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**The 1996 Japan-U.S. Cooperative High-Seas
Salmon Research Cruise of the *Wakatake maru* and
a Summary of 1991-1996 Results**

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Cruise Report

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Abstract

A cooperative Japan-U. S. high seas salmon research cruise program, begun in 1991, in the central North Pacific and Bering Sea in June and July was continued in 1996. The objective of these cruises is to collect data for salmon stock assessment in the North Pacific Ocean. Research cruise activities included collection of data on physical oceanography, primary production, macro-zooplankton, micro-nekton, salmonids, and salmonid predators. A total of 6,013 salmonids was caught by longline and gillnet. Chum salmon were abundant in the catch (75% of salmonids), followed by sockeye (15%), coho (4%), chinook (3%), and pink salmon (2%), and steelhead trout (<1%). Three Dolly Varden were caught. A total of 691 salmon (95% chum, 4% sockeye, and 1% chinook) were tagged and released north of 47°30'N from longline operations. Snouts from 17 steelhead with clipped fins were sampled for later potential recovery of coded-wire tags.

Since 1994, there has been an apparent warming trend in June and July sea surface temperatures in the central North Pacific and the Bering Sea. In 1996, the average sea surface temperature was 1.1°C warmer in the central North Pacific and 0.6°C warmer in the Bering Sea than the previous five year average (1991-1995).

In the Subarctic Current, relative abundance of chum salmon caught in research-mesh gillnets has increased substantially. In 1996, chum salmon were the smallest mean size observed since the beginning of the program in 1991. Age composition of the catch in 1996 was not analyzed, but small mean size of chum salmon may be due to a large proportion of young (ocean age .1) fish in the catch. From 1995 to 1996, pink and coho salmon relative abundance and mean size decreased. Gelatinous zooplankton (ctenophores, coelenterates, and salps) have been the most common prey of chum salmon since 1994. Since 1991, coho salmon have fed almost exclusively on squid, and pink salmon have fed on amphipods, squid, and pteropods. Steelhead often ate squid and fish, and small pieces of floating debris were found in their stomachs contents in 1996.

In the Bering Sea, relative abundance of sockeye and chum salmon increased substantially in 1996, and mean sizes were the smallest observed since 1991. Relative abundance of pink salmon was much larger in odd years than even. In 1996, the mean size of pink salmon was larger than in 1991 to 1994, but smaller than in 1995. Since 1993, the relative abundance of chinook salmon has increased, and the mean size of chinook was larger in 1996 than in 1995. Sockeye salmon fed on squid, fish, amphipods, and copepods and increased their predation on euphausiids in 1996. In addition to gelatinous zooplankton, chum salmon preyed on fish, pteropods, and amphipods and, in 1996 consumed substantially more euphausiids than in previous years. Pink salmon ate squid, amphipods, copepods, and euphausiids, and in 1996, increased their predation on fish. Chinook salmon consumed squid, fish, and euphausiids. More empty sockeye, chum, pink, and coho salmon, and steelhead stomachs were observed in gillnet-caught fish than in longline-caught fish. However, the percentage of empty chinook salmon stomachs was higher among longline-caught fish.

Introduction

Since 1991, the National Research Institute of Far Seas Fisheries, Fisheries Agency of Japan, has sponsored high-seas salmonid (*Oncorhynchus* spp.) research cruises in June and July in the central North Pacific Ocean and Bering Sea in cooperation with the Fisheries Research Institute, University of Washington (Ishida et al. 1991, 1992; Davis and Tadokoro 1994; Nagasawa et al. 1994a; Myers et al. 1995). The objective of these cruises is to collect data for salmon stock assessment in the North Pacific Ocean. Samples were collected to monitor primary production and macro-zooplankton and micro-nekton abundance, and data were gathered on salmonid abundance, distribution, stock identification, condition, growth, and feeding ecology. In this report, we briefly outline the sampling methodology and results of fishing activities in 1996 and summarize data on salmonid abundance, fish size, and food habits for 1991 to 1996.

Methods

The cruise track was located along a north-south transect between 38°30'N and 58°30'N latitude at 179°30'W longitude, and included an east-west transect between 177°30'W and 177°30'E in the central Bering Sea at 56°30'N latitude (Fig. 1). The cruise track included 28 fishing stations, where oceanographic data, primary production, and zooplankton samples were collected and longline and gillnet fishing operations were conducted. In addition, there were 56 transit stations, where a reduced set of oceanographic, primary production, and zooplankton samples were collected while enroute to and from the fishing research area (Fig. 1).

Much of the research gear used in 1996 was identical to that used in previous years including the following: a CTD (conductivity, temperature, depth sensor) for oceanographic studies; Norpac, bongo, and fish larval nets for collection of macro-zooplankton and micro-nekton; a salmon gillnet (overall length 2.45 km) configured with commercial-mesh (A-gear; 115 mm mesh size) and research-mesh (C-gear; 48-157 mm mesh size); and a surface longline (overall length 3.36 km) for the capture of salmonids (Table 1; Ishida et al. 1991, 1992; Davis and Tadokoro 1994; Nagasawa et al. 1994a; Myers et al. 1995). A Go-Flow water sampler was used for the first time in 1996 to collect water samples at various depths between 10 m and 150 m (Table 1).

Many research activities conducted aboard the *Wakatake maru* were identical to those in earlier years including collection of salmon biological data (fork length, body and gonad weight, and a scale sample) and tissues for stock identification, ocean growth, and body condition; inspection of fish for recovery of snouts from fin-clipped fish; and catching live fish for tagging (Table 2). In 1996, several new research activities were added including collection of blood serum to determine levels of insulin-like growth factor-1 (IGF-1) in salmonids and gonadotropin levels in chum salmon (*O. keta*); collection of tissue samples from salmonids, micro-nekton, salmonid predators, other fishes, and other organisms to determine heavy C-N isotope ratios; and examination of salmon stomach contents from fish caught by gillnet (Table 2). The summary of research gear and activities is provided in table format so that our sampling methods can be easily compared with methods used on other salmon surveys (Tables 1 and 2).

To summarize the 1991 to 1996 results concerning salmon abundance, size-at-age, and salmon stomach contents, data were grouped according to oceanographic region using definitions given by Dodimead et al. (1963) and Favorite et al. (1976) and summarized by Myers et al. (1995). The mean catch per unit of effort (number of salmonids caught in 30-

tans [1500 m] of research-mesh gillnet [C-gear]) was calculated by oceanographic region for each year. To summarize fish size data, mean fork length and body weight of salmon caught in the research-mesh gillnet (C-gear) were calculated for the central North Pacific Ocean and Bering Sea from 1991 to 1996. Ages of salmon caught in 1996 were not determined, and size-at-age data for the current year were not available. For the 1991-1995 period, however, age composition and mean size-at-age data (mean fork length and body weight) for salmon caught in C-gear were calculated by oceanographic region.

The method used for ship-board examination of salmon stomach contents has been described in earlier reports (Ishida et al. 1991, 1992; Davis and Tadokoro 1994; Nagasawa et al. 1994a). The total stomach content weight was obtained by subtraction of the empty stomach weight from the full stomach weight. The volume (%) of each prey category was visually estimated. The results of food habits studies in 1991-1996 were grouped by salmon species, oceanographic region, year, and fishing gear type (longline or gillnet). Mean prey weight, mean index of stomach content weight ($SCI = \text{prey weight} \times 100 / \text{salmon body weight}$), and mean composition by volume were calculated from among those fish that contained prey. The mean percent composition by volume was calculated by summing the observed percent volume among all the fish in a stratum and dividing by the number of fish containing prey.

Results and Discussion

OCEANOGRAPHY

The saline surface water of the Transition Zone was located south of 40°30'N, and the Subarctic Boundary, defined by the position of the vertical 34.0 ‰ isohaline, was between 40°30'N and 41°30'N (Fig. 2). The Transition Domain was located between 41°30'N and 43°30'N. The Subarctic Current, an eastward-flowing current typically having cool, dilute surface waters and relatively homogeneous conditions, was located between 44°30'N and 48°30'N (Fig. 2). The Ridge Domain was between 49°30'N and 50°30'N, and was characterized by cold, saline, upward-flowing water in the intermediate layer. The westward-flowing current of the Alaska Stream, containing warm, dilute water, was at 51°30'N. Northwards of 52°30'N, the stations were located in the Bering Sea, a region of cold, saline surface waters (Fig. 2).

There has been a warming trend in sea surface temperatures in the central North Pacific and Bering Sea since 1994. The average sea surface temperature in the central North Pacific in June and July was 0.84°C warmer in 1996 than in 1995 and 1.08°C warmer in 1996 than the previous five year average (1996 mean=10.40°C; 1995 mean=9.56°C; 1991-1995 mean=9.32°C). The position of the Subarctic Boundary in 1996 was approximately 41°N, which was in the same vicinity as in 1991 and 1994, but the boundary was further north in 1992, 1993, and 1995 (42°N-43°N). The average sea surface temperature in the Bering Sea in July was 0.22°C warmer in 1996 than in 1995 and 0.60°C warmer than the previous five-year average (1996 mean=7.51°C; 1995 mean=7.29°C; 1991-1995 mean=6.91°C).

SALMONID CATCHES

Due to several storms in 1996, we canceled the last two fishing stations in the central Bering Sea (stations 27 and 28; Fig. 1). A total of 6,013 salmonids was caught by longline and gillnet (Table 3). Chum salmon were the most abundant fish in the catch

(75% of salmonids), followed by sockeye (*O. nerka*, 15%), coho (*O. kisutch*, 4%), chinook (*O. tshawytscha*, 3%), pink salmon (*O. gorbuscha*, 2%), and steelhead trout (*O. mykiss*, <1%). Three Dolly Varden (*Salvelinus malma*) were caught (Table 3). Because there may have been some species misidentification, these are tentative results until later confirmed by scale examination. In 1996, sockeye salmon were caught as far south as 47°30'N but, in 1995, they were caught one degree (latitude) further south (Myers et al. 1995). Coho salmon and steelhead trout were the most southerly distributed salmonids (41°30'N), chum salmon were caught north of 42°30'N, and pink and chinook salmon were caught north of 44°30'N (Table 3).

A total of 691 salmon (95% chum, 4% sockeye, and 1% chinook) was tagged and released north of 47°30'N from longline operations (Table 3). Snouts from 17 steelhead with clipped fins were sampled for later potential recovery of coded-wire tags.

NON-SALMONID CATCHES

Significant catches of non-salmonids included neon flying squid (*Ommastrephes bartramii*, n=529) and Pacific pomfret (*Brama japonica*, n=352; Table 3). Perhaps due to warm sea surface temperatures, neon flying squid and Pacific pomfret were caught 2° and 3° (latitude), respectively, further north in 1996 than in 1995 (Myers et al. 1995).

SALMONID ABUNDANCE BY OCEANOGRAPHIC REGION, 1991 TO 1996

Salmonids were not abundant in the Transition Zone, but chum and coho salmon have been caught south of the Subarctic Boundary in 1991 and 1993 (Table 4). If the position of the vertical 34.0 ‰ isohaline accurately delineates the Subarctic Boundary, then this boundary does not form an absolute limit to the southern distribution of chum and coho salmon in summer (Nagasawa et al. 1994b).

Chum and coho salmon and steelhead were the most abundant salmonids in the Transition Domain (Table 4). Chum salmon were more abundant in 1996 than 1995, but for the last three years (1994-1996) chum salmon were approximately one third as abundant in this area as in the earlier three years (1991-1993). Abundance of coho salmon in the Transition Domain was the lowest in 1996 than in any year since 1991 (Table 4).

Five species of salmon and steelhead were caught in the Subarctic Current region and chum and coho salmon and steelhead were the most abundant species (Table 4). Chum salmon abundance in this area in 1993 and 1996 was twice that of the other years.

Salmonids were approximately three to nine times more abundant in the Bering Sea than in the Subarctic Current, and chum, pink, and sockeye salmon were the most common species (Table 4). Pink salmon were more plentiful in odd years, and chum salmon abundance was higher in even years. The magnitude of the odd and even year fluctuations in abundance was larger for pink salmon (approximately 25X) than for chum salmon abundance (2-4X; Table 4). Relative abundance of sockeye salmon in the Bering Sea were approximately 1.5 to 2.5 times higher in 1993, 1994, and 1996 than in the other years (Table 4).

SALMONID SIZE, 1991 TO 1996

The mean length and body weight of chum and chinook salmon and steelhead caught in the central North Pacific Ocean was smaller in 1996 than in any year since 1991, and pink and coho salmon were smaller in 1996 than in 1995 (Table 5). In the Bering Sea, the size of sockeye and chum salmon was smaller in 1996 than in any year since 1991. However, the summary of average size does not account for the age composition of the catch (Table 5). Therefore, comparisons of fish size for the 1996 catch are preliminary because the mean size may reflect differences in age composition rather than actual differences in size.

In the period from 1991 to 1995 most sockeye salmon caught in the Bering Sea were ocean age .1 and .2 (81%-95%; Table 6). In 1991 and 1993, ocean age .1 was the prevailing age group (52%-59%), and in 1992, 1994, and 1995, ocean age .2 was the dominant group (54%-72%). Ocean age .1 sockeye salmon increased in average size from 1991 to 1994, and decreased in average size in 1995. Ocean age .2 fish remained approximately the same size from 1991 to 1994, and increased in 1995 (Table 6).

Most chum salmon caught in the Transition Domain were ocean age .2 (58%-83%; Table 7). The average size of ocean age .2 chum salmon in 1995 was the largest size observed from 1991 to 1995. In the Subarctic Current, ocean age .2 chum salmon was the prevailing age group in 1991-1994 (51%-83%) and ocean age .3 was dominant in 1995 (62%; Table 7). In 1995, ocean age .2 chum salmon were larger than those caught in previous years. In the Bering Sea, ocean age .1 was the dominant age group in 1992 (36%), ocean age .2 predominated in 1993 (51%), and ocean age .3 chum salmon prevailed in 1991, 1994, and 1995 (40%-44%; Table 7). The average sizes of ocean age .1, .2, and .3 chum salmon were larger in odd years than in even years (Table 7).

All pink and coho salmon in the catch were maturing ocean age .1 (Table 8 and 9). In 1991 to 1994, pink salmon caught in the Subarctic Current were smaller in odd years than in even years. In 1995, the mean size of pink salmon in the Bering Sea was larger than in the previous four years (Table 8).

The majority of chinook salmon caught in the Bering Sea was ocean age .1 and .2 (67%-97%; Table 10). Ocean age .2 was the dominant age group in 1992, 1993, and 1995, and ocean age .1 was dominant in 1991 and 1994. In 1995, the mean sizes of ocean age .1 and .2 were smaller than in the previous years, 1991 to 1994 (Table 10).

In the Subarctic Current in 1991, 1994 and 1995, ocean age .1 was the dominant age group in the steelhead catch (Table 11).

SALMONID FOOD HABITS, 1991 TO 1996

Squid, hyperiid amphipods, and euphausiids were important prey for sockeye salmon in all oceanographic regions north of the Subarctic Current (Table 12). In addition to these prey categories, in the Ridge Domain, sockeye salmon commonly fed on copepods and pteropods. Pteropods were an important prey item in the Alaska Stream in 1991 and from 1995 to 1996. In the Bering Sea, squid, amphipods, euphausiids, fish, copepods, and pteropods were important prey of sockeye salmon from 1991 to 1996 (Table 12).

Gelatinous zooplankton (ctenophores, coelenterates, and salps) was the most common prey of chum salmon in all years and oceanographic regions, although some gelatinous zooplankton may have been considered unidentified prey in the early years of the

study (1991-1992; Table 13). In addition to the gelatinous zooplankton, amphipods, chaetognaths, heteropods, and appendicularia comprised the majority of prey items of chum salmon in the Transition Domain and Subarctic Current from 1991 to 1996. In the Subarctic Current, chum salmon also fed on euphausiids (1995) and pteropods (1993, 1996). In the Bering Sea (1991-1996) chum salmon stomachs contained items from more prey categories including gelatinous zooplankton, euphausiids, amphipods, pteropods, fish, and squid. In 1991 and 1993, appendicularia were abundant in chum stomach contents (Table 13).

In the Subarctic Current, the prey of pink salmon included amphipods and pteropods every year except 1992 when there were no fish sampled (Table 14). Squid and copepods were also commonly found in pink salmon stomach contents in 1991, and 1994 to 1996. Euphausiids were a significant prey item north of the Subarctic Current. In the Bering Sea from 1991 to 1996, squid and fish were important prey, and, in addition, euphausiids, copepods, and amphipods were commonly eaten by pink salmon (Table 14).

Squid was the most abundant prey item found in coho salmon stomachs in all oceanographic regions (1991-1996; Table 15). In addition to squid, fish (1994-1995) and pteropods (1991-1996) were a component of the diet of coho salmon caught in the Transition Domain. Hyperiid amphipods were commonly eaten by coho salmon in the Transition Domain and Subarctic Current (Table 15).

Like coho, chinook salmon fed heavily on squid in all oceanographic regions (1991-1996; Table 16). Sample sizes were small in all areas except in the Bering Sea, where chinook salmon included fish and euphausiids in their diets in addition to squid (1991-1996; Table 16).

Steelhead trout fed primarily on squid and fish in the central North Pacific Ocean (1991-1996; Table 17). Small pieces of floating debris including bits of foam, plastic, and wood were detected in the stomach contents of steelhead caught in the Subarctic Current in 1996 (Table 17).

The percentage of empty stomachs of sockeye, chum, pink, and coho salmon, and steelhead stomachs was higher among fish collected by gillnet than by longline (Tables 12-17). Interestingly, chinook salmon exhibited the opposite result; the proportion of empty stomachs was higher in chinook salmon collected by longline suggesting that the feeding behavior of chinook may be different than other salmon. Differences in the percentage of empty salmon stomachs between the two fishing gears and among salmon species result from the interaction of the timing when diurnal salmon feeding intensifies, when salmon are vulnerable to the fishing gear, and how long after the salmon are caught they are retrieved from the fishing gear.

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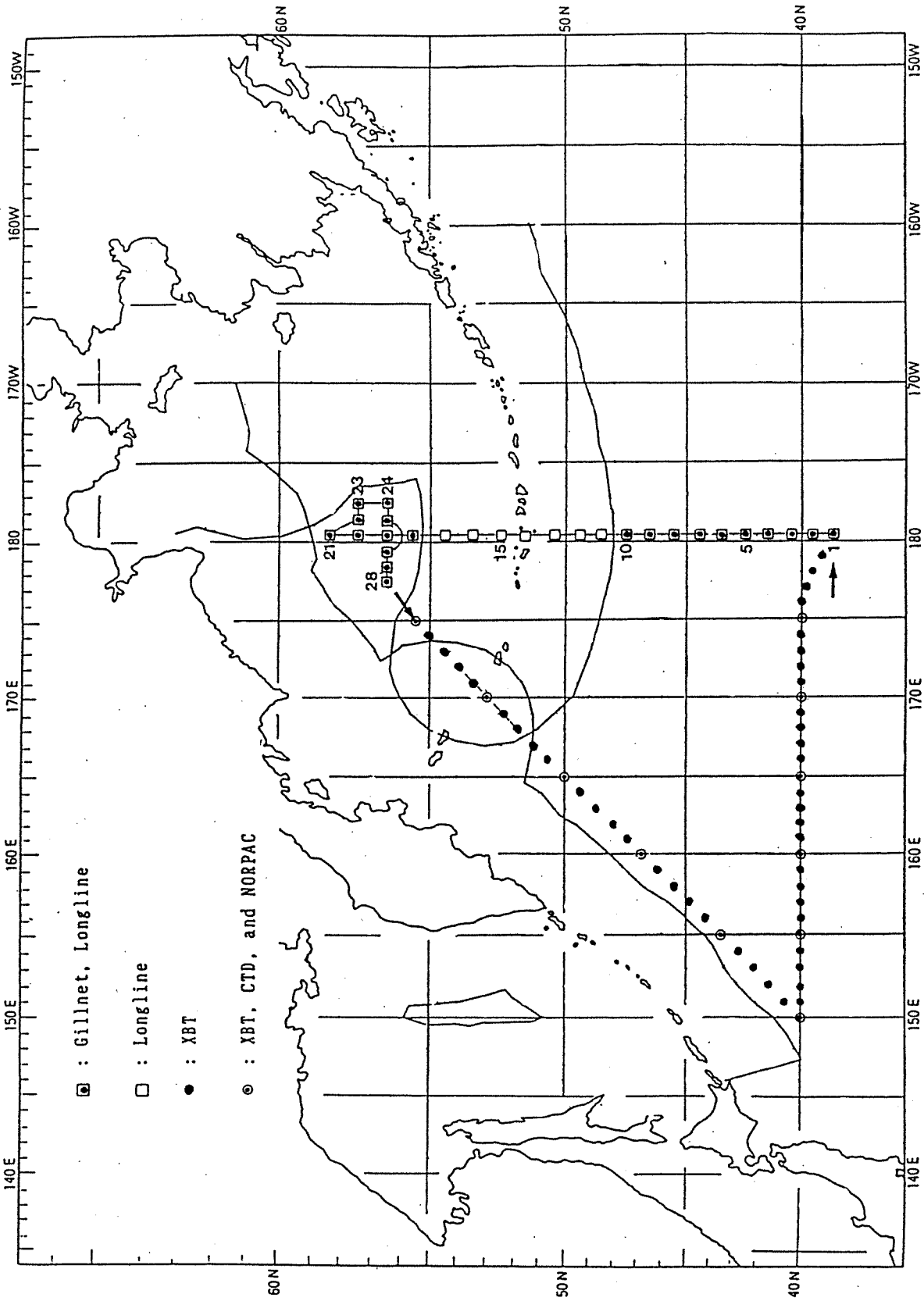


Figure 1. Cruise track of the summer 1996 salmon research cruise of the *Wakatake maru*. The cruise track included 28 fishing stations along a north-south transect at 179°30'W longitude, an east-west transect at 56°30'N latitude in the central Bering Sea, and 56 transit stations enroute to and returning from the fishing research area.

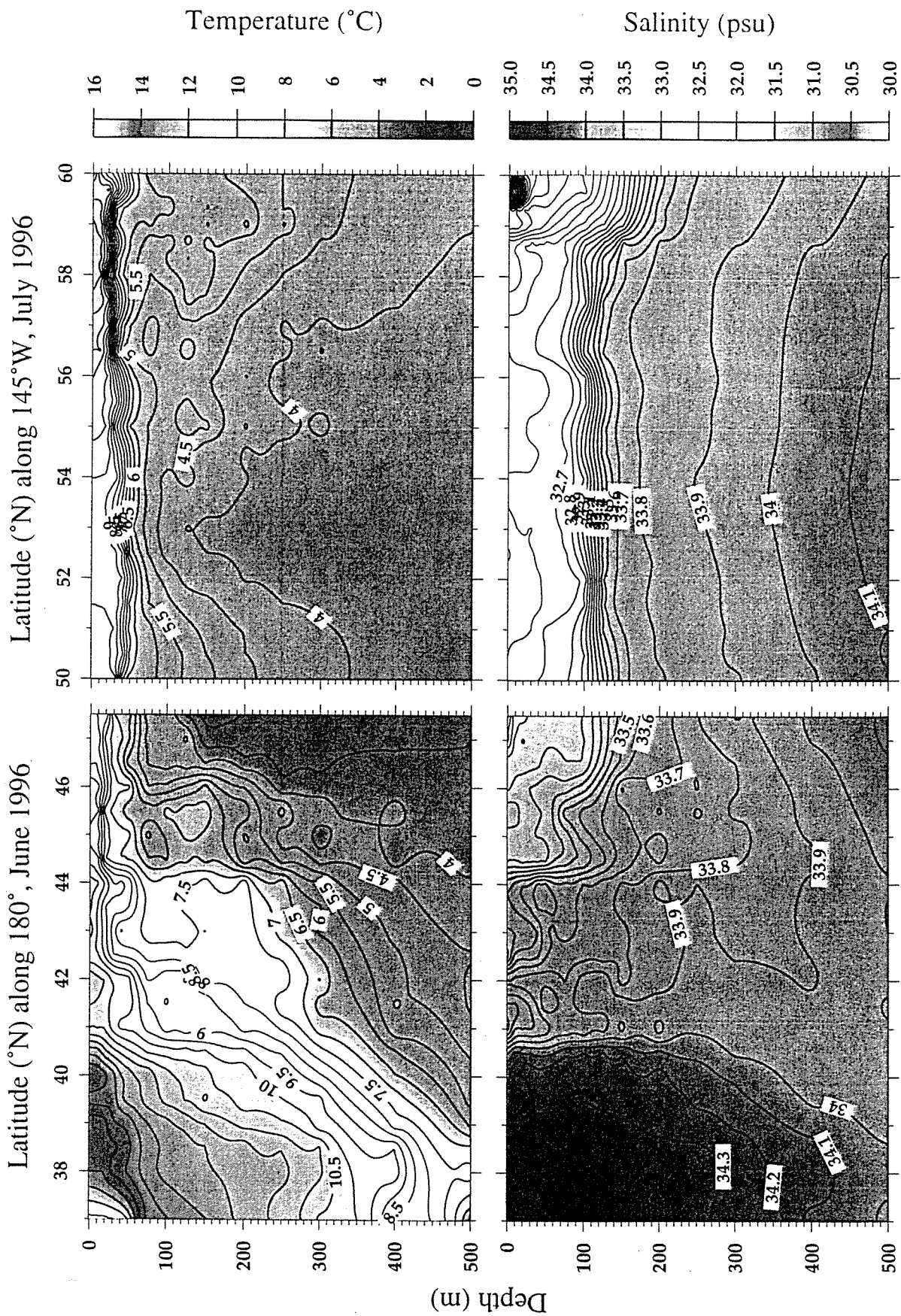


Figure 2. Temperature and salinity profiles of the 180° (upper and lower left) and 145° W (upper and lower right) transect lines, from CTD data.

Table 1. Description of research gear and fishing operations conducted aboard the *Wakatake maru* in 1996. Sampling stations included fishing stations (F-stations) and transit stations (T-stations) that were located along a direct route going to and returning from the fishing area.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
A. Hydrographic					
Conductivity, Temperature, and Depth Sensor (CTD)	Collect temperature and salinity data by depth	Alec Memory CTD sensor made by the Alec Electronics Co. Ltd., Japan	Vertical tow; surface to 600 m or to the bottom; work on deck and data processing done by officers and crew	Temperature and salinity recorded at 1 m intervals and outputted to paper	Collected at all F-stations; T-stations at 5° longitude intervals
Expendable Bathy-Thermograph (XBT)	Collect temperature data by depth		Vertical tow; surface to 460 m; work on deck and data processing done by officers and crew	Temperature and depth recorded at 1 m intervals and outputted to paper and floppy disk	Collected at all T-stations
Salinity Reference Sample	Collect water samples for laboratory determination of salinity and to standardize CTD and XBT data	Bucket water sampler	Surface collection; work done by crew	Water sample stored in brown bottles sealed with a cork	Collected at all F-stations; T-stations at 5° longitude intervals
Secchi Disk Depth	Estimate water transparency	White disk tied to a rope measured at 1 m intervals; disk diameter=??	Daylight; disk lowered over the ship's side by the crew	Disk is lowered into the water and the depth is recorded when the disk disappears from view	Collected at all F-stations; T-stations at 5° longitude intervals

Table 1. Continued.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
B. Phytoplankton Chlorophyll-a, Nutrients, and Phytoplankton Species Identification	Estimate phytoplankton biomass, measure dissolved nutrient levels (phosphate, nitrate) and identify phytoplankton species	Bucket water sampler	Surface collection; Work done by crew and research staff	Chlorophyll-a: 1 l seawater is filtered and the filter is frozen at -50°C; Nutrients: 50-60 ml seawater is frozen at -50°C; Phytoplankton: 1 l seawater preserved in 5% formalin	Collected at F-stations 1-21; Chlorophyll-a samples also collected at T-stations at 5° longitude intervals; Samples later analyzed in the laboratory
	Identify diatom species assemblages by depth and oceanographic domain	Go-Flow water sampler	Water samples collected at 10 m, 20 m, 30 m, 40 m, 50 m, 75 m, 100 m, and 150 m depths	1 l seawater sample preserved in 5% formalin	Collected at F-stations: 2, 7, 11, and 18 to represent conditions in the Transition Zone, Transition Domain, Subarctic waters, and Bering Sea

Table 1. Continued.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
C. Zooplankton					
Norpac Net	Estimate biomass and identification of macro-zooplankton	Ring diameter: 0.45 m; Mesh size: 0.335 mm; Filtering cloth: GG54; Length of cylindrical portion of net: 0.650 m; Length of conical portion of net: 1.3 m; The design of the Norpac was improved in 1995 by insertion of a cylindrical section of cloth between the net opening and the conical-shaped tail section; The remodelled design has improved filtration efficiencies over the older Norpac design	Vertical tow; 0-150 m; Depression weight: 15 kg; Ship speed: 0 kts, drifting; Wire speed: 1 m/sec; Work done by crew and research staff	Bottled with 7% formalin; sample bottles color-coded with yellow tape	Collected at all F-stations and T-stations at 5° longitude intervals; Flow meter used and calibrated 5X; Wire angle measured and added wire length recorded; Samples later analyzed in the laboratory
Bongo Net	Estimate biomass and identification of macro-zooplankton; Intercalibration with Norpac net	Ring diameter: 0.70 m; Overall length: 3.5 m; 2 rings: 1 designated red, mesh size=0.600 mm, 1 designated blue, mesh size=0.335 mm	Vertical tow; 0-150 m; Depression weight: 50 kg; Ship speed: 0 kts, drifting Wire speed: 1 m/sec; Work done by crew and research staff	Bottled with 7% formalin; sample bottles color-coded with red and blue tape	Collected at all F-stations; Flow meter used and calibrated 5X; Wire angle measured and added wire length recorded

Table 1. Continued.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
C. Zooplankton (cont'd)					
Bongo Net	Collect macro-zooplankton for analysis of heavy C-N isotope ratios to describe ecosystem trophodynamics	Additional bongo net tows	Oblique and vertical tows 0-350 m repeated several times to collect a large biomass	Samples from tows at one station combined in a cotton bag and frozen at -50° C	Collected at F-stations: 2, 7, 11, and 18 to represent conditions in the Transition Zone, Transition Domain, Subarctic waters, and Bering Sea
Fish Larval Net	Collect fish larvae and micro-nekton	Ring diameter: 1.3 m Overall length: 4.5 m Mesh size: 2.0 mm (frontal portion), 0.335 mm (codend)	Horizontal tow at the surface; Ship speed: 2 kts; Wire speed: stationary; net towed for 10 minutes; Work done by crew and research staff	Sample placed in a cotton bag and stored in a bucket with 10% formalin	Collected at all F-stations; No flow meter used
	Collect micro-nekton for analysis of heavy C-N isotope ratios to describe ecosystem trophodynamics	Additional fish larval net tows	Horizontal tow at the surface	Sample placed in a cotton bag and frozen at -50° C	Collected at F-stations: 2, 7, 11, and 18 to represent conditions in the Transition Zone, Transition Domain, Subarctic waters, and the Bering Sea

Table 1. Continued.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
D. Salmonids					
Gillnet	Salmon abundance; Biological data for ocean ecology and stock assessment; Tissue samples for stock identification, fish growth, and condition	Overall length: 2.45 km (49 tans; 50m/tan); Depth approx. 7.5 m; Net configuration [research (C) or commercial (A) mesh size (mm)/amount (tans)]: North of 45°30N: A115/15, C48/3, C93/3, C157/3, C106/3, C63/3, C121/3, C72/3, C138/3, C82/3, C55/3, A115/4; 38°30N-45°30N: C29/1 and C37/1 (saury net) substituted for 2 tans of A-gear	Set 1600 (local time) and hauled 0400 the next morning; Work done by crew and research staff	Routine biological data: count all fish by species and mesh size and measure a maximum of 60 fish per species per mesh size for fork length, body weight, sex, gonad weight, and scale samples	Collected at all F-stations outside the U.S. 200-mile zone (outside EEZ; St. 1-10, 18-28); Routine scale collection: 1 scale per fish from sockeye, chum, and pink; 2 scales per fish from coho, chinook, and steelhead

Table 1. Continued.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
D. Salmonids (cont'd)					
Surface Longline	Capture of live fish; Fish that have recently fed	Overall length: approx. 3.36 km (30 hatchi [baskets]); Hachi mainline length: approximately 112 m; Number of branch lines per hatchi: 47; Interval between branch lines: approx. 2.1 m; Fishing depth of hooks: 1.3 m; Bait: salted Japanese anchovy	Set 30 minutes before sunset (local) time, and hauled 30 minutes after sunset; Work done by crew and research staff	Routine biological data: count all fish by species and measure a maximum of 60 fish per species for fork length, body weight, sex, gonad weight, and a scale sample; When conducting tagging operations, viable fish were measured for fork length, a scale removed, and fish were double-tagged with JFA and FRI tags	Collected at all F-stations; in the North Pacific and Bering Sea; Fish were tagged with two Peterson disk tags attached to the fish in front of the dorsal fin with a plastic cinch

Table 2. Description of research activities conducted aboard the *Wakatake maru* in 1996.

Subject	Species	Sample	Fishing Gear	Method	Data or Samples Collected
A. Salmonid Feeding Ecology	All salmon and steel-head	Stomach contents	Longline and commercial mesh gillnet (A115)	Stomachs from esophagus to pyloric valve collected from up to 10 fish of each species per gear per station	Prey weight, % composition by prey type, % empty stomachs, collected on board ship; Occasionally, specimens of prey organisms were preserved in formalin for later species identification
Bioenergetics	Salmonid prey	Fresh, whole specimens	Fish larval net	Extra tows of the fish larval net	Specimens were frozen for later caloric content analysis
Trophodynamics	All salmon and steel-head	5 g sample of muscle	Longline	Muscle tissue was removed from the area immediately anterior to dorsal fin from 5 fish per species at F- stations 2, 7, 11, 18.	Samples frozen for analysis of heavy C-N isotope ratios

Table 2. Continued.

Subject	Species	Sample	Fishing Gear	Method	Data or Samples Collected
B. Salmonid Ocean Growth	All salmon and steel-head	Paired blood serum and otolith samples	Gillnet and Longline	Blood and otoliths were sampled from a range of sizes of each species	Serum samples frozen at -50° C for analysis of insulin-like growth factor 1 (IGF-1); Heads frozen for later removal of otoliths and analysis of growth patterns
Growth Indices	All salmon and steel-head	Paired blood serum and otolith samples	Gillnet and Longline	Blood and otoliths were sampled from a range of sizes of each species	Serum samples frozen at -50° C for analysis of insulin-like growth factor 1 (IGF-1); Heads frozen for later removal of otoliths and analysis of growth patterns
Growth Rates	Sockeye, chum, and pink	Muscle	Gillnet [research mesh (C)]	Muscle sample (half a fillet) approximately 2.5 cm wide was removed from area immediately behind the pectoral fin	Muscle sample frozen for RNA-DNA analysis to determine rate of protein synthesis at F-stations 9 and 10 in the North Pacific and F-stations 19 and 20 in the Bering Sea
Age and Growth Validation	Chum, sockeye, and chinook	Marked fish	Longline	During tagging operations fish were injected with OTC and released for recovery in inshore fisheries	Tag numbers (JFA and FRI), scale samples, and accompanying biological data
Maturation	Chum	Blood serum samples	Longline and Gillnet	Blood sampled from a range of sizes of chum salmon	Serum samples frozen for later analysis of gonadotropin levels

Table 2. Continued.

Subject	Species	Sample	Fishing Gear	Method	Data or Samples Collected
C. Stock Identification	Chum	Muscle, heart, liver, and eye	Gillnet [research-mesh (C-gear)]	Tissue samples removed from fish during collection of routine biological data	Tissue samples frozen from a maximum of 100 chum from each of 2 stations in the North Pacific (9 & 10) and Bering Sea (19&20); Accompanying biological data and scale samples
Parasites	Chinook	Muscle, heart, liver, and eye	Gillnet	Tissue samples removed from fish during collection of routine biological data	Tissue samples frozen from a maximum 100 chinook salmon; Accompanying biological and scale samples
	Chinook	Brain tissue	Gillnet	Tissue samples removed from fish during collection of routine biological data	Tissue samples frozen from a maximum 100 chinook salmon; Incidence of <i>Myxobolus arcticus</i> and <i>M. neurobius</i> determined later in the laboratory
	Sockeye	Visceral adhesion	Gillnet and longline	Observation during routine biological data collection	Incidence of visceral adhesion (indicator of the presence of <i>Philonema anchorrhynchii</i>) recorded on biological data sheets

Table 2. Continued.

Subject	Species	Sample	Fishing Gear	Method	Data or Samples Collected
C. Stock Identification (cont'd)					
Morphometry and Gel Electrophoresis (Species Verification/ Stock Identification)	Dolly Varden	Round sample	Gillnet and longline	Collected a round sample when Dolly Varden were caught	Round sample frozen in block; Accompanying length and weight data
D. Tagging					
High Seas Coded-Wire Tag Recovery	All salmon and steel-head	Snouts	Gillnet and longline	Snouts were removed from fish lacking the adipose fin or left ventral fin or both	Snouts salted and frozen
High Seas Tagging	Chum, sockeye, and chinook	Live fish	Longline	Fish were tagged with JFA and FRI disk-tags placed in front of the dorsal fin on the same cinch; caught and released in the North Pacific and Bering Sea F-stations 11-26	Scales and fork length collected when fish tagged
E. Salmonid Body Condition	All salmon and steel-head	Incidence of salmon lice	Gillnet and longline	Salmon were observed for the incidence of parasites during routine biological data collection	Number and position of salmon lice (<i>Lepeophtheirus salmonis</i>) on the salmon; Accompanying biological data

Table 2. Continued.

Subject	Species	Sample	Fishing Gear	Method	Data or Samples Collected
E. Salmonid Body Condition (cont'd)	All salmon and steel-head	Examination of slash marks	Gillnet and longline	Salmon were observed for the presence of injuries during the course of collecting routine biological data	Photographs taken of injured fish; Accompanying biological data
F. Non-salmonid Catches	Salmon sharks	Stomach and 5-g muscle sample	Gillnet and longline	Collected a sample when shark was caught	Length and sex recorded; Stomach and muscle sample frozen; Stomach will be examined to investigate shark predation; Muscle will be analyzed to determine heavy C-N isotope ratios
	Pacific Saury	Round sample	Gillnet (research-mesh 29 and 37 mm)	Small mesh size was used from 38°30N to 45°30N	Length measured; Maximum 100 fish per mesh size; Round sample frozen; Muscle will later be collected and analyzed for heavy C-N isotope ratios
	Walleye Pollock	Round sample	Gillnet and longline	Collected a sample when pollock was caught	Fork length and body weight measured; Round sample frozen; Muscle will later be collected and analyzed for heavy C-N isotope ratios

Table 2. Continued.

Subject	Species	Sample	Fishing Gear	Method	Data or Samples Collected
F. Non-salmonid Catches (cont'd)	All squid	Round sample	Gillnet and longline	Collected a sample when squid was caught	Mantle length recorded; Round sample frozen; Maximum 10 individuals per station (Neon Flying squid); Squid liver will be analyzed for levels of pollutants; Muscle will be analyzed for heavy C-N isotope ratios
	Pacific Pomfret	Round sample	Gillnet and longline	Collected a sample when pomfret was caught	Fork length measured; Round sample frozen; Muscle will later be collected and analyzed for heavy C-N isotope ratios
	Other by-catch	Round sample	Gillnet and longline	Collected a sample when caught; Maximum of 5 per species	Fork length measured; Round sample frozen; Muscle will later be collected and analyzed for heavy C-N isotope ratios

Table 3. Continued.

Sta	Date	Location	Temperature 0 m 100 m	Salinity 0 m 100 m	Gear	Sock- eye	Chum	Pink	Coho	Chi- nock	Steel- head	Dolly Varden	Total Salmonids	Neon Flying Squid	Other Squids	Pacific Pomfret	Atka Mackerel	Lanceet Fish	Walleye Pollock	Sharks	Pacific Saury	Dagger Tooth	Other Fishes	
18	4-Jul-96	55°30'N 179°30'W	7.10 2.06	32.93 32.99	B Tagged C	1 0 67	85 44 237	0 0 6	0 0 0	0 0 0	0 0 0	0 0 0	86 44 310	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	
					A Total	18 86	94 416	5 11	0 0	0 0	0 0	0 0	117 513	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	
19	5-Jul-96	56°30'N 179°30'W	7.00 2.25	32.92 32.99	B Tagged C	2 0 53	156 74 202	1 0 4	0 0 0	0 0 2	0 0 0	0 0 0	159 74 261	0 0 13	0 0 0	0 0 0	0 0 0	0 0 0	1 0 0	0 0 0	0 0 0	0 0 0	0 0 0	
					A Total	48 103	118 476	11 16	0 0	3 5	0 0	0 0	180 600	0 14	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0
20	6-Jul-96	57°30'N 179°30'W	8.00 2.14	32.68 32.97	B Tagged C	5 0 36	148 81 144	1 0 20	0 0 0	0 0 14	0 0 0	0 0 0	154 81 214	0 0 1	0 0 0	0 0 0	0 0 0	0 0 0	2 0 0	0 0 0	0 0 0	0 0 0	0 0 0	
					A Total	17 58	100 392	21 42	0 0	14 28	0 0	0 0	152 520	0 1	0 0	0 0	0 0	0 0	0 0	2 0	0 0	0 0	0 0	0 0
21	7-Jul-96	58°30'N 179°30'W	7.80 3.13	32.67 33.03	B Tagged C	4 0 17	111 54 86	1 0 5	0 0 0	3 0 5	0 0 0	1 0 1	120 54 114	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	
					A Total	31 52	148 345	5 11	0 0	3 11	0 0	0 2	187 421	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
22	10-Jul-96	57°30'N 178°30'W	6.80 3.48	32.71 32.99	B Tagged C	9 0 39	246 102 227	0 0 1	0 0 0	3 0 1	0 0 0	0 0 1	258 102 269	0 0 0	0 0 0	0 0 0	0 0 1	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	
					A Total	41 89	161 634	3 4	0 0	5 9	0 0	0 1	210 737	0 0	0 0	0 0	0 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0
23	11-Jul-96	57°30'N 177°30'W	7.00 3.59	32.76 32.91	B Tagged C	6 4 75	136 65 292	1 0 1	0 0 0	5 0 9	0 0 0	0 0 0	148 69 377	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 2	0 0 0	0 0 0	0 0 0	0 0 0	
					A Total	53 134	79 507	5 7	2 2	3 17	0 0	0 0	142 667	0 0	0 0	0 0	0 1	0 0	0 0	1 3	0 0	0 0	0 0	0 0

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 *Wakatake maru*, 1991-1996. Research-mesh gillnet is composed of 3 tans each for the following mesh sizes: 48 mm, 55 mm, 63 mm, 72 mm, 82 mm, 93 mm, 106 mm, 121 mm, 138 mm, and 157 mm.

Year	Sampling Dates	No. of Sta.	Locations	Mean		Mean Catch per 30 tans C-gear										
				Temperature 0 m 100 m	Salinity 0 m 100 m	Sock- eye	Chum	Pink	Coho	Steel- head	Dolly	Total				
													Chi-	Varden	Salmonids	
Central North Pacific - Transition Zone																
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	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	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	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	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	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	0.0	0.7
Central North Pacific - Transition Domain																
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	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	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	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	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	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	0.0	43.4
Central North Pacific - Subarctic Current																
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	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	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	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	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	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	0.0	68.5
Central 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	0.0	77.0
Central Bering Sea																
1996	4-14 Jul	9	55°N-58°N, 177°W-179°E	7.5	2.9	32.8	33.0	55.1	200.7	4.8	0.1	6.8	0.0	0.2	0.0	267.7
1995	5-15 Jul	11	55°N-58°N, 177°W-177°E	7.5	2.0	32.9	33.1	37.8	63.8	174.5	0.5	6.5	0.0	0.2	0.0	283.3
1994	5-15 Jul	11	55°N-58°N, 177°W-177°E	6.7	1.8	32.9	33.2	50.3	224.0	13.1	0.0	5.2	0.0	0.2	0.0	292.7
1993	6-16 Jul	11	55°N-58°N, 177°W-177°E	7.2	2.1	33.1	33.2	58.2	111.6	141.2	0.8	1.4	0.0	0.0	0.0	313.2
1992	4-14 Jul	11	55°N-58°N, 177°W-177°E	6.4	2.5	33.0	33.3	22.8	257.5	9.0	0.3	5.4	0.0	0.5	0.0	295.5
1991	1-8 Jul	8	55°N-58°N, 180°W-177°W	7.6	2.2	33.0	33.2	22.9	53.9	365.5	0.0	9.9	0.0	0.0	0.0	452.1

Table 5. Mean fork length (mm) and body weight (g) of salmonids caught in the research-mesh gillnet (C-gear) during fishing operations of the *Wakatake maru*, 1991-1996.

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																			
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																			
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 6. Ocean age composition (%) and mean fork length (mm), body weight (g), and standard deviation (sd) of sockeye salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *Wakatake maru*, 1991-1995.

Year	Sampling Dates	Ocean Age .1			Ocean Age .2			Ocean Age .3			Ocean Age .4															
		% N Age	Fork length (mm) mean	Body weight (g) mean	% N Age	Fork length (mm) mean	Body weight (g) mean	% N Age	Fork length (mm) mean	Body weight (g) mean	% N Age	Fork length (mm) mean	Body weight (g) mean													
Central North Pacific - Subarctic Current (44°N-47°N, 180°)																										
1995	25-27 Jun	0			0			2	100	606	9	2950	354	0												
1994	25-27 Jun	2	50	365	49	464	91	1	25	452	980	3200	0	0												
1993	26-28 Jun	0			0			0					0	0												
1992	23-25 Jun	0			0			0					0	0												
1991	20-21 Jun	2	100	315	5	295	7	0	2				0	0												
Central Bering Sea (55°N-58°N, 177°W-177°E)																										
1995	5-16 Jul	44	11	330	45	399	200	292	72	495	30	1447	354	70	17	586	58	2599	792	2	0	624	63	2925	601	
1994	5-15 Jul	133	37	430	26	404	97	209	57	474	30	1189	255	23	6	583	38	2643	651	0						
1993	6-16 Jul	297	52	351	25	430	101	246	43	483	36	1301	329	31	5	571	44	2423	773	2	0	628	20	3275	601	
1992	4-14 Jul	92	39	337	31	392	105	126	54	483	31	1364	324	16	7	584	46	2929	803	1	0	650	33	4500	460	
1991	1-8 Jul	101	59	313	21	332	70	38	22	480	39	1335	477	30	18	595	44	2851	781	2	1	653	33	4225	460	

Table 8. Ocean age composition (%) and mean fork length (mm), body weight (g) and standard deviation (sd) of pink salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *Wakatake maru*, 1991-1995.

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°)							
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°)							
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)							
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 9. Ocean age composition (%) and mean fork length (mm), body weight (g), and standard deviation (sd) of coho salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *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°)							
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°)							
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)							
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 10. Ocean age composition (%) and mean fork length (mm), body weight (g), and standard deviation (sd) of chinook salmon caught in the research-mesh gillnet (C-gear) during fishing operations of the *Wakatake maru*, 1991-1995.

Year	Sampling Dates	Ocean Age .1			Ocean Age .2			Ocean Age .3			Ocean Age .4							
		% N Age	Fork length (mm) mean	Body weight (g) mean	% N Age	Fork length (mm) mean	Body weight (g) mean	% N Age	Fork length (mm) mean	Body weight (g) mean	% N Age	Fork length (mm) mean	Body weight (g) mean					
Central North Pacific - Subarctic Current (44°N-47°N, 180°)																		
1995	25-27 Jun	0	562	2200	1	50	832	7800	0									
1994	25-27 Jun	0	616	3150	3	100	477	0	0									
1993	26-28 Jun	0	624	3700	1	100	0	0	0									
1992	23-26 Jun	0	575	2300	1	100	0	0	0									
1991	20-21 Jun	0	572	2625	2	100	926	0	0									
Central North Pacific - Ridge Domain (47°N, 180°)																		
1992	26-Jun	0			0				0									
Bering Sea (55°N-58°N, 177°E-177°W)																		
1995	5-16 Jul	18	339	442	43	65	525	1813	522	4	6	726	4725	1300	1	2	812	6800
1994	5-15 Jul	25	374	595	11	21	543	2179	740	17	32	720	4855	1129	0			
1993	6-16 Jul	1	352	480	7	59	573	2340	314	3	25	716	4710	2175	1	8	862	8600
1992	4-14 Jul	17	356	525	116	23	49	2333	709	6	13	654	3822	648	1	2	850	7650
1991	1-8 Jul	45	345	497	120	21	31	1816	634	2	3	715	4050	71	0			

Table 11. Ocean age composition (%) and mean fork length (mm), body weight (g), and standard deviation (sd) of steelhead trout caught in the research-mesh gillnet (C-gear) during fishing operations of the *Wakatake maru*, 1991-1995.

Year	Sample Dates	Ocean Age .1				Ocean Age .2				Ocean Age .3				
		% N Age		Fork length (mm)		% N Age		Fork length (mm)		% N Age		Fork length (mm)		
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
Central North Pacific - Transition Domain (41°N-45°N, 180°)														
1995	22-24 Jun	0				1	100	682				3000		0
1994	21-24 Jun	9	100	564	16	1812	189							0
1993	23-25 Jun	1	50	540		1520		656				2650		0
1992	21-22 Jun	0						718				4000		0
1991	15-19 Jun	8	73	542	49	1608	434	741	24	4533	797			0
Central North Pacific - Subarctic Current (44°N-47°N, 180°)														
1995	25-27 Jun	16	73	574	41	1791	317	672	51	3050	752	1	4	700
1994	25-27 Jun	21	84	551	44	1850	231	692	61	3538	1090	0		3000
1993	26-28 Jun	4	40	563	24	1695	93	688	70	2975	424	0		
1992	23-25 Jun	0						663	49	2867	568	0		
1991	20-21 Jun	2	75	522	60	1315	403	710		3800		0		
Central North Pacific - Ridge Domain (47°N, 180°)														
1992	26-Jun	1	50	548		1530		658		2350		0		

Table 12. Sockeye salmon stomach contents data continued.

Year	Gear	N	Empty	Prey Weight (g)	SCI	Mean % composition by volume												
						EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE	Other	Unid	
Central North Pacific - Ridge Domain																		
(47°N-49°N, 180°)																		
1996	A	0																
1996	B	9	0	20	0.82	30	7	23	2	21	10	6	0	1	0	0		
1995	B	8	0	25	1.09	0	22	20	0	51	2	1	0	4	0	0		
1994	B	6	17	11	0.43	0	37	6	0	40	17	0	0	0	0	0		
1993	B	0																
1992	B	0																
1991	B	3	33	20	0.90	40	25	8	0	0	12	0	0	0	0	15		
Central North Pacific - Alaska Stream																		
(49°N-51°N, 180°)																		
1996	A	0																
1996	B	4	25	14	0.56	12	0	35	0	40	12	1	0	0	0	0		
1995	B	21	0	25	0.99	26	6	14	1	8	21	4	4	2	13	1		
1994	B	27	4	25	1.01	14	2	26	0	45	7	1	0	0	1	4		
1993	B	2	0	11	0.39	0	0	65	0	0	0	0	35	0	0	0		
1992	B	2	0	13	0.90	10	0	25	0	65	0	0	0	0	0	0		
1991	B	18	33	5	0.34	17	2	28	0	6	42	0	0	0	1	4		
Bering Sea																		
(52°N-58°N, 180° & 177°E-177°W)																		
1996	A+B	134	16	12	0.70	24	2	16	1	15	12	19	0	0	1	0		
1996	A	90	22	11	0.64	21	14	15	2	16	8	24	0	0	0	0		
1996	B	44	5	15	0.80	27	10	19	0	13	18	10	0	0	2	1		
1995	B	144	1	10	0.67	9	6	36	5	22	12	9	0	0	1	0		
1994	B	116	9	11	0.93	16	20	30	0	21	4	7	0	0	1	0		
1993	B	78	15	9	0.66	3	10	19	1	31	3	28	0	0	3	2		
1992	B	37	14	13	0.68	11	29	21	0	18	0	14	0	2	2	3		
1991	B	69	14	9	0.55	13	5	7	1	32	13	14	0	0	5	2		

Table 13. Mean percent composition of stomach contents summarized by oceanographic region for chum salmon caught during fishing operations of the *Wakatake maru*, 1991-1996. Gear=A (commercial-mesh gillnet), B (surface longline), and A+B (both gear combined). % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=prey weight X 100/body weight. EU=euphausiids, CO=copepods, AM=amphipods, DE=decapods, SQ=squids, PT=pteropods (shelled and naked), FI=fish, PO=polychaetes, CH=chaetognaths, GE=gelatinous zooplankton, including coelenterates, ctenophores, and saps, Other=rare groups that may include appendicularia, mysids, heteropods, and cladocera, Unid=unidentified material.

Year	Gear	N	Empty	Prey Weight (g)	SCI	Mean % composition by volume														
						EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE	Other	Unid			
Central North Pacific - Transition Zone																				
(38°N-41°N, 180)																				
1996	A+B	0																		
1995	B	0																		
1994	B	0																		
1993	B	14	14	5	0.62	0	4	0	0	1	0	11	0	2	65	0	17			
1992	B	0																		
1991	B	0																		
Central North Pacific - Transition Domain																				
(41°N-45°N, 180)																				
1996	A+B	10	0	14	1.22	4	4	2	0	0	0	4	4	21	17	34 ¹	10			
1996	A	1	0	44	3.12	2	2	0	0	0	0	0	0	0	0	80 ²	16			
1996	B	9	0	11	1.00	4	5	2	0	1	0	4	4	23	19	29 ¹	9			
1995	B	7	0	9	0.85	0	3	1	0	0	0	32	0	9	51	4	0			
1994	B	19	0	10	1.07	1	1	2	0	5	2	1	0	36	37	11 ³	4			
1993	B	24	4	9	1.11	0	5	6	0	0	11	7	1	29	23	11 ²	7			
1992	B	10	0	9	1.04	39	5	10	0	0	0	3	2	0	3	0	38			
1991	B	14	0	16	1.92	5	0	18	0	0	0	0	0	0	2	0	75			
Central North Pacific - Subarctic Current																				
(44°N-47°N, 180)																				
1996	A+B	67	0	8	0.72	1	1	5	0	6	8	1	5	10	43	8	12			
1996	A	30	0	6	0.49	1	1	2	0	2	2	0	10	9	43	12 ¹	18			
1996	B	37	0	9	0.90	1	1	7	0	10	13	2	1	10	43	6	6			
1995	B	41	0	8	0.70	28	3	5	0	3	6	0	1	1	50	0	3			
1994	B	25	0	11	1.16	0	0	0	0	0	3	0	0	17	32	0	48			
1993	B	39	0	12	1.61	0	3	5	0	1	17	0	7	4	2	45 ²	16			
1992	B	18	11	5	0.62	6	1	26	0	8	9	0	2	12	11	0	25			
1991	B	34	9	13	1.32	0	0	4	0	2	0	0	0	0	2	0	92			

Table 13. Chum salmon stomach contents data continued.

Year	Gear	N	Empty	Mean Prey Weight (g)	SCI	Mean % composition by volume													Other	Unid
						EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE					
Central North Pacific - Ridge Domain																				
(47°N-49°N, 180°)																				
1996	A	0																		
1996	B	27	15	13	0.93	15	7	23	0	4	41	0	0	5	5	0	0	0		
1995	B	29	0	11	0.95	48	3	11	0	5	2	1	0	11	16	0	3	3		
1994	B	40	0	7	0.76	7	2	4	0	2	20	1	0	3	28	0	33	33		
1993	B	38	3	11	1.19	2	0	2	0	3	28	0	1	2	0	61 ²	1	1		
1992	B	9	11	5	0.66	0	4	47	0	0	0	5	0	23	0	0	21	21		
1991	B	40	3	8	1.33	8	8	3	0	1	5	0	0	10	1	0	64	64		
Central North Pacific - Alaska Stream																				
(49°N-51°N, 180°)																				
1996	A	0																		
1996	B	10	20	19	0.56	9	0	25	13	8	4	16	1	1	23	0	0	0		
1995	B	28	4	12	0.91	34	0	1	0	10	19	0	10	1	25	0	0	0		
1994	B	40	5	10	1.02	19	3	15	0	14	30	5	0	0	10	3	1	1		
1993	B	6	17	14	1.22	0	0	4	6	0	1	2	82	1	4	0	0	0		
1992	B	5	0	5	0.47	0	4	32	0	0	6	0	0	15	29	0	14	14		
1991	B	47	4	10	1.27	2	1	5	0	2	17	3	0	1	0	0	69	69		
Bering Sea																				
(52°N-58°N, 180° & 177°E-177°W)																				
1996	A+B	238	6	15	1.00	39	3	9	0	2	20	10	0	0	13	4	0	0		
1996	A	88	11	12	0.66	44	2	8	0	1	16	18	0	0	6	5	0	0		
1996	B	150	3	17	1.18	37	3	9	0	3	22	5	0	0	17	4	0	0		
1995	B	216	2	14	1.01	23	1	12	1	7	9	22	0	0	23	0	2	2		
1994	B	278	1	11	0.99	13	6	13	0	5	7	2	0	3	39	1	11	11		
1993	B	292	4	16	1.42	6	2	4	0	10	5	14	1	0	27	29 ²	2	2		
1992	B	235	1	19	1.33	26	17	13	0	13	0	5	0	1	6	0	19	19		
1991	B	311	1	23	1.53	8	2	4	0	3	4	1	0	0	11	22 ²	45	45		

¹heteropods²appendicularia³ostracods

Table 14. Mean percent composition of stomach contents summarized by oceanographic region for pink salmon caught during fishing operations of the *Wakatake maru*, 1991-1996. Gear=A (commercial-mesh gillnet), B (surface longline), and A+B (both gear combined). % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=prey weight X 100/body weight. EU=euphausiids, CO=copepods, AM=amphipods, DE=decapods, SQ=squids, PT=pteropods (shelled and naked), FI=fish, PO=polychaetes, CH=chaetognaths, GE=gelatinous zooplankton, including coelenterates, ctenophores, and salps, Other=rare groups that may include appendicularia, mysids, heteropods, and cladocera, Unid=unidentified material.

Year	Gear	N	Empty	Mean Prey Weight (g)	% Mean Prey Mean												
					SCI	EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE	Other	Unid
Central North Pacific - Transition Zone																	
(38°N-41°N, 180)																	
1996	A+B	0															
1995	B	0															
1994	B	0															
1993	B	0															
1992	B	0															
1991	B	0															
Central North Pacific - Transition Domain																	
(41°N-45°N, 180)																	
1996	A+B	0															
1995	B	3	0	17	1.83	0	3	6	0	2	0	17	0	43	0	29 ¹	0
1994	B	21	5	6	0.62	1	52	11	0	0	16	1	0	11	0	7	1
1993	B	0															
1992	B	0															
1991	B	1	0	7	0.96	10	0	90	0	0	0	0	0	0	0	0	0
Central North Pacific - Subarctic Current																	
(44°N-47°N, 180)																	
1996	A+B	7	14	6	0.36	0	10	28	0	21	19	1	0	0	8	11 ²	2
1996	A	3	33	1	0.08	0	0	52	0	0	15	0	0	0	0	33 ²	0
1996	B	4	0	8	0.50	0	15	16	0	31	21	1	0	0	13	0	3
1995	B	5	40	5	0.50	0	21	12	0	30	1	33	0	3	0	0	0
1994	B	18	0	16	1.41	0	11	15	0	26	17	4	0	15	0	2	10
1993	B	1	0	1	0.09	0	0	30	0	0	70	0	0	0	0	0	0
1992	B	0															
1991	B	13	0	10	1.29	7	4	24	0	10	49	0	0	0	0	0	6

Table 14. Pink salmon stomach contents data continued.

Year	Gear	N	Mean Prey		Mean % composition by volume													Other	Unid
			Empty	Weight (g)	SCI	EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE				
Central North Pacific - Ridge Domain																			
(47°N-49°N, 180°)																			
1996	A	0																	
1996	B	1	0	13	1.21	20	35	35	0	5	5	0	0	0	0	0	0		
1995	B	22	5	17	1.71	1	32	19	0	27	8	0	0	5	0	0	0		
1994	B	15	0	35	2.72	20	10	5	0	52	12	0	0	0	0	1	0		
1993	B	3	0	17	1.92	22	2	13	0	21	40	0	0	0	0	2	0		
1992	B	2	0	4	0.39	3	5	67	0	0	0	25	0	0	0	0	0		
1991	B	40	0	17	2.19	43	30	2	0	8	14	1	0	2	0	0	0		
Central North Pacific - Alaska Stream																			
(49°N-51°N, 180°)																			
1996	A+B	0																	
1995	B	14	0	17	1.44	27	1	14	1	10	20	24	3	0	0	0	0		
1994	B	8	0	25	2.15	17	25	11	0	24	7	6	0	0	0	10 ³	0		
1993	B	2	0	10	0.95	0	3	15	0	0	15	60	2	0	5	0	0		
1992	B	0																	
1991	B	47	9	10	1.07	13	2	18	0	8	51	6	0	0	0	2	0		
Bering Sea																			
(52°N-58°N, 180° & 177°E-177°W)																			
1996	A+B	52	8	19	1.43	21	5	5	3	14	2	50	0	0	0	0	0		
1996	A	47	9	20	1.47	24	3	3	4	13	1	52	0	0	0	0	0		
1996	B	5	0	12	1.09	3	20	15	0	21	11	30	0	0	0	0	0		
1995	B	186	0	15	1.19	9	8	14	5	26	12	26	0	0	0	0	0		
1994	B	28	0	17	1.37	23	12	8	4	28	2	23	0	0	0	0	0		
1993	B	159	3	16	1.36	2	6	10	0	28	2	50	0	0	0	2	0		
1992	B	14	0	27	1.96	14	12	6	4	40	0	21	0	0	0	0	3		
1991	B	312	7	17	1.42	14	7	11	0	33	6	21	0	0	1	0	7		

¹cladocera
²heteropods
³mysids

Table 15. Coho salmon stomach contents data continued.

Year	Gear	N	Empty	Prey Mean Weight (g)	SCI	Mean % composition by volume											
						EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE	Other	Unid
Central North Pacific - Ridge Domain																	
(47°N-49°N, 180°)																	
1996	A+B	0	0	68	3.71	0	0	1	0	0	98	0	1	0	0	0	0
1995	B	4	0	97	3.75	25	0	0	0	0	75	0	0	0	0	0	0
1994	B	4	0	29	1.47	0	0	0	0	0	95	5	0	0	0	0	0
1993	B	1	0	83	4.15	0	0	0	0	0	100	0	0	0	0	0	0
1992	B	1	0														
1991	B	0															
Central North Pacific - Alaska Stream																	
(49°N-51°N, 180°)																	
1996	A+B	0	0	47	2.47	85	0	0	0	0	10	0	5	0	0	0	0
1995	B	1	0														
1994	B	0															
1993	B	0															
1992	B	0															
1991	B	1	0	7	0.28	20	0	0	0	0	40	0	40	0	0	0	0
Bering Sea																	
(52°N-58°N, 180° & 177°E-177°W)																	
1996	A	2	0	76	2.07	0	0	0	0	0	0	0	100	0	0	0	0
1996	B	0															
1995	B	0															
1994	B	0															
1993	B	0															
1992	B	2	0	9	0.63	87	0	5	0	5	0	0	3	0	0	0	0
1991	B	2	0	11	0.30	50	0	0	0	50	0	0	0	0	0	0	0

Table 16. Mean percent composition of stomach contents summarized by oceanographic region for chinook salmon caught during fishing operations of the *Wakatake maru*, 1991-1996. Gear=A (commercial-mesh gillnet), B (surface longline), and A+B (both gear combined). % empty=percent of stomachs that did not contain stomach contents. Empty stomachs were not included in other table entries. SCI=prey weight X 100/body weight. EU=euphausiids, CO=copepods, AM=amphipods, DE=decapods, SQ=squids, PT=pteropods (shelled and naked), FI=fish, PO=polychaetes, CH=chaetognaths, GE=gelatinous zooplankton, including coelenterates, ctenophores, and salps, Other=rare groups that may include appendicularia, mysids, heteropods, and cladocera, Unid=unidentified material.

Year	Gear	N	Empty	Prey Weight (g)	SCI	Mean % composition by volume											
						EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE	Other	Unid
Central North Pacific - Transition Zone																	
(38°N-41°N, 180)																	
1996	A+B	0															
1995	B	0															
1994	B	0															
1993	B	0															
1992	B	0															
1991	B	0															
Central North Pacific - Transition Domain																	
(41°N-45°N, 180)																	
1996	A+B	0															
1995	B	0															
1994	B	0															
1993	B	0															
1992	B	0															
1991	B	0															
Central North Pacific - Subarctic Current																	
(44°N-47°N, 180)																	
1996	A	2	0	19	0.26	0	0	0	0	0	100	0	0	0	0	0	0
1996	B	0															
1995	B	1	100														
1994	B	3	0	13	0.28	0	0	0	0	0	100	0	0	0	0	0	0
1993	B	3	33	74	1.94	0	0	0	0	0	100	0	0	0	0	0	0
1992	B	0															
1991	B	2	0	23	0.49	0	0	2	0	63	0	0	0	0	0	0	35

Table 16. Chinook salmon stomach contents continued.

Year	Gear	N	Empty	Prey	Mean	Mean % composition by volume											
						Weight (g)	SCI	EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE
Central North Pacific - Ridge Domain																	
(47°N-49°N, 180°)																	
1996	A+B	0															
1995	B	2	0	39	1.21	0	0	0	0	0	100	0	0	0	0	0	0
1994	B	0															
1993	B	0															
1992	B	0															
1991	B	0															
Central North Pacific - Alaska Stream																	
(49°N-51°N, 180°)																	
1996	A+B	0															
1995	B	1	0	43	0.95	0	0	0	0	0	100	0	0	0	0	0	0
1994	B	0															
1993	B	0															
1992	B	0															
1991	B	0															
Bering Sea																	
(52°N-58°N, 180° & 177°E-177°W)																	
1996	A+B	72	19	25	1.03	18	0	2	1	46	1	32	0	0	0	0	0
1996	A	43	16	31	1.12	4	0	3	0	54	0	39	0	0	0	0	0
1996	B	29	24	14	0.88	41	1	2	0	34	1	21	0	0	0	0	0
1995	B	44	16	10	0.63	16	0	0	0	52	0	29	0	0	0	0	3
1994	B	26	31	12	0.54	20	0	10	0	58	1	8	0	0	3	0	0
1993	B	12	17	12	0.54	27	0	0	0	39	0	34	0	0	0	0	0
1992	B	37	19	18	0.78	43	4	0	0	44	0	9	0	0	0	0	0
1991	B	30	17	19	0.86	33	1	0	0	43	0	23	0	0	0	0	0

Table 17. Steelhead trout stomach contents data continued.

Year	Gear	N	Empty	N	Weight (g)	SCI	EU	CO	AM	DE	SQ	PT	FI	PO	CH	GE	Other	Unit	Mean % composition by volume									
																			Mean	Prey	%							
Central North Pacific - Ridge Domain																												
(47°N-49°N, 180°)																												
1996	A	0																										
1996	B	6	0	30	0.75	0	0	0	3	0	38	0	59	0	0	0	0	0	0									
1995	B	1	0	194	3.88	0	0	0	0	0	90	0	10	0	0	0	0	0	0									
1994	B	3	0	76	1.47	0	0	0	0	0	83	0	17	0	0	0	0	0	0									
1993	B	1	0	41	1.78	0	0	0	0	0	95	5	0	0	0	0	0	0	0									
1992	B	2	0	99	2.79	0	0	0	0	0	80	0	20	0	0	0	0	0	0									
1991	B	0																										
Central North Pacific - Alaska Stream																												
(49°N-51°N, 180°)																												
1996	A+B	0																										
1995	B	0																										
1994	B	2	0	28	0.72	0	0	0	0	0	50	0	50	0	0	0	0	0	0									
1993	B	1	100																									
1992	B	1	0	40	0.85	0	0	0	0	0	60	0	40	0	0	0	0	0	0									
1991	B	0																										
Bering Sea																												
(52°N-58°N, 180° & 177°E-177°W)																												
1996	A+B	0																										
1995	B	0																										
1994	B	0																										
1993	B	0																										
1992	B	0																										
1991	B	0																										

1 foam, plastic, wood