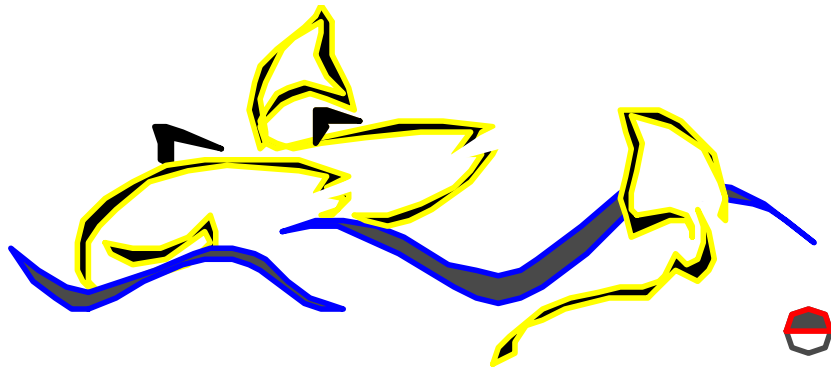


SAFS-UW-0501
February 2005

High Seas Salmon Research Program, 2004

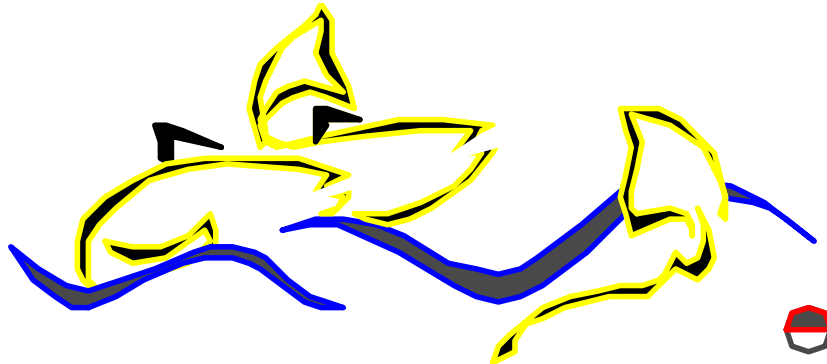
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High Seas Salmon Research Program, 2004

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**Final Report for 2004:
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Preface

The High Seas Salmon Research Program is a long-term (1953-present) research program at the Fisheries Research Institute (FRI), School of Aquatic and Fishery Sciences (SAFS), University of Washington. During our 52-year history, the faculty, staff, and students of the High Seas Salmon Research Program have carried out scientific investigations of the abundance, distribution, migration patterns, stock origins, life history, and ecology of Pacific salmon (*Oncorhynchus* spp.) in the North Pacific Ocean and Bering Sea. The results of our work have been used by the U.S. government and others to address issues of concern related to research, conservation, and management of salmon in the ocean. We are committed to continuing this long-term research, addressing current research problems, and identifying emerging issues of concern. The High Seas Salmon Research Program is dedicated to providing professional and public service at local, regional, state, national, and international levels. We promote and benefit from collaboration with other people, and our work could not be done without the provision of data, samples, ship time, and many other cooperative activities with agencies and organizations in the USA, Canada, Japan, Korea, and Russia. The High Seas Salmon Research Program is funded entirely by external grants and contracts, and we gratefully acknowledge this support.

In 2004 the grant and contract work of the High Seas Salmon Research Program included five projects: (1) “North Pacific Anadromous Fish Commission (NPAFC) Research Coordination,” (2) “Migration Studies of Salmon in the Bering Sea,” (3) “Diet Overlap and Potential Feeding Competition Between Yukon River Chum Salmon and Hatchery Salmon in the Gulf of Alaska in Summer,” (4) “Estimates of the Bycatch of Yukon River Chinook Salmon in U.S. Groundfish Fisheries in the Eastern Bering Sea, 1997-1999,” and (5) “Global Ocean Ecosystems Dynamics (GLOBEC) 2000: Feeding, Growth, Condition, and Energetics of Juvenile Pink Salmon in the Northern Gulf of Alaska.” This final report for 2004 includes reports on specific tasks as described in the Statement of Work for “NPAFC Research Coordination” (National Oceanic and Atmospheric Administration (NOAA) Contract No. 50ABNF-1-0002), as well as related tasks funded by the other grants and contracts.

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Introduction

In 2004 the grant and contract work of the High Seas Salmon Research Program, Fisheries Research Institute (FRI), School of Aquatic and Fishery Sciences (SAFS), University of Washington, included five projects: (1) “North Pacific Anadromous Fish Commission (NPAFC) Research Coordination,” (2) “Migration Studies of Salmon in the Bering Sea,” (3) “Diet Overlap and Potential Feeding Competition Between Yukon River Chum Salmon and Hatchery Salmon in the Gulf of Alaska in Summer,” (4) “Estimates of the Bycatch of Yukon River Chinook Salmon in U.S. Groundfish Fisheries in the Eastern Bering Sea, 1997-1999,” and (5) “Global Ocean Ecosystems Dynamics (GLOBEC) 2000: Feeding, Growth, Condition, and Energetics of Juvenile Pink Salmon in the Northern Gulf of Alaska.” This final report for 2004 includes reports on specific tasks as described in the Statement of Work for “NPAFC Research Coordination” (National Oceanic and Atmospheric Administration (NOAA) Contract No. 50ABNF-1-0002), as well as related tasks funded by the other grants and contracts.

1. NPAFC Research Coordination

Since 1955, the U.S. Government has contracted the FRI/SAFS to conduct research on issues related to Pacific salmon and steelhead trout in the North Pacific Ocean. This work has included participation of SAFS scientists in the deliberations of the International North Pacific Fisheries Commission (INPFC, 1955-1992) and the North Pacific Anadromous Fish Commission (NPAFC, 1993-present). The results of our research have been used by the U.S. Government to establish a strong scientific basis for conservation and management of U.S. salmon stocks in international waters. This project is a continuation of research coordination efforts and international cooperative high seas salmon research in support of U.S. commitments to the NPAFC. The “NPAFC Research Coordination” project operates under the National Oceanic and Atmospheric Administration (NOAA) Authorization Act of 1992 (PL 102-567, Title VIII: North Pacific Anadromous Stocks Convention). Our funding agency, the Auke Bay Laboratory (ABL), Alaska Fisheries Science Center (AFSC), National Marine Fisheries Service (NMFS), NOAA, Juneau, Alaska, is charged with the mission of stewardship for this program. Our work is closely coordinated with our colleagues at ABL’s Ocean Carrying Capacity (OCC) Research Program (<http://www.afsc.noaa.gov/abl/occ/research1.htm>).

In 1993 the Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean established the NPAFC. The Convention prohibits salmon fishing in international waters of the North Pacific Ocean and Bering Sea, and emphasizes the importance of scientific research for the conservation of anadromous salmon stocks. The development of the NPAFC science plan was coordinated with the North Pacific Marine Sciences Organization (PICES). The overarching goal of this plan is to investigate the effects of change in the productivity of the North Pacific Ocean on Pacific salmon, including: (1) current trends in ocean productivity and effects on carrying capacity, and (2) changes in biological characteristics of salmon (growth, size and age at maturity, oceanic distribution, survival, and abundance).

In 2000 the NPAFC adopted a new five-year science plan (2001-2005) that emphasizes cooperative science activities in three areas: (1) Bering Sea salmon research, (2) juvenile salmon research in eastern and western North Pacific waters, and (3) winter salmon research. An important aspect of research in all three areas is to investigate the stock-specific abundance, distribution, growth, and other biological characteristics of Asian and North American salmon with respect to ocean productivity and salmon carrying capacity in the North Pacific Ocean and Bering Sea. At the 2001 annual meeting of NPAFC, Canada, Japan, Russia, and the United States agreed to plan and coordinate a new international program called BASIS (Bering-Aleutian Salmon International Survey). The results of the 5-year (2002-2006) research program that was developed by NPAFC will form the baseline for long-term, large-scale ecosystem and climate change research on salmon in the Bering Sea. The SAFS/UW is a collaborator in the BASIS research program (<http://www.npafc.org/BASIS/>), and our work is closely coordinated with colleagues at ABL/OCC (<http://www.afsc.noaa.gov/abl/occ/basis.htm>), Alaska Department of Fish and Game, Hokkaido National Fisheries Research Institute (Kushiro, Japan), National Salmon Resources Center (Sapporo, Japan), Pacific Scientific Fisheries Research Center (TINRO-centre, Vladivostok, Russia), Kamchatka Fisheries and Oceanography Research Institute (KamchatNIRO, Petropavlovsk-Kamchatskii, Russia), Pacific Biological Station (Nanaimo, B.C., Canada), and the National Fisheries Research and Development Institute (Busan, Korea).

Our NPAFC Research Coordination contract in 2004 included work in two major areas: (1) international cooperative high seas salmon research and (2) participation in NPAFC workshops, symposia, and meetings.

1.1 International Cooperative High Seas Salmon Research

Participation in cooperative cruises on foreign salmon research vessels has proven to be a cost-efficient and effective method for U.S. scientists to obtain up-to-date samples and data on the distribution, abundance, growth, and stock origins of salmon in offshore waters. Our international cooperative salmon research began in 1983 with participation of FRI scientists in high seas salmon tagging cruises aboard U.S.S.R. research vessels in the North Pacific Ocean and Bering Sea. In 2004 our contract work included cooperative NPAFC high seas salmon tagging research, high seas salmon research vessel cruises, and salmon scale sample and data exchanges.

1.1.1 Cooperative NPAFC high seas salmon tagging

1.1.1.1 High seas disk and data storage tags

For most natural populations of Pacific Rim salmon and steelhead, the historical high seas tagging database (1954-present) is the only direct information available on ocean ranges, seasonal migration patterns, overlaps in distribution, and individual migration and growth rates. Information from high seas tagging is often used to validate the results of other high seas salmon stock identification methods. Since the beginning of the high seas tagging program in 1954, the U.S. government has contracted FRI/SAFS to do this work.

In recent years, the high seas tag database has continued to provide direct, stock-specific information on offshore distribution and migration patterns. R. Walker serves as the U.S. representative/co-operator with the NPAFC high seas salmon tagging program.

Since 1956, SAFS has served as the North American processing center for recovery of high seas salmonid tags. This activity requires advertising for tag returns, returning tags and recovery information to appropriate agencies, returning information on tag recoveries and a reward to fishermen and processors who return high seas tags, and reporting new tag recoveries in documents for NPAFC (Walker et al. 2003, 2004a).

Each year in the spring, we advertise for return of high seas salmon tags by mailing approximately 1,400 informational packets to addresses in Alaska, British Columbia, Washington, Oregon and California. These packets are sent to federal, state, and tribal fisheries research and management agencies, fishermen's organizations, salmon buyers and processors, and post offices. The informational packet includes a letter explaining the tagging program and the importance of returning tags, a poster advertising for tag returns (Fig. 1), and a business-reply envelope that includes a form for recording recovery information (tag number, date, location, fishing gear) and salmon biological data (species, sex, body weight, and how to collect scales).

Since 1991, we have offered a custom-embroidered cap as a reward for people who return high seas tags. The reward caps are embroidered with colorful, stylized salmon and lettering emphasizing the cooperative aspects of the high seas tagging program. As added incentive for return of high seas tags, the NPAFC conducted a drawing at their annual meeting in Sapporo, October, 2004, and winners from among those who returned high-seas tags over the last several years were selected to receive rewards of \$5000 (first prize), \$3000 (second prize), \$1500 (third prize) and \$500 (fourth prize).

The behavior and habitat of salmon on the high seas are poorly known. The ocean temperatures and depths where salmon swim and the routes of their migrations can only be inferred from fishing, oceanographic sampling, tagging studies, and stock identification. Since 1998 NMFS and SAFS scientists have collaborated in the deployment of data storage tags (DSTs) that measure water temperature or water temperature and depth for international cooperative high seas programs. These new tagging technologies have enabled us to get precise detailed data from individual fish as they migrate, and data from a few recoveries have already yielded a wealth of information.

U.S. high-seas tags are 20 mm diameter plastic red-and-white Petersen disk tags. Three types of DSTs were used in 2004. One type (LTD) is a small circuit board potted in a clear urethane, manufactured by Lotek Marine Technologies. Model LTD_1100-500 is 27 x 16 x 8 mm and weighs 5 g. These tags record temperature and depth data. iButton-type tags are Thermonchron iButton data storage devices (DS-1921H-F5 and DS-1921Z-F5) manufactured by Dallas Semiconductor, Inc., and repackaged in urethane for fish tagging by AlphaMach, Inc.; they record temperature data only. Model iBKrill tags are hexagonal, 25 x 13 x 8 mm and weigh 3.2 g. Model DST CTD tags are housed in a 27 x 16 x 8 mm ceramic shell and weigh 8 g. These tags, manufactured by Star-Oddi, record salinity, temperature, and depth data. LTD and iButton tags were attached to fish just anterior to the dorsal fin using two 76 or 64 mm nickel pins, with labeled U.S. and Japanese disk tags placed on the pins on the other side of the fish. DST CTD tags were

attached in the same location, but were affixed with stainless steel wire, with a small oval plastic plate on the opposite side of the fish. U.S. and Japanese disk tags were placed on the wires either under the tag or over the plate.

In addition to the tags used in 2004, there were recoveries of three models of tags used in previous years, tags which are similar in size and data type to those used in 2004. Lotek LTD_1100-300 is the same size and shape as LTD_1100-500. AlphaMach iB4 tags are oval, 24 x 16 x 8 mm and weigh 3.8 g in air. Model iBLite tags are hexagonal, 26 x 17 x 7 mm and weigh 3 g.

In 2004, 307 DSTs were placed on 306 salmon (one salmon was double-tagged) in the central North Pacific Ocean and Bering Sea during research cruises aboard two Japanese vessels in June and July (Walker et al. 2004a; a pdf file of this report is available online at: <http://www.fish.washington.edu/research/publications/pdfs/0406.pdf>). Scientists aboard the *Wakatake maru* tagged viable salmon caught by longline in the central North Pacific and central Bering Sea (Fig. 2; Morita et al. 2004, Nagasawa et al. 2004, Walker et al. 2004a). In the central North Pacific Ocean, 103 salmon were disk tagged and released, including 3 sockeye, 43 chum, 8 pink, 47 coho, and 2 chinook salmon. Four of the disk-tagged salmon were also tagged with DSTs, including 2 sockeye salmon (1 iButton, 2 CTD) and 2 chinook salmon (1 iButton, 1 LTD). In the central Bering Sea, 614 disk-tagged salmon were released, including 27 sockeye, 530 chum, 23 pink, 3 coho, and 31 chinook salmon. Among disk-tag releases in the central Bering Sea, 153 salmon were also tagged with DSTs. These releases included 19 sockeye (11 iButton, 8 LTD), 85 chum (33 iButton, 40 LTD, 12 CTD), 19 pink (19 iButton), and 30 chinook salmon (10 iButton, 19 LTD, 1 CTD).

Scientists aboard the *Kaiyo maru* in the central North Pacific and central Bering Sea tagged a total of 341 salmon (Fig. 2; Nagasawa et al. 2004, Walker et al. 2004a). Approximately one-third of the fish tagged were caught by hook and line (n=120; 35%) and two-thirds by trawl net (n=221; 65%). Of the tagged salmon, 148 were tagged with archival tags (21 sockeye, 95 chum, 17 pink, 11 coho, 4 chinook; one chinook salmon carried two tags), and the remainder were tagged with disk tags only. Five CTD, 47 LTD, and 97 iButton tags were used. Approximately 54% (81 of 149) of the tags were placed on fish likely to be immature (sockeye, chum, and chinook salmon less than 500 mm). These fish will return in 2005 or following years. The remaining tags were placed on salmon likely to be maturing in 2004.

From 1 October 2003 through 30 September 2004, seven high-seas salmon tags from recoveries in North America have been reported. All were from chinook (2) and sockeye (5) salmon and all carried DSTs. Three were from fish tagged in previous years as immature fish (2 chinook and 1 sockeye salmon). One chinook salmon, tagged with a temperature-depth tag in the Bering Sea in 2002, was recovered almost two years later in the Yukon River. The remarkable data on this tag show a complete record of the temperatures and depths experienced by the fish over two years (Fig. 3). The behavior of the fish differed markedly between the two winters. During the first winter, as an immature fish, the chinook salmon remained below 100 m at temperatures of about 4°C. During the second winter before returning to spawn, the fish was at depths above 50 m at temperatures of 1° to 5°C. The maximum depth this tag model could record was 350 m, which the fish often exceeded. This recovery is also notable as a rare recovery of a

Yukon River chinook salmon (9 previous recoveries of high seas tagged fish; 17 coded-wire tag recoveries; Myers et al. 2004a), and the data may provide insight on the wintering areas of different maturity stages of this stock. Two temperature-only (iB4) data tags on the other two immature fish (1 sockeye, 1 chinook) unfortunately failed. However, the other chinook salmon recovery (a fish tagged at 50°58'N, 160°01'W) provides useful information on the offshore distribution of immature Columbia River chinook salmon. A coded-wire tagged Columbia River chinook was also caught near this location in 2003 (52°51'N, 160°10'W; Myers et al. 2004a).

Two sockeye salmon tagged with CTD tags were caught in south central Alaska (Figs. 4 and 5). One fish was tagged in the Bering Sea west of the Pribilof Islands and caught on the south side of the Alaska Peninsula. This was the first recovery of a maturing sockeye from south central Alaska which had been tagged in the Bering Sea. An immature fish tagged just north of False Pass is the only other Bering Sea location for these stocks. All other recoveries of central Alaska sockeye have come primarily from fish tagged in the Gulf of Alaska, with a few fish tagged south of the eastern and central Aleutian Islands. The other sockeye recovery was on Kodiak Island in a stream draining to Olga Bay. This fish was tagged south of the central Aleutians. Both tags showed travel at depths generally less than 30 m. Due to a manufacturing defect, the salinity sensors on both tags gave values which were unrealistically high for this area. A third sockeye tagged with a temperature-depth tag in the central Bering Sea was caught in the Kanektok River, draining to Kuskokwim Bay. The data on this tag also indicate travel at less than 30 m (Fig. 6). A fourth sockeye, carrying a temperature-depth tag, was caught on the south side of the Alaska Peninsula, but the LTD tag on this fish failed.

Eight salmon carrying DSTs were recovered in waters of Japan (2 chum) and Russia (1 sockeye, 2 chum, and 3 pink) from tagging operations in 2003 and 2004 in the Bering Sea. Notable data tag recoveries from Asia include the first recovery for a Russian chum and hatchery fish, the first recoveries for Russian pink salmon, and the second recovery for Russian sockeye. The Sakhalin hatchery chum (LTD 1396) and Hokkaido chum salmon tagged at approximately the same time and location (LTDs 1603 and 1709) experienced similar temperature and depth patterns, but the Russian fish returned much more quickly (Figs. 7 and 8). The tag from another chum salmon, caught off the eastern coast of Kamchatka, provides temperature data for the short duration the fish was at large after tagging in the Bering Sea (Fig. 9). Temperature data tags from two pink salmon caught in eastern Kamchatka are the first DSTs from Asian pink salmon (Fig. 10). A DST on a third pink salmon failed. A Russian sockeye salmon carrying a DST was likely returning to the western coast of Kamchatka when it was caught at the southern tip of the Kamchatka Peninsula. The data indicate that this sockeye salmon also traveled at depths less than 30 m (Fig. 11). Three chum salmon carrying only disk tags were also recovered in Japan in 2003.

One pink salmon carrying a temperature tag was recovered by the vessel that tagged it seven hours after it was released in the Bering Sea.

1.1.1.2 High seas coded-wire tags

In 1980 a U.S. scientist aboard a Japanese research vessel noted several steelhead with missing adipose fins (ad-clipped) in the catch. Coded-wire tags (CWTs) were recovered from the snouts of these fish, and NMFS/ABL became responsible for analyzing snout samples from ad-clipped salmon and steelhead recovered during high seas research and commercial fishing operations. Information on high seas recoveries of CWT salmonids has been reported annually to the INPFC (1981-1992) and to the NPAFC (1993-present). The Regional Mark Processing Center, Pacific States Marine Fisheries Commission, incorporates the high seas CWT recovery data into their coastwide, on-line CWT recovery data set (Regional Mark Information System (RMIS), <http://www.rmis.org/>). We collaborate with NMFS scientists in this program by assisting in the recovery of CWT salmon and steelhead during NPAFC cooperative high seas salmon research vessel cruises, maintaining, updating, and correcting the historical high seas CWT database, reporting recoveries to NPAFC, and fulfilling requests from other agencies for high seas salmonid CWT data.

During Japanese high seas salmon research vessel operations in 2004, snouts were collected from 2 chinook salmon, 1 pink salmon, and 16 steelhead trout with missing adipose fins (Table 1). Snouts were packed with salt, and sent to the NMFS/ABL for potential recovery of coded-wire tags. In addition, at the NPAFC meetings we coordinated an exchange of snout samples and associated data from 90 ad-clipped steelhead caught in summer 2003-2004 research cruises in the far western Pacific Ocean near the Kurile Islands. The results from examination of these samples for CWTs will be reported at the 2005 annual meeting of NPAFC.

In 2004 data for 29 new recoveries of CWT salmonids were reported to the NPAFC (Myers et al. 2004a; a pdf file of this report is available online at <http://www.fish.washington.edu/research/publications/pdfs/0404.pdf>). Reported recoveries are from U.S. groundfish (trawl) fisheries in the eastern Bering Sea and Gulf of Alaska portions of the U.S. Exclusive Economic Zone (26 recoveries) and from U.S. and Japanese salmon research vessel operations in the Bering Sea, Gulf of Alaska, and central North Pacific Ocean (3 recoveries). Starting in 2003, recoveries of CWT salmon caught by the Pacific hake (*Merluccius productus*) fishery along the U.S. West Coast were no longer processed by ABL or reported to NPAFC.

Twenty-four CWT chinook salmon (*O. tshawytscha*) were recovered in the salmon bycatch of the U.S. groundfish (trawl) fisheries in the Bering Sea and Gulf of Alaska (Table 2), and two CWT chinook salmon were recovered during salmon research vessel operations (Table 3). The locations of new recoveries of CWT chinook salmon are shown by province, state, or geographic region in Figs. 12-19. One groundfish trawl recovery was a slight westward extension of the known ocean range of Southeast Alaska chinook salmon in the Bering Sea (from 166°25'W to 167°55'W; Fig. 14). One research vessel recovery was a slight westward extension of the known ocean range of Cook Inlet chinook salmon (from 178°14'W to 179°00'W; Fig. 13). Two CWT British Columbia chum salmon (*O. keta*) were recovered in the Bering Sea trawl fishery (Table 4; Fig. 19). One Oregon steelhead trout (*O. mykiss*) was recovered in the central North Pacific Ocean (Table 3, Fig. 20).

1.1.2 Participation in NPAFC salmon research vessel cruises

In 2004 two SAFS scientists participated in cooperative salmon research vessel cruises aboard Japanese vessels in the North Pacific Ocean and Bering Sea beyond the 200-mile limit, as part of the NPAFC program of cooperative international salmon research. This work included the collection of biological samples and data pertinent to the continuation of existing long-term time series of high seas salmonid diet and growth characteristics, as well as sample processing, updating data series, and preparation of NPAFC documents reporting on updated time-series data.

1.1.2.1 Wakatake maru cruise

One SAFS scientist (N. Davis) participated in the *Wakatake maru* research cruise, which surveyed the central North Pacific and Bering Sea from June 9 to July 21, 2004 (Fig. 2; Morita et al. 2004). The *Wakatake maru* conducted a gillnet and longline survey at 180° in the central North Pacific in June and in the Bering Sea in July (Morita et al. 2004; Fig. 2). Research activities included the collection of data on oceanography, primary production, zooplankton, salmonid fishes, and other organisms. A total of 6,510 salmonids was caught by longline and gillnet: 685 fishes in the central North Pacific Ocean and 5,825 fishes in the central Bering Sea. In the North Pacific coho and chum salmon were the most abundant species (40.4% and 39.6%, respectively), followed by pink salmon (9.6%), sockeye salmon (4.2%), steelhead trout (3.9%), and chinook salmon (2.2%). In the Bering Sea, chum salmon was the most abundant species (76.4%), followed by pink (9.9%), sockeye (9.7%), chinook (3.7%), and coho salmon (0.3%).

Abundance of sockeye salmon in the central North Pacific in 2004 was lower than in 2003, and the catch per unit of effort (CPUE; number of fish caught per 1500 m of research-mesh gillnet) was less than the 14-year mean (2004: 1.3, 14-year mean: 1.8; Fig. 21; Table 5). Abundance of sockeye salmon in the central North Pacific was higher in 1998–2004 than in the earlier period (1991–1997). Sockeye salmon fork length at age was slightly larger in 2004 than in 2003 (Table 6) and most of the sockeye salmon caught in this area were immature age-1.2 (34%) and age-2.2 (33%; Fig. 22; Table 7). In the Bering Sea the highest abundance of sockeye was observed in 2001, however, sockeye salmon abundance has declined since, and in 2004 remained at the same level as 2003 (2004: 22.4, Fig. 23; Table 5). Mean body size of ocean age-1 and -3 sockeye salmon was smaller in 2004 than in 2003, while the size of ocean age-2 fish was approximately the same in both years (Table 6). Immature age-1.1 (20%) and -1.2 (29%) and immature and maturing age-2.2 (23%) were the most common age groups of sockeye salmon caught in the Bering Sea in 2004 (Fig. 24; Table 8).

The relative abundance of chum salmon in the central North Pacific has been above the 14-year average since 2001 (2004: 21.9; 14-year average 17.7; Fig. 21; Table 5). In 2004 the size of ocean age-1 chum salmon remained approximately the same, and body weight of ocean age .2 and -3 decreased when compared with 2003 (Table 9). Immature ocean age-1 (52%) and -2 (36%) were the common ages of chum salmon caught in the central North Pacific Ocean (Fig. 22; Table 10). Chum salmon were less abundant in the Bering Sea in odd-numbered years when pink salmon abundance was high (Fig. 23; Table 5), and chum salmon abundance was at a minimum level every four years (1991,

1995, 1999 and 2003; Fig. 23). In 2004, ocean age-.1, -.2, -.3, and .4 chum salmon were smaller than fish caught in 2003 (Table 9). Most chum salmon caught in the Bering Sea in 2004 were immature ocean age-.1 (19%),-.2 (45%), and -.3 (16%) fish (Fig. 24; Table 10).

Relative abundance of pink salmon caught in 2004 in the central North Pacific was higher than the even-numbered year average (Fig. 21; Table 5). All pink salmon in the catches were maturing ocean age .1 (Table 11). Pink salmon fork length increased and body weight decreased, thereby reducing the condition factor of pink salmon in 2004 as compared to 2003. In the Bering Sea, pink salmon were substantially more abundant than had been observed during previous even-numbered years since 1992 (Fig. 23, Table 5). The size of pink salmon was less in 2004 than the previous year (Table 11).

In 2004, abundance of coho salmon in the central North Pacific was approximately equal to the 14-year average (2004: 10.1; 14-year average 10.9; Fig. 21, Table 5). All coho salmon caught by the *Wakatake maru* are maturing ocean age-.1 fish (Table 12). Mean fork length and body weight of coho caught in the central North Pacific was less than fish caught in this area in 2003.

Chinook salmon were more abundant in the central North Pacific Ocean in 2004 than years since 1991 (Fig. 21; Table 5). Most (75%) chinook salmon caught in this area were immature ocean age-.2 (61%) and were somewhat smaller in size than chinook of the same age caught in 2003 (Tables 13 and 14). In the Bering Sea, chinook salmon abundance was approximately equal to the 14-year mean (2004: 6.8; 14-year mean: 6.9, Fig. 23, Table 5). Chinook salmon were mostly immature age-1.2 (39%) fish, and the size at age of ocean age -.2 and -.3 fish increased in 2004 over the previous year (Tables 13 and 15).

In 2004, the relative abundance of steelhead trout in the central North Pacific remained at the same level it was in 2003 (2004: 1.0), which was the fifth consecutive year that steelhead abundance has been below the long-term average (14-year average: 1.65, Fig. 21, Table 5). Mean fork length and body weight of ocean age-.1 and -.2 steelhead were smaller in 2004 than 2003, and most of the fish were maturing ocean age -.2 fish (74%; Tables 16 and 17).

During the 2004 cruise of the *Wakatake maru*, 868 salmonid stomach contents were examined. The total included 272 samples collected from the central North Pacific (41°-50°N; Table 18), 3 samples collected in the vicinity of the Aleutian Islands (51°30'N; Table 19) and 593 samples collected in the Bering Sea (52°-58°N; Table 20).

Chum salmon stomach contents samples collected in the central North Pacific had the lowest frequency of empty stomachs (5%) as compared with other salmon species collected from the same location (14%-38%; Table 18). Predominately zooplanktonivorous salmon, such as sockeye, chum, and pink salmon, had a lower (<1.0) index of stomach content weight (SCI= prey weight/body weight X 100) than predominately micro-nektonic feeders, such as coho and chinook salmon, and steelhead (Table 18), and may indicate a relatively low abundance of zooplanktonic prey for salmon in this area of the central North Pacific.

Relatively few stomach samples are collected from the Aleutian Islands area because only one station in the *Wakatake maru* survey is located there (Amchitka Pass, Fig. 2;

Table 19). In 2004 three samples were collected from this area, including one chum salmon, feeding primarily on gelatinous zooplankton, and two pink salmon consuming a high proportion of crab zoea.

In the central Bering Sea, small-sized prey, such as post-larval fish and euphausiids may be more abundant than in the central North Pacific because of the higher index of stomach fullness and proportion of these items observed in sockeye, chum, and pink salmon stomach contents in this area (Table 20). Examination of sockeye, chum, pink, coho, and chinook salmon stomach contents indicated that all these species had SCI values > 1.0 and SCI values had increased substantially (1.5 to 2 times) over values observed in central North Pacific samples. In the Bering Sea euphausiids are an important prey of predominantly zooplanktonivorous salmon species (sockeye, chum, pink salmon), as well as predominantly micro-nektonivorous salmon species, e.g., chinook and coho salmon.

1.1.2.2 Kaiyo maru cruise

From 1993 to 2002 SAFS scientists participated in cooperative Japan-U.S. salmon gillnet surveys conducted aboard the T/S *Oshoro maru* in the central North Pacific Ocean and Gulf of Alaska (GOA), primarily along a 145°W-longitude transect in the central GOA in early July. In 2003, the R/V *Kaiyo maru* instead of the T/S *Oshoro maru* sampled on the 145°W-longitude transect and elsewhere in the GOA. Two SAFS scientists (K. Myers and R. Walker) participated in the *Kaiyo maru* cruise in the GOA in 2003, but that survey was conducted later in the year (August) and using a different gear (trawl) than the *Oshoro* surveys (Myers et al. 2004b).

In 2004 one SAFS scientist (R. Walker) participated in the cooperative Japan-U.S. BASIS salmon research cruise of the *Kaiyo maru* from 17 June to 16 July 2004 (funded in part by the NPAFC Special Fund for Scientific Research). The 2004 *Kaiyo maru* cruise was conducted primarily in the Bering Sea, with a few research stations in the North Pacific Ocean, and was similar to surveys carried out by this vessel in 2002 and 2003 (Fig. 2). The primary objective of the 2004 *Kaiyo maru* survey was to collect oceanographic and biological data in the Bering Sea and central North Pacific Ocean, particularly to study distribution of immature and maturing (Japanese) chum salmon. Four north-south transects were fished (170°W, 175°W, 180°, and 175°E). These transects cut across the Aleutian Islands, and five stations at the southern ends of three transects were in the North Pacific Ocean in the Alaska Current. Sea surface temperatures (SSTs) were cool in both the Bering Sea (6.5°-9.1°C; average 8.0°C; Table 21) and North Pacific (5.6°-8.8°C; average 7.7°C; Table 21). Surface temperatures in the Bering Sea were generally higher at northern stations.

The total trawl catch at 25 stations was 3,731 salmon, mostly chum salmon (n=3,048; Table 21). An additional 120 salmon were caught on hook and line for tagging. Highest catches were at central stations in the Bering Sea, between 53°N and 56°N, and 175°W and 180°. Relatively few salmon were caught at four of the five North Pacific stations. Sockeye salmon (n=365), primarily immatures, and maturing pink salmon (n=123) were caught mainly at eastern stations. Chinook salmon (n=188) were caught primarily at northeastern stations, near or west of the shelf break. Chum salmon, mostly immatures,

were caught throughout the survey area. Very few coho salmon (n=7, nearly all in the North Pacific) and no steelhead trout were caught. Pink and coho salmon were maturing, but chum, sockeye, and chinook salmon were mostly immature, reflecting that many maturing fish had already moved to inshore waters by July. A total of 341 salmon were tagged, 221 from trawl catches and 120 from hook and line catches (Table 22). For further details on tagging, see section 1.1.1.1. No opportunity was available to U.S. scientists for shipboard collection and processing salmon diet samples during the 2004 *Kaiyo maru* cruise.

1.1.3 Historical scale collections

As part of our NOAA contract work we also update and maintain a historical collection of salmon scales and associated biological data, and coordinate fulfilling requests to the U.S. government for NPAFC-related salmon scale sample and data exchanges. The collection includes salmon scales, acetate impression of scales, associated biological data, and scale measurement data (1956 through present), including samples from U.S., Canadian, and Japanese INPFC-related high seas research cruises and observer programs (1955-1992), cooperative U.S.-U.S.S.R. high seas salmon research (1983-1991, cooperative NPAFC-related research (1992-present), and various NMFS high seas observer programs (1976-present). Our high seas scale collections from historical FRI/SAFS tagging studies comprise over 240,000 scales from 1956-1991. We are also the repository of scales collected during high seas salmon research by the former Bureau of Commercial Fisheries (BCF, now NMFS) from 1955-1973, and from various NMFS observer programs (Japanese mothership and squid driftnet fisheries, and some salmon bycatch samples from Bering Sea and Gulf of Alaska groundfish fisheries). We also have an extensive collection of acetate impressions of scales and biological data from Canadian high seas salmon research in the Gulf of Alaska (1962-1969), and from *Oshoro maru* (1980-2002) and *Wakatake maru* (1991-2002) cruises in the central North Pacific, Bering Sea, and Gulf of Alaska, as well as a unique historical collection of acetate impressions and scales from major stocks of Russian salmon. There is also an electronic archive of scale measurement data from over 100,000 fish from six salmonid species. These historical scale collections and electronic data bases are useful for retrospective analyses of age, growth, and stock composition of salmon in the North Pacific Ocean and Bering Sea. In 2004, these collections and databases were updated with new acquisitions from NPAFC cooperative research cruises, as well other related projects.

1.1.4 Otolith Mark Recoveries

During the *Oshoro maru* research cruise in the Gulf of Alaska in July 2002, otoliths were collected from 446 chum salmon and 63 pink salmon at seven gillnet stations along the 145°W transect (51°-56°N; Myers et al. 2004c; a pdf file of this report is available online at: <http://www.fish.washington.edu/research/publications/pdfs/0405.pdf>). The otoliths were examined for thermal marks at the Alaska Department of Fish and Game, Division of Commercial Fisheries, Mark, Tag, and Age Laboratory (<http://tagotoweb.adfg.state.ak.us/>). Thermal marks were found on the otoliths of 35 chum salmon (8% of total, n=446 fish). None of the pink salmon otoliths were thermally-marked. Because of the release of duplicate marks only nine of the marked

chum salmon (26% of total, n=35 fish) could be identified to both brood year (1999 or 2000) and hatchery of origin. An additional seven fish could be identified to hatchery of origin, and were either brood year 1999 or 2000 fish. In these cases, age determinations or body size data or both could be used to determine the brood year of four fish. Similar to the results of a previous study, thermally-marked Alaska hatchery chum salmon (Prince William Sound, n=2 fish; Southeast Alaska, n=12 fish) were distributed along the entire 145°W transect in July. Samples that could be identified to country or hatchery of origin included the first two reported recoveries of otolith-marked Asian (1 Japan, 1 Russia) hatchery chum salmon from the central Gulf of Alaska (Fig. 25). These recoveries corroborate published estimates from genetic stock identification research, indicating that Asian and North American chum salmon intermingle in the central Gulf of Alaska (49-56°N, 145°W) in July. The continent of origin of 18 thermally-marked chum salmon (51% of total, n=35 fish) could not be identified because of duplicate marks released by hatcheries in Russia, Alaska, British Columbia, and Washington. In our document reporting these results to NPAFC (Myers et al. 2004c), we encouraged the NPAFC's Ad Hoc Working Group on Salmon Marking to develop a complete repository of digital images or photographs with measurements or voucher specimens of otolith marks. This would increase the accuracy of identification of thermally marked salmon caught in Convention waters where Asian and North American salmon intermingle. We also encouraged the reporting to NPAFC of all thermally-marked salmon recovered from research vessel catches in the Convention area.

1.2 Participation in NPAFC Workshops, Symposia, and Meetings

Part of our "NPAFC Research Coordination" contract work involves preparation of necessary documents, reports, and publications for NPAFC meetings and participation in these meetings. The 2004 NPAFC Research Planning and Coordinating Meeting (RPCM) was held on May 12-13 at the Petropavlovsk Public Library, Petropavlovsk-Kamchatsky, Russia. SAFS scientists (K. Myers and R. Walker) participated in the meeting. K. Myers was appointed as Rapporteur for the meeting, and R. Walker was appointed to the Editorial Group. The Rapporteur and the Secretariat in cooperation with the Editorial Group prepared a summary report of the meeting (NPAFC 2004a). K. Myers was appointed Rapporteur for preparation of a summary report of all research by NPAFC member nations for both the 11th and 12th Annual Meetings of the Committee on Scientific Research and Statistics (CSRS). K. Myers and R. Walker participated in the deliberations of the Committee on Scientific Research and Statistics (CSRS) at both meetings. The CSRS annual reports were prepared with the help of K. Myers and the editorial committee, which included R. Walker (NPAFC 2003b, 2004b). R. Walker also assisted with the compilation of catch and hatchery release statistics for US Pacific Northwest salmon for the 12th Annual Meeting of the CSRS (Colpo and Walker 2004). SAFS scientists provided summaries of international salmon research activities for the NPAFC newsletter (Myers 2004, Walker 2004a). K. Myers has served since 1998 as the U.S. member of the Science Sub-Committee of CSRS, and is a U.S./CSRS Point of Contact for the NPAFC Secretariat. The NPAFC International Workshop, "BASIS-2004: Salmon and Marine Ecosystems in the Bering Sea and Adjacent Waters," October 30-31, 2004 in Sapporo, Japan was attended by SAFS scientists (K. Myers and R. Walker). K. Myers was on the organizing committee and chaired Session 5: Distribution and

Migration of Salmon. R. Walker made an oral presentation “New Information from Archival Tags from Bering Sea Tagging, 1998-2003” (Walker et al. 2004b). Additional participation by SAFS scientists in this workshop is described in section 2.5.

K. Myers serves as a U.S. member of NPAFC’s Bering Aleutian Salmon International Survey (BASIS) working group. She is also a U.S. contact for the Annual BASIS Report and Implementation Plan Drafting Committee and the Proposal Drafting Committee for the BASIS Working Group, and prepared the annual reports of the results of BASIS research in 2002 and 2003 (NPAFC 2003d, 2004c), and coordinated a revision of the 2002-2006 BASIS research plan that was requested by Russia (NPAFC 2004d). K. Myers and R. Walker participated in a 1-day meeting of the BASIS Working Group held in Petrovavlovsk-Kamchatsky, Russia on May 14, 2004. K. Myers served as the U.S. member of the editorial group, which prepared a report of the meeting (NPAFC 2004e).

2. Migration Studies of Salmon in the Bering Sea

This collaborative project with scientists at the Alaska Fisheries Science Center, NMFS, is an extension of work in support of U.S. research commitments to the NPAFC, which operates under the NOAA Authorization Act of 1992 (PL 102-567, Title VIII: North Pacific Anadromous Stocks Convention). Declines in runs of several salmon species and changes in oceanographic conditions in the Bering Sea prompted NPAFC member nations to propose the Bering-Aleutian Salmon International Survey (BASIS), a cooperative international research program with a focus on the Bering Sea and salmon stocks which use the Bering Sea. The implementation of BASIS began in summer of 2002 with several cooperative cruises.

Work by SAFS scientists in 2004 included: (1) participation in BASIS and related cooperative salmon research cruises, (2) bioenergetic modeling of salmon the western Bering Sea, (3) coordination and implementation of NPAFC salmon tagging, partially funded by the North Pacific Research Board (NPRB), (4) preparation of a review of historical data on salmon distribution, migration, and interceptions in the Bering Sea, and (5) participation in NPAFC meetings.

2.1 Participation in BASIS high seas salmon research cruises

An SAFS scientist, R. Walker, participated in a Japan BASIS cruise in 2004 (funded in part by NOAA Contr. 50-ABNF-00002 and the NPAFC Special Fund for Scientific Research; see section 1.1.2.2). BASIS-related work during this cruise included (1) tagging of salmon, primarily with archival data storage tags (see section 2.3) (2) collection of tissue samples for analysis of infection of salmon with the marine parasite *Ichthyophonus*, and (3) collection of fin samples of sockeye and chinook salmon for genetic stock identification using DNA techniques.

Ichthyophonus hoferi is a protozoan parasite acquired in marine waters which causes high freshwater mortality in Yukon River chinook salmon and has recently been detected in Japanese chum salmon. Samples were taken to determine prevalence and level of infection by *Ichthyophonus* in salmon in marine waters and to investigate possible sources of infection. Tissue samples (heart, liver, and spleen) were collected from 921 salmon (229 sockeye, 494 chum, 109 pink, 5 coho, and 154 chinook) and 80 other fish (79 Atka mackerel *Pleurogrammus monopterygius* and 1 prowfish *Zaprora silenus*). Samples were returned to the University of Washington, where they are being

histologically analyzed for the presence of *Ichthyophonus* by scientists from SAFS and the Biological Resources Discipline of the U.S. Geological Survey.

Determination of stock distribution in the Bering Sea is an important component of BASIS. As part of a coordinated program by U.S., Japanese, and Russian scientists, fin clip samples were taken for DNA analysis. A total of 495 samples were collected from 308 sockeye salmon and 187 chinook salmon. Samples were returned to the Auke Bay Laboratory of the U.S. National Marine Fisheries Service and the Alaska Department of Fish and Game for analysis. Samples are being analyzed under a grant to NPAFC from NPRB.

2.2 Bioenergetic modeling and related studies of salmon in the Bering Sea

Changes in oceanographic conditions may adversely affect growth of salmon, leading to smaller sizes, lower survival rates, and reduced fecundity. N. Davis is coordinating our work on bioenergetic modeling and related studies of salmon in the western Bering Sea. An analysis of seasonal changes in total lipid content in the white muscle of immature chum salmon caught by the *Kaiyo maru* in the Bering Sea in 2002 showed that in summer lipid content is low and lipid content increases substantially in the fall (Nomura et al. 2004). Activities in 2003-2004 included acquisition and organization of diet, plankton, and oceanographic data for growth potential analyses from Japanese and Russian high seas BASIS cruises. We also assisted NMFS in the coordination of sample and data collection for growth, stock identification, and other BASIS-related analyses.

2.3 Coordination of NPAFC Salmon Tagging

The goal of “NPAFC Salmon Tagging” (NPRB, Project #: R0204, J. Helle, PI, <http://www.nprb.org/>) is to gain a better understanding of the distribution patterns, habitat utilization, and movements of Asian and North American salmon migrating in the Bering Sea and adjacent waters. The research is coordinated by the NPAFC/BASIS Working Group. R. Walker is the U.S. point of contact for NPAFC salmon tagging. The NPRB funding is used by NPAFC primarily to purchase tags that are deployed on salmon caught during BASIS research vessel cruises in the Bering Sea and adjacent waters. Several types of tags, ranging from simple numbered plastic discs to complex electronic tags that record sea temperature and depth have been deployed during BASIS research cruises. Oceanographic data from these tags can be used to infer migration routes of salmon and possible exposure to adverse ocean conditions (Walker 2003, 2004b).

In 2004 there were 25 reported recoveries in Asia and North America from salmon tagged and released with electronic data storage (DST) tags (Table 23; Walker 2004b). Seventeen salmon were recovered in Asia (16 Japan, 1 Russia), seven in North America (6 Alaska, 1 Washington), and one was recovered by the vessel that tagged it seven hours after it was released in the Bering Sea. Three tags were CTD tags (recording conductivity (salinity), temperature, and depth), eleven were TD tags (temperature and depth), and eleven were iButton tags (temperature only). These recoveries provide important new time-series data that show the temperature-depth habitats of maturing Russian, Japanese, and western Alaska salmon from release in common feeding grounds

in the central Bering Sea in July to recovery in coastal fisheries, natal streams, or hatcheries, including:

- the first recovery from an immature salmon and first recovery of a Yukon River chinook (extraordinary data include two winters at sea before fish returned) (Fig. 3),
- the first recovery of a maturing sockeye from south central Alaska which had been tagged in the Bering Sea (Fig. 4) and
- the first DST from a salmon from the north coast of the Sea of Okhotsk (Fig 26).

The large number of recoveries is due to the large number of tags deployed in 2004. The recovery rate for DSTs released in 2004 is 7.2%, despite the fact that a large proportion of the tags were placed on immature salmon in order to get valuable data on over-wintering behavior of fish.

Additional information on NPAFC Salmon Tagging and NPAFC's tag recovery and reward program can be found on the NPAFC web page (<http://www.npafc.org/>, see "Fish Tag Recovery Program").

2.4 Review of historical data on salmon distribution, migration, and interceptions in the Bering Sea

In 2003-2004, R. Walker and N. Davis compiled historical oceanographic information, catch statistics, tagging data, food habits, and stock identification studies for a comprehensive review of distribution, migration, and interceptions of salmon in the Bering Sea. This will include new maps of stock distribution using historical tagging data and mapping of salmon catches in the Bering Sea. The report will be completed in 2005.

2.5 Participation in NPAFC/BASIS meetings

R. Walker was appointed as a U.S. Point of Contact for salmon tagging for the BASIS Working Group, and summarized progress on "NPAFC Salmon Tagging" research at 2004 NPAFC meetings (NPAFC 2004 a,b,c,e; Walker 2004a,b). N. Davis was appointed as a U.S. Point of Contact for salmon food habits and bioenergetics modeling for the BASIS Working Group, and analyzed Bering Sea salmon diet overlap in fall and evaluated the potential for interactions among salmon (Davis et al. 2004a). On 30 October-1 November 2004, N. Davis made an oral presentation "Salmon Food Habits Studies in the Bering Sea, 1960 to Present" at the NPAFC International Workshop "BASIS-2004: Salmon and Marine Ecosystems in the Bering Sea and Adjacent Waters" in Sapporo, Japan (Davis et al. 2004b). An extended abstract of her presentation was submitted for inclusion in an upcoming NPAFC Technical Report.

3. Diet Overlap and Potential Feeding Competition Between Yukon River Chum Salmon and Hatchery Salmon in the Gulf of Alaska in Summer

With funding from the Yukon River Drainage Fisheries Association (YR DFA; contract no. 2004-001), we investigated diet overlap and potential feeding competition

between Yukon River chum salmon and hatchery chum, pink, and sockeye salmon in offshore waters (primarily, international waters beyond the U.S. 200-mile zone) of the Gulf of Alaska in summer (Myers et al. 2004d; a pdf file of this report is available online at: <http://www.fish.washington.edu/research/publications/pdfs/0407.pdf>). The specific objectives of this study were: (1) to estimate salmon diet overlap by species, body size group, and region, (2) to provide information on the times and areas where intermingling of hatchery salmon and Yukon River chum salmon in the Gulf of Alaska are likely to occur, and (3) to evaluate these results with respect to the potential effects of large-scale releases of hatchery salmon on the marine growth and survival of Yukon River chum salmon in the Gulf of Alaska.

We collected salmon stomach contents data aboard Japanese research vessels during NOAA-funded international cooperative high seas salmon research cruises in the Gulf of Alaska in summer 1993-2003. The pooled (summer 1993-2003) stomach contents data were stratified into six geographic regions, including two (North and South) latitudinal regions and three (West, Mid, East) longitudinal regions in the Gulf of Alaska. The boundary of the two latitudinal regions was defined by the position of the annual summer (July) sea surface temperature minimum, which is associated with two distinct summer feeding zones for salmon in our Gulf of Alaska study area. The three longitude regions (West, 157°-165°W; Mid, 149°W-156°W; and East, 139°W-148°W) included transect lines with the most similar oceanographic conditions.

We assumed that similarity in diets is likely to be highest among salmon of similar body sizes. The results of a previous study indicated that in the Gulf of Alaska, pink and sockeye salmon between the body weights of 600 and 1200g switch from feeding on zooplankton to squid. We stratified our stomach contents data into three body size groups (small= \leq 600 g, medium = 600-1200 g, and large = $>$ 1200 g) of chum, sockeye, and pink salmon in each of the six geographic regions.

Diet overlaps of the three species (chum, pink, and sockeye salmon) and body-size groups in the six regions of our Gulf of Alaska study area were estimated using a modified Schoener's index, called the Percent Similarity Index (PSI). For each species and body-size group, we also calculated an index of diet quality (Q) or the mean number of calories consumed per fish in each of the six regional strata.

The North Pacific Anadromous Fish Commission (NPAFC) high seas salmon tag recovery database (1956-2003), the high seas coded-wire tag recovery database (1980-2004), and the otolith mark recovery database (1997-2002) were used to plot maps of the ocean distribution of Yukon River chum salmon and salmon from geographic regions that produce the majority of hatchery chum (Japan, Prince William Sound, and Southeast Alaska), pink (Prince William Sound and Kodiak Island), and sockeye salmon (Cook Inlet and Prince William Sound) by month with respect to the Gulf of Alaska food habits study area. We also reviewed information from the literature on the genetic stock composition of immature and maturing chum salmon in the Gulf of Alaska. These data were used to infer spatial and temporal overlap in distribution and potential feeding competition between Yukon River chum salmon and hatchery chum, pink, and sockeye salmon in the Gulf of Alaska in summer.

Food habits data from 4,996 salmon stomachs collected in 1993-2003 were analyzed,

including 1,719 chum, 1,499 pink, and 1,778 sockeye salmon. The samples included a mixture of immature and maturing chum and sockeye salmon and maturing pink salmon. For all body weight groups of chum salmon the percentages of fish with empty stomachs, which may indicate poor feeding conditions, were highest in the eastern regions of our Gulf of Alaska study area. The quality of chum salmon diets was low compared to the diets of all size groups of pink salmon and large-size sockeye salmon in all geographical regions where the species co-occurred. The diets of medium- and small-size chum and sockeye salmon were often similar in quality, except in the eastern regions of the study area, where chum salmon had lower quality diets than sockeye salmon. Overlap in the diets of chum, pink, and sockeye salmon in the Gulf of Alaska varied by species, body size group, and geographic region.

The PSI values for pairwise comparisons between different size groups of chum salmon in regions north of the SST minimum were usually high, and tended to be higher in northern regions than in southern regions. In northern regions, the prey category with the highest PSI values for all size groups of chum salmon was usually pteropods, which are a low-calorie food. In the three southern regions, PSI values were highest for small- and medium-size chum salmon that fed on amphipods, which are also a relatively low-calorie food (although they have a higher caloric content than pteropods). The PSI values were moderate to low in the Southwest region, and were high in the Southeast region.

The PSI values for pairwise comparisons between different size groups of chum and pink salmon were usually low to moderate. The PSI values for pairwise comparisons between different size groups of chum and sockeye salmon were often higher in northern regions than in southern regions. Interspecific overlap in diets tended to be highest when all species were feeding on amphipods or pteropods or both.

Limited data from high seas tagging experiments indicate that immature Yukon River chum salmon are distributed in the Gulf of Alaska throughout the summer, although their distribution shifts to the north and west as the season progresses. Older age groups of immature Yukon River chum salmon tend to be distributed farther to the north and west than younger age groups. Maturing Yukon River chum salmon are distributed primarily in the northern regions of our study area. Maturing Yukon River chum migrate from the Gulf of Alaska to the Bering Sea in June and July. By July maturing Yukon River summer chum salmon have left the Gulf of Alaska, and maturing Yukon River fall chum salmon may occur only in the Northwest region of our study area.

High seas salmon tag, otolith-mark, and genetic data indicate that in our study area in summer overlaps in the distributions and diets of Yukon River chum salmon and Japanese hatchery chum salmon are most likely to occur in the West regions, and overlaps with Alaskan hatchery chum, pink, and sockeye salmon are most likely to occur in the Mid and East regions.

In our Gulf of Alaska study area in summer, the highest potential for feeding competition between maturing Yukon River chum salmon and hatchery chum salmon is probably in the Northwest region. Tag recovery data indicate that by late June and early July, many maturing Yukon River and Japanese hatchery chum salmon have already migrated to the Bering Sea. Previously published genetic stock composition estimates indicate that approximately 30% of maturing chum salmon in the western regions of our

study area in summer are Japanese hatchery fish, and only 10% are western Alaska fish. Even though similarity in the diets of different size groups of chum salmon in the Northwest region was high, the quality of large- and medium-size chum salmon diets was also high relative to other regions of our study area, and percentages of fish with empty stomachs were low. These results suggest that the potential for intra-specific feeding competition between maturing Yukon River chum salmon and Japanese hatchery salmon in our Gulf of Alaska study area in summer may be relatively low.

Our results indicate that the highest potential for feeding competition between immature Yukon River chum salmon and Alaska hatchery salmon is in the eastern regions of our study area. Chum salmon in the Northeast and Southeast regions had relatively high percentages of empty stomachs and low calorie prey (e.g., gelatinous zooplankton) in their diets compared to fish in other regions. Although chum salmon have a diverse diet, it is likely that competition for food within and between stocks of chum salmon could occur, particularly when chum salmon are locally abundant. The potential for intra-specific feeding competition between immature Yukon River chum salmon and Alaska hatchery chum salmon may be particularly high in the Northeast region, where all size groups of chum salmon had lower diet quality and higher diet similarity than in the Southeast region. The potential for inter-specific competition with Alaska hatchery pink and sockeye salmon also seems to be higher in the Northeast region than in the Southeast region. In the Northeast region, the diets of large- and medium-size pink salmon and large-size sockeye salmon contained higher percentages of high-calorie zooplankton and squid and the diets of large-size chum salmon contained a higher percentage of low-calorie gelatinous zooplankton than in the Southeast region. Previous studies have indicated that when pink salmon abundance is high, chum salmon may switch their diets to alternative low-calorie prey, e.g., gelatinous zooplankton, which decreases feeding competition with other zooplanktivorous salmon.

We hypothesize that inter- and intra-specific competition with hatchery salmon in the Gulf of Alaska may reduce the growth of immature Yukon River chum salmon, particularly when adverse oceanographic and climatic conditions limit prey availability. We also hypothesize that reductions in growth due to competition with hatchery fish may reduce the survival of immature Yukon River chum salmon by several possible mechanisms, e.g., an increase in predation, a decrease in storage of lipids, and an increase in parasites and diseases.

In conclusion, our results indicate that overlap in the diets and geographic distribution of Yukon River chum salmon and hatchery salmon in the Gulf of Alaska in summer varies by species, body size group, and geographic region. Regions of the Gulf of Alaska with the highest potential for feeding competition between Yukon River chum salmon and hatchery chum, pink, and sockeye salmon in summer were identified. Overlap in diets among different size groups of chum salmon in these regions was high, indicating a strong potential for intra-specific feeding competition between Yukon River and hatchery chum salmon. Although inter-specific overlap in salmon diets was low to moderate, the quality of chum salmon diets in the Gulf of Alaska was low compared to the diets of pink and sockeye salmon. Consumption of low quality prey (e.g., gelatinous zooplankton) by chum salmon may decrease intra-specific competition between different size or maturity groups of chum salmon and inter-specific competition with pink and sockeye salmon.

When the amount or quality of prey available to chum salmon is reduced by abundant stocks of hatchery salmon, adverse climatic and oceanographic changes are more likely to result in a decrease the ocean growth and survival of chum salmon.

A better understanding of the spatial and temporal patterns of ocean distribution, abundance, food habits and feeding behavior, growth, and bioenergetics of hatchery and wild salmon and their prey is needed. Future investigations of potential feeding competition between Yukon River chum salmon and hatchery salmon should be expanded to include other oceanic regions where they are distributed, particularly the central North Pacific Ocean, Aleutian Islands, and eastern Bering Sea. Little is known about interactions between immature and maturing Yukon River chum salmon and hatchery salmon in coastal and offshore waters within the U.S. 200-mile zone. In the international waters of the Gulf of Alaska, new field research should focus on interactions between maturing Yukon River chum salmon and Japanese hatchery chum salmon in the western regions of our study area, and immature Yukon River chum salmon and Alaska hatchery chum, pink, and sockeye salmon in the Mid and East regions of our study area. Historical salmon food habits data collected in the Gulf of Alaska and other oceanic regions during the winter, spring, and fall seasons should be incorporated into the existing summer database. Further analyses of these data would expand our knowledge of other critical locations and seasons when inter- and intra-specific competition between Yukon River chum salmon and hatchery salmon are most likely to occur. Finally, new research should emphasize the development and application of methods to identify the stock origins of individual fish in mixed-stock ocean fishery and research vessel samples, including the tagging or marking of all hatchery salmon released into the North Pacific Ocean and Bering Sea.

4. Estimates of the Bycatch of Yukon River Chinook Salmon in U.S. Groundfish Fisheries in the Eastern Bering Sea, 1997-1999

In 2002-2004, the Yukon River Drainage Fisheries Association (YR DFA) funded SAFS scientists to conduct research on stock origins of chinook salmon in incidental catches by groundfish fisheries in the eastern Bering Sea. The effect on western Alaska chinook salmon of incidental catches by commercial groundfish fisheries has been a major concern since 1977, when the NMFS began to monitor and estimate salmon bycatch by groundfish vessels operating in the U.S. EEZ. Most of the chinook salmon bycatch in Bering Sea and Aleutian Island (BSAI, Appendix Fig. 1) groundfish fisheries is taken by the walleye pollock (*Theragra chalcogramma*) trawl fisheries.

In a similar study conducted in the 1980s (Myers and Rogers 1988), SAFS scientists used scale pattern analysis to estimate the age, regional stock composition, and interceptions of western Alaska chinook salmon in incidental catches by foreign and joint-venture groundfish fisheries operating in the BSAI area of the U.S. EEZ in 1979–1982. This was a period (1977–1986) of high abundance of western Alaska chinook salmon, and an estimated 60% of the total chinook salmon bycatch in the Bering Sea groundfish fisheries was western Alaska stocks. During the late 1990s returns of chinook salmon to western Alaska rivers declined to record lows. Because of this decline in

abundance, the results of the earlier study may overestimate the contribution of western Alaska chinook salmon to the groundfish bycatch in recent years.

In 2003, we completed work to estimate the age and stock composition of chinook salmon in 1997–1999 BSAI groundfish fishery bycatch samples collected by the North Pacific Groundfish Observer Program, NMFS (Myers et al. 2003b). Scale measurement data from mature chinook salmon returning to major production regions in Asia and North America were used to establish five brood-year specific baselines (BY 1991–1995). Maximum likelihood estimates (MLE) of the proportions of regional (Russia, Western Alaska, Central Alaska, and Southeast Alaska/British Columbia) and western Alaska subregional (Yukon, Kuskokwim, and Bristol Bay) stock groups in the fishery (mixture) bycatch samples were calculated. Accuracies of the brood-year models were evaluated by computer simulations and by test mixture samples of baseline scales that were not included in the 4-group regional models.

During the period of our study, the largest bycatch samples were taken during winter (January and February) and late summer–fall (September and October) in the BSAI area east of 170°W. The 1997–1999 bycatch samples were dominated by age 1.2 fish in summer and ages 1.3 and 1.4 fish in winter. In contrast, the previous SAFS study found that younger (age 1.2) fish dominated winter bycatch samples in 1979–1982. This difference may be related to an eastward shift in the fishery area from offshore areas (west of 170°W) in 1979–1982 to inshore areas (east of 170°W) in 1997–1999. In winter, immature age-2 chinook salmon may be distributed farther offshore than older age groups of immature and maturing fish.

As in the previous SAFS study of 1979–1982 samples from the BSAI, our results indicate that western Alaska was the dominant regional stock of chinook salmon in bycatch samples from the groundfish fisheries in the eastern Bering Sea. The estimated regional stock composition of chinook salmon in the five brood-year strata averaged 56% Western Alaska, 31% Central Alaska, 8% Southeast Alaska–British Columbia, and 5% Russia. In winter age-1.4 western Alaska chinook salmon were largely from the Yukon and Kuskokwim sub-regions, and percentages of Bristol Bay fish were highest in samples of age-1.3 fish. In fall age-1.2 western Alaska chinook salmon were predominantly from the Kuskokwim and Bristol Bay subregions, and there was a large component of Cook Inlet chinook salmon stocks.

The results of both SAFS studies indicate that: (1) the proportions of the three western Alaskan subregional stocks (Yukon, Kuskokwim, and Bristol Bay) in the BSAI area vary considerably with such factors as brood year, time, and area; (2) Yukon River chinook salmon are often the dominant stock in the BSAI in winter, particularly among age 1.2 fish in the western BSAI (west of 170°W) and age 1.4 fish in the eastern BSAI (east of 170°W); (3) Bristol Bay and Cook Inlet are the dominant stocks of age 1.2 chinook salmon in the eastern BSAI in fall; and (4) age 1.1 chinook salmon in the eastern BSAI in fall are largely Gulf of Alaska stocks (Cook Inlet, southeast Alaska-British Columbia).

The spatial and temporal distributions of Yukon, Cook Inlet, southeast Alaska, and British Columbia chinook salmon in the eastern Bering Sea were corroborated by recoveries of CWT fish. The results of previous scale pattern analyses of samples from the Japanese mothership salmon driftnet fishery in the Bering Sea and historical high seas

tagging studies indicate that in summer immature western Alaska chinook salmon are distributed farther to the west in the Bering Sea than other North American stocks, which may explain their relatively low percentages in fall 1997-1999 bycatch samples from the eastern BSAI.

In 2004, our primary objective was to estimate the bycatch of Yukon River chinook salmon by the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries during the period of low returns of chinook salmon to western Alaska rivers in the late 1990s (Myers et al. 2004e). We used scale pattern analysis to estimate the age and stock composition of chinook salmon in the BSAI bycatch samples collected in 1997-1999, and compared our results to previously published studies. Our age and stock composition estimates were applied to National Marine Fisheries Service (NMFS) estimates of the BSAI bycatch to estimate interceptions of Yukon River chinook salmon by the BSAI fisheries in 1997-1999. To evaluate the potential effects of the BSAI bycatch on Yukon River chinook salmon resources, we estimated the adult equivalent (AEQ) bycatch, i.e., interception estimates adjusted to account for natural ocean mortality of immature fish in the bycatch. The AEQ bycatch estimates were apportioned to the year that fish would have returned to the Yukon River had they not been intercepted, and compared to Yukon River catch and escapement estimates in 1997-2000. The management and conservation implications of our results are discussed.

The principal results show that most of the BSAI bycatch in 1997-1999 occurred in the eastern portion of the fishery area (east of 170°W). Fall bycatch samples were dominated by age 1.2 Bristol Bay and Cook Inlet chinook salmon. Winter bycatch samples were dominated by age 1.3 and 1.4 western Alaska chinook salmon. Western Alaska chinook salmon stocks were 48% of the total bycatch in 1997 and 1998, and 60% of the total in 1999. The estimated interceptions of Yukon River chinook salmon were 7,266 fish in 1997, 8,908 fish in 1998, and 3,074 fish in 1999. The AEQ bycatches of Yukon River chinook salmon were 6,522 fish in 1997, 7,510 fish in 1998, and 2,721 fish in 1999. The AEQ bycatch was equal to 1.4-4.5% of the minimum run, 11.5-50.8% of the minimum (lower river) escapement, 9.7-37.5% of upper river (Canadian) escapement, 3.1-35.2% of the Alaska commercial catch, 6.2-9.0% of the Alaska subsistence catch, or 22.1-83.6% of the Canadian catch of chinook salmon in the Yukon River in 1997-2000.

We conclude that in the eastern Bering Sea in winter, immature (age 1.2 and 1.3) chinook salmon are more abundant along the outer shelf break (west of 170°W), and maturing (age 1.3-1.5) chinook salmon are more abundant along the inner shelf break (east of 170°W). Other factors that may influence the age composition of chinook salmon in the BSAI bycatch include year class strength, seasonal- and age-specific changes in the vertical distribution of chinook salmon, and long-term decreases in body size and increases in age at maturity of western Alaska chinook salmon. Despite the decline in abundance of western Alaska chinook salmon in the late 1990s, western Alaska was the dominant regional stock (average 56%) in BSAI bycatch samples in 1997-1999. As in the results of a previous study of chinook salmon bycatch by foreign and joint venture (JV) groundfish fisheries in the BSAI in the late 1970s and early 1980s, we found that: (1) the proportions of the three western Alaskan subregional stocks (Yukon, Kuskokwim, and Bristol Bay) in the BSAI area vary considerably with such factors as brood year,

time, and area; (2) Yukon River chinook salmon are often the dominant stock in the BSAI in winter, particularly among age 1.2 fish in the western BSAI (west of 170°W) and age 1.4 fish in the eastern BSAI (east of 170°W); (3) Bristol Bay and Cook Inlet are the dominant stocks of age 1.2 chinook salmon in the eastern BSAI in fall; and (4) age 1.1 chinook salmon in the eastern BSAI in fall are largely Gulf of Alaska stocks (Cook Inlet, southeast Alaska-British Columbia). The results of previous scale pattern analyses and tagging studies suggest that in summer immature Yukon River chinook salmon are distributed farther to the west in the Bering Sea than other North American stocks, which may explain their relatively low percentages in fall 1997-1999 bycatch samples from the eastern BSAI.

Our estimates of interceptions of Yukon River chinook salmon by U.S. groundfish fisheries in the BSAI in 1997-1999 were higher than estimated interceptions by the foreign and JV trawl fisheries in the BSAI after 1980. The accuracies of our interception estimates, however, depend on the accuracy of the NMFS estimates of chinook salmon bycatch. The high levels of uncertainty associated with the NMFS salmon bycatch estimates should be a major consideration, if our results are used to develop fishery management or conservation measures for Yukon River chinook salmon.

Our estimates of the AEQ bycatch of Yukon River chinook salmon by the domestic groundfish fisheries in the BSAI in 1977-1999 are not large enough to explain the low returns to the Yukon River in the late 1990s. The 1997-1999 BSAI bycatch apparently had the largest effect on local utilization and escapement of Yukon River chinook salmon in 1998 and 2000. The estimated AEQ bycatch of Yukon River chinook salmon represents a loss of fishing opportunity for commercial and subsistence fishermen, as well as a substantial loss of escapement to spawning grounds in 1998-2000. We conclude that in years when salmon returns to the Yukon River are low, even relatively low incidental catches of salmon by non-target marine fisheries may reduce local utilization of chinook salmon resources and impede management and conservation efforts in western Alaska.

Regulations implemented in 1999, which spread fishing effort over time to protect Steller sea lions (*Eumetopias jubatus*), apparently increased the portion of the chinook salmon bycatch taken in winter, as well as the estimated percentages of Yukon River chinook salmon in the bycatch. Future management efforts to conserve Yukon River chinook salmon should emphasize methods that will reduce the winter (January-June) bycatch of maturing (age 1.3, 1.4, and 1.5) chinook salmon in eastern BSAI (east of 170°W). For example, accounting towards bycatch limits could begin on September 1, with the amount carried over to the next winter season.

In addition, the BSAI chinook salmon bycatch samples and data could be used more effectively to manage and conserve Yukon River chinook salmon. For example, NMFS Observer Program chinook salmon samples and data could be used to calculate annual estimates of the maturity, age, and stock composition of the chinook salmon in the bycatch samples. A new scale sampling scheme could be designed by NMFS to improve time and area coverage of the fishery and to estimate the variance of age composition

estimates. Samples for DNA analysis (fin clips) could be collected by observers from the same fish that are sampled for scales. Information from the BSAI chinook salmon bycatch samples and data could be used by salmon fishery managers to improve both preseason and inseason stock assessments of Yukon River chinook salmon. Once comprehensive baselines are established, genetic (DNA) stock identification may prove to be an efficient tool for inseason estimates of the stock composition of chinook salmon in the BSAI bycatch.

5. GLOBEC 2000: Feeding, Growth, Condition, and Energetics of Juvenile Pink Salmon in the Northern Gulf of Alaska

The High Seas Salmon Research Program staff has been collaborating with SAFS faculty (D. Beauchamp, PI) and graduate students (J. Moss, A. Cross), as well as scientists at the University of Alaska Fairbanks (UAF), School of Fisheries and Ocean Sciences (L. Haldorson, PI) for the past 4 years in a study to understand conditions that favor rapid growth and survival of juvenile pink salmon in the coastal Gulf of Alaska (CGOA). This research is part of the U.S. GLOBEC/CGOA component of the Northeast Pacific Program (<http://globec.oce.orst.edu/groups/nep/projects/>). This work is also coordinated with scientists at ABL/AFSC, NMFS, who are conducting GLOBEC research on factors affecting the distribution of juvenile salmon in the Gulf of Alaska (<http://globec.oce.orst.edu/groups/nep/projects/>). The results will contribute directly to the GLOBEC program goal, which is to understand how production of upper trophic level species is linked to variation in oceanographic conditions in the CGOA.

The major objectives of our GLOBEC research are:

- (1) Describe spatial and temporal variation in juvenile pink salmon diets and surface zooplankton abundance from Prince William Sound (PWS) and the adjacent continental shelf from July to October;
- (2) Measure prey selectivity by pink salmon as a function of size, time, and location;
- (3) Measure growth and condition of pink salmon and relate them to prey availability and water temperature;
- (4) Estimate daily ration of pink salmon with field experiments and bioenergetic models;
- (5) Evaluate spatial and temporal variation in the growth potential of pink salmon in the marine environment over the continental shelf using foraging and bioenergetic models; and
- (6) Determine the relationship between pink salmon prey use and prey use by other planktivorous fishes over the continental shelf.

In 2004 an additional year of process-oriented fieldwork was conducted in 3 phases with cruises in July, August and September. UAF scientists participated in these cruises and collected samples for future diet and growth analyses (stomach contents and scale pattern analyses). SAFS scientists, graduate students, and UAF colleagues have submitted papers that will be published in an up-coming volume of Deep Sea Research II that summarize the results from 1999-2001 studies on PWS and CGOA juvenile pink

salmon (Armstrong et al., in press, “Distribution, size, and interannual, seasonal and diel food habits of northern Gulf of Alaska juvenile pink salmon, *Oncorhynchus gorbuscha*” and Cross et al., in press, “ Consumption demand of juvenile pink salmon in Prince William Sound and the coastal Gulf of Alaska in relation to prey biomass”). SAFS scientists and graduate students meanwhile worked on further analyses of diet and growth from juvenile pink salmon samples collected in Prince William Sound, and along the Seward Line in 2002 (July, August and October cruises) and in 2003 when sampling was conducted at both locations and along an additional cruise tract, (the Cape Fairfield Line) to identify the water masses of the Alaska Coastal Current, the Transition Zone and the Shelf waters. Juvenile pink salmon sampled from these areas are being analyzed for diet differences and growth potential. Work continues to integrate the 2002 and 2003 data into the body of data collected from 1999, 2000, and 2001. Interannual comparisons will be made regarding juvenile pink salmon diet, growth and survival.

SAFS and UAF scientists attended the 13th annual meetings of PICES/NPMSO and interacted with colleagues on topics of impacts of large-scale climate change, mechanisms that regulate North Pacific marine ecosystems, and the role of gelatinous zooplankton in coastal and oceanic ecosystems (Dagg et al. 2004).

Further work will integrate these food habits with fish condition, growth and survival data, zooplankton abundance, and water temperature to develop foraging and bioenergetics models. These models will enable assessment of habitat quality and growth conditions for juvenile pink salmon, and, therefore address how tertiary production is affected by changes in ocean conditions.

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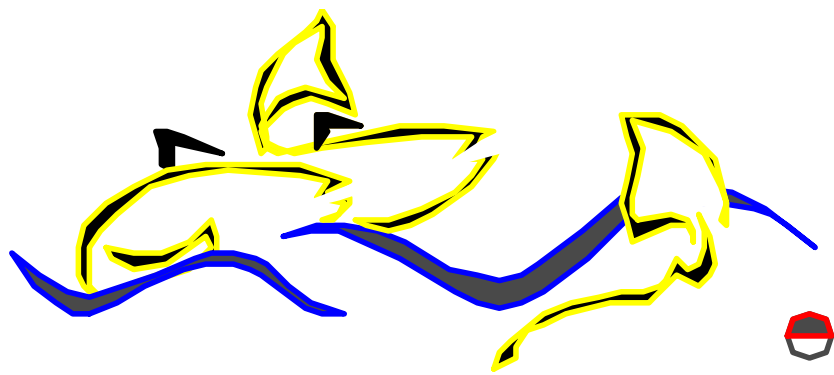
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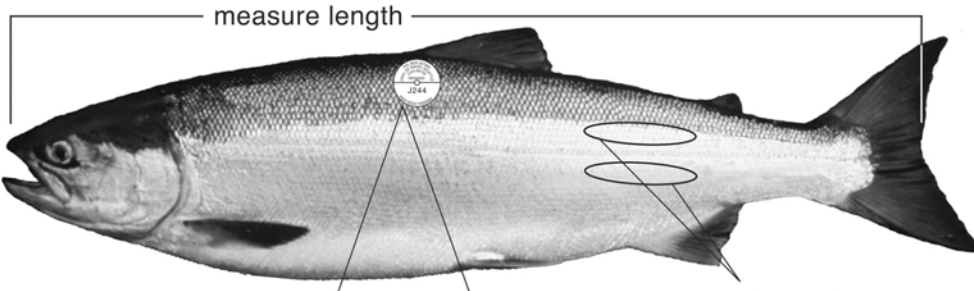
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RETURN HIGH SEAS SALMON AND STEELHEAD TAGS



RETURN high-seas salmon tag

- ENTER drawing
- GET embroidered cap

North Pacific Anadromous Fish Commission Tag Drawing 2004

- \$5,000 1st
- \$3,000 2nd
- \$1,500 3rd
- \$ 500 4th

Examples of high seas tags

Tag color is red and white

Some fish carry an electronic tag

SPECIAL \$200 REWARD FOR THIS TAG

Scrape off scales from these areas on both sides of the fish and place the scales into a folded piece of paper

- Collect tag, if tag cannot be collected then get tag number and description
- Collect scales and carefully measure fish length as shown
- Record location, date, species, gear, sex, and weight
- Send your name, address, and phone number for cash drawing

Send to: **High Seas Salmon Research Program
School of Aquatic & Fishery Sciences
University of Washington
Box 355020
Seattle, WA 98195-5020**

call: 206-543-1101 e-mail: kwmyers@u.washington.edu

Websites: <http://www.fish.washington.edu/research/highseas/>
<http://www.npafc.org/>

INTERNATIONAL HIGH SEAS SALMON TAGGING

Fig. 1. Poster advertising for return of high seas disk and data storage tags, 2004-2005.

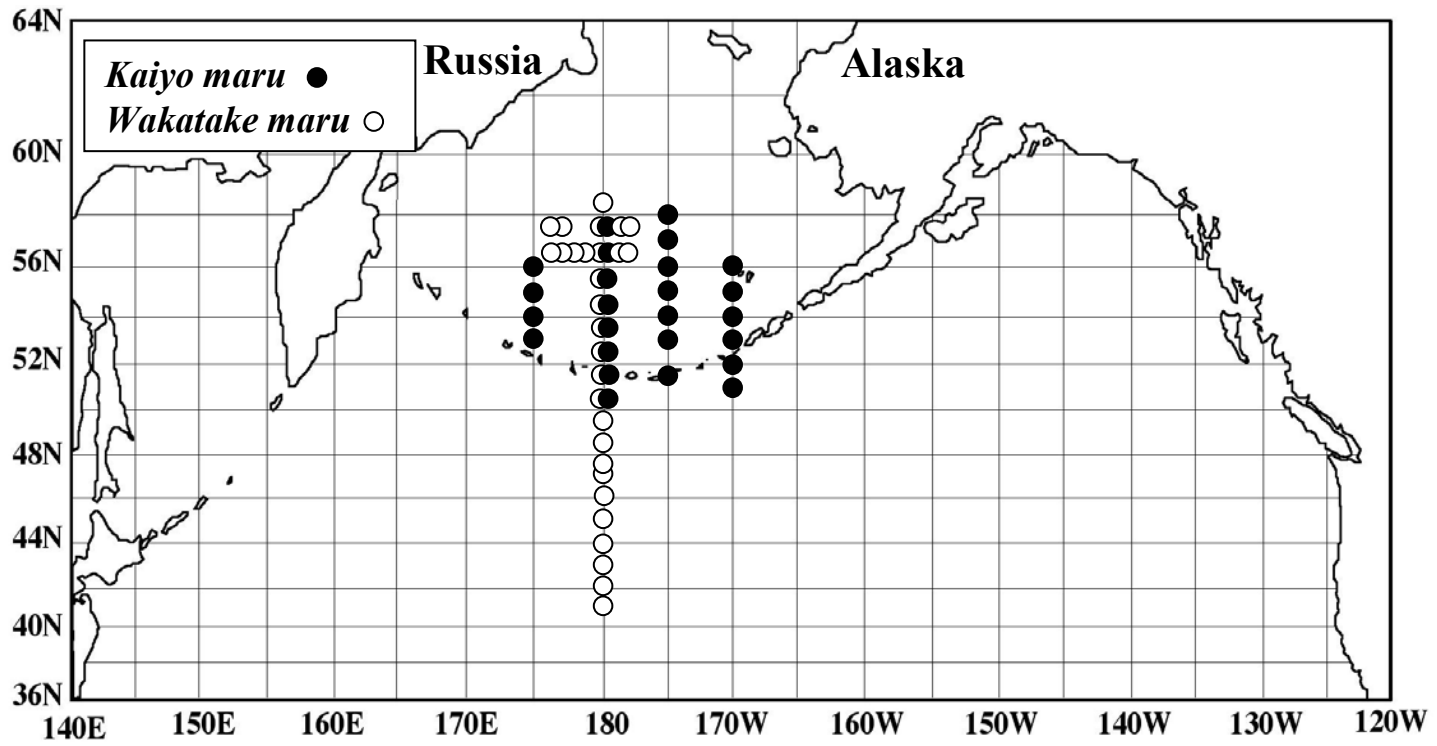


Fig. 2. Sampling areas of international cooperative high seas salmon research cruises in 2004.

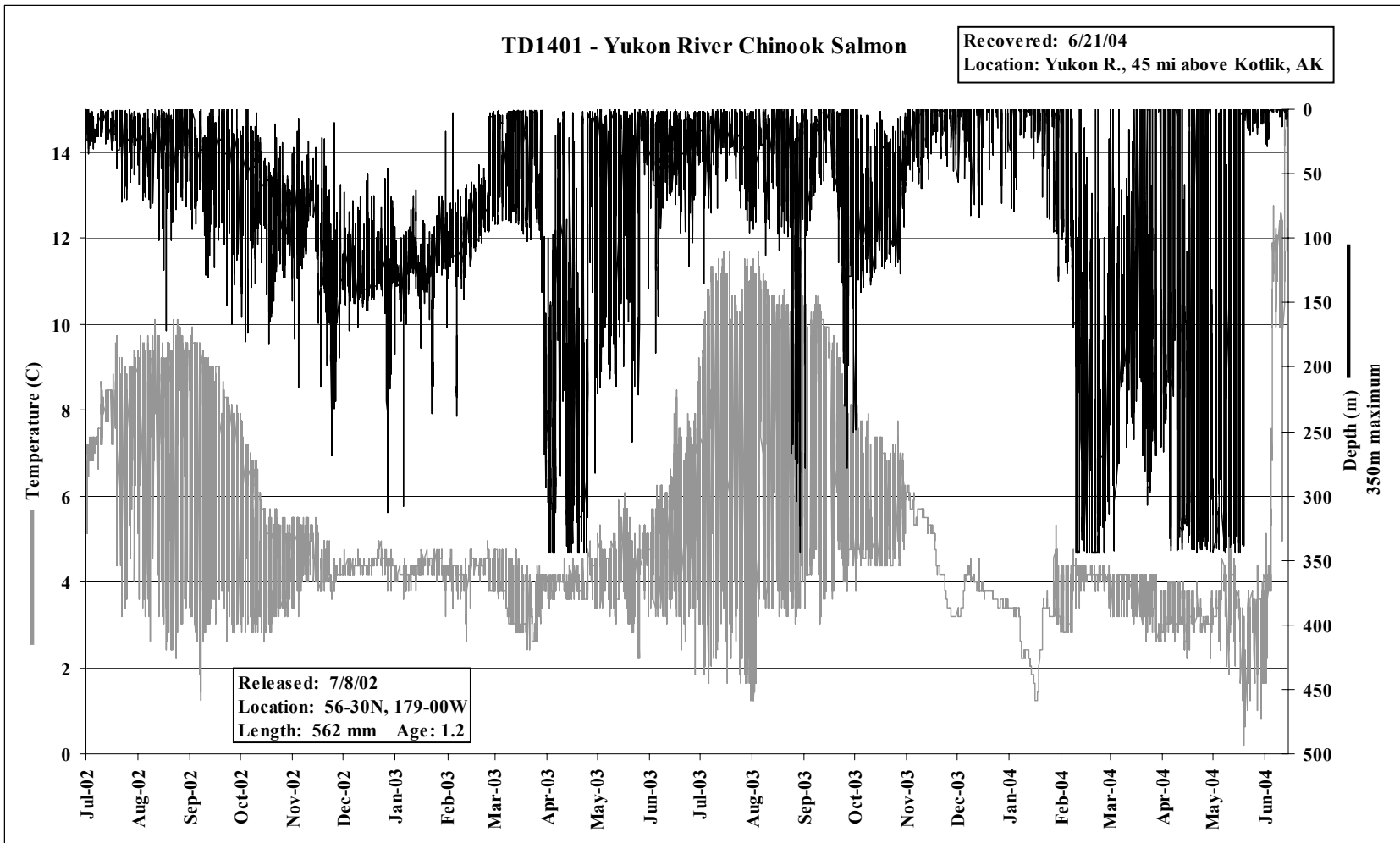


Fig. 3. Temperature and depth data recorded on a data storage tag placed on a 562 mm chinook salmon in the Bering Sea on 8 July 2002 and recovered in the Yukon River, Alaska, on 21 June 2004.

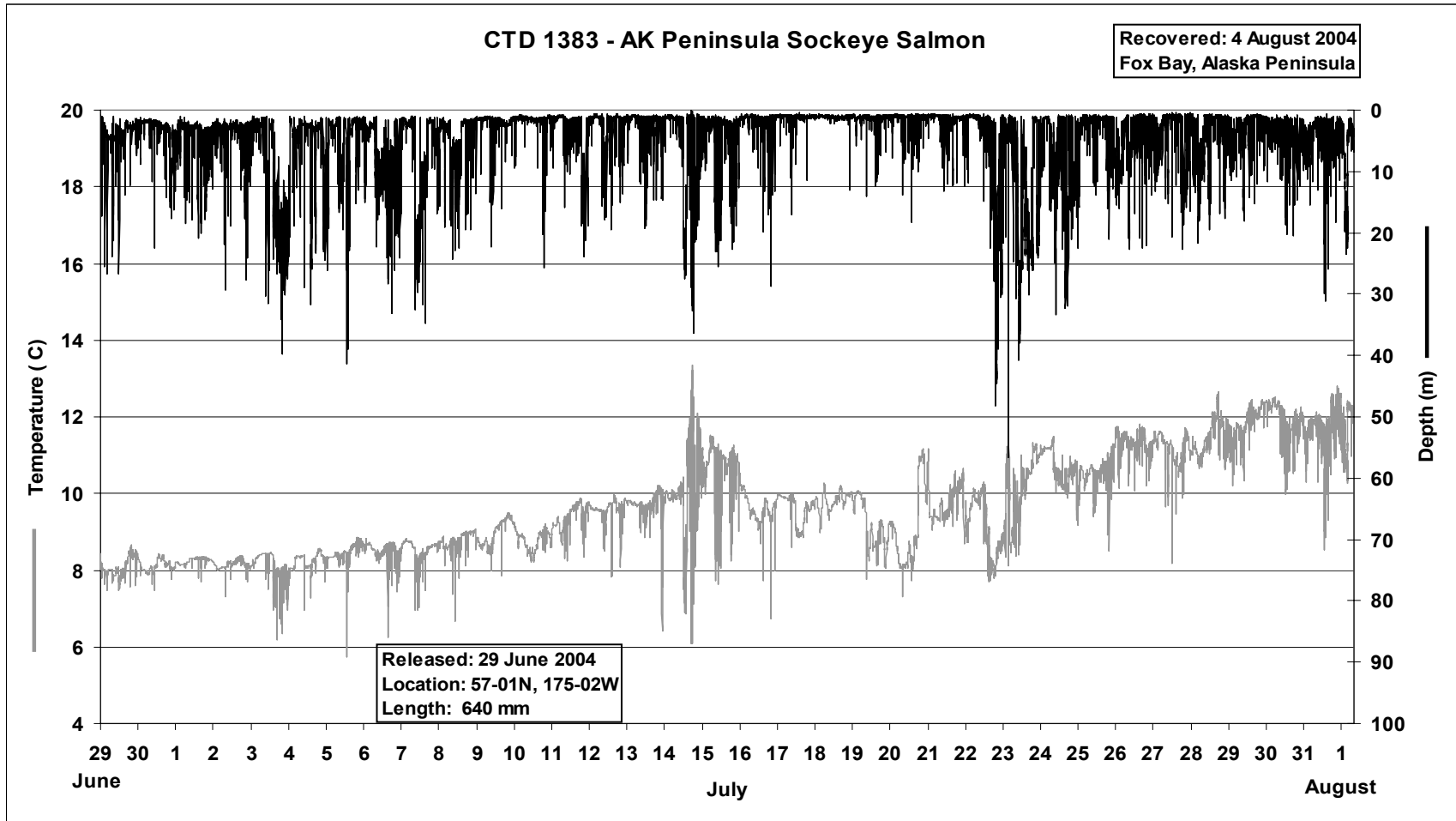


Fig. 4. Temperature and depth data recorded on a data storage tag placed on a 640 mm sockeye salmon in the Bering Sea on 29 June 2004 and recovered on the south coast of the Alaska Peninsula on 4 August 2004.

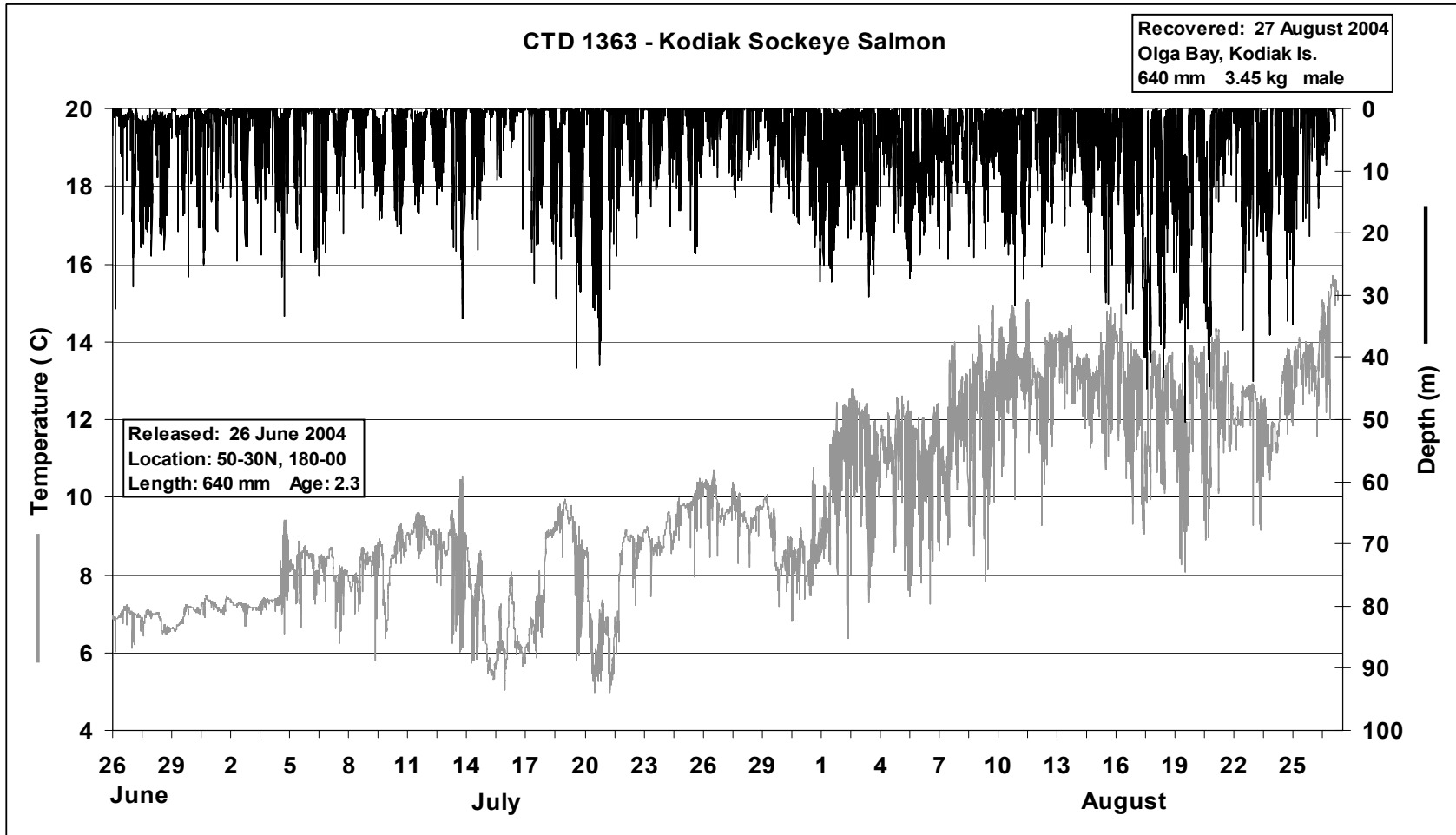


Fig. 5. Temperature and depth data recorded on a data storage tag placed on a 640 mm sockeye salmon in the central North Pacific Ocean on 26 June 2004 and recovered on Kodiak Island on 27 August 2004.

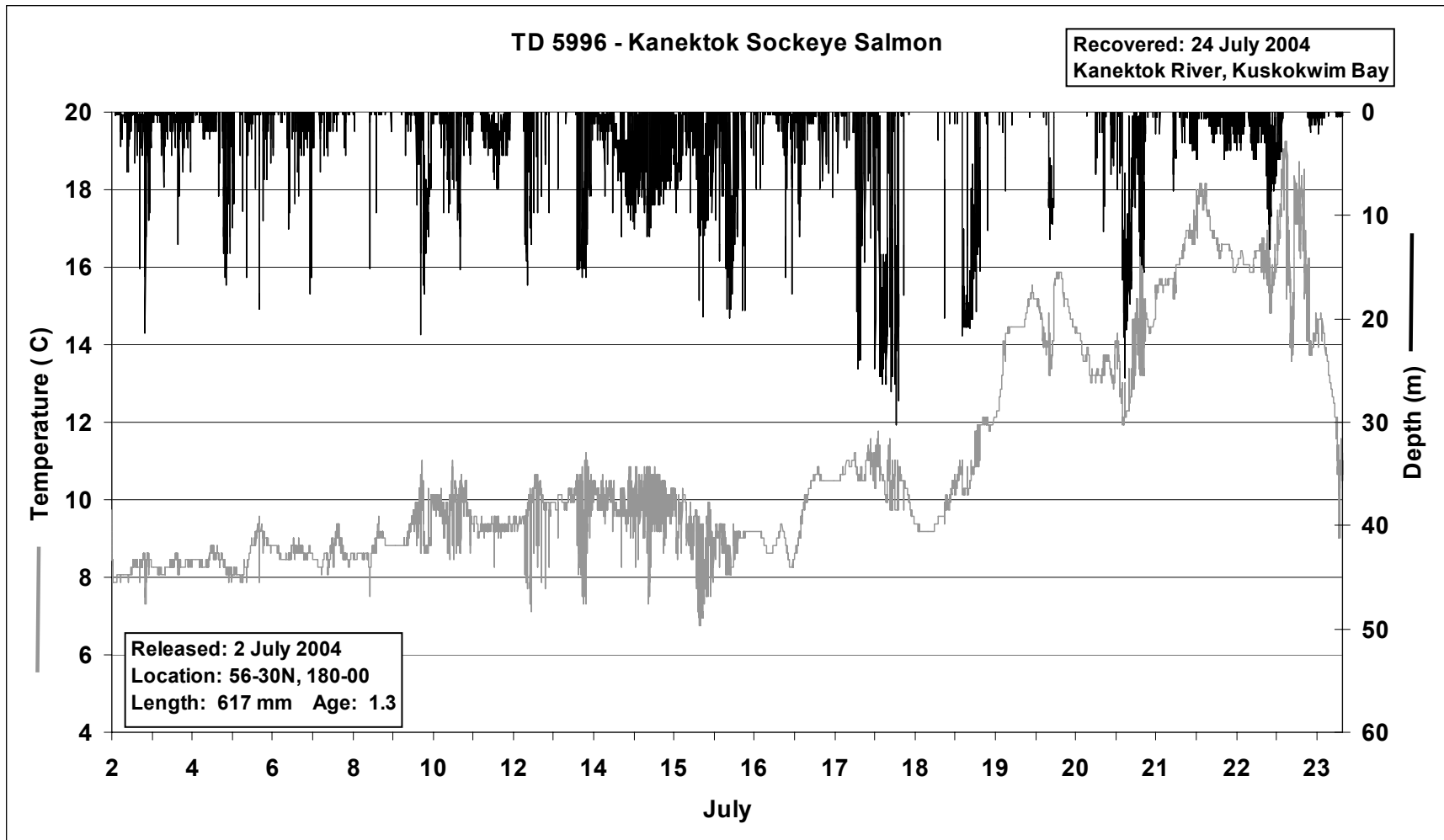


Fig. 6. Temperature and depth data recorded on a data storage tag placed on a 617 mm sockeye salmon in the Bering Sea on 2 July 2004 and recovered in the Kanektok River, Kuskokwim Bay, on 23 July 2004.

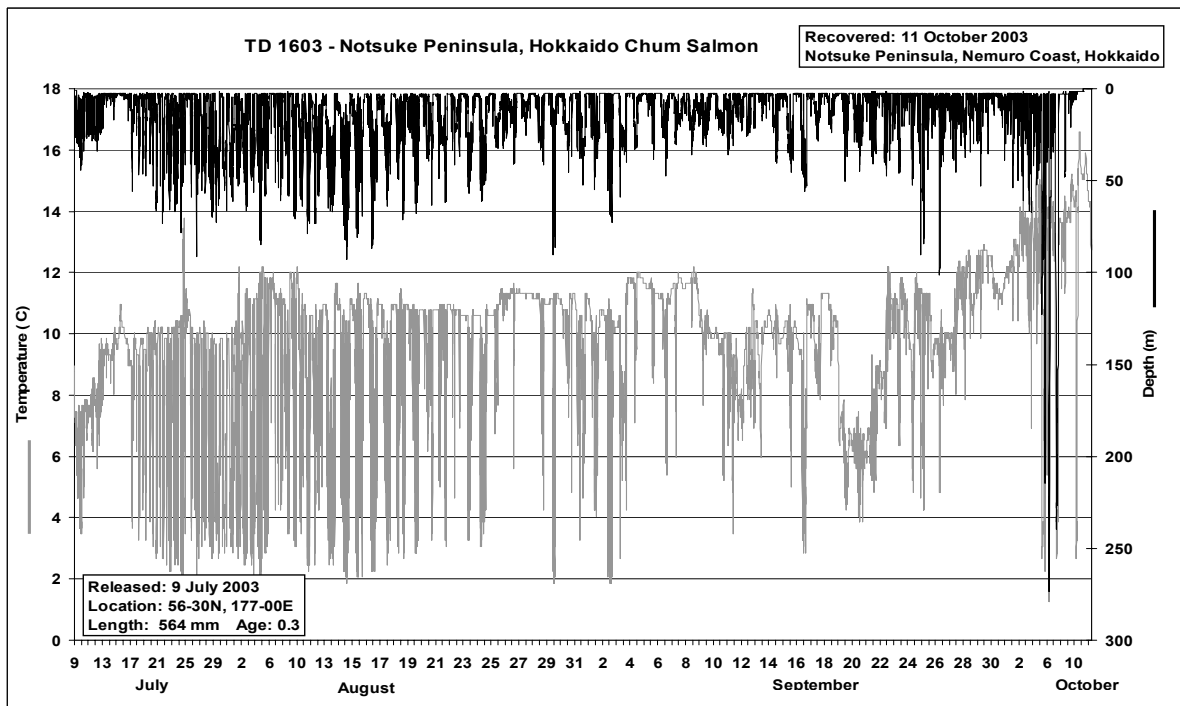
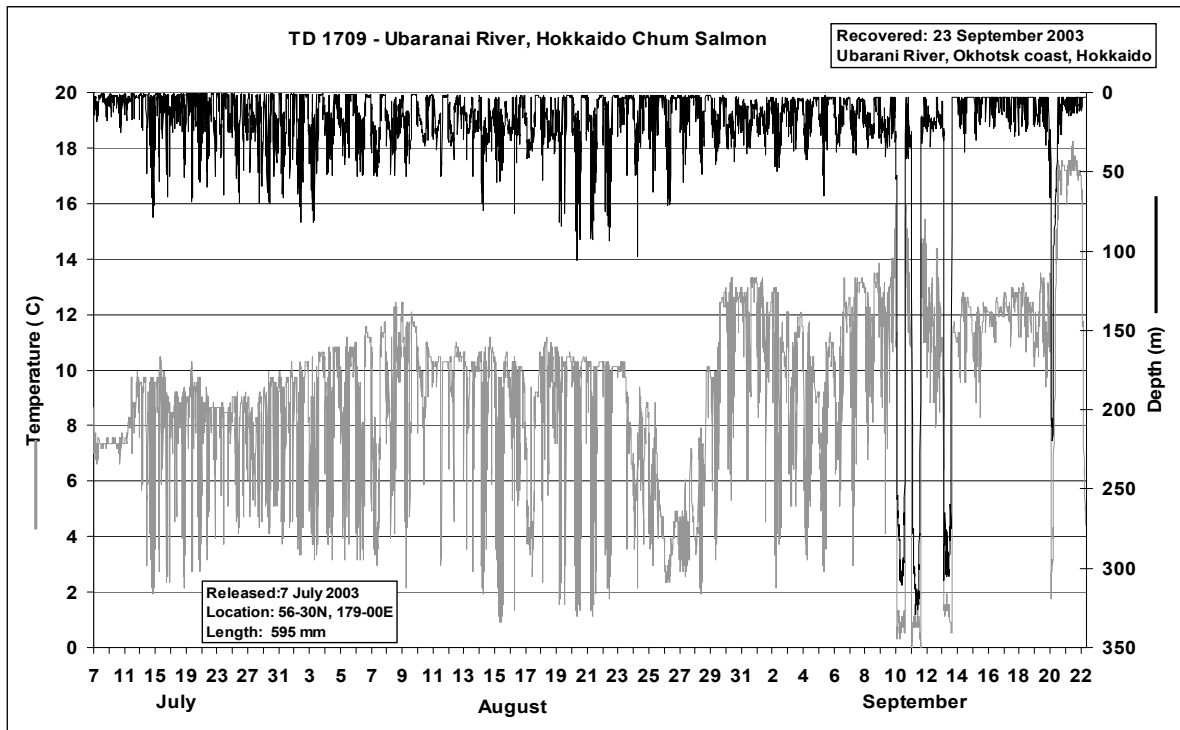


Fig. 8. Temperature and depth data recorded on data storage tags placed on two chum salmon in the Bering Sea on 7 July 2003 (top) and 9 July 2003 (bottom) and recovered in Hokkaido, Japan, on the Okhotsk coast on 23 September 2003 (top) and the Nemuro coast on 11 October 2003 (bottom).

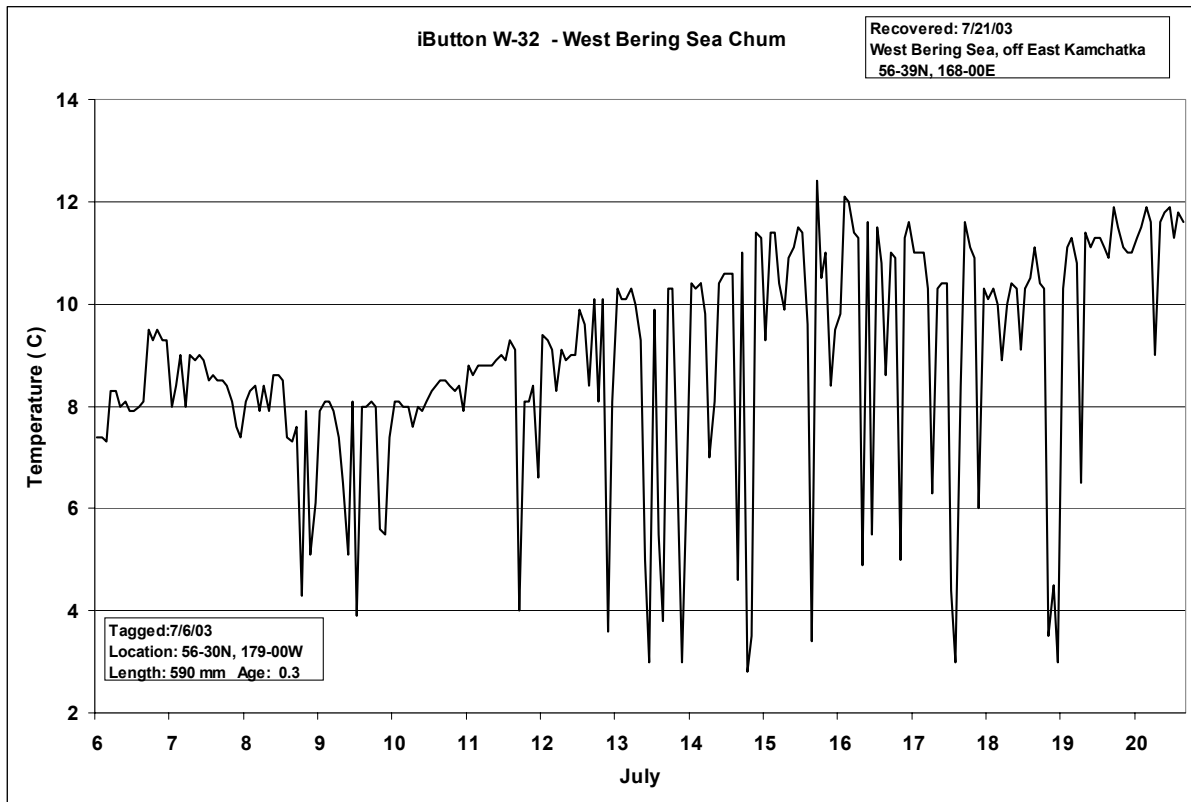


Fig. 9. Temperature data recorded on a data storage tags placed on a 590 mm chum salmon in the Bering Sea on 6 July 2003 and recovered in the western Bering Sea off the eastern coast of Kamchatka on 21 July 2003.

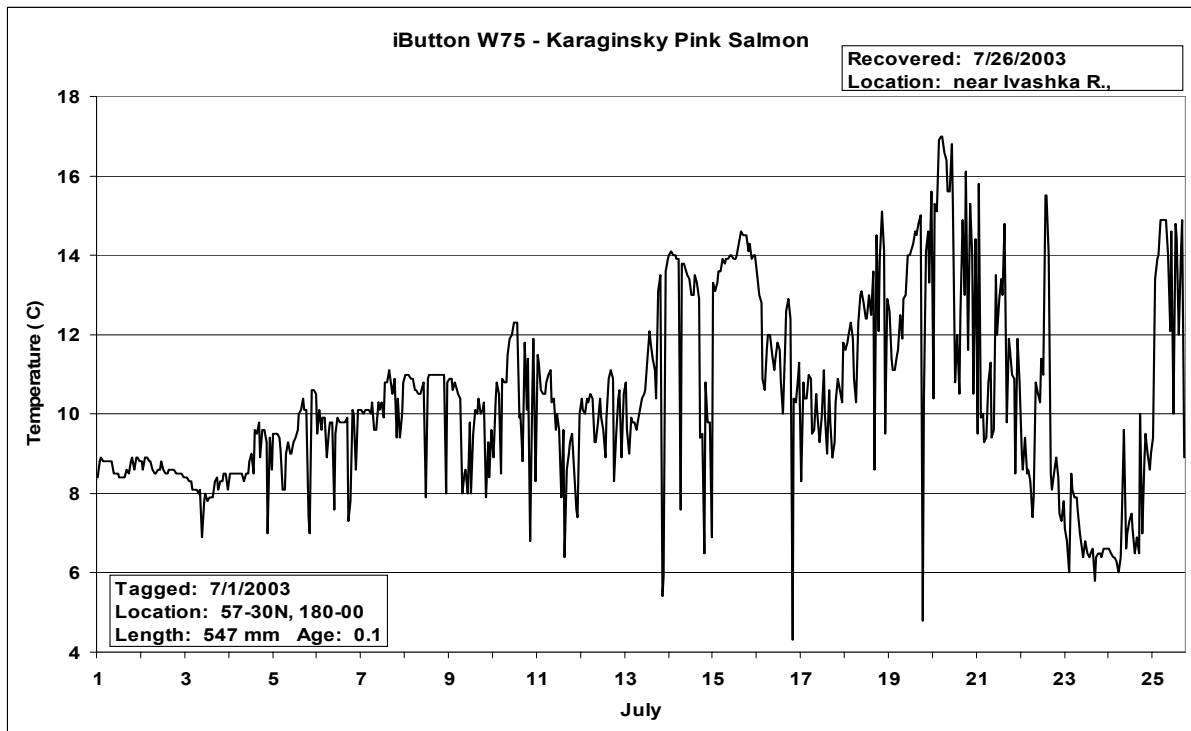
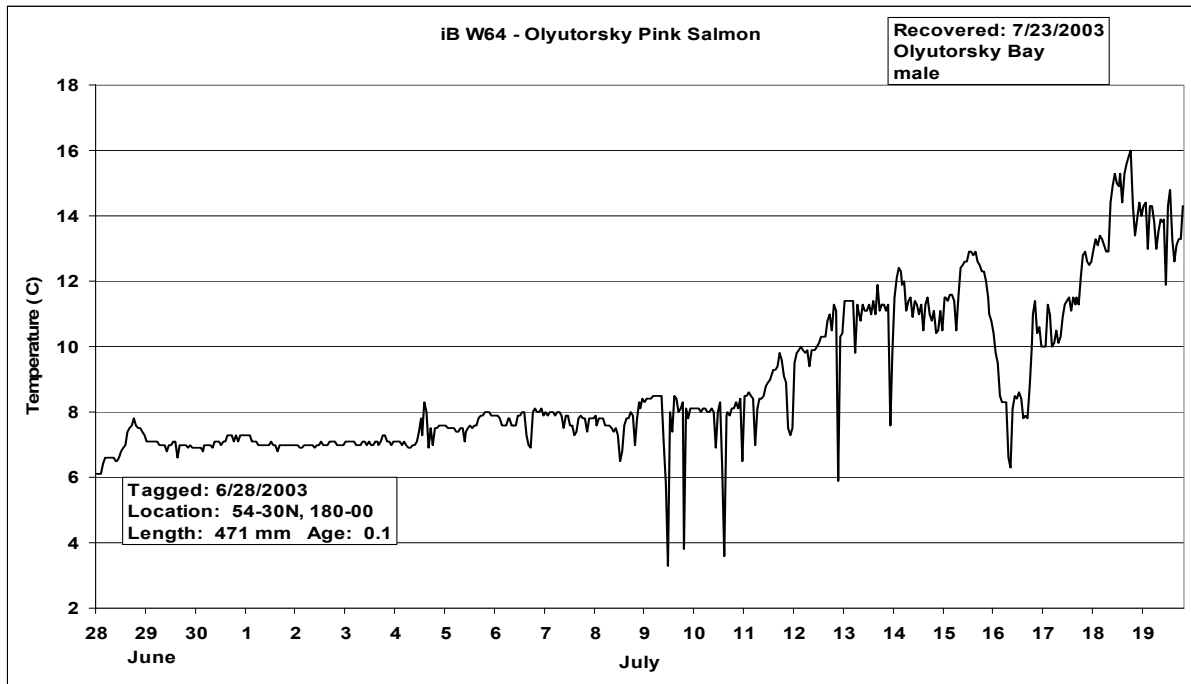


Fig. 10. Temperature data recorded on two data storage tags placed on two pink salmon in the Bering Sea on 28 June 2003 (top) and 1 July 2003 (bottom) and recovered in Olyutorsky Bay on 23 July 2003 (top) and Karaginsky Bay on 26 July 2003 (bottom).

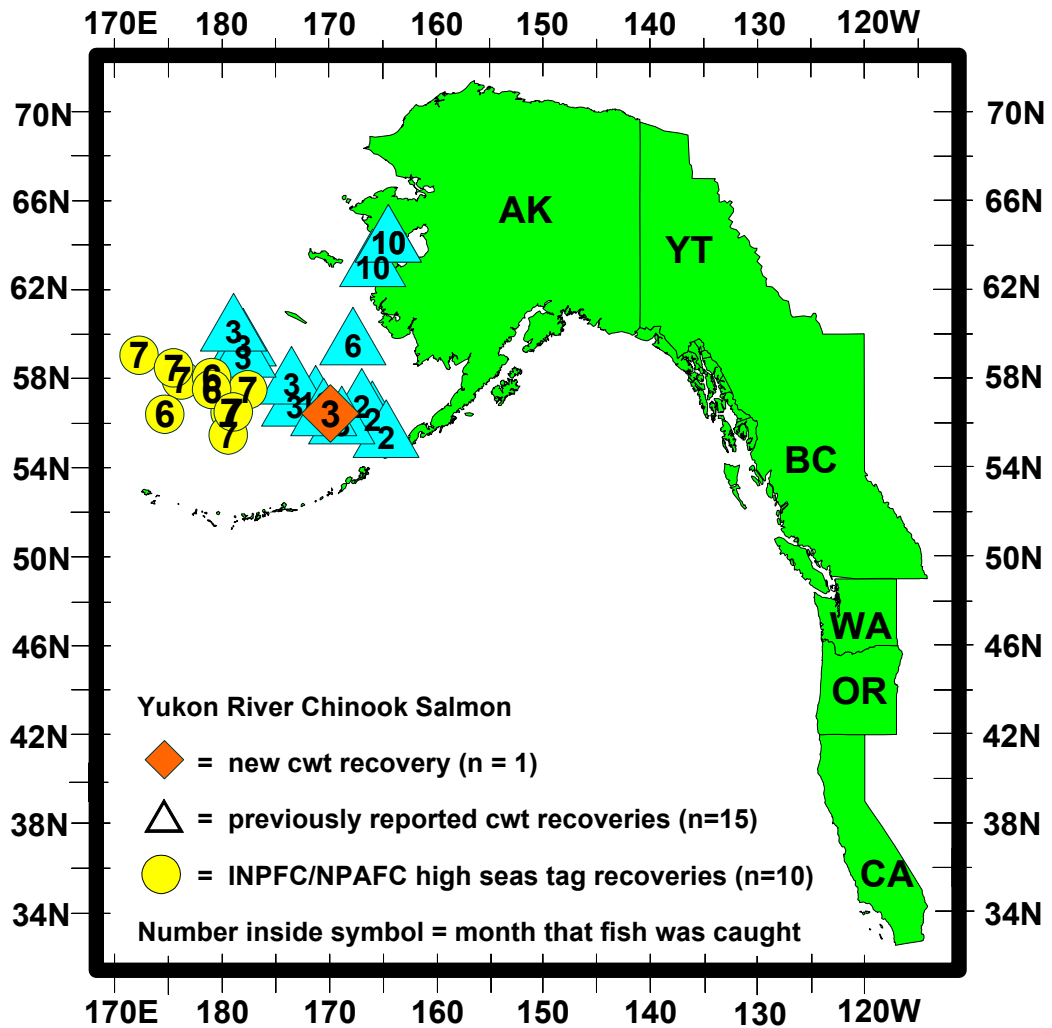


Fig. 12. The ocean distribution of Yukon River chinook salmon, as shown by high seas tag recoveries, 1956-2004. Processing plant recoveries of coded wire tagged (cwt) fish are not included. The geographic location of one new recovery of a cwt fish (Table 2, Fish no. 1) is indicated in the figure by a closed diamond. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

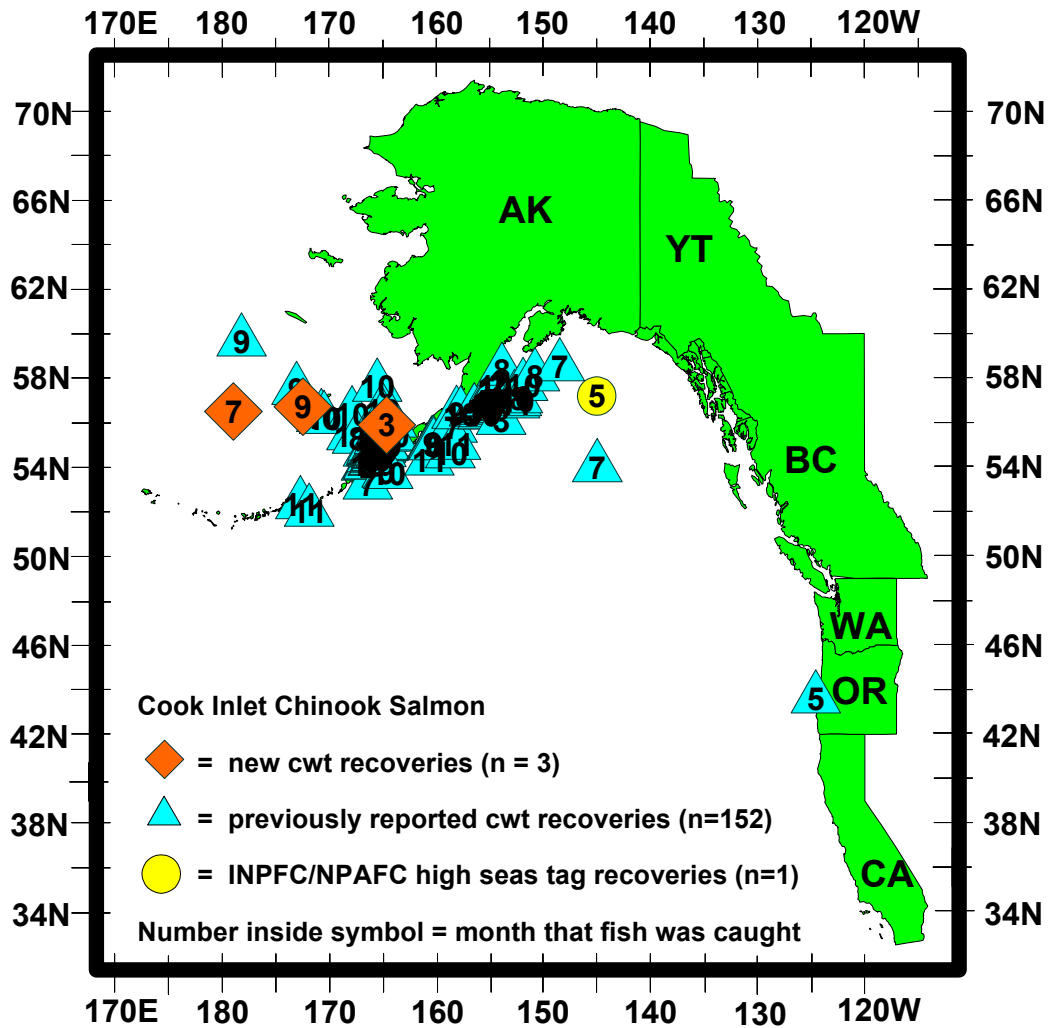


Fig. 13. The ocean distribution of Cook Inlet chinook salmon, as shown by high seas tag recoveries, 1956-2004. Processing plant recoveries of coded wire tagged (cwt) fish are not included. The geographic locations of three new recoveries of cwt fish (Table 2, Fish nos. 3 and 5; Table 3.1) are indicated in the figure by closed diamonds. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

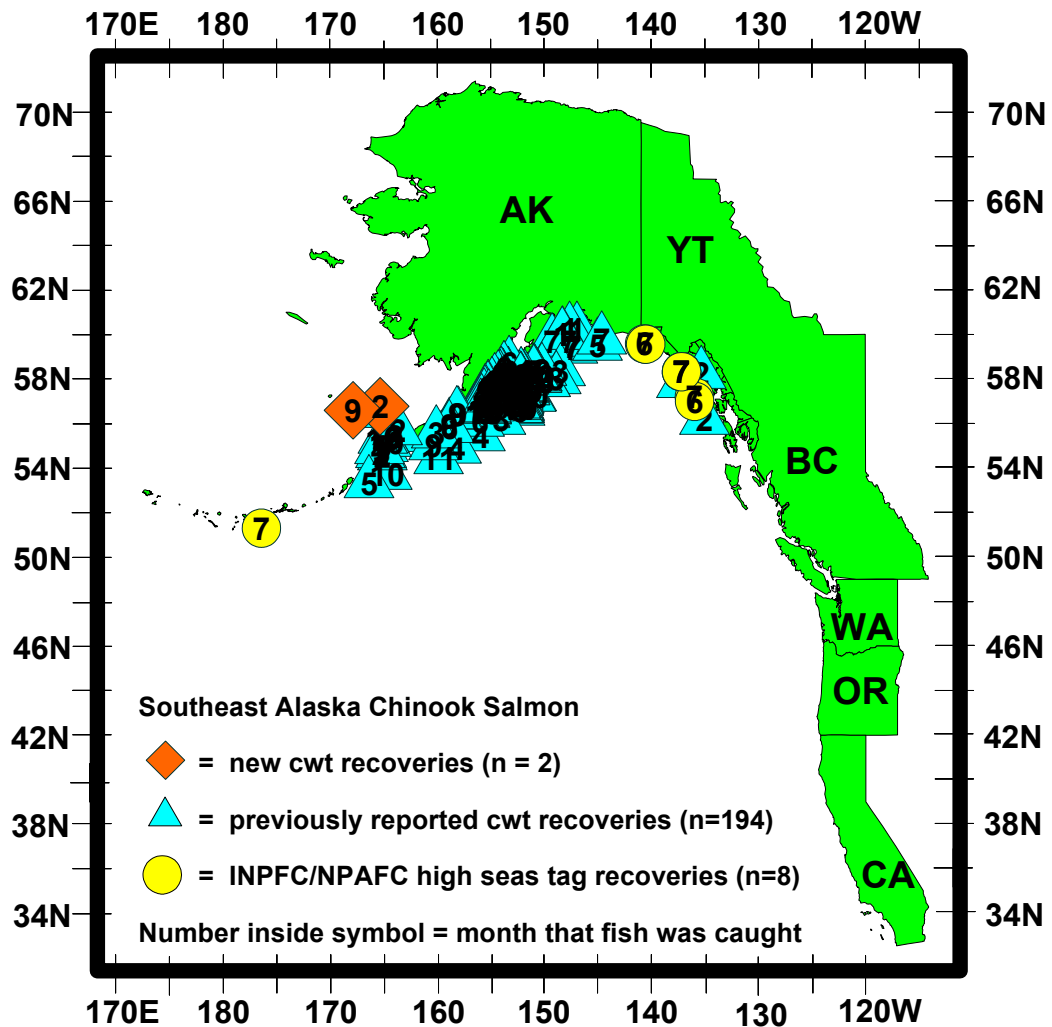


Fig. 14. The ocean distribution of Southeast Alaska chinook salmon, as shown by high seas tag recoveries, 1956-2004. Processing plant recoveries of coded wire tagged (cwt) fish are not included. The geographic locations of two new recoveries of cwt fish (Table 2, Fish nos. 7 and 8) are indicated in the figure by closed diamonds. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

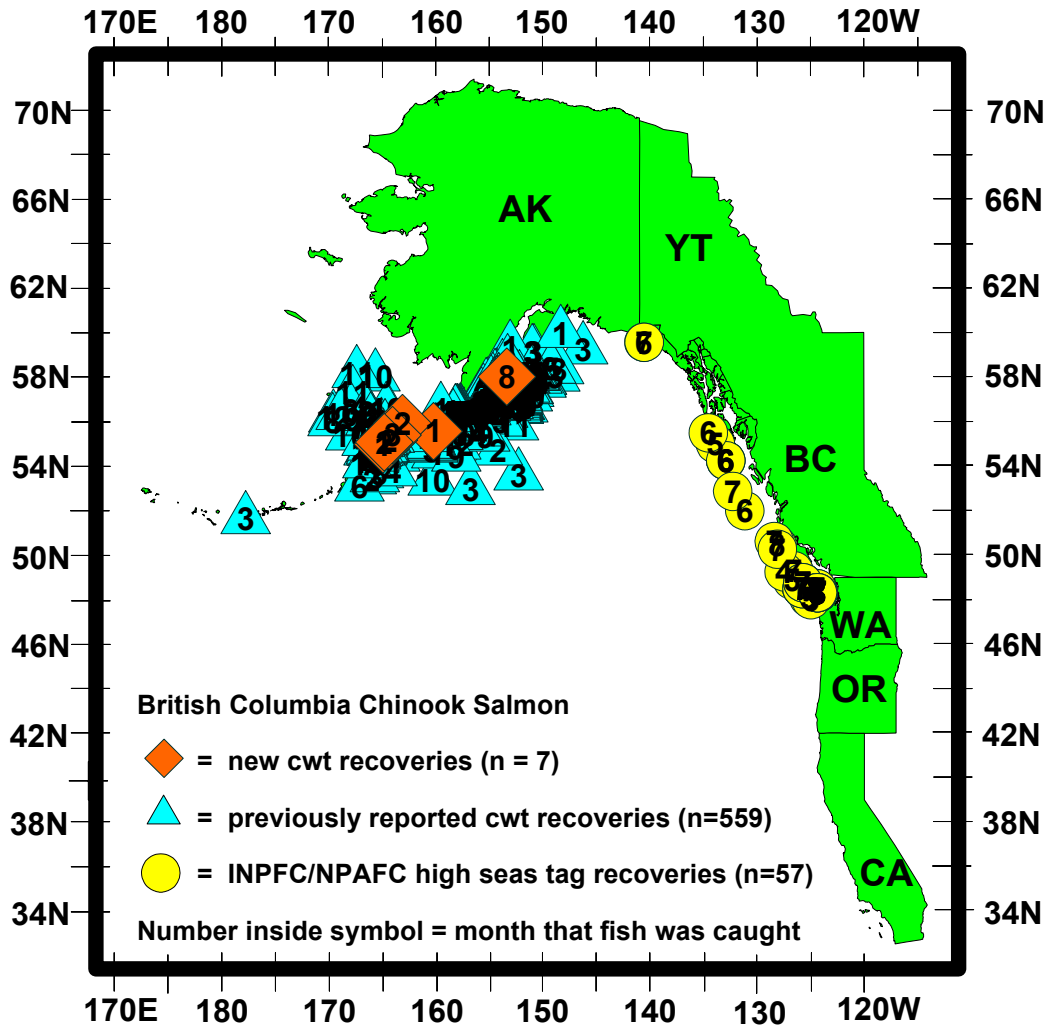


Fig. 15. The ocean distribution of British Columbia chinook salmon, as shown by high seas tag recoveries, 1956-2004. Processing plant recoveries of coded wire tagged (cwt) fish are not included. The geographic locations of seven new recoveries of cwt fish (Table 2, Fish nos. 10, 11, 12, 13, 16, 21, and 23) are indicated in the figure by closed diamonds. Coastal recoveries south of British Columbia are not shown. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

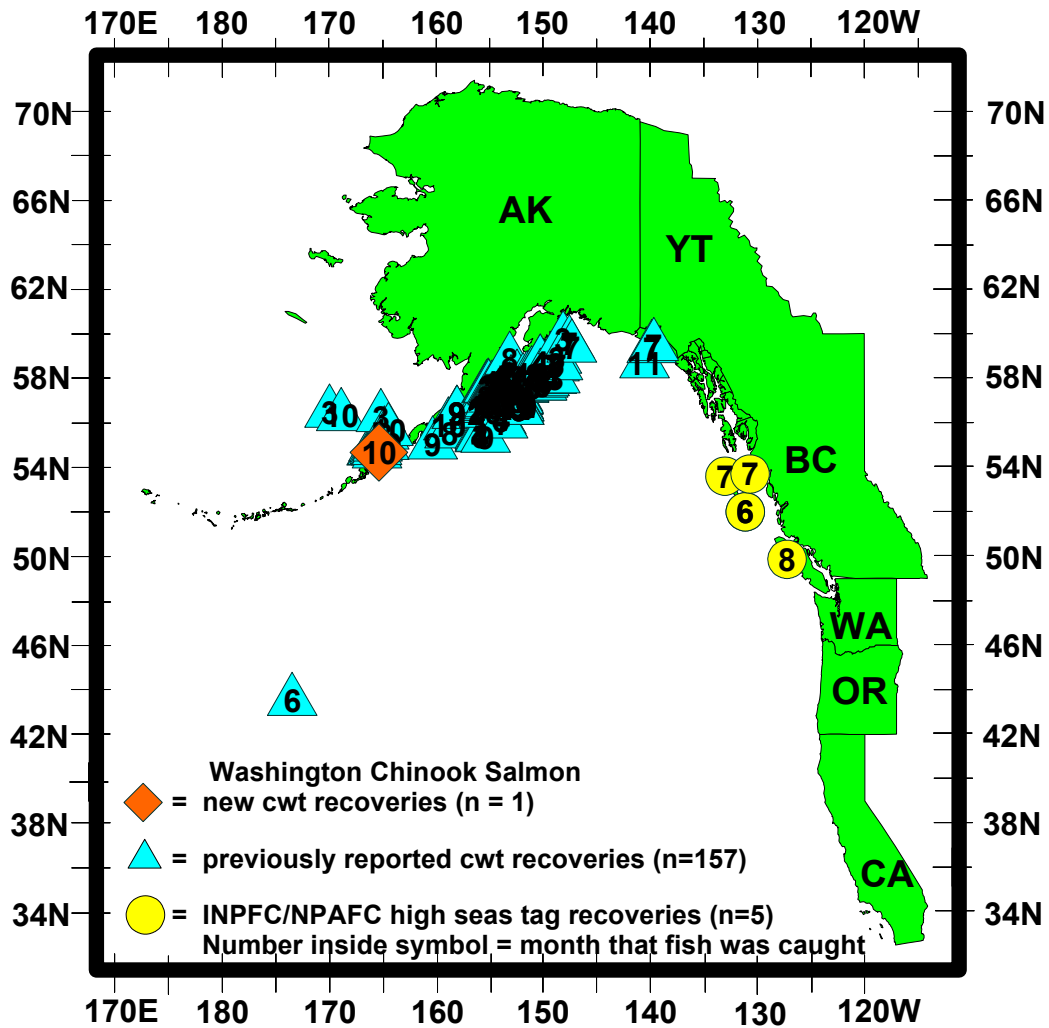


Fig. 16. The ocean distribution of Washington chinook salmon, as shown by high seas tag recoveries, 1956-2004. Processing plant recoveries of coded wire tagged (cwt) fish are not included. The geographic location of one new recovery of a cwt fish (Table 2, Fish no. 17) is indicated in the figure by a closed diamond. Coastal recoveries south of British Columbia are not shown. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

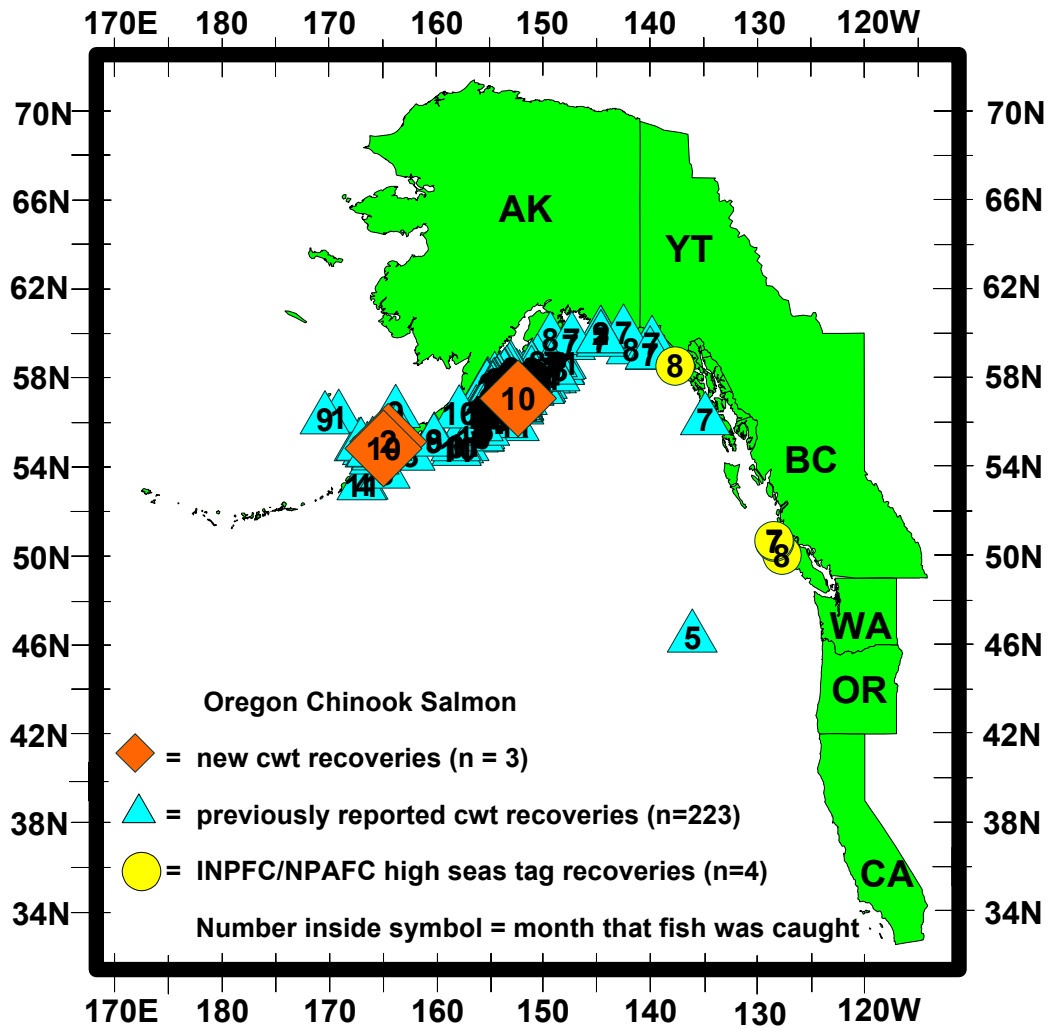


Fig. 17. The ocean distribution of Oregon chinook salmon, as shown by high seas tag recoveries, 1956-2004. Processing plant recoveries of coded wire tagged (cwt) fish are not included. The geographic locations of three new recoveries of cwt fish (Table 2, Fish nos. 19, 20, and 24) are indicated in the figure by closed diamonds. Coastal recoveries south of British Columbia are not shown. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

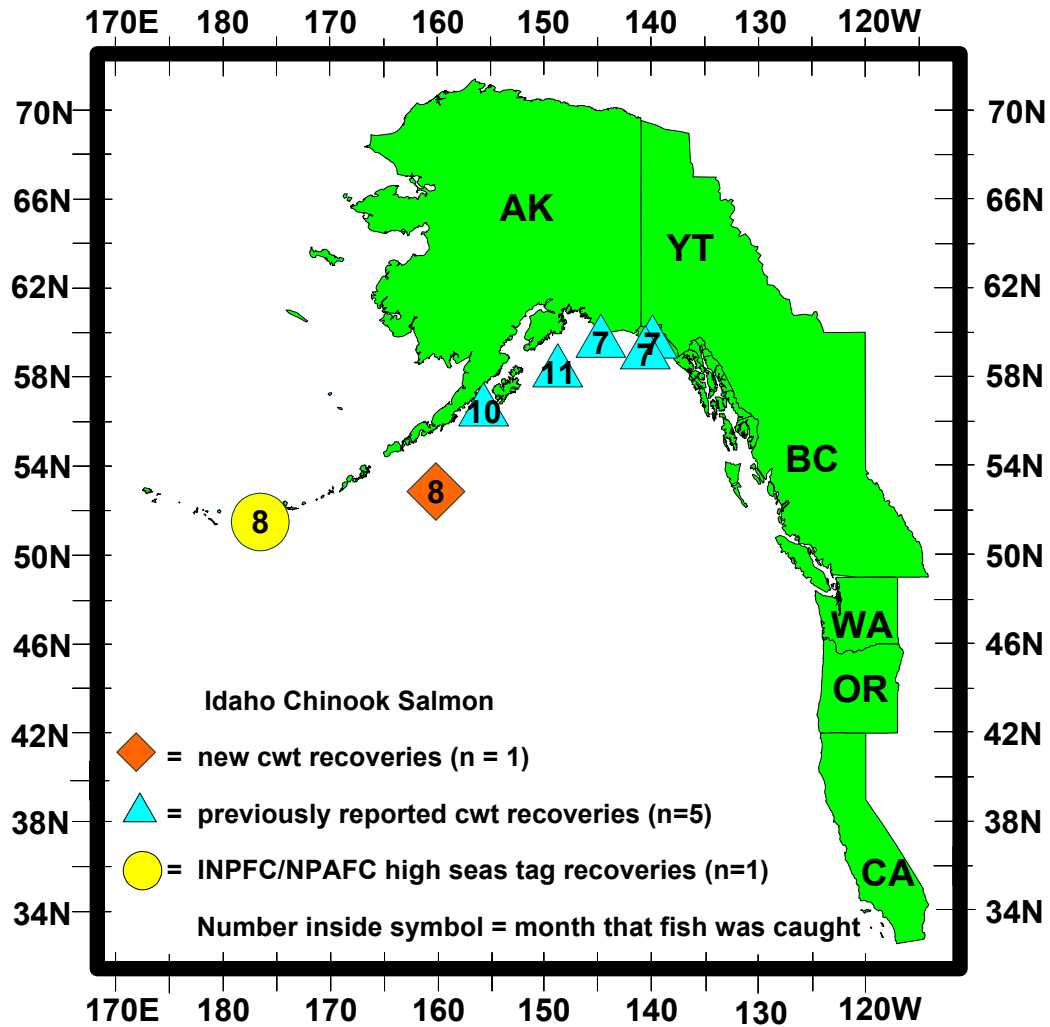


Fig. 18. The ocean distribution of Idaho chinook salmon, as shown by high seas tag recoveries, 1956-2004. The geographic location of one new recovery of a cwt fish (Table 3.2) is indicated in the figure by a closed diamond. Coastal recoveries south of British Columbia are not shown. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

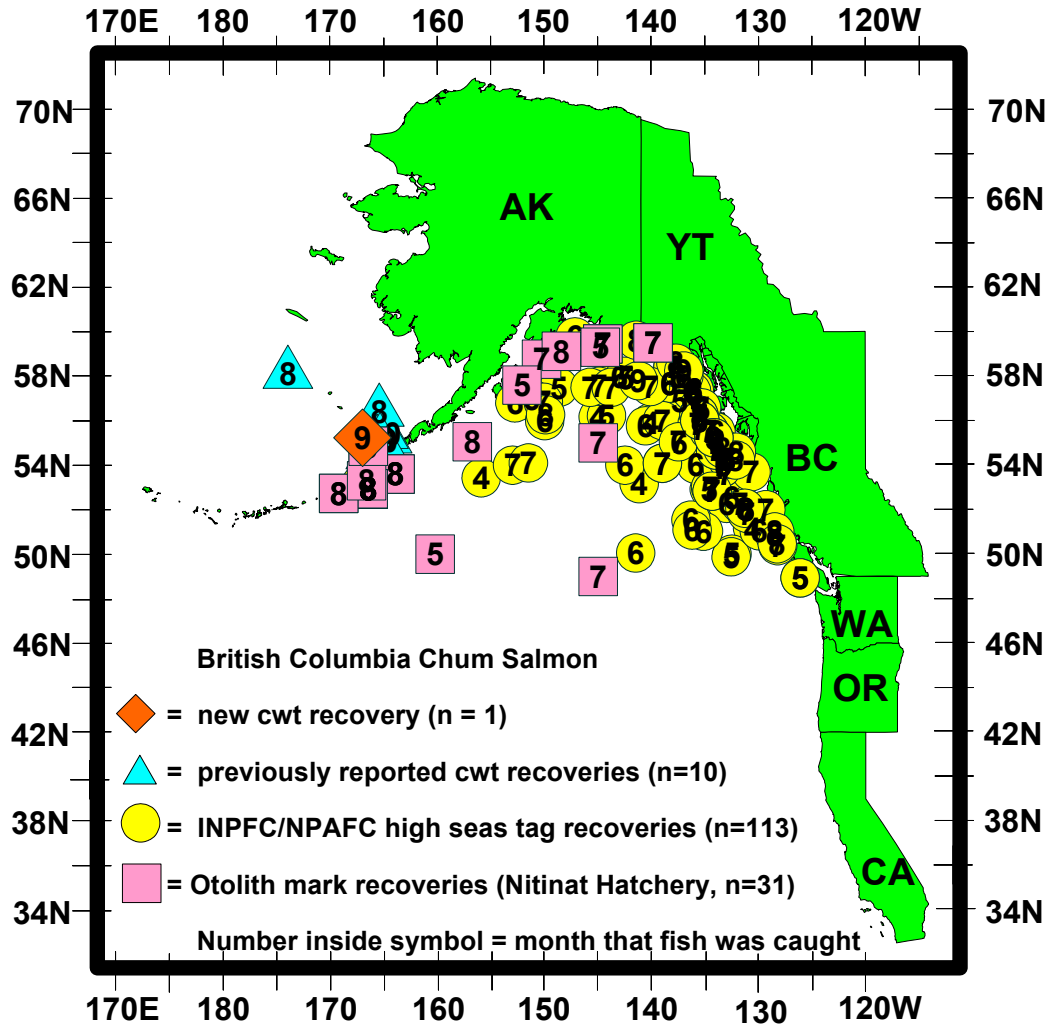


Fig. 19. The ocean distribution of British Columbia chum salmon, as shown by high seas tag and otolith mark recoveries, 1956-2004. The geographic location of one new recovery of a coded-wire tagged fish (Table 4) is indicated in the figure by a closed diamond. Recoveries of otolith-marked immature and maturing British Columbia hatchery chum salmon (Nitinat Hatchery, Vancouver Island) in 1997 and 1998 were reported by Farley and Munk (1998), Carlson et al. (2000), and Urawa et al. (2000). An additional 38 recoveries of otolith-marked British Columbia chum salmon in the 1994-1996 Bering Sea walleye pollock (*Theragra chalcogramma*) trawl fishery, reported by Ignell et al. (1997), are not shown. Processing plant recoveries of CWT fish are not shown. AK=Alaska, YT=Yukon Territory, BC=British Columbia, WA=Washington, OR=Oregon, CA=California.

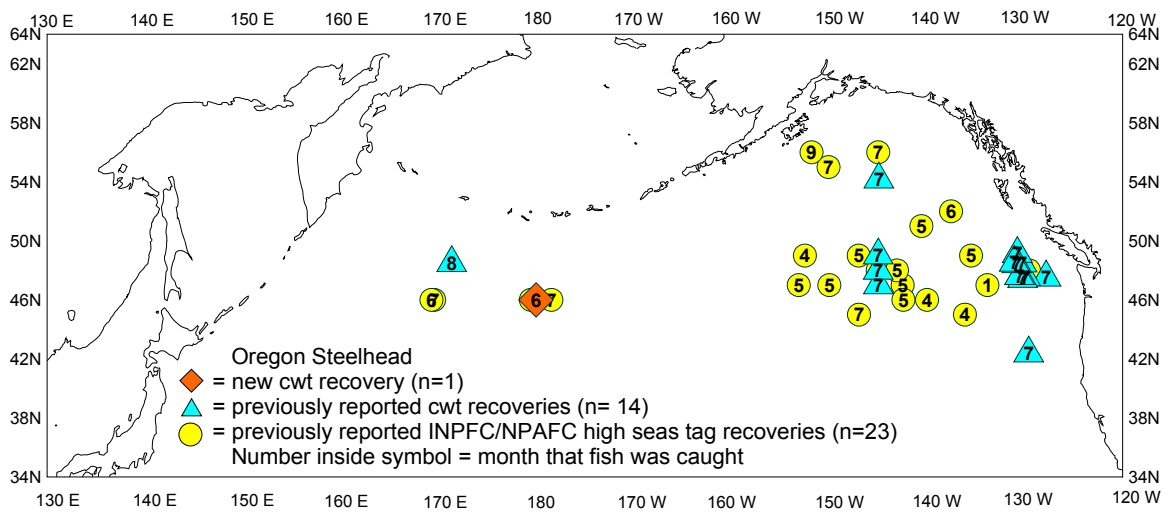


Fig. 20. The ocean distribution of Oregon steelhead trout, as shown by INPFC/NPAFC high seas tag and CWT recoveries, 1956-2004. The geographic location of one new recovery of a CWT steelhead (Table 2.3) is indicated by a closed diamond.

Central North Pacific

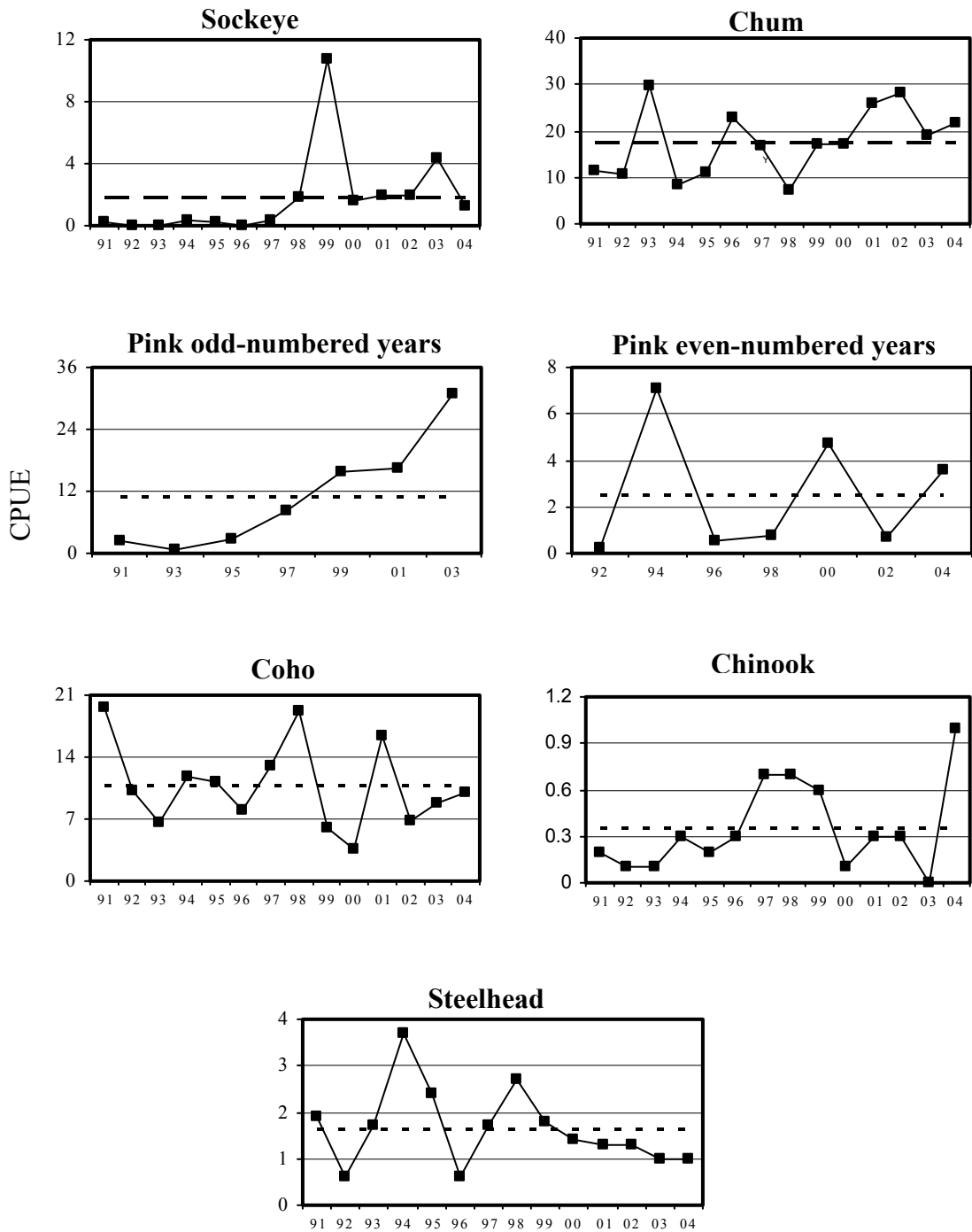
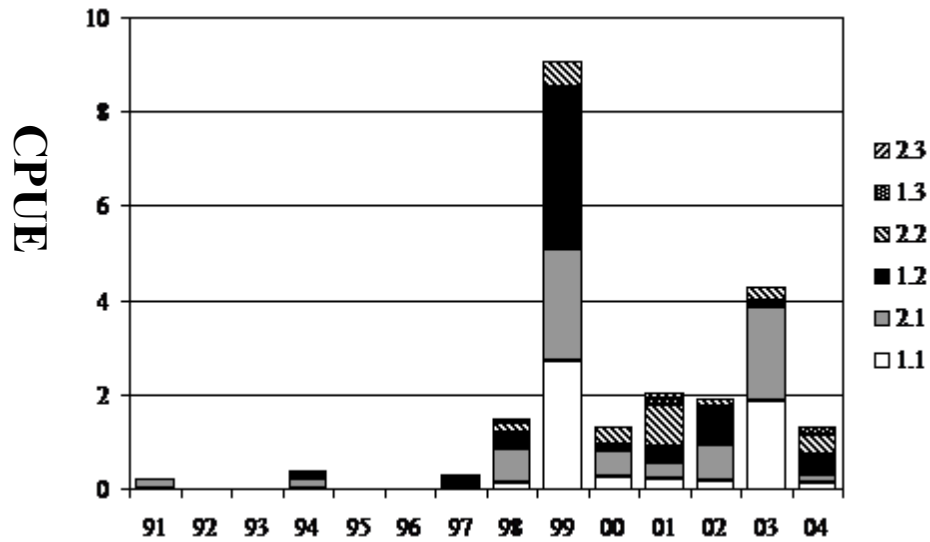


Fig. 21. Annual catch (number of salmonids) per unit of effort (CPUE; 30-tans, 1500 m) by research-mesh gillnet (C-gear) from fishing operations of the *Wakatake maru* in the central North Pacific Ocean 1991-2004. Solid line=annual CPUE, dashed line=mean CPUE 1991-2004.

Sockeye Central North Pacific



Chum Central North Pacific

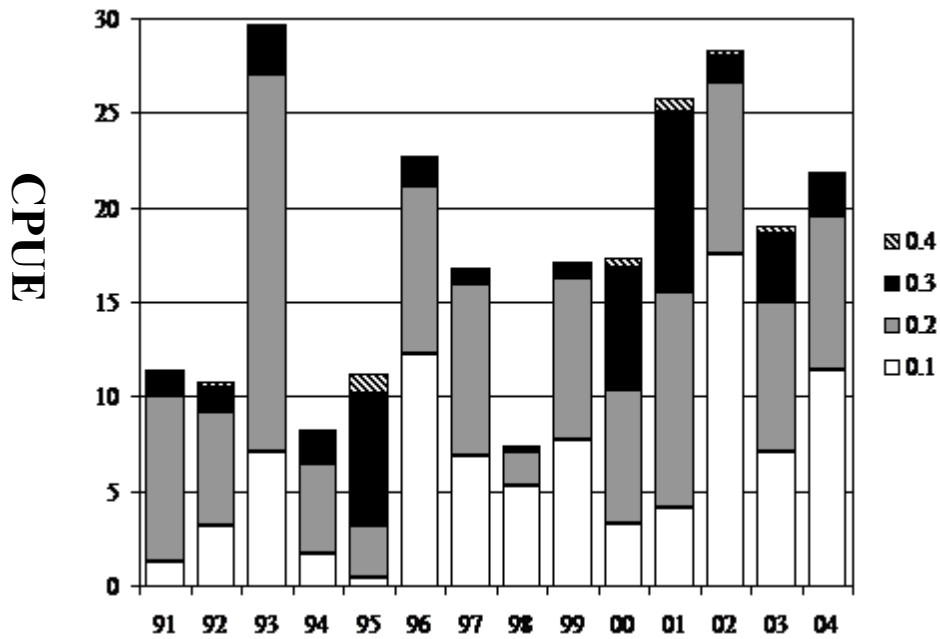


Fig. 22. Estimates of CPUE represented by each age group of sockeye and chum salmon in the central North Pacific Ocean, 1991-2004. CPUE=number of fish per unit (30-tans) of effort by C-gear (research-mesh gillnet). Values estimated by multiplying CPUE by % age composition and dividing by 100.

Central Bering Sea

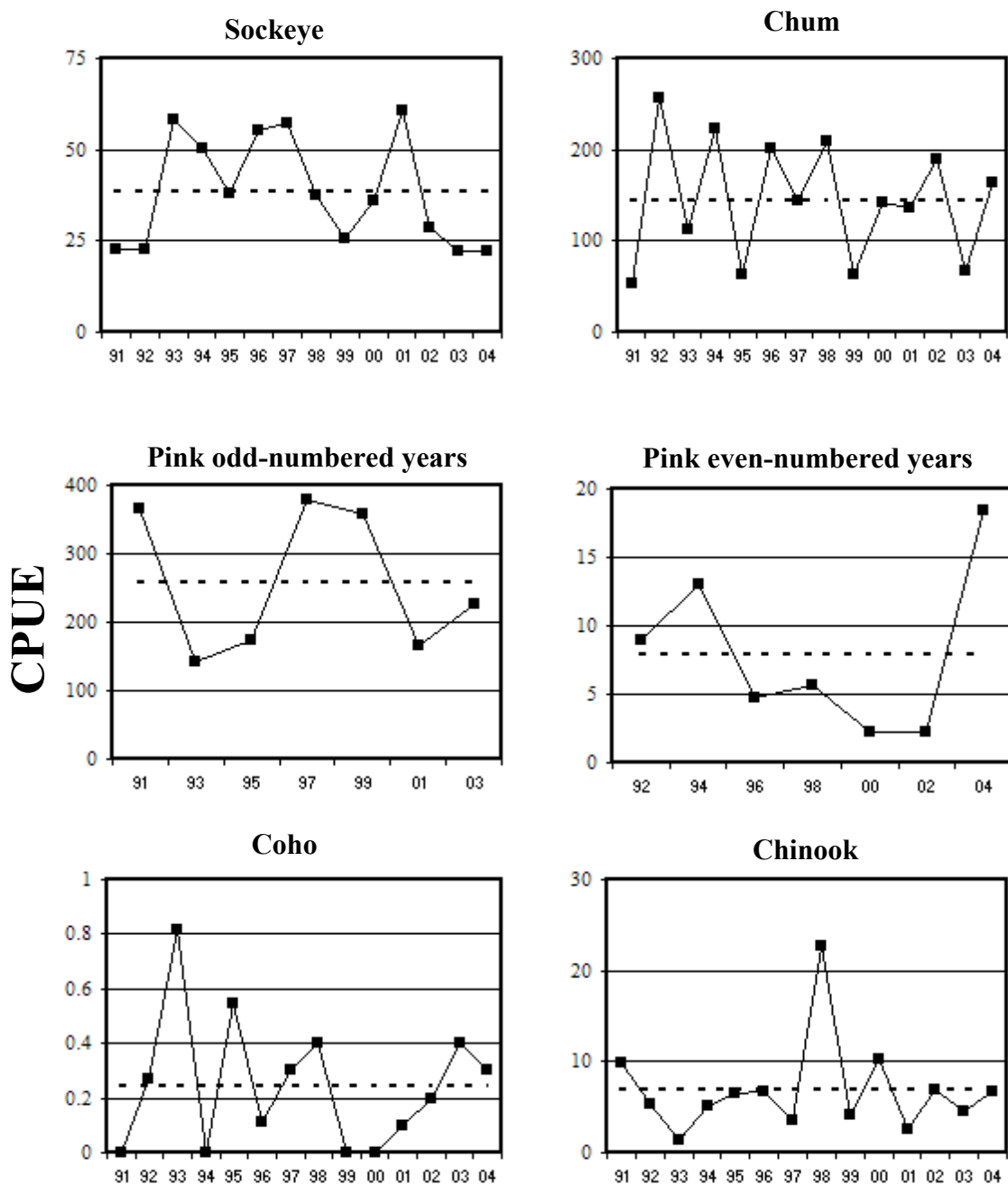


Fig. 23. Annual catch (number of salmonids) per unit of effort (CPUE; 30-tans, 1500 m) by research-mesh gillnet (C-gear) from fishing operations of the *Wakatake maru* in the central North Pacific Ocean 1991-2004. Solid line=annual CPUE, dashed line=mean CPUE 1991-2004.

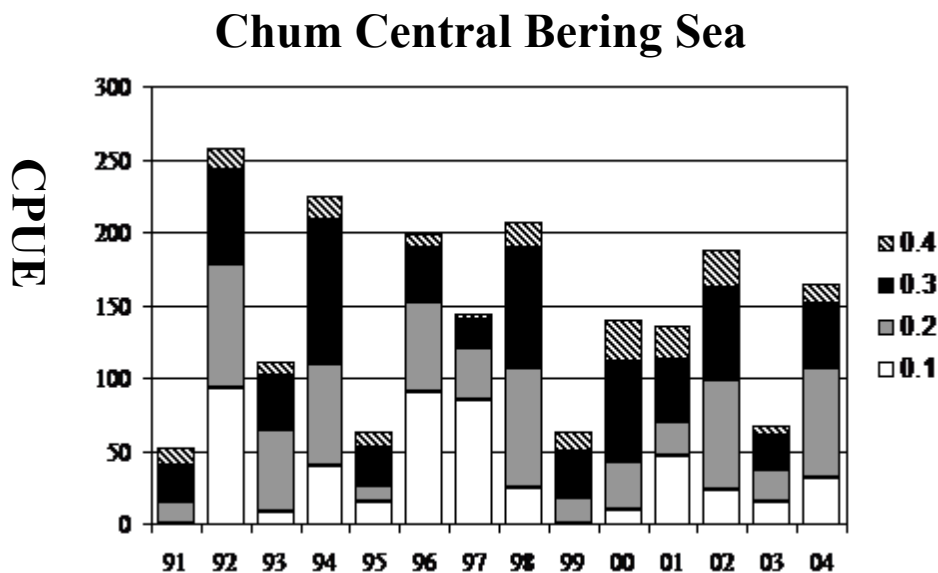
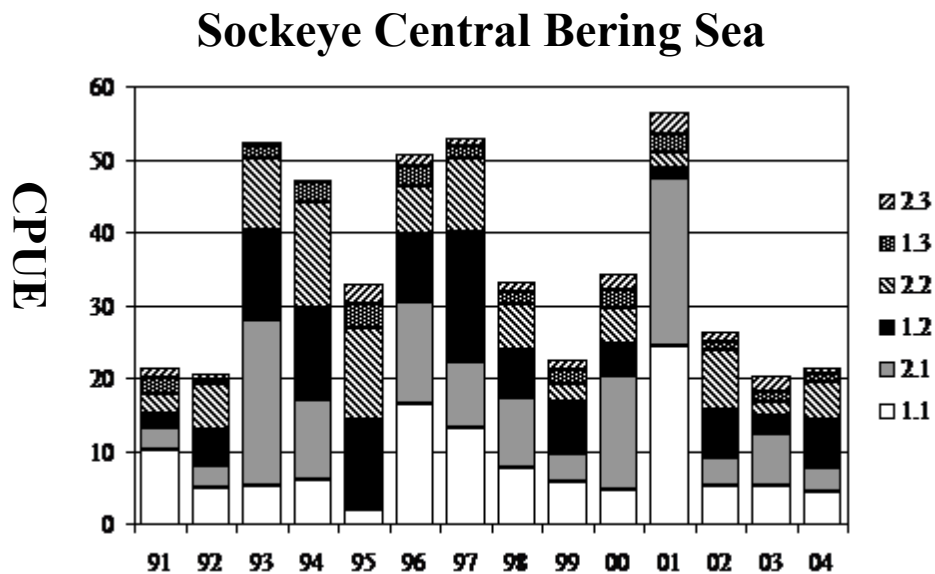


Fig. 24. Estimates of CPUE represented by each age group of sockeye and chum salmon in the central Bering Sea, 1991-2004. CPUE=number of fish per unit (30-tans) of effort by C-gear (research-mesh gillnet). Values estimated by multiplying CPUE by % age composition and dividing by 100.

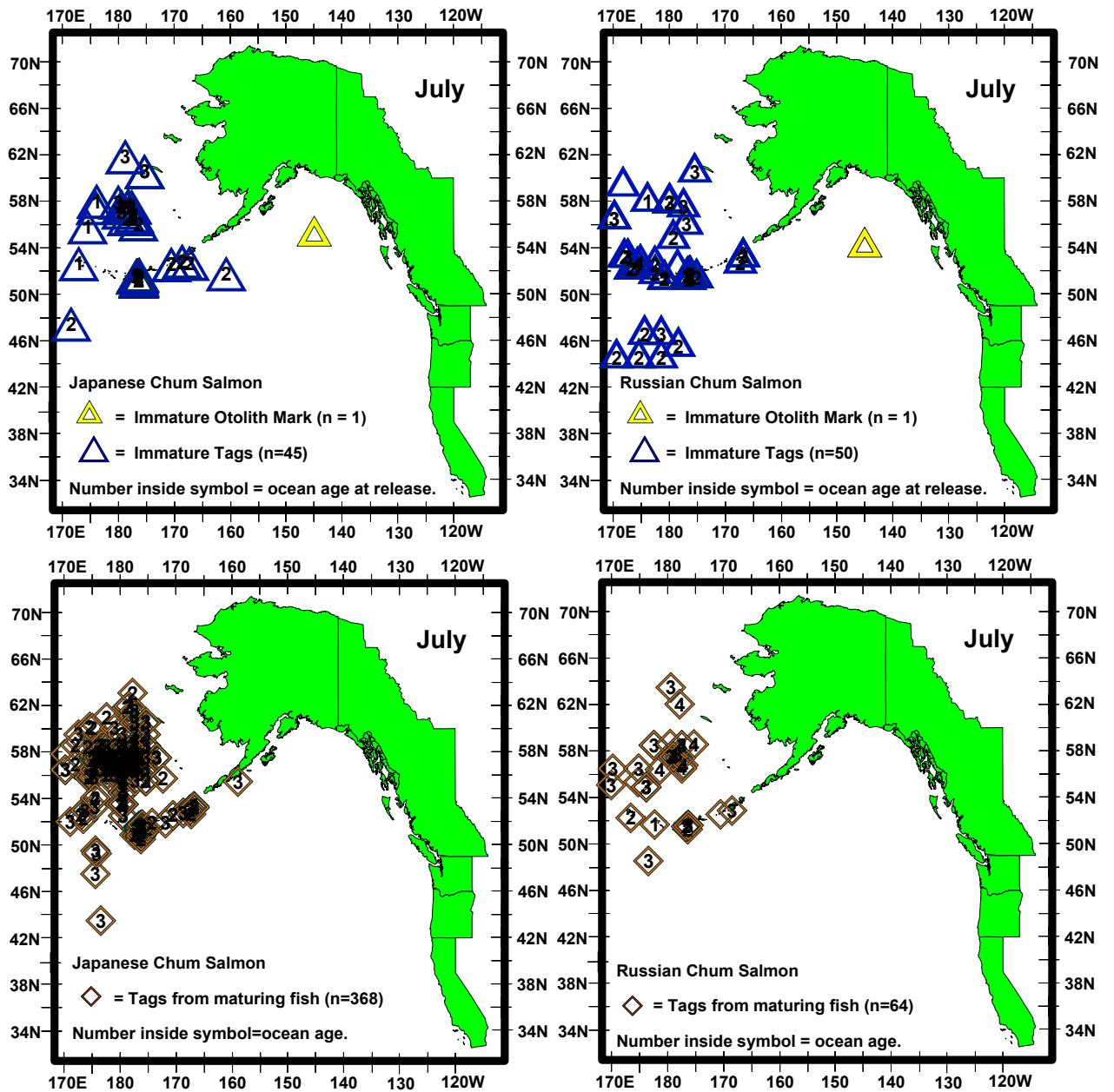


Fig. 25. Maps showing July 2002 Gulf of Alaska recovery locations of an otolith-marked Japanese hatchery chum salmon (top left panel, 1 fish) and an otolith-marked Russian hatchery chum salmon (upper right panel, 1 fish) with respect to information from high seas tagging experiments (1956-2003). The maturity of the Japanese chum salmon was unknown, but for purposes of illustration we assumed that it was an immature fish. The symbols for tags indicate the release locations of tagged immature fish (top panels) and maturing fish (bottom panels) that were later recovered in Japan and Russia. Recoveries of high seas tagged salmon from release locations west of 170°E are not shown.

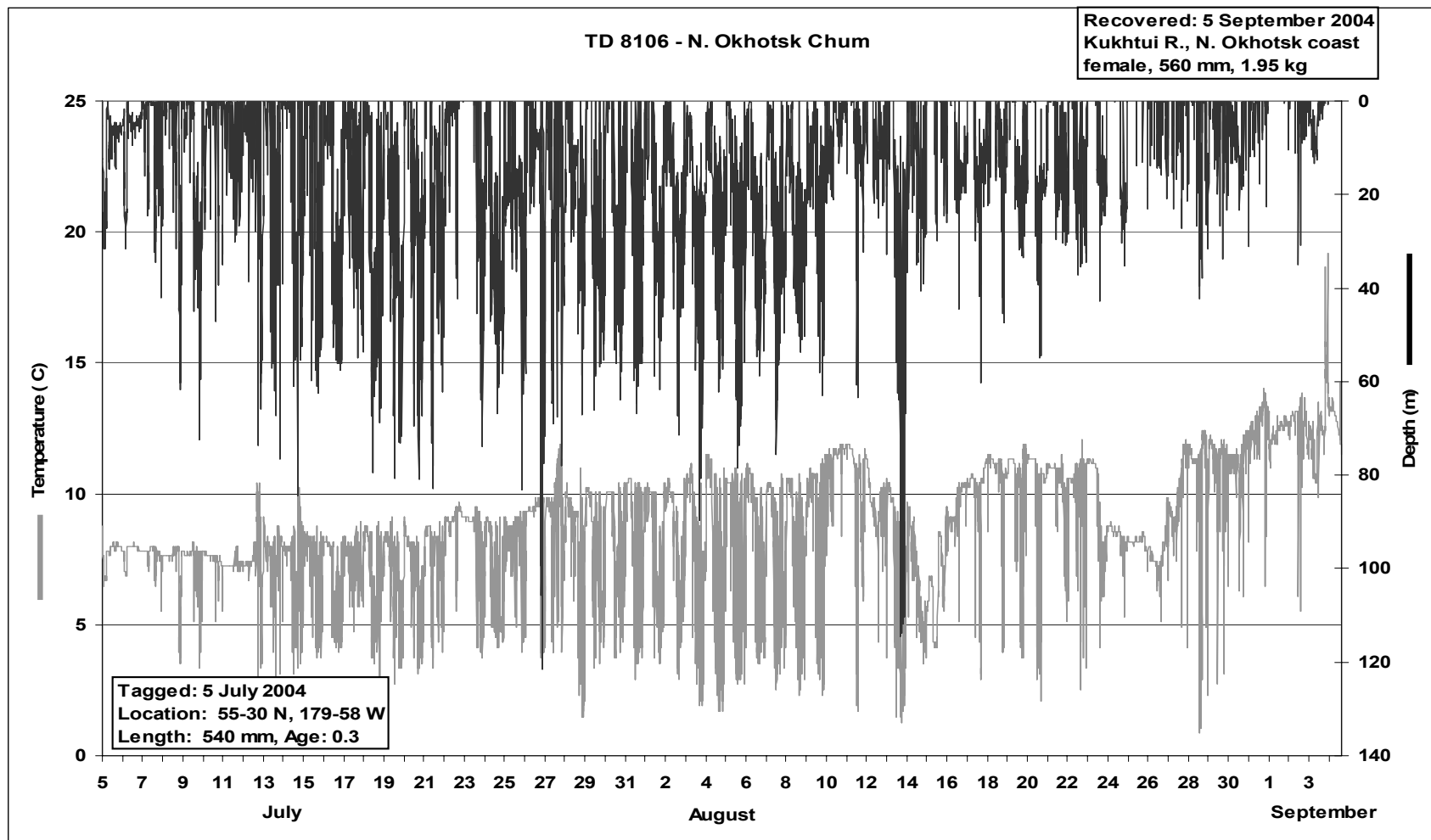


Fig. 26. Temperature and depth data recorded on a data storage tag placed on a 540 mm chum salmon in the Bering Sea on 5 July 2004 and recovered in the Kukhtui River, north Okhotsk Sea coast of Russia, on 5 September 2004.

Table 1. Snout samples collected for potential recovery of coded-wire tags from adipose fin-clipped salmonids caught by the *Wakatake maru*, summer, 2004. Gear: A=commercial-mesh gillnet; C=research-mesh gillnet; followed by mesh size (mm); B=surface longline..

Date	Location		Gear	Species	Fork Length (mm)	Body Weight (g)	Sex	Gonad Weight (g)	Age	Sample Number
	Latitude	Longitude								
6/18/04	42°00'N	180°00'	A115	steelhead	566	1790	M	3	1.1	11-16
6/19/04	43°00'N	180°00'	A115	steelhead	583	2000	M	5	1.1	21-4
6/20/04	44°00'N	180°00'	A115	steelhead	550	1570	M	3	1.1	34-6
6/20/04	44°00'N	180°00'	A115	steelhead	662	2550	F	15	1.2	34-7
6/21/04	45°00'N	180°00'	C157	steelhead	823	6200	M	5	1.2	40-2
6/21/04	45°00'N	180°00'	A115	steelhead	650	2550	M	1	1.2	46-1
6/21/04	45°00'N	180°00'	A115	steelhead	637	2350	F	5	1.1	46-2
6/21/04	46°00'N	180°00'	B	steelhead	715	3580	F	17	1.2	47-7
6/22/04	46°00'N	180°00'	C121	steelhead	660	3000	M	6	1.2	49-8
6/22/04	46°00'N	180°00'	A115	steelhead	607	2300	M	5	1.1	58-6
6/22/04	46°00'N	180°00'	A115	steelhead	693	3800	F	25	1.2	58-7
6/22/04	46°00'N	180°00'	A115	steelhead	686	3250	F	28	1.2	58-8
6/23/04	47°00'N	180°00'	A115	steelhead	558	1900	M	5	1.1	68-10
6/24/04	47°30'N	180°00'	C106	steelhead	538	1520	M	5	1.1	75-9
6/24/04	48°30'N	180°00'	B	steelhead	738	3950	M	5	1.2	83-7
6/26/04	50°30'N	180°00'	B	steelhead	686	3480	F	38	1.3	84-6
7/6/04	57°30'N	179°00'W	A115	pink	459	1360	M	105	0.1	168-5
7/7/04	57°30'N	178°00'W	A115	chinook	605	2850	M	2	1.2	191-1
7/9/04	56°30'N	179°00'W	C121	chinook	592	2450	M	5	X.2	231-15

Table 2. Release and recovery information for coded-wire tagged chinook salmon (*Oncorhynchus tshawytscha*) caught in 2002-2004 U.S. commercial groundfish trawl fisheries for walleye pollock (*Theragra chalcogramma*) in the Bering Sea, Aleutian Islands, and Gulf of Alaska. All recoveries in the table are reported for the first time (1 September 2003-31 August 2004 reporting period). Run type: SP=spring, SU=summer, F=fall. Rearing type: H=hatchery, W=wild. State: AK=Alaska, BC=British Columbia, OR=Oregon, WA=Washington, YT=Yukon Territory. TSFT=Tip of snout to fork of tail length. Wt=whole body weight. Sex: M=male, F=female. NMFS statistical areas are shown in Appendix Fig. 1.

Fish no.	Tag code	Species	Stock short name	Run type	Rearing type	Brood year	Release site (Region ¹)	Release site (Basin ²)	Release location	State	Release agency ³	Release date (yymmdd)	Recovery date (yymmdd)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)	Hemisphere	TSFT (mm)	Wt (gm)	Sex
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1. Bering Sea Recoveries

1.	182353	CHINOOK	S-YUKON R	SP	H	99	YUKN	YUKN	R-WOLF CR/YUKN	YT	CDFO	000610	030303	56	26	169	55	W	650	3300	F
2.	184412	CHINOOK	S-YUKON R	SP	H	00	YUKN	YUKN	R-MCCLINTO CK R	YT	CDFO	010608	040319	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 513					610	2580	F
3.	310241	CHINOOK	DECEPTION CR 247-41		H	00	CNAK	COOK	DECEPTION CR 247-41	AK	ADFG	010619	030316	55	54	164	41	W	530	1900	F
4.	310242	CHINOOK	DECEPTION CR 247-41		H	00	CNAK	COOK	DECEPTION CR 247-41	AK	ADFG	010619	030729	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 517					660	3470	F
5.	310241	CHINOOK	DECEPTION CR 247-41		H	00	CNAK	COOK	DECEPTION CR 247-41	AK	ADFG	010619	030912	56	43	172	30	W	710	5090	M

Table 2. (cont'd)

1. Bering Sea Recoveries

Fish no.	Tag code	Species	Stock short name	Run type	Rearing type	Brood year	Release site (Region ¹)	Release site (Basin ²)	Release location	State	Release agency ³	Release date (yymmdd)	Recovery date (yymmdd)	Latitude (deg)	Latitude (min)	Longitude (deg)	Long (min)	Hemisphere	TSFT (mm)	Wt (gm)	Sex
6.	310243	CHINOOK	DECEPTION CR 247-41		H	00	CNAK	COOK	DECEPTION CR 247-41	AK	ADFG	010619	030930	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 519							
7.	040142	CHINOOK	UNUK R 101-75		W	98	SEAK	SEAK	UNUK R 101-75	AK	ADFG	991018	040217	56	47	165	22	W	890	9540	F
8.	040157	CHINOOK	CRYSTAL CR		H	99	SEAK	SEAK	AUKE BAY 111-50	AK	DIPC	010613	030930	56	36	167	55	W	620	3090	
9.	184348	CHINOOK	S-BULKLEY R UP	SP	H	00	NASK	SKNA	R-BULKLEY R UP	BC	CDFO	020503	040125	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 517					590	2600	
10.	184354	CHINOOK	S-ATNARKO R LOW	SU	H	99	COBC	CCST	R-ATNARKO R LOW	BC	CDFO	000606	040219	55	5	164	51	W	880	8840	F
11.	184654	CHINOOK	S-ATNARKO R LOW	SU	H	01	COBC	CCST	R-ATNARKO R LOW	BC	CDFO	020605	040308	55	24	164	5	W	560	2200	F
12.	184307	CHINOOK	S-KENNEDY R LOW	F	H	99	WCVI	SWVI	R-KENNEDY R LOW	BC	CDFO	000530	040207	55	10	164	25	W	730	5380	
13.	184703	CHINOOK	S-KENNEDY R LOW	F	H	00	WCVI	SWVI	R-KENNEDY R LOW	BC	CDFO	010525	030216	55	56	163	9	W	480	1800	

Table 2. (cont'd)

1. Bering Sea Recoveries

Fish no.	Tag code	Species	Stock short name	Run type	Rearing type	Brood year	Release site (Region ¹)	Release site (Basin ²)	Release location	State	Release agency ³	Release date (yymmdd)	Recovery date (yymmdd)	Latitude (deg)	Latitude (min)	Longitude (deg)	Long (min)	Hemisphere	TSFT (mm)	Wt (gm)	Sex
14.	184701	CHINOOK	S-KENNEDY R LOW	F	H	00	WCVI	SWVI	R-KENNEDY R LOW	BC	CDFO	010525	040225	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 509					650	3155	F
15.	183224	CHINOOK	S-KENNEDY R LOW	F	H	01	WCVI	SWVI	R-KENNEDY R LOW	BC	CDFO	020601	031008	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 509					500	1600	M
16.	184360	CHINOOK	S-SARITA R	F	H	00	WCVI	SWVI	R-POETT - NOOK	BC	CDFO	010606	040123	54	59	164	58	W	670	4040	
17.	210165	CHINOOK	QUINAULT LK (21)	F	H	99	NWC	QEQU	QUINAULT LK (21)	WA	QDNR	000831	021011	54	40	165	24	W	690	4400	
18.	630778	CHINOOK	PRIEST RAPIDS (36)	F	H	00	CECR	KLIC	KLICKITAT R 30.0002	WA	WDFW	010531	030912	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 519					580	2780	F
19.	093028	CHINOOK	SANTIAM R S FK	SP	H	99	LOCR	WILL	SANTIAM R S FK	OR	ODFW	010312	040208	55	8	164	31	W	750	5670	F
20.	093315	CHINOOK	SALMON R	F	H	00	NOOR	SIYA	SALMON R	OR	ODFW	010825	031001	54	50	164	58	W	640	3720	M

Table 2. (cont'd)

2. Gulf of Alaska Recoveries

Fish no.	Tag code	Species	Stock short name	Run type	Rearing type	Brood year	Release site (Region ¹)	Release site (Basin ²)	Release location	State	Release agency ³	Release date (yyymmdd)	Recovery date (yyymmdd)	Latitude (deg)	Latitude (min)	Longitude (deg)	Long (min)	Hemisphere	TSFT (mm)	Wt (gm)	Sex
21.	182246	CHINOOK	S-CHUCK-WALLA R	SP	H	00	COBC	RIVR	R-CHUCK-WALLA R	BC	CDFO	010624	030826	58	1	153	24	W	670	4500	M
22.	184557	CHINOOK	S-NITINAT R	F	H	00	WCVI	SWVI	R-NITINAT LK	BC	CDFO	010606	030223	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 630					470	1350	M
23.	184309	CHINOOK	S-KENNEDY R LOW	F	H	01	WCVI	SWVI	R-KENNEDY R LOW	BC	CDFO	020601	040121	55	34	160	15	W	550	2025	M
24.	092109	CHINOOK	GARDINER CR (UMPQUA)	F	H	01	SOOR	UMPQ	UMPQUA R	OR	ODFW	20020619	031009	57	5	152	24	W	510	2200	

¹Region: CECR=Central Columbia R, CNAK=central Alaska, COBC=Coastal British Columbia, LOCR=Lower Columbia R, NASK=Nass R - Skeena R, NOOR=North Coastal Oregon, NWC=North Washington Coast, SEAK=Southeast Alaska, SOOR=South Coastal Oregon, WCVI=Western Vancouver Island, YUKN=Yukon Territory (Yukon R in Yukon Territory only).

²Basin (if different than region): CCST=Central Coastal BC, COOK=Cook Inlet, KIIC=Klickitat R, QEQU=Queets R - Quinault R, RIVR=Rivers and Smith Inlets, SIYA=Siletz R - Yaquina R, SKNA=Skeena R, SWVI=SW Vancouver I, UMPQ=Umpqua, WILL=Willamette R.

³Agency: ADFG=Alaska Department of Fish & Game, CDFO=Canadian Department of Fisheries and Oceans, DIPC=Douglas Island Pink & Chum, Inc., ODFW=Oregon Department of Fish & Wildlife, QDNR=Quinault Department of Natural Resources, WDFW=Washington Department of Fish & Wildlife.

Table 3. Release and recovery information for coded-wire tagged salmonids (*Oncorhynchus* spp.) caught in Japanese salmon research gillnets, trawls, and longlines in the Bering Sea and North Pacific Ocean. All recoveries in the table are reported for the first time (1 September 2003 - 31 August 2004 reporting period). Species: CHIN=chinook salmon (*O. tshawytscha*), STEEL=steelhead trout (*O. mykiss*). Run type: W=winter. Rearing type: H= Hatchery. State: AK = Alaska, ID=Idaho, OR = Oregon. TSFT = Tip of snout to fork of tail length. Wt = whole body weight. Sex: M = male, F = female. Gear: G=research gillnet, L=research longline, T=research trawl.

Tag code	Species	Stock short name	Run type	Rearing type	Brood year	Release site (Region ¹)	Release site (Basin ²)	Release location	Release State	Release agency ³	Release date (yymmdd)	Recovery date (yymmdd)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)	Hemisphere	TSFT (mm)	Wt (gm)	Sex	Gear	Vessel type
2.1 Bering Sea Recoveries																						
310251	CHIN	CROOK-ED CR 244-30		H	01	CNAK	COOK	CROOKED CR 244-30	AK	ADFG	020605	040709	56	30	179	0	W	592	2450	M	G	Japan
2.2 Gulf of Alaska Recoveries																						
108671	CHIN	S FK SALMON		H	00	SNAK	SALM	SFK SAL@ KNOX BRIDGE	ID	IDFG	020328	030803	52	51	160	10	W	529	2040	F	T	Japan
2.3 Central North Pacific Ocean Recoveries																						
093350	STEEL	HOOD R	W	H	01	CECR	HOO	HOOD R E FK	OR	ODFW	020515	040621	46	0	180	0		715	3580	F	L	Japan

¹Region: CNAK=central Alaska, LOCR=Lower Columbia R, NOOR=North Coastal Oregon, NWC=North Washington Coast, SEAK=Southeast Alaska, SNAK=Snake R, UPCR=Upper Columbia R, YUKN=Yukon Territory (Yukon R. in Yukon Territory only).

²Basin (if different than region): CLEA=Clearwater R, COOK=Cook Inlet, GRIA=Grand Ronde R-Imnaha R-Asotin Cr, MEOK=Methow R - Okanogan R, QUHO=Quillayute R-Hoh R, WTN=Wilson, Trask, Nestucca, YOCL=Youngs Bay-Clatskanie R.

³Agency: ADFG=Alaska Department of Fish & Game, CDFO=Canadian Department of Fisheries and Oceans, DIPC=Douglas Island Pink and Chum, Inc., FWS=U.S. Fish and Wildlife Service, IDFG=Idaho Department of Fish and Game, ODFW=Oregon Department of Fish & Wildlife, SJ=Sheldon Jackson College, SSRA=Southern Southeast Regional Aquaculture Association, WDFW=Washington Department of Fish & Wildlife.

Table 4. Release and recovery information for coded-wire tagged chum salmon (*Oncorhynchus keta*) caught in 2003 U.S. commercial groundfish trawl fisheries for walleye pollock (*Theragra chalcogramma*) in the Bering Sea. All recoveries in the table are reported for the first time (1 September 2003-31 August 2004 reporting period). Run type: F=fall. Rearing type: H=hatchery. State: BC=British Columbia. TSFT=Tip of snout to fork of tail length. Wt=whole body weight. Sex: U=unknown. NMFS statistical areas are shown in Appendix Fig. 1.

Fish no.	Tag code	Species	Stock short name	Run type	type	Brood year	Release site (Region ¹)	Release site (Basin ²)	Release location	State	Release agency ³	Release date (yyymmdd)	date (yyymmdd)	(deg)	(min)	Longitude (deg)	Long (min)	Hemisphere	TSFT (mm)	Wt (gm)	Sex
1.	184658	CHUM	S-SLIAMMON R	F	H	00	GST	GSMN	R-SLIAMMON R	BC	CDFO	010523	030816	Processing plant recovery from catch in NMFS Bering Sea Statistical Area 517			W	550	1970	U	
2.	184660	CHUM	S-SLIAMMON R	F	H	00	GST	GSMN	R-SLIAMMON R	BC	CDFO	010523	030921	55	14	167	1	W	560	2010	U

¹Region: GST=Georgia Strait.

²Basin (if different than region): Georgia Strait – Mainland North.

³Agency: CDFO=Canadian Department of Fisheries and Oceans.

Table 5. Mean catch (number of salmonids) per unit (30-tans, 1500 m) of effort by research-mesh gillnet (C-gear) caught by *Wakatake maru* cruises, 1991-2004. C-gear is composed of 3 tans each of the following mesh sizes: 48, 55, 63, 72, 82, 93, 106, 121, 138, and 157 mm.

Year	Sampling Dates	No. of Sta.	Locations	Mean Temperature		Mean Salinity		Mean Catch per 30 tans C-gear									
				0 m	100m	0 m	100m	Sock-eye	Chum	Pink	Coho	Chi-nook	Steel-head	Dolly Varden	Masu	Total	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
2002	15-23 Jun	8	41°N-47°N, 180°	8.5	5.4	33.3	33.5	1.9	28.3	0.7	6.9	0.3	1.3	0.0	0.0	39.3	
2003	14-21 Jun	8	41°N-47°N, 180°	8.2	6.0	33.3	33.5	4.3	19.0	31.0	8.9	0.0	1.0	0.0	0.0	64.0	
2004	17-24 Jun	8	41°N-47°N, 180°	8.8	5.6	33.2	33.4	1.3	21.9	3.6	10.1	1.0	1.0	0.0	0.0	38.9	
Central Bering Sea																	
1991	1-8 Jul	8	55°N-58°N, 180°W-177°W	7.6	2.2	33.0	33.2	22.9	53.9	365.5	0.0	9.9	0.0	0.0	0.0	452.1	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
2002	1-14 Jul	13	55°N-58°N, 178°W-176°E	7.0	2.2	33.1	33.2	28.5	189.5	2.2	0.2	6.9	0.0	0.0	0.0	227.2	
2003	29 Jun-12 Jul	14	55°N-58°N, 178°W-176°E	7.8	2.6	32.9	33.2	22.4	67.6	227.6	0.4	4.6	0.0	0.0	0.0	322.5	
2004	2-14 Jun	14	55°N-58°N, 178°W-176°E	8.2	2.7	33.1	33.2	22.4	164.4	18.4	0.3	6.8	0.0	0.0	0.0	212.2	

Table 6. Number sampled (n), mean, and standard deviation (sd) of fork length (FL, mm), body weight (BW, g), and condition factor (CF=10⁶*BW/FL³) of sockeye salmon caught by the *Wakatake maru* research gillnet, 1991-2004, by region and ocean age.

Sockeye Salmon-Central North Pacific

Year	% Age		F L		B W		CF		n	% Age		F L		B W		CF	
	n	Age	mean	sd	mean	sd	mean	sd		n	Age	mean	sd	mean	sd	mean	sd
Ocean Age .1																	
1991	2	100	315	5	295	7	9.5	0.2	0								
1992	0								0								
1993	0								0								
1994	2	50	365	49	464	91	9.7	2.0	1	25	452		980		10.6		
1995	0								0								
1996	0								0								
1997	0								5	100	461	41	1116	304	11.3	1.7	
1998	10	59	336	23	361	80	9.4	0.7	6	35	435	22	907	55	11.1	1.2	
1999	54	54	325	21	384	73	11.1	1.2	46	46	436	22	921	127	11.0	0.7	
2000	6	50	310	11	308	16	10.4	0.9	6	50	419	24	817	118	11.0	0.4	
2001	5	28	322	8	326	30	9.8	0.9	11	61	458	36	1097	482	11.0	1.2	
2002	6	50	364	32	493	83	10.3	1.4	6	50	469	22	1103	253	10.5	1.2	
2003	27	90	323	21	377	72	11.2	1.2	3	10	443	52	1037	418	11.5	1.6	
2004	2	22	326	6	350	14	10.1	0.2	6	67	457	18	1052	143	11.0	0.9	
Ocean Age .3																	
1991	0																
1992	0																
1993	0																
1994	1	25	615		3200		13.8										
1995	2	100	606	8	2950	354	13.2	1.0									
1996	0																
1997	0																
1998	1	6	610		3000		13.2										
1999	0																
2000	0																
2001	2	11	544	14	1925	205	11.9	0.3									
2002	0																
2003	0																
2004	1	11	624		3450		14.2										

Table 6. (continued)

Sockeye Salmon-Central Bering Sea

Year	n	% Age	F L		B W		CF		n	% Age	F L		B W		CF	
			mean	sd	mean	sd	mean	sd			mean	sd	mean	sd		
Ocean Age .1									Ocean Age .2							
1991	101	59	313	21	332	70	10.7	1.1	38	22	480	39	1335	477	11.7	1.3
1992	92	39	337	31	392	105	10.1	1.3	126	54	483	31	1364	324	12.0	1.5
1993	297	52	351	25	430	101	9.8	1.0	246	43	483	36	1301	329	11.3	1.1
1994	133	37	340	26	404	97	10.2	1.5	209	57	474	30	1189	255	11.1	1.1
1995	37	10	330	45	399	200	10.5	1.0	292	73	495	30	1447	354	11.8	1.0
1996	270	59	340	29	382	119	9.5	1.1	139	30	472	38	1250	355	11.6	1.4
1997	215	41	341	25	422	97	10.5	0.9	273	53	461	28	1112	217	11.2	1.1
1998	221	56	331	36	403	219	10.9	5.1	141	36	471	43	1275	471	11.8	1.8
1999	121	46	300	24	254	70	9.2	1.5	104	39	477	36	1290	355	11.6	1.5
2000	235	60	317	19	321	63	10.0	1.3	104	27	460	38	1099	311	11.0	1.1
2001	622	83	308	25	314	73	10.6	1.7	44	6	463	36	1066	262	10.6	1.0
2002	125	34	324	26	366	87	10.7	1.3	200	55	476	31	1250	298	11.5	1.1
2003	186	61	345	32	465	126	11.1	0.8	65	21	480	41	1329	463	11.6	1.1
2004	106	36	331	32	392	111	10.6	1.2	158	53	480	35	1327	384	11.7	1.0
Ocean Age .3									Ocean Age .4							
1991	30	18	595	44	2851	781	13.2	1.7	2	1	653	33	4225	460	15.2	0.6
1992	16	7	584	46	2929	803	14.5	3.1	1	0	650		4500		16.4	
1993	31	5	571	44	2423	773	12.6	1.8	2	0	628	20	3275	601	13.1	1.2
1994	23	6	583	38	2643	651	13.1	1.3	0							
1995	70	17	586	58	2599	792	12.6	1.8	2	0	624	63	2925	601	12.1	1.2
1996	48	11	585	54	2659	865	12.9	1.9	0							
1997	30	6	574	58	2489	802	12.6	1.2	0							
1998	33	8	574	44	2715	768	14.0	2.0	0							
1999	40	15	583	41	2691	661	13.3	1.7	0							
2000	53	13	603	42	3198	837	14.2	1.6	0							
2001	70	10	576	46	2605	744	13.3	1.9	4	1	618	30	3335	675	14.0	1.0
2002	30	8	577	62	2584	1024	12.8	1.8	6	2	617	30	3258	663	13.7	1.1
2003	50	17	602	39	3039	767	13.6	1.3	2	1	626	51	3250	778	13.1	0.0
2004	28	10	594	40	2990	732	14.0	2.5	4	1	641	23	3863	320	14.7	0.9

Table 7. Percent ocean and freshwater (FW) age composition and maturity at age of sockeye salmon caught in the central North Pacific by the *Wakatake maru* research gillnet, 1991-2004. Values indicate the percentage of fish in each age and maturity class, grouped by year. I=immature, M=mature, T=total. FW X = unknown freshwater age.

Sockeye Salmon-Central North Pacific

Year	n	FW Age 0			FW Age 1			FW Age 2			FW Age 3			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 1																			
1991	2	0	0	0	0	0	0	100	0	100	0	0	0	0	0	0	100	0	100
1992	0																		
1993	0																		
1994	2	0	0	0	0	0	0	50	0	50	0	0	0	0	0	0	50	0	50
1995	0																		
1996	0																		
1997	0																		
1998	10	6	0	6	6	0	6	41	0	41	6	0	6	0	0	0	59	0	59
1999	54	2	0	2	25	0	25	22	0	22	0	0	0	5	0	5	54	0	54
2000	6	0	0	0	17	0	17	33	0	33	0	0	0	0	0	0	50	0	50
2001	5	0	0	0	11	0	11	17	0	17	0	0	0	0	0	0	28	0	28
2002	6	0	0	0	8	0	8	42	0	42	0	0	0	0	0	0	50	0	50
2003	27	0	0	0	43	0	43	47	0	47	0	0	0	0	0	0	90	0	90
2004	2	0	0	0	11	0	11	11	0	11	0	0	0	0	0	0	22	0	22
Ocean Age 2																			
1991	0																		
1992	0																		
1993	0																		
1994	1	0	0	0	0	0	0	25	0	25	0	0	0	0	0	0	25	0	25
1995	0																		
1996	0																		
1997	5	0	0	0	100	0	100	0	0	0	0	0	0	0	0	0	100	0	100
1998	6	0	0	0	18	0	18	12	0	12	0	0	0	6	0	6	35	0	35
1999	46	3	0	3	30	2	32	5	0	5	0	0	0	5	1	6	43	3	46
2000	6	17	0	17	8	0	8	25	0	25	0	0	0	0	0	0	50	0	50
2001	11	0	0	0	11	6	17	44	0	44	0	0	0	0	0	0	56	6	61
2002	6	0	0	0	42	0	42	8	0	8	0	0	0	0	0	0	50	0	50
2003	3	0	0	0	3	0	3	7	0	7	0	0	0	0	0	0	10	0	10
2004	6	0	0	0	34	0	34	33	0	33	0	0	0	0	0	0	67	0	67

Table 7. (continued)

Sockeye Salmon-Central North Pacific

Year	n	FW Age 0			FW Age 1			FW Age 2			FW Age 3			FW X			All FW Ages		
		I	M	Tot	I	M	Tot	I	M	Tot	I	M	T	I	M	T	I	M	T
Ocean Age 3																			
1991	0																		
1992	0																		
1993	0																		
1994	1	0	0	0	0	25	25	0	0	0	0	0	0	0	0	0	25	0	25
1995	0																		
1996	2	0	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	100	100
1997	0																		
1998	1	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	6	6
1999	0																		
2000	0																		
2001	2	0	0	0	6	0	6	0	6	6	0	0	0	0	0	0	6	6	11
2002	0																		
2003	0																		
2004	1	0	0	0	0	11	11	0	0	0	0	0	0	0	0	0	0	11	11

Table 8. Percent ocean and freshwater age composition and maturity at age of sockeye salmon caught in the central Bering Sea by the *Wakatake maru* research gillnet, 1991-2004. Values indicate the percentage of fish in each age and maturity class, grouped by year. I=immature, M=mature, T=total. FW X = unknown freshwater age.

Sockeye Salmon-Central Bering Sea																			
Year	n	FW Age 0			FW Age 1			FW Age 2			FW Age 3			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 1																			
1991	80	0	0	0	44	0	44	13	0	13	0	0	0	2	0	2	59	0	59
1992	92	1	0	1	22	0	22	13	0	13	0	0	0	3	0	3	39	0	39
1993	297	0	0	0	9	0	9	38	1	39	1	0	1	3	0	3	51	1	52
1994	133	0	0	0	12	0	12	22	0	22	0	0	0	2	0	2	36	0	36
1995	37	1	0	1	5	0	5	1	0	1	0	0	0	1	0	1	9	0	9
1996	266	1	0	1	30	0	30	25	0	25	0	0	0	3	0	3	60	0	60
1997	215	0	0	0	23	0	23	16	0	16	0	0	0	2	0	2	42	0	42
1998	177	2	0	2	20	0	20	26	0	26	1	0	1	3	0	3	51	0	51
1999	121	0	0	0	23	0	23	15	0	15	0	0	0	6	0	6	45	0	46
2000	235	1	0	1	13	0	13	43	0	43	1	0	1	2	0	2	60	0	60
2001	622	2	0	2	40	0	40	38	0	38	1	0	1	3	0	3	84	0	84
2002	125	1	0	1	18	0	18	14	0	14	0	0	0	1	0	1	34	0	34
2003	186	1	0	1	23	0	23	31	1	32	2	0	2	3	0	3	60	1	61
2004	105	0	0	0	20	0	20	14	0	14	1	0	1	1	0	1	36	0	36
Ocean Age 2																			
1991	31	0	0	0	7	1	9	10	1	12	1	0	1	1	1	1	19	4	23
1992	125	0	0	1	19	3	22	23	4	27	1	0	1	2	1	3	46	8	53
1993	246	0	0	0	19	2	21	16	2	17	0	0	0	4	0	4	39	3	43
1994	209	0	0	0	23	2	25	27	2	29	1	0	1	2	0	3	54	4	57
1995	292	0	0	0	26	5	32	26	7	33	1	0	1	5	1	6	59	14	73
1996	133	0	0	0	15	1	17	11	0	12	0	0	0	1	0	1	28	2	30
1997	273	0	0	0	27	3	31	16	2	18	1	0	1	3	1	4	47	6	53
1998	136	1	0	1	16	1	17	15	2	17	1	1	1	2	1	3	35	5	39
1999	104	0	0	0	25	4	28	9	0	9	0	0	0	1	1	2	35	5	39
2000	104	0	0	0	12	0	12	13	1	14	0	0	0	1	0	1	26	1	27
2001	44	0	0	0	2	0	2	4	0	4	0	0	0	0	0	0	6	0	6
2002	200	1	0	1	22	1	23	27	2	29	0	0	0	1	0	1	51	3	54
2003	65	1	0	1	10	1	11	7	2	9	0	0	0	0	0	0	18	3	21
2004	157	0	0	0	29	1	30	20	3	23	0	0	0	0	0	0	49	4	53

Table 8. (continued)

Sockeye Salmon-Central Bering Sea																			
Year	n	FW Age 0			FW Age 1			FW Age 2			FW Age 3			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 3																			
1991	23	0	0	0	4	5	10	1	4	5	1	1	1	1	0	1	7	10	17
1992	16	0	0	0	0	3	3	0	3	3	0	0	0	0	0	0	0	6	7
1993	31	0	0	0	1	2	3	1	1	1	0	0	0	0	0	0	2	3	5
1994	23	0	0	0	1	3	5	0	1	1	0	0	0	0	0	0	2	5	6
1995	70	0	0	0	3	5	9	1	6	7	0	0	0	1	0	1	6	12	17
1996	45	0	0	1	2	3	5	1	2	3	0	0	0	0	1	1	4	7	10
1997	30	0	0	0	1	2	3	0	2	2	0	0	0	0	1	1	2	4	6
1998	33	0	0	0	1	3	4	1	3	4	0	0	0	1	1	1	1	7	10
1999	40	0	0	1	3	5	8	1	4	5	0	0	0	0	1	1	5	11	15
2000	53	0	0	0	1	7	7	1	5	6	0	0	0	0	1	1	2	12	14
2001	70	0	0	0	1	3	4	2	3	5	0	0	0	0	0	0	3	7	10
2002	30	0	0	0	2	1	3	2	3	5	0	0	0	0	0	0	4	4	8
2003	50	0	1	1	2	4	6	0	10	10	0	0	0	0	0	0	2	15	17
2004	28	0	0	0	2	3	5	1	3	4	0	1	1	0	0	0	3	7	10
Ocean Age 4																			
1991	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
1992	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0																		
1994	0																		
1995	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0																		
1997	0																		
1998	0																		
1999	0																		
2000	0																		
2001	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	6	0	0	0	0	1	1	0	2	2	0	0	0	0	0	0	0	3	3
2003	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
2004	4	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1

Table 9. Number sampled (n), mean, and standard deviation (sd) of fork length (FL, mm), body weight (BW, g), and condition factor (CF=10⁶*BW/FL³) of chum salmon caught by the *Wakatake maru* research gillnet, 1991-2004, by region and ocean age.

Chum Salmon-Central North Pacific

Year	% Age		F L		B W		C F		n	% Age		F L		B W		C F	
	n	Age	mean	sd	mean	sd	mean	sd		n	Age	mean	sd	mean	sd	mean	sd
Ocean Age .1									Ocean Age .2								
1991	11	11	315	20	300	79	9.4	0.9	81	77	418	25	784	166	10.6	1.0	
1992	30	29	315	12	298	49	9.5	0.8	57	56	423	19	846	167	11.1	1.1	
1993	60	24	337	19	383	95	10.0	2.1	169	67	420	22	805	138	10.8	1.2	
1994	15	20	339	18	415	59	10.6	1.0	44	58	418	28	806	200	10.9	1.1	
1995	7	7	326	25	332	32	9.8	1.8	26	24	473	33	1258	297	11.7	0.8	
1996	111	54	319	18	316	62	9.7	0.9	81	39	437	22	939	159	11.2	1.0	
1997	58	41	309	21	289	68	9.7	1.2	77	54	428	27	865	250	10.9	1.9	
1998	48	73	310	18	285	50	9.5	0.9	15	23	406	22	742	207	10.9	2.0	
1999	68	43	336	22	379	59	9.8	1.7	82	52	414	26	795	128	11.3	2.0	
2000	31	19	322	14	331	53	9.9	1.0	66	41	436	19	947	188	11.4	1.7	
2001	32	15	307	13	282	62	9.6	1.4	96	45	449	35	1064	251	11.6	1.4	
2002	117	64	293	17	254	39	10.1	1.5	56	31	422	26	810	167	10.7	1.0	
2003	54	37	314	14	333	51	11	0.8	62	42	435	34	962	219	11.6	1.2	
2004	79	52	318	15	353	52	10.9	0.9	56	37	439	21	920	216	10.7	1.4	
Ocean Age .3									Ocean Age .4								
1991	13	12	504	51	1520	569	11.5	1.0	0								
1992	12	12	485	18	1306	196	11.4	1.0	3	3	576	49	2333	551	12.1	1.2	
1993	23	9	488	29	1376	451	11.6	2.1	1	0	494		1570		13.0		
1994	16	21	481	28	1214	249	10.8	1.2	1	1	488		1220		10.5		
1995	64	60	494	25	1463	265	12.1	1.6	10	9	522	35	1795	419	12.6	2.5	
1996	13	6	479	32	1212	248	11.0	0.8	1	1	530		1620		10.9		
1997	7	5	499	47	1469	428	11.6	1.0	0								
1998	2	3	515	7	1590	127	11.7	1.4	1	1	573		2300		12.2		
1999	8	5	464	43	1156	415	11.2	1.3	0								
2000	60	37	475	25	1219	240	11.2	1.0	5	3	480	46	1338	393	11.9	0.7	
2001	77	37	488	23	1420	259	12.1	1.6	7	3	527	20	1644	324	11.1	1.3	
2002	9	5	491	27	1448	320	12.3	3.6	1	0	580		2050		10.5		
2003	29	20	538	38	1989	511	12.5	0.9	2	1	544	17	1940	269	12.0	0.5	
2004	15	10	495	21	1287	238	10.5	0.8	1	1	590		2600		12.7		

Table 9. (continued)

Chum Salmon-Central Bering Sea																	
Year	%		F L		B W		CF		n	%		F L		B W		CF	
	n	Age	mean	sd	mean	sd	mean	sd		Age	mean	sd	mean	sd	mean	sd	
Ocean Age .1									Ocean Age .2								
1991	2	1	363	11	450	14	9.4	0.6	112	29	449	34	995	272	10.8	1.0	
1992	928	36	350	22	423	89	9.7	1.1	857	33	429	32	885	265	10.7	1.3	
1993	78	7	368	20	488	90	9.7	0.9	544	51	442	29	942	223	10.7	1.1	
1994	328	18	356	22	438	102	9.6	1.0	582	31	437	32	887	226	10.5	1.1	
1995	155	24	364	44	515	224	10.4	1.7	107	17	482	33	1280	337	11.2	1.6	
1996	732	45	342	21	375	95	9.2	1.0	503	31	440	32	921	231	10.7	1.0	
1997	749	59	340	17	407	76	10.3	0.9	324	25	442	35	955	297	10.8	1.9	
1998	281	14	341	21	396	159	9.8	1.3	786	39	425	37	837	266	10.6	1.3	
1999	0								175	28	453	30	1091	263	11.6	1.4	
2000	106	7	350	25	439	113	10.1	1.3	354	23	466	32	1145	261	11.2	1.0	
2001	594	35	339	22	403	79	10.4	1.6	284	17	466	39	1163	329	11.2	1.0	
2002	266	12	352	28	421	102	9.6	1.3	900	40	451	34	1001	270	10.8	1.3	
2003	202	22	361	23	493	109	11	2.0	302	33	444	33	991	275	11.1	1.5	
2004	406	20	362	25	467	98	9.8	1.1	950	45	443	28	931	213	10.6	1.1	
Ocean Age .3									Ocean Age .4								
1991	171	44	556	39	2071	504	11.9	1.4	84	22	604	45	2844	703	12.8	2.0	
1992	629	25	514	40	1657	487	11.8	1.6	154	6	586	46	2578	686	12.6	1.6	
1993	352	33	535	42	1835	518	11.7	1.3	83	8	588	56	2564	885	12.2	1.2	
1994	824	44	510	35	1484	342	11.1	1.2	133	7	562	47	2126	654	11.7	1.4	
1995	259	40	523	38	1701	424	11.7	1.1	115	18	574	36	2316	468	12.2	1.6	
1996	292	18	534	44	1740	465	11.2	1.2	82	5	581	58	2355	785	11.6	1.2	
1997	169	13	541	45	1866	507	11.6	1.7	36	3	608	48	2621	815	11.4	1.4	
1998	776	38	538	45	1834	491	11.6	1.5	182	9	595	41	2524	585	11.8	1.4	
1999	314	50	527	56	1904	720	12.4	1.4	130	21	610	39	2941	678	12.8	1.8	
2000	739	48	520	41	1695	490	11.8	1.2	319	21	583	51	2672	906	13.0	2.4	
2001	513	31	565	44	2252	585	12.3	1.7	277	16	604	53	2863	821	12.8	3.4	
2002	746	33	550	49	1950	574	11.5	1.5	306	14	604	47	2715	697	12.1	1.6	
2003	336	36	558	47	2176	622	12.3	1.8	78	8	637	46	3434	829	13.0	1.2	
2004	568	27	527	41	1671	464	11.2	1.2	169	8	600	45	2528	666	11.5	1.2	

Table 9. (continued)

Chum Salmon-Central Bering Sea																
Year	n	% Age	F L		B W		CF		n	% Age	F L		B W		CF	
			mean	sd	mean	sd	mean	sd			mean	sd	mean	sd	mean	sd
Ocean Age .5									Ocean Age .6							
1991	17	4	613	27	3119	466	13.5	1.2	0							
1992	3	0	600	72	3017	1158	13.5	1.1	0							
1993	7	1	594	40	2617	647	12.3	1.1	0							
1994	4	0	573	61	2330	605	12.3	1.7	0							
1995	7	1	613	44	2957	793	12.6	1.0	0							
1996	9	1	619	62	2813	1197	11.5	2.3	1	0	591		2500			12.1
1997	2	0	560	85	2250	1344	11.9	2.1	1*	0	663		3500			12.0
1998	10	0	622	47	3108	545	13.0	2.3	1	0	624		2550			10.5
1999	5	1	635	17	3428	254	13.4	1.3	1	0	657		3490			12.3
2000	9	1	646	39	3500	728	12.8	1.2	1	0	728		5300			13.7
2001	18	1	629	53	3184	1064	12.4	2.1	0							
2002	25	1	637	44	3275	730	12.4	0.1	1*	0	605		2300			10.4
2003	9	1	631	44	3352	1037	13.0	1.6	0							
2004	2	0	640	93	2985	1322	11.0	0.2	1	0	646		2850			10.6

*Chum salmon may be ocean age 7.

Table 10. Percent ocean age composition and maturity at age of chum salmon caught by the *Wakatake maru* research gillnet, 1991-2004. Values indicate the percentage of fish in each age and maturity class, grouped by year and region. I=immature, M=mature, T=total.

Year	N	Ocean age .1			Ocean age .2			Ocean age .3			Ocean age .4			Ocean age .5			Ocean age .6			Total	
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M			
Chum Salmon-Central North Pacific																					
1991	105	11	0	11	72	5	77	6	7	12	0	0	0	0	0	0	0	0	0	89	11
1992	102	29	0	29	48	8	56	6	6	12	1	2	3	0	0	0	0	0	0	84	16
1993	253	24	0	24	64	3	67	6	3	9	0	0	0	0	0	0	0	0	0	94	6
1994	76	20	0	20	54	4	58	13	8	21	1	0	1	0	0	0	0	0	0	88	12
1995	104	4	0	4	20	5	25	44	17	62	5	5	10	0	0	0	0	0	0	73	27
1996	205	53	1	54	38	2	39	5	1	6	0	1	1	0	0	0	0	0	0	96	4
1997	142	40	1	41	47	8	54	3	2	5	0	0	0	0	0	0	0	0	0	89	11
1998	65	72	0	72	19	5	23	3	0	3	0	2	2	0	0	0	0	0	0	94	6
1999	150	45	0	45	50	0	50	2	3	5	0	0	0	0	0	0	0	0	0	97	3
2000	162	19	0	19	38	3	41	31	6	37	3	1	3	0	0	0	0	0	0	90	10
2001	205	16	0	16	42	2	44	29	8	37	2	1	3	0	0	0	0	0	0	89	11
2002	180	62	0	62	28	4	32	2	3	5	0	1	1	0	0	0	0	0	0	92	8
2003	147	37	0	37	37	5	42	4	15	19	1	1	2	0	0	0	0	0	0	79	21
2004	151	52	0	52	36	1	37	8	2	10	0	1	1	0	0	0	0	0	0	97	3
Chum Salmon-Central Bering Sea																					
1991	370	0	0	0	23	6	29	10	36	46	1	20	21	0	5	5	0	0	0	34	66
1992	2570	36	0	36	31	3	33	13	11	25	1	5	6	0	0	0	0	0	0	80	20
1993	1064	7	0	7	45	6	51	13	20	33	1	7	8	0	1	1	0	0	0	66	34
1994	1869	17	0	18	29	2	31	30	15	44	2	5	7	0	0	0	0	0	0	78	22
1995	642	23	2	24	13	4	17	22	18	40	3	15	18	0	1	1	0	0	0	61	39
1996	1606	45	0	45	30	1	31	11	7	18	2	3	5	0	1	1	0	0	0	89	11
1997	1281	58	0	59	23	3	25	4	9	13	1	2	3	0	0	0	0	0	0	85	15
1998	2004	12	0	12	37	3	39	18	21	39	2	7	9	0	0	1	0	0	0	69	31
1999	624	0	0	0	26	2	28	29	22	50	2	19	21	0	1	1	0	0	0	56	44
2000	1551	7	0	7	20	3	23	32	16	48	6	15	21	0	1	1	0	0	0	65	35
2001	1661	34	0	34	15	2	17	10	21	31	4	13	17	0	1	1	0	0	0	63	37
2002	2225	12	0	12	37	3	40	17	16	33	3	11	14	0	1	1	0	0	0	69	31
2003	912	22	0	22	30	2	32	12	24	36	0	9	9	0	1	1	0	0	0	64	36
2004	2076	19	0	19	45	1	46	16	11	27	1	7	8	0	0	0	0	0	0	81	19

Table 11. Number sampled, mean, and standard deviation of fork length (FL, mm), body weight (BW, g) and condition factor ($CF=10^6 \cdot BW/FL^3$) of pink salmon caught by the *Wakatake maru* research gillnet, 1991-2004, grouped by ocean age and region.

Year	Ocean Age .1							
	N	% Age	Fork length (mm)		Body weight (g)		Condition Factor	
			mean	sd	mean	sd	mean	sd
Pink Salmon- Central North Pacific								
1991	22	100	422	34	784	247	10.1	1.0
1992	3	100	455	5	917	40	9.7	0.5
1993	8	100	429	21	738	134	9.3	1.0
1994	73	100	456	29	1027	214	10.7	1.0
1995	24	100	461	27	1099	349	11.0	1.6
1996	5	100	436	45	844	349	9.6	1.4
1997	85	100	433	23	936	150	11.5	1.7
1998	7	100	461	21	1114	148	11.3	0.9
1999	152	100	411	23	780	132	11.2	1.6
2000	43	100	454	34	1087	280	11.4	1.0
2001	131	100	434	21	988	145	12.0	0.8
2002	5	100	434	42	960	392	11.3	1.2
2003	221	100	446	24	1103	234	12.3	1.3
2004	28	100	462	30	1066	246	10.7	1.4
Pink Salmon- Central Bering Sea								
1991	2621	100	447	37	1108	362	12.0	1.2
1992	100	100	451	27	1153	255	12.4	1.1
1993	1434	100	449	27	1106	240	12.1	1.1
1994	143	100	444	30	1055	262	11.9	1.1
1995	1749	100	470	29	1298	266	12.4	1.2
1996	43	100	455	35	1117	275	11.7	1.4
1997	1537	100	446	27	1117	244	12.5	2.0
1998	60	100	414	40	859	342	11.7	2.1
1999	2485	100	441	31	1100	260	12.7	1.3
2000	27	100	455	35	1165	290	12.1	0.7
2001	1882	100	461	26	1220	247	12.3	1.1
2002	26	100	450	37	1086	329	11.6	1.1
2003	2403	100	484	31	1484	313	13.0	1.4
2004	255	100	449	29	1135	270	12.4	1.2

Table 12. Number sampled, mean, and standard deviation of fork length (FL, mm), body weight (BW, g), and condition factor ($CF=10^6 \cdot BW/FL^3$) of coho salmon caught by the *Wakatake maru* research gillnet, 1991-2004, grouped by ocean age and region.

Ocean Age .1								
Year	N	% Age	Fork length (mm)		Body Weight (g)		Condition Factor	
			mean	sd	mean	sd	mean	sd
Coho Salmon - Central North Pacific								
1991	197	100	521	40	1678	407	11.7	1.0
1992	103	100	505	37	1563	367	11.9	1.1
1993	67	100	517	51	1703	505	12.0	1.5
1994	121	100	523	39	1735	432	11.9	1.4
1995	99	100	530	45	1823	469	12.0	1.5
1996	79	100	517	38	1666	394	11.8	1.0
1997	132	100	508	41	1698	450	12.8	2.1
1998	190	100	529	40	1914	450	12.7	1.5
1999	60	100	514	36	1659	330	12.2	2.4
2000	36	100	537	57	1978	370	12.9	1.8
2001	129	100	556	35	2281	432	13.1	1.3
2002	46	100	548	36	2139	324	13.1	2.2
2003	71	100	547	39	2278	484	13.8	1.1
2004	80	100	533	31	1787	332	11.7	1.0
Coho Salmon - Central Bering Sea								
1991	0							
1992	3	100	568	37	2450	492	13.3	0.1
1993	9	100	556	33	2166	581	12.4	2.1
1994	0							
1995	5	100	605	35	2910	667	12.9	1.0
1996	1	100	630		3800		15.2	
1997	3	100	518	72	1740	1095	11.4	2.3
1998	3	100	556	62	2430	725	13.8	0.4
1999	0							
2000	0							
2001	1	100	582		2150		10.9	
2002	1	100	599		2650		12.3	
2003	5	100	588	63	2656	629	13.0	1.2
2004	4	100	570	36	2355	618	12.5	1.2

Table 13. Number sampled, mean (av) and standard deviation (sd) of fork length (FL, mm), body weight (BW, G) and condition factor (CF= $10^6 \cdot BW/FL^3$) of chinook salmon caught by the *Wakatake maru* research gillnet, 1991-2004, grouped by ocean age and region.

Chinook Salmon-Central North Pacific																	
Year	% Age		F L		B W		CF										
	n		mean	sd	mean	sd	mean	sd									
Ocean Age .1					Ocean Age .2												
1991	0									2	100	683	4	4650	212	14.6	0.9
1992	0									1	100	575		2300		12.1	
1993	0									1	100	624		3700		15.2	
1994	0									3	100	616	33	3150	477	13.4	0.3
1995	0									1	50	562		2200		12.4	
1996	3	100	395	44	823	320	12.9	0.8		0							
1997	0									6	86	641	47	3408	1026	12.6	2.2
1998	0									6	86	582	39	2488	472	12.5	0.7
1999	0									5	100	617	30	3220	448	13.6	0.6
2000	0									1	100	600		3100		14.4	0.0
2001	0									2	100	683	4	4650	212	14.6	0.9
2002	0									1	50	602		2600		11.9	
2003	0									1	100	652		3920		14.1	
2004	1	13	326		400		11.5			6	75	605	35	2875	703	12.8	1.2
Ocean Age .3					Ocean Age .4												
1991	0									0							
1992	0									0							
1993	0									0							
1994	0									0							
1995	1	50	832		7800		13.5			0							
1996	0									0							
1997	1	14	700		4400		12.8			0							
1998	1	14	780		6850		14.4			0							
1999	0									0							
2000	0									0							
2001	0									0							
2002	1	50	714		4400		12.1			0							
2003	0									0							
2004	1	12	753		5100		11.9			0							

Table 13. (continued)

Chinook Salmon-Central Bering Sea

Year	%		F L		B W		CF		n	%		F L		B W		CF	
	n	Age	mean	sd	mean	sd	mean	sd		Age	mean	sd	mean	sd	mean	sd	
Ocean Age .1									Ocean Age .2								
1991	45	66	345	26	497	120	11.9	1.3	21	31	530	57	1816	634	11.8	0.8	
1992	17	36	356	27	525	116	11.4	0.9	23	49	567	47	2333	709	12.6	1.5	
1993	1	8	352		480		11.0		7	59	573	25	2340	314	12.4	0.6	
1994	25	47	374	31	620	173	11.3	1.0	11	21	543	57	2179	740	13.1	1.5	
1995	18	27	339	31	442	128	11.1	0.9	43	65	525	52	1813	522	12.3	1.7	
1996	24	43	407	31	826	221	12.0	1.0	25	45	567	46	2382	632	12.8	1.0	
1997	12	35	350	24	478	94	11.1	0.8	19	56	550	35	1954	390	11.6	0.8	
1998	140	60	348	41	528	311	11.7	1.2	62	27	545	57	2202	793	13.1	0.9	
1999	13	30	330	27	403	114	10.9	1.0	22	51	533	60	1936	694	12.5	2.2	
2000	36	33	326	49	421	329	11.0	1.6	50	46	520	51	1779	524	12.3	0.9	
2001	24	73	345	28	476	136	11.4	1.3	5	15	492	99	1660	736	12.6	1.7	
2002	24	29	353	32	492	102	11.2	1.3	39	46	545	38	2026	427	12.4	1.1	
2003	29	46	372	32	649	179	12.3	0.8	32	51	547	42	2122	529	12.7	0.9	
2004	10	11	369	26	589	94	11.7	0.7	57	63	581	50	2501	605	12.6	1.8	
Ocean Age .3									Ocean Age .4								
1991	2	3	715	18	4050	71	11.1	1.0	0								
1992	6	13	654	27	3822	648	13.6	0.8	1	2	850		7650		12.5		
1993	3	25	716	95	4710	2175	12.3	1.1	1	8	862		8600		13.4		
1994	17	32	720	41	4855	1129	12.8	1.0	0								
1995	4	6	726	61	4725	1300	12.2	0.8	1	2	812		6800		12.7		
1996	7	12	732	46	5121	1366	12.7	1.1	0								
1997	3	9	714	100	4650	2079	12.2	0.9	0								
1998	30	13	678	76	4346	1434	13.3	1.6	0								
1999	8	19	658	64	3566	1236	12.1	0.8	0								
2000	22	20	671	48	4030	1122	13.1	2.0	1	1	728		5300		13.7		
2001	3	9	603	56	2260	754	10.1	1.7	1	3	780		6300		13.3		
2002	21	25	695	65	4324	1136	12.5	0.9	0								
2003	2	3	634	95	3485	1294	13.4	0.9	0								
2004	23	26	684	65	4230	1195	12.9	0.8	0								

Table 14. Percent ocean and freshwater (FW) age composition and maturity at age of chinook salmon caught in the central North Pacific Ocean by the *Wakatake maru* research gillnet, 1991-2004. Values indicate the percentage of fish in each age and maturity class, grouped by year. I=immature, M=mat, T=total. FW X = unknown freshwater age.

Chinook, Central North Pacific																
Year	N	FW Age 0			FW Age 1			FW Age 2			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 1																
1991	0															
1992	0															
1993	0															
1994	0															
1995	0															
1996	3	0	0	0	33	0	33	0	0	0	67	0	67	100	0	100
1997	0															
1998	0															
1999	0															
2000	0															
2001	0															
2002	0															
2003	0															
2004	1	0	0	0	13	0	13	0	0	0	0	0	0	13	0	13
Ocean Age 2																
1991	2	0	0	0	100	0	100	0	0	0	0	0	0	100	0	100
1992	1	0	0	0	0	0	0	0	0	0	100	0	100	100	0	100
1993	1	0	0	0	0	0	0	0	0	0	100	0	100	100	0	100
1994	3	0	0	0	33	0	33	0	0	0	67	0	67	100	0	100
1995	1	0	0	0	0	0	0	50	0	50	0	0	0	50	0	50
1996	0															
1997	6	0	0	0	71	0	71	0	0	0	14	0	14	86	0	86
1998	6	0	0	0	57	0	57	0	0	0	29	0	29	86	0	86
1999	5	0	0	0	80	0	80	0	0	0	20	0	20	100	0	100
2000	1	0	0	0	100	0	100	0	0	0	0	0	0	100	0	100
2001	2	0	0	0	50	0	50	0	0	0	50	0	50	100	0	100
2002	1	0	0	0	0	0	0	0	0	0	50	0	50	50	0	50
2003	1	0	0	0	100	0	100	0	0	0	0	0	0	100	0	100
2004	6	0	0	0	37	13	50	0	0	0	24	0	24	61	13	74

Table 14. (continued)

Chinook, Central North Pacific																
Year	N	FW Age 0			FW Age 1			FW Age 2			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 3																
1991	0															
1992	0															
1993	0															
1994	0															
1995	1	0	0	0	0	0	0	0	0	0	50	0	50	50	0	50
1996	0															
1997	1	0	0	0	14	0	14	0	0	0	0	0	0	14	0	14
1998	1	0	0	0	14	0	14	0	0	0	0	0	0	14	0	14
1999	0															
2000	0															
2001	0															
2002	1	0	0	0	50	0	50	0	0	0	0	0	0	50	0	50
2003	0															
2004	1	0	0	0	0	0	0	0	0	0	13	0	13	13	0	13

Table 15. Percent ocean and freshwater (FW) age composition and maturity at age of chinook salmon caught in the central Bering Sea Ocean by the *Wakatake maru* research gillnet, 1991-2004. Values indicate the percentage of fish in each age and maturity class, grouped by year. I=immature, M=mat, T=total. FW X = unknown freshwater age.

Chinook, Central Bering Sea																
Year	N	FW Age 0			FW Age 1			FW Age 2			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 1																
1991	27	0	0	0	49	0	49	0	0	0	29	0	29	77	0	77
1992	17	0	0	0	23	0	23	0	0	0	13	0	13	36	0	36
1993	1	0	0	0	0	0	0	0	0	0	8	0	8	8	0	8
1994	24	0	0	0	40	0	40	0	0	0	6	0	6	46	0	46
1995	18	0	0	0	21	0	21	0	0	0	6	0	6	27	0	27
1996	19	0	0	0	24	2	27	0	0	0	16	0	16	40	2	42
1997	12	0	0	0	27	0	27	3	0	3	6	0	6	35	0	35
1998	98	0	0	0	36	1	37	0	0	0	15	0	15	51	1	52
1999	13	5	0	5	17	0	17	2	0	2	7	0	7	31	0	31
2000	36	0	0	0	27	0	27	0	0	0	6	0	6	33	0	33
2001	24	0	0	0	55	0	55	0	0	0	18	0	18	73	0	73
2002	24	0	0	0	19	0	19	1	0	1	9	0	9	29	0	29
2003	3	0	0	0	0	0	0	0	0	0	8	0	8	8	0	8
2004	10	0	0	0	10	0	10	1	0	1	0	0	0	11	0	11
Ocean Age 2																
1991	8	0	0	0	17	0	17	0	0	0	6	0	6	23	0	23
1992	23	0	0	0	36	0	36	0	0	0	13	0	13	49	0	49
1993	7	0	0	0	50	0	50	0	0	0	8	0	8	58	0	58
1994	11	0	0	0	15	0	15	0	0	0	6	0	6	21	0	21
1995	43	0	0	0	53	0	53	0	0	0	12	0	12	65	0	65
1996	19	0	0	0	31	0	31	0	0	0	11	0	11	42	0	42
1997	19	0	0	0	32	0	32	3	0	3	22	0	22	56	0	56
1998	62	2	0	2	22	0	22	0	0	0	10	0	10	33	0	33
1999	22	0	0	0	33	0	33	0	0	0	19	0	19	52	0	52
2000	50	0	0	0	38	0	38	0	0	0	8	0	8	46	0	46
2001	5	0	0	0	15	0	15	0	0	0	0	0	0	15	0	15
2002	39	0	0	0	39	0	39	0	0	0	7	0	7	46	0	46
2003	32	0	0	0	62	0	62	3	0	3	22	0	22	87	0	87
2004	57	0	0	0	39	1	40	0	0	0	23	0	23	62	1	63

Table 15. (continued)

Chinook, Central Bering Sea																
Year	N	FW Age 0			FW Age 1			FW Age 2			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 3																
1991	0															
1992	6	0	0	0	6	0	6	0	0	0	6	0	6	13	0	13
1993	3	0	0	0	17	0	17	0	0	0	8	0	8	25	0	25
1994	17	0	0	0	19	2	21	0	0	0	11	0	11	31	2	33
1995	4	0	0	0	5	0	5	0	0	0	2	0	2	6	0	6
1996	7	0	0	0	7	2	9	2	0	2	4	0	4	13	2	16
1997	3	0	0	0	3	0	3	0	0	0	6	0	6	9	0	9
1998	29	0	0	0	11	0	11	0	0	0	4	0	4	15	0	15
1999	7	0	0	0	14	0	14	0	0	0	2	0	2	17	0	17
2000	22	0	0	0	16	0	16	0	0	0	5	0	5	20	0	20
2001	3	0	0	0	9	0	9	0	0	0	0	0	0	9	0	9
2002	21	0	0	0	21	0	21	0	0	0	4	0	4	25	0	25
2003	2	0	0	0	5	0	5	0	0	0	0	0	0	5	0	5
2004	23	0	0	0	19	0	19	1	0	1	6	0	6	26	0	26
Ocean Age 4																
1991	0															
1992	1	0	0	0	2	0	2	0	0	0	0	0	0	2	0	2
1993	1	0	0	0	8	0	8	0	0	0	0	0	0	8	0	8
1994	0															
1995	1	0	0	0	0	0	0	0	0	0	2	0	2	2	0	2
1996	0															
1997	0															
1998	0															
1999	0															
2000	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1
2001	1	0	0	0	3	0	3	0	0	0	0	0	0	3	0	3
2002	0															
2003	0															
2004	0															

Table 16. Number sampled (n), mean, and standard deviation (sd) of fork length (FL, mm), body weight (BW, g), and condition factor (CF=10⁶*BW/FL³) of steelhead trout caught by the *Wakatake maru* research gillnet, 1991-2004, by ocean age.

Steelhead Trout-Central North Pacific																
Year	n	% Age	F L		B W		C F		n	% Age	F L		B W		C F	
			mean	sd	mean	sd	mean	sd			mean	sd	mean	sd	mean	sd
Ocean Age .1									Ocean Age .2							
1991	10	71	538	49	1549	424	9.7	1.1	4	29	734	24	4350	747	10.9	1.1
1992	1	17	548		1530		9.3		5	83	673	43	2990	728	9.7	1.0
1993	5	42	558	23	1660	112	9.6	1.1	7	58	683	65	2929	406	9.4	2.3
1994	30	88	555	38	1839	216	11.0	2.7	4	12	692	61	3538	1090	10.5	1.1
1995	16	70	574	41	1791	317	9.4	0.6	6	26	674	46	3042	673	9.8	0.9
1996	6	100	555	11	1662	155	9.7	0.7	0							
1997	8	47	547	59	1721	597	10.1	1.1	8	47	691	33	3164	349	9.6	0.8
1998	15	56	550	51	1712	455	10.2	1.8	10	37	657	44	2675	626	9.3	0.9
1999	8	42	571	76	1749	640	9.2	0.9	9	47	689	71	3158	945	9.4	0.6
2000	2	15	557	1	1645	7	9.5	0.0	9	64	698	44	3822	755	11.1	1.1
2001	5	50	586	17	1928	101	9.6	0.8	5	50	709	46	3460	934	9.5	1.0
2002	4	44	551	20	1690	218	10.1	0.6	5	56	752	83	4530	1449	10.3	1.0
2003	3	50	544	63	1743	571	10.5	0.1	3	50	752	35	3960	524	9.4	2
2004	1	13	538		1520		9.8		7	87	710	58	3642	1223	9.9	1.1
Ocean Age .3																
1991	0															
1992	0															
1993	0															
1994	0															
1995	1	4	700		3000		8.7									
1996	0															
1997	1	6	800		4850		9.5									
1998	2	7	692	28	3350	71	10.1	1.0								
1999	2	11	747	57	4155	771	10.0	0.4								
2000	3	21	750	3	4300	522	10.2	1.2								
2001	0															
2002	0															
2003	0															
2004	1	11	624		3450		14.2									

Table 17. Percent ocean and freshwater (FW) age composition and maturity at age of steelhead trout caught in the central North Pacific by the *Wakatake maru* research gillnet, 1991-2004. Values indicated the percentage of fish in each age and maturity class, grouped by year. I=immature, M=mature, Tot=total. FW X = unknown freshwater age.

Steelhead, Central North Pacific																			
Year	N	FW Age 1			FW Age 2			FW Age 3			FW 4			FW X			All FW Ages		
		I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T
Ocean Age 1																			
1991	10	0	0	0	14	0	14	0	0	0	0	0	0	36	21	57	50	21	71
1992	1	0	0	0	17	0	17	0	0	0	0	0	0	0	0	0	17	0	17
1993	5	8	0	8	8	0	8	8	0	8	0	0	0	17	0	17	42	0	42
1994	30	27	3	29	6	0	6	0	0	0	0	0	0	32	21	53	65	24	88
1995	16	0	13	13	0	22	22	4	0	4	0	0	0	4	26	30	9	61	70
1996	6	17	17	33	17	0	17	0	0	0	0	0	0	50	0	50	83	17	100
1997	8	0	6	6	6	0	6	0	0	0	0	0	0	12	24	35	18	29	47
1998	15	7	11	18	0	4	4	4	15	19	0	15	15	0	0	0	11	44	56
1999	7	0	22	22	0	6	6	0	6	6	0	0	0	0	6	6	0	39	39
2000	2	0	7	7	0	0	0	0	7	7	0	0	0	0	0	0	0	14	14
2001	5	10	0	10	10	0	10	20	0	20	0	0	0	0	10	10	40	10	50
2002	4	22	11	33	0	0	0	0	0	0	11	0	11	0	0	0	33	11	44
2003	3	17	0	17	0	0	0	0	17	17	16	0	16	0	0	0	33	17	50
2004	1	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	13	13
Ocean Age 2																			
1991	4	0	0	0	0	14	14	0	0	0	0	0	0	7	7	14	7	21	29
1992	5	0	17	17	17	33	50	0	0	0	0	0	0	0	17	17	17	67	83
1993	7	8	8	17	8	8	17	0	0	0	0	0	0	8	17	25	25	33	58
1994	4	0	6	6	0	0	0	0	0	0	0	0	0	3	3	6	3	9	12
1995	6	0	9	9	0	4	4	0	0	0	0	0	0	0	13	13	0	26	26
1996	0																		
1997	8	0	12	12	0	6	6	0	0	0	0	0	0	12	18	29	12	35	47
1998	10	0	11	11	0	4	4	0	11	11	0	11	11	0	0	0	0	37	37
1999	9	0	6	6	0	0	0	0	17	17	0	0	0	0	28	28	0	50	50
2000	9	0	29	29	0	0	0	0	36	36	0	0	0	0	0	0	0	64	64
2001	5	20	30	50	0	0	0	0	0	0	0	0	0	0	0	0	20	30	50
2002	5	0	22	22	0	23	23	0	0	0	0	11	11	0	0	0	0	56	56
2003	3	0	17	17	0	0	0	0	33	33	0	0	0	0	0	0	0	50	50
2004	7	0	25	25	13	12	25	0	37	37	0	0	0	0	0	0	13	74	87

Table 17. (continued)

Steelhead, Central North Pacific

Year	N	FW Age 1			FW Age 2			FW Age 3			FW 4			FW X			All FW Ages		
		Imm	Mat	Tot	Imm	Mat	Tot	Imm	Mat	Tot	Imm	Mat	Tot	Imm	Mat	Tot	Imm	Mat	Tot
Ocean Age 3																			
1991	0																		
1992	0																		
1993	0																		
1994	0																		
1995	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	4	0	4
1996	0																		
1997	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0	6	6
1998	2	0	4	4	0	0	0	0	0	0	0	4	4	0	0	0	0	7	7
1999	2	0	0	0	0	6	6	0	0	0	0	0	0	0	6	6	0	11	11
2000	3	0	7	7	0	0	0	0	14	14	0	0	0	0	0	0	0	21	21
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0																		
2003	0																		
2004	0																		

Table 18. Mean percent composition of stomach contents of salmonids caught in the central North Pacific by the *Wakatake maru*, 1991-2004. % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. PW=prey weight, SCI=PW*100/body weight, SD=standard deviation. Prey composition based on visual estimates. 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), OTH=other groups, and UN=unidentified material.

Central North Pacific Ocean																			
Species	Year	N	% empty	Mean PW	SD PW	Mean SCI	SD SCI	Mean % composition by volume											
								EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN
Sockeye	1991	22	32	7	9	0.46	0.47	19	5	24	0	5	35	0	0	1	0	0	11
	1992	3	0	9	8	0.65	0.78	7	0	33	0	43	17	0	0	0	0	0	0
	1993	2	0	11	7	0.39	0.14	0	0	65	0	0	0	0	35	0	0	0	0
	1994	26	4	25	24	0.91	0.76	15	10	12	0	54	8	1	0	0	0	0	0
	1995	15	0	40	34	1.50	1.12	35	16	11	0	33	2	1	0	2	0	0	0
	1996	10	10	20	14	0.82	0.34	30	7	23	0	21	10	6	0	1	0	2	0
	1997	27	0	18	23	0.98	1.01	24	26	9	0	27	2	0	3	7	0	2	0
	1998	18	33	12	17	0.78	0.86	0	10	13	0	61	0	8	2	0	0	6	0
	1999	34	38	2	3	0.34	0.52	10	15	31	0	10	10	0	11	8	0	1	4
	2000	16	50	23	36	1.45	1.79	0	2	4	0	57	24	13	0	0	0	0	0
	2001	32	13	12	20	0.70	0.67	3	6	45	0	13	18	3	0	1	0	9	2
	2002	20	15	12	14	0.80	0.94	4	3	36	0	37	10	0	6	1	0	3	0
	2003	30	33	21	55	1.21	1.58	6	1	24	0	32	15	2	5	12	0	3	0
2004	16	25	5	4	0.53	0.41	11	12	41	0	18	0	3	0	7	0	8	0	
Chum	1991	134	5	11	9	1.36	0.78	4	3	5	0	1	8	1	0	3	1	0	74
	1992	42	7	6	4	0.71	0.49	13	3	27	0	3	4	2	1	12	9	0	26
	1993	117	3	11	7	1.27	0.72	1	3	4	0	1	16	3	7	8	11	37	9
	1994	106	5	9	8	0.92	0.68	6	1	3	0	2	20	1	0	12	27	2	26
	1995	98	1	9	8	0.80	0.60	36	2	6	0	5	8	3	0	5	33	0	2
	1996	103	4	10	10	0.83	0.72	4	3	9	0	5	15	1	4	10	31	9	9
	1997	94	4	8	7	0.82	0.64	17	5	7	0	1	8	2	5	32	19	2	2
	1998	87	18	6	13	0.64	0.46	1	4	8	0	0	18	2	7	11	21	5	23
	1999	47	15	7	11	0.60	0.50	3	5	12	0	0	14	1	0	14	36	0	15
	2000	51	4	9	8	0.83	0.70	0	2	2	0	6	9	0	8	1	61	9	2
	2001	84	5	14	14	0.92	0.69	3	1	3	0	2	19	1	4	0	65	2	0
	2002	88	2	15	15	1.40	0.81	0	2	20	0	1	27	0	0	12	33	5	0
	2003	79	9	11	11	0.74	0.50	0	3	1	0	4	2	0	4	10	61	13	2
2004	79	5	7	7	0.75	0.56	1	1	6	0	0	21	3	2	20	40	6	0	

Table 18. (continued)

Central North Pacific Ocean																			
Species	Year	N	% empty	Mean PW	SD PW	Mean SCI	SD SCI	Mean % composition by volume											
								EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN
Pink	1991	101	4	13	9	1.56	0.99	24	14	13	0	8	35	3	0	1	0	1	1
	1992	2	0	4	1	0.39	0.09	2	5	68	0	0	0	25	0	0	0	0	0
	1993	6	0	12	10	1.29	1.09	11	1	17	0	11	36	20	1	0	2	1	0
	1994	62	2	18	21	1.56	1.61	8	27	10	0	25	14	2	0	8	0	3	3
	1995	34	9	18	10	1.75	0.89	12	24	15	0	22	6	10	0	8	0	3	0
	1996	8	13	7	7	0.48	0.49	3	14	29	0	19	17	1	0	0	7	9	1
	1997	60	3	15	14	1.52	1.42	14	60	7	0	2	5	3	0	8	0	1	0
	1998	12	0	18	21	1.57	1.74	5	22	21	0	26	1	4	0	0	0	21	0
	1999	40	13	9	8	1.02	0.84	5	52	7	0	12	9	3	0	10	0	2	0
	2000	13	8	32	23	2.44	1.56	8	0	1	0	74	0	4	0	1	0	12	0
	2001	32	3	16	10	1.54	0.98	14	26	17	0	24	12	3	0	4	0	0	0
	2002	12	0	32	30	2.43	2.15	0	6	21	0	55	8	2	0	0	3	5	0
	2003	55	9	48	32	4.02	2.31	7	0	1	0	81	6	5	0	0	0	0	0
2004	51	14	9	9	0.86	1.02	12	10	38	0	18	6	1	0	12	0	3	0	
Coho	1991	83	6	34	30	1.78	1.45	3	0	16	0	71	7	2	0	1	0	0	0
	1992	20	0	16	23	0.95	1.23	5	1	43	0	45	1	2	0	1	2	0	0
	1993	36	8	23	25	1.30	1.20	0	0	4	0	65	27	3	0	0	1	0	0
	1994	45	11	44	46	2.30	2.11	3	0	8	0	73	9	7	0	0	0	0	0
	1995	61	3	46	32	2.65	1.75	2	0	3	0	86	2	7	0	0	0	0	0
	1996	82	24	24	36	1.28	1.45	3	0	12	0	74	6	1	0	0	3	1	0
	1997	130	26	26	25	1.68	1.59	6	1	6	0	64	5	18	0	0	0	0	0
	1998	88	20	45	41	2.14	1.76	0	0	1	0	94	2	3	0	0	0	0	0
	1999	18	67	37	50	1.83	2.46	0	0	1	0	82	0	2	0	0	0	15	0
	2000	43	19	52	46	2.72	2.75	0	0	1	0	84	1	14	0	0	0	0	0
	2001	45	13	54	57	2.38	2.38	0	0	4	0	92	0	4	0	0	0	0	0
	2002	48	33	52	56	2.21	2.32	0	0	17	0	73	0	3	0	0	6	1	0
	2003	52	12	59	56	2.19	1.70	0	0	0	0	88	12	0	0	0	0	0	0
2004	87	38	34	44	1.74	2.37	0	0	5	0	77	9	9	0	0	0	0	0	

Table 18. (continued)

Central North Pacific Ocean																				
Species	Year	N	% empty	Mean PW	SD PW	Mean SCI	SD SCI	Mean % composition by volume												
								EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN	
Chinook	1991	2	0	23	29	0.48	0.57	0	0	2	0	63	0	0	0	0	0	0	35	
	1992	0																		
	1993	3	33	74	80	1.94	1.91	0	0	0	0	100	0	0	0	0	0	0	0	
	1994	3	0	13	6	0.28	0.07	0	0	0	0	100	0	0	0	0	0	0	0	0
	1995	4	25	40	34	1.12	0.95	0	0	0	0	100	0	0	0	0	0	0	0	0
	1996	2	0	19	25	0.26	0.30	0	0	0	0	100	0	0	0	0	0	0	0	0
	1997	26	31	27	28	1.06	1.17	17	0	0	0	78	0	5	0	0	0	0	0	0
	1998	9	22	50	37	1.45	0.82	0	0	0	0	100	0	0	0	0	0	0	0	0
	1999	3	33	36	26	1.25	0.95	0	0	0	0	50	0	50	0	0	0	0	0	0
	2000	4	25	51	47	1.41	1.47	0	0	0	0	100	0	0	0	0	0	0	0	0
	2001	9	33	36	25	0.88	0.61	0	0	0	0	100	0	0	0	0	0	0	0	0
	2002	3	33	39	43	1.42	1.74	0	0	0	0	100	0	0	0	0	0	0	0	0
	2003	6	17	41	32	1.24	1.05	0	0	0	0	100	0	0	0	0	0	0	0	0
	2004	13	31	65	48	1.75	1.21	0	0	0	0	91	0	9	0	0	0	0	0	0
Steelhead	1991	14	0	33	35	1.56	1.75	0	0	15	0	70	2	11	0	0	0	2	0	
	1992	8	0	35	50	1.10	1.43	14	0	13	0	50	0	23	0	0	0	0	0	
	1993	14	25	20	20	0.91	0.86	2	0	35	0	60	3	0	0	0	0	0	0	
	1994	18	0	33	38	1.05	0.94	0	0	4	0	62	5	29	0	0	0	0	0	
	1995	10	30	36	70	0.94	1.37	0	0	8	0	33	1	51	0	0	0	7	0	
	1996	21	10	19	29	0.80	1.32	0	0	6	0	40	0	45	0	0	0	9	0	
	1997	55	18	10	11	0.51	0.62	2	0	9	0	16	1	29	18	0	0	25	0	
	1998	21	14	31	36	1.48	1.82	0	0	0	0	69	1	20	0	0	0	10	0	
	1999	9	11	17	15	0.48	0.40	0	1	4	0	12	1	81	0	0	0	1	0	
	2000	28	4	51	48	1.41	1.07	0	0	0	0	54	0	31	14	0	0	1	0	
	2001	25	16	17	20	0.75	1.02	0	0	3	0	27	0	51	16	0	0	1	2	
	2002	23	4	84	62	2.60	1.40	0	0	0	0	85	0	12	1	0	0	2	0	
	2003	12	25	85	77	2.38	1.46	0	0	0	0	76	0	24	0	0	0	0	0	
	2004	26	15	51	63	1.61	1.74	0	0	2	0	71	0	17	5	0	0	5	0	

Table 19. Mean percent composition of stomach contents of salmon caught in the central Aleutian Islands (51°30N, 180°) by the *Wakatake maru*, 1991-2004. % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. PW=prey weight, SCI=PW*100/body weight, SD=standard deviation. Prey composition based on visual estimates. 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), OTH=other groups, and UN=unidentified material. No samples of chinook salmon or steelhead were collected in this area.

Central Aleutian Islands																			
Species	Year	N	% empty	Mean PW	SD PW	Mean SCI	SD SCI	Mean % composition by volume											
								EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN
Sockeye	1991	3	67	7	-	0.41	-	0	5	10	0	0	0	5	0	0	0	0	80
	1992	3	0	5	4	0.44	0.31	3	3	47	0	0	0	24	0	23	0	0	0
	1993	7	57	1	0	0.11	0.03	7	3	17	0	33	7	0	0	0	0	0	33
	1994	7	14	14	9	0.96	0.58	0	0	70	2	2	8	0	0	0	0	18	0
	1995	14	0	10	7	0.51	0.40	1	5	21	0	6	30	5	6	3	20	3	0
	1996	4	25	14	16	0.56	0.52	12	0	35	0	40	12	1	0	0	0	0	0
	1997	3	0	8	5	0.50	0.34	26	0	2	0	0	4	3	20	0	15	30	0
	1998	0																	
	1999	3	33	1	1	0.11	0.05	0	7	15	0	0	25	53	0	0	0	0	0
	2000	0																	
	2001	0																	
	2002	2	0	2	1	0.15	0.10	0	0	73	0	0	0	2	0	0	21	4	0
	2003	0																	
	2004	0																	
Chum	1991	20	0	10	7	1.19	0.87	0	0	2	0	0	4	1	0	0	11	0	82
	1992	8	13	14	5	1.42	0.75	1	2	22	0	9	0	1	0	0	65	0	0
	1993	19	0	14	7	1.52	0.76	0	0	0	0	0	0	1	0	0	0	99	0
	1994	20	0	9	4	1.23	0.85	24	4	22	0	18	1	9	0	0	15	5	2
	1995	8	0	18	10	1.25	0.58	1	0	1	0	0	8	1	33	0	56	0	0
	1996	10	20	19	33	0.56	0.73	9	0	25	0	8	4	16	1	1	23	13	0
	1997	2	0	16	1	2.29	0.30	0	0	1	0	0	3	0	0	48	0	48	0
	1998	10	0	17	12	1.05	0.55	0	1	9	0	1	26	2	24	0	27	0	10
	1999	2	0	13	2	1.26	0.33	0	0	1	0	0	2	0	0	1	96	0	0
	2000	0																	
	2001	0																	
	2002	7	0	26	20	1.41	0.41	0	1	2	0	0	1	0	0	7	69	20	0
	2003	4	0	22	16	1.32	0.42	0	1	0	0	0	0	0	0	2	52	45	0
	2004	1	0	2	-	0.10	-	0	1	3	0	5	1	0	5	5	78	2	0

Table 19. (continued)

Central Aleutian Islands																			
Species	Year	N	% empty	Mean	SD	Mean	SD	Mean % composition by volume											
				PW	PW	SCI	SCI	EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN
Pink	1991	20	5	6	5	0.72	0.68	9	19	9	0	1	22	7	0	0	0	1	32
	1992	0																	
	1993	20	10	4	4	0.39	0.38	2	1	37	1	8	0	39	0	0	0	12	0
	1994	2	0	12	9	0.96	0.47	0	0	25	0	0	20	15	0	0	0	40	0
	1995	10	0	10	6	0.89	0.45	2	0	19	0	13	28	33	4	0	0	1	0
	1996	0																	
	1997	0																	
	1998	0																	
	1999	9	0	3	3	0.36	0.26	0	16	37	2	2	13	9	0	20	0	1	0
	2000	0																	
	2001	4	0	2	1	0.12	0.07	0	2	3	0	6	39	50	0	0	0	0	0
	2002	0																	
	2003	10	0	6	7	0.46	0.46	0	1	2	0	27	12	34	0	1	0	23	0
	2004	2	0	8	9	0.64	0.76	0	0	18	71	3	0	7	0	0	0	1	0
Coho	1991	1	0	3	-	0.10	-	0	0	0	0	100	0	0	0	0	0	0	0
	1992	0																	
	1993	0																	
	1994	0																	
	1995	0																	
	1996	0																	
	1997	1	0	68	-	3.82	-	0	0	0	0	0	0	100	0	0	0	0	0
	1998	0																	
	1999	0																	
	2000	0																	
	2001	0																	
	2002	0																	
	2003	0																	
	2004	0																	

Table 20. Mean percent composition of stomach contents of salmon caught in the central Bering Sea by the *Wakatake maru*, 1991-2004. % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. PW=prey weight, SCI=PW*100/body weight, SD=standard deviation. Prey composition based on visual estimates. 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), OTH=other groups, and UN=unidentified material. No samples of steelhead were collected.

Central Bering Sea																			
Species	Year	N	% empty	Mean PW	SD PW	Mean SCI	SD SCI	Mean % composition by volume											
								EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN
Sockeye	1991	66	12	9	8	0.56	0.49	13	5	7	0	33	13	14	0	0	5	3	7
	1992	33	15	14	28	0.70	1.13	12	33	19	0	20	0	13	0	0	3	0	0
	1993	72	11	10	10	0.68	0.69	3	10	19	1	31	3	29	0	0	0	3	1
	1994	115	10	11	11	0.90	0.90	15	20	30	0	21	5	7	0	0	1	1	0
	1995	144	1	10	8	0.67	0.55	9	6	36	6	22	12	8	0	0	1	0	0
	1996	134	16	12	14	0.70	0.77	23	13	16	1	15	12	19	0	0	1	0	0
	1997	114	11	7	7	0.51	0.47	9	21	25	9	10	11	11	0	0	0	4	0
	1998	113	19	12	17	1.21	1.42	28	18	19	2	14	8	10	0	0	1	0	0
	1999	117	15	7	10	0.64	0.64	12	8	29	1	29	9	9	0	0	2	1	0
	2000	133	8	16	29	0.84	0.92	12	11	28	1	17	4	25	0	1	0	1	0
	2001	195	17	8	10	0.66	0.65	26	14	13	0	10	17	16	0	3	1	0	0
	2002	139	12	11	15	0.87	0.87	19	10	34	0	19	4	14	0	0	0	0	0
	2003	155	37	11	13	0.68	0.62	20	2	8	1	33	6	23	3	0	0	4	0
2004	143	20	18	25	1.12	1.15	24	13	30	0	19	1	12	0	0	0	0	1	
Chum	1991	291	1	24	16	1.54	0.76	9	2	4	0	3	4	1	0	0	10	24	43
	1992	227	1	19	11	1.32	0.84	26	18	13	0	13	0	5	0	1	4	0	20
	1993	272	4	16	10	1.41	0.76	6	2	4	0	10	6	16	1	0	29	24	2
	1994	279	1	11	9	0.99	0.65	13	6	13	0	5	7	2	0	3	39	1	11
	1995	216	2	14	9	1.01	0.69	23	1	12	1	7	9	22	0	0	23	0	2
	1996	238	6	15	15	1.00	0.88	39	3	9	0	2	20	10	0	0	13	4	0
	1997	174	3	14	12	1.05	0.79	20	2	6	1	5	28	5	5	2	8	16	2
	1998	316	5	13	11	1.02	0.79	19	9	14	1	4	19	7	10	0	11	1	5
	1999	226	4	15	12	0.71	0.47	11	2	2	0	3	21	3	1	0	53	1	3
	2000	184	4	18	12	1.10	0.90	28	4	7	0	3	9	8	0	1	40	0	0
	2001	199	3	35	24	1.51	0.86	18	1	1	0	2	46	2	0	0	29	1	0
	2002	242	5	15	14	1.01	0.87	31	4	14	0	7	20	6	0	1	12	4	1
	2003	183	0	21	16	1.34	0.98	21	2	1	0	7	23	5	1	1	30	8	1
2004	180	8	17	14	1.18	0.84	31	11	8	0	6	11	9	1	1	22	0	0	

Table 20. (continued)

Central Bering Sea																			
Species	Year	N	% empty	Mean	SD	Mean	SD	Mean % composition by volume											
				PW	PW	SCI	SCI	EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN
Pink	1991	292	8	18	17	1.56	1.92	14	5	11	0	36	4	22	0	0	2	1	5
	1992	14	0	27	25	1.94	1.65	14	12	6	0	40	0	21	0	0	0	4	3
	1993	139	1	17	15	1.49	1.21	2	7	6	0	30	3	51	0	0	0	1	0
	1994	28	0	17	17	1.37	1.39	23	12	8	4	28	2	23	0	0	0	0	0
	1995	186	0	15	12	1.19	0.83	9	8	14	5	26	12	26	0	0	0	0	0
	1996	52	8	19	19	1.43	1.28	21	5	5	3	14	2	50	0	0	0	0	0
	1997	181	16	10	8	0.88	0.75	9	14	16	6	15	10	27	0	0	0	3	0
	1998	31	13	12	14	1.46	1.44	12	16	11	4	15	6	36	0	0	0	0	0
	1999	271	8	10	10	0.89	0.83	13	19	7	1	17	10	31	1	0	0	1	0
	2000	5	0	24	14	2.22	1.28	0	0	0	0	19	0	81	0	0	0	0	0
	2001	185	3	19	17	1.49	1.19	32	7	3	0	20	10	26	0	1	0	1	0
	2002	40	10	14	12	1.23	1.00	34	8	10	0	10	2	36	0	0	0	0	0
	2003	168	6	21	18	1.35	1.15	17	4	2	1	40	2	30	0	1	0	3	0
2004	143	9	21	23	1.71	1.68	26	15	12	0	17	2	28	0	0	0	0	0	
Coho	1991	1	0	18	-	0.50	-	100	0	0	0	0	0	0	0	0	0	0	0
	1992	2	0	9	2	0.63	0.46	88	0	5	0	5	0	2	0	0	0	0	0
	1993	0																	
	1994	0																	
	1995	0																	
	1996	2	0	76	41	2.07	1.38	0	0	0	0	0	0	100	0	0	0	0	0
	1997	8	50	16	13	0.94	0.89	15	0	0	0	36	0	49	0	0	0	0	0
	1998	1	100																
	1999	0																	
	2000	0																	
	2001	1	100																
	2002	4	0	29	32	0.97	1.02	49	2	0	0	25	0	24	0	0	0	0	0
	2003	9	22	13	5	0.74	0.44	39	0	0	0	40	0	21	0	0	0	0	0
2004	13	15	28	20	1.20	0.77	50	0	0	0	30	0	18	0	0	0	2	0	

Table 20. (continued)

Central Bering Sea																				
Species	Year	n	% empty	Mean PW	SD PW	Mean SCI	SD SCI	Mean % composition by volume												
								EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UN	
Chinook	1991	30	13	19	40	0.83	0.87	32	1	0	0	43	0	23	0	0	0	0	1	
	1992	37	19	18	26	0.78	0.97	43	4	0	0	44	0	9	0	0	0	0	0	
	1993	12	17	12	12	0.54	0.52	27	0	0	0	39	0	34	0	0	0	0	0	
	1994	26	31	11	12	0.51	0.42	20	0	10	0	58	0	8	0	1	3	0	0	
	1995	44	16	10	9	0.63	0.55	16	0	0	0	52	0	29	0	0	0	0	0	3
	1996	72	19	25	38	1.03	1.00	18	0	2	0	47	1	32	0	0	0	0	0	0
	1997	53	34	13	22	0.54	0.66	29	0	0	0	52	0	19	0	0	0	0	0	0
	1998	96	34	15	20	0.82	0.86	12	3	2	0	66	0	16	0	0	0	0	0	1
	1999	22	32	4	6	0.38	0.41	9	0	6	0	36	4	45	0	0	0	0	0	0
	2000	60	27	35	82	1.10	1.58	29	1	0	0	36	0	34	0	0	0	0	0	0
	2001	40	35	4	4	0.50	0.60	6	0	0	0	34	2	58	0	0	0	0	0	0
	2002	89	30	23	35	0.73	0.79	34	1	0	0	44	0	21	0	0	0	0	0	0
	2003	77	43	14	22	0.67	0.73	11	0	0	0	61	2	26	0	0	0	0	0	0
	2004	114	39	32	53	1.13	1.59	32	0	0	0	49	0	18	0	0	0	0	0	1

Table 21. Locations, sea surface temperatures (°C, SST), and catches for 2004 *Kaiyo maru* fishing stations. Stations are ordered by transect (east to west) and latitude (north to south), not by date of operation. Catches are for 1-hour tows of surface trawl. NP = North Pacific Ocean; BS = Bering Sea.

Transect	Station	Date	Latitude	Longitude	Location	SST	Sockeye	Chum	Pink	Coho	Chinook	Total
170°W	6	6/28	55°40'	170°05'W	BS	9.1	16	56	11	0	0	83
	5	6/28	55°04'	170°01'W	BS	8.5	6	46	0	0	1	53
	4	6/27	53°56'	170°01'W	BS	7.2	14	49	5	0	0	68
	3	6/27	53°05'	170°22'W	BS	7.6	82	71	4	0	0	157
	2	6/26	51°49'	170°00'W	NP	8.6	89	148	9	0	0	246
	1	6/26	50°53'	170°10'W	NP	8.8	13	70	20	0	0	103
175°W	7	6/29	57°58'	174°42'W	BS	8.7	14	100	9	0	81	204
	8	6/29	57°08'	175°12'W	BS	8.8	14	72	10	0	16	112
	9	6/30	56°01'	174°42'W	BS	8.2	13	173	10	0	31	227
	10	6/30	55°11'	175°00'W	BS	8.4	8	321	13	0	7	349
	11	7/1	54°10'	175°02'W	BS	7.9	5	160	5	0	8	178
	12	7/1	53°11'	175°00'W	BS	7.9	0	33	10	1	0	44
	13	7/2	51°40'	175°06'W	NP	8.3	14	75	2	5	1	97
180°	21	7/6	57°20'	179°53'W	BS	8.4	1	75	0	0	29	105
	20	7/6	56°21'	179°52'W	BS	8.3	2	144	0	0	10	156
	19	7/5	55°20'	180°00'	BS	8.3	1	170	0	0	0	171
	18	7/5	54°35'	179°46'E	BS	7.7	17	633	4	0	2	656
	17	7/4	53°22'	179°49'W	BS	7.4	16	278	2	0	0	296
	16	7/4	52°38'	179°51'E	BS	6.5	0	16	0	0	0	16
	15	7/3	51°25'	179°52'W	NP	5.6	1	9	0	0	0	10
	14	7/3	50°38'	180°00'	NP	7.4	6	16	1	1	0	24
175°E	22	7/7	55°57'	175°17'E	BS	8.8	3	101	3	0	0	107
	23	7/7	55°05'	175°14'E	BS	7.9	5	179	3	0	0	187
	24	7/8	53°57'	175°16'E	BS	8.1	24	35	1	0	2	62
	25	7/8	52°58'	175°16'E	BS	7.2	1	18	1	0	0	20
Total						365	3048	123	7	188	3731	

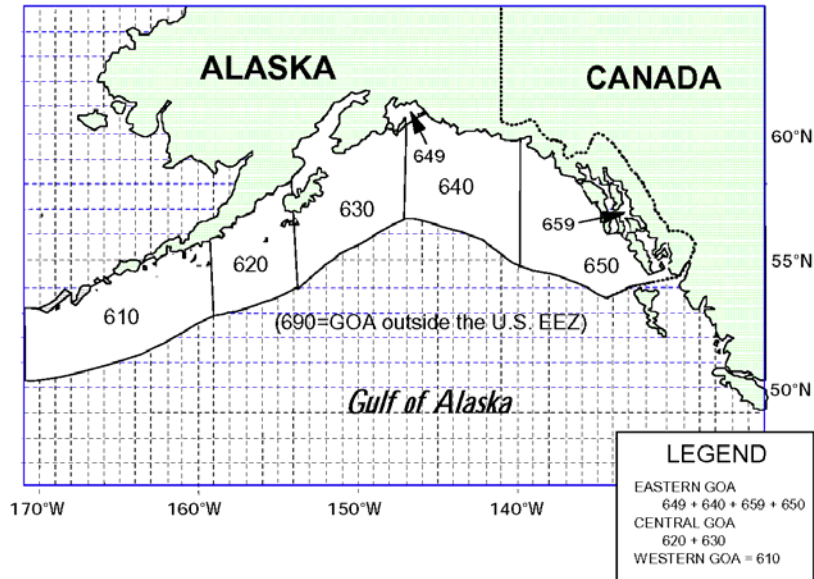
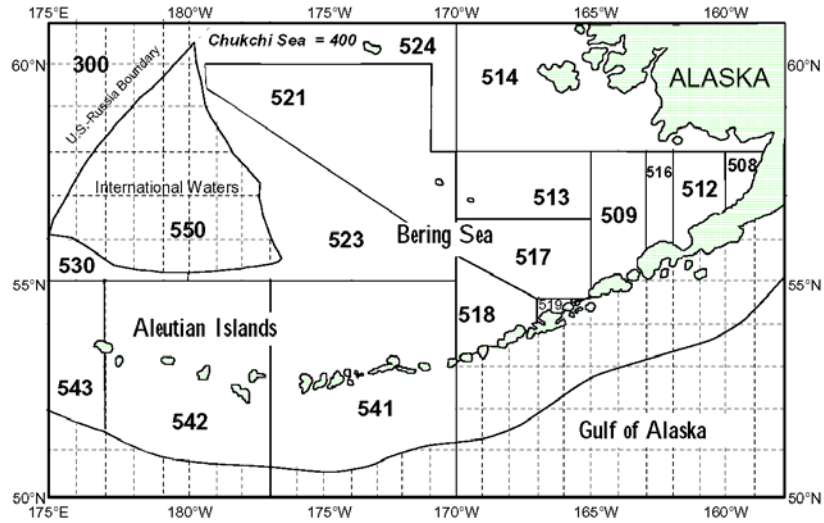
Table 22. Numbers of salmon tagged at 2004 *Kaiyo maru* fishing stations, by gear type. Stations are ordered by transect (east to west) and latitude (north to south), not by date of operation. Catches are for 1-hour tows of surface trawl. SST = sea surface temperatures (°C); NP = North Pacific Ocean; BS = Bering Sea. Tran. = transect; Sta. = station number; SO = sockeye; CU = chum; PI = pink; CO = coho; CH = chinook; T = total.

Tran.	Sta.	Date	Latitude	Longitude	Location	Tagged salmon - trawl catch						Tagged salmon - hook & line					
						SO	CU	PI	CO	CH	T	SO	CU	PI	CO	CH	T
170°W	6	6/28	55°40'	170°05'W	BS	0	3	0	0	0	3	-	-	-	-	-	-
	5	6/28	55°04'	170°01'W	BS	2	6	0	0	1	9	-	-	-	-	-	-
	4	6/27	53°56'	170°01'W	BS	1	7	0	0	0	8	0	4	0	0	0	4
	3	6/27	53°05'	170°22'W	BS	7	6	1	0	0	14	-	-	-	-	-	-
	2	6/26	51°49'	170°00'W	NP	0	9	0	0	0	9	4	0	0	0	0	4
	1	6/26	50°53'	170°10'W	NP	1	0	5	0	0	6	-	-	-	-	-	-
175°W	7	6/29	57°58'	174°42'W	BS	5	0	0	0	1	6	-	-	-	-	-	-
	8	6/29	57°08'	175°12'W	BS	1	4	1	0	0	6	1	5	2	0	0	8
	9	6/30	56°01'	174°42'W	BS	2	21	2	0	0	25	-	-	-	-	-	-
	10	6/30	55°11'	175°00'W	BS	1	13	0	0	0	14	0	8	1	0	1	10
	11	7/1	54°10'	175°02'W	BS	2	3	0	0	0	5	-	-	-	-	-	-
	12	7/1	53°11'	175°00'W	BS	0	1	1	1	0	3	0	1	1	0	0	2
	13	7/2	51°40'	175°06'W	NP	1	14	0	1	0	16	1	3	1	6	0	11
180°	21	7/6	57°20'	179°53'W	BS	0	3	0	0	0	3	-	-	-	-	-	-
	20	7/6	56°21'	179°52'W	BS	0	10	0	0	1	11	-	-	-	-	-	-
	19	7/5	55°20'	180°00'	BS	0	4	0	0	0	4	0	30	0	0	0	30
	18	7/5	54°35'	179°46'E	BS	1	36	1	0	0	38	-	-	-	-	-	-
	17	7/4	53°22'	179°49'W	BS	0	20	2	0	0	22	2	37	0	1	0	40
	16	7/4	52°38'	179°51'E	BS	0	2	0	0	0	2	-	-	-	-	-	-
	15	7/3	51°25'	179°52'W	NP	0	0	0	0	0	0	0	0	0	2	0	2
	14	7/3	50°38'	180°00'	NP	0	2	0	0	0	2	-	-	-	-	-	-
175°E	22	7/7	55°57'	175°17'E	BS	1	4	0	0	0	5	-	-	-	-	-	-
	23	7/7	55°05'	175°14'E	BS	0	7	0	0	0	7	0	9	0	0	0	9
	24	7/8	53°57'	175°16'E	BS	0	1	0	0	0	1	-	-	-	-	-	-
	25	7/8	52°58'	175°16'E	BS	0	2	0	0	0	2	0	0	0	0	0	0
Total						25	178	13	2	3	221	8	97	5	9	1	120

Table 23. Recoveries of data storage tags in 2004, by tag type. CTD tags record conductivity (salinity), temperature, and depth); TD tags record temperature and depth; and iB (iButton) tags record temperature only. Tagging location designated as NP (North Pacific Ocean) or BS (Bering Sea).

Tag Type	Tag No.	Species	Location	Tagging Latitude	Tagging Longitude	Release Date	Recovery Date	Recovery Area
CTD	1363	sockeye	NP	50°30	180°00	6/26/04	8/27/04	Kodiak, Alaska
CTD	1379	chum	BS	56°30	178°00W	7/7/04	9/21/04	Pacific coast, Hokkaido
CTD	1383	sockeye	BS	57°01	175°02W	6/29/04	8/4/04	Sand Point, Alaska
TD	1401	chinook	BS	56°30	179°00W	7/8/02	6/21/04	Yukon R., Alaska
TD	5980	chum	BS	54°30	180°00	7/13/04	10/11/04	Okhotsk coast, Hokkaido
TD	5991	chum	BS	56°30	180°00	7/2/04	9/16/04	Pacific coast, Hokkaido
TD	5996	sockeye	BS	56°30	180°00	7/2/04	7/24/04	Kanektok, Alaska
TD	7430	chum	BS	56°30	180°00	7/2/04	9/29/04	Pacific coast, Hokkaido
TD	7467	chum	BS	56°30	179°00W	7/8/04	10/22/04	Nemuro coast, Hokkaido
TD	7469	chum	BS	56°30	179°00E	7/9/04	9/27/04	Pacific coast, Hokkaido
TD	7473	chum	BS	56°30	179°00E	7/9/04	10/1/04	Pacific coast, Hokkaido
TD	7480	chum	BS	56°30	178°00E	7/10/04	9/24/04	Pacific coast, Hokkaido
TD	7491	sockeye	NP	52°00	169°52W	6/26/04	9/12/04	Sand Point, Alaska
TD	8106	chum	BS	55°30	179°58W	7/5/04	9/5/04	N. Okhotsk coast, Russia
iB	G-02	sockeye	NP	50°58	160°01W	8/2/03	7/2/04	Ketchikan, SE Alaska
iB	G-03	chinook	NP	50°58	160°01W	8/2/02	5/13/04	Columbia R., Wash.
iB	K-050	chum	BS	57°01	175° 03W	6/29/04	10/11/04	Nemuro coast, Hokkaido
iB	K-052	chum	BS	55°11	175°00W	6/30/04	10/6/04	Nemuro coast, Hokkaido
iB	W-148	pink	BS	57°30	178°00W	7/6/04	7/7/04	Bering Sea
iB	W-149	chum	BS	57°30	179°00W	7/5/04	10/2/04	Nemuro coast, Hokkaido
iB	W-153	chum	BS	56°30	177°00E	7/11/04	9/21/04	Pacific coast, Hokkaido
iB	W-154	chum	BS	56°30	177°00E	7/11/04	9/29/04	Nemuro coast, Hokkaido
iB	W-179	chum	BS	57°30	177°00E	7/12/04	9/21/04	Pacific coast, Hokkaido
iB	W-185	chum	BS	57°30	176°00E	7/13/04	10/22/04	Nemuro coast, Hokkaido
iB	W-188	chum	BS	57°30	176°00E	7/13/04	9/2/04	Pacific coast, Hokkaido

Appendix



Appendix Fig. 1. U.S. National Marine Fisheries Service (NMFS) statistical areas in the Bering Sea and Aleutian Islands (top panel) and Gulf of Alaska (bottom panel).