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PACIFIC SALMON and the HIGH SEAS SALMON FISHERIES OF JAPAN

by
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U.S. DEPARTMENT OF COMMERCE
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NOTICE

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2.0 INTRODUCTION

The International Convention for the High Seas Fisheries of the North Pacific Ocean between Canada, Japan and the United States entered into force in June 1953 and remains in force until one year from the day on which one of the nations has given notice of an intention of terminating the Convention. Under the terms of the Convention, Japan has abstained from fishing for salmon in the North Pacific Ocean east of the meridian which passes through the western extremity of Atka Island at approximately 175°20'W longitude, and both Canada and Japan have abstained from fishing for salmon in the Bering Sea east of meridian 175°W longitude. In high seas waters to the west of the abstention lines, Japanese vessels--but not Canadian--have fished for salmon since the Convention went into effect. In the process, many millions of U.S. salmon found in those waters have been caught.

In 1976 U.S. Public Law 94-265, commonly referred to as the Fishery Conservation and Management Act of 1976 (FCMA), was entacted. The FCMA establishes exclusive fishery management authority by the United States over salmon of U.S. origin within a 200-mile fishery conservation zone and also throughout their migratory range beyond than zone, except when they are found within any nation's territorial sea or fishery conservation zone recognized by the U.S. The FCMA also states that the total allowable level of foreign fishing, if any, with respect to any fishery subject to the exclusive fishery management authority of the United States shall be that portion of the optimum yield which will not be harvested by U.S. fishermen--the term "optimum" meaning the amount of fish which will provide the greatest overall benefit to the United States and representing the maximum sustainable yield adjusted for relevant economic, social or ecological factors. In addition to the foregoing and numerous other provisions, the FCMA established eight Regional Fishery Management Councils, one of them being the North Pacific Council which has authority over the fisheries in the Arctic Ocean, Bering Sea, and Pacific Ocean seaward of Alaska. A major function of each of the Councils is the preparation of a fishery management plan for each fishery within its geographic area of authority.

The situation with respect to Japan's high seas salmon fishing activities, the North Pacific Fisheries Convention, and the U.S. Fishery Conservation and Management Act can be summed up thusly:

--Japanese vessels have fished for salmon on the high seas west of 175°W longitude for over two decades--

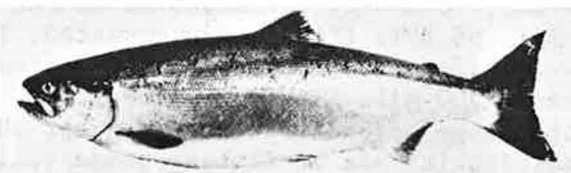
--Vast numbers of salmon originating in U.S. streams have been caught by Japanese fishermen west of the North Pacific Fisheries Convention's abstention lines--

--The U.S. salmon intercepted on the high seas by Japanese vessels or otherwise lost as a consequence of their fishing activities could be fully utilized by U.S. fishermen--

--There is no allowable level of fishing by Japanese vessels for salmon of U.S. origin.

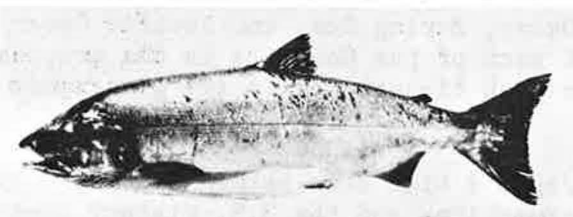
The provisions of the North Pacific Fisheries Convention with respect to salmon are obviously inconsistent with the provision of the FCMA.

On February 10, 1977 the United States gave notice to Canada and Japan of an intention of terminating the North Pacific Fisheries Convention because of its inconsistency with the Fishery Conservation and Management Act. In October 1977, the three nations initiated negotiations on the restructuring of the Convention. Another round of talks is scheduled for mid-January 1978. In connection with these negotiations---and also with the view toward providing the North Pacific Regional Fisheries Management Council with background information which might be useful in developing a fishery management plan for the high seas salmon fisheries of Japan---we have prepared this report. It is believed that the information presented here will also be of interest to salmon fishermen and processors, fisheries managers and the scientific community.

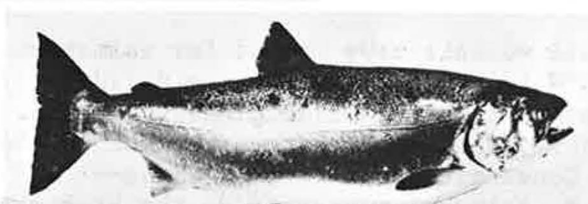


Sockeye Salmon, *Oncorhynchus nerka*

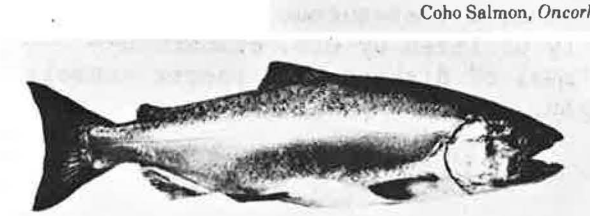
Pink Salmon, *Oncorhynchus gorbuscha*



Chum Salmon, *Oncorhynchus keta*



Coho Salmon, *Oncorhynchus kisutch*



Chinook Salmon, *Oncorhynchus tshawytscha*

(Photos: Wash. Dept. Fish.)

3.0 RESOURCE BASE (PACIFIC SALMON)

3.1 General Life History Features

3.1.1 Taxonomy

Pacific salmon (Oncorhynchus spp.) belong to the order Salmoniformes and the family Salmonidae (Hart, 1973). It is generally accepted that salmon evolved from the freshwater trout (genus Salmo), probably between a half-million and one million years ago in the Pleistocene period (Neave, 1958). Since then 6 species 3.1/ have evolved--one of which, the masu salmon (O. masou) is native only to Asia. The other 5 species--sockeye salmon (O. nerka), pink salmon (O. gorbuscha), chum salmon (O. keta), coho salmon (O. kisutch), and chinook salmon (O. tshawytscha)--which are native to both Asia and North America will be dealt with here.

Other common names by which the various species are identified are listed below (North America only):

Sockeye salmon (red, blueback salmon)
Pink salmon (humpy, humpback salmon)
Chum salmon (dog salmon)
Coho salmon (silver, silversides, hooknose salmon)
Chinook salmon (king, spring, tyee, blackmouth, quinnat salmon)

Salmon are robust soft-rayed fishes with cycloid scales, adipose fins and large mouths with well-developed teeth on the jaws, vomer, palatines and tongue (Hart, 1973). Pyloric caeca are numerous and sexual dimorphism in secondary sex characteristics is strongly developed at spawning time. Salmon have 13 to 19 rays in the anal fin as opposed to 8 to 12 in the trout. Distinguishing charateristics for the individual species are listed in Table 3.1.

3.1/ Some taxonomists also accord species status to (O. iwame) and (O. rhodurus) both of which are little known outside of Japan. This paper, however, proceeds on the premise of Behnke (1965)--that (O. iwane) and (O. rhodurus) should be considered only as varieties of (O. masou) rather than as separate species.

Table 3.1.--Distinguishing characteristics of 5 species of salmon indigenous to North America (adapted from Hart, 1973).

Species	Life Stage: Adult	Young (Prior to seaward migration)
Sockeye	Long, slender, closely-spaced gill rakers on the first gill arch. Fine black speckling on the back. The flesh is red.	Uniform, unmottled, green back. Sides silver without green irridescence. Parr marks (bars on sides) short, oval, usually mostly above lateral line.
Pink	Small scales. Large, very dark oval spots on the back and all over the caudal fin. The flesh is pink.	Without parr marks. Blue to greenish color along back. Sides silvery.
Chum	Absence of large, black spots from body end fins. Slender caudal peduncle. Dark color on tips of all fins but the dorsal. The flesh is pale pink.	Green irridescence on back. Parr marks as slender bars scarcely extending below lateral line.
Coho	Black spotting confined to back and upper lobe of caudal fin. The flesh ranges from pink to red.	Long, narrow parr marks, extending above and below lateral line. Parr marks narrower than interspaces. White on leading edge of anal fin. Anal fin with first ray elongate.
Chinook	Black spotting on back, dorsal fin and both lobes of caudal fin. Salmon over 30 pounds (14 kg) are likely to be chinooks. The flesh ranges from white to red.	Parr marks long vertical bars wider than spaces between bars. Parr marks approximately divided by the lateral line.

3.1.2 General Distribution

It is necessary, prior to discussing the general distribution of Pacific salmon, to establish that all members of the genus are anadromous, meaning that they spend a portion of their lives in the ocean, but when approaching maturity, they return to fresh water to spawn. Juvenile salmon, in turn, spend a period in fresh water before migrating to sea to resune the cycle. Subpopulations of some species--sockeye, coho, and to a lesser extent chinook and pink salmon, remain in fresh water throughout their life.

Excluding limited transplants to such places as New Zealand and the Great Lakes, Pacific salmon inhabit a major part of the temperate and subarctic North Pacific Ocean and adjacent coastal areas, and even extend--to a much lesser extent--beyond the Bering Strait to as far as the Coppermine and Lena rivers on the Arctic coasts of North America and Asia respectively. Distribution by species is shown in Figures 3.1-3.5. References are in Table 3.2.

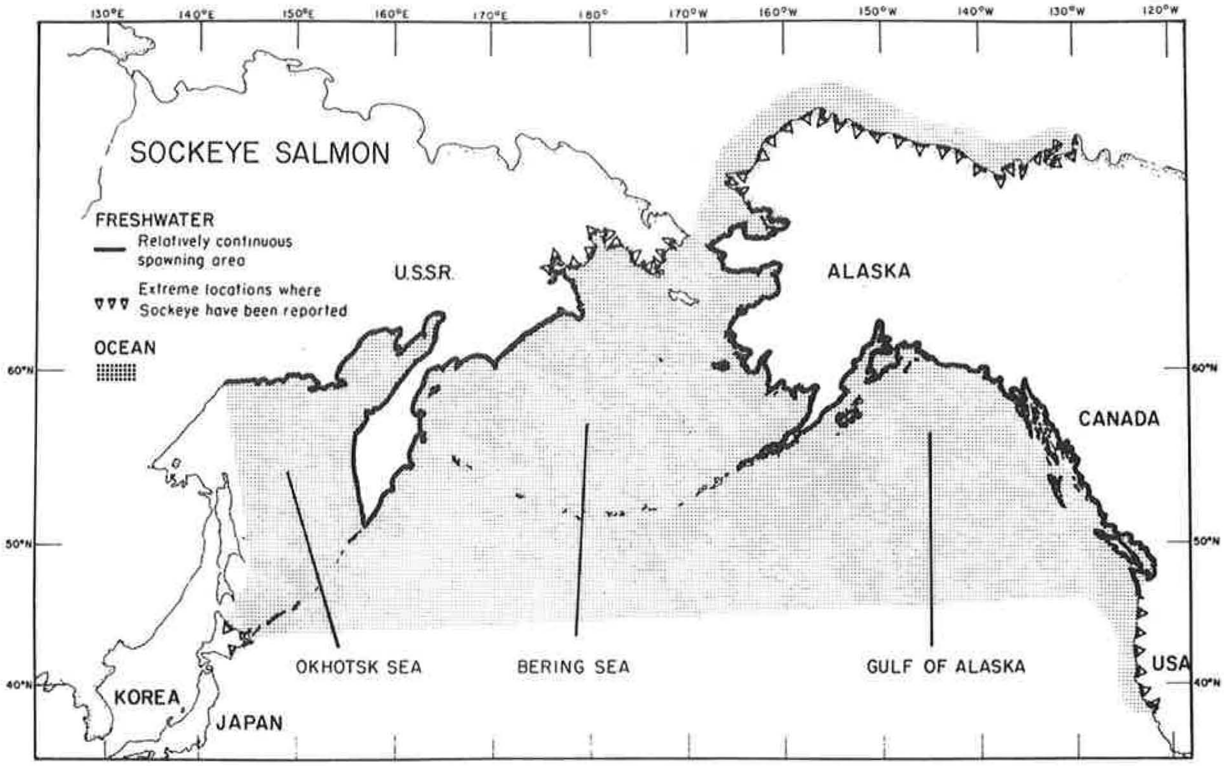


Figure 3.1.--Generalized freshwater and ocean distribution of sockeye salmon (see Table 3.2 for references).

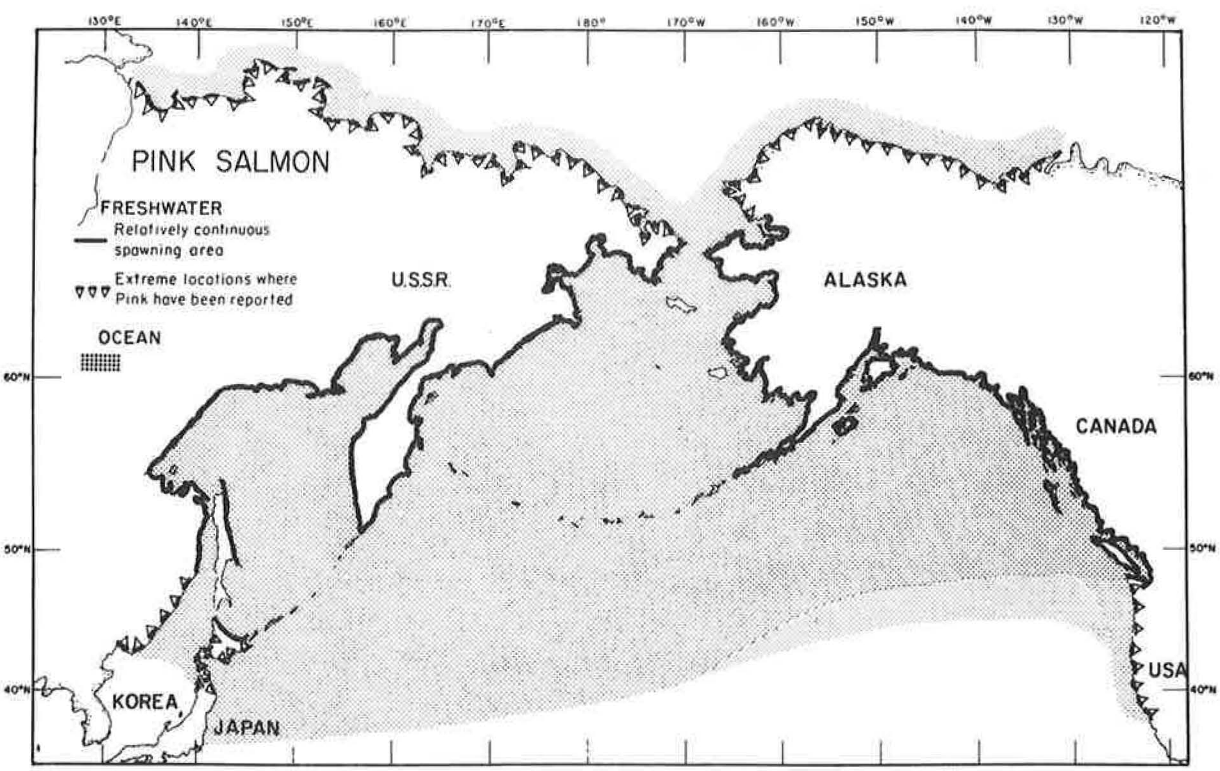


Figure 3.2.--Generalized freshwater and ocean distribution of pink salmon (see Table 3.2 for references).

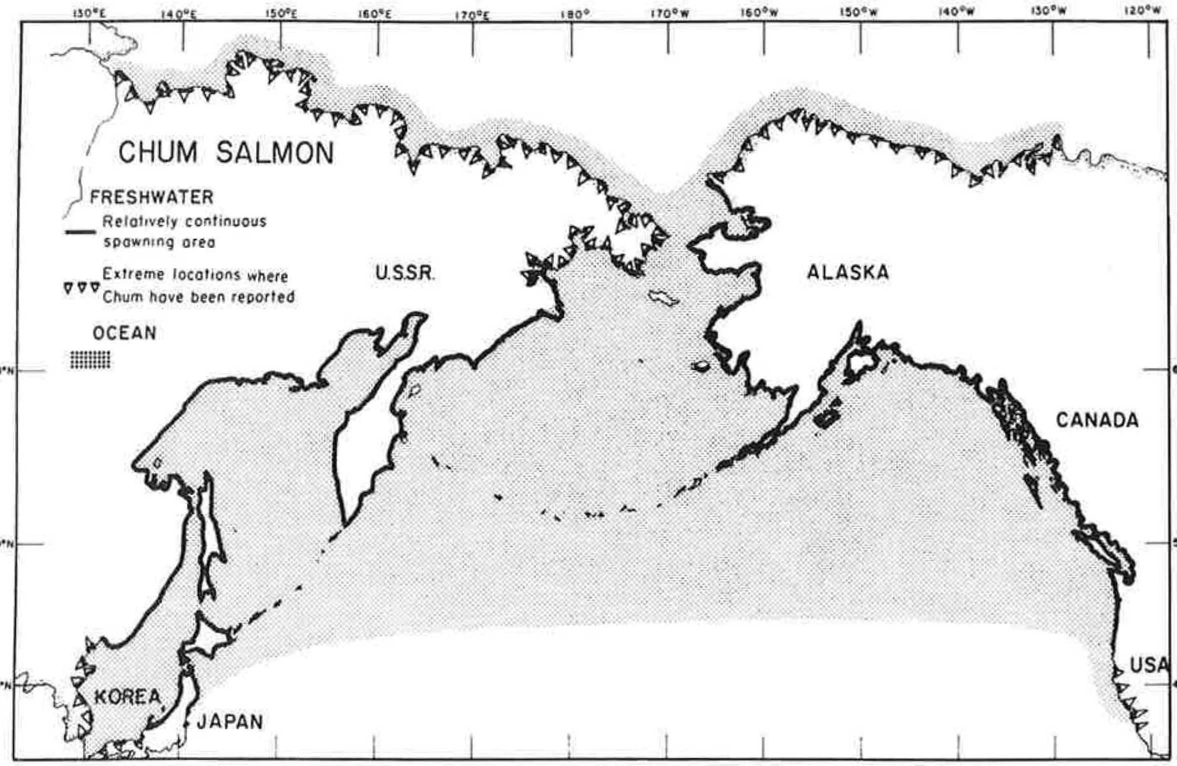


Figure 3.3.--Generalized freshwater and ocean distribution of chum salmon (see Table 3.2 for references).

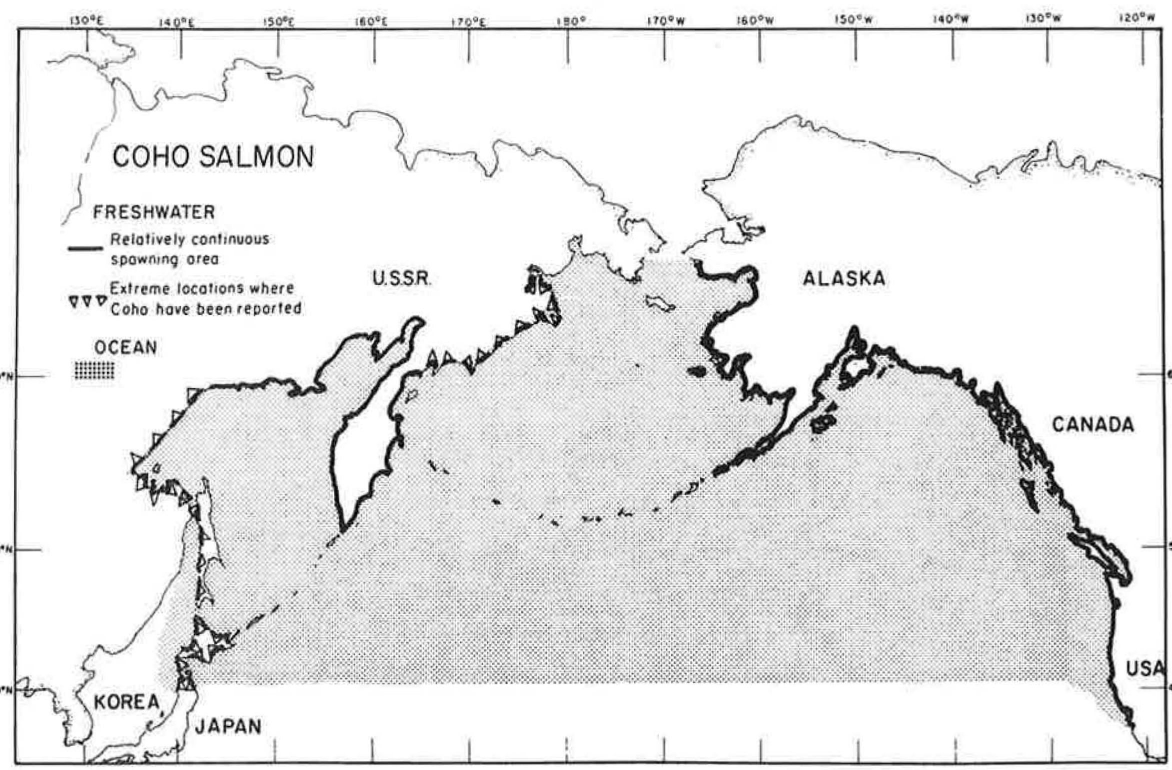


Figure 3.4.--Generalized freshwater and ocean distribution of coho salmon (see Table 3.2 for references).

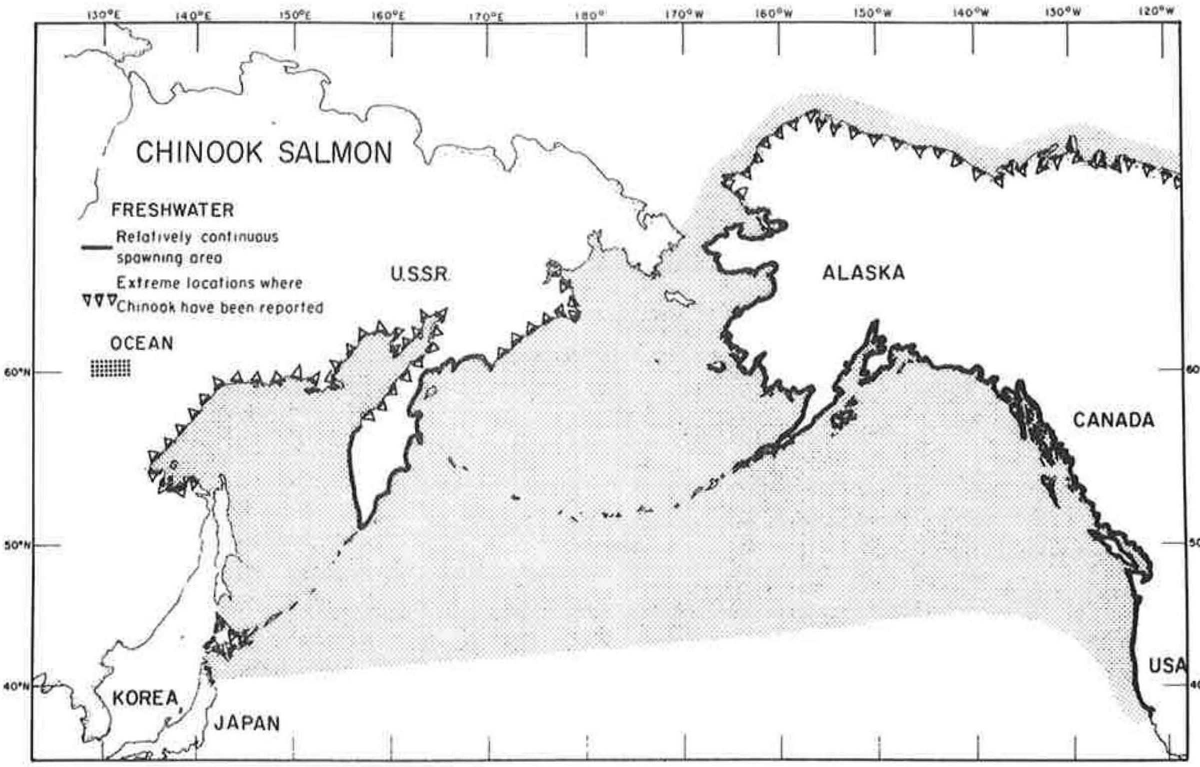


Figure 3.5.--Generalized freshwater and ocean distribution of chinook salmon (see Table 3.2 for references).

Table 3.2.--Sources of information concerning the distribution of 5 species of Pacific salmon shown in Figures 3.1-3.5,

Feature of the Distribution	Species: Sockeye	Chum	Pink	Chinook	Coho
Fresh Water					
Asia					
Relatively continuous spawning grounds1/	Shmidt (1950); Lindberg and Legeza (1965); Sano (1967); Berg (1948); Andriyashev (1954)				
Areas beyond relatively continuous spawning grounds where species have been reported	Lindberg and Legeza (1965), Andriyashev (1954), Trudy Institut Okeanologii (1955), Foerster (1968)	Shmidt (1950), Sano (1967)	Shmidt (1950), Ishida (1967)	Shmidt (1950), Berg (1948)	Shmidt (1950) Andriyashev (1954)
North America					
Relatively continuous spawning grounds	Atkinson, Rose and Duncan (1967); Aro and Shepard (1967)				
Areas beyond relatively continuous spawning grounds where species have been reported	Hallock and Fry (1967); Hunter (1969)			Hunter (1969)	None
Marine					
General distribution	French et al (1976)	Neave, Yonemori, and Bakkala (1976)	Neave, Ishida and Murai (1967)	Major et al. (In Press)	Godfrey, Henry and Machidori (1975)

1/ Estimated on the basis of information presented in the references.

3.1.3 Relative Geographic and Bathymetric Abundance

3.1.3.1 Sockeye Salmon

Sockeye salmon, like all species of Pacific salmon, are the objects of intensive fisheries and are heavily exploited not only along the coasts of Asia and North America, but on the high seas as well by Japan's mothership and landbased salmon fisheries (the mothership and landbased fishing areas are delineated in Figure 4.1). Because the coastal fisheries operate during period of peak abundance, commercial catches provide a general idea of the relative abundance of a particular species of salmon in the various regions. The accuracy of commercial catches as indicators of regional abundace is refined, of course, by adjusting the data to reflect the numbers of fish that are intercepted outside their region of origin i.e., in adjacent regions or on the high seas. Estimates of the number of interceptions, by area of origin, are presently available for the Japanese mothership fishery and for fisheries along the Pacific coast of North America. Using these data, the commercial catches will be adjusted accordingly in our discussions on regional abundance. Although there have been no definitive studies to determine the area of origin of salmon captured in the Japanese landbased fishery, all fish taken there have arbitrarily been assigned to Asia. U.S. scientists hold it probable, however, that some of these fish are of North American origin. This is a subject that begs further study.

The average number of sockeye salmon taken commercially in the various fishing areas during 1952-75, is shown in Figure 3.6. Note that a segment (2.3 million) of the average annual catch of sockeye by the Japanese mothership fishery (7.6 million) has been allocated to western Alaska and that with this adjustment, the commercial catch in North America (20.8 million) is roughly 2½ times that of Asia (7.9 million).

Principal stocks of sockeye salmon in Asia are confined to river systems of the Kamchatka Peninsula with about 90% of the commercial catch coming from the Ozernaia and Kamchatka Rivers.

In North America the most abundant stock of sockeye salmon is that produced in western Alaska, primarily by rivers tributary to Bristol Bay, where catches (unadjusted for mothership interceptions) have avereaged 7.7 million fish annually (ranged 0.9-24.5 million). A second center of production is in British Columbia where an average of 4.7 million fish have been taken annually. The Fraser River, the major producer in British Columbia, has also provided nearly all of Washington State's annual catch of 1.9 million sockeye (National Marine Fisheries Service, 1977[3.2/]). Other important stocks in British Columbia are those of the Smith and

3.2/ National Marine Fisheries Service (1977). Final environmental impact statement/preliminary fishery management plan: troll salmon fishery of the Pacific Coast. U.S. Dep. Commerce, Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Northwest Region, Seattle, Wash., 128 p. (Processed).

Rivers inlets, and the Skeena and Nass rivers. Central Alaska provided average catches of 3.3 million sockeye annually. Important production areas there are the Chignik, Karluk and Copper rivers and streams emptying into Cook Inlet. Fewer sockeye are produced in southeastern Alaska (average: 0.9 million fish annually) and in Washington State south of Puget Sound where catches averaged only about 50,000 fish per year.

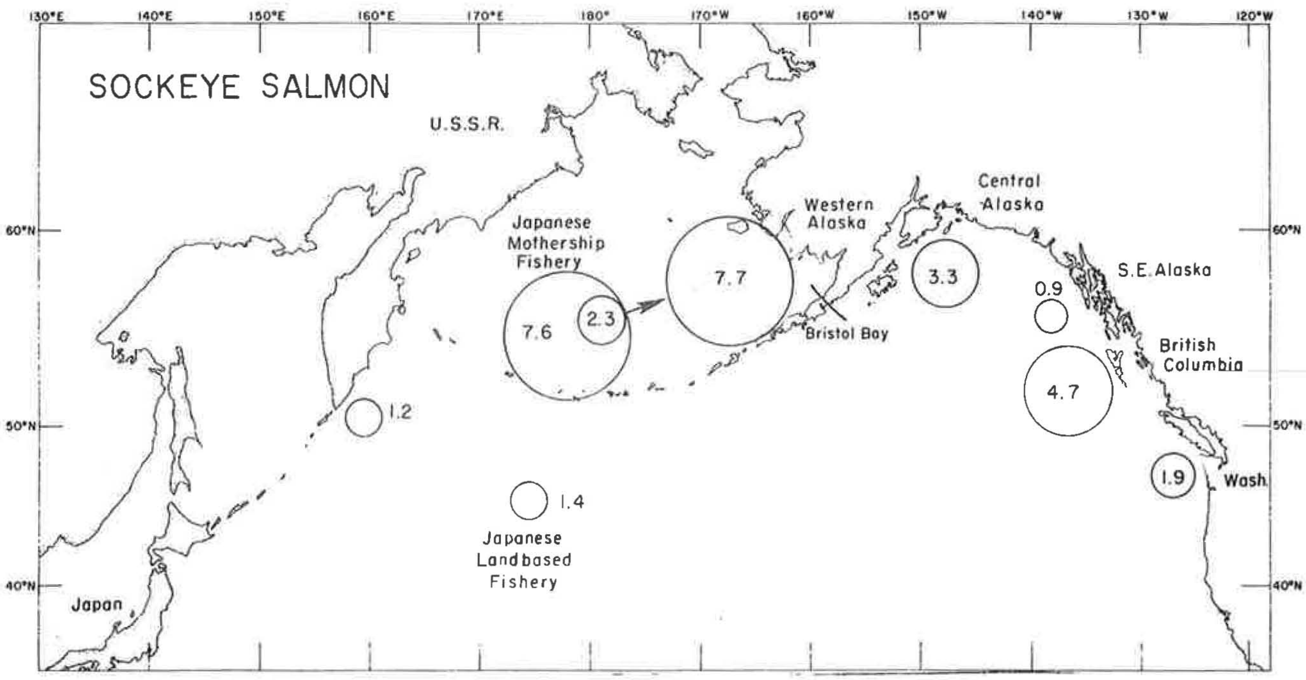


Figure 3.6.--Commercial catches of sockeye salmon in North America, Asia, and on the high seas. Averages (millions of fish) are based on years 1952-75 except for the number of western Alaskan sockeye that are intercepted by the Japanese mothership fishery (circle within a circle), which is based on years 1956-75. See Appendix 1 and text Table 5.2 for sources of data.

It is appropriate to discuss the oceanic distribution of sockeye salmon in terms of 3 broad areas of origin: (1) Asia, (2) western Alaska, and (3) other North American regions. This information has been summarized by French et al, (1976) as follows (See Figure 3.7):

> "Asian sockeye salmon overlap in distribution with North American sockeye (mainly western Alaska stocks) over fairly broad areas of the North Pacific Ocean and Bering Sea. Intermingling of immature fish of the two continental groups is mainly in the area between 170°E and 175°W in both the North Pacific Ocean and the Bering Sea. Intermingling of maturing fish extends from about 167°E to about 177°W in the North Pacific Ocean and from about 171°E to 177°W in the Bering Sea. Extremes of migration probably exceed these limits somewhat. In general, the center of abundance of Asian fish is west of 175°E and the center of abundance of western Alaska sockeye is east of this parallel.

Overlap of Asian sockeye salmon with North American stocks other than Western Alaska, Figure 95 (Figure 3.7 of the present paper), is probably very minimal and occurs mainly in the central Aleutian Islands area of the North Pacific Ocean.

As observed in Figure 95 (Figure 3.7 of the present paper), intermingling of sockeye salmon from western Alaska and other North American areas is widespread in the North Pacific Ocean--extending from near 140°W to the western Aleutian Islands. Intermingling of both immature and maturing fish occurs throughout this general area during some part of the year."

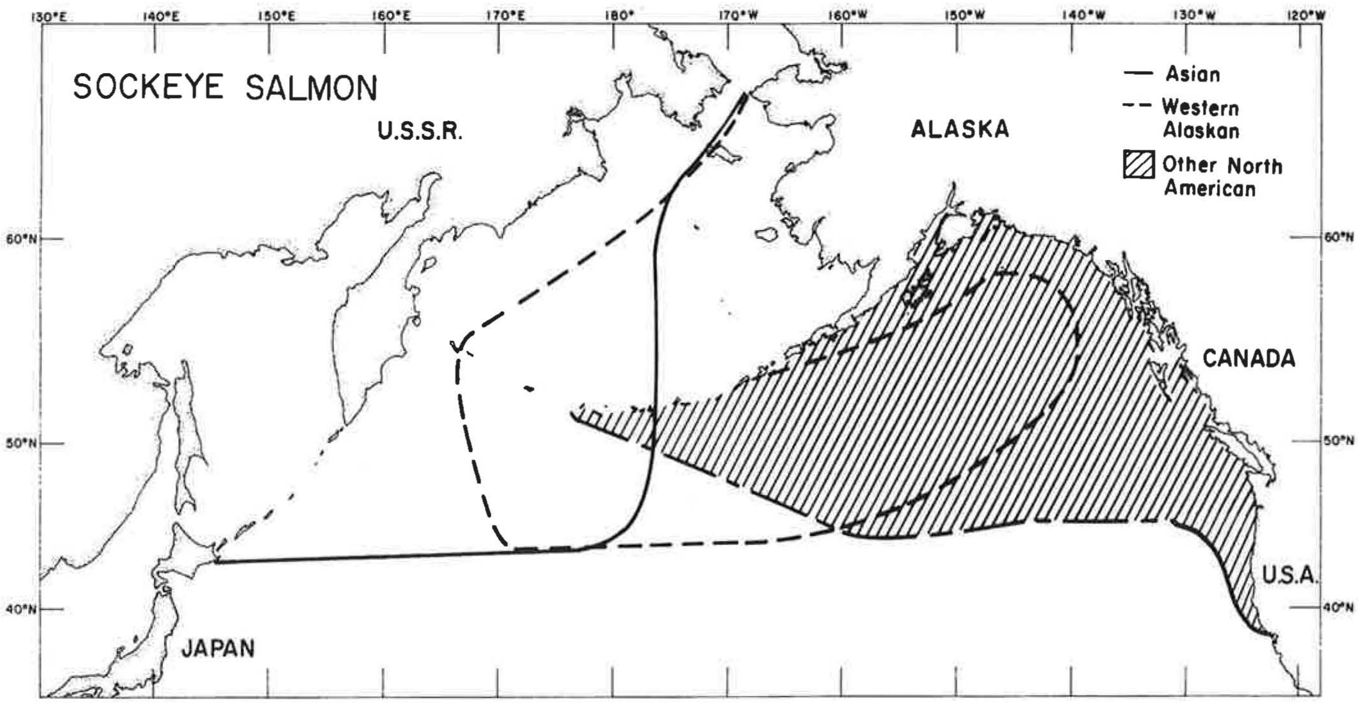


Figure 3.7.--Generalized ocean distribution of sockeye salmon from Asia, western Alaska, and other North American areas (adapted from French et al., 1976).

In addition to their geographic distribution, it is also instructive to study the bathmetric distribution of Pacific salmon. Sockeye, according to French et al, (1976), inhabit near-surface waters, mainly the upper 10 m, during their life at sea. Some occupy depths to at least 60 m in spring but apparently do not descend this deep in summer (Manzer, 1964; Machidori, 1966). The extent of the depth distribution may be limited by the thermocline—that layer in the water column where the temperature gradient is the sharpest. There is also some evidence of diurnal (within day) movements--there being a tendency for a larger proportion of the fish being located deeper during the daylight hours.

3.1.3.2 Pink Salmon

Before discussing the relative importance of the various regions in the production of pink salmon, some introductory remarks are in order concerning the 2-year life cycle of the species. Because of their rigid life span, populations of pink salmon from any two consecutive years are genetically separated. Furthermore, there is no consistent relation between the even- and odd-year cycles over the entire range of the species. In some areas (see western Alaska, Washington State and U.S.S.R. in Figure 3.8), the level of abundance in either the even- or odd-year cycle might be much higher than in the other, while in other areas (central and southeastern Alaska, British Columbia, and Japan) differences between even- and odd-year cycles are not at all striking.

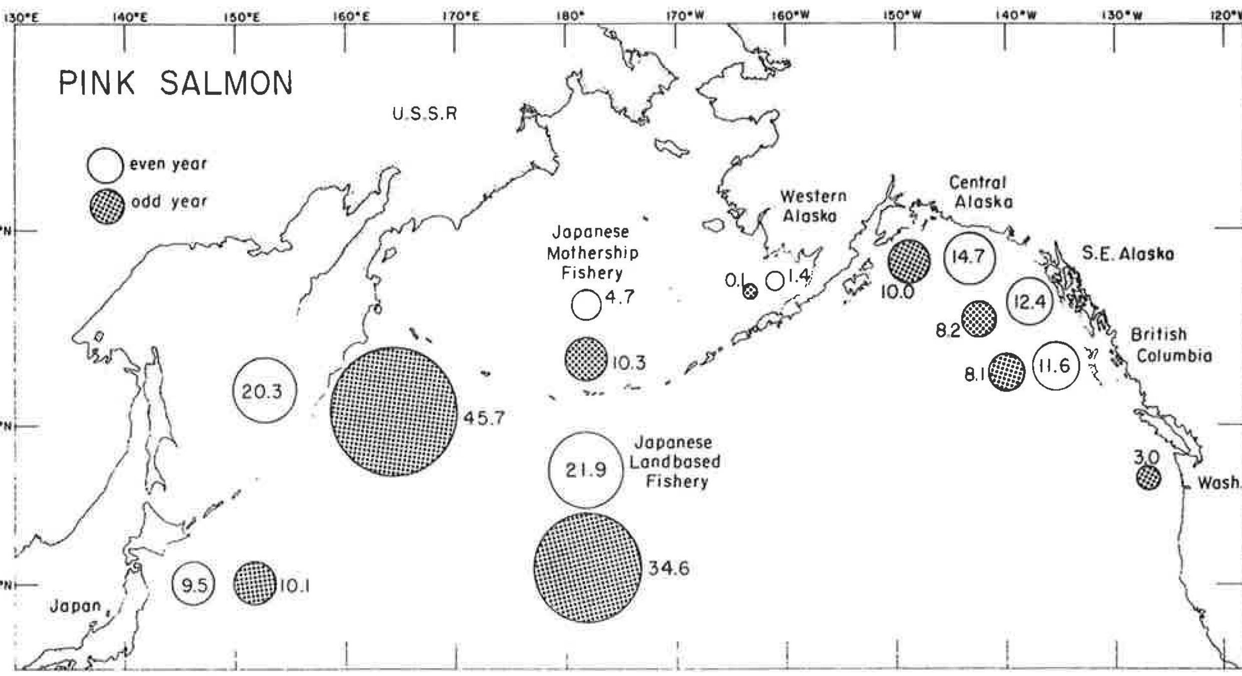


Figure 3.8.--Commercial catches of pink salmon in North America, Asia, and on the high seas. Averages (millions of fish) are based on years 1952-75. See Appendix 1 for sources of data.

Commercial catches of pink salmon can be compared for even-years, odd-years and even- and odd-years combined. In terms of even-year production, the average annual strength of pink salmon runs to Asia and North America is of the same order of magnitude (56.4 and 40.1 million fish respectively). In odd years, however, the average Asian catch of pink salmon is 100.7 million fish, exceeding by roughly 3½ times the 28.8 million taken in North America. Interceptions of western Alaskan pink salmon by the Japanese mothership fishery are not large (an average of slightly under 50,000 fish in even years; about 2,000 in odd years [see section 5.1.2 for computations]).

Although commercial catches provide an adequate base upon which to measure relative abundance for the two continents, they are less useful for ranking the areas of production within North America. Many North American fisheries operate on mixed regional stocks, taking large numbers of pink salmon from regions other than the region recording their capture. The National Marine Fisheries Service (see footnote 3.2) estimates that during 1967-74 Canadian fishermen intercepted an average of 204,000 pink salmon that originated in southeastern Alaska and another 204,000 than originated in Washington State. U.S. fishermen, on the other hand, landed an average of 1½ million Canadian pink salmon during the same period. Were adjustments of this magnitude applied to the commercial catch data presented in Figure 3.8, central Alaska would emerge as the top producer of commercially caught pink salmon (24.7 million fish annually, with even- and odd-year cycles combined) followed by British Columbia and southeastern Alaska (each with about 21 million fish annually). The 3 regions together produce 95% of North America's commercially caught pink salmon.

Data summarized by Takagi et al, (In Press) provide a basis for defining the ocean distribution of Asian, western Alaskan and other North American stocks of pink salmon. Considering the Asian stocks first, it can be seen (Figure 3.9) that the easterly movement of Asian pink salmon extends to about 158°W in the Gulf of Alaska. This is somewhat farther east than Asian sockeye salmon are found (1~~97~~75°W), but not as far east as the maximum noted for Asian chum salmon (140°W). Asian pink salmon also extend far to the east in the Bering Sea--specimens tagged as far east as 173°W just north of the Aleutian Islands have been recovered on the Asian mainland.

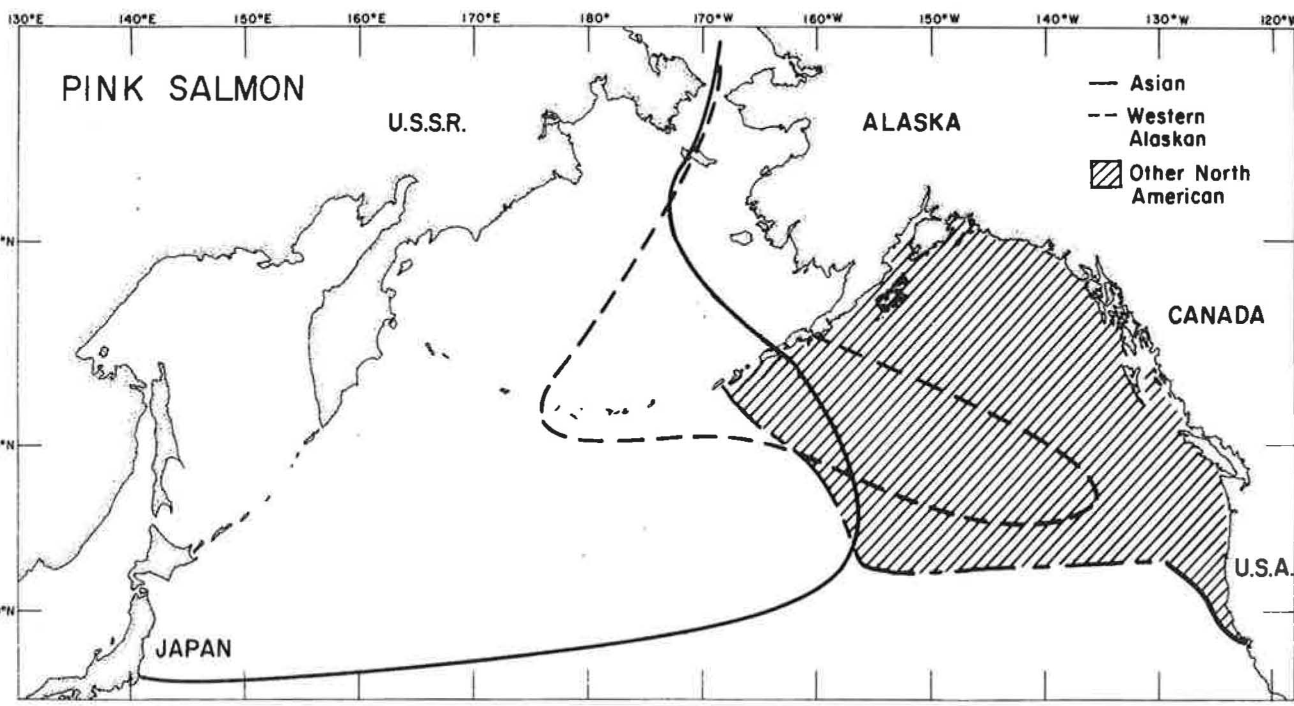


Figure 3.9.--Generalized ocean distribution of pink salmon from Asia, western Alaska, and other North American areas.

The northern and southern migratory limits of Asian pink salmon are not well defined, particularly between 170°E and 160°W in the North Pacific Ocean and between 170°E and 175°W in the Bering Sea. Pink salmon of unidentified origin have been captured, however, as far south as about 36°N in the former area and as far north as 64°N in the latter. Because it seems likely that at least some of these were Asian fish, the range of Asian fish shown in Figure 3.9 has been extended to include these areas.

Western Alaskan pink salmon, at various times during their lives, occupy most of the eastern half of the Bering Sea--extending as far west as about 175°E in the Aleutian Island area. They are also found in the Gulf of Alaska, generally between 45°N and 55°N and as far east as 135°W. Other North American stocks occur throughout the Gulf of Alaska and in the eastern North Pacific Ocean as far south as 45°N. Pink salmon from main production areas of North America (central Alaska, southeastern Alaska and British Columbia) are not found west of 160°W.

Intermingling of Asian and North American pink salmon occurs mainly in a triangular area with vertices at approximately 162°W, 50°N; 176°E, 50°N, and 173°W, 60°N. Intermingling within this area mainly involves pink salmon from east Kamchatka and western Alaska.

Information concerning the vertical distribution of pink salmon is scant, but Machidori (1966) reported that they may inhabit near-surface waters to a greater degree than the other species of salmon.

3.1.3.3 Chum Salmon

The relative magnitude of the commercial catches of chum salmon is shown in Figure 3.10. Based on these long-term averages (1952-75), the Japanese mothership fishery emerges as the chief exploiter of chum salmon (9.2 million fish annually). Of this total, only 130,000 are estimated to be of western Alaskan origin; the remainder having come from Asia. Overall, the average catch of 30 million chum salmon taken in Asian exceeds by 3.3 times the 9 million taken in North America (see section 5.1.3 for computations).

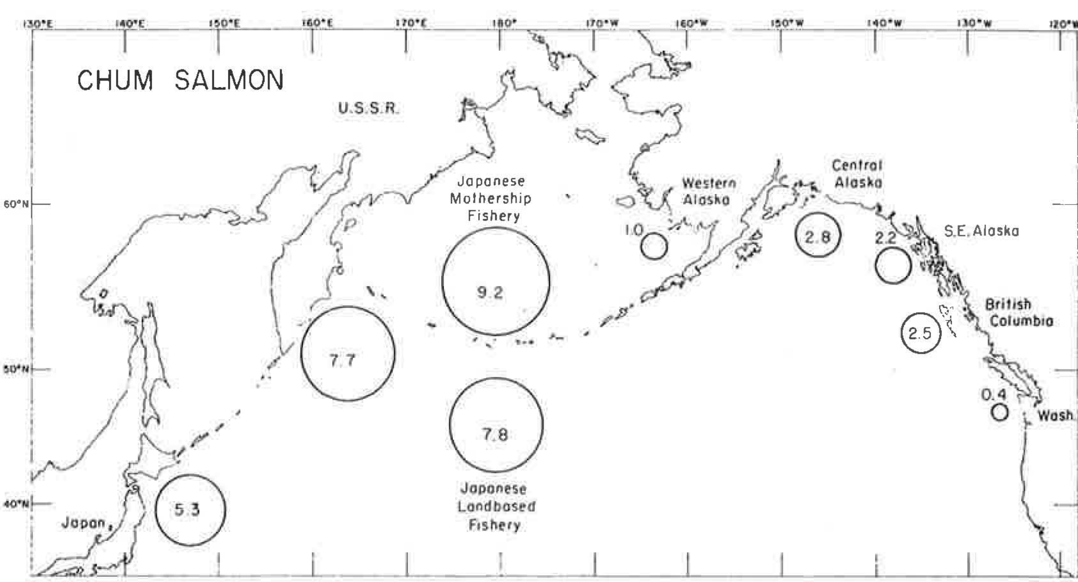


Figure 3.10.--Commercial catches of chum salmon in North America, Asia, and on the high seas. Averages (millions of fish) are based on years 1952-75. See Appendix 1 for sources of data.

The relative magnitude of the commercial catches in regions of North America shows that most chum salmon are produced north of Washington State. Catches in Washington State have averaged only 0.4 million fish annually (1952-75), whereas those in each of the regions of British Columbia, southeast Alaska and central Alaska averaged 2.0 million or more fish annually. Western Alaska also provided relatively large commercial catches during this period, averaging 1.0 million fish. The commercial catches of chum salmon mentioned above have not been adjusted to reflect fish intercepted outside their area of origin. The National Marine Fisheries Service (see footnote 3.2) reports these interceptions to be minimal. According to Mattson (1962), however, subsistence (personal use) catches in western Alaska may range upward to 2 million fish in some years. Thus, western Alaska is a more productive area than indicated from commercial catches and may equal or surpass one or more of the other important areas in total production.

Tag data summarized by French, Bakkala and Sutherland (1975) provide the basis for the distributional limits of Asian, western Alaskan and other North American chum salmon proposed in Figure 3.11. Most striking is the extent to which Asian chum salmon are distributed eastward (there have been many recoveries on the Asian mainland of chum salmon that had been tagged in the Gulf of Alaska--one as far east as 140°W). Asian chums intermingle with western Alaskan chums in the central Bering Sea and with both western Alaskan and other North American chums throughout much of the Gulf of Alaska.

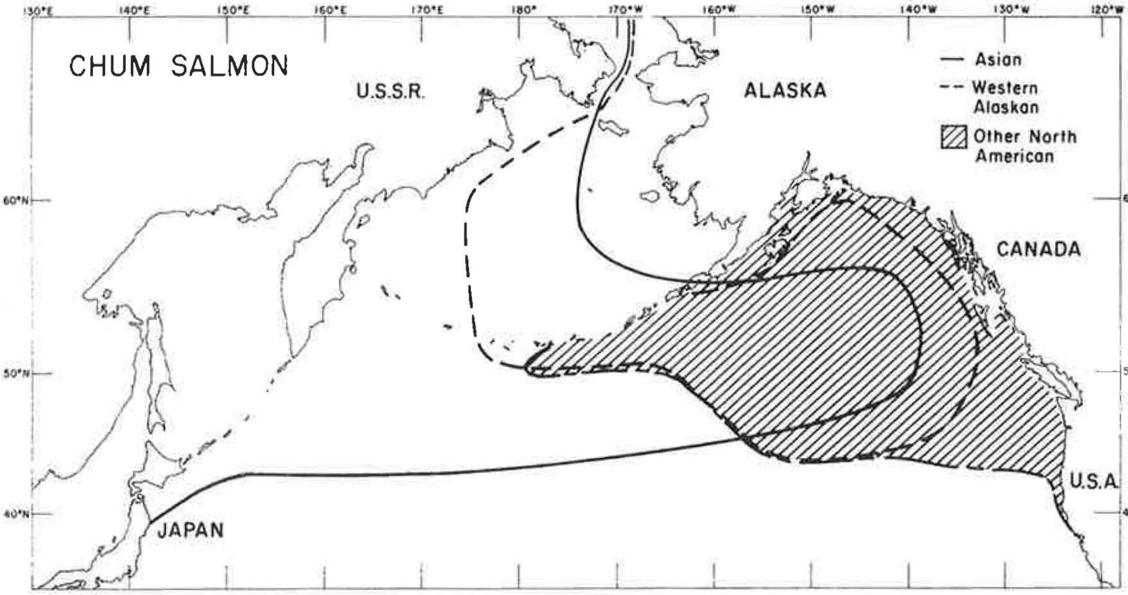


Figure 3.11.--Generalized ocean distribution of chum salmon in Asia, western Alaska, and other North American areas.

Although chum salmon are abundant in surface waters as maturing fish in spring and summer and as immatures in summer, they may be less closely tied to the surface than species such as sockeye, pink, and coho salmon. Juvenile chums in coastal waters have been found to depths of 95 m off British Columbia (LeBrasseur and Barner, 1964). In offshore waters, maturing fish in May and June have been found to depths of 60 m and immature fish to 40 m in summer (Manzer, 1964; Machidori, 1966). At times, a majority of the fish are present at depths greater than 10 m.

3.1.3.4 Coho Salmon

The average commercial catch of coho salmon in North America was roughly twice as large as that in Asia over the 24-year period 1952-75 (7.3 million vs 4.0 million respectively as shown in Figure 3.12). The difference between continents would have been even greater were catches expanded to include fish taken in North America with sport gear. There is no reported sport catch in Asia.

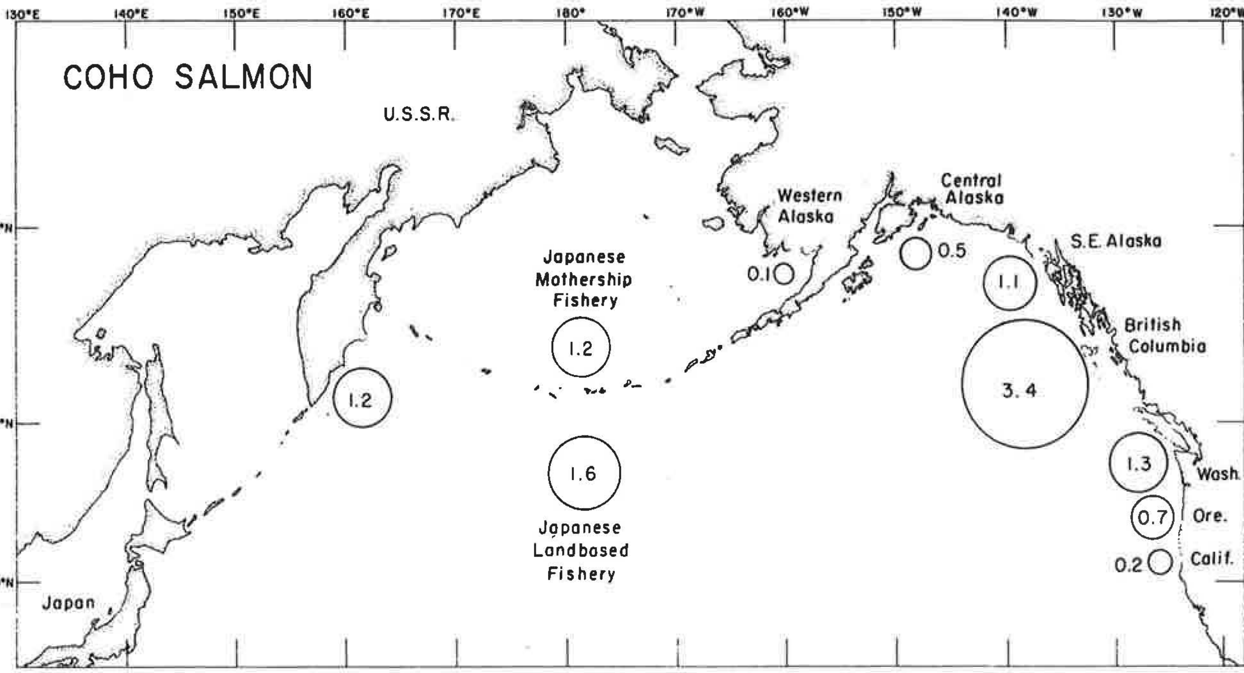


Figure 3.12.--Commercial catches of coho salmon in North America, Asia, and on the high seas. Averages (millions of fish) are based on years 1952-75. See Appendix 1 for sources of data.

There is really inadequate information on which to estimate the total number of western Alaskan coho landed in the Japanese mothership fishery. That some are taken, however, can be ascertained by exaimning the tag returns from the International North Pacific Fisheries Commission (INPFC) 2° x 5° statistical area 8050[3.3] south of Adak Island. Inasmuch as approximately one-half of the mainland recoveries of coho salmon tagged in area 8050 were recovered in western Alaska (the other one half having been recovered in Asia) it follows that about one-half of the mothership catch in area 8050 are from western Alaska. This amounts to an average of 20,000 coho over the period 1956-75 (see Section 5.1.4 for computations). For reasons to be elaborated upon in discussion concerning the limits of distribution of the regional stocks, this figure (20,000) should be regarded as a minimum estimate of the number of western Alaskan coho taken in the Japanese mothership fishery.

3.3/ See Section 4.3.3.1 for a description of the statistical reporting areas for the Japanese mothership salmon fishery.

As was done with sockeye and pink salmon in earlier sections, some adjustments have to be made before the commercial catches in the various regions of North America can be accepted as true indices of abundance. North American troll fisheries, fishing in areas where the regional stocks are mixed, take large numbers of coho salmon from regions other than the one to whose catch they were attributed. Stocks of U.S. coho, for example, in addition to being heavily exploited by Canadian trollers off the British Columbia coast, are also caught by Canadian trollers off the Alaskan and Washington coasts. According to the National Marine Fisheries Service (see footnote 3.2), an average of 1.4 million coho of U.S. origin (1.3 million from the Washington-Oregon-California region; 0.1 million from Alaska) were intercepted by Canadian trollers in 1967-74. Reciprocal interceptions of Canadian cohoes were 0.1 and 0.4 million fish in Alaska and Washington-Oregon-California respectively. With adjustments of this magnitude, the Washington-Oregon-California area emerges as the leading contributer to the North American commercial catch of coho salmon with slightly over 3 million fish annually, followed by British Columbia (2.5 million) and southeast Alaska (1.1 million).

The distributional limits of coho salmon from Asia, western Alaska and other North American areas cannot be precisely defined, particularly in the critical mid-ocean areas where the continental stocks are most likely to intermingle. There have been no stock identification studies for coho salmon on the high seas (involving scales, parasites, etc. as indicators of continent of origin) nor has there been adequate tagging. In the broad mid-ocean area lying between 175°E and 165°W, for example, only in the area immediately south of Adak Island have enough coho been tagged to yield inshore recoveries. Tagged coho from this area returned to the two continents in approximately equal numbers indicating wholesale intermingling in the mid-ocean area. But over the remainder of that broad area--stretching from 40°N in the south to the Bering Strait in the north--virtually nothing is known about the continental origin of the coho salmon present. This gap in our knowledge is even more glaring when we consider than commercial catches from within ths broad area, south of the Aleutian Islands between 175°E and 175°W are often large (1.8 million fish in the mothership fishery in 1964 and 1.5 million in the landbased fishing area in 1974, for example). The distributional limits of coho salmon from the 3 regions as depicted in Figure 3.13 are, therefore, highly provisional.

Like other species of salmon, coho inhabit near-surface waters, primarily less than 10 m. Their depth distribution tends to be somewhat greater during the daytime than at night and the thermocline probably limits extremes of depths inhabited.

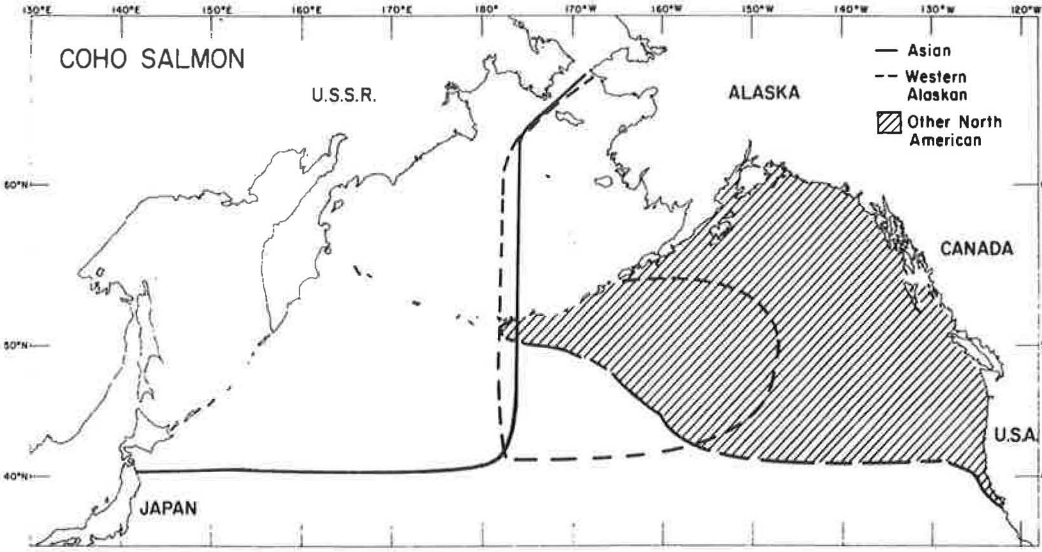


Figure 3.13.—Generalized ocean distribution of coho salmon from Asia, western Alaska, and other North American areas.

3.1.3.5 Chinook Salmon

Chinook salmon, the least abundant of the 5 species of Pacific salmon discussed here, are roughly 14 times more abundant in North America than in Asia in terms of commercial catches (Figure 3.14). This ratio would increase to about 15 to 1 if estimates of the North American subsistence and sport catches were included. The USSR coastal catch of chinook salmon averaged only 90,000 fish during 1952-75; the Japanese mothership catch only 177,000 and the Japanese landbased catch only 96,000. The North American catch, on the other hand, averaged over 3 million fish during the same period. Moreover, it is estimated (see Section 5.1.5) that an average of 132,000 (75%) of the chinook taken by the Japanese mothership fishery are of western Alaskan origin.

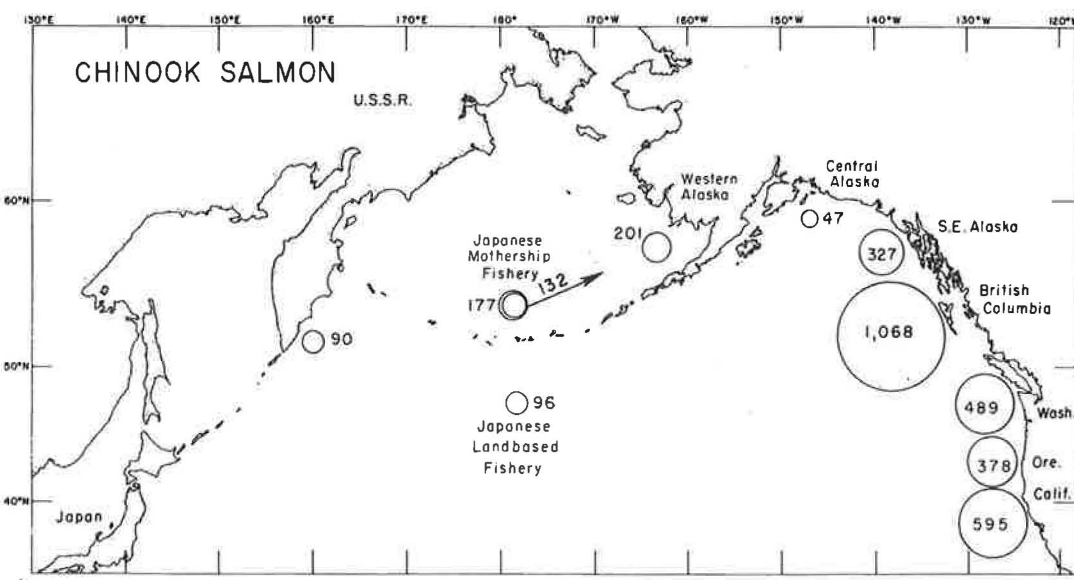


Figure 3.14.—Commercial catches of chinook salmon in North America, Asia, and on the high seas. Averages (thousands of fish) are based on years 1952-75 except for the number of western Alaskan chinook that are intercepted by the Japanese mothership fishery (circle within a circle), which is based on years 1956-75. See Appendix 1 and text Table 5.10 for sources of data.

As with sockeye, pink and coho salmon, commercial catch data must be adjusted in order to obtain a true ranking of the production areas within North America. Chinook salmon, like coho, are subject to intensive troll fisheries that frequently operate on mixed regional stocks. The National Marine Fisheries Service (see footnote 3.2) estimates that during 1967-74, Canadian trollers intercepted an average of 676,000 chinook salmon (all from Washington-Oregon-California) and that U.S. trollers intercepted 238,000 British Columbia chinook salmon. Were adjustments of this magnitude applied to the commercial catch data presented in Figure 3.14, the Washington-Oregon-California region would be the top producer of chinook salmon (slightly over 2 million fish annually). British Columbia would rank second (630 thousand) followed by western, southeastern, and central Alaska in order.

Ocean distribution is not as well defined for chinook salmon as for sockeye, chum, and pink salmon. Only 11 chinook salmon that were tagged and released on the high seas have been recovered inshore--all in North America. These few recoveries reveal, however, that chinook salmon are capable of moving great distances away from their river of origin. One western Alaskan chinook was tagged as far west as 172°E in the Bering Sea and 2 chinook from other regions of North America were tagged as far west as 176°W in the North Pacific Ocean just south of Adak Island. The latter migrations (approximately 1,650 and 2,050 nautical miles [straight line]) are among the longest recorded for Pacific salmon, with only a few chum salmon having exceeded these distances. The migrations of three other tagged chinook salmon (although they were recovered at sea rather than on the mainland) aid in establishing, at least provisionally, the distributional limits of the regional stocks of chinook salmon. Two of the three, one tagged just south of Adak Island and the other tagged in the central Bering Sea (both near 176°W), were recovered after long migrations to the west (toward Asia). The third received its tag west of Attu Island (171°E) and was recovered far to the east (toward western Alaska) near 177°W.

Because chinook salmon, presumed to be Asian, have been noted as far east as 176°W, in both the Bering Sea and North Pacific Ocean, the distributional limits of Asian chinook shown in Figure 3.15 have been extended to include these locations. Similarly, and with the added information derived from scale pattern and maturity studies (Major et al, In Press), the distribution of western Alaskan fish has been extended as far west as 160°-165°E. Chinook salmon from other North American areas are shown as far west as Adak Island (176°W) and over a wide expanse of the Gulf of Alaska. Principal intermingling of Asian and North American stocks, in this model, would occur between 170°E and 175°W and would mostly involve Asian and western Alaskan stocks.

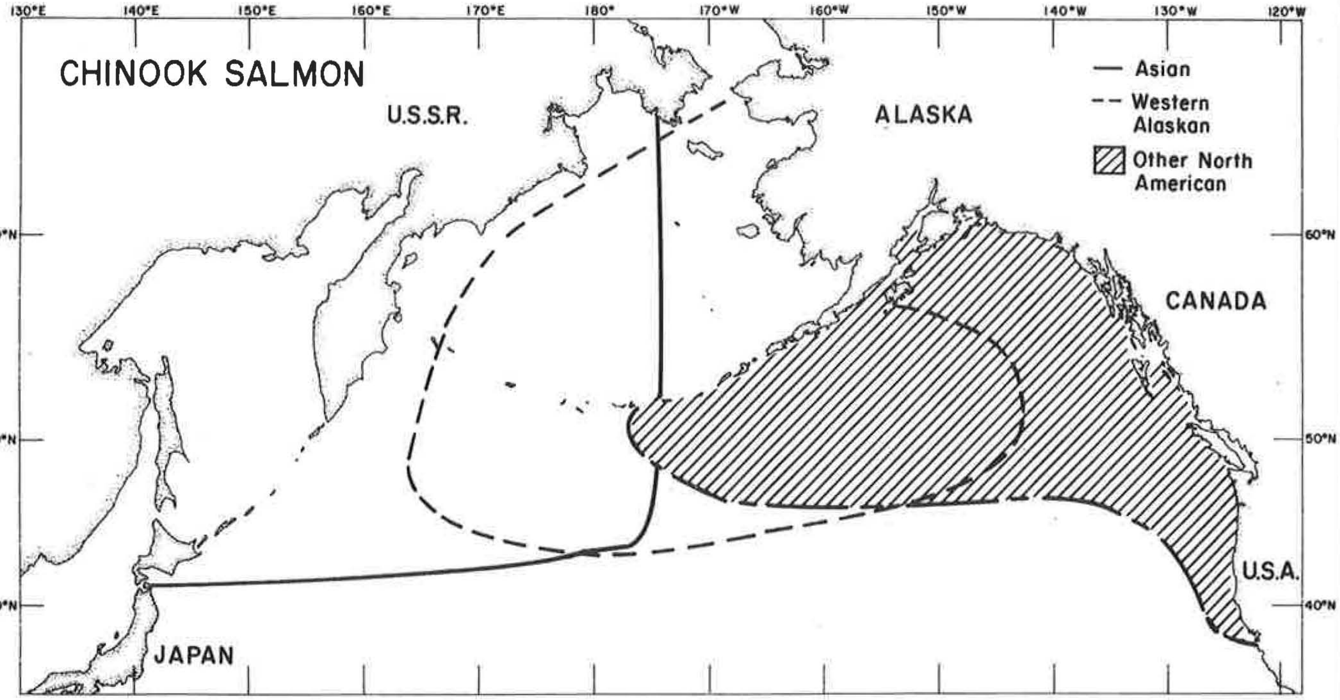


Figure 3.15.--Generalized ocean distribution of chinook salmon from Asia, western Alaska, and other North American areas.

Chinook salmon, in common with other species of salmon, abound in near-surface waters of the ocean at least during the darker hours of the day as evidenced by the use of surface gear extending only 6 m deep by the Japanese high seas gillnet fishery. There is both direct and indirect information, however, that chinook may also occur at great depths. This general observation by troll and sports fishermen was strengthened by the research of Taylor (1969), who found chinook off British Columbia as deep as at least 128 m, and not at all uncommon at depths to 110 m. Furthermore, chinook are practically the only species of salmon taken by Japanese bottomfish trawlers in the Bering Sea[3.4/] even at times of the year when other species are known to be much more plentiful in surface waters. This indicates that the chinook were taken at depth while the trawls were being fished on or near the bottom and not as the trawls were being set or retrieved through the surface layers.

3.4/ Unpublished reports of U.S. observers aboard Japanese trawlers in the North Pacific Ocean and Bering Sea, 1973-77, U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Northwest and Alaska Fish. Center, Seattle, Wash.

3.1.4 Migration and Behavior

3.1.4.1 Sockeye Salmon

French et al (1976), drawing heavily on the works of Kondo et al (1965), Margolis et al (1966) and on studies of the abundance and direction of migration based on purse seine catches, have constructed provisional models of migration of the 3 regional stocks. Migration by area of origin (Asia, western Alaska and other North Amaerican) will be discussed in the ensuing paragraphs.

The migration of Asian sockeye is depicted in Figure 3.16[3.5/]. During the first 11 months at sea, roughly July of one year through May 31 of the next, the young fish (called .0's and .1's before and after January 1 respectively) move southward along the Bering Sea and Okhotsk Sea coasts of the Kamchatka Peninsula and eventually eastward in the Pacific Ocean to winter feeding areas (Figure 3.16A). Spring migration of the .1's, coinciding with seasonal warming of the surface temperatures, is northward into the Bering Sea west of 175°W (Figure 3.16B).

Fall, winter and spring find the fish (now .1 before January 1 and .2 after January 1) sweeping south and eventually southeasterly to the same winter feeding grounds occupied a year earlier (Figure 3.16C). From this general area between approximately 150°E and 177°W, and from about 43°N to 50°N, the maturing component of age .2 sockeye begin their homeward migration (Figure 3.16D). Those that do not mature at age .2 (and this represents the greater proportion of most Asian runs) return again to the Bering Sea (Figure 3.16E) and eventually back again to the Pacific feeding grounds a year later (Figure 3.16F) from whence they too, as .3's, finally undertake their homeward migration as depicted for maturing .2's in Figure 3.16D.

3.5/ Figure 3.16 shows migrations of Asian sockeye salmon by ocean age .0 to .3. This system of age designation shows the number of annuli in fresh water by a figure preceding the dot and the number of annuli in the ocean by a figure following the dot. Thus, a .3 fish is one whose scale reflects three annuli at sea (freshwater age unspecified), a 2. fish is one whose scale shows two annuli in fresh water (ocean age unspecified), and an age 2.3 fish is one with two annuli in fresh water and 3 at sea. Total age (year of life) is obtained by adding 1 to the sum of the freshwater and ocean ages.

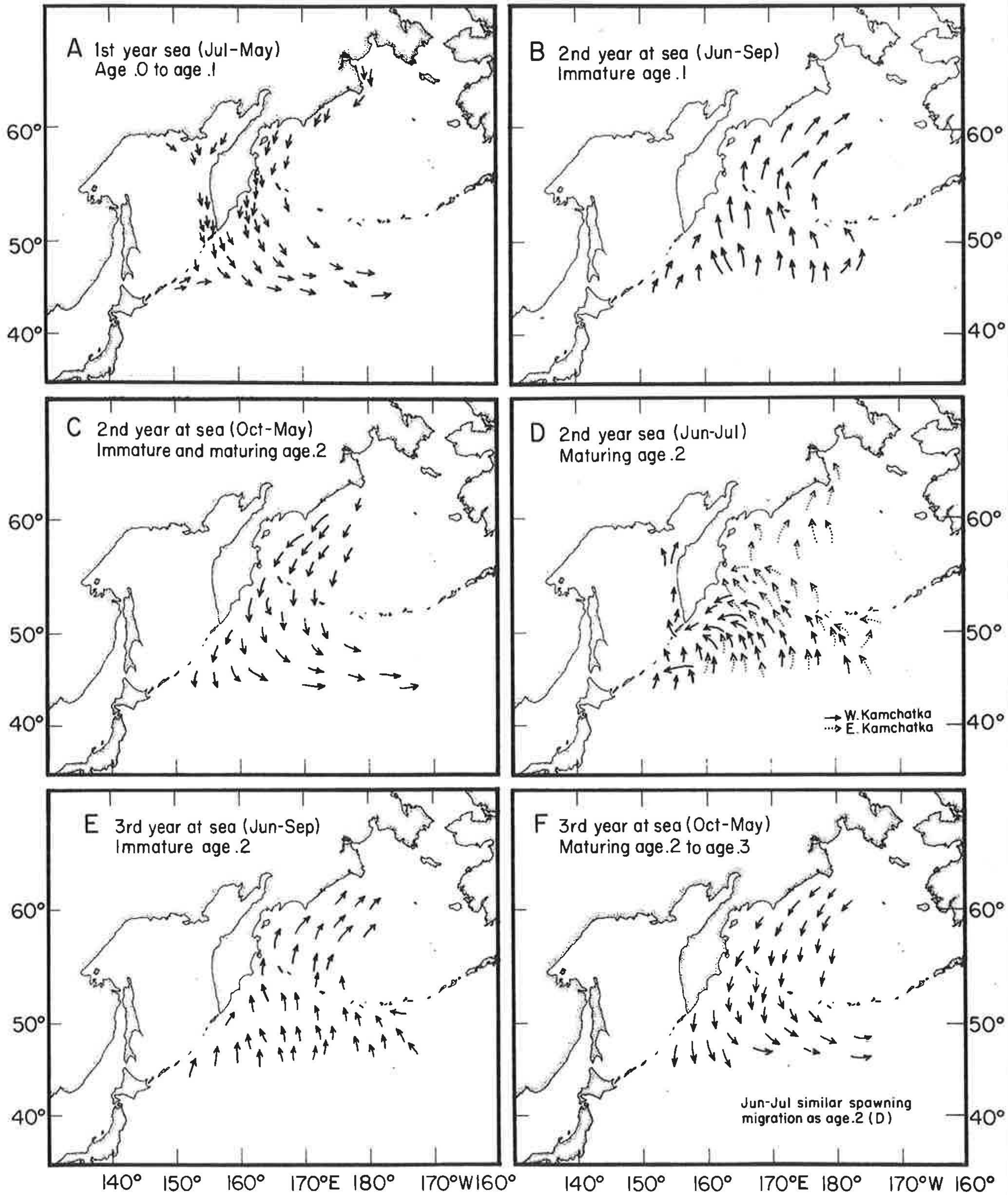


Figure 3.16.--Model of migration of Asian sockeye salmon (French et al., 1976).

The migrations of western Alaskan sockeye are shown sequentially in Figure 3.17. During their first 11 months at sea, the young fish move westward along the north side of the Alaska Peninsula and Aleutian Islands and eventually shift south into the North Pacific Ocean between 150°W and 180° as far south as 45°N (Figure 3.17A). During the second summer most redistribute themselves within the same general area but some move northward into the Bering Sea between 175°W and 170°E (Figure 3.17B).

In fall and winter, the center of distribution shifts southeastward where there is a separation of those fish that will remain at sea another year as immatures and those fish that will mature and spawn within the year. Maturing fish do not move as far south as the immatures and their concentrations remain north of 50°N from about 140°W to 165°E (Figure 3.17E) until they depart for spawning streams the following spring (Figure 3.17F). Immature Bristol Bay sockeye salmon continue their southeastward movement until concentrations become located between 45°N and 50°N and between 145°W to 175°E (Figure 3.17C) from which locale they repeat the maturation sequence laid out in Figures 3.17D, 3.17E and 3.17F. Separation of the immature and maturing components of the stock is most pronounced in the early spring.

Sockeye from regions of North America other than western Alaska (central Alaska to the Columbia River) primarily occur east of 160°W although some individuals have been shown by tagging studies to range westward to the central Aleutian Islands at about 176°-177°W. The movement of these other North American stocks during their life at sea is shown in Figure 3.18.

3.1.4.2 Pink Salmon

Migration routes of Asian and North American pink salmon, as indicated by tagging data and research vessel surveys (summarized by Takagi, Hartt and Dell, In Press) are depicted in Figures 3.19 and 3.20 respectively. Migration of Asian pink salmon is described in terms of 2 broad regional stocks—the east Kamchatka and Bering Sea populations constituting one regional stock and populations from Japan and the Okhotsk Sea coast making up the other. Migration of North American fish is described in terms of the familiar western Alaska and other North American groupings. For each regional stock, migration is expressed in 2 parts--the first summer, fall and winter at sea making up one part, and the final spring and summer at sea making up the other.

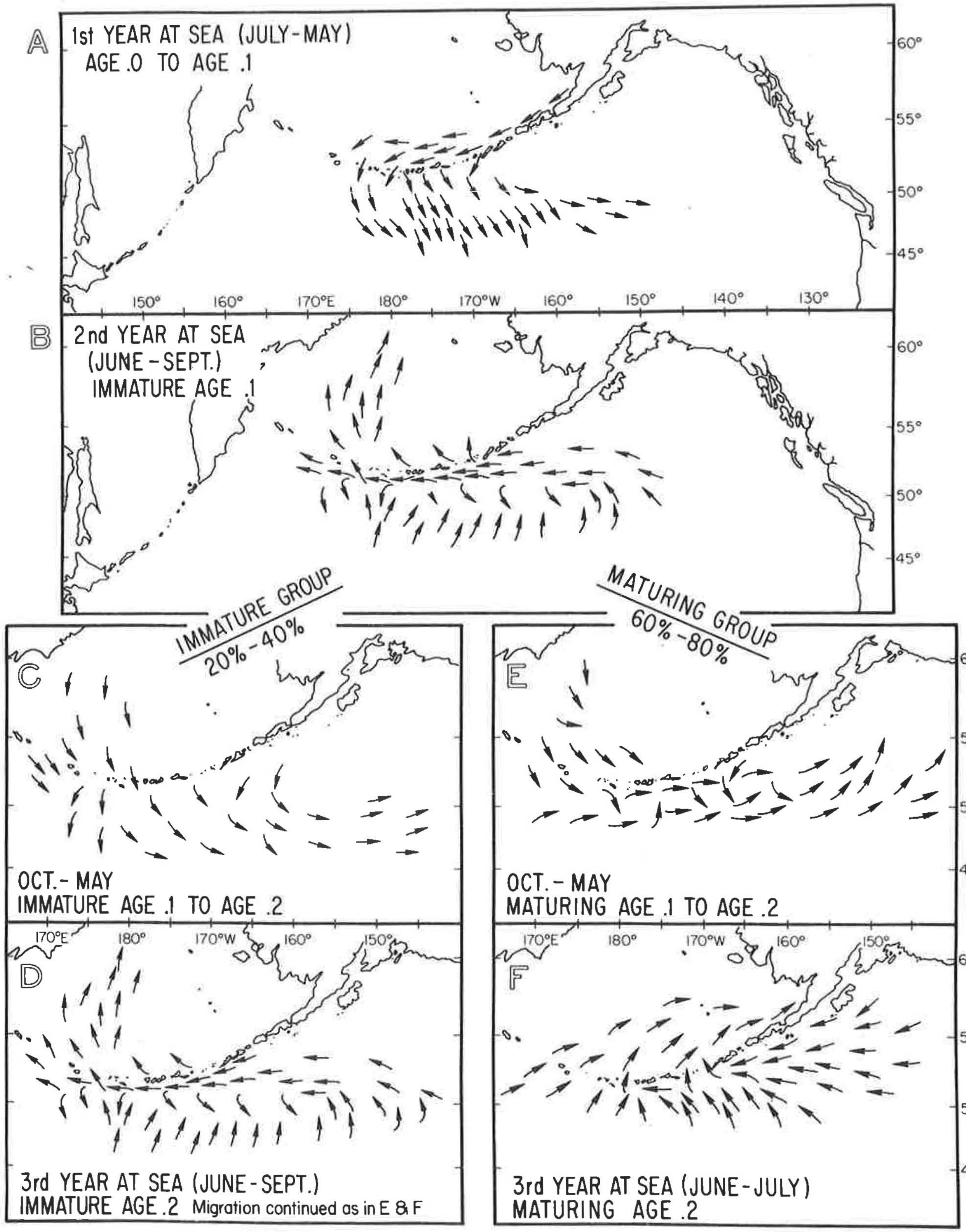


Figure 3.17.--Model of migration of western Alaskan sockeye salmon (French et al., 1976).

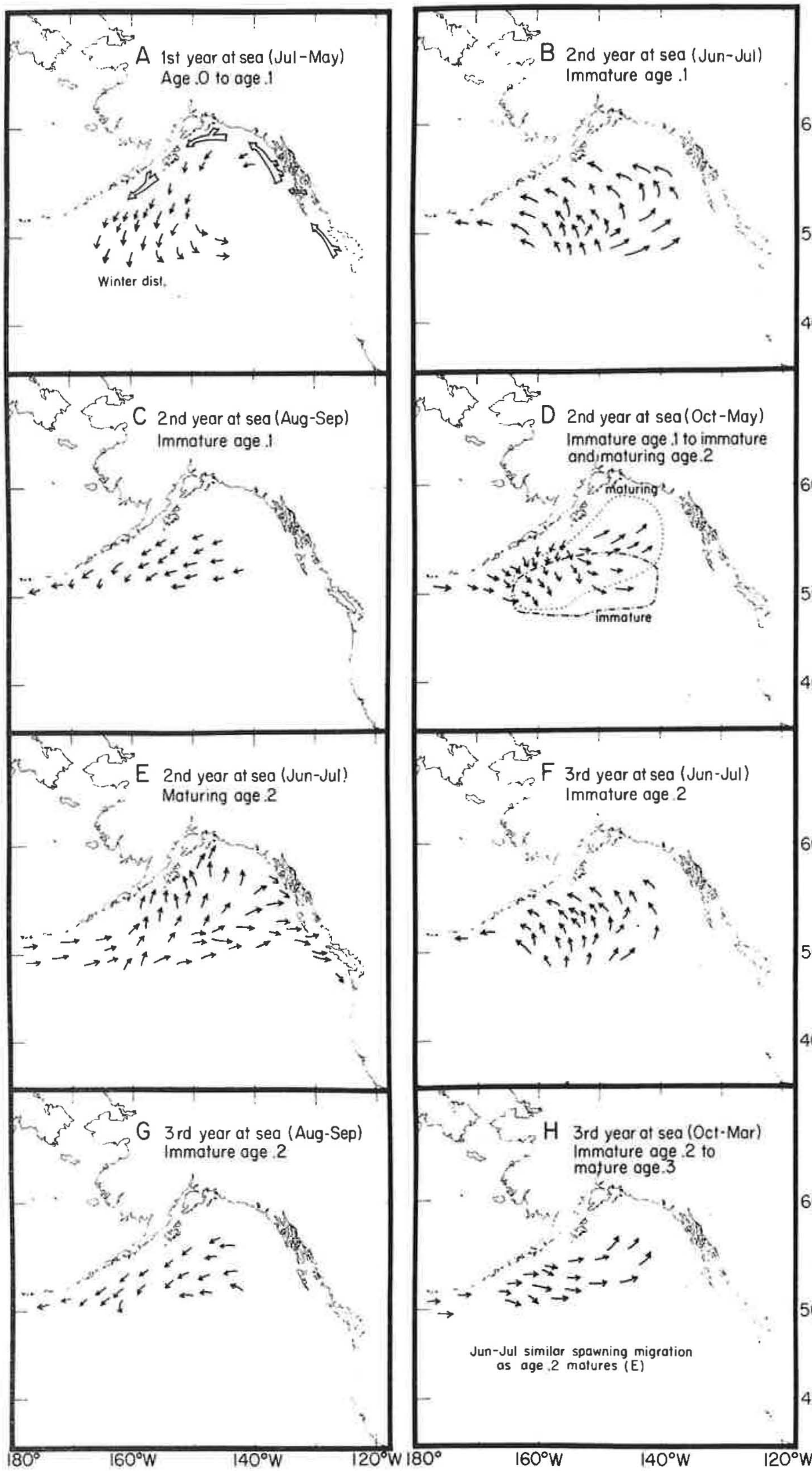


Figure 3.18.--Model of migration of other North American sockeye salmon (French et al., 1976).

Juvenile pink salmon from the East Kamchatka and Bering Sea coasts move southward near shore during their first summer at sea, eventually veering east as they approcach the tip of the Kamchatka Peninsula and the northern Kurile Islands. Continuing east at about 45°-50°N, and possibly farther south, the main body of fish distributes itself eastward to about 158° during the first fall and winter at sea (Figure 3.19A). During the final spring and summer, movement is generally in a north and north-easterly direction as the maturing pink salmon return to their native streams (Figure 3.19B).

Pink salmon that originate in Japan and along the Okhotsk Sea coast, according to Takagi et al (In Press), do not migrate as far east as the previously described East Kamchatka and Bering Sea stocks. After departing the coastal areas as juveniles none, during the fall and winter, move farther east than 177°E. Major concentrations appear to remain west of 165°E between 40°N and 46°N.

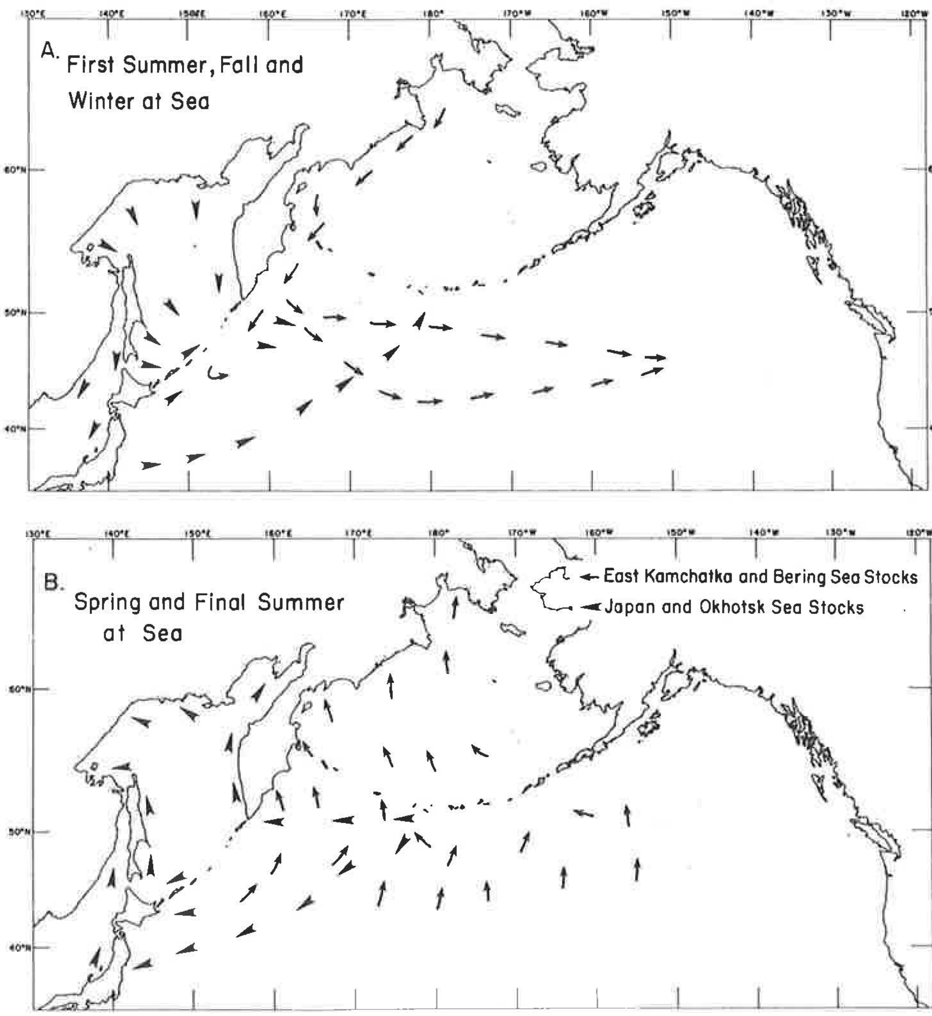


Figure 3.19.--Model of migration of Asian pink salmon.

The migration of North American pink salmon, again according to Takagi et al (In Press), can be described in greater detail. After leaving fresh water, juvenile fish from Washington State and British Columbia migrate northward in a narrow band along the coast, starting in July and continuing into the fall. Juveniles from southeastern Alaska join those from the southern stocks and begin similar northward movements. Central Alaska juveniles are thought to migrate west and southwest in the northern Gulf of Alaska and along the Alaska Peninsula, also relatively close to shore. Fish from southeast Alaska may also continue westward along these routes. Rates of travel for these initial ocean migrations have been estimated at 10 nautical miles per day (Royce, Smith and Hartt, 1968).

Sometime in the fall or early winter, juvenile salmon disperse offshore in a southerly direction. The more southern British Columbia and Washington stocks probably begin these southerly movements when they reach northeast or northern Gulf waters. This movement for southeast and central Alaska fish is thought to take place from locations in the northern Gulf and along the Alaska Peninsula. These migrations continue until more southerly waters are reached.

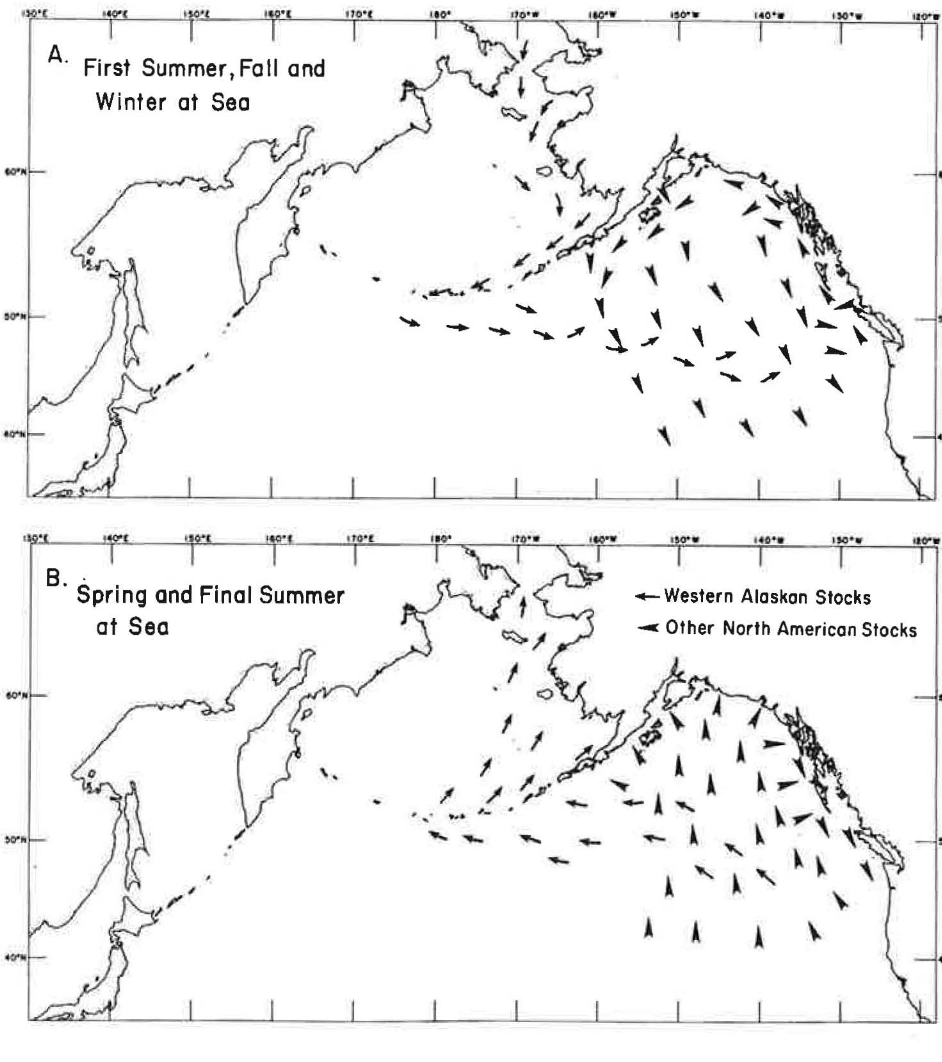


Figure 3.20.--Model of migration of North American pink salmon.

From waters occupied in late winter and early spring, lying mainly south of 50°N, pink salmon conduct return migrations over a broad front with the major direction northward. Some east or west directional movements may also take place by early spawning races or by those stocks such as western Alaska fish, which have great distances to migrate. Northward movements may continue beyond latitudes of ultimate destinations, which are then followed by return migration to the south, but using near shore routes to reach spawning streams (Neave, 1964).

The western Alaska pink salmon move north or northwestward from early spring locations and by early July have reached the Bering Sea.

3.1.4.3 Chum Salmon

Information from tagging experiments and research vessel catches as summarized by Neave, et al (1976) provides the basis for describing the migrations of chum salmon. The migrations of Asian Chums will be considered first, followed by the migrations of North American chums.

Generalized migration patterns of Asian chum salmon are shown in Figure 3.21. Stocks are grouped by the following geographic areas: (1) Japan, Kurile Islands and the southern half of Sakhalin Island, (2) the Okhotsk Sea coast including the northern half of Sakhalin Island, and (3) the east coast of the Kamchatka Peninsula northward to Anadyr Gulf. For each group of stocks, migration is portrayed by maturity stage (maturing and immature chum salmon) and by season (late summer, fall, and winter; spring and early summer for immatures and spring and summer for maturing fish).

Figure 3.21A shows the late summer, fall, and winter migration of immature chum salmon ranging from those newly arrived from freshwater (arrows projecting seaward from the coasts) to those destined to mature the following year (arrows reaching as far east as the Gulf of Alaska). Migration is generally south during this period, culminating with the extension into waters south of 50°N in the winter. Fish in the western North Pacific move further south than those in the central North Pacific probably because cold water extends further south in the western area.

Spring and early summer (Figure 3.21B) find Asian chum salmon that are not destined to mature in that year moving northward. Many move into the Bering Sea but a substantial number remain in the western and central North Pacific Ocean. During this same period, and extending until the latest migrating stocks reach their river of origin, maturing fish are undertaking their homeward migration (Figure 3.21C). It is readily seen from Figure 3.21C that maturing chum salmon from the coastal streams in the Sea of Okhotsk are much more closely confined to the waters off Kamchatka than are chums from Japan and East Kamchatka.

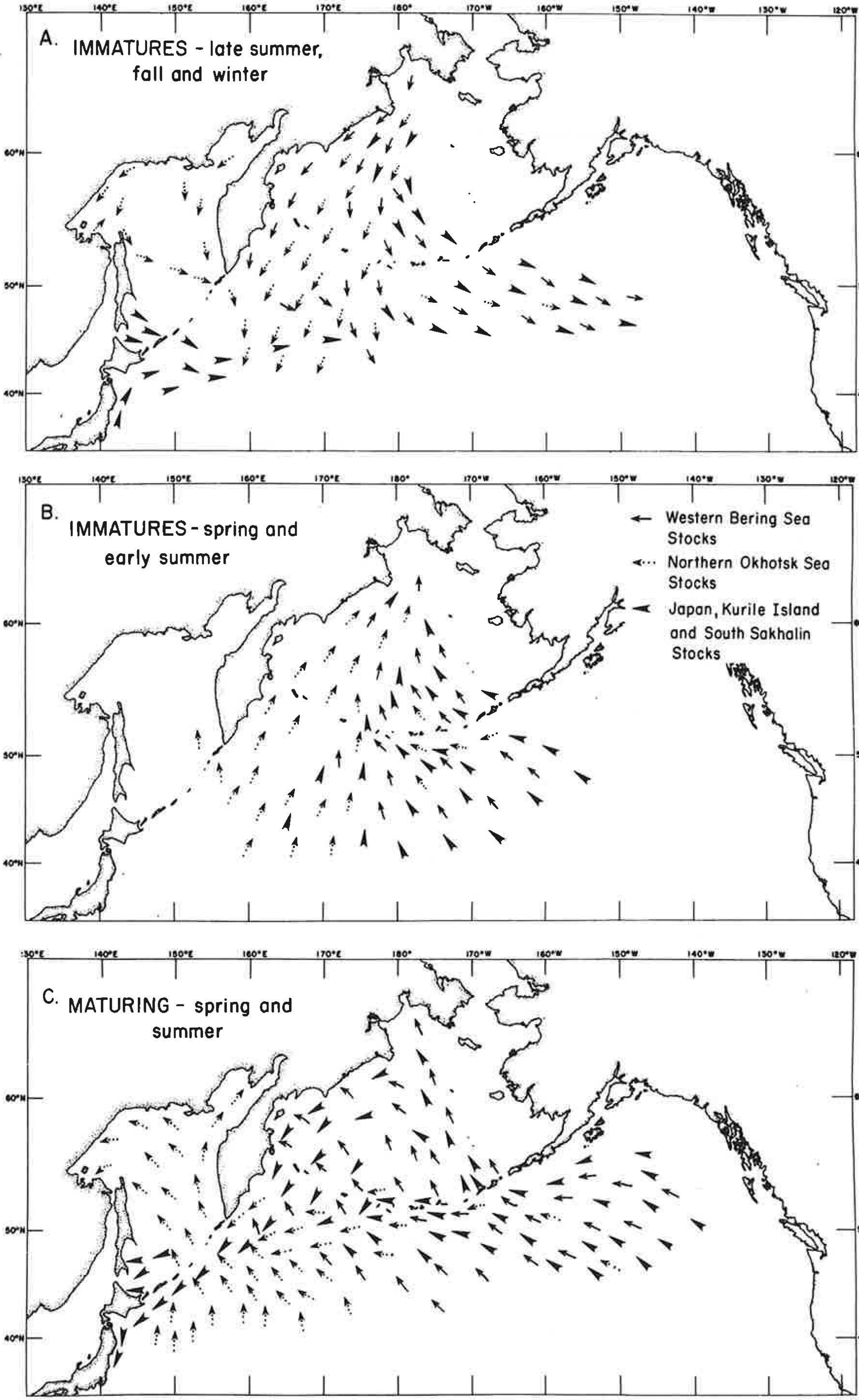


Figure 3.21.--Model of migration of Asian chum salmon.

Comparable migration patterns for North American chum salmon (using the same maturity stages and seasonal periods as for Asian in the preceding discussion) are shown in Figure 3.22. Figure 3.22A depicts the movement in late summer, fall, and winter of immature chum salmon including those newly arrived from freshwater (arrows near the coast). By late fall or winter the new arrivals (from western Alaskan streams) have largely vacated the Bering Sea and in company with older immatures migrate to more southerly and easterly waters, primarily south of 50°N and east of 155°W. As they travel, they are joined by new arrivals from other North American areas.

The southerly migrations of late summer, fall and winter are reversed in the following spring and early summer (Figure 3.22B). First, the older immatures and then the younger immatures that are just completing their first year at sea, move northward and westward with a minor component (made up of fish from both western Alaskan and other Northern American streams) migrating as far west as the central Aleutian Islands. There is no evidence that migrations continue into the Bering Sea for immatures of either regional stock.

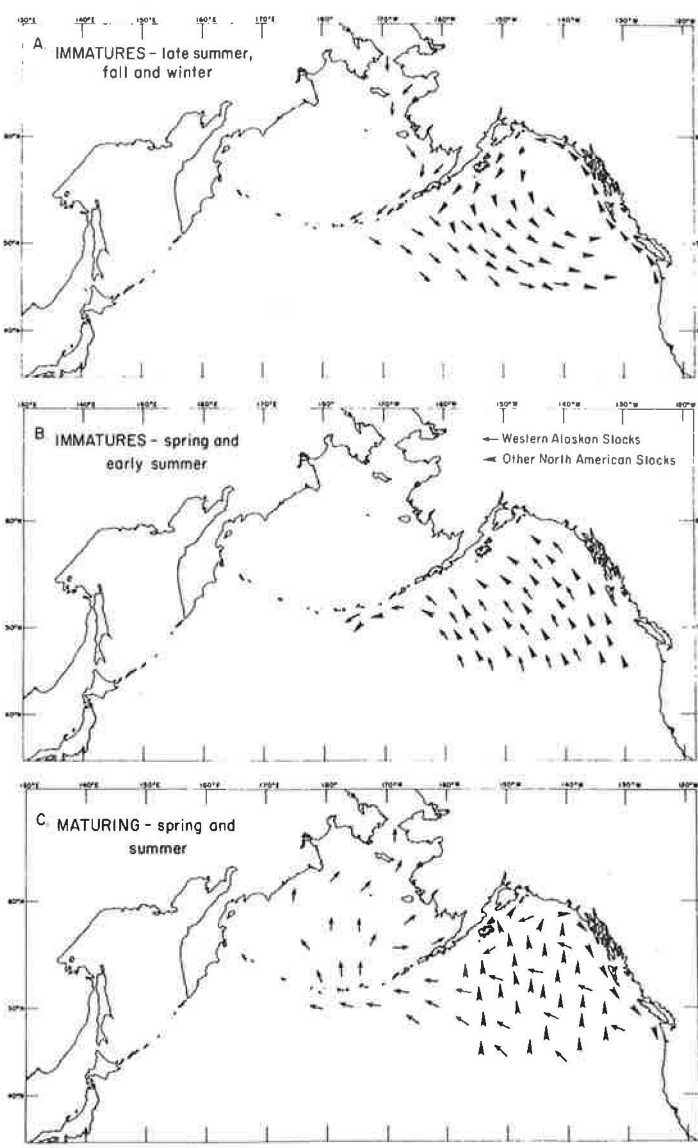


Figure 3.22.--Model of migration of North American chum salmon.

Immature chums repeat these seasonal movements each year but in the year of maturity migrations are different. In the fall or winter preceding the return to fresh water for spawning, only some components of the maturing group move into the more southern waters lying south of 50°N. The majority remain in more northerly waters, but shift eastward sometime in winter.

Migrations toward spawning streams for western Alaskan chum salmon begin from diverse locations. These range from near the British Columbia and south-east Alaskan coasts, from the far northern Gulf of Alaska, and from as far west as the central Aleutian Islands. Movement through Aleutian Island passes is mainly in June. Migrations through the Bering Sea, the routes of which are thought to be mainly in the central and western Bering Sea but which for some fish carry them near the Siberian coast, are rapid as runs peak in coastal waters in July.

Migrations of other North American stocks are northward into the Gulf of Alaska from May to July. Migrations for these stocks are probably more leisurely than those of western Alaskan stocks because a majority already occupy more northern waters relatively close to their spawning streams.

For central Alaskan stocks, a continuation of movements to the north takes them into coastal waters near their streams of origin. For fish from southeastern Alaska and more southern regions, movements are initially north, then eastward, and finally southward along the coast to home streams.

3.1.4.4 Coho Salmon

Results of high seas research on coho salmon have not been adequate to diagram migration routes. Information available from tagging and catches by research vessels allow, however, for some general comments on the migration of coho. In the main, the following comments are excerpts from Godfrey et al (1975).

There is relatively little information on the distribution of age .0 Asian coho salmon during their first summer and winter in the ocean. Limited catches of .0's suggest, however, that during this time the young coho disperse southward in the western North Pacific Ocean to at least 40°N. Such dispersal would occur in association with the cooling of surface waters in a general north-to-south direction. Eventually (perhaps during the first summer or winter, but possibly not until the spring or early summer) some Asian coho move east as far as Adak Island.

Maturing Asian coho are taken in increasingly large numbers during late spring and early summer progrssively northward over a broad east-west front from Adak to the Kurile Islands. Peaks of abundance occur along the western Aleutian Islands and off the southern tip of the Kamchatka Peninsula during late July-early August, followed by movements to the east coast of Kamchatka and further north, and to the west coast of Kamchatka and other locations in the northern Okhotsk Sea.

Most young coho salmon from streams in California, Oregon, Washington, and British Columbia proceed rapidly northward, generally within 25 miles of the coast. Some do not move far from their home stream while others reach waters off central Alaska and Kodiak Island. This initial journey is attained by late summer. Tag recoveries have shown that juvenile coho salmon from western Alaska also penetrate into the Gulf of Alaska.

During winter, in association with the cooling of near-surface waters, these fish disperse southward, probably to at least 40°N. Then as the waters warm in spring and summer, movement is again northward over a broad east-west front until the individual stocks commence the directional movement required to return them to their natal streams. For western Alaskan and central Alaskan stocks movement would continue northward but at some point in time and space the more southerly stocks would have to swing south along the coast of southeastern Alaska and British Columbia. Tagging studies lend credence to this proposition. With few exceptions coho that had been tagged as maturing fish off southeastern Alaska and the northern Queen Charlotte Islands, were recovered to the south--in British Columbia, in Puget Sound, on the Washington coast, in the Columbia River, and off the coasts of Oregon and California.

3.1.4.5 Chinook Salmon

As with coho salmon, there is inadequate information upon which to construct hypothetical models of the migration of chinook salmon at sea. An exception, of course, would be the fairly well-defined migration of chinook salmon originating in streams from California to southeastern Alaska. Young chinook from this area generally migrate northward on their feeding migrations and southward as maturing fish (National Marine Fisheries Service--see footnote 3.2). Some, as we have seen earlier, migrate as far west as Adak Island but their principal concentrations are in the eastern Gulf of Alaska and North Pacific Ocean relatively close to shore.

There is only fragmentary information about the timing and the routes traveled by young chinook salmon from western Alaska and Asia as they disperse themselves at sea. It is known only that young chinook salmon (presumably of western Alaskan origin) are taken in bottom trawls in the central Bering Sea during their first winter at sea. During their second summer and fall, chinook salmon believed to be of western Alaskan and Asian origin are encoutered over a wide area embracing the eastern Aleutian Islands and much of the Bering Sea. Their distribution in these areas is not as extensive, however, as that which they will ultimately attain as older fish.

Table 3.3.--Age composition at maturity of Pacific salmon from selected rivers and areas.

Species and river (or area)	1.0	2.0	0.1	1.1	2.1	3.1	4.1	0.2	1.2	2.2	3.2	0.3	1.3	2.3	3.3	0.4	1.4	2.4	0.5	1.5	0.6	Other	Authority
									(percent)														
Sockeye Salmon																							
Bristol Bay, Alaska									25	46			17	11								1	Rogers (1973)
Karluk River, Alaska					1	2			1	56	19		2	16	3							<1	Rounsefell (1958)
Skeene River, B.C.									49	8			40	3								<1	Larkins and McDonald (1968)
Fraser River, B.C.				2					89	2			7									<1	Killick and Clemens (1963)
Pink Salmon																							
All Areas			100																				Hart (1973)
Chum Salmon																							
Alaska								6				74				20							{
British Columbia								21				43				32			4				{Bakkala (1970)
Washington								54				42				4							{
Oregon								10				89				1							{
Coho Salmon																							
Alaska		1		33	62	4	<1		<1														{
British Columbia	1	<1	1	97	<1			<1	1	<1													{Drucker (1972)
Columbia River2/	6			84	10																		{
Waddell Creek, CA	18			82																			{
Chinook Salmon																							
Yukon River, Alaska									<1	2			15	11			53	6		12			U.S. Fish. Wildl. Serv. (Date unkn)1/
Cook Inlet, Alaska				<1					13			<1	37			1	44	<1	2	1	<1		Yancey and Thorsteinson (1963)
Washington State (Coastal Sport Fishery)			6	<1				46	1			42	<1			4	<1		<1				Wright and Bernhardt (1972)
Columbia River2/			9					22				56				13							Van Hyning (1973)

1/ Yukon River Basin (Anvik to Marshall), Alaska. U.S. Dep. Int., Fish. Wildl. Serv. Prog. Rep. 5 on the Fish and Wildlife Resources

2/ Fall chinook (O. fish) only.

3.2 Specific Life History Features

3.2.1 Maturity and longevity

The ages attained at maturity for the various species are shown in Table 3.3. Although at least some of the samples on which these computations were made were from commercial catches alone or escapement alone (and, therefore, reflect bias introduced by gear selectivity), the data are believed to adequately portray the age composition at maturity of the various stocks involved. All Pacific salmon die after spawning.

Among sockeye salmon there is a vast range in ages at which individuals mature and return to fresh water to spawn. Rounsefell (1958) reported sockeye maturing at ages 3-8 with 21 different freshwater age-ocean age combinations. Some fish went to sea shortly after hatching while others spent as many as 4 winters in fresh water. Similarly, ocean life varied from a few months to slightly over 4 years. The 21 age combinations at which sockeye matured were as follows: (recall that the number before the dot is the number of winters in fresh water, after hatching, and the number after the dot is the number of winters at sea) 2.0, 3.0, 4.0, 1.1, 2.1, 3.1, 4.1, 0.2, 1.2, 2.2, 3.2, 4.2, 0.3, 1.3, 2.3, 3.3, 4.3, 0.4, 1.4, 2.4, and 3.4. Most sockeye, however, mature at ages 1.2, 2.2, 1.3 and 2.3 (total ages 4-6) although in a few populations 1.4, 3.2 and 3.3 fish may form substantial proportions of the spawning fish.

Of all species of Pacific salmon, age at maturity of pink salmon is the least variable--there being agreement in North America that nearly all mature and die after one winter in the ocean (designated age 0.1). There is essentially no freshwater life because pink salmon enter the ocean soon after hatching. At maturity, pink salmon are smallest of the Pacific salmon followed in order of increasing size by sockeye, coho, chum and chinook salmon.

All chum salmon migrate to sea before their first winter, therefore as age 0. fish. They then spend from one to six winters at sea before reaching maturity but those maturing at less than age .2 and more than age .4 are insignificant in number. The species most commonly matures at age .3 (Table 3.3) but the proportions of age .2 or age .4 fish are also substantial in certain years and areas. The importance of these latter age groups varies by geographical location. Age .4 fish are more abundant than age .2 fish in British Columbia and Alaska while age .2 fish form a higher proportion of the runs in Oregon and Washington. Considerable annual variation occurs in the age make-up of runs to a given locality or stream (Table 3.4).

Table 3.4.--Yearly variation in age composition of chum salmon as shown by samples from selected areas (data from Regnart, Fridgen, and Geiger, 1967; Thorsteinson, Noerenberg and Smith, 1963; Pritchard, 1943; Oakley, 1966).

Location	Year	Sample size	Age 0.2 (Percent)	0.3	0.4	0.5
Western Alaska	1961	97	4.1	75.3	20.6	0
(Yukon River)	1962	915	1.9	69.3	28.8	0
	1963	650	6.0	83.3	10.2	0.5
	1964	268	3.2	63.0	3.7	0
	1965	486	0.2	97.3	2.5	0
Central Alaska	1952	187	23.5	47.1	29.4	0
(Prince William Sound)	1953	819	8.4	76.4	15.1	0
	1954	100	45.0	45.0	10.0	0
	1955	55	10.9	81.8	7.3	0
	1956	617	11.0	86.2	2.8	0
	1957	218	6.9	72.0	21.1	0
	1958	141	15.6	76.6	7.8	0
British Columbia	1933	160	14.4	24.4	59.4	1.8
(Nootka)	1934	124	16.9	73.3	9.0	0.8
	1935	186	17.2	44.6	36.6	1.6
	1941	518	9.1	50.6	39.6	0.7
Oregon	1947	65	32.3	66.2	1.5	0
(Tillamook Bay)	1949	287	4.9	94.7	0.4	0
	1950	481	76.2	22.5	1.3	0
	1959	310	51.2	48.0	0.8	0
	1960	92	68.2	30.8	1.0	0
	1961	123	83.4	16.0	0.6	0

Coho salmon have been reported to mature at ages 0.1, 0.2, 0.3, 1.0, 1.1, 1.2, 2.0, 2.1, 2.2, 3.1, and 4.1, although the vast majority mature as 1.1's and 2.1's, that is age 3 and age 4 fish (Drucker, 1972). Southward from British Columbia a very high percentage migrate seaward after one winter in fresh water (freshwater 1.) but Alaskan coho commonly spend two winters in fresh water (freshwater age 2.). In some areas (the Columbia River and Waddell Creek, California) significant proportions return as "precocious" males the same year that they migrated to sea (ocean age .0), but most spend 2 growing seasons in the ocean--returning late in the year following that in which they entered the sea (ocean age .1).

Ages of maturing chinook salmon have been reported as 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 2.1, 2.2, 2.3, 2.4, and 2.5 although the vast majority of the fish mature at ages 3-6. Total age at maturity, like freshwater age and ocean age (the components making up total age) tends to be greater in the north than in the south. From California northward to Cook Inlet, Alaska, for example, three-, four-, and five-year-old fish prevail (there are significant numbers of six-year-olds in some areas, but few if any seven- or eight-year-olds). Five- and six-year-olds dominate the runs from Bristol Bay northward, but seven- and even eight-year-olds are not uncommon. This south-north change in age structure is illustrated by the age composition of chinook salmon from selected areas of the North American Coast as shown in Table 3.3.

Data in Table 3.3 illustrate, for most species, a cline in ages from north to south with a greater proportion of fish reaching maturity at younger ages in the south. This is reflected in both the freshwater and ocean ages and is evident for all species except for pink salmon. Factors governing age at maturity have not been clearly defined. Foerster (1968) concludes that both heredity and environmental influences on growth may play important roles. The eveidence for heredity appears to have the strongest basis as demonstrated by Godfrey (1958) and Ricker (1972).

Some salmon stocks mature rather consistently at a certain age, the clearest example being pink salmon with their rigid two-year life cycle, but also occurring in some sockeye stocks that mature mainly in their fourth year. When the abundance of one line considerably exceeds the other it is called a "dominant" line and the resulting imbalance of population size produces a cycle of abundance. This phenomenon is most frequently observed in pink salmon stocks, but also occurs in some sockeye salmon stocks such as in Bristol Bay and in the Adams River sockeye of the Fraser River system.

Ricker (1962) reviewed the cyclic nature of pink salmon stocks and observed that all degrees of dominance exists for this species from complete dominance of one line (odd or even-year runs) to the absence of a dominant line. The most extensive and extreme development of dominance was observed in the mid 1920's. Dominance had existed in some regions before commercial fishing began, but it usually became intensified after large-scale fishing started. In other regions dominance first became recognizable after fishing was well developed. A shift in dominance from one line to another has frequently occurred, while in other cases one line has remained dominant since records were kept.

The exact nature of the factors governing dominance have not yet been defined although various suggestions have been offered. The most likely hypothesis involves predation. In years of high abundance of fry, the fish-consuming capacity of predators become saturated which reduces the mortality rate and leaves a larger number of survivors to perpetuate the line. For the subdominant lines, mortality from predation is proportionately much higher and prevents these lines from reaching the abundance of the dominant line. It has also been suggested that fishing may intensify or even initiate dominance by taking a larger percentage of the subdominant lines although in recent years this possibility has probably been lessend by better management and regulation of fishing.

3.2.2 Reproduction

3.2.2.1 Return to Coastal Waters and Rivers of Origin

The bulk of adult salmon return to coastal waters and enter streams and rivers during summer and early fall, with the more northerly populations generally returning earlier than those to the south. Over the entire range of the genus, however, and even in certain more restricted locales, salmon return year-round. On the west coast of North America, for example, four seasonal runs of chinook salmon have been delineated--winter, spring, summer and fall, with the majority returning as fall-run fish from August to November. Spring runs, entering streams from March to June, are common from Washington State southward. In the Columbia River, the winter run arrives in February-April; the summer run in June and July. The Sacramento River winter run arrives in November-January. Similarly, chum salmon--particularly those in Asia, are often referred to as summer and autumn runs, depending on the time of entry into fresh water. Summer runs, more common in northern streams, enter from July to early September; autumn runs from October to January. Sockeye, pink and coho salmon usually have only one seasonal run that enters fresh water over a relatively short period. Sockeye and pink salmon arrive earliest, normally peaking in July and August, while coho arrive from late summer to early winter.

UPRIVER MIGRATION OF SPAWNING SOCKEYE SALMON,
FRASER RIVER, B.C., CANADA (Photo: Anon.)

3.2.2.2 Spawning

The location and type of spawning area utilized by Pacific salmon varies tremendously, not only between but within species. Pink, coho, and to a lesser extent chum salmon spawn in small streams and tributaries to larger rivers usually within 250 km from the sea--pinks and chums often spawning within the tidal zone. Chum salmon also spawn in large river systems such as the Amur River, USSR, and the Yukon River where adults are known to migrate upstream as far as 2,500 km. Chinook and sockeye salmon, like chums, may spawn near the sea or far upstream. Chinook, associated primarily with larger river systems, have been found spawning as far as 3,200 km up the Yukon River while sockeye, whose spawning is always associated with lake systems, may attain locations as far as 1,450 km from the sea at an altitude of almost 2,000 m.

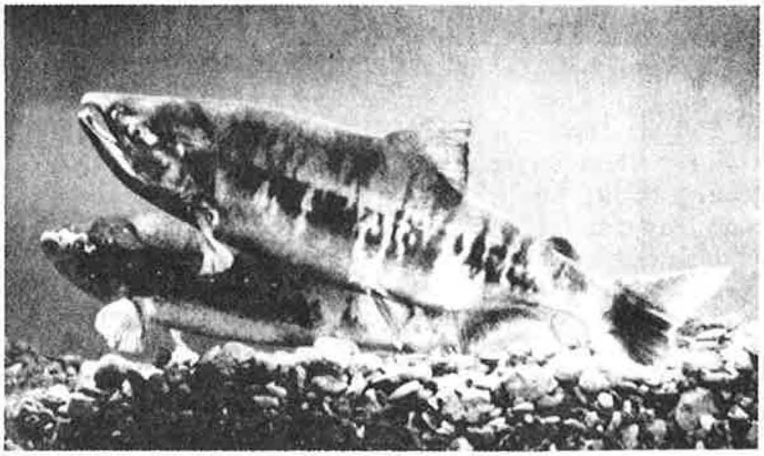
The maturation process, together with the lengthy migrations required for some stocks of salmon, requires a great deal of energy. Countless generations of natural selection have bestowed upon individuals of each spawning subpopulation enough body reserve to sustain them without additional feeding on their upstream migration. Fish destined to spawn far upstream, for example, will have greater stores of energy as they enter fresh water than will those whose spawning grounds are near the sea. Idler and Clemens (1959) determined that one subpopulation of sockeye salmon used 90-96% of their stored body fat and 33-53% of their protein reserves while moving up the Fraser River to their spawning grounds, 1,080 km from the sea at an altitude of 691 m.

The timing of the migration, like the amount of energy required, is subpopulation specific, having been honed by never-ending processes of adaption. Peak numbers of a particular subpopulation of salmon arrive at certain points enroute to the spawning grounds within a very short interval each year--a timing closely attuned to stream conditions (Thompson, 1959).

Sockeye are unique among Pacific salmon in that their spawning grounds are almost invariably in association with a lake. Adult fish often spend considerable time resting in the lake before preceeding to the spawning gravels--usually above, but sometimes below or even in the lake itself. The lake also serves as a rearing area for young sockeye salmon.

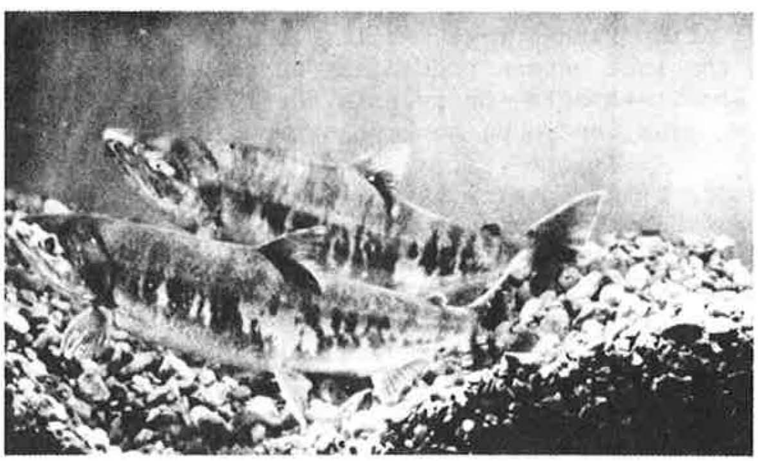
Time of spawning is related to time of entry into fresh water, but in some cases very loosely so. Fulton (1968) reports, for example, that in the Columbia River all three seasonal races of chinook salmon (spring, summer and fall) can be found spawning to some extent during September. Slater (1963) found that the winter run of chinook salmon enters the Sacramento River in November-January but does not spawn until late April-late July. For species other than chinook, the time of spawning is more easily generalized. Sockeye and pink salmon spawn from August through November; coho November-January and chums June-January.

The actual spawning act is essentially the same for all species of Pacific salmon. The female excavates the redd (nest) and deposits her eggs in several pockets within the redd. Following fertilization by sperm from the attending males, the female covers the eggs with 15-40 cm of gravel.



Male (foreground) and female before redd construction.

Female digging redd by turning on side, rapidly flexing body, and fanning streambed with caudal fin. The female excavated the redd alone and repeated the digging motion every 1 to 5 minutes.



To start the spawning act, the male and female lowered their bodies into the redd.

CONSTRUCTION OF REDD AND SPAWNING BEHAVIOR OF CHUM SALMON
(Photos: Selected from series in Sano and Nagasawa, 1958)

According to Rounsefell (1957), the number of eggs carried by mature females varies by species, population, and the age and size of the individual female. Overall averages are approximately as follows:

Pink	1,800	Sockeye	3,600
Chum	2,500	Chinook	4,800
Coho	2,800		

Under normal conditions almost all of the eggs are extruded by the female although there is evidence (Semko, 1954; Lister and Walker, 1966) that egg retention increases when spawning density is high.

Variation in average egg content between stocks probably represents an adaptation of the fish to their environment, with those stocks encountering relatively favorable conditions for the survival of their young needing fewer eggs to maintain their numbers (Thompson, 1959). It is also apparent that fecundity is lower for species with a shorter freshwater life history (pink and chum salmon). Neave (1948) asserted that these species must suffer less natural mortality than other species of salmon. The relatively high egg production of sockeye, chinook and coho salmon is, on the other hand, probably an adaptation to the greater mortalities sustained by these species during longer freshwater residencies.

Spawning, for all species of salmon, is usually in fast-moving (0.3-1.5 m/sec), highly oxygenated waters here there are riffles and stream underflow. Water depth may vary from 4.6 m (Chapman, 1943) to less than enough to cover the fishes' back. Stream bottom materials are mainly small gravel (less than 15 c in diameter) with some silt, sand, and some larger gravel mixed in (Burner, 1951). Smaller species generally select spawning areas with a higher proportion of smaller gravel than do the larger species.

The size of redds also varies with the size of the species--averaging 1.8 m for sockeye, 2.3 m for chum, 2.8 m for coho and 5.1 m for fall run chinook salmon in the Columbia River system. Experiments in artificial spawning channels in Canada have demonstrated that pink salmon produced the maximum number of fry when about 1.3 m of spawning area was provided for each female (International Pacific Salmon Fisheries Commission, 1972). In a natural stream in Alaska, maximum production of pink and chum salmon fry (500/m) was obtained with about 1 m of spawning area per female (McNeil, 1969).

In instances where spawning grounds have been destroyed or altered for other uses, natural production has been supplemented by construction of artificial spawning channels and development of hatchery systems to incubate, hatch, and grow young salmon. This aspect will not be covered in this report although activities here are quite extensive--for example, there are currently over 100 salmon hatcheries in operation along the Pacific Coast of the United States.

SALMON HATCHERY

ARTIFICIAL SPAWNING CHANNEL

HOLDING POND FOR JUVENILE SALMON

IMPROVING NATURAL SPAWNING GROUND

(Photos: Wash. Dept. Fish.)

3.2.3 Growth and Mortality

Pacific salmon grow and sustain mortalities throughout their entire life—from the time they are deposited in the gravel as fertilized eggs to the time they return to the spawning grounds as mature adults. However, neither growth nor mortality occur at a constant rate. Growth on one hand, is slow during freshwater life (for those species having a freshwater life), very rapid during the first summer or two at sea and (for those that remain) slower thereafter. Greatest mortalities are incurred, on the other hand, during the early stages of life. Because growth and mortality vary with life stage, it is appropriate, before discussing growth and mortality per se, to describe the phases of life not yet covered in this review, that is, from the time the fertilized eggs are deposited in the gravel to the time the young fish enter the ocean.

The initial phases of the young salmon's life are greatly influenced by temperature. Incubation time (the time elapsed between fertilization and hatching) is largely a function of temperature. Velson and Alderdice (In Press) showed, for example, that incubation time for chinook salmon is 33 days at 15.9°C and 178 days at 1.6°C. There is insufficient information they reported, from which to derive similar calculations for the other species, particularly pink salmon. Temperature also affects the newly hatched young. Depending on temperature, the young fish remains in the gravel a few additional weeks until the yolk sac is absorbed. Gradually during this period the young fish becomes less dependent on its yolk sac for nutrition and begins to take more and more external food. Emergence from the gravel is usually in the spring although it may be protracted throughout much of the year for chinook salmon because of their varied spawning seasons.

The length of time that young salmon spend in fresh water varies by species and stock. Pinks and lower-river chums migrate to sea soon after emerging from the gravel, their migration usually being brief--lasting only a few days. Although the early life history of chum salmon originating far upstream, such as in the Yukon River, has been little studied, it is certain that some facets must differ substantially from the lower-river populations, the timing and duration of the seaward migration being a couple of good examples.

Chinook salmon are intermediate in terms of their freshwater life in that they migrate to sea either in their first spring and summer life (called ocean-type fish) or after having spent an additional year in fresh water (called stream-type fish). Spawning populations in Asia and Alaska (particularly north of Cook Inlet) are exclusively stream-type while both types occur to the south. In the latter region, spring-run fish usually remain in fresh water just over a year while fall-run fish move to sea during their first year.

Sockeye and coho salmon spend at least one and sometimes two or more years in fresh water. Only on rare occasions do these species migrate to sea during their first year. Young coho characteristically spend their fresh water life in their small natal streams whereas young sockeye occupy lakes.

Spring is the principal period of seaward migration for all species of Pacific salmon. For pinks and lower-river chums, seaward migration is relatively uncomplicated--occurring in their first year shortly following emergence from the gravel. Fall-run chinook salmon also migrate to sea during their first year--some after spending only a few days, but others after spending a month or more in fresh water.

The seaward migration of other species and populations (sockeye, chinook, and coho that have spent a year or more in fresh water and up-river chums that migrate in their first year) is much more complex. Consider, for example, the findings of Hartman, Heard and Drucker (1967) who reported on sockeye salmon, the best researched species of all Pacific salmon:

> "Smolt migrations to salt water closely follow spring breakup of the ice and warming of the lake water. The time of smolt migration is correlated closely with latitude: migration is earlier in southern streams than in northern streams. The duration of seasonal migration appears to be strongly related to travel distance to the trunk river outlet. The smolt exodus is rapid and regular in single-lake systems but irregular and extended in multilake or multibasin systems. The frequency distribution of smolts migrating from two-lake or two basin systems is usually bimodal. Most migrations commence as water temperatures near 40 F (4.4°C) and are over when temperatures approach 50 F (10.0°C). Migrations of smolts...are mainly confined to the darkest hours of the night. In general, in any one season, the oldest and the largest smolts in each age-group migrate first. Other factors, such as the thickness of the ice, effectiveness of solar radiation in melting ice and warming water, and daily weather (including sunlight and wind), also influence seasonal and diel migration patterns. Underwater observations of smolts at night during migration show that they are schooled, travel in upper water levels in shallow rivers and deeper (but not near the bottom) in deeper rivers, and usually face downstream and swim as they migrate."

3.2.3.1 Sockeye Salmon

Regardless of the relative amounts of time spent in the freshwater and marine environment, Pacific salmon attain most of their growth in the ocean. This difference in growth is illustrated by increments in length attained by three populations of sockeye salmon in fresh water and at sea for various age groups (Table 3.5). While most fish are 15 cm or less when they enter the sea as juveniles, their size when they return to fresh water as adults ranges from 50 to 65 cm. The ocean growth of sockeye salmon by life history group in both length and weight are shown in Figure 3.23. Both Table 3.5 and Figure 3.23 show that the percentage growth in length is greatest in the first year of ocean life, and declines in subsequent years. Figure 3.23 shows that percentage gain in weight follows a similar pattern, with the percentage gain being greatest during the first year of ocean life and diminishing thereafter. The weight of sockeye salmon increases from less than 1 decagram at time of entry into the ocean to as much as 3 kg at maturity for fish having spent 4 winters (5 growing seasons) at sea.

Table 3.5.—Average length increments (centimeters) per year of residence in lake and sea for Cultus, Dalnee, and Karluck Lakes, sexes combined. (Adapted from Foerster, 1968.)

	Cultus Lake, B.C.					Dalnee Lake, USSR				Karluk Lake, Alaska				
	1.1	1.2	1.3	2.2	2.3	1.2	1.3	2.2	2.3	2.1	2.2	2.3	3.1	3.2
First year in fresh water	9.6	10.5	10.2	6.1	6.4	12.8	12.9	10.3	10.4	6.9	6.7	7.5	5.7	6.8
Second year in fresh water	-	-	-	8.0	8.9	-	-	7.3	6.7	5.8	5.9	5.0	4.7	3.8
Third year in fresh water	-	-	-	-	-	-	-	-	-	-	-	-	3.8	4.5
First ocean summer	-	-	-	-	-	15.2	14.4	15.6	13.7	-	-	-	-	-
First ocean winter	-	-	-	-	-	3.8	3.4	3.6	3.3	-	-	-	-	-
First ocean year	25.8	21.3	21.0	23.3	19.5	19.0	17.8	19.2	17.0	24.3	20.0	19.5	23.9	22.0
Second ocean summer	-	-	-	-	-	11.6	8.9	10.0	7.7	-	-	-	-	-
Second ocean winter	-	-	-	-	-	3.5	2.8	3.8	2.7	-	-	-	-	-
Second ocean year	-	19.8	17.9	17.2	13.8	15.1	11.7	13.8	10.4	-	17.3	13.6	-	14.4
Third ocean summer	-	-	-	-	-	-	7.9	-	6.4	-	-	-	-	-
Third ocean winter	-	-	-	-	-	-	2.8	-	2.6	-	-	-	-	-
Third ocean year	-	-	10.4	-	9.2	-	10.7	-	9.0	-	-	10.3	-	-
Portion of last ocean year	14.6	7.4	5.5	6.6	3.5	6.6	4.7	5.2	4.1	14.4	6.5	6.3	13.2	5.1
Total average length:	50.0	59.0	65.0	61.2	61.3	53.5	57.8	55.8	57.6	51.4	56.4	62.0	51.3	56.6

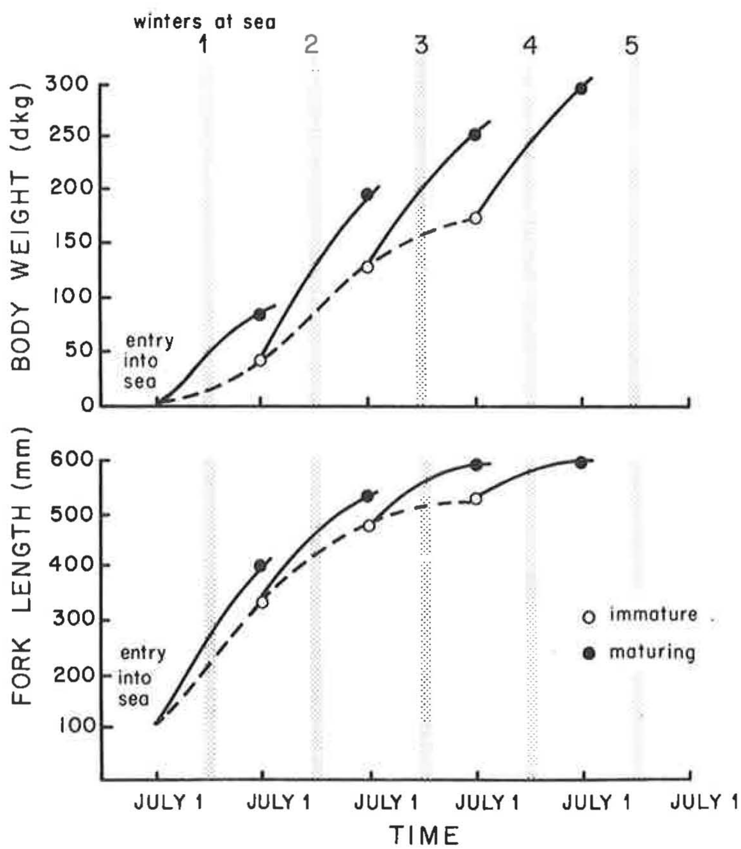


Figure 3.23.—Estimated mean body lengths and weights of sockeye salmon on July 1 (Lander et al., 1966). Connecting lines indicate related stages, not actual growth.

Mortality of Pacific salmon is almost always expressed in terms of the freshwater and marine phases of life. It is important to understand, however, that the so-called "marine" phase actually includes the seaward migration--which rightfully belongs in the freshwater phase. This rather unwieldy and misleading grouping develops becasue seaward migrants are usually enumerated (and mortality calculated) at points far upstream from the ocean--where streams are small and where the subpopulations under study have not yet become intermixed with other subpopulations. Except for certain unique situations such as exist in the Snake and Columbia Rivers, where the mortality of seaward migrants has been studied extensively in conjuction with dams, there is little information on mortalities incurred while young salmon are migrating seaward.

It has been widely documented for sockeye salmon, nonetheless, that even when losses suffered during seaward migration are attributed to the marine phase, the losses sustained in fresh water (in absolute terms) are many times those in the ocean.

Foerster (1968) expressed this in the following hypothetical mortality table:

(A)	Loss during upstream migration	5% of egg potential
(B)	Loss during spawning and incubation	50% of remaining eggs
(C)	Loss during emergence from the redds and migration into the lake	75% of remainder
(D)	Loss during lake residence	92% of remainder
(E)	Natural mortality in ocean (including seaward migration)	90% of remainder

Thus, seaward migrants constitute only 0.95% of the eggs that had been carried back to fresh water from the ocean by the parent generation (A-D above). Or, expressed in terms of potential egg deposition of the spawners actually reaching the spawning grounds (B-D above), natural survival would be 1.0% by this model; natural mortality would be 99.0% by the time the fish departed for the ocean.

In the natural environment there are, of course, wide fluctuations in egg-migrant survival--depending on the location, year and particular conditions encountered. Foerster (1968) reported the following minimum and maximum egg-migrant survival rates for several North American rearing areas (survival being the complement of mortality or 1-mortality):

Area	Egg-migrant survival (percent) Minimum	Maximum
Cultus Lake, B.C.	0.86	7.78
Port John Lake, B.C.	0.50	5.50
Lakelse Lake, B.C.	0.40	8.40
Babine Lake, B.C.	0.50	5.90
Chilko Lake, B.C.	2.58	6.74
Little Kitoi Lake, Alaska	1.98	8.52

Percentage survival during the marine phase of the sockeye's life is greater than that during the freshwater phase but is still not without variability both between and within river systems (Table 3.6).

Table 3.6.--Estimated percentage ocean survival of sockeye salmon based on the estimated number of seaward migrants and returning adults. (Adapted from Foerster, 1968.)

Area	Including catch	Excluding catch
Bare Lake, Alaska	4.9	-
Chilko Lake, B.C.	9.6	-
Karluk Lake, Alaska		
Age 2. smolts	17.4	-
Age 3. smolts	25.7	-
Babine Lake, B.C.		
1946-48	1.8	-
1955-58	4.6	-
Cultus Lake, B.C.	3.5	-
Port John Lake, B.C.		
1949	-	3.1
1948-56	-	8.4

Ricker (1976) in his review of earlier studies on the ocean growth and mortality of sockeye salmon estimated the potential gain that would accrue from coastal fisheries as opposed to oceanic fisheries. If North American sockeye that are presently intercepted by Japan's high seas fisheries were harvested instead by conventional coastal fisheries, the gain in weight would be 76% of the total presently taken on the high seas. This potential gain is in addition, of course, to the gains that might be brought about by the (inshore) management agencies, ability to manage the runs on a river by river basis.

3.2.3.2 Pink Salmon

Characteristics of marine growth of pink salmon are provided by studies of LeBrasseur and Parker (1964) who determined the lengths and growth rates for a stock of central British Columbia pink salmon at various stages throughout their life at sea (Table 3.7). They recognized three major periods of growth. In the first period, the initial 40-days of ocean residence, growth rate was highest with length increasing from 3.5 to 8.4 cm. Thereafter growth gradually declined to a minimum in March with lengths increasing in this period from 8.4 to 32.5 cm. The final period was marked by a rapid rate of growth in spring followed by a declining rate after the fish had reached coastal waters and entered the coastal fishery. LeBrasseur and Parker concluded that for this particular stock, growth was a continuing process with no complete cessation at any time during the period of ocean residence.

Table 3.7.--Growth of pink salmon during its sea life (adapted from LeBrasseur and Parker, 1964).

Days after entrance into the sea	Date	Length (cm)	Stage of sea life
0	April 20	3.5	
			Initial period near estuary
30	May 20	6.1	
			First summer at sea
150	September 17	15.7	
			Fall and early winter
270	January 15	27.4	
			Late winter
360	April 15	35.0	
			Spring
420	June 14	46.4	
			Return to inshore waters and entry into fishery
480	August 13	51.9	

Because of their small size when they move to the sea, mortality of pink salmon is especially severe during the brief freshwater and early marine phases of life--greatly exceeding that occurring later. Parker (1968) estimated that losses of pink salmon average 2-4% per day during the initial 40 days of sea life and 0.4-0.8% per day for the remaining period of ocean residence. Using data from a second stream, Parker (1962) estimated the mortality of pink salmon by stage of life (Table 3.8). As with chum salmon mortality of pink salmon was highest during the juvenile coastal period and next highest during the egg to fry stages in fresh water. Mortality was lower later.

Table 3.8.--Estimated mortality for pink salmon from Hook Nose Creek, British Columbia, during various life stages (adapted from Parker 1962).

Life history stage	Months	Survival Percent
Egg - fry	7	7.8
Coastal (juvenile)	5	5.4
Pelagic	10	84.4
Coastal (adults)	2	93.0
Fishing	--	35.0
Total	24	0.12

The rapid growth of pink salmon in their last few months at sea results in yields being much higher to a coastal fishery than an offshore fishery that takes fish prior to their reaching maximum size. Ricker (1976) has estimated gains in yield to a coastal fishery as 49% for Bering Sea and 163% for British Columbia pink salmon over that realized by an offshore fishery which takes the fish prior to May 1. The increase in yield would be even higher (by about 1/3) if noncatch losses were accounted for--such as losses caused by predators removing fish from the nets and by dead or injured fish dropping out of the nets before they are retrieved.

3.2.3.3 Chum Salmon

Chum salmon fry range from about 3 to 5.5 cm in length when they enter estuaries and from 10 to 15 cm when they enter the ocean proper. By September the fish generally average 17 to 22 cm (Hartt and Dell, 1973). The size of chum salmon on July 1 at successive life history stages (Figure 3.24) shows that the percentage increment in both length and weight is greatest during the first year at sea and then diminishes in subsequent years. Immature fish are smaller than maturing fish at a given age. Chum salmon, from their small size when they enter the ocean, may grow as large as (roughly) 60 cm and 2.5 kg at maturity.

Seasonally, the ocean growth of chum salmon is greatest during the summer. During the last summer at sea the fish continue to grow rapidly--growth being greater in the final one to three months than in the months immediately preceeding (LaLanne, 1971).

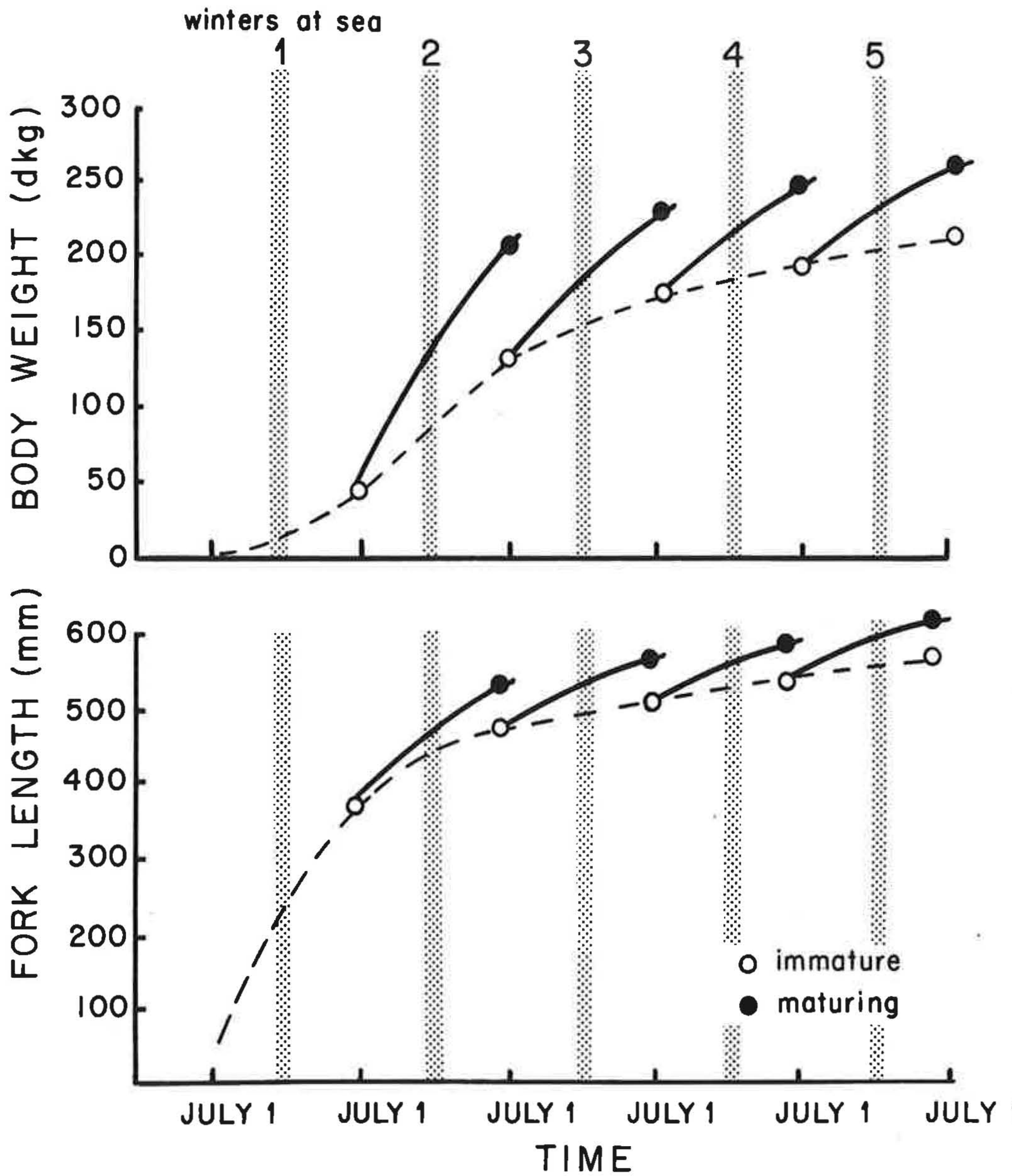


Figure 3.24.--Estimated mean body lengths and weights of chum salmon on July 1 (Lander et al., 1966). Connecting lines indicate related stages, not actual growth.

Parker (1962) estimated total mortality for Hook Nose Creek, British Columbia chum salmon throughout their life history (Table 3.9). Mortality was highest (at least on a per-month basis) during the juvenile coastal period, and next highest during the egg to fry stages in fresh water. Mortality was much lower in the other life stages. Similarly, Levanidov (1964) estimated total marine and freshwater mortality for summer run chum salmon in five Amur River tributaries as follows:

Year	Fry to adult Percent	Egg to adult Percent
1955	98.50	99.98
1956	96.80	99.82
1957	97.10	99.62
1958	98.20	99.82
1960	96.90	99.89
Mean (over 5 years)	97.50	99.79

Table 3.9.--Estimated mortality for chum salmon from Hook Nose Creek, British Columbia, during various life stages (adapted from Parker, 1962).

Life history stage	Months	Survival Percent
Egg - fry	7	7.8
Coastal (juvenile)	5	5.4
Pelagic	34	56.6
Coastal (adults)	2	93.0
Fishing	--	35.0
Total	48	0.08

Fishing mortality has been estimated for a few coastal areas and time periods:

Area	Year(s)	Fishing Mortality Percent	Authority
Amur River (summer fish)	1950-53	50-55	Levanidov (1964)
Japan	1955-58	75	Committee on Biology and Research (1961)
British Columbia			
Central coast	1934-49	40-50	Neave (1966)
Johnstone Strait	1949, 1950, 1953	50-52	Do
Oregon (Tillamook Bay)	1953	39	Oakley (1966)

Ricker (1976) has demonstrated that growth rates considerably exceed any reasonable estimate of mortality in the next to final, and final year of ocean residence. Thus, a fishery that harvests salmon at any time prior to their arrival inshore would markedly decrease the yield over that realized by a coastal fishery. In the case of chum salmon, the increase in yield by taking fish inshore is 156% greater than that for fish taken offshore on May 1 of their final year at sea. These gains are even greater (perhaps doubling in the case of immature fish) if losses caused by the fishing operations, other than the actual catch, are accounted for. These include fish that are attacked by predators while caught in the net, fish that die or become injured and then drop out of the net, and fish that fall out of the net while it is being retrieved.

3.2.3.4 Coho Salmon

Most coho salmon spend about 18 months at sea (a summer, a winter and then another summer) before returning to spawn. During this period they grow more rapidly than other species of salmon including pink salmon whose ocean life is also 18 months, particularly in terms of weight. Lander et al (1966), whose growth data on several species of salmon are depicted in Figure 3.25 for comparative purposes, concluded that the estimated average weight of coho salmon on July 1 of the second summer of life on the high seas was much greater than that of the other species regardless of stage of maturity. All of the coho and pink salmon were maturing by that time, of course; some sockeye were mature, others immature, and all chums taken were immatures. The same general pattern prevailed for lengths but was not as pronounced. Ricker (1976) observed that from April to September of their final season at sea coho increase in weight from an average of 0.8 to 4.0 kg. This spectacular growth is an argument for delaying the opening of the troll fishery off the North American west coast (Loeffel and Wendler, 1969).

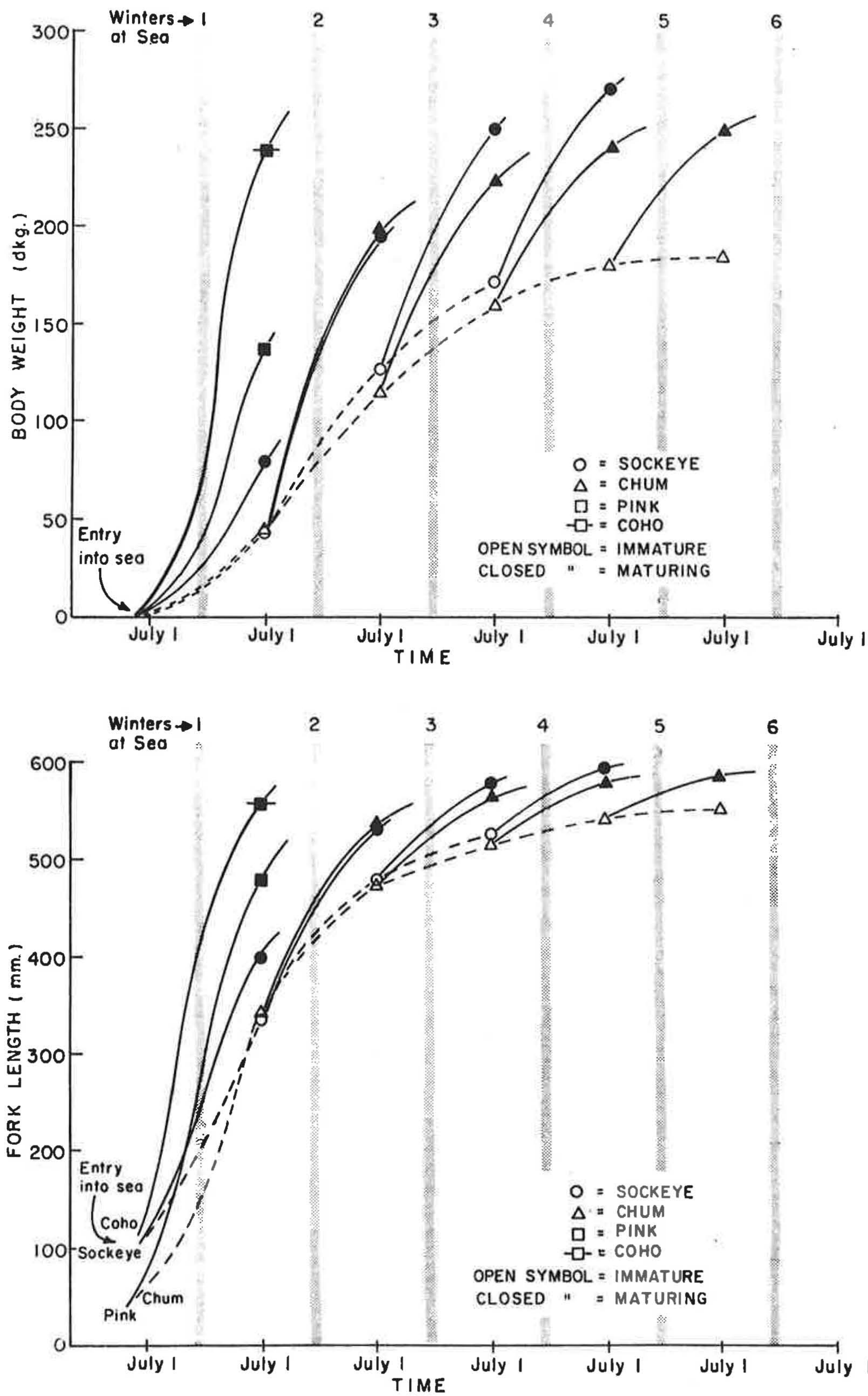


Figure 3.25.—Estimated mean lengths and weights of sockeye, pink, chum, and coho salmon on July 1 (Lander et al., 1966). Connecting lines indicate related stages, not actual growth.

Like other species of salmon, a large part of the loss of coho in streams occurs when the eggs are incubating in the gravel. Summertime stream levels, however, also greatly influence the survival of coho salmon during their year or more of residence in fresh water. Egg-to-migrant survival of coho salmon from several North American streams is shown in Table 3.10.

Table 3.10.--Average freshwater survival of coho salmon from various streams along the Pacific coast of North America, arranged geographically from north to south (adapted from Drucker, 1972).

Stream	Egg to age 1 Smolt survival (Percent)
Nile Creek, B.C.	1.40
Hooknose Creek, B.C.	1.30
Sweltzer Creek, B.C.	0.13 1/
Sweltzer Creek, B.C.	0.33 2/ 3/
Minter Creek, Wash.	3.22
Deer Creek, Oreg.	12.00
Waddell Creek, Calif.	1.35

1/ Before predator fish were controlled.
2/ After predator fish were controlled.
3/ Geometric mean.

Lander and Henry (1973) provided data on the early ocean mortality of coho, estimating that 5-6% of the smolt produced in Columbia River hatcheries in brood years 1965 and 1966 survived until the onset of ocean troll fishing, 13.5 months after release.

Ricker (1976) concluded that mortality caused by trolling averages about one fish killed (mostly sub-legal size) for every two that are boated.

3.2.3.5 Chinook Salmon

Loeffel and Wendler (1968) used the research of Rich (1925), Van Hyning (1951), Fraser (1917, 1921), Parker and Kirkness (1956), and Milne and Godfrey 3.6/ to derive a general growth curve for chinook salmon taken southward from southeastern Alaska (Figure 3.26). They develop separate curves for ocean-type and stream-type fish. This approach, as Loeffel and Wendler (1969) emphasized, provides an approximation of the growth curve but cannot be regarded as precise, mainly because in each curve different stocks are included. They felt, nonetheless, that the curves provide evidence that both ocean-type and stream-type fish put on most of their growth in the spring and summer months, and that the rate of increase in length slows with age. They suggest, too, that ocean-type chinook gain an early growth advantage over stream-type chinook of 10-13 cm (4-5 inches) that is gradually overcome with increasing age.

3.6/ Milne, D.J. (Prepared by H. Godfrey) 1964. Sizes and ages of chinook *Oncorhynchus tshawytscha* and coho *O. kisutch* salmon in the British Columbia troll fisheries (1952-1959) and the Fraser River gillnet fishery (1956-1959). Fish. Res. Bd. Can., Ms Rep. 776: 43 p.

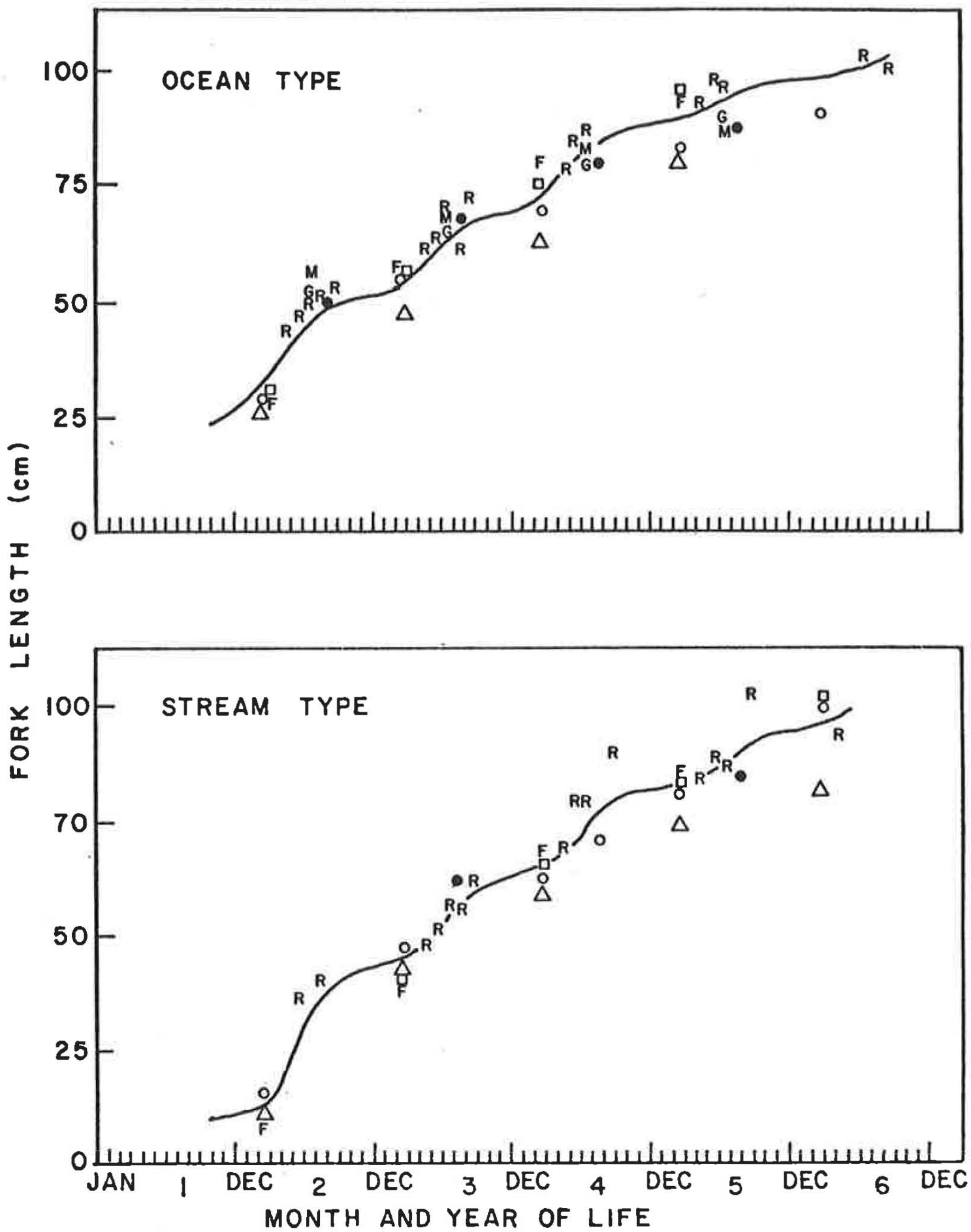


Figure 3.26.--Composite growth curves for North American chinook salmon (adapted from Loeffel and Wendler, 1969). Symbols and related references are as follows: triangles--Parker and Kirkness (1956), area 1: open circles--Parker and Kirkness (1956), area 2; F--Fraser (1917); squares--Fraser (1921); M--Milne, area 1; G--Milne, area 2 (see text footnote 3.6); R--Rich (1925); and darkened circles--Van Hyning (1951).

Ricker (1976) reported that the growth rate of chinook salmon during their final year or months in the ocean was the slowest of all species of Pacific salmon found in North America.

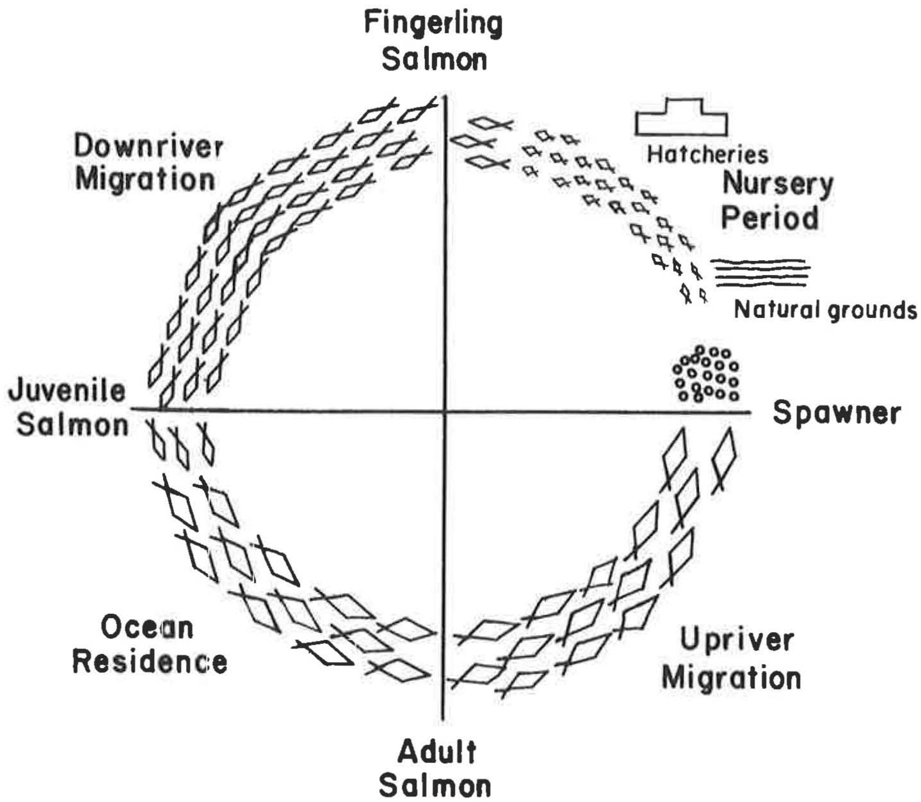
Compared to other species of salmon, there is only scanty information on the egg-to-migrant survival of chinook salmon. For fall chinook (the seasonal race that is comparable to chum and pink salmon in that the young migrate seaward in their first year), egg-to-migrant survival averaged 14.5% over a 4-year period in Fall Creek, California (Wales and Coots, 1955). This survival rate is higher than that reported for either chum or pink salmon. Similarly, Major and Mighell (1969) reported that egg-to-migrant survival of spring chinook in the Yakima River, Washington averaged 10.7%—again higher than that reported for sockeye and coho, species, like spring chinook, that spend a year or more in fresh water before migrating seaward. In both studies, however, seaward migrants were counted at a location that was several hundred km from the sea and they would, therefore, have faced additional mortality enroute to the ocean. Recent studies on the Snake and mid-Columbia Rivers have shown, furthermore, that mortalities sustained by upriver populations of salmon as they migrate seaward via the main trunks of their river systems are intensified by the presence of dams along the migration routes.[3.7/]

Parker (1962) reports that after the initial period of high loss, annual survival (excluding the effects of fishing) of tagged chinook salmon in southeastern Alaska was about 66%. The general order of magnitude was 73% for all 5 species of salmon for which data were analyzed. Natural ocean mortality of chinook salmon, he concluded, is relatively constant. Ricker (1976) estimated that mortality caused by trolling for chinook averages about one fish killed for every two that are boated. He tentatively estimated, furthermore, that the increase in weight of the total catch from discontinuing ocean trolling for Columbia River chinook salmon and increasing river fishing correspondingly would be between 63 and 98%.

3.2.4 Ecological and Community Relationships

Because of the complexities inherent in dealing with 5 species and innumerable subpopulations of a group of anadromous fishes, some selectivity is called for in describing the ecological and community relationships involved. Although the freshwater phase of the salmon's life has, for obvious reasons, been much more thoroughly studied than the marine phase, information presented in this, the final section of this review, will deal fairly equally with each phase. There has also been occasional reference to ecological and community relationships in the earlier sections, particularly those on reproduction and growth and mortality.

3.7/ Raymond, H.L. 1977. Effects of dams and impoundments on seaward migrations of juvenile chinook salmon and steelhead trout from the Snake River, 1966-75. U.S. Dep. Commer., Natl. Ocean. Atmos. Admin., Natl. Mar. Fish. Serv., Northwest and Alaska Fish. Center, Seattle, Wash. Unpubl. manuscr.



THE LIFE CYCLE OF THE PACIFIC SALMON

3.2.4.1 Freshwater Phase

The freshwater residence of Pacific salmon embraces three distinct life history stages, (1) the upstream migration and spawning of the adult fish, (2) the incubation, hatching and subsequent lake and/or stream residence of the young fish and (3) seaward migration. Much of the material presented here is from Foerster's (1968) treatise on sockeye salmon but is applicable in a general way to other species of salmon as well.

Adult salmon, according to Foerster (1968), are directly preyed upon in fresh water by harbor seals, bears, gulls and man. Also, man's deterioration of the environment impacts adversely on adult salmon although through such activities as stream clearance and the construction of fishways into previously inaccessible areas, man's activities can be beneficial. High water temperatures, high carbon dioxide levels, disease and parasites are other factors mentioned by Foerster as adversely affecting adult salmon.

Losses also accrue during the spawning and embryonic stages of the reproductive cycle. Overcrowding on the spawning grounds--either by members of the same species or other species of salmon--is an initial source of mortality in this stage. Females arriving late on the spawning grounds under circumstances of overcrowding either superimpose their eggs on existing redds (destroying embryos in the process), they utilize marginal spawning areas where survival is poor, or they may fail to deposit all of their eggs. Extraordinary numbers of decaying carcasses can also deplete oxygen supplies to the redds in areas of overcrowding, leading to the loss of embryos. Scouring or exposure of the redds resulting from extreme water levels are other sources of loss during the incubation period.

Following the emergence from the gravel the young fish, in addition to being subjected to the vicissitudes of the physical environment, also become players in a complex predator-prey relationship in which they are simultaneously predators, competitors, and the objects of predation. Food items consumed by salmon in fresh water vary with stage of life and species but are known to include larvae, many forms of zooplankton, insects, and small fishes. Principal competitors are salmon (of the same or other species) and other small resident fishes. Commonly mentioned predators are char (genus Salvelinus), trout, northern squawfish (Ptychocheilus oregonensis), sculpins (genus Cottus), young salmon themselves (primarily coho but also sockeye and chinook), kingfishers, and certain types of fish-eating ducks.

Neave (1953) classified salmon mortalities into 3 categories--those which are density dependent, those which are inversely related to density, and those which are independent of density. Density dependent mortality operates through competition for some limiting environmental feature (such as suitable redd-building sites or food items). Its influence becomes progressively worse as population density increases and tends to adjust the population to an optimum (Parker, 1962). Mortality inversely related to density has the opposite effect in that losses are proportionately higher on small populations. In years when young salmon are abundant, for example, predators may become satiated with food and consume a lower proportion than in years of low abundance. This type of mortality may stabilize a population at a low level after it was brought there by other factors and may account for the cyclic dominance observed in some stocks. The final type of mortality is independent of density and is caused by fluctuations of the environment. A rock slide impeding upstream migration, for example, can eliminate a fraction of a population regardless of its size.

Raymond (ms, 1977 [see footnote 3.7]) points out that populations of young salmon migrating seaward past a series of dams in the Snake and mid-Columbia Rivers are affected adversely not only by the physical aspects of the dams (mortalities sustained while passing through turbines, for example) but may be further reduced by mortalities brought about by nitrogen supersaturation. Furthermore, the fish are often delayed as they pass through slow-moving waters impounded behind the dams, thereby increasing their exposure to predation and other sources of mortality.

STREAM CLEARANCE

BEFORE AFTER

(Photos: Wash. Dept. Fish.)

3.2.4.2 Marine Phase

While at sea, salmon inhabit the subarctic region of the North Pacific Ocean--an area characterized by relatively low salinity in the upper layers occupied by salmon. There is no evidence that the distribution of the species is influenced by the rather small variability of salinity within this region (Figure 3.27).

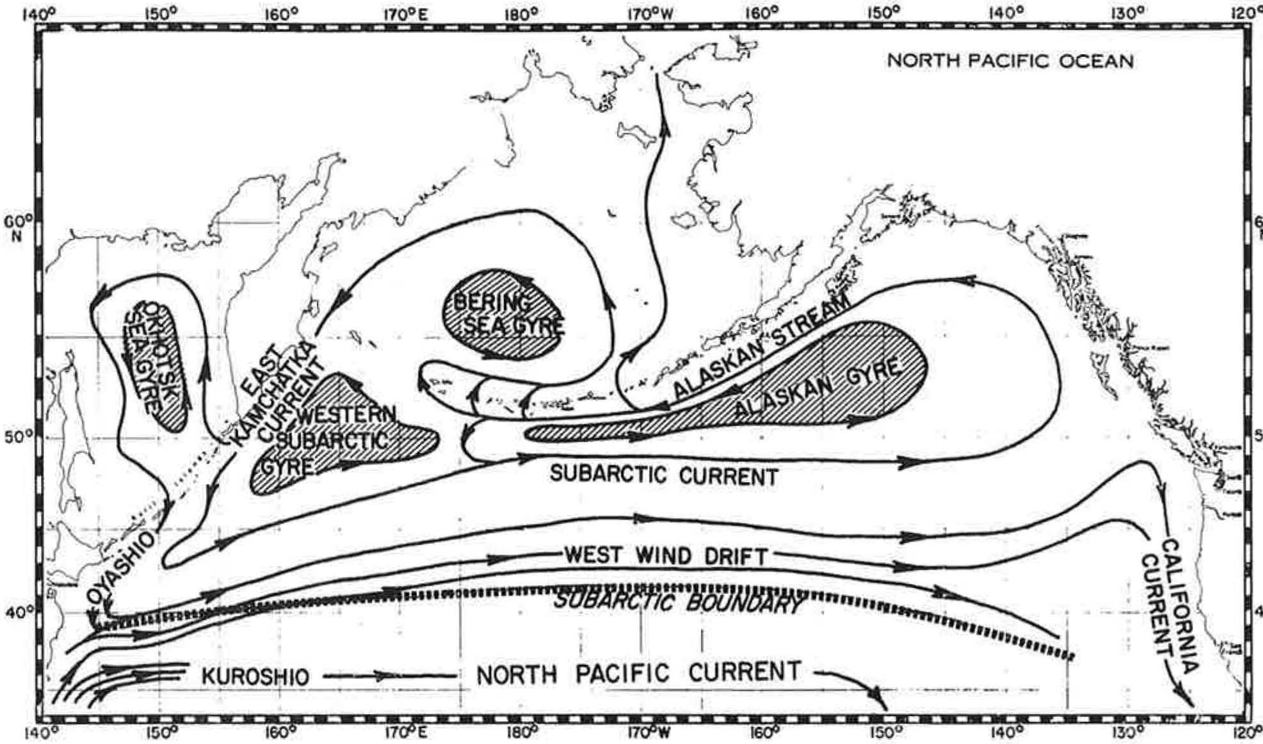


Figure 3.27.--Schematic diagram of surface circulation in the Subarctic North Pacific (Dodimead, Favorite, and Hirano, 1963).

The dominant feature of surface circulation in the subarctic region is an easterly flow along its southern boundary and a return westerly flow just south of the Alaska Peninsula and Aleutian Islands. These currents play a major role in creating an environment and a climate in which salmon can live but there is little evidence that the distribution of salmon is determined by strict adherence to, or avoidance of, particular ocean currents.

Salmon at sea are encountered at temperatures ranging from 1°C to 15°C but are most frequently encountered at temperatures from 2°C to 11°C (Manzer et al, 1965; Major et al, In Press). The seasonal shifting of salmon distributions southeastward in winter and northwestward in summer is an apparent response to warming and cooling of surface waters. The effect, however, may be indirect--possibly through control of the location and abundance of food organisms.

The food items consumed by salmon in the ocean vary by stage of life, species, season, area and even individual fish. Juveniles in inshore areas take mostly food organisms in the classes crustacea and insecta (and small fishes) while the diet of larger fish on the high seas expands to include as many as 40 types of food organisms (Andrievskaya, 1958). Various investigations have shown the 3 main types of food are zooplankton, squid and fish in no particular order. Availability rather than choice seems to have the greatest influence on the major categories of food consumed (French et al, 1976; LeBrasseur, 1966). Pink and sockeye salmon are similar in their feeding habits--both tending to take a higher proportion of smaller food items than chum, chinook and coho (Andrievskaya, 1958; Maeda, 1954). Ito (1964), however, found that the composition and weight of stomach contents of pink and coho salmon differed for even- and odd-numbered years. Generally, fish and squid are prominent in even-numbered years; zooplankton in odd-numbered years. French et al (1976) reported, furthermore, that relative amounts of the various types of zooplankton consumed (calanoids, euphausiids, amphipods, copepods, etc.,) is highly variable. Machidori (1972a; 1972b) observed that over a fairly limited time span and geographic range (mid-June to early July, 1967 at about 174°-178°E and 44°-47°N) there was a sharp north-south gradient in the quantity (by weight) of food in the stomachs of coho salmon. Stomachs were fuller to the north, where surface temperatures were cooler (9°C and lower approximately), and contained appreciably less food (with few squid, but more fish, euphausiids and pteropods) to the south where surface temperatures were higher. He noted too, that high and similar CPUE's for coho occurred in different ocean domains (Dodimead et al, 1963), and his data indicate that relatively good catches of coho, and coho with greater stomach contents, were associated with surface temperatures of a limited range rather than with particular domains or their locations.

Asian pink salmon, because of the great disparity between the size of the even-year and odd-year cycles, have been studied by several authors to examine questions of interspecific and intraspecific competition. On the matter of interspecific competition, Grachev (1967) reported that when eastern Kamchatkan pink salmon were present in the ocean in high-cycle (odd-year) abundance, first and second-year Kamchatka River chinook salmon attained less growth than in years when the pinks were at low-cycle abundance. That chinook salmon in their third and fourth year in the ocean were not similarly affected was attributed to the fact that the older (larger) chinook take different food items than the smaller pink salmon and, as a result, are not in competition with them.

On the question of intraspecific competition, Semko (1939) demonstrated that an inverse relationship existed between the average size and the abundance of western Kamchatkan pink salmon (Figure 3.28). Without exception, the average size was small in years of high abundance and large in years of low abundance. Semko (1954) also summarized changes in body length of Bolshaia River pink salmon over a period of 20 years (Table 3.11) and concluded that the observed inverse relationship between population size and body length was caused by differences in the suitability of the ocean feeding grounds--that in years of high abundance, more and more fish were obliged to forage in areas of marginal productivity.

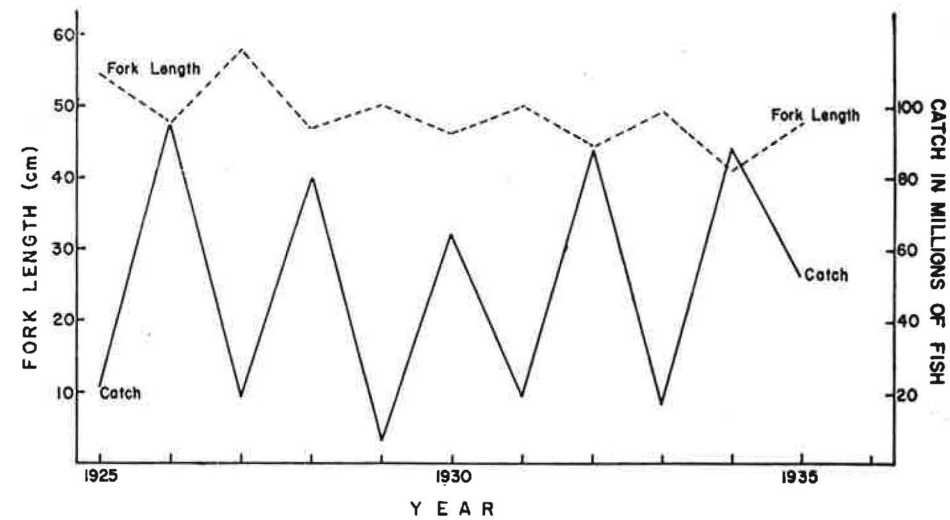


Figure 3.28.--Comparison of the catch and fork length of western Kamchatkan pink salmon (Semko, 1939).

Table 3.11.--Fluctuations in the length ranges of west Kamchatkan pink salmon of "big" and "poor" years (Semko, 1954).

	Overall range in body length (cm)		Range of main* group (cm)	
Sex	"Big" year	"Poor" year	"Big" year	"Poor" year
Males	34-59	37-63	41-56	45-59
Females	36-52	40-55	41-51	43-52
Both sexes	34-59	37-63	41-56	43-59

*Fish of all size classes which comprise separately not less than 1% of the population.

Godfrey (1959) made similar comparisons for salmon taken in British Columbia (1944-58) and reported that odd-year pinks were invariably larger than those of the even-year cycle. That the odd-year cycle is also consistently the more abundant of the two cycles, suggests that the observed variation is not associated with abundance but brought about, rather, by genetic influences including the possible utilization of different ocean feeding areas.

Pacific salmon are by far the most abundant group of fishes inhabiting the epipelagic zone of the subarctic region of the North Pacific Ocean. Other than salmon only 37 species of fish have been reported in gillnet surveys in the epipelagic zone and these have been present in much smaller numbers and more limited range than salmon (Larkins, 1964). Only six species (albacore tuna, Atka mackerel, salmon shark, jack mackerel, Pacific herring and pomfret) could be classified as abundant and then only in some limited parts of the salmon's distribution.

Within the subarctic region, the relative abundance of the 5 species of salmon themselves is best expressed in terms of the western region (where Asian fish predominate) and the eastern region (where North American fish prevail). Major et al (In Press) reported that samples from the mothership fishery and Japanese research vessels (fishing mostly in the western Pacific in 1962-70) were composed of 62% pink, 27% chum, 8% sockeye, 3% coho and less than 1% chinook salmon. These percentages were very similar to those reported for the Asian commercial catches from 1952-75--64% pink, 24% chum, 8% sockeye, 3% coho and less than 1% chinook salmon. North American commercial catches, which would be more indicative of the composition in the eastern Pacific, were composed of 48% pink, 25% sockeye, 12% chum, 10% coho and 4% chinook salmon. These percentages represent overall averages, of course, and would be expected to vary from year to year if cyclic abundance--particularly the cyclic abundance of Asian pink salmon were taken into account.

Predation, although it is probably the principal cause of mortality for salmon at sea, has not been widely studied. Salmon (mackerel) sharks do appear to be a major predators, however. Sano (1959, 1960) reported that of 248 salmon sharks taken in gillnets fished by Japan's high seas fleet in 1959, 70% had fed on salmon, with sockeye having been the species most frequently consumed followed by pink and chum salmon. The humpback and killer whales are other predators on the high seas (Tomilin, 1957). Closer to shore, salmon are the victims of beluga whales, harbor and fur seals, and sea lions.

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4.0 DESCRIPTION OF THE HIGH SEAS SALMON FISHERIES OF JAPAN

Japan presently has two high seas salmon fisheries in the North Pacific Ocean, a mothership (factoryship) gillnet fishery and a landbased driftnet fishery. Both fisheries began in 1952. Japan also has two high seas salmon fisheries in the Japan Sea, a gillnet fishery and a longline fishery. From 1952 through 1971, there was a third Japanese high seas salmon fishery in the North Pacific Ocean, a landbased longline fishery which operated off northern Japan to 160°E (1952-70) or 165°E (1971). For a short period in the 1950's (1955-58), Japan had a mothership salmon fishery in the Okhotsk Sea. During the 1930's and early 1940's, there was a Japanese mothership gillnet fishery for salmon just outside the territorial seas off the Kamchatka Peninsula and a landbased driftnet fishery that operated up to 50 miles offshore from the northern Kurile Islands. Thus, over the years, there have been several Japanese high seas salmon fisheries. Only the first two fisheries mentioned, however, are described in detail in this report.

4.1 Operational Characteristics

4.1.1 Areas of Operation

The areas fished by the North Pacific mothership gillnet fishery during 1959-76 and the landbased driftnet fishery during 1952-76 are shown in Figure 4.1. For several years prior to 1959 the mothership fishery also operated off the southeast coast of Kamchatka between 155°E and 160°E. In 1977, all waters inside a 200-mile line off the coast of the U.S.S.R. were closed to Japan's high seas salmon fisheries.

Waters indicated as Areas A and B in Figure 4.1 were so designated by the Japanese-Soviet Northwest Pacific Fisheries Commission which was established under the Japan-U.S.S.R. Fisheries Treaty for the Northwest Pacific Ocean, signed in 1956. The eastern boudaries of the fishing areas--175°W in the Bering Sea and 175°20'W in the North Pacific Ocean--represent the provisional abstention lines established by the International Convention for the High Seas Fisheries of the North Pacific Ocean, a convention signed by Canada, Japan and the United States in May 1952 and which entered into force in June 1953. Other boundaries were agreed upon by Japan and the U.S.S.R.

Within the landbased driftnet fishing area, small vessels (less than 7 tons) are licensed to fish only as far east as 147°E or 149°E. Larger vessels (40-90 tons) are licensed to fish east to the abstention line.

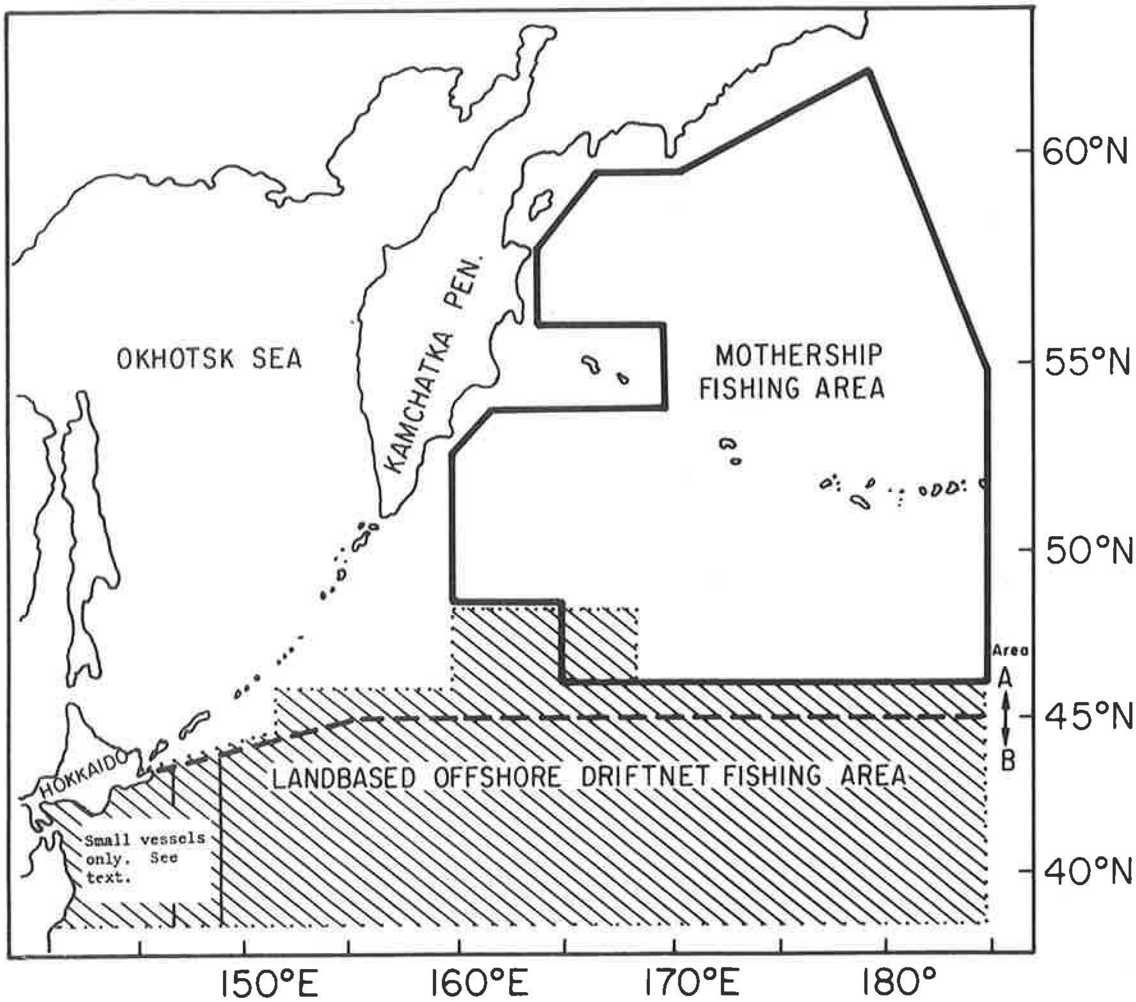


Figure 4.1.--Areas fished by the Japanese mothership salmon fishery, 1959-76, the landbased offshore driftnet fishery, 1952-76. Source of information: Fisheries Agency of Japan (personal communication).

4.1.2 Fishing Seasons

The fishing season for the mothership fishery has usually begun around May 20 and ended shortly after July 20. Before 1959, the fleet started fishing in early or mid-May and occasionally fished until late August. In 1960 and 1963-64, the motherships fished into early August. The land-based driftnet fishery has usually begun in early May, with the vessels restricted to Area B until the catch quota for that area was attained, or June 30, whichever came earlier. After that time, the vessels fished in that portion of Area A open to the fishery.

In 1977, because of lengthy negotiations between Japan and the U.S.S.R. on salmon catch quotas and other matters, the mothership and landbased driftnet fisheries did not commence fishing until almost the end of May.

4.1.3 Fishing Operations

4.1.3.1 Mothership Fishery 4.1/

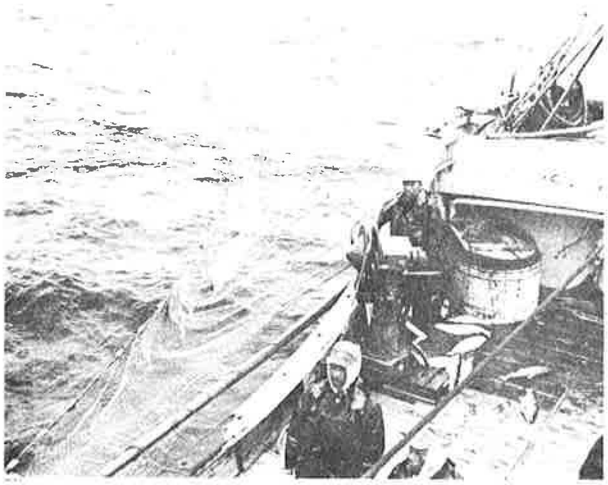
The mothership salmon fleet, which consisted of 6 motherships and 245 catcher-boats in 1977 (as compared to 10 motherships and 332 catcher-boats during 1972-76) departs for the fishing area from Hokkaido a week or so before the start of the season. The motherships range from 8,000 to 14,000 tons, have an overall length of 120 to 184 meters, are powered by engines of 5,000 to 7,600 hp, and carry crews of 300 to 350 to process the catch. Most of the salmon are canned but some are frozen. Each mothership has 1 or 2 canning lines, with a line capacity of 180 to 250 cans per minute. The processed products are transported to Japan by cargo and supply ships during the season. In 1977, each mothership was accompanied by approximately 40 catcher-boats (as compared to 32-34 catcher-boats per mothership in 1972-76). The catcher-boats have steel or wooden hulls, range from 75 to 100 net tons, are powered by diesel engines of 270 to 450 hp, and carry crews of 20 to 22 fishermen per boat.

The companies invloved in the fishery have divided the mothership fishing area into 169 blocks, the average size of which is about 14,250 square km--110 km (69 statute miles) north to south and 130 km (80 statute miles) east to west. On a given day, only those catcher-boats assigned to a particular mothership are permitted to occupy a specified block plus one-half of an adjacent block. Intention to fish in a certain block is communicated to one of two motherships which rotate as coordinators of fleet operations. In 1977, all blocks or portions thereof lying within 200 miles of the U.S.S.R. coast were closed to the mothership fishery.

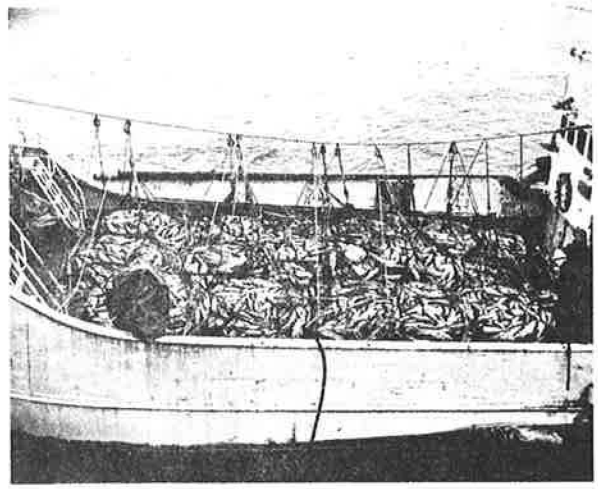
The deployment of catcher-boats is controlled by the director of fishing operations aboard each mothership. Four of the catcher-boats from each mothership are used as scouting vessels to search for concentrations of salmon, usually at some distance and in various directions from the mothership (but not in blocks occupied by catcher-boats from other motherships). The remaining catcher-boats are assigned fishing stations in a block, there being 40 such stations per block. All catcher-boats are required to unload catches at the motherships every day, except under unusual circumstances such as mechanical failure and stormy weather. Generally, catcher-boats assigned to stations closest to the mothership on one day are the first to unload their catches and have the most time for running, hence are assigned stations farthest from the mothership the following day.

4.1/ Much of the information on vessels, fishing operations and gear in the mothership fishery is taken from Dr. Francis M. Fukuhara's doctoral thesis (unpublished). Other sources of information include Neo (1964), Fredin and Worlund (1974) and Japanese fisheries trade journals.

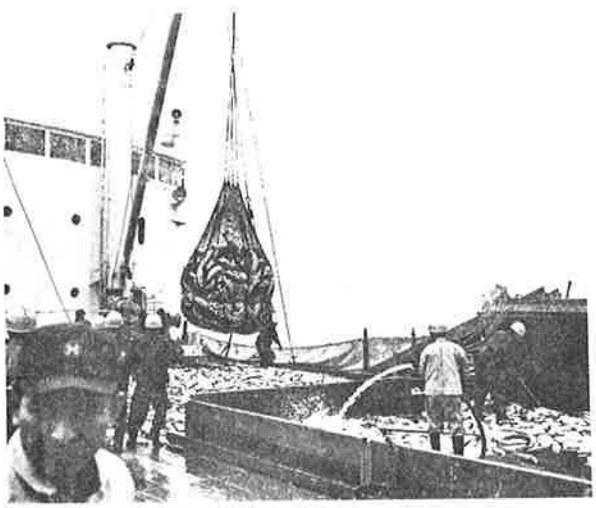
JAPANESE HIGH SEAS MOTHERSHIP SALMON FISHERY



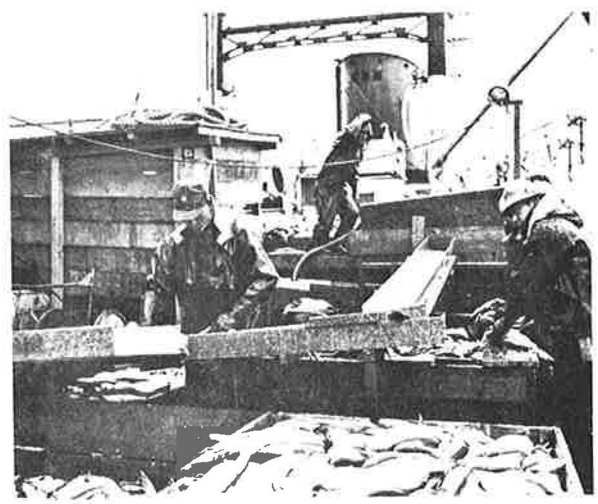
Taking in gillnets



Salmon ready for delivery
to factoryship



Transfer of salmon
to factoryship



Cleaning salmon aboard
the factoryship

(Photos: Chitwood, NMFS)

Details as to netting, net length and mesh sizes used in 1977 are not known, but historically the catcher-boats used monofilament gillnets and each was allowed to fish 16.5 km (10.2 statute miles) of net each day in waters east of 170°25'E or between 165°E and 170°25'E south of a line connecting 47°N and 48°N (Figure 4.2). In such waters, up to 60% of the net's length could be of 121 mm (4.8 inches) mesh, stretched measure, with the remaining 40% being 130 mm (5.1 inches) mesh. In the other part of the mothership area, the maximum length of gillnet that a catcher-boat was allowed to fish each day was 13.2 km (8.2 statute miles), with no more than 40% of the net having 121 mm mesh. 4.2/

The setting operation, which takes place in late afternoon, requires about 2 hours. Hauling, which usually begins shortly after midnight, takes 4-6 hours. Actual fishing time ranges from 9-12 hours or more. On a given day, the present fleet (245 catcher-boats) is capable of fishing 3,200 to 4,000 km (2,000 to 2,500 statute miles) of gillnet, depending on the distribution of the motherships in the area.

4.1.3.2 Landbased Driftnet Fishery 4.3/

Two substantially different categories of vessels make up the landbased driftnet fleet, those that are less than 7 tons and those that range from 40 to 90 tons. Vessels under 7 tons far outnumber the larger vessels. In 1975, for example, there were 1,120 of the smaller vessels as compared to 371 vessels in th 40-90 ton class.

The smaller vessels operate out of numerous ports on the east coast of Hokkaido and northern Honshu. Approximately two-thirds of them (729 vessels out of 1,120 in 1975) are licensed to fish to 147°E, with the remaining one-third licensed to fish to 149°E. Most of the vessels, however, remain much closer to shore and make trips of 1 or 2 days. Catches, which amount to 10-15% of the total taken by the larger vessels, are generally landed fresh.

The larger vessels in the fishery operate out of the same ports as the small vessels but fish much farther to the east. Each fishing trip lasts from 2 weeks to a month. Catches are landed either frozen or salted.

4.2/ Fishing effort is measured in units of length called "tans." There are 50 meters in a tan, 330 tans in 16.5 km of gillnet, and 264 tans in 13.2 km of gillnet. Depending on the area fished, 330 or 264 tans represents one day's fishing by a catcher-boat.

4.3/ Information on vessels, operations and gear used in the landbased offshore driftnet fishery was provided by various individuals in the Fisheries Agency of Japan (personal communication).

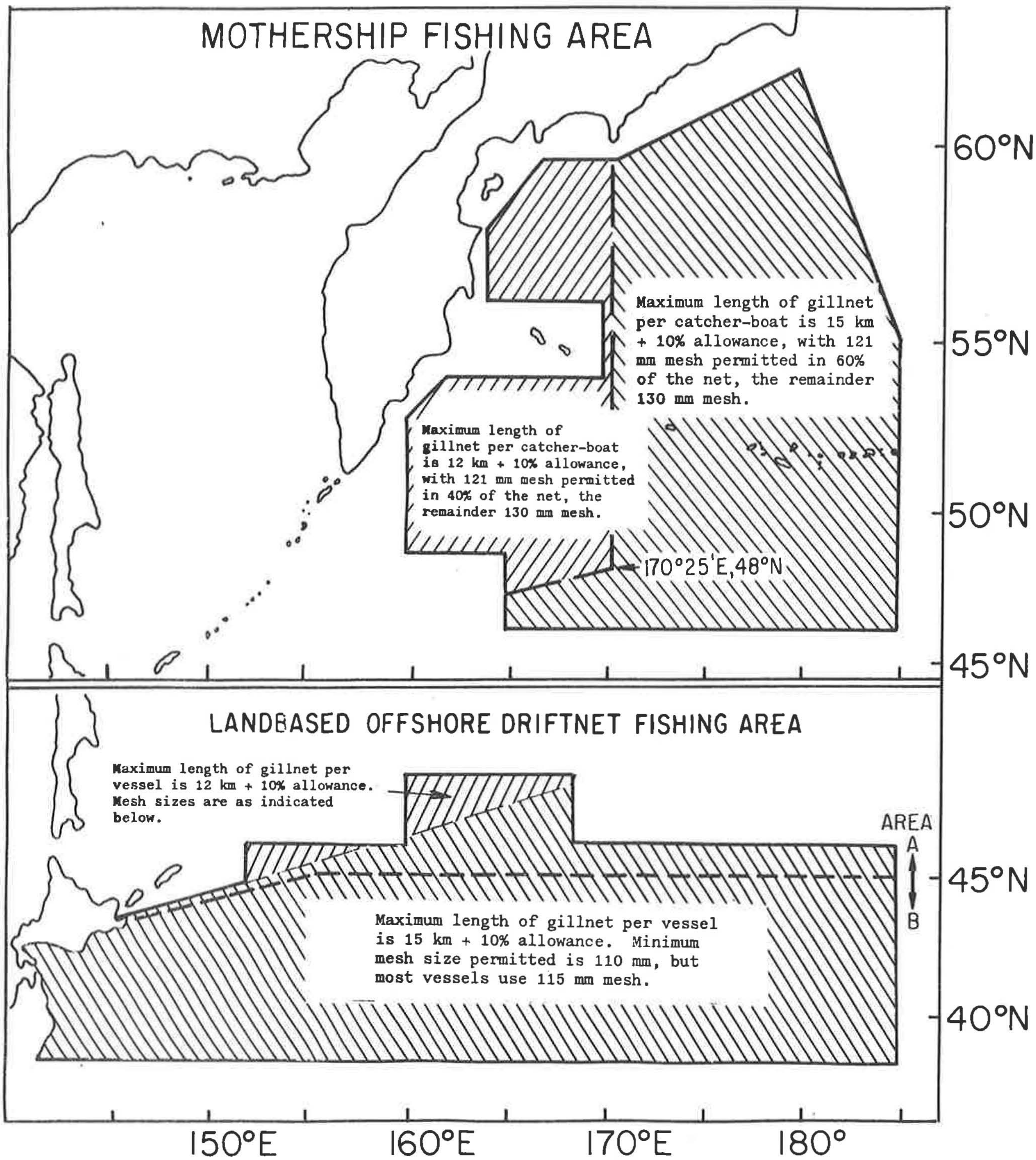


Figure 4.2. Restrictions on the lengths and mesh sizes of gillnets used in the Japanese mothership and landbased offshore driftnet fisheries for salmon. Information source: Fisheries Agency of Japan (personal communication).

4.2 Regulatory History

4.2.1 Domestic Measures (Japan)

4.2.1.1 Licensing

Vessels used in Japan's diverse salmon fisheries (Table 4.1) are licensed by the Fisheries Agency of Japan and appropriate Prefectural Agencies in Hokkaido and northern Honshu. The latter also license the units of fixed gear and certain miscellaneous types of gear used in the coastal fishery. Areas of operation are designated on all licenses. In the case of the mothership fishery, the specific mothership to which a catcher-boat delivers its catches is designated on the license. The catcher-boat cannot deliver its catch to a different mothership.

The numbers of licenses issued for the various salmon fisheries are closely controlled. The philosopy underlying the licensing system has been to hold the total vessel tonnage in a given fishery at a given level; hence as the size of replacement vessels has increased the number of licenses issued for the fishery has been reduced. To cite an example given by the Fisheries Agency of Japan (personal communication): the total tonnage of vessels in the landbased offshore driftnet fishery was fairly uniform during 1970-75 but the size of replacement vessels increased; consequently, the total number of licenses was reduced from 1,713 in 1970 to 1,491 in 1975. Reductions in catch quotas for the mothership and landbased driftnet fisheries, however, have required reductions not only in the numbers of licenses issued but total vessel tonnages in the fisheries.

Table 4.1.--Organization of Japan's salmon fisheries.

Fishery number	Fishery category and components a/	Area of operation b/	Licensing agency c/	No. of vessels licensed in 1975	Catch restrictions d/
1.	Mothership gillnet	No. Pac. Oc. & Bering Sea, to 175°W	JFA	10 motherships 332 catcher-boats	Quota
	Landbased offshore driftnet				
2.	Vessels ≥7 g.t.	No. Pac. Oc., to 175°W	JFA	371	"
3.	" <7 g.t.	" " " to 147°E and 149°E	PG's	729/391 e/	"
4.	Landbased offshore longline	No. Pac. Oc., to 160°E (165°E in 1971)	JFA	-	f/
	Coastal				
	Driftnet				
5.	Vessels ≥30 g.t.	Japan Sea side of Hokkaido and Honshu	JFA	{170}	Quota
6.	" <30 g.t.	" " " " " " "	"		"
7.	" <5 g.t.	Tsugaru Strait, out to 10 km offshore	"	~100	"
	Longline				
8.	Vessels 10-30 g.t.	Japan Sea side of Hokkaido and Honshu	PG's	348	"
9.	" <10 g.t.	" " " " " " "	"	1,814	No Quota
10.	" " "	Pac. Oc. " " " " "	"	139	" "
11.	" <5 g.t.	Soya Strait - Territorial waters	"	g/	" "
	Set net (Trap)				
12.	Salmon, large net	Hokkaido & Honshu - Territorial waters	"	478 h/	" "
13.	Other, " "	" " " " "	"	{6,866} h/	" "
14.	Small net	" " " " "	"		" "
15.	Miscellaneous gear	" " " " "	"	g/	" "

a/ The landbased offshore longline fishery was discontinued after 1971. b/ See Figure 1 regarding Fishery No's. 1-3 and text regarding Fishery No. 4. c/ JFA-Fisheries Agency of Japan; PG-Prefectual Government. d/ Total catch quotas established by the Japanese-Soviet NW Pac. Fish. Comm., allocations by the Japanese Ministry of Agriculture and Forestry. e/ 729 vessels, all under 5 tons, licensed to fish east to 147°E; 391 vessels, 5-7 tons, licensed to fish to 149°E. f/ Formerly had quota. g/ Not available. h/ Number licensed in 1974. INFORMATION SOURCE: Fisheries Agency of Japan (personal communication).

4.2.1.2 Reporting of Fisheries Statistics

Catch quotas and allocations and management of domestic salmon resources make it necessary for the Fisheries Agency of Japan to collect current statistics on catches by the various Japanese salmon fisheries.

In the mothership fishery, Japanese fisheries inspectors receive daily reports of catches (in kilograms) by species, fishing effort (in tans), and fishing position for each catcher-boat. Total daily catches by all of the catcher-boats attached to a mothership are converted to numbers of fish by species using average weights obtained from samples taken by the inspectors aboard the mothership (30 fish of each species per day from each of 5 catcher-boats). The information is transmitted to the Fisheries Agency of Japan. Several months after the end of a fishing season, the Agency has provided to the International North Pacific Fisheries Commission (INPFC) statistics on the numbers of fish caught by species and fishing effort in numbers of tans for each 2° x 5° statistical area and 10-day period. The agency has also provided INPFC with the metric tons of each species taken by the mothership fishery as a whole during each 10-day period.

When the mothership catches are landed in Japan, the Ministry of Transportation of Japan collects data on the numbers of 48-lb cases of canned salmon and cartons of frozen large and small salmon landed.[4.4] This information is given to the Fisheries Agency and serves as a check on the catches reported directly from the motherships.

In the landbased offshore driftnet fishery, each vessel keeps a logbook in which the location, number of tans of gear set, and the number of each species of salmon caught is recorded for each day's fishing. The logbook information is reported to Fisheries Agency inspectors when the vessels land at their home ports. In the case of the smaller vessels (under 7 gt), the time lag between actual catches and reporting of logbook information is only 1 or 2 days. For the larger vessels, however, the time lag might be more than a month. Because of the delay, the Agency uses patrol vessels to make daily estimates of total catches by the larger vessels. The estimates are obtained by counting the number of vessels fishing in an area and applying catch rates for a sample of them to the total. By combining the logbook data for the smaller vessels with the estimates of catches by the larger vessels, the Fisheries Agency obtains daily estimates of cumulative numbers of salmon caught. However, since the catch quotas are set in tons of fish (round weight), not numbers of fish, it is necessary to convert the catches from numbers of fish to tons. Two sources of information are used to make the conversion: data on average weights obtained by the Agency's research vessels operating in the area fished by the larger vessels and fish tickets. The latter are made out by buyers at the time of purchase from the vessels and indicate the kilograms of fish involved in the transactions. Agency inspectors compare the tickets with the numbers of fish recorded in vessel logbooks to obtain estimates of average weights.

4.4/ A carton of frozen large salmon contains 3 or 4 fish, a carton of frozen small salmon approximately 10 fish.

Statistics reported to INPFC for the landbased offshore driftnet fishery have been sadly lacking in detail. Prior to 1970, with the exception of 1962, only the annual catches by small and large vessels combined and monthly catches by the large vessels were reported. No areal breakdown was given. In 1970-73, tonnages of salmon caught monthly by the larger vessels were reported separately for waters east and west of 165°E. Catch and effort data for 1974-75 and also 1962 were reported for the larger vessels by 2° x 5° statistical areas and month. Much more would be known about the operations of the fishery and its impact on North American salmon runs if the catch and effort data had been reported in the same detail as for the mothership fishery.

4.2.2 Japan-U.S.S.R. Fisheries Treaty for the Northwest Pacific Ocean

4.2.2.1 Catch Quotas

The Japanese-Soviet Northwest Pacific Fisheries Commission has set catch quotas for Japan's high seas salmon fisheries since 1957. The Ministry of Agriculture and Forestry of Japan allocates the quotas to various fisheries in Area A, Area B and the Japan Sea. Annual quotas and allocations are given in Table 4.2. Year-to-year changes are depicted in Figure 4.3 for even- and odd-numbered years, the quotas for the two sets of years being different because Asian pink salmon are more abundant in odd-numbered years than in even-numbered years.

Table 4.2.—Catch quotas and allocations for Japanese salmon fisheries, in metric tons, 1957-76 (round weights).

Year	Area A			Area B and Japan Sea a/				Total
	Mothership fishery	Landbased offshore fishery	Total	Landbased offshore longline	Landbased offshore driftnet	Japan Sea gillnet & longline b/	Total	All areas & fisheries
1957	87,000	20,000	107,000		No quota			120,000 c/
1958	85,169	18,333	103,502		" "			110,000 d/
1959	70,834	14,166	85,000		" "			85,000
1960	54,000	13,500	67,500		" "			67,500
1961	53,600	11,400	65,000		" "			65,000
1962	44,665	10,335	55,000		Quota not allocated		60,000	115,000
1963	46,290	10,710	57,000		" " "		63,000	120,000
1964	44,665	10,335	55,000	14,760	37,240	3,000	55,000	110,000
1965	45,478	10,522	56,000	15,700	39,800	3,500	59,000	115,000
1966	38,981	9,019	48,000	12,610	32,390	3,000	48,000	96,000
1967	42,635	9,865	52,500	14,700	37,400	3,400	55,500	108,000
1968	37,763	8,737	46,500	12,180	31,370	2,950	46,500	93,000
1969	40,400	9,350	49,750	14,000	35,450	5,800	55,250	105,000
1970	36,545	8,455	45,000	11,150	28,750	5,100	45,000	90,000
1971	37,357	8,643	46,000	12,300	31,400	5,300	49,000	95,000
1972	35,236	8,174	43,500	e/	38,600	4,900	43,500	87,000
1973	35,732	8,268	44,000	e/	41,800	5,200	47,000	91,000
1974	33,702	7,798	41,500	e/	36,700	4,800	41,500	83,000
1975	34,108	7,892	42,000	e/	40,000	5,000	45,000	87,000
1976	32,484	7,516	40,000	e/	35,400	4,600	40,000	80,000
1977	23,957	5,543	29,500	e/	28,900	3,600	32,500	62,000

a/ Outside territorial waters on both the Pacific Ocean and Japan Sea sides of Japan.
b/ Including the driftnet fishery in Tsugaru Strait (Fishery No. 7 of Table 2).
c/ Includes 13,000 m.t. for the mothership fishery in the Okhotsk Sea.
d/ Includes 6,498 m.t. for the mothership fishery in the Okhotsk Sea.
e/ Fishery discontinued.

DATA SOURCE: Fisheries Agency of Japan (communicated to American Embassy, U.S. Dept. of State, Tokyo).

During the early years of the Japanese-Soviet Fisheries Commission, catch quotas were reduced sharply in both the odd- and even-numbered years in Area A. Annual reductions from the early 1960's through 1976 were not as sharp but their cumulative totals over the years were substantial. The 1977 quota was again reduced sharply--by approximately 30% from the 1975 quota.

Catch quotas in Area B and the Japan Sea combined have also been reduced substantially since they were first imposed in 1962, the sharpest annual reduction (12,500 mt) applying to the 1977 quota.

The catch quotas and allocations are for all species of salmon combined. With one exception, the Japan-Soviet Commission has not set catch quotas for individual species. The exception is the restriction on the number of sockeye that the mothership fishery has been allowed to catch in recent years, a matter taken up in the following section.

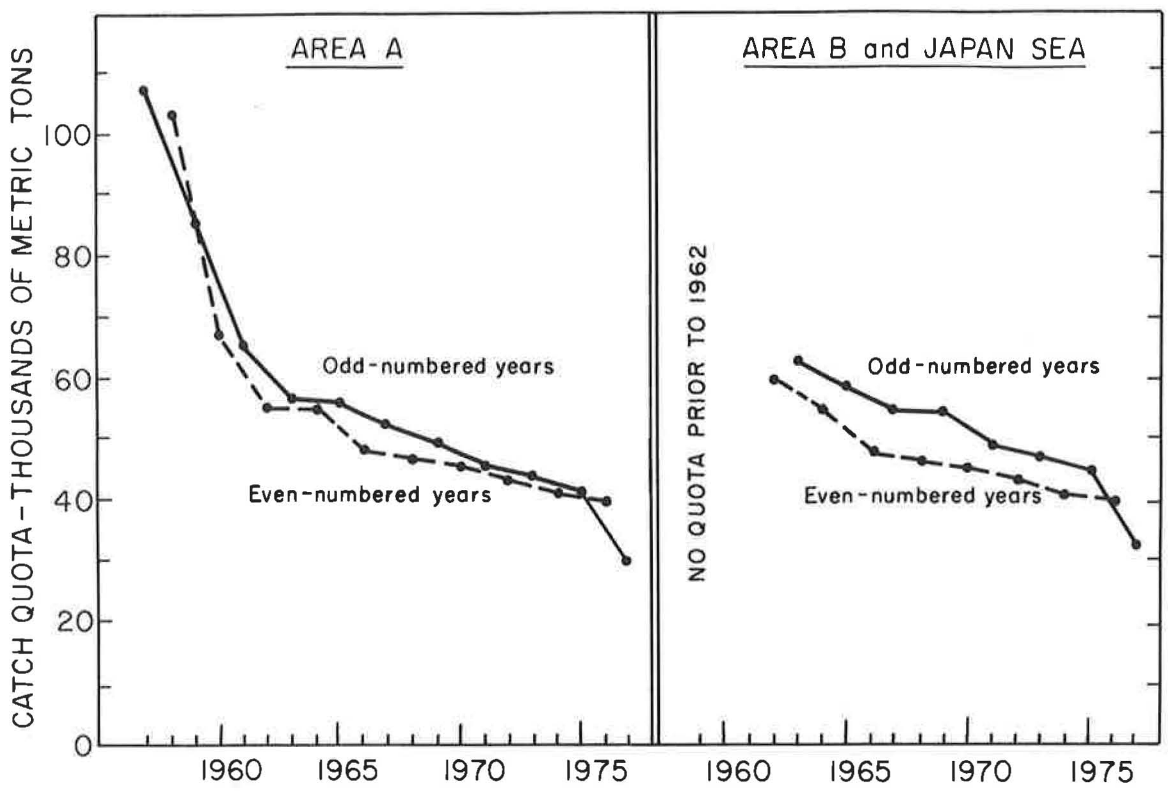


Figure 4.3.--Catch quotas for Japanese salmon fisheries in Area A and outside the territorial waters of Japan in Area B and the Japan Sea, 1957-77. (See Figure 4.1 for area boundaries and Table 4.2 for separate quotas for the Okhotsk Sea in 1957-58 and allocations to fisheries.)

4.2.2.2 Time-Area Closures, Vessel Limitations and Restrictions, and Sockeye Catch Quotas

Information on all of the time-area closures and vessel limitations and restrictions imposed on Japan's high seas salmon fisheries during the early years of the Japanese-Soviet Fisheries Commission is not available. Some that were imposed are as follows: (1) the Okhotsk Sea was closed to fishing by Japanese salmon motherships after 1958; (2) the western boudary of the North Pacific mothership fishing area off the southeast coast of the Kamchatka Peninsula, an area where Asian salmon concentrate in large numbers while migrating to their spawning streams, was moved from 155°E in 1958 to 160°E in 1959; and (3) minimum distances between gillnet sets in the mothership fishery were required to be 10 km (6.2 miles) in waters west of 170°25'E and 8 km (5.0 miles) in waters east of that longitude.

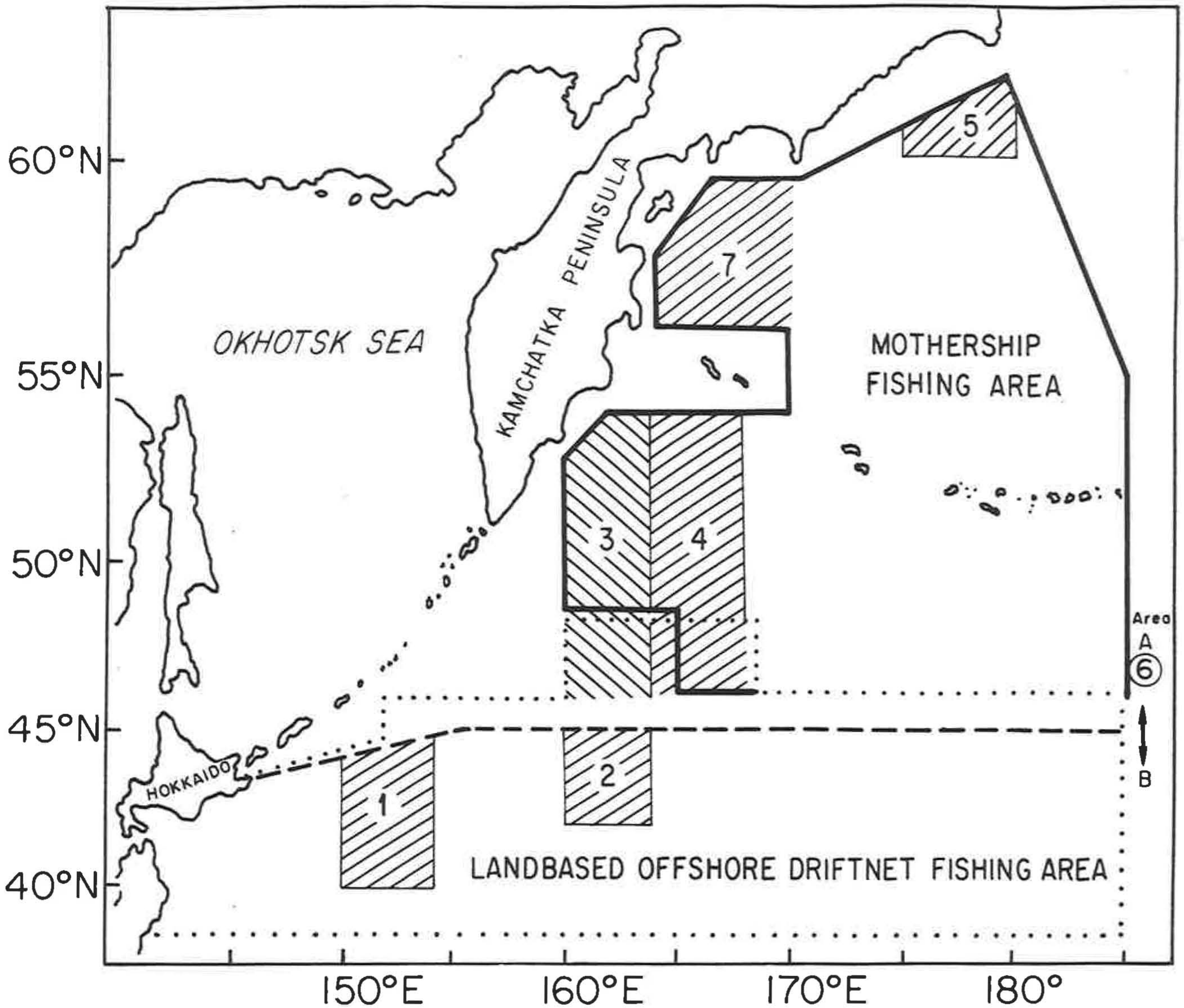
Turning to more recent years, Figure 4.4 shows the Japanese-Soviet time-area closures, vessel limitations and catch quotas for sockeye imposed on Japan's high seas salmon fisheries in 1973-76. Although all seven of the restrictions were established with the view toward controlling high seas interceptions of salmon originating in U.S.S.R. streams, some of them perhaps also served to control or reduce interceptions of North American salmon, specifically western Alaska chinooks (and possibly chums) in the case of the fifth restriction, Bristol Bay sockeye in the case of the sixth restriction, and possibly western Alaska chinooks in the case of the seventh restriction.

In 1977, all waters within 200 miles of the U.S.S.R. coast were closed to Japan's high seas salmon fisheries. Information on other restrictions, such as those which were in effect during 1973-76, is not available.

4.2.2.3 Patrol Vessels and Inspectors

Procedures for patrolling and inspecting Japan's high seas salmon fisheries in 1977 are not known, but, as of the 1976 season, the mothership fishery was patrolled by six Japanese and two or three Societ enforcement vessels. Additionally, the Fisheries Agency of Japan had two inspectors aboard each mothership. The landbased driftnet fishery was patrolled by four Japanese enforcement vessels with Soviet inspectors aboard from time to time.

Officers on the patrol vessels check licenses, fishing locations, lengths of nets, mesh sizes, and distances between gillnet sets (in the mothership fishery). In the landbased fishery they also count the number of vessels fishing in various areas; obtain catch data from a sample of the vessels; and make estimates of total catches which are communicated by radio to inspectors stationed in the home ports. The inspectors aboard the motherships certify the accuracy of fishery statistics and communicate them daily to the chief inspector (aboard a patrol vessel) who in turn transmits them by radio to the Fisheries Agency of Japan. The inspectors also check catcher-boats for compliance with gear limitations and restrictions; make certain that catches are transferred daily from catcher-boats to motherships; verify mothership logs for position and weather and sea conditions; and sample the catches for biological data (sex, body weight and age).



RESTRICTIONS

1 Limited to 100 vessels, April 30 through May 30.

2 Limited to 150 vessels, April 30 through May 30.

3 Closed to fishing, May 15 through June 25/30. (June 25, 1973-75 and June 30, 1976.)

4 Limited to 3 motherships, May 15 through June 20/25. (June 20, 1973-75 and June 25, 1976.)

5 Closed to fishing after June 30.

6 Total catch of sockeye in Area A limited to following:

1973 - 7.0 million fish
1974 - 6.0 " "
1975 - 5.4 " "
1976 - 3.0 " "

Of the above total, catch of sockeye north of 48°N and west of 165°E limited to the following:

1973 - 2.25 million fish
1974 - 1.80 " "
1975 - 1.50 " "
1976 - 0.50 " "

7 Limited to 2 motherships throughout the season.

Figure 4.4. Time-area closures and sockeye salmon catch limits established for Japanese high seas salmon fisheries by the Japanese-Soviet Northwest Pacific Fisheries Commission, 1973-76. Information source: Fisheries Agency of Japan (communicated to American Embassy, U.S. Dept. of State, Tokyo).

4.2.3 International Convention for the High Seas Fisheries of the North Pacific Ocean

4.2.3.1 Abstention Provisions

The International Convention for the High Seas Fisheries of the North Pacific Ocean, commonly referred to as the North Pacific Fisheries Treaty, was signed by Canada, Japan and the United States in May 1952 and entered into force in June 1953. The salient feature of the Convention in regard to regulation of Japan's high seas salmon fisheries was the establishment of provisional lines at 175°W in the Bering Sea and 175°20'W in the North Pacific Ocean east of which Japan agreed to abstain from fishing for salmon for a period of 5 years.[4.5/] [4.6/] Extension of the abstention provisions beyond 5 years (1958) required the United States to demonstrate that its salmon stocks reasonably satisfied three conditions for abstention, the conditions being, in effect, that the stocks were fully utilized, properly managed, and extensively studied.

Since the Convention entered into force, there have been no changes in the provisional salmon abstention lines, and the United States has submitted to INPFC numerous documents which, in its view, clearly demonstrate that its salmon stocks satisfy all the conditions for abstention.[4.7/] In 1959, Canada agreed that the evidence submitted by the U.S. demonstrated that Bristol Bay sockeye salmon stocks were being fully utilized. Japan's position over the years, however, has been that neither the United States nor Canada has submitted sufficient evidence to demonstrate that their salmon stocks meet the conditions for abstention. No agreement had been reached on the matter and INPFC has made no recommendation that any of the salmon stocks originally covered by the abstention provisions of the Convention no longer meet the conditions for abstention. Hence, Japan has been obligated to abstain from fishing for salmon east of the provisional abstention lines.[4.8/]

4.5/ In the Bering Sea, the provisional line follows the meridian of 175°W from the Aleutian Islands to approximately 63°N, then arcs and angles north and east to Cape Prince of Wales on the west coast of Alaska. In the North Pacific Ocean, the provisional line follows the meridian passing through the western extremity of Atka Island.

4.6/ Canada also agreed to abstain from fishing for salmon in high seas waters east of 175°W in the Bering Sea.

4.7/ Of 38 salmon abstention documents submitted to INPFC by the United States over the past 20 years, 32 have been published by INPFC. The remaining 6 documents, which were submitted in recent years, are expected to be published in the near future.

4.8/ Canada has also continued to abstain from fishing for salmon east of 175°W in the Bering Sea.

4.2.3.2 Surveillance and Enforcement by the United States

United States law enforcement officials of the National Marine Fisheries Service and Coast Guard make frequent patrols along the salmon abstention lines and over a broad area north and south of the Aleutian Islands. Vessels and aircraft are used in these patrols. The purpose is to check for conformance with or violations of U.S. laws and fisheries agreements the United States has not only with Japan but other nations as well. From time to time, U.S. enforcement officers board the Japanese salmon vessels west of the abstention lines. Such boarding takes place after permission from appropriate Japanese officials is obtained.

During the course of surveillance activities in July 1974, U.S. officials observed 22 vessels from the landbased driftnet fishery between 176°W and 180° at approximately 49°N. One of the vessels was fishing. In May 1976, 37 vessels from the same fishery were observed between 180° and 173°E, 49°N to 50°N. No nets were seen in the water. The areas in which the vessels were observed in the two years are far to the north of the fishing area for which they are licensed by the Fisheries Agency of Japan (Figure 4.1) and are areas in which North American salmon are present. Although only one of the vessels was seen to be fishing, it is not known how much more fishing, if any, was done by the 59 vessels before or after having been sighted. Nor is it known how many, if any, North American salmon were intercepted. Notwithstanding the lack of information on these matters, the presence of the landbased driftnet vessels in the waters mentioned is cause for concern about their impact on North American salmon and the accuracy of catch statistics reported for the fishery, in addition to raising doubts as to the effectiveness of Japan's enforcement of its domestic fisheries regulations.

4.2.3.3 Violations of the Abstention Lines

A number of violations of the salmon abstention lines by Japanese vessels from both the mothership and landbased driftnet fisheries have been observed by U.S. enforcement officers since 1961. From 1961 through 1975, 31 vessels were sighted east of the abstention lines--25 in the North Pacific Ocean, 6 in the Bering Sea. In most instances, the violating vessels were observed one or two degrees of longitude east of the abstention lines. Seven vessel, however, were observed fishing in the Gulf of Alaska between 153°W and 158°W, 52°N-58°N, such location being hundreds of miles east of the abstention line at 175°20'W in the North Pacific Ocean.

4.2.4 Recent Regulatory Developments

Under Public Law 94-265, cited as the Fishery Conservation and Management Act of 1976 (FCMA), the United States established exclusive fishery management authority over salmon of U.S. origin within a 200-mile fishery conservation zone and also throughout their migratory range beyond the zone, except when they are found within any foreign nation's territorial sea or fishery conservation zone recognized by the U.S. The effective date of the FCMA was March 1, 1977. Its provisions with respect to salmon, however, were not in effect during the 1977 high seas salmon fishing season because the North Pacific Fisheries Convention remained in force.

In the spring of 1977, the U.S.S.R. proclaimed a 200-mile fishery conservation zone off its coast and closed that zone to high seas salmon fishing by Japanese vessels in 1977. More recently Japan has also proclaimed a 200-mile fishery conservation zone off its coast.

The approximate location of the U.S. and U.S.S.R. 200-mile lines in relation to the Japanese mothership and landbased driftnet fisheries is shown in Figure 4.5. The point where the U.S.S.R. 200-mile line and Japan's recently-established 200-mile line meet off the southern Kuriles is not known. The matter is being discussed by the two nations.

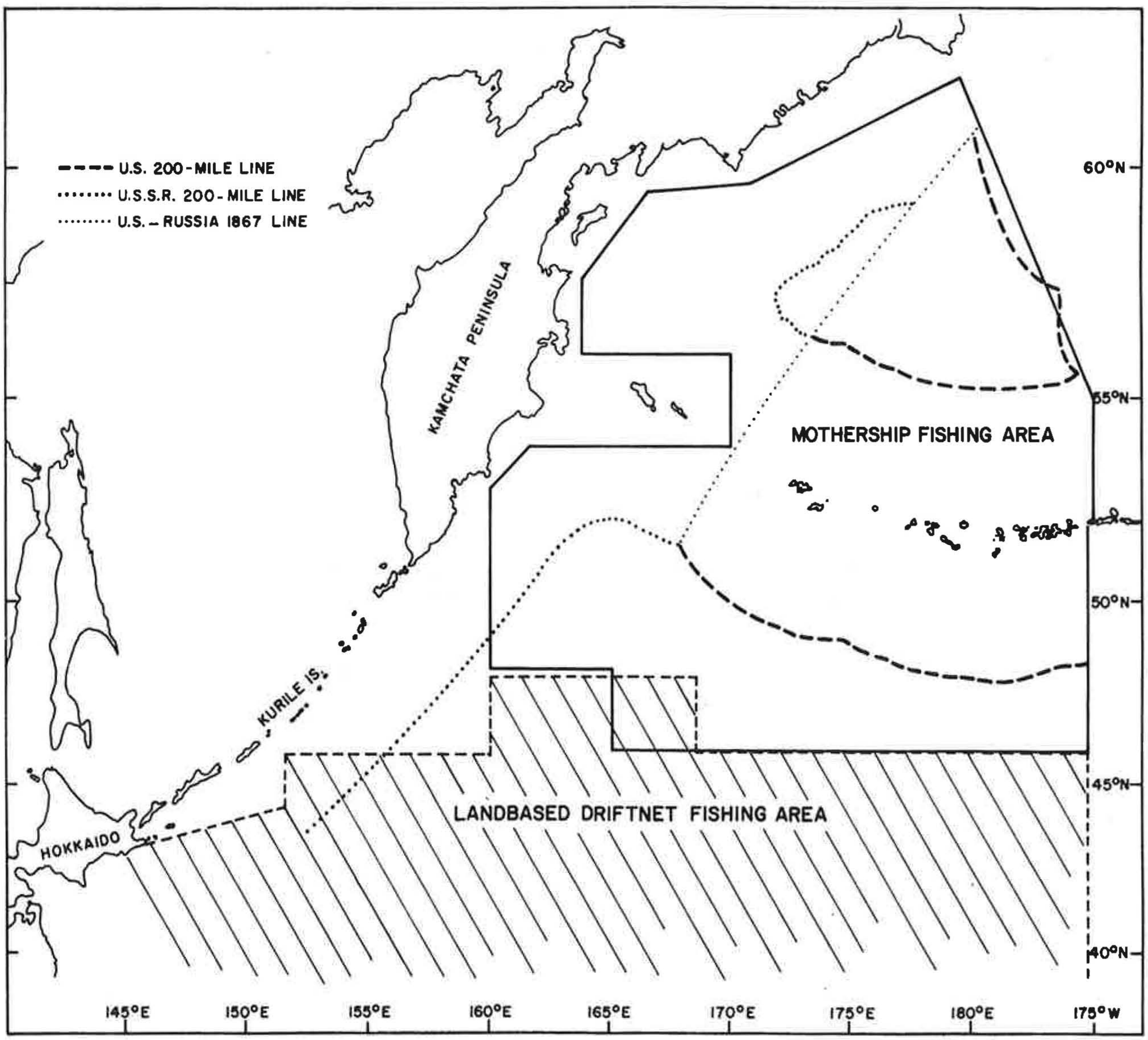


Figure 4.5. Approximate locations of the U.S. and U.S.S.R. 200-mile lines in relation to the Japanese mothership and landbased driftnet fishing areas. (200-mile lines truncated at the U.S.-Russia 1867 Line.)

4.3 History of Exploitation

4.3.1 Fleet Size and Fishing Effort

4.3.1.1 Mothership Fishery

The North Pacific mothership salmon fishery began in 1952 with 3 motherships and 57 catcher-boats comprising the fleet. The size of the fleet increased over the next several years to 16 motherships and 460 catcher-boats in 1959. Since then the fleet has been reduced on four separate occasions--most recently in 1977--until present fleet size is 6 motherships and 245 catcher-boats.

The numbers of motherships and catcher-boats in the fleet each year during 1952-77 and the millions of tans of gillnets fished annually are given in Table 4.3. Before 1956 the fleet fished almost entirely to the west of 175°E in the North Pacific Ocean. Less than 5% of the total effort during 1952-55 was to the east of 175°E in the North Pacific Ocean, and none in the Bering Sea. In 1956, the fleet expanded its operations east of 175°E in the North Pacific Ocean and began fishing in the Bering Sea. All fishing since 1959 has been east of 160°E (Figure 4.1).

Table 4.3.--Fleet size and fishing effort, North Pacific mothership salmon fishery, 1952-77.

Year	No. of motherships	No. of catcher-boats	Millions of tans fished
1952	3	57	0.5
1953	3	105	1.3
1954	7	205	3.3
1955	12	347	7.0
1956	14	447	9.3
1957	14	405	6.6
1958	15	432	8.6
1959	16	460	7.1
1960	12	410	6.5
1961	12	410	5.0
1962	11	369	5.8
1963	11	369	6.0
1964	11	369	7.5
1965	11	369	6.1
1966	11	369	5.2
1967	11	369	5.2
1968	11	369	5.9
1969	11	369	6.2
1970	11	369	6.0
1971	11	369	5.8
1972	10	332	5.9
1973	10	332	5.9
1974	10	332	5.4
1975	10	332	5.7
1976	10	332	5.9[a/]
1977	6	245	b/

a/ Preliminary.
b/ Not available.

DATA SOURCES: INPFC Statistical Yearbooks, 1952-75 (1974-75 In Press) and Fisheries Agency of Japan.

4.3.1.2 Landbased Driftnet Fishery

The landbased offshore driftnet fishery also began in 1952. Details on the numbers of vessels in the fishery in the 1950's are not available. Approximately 325 vessels of the 40-90 ton class and 1,200-1,500 vessels under 7 tons fished during the 1960's. Information provided by the Fisheries Agency of Japan shows the numbers of vessels in the Fishery during 1970-77 as follows:

	Vessel size	
Year	≤7 tons	40-90 tons
1970	1,388	325
1971	1,382	325
1972	1,232	374
1973	1,110	374
1974	1,120	374
1975	1,120	371
1976	1,120	368
1977	832	297

Data on the millions of tans fished by the landbased driftnet fishery are available only for the larger vessels and only for 1962, 1974 and 1975. The larger vessels fished 6.9 million tans of gillnet in 1962 and 6.0 million tans in 1974 and 1975.

The longitudinal distribution of fishing effort by the larger vessels in each of the 3 years was as follows:

	Total effort (millions	Percent of total effort			
Year	of tans)	West of 165°E	165°E-170°E	170°E-175°E	East of 175°E
1962	6.9	87.1	12.7	0.2	None
1974	6.0	48.2	23.2	15.4	13.2
1975	6.0	37.6	27.8	17.0	17.6

The foregoing data show a pronounced eastward shift in fishing effort in 1974-75 as compared to 1962.

4.3.2 Annual Catches

4.3.2.1 Mothership Fishery

Annual catches of salmon by the North Pacific mothership fishery since 1952 are given in Table 4.4 and shown in Figure 4.6.

The catch of sockeye by the mothership fishery, which was less than a million fish in 1952, reached 12.2 million fish in 1955 and averaged about that same number through 1962. Since then, the catch has declined to the recent level of 2 to 3 million fish. As in the case of sockeye, catches of pink, chum and coho salmon also increased markedly between 1952 and 1955. Pink catches were very large during 1955-59, averaging 16 million fish annually, but dropped sharply after 1959. Average annual catch in 1960-66 was only 3 million fish. However, there has been an upward trend in the pink catches since 1966. Chum catches averaged 14 million fish annually from 1955 through 1960, but then dropped to the much lower level of 6 million fish during 1961-65. The past 10 years have seen a recovery in catches of chums as well as pinks. Coho catches were larger during the 1950's than in the past 15 years. Chinook catches, on the other hand, have been larger during the past 10-15 years than they were in the 1950's.

Table 4.4. Catch of salmon by the Japanese North Pacific mothership fishery, in thousands of fish, 1952-75.[a/]

Year	Sockeye	Pink	Chum	Coho	Chinook	Total
1952	736	699	626	24	1	2,086
1953	1,580	3,065	2,707	340	8	7,700
1954	3,816	5,804	9,404	1,398	74	20,496
1955	12,164	16,508	18,573	3,184	74	50,503
1956	9,634	12,006	17,167	3,758	136	42,701
1957	19,822	21,046	9,246	340	31	50,485
1958	11,971	13,199	17,165	3,342	45	45,722
1959	9,125	18,856	12,859	1,423	68	42,331
1960	12,879	1,885	10,517	962	180	26,423
1961	12,998	3,263	6,128	284	31	22,704
1962	10,590	1,139	6,372	1,532	122	19,755
1963	8,903	6,732	5,858	1,895	87	23,475
1964	7,097	2,281	8,641	3,535	410	21,964
1965	12,038	4,429	6,036	1,177	185	23,865
1966	7,254	2,553	8,562	469	208	19,046
1967	8,087	7,781	6,837	226	128	23,059
1968	6,373	3,823	8,107	898	362	19,563
1969	5,935	6,972	7,721	1,306	554	22,488
1970	6,944	1,726	9,638	180	437	18,925
1971	3,554	8,202	9,968	454	206	22,384
1972	3,184	3,795	13,373	614	261	21,227
1973	2,613	12,018	7,857	989	119	23,596
1974	2,282	7,556	9,283	1,085	361	20,567
1975	2,171	14,654	7,367	356	162	24,710

a/ See Appendix 1 for data sources.

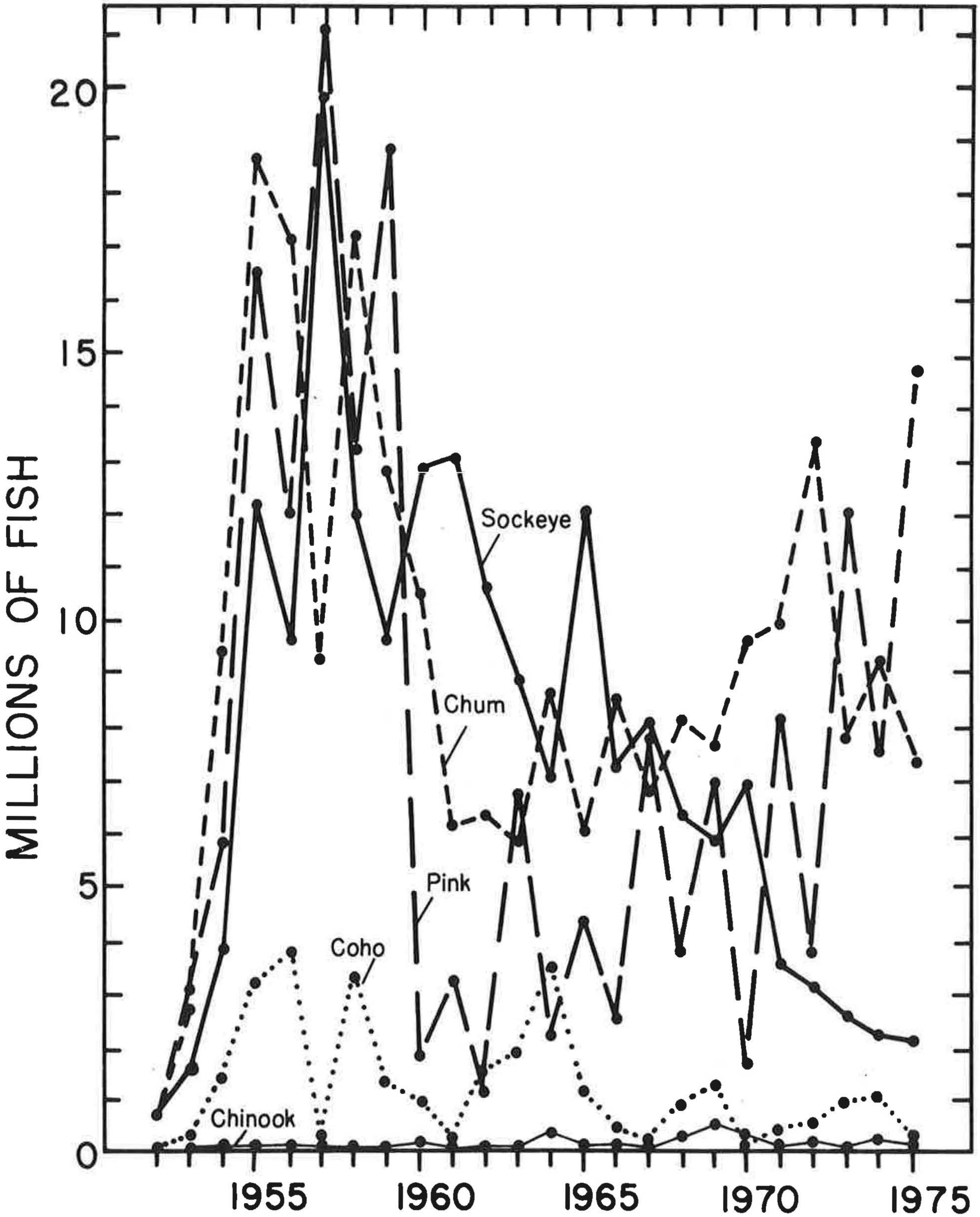


Figure 4.6. Annual catch of salmon by the Japanese North Pacific mothership fishery, 1952-75. (From Table 4.3.)

Since 1956, sockeye catches by the mothership fishery have more or less followed the cyclic pattern of the Bristol Bay sockeye runs, being larger in peak and post-peak years of the Bristol Bay cycle than in other cycle-years.4.9/ It is not to be inferred from this association, however, that most or all of the sockeye taken by the mothership fishery are of Bristol Bay origin. The mothership catches of pinks have followed the pronounced 2-year cycle of the Asian pink salmon runs, the odd-year catches being more than twice as large as the even-year catches. Chum and coho salmon catches, on the other hand, have been larger in even-years than in odd-years, indicating that the fishery turns to these two species to achieve its catch quota in years when pinks are less abundant. As for chinook salmon, there has been some parallelism in catches east of 170°E in the Bering Sea in one year and the catches in western Alaska 1 or 2 years later.

Deck load of salmon on a Japanese mothership
(Photo: Fukuhara, NMFS)

4.9/ The Bristol Bay sockeye runs have historically followed a 5-year cycle, with an occasional shift to a 4-year cycle. The 5-year cycle consists of a peak year, a post-peak year, two mid-cycle years, and a pre-peak year. For example, 1960 was a peak year, 1961 a post-peak year, 1962 and 1963 mid-cycle years, and 1964 a pre-peak year. A 4-year cycle has only one mid-cycle year.

4.3.2.2 Landbased Driftnet Fishery

Annual catches by the landbased offshore driftnet fishery since 1952 are given in Table 4.5 and shown in Figure 4.7.

The catch of sockeye by the landbased driftnet fishery increased from less than 100,000 fish in 1952 to 1.5 million fish in 1960, was about 1.2 million fish in 1961, declined to negligible quantities during 1962-65, but has since averaged about 3 million fish annually. In recent years, the catch of sockeye by the landbased fishery has exceeded that of the mothership fishery. Pink catches peaked in the late 1950's and early 1960's. The largest catch in an even-numbered year was 25 million fish in 1958, and the largest catch in an odd-numbered year was 35 million fish in 1959, with the 1961 catch almost the same. Catches have since had a downward trend. The catch of chums increased from less than a million fish in 1952 to the level of 11-12 million fish in 1966-67, dropped to a lower level of approximately 6-8 million fish during 1968-73, but was the largest on record in 1974, over 12 million fish. Coho catches have generally had an upward trend over the history of the fishery. Peak catch was 3.8 million fish in 1973, with the 1974 catch not much less than that. Chinook catches have also generally increased over the history of the fishery. Catches in recent years have averaged about 145,000 fish annually compared to 40,000 fish in the 1950's and 100,000 fish in the 1960's.

Table 4.5.--Catch of salmon by the Japanese landbased offshore driftnet fishery, in thousands of fish, 1952-75.a/

Year	Sockeye	Pink	Chum	Coho	Chinook	Total
1952	89	13,344	684	126	8	14,251
1953	191	10,270	1,476	272	17	12,226
1954	344	9,193	2,659	490	31	12,717
1955	511	22,396	3,949	728	46	27,630
1956	271	21,534	2,094	386	24	24,309
1957	488	30,353	3,770	695	44	35,350
1958	903	24,833	9,155	803	45	35,739
1959	845	35,129	9,045	1,204	70	46,293
1960	1,627	20,129	8,684	1,376	111	31,927
1961	1,192	34,559	6,104	1,486	77	43,418
1962	154	14,021	7,577	1,289	124	23,165
1963	18	31,255	7,538	1,492	102	40,405
1964	108	17,247	8,956	1,624	195	28,130
1965	159	29,142	8,330	1,913	93	39,637
1966	703	16,032	11,848	1,458	112	30,153
1967	2,566	23,051	11,078	1,329	110	38,134
1968	2,769	15,899	8,457	1,421	88	28,634
1969	2,495	23,610	4,908	3,328	83	34,424
1970	2,966	13,403	6,585	2,259	101	25,314
1971	3,026	16,977	6,250	2,373	134	28,760
1972	3,718	17,578	8,981	2,423	107	32,807
1973	3,316	24,227	7,837	3,796	165	39,341
1974	3,158	14,424	12,531	3,560	188	33,861
1975	2,982	19,049	11,759	3,556	137	37,483

a/ See Appendix 1 for data sources.

During the 1950's, the mothership fishery caught about 50% more salmon than the landbased driftnet fishery. Since 1960, however, the total catch by the landbased driftnet fishery has been 50% greater than the mothership catch. The larger catches by the landbased fishery during the past 15 years are due to a larger allocation of the overall catch quota and the gearter number of pinks in the catch.

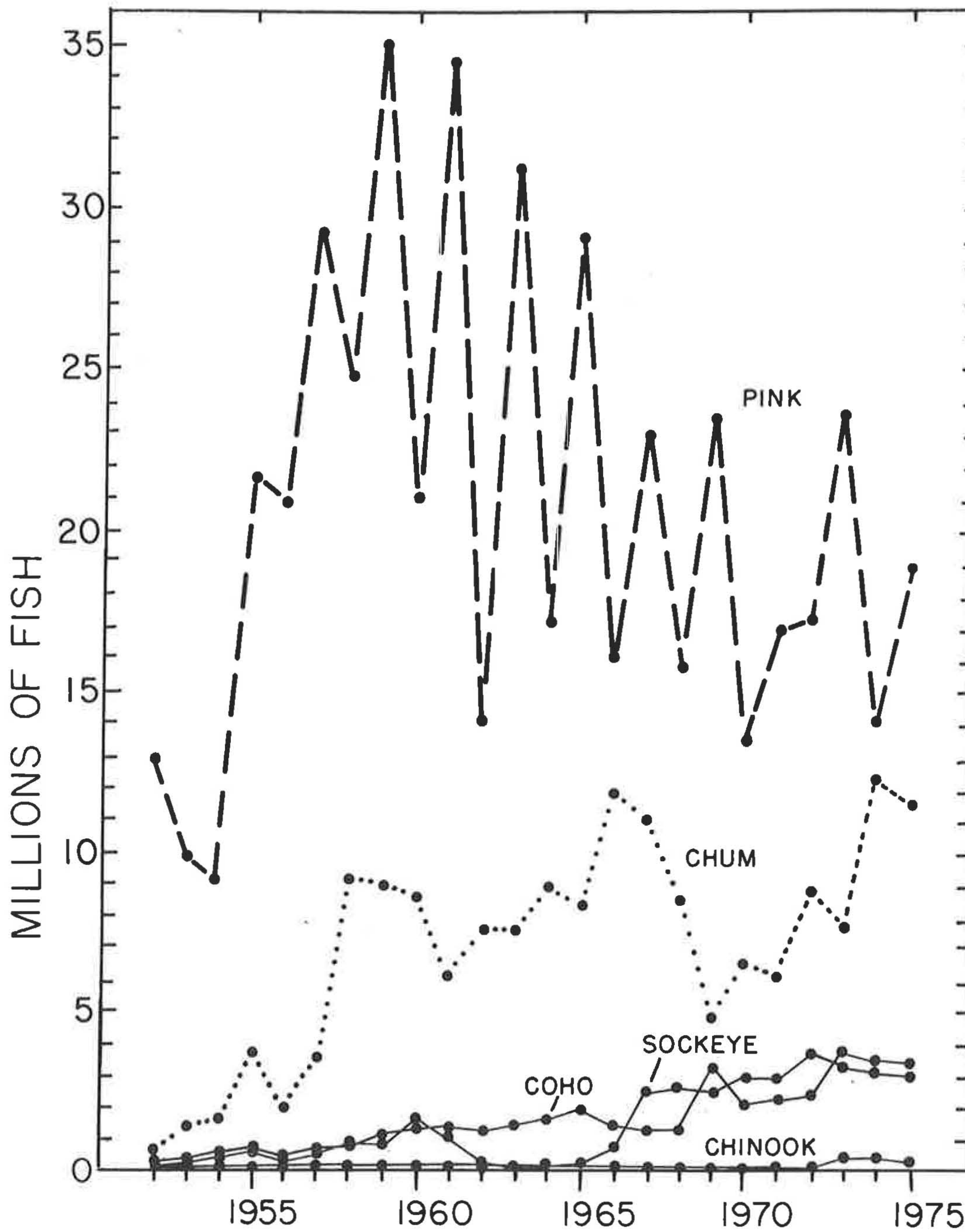


Figure 4.7.--Annual catch of salmon by the Japanese landbased offshore driftnet fishery, 1952-75. (From Table 4.4.)

4.3.3 Distribution of Annual Catches

4.3.3.1 Mothership Fishery

The average annual catch of each species of salmon in 10 subareas of the mothership fishing area (Figure 4.8)4.10/ is given in Table 4.6 for each 5-year period since 1956. Table 4.7 gives the percentage of the mothership catch taken in each subarea, by 5-year period. Data for pink salmon are separated for odd- and even-numbered years.

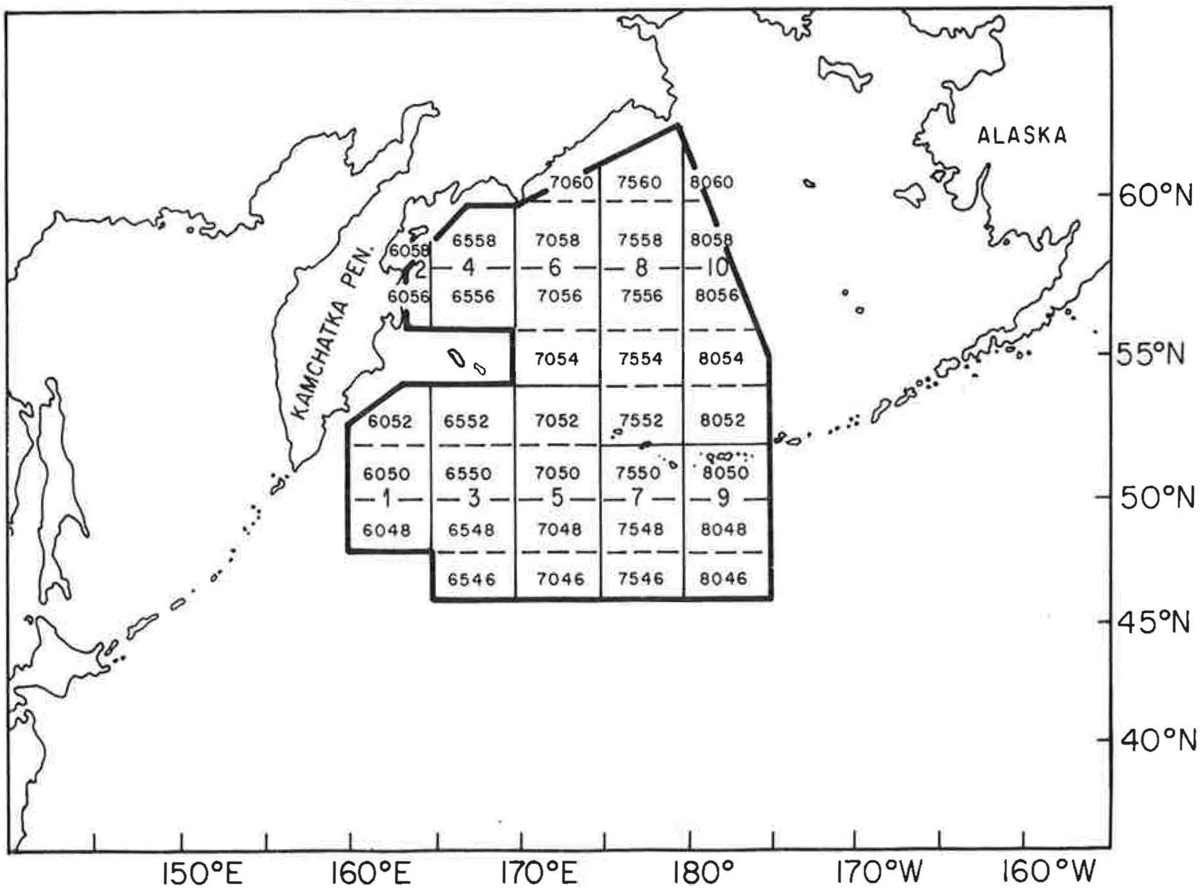


Figure 4.8.--Japanese mothership salmon fishing area (since 1959), designated subareas, and 2^{o} x 5^{o} statistical reporting areas. (From Fredin and Worlund, 1974.)

4.10/ For purposes of various studies by the Fisheries Data and Management Systems Division of the Northwest and Alaska Fisheries Center, the mothership fishing area has been divided into the 10 subareas indicated in Figure 4.7. Within each of the subareas are two to five statistical areas used by the Fisheries Agency of Japan for reporting catch and fishing effort data. Most of the statistical reporting areas, which are also indicated in Figure 4.7, encompass 2° of latitude and 5° of longitude. Each statistical area is identified by a 4-digit number representing the intersection of a meridian (the first 2 digits) with a parellel (the second pair of digits) at the southwest corner of the area.

There have been some major changes in the distribution of catches in the mothership fishing area over the past 20 years. Catches of sockeye, coho, and, in odd-numbered years, pink salmon have shifted from west to east in the North Pacific Ocean (Subareas 1, 3, 5, 7 and 9). The Bering Sea, particularly Subareas 8 and 10, has become increasingly important for catches of chums and chinooks and pinks in even-numbered years. These changes carry a significant implication, i.e., that the farther east in the mothership area the salmon are caught the more likely that fish of North American origin will be intercepted. In this regard, the closure of the U.S.S.R. 200-mile zone to Japan's high seas salmon fisheries could result in an even greater eastward shift in fishing effort by the mothership fishery unless other measures are taken.

Table 4.6.--Average annual catch of salmon by the Japanese mothership fishery, in thousands of fish by species, subarea and 5-year period, 1956-75. a/

Species	Years	North Pacific Ocean Subareas						Bering Sea Subareas						Total
		1	3	5	7	9	Subtotal	2	4	6	8	10	Subtotal	
Sockeye	1956-60	2,608	4,543	2,258	473	76	9,958	-	125	220	688	1,143	2,176	12,134
	1961-65	1,495	4,237	1,265	525	1,038	8,560	4	265	243	400	854	1,766	10,326
	1966-70	737	2,492	1,506	571	620	5,926	10	133	150	182	516	991	6,917
	1971-75	242	868	619	417	154	2,300	18	104	103	120	117	462	2,762
Pink (Odd Yrs)	1956-60	5,450	4,178	2,044	408	-	12,080	-	816	2,813	1,604	884	6,117	18,197
	1961-65	1,020	1,527	576	103	118	3,344	7	588	458	243	170	1,466	4,810
	1966-70	880	1,506	794	308	307	3,795	108	906	1,298	520	750	3,582	7,377
	1971-75	1,597	2,120	2,245	1,549	360	7,871	239	812	889	892	919	3,751	11,622
Pink (Even Yrs)	1956-60	3,846	1,012	223	25	2	5,108	-	178	38	43	90	349	5,457
	1961-65	350	826	174	60	44	1,454	2	140	66	28	20	256	1,710
	1966-70	233	652	431	124	90	1,530	54	582	221	157	154	1,168	2,698
	1971-75	474	1,118	1,044	493	146	3,275	190	988	415	564	343	2,500	5,775
Chum	1956-60	2,667	4,089	3,126	440	13	10,335	-	257	415	443	851	1,966	12,301
	1961-65	820	2,178	1,019	465	324	4,806	6	418	363	540	474	1,801	6,607
	1966-70	608	1,560	1,227	518	502	4,415	23	480	537	1,115	1,602	3,757	8,172
	1971-75	734	1,481	1,144	842	356	4,557	90	485	668	1,620	2,148	5,011	9,568
Coho	1956-60	602	682	496	30	3	1,813	-	1	5	+	+	6	1,819
	1961-65	59	250	810	472	92	1,683	-	+	+	1	+	1	1,684
	1966-70	4	20	169	230	193	616	-	-	-	-	-	-	616
	1971-75	48	89	179	249	132	697	2	1	+	-	+	3	700
Chinook	1956-60	14	13	10	+	+	37	-	2	7	6	30	45	82
	1961-65	10	31	30	13	8	92	-	8	20	27	18	73	165
	1966-70	7	19	20	12	11	69	+	21	35	104	108	268	337
	1971-75	10	15	13	18	10	66	2	8	19	49	74	152	218

a/ See Appendix 1 for data sources.

Table 4.7.--Percentage of Japanese mothership catch of salmon taken in each of the 10 subareas of the mothership fishing area, by species and 5-year period, 1956-75. a/

Species	Years	North Pacific Ocean Subareas						Bering Sea Subareas					
		1	3	5	7	9	Total	2	4	6	8	10	Total
Sockeye	1956-60	21	37	19	4	1	82	–	1	2	6	9	18
	1961-65	14	41	12	5	10	82	+	3	2	4	8	17
	1966-70	11	16	22	8	9	86	+	2	2	3	7	14
	1971-75	9	31	22	15	6	83	1	4	4	4	4	17
Pink (Odd Yrs)	1956-60	30	23	11	2	–	66	–	5	15	9	5	34
	1961-65	21	32	12	2	2	69	+	12	10	5	4	31
	1966-70	12	20	11	4	4	51	2	12	18	7	10	49
	1971-75	14	18	19	13	3	67	2	7	8	8	8	33
Pink (Even Yrs)	1956-60	70	19	4	+	+	93	–	3	1	1	2	7
	1961-65	20	48	10	4	3	85	+	8	4	2	1	15
	1966-70	9	24	16	5	3	57	2	22	8	6	6	44
	1971-75	8	19	18	9	3	57	3	17	7	10	6	43
Chum	1956-60	22	33	25	4	+	84	–	2	3	4	7	16
	1961-65	12	33	15	7	5	72	+	6	6	8	7	27
	1966-70	7	19	15	6	6	53	+	6	7	14	20	47
	1971-75	8	15	12	9	4	48	1	5	7	17	22	52
Coho	1956-60	33	37	27	2	+	99	–	+	+	+	+	+
	1961-65	3	15	48	28	5	99	–	+	+	+	+	+
	1965-70	1	3	27	37	31	99	–	–	–	–	–	–
	1971-75	7	13	25	36	19	100	+	+	+	–	+	+
Chinook	1956-60	17	16	12	+	+	45	–	2	9	7	37	55
	1961-65	6	19	18	8	5	56	–	5	12	16	11	44
	1966-70	2	6	6	4	3	21	+	6	10	31	32	79
	1971-75	5	7	6	8	5	31	1	4	9	22	34	70

a/ All figures are rounded to whole numbers, hence some totals do not equal 100%. Percentages <0.5 are indicated by +. Data are from Table 4.6.

4.3.3.2 Landbased Driftnet Fishery

Data on the tonnages of salmon caught by the larger vessels of the land-based driftnet fishery west and east of 165°E show a substantial difference between 1962 and 1970-75 in regard to area of catch (Table 4.8). In 1962, the large vessels took nearly 90% of the catch to the west of 165°E and only slightly over 10% east of that longitude. During 1970-75, approximately 55% of the catch by that component of the fishery was taken to the west of 165°E. The percentage for the fishery as a whole (large and small vessels combined) was about 59%, the increase resulting from the inclusion of approximately 4,250 mt taken annually by the small vessels in the far western sector of the landbased driftnet area (west of 147°-149°E).[4.11]

4.11/ The Fisheries Agency of Japan reports the catches of salmon by small vessels in the landbased driftnet fishery during 1970 - 75 as follows: 1970 - 4,413 mt; 1971 - 4,650 mt; 1972 - 4,061 mt; 1973 - 4,217 mt; 1974 - 3,996 mt; and 1975 - 4,145 mt.

Table 4.8. Catch of salmon by the large vessels (40-90 tons) of the Japanese landbased driftnet fishery west and east of 165°E, 1962 and 1970-75, in metric tons.[a/]

Year	Species	Catch-metric tons			Percent by area	
		West of 165°E	East of 165°E	Total	West of 165°E	East of 165°E
1962	Sockeye	77	147	224	34	66
	Pink	16,431	341	16,772	98	2
	Chum	12,119	1,494	13,613	89	11
	Coho	2,041	1,733	3,774	54	46
	Chinook	392	119	511	77	23
	Total	31,060	3,834	34,894	89	11
1970	Sockeye	1,266	3,521	4,787	26	74
	Pink	10,949	2,646	13,595	81	19
	Chum	5,469	6,217	11,686	47	53
	Coho	289	4,672	4,961	6	94
	Chinook	201	196	397	51	49
	Total	18,174	17,252	35,426	51	49
1971	Sockeye	1,278	3,272	4,550	28	72
	Pink	14,831	1,872	16,703	89	11
	Chum	5,158	5,646	10,804	48	52
	Coho	158	5,455	5,613	3	97
	Chinook	202	328	530	38	62
	Total	21,627	16,573	38,200	57	43
1972	Sockeye	1,425	4,189	5,614	25	75
	Pink	14,983	2,910	17,893	84	16
	Chum	8,574	7,469	16,043	53	47
	Coho	130	5,985	6,115	2	98
	Chinook	252	284	536	47	53
	Total	25,364	20,837	46,201	55	45
1973	Sockeye	1,530	3,160	4,690	33	67
	Pink	18,068	3,689	21,757	83	17
	Chum	7,608	6,464	14,072	54	46
	Coho	586	7,976	8,562	7	93
	Chinook	258	515	773	33	67
	Total	28,050	21,804	49,854	56	44
1974	Sockeye	384	3,831	4,215	9	91
	Pink	10,271	1,782	12,053	85	15
	Chum	11,516	8,196	19,712	58	42
	Coho	831	6,320	7,151	12	88
	Chinook	238	686	924	26	74
	Total	23,240	20,815	44,055	53	47
1975	Sockeye	764	3,228	3,992	19	81
	Pink	12,158	2,788	14,946	81	19
	Chum	11,713	8,796	20,509	57	43
	Coho	373	7,040	7,413	5	95
	Chinook	158	507	665	24	76
	Total	25,166	22,359	47,525	53	47

a/ See Appendix 1 for data sources.

Statistics for 1962 and 1974-75 permit a more detailed examination of the catches by the large vessels east of 165°E (Table 4.9). In 1962, about 3.7 thousand mt (2.1 million fish) were caught between 165°E and 170°E, a relatively small quantity between 170°E and 175°E, and none east of 175°E. In 1974-75, about 8-10 thousand mt (5.3-6.7 million fish) were caught between 165°E and 170°E, approximately 6.2 thousand mt (3.7 million fish) were taken between 170°E and 175°E, and 6.4-6.9 thousand mt (3.3-4.0 million fish) were caught east of 175°E.

Of particular concern to the United States is the increase in the quantity of sockeye and coho salmon caught by the landbased driftnet fishery east of 165°E in recent years--since the mid-1960's (Table 4.4)--because of the possible occurrence (and interception) of U.S. salmon in those waters.

Table 4.9.--Catch of salmon by the large vessels (40-90 tons) of the Japanese landbased driftnet fishery in each 5°-interval of longitude east of 165°E, 1962 and 1974-75, in metric tons and thousands of fish. a/

		Catch - metric tons					Catch - thousands of fish				
Year	Species	165°E-170°E	170°E-175°E	175°E-180°	175°W-180°	Total	165°E-170°E	170°E-175°E	175°E-180°	175°W-180°	Total
1962	Sockeye	147	0	0	0	147	131	0	0	0	131
	Pink	341	0	0	0	341	264	0	0	0	264
	Chum	1,463	31	0	0	1,494	1,120	23	0	0	1,143
	Coho	1,671	62	0	0	1,733	568	19	0	0	587
	Chinook	117	2	0	0	119	26	0	0	0	26
	Total	3,739	95	0	0	3,834	2,109	42	0	0	2,151
1974	Sockeye	2,287	1,130	197	217	3,821	1,721	835	146	164	2,866
	Pink	855	475	120	332	1,782	792	442	113	301	1,648
	Chum	3,673	1,750	774	1,999	8,196	2,343	1,110	495	1,296	5,244
	Coho	803	2,593	1,790	1,134	6,320	385	1,296	884	612	3,177
	Chinook	197	177	134	178	686	42	39	28	32	141
	Total	7,815	6,125	3,015	3,860	20,815	5,283	3,722	1,666	2,405	13,076
1975	Sockeye	2,316	748	157	7	3,228	1,722	559	117	5	2,403
	Pink	2,021	521	154	92	2,788	2,117	548	160	92	2,917
	Chum	4,258	3,045	1,222	271	8,796	2,394	1,727	713	155	4,989
	Coho	940	1,805	3,296	999	7.040	484	892	1,535	461	3,372
	Chinook	133	172	160	42	507	24	34	39	10	107
	Total	9,668	6,291	4,989	1,411	22,359	6,741	3,760	2,564	723	13,788

a/ See Appendix 1 for data sources.

4.3.4 Estimates of Potential Catches of Salmon in Certain Sectors of the Japanese Salmon Mothership and Landbased Driftnet Fishing Areas

4.3.4.1 Mothership Salmon Fishery

U.S. scientists have made estimates of what the annual catches of salmon by the Japanese mothership salmon fishery would have been during 1964-75 if the fishery had confined its operations to that sector of the mothership area west of 170°E longitude, exclusive of waters lying inside the U.S.S.R. 200-mile zone (Figure 4.9), and the fishing effort generated by 245 catcher-boats (the present fleet size) had been distributed as follows during each 10-day period of the fishing season from May 22-31 through July 21-30:

Statistical	Area	6048	-	50	thousand	tans
"	"	6050	-	10	"	"
"	"	6546	-	180	"	"
"	"	6548	-	240	"	"
"	"	6550	-	160	"	"
Total per 10-day period			-	640		

*Based on 264 tans of gillnet per catcher-boat per day.

The estimates, in thousands of fish and in number of metric tons, are given in Table 4.10.[4.12]

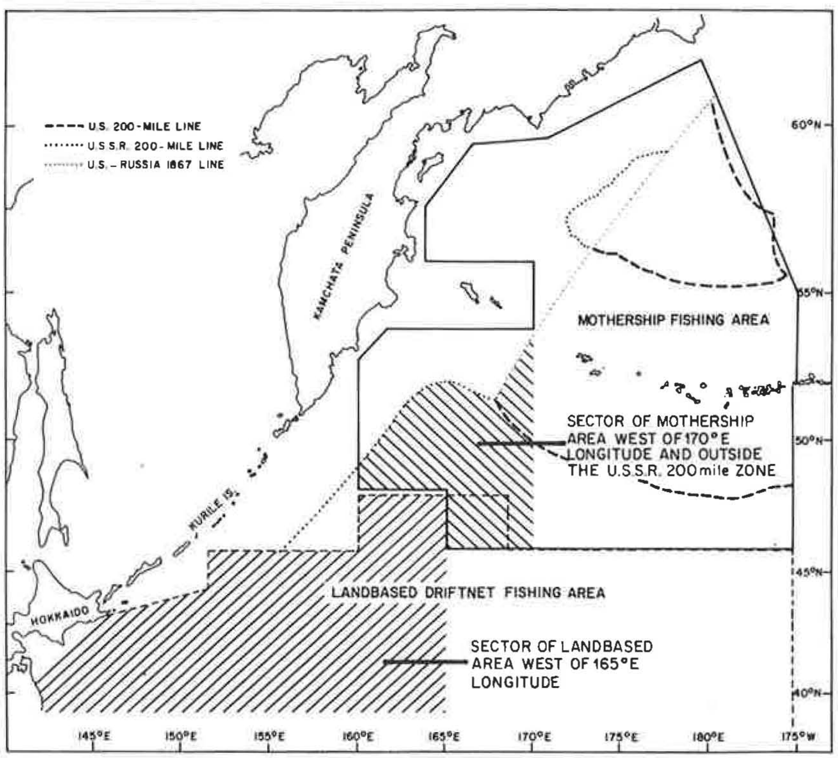


Figure 4.9.--The Japanese mothership and landbased driftnet salmon fishing areas and the U.S. and U.S.S.R. 200-mile lines. (The U.S. and U.S.S.R. 200-mile lines are truncated at the U.S.-Russia 1867 line. The U.S.S.R. 200-mile line off the southern Kurile Islands is also truncated because its point of intersection with Japan's recently-established 200-mile line is not known.)

4.12/ The estimates do not include potential catches in a small portion of Statistical Area 6552 lying outside the U.S.S.R. 200-mile zone.

The estimates of potential catches indicate that the average annual catch during 1964–75 would have ranged from 17,900 mt (Part A of Table 4.10) to 30,200 mt (Part B of Table 4.10), with a mid-point of approximately 24,000 mt.

Based on the foregoing data, it is concluded that the mothership salmon fishery could be expected to achieve an annual catch equivalent to the quota allocated to it in 1977 (23,957 mt) by fishing only in waters to the west of 170°E longitude lying outside the U.S.S.R. 200-mile zone.

Table 4.10.—Estimates of potential catches of salmon by the Japanese mothership salmon fishery in waters to west of 170°E longitude lying outside the U.S.S.R. 200-mile zone, in thousands of fish and number of metric tons, 1964–75.

	Thousands of fish						Metric tons[a/]					
Year	Sockeye	Pink	Chum	Coho	Chinook	Total	Sockeye	Pink	Chum	Coho	Chinook	Total
A. Estimates based on observed CPUE's for statistical areas and 10-day periods in which at least 10,000 tans were fished.[b/]												
1964	3,396	1,335	2,597	290	47	7,665	6,761	1,784	5,381	677	130	14,733
1965	5,982	1,993	3,929	1,469	91	13,464	12,281	2,736	7,544	3,222	233	26,016
1966	6,822	1,278	5,026	249	62	13,437	14,756	1,640	10,736	563	183	27,878
1967	4,394	2,719	2,217	16	34	9,380	9,069	3,714	4,618	43	99	17,543
1968	2,821	1,355	2,208	12	20	6,416	5,670	1,733	4,608	28	51	12,090
1969	2,965	1,391	1,913	5	24	6,298	5,829	1,850	3,862	10	51	11,602
1970	4,795	821	3,098	261	29	9,004	8,981	993	6,391	630	66	17,061
1971	1,773	3,586	2,935	+	19	8,313	3,211	4,479	5,612	+	40	13,342
1972	2,071	3,548	4,505	2,050	56	12,230	3,504	4,027	7,951	4,446	122	20,050
1973	1,846	7,320	3,886	851	113	14,016	3,314	8,813	6,933	1,779	320	21,159
1974	1,258	3,318	3,995	6	27	8,604	2,169	3,862	7,407	14	63	13,515
1975	1,321	10,586	3,005	250	31	15,193	2,264	11,825	5,196	518	66	19,869
Ave.												17,905
B. Same as above but including estimates for statistical areas and 10-day periods in which less than 10,000 tans were fished (using observed CPUE's from adjacent statistical areas or 10-day periods)[b/]												
1964	3,653	1,410	2,970	2,158	155	10,346	7,273	1,884	6,154	5,037	427	20,775
1965	8,367	2,930	5,425	1,962	128	18,812	17,177	4,023	10,416	4,303	328	36,247
1966	9,460	1,791	6,572	462	95	18,380	20,462	2,298	14,038	1,405	281	38,124
1967	6,120	4,446	4,084	2,222	102	16,974	12,632	6,073	8,507	5,942	297	33,451
1968	5,242	2,459	4,126	703	39	12,569	10,536	3,145	8,611	1,652	99	24,043
1969	5,905	4,296	4,523	635	79	15,438	11,609	5,714	9,132	1,248	168	27,871
1970	9,919	1,769	6,132	598	53	18,471	18,578	2,139	12,650	1,444	121	34,932
1971	2,331	6,711	3,597	+	27	12,666	4,221	8,382	6,877	+	57	19,537
1972	2,470	5,419	6,482	3,692	79	18,142	4,179	6,151	11,441	8,008	172	29,951
1973	2,109	9,103	7,106	2,557	214	21,089	3,786	10,960	12,677	5,344	606	33,373
1974	2,309	5,489	6,833	1,322	126	16,079	3,981	6,389	12,668	3,120	292	26,450
1975	1,829	20,233	5,147	1,165	46	28,420	3,135	22,600	8,899	2,412	98	37,144
Ave.												30,158

a/ Number of fish converted to metric tons using average annual weights reported in INPFC Statistical Yearbooks.
b/ CPUE's are from Appendix 1. Fishing effort in each 10-day period distributed as indicated in text.

4.3.4.2 Landbased Driftnet Fishery

The small vessels (less than 7 tons) in the Japanese landbased driftnet fishery operate only in waters to the west of 147°E or 149°E longitude. Because the area of operation for this component of the fishery is far to the west in the North Pacific Ocean, the analysis of landbased driftnet fishery statistics by U.S. scientists pertains only to the large-vessel component of the fishery.

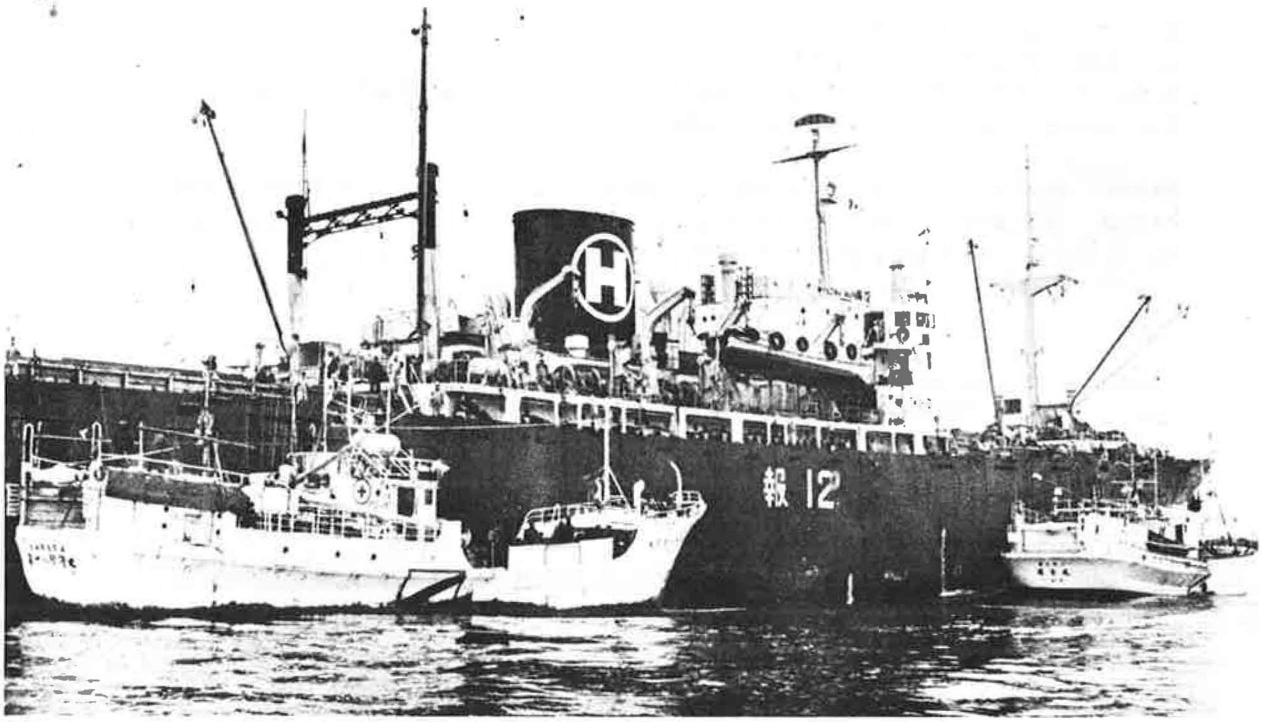
Annual catch and fishing effort in waters west of 165°E longitude by the large vessels in the landbased driftnet fishery in 1962 and 1970-75 are given in Table 4.11. Also given are CPUE's, in thousands of metric tons per million tans, in 1962 and 1974-75 (the only years for which detailed data on fishing effort have been provided to INPFC) and estimates of the total effort that would have been required in those 3 years to achieve a catch of 31,843 mt--the 1977 catch quota for the large vessels in the landbased driftnet fishery (26,300 mt in Zone B and 5,543 mt in Zone A, the two zones having been so designated by the Japan-U.S.S.R. Northwest Pacific Fisheries Commission).

Based on the data presented in Table 4.11, it is concluded that the landbased driftnet fishery could achieve a catch equivalent to its 1977 quota by fishing only in waters to the west of 165°E longitude.

Table 4.11.--Annual catch and fishing effort by the large-vessel component of the Japanese landbased driftnet fishery west of 165°E longitude, 1962 and 1970-75, and estimates of the quantity of fishing effort required to achieve a catch of 31,843 m.t. west of 165°E.a/ b/

Year	Catch (metric tons)	Fishing effort (millions of tans)	CPUE (thousands of m.t. per million tans)	Estimated effort required to catch 31,843 m.t. (millions of tans)c/
1962	31,060	6.0	5.18	6.2
1970	18,174	d/	d/	e/
1971	21,627	d/	d/	e/
1972	25,364	1.8	14.09	2.3
1973	28,050	2.6	10.79	3.0
1974	23,240	2.9	8.01	4.0
1975	25,166	2.3	10.94	2.9

a/ The 1977 catch quota for the large vessels of the landbased driftnet fishery east and west of 165°E was 31,843 m.t.
b/ Catch data are from Table 4.8. Effort data are from the INPFC Secretariat (1962) and Fisheries Agency of Japan (1972-75).
c/ Total fishing effort (in millions of tans) by the large vessels in the landbased driftnet fishery throughout the entire fishing area (west and east of 165°E) was 6.9 in 1962, 5.2 in 1972, 5.8 in 1973, and 6.0 in 1974 and 1975.
d/ Not available.
e/ Not estimated.



JAPANESE SALMON MOTHERSHIP WITH CATCHER VESSELS (Photo: USCG)

5.0 INTERCEPTIONS OF NORTH AMERICAN SALMON AND CATCHES OF ASIAN SALMON BY THE JAPANESE HIGH SEAS SALMON FISHERIES

This section of the report deals almost entirely with the Japanese mothership salmon fishery. Not enough is known about the continental origins of salmon in the area fished by the landbased driftnet fishery to make estimates of the interceptions of North American salmon and catches of Asian salmon by that fishery. As for the landbased longline fishery which operated through the 1971 season, the species composition of the catch (over 90% pink salmon, with most of the remainder comprised of chum salmon) and the area in which the fleet fished (west of 160°E except in 1971 when the vessels fished at 165°E) indicate that for all practical purposes none of the salmon caught were of North American origin. In regard to interceptions of North American salmon, those which originate in streams in the Aleutian Islands are excluded from consideration because of the scanty information on their ocean distribution.

JAPANESE CATCHER VESSEL WITH LOAD OF SALMON
(Photo: Fukuhara, NMFS)

5.1 Interceptions of North American Salmon by the Mothership Fishery

For many years United States scientists have made estimates of the interceptions of North American salmon by the Japanese mothership salmon fishery. The estimates are derived from several kinds of information gathered under INPFC research programs which date back to the mid-1950's: age composition data for sockeye salmon; tag recovery data for pink, chum, and coho salmon; and scale characters for chinook salmon. They are made for specific 2° x 5° statistical areas because catch statistics for the mothership fishery are reported in that manner. The estimates of interceptions have some shortcomings. For example, there are gaps in the information on the distribution and intermingling of salmon from the two continents in the mothership fishing area; sampling errors are substantial in numerous instances; and a number of assumptions have been carried in the analyses. Further research might lead to revised and more accurate estimates of the interceptions of North American salmon.

5.1.1 Sockeye Salmon

According to Fredin and Worlund (1974), sockeye salmon of Northern American origin are intercepted by the Japanese mothership salmon fishery in the areas and periods shown in Figures 5.1 and 5.2. The vast majority of these salmon are of Bristol Bay origin.[5.1/] Only small numbers of North American sockeye of non-Bristol Bay origin are taken.[5.2/]

5.1/ Bristol Bay sockeye are defined as those originating in the five fishing districts in the Bay (Togiak, Nushagak, Naknek-Kvichak, Egegik and Ugashik) and the north side of the Alaska Peninsula.

5.2/ Based on tagging and parasitological data, Fredin and Worlund (1974) estimate that only 2% and 10%, respectively, of the mature and immature North American sockeye intercepted by the Japanese mothership salmon in Subareas 7 and 9 (see Figure 4.8) are of non-Bristol Bay origin. They are produced in streams to the north of Bristol Bay in western Alaska, in central and southeastern Alaska, and in British Columbia. It appears that no North American sockeye of non-western Alaska origin are intercepted in the Bering Sea or west of 175°E in the North Pacific Ocean.

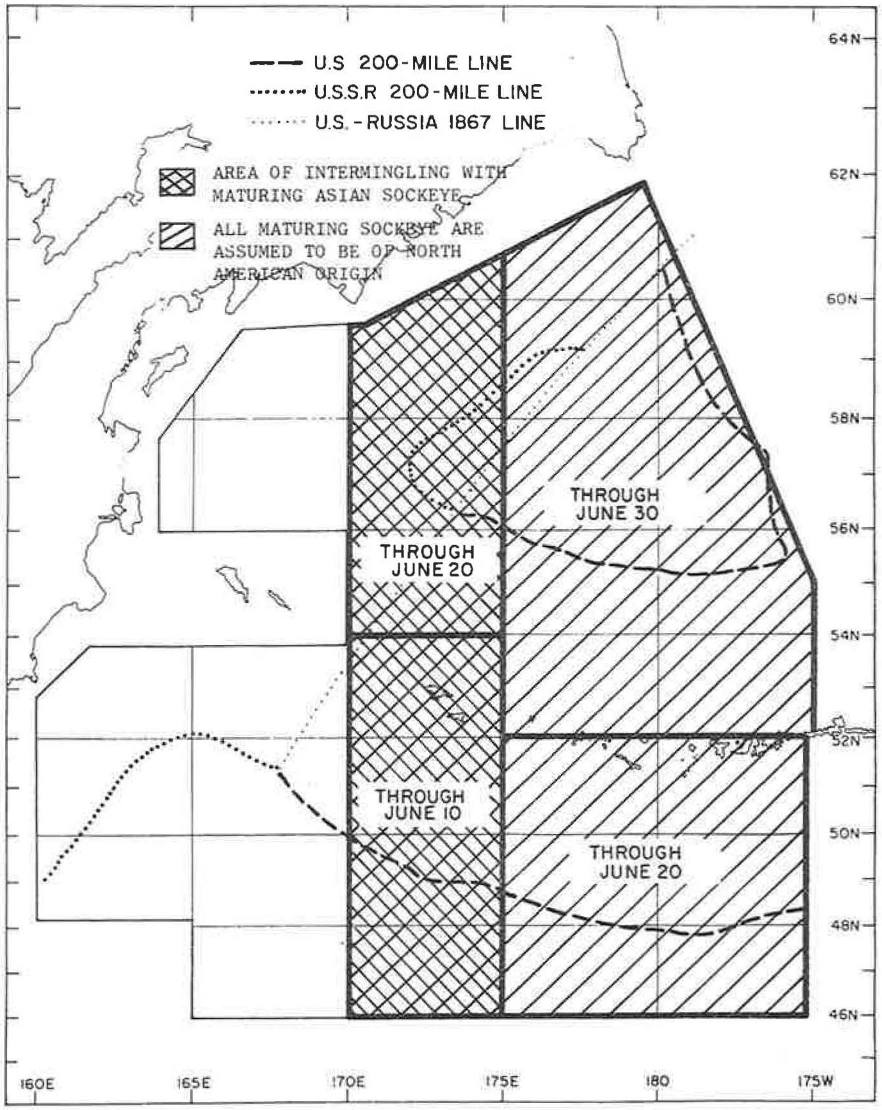


Figure 5.1.--Occurrence of maturing North American sockeye salmon in the Japanese salmon mothership area during the fishing season. (From Fredin and Worlund, 1974.)

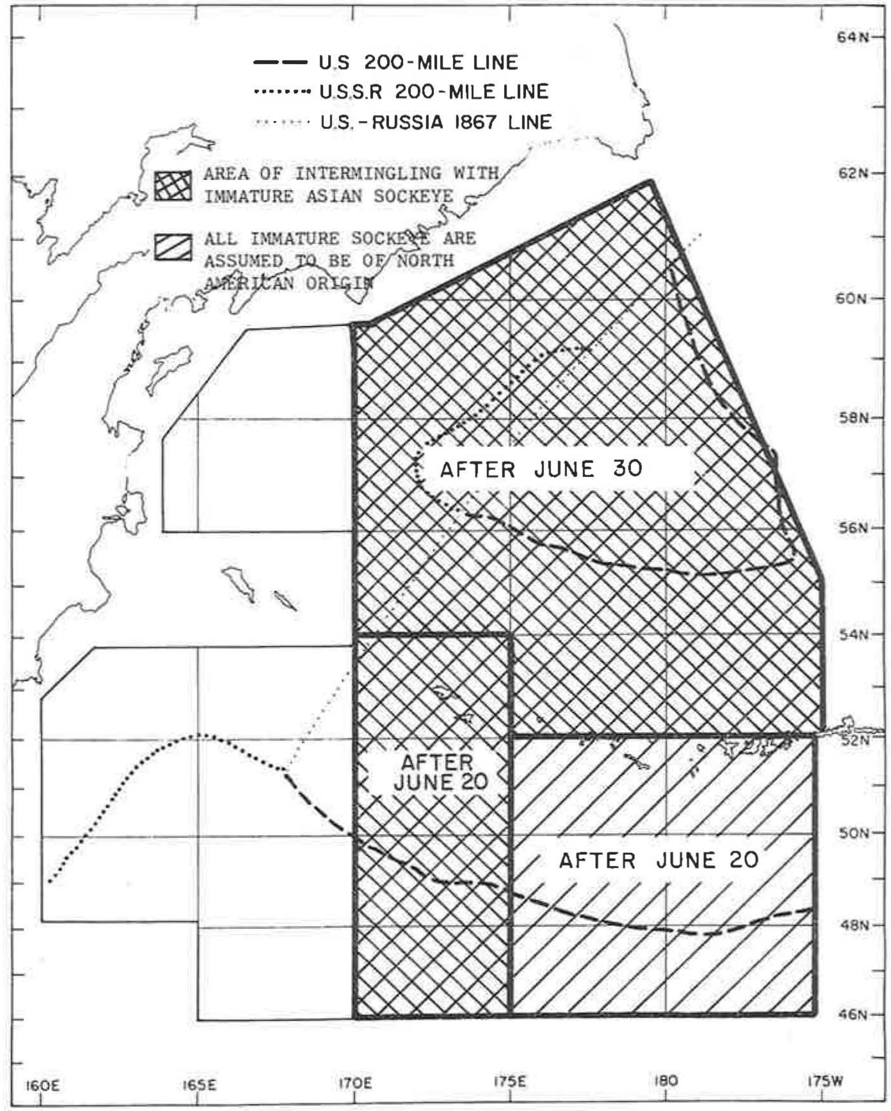


Figure 5.2.--Occurrence of immature North American sockeye salmon in the Japanese salmon mothership area during the fishing season. (From Fredin and Worlund, 1974.)

Estimates by U.S. scientists of the annual interceptions of maturing and immature North American sockeye by the mothership fishery during 1956-75 are given in Table 5.1 for each 2° x 5° statistical area.5.3/

The total number of North American sockeye intercepted by the mothership fishery during 1956-75 is estimated to have been nearly 46 million fish, or an average of 2.3 million fish per year. Annual interceptions of matures, which accounted for 85% of the total over the 20-year period, ranged from 0.2 to 6.4 million fish. The range for immatures was 11 thousand to 1.2 million fish. Within each cycle of the Bristol Bay sockeye run since 1956, average annual interceptions were as follows:

	Est. ave. annual interception (thousands of fish)		
Cycle	Matures	Immatures*	Total
1956-59	2,451	247	2,698
1960-64	2,296	130	2,426
1965-69	2,119	421	2,540
1970-74	1,176	557	1,733

*Intercepted in 1955-58, 1959-63, etc., with the interception in 1955 estimated to have been 41 thousand fish.

There was a decrease in the number of matures intercepted over the 4 cycles but an increase in the interception of immatures. Total interceptions decreased.

5.3/ The estimates of interceptions of mature western Alaska sockeye given in Table 5.1 agree fairly well with unpublished estimates by a Japanese salmon scientist. U.S. scientists estimate that a total of 37.8 million maturing sockeye were intercepted during 1956-74; the estimate by the Japanese scientist is 35.7 million fish. Average annual difference between the two sets of estimates is only 100,000 fish. The estimates for interceptions of immature fish, which the Japanese scientist first made in 1970, differ by a substantially greater quantity. He estimates the total for 1970-74 as 1.8 million fish; this compares to a total of nearly 3 million fish as estimated by U.S. scientists.

Table 5.1.--Estimates of interceptions of North American sockeye salmon by the Japanese mothership salmon fishery, in thousands of fish, 1956-75.a/

(a) Mature Sockeye

Stat.										Year										
Area	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
7046	17	0	32	12	0	3	117	0	6	0	20	25	2	13	6	63	52	193	12	139
7048	206	118	119	131	6	63	94	45	45	29	361	70	375	94	140	146	160	177	47	0
7050	353	968	157	95	125	609	12	290	0	247	153	0	81	22	133	49	32	0	1	0
7052	80	341	41	34	24	35	4	2	0	58	22	0	8	+	27	7	4	0	0	0
7054	0	14	0	0	0	12	0	0	0	52	1	0	0	+	0	16	0	0	0	+
7056	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0
7058	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0
7060	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	0
7546	0	0	0	0	0	0	0	0	0	0	1	0	+	1	+	+	1	32	5	119
7548	244	0	17	21	0	23	47	0	35	146	182	99	157	339	257	149	157	114	42	192
7550	377	297	0	272	533	519	346	236	68	1,001	115	239	95	167	423	113	123	48	24	101
7552	648	1,591	0	0	285	209	9	288	1	337	25	51	+	13	27	32	6	11	45	25
7554	92	331	0	0	45	0	0	33	5	67	2	3	6	23	6	15	10	9	24	14
7556	0	12	0	0	11	0	0	0	1	190	2	17	21	3	33	16	18	+	5	2
7558	0	155	0	0	15	0	0	0	2	15	6	0	22	3	52	6	14	0	+	+
7560	0	0	0	0	10	0	0	0	+	5	41	+	1	6	1	1	1	+	+	0
8046	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	6	+	+	0	30
8048	0	0	0	0	0	0	5	0	16	538	96	1	+	215	323	67	63	13	0	0
8050	0	0	0	0	137	1,810	200	6	47	1,974	280	130	4	135	1,167	55	2	23	0	0
8052	195	635	0	0	1,200	2,001	0	29	+	323	66	38	+	79	283	25	4	1	18	4
8054	219	980	0	0	838	517	0	2	+	449	74	161	23	100	146	38	17	2	6	14
8056	0	724	0	0	145	21	0	0	23	451	55	28	61	15	367	35	38	1	17	4
8058	0	277	0	0	233	0	0	0	4	182	28	1	7	13	60	1	7	+	3	+
8060	0	0	0	0	32	0	0	0	0	1	1	+	+	+	+	0	+	0	0	0
Total	2,431	6,443	366	565	3,639	5,822	834	931	253	6,097	1,531	863	863	1,241	3,451	840	709	624	249	644

Table 5.1.--Estimates of interceptions of North American sockeye salmon by the Japanese mothership salmon fishery, in thousands of fish, 1956-75.a/ --continued.

(b) Immature Sockeye (.2 Age)

Stat.										Year										
Area	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
7046	1	0	0	8	21	3	2	0	+	+	0	+	0	0	+	0	1	4	0	+
7048	25	0	0	10	12	0	22	10	3	+	0	+	0	+	5	0	5	24	10	0
7050	145	2	21	16	121	98	47	11	6	6	23	1	80	1	71	+	8	57	75	20
7052	76	2	12	27	88	7	1	12	8	77	26	+	110	9	28	14	1	5	19	0
7054	0	0	0	0	0	0	0	0	0	1	0	0	0	2	+	1	1	0	9	2
7056	6	0	0	0	0	8	0	0	0	35	0	0	0	7	10	3	5	11	1	19
7058	68	0	0	0	0	11	0	0	0	88	0	0	0	+	75	1	17	27	24	21
7060	0	0	0	0	0	0	0	2	0	+	0	0	0	0	8	+	1	0	0	0
7546	+	0	0	0	0	0	0	0	+	0	+	0	54	+	+	+	+	3	6	4
7548	4	0	0	0	0	0	0	3	15	0	+	0	22	204	52	194	+	14	60	29
7550	345	0	0	0	31	0	0	12	162	+	1	14	209	3	173	182	+	82	190	29
7552	1	0	0	0	0	0	0	0	+	0	+	0	8	0	+	0	0	0	0	+
7554	0	0	0	0	0	0	0	0	+	0	0	0	0	0	3	0	+	2	0	7
7556	0	1	0	4	0	0	0	0	1	2	4	1	0	4	27	0	12	5	5	10
7558	0	1	0	14	0	0	0	4	26	95	0	5	6	14	63	3	8	4	2	9
7560	0	0	0	6	0	0	0	5	36	12	0	0	3	4	40	+	55	0	0	0
8046	0	0	0	0	0	0	0	0	0	0	0	0	70	+	+	+	0	0	+	+
8048	7	0	0	0	0	0	0	0	18	0	1	0	18	116	5	108	+	0	38	+
8050	153	0	0	0	0	0	0	0	538	0	0	0	70	32	386	69	+	14	199	43
8052	28	0	0	0	0	0	0	0	0	0	0	0	0	+	1	0	0	0	3	+
8054	17	0	0	0	0	0	0	0	+	0	0	0	1	19	4	2	2	+	29	+
8056	11	3	0	0	6	0	0	0	3	+	0	0	120	56	218	3	30	2	22	8
8058	17	2	0	0	30	0	0	0	13	78	2	0	18	42	43	10	66	4	13	19
8060	0	0	0	0	0	0	0	0	13	4	0	0	0	+	+	+	+	0	0	0
Total	904	11	33	85	309	127	72	59	842	398	57	21	789	513	1,212	590	212	258	705	220

Table 5.1.--Estimates of interceptions of North American sockeye salmon by the Japanese mothership salmon fishery, in thousands of fish, 1956-75.a/ --continued.

(c) Mature and .2 Immature Sockeye

Stat.	Year																			
Area	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
7046	18	0	32	20	21	6	119	0	6	+	20	25	2	13	6	63	53	197	12	139
7048	231	118	119	141	18	63	116	55	48	29	361	70	375	94	145	146	165	201	57	0
7050	498	970	178	111	246	707	59	301	6	253	176	1	161	23	204	49	40	57	76	20
7052	156	343	53	61	112	42	5	14	8	135	48	+	118	9	55	21	5	5	19	0
7054	0	14	0	0	0	12	0	0	0	53	1	0	0	2	+	17	1	0	9	2
7056	6	0	0	0	0	8	0	0	0	67	0	0	0	7	10	3	5	11	1	19
7058	68	0	0	0	0	11	0	0	0	88	+	0	0	+	75	1	17	27	24	21
7060	0	0	0	0	0	0	0	2	0	+	0	0	0	0	8	+	1	0	0	0
7546	+	0	0	0	0	0	0	0	+	0	1	0	54	1	+	+	1	35	11	123
7548	248	0	17	21	0	23	47	3	50	146	182	99	179	543	309	343	157	128	102	221
7550	722	297	0	272	564	519	346	248	230	1,001	116	253	304	170	596	295	123	130	214	130
7552	649	1,591	0	0	285	209	9	288	1	337	25	51	8	13	27	32	6	11	45	25
7554	92	331	0	0	45	0	0	33	5	67	2	3	6	23	9	15	10	11	24	21
7556	0	13	0	4	11	0	0	0	2	192	6	18	21	7	60	16	30	5	10	12
7558	0	156	0	14	15	0	0	4	28	110	6	5	28	17	115	9	22	4	2	9
7560	0	0	0	6	10	0	0	5	36	17	41	+	4	10	41	1	56	+	+	0
8046	0	0	0	0	0	0	0	0	0	0	0	0	70	+	+	6	+	+	+	30
8048	7	0	0	0	0	0	5	0	34	538	97	1	18	331	328	175	63	13	38	+
8050	153	0	0	0	137	1,810	200	6	585	1,974	280	130	74	167	1,553	124	2	37	199	43
8052	223	635	0	0	1,200	2,001	0	29	+	323	66	38	+	79	284	25	4	1	21	4
8054	236	980	0	0	838	517	0	2	+	449	74	161	24	119	150	40	19	2	35	14
8056	11	727	0	0	151	21	0	0	26	451	55	28	181	71	585	38	68	3	39	12
8058	17	279	0	0	263	0	0	0	17	260	30	1	25	55	103	11	73	4	16	19
8060	0	0	0	0	32	0	0	0	13	5	1	+	+	+	+	+	+	0	0	0
Total	3,335	6,454	399	650	3,948	5,949	906	990	1,095	6,495	1,588	884	1,652	1,754	4,663	1,430	921	882	954	864

a/ Estimates in areas of intermingling are from Fredin and Worlund (1974a and 1974b), Worlund (1975 and 1976), and Worlund and Gangmark (1977); estimates for other areas are from catch statistics reported in INPFC Statistical Yearbooks and age composition data provided by the Fisheries Agency of Japan (personal communication).

The mothership interceptions, which have generally followed the strong cyclic pattern of catches in Bristol Bay, represented 23% of the total catch of western Alaska sockeye during 1956-75 (Table 5.2 and Figure 5.3).5.4/ The mothership fishery accounted for 5-10% of the total catch in 3 of the 20 years, 15-25% in 13 years, and 33-53% in 4 years. The percentages in each of the 4 cycles completed since 1956 were as follows:

	Ann. ave. interception & coastal catch - 1000's of fish			% caught
Cycle	Interception	Coastal catch	Total catch	by M'ships
1956-59	2,698	6,389	9,087	29.7
1960-64	2,426	8,120	10,546	23.0
1965-69	2,540	9,709	12,249	20.7
1970-74	1,733	7,204	8,937	19.4

There was a decrease in the percentage taken by the mothership fishery over the 4 cycles.

5.4/ Since western Alaska fish have accounted for 98-99% of the interceptions of North American sockeye by the mothership fishery, the interceptions are compared with catches in western Alaska. Interceptions of other species are also compared with catches in western Alaska because that region produces practically all of the North American salmon taken by the mothership fishery.

Table 5.2.--Estimates of the interceptions of North American sockeye salmon by the Japanese mothership salmon fishery and commercial catches in western Alaska, 1956-75, in thousands of fish.

Year	Mothership interceptions a/	Western AK catch b/	Total catch	Percent caught by motherships
1956	2,472	10,252	12,724	19
1957	7,347	6,603	13,950	53
1958	377	3,459	3,836	10
1959	598	5,243	5,841	10
1960	3,724	14,398	18,122	21
1961	6,131	12,302	18,433	33
1962	961	4,974	5,935	16
1963	1,003	3,096	4,099	24
1964	312	5,831	6,143	5
1965	6,939	24,455	31,394	22
1966	1,929	9,560	11,489	17
1967	920	4,555	5,475	17
1968	884	3,030	3,914	23
1969	2,030	6,943	8,973	23
1970	3,964	20,932	24,896	16
1971	2,052	9,939	11,991	17
1972	1,299	2,596	3,895	33
1973	836	933	1,769	47
1974	507	1,618	2,125	24
1975	1,349	5,050	6,399	21
Total	45,634	155,769	201,403	23

a/ Includes immatures caught in preceding year (estimated as 45 thousand fish in 1955 and as given in Table 5.1 for other years).

b/ Bristol Bay and the north side of the Alaska Peninsula. See Appendix 1 for data sources.

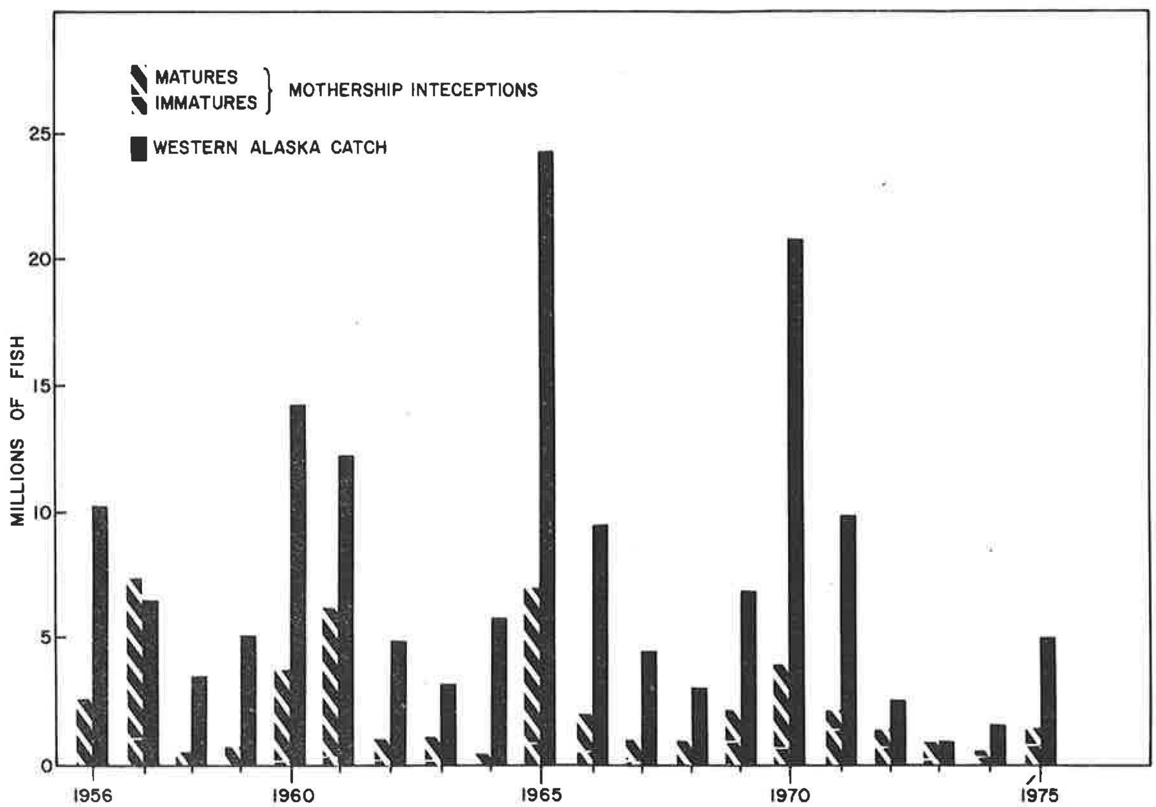


Figure 5.3.--Estimates of interceptions of North American sockeye by the Japanese mothership salmon fishery and catches in western Alaska, 1956-75 runs. (Immatures intercepted in the year preceding the run. Data from Table 5.2.)

The estimates of interceptions do not reflect the full impact of the mothership fishery on the coastal fishery in western Alaska. They do not include the dead fish which drop out of gillnets fished on the high seas, hence are not landed. They do not indicate the numbers of fish which escape from the nets but die as a result of injury. Nor do they depict the increase in biomass (gain in weight adjusted for natural mortality) which accrues between the time the fish are subjected to a high seas fishery and the time they enter the inshore fishery. An analysis by Ricker (1976) of all of these factors indicates that, if high seas interceptions of North American sockeye were to cease, the benefits to U.S. fishermen would be 1.76 times the tonnage of such fish taken pelagically. Thus, although the interception of 46 million sockeye over a 20-year period in itself clearly indicates a substantial impact on U.S. fishermen, the impact of high seas salmon fishing is significantly greater when viewed in terms of the tonnage lost.

5.1.2 Pink Salmon

All of the recoveries in North America of pink salmon tagged in the Japanese salmon mothership fishing area have been from fisheries or streams in western Alaska (excluding the Aleutian Islands). It appears that the quantity of North American pink salmon of non-western Alaska origin in the mothership fishing area is so small that it can be ignored. Hence, all of the North American pink salmon intercepted by the mothership fishery are considered to be of western Alaska origin (again excluding the Aleutian Islands).

5.1.2.1 Procedure for Estimating Interceptions

Estimates of the annual interceptions of western Alaska pink salmon have been derived from tag recoveries during 1956-76 (treated separately for odd- and even-numbered years) and mothership catch statistics.[5.5/] The estimating procedure consists of applying the values obtained from the following equation to catches in those sectors of the mothership fishing area where tag recoveries indicated the presence of western Alaska pinks:

$$X = \frac{A+B}{A+B+C+D}$$

where, for a given high seas area, X is the percent western Alaska fish in a mixture with Asian fish, A is the number of tagged fish recovered in western Alaska, B is the number of high seas recoveries of tagged fish apparently destined for western Alaska, C is the number of tagged fish recovered in Asia, and D is the number of high seas recoveries of tagged fish apparently destined for Asia.

5.5/ Tag recovery data used in estimating the interceptions of North American pink, chum and coho salmon by the mothership fishery are from Aro et al (1971) and Aro (1972, 1974 and 1977).

The estimating procedure suffers some major shortcomings. These include the limited tag recovery data for several sectors of the mothership fishing area; the likelihood of different rates of tag recovery (or reporting thereof) in Asia, western Alaska and on the high seas; the questionable representativeness of the tagging locations and times; and possible errors in reporting of recovery locations. Because of shortcomings such as these the estimates of interceptions from the tag recovery data could be misleading. In spite of this fact, we believe they serve a worthwhile purpose in providing some information on interceptions and that the reader will recognize them as first approximations.

5.1.2.2 Percentages of Western Alaska Pink Salmon in Catches in Odd-Numbered Years

Estimates of the percentages of western Alaska pink salmon in mothership catches in odd-numbered years (and also even-numbered years) are presented for various sectors of the mothership area, the sectors being selected on the basis of the presence or absence of tag recoveries in western Alaska and the quantity of tag recovery data which can be accommodated in a single chart.

5.1.2.2.1 East of 180°, south of the Aleutians

There have been only 2 recoveries reported in western Alaska for pink salmon tagged in the mothership area in odd-numbered years during 1957-75. Both were tagged a short distance south of Adak Island in 8050 (Figure 5.4).[5.6] In sharp contrast, 33 recoveries have been reported in Asia from odd-year taggings at the same location. Nearly 100 high seas recoveries from taggings in 8050 and another Asian recovery of a fish tagged at 177°W/50°N further indicate the preponderance of Asian pinks in 8050 in odd-numbered years.

Values used to estimate the percent western Alaska pink salmon in 8050 for odd-year runs are A = 2, B = 0, C = 34, and D = 96, from which X = 2 ÷ 132 or about 2%.

South of 8050 in Subarea 9, only 1 recovery of a tagged pink salmon has been reported. That fish was tagged a short distance west of the abstention line at 49°30'N (Figure 5.5). The recovery of another pink tagged a short distance east of the abstention line near 48°N has also been reported. Both recoveries were made on the high seas and undoubtedly were fish destined for Asia.

5.6/ Recoveries of 2 more pink salmon tagged south of Adak Island in odd-numbered years have been reported from the Aleutian Islands.

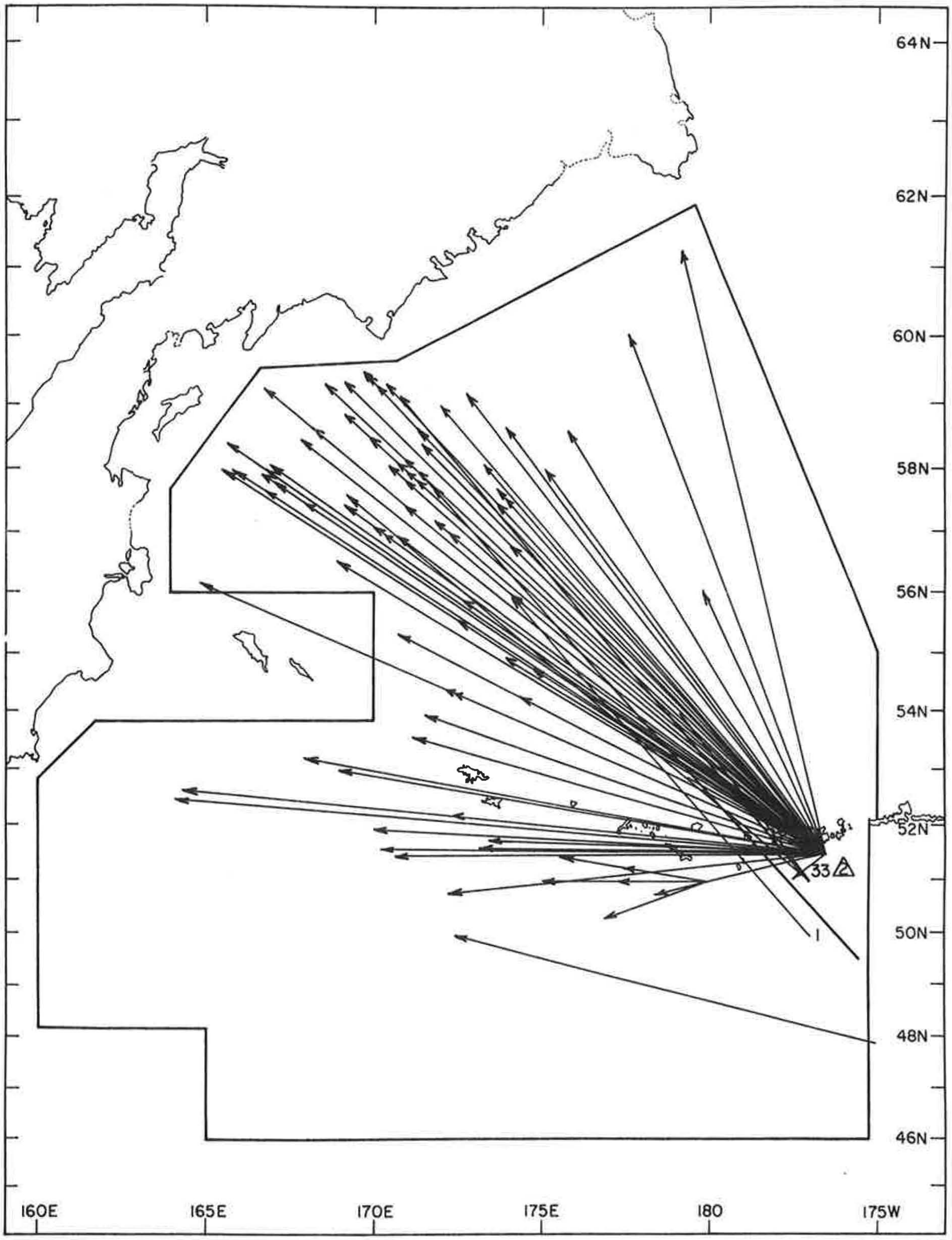


Figure 5.4.--Coastal recoveries in Asia and western Alaska and high seas recoveries of pink salmon tagged between 175°W and 180°, south of the Aleutians to 46°N, in odd-numbered years, 1957 to 1975. (No's. recovered in coastal areas are shown beside the tagging locations, with recoveries in western Alaska enclosed by a triangle. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

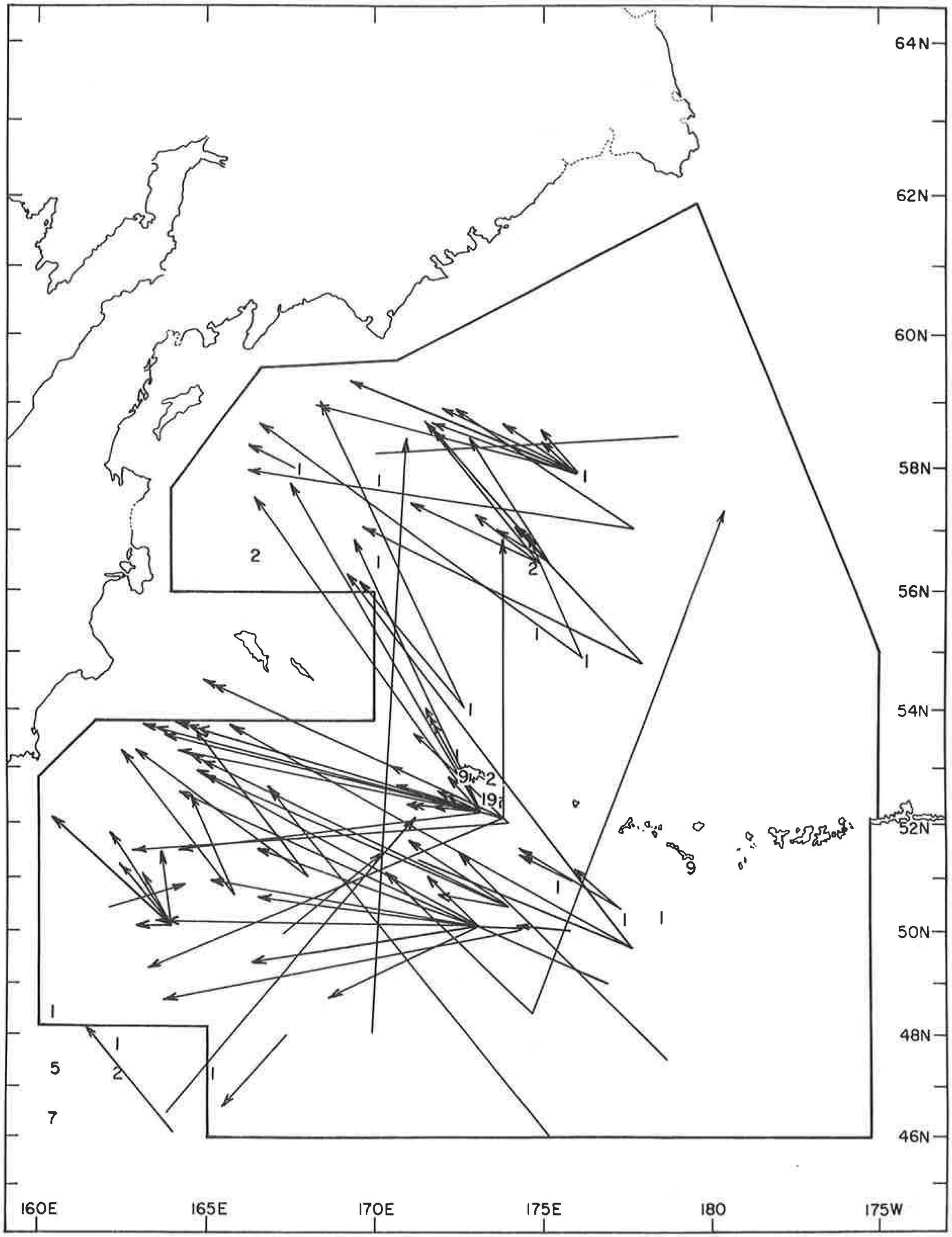


Figure 5.5.--Coastal recoveries in Asia and high seas recoveries of pink salmon tagged between 160°E and 180°, north of 46°N, in odd-numbered years, 1957-75. (No recoveries reported from western Alaska. No's. recovered in Asia are shown beside the tagging locations. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

Because of the limited tag recovery data for waters south of 50°N between 175°W and 180°, we have examined the recoveries from taggings south of the Aleutians between 175°E and 180° (Figure 5.5) in making a determination as to the percent western Alaska pinks in catches from 8046-48. Taggings in Subarea 7 have produced 12 recoveries in Asia, all except one being from the Karaginski fishing district of the U.S.S.R., far to the northwest of the tagging locations. There have, in addition, been 11 high seas recoveries, some of which were also to the northwest of the tagging locations. These coastal and high seas recoveries suggest not only that all of the pink salmon in Subarea 7 are of Asian origin but that many of them enter the subarea by migrating in a northwesterly direction through 8046-48. If this is the case, the interception of western Alaska pinks in catches in 8046-48 can be presumed to be the same as it appears to be in Subarea 7, that is, zero.

5.1.2.2.2 East of 180°, north of the Aleutians

Odd-year taggings in the mothership area north of the Aleutians and east of 180° have provided 13 recoveries in Asia and 66 high seas recoveries of fish apparently bound for Asia (Figure 5.6). Taggings along 175°W outside the mothership area have produced 10 more high seas recoveries, all indicating movement toward Asia. There is no evidence from any of these taggings that western Alaska pinks are present in Subarea 10 in odd-numbered years. Although some of them probably migrate through the subarea enroute from waters south of Adak Island to their home streams, the number is undoubtedly quite small, judging from the size of the catches in Bristol Bay and the Arctic-Yukon-Kuskokwim fishing district in odd-numbered years. In the circumstance, we have assumed that the interception of such fish is zero.

5.1.2.2.3 West of 180°

Not only for Subarea 7 but for the rest of the mothership area to the west of 180°, the tag recovery data (Figure 5.5) indicate that it is not unreasonable to conclude that no western Alaska pinks are intercepted by the mothership fishery in odd-numbered years. The same conclusion could probably be reached simply by comparing the small average annual catch in western Alaska in odd-numbered years during 1957-75 with the corresponding figure for the combined catch by the U.S.S.R. and the mothership fishery west of 180°: approximately 80 thousand fish vs. nearly 50 million fish.

5.1.2.3 Percentages of Western Alaska Pink Salmon in Catches in Even-Numbered Years

There are large portions of the mothership area for which no or only a very few recoveries of pink salmon tagged in even-numbered years have been reported. These are the waters east of 175°E and south of 50°N and much of the Bering Sea (Figures 5.7 and 5.8). Most of the reported recoveries have been from tagging locations in 7550 and 8050 and Subarea 1.

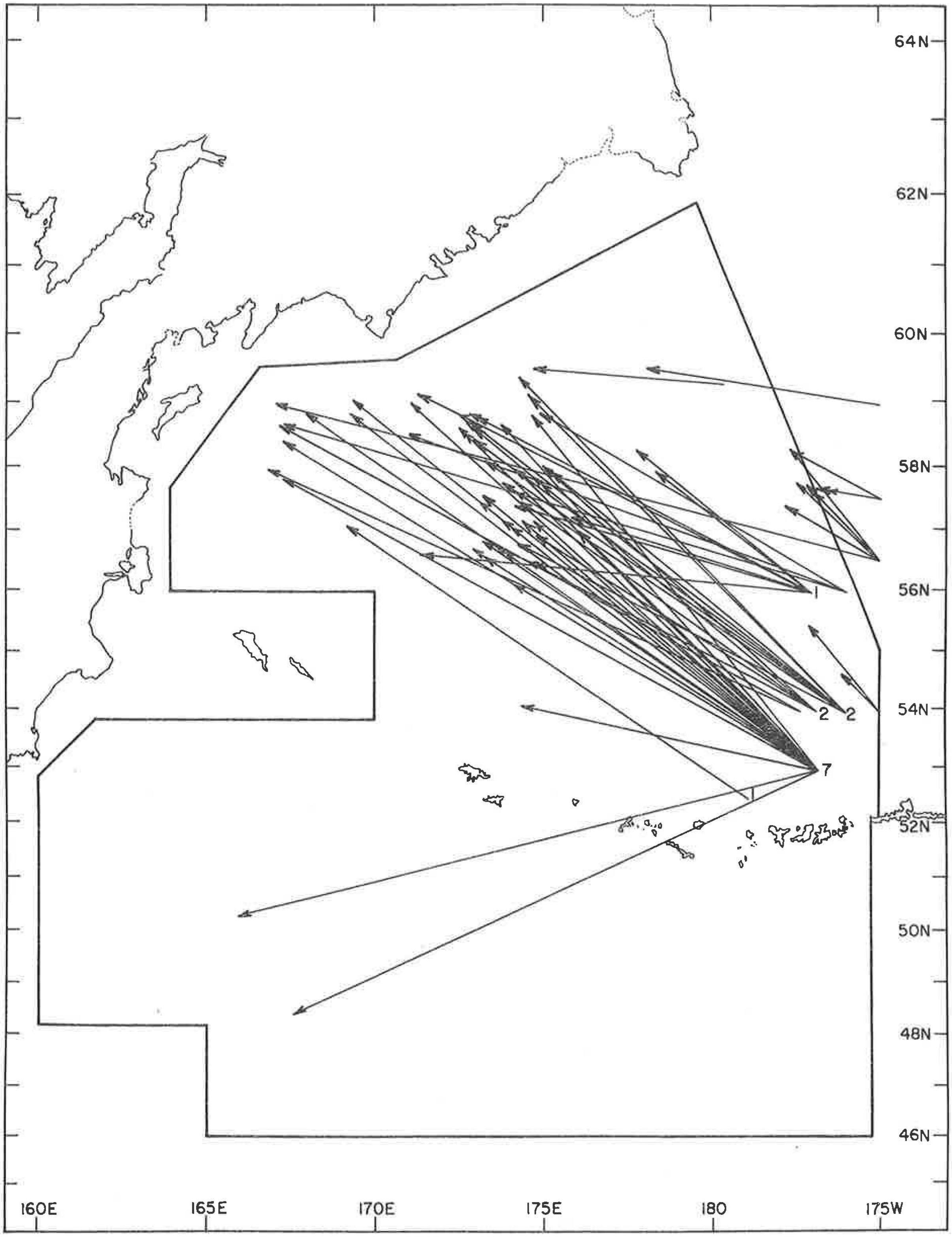


Figure 5.6.--Coastal recoveries in Asia and high seas recoveries of pink salmon tagged between 175°W and 180°, north of the Aleutians, in odd-numbered years, 1957-75. (No recoveries reported from western Alaska. No's. recovered in Asia are shown beside the tagging locations. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

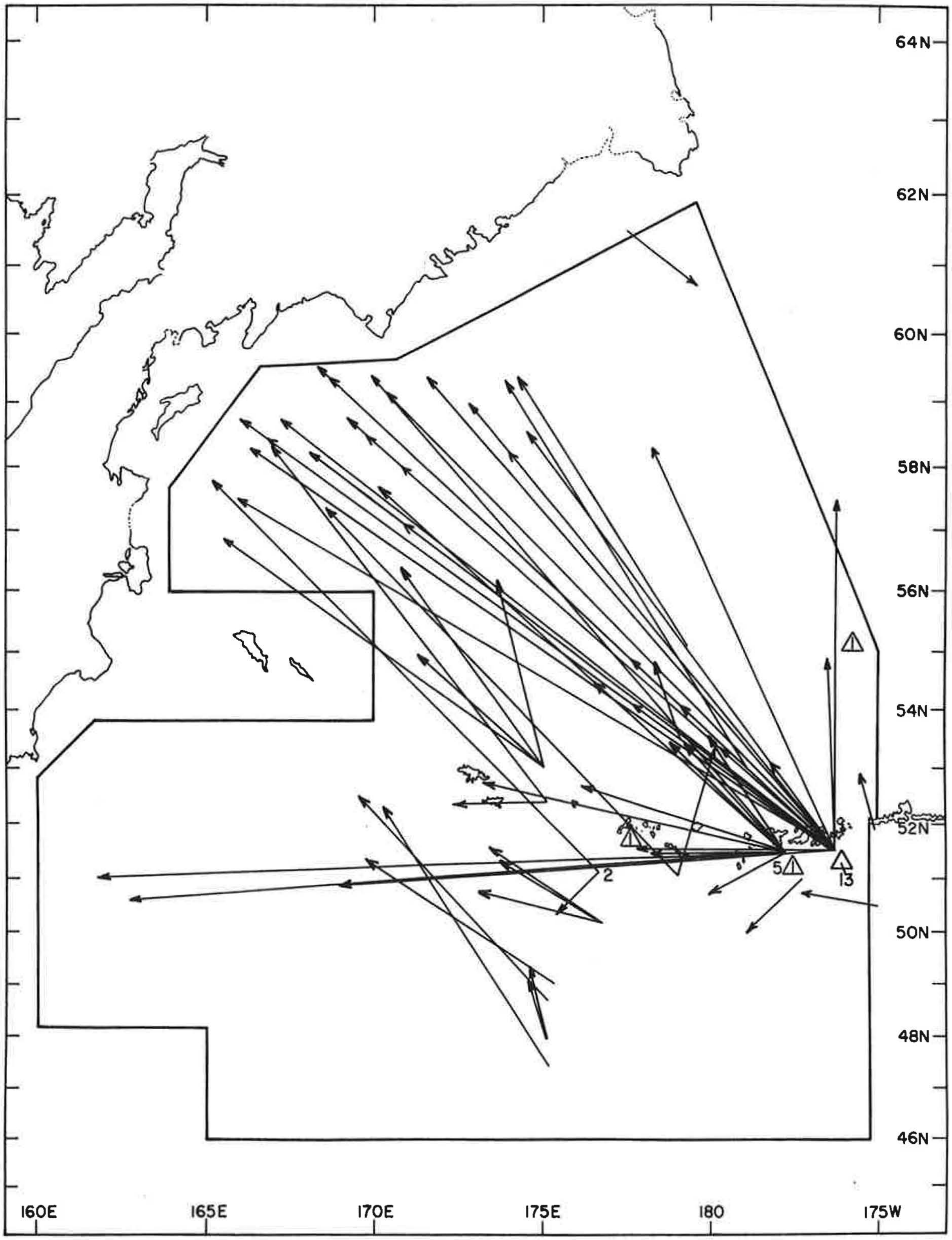


Figure 5.7.--Coastal recoveries in Asia and western Alaska and high seas recoveries of pink salmon tagged between 175°W and 175°E, north of 46°N, in even-numbered years, 1956-76. (No's. recovered in coastal areas are shown beside the tagging locations with the recoveries in western Alaska enclosed by triangles. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

5.1.2.3.1 East of 175°E, South of the Aleutians

The tag recoveries indicate a substantially larger percentage of western Alaska pinks in mothership catches in 7550-8050 in even-numbered years than in odd-numbered years: A = 15, B = 0, C = 7, and D = 45, with X, the percentage western Alaska pinks, being estimated as 15 ÷ 67 or 22% (Figure 5.7).5.7/ In making this estimate, 1 high seas recovery near 180°/53°N of a fish tagged near 179°E/51°N has been excluded from the B-value, and 2 high seas recoveries near 176°W at 55°N and 57°N from taggings south of Adak Island have been excluded from the D-value. Two high seas recoveries from taggings a short distance east of the abstention line have also been excluded from consideration.

For the mothership area south of 50°N and east of 175°E (7546-48 and 8046-48) we assume, on the basis of our review of tagging data for odd-years, that all of the pinks in these waters in even-years are moving in a northwesterly direction to streams in Asia and that no western Alaska pinks are intercepted.

5.1.2.3.2 East of 175°E, North of the Aleutians

Bering Sea taggings between 175°E and 175°W (Figure 5.7) have produced 1 recovery in western Alaska, 1 high seas recovery indicating movement toward western Alaska, no Asian recoveries, and 8 high seas recoveries indicating migrations toward Asia. Taggings between 170°E and 175°E (Figure 5.8) have produced 11 high seas recoveries, 8 indicating movement toward Asia and 3 toward western Alaska. The latter recoveries were made close to or east of 175°E.

The tagging data indicate that some western Alaska pinks are intercepted by the mothership fishery east of about 175°E in the Bering Sea in even-numbered years. It appears that the interceptions in Subarea 8 and most of those in Subarea 10 would be in waters to the south of 56°N, or in 7552-54 and 8052-54. As for the percentages of western Alaska pinks in the mothership catches from those 4 statistical areas, we make first guesses of 20% for 8052-54 (about the same as in 7550-8050) and 10% for 7552-54. The latter percentage is lower because it is assumed that western Alaska pinks found immediately south of the Aleutians and to the west of 180° generally move in a northeasterly direction to Subarea 10 after passing between the islands rather than northerly into Subarea 8.

5.1.2.3.3 West of 175°E

For the mothership area to the west of 175°E (Figure 5.8), it is assumed that no western Alaska pinks are intercepted.

5.7/ In addition to the recoveries reported from western Alaska, 5 pinks tagged south of Adak Island in even-years have been recovered in the Aleutian Islands.

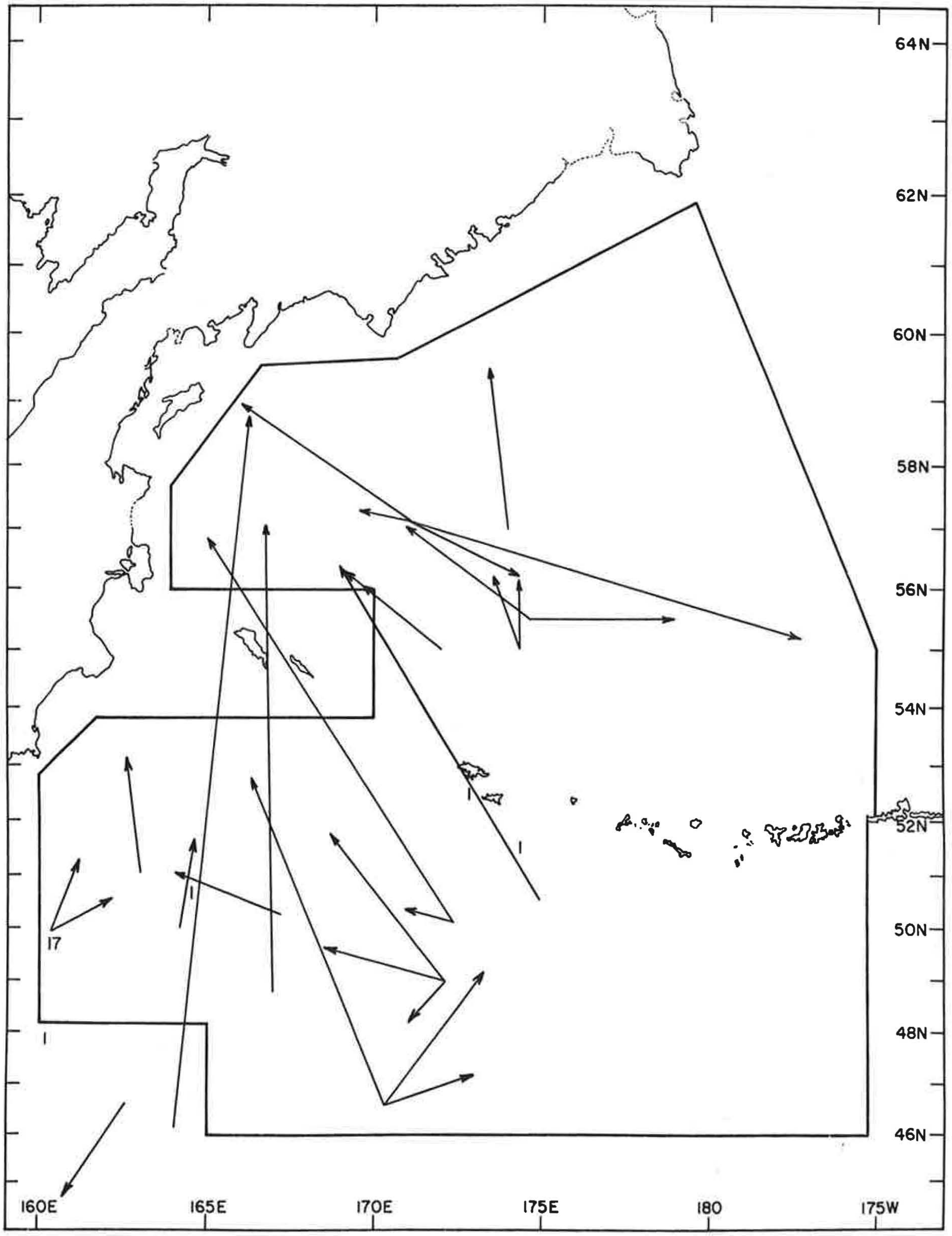


Figure 5.8.--Coastal recoveries in Asia and high seas recoveries of pink salmon tagged between 160°E and 175°E, north of 46°N, in even-numbered years, 1956-76. (No recoveries reported from western Alaska. No's. recovered in Asia are shown beside the tagging locations. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

5.1.2.4 Generalized Areas of Occurrence of North American Pink Salmon in the Mothership Fishing Area

The areas of occurrence of North American (western Alaska) pink salmon in the Japanese salmon mothership fishery area are depicted in Figure 5.9. The areas are generalized to correspond with the boundaries of 2° x 5° statistical areas because catch statistics are reported by statistical area.

In even-numbered years, the area of occurrence of North American pink salmon in the mothership fishing area is bounded by 50°N on the south, 175°E on the west, 56°N on the north, and the abstention lines on the east. In odd-numbered years, Statistical Area 8050 is the only part of the mothership area in which North American pinks occur.

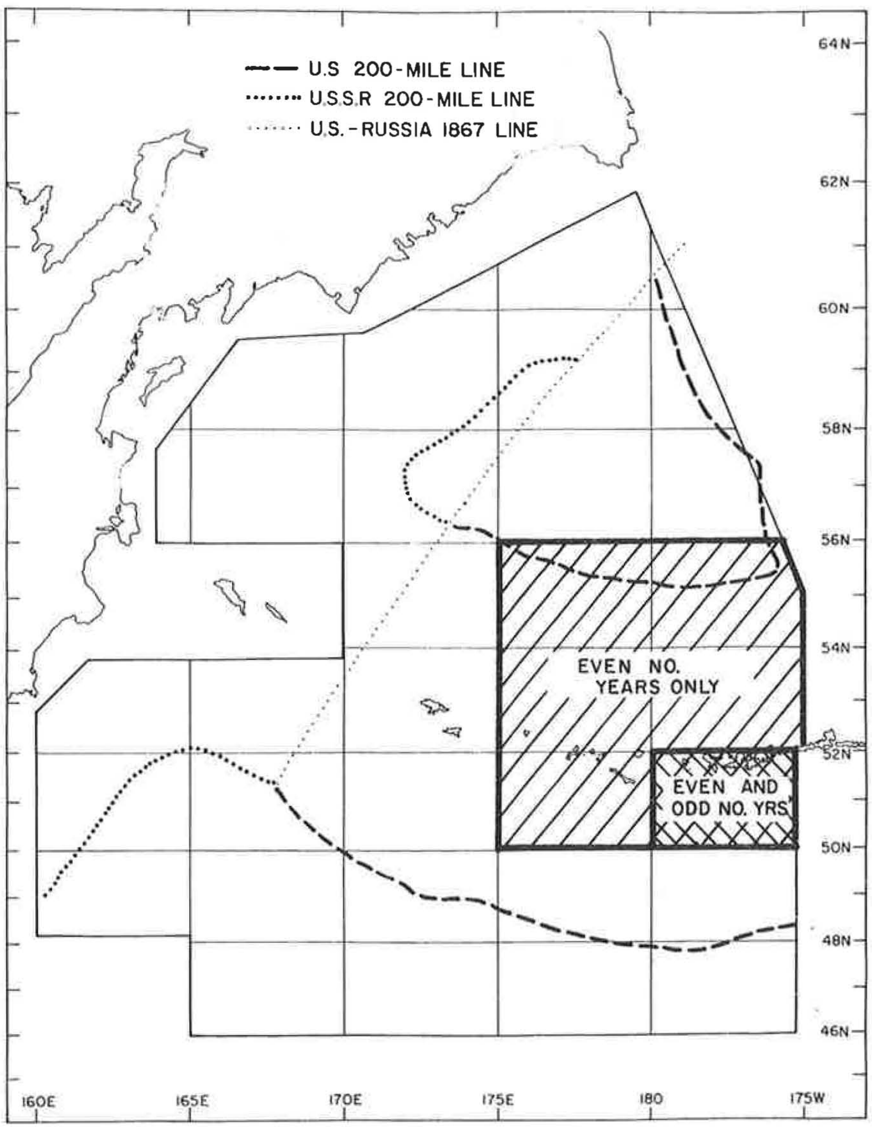


Figure 5.9.--Occurrence of North American pink salmon in the Japanese salmon mothership fishing area and areas of intermingling with Asian pink salmon.

5.1.2.5 Estimates of Annual Interceptions

Table 5.3 gives the estimates of annual interceptions of North American pink salmon by the Japanese mothership salmon fishery during 1956-75, by 2° x 5° statistical area.

The average annual interception of North American pink salmon by the mothership fishery in even-numbered years between 1956 and 1974 is estimated to have been slightly under 50 thousand fish. Excluding 1974, the average drops to 25 thousand fish. The estimate for odd-numbered years between 1957 and 1975 is a mere 2 thousand fish per year.

Table 5.3. Estimates of interceptions of North American pink salmon by the Japanese mothership salmon fishery, in thousands of fish, 1956-75.[a/] [b/]

	Statistical Area						
Year	7550	7552	7554	8050	8052	8054	Total
1956	10	2	1	1	1	1	16
1957	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0
1960	2	4	2	+	6	14	28
1961	0	0	0	2	0	0	2
1962	16	+	0	9	0	0	25
1963	0	0	0	+	0	0	+
1964	6	+	+	9	+	+	15
1965	0	0	0	2	0	0	2
1966	3	1	+	14	2	3	23
1967	0	0	0	4	0	0	4
1968	16	1	4	4	+	2	27
1969	0	0	0	3	0	0	3
1970	18	1	+	24	10	7	60
1971	0	0	0	5	0	0	5
1972	14	4	3	+	1	7	29
1973	0	0	0	4	0	0	4
1974	95	57	28	42	11	20	253
1975	0	0	0	4	0	0	4

a/ All North American pinks are assumed to be of western Alaska origin.

b/ Obtained by multiplying the annual mothership catches in the indicated Statistical Areas by the following estimates of the percentage of North American pinks in the catches:

7550:	22%	in	even-years,	zero	in	odd-years		
7552-54:	10%	"	"	" ,	"	"	"	"
8050:	22%	"	"	" ,	2%	"	"	"
8052-54:	20%	"	"	" ,	zero	"	"	"

Estimates of annual interceptions and catches of pink salmon in western Alaska are compared in Table 5.4. The interceptions appear to have had little bearing on the catches in western Alaska.

Table 5.4.--Estimates of the interceptions of North American pink salmon by the Japanese mothership salmon fishery and commercial catches in western Alaska, 1956-75, in thousands of fish.

Year	Mothership interceptions[a/]	Western AK catch[b/]	Total catch	Percent caught by motherships
1956	16	120	136	12
1957	0	3	3	0
1958	0	1,196	1,196	0
1959	0	10	10	0
1960	28	337	365	8
1961	2	38	40	5
1962	25	979	1,004	2
1963	+	63	63	+
1964	15	1,571	1,586	1
1965	2	3	5	40
1966	23	2,522	2,545	1
1967	4	31	35	11
1968	27	2,083	2,110	1
1969	3	90	93	3
1970	60	557	617	10
1971	5	5	10	50
1972	29	174	203	14
1973	4	49	53	8
1974	153	1,160	1,413	18
1975	4	34	38	11
Total	500	11,025		4

a/ From Table 5.3.
b/ Bristol Bay, north side of the Alaska Peninsula, and the Arctic-Yukon-Kuskokwim fishing district. See Appendix 1 for data sources.

5.1.3 Chum Salmon

Tag recoveries have shown that most of the North American chum salmon found in the Japanese salmon mothership fishing area originate in streams in western Alaska, but some originate in streams outside of western Alaska[5.8].

5.1.3.1 Procedure for Estimating Interceptions

Because North American chums of western Alaska and non-western Alaska origins occur in the mothership fishing area, we have estimated the interceptions by the mothership fishery in two steps. The first step involves western Alaska chums only and the estimating procedure described for pink salmon (Section 5.1.2.1). In the second step, the ratio of tag recoveries in North American coastal areas outside of western Alaska to tag recoveries in western Alaska is calculated, and that ratio is multiplied by the estimates of interceptions of western Alaska chums in those sectors of the mothership area in which North American chums of non-western Alaska origin have been found.

The procedure is cumbersome, but it provides some indication as to the relative numbers of western Alaska and non-western Alaska chum salmon intercepted by the mothership fishery. Also in connection with the procedure, it can be demonstrated mathematically that it results in an over-estimation of the interceptions of North American fish. The extent of over-estimation is not substantial, however, when the estimates of the percentage of western Alaska fish in the mothership catches and the ratio of tag recoveries in non-western Alaska coastal areas to tag recoveries in western Alaska are both small.

5.1.3.2 Percentage of Western Alaska Chum Salmon in Catches

Our estimates of the percentages of western Alaska chum salmon in catches in various sectors of the mothership fishing area are for mature and immature fish combined, but they are based on the recoveries of tagged matures. We have not attempted to make separate estimates of the interceptions of immature chums because tag recovery data for immatures are limited and the catches of chums in most parts of the mothership area are not easily categorized according to maturity.

5.8/ Included in the category of western Alaska chums (and chinooks) are those fish which originate in that portion of the Yukon River lying in Canada.

5.1.3.2.1 East of 175°E, South of the Aleutians

Mature western Alaska chum salmon have been tagged a short distance east of the abstention line near 52°N (Figure 5.10), south of Adak Island in 8050 (Figure 5.11), and in 7550 (Figure 5.12).5.9/ The vast majority of the recoveries from tagging locations shown in Figures 5.10 through 5.12, however, have been in Asia or on the high seas in the direction of Asia. It appears that for the mothership area east of 175°E and south of the Aleutians western Alaska chums are present only in 7550-8050.

The percentage of western Alaska chums in the mothership catches in 7550-8050 is estimated as follows: A = 8, B = 0, C = 157, D = 104, and X = 8 ÷ 269 or 3%. The high seas recovery near 176°W/58°30'N of a fish tagged near 170°E/51°N (Figure 5.12) is excluded from the B- as well as the D-value because it is not known whether the fish was migrating to a stream in western Alaska or headed for Asia (Anadyr Bay). Recoveries from taggings east of the abstention line (Figure 5.10) are also excluded from consideration.

As indicated previously, the estimate of 3% is assumed to represent not only the percentage of western Alaska chums in the catches of mature fish in 7550-8050 but the catches of immatures as well. In this instance, tag recovery data for immature chums are sufficient for making a judgment as to the reasonableness of the assumption. The data are from taggings in 7550-8050 and are as follows: A = 9, B = 1, C = 76, D = 171, and X = 10 ÷ 257 or 4% about the same as obtained from tagging data for matures.5.10/

5.9/ One recovery of a mature chum salmon tagged south of Adak Island has been reported from southeastern Alaska.

5.10/ In addition to the 9 recoveries in western Alaska (A-value) and the recovery of a tagged fish near 169°30'W/56°30'N (B-value), 4 recoveries have been reported from southeast Alaska, 1 recovery near the Shumagin Islands, and 1 recovery at 150°30'W/47°N.

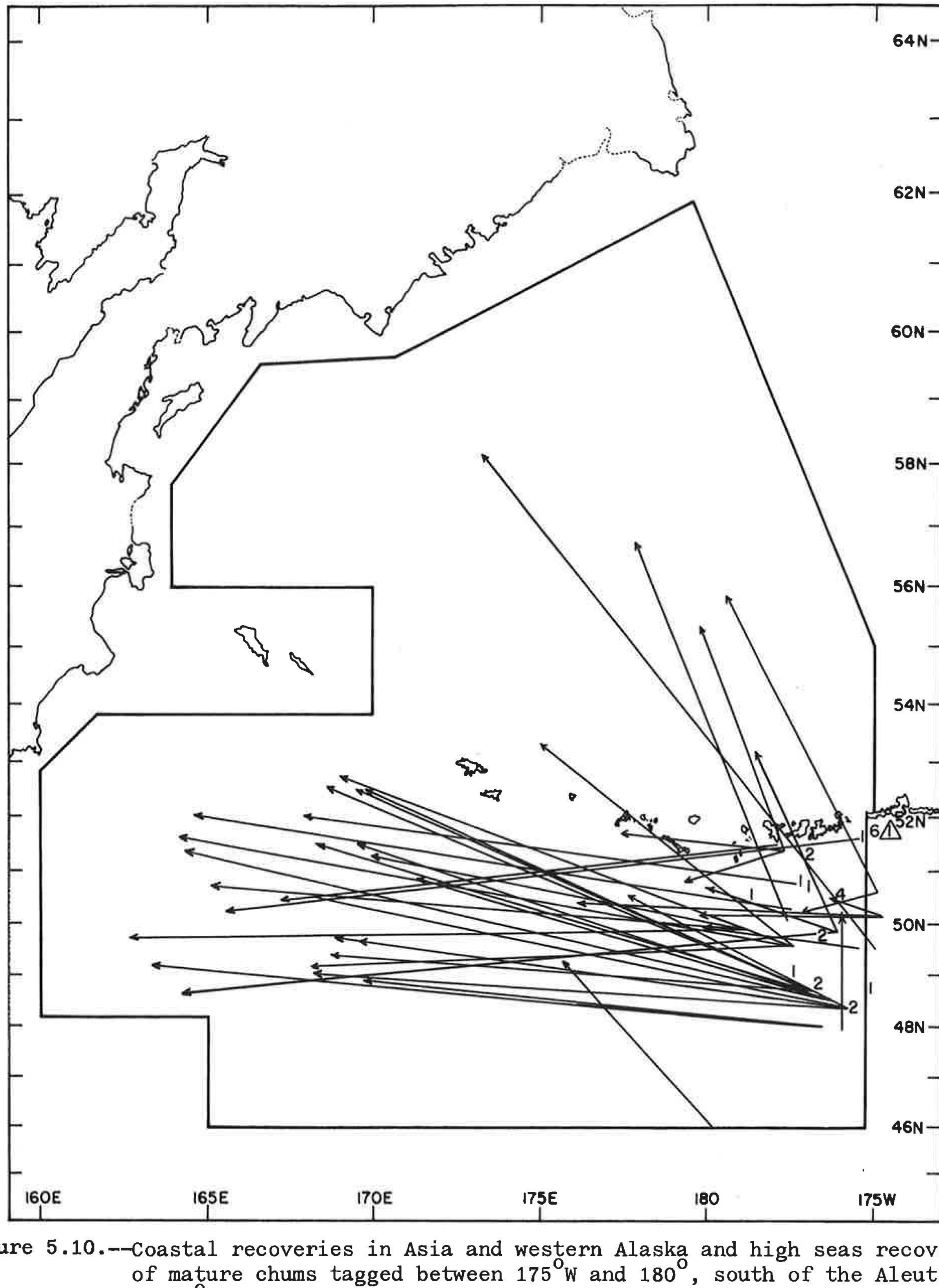


Figure 5.10.--Coastal recoveries in Asia and western Alaska and high seas recoveries of mature chums tagged between 175°W and 180°, south of the Aleutians to 46°N excluding taggings south of Adak Island, 1956-76. (No's. recovered in coastal areas are shown beside tagging locations, with the recovery in western Alaska enclosed by a triangle. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

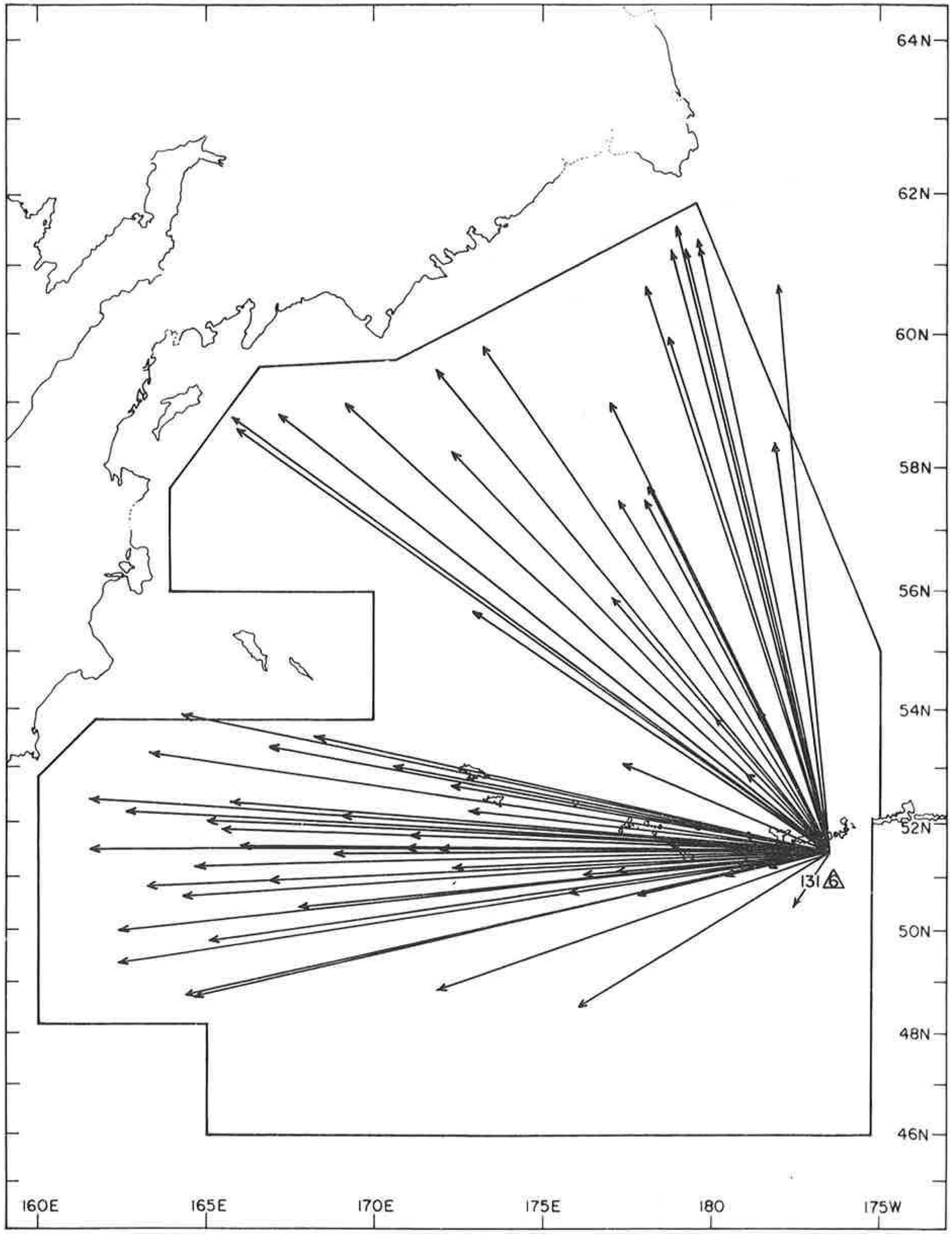


Figure 5.11.--Coastal recoveries in Asia and western Alaska and high seas recoveries of mature chums tagged south of Adak Island, 1956-76. (No's. recovered in coastal areas are shown beside the tagging locations, with the recoveries in western Alaska enclosed by a triangle. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

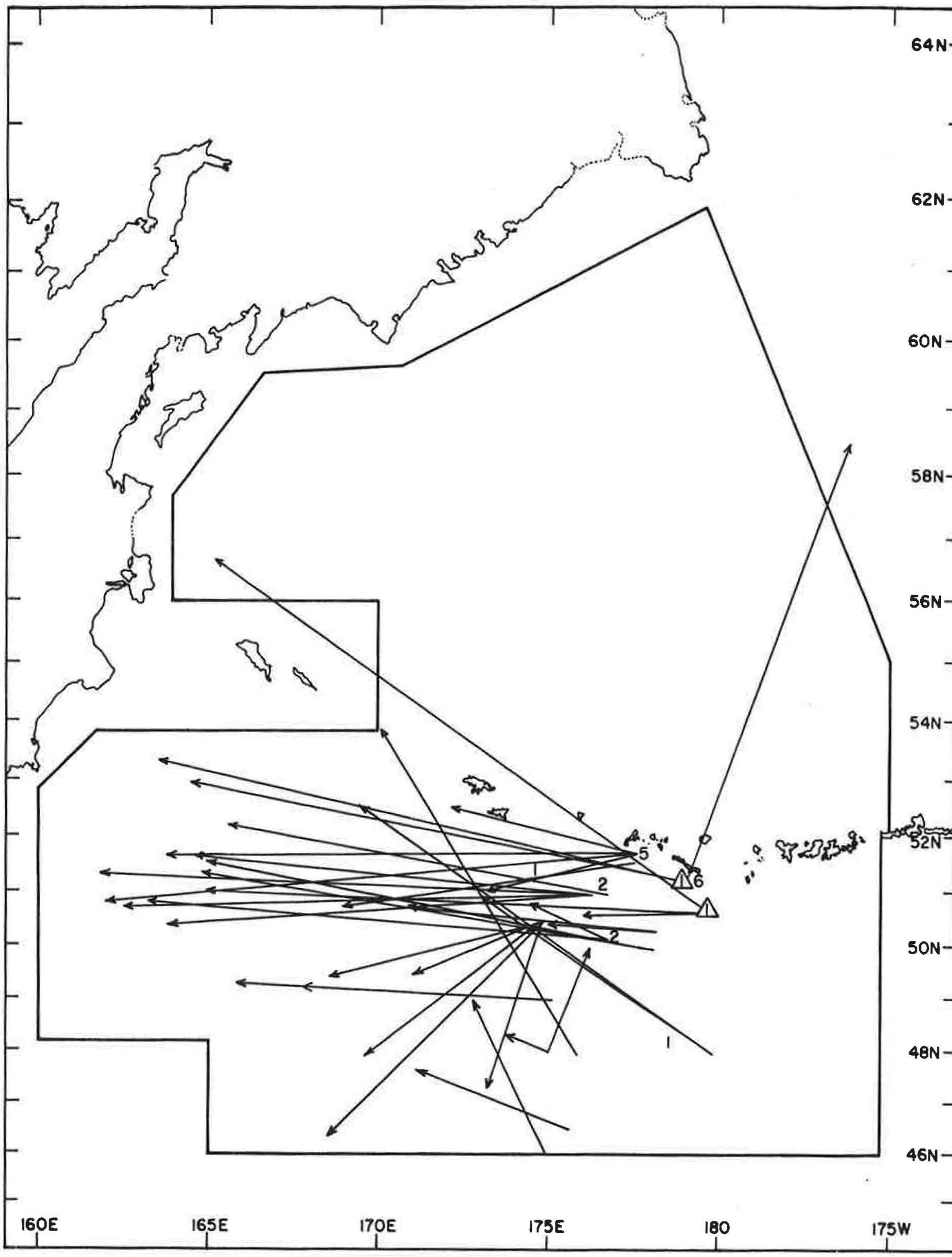


Figure 5.12.--Coastal recoveries in Asia and western Alaska and high seas recoveries of mature chums tagged between 175°E and 180°, south of the Aleutians to 46°N, 1956-76. (No's. recovered in coastal areas are indicated beside the tagging locations, with the recoveries in western Alaska enclosed by triangles. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

5.1.3.2.2 East of 175°E, North of the Aleutians

Taggings of mature chums a short distance west of 175°E near 60°N (Figure 5.13), in 7552 (Figure 5.14), and near or on the boundary of the mothership area in Subarea 10 (Figure 5.15) have produced recoveries in western Alaska. Three high seas recoveries from taggings in 7556 (Figure 5.14) showed movement toward western Alaska. One of the tagged fish appeared to be migrating to Bristol Bay, the other two apparently migrating to Alaskan streams north of Bristol Bay, but possibly Anadyr Bay in Asia. Taggings in 7560 produced one recovery showing a northeasterly migration to waters off Anadyr Bay (Figure 5.14), and a slight north-easterly movement was shown by 3 fish tagged and recovered on the high seas east of 180° (Figure 5.15). However, most of the recoveries from Bering Sea taggings in the mothership area east of 175°E have been reported from Asia or on the high seas west of the tagging locations. Taggings east of the mothership area produced 1 recovery in western Alaska, several in Asia, and several to the west in the mothership area (Figure 5.15).

To estimate the percentage of western Alaska chums in the mothership catches east of 175°E in the Bering Sea, we have combined the 3 coastal recoveries from taggings near 175°E/60°N (Figure 5.13) with the recovery data from taggings within the mothership area east of 175°E and north of the Aleutians (Figures 5.14 and 5.15). Resulting values are $A = 4$, $B = 0$, $C = 48$, and $D = 25$, with X estimated as $4 \div 77$ or 5%. The 3 high seas recoveries to the east from taggings in 7556 (Figure 5.14) are excluded from the B-value, and the 3 high seas recoveries showing the northeasterly movement from tagging locations in Subarea 10 (Figure 5.15), as well as recoveries from taggings outside the mothership area, are excluded from consideration.

5.1.3.2.3 West of 175°E

Based on the tag recovery data shown in Figures 5.13 and 5.16 through 5.18 (and noting that the 3 coastal recoveries from taggings near 175°E/60°N have been included in the estimate of the percentage of western Alaska chums in mothership catches east of 175°E), it is assumed that all of the chums caught west of 175°E are of Asian origin. The high seas recoveries showing an easterly component in their movement are either ignored or are presumed to be fish destined to streams in Asia.

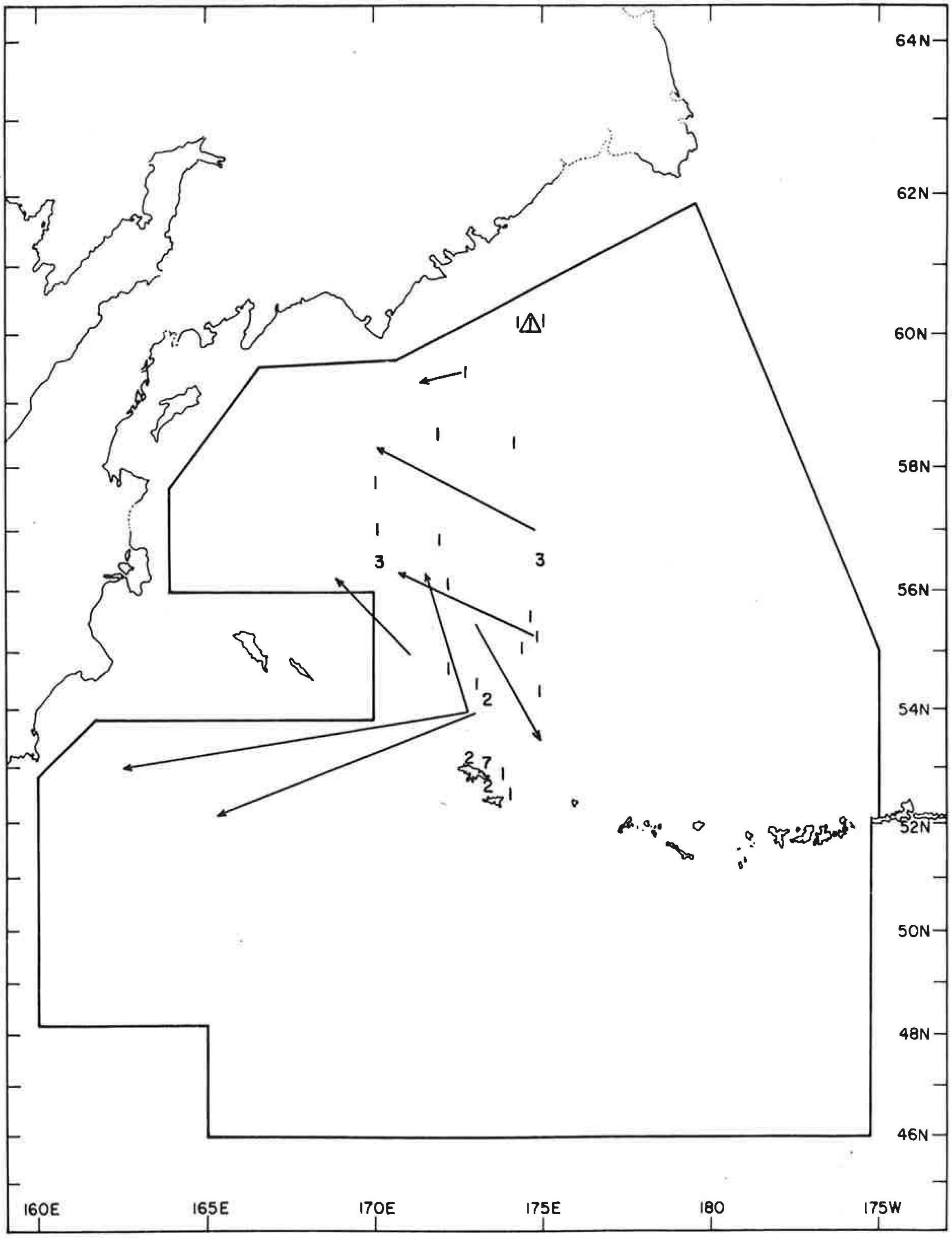


Figure 5.13.--Coastal recoveries in Asia and western Alaska and high seas recoveries of mature chums tagged between 170°E and 175°E, north of the Aleutians, 1956-76. (No's. recoveried in coastal areas are indicated beside the tagging locations, with the recovery in western Alaska enclosed by a triangle. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

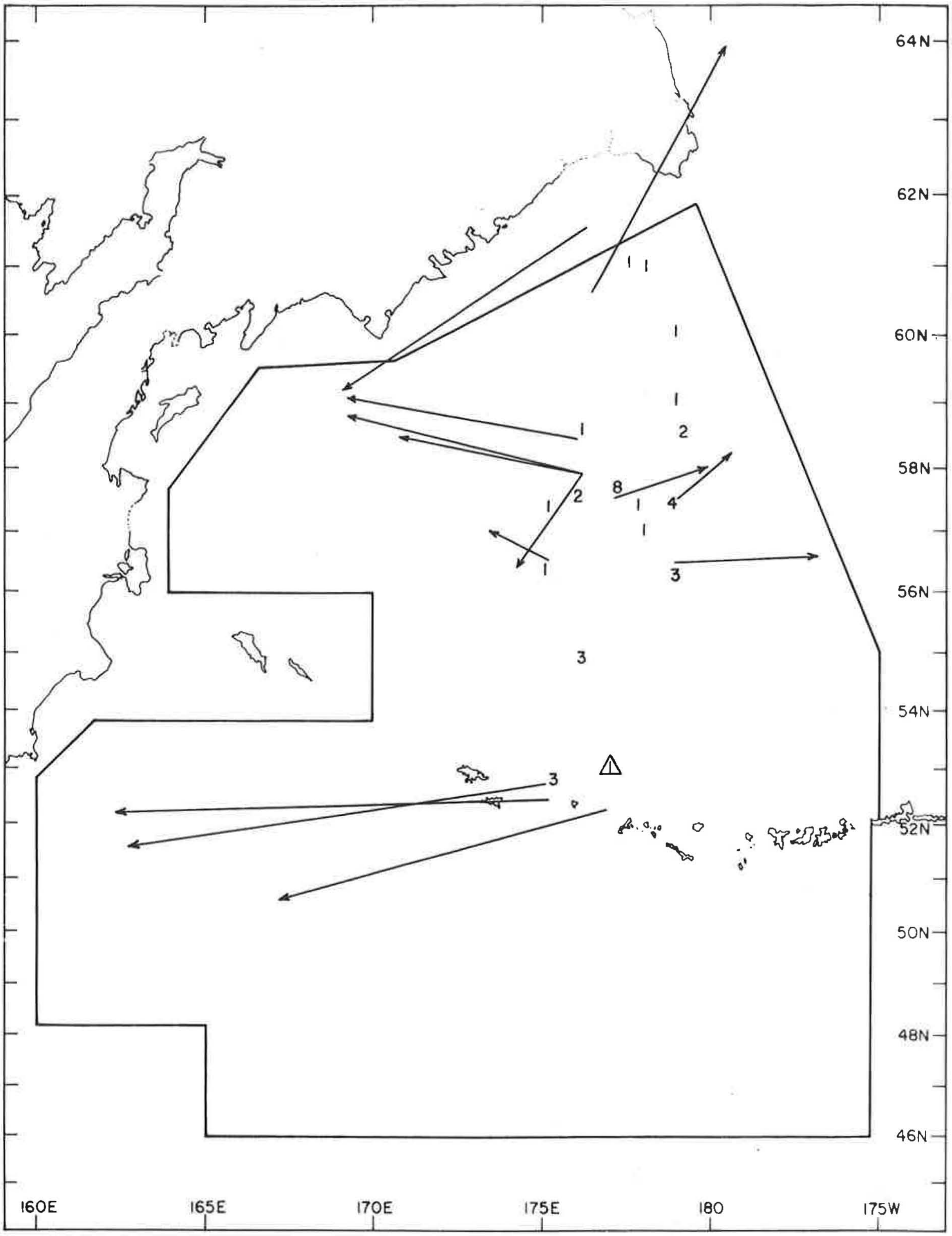


Figure 5.14.--Coastal recoveries in Asia and western Alaska and high seas recoveries of mature chums tagged between 175°E and 180°, north of the Aleutians, 1956-76. (No's. recovered in coastal areas are indicated beside the tagging locations, with the recovery in western Alaska enclosed by a triangle. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

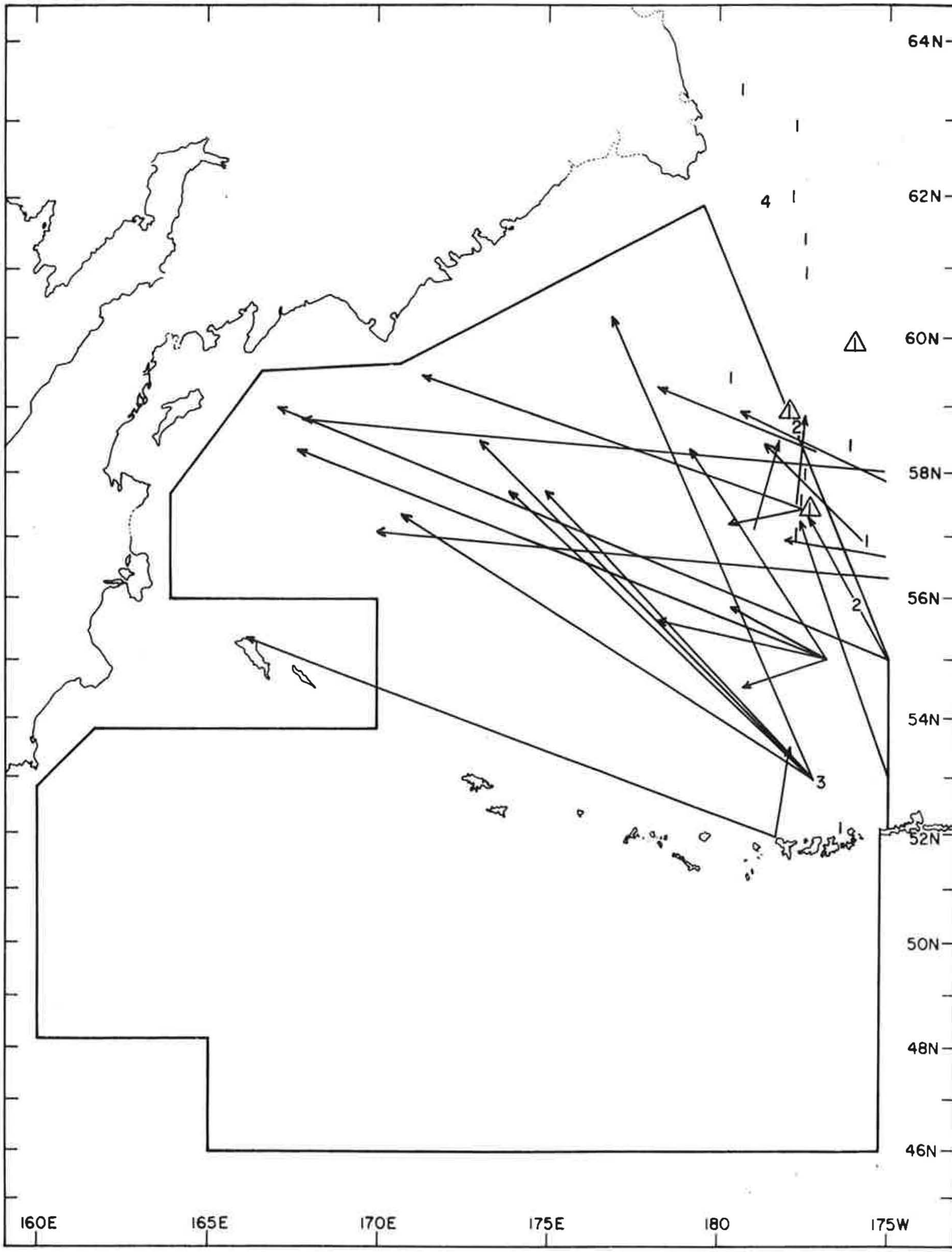


Figure 5.15.--Coastal recoveries in Asia and western Alaska and high seas recoveries of mature chums tagged between 175°W and 180°, north of the Aleutians, 1956-76. (No's. recovered in coastal areas are indicated beside the tagging locations, with the recoveries in western Alaska enclosed by triangles. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

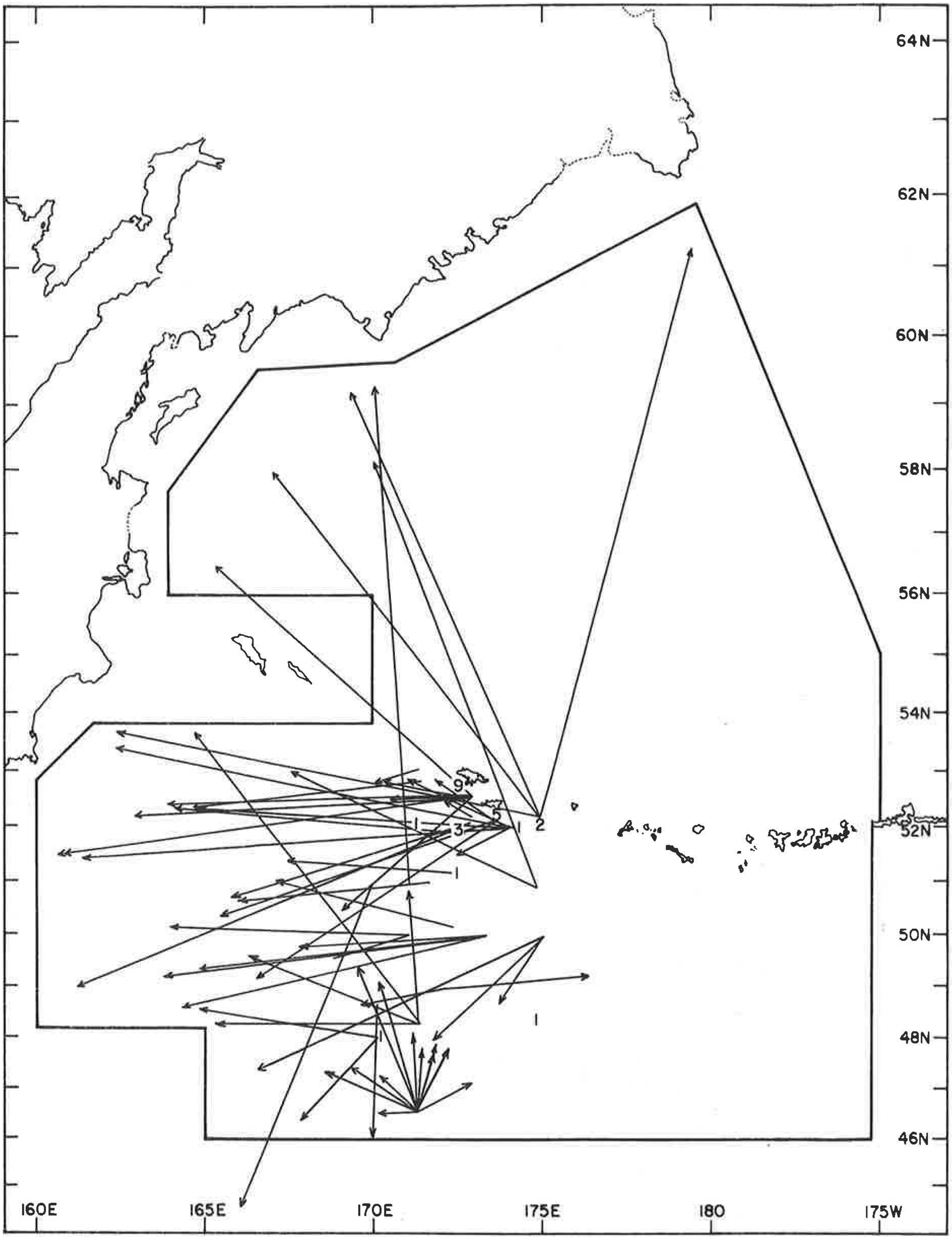


Figure 5.16.--Coastal recoveries in Asia and high seas recoveries of mature chums tagged between 170°E and 175°E, south of the Aleutians to 46°N, 1956-76. (No recoveries reported from western Alaska. No's. recovered in Asia are shown beside the tagging locations. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

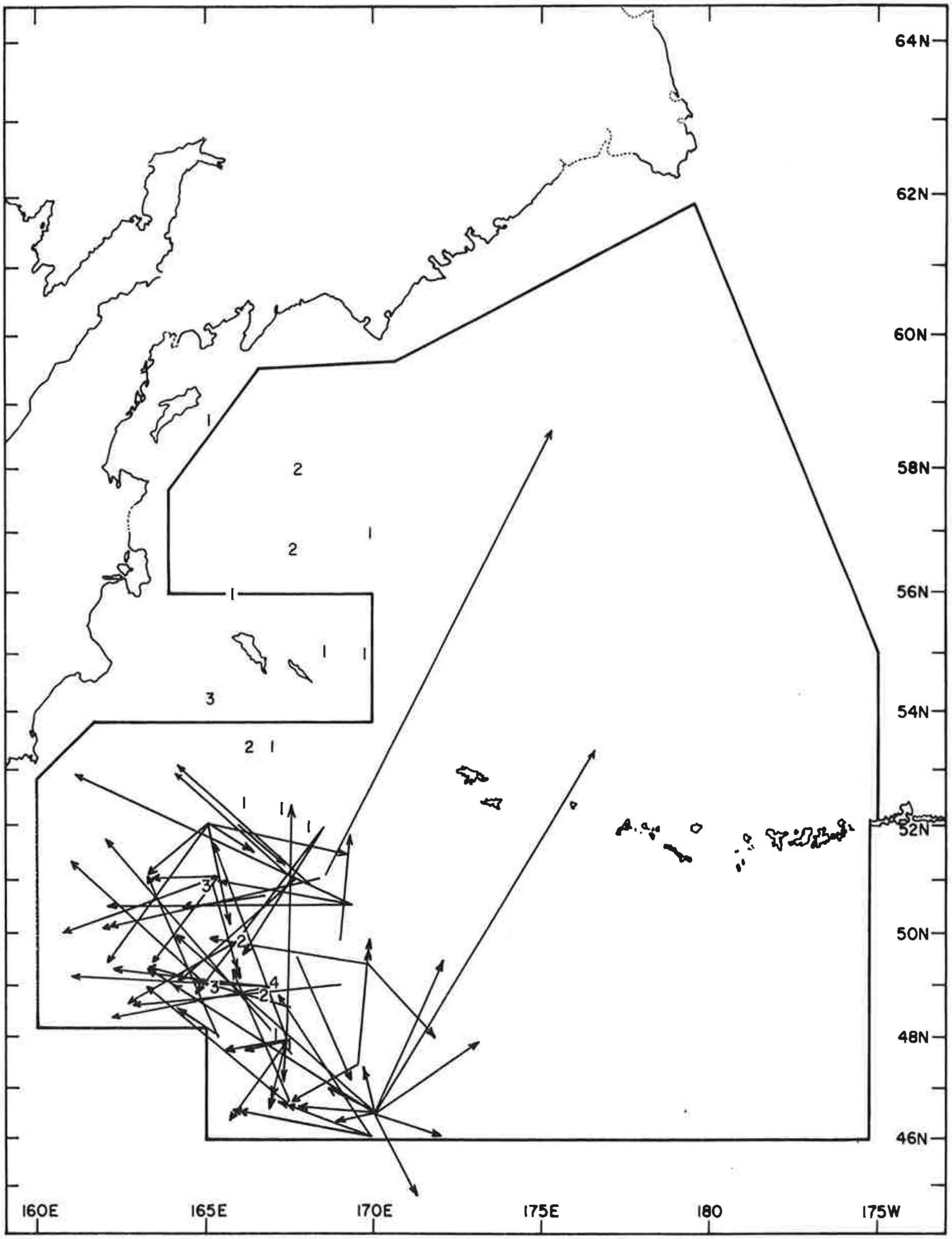


Figure 5.17.--Coastal recoveries in Asia and high seas recoveries of mature chums tagged between 165°E and 170°E, north of 46°N, 1956-76. (No recoveries reported from western Alaska. No's. recovered in Asia are shown beside the tagging locations. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

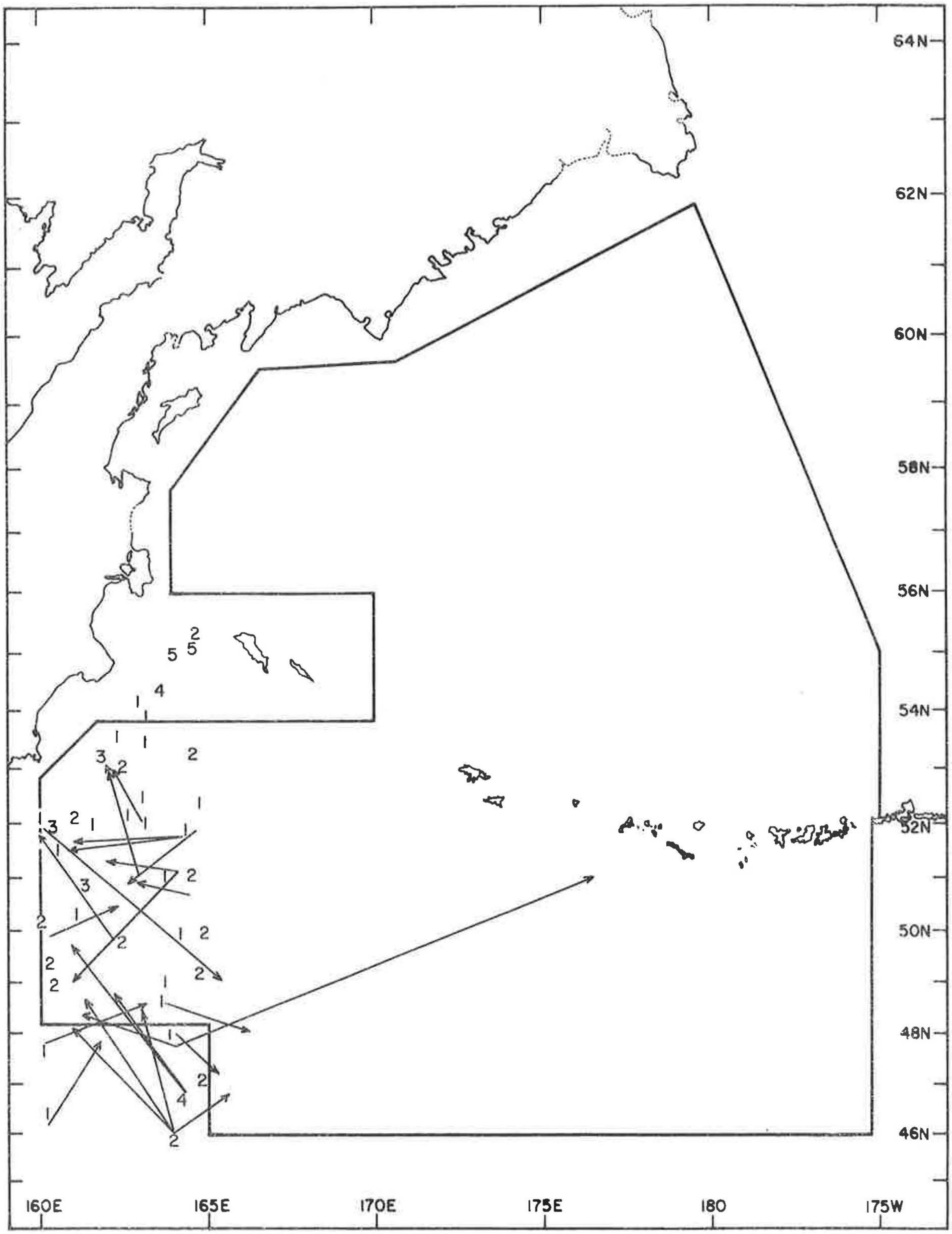


Figure 5.18.--Coastal recoveries in Asia and high seas recoveries of mature chums tagged between 160°E and 165°E, north of 46°N, 1956-76. (No recoveries reported from western Alaska. No's. recovered in Asia are shown beside the tagging locations. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

5.1.3.3 Percentage of Non-western Alaska Chum Salmon in Catches

Approximately 10% of the recoveries in North America of mature chum salmon tagged in Statistical Areas 7550 and 8050 have been reported from non-western Alaska areas, 90% in western Alaska. For immature chums tagged in the same statistical areas, about one-third of the recoveries in North America have been reported from non-western Alaska areas, two-thirds in western Alaska. No recoveries from taggings of chum salmon elsewhere in the mothership area have been reported from non-western Alaska areas.

Because of the difficulty in separating the mothership catches of mature chum salmon from immatures, it is necessary to derive a single figure for estimating the percentage of North American chums of non-western Alaska origin in the mothership catches in Statistical Areas 7550 and 8050. We have derived such a figure from the ratio of the mid-point of the percentages of North American recoveries of tagged mature and immature chum salmon reported from non-western Alaska areas (approximately 20%) to the mid-point of the percentages of North American recoveries of matures and immatures reported from western Alaska (approximately 80%). The ratio, 0.25, is multiplied by the percentage of western Alaska chums in the mothership catches in Statistical Areas 7550 and 8050 to obtain an estimate of the percentage of North American chums of non-western Alaska origin in catches from the same statistical areas. The resulting estimate is 0.25 times 3% (Section 5.1.3.2.1), or slightly less than 1%.

5.1.3.4 Generalized Area of Occurrence of North American Chum Salmon in the Mothership Fishing Area

The area of occurrence of North American chum salmon in the Japanese salmon mothership area is depicted in Figure 5.19. As in the case of pink salmon the boundaries correspond with the boundaries of 2° x 5° statistical areas.

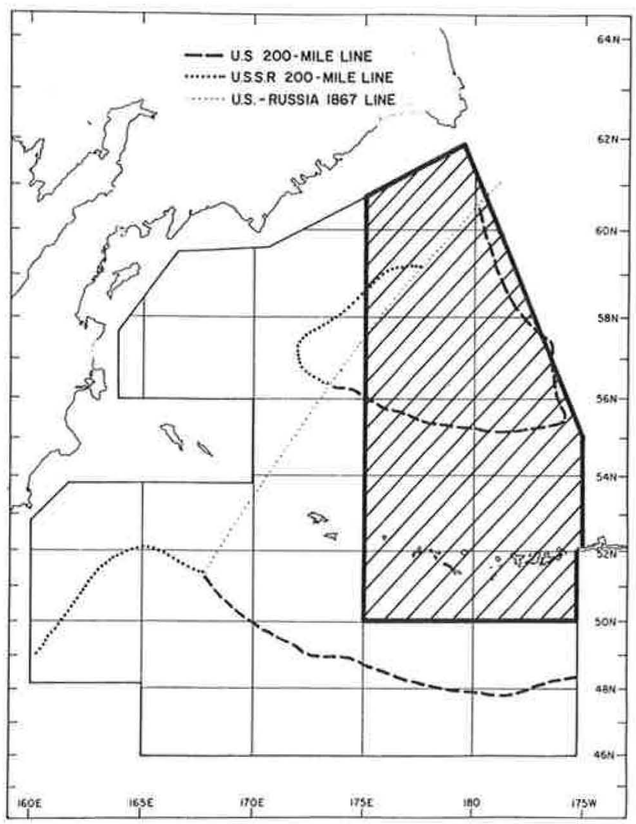


Figure 5.19.--Occurrence of North American chum salmon in the Japanese salmon mothership fishing area and area of intermingling with Asian chum salmon.

5.1.3.5 Estimates of Annual Interceptions

Table 5.5 gives the estimates of annual interceptions of North American chum salmon by the Japanese mothership salmon fishery during 1956-75, by statistical area.

The average annual interception of North American chum salmon during 1956-75 is estimated to have been 130 thousand fish. Interceptions during 1966-75 averaged 185 thousand chums annually as compared to 75 thousand during 1956-65.

Table 5.5.--Estimates of interceptions of North American chum salmon by the Japanese mothership salmon fishery, in thousands of fish, 1956-75. a/

Year	Statistical Area												Total
	7550	7552	7554	7556	7558	7560	8050	8052	8054	8056	8058	8060	
1956	34	36	18	0	0	0	1	8	10	5	34	0	146
1957	4	9	4	1	3	0	0	2	5	7	5	0	40
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	12	0	0	2	6	2	0	0	0	0	0	0	22
1960	8	16	5	1	4	4	1	19	28	36	47	5	174
1961	21	8	0	0	0	0	15	14	3	+	0	0	61
1962	19	+	0	0	0	0	16	0	0	0	0	0	35
1963	4	8	3	+	3	30	+	1	+	0	+	4	53
1964	8	+	4	4	30	18	10	+	+	12	37	7	130
1965	14	5	1	4	8	9	11	1	2	6	28	2	91
1966	5	2	4	29	7	2	15	4	5	19	15	+	107
1967	8	3	+	6	13	9	4	1	8	6	22	2	82
1968	8	2	6	16	13	17	4	+	1	41	44	+	152
1969	9	2	5	5	13	23	10	5	20	49	30	1	172
1970	28	3	4	26	46	23	34	12	10	70	34	+	290
1971	11	5	3	23	40	15	5	4	8	81	54	2	251
1972	8	2	7	42	45	76	+	1	8	66	80	1	336
1973	16	4	10	24	14	+	4	+	7	20	30	0	129
1974	24	14	11	10	18	+	25	7	42	44	11	0	206
1975	9	7	8	9	17	0	5	2	4	12	53	0	126

a/ Obtained by multiplying the annual mothership catches in the indicated Statistical Areas by the following estimates of the percentage of North American chums in the catches:

7550 and 8050: 4% (3% western Alaska and less than 1% other North American origins);
7552-60 and 8052-60: 5% (western Alaska)

A comparison of mothership interceptions with commercial and subsistence catches in western Alaska (Table 5.6) indicates that the mothership fishery accounted for about 7% of the total catch of western Alaska chum salmon during 1956-75.

Table 5.6.--Estimates of the interceptions of North American chum salmon by the Japanese mothership salmon fishery and combined commercial and subsistence catches in western Alaska, 1956-75, in thousands of fish.

Year	Mothership interceptions a/	Western AK catch b/ c/	Total catch	Percent caught by motherships
1956	146	1,364	1,510	10
1957	40	1,144	1,184	3
1958	0	1,223	1,223	0
1959	22	1,496	1,518	1
1960	174	2,270	2,444	7
1961	61	1,594	1,655	4
1962	35	1,760	1,795	2
1963	53	1,238	1,291	4
1964	130	1,939	2,069	6
1965	91	1,353	1,444	6
1966	107	1,088	1,195	9
1967	82	1,260	1,342	6
1968	152	1,155	1,307	12
1969	172	1,289	1,461	12
1970	290	2,032	2,322	12
1971	251	1,821	2,072	12
1972	336	1,722	2,058	16
1973	129	2,497	2,626	5
1974	206	2,854	3,060	7
1975	126	2,837	2,963	4
Total	2,603	33,936	36,539	7

a/ From Table 5.5.
b/ Bristol Bay, north side of the Alaska Peninsula, and the Arctic-Yukon-Kuskokwim fishing district.
c/ See Appendix 1 for sources of data on commercial catches. Subsistence catch during 1956-59 is estimated as 610 thousand fish annually. Data on subsistence catches in 1960-75 were provided by the Alaska Department of Fish and Game (personal communication).

5.1.4 Coho Salmon

Tagging data for coho salmon in the Japanese mothership fishing area are extremely limited with respect to areal coverage of taggings and the number of recoveries (Figure 5.20). From the data that are available it appears that western Alaska coho salmon occur only in Statistical Area 8050. As for North American coho salmon of non-western Alaska origin, one recovery of a fish tagged in 8050 has been reported from Kodiak Island. Based on the recoveries in North America as compared to recoveries in Asia and on the high seas, we have estimated that North American fish account for approximately 55% of the mothership catch of coho salmon in Statistical Area 8050, about 90% of the North American fish being of western Alaska origin, the other 10% of non-western Alaska origin. These percentages are obviously rough estimates.

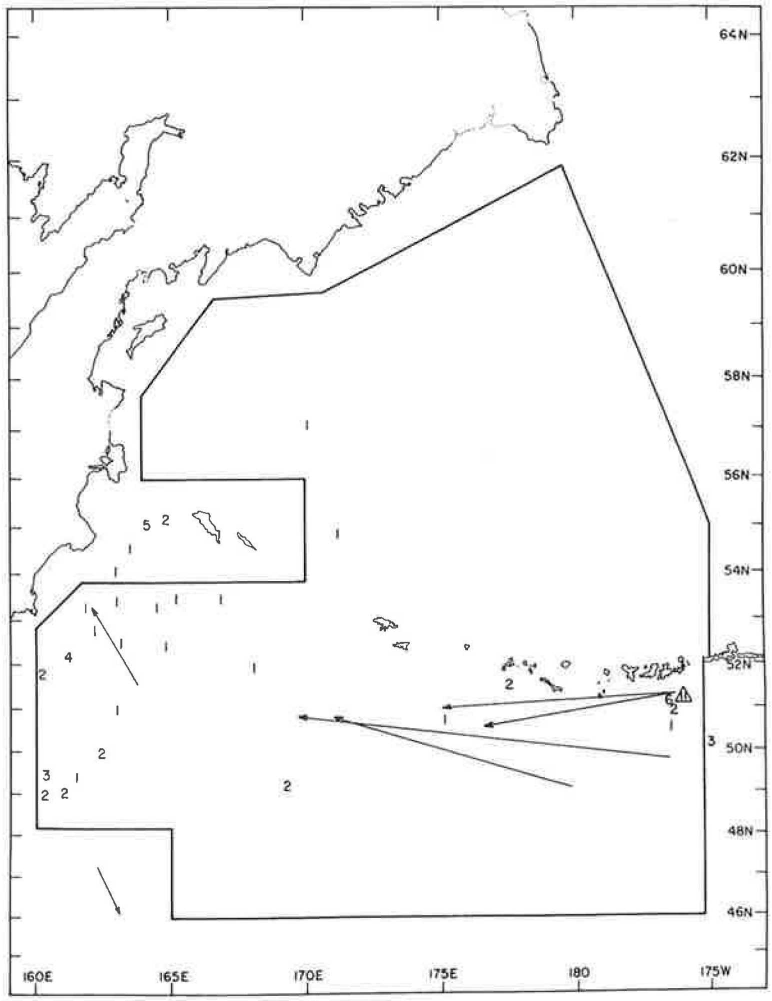


Figure 5.20.--Coastal recoveries in Asia and western Alaska and high seas recoveries of coho salmon tagged between 160°E and 175°W, north of 46°N, 1956-76. (No's. recovered in coastal areas are shown beside the tagging locations, with the recoveries in western Alaska enclosed by a triangle. Each arrow indicates one high seas recovery and migration of at least one degree of longitude or latitude from the tagging site. See text for data sources.)

Estimates of annual interceptions of North American coho salmon in Statistical Area 8050 during 1956-75 are as follows:

Year	Thousands of fish	Year	Thousands of fish
1956	7	1966	0
1957	0	1967	0
1958	0	1968	3
1959	0	1969	+
1960	0	1970	20
1961	0	1971	24
1962	+	1972	0
1963	0	1973	13
1964	175	1974	149
1965	0	1975	4

The average over the 20-year period was 20 thousand fish, that average resulting mainly from interceptions in two years, 1964 and 1974.

Mothership interceptions in Statistical Area 8050 represented about 10% of the total catch of western Alaska coho salmon during 1956-75 (Table 5.7). Excluding 1964 and 1974, the percentage drops to 2-3%. What is not known, however, is how many North American coho salmon have been intercepted elsewhere in the mothership fishing area (or the landbased driftnet fishing area). Additional taggings or other studies are needed before a determination on the matter can be made.

Table 5.7.--Estimates of the interceptions of North American coho salmon by the Japanese mothership salmon fishery and commercial catches in western Alaska, 1956-75, in thousands of fish.

Year	Mothership interceptions a/	Western AK catch b/	Total catch	Percent caught by motherships
1956	7	72	79	9
1957	0	87	87	0
1958	0	193	193	0
1959	0	76	76	0
1960	0	66	66	0
1961	0	67	67	0
1962	+	124	124	+
1963	0	121	121	0
1964	175	105	280	62
1965	0	57	57	0
1966	0	119	119	0
1967	0	172	172	0
1968	3	333	336	1
1969	+	263	263	+
1970	20	121	141	14
1971	24	46	70	34
1972	0	70	70	0
1973	13	282	295	4
1974	149	265	409	36
1975	4	192	196	2
Total	395	2,831	3,226	12

a/ From Section 5.1.4.
b/ See Appendix 1 for data sources.

5.1.5 Chinook Salmon

Major, Murai and Lyons (1975) describe a procedure for estimating the percentage of western Alaska chinook salmon in the mothership catches from scale characters. Samples available for making such estimates for any single year, however, are frequently small. Hence we have pooled the samples collected over several years (1966-72) to estimate the percentages of western Alaska chinooks in the various statistical areas by month (Table 5.8). It is concluded from these data that western Alaska chinook salmon occur in every part of the mothership fishing area except Statistical Area 6048.

Table 5.8.--Estimates of the percentages of western Alaska chinook salmon in catches by the Japanese mothership salmon fishery.

Statistical Area	Percent in pooled samples, 1966-72[a/] May	June	July	Average of monthly percentages[b/]
6048	*	0	*	0
6050	*	2	8	5
6052	*	28	25	26
6056	*	*	*	(56)
6058	*	*	*	(69)
6546	13	13	*	13
6548	15	24	21	20
6550	*	29	18	24
6552	49	46	20	38
6556	*	*	56	56
6558	*	*	69	69
7046	18	24	0	14
7048	53	24	*	38
7050	33	41	*	37
7052	*	*	*	(37)
7054	*	25	*	25
7056	*	*	41	41
7058	*	*	79	79
7060	*	*	*	(79)
7546	*	55	40	48
7548	*	*	57	57
7550	*	83	*	83
7552	*	*	*	(70)
7554	*	70	*	70
7556	*	32	*	32
7558	*	74	80	77
7560	*	81	65	73
8046	*	*	83	83
8048	92	54	78	75
8050	*	87	*	87
8052	*	100	*	100
8054	*	100	*	100
8056	*	97	100	98
8058	*	97	92	94
8060	*	*	*	(94)

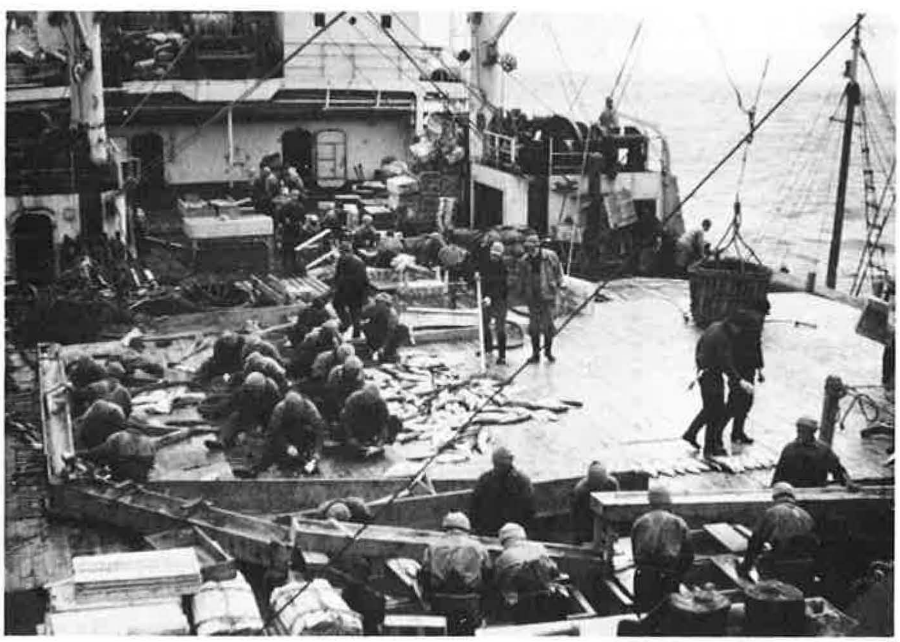
a/ An asterisk denotes no samples available.
b/ Figures in parentheses are averages for adjacent statistical areas: 6056/6556; 6058/6558; 7052/7050; 7070/7058; 7552/7554; and 8060/8058.

The average of the monthly percentages given in Table 5.8 provide estimates of the annual interceptions of western Alaska chinooks. In addition to those interceptions, tag recovery data (even more limited than for coho salmon) indicate that North American chinooks of non-western Alaska origin are caught by the mothership fishery between 175°W and 180°, south of the Aleutians, that is, in Statistical Areas 8046, 8048 and 8050. For those statistical areas we assume that one-half of the chinooks which are not of western Alaska origin come from streams in Asia, the other one-half from North American streams outside of western Alaska.

Estimates of the percentages of North American chinooks in mothership catches and the annual interceptions during 1956-75 are given for each statistical area in Table 5.9.

Estimates of annual interceptions range from 5 thousand fish (1958) to 438 thousand fish (1969), with the average for the 20-year period being 130 thousand fish. Interceptions increased sharply in 1964 and averaged about 185 thousand fish per year during 1965-75.

The estimated interceptions by the mothership fishery represented about 30% of the total catch of western Alaska chinooks during 1956-73 (Table 5.10 and Figure 5.21). In some years, the interceptions approached or exceeded the inshore catches (averaged over the first 2 years following the year of interception). In terms of loss to western Alaska fisheries, the magnitude of the interceptions takes on greater significance when the average weights of the chinooks are considered: 4-6 pounds in mothership fishery vs. about 20 pounds in the inshore fisheries, such difference undoubtedly far offsetting natural mortality during the 1-2 years the fish would have remained at sea before returning to their home streams.



PROCESSING SALMON ABOARD A JAPANESE MOTHERSHIP
(Photo: Fukuhara, NMFS)

Table 5.9.--Estimates of the percentages of North American chinook salmon in catches by the Japanese mothership salmon fishery and annual interceptions, in thousands of fish, 1956-75.[a]

Stat. Area	Percent North American	Interceptions - thousands of fish 1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
6048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6050	5	0.4	0.1	0.4	0.2	0.2	+	0.2	0.2	+	0.1	+	0.2	+	0.3	0.1	0.1	+	0.2	0.1	+
6052	26	1.0	0.8	0.5	0.3	0.3	+	0.5	1.3	0.8	1.0	0.3	1.3	0.8	1.6	0.8	+	1.3	1.0	0.5	1.0
6056	56	0	0	0	0	0	0	0	+	+	+	+	+	0.6	0.6	+	+	1.7	0.6	1.7	+
6058	69	0	0	0	0	0	0	0	0	0	0	+	0	0	+	0	0	+	0	0	+
6546	13	1.0	+	0.8	0.4	0.1	+	3.4	+	0.6	0.8	0.3	0.1	0.3	0.1	+	0.3	1.0	0.4	0.1	0.3
6548	20	0.6	+	1.0	2.0	1.2	1.0	5.2	1.0	2.4	1.0	1.8	1.0	1.2	0.4	0.4	0.4	1.0	3.8	0.6	0.6
6550	24	0.2	0.5	1.2	1.4	1.0	0.7	4.3	1.7	1.0	2.2	2.2	2.6	1.4	0.7	0.7	1.2	1.0	1.4	1.0	0.5
6552	38	0.8	0.4	0.4	0.8	1.1	0.4	3.4	0.8	1.1	4.2	2.7	2.3	2.3	4.2	0.4	1.1	0.4	0.8	0.8	0.4
6556	56	+	+	0	+	2.2	0	0	+	1.7	5.6	11.2	+	9.5	1.1	+	1.7	2.2	0.6	3.9	5.0
6558	69	+	+	0	0.7	3.4	+	0	4.1	9.7	6.2	16.6	6.9	9.0	10.4	2.8	2.1	2.8	1.4	1.4	5.5
7046	14	2.0	0	+	0.1	1.3	+	0.8	0.1	4.3	1.8	3.9	1.1	0.3	1.0	+	0.1	0.1	0.7	0.1	0.8
7048	38	2.3	+	+	1.1	1.5	0.8	6.8	1.1	19.0	1.1	4.2	2.3	2.3	1.1	0.4	0.8	1.1	1.1	5.7	1.1
7050	37	1.1	0.7	0.7	0.7	0.4	0.7	2.2	2.2	1.5	1.1	1.1	1.5	3.0	1.5	1.1	1.5	0.7	1.1	2.2	0.4
7052	37	0.7	0.4	0.4	0.7	+	+	0.4	+	0.4	1.1	0.7	0.4	0.7	0.7	0.4	1.1	+	0.7	0.4	+
7054	25	+	+	0	0.2	0	+	0	+	+	0.5	0.2	+	0.2	0.2	+	2.8	0.2	0.2	0.5	+
7056	41	+	+	0	2.0	0	+	0	0.4	0.8	4.1	0.8	0.4	13.1	3.7	0.8	1.6	5.3	0.4	0.8	3.7
7058	79	0.8	+	0	13.4	8.7	+	0	7.1	45.8	14.2	7.1	10.3	26.1	11.8	37.9	7.9	12.6	2.4	2.4	18.2
7060	79	0	0	0	0	0	0	0	+	+	+	+	0.8	+	+	4.0	+	+	+	0	0
7546	48	+	0	0	0	0	0	0	+	0.5	3.8	1.9	+	1.4	8.2	+	0.5	+	1.4	0.5	4.3
7548	57	0.6	0	+	+	0	+	+	1.1	23.9	+	1.1	0.6	0.6	6.3	1.7	5.7	0.6	1.1	12.5	2.8
7550	83	0.8	+	0	+	0.8	0.8	1.7	0.8	5.8	0.8	0.8	1.7	5.8	1.7	3.3	2.5	0.8	4.2	24.9	1.7
7552	70	3.5	1.4	0	0	1.4	0.7	+	0.7	+	2.1	1.4	2.1	+	0.7	1.4	2.1	0.7	1.4	4.9	0.7
7554	70	2.1	0.7	0	0	+	0	0	+	+	0.7	0.7	+	2.1	9.1	1.4	1.4	1.4	2.1	4.9	1.4
7556	32	0	+	0	+	1.0	0	0	0	1.0	1.6	3.8	1.0	15.0	3.2	12.2	2.6	10.6	1.3	5.1	1.6
7558	77	0	1.5	0	3.1	5.4	0	0	1.5	52.4	5.4	3.1	10.0	55.4	25.4	65.4	28.5	26.2	1.5	19.2	5.4
7560	73	0	0	0	0.7	2.1	0	0	13.9	9.5	10.2	5.1	5.1	21.9	67.9	27.0	3.6	31.4	+	+	0
8046[b]	91	0	0	0	0	0	0	0	0	+	+	0	0	7.3	19.1	+	+	+	+	+	5.5
8048[c]	87	0.9	0	0	0	0	0	+	0	9.6	+	1.7	0	1.7	4.4	0.9	3.5	0.9	+	7.8	+
8050[d]	93	0.9	0	0	0	+	0.9	0.9	+	25.1	+	1.9	0.9	2.8	0.9	8.4	3.7	+	1.9	21.4	0.9
8052	100	20.0	+	0	0	6.0	5.0	0	+	+	+	11.0	+	+	5.0	25.0	3.0	1.0	+	9.0	+
8054	100	14.0	2.0	0	0	14.0	3.0	0	+	+	1.0	5.0	4.0	2.0	78.0	16.0	5.0	4.0	1.0	66.0	3.0
8056	98	1.0	3.9	0	0	26.5	+	0	0	12.7	4.9	12.7	4.9	27.4	95.1	86.2	31.4	39.2	8.8	87.2	8.8
8058	94	0.9	2.8	0	0	55.5	0	0	+	25.4	29.1	8.5	7.5	13.2	70.5	47.0	27.3	21.6	5.6	3.8	35.7
8060	94	0	0	0	0	0.9	0	0	2.8	0.9	0.9	+	0.9	+	2.8	+	0.9	+	0	0	0
Total		55.6	15.2	5.4	27.8	135.0	14.0	29.8	40.8	255.9	105.5	111.8	69.9	227.4	437.7	345.7	144.4	169.8	47.1	289.4	109.3

a/ Obtained by multiplying the annual mothership catches in the Statistical Areas by the indicated estimates of the percentages of North American chinooks.

b/ 83% western Alaska plus 8% other North American origins.
c/ 75% western Alaska plus 12% other North American origins.
d/ 87% western Alaska plus 6% other North American origins.

Table 5.10.--Estimates of the interceptions of North American chinook salmon by the Japanese mothership salmon fisheries and combined commercial and subsistence catches in western Alaska, 1956-75, in thousands of fish.

Year	Mothership interceptions a/	Western AK catch b/ c/	Total catch d/	Percent caught by motherships d/
1956	56	158	250	22
1957	15	181	229	7
1958	5	207	225	2
1959	28	220	290	10
1960	135	221	412	33
1961	14	302	280	5
1962	30	252	328	9
1963	41	279	357	11
1964	256	318	551	46
1965	106	313	430	25
1966	112	277	456	24
1967	70	370	404	17
1968	227	317	596	38
1969	438	352	810	54
1970	346	386	672	51
1971	144	359	414	35
1972	170	292	414	41
1973	47	249	267	18
1974	289	240	e/	e/
1975	109	200	e/	e/
Total	2,240 (1956-73)	5,493	7,385	30

a/ From Table 5.9.
b/ Bristol Bay, north side of the Alaska Peninsula, and the Arctic-Yukon-Kuskokwim fishing district.
c/ See Appendix 1 for sources of data on commercial catches. Subsistence catch during 1956-59 is estimated as 25 thousand fish annually. Data on subsistence catches in 1960-75 were provided by the Alaska Department of Fish and Game (personal communication).
d/ Based on interception in indicated year plus the average annual catch in western Alaska 1- and 2-years later.

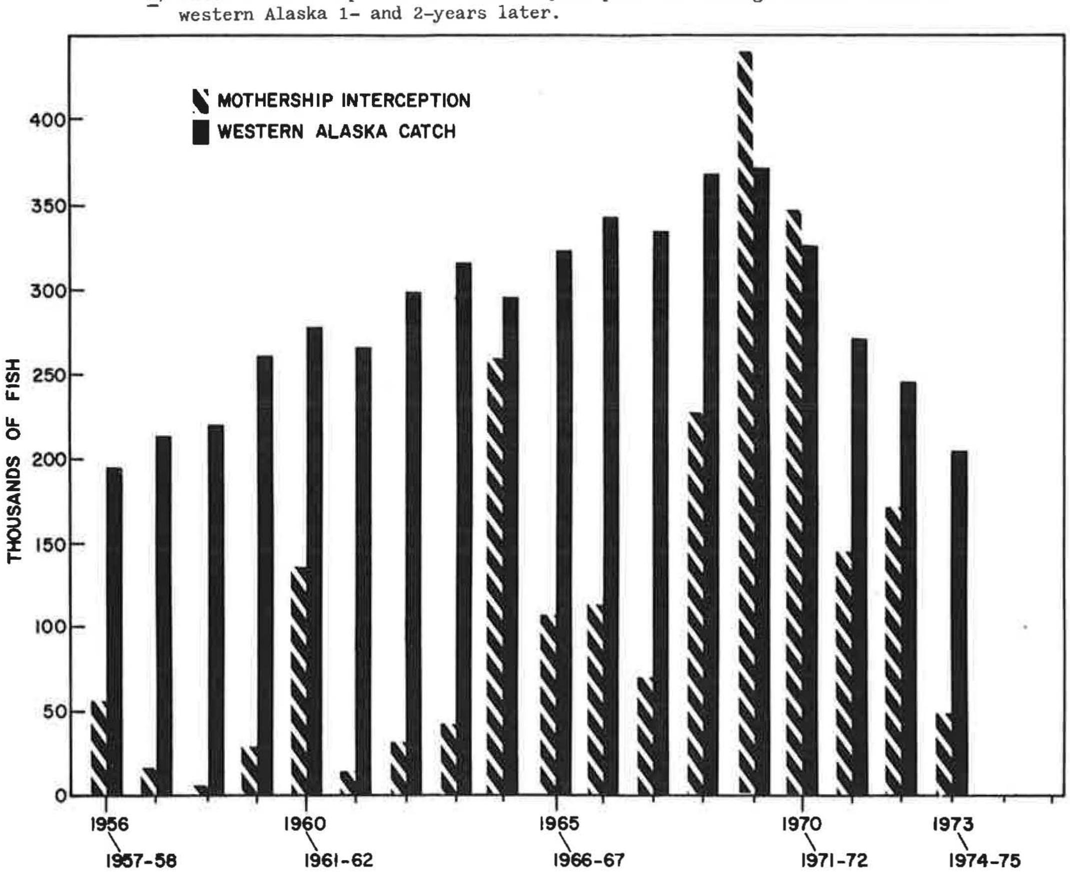


Figure 5.21.--Estimates of interceptions of North American chinooks by the Japanese mothership salmon fishery in one year and average catches in western Alaska 1- and 2-years later, 1956-1957/58 to 1973-1974/75. (From Table 5.10.)

5.1.6 Average Annual Interceptions and Key Areas of Vulnerability, 1964-73

An overview of the interceptions of North American salmon by the mothership fishery--one which covers two 5-year cycles of the Bristol Bay sockeye runs and also takes into account the increase in late-season fishing effort in the Bering Sea that began in 1964--is given by the estimates of average annual interceptions, by species and statistical area, during 1964-73 in Table 5.11 and Figure 5.22.

Most of the North American salmon that were intercepted in 1964-73 were taken inside the U.S. 200-mile zone or east of 175°E in Bering Sea waters lying outside the U.S. zone. The distribution of the interceptions (as well as the annual averages) would have been different, of course, if the distribution (and quantity) of fishing effort had been different.

Table 5.11.--Estimates of the average annual interceptions of North American salmon by the Japanese mothership salmon fishery, 1964-73. in thousands of fish.

Stat. Area	Interceptions - thousands of fish							
	Sockeye Matures	Sockeye Immatures	Sockeye Total	Pink	Chum	Coho	Chinook	Total
6048	0	0	0	0	0	0	0	0
6050	0	0	0	0	0	0	+	+
6052	0	0	0	0	0	0	1	1
6056	0	0	0	0	0	0	+	+
6058	0	0	0	0	0	0	+	+
6546	0	0	0	0	0	0	+	+
6548	0	0	0	0	0	0	1	1
6550	0	0	0	0	0	0	1	1
6552	0	0	0	0	0	0	2	2
6556	0	0	0	0	0	0	3	3
6558	0	0	0	0	0	0	7	7
7046	38	+	38	0	0	0	1	39
7048	160	4	164	0	0	0	3	167
7050	72	25	97	0	0	0	1	98
7052	13	28	41	0	0	0	1	42
7054	7	+	7	0	0	0	+	7
7056	3	7	10	0	0	0	3	13
7058	+	21	21	0	0	0	18	39
7060	+	1	1	0	0	0	1	2
7546	3	6	9	0	0	0	2	11
7548	164	50	214	0	0	0	4	218
7550	239	83	322	6	12	0	3	343
7552	50	1	51	1	3	0	1	56
7554	15	+	15	1	4	0	2	22
7556	30	6	36	0	18	0	5	59
7558	12	22	34	0	23	0	27	84
7560	6	15	21	0	19	0	18	58
8046	1	7	8	0	0	0	3	11
8048	133	27	160	0	0	0	2	162
8050	382	111	493	7	10	24	5	539
8052	82	+	82	1	3	0	4	90
8054	101	3	104	2	7	0	12	125
8056	107	43	150	0	37	0	32	219
8058	30	28	58	0	37	0	26	121
8060	+	2	2	0	2	0	1	5
Total	1,648	490	2,138	18	175	24	190	2,545

DATA SOURCE: Tables 5.1, 5.3, 5.5 and 5.9 and Section 5.1.4.

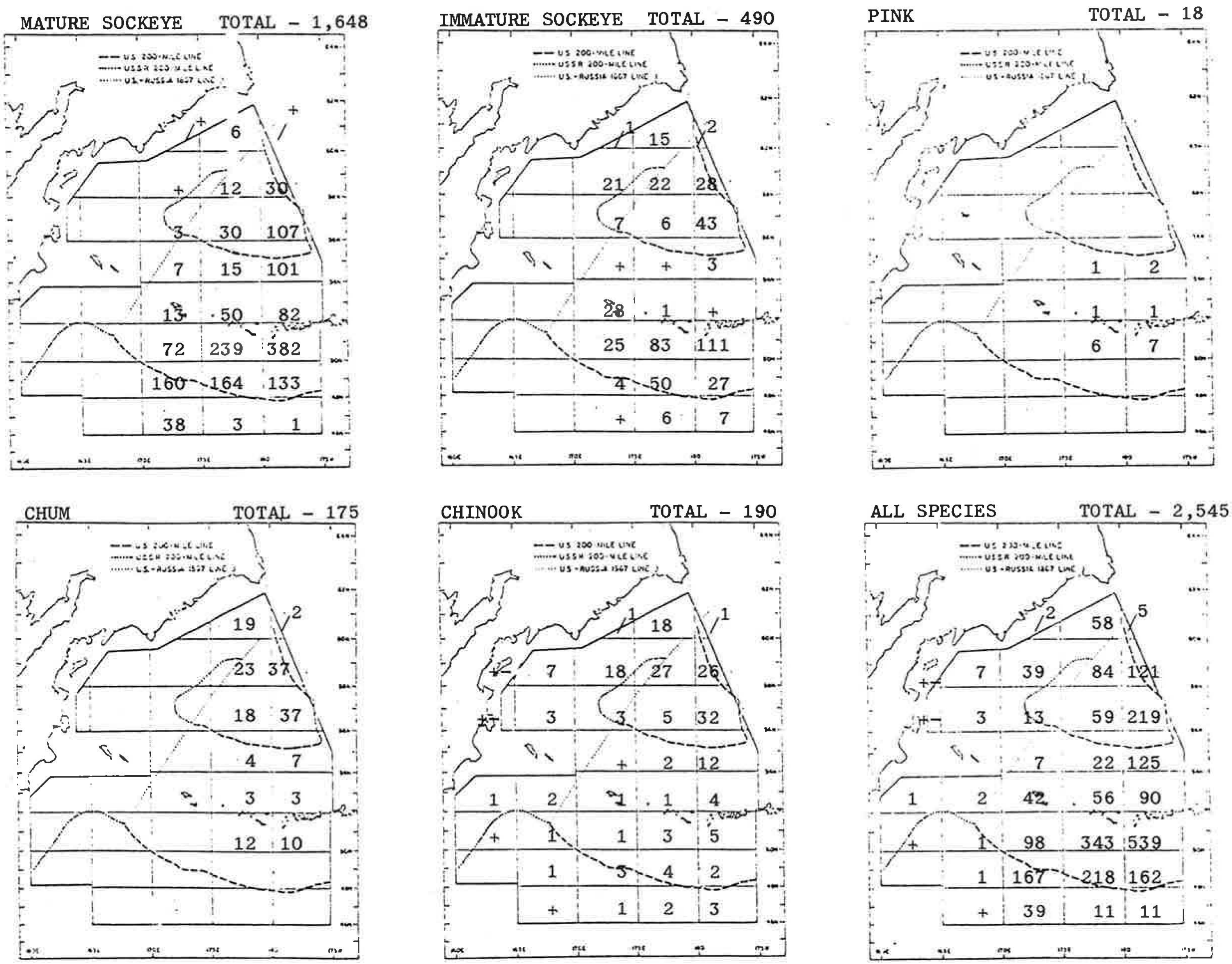


Figure 5.22.--Estimates of the average annual interceptions of North American salmon by the Japanese mothership salmon fishery, 1964-73, in thousands of fish. (Not shown separately but included in the total is the estimate of 24 thousand coho salmon intercepted in Stat. Area 8050. Data are from Table 5.11.)

No attempt is made here to estimate what the interceptions in the various 2° x 5° statistical areas could have been if the quantity and distribution of fishing effort had been different, but key areas of vulnerability to the mothership fishery are shown for North American sockeye (matures and immatures separately) and chinook salmon in Figures 5.23-5.25.[5.11]

Figure 5.23 shows maturing North American sockeye were most heavily concentrated inside the U.S. 200-mile zone east of 175°E (except for Statistical Area 7554) during 1964-73, but that substantial interceptions could have been (and were) made in other parts of the mothership fishing area as well. Immature North American sockeye are concentrated from about 48°N to the Aleutians as far west as 175°E and in Statistical Area 7052 (Figure 5.24). North American chinooks are most heavily concentrated east and north of a line running along 180° from the Aleutians to 58°N and then angling westward along that latitude (Figure 5.25).

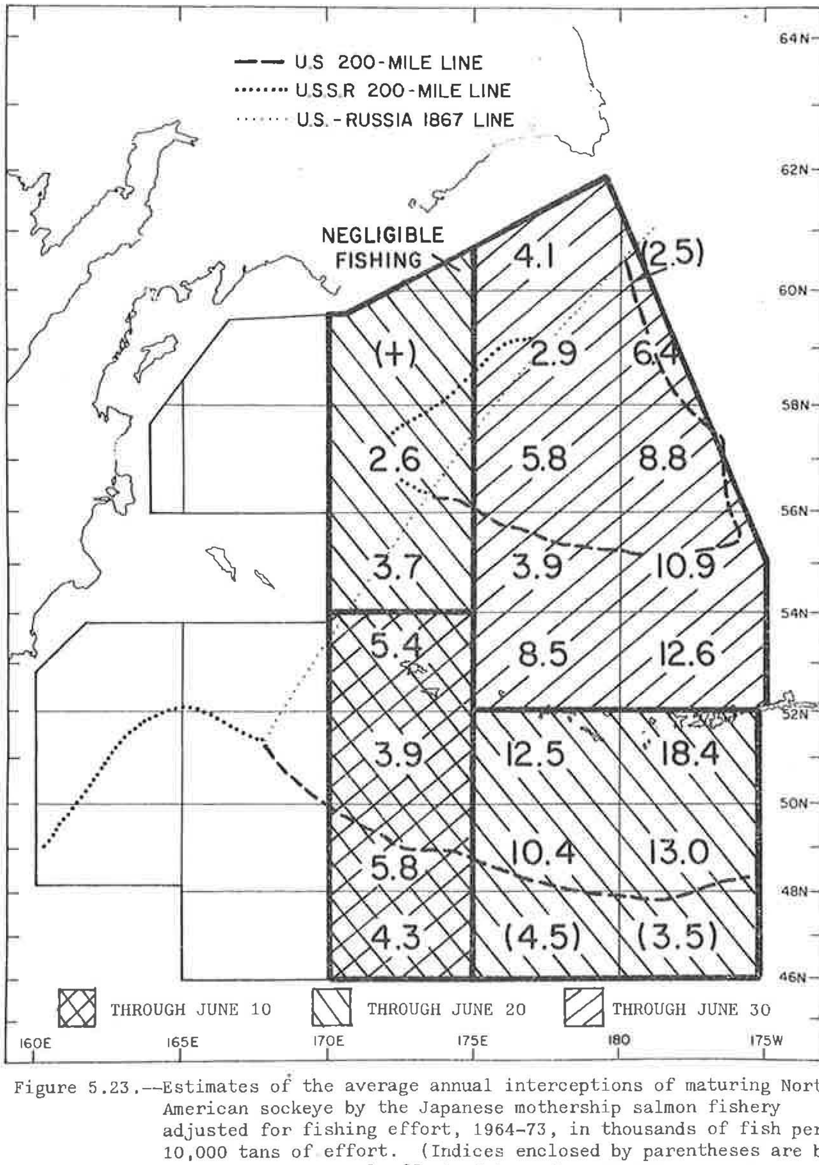


Figure 5.23.--Estimates of the average annual interceptions of maturing North American sockeye by the Japanese mothership salmon fishery adjusted for fishing effort, 1964-73, in thousands of fish per 10,000 tans of effort. (Indices enclosed by parentheses are based on an average annual effort of less than 10,000 tans. Data are from Table 5.11 and INPFC Statistical Yearbooks.)

5.11/ Areas of vulnerability and interception of North American pink, chum, and coho salmon lie within those for sockeye and chinook salmon.

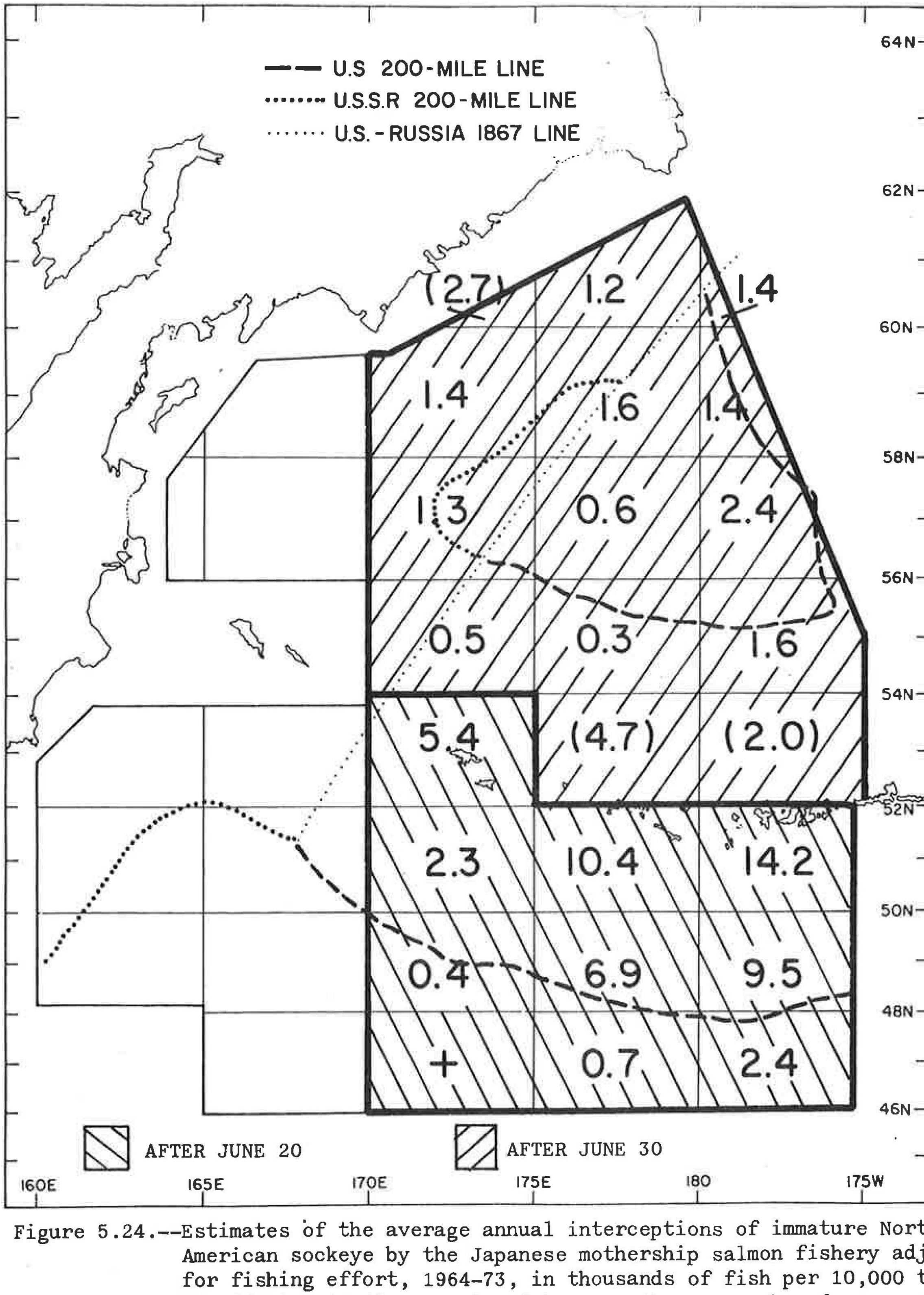


Figure 5.24.--Estimates of the average annual interceptions of immature North American sockeye by the Japanese mothership salmon fishery adjusted for fishing effort, 1964-73, in thousands of fish per 10,000 tans of effort. (Indices enclosed by parentheses are based on an average annual effort of less than 10,000 tans. Data are from Table 5.11 and INPFC Statistical Yearbooks.)

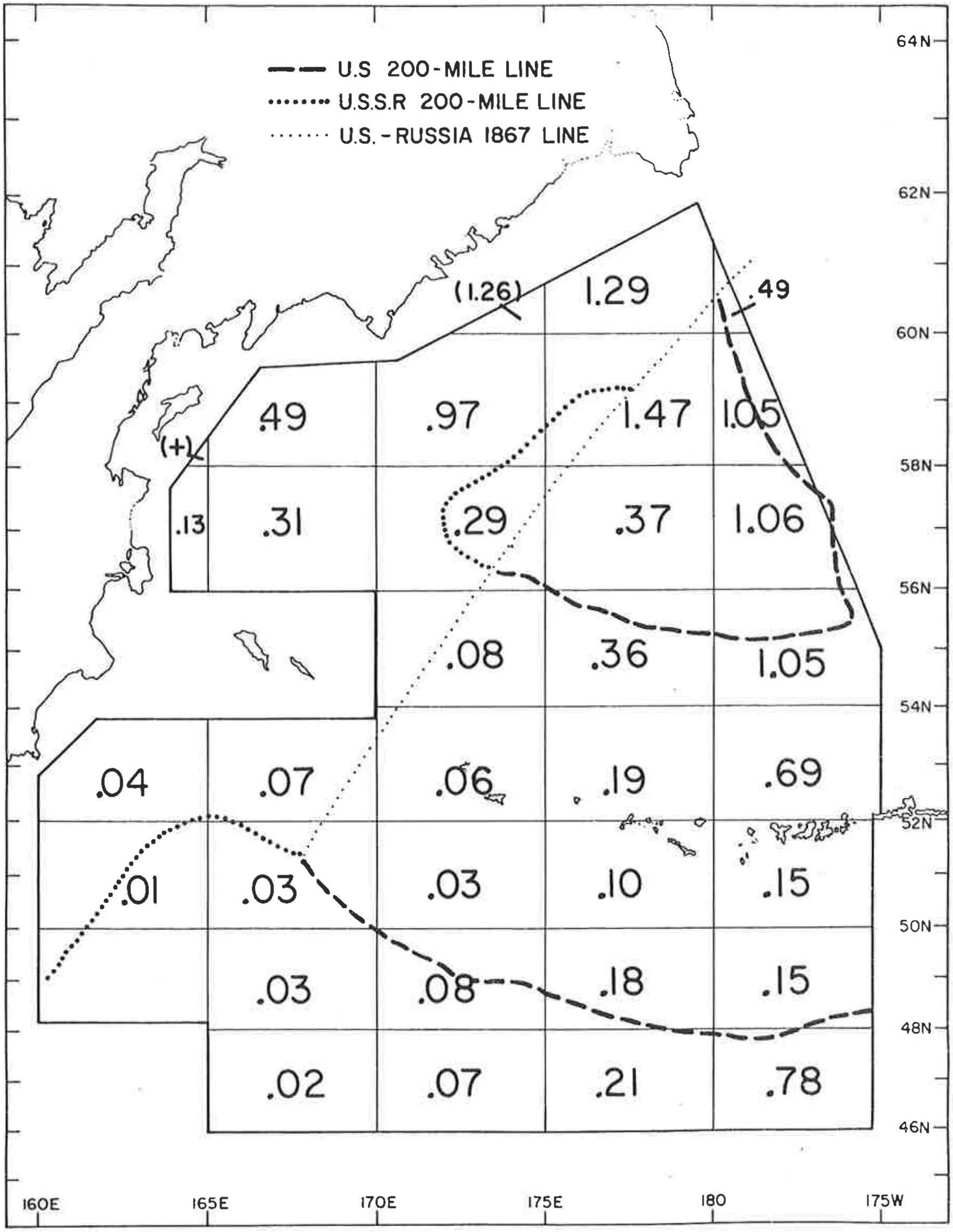


Figure 5.25.--Estimates of average annual interceptions of North American chinooks by the Japanese mothership salmon fishery adjusted for fishing effort, 1964-73, in thousands of fish per 10,000 tans of effort. (Season totals. Indices enclosed by parentheses are based on an average annual effort of less than 10,000 tans. Data are from Table 5.11 and INPFC Statistical Yearbooks.)

5.2 Catches of Asian Salmon by the Mothership Fishery

Estimates of the annual catches of Asian salmon by the Japanese mothership salmon fishery can be obtained by subtracting the estimates of interceptions of North American salmon from the total catches reported in INPFC Statistical Yearbooks.5.12/ Annual average catches of Asian salmon during 1964-73 are given in Table 5.12 and Figure 5.26 by species and statistical area.

As in the case of the interceptions of North American salmon, the distribution of the catches of Asian salmon during 1964-73 would have been different if the quantity and distribution of fishing effort had been different.

Table 5.12.—Estimates of the average annual catches of Asian salmon by the Japanese mothership salmon fishery, 1964-73, in thousands of fish.

Stat.	Catch - thousands of fish					
Area	Sockeye	Pink	Chum	Coho	Chinook	Total
6048	127	242	182	12	4	567
6050	161	175	188	12	2	538
6052	371	223	303	10	2	909
6056	14	114	51	1	1	181
6058	+	+	+	+	+	+
6546	237	150	266	17	3	673
6548	721	302	544	40	6	1,613
6550	745	465	517	27	5	1,759
6552	453	337	309	8	3	1,110
6556	61	358	175	+	3	597
6558	112	323	337	+	3	775
7046	70	84	172	207	9	542
7048	316	274	435	116	6	1,147
7050	329	407	423	26	3	1,188
7052	56	132	119	1	1	309
7054	18	98	62	+	2	180
7056	28	187	184	+	5	404
7058	64	264	365	+	4	697
7060	1	4	9	+	+	14
7546	0	27	67	149	2	245
7548	0	148	207	159	3	517
7550	0	178	292	32	+	502
7552	+	52	51	+	1	104
7554	1	49	86	+	1	137
7556	9	91	341	+	11	452
7558	34	93	435	+	9	571
7560	27	47	365	+	7	446
8046	0	5	15	71	+	91
8048	0	75	115	54	1	245
8050	0	109	252	19	+	380
8052	+	18	55	+	0	73
8054	2	67	133	+	0	202
8056	17	144	702	+	1	864
8058	22	98	710	+	1	831
8060	5	2	31	+	+	38
Total	4,001	5,342	8,498	961	99	18,901

DATA SOURCES: INPFC Statistical Yearbooks and Table 5.11.

5.12/ In the case of sockeye, U.S. scientists do not classify to continent of origin fish of ages .3 and .4 caught in Subareas 5, 7 and 9 after June 20 or in Subareas 6, 8 and 10 after June 30. The average annual catch of such fish during 1964-73 was 170 thousand fish. They are not included in either the estimates of interceptions of North American sockeye or catches of Asian sockeye.

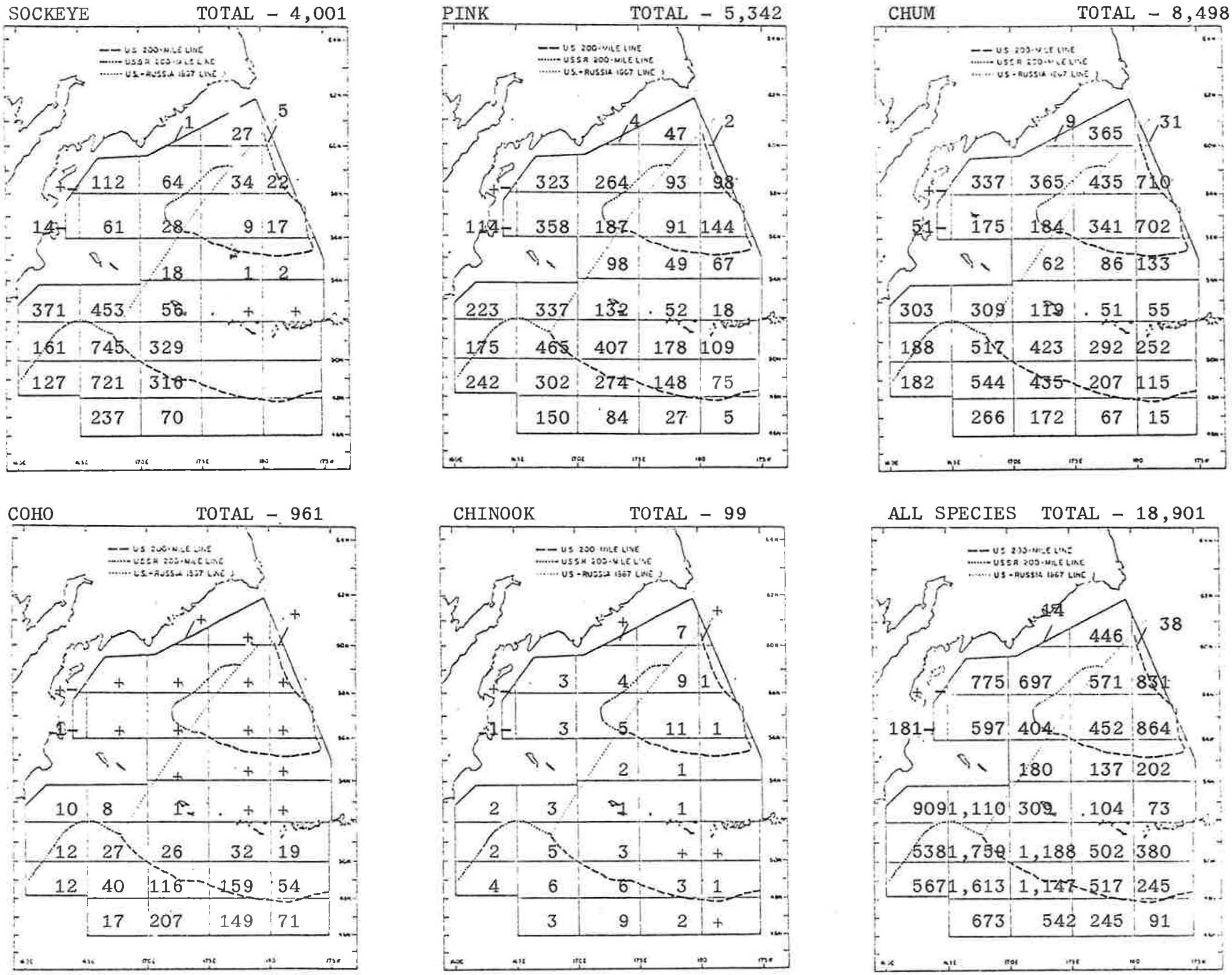


Figure 5.26.--Estimates of the average annual catches of Asian salmon by the Japanese mothership salmon fishery, 1964-73, in thousands of fish. (Data are from Table 5.12.)

5.3 Catches by the Mothership Fishery in Relation to 200-Mile Zones

The approximate percentage of each statistical area of the Japanese salmon mothership fishing area lying inside the U.S. 200-mile zone, inside the U.S.S.R. 200-mile zone, or outside both zones is shown in Figure 5.27. Estimates of the average annual catches of North American and Asian salmon during 1964-73 in relation to the 200-mile zones of the U.S. and U.S.S.R. (see Figure 5.28) are given in Table 5.13.

A little under 70% of the mothership interceptions of North American salmon during 1964-73 were inside the U.S. 200-mile zone, slightly over 5% in the U.S.S.R. 200-mile zone, somewhat under 20% outside the U.S. and U.S.S.R. zones in the Bering Sea, and the remainder (8%) in the North Pacific Ocean to the south of the zones of the two nations. Approximately 55% of the catch of Asian salmon was taken inside the 200-mile zones of the U.S. (26%) and U.S.S.R. (29%), a littles less than 15% outside the two zones in the Bering Sea, and the remainder (32%) to the south of the 200-mile lines in the North Pacific Ocean. For both North American and Asian salmon, the percentages taken inside and outside either or both zones varied by species.

Outside the U.S.S.R. 200-mile zone (which was closed to the mothership fishery in 1977), the average annual catches during 1964-73 are estimated to have been 2.4 million North American salmon and 13.4 million Asian salmon.

5.4 The Landbased Driftnet Fishery

As mentioned previously, not enough is known about the origins of salmon in the area fished by the Japanese landbased driftnet fishery to separate the catches by that fishery into continental categories. The lack of information is of concern to the United States because many millions of sockeye salmon have been caught by the landbased driftnet fishery in waters east of 165°E since 1967, and the catches of coho salmon east of 175°E were also large in 1974 and 1975 (2 of the only 3 years between 1956 and 1975 for which detailed catch effort statistics for the landbased driftnet fishery have been made available to INPFC).

In the case of coho salmon, there has been very little tagging east of 175°E, south of 50°N in the mothership fishing area or in the landbased driftnet area. More taggings (or racial studies) are needed. As for sockeye salmon, some high seas recoveries of fish tagged in May and early June in waters close to the area fished by landbased driftnet vessels stronlgly suggest that North American sockeye are vulnerable to the landbased fishery (Figure 5.29). It is possible that substantial numbers of North American sockeye salmon have been intercepted by the landbased driftnet fishery since the mid-1960's.

5.5 The Landbased Longline Fishery

For reasons given earlier, we believe that it is higly unlikely that many, if any, North American salmon were caught by the Japanese landbased longline fishery in the years (1952-71) that it operated.

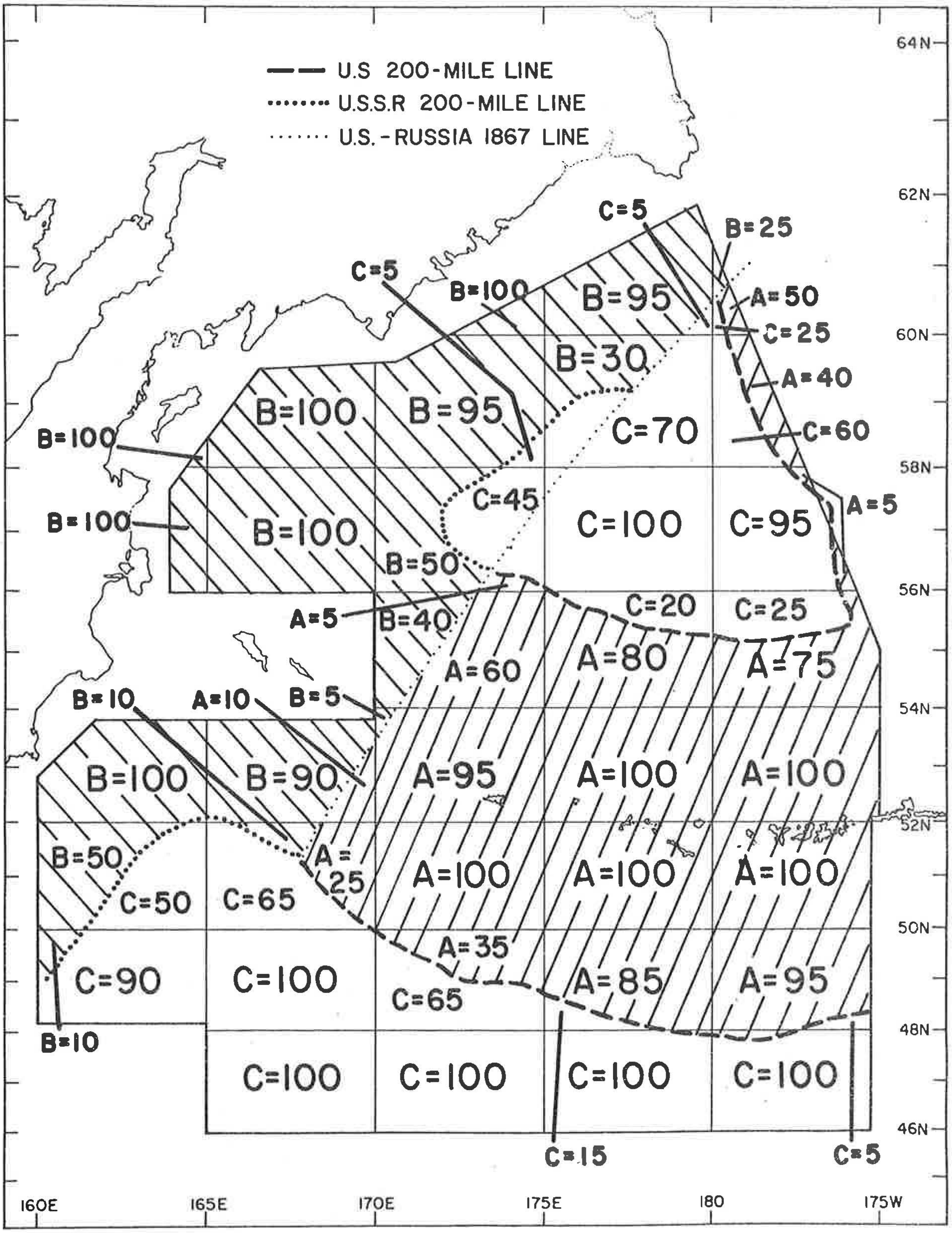


Figure 5.27.--Approximate percentage of each statistical area of the Japanese salmon mothership fishing area lying inside the U.S. 200-mile zone (A), inside the U.S.S.R. 200-mile zone (B), or outside both the U.S. and U.S.S.R. zones (C).

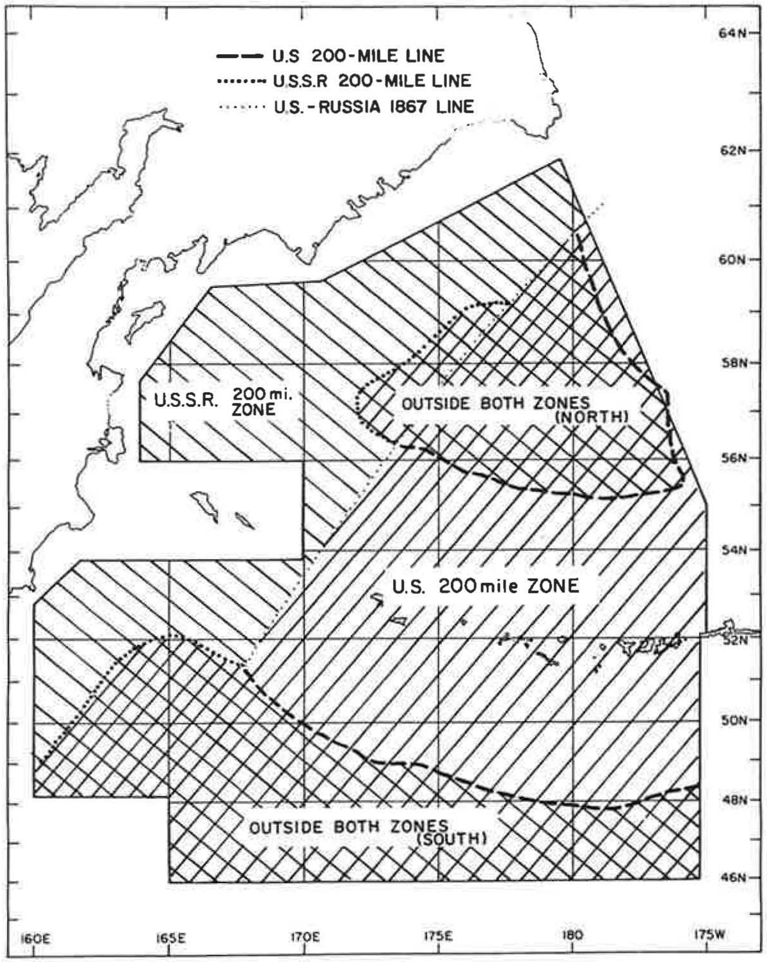
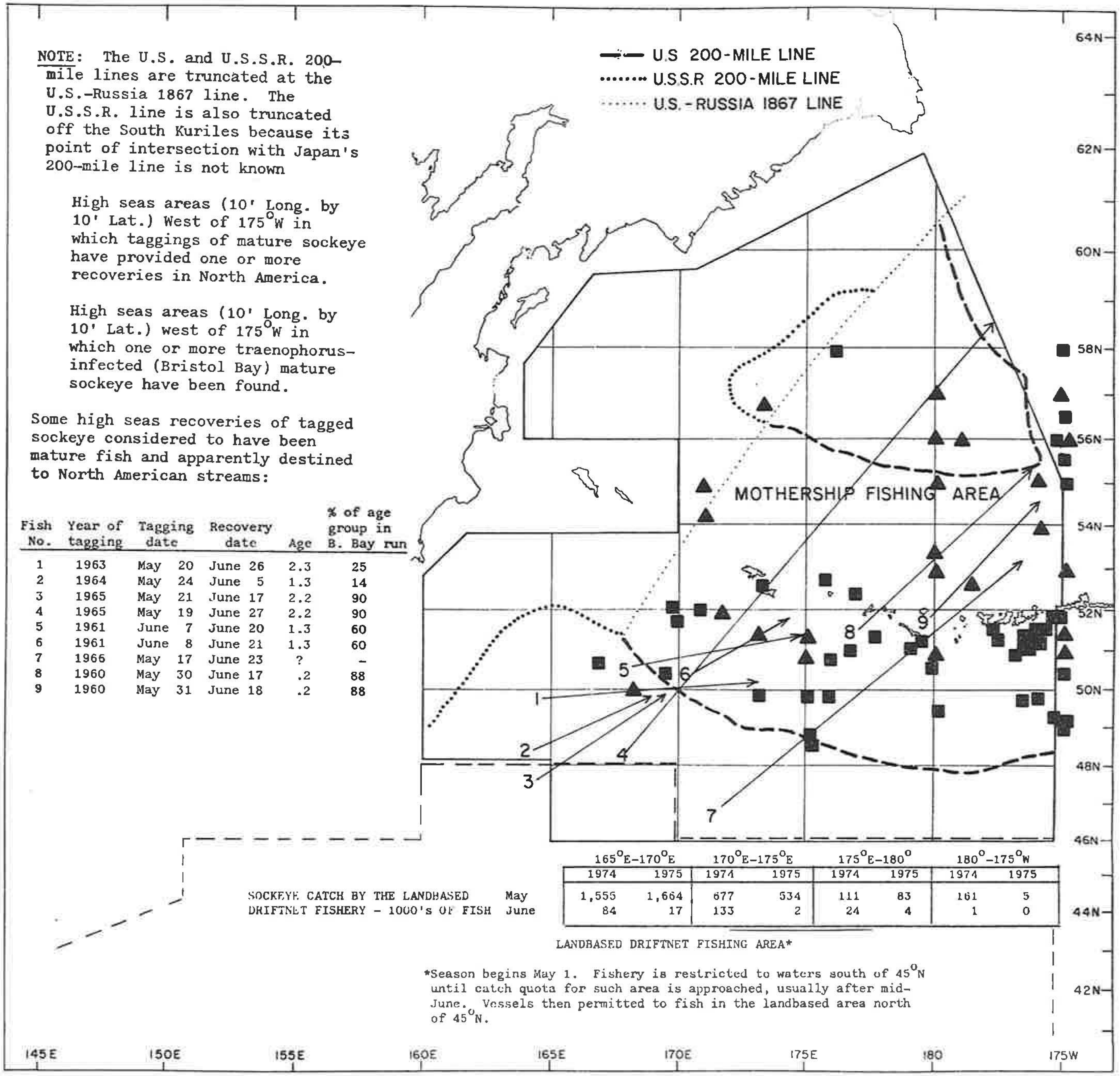


Figure 5.28.--Approximate locations of the U.S. and U.S.S.R. 200-mile lines in the Japanese salmon mothership fishing area. (Lines truncated at the U.S.-Russia 1867 line.)

Table 5.13.--Estimates of the average annual catches of North American (NA) and Asian (A) salmon by the Japanese salmon mothership fishery during 1964-73 in relation to the U.S. and U.S.S.R. 200-mile zones, in thousands of fish. (Data are from Tables 5.11 and 5.12 prorated to the percentage of each statistical area lying inside/outside the U.S./U.S.S.R. 200-mile zones as indicated in Figure 5.27. Differences between totals given here and in Tables 5.11 and 5.12 are due to rounding.)

Sector of the fishing area	Species	Catch - 1000's of fish			% by origin		% by Sector	
		NA	A	Total	NA	A	NA	A
a. Inside the U.S. 200-mile zone	S	1,601	751	2,352	68	32	75	19
	P	17	1,536	1,553	1	99	100	29
	C	53	2,334	2,387	2	98	30	27
	Co	24	312	336	7	93	100	32
	Ch	45	14	59	76	24	24	14
	Total	1,740	4,947	6,687	26	74	68	26
b. Inside the U.S.S.R. 200-mile zone	S	61	1,255	1,316	5	95	3	31
	P	0	1,947	1,947	0	100	0	36
	C	26	2,272	2,298	1	99	15	27
	Co	0	28	28	0	100	0	3
	Ch	58	30	88	66	34	30	32
	Total	145	5,532	5,677	3	97	6	29
c. Outside both the U.S. and U.S.S.R. 200-mile zones - North	S	273	82	355	77	23	13	2
	P	0	478	478	0	100	0	9
	C	96	1,916	2,012	5	95	55	23
	Co	0	+	+	0	100	0	+
	Ch	77	21	98	79	21	40	22
	Total	446	2,497	2,943	15	85	18	13
d. Outside both the U.S. and U.S.S.R. 200-mile zones - South	S	202	1,912	2,114	10	90	9	48
	P	0	1,381	1,381	0	100	0	26
	C	0	1,977	1,977	0	100	0	23
	Co	0	621	621	0	100	0	65
	Ch	12	30	42	29	71	6	32
	Total	214	5,921	6,135	3	97	8	32
e. Total - All Sectors (Items a through d)	S	2,137	4,000	6,137	35	65		
	P	17	5,342	5,359	+	100		
	C	175	8,499	8,674	2	98		
	Co	24	961	985	2	98		
	Ch	192	95	287	67	33		
	Total	2,545	18,897	21,442	12	88		
f. Total outside the U.S.S.R. 200-mile zone (Items a, c and d)	S	2,076	2,745	4,821	43	57	97	69
	P	17	3,395	3,412	+	100	100	64
	C	149	6,227	6,376	2	98	85	73
	Co	24	933	957	3	97	100	97
	Ch	134	65	199	67	33	70	68
	Total	2,400	13,365	15,765	15	85	94	71



Fish No.	Year of tagging	Tagging date	Recovery date	Age	% of age group in B. Bay run
1	1963	May 20	June 26	2.3	25
2	1964	May 24	June 5	1.3	14
3	1965	May 21	June 17	2.2	90
4	1965	May 19	June 27	2.2	90
5	1961	June 7	June 20	1.3	60
6	1961	June 8	June 21	1.3	60
7	1966	May 17	June 23	?	-
8	1960	May 30	June 17	.2	88
9	1960	May 31	June 18	.2	88

SOCKEYE CATCH BY THE LANDBASED DRIFTNET FISHERY - 1000's OF FISH

	165°E-170°E		170°E-175°E		175°E-180°		180°-175°W	
	1974	1975	1974	1975	1974	1975	1974	1975
May	1,555	1,664	677	534	111	83	161	5
June	84	17	133	2	24	4	1	0

Figure 5.29.--Evidence illustrating the reason for U.S. concern about the effect of the Japanese landbased driftnet fishery on North American sockeye salmon.

6.0 WORLD CATCH OF PACIFIC SALMON, VESSELS AND GEAR, AND PRODUCTS AND MARKETS

This section reviews information on the world catch of Pacific salmon, vessels and gear employed in the salmon fisheries, and products of and markets for Pacific salmon.

6.1 Catch of Salmon by Commercial Fisheries of Japan, Canada, U.S. and U.S.S.R.

Our review of the catches of salmon by commercial fisheries of Japan, Canada, U.S. and U.S.S.R. covers two periods, the first from 1920-44 and the second from 1952-75. During the several years between the two periods Japan's salmon fishing activities almost completely ceased because of World War II and its aftermath. Data for the period since 1952 are described more fully than are the catches for the earlier period.

6.1.1 Average Annual Catches, 1920-44 and 1952-75

The average annual catch of salmon by Canada, Japan, U.S. and U.S.S.R. was about 285 million fish during 1920-44, but it dropped to slightly under 200 million fish during 1952-75 (Table 6.1). Most of the reduction was in pink salmon catches (69 million less fish), but there were reductions also in the average catches of sockeye (11 million less) and chums (8 million less). Average catches of coho salmon were greater by 3 million fish and there was an increase of 0.3 million fish in chinook catches.

Between 1920 and 1944, pink salmon accounted for 65% of the total catch and predominated in the numbers of salmon landed by each nation. Chums made up 17% of the total catch and ranked second to pinks in numbers landed in Japan, Canada and the U.S.S.R. but a distant third in catches in the U.S. where sockeye ranked second. Sockeye represented 14% of the all-nation salmon catch, coho 3% and chinook 1%. Japan led the four nations with 41% of the catch, followed by the U.S. with 32%, the U.S.S.R. with 20% and Canada with 7%.

Coastal fisheries on the two sides of the North Pacific Ocean accounted for all of the salmon caught during 1920-44 except for those taken by a Japanese mothership gillnet fishery outside territorial waters off Kamchatka and a landbased gillnet fleet that fish offshore from the northern Kurile Islands in the 1930's and early 1940's. The two high seas fisheries together caught about 23 million salmon annually, or less than 20% of Japan's total catch. Most of Japan's coastal catch was taken by fisheries it operated in Siberia, Sakhalin and the Kuriles rather than by fisheries in Hokkaido and Honshu. The precise percentage cannot be determined from available data, but it appears that only 5 to 10% of Japan's coastal catch was from the latter two islands.

Table 6.1.--Average annual catch of salmon by commercial fisheries of Canada, Japan, U.S. and U.S.S.R., 1920-44 and 1952-75, in millions of fish.

Species	Catch - millions of fish					Percent by nation (by species)				Percent by species (all nations)
	Canada	Japan	U.S.	U.S.S.R.	All nations	Canada	Japan	U.S.	U.S.S.R.	
1920-1944										
Sockeye	4.2	8.9	24.2	2.7 a/	40.0	10	22	61	7	14
Pink	8.7	87.8 b/	49.6	37.9 c/	184.0	5	48	27	20	65
Chum	4.6	19.8	9.0	14.3	47.7	10	41	19	30	17
Coho	2.1	1.2	4.3	0.9	8.5	25	14	50	11	3
Chinook	0.6	+	2.6	+ a/	3.2	19	+	81	+	1
All species	20.2	117.7	89.7	55.8	283.4	7	41	32	20	100
1952-1975										
Sockeye	4.8	9.1	13.7	1.2	28.8	16	32	48	4	14
Pink	9.9	46.7 b/	25.0	33.0	114.6	8	41	22	29	58
Chum	2.5	22.7	6.5	7.7	39.4	6	58	16	20	20
Coho	3.4	2.9	4.0	1.2	11.5	30	25	35	10	6
Chinook	1.1	0.3	2.0	0.1	3.5	31	9	57	3	2
All species	21.7	81.7	51.2	43.2	197.8	11	41	26	22	100
Changes between periods: 1952-75 minus 1920-44										
Sockeye	0.6	0.2	-10.5	-1.5	-11.2	6	10	-13	-3	0
Pink	1.2	-41.1	-24.6	-4.9	-69.4	3	-7	-5	9	-7
Chum	-2.1	2.9	-2.5	-8.4	-8.3	-4	17	-3	-10	3
Coho	1.3	1.7	-0.3	0.3	3.0	5	11	-15	-1	3
Chinook	0.5	0.3	-0.6	0.1	0.3	12	9	-24	3	1
All species	1.5	-36.0	-38.5	-12.6	-85.6	4	0	-6	2	---

a/ Average is based on catches in 1927-36 and 1940-44.
b/ Includes masu.
c/ Average is based on catches in 1925-36 and 1940-44.

DATA SOURCES: See Appendix 1.

Between 1952 and 1975, pink salmon predominated in the all-nation catch (58% of the total) but to a lesser degree than in 1920-44 (65%). Chums accounted for 20% of the total catch (compared to 17% in 1920-44), sockeye 14% (same as in 1920-44), coho 6% (up from 3% in 1920-44), and chinook 2% (also up slightly from 1920-44). Japan again led the four nations ith 41% of the total catch (the same percentage as in 1920-44), even though its average annual catch dropped by 36 million fish (from 118 to 82 million). The fraction of the 1952-75 catch taken by the U.S. was 26% (a drop from 32% in 1920-44), reflecting the largest decrease in average annual catch of any of the four nations (from 90 million salmon in 1920-44 to 51 million in 1952-75). Some of the decrease in the U.S. catch, particularly sockeye, can be attributed to interceptions by Japan's mothership salmon fishery and possibly its landbased offshore driftnet fishery. Although the average catch by the U.S.S.R. also dropped (by nearly 13 million fish), its fraction of the total catch increased from 20% in 1920-44 to 22% in 1952-75. The fraction taken by Canada, hich experienced an increase of 1.4 million fish in average annual catch, rose from 7% in 1920-44 to 11% in 1952-75.

During 1952-75, Japan's high seas fisheries in the North Pacific Ocean and Okhotsk Sea (1955-58) accounted for more than 80% of that nation's catch of salmon, just about the reverse of the case prior to 1945 hen most of Japan's catch was taken by coastal fisheries. Another difference between Japan's 1920-44 and 1952-75 catches is that Asian salmon constituted the entire catch in the earlier period but substantial numbers of North American salmon have been taken on the high seas since 1952.

6.1.2 Annual Catches, 1952-75

There have been numerous changes in the annual catches of salmon by the four nations since 1952. These are described for each species and some briefly generalized explanations regarding the changes are offered.

6.1.2.1 Sockeye

Japanese and Soviet catches of sockeye have declined since the early or middle 1950's (Table 6.2 and Figure 6.1). This is due to a combination of events: an apparent decrease in the abundance of Asian sockeye, Japanese-Soviet restrictions on sockeye catches allowed by Japan's mothership fishery, and a reduction in the numbers of Bristol Bay sockeye intercepted by the mothership fishery in recent years. Canada's catch of sockeye has remained reasonably stable since 1952. As for the U.S., its annual catches reflect a strong cyclic characteristic of the Bristol Bay sockeye runs and were also reasonably stable over successive 4- or 5-year cycles through 1971. Since then, catches have been below the averages of previous corresponding cycle-years. There are two reasons for this: unfavorable environmental conditions which affected the survival of Bristol Bay sockeye in the early 1970's and severe restrictions on the Bristol Bay fishery during 1972-75.

In regard to U.S. catches of sockeye, they would have been substantially greater, particularly in peak and post-peak years of the Bristol Bay cycle, if there had been no high seas salmon fishing. Soviet catches ould also have been much greater, of course.

Table 6.2.--Commercial catch of sockeye salmon by the high seas fisheries of Japan and the coastal fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75, in millions of fish and thousands of metric tons.[a]

Year	Millions of fish						Thousands of metric tons					
	High seas	Coastal				Total	High seas	Coastal				Total
	Japan	Japan	Canada	U.S.	U.S.S.R.	catch	Japan	Japan	Canada	U.S.	U.S.S.R.	catch
1952	0.8	-	4.9	18.2	3.2	27.1	1.7	-	14.0	47.2	9.2	72.1
1953	1.8	-	5.9	13.9	1.8	23.4	4.1	-	16.0	36.3	5.1	61.5
1954	4.2	-	6.7	14.6	1.4	26.9	9.8	-	21.3	41.1	4.0	76.2
1955	13.0	-	2.8	9.8	1.1	26.7	26.5	-	7.6	25.6	3.1	62.8
1956	10.6	-	3.3	15.9	2.0	31.8	20.5	-	9.8	41.1	5.7	77.1
1957	20.6	-	3.0	11.7	1.2	36.5	43.3	-	7.1	29.7	3.5	83.6
1958	12.9	-	12.0	11.6	0.3	36.8	25.6	-	33.6	31.0	1.0	91.2
1959	10.0	-	3.3	10.1	1.4	24.8	19.8	-	8.2	25.7	4.0	57.7
1960	14.6	-	2.9	19.2	1.4	38.1	30.6	-	7.0	43.2	4.0	84.8
1961	14.2	-	4.6	17.5	2.7	39.0	36.7	-	12.1	47.2	7.8	103.8
1962	10.8	-	3.5	10.1	1.4	25.8	24.8	-	9.1	26.3	4.6	64.8
1963	8.9	-	2.1	7.6	1.2	19.8	19.1	-	5.4	18.9	3.4	46.8
1964	7.2	-	3.6	10.5	1.0	22.3	14.3	-	10.4	26.0	2.7	53.4
1965	12.2	-	3.0	30.8	1.5	47.5	25.0	-	7.4	66.6	4.2	103.2
1966	8.0	-	4.0	16.5	1.2	29.7	16.6	-	11.7	46.3	3.7	78.3
1967	10.7	-	6.7	10.8	1.0	29.2	20.5	-	16.8	30.0	3.0	70.3
1968	9.1	-	6.3	9.1	0.8	25.3	16.8	-	18.8	24.8	2.2	62.6
1969	8.4	-	4.3	13.1	0.6	26.4	15.5	-	10.9	33.5	1.6	61.5
1970	10.0	-	4.1	29.0	1.6	44.7	17.9	-	11.4	72.4	4.5	106.2
1971	6.6	+	6.3	17.4	0.8	31.1	11.0	+	17.3	48.1	2.2	78.6
1972	6.9	-	3.6	7.9	0.3	18.7	11.0	-	9.5	21.8	1.0	43.3
1973	5.9	-	7.6	7.2	0.7	21.4	9.4	-	21.5	22.2	1.7	54.8
1974	5.4	-	7.2	7.4	0.4	20.4	8.2	-	21.7	21.4	1.1	52.4
1975	5.2	-	2.3	9.1	0.5	17.1	7.7	-	5.7	23.7	1.5	38.6

a/ See Appendix 1 for data sources. A negligible catch is indicated by +.

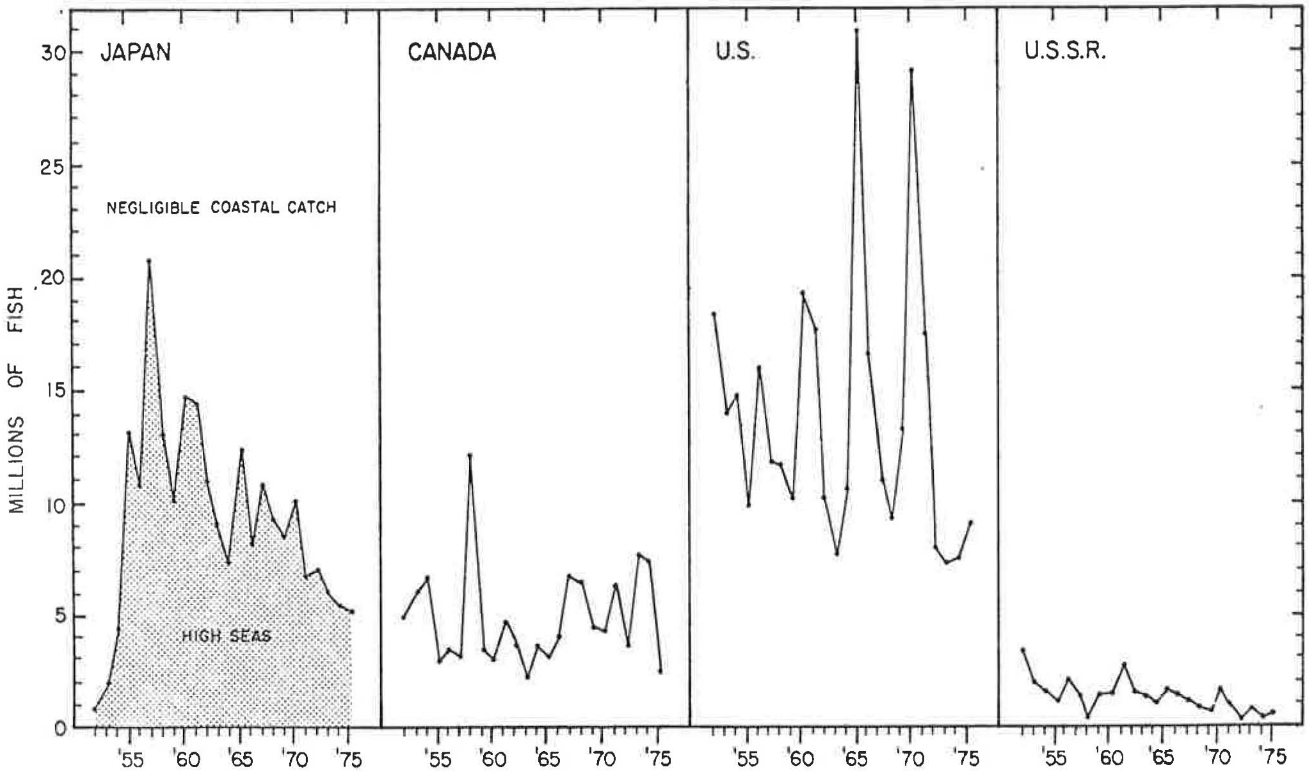


Figure 6.1.--Catch of sockeye salmon by commercial fisheries of Japan, Canada, U.S. and U.S.S.R., 1952-75. (Data are from Table 6.2.)

6.1.2.2 Pink

Japan's high seas catch of pink salmon reached nearly 70 million fish in 1957 but has decreased by about 4 million in each odd-numbered year since then (Table 6.3 and Figure 6.2). As for even-numbered years, the high seas catch was close to 45 million fish in 1956 and 1958 but dropped to 28 million in 1960. Since then the catch in each even-numbered year has declined by about 1 million fish. The reductions in high seas catches after the late 1950's are associated with successively smaller catch quatas set by the Japan-U.S.S.R. Northwest Pacific Fisheries Commission for Japan's high seas fisheries. The quota system itself as initiated because of concern over the sharp drop in Soviet catches of pinks (and also other species of salmon) in the late 1950's. Since 1961, the Soviet catch of pinks has increased by an average of 4 million fish in each odd-numbered year, or nearly the same as the average decrease in the high seas catch in such years. Soviet catches in even-numbered years changed very little between 1960 and 1972 but increased sharply in 1974.

The catch of pink and masu salmon by Japan's coastal fishery, which includes the Japan Sea, has not changed greatly over the past 20 years.

On the North American side of the Pacific Ocean, catches in even-numbered years have been 35-45% larger than in odd-numbered years, a sharp contrast to the Japanese and Soviet catches which have been nearly twice as large in odd-numbered years as in even-numbered years. Canadian catches in recent even- and odd-years have been smaller than they were in 1962-63, and U.S. catches have had a downward trend since the late 1960's.

Table 6.3.—Commercial catch of pink salmon by the high seas fisheries of Japan and the coastal fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75, in millions of fish and thousands of metric tons.[a]

Year	Millions of fish						Thousands of metric tons					
	High seas	Coastal				Total catch	High seas	Coastal				Total catch
	Japan	Japan[b]	Canada	U.S.	U.S.S.R.		Japan	Japan[b]	Canada	U.S.	U.S.S.R.	
1952	14.8	5.2	11.2	19.9	37.0	88.1	17.9	7.5	23.3	32.6	57.9	139.2
1953	13.8	3.2	11.1	21.7	92.5	142.3	16.8	4.5	28.0	43.7	142.3	235.3
1954	16.0	4.1	5.4	22.9	29.8	78.2	19.3	5.8	11.7	37.2	46.2	120.2
1955	49.2	6.1	11.2	30.0	59.3	155.8	65.4	8.7	28.7	59.3	88.3	250.4
1956	44.8	10.9	7.4	26.4	45.4	134.9	55.7	15.6	13.1	43.5	72.1	200.0
1957	69.1	9.5	11.3	16.9	71.5	178.3	81.8	13.6	26.0	33.1	106.4	260.9
1958	46.0	18.1	6.9	26.1	24.5	121.6	65.5	25.9	15.4	42.7	38.4	187.9
1959	63.1	12.8	6.8	13.5	32.4	128.6	82.8	18.2	15.9	26.3	47.1	190.3
1960	28.1	17.2	4.1	16.1	13.2	78.7	36.1	24.5	7.7	24.0	19.6	111.9
1961	49.1	7.2	8.3	22.3	21.5	108.4	65.4	10.3	22.7	50.1	30.3	178.8
1962	27.1	7.6	23.4	43.9	10.8	112.8	28.9	11.3	42.5	64.7	16.3	163.7
1963	55.6	9.2	12.2	40.6	24.6	142.2	62.0	13.0	27.5	67.3	35.7	205.5
1964	27.3	5.6	9.6	45.3	10.6	98.4	30.3	7.6	16.7	73.0	14.6	142.2
1965	51.7	9.5	5.1	21.1	34.7	122.1	53.3	13.4	10.4	36.2	47.9	161.2
1966	30.5	9.6	17.3	40.1	14.0	111.5	32.8	13.7	33.3	74.0	20.7	174.5
1967	49.1	14.8	9.8	10.9	33.1	117.7	50.7	20.7	23.4	23.7	50.7	169.2
1968	26.8	11.5	19.6	44.7	10.1	112.7	31.1	16.3	25.2	67.5	16.3	156.4
1969	48.2	16.7	2.6	26.8	42.8	137.1	51.3	23.1	6.3	51.1	63.4	195.2
1970	22.7	9.0	13.6	31.2	11.1	87.6	25.7	12.8	24.0	53.2	16.2	131.9
1971	39.8	12.4	8.5	26.0	38.8	125.5	42.9	17.6	17.6	45.1	58.4	181.6
1972	21.4	6.9	14.2	15.9	13.6	72.0	25.5	10.0	18.2	24.4	20.4	98.5
1973	36.2	9.9	6.5	12.2	49.9	114.7	40.0	14.4	13.3	22.3	66.4	156.4
1974	22.0	7.9	7.4	9.9	23.3	70.5	24.5	11.7	11.2	18.7	32.0	98.1
1975	33.7	10.5	4.6	14.4	~47.7	110.9	34.9	14.5	10.2	26.4	69.0	155.0

a/ See Appendix 1 for data sources.
b/ Includes masu salmon.

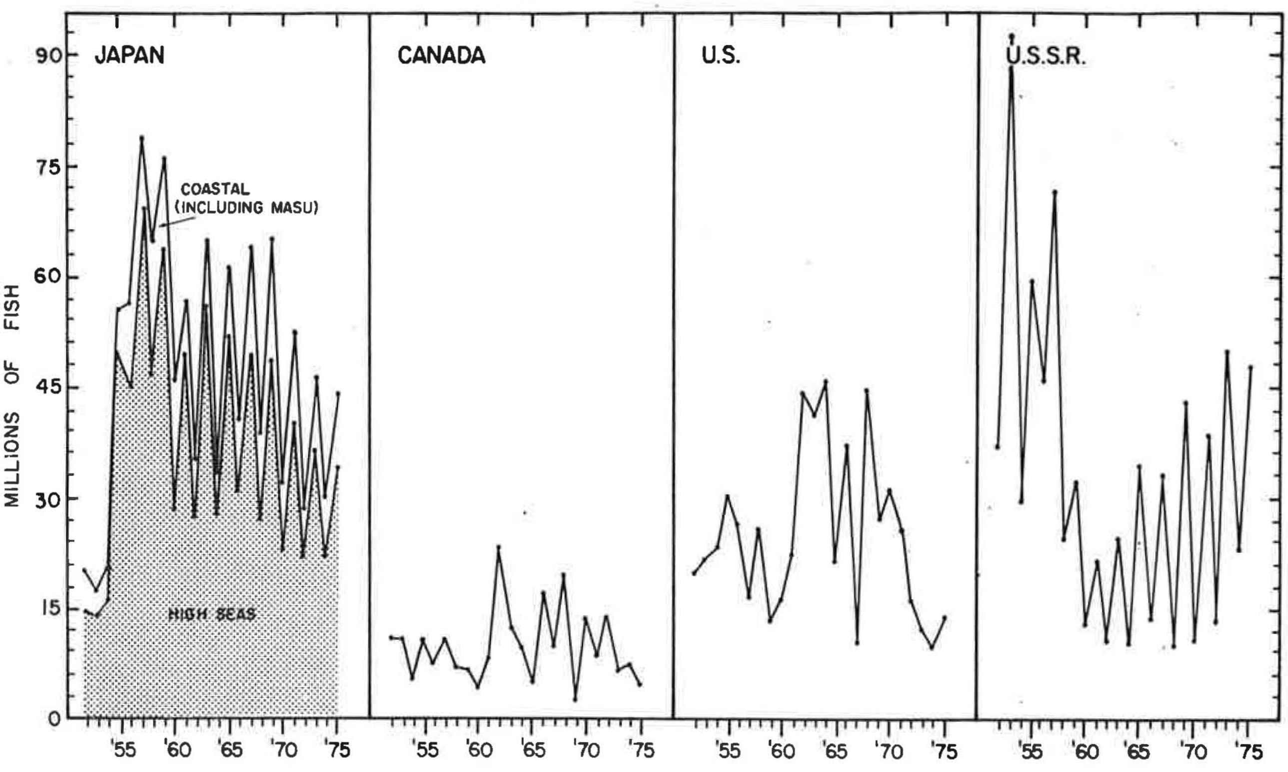


Figure 6.2.—Catch of pink salmon by commercial fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75. (Data are from Table 6.3.)

6.1.2.3 Chum

Japan's high seas fisheries caught an average of 23 million chums a year between 1955 and 1960 and have since had an average annual catch of about 18 million fish (Table 6.4 and Figure 6.3). The catch in Japan's coastal fishery has increased remarkably over the years, a result of a highly successful hatchery propagation program in that country. The situation with respect to Japan's chum catches contrasts sharply with the steep and steady decline in Soviet catches from the mid-1950's through the early 1970's. It appears that Japan's high seas fisheries have had a severe impact on stocks of chum salmon originating in the U.S.S.R.

In Canada, the chum catches decreased from the early 1950's through the mid-1960's but have since levelled off or recovered somewhat. U.S. catches had a downward trend from the early 1950's through the 1960's but have since shown some signs of recovery. As for the underlying reason or reasons for the changes in Canadian and U.S. catches of chum salmon, no explanation is attempted here. It appears, however, that Japan's high seas salmon fisheries have had little to do with the changes.

Table 6.4.--Commercial catch of chum salmon by the high seas fisheries of Japan and the coastal fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75, in millions of fish and thousands of metric tons.[a/]

Year	Millions of fish						Thousands of metric tons					
	High seas	Coastal				Total	High seas	Coastal				Total
	Japan	Japan	Canada	U.S.	U.S.S.R.	catch	Japan	Japan	Canada	U.S.	U.S.S.R.	catch
1952	1.3	2.1	2.5	9.1	11.6	26.6	2.6	6.4	14.5	36.6	44.0	104.1
1953	4.2	2.3	4.7	7.8	9.0	28.0	9.2	6.9	24.7	30.1	34.0	104.9
1954	12.1	3.2	5.8	9.4	13.9	44.4	27.1	9.8	33.7	36.6	52.6	159.8
1955	26.0	2.3	1.6	4.0	17.4	51.3	51.4	6.9	8.2	15.6	65.6	147.7
1956	22.6	1.8	2.5	7.6	20.3	54.8	43.6	5.4	12.4	28.1	77.3	166.8
1957	16.5	3.0	2.4	8.8	8.5	39.2	30.5	9.3	12.4	33.1	32.0	117.3
1958	29.3	3.2	3.2	7.2	7.3	50.2	58.2	9.8	17.3	27.7	27.7	140.7
1959	23.4	1.8	2.0	4.6	10.1	41.9	45.9	5.6	10.5	17.5	38.2	117.7
1960	20.7	1.9	1.8	6.8	11.3	42.5	42.9	5.6	9.2	22.6	43.3	123.6
1961	13.5	3.3	1.2	5.8	9.5	33.3	28.9	10.1	6.6	22.2	36.4	104.2
1962	15.4	3.5	1.5	7.4	9.2	37.0	30.1	11.9	8.2	27.1	34.0	111.3
1963	15.2	4.3	1.5	4.8	9.4	35.2	31.2	13.1	7.0	17.7	33.6	102.6
1964	19.3	4.5	2.3	7.6	6.5	40.2	37.1	13.5	10.9	29.9	25.4	116.8
1965	15.6	5.6	0.6	3.9	8.5	34.2	29.1	16.7	3.0	15.0	31.5	95.3
1966	22.3	4.9	1.3	6.9	7.9	43.3	42.9	14.7	7.0	25.6	27.6	117.8
1967	19.1	5.5	1.1	3.9	5.1	34.7	35.2	16.5	5.5	15.6	20.6	93.4
1968	17.3	3.0	3.1	6.6	4.4	34.4	33.7	8.9	16.6	27.6	13.7	100.5
1969	12.9	5.1	1.3	3.2	1.5	24.0	25.3	15.0	6.1	11.1	5.9	63.4
1970	17.2	6.6	3.7	7.8	3.1	38.4	34.7	19.8	16.8	26.0	12.4	109.7
1971	16.7	9.4	1.3	7.9	3.5	38.8	31.7	28.2	5.4	25.9	10.5	101.7
1972	22.3	8.0	6.1	8.0	1.4	45.8	40.4	24.1	30.2	29.8	5.1	129.6
1973	15.7	10.7	6.2	6.6	1.4	40.6	28.5	32.0	32.7	26.0	5.2	124.4
1974	21.8	12.2	2.2	5.2	1.9	43.3	37.5	40.0	12.5	19.3	7.1	116.4
1975	19.1	17.9	1.1	4.5	1.8	44.4	33.7	59.1	5.4	15.0	6.7	119.9

a/ See Appendix 1 for data sources.

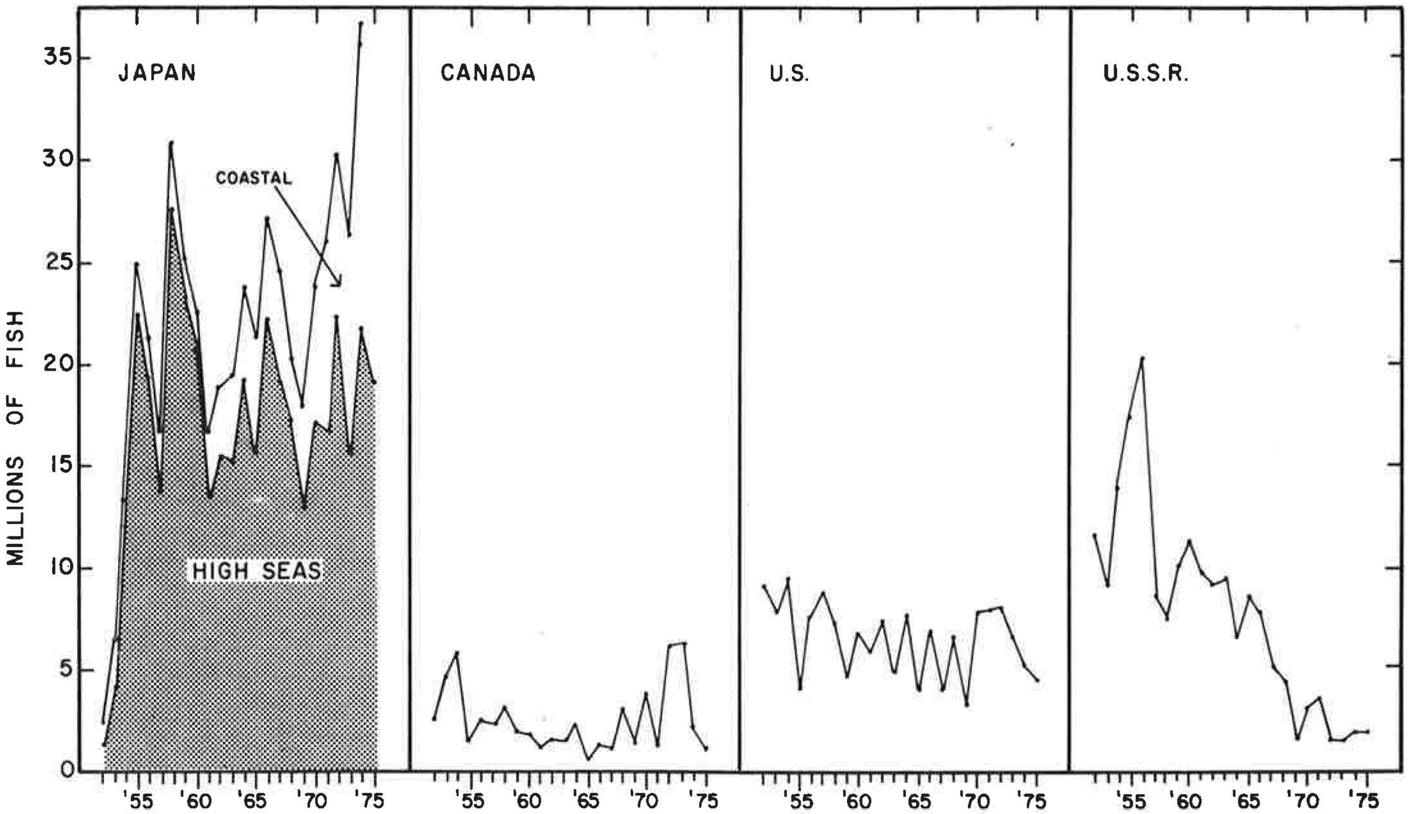


Figure 6.3.--Catch of chum salmon by commercial fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75. (Data are from Table 6.4.)

6.1.2.4 Coho

There has been a general increase in the catch of coho salmon by Japan's high seas fisheries, Canadian and U.S. catches since 1961 have been about 35% larger than they were in 1952-60, and Soviet catches show a decline from the early 1950's through the mid-1960's with a levelling off after that (Table 6.5 and Figure 6.4). The increase in Japan's high seas catch is attributed to its landbased driftnet fishery and an easterly shift in recent years in the area fished by that fleet. The higher level of catches by Canada and the U.S. over the past 15 years is associated ith the successful U.S. hatchery propagation program for that species. As for the Soviet catches, there is no doubt but that the high seas fishery has had an adverse impact but to what extent cannot be determined until more detailed data on the landbased driftnet fishery are made available and more is known about the continental origins of coho salmon caught by that fishery.

Table 6.5.--Commercial catch of coho salmon by the high seas fisheries of Japan and the coastal fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75, in millions of fish and thousands of metric tons.[a/]

Year	Millions of fish						Thousands of metric tons					
	High seas	Coastal				Total	High seas	Coastal				Total
	Japan	Japan	Canada	U.S.	U.S.S.R.	catch	Japan	Japan	Canada	U.S.	U.S.S.R.	catch
1952	0.2	+	2.7	4.8	1.4	9.1	0.4	+	10.1	18.8	4.6	33.9
1953	0.6	+	2.9	3.3	1.9	8.7	1.4	+	10.5	12.2	6.5	30.6
1954	1.9	+	2.4	3.6	2.2	10.1	4.1	+	9.4	13.2	7.5	34.2
1955	4.3	+	3.0	3.3	1.9	12.5	10.9	+	10.7	12.2	6.3	40.1
1956	4.3	+	3.0	3.5	1.1	11.9	10.0	+	11.4	12.7	3.8	38.2
1957	1.1	+	3.1	3.4	1.5	9.1	2.7	+	10.3	11.5	5.2	29.7
1958	4.2	+	3.0	2.8	0.8	10.8	11.2	+	11.2	10.2	2.8	35.4
1959	2.6	+	2.9	2.6	1.1	9.2	6.2	+	8.9	8.8	3.9	27.8
1960	2.5	+	2.0	1.9	0.6	7.0	6.0	+	6.5	6.2	1.9	20.6
1961	1.8	+	3.3	2.8	1.3	9.2	4.3	+	11.2	10.6	4.5	30.6
1962	2.8	+	3.6	3.6	1.3	11.3	8.4	+	12.1	12.6	4.7	37.8
1963	3.4	+	3.4	3.6	2.2	12.6	9.5	+	11.6	12.3	7.4	40.8
1964	5.2	+	4.1	4.7	0.3	14.3	12.5	+	14.4	17.5	1.1	45.5
1965	3.1	+	4.4	4.6	1.0	13.1	7.2	+	16.6	17.2	2.9	43.9
1966	1.9	+	5.4	5.0	0.9	13.2	4.7	+	17.5	18.8	3.3	44.3
1967	1.6	+	3.3	4.4	1.0	10.3	3.8	+	10.2	17.2	3.6	34.8
1968	2.3	+	5.3	5.3	1.0	13.9	5.6	+	15.1	17.3	3.2	41.2
1969	4.6	+	2.4	3.0	1.0	11.0	9.6	+	8.0	9.8	3.3	30.7
1970	2.4	+	3.9	5.0	1.6	12.9	5.4	+	13.6	19.6	4.6	43.2
1971	2.8	+	4.8	5.6	1.3	14.5	6.8	+	14.1	18.3	4.4	43.6
1972	3.0	+	3.4	4.2	0.5	11.1	7.5	+	10.5	14.4	1.9	34.3
1973	4.8	-	3.5	4.4	0.7	13.4	10.6	-	11.2	15.2	2.1	39.1
1974	4.6	-	3.7	5.9	1.2	15.4	9.7	-	10.4	19.7	3.9	43.7
1975	3.9	-	2.3	3.8	1.2	11.2	8.2	-	7.7	13.1	3.8	32.8

a/ See Appendix 1 for data sources. A negligible catch is indicated by +.

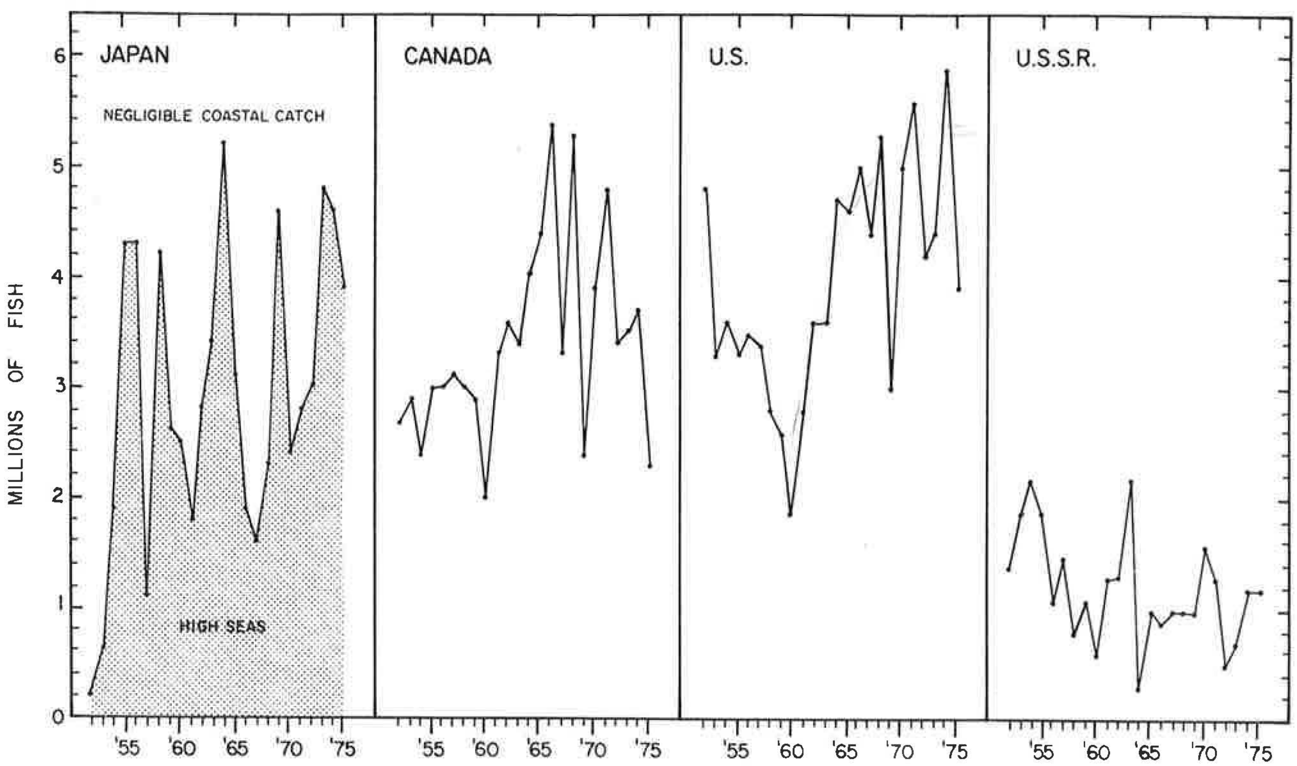


Figure 6.4.--Catch of coho salmon by commercial fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75. (Data are from Table 6.5.)

6.1.2.5 Chinook

There have been upward trends in the catches of chinooks by Japan's high seas fishery, by Canada since 1961, by the U.S. since 1967, and by the U.S.S.R. (Table 6.6 and Figure 6.5). The trend in the high seas catch is ascribed to a general increase in fishing by the Japanese mothership fishery in the Bering Sea where many chinooks of western Alaska origin are intercepted. The increases in Canadian and U.S. catches are associated with greater hatchery production in the U.S. The increase in the much lower level of catch in the U.S.S.R. might be due to an increase in abundance of Asian chinooks or more intensive fishing. Regarding the trend in the U.S. catch since the mid-1960's, it as preceded by a substantial decline during the late 1950's and early 1960's.

Table 6.6.--Commercial catch of chinook salmon by high seas fisheries of Japan and the coastal fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75, in millions of fish and thousands of metric tons.[a/]

Year	Millions of fish						Thousands of metric tons					
	High seas	Coastal				Total	High seas	Coastal				Total
	Japan	Japan	Canada	U.S.	U.S.S.R.	catch	Japan	Japan	Canada	U.S.	U.S.S.R.	catch
1952	0.01	+	0.90	2.38	0.06	3.35	0.04	0.01	6.54	17.48	0.66	24.73
1953	0.02	+	1.01	2.22	0.09	3.34	0.11	0.01	7.11	16.89	0.88	25.00
1954	0.10	+	0.88	2.36	0.06	3.40	0.42	0.02	6.10	16.00	0.65	23.19
1955	0.12	+	0.87	2.78	0.13	3.90	0.53	0.01	5.68	18.67	1.34	26.23
1956	0.16	+	0.98	2.65	0.11	3.90	0.53	0.01	6.21	16.99	1.10	24.84
1957	0.08	+	0.94	2.12	0.09	3.23	0.33	0.02	5.74	13.24	0.90	20.23
1958	0.10	+	1.07	1.85	0.07	3.09	0.41	0.02	6.45	11.94	0.70	19.52
1959	0.15	+	0.95	1.91	0.10	3.11	0.57	0.01	6.13	12.46	0.98	20.15
1960	0.31	+	0.74	1.69	0.07	2.81	1.12	0.01	4.68	11.39	0.70	17.90
1961	0.12	+	0.68	1.93	0.06	2.79	0.51	0.02	4.12	12.78	0.65	18.08
1962	0.25	+	0.72	1.59	0.10	2.66	1.03	0.02	4.11	11.81	0.96	17.93
1963	0.19	+	0.80	1.89	0.12	3.00	0.71	0.03	4.61	12.71	1.00	19.06
1964	0.62	+	0.97	2.04	0.16	3.79	2.00	0.03	6.06	13.55	1.43	23.07
1965	0.29	+	0.98	1.90	0.11	3.28	0.98	0.03	5.75	14.15	1.09	22.00
1966	0.33	+	1.16	1.69	0.09	3.27	1.22	0.03	6.95	11.68	1.02	20.90
1967	0.24	+	1.13	1.57	0.09	3.03	0.96	0.03	6.96	12.11	0.91	20.97
1968	0.46	+	1.08	1.73	0.08	3.35	1.40	0.02	6.91	12.02	0.83	21.18
1969	0.64	+	1.10	1.98	0.12	3.84	1.53	0.03	6.45	13.02	1.20	22.23
1970	0.58	+	1.21	2.11	0.14	4.04	1.61	0.03	6.56	14.75	1.41	24.36
1971	0.34	0.02	1.59	1.98	0.18	4.11	1.03	0.12	8.70	14.16	1.98	25.99
1972	0.37	+	1.55	1.86	0.20	3.98	1.12	0.03	8.35	12.88	2.18	24.56
1973	0.28	0.01	1.42	2.71	0.21	4.63	1.12	0.07	7.56	17.72	2.22	28.69
1974	0.55	0.01	1.47	2.03	0.17	4.23	1.77	0.09	7.64	13.00	1.78	24.28
1975	0.30	0.02	1.41	2.11	~0.18	4.02	1.02	0.09	7.29	13.91	~1.91	24.22

a/ See Appendix 1 for data sources. A catch under 5 thousand fish is indicated by +.

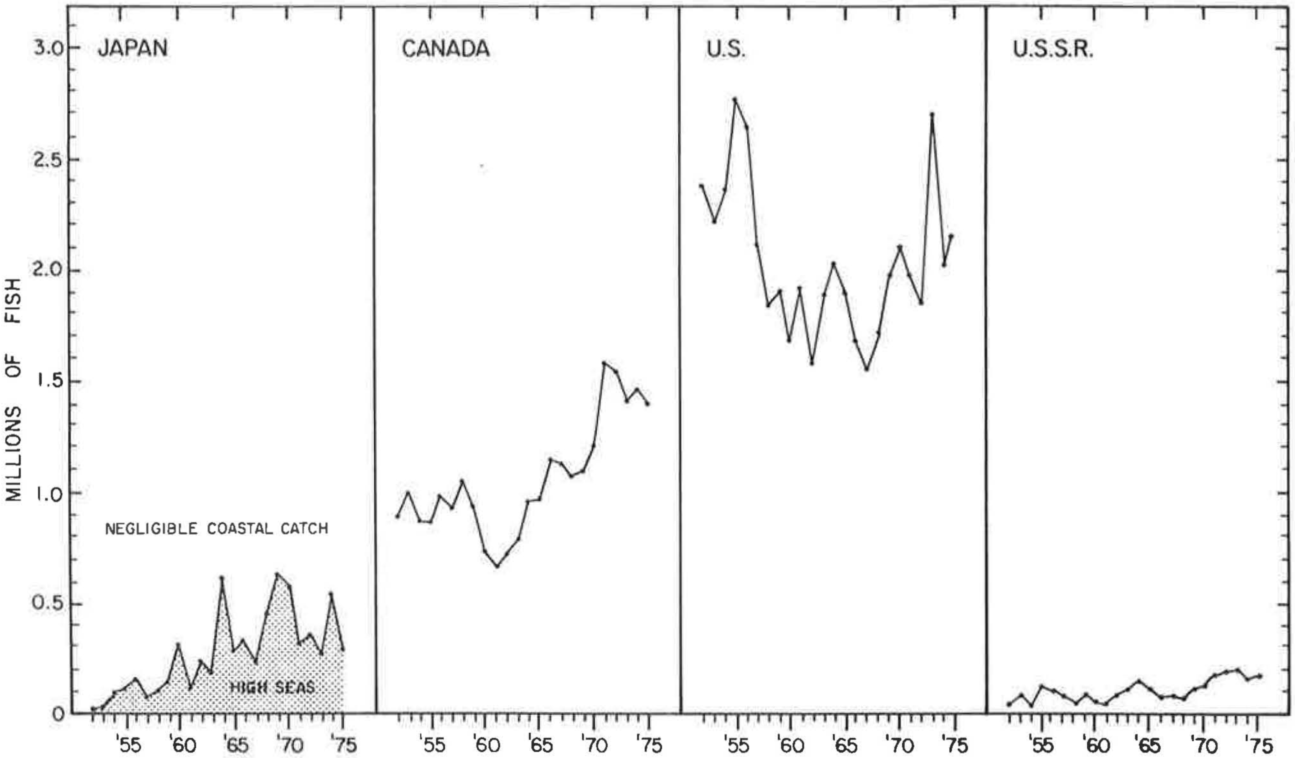
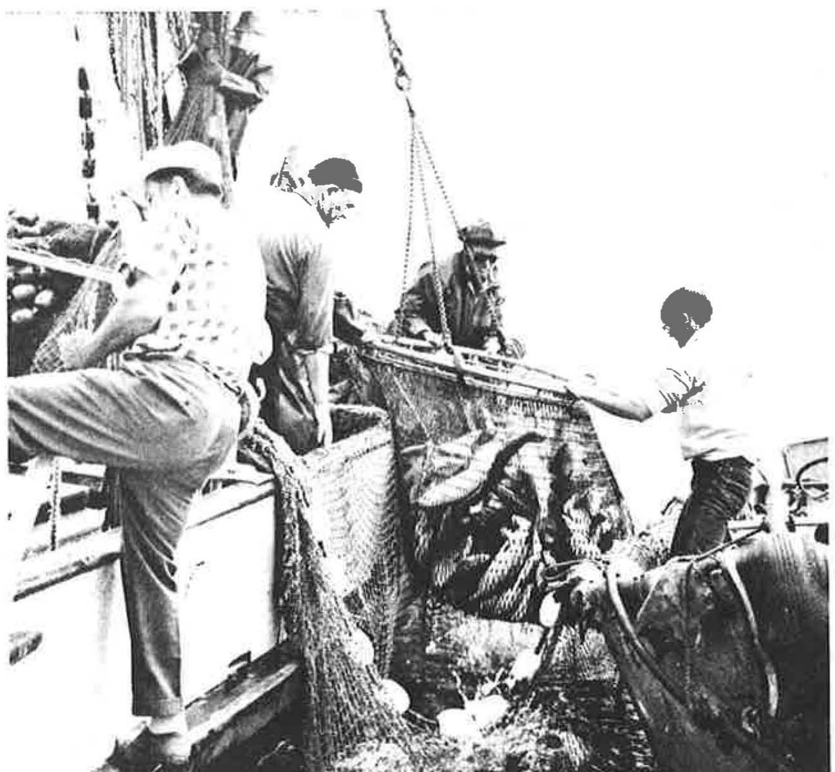


Figure 6.5.--Catch of chinook salmon by commercial fisheries of Japan, Canada, U.S., and U.S.S.R., 1952-75. (Data are from Table 6.6.)



U.S. PURSE SEINER WITH A LOAD OF SALMON
(Photo: Wash. Dept. Fish.)

6.2 Vessels and Gear

During 1971-74, approximately 12 types of fishing gear were employed in the Pacific salmon fishery. Major fishing gear included gillnet (drift and anchored types), purse seine, troll line, drift longline, set net, and trap net. Minor fishing gear included reefnet, beach seine, floating trap, fish wheel, pound net, and weir. The relative number of fishing units by gear type is presented in Table 6.7.

6.2.1 Fishing Units

Factoryships are used only by Japan in her high seas salmon fishery. Ten factoryships operated annually during 1972-74 (In 1977, however, the fleet was down to six factoryships--see Section 4.1.3.1). These factoryships ranged in size from 7,800 to 14,000 tons and each was accompanied by 32 to 34 catcher vessels (75 to 100 net tons each) fishing drift gillnets. Since 1972, a total of 332 catcher vessels has accompanied the motherships annually. (In 1977 the number of catchers was down to 245--see Section 4.1.3.1). These factoryships process salmon, offloaded from catcher vessels, into canned, salted, and frozen salmon products.

Excluding Canada, an average of 11,333 fishing craft fished gillnets annually during 1971-74. The U.S. gillnet fishery consisted of 1,363 vessels (holding capacity of over 5 net tons) and 7,993 boats (holding capacity of less than 5 net tons). Japan had a total of 1,977 gillnet vessels of which 332 were attached to the motherhsip fishery. (Canada had an average of 3,702 gillnet vessels during 1966-69. More recent information is unavailable). The 214 gillnet units of U.S.S.R. were placed under the minor fishing gear category in Table 6.7 because it was unclear as to effort--units of gillnet gear or number of vessels.

Purse seines are fished by the United States and Canada. In the United States, furthermore, they are fished only in Alaska and Washington. During 1971-73, an average of 1,119 vessels and 1,188 boats (seine skiffs included) fished purse seines in the United States. (In Canada, an approximate average of 378 vessels fished purse seines annually during 1966-69. More recent information is unavailable.)

Troll lines are fished only by the United States and Canada. An average of 4,031 vessels and 6,428 boats (10,459 total) fished troll lines annually in the United States during 1971-74. (Canada had an average of 3,350 troll vessels during 1966-69. More recent information is unavailable.) Unlike other North American salmon fisheries, troll-caught salmon are dressed and iced aboard the fishing craft.

Drift longline gear is fished only by Japan. An average of 1,304 vessels fished this gear annually during 1972-74; the 1974 count, however, was down to 894 longline vessels.

Set nets and trap nets are fished by Japan and U.S.S.R. respectively. An average of 472 licensed set net units was reported for Japan and 335 units of trap net for U.S.S.R.

Minor fishing gear of the Pacific salmon fishery include reefnets, beach seines, floating traps, fish wheels, pound nets, weirs, and gillnets (Table 6.7). In the United States, floating traps, beach seines, fish wheels, and pound nets are prohibited in the general commercial fisheries but are still employed to a small extent by Indians.

Reefnets are fished only in Puget Sound, Washington. The fishery consisted of an average of 57 units of gear and 114 boats annually during 1971-73.

Beach seining for salmon in the United States is carried out on Indian Reservations. As indicated in Table 6.7, 12 or more units ere fished annually in Alaska and Washington. In the U.S.S.R. an average of 49 units of beach seine was fished annually.

Floating traps and fish wheels are used only in Alaska. An average of nine units of each gear was fished annually.

Pound nets are fished only in the United States. An average of three units was fished annually.

Finally, averages of five weirs and 214 units of "gillnet gear" were fished annually in the U.S.S.R.

Table 6.7.--Fishing gear and crafts of the Pacific salmon fishery--annual average of 1971-74.1/

Major fishing gear/crafts 2/

Country 3/	Factory-ship	Gillnet 4/ Vessel	Gillnet 4/ Boat	Purse seine 5/ Vessel	Purse seine 5/ Boat	Troll Vessel	Troll Boat	Drift longline vessel	Set/trap net
U.S. total	0	1,363	7,993	1,119	1,188	4,031	6,428	0	0
Alaska	0	842	5,677	864	933	753	1,319	0	0
Washington	0	455	1,511	255	255	968	2,273	0	0
Oregon	0	66	805	0	0	910	1,523	0	0
California	0	0	0	0	0	1,400	1,313	0	0
Canada6/	0	-------------(Data not available)					--------------------	0	0
Japan	10	(1,977)7/		0	0	0	0	1,304	472
U.S.S.R.	0	8/	8/	0	0	0	0	0	335

Minor fishing gear/crafts

Country	Reefnet Gear	Reefnet Boat	Beach Seine	Floating trap	Fish wheel	Pound net	Weir	Gillnet
U.S. total	57	114	12	9	9	3	0	---
Alaska	0	0	9/	9	9	0	0	---
Washington	57	114	(12)10/	0	0	3	0	---
Canada	0	0	0	0	0	0	0	---
Japan	0	0	0	0	0	0	0	---
U.S.S.R.	0	0	49	0	0	0	5	214

1/ Annual average of 1971-73 for United States and Union of Soviet Socialist Republics, and average of 1972-74 for Japan. Source: Appendix 3, 4 and 27.
2/ Fishing craft categories of vessel (holding capacity of over 5 net tons) and boat (holding capacity of less than 5 net tons) apply to U.S. fishery only--per U.S. fishery statistics.
3/ Data are not available on other countries such as the Republic of Korea and Peoples Republic of Korea.
4/ U.S. fishery consists of drift and anchored (set or stake) gillnets. Canada and Japan are drift gillnets.
5/ Seine skiffs are included under boat.
6/ Information for the period 1971-74 is unavailable. The approximate annual average during the pre-license limitation years of 1966-69 was 3,702 gillnet vessels, 378 purse seine vessels, and 3,350 troll vessels as estimated from the data in Campbell (1971).
7/ Comprised of 332 gillnet vessels of the mothership salmon fishery and 1,645 landbased gillnet vessels.
8/ Reported under minor fishing gear/craft.
9/ Included under purse seine in U.S. fishery statistics.
10/ Average of 1968-70 data.

6.2.2 Catch by Gear

The average annual catch (1970-73) of Pacific salmon by gear is presented in Figure 6.6.

6.2.2.1 By Country

In the United States, purse seines accounted for 52% (70,747 mt) of the annual salmon catch. This was followed by gillnets (drift and anchored types) with 38% (51,700 mt) of the catch, trolls 8% (10,884 mt) and other gear 2% (2,721 mt).

In Canada, purse seines also accounted for the largest share of the salmon catch with 44% (32,832 mt). This was followed by gillnets with 35% (26,116 mt), and trolls 21% (15,670 mt).

Gillnets accounted for 68% (87,215 mt) of the annual salmon catch by Japan. This was followed by set nets with 22% (28,217 mt), longlines 8% (10,261 mt), and other gear 2% (2,565 mt).

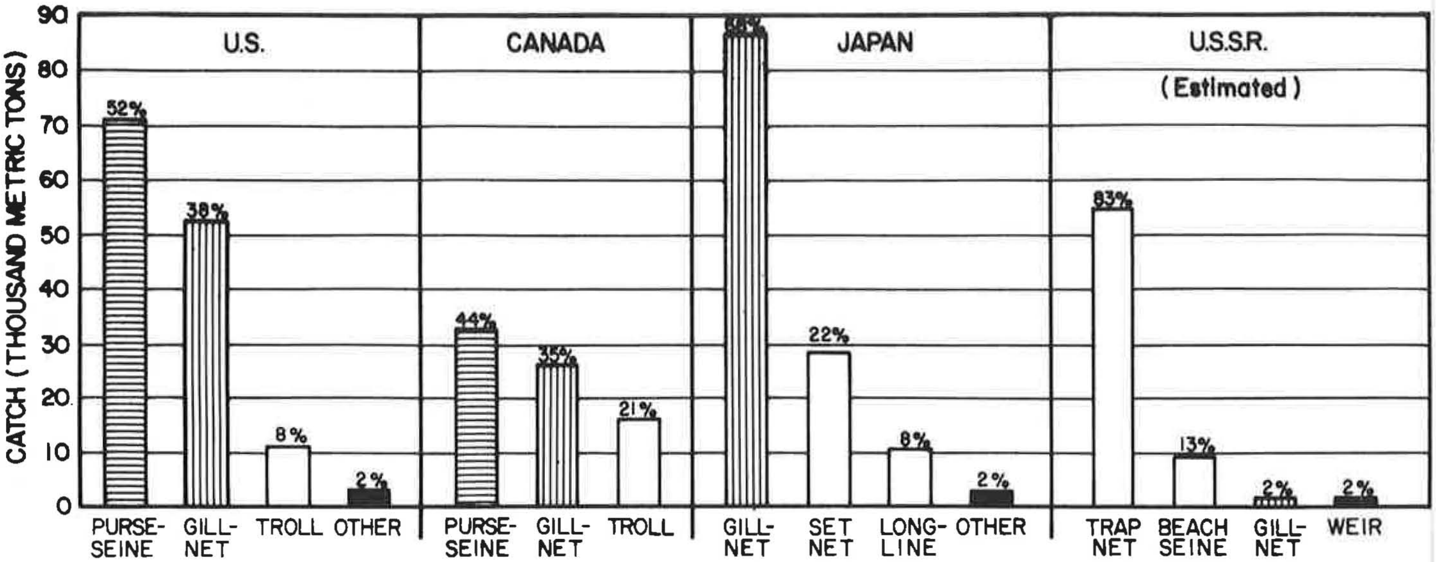
Information on the U.S.S.R. is an approximation based on the judgement of the authors of this report. Approximately 83% (54,175 mt) of the annual salmon catch is believed to be by trap nets. This was followed by beach seines, 13% (8,485 mt), and gillnets and weirs, 2% (1,315 mt) each.

6.2.2.2 By Continent and Total

Purse seines accounted for 49% of the annual salmon catch in North America. This was followed by gillnets (37%), trolls (13%), and other gear (1%).

In contrast, gillnets accounted for 46% of the annual salmon catch in Asia, followed by set and trap nets (43%), longlines (5%), beach seines (4%), and other gear (2%).

Overall, 41% of the annual world catch of Pacific salmon were taken by gillnet, 26% by purse seines, 20% by set and trap nets, 7% by troll, and 2% each by longlines, beach seines, and other gear.

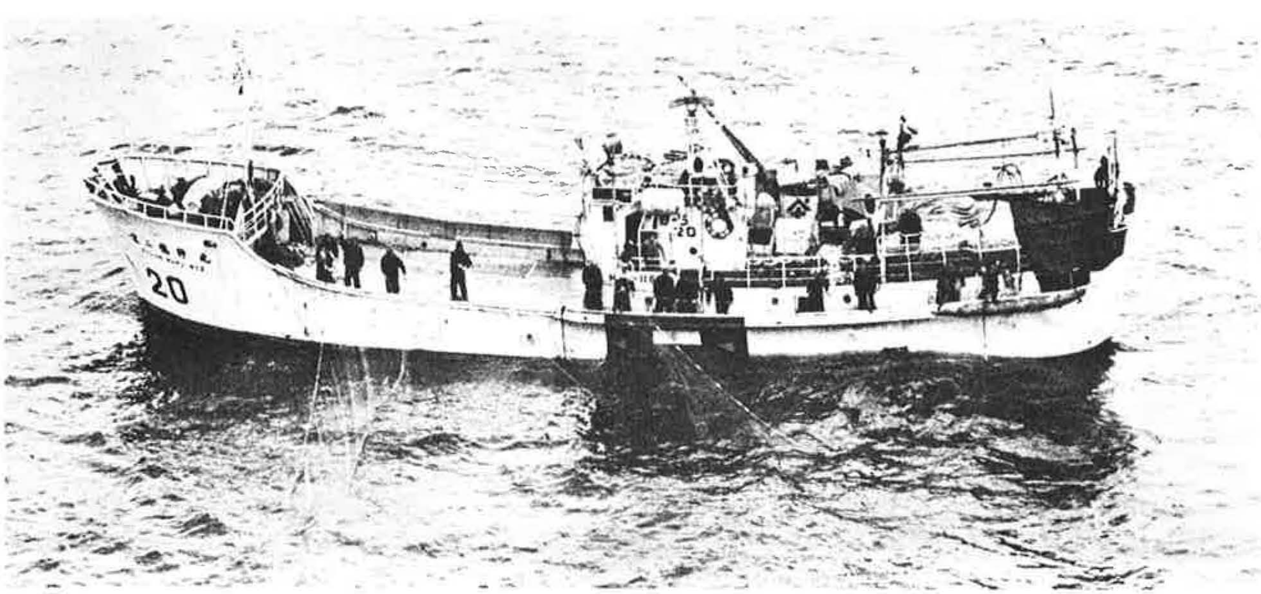


By Continent and Total

Gear	North America Catch (mt)	North America Percent	Asia Catch (mt)	Asia Percent	Total Catch (mt)	Total Percent
Purse Seine	103,579	49	0	0	103,579	26
Gillnet	77,816	37	88,520	46	166,336	41
Troll	26,554	13	0	0	26,554	7
Set/trap net	0	0	82,393	43	82,392	20
Longline	0	0	10,261	5	10,261	2
Beach Seine	*	*	8,485	4	8,485	2
Other	2,721	1	3,870	2	6,591	2
Total	210,670	100	193,528	100	404,198	100

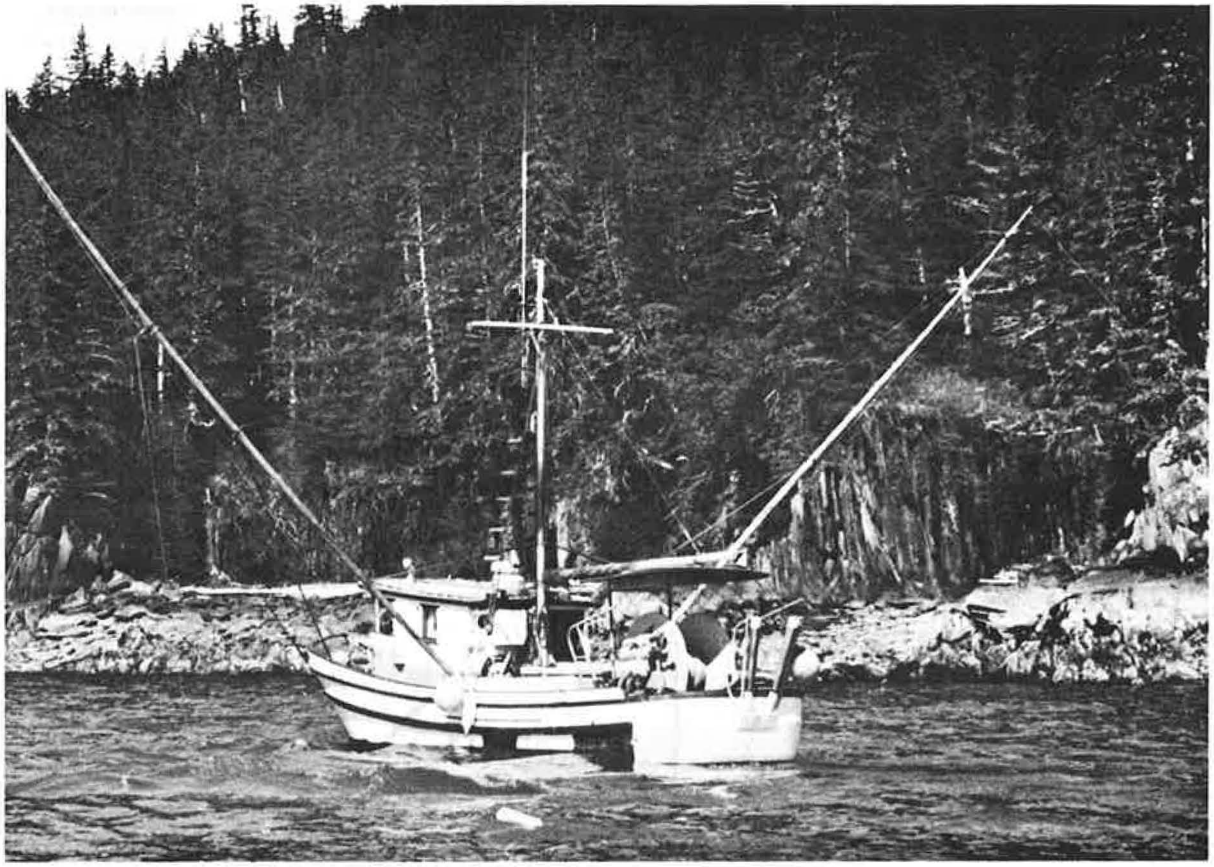
* U.S. beach seine catch of less than 1%

Figure 6.6.--Average annual catch of Pacific salmon by gear, 1970-73. (Source: Appendix 5.)

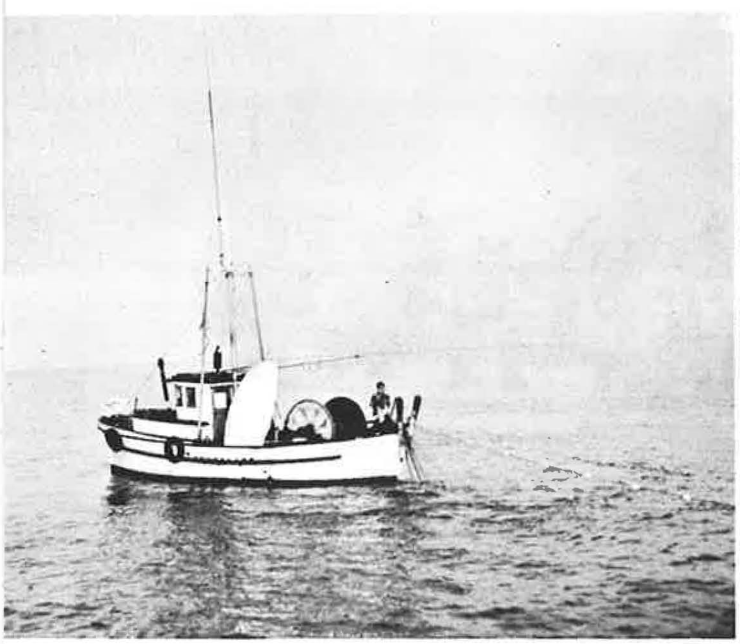


JAPANESE SALMON GILLNETTER (Photo: USCG)

U.S. COMMERCIAL SALMON FISHERY



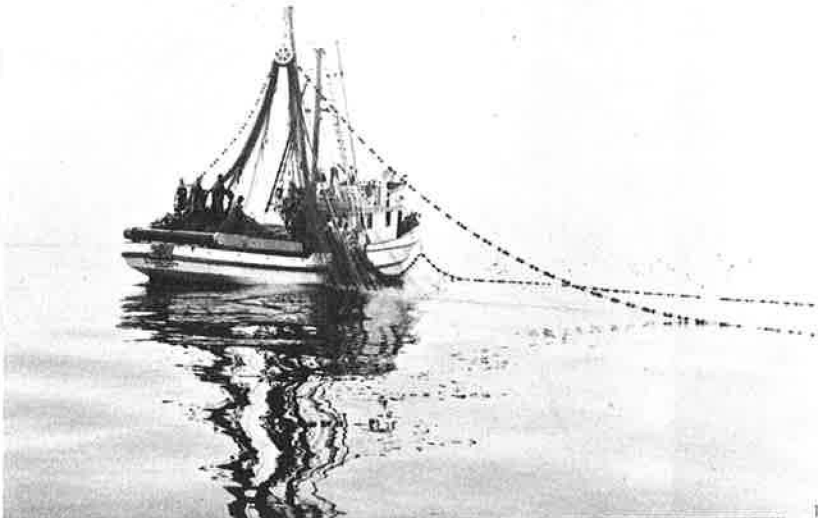
SALMON TROLLER (Photo: Wash. Dept. Fish.)



SALMON GILLNETTER, PUGET SOUND, WASHINGTON (Photo: Wash. Dept. Fish.)

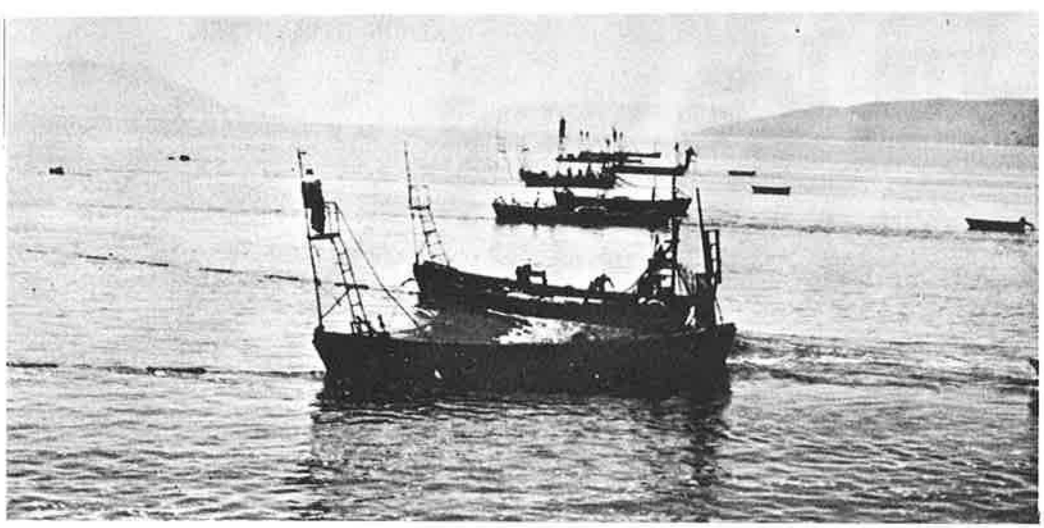
SALMON GILLNETTERS, BRISTOL BAY, ALASKA (Photo: Kasahara, INPFC)

U.S. COMMERCIAL SALMON FISHERY



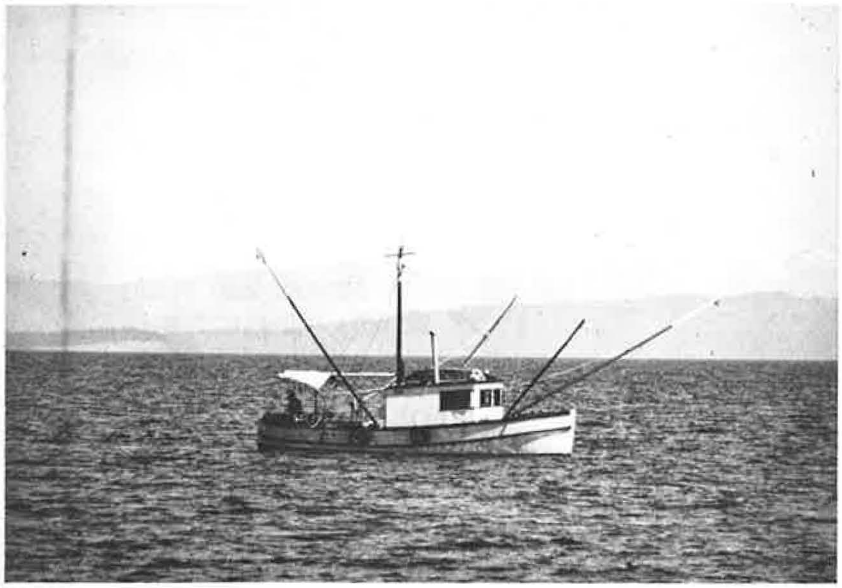
SALMON PURSE SEINER AND FLEET
PUGET SOUND, WASHINGTON

(Photos: Wash.
Dept. Fish.)



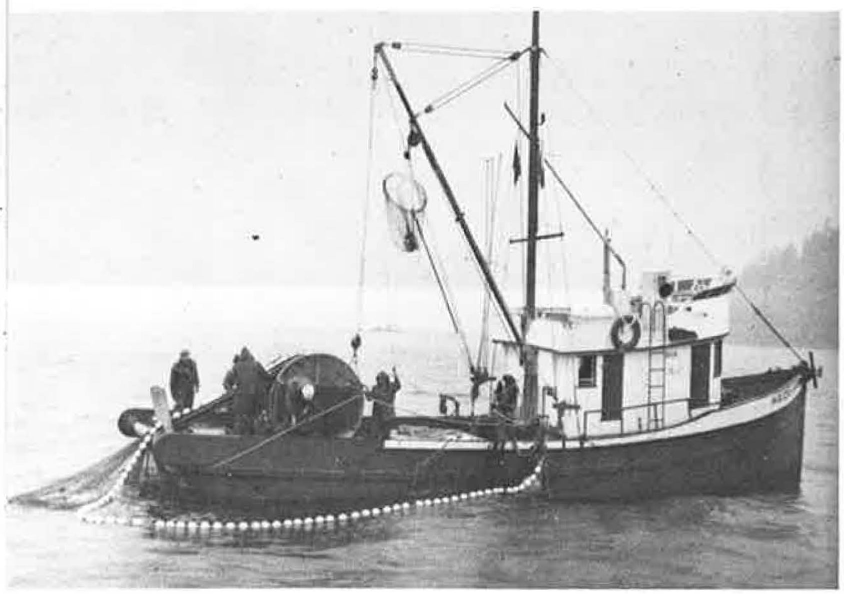
SALMON REEFNETTERS
PUGET SOUND, WASHINGTON

CANADIAN COMMERCIAL SALMON FISHERY



SALMON TROLLER

SALMON GILLNETTER



SALMON DRUM SEINER

(Photos: Fish. & Mar. Serv., Canada, and Gov't. of B.C.)

U.S.S.R. COMMERCIAL SALMON FISHERY

FISHING A FLOATING SALMON TRAP IN INSHORE WATERS,
WEST COAST OF KAMCHATKA, U.S.S.R. (Photo: Atkinson)

6.3 Products and Markets Relating to Pacific Salmon

Important commercial fisheries in Canada, Japan, United States and U.S.S.R., and subsistence and recreational fisheries in Canada and United States are maintained by the Pacific salmon resource. In addition, the resource provides aesthetic experience annually to a million people who view salmon at fishways, hatcheries, and at natural spawning grounds.

A wide variety of food and industrial products results from the commercial salmon fishery--canned salmon, smoked salmon, salted salmon, pickled salmon, kippered salmon, salmon steak, salmon fillet, salted salmon roe/eggs, salmon eggs for bait, fish meal, etc. These products are traded extensively in the international marketplace.

In Canada and the United States subsistence salmon fishing still plays an important role in the well-being of many native communities.

In the recreational (sport) salmon fishery, over a million sport anglers pursue salmon annually along the Pacific coast of Canada and United States. Thousands of anglers, in addition, pursue salmon in the Great Lakes and in certain freshwater lakes in Oregon, Idaho, California, and British Columbia, Canada.

In the United States the Pacific salmon resource supports what probably is the most valuable combined commercial and recreational fishery.

6.3.1 Commercial Salmon Fishery

The supply and demand for Pacific salmon products in the domestic and international markets is a complex subject, and a thorough treatment of it is beyond the intent of this report. Therefore, only a general examination is made on this subject, with emphasis on the countries that land and process Pacific salmon. Prior to this, information on world commercial landings of Pacific salmon and their apparent consumption is presented as the background on the subject.

6.3.1.1 World Overview

During 1971-75 an average of 383.380 mt (845 million pounds), round weight, of Pacific salmon was landed annually in the world (Figure 6.7). Japan accounted for 38% (146,140 mt) of the landings followed by the United States (28%, 108,850 mt), Canada (17%, 65,500 mt), and U.S.S.R. (17%, 62,890 mt). Not included were the minor landings of Pacific salmon by the Republic of Korea and Peoples Republic of Korea, as evidenced from the import by Japan of fresh/frozen salmon from those countries. The world landing was composed of 36% pink, 32% chum, 14% sockeye, 10% coho, 7% chinook, and 1% masu salmon. Japan led in the landings of chum salmon (62%, or 76,380 mt) and masu salmon (100%, or 3,150 mt), while the United States led in sockeye (51%, or 27,580 mt), coho (42%, or 16,120 mt) and chinook salmon (56%, or 14,570 mt), and U.S.S.R. in pink salmon (36%, or 49,240 mt).

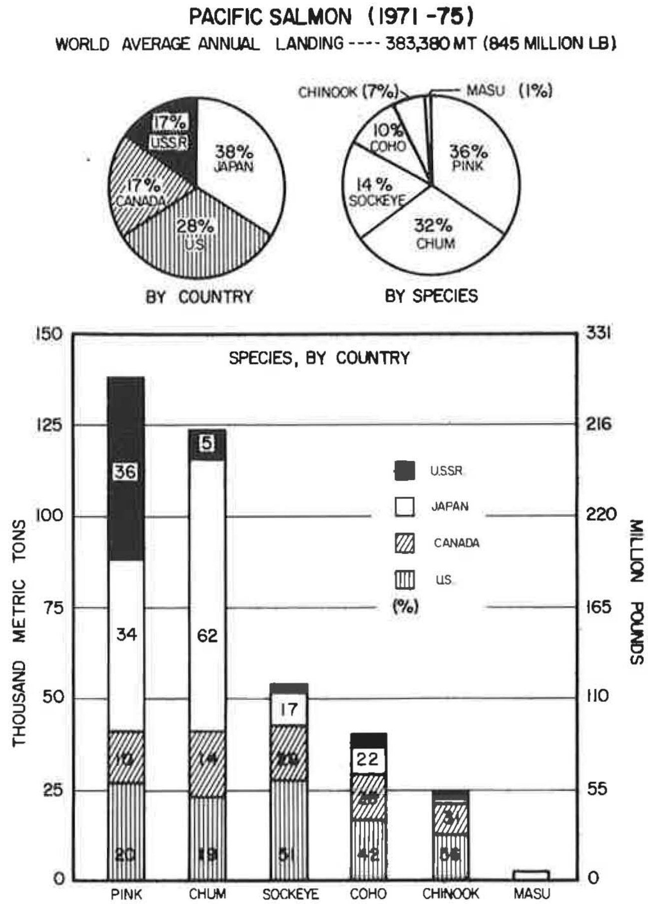


Figure 6.7.--Average annual landings of Pacific salmon by country and species, 1971-75. (Source: Appendix 6.)

The apparent, average annual consumption (in round-weight) of Pacific salmon by country during 1966-70 is shown in Table 6.8. Information is not available for more recent years. The United States with 28% of the consumption and Japan with 25% were apparently the leading consumer. U.S.S.R. accounted for 12%, Canada 7%, and all other countries, 28%. As indicated by the footnote in the table these are, however, overestimates (especially for "other" countries and the total) because Atlantic salmon and other salmonid fishes are also believed to be included in the estimates.

The United States and Japan are not only the leading countries in Pacific salmon landings but in consumption as well. General information on Pacific salmon products are trade by country--United States, Canada, Japan and U.S.S.R.--follows.

Table 6.8.--Apparent average annual consumption of Pacific salmon by country (1966-70)--in round-weight.

	Average annual consumption (1966-70) 1/					
	U.S.	Canada	Japan	U.S.S.R.	Other 2/	Total 2/
Metric tons	129,094	34,745	114,851	58,605	130,999	468,294
Million lb	284.6	76.6	253.2	129.2	288.8	1,032.4
Percent	28	7	25	12	28	100

1/ Source: Appendix 6.
2/ These are most likely overestimates because Atlantic salmon and other salmonid fishes are believed to be included.

6.3.1.2 United States

6.3.1.2.1 Current Overview

An overview of the current situation (1970-74) in U.S. Pacific salmon products and trade is presented in Figure 6.8. The United States landed an average of 277.0 million pounds (round weight) of Pacific salmon annually valued at $100.3 million at the ex-vessel (fisherman) level. Of this landed weight, approximately 85% was processed into food products and 1% into industrial products. The remaining 14%, in the form of dressed, head-off or head-on salmon weighing 30.8 million pounds, was exported to Japan, France, United Kingdom, Sweden, etc. The 12.9 million pounds of imported dressed, head-off salmon valued at $11.0 million is assumed to supply the domestic food products area. As shown, 98% was imported from Canada and 2% from Japan.

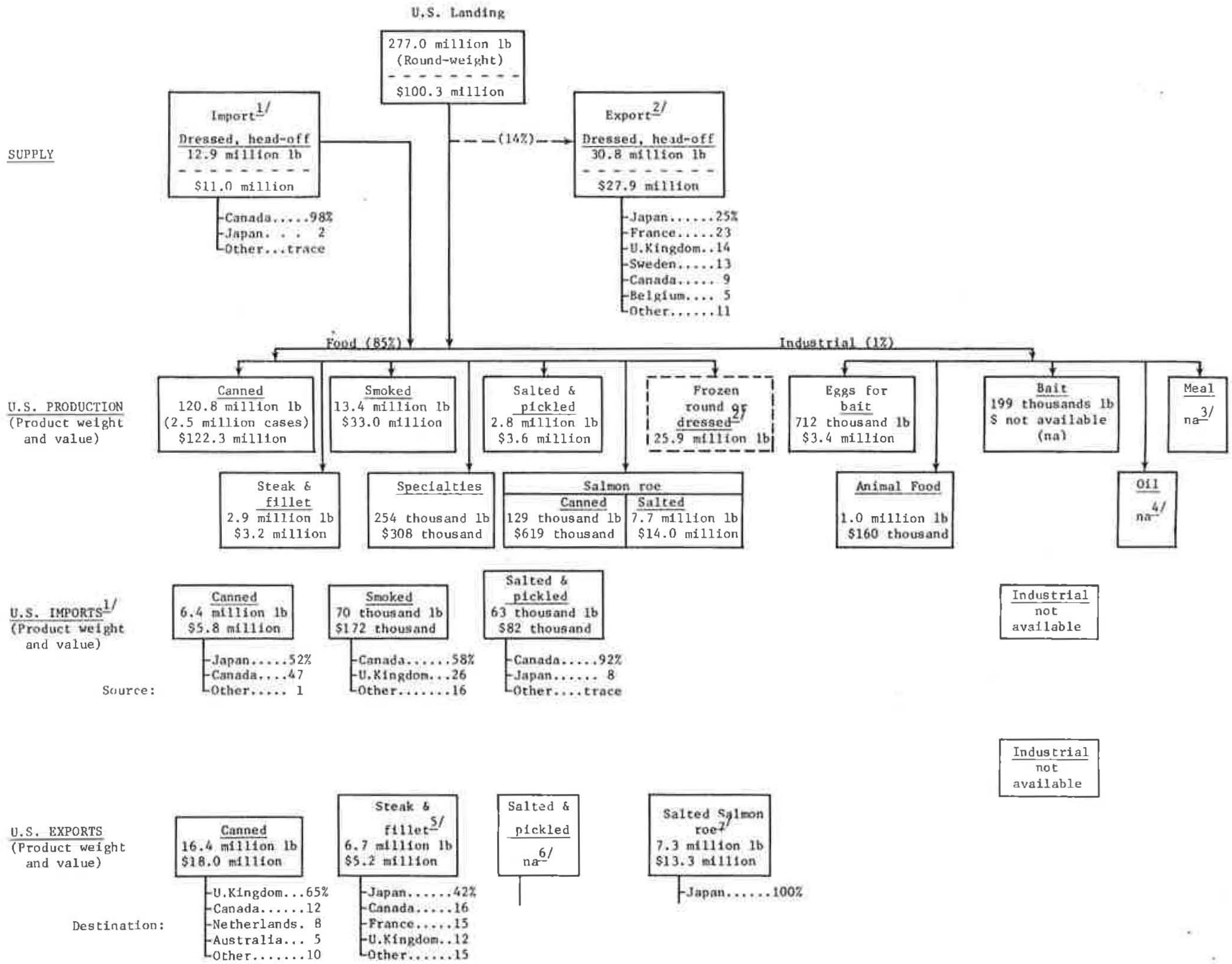
Total U.S. production of food items from salmon (excluding the intermediate form of frozen, round/dressed) averaged approximately 148.0 million pounds (product weight) with a value of $177.0 million (Figure 6.8). Nearly 82% (120.8 million pounds) was in the form of canned salmon valued at $122.3 million. This was followed by the 13.4 million pounds of smoked salmon ($33.0 million), 7.7 million pounds of salted salmon roe ($14.0 million), 2.9 million pounds of steaks and fillets ($3.2 million), 2.8 million pounds of salted and pickled salmon ($3.6 million), 254 thousand pounds of specialities ($308 thousand), and 129 thousand pounds of canned salmon roe ($619 thousand). However, these quantities (especially steaks and fillets) may be an underestimate because some of the frozen salmon would be taken out of cold storage and sold eventually in the form of frozen-fresh salmon at retail outlets.

During 1970-74, the United States imported annually an average of 6.5 million pounds (product-weight) of salmon food products valued at $6.0 million (Figure 6.8). Canned salmon comprised 98% of the imports--6.4 million pounds valued at $5.8 million of which 52% came from Japan and 47% from Canada. The remaining 2% was composed of smoked and salted/pickled salmon imports. Information on the imports of other salmon products (if any) is not available. When the previously cited import of dressed, head-off salmon is included, the total U.S. import comes to 19.4 million pounds annually valued at $17.0 million.

During the same period (1970-74) the United States exported annually an average of 30.4 million pounds (product-weight) of prepared salmon products valued at $36.5 million (Figure 6.8). Approximately 54% of the total export was canned salmon (16.4 million pounds valued at $18.0 million) with 65% going to the United Kingdom. Of the 6.7 million pounds of salmon steaks and fillets valued at $5.2 million, approximately 42% was exported to Japan. It was assumed that nearly all of the average 7.3 million pounds of salted salmon roe (valued at $13.3 million) was exported annually to Japan. By including the previously cited export of dressed, head-off or head-on salmon, the annual export total came to 61.2 million pounds valued at $64.4 million.

On industrial products, an estimated 1% of domestic landing went into the production of 712 thousand pounds of eggs-for-bait valued at $3.4 million; 199 thousand pounds of bait ($ not available); and 1.0 million pounds of animal food ($160 thousand). Information on imports and exports of industrial products is not available.

PACIFIC SALMON--UNITED STATES
CURRENT ANNUAL PRODUCT FLOW AND TRADE (1970-74)



1/ Imports also include some quantity (probably minor) of Atlantic salmon products.

2/ Some duplication in the quantity may exist between frozen salmon export and U.S. production of frozen salmon. The latter essentially is an intermediate product form from which products such as smoked, cured, frozen/fresh steak, etc. are prepared as well as exported in that form.

3/ Data are not available since 1957. Annual average during 1952-56 was 2.2 million lb.

4/ Data are not available since 1968. Annual average during 1961-65 was 298 thousand lb.

5/ This export quantity (6.7 million lb) exceeds U.S. production of 2.9 million lb. All or part of steaks and fillets produced for export is, apparently, not recorded under U.S. production statistics.

6/ Data are not available since 1965. Annual average during 1960-64 was 664 thousand lb.

7/ Not reported in U.S. export statistics but assumed in this report as the amount exported to Japan.

Figure 6.8.--Current annual production and trade in Pacific salmon products, United States. (1970-74 average. Source: Appendix 6-10.)

6.3.1.2.2 Trend in U.S. Salmon Products

6.3.1.2.2.1 Food Products

The trend in different types of food products prepared from salmon during 1940-74 is presented in Figure 6.9. U.S. canned salmon production declined steadily from the average 288 million pounds of 1940-44 to the average 120 million pounds of 1970-74.

Production of smoked salmon remained fairly steady at 12.0-14.0 million pounds annually (Figure 6.9). The average value in 1974 was $2.99/lb. (For those interested, a general treatment of the smoked fish production and market (all species) of the United States is contained in the report by Low et al 1976.)

The U.S. production of salted and pickled salmon also declined during 1940-74 (Figure 6.9). The average production was 9.9 million pounds annually during 1940-45, and by 1970-74 it was down to 2.8 million pounds annually. The average value at the processed level in 1974 was $1.81/lb.

Starting in 1945, salmon steak and fillet production generally fluctuated around the 2 million pounds level (Figure 6.9). However, as noted earlier in this section this production volume is probably an underestimate considering (1) the reported export alone of 6.7 million pounds of steaks and fillets annually by the United States during 1970-74, and (2) the withdrawal of frozen salmon from cold storage for use in the frozen-fresh market.

Frozen salmon (round or dressed) is essentially an intermediate product form. Some may be exported while others are withdrawn from cold storage for use in the production of cured and smoked salmon, etc., or for sale in the frozen-fresh salmon market. Because of the nature of this product the trend in production will not be examined.

Information is not consistently available on U.S. production of salmon specialities. When available, approximately 150-300 thousand pounds of specialty items were produced annually (Figure 6.9).

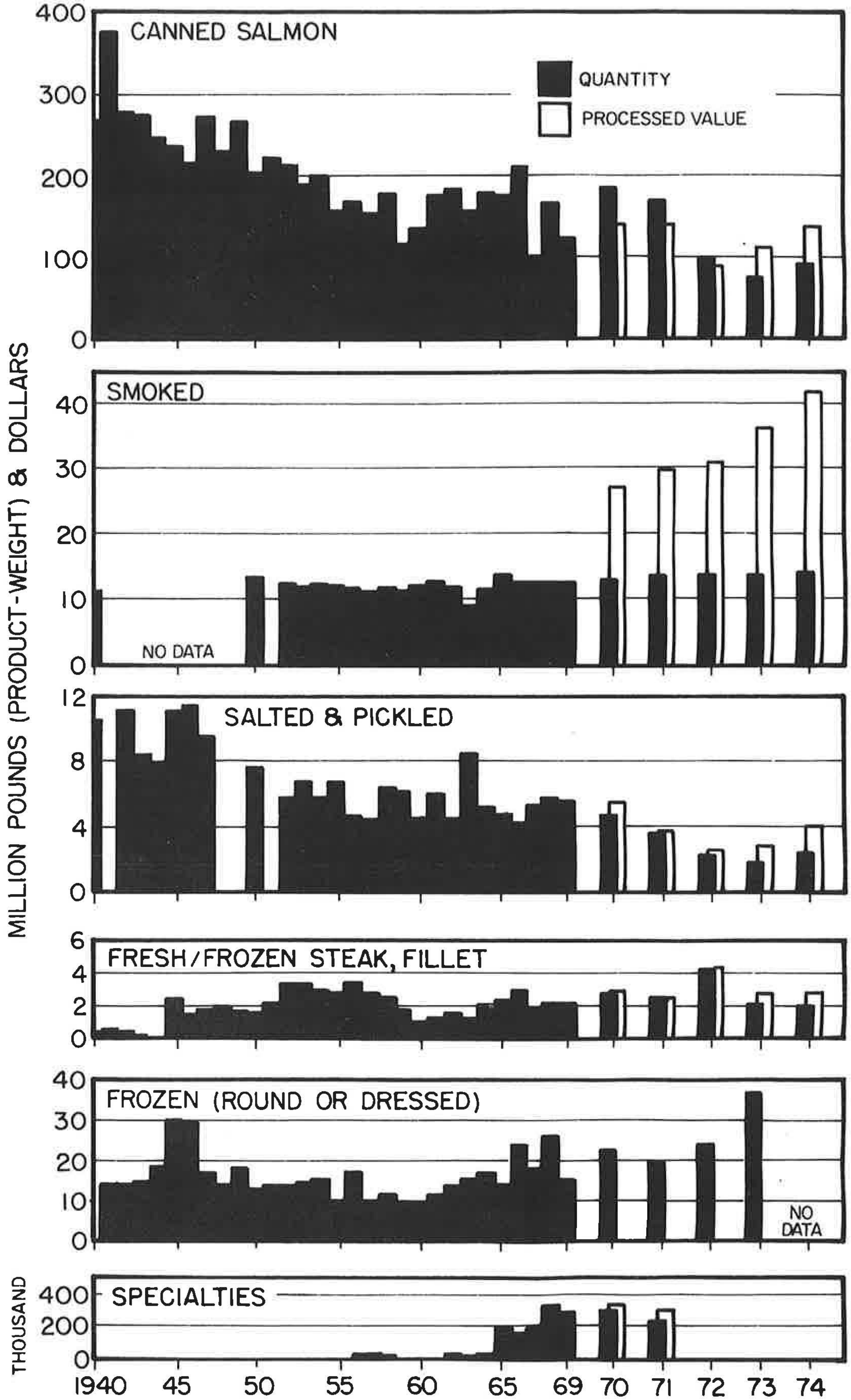
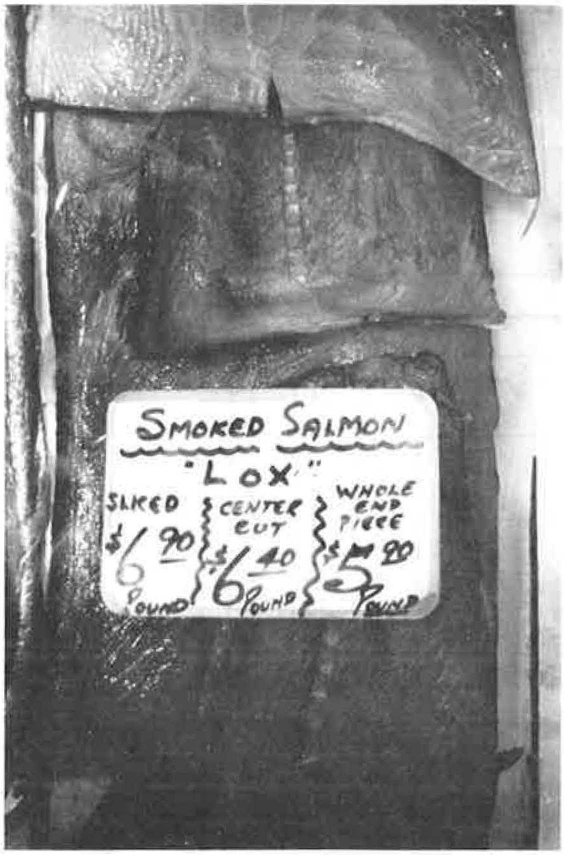


Figure 6.9.--Trend in different types of food products from Pacific salmon— United States, 1940-74. (Source: Appendix 7.)

SALMON PRODUCTS -- RETAIL LEVEL, SEATTLE, WASHINGTON, 1976
(Photo: NWAFC, NMFS)



SALTED SALMON

Figure 6.10 shows the trend in food products prepared from the roe of Pacific salmon. Prior to 1963, the production of salted salmon roe in the United States was less than 500 thousand pounds annually. Since then, production increased rapidly to a peak of 10.2 million pounds in 1970 with a decline thereafter to 5.6 million pounds by 1974. Most of the production was assumed as exported to Japan. Average processed value in 1970 was $1.14/lb and by 1974, $3.02/lb.

The production of canned salmon eggs generally fluctuated between 100-300 thousand pounds annually (Figure 6.10). The average processed value in 1970 was $3.71/lb and by 1974, $7.37/lb.

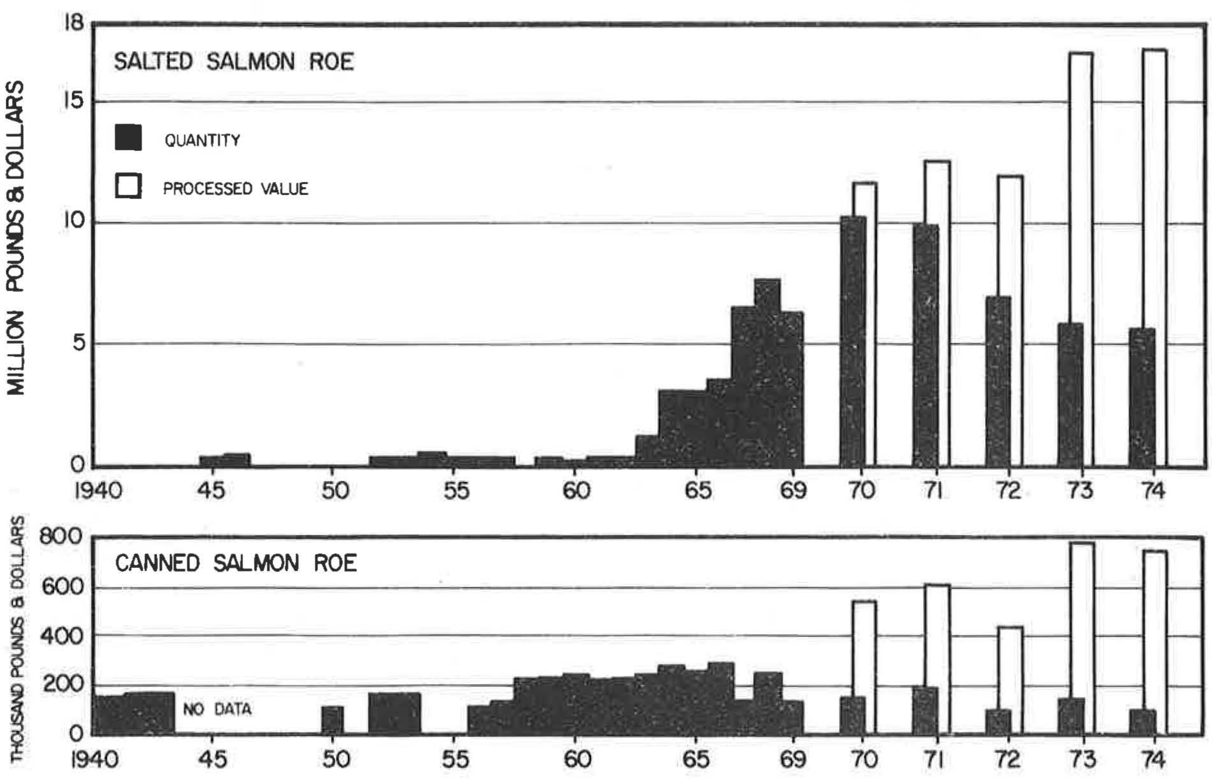


Figure 6.10.--Trend in food products from the roe of Pacific salmon--United States, 1940-74. (Source: Appendix 7.)

6.3.1.2.2.2 Industrial Products

The trend in different types of industrial products prepared from salmon during 1940-74 is presented in Figure 6.11. Salmon eggs for bait (e.g., for trout fishing) reached a production peak of 1.7 million pounds in 1958. Production during 1970-74 averaged 712 thousand pounds annually with an average value of $4.74/lb.

Fish meal from salmon reached a production high of 4.9 million pounds in 1951 with a decline to 1.2 million pounds in 1956 (Figure 6.11). Production data are not available since 1956.

Production of oil from salmon in general declined (Figure 6.11). Production during 1940-55 fluctuated between 0.6 and 1.6 million pounds, and during 1956-65 dropped to 134-675 thousand pounds annually. Data are not available since 1967.

The use of salmon for bait was generally less than 400 thousand pounds annually with the exception of the 0.5 to 1.4 million pounds during the 1960's (Figure 6.11). Since 1971, the use of salmon for bait has been negligible.

The use of salmon for animal food ranged between the 1970 high of 1.5 million pounds to, probably, none (Figure 6.11). Data are not available since 1971. Whether that part of the subsistence salmon catch used to feed sled dogs in Alaska is included here is not known.

A wide variety of valuable food and industrial products, then, are realized from the U.S. commercial salmon fishery. However, a change in the composition of products, especially food products, is evident. This change is assumed to be a function of supply and demand as related in large part to the international market for salmon products. An understanding and reporting on the mechanisms of this change is beyond this report. However, the following section provides a general insight into this change in products.

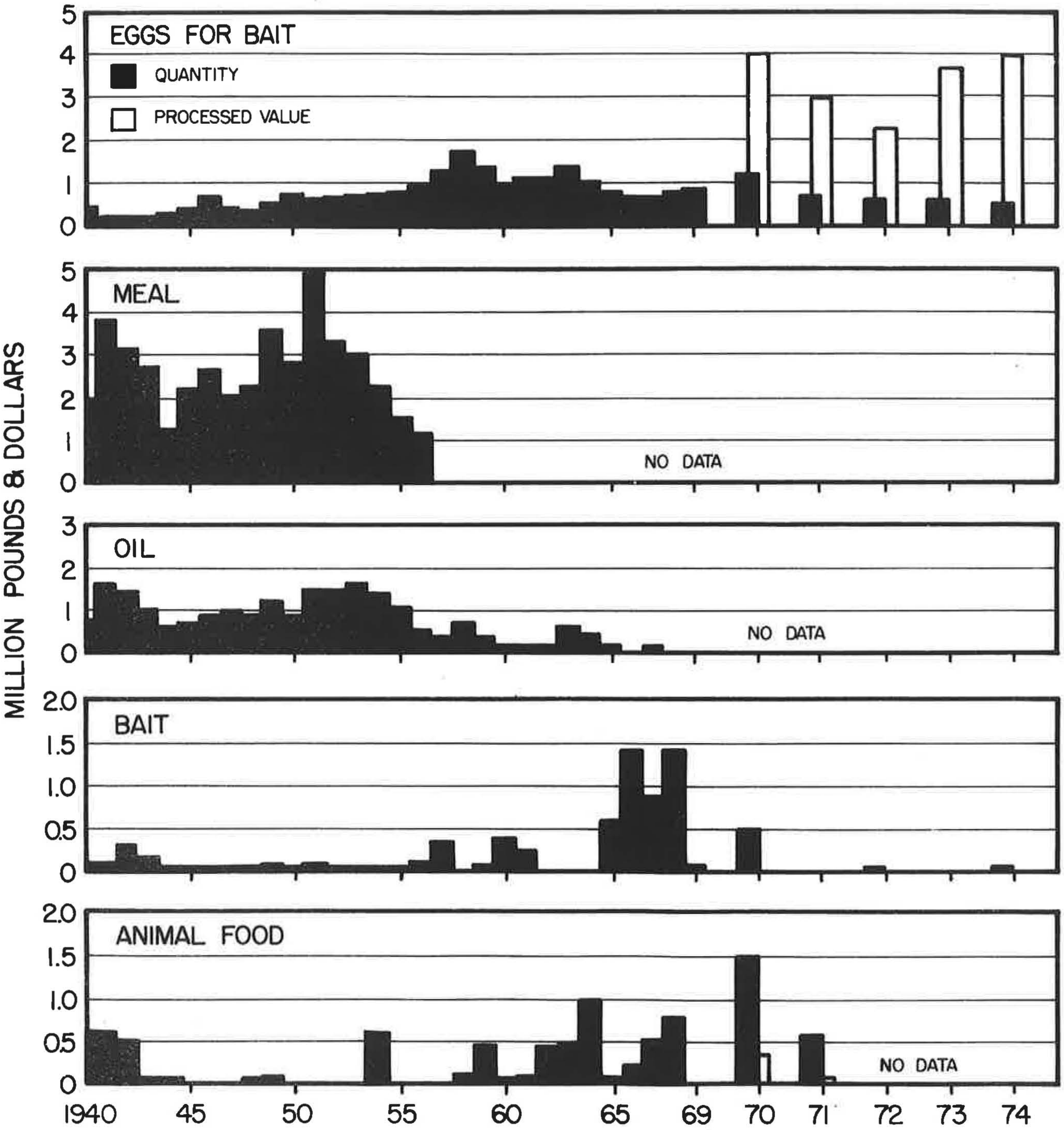


Figure 6.11.--Trend in different types of industrial products from Pacific salmon--United States, 1940-74. (Source: Appendix 8.)

6.3.1.2.2.3 Change in Food Product Composition

Although canned salmon dominates the food product area, the proportion of U.S. Pacific salmon catch that went into cans declined steadily since 1962 (Figure 6.12). This decline, in varying degrees, was evident for all five species taken by the U.S. commercial salmon fishery. The assumptions and procedure used in arriving at the proportions are contained in Appendix 11. The procedure was simply one of converting the reported product weight of canned salmon into round weight (using the factor 0.70) and comparing it to landed weight.

Most of the pink salmon taken by the U.S. commercial fishery was canned. An average 10% decline, however, took place between 1955 and 1975--from an average 91% canned during 1955-59 to an average 81% canned during 1971-75 (Figure 6.12).

Most of the sockeye salmon catch during 1955-68 was canned (94% average). It declined thereafter (1969-75) with wide fluctuations to an average 77% canned (Figure 6.12).

The decline in canned chum salmon was the most dramatic for all species. From an average 96% canned during 1955-58, the proportion of chum salmon that went into the canned product declined steadily, with wide fluctuations in the seventies, to a low of 24% by 1975 (Figure 6.12).

Approximately 52% of the coho salmon catch was canned during 1955-61. It declined thereafter to a low of 6% canned in 1975 (Figure 6.12).

Of all species, chinook salmon was the lowest as to proportion of the catch that went into canned product. It declined from an average 31% canned to the 3% low in 1975 (Figure 6.12).

Overall, the proportion of U.S. salmon catch that went into canned product declined from an average 82% during 1955-62 to an average 56% during 1971-75. It is believed that the intermediate product form—dressed, head-off or head-on salmon—represents the bulk of the change experienced in product composition. This change is associated with the trend in Alaska where 62-88% of the U.S. commercial salmon catch is made annually. For chum, coho and chinook salmon an increasing proportion of Alaska's catch went into the dressed, head-off (or head-on) product (Figure 6.13). For pink and sockeye, canned product has remained the dominant form. The production of cured salmon in Alaska proper declined during 1962-74.

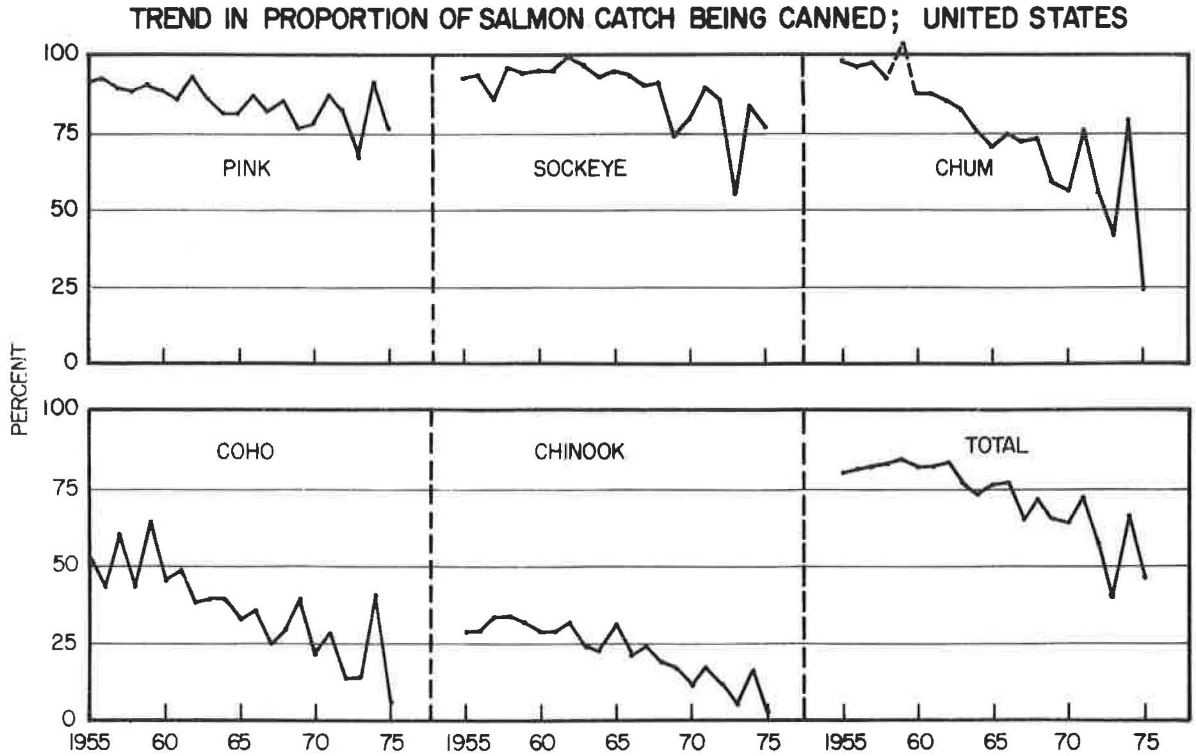


Figure 6.12.--Trend in proportion of U.S. Pacific salmon catch going into canned product, 1955-75. (Source: Appendix 11.)

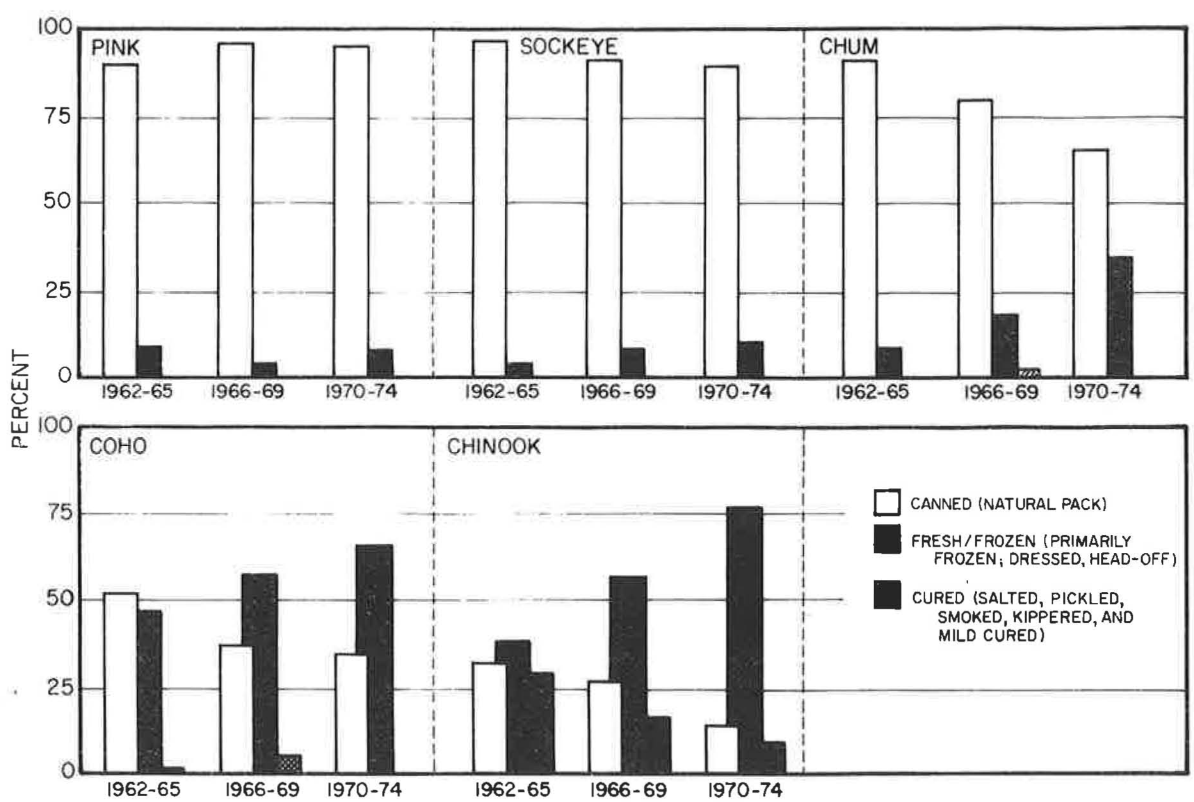


Figure 6.13.--Food product disposition of Pacific salmon landed in Alaska. 1962-74. (Estimated from Appendix 12.)

Reflective of the change in product composition was the change in the number of plants in Alaska processing different types of products from salmon (Figure 6.14). During 1962-74, the number of plants in Alaska that processed canned salmon declined from the high of 84 plants in 1963 to a low of 47 plants in 1973. Inversely, the number of plants that processed fresh/frozen salmon products increased from a low of 33 plants in 1963 to a high of 95 plants in 1973. The number of plants that processed cured salmon products declined from a high of 58 plants in 1964 to a low of 15 plants in 1973. Plants processing salmon roe increased from 45 in 1967 to 92 plants in 1969 and have averaged about 70 plants since then. Plant counts are not additive since a single plant may be involved in the processing of several or more of the different products.

Indicative also of the trend towards dressed, head-off or head-on salmon was the trend in salmon exports of this product form.

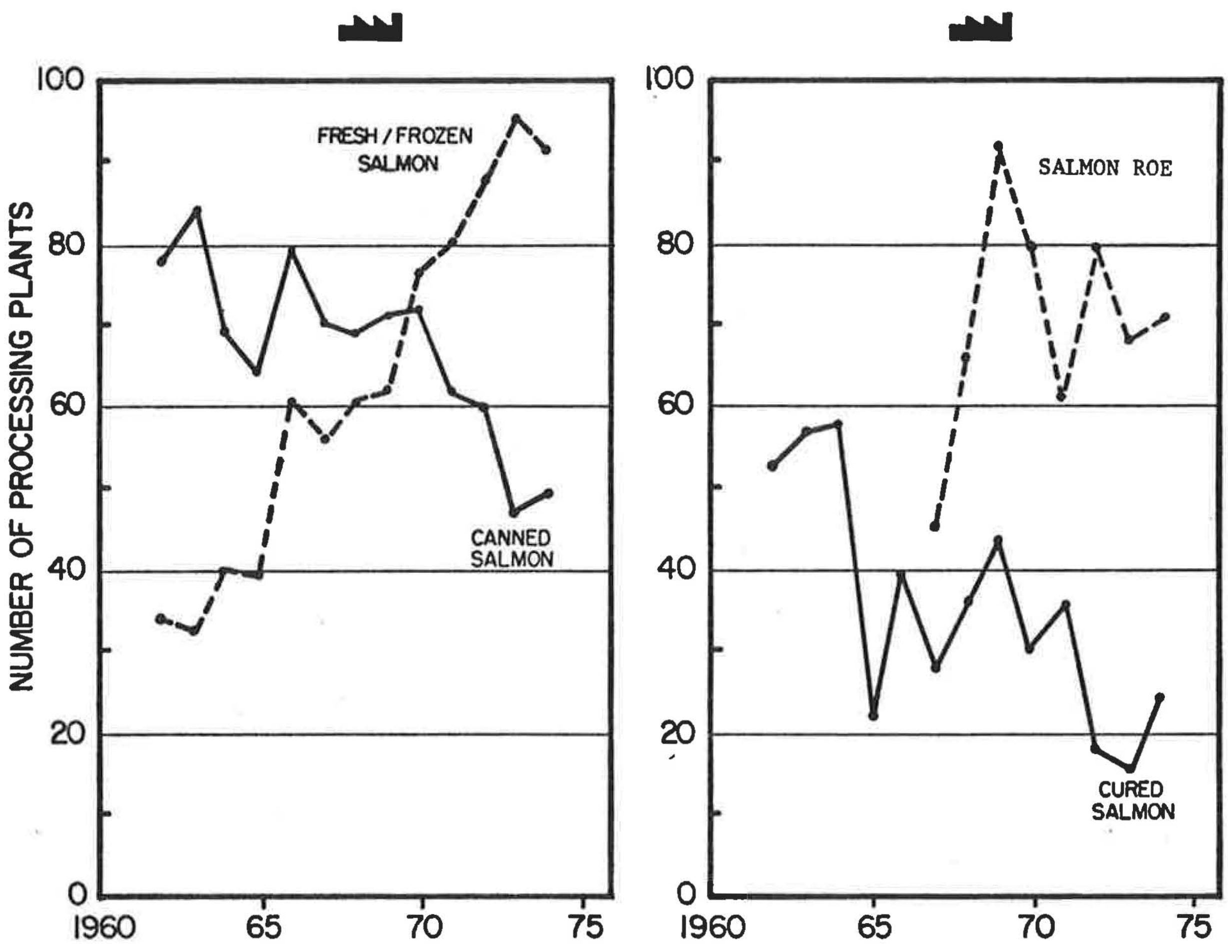


Figure 6.14.--Number of plants in Alaska processing different types of products from Pacific salmon, 1962-74. (Source: Appendix 13.)

CANNERY TENDER WITH A LOAD OF SOCKEYE SALMON. GILLNET FISHERY, BRISTOL BAY, ALASKA (Photo: Anon.)

CANNED SALMON AT A CANNERY IN SOUTHEAST ALASKA (Photo: Scudder, USFWS)

6.3.1.2.3 U.S. Trade in Edible Salmon Products

The general trend in U.S. trade on Pacific salmon products during 1940-74 is presented in Figure 6.15. The United States was a net exporter of salmon products (largely canned salmon) during 1940-49. During 1950-59, the United States was a net importer of salmon products--U.S. catch during this ten-year period was about the lowest in the history of the commercial salmon fishing. In the five-year period of 1960-64 there was, essentially, a trade balance on salmon products. In the final ten-year period (1965-74) the United States was a net exporter with significant increase in export of fresh/frozen salmon and salmon roe products. The sources of U.S. imports, and destinations of U.S. exports for the latest five-year period (1970-74) were identified in Figure 6.8.

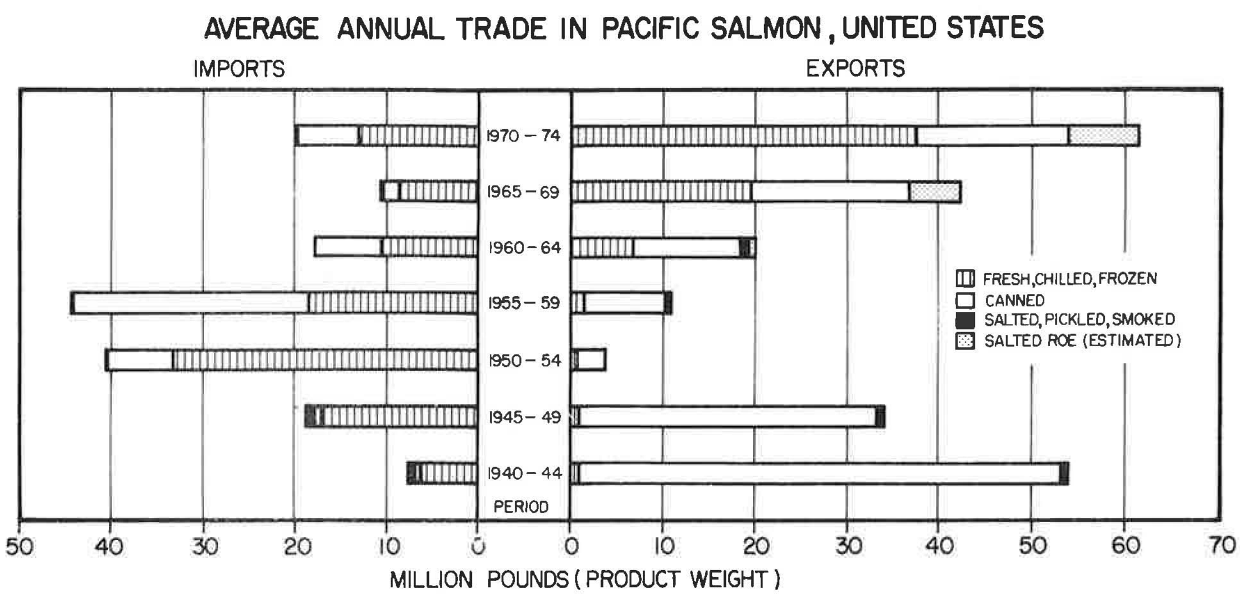


Figure 6.15.--U.S. imports and exports of Pacific salmon products--annual averages by 5-year periods, 1940-74. (Source: Appendix 14-15.)

The relative standing of salmon in overall U.S. trade on edible fishery products during 1940-74 is indicated in Figure 6.16. Since 1940, total U.S. imports of edible fishery products increased approximately 634%--from 302.5 million pounds in 1940 to 2.2 billion pounds in 1974. The record high in imports was the 2.4 billion pounds of 1973. The value of imports, likewise, increased significantly with a record high of $1.5 billion in 1974.

Salmon imports averaged 8.0 million pounds (or, 2.3% of total fishery imports) annually during 1940-46; increased to an average of 35.4 million pounds (or, 4.6% of total fishery imports) during 1947-62; decreased to 10.1 million pounds (or, 1.0% of total fishery imports) during 1963-71; and increased to an average 26.0 million pounds (or, 1.0% of total fishery imports) annually during 1972-74 (Figure 6.16 and see also Appendix 14 for percentage estimates). The record high in salmon imports during 1940-74 was the 55.5 million pounds in 1958. Overall, salmon imports constituted 7% or less annually of total U.S. imports, and since 1962 were 1% or less annually.

The trend in total U.S. exports of edible fishery products during 1940-74 generally followed a "U" shaped curve (Figure 6.16). From 239.3 million pounds in 1943, exports decreased to a low of 48.6 million pounds (1961), then increased to the high of 259.5 million pounds in 1973 valued at $271.1 million. In 1974, the quantity of edible fishery products exported by the U.S. was but 8.8% of U.S. imports (thus a net import of 2.0 billion pounds) while the export value was but 14.6% of imports, or a net trade deficit of $1.3 billion.

Salmon exports have consistently served as the base for U.S. exports of edible fishery products during 1940-74 (Figure 6.16). The exceptions were the five years of 1948 and 1950-53. The overall trend was also "U" shaped. An average of 52.5 million pounds (30.4% of total export value) was exported annually during 1940-47; an average of 9.0 million pounds (11.7% of total export) valued at $5.8 million (23.6% of total export value) during 1948-63; and, during 1964-74, an average of 51.2 million pounds (33.1% of total export) valued at $44.6 million (37.5% of total export value). (See Appendix 15 for percentage estimates). The record high in salmon exports took place in 1973--83.6 million pounds valued at $103.1 million. The Pacific salmon, via the U.S. commercial salmon fishery, therefore, contributes significantly to U.S. exports of edible fishery products.

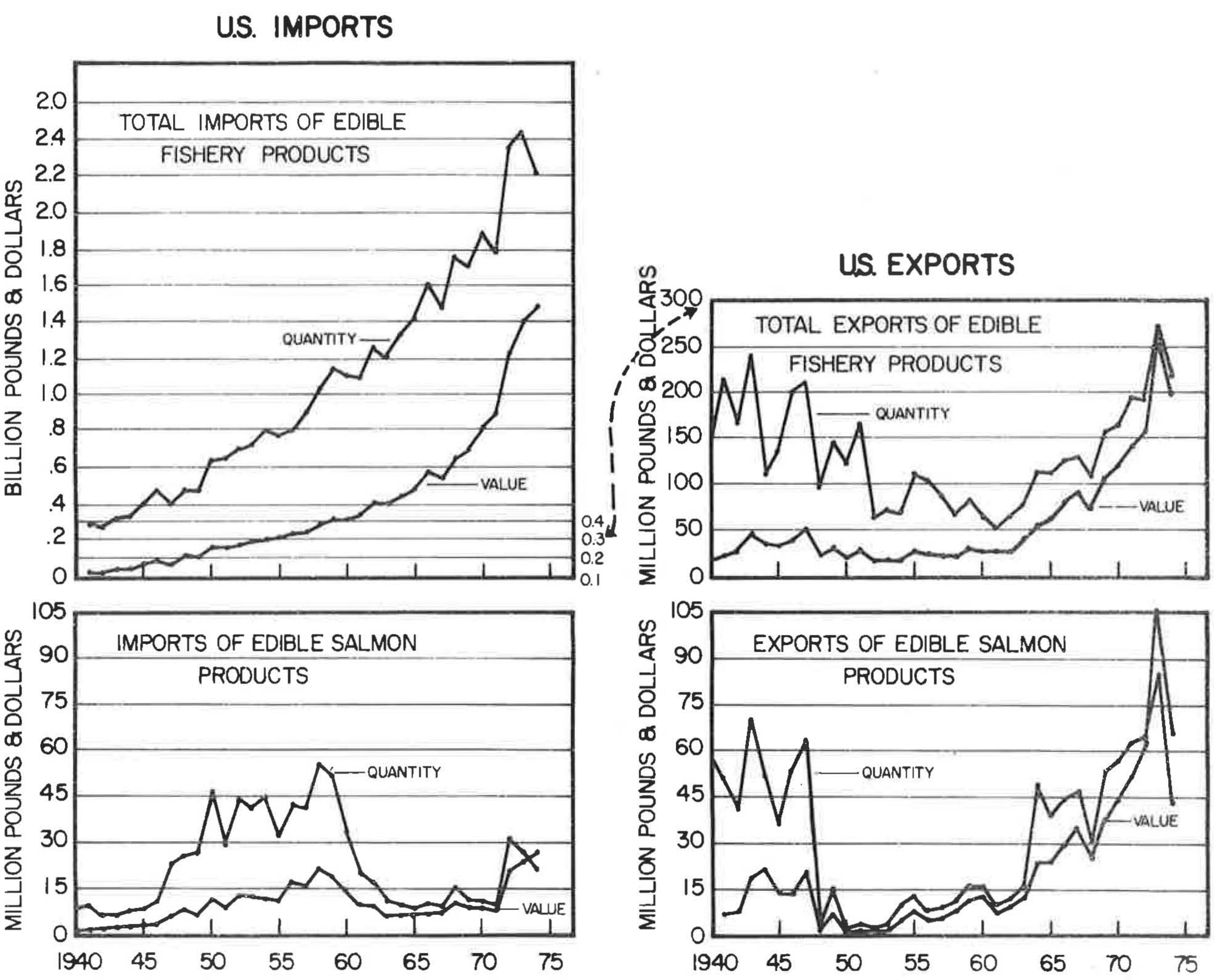


Figure 6.16.--Trend in U.S. imports and exports of all edible fishery products, and of salmon, 1940-74. (Source: Appendix 14-15.)

6.3.1.2.4 Industry Overview

The general composition of the U.S. commercial salmon fishery in terms of fishing labor, vessels and boats, and canning plants is presented in Figure 6.17. (Information prior to 1959 is unavailable). Information on salmon catch by state is also included in the figure as a point of reference.

Commercial salmon catch in the United States fluctuated between 196.8 and 410.1 million pounds during 1959-75. Alaska accounted for 62-88% of the catch and was followed by Washington, Oregon, and California (Figure 6.17). By species, the catch was composed of approximately 34% pink, 28% sockeye 17% chum, 11% coho, and 10% chinook salmon (Appendix 16).

The number of people fishing for salmon (full-time and part-time on vessels, boats, and on shore) increased by nearly 68% (15,000 people) during 1959-73--from 22,000 in 1959 to 37,000 people in 1969-73 (Figure 6.17). The overall rate of increase was highest for Oregon--a 207% increase from the 1,545 people in 1959 to the 4,746 people in 1973. For the latest 5-year period (1969-73) an average of 18,470 people (51%) fished in Alaskan waters. This was followed by Washington (22% or 8,019 people), California (16% or 5,613 people), and Oregon (11%, or 3,867 people).

Salmon fishing vessels (5 net-tons in holding capacity or over) and boats (less than 5 net-tons in holding capacity) increased by nearly 79% (10,092 units) during 1959-73--from 12,739 vessels and boats in 1959 to 22,831 in 1973 (Figure 6.17). The overall rate of increase in vessels and boats during 1959-73 was highest for Oregon with a 145% increase. For the latest five-year period (1969-73) an average of 51% (11,365 units) of the vessels and boats fished in Alaskan waters. This was followed by Washington (25% or 5,594 units), Oregon (12%, or 2,758 units), and California (12% or 2,677 units).

On a U.S.-wide basis, the only information available on the processing sector of the salmon industry is number of canning plants. That is, outside of Alaska, information on number of plants processing other product forms such as smoked salmon, kippered salmon, etc. is unavailable (for example, in Washington, Oregon, California, New York, etc.).

From 1959-69, the number of plants producing natural pack cans of salmon fluctuated between 104 and 118 plants (Figure 6.17). Thereafter, the number dropped to 81 plants in 1970 and down to 72 plants during 1971-73.

Plants canning smoked salmon increased from the 18 plants in 1961 to a peak of 36 plants, then down to 17 plants in 1973 (Figure 6.17). Information is not available for years prior to 1961.

The number of plants canning eggs for bait fluctuated between 6 and 11 plants while those producing salmon caviar fluctuated between 3 and 5 plants (Figure 6.17).

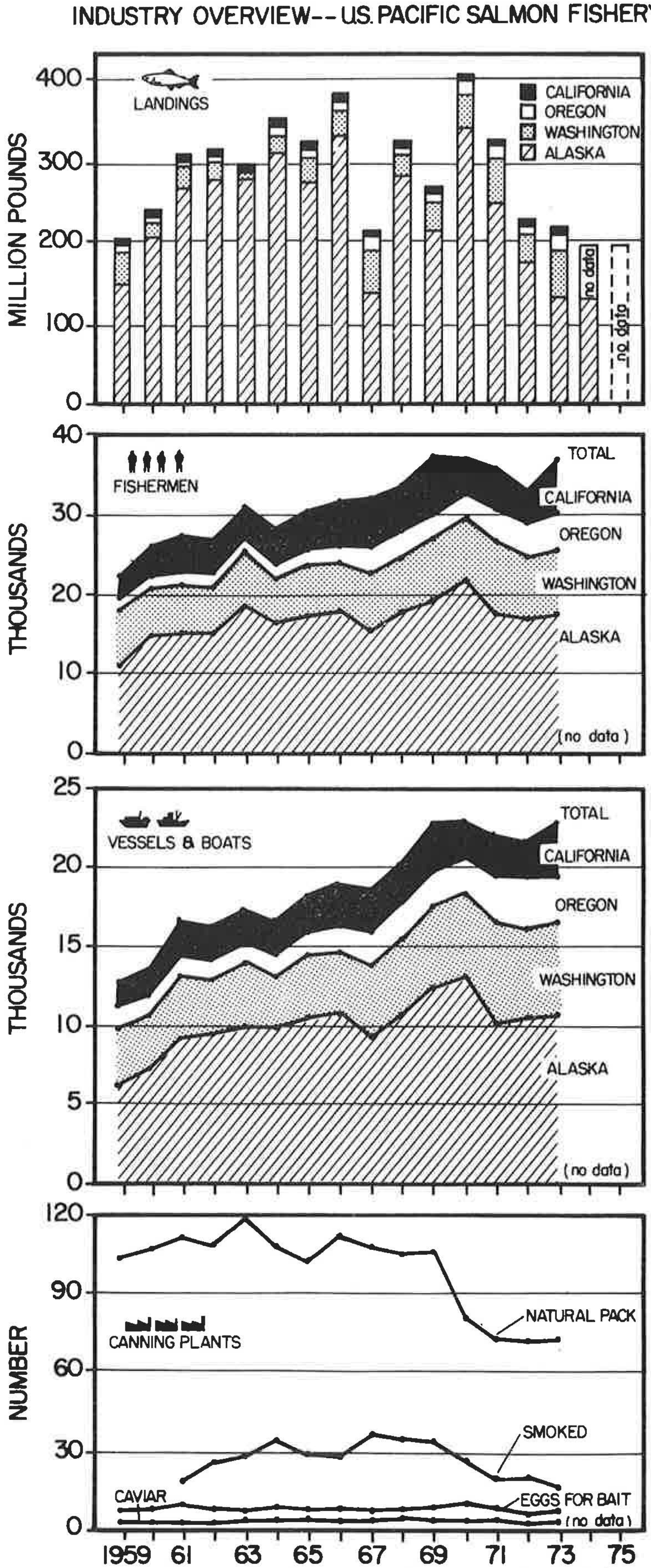


Figure 6.17.—Trend in catch, fishing labor, vessels and boats by state, and number of canning plants--U.S. commercial salmon fishery, 1959-75. (Source: Appendix 16.)

The preceding information on fishing labor and capital (vessels, boats, and plants) provides only a general overview of the U.S. commercial salmon industry. It is much more complex than that. For example, a person fishing for salmon may also be engaged in other fisheries during the year; a salmon troll vessel may also be used in the tuna troll fishery; and a salmon processing plant may also process other fish and shellfish during the year.

6.3.1.2.5 Other Aspects (Consumption and Price)

Although the Pacific salmon resource has supported a U.S. industry for more than a century, a comprehensive study on its structure and performance has not been undertaken. Numerous studies, however, were made on various segments and aspects of the U.S. salmon industry, but reporting that information is beyond the intent of this report. For those interested, a partial listing of studies related to the structure, performance and market aspects of the U.S. salmon industry is contained in Appendix 17.

This section on the U.S. commercial salmon fishery will be concluded with information on (1) the apparent regional pattern in consumption of fresh and frozen, and canned salmon products in the United States and (2) the trend in wholesale prices for some selected salmon products.

A consumer panel survey conducted under the auspices of the National Marine Fisheries Service in 1969 (Nash 1970) indicated the following regional pattern in consumption of salmon products (Figure 6.18):

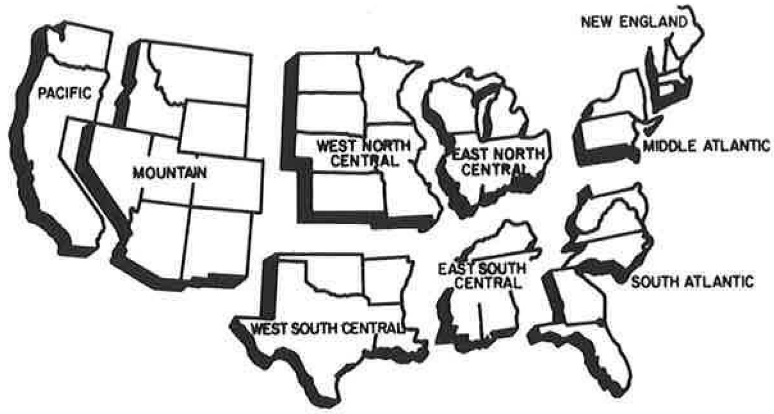
1. Per capita consumption of fresh and frozen salmon was highest in the Pacific region with 0.741 pounds per capita.

2. Per capita consumption of canned salmon was highest in the East South Central region with 2.734 pounds. On the basis of total consumption, however, the Middle Atlantic and East North Central regions were highest with 18% each followed by South Atlantic region (17%), etc.

3. For products combined, total consumption of salmon was highest in the Middle Atlantic and East North Central regions with 17% each. These were followed by 15% each in the South Atlantic and Pacific regions. 12% in the East South Central region, etc.

For those interested, also reported in the National Marine Fisheries Service study was the purchase of salmon along socioeconomic characteristics (e.g., age, education and occupation of household head; age and sex of children; race; religion; etc.).

REGIONS



APPARENT REGIONAL CONSUMPTION PATTERN, 1969 1/

Region	Population 2/ (Thousands)	Fresh and Frozen Salmon: Pounds/Capita 3/	Fresh and Frozen Salmon: Total Pounds (Thousands)	Fresh and Frozen Salmon: Percent	Canned Salmon: Pounds/Capita 3/	Canned Salmon: Total Pounds (Thousands)	Canned Salmon: Percent	Products Combined: Pounds/Capita 3/	Products Combined: Total Pounds (Thousands)	Products Combined: Percent
New England	11,466	0.125	1,433	4	0.879	10,079	3	1.004	11,512	4
Middle Atlantic	37,242	0.082	3,054	9	1.422	52,958	18	1.504	56,012	17
E. North Central	39,759	0.078	3,101	9	1.300	51,687	18	1.378	54,788	17
W. North Central	16,206	0.055	891	2	1.393	22,575	8	1.448	23,466	7
South Atlantic	30,145	0.071	2,140	6	1.629	49,106	17	1.700	51,246	15
E. South Central	13,054	0.262	3,420	10	2.734	35,690	12	2.996	39,110	12
W. South Central	19,337	0.019	367	1	1.583	30,610	10	1.602	30,977	9
Mountain	8,102	0.228	1,847	5	1.453	11,772	4	1.681	13,619	4
Pacific	26,095	0.741	19,336	54	1.185	30,923	10	1.926	50,259	15
Total	201,406		35,589	100		295,400	100		330,989	100

1/ A gross approximation of the apparent consumption pattern of fresh and frozen and canned salmon in the United States in 1969 based on consumer surveys. Total pounds were estimated to arrive at the percentage shown and do not necessarily represent actual quantities consumed.

2/ Source: Miller and Nash (1971).

3/ Source: Nash (1970)

Figure 6.18.--Apparent regional pattern in the consumption of fresh and frozen salmon, and canned salmon, United States, 1969.

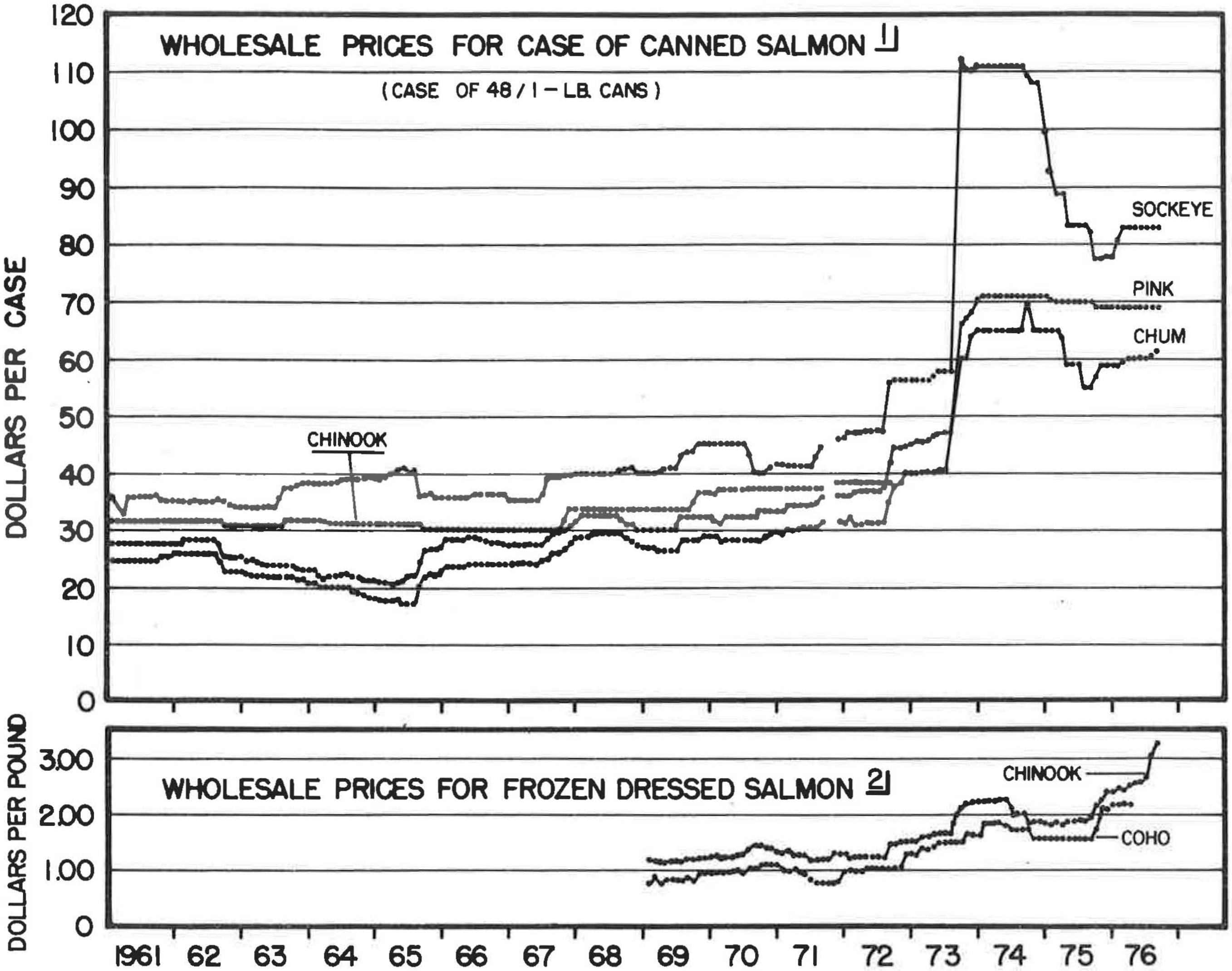
The trend in some wholesale prices (in current dollars) of canned and frozen/dressed salmon during 1961-76 is presented in Figure 6.19. However, since the movement of price (as expressed in current dollars) is influenced by inflation, "real prices" will also be discussed to provide a general perspective on the influence of price inflation. Real price is derived by deflating current price by a price index. The U.S. wholesale price index, all commodities, with base year at 1967 (1967 = 100) was selected for computing real price (See Appendix 18). Real prices and the percentage increase in price based on real prices are indicated by bracketed figures [].

On wholesale price of canned salmon, of obvious note was the sharp increase in price-per-case during the latter part of 1972 and the dramatic increase in prices during the latter part of 1973 that led to a near doubling in prices just within that period. These increases were primarily the result of extremely low supplies of canned salmon--a condition caused by the combination of lower landings in 1972 and 1973 and higher production of fresh/frozen salmon, resulting in two consecutive years of smallest packs of U.S. canned salmon ever recorded (Natl. Mar. Fish. Serv. 1974b).

On canned sockeye salmon it is believed, however, that only a minor amount of cases was actually sold at the quoted price centering around the $110.00 per pack level6.1/. Low landings in 1974 and 1975 (see Figure 6.17) along with other factors consequently kept prices up at the new levels through July 1976: (1) approximately $83.00/case [$45.03/case] for sockeye, up 130% [19%] from the $36.00/case [$37.82/case] of January 1961; (2) $69.00/case [$37.44/case] for pink, up 150% [29%] from the $27.63/case [$29.02/case] of January 1961; and (3) $60.40/case [$32.77/case] for chum, up 145% [27%] from the $24.63/case [$23.87/case] of January 1961. Prices on chinook salmon were not available since the $38.50/case quoted in August 1972.

Wholesale prices at New York for frozen/dressed chinook and coho salmon are presented in the bottom panel of Figure 6.19. Chinook salmon was prices at $1.19/lb [$1.14/lb] in January 1969, and by July 1976 at $3.05/lb [$1.65/lb] representing a price increase of 157% [45%]. Coho salmon was prices at $0.83/lb [$0.79/lb] in January 1969, and by June 1976 at $2.15/lb [$1.17/lb] representing a price increase of 159% [48%]. Information on prices prior to 1969 is not readily available.

6.1/ Personal communication. Salmon packers and brokers, Seattle, Wash. January 1977.



1/ Average of weekly price quotations (not necessarily the sale prices) by Seattle brokers and canners for top quality stock only. Does not include discounts and promotional allowances.

2/ Wholesale prices (primarily f.o.b. at warehouse) for frozen dressed salmon at New York.

Figure 6.19.--Trend in some U.S. wholesale prices (current dollars) of canned and frozen/dressed salmon, 1961-76. (Source: Natl. Mar. Fish. Serv. 1968b, 1969b, 1970b, 1972b, 1975c, 1975d and 1976d.)

6.3.1.3 Canada

6.3.1.3.1 Current Overview

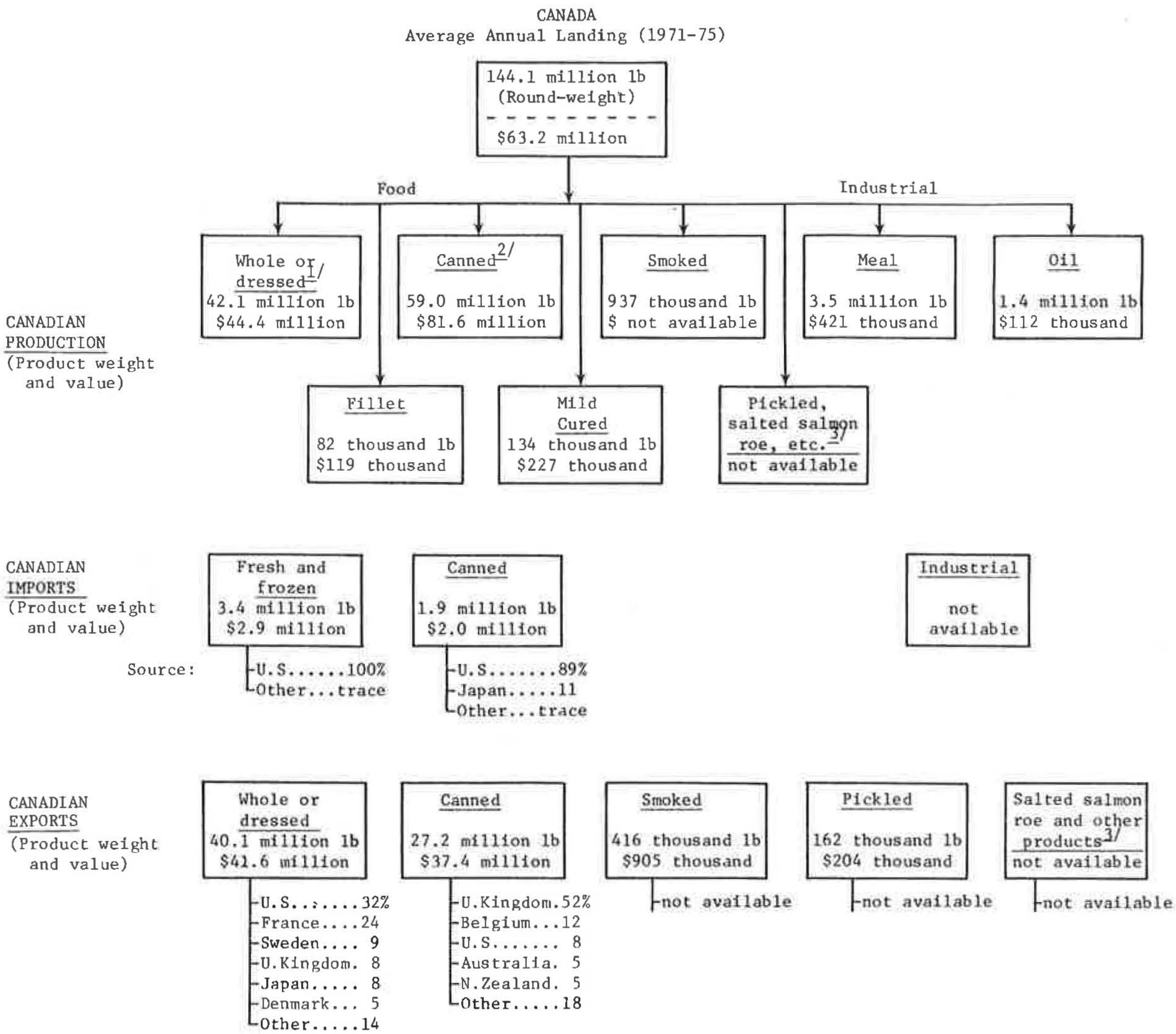
An overview of Canada's current situation (1971-75) in Pacific salmon products and trade is presented in Figure 6.20. Canada (via the Province of British Columbia) landed an average of 144.1 million pounds (round-weight) of Pacific salmon annually valued at $63.2 million ($ Canadian) at the ex-vessel level.

Production of food items from salmon totaled approximately 102.2 million pounds (product-weight) with a value in excess of $126.4 million (Figure 6.20). Canned salmon comprised nearly 58% of this total with 59.0 million pounds valued at $81.6 million. This was followed by the essentially intermediate product form of whole or dressed salmon at 42.1 million pounds ($44.4 million), then smoked salmon, mild-cured salmon, and frozen salmon fillet. Information on other products such as pickled salmon and salted salmon roe is not readily available.

Industrial products from salmon consisted of 3.5 million pounds annually of fish meal valued at $421 thousand, and 1.4 million pounds of oil valued at $112 thousand (Figure 6.20). These are gross approximations as data for several of the years are not available.

During 1971-75, Canada imported from the United States an annual average of 3.4 million pounds of fresh and frozen salmon valued at $2.9 million (Figure 6.20). Canada also imported an average of 1.9 million pounds of canned salmon valued at $2.0 million, of which 89% was from the United States and 11% from Japan. Information on imports of other salmon products is not available.

Exports during the same period (1971-75) consisted of 40.1 million pounds of whole and dressed salmon valued at $41.6 million (Figure 6.20). These were destined primarily for the United States (32%) and France (24%). Primary destinations of the 27.2 million pounds of canned salmon valued at $37.4 million were United Kingdom (52%) and Belgium-Luxembourg (12%). An average of 416 thousand pounds of smoked salmon ($905 thousand) and 162 thousand pounds of pickled salmon ($204 thousand) were also exported annually. Information on their destinations, however, is not available. Finally, salted salmon roe is processed and exported to Japan but data on this are not available.



1/ Includes salmon steaks.

2/ Approximately 1.2 million cases of 48 1-lb cans.

3/ Salted salmon roe is processed and exported to Japan but data are not available.

Figure 6.20.--Current annual production and trade in Pacific salmon products, Canada. (1971-75 average. Source: Appendix 19-21.)

6.3.1.3.2 Trend in Canadian Salmon Products

6.3.1.3.2.1 Food Products

The trend in different types of food items prepared from salmon by Canada during 1953-75 is presented in Figure 6.21. Salmon landings for 1950-75 are also included in the figure as a point of reference.

Production of canned salmon and whole/dressed salmon generally followed the trend in landings. Viewed in terms of the percentage of the landings going into these two product forms, however, a change is apparent. The approximate percentage of the landings that went into canned salmon declined to 58% during 1971-75 from the 69% of 1954-58, while the approximate percentage of the landings that went into whole/dressed salmon increased to 35% during 1971-75 from the 25% of 1954-58. These estimates were derived by converting the product-weight data in Appendix 19 to round-weight using the factor 0.70 for canned salmon and 0.85 for whole/dressed salmon.

Production of frozen salmon fillet and mild-cured salmon both declined during the period covered in Figure 6.21. Frozen fillet declined from the high of 1.4 million pounds in 1954 to 132 thousand pounds in 1975. Mild-cured salmon declined from the 500-600 thousand pounds of the mid-fifties to 113 thousand pounds in 1972. The production of smoked salmon, which is based on data of the Food and Agriculture Organization, U.N., increased during 1954-74—from approximately 200 thousand pounds per year to the high of 1.1 million pounds during 1972-73.

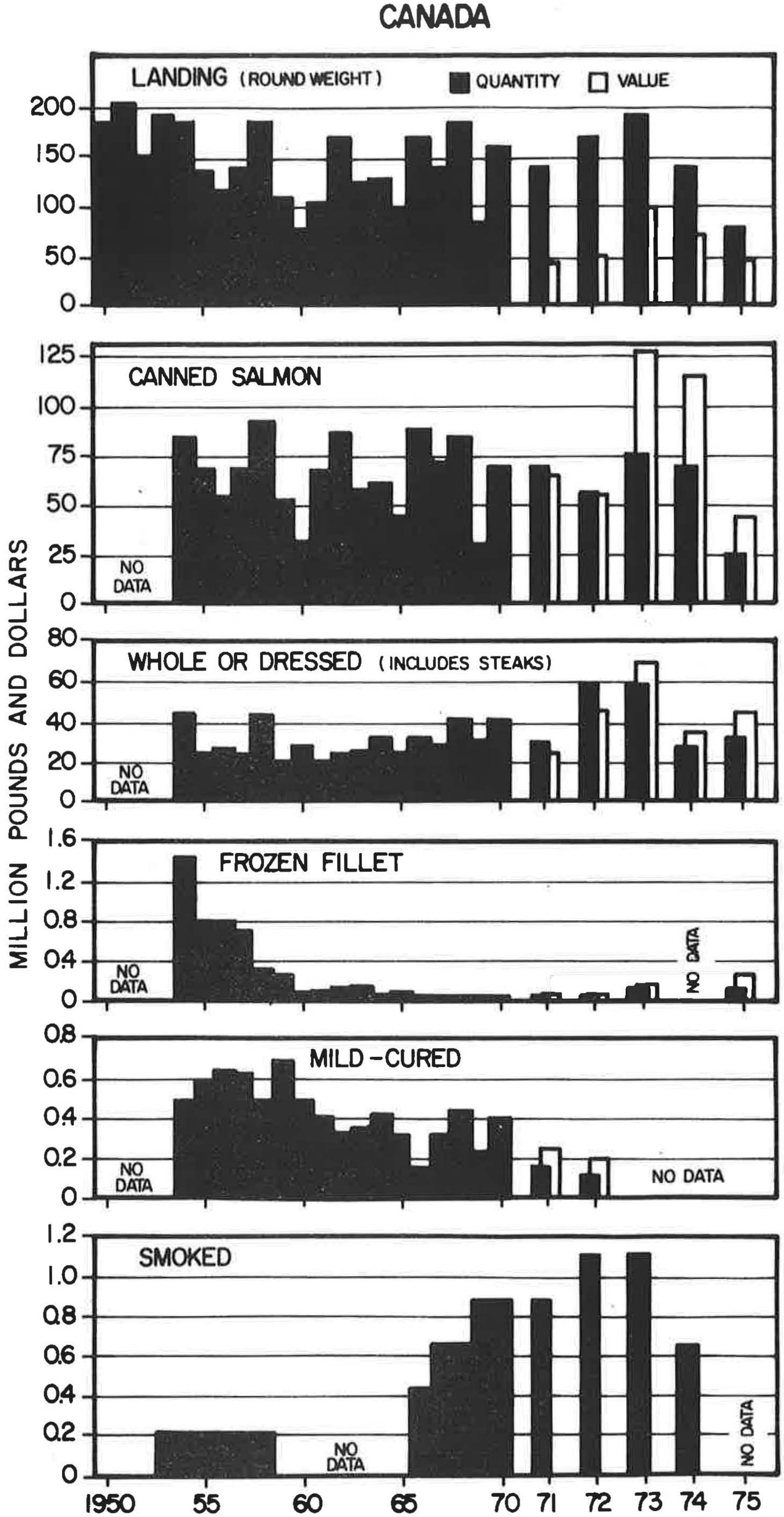


Figure 6.21.--Trend in landings and different types of food products from Pacific salmon--Canada, 1950-75. (Source: Appendix 19.)

6.3.1.3.2.2 Industrial Products

The trend in industrial products from salmon in Canada during 1954-73 is presented in Figure 6.22. Production of fish meal generally fluctuated between 2.0 to 4.0 million pounds. Production of oil fluctuated between 1.0 to 1.8 million pounds with the exception of the 9.8 million pounds in 1958.

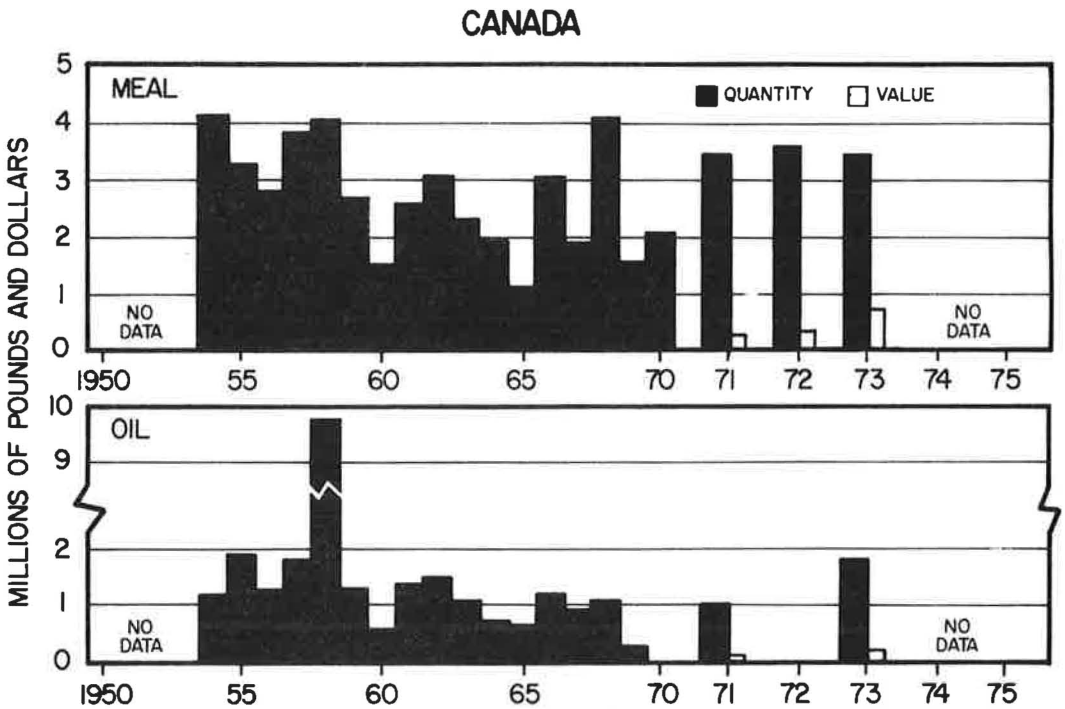


Figure 6.22.--Trend in different types of industrial products from Pacific salmon--Canada, 1950-75. (Source: Appendix 19.)

6.3.1.3.3 Canadian Trade in Edible Salmon Products

Total export of salmon products from Canada during 1958-75 ranged between 32 and 93 million pounds, product-weight (Figure 6.23). Major export items were canned salmon and whole/dressed salmon. The destinations of these products during the most recent years (1971-75) were shown earlier in Figure 6.20. Export of whole/dressed salmon began to increase from about the mid-sixties--a trend similar to U.S. export of fresh/frozen salmon (see Figure 6.15). The export of smoked and pickled salmon ranged between 372 thousand and 833 thousand pounds during 1966-75 (see also Appendix 22).

Information on imports is not available for years prior to 1966. Available data indicate fresh/frozen salmon and canned salmon as major import items (Figure 6.23). Total imports of salmon products during 1966-75 ranged between 1.4 and 7.0 million pounds annually.

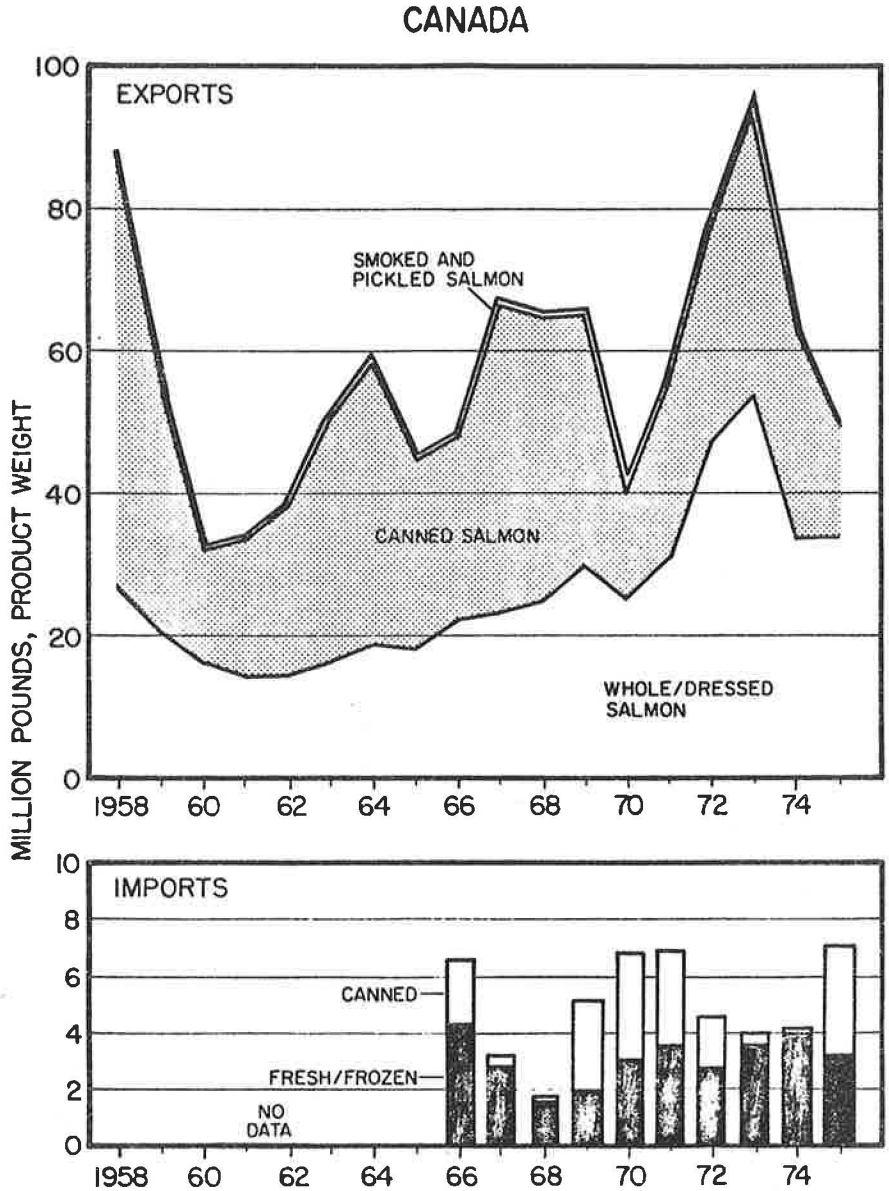


Figure 6.23.--Trend in Canadian exports and imports of Pacific salmon products, 1958-75. (Source: Appendix 22.)

6.3.1.3.4 Other Aspects

Information is not readily available on other aspects of the Canadian salmon industry and market such as fishing labor, vessels and boats, number of processing plants, and prices.

6.3.1.4 Japan

6.3.1.4.1 Current Overview

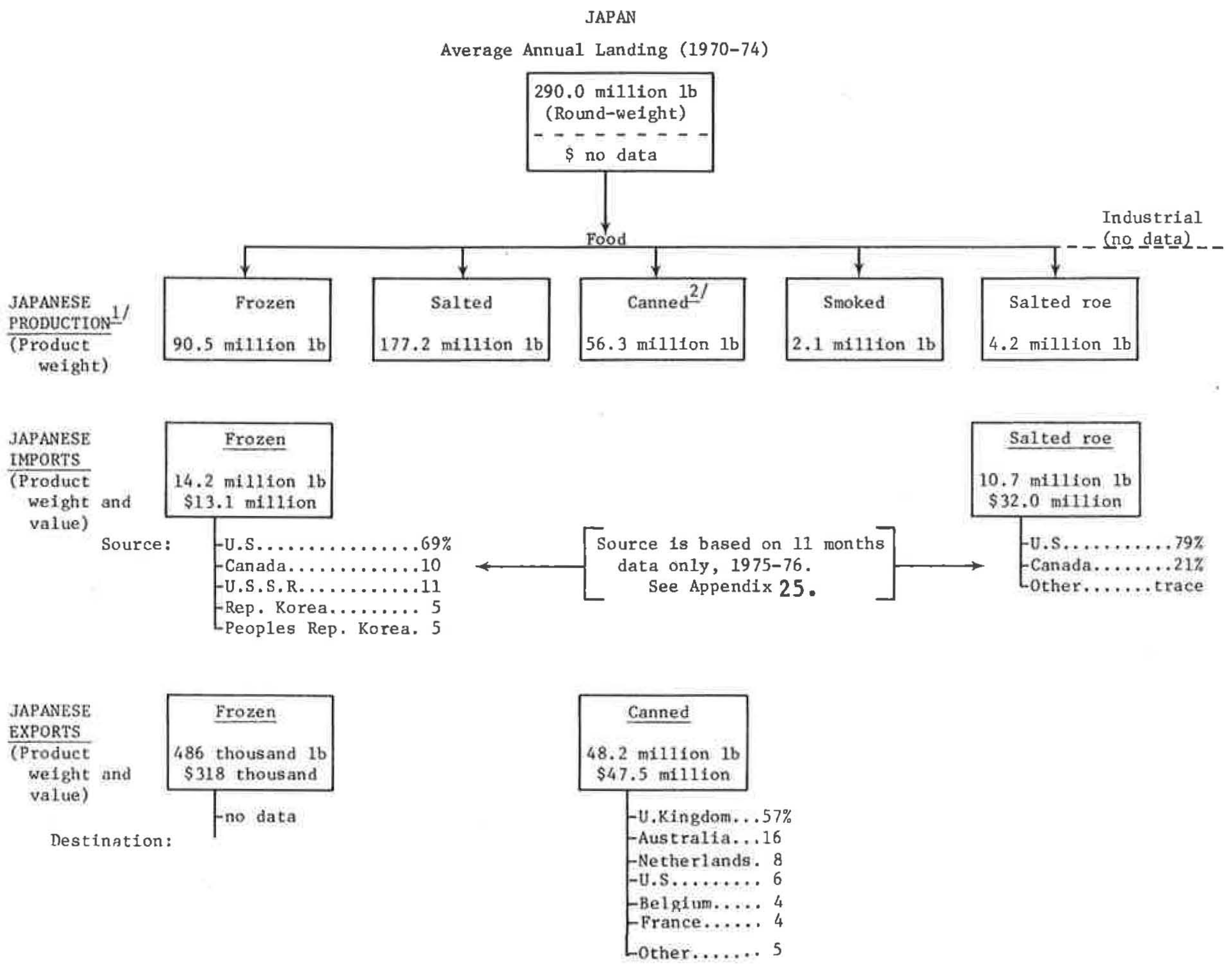
An overview of the current situation (1970-74) in Pacific salmon products and trade for Japan is presented in Figure 6.24. Japan landed an average 290 million pounds (round-weight) of Pacific salmon annually during 1970-74. The high-seas mothership fishery accounted for 27% (78.3 million pounds) of the annual catch.

Primary food products from the Japanese salmon fishery were salted, frozen, and canned salmon. Average annual production was 177.2 million pounds (product-weight) of salted salmon, 90.5 million pounds of frozen salmon, 56.3 million pounds of canned salmon, 2.1 million pounds of smoked salmon, and 4.2 million pounds of salted salmon roe (Figure 6.24). The approximate total comes to 330.3 million pounds which is in excess of domestic catch and frozen salmon imports combined. This apparent discrepancy is believed to be caused, in part, by the probable inclusion of steelhead trout, <u>Salmo gairdneri</u>, (sea-going rainbow trout), and perhaps even rainbow trout, <u>Salmo gairdneri</u>, under salmon/trout food product categories in Japanese fishery statistics. Information on other edible products, as well as industrial products from salmon, is not available.

During 1970-74, Japan imported annually an average of 14.2 million pounds ($13.1 million value) of frozen salmon and 10.7 million pounds ($32.0 million) of salted salmon roe (Figure 6.24). Information on the sources of these imports is not available but as indicated in the figure, 69% of the frozen salmon imports during 11 months of 1975-76 came from the United States, followed by U.S.S.R. (11%), Canada (10%), Republic of Korea (5%), and Peoples Republic of Korea (5%). For salted salmon roe, 79% came from the United States and 21% from Canada during the same 11 months of 1975-76.

Information on exports is limited to frozen and canned salmon products. During 1970-74, Japan annually exported 486 thousand pounds ($318 thousand value) of frozen salmon (destination unknown) and 48.2 million pounds ($47.5 million value) of canned salmon. The primary destination of canned salmon export was the United Kingdom (57%). This was followed by Australia (16%), Netherlands (8%), United States (6%), etc. (Figure 6.24).

In general, it appears that salted salmon and fresh/frozen salmon are the major salmon products consumed in Japan. On a world-wide basis, Japan is probably the largest consumer of salted salmon and salted salmon roe.



1/ Data on value are not available.

2/ Approximately 1.1 million cases of 48 1-lb cans.

Figure 6.24.--Current annual production and trade in Pacific salmon products, Japan. (1970-74 average. Source: Appendix 23-25.)

6.3.1.4.2 Trend in Japanese Salmon Products

The trend in different types of food items prepared from salmon by Japan during 1950-74 is presented in Figure 6.25. Salmon landings starting from 1915 are also included in the figure as a point of reference.

Historically, the most productive period in salmon landings for Japan was between 1934 and 1943 with a record 814.0 million pounds (369,236 mt) in 1941. The post World War II recovery was aided much with the resumption of the Japanese high-seas mothership salmon fishery in 1952 (Figure 6.25). By 1971-75, a net decline in landings of approximately 128 million pounds took place since the high of 438.7 million pounds in 1958. A large part of the Japanese salmon fishery has, since 1953 been under international treaties and agreements.

In terms of quantity, the major products since 1950 were salted, canned, and frozen salmon (Figure 6.25). In general, a change in product composition has taken place. Salted salmon production (and probably frozen, although data on earlier years are unavailable) increased over the years while canned salmon production declined. This trend is somewhat similar to that experienced in the United States of decline in the production of canned salmon and an increase in frozen salmon. By fishery, the mothership operations accounted for only 2-6% of salted salmon production since 1960; between 46 and 49% of canned salmon production during 1955-71 and 30% during 1972-74; and between 26 and 57% of frozen salmon production during 1968-74.

Smoked salmon production increased by nearly ten times since 1955—from approximately 220 thousand pounds to over 2 million pounds (Figure 6.25). None were produced by the mothership salmon fishery.

The salted salmon roe category is comprised of two product forms: (1) salted salmon roe encased in membrane, "sujiko" in Japanese and (2) salted salmon eggs (individual or loose eggs), "ikura" in Japanese. As indicated in Figure 6.25, information on production of salted salmon roe from the "other" salmon fisheries of Japan is not available for years prior to 1970. Total production during 1970-74 ranged between 3.0 and 6.1 million pounds with the mothership salmon fishery accounting for 9-19% of the totals.

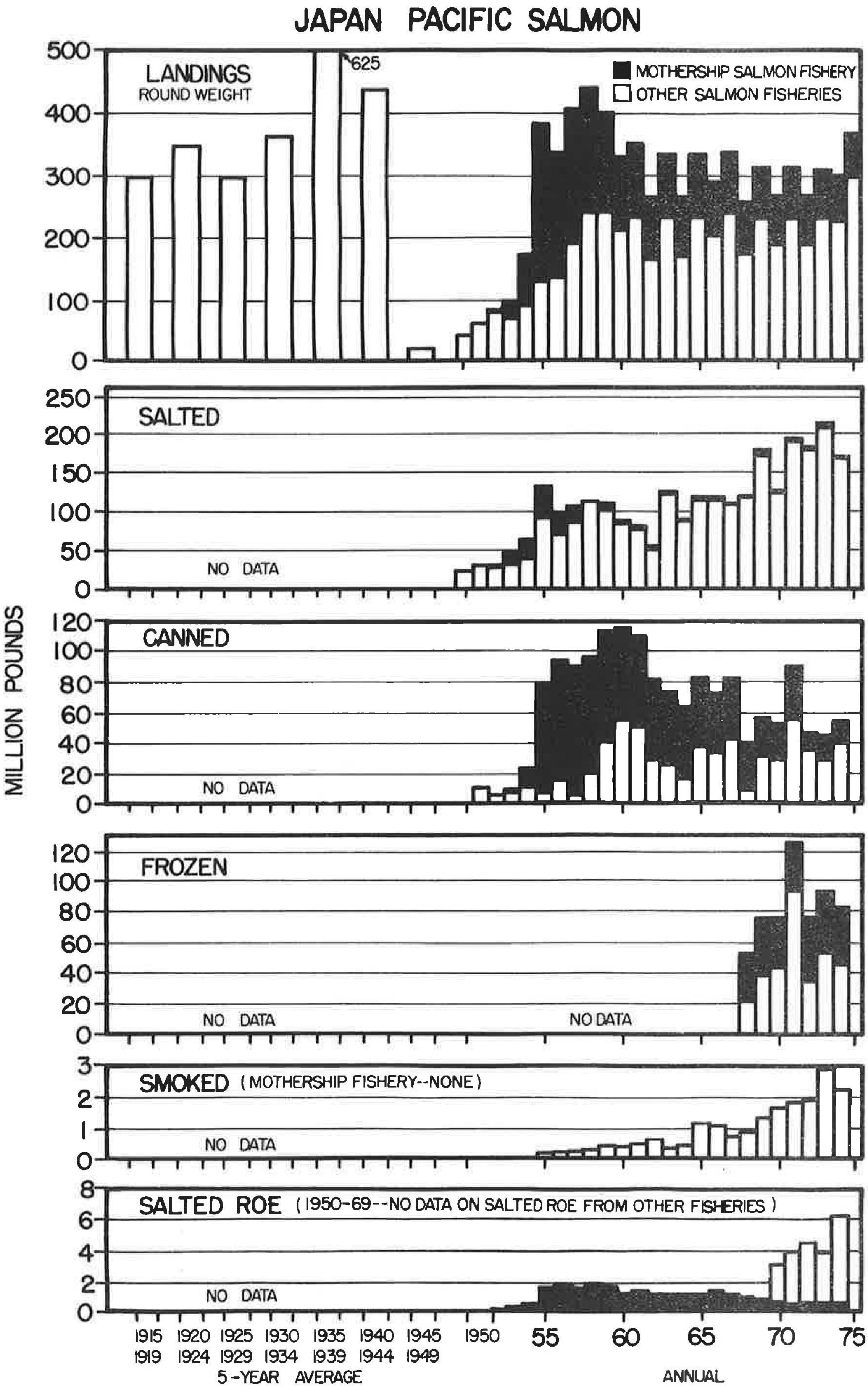


Figure 6.25.—Trend in landings and different types of food products from Pacific salmon--Japan, 1955-75. (Source: Appendix 23 and 26.)

6.3.1.4.3 Japanese Trade in Edible Salmon Products

Information is available only on the exports of canned and frozen salmon, and imports of salted salmon roe and frozen salmon (Figure 6.26). During 1958-74, the export of canned salmon by Japan declined steadily from the 1959 high of 137.1 million pounds (product-weight) to 28.4 million pounds ($44.6 million value) by 1974--a decline of nearly 80%. As shown earlier in Figure 6.24 the primary destinations of Japanese canned salmon exports during 1970-74 were United Kingdom (57%), Australia (16%), Netherlands (8%), and United States (6%). Similarly, the export of frozen salmon declined considerably. An average of only 330 thousand pounds ($344 thousand value) of frozen salmon was exported annually in 1973-74 as compared to the 13.1 million pounds of 1958, or the 5.3 million pounds of 1960.

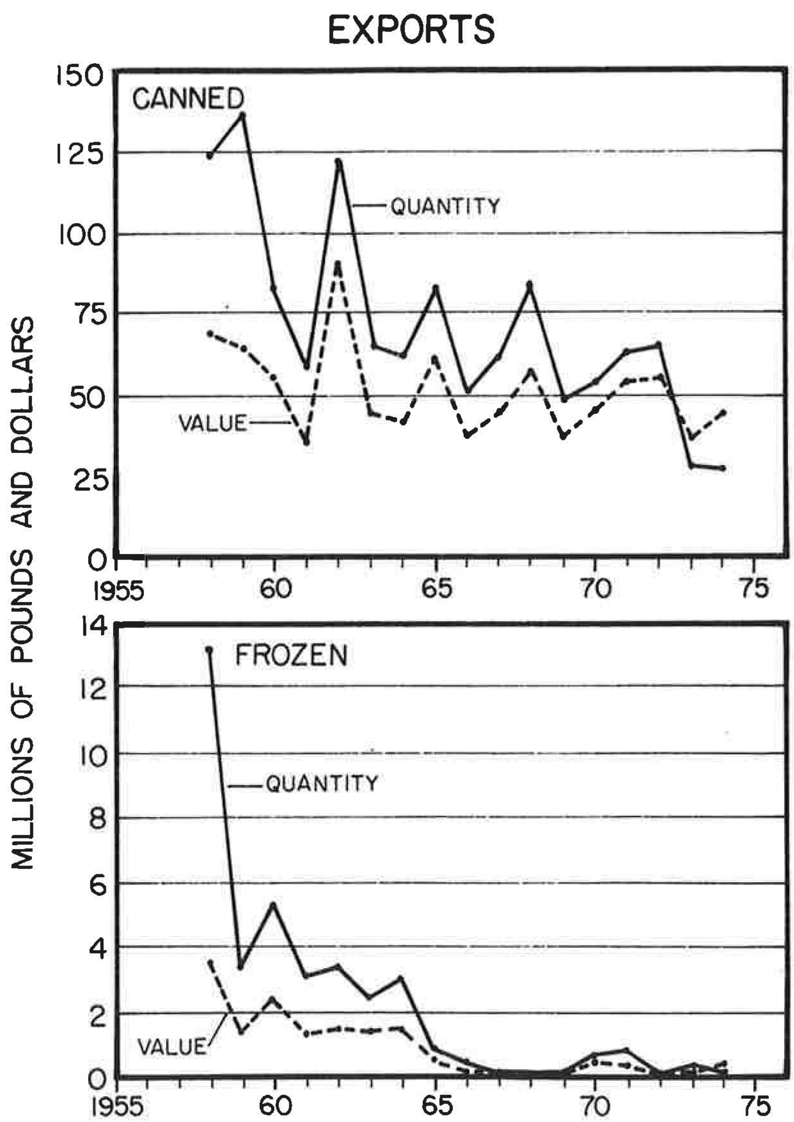


Figure 6.26.--Japanese exports and imports of Pacific salmon products, 1958-75. (Source: Appendix 24.)

Imports of salted salmon roe by Japan ranged between 6.8 and 11.7 million pounds annually during 1969-75. It is an extremely high-valued product as indicated in Figure 6.26. For example, the 7.7 million pounds imported in 1975 were valued at $40.1 million, or approximately $5.21/lb. As indicated earlier in Figure 6.24 the apparent sources of salted roe imports were the United States and Canada.

Frozen salmon imports fluctuated between a high of 33.4 million pounds and a low of 4.9 million pounds during 1969-75. Information on sources of these imports is not available but based on the 11-month data of 1975-76 (see Figure 6.24), the United States was a primary source (60%) followed by U.S.S.R. (11%), Canada (10%), Republic of Korea (5%), and Peoples Republic of Korea (5%).

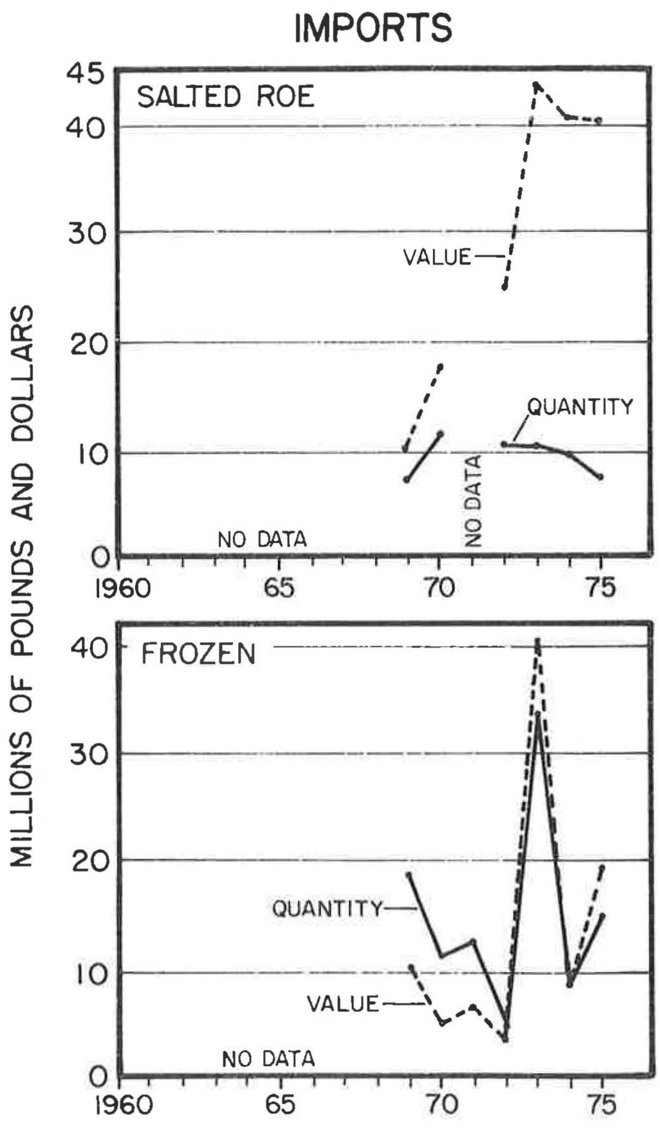


Figure 6.26.--(continued)

6.3.1.4.4 Industry Overview: Operational Units and Prices

6.3.1.4.4.1 Operational Units

Partial information on the operational units of the Japanese salmon fishery from 1952-75 is presented in Figure 6.27. Units covered are factory and fishing vessels, fixed-net operations and labor (fishermen, mothership workers, and ship's crews).

Since its resumption in 1952, the Japanese high-seas salmon mothership fishery grew from three motherships in 1952-53 to 16 motherships during 1956-59, and down to the 10 motherships during 1972-75. (In 1977, however, the fleet was down to six motherships--see Section 4.1.3.1). The catcher (fishing) vessels of the mothership fishery increased from the 57 catchers of 1952 to a high of 506 catchers in 1956, then down to 332 catchers in 1972-75. (In 1977 the fleet was composed of 245 catchers--see Section 4.1.3.1). The fishing gear employed in the mothership fishery is the drift gillnet.

The number of fishing vessels in Japan's other salmon gillnet fishery declined by approximately 26% during the period for which data are available (1957-75). The number of vessels declined from an average annual 2,230 vessels (1957-62) down to 1,659 vessels (1971-75).

For the period where data are available (1964-75), the number of vessels in the Japanese salmon longline fishery increased to a high of 3,489 vessels in 1969 with a decline to the 849 vessels in 1974 and 1,580 vessels in 1975 (Figure 6.27).

During 1957-75, the number of licensed operations in the Japanese fixed-net salmon fishery declined during the early sixties, then increased thereafter to the high of 518 licensed operations in 1974 (Figure 6.27).

Provisional estimates on the labor force of the Japanese salmon fishery (fishing labor, mothership workers, and ship's crews) are presented in the bottom panel of Figure 6.27. With the exception of the mothership fishery labor force, most of the data on the other fisheries were estimated for this report (see Appendix 27). The mothership salmon fishery reached a high of 17,057 people in 1956 then declined to an average 10,884 people by 1972-75. (The 1977 labor count was unavailable at the time of this report). The labor complement of the gillnet fishery ranged between 11,138 and 13,009 people during 1964-75. Labor in the salmon longline fishery increased from 10,660 people in 1964 to a high of 17,445 in 1969 with a low of 4,470 in 1974. The labor force in the salmon fixed-net fishery generally increased during 1964-75--from 4,605 people in 1964 to an average 6,636 during 1974-75. For the period 1964-75, the estimated total labor force of the Japanese salmon fishery was between 22,838 and 35,635 people.

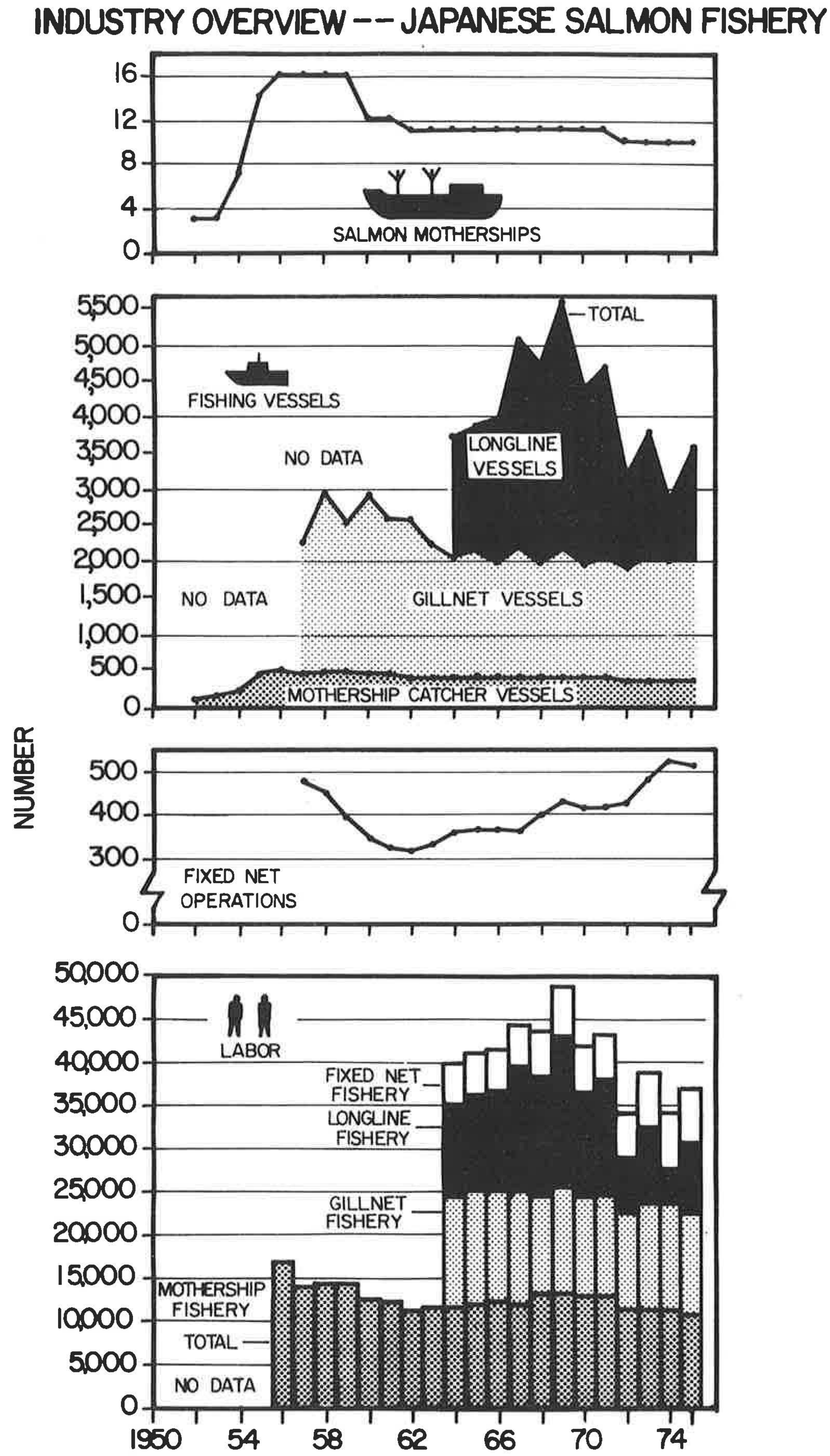


Figure 6.27.--Trend in operating units of the Japanese salmon fishery, 1952-75. (Source: Appendix 27.)

6.3.1.4.4.2 Prices

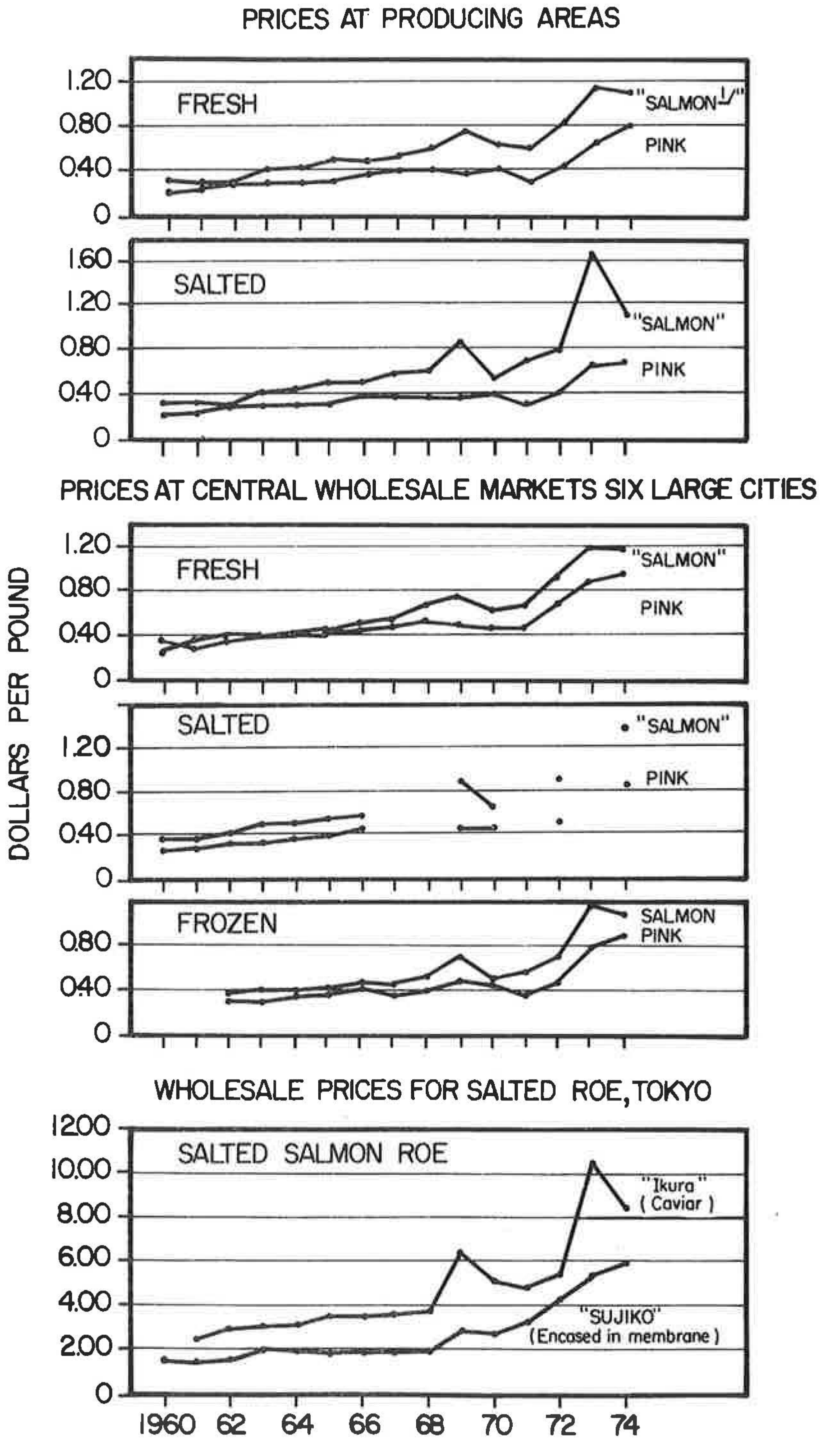
In Japan and the United States, and probably for the world, prices on most salmon products rose significantly in 1973 (see the earlier information on U.S. prices). A generally concluded reason for this significant rise in prices (in addition to inflationary factors) was the combination of overall low inventories of salmon products in the world, the low supplies (catch) of salmon in the United States in 1972 and 1973, and the highly competitive buying actions of Japanese firms in 1973. The last is generally attributed to the historical (since WW II) rise in the strength of the Japanese yen against world currency, especially against the U.S. dollar--the value of the yen ranged from 263.3 to 266.8 to the dollar during April-October, 1973, compared to, say, the average of 303 yen per dollar during 1972. In other words, Japanese firms essentially went on a "buying spree" (thus driving up prices) in 1973 for U.S. fishery goods such as salmon and king crab because more of these products were available per yen.

Similar to the treatment earlier of U.S. prices in "real price" terms, the discussion to follow on Japanese prices will also show estimated real prices and percentage increase on the basis of real prices by brackets [ ]. Deflators used were: (1) Japanese wholesale price index (all commodities) for wholesale prices and (2) Japanese consumer price index (general), urban area, for retail prices. Index year is 1965, or 1965 = 100 (see Appendix 18).

Information on prices (in current dollars as converted from yen/kg) in Japan for salmon products at the "Producing Area" and at "Central Wholesale Markets" during 1960-74 is presented in Figure 6.28.

As shown in Figure 6.28, the prices of fresh "salmon" (chum, sockeye, chinook and coho combined) and pink salmon at the producing (processing) area increased steadily over the period covered. The price of fresh "salmon" increased to $1.10/lb [$0.65/lb] in 1974 from the $0.34/lb [$0.35/lb] of 1960 for a 224% [87%] increase. Fresh pink salmon increased in price to $0.81/lb [$0.48/lb] by 1974 from the $0.20/lb [$0.21/lb] of 1960 for a 305% [140%] increase. Similarly, the price of salted "salmon" at the producing area increased to $1.13/lb [$0.67/lb] in 1974 (after reaching the high of $1.68 in 1973) from the $0.33/lb [$0.34/lb] of 1960 for a 242% [97%] increase. Salted pink salmon rose to a high of $0.71/lb [$0.42/lb] in 1974 from the $0 22/lb [$0.22/lb] of 1960 for a 200% [91%] increase.

The middle panel in Figure 6.28 shows the average prices for "salmon" and pink salmon products at the central wholesale markets of the six largest cities in Japan. Wholesale prices on all products (fresh, salted, and frozen salmon) increased through the years, especially since 1972. Wholesale price of fresh "salmon" increased to $1.15/lb [$0.68/lb] by 1974 from the $0.35/lb [$0.36/lb] of 1960 for a 229% [89%] increase. Fresh pink salmon rose to a high of $0.96/lb [$0.57/lb] in 1974 from the $0.24/lb [$0.24/lb] of 1960 for an increase of 330% [137%]. Prices on salted salmon products are unavailable for some of the years. Salted "salmon" was priced at $1.36/lb [$0.80/lb] in 1974, up 288% [122%] from the $0.35/lb [$0.36/lb] of 1960. Salted pink salmon was priced at $0.83/lb [$0.49/lb] in 1974, up 232% [88%] from the $0.25/lb [$0.25/lb] of 1960. Finally, the wholesale price of frozen "salmon" was $1.12/lb [$0.66/lb] in 1974 (after reaching the high of $1.20/lb in 1973) up 211% [78%] from the $0.36/lb [$0.37/lb] of 1962, and the price of frozen pink salmon reached a high of $0.93/lb [$0.55/lb] in 1974, up 191% [67%] from the $0.32/lb [$0.33/lb] of 1962.



1/ "Salmon" is composed of chum, sockeye, chinook and coho.

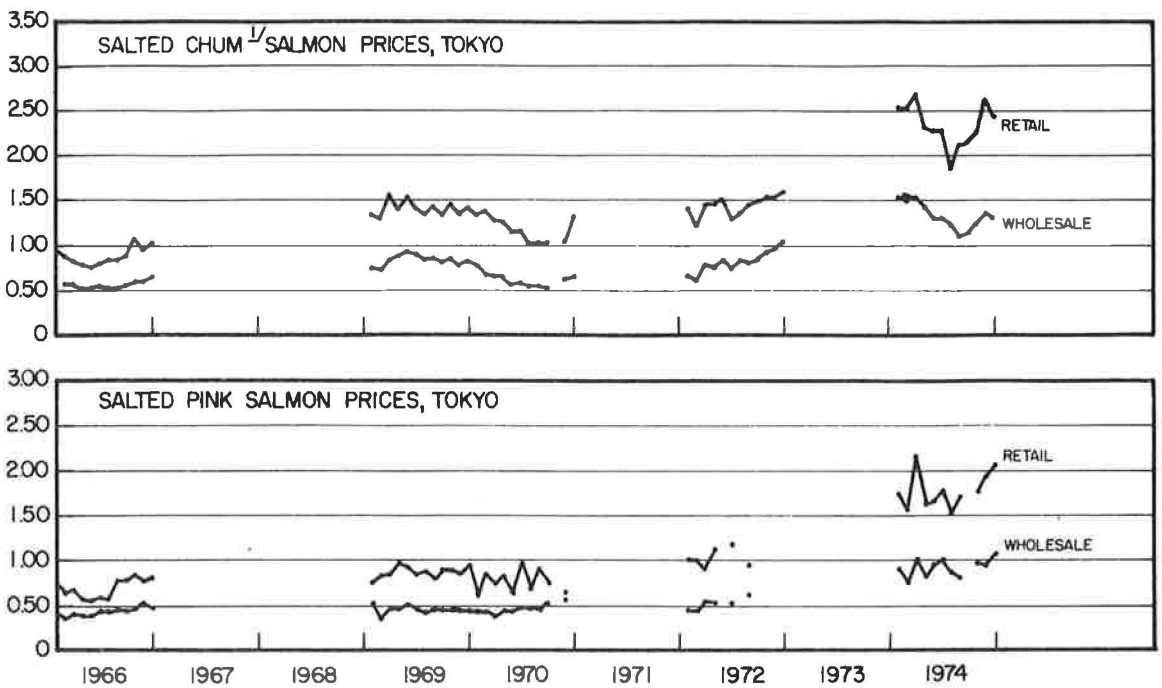
Figure 6.28.--Trend in prices of salmon products, Japan, 1960-74. (Source: Appendix 28.)

Wholesale prices of salted salmon roe products at Tokyo, Japan, are presented in the bottom panel of Figure 6.28. Until 1968 the wholesale prices on both products were fairly stable, or any increase, fairly small. Thereafter, prices increased considerably. "Ikura" (separated salmon eggs) rose to $8.39/lb [$4.95/lb] in 1974 (after reaching a high of $10.26/lb in 1973) up 234% [95%] from the $2.51/lb [$2.54/lb] of 1961. "Sujika" (salmon eggs encased in membrane) rose to a high of $5.88/lb [$3.47/lb] in 1974, up 261% [109%] from the $1.63/lb [$1.66'lb] of 1960.

Partial information on wholesale and retail prices for salted chum and pink salmon at Tokyo, Japan, for 1966-74 is presented in Figure 6.29. The 1967, 1968, 1971, and 1973 issues of the Japanese statistical annuals containing this information were not available at the Northwest and Alaska Fisheries Center, NMFS during the preparation of this report. Although not shown in the figure, prices at the "Distributor" level (between wholesale and retail levels) are documented in Appendix 29.

Wholesale price of salted chum salmon at Tokyo averaged $0.57/lb [$0.56/lb] in 1966 and by 1974 it was $1.29/lb [$0.76/lb] for an increase of 126% [36%] (Figure 6.29). Retail price of salted chum salmon averaged $0.88/lb [$0.84/lb] in 1966 and $2.32 [$1.15/lb] in 1974 for an increase of 164% [37%].

The average wholesale price of salted pink salmon at Tokyo was $0.42/lb [$0.41/lb] in 1966 and $0.89/lb [$0 53/lb] in 1974 for an increase of 112% [29%]. The average retail price of salted pink salmon was $0.66/lb [$0.62/lb] in 1966 and $1.72/lb [$0.85/lb] in 1974 for an increase of 161% [37%].



1/ Classified as salted "salmon" in 1966 and as salted chum since 1969.

Figure 6.29.--Wholesale and retail prices of salted chum and pink salmon at Tokyo, 1966-74. (Source: Appendix 29.)

6.3.1.5 Union of Soviet Socialists Republics

Information available at the Northwest and Alaska Fisheries Center, NMFS on the U.S.S.R. salmon fishery is limited to landings and export of canned salmon (Table 6.9).

Pacific salmon landings by U.S.S.R. declined from an average annual 342.0 million pounds in 1950-54 to 120.4 million pounds in 1970-74--a decline of 65% (Table 6.9).

Products from salmon were fresh/frozen, salted, smoked, and canned salmon as inferred from the 1957 data on products and more recent data on exports of canned salmon. By assuming the following approximate round weight to product weight conversion factors of 0.85 for fresh/frozen and salted salmon, and 0.70 for smoked salmon, it appeared that 62% of this 1957 landings was processed into salted salmon, 27% into canned, 9% into fresh/frozen, and 2% into smoked salmon. Whether this product composition held for more recent years is not known.

The U.S.S.R. exported an average of 9.7 million pounds ($8.3 million value) of canned salmon annually during 1970-74 (Table 6.9). Based on the 1972-74 data on destinations of canned salmon exports, it appeared that approximately 24% was exported to France, 24% to United Kingdom, 14% to Belgium-Luxembourg, 4% to Czechoslovakia, 3% to German Democratic Republic, and 31% to other countries. Information on export of other salmon products is not available but approximately 1.3 million pounds of fresh/frozen salmon was exported to Japan during an 11-month period in 1975-76 (see Appendix 25).

6.3.1.6 Republic of Korea

Information is not available on Pacific salmon landings and products. As indicated earlier, however, Japan imported a total of 584 thousand pounds of fresh/frozen salmon from the Republic of Korea during a 11-month period in 1975-76 (see Appendix 25).

6.3.1.7 Peoples Republic of Korea

Information is not available on Pacific salmon landings and products. As indicated earlier, however, Japan imported a total of 530 thousand pounds of fresh/frozen salmon from the Peoples Republic of Korea during a 11-month period in 1975-76 (see Appendix 25).

Table 6.9.--Pacific salmon landings, products. and trade--U.S.S.R., 1950-74.

Year	Landings[1/] Metric tons	Landings[1/] Pounds	Products[2/] Fresh/ frozen	Products[2/] Salted	Products[2/] Smoked	Products[2/] Canned	Exports[2/] Canned Quantity	Exports[2/] Canned Value
	- - - - - - - - - - - - - - (Thousand pounds and dollars) - - - - - - - - - - - - - -							
1950	110,120	242,771	--	--	--	--	--	--
51	249,320	549,651	--	--	--	--	--	--
52	116,360	256,527	--	--	--	--	--	--
53	188,780	416,184	--	--	--	--	--	--
54	110,950	244,600	--	--	--	--	--	--
55	164,640	362,965	--	--	--	--	--	--
56	160,000	352,736	--	--	--	--	--	--
57	148,000	326,281	25,573	172,179	3,968	--	--	--
58	70,600	155,645	--	--	--	--	5,512	3,171
59	94,194	207,660	--	--	--	--	10,141	5,493
1960	69,541	153,310	--	--	--	--	5,291	2,646
61	79,700	175,707	--	--	--	--	8,157	4,871
62	60,560	133,511	--	--	--	--	9,259	5,784
63	81,071	178,729	--	--	--	--	9,039	4,750
64	45,253	99,765	--	--	--	--	7,055	3,780
65	87,626	193,180	--	--	--	--	7,937	4,099
66	56,223	123,949	--	--	--	--	7,937	4,712
67	78,882	173,903	--	--	--	--	5,952	3,372
68	36,190	79,784	--	--	--	--	10,141	5,882
69	75,468	166,377	--	--	--	--	8,157	5,538
1970	39,048	86,085	--	--	--	--	10,362	6,913
71	77,595	171,066	--	--	--	--	9,921	6,579
72	30,614	67,492	--	--	--	--	9,259	6,883
73	77,718	171,337	--	--	--	--	10,582	10,424
74	48,000	105,821	--	--	--	--	8,157	10,481

Canned salmon exports by country of destination

Destination	1970	1971	1972	1973	1974
	- - - - (Thousand pounds) - - - - - - - - - - -				
Belgium & Lurembourg	--	--	1,543	1,543	882
Czechoslovakia	661	441	441	441	220
France	--	--	1,764	2,646	2,205
German Democratic Rep.	661	220	441	220	220
United Kingdom	5,512	5,071	2,866	2,205	1,543
Other	3,527	4,189	2,205	3,527	3,086
Total	10,361	9,921	9,260	10,582	8,156

1/ In round-weight. Data source: 1950-53, Int. North Pac. Fish. Comm., (ms 1974); 1974, Food Agric. Organ., U.N. (1975a).

2/ In product weight. Imports (if any) are not reported. Data source: Food Agric. Organ., U.N. (1965b-1975b).

6.3.1.8 Summary on Commercial Salmon Products and Trade

A partial summary on current average annual landings of Pacific salmon and processed products, by country, is presented in Table 6.10. Japan led in landings with approximately 289.9 million pounds annually. This was followed by the United States with 277.0 million pounds, Canada 159.6 million pounds, and U.S.S.R. 124.9 million pounds. Information on the landings of the Republic of Korea and the Peoples Republic of Korea is not available.

Based on the production data of the United States, Japan and Canada, it appears that nearly 99% of their landings went towards edible food products (Table 6.10). On the basis of product weight, approximately 37% was canned salmon, 30% fresh/frozen salmon, 28% salted salmon, 3% smoked salmon, 2% salted salmon roe and a trace of specialities. Overall, Japan was the dominant producer of salted salmon and fresh/frozen salmon products, and the United States was the dominant producer of canned salmon, smoked salmon, and salted salmon roe products. In general, most of the salted salmon roe was probably consumed in Japan. The United States probably consumed annually 47-50% of the total canned salmon and most of the smoked salmon produced in the world.

Overall, Japan and the United States are not only the leading countries in Pacific salmon landings but in consumption of salmon products as well. Outside of Japan and the United States, and possible U.S.S.R., the United Kingdom appears to be the next largest consumer of salmon products based on the volume of her salmon imports. It is not known, however, what fraction of the imports to the United Kingdom was in turn exported by that country.

Table 6.10.--Partial summary on current Pacific salmon landings and products by country--annual averages of 1970-74, -75.

	Landings		Edible products						Industrial products				
Country	Metric ton	Thousand pounds	Fresh/ Frozen	Salted	Canned	Smoked	Specialties	Salted roe	Meal	Oil	Animal food	Bait	Eggs for bait
	(Round-weight)		(Thousand pounds, product weight)										
United States	125,644	276,995	59,590 1/	2,811 2/	120,823	13,387	254	7,798	--	--	1,000	100	712
Japan	131,510	289,927	90,487	177,177	56,284	2,060	--	4,174	--	--	--	--	--
Canada	72,374	159,556	42,206 3/	134 4/	58,985	937	--	--	3,465	1,407	--	--	--
U.S.S.R. 5/	56,660	124,913	--	--	--	--	--	--	--	--	--	--	--
Rep. Korea 5/	--	--	--	--	--	--	--	--	--	--	--	--	--
Peoples Rep. Korea 5/	--	--	--	--	--	--	--	--	--	--	--	--	--

1/ Comprised of frozen salmon exports, frozen round/dressed salmon, and production of steaks and fillets.
2/ Salted, pickled, and cured products combined.
3/ Round or dressed salmon, steaks, and fillets combined.
4/ Mild-cured salmon.
5/ See discussions in text for partial information on products.

A partial summary on current annual world trade in Pacific salmon products is presented in Table 6.11. The primary destination of canned salmon export was Europe. The United Kingdom received annually about 54% of the canned salmon exports, France (4%), Belgium (6%), and Netherlands (5%). Outside of Europe, Australia received 10% of the canned salmon exports.

On fresh/frozen salmon exports outside of the producing countries, the primary destination was again apparently Europe (Table 6.11). France received annually about 24% of the exports, United Kingdon (11%), Sweden (11%), Denmark (3%), and Belgium (2%). Among the producing/exporting countries, the United States and Japan were primary receivers of fresh/frozen salmon exports.

The primary receivers of U.S. salmon steak/fillet exports were Japan, Canada, France and United Kingdom. The receiver of salted salmon roe exports by the United States and Canada is assumed to be Japan.

Overall, the primary importers of salmon products from the producing countries were: United Kingdom (33%), France (12%), Australia (5%), Belgium (4%), and Sweden (4%). Among the producing countries, Japan received approximately 12% of the exports, and United States, 10%.

These percentages are necessarily provisional, since detailed information on salmon fisheries and trade of countries such as the U.S.S.R., Republic of Korea, and Peoples Republic of Korea is lacking.

Table 6.11.--Partial summary on current annual world trade in Pacific salmon products--average of 1970-74, 175. (In million pounds.)

Exported product	Canned salmon				Fresh or frozen salmon						Steak/ fillet	Salted roe 1/		Product Total
Exporting country	U.S.	Japan	Canada	U.S.S.R. 2/	U.S.	Japan 3/	Canada	U.S.S.R.	ROK 4/	PROK 5/	U.S.	U.S.	Canada	
Exported quantity	16.4	48.2	27.2	9.3	30.8	0.5	40.1	--	--	--	6.7	(8.4)	(2.3)	188.1 6/
Destination														
United States . .		2.9	2.2	--		--	12.8	--	--	--			--	17.9
Japan	--		--	--	7.7	--	3.2	(1.3) 7/	(0.6) 7/	(0.5) 7/	2.8	8.4	2.3	24.4
Canada	2.0	--		--	2.8	--		--	--	--	1.1	--		5.9
U.S.S.R.	--	--	--		--	--	--		--	--	--	--	--	-
United Kingdom .	10.7	27.5	14.1	2.2	4.3	--	3.2	--	--	--	0.8	--	--	62.8
France	--	1.9	--	2.2	7.1	--	9.6	--	--	--	1.0	--	--	21.8
Belgium	--	1.9	3.3	1.3	1.5	--	--	--	--	--	--	--	--	8.0
Netherlands . . .	1.3	3.9	--	--	--	--	--	--	--	--	--	--	--	5.2
Australia	0.8	7.7	1.4	--	--	--	--	--	--	--	--	--	--	9.9
New Zealand . . .	--	--	1.4	--	--	--	--	--	--	--	--	--	--	1.4
Denmark	--	--	--	--	--	--	2.0	--	--	--	--	--	--	2.0
Sweden	--	--	--	--	4.0	--	3.6	--	--	--	--	--	--	7.6
Czechoslovakia .	--	--	--	0.4	--	--	--	--	--	--	--	--	--	0.4
German Dem. Rep..	--	--	--	0.3	--	--	--	--	--	--	--	--	--	0.3
Other 8/	1.6	2.4	4.8	2.9	3.4	--	5.7	--	--	--	1.0	--	--	21.8

1/ Estimates as derived from Appendix 24 and 26.
2/ 1972-74 annual average (see Table 6.9).
3/ Information on destination was unavailable.
4/ Republic of Korea (or South Korea).
5/ People's Republic of Korea (or North Korea).
6/ Excludes the quantities of fresh or frozen salmon exported by Japan, U.S.S.R., ROK, and PROK.
7/ Total for 11 months' export in 1975-76 (see Appendix 25).
8/ May include quantities of those countries listed.

6.3.2 Salmon Sport Fishery

The Pacific salmon resource supports a large and viable sport fishery along the Pacific coast of the United States and Canada. Probably over a million anglers annually fish for salmon in Alaska, Washington, Oregon, Idaho, and California and, although information is not available, probably several hundred thousand or more salmon anglers also fish in British Columbia, Canada. Total sport catch of salmon along the Pacific coast increased by 150% since 1961--from 1.0 million fish to over 2.5 million fish by 1974.

Large and important sport fisheries in the Great Lakes and certain freshwater areas in Oregon, Idaho, California, and British Columbia are also maintained by Pacific salmon. On the former, the successful plantings of Pacific coast coho and chinook salmon into parts of the Great Lakes (especially Lake Michigan) by the Michigan Department of Natural Resources in the mid-sixties led to a salmon sport catch of 1.5 million fish (767,720 coho and 704,650 chinook) in the state of Michigan alone by 1975. On the latter, the catch of kokanee salmon (lacustrine stocks, or land-locked variety of the sockeye salmon) in Lake Pend Oreille, Idaho, for example, ranged between 359 and 809 thousand fish during 1951-63, while an estimated catch of 977 thousand kokanee salmon was reported for the 1969/70 season in British Columbia.

Although the above freshwater salmon sport fisheries are large and important, the emphasis in this report will be on the sport fisheries operating on the anadromous form of Pacific salmon--that is on those salmon migrating out to sea and returning to fresh water to spawn. Furthermore, emphasis will be on U.S. and Canadian fisheries since information on the salmon sport fisheries of Japan and U.S.S.R. (if any) is not available.

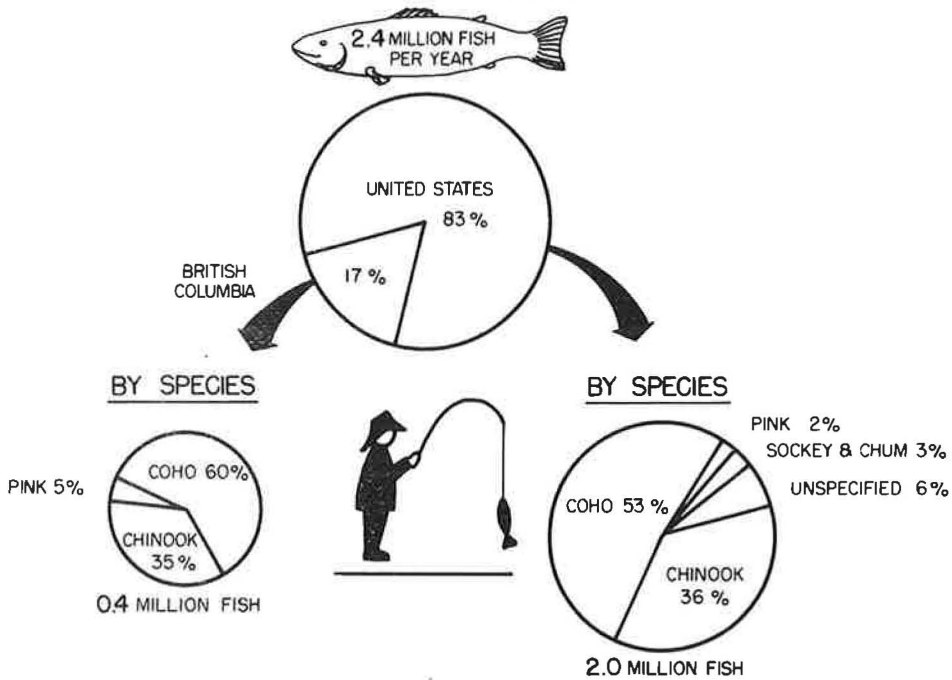
STREAM FISHING FOR PINK SALMON. DUNGENESS RIVER, WASHINGTON, 1973.
(Photo: Wash. Dept. Fish.)

6.3.2.1 Pacific Coast Salmon Sport Fishery

6.3.2.1.1 Catch

Currently (1970-74), an average of 2.4 million salmon are taken annually by sport anglers along the Pacific coast of the United States and Canada (Figure 6.30). The United States accounted for 83% (2.0 million fish) of the catch and British Columbia 17% (0.4 million fish). Coho and chinook salmon comprised the bulk of the catches for both countries--a catch of 53% coho and 36% chinook for the United States, and 60% coho and 35% chinook for British Columbia. The coho and chinook catches of the United States should be greater than estimated since the unspecified category (6% catch) in the figure is believed to be composed primarily of these two species. For the United States, Washington State led in catch (58%), followed by Oregon (22%), California (11%), Alaska (8%), and Idaho (1%).

CURRENT AVERAGE ANNUAL SALMON SPORT CATCH
PACIFIC COAST (1970-74)



U.S. CATCH BY SPECIES AND STATE

	COHO	CHINOOK	PINK	SOCKEYE CHUM	UNSPECIFIED	TOTAL
US AVERAGE ANNUAL CATCH THOUSAND FISH	1,063.3	715.5	49.1	53.1	127.8	2,008.8
PERCENT BY STATE						
ALASKA	6%	3%	76%	98%	0%	8%
WASHINGTON	62	52	23	2	100	58
OREGON	28	19	1	0	0	22
IDAHO	0	1	0	0	0	1
CALIFORNIA	4	25	0	0	0	11
TOTAL	100	100	100	100	100	100

Figure 6.30.--Current average annual sport catch of salmon along the Pacific coast of United States and Canada. (Source: Appendix 30-35.)

Partial estimates on the total sport catch of salmon by country and species during 1950-74 are presented in Figure 6.31. These are partial estimates because some catch data, especially those of the fifties, are either unavailable or incomplete. As indicated in the figure, salmon sport catch along the Pacific coast rose continuously with a 150% increase since 1961. Coho and chinook salmon comprised the bulk of the sport catch.

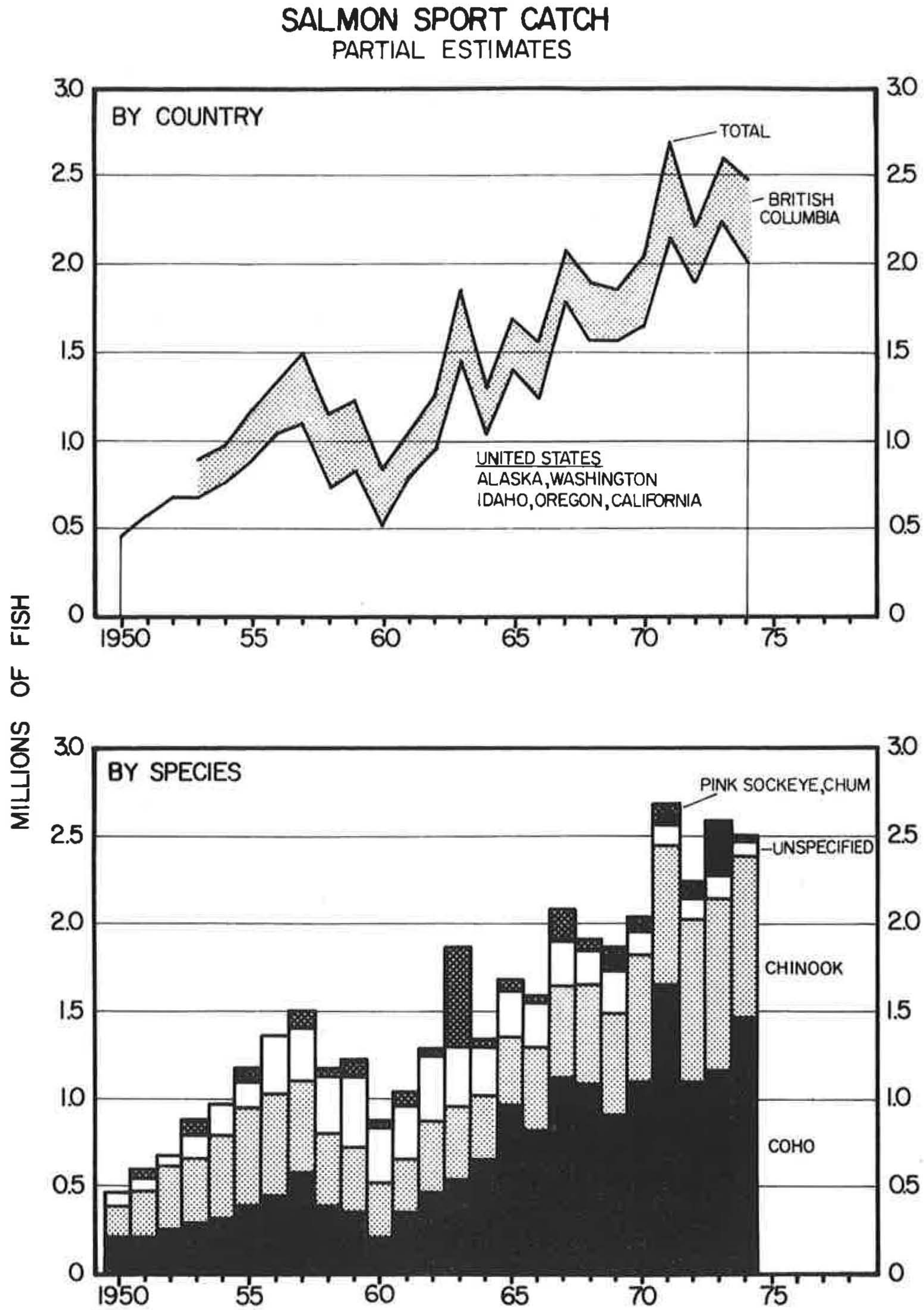


Figure 6.31.--General trend in Pacific salmon sport catch by country and species, 1950-74. (Source: Appendix 30.)

6.3.2.1.2 Effort

Information on fishing effort is available in the form of number of anglers, number of angler-trips or angler-days, and number of boat-days but these, however, varied among the reporting agencies. The general trend in U.S. salmon sport catch and effort by fishing areas for 1950-74 is shown in Figure 6.32. Fishing success, as represented by catch-per-unit-effort, is discussed later.

Salmon sport catch and effort in Washington increased steadily since 1950; the exception is the dip centering around 1960 (Figure 6.32). In 1974, an estimated 531,800 resident and non-resident salmon anglers fished out of Washington--a 76% increase from the 302,700 salmon anglers of 1964. Since 1970, marine angler-trips increased by nearly 200% (1.7 million trips by 1974) while total catch (marine and freshwater) increased by nearly 318% (1.3 million fish catch by 1974).

Salmon sport catch and effort in Oregon followed two general trends--an increase during 1955-67, and a leveling-off during 1968-74 (Figure 6.32). Overall, the combined number of salmon and steelhead anglers increased by approximately 233% during 1953-74; an estimated 317,400 salmon-steelhead anglers by 1974. Marine angler-trips fluctuated between 290,400 and 381,500 trips during 1964-74. Total catch (marine and freshwater) rose from the 90 thousand plus fish of 1950-55 to the 431 thousand fish average of 1968-74; an increase of approximately 379%.

Information is not available on the number of salmon anglers for California (Figure 6.32). During 1962-73, marine angler-days generally declined during the earlier years but increased thereafter to the peak of 275,000 angler-days in 1971. Salmon sport catch in the marine area reached a high of 255,600 fish in 1971.

Salmon sport fishing in Idaho is confined to the take of chinook salmon in freshwater areas of the Snake River system. The number of anglers (salmon and steelhead anglers combined) fluctuated between 21,700 and 47,300 anglers during 1966-73. Catch declined steadily from the high of 39,000 chinook salmon in 1957 to the low of 1,600 fish in 1974 (Figure 6.32).

The information on Alaska's salmon sport fishery is provisional at this time (Figure 6.32 and Appendix 34). An estimated 113,400 combined salmon-steelhead anglers were reported for 1970.

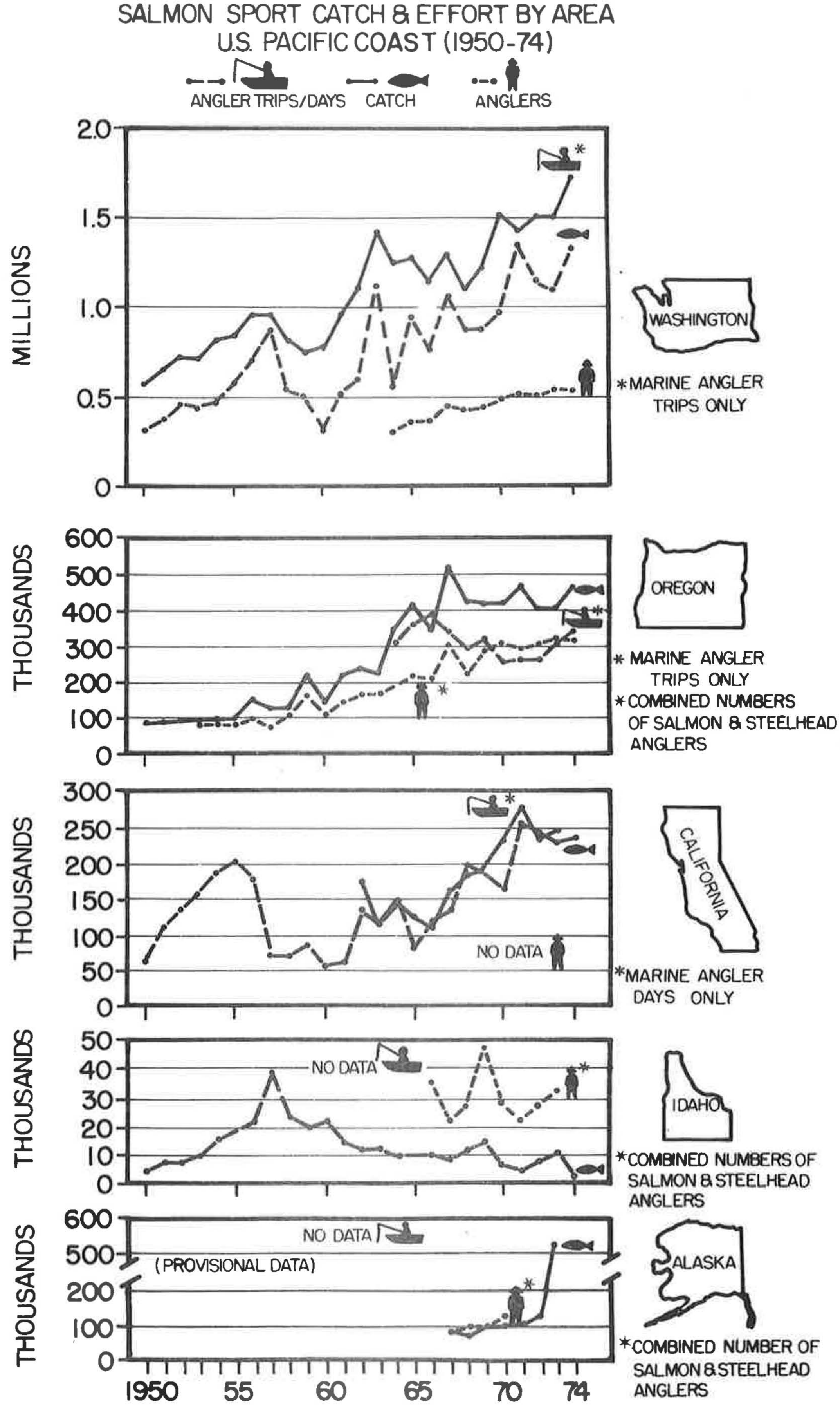


Figure 6.32.--Trend in salmon sport catch and effort--U.S. Pacific coast, 1950-74. (Source: Appendix 31-34.)

WASHINGTON -- SALMON SPORT FISHERY

SALTWATER FISHING

Sampling a sport catch
for information

Netting a salmon

(Photos: Wash. Dept. Fish.)

FRESHWATER FISHING

Sockeye salmon catch,
Lake Washington
(Photo: Thompson, NMFS)

WASHINGTON -- SALMON SPORT FISHERY

SALMON DERBY TIME -- PUGET SOUND, WASHINGTON

Catch on display

Possible winner

(Photos: P. Washington, NMFS)

Salmon sport catch in British Columbia, Canada generally fluctuated around the 300,000 fish level during 1953-69, and around the 400,000 fish level during 1970-74 (Figure 6.33). The number of boat-days increased by approximately 81% during 1960-74; from 204,700 to 370,500 boat-days. Information is not available on number of anglers.

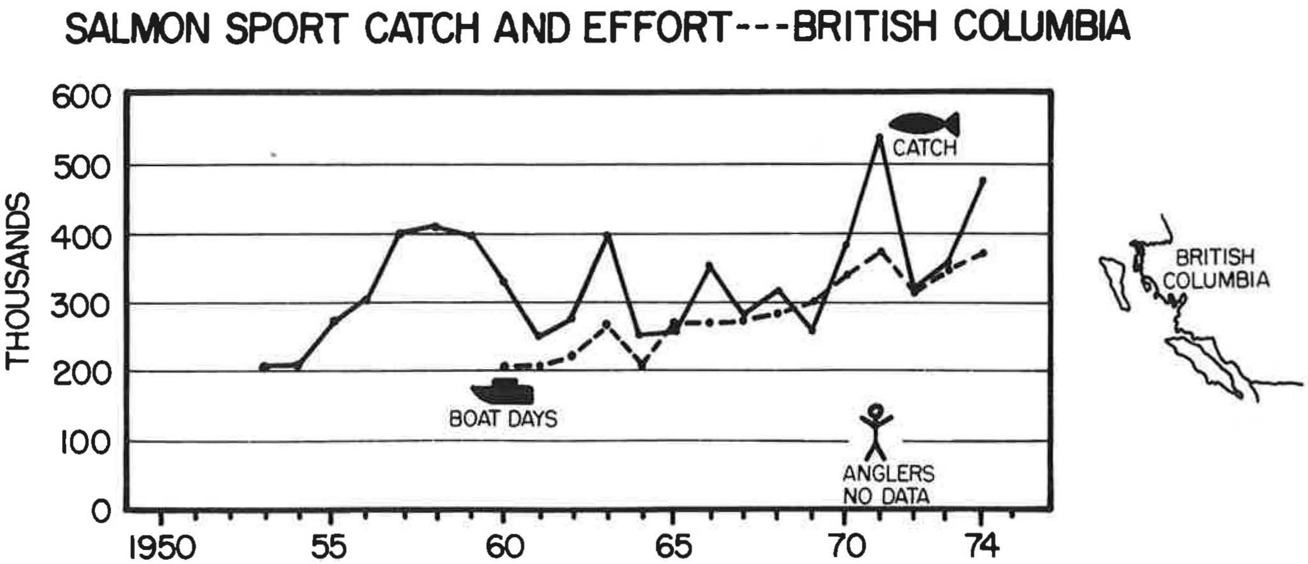


Figure 6.33.--Trend in British Columbia, Canada salmon sport catch and effort, 1950-74. (Source: Appendix 35.)

Overall, the trend in the Pacific coast salmon sport fishery has been one of increasing participation, effort, and catch.

BRITISH COLUMBIA -- SALMON SPORT FISHERY

Angler with chinook salmon. Rivers Inlet, B.C., Canada. (Photo: Fish. Mar. Serv., B.C.)

Salmon sport fishing scene (Photo: Info. Canada)

6.3.2.1.3 Fishing Success

Estimates on fishing success are available only for the Washington, Oregon, California, and British Columbia fisheries (Figure 6.34). These estimates, in turn, varied as to the unit used to measure fishing success. Washington reported success on the basis of catch-per-marine-angler trip and showed a somewhat level trend with fluctuations around the 0.6-0.7 fish-per-trip level during 1950-74. Fishing success in Oregon declined in general from a peak of 1.4 fish in 1965 to about 1.0 fish-per-marine-angler trip in the seventies. Fishing success in California during 1962-73 fluctuated between 0.66 to 1.05 fish per-marine-angler-day. British Columbia reprots success on the basis of catch-per-boat-day. During 1960-74, success in British Columbia fluctuated between 0.92 to 1.62 fish-per-boat-day.

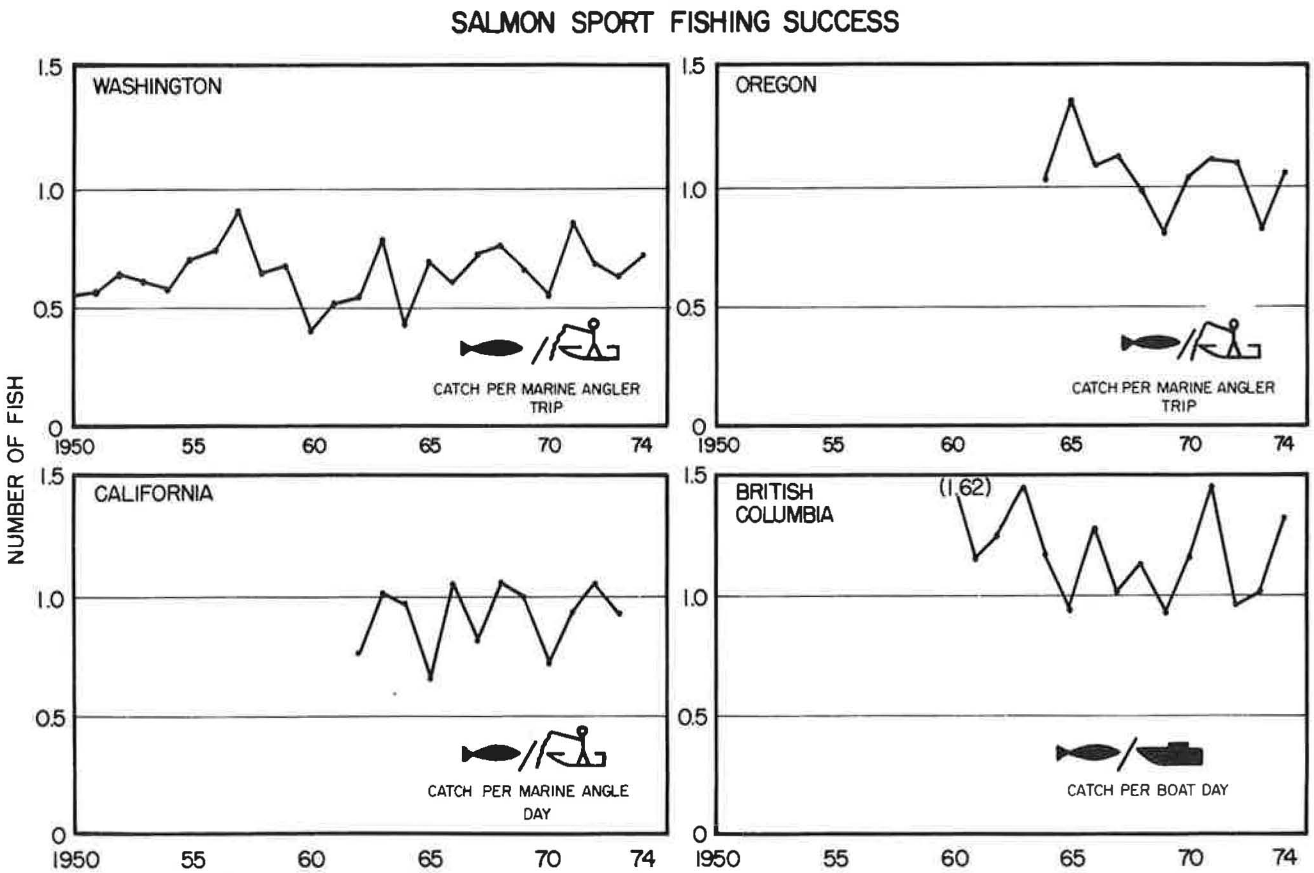


Figure 6.34.--General trend in salmon sport fishing success--Washington, Oregon, California and British Columbia, 1950-74. (Source: Appendix 31-34.)

The preceding information on catch, effort, and fishing success is confined to the Pacific coast sport fisheries operating on the anadromous form of Pacific salmon. As indicated earlier, however, there are several significant salmon sport fisheries located in freshwater habitats--the Great Lakes salmon fishery and the Kokanee salmon fishery.

6.3.2.2 Great Lakes Salmon Sport Fishery

Sport fishing for salmon in the Great Lakes started essentially in 1967 following the successful plantings in the mid-sixties of coho and chinook salmon by the Michigan Department of Natural Resources (Tody and Tanner 1966; Borgeson and Tody 1967; Borgeson 1970; Michigan Dept. Nat. Resour. 1973; Parsons 1973). Now a viable and large sport fishery in the Great Lakes is maintained by coho and chinook salmon.

Table 6.12 shows the remarkable growth of the Great Lakes salmon sport fishery based on the Michigan State fishery. (Michigan anglers were estimated as accounting for approximately 90% of the coho and 99% of the chinook salmon catch recorded for Michigan, Indiana, Illinois, Ohio, Pennsylvania, Wisconsin, Minnesota, New York, and Ontario, Canada, during 1967-70. Estimated from the data of Parsons 1973.) From a start of 54,800 coho salmon catch in 1966 and 117,000 chinook salmon catch in 1969, the Michigan fishery thereafter rose to a catch of 767,720 coho and 704,650 chinook by 1975. Approximately 200,000 combined, salmon-steelhead anglers pursued salmon in 1971 expending approximately 1.6 million salmon angler-trips.

Table 6.12.--State of Michigan's Great Lakes salmon sport fishery, 1967-75.

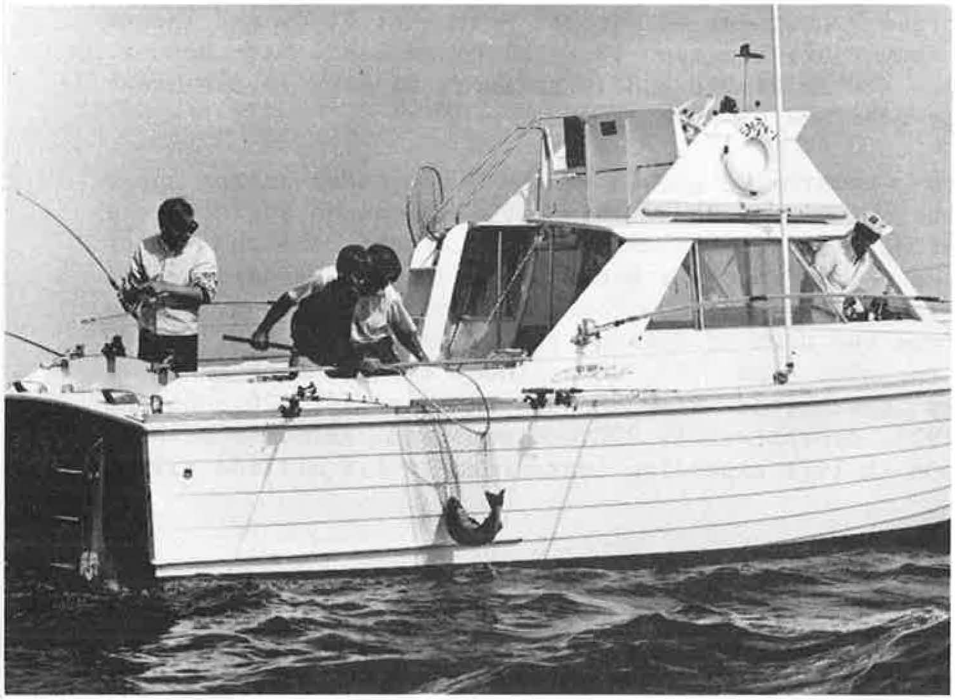
Year	Catch			Anglers	Angler days
	Coho	Chinook	Total		
	(Thousands)				
1967	54.8	0	54.8	--	--
68	108.0	0	108.0	--	--
69	363.0	117.0	480.0	--	--
1970	657.9	201.5	859.4	180.0 1/	1,755.0 1/
71	739.1	303.6	1,042.7	200.0 1/	1,624.6 2/
72	561.3	378.8	940.1	--	--
73	452.3	492.1	944.4	--	--
74	--	--	--	--	--
75	767.7	704.6	1,472.3	--	--

1/ Salmon-steelhead anglers and angler days.
2/ Salmon angler days.

Source: 1967-68 data, Mich. Dept. Nat. Resour. (1970); 1969 data, Jamsen and Ellefson (1971); 1970-71 catch data and 1971 effort data, Jamsen (1973); 1970 effort data, Ellefson and Jamsen (1971); 1972-75 data, personal communication, Mich. Dept. Nat. Resour., 1976.

MICHIGAN -- SALMON SPORT FISHERY

A HELPING HAND



Netting a salmon in Lake Michigan

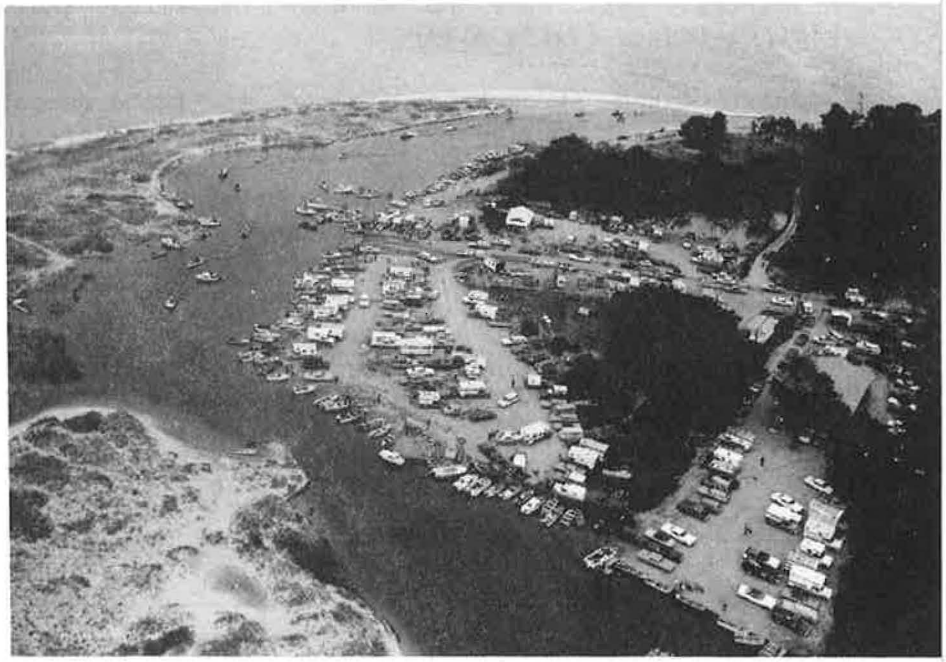
RETURNING HOME

Salmon sport fishing boats returning to Manistee from Lake Michigan

(Photos: Mich. Dept. Nat. Resour.)

MICHIGAN -- SALMON SPORT FISHERY

LAUNCH SITE



Salmon sport fishing boats at Platte River

COMPANIONS WITH PRIZE

Taking a photo of a successful outing

(Photos: Mich. Dept. Nat. Resour.)

6.3.2.3 Kokanee Salmon Sport Fishery

The kokanee salmon is the lacustrine, or land-locked, variety of sockeye salmon. Although recent information on the kokanee sport fishery is lacking, past data on several fisheries indicate its magnitude and significance (Table 6.13).

Sport catch of kokanee salmon in Idaho ranged between 358,900 and 809,000 fish during the period where data are available. Angler trips ranged between 39,600 and 72,600 trips. In California a sport catch of 58,500 kokanee from Lake Arrowhead was reported for 1958. In British Columbia, a catch of 352,900 kokanee salmon by 37,800 anglers was reported for the 1969/70 season.

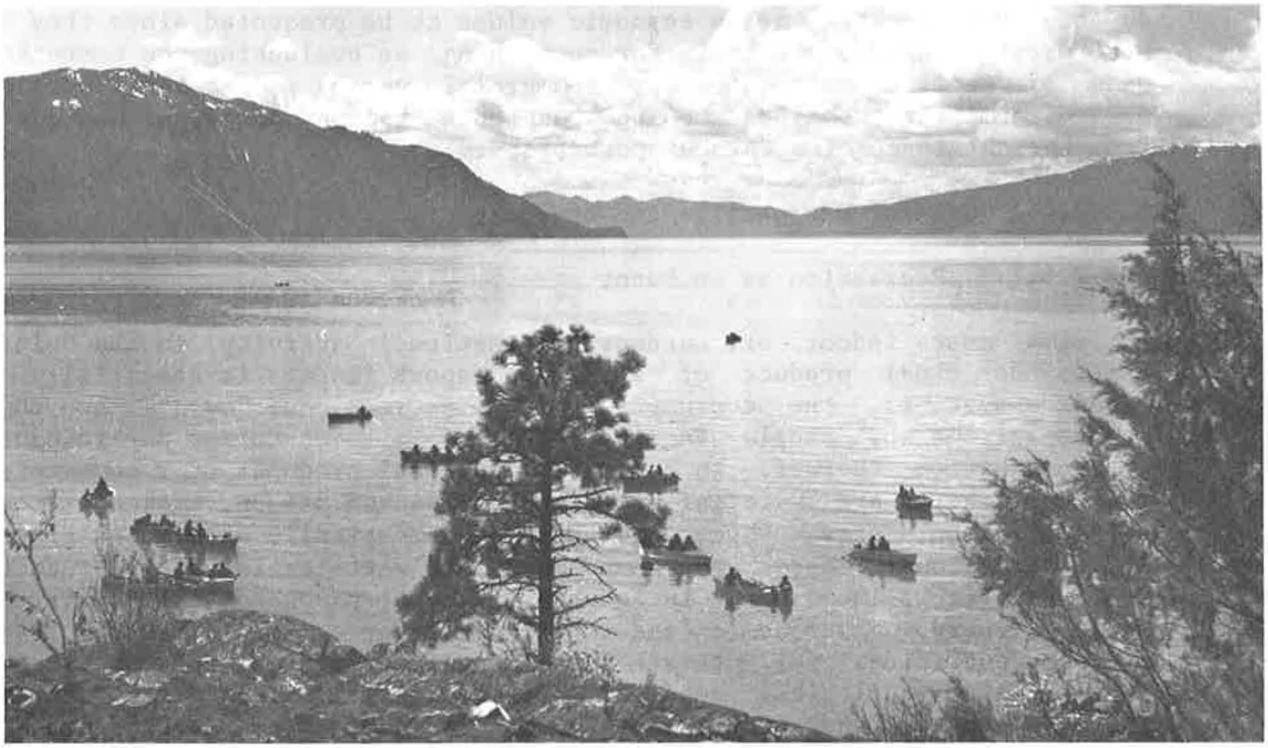
Table 6.13.--Partial information on catch and effort for selected kokanee sport fisheries, 1951-69.

	Idaho Pend Oreille Lake		California Lake Arrowhead	British Columbia		
Year	Angler trips	Catch	Catch	No. of anglers	Angler trips	Catch
	(Thousands)					
1951	--	650.0	--	--	--	--
52	--	451.8	--	--	--	--
53	--	794.9	--	--	--	--
54	72.6	689.4	--	--	--	--
55	49.4	410.1	--	--	--	--
56	65.0	663.4	--	--	--	--
57	52.8	534.0	--	--	--	--
58	67.4	723.9	58.5	--	--	--
59	54.3	809.1	--	--	--	--
1960	52.7	597.6	--	--	--	--
61	59.9	562.4	--	--	--	--
62	39.6	358.9	--	--	--	--
63	51.4	674.0	--	--	--	--
64	--	--	--	--	--	--
65	--	--	--	--	--	--
66	--	--	--	--	--	--
67	--	--	--	--	--	--
68	--	--	--	--	--	--
69	42.9	494.4	--	37.8	352.9	977.0

Source: Idaho data--Idaho Fish Game Dept (1952-54, 1970); Mallet (1965).
California data--Beland (1961).
British Columbia data--Dept. Recr. Conser. 1971, personal communication.

IDAHO -- KOKANEE SALMON SPORT FISHERY

LAKE PEND OREILLE
Site of and setting for diversion from the
more mundane activities of day-to-day life



(Photos: Idaho Dept. Fish and Game)

6.3.2.4 Salmon Sport Fishery Values

Methods and procedures for valuing a recreational activity such as salmon sport fishery and fishing are still in developmental stages. Therefore, only a general treatment will be made on this subject based on the approach and analysis contained in Appendix 36. Caution is advised on the use of the gross economic values to be presented since they do not provide an adequate basis for such things as evaluating the competing uses of Pacific salmon (e.g., commercial versus recreational use) or for determining benefits to the nation, a region, state, or community from the existence of a salmon sport fishery.

6.3.2.4.1 General Perspective and Approach

6.3.2.4.1.1 Recreation as an Event

As with most indoor or outdoor recreational activity in the United States the final product of a salmon sport fishery is essentially an "event"--that is, the consumption of a recreational "event", and thus an experience by people in the form as a spectator or participant, or combination thereof. In contrast, the final products of a commercial salmon fishery are material goods such as canned salmon, smoked salmon, salted salmon, etc., which are consumed domestically as well as placed in international trade. The human needs and wants satisfied by products from Pacific salmon are, in general, social-psychological for salmon sport fishery, gastronomic (and nutritional) for commercial salmon fishery, and nutritional for subsistence salmon fishery. Along with satisfying the social-psychological need, a sport-caught salmon would also satisfy the gastronomic and nutritional needs if the salmon is retained and consumed by the sport angler.

Although the final product of salmon sport fishing is that event where the actual fishing takes place, the activities preceeding and following it are equally pertinent.

6.3.2.4.1.2 Recreation as a Whole Experience

In his approach to the field of outdoor recreation, Clawson (1963, 1965) regarded as basic the concept of the whole recreation experience. He stated that almost every outdoor recreation experience included five rather well-defined phases,

1. Anticipation, or planning
2. Travel to the site
3. On site (fishing for salmon in the case of this report)
4. Travel back
5. Recollection

and each is essential to the whole. All of the costs of the whole experience must be balanced against all the satisfactions.

Basic values underlying the whole recreational experience are assumed as social-psychological. Interwoven with these values are economic considerations.

6.3.2.4.1.3 Social-Psychological Values

In each phase of the whole recreation experience, a complex set of social values underlie the satisfactions pursued and experienced. For example, the salmon sport fishing event (on-site phase of Clawson) would involve complex social value-satisfaction sets of:

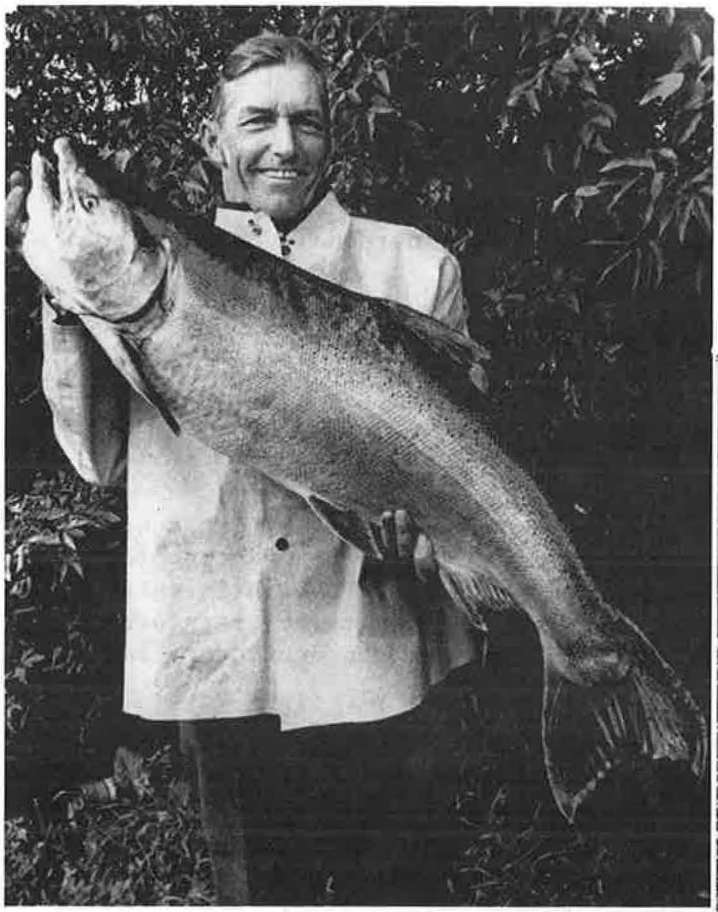
--Catching a trophy-size salmon
--Catching the limit
--Catching a delictable fresh salmon(s) for personal consumption or to share with relatives and friends
--Thrill of the strike
--Thrill of the contest in landing the salmon
--Solitude
--Companionship
--Enjoying the scenery
--Being outdoors
--etc.

These exist in various degrees of emphasis and priority between people. Of course, some degree of dissatisfaction would result if the anticipated experience is not realized--but then this may, paradoxically, reinforce the anticipation of realizing the satisfaction on the next trip, and the next,---.

The expression of social-psychological values in economic terms is generally available in most "marketed" recreational activity (indoor and outdoor). It is with a "non-marketed" type of recreational activity such as salmon sport fishing, however, where difficulty is encountered as far as economic valuations are concerned. The rationale and approach underlying the gross economic values for salmon sport fishery developed in this report follows.

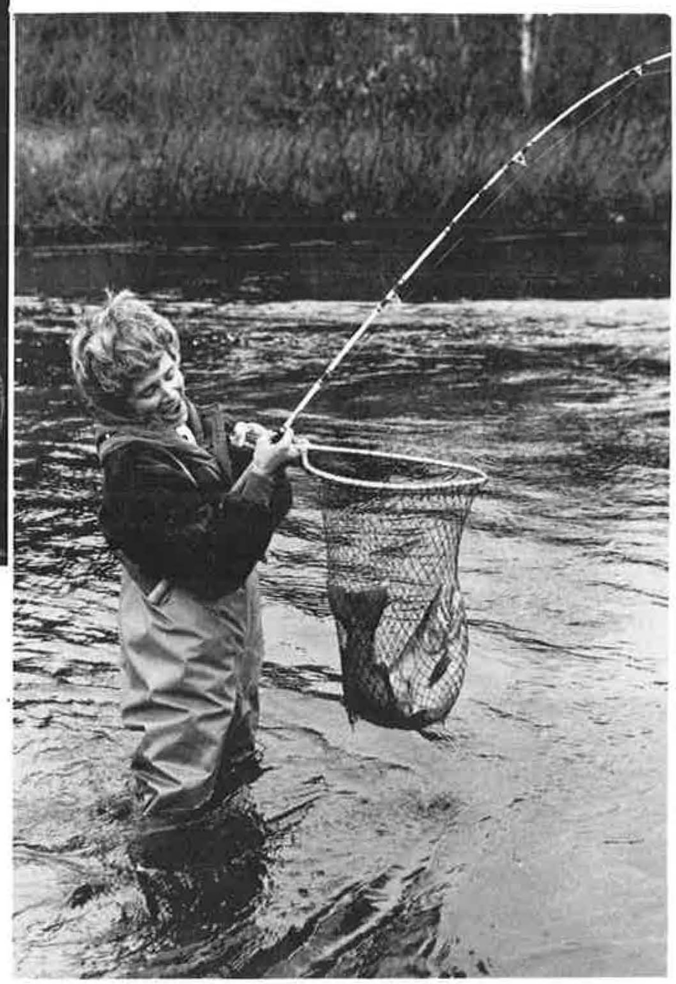
VALUES AND EXPECTATIONS -- THE MICHIGAN EXPERIENCE

TROPHY



Near record coho salmon (30 lb, 8 oz) taken in Traverse Bay. (Photo: Dann Perszyk, Traverse City Record Eagle)

HAPPINESS IS



Stream fishing for salmon (Photo: Mich. Dept. Nat. Resour.)

6.3.2.4.1.4 Economic Values

The implied value of socio-economic activities in this report is viewed in terms of the consumer and the monetary price he is assumed to be willing to pay for goods and services connected with the consumption of a final product. Four examples (taken from Appendix 36) are given in Table 6.14 to illustrate this approach. The first three are examples of marketed products, and the last is an example of a "non-marketed" product.

Final products of the first activity in Table 6.14, commercial salmon fishery, are material goods--canned salmon, smoked salmon, etc. These are produced and distributed through the private sector of our economy and, thus marketed to satisfy the gastronomic experience of the consumer. For salmon products consumed in the United States, the primary economic value indicator of the final product is retail price. Included in the retail price is the price of other goods and services that went into making the product available such as labor and materials in harvesting and processing, transportation, storage, brokerage, etc. Since the final consumptive act (eating) would most probably take place either at home or at a restaurant, the gross economic value should include not only the retail price of the product but also the price of other goods and services related to its consumption such as transportation to and from, say, the fish market, restaurant, the price of energy used in baking the salmon, etc. However, since these salmon products are extensively marketed, the above mentioned price for other goods and services on personal transportation, etc., would probably be negligible if not difficult to ascertain. Although not indicated in Table 6.14, the primary value indicator of salmon products exported by the United States would be the export value (or price).

Table 6.14.--A typology on some socioeconomic activities and valuations.

Activity	Resource type	Final product	Allocation 1/	Consumption aspect: Experience	Consumption aspect: Action	Primary economic value indicator of the product	Other economic value indicators, re: to final consumptive act
Commercial salmon fishery	Natural	Canned salmon Smoked salmon Fresh salmon etc. (material good)	Marketed	Gastronomic	Consumptive	Retail price	Price of goods and services related to personal transportation to and from the retail outlet
Professional football	Human	Athletic contest (event)	Marketed	Social-psychological	Spectator	Admission price	(A) Price of goods and services related to personal transportation (and lodging) needs to and from the source of the final product
Trip to Disneyland	Man-made	Entertainment (event)	Marketed	Social-psychological	Spectator-participatory	Admission price plus facility-use price	Ditto (A)
Sport salmon fishery	Natural	Fishing (event)	Non-marketed	Social-psychological	Participatory	(Net economic value)	Ditto (A) + (B) Price of goods and services related to the participatory aspects in consuming the final product

1/ "Marketed" = primarily through private enterprise, or private sector of our economy. "Non-marketed" = largely through our public sector.

Source: Appendix 36.

In contrast to commercial salmon fishing activities, the remaining examples in Table 6.14 are related to activities where the final products are "events" rather than material goods. Professional football and a trip to Disneyland are examples of marketed recreation products, while salmon sport fishing is essentially a non-marketed product.

Professional football is an activity using human resources to arrive at a final product which is an athletic contest (Table 6.14). It is marketed and satisfies the social-psychological experience of the consumer through his consumptive action as a spectator. The primary economic value indicator of this final product is represented by the admission (ticket) price to the stadium--the stadium being Clawson's (1965) on-site phase of a whole recreation experience. Since the final product is not extensively distributed and made available (televised games excepted) as in material goods such as canned salmon, clothing, shoes, etc., other relevant economic values needed to determine the gross value related to this product would essentially be the price of goods and services related to personal transportation (and lodging) to and from the source of the final product--the athletic arena where the final consumptive act takes place. This generally relates to the other phases (planning, travel to, travel back, etc.) of the whole recreation experience.

A trip to Disneyland is presented as an example where both admission and facility-use prices are placed on the final product (Table 6.14). It is an activity where the final product is marketed entertainment with consumptive action carried out on the part of the consumer as both a spectator and participant. The primary economic value indicator of this final product is the admission price (to the grounds) plus facility-use price (for rides, etc.). Other relevant economic values would be the price of goods and services related primarily to personal transportation (and lodging) to and from Disneyland.

Thus far, what was shown for recreation activities were marketed final products in the form of events. A price was associated with each event such as price per football game, price per day at Disneyland, and price per separate facility used at Disneyland. The final example in Table 6.14, salmon sport fishing, is essentially a non-marketed public product and, therefore, an event devoid of a market price. In its place economists have introduced the term "net economic value." For recreational fishing according to Brown et al (1964),

> "Net economic value' will be our best estimate of the monetary value of the sport fishery resource which might exist if the resource were owned by a single individual, and a market existed for the opportunity to fish for salmon and steelhead. This net economic value would approximate the value of the resource to a single owner who could charge sport anglers for his permission to fish for salmon and steelhead.
>
> The advantage of the above definition of net economic value is that it comes closest to imputing a value to the fishery resource comparable to what its value might be if it were privately owned."

The final product of the salmon sport fishery activity is fishing. More appropriately, a day, or half-a-day, or hours of fishing (or trip). As indicated in the table this final product is "non-marketed" in the United States. It satisfies the social-psychological experience of the consumer primarily through the consumptive action of participation. If a salmon is caught and consumed by the sportsman, then his gastronomic and nutritional experiences would also be satisfied. The primary economic value indicator of the final product is "net economic value" expressed on a per-day or -trip basis. For example, Brown et al (1976) estimated a net economic value (in terms of 1974 dollars) of $22.00 per day for salmon and steelhead sport fishing in Oregon. Other economic values would be the price of goods and services related to personal transportation (and lodging) to the fishing sites as well as the price of goods and services related to the participatory aspects in consuming the final product by an individual (e.g., purchase or rental price of boat, fishing gear, bait, etc.).

Economic values of the U.S. Pacific coast salmon sport fishery will be represented by three estimates: (1) gross expenditure value--that is, the estimated amount spent by salmon anglers on durable and non-durable goods and on services to pursue salmon sport fishing; (2) gross "net economic value"--that is, the total implied "admission"-type value; and (3) aggregate value--the sum of expenditure and "net economic" values.

6.3.2.4.2 Salmon Sport Fishery Value

In 1974, approximately $104.8 million was estimated as spent by consumers (anglers) in pursuit of salmon sport fishing in Washington, Oregon, Idaho, and California (Appendix 36, Table 4). The Alaska, Great Lakes and kokanee salmon sport fisheries are not included in this estimate. Again, caution is advised in the interpretation and use of this estimate which is based on expenditures only--for transportation, lodging, fishing equipment, charter boat fee, etc. For example, if the salmon resource was to decline, disappear, or be closed to sport fishing, then part or all of the money (especially the current or variable type expenditures) previously spent on salmon sport fishing would be used for other purposes by the consumers. Thus, value is not lost but transferred. However, the importance of these expenditures cannot be denied since many people, industries, and communities depend on it for their economic well-being. For example, a total of 425 sport fishing charter vessels was reported for the state of Washington in 1976. Crutchfield and Schelle (1977) estimated that the charter fleet realized a gross revenue of $12.0-13.4 million from the estimated 443,387 passengers (salmon angler trips) of 1976. They also estimated that the present value of all capital invested in Washington's charter fleet as of 1976 was $27.3 million. Phase II of their study will examine, among other factors, the impact of the charter fleet on the economy and employment in local communities.

The imputed net economic value of the Washington, Oregon, Idaho and California salmon sport fishery in 1974 was approximately $58.6 million (Appendix 36, Table 4). Although hypothetical, this estimate represents the economic yield of the Pacific salmon sport fishery and a measure of the annual monetary loss to society if the fishery were lost (this is the amount by which our society would be worse-off).

Viewed in terms of a whole recreation experience and in national perspective, the implied on-site admission, or gross net economic value of $58.6 million, and the gross expenditure value of $104.8 million, total up to a $163.4 million aggregate for the U.S. Pacific coast salmon sport fishery (excluding Alaska) in 1974.

6.3.3 Subsistence Salmon Fishery

The use of Pacific salmon for subsistence purpose predates commercial and recreational uses. In Canada and the United States subsistence salmon catch still plays an important role in the culture and well-being of many native Indian communities. Information on the status of this fishery on the Asian side of the Pacific Ocean is not available.

More recent information (1970-73) shows a Canadian subsistence salmon catch (British Columbia and Yukon Territory) of approximately 409,000 fish annually (1,274 mt or 2.8 million pounds), and a United States (Alaska only) catch of approximately 707,000 fish (2,683 mt or 5.9 million pounds) (Table 6.15). The United States catch is a minimum estimate since information on this fishery is not available for Washington, Oregon and California.

In terms of weight the Canadian catch was comprised largely of sockeye salmon (58%) followed by chum, chinook, coho and pink. The Alaska catch was predominantly chum salmon (58%) followed by chinook, sockeye, coho and pink.

Table 6.15.--Subsistence salmon catch by country and species, 1970-73.

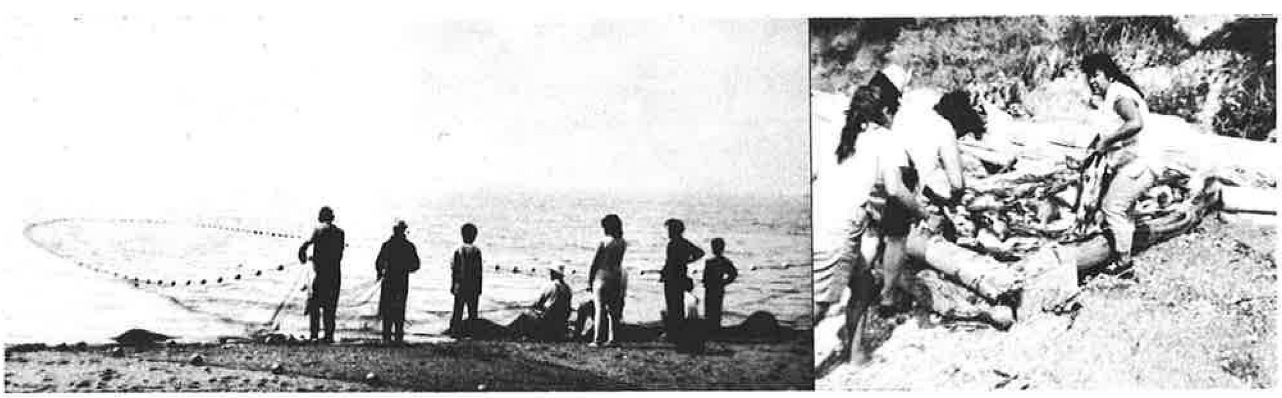
Country	Year	Species: Sockeye	Pink	Chum	Coho	Chinook	Total
		--(numbers of fish)--					
CANADA1/ (British Columbia and Yukon Territory)	1970	255,109	32,696	47,966	35,677	28,504	399,952
	1971	283,918	45,745	42,378	35,162	22,082	429,285
	1972	235,911	14,507	54,730	33,896	27,747	366,791
	1973	289,493	55,996	49,769	23,633	20,597	439,488
	Average (1970-73)						
	In numbers--	266,108	37,236	48,711	32,092	24,732	408,879
	In metric tons2/--	735	71	233	102	133	1,274
	In pounds--	1,620,381	156,527	513,672	224,869	293,212	2,808,661
UNITED STATES Washington, Oregon and California		--No data available--					
Alaska1/	1970	218,819	11,730	602,959	11,783	95,878	941,169
	1971	172,413	10,496	417,655	9,974	75,377	685,915
	1972	135,744	21,804	305,731	11,051	68,539	542,869
	1973	113,738	6,417	455,572	9,539	71,953	657,219
	Average (1970-73)						
	In numbers--	160,178	12,612	445,479	10,587	77,937	706,793
	In metric tons2/--	447	20	1,548	36	632	2,683
	In pounds--	985,466	44,092	3,412,721	79,366	1,393,307	5,914,952
JAPAN		--No data available--					
U.S.S.R		--No data available--					

1/ Source: Int. North Pac. Fish. Comm. (1972-75).
2/ Converted to weight on the basis of average weight per fish (by year and species) estimated from Tables 1 and 2 in INPFC Statistical Yearbooks, 1970-73 (Int. North Pac. Fish. Comm. 1972-75).

A study by Regnart and Geiger (1974) on the native salmon fishery in the northwest region of Alaska showed a minimum total catch during 1961-67 of 4.4 million salmon for subsistence purposes compared to a commercial catch of 1.5 million. The major portion of the subsistence catch was sun-dried or smoked for later consumption, while the head and viscera of the salmon were fed to sled dogs. Information on product forms and disposition of subsistence salmon catch in other areas of the United States and Canada is not readily available.

U.S. SUBSISTENCE SALMON FISHERY

Drying salmon at a native village, Kuskokwim, Alaska (Photo: Scudder, USFWS)

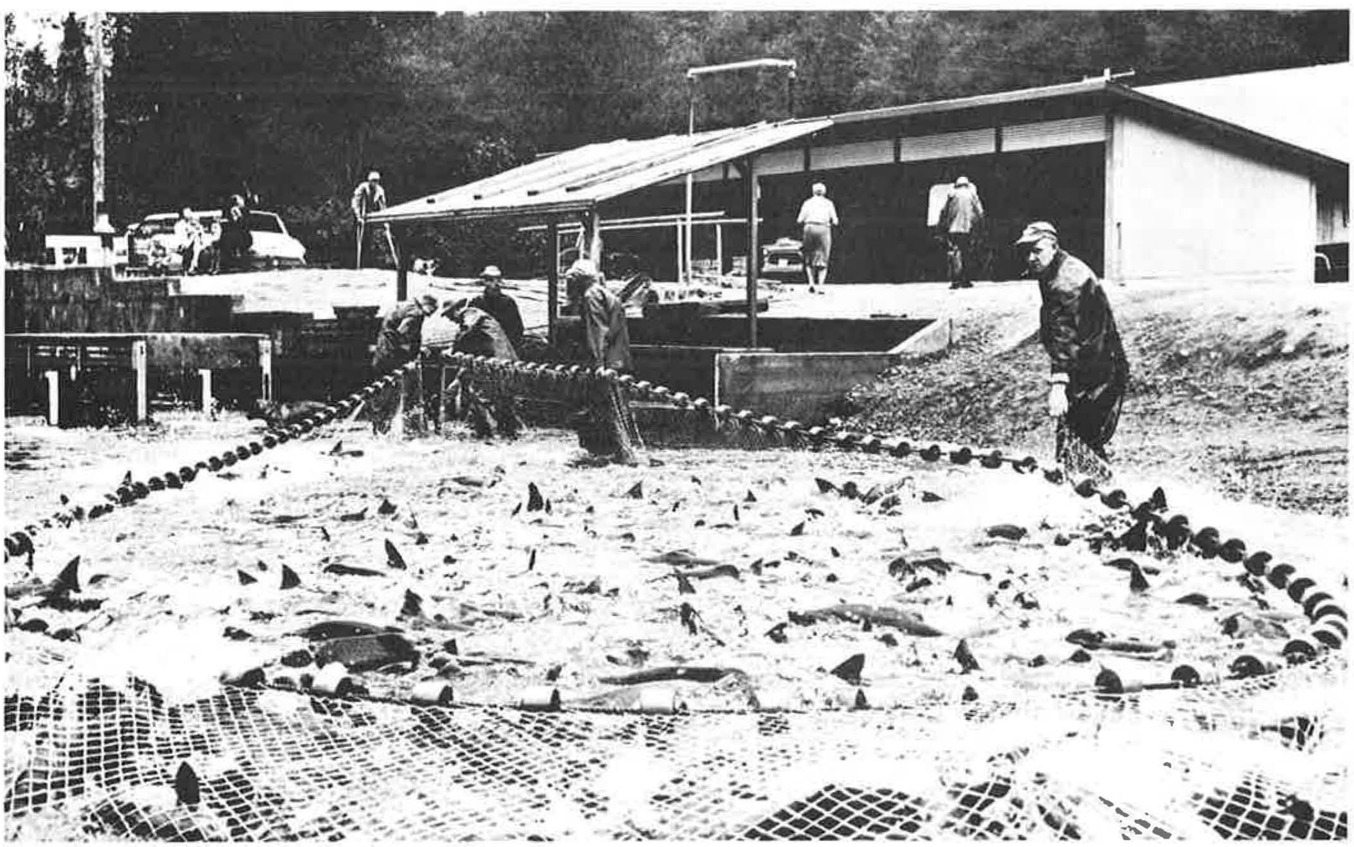


Beach seining for salmon, Washington State (Photo: Wash. Dept. Fish.)

6.3.4 Pacific Salmon Resource and Aesthetics

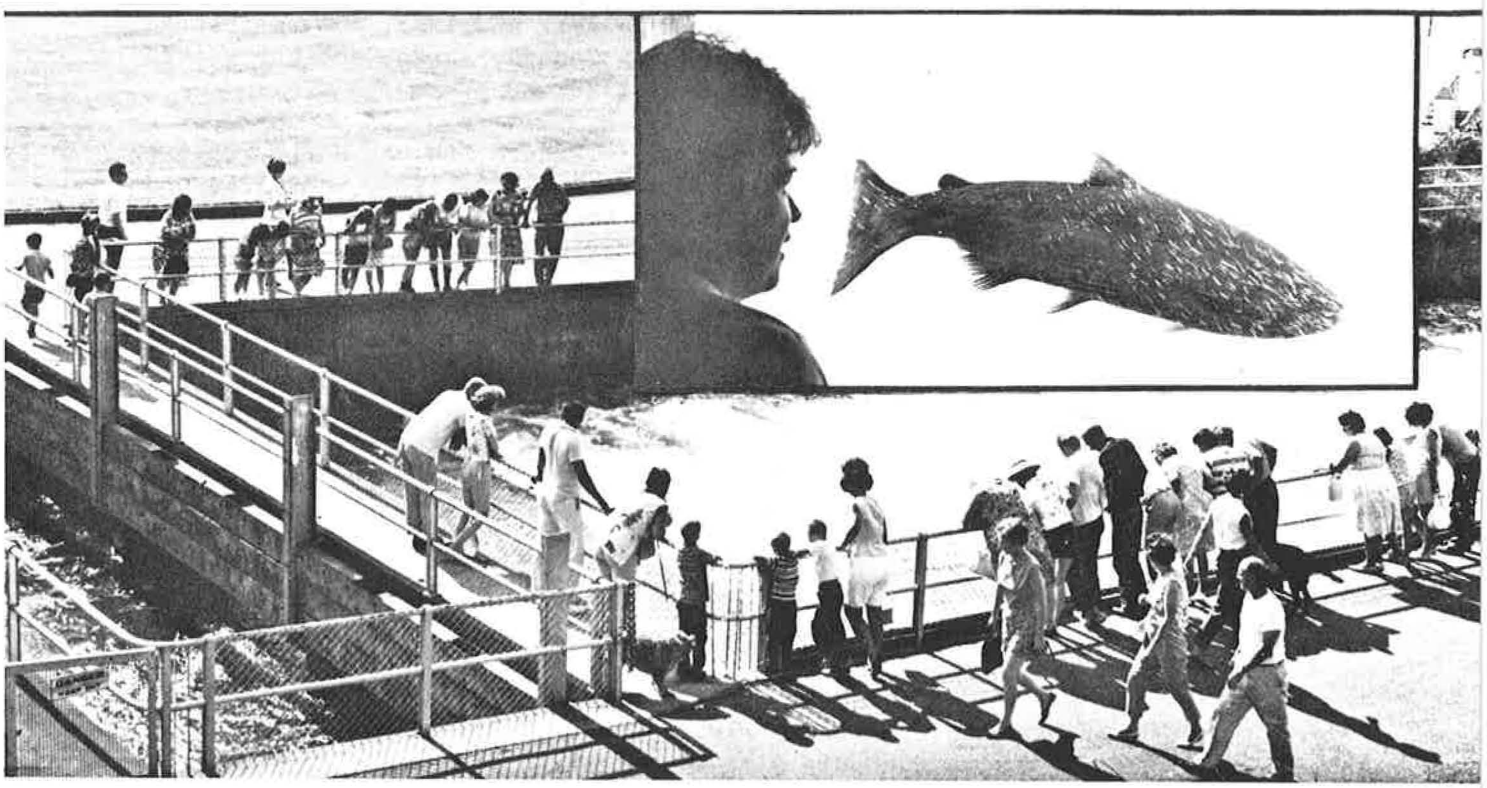
The Pacific salmon resource not only maintains valuable commercial, sport, and subsistence fisheries but also provides aesthetic enjoyment especially to people living in or visiting the Pacific coast of the United States and Canada where nearly 4,500 salmon streams and lakes are located. The anadromous nature of salmon, their observable return through many obstacles to their native streams and lakes to spawn and finally die, the millions of people, annually, who view salmon in fishways, at hatcheries and spawning grounds, etc., all combine to impart a degree of social-psychological impact probably not found with any other fishery resource in the United States (Ebel et al 1975).

COLLECTING SALMON SPAWNERS AT A HATCHERY



(Photo: Wash. Dept. Fish.)

PEOPLE WATCHING SALMON AT A WATERFALL AND AT A FISH PASSAGE FACILITY



(Photos: Upper--Wash. Dept. Fish.; Lower--U.S. Army Corps Engin. and Chelan County PUD)

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8.0 APPENDIX

APPENDIX 1

SOURCES OF INFORMATION ON THE CATCHES OF PACIFIC SALMON BY THE COMMERCIAL FISHERIES OF CANADA, JAPAN, UNITED STATES AND THE U.S.S.R., 1952-75

1.0 Canada

1.1 Annual catch in metric tons, by species:

1952-71: Table 63, INPFC ms.[1/]

1972-75: Table 2, INPFC Statistical Yearbooks.[2/]

1.2 Annual catch in number of fish, by species:

1952-71: Table 62, INPFC ms.

1972-75: Table 1, INPFC Statistical Yearbooks

2.0 Japan

2.1 Mothership Fisheries

2.1.1 Annual catch in metric tons, by species:

1952-71: Table 51, INPFC ms.

The 1955-58 statistics include catches by a mothership fishery which operated in the Okhotsk Sea during those years. Tonnages landed by the Okhotsk Sea fishery are combined with the landings by the North Pacific mothership fishery (which has operated in the Pacific Ocean and Bering Sea). Estimates of the tonnages taken by each of the mothership fisheries in 1955-58 can be obtained by prorating the combined catch according to numbers of fish taken by the two fisheries (see Section 2.1.2.1).

1972-75: Table 2, INPFC Statistical Yearbooks

1/ The manuscript, "Historical catch statistics for salmon of the North Pacific Ocean," will be published as an INPFC Bulletin in the near future.

2/ The 1975 Statistical Yearbook is in press.

2.1.2 Catch in number of fish, by species.

2.1.2.1 Annual totals.

1952-71: Table 52, INPFC ms.

Catches in 1955-58 are reported separately for the Okhotsk Sea and North Pacific mothership fisheries and can be used to estimate the tonnages of salmon landed by the two fisheries in those years.

1972-75: Table 1, INPFC Statistical Yearbooks.

2.1.2.2 Catch by 2^o x 5^o statistical area and 10-day period.

1952-59: Manzer et al, App. D, INPFC Bull. 15 (1965).

1960-67: Table 9, INPFC Statistical Yearbooks.

1968-69: Table 10, INPFC Statistical Yearbooks.

1970-75: Table 13, INPFC Statistical Yearbooks.

2.2 Landbased Offshore Driftnet Fishery

2.2.1 Catch in metric tons, by species.

2.2.1.1 Annual totals.

As indicated in footnotes to Table 53 of the manuscript, the statistics for 1952-57 differ from those for 1958-71 in two respects. First, the 1952-57 data include catches by the coastal gillnet fishery (CGN) as well as the landbased offshore driftnet fishery (LBDN) whereas the 1958-71 statistics are for the latter fishery only. Second, the 1952-57 statistics are for two species categories--pink and masu combined, and sockeye, chum, coho and chinook combined--but the 1958-71 statistics are separated by species. To bring the 1952-57 data into conformity with the 1958-71 statistics, the catch of each species of salmon by the LBDN fishery during the earlier years is estimated as follows:

a. For each of the two species categories, the percentages of the catches taken by the LBDN fishery during 1958-69 are calculated from the combined catches by that fishery and the CGN fishery. The calculations are given in Appendix Table 1.1.

b. Catches of each of the two species categories by the LBDN fishery in 1952-57 are estimated by applying the average percentages taken by that fishery during 1958-69 to the combined catches by the LBDN and CGN fisheries in 1952-57. The estimates are given in Appendix Table 1.2.

c. Species composition of the catches of sockeye, chum, coho and chinook salmon by the LBDN fishery in 1952-57 is assumed to be the same as the composition of the combined catch of the four species by that fishery during 1958-69: 7.5% sockeye, 73.1% chum, 17.3% coho and 2.1% chinook (Table 53, INPFC ms). Applying these percentages to the catches shown in Appendix Table 2.2 provides estimates of the catch of each of the four species in 1952-57. As for pink and masu, it is assumed that no masu were caught by the LBDN fishery. The estimates of annual catches of the five species in 1952-57 are given in Appendix Table 1.3.

Appendix Table 1.1.--Catches of salmon by the Japanese landbased offshore driftnet (LBDN) and coastal gillnet (CGN) fisheries, in metric tons, 1958-69.[a/]

Year	Fishery	Data source	Sockeye, Chum, Coho and Chinook		Pink and Masu	
			Catch	% by Fishery	Catch	% by Fishery
1958	LBDN + CGN	Table 16, 1959 INPFC Stat. Yearbook	24,642		49,985	
	LBDN	Table 53, INPFC MS (1974)	23,123	93.8	36,256	72.5
	CGN	From above	1,519	6.2	13,729	27.5
1959	LBDN + CGN	Table 14, 1960 INPFC Stat. Yearbook	24,257		60,317	
	LBDN	Same as 1958	23,913	98.6	48,302	80.1
	CGN	From above	344	1.4	12,015	19.9
1960	LBDN + CGN	Table 14, 1961 INPFC Stat. Yearbook	25,461		42,005	
	LBDN	Same as 1958	25,406	99.8	28,080	66.8
	CGN	From above	56	0.2	13,925	33.2
1961	LBDN + CGN	Table 14, 1962 INPFC Stat. Yearbook	19,138		55,891	
	LBDN	Same as 1958	18,910	98.8	49,316	88.2
	CGN	From above	220	1.2	6,575	11.8
1962	LBDN + CGN	Table 14, 1963 INPFC Stat. Yearbook	19,282		23,326	
	LBDN	Same as 1958	18,468	95.8	17,106	73.3
	CGN	From above	814	4.2	6,220	26.7
1963	LBDN + CGN	Table 14, 1964 INPFC Stat. Yearbook	20,764		41,379	
	LBDN	Same as 1958	20,159	97.1	35,818	86.5
	CGN	From above	605	2.9	5,561	13.5
1964	LBDN + CGN	Table 11, 1964 INPFC Stat. Yearbook	21,322		24,028	
	LBDN	Same as 1958	21,286	99.8	19,972	83.1
	CGN	From above	36	0.2	4,056	16.9
1965	LBDN + CGN	Table 11, 1965 INPFC Stat. Yearbook	21,426		38,012	
	LBDN	Same as 1958	20,612	96.2	32,319	85.0
	CGN	From above	814	3.8	5,693	15.0
1966	LBDN + CGN	Table 11, 1966 INPFC Stat. Yearbook	26,661		23,428	
	LBDN	Same as 1958	25,887	97.1	18,677	79.7
	CGN	From above	784	2.9	4,751	20.3
1967	LBDN + CGN	Table 11, 1967 INPFC Stat. Yearbook	26,563		30,280	
	LBDN	Same as 1958	26,155	98.5	25,517	84.3
	CGN	From above	408	1.5	4,763	15.7
1968	LBDN + CGN	Table 12, 1968 INPFC Stat. Yearbook	24,445		27,285	
	LBDN	Same as 1958	23,161	94.8	19,937	73.1
	CGN	From above	1,284	5.2	7,348	26.9
1969	LBDN + CGN	Table 12, 1969 INPFC Stat. Yearbook	20,980		34,651	
	LBDN	Same as 1958	20,231	96.4	27,293	78.8
	CGN	From above	749	3.6	7,358	21.2
Average Percentages						
	LBDN			97.2		74.8[b/] 83.8[c/]
	CGN			2.8		25.2[b/] 16.2[c/]

a/ Combined catches by the LBDN and CGN fisheries after 1969 are not given in the INPFC Statistical Yearbooks.
b/ Even-numbered years.
c/ Odd-numbered years.

Appendix Table 1.2.--Estimates of catches of salmon by the Japanese landbased offshore driftnet (LBDN) and landbased coastal gillnet (CGN) fisheries, in metric tons, 1952-57.

Year	Sockeye, Chum, Coho and Chinook					Pink and Masu				
	Total catch, LBDN + CGN[a/]	Est. percent[b/] LBDN	CGN	Est. catch LBDN	CGN	Total catch, LBDN + CGN[a/]	Est. percent[b/] LBDN	CGN	Est. catch LBDN	CGN
1952	1,834	97.2	2.8	1,783	51	21,765	74.8	25.2	16,280	5,485
1953	3,956	"	"	3,845	111	14,952	83.8	16.2	12,530	2,422
1954	7,125	"	"	6,925	200	14,993	74.8	25.2	11,215	3,778
1955	10,582	"	"	10,286	296	32,605	83.8	16.2	27,323	5,282
1956	5,611	"	"	5,454	157	35,122	74.8	25.2	26,271	8,851
1957	10,102	"	"	9,819	283	44,190	83.8	16.2	37,031	7,159

a/ Data are from Table 53, INPFC ms.
b/ Data are from Appendix Table 1.1.

Appendix Table 1.3.--Estimates of catches of salmon by the Japanese landbased offshore driftnet fishery, in metric tons by species, 1952-57.

Year	Sockeye, chum, coho and chinook[b/]									Pink
	Est. total catch[a/]	Sockeye Est. %	Est. catch	Chum Est. %	Est. catch	Coho Est. %	Est. catch	Chinook Est. %	Est. catch	Est. total catch[a/]
1952	1,783	7.5	134	73.1	1,303	17.3	309	2.1	37	16,280
1953	3,845	"	288	"	2,811	"	665	"	81	12,530
1954	6,925	"	519	"	5,062	"	1,198	"	146	11,215
1955	10,286	"	771	"	7,519	"	1,780	"	216	27,323
1956	5,454	"	409	"	3,987	"	944	"	114	26,271
1957	9,819	"	736	"	7,178	"	1,699	"	206	37,031

a/ Data are from Appendix Table 1.2.
b/ Species composition is estimated from catch statistics during 1958-69 (Table 53, INPFC ms).

<u>1972 and 1974</u>: Dr. Y. Yabuta, Fisheries Agency of Japan (personal communication).

Dr. Yabuta has provided the following catch data for 1972 and 1974:

Species	Catch in m.t.[3/] 1972	1974
Sockeye	5,626	4,222
Pink	21,199	15,462
Chum	16,759	20,275
Coho	6,120	7,156
Chinook	558	936
Total	50,262	48,051

<u>1973 and 1975</u>: Table 2, INPFC Statistical Yearbooks.

2.2.1.2 Catch by large vessels east and west of 165°E in 1962 and 1970-75.[4/]

<u>1962</u>: INPFC Secretariat (correspondence dated October 21, 1963).

<u>1970-75</u>: Table 15, INPFC Statistical Yearbooks.

2.2.1.3 Catch by large vessels by $2^{\circ} \times 5^{\circ}$ statistical area and month in 1962 and 1974-75.[4/]

<u>1962</u>: INPFC Secretariat (correspondence dated October 21, 1963).

<u>1974-75</u>: Fisheries Agency of Japan (processed reports filed with INPFC).

3/ The catches reported by Dr. Yabuta are greater than the catches given in the 1972 and 1974 INPFC Statistical Yearbooks. The latter do not include catches by small vessels in the fishery whereas Dr. Yabuta's figures are for all vessels (large and small) in the fishery.

4/ No data have been provided to INPFC for other years.

2.2.2 Catch in number of fish, by species

2.2.2.1 Annual totals, 1952-75.

The catches given in Appendix Table 2.3 for 1952-57, in Table 53, INPFC ms for 1958-71, by the Fisheries Agency of Japan for 1972, and in Table 2 of the INPFC Statistical Yearbooks for 1973-75 can be converted to numbers of fish using the average annual weights given in Appendix Table 1.4.[5/]

2.2.2.2 Catch by large vessels by $2^{\circ} \times 5^{\circ}$ statistical area and month in 1962 and 1974-75.

See Section 2.2.1.3.

2.3 Landbased Offshore Longline Fishery

2.3.1 Annual catch in metric tons, by species, 1952-71: Table 54, INPFC ms.

The landbased offshore longline fishery did not operate after 1971. As in the case of the landbased offshore driftnet fishery, the 1952-57 statistics for the longline fishery include landings by coastal vessels as well as offshore vessels. Additionally, the 1952-59 catches are reported for two species categories whereas the 1960-71 statistics are for individual species. To bring the data for the earlier years into conformity with the later data, catches by the landbased offshore longline (LBLL) and coastal longline/angling (CLL/A) fisheries in 1952-57 and the species composition of the catches during 1952-59 are made as follows:

5/ The reason for using this procedure for obtaining data on the numbers of fish caught by the landbased driftnet fishery rather than using the statistics reported in Table 1 of the Statistical Yearbooks is that the latter represent only the catches by the large vessels in the fishery.

Appendix Table 1.4.--Average weights of salmon caught by the Japanese landbased offshore driftnet fishery, in grams, 1952-75.a/ b/

Year	Sockeye	Pink	Chum	Coho	Chinook
1952-57	(1,508)	(1,220)	(1,904)	(2,444)	(4,688)
1958	(1,508)	1,460	2,140	(2,444)	(4,688)
1959	(1,508)	1,375	2,141	(2,444)	(4,688)
1960	(1,508)	1,395	2,196	(2,444)	(4,688)
1961	(1,508)	1,427	2,149	(2,444)	(4,688)
1962	1,347	1,220	1,813	3,072	4,522
1963	1,688	1,146	2,052	2,832	4,286
1964	1,524	1,158	1,792	2,618	4,197
1965	1,889	1,109	1,827	2,413	5,115
1966	1,288	1,165	1,754	2,482	5,067
1967	1,480	1,107	1,675	2,438	5,121
1968	1,428	1,254	1,813	2,415	5,036
1969	1,536	1,156	1,849	2,100	4,049
1970	1,634	1,242	1,971	2,185	4,315
1971	1,519	1,193	1,868	2,424	4,282
1972	1,513	1,206	1,866	2,526	5,204
1973	1,418	1,054	1,848	2,257	4,772
1974	1,337	1,072	1,618	2,010	4,978
1975	1,345	974	1,786	2,088	4,926

a/ Average weights are for salmon caught by the larger vessels in the LBDN fishery.

b/ Figures enclosed by parentheses are averages of annual weights in certain other years: 1962-74 for sockeye, coho and chinook and 1958-74 for pink. (Averages were calculated prior to the receipt of data for 1975.)

DATA SOURCES: Table 90, INPFC ms and Tables 11 and 15, 1972-75 INPFC Statistical Yearbooks.

a. For each of the two species categories (pink and masu combined and sockeye, chum, coho and chinook combined), the percentages of the catches taken by the LBLL fishery during 1958-69 are calculated from the combined catches by that fishery and the CLL/A fishery (Appendix Table 1.5).

b. Catches of each of the two species categories by the LBLL fishery in 1952-57 are estimated by applying the average percentages taken by that fishery during 1958-69 to the combined catches by the LBLL and CLL/A fisheries in 1952-57 (Appendix Table 1.6).

c. Species composition of the catches of sockeye, chum, coho and chinook salmon by the LBLL fishery in 1952-59 is assumed to be the same as the composition of the combined catch of the four species during 1960-69: 0.5% sockeye, 96.9% chum, 1.1% coho and 1.5% chinook (Table 54, INPFC ms). By applying these percentages to the catches shown in Appendix Table 1.6 and the 1958-59 catches (Table 54, INPFC ms), estimates of the catch of each of the four species in 1952-59 are obtained. With regard to pink and masu salmon, it is assumed that no masu have been taken by the LBLL fishery. The estimates of annual catches of the five species are given in Appendix Table 1.7.

2.3.2 Annual catch in numbers of fish, by species, 1952-71.

The catches given in Appendix Table 2.7 for 1952-59 and in Table 54, INPFC ms for 1960-71 can be converted to numbers of fish using the average annual weights given in Appendix Table 1.8.

Appendix Table 1.5.--Catches of salmon by the Japanese landbased offshore longline (LBLL) and coastal longline/angling (CLL/A) fisheries, in metric tons, 1958-69.[a]

Year	Fishery	Data source	Sockeye, chum, coho and chinook Catch	Sockeye, chum, coho and chinook % by fishery	Pink and Masu Catch	Pink and Masu % by fishery
1958	LBLL + CLL/A	Table 16, 1959 INPFC Stat. Yearbook	3,077		16,010	
	LBLL	Table 54, INPFC MS (1974)	2,736	88.9	7,139	44.6
	CLL/A	From above	341	11.1	8,871	55.4
1959	LBLL + CLL/A	Table 14, 1960 INPFC Stat. Yearbook	2,861		13,950	
	LBLL	Same as 1958	2,859	99.9	9,246	66.3
	CLL/A	From above	2	0.1	4,704	33.7
1960	LBLL + CLL/A	Table 14, 1961 INPFC Stat. Yearbook	3,898		14,457	
	LBLL	Same as 1958	3,679	94.4	5,534	38.3
	CLL/A	From above	219	5.6	8,923	61.7
1961	LBLL + CLL/A	Table 14, 1962 INPFC Stat. Yearbook	2,808		13,675	
	LBLL	Same as 1958	2,808	100.0	11,155	81.6
	CLL/A	From above	0	-	2,520	18.4
1962	LBLL + CLL/A	Table 14, 1963 INPFC Stat. Yearbook	2,881		13,159	
	LBLL	Same as 1958	2,876	99.8	10,157	77.2
	CLL/A	From above	5	0.2	3,002	22.8
1963	LBLL + CLL/A	Table 14, 1964 INPFC Stat. Yearbook	3,604		22,248	
	LBLL	Same as 1958	3,601	99.9	16,606	74.6
	CLL/A	From above	3	0.1	5,642	25.4
1964	LBLL + CLL/A	Table 11, 1964 INPFC Stat. Yearbook	3,264		9,657	
	LBLL	Same as 1958	3,263	100.0	7,290	75.5
	CLL/A	From above	1	+	2,367	24.5
1965	LBLL + CLL/A	Table 11, 1965 INPFC Stat. Yearbook	2,439		20,581	
	LBLL	Same as 1958	2,331	95.6	14,902	72.4
	CLL/A	From above	108	4.4	5,679	27.6
1966	LBLL + CLL/A	Table 11, 1966 INPFC Stat. Yearbook	3,944		18,149	
	LBLL	Same as 1958	3,835	97.2	10,843	59.7
	CLL/A	From above	109	2.8	7,306	40.3
1967	LBLL + CLL/A	Table 11, 1967 INPFC Stat. Yearbook	2,441		25,647	
	LBLL	Same as 1958	2,402	98.4	14,556	57.8
	CLL/A	From above	39	1.6	11,091	42.2
1968	LBLL + CLL/A	Table 12, 1968 INPFC Stat. Yearbook	1,503		12,783	
	LBLL	Same as 1958	1,471	97.9	6,308	49.3
	CLL/A	From above	32	2.1	6,475	50.7
1969	LBLL + CLL/A	Table 12, 1969 INPFC Stat. Yearbook	667		27,690	
	LBLL	Same as 1958	647	97.0	14,694	53.1
	CLL/A	From above	20	3.0	12,996	46.9
Average percentages						
	LBLL			97.4		57.4[b] 67.6[c]
	CLL/A			2.6		42.6[b] 32.4[c]

a/ Combined catches by the LBLL and CLL/A fisheries in 1970-71 are not given in the INPFC Statistical Yearbooks.
b/ Even-numbered years.
c/ Odd-numbered years.

Appendix Table 1.6.--Estimates of catches of salmon by the Japanese landbased offshore longline (LBLL) and landbased coastal longline/angling (CLL/A) fisheries, in metric tons, 1952-57.

Year	Sockeye, Chum, Coho and Chinook					Pink and Masu				
	Total catch[a/]	Est. percent[b/]		Est. catch		Total catch[a/]	Est. percent[b/]		Est. catch	
	LBLL + CLL/A	LBLL	CLL/A	LBLL	CLL/A	LBLL + CLL/A	LBLL	CLL/A	LBLL	CLL/A
1952	15	97.4	2.6	15	+	1,163	57.4	42.6	668	495
1953	4	"	"	4	+	649	67.6	32.4	439	210
1954	+	"	"	+	+	1,538	57.4	42.6	883	655
1955	59	"	"	57	2	1,211	67.6	32.4	819	392
1956	318	"	"	310	8	9,426	57.4	42.6	5,411	4,015
1957	1,728	"	"	1,683	45	14,887	67.6	32.4	10,064	4,823

a/ Data are from Table 54, INPFC ms.
b/ Data are from Appendix Table 1.5.

Appendix Table 1.7.--Estimates of catches of salmon by the Japanese landbased offshore longline fishery, in metric tons by species, 1952-59.

Year	Sockeye, Chum, Coho and Chinook[b/]									Pink
	Total catch[a/]	Sockeye		Chum		Coho		Chinook		Total catch[a/]
		Est. %	Est. catch	Est. %	Est. catch	Est. %	Est. catch	Est. %	Est. catch	
1952	15	0.5	+	96.9	15	1.1	+	1.5	+	668
1953	4	"	+	"	4	"	+	"	+	439
1954	+	"	+	"	+	"	+	"	+	883
1955	57	"	+	"	55	"	1	"	1	819
1956	310	"	2	"	300	"	3	"	5	5,411
1957	1,683	"	8	"	1,631	"	19	"	25	10,064
1958	2,736	"	14	"	2,651	"	30	"	41	7,139
1959	2,859	"	14	"	2,770	"	32	"	43	9,246

a/ Catches in 1952-57 are from Appendix Table 1.6, and 1958-59 catches are from Table 54, INPFC ms.
b/ Species composition is estimated from catch statistics for 1960-69 (Table 54, INPFC ms).

Appendix Table 1.8.--Average weights of salmon caught by the Japanese landbased offshore longline fishery, in grams, 1952-71.[a]

Year	Sockeye	Pink	Chum	Coho	Chinook
1952-57	(1,521)	(924)	(1,981)	(2,011)	(4,965)
1958	(1,521)	1,270	1,982	(2,011)	(4,965)
1959	(1,521)	1,016	1,872	(2,011)	(4,965)
1960	(1,521)	921	2,224	(2,011)	(4,965)
1961	(1,521)	989	2,068	(2,011)	(4,965)
1962	500	853	1,976	2,400	4,600
1963	1,000	941	1,959	3,125	9,333
1964	2,000	940	1,831	3,250	4,154
1965	3,000	822	1,929	1,000	3,889
1966	1,000	913	2,020	2,000	5,667
1967	1,000	796	1,944	1,000	6,000
1968	2,000	888	1,985	2,333	4,333
1969	(1,521)	832	2,108	1,500	4,000
1970	1,686	922	1,935	2,000	3,872
1971	1,500	848	1,900	1,500	3,800

a/ Figures enclosed by parentheses are averages of annual weights in other years: 1962-68 and 1970-71 for sockeye; 1958-71 for pink and chum; and 1962-71 for coho and chinook.

DATA SOURCE: Table 90, INPFC ms.

2.4 Coastal Fishery

The catches reported in the INPFC manuscript for Japan's coastal fishery include landings by fisheries in the Japan Sea as well as catches along the coast. Additionally, catches of masu salmon are included with pink salmon. Catch statistics reported in INPFC Statistical Yearbooks, on the other hand, separate the Japan Sea catches from catches along the coast and do not include masu salmon.

2.4.1 Annual catch in metric tons, by species.

1952-71: Table 55, INPFC ms and Fisheries Agency of Japan (personal communication).[6/]

The 1952-57 statistics given in Table 55 of the INPFC manuscript are incomplete because they do not include catches by the coastal gillnet or longline/angling fisheries. Estimates of total catches during these 6 years can be obtained, however, by adding (a) the catches derived for the coastal gillnet fishery in Appendix Table 1.2, (b) the catches shown for the coastal longline/angling fishery in Appendix Table 1.6, and (c) the catches given for traps and miscellaneous other gear in Table 55 of the INPFC manuscript. The resulting totals are given in Appendix Table 1.9.

With regard to species composition, Table 2 of the INPFC Statistical Yearbooks for 1970-74 shows that chum salmon accounted for 99.8% of the combined catch of sockeye, chum, coho and chinook during those 5 years, with chinooks

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6/ The 1971 catch reported for pink and masu salmon in the INPFC manuscript should be changed from 17,453 m.t. to 17,557 m.t. according to information received from Dr. Yabuta.

Appendix Table 1.9.--Estimates of catches of salmon by the Japanese coastal fishery, in metric tons by gear type, 1952-57.

Year	Gear	Sockeye, Chum, Coho and Chinook	Pink and Masu
1952	Gillnet	51	5,485
	Longline/Angling	+	495
	Trap and Other	6,398	1,474
	Total	6,449	7,454
1953	Gillnet	111	2,422
	Longline/Angling	+	210
	Trap and Other	6,837	1,894
	Total	6,948	4,526
1954	Gillnet	200	3,778
	Longline/Angling	+	655
	Trap and Other	9,574	1,369
	Total	9,774	5,802
1955	Gillnet	296	5,282
	Longline/Angling	2	392
	Trap and Other	6,654	2,998
	Total	6,952	8,672
1956	Gillnet	157	8,851
	Longline/Angling	8	4,015
	Trap and Other	5,198	2,726
	Total	5,363	15,592
1957	Gillnet	283	7,159
	Longline/Angling	45	4,823
	Trap and Other	8,981	1,637
	Total	9,309	13,619

DATA SOURCES: Gillnet--Appendix Table 1.2; Longline/Angling--Appendix Table 1.6; Trap and Other--Table 55, INPFC ms.

accounting for practically all of the remainder (0.2%). The composition of the combined catch of these four species during 1952-69 can be assumed to have been the same as it was in 1970-74. As for pink and masu salmon, a comparison of the 1970-71 catch statistics presented in Table 55 of the INPFC manuscript and 1972-73 catch data recently furnished by the Fisheries Agency of Japan with catches reported in the INPFC Statistical Yearbooks indicates that the catches of pink and masu salmon in each of the 4 years were as follows:

	Catch - m.t.		
Year	Pink	Masu	Total
1970	9,423	3,356	12,779
1971	12,135	5,422	17,557
1972	6,512	3,535	10,047
1973	9,817	4,548	14,365

The average annual catch of masu during 1970-73 was about 4,200 m.t. Prior to 1970, according to Japanese fisheries scientists (personal communication), the coastal fishery generally caught 2,000 to 3,000 m.t. of masu salmon annually. Because of the apparent difference between the pre-1970 and 1970-73 catch levels, no attempt is made to separate the pink and masu catches by the coastal fishery.

Estimates of annual catches in 1952-71 are given in Appendix Table 1.10.

Appendix Table 1.10.--Estimates of catches of salmon by the Japanese coastal fishery, in metric tons, 1952-75.[a/]

Year	Sockeye, Chum, Coho and Chinook[b/] Total catch	Sockeye Est. catch	Chum Est. catch	Coho Est. catch	Chinook Est. catch	Pink and Masu Total catch
1952	6,449	-	6,436	+	13	7,454
1953	6,948	-	6,934	+	14	4,526
1954	9,774	-	9,754	+	20	5,802
1955	6,952	-	6,938	+	14	8,672
1956	5,363	-	5,352	+	11	15,592
1957	9,309	-	9,290	+	19	13,619
1958	9,868	-	9,848	+	20	25,887
1959	5,586	-	5,575	+	11	18,239
1960	5,660	-	5,649	+	11	24,513
1961	10,137	-	10,117	+	20	10,293
1962	11,967	-	11,943	+	24	11,292
1963	13,136	-	13,110	+	26	13,007
1964	13,503	-	13,476	+	27	7,615
1965	16,718	-	16,685	+	33	13,350
1966	14,779	-	14,749	+	30	13,688
1967	16,556	-	16,523	+	33	20,689
1968	8,935	-	8,917	+	18	16,336
1969	15,075	-	15,044	+	31	23,095
1970	19,821	-	19,789	+	32	12,779
1971	28,283	+	28,157	1	125	17,557
1972	24,171	-	24,129	12	30	10,047
1973	32,099	-	32,030	-	69	14,365
1974	51,594	-	39,978	-	90	11,526[c/]
1975	73,714	-	59,117	-	94	14,503[c/]

a/ Includes Japan Sea oatches.
b/ Assumed to be 99.8% chum, 0.2% chinook, negligible coho, and no sockeye during 1952-69.
c/ Includes a preliminary estimate of 4,200 m.t. of masu. See text.

DATA SOURCES: 1952-57, Appendix Table 1.9.
1958-69, Table 55, INPFC ms.
1970-75, Table 2, INPFC Statistical Yearbooks and Fisheries Agency of Japan.

1972-75: Table 2, INPFC Statistical Yearbooks and Fisheries Agency of Japan (personal communication).

Catches of all species except masu salmon are given in the INPFC Statistical Yearbooks. Catches of masu salmon in 1972-73 have been provided by Dr. Yabuta. It is assumed that the masu catch in 1974 and 1975 was 4,200 m.t., the average annual catch during 1970-73. Our estimates of catches of all species during 1972-75 are included in Appendix Table 1.10.

2.4.2 Annual catch in numbers of fish, by species, 1952-75.

The catches given in Appendix Table 1.10 can be converted to number of fish using the average annual weights shown in Appendix Table 1.11.

3.0 United States

3.1 Annual catch in metric tons, by species

1952-71: Tables 67 (Alaska), 77 (Washington), 79 (Oregon) and 81 (California), INPFC ms.

1972-75: Table 2, INPFC Statistical Yearbooks.

3.2 Annual catch in numbers of fish, by species.

1952-71: Tables 68 (western Alaska), 69 (central Alaska), 70 (southeastern Alaska), 78 (Washington) and 80 (Oregon), INPFC ms. Data for California are from INPFC Document 1537 (1952-54 and 1956-58), INPFC Statistical Yearbook (1955), and Table 82, INPFC ms (1959-71).

1972-75: Table 1, INPFC Statistical Yearbooks.

Appendix Table 1.11.--Average weights of salmon caught by the Japanese coastal fishery, in grams, 1952-74.[a/]

Year	Pink[b/]	Chum	Coho	Chinook
1952-61	(1,427)	(3,052)	c/	(6,096)
1962	1,494	3,436	c/	(6,096)
1963	1,420	3,021	3,600	(6,096)
1964	1,367	3,001	c/	(6,096)
1965	1,412	2,992	c/	(6,096)
1966	1,421	3,003	c/	(6,096)
1967	1,400	3,000	2,500	(6,096)
1968	1,417	2,984	c/	(6,096)
1969	1,382	2,955	c/	(6,096)
1970	1,425	3,000	c/	(6,096)
1971	1,421	3,000	(2,833)	5,682
1972	1,447	3,001	2,400	6,000
1973	1,458	3,001	d/	6,273
1974	1,483	3,281	d/	6,429
1975	1,386	3,295	d/	5,875

a/ Figures shown in parentheses are averages of annual weights in other years: 1962-74 for pink and chum; 1963, 1967 and 1972 for coho; and 1971-74 for chinook. (Averages were calculated prior to the receipt of data for 1975.)
b/ Averages are for pink salmon taken in coastal fishery components other than the Japan Sea, but are assumed to apply to pink salmon caught in the Japan Sea and to masu.
c/ Not estimated because of apparent negligible catch.
d/ No catch reported.

DATA SOURCES: 1962-70: Table 90, INPFC ms.
1971-75: Tables 11 and 12, INPFC Statistical Yearbooks.

3.3 Annual catch, by district, in western Alaska, in numbers of fish:

<u>1952-71</u>: Tables 71 (sockeye), 73 (pink), 74 (chum), 75 (coho), and 76 (chinook), INPFC ms.

<u>1972-75</u>: Table 18, INPFC Statistical Yearbooks.

4.0 U.S.S.R.

4.1 Annual catch in metric tons, by species

<u>1952-73</u>: Tables 33 (sockeye), 35 (pink), 37 (chum), 39 (coho) and 41 (chinook), INPFC ms.

<u>1974</u>: INPFC Document 1751.

<u>1975</u>: Foreign Fisheries Information Release No. 76-5 (29 March 1976), NMFS, NOAA, Terminal Island, CA.

Catches of coho and chinook salmon are not reported separately in this release. It is estimated that coho accounted for two-thirds of the combined catch of the two sepcies, chinook one-third.

4.2 Annual catch in numbers of fish, by species.

<u>1952-61</u>: Catches in metric tons can be converted to numbers of fish using average annual weights during 1962-73. The latter can be obtained from Tables 33-34 (sockeye, 35-36 (pink), 37-38 (chum), 39-40 (coho) and 41-42 (chinook), INPFC ms.

<u>1962-73</u>: Tables 34 (sockeye), 36 (pink), 38 (chum), 40 (coho) and 42 (chinook), INPFC ms.

<u>1974</u>: INPFC Document 1751.

<u>1975</u>: Catches in m.t. can be converted to numbers of fish using average annual weights during 1962-74.

APPENDIX 2

FISHING EFFORT AND CPUE'S FOR THE JAPANESE MOTHERSHIP SALMON FISHERY IN WATERS OUTSIDE THE U.S.S.R. 200-MILE ZONE IN STATISTICAL AREAS 6048, 6050, 6546, 6548 AND 6550[a/]

1964 Season

Stat. area[b/]	Fishing period	Fishing effort (1000's of tans)[c/]	CPUE - No. of fish per tan[d/]				
			Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	20	1.43	+	0.97	+	0.007
	Jun 1-10	140	1.24	1.27	1.61	+	0.009
	" 11-20	70	0.99	1.48	1.01	+	0.011
	" 21-30	104	1.05	0.49	0.75	+	0.011
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(0.01)	(+)	(0.27)	(1.19)	(0.094)
6050	May 21-31	*	(1.43)	(+)	(0.97)	(+)	(0.007)
	Jun 1-10	*	0.76	0.63	0.49	+	0.007
	" 11-20	*	(0.99)	(1.48)	(1.01)	(+)	(0.011)
	" 21-30	26	1.00	0.28	0.81	+	0.010
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(0.01)	(+)	(0.27)	(1.19)	(0.094)
6546	May 21-31	144	2.08	0.32	1.62	+	0.009
	Jun 1-10	134	1.33	0.76	1.10	+	0.007
	" 11-20	56	1.15	1.05	1.55	0.01	0.017
	" 21-30	*	(1.23)	(0.28)	(0.54)	(+)	(0.007)
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	(+)	(+)	(0.31)	(2.04)	(0.059)
	" 21-31	*	(0.01)	(+)	(0.27)	(1.19)	(0.094)
6548	May 21-31	302	2.09	+	0.92	+	0.014
	Jun 1-10	269	1.45	0.60	0.56	+	0.006
	" 11-20	292	1.70	1.29	1.50	+	0.013
	" 21-30	64	1.23	0.28	0.54	+	0.007
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	(0.02)	(0.01)	(0.22)	(2.55)	(0.142)
	" 21-31	12	0.01	+	0.27	1.19	0.094
6550	May 21-31	82	1.37	+	1.39	+	0.011
	Jun 1-10	76	0.97	0.34	0.93	+	0.009
	" 11-20	138	1.34	0.97	0.99	+	0.010
	" 21-30	64	1.05	0.24	0.91	+	0.007
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	(0.02)	(0.01)	(0.22)	(2.55)	(0.142)
	" 21-31	*	(0.01)	(+)	(0.27)	(1.19)	(0.094)

a/ Data are from INPFC Stat. Yearbooks

b/ Estimated percent of area outside the USSR 200-mile zone: 6048-90%; 6050-50%; 6546-100%; 6548-100%; and 6550-90%.

c/ An asterisk indicates less than 10,000 tans in that portion of the stat. area outside the USSR 200-mile zone.

d/ Figures enclosed in parentheses are for an adjacent statistical area within the same 10-day period because fishing effort in the indicated statistical area (as a whole) and fishing period was less than 10,000 tans. A dash (-) indicates either a zero CPUE or that no CPUE was available from an adjacent statistical area. A plus sign (+) indicates that the CPUE was greater than zero but less than 0.01 (sockeye, pink, chum and coho salmon) or 0.001 (chinook salmon).

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1965 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	*	(2.68)	(0.11)	(2.80)	(-)	(+)
	Jun 1-10	*	(2.79)	(1.24)	(1.80)	(-)	(0.002)
	" 11-20	20	2.64	1.28	2.25	-	0.005
	" 21-30	*	(1.83)	(1.34)	(1.08)	(0.04)	(0.20)
	Jul 1-10	*	(1.82)	(0.97)	(0.83)	(0.04)	(0.006)
	11-20	*	0.61	0.17	1.33	0.80	0.014
	21-31	*	(0.98)	(0.04)	(1.34)	(0.68)	(0.010)
6050	May 21-31	*	(1.53)	(+)	(0.84)	(-)	(0.001)
	Jun 1-10	*	(2.33)	(0.23)	(1.25)	(-)	(0.004)
	" 11-20	24	1.75	0.47	1.67	-	0.003
	" 21-30	*	(2.11)	(0.51)	(0.90)	(+)	(0.005)
	Jul 1-10	10	1.82	0.97	0.83	0.04	0.006
	11-20	30	1.56	0.36	1.14	0.29	0.018
	21-31	16	0.98	0.04	1.34	0.68	0.010
6546	May 21-31	15	1.08	0.21	1.21	-	+
	Jun 1-10	*	(2.79)	(1.24)	(1.80)	(-)	(0.002)
	" 11-20	*	(2.87)	(1.52)	(1.89)	(+)	(0.008)
	" 21-30	*	(1.83)	(1.34)	(1.08)	(0.04)	(0.020)
	Jul 1-10	26	+	0.01	0.17	2.42	0.144
	11-20	22	+	+	0.12	2.25	0.094
	21-31	*	(-)	(-)	(-)	(-)	(-)
6548	May 21-31	55	2.68	0.11	2.80	-	+
	Jun 1-10	21	2.79	1.24	1.80	-	0.002
	11-20	143	2.87	1.52	1.89	+	0.008
	21-30	64	1.83	1.34	1.08	0.04	0.020
	Jul 1-10	11	1.37	0.58	0.79	0.24	0.006
	11-20	46	1.13	0.18	1.21	1.11	0.055
	21-31	*	(1.95)	(+)	(0.67)	(0.65)	(0.018)
6550	May 21-31	*	1.53	+	0.84	-	0.001
	Jun 1-10	19	2.33	0.23	1.25	-	0.004
	11-20	190	3.14	0.57	1.56	+	0.008
	21-30	43	2.91	2.00	0.76	+	0.049
	Jul 1-10	50	2.15	1.17	0.81	0.02	0.035
	11-20	51	1.66	0.13	1.09	0.80	0.034
	21-31	29	1.95	+	0.67	0.65	0.018

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1966 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tans[d] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	+	(1.91)	(0.05)	(1.73)	(+)	(0.010)
	Jun 1-10	17	0.76	0.75	2.63	-	0.012
	" 11-20	59	0.95	0.97	2.12	+	0.016
	" 21-30	19	1.12	0.41	1.21	+	0.016
	Jul 1-10	*	(3.90)	(0.36)	(2.24)	(0.14)	(0.019)
	" 11-20	*	(4.36)	(0.42)	(1.87)	(0.77)	(0.107)
	" 21-30	*	(-)	(-)	(-)	(-)	(-)
6050	May 21-31	*	(2.34)	(0.05)	(1.75)	(-)	(0.011)
	Jun 1-10	*	(0.76)	(0.75)	(2.63)	(-)	(0.012)
	" 11-20	10	0.61	1.30	2.07	+	0.018
	" 21-30	*	1.28	0.27	0.93	-	0.024
	Jul 1-10	*	(2.24)	(0.31)	(1.76)	(-)	(0.007)
	" 11-20	*	(5.44)	(0.15)	(3.12)	(0.13)	(0.026)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6546	May 21-31	93	1.92	0.11	1.76	+	0.009
	Jun 1-10	102	1.75	0.43	1.59	+	0.008
	" 11-20	*	(1.55)	(1.12)	(1.14)	(-)	(0.008)
	" 21-30	*	(1.39)	(0.63)	(1.18)	(+)	(0.011)
	Jul 1-10	*	(3.90)	(0.36)	(2.24)	(0.14)	(0.019)
	" 11-20	*	(4.36)	(0.42)	(1.87)	(0.77)	(0.107)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6548	May 21-31	117	1.91	0.05	1.73	+	0.010
	Jun 1-10	80	1.43	0.23	1.60	-	0.007
	" 11-20	114	1.55	1.12	1.14	-	0.008
	" 21-30	168	1.39	0.63	1.18	+	0.011
	Jul 1-10	138	3.90	0.36	2.24	0.14	0.019
	" 11-20	19	4.36	0.42	1.87	0.77	0.107
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6550	May 21-31	111	2.34	0.05	1.75	-	0.011
	Jun 1-10	35	1.26	0.16	1.32	-	0.006
	" 11-20	90	1.41	1.18	0.98	-	0.021
	" 21-30	110	1.44	0.59	0.96	+	0.020
	Jul 1-10	115	3.71	0.17	2.75	0.04	0.013
	" 11-20	15	5.44	0.15	3.12	0.13	0.026
	" 21-31	*	(-)	(-)	(-)	(-)	(-)

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1967 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	*	(2.08)	(+)	(1.21)	(+)	(0.004)
	Jun 1-10	*	0.76	0.01	1.33	-	0.002
	" 11-20	*	(1.69)	(0.18)	(1.41)	(-)	(0.016)
	" 21-30	32	1.45	2.10	1.10	+	0.024
	Jul 1-10	28	0.41	6.52	1.29	0.15	0.035
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6050	May 21-31	*	(1.99)	(+)	(1.32)	(-)	(0.010)
	Jun 1-10	*	(0.76)	(0.01)	(1.33)	(-)	(0.002)
	" 11-20	12	1.69	0.18	1.41	-	0.016
	" 21-30	59	2.31	0.77	1.13	-	0.023
	Jul 1-10	20	1.13	3.68	1.38	+	0.028
	" 11-20	*	(1.94)	(2.42)	(1.44)	(+)	(0.002)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6546	May 21-31	125	1.65	0.02	1.51	+	0.005
	Jun 1-10	104	1.69	0.10	1.23	-	0.007
	" 11-20	*	(2.12)	(1.12)	(0.89)	(-)	(0.017)
	" 21-30	*	(1.64)	(3.03)	(0.56)	+	(0.028)
	Jul 1-10	*	(0.01)	(0.11)	(2.04)	(2.62)	(0.067)
	" 11-20	*	(0.22)	(+)	(2.26)	(3.01)	(0.082)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6548	May 21-31	100	2.08	+	1.21	+	0.004
	Jun 1-10	149	1.87	0.01	0.64	-	0.005
	" 11-20	121	2.12	1.12	0.89	-	0.017
	" 21-30	43	1.64	3.03	0.56	+	0.028
	Jul 1-10	*	(2.70)	(3.83)	(0.54)	(0.04)	(0.035)
	" 11-20	*	(0.29)	(+)	(1.31)	(2.94)	(0.057)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6550	May 21-31	110	1.99	+	1.32	+	0.010
	Jun 1-10	51	2.03	0.16	1.02	-	0.007
	" 11-20	102	1.98	1.22	0.91	-	0.018
	" 21-30	201	2.22	2.35	0.55	+	0.019
	Jul 1-10	86	2.70	3.83	0.54	0.04	0.035
	" 11-20	*	(0.29)	(+)	(1.31)	(2.94)	(0.057)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1968 Season

Stat. area[b/]	Fishing period	Fishing effort (1000's of tans)[c/]	CPUE - No. of fish per tan[d/] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	22	1.03	0.01	1.60	-	0.007
	Jun 1-10	75	1.53	0.41	0.99	+	0.019
	" 11-20	49	1.75	0.63	0.97	+	0.013
	" 21-30	43	1.37	0.72	0.94	0.02	0.015
	Jul 1-10	*	(1.91)	(1.44)	(1.71)	(0.03)	(0.005)
	" 11-20	*	(2.47)	(0.61)	(1.75)	(0.02)	(0.002)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6050	May 21-31	*	(1.03)	(0.01)	(1.60)	(-)	(0.007)
	Jun 1-10	*	(1.53)	(0.41)	(0.99)	(-)	(0.019)
	" 11-20	*	(1.75)	(0.63)	(0.97)	(+)	(0.013)
	" 21-30	*	(1.37)	(0.72)	(0.94)	(0.02)	(0.015)
	Jul 1-10	*	1.91	1.44	1.71	0.03	0.005
	" 11-20	14	2.47	0.61	1.75	0.02	0.002
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6546	May 21-31	36	0.96	0.10	1.12	-	0.003
	Jun 1-10	132	0.94	1.04	0.99	+	0.014
	" 11-20	*	(1.43)	(1.13)	(0.89)	(+)	(0.011)
	" 21-30	*	(+)	(0.54)	(0.94)	(1.55)	(0.014)
	Jul 1-10	*	(+)	(0.17)	(1.21)	(1.57)	(0.019)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6548	May 21-31	307	1.40	0.13	1.24	+	0.009
	Jun 1-10	127	1.19	0.63	0.88	+	0.012
	" 11-20	91	1.43	1.13	0.89	+	0.011
	" 21-30	*	(1.13)	(1.08)	(1.06)	(0.02)	(0.003)
	Jul 1-10	*	(2.03)	(0.99)	(1.50)	(0.02)	(0.005)
	" 11-20	*	(2.63)	(0.35)	(1.07)	(0.42)	(0.019)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6550	May 21-31	173	1.57	0.04	0.90	+	0.010
	Jun 1-10	130	1.14	0.64	0.83	+	0.012
	" 11-20	194	1.49	0.87	0.92	+	0.007
	" 21-30	22	1.13	1.08	1.06	0.02	0.003
	Jul 1-10	63	2.03	0.99	1.50	0.02	0.005
	" 11-20	*	(3.06)	(0.41)	(1.71)	(0.06)	(0.011)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1969 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d]				
			Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	*	(2.01)	(+)	(0.57)	(-)	(0.014)
	Jun 1-10	*	(1.59)	(0.04)	(0.45)	(-)	(0.066)
	" 11-20	19	1.37	1.54	1.02	+	0.030
	" 21-30	15	1.01	0.90	0.77	+	0.046
	Jul 1-10	*	(1.03)	(2.50)	(0.96)	(+)	(0.044)
	" 11-20	*	(1.72)	(1.62)	(1.43)	(0.04)	(0.026)
	" 21-31	*	(2.60)	(1.15)	(2.89)	(0.09)	(-)
6050	May 21-31	18	2.01	+	0.51	-	0.014
	Jun 1-10	*	1.59	0.04	0.45	-	0.066
	" 11-20	*	(1.37)	(1.54)	(1.02)	(+)	(0.030)
	" 21-30	*	(1.01)	(0.90)	(0.77)	(+)	(0.044)
	Jul 1-10	38	1.03	2.50	0.96	+	0.044
	" 11-20	14	1.72	1.62	1.43	0.04	0.026
	" 21-31	*	2.60	1.15	2.89	0.09	(0.051)
6546	May 21-31	48	1.25	0.01	0.57	-	0.002
	Jun 1-10	54	1.48	0.36	1.24	-	0.004
	" 11-20	38	1.38	1.65	1.25	0.01	0.015
	" 21-30	*	(+)	(0.02)	(0.07)	(1.11)	(0.011)
	Jul 1-10	*	(0.02)	(0.01)	(0.09)	(2.05)	(0.109)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6548	May 21-31	160	1.74	0.01	0.84	-	0.003
	Jun 1-10	174	1.36	0.19	1.02	-	0.007
	" 11-20	81	1.02	1.32	1.02	+	0.007
	" 21-30	*	(0.49)	(1.19)	(0.41)	(+)	(0.020)
	Jul 1-10	*	(1.82)	(1.89)	(1.34)	(+)	(0.039)
	" 11-20	*	(1.72)	(1.62)	(1.43)	(0.04)	(0.026)
	" 21-31	*	(2.60)	(1.15)	(2.89)	(0.09)	(0.051)
6550	May 21-31	191	2.10	+	0.59	-	0.005
	Jun 1-10	57	1.73	0.06	0.38	-	0.016
	" 11-20	10	0.72	1.03	0.88	-	0.004
	" 21-30	*	(0.33)	(1.80)	(0.93)	(-)	(0.012)
	Jul 1-10	16	1.82	1.89	1.34	+	0.039
	" 11-20	*	(2.48)	(4.54)	(1.08)	(0.01)	(0.012)
	" 21-31	*	(2.60)	(1.15)	(2.89)	(0.09)	(0.051)

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1970 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d]				
			Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	*	(-)	(-)	(-)	(-)	(-)
	Jun 1-10	*	(1.42)	(0.27)	(0.81)	(-)	(0.003)
	" 11-20	*	(1.36)	(0.50)	(1.22)	(-)	(0.003)
	" 21-30	*	(1.51)	(0.76)	(1.01)	(-)	(0.008)
	Jul 1-10	*	(0.88)	(0.61)	(1.64)	(+)	(0.004)
	" 11-20	*	(1.79)	(0.36)	(2.13)	(0.02)	(0.012)
	" 21-31	*	(4.81)	(0.49)	(2.26)	(0.69)	(0.019)
6050	May 21-31	*	(-)	(-)	(-)	(-)	(-)
	Jun 1-10	*	(1.53)	(0.22)	(0.66)	(-)	(0.006)
	" 11-20	*	(1.36)	(0.50)	(1.22)	(-)	(0.003)
	" 21-30	*	1.51	0.76	1.01	-	0.008
	Jul 1-10	45	0.88	0.61	1.64	+	0.004
	" 11-20	42	1.79	0.36	2.13	0.02	0.012
	" 21-31	*	(2.69)	(0.40)	(2.37)	(0.08)	(0.014)
6546	May 21-31	*	(1.49)	(0.26)	(0.56)	(-)	(0.005)
	Jun 1-10	*	(1.42)	(0.27)	(0.81)	(-)	(0.003)
	" 11-20	*	(0.39)	(0.37)	(0.84)	(+)	(0.002)
	" 21-30	*	(1.76)	(0.62)	(1.44)	(+)	(0.003)
	Jul 1-10	*	(1.48)	(0.30)	(1.45)	(+)	(0.027)
	" 11-20	*	(4.30)	(0.50)	(1.76)	(0.33)	(0.024)
	" 21-31	*	(4.81)	(0.49)	(2.26)	(0.69)	(0.019)
6548	May 21-31	*	(1.49)	(0.26)	(0.56)	(-)	(0.005)
	Jun 1-10	42	1.42	0.27	0.81	-	0.003
	" 11-20	*	(1.36)	(0.50)	(1.22)	(-)	(0.003)
	" 21-30	42	1.76	0.62	1.44	+	0.003
	Jul 1-10	20	1.48	0.30	1.45	+	0.027
	" 11-20	34	4.30	0.50	1.76	0.33	0.024
	" 21-31	26	4.81	0.49	2.26	0.69	0.019
6550	May 21-31	*	(1.21)	(0.06)	(0.60)	(-)	(0.004)
	Jun 1-10	36	1.53	0.22	0.66	-	0.006
	" 11-20	10	1.36	0.50	1.22	+	0.003
	" 21-30	42	1.21	0.48	1.16	-	0.007
	Jul 1-10	83	1.81	0.22	1.50	+	0.021
	" 11-20	25	3.08	0.26	2.88	0.06	0.021
	" 21-31	*	(4.81)	(0.49)	(2.26)	(0.69)	(0.019)

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1971 Season

Stat area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d]				
			Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	75	0.84	+	2.53	-	0.004
	Jun 1-10	61	0.74	0.21	1.73	-	0.011
	" 11-20	*	(0.59)	(1.70)	(1.10)	(-)	(0.009)
	" 21-30	*	(0.44)	(3.72)	(0.48)	(-)	(0.003)
	Jul 1-10	*	(0.52)	(4.25)	(0.42)	(-)	(0.008)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6050	May 21-31	44	0.74	+	2.39	-	0.010
	Jun 1-10	11	0.56	0.52	1.91	-	0.009
	" 11-20	32	0.59	1.70	1.10	-	0.009
	" 21-30	18	0.44	3.72	0.48	-	0.003
	Jul 1-10	24	0.52	4.25	0.42	-	0.008
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6546	May 21-31	152	1.03	0.59	1.80	-	0.009
	Jun 1-10	36	1.07	1.16	1.23	-	0.004
	" 11-20	*	(0.81)	(1.98)	(1.21)	(-)	(0.008)
	" 21-30	*	(0.62)	(3.67)	(0.91)	(-)	(0.016)
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6548	May 21-31	158	1.16	0.06	2.07	-	0.006
	Jun 1-10	28	0.87	1.79	1.09	-	0.005
	" 11-20	32	0.81	1.98	1.21	-	0.008
	" 21-30	35	0.62	3.67	0.91	+	0.016
	Jul 1-10	*	(0.52)	(4.25)	(0.42)	(-)	(0.008)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6550	May 21-31	140	1.08	+	1.87	-	0.006
	Jun 1-10	71	0.69	0.98	1.88	-	0.006
	" 11-20	83	0.47	3.00	1.03	-	0.012
	" 21-30	157	0.56	4.43	0.48	+	0.012
	Jul 1-10	*	(0.59)	(3.75)	(0.47)	(-)	(0.004)
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1972 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	*	(1.06)	(0.21)	(1.22)	(-)	(0.011)
	Jun 1-10	*	(1.08)	(0.42)	(0.80)	(-)	(0.008)
	" 11-20	*	0.52	2.26	1.53	-	0.059
	" 21-30	37	0.17	0.96	1.75	+	0.060
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	(1.03)	(1.39)	(3.72)	(0.72)	(0.034)
	" 21-31	*	(0.64)	(0.55)	(3.46)	(1.05)	(0.019)
6050	May 21-31	*	(1.22)	(0.24)	(1.06)	(-)	(0.004)
	Jun 1-10	*	(1.20)	(0.73)	(0.79)	(+)	(0.012)
	" 11-20	18	0.82	0.82	1.42	-	0.008
	" 21-30	12	0.29	0.73	1.67	+	0.008
	Jul 1-10	*	(-)	(-)	(-)	(-)	(-)
	" 11-20	*	1.03	1.39	3.72	0.72	0.034
	" 21-31	*	0.64	0.55	3.46	1.05	0.019
6546	May 21-31	262	0.79	0.32	1.23	-	0.009
	Jun 1-10	143	0.54	1.03	1.14	0.01	0.035
	" 11-20	33	0.32	1.69	0.85	-	0.022
	" 21-30	*	(0.53)	(1.58)	(1.53)	(+)	(0.057)
	Jul 1-10	*	(0.02)	(1.30)	(0.73)	(1.25)	(0.005)
	" 11-20	*	(0.01)	(1.70)	(1.92)	(2.13)	(0.006)
	" 21-31	*	(0.41)	(2.17)	(2.44)	(2.47)	(0.015)
6548	May 21-31	162	1.06	0.21	1.22	-	0.011
	Jun 1-10	13	1.08	0.42	0.80	+	0.008
	" 11-20	67	0.89	1.32	1.11	-	0.014
	" 21-30	32	0.53	1.58	1.53	+	0.057
	Jul 1-10	*	(0.01)	(1.28)	(0.75)	(1.24)	(0.006)
	" 11-20	32	0.01	1.70	1.92	2.13	0.006
	" 21-31	18	0.41	2.17	2.44	2.47	0.015
6550	May 21-31	122	1.22	0.24	1.06	-	0.004
	Jun 1-10	69	1.20	0.73	0.79	+	0.012
	" 11-20	124	1.23	1.06	1.32	-	0.011
	" 21-30	30	0.78	1.10	1.97	+	0.018
	Jul 1-10	*	(0.01)	(1.28)	(0.75)	(1.24)	(0.006)
	" 11-20	20	0.16	1.47	2.10	2.45	0.010
	" 21-31	22	0.06	1.72	2.01	3.30	0.007

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1973 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	58	0.88	0.01	1.34	-	0.003
	Jun 1-10	*	(1.14)	(0.88)	(1.05)	(-)	(0.008)
	" 11-20	*	0.44	2.86	0.81	-	0.026
	" 21-30	*	(0.38)	(4.62)	(0.35)	(-)	(+)
	Jul 1-10	14	0.11	4.27	1.00	0.06	0.056
	" 11-20	116	+	6.46	0.71	0.29	0.115
	" 21-31	60	0.03	6.56	0.96	0.54	0.092
6050	May 21-31	*	1.11	.01	1.12	-	0.006
	Jun 1-10	*	(0.65)	(0.74)	(0.94)	(-)	(0.011)
	" 11-20	*	(0.44)	(2.86)	(0.81)	(-)	(0.026)
	" 21-30	*	0.38	4.62	0.35	+	+
	Jul 1-10	17	0.36	4.37	0.78	-	+
	" 11-20	14	0.10	4.33	2.99	1.18	0.033
	" 21-31	10	0.06	6.38	0.92	0.30	0.090
6546	May 21-31	142	0.85	0.77	1.31	+	0.007
	Jun 1-10	122	0.60	2.41	0.92	-	0.010
	" 11-20	35	0.20	3.42	0.66	-	0.009
	" 21-30	*	(0.36)	(3.68)	(0.29)	(+)	(0.003)
	Jul 1-10	*	(0.33)	(3.20)	(1.12)	(0.08)	(0.050)
	" 11-20	*	(0.04)	(0.44)	(2.47)	(2.00)	(0.242)
	" 21-31	*	(+)	(0.02)	(4.69)	(3.19)	(0.009)
6548	May 21-31	136	1.20	0.04	1.11	-	0.003
	Jun 1-10	94	1.14	0.88	1.05	-	0.008
	" 11-20	77	0.34	3.41	0.66	-	0.010
	" 21-30	10	0.36	3.68	0.29	+	0.003
	Jul 1-10	26	0.33	3.20	1.12	0.08	0.050
	" 11-20	44	0.04	0.44	2.47	2.00	0.242
	" 21-31	*	(0.15)	(0.32)	(4.96)	(1.79)	(0.026)
6550	May 21-31	138	1.71	0.01	1.07	-	0.010
	Jun 1-10	76	0.65	0.74	0.94	-	0.011
	" 11-20	54	0.34	3.97	0.63	-	0.006
	" 21-30	60	0.51	4.19	0.51	+	0.007
	Jul 1-10	60	0.53	4.00	0.87	+	0.028
	" 11-20	*	(0.04)	(0.44)	(2.47)	(2.00)	(0.242)
	" 21-31	15	0.15	0.32	4.96	1.79	0.026

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1974 Season

Stat. area[b/]	Fishing period	Fishing effort (1000's of tans)[c/]	CPUE - No. of fish per tan[d/] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	14	0.30	0.26	2.35	-	0.007
	Jun 1-10	*	(0.36)	(1.58)	(1.09)	(-)	(0.008)
	" 11-20	*	(0.48)	(3.19)	(1.17)	(-)	(0.008)
	" 21-30	*	(0.47)	(1.21)	(2.94)	(+)	(0.014)
	Jul 1-10	10	0.63	2.61	2.31	+	0.060
	" 11-20	*	(-)	(-)	(-)	(-)	(-)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6050	May 21-31	20	0.67	0.13	1.61	-	0.005
	Jun 1-10	*	(0.30)	(1.51)	(0.79)	(-)	(0.005)
	" 11-20	*	(0.28)	(3.12)	(0.77)	(-)	(0.013)
	" 21-30	*	(0.47)	(1.21)	(2.94)	(+)	(0.014)
	Jul 1-10	32	0.81	2.30	2.41	+	0.017
	" 11-20	*	(1.91)	(2.30)	(3.62)	(0.15)	(0.018)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6546	May 21-31	39	0.72	0.16	1.76	-	0.006
	Jun 1-10	39	0.45	1.90	0.99	-	0.013
	" 11-20	*	(0.48)	(3.19)	(1.17)	(-)	(0.008)
	" 21-30	*	(0.31)	(0.71)	(2.47)	(+)	(0.008)
	Jul 1-10	*	(0.98)	(1.46)	(3.27)	(0.01)	(0.021)
	" 11-20	*	(0.26)	(0.83)	(0.65)	(2.88)	(0.177)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6548	May 21-31	149	0.51	0.55	1.50	-	0.005
	Jun 1-10	71	0.36	1.58	1.09	-	0.008
	" 11-20	48	0.48	3.19	1.17	-	0.008
	" 21-30	*	(0.47)	(1.21)	(2.94)	(+)	(0.014)
	Jul 1-10	33	0.98	1.46	3.27	0.01	0.021
	" 11-20	*	(0.26)	(0.83)	(0.65)	(2.88)	(0.177)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)
6550	May 21-31	172	0.67	0.20	1.64	-	0.006
	Jun 1-10	23	0.30	1.51	0.79	-	0.005
	" 11-20	60	0.28	3.12	0.77	-	0.013
	" 21-30	24	0.47	1.21	2.94	+	0.014
	Jul 1-10	65	0.87	1.08	3.40	+	0.020
	" 11-20	*	(2.54)	(1.13)	(1.68)	(0.60)	(0.072)
	" 21-31	*	(-)	(-)	(-)	(-)	(-)

APPENDIX 2--Continued. (See 1964 data for explanation of footnotes)

1975 Season

Stat. area[b]	Fishing period	Fishing effort (1000's of tans)[c]	CPUE - No. of fish per tan[d] Sockeye	Pink	Chum	Coho	Chinook
6048	May 21-31	*	(1.06)	(0.23)	(1.00)	(-)	(0.005)
	Jun 1-10	*	(0.48)	(2.03)	(1.05)	(-)	(0.006)
	" 11-20	*	(0.33)	(3.86)	(0.41)	(+)	(0.005)
	" 21-30	*	(0.52)	(3.75)	(0.86)	(-)	(0.008)
	Jul 1-10	22	0.20	6.52	1.17	+	0.008
	" 11-20	14	0.13	9.66	0.74	0.30	0.010
	" 21-31	21	0.13	11.08	2.15	1.54	0.012
6050	May 21-31	*	(0.87)	(0.02)	(1.05)	(-)	(0.007)
	Jun 1-10	*	(0.48)	(2.03)	(1.05)	(-)	(0.006)
	" 11-20	*	(0.25)	(3.01)	(0.42)	(-)	(0.005)
	" 21-30	*	(0.29)	(3.51)	(0.59)	(-)	(0.009)
	Jul 1-10	42	0.30	5.44	1.29	-	0.011
	" 11-20	16	0.60	3.70	3.31	+	0.013
	" 21-31	*	(0.13)	(11.08)	(2.15)	(1.54)	(0.012)
6546	May 21-31	99	0.65	1.64	0.52	-	0.006
	Jun 1-10	99	0.32	1.87	0.96	+	0.008
	" 11-20	*	(0.33)	(3.86)	(0.41)	(+)	(0.005)
	" 21-30	*	(0.52)	(3.75)	(0.86)	(-)	(0.008)
	Jul 1-10	*	(0.30)	(4.58)	(1.50)	(+)	(0.014)
	" 11-20	10	0.15	4.23	1.27	0.28	0.010
	" 21-31	*	(0.13)	(11.08)	(2.15)	(1.54)	(0.012)
6548	May 21-31	159	1.06	0.23	1.00	-	0.005
	Jun 1-10	27	0.48	2.03	1.05	+	0.006
	" 11-20	22	0.33	3.86	0.41	+	0.005
	" 21-30	37	0.52	3.75	0.86	-	0.008
	Jul 1-10	18	0.30	4.58	1.50	+	0.014
	" 11-20	49	0.25	6.62	1.35	0.39	0.023
	" 21-31	*	(0.13)	(11.08)	(2.15)	(1.54)	(0.012)
6550	May 21-31	118	0.87	0.02	1.05	-	0.007
	Jun 1-10	*	(0.48)	(2.03)	(1.05)	(-)	(0.006)
	" 11-20	16	0.25	3.01	0.42	+	0.005
	" 21-30	76	0.37	3.58	0.79	-	0.009
	Jul 1-10	24	0.40	4.21	1.17	+	0.010
	" 11-20	10	0.42	5.83	1.35	0.05	0.016
	" 21-31	*	(0.13)	(11.08)	(2.15)	(1.54)	(0.012)

Appendix 3. Operating units of U.S. Pacific salmon fishery, by state, 1964-73.1/

Year	Gear/Vessel/Boat unit2/ Purse seine Vessel	Purse seine Boat3/	Drift gillnet Vessel	Drift gillnet Boat	Anchored gillnet Vessel	Anchored gillnet Boat	Troll Vessel	Troll Boat	Gear units Floating trap	Fish wheel	Haul seine4/	Pound net	Reefnet Gear	Reefnet Boat5/	Dip6/ net
							Alaska7/								
1964	900	1,780	464	2,924	0	2,483	508	700	4	6	--	0	0	0	0
65	856	1,944	484	3,250	17	2,452	647	719	4	11	--	0	0	0	0
66	774	1,968	596	3,576	28	2,522	614	750	4	11	--	0	0	0	0
67	736	1,434	406	3,232	19	1,911	568	849	4	8	--	0	0	0	0
68	958	1,598	706	3,310	47	2,237	521	1,223	4	6	--	0	0	0	0
69	714	1,721	622	3,684	36	2,423	(1,248)	(2,320)	4	7	--	0	0	0	0
1970	1,031	1,723	802	3,619	41	2,398	(1,369)	(2,107)	4	5	--	0	0	0	0
71	909	648	759	3,502	22	2,161	895	1,205	14	11	--	0	0	0	0
72	816	1,054	825	3,312	29	2,500	684	1,249	10	8	--	0	0	0	0
73	868	1,096	846	3,086	46	2,471	681	1,502	4	--	--	0	0	0	0
							Washington								
1964	212	216	221	985	0	324	821	801	0	0	20	2	63	126	--
65	288	292	238	1,078	0	320	793	907	0	0	25	2	76	152	--
66	225	225	228	1,000	0	321	812	979	0	0	16	2	52	104	--
67	343	347	286	1,072	0	305	797	1,327	0	0	28	2	63	126	--
68	179	179	302	1,099	0	281	796	1,855	0	0	8	3	55	110	--
69	317	317	339	1,096	0	324	752	1,730	0	0	18	4	63	126	--
1970	271	271	358	1,205	0	365	826	1,800	0	0	10	2	54	108	--
71	277	277	376	1,121	0	372	1,012	2,910	0	0	--	3	52	104	--
72	192	192	414	1,089	1	330	947	2,313	0	0	--	2	48	96	--
73	295	295	573	1,271	0	350	945	1,597	0	0	--	1	71	142	--
							Oregon								
1964	0	0	0	444	0	101	480	435	0	0	0	0	0	0	0
65	0	0	2	465	0	129	487	504	0	0	0	0	0	0	0
66	0	0	0	459	0	117	629	513	0	0	0	0	0	0	0
67	0	0	2	604	0	127	826	782	0	0	0	0	0	0	0
68	0	0	2	542	0	110	784	1,075	0	0	0	0	0	0	0
69	0	0	6	576	0	104	721	995	0	0	0	0	0	0	0
1970	0	0	0	490	0	101	830	1,000	0	0	0	0	0	0	0
71	0	0	45	404	0	144	817	1,554	0	0	0	0	0	0	0
72	0	0	56	835	0	199	861	1,390	0	0	0	0	0	0	0
73	0	0	97	633	0	200	1,052	1,625	0	0	0	0	0	0	0
							California								
1964	0	0	0	0	0	0	1,115	1,134	0	0	0	0	0	0	0
65	0	0	0	0	0	0	1,344	940	0	0	0	0	0	0	0
66	0	0	0	0	0	0	1,369	1,248	0	0	0	0	0	0	0
67	0	0	0	0	0	0	1,437	1,139	0	0	0	0	0	0	0
68	0	0	0	0	0	0	1,218	1,163	0	0	0	0	0	0	0
69	0	0	0	0	0	0	1,491	1,552	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	1,124	1,077	0	0	0	0	0	0	0
71	0	0	0	0	0	0	1,242	1,298	0	0	0	0	0	0	0
72	0	0	0	0	0	0	1,237	909	0	0	0	0	0	0	0
73	0	0	0	0	0	0	1,722	1,731	0	0	0	0	0	0	0

1/ Source: Natl. Mar. Fish. Serv. 1967a-76a.

2/ Vessel consists of motor vessel with capacity of 5 net tons or over. Boat consists of motor and nonmotor boat with capacity of less than 5 net tons.

3/ Includes seine skiffs.

4/ Haul seine units of Alaska are included under purse seine.

5/ Non-motor boats anchored on fishing ground.

6/ Dip netting for salmon (and smelt) is conducted on Indian reservations in Washington. The number of dip nets used for salmon fishing could not be identified from the total units reported.

7/ Explanation is not available on the large numbers of troll vessels and boats recorded for 1969 and 1970.

Appendix 4. Operating units of the U.S.S.R. Pacific salmon fishery, 1970-73.

	Fishing gear[1/]				
Year	Trap net	Beach seine	Drift net	Fixed gillnet	Zaedzka (weir)
	(Units)				
1969	377	74	--	--	--
70	--	--	--	--	--
71	347	58	212	5	7
72	264	37	80	--	5
73	395	52	220	124	4

1/ Sum of the upper range in effort reported for each fishing area.
Source: Inter. North Pac. Fish. Comm. 1972-76.

Appendix 5. Salmon catch by gear and country, 1970-74.

Country/ gear	1970	1971	1972	1973	Average	Percent
	CATCH					
	(Thousand fish)					
United States[1]						
Purse seine	37,115.3	33,485.3	20,155.8	16,248.1	21,400.9	52
Gillnet[2]	33,824.3	19,613.3	13,049.0	11,637.2	15,624.8	38
Troll	3,467.8	4,829.2	3,699.7	4,417.1	3,282.8	8
Other[3]	521.8	879.3	961.6	859.9	644.5	2
Total	74,929.2	58,807.1	37,866.1	33,162.3	40,953.0	100
Canada[1]						
Purse seine	11,203.9	8,113.3	15,865.2	10,031.2	9,042.7	44
Gillnet	10,302.1	7,631.7	8,235.1	10,292.3	7,292.2	35
Troll	5,012.2	6,660.9	4,678.2	4,993.5	4,269.0	21
Total	26,518.1	22,406.0	28,779.1	25,317.0	20,603.9	100

(Metric tons)

Japan[4]	1970	1971	1972	1973	1974	Average catch 1970-74	Average catch 1970-71	Average catch 1972-74	Percent 70-74	Percent 70-71	Percent 70-74
Gillnet[5]	82,024	84,247	89,861	93,291	85,447	86,974	83,136	89,533	67	64	69
Longline	13,791	18,573	2,749	4,058	3,071	8,448	16,182	3,293	6	13	2
Set net	16,700	24,678	20,627	29,365	36,247	25,523	20,689	28,746	20	16	22
Small set net	3,613	6,976	3,680	5,531	4,553	4,871	5,294	4,588	4	4	4
Pole, line	718	1,104	724	1,015	849	882	911	863	1	1	1
Other	1,050	3,723	1,960	2,749	2,364	2,369	2,386	2,358	2	2	2
Total	117,896	139,301	119,601	136,009	132,531	129,067	128,598	129,381	100	100	100

U.S.S.R.[6]	1969	1971	1972	1973	Average	Percent[7]
Trap net	[not available]					(83)
Beach seine						(13)
Fixed gillnet						
Drift net						(2)
Weir						2
Total	39,047	77,591	30,614	77,718	56,242	(100)

1/ Source: Int. North Pac. Fish. Comm. (1972-75).
2/ Drift and set gillnets combined.
3/ Beach seine, fish wheel, reef net, trap, dip net, and other incidental gear.
4/ Source: Min. Agric. For., Japan (1976a).
5/ Drift gillnets of the mothership and coastal salmon fisheries.
6/ Effort data were available but they could not be related to catch. Source: same as footnote 1/.
7/ Approximate catch composition by gear as based on the judgement of the authors of this report.

Appendix 6. Average annual landing (1971-75) of Pacific salmon by species and country, and approximate average annual consumption (1966-70) by country--in round-weight.

	Average Annual Landing (1971-75) a/								
Species	Total	U.S.	Canada	Japan	U.S.S.R.	U.S.	Canada	Japan	U.S.S.R.
	-------------Metric tons and (million pounds)--------					------------------------(Percent)---------			
Sockeye	54,000 (119.1)	27,580 (60.8)	15,460 (34.1)	9,460 (20.9)	1,500 (3.3)	51	29	17	3
Pink	138,020 (304.3)	27,380 (60.4)	14,100 (31.1)	47,300 (104.3)	49,240 (108.5)	20	10	34	36
Chum	123,740 (272.8)	23,200 (51.2)	17,240 (38.0)	76,380 (168.4)	6,920 (15.3)	19	14	62	5
Coho	38,680 (85.3)	16,120 (35.5)	10,780 (23.8)	8,560 (18.9)	3,220 (7.1)	42	28	22	8
Chinook	25,790 (56.8)	14,570 (32.1)	7,920 (17.5)	1,290 (2.8)	2,010 (4.4)	56	31	5	8
Masu	3,150 (6.9)	0 (0)	0 (0)	3,150 (6.9)	0 (0)	0	0	100	0
Total	383,380 (845.2)	108,850 (240.0)	65,500 (144.5)	146,140 (322.2)	62,890 (138.6)	28	17	38	17

	Average annual consumption (1966-1970) b/					
	U.S.	Canada	Japan	U.S.S.R.	Other c/	Total c/
Metric tons	129,094	34,745	114,851	58,605	130,999	468,294
Million lb	284.6	76.6	253.2	129.2	288.8	1,032.4
Percent	28	7	25	12	28	100

a/ Source: Masu salmon is from Food Agric. Organ., U.N. (1975a); all other species is from Tables 6.2-6.6 of this report

b/ Estimated from the data in Table IX-1, Natl. Mar. Fish. Serv. (1973b). More recent information is unavailable.

c/ These are most likely overestimates because Atlantic salmon and other salmonid fishes are believed to be included.

Appendix 7. Processed food products from Pacific salmon--United States, 1940-74.

Year	Flesh										Roe				Frozen salmon
	Fillet & steak		Canned[1/]		Salted, pickled, cured		Smoked		Specialties		Canned[1/]		Salted		Dressed/ round[2/]
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity
1940	251	31	267,196	37,614	10,575	1,666	10,967	3,563	--	--	164	53	292	27	13,808
41	476	104	374,351	67,043	--	--	--	--	--	--	147	62	--	--	14,972
42	372	87	279,055	61,556	11,126	2,172	--	--	--	--	166	94	--	--	14,883
43	39	8	273,019	62,607	8,550	1,713	--	--	--	--	171	75	--	--	15,245
44	--	--	245,672	55,982	8,087	1,806	--	--	--	--	--	--	--	--	18,767
45	2,368	617	234,674	52,201	11,190	2,462	--	--	--	--	--	--	299	28	29,857
46	1,278	423	215,671	69,676	11,652	3,143	--	--	--	--	--	--	317	29	29,060
47	1,774	743	269,693	119,918	9,579	2,932	--	--	--	--	--	--	--	--	16,368
48	1,916	841	230,592	119,857	--	--	--	--	--	--	--	--	--	--	13,886
49	1,668	704	264,768	103,187	--	--	--	--	--	--	--	--	--	--	17,959
1950	1,623	834	206,365	109,173	7,737	3,931	12,962	10,028	--	--	115	66	--	--	12,585
51	2,061	1,100	222,274	108,156	--	--	--	--	--	--	--	--	--	--	13,419
52	3,251	1,596	213,367	97,646	5,758	2,498	12,530	9,787	--	--	165	106	233	60	13,212
53	3,181	1,557	186,826	81,620	6,809	2,839	12,105	9,692	--	--	165	114	198	63	14,233
54	2,868	1,453	119,168	91,797	5,835	2 562	12,503	9,389	--	--	--	--	497	180	15,720
55	2,765	1,470	157,195	80,894	6,685	3,397	12,190	10,571	--	--	--	--	247	88	10,342
56	3,324	2,087	167,858	94,806	4,667	2,773	11,815	11,196	12	9	114	72	326	134	16,500
57	2,735	1,492	153,548	85,860	4,508	2,596	11,049	10,888	27	27	136	123	346	140	10,119
58	2,414	1,612	178,831	92,592	6,396	4,622	11,635	12,289	8	7	225	275	--	--	11,480
59	1,630	1,098	117,855	71,469	6,111	4,851	11,390	12,371	--	--	231	263	329	129	9,659
1960	888	638	135,753	87,922	4,369	3,867	12,264	15,662	--	--	242	315	226	99	9,896
61	1,153	821	117,115	116,627	5,986	5,506	12,634	18,211	--	--	219	297	348	160	11,550
62	1,475	1,112	182,158	106,478	4,393	4,174	11,877	17,539	16	21	219	355	331	191	14,570
63	1,078	787	157,786	87,637	8,458	9,481	8,508	12,393	7	8	233	426	1,117	529	15,575
64	1,979	1,345	180,302	95,630	5,170	4,533	11,453	17,649	21	27	286	549	3,127	1,783	16,885
65	2,177	1,729	174,234	122,592	4,803	3,970	13,532	20,649	169	247	264	507	2,995	2,125	14,107
66	2,887	2,452	209,023	135,953	4,330	3,961	12,636	19,792	143	181	290	609	3,640	3,228	24,073
67	1,788	1,492	99,373	76,027	5,191	4,544	12,417	19,702	169	204	132	361	6,615	7,809	18,299
68	1,959	1,760	165,353	117,895	5,720	4,947	12,378	21,310	314	312	261	735	7,663	9,146	27,186
69	2,095	2,085	122,300	90,178	5,559	4,561	12,350	24,948	275	307	130	491	6,282	6,427	15,575
1970	2,730	2,806	183,453	138,659	4,707	5,388	12,668	26,884	283	320	144	535	10,227	11,657	22,974
71	2,497	2,310	168,332	137,727	3,409	3,468	13,408	29,430	226	296	185	609	9,834	12,468	19,515
72	5,214	5,281	92,833	87,337	2,105	2,340	13,441	30,819	--	--	94	434	6,900	11,857	24,087
73	1,991	2,687	71,743	111,036	1,658	2,660	13,468	35,955	--	--	120	775	5,753	16,891	37,012
74	1,856	2,780	87,757	136,946	2,177	3,934	13,948	41,694	--	--	101	744	5,633	17,003	--

1/ Converted from case to pound on the basis of 48 cans of 16 ounces each, net weight, per case (Natl. Mar. Fish. Serv. 1975a).

2/ Primarily an intermediate form from which frozen/fresh, cured, smoked, etc. products are derived, or is exported in that form. Information on value is unavailable. Source: 1940-73 data, Natl. Mar. Fish. Serv. (1943a-1976a); 1974 data, Natl. Mar. Fish. Serv. (1976b).

Appendix 8. Industrial products from Pacific salmon--United States, 1940-74.

Year	Industrial products									
	Meal		Oil 1/		Bait		Eggs for bait		Animal food	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousand pounds and dollars)									
1940	1,938	48	733	82	90	1	428	128	559	6
41	3,784	99	1,556	137	84	1	167	66	602	6
42	3,076	94	1,435	145	299	4	220	106	500	1
43	2,692	77	977	101	187	3	223	105	20	1
44	1,250	42	598	145	33	1	252	99	17	1
45	2,164	70	727	92	68	2	399	188	--	--
46	2,608	152	932	198	35	2	690	343	--	--
47	2,030	144	991	200	14	1	432	232	5	1
48	2,304	112	873	169	22	1	362	161	29	4
49	3,520	246	1,252	100	56	3	514	276	15	1
1950	2,802	153	916	93	*	*	673	382	*	*
51	4,920	278	1,505	166	136	6	628	381	--	--
52	3,268	196	1,474	133	9	1	635	413	--	--
53	2,984	185	1,629	166	3	*	683	486	--	--
54	2,336	138	1,373	142	17	1	727	575	582	57
55	1,466	89	1,092	92	2	*	743	681	--	--
56	1,172	60	553	98	178	22	971	772	--	--
57	--	--	413	72	339	35	1,306	1,063	--	--
58	--	--	675	95	15	2	1,728	1,162	150	9
59	--	--	330	50	89	14	1,349	1,003	461	50
1960	--	--	150	20	372	12	936	918	75	1
61	--	--	147	25	250	11	1,149	1,066	110	1
62	--	--	72	22	--	--	1 151	943	416	10
63	--	--	645	53	--	--	1,412	1,486	470	22
64	--	--	491	43	--	--	1,052	2,163	959	52
65	--	--	134	26	646	15	756	1,549	115	2
66	--	--	--	--	1,388	155	646	1,290	239	42
67	--	--	147	26	896	61	626	1,657	534	--
68	--	--	--	--	1,409	103	741	2,141	780	--
69	--	--	--	--	78	4	809	1,943	--	--
1970	--	--	--	--	510	--	1,190	4,062	1,476	298
71	--	--	--	--	--	--	650	2,925	561	22
72	--	--	--	--	72	12	572	2,328	--	--
73	--	--	--	--	--	--	606	3,646	--	--
74	--	--	--	--	16	8	544	3,925	--	--

* Less than 500 pounds or $500.

1/ Reported in gallons for same years. Converted to pounds on the basis of 7.5 pounds to a gallon.

Source: 1940-73, Natl. Mar. Fish. Serv. (1943a-1976a).
1974, Natl. Mar. Fish. Serv. (1976b).

Appendix 9. Imports of salmon to the United States by country of origin, 1970-74.1/

Country	1970		1971		1972		1973		1974	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousand pounds and dollars)									
					Fresh/Chilled/Frozen2/					
Canada	7,291	6,511	6,978	5,752	18,549	11,852	18,008	16,323	12,270	13,821
Japan	102	80	691	250	138	84	202	156	183	235
Other	54	65	15	25	9	5	27	55	30	61
Total	7,447	6,656	7,684	6,027	18,696	11,941	18,237	16,534	12,483	14,117
					Salted/Pickled					
Canada	81	79	89	78	1	2	20	34	98	181
Japan	4	6	2	4	2	3	3	7	--	--
Other	1	*	0	0	0	0	0	0	--	--
Total	86	85	91	82	3	5	23	41	111	201
					Smoked/Kippered					
Canada	12	19	37	56	56	86	56	99	42	107
U. Kingdom	11	39	22	73	18	67	19	79	21	83
Other	11	26	17	32	5	20	9	30	13	44
Total	34	84	76	161	79	173	84	208	76	234
					Canned					
Canada	1,495	823	1,101	765	4,755	3,334	2,646	2,046	5,051	7,130
Japan	739	505	416	333	6,884	4,677	5,207	4,136	3,490	4,685
Norway	188	122	2	2	1	1	*	1	--	--
Other	19	127	32	32	7	27	6	14	12	49
Total	2,441	1,577	1,551	1,132	11,647	8,039	7,859	6,197	8,553	11,864

1/ In product weight. Includes some quantity (probably minor) of Atlantic Salmon products.

2/ Primarily round Salmon (dressed, head-off).

Source: U. S. Bureau of Census (1971a - 1975a).

Appendix 10. U.S. exports of salmon by country of destination, 1970-74.1/

Country	1970		1971		1972		1973		1974	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	----------------------------(Thousand pounds and dollars)----------------------------									
					Fresh/Chilled/Frozen2/					
Canada	2,818	952	2,345	1,353	1,382	871	4,283	3,753	2,789	2,981
Sweden	2,561	1,599	3,220	1,948	6,001	4,475	3,991	3,924	4,092	4,464
U. Kingdom	2,748	2,077	3,712	2,580	5,572	5,005	6,065	7,061	3,426	3,925
France	4,136	3,505	5,626	3,960	9,607	9,204	8,618	8,766	6,945	9,556
Belgium	784	557	890	728	1,440	1,314	2,250	2,280	1,921	2,593
Japan	2,697	1,182	4,115	1,995	2,455	1,149	25,162	24,380	3,836	3,918
Other	1,574	872	2,470	1,855	3,037	2,646	5,326	4,206	3,100	4,595
Total	17,318	10,744	22,378	14,419	29,494	24,664	55,695	54,370	26,109	32,032
					Fillet/Steak/Portion					
Canada	1,542	989	1,638	1,080	1,315	794	382	317	448	366
U. Kingdom	1,472	1,251	1,160	962	661	661	537	615	121	147
Frace	1,469	1,441	1,329	1,104	1,001	861	858	1,033	344	487
Japan	4,979	2,644	5,377	2,966	1,030	579	2,405	2,396	371	968
Other	1,420	1,075	1,009	728	1,184	892	866	910	674	923
Total	10,882	7,400	10,513	6,840	5,191	3,787	5,048	5,271	1,958	2,891
					Canned					
Canada	3,970	2,822	3,496	2,747	1,927	1,895	211	235	138	140
U. Kingdom	8,399	6,865	10,364	9,513	15,832	15,674	13,464	21,559	5,328	8,308
Netherlands	1,671	1,335	1,964	1,606	1,387	1,418	1,041	1,738	413	662
Australia	437	342	575	496	666	666	908	1,548	1,164	2,095
Other	2,334	1,770	1,834	1,567	1,546	1,246	1,317	1,733	1,277	2,053
Total	16,811	13,134	18,233	15,929	21,358	20,899	16,941	26,813	8,320	13,258

1/ In product weight.
2/ Primarily round Salmon (dressed, head off).

Source: U. S. Bureau of Census (1971b-1975b).

Appendix 11. Approximate proportion of U.S. Pacific salmon catch going into canned product, 1955-75. 1/

Year	Landing	Canned: Product weight	Canned: Round-weight	Percent of landing	Landing	Canned: Product weight	Canned: Round-weight	Percent of landing	Landing	Canned: Product weight	Canned: Round-weight	Percent of landing
	(Thousand pounds)				(Thousand pounds)				(Thousand pounds)			
	Chinook				Sockeye				Coho			
1955	42,742	8,461	12,087	28	55,458	35,970	51,386	93	26,212	10,021	14,316	55
56	38,397	7,901	11,287	29	86,517	56,797	81,139	94	29,173	9,050	12,929	44
57	28,234	6,814	9,734	34	76,911	46,250	66,071	86	22,894	9,770	13,957	61
58	27,593	6,589	9,413	34	67,825	45,617	65,167	96	23,311	7,256	10,366	44
59	27,414	6,051	8,644	32	53,790	35,369	50,527	94	20,205	9,145	13,064	65
1960	24,057	4,809	6,870	29	95,326	63,188	90,269	95	13,665	4,429	6,327	46
61	26,962	5,523	7,890	29	103,644	69,200	98,857	95	23,201	7,931	11,330	49
62	25,111	5,557	7,939	32	58,049	40,162	57,374	99	27,752	7,553	10,790	39
63	27,179	4,649	6,641	24	43,424	29,086	41,551	96	28,131	7,947	11,353	40
64	28,732	4,599	6,570	23	57,350	37,291	53,273	93	38,071	10,515	15,021	40
65	29,316	6,317	9,024	31	148 119	97,978	139,969	94	38,515	8,951	12,787	33
66	27,223	4,016	5,737	21	102,012	66,506	95,009	93	38,755	9,865	14,093	36
67	26,181	4,387	6,267	24	66,013	41,432	59,189	90	38,290	6,668	9,526	25
68	25,838	3,370	4,814	19	54,047	34,301	49,001	91	37,786	7,868	11,240	30
69	28,028	3,334	4,763	17	81,444	42,304	60,434	74	21,326	5,932	8,474	40
1970	31,685	2,444	3,491	11	159,568	87,897	125,567	79	43,708	6,455	9,221	21
71	30,501	3,655	5 221	17	106,420	66,612	95,160	89	39,875	8,191	11,701	29
72	26,863	2,335	3,336	12	49,114	29,371	41,959	85	31,520	3,166	4,523	14
73	35,992	1,262	1,803	5	50,709	19,534	27,906	55	32,867	3,130	4,471	14
74	26,829	3,097	4,424	16	53,916	31,315	44,736	83	37,839	10,762	15,374	41
75	31,252	702	1,003	3	52,324	27,963	39,947	76	28,020	1,137	1,624	6
	Pink				Chum				Total			
1955	126,083	80,360	114,800	91	32,614	22,384	31,977	98	282,005	157,196	224,566	80
56	88,205	57,155	81,650	93	54,859	36,955	52,793	96	297,151	167,858	239,797	81
57	73,169	46,336	66,194	90	65,208	44,378	63,397	97	266,416	153,548	219,354	82
58	120,723	75,292	107,560	89	68,047	44,077	62,967	92	307,499	178,831	255,473	83
59	61,740	39,352	56,217	91	38,535	27,939	39,913	(1.04)	201,684	117,856	168,366	84
1960	52,588	32,904	47,006	89	49,811	30,422	43,460	87	235,447	135,752	193,931	82
61	108,452	64,977	92,824	86	48,139	29,483	42,119	87	310,398	177,114	253,020	82
62	143,309	92,857	132,653	93	60,345	36,028	51,469	85	314,566	182,157	260,224	83
63	156,603	93,911	134,159	86	38,840	22,194	31,706	82	294,177	157,787	225,410	77
64	162,325	93,123	133,033	82	65,842	34,774	49,677	75	352,246	180,302	257,574	73
65	79,655	45,596	65,137	82	31,266	15,391	21,987	70	326,806	174,233	248,904	76
66	163,016	99,291	141,844	87	56,506	29,345	41,921	74	387,512	209,023	298,604	77
67	51,721	29,590	42,271	82	34,459	17,295	24,707	72	216,664	99,372	141,960	65
68	148,472	88,395	126,279	85	61,466	31,418	44,883	73	327,609	165,352	236,217	72
69	112,214	60,550	86,500	77	24,816	10,183	14,547	59	267,828	122,303	174,719	65
1970	117,762	64,313	91,876	78	57,396	22,344	31,920	56	410,119	183,453	262,076	64
71	99,096	60,056	85,794	87	56,423	29,818	42,597	75	332,315	168,332	240,474	72
72	50,000	29,140	41,629	83	74,308	28,820	41,171	55	231,805	92,832	132,617	57
73	49,423	23,336	33,337	67	52,655	14,971	21,387	41	221,646	62,427	89,181	40
74	37,347	23,998	34,283	92	40,889	22,315	31,879	78	196,820	91,554	130,791	66
75	56,198	29,952	42,789	76	33,797	5,593	7,990	24	201,519	65,347	93,353	46

1/ Product weight was converted to round (landed) weight using the conversion factor 0.70.

Source: 1955-73, Natl. Mar. Fish. Serv. (1958a-1976a). 1974-75 catch, Natl. Mar. Fish. Serv. (1976c). 1974 canned data, Natl. Mar. Fish. Serv. (1976b). 1975 canned data, National Fishermen (1976).

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Appendix 13. Number of salmon processing plants in Alaska by district, 1962-74. 1/

	Canned				Fresh/frozen				Cured				Salmon roe			
Year	SE	Cen.	Wes.	Total	SE	Cen.	Wes.	Total	SE	Cen.	Wes.	Total	SE	Cen.	Wes.	Total
	(Number of plants)															
1962	20	40	19	78	12	15	9	34	20	17	16	53	--	--	--	--
63	24	40	21	84	14	15	7	33	23	19	15	57	--	--	--	--
64	21	35	16	69	15	15	10	40	21	25	12	58	--	--	--	--
65	19	32	19	64	16	14	9	39	6	10	8	22	--	--	--	--
66	20	37	23	79	22	20	21	61	10	13	16	39	--	--	--	--
67	21	31	19	70	19	18	20	56	7	9	12	28	20	11	14	45
68	20	30	19	69	19	22	20	61	7	11	18	36	23	24	19	66
69	17	35	19	71	18	25	19	62	6	20	17	43	26	39	27	92
1970	18	35	19	72	24	23	30	77	4	11	15	30	23	29	27	79
71	13	30	19	62	21	28	31	80	5	15	15	35	13	30	18	61
72	14	32	14	60	26	33	29	88	2	9	7	18	22	36	21	79
73	14	24	9	47	27	39	29	95	0	8	7	15	21	27	20	68
74	16	23	10	49	25	33	33	91	1	13	10	24	22	28	20	70

1/ Districts: Southeastern (SE); Central (Cen); and Western (Wes.).

Source: Alaska Dept. Fish Game (no date).

Appendix 14. U.S. imports of edible salmon products, 1940-74.

Year	U.S. salmon imports										Total U.S. imports of edible products		Percent salmon	
	Round/dressed[1/]		Canned		Smoked/kippered		Salted/pickled		Total					
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousand pounds and dollars)												(Percent)	
1940	7,098	814	216	32	5	2	864	160	8,183	1,008	302,518	29,073	3	4
41	8,053	972	277	43	3	1	929	167	9,262	1,183	305,875	28,040	3	4
42	5,193	986	130	17	24	6	969	197	6,316	1,206	277,199	28,984	2	4
43	5,208	1,450	25	6	4	1	1,120	293	6,357	1,750	324,476	43,689	2	4
44	5,290	1,538	195	65	29	6	1,963	662	7,477	2,271	339,431	53,431	2	4
45	6,572	1,690	169	68	30	10	1,257	376	8,028	2,144	404,768	76,434	2	3
46	9,323	2,817	56	26	30	11	1,029	311	10,438	3,165	473,539	89,986	2	4
47	22,007	5,332	32	12	22	7	780	286	22,841	5,637	407,636	83,275	6	7
48	23,952	7,159	882	299	123	51	773	288	25,730	7,797	472,742	111,660	5	7
49	24,747	5,658	918	255	84	35	683	266	26,432	6,214	470,517	113,753	6	6
1950	44,975	10,920	419	113	23	13	568	268	45,985	11,314	639,725	158,414	7	7
51	27,526	7,505	568	193	22	14	426	218	28,542	7,930	646,668	158,363	4	5
52	33,587	8,242	9,544	3,215	13	9	428	227	43,572	11,693	705,118	183,121	6	6
53	27,364	7,010	12,165	4,325	4	1	343	174	39,876	11,510	726,195	195,860	6	6
54	32,902	7,402	11,371	3,723	30	16	132	67	44,435	11,208	804,054	203,722	6	6
55	16,945	5,488	14,644	5,173	10	7	67	41	31,666	10,709	780,185	208,973	4	5
56	12,940	5,427	28,802	11,650	8	7	40	23	41,790	17,107	801,655	234,699	5	7
57	15,677	5,698	24,401	9,470	21	22	82	47	40,181	15,237	900,227	252,788	4	6
58	26,180	9,389	29,226	11,271	7	7	70	40	55,483	20,707	1,020,326	283,822	5	7
59	19,700	7,232	31,154	11,130	40	46	14	7	50,908	18,415	1,141,114	315,650	4	6
1960	13,472	6,340	19,113	7,541	48	55	8	7	32,641	13,943	1,095,014	310,596	3	5
61	12,309	5,909	7,167	3,545	25	30	16	6	19,517	9,490	1,087,175	339,318	2	3
62	9,735	5,539	6,843	3,436	45	56	19	7	16,642	9,038	1,255,532	405,832	1	2
63	8,898	5,103	1,249	605	83	111	52	38	10,282	5,857	1,196,977	399,928	1	2
64	8,818	5,560	236	128	102	135	3	4	9,159	5,827	1,318,099	433,674	1	1
65	7,861	5,154	101	80	90	122	40	29	8,092	5,385	1,398,778	479,412	1	1
66	8,296	5,914	589	345	89	130	42	32	9,016	6,421	1,593,714	568,091	1	1
67	8,815	6,502	121	106	51	79	9	7	8,996	6,694	1,470,437	538,301	1	1
68	9,811	7,062	4,955	2,820	40	73	114	114	14,920	10,069	1,741,365	643,165	1	2
69	8,425	6,892	2,217	1,376	44	78	94	97	10,780	8,443	1,706,571	704,809	1	1
1970	7,448	6,656	2,441	1,577	34	85	86	85	10,009	8,403	1,873,300	812,530	1	1
71	7,684	6,027	1,551	1,132	76	161	91	81	9,402	7,401	1,785,470	887,070	1	1
72	18,696	11,941	11,647	8,039	79	173	3	5	30,425	20,158	2,341,138	1,233,292	1	2
73	18,237	16,534	7,859	6,197	84	208	23	40	26,203	22,979	2,416,193	1,398,484	1	2
74	12,483	14,031	8,553	11,864	76	234	111	201	21,223	26,330	2,211,997	1,477,918	1	2

1/ Primarily dressed, head-off

Source: 1940-73, Natl. Mar. Fish. Serv. (1943a-1976a). 1974 data, Natl. Mar. Fish Serv. (1975-b)

Appendix 15. U.S. exports of edible salmon products, 1940-74.

Year	U.S. salmon exports[1/]												Total U.S. exports of edible products[1/]		Percent salmon	
	Fresh/frozen[2/]		Fillet & steak[3/]		Canned		Salted/pickled		Salted roe[4/]		Total					
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousand pounds and dollars)														(Percent)	
1940	1,654	92	--	--	56,212	10,116	251	55	--	--	58,117	10,263	144,804	17,115	40	60
41	1,945	130	--	--	48,054	6,304	218	52	--	--	50,217	6,486	215,990	21,479	23	30
42	208	34	--	--	39,994	7,312	84	13	--	--	40,286	7,359	167,080	27,876	24	26
43	8	3	--	--	69,486	18,014	18	5	--	--	69,512	18,022	239,260	43,244	29	42
44	400	44	--	--	50,156	21,205	41	16	--	--	50,597	21,265	112,230	31,929	45	67
45	856	140	--	--	34,548	13,279	256	49	--	--	35,660	13,468	135,979	30,855	26	44
46	127	44	--	--	51,359	12,890	1,339	492	--	--	52,825	13,426	200,398	38,353	26	35
47	593	217	--	--	61,574	19,745	781	304	--	--	62,948	20,266	207,486	49,281	30	41
48	130	58	--	--	2,641	1,305	162	62	--	--	2,933	1,425	95,085	21,020	3	7
49	2,172	340	--	--	12,832	6,041	158	58	--	--	15,162	6,439	146,660	29,212	10	22
1950	52	23	--	--	1,681	811	98	50	--	--	1,831	884	121,623	18,856	2	5
51	802	220	--	--	2,060	1,007	61	35	--	--	2,923	1,262	165,624	27,072	2	5
52	267	97	--	--	1,428	820	162	88	--	--	1,857	1,005	62,056	15,511	3	6
53	848	330	--	--	2,277	1,112	239	125	--	--	3,364	1,567	69,308	17,084	5	9
54	1,780	583	--	--	7,227	3,715	388	225	--	--	9,395	4,523	62,724	16,238	15	28
55	826	339	--	--	10,429	6,599	547	340	--	--	11,802	7,278	109,750	24,923	11	29
56	1,676	694	--	--	5,213	3,606	636	399	--	--	7,525	4,699	101,918	22,939	7	20
57	1,032	446	--	--	6,688	4,740	353	226	--	--	8,073	5,412	85,221	20,549	10	26
58	1,083	476	--	--	9,227	6,669	491	357	--	--	10,801	7,502	65,468	19,440	16	39
59	1,467	659	--	--	13,826	10,639	491	372	--	--	15,784	11,400	80,688	26,747	20	43
1960	2,849	1,677	--	--	11,924	9,830	529	435	--	--	15,302	11,942	61,454	25,622	25	47
61	1,104	652	--	--	7,190	5,583	641	596	--	--	8,935	6,831	48,550	25,397	18	27
62	1,514	876	--	--	8,983	7,297	569	528	--	--	11,066	8,701	62,475	26,406	18	33
63	4,953	2,563	--	--	10,228	8,239	577	510	1,061	503	16,819	11,815	75,961	38,251	22	31
64	22,676	5,431	--	--	20,936	14,856	1,006	747	2,971	1,694	47,589	22,728	109,683	52,037	43	44
65	10,644	5,396	--	--	24,900	15,920	--	--	2,845	2,019	38,389	23,335	109,958	59,032	35	40
66	19,904	10,676	--	--	20,484	14,561	--	--	3,458	3,067	43,846	28,304	125,526	76,968	35	37
67	18,980	11,527	--	--	20,569	15,610	--	--	6,284	7,419	45,833	34,556	128,247	87,238	36	40
68	16,364	10,167	--	--	5,726	4,604	--	--	7,280	8,689	29,370	23,460	103,551	69,336	28	34
69	30,568	19,141	--	--	15,536	11,565	--	--	5,968	6,106	52,162	36,812	157,377	103,002	33	36
1970	17,739	11,031	10,882	7,400	16,811	13,134	--	--	9,716	11,074	55,148	42,639	162,360	116,852	34	36
71	23,481	15,525	10,313	6,840	18,233	17,930	--	--	9,342	11,845	61,569	50,140	191,543	136,652	32	37
72	30,391	25,379	5,191	3,787	21,411	20,938	--	--	6,555	11,264	63,548	61,368	189,563	153,694	34	40
73	56,140	54,944	5,048	5,271	16,965	26,834	--	--	5,465	16,046	83,618	103,095	259,519	271,107	32	38
74	26,426	32,439	1,958	2,891	8,322	13,262	--	--	5,351	16,153	42,057	64,745	195,465	215,582	22	30

1/ Includes "exports of foreign fishery products" category of U.S. Statistics starting in 1961.

2/ This category is comprised primarily of round salmon (dressed, head-on or head-off). Through 1969, however, salmon fillets and steaks were also included under this category.

3/ Fresh, chilled, or frozen fillets, steaks, or portions. This category appeared in U.S. Bureau of Census export data starting in 1970.

4/ Export data were not available on this product. For this report, however, it was assumed that 95% of the domestic production of salted salmon roe (Appendix 7) was exported to Japan.

Source: 1940-73. Natl. Mar. Fish. Serv. (1943a-1976a).
1974. Natl. Mar. Fish. Serv. (1975b).
Fillet and steak export data are from U.S. Bur. Census (1971b-1975b).

Appendix 16. Salmon catch and number of operating units in the U.S. commercial salmon fishery, 1959-75.

Salmon Landings										
Year	By state					By species				
	Alaska	Wash.	Ore.	Calif.	Total	Sockeye	Pink	Chum	Coho	Chinook
	(million pounds)									
1959	147.3	42.3	5.3	6.8	201.7	53.8	61.7	38.5	20.2	27.4
60	207.1	16.5	5.6	6.2	235.4	95.3	52.6	49.8	13.7	24.0
61	264.8	29.9	7.0	8.6	310.3	103.6	108.4	48.1	23.2	27.0
62	277.8	22.8	7.2	6.7	314.5	58.0	143.3	60.3	27.8	25.1
63	223.1	55.0	8.3	7.9	294.3	43.4	156.6	38.8	28.1	27.2
64	311.6	21.3	9.9	9.5	352.3	57.4	162.3	65.8	38.1	28.7
65	274.8	30.4	11.8	9.7	326.7	148.1	80.0	31.3	38.5	29.3
66	333.3	32.4	12.4	9.4	387.5	102.0	163.0	56.5	38.8	27.2
67	138.5	53.4	17.4	7.4	216.7	66.0	51.7	34.5	38.3	26.2
68	285.3	25.8	9.6	7.0	327.7	54.0	148.5	61.5	37.8	25.8
69	219.2	32.0	10.6	6.1	267.9	81.4	112.2	24.8	21.3	28.0
1970	346.5	37.6	19.4	6.6	410.1	160.0	117.8	57.4	43.7	31.7
71	251.7	55.0	17.0	8.1	331.8	105.9	99.1	56.4	39.9	30.5
72	179.7	34.0	11.7	6.4	231.8	49.1	50.0	74.3	31.5	26.9
73	136.5	58.5	16.9	9.7	221.6	50.1	49.4	52.7	32.9	36.0
74 1/	131.6	--	--	--	196.8	53.9	37.4	40.9	37.8	26.8
75 1/	--	--	--	--	201.5	52.3	56.2	33.8	28.0	31.2

Operating Units										
Year	Fishermen 2/					Vessels & boats 3/				
	Alaska	Wash.	Ore.	Calif.	Total	Alaska	Wash.	Ore.	Calif.	Total
	(number)									
1959	10,593	6,810	1,545	3,060	22,008	6,089	3,745	1,240	1,665	12,739
60	14,294	6,029	1,678	3,742	25,743	7,163	3,403	1,253	1,812	13,631
61	14,736	6,119	1,789	4,380	27,024	9,156	3,919	1,360	2,121	16,556
62	14,695	5,871	1,668	4,159	26,393	9,507	3,427	1,247	2,034	16,215
63	18,305	6,804	1,806	3,754	30,669	9,910	3,964	1,358	2,017	17,249
64	16,108	5,572	1,840	4,495	28,015	9,759	3,230	1,374	2,249	16,612
65	17,176	6,279	1,945	4,754	30,154	10,369	4,001	1,496	2,284	18,150
66	17,884	5,820	2,244	5,715	31,663	10,828	3,834	1,638	2,617	18,917
67	15,233	7,282	3,225	6,189	31,929	9,159	4,549	2,268	2,576	18,552
68	17,538	6,856	3,397	5,805	33,596	10,600	4,752	2,483	2,381	20,216
69	19,022	7,675	3,160	7,382	37,239	12,517	4,941	2,331	3,043	22,832
1970	21,697	7,640	3,222	4,402	36,961	13,090	5,146	2,337	2,201	22,774
71	17,475	9,139	3,961	5,080	35,655	10,101	6,407	2,942	2,540	21,990
72	16,731	7,696	4,246	4,292	32,965	10,477	5,576	3,341	2,146	21,540
73	17,427	7,946	4,746	6,908	37,027	10,638	5,898	2,841	3,454	22,831

Operating Units (cont'd)				
Year	Canning plants			
	Natural pack	Smoked	Caviar	Eggs for bait
	(number)			
1959	104	--	3	7
60	107	--	3	8
61	111	18	3	10
62	108	25	3	8
63	118	28	4	7
64	108	34	4	9
65	102	29	4	8
66	112	28	4	8
67	108	36	4	7
68	105	35	5	7
69	106	34	4	9
1970	81	27	4	11
71	72	19	4	9
72	72	20	3	6
73	72	17	3	7

Appendix 16.-- (Cont'd)

1/ Catch by state was unavailable at the time of this report.

2/ Number of full-time and part-time fishermen on vessels, boats and on shore under the fishing gear categories shown in footnote 3.

3/ Number of vessels (5 net tons or over) and boats (less than 5 net tons) recorded under the following fishing gear categories:

State	District	Operating units, gear
Alaska	Southeastern	Purse seine, floating trap, gillnet, troll
	Central	Purse seine, gillnet, troll
	Western	Purse Seine, gillnet, fish wheel
Washington	Puget Sound	Purse seine, pound net, gillnet, troll, reefnet
	Coastal	Gillnet, troll
	Columbia River	Gillnet, troll
Oregon	Columbia River	Gillnet, troll
	Coastal	Troll
California	Northern	Troll
	San Francisco	Troll
	Monterey	Troll
	Santa Barbara	Troll
	San Pedro	Troll

Data Source: 1959-73, Natl. Mar. Fish. Serv. (1962a-1976a).
1974-75, Natl. Mar. Fish. Serv. (1976c).

Appendix 17--Partial listing of reports touching on the structure, performance, or market aspects of the U.S. Pacific salmon fishery.

Published reports

Crutchfield, James A., and Dougald MacFarlane. 1968. Economic valuation of the 1965-1966 salt-water fisheries of Washington. Wash. Dept. Fish., Res. Bull. No. 8. 57 p.

Crutchfield, James A., and Guilio Pontecorvo. 1969. The Pacific salmon fisheries: A study of irrational conservation. Resources for the Future, Inc. Johns Hopkins Press, Baltimore, Md. 220 p.

Economic and Marketing Research Division. Food fish: Market review and outlook. Published quarterly by Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Wash. D.C. Current Economic Analysis F-series.

National Marine Fisheries Service. 1973. Basic economic indicators: Salmon, 1947-72. Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Curr. Econ. Stat. No. 6129. 61 p.

O'Rourke, A.D., and D.B. DeLoach. 1971. The California fresh and frozen fishery trade. Univ. Calif., Calif. Agr. Exp. Sta., Bull. 850. 79 p.

Processed reports (These may not be available to the general public because of the limited number of copies prepared, or because of the provisional nature of the data/report.)

Owers, James. Costs and earnings of Alaskan fishing vessels-an economic survey. Alaska Commercial Fisheries Entry Commission. Sept. 10, 1974. 40 p.

The following are Research File Manuscripts of the Economic Research Division, National Marine Fisheries Service:

Bell, Frederick W. The factors behind different growth rates of U.S. fisheries. File Manuscr. No. 13, Jan. 1969. 10 p.

Nash. D.A., A.A. Sokoloski, and D.P. Cleary. Elememts crucial to the future of Alaskan commercial fisheries. File Manuscr. No. 24. Aug. 1969. 58 p.

Bell, Frederick W., Darrel A. Nash, Ernest W. Carlson, Frederick V. Waugh, Richard K. Kinoshita, and Richard F. Fullenbaum. The future of the world's fishery resources: Forecasts of demand, supply and prices to the year 2000 with a discussion of implications for public policy. File Manuscr. No. 71-1, Dec. 1970. 250 p.

Bell, Frederick W., Darrel A. Nash, Ernest W. Carlson, Frederick V. Waugh, Richard K. Kinoshita, and Richard F. Fullenbaum. Appendix to the future world's fishery resources: Forecasts of demand, supply and prices to the year 2000 with a discussion of implications for public policy. File Manuscr. No. 71-2, Dec. 1970. 140 p.

Schary, Philip B., Robert E. Shirley, and B. Linn Soule. Distribution of fresh and frozen salmon: Analysis and simulation. File Manuscr. No. 94, Sept. 1971. 55 p.

Schary, Philip B., Robert E. Shirley, and B. Linn Soule. Analysis of the distribution system for northwest-originated fresh and frozen salmon, Vol. I. File Manuscr. No. 95-1, Sept. 1971. 184 p.

Schary, Philip B., Robert E. Shirley, and B. Linn Soule. Analysis of the distribution system for northwest-originated fresh and frozen salmon, Vol. II. File Manuscr. No. 95-2, Sept. 1971. 159 p.

Bell, Frederick W., and Richard K. Kinoshita. The measurement and analysis of labor productivity changes in United States fisheries. File Manuscr. No. 106, July 1971. 229 p.

Bell, Frederick W., and Richard Kinoshita. Productivity gains in U.S. fisheries. File Manuscr. No. 113, Oct. 1972. 27 p.

Bell, Frederick W., William E. Schaaf, Ernest W. Carlson, and George Hirschhorn. Executive summary for the extent of capitalization in United States fisheries. File Manuscr. No. 127, Aug. 1972. 23 p.

Bell, Frederick W., William E. Schaaf, Ernest W. Carlson, and George Hirschhorn. The extent of capitalization in United States fisheries. File Manuscr. No. 128, Aug. 1972. 419 p.

Bell, Frederick W., William E. Schaaf, Ernest W. Carlson, and George Hisrchhorn. Appendix to the extent of capitalization in United States fisheries. File Manuscr. No. 129, Aug. 1972. pp. 423-622.

Penn, Erwin W. Price spreads and cost analyses for finfish and shellfish products at different marketing levels (Revised). File Manuscr. No. 136, Mar. 1973. 113 p.

Noetzel, Bruno G. Some notes on costs of canned salmon imported from Japan. File Manuscr. No. 146, Jul. 1970. 29 p.

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Appendix 18. U.S. wholesale price index (1960-76), and Japanese wholesale and consumer price index (1967-74).

U.S. Wholesale Price Index, All Commodities[1/]

1967=100

Year	Avg.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1960	94.9	94.7	94.7	95.2	95.2	95.0	94.8	95.0	94.6	94.6	94.9	94.9	94.8
61	94.5	95.2	95.2	95.2	94.7	94.3	93.8	94.2	94.3	94.3	94.3	94.3	94.6
62	94.8	95.0	94.9	94.9	94.6	94.4	94.3	94.6	94.7	95.4	94.8	94.9	94.6
63	94.5	94.7	94.4	94.2	94.0	94.3	94.5	94.8	94.6	94.5	94.7	94.9	94.5
64	94.7	95.2	94.7	94.6	94.5	94.3	94.3	94.6	94.5	94.9	95.0	94.9	94.9
65	96.6	95.2	95.4	95.5	95.9	96.2	96.9	97.0	97.0	97.1	97.2	97.5	98.1
66	99.8	98.6	99.3	99.3	99.4	99.5	99.6	100.3	100.7	100.7	100.1	99.8	99.8
67	100.0	100.1	99.9	99.6	99.2	99.7	100.2	100.3	100.0	100.1	100.1	100.1	100.8
68	102.5	101.1	101.9	102.1	102.1	102.4	102.5	102.8	102.5	102.9	102.9	103.3	103.6
69	106.5	104.3	104.7	105.3	105.5	106.3	106.7	106.8	106.9	107.1	107.4	108.1	108.5
1970	110.4	109.3	109.7	109.9	109.9	110.1	110.3	110.9	110.5	111.0	111.0	110.9	111.0
71	113.9	111.8	112.8	113.0	113.3	113.8	114.3	114.6	114.9	114.5	114.4	114.5	115.4
72	119.1	116.3	117.3	117.4	117.5	118.2	118.8	119.7	119.9	120.2	120.0	120.7	122.9
73	134.7	124.5	126.9	129.8	130.5	133.2	136.0	134.3	142.1	139.7	138.7	139.2	141.8
74	160.1	146.6	149.5	151.4	152.7	155.0	155.7	161.7	167.4	167.2	170.2	171.9	171.5
75	174.9	171.8	171.3	170.4	172.1	173.2	173.7	175.7	176.7	177.7	178.9	178.2	178.7
76	182.9	179.3	179.3	179.6	181.3	181.8	183.1	184.3	183.7	184.7	185.2	185.6	187.1

Japanese Price Index[2/]
1965=100

Year	Wholesale (All commodities)	Consumer (General, Urban)
1960	98.0	74.0
1961	99.0	77.9
1962	97.3	83.2
1963	99.0	89.5
1964	99.2	92.9
1965	100.0	100.0
1966	102.4	105.1
1967	104.3	109.2
1968	105.1	115.0
1969	107.4	121.3
1970	111.3	130.7
1971	110.4	138.7
1972	111.3	145.0
1973	129.0	161.9
1974	169.4	201.5

1/ Source: U.S. Dept. Labor, Bur. Labor Stat., Wash., D.C. 20212. (Typewritten) 2 p.

2/ Source: Min. For. Agric., Japan (1966b-1968b, 1972b, 1976b).

Appendix 19. Pacific salmon landings and products--Canada, 1950-75.

			Food products[1/]										Industrial products[1/]			
	Landings[2/]		Canned		Whole/dressed[3/]		Frozen/fillet		Mild cured		Smoked		Meal		Oil	
Year	Metric tons	Thousand pounds	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
			(Thousand pounds and thousand Canadian dollars)													
1950	83,942	185,058									--	--				
51	91,334	201,355									--	--				
52	68,322	150,623									--	--				
53	86,338	190,341									220	--				
54	82,248	181,324	83,702	38,436	43,642	10,165	1,440	593	488	240	220	--	4,222	251	1,149	81
55	60,880	134,216	67,719	32,665	26,272	8,572	791	336	586	328	220	--	3,308	233	1,890	195
56	52,956	116,747	53,514	31,851	27,907	11,038	790	430	628	425	220	--	2,814	177	1,344	119
57	61,545	135,682	68,391	35,295	23,975	7,915	689	379	608	401	220	--	3,836	225	1,833	157
58	83,939	185,052	91,332	58,873	42,879	14,625	311	169	491	378	220	--	4,048	252	9,757	688
59	49,579	109,302	51,835	34,594	20,356	9,062	238	126	692	531	--	--	2,724	154	1,293	85
1960	35,084	77,346	30,571	23,013	27,791	11,756	91	66	485	472	--	--	1,448	68	546	34
61	56,750	125,111	67,624	46,333	21,266	9,723	101	68	401	377	--	--	2,562	133	1,390	74
62	75,944	167,426	87,302	55,967	24,496	12,286	119	80	330	329	--	--	3,072	190	1,476	77
63	56,028	123,519	57,928	34,667	26,541	13,016	134	85	351	365	--	--	2,314	127	1,069	82
64	58,366	128,674	60,424	48,873	32,254	17,367	84	56	422	431	--	--	1,858	114	710	57
65	43,165	95,162	44,202	35,274	25,036	14,729	81	54	313	321	--	--	1,056	72	594	46
66	76,449	168,540	87,829	64,365	31,602	19,585	13	9	147	155	441	--	3,008	233	1,184	96
67	62,929	138,733	70,600	57,311	28,971	18,935	13	10	324	369	661	--	1,882	128	930	45
68	82,608	182,118	84,086	67,701	42,236	27,567	37	27	438	566	661	--	4,068	266	1,100	39
69	37,742	83,206	30,285	30,373	30,613	23,452	26	20	231	367	882	--	1,480	103	318	14
1970	72,433	159,686	68,680	59,160	41,641	33,701	35	28	395	704	882	--	2,054	158	--	--
71	63,177	139,280	67,959	66,135	30,455	24,422	37	41	156	250	882	--	3,364	263	1,044	71
72	76,831	169,382	57,064	55,655	60,050	46,389	35	45	113	204	1,102	--	3,590	311	--	--
73	86,861	191,494	75,543	127,921	60,139	70,329	124	145	--	--	1,102	--	3,441	690	1,770	152
74	63,501	139,994	69,015	114,575	28,481	34,970	--	--	--	--	661	--	--	--	--	--
75	36,384	80,212	25,342	43,802	31,497	45,687	132	246	--	--	--	--	--	--	--	--

1/ In product weight. Data on all products, except smoked, are from Environ. Canada (no date). Smoked salmon data are from Food Agric. Organ., U.N. (1952b-1975b).

2/ In round weight. Data source: 1950-71, Int. North Pac. Fish. Comm. (ms 1974); 1972-75, Environ. Canada (no date).

3/ Includes steaks.

Appendix 20. Canadian exports of Pacific salmon by country of destination, 1970-74.

Destination	1970		1971		1972		1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(Thousand pounds and thousand Canadian dollars)											
	Whole or dressed											
U. Kingdom	3,347	2,907	3,776	2,890	4,588	4,001	3,871	4,092	2,304	2,672	1,440	1,869
Denmark	986	689	1,588	1,070	1,914	1,404	2,352	2,234	1,843	1,932	1,492	1,809
France	6,733	6,469	8,292	6,729	11,082	10,835	9,050	12,164	7,833	10,823	12,191	18,369
Sweden	2,368	1,546	3,135	1,919	4,052	2,927	4,004	3,835	4,215	4,387	3,530	4,392
Japan	337	171	1,826	974	1,371	1,017	10,732	11,265	1,219	1,344	1,548	2,158
U.S.	7,105	6,119	7,319	5,864	18,117	11,302	17,083	16,292	12,022	13,060	8,755	10,922
Other	3,867	3,586	5,075	4,432	6,060	5,692	6,903	8,860	4,674	6,465	5,068	7,780
Total	24,743	21,487	31,010	23,878	47,184	37,178	53,995	58,742	34,110	40,683	34,024	47,299
	Canned											
U. Kingdom	6,186	6,568	12,740	13,572	15,679	17,369	21,623	41,141	11,834	22,193	8,426	15,229
Belgium	1,700	1,495	3,347	2,703	2,513	2,138	4,775	6,051	2,921	4,547	2,524	4,003
New Zealand	2,079	1,697	1,285	1,021	1,318	1,157	2,806	4,006	1,135	1,898	571	866
U.S.	362	395	1,196	932	4,295	3,027	2,396	2,250	3,840	6,324	15	20
Australia	324	290	--	--	1,184	1,127	1,120	2,002	3,448	6,261	454	915
Other	4,824	3,643	5,686	4,277	4,746	3,661	5,637	5,935	5,223	7,914	3,292	4,468
Total	15,475	14,088	24,254	22,505	29,735	28,479	38,357	61,385	28,401	49,137	15,282	25,501
	Smoked 1/											
South Africa	214	424	134	258	--	--	--	--	--	--	--	--
Australia	163	323	101	198	--	--	--	--	--	--	--	--
Other	282	488	226	409	--	--	--	--	--	--	--	--
Total	659	1,235	461	865	659	1,233	573	1,372	209	547	179	507
	Pickled 1/											
Sweden	43	82	--	--	--	--	--	--	--	--	--	--
Other	131	63	--	--	--	--	--	--	--	--	--	--
Total	174	145	146	101	170	149	95	153	163	251	238	365

1/ Breakdown by country of destination is not available for smoked salmon starting in 1972, and for pickled salmon, starting in 1971. Furthermore, these products may have included Atlantic salmon but for this report it was assumed that the products are from Pacific salmon.

Source: Environ. Canada (no date).

Appendix 21. Canadian imports of Pacific salmon by country of origin, 1970-74.

Origin	1970 Quantity	1970 Value	1971 Quantity	1971 Value	1972 Quantity	1972 Value	1973 Quantity	1973 Value	1974 Quantity	1974 Value	1975 Quantity	1975 Value
	(Thousand pounds and thousand Canadian dollars)											
	Fresh/frozen 1/											
U.S.	2,994	1,814	3,593	2,239	2,738	2,008	3,463	3,584	3,854	3,018	3,206	3,691
Other	0	0	0	0	0	0	2	5	22	24	--	1
Total	2,994	1,814	3,593	2,239	2,738	2,008	3,465	3,589	3,876	3,042	3,206	3,692
	Canned 1/											
U.S.	3,801	2,684	3,052	2,728	1,724	1,585	540	772	216	266	2,956	3,656
Japan	4	12	194	174	--	--	--	--	--	--	818	953
Other	9	6	10	11	7	9	9	13	2	8	4	7
Total	3,814	2,702	3,256	2,913	1,731	1,594	549	785	218	274	3,778	4,616

1/ In product weight and probably includes a minor amount of Atlantic salmon products.

Source: Environ. Canada (no date).

Appendix 22. Canadian exports and imports of Pacific salmon products, 1958-75.

Year	Salmon Exports[1/]							
	Whole/dressed		Canned		Smoked		Pickled	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	------------------(Thousand pounds and Canadian dollars)------------------							
1958	27,117	9,740	61,288	31,564	220	111	--	--
59	20,062	7,516	34,171	23,425	220	137	--	--
1960	16,094	8,081	15,653	11,409	220	172	--	--
61	14,550	7,360	18,519	12,690	220	138	--	--
62	14,550	7,856	23,589	14,531	220	178	--	--
63	16,094	9,025	33,730	17,805	220	214	--	--
64	18,739	11,072	39,683	23,970	220	242	--	--
65	18,298	11,135	26,455	17,285	220	287	--	--
66	22,230	15,101	25,455	18,616	320	371	469	307
67	23,090	16,948	43,496	33,311	430	571	385	280
68	24,925	18,152	39,949	30,629	435	623	357	236
69	30,180	23,169	35,209	29,767	450	703	281	199
1970	24,742	21,487	15,475	14,088	659	1,233	174	145
71	31,011	23,878	24,254	22,505	461	865	146	101
72	47,184	37,178	29,735	28,479	659	1,235	170	149
73	53,995	58,742	38,357	61,385	573	1,372	95	153
74	34,110	40,683	28,401	49,137	209	547	163	251
75	34,024	47,299	15,282	25,501	179	507	238	365

Year	Salmon Imports[2/]			
	Fresh/frozen		Canned	
	Quantity	Value	Quantity	Value
	-------(Thousand pounds and Canadian dollars)---------			
1958	--	--	--	--
59	--	--	--	--
1960	--	--	--	--
61	--	--	--	--
62	--	--	--	--
63	--	--	--	--
64	--	--	--	--
65	--	--	--	--
66	4,319	1,759	2,333	1,712
67	2,810	1,529	345	245
68	1,418	825	9	6
69	1,918	1,322	3,129	2,107
1970	2,993	1,814	3,815	2,702
71	3,593	2,239	3,256	2,913
72	2,738	2,008	1,731	1,594
73	3,466	3,589	549	785
74	3,876	3,042	218	274
75	3,206	3,692	3,779	4,616

1/ 1958-65 data are from Food Agric. Organ., U.N. (1960b-1966). 1966-75 data are from Environ. Canada (no date).

2/ Source: Environ. Canada (no date).

Appendix 23. Japanese salmon landings in addition to partial information on values, 1955-75.

Period/year	Landings (round-weight)[1/] Mothership fishery	Other fisheries[3/]	Total	Mothership fishery	Other fisheries[3/]	Total	Percent mothership	Processed value[2/] Mothership fishery	Other fishery[3/]	Total
	(Metric tons)			(Million pounds)			(Percent)	(Million dollars)		
5-year average										
1915-1919	0	134,924	134,924	0	297.4	297.4	0	0	--	--
1920-1924	0	157,218	157,218	0	346.6	346.6	0	0	--	--
1925-1929	0	136,470	136,470	0	300.9	300.9	0	0	--	--
1930-1934	0	166,027	166,027	0	366.0	366.0	0	0	--	--
1935-1939	0	283,509	283,509	0	625.0	625.0	0	0	--	--
1940-1944	0	200,091	200,091	0	441.1	441.1	0	0	--	--
1945-1949	0	8,793	8,793	0	19.4	19.4	0	0	--	--
Annual										
1950	0	19,548	19,548	0	43.1	43.1	0	0	--	--
51	0	27,776	27,776	0	61.2	61.2	0	0	--	--
52	3,786	34,758	38,544	8.3	76.6	84.9	10	--	--	--
53	14,682	29,599	44,281	32.4	65.2	97.6	33	--	--	--
54	41,610	37,037	78,647	91.7	81.6	173.3	53	--	--	--
55	116,210	56,291	172,501	256.2	124.1	380.3	67	--	--	--
56	92,870	59,703	152,573	204.7	131.6	336.3	61	49.2	--	--
57	100,001	84,007	184,008	220.5	185.2	405.7	54	66.7	--	--
58	91,618	107,377	198,995	202.0	236.7	438.7	46	51.2	--	--
59	70,917	110,140	181,057	156.3	242.8	399.1	39	44.5	--	--
1960	53,979	94,542	148,521	119.0	208.4	327.4	36	56.4	--	--
61	53,574	104,748	158,322	118.1	230.9	349.0	34	53.9	--	--
62	44,600	74,340	118,940	98.3	163.9	262.2	38	46.9	--	--
63	46,269	104,277	150,546	102.0	229.9	331.9	31	45.1	--	--
64	44,449	75,580	120,029	98.0	166.6	264.6	37	44.4	31.4	75.8
65	45,430	103,780	149,210	100.2	228.8	329.0	30	52.2	49.8	102.0
66	38,931	89,915	128,846	85.8	198.2	284.0	30	41.1	55.5	96.6
67	42,543	108,906	151,449	93.8	240.1	333.9	28	45.4	73.7	119.1
68	37,643	77,592	115,235	83.0	171.1	254.1	33	39.6	59.7	99.3
69	40,271	103,042	143,313	88.8	227.2	316.0	28	55.1	52.4	107.5
1970	36,409	83,407	119,816	80.3	183.9	264.2	30	48.4	70.4	118.8
71	37,238	104,572	141,810	82.1	230.5	312.6	26	41.6	88.5	130.1
72	35,205	86,407	121,612	77.6	190.5	268.1	29	43.9	107.1	151.0
73	35,588	103,429	139,017	78.5	228.0	306.5	26	69.6	195.2	264.8
74	33,563	101,916	135,479	74.0	224.7	298.7	25	59.6	212.4	272.0
75	33,907	132,390	166,290	74.8	291.9	366.6	26	60.3	281.7	342.0

1/ 1915-51 and 1973-75 data are from Min. Agric. For., Japan (1977a). 1952-72 data are from Int. North Pac. Fish. Comm. (ms 1974).

2/ Assumed as representing the value of salmon at various stages of processing -- e.g., whole, dressed, salted, canned, etc. Source: Min. Agric. For., Japan (1969a and 1977a). Converted from yen using 360 yen = U.S. $1.00 (1964-70), 348 yen (1971), 303 yen (1972), 271 yen (1973), 292 yen (1974) and 297 yen (1975).

3/ Composed of other driftnet and longline fisheries and coastal trapnet and freshwater salmon fisheries of Japan.

Appendix 24.--Japanese exports and imports of Pacific salmon products, 1958-75.1/

	Export2/				Import3/			
	Frozen4/		Canned		Frozen4/		Salted roe	
Year	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	- - - - - - - - - - - - - (Thousand pounds			and dollars) - - - - - - - - - - - - -				
1958	13,139	3,564	123,678	68,615	--	--	--	--
59	3,527	1,408	137,126	64,857	--	--	--	--
1960	5,291	2,536	82,672	57,371	--	--	--	--
61	3,086	1,358	58,863	37,097	--	--	--	--
62	3,527	1,639	121,694	91,238	--	--	--	--
63	2,646	1,403	65,697	45,343	--	--	--	--
64	3,086	1,471	61,949	42,524	--	--	--	--
65	882	547	83,113	60,963	--	--	--	--
66	441	281	50,485	38,245	--	--	--	--
67	60	39	60,626	46,337	--	--	--	--
68	42	28	83,995	58,338	--	--	--	--
69	40	44	49,162	38,095	18,470	10,497	6,828	10,254
1970	789	600	52,910	44,948	11,493	5,529	11,667	17,790
71	882	260	63,052	53,757	12,533	6,525	--	--
72	100	42	67,020	55,887	4,903	3,229	10,697	24,908
73	441	363	29,542	38,238	33,400	40,891	10,732	44,163
74	220	326	28,439	44,566	8,724	9,168	9,557	41,120
75	--	--	--	--	15,042	19,726	7,685	40,071

1/ Information on export and import of products other than those shown is not available. Quantity is in product weight.

2/ Source: Food Agric. Organ., U.N. (1962b-1975b).

3/ Source: Natl. Oceanic Atmos. Adm., Natl. Mar. Fish. Serv., Terminal Is., Calif. Foreign Fishery Information Release. Various Releases during 1970-76 and various pagination.

4/ Assumed as dressed, head-off or head-on frozen salmon.

Appendix 25. Partial information on Japanese exports and imports of Pacific salmon products by country (destination or origin) for selected time periods.

Export[1/]

Destination	1970	1971	1972	1973	1974	1970-74 average	Percent
	(Thousand pounds and dollars)						
			Frozen[2/]				
Total quantity	789	882	100	441	220	486	
Total value	600	260	42	363	326	318	
			Canned				
Australia	5,512	10,362	11,464	7,055	5,291	7,937	16
Belgium	1,984	3,086	2,425	882	1,102	1,896	4
France	1,984	2,866	3,748	661	661	1,984	4
Netherlands	3,968	4,189	5,291	2,205	2,646	3,660	8
U. Kingdom	35,935	38,140	33,069	15,873	13,889	27,381	57
U.S.	--	1,102	8,378	1,543	3,748	2,954	6
Other	3,527	3,307	2,645	1,323	1,102	2,381	5
Total quantity	52,910	63,052	67,020	29,542	28,439	48,193	100
Total value[3/]	44,948	53,757	55,887	38,238	44,566	47,479	

Import (11 month data)[4/]

Origin	Fresh/frozen Quantity	Value	Percent quantity	Origin	Salted roe Quantity	Value	Percent quantity
	(Thousand pounds and dollars)						
U.S.	7,990	13,046	69	U.S.	10,840	50,958	79
Canada	1,165	2,059	10	Canada	2,810	14,529	21
U.S.S.R.	1,319	814	11	Other	3	13	*
Rep. of Korea	584	280	5	Total	13,653	65,500	100
Peoples Rep. Korea	530	164	5				
Other	11	7	*				
Total	11,599	16,370	100				

1/ Source: Food Agric. Organ., U.N. (1971b-1975b).
2/ Country of destination is not available on frozen salmon exports.
3/ Value by country is not available.
4/ Total imports for 11 months: Oct.-Nov. of 1975; Jan.-Feb., Apr.-Oct. of 1976. Source: Natl. Oceanic Atmos. Adm., Natl. Mar. Fish. Serv., Terminal Is., Calif. Foreign Fishery Information Release. Various releases and pagination, 1975-76.

Appendix 26. Japanese salmon products, 1950-74.[1/]

Year	Salted			Canned[2/]			Frozen			Smoked			Salted roe		
	On mothership	Other[3/]	Total	On mothership	Other[3/]	Total	On mothership	Other[3/]	Total	On mothership	Other[3/]	Total	On mothership	Other[3/]	Total
	(Thousand pounds, product weight)														
1950	0	23,148	(23,148)	0	441	(441)	0	--	--	0	--	--	0	--	--
51	0	29,542	(29,542)	0	11,023	(11,023)	0	--	--	0	--	--	0	--	--
52	3,624	29,445	(33,069)	0	5,512	(5,512)	3,589	--	--	0	--	--	44	--	--
53	10,487	34,707	(45,194)	1,823	7,436	(9,259)	10,121	--	--	0	--	--	229	--	--
54	24,504	40,311	(64,815)	12,959	10,851	(23,810)	25,778	--	--	0	--	--	562	--	--
55	41,292	91,425	(132,717)	71,266	8,100	(79,366)	37,194	--	--	0	220	(220)	1,700	--	--
56	26,116	70,445	(96,561)	78,177	16,180	(94,357)	30,249	--	--	0	220	(220)	1,744	--	--
57	20,311	85,069	(105,380)	83,601	5,686	(89,287)	50,066	--	--	0	220	(220)	1,380	--	--
58	11,969	101,347	(113,316)	75,203	20,256	(95,459)	50,776	--	--	0	220	(220)	1,812	--	--
59	8,486	100,862	(109,348)	71,795	40,419	(112,214)	31,206	--	--	0	441	(441)	1,594	--	--
1960	4,627	81,591	86,218	58,598	55,329	113,927	26,713	--	--	0	414	414	1,104	--	--
61	4,709	76,006	80,715	58,933	50,062	108,995	23,367	--	--	0	452	452	1,228	--	--
62	3,382	54,864	58,246	52,694	28,040	80,734	17,853	--	--	0	615	615	950	--	--
63	2,654	119,124	121,778	47,222	24,564	71,786	20,915	--	--	0	320	320	1,082	--	--
64	3,280	87,503	90,783	45,055	16,479	61,534	25,179	--	--	0	410	410	988	--	--
65	3,854	114,414	118,268	45,730	36,570	82,300	29,742	--	--	0	1,232	1,232	829	--	--
66	3,459	114,525	117,984	39,167	31,810	70,977	23,064	--	--	0	1,111	1,111	1,142	--	--
67	3,455	108,871	112,326	40,593	40,779	81,372	28,715	--	--	0	681	681	1,034	--	--
68	--	--	121,019	30,258	8,525	38,783	29,905	21,087	50,992	0	774	774	791	--	--
69	4,594	171,798	176,392	25,333	29,460	54,793	38,195	37,833	76,028	0	1,272	1,272	774	--	--
1970	4,259	121,068	125,327	23,221	28,051	51,272	34,145	41,766	75,911	0	1,609	1,609	578	2,425	3,003
71	--	--	193,326	25,229	63,951	89,180	32,789	91,782	124,571	0	1,794	1,794	536	3,271	3,807
72	4,696	177,053	181,749	12,751	32,696	45,447	43,444	33,126	76,570	0	1,878	1,878	483	3,928	4,411
73	--	--	211,218	15,135	28,523	43,658	40,602	52,527	93,129	0	2,855	2,855	633	2,925	3,558
74	4,043	170,220	174,263	14,350	37,511	51,861	37,313	44,941	82,254	0	2,163	2,163	536	5,553	6,089

1/ Information on fresh salmon product is not available. Data source of products listed: Estimates in parenthesis are from Food Agric. Organ., U.N. (1952b-59b). Other data are from Min. Agric. For., Japan (1965a-1967a and 1966b-1968b, 1971b-1972b, 1974b, 1976b).
2/ Reported in cases in Japanese statistics. Converted to pounds on the basis of 21.6 kg/case, or 47.6 lb/case.
3/ Primarily on-land processing except for salted salmon where approximately 50 percent is salted aboard fishing vessels.

Appendix 27. Partial information on operating units of the Japanese salmon fishery, 1951-75.

	Mothership salmon fishery						Other salmon fisheries							
	Vessels		Labor				Vessels			Licensed	Labor 1/			
Year	Mothership	Catcher	Mothership	Catcher	Total	Canning lines	Gillnet	Longline	Total	Fixed net	Gillnet	Longline	Fixed net	Total
	(Number of units or persons)													
1951	0	0	0	0	0	0	--	--	--	--	--	--	--	--
52	3	57	--	--	--	--	--	--	--	--	--	--	--	--
53	3	105	--	--	--	--	--	--	--	--	--	--	--	--
54	7	205	--	--	--	--	--	--	--	--	--	--	--	--
55	14	406	--	--	--	--	--	--	--	--	--	--	--	--
56	16	506	--	--	17,057	38	--	--	--	--	--	--	--	--
57	16	461	--	--	14,350	35	1,856	--	--	476	--	--	--	--
58	16	460	--	--	14,459	37	2,502	--	--	450	--	--	--	--
59	16	460	--	--	14,621	38	2,097	--	--	395	--	--	--	--
1960	12	410	--	--	12,399	31	2,526	--	--	343	--	--	--	--
61	12	410	--	--	12,252	32	2,195	--	--	320	--	--	--	--
62	11	369	--	--	11,439	--	2,206	--	--	311	--	--	--	--
63	11	369	--	--	11,604	--	1,894	--	--	336	--	--	--	--
64	11	369	4,181	7,627	11,808	--	1,704	1,674	3,378	353	12,626	10,660	4,605	27,891
65	11	369	2/	2/	12,030	--	1,758	1,730	3,488	359	(13,009)	(11,072)	(4,667)	(28,748)
66	11	369	4,224	7,954	12,178	--	1,653	1,907	3,560	360	12,807	11,713	4,775	29,295
67	11	369	4,105	7,962	12,067	--	1,794	2,885	4,679	357	13,000	14,427	4,682	32,109
68	11	369	4,405	8,252	12,657	--	1,595	2,778	4,373	395	(11,484)	(13,890)	(5,135)	(30,509)
69	11	369	2/	2/	12,719	--	1,750	3,489	5,239	430	(12,600)	(17,445)	(5,590)	(35,635)
1970	11	369	4,353	8,261	12,614	--	1,607	2,447	4,054	409	(11,570)	(12,235)	(5,317)	(29,122)
71	11	369	4,324	8,029	12,353	--	1,682	2,662	4,344	408	(12,110)	(13,310)	(5,304)	(30,724)
72	10	332	3,824	7,232	11,056	--	1,547	1,248	2,795	420	(11,138)	(6,240)	(5,460)	(22,838)
73	10	332	3,788	7,175	10,963	--	1,713	1,771	3,484	478	(12,334)	(8,855)	(6,214)	(27,403)
74 3/	10	332	(3,800)	7,281	(11,081)	--	1,676	894	2,570	518	(12,067)	(4,470)	(6,734)	(23,271)
75	10	332	(3,800)	6,634	(10,434)	--	1,677	1,580	3,760	503	(12,074)	(7,900)	(6,539)	(26,513)

1/ Estimates in parenthesis are gross approximations based on the following average crew members per vessel: 1965 data--7.4 crew/gillnet vessel; 6.4 crew/longline vessel; and 13.0 crew/fixed net operation. 1968-75 data--7.2 crew/gillnet vessel; 5.0 crew/longline vessel; and 13.0 crew/fixed net operation.

2/ Statistical annuals for these years are unavailable at the Northwest and Alaska Fish. Ctr. NMFS.

3/ Mothership labor force was estimated on the basis of 380 personnel per mothership.

Data source: Min. Agric. For., Japan (1966a-1977a).

Appendix 28. Average annual prices of salmon products at producing areas and wholesale markets, Japan, 1960-74. 1/

Prices at "producing areas" 2/

Year	Fresh: "Salmon category 3/": Chum	Fresh: "Salmon category": Sockeye	Fresh: "Salmon category": Chinook	Fresh: "Salmon category": Coho	Fresh: Average	Fresh: Pink Salmon	Salted: Salmon category: Chum	Salted: Salmon category: Sockeye	Salted: Salmon category: Chinook	Salted: Salmon category: Coho	Salted: Average	Salted: Pink Salmon
	- - - (Dollar per pound) - - -											
1960	0.34	0.55	0.37	0.35	0.34	0.20	0.33	0.36	0.31	0.31	0.33	0.22
61	0.27	0.33	0.38	0.28	0.28	0.24	0.31	0.35	0.27	0.30	0.31	0.23
62	0.33	0.49	0.40	0.31	0.33	0.28	0.34	0.50	0.29	0.32	0.27	0.29
63	0.41	0.67	0.47	0.44	0.41	0.29	0.41	0.64	0.39	0.44	0.41	0.30
64	0.40	0.63	0.41	0.46	0.42	0.30	0.41	0.69	0.42	0.56	0.45	0.30
65	0.49	0.72	0.52	0.47	0.47	0.32	0.50	0.76	0.47	0.45	0.49	0.33
66	0.47	0.56	0.56	0.52	0.47	0.38	0.47	0.59	0.52	0.58	0.49	0.38
67	0.52	0.60	0.61	0.56	0.54	0.39	0.52	0.64	0.57	0.65	0.57	0.39
68	0.62	0.51	0.65	0.57	0.61	0.40	0.55	0.57	0.60	0.79	0.60	0.38
69	0.75	0.84	0.85	0.84	0.75	0.37	0.82	0.93	0.82	0.83	0.86	0.37
1970	--	--	--	--	0.62	0.41	--	--	--	--	0.54	0.41
71	--	--	--	--	0.60	0.31	--	--	--	--	0.68	0.31
72	--	--	--	--	0.82	0.44	--	--	--	--	0.80	0.42
73	--	--	--	--	1.15	0.65	--	--	--	--	1.68	0.66
74	--	--	--	--	1.10	0.81	--	--	--	--	1.13	0.71

Prices at central wholesale markets, 6 largest cities

Year	Fresh: "Salmon"	Fresh: Pink	Salted: "Salmon"	Salted: Pink	Frozen: "Salmon"	Frozen: Pink
	- - - (Dollar per pound) - - -					
1960	0.35	0.24	0.35	0.25	--	--
61	0.30	0.34	0.34	0.26	--	--
62	0.34	0.36	0.40	0.33	0.36	0.32
63	0.38	0.38	0.47	0.33	0.40	0.28
64	0.41	0.41	0.49	0.36	0.39	0.36
65	0.44	0.42	0.54	0.38	0.42	0.35
66	0.49	0.45	0.56	0.43	0.42	0.46
67	0.52	0.46			0.45	0.37
68	0.66	0.53			0.52	0.40
69	0.74	0.48	0.86	0.43	0.73	0.49
1970	0.61	0.45	0.63	0.45	0.51	0.45
71	0.63	0.45			0.57	0.37
72	0.91	0.67	0.89	0.51	0.70	0.49
73	1.18	0.87			1.20	0.80
74	1.15	0.96	1.36	0.83	1.12	0.93

Prices at central wholesale market, Tokyo

Year	Fresh: "Salmon"	Fresh: Pink	Salted: "Salmon"	Salted: Pink	Frozen: "Salmon"	Frozen: Pink	Salted roe: Encased 4/	Salted roe: Caviar 5/
	- - - (Dollar per pound) - - -							
1960	--	--	0.34	0.25	0.28	0.19	1.63	--
61	--	--	0.33	0.24	0.32	0.24	1.35	2.51
62	--	--	0.40	0.32	0.36	0.23	1.56	2.91
63	--	--	0.46	0.33	0.40	0.27	1.68	3.01
64	--	--	0.48	0.37	0.40	0.39	1.87	3.03
65	--	--	0.54	0.39	0.41	0.45	1.82	3.41
66	0.49	0.49	0.55	0.43	0.41	0.51	1.85	3.41
67			0.62	0.45			1.78	3.54
68			0.67	0.46			1.90	3.76
69	0.74	0.50	0.83	0.45	0.71	0.53	2.82	6.30
1970	0.61	0.37	0.58	0.46	0.49	0.46	2.67	5.01
71			0.64	0.42			3.23	4.78
72	0.91	0.71	0.79	0.53	0.68	0.55	4.14	5.29
73			1.44	0.82			5.25	10.26
74	1.17	0.78	1.28	0.86	1.17	0.78	5.88	8.39

1/ Yen/kg prices in Japanese statistics were converted to $/lb using the following conversion rates: 1960-70 = 360 yen to U.S. $1; 1971 = 348 yen; 1972 = 303 yen; 1973 = 271 yen; 1974 = 292 yen.

2/ Assumed as the processed value at landing ports and areas in Japan.

3/ In Japanese fishery statistics, salmon landings and products are often classified along "sake" (chum, sockeye, chinook and coho salmon) and "masu" (primarily pink salmon but may also include cherry salmon and steelhead trout) categories. In this appendix table the "salmon" category corresponds to the "sake" category.

4/ Encased in ovariian membrane or skein "Shizuko" in Japanese.

5/ Loose, or individual eggs. "Ikura" in Japanese.

Data source: Min. Agric. For., Japan (1966b-1968b, 1971b-1972b, 1974b, 1976b).

Appendix 29. Salted chum and pink salmon prices at wholesale, distributor, and retail levels, Tokyo, Japan (1966-74 1/), and Japan-United States monetary exchange rates (1970-76).

Year	Level	Month 1	2	3	4	5	6	7	8	9	10	11	12	Ave.
		(Dollar per pound)												
		Salted Chum Salmon 2/												
1966	Wholesale	--	0.57	0.58	0.51	0.52	0.55	0.52	0.52	0.54	0.59	0.60	0.65	0.57
	Distributor	0.58	0.62	0.60	0.55	0.55	0.56	0.55	0.56	0.57	0.61	0.63	0.70	0.59
	Retail	0.94	0.88	0.83	0.79	0.76	0.80	0.83	0.86	0.89	1.07	0.96	1.01	0.88
1967	Wholesale													
	Distributor													
	Retail													
1968	Wholesale													
	Distributor													
	Retail													
1969	Wholesale	0.76	0.75	0.86	0.89	0.93	0.90	0.84	0.84	0.82	0.85	0.79	0.81	0.84
	Distributor	0.85	0.84	0.89	0.93	0.96	0.95	0.90	0.96	0.95	0.94	0.90	0.92	0.92
	Retail	1.32	1.30	1.55	1.40	1.52	1.41	1.37	1.41	1.37	1.44	1.35	1.40	1.40
1970	Wholesale	0.79	0.68	0.66	0.65	0.57	0.59	0.56	0.54	0.51	--	0.62	0.67	0.60
	Distributor	0.84	0.83	0.72	0.69	0.72	0.60	0.63	0.57	0.61	--	0.68	0.73	0.66
	Retail	1.34	1.37	1.28	1.26	1.16	1.16	1.00	1.12	1.12	--	1.13	1.31	1.16
1971	Wholesale													
	Distributor													
	Retail													
1972	Wholesale	0.65	0.62	0.79	0.74	0.83	0.74	0.83	0.81	0.85	0.92	0.98	1.04	0.84
	Distributor	0.75	0.76	0.86	0.82	0.91	0.77	0.85	0.88	0.89	0.96	1.01	1.10	0.89
	Retail	1.40	1.22	1.44	1.44	1.50	1.29	1.34	1.44	1.48	1.51	1.52	1.59	1.42
1973	Wholesale													
	Distributor													
	Retail													
1974	Wholesale	1.51	1.50	1.52	1.41	1.30	1.30	1.22	1.09	1.14	1.26	1.34	1.30	1.29
	Distributor	1.85	1.79	1.86	1.70	1.66	1.57	1.42	1.35	1.39	1.57	1.68	1.56	1.57
	Retail	2.53	2.53	2.69	2.31	2.29	2.28	1.84	2.12	2.14	2.27	2.61	2.45	2.32

1/ Statistical annuals for 1967-68, 1971 and 1973 were unavailable during preparation of this report. Converted from yen/kg using the Japan-U.S. exchange rates in this appendix.
2/ Reported as salted "salmon" for 1966, and salted chum from 1969.

Source: Min. Agric. For., Japan (1966b-1968b, 1971b-1972b, 1974b, 1976b).

Appendix 29. (Cont'd).

Year	Level	Month 1	2	3	4	5	6	7	8	9	10	11	12	Ave.
		(Dollar per pound)												
		Salted Pink Salmon												
1966	Wholesale	0.40	0.37	0.40	0.39	0.39	0.43	0.42	0.44	0.44	0.48	0.51	0.49	0.42
	Distributor	0.42	0.44	0.42	0.41	0.43	0.45	0.42	0.46	0.46	0.49	0.52	0.52	0.49
	Retail	0.76	0.64	0.67	0.57	0.54	0.59	0.59	0.78	0.79	0.83	0.78	0.82	0.66
1967	Wholesale													
	Distributor													
	Retail													
1968	Wholesale													
	Distributor													
	Retail													
1969	Wholesale	0.51	0.35	0.47	0.48	0.50	0.46	0.42	0.44	0.43	0.44	0.43	0.43	0.45
	Distributor	0.70	0.64	0.68	0.63	0.53	0.49	0.47	0.47	0.47	0.49	0.48	0.53	0.51
	Retail	0.76	0.82	0.85	0.97	0.92	0.85	0.87	0.80	0.88	0.90	0.86	0.94	0.88
1970	Wholesale	0.42	0.42	0.39	0.43	0.45	0.48	0.47	0.46	0.51	--	0.57	--	0.45
	Distributor	0.46	0.45	0.41	0.47	0.48	0.49	0.48	0.47	0.52	--	0.59	--	0.47
	Retail	0.63	0.84	0.75	0.82	0.66	0.97	0.69	0.90	0.74	--	0.63	--	0.78
1971	Wholesale													
	Distributor													
	Retail													
1972	Wholesale	0.46	0.45	0.55	0.53	--	0.51	--	0.61	--	--	--	--	0.51
	Distributor	0.48	0.52	0.56	0.56	--	0.53	--	0.64	--	--	--	--	0.54
	Retail	1.01	0.99	0.90	1.12	--	1.19	--	0.93	--	--	--	--	1.06
1973	Wholesale													
	Distributor													
	Retail													
1974	Wholesale	0.90	0.74	1.00	0.82	0.94	1.00	0.85	0.81	--	0.97	0.96	1.08	0.89
	Distributor	1.14	0.84	1.15	1.00	1.17	1.21	0.97	1.03	--	1.24	1.21	1.30	1.07
	Retail	1.73	1.58	2.14	1.62	1.65	1.78	1.52	1.70	--	1.75	1.93	2.07	1.72

Appendix 29. (Cont'd).

Japan-United States Exchange Rate, Monthly, 1970-76. (yen per dollar, end of month rate)

	1970	1971	1972	1973	1974	1975	1976
Jan.	*	357.6	310.4	301.2	299.0	297.8	303.7
Feb.	*	357.4	304.2	270.0	287.6	286.6	302.2
Mar.	*	357.4	304.2	265.8	276.0	293.8	299.7
Apr.	*	357.4	304.8	265.5	279.8	293.3	299.4
May	358.9	357.4	304.6	265.0	281.9	291.4	
June	358.7	357.4	301.1	263.3	284.1	296.4	
July	358.7	357.4	301.1	263.6	297.8	297.4	
Aug.	358.2	339.0	301.1	265.3	302.7	297.9	
Sept.	357.9	334.2	301.1	265.7	298.5	302.7	
Oct.	357.6	329.3	301.1	266.8	299.9	301.8	
Nov.	357.6	327.6	301.1	280.0	300.1	303.0	
Dec.	357.6	314.8	302.0	280.0	301.0	305.2	

* Assumed as 360.0

Source: International Financial Statistics, International Monetary Fund.

Appendix 30. Partial information on salmon sport catch by species for U.S. Pacific coast and British Columbia, Canada, 1950-74.

	Salmon sport catch																	
	Coho			Chinook			Pink			Sockeye & chum			Species unspecified			Total catch		
Year	U.S.	B.C.	Total	U.S.	B.C.	Total	U.S.	B.C.	Total	U.S.	B.C.	Total	U.S.	B.C	Total	U.S.	B.C.	Total
	(Thousands of fish)																	
1950	208.8	--	208.8	187.1	--	187.1	--	--	--	--	--	--	76.0	--	76.0	471.9	--	471.9
51	224.8	--	224.8	258.7	--	258.7	28.6	--	28.6	--	--	--	74.0	--	74.0	586.1	--	586.1
52	276.5	--	276.5	353.9	--	353.9	--	--	--	--	--	--	63.0	--	63.0	693.4	--	693.4
53	235.8	61.8	297.6	313.3	51.6	364.9	73.9	--	73.9	--	--	--	63.0	91.1	154.1	686.0	204.5	890.5
54	289.7	35.8	325.5	421.5	43.0	464.5	--	--	--	--	--	--	59.0	131.4	190.4	770.2	210.2	980.4
55	324.9	78.0	402.9	490.3	54.7	545.0	91.1	--	91.1	--	--	--	--	142.0	142.0	906.3	274.7	1,181.0
56	398.8	70.9	469.7	502.1	64.3	566.4	--	--	--	--	--	--	156.0	169.8	325.8	1,056.9	305.0	1,361.9
57	459.1	126.5	585.6	433.9	93.4	527.3	83.9	10.2	94.1	--	--	--	130.0	166.2	296.2	1,106.9	396.3	1,503.2
58	306.2	96.1	402.3	319.1	88.7	407.8	--	3.1	3.1	--	0.4	0.4	128.0	220.6	348.6	753.3	408.9	1,162.2
59	287.9	90.1	378.0	284.8	65.6	350.4	39.8	36.8	76.6	--	--	--	221.0	204.0	425.0	833.5	396.5	1,230.0
1960	128.7	97.6	226.3	260.3	45.8	306.1	--	0.8	0.8	--	--	--	146.0	187.2	333.2	535.0	331.4	866.4
61	275.4	78.9	354.3	266.7	40.6	307.3	38.2	26.4	64.6	--	0.1	0.1	224.0	104.4	328.4	804.3	250.4	1,054.7
62	398.7	82.9	481.6	343.6	56.0	399.6	--	3.4	3.4	--	0.1	0.1	238.0	133.8	371.8	980.3	276.2	1,256.6
63	457.5	99.6	557.1	359.4	52.3	411.7	428.0	111.0	539.0	--	0.1	0.1	226.0	130.2	356.2	1,470.9	393.2	1,864.1
64	556.9	98.2	655.1	343.9	42.2	386.1	--	2.3	2.3	--	*	*	161.0	110.5	271.5	1,061.8	253.2	1,315.0
65	879.8	105.9	985.7	336.6	43.4	380.0	43.8	9.6	53.4	0.4	*	0.4	174.5	95.3	269.8	1,435.1	254.2	1,689.3
66	672.7	174.5	847.2	403.5	68.9	472.4	1.6	4.8	6.4	0.4	0.2	0.6	161.0	104.6	265.6	1,239.2	353.0	1,592.2
67	975.1	173.2	1,148.3	416.8	79.8	496.6	105.6	28.9	134.5	23.3	1.1	24.4	278.3	--	278.3	1,799.1	283.0	2,082.1
68	880.9	218.5	1,099.4	464.4	96.3	560.7	12.3	3.5	15.8	22.1	2.1	24.2	204.6	--	204.6	1,584.3	320.4	1,904.7
69	781.9	143.9	925.8	481.0	99.4	580.4	59.2	36.4	95.6	25.4	1.4	26.8	245.9	--	245.9	1,593.4	281.1	1,874.5
1970	866.9	236.9	1,103.8	606.2	139.2	745.4	34.9	10.6	45.5	26.4	0.5	26.9	136.0	--	136.0	1,670.4	387.2	2,057.6
71	1,298.6	371.1	1,669.7	648.2	122.8	771.0	51.3	46.0	97.3	22.5	0.2	22.7	145.9	--	145.9	2,166.5	540.1	2,706.6
72	968.8	156.1	1,124.9	757.5	153.7	911.2	36.8	5.4	42.2	39.8	1.9	41.7	121.4	--	121.4	1,924.3	317.1	2,241.4
73	1,007.2	176.5	1,183.7	811.2	148.2	959.4	122.2	25.8	148.0	173.3	4.5	177.8	147.6	--	147.6	2,261.5	355.0	2,616.5
74	1,175.0	312.6	1,487.6	754.5	158.9	913.4	0.1	8.9	9.0	3.5	3.4	6.9	88.0	--	88.0	2,021.1 1/	483.8	2,504.9

* Less than 50 fish.
1/ Excluding Alaska--no data.
Source: Appendix 31-35

Appendix 31. Salmon sport catch and effort in California and Idaho. 1950-74.

	California						Idaho		
	Catch 1/ Marine catch			Effort		Catch/effort	Catch 2/ Freshwater		Effort
Year	Coho	Chinook	Total	Anglers	Marine angler days 3/	Marine, catch per angler day 3/	Chinook	Total	Anglers 4/
	- - - - - - - (Thousands)	- - -	- - -	- - -	- - -	(Number of fish)	- - - - - - (Thousands)	- - -	- - -
1950	5.0	57.0	62.0	--	--	--	4.4	4.4	--
51	8.0	103.0	111.0	--	--	--	6.8	6.8	--
52	10.0	123.0	133.0	--	--	--	7.1	7.1	--
53	11.0	141.0	152.0	--	--	--	8.7	8.7	--
54	14.0	171.0	185.0	--	--	--	15.0	15.0	--
55	15.0	184.0	199.0	--	--	--	19.0	19.0	--
56	13.0	163.0	176.0	--	--	--	21.0	21.0	--
57	5.0	64.0	69.0	--	--	--	39.0	39.0	--
58	5.0	65.0	70.0	--	--	--	24.0	24.0	--
59	8.0	76.0	84.0	--	--	--	20.0	20.0	--
1960	6.0	50.0	56.0	--	--	--	21.0	21.0	--
61	4.0	55.0	59.0	--	--	--	13.0	13.0	--
62	13.0	120.0	133.0	--	172.2	0.77	12.0	12.0	--
63	33.0	84.0	117.0	--	115.3	1.01	12.0	12.0	--
64	40.0	101.0	141.0	--	144.7	0.97	8.0	8.0	--
65	21.0	60.0	81.0	--	122.7	0.66	Closed	0	--
66	32.4	88.5	120.9	--	114.9	1.05	8.5	8.5	35.9
67	50.3	81.6	131.9	--	160.3	0.82	7.7	7.7	23.0
68	40.4	154.2	194.6	--	185.0	1.05	11.5	11.5	26.4
69	28.0	156.0	184.6	--	183.2	1.00	13.0	13.0	47.3
1970	14.6	147.8	162.4	--	226.5	0.72	5.7	5.7	27.4
71	67.4	188.2	255.6	--	275.0	0.93	3.6	3.6	21.7
72	44.0	201.0	245.0	--	234.5	1.04	6.7	6.7	26.3
73	31.0	198.0	229.0	--	245.8	0.93	9.7	9.7	32.2
74	77.0	157.0	234.0	--	--		1.6	1.6	--

1/ Ocean catch only; no data on freshwater catch. Source: 1950-65, Inter. North. Pac. Fish. Comm. (ms 1974); 1966-74, Pac. Mar. Fish. Comm. (1968-76).

2/ Catch in the Snake River system. Source: 1950-65, Idaho Dept. Fish Game (1968-70); 1966-74, Pac. Mar. Fish. Comm. (1968-76).

3/ Estimated from the party boat and skiff catch, and fish per-angler-day data reported in: Jensen and Swartzell (1967); Heimann and Frey (1968a, 1968b); Heimann and Carlisle (1970); Pinkas (1970, 1974); Bell (1971); Oliphant (1973); and McAllister (1975).

4/ Combined number of salmon and steelhead anglers. Source: Pac. Mar. Fish. Comm. (1968-76).

Appendix 32. Salmon sport catch and effort in Oregon, 1950-74.

Oregon									
	Catch[1/] Marine and freshwater catch					Effort		Catch/effort[2/]	
Year	Coho	Chinook	Pink	Species unspecified	Total	Anglers[3/]	Marine angler trips[4/]	Catch per salmon angler[5/]	Marine, catch per angler trip[6/]
	- - - - - - - - - - - - - (Thousands)- -							(Number of fish) - - - - - - -	
1950	3.0	11.0	--	76.0	90.0	--	--	--	--
51	6.0	10.0	--	74.0	90.0	--	--	--	--
52	16.0	11.0	--	63.0	90.0	--	--	--	--
53	13.0	15.0	--	63.0	91.0	95.3	--	(0.53)	--
54	22.0	17.0	--	59.0	98.0	92.3	--	(0.57)	--
55	44.0	59.0	--	--	103.0	82.7	--	(0.49)	--
56	--	--	--	156.0	156.0	96.5	--	(0.94)	--
57	--	--	--	130.0	130.0	74.4	--	(0.96)	--
58	--	--	--	128.0	128.0	112.0	--	(0.59)	--
59	--	--	--	221.0	221.0	165.7	--	(0.77)	--
1960	--	--	--	146.0	146.0	113.7	--	(0.85)	--
61	--	--	--	224.0	224.0	142.1	--	(1.10)	--
62	--	--	--	238.0	238.0	159.4	--	1.10	--
63	--	--	--	226.0	226.0	160.7	--	1.41	--
64	188.0	28.0	--	132.0	348.0	190.1	314.4	1.33	1.03
65	258.0	36.0	--	120.0	414.0	218.0	361.5	1.60	1.36
66	206.0	39.0	--	108.0	353.0	213.3	381.5	1.35	1.08
67	336.0	43.0	--	143.0	522.0	303.6	336.2	1.50	1.12
68	258.0	26.0	--	143.0	427.0	230.9	290.4	1.52	0.97
69	226.0	32.0	--	166.0	424.0	284.9	317.9	1.22	0.80
1970	280.0	142.0	--	--	422.0	310.8	251.6	1.36	1.03
71	335.0	128.7	--	--	463.7	288.4	258.9	1.61	1.11
72	271.4	135.1	--	--	406.5	305.0	255.6	1.32	1.10
73	254.6	150.0	2.0	--	406.6	315.9	310.1	1.29	0.82
74	339.1	125.9	*	--	465.0	317.4	335.8	1.47	1.05

* Less than 50 fish.
1/ Source: 1950-69, Int. North Pac. Fish. Comm. (ms 1974); 1970-74, Pac. Mar. Fish. Comm. (1972-76).
2/ Catch per effort cannot be estimated from the information given in this table. Estimates shown were obtained from the sources indicated in footnotes 5 and 6.
3/ Combined number of salmon and steelhead anglers that actually fished. Estimated from data reported by Koski (no date) and Daily (no date).
4/ Source: Ore. Wild. Comm. (no date). Marine, or offshore angler trips only.
5/ Source: Koski (no date) and Daily (no date. Estimates in parenthesis have not been corrected for nonresponse bias.
6/ Source: Ore. Wild. Comm. (no date).

Appendix 33. Salmon sport catch and effort in Washington, 1950-74.

	Washington									
	Marine catch							Effort		Catch/effort
Year	Coho[3/]	Chinook[3/]	Pink	Sockeye & chum	Marine Total	Freshwater catch	Total catch[4/]	Anglers	Marine Angler trips	Marine, catch per trip[2/]
	(Thousands)									(Number of fish)
1950	200.8	114.7	0	--	315.5	--	315.5	--	576.8	0.55
51	210.8	138.9	28.6	--	378.3	--	378.3	--	658.0	0.57
52	250.5	212.8	0	--	463.3	--	463.3	--	716.6	0.65
53	211.8	148.6	73.9	--	434.3	--	434.3	--	707.0	0.61
54	253.7	218.5	0	--	472.2	--	472.2	--	807.8	0.58
55	265.9	228.3	91.1	--	585.3	--	585.3	--	837.1	0.70
56	385.8	318.1	0	--	703.9	--	703.9	--	956.0	0.74
57	454.1	330.9	83.9	--	868.9	--	868.9	--	964.1	0.90
58	301.2	230.1	0	--	531.3	--	531.3	--	814.4	0.65
59	279.9	188.8	39.8	--	508.5	--	508.5	--	750.1	0.68
1960	122.7	189.3	0	--	312.0	--	312.0	--	778.3	0.40
61	271.4	198.7	38.2	--	508.3	--	508.3	--	971.2	0.52
62	385.7	211.6	0	--	597.3	--	597.3	--	1,107.0	0.54
63	424.5	263.4	428.0	--	1,115.9	--	1,115.9	--	1,432.2	0.78
64	328.9	206.9	0	--	535.8	29.0	564.8	302.7	1,252.7	0.43
65	600.8	240.6	43.8	0.4	885.6	54.5	940.1	366.8	1,278.8	0.69
66	434.3	267.5	1.6	0.4	703.8	53.0	756.8	372.9	1,147.6	0.61
67	557.4	274.2	95.9	1.5	929.0	135.3	1,064.3	450.9	1,295.0	0.72
68	552.4	262.6	0.5	0.1	815.6	61.6	877.2	428.9	1,091.2	0.75
69	497.5	267.1	32.1	*	796.7	79.9	876.6	444.7	1,215.5	0.66
1970	540.2	300.1	1.7	0.4	842.4	136.0	978.4	488.9	1,509.8	0.56
71	845.7	313.4	39.6	0.2	1,198.9	145.9	1,344.8	511.2	1,414.8	0.85
72	615.9	401.4	0	0.2	1,017.5	121.4	1,138.9	505.3	1,505.2	0.68
73	533.3	400.1	14.4	0	947.8	147.6	1,095.4	532.7	1,508.3	0.63
74	758.9	470.0	0.1	3.5	1,232.5	88.0	1,320.5	531.8	1,732.2	0.71

* Less than 50 fish.

1/ Source: 1950-71, Int. North Pac. Fish. Comm. (ms 1974); 1972-73, Nye and Ward (no date); 1974, Nye et al (no date). Species composition is not available on freshwater catch.

2/ Compiled from: Haw et al (1967); Nye and Ward (no date); and Nye et al (no date).

3/ Catches of Oregon sport fishermen in the Columbia River area are included in these Washington estimates for 1950-64.

4/ Partial totals through 1963.

Appendix 34. Salmon sport catch and effort in Alaska. 1967-74.

	Alaska							
	Catch 1/						Effort 1/	
	Marine and freshwater catch							
Year	Coho	Chinook	Pink	Sockeye	Chum	Total	Anglers 2/	Angler trips
	(Thousands)							
1967	31.4	10.3	9.7	21.8	0	73.2	77.0	--
68	30.1	10.1	11.8	22.0	0	74.0	90.6	--
69	30.4	12.9	27.1	24.6	0.8	95.8	99.3	--
1970	32.1	10.6	33.2	(26.0)		101.9	113.4	--
71	50.5	14.3	11.7	(22.3)		98.8	--	--
72	37.5	13.3	36.8	(39.6)		127.2	--	--
73	188.3	53.4	105.8	144.7	28.6	520.8	--	--
74	--	--	--	--	--	--	--	--

1/ Source: Pac. Mar. Fish. Comm. (1969-76). These estimates are provisional subject to revision as indicated in Pac. Mar. Fish. Comm. (1976).
2/ Combined number of salmon and steelhead anglers.

Appendix 35. Salmon sport catch and effort in British Columbia, Canada, 1952-74.

	British Columbia									
	Catch 1/							Effort 2/		Catch/effort
			Grilse 3/							
Year	Coho	Chinook	Coho	Chinook	Pink	Sockeye & chum	Total	Anglers	Boat days	Catch per boat-day 4/
	(Thousands)									(Number of fish)
1952	--	--	--	--	--	--	--	--	--	--
53	61.8	51.6	(91.1)		--	--	204.5	--	--	--
54	35.8	43.0	(131.4)		--	--	210.2	--	--	--
55	78.0	54.7	(142.0)		--	--	274.7	--	--	--
56	70.9	64.3	(169.8)		--	--	305.0	--	--	--
57	126.5	93.4	(166.2)		10.2	--	396.3	--	--	--
58	96.1	88.7	(220.6)		3.1	0.4	408.9	--	--	--
59	90.1	65.6	(204.0)		36.8	--	396.5	--	--	--
1960	97.6	45.8	(187.2)		0.8	--	331.4	--	204.7	1.62
61	78.9	40.6	(104.4)		26.4	0.1	250.4	--	213.2	1.17
62	82.9	56.0	(133.8)		3.4	0.1	276.2	--	223.5	1.24
63	99.6	52.3	(130.2)		111.0	0.1	393.2	--	268.5	1.46
64	98.2	42.2	(110.5)		2.3	*	253.2	--	216.1	1.17
65	105.9	43.4	(95.3)		9.6	*	254.2	--	267.2	0.95
66	174.5	68.9	(104.6)		4.8	0.2	353.0	--	276.2	1.28
67	104.4	62.6	68.8	17.2	28.9	1.1	283.0	--	277.4	1.02
68	140.4	71.1	78.1	25.2	3.5	2.1	320.4	--	285.5	1.12
69	86.8	79.7	57.1	19.7	36.4	1.4	281.1	--	305.5	0.92
1970	154.0	91.1	82.9	48.1	10.6	0.5	387.2	--	335.7	1.15
71	295.5	101.0	75.6	21.8	46.0	0.2	540.1	--	372.9	1.45
72	107.7	118.2	48.4	35.5	5.4	1.9	317.1	--	325.6	0.97
73	119.2	116.0	57.3	32.2	25.8	4.5	355.0	--	350.1	1.01
74	247.3	122.0	65.3	36.7	8.9	3.4	483.8	--	370.5	1.31

* Less than 50 fish.

1/ Source: 1950-71, Inter. North Pac. Fish. Comm. (ms 1974); 1972-74,, Environ. Canada (1973-75).

2/ Boat-day data source: Environ. Canada (1961-75).

3/ Term and category applied to coho and chinook salmon weighing 3 lb (1,361g) and under.

4/ Source: see footnote 2.

Appendix 36

ECONOMIC VALUATION OF SALMON SPORT FISHERY

The general rationale, approach, and valuation procedures underlying the economic values estimated for the salmon sport fishery of this report is developed in this appendix.

1. Economic Values

In the United States, salmon sport fishing is essentially a nonmarketed outdoor recreation activity. As such, market prices for the final product (sport fishing) are absent. In its place, economists have introduced the term "net economic value." For recreational fishing according to Brown et al (1964),

> "Net economic value' will be our best estimate of the monetary value of the sport fishery resource which might exist if the resource were owned by a single individual, and market existed for the opportunity to fish for salmon and steelhead. This net economic value would approximate the value of the resource to a single owner who could charge sport anglers for his permission to fish for salmon and steelhead.
>
> The advantage of the above definition of net economic value is that it comes closest to imputing a value to the fishery resource comparable to what its value might be if it were privately owned."

Currently, the net value of sport fishing is this "net economic value" expressed on a per-day or per-trip basis. The general approach used to measure this value is the simulation of a demand curve for the experience by the travel cost-user intensity method on a resource under an assumed single ownership with capabilities of charging for the opportunity to fish. As summarized by Mathews and Wendler (1968):

> "This method was first suggested by Hotelling (1949), refined by Clawson (1959) and applied recently by Brown (1964) et al to measure the net value of recreational salmon and steelhead fishery in Oregon."

and in general, demand for a salmon sport fishery can be expressed as:

$$"D = f(P, C, Z, T)$$

where:

D = Fishing days demanded per unit of population.
P = Price per day charged for fishing (at present zero for salmon fishing in Washington and nominal in Oregon).
C = Average cost per trip of gaining access to the fishery.
Z = Average catch-per-angler day.
T = An index reflecting income and leisure"

Generally, D should increase with increases in either Z or T and decrease with increase in either P or C.

A second approach to evaluation of net economic value of salmon sport fishery is found in the study by Mathews and Brown (1970). Here the technique was one of asking hypothetical evaluation questions, through questionnairs mailed to salmon sport fishermen in the state of Washington, to determine how much the "sport" was worth to them over and above their actual fishing expenditures. Two major questions were asked, (1) the price associated with willingness to pay (for the right to fish) and (2) the minumum price associated with willingness to sell (their assumed possession of a right to fish). The response based on the latter question (sell) was used to arrive at net value estimates of the Washington salmon sport fishery.

A third approach to estimating recreational values is through simulated market prices. This approach, with estimates, is found in the guidelines of the Water Resources Council (1971, 1973). However, strong objections to this approach, as well as the estimates, have been made by economists (Idaho Cooperative Fishery Unit, 1973).

A partial summary of net values estimated for salmon and steelhead sports fisheries in the United States and Canada is presented in Appendix 36 Table 1. Expenditure values are also included in the table.

The unit economic values most relevant to this report are the per-day estimates in the "gross expenditure" and "net economic" value categories for the Pacific Northwest area and the Water Resources Council's net economic value estimate. The derivation of gross economic values for the salmon sport fishery will be based on median values selected from the range in unit values given in Appendix 36 Table 1. In order to bring the gross values to be developed into proper perspective, however, a typology on socio-economic activities and valuation is first developed and presented.

2. Socio-Economic Activities and Valuations

In our society money is the medim of exchange in economic related activities (as contrasted to, say, power which is the primary medium of exchange in our political activities). Ours is a market economy based on the price system and thus, prices delineate the units of money that are placed on a marketed commodity (good or service) of a certain quality. These prices, in a competitive market according to economic theory, are arrived through the interation of supply and demand. On the demand side a price paid reflects the "utility" of the commodity to the consumer or buyer; that is utility is the property or capacity of the commodity to satisfy human needs or wants. On the supply side a price received for the commodity reflects the value of the various resources that went into its production or availability. From an accounting sense price is perceived differently. The price of a commodity represents monetary cost to the buyer while to the seller it represents monetary revenue.

Appendix 36 Table 1.--Economic values reported for salmon and steelhead sport fisheries.1/

			Gross expenditure value			Net economic value			
Area	Species	Year	Total ($ million)	Per day (dollar)	Per fish (dollar)	Total ($ million)	Per day (dollar)	Per fish (dollar)	Source
Oregon	Salmon	1962	15.0-21.0	(16.60)	51.14	2.5-3.1	8.00	24.64 2/	Brown et al (1964)
	Steelhead		--	--	(23.17)*	--	--	--	
Oregon	Salmon	1962	--	(16.60)	--	--	20.00	--	Brown et al (1972)
	Steelhead		--	--	--	--	--	--	
Columbia River	Salmon - Steelhead	1965	(33.4)	(16.60)	(36.00)	5.8	8.00	17.35	Richards (1969)
Washington	Salmon	1966	50.0	(43.57)	(71.03)	5.0-8.0	(6.97)	11.09	Crutchfield and MacFarlane (1968)
Washington	Salmon	1967	24.5*	(14.44)*	(22.96)*	65.6	28.00	(51.24)	Mathews and Brown (1970)
Idaho	Salmon	1968	.376*	(5.78)*	(32.70)*	.217	8.00	(18.86)	Gordon (no date)
	Steelhead	"	1.752*	(9.12)*	(71.51)*	.649	15.00	(26.49)	
British Columbia 3/	Steelhead	1968	.787	(73.57)	(255.93)	.130	11.50	(41.94)	Pearse-Bowden (1970)
British Columbia	Steelhead	1969							
	B.C. Resident:		(3.168)	10.80	(94.70)	--	--	--	Pearse-Bowden (1971)
	Non Canadian:		(.570)	42.50	(167.50)	--	--	--	
Washington	Steelhead	1968	(16.8)	(13.56)	(53.13)	--	--	--	Wn. St. Game Dept. (1969)
	Steelhead	1969	--	--	60.00	--	--	--	Wn. St. Game Dept. (1971)
Michigan (Great Lakes)	Salmon - Steelhead	1970	15.5*	8.77*	(13.22)*	8.3	4.75	(7.12)	Ellefson (1973)
United States	Salmon - Steelhead	1971	--	--	--	--	9.00 4/	--	Water Resources Council (1971)
Oregon	Salmon - Steelhead	1974	--	--	--	--	22.00 5/	--	Brown et al (1976)

* = Current (or variable, or direct) expenditures only.

1/ Values in parentheses were estimated from data in the source article or in combination with other catch and effort statistics.

2/ Estimate by Richards (1969)

3/ Values to British Columbia from expenditures by non-Canadian sport fishermen.

4/ The upper value in the $3.00 to $9.00 range in simulated market price for specialized recreation day such as salmon fishing.

5/ Update of the 1962 Oregon net economic value [illegible].

For this document and for simplicity, the economic value of socioeconomic activities will be viewed in terms of the consumer and the monetary price he is assumed to be willing to pay to consume the final product related to an activity. Appendix 36 Table 2 sets the background for this through a typology on some selected social-economic activities.

The first activity in the table, commercial salmon fishery, is related to a natural resource (salmon). Final products from this activity are material goods—canned, salted, smoked, fresh salmon, etc. These products are produced and distributed through the private sector or our economy, and thus "marketed," to satisfy the gastronomic experience of the consumer. For salmon products consumed in the United States, the primary economic value indicator of the final product is retail price. Included in the retail price is the price of other goods and services (that went into producing and making the final product available) such as labor and materials in harvesting, processing, transportation, storage, brokerage, and administrative services, etc. Since the final consumptive act (eating) would most probably take place either at home or at a restaurant, the aggregate monetary value should consist of the retail price of the product plus the price of other goods and services related to personal transportation to and from, say, the fish market, the price of electricity used in baking the salmon, etc. However, since these salmon products are marketed and thus extensively distributed and made available at many outlets, the above mentioned price for other goods and services on personal transportation, etc., would be negligible if not difficult to ascertain.

In contrast to commercial salmon the other examples in Appendix 36 Table 2 are those of outdoor or indoor recreation activities where the final products are "events" rather than material goods.

Professional football is an activity using human resources to arrive at a final product with is an athletic contest. It is marketed and satisfies the social-psychological experience of the consumer through his consumptive action as a spectator. The primary economic value indicator of this final product is represented by the admission (ticket) price. Since the final product is not extensively distributed and made available (televised games excepted) as in material goods (e.g., canned salmon, clothing, shoes, etc.), other relevant economic values would be the price of goods and services related to personal transportation (and lodging) needs to and from the source of the final product--the athletic arena where the final consumptive act takes place.

A state play is similar to professional football in all aspects along the typology presented in Appendix 36 Table 2 except for the final product which is a "drama." Again, admission (ticket) price is the primary economic value indicator of the final product with other relevant economic values being the price of goods and services related to personal transportation (and lodging) needs to the theatre.

Appendix 36 Table 2.--A typology on some socioeconomic activities and valuations.

Activity	Resource type	Final product	Allocation[1/]	Consumption aspect: Experience	Consumption aspect: Action	Primary economic value indicator of the product	Other economic value indicators, re: to final consumptive act
Commercial salmon fishery	Natural	Canned salmon Smoked salmon Fresh salmon etc. (material good)	Marketed	Gastronomic	Consumptive	Retail price	Price of goods and ser ices related to personal transportation to and from the retail outlet
Professional football	Human	Athletic contest (event)	Marketed	Social-psychological	Spectator	Admission price	(A) Price of goods and services related to personal transportation (and lodging) needs to and from the source of the final product
Stage play	Human	Drama (event)	Marketed	Social-psychological	Spectator	Admission price	Ditto (A)
Skiing	Natural	Skiing (event)	Marketed	Social-psychological	Participatory	Facility-use price	Ditto (A) + (B) Price of goods and services related to the participatory aspects in consuming the final product
Trip to Disneyland	Man-made	Entertainment (event)	Marketed	Social-psychological	Spectator-participatory	Admission price plus facility-use price	Ditto (A)
Salmon sport fishery	Natural	Fishing (event)	Non-marketed	Social-psychological	Participatory	(Net economic value)	Ditto (A) + Ditto (B)
Camping	Natural	Camping (event)	Non-marketed	Social-psychological	Participatory	(Net economic value)	Ditto (A) + Ditto (B)
			Semi-marketed	Social-psychological	Participatory	Facility-use price[2/] (campground site)	Ditto (A) + Ditto (B)
Hunting	Natural	Hunting (event)	Non-marketed	Social-psychological	Participatory	(Net economic value)	Ditto (A) + Ditto (B)
			Marketed	Social-psychological	Participatory	Admission or membership price to private hunting preserve	Ditto (A) + Ditto (B)

1/ "Marketed" - primarily through private enterprise, or private sector of our economy. "Non-marketed" = largely through our public sector. "Semi-marketed" = some aspect of market allocation practiced by the public sector.
2/ Minimal price charged on public lands and parks.

The final product of the outdoor activity, skiiing, is the action of skiing which is marketed and satifies the social-phychological experience of the consumer through his consumptive action by way of participation (in contrast to the consumptive action by way of participation (in contrast to the consumptive action as spectator in professional football and stage play). In general, access to most ski areas are open to all and there is no admission price even though the slopes are privately owned or managed. Consumption of the final product, however, usually requires the use of a complementary service* in the form of ski tow facilities. Therefore, the primary economic value indicator for this final product (skiing) is the facility-use price. Since the Consumptive action is participatory, other relevant economic values would be the previously indicated price of goods and services related to personal transportation (and lodging) to the ski area plus, now, the price of goods and services related to the participatory aspects in consuming the final product by an individual (e.g., purchase or rental of ski equipment, clothing, etc.).

A trip to Disneyland is presneted as an example where both admission and facility-use prices are placed on the final product. It is an activity where the final product is marketed entertainment with consumptive action carried out on the part of the consumer both as a spectator and participant. The primary economic value indicator of this final product is the admission price (to the gounds) plus facility-use price (for rides, etc.). Other economic values would be the price of goods and services related primarily to personal transportation (and lodging) needs to Disneyland.

Thus far, what has been shown for outdoor or indoor recreation were marketed final products in the form of events. There was also a price associated with each event such as price per football game, per stage play, per day on the ski slopes, per day at Disneyland, and per separate facility used at Disneyland. The remaining recreational activities and their final products in the table are examples of events, where because they are related primarily to "public" goods, market prices for the final products as such are absent. In its place economists have introduced the term "net economic value."

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* Complementary service in the sense that without the tow facilities the final product (skiing) cannot be consumed. An unlikely substitute to the use of the tow facilities is walking up the slope. Another example in the area of complementarity is the tire and wheel of automobiles. Each alone serves no functional use.

The final product of the sport salmon fishery activity is fishing. More appropriately, a day, or half-a-day, or hours of fishing (or trip). As indicated in the table this final product is non-marketed in the United States. It satisfies the social-psychological experience of the consumer through the consumptive action of participation. If a salmon is caught and consumed by the sportsman, then his gastronomic experience would also be satisfied. Currently, the primary economic value indicator of the final product is "net economic value" expressed on a per-day or -trip basis. As in skiing, other economic values would be the price of goods and services related to personal transportation (and lodging) needs to the fishing sites as well as the price of goods and services related to the participatory aspects in consuming the final product by an individual (e.g., purchase or rental price of boat, fishing gear bait, etc.).

Camping on public lands and parks is similar to salmon sport fishing along the typology of Appendix 36 Table 2. A variation is also indicated in its allocation by the term semi-marketed. This covers those situations where a quasi-price is placed on the final product by way of a facility-use price (campground site) by public agencies. There is general agreement that this price is extremely minimal and at most may probably cover only administrative and enforcement costs and thus, would not be comparable to the facility-use price associated with skiing.

The final example, hunting, is similar to salmon sport fishing and camping as to the typology. There are, however, may variations to this activity and final product. The polar examples being the nonmarketed hunting of public animals on public lands to the marketed product (hunting) on private hunting preserves where admission or membership prices are placed in relation to the product.

The typology suggestes the classification of economic parameters under two categories--"primary economic value indicator" and "other economic value indicator." In relation to the unit economic values presented earlier in Appendix 36 Table 1, the "net economic value" is comparable to the "primary economic value indicator" of the typology and the "gross expenditure value" to the "other economic value indicator" of the typology. Furthermore, this general approach is also related to Clawson's (1963. 1965) concept of veiwing recreation in terms of the whole experience.

In his approach to the field of outdoor recreation, Clawson regarded as basic the concept of the whole recreation experience. He stated that almost every outdoor recreation experience includes five rather well-defined phases,

1. Anticipation, or planning
2. Travel to the site
3. On site (sport fishing for salmon in the case of this report)
4. Travel back
5. Recollection

and each is essential to the whole, All of the costs (assumed as economic and non-economic) of the whole experience must be balanced against all the satisfactions. Clawson feels that probably more than half of the total satisfaction of the experience arised in the Recollection phase. This experience, then, gradually leads to the planning of the next experience, and so the cycle begins. The general relation between this whole recreation experience concept, the typology of Appendix 36 Table 2, and the unit economic values of Appendix 36 Table 1 is summarized in Appendix 36 Table 3.

The rationale and approach of the Appendix 36 Table 3 underlie the development of gross economic values for the salmon sport fishery. Caution is advised, however, to view the economic values as approximations only of the general magnitude, or apparent demand in monetary terms that consumers appear to place on the products (experiences) provided by the salmon sport fishery.

3. Economic Values of the 1974 U.S. Pacific Coast Salmon Sport Fishery

Economic valuation of the U.S. Pacific coast salmon sport fishery is limited to the 1974 fishery of Washington, Oregon, Idaho and California. The Alaska fishery was not included because of the absence of catch data for 1974 as well as the provisional nature of the data for the previous years. The median of the range in unit "gross expenditure" and "net economic" values were used to extimate total gross expenditure value, total net economic value, and aggregate value. The data and valuation procedure used and the economic values estimated for the 1974 salmon sport fishery are presented in Appendix 36 Table 4.

The gross expenditure value of the 1974 salmon sport fishery was $104.8 million--the approximate amount estimated as spent by consumers in pursuit of salmon sport fishing along Washington, Oregon, Idaho and California. The implied net economic value of the fishery was approximately $58.6 million--that that is, the hypothetical "admission"-type value. The aggregate value came to approximately $163.4 million.

Appendix 36 Table 3.--General relationship between the recreation experience phases, economic value indicators, and unit economic values of salmon sport fishing.

Recreation experience phase (Clawson, 1965)	Economic value indicator (Appendix 36 Table 2)	Salmon Unit economic value (Appendix 36 Table 1)
Anticipation, or planning	"Other 1/.." category	Gross expenditure value
Travel to the site	"Other 1/.." category	Gross expenditure value
On site	"Primary 2/.." category	"Net economic value" (plus on-site gross expenditure value of goods and services)
Travel back	"Other 1/.." category	Gross expenditure value
Recollection	"Other 1/.." category	Gross expenditure value

1/ Price of durable and non-durable goods and services related to (1) personal transportation (and lodging) to and from the site of the final product and (2) participatory aspects in consuming the final product.
2/ The retail, admission, or facility-use prices of the final product.

Appendix 36 Table 4.--Valuation of the 1974 U.S. Pacific coast salmon sport fishery (excluding Alaska).

Unit Values	
Total salmon catch, 1974.	2,021,100 fish 1/
Salmon catch per angler trip or day:	
Range	0.71 2/ to 1.05 3//day
Median	0.88 fish/day
Gross expenditure value in 1974 dollars: 4/	
Range	\$26.68 5/ to \$64.55 6//day
Median	\$45.62/day
Per fish	\$51.84 7/
Net economic value in 1974 dollars: 4/	
Range	\$10.68 8/ to \$40.32 9//day
Median	\$25.50/day
Per fish	\$28.98 10/

Gross Values 11/	
Gross expenditure value = 2,021,000 (\$51.84) =	\$ 104,773,824
Net economic value = 2,021,000 (\$28.98) =	\$ 58,571,478
Aggregate value =	\$ 163,345,302

1/ Salmon catch of Washington, Oregon, Idaho and California. Source: Appendix 31-33.
2/ Marine catch per-angler-trip, Washington (Appendix 33).
3/ Marine catch per-angler-trip, Oregon (Appendix 32).
4/ Original values were adjusted to 1974 dollars based on changes in the Consumer Price Index (U.S. Bur. Census 1975), Appendix 36 Table 1.
5/ The original \$16.60 value estimated from Brown et al (1964).
6/ The original \$43.57 value estimated from Crutchfield and MacFarlane (1968); Appendix 36, Table 1.
7/ Value per fish = \$45.62 ÷ 0.88 = \$51.84.
8/ The original \$9.00 value from Water Resource Council (1971); Appendix 36 Table 1.
9/ The original \$28.00 value from Mathews and Brown (1970); Appendix 36 Table 1.
10/ Value per fish = \$25.50 ÷ 0.88 = \$28.98.
11/ Estimated on the basis of total salmon catch multiplied by per fish values. Actual computation should be on the basis of angler trips/days multiplied by per-trip/day values. However, information on angler trips/days was not consistent nor available on some of the fisheries, thus leading to the use of catch and per-fish values in this report.