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# International Salmon Research Aboard the R/V *Wakatake maru* in the Central North Pacific Ocean and Bering Sea during the Summer of 2005

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## Abstract

An annual high-seas salmonid research cruise was conducted in the central North Pacific Ocean and Bering Sea from June 8 to July 20, 2005 onboard the Japanese research vessel, *Wakatake maru,* to investigate salmon stock condition. Research cruise activities included collection of data on oceanography, primary production, zooplankton, salmonids, and other organisms. Average sea surface temperatures in the North Pacific were 1.2°C cooler than in 2004. In the Bering Sea, sea surface temperatures in 2005 were 0.3°C cooler than in 2004. A total of 7,606 salmonids was caught by longline and gillnet: 1,384 fish in the central North Pacific Ocean (St. 3-13) and 6,222 fish in the central Bering Sea (St. 14-27). In the North Pacific Ocean, chum salmon was the most abundant species (31.7% of the salmonid catch), followed by sockeye (26.7%), coho (23.0%), pink (13.9%), steelhead trout (4.3%), and chinook salmon (0.4%). In the Bering Sea, pink salmon was the most abundant species (62.4% of the salmonid catch), followed by sockeye (22.6%), chum (14.3%), chinook (0.5%), and coho salmon (0.2%). Three snouts from adipose-fin clipped salmonids (all steelhead) showed a positive response from a coded-wire tag detector and were retained for later retrieval of the tags. A total of 383 disk tags were placed on salmon and steelhead during the survey, including 11 sockeye, 68 chum, 5 pink, 58 coho, and 1 chinook salmon, and 3 steelhead in the central North Pacific, and 71 sockeye, 79 chum, 83 pink, and 4 chinook salmon in the Bering Sea. A total of 138 data storage tags were placed on salmon during the survey, including geolocating (position, temperature, depth) tags placed on 14 sockeye and 6 chum, conductivity, temperature, and depth (CTD) tags placed on 5 sockeye, 4 chum, and 1 chinook, temperature (ibutton) tags placed on 3 pink, 2 coho, and 2 chinook salmon, and temperature and depth (LTD) tags placed on 44 sockeye, 14 chum, 30 pink, 11 coho, and 2 chinook salmon. A total of 775 salmon stomach samples was examined during the cruise. Samples for stable isotopic analysis were collected from 301 salmon and 64 individual prey organisms. Tissue samples were collected from four salmon sharks for investigation of reproductive biology. A total of 193 fish were examined for sea lice. All sea lice were tentatively identified as *Lepeophtheirus salmonis*. Brain, pituitary, gonad, and blood samples were obtained from 36 chum salmon for endocrine studies.


## Introduction

The main objective of this research cruise is to monitor the stock condition of salmon (*Oncorhynchus* spp.) in the central North Pacific Ocean and Bering Sea. A recent decrease in body size and increase in age of chum salmon (*O. keta*) at maturity has been reported (Kaeriyama 1989; Ishida et al. 1993; Helle and Hoffman 1995; Bigler et al. 1996). A scale pattern analysis showed that Japanese chum salmon suffered growth reduction after the second year of ocean life (Kaeriyama 1998). Urawa (2000) estimated that this reduction occurs in the Bering Sea, where chum salmon density increases in summer. To investigate these issues, a survey has been conducted annually in the central North Pacific Ocean and Bering Sea during summer. Routine observations have included collection of physical oceanographic data,

estimates of primary production, and investigations into the relationships among zooplankton, salmonid, and higher trophic levels. This document summarizes the R/V *Wakatake maru* cruise conducted in these waters during June and July 2005.

## Methods

*Research Vessel and Survey Areas*

The *Wakatake maru* (666 gross tons) departed Kushiro on June 8, 2005 and returned to Kushiro on July 20, 2005. There were 25 experimental fishing stations during the cruise (Fig. 1). Nineteen fishing stations were located in the vicinity of 180° longitude from 41°N to 58°30'N latitude. In addition, 6 fishing stations were located in international waters of the central Bering Sea. Oceanographic data were collected at each fishing station and between stations. Additional oceanographic data were collected enroute to and from the fishing area (Table 1).

*Physical Oceanography*

Seawater temperature and salinity data have been collected in the same manner since 1999 (Kawana et al. 1999, Urawa et al. 2000, Fukuwaka et al. 2001, Tanaka et al. 2002, Fukuwaka et al. 2003, Morita et al. 2004). An expendable bathythermograph (XBT), which recorded data at 1-m increments from the surface to 780 m, was used at 1°-longitude intervals on the outbound, eastward transit at 40°N, and at 1°-latitude intervals between fishing stations (n = 50). The conductivity, temperature, and depth sensor (CTD) was used at 5°-longitude intervals along the eastward transit and at fishing stations (n = 39). The XCTD (expendable CTD) was used at 1°-longitude intervals on the return leg from the Bering Sea (n = 27). The CTD and XCTD record data in 1-m intervals from the surface to approximately 1000 m.

*Primary Production*

Seawater was sampled by hand with a bucket and using Niskin bottles attached to the CTD at 32 stations (Table 1). Chlorophyll samples were collected at seven standard depth layers (0, 10, 30, 50, 75, 100, and 150 m). Water (300-500 ml) from each layer was filtered through a glass fiber filter (Whatman GF/F) and nucleporefilters (pore sizes: 2 μm and 10 μm) using a vacuum pump (100-150 mm Hg). Filters containing chlorophyll-a were soaked with 6 ml of N-dimethylformaide and stored in the freezer. In addition, a water sample (6 ml × 2) from each depth layer was frozen for nutrient analysis. One-liter samples of surface water were fixed in 2% borax-buffered formalin for phytoplankton identification. Chlorophyll and water samples were sent to the National Research Institute of Fisheries Science, Fisheries Research Agency, Yokohama, Japan for analysis.

*Zooplankton Collection*

Macro-zooplankton were sampled with a remodeled NORPAC net (0.45 m ring diameter, 1.93 m net length, 0.33 mm mesh size) at 25 fishing stations and 6 transit stations located at intervals of 5° longitude from 150°E to 160°E. The net was towed vertically from 150 m to the surface. A calibrated flow meter was attached to the opening of the net in a position slightly off-center. Samples were fixed in 5% borax-buffered formalin in seawater.

Large macro-zooplankton were collected at 25 fishing stations using an Ocean Research Institute (ORI) net (1.60 m diameter, 7.5 m in overall length, 0.67 mm mesh size). The ORI net was towed along side of the vessel at the surface at a speed of 1.5-2 knots for 10 min around 23:00 hrs. Samples were fixed in 10% borax-buffered formalin in seawater. When the ORI net collected more sample material than the capacity of the sample bottle, then the total volume was measured and a subsample was retained.

*Fishing Operations*

A gillnet and longline were used for experimental fishing operations to collect salmonids and other pelagic fish. The gillnet was used at 8 stations in the central North Pacific Ocean and 10 stations in the central Bering Sea, outside of the U.S. EEZ (Fig. 1, Table 1). The gillnet was set at 16:00 in the afternoon (Local Mean Time [LMT], GMT + 12) and retrieved at 04:00 the following morning. The gillnet configuration consisted of a variable-mesh research gillnet (C-gear: 3 tans each of 48, 55, 63, 72, 82, 93, 106, 121, 138, and 157 mm mesh size, one tan is 50 m long) combined with panels of a commercial-mesh gillnet (A-gear: 19 tans of 115 mm mesh size, one tan is 50 m long). The longline was used at 25 fishing stations, where it was set 30 minutes before sunset and hauled 30 minutes after sunset (LMT). The longline comprised 30 hachi (overall length 3.32 km; 1 hachi is 110.68 m long with 49 hooks) and it was baited with salted Japanese anchovy (*Engraulis japonicus*).

*Fish Examination*

Salmonids were processed soon after removal from the fishing gear. For each mesh size, the catch was sorted and counted by species. Biological data were collected from a maximum of 60 individuals of each species from each mesh size (gillnet operation, mesh sizes = 11) and from a maximum of 60 individuals per species from longline mortalities. The biological data included fork length (FL, mm), body weight (BW, g), sex, and gonad weight (GW, g). One scale (pink salmon *O. gorbuscha*), two scales (sockeye *O. nerka*, chum, coho *O. kisutch*, and chinook salmon *O. tshawytscha*), or a scrape scale sample (steelhead *O. mykiss*) were collected. Scales were collected from the INPFC-preferred (International North Pacific Fisheries Commission) area on the body for age determination (Davis et al. 1990). The presence of external injuries on salmon and visceral adhesions in sockeye salmon and other species were recorded (Nagasawa et al. 1997). Salmonids were inspected for the presence of clipped fins. If the fish had a clipped adipose fin, the snout was removed, salted, and frozen for later screening with a CWT detector wand. Snouts producing a positive response from the detector were retained for later recovery of the CWT.

All non-salmonid catches were identified and counted by mesh size. Body lengths were measured for non-salmonid fish, squid, and other organisms, and a few were frozen for taxonomic and ecological studies. Frozen neon flying squid (*Ommastrephes bartramii*) were sent to the National Research Institute of Far Seas Fisheries, Shimizu, and dead birds were sent to the Graduate School of Fisheries Science, Hokkaido University, Hakodate, for further examination. Salmon shark (*Lamna ditropis*) was measured for body length, and sexual maturity examined. Blood, cartilage and gonads were frozen and DNA samples were preserved in alcohol.

*Examination of Salmonid Stomach Contents*

Stomach samples were collected from all species of salmon and steelhead trout. These samples were collected from a maximum of 10 fish per species from longline mortalities and from a variety of research-mesh sizes (C-gear) and commercial-mesh gillnet (A-gear). Samples were examined while onboard the vessel. The stomach samples were weighed to the nearest gram before and after removal of the contents, and weight of the stomach contents was obtained by subtraction. The stomach contents were examined using a binocular microscope and separated into several general prey categories. The percent volume in each prey category was estimated by eye.

*Sample Collection of Salmon and their Prey for Stable Isotopic Analysis*

Samples of salmon and their prey were collected to make a spatial comparison of stable isotope ($^{15}N$ and $^{13}C$) values the central North Pacific and Bering Sea and to detect differences in

trophic position among salmon species. Prey items were collected to evaluate prey contributions to the isotopic signature of salmon. An approximate 1-g sample of salmon muscle tissue from the dorsal surface and behind the head was removed and frozen with the salmon's stomach contents. Whole prey organisms were collected from stomach contents and extra material from ORI net sampling and kept frozen.

*Stock Identification using Genetic Marker and Otolith Thermal Marking*

Scales were collected from all measured chum salmon caught by research-mesh sizes (C-gear) and from a maximum of 60 sockeye or chinook salmon caught by research- and commercial-mesh size gillnet (C- and A-gear). Dried chum salmon scales were sent to the National Salmon Resources Center (NASREC), Sapporo, and dried sockeye and chinook salmon scales were sent to the Alaska Department of Fish and Game, Anchorage, for stock identification using DNA.

Both sagittal otoliths were collected from all measured chum salmon caught by research-mesh sizes (C-gear) to detect thermal marks on the otolith. Dried otoliths were sent to NASREC for further examination.

*Sea lice sampling*

Sockeye, chum, pink, coho, and chinook salmon, and steelhead trout were inspected for the identification and prevalence of sea lice. Dead salmon caught by longline, or those that were not in good enough condition to tag, as well as salmon caught by commercial gillnet (gear A 115 mm mesh) gear were examined for sea lice. Fish were placed individually in a solid tray to ensure any sea lice that might drop off the fish would be retained in the tray. The right and left side of the fish were inspected for the percentage of scale loss and degree of skin damage caused by sea lice. The fish body was divided into six sections ([1] head, [2] dorsal area between the head and the posterior insertion of the dorsal fin, [3] dorsal area posterior to the dorsal fin and extending to the caudal peduncle, [4] ventral area posterior to the head and extending to the anterior insertion of the ventral fin, [5] ventral area from the anterior insertion of the ventral fin to the caudal peduncle, and [6] the caudal fin). Each section was examined using a hand lens for the presence and frequency of infestation by sea lice. The sea lice life history stage (copepodite, chalimus, and adult) was recorded. The adult stage was tentatively identified to species. All sea lice (excluding the copepodite stage) were collected from each fish, including any that may have dropped off into the tray, and were preserved in individual glass vials containing 70% ethanol. These samples were sent to PBS (Nanaimo) for confirmation of species identification. An opercular punch was collected for DNA analysis from each fish. These were preserved in individual vials containing 95% ethanol and sent to PBS (Nanaimo) for stock identification of salmon.

*Disk Tags*

Live salmon caught in a healthy condition were put into a recovery tank soon after removal from the longline. Fish were tagged with two disk tags issued by the Fisheries Agency of Japan (FAJ) and University of Washington (UW). Both disk tags were placed on one plastic cinch strap and applied to the fish anterior to the dorsal fin. The fork length was measured and two scales were collected before the fish was released to the sea.

*Data Storage Tags*

Four types of data storage tags (DSTs) were placed on salmon. Three of the four DSTs, including CTD tags (record conductivity, temperature, and depth data), LTD tags (record temperature and depth data), and ibutton tags (record temperature data), are the same types of DSTs used in 2004 (Morita et al. 2004). A geolocating DST tag was the fourth type placed on salmon during this cruise. This DST is manufactured by Lotek Marine Technologies,

Newfoundland, Canada (model LTD_2400; size = 11 x 35 mm, weight in air = 6 g, weight in water = 4 g, memory size = 128 KB for a daily log and 384 KB, or 65,536 records for the time series). This DST records temperature and depth data, and estimates the fish's geographical position based on ambient light levels. All data storage tags were placed externally on the fish immediately anterior to the dorsal fin. Disk tags were used at the DST attachment site to act as backing plates.

*Other Sampling and Research*

The brain, pituitary, gonad, liver, and blood samples of chum salmon were collected for (1) molecular endocrine analysis of the spawning migration, including the role of salmon gonadotropin-releasing hormone (sGnRH) and (2) analysis of endocrinological changes of the fish during its spawning migration from the Bering Sea to Japan. Fish caught in a healthy condition were placed in a recovery tank soon after detachment from a longline hook. After removal from the tank, chum salmon length and weight were measured and a scale sample collected. Blood samples were collected from the caudal vasculature and centrifuged to obtain plasma samples for analyzing levels of steroid hormones. These samples were stored at –20°C. The gonad and liver were dissected out and weighed to calculate gonadsomatic index (GSI, gonad weight / body weight x 100) and hepatosomatic index (HSI, liver weight / body weight x 100). The brain and pituitary were hemisected and frozen in liquid nitrogen for determination of the level of mRNAs encoding hypothalamic hormones and pituitary hormones. In some fish, the olfactory epithelium, olfactory bulb, telencephalon, optic tectum, hypothalamus, cerebellum, and medulla oblongata were collected to investigate genes related to the homing migration. These tissue samples were stored at –50°C. Additional brain and pituitary samples were fixed in Zamboni solution and stored in 70% ethanol for histological analyses. These tissue samples were kept in a refrigerator.

To investigate energy contents of salmon, sockeye, chum, and pink salmon round samples were collected from gillnet catches and sent to the Graduate School of Fisheries Science, Hokkaido University, Hakodate, for further examination. To investigate lipid contents of chum and pink salmon, gutted fish were collected from catches of research-mesh gillnet and sent to NASREC for further examination. A small number of round samples of unusual diseased fish were also collected and sent to NASREC.

To investigate the effect of plastic pollution on seabirds, plastic debris were collected using a neuston net at 5°-longitude intervals along the eastward transit and at fishing stations (n = 40). The neuston net (0.5×0.5 m square mouth, 3 m net length, 0.33 mm mesh size) was towed along side of the vessel at the surface at a speed of 2-3 knots for 10 min. Plastic debris were sorted on board the ship and frozen.

## Results

*Physical Oceanography*

The position of oceanographic domains was identified along the 180° transect according to the seawater characteristics described by Dodimead et al. (1963) and Favorite et al. (1976) (Fig. 2, 3). Stations 1 and 2 where located in the Transition Zone, an area characterized by relatively saline waters (> 34.0 psu) (Fig. 3). A vertical 34.0 psu isohaline characterizes the Subarctic Boundary, which separates subtropical and subarctic waters. The Boundary was located between 40°N (St. 2) and 41°N (St. 3). In 2005, the Subarctic Boundary was located at the same latitude that it was observed in 1997, 1998, 2000, 2003, and 2004, however, the Boundary was located 1° latitude south of its position in 1991-1996 and 2001 and 2002 (Davis et al. 1996, Nagasawa et al. 1997; Ueno et al. 1998, Kawana et al. 1999, Urawa et al. 2000, Fukuwaka et al.

2001; Tanaka et al. 2002, Fukuwaka et al. 2003, Morita et al. 2004). The southern limit of the Transition Domain is the Subarctic Boundary and northern limit is delineated by cold water (< 4°C) below 100 m depth in the central North Pacific. The Transition Domain was located between 40°N and 46°N (between St. 2 and St. 8) (Fig. 2). The Subarctic Current, an eastward-flowing surface current of cool, dilute waters can be identified by cold water (near 3.5°C) at approximately 125 m. This current was located between 45°N (St. 7) and 50°30'N (St. 13). Further to the north, at 50°30'N (Station 13), the westward-flowing Alaska Current was observed. Fed by freshwater run-off, this current has warm (> 4°C) and dilute (< 33.6 psu) waters at depths less than 100 m.

Station 14 was located in Amchitka Pass in the Aleutian Islands, one of several locations where North Pacific waters enter the Bering Sea. Stations north of 52°00'N (St. 15 through St. 30) were located in the Bering Sea. The central Bering Sea is characterized by a cold, saline surface layer (depth to approximately 200 m), which is produced by cooling and mixing during the previous winter. This year, superficial warming of the sea surface during the summer produced a shallow seasonal thermocline at 30 to 50 m (Fig. 2).

In 2005, average sea surface temperatures in the North Pacific were 1.2°C cooler than in 2004 (St. 3-13; 2005 mean = 7.6°C, 2004 mean = 8.8°C). In the Bering Sea, sea surface temperatures in 2005 (St. 14-28; mean = 7.5°C) were 0.3°C cooler than in 2004 (mean = 7.8°C).

*Salmonid Catches*

A total of 7,606 salmonids was caught by longline and gillnet: 1,384 fish in the central North Pacific Ocean (St. 3-13) and 6,222 fish in the central Bering Sea (St. 14-27; Table 2). In the North Pacific Ocean, chum salmon was the most abundant species (31.7% of the salmonid catch), followed by sockeye (26.7%), coho (23.0%), pink (13.9%), steelhead trout (4.3%) and chinook salmon (0.4%). In the Bering Sea, pink salmon was the most abundant species (62.4% of the salmonid catch), followed by sockeye (22.6%), chum (14.3%), chinook (0.5%), and coho salmon (0.2%).

*Non-Salmonid Catches*

Pacific pomfret (*Brama japonica*: n = 377), and eight-armed squid (*Gonatopsis borealis*: n = 138) were particularly abundant in the catch (Table 2). In addition, 41 boreal clubhook squid (*Onychoteuthis borealijaponicus*), 25 square tail (*Tetragonurus cuvieri*), five Atka mackerel (*Pleurogrammus monopterygius*), four longnose lancetfish (*Alepisaurus ferox*), four spiny dogfish (*Squalus acanthias*), and four salmon sharks were caught. Other non-salmonid fishes and squids included in the catch were two Pacific lamprey (*Entosphenus tridentatus*), two black rockfish (*Sebastes melanops*) and one neon flying squid.

Tissue samples from the salmon sharks, including vertebrae, muscle, gonads, and blood, were collected for investigation of reproductive biology. Samples were brought to researchers at the University of Washington, Seattle, for analysis.

*Trends in Mean Fish Size at Age*

Preliminary data on mean length (FL, mm) at age for salmon caught in research mesh gillnet (C-gear) were plotted for the period 1991 to 2005 for the central North Pacific Bering Sea to investigate trends in mean fish size. Size data for sockeye in the central North Pacific has been available from ocean age-1 and -2 fish regularly since 1998,which may indicate a shift in distribution of these ages of sockeye salmon to this area after 1997 (Fig. 4) In the Bering Sea, trends indicate that the size of ocean age -1 and -2 sockeye and ocean age -1 chum salmon have increased since 2001, while ocean age-3 sockeye and ocean age-3 and -4 chum salmon have decreased since 2003. The size of maturing coho salmon in the central North Pacific has generally decreased since 2001 (Fig. 5) and chinook salmon ocean age -1 and -2 were smaller in

2005 than last year in both areas. However, since 2003, ocean age-3 fish have increased in mean size (Fig. 6). In the central North Pacific, mean size of steelhead ocean age-2 and -3s have decreased since 2002.

*Coded-Wire Tags*

We found 25 fish (all steelhead) that were adipose-fin clipped (Table 3). After screening with a CWT detector, three snouts were determined to contain a CWT. The three snouts were retained and later sent to the Auke Bay Laboratory (U.S. National Marine Fisheries Service) for collection and reading of the coded-wire tags.

*Examination of Salmonid Stomach Contents*

During the cruise, a total of 775 samples of stomach contents was examined. This total included samples collected from 174 sockeye, 252 chum, 179 pink, 89 coho, and 31 chinook salmon, and 50 steelhead. Preliminary results showed that chum salmon had the lowest frequency of empty stomachs as compared with other salmon (Table 4). The proportion of empty stomachs of pink, coho, and chinook salmon was lower in the Bering Sea than the central North Pacific. The dominant prey categories varied by geographical area. Sockeye and pink salmon included more squid and fish and coho and chinook included more fish in their diets in the Bering Sea than in the central North Pacific. Chum salmon stomach contents had a high proportion of gelatinous zooplankton in both areas, however more euphausiids and less chaetognaths were found in samples obtained in the Bering Sea.

*Sample Collection of Salmon and their Prey for Stable Isotopic Analysis*

Muscle samples from 153 salmon were collected in the central North Pacific (34 sockeye, 45 chum, 36 pink, 35 coho, and 3 chinook salmon) and 28 samples of individual prey items were collected. In the Bering Sea, 148 muscle samples were collected (39 sockeye, 39 chum, 37 pink, 7 coho, and 26 chinook salmon) and 36 samples of prey items were collected. All samples were brought to University of Washington, Seattle, for later analysis.

*Stock Identification using Genetic Marker and Otolith Thermal Marking*

A total of 1,683 scale samples were collected in the central North Pacific and Bering Sea for genetic stock identification. This total includes scales collected from 888 sockeye, 771 chum, and 24 chinook salmon. A total of 755 pairs of sagittal otoliths were collected from chum salmon in the central North Pacific (n = 482) and Bering Sea (n = 273) to detect the presence of thermal marks.

*Sea lice sampling*

A total of 193 fish were examined for sea lice (Table 5). All sea lice were tentatively identified as *Lepeophtheirus salmonis*. Pink salmon were the most frequently sampled (n = 107), followed by chum (n = 40), coho (n = 25), sockeye (n = 13), and chinook salmon (n = 4), and steelhead trout (n = 4).

*Disk Tags*

A total of 383 salmonids were disk tagged during the survey. In the central North Pacific (St. 3-13), 146 disk tags were placed on fish, including 11 sockeye, 68 chum, 5 pink, 58 coho, and 1 chinook salmon, and 3 steelhead. In the Bering Sea (St. 14-27) a total of 237 disk tags were placed on salmon including 71 sockeye, 79 chum, 83 pink, and 4 chinook salmon.

*Data Storage Tags*

A total of 138 DSTs were placed on salmon during the survey (Table 6). This total included 20 geolocating tags (sockeye n = 14 and chum n = 6), 10 CTD tags (sockeye n = 5, chum n = 4,

and chinook n = 1), and seven ibutton tags (pink n = 3, coho n = 2, and chinook salmon n = 2). One hundred and one LTDs were placed on sockeye (n = 44), chum (n = 14), pink (n = 30), coho (n = 11), and chinook salmon (n = 2).

*Collection of Salmon in Unusual Condition*

To monitor the incidence of fish with unusual conditions, round samples or tissues were collected from fish that showed unusual characteristics. Ten salmon with black spots on their scales where frozen as round samples and other round samples included an unusually skinny fish and one with severe skin erosion, possibly resulting from a fungal infection. The testis from another salmon possibly containing a tumor was preserved in formalin for later histological analysis. All samples were provided to researchers at the National Salmon Conservation Center, Sapporo, for analysis.

*Other Sampling and Research*

Brain and pituitary samples were collected from a total of 36 chum salmon at 13 stations (St. 15 – 24, in the Bering Sea; Table 7). Olfactory epithelium, olfactory bulb, telencephalon, optic tectum, hypothalamus, cerebellum, and medulla oblongata were collected from 20 chum salmon at St. 15-19. Samples collected from 16 chum salmon at St. 20-24 were fixed in Zamboni solution and stored in 70% ethanol. Blood samples were collected from 36 chum salmon.

Thirty round samples each of sockeye, chum, pink, and coho salmon were collected from gillnet catches to investigate energy contents. A total of 398 gutted fish was collected from 99 chum and 49 pink salmon in the central North Pacific and from 200 chum and 50 pink salmon in the Bering Sea for lipid content analysis.

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**Table 1.** Research activities conducted at each station during the *Wakatake maru* cruise in 2005.

| NO | ST | Date | | | Latitude | | Longitude | | | XBT | XCTD | CTD | Neuston | Primary | NORPAC | ORI | Gillnets | Longline | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | T-1 | 2005 | 6 | 9 | 40 | 0 | 150 | 0 | E | ○ | | ○ | ○ | ○ | ○ | | | | |
| 2 | T-2 | 2005 | 6 | 9 | 40 | 0 | 151 | 0 | E | ○ | | | | | | | | | |
| 3 | T-3 | 2005 | 6 | 9 | 40 | 0 | 152 | 0 | E | ○ | | | | | | | | | |
| 4 | T-4 | 2005 | 6 | 10 | 40 | 0 | 153 | 0 | E | ○ | | | | | | | | | |
| 5 | T-5 | 2005 | 6 | 10 | 40 | 0 | 154 | 0 | E | ○ | | | | | | | | | |
| 6 | T-6 | 2005 | 6 | 10 | 40 | 0 | 155 | 0 | E | ○ | | ○ | ○ | ○ | ○ | | | | |
| 7 | T-7 | 2005 | 6 | 10 | 40 | 0 | 156 | 0 | E | ○ | | | | | | | | | |
| 8 | T-8 | 2005 | 6 | 10 | 40 | 0 | 157 | 0 | E | ○ | | | | | | | | | |
| 9 | T-9 | 2005 | 6 | 10 | 40 | 0 | 158 | 0 | E | ○ | | | | | | | | | |
| 10 | T-10 | 2005 | 6 | 11 | 40 | 0 | 159 | 0 | E | ○ | | | | | | | | | |
| 11 | T-11 | 2005 | 6 | 11 | 40 | 0 | 160 | 0 | E | ○ | | ○ | ○ | ○ | ○ | | | | |
| 12 | T-12 | 2005 | 6 | 11 | 40 | 0 | 161 | 0 | E | ○ | | | | | | | | | |
| 13 | T-13 | 2005 | 6 | 11 | 40 | 0 | 162 | 0 | E | ○ | | | | | | | | | |
| 14 | T-14 | 2005 | 6 | 11 | 40 | 0 | 163 | 0 | E | ○ | | | | | | | | | |
| 15 | T-15 | 2005 | 6 | 11 | 40 | 0 | 164 | 0 | E | ○ | | | | | | | | | |
| 16 | T-16 | 2005 | 6 | 11 | 40 | 0 | 165 | 0 | E | ○ | | ○ | ○ | ○ | | | | | |
| 17 | T-17 | 2005 | 6 | 12 | 40 | 0 | 166 | 0 | E | ○ | | | | | | | | | |
| 18 | T-18 | 2005 | 6 | 12 | 40 | 0 | 167 | 0 | E | ○ | | | | | | | | | |
| 19 | T-19 | 2005 | 6 | 12 | 40 | 0 | 168 | 0 | E | ○ | | | | | | | | | |
| 20 | T-20 | 2005 | 6 | 12 | 40 | 0 | 169 | 0 | E | ○ | | | | | | | | | |
| 21 | T-21 | 2005 | 6 | 12 | 40 | 0 | 170 | 0 | E | ○ | | ○ | ○ | ○ | | | | | |
| 22 | T-22 | 2005 | 6 | 12 | 40 | 0 | 171 | 0 | E | ○ | | | | | | | | | |
| 23 | T-23 | 2005 | 6 | 13 | 40 | 0 | 172 | 0 | E | ○ | | | | | | | | | |
| 24 | T-24 | 2005 | 6 | 13 | 40 | 0 | 173 | 0 | E | ○ | | | | | | | | | |
| 25 | T-25 | 2005 | 6 | 13 | 40 | 0 | 174 | 0 | E | ○ | | | | | | | | | |
| 26 | T-26 | 2005 | 6 | 13 | 40 | 0 | 175 | 0 | E | ○ | | ○ | ○ | ○ | | | | | |
| 27 | T-27 | 2005 | 6 | 13 | 40 | 0 | 176 | 0 | E | ○ | | | | | | | | | |
| 28 | T-28 | 2005 | 6 | 13 | 39 | 45 | 177 | 0 | E | ○ | | | | | | | | | |
| 29 | T-29 | 2005 | 6 | 14 | 39 | 30 | 178 | 0 | E | ○ | | | | | | | | | |
| 30 | T-30 | 2005 | 6 | 14 | 39 | 15 | 179 | 0 | E | ○ | | | | | | | | | |
| 31 | ST-1 | 2005 | 6 | 14 | 39 | 0 | 180 | 0 | | ○ | | ○ | ○ | ○ | | | | | |
| 32 | T-31 | 2005 | 6 | 14 | 39 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 33 | ST-2 | 2005 | 6 | 14 | 40 | 0 | 180 | 0 | | | | ○ | ○ | ○ | | | | | |
| 34 | T-32 | 2005 | 6 | 14 | 40 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 35 | ST-3 | 2005 | 6 | 15 | 41 | 0 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 36 | T-33 | 2005 | 6 | 16 | 41 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 37 | ST-4 | 2005 | 6 | 16 | 42 | 0 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 38 | T-34 | 2005 | 6 | 17 | 42 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 39 | ST-5 | 2005 | 6 | 17 | 43 | 0 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 40 | T-35 | 2005 | 6 | 18 | 43 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 41 | ST-6 | 2005 | 6 | 18 | 44 | 0 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 42 | T-36 | 2005 | 6 | 19 | 44 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 43 | ST-7 | 2005 | 6 | 19 | 45 | 0 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 44 | T-37 | 2005 | 6 | 20 | 45 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 45 | ST-8 | 2005 | 6 | 20 | 46 | 0 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 46 | T-38 | 2005 | 6 | 21 | 46 | 30 | 180 | 0 | | ○ | | | | | | | | | |
| 47 | ST-9 | 2005 | 6 | 21 | 47 | 0 | 180 | 0 | | | | ○ | ○ | ○ | | ○ | ○ | ○ | |
| 48 | ST-10 | 2005 | 6 | 22 | 47 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 49 | T-39 | 2005 | 6 | 23 | 48 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 50 | ST-11 | 2005 | 6 | 23 | 48 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | | ○ | |
| 51 | T-40 | 2005 | 6 | 24 | 49 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 52 | ST-12 | 2005 | 6 | 24 | 49 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | | ○ | |
| 53 | T-41 | 2005 | 6 | 25 | 50 | 0 | 180 | 0 | | ○ | | | | | | | | | |

**Table 1.** (continued)

| NO | ST | Date | | | Latitude | | Longitude | | | XBT | XCTD | CTD | Neuston | Primary | Norpac | ORI | Gillnets | Long line | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 54 | ST-13 | 2005 | 6 | 25 | 50 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | | ○ | |
| 55 | T-42 | 2005 | 6 | 26 | 51 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 56 | ST-14 | 2005 | 6 | 26 | 51 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | | ○ | |
| 57 | T-43 | 2005 | 6 | 27 | 52 | 0 | 179 | 40 | W | ○ | | | | | | | | | |
| 58 | ST-15 | 2005 | 6 | 27 | 52 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | | ○ | |
| 59 | T-44 | 2005 | 6 | 28 | 53 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 60 | ST-16 | 2005 | 6 | 28 | 53 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | | ○ | |
| 61 | T-45 | 2005 | 6 | 29 | 54 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 62 | ST-17 | 2005 | 6 | 29 | 54 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | | ○ | |
| 63 | T-46 | 2005 | 6 | 30 | 55 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 64 | ST-18 | 2005 | 6 | 30 | 55 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 65 | T-47 | 2005 | 7 | 1 | 56 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 66 | ST-19 | 2005 | 7 | 1 | 56 | 30 | 180 | 0 | | | | ○ | | ○ | ○ | ○ | ○ | ○ | Neuston net cancelled |
| 67 | T-48 | 2005 | 7 | 2 | 57 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 68 | ST-20 | 2005 | 7 | 2 | 57 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 69 | T-49 | 2005 | 7 | 3 | 58 | 0 | 180 | 0 | | ○ | | | | | | | | | |
| 70 | ST-21 | 2005 | 7 | 7 | 58 | 30 | 180 | 0 | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |
| 71 | ST-22 | 2005 | 7 | 8 | 57 | 30 | 179 | 0 | W | | | ○ | ○ | | ○ | ○ | ○ | ○ | |
| 73 | ST-23 | 2005 | 7 | 9 | 57 | 30 | 178 | 0 | W | | | ○ | ○ | | ○ | ○ | ○ | ○ | |
| 74 | ST-24 | 2005 | 7 | 10 | 56 | 30 | 178 | 0 | W | | | ○ | ○ | | ○ | ○ | ○ | ○ | |
| 75 | ST-25 | 2005 | 7 | 11 | 56 | 30 | 179 | 0 | W | | | ○ | ○ | | ○ | ○ | ○ | ○ | |
| 76 | ST-26 | 2005 | 7 | 12 | 56 | 30 | 179 | 0 | E | | | ○ | ○ | | ○ | ○ | ○ | ○ | |
| 77 | ST-27 | 2005 | 7 | 13 | 56 | 30 | 178 | 0 | E | | | ○ | ○ | | ○ | ○ | ○ | ○ | |
| 78 | T-50 | 2005 | 7 | 14 | 56 | 0 | 176 | 0 | E | | ○ | | | | | | | | |
| 79 | T-51 | 2005 | 7 | 14 | 55 | 30 | 175 | 0 | E | | ○ | ○ | ○ | ○ | | | | | |
| 80 | T-52 | 2005 | 7 | 14 | 55 | 0 | 174 | 0 | E | | ○ | | | | | | | | |
| 81 | T-53 | 2005 | 7 | 14 | 54 | 30 | 173 | 0 | E | | ○ | | | | | | | | |
| 82 | T-54 | 2005 | 7 | 15 | 54 | 0 | 172 | 0 | E | | ○ | | | | | | | | |
| 83 | T-55 | 2005 | 7 | 15 | 53 | 30 | 171 | 0 | E | | ○ | | | | | | | | |
| 84 | T-56 | 2005 | 7 | 15 | 53 | 0 | 170 | 0 | E | | ○ | ○ | ○ | ○ | | | | | |
| 85 | T-57 | 2005 | 7 | 15 | 52 | 20 | 169 | 0 | E | | ○ | | | | | | | | |
| 86 | T-58 | 2005 | 7 | 15 | 51 | 40 | 168 | 0 | E | | ○ | | | | | | | | |
| 87 | T-59 | 2005 | 7 | 15 | 51 | 10 | 167 | 0 | E | | ○ | | | | | | | | |
| 88 | T-60 | 2005 | 7 | 16 | 50 | 40 | 166 | 0 | E | | ○ | | | | | | | | |
| 89 | T-61 | 2005 | 7 | 16 | 50 | 0 | 165 | 0 | E | | ○ | ○ | ○ | ○ | | | | | |
| 90 | T-62 | 2005 | 7 | 16 | 49 | 20 | 164 | 0 | E | | ○ | | | | | | | | |
| 91 | T-63 | 2005 | 7 | 16 | 48 | 40 | 163 | 0 | E | | ○ | | | | | | | | |
| 92 | T-64 | 2005 | 7 | 16 | 48 | 0 | 162 | 0 | E | | ○ | | | | | | | | |
| 93 | T-65 | 2005 | 7 | 16 | 47 | 30 | 161 | 0 | E | | ○ | | | | | | | | |
| 94 | T-66 | 2005 | 7 | 17 | 46 | 50 | 160 | 0 | E | | ○ | ○ | ○ | ○ | ○ | | | | |
| 95 | T-67 | 2005 | 7 | 17 | 46 | 10 | 159 | 0 | E | | ○ | | | | | | | | |
| 96 | T-68 | 2005 | 7 | 17 | 45 | 30 | 158 | 0 | E | | ○ | | | | | | | | |
| 97 | T-69 | 2005 | 7 | 17 | 44 | 50 | 157 | 0 | E | | ○ | | | | | | | | |
| 98 | T-70 | 2005 | 7 | 17 | 44 | 10 | 156 | 0 | E | | ○ | | | | | | | | |
| 99 | T-71 | 2005 | 7 | 18 | 43 | 30 | 155 | 0 | E | | ○ | ○ | ○ | ○ | ○ | | | | |
| 100 | T-72 | 2005 | 7 | 18 | 42 | 50 | 154 | 0 | E | | ○ | | | | | | | | |
| 101 | T-73 | 2005 | 7 | 18 | 42 | 10 | 153 | 0 | E | | ○ | | | | | | | | |
| 102 | T-74 | 2005 | 7 | 18 | 41 | 20 | 152 | 0 | E | | ○ | | | | | | | | |
| 103 | T-75 | 2005 | 7 | 19 | 40 | 40 | 151 | 0 | E | | ○ | | | | | | | | |
| 104 | T-76 | 2005 | 7 | 19 | 40 | 0 | 150 | 0 | E | | ○ | ○ | ○ | | ○ | | | | |

**Table 2.** Salmonids, other fishes, and squid catches at each station with sea surface temperature (SST, °C) during the summer research cruise of *Wakatake maru*, 2005. B-gear, surface longline; C-gear, salmon research gillnet (mesh sizes = 48, 55, 63, 72, 82, 93, 106, 121, 138 and 157 mm); A-gear, commercial gillnet (mesh size = 115 mm). The number of fish tagged with disk tags and released is listed for each station.

| St | Date | Lat | Long | SST | Gear | No. unit | Sockeye | Chum | Pink | Coho | Chinook | Steel | Salmonid total | Eight-armed squid | Hook-armed squid | Salmon shark | Spiny dogfish | Lancet fish | Pacific pomfret | Atka mackerel | Square tail | Other fishes & squids | Seabirds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 20050615 | 4100N | 18000 | 10.6 | B | 30 | 0 | 2 | 0 | 4 | 0 | 0 | 6 | 0 | 1 | 0 | 0 | 1 | 82 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 0 | 15 | 0 | 6 | 0 | 1 | 22 | 1 | 8 | 0 | 0 | 0 | 92 | 0 | 20 | 0 | 1 |
| | | | | | A | 19 | 0 | 0 | 0 | 14 | 0 | 1 | 15 | 0 | 0 | 0 | 0 | 0 | 80 | 0 | 0 | 1 | 0 |
| | | | | | Total | | 0 | 17 | 0 | 24 | 0 | 2 | 43 | 1 | 9 | 0 | 0 | 1 | 254 | 0 | 20 | 1 | 1 |
| | | | | | Releases | | 0 | 1 | 0 | 3 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 20050616 | 4200N | 18000 | 10.5 | B | 30 | 0 | 2 | 0 | 52 | 0 | 1 | 55 | 0 | 0 | 0 | 0 | 0 | 77 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 0 | 16 | 0 | 44 | 0 | 3 | 63 | 12 | 21 | 1 | 0 | 0 | 31 | 0 | 3 | 0 | 0 |
| | | | | | A | 19 | 0 | 2 | 0 | 58 | 0 | 6 | 66 | 0 | 0 | 0 | 2 | 0 | 15 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 0 | 20 | 0 | 154 | 0 | 10 | 184 | 12 | 21 | 1 | 2 | 0 | 123 | 0 | 3 | 0 | 0 |
| | | | | | Releases | | 0 | 2 | 0 | 39 | 0 | 1 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 20050617 | 4300N | 18000 | 8.3 | B | 30 | 0 | 3 | 0 | 9 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 0 | 31 | 2 | 21 | 0 | 1 | 55 | 18 | 11 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| | | | | | A | 19 | 0 | 18 | 1 | 30 | 0 | 7 | 56 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 0 | 52 | 3 | 60 | 0 | 8 | 123 | 18 | 11 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 |
| | | | | | Releases | | 0 | 3 | 0 | 5 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 20050618 | 4400N | 18000 | 7.2 | B | 30 | 0 | 0 | 0 | 5 | 0 | 2 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 0 | 12 | 2 | 31 | 0 | 2 | 47 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | A | 19 | 0 | 4 | 2 | 19 | 1 | 3 | 29 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 0 | 16 | 4 | 55 | 1 | 7 | 83 | 6 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 0 | 0 | 0 | 3 | 0 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 20050619 | 4500N | 18000 | 7.3 | B | 30 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 52 | 10 | 5 | 4 | 0 | 1 | 72 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | A | 19 | 0 | 1 | 2 | 4 | 0 | 1 | 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 52 | 11 | 7 | 12 | 0 | 2 | 84 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | | | | | Releases | | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 20050620 | 4600N | 18000 | 6.2 | B | 30 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 152 | 25 | 10 | 4 | 1 | 7 | 199 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | A | 19 | 2 | 9 | 7 | 3 | 1 | 8 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 154 | 34 | 17 | 8 | 2 | 15 | 230 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 2. (continued)

| St | Date | Lat | Long | SST | Gear | No. unit | Sockeye | Chum | Pink | Coho | Chinook | Steel | Salmonid total | Eight-armed squid | Hook-armed squid | Salmon shark | Spiny dogfish | Lancet fish | Pacific pomfret | Atka mackerel | Squaretail | Other fishes & squids | Seabirds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 20050621 | 4700N | 18000 | 6.1 | B | 30 | 0 | 3 | 2 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 91 | 96 | 64 | 0 | 0 | 5 | 256 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | A | 19 | 1 | 22 | 27 | 1 | 0 | 9 | 60 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 92 | 121 | 93 | 1 | 0 | 15 | 322 | 54 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 0 | 3 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 20050622 | 4730N | 18000 | 6.7 | B | 30 | 0 | 8 | 1 | 1 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 59 | 86 | 46 | 0 | 2 | 0 | 193 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | A | 19 | 0 | 13 | 17 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 59 | 107 | 64 | 1 | 2 | 0 | 233 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 0 | 7 | 1 | 1 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 20050623 | 4830N | 18000 | 6.3 | B | 30 | 2 | 33 | 0 | 1 | 0 | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 2 | 30 | 0 | 1 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 20050624 | 4930N | 18000 | 6.7 | B | 30 | 3 | 15 | 2 | 1 | 1 | 0 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 3 | 13 | 1 | 1 | 1 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 20050625 | 5030N | 18000 | 7.8 | B | 30 | 7 | 13 | 3 | 1 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 6 | 9 | 2 | 1 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 20050626 | 5130N | 18000 | 5.9 | B | 30 | 3 | 2 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 20050627 | 5230N | 18000 | 5.6 | B | 30 | 1 | 4 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Releases | | 1 | 2 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 20050628 | 5330N | 18000 | 7.8 | B | 30 | 4 | 25 | 5 | 0 | 0 | 0 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | | | | | Releases | | 3 | 18 | 5 | 0 | 0 | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 20050629 | 5430N | 18000 | 7.0 | B | 30 | 0 | 23 | 16 | 0 | 0 | 0 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | | | | | Releases | | 0 | 17 | 10 | 0 | 0 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 20050630 | 5530N | 18000 | 7.2 | B | 30 | 6 | 18 | 10 | 0 | 0 | 0 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 36 | 12 | 438 | 0 | 0 | 0 | 486 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| | | | | | A | 19 | 16 | 22 | 400 | 1 | 0 | 0 | 439 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | | | | Total | | 58 | 52 | 848 | 1 | 0 | 0 | 959 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 |
| | | | | | Releases | | 6 | 12 | 7 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 2. (continued)

| St | Date | Lat | Long | SST | Gear | No. unit | Sockeye | Chum | Pink | Coho | Chinook | Steel | Salmonid total | Eight-armed squid | Hook-armed squid | Salmon shark | Spiny dogfish | Lancet fish | Pacific pomfret | Atka mackerel | Squaretail | Other fishes & squids | Seabirds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | 20050701 | 5630N | 18000 | 7.5 | B | 30 | 3 | 21 | 16 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 32 | 82 | 351 | 1 | 2 | 0 | 468 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | | | | A | 19 | 34 | 67 | 323 | 0 | 0 | 0 | 424 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 69 | 170 | 690 | 1 | 2 | 0 | 932 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | | | | Releases | | 3 | 14 | 9 | 0 | 0 | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 20050702 | 5730N | 18000 | 7.3 | B | 30 | 4 | 3 | 8 | 0 | 1 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 39 | 21 | 241 | 0 | 0 | 0 | 301 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| | | | | | A | 19 | 26 | 19 | 330 | 0 | 0 | 0 | 375 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | | | | | Total | | 69 | 43 | 579 | 0 | 1 | 0 | 692 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 |
| | | | | | Releases | | 4 | 0 | 5 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 20050707 | 5830N | 18000 | 8.0 | B | 30 | 10 | 1 | 30 | 0 | 2 | 0 | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 125 | 19 | 299 | 2 | 2 | 0 | 447 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | A | 19 | 50 | 15 | 189 | 0 | 1 | 0 | 255 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 185 | 35 | 518 | 2 | 5 | 0 | 745 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | Releases | | 9 | 0 | 23 | 0 | 1 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 20050708 | 5730N | 17900W | 8.6 | B | 30 | 2 | 6 | 1 | 0 | 2 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 93 | 12 | 239 | 1 | 5 | 0 | 350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | | | | A | 19 | 42 | 16 | 204 | 0 | 3 | 0 | 265 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | Total | | 137 | 34 | 444 | 1 | 10 | 0 | 626 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | | | | | Releases | | 2 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 20050709 | 5730N | 17800W | 8.4 | B | 30 | 18 | 5 | 28 | 0 | 1 | 0 | 52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | | | | | C | 30 | 121 | 14 | 96 | 0 | 0 | 0 | 231 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | | | | A | 19 | 53 | 12 | 74 | 0 | 1 | 0 | 140 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | | | | Total | | 192 | 31 | 198 | 0 | 2 | 0 | 423 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 |
| | | | | | Releases | | 18 | 0 | 18 | 0 | 1 | 0 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 20050710 | 5630N | 17800W | 8.1 | B | 30 | 16 | 10 | 5 | 0 | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | C | 30 | 109 | 27 | 65 | 0 | 0 | 0 | 201 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 |
| | | | | | A | 19 | 72 | 7 | 61 | 0 | 0 | 0 | 140 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| | | | | | Total | | 197 | 44 | 131 | 0 | 0 | 0 | 372 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 9 |
| | | | | | Releases | | 16 | 4 | 1 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 2. (continued)

| St | Date | Lat | Long | SST | Gear | No. unit | Sockeye | Chum | Pink | Coho | Chinook | Steel | Salmonid total | Eight-armed squid | Hook-armed squid | Salmon shark | Spiny dogfish | Lancet fish | Pacific pomfret | Atka mackerel | Squaretail | Other fishes & squids | Seabirds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 20050711 | 5630N | 17900W | 7.8 | B | 30 | 1 | 7 | 4 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 101 | 40 | 71 | 0 | 3 | 0 | 215 | 13 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| | | | | | A | 19 | 56 | 46 | 70 | 0 | 2 | 0 | 174 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | Total | | 158 | 93 | 145 | 0 | 5 | 0 | 401 | 13 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| | | | | | Releases | | 1 | 3 | 3 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 20050712 | 5630N | 17900E | 7.9 | B | 30 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 80 | 150 | 92 | 1 | 4 | 0 | 327 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | | | | | A | 19 | 40 | 37 | 90 | 1 | 0 | 0 | 168 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | | | | | Total | | 122 | 187 | 182 | 2 | 4 | 0 | 497 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| | | | | | Releases | | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 20050713 | 5630N | 17800E | 8.5 | B | 30 | 4 | 8 | 1 | 1 | 1 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | C | 30 | 146 | 119 | 67 | 1 | 1 | 0 | 334 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | A | 19 | 63 | 20 | 57 | 1 | 0 | 0 | 141 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | Total | | 213 | 147 | 125 | 3 | 2 | 0 | 490 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | | Releases | | 4 | 7 | 1 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | | | | B | 750 | 86 | 212 | 134 | 80 | 8 | 4 | 524 | 0 | 1 | 0 | 0 | 3 | 159 | 2 | 0 | 1 | 1 |
| | | | | | C | 480 | 1236 | 787 | 2088 | 116 | 20 | 20 | 4267 | 138 | 40 | 3 | 0 | 0 | 123 | 3 | 25 | 1 | 31 |
| | | | | | A | 304 | 455 | 330 | 1854 | 132 | 9 | 35 | 2815 | 0 | 0 | 1 | 4 | 1 | 95 | 0 | 0 | 3 | 20 |
| | | | | | Total | | 1777 | 1329 | 4076 | 328 | 37 | 59 | 7606 | 138 | 41 | 4 | 4 | 4 | 377 | 5 | 25 | 5 | 52 |
| | | | | | Releases | | 82 | 147 | 88 | 58 | 5 | 3 | 383 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 3. Salmonids missing the adipose fin in the catch of the *Wakatake maru*, summer, 2005. Samples indicated with an asterisk (n = 3) showed a positive response for a CWT from the CWT-detector wand and were sent to NMFS (Auke Bay) for recovery of the tag. Gear: A = commercial-mesh gillnet; C = research-mesh gillnet followed by mesh size (mm); and B = surface longline. – no data.

| | Location | | | | Fork length | Body weight | | Gonad weight | | Sample |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Lat. | Long. | Gear | Species | (mm) | (g) | Sex | (g) | Age | number |
| 6/16/05 | 41°00N | 180°00' | C121 | steelhead | 588 | 2210 | M | 7 | 1.1 | 5-6 |
| 6/16/05 | 41°00'N | 180°00' | A115 | steelhead | 676 | 3620 | F | 18.5 | 1.3 | 6-15 |
| 6/17/05 | 42°00'N | 180°00' | C138 | steelhead | 673 | 3530 | M | 3 | 1.2 | 10-1* |
| 6/17/05 | 42°00'N | 180°00' | C93 | steelhead | 520 | 1780 | F | 6 | 1.1 | 14-18* |
| 6/17/05 | 42°00'N | 180°00' | C82 | steelhead | 482 | 1150 | M | 3 | 1.1 | 15-18 |
| 6/17/05 | 42°00'N | 180°00' | A115 | steelhead | 578 | 2160 | F | 7 | 1.1 | 16-2 |
| 6/17/05 | 42°00'N | 180°00' | A115 | steelhead | 558 | 2000 | M | 2 | 1.1 | 16-6 |
| 6/17/05 | 42°00'N | 180°00' | A115 | steelhead | 566 | 1950 | M | 3 | 1.1 | 16-7* |
| 6/18/05 | 43°00'N | 180°00' | A115 | steelhead | 554 | 1740 | M | 3 | 1.1 | 27-21 |
| 6/18/05 | 43°00'N | 180°00' | A115 | steelhead | 571 | 1890 | - | - | 1.1 | 27-22 |
| 6/18/05 | 43°00'N | 180°00' | A115 | steelhead | 547 | 1940 | M | 2 | 1.1 | 27-23 |
| 6/18/05 | 43°00'N | 180°00' | A115 | steelhead | 540 | 1740 | M | 3 | 1.1 | 27-24 |
| 6/19/05 | 44°00'N | 180°00' | A115 | steelhead | 568 | 1680 | F | 22 | 1.1 | 29-27 |
| 6/19/05 | 44°00'N | 180°00' | A115 | steelhead | 543 | 1420 | M | 1 | 1.1 | 29-28 |
| 6/19/05 | 44°00'N | 180°00' | C93 | steelhead | 538 | 1630 | M | 1 | 1.1 | 38-13 |
| 6/21/05 | 46°00'N | 180°00' | C93 | steelhead | 861 | 5270 | M | 2 | 1.2 | 49-25 |
| 6/21/05 | 46°00'N | 180°00' | C121 | steelhead | 738 | 3530 | - | - | 1.2 | 56-3 |
| 6/21/05 | 46°00'N | 180°00' | A115 | steelhead | 446 | 1590 | F | 14 | 1.1 | 62-22 |
| 6/21/05 | 46°00'N | 180°00' | A115 | steelhead | 650 | 2810 | F | 22 | 1.2 | 62-23 |
| 6/21/05 | 46°00'N | 180°00' | A115 | steelhead | 661 | 2630 | F | 19 | 1.2 | 62-24 |
| 6/21/05 | 47°00'N | 180°00' | B | steelhead | 648 | 2550 | F | 17 | X.2 | 63-2 |
| 6/22/05 | 47°00'N | 180°00' | A115 | steelhead | 746 | 3800 | M | 9 | 1.3 | 64-18 |
| 6/22/05 | 47°00'N | 180°00' | A115 | steelhead | 662 | 2930 | M | 13 | 3.2 | 64-19 |
| 6/22/05 | 47°00'N | 180°00' | A115 | steelhead | 735 | 3800 | F | 15 | 1.2 | 64-20 |
| 6/22/05 | 47°00'N | 180°00' | C93 | steelhead | 554 | 1620 | M | 13 | 1.1 | 73-15 |

Table 4. Mean percent prey composition of stomach contents (by volume) of salmonids sampled during the cruise of the *Wakatake maru*, summer 2005. Prey composition based on visual estimates. CNP = central North Pacific (Stations 3-13), ALEUT = Aleutian Is. (Station 14), BS = Bering Sea (Stations 15-27). Percent empty = percent of stomachs that did contain stomach contents. Empty stomachs were not included in other table entries. PW = prey weight, SCI = PW * 100 / body weight, SD = standard deviation. Prey categories are EU = euphausiids, CO = copepods, AM = amphipods, CR = crab larvae, SQ = squids, PT = pteropods, FI = fish, PO = polychaetes, CH = chaetognaths, GE = gelatinous zooplankton (coelenterates, ctenophores, and salps), OTH = other groups, and UN = unidentified material.

| Area | Species | N | % empty | Mean PW | SD PW | Mean SCI | SD SCI | EU | CO | AM | CR | SQ | PT | FI | PO | CH | GE | OTH | UN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CNP | Sockeye | 61 | 30 | 3 | 2 | 0.42 | 0.37 | 15 | 24 | 20 | 0 | 6 | 2 | 2 | 0 | 19 | 0 | 12 | 0 |
| | Chum | 97 | 1 | 8 | 6 | 0.79 | 0.48 | 7 | 2 | 3 | 0 | 0 | 5 | 2 | 5 | 13 | 38 | 24 | 1 |
| | Pink | 56 | 20 | 10 | 11 | 0.76 | 0.81 | 30 | 15 | 11 | 0 | 11 | 13 | 11 | 0 | 1 | 0 | 6 | 2 |
| | Coho | 80 | 30 | 28 | 32 | 1.46 | 1.69 | 2 | 0 | 2 | 0 | 78 | 11 | 5 | 0 | 0 | 0 | 2 | 0 |
| | Chinook | 5 | 40 | 112 | 113 | 1.79 | 1.58 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Steelhead | 50 | 6 | 39 | 44 | 1.43 | 1.43 | 3 | 0 | 1 | 0 | 32 | 1 | 47 | 15 | 0 | 0 | 1 | 0 |
| ALEUT | Sockeye | 1 | 0 | 8 | - | 0.21 | - | 0 | 2 | 3 | 0 | 0 | 5 | 0 | 30 | 30 | 30 | 0 | 0 |
| | Chum | 0 | | | | | | | | | | | | | | | | | |
| | Pink | 1 | 0 | 2 | - | 0.14 | - | 0 | 66 | 10 | 11 | 5 | 5 | 3 | 0 | 0 | 0 | 0 | 0 |
| | Coho | 0 | | | | | | | | | | | | | | | | | |
| | Chinook | 0 | | | | | | | | | | | | | | | | | |
| | Steelhead | 0 | | | | | | | | | | | | | | | | | |
| BS | Sockeye | 112 | 29 | 5 | 7 | 0.45 | 0.51 | 13 | 5 | 13 | 0 | 35 | 6 | 21 | 1 | 1 | 0 | 5 | 0 |
| | Chum | 152 | 4 | 16 | 14 | 0.86 | 0.57 | 20 | 1 | 1 | 0 | 5 | 14 | 4 | 2 | 0 | 50 | 3 | 0 |
| | Pink | 124 | 13 | 14 | 16 | 0.98 | 1.21 | 18 | 2 | 7 | 0 | 42 | 4 | 25 | 0 | 0 | 0 | 2 | 0 |
| | Coho | 10 | 10 | 36 | 24 | 1.30 | 0.75 | 11 | 0 | 0 | 0 | 35 | 0 | 54 | 0 | 0 | 0 | 0 | 0 |
| | Chinook | 27 | 30 | 13 | 15 | 0.49 | 0.51 | 3 | 0 | 0 | 0 | 78 | 0 | 19 | 0 | 0 | 0 | 0 | 0 |
| | Steelhead | 0 | | | | | | | | | | | | | | | | | |

Table 5. Number of salmon examined for sea lice by gear type.

| Species | Gear | Number of fish examined |
|---|---|---|
| Sockeye | Longline | 4 |
| | Gillnet | 9 |
| Chum | Longline | 29 |
| | Gillnet | 11 |
| Pink | Longline | 45 |
| | Gillnet | 62 |
| Coho | Longline | 19 |
| | Gillnet | 6 |
| Chinook | Longline | 3 |
| | Gillnet | 1 |
| Steelhead | Longline | 1 |
| | Gillnet | 3 |
| Total | Longline | 101 |
| | Gillnet | 92 |
| Grand Total | | 193 |

Table 6. Archival data storage tags placed on salmonids in the North Pacific Ocean and Bering Sea by researchers onboard the *Wakatake maru* in 2005. Geo tags record geographical position, temperature and depth data (Lotek LTD_2400); LTD tags record temperature and depth data (LTD_100-500); CTD tags record salinity, temperature, and depth (StarOddi DST CTD); and iBK tags record temperature only (AlphaMach iButtonKrill). FAJ = Fisheries Agency of Japan.

| Data tag # | Tag model | Species | Release date | Release latitude | Release longitude | Fork length (mm) | Age | US Disk | FAJ Disk |
|---|---|---|---|---|---|---|---|---|---|
| 8114 | LTD | coho | 06/16/05 | 42°00´N | 180°00´ | 538 | 1.1 | LL8105 | MM3005 |
| 8115 | LTD | coho | 06/16/05 | 42°00´N | 180°00´ | 570 | X.1 | LL8106 | MM3006 |
| 8116 | LTD | coho | 06/16/05 | 42°00´N | 180°00´ | 482 | 1.1 | LL8107 | MM3007 |
| 9414 | LTD | coho | 06/16/05 | 42°00´N | 180°00´ | 546 | 2.1 | LL8108 | MM3008 |
| 9415 | LTD | coho | 06/16/05 | 42°00´N | 180°00´ | 556 | 2.1 | LL8109 | MM3009 |
| 9417 | LTD | coho | 06/17/05 | 43°00´N | 180°00´ | 522 | 1.1 | LL8149 | MM3049 |
| 9418 | LTD | coho | 06/17/05 | 43°00´N | 180°00´ | 536 | 2.1 | LL8150 | MM3050 |
| 9420 | LTD | coho | 06/17/05 | 43°00´N | 180°00´ | 502 | X.1 | LL8154 | MM3054 |
| 9421 | LTD | coho | 06/18/05 | 44°00´N | 180°00´ | 492 | 2.1 | LL8158 | MM3058 |
| K112 | iBK | pink | 06/21/05 | 47°00´N | 180°00´ | 520 | 0.1 | LL8166 | MM3066 |
| 9422 | LTD | coho | 06/22/05 | 47°30´N | 180°00´ | 585 | 2.1 | LL8175 | MM3075 |
| 9423 | LTD | chum | 06/23/05 | 48°30´N | 180°00´ | 544 | 0.3 | LL8177 | MM3077 |
| 9424 | LTD | chum | 06/23/05 | 48°30´N | 180°00´ | 608 | 0.5 | LL8178 | MM3078 |
| 9425 | LTD | chum | 06/23/05 | 48°30´N | 180°00´ | 593 | 0.3 | LL8179 | MM3079 |
| 9426 | LTD | chum | 06/23/05 | 48°30´N | 180°00´ | 540 | 0.3 | LL8180 | MM3080 |
| 9427 | LTD | coho | 06/23/05 | 48°30´N | 180°00´ | 568 | 2.1 | LL8204 | MM3104 |
| 9428 | LTD | sockeye | 06/23/05 | 48°30´N | 180°00´ | 450 | 1.2 | LL8205 | MM3105 |
| 1898 | CTD | chinook | 06/24/05 | 49°30´N | 180°00´ | 645 | X.2 | LL8211 | MM3111 |
| 9429 | LTD | sockeye | 06/24/05 | 49°30´N | 180°00´ | 605 | 2.2 | LL8212 | MM3112 |
| 9430 | LTD | sockeye | 06/24/05 | 49°30´N | 180°00´ | 625 | 1.4 | LL8213 | MM3113 |
| 9431 | LTD | sockeye | 06/24/05 | 49°30´N | 180°00´ | 525 | 1.2 | LL8219 | MM3119 |
| K113 | iBK | coho | 06/24/05 | 49°30´N | 180°00´ | 553 | 2.1 | LL8227 | MM3127 |
| 9432 | LTD | chum | 06/24/05 | 49°30´N | 180°00´ | 570 | 0.3 | LL8228 | MM3128 |
| K114 | iBK | pink | 06/25/05 | 50°30´N | 180°00´ | 476 | 0.1 | LL8229 | MM3129 |
| 9433 | LTD | chum | 06/25/05 | 50°30´N | 180°00´ | 574 | 0.3 | LL8230 | MM3130 |
| 1900 | CTD | sockeye | 06/25/05 | 50°30´N | 180°00´ | 654 | 1.3 | LL8238 | MM3138 |
| 1902 | CTD | sockeye | 06/25/05 | 50°30´N | 180°00´ | 576 | 2.3 | LL8239 | MM3139 |
| A13245 | Geo | sockeye | 06/25/05 | 50°30´N | 180°00´ | 610 | 2.3 | LL8240 | MM3140 |
| K117 | iBK | coho | 06/25/05 | 50°30´N | 180°00´ | 540 | 2.1 | LL8241 | MM3141 |
| 9434 | LTD | sockeye | 06/25/05 | 50°30´N | 180°00´ | 600 | 1.3 | LL8242 | MM3142 |
| 9435 | LTD | sockeye | 06/25/05 | 50°30´N | 180°00´ | 610 | 1.3 | LL8243 | MM3143 |
| A13250 | Geo | sockeye | 06/25/05 | 50°30´N | 180°00´ | 545 | 2.2 | LL8246 | MM3146 |
| 9436 | LTD | sockeye | 06/26/05 | 51°30´N | 180°00´ | 512 | 2.2 | LL8249 | MM3149 |
| 9437 | LTD | chum | 06/26/05 | 51°30´N | 180°00´ | 636 | X.5 | LL8250 | MM3150 |
| K116 | iBK | pink | 06/27/05 | 52°30´N | 180°00´ | 430 | 0.1 | LL8251 | MM3151 |
| 9438 | LTD | pink | 06/28/05 | 53°30´N | 180°00´ | 454 | 0.1 | LL8255 | MM3155 |
| 9439 | LTD | pink | 06/28/05 | 53°30´N | 180°00´ | 466 | 0.1 | LL8256 | MM3156 |
| A13243 | Geo | sockeye | 06/28/05 | 53°30´N | 180°00´ | 456 | 2.2 | LL8257 | MM3157 |
| 9440 | LTD | pink | 06/28/05 | 53°30´N | 180°00´ | 485 | 0.1 | LL8268 | MM3168 |
| 9441 | LTD | pink | 06/28/05 | 53°30´N | 180°00´ | 441 | 0.1 | LL8269 | MM3169 |
| 9442 | LTD | chum | 06/28/05 | 53°30´N | 180°00´ | 578 | 0.3 | LL8270 | MM3170 |
| 2002 | CTD | chum | 06/28/05 | 53°30´N | 180°00´ | 619 | 0.4 | LL8271 | MM3171 |
| 9443 | LTD | chum | 06/28/05 | 53°30´N | 180°00´ | 610 | 0.3 | LL8272 | MM3172 |

Table 6. (continued)

| Data tag # | Tag model | Species | Release date | Release latitude | Release longitude | Fork length (mm) | Age | US Disk | FAJ Disk |
|---|---|---|---|---|---|---|---|---|---|
| 9444 | LTD | chum | 06/28/05 | 53°30´N | 180°00´ | 560 | 0.3 | LL8273 | MM3173 |
| 9445 | LTD | pink | 06/29/05 | 54°30´N | 180°00´ | 504 | 0.1 | LL8286 | MM3186 |
| 9446 | LTD | pink | 06/29/05 | 54°30´N | 180°00´ | 440 | 0.1 | LL8287 | MM3187 |
| 9447 | LTD | pink | 06/29/05 | 54°30´N | 180°00´ | 462 | 0.1 | LL8307 | MM3207 |
| A13257 | Geo | chum | 06/29/05 | 54°30´N | 180°00´ | 589 | 0.4 | LL8308 | MM3208 |
| A13244 | Geo | sockeye | 06/30/05 | 55°30´N | 180°00´ | 486 | 2.2 | LL8309 | MM3209 |
| 9448 | LTD | chum | 06/30/05 | 55°30´N | 180°00´ | 565 | 0.3 | LL8314 | MM3214 |
| A13249 | Geo | sockeye | 06/30/05 | 55°30´N | 180°00´ | 541 | 2.2 | LL8315 | MM3215 |
| 9449 | LTD | pink | 06/30/05 | 55°30´N | 180°00´ | 493 | 0.1 | LL8316 | MM3216 |
| 9450 | LTD | pink | 06/30/05 | 55°30´N | 180°00´ | 463 | 0.1 | LL8317 | MM3217 |
| 9451 | LTD | sockeye | 06/30/05 | 55°30´N | 180°00´ | 516 | 1.2 | LL8318 | MM3218 |
| 9452 | LTD | pink | 06/30/05 | 55°30´N | 180°00´ | 500 | 0.1 | LL8319 | MM3219 |
| 9453 | LTD | pink | 06/30/05 | 55°30´N | 180°00´ | 543 | 0.1 | LL8320 | MM3220 |
| 9454 | LTD | pink | 06/30/05 | 55°30´N | 180°00´ | 503 | 0.1 | LL8321 | MM3221 |
| 1903 | CTD | sockeye | 06/30/05 | 55°30´N | 180°00´ | 570 | 1.3 | LL8322 | MM3222 |
| 1916 | CTD | sockeye | 06/30/05 | 55°30´N | 180°00´ | 517 | 1.3 | LL8323 | MM3223 |
| 9455 | LTD | pink | 06/30/05 | 55°30´N | 180°00´ | 504 | 0.1 | LL8324 | MM3224 |
| 9456 | LTD | pink | 07/01/05 | 56°30´N | 180°00´ | 410 | 0.1 | LL8334 | MM3234 |
| 9458 | LTD | pink | 07/01/05 | 56°30´N | 180°00´ | 489 | 0.1 | LL8335 | MM3235 |
| 9459 | LTD | chum | 07/01/05 | 56°30´N | 180°00´ | 690 | 0.4 | LL8337 | MM3237 |
| A13251 | Geo | sockeye | 07/01/05 | 56°30´N | 180°00´ | 660 | 2.3 | LL8343 | MM3243 |
| A13252 | Geo | sockeye | 07/01/05 | 56°30´N | 180°00´ | 617 | 2.3 | LL8344 | MM3244 |
| 9460 | LTD | chum | 07/01/05 | 56°30´N | 180°00´ | 588 | 0.3 | LL8350 | MM3250 |
| A13253 | Geo | sockeye | 07/01/05 | 56°30´N | 180°00´ | 579 | 2.2 | LL8351 | MM3251 |
| 9461 | LTD | chum | 07/01/05 | 56°30´N | 180°00´ | 578 | 0.3 | LL8354 | MM3254 |
| A13259 | Geo | chum | 07/01/05 | 56°30´N | 180°00´ | 598 | 0.3 | LL8355 | MM3255 |
| 2006 | CTD | chum | 07/01/05 | 56°30´N | 180°00´ | 555 | 0.4 | LL8360 | MM3260 |
| 9462 | LTD | pink | 07/02/05 | 57°30´N | 180°00´ | 453 | 0.1 | LL8362 | MM3262 |
| 9463 | LTD | pink | 07/02/05 | 57°30´N | 180°00´ | 426 | 0.1 | LL8363 | MM3263 |
| A13254 | Geo | sockeye | 07/02/05 | 57°30´N | 180°00´ | 578 | 1.3 | LL8366 | MM3266 |
| A13255 | Geo | sockeye | 07/02/05 | 57°30´N | 180°00´ | 650 | X.X | LL8367 | MM3267 |
| 9464 | LTD | sockeye | 07/02/05 | 57°30´N | 180°00´ | 642 | X.3 | LL8369 | MM3269 |
| 9465 | LTD | pink | 07/07/05 | 58°30´N | 180°00´ | 545 | 0.1 | LL8370 | MM3270 |
| 9466 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 536 | 1.3 | LL8371 | MM3271 |
| 9467 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 522 | 2.2 | LL8372 | MM3272 |
| 9468 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 510 | 2.2 | LL8373 | MM3273 |
| 9470 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 496 | 1.2 | LL8374 | MM3274 |
| 9471 | LTD | pink | 07/07/05 | 58°30´N | 180°00´ | 505 | 0.1 | LL8375 | MM3275 |
| 9472 | LTD | pink | 07/07/05 | 58°30´N | 180°00´ | 491 | 0.1 | LL8376 | MM3276 |
| 9475 | LTD | pink | 07/07/05 | 58°30´N | 180°00´ | 464 | 0.1 | LL8377 | MM3277 |
| 9476 | LTD | pink | 07/07/05 | 58°30´N | 180°00´ | 492 | 0.1 | LL8378 | MM3278 |
| K103 | iBK | chinook | 07/07/05 | 58°30´N | 180°00´ | 590 | 1.2 | LL8379 | MM3279 |
| 9477 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 510 | 2.2 | LL8380 | MM3280 |
| 9479 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 486 | 2.2 | LL8401 | MM3301 |
| 9480 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 495 | 2.2 | LL8402 | MM3302 |
| 9481 | LTD | sockeye | 07/07/05 | 58°30´N | 180°00´ | 490 | 1.2 | LL8403 | MM3303 |
| K111 | iBK | chinook | 07/08/05 | 57°30´N | 179°00´ W | 571 | 1.2 | LL8404 | MM3304 |
| 9482 | LTD | sockeye | 07/08/05 | 57°30´N | 179°00´ W | 500 | 1.2 | LL8405 | MM3305 |
| 9483 | LTD | chinook | 07/08/05 | 57°30´N | 179°00´ W | 535 | X.2 | LL8406 | MM3306 |
| 9484 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 486 | 1.2 | LL8408 | MM3308 |

Table 6. (continued)

| Data tag # | Tag model | Species | Release date | Release latitude | Release longitude | Fork length (mm) | Age | US Disk | FAJ Disk |
|---|---|---|---|---|---|---|---|---|---|
| 9485 | LTD | pink | 07/09/05 | 57°30´N | 178°00´ W | 458 | 0.1 | LL8409 | MM3309 |
| 9486 | LTD | pink | 07/09/05 | 57°30´N | 178°00´ W | 459 | 0.1 | LL8410 | MM3310 |
| 9487 | LTD | pink | 07/09/05 | 57°30´N | 178°00´ W | 465 | 0.1 | LL8411 | MM3311 |
| 9488 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 439 | 2.2 | LL8412 | MM3312 |
| 9489 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 483 | 2.2 | LL8413 | MM3313 |
| 9490 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 456 | 2.2 | LL8414 | MM3314 |
| 9491 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 530 | 2.2 | LL8415 | MM3315 |
| 9492 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 495 | 1.2 | LL8416 | MM3316 |
| 9493 | LTD | pink | 07/09/05 | 57°30´N | 178°00´ W | 496 | 0.1 | LL8417 | MM3317 |
| 9511 | LTD | pink | 07/09/05 | 57°30´N | 178°00´ W | 482 | 0.1 | LL8418 | MM3318 |
| 9512 | LTD | pink | 07/09/05 | 57°30´N | 178°00´ W | 467 | 0.1 | LL8419 | MM3319 |
| 9513 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 475 | 2.2 | LL8420 | MM3320 |
| 9514 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 488 | 1.2 | LL8421 | MM3321 |
| 9515 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 492 | 1.2 | LL8422 | MM3322 |
| 9738 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 512 | 2.2 | LL8423 | MM3323 |
| 9739 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 509 | 1.2 | LL8424 | MM3324 |
| 10004 | LTD | chinook | 07/09/05 | 57°30´N | 178°00´ W | 650 | 1.3 | LL8425 | MM3325 |
| 10005 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 534 | X.2 | LL8443 | MM3343 |
| 10006 | LTD | sockeye | 07/09/05 | 57°30´N | 178°00´ W | 590 | 2.3 | LL8444 | MM3344 |
| 10009 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 490 | 1.2 | LL8445 | MM3345 |
| 10010 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 492 | 2.2 | LL8446 | MM3346 |
| 10011 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 575 | 2.3 | LL8447 | MM3347 |
| 10012 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 528 | 2.2 | LL8448 | MM3348 |
| 10013 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 460 | 1.2 | LL8449 | MM3349 |
| 10014 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 554 | 2.2 | LL8450 | MM3350 |
| 10015 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 475 | 1.2 | LL8451 | MM3351 |
| 10016 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 490 | 1.2 | LL8452 | MM3352 |
| 10022 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 540 | 1.3 | LL8453 | MM3353 |
| 10017 | LTD | pink | 07/10/05 | 56°30´N | 178°00´ W | 488 | 0.1 | LL8459 | MM3359 |
| 10018 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 496 | 1.2 | LL8460 | MM3360 |
| 10019 | LTD | sockeye | 07/10/05 | 56°30´N | 178°00´ W | 480 | 2.2 | LL8461 | MM3361 |
| A13260 | Geo | chum | 07/10/05 | 56°30´N | 178°00´ W | 538 | X.X | LL8462 | MM3362 |
| A13261 | Geo | chum | 07/10/05 | 56°30´N | 178°00´ W | 543 | 0.3 | LL8463 | MM3363 |
| A13263 | Geo | chum | 07/10/05 | 56°30´N | 178°00´ W | 550 | 0.3 | LL8465 | MM3365 |
| 2009 | CTD | chum | 07/11/05 | 56°30´N | 179°00´ W | 563 | 0.3 | LL8466 | MM3366 |
| 10024 | LTD | pink | 07/11/05 | 56°30´N | 179°00´ W | 535 | 0.1 | LL8468 | MM3368 |
| 10025 | LTD | sockeye | 07/11/05 | 56°30´N | 179°00´ W | 461 | 2.2 | LL8471 | MM3371 |
| A13265 | Geo | chum | 07/11/05 | 56°30´N | 179°00´ W | 523 | 0.3 | LL8472 | MM3372 |
| 2015 | CTD | sockeye | 07/12/05 | 56°30´N | 179°00´ E | 554 | X.3 | LL8473 | MM3373 |
| 10026 | LTD | sockeye | 07/12/05 | 56°30´N | 179°00´ E | 535 | 1.2 | LL8474 | MM3374 |
| A13267 | Geo | sockeye | 07/13/05 | 56°30´N | 178°00´ E | 478 | 2.2 | LL8475 | MM3375 |
| A13268 | Geo | sockeye | 07/13/05 | 56°30´N | 178°00´ E | 542 | 1.3 | LL8478 | MM3378 |
| 2021 | CTD | chum | 07/13/05 | 56°30´N | 178°00´ E | 543 | 0.3 | LL8483 | MM3383 |
| A13270 | Geo | sockeye | 07/13/05 | 56°30´N | 178°00´ E | 596 | X.X | LL8484 | MM3384 |
| A13271 | Geo | sockeye | 07/13/05 | 56°30´N | 178°00´ E | 603 | 2.3 | LL8485 | MM3385 |

Table 7. Number of tissue samples collected from chum salmon for endocrine studies during the summer research cruise of *Wakatake maru*, 2005.

| Station no. | Olfactory epithelium | Brain | Pituitary | Blood |
|---|---|---|---|---|
| 15 | 2 | 2 | 2 | 2 |
| 16 | 4 | 4 | 4 | 4 |
| 17 | 4 | 4 | 4 | 4 |
| 18 | 4 | 4 | 4 | 4 |
| 19 | 6 | 6 | 6 | 6 |
| 20 | | 3 | 3 | 3 |
| 21 | | 1 | 1 | 1 |
| 22 | | 5 | 5 | 5 |
| 23 | | 5 | 5 | 5 |
| 24 | | 2 | 2 | 2 |
| Total | 20 | 36 | 36 | 36 |

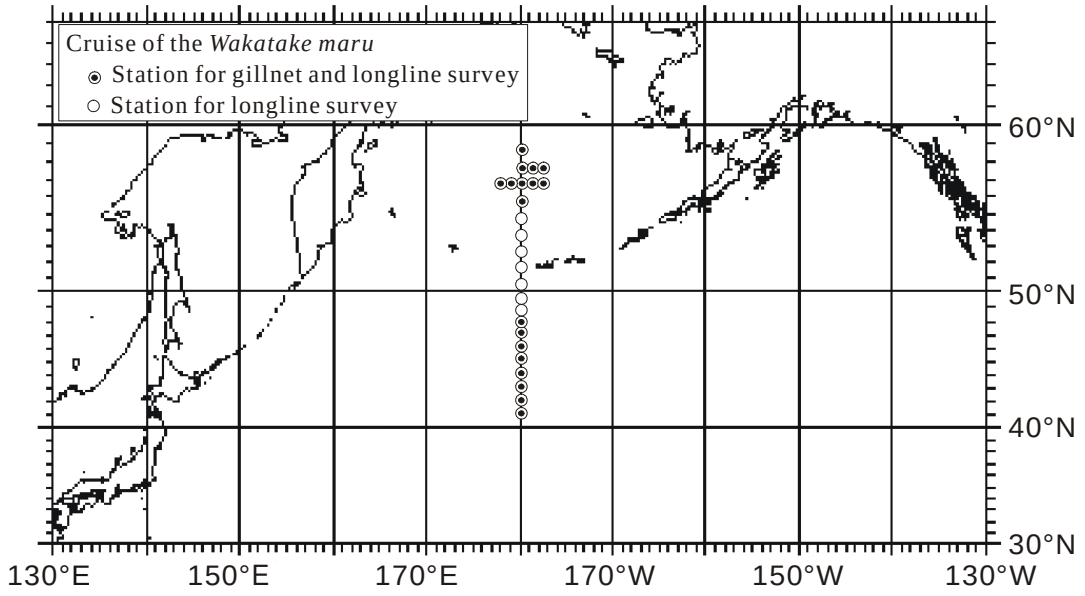


**Fig. 1.** Survey area of the R/V *Wakatake maru* salmon research cruise, summer 2005.

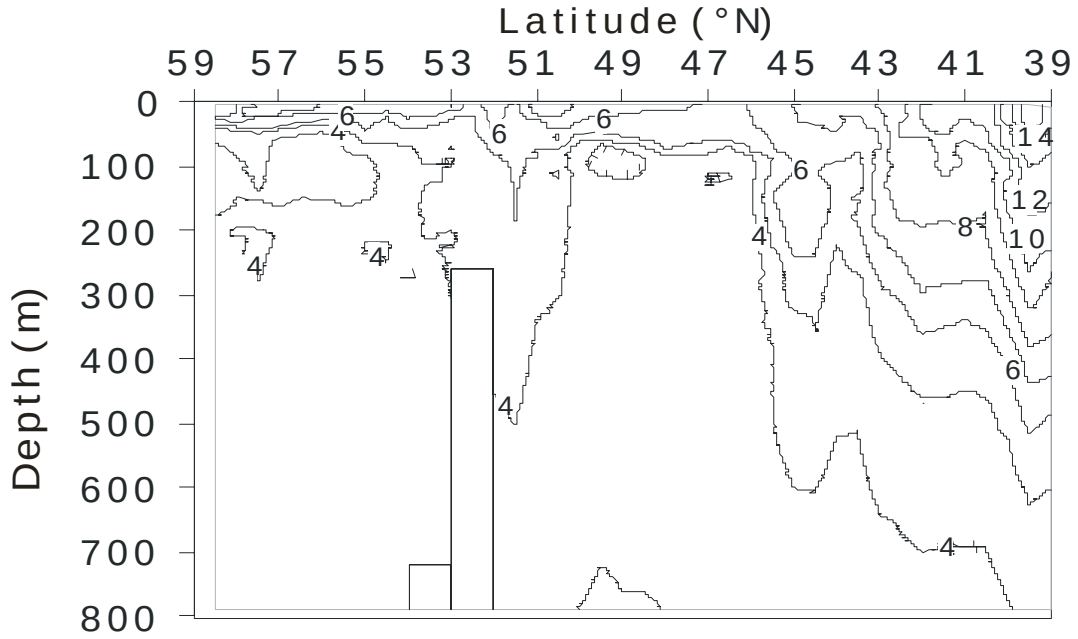


**Fig. 2.** Vertical section of water temperature (°C) along the 180° transect of the *Wakatake maru* cruise, 2005.

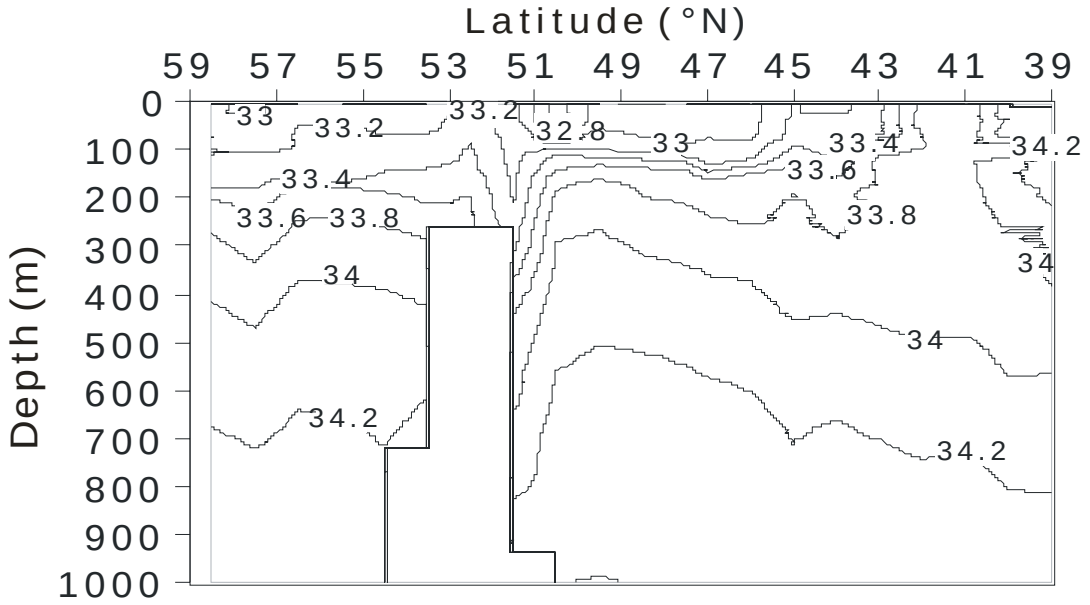


**Fig. 3.** Vertical section of salinity (psu) along the 180° transect of the *Wakatake maru* cruise, 2005.

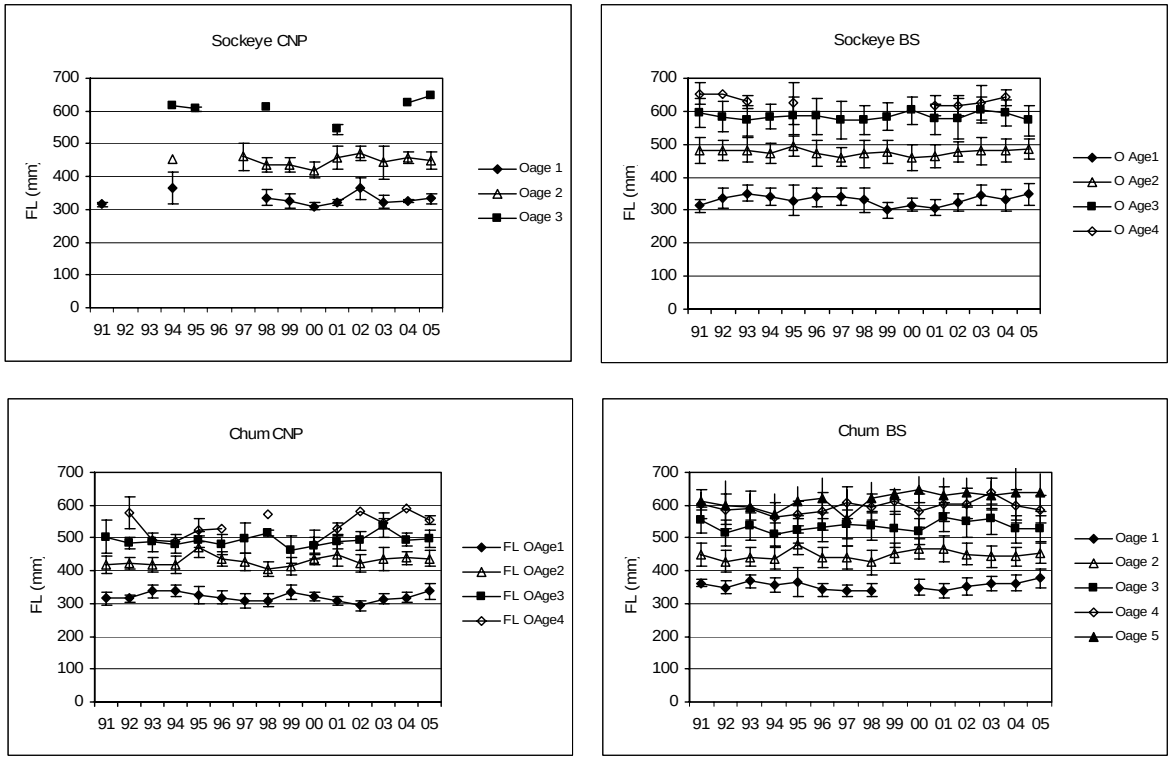


**Fig. 4.** Mean fork length (+/- one standard deviation) at ocean age by year for sockeye and chum salmon caught in the research-mesh gillnet (C-gear), 1991-2005. Fish were caught in the central North Pacific (CNP) and Bering Sea (BS).

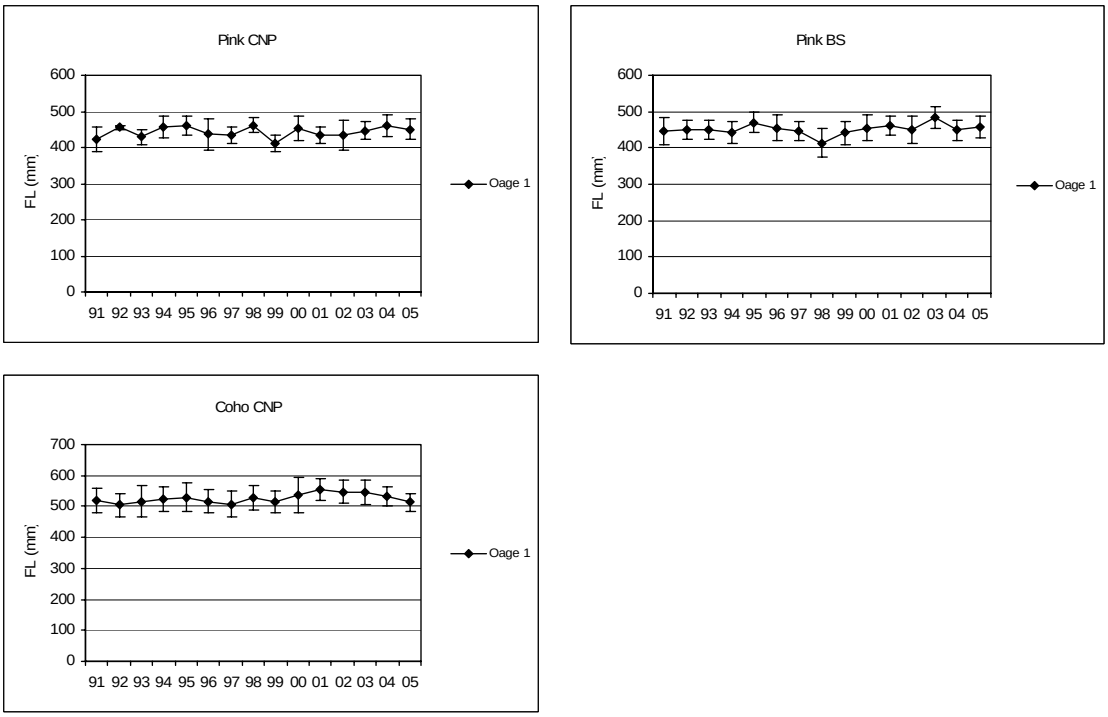


**Fig. 5.** Mean fork length (+/- one standard deviation) at ocean age by year for pink and coho salmon caught in the research-mesh gillnet (C-gear), 1991-2005. Fish were caught in the central North Pacific (CNP) and Bering Sea (BS).

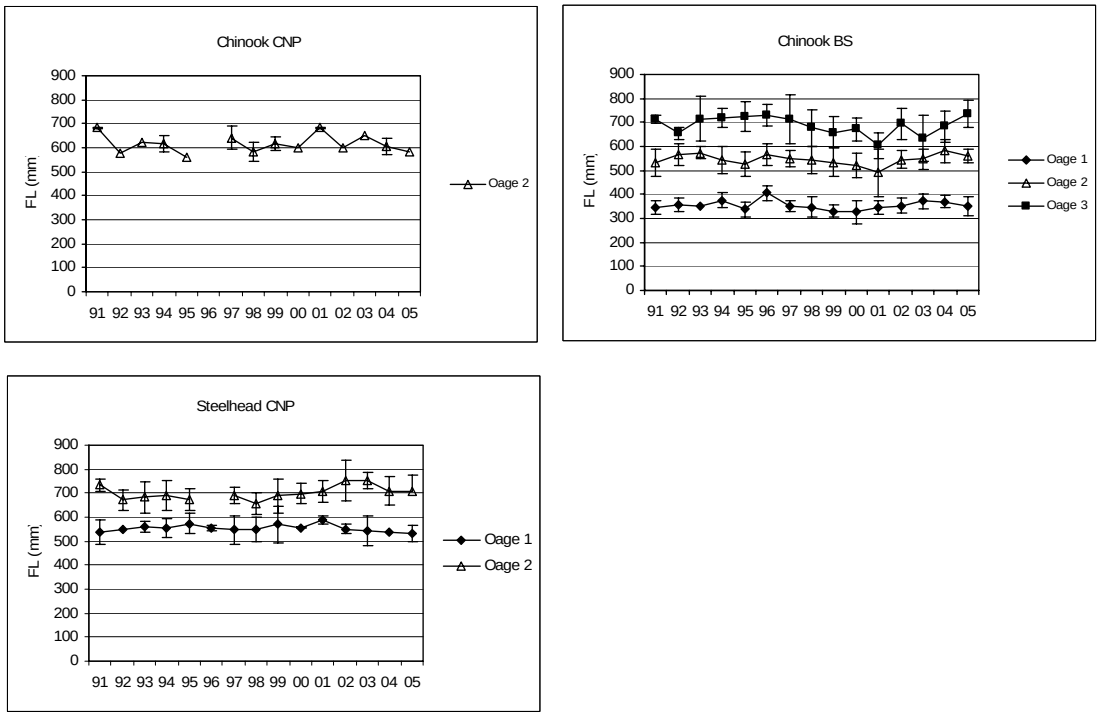


**Fig. 6.** Mean fork length (+/- one standard deviation) at ocean age by year for chinook salmon and steelhead caught in the research-mesh gillnet (C-gear), 1991-2005. Fish were caught in the central North Pacific (CNP) and Bering Sea (BS).