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Migrations, Abundance, and Origins of Salmonids in Offshore Waters of the North Pacific - 1997

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Annual Report

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Migrations, Abundance, and Origins of Salmonids in Offshore Waters of the North Pacific - 1997

Abstract

This report summarizes research on high-seas salmonids conducted in FY 1997 (October 1996-September 1997) by the Fisheries Research Institute (FRI), University of Washington, under contract to the U.S. National Marine Fisheries Service (NMFS). This work is largely in response to U.S. research commitments to the North Pacific Anadromous Fish Commission (NPAFC). The research was conducted in two major areas: (1) stock origin studies (including scale pattern analysis and tagging) and (2) ocean ecology, carrying capacity, climate change, and stock assessment (including cooperative international cruises, food habits and bioenergetics, growth studies, models of carrying capacity, and coordination with NMFS research). A study of age 0.3 chum salmon in the 1994 Bering Sea pollock B-season bycatch found that approximately 18% were of western and central Alaska origin. Sampling and tagging were carried out aboard two Japanese research vessels in June and July in the central North Pacific Ocean, Bering Sea, and Gulf of Alaska. A newly designed disk tag was attached to 818 salmonids in cooperative tagging with Japanese scientists. Oxytetracycline (in a higher dosage than used in previous years) was injected into 503 tagged fish for studies of periodic growth structures on otoliths. Eighteen recoveries of tagged salmon (1 sockeye, 13 chum, and 4 pink salmon) have been reported in the last year. Salmonids were examined for missing fins, and coded-wire tags were recovered from 7 steelhead (4 from Idaho, 3 from Washington). Research gillnet catch, age, weight, and length data, and stomach contents data from cooperative Japan-U.S. cruises is summarized by oceanographic region. Bioenergetic modeling of sockeye, pink, chum, and coho salmon feeding and growth in the central North Pacific and Bering Sea in June and July indicates salmon are feeding at a rate close to their physiological maximum. Scale growth studies indicate that age 0.2 chum salmon in the central Aleutians had significantly lower growth in 1983-95 compared to those in 1956-70. Adult pink salmon showed few differences between the periods. Studies of levels of a growth hormone in salmon caught in the western, central, and eastern North Pacific found significant differences between species. In all species except pink salmon, hormone levels were positively correlated with body weight and liver weight. Hormone levels were higher in pink and coho salmon in the eastern North Pacific. Significant progress was made in modeling of carrying capacity, including literature review and acquisition of data sets of zooplankton abundance and salmon abundance, food habits, and growth. Salmon life history and nutrient-phytoplankton-zooplankton models were developed. An FRI scientist participated in one leg of an NMFS salmon research cruise in the Aleutian Islands. This report also summarizes the participation of High-Seas Project personnel in NPAFC meetings and activities, and other miscellaneous activities that were required to meet NPAFC-related obligations pertaining to salmon.

Introduction

Since 1955, the U.S. Government has contracted the Fisheries Research Institute (FRI), University of Washington, to conduct research on issues related to Pacific salmon and steelhead trout (*Oncorhynchus* spp.) in the North Pacific Ocean and to participate in the deliberations of the International North Pacific Fisheries Commission (INPFC, 1955-1992) and the North Pacific Anadromous Fish Commission (NPAFC, 1993-present). This report summarizes research on high-

seas salmonids conducted in FY 1997 (October 1996-September 1997) by FRI under contract to the Auke Bay Laboratory (ABL), U.S. National Marine Fisheries Service (50ABNF700003). The research was conducted in two major areas: (1) stock origin studies (including scale pattern analysis and tagging) and (2) ocean ecology, carrying capacity, climate change, and stock assessment (including cooperative international cruises, food habits and bioenergetics, growth studies, models of carrying capacity, and coordination with ABL research). In addition, this report summarizes the participation of High-Seas Project personnel in NPAFC meetings and activities, and other miscellaneous activities that were required to meet NPAFC-related obligations pertaining to salmon.

I. International Cooperative High-Seas Salmon Research

A. Stock Origin Studies for Research, Management, and Enforcement

I. SCALE PATTERN ANALYSES

Origins of 1994 chum salmon bycatch

Stock-composition estimates were produced using scale-pattern analysis for the age 0.3 chum salmon (*Oncorhynchus keta*) found in the incidental catch of the 1994 B-season walleye pollock (*Theragra chalcogramma*) fishery in the eastern Bering Sea and Aleutian Islands (BSAI; Patton 1997; Patton et al. in review). Two prior-brood-year stock baselines and one equivalent-brood-year stock baseline were evaluated for use in conditional maximum-likelihood discrimination models. The accuracy of each baseline model was assessed through a series of simulation runs using hypothetical stock mixtures. The equivalent-brood-year baseline model was found to be most accurate when allocating mixtures into several cluster-based standard groups on the basis of principal-component comparisons. The accuracy of this model, as assessed through simulation runs using hypothetical stock mixtures, was 83.3-92.3%. Unweighted composition estimates indicated that roughly equivalent proportions of the fleet-wide bycatch sample originated from regional groups representing Russia and southwestern Hokkaido (26.6%), western and central Alaska (24.1%), and southern southeast Alaska and British Columbia (27.5%). The Japanese standard group also accounted for a significant percentage of the bycatch (13.9%). Estimated proportions of northern southeast Alaska and Washington groups were relatively low (3.2% and 4.8%, respectively). Weighted interception estimates, which are conditional on the accuracy of NMFS stratified bycatch estimates, indicated that about 50% of the incidentally-caught chum salmon originated from Asia (Russia and Japan), 18% originated from western and central Alaska, and 32% originated from southeast Alaska, British Columbia, and Washington (Table 1). These proportions suggest approximately 13,850 of the estimated 74,500 chum salmon taken incidentally in the 1994 BSAI B-season pollock fishery originated from the rivers of western and central Alaska. By comparison, the total estimated chum salmon runs for the western Alaska and central Alaska regions were 4.4 and 3.8 million fish, respectively, during 1994. The proportion of western Alaskan chum salmon in the incidental catch increased over the course of the B-season fishery; however, the numbers of western Alaskan chum salmon intercepted remained relatively stable. Contrary to what was previously known about chum salmon ocean distribution from high-seas tagging studies, these results suggest that significant numbers of immature North American chum salmon are present in the waters of the eastern Bering Sea during the late summer months. Fleet-wide, unweighted composition estimates produced in this study corroborate the findings of a

concurrent allele-frequency-based stock composition study, which used an independently-collected sample of the intercepted chum salmon from the 1994 pollock B-season.

Preliminary study of origins of Russian sockeye catches

A Russian fishery scientist, Alexander Bugaev, from KamchatNIRO was in residence at FRI for five weeks of training in scale pattern measurement and analysis techniques. He brought scale samples from Kamchatka rivers and from a Japanese driftnet fishery operating in the Russian 200-mile zone. Although neither time nor the samples he brought were adequate for a full analysis, a preliminary analysis was completed on one age class from one year in order to demonstrate the methodology. It is anticipated that this training will be useful in future cooperative studies of origin of stocks of sockeye (*O. nerka*) in commercial catches off of Kamchatka.

NPAFC sockeye salmon scale aging test

The most accurate results from stock identification of salmon using scale pattern analysis are obtained when both baseline and mixture samples are composed of fish of the same age class and brood year. For accurate stock identification results, therefore, consistency in scale age determinations in both the baseline and mixture samples is critical. For baseline samples, however, resource agency scale experts may have used additional knowledge of stock-specific life history traits to assist in determining age from scales. At the March 1997 NPAFC research planning meeting in Vancouver, B.C., the Working Group on Stock Identification and Growth discussed the need to test inter-laboratory variation in scale age and growth data. As a first step, FRI sent a set of acetate impressions of scales from adult sockeye salmon to a contact person in each laboratory: Pacific Biological Station (D. Welch), National Research Institute of Far Seas Fisheries (Y. Ishida), Hokkaido Salmon Hatchery (M. Kaeriyama), KamchatNIRO (V. Bugaev), SakhNIRO (F. Rukhlov), TINRO-Centre (V. Radchenko), and Auke Bay Laboratory (J. Helle). The samples (2 scales per fish, 30 fish per card, and 8 cards) were collected from maturing sockeye salmon caught in several different rivers that were not identified to the recipients. The preliminary results of this test will be discussed by the Working Group at the 1997 annual meeting.

2. HIGH-SEAS TAGGING PROGRAM

Processing center for tag recoveries

FRI is 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 a document for NPAFC (Myers and Walker 1996; Myers et al. 1997).

In the spring, we advertised for return of high-seas salmon tags by mailing approximately 1400 informational packets to addresses in Alaska, British Columbia, Washington, Oregon, and California. These packets were sent to federal, state, and tribal fisheries research and management agencies, fishermen's organizations, salmon buyers and processors, and post offices. The informational packet included 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, length, and how to collect scales).

Since 1991, we have offered a cap as a reward for people who return high-seas tags. The cap has been a popular item, and in 1997 we changed the cap style to an updated "unstructured" cap design and a new custom embroidered logo. The new reward caps are embroidered with the

profile of a tagged salmon and the words "International High Seas Tagging" to emphasize the cooperative nature of the high seas tagging program of NPAFC-member countries.

Tag design

A new tag design was developed for international cooperative high seas salmon tagging. In addition to the tag number and legend "High Seas Tagging", the tag displays in English, Japanese, and Russian the addresses for returns of tags to processing centers in North America, Japan, and Russia. The tags were used for the first time this summer aboard Japanese research vessels in cooperative double-tagging.

High-seas tagging

Tagging operations on viable salmonids caught by longlines were conducted by scientists aboard the R/V *Wakatake maru* along a transect in the central North Pacific and Bering Sea (47°30'N to 58°30'N at 179°30'W and at 56°30'N between 177°30'W and 177°30'E; Fig. 2; Nagasawa et al. 1997a). Fish were double-tagged with FAJ (Fisheries Agency of Japan) and FRI (newly-designed) Petersen disk-tags. These tagging experiments resulted in the release of 779 salmonids, including 85 sockeye, 404 chum, 260 pink (*O. gorbuscha*), 11 coho (*O. kisutch*), 5 chinook salmon (*O. tshawytscha*), and 14 steelhead trout (*O. mykiss*).

In 1997, a significant effort was made by T/S *Oshoro maru* personnel to minimize handling and holding time of salmon prior to release at stations in the central Gulf of Alaska. However, longline catches of salmon in the Gulf of Alaska were low in 1997, probably because of a warm surface water temperatures (12°-13°C; Myers et al. 1997a). Eleven salmon (17 in 1996) in the central North Pacific Ocean and 28 salmon (33 salmon in 1996) in the Gulf of Alaska were tagged and released (Fig. 2). Dummy archival tags were attached to two salmon released along the 145°W transect.

High-seas tag recoveries

From 1 September 1996 through 31 August 1997, eighteen Japan-U.S. tags were returned (1 sockeye, 13 chum, and 4 pink salmon; Myers et al. 1997b). These tagged salmon were released from 1995 to 1997 during cooperative Japan-US tagging operations aboard the *Wakatake maru* and *Oshoro maru* in the central Aleutian Islands, Bering Sea, and Gulf of Alaska in June and July. The only North American recovery was a sockeye salmon released in the central Gulf of Alaska in early July 1997 and recovered approximately one month later in the San Juan Islands, Washington. Two immature chum salmon released in the central Bering Sea in mid-July 1995 were recovered as adults in September and October 1996 in Hokkaido, Japan. Eleven maturing chum salmon released in July 1996 in the central Aleutian Islands and Bering Sea were recovered in Hokkaido (10 fish) and southeastern Kamchatka (1 fish) from August to November 1996. All four tagged pink salmon were recaptured during high-seas research gillnet operations on the day following their release.

Snout collection for potential recovery of coded-wire tags

Snouts were collected by the *Wakatake maru* from fin-clipped salmonids because these fish may contain a coded-wire tag (Table 2). Forty-five steelhead trout with clipped fins (53% of the steelhead trout catch) were caught between 41°00'N and 48°30'N. Clipped fins included adipose, dorsal, left ventral, and left pectoral fins. The snouts were collected for potential recovery of coded-wire tags. Snouts were salted and sent to ABL for recovery of coded-wire tags. Six of the steelhead contained wire tags (S. Fowler, ABL, personal communication). Two were released from coastal Washington hatcheries (22 June recovery at 180°, 41°N of 572 mm Salmon R. [Queets tributary] female; 29 June recovery at 179°30'W, 48°30'N of 700 mm Lake Quinault winter-run

female). Four were released from Snake River hatcheries in Idaho (23 June recovery at 180°, 43°N of 710 mm Sawtooth Hatchery summer-run female; 25 June recovery at 180°, 45°N of 546 mm Little Salmon R. male; 26 June recovery at 180°, 45°N of 574 mm Sawtooth Hatchery summer-run male; 29 June recovery at 180°, 47°30'N of 702 mm Little Salmon R. female).

Aboard the *Oshoro maru*, snouts were collected from 24 salmonids lacking adipose fins (22 steelhead and 2 sockeye salmon). Two of the steelhead contained wire tags, but one was not coded (S. Fowler, ABL, personal communication). The other tagged steelhead, a juvenile (age 1.0) fish recovered at 145°W, 52°N on 8 July, originated from a release of hatchery fish into a coastal Washington stream (Salmon R., tributary of the Queets R.).

Maintenance and updating of tag release and recovery databases

The high-seas salmon tag release and recovery databases were updated with data provided at the 1996 NPAFC annual meeting. Japan reported double-tagging operations conducted with the United States. The release database was updated with 38 operations in which 741 fish were tagged and released. Eight fish were added to the tag recovery database (2 recoveries from Japan, 6 recoveries from Alaska). The updated databases are available to all national sections. Preliminary information from documents prepared for the 1997 NPAFC annual meeting indicates 818 fish were tagged in 31 operations. New tag release and recovery information will be added to the databases in the next year of the contract.

Tag databases are now archived on compact disks (ISO 9660 format, readable by DOS/Windows, Macintosh, and Unix systems), as well as on diskettes and hard disks on desktop computers. Copies of the compact disks, which also contain FRI high seas research and scale pattern analysis data, are kept at FRI and a remote site; a copy is also being provided to ABL. Updated CD copies will be created as needed. Four errors in the tag recovery database were corrected when the database was transferred from magnetic tape to compact disk.

B. Ocean Ecology, Carrying Capacity, Climate Change, and Stock Assessment

I. SALMON RESEARCH VESSEL CRUISES

Wakatake maru

One FRI scientist (N. Davis) participated in the cooperative Japan-U.S. salmon research cruise on board the R/V *Wakatake maru* from June 11 to July 25, 1997 (Nagasawa et al. 1997a). In 1997, the (old) *Wakatake maru* (424 gross tons) that was used in the earlier years of this cruise series (1991-1996) was replaced by a new ship. The (new) *Wakatake maru* is configured for gillnet and longline fishing and is a substantially larger ship (666 gross tons). The research cruise was conducted in the central North Pacific Ocean (NPO) and Bering Sea. The cruise track included fishing stations along a north-south transect at 180°00' longitude (from 39°00'N to 47°30'N) and 179°30'W from (48°30'N to 58°30'N), and an east-west transect at 56°30'N in the central Bering Sea (Fig. 2). Research cruise activities included collection of data on oceanography, primary production, zooplankton, micro-nekton, salmonids, non-salmonids, salmonid predators, and salmonid parasites and diseases. The research cruise provided an opportunity for a variety of studies including the following: salmonid food habits, including estimates of digestion rates and daily ration; trophodynamics; salmon age and growth validation; stock identification; salmonid tagging and tag recovery; characterization of external body condition (injuries, scars, slash marks, and external parasites); and collection of Pacific pomfret (*Brama japonica*), Pacific saury (*Cololabis saira*), and neon flying squid (*Ommastrephes bartrami*) for studies of their ecology. Results of oceanographic data indicated the average sea surface temperature was 0.90°C cooler in

the central North Pacific, and 0.61°C warmer in the Bering Sea in 1997 than in 1996. Longlines were used at 28 locations, and gillnets were fished at 21 locations outside the U.S. 200-mile EEZ. A total of 15,914 salmonids was caught by longline and gillnet. In the central NPO (39°00'N-51°30'N), a total of 1,142 salmonids was caught. Coho salmon were the most abundant salmon in the NPO catch (40% of salmonids), followed by chum (25%), pink (18%), steelhead (8%), sockeye (6%), and chinook salmon (3%). In the central Bering Sea (52°30'N-58°30'N), a total of 14,772 salmonids was caught. Pink salmon were the most abundant salmon in the Bering Sea catch (72% of salmonids), followed by chum (19%), sockeye (9%), chinook and coho salmon (both <1%). One Dolly Varden (*Salvelinus malma*) was caught.

Oshoro maru

Two FRI scientists (K. Myers and K. Aydin) participated in the cooperative Japan-US salmon research cruise on board the T/S *Oshoro maru* from 30 June to 15 July 1997 (Myers et al. 1997a). Salmon surveys conducted aboard the *Oshoro maru* along 180° longitude in the central NPO in June since 1978 have provided a valuable time series of fisheries and oceanographic data. This was the fourth consecutive year of cooperative Japan-U.S. sampling for salmon along a 145°W-longitude transect in the central Gulf of Alaska in early July. The primary objective of the 1997 cooperative research was to continue the collection of oceanographic and biological data along the 180° and 145°W transects (Fig. 2). In 1997, mid-June mean sea surface temperatures (SSTs; 9.2°C) at gillnet fishing stations were 2.1°C cooler along the 180° transect and early July mean SSTs (12.4°C) were 2.5°C warmer along the 145°W transect than in 1996. This reverses a warming trend in mean SSTs at 180° stations and a cooling trend at 145°W stations that was observed over the previous three years. Average (1994-97) surface temperatures increase and surface salinities decrease from south to north along the 145°W transect, and there are significant annual deviations from these average trends (Fig. 3, Table 3). Catches by gillnet totaled 2,036 salmonids, including 225 salmonids (361 in 1996) in the central NPO (180° transect) and 1,811 salmonids (1,982 in 1996) in the Gulf of Alaska. Biological samples and data were collected for various other cooperative studies of salmon distribution, abundance, stock origins, maturity and growth, food habits, bioenergetics, and other aspects of ocean biology and ecology; results will be reported later.

Salmonid abundance, maturity, age, and size in the central North Pacific Ocean, Bering Sea, and Gulf of Alaska

The *Wakakate maru* crosses several oceanic regions in the central NPO while conducting research gillnet operations along the 180° transect in late June. The most southerly region is the Transition Zone (39°-40° N in 1997) where surface water salinities are greater than 34.00 psu (practical salinity units, roughly equivalent to parts per thousand). The Transition Domain (41°-45°N in 1997) is characterized by salinities greater than 33.2 psu at the surface and greater than 33.4 psu at approximately 200 m. The Subarctic Current (46°-47°N in 1997) is identified by water temperatures of 3.5°C and salinities of 33.4 psu at approximately 125 m.

In the Transition Zone, salmonids were not abundant but chum and coho salmon have been caught south of the Subarctic Boundary (a vertical 34.00 psu isohaline which separates the Transition Zone and Transition Domain) in 1991, 1993, and 1997 (Table 4; Nagasawa et al. 1997b). Chum and coho salmon and steelhead trout were the most abundant salmonids in the Transition Domain. Catch per unit of effort (CPUE; number of salmon caught per 30-tans [1500 m] of research mesh [C-gear]) data indicate chum salmon were relatively abundant in the Transition Domain in the first three years (1991-1993), not abundant in the next three years (1994-1996), and are again at a high level in 1997. Coho salmon and steelhead have been relatively abundant every third year (1991, 1994, 1997) separated by two years of relatively lower

abundance. The abundance of coho salmon in 1997, after the lowest year in 1996, rebounded to an abundance level higher than in any year since 1991.

In the Subarctic Current, salmonids are more plentiful than in the Transition Domain. Although five species of salmon and steelhead trout were caught in the Subarctic Current region, chum and coho salmon were the most abundant species (Table 4). Chum salmon were less abundant in this area in 1997 than in 1996. Coho salmon were more abundant south of the Subarctic Current in 1997 than in 1996. Pink salmon have been relatively abundant every third year (1991, 1994, 1997).

In the Bering Sea in early and mid-July 1997, the abundance of salmon was higher than in all the years sampled (Table 4). Most of this is from the high abundance of pink and chum salmon in that area in 1997. In 1997, sockeye salmon were at their second-most abundant level since 1991. Chum salmon seem to be continuing a pattern of lower abundance in the Bering Sea in odd-years when pink salmon are abundant, and in 1997 chinook salmon were less abundant than they had been since 1993.

Because salmon age composition data for salmon caught by the *Wakatake maru* in 1997 are not yet analyzed, only data from 1991-1996 are used in the following analysis (Tables 5-10). Statistical analysis of biological data will be reported later. In the Bering Sea, sockeye salmon were generally ocean age .1 and .2 (Table 5). In 1995, the proportion of ocean age .1s was the smallest of the six years (11%), which may indicate poor early ocean survival of sockeye that migrated to the ocean in 1994. In 1996, the proportion of ocean age .1s had increased to 59%, as high as any year since 1991. Ocean age .2 chum salmon caught in the Transition Domain are the predominant age group in the catch in 1991-1996 (Table 6). The predominant age class in more northerly catches is ocean age .1, .2, or .3, depending on the year. In the Bering Sea, the predominant age groups were generally ocean age .2 and .3, but in 1992 and 1996, ages .1 and .2 were the prevailing ages. The size (length and weight) of ocean age .1 and .2s in the Bering Sea were slightly larger in odd years than in even years, but this tendency disappears in older fish. All the pink and coho salmon caught on the *Wakatake maru* cruises are ocean age .1 maturing fish (Tables 7 and 8). There is a strong odd-year dominant cycle of pink salmon in the central Bering Sea, a pattern of abundance not evident in the central NPO. Coho salmon were relatively more abundant in the central NPO than in the central Bering Sea. Ocean age .1 was the predominant age of chinook salmon caught in the Bering Sea in 1991 and 1994, otherwise fish were predominantly ocean age .2 (Table 9). The weight of ocean age .1, .2, and .3 chinook salmon in 1996 was the heaviest of all years sampled 1991-96. Ocean age .1s and .2s are the most common age of steelhead caught in the central NPO by the *Wakatake maru* (Table 10). Composite size data (mean length and weight of all ages combined) for 1997 are shown in Table 11.

The *Oshoro maru* salmon research cruise in the central North Pacific (180°, 39°-45°N) is in mid June, approximately one week earlier than the *Wakatake maru* cruise (Myers et al. 1997a). In contrast to the *Wakatake maru* data, no salmonids have been caught south of the Subarctic Boundary during the 1994-97 *Oshoro maru* mid-June surveys (Transition Zone, Table 12). In 1997, the approximate southern limit of salmon distribution in the central North Pacific in mid-June was at 40°N (Table 12). This was a one-degree southward shift from the southern limit in 1996. One sockeye salmon was caught at 180°, 45°N in the Transition Domain; no sockeye salmon were caught in the Transition Domain in previous (1994-1996) surveys. The abundance of coho salmon was substantially lower and abundance of pink salmon was substantially higher in both the Transition Domain and Subarctic Current than in 1996.

Along the 145°W transect in early July, salmonids were caught by research gillnet in two oceanic areas: (1) the Subarctic Current (50°-51°N), which is marked in this region by the

precipitous descent of the 4°C isotherm from approximately 100 m to 300 m below the surface, and (2) the Dilute Domain (52°N-56°N), which is characterized by relatively warm (> 10°C) and dilute (32.8 psu isohaline below 80 m) surface waters. A prominent oceanographic feature of the central Gulf of Alaska, the Ridge Domain, which is characterized by cold (4°C isotherm within 100 m of the surface), nutrient-rich, and oxygen-poor water, has usually been located to the west of the 145° W survey line from 1994 to 1997. In 1997, salmon were caught in the Ridge Domain at two gillnet stations located to the west of the 145° W transect. Sampling has not been conducted far enough to the south to determine the position of the Subarctic Boundary or the southern limit of salmonid distribution along 145°W. From 1994 to 1996, the relative abundance of sockeye salmon in catches in the Dilute Domain area of the 145°W transect decreased; this trend was reversed in 1997 (Table 12). The sockeye salmon in the catch were predominantly maturing, ocean age .2 fish (Table 13). The abundance of chum salmon (predominantly immature, ocean ages .1 and .2) in this area has been decreasing since 1995 (Tables 12 and 14). The abundance of both pink and coho salmon in the Dilute Domain in 1997 was approximately 50% of their peak abundance over the previous three years. Although there are only four consecutive years of sampling, abundance data indicate that maturing pink and coho salmon in this region may have opposite-year dominance cycles, with pink salmon predominating in odd years (Table 12). The abundance of chinook salmon (predominantly immature fish) in all areas along the 145°W transect is low (Tables 12 and 15). Steelhead caught at central Gulf of Alaska stations are predominantly juvenile, ocean age .0 fish (Table 16). Fork lengths, body weights, and condition factors of salmonids in the 1994-97 *Oshoro maru* research gillnet (C-gear) catches are summarized by species, age group and oceanic area (Tables 17-22). Preliminary statistical analyses of these biological data indicate that variation between stations within one year is as high as variation between years or between oceanic areas.

2. FOOD HABITS AND BIOENERGETICS

Bioenergetic modeling

A study, initiated in FY96 and completed in FY97, investigated the relationship between salmon prey consumption and growth (Davis et al. in press). Bioenergetic models were used to estimate growth and daily ration for common age and maturity groups of sockeye, chum, pink, and coho salmon caught in the central NPO and Bering Sea in summer. Assuming a constant daily ration for 60 days in June and July and temperatures of 5-9°C, an immature ocean age .1 sockeye salmon (361-568 g) required a daily ration of 3.6-4.1% wet body weight (bw)/day, an immature ocean age .2 chum salmon (1042-1547 g) required 3.3-3.9% bw/day, and a maturing ocean age .1 pink salmon (912-1313 g) required 2.7-3.1% bw/day. A maturing ocean age .1 coho salmon (1909-2975 g) required 2.6-2.9% bw/day at 9-11°C. Model simulations indicate that salmon are feeding at a rate close to their physiological maximum. Therefore, any decrease in daily ration could cause significant decreases in growth over a time period as short as two months. When prey is abundant, conditions favorable to salmon growth may be bounded at high temperatures by metabolic rates and at low temperatures by consumption rates.

A standard computer format for stomach content data was created to allow analysis of databases from different sources to determine trends through time and among several oceanic areas. Reformatting of the data from recent *Oshoro maru* cruises in the Gulf of Alaska has been completed, and reformatting of data from recent *Wakatake maru* cruises in the central NPO and Bering Sea has been partially completed.

Food habits

The results of shipboard examination of salmonid stomach contents on the *Wakatake maru* in 1997 indicated that stomachs of sockeye and pink salmon contained squid, appendicularians, chaetognaths, fish, and crustacean zooplankton (copepods, euphausiids, hyperiid amphipods, and ostracods). Fish in the stomachs of sockeye and pink salmon included *Hemilepidotus* sp., myctophids, larval fish, and Atka mackerel (*Pleurogrammus monopterygius*). Sockeye salmon stomach contents also included polychaetes, and pink salmon stomach contents included crab zoea.

Chum salmon had many of the same prey in their stomachs as sockeye and pink salmon including squid, appendicularians, chaetognaths, polychaetes, fish, and crustacean zooplankton (copepods, euphausiids, and ostracods). Chum salmon were also feeding on heteropods, pteropods, and gelatinous forms, such as siphonophores, salps, and ctenophores. Identifiable fish prey contained in chum salmon stomachs were larval fish and *Hemilepidotus* sp.

Coho salmon stomachs contained squid, copepods, hyperiid amphipods, pteropods, and fish. The fish identified from coho salmon stomachs included Pacific saury, Atka mackerel, three-spine sticklebacks (*Gasterosteus aculeatus*), and *Hemilepidotus* sp. In addition, in the central North Pacific, fresh Japanese anchovies (*Engraulis japonicus*) were found in coho stomach contents. This is a first record of Japanese anchovy observed as far east as 180° longitude (Nagasawa and Davis 1997a).

Chinook salmon stomachs contained squid, euphausiids, and fish. Fish prey included *Hemilepidotus* sp., Atka mackerel, and myctophids. In addition, in the central North Pacific, a chinook was found to contain two small daggertooth (*Anotopterus pharao* FL=140 mm and 165 mm) in its stomach. Daggertooths are regarded as predators of salmon, and not generally as prey. Perhaps this observation points to the importance of relative predator and prey body size over prey identity in investigations of oceanic food habits.

Steelhead trout were found to consume crustacean zooplankton (copepods, euphausiids, and amphipods), pteropods, and fish. The fish prey included Atka mackerel and three-spine sticklebacks. On several occasions, steelhead were found to contain floating debris including plastic sheet material, plastic foam, and wood in their stomach contents.

Four years of sampling along a 145°W transect by the *Oshoro maru* in the central Gulf of Alaska have shown some striking differences in the food habits of salmonids in Ridge/Dilute Domain versus Subarctic Current areas (Table 23 and 24). In the Subarctic Current, squid, primarily *Berryteuthis anonychus*, has been the dominant prey of all species except chum salmon, which had a much more diverse diet (primarily euphausiids, amphipods, pteropods, and gelatinous zooplankton). This corroborates the results of earlier studies, and highlights the importance of *B. anonychus* in the diets of salmon in the Subarctic Current area of the Gulf of Alaska. In the Dilute Domain, prey composition of stomach contents of sockeye, chum, and pink salmon was more diverse and the mean stomach content index (prey weight*100/body weight) was often lower than in the Subarctic Current. Coho, chinook, and steelhead tend to specialize in feeding on squid and fish, regardless of oceanic area.

This was the second year of shipboard analyses of stomach contents of salmon caught in the Aleutian Islands in August 1997 during the cruise of the F/V *Great Pacific*. Preliminary analyses were completed for samples collected from immature sockeye and chum salmon at fishing stations from Unalaska Island to Attu Island (Table 25). For both sockeye and chum salmon, percentage of empty stomachs was higher in the nearshore (shelf) habitat and lower in slope and oceanic habitats in 1997 than in 1996 (Carlson et al. 1996). For stomachs containing prey, mean stomach fullness and mean percent volume of euphausiids in 1997 was substantially lower than in

1996. Analyses of food habits data collected from other species, and from 380 salmonids caught in areas both south and north of Unimak Pass will be reported later.

Salmonid stomach evacuation rate experiment

During the cruise of the *Wakatake maru* a new shipboard experiment was conducted to estimate stomach evacuation rates and daily ration. In the Bering Sea (at 57°30'N, 178°30'W), eight short-duration gillnet sets were conducted in one 24-hour period. These gillnet operations were made on July 11 and July 12 at different locations 3.8 to 5.0 nautical miles apart. The purpose of these multiple gillnet operations was to collect samples from which diel variation in feeding activity of salmonids might be observed. A short gillnet composed of 19 tans of commercial-type gillnet (A-gear) was set at 06:00, 09:00, 12:00, 15:00, 18:00, 21:00, 24:00, and 03:00 (local time), and retrieved after a 2-hour soak-time. Salmonid stomachs were removed and frozen for later examination of stomach content weight and prey composition. A total of 651 salmon stomachs was collected including sockeye (n=215), chum (94), pink (n=333), coho (n=1), and chinook (n=8) stomachs. Sockeye, chum, and pink salmon were caught in each of the eight gillnet operations. The stomach samples have not yet been analyzed, but the objective is to use the computer program MAXIMS to analyze the changes in stomach content weight to estimate stomach evaluation rates and daily ration for sockeye, chum, and pink salmon.

3. GROWTH STUDIES

Oxytetracycline marking experiments

Oxytetracycline (OTC) was evaluated as an otolith-marking agent in recent high-seas salmon studies (Davis 1997). Oxytetracycline was selected as a possible otolith-marking agent because it is absorbed at calcification sites in a fish's body and will fluoresce under ultraviolet light. Successful otolith marking with OTC, in combination with a record of injection date and final date of otolith recovery, would provide valuable information with which to interpret the timing of periodic growth structures on the otolith. Two experiments had been conducted to produce an OTC mark on the otolith during high-seas salmon research cruises. In 1995 and 1996, chum salmon were tagged and experimentally injected with OTC, then placed in a tank or released to the sea. The dosage of OTC was approximately 25 mg OTC/kg fish weight, injected into the salmon's dorsal musculature. In spring 1997, the otoliths were examined whole or in half-section at 40-100X magnification with a fluorescence microscope equipped with an ultraviolet emission filter (360-390 nm wavelength).

It was impossible to identify with confidence an OTC mark on otoliths from chum salmon in the tank experiment, or from otoliths recovered from fish released in tagging experiments. Perhaps the dosage was too low to make a reliable mark. Therefore, the tagging experiment was repeated during the 1997 summer research cruise of the *Wakatake maru*, but the OTC dosage was increased to 50 mg OTC/kg fish, and the OTC was injected into the peritoneal cavity. This experiment resulted in the release of 503 double-tagged and OTC-injected fish including 48 sockeye, 403 chum, 25 pink, 10 coho, 3 chinook salmon, and 14 steelhead trout. We are currently encouraging recovery of head samples from tagged fish recovered in inshore areas.

Annulus formation

An analysis was initiated on timing of ocean annulus formation on chinook salmon scales. No papers have previously reported when annulus formation occurs on chinook scales. There is also no stock-specific information on time of ocean annulus formation for any salmon species. Historical scale samples collected from chinook salmon throughout the year by U.S. NMFS

observers on foreign trawlers in the Bering Sea and Gulf of Alaska are being used to examine the relationship of annulus formation to temperature, season, and oceanic region. Scale data (number of post-annulus circuli by month) collected from chinook salmon caught throughout the year in Washington waters were provided by Washington Department of Fish and Wildlife (WDFW). The WDFW data were collected from coded-wire tagged fish, and can be used to examine the hypotheses that there are differences in time of annulus formation between different stocks and between different life-history types within a single stock. The results of these studies will be reported later.

Scale growth studies

Studies were initiated to investigate whether long-term collections of scale samples could provide further information on recent observations related to ocean growth and abundance of Pacific salmon. Growth patterns on scales of pink and chum salmon were examined to determine if there were differences in growth between the periods before and after the change in oceanographic conditions which occurred around 1976-1977 and if changes in relative abundances of the two species were correlated with any changes in growth (Walker et al. in press). The scales were collected by the Fisheries Research Institute of the University of Washington (1956-91), the U.S. Bureau of Commercial Fisheries (1967-71), and the Fisheries Agency of Japan (1981-95). Scales collected in late June from adult age 0.1 pink salmon and primarily immature age 0.2 chum salmon were measured. The scales were from fish caught in the North Pacific Ocean south of Adak Island in the central Aleutians. Measurements were made of each circulus in the last year of ocean residence and to the edge of each preceding annular mark. Chum salmon caught in this area in 1983-95 had significant decreases in fork length and in growth at the edge of the scale compared to those caught in earlier years (1956-70). Pink salmon showed fewer differences in growth between periods, although odd-year pinks were smaller in 1983-95 than in 1959-67. Scale-edge growth of chum salmon was negatively correlated with Asian pink and chum salmon abundance. Adult pink salmon abundance may exert an influence on the third-year growth of chum salmon in this area.

Studies have begun of growth on scales collected from salmon caught during high-seas research cruises in the central Aleutian Islands and Gulf of Alaska. The studies were begun with measurements of scales of chum, pink, and sockeye salmon caught by Japanese research vessels starting in 1991 and examined for stomach contents. Scale measurements (particularly growth at the edge of the scale) will be compared to stomach contents and other measures of condition and growth. Measurements are being taken to the end of each annular mark and the edge of the scale, and to every circulus on the scale. Measurements will also be made of scales collected in earlier years from Japanese and U.S. research cruises.

Growth hormone studies

The first study of blood plasma levels of insulin-like growth factor-I (IGF-I) in Pacific salmon in offshore waters of the North Pacific Ocean was completed (Myers et al. in press). IGF-I is an important regulator of growth and development in teleosts. Previous research has shown that seasonal increases in IGF-I in salmon precede rapid growth, and may be associated with environmental cues (water temperature, photoperiod). We collected blood samples from salmon caught by research trawl in three regions of the North Pacific Ocean (western, central, eastern) during an offshore survey in January 1996. Plasma IGF-I levels were determined by radioimmunoassay. All of the samples were analyzed by the same assay so that inter- and intra-specific comparisons could be made. Mean IGF-I levels were significantly different among the five species sampled: pink (mean = 28 ng/ml, n = 14), chum (mean = 33 ng/ml, n=28), chinook (mean = 48 ng/ml, n = 15), sockeye (mean = 84 ng/ml, n = 13), and coho (mean = 120 ng/ml, n =26) salmon. High levels of IGF-I in coho salmon correlates with high growth rates in this species

found in other studies. There were significant positive correlations between body weight, liver weight, and IGF-I levels in all species except pink salmon. Samples were not collected at enough stations to adequately evaluate correlations between IGF-I and environmental factors. There were significant intra-specific differences in mean IGF-I levels by ocean age and region. Size of age .1 pink salmon was not significantly different by ocean region, but mean IGF-I levels in pink salmon were significantly higher in the eastern North Pacific than in the western region, which may indicate earlier resumption of rapid spring growth in the Gulf of Alaska. Similarly, body size and IGF-I levels in age .1 coho salmon were significantly higher in the eastern North Pacific, than in the central region. IGF-I may be a useful measure of ocean growth rates of salmon in the North Pacific Ocean, but additional data on the significance of high or low levels of IGF-I are needed. Analyses of blood serum samples collected during cruises of the *Wakatake maru* in 1996, the *Oshoro maru* in 1996 and 1997, and the *Great Pacific* in 1997 will be reported later.

4. CARRYING CAPACITY

Several aspects of carrying capacity research were begun or brought close to completion in the Base Period. A literature review on the trophic aspects of carrying capacity is being drafted for completion in October 1998. This review is based on both literature and work performed in spring 1997 adapting basin models of habitat distribution (in terms of individuals) to biomass terms appropriate for migratory salmon. There will also be a review of information on environmental noise and forcing in the North Pacific, and resulting models which link this noise to salmon production. In addition to providing a general discussion on mechanisms of carrying capacity, this review will discuss the role of trophic adaptation in determining biomass production in salmon. Once completed, this review will be submitted for publication.

Components of several data sets related to changes in salmon growth have been obtained; others will become available in the next year from publications of other institutions. Data from specific Bristol Bay sockeye runs were also obtained, and are being compared to local densities of high seas catches. In addition, size data from many stocks were obtained and used to estimate high-seas salmon food consumption based on bioenergetic models. Final work utilizing these size data will be performed and published after finishing analysis of food habits data.

Data from food habits studies conducted by Dr. William Percy (Oregon State University) during 1980-85 were entered from original records. The collection and data-recording methods between this data set and the FRI food habits data set from the 1990s was calibrated, resulting in an extensive database of high seas salmonid food habits.

In a study of local densities of salmon stocks, preliminary analysis of the high-seas tag-release database indicated that, while patchiness in tagging effort over time may affect the ability to use this database for modeling, spatial autocorrelation analysis (currently underway) may reveal details of stock-specific patchiness of salmon distribution in the Gulf of Alaska. The tag-release database itself was updated into Standard Query Language (SQL) in an effort to increase accessibility to future users.

Zooplankton data from the Gulf of Alaska have been collected and entered for fishing operations in which salmon food habits studies were conducted. This represents the only post-1976/77 regime shift source of data that can be used to directly link salmon feeding to prey availability on the high seas. In addition, a document is being prepared on cycles of abundance of secondary consumers, such as squid, in salmon stomachs. Because squid are difficult to sample directly, the varying stomach contents of salmon species with differing affinities for squid shall be used as a proxy for cycling feeding conditions.

In addition, data were obtained on oceanographic conditions, zooplankton abundance, and biological condition (length, weight, maturity status) of high-seas salmon, and these data were linked with specific food habits data. A substantial analysis of this database, comprising eight years of data, is forthcoming. During the Option Years, this database will be combined with food habits data collected by LeBrasseur during the 1960s and 1970s, and data from the *Great Pacific* cruises of ABL in 1996 and 1997 (Carlson et al. 1996, 1997).

The following computer models were developed or utilized during the Base Period. Most work during this period concentrated on the development of trophic models to investigate both top-down and bottom-up forcing of salmon productivity.

Salmon life history modeling. A general framework for a life-history model was developed which will combine aspects of several existing life-history models. This model is currently awaiting further data preparation. A related, but not identical model begun in the Base Year is a study of evolutionary niche space and inter- and intra-species competition of salmon as evidenced by feeding patterns.

Nutrient-phytoplankton-zooplankton modeling. During the base period, a trophic model, utilizing the software packages ECOPATH and extended by ECOSIM, was developed and calibrated using a combination of food habits and growth studies, fisheries data, and bioenergetics models. This model was tested and used to model the interplay between biological and physical elements of the North Pacific. Specifically, the question was asked: given set levels and frequencies of environmental forcing with shifts on the scale of known regime shifts, what patterns might be seen in biological feedback from both upper and lower trophic levels?

Preliminary work, presented in seminars and workshops offered in 1997, revealed the possibility of a link between hatchery production and regime shifts, which when acting in conjunction with 20-year cycling production regimes, may lead to increases in salmon predator populations, which may lead to more severe crashes in salmon populations during the low portions of the cycle.

The work is continuing along two lines. First, theoretical examinations are being performed on specific complex mathematical properties of the subarctic North Pacific food web, with analysis focusing on possible sudden shifts occurring between steady states and the role of spatial heterogeneity. Second, examination is being made of records for evidence of historical shifts in populations of oceanic salmon predators. Both of these studies should result in publications submitted in the first Option Year.

Final model. Work on the final model is part of a Ph.D. dissertation by K. Aydin to be completed at the end of the Second Option Year. As part of this work, a book chapter was completed on ecosystem management (Francis et al. in press). This involved original research on the subject of succession and stability in marine ecosystems.

5. RESEARCH COORDINATION WITH ABL

All research by FRI in FY 97 was fully coordinated with ABL. This coordination included assistance in the writing and review of research plans and results, provision of a participant (K. Myers) for research cruises aboard ABL-chartered vessels (Fig. 2; Carlson et al. 1997), provision of samples, databases, and other ocean salmon research information to ABL, and participation in an annual review by ABL (29-30 September 1997) of the results of FRI's high-seas salmon research.

II. NPAFC Participation

K. Myers participated as scientific advisor and prepared the Rapporteur's Report for the Committee on Scientific Research and Statistics (CSRS) at the fourth annual meeting of NPAFC in Tokyo, Japan, October 21-25, 1996. Nine documents were submitted or co-authored for this meeting (Carlson et al. 1996; Davis et al. 1996; Hiramatsu et al. 1996; Ishida et al. 1996; Myers et al. 1996a,b; Myers and Walker 1996; Sato et al. 1996; Ueno et al. 1996).

K. Myers, R. Walker, and N. Davis participated in the NPAFC Symposium "Assessment and Status of Pacific Rim Salmonid Stocks" held in Sapporo, Japan, 28-29 October, 1996, where the following research papers were presented:

- Growth studies from 1956-94 collections of pink and chum salmon scales in the central North Pacific Ocean. R.V. Walker, K.W. Myers, and S. Ito. (oral presentation)
- High-seas salmon food habits and simulated ocean growth and prey consumption. N.D. Davis, K.W. Myers, and Y. Ishida. (poster)
- Blood plasma levels of insulin-like growth factor-I in Pacific salmon in offshore waters in winter. K.W. Myers, N.D. Davis, W.W. Dickhoff, and S. Urawa. (poster)

All three papers will be published in proceedings of the symposium.

K. Myers, R. Walker, and N. Davis participated in NPAFC Research Planning and Coordination Meeting, March 4-5, 1996, Vancouver, Canada.

Five documents will be submitted or co-authored for the fifth annual meeting of NPAFC in October 1997 (Carlson et al. 1997; Mackas et al. 1997; Myers et al. 1997a,b; Nagasawa et al. 1997a).

In coordination with the Secretariat, K. Myers and Cathy Schwartz, a graphic designer, at FRI prepared two biannual summaries of international NPAFC-related salmonid research and activities for NPAFC newsletters published in spring and autumn, 1997.

N. Davis was appointed to the Methodology Standardization Working Group (MSWG) at the 1996 NPAFC annual meeting. The MSWG was formed to focus on ocean salmon research survey methods and to consider data quality and comparability over time for a given program and among different salmon research programs. Progress for the MSWG in 1997 has centered on summarizing the methodologies used by each nation's salmon research program. Questionnaires were sent to scientists conducting research cruises in order to compile a summary of each nation's routine survey methods as a document for CSRS at the 1997 NPAFC annual meeting. The U. S. section of this report summarizes the methodologies used on ABL research cruises, including the cruise series of the *F/V Great Pacific* in the Gulf of Alaska and the Aleutian Islands (part of the Ocean Carrying Capacity Program), and the inshore monitoring cruise series of the *R/V John N. Cobb* in southeastern Alaska (part of the U.S. GLOBEC program in the northeastern Pacific Ocean).

III. Miscellaneous Activities

A. Bristol Bay Sockeye

Project personnel responded to questions from NOAA/NMFS, Alaska Department of Fish and Game, and commercial fishing interests concerning possible causes for a 1997 Bristol Bay sockeye catch substantially below forecast levels. Information was provided on catch quotas for the Japanese driftnet fishery in the Russian 200-mile zone. Project personnel also attended a discussion group of FRI, other University, and International Pacific Halibut Commission scientists on possible causes for the erroneous forecasts and lower catch.

B. Salmon Publications Bibliography

Project personnel compiled an extensive abstracted bibliography of U.S.-originated scientific literature related to high seas salmon for the use of the Scientific Committee of NPAFC. Sources included journal and book articles, workshop proceedings, and publications by Alaska Department of Fish and Game.

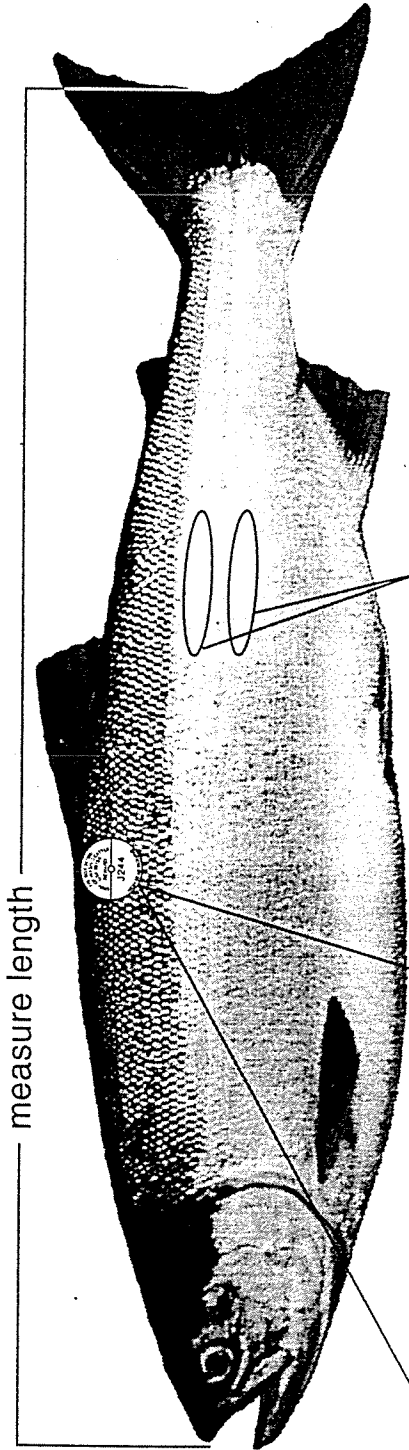
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RETURN HIGH SEAS SALMON AND STEELHEAD TAGS



measure length

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

Examples of high seas disk tags

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Tag color is red/white or solid red

- 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 to: **High Seas Project**
University of Washington
Fisheries Research Institute
Box 357980
Seattle, WA 98195-7980

For details call: (206) 543-1101

RETURN a high seas salmon tag (or tag number and description)

GET a custom embroidered cap as a reward



INTERNATIONAL HIGH SEAS SALMON TAGGING

Figure 1. Poster advertising for return of high-seas salmon tags to FRI, 1997.

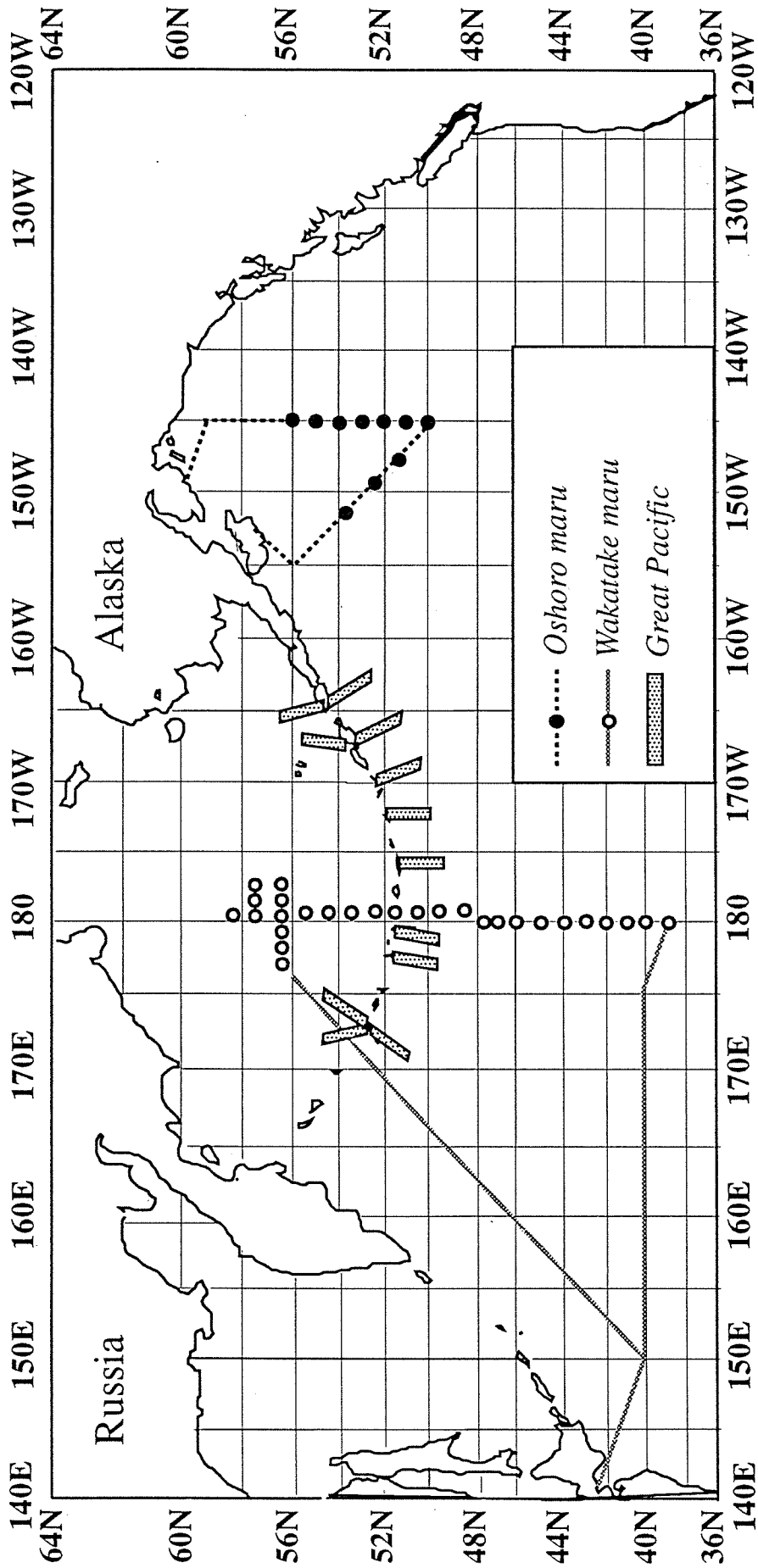


Figure 2. Cruise tracks of vessels on which FRI personnel participated in salmon research, 1997.

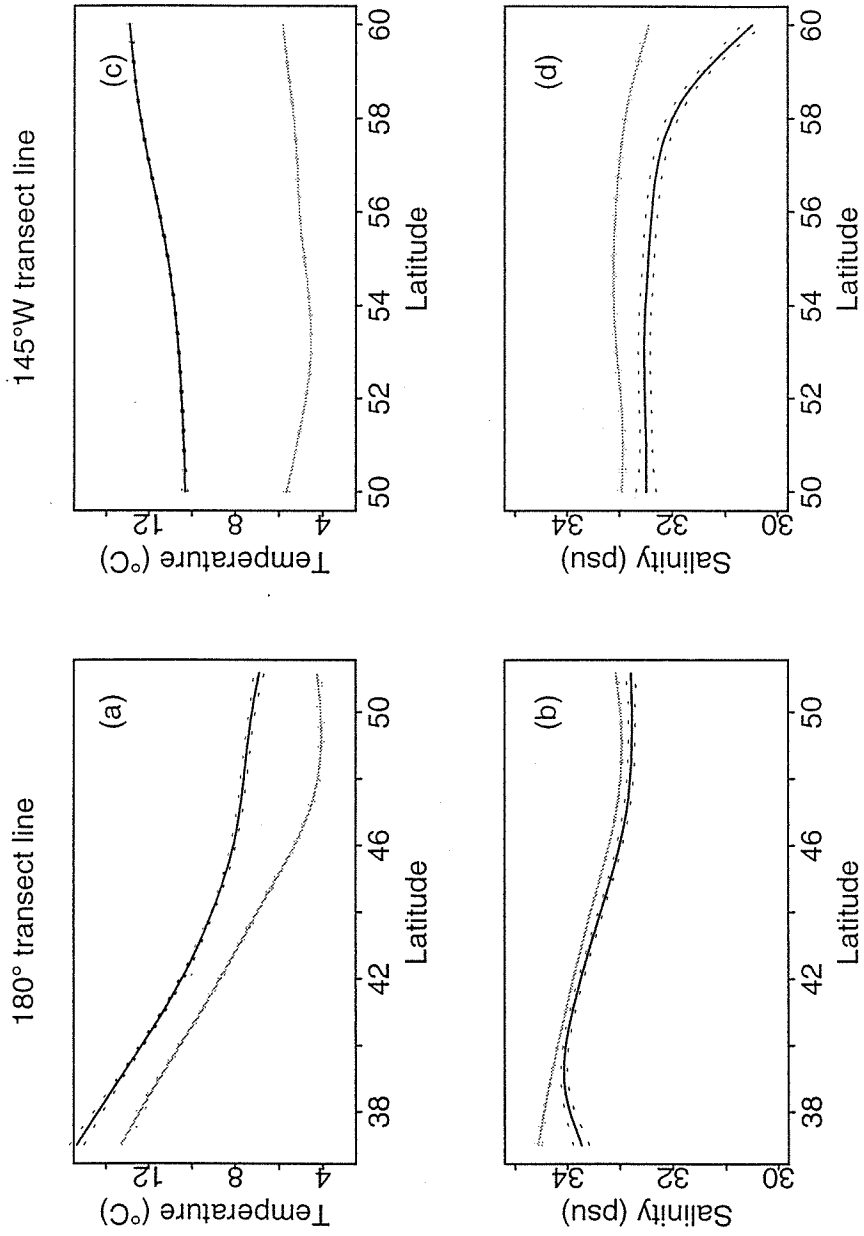


Figure 3. Effect of latitude on temperature (a, c) and salinity (b, d), averaged over four years (1994-97), along 180° and 145°W transect lines of the *Oshoro maru*. Solid lines indicate smoothed fit of temperature and salinity at 0 m (dark) and 100 m (gray). Dotted lines show 2 x standard error of fit on latitude.

Table 1. Extrapolated total interceptions of chum salmon from each region stock group. The interception estimates were stratified by week and by NMFS statistical reporting area, and the weekly estimates were summed to provide an overall estimate of interceptions from each region. The total percentage of interceptions from each region is also indicated. Total interceptions by stratum were based on stratified NMFS chum salmon bycatch estimates. Standard deviations of extrapolated interception estimates were based on 500 bootstrapped composition estimates with random resampling of both the mixture and baseline samples.

Stratum	Estimated interceptions (90% confidence interval)										Total	
	Japan	Russia (including SW Hokkaido)	Western Alaska- central Alaska	Northern SE Alaska	Southern SE Alaska- British Columbia (including Grays Harbor and Skagit River)	Washington						
	Week strata											
Aug 15 - Aug 20	2700	17431	4072	4448	3268	624	(850-4549)	(14991-19871)	(2210-5934)	(2639-6257)	(1824-4711)	32543
Aug 21 - Aug 27	2442	5451	794	2316	1402	265	(1066-3818)	(3925-6978)	(0-1800)	(1169-3463)	(517-2287)	12671
Aug 28 - Sept 3	2694	1733	2925	1006	3670	759	(1973-3415)	(1164-2302)	(2210-3640)	(507-1505)	(3035-4305)	12787
Sept 4 - Sept 10	883	929	2408	268	2162	156	(470-1295)	(565-1294)	(1875-2942)	(0-560)	(1799-2325)	6806
Sept 11 - Sept 17	303	558	663	275	908	455	(70-536)	(315-800)	(407-919)	(54-495)	(647-1169)	3162
Sept 18 - Sept 24	477	791	2326	300	1232	37	(120-834)	(413-1169)	(1720-2932)	(0-699)	(880-1585)	5163
Sept 25 - Oct 4	149	536	662	46	71	28	(0-298)	(344-728)	(458-866)	(0-145)	(0-159)	1492
Pooled	9648	27430	13850	8658	12713	2325	(4550-14746)	(21718-33142)	(8879-19033)	(4368-13125)	(8702-16742)	60711
Percentage	12.9%	36.8%	18.6%	11.6%	17.0%	3.1%	(6.1%-19.8%)	(29.1%-44.4%)	(11.9%-25.5%)	(5.9%-17.6%)	(11.7%-22.4%)	
	Area strata											
NMFS Area 509	125	509	248	500	189	345	(0-326)	(227-790)	(36-460)	(225-775)	(15-363)	1916
NMFS Area 513	475	1189	673	332	355	52	(203-748)	(896-1482)	(390-956)	(115-530)	(181-529)	3076
NMFS Area 517	7793	12695	13562	6058	18142	2461	(5710-9877)	(10554-14836)	(11105-16019)	(4285-7832)	(16056-20228)	60711
NMFS Area 519	178	134	207	3	134	21	(96-259)	(73-194)	(125-289)	(0-15)	(84-184)	677
NMFS Area 521	1147	2977	2894	74	523	263	(458-1836)	(2291-3663)	(2131-3657)	(0-287)	(190-856)	7878

Table 2. Catch location and biological data for fin-clipped salmonids caught by the R/V *Wakatake maru* in 1997 (N=45). A and C gear are gillnets followed by the mesh size; B gear is a surface longline. A=adipose fin clip, D=dorsal fin clip, LV=left ventral fin clip*, LPct=left pectoral fin clip.

Date	Location	Species	Length (mm)	Body Weight (g)	Sex	Gonad Weight (g)	Gear	Sample Number	Fin Clip
6-22-97	4100N 18000	steelhead	572	2000	F	18	C157	8-01	A, D
6-23-97	4300N 18000	steelhead	600	2060	M	1	B	23-11	A, D
6-23-97	4300N 18000	steelhead	710	2320	F	20	B	23-12	A, D
6-23-97	4300N 18000	steelhead	594	1940	M	3	B	23-13	A, D
6-23-97	4300N 18000	steelhead	555	1720	F	7	B	23-30	A, D
6-24-97	4300N 18000	steelhead	712	3650	M	5	A115	25-11	A, D
6-24-97	4300N 18000	steelhead	562	1850	M	5	A115	26-05	A, D
6-24-97	4300N 18000	steelhead	576	1680	M	10	C121	31-11	A, D
6-24-97	4300N 18000	steelhead	700	3640	F	18	C121	31-12	A, D
6-24-97	4300N 18000	steelhead	592	1930	F	30	C106	33-15	A, D
6-25-97	4400N 18000	steelhead	676	2950	F	27	C121	38-03	A, LV
6-25-97	4400N 18000	steelhead	554	1540	M	4	C106	39-08	A, D
6-25-97	4400N 18000	steelhead	610	1940	M	6	A115	43-05	A, LPct
6-25-97	4400N 18000	steelhead	534	1540	M	5	A115	43-06	A, D
6-25-97	4400N 18000	steelhead	546	1500	M	4	A115	43-07	A
6-25-97	4400N 18000	steelhead	562	1720	M	4	A115	43-08	A, D
6-25-97	4400N 18000	steelhead	563	1810	M	10	A115	43-09	A, D
6-25-97	4400N 18000	steelhead	601	1840	M	13	A115	43-10	A area miss**
6-25-97	4500N 18000	steelhead	572	1730	F	16	B	44-10	A
6-25-97	4500N 18000	steelhead	700	2990	F	29	B	44-16	A, D
6-25-97	4500N 18000	steelhead	546	1430	M	2	B	44-21	A, D, LV, LPct
6-26-97	4500N 18000	steelhead	574	2000	M	3	C121	48-02	A, D
6-26-97	4500N 18000	steelhead	624	2800	M	2	C121	48-03	A
6-26-97	4500N 18000	steelhead	534	1400	M	5	A115	49-08	A, D
6-26-97	4500N 18000	steelhead	600	1980	M	2	A115	49-09	A, D
6-26-97	4500N 18000	steelhead	602	2100	M	5	A115	49-11	A, LV
6-26-97	4500N 18000	steelhead	555	1600	M	3	A115	49-12	A, D
6-26-97	4500N 18000	steelhead	518	1220	F	4	C093	52-09	A, D
6-26-97	4600N 18000	steelhead	534	1580	F	7	B	53-05	A, D, LPct

Table 2. Continued.

Date	Location	Species	Length (mm)	Body Weight (g)	Sex	Gonad Weight (g)	Gear	Sample Number	Fin Clip
6-26-97	4600N 18000	steelhead	574	1820	M	1	B	53-13	A, D, LV
6-27-97	4600N 18000	steelhead	546	1600	F	12	A115	58-01	A
6-27-97	4600N 18000	steelhead	682	2960	F	27	A115	58-02	A
6-27-97	4600N 18000	steelhead	561	1620	M	5	A115	58-04	A
6-27-97	4700N 18000	steelhead	597	1780	F	13	B	64-08	A
6-28-97	4700N 18000	steelhead	585	1930	F	10	A115	71-17	A, D
6-28-97	4700N 18000	steelhead	722	3300	F	41	A115	71-18	A, D
6-28-97	4700N 18000	steelhead	558	1600	F	5	A115	71-19	A, D
6-28-97	4700N 18000	steelhead	520	1300	F	10	A115	74-07	A, D
6-28-97	4730N 18000	steelhead	570	1800	F	10	B	77-29	A, D
6-28-97	4730N 18000	steelhead	516	1320	M	4	B	77-30	A, D
6-29-97	4730N 18000	steelhead	620	2620	M	15	C121	87-02	A
6-29-97	4730N 18000	steelhead	730	3300	M	15	C138	88-01	A
6-29-97	4730N 18000	steelhead	702	3200	F	20	C138	88-02	A
6-29-97	4830N 17930W	steelhead	582	1860	M	3	B	90-09	A, D
6-29-97	4830N 17930W	steelhead	700	3740	F	23	B	90-10	A, D

*Absence of the left ventral fin may indicate the fish originated from the Columbia River. The Columbia Basin steelhead policy states that a left ventral clip (single or in combination) is reserved for coded-wire tags placed in Columbia River Basin steelhead and may not be used without a coded-wire tag (Johnson and Longwill 1993). An adipose clip may be used in conjunction with the left-ventral clip and coded-wire tag to indicate a harvestable coded-wire tagged steelhead. The adipose clip (single or in combination) on steelhead in the Columbia Basin is reserved (effective 9/83) to identify harvestable fish and is no longer a flag indicating a coded-wire tag.

**Area on the dorsal side where the adipose fin is located was missing, perhaps caused by a bite from a predator. Although it was unknown whether this steelhead was adipose fin-clipped or not, I decided to collect the snout anyway because the majority of steelhead that we caught were adipose fin-clipped.

Table 3. Gillnet stations by oceanographic region along summer transect lines of the *Oshoro maru*, 1994-97. Temperature and salinity anomalies are deviations from fitted latitudinal trends averaged by year (see Figure 3.). Significance level of a two-tailed t-test of yearly deviation from latitudinal trend is indicated as follows: (*) $P < 0.05$; (***) $P < 0.001$.

Zone	Number of Year Stations	Station Locations	Sampling Dates	Temperature Anomaly, °C		Salinity Anomaly, psu	
				at 0m	at 100m	at 0m	at 100m
Central Gulf of Alaska - Ridge/Dilute Domains							
1997	5	52-56°N along 145°W	July 8-July 12	1.50 (***)	-0.23 (*)	0.20 (*)	0.09
1996	5	52-56°N along 145°W	July 3-July 7	-0.92 (***)	-0.12	0.31 (*)	-0.01
1995	4	53-56°N along 145°W	July 8-July 10	-0.49 (***)	0.06	-0.43 (*)	-0.06
1994	6	51-56°N along 145°W	July 3-July 8	0.29 (*)	0.72 (*)	-0.12	-0.10
Central Gulf of Alaska - Subarctic Current							
1997	2	50-51°N along 145°W	July 6-July 7	1.55 (*)	-0.26 (*)	0.05 (*)	0.03
1996	2	50-51°N along 145°W	July 8-July 9	-0.50 (*)	0.30	0.10 (*)	0.02
1995	1	51° 30' N, 145° 00' W	July 6	-0.97 (*)	-0.10	-0.04	0.00
1994	1	50° 00' N, 145° 00' W	July 2	0.18	0.84	0.10	0.34
Central North Pacific - Subarctic Current							
1997	2	46-47°N along 180° 00	June 18-June 19	-0.59 (***)	-0.19	0.01	-0.03
1996	3	45-47°N along 180° 00	June 17-June 19	0.82 (***)	-0.06	-0.07 (*)	-0.01
1995	3	45-47°N along 180° 00	June 17-June 19	-0.42	0.29	0.02	0.08
1994	2	45-46°N along 180° 00	June 17-June 18	-1.29	-0.01	0.06	0.00
Central North Pacific - Transition Domain							
1997	4	40-45°N along 180° 00	June 12-June 17	-1.12 (***)	-0.27	-0.07	-0.09 (*)
1996	4	41-44°N along 180° 00	June 13-June 16	0.68 (*)	-0.21	-0.16	0.00
1995	3	42-44°N along 180° 00	June 14-June 16	0.13	1.00	0.21	0.27
1994	2	42-43°N along 180° 00	June 14-June 15	-0.23	0.10	0.2	0.04
Central North Pacific - Transition Zone							
1997	1	39° 00' N, 180° 00	June 11	-0.30	-0.18	0.32 (*)	0.00
1996	2	39-40°N along 180° 00	June 11-June-12	0.78 (*)	0.30	-0.06	0.03
1995	2	40-41°N along 180° 00	June 12-June 13	0.03	0.34	0.18	0.09
1994	4	39-41°N along 180° 00	June 11-June 13	0.64	0.53	0.10	0.02

Table 4. Mean catch (number of salmonids) per unit (30-tans, 1500 m) of effort by C-gear (research-mesh gillnet) calculated by oceanographic region for the *R/V Wakatake mariu*, 1991-1997. Research-mesh gillnet is composed of 3 tans each following mesh sizes: 48 mm, 55 mm, 63 mm, 82 mm, 93 mm, 106 mm, 121 mm, 138 mm, and 157 mm.

Year	Sampling Dates	Sta.	Locations	Mean		Mean		Mean Catch per 30 tans C-gear					Total		
				Temperature	Salinity	Temperature	Salinity	Chum	Pink	Coho	Steel-head	Dolly		Varden	
Central North Pacific - Transition Zone															
1997	19-20 Jun	2	39°N-40°N, 180°	13.3	11.0	34.3	34.3	0.0	2.0	0.0	0.5	0.0	0.0	0.0	2.5
1996	15-17 Jun	3	38°N-40°N, 180°	14.3	11.2	34.2	34.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	18-21 Jun	4	38°N-41°N, 180°	13.0	10.8	34.1	34.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	18-20 Jun	3	38°N-40°N, 180°	14.2	11.6	34.3	34.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	17-22 Jun	5	38°N-42°N, 180°	12.9	10.6	34.2	34.2	0.0	13.4	0.0	0.0	0.0	0.0	0.0	13.4
1992	17-20 Jun	4	38°N-41°N, 180°	12.8	10.2	34.2	34.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	12-14 Jun	3	38°N-40°N, 180°	14.3	11.2	34.2	34.3	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.7
Central North Pacific - Transition Domain															
1997	21-25 Jun	5	41°N-45°N, 180°	10.0	7.7	33.5	33.6	0.2	11.6	1.4	21.0	0.2	2.4	0.0	36.8
1996	18-20 Jun	3	41°N-43°N, 180°	11.8	8.0	33.6	33.7	0.0	5.0	0.0	1.3	0.0	0.7	0.0	7.0
1995	22-24 Jun	3	42°N-44°N, 180°	10.6	8.4	33.7	33.9	0.0	3.7	2.0	9.0	0.0	0.3	0.0	15.0
1994	21-24 Jun	4	41°N-44°N, 180°	10.5	8.6	33.9	33.9	0.0	9.0	1.3	11.0	0.0	2.5	0.0	23.8
1993	23-25 Jun	2	43°N-44°N, 180°	9.2	7.7	33.7	33.9	0.0	27.5	0.0	8.5	0.0	1.0	0.0	37.0
1992	21-22 Jun	2	42°N-43°N, 180°	9.4	9.1	33.7	34.0	0.0	15.0	0.0	5.5	0.0	0.5	0.0	21.0
1991	15-19 Jun	5	41°N-45°N, 180°	10.4	8.3	33.5	33.8	0.0	10.6	0.4	29.2	0.0	3.2	0.0	43.4
Central North Pacific-Subarctic Current															
1997	26-28 Jun	3	46°N-47°N, 180°	8.8	4.8	32.8	33.0	0.7	35.3	24.7	8.3	2.0	1.7	0.0	72.7
1996	21-26 Jun	4	44°N-47°N, 180°	9.2	5.1	33.1	33.2	0.0	53.0	1.3	19.0	0.8	1.0	0.0	75.0
1995	25-27 Jun	3	45°N-47°N, 180°	7.8	4.7	33.0	33.2	0.7	33.0	6.7	25.7	0.7	7.7	0.0	74.3
1994	25-27 Jun	3	45°N-47°N, 180°	6.5	3.9	32.9	33.0	1.3	15.3	22.0	25.0	1.0	9.0	0.0	73.7
1993	26-28 Jun	3	45°N-47°N, 180°	7.3	3.6	33.0	33.2	0.0	58.3	2.7	16.3	0.3	5.0	0.0	82.7
1992	23-25 Jun	3	44°N-46°N, 180°	7.6	4.8	33.2	33.3	0.0	12.7	0.3	19.3	0.3	1.0	0.0	33.7
1991	20-21 Jun	3	46°N-47°N, 180°	7.4	4.5	33.0	33.1	1.0	30.5	10.5	24.0	1.0	1.5	0.0	68.5
North Pacific Ridge Domain															
1992	26-Jun	1	47°N, 180°	6.7	3.1	33.0	33.1	0.0	40.0	1.0	34.0	0.0	2.0	0.0	77.0
Bering Sea															
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	584.5
1996	4-14 Jul	9	55°N-58°N, 177°W-179°E	7.5	2.9	32.8	33.0	55.1	200.7	4.8	0.1	6.8	0.0	0.2	267.7
1995	5-15 Jul	11	55°N-58°N, 177°W-177°E	7.5	2.0	32.9	33.1	37.8	63.8	174.5	0.5	6.5	0.0	0.2	283.3
1994	5-15 Jul	11	55°N-58°N, 177°W-177°E	6.7	1.8	32.9	33.2	50.3	224.0	13.1	0.0	5.2	0.0	0.2	292.7
1993	6-16 Jul	11	55°N-58°N, 177°W-177°E	7.2	2.1	33.1	33.2	58.2	111.6	141.2	0.8	1.4	0.0	0.0	313.2
1992	4-14 Jul	11	55°N-58°N, 177°W-177°E	6.4	2.5	33.0	33.3	22.8	257.5	9.0	0.3	5.4	0.0	0.5	295.5
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	452.1

Table 5. Ocean age composition (%), mean fork length (FL, mm), body weight (BW, g), and standard deviation (sd) of sockeye salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *R/V Wakatake mariu*, 1991-1996.

Sampling Year Dates	Ocean Age .1			Ocean Age .2			Ocean Age .3			Ocean Age .4		
	% N	FL (mm) mean sd	BW (g) mean sd	% N	FL (mm) mean sd	BW (g) mean sd	% N	FL (mm) mean sd	BW (g) mean sd	% N	FL (mm) mean sd	BW (g) mean sd
Central North Pacific - Subarctic Current (44°N-47°N, 180°)												
1996 21-26 Jun	0			0			0			0		
1995 25-27 Jun	0			0			2	100	606	9	2950	354
1994 25-27 Jun	2	50	365	49	464	91	1	25	452		980	
1993 26-28 Jun	0			0			0			0		
1992 23-25 Jun	0			0			0			0		
1991 20-21 Jun	2	100	315	5	295	7	2			2		
Bering Sea (55°N-58°N, 177°W-177°E)												
1996 4-14 Jul	270	59	340	29	382	119	139	30	472	38	1250	355
1995 5-16 Jul	44	11	330	45	399	200	292	72	495	30	1447	354
1994 5-15 Jul	133	37	430	26	404	97	209	57	474	30	1189	255
1993 6-16 Jul	297	52	351	25	430	101	246	43	483	36	1301	329
1992 4-14 Jul	92	39	337	31	392	105	126	54	483	31	1364	324
1991 1-8 Jul	101	59	313	21	332	70	38	22	480	39	1335	477
							48	11	585	54	2659	865
							70	17	586	58	2599	792
							23	6	583	38	2643	651
							31	5	571	44	2423	773
							16	7	584	46	2929	803
							30	18	595	44	2851	781
							0					
							2	0	624	63	2925	601
							0					
							2	0	628	20	3275	601
							1	0	650		4500	
							2	1	653	33	4225	460

Table 7. Ocean age composition (%), mean fork length (FL, mm), body weight (BW, g), and standard deviation (sd) of pink salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *R/V Wakatake maru*, 1991-1996.

Year	Sampling Dates	Ocean Age .1					
		N	% at Age	Fork length (mm)		Body weight (g)	
				mean	sd	mean	sd
Central North Pacific - Transition Domain (41°N-45°N, 180°)							
1996	18-20 Jun	0					
1995	22-24 Jun	6	100	467	33	1186	328
1994	21-24 Jun	7	100	469	38	1063	265
1993	23-25 Jun	0					
1992	21-22 Jun	0					
1991	15-19 Jun	2	100	431	21	860	198
Central North Pacific - Subarctic Current (44°N-47°N, 180°)							
1996	21-26 Jun	5	100	436	45	844	349
1995	25-27 Jun	18	100	459	26	1070	360
1994	25-27 Jun	66	100	455	28	1023	210
1993	26-28 Jun	8	100	429	21	738	134
1992	23-25 Jun	2	100	458	0	920	57
1991	20-21 Jun	21	100	423	35	787	252
Central North Pacific - Ridge Domain (47°N, 180°)							
1992	26-Jun	1	100	450		910	
Bering Sea (55°N-58°N, 177°E-177°W)							
1996	4-14 Jul	43	100	455	35	1117	275
1995	5-16 Jul	1749	100	470	29	1298	266
1994	5-15 Jul	143	100	444	30	1055	262
1993	6-16 Jul	1434	100	449	27	1106	240
1992	4-14 Jul	100	100	451	27	1153	255
1991	1-8 Jul	1315	100	447	41	1108	362

Table 8. Ocean age composition (%), mean fork length (FL, mm), body weight (BW, g), and standard deviation (sd) of coho salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *R/V Wakatake maru*, 1991-1996.

Year	Sampling Dates	Ocean Age .1					
		N	% Age	Fork length (mm)		Body Weight (g)	
				mean	sd	mean	sd
Central North Pacific - Transition Domain (41°N-45°N, 180°)							
1996	18-20 Jun	4	100	542	20	1925	155
1995	22-24 Jun	26	100	525	40	1786	328
1994	21-24 Jun	43	100	516	39	1563	414
1993	23-25 Jun	18	100	506	58	1562	472
1992	21-22 Jun	11	100	512	55	1678	486
1991	15-19 Jun	146	100	519	38	1611	343
Central North Pacific - Subarctic Current (44°N-47°N, 180°)							
1996	21-26 Jun	75	100	516	39	1653	399
1995	25-27 Jun	73	100	532	46	1836	512
1994	25-27 Jun	78	100	527	39	1829	415
1993	26-28 Jun	49	100	521	48	1755	512
1992	23-25 Jun	58	100	503	31	1514	340
1991	20-21 Jun	49	100	526	39	1821	419
Central North Pacific - Ridge Domain (47°N, 180°)							
1992	26-Jun	34	100	507	39	1611	367
Bering Sea (55°N-58°N, 177°E-177°W)							
1996	4-14 Jul	1	100	630		3800	
1995	5-16 Jul	5	100	605	35	2910	668
1994	5-15 Jul	0					
1993	6-16 Jul	9	100	556	33	2166	581
1992	4-14 Jul	3	100	568	37	2450	492
1991	1-8 Jul	0					

Table 9. Ocean age composition (%), mean fork length (FL, mm), body weight (BW, g), and standard deviation (sd) of chinook salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *R/V Wakatake maru*, 1991-1996.

Year	Sampling Dates	Ocean Age .1			Ocean Age .2			Ocean Age .3			Ocean Age .4		
		% N Age	FL (mm) mean sd	BW (g) mean sd	% N Age	FL (mm) mean sd	BW (g) mean sd	% N Age	FL (mm) mean sd	BW (g) mean sd	% N Age	FL (mm) mean sd	BW (g) mean sd
Central North Pacific - Subarctic Current (44°N-47°N, 180°)													
1996	21-26 Jun	3	100	395	44	823	320	0					
1995	25-27 Jun	0						1	50	562	2200		
1994	25-27 Jun	0						3	100	616	33	3150	477
1993	26-28 Jun	0						1	100	624	3700		
1992	23-26 Jun	0						1	100	575	2300		
1991	20-21 Jun	0						2	100	572	82	2625	926
Central North Pacific - Ridge Domain (47°N, 180°)													
1992	26-Jun	0						0					
Bering Sea													
1996	4-14 Jul	24	43	407	31	826	221	25	45	567	46	2382	632
1995	5-16 Jul	18	27	339	31	442	128	43	65	525	52	1813	522
1994	5-15 Jul	25	47	374	31	595	210	11	21	543	57	2179	740
1993	6-16 Jul	1	8	352		480		7	59	573	25	2340	314
1992	4-14 Jul	17	36	356	27	525	116	23	49	567	47	2333	709
1991	1-8 Jul	45	66	345	26	497	120	21	31	530	57	1816	634
								7	12	732	46	5121	1366
								4	6	726	61	4725	1300
								17	32	720	41	4855	1129
								3	25	716	95	4710	2175
								6	13	654	27	3822	648
								2	3	715	18	4050	71
								0					
								1	2	812			6800
								0					
								1	8	862			8600
								1	2	850			7650
								0					

Table 10. Ocean age composition (%), mean fork length (FL, mm), body weight (BW, g), and standard deviation (sd) of steelhead trout caught in the research-mesh gillnet (C-gear) during fishing operations of the *RV Wakatake maru*, 1991-1996.

Year	Sample Dates	Ocean Age .1					Ocean Age .2					Ocean Age .3				
		N	% Age	FL (mm)	mean	sd	N	% Age	FL (mm)	mean	sd	N	% Age	FL (mm)	mean	sd
Central North Pacific - Transition Domain (41°N-45°N, 180°)																
1996	18-20 Jun	2	100	555	11	1770	212	0								
1995	22-24 Jun	0						1	100	682		3000				
1994	21-24 Jun	9	100	564	16	1812	189	0								
1993	23-25 Jun	1	50	540		1520		1	50	656		2650				
1992	21-22 Jun	0						1	100	718		4000				
1991	15-19 Jun	8	73	542	49	1608	434	3	27	741	24	4533	797			
Central North Pacific - Subarctic Current (44°N-47°N, 180°)																
1996	21-26 Jun	4	100	555	12	1608	116	0								
1995	25-27 Jun	16	73	574	41	1791	317	5	23	672	51	3050	752			
1994	25-27 Jun	21	84	551	44	1850	231	4	16	692	61	3538	1090			
1993	26-28 Jun	4	40	563	24	1695	93	6	60	688	70	2975	424			
1992	23-25 Jun	0						3	100	663	49	2867	568			
1991	20-21 Jun	2	75	522	60	1315	403	1	25	710		3800				
Central North Pacific - Ridge Domain (47°N, 180°)																
1992	26-Jun	1	50	548		1530		1	50	658		2350				0

Table 11. Mean fork length (mm) and body weight (g) of salmonids caught in the research-mesh gillnet (C-gear) during fishing operations of the R/V *Wakatake maru*, 1991-1997.

Year	Sampling Dates	Sockeye			Chum			Pink			Coho			Chinook			Steelhead		
		N	Fork Length (mm)	Body Weight (g)	N	Fork Length (mm)	Body Weight (g)	N	Fork Length (mm)	Body Weight (g)	N	Fork Length (mm)	Body Weight (g)	N	Fork Length (mm)	Body Weight (g)	N	Fork Length (mm)	Body Weight (g)
Central Pacific Ocean																			
1997	19-28 Jun	6	464	1108	155	385	718	83	433	937	132	507	1698	7	649	3550	18	628	2548
1996	15-26 Jun	0			221	374	621	5	436	844	80	514	1665	3	395	823	6	555	1622
1995	18-27 Jun	2	606	2950	111	478	1376	26	461	1095	104	529	1806	2	697	5000	24	603	2144
1994	18-27 Jun	4	449	1277	81	418	826	73	456	1027	121	523	1735	3	616	3150	37	578	2112
1993	17-28 Jun	0			296	410	779	8	429	738	67	517	1703	1	624	3700	17	635	2382
1992	17-25 Jun	0			107	403	784	3	455	917	103	505	1563	1	575	2300	6	652	2746
1991	12-21 Jun	2	315	295	113	417	819	23	423	793	197	521	1678	2	572	2625	19	584	2214
Bering Sea																			
1997	6-17 Jul	565	419	910	1346	402	814	1537	445	1117	3	552	1740	34	494	1671	0		
1996	4-14 Jul	496	401	851	1806	419	896	43	455	1117	1	630	3800	61	518	2023	0		
1995	5-15 Jul	416	495	1564	702	491	1489	1919	469	1291	6	601	2875	71	486	1598	0		
1994	5-15 Jul	554	423	919	2281	461	1138	143	444	1055	0			56	523	2322	0		
1993	6-16 Jul	637	419	907	1223	481	1343	1434	449	1106	9	556	2166	15	592	3015	0		
1992	4-14 Jul	247	435	1125	2821	432	777	100	451	1153	3	568	2450	59	503	1916	0		
1991	1-8 Jul	183	401	1033	423	537	1973	1315	447	1108	0			78	419	1083	0		

Table 12. Catch (number of salmonids) per unit effort by C-gear, summarized by oceanic region, *Oshoro maru* 1994-97. One unit effort is equal to one operation of the 30-tan (1500 m) non-selective research mesh gillnet. One-way ANOVAs performed between years within domains on both raw and log-transformed data revealed no significant differences, due to high catch variability within years.

Domain	Year	Total Stations	C.P.U.E.											
			Socketeye mean (s.d.)	Chum mean (s.d.)	Pink mean (s.d.)	Coho mean (s.d.)	Chinook mean (s.d.)	Steelhead mean (s.d.)						
Central Gulf of Alaska - Ridge/Dilute Domains														
	1997	5	59.6	22.9	48.0	39.5	21.0	15.4	10.2	5.7	0.0	0.0	3.4	2.5
	1996	5	33.8	16.6	65.2	40.1	15.4	14.8	20.4	10.6	0.4	0.9	6.2	6.6
	1995	4	36.3	13.0	88.8	4.2	42.5	5.4	13.5	4.7	0.5	0.6	4.0	2.9
	1994	6	42.5	32.6	26.0	24.7	30.8	14.7	14.0	6.8	0.2	0.4	2.3	2.7
Central Gulf of Alaska - Subarctic Current														
	1997	2	14.5	6.4	14.5	0.7	0.0	0.0	2.0	1.4	0.0	0.0	0.0	0.0
	1996	2	7.5	6.4	10.5	3.5	16.0	1.4	6.0	7.1	0.0	0.0	2.0	0.0
	1995	1	29.0	-	68.0	-	18.0	-	15.0	-	1.0	-	8.0	-
	1994	1	9.0	-	10.0	-	27.0	-	0.0	-	0.0	-	2.0	-
Central North Pacific - Subarctic Current														
	1997	2	8.0	1.4	22.5	14.8	29.5	3.5	2.0	1.4	0.5	0.7	1.0	0.0
	1996	3	0.0	0.0	33.7	24.2	3.3	2.1	24.3	11.0	0.7	0.6	2.0	1.7
	1995	3	1.7	1.5	12.0	8.2	14.3	19.7	24.0	36.5	0.0	0.0	1.3	1.5
	1994	2	0.0	0.0	27.5	9.2	18.0	5.7	16.5	3.5	0.5	0.7	5.0	2.8
Central North Pacific - Transition Domain														
	1997	4	0.3	0.5	8.0	5.4	5.8	7.3	3.0	3.4	0.0	0.0	1.3	1.5
	1996	4	0.0	0.0	5.8	6.9	0.5	1.0	7.0	8.2	0.0	0.0	1.0	0.8
	1995	3	0.0	0.0	0.7	0.6	0.0	0.0	2.3	1.5	0.0	0.0	0.3	0.6
	1994	2	0.0	0.0	24.0	25.5	4.5	3.5	38.0	28.3	0.0	0.0	0.5	0.7
Central North Pacific - Transition Zone														
	1997	1	0.0	-	0.0	-	0.0	-	0.0	-	0.0	-	0.0	-
	1996	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1995	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1994	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 13. Ocean age composition and maturity at age of sockeye salmon caught by the *Oshoro maru* research gillnet, 1994-97. Percent values indicate average percentage of fish in specific age class and maturity in each catch, grouped by oceanic region and year.

Ocean Zone	Year	N	Percent of (year x domain) catch in each category												%Mature Overall	
			Ocean Age 1			Ocean Age 2			Ocean Age 3			Ocean Age 4				
			Immature	Mature	Total	Immature	Mature	Total	Immature	Mature	Total	Immature	Mature	Total		
Central Gulf of Alaska - Ridge/Dilute Domains																
	*1997	310	2	2	4	6	65	71	25	25	25					91.9
	1996	154	10	3	13	5	54	58	28	28	28	1	1	1		85.1
	1995	132	10	11	20	2	45	47	33	33	33					88.6
	1994	214	4	3	7	18	57	75	17	17	17	0.47	0.47	0.47		78.0
Central Gulf of Alaska - Subarctic Current																
	1997	28	7	7	14	18	61	79	7	7	7					75.0
	1996	13	15	15	15	77	77	77	8	8	8					84.6
	1995	22	5	9	14	9	59	68	14	14	14	5	5	5		86.4
	1994	35	37	37	37	14	49	63								48.6
Central North Pacific - Subarctic Current																
	1997	15	27	27	27	67	7	73								6.7
	1995	2	50	50	50	50		50								0.0
	1994	1	100	100	100											0.0
Central North Pacific - Transition Domain																
	1997	1	100	100	100											0.0

*Catch included 1 immature ocean-age 5 fish.

Table 14. Ocean age composition and maturity at age of chum salmon caught by the *Oshoro maru* research gillnet, 1994-97. Percent values indicate average percentage of fish in specific age class and maturity in each catch, grouped by oceanic region and year.

Ocean Zone	Year	N	Percent of (year x domain) catch in each category												%Mature Overall		
			Ocean Age 1		Ocean Age 2		Ocean Age 3		Ocean Age 4		Immature	Mature	Total				
			Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature				Immature		Mature	Total
Central Gulf of Alaska - Ridge/Dilute Domains																	
	*1997	277	40	3	43	53	1	55	2	0.36	3						4.7
	1996	276	17	1	18	74	3	77	1	3	4						7.2
	1995	315	8	3	11	59	19	77	6	5	11		0.32	0.32			26.7
	1994	133	47	7	53	31	10	41	2	4	6						20.3
Central Gulf of Alaska - Subarctic Current																	
	1997	29	41		41	59		59									0.0
	1996	18				100		100									0.0
	1995	62	2		2	81	11	92	5	2	6						12.9
	1994	80	8		8	59	11	70	14	8	21		1	1			20.0
Central North Pacific - Subarctic Current																	
	1997	41	76		76	15		15	2	2	5		2	2	5		4.9
	1996	58	48		48	34	9	43	2	7	9						15.5
	1995	23	39		48	13	9	22	17	9	26		4	4			30.4
	1994	43	56		56	40	2	42		2	2						4.7
Central North Pacific - Transition Domain																	
	1997	25	52		52	44		44	4		4						0.0
	1996	15	47		47	47	7	53						100	100		6.7
	1995	1															0.0
	1994	42	5		14	50	17	67	14	5	19						31.0

*Catch included 1 immature ocean-age 0 fish.

Table 15. Ocean age composition and maturity at age of chinook salmon caught by the *Oshoro maru* research gillnet, 1994-97. Percent values indicate average percentage of fish in specific age class and maturity in each catch, grouped by oceanic region and year.

Ocean Zone	Year	N	Percent of (year x domain) catch in each category								%Mature Overall			
			Ocean Age 1		Ocean Age 2		Ocean Age 3		Ocean Age 4					
			Immature	Mature	Total	Immature	Mature	Total	Immature	Mature	Total	Immature	Mature	Total
Central Gulf of Alaska - Ridge/Dilute Domains														
	1997	0												0.0
	1996	3	33			67								0.0
	1995	1			100									0.0
	1994	0												0.0
Central Gulf of Alaska - Subarctic Current														
	1997	0												0.0
	1996	0												0.0
	1995	1			100									0.0
	1994	2			50			50						0.0
Central North Pacific - Subarctic Current														
	1997	1							100					100.0
	1996	1			100									0.0
	1995	0												0.0
	1994	1			100									0.0

Table 16. Ocean age composition and maturity at age of steelhead caught by the *Oshoro maru* research gillnet, 1994-97. Percent values indicate average percentage of fish in specific age class and maturity in each catch, grouped by oceanic region and year.

Ocean Zone	N	Percent of (year x domain) catch in each category												%Mature Overall
		Ocean Age 0			Ocean Age 1			Ocean Age 2			Ocean Age 3			
		Immature	Mature	Total	Immature	Mature	Total	Immature	Mature	Total	Immature	Mature	Total	
Central Gulf of Alaska - Ridge/Dilute Domains														
1997	22	45	32	77	14	14	14	9	9	9	3	3	3	54.6
*1996	31	61	61	61	16	10	26	6	6	6	3	3	3	19.4
1995	8				75		75	13	13	13	13	13	13	25.0
1994	12	92	8	100										8.3
Central Gulf of Alaska - Subarctic Current														
1997	0													25.0
1996	4	50		50	25		25	25	25	25				0.0
1995	7				100		100							44.4
1994	9	11		11	44	33	78	11	11	11				
Central North Pacific - Subarctic Current														
1997	2				50		50				50	50	50	100.0
1996	4				75		75	25	25	25				75.0
1995	4				50		50			50	50	50	50	50.0
1994	7				86		86	14	14	14				14.3
Central North Pacific - Transition Domain														
1997	4				50		50			50	50	50	50	100.0
1996	4				50		100							50.0
1995	1				100		100							0.0
1994	1				100		100							0.0

*Catch included 1 mature ocean-age 4 fish.

Table 17. Number sampled, mean and standard deviation of fork length (FL, cm), body weight (BW, g), and condition factor (CF, BW/FL³*10⁶) of sockeye salmon caught by the *Oshoro mariu* research gillnet, 1994-97, grouped by ocean age.

Zone	Ocean Age 1			Ocean Age 2			Ocean Age 3			Ocean Age 4															
	N	FL s.d.	BW s.d.	CF s.d.	N	FL s.d.	BW s.d.	CF s.d.	N	FL s.d.	BW s.d.	CF s.d.													
Central Gulf of Alaska - Ridge/Dilute Domains																									
*1997	12	413	80	1005	657	13	1	221	552	35	2209	464	13	2	76	612	38	2989	633	13	1	0			
1996	20	359	52	589	458	12	1	90	563	46	2475	647	13	1	43	626	40	3360	669	14	1	1	610	3400	15
1995	27	349	23	527	133	12	2	62	546	47	2083	565	12	1	43	607	41	2878	561	13	2	0			
1994	16	347	25	503	99	12	2	160	555	39	2255	463	13	2	37	603	35	2775	528	13	1	1	650	2750	10
Central Gulf of Alaska - Subarctic Current																									
1997	4	457	82	1295	714	12	2	22	539	27	2031	398	13	1	2	617	59	2970	891	12	0	0			
1996	2	369	4	550	14	11	1	10	578	29	2638	410	14	1	1	650	40	4050	15	15	0	0			
1995	3	386	48	680	314	11	1	15	537	50	2157	577	14	3	3	593	105	3167	679	16	6	0		3000	11
1994	13	360	14	504	63	11	1	22	545	32	2248	446	14	1	0							0			
Central North Pacific - Subarctic Current																									
1997	4	329	38	436	116	12	2	11	442	27	896	166	10	1	0							0			
1996	0							0							0							0			
1995	1	288		250		10		1	444		1200		14		0							0			
1994	1	312		350		12		0						0								0			

* includes one ocean-age 5 fish, FL 924, BW 7300, CF 9

Table 18. Number sampled, mean and standard deviation of fork length (FL, cm), body weight (BW, g), and condition factor (CF, BW/FL³*10⁶) of chum salmon caught by the *Oshoro maru* research gillnet, 1994-97, grouped by ocean age.

Zone	Ocean Age 1			Ocean Age 2			Ocean Age 3			Ocean Age 4																			
	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	CF s.d.													
Central Gulf of Alaska - Ridge/Dilute Domains																													
*1997	118	386	30	719	187	12	1	151	457	28	1123	211	12	1	7	510	56	1546	495	11	2	0							
1996	51	405	32	771	185	11	2	213	471	27	1217	209	12	1	12	586	97	2698	1428	12	1	0							
1995	34	421	75	803	212	11	3	244	490	30	1387	245	12	2	36	527	28	1721	307	12	1	1	528	1540			10		
1994	71	390	16	696	132	12	2	54	464	31	1205	313	12	1	8	492	37	1494	452	12	2	0							
Central Gulf of Alaska - Subarctic Current																													
1997	12	370	24	640	138	12	1	17	444	27	1145	190	13	1	0														
1996	0							18	476	49	1237	268	12	2	0														
1995	1	402		640		10		57	470	33	1219	271	12	1	4	510	23	1550	283	12	1	0							
1994	6	358	27	503	132	11	1	56	450	27	1057	244	11	1	17	497	48	1572	642	12	2	1	680	3950			13		
Central North Pacific - Subarctic Current																													
1997	31	312	10	337	30	11	1	6	396	35	673	175	11	1	2	478	11	1210	184	11	1	2	466	118	1410	1174	12	2	
1996	28	321	26	322	49	10	1	25	437	20	927	140	11	1	5	472	17	1196	118	11	0	0							
1995	11	319	12	342	38	11	1	5	431	8	902	109	11	1	6	500	57	1195	374	10	2	1	575	2200			12		
1994	24	316	23	362	90	11	1	18	406	24	733	132	11	1	1	472		1100		10		0							
Central North Pacific - Transition Domain																													
1997	13	303	10	294	36	10	1	11	418	15	814	82	11	0	1	450		820		9		0							
1996	7	329	16	354	57	10	1	8	426	16	863	102	11	1	0							0							
1995	0							0							0							0							
1994	6	334	16	472	89	13	3	28	412	27	809	172	11	1	8	454	22	1045	209	11	1	0							

* includes one ocean-age 0 fish, FL 402, BW 760, CF 12

Table 19. Number sampled, mean and standard deviation of fork length (FL, cm), body weight (BW, g), and condition factor (CF, BW/FL³*10⁶) of pink salmon caught by the *Oshoro maru* research gillnet, 1994-97. All fish were ocean age 1.

Zone	Ocean Age 1						
	N	FL s.d.	BW s.d.	CF s.d.			
Central Gulf of Alaska - Ridge/Dilute Domains							
1997	102	475	26	1298	216	12	1
1996	71	466	31	1217	339	12	2
1995	170	483	31	1337	370	12	2
1994	186	483	28	1472	424	13	2
Central Gulf of Alaska - Subarctic Current							
1997	0						
1996	30	493	32	1582	358	13	2
1995	18	475	25	1326	383	12	2
1994	99	492	32	1699	471	14	2
Central North Pacific - Subarctic Current							
1997	53	419	24	841	138	11	1
1996	10	427	25	843	189	11	1
1995	44	410	28	733	141	11	2
1994	38	427	23	839	144	11	1
Central North Pacific - Transition Domain							
1997	19	427	27	884	243	11	1
1996	2	418	6	760	28	10	0
1995	0						
1994	11	430	15	894	95	11	1

Table 20. Number sampled, mean and standard deviation of fork length (FL, cm), body weight (BW, g), and condition factor (CF, BW/FL³*10⁶) of coho salmon caught by the *Oshoro maru* research gillnet, 1994-97. All fish were ocean age 1.

Zone	Ocean Age 1			
	N	FL s.d.	BW s.d.	CF s.d.
Central Gulf of Alaska - Ridge/Dilute Domains				
1997	60	582 46	2713 703	13 1
1996	111	587 44	2817 659	14 2
1995	51	579 40	2607 565	13 2
1994	87	602 50	3021 815	14 2
Central Gulf of Alaska - Subarctic Current				
1997	4	544 89	2390 1062	14 0
1996	12	602 40	3237 468	15 2
1995	15	566 57	2671 856	14 1
1994	32	566 57	2649 837	14 2
Central North Pacific - Subarctic Current				
1997	4	465 83	1195 698	11 1
1996	67	505 43	1592 465	12 1
1995	70	518 38	1772 402	13 1
1994	33	529 41	1880 465	12 1
Central North Pacific - Transition Domain				
1997	11	485 62	1474 741	12 1
1996	30	510 37	1547 341	12 2
1995	7	545 57	1940 469	12 1
1994	76	522 40	1759 420	12 2

Table 21. Number sampled, mean and standard deviation of fork length (FL, cm), body weight (BW, g), and condition factor (CF, BW/FL³*10⁶) of chinook salmon caught by the *Oshoro maru* research gillnet, 1994-97, grouped by ocean age.

Zone	Ocean Age 1				Ocean Age 2				Ocean Age 3			
	N	FL s.d.	BW	s.d. CF s.d.	N	FL s.d.	BW	s.d. CF s.d.	N	FL s.d.	BW	s.d. CF s.d.
Central Gulf of Alaska - Ridge/Dilute Domains												
1997	0				0				0			
1996	1	374	550	11	2	563	10	2480	28	14	1	
1995	0				1	652	4100		15			
1994	0				0							
Central Gulf of Alaska - Subarctic Current												
1997	0				0							
1996	0				0							
1995	0				1	644	3800		14			
1994	0				1	620	3250		14		7000	15
Central North Pacific - Subarctic Current												
1997	0				1	642	3400		13			
1996	0				1	654	3360		12			
1995	0				0							
1994	0				1	680	4150		13			

Table 22. Number sampled, mean and standard deviation of fork length (FL, cm), body weight (BW, g), and condition factor (CF, BW/FL³*10⁶) of steelhead caught by the *Oshoro maru* research gillnet, 1994-97, grouped by ocean age.

Zone	Ocean Age 0			Ocean Age 1			Ocean Age 2			Ocean Age 3																	
	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	N	FL s.d.	BW s.d.	CF s.d.											
Central Gulf of Alaska - Ridge/Dilute Domains																											
1997	17	325	39	389	150	11	2	3	573	25	1993	186	11	1	2	746	35	4000	707	10	3	0	1	700	3250	9	
*1996	19	323	22	342	88	10	1	8	525	45	1461	233	10	2	2	721	7	2910	14	8	0	0	1	675	2550	8	
1995	0							6	548	34	1897	546	11	3	1	609	3100					0	1				
1994	12	327	28	372	80	11	1	0							0								0				
Central Gulf of Alaska - Subarctic Current																											
1997	0							0								0								0			
1996	2	337	55	520	99	14	4	1	518	1580			11		1	732	4930						0	1			
1995	0							7	557	56	1901	672	11	1	0									0	0		
1994	1	400		700		11		7	535	38	1674	387	11	1	1	726	4500						0	1			
Central North Pacific - Subarctic Current																											
1997	0							1	575	1800			9			0								1	662	2700	9
1996	0							3	560	39	1703	278	10	1	1	604	1880							0			
1995	0							2	578	22	1900	198	10	0	0	2	676	25	3150	3041	11	11	0	0			
1994	0							6	524	22	1547	232	11	1	1	1	664	3200					0	0			
Central North Pacific - Transition Domain																											
1997	0							2	552	15	1380	170	8	2		2	713	18	3650	212	10	0		0			
1996	0							4	558	15	1850	319	11	1	0	0								0			
1995	0							1	542	1400			9		0	0								0			
1994	0							1	582	2000			10		0	0								0			

* includes one ocean-age 4 fish, FL 800, BW 3950, CF 8

Table 23. Mean % composition of stomach contents of salmonids caught in the Central Gulf of Alaska - Ridge/Dilute Domains, by the *Oshoro mariu*. PW=prey weight; % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=PW*100/body weight. Prey is composition based on visual estimates.

Species	Year	N	% mean		Mean % composition by volume*														
			empty	pw	EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UNID			
Sockeye	1997	142	13	13	0.55	25	49	5	0	9	2	5	2	0	0	0	0	2	0
	1996	96	25	26	0.96	6	14	9	0	62	2	5	0	0	0	0	0	0	2
	1995	67	52	25	1.00	6	3	3	0	48	17	7	0	0	0	0	0	2	16
	1994	90	18	21	0.97	9	5	21	0	49	6	4	2	0	0	0	0	0	5
Chum	1997	122	27	6	0.58	22	5	3	0	0	14	1	7	0	26	1	0	0	22
	1996	105	42	5	0.30	25	3	9	0	1	4	2	2	0	27	0	0	0	27
	1995	70	51	8	0.55	9	0	3	0	0	5	3	8	0	2	0	0	0	69
	1994	97	19	4	0.35	3	0	32	0	1	21	0	1	0	3	0	0	0	39
Pink	1997	117	12	11	0.83	27	53	6	0	2	9	1	0	0	0	0	0	0	1
	1996	76	29	14	1.04	7	13	13	2	45	5	4	0	0	0	0	0	11	1
	1995	68	54	9	0.63	12	10	11	0	20	28	6	1	0	0	0	0	0	13
	1994	94	27	11	0.69	1	10	18	2	36	20	3	0	0	0	0	0	0	10
Coho	1997	88	56	17	0.63	13	4	2	0	59	7	14	0	0	0	0	0	0	0
	1996	92	27	43	1.50	0	0	0	0	99	0	1	0	0	0	0	0	0	0
	1995	65	54	17	0.68	15	0	2	0	65	0	18	0	0	0	0	0	0	0
	1994	89	34	41	1.47	3	0	7	0	73	9	7	0	0	0	0	0	0	1
Chinook	1997	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1996	7	29	42	1.57	0	0	0	0	80	0	0	0	0	0	0	0	0	20
	1995	5	40	32	0.76	0	0	0	0	100	0	0	0	0	0	0	0	0	0
	1994	9	11	48	1.18	0	0	0	0	81	0	0	0	0	0	0	0	0	19
Steelhead	1997	26	8	29	1.60	0	0	3	0	10	8	58	0	0	0	0	0	21	0
	1996	42	38	19	1.30	0	0	1	0	44	0	29	4	0	0	0	0	18	4
	1995	40	35	13	0.68	0	0	0	0	47	8	32	12	0	0	0	0	0	0
	1994	17	18	3	0.55	0	0	9	0	43	9	33	0	0	0	0	0	0	6

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

Table 24. Mean % composition of stomach contents of salmonids caught in the Central Gulf of Alaska - Subarctic Current, by the *Oshoro maru*. PW=prey weight; % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=PW*100/body weight. Prey is composition based on visual estimates.

Species	Year	N	empty	pw	SCI	Mean % composition by volume														
						EU	CO	AM	CR	SQ	PT	FI	PO	CH	GE	OTH	UNID			
Sockeye	1997	50	12	38	1.83	0	0	0	0	0	93	3	4	0	0	0	0	0	0	0
	1996	39	18	30	1.21	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
	1995	11	27	30	1.35	0	0	0	0	88	0	0	0	0	0	0	0	0	0	13
	1994	12	25	20	1.19	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
Chum	1997	36	14	7	0.73	6	0	1	0	0	0	1	0	7	0	28	0	56	0	0
	1996	25	44	6	0.43	2	0	2	0	7	2	0	0	0	0	37	1	49	0	0
	1995	10	0	12	0.74	0	0	0	0	0	0	0	0	0	0	29	0	72	0	0
	1994	16	50	2	0.17	0	0	0	0	0	13	0	0	1	0	1	0	84	0	0
Pink	1997	1	0	11	0.71	0	0	0	0	60	20	20	0	0	0	0	0	0	0	0
	1996	51	6	18	1.09	0	0	0	0	71	23	6	0	0	0	0	0	0	0	0
	1995	10	20	5	0.30	1	0	18	0	49	3	0	0	0	0	0	0	21	9	0
	1994	14	21	8	0.45	0	0	0	0	66	25	0	0	0	0	0	0	9	0	0
Coho	1997	11	27	59	2.10	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
	1996	22	45	36	1.18	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
	1995	19	37	42	1.82	0	0	0	0	92	0	0	0	0	0	0	0	0	0	8
	1994	1	100	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinook	1997	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1996	1	100	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1995	2	100	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1994	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steelhead	1997	8	25	24	0.92	0	0	0	0	83	0	0	0	17	0	0	0	0	0	0
	1996	5	0	13	0.50	0	0	1	0	51	26	22	0	0	0	0	0	0	0	0
	1995	19	11	15	1.02	0	0	18	0	61	0	9	9	0	0	0	0	0	3	0
	1994	1	0	1	0.07	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0

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

Table 25. Mean body weight, prey weight, stomach content index, fullness, digestion, % empty stomachs, and % volume of prey for chum and sockeye salmon caught in nearshore, slope, and oceanic habitats in the Aleutian Islands in August 1997.

Data	Chum				Sockeye			
	Nearshore	Slope	Oceanic	Total	Nearshore	Slope	Oceanic	Total
No. fish	17	19	68	104	19	19	102	140
Mean BW (g)	1770	1298	1099	1248	731	580	796	758
Mean PW (g)	4.41	13.84	8.43	8.76	1.37	1.79	3.57	3.03
Mean SCI	0.22	0.95	0.82	0.74	0.20	0.30	0.47	0.41
Mean Full	1.00	1.58	1.65	1.53	0.89	1.53	1.74	1.59
Mean Dig	2.36	2.63	2.40	2.44	1.81	1.84	1.94	1.91
% Empty	17.65	0.00	4.41	5.77	15.79	0.00	4.90	5.71
Prey category	Mean % Volume							
Fish	1.43	0.00	1.03	0.89	0.19	0.26	8.38	6.22
Squid	2.14	0.00	0.34	0.53	0.00	0.00	8.11	5.96
Pteropod	0.00	0.05	12.31	8.17	15.94	0.26	18.26	15.39
Chaetognath	2.86	0.00	0.00	0.41	0.00	0.00	0.00	0.00
Polychaete	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Decapod	0.00	0.26	0.03	0.07	6.25	1.53	0.62	1.43
Euphausiid	7.57	5.53	5.52	5.82	56.69	22.63	19.81	24.69
Amphipod	5.79	17.89	17.46	15.88	17.81	71.11	22.57	28.98
Copepod	3.57	0.00	3.94	3.12	0.00	3.68	14.21	10.97
Gelatinous	18.93	10.53	19.35	17.58	0.00	0.00	0.26	0.19
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.38
Unidentified	57.71	65.74	40.02	47.53	3.13	0.53	7.27	5.80

BW = body weight

PW = prey weight

SCI = stomach content index = $(PW/BW) \times 100$

Full = stomach fullness index: 0 = empty, 1 = 1/4 full, 2 = 1/2 full, 3 = 3/4 full, 4 = full

Dig = digestion index: 1 = fresh, 2 = partly digested, 3 = well digested

% Empty = percentage of fish with empty stomachs