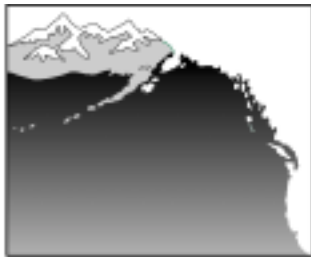


SAFS-UW-0109
September 2001

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Final Report to:

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Abstract

Direct information from high seas tagging studies indicates that Yukon River chinook salmon are concentrated in the Bering Sea. These results are supported by scale pattern analysis (SPA), which estimates that immature western Alaska (particularly Yukon River) chinook salmon are the dominant population in the northwestern and central Bering Sea in summer and in the southeastern Bering Sea (west of 170°W) in winter. SPA indicates that immature Yukon chinook salmon are also distributed well offshore in the central North Pacific Ocean (north of 46°N) in spring-early summer (June). Parasite analysis of chinook salmon continental origins supports scale pattern results for Bering Sea distribution of western Alaska salmon. Existing data are inadequate for inferring the distribution and migration routes of juveniles in their first year at sea and adults in their last spring at sea. New ocean research on salmon distribution, carrying capacity, ecology, run forecasting, response to climate change, and stock and fishery interactions is recommended.

Introduction

In this paper we summarize information on the general state of knowledge and current hypotheses about ocean migration and residency of Yukon River chinook salmon (*Oncorhynchus tshawytscha*), including a brief comparison with what is known about ocean migration and residency of other North Pacific chinook salmon stocks. The first section of our results and discussion is a summary of information from previously published reviews of ocean distribution and migration patterns of chinook salmon, which include data collected from 1955 through 1986. Subsequent sections also include new data from 1987-present and information from other publications and processed reports not covered by the earlier reviews. Information on current and potential future directions for ocean research on Yukon River chinook salmon is also discussed.

Methods

Throughout the paper we assume that data on the distribution of chinook salmon in the Bering Sea and western Alaska chinook salmon in all ocean regions are representative of the distribution of Yukon River chinook salmon. Distribution and relative abundance data were taken from published scientific literature, processed agency reports, and databases maintained and updated annually with new information by the High Seas Salmon Research Program, School of Aquatic and Fishery Sciences, University of Washington. These databases include the high seas tag (1956-present) and coded-wire tag (1981-present) recovery databases and high seas research and fishery catch and effort data files (1955-present). Additional data on high seas salmon research have been provided on different occasions by the Canadian Department of Fisheries and Oceans, the Fisheries Agency of Japan, Russia's Pacific Research Institute of Fisheries and Oceanography, and the U.S. National Marine Fisheries Service. Material has also been extracted from International North Pacific Fisheries Commission (INPFC) and North Pacific Anadromous Fish Commission (NPAFC) documents submitted by the Contracting Parties (Canada, Japan, Russia, and the United States). Methods for the scale pattern analyses are described in cited references. Freshwater and ocean age designation for salmon follows the European formula (Koo 1962). In this notation, a number preceding a dot is the number of years (winters) that the fish spent in freshwater, and a number following a dot is the number of years spent in the ocean. For example, an age-1.4 chinook salmon spent one year in freshwater and four years in the ocean. All salmon in the ocean are assigned the same birthday, that is, all fish become one year older on January 1. We followed the definitions for salmon life-history and maturity stage established in previous reviews, that is, a "juvenile" fish is in its first ocean year (ocean age-.0), an "immature" fish is in its second or subsequent ocean year (ocean age-.1 or older) but not its last ocean year, and a "maturing" fish is in its last ocean year.

Results and Discussion

Summary of information from published reviews of historical data (1955-1986)

Historical research related to high seas salmon driftnet fisheries and various other ocean interception fisheries has yielded data on the ecology and biology of salmon in the North Pacific Ocean since the mid-1950s. Some of the early research in the mid-1950s by INPFC member nations was simply to ascertain the range limits and migration routes of the different species of Pacific salmon (Jackson and Royce 1986). Field investigations of ocean distribution, migration patterns, abundance, and stock origins of chinook salmon have always been limited by the low abundance of this species in research vessel catches. Data acquired over the past 47 years by numerous vessels conducting different lines of research have added more detail, and the data can be combined to show oceanic distribution and relative abundance of chinook salmon. However, these data were collected over many years, and distribution of effort has been spotty. For example, there has been very little research vessel effort south of 50°N between 175°W and 155°W, and most of the Gulf of Alaska data were collected in the 1960s. The great majority of research effort has occurred in summer, and information from other seasons is much less extensive. Additional data are limited to the times and areas of intensive coastal and high seas commercial fisheries for salmon and other species.

Mason (1965) provided the first comprehensive review of INPFC data (1955-1962) on chinook salmon in offshore waters. Over the entire 8-year period combined research gillnet and

longline catches by Canada, Japan, and the United States in the Bering Sea and North Pacific Ocean were less than 2,000 chinook salmon, illustrating the extremely low abundance of chinook salmon in near-surface research catches. By combining research and Japanese mothership fishery catch data he was able to develop the first relatively complete picture of the broad-scale distribution of chinook salmon in offshore waters. Mason's results indicated that chinook salmon (primarily immature fish) are distributed across the North Pacific Ocean from at least 41°N to the Aleutian Chain, and in the Bering Sea westward from Bristol Bay to Kamchatka and northward from the Aleutian Islands to 60°N. In spring (May) chinook salmon were distributed south of the Aleutians to 42°N latitude in the central North Pacific and to 40°N close to Japan, and the greatest concentrations were south of the Komandorski Islands and east to 175°E, where abundance appeared to increase in June and peak in July concurrently with a westward shift in distribution toward the coast of Kamchatka. In June, the greatest concentrations of immature chinook salmon were in the central Bering Sea, and these concentrations apparently shifted westward of 180° in July, and further westward in August.

Major et al. (1978) updated previous summaries of INPFC data with information collected primarily through 1970, and summarized significant new information as follows:

General distribution of juvenile (ocean age-.0) chinook. In their first summer and fall in the ocean, juvenile (ocean age-.0) chinook salmon tend to be distributed close to shore rather than in offshore waters; by winter (December and January) they also occur in offshore waters.

General distribution of ocean age-.1 chinook. In their second summer and fall in the ocean (ocean age-.1) chinook are distributed over a wide area (coastal Gulf of Alaska, eastern Aleutian Islands, most of the Bering Sea, and the North Pacific Ocean south and eastward from the tip of the Kamchatka Peninsula to the central Aleutian Islands) but have not yet attained their maximum offshore distribution; the only substantial catches in offshore waters were in the central Bering Sea where stocks are primarily of Yukon River, Kuskokwim River, and Bristol Bay origin.

Major distribution area/maturity. Among three offshore regions—the western North Pacific Ocean and the Bering and Okhotsk seas—the greatest concentration of all ocean-age groups (age-.1 and older) is in the Bering Sea. In the western and central Bering Sea in summer (June-July) most chinook salmon are immature and the few maturing fish appear to be bound for Russian (Kamchatka Peninsula) rivers;

Vertical distribution. The vertical distribution of chinook salmon in offshore waters is not well defined, but they frequent greater depths (e.g., depths to 110 m in coastal waters) than other salmon species and are captured in offshore waters in trawls fished on or near the bottom.

Distribution and sea surface temperature. The abundance of chinook salmon appeared to be independent of sea surface temperature at the range where they were encountered (2.0-11.5°C).

Distribution of western Alaska (including Canadian Yukon) chinook from tagging. At the time of Major et al.'s report there were eight coastal recoveries of high seas tagged salmon (3 Yukon R., 1 Kuskokwim R., 2 Bristol Bay, 1 Yakutat, and 1 Columbia R.). These recoveries showed that western Alaskan chinook salmon occurred in the Bering Sea as far west as 172°12'E (at

59°03'N) and in the North Pacific Ocean just south of Adak (as far west as 176°18'W (at 51°36'N), where they mixed with chinook from a wide coastal range (Yakutat to the Columbia R.).

Distribution of western Alaska (including Yukon Territory) chinook from scale analysis. Scale growth patterns showed that western Alaskan-type chinook salmon increased in proportion from west to east within the area of the former Japanese mothership fishery (160°E-175°W), particularly in the Bering Sea in summer where high-seas driftnet catches of immature fish were highest.

Distribution of other N. American stocks. Stocks from N. American streams other than western Alaska were known from tag experiments to occur in the North Pacific Ocean as far west as 176°34'W (at 51°29'N), and were widely scattered in the Gulf of Alaska and farther south, principally close to shore.

Distribution of Russian stocks. At the time of Major et al.'s summary there were no reported recoveries of tagged salmon from Russia. Indirect information from scale, maturity, and distribution studies suggested that Russian chinook range as far south in the western North Pacific Ocean as about 40°N and as far east as about 180°, and are widely distributed in the Bering Sea to at least as far west as 160-165°E.

Ocean age composition of chinook in offshore waters. Ocean ages-.2 and -.3 fish dominated in offshore research and commercial driftnet fishery catches, with only small proportions of age-.1, -.4, and -.5 fish, and proportions of age-.2 fish increased in catches over the May-July period regardless of fishing area.

Hartt and Dell (1986) provided some additional information on the distribution of juvenile (age-.0) chinook salmon in the eastern Bering Sea and North Pacific Ocean. Most of their sampling was done in relatively nearshore waters from May to October 1964-1968 with fine-mesh purse seines. In the eastern Bering Sea, juvenile chinook salmon first appeared in their catches in late June, and were caught in all subsequent time periods. The westernmost catches of juvenile chinook were south of the central Aleutian Islands during July. Data were inadequate for inferring migration patterns between juvenile and immature age-.1 stages, but indicated that western Alaskan stocks migrated farther offshore than stocks from other North American production areas to the south. The mixing of juvenile age-.0 and immature age-.1 chinook in both coastal and offshore waters appeared to be unique compared to other Pacific salmon species. There was no evidence of overlap in distribution of Bering Sea and Gulf of Alaska chinook salmon stocks at the juvenile stage. The direction of local movements of juveniles in the eastern Bering Sea was variable, apparently influenced by strong tidal currents and rich feeding conditions.

In the most recent comprehensive review of historical information, Healey (1991) used high seas disk tag data (1956-1984; C. Harris, Fisheries Research Institute, University of Washington, pers. comm.) and coded wire tag recovery data (1980-1986; Dahlberg 1982; Wertheimer and Dahlberg 1983, 1984; Dahlberg and Fowler 1985; Dahlberg et al. 1986) and the results of scale pattern analyses (Major et al. 1978; Myers et al. 1984; Ito et al. 1985, 1986; and Myers 1986) to describe the distribution and relative abundance of regional stock groups of chinook salmon in

the Bering Sea and North Pacific Ocean. Healey concluded that in the Bering Sea western Alaskan chinook salmon (including Canadian Yukon fish) are the most abundant stock group, and Russian and central Alaskan stocks are about half as abundant as western Alaskan chinook salmon. The abundance of the southeast Alaska-British Columbia stock group in the Bering Sea is low. In the western North Pacific Ocean, there is a broad mixture of Russian, western Alaskan, and central Alaskan stocks, and western Alaskan chinook are probably no more abundant than Russian stocks. Central Alaskan stocks are probably less abundant than Russian chinook salmon in the Bering Sea and western North Pacific Ocean. Abundance of southeast Alaska and British Columbia chinook salmon is low in both the Bering Sea and western North Pacific Ocean. These stocks, as well as Washington, Oregon, Idaho, and California stocks, are probably distributed mainly in the eastern North Pacific with the greatest concentrations in coastal waters over the continental shelf. Healey notes that “virtually all chinook captured in the Bering Sea and western North Pacific Ocean are stream-type” (fish that spent one or more winters in freshwater before migrating to the ocean). However, the accuracy of freshwater ages, which were determined from the scales of chinook salmon in high seas mixtures, is not known.

New information (not included in previously published summaries) on the general ocean distribution of chinook salmon

Japanese research gillnet data clearly show the broad ocean distribution of chinook salmon in summer (June-July 1972-1990; Fig. 1; Ishida and Ogura 1992). The nets, constructed of 10 different mesh sizes to reduce size selectivity, are soaked overnight, and sample only surface waters (to about 8-m deep). Chinook salmon are caught in the nets while actively feeding at the surface before sunrise. These data indicate that the highest summer concentrations of chinook salmon are in the central Bering Sea between 170°E and 170°W, where immature Yukon River chinook salmon are estimated by tagging, parasite, and scale pattern studies to be the major stock component.

We examined fall, winter, and spring patterns of distribution and abundance of chinook salmon by combining data from gillnet, longline, and purse seine gear used by Japanese, Canadian, Russian, and U.S. research vessels from 1955 to 1991 (Fig. 2). By autumn chinook salmon seem to have moved to Gulf of Alaska and Kamchatka coastal waters, but there are almost no research vessel data for the western Bering Sea, which is probably the main area of distribution of immature Yukon River chinook salmon in autumn. Very minimal data from winter show a few fish in the central eastern North Pacific, south of the Alaska Peninsula; there is no information from the southern part of their distribution in winter. Research vessel catches in spring show that chinook salmon are distributed well offshore in the North Pacific Ocean along the southern edge of their ranges, south of about 45°N. Clearly, the historical high seas salmon research vessel data are inadequate for showing the autumn, winter, and spring distribution of chinook salmon in the North Pacific Ocean and Bering Sea.

The Japanese high seas salmon driftnet fisheries were terminated in 1991, and since then high seas salmon research programs have been greatly reduced. One research vessel, the *Wakatake maru*, has been used for annual surveys in the central North Pacific and Bering Sea along the 180° longitude in summer (June-July, 1991-2001). The *Wakatake maru* data show the low relative abundance of chinook salmon compared to other species in high seas research gillnet catches, and the higher relative abundance of chinook salmon in the central Bering Sea than in the central North Pacific Ocean (Table 1). In 1998 and 2000, chinook salmon abundance in the

Bering Sea was relatively high, when young ocean age-.1 fish predominated in the catches (Table 2). Immature chinook salmon in the central North Pacific in summer from the Subarctic Current to the Aleutians feed primarily on squid (*Berryteuthis anonychus*), and in the Bering Sea their diets are more diversified, also including fish and euphausiids (Table 3). Another Japanese research vessel, the *Oshoro maru*, has been used for summer salmon surveys the central North Pacific Ocean and Gulf of Alaska, where the few chinook salmon caught by research gillnets were predominantly immature ocean age-.2 fish feeding primarily on squid (Tables 4 -6). Sonic tracking by Japanese scientists of four chinook salmon (probably immature) in the central Bering Sea in summer showed that they swam in or below the thermocline, which was about 20-40 m deep in most areas, with occasional vertical movements toward the surface or deeper layers (Ogura and Ishida 1995). Occasional winter surface-trawl surveys by Japan have shown aggregations of juvenile chinook salmon moving offshore into the western North Pacific Ocean in December-February (Nagasawa et al. 1994; Ueno et al. 1997; Ishida et al. 1999). The February 1998 trawl survey was the only one that included stations in the Bering Sea, where chinook was the only salmon species in the catch (Ishida et al. 1999).

Data from chinook salmon bycatch in commercial trawl fisheries provide a more complete picture of fall, winter, and spring chinook salmon distribution in the eastern Bering Sea than the research vessel data shown in Figure 2. The largest reported catches by foreign and joint-venture groundfish fisheries in the U.S. 200-mile zone in eastern Bering Sea were in 1979 and 1980 (over 100,000 and 201,000), and catches declined after 1980. Incidental chinook salmon catches were usually highest in demersal (4-6 m above the bottom) trawl fisheries operating along the 200-m contour during the late fall, winter, and early spring (Nelson et al. 1978, 1979, 1980, 1981a, 1981b, 1982, 1983; Berger et al. 1984, 1985). Chinook salmon are more closely associated with the bottom than other species of Pacific salmon, and decreased activity of chinook salmon during winter months may cause increased susceptibility to trawls (Natural Resource Consultants 1984). The decline in incidental catches of chinook salmon after 1981 may have been related to an increase in the use of pelagic (mid water) trawls (Nelson et al. 1981a). Analyses of bycatch data from U.S. groundfish fisheries in the eastern Bering Sea indicate that immature chinook salmon enter the eastern Bering Sea in autumn, remain there throughout the winter and spring, and then move to other areas in summer (ADFG/NPFMC 1999). Data from commercial trawl operations off the U.S. west coast (1985-1990) indicated a seasonal shift in abundance and depth distribution of chinook salmon, that is, catches were higher in winter and were dispersed throughout a depth range of 100-482 m, than in summer when catches were low and occurred at shallower depths (less than 220 m, Erickson and Pikitch 1994). Recent U.S. research trawl surveys in the eastern Bering Sea (Bristol Bay) in summer have found juvenile chinook salmon distributed within the coastal domain (Farley et al. 2000).

Russian research trawl surveys have provided new information on chinook salmon distribution and migration patterns in the western Bering Sea (Radchenko and Chigirinsky 1995, Radchenko and Glebov 1998, Smorodin et al. 2001). Concentrations of chinook salmon smolts are found on the Korfa-Karaginsky shelf in early October (Radchenko and Chigirinsky 1995). Most juvenile (ocean age-.0) chinook salmon off eastern Kamchatka leave coastal waters and move offshore into the Bering Sea by late September-early October (Smorodin et al. 2001). The general seasonal movements of all other age groups (age-.1 and older) of chinook salmon appear to be similar, that is, distribution shifts southeastward in fall-winter and northwestward in spring-summer. In spring (May) maturing chinook salmon are distributed in the western Bering Sea,

and by late June-early July they are finishing the ocean phase of their return migration. In summer and autumn, immature chinook salmon move from the eastern Bering Sea into the western Bering Sea, where their distribution appears to shift from the eastern part of the Russian EEZ in late June to the western Aleutian Basin and shelf and continental slope of the Navarin region by early October (Fig. 3; Radchenko and Chigirinsky 1995). Immature age-.1 chinook salmon are distributed mainly in pelagic waters, where they feed on juvenile squid and euphausiids, and older, larger immatures (ocean age-.2 and older) tend to be distributed at or near the bottom (180 m and above) along the outer shelf, where they feed on adult squid (*Berryteuthis magister*) (Radchenko and Glebov 1998). In November-December immature chinook salmon begin to leave the western Bering Sea (Fig. 3; Radchenko and Chigirinsky 1995). In winter ocean age-.2 or older chinook salmon are distributed in near-bottom layers of the northern and western Bering Sea shelf and along the entire 200-m contour of the eastern Bering Sea shelf, where they continue to feed mainly on gonatid squids (Fig. 3; Radchenko and Glebov 1998).

Information from tagging studies

Much of the INPFC-related salmon research was directed at the stock composition of salmon caught in the salmon fisheries and the delineation of ranges of stocks in relation to the fisheries areas (Jackson and Royce 1986). To this end, extensive tagging programs were implemented, and tags have been applied to fish on the high seas for recovery inshore since 1955. After the end of the high seas salmon driftnet fisheries in 1991, the high seas tagging program was greatly reduced, and at present the only high seas salmon tagging operations in the Bering Sea, which is the main area of ocean distribution of Yukon chinook salmon, are done by scientists aboard the Japanese research vessel *Wakatake maru* in July. Since 1980 the catches of high seas research vessels and commercial groundfish (trawl) vessels in the U.S. 200-mile zone have been examined for salmon and steelhead with missing adipose fins to recover coded-wire tags (CWTs).

Western Alaska chinook salmon. All western Alaska recoveries of chinook salmon tagged and released during high seas salmon investigations by Japan, Russia, and the United States (1955-2000) have come from fish tagged in the Bering Sea or just south of the Aleutians (Fig. 4, Table 7). One tag was recovered in the Canadian Yukon and the remainder were recovered in western Alaska (8 Yukon fish, 4 Bristol Bay fish, and 2 Kuskokwim fish). All but one of these tagged fish were released west of 179°W in June and July. These data show that immature Yukon, Kuskokwim, and Bristol Bay chinook salmon mix in offshore waters of the Bering Sea in summer, and suggest that Yukon River chinook salmon are the predominant stock of western Alaskan salmon in the central and northwestern Bering Sea in summer. The release locations of two maturing fish recovered in Bristol Bay suggest a possible spring migration corridor running northeastward from the south-central Aleutians and along the north side of the Alaskan Peninsula to Bristol Bay. Although there are no returns of tagged salmon to the Yukon River from the North Pacific, a reasonable assumption is that Yukon chinook salmon are also distributed well offshore south of the Aleutian Islands and perhaps into the Gulf of Alaska (Rogers 1987).

All nine ocean recoveries of CWT western Alaskan chinook salmon are from Canadian Yukon (Whitehorse Hatchery) fish in the bycatch of trawl fisheries in the eastern Bering Sea (Fig. 5, Table 8). We think it is reasonable to assume, however, that wild Yukon fish would have distribution patterns similar to hatchery fish. One recovery on the eastern Bering Sea shelf

in June was probably a maturing fish, and suggests that Yukon fish may approach the river mouth from the south. The other recoveries were from fish caught in winter (December-March) along the eastern Bering Sea shelf break (200-m depth contour) northwestward from Unimak Pass to the international boundary.

The overall pattern of all recoveries of tagged Yukon chinook salmon suggests seasonal movement of immature Yukon chinook salmon between summer feeding grounds in the central and northwestern Bering Sea and wintering areas in the southeastern Bering Sea. There are not enough tag recoveries to make quantitative estimates of stock composition of chinook salmon in the Bering Sea and North Pacific Ocean.

Other North American chinook salmon. There are recoveries of CWT central and southeastern Alaska, British Columbia, Washington, Oregon, and California chinook salmon from trawl fisheries in the southeastern Bering Sea (Figs. 6-12, Tables 9-10). The relatively low number of recoveries from Alaskan stocks reflects the pattern of coded-wire tag releases rather than the relative abundance of the stocks. Coded-wire tagged fish are released primarily from North American hatcheries south of the Alaska Peninsula, and provide little or no information on Russian and western and central Alaskan stocks. Canada does not report recoveries of CWT chinook salmon from their research or commercial trawl fisheries.

The number of CWT recoveries from all release locations except the Yukon and Central Alaska (Cook Inlet, Kodiak) were substantially higher in the Gulf of Alaska or the U.S. West Coast than in the Bering Sea. Most Bering Sea recoveries of CWT Alaska chinook salmon were in September-November, suggesting fall movements of immature chinook salmon from pelagic summer feeding areas in the Bering Sea to wintering areas in the Aleutians, North Pacific Ocean, and Gulf of Alaska. However, a few December-March recoveries of CWT Alaska, British Columbia, Washington, and Oregon chinook salmon in the Bering Sea indicates that some fish from these regions may overwinter in the southeastern Bering Sea.

One chinook salmon recovered in a troll fishery off Yakutat, Alaska, and one Columbia River chinook salmon (returning to the Salmon R., Idaho) were recovered from high seas releases of immature chinook salmon caught south of Adak Island in the central Aleutians (Fig. 4). One high seas research vessel recovery of a CWT Columbia River chinook salmon (age 1.1) at 43°30'N, 173°30'W in June is a southwestern range limit for North American chinook salmon in the North Pacific Ocean. These few recoveries suggest that the distribution of North American chinook salmon in the North Pacific Ocean is much broader than indicated by Gulf of Alaska and U.S. West Coast recoveries of tagged chinook salmon.

Asian chinook salmon. There are only two Asian recoveries of chinook tagged on the high seas, one tagged off Hokkaido and one south of the central Aleutians (Fig. 4).

Information from scale pattern analysis

Given the nature of sampling opportunities from the fisheries and the accessibility of known-origin reference materials from Asia and North America, scale pattern analysis (SPA) has proved to be the most useful approach for estimates of stock mixtures of salmon on the high seas.

SPA shows western Alaska (particularly Yukon River) chinook salmon predominate in the Bering Sea. There is a mix of Asian and North American (western and south central Alaskan) stocks from south of the Aleutians down to 46°N, with wide variations in estimated proportions between years. South of 46°N, in the landbased salmon fishery area, the chinook are estimated to be predominately Asian (Myers et al. 1984, 1987; Myers and Rogers 1988; Davis 1990, 1991).

Chinook salmon in the 1979, 1981, and 1982 catches by groundfish fisheries in the eastern Bering Sea were predominantly ages 1.2 (56%) and 1.3 (26%). Regional stock proportion estimates indicated that western Alaska, which included Canadian Yukon fish, was the predominant regional stock of ages 1.2 and 1.3 fish. The proportions of the three western Alaskan subregional stocks (Yukon, Kuskokwim, and Bristol Bay) varied considerably with such factors as brood year, time, and area (Table 11). Bristol Bay and central Alaska (primarily Cook Inlet) stocks predominated in fall (October-November) catches in the eastern portion of the fishery area (east of 170°W), and Yukon fish predominated in winter (January-February) catches in the western portion (west of 170°W).

Other scale pattern studies have shown western Alaska to be the predominant regional stock in May-June samples of immature chinook salmon in the Bering Sea west of 180° (Major et al. 1975, 1977a, 1977b; Ito et al. 1986; Myers et al. 1987, Davis 1990). Myers et al. (1987) also noted considerable annual variability in estimated proportions of age-1.2 Yukon, Kuskokwim, and Bristol Bay chinook salmon in the central Bering Sea in July, 1975-1981 (Table 12). In June, Yukon chinook were the predominant stock in catches in the central North Pacific Ocean between 170°E and 175°E and in the central Bering Sea between 175°E and 180°. In July 1979-1981, proportions of Yukon chinook were higher in catches from the western portion of the fishery area (175°E-180°) than in the eastern portion (180°-175°W). Rogers (1987) used these estimates to calculate interceptions of Yukon River chinook salmon by the Japanese high seas driftnet fisheries, and found that these interceptions often amounted to over 20% of the domestic catch in the 1970s and even in 1986.

Information from parasites

Parasites acquired in freshwater and found only in one region or on one continent have also been used to determine the freshwater origin of chinook caught on the high seas. Japanese scientists examined two myxosporean brain parasites, *Myxobolus arcticus* and *M. neurobius*, in adult head and smolt samples from two Asian rivers and from North American rivers from the Yukon to the Sacramento (Urawa et al. 1990; Urawa and Nagasawa 1991). *Myxobolus arcticus*, the "Asian" indicator parasite, is also found in some North American chinook (as well as in other species) from British Columbia and southeastern Alaska. We used the interpretation of Urawa et al. (1998) regarding the continent of origin of chinook salmon with parasite "tags," but consider their data to be indirect evidence (not proof of origin) for Russian salmon. In the Bering Sea and the central and western North Pacific, parasite data generally agree with SPA estimates: there are few infected chinook in the Bering Sea (indicating mostly North American origins), and much higher infection rates south of the Aleutians (presumably indicating Asian fish; Fig. 13). *Myxobolus neurobius* has been found only in Columbia River chinook and so far has not been detected in high seas samples.

Summary of Ocean Distribution and Migration Patterns of Yukon Chinook

Data are inadequate for inferring the migration patterns of juvenile (ocean age-.0) Yukon River chinook salmon. If their behavior is similar to other juvenile chinook salmon, then in summer they are probably distributed in the coastal domain rather than in offshore waters, and by winter (December and January) they also occur in offshore waters. Between juvenile and age-.1 stages they probably migrate farther offshore than most other North American chinook salmon stocks. By their second fall in the ocean (ocean age-.1) Yukon chinook salmon may range over a broad area, including most of the Bering Sea and the North Pacific Ocean, north of 46°N and south and eastward from the western Aleutians, where they are distributed in pelagic waters.

The maximum offshore distribution of Yukon chinook salmon is apparently reached in their third and fourth years in the ocean (immature ocean ages-.2 and -.3), when they migrate between summer-fall feeding areas in the central, western, and northwestern Bering Sea to winter-spring feeding areas in the southeastern Bering Sea, Aleutians, and North Pacific Ocean. In spring (May) immature (ages-.1, -.2, and .3) Yukon chinook salmon are probably distributed in the central North Pacific and Bering Sea earlier than other salmon species and stocks. In June-early July immature Yukon chinook salmon move from the eastern Bering Sea and central North Pacific into the central Bering Sea, where in late June they are distributed in international waters (Donut Hole) and in the eastern part of the Russian EEZ. From mid July to September their distribution shifts north and westward, and by early October their northwestward distribution extends to the western Aleutian Basin and shelf and continental slope of the Navarin region (Siberian Coast), where larger, immature (ocean age-.2 and -.3) chinook salmon are distributed mainly at or near the bottom (180 m and above) along the outer shelf.

The highest summertime concentrations of chinook salmon are in the central Bering Sea between 170°E and 170°W, where immature Yukon River chinook salmon are the major component in mixtures of Russian, western Alaska, and central Alaska (primarily Cook Inlet) chinook stocks. These concentrations of Yukon chinook shift westward of 180° in July. Limited data from sonic tracking indicates that immature chinook salmon in this area swim in or below the thermocline (about 20-40 m deep) with occasional vertical movements toward the surface or deeper layers.

In November-December immature Yukon chinook salmon begin to leave the western Bering Sea. Groundfish research and commercial trawl data show that in winter (December-March) ocean age-.2 or older chinook salmon are distributed in near-bottom layers of the northern and western Bering Sea shelf and along the entire 200-m contour of the eastern Bering Sea shelf. Scale pattern estimates indicate that the greatest winter concentrations of Yukon chinook salmon in the eastern Bering Sea are west of 170°W. In their last spring (June), adult Yukon River chinook salmon are distributed on the eastern Bering Sea shelf, but data are inadequate for inferring their return migration routes.

Current YR DFA analysis

The only stock mixing-proportion estimates for chinook salmon in the eastern Bering Sea are from a period of relatively high abundance of Yukon chinook salmon in the late 1970s and early 1980s (Myers and Rogers 1988). The large incidental catches of chinook salmon in eastern

Bering Sea trawl fisheries in 1979-1980 preceded large runs to the Yukon River in 1980-1981, so the effect of the interceptions was probably not significant. The current Yukon River Drainage Fisheries Association (YRDFA) analysis of chinook scale samples, including the final analysis to be conducted in FY 2002, will provide mixing-proportion estimates for chinook salmon in eastern Bering Sea trawl fisheries in 1997-1999, a period of relatively low abundance of Yukon chinook salmon. If the major component stocks of western and central Alaska chinook salmon can be accurately identified, then the analysis will provide information on possible shifts from the previous period in distribution and relative abundance of Yukon R. chinook salmon, as well as new estimates of the stock composition and distribution patterns among various year classes and age groups of chinook salmon within the times and areas of the fishery.

Research Recommendations

We recommend new ocean research on Yukon River chinook salmon carrying capacity, growth, and stock and fishery interactions. There are many important questions that should be addressed, for example:

1. What is the range of interannual variation in seasonal distribution and migration patterns of Yukon River chinook salmon at each ocean life-history stage? Where are their critical habitats and foraging areas? What are the boundaries of these areas, the conditions that define the boundaries (spatial, temporal), and their residence times in these areas?
2. What are the primary ocean prey, predators, and competitors of Yukon River chinook? What is the range of variation in spatial and temporal overlap of salmon and their predators and prey, and how do changes in ocean conditions affect predator-prey-competitor relations?
3. What and where are the best habitats for promoting summer growth and winter survival of Yukon River chinook salmon? How does environment and body condition (e.g., temperature, photoperiod, lipid content) influence their winter survival and age at maturity?
4. What role does vertical distribution and migration play in growth, bioenergetics, and survival of Yukon River salmon in different seasons?
5. Is there any evidence for competition or density-dependent growth or mortality between Yukon River chinook salmon and Asian salmon stocks in the Bering Sea (e.g., Russian pink salmon, Hokkaido chum salmon)?
6. How do short-term climate change (e.g., warm winters vs. cold winters, El Niño vs. La Niña) and longer-term climate change (e.g., Arctic Oscillation, Pacific Decadal Oscillation) affect salmon distribution, migration, and foraging patterns?
7. Can research trawl data be used to accurately estimate salmon abundance? How are salmon behavior (distribution, migration, and feeding patterns) and environmental conditions related to their abundance and survival, and can fishery managers use this information to accurately forecast adult returns?
8. When and where do stock-specific aggregations of Yukon River chinook salmon form in the ocean? When and where are they most susceptible to interception fisheries? What are the catches and bycatches of Yukon River chinook salmon in coastal and offshore fisheries outside the US EEZ?
9. Are large releases of hatchery salmon affecting the carrying capacity of wild Yukon River chinook salmon in the Bering Sea?

The best approach to resolving these issues is a long-term, multidisciplinary research and monitoring effort to provide data for ocean assessment, management, and conservation of Yukon River chinook salmon stocks. A directed research effort on juvenile Yukon River chinook salmon in the coastal domain is essential to understanding the causes of short- and long-term variation in ocean survival. Given their low abundance relative to other salmon species in research catches, however, a directed high seas research effort on chinook salmon is not practical. We recommend developing a program of high seas research on Yukon chinook in conjunction with ongoing research on other salmon species, as well as by making better use of opportunities to collect samples and data from chinook salmon bycatch in large-scale commercial trawl fisheries. Because Yukon chinook salmon migrate across international boundaries and in the international waters of the Bering Sea and North Pacific Ocean, this research effort should be closely coordinated with Canada, Russia, and Japan under the auspices of the NPAFC. At present, the NPAFC is actively developing and implementing a new cooperative program of research on salmon in the Bering Sea.

Acknowledgments

We thank our many colleagues in Canada, Japan, Russia, and the United States for providing some of the data and samples used in this report. Funding for this work was provided by the Yukon River Drainage Fisheries Association through a grant from NOAA.

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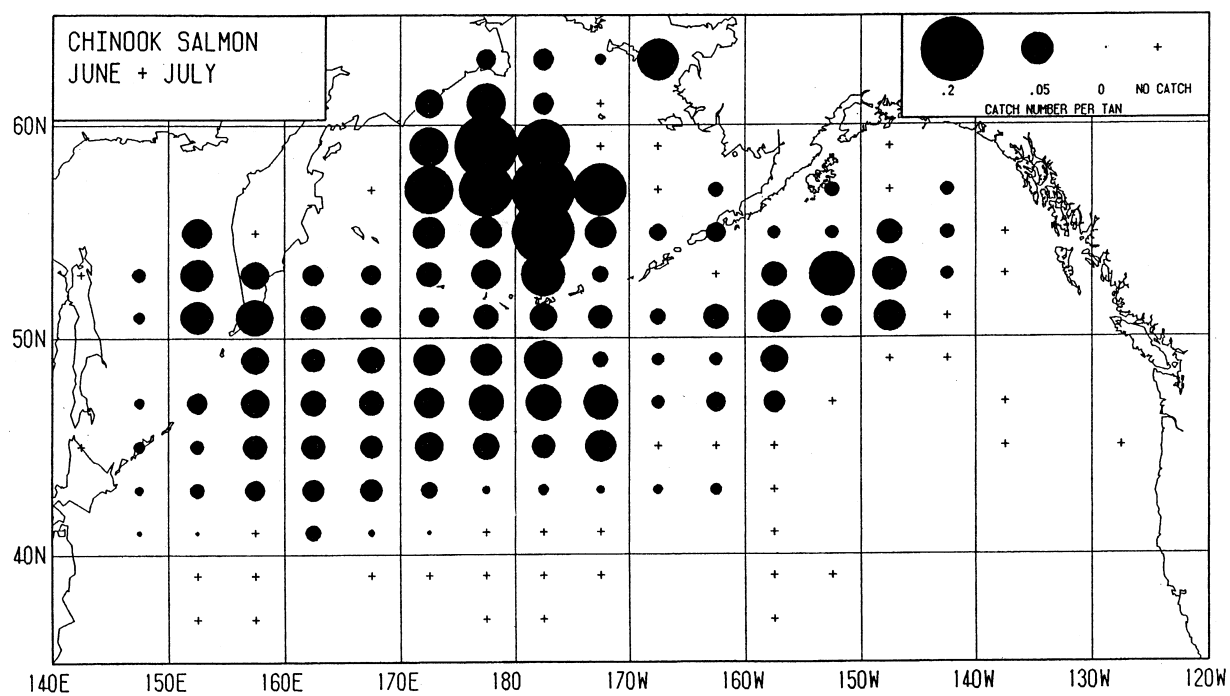


Fig. 1. Summer (June-July) distribution and relative abundance of chinook salmon in the North Pacific Ocean and Bering Sea based on surface research gillnet data collected by Japanese salmon research vessels, 1972-1990 (from Ishida and Ogura 1992).

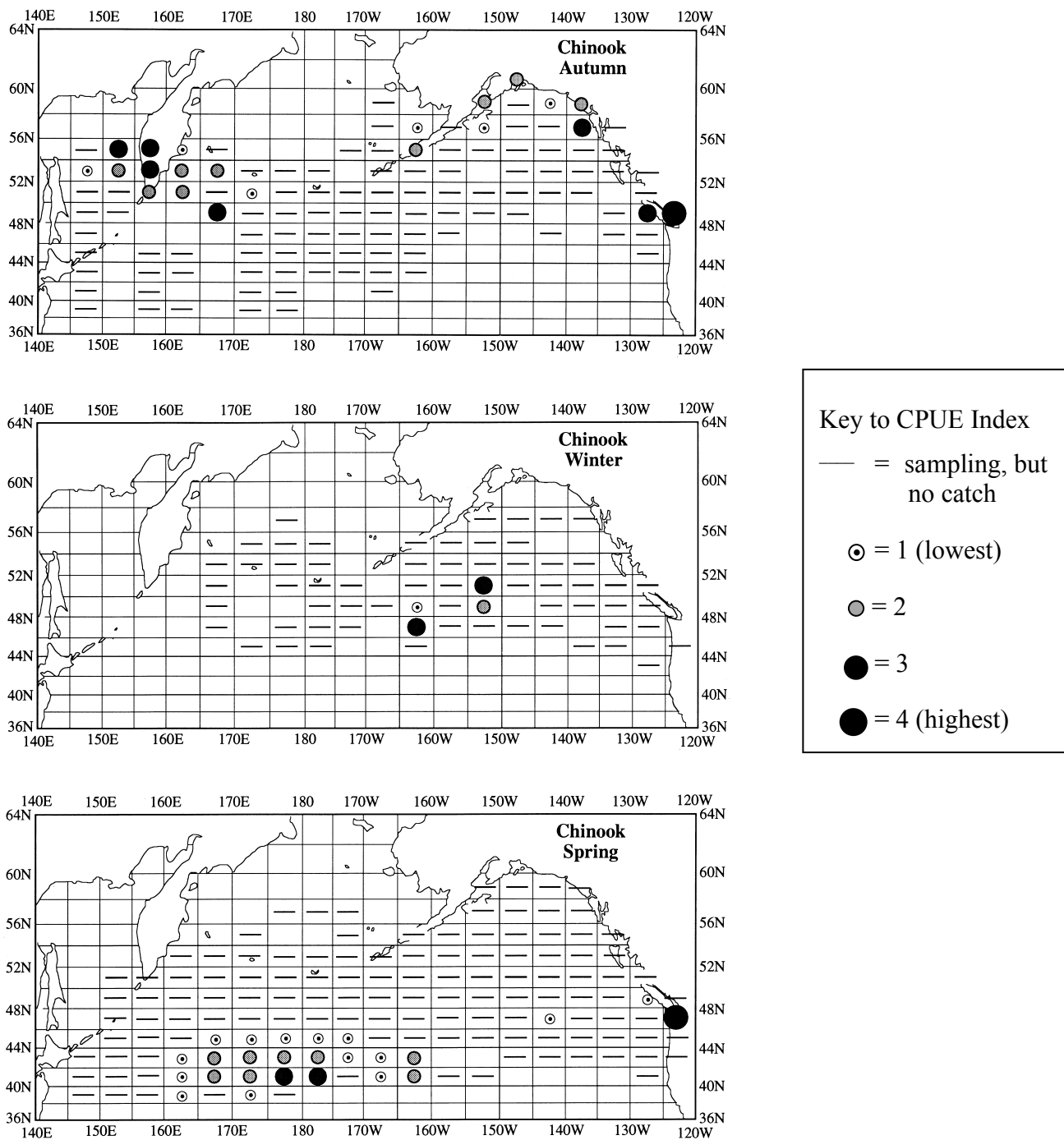


Fig. 2. Autumn (September-November), winter (December-February), and spring (March-May) distribution and relative abundance of chinook salmon in the North Pacific Ocean and Bering Sea. Catch per unit effort (CPUE) data were combined from surface gillnet, longline, and purse seine gear used by Canadian, Japanese, Russian, and U.S. research vessels, 1955-1991. CPUE values were calculated for each gear type by season and location, and ranked within gear type. CPUE values were converted to a quartile position for that gear type, and quartile values for the different gear types were combined to yield an overall relative abundance for that stratum.

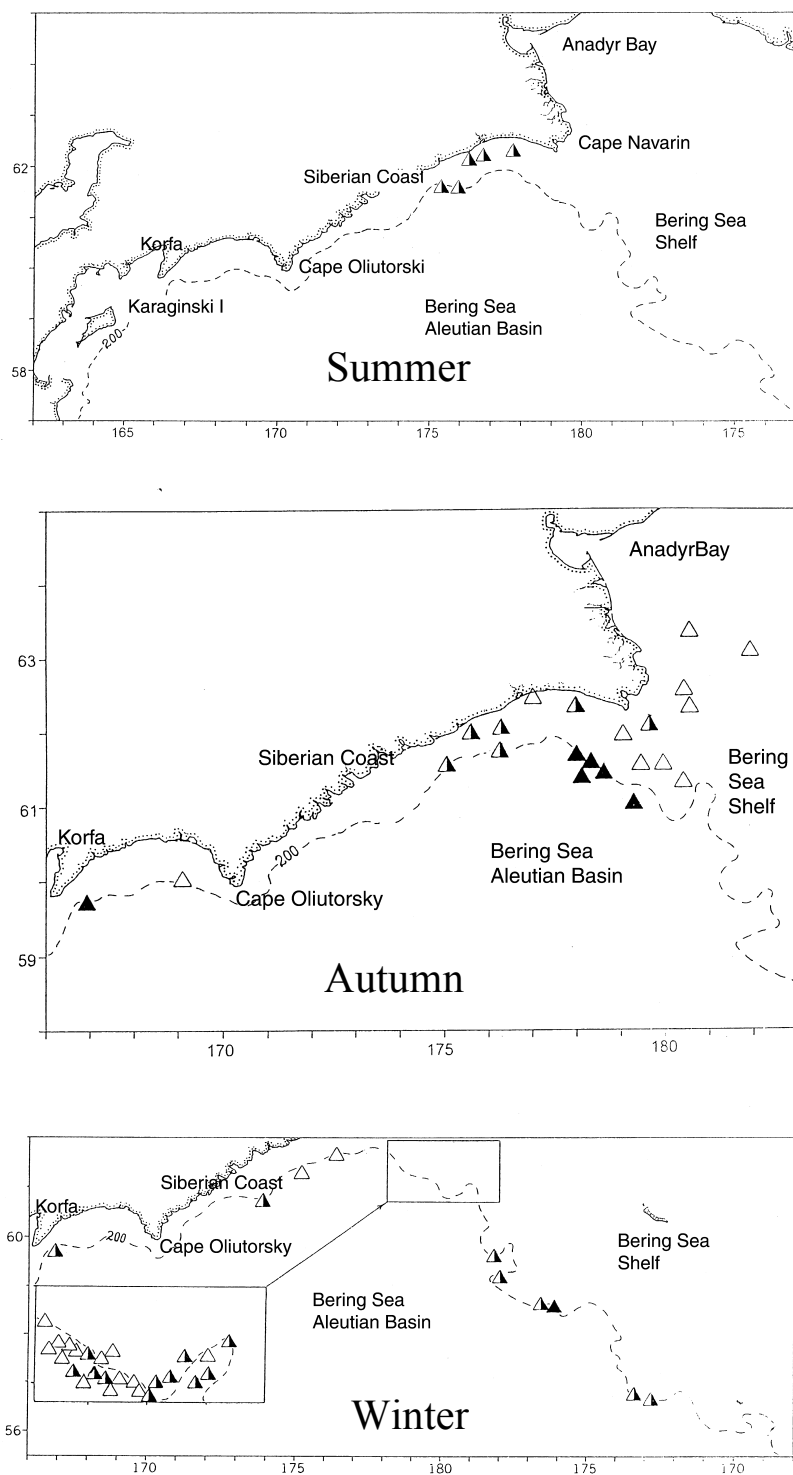


Fig. 3. Chinook salmon catch distribution during Russian groundfish trawl surveys in the western Bering Sea (adapted from Radchenko and Glebov 1998). Open triangles = catch locations in first month of season; half-closed triangles = catch locations in second month of season; closed triangles = catch locations in third month of season.

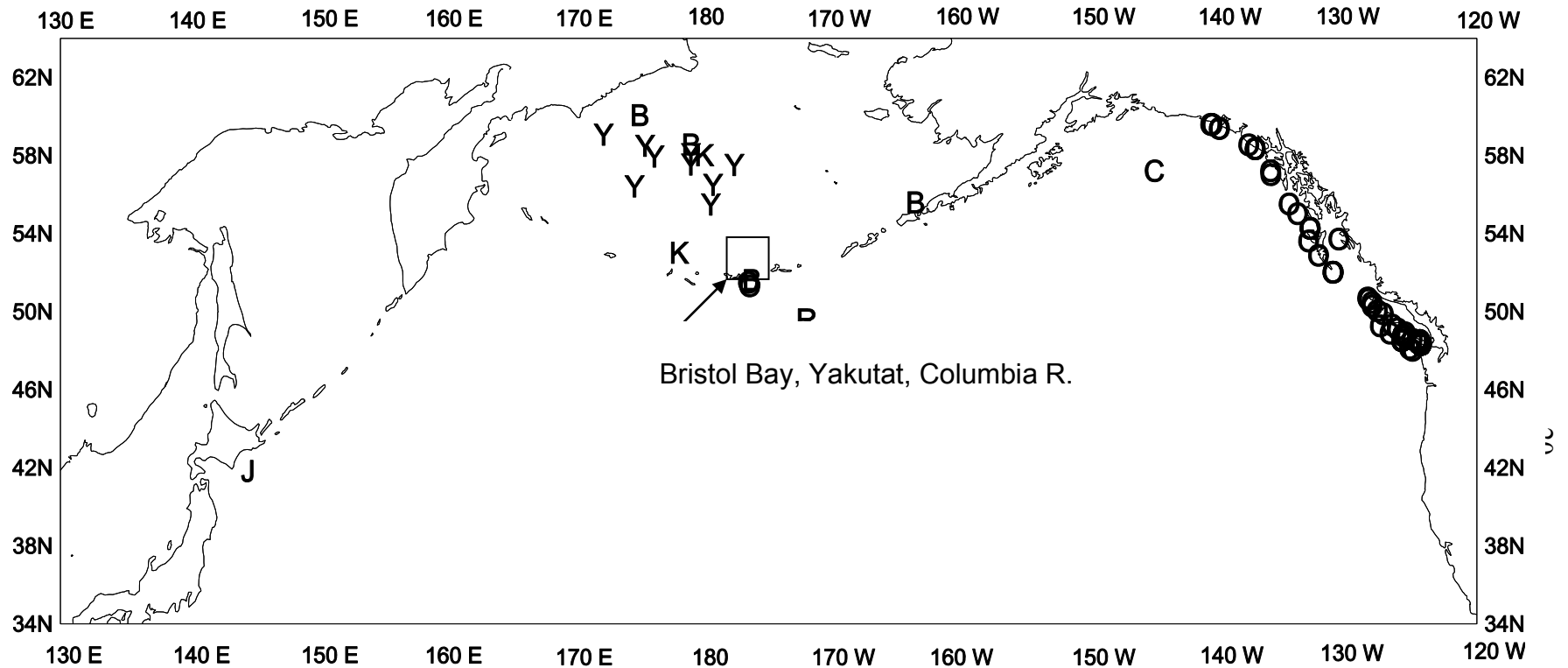


Fig. 4. Ocean release locations of tagged chinook salmon recovered in Japan (J, $n=1$), Russia (R, $n=1$), Yukon River (Y, $n=9$), Kuskokwim River (K, $n=2$), Bristol Bay (B, $n=4$), Cook Inlet (C, $n=1$), and other North American areas (O), including Yakutat ($n=1$), southeastern Alaska ($n=7$), British Columbia ($n=57$), Washington ($n=24$), Columbia River/Snake R. ($n=15$), and Oregon ($n=2$).

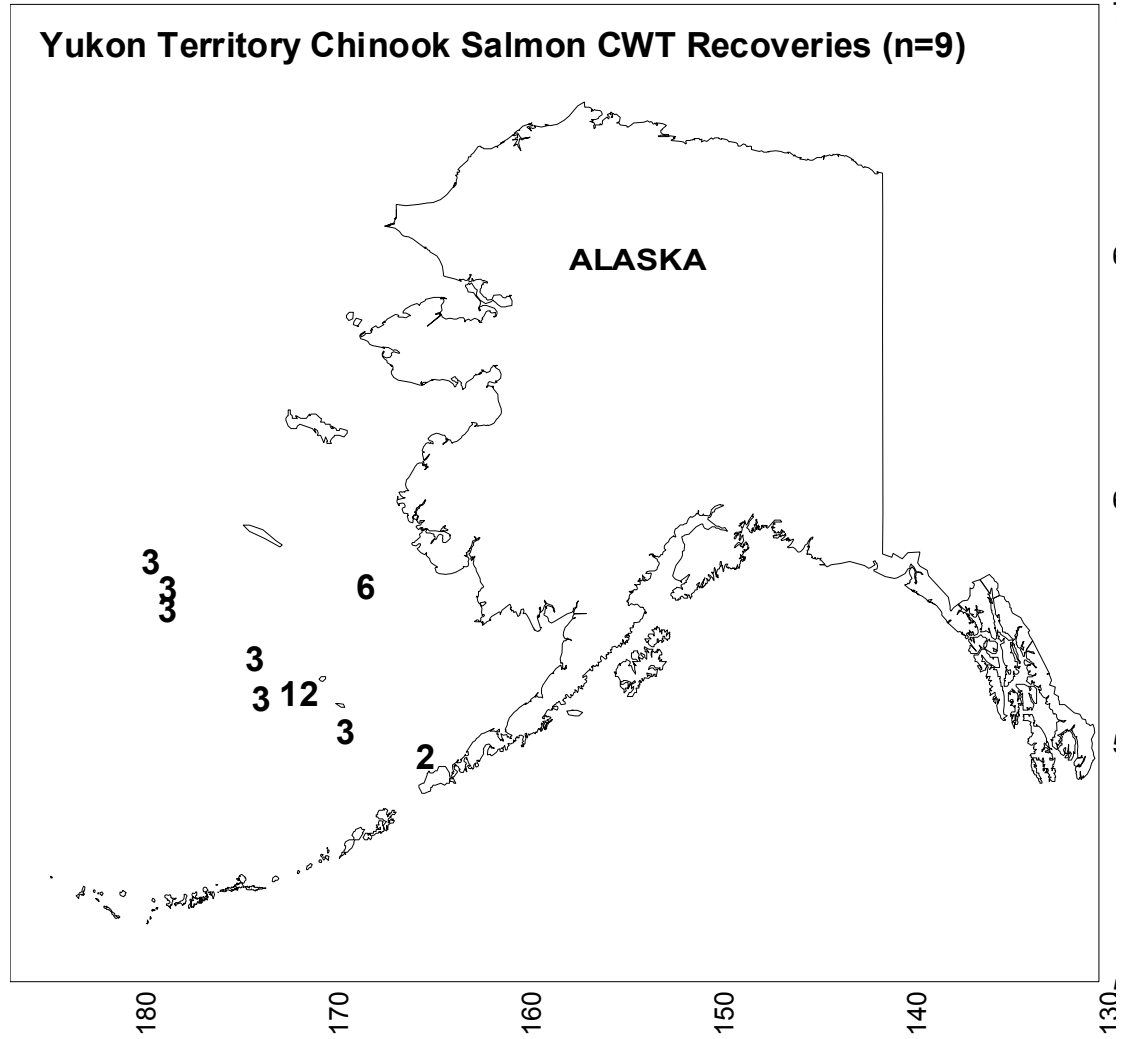
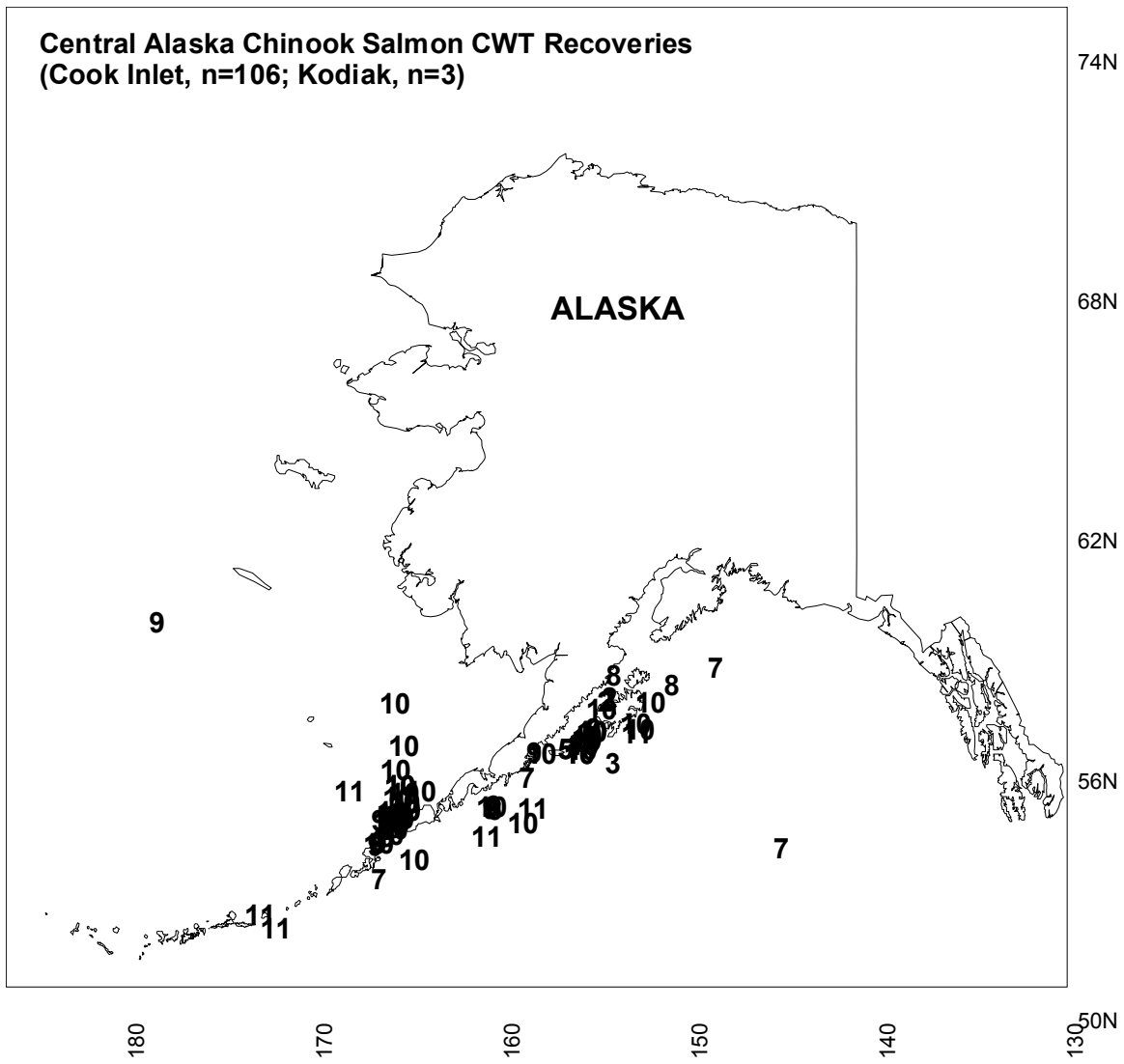


Fig. 5. Map showing recovery locations (number = month of recovery) of coded-wire tagged Yukon Territory chinook salmon in the Bering Sea and Gulf of Alaska.



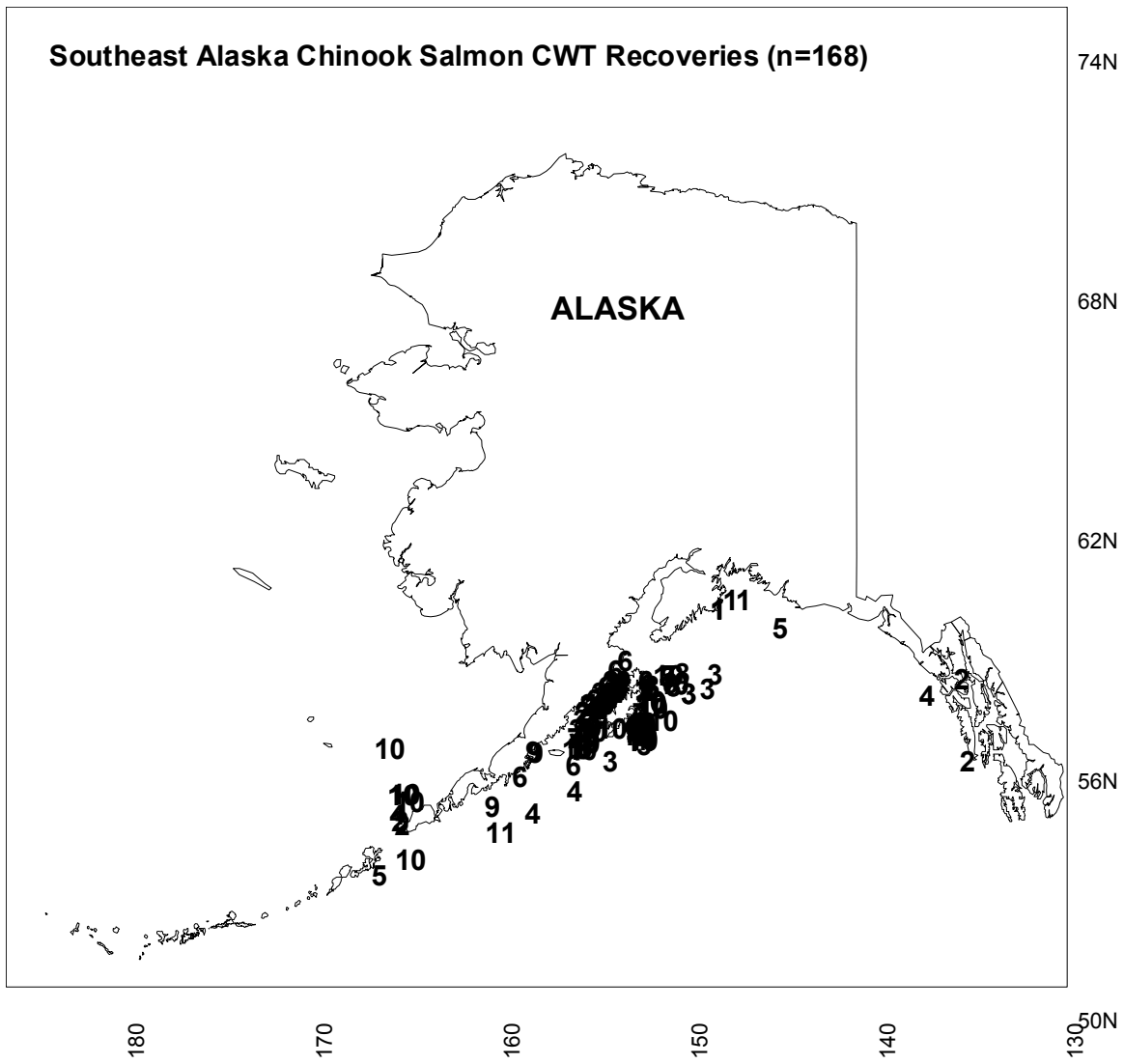


Fig. 7. Map showing recovery locations (number = month of recovery) of coded-wire tagged Southeast Alaska chinook salmon in the Bering Sea and Gulf of Alaska.

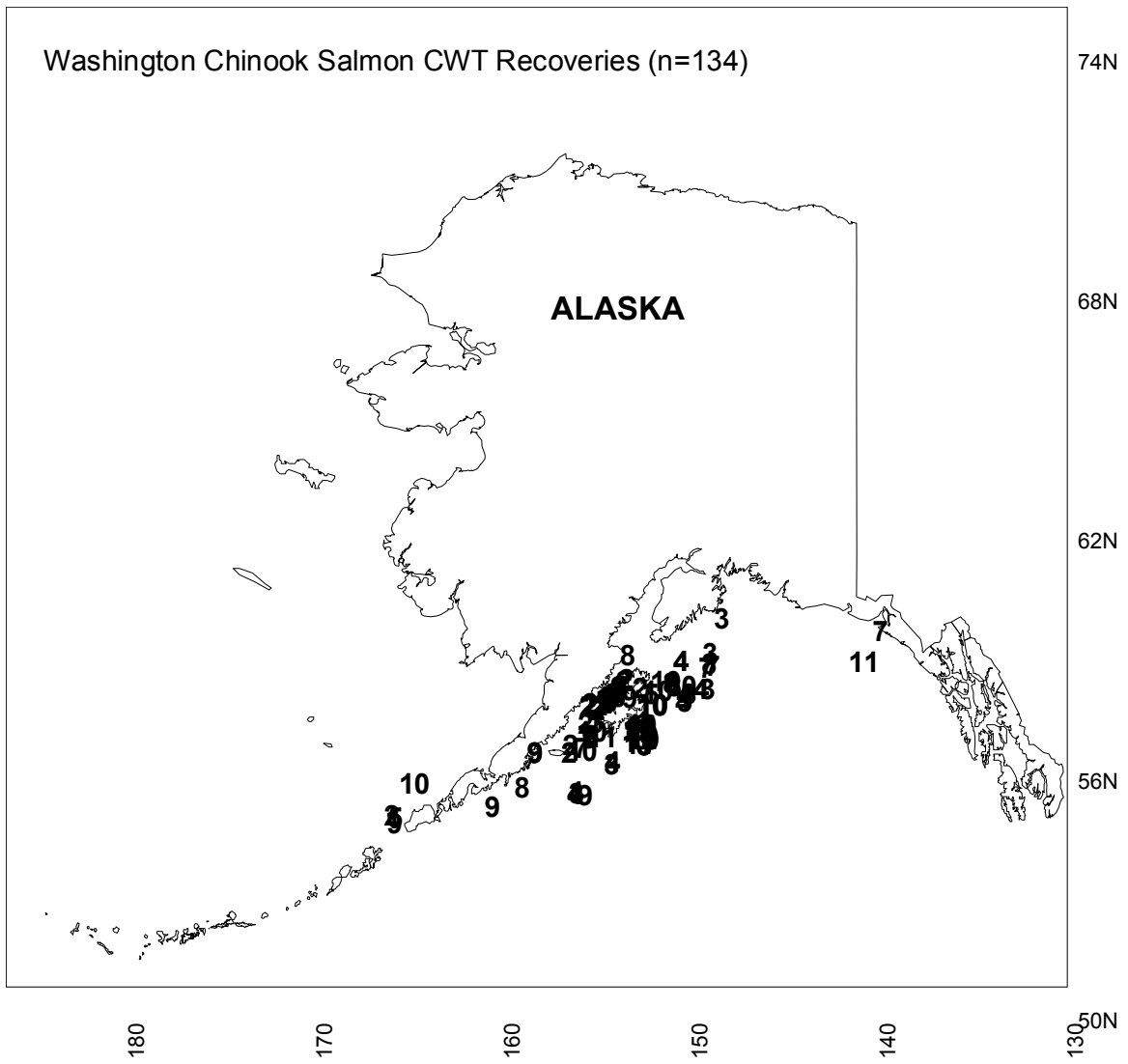


Fig. 9. Map showing recovery locations (number = month of recovery) of coded-wire tagged Washington chinook salmon in the Bering Sea and Gulf of Alaska.

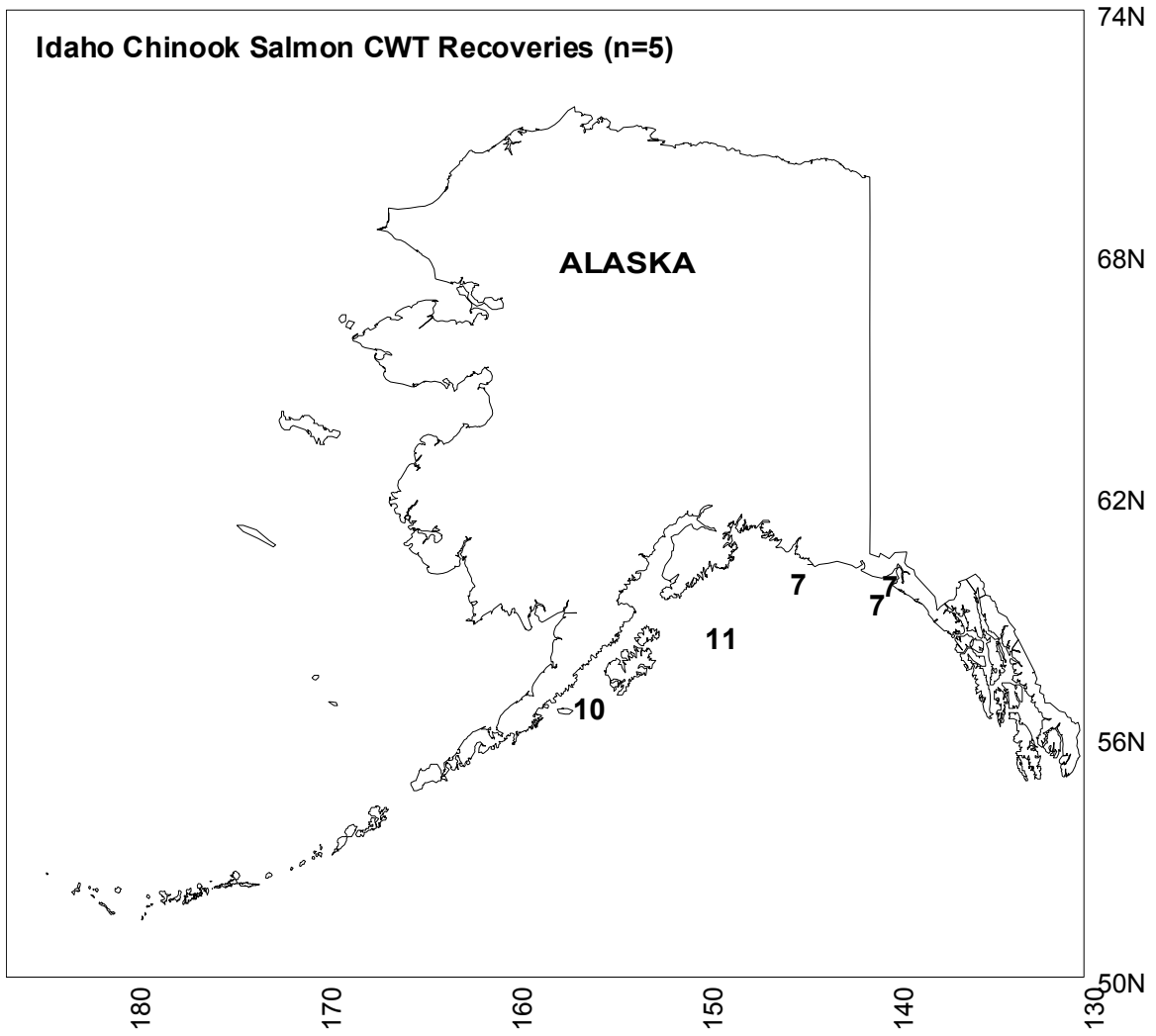


Fig. 10. Map showing recovery locations (number = month of recovery) of coded-wire tagged Idaho chinook salmon in the Bering Sea and Gulf of Alaska.

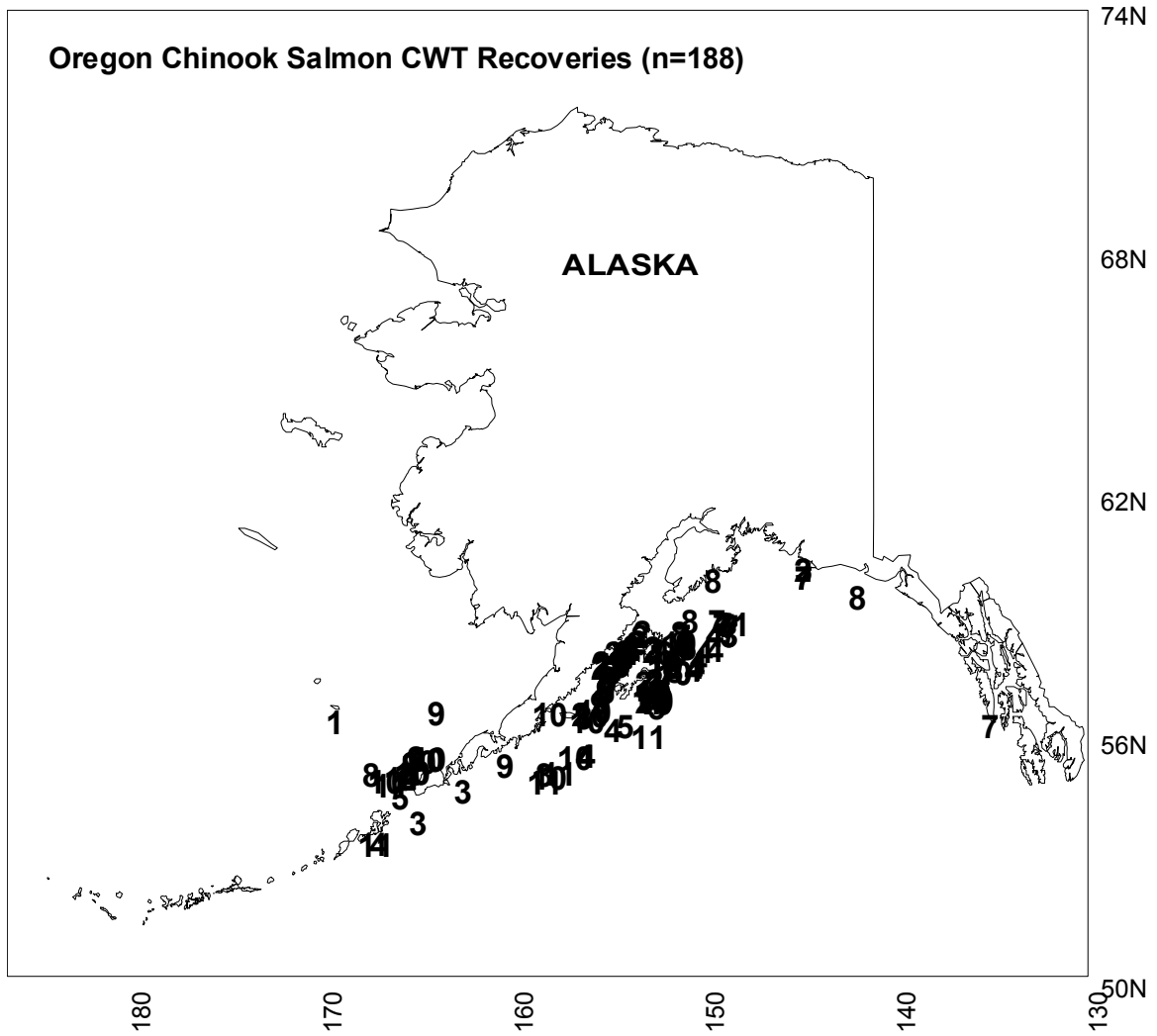


Fig. 11. Map showing recovery locations (number = month of recovery) of coded-wire tagged Oregon chinook salmon in the Bering Sea and Gulf of Alaska.

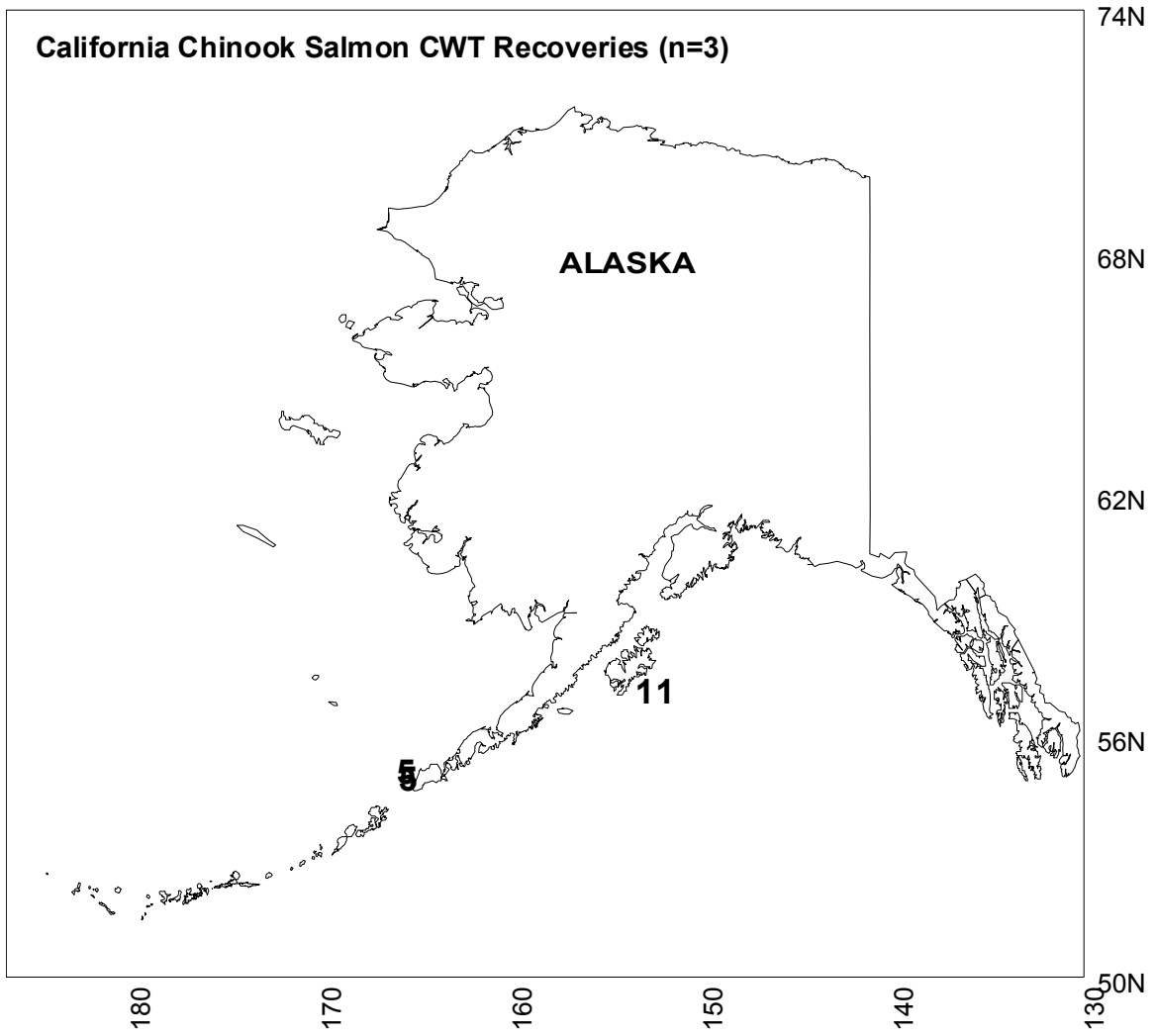


Fig. 12. Map showing recovery locations (number = month of recovery) of coded-wire tagged California chinook salmon in the Bering Sea and Gulf of Alaska.

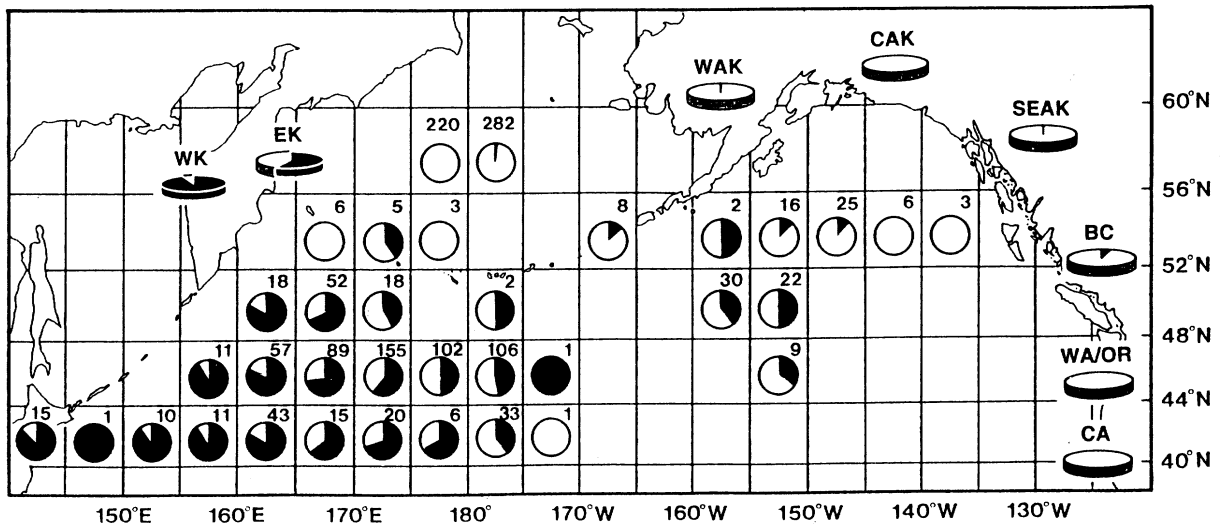


Fig. 13. Prevalence (indicated by black shading in pie chart) of *Myxobolus arcticus* in chinook salmon in the North Pacific Ocean and Bering Sea by 4° x 5° area in summer, 1988-1990 (from Urawa et al. 1998). Numbers within area are the number of fish examined. Three-dimensional pie charts indicate the baseline prevalences of the parasite in western Kamchatka (WK), eastern Kamchatka (EK), western Alaska (WAK), central Alaska (CAK), southeastern Alaska (SEAK), British Columbia (BC), Washington and Oregon (WA/OR), and California (CA) chinook stocks.

Table 1. Mean catch (number of salmonids) per unit (30-tans, 1500 m) of effort (research-mesh gillnet) by the Japanese salmon research vessel *Wakatake maru*, 1991-2001, in international waters of the North Pacific Ocean and Bering Sea. Research-mesh gillnet is composed of 3 tans each of the following mesh sizes: 48, 55, 63, 72, 82, 93, 106, 121, 138, and 157 mm. No. of Sta. = number of stations sampled.

Year	Sampling Dates	No. of Sta.	Locations	Mean		Mean		Mean Catch per 30 tans C-gear								
				Temperature		Salinity		Sock-Eye	Chum	Pink	Coho	Chi-nook	Steel-head	Dolly Varden	Masu	Total
				0 m	100	0 m	100									
Central North Pacific																
2001	14-23 Jun	10	39°N-47°N, 180°	9.8	6.5	33.5	33.6	2.0	25.8	16.4	16.5	0.3	1.3	0.0	0.0	62.1
2000	12-22 Jun	10	39°N-47°N, 180°	9.0	6.8	33.3	33.5	1.6	17.3	4.7	3.7	0.1	1.4	0.0	0.0	28.8
1999	16-26 Jun	10	39°N-47°N, 180°	8.6	6.6	33.2	33.3	10.8	17.1	15.9	6.1	0.6	1.8	0.0	0.0	52.3
1998	17-28 Jun	10	39°N-47°N, 180°	9.7	6.9	33.4	33.5	1.8	7.4	0.8	19.3	0.7	2.7	0.0	0.1	32.8
1997	19-28 Jun	10	39°N-47°N, 180°	10.3	7.5	33.4	33.6	0.3	16.8	8.1	13.1	0.7	1.7	0.0	0.0	40.7
1996	15-27 Jun	10	38°N-47°N, 180°	11.5	7.8	33.6	33.7	0.0	22.7	0.5	8.0	0.3	0.6	0.0	0.0	32.1
1995	18-27 Jun	10	38°N-47°N, 180°	10.7	8.2	33.6	33.8	0.2	11.1	2.6	11.2	0.2	2.4	0.0	0.0	26.9
1994	18-27 Jun	10	38°N-47°N, 180°	10.4	8.1	33.7	33.7	0.4	8.2	7.1	11.9	0.3	3.7	0.0	0.0	31.6
1993	17-28 Jun	10	38°N-47°N, 180°	10.4	7.9	33.7	33.9	0.0	29.7	0.8	6.6	0.1	1.7	0.0	0.0	25.4
1992	17-25 Jun	10	38°N-47°N, 180°	9.9	7.7	33.7	33.8	0.0	10.8	0.2	10.3	0.1	0.6	0.0	0.0	22.0
1991	12-21 Jun	10	38°N-47°N, 180°	11.0	8.4	33.6	33.8	0.2	11.4	2.3	19.6	0.2	1.9	0.0	0.0	35.6
Bering Sea																
2001	1-13 Jul	13	55°N-58°N, 178°W-176°E	5.4	1.7	33.1	33.2	60.8	136.5	164.9	0.1	2.5	0.0	0.0	0.0	364.8
2000	30 Jun-12 Jul	11	55°N-58°N, 178°W-178°E	7.9	1.8	33.0	33.2	36.1	141.5	2.2	0.0	10.2	0.0	0.0	0.0	189.9
1999	4-14 Jul	11	55°N-58°N, 178°W-178°E	6.5	1.9	32.9	33.0	25.5	64.1	357.3	0.0	4.1	0.0	0.0	0.0	450.9
1998	6-16 Jul	11	55°N-58°N, 177°W-177°E	7.0	2.5	32.3	33.0	37.7	209.6	5.6	0.4	22.7	0.0	5.0	0.0	281.1
1997	6-17 Jul	10	55°N-58°N, 177°W-177°E	8.4	3.0	32.8	32.9	57.0	143.9	379.7	0.3	3.5	0.0	0.1	0.0	584.5
1996	4-14 Jul	9	55°N-58°N, 177°W-179°E	7.5	2.9	32.8	33.0	55.1	200.7	4.8	0.1	6.8	0.0	0.2	0.0	267.7
1995	5-15 Jul	11	55°N-58°N, 177°W-177°E	7.5	2.0	32.9	33.1	37.8	63.8	174.5	0.5	6.5	0.0	0.2	0.0	283.3
1994	5-15 Jul	11	55°N-58°N, 177°W-177°E	6.7	1.8	32.9	33.2	50.3	224.0	13.1	0.0	5.2	0.0	0.2	0.0	292.7
1993	6-16 Jul	11	55°N-58°N, 177°W-177°E	7.2	2.1	33.1	33.2	58.2	111.6	141.2	0.8	1.4	0.0	0.0	0.0	313.2
1992	4-14 Jul	11	55°N-58°N, 177°W-177°E	6.4	2.5	33.0	33.3	22.8	257.5	9.0	0.3	5.4	0.0	0.5	0.0	295.5

Table 2. Number sampled, mean, and standard deviation (sd) of fork length (FL, mm), body weight (BW, g), and condition factor ($10^6 \cdot BW/FL^3$) of chinook salmon caught in international waters of the North Pacific Ocean and Bering Sea by the *Wakatake maru* research gillnet, 1991-2001, grouped by ocean age and oceanographic domain.

Year	Ocean Age-1								Ocean Age-2							
	N	% Age	FL (mm)		B W (g)		CF		N	Age	FL (mm)		B W (g)		CF	
			mean	sd	mean	sd	mean	sd			mean	sd	mean	sd		
Central North Pacific - Subarctic Current (44°N-47°N, 180°)																
2001	0								0							
2000	0								1	100	600		3100		14.4	
1999	0								5	100	617	30	3220	448	13.6	0.6
1998	0								6	86	582	39	2488	472	12.5	0.7
1997	0								6	86	641	47	3408	1026	12.6	2.2
1996	3	100	395	44	823	320	12.9	0.8	0							
1995	0								1	50	562		2200		12.4	
1994	0								3	100	616	33	3150	477	13.4	0.3
1993	0								1	100	624		3700		15.2	
1992	0								1	100	575		2300		12.1	
1991	0								2	100	572	82	2625	926	13.8	1.0
Bering Sea (55°-58°N, 177°E-177°W)																
2001	24	73	345	28	476	136	11.4	1.3	5	15	492	99	1660	736	12.6	1.7
2000	36	33	326	49	421	329	11.0	1.6	50	46	520	51	1779	524	12.3	0.9
1999	13	30	330	27	403	114	10.9	1.0	22	51	533	60	1936	694	12.5	2.2
1998	0	60	348	41	528	311	11.7	1.2	62	27	545	57	2202	793	13.1	0.9
1997	12	35	350	24	478	94	11.1	0.8	19	56	550	35	1954	390	11.6	0.8
1996	24	43	407	31	826	221	12.0	1.0	25	45	567	46	2382	632	12.8	1.0
1995	18	27	339	31	442	128	11.1	0.9	43	65	525	52	1813	522	12.3	1.7
1994	25	47	374	31	620	173	11.3	1.0	11	21	543	57	2179	740	13.1	1.5
1993	1	8	352		480		11.0		7	59	573	25	2340	314	12.4	0.6
1992	17	36	356	27	525	116	11.4	0.9	23	49	567	47	2333	709	12.6	1.5
1991	45	66	345	26	497	120	11.9	1.3	21	31	530	57	1816	634	11.8	0.8

Table 2 (cont'd)

Year	Ocean Age-3								Ocean Age-4							
	N	% Age	FL (mm)		B W (g)		CF		N	Age	FL (mm)		B W (g)		CF	
mean			sd	mean	sd	mean	sd	mean			sd	mean	sd	mean	sd	
Central North Pacific - Subarctic Current (44°N-47°N, 180°)																
2001	0									0						
2000	0									0						
1999	0									0						
1998	1	14	780		6850			14.4		0						
1997	1	14	700		4400			12.8		0						
1996	0									0						
1995	1	50	832		7800			13.5		0						
1994	0									0						
1993	0									0						
1992	0									0						
1991	0									0						
Bering Sea (55°-58°N, 177°E-177°W)																
2001	3	9	603	56	2260	754	10.1	1.7	1	3	780		6300		13.3	
2000	22	20	671	48	4030	1122	13.1	2.0	1	1	728		5300		13.7	
1999	8	19	658	64	3566	1236	12.1	0.8	0							
1998	30	13	678	76	4346	1434	13.3	1.6	0							
1997	3	9	714	100	4650	2079	12.2	0.9	0							
1996	7	12	732	46	5121	1366	12.7	1.1	0							
1995	4	6	726	61	4725	1300	12.2	0.8	1	2	812		6800		12.7	
1994	17	32	720	41	4855	1129	12.8	1.0	0							
1993	3	25	716	95	4710	2175	12.3	1.1	1	8	862		8600		13.4	
1992	6	13	654	27	3822	648	13.6	0.8	1	2	850		7650		12.5	
1991	2	3	715	18	4050	71	11.1	1.0	0							

Table 3. Diets of chinook salmon caught in the central North Pacific (Subarctic Current) and Bering Sea along the 180° longitude transect line by the *Wakatake maru*, 1991-2001. PW=prey weight, % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=PW*100/body weight. Prey composition is based on visual estimates.

Area	Year	N	% empty	Mean PW	Mean SCI	Mean % composition by volume											
						EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UNID
North Pacific, Subarctic Current	2001	5	60	23	0.49	0	0	0	0	100	0	0	0	0	0	0	0
	2000	2	50	1	0.05	0	0	0	0	100	0	0	0	0	0	0	0
	1999	3	33	24	0.83	0	0	0	0	50	0	50	0	0	0	0	0
	1998	5	0	41	1.54	0	0	0	0	100	0	0	0	0	0	0	0
	1997	24	29	28	1.12	12	0	0	0	83	0	5	0	0	0	0	0
	1996	2	0	19	0.26	0	0	0	0	100	0	0	0	0	0	0	0
	1995	1	100														
	1994	3	0	13	0.28	0	0	0	0	100	0	0	0	0	0	0	0
	1993	3	33	74	1.94	0	0	0	0	100	0	0	0	0	0	0	0
	1992	0															
1991	2	0	23	0.49	0	0	2	0	63	0	0	0	0	0	0	0	35
Bering Sea	2001	40	35	4	0.50	6	0	0	0	34	2	58	0	0	0	0	0
	2000	60	27	26	0.81	29	1	0	0	36	0	34	0	0	0	0	0
	1999	22	32	3	0.26	9	0	6	0	36	4	45	0	0	0	0	0
	1998	96	34	15	0.82	12	3	2	0	66	0	16	0	0	0	0	1
	1997	54	35	13	0.54	29	0	0	0	52	0	19	0	0	0	0	0
	1996	72	19	25	1.03	18	0	2	0	47	1	32	0	0	0	0	0
	1995	44	16	10	0.63	16	0	0	0	52	0	29	0	0	0	0	3
	1994	26	31	12	0.54	20	0	10	0	58	1	8	0	0	3	0	0
	1993	12	17	12	0.54	27	0	0	0	39	0	34	0	0	0	0	0
	1992	37	19	18	0.78	43	4	0	0	44	0	9	0	0	0	0	0
1991	30	17	19	0.86	33	1	0	0	43	0	23	0	0	0	0	0	

Prey categories are EU=euphausiids, CO=copepods, AM=amphipods, CR=crab larvae, SQ=squids, PT=pteropods, FI=fish, PO=polychaetes, CH=chaetognaths, GE=gelatinous zooplankton (coelenterates, ctenophores, and salps),

Table 5. Number sampled, mean and standard deviation (sd) of fork length (FL, mm), body weight (BW, g), and condition factor (CF = $10^6 * BW/FL^3$) of chinook salmon caught in international waters of the central North Pacific Ocean and Gulf of Alaska by the *Oshoro maru* research gillnet, 1994-2001, grouped by ocean age.

Transect Line	Ocean Domain	Ocean Age-1								Ocean Age-2															
		FL				BW				CF				FL				BW				CF			
		Year	N	mean	sd	mean	sd	mean	sd	N	mean	Sd	mean	sd	mean	sd	mean	sd							
145°W - Central Gulf of Alaska	Gulf of Alaska Gyre	2001								3	618.0	50.0	3246.7	1051.9	13.4	1.2									
		2000								1	705.0	-	4610.0	-	13.2	-									
		1999								5	642.0	26.5	3512.0	435.3	13.2	0.5									
		1998								4	645.0	72.6	3880.0	1625.0	13.9	1.0									
		1996	1	374.0	-	550.0	-	10.5	-	2	563.0	9.9	2480.0	28.3	13.9	0.6									
		1995								1	652.0	-	4100.0	-	14.8	-									
	Subarctic Current	2001	3	626.7	28.2	3610.0	788.9	14.5	1.4	1	791.0	-	6800.0	-	13.7	-									
		1998								2	655.5	84.1	4350.0	1697.1	15.0	0.2									
		1995								1	644.0	-	3800.0	-	14.2	-									
	165°W - Western Gulf of Alaska	Gulf of Alaska Gyre	1999								5	576.4	20.4	2586.0	428.0	13.4	1.1								
Subarctic Current		1998								1	676.0	-	4700.0	-	15.2	-									
180° - Central North Pacific	Subarctic Current	1997								1	642.0	-	3400.0	-	12.8	-									
		1996								1	654.0	-	3360.0	-	12.0	-									
		1994								1	680.0	-	4150.0	-	13.2	-									

Table 5 (Cont'd)

Transect Line	Ocean Domain	Year	Ocean Age-3						
			FL		BW		CF		
		N	mean	sd	mean	sd	mean	sd	
145°W - Central Gulf of Alaska	Gulf of Alaska Gyre	2001							
		2000							
		1999							
		1998							
		1996							
		1995							
	Subarctic Current	2001							
		1998							
		1995							
	165°W - Western Gulf of Alaska	Gulf of Alaska Gyre	1999	1	722.0	-	5100.0	-	13.6
Subarctic Current		1998							
180° - Central North Pacific	Subarctic Current	1997							
		1996							
		1994							

Table 6. Mean % composition of stomach contents of chinook salmon caught in international waters of the Gulf of Alaska along the 145° W transect line by the *Oshoro maru*, 1994-2001. PW=prey weight; % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI= $PW \times 100 / \text{body weight}$. Prey composition is based on visual estimates.

Species	Year	N	% empty	mean pw	mean SCI	Mean % composition by volume											
						EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UNID
145°W -	2001	5	0	22	0.65	7	1	0	0	72	0	0	0	0	0	20	0
Central Gulf of	2000	3	67	2	0.06	0	0	0	0	100	0	0	0	0	0	0	0
Alaska, Gulf	1999	10	60	37	0.68	23	0	0	0	25	0	0	0	0	0	0	53
of Alaska	1998	17	47	15	0.47	0	0	6	0	94	0	0	0	0	0	0	0
Gyre	1997	0															
	1996	7	29	42	1.57	0	0	0	0	80	0	0	0	0	0	0	20
	1995	5	40	32	0.76	0	0	0	0	100	0	0	0	0	0	0	0
	1994	9	11	48	1.18	0	0	0	0	81	0	0	0	0	0	0	19
145°W -	2001	8	0	72	1.86	0	0	0	0	100	0	0	0	0	0	0	0
Central Gulf of	2000	0															
Alaska,	1999	0															
Subarctic	1998	8	25	65	1.45	0	0	0	0	99	0	0	0	0	0	0	1
Current	1997	0															
	1996	1	100														
	1995	2	100														
	1994	0															

Prey categories are: EU=euphausiids, AM=amphipods, CR=crab larvae, SQ=squids, PT=pteropods (shelled and naked), FI=fish, PO=polychaetes, CH=chaetognaths, GE=gelatinous zooplankton, including coelenterates, ctenophores, and salps. OTH=other groups, UNID=unidentified material.

Table 7. High seas tag release and recovery information for all chinook salmon recovered in western Alaska and the Canadian Yukon (1955-2000). FAJ = Fisheries Agency of Japan; FRI = Fisheries Research Institute, University of Washington; Imm = immature, Mat = mature; M=Male, F=Female, U=unknown sex; YUKN = Yukon, BRIS = Bristol Bay, KUSK = Kuskokwim.

Release Agency	Tag code	Release Date (yyymmdd)	Release location	Release length (mm)	Estimated release age*	Maturity at release	Estimated recovery age	Sex	Recovery basin	Recovery location	Recovery date (yyymmdd)	Recovery length (mm)	Description of recovery location	
FRI	21680	610624	55-35N	163-35W	665	X.3	Mat	1.3	U	BRIS	58-15N	157-35W	610706	Egegik District
FRI	40372	640609	51-36N	176-18W	745	1.3	Mat	1.3	U	BRIS	58-55N	159-46W	640708	Togiak Bay (Commercial Fishery)
FAJ	NE3420	650719	60-03N	175-00E	480	1.2	Imm	1.4	F	BRIS	58-37N	158-31W	670621	700 Nushagak Bay (commercial fishery)
FAJ	E0168	750620	58-33N	179-00E	630	1.3	Imm	1.4	U	BRIS			770616	Nushagak District
FAJ	SE5377	660730	58-00N	180-00W	530	1.2	Imm	1.4	U	KUSK	60-51N	161-18W	680622	850 Kuskokwim R.
FRI/USSR	Q00713	850706	53-00N	178-03E	560	1.2	Imm	1.4	F	KUSK	60-47N	161-41W	870625	Kuskokwim R., near Bethel, AK
FAJ	12361	590704	57-56N	176-09E	558	1.2	Imm	1.3	M	YUKN	62-35N	164-52W	600609	Yukon R. Delta
FAJ	NE3323	650718	58-29N	175-25E	500	X.X	Imm		U	YUKN	64-40N	155-30W	670602	Middle Yukon R., near Ruby, Ak
FAJ	B3653	720718	59-03N	172-12E	700	1.3	Imm	1.5	U	YUKN	62-35N	164-58W	740625	780 Yukon R. Delta, near Kwikluak Pass
FAJ	E0127	750618	57-31N	178-59E	560	X.X	Imm		F	YUKN	62-32N	165-00W	770628	850 Yukon R. Delta
FAJ	E0159	750619	58-03N	178-59E	530	1.2	Imm	1.4	U	YUKN	61-45N	162-00W	770600	Lower Yukon R.

Table 7 (Cont'd)

Release Agency	Tag code	Release Date (yymmdd)	Release location	Release length (mm)	Estimated release age*	Maturity at release	Estimated recovery age	Sex	Recovery basin	Recovery location	Recovery date (yymmdd)	Recovery length (mm)	Description of recovery location		
FAJ	Y0015	850624	56-24N	174-36E	575	1.2	Imm	1.3	M	YUKN	64-40N	141-00W	860720	800	Upper Yukon R. , Canada, (river mile 1220, 2 miles upstream from US/Canada border)
FAJ	Y0103	850702	55-28N	179-28W	415	1.1	Imm	1.4	F	YUKN	65-37N	150-08W	880724		Middle Yukon R., near Rampart, AK
FAJ	Z1534	860703	57-30N	177-39W	604	1.2	Imm	1.3	U	YUKN	62-19N	163-51W	870625		Lower Yukon R.
FAJ/U.S.	CC5830	910712	56-29N	179-18W	602	1.2	Imm	1.3	U	YUKN	65-10N	152-04W	920703		Middle Yukon R., near Tanana, AK

* The age at release was determined by visual examination of scale patterns. The number before the dot is the number of winters in freshwater, and the number after the dot is the number of winters in the ocean. We assumed that all fish spent one winter in freshwater. X = scale was regenerated.

Table 8. Recoveries of coded-wire tagged Canadian Yukon Territory (Whitehorse Hatchery) chinook salmon in the bycatch of trawl fisheries in the eastern Bering Sea.

Tag Code	Recovery date (yymmdd)	Recovery Location	Recovery length (mm)	Recovery weight (g)	Estimated recovery age*	Sex	Brood year	Release date (yymmdd)	Release weight (g)	Yukon River release location	Run	Release stage
026006	920325	56-44N 173-15W	620	2900	0.3	F	88	890606	2.30	R-MITCHIE CR	Spring	Fed fry
180322	940314	60-06N 178-58W	687		0.3	F	90	910808	2.30	R-WOLF CR/YUKN	Summer	Fed fry
180830	950224	55-19N 164-43W		1800	0.3	F	91	920604	2.23	R-MITCHIE CR	Summer	Fed fry
181215	941206	56-52N 171-18W	400	1000	0.1	M	92	930606	2.28	R-WOLF CR/YUKN	Summer	Fed fry
181216	970602	59-29N 167-49W	833	7500	0.4	M	92	930615	2.30	R-YUKON R	Summer	Fed fry
181428	980310	59-26N 178-05W	760	5400	0.4	F	93	940601	2.27	R-MITCHIE CR	Spring	Smolt
182554	000316	55-56N 168-52W	550	2080	0.3		96	970611	2.26	R-MITCHIE CR	Landlocked	Emergent Fry
182823	980329	58-56N 178-06W	650	3310	0.2	F	95	960604	2.40	R-FOX CR	Spring	Smolt
183348	990330	57-43N 173-34W	660	3320	0.3	M	95	960604	2.45	R-JUDAS CR	Spring	Smolt

* The number before the dot is the number of winters in freshwater, and the number after the dot is the number of winters in the ocean. Whitehorse hatchery chinook salmon migrate to the ocean in the year of release, regardless of run type or release stage (P. Milligan, Canadian Dept. Fish. & Oceans, pers. comm.). For fish caught in the winter, one year was added to the ocean age on January 1.

Table 9. Combined US groundfish trawl and high seas research vessel recoveries of coded-wire tagged chinook salmon (number of fish) by ocean recovery region, ocean age of fish at recovery, and release location (state, region). Only data records with latitude and longitude of recovery were included. AK = Alaska, YT = Yukon Territory, BC = British Columbia, WA = Washington, ID = Idaho, OR = Oregon, CA = California, UK = Unknown; Release Regions: CECA = central Coastal California, CECR = central Columbia R., COOK = Cook Inlet, COBC = Coastal British Columbia, CRGN = Columbia R. (general or unknown), FRTH = Fraser R.-Thompson R., GRAY = Grays Harbor, GST = Georgia Strait, HOOD = Hood Canal, JUAN = Strait of Juan De Fuca, KLAM = Klamath R. - Trinity R., KODI = Kodiak, LOCR = lower Columbia R., MPS = mid Puget Sound, NASK = Nass R.-Skeena R., NOCA = North coastal California, NOOK = Nooksack R., NOOR = North coastal Oregon, NWC = North coastal Washington, ORGN = Oregon (general or unknown), QCI = Queen Charlotte Islands, SACR = Sacramento R., SEAK = Southeast Alaska, SJOA = San Joaquin R., SNAK = Snake R., SOCA = South coastal California, SOOR = South coastal Oregon, SPS = south Puget Sound, STIL = Stillaguamish R - Snohomish R, UPCR = upper Columbia R., WILP = Willapa R., YUKN = Yukon Territory. T = Total. GT = Grand Total, all ocean recovery regions.

Release Location		Ocean recovery region and ocean age* of chinook salmon													
		Bering Sea							Gulf of Alaska						
State	Region	.0	.1	.2	.3	.4	.5	T	.0	.1	.2	.3	.4	.5	T
AK	COOK		25	30	2			57	1	36	11		1		49
	KODI		2	1				3							
	SEAK		3	1	3	1		8		34	94	32			160
AK Total			30	32	5	1		68	1	70	105	32	1		209
YT	YUKN	1	1	5	2			9							
BC	COBC		4	3	9			16		6	43	18	2		69
	FRTH		22	11	5			38		54	32	13			99
	GST			1				1		2	3	2	1		8
	NASK		3	4	10	1		18		13	24	11	4		52
	QCI									2	5				7
	WCVI		7	15	17	1	1	41		24	111	32	3		170
Canada Total			37	35	46	4	1	123		101	218	76	10		405
WA	NWC			3				3		9	18	3	3		33
	NOOK				1			1							
	GRAY				1			1		8	9	6	5	2	30
	STIL														
	JUAN										1				1

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon														
		Bering Sea							Gulf of Alaska							
State	Region	.0	.1	.2	.3	.4	.5	T	.0	.1	.2	.3	.4	.5	T	
	HOOD															
	MPS															
	SPS															
	WILP									4	1	2			7	
	LOCR									5	6	2			13	
	CECR									1	4	1	3	1	10	
	UPCR									1	7	24	3		35	
	CRGN															
	SNAK															
WA																
Total				3	2			5		2	37	60	19	9	2	129
ID	SNAK									5						5
ID Total										5						5
OR	CECR									2	2	2				6
	LOCR		1	3				4		2	31	55	7	1		96
	NOOR		3	4	4			11			14	22	12	2		50
	ORGN															
	SNAK															
	SOOR		1	2		1		4				12	2	3		17
OR Total			5	9	4	1		19		4	47	91	21	6		169
UK	CRGN															
UK Total																
CA	CECA			1				1								
	KLAM															
	NOCA															
	SACR			1				1				1				1
	SJOA															
	SOCA															
CA Total				2				2				1				1
Grand Total			72	81	57	6	1	217		12	255	475	148	26	2	918

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon										GT
		North-Eastern Pacific	South-central North Pacific	US West Coast							T	
State	Region	.1	.1	.0	.1	.2	.3	.4	.5	.6	T	GT
												10
AK	COOK							1			1	7
	KODI											3
	SEAK											16
												8
AK Total								1			1	27
YT	YUKN											8
BC	COBC							1			1	9
												86
	FRTH				28	47	10	3	1			22
	GST				3	12	1					6
	NASK											89
	QCI											16
	WCVI											70
												7
Canada Total					31	59	11	4	1		106	21
WA	NWC			1	1	3						1
	NOOK				6	9	3					63
	GRAY											1
	STIL				3						3	3
	JUAN				1						1	2
	HOOD				7	10	3				20	20
	MPS				19	12	3				34	34
	SPS				19	10	7				36	36

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon										GT
		North-Eastern Pacific	South-central North Pacific	US West Coast							T	
State	Region	.1	.1	.0	.1	.2	.3	.4	.5	.6	T	GT
	WILP					1					1	8
	LOCR		1	4	166	121	15	1			307	321
	CECR			1	45	13	2				61	71
												13
	UPCR			1	83	8	4	2			98	3
	CRGN				8	2	2				12	12
												23
	SNAK			7	170	50	10				237	7
WA												96
Total			1	14	528	239	49	3			833	8
ID	SNAK				5	4	1				10	15
ID Total					5	4	1				10	15
OR	CECR	1		7	19	5					31	38
												46
	LOCR				185	146	30	1			362	2
												10
	NOOR				17	12	7	3			39	0
	ORGN					1					1	1
	SNAK				1		1				2	2
												63
	SOOR			5	239	292	71	9	1		617	8
												12
OR Total		1		12	461	456	109	13	1		1052	41
UK	CRGN					1					1	1
UK Total						1					1	1
CA	CECA				13	24	10				47	48
												54
	KLAM			2	187	305	43	3		1	541	1

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon										GT
		North-Eastern Pacific	South-central North Pacific	US West Coast							T	
State	Region	.1	.1	.0	.1	.2	.3	.4	.5	.6	T	GT
	NOCA					1					1	1
	SACR				59	48	7	1			115	7
	SJOA				19	13	2				34	34
	SOCA					1	1				2	2
	CA Total			2	278	392	63	4		1	740	74
	Grand Total	1	1	28	1303	1151	233	25	2	1	2743	3880

* The number after the dot is the number of winters in the ocean. For fish caught in the winter, one year was added to the ocean age on January 1.

Table 10. Combined US groundfish trawl and high seas research vessel recoveries of coded-wire tagged chinook salmon (number of fish) by ocean recovery region and recovery month, ocean age of fish at recovery, and release location (state). Only data records with latitude and longitude of recovery were included. AK = Alaska, YT = Yukon Territory, BC = British Columbia, WA = Washington, ID = Idaho, OR = Oregon, CA = California, UK = Unknown. T = Total.

State	Ocean age*	Ocean recovery region and recovery month																									
		Bering Sea												Gulf of Alaska													
		1	2	3	4	5	6	7	8	9	10	11	12	T	1	2	3	4	5	6	7	8	9	10	11	12	T
YT	.1												1	1													
	.2			1									1	1													
	.3		1	4									5	5													
	.4			1			1						2	2													
YT	Total		1	6			1					1	9	9													
AK	.0																				1					1	
	.1							8	21	1		30	30	30		1			3	1	1		6	40	7	1	70
	.2		1					1	6	11	2	32	32	32	1	39	9	3	1	9	6	6	5	12	1	105	
	.3		1	1	1				1		1	5	5	5	5	8	7	1		1	3		2	5		32	
	.4		1									1	1	1							1					1	
AK	Total		3	1	1				3	4	33	3	68	68	9	48	16	4	4	1	1	7	3	57	8	1	209
BC	.1		1							1	25	2	7	36		1				1	3	1	3	58	22	2	101
	.2	2	8	1	1		1		1	7	12		1	34	3	88	20	0	1	2	9	2	9	28	7	1	218
	.3	7	15	8	2	1			1	2	4	1		41	6	20	16	4	1	0	4		9	5	1	76	
	.4		1		1									2	2	2	2			1	2		1			10	
	.5				1									1													
BC	Total	9	25	9	5	1	1	1	1	0	41	3	8	114	9	111	38	4	2	4	8	3	2	91	30	3	405
WA	.0																						1		1		2
	.1															1		2			1	1	5	14	10	3	37

Table 10 (Cont'd)

		Ocean recovery region and recovery month																									
		Bering Sea												Gulf of Alaska													
State	Ocean age*	1	2	3	4	5	6	7	8	9	10	11	12	T	1	2	3	4	5	6	7	8	9	10	11	12	T
CA	.6					2							2											1		1	
Total										3				6			4		3	5	3	7	20				
Grand Total		12	32	16	7	5	2	1	5	9	81	8	9	217	6	250	77	8	9	8	0	0	1	1	71	7	918

		Ocean recovery region and recovery month										
		US West Coast										
State	Ocean age*	UK	4	5	6	7	8	9	10	11	T	
YT	.1											
	.2											
	.3											
	.4											
YT Total												
AK	.0											
	.1											
	.2											
	.3											
	.4			1							1	
AK Total				1							1	
BC	.1		2	4	3	12	8	2			31	
	.2			12	17	20	6	2	2		59	
	.3		1	8		1	1				11	

Table 10 (Cont'd)

State	Ocean age*	Ocean recovery region and recovery month									
		US West Coast									
		UK	4	5	6	7	8	9	10	11	T
	.4		1	1	1	1					4
	.5			1							1
BC											
Total			4	26	21	34	15	4	2		106
WA	.0			2		1	4	7			14
						16					
	.1		5	92	81	7	85	72	26		528
	.2		9	42	61	66	35	20	6		239
	.3		1	17	14	11	5			1	49
	.4				1	2					3
	.5										
WA				15	15	24	12				
Total			15	4	6	7	9	99	32	1	833
ID	.0										
	.1			1		3		1			5
	.2			1	1	2					4
	.3					1					1
ID											
Total				2	1	6		1			10
OR	.0			4	1	2	2	3			12
						13					
	.1	1	6	54	53	3	87	95	32		461
				13							
	.2		64	0	58	64	51	33	56		456
	.3		21	43	20	12	6	3	4		109
	.4			8	3	2					13
	.5			1							1
OR				24	13	21	14	13			105
Total		1	91	0	5	3	6	4	92		2

Table 10 (cont'd)

State	Ocean age*	Ocean recovery region and recovery month									
		US West Coast									
		UK	4	5	6	7	8	9	10	11	T
UK	.2				1						1
UK											
Total					1						1
CA	.0						2				2
	.1		9	51	23	45	66	46	38		278
				13							
	.2		74	2	43	40	31	19	53		392
	.3	1	9	27	12	9	2	3			63
	.4		1	1	2						4
	.6			1							1
CA				21			10				
Total		1	93	2	80	94	1	68	91		740
Grand			20	63	39	59	39	30	21		274
Total		2	3	4	4	4	1	6	7	1	3

* The number after the dot is the number of winters in the ocean. For fish caught in the winter, one year was added to the ocean age on January 1.

Table 11. Western Alaskan subregional stock composition estimates by statistical area, age, and month for chinook salmon in incidental catches by foreign and joint-venture groundfish fisheries in the Bering Sea portion of the U.S. exclusive economic zone in 1979 and 1981. An estimate of zero with no confidence interval indicates that the stock is not present. An estimate of zero with a confidence interval indicates a positive estimate of less than 0.5%. Estimates with lower confidence limits of zero are considered nonsignificant. N = sample size. (From Table 4, Myers and Rogers 1988.)

Age	Month	Year	N	% Composition by region (90% confidence intervals)					
				Russia	Western Alaska			Central Alaska	Southeastern Alaska-British Columbia
					Yukon	Kuskokwim	Bristol Bay		
Area 1 (east of 170°W)									
1.2	October	1979	81	0	7 (0-25)	0	38 (17-60)	40 (17-63)	15 (0-30)
	November	1981	99	11(0-23)	0	25 (0-50)	51 (29-74)	10 (0-28)	3 (0-12)
Area 2 (west of 170°W)									
1.2	January	1979	84	3 (0-15)	49 (23-74)	27 (0-61)	4 (0-37)	17 (0-38)	0
	February		553	0	51 (40-62)	12 (0-24)	12 (0-27)	25 (17-33)	0
	April	1981	142	3 (0-10)	0	23 (2-43)	69 (49-90)	0	5 (0-11)
1.3	February	1979	186	7 (0-19)	48 (26-69)	29 (3-55)	6 (0-25)	7 (0-21)	3 (0-9)

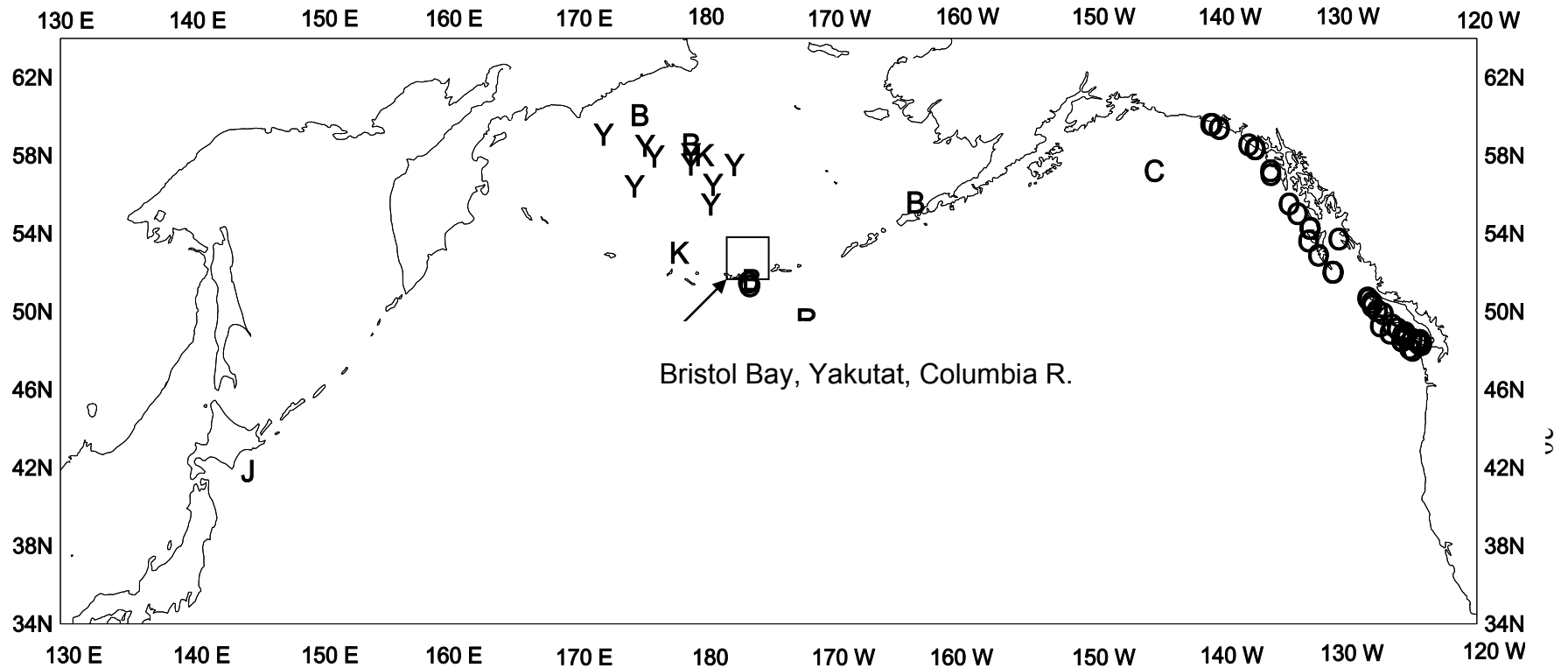


Fig. 4. Ocean release locations of tagged chinook salmon recovered in Japan (J, n=1), Russia (R, n=1), Yukon River (Y, n=9), Kuskokwim River (K, n=2), Bristol Bay (B, n=4), Cook Inlet (C, n=1), and other North American areas (O), including Yakutat (n=1), southeastern Alaska (n=7), British Columbia (n=57), Washington (n=24), Columbia River/Snake R. (n=15), and Oregon (n=2).

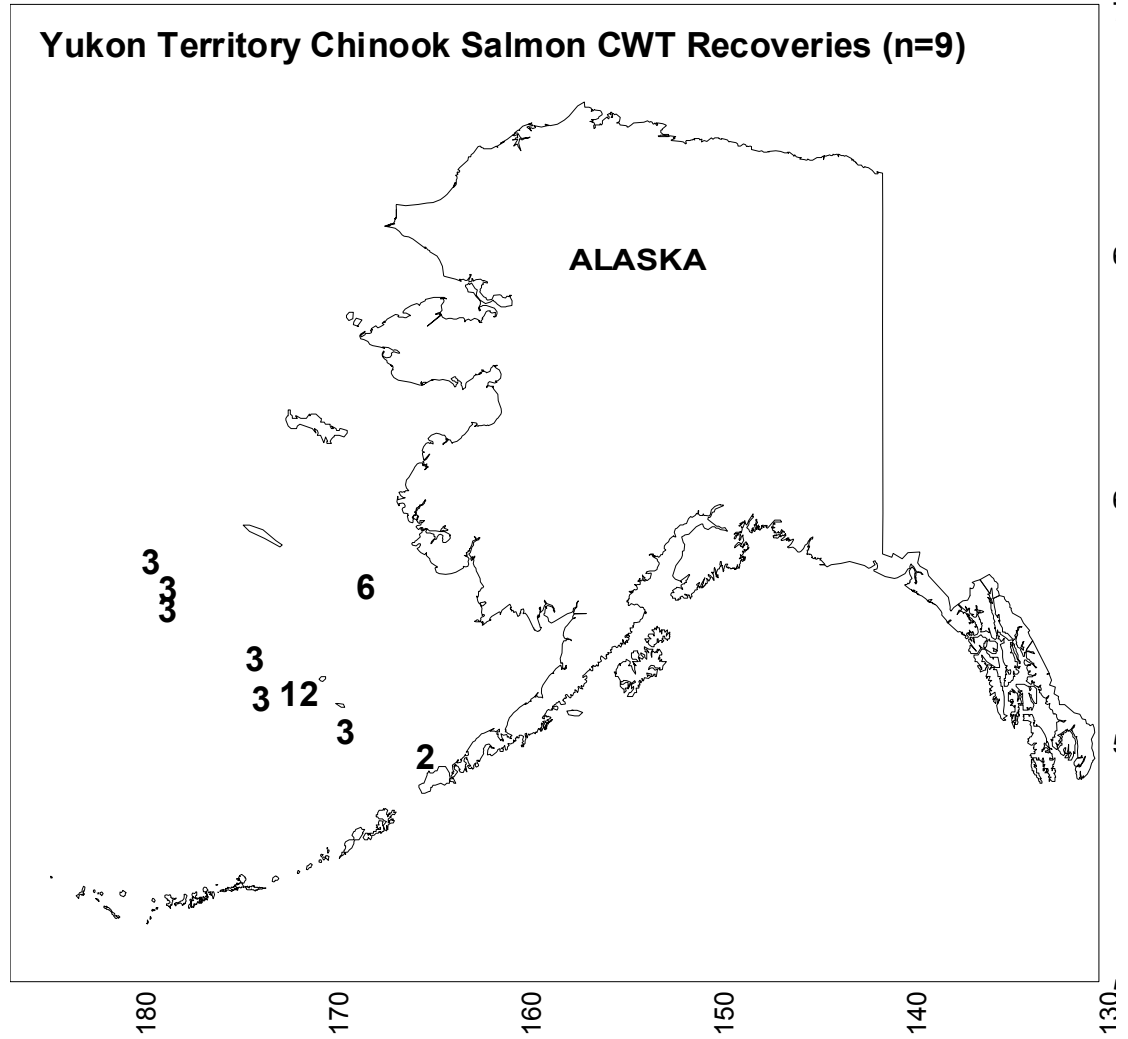
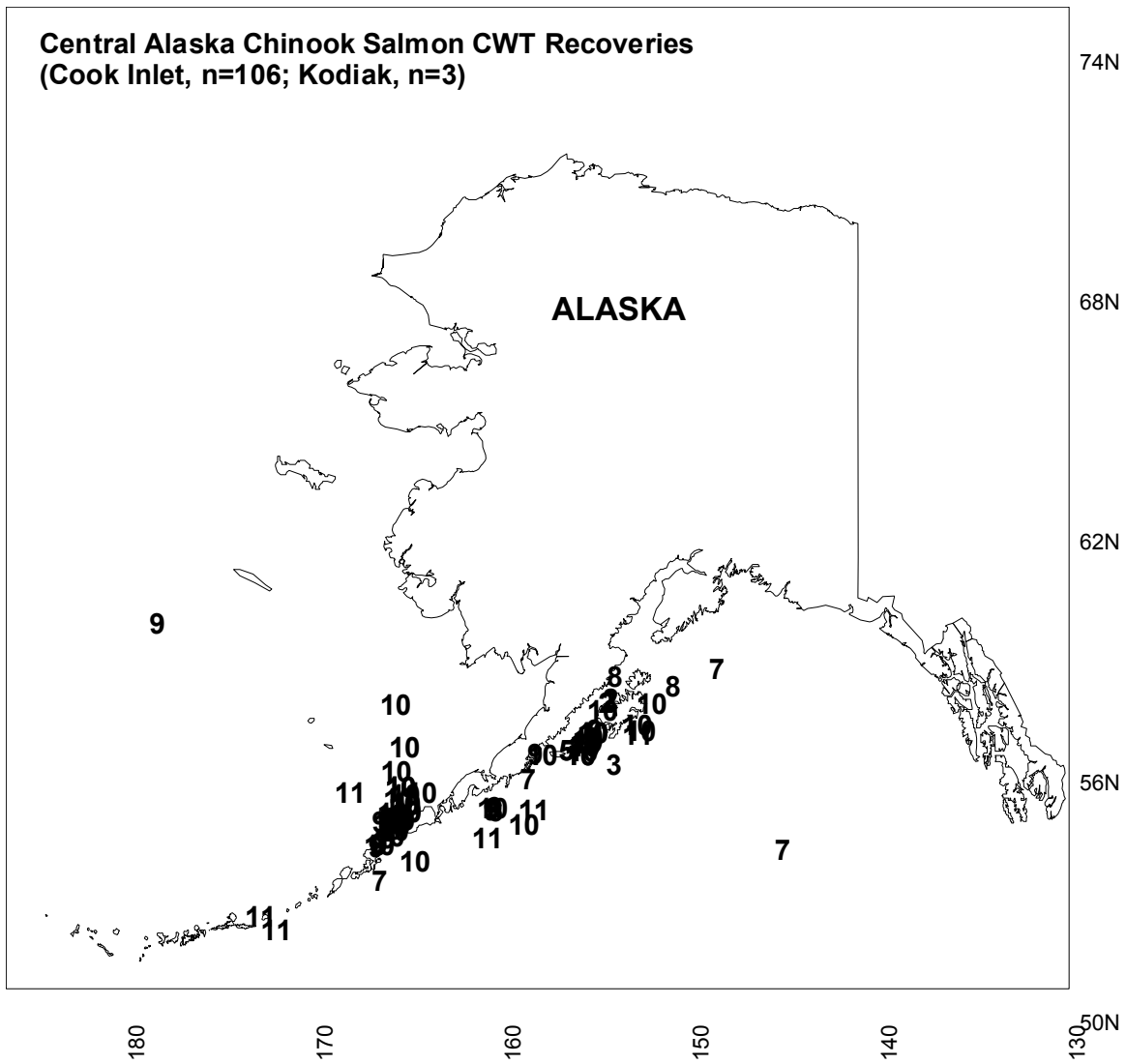


Fig. 5. Map showing recovery locations (number = month of recovery) of coded-wire tagged Yukon Territory chinook salmon in the Bering Sea and Gulf of Alaska.



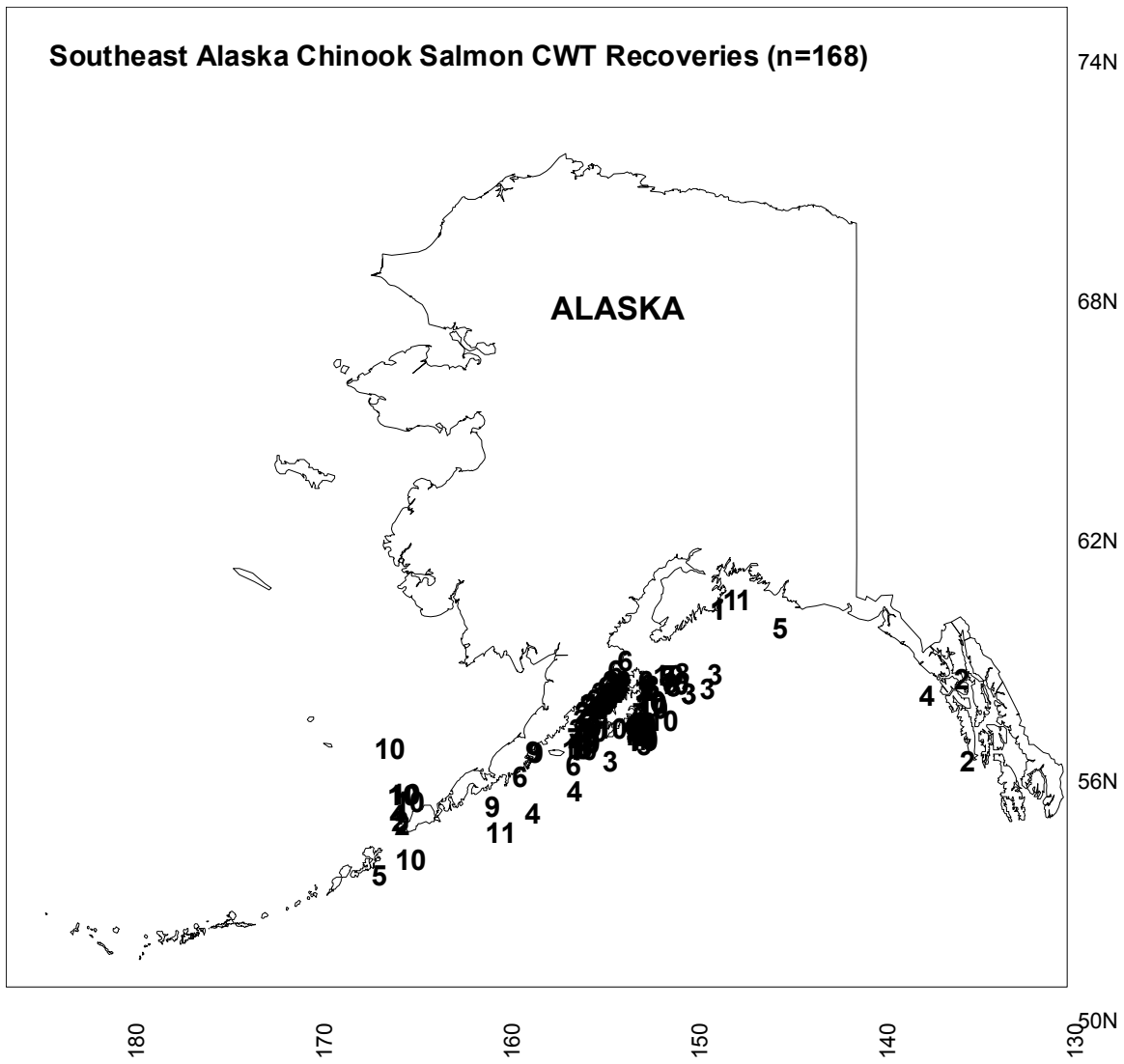


Fig. 7. Map showing recovery locations (number = month of recovery) of coded-wire tagged Southeast Alaska chinook salmon in the Bering Sea and Gulf of Alaska.

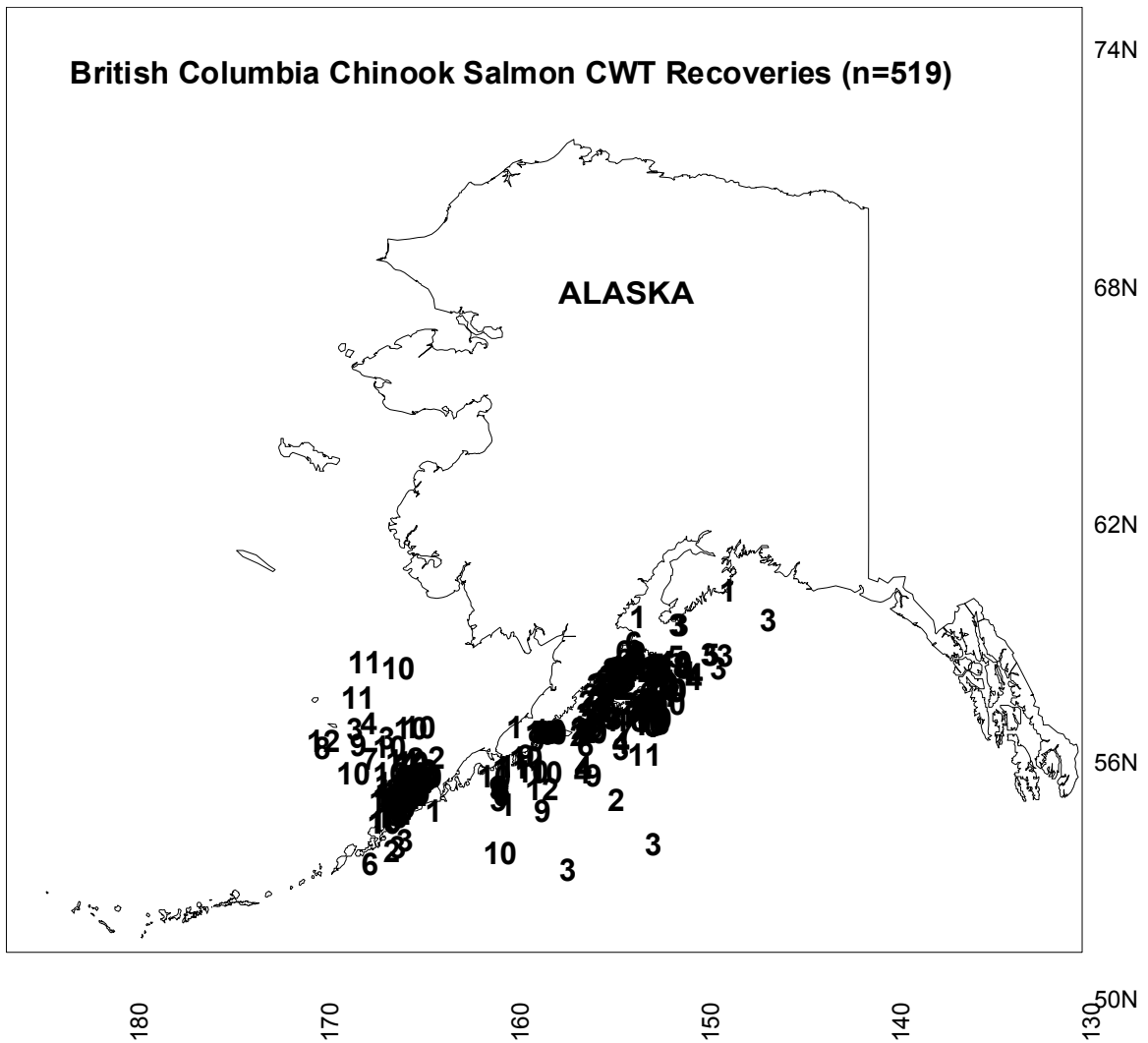


Fig. 8. Map showing recovery locations (number = month of recovery) of coded-wire tagged British Columbia chinook salmon in the Bering Sea and Gulf of Alaska.

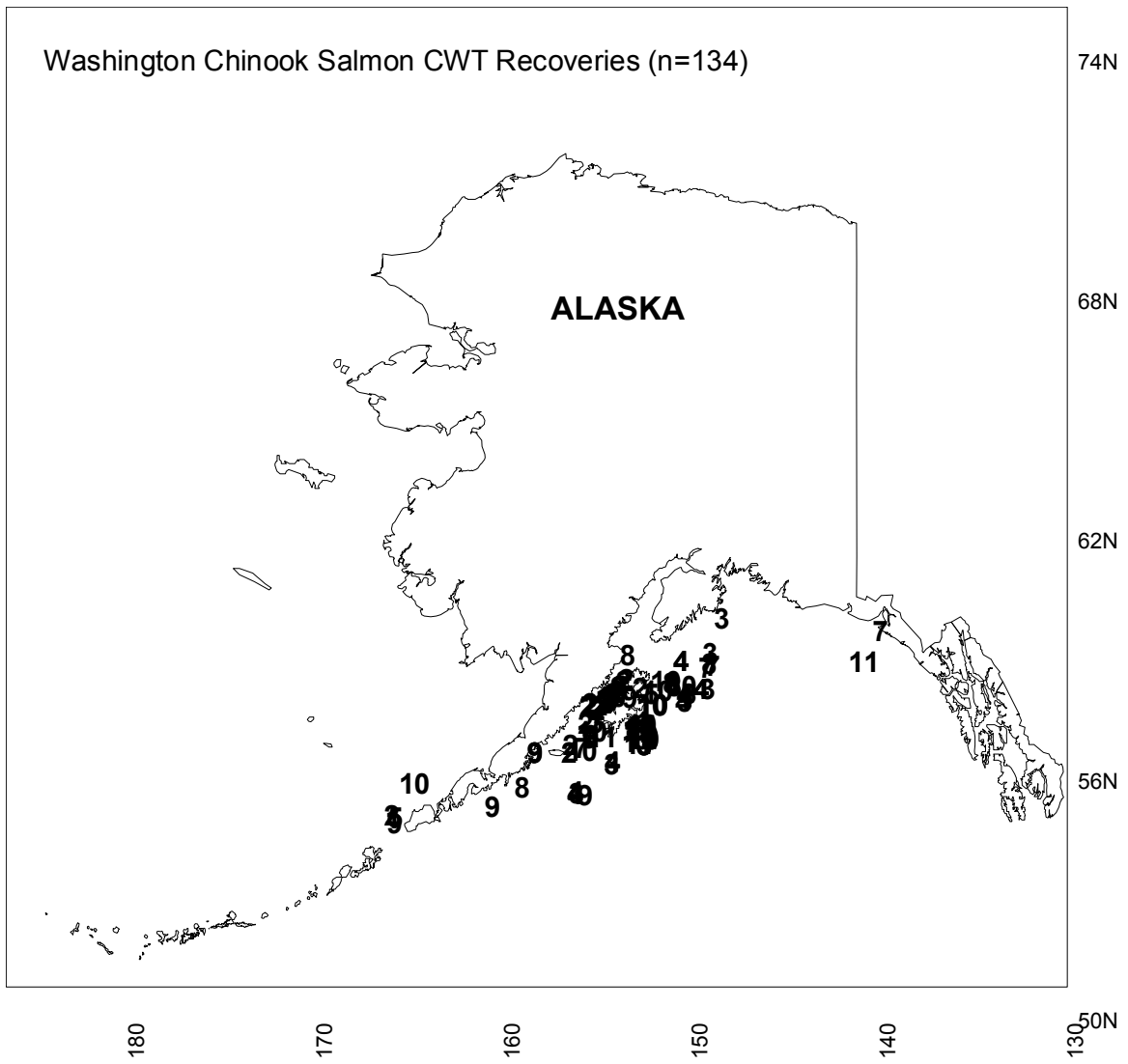


Fig. 9. Map showing recovery locations (number = month of recovery) of coded-wire tagged Washington chinook salmon in the Bering Sea and Gulf of Alaska.

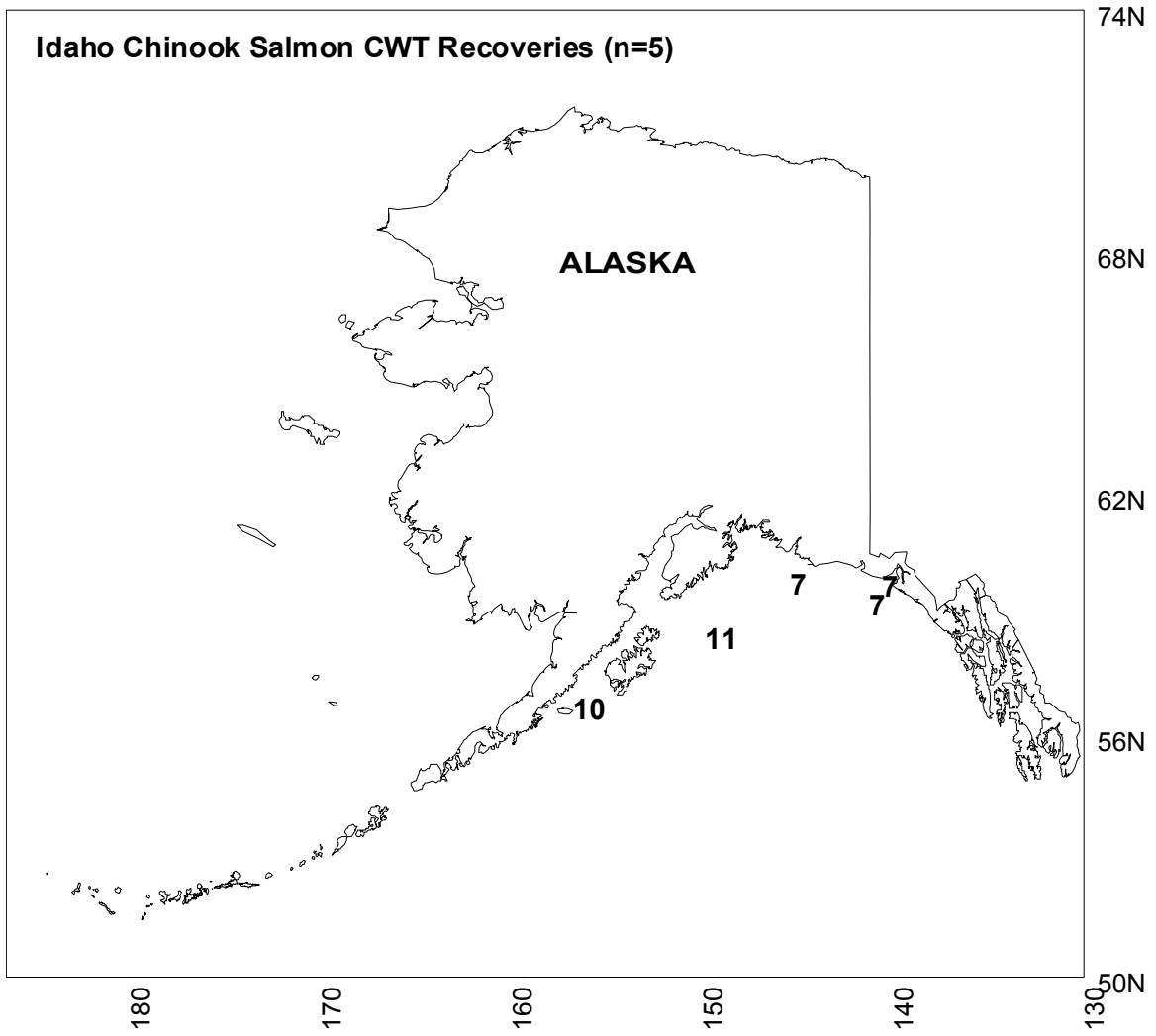


Fig. 10. Map showing recovery locations (number = month of recovery) of coded-wire tagged Idaho chinook salmon in the Bering Sea and Gulf of Alaska.

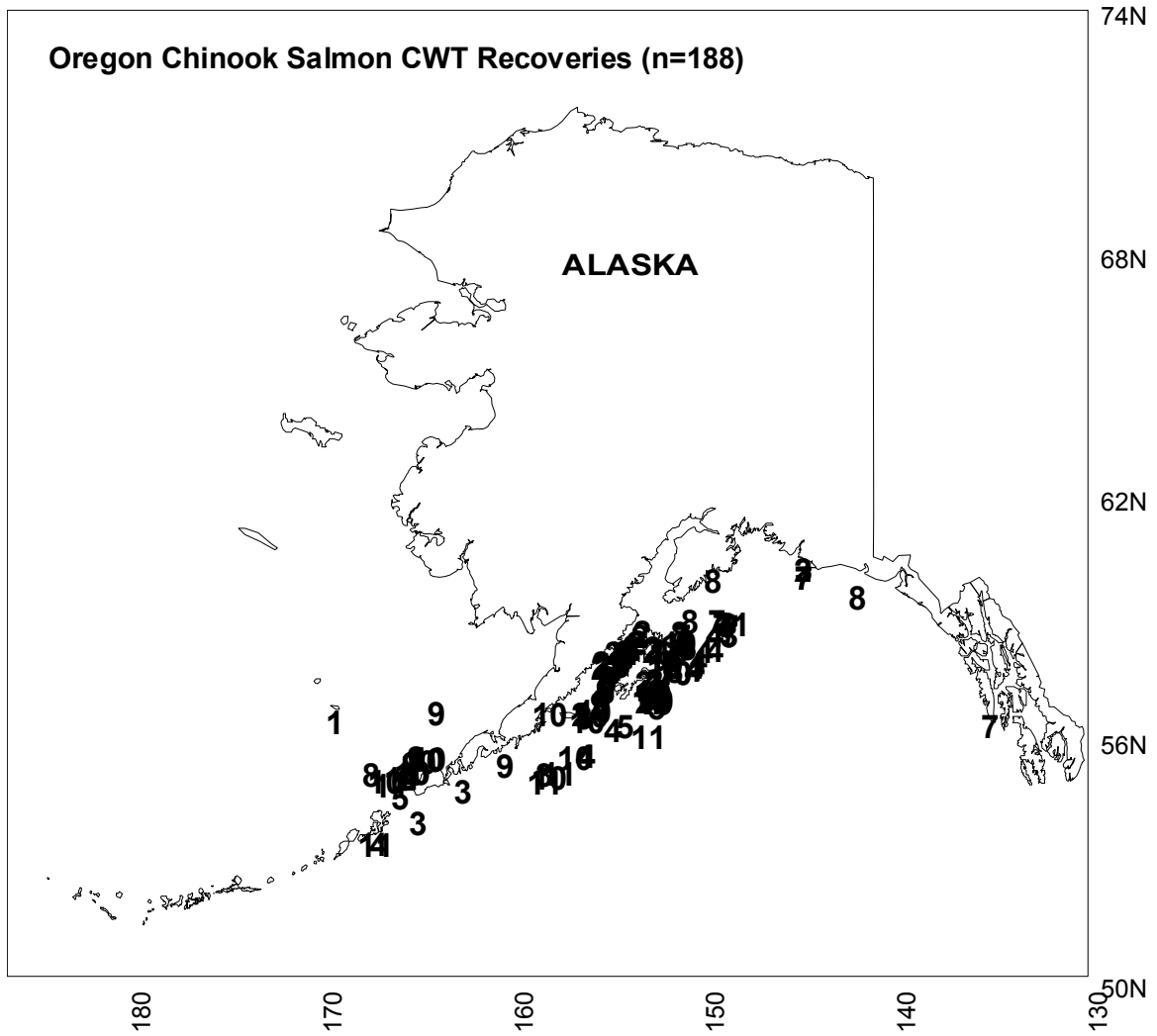


Fig. 11. Map showing recovery locations (number = month of recovery) of coded-wire tagged Oregon chinook salmon in the Bering Sea and Gulf of Alaska.

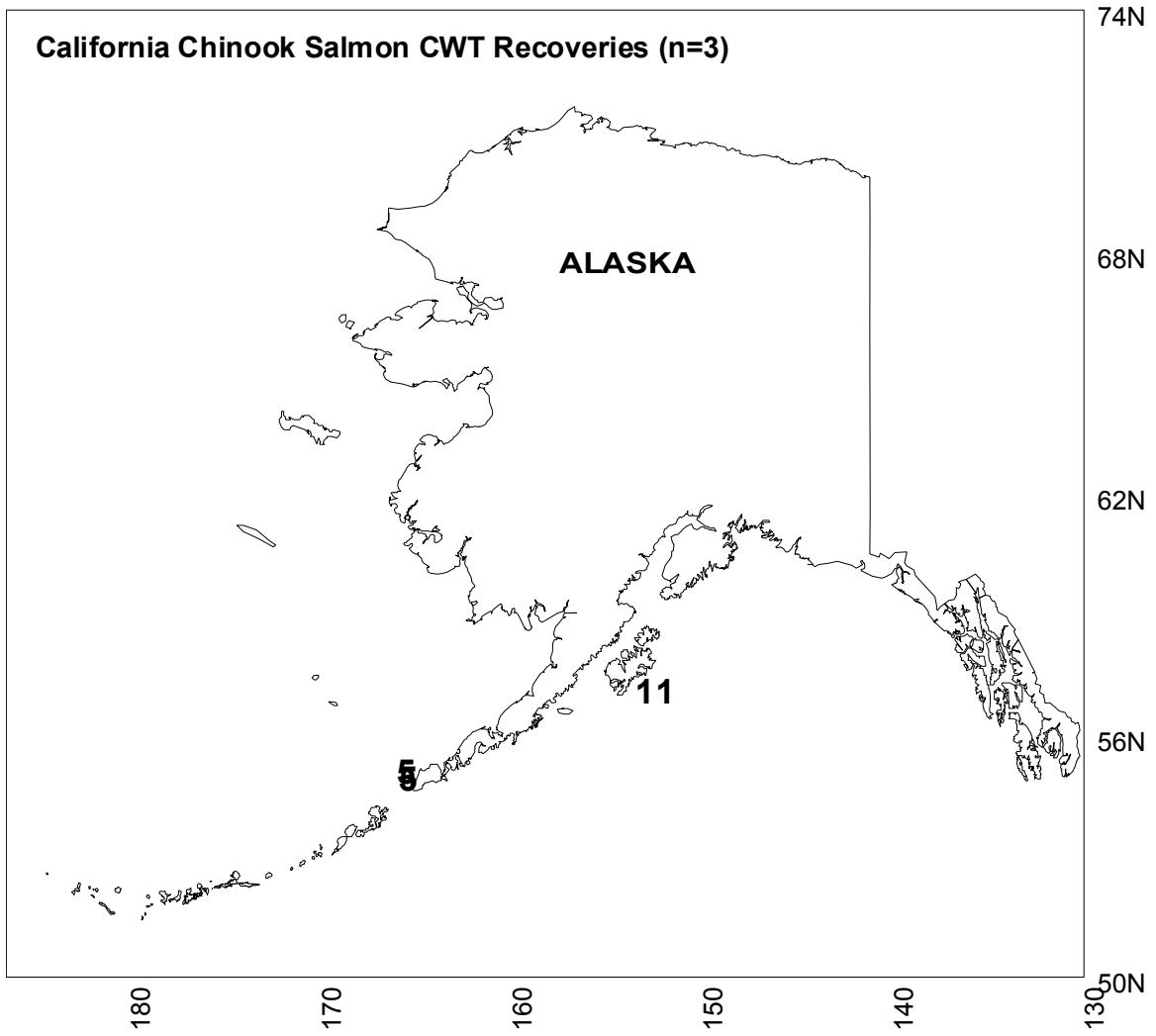


Fig. 12. Map showing recovery locations (number = month of recovery) of coded-wire tagged California chinook salmon in the Bering Sea and Gulf of Alaska.

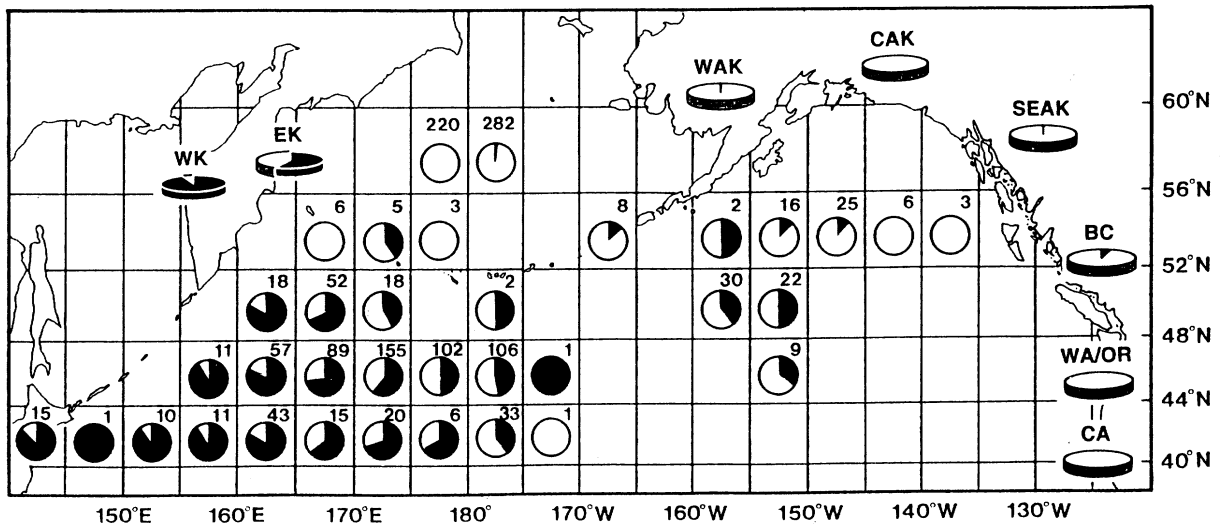


Fig. 13. Prevalence (indicated by black shading in pie chart) of *Myxobolus arcticus* in chinook salmon in the North Pacific Ocean and Bering Sea by 4° x 5° area in summer, 1988-1990 (from Urawa et al. 1998). Numbers within area are the number of fish examined. Three-dimensional pie charts indicate the baseline prevalences of the parasite in western Kamchatka (WK), eastern Kamchatka (EK), western Alaska (WAK), central Alaska (CAK), southeastern Alaska (SEAK), British Columbia (BC), Washington and Oregon (WA/OR), and California (CA) chinook stocks.

Table 1. Mean catch (number of salmonids) per unit (30-tans, 1500 m) of effort (research-mesh gillnet) by the Japanese salmon research vessel *Wakatake maru*, 1991-2001, in international waters of the North Pacific Ocean and Bering Sea. Research-mesh gillnet is composed of 3 tans each of the following mesh sizes: 48, 55, 63, 72, 82, 93, 106, 121, 138, and 157 mm. No. of Sta. = number of stations sampled.

Year	Sampling Dates	No. of Sta.	Locations	Mean		Mean		Mean Catch per 30 tans C-gear								
				Temperature		Salinity		Sock-Eye	Chum	Pink	Coho	Chi-nook	Steel-head	Dolly Varden	Masu	Total
				0 m	100	0 m	100									
Central North Pacific																
2001	14-23 Jun	10	39°N-47°N, 180°	9.8	6.5	33.5	33.6	2.0	25.8	16.4	16.5	0.3	1.3	0.0	0.0	62.1
2000	12-22 Jun	10	39°N-47°N, 180°	9.0	6.8	33.3	33.5	1.6	17.3	4.7	3.7	0.1	1.4	0.0	0.0	28.8
1999	16-26 Jun	10	39°N-47°N, 180°	8.6	6.6	33.2	33.3	10.8	17.1	15.9	6.1	0.6	1.8	0.0	0.0	52.3
1998	17-28 Jun	10	39°N-47°N, 180°	9.7	6.9	33.4	33.5	1.8	7.4	0.8	19.3	0.7	2.7	0.0	0.1	32.8
1997	19-28 Jun	10	39°N-47°N, 180°	10.3	7.5	33.4	33.6	0.3	16.8	8.1	13.1	0.7	1.7	0.0	0.0	40.7
1996	15-27 Jun	10	38°N-47°N, 180°	11.5	7.8	33.6	33.7	0.0	22.7	0.5	8.0	0.3	0.6	0.0	0.0	32.1
1995	18-27 Jun	10	38°N-47°N, 180°	10.7	8.2	33.6	33.8	0.2	11.1	2.6	11.2	0.2	2.4	0.0	0.0	26.9
1994	18-27 Jun	10	38°N-47°N, 180°	10.4	8.1	33.7	33.7	0.4	8.2	7.1	11.9	0.3	3.7	0.0	0.0	31.6
1993	17-28 Jun	10	38°N-47°N, 180°	10.4	7.9	33.7	33.9	0.0	29.7	0.8	6.6	0.1	1.7	0.0	0.0	25.4
1992	17-25 Jun	10	38°N-47°N, 180°	9.9	7.7	33.7	33.8	0.0	10.8	0.2	10.3	0.1	0.6	0.0	0.0	22.0
1991	12-21 Jun	10	38°N-47°N, 180°	11.0	8.4	33.6	33.8	0.2	11.4	2.3	19.6	0.2	1.9	0.0	0.0	35.6
Bering Sea																
2001	1-13 Jul	13	55°N-58°N, 178°W-176°E	5.4	1.7	33.1	33.2	60.8	136.5	164.9	0.1	2.5	0.0	0.0	0.0	364.8
2000	30 Jun-12 Jul	11	55°N-58°N, 178°W-178°E	7.9	1.8	33.0	33.2	36.1	141.5	2.2	0.0	10.2	0.0	0.0	0.0	189.9
1999	4-14 Jul	11	55°N-58°N, 178°W-178°E	6.5	1.9	32.9	33.0	25.5	64.1	357.3	0.0	4.1	0.0	0.0	0.0	450.9
1998	6-16 Jul	11	55°N-58°N, 177°W-177°E	7.0	2.5	32.3	33.0	37.7	209.6	5.6	0.4	22.7	0.0	5.0	0.0	281.1
1997	6-17 Jul	10	55°N-58°N, 177°W-177°E	8.4	3.0	32.8	32.9	57.0	143.9	379.7	0.3	3.5	0.0	0.1	0.0	584.5
1996	4-14 Jul	9	55°N-58°N, 177°W-179°E	7.5	2.9	32.8	33.0	55.1	200.7	4.8	0.1	6.8	0.0	0.2	0.0	267.7
1995	5-15 Jul	11	55°N-58°N, 177°W-177°E	7.5	2.0	32.9	33.1	37.8	63.8	174.5	0.5	6.5	0.0	0.2	0.0	283.3
1994	5-15 Jul	11	55°N-58°N, 177°W-177°E	6.7	1.8	32.9	33.2	50.3	224.0	13.1	0.0	5.2	0.0	0.2	0.0	292.7
1993	6-16 Jul	11	55°N-58°N, 177°W-177°E	7.2	2.1	33.1	33.2	58.2	111.6	141.2	0.8	1.4	0.0	0.0	0.0	313.2
1992	4-14 Jul	11	55°N-58°N, 177°W-177°E	6.4	2.5	33.0	33.3	22.8	257.5	9.0	0.3	5.4	0.0	0.5	0.0	295.5

Table 2. Number sampled, mean, and standard deviation (sd) of fork length (FL, mm), body weight (BW, g), and condition factor ($10^6 \cdot BW/FL^3$) of chinook salmon caught in international waters of the North Pacific Ocean and Bering Sea by the *Wakatake maru* research gillnet, 1991-2001, grouped by ocean age and oceanographic domain.

Year	Ocean Age-1								Ocean Age-2							
	N	% Age	FL (mm)		B W (g)		CF		N	Age	FL (mm)		B W (g)		CF	
			mean	sd	mean	sd	mean	sd			mean	sd	mean	sd		
Central North Pacific - Subarctic Current (44°N-47°N, 180°)																
2001	0								0							
2000	0								1	100	600		3100		14.4	
1999	0								5	100	617	30	3220	448	13.6	0.6
1998	0								6	86	582	39	2488	472	12.5	0.7
1997	0								6	86	641	47	3408	1026	12.6	2.2
1996	3	100	395	44	823	320	12.9	0.8	0							
1995	0								1	50	562		2200		12.4	
1994	0								3	100	616	33	3150	477	13.4	0.3
1993	0								1	100	624		3700		15.2	
1992	0								1	100	575		2300		12.1	
1991	0								2	100	572	82	2625	926	13.8	1.0
Bering Sea (55°-58°N, 177°E-177°W)																
2001	24	73	345	28	476	136	11.4	1.3	5	15	492	99	1660	736	12.6	1.7
2000	36	33	326	49	421	329	11.0	1.6	50	46	520	51	1779	524	12.3	0.9
1999	13	30	330	27	403	114	10.9	1.0	22	51	533	60	1936	694	12.5	2.2
	14															
1998	0	60	348	41	528	311	11.7	1.2	62	27	545	57	2202	793	13.1	0.9
1997	12	35	350	24	478	94	11.1	0.8	19	56	550	35	1954	390	11.6	0.8
1996	24	43	407	31	826	221	12.0	1.0	25	45	567	46	2382	632	12.8	1.0
1995	18	27	339	31	442	128	11.1	0.9	43	65	525	52	1813	522	12.3	1.7
1994	25	47	374	31	620	173	11.3	1.0	11	21	543	57	2179	740	13.1	1.5
1993	1	8	352		480		11.0		7	59	573	25	2340	314	12.4	0.6
1992	17	36	356	27	525	116	11.4	0.9	23	49	567	47	2333	709	12.6	1.5
1991	45	66	345	26	497	120	11.9	1.3	21	31	530	57	1816	634	11.8	0.8

Table 2 (cont'd)

Year	Ocean Age-3								Ocean Age-4							
	N	% Age	FL (mm)		B W (g)		CF		N	Age	FL (mm)		B W (g)		CF	
mean			sd	mean	sd	mean	sd	mean			sd	mean	sd	mean	sd	
Central North Pacific - Subarctic Current (44°N-47°N, 180°)																
2001	0									0						
2000	0									0						
1999	0									0						
1998	1	14	780		6850			14.4		0						
1997	1	14	700		4400			12.8		0						
1996	0									0						
1995	1	50	832		7800			13.5		0						
1994	0									0						
1993	0									0						
1992	0									0						
1991	0									0						
Bering Sea (55°-58°N, 177°E-177°W)																
2001	3	9	603	56	2260	754	10.1	1.7	1	3	780		6300		13.3	
2000	22	20	671	48	4030	1122	13.1	2.0	1	1	728		5300		13.7	
1999	8	19	658	64	3566	1236	12.1	0.8	0							
1998	30	13	678	76	4346	1434	13.3	1.6	0							
1997	3	9	714	100	4650	2079	12.2	0.9	0							
1996	7	12	732	46	5121	1366	12.7	1.1	0							
1995	4	6	726	61	4725	1300	12.2	0.8	1	2	812		6800		12.7	
1994	17	32	720	41	4855	1129	12.8	1.0	0							
1993	3	25	716	95	4710	2175	12.3	1.1	1	8	862		8600		13.4	
1992	6	13	654	27	3822	648	13.6	0.8	1	2	850		7650		12.5	
1991	2	3	715	18	4050	71	11.1	1.0	0							

Table 3. Diets of chinook salmon caught in the central North Pacific (Subarctic Current) and Bering Sea along the 180° longitude transect line by the *Wakatake maru*, 1991-2001. PW=prey weight, % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=PW*100/body weight. Prey composition is based on visual estimates.

Area	Year	N	% empty	Mean PW	Mean SCI	Mean % composition by volume											
						EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UNID
North Pacific, Subarctic Current	2001	5	60	23	0.49	0	0	0	0	100	0	0	0	0	0	0	0
	2000	2	50	1	0.05	0	0	0	0	100	0	0	0	0	0	0	0
	1999	3	33	24	0.83	0	0	0	0	50	0	50	0	0	0	0	0
	1998	5	0	41	1.54	0	0	0	0	100	0	0	0	0	0	0	0
	1997	24	29	28	1.12	12	0	0	0	83	0	5	0	0	0	0	0
	1996	2	0	19	0.26	0	0	0	0	100	0	0	0	0	0	0	0
	1995	1	100														
	1994	3	0	13	0.28	0	0	0	0	100	0	0	0	0	0	0	0
	1993	3	33	74	1.94	0	0	0	0	100	0	0	0	0	0	0	0
	1992	0															
1991	2	0	23	0.49	0	0	2	0	63	0	0	0	0	0	0	0	35
Bering Sea	2001	40	35	4	0.50	6	0	0	0	34	2	58	0	0	0	0	0
	2000	60	27	26	0.81	29	1	0	0	36	0	34	0	0	0	0	0
	1999	22	32	3	0.26	9	0	6	0	36	4	45	0	0	0	0	0
	1998	96	34	15	0.82	12	3	2	0	66	0	16	0	0	0	0	1
	1997	54	35	13	0.54	29	0	0	0	52	0	19	0	0	0	0	0
	1996	72	19	25	1.03	18	0	2	0	47	1	32	0	0	0	0	0
	1995	44	16	10	0.63	16	0	0	0	52	0	29	0	0	0	0	3
	1994	26	31	12	0.54	20	0	10	0	58	1	8	0	0	3	0	0
	1993	12	17	12	0.54	27	0	0	0	39	0	34	0	0	0	0	0
	1992	37	19	18	0.78	43	4	0	0	44	0	9	0	0	0	0	0
1991	30	17	19	0.86	33	1	0	0	43	0	23	0	0	0	0	0	

Prey categories are EU=euphausiids, CO=copepods, AM=amphipods, CR=crab larvae, SQ=squids, PT=pteropods, FI=fish, PO=polychaetes, CH=chaetognaths, GE=gelatinous zooplankton (coelenterates, ctenophores, and salps),

Table 5. Number sampled, mean and standard deviation (sd) of fork length (FL, mm), body weight (BW, g), and condition factor (CF = $10^6 * BW/FL^3$) of chinook salmon caught in international waters of the central North Pacific Ocean and Gulf of Alaska by the *Oshoro maru* research gillnet, 1994-2001, grouped by ocean age.

Transect Line	Ocean Domain	Ocean Age-1								Ocean Age-2															
		FL				BW				CF				FL				BW				CF			
		Year	N	mean	sd	mean	sd	mean	sd	N	mean	Sd	mean	sd	mean	sd	mean	sd							
145°W - Central Gulf of Alaska	Gulf of Alaska Gyre	2001								3	618.0	50.0	3246.7	1051.9	13.4	1.2									
		2000								1	705.0	-	4610.0	-	13.2	-									
		1999								5	642.0	26.5	3512.0	435.3	13.2	0.5									
		1998								4	645.0	72.6	3880.0	1625.0	13.9	1.0									
		1996	1	374.0	-	550.0	-	10.5	-	2	563.0	9.9	2480.0	28.3	13.9	0.6									
		1995								1	652.0	-	4100.0	-	14.8	-									
	Subarctic Current	2001	3	626.7	28.2	3610.0	788.9	14.5	1.4	1	791.0	-	6800.0	-	13.7	-									
		1998								2	655.5	84.1	4350.0	1697.1	15.0	0.2									
		1995								1	644.0	-	3800.0	-	14.2	-									
	165°W - Western Gulf of Alaska	Gulf of Alaska Gyre	1999								5	576.4	20.4	2586.0	428.0	13.4	1.1								
Subarctic Current		1998								1	676.0	-	4700.0	-	15.2	-									
180° - Central North Pacific	Subarctic Current	1997								1	642.0	-	3400.0	-	12.8	-									
		1996								1	654.0	-	3360.0	-	12.0	-									
		1994								1	680.0	-	4150.0	-	13.2	-									

Table 5 (Cont'd)

Transect Line	Ocean Domain	Ocean Age-3							
		Year	FL		BW		CF		
			N	mean	sd	mean	sd	mean	sd
145°W - Central Gulf of Alaska	Gulf of Alaska Gyre	2001							
		2000							
		1999							
		1998							
		1996							
		1995							
	Subarctic Current	2001							
		1998							
		1995							
	165°W - Western Gulf of Alaska	Gulf of Alaska Gyre	1999	1	722.0	-	5100.0	-	13.6
Subarctic Current		1998							
180° - Central North Pacific	Subarctic Current	1997							
		1996							
		1994							

Table 6. Mean % composition of stomach contents of chinook salmon caught in international waters of the Gulf of Alaska along the 145° W transect line by the *Oshoro maru*, 1994-2001. PW=prey weight; % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=PW*100/body weight. Prey composition is based on visual estimates.

Species	Year	N	% empty	mean pw	mean SCI	Mean % composition by volume											
						EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UNID
145°W -	2001	5	0	22	0.65	7	1	0	0	72	0	0	0	0	0	20	0
Central Gulf of	2000	3	67	2	0.06	0	0	0	0	100	0	0	0	0	0	0	0
Alaska, Gulf	1999	10	60	37	0.68	23	0	0	0	25	0	0	0	0	0	0	53
of Alaska	1998	17	47	15	0.47	0	0	6	0	94	0	0	0	0	0	0	0
Gyre	1997	0															
	1996	7	29	42	1.57	0	0	0	0	80	0	0	0	0	0	0	20
	1995	5	40	32	0.76	0	0	0	0	100	0	0	0	0	0	0	0
	1994	9	11	48	1.18	0	0	0	0	81	0	0	0	0	0	0	19
145°W -	2001	8	0	72	1.86	0	0	0	0	100	0	0	0	0	0	0	0
Central Gulf of	2000	0															
Alaska,	1999	0															
Subarctic	1998	8	25	65	1.45	0	0	0	0	99	0	0	0	0	0	0	1
Current	1997	0															
	1996	1	100														
	1995	2	100														
	1994	0															

Prey categories are: EU=euphausiids, AM=amphipods, CR=crab larvae, SQ=squids, PT=pteropods (shelled and naked), FI=fish, PO=polychaetes, CH=chaetognaths, GE=gelatinous zooplankton, including coelenterates, ctenophores, and salps. OTH=other groups, UNID=unidentified material.

Table 7. High seas tag release and recovery information for all chinook salmon recovered in western Alaska and the Canadian Yukon (1955-2000). FAJ = Fisheries Agency of Japan; FRI = Fisheries Research Institute, University of Washington; Imm = immature, Mat = mature; M=Male, F=Female, U=unknown sex; YUKN = Yukon, BRIS = Bristol Bay, KUSK = Kuskokwim.

Release Agency	Tag code	Release Date (yyymmdd)	Release location	Release length (mm)	Estimated release age*	Maturity at release	Estimated recovery age	Sex	Recovery basin	Recovery location	Recovery date (yyymmdd)	Recovery length (mm)	Description of recovery location	
FRI	21680	610624	55-35N	163-35W	665	X.3	Mat	1.3	U	BRIS	58-15N	157-35W	610706	Egegik District
FRI	40372	640609	51-36N	176-18W	745	1.3	Mat	1.3	U	BRIS	58-55N	159-46W	640708	Togiak Bay (Commercial Fishery)
FAJ	NE3420	650719	60-03N	175-00E	480	1.2	Imm	1.4	F	BRIS	58-37N	158-31W	670621	700 Nushagak Bay (commercial fishery)
FAJ	E0168	750620	58-33N	179-00E	630	1.3	Imm	1.4	U	BRIS			770616	Nushagak District
FAJ	SE5377	660730	58-00N	180-00W	530	1.2	Imm	1.4	U	KUSK	60-51N	161-18W	680622	850 Kuskokwim R.
FRI/USSR	Q00713	850706	53-00N	178-03E	560	1.2	Imm	1.4	F	KUSK	60-47N	161-41W	870625	Kuskokwim R., near Bethel, AK
FAJ	12361	590704	57-56N	176-09E	558	1.2	Imm	1.3	M	YUKN	62-35N	164-52W	600609	Yukon R. Delta
FAJ	NE3323	650718	58-29N	175-25E	500	X.X	Imm		U	YUKN	64-40N	155-30W	670602	Middle Yukon R., near Ruby, Ak
FAJ	B3653	720718	59-03N	172-12E	700	1.3	Imm	1.5	U	YUKN	62-35N	164-58W	740625	780 Yukon R. Delta, near Kwikluak Pass
FAJ	E0127	750618	57-31N	178-59E	560	X.X	Imm		F	YUKN	62-32N	165-00W	770628	850 Yukon R. Delta
FAJ	E0159	750619	58-03N	178-59E	530	1.2	Imm	1.4	U	YUKN	61-45N	162-00W	770600	Lower Yukon R.

Table 7 (Cont'd)

Release Agency	Tag code	Release Date (yymmdd)	Release location	Release length (mm)	Estimated release age*	Maturity at release	Estimated recovery age	Sex	Recovery basin	Recovery location	Recovery date (yymmdd)	Recovery length (mm)	Description of recovery location		
FAJ	Y0015	850624	56-24N	174-36E	575	1.2	Imm	1.3	M	YUKN	64-40N	141-00W	860720	800	Upper Yukon R. , Canada, (river mile 1220, 2 miles upstream from US/Canada border)
FAJ	Y0103	850702	55-28N	179-28W	415	1.1	Imm	1.4	F	YUKN	65-37N	150-08W	880724		Middle Yukon R., near Rampart, AK
FAJ	Z1534	860703	57-30N	177-39W	604	1.2	Imm	1.3	U	YUKN	62-19N	163-51W	870625		Lower Yukon R.
FAJ/U.S.	CC5830	910712	56-29N	179-18W	602	1.2	Imm	1.3	U	YUKN	65-10N	152-04W	920703		Middle Yukon R., near Tanana, AK

* The age at release was determined by visual examination of scale patterns. The number before the dot is the number of winters in freshwater, and the number after the dot is the number of winters in the ocean. We assumed that all fish spent one winter in freshwater. X = scale was regenerated.

Table 8. Recoveries of coded-wire tagged Canadian Yukon Territory (Whitehorse Hatchery) chinook salmon in the bycatch of trawl fisheries in the eastern Bering Sea.

Tag Code	Recovery date (yymmdd)	Recovery Location	Recovery length (mm)	Recovery weight (g)	Estimated recovery age*	Sex	Brood year	Release date (yymmdd)	Release weight (g)	Yukon River release location	Run	Release stage
026006	920325	56-44N 173-15W	620	2900	0.3	F	88	890606	2.30	R-MITCHIE CR	Spring	Fed fry
180322	940314	60-06N 178-58W	687		0.3	F	90	910808	2.30	R-WOLF CR/YUKN	Summer	Fed fry
180830	950224	55-19N 164-43W		1800	0.3	F	91	920604	2.23	R-MITCHIE CR	Summer	Fed fry
181215	941206	56-52N 171-18W	400	1000	0.1	M	92	930606	2.28	R-WOLF CR/YUKN	Summer	Fed fry
181216	970602	59-29N 167-49W	833	7500	0.4	M	92	930615	2.30	R-YUKON R	Summer	Fed fry
181428	980310	59-26N 178-05W	760	5400	0.4	F	93	940601	2.27	R-MITCHIE CR	Spring	Smolt
182554	000316	55-56N 168-52W	550	2080	0.3		96	970611	2.26	R-MITCHIE CR	Landlocked	Emergent Fry
182823	980329	58-56N 178-06W	650	3310	0.2	F	95	960604	2.40	R-FOX CR	Spring	Smolt
183348	990330	57-43N 173-34W	660	3320	0.3	M	95	960604	2.45	R-JUDAS CR	Spring	Smolt

* The number before the dot is the number of winters in freshwater, and the number after the dot is the number of winters in the ocean. Whitehorse hatchery chinook salmon migrate to the ocean in the year of release, regardless of run type or release stage (P. Milligan, Canadian Dept. Fish. & Oceans, pers. comm.). For fish caught in the winter, one year was added to the ocean age on January 1.

Table 9. Combined US groundfish trawl and high seas research vessel recoveries of coded-wire tagged chinook salmon (number of fish) by ocean recovery region, ocean age of fish at recovery, and release location (state, region). Only data records with latitude and longitude of recovery were included. AK = Alaska, YT = Yukon Territory, BC = British Columbia, WA = Washington, ID = Idaho, OR = Oregon, CA = California, UK = Unknown; Release Regions: CECA = central Coastal California, CECR = central Columbia R., COOK = Cook Inlet, COBC = Coastal British Columbia, CRGN = Columbia R. (general or unknown), FRTH = Fraser R.-Thompson R., GRAY = Grays Harbor, GST = Georgia Strait, HOOD = Hood Canal, JUAN = Strait of Juan De Fuca, KLAM = Klamath R. - Trinity R., KODI = Kodiak, LOCR = lower Columbia R., MPS = mid Puget Sound, NASK = Nass R.-Skeena R., NOCA = North coastal California, NOOK = Nooksack R., NOOR = North coastal Oregon, NWC = North coastal Washington, ORGN = Oregon (general or unknown), QCI = Queen Charlotte Islands, SACR = Sacramento R., SEAK = Southeast Alaska, SJOA = San Joaquin R., SNAK = Snake R., SOCA = South coastal California, SOOR = South coastal Oregon, SPS = south Puget Sound, STIL = Stillaguamish R - Snohomish R, UPCR = upper Columbia R., WILP = Willapa R., YUKN = Yukon Territory. T = Total. GT = Grand Total, all ocean recovery regions.

Release Location		Ocean recovery region and ocean age* of chinook salmon													
		Bering Sea							Gulf of Alaska						
State	Region	.0	.1	.2	.3	.4	.5	T	.0	.1	.2	.3	.4	.5	T
AK	COOK		25	30	2			57	1	36	11		1		49
	KODI		2	1				3							
	SEAK		3	1	3	1		8		34	94	32			160
AK Total			30	32	5	1		68	1	70	105	32	1		209
YT	YUKN	1	1	5	2			9							
BC	COBC		4	3	9			16		6	43	18	2		69
	FRTH		22	11	5			38		54	32	13			99
	GST			1				1		2	3	2	1		8
	NASK		3	4	10	1		18		13	24	11	4		52
	QCI									2	5				7
	WCVI		7	15	17	1	1	41		24	111	32	3		170
Canada Total			37	35	46	4	1	123		101	218	76	10		405
WA	NWC			3				3		9	18	3	3		33
	NOOK				1			1							
	GRAY				1			1		8	9	6	5	2	30
	STIL														
	JUAN										1				1

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon														
		Bering Sea							Gulf of Alaska							
State	Region	.0	.1	.2	.3	.4	.5	T	.0	.1	.2	.3	.4	.5	T	
	HOOD															
	MPS															
	SPS															
	WILP									4	1	2			7	
	LOCR									5	6	2			13	
	CECR									1	4	1	3	1	10	
	UPCR									1	7	24	3		35	
	CRGN															
	SNAK															
WA																
Total				3	2			5		2	37	60	19	9	2	129
ID	SNAK									5						5
ID Total										5						5
OR	CECR									2	2	2				6
	LOCR		1	3				4		2	31	55	7	1		96
	NOOR		3	4	4			11			14	22	12	2		50
	ORGN															
	SNAK															
	SOOR		1	2		1		4				12	2	3		17
OR Total			5	9	4	1		19		4	47	91	21	6		169
UK	CRGN															
UK Total																
CA	CECA			1				1								
	KLAM															
	NOCA															
	SACR			1				1				1				1
	SJOA															
	SOCA															
CA Total				2				2				1				1
Grand Total			72	81	57	6	1	217		12	255	475	148	26	2	918

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon										GT
		North-Eastern Pacific	South-central North Pacific	US West Coast							T	
State	Region	.1	.1	.0	.1	.2	.3	.4	.5	.6	T	GT
												10
AK	COOK							1			1	7
	KODI											3
	SEAK											16
												8
AK Total								1			1	27
YT	YUKN											8
BC	COBC							1			1	9
												86
	FRTH				28	47	10	3	1			22
	GST				3	12	1					6
	NASK											89
	QCI											16
	WCVI											70
												7
Canada Total					31	59	11	4	1		106	21
WA	NWC			1	1	3						1
	NOOK				6	9	3					63
	GRAY											1
	STIL				3						3	3
	JUAN				1						1	2
	HOOD				7	10	3				20	20
	MPS				19	12	3				34	34
	SPS				19	10	7				36	36

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon										GT
		North-Eastern Pacific	South-central North Pacific	US West Coast							T	
State	Region	.1	.1	.0	.1	.2	.3	.4	.5	.6	T	GT
	WILP					1					1	8
	LOCR		1	4	166	121	15	1			307	321
	CECR			1	45	13	2				61	71
												13
	UPCR			1	83	8	4	2			98	3
	CRGN				8	2	2				12	12
												23
	STAK			7	170	50	10				237	7
WA												96
Total			1	14	528	239	49	3			833	8
ID	STAK				5	4	1				10	15
ID Total					5	4	1				10	15
OR	CECR	1		7	19	5					31	38
												46
	LOCR				185	146	30	1			362	2
												10
	NOOR				17	12	7	3			39	0
	ORGN					1					1	1
	STAK				1		1				2	2
												63
	SOOR			5	239	292	71	9	1		617	8
												12
OR Total		1		12	461	456	109	13	1		1052	41
UK	CRGN					1					1	1
UK Total						1					1	1
CA	CECA				13	24	10				47	48
												54
	KLAM			2	187	305	43	3		1	541	1

Table 9 (Cont'd)

Release Location		Ocean recovery region and ocean age* of chinook salmon										GT
State	Region	North-Eastern Pacific	South-central North Pacific	US West Coast							T	GT
		.1	.1	.0	.1	.2	.3	.4	.5	.6		
	NOCA					1					1	1
	SACR				59	48	7	1			115	7
	SJOA				19	13	2				34	34
	SOCA					1	1				2	2
	CA Total			2	278	392	63	4		1	740	74
	Grand Total	1	1	28	1303	1151	233	25	2	1	2743	3880

* The number after the dot is the number of winters in the ocean. For fish caught in the winter, one year was added to the ocean age on January 1.

Table 10. Combined US groundfish trawl and high seas research vessel recoveries of coded-wire tagged chinook salmon (number of fish) by ocean recovery region and recovery month, ocean age of fish at recovery, and release location (state). Only data records with latitude and longitude of recovery were included. AK = Alaska, YT = Yukon Territory, BC = British Columbia, WA = Washington, ID = Idaho, OR = Oregon, CA = California, UK = Unknown. T = Total.

State	Ocean age*	Ocean recovery region and recovery month																									
		Bering Sea												Gulf of Alaska													
		1	2	3	4	5	6	7	8	9	10	11	12	T	1	2	3	4	5	6	7	8	9	10	11	12	T
YT	.1												1	1													
	.2			1									1	1													
	.3		1	4									5	5													
	.4			1				1					2	2													
YT	Total		1	6				1					1	9													
AK	.0																						1				1
	.1								8	21	1		30		1			3	1	1		6	40	7	1	70	
	.2		1						1	11	2		32	4	39	9	3	1	9	6	6	5	12	1		105	
	.3		1	1	1				1				5	5	8	7	1		1	3		2	5			32	
	.4		1										1	1						1						1	
AK	Total		3	1	1				3	4			68	9	48	16	4	4	1	1	7	3	57	8	1	209	
BC	.1		1							1	25	2	7	36		1			1	3	1	3	58	22	2	101	
	.2	2	8	1	1		1		1	7	12		1	34	3	88	20	0	1	2	9	2	9	28	7	1	218
	.3	7	15	8	2	1		1		2	4	1		41	6	20	16	4	1	0	4		9	5	1	76	
	.4		1		1									2	2	2	2			1	2		1			10	
	.5				1									1													
BC	Total	9	25	9	5	1	1	1	1	0	41	3	8	114	3	111	38	4	2	4	8	3	2	91	30	3	405
WA	.0																					1		1		2	
	.1															1		2			1	1	5	14	10	3	37

Table 10 (Cont'd)

		Ocean recovery region and recovery month																									
		Bering Sea												Gulf of Alaska													
State	Ocean age*	1	2	3	4	5	6	7	8	9	10	11	12	T	1	2	3	4	5	6	7	8	9	10	11	12	T
CA	.6					2								2													
Total										3					6			4		3	5	3	7	20		1	
Grand Total		12	32	16	7	5	2	1	5	9	81	8	9	217	6	250	77	8	9	8	0	0	1	1	71	7	918

		Ocean recovery region and recovery month										
		US West Coast										
State	Ocean age*	UK	4	5	6	7	8	9	10	11	T	
YT	.1											
	.2											
	.3											
	.4											
YT Total												
AK	.0											
	.1											
	.2											
	.3											
	.4			1							1	
AK Total				1							1	
BC	.1		2	4	3	12	8	2			31	
	.2			12	17	20	6	2	2		59	
	.3		1	8		1	1				11	

Table 10 (Cont'd)

State	Ocean age*	Ocean recovery region and recovery month									
		US West Coast									
		UK	4	5	6	7	8	9	10	11	T
	.4		1	1	1	1					4
	.5			1							1
BC											
Total			4	26	21	34	15	4	2		106
WA	.0			2		1	4	7			14
						16					
	.1		5	92	81	7	85	72	26		528
	.2		9	42	61	66	35	20	6		239
	.3		1	17	14	11	5			1	49
	.4				1	2					3
	.5										
WA				15	15	24	12				
Total			15	4	6	7	9	99	32	1	833
ID	.0										
	.1			1		3		1			5
	.2			1	1	2					4
	.3					1					1
ID											
Total				2	1	6		1			10
OR	.0			4	1	2	2	3			12
						13					
	.1	1	6	54	53	3	87	95	32		461
				13							
	.2		64	0	58	64	51	33	56		456
	.3		21	43	20	12	6	3	4		109
	.4			8	3	2					13
	.5			1							1
OR				24	13	21	14	13			105
Total		1	91	0	5	3	6	4	92		2

Table 10 (cont'd)

State	Ocean age*	Ocean recovery region and recovery month									
		US West Coast									
		UK	4	5	6	7	8	9	10	11	T
UK	.2				1						1
UK											
Total					1						1
CA	.0						2				2
	.1		9	51	23	45	66	46	38		278
				13							
	.2		74	2	43	40	31	19	53		392
	.3	1	9	27	12	9	2	3			63
	.4		1	1	2						4
	.6			1							1
CA				21			10				
Total		1	93	2	80	94	1	68	91		740
Grand			20	63	39	59	39	30	21		274
Total		2	3	4	4	4	1	6	7	1	3

* The number after the dot is the number of winters in the ocean. For fish caught in the winter, one year was added to the ocean age on January 1.

Table 11. Western Alaskan subregional stock composition estimates by statistical area, age, and month for chinook salmon in incidental catches by foreign and joint-venture groundfish fisheries in the Bering Sea portion of the U.S. exclusive economic zone in 1979 and 1981. An estimate of zero with no confidence interval indicates that the stock is not present. An estimate of zero with a confidence interval indicates a positive estimate of less than 0.5%. Estimates with lower confidence limits of zero are considered nonsignificant. N = sample size. (From Table 4, Myers and Rogers 1988.)

Age	Month	Year	N	% Composition by region (90% confidence intervals)					
				Russia	Western Alaska			Central Alaska	Southeastern Alaska-British Columbia
					Yukon	Kuskokwim	Bristol Bay		
Area 1 (east of 170°W)									
1.2	October	1979	81	0	7 (0-25)	0	38 (17-60)	40 (17-63)	15 (0-30)
	November	1981	99	11(0-23)	0	25 (0-50)	51 (29-74)	10 (0-28)	3 (0-12)
Area 2 (west of 170°W)									
1.2	January	1979	84	3 (0-15)	49 (23-74)	27 (0-61)	4 (0-37)	17 (0-38)	0
	February		553	0	51 (40-62)	12 (0-24)	12 (0-27)	25 (17-33)	0
	April	1981	142	3 (0-10)	0	23 (2-43)	69 (49-90)	0	5 (0-11)
1.3	February	1979	186	7 (0-19)	48 (26-69)	29 (3-55)	6 (0-25)	7 (0-21)	3 (0-9)

Table 12. Western Alaskan subregional stock composition estimates for immature age-1.2 chinook salmon in subareas of the Japanese mothership salmon fishery, 1975-1981. An estimate of zero without a confidence interval indicates a negative estimate, that is, the stock was not present. An estimate of zero with a confidence interval indicates a positive estimate of less than 0.5%. Estimates with lower confidence limits of zero are considered nonsignificant. N = sample size. (Adapted from Table 4, Myers et al. 1987.)

Subarea	Month	Year	N	% Composition by region (90% confidence intervals)					
				Russia	Western Alaska			Central Alaska	Southeastern Alaska-British Columbia
					Yukon	Kuskokwim	Bristol Bay		
Central Bering Sea									
175°E-180°	June	1976	104	20 (3-37)	36 (5-67)	32 (3-62)	0	12 (0-27)	0
		1975	127	5 (0-20)	75 (49-100)	0	17 (0-38)	0	3 (0-9)
	July	1979	153	0	45 (27-62)	22 (1-42)	12 (0-35)	21 (9-34)	0
		1980	266	8 (4-13)	63 (45-80)	29 (12-46)	0	0	0
		1981	161	0	64 (44-84)	15 (0-38)	12 (2-22)	9 (0-20)	0
180°-175°W	July	1977	254	4 (0-20)	22 (0-51)	29 (0-70)	40 (20-60)	0 (0-12)	5 (0-12)
		1978	103	7 (0-19)	69 (46-93)	0	11 (0-30)	7 (0-24)	6 (0-15)
		1979	184	1 (0-8)	28 (12-45)	29 (2-56)	21 (0-48)	21 (6-36)	0
		1980	185	2 (0-8)	33 (5-61)	60 (31-88)	5 (0-25)	0	0
		1981	122	7 (0-17)	58 (33-83)	7 (0-34)	15 (2-28)	13 (0-27)	0
North Pacific Ocean (north of 46°N)									
170°E- 175°E	June	1978	261	16 (4-28)	44 (26-62)	11 (0-29)	0	21 (5-38)	8 (1-16)
		1979	132	16 (3-29)	36 (20-52)	18 (3-33)	0	30 (13-47)	0
		1981	371	22 (13-31)	39 (23-55)	14 (0-32)	1 (0-6)	22 (11-34)	2 (0-7)