

# The 2004 Japan-U.S. Cooperative High-Seas Salmon Research Cruise of the R/V *Wakatake maru*

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# The 2004 Japan-U.S. Cooperative High-Seas Salmon Research Cruise of the R/V *Wakatake maru*

**Abstract:** An annual high-seas research cruise to investigate the stock condition of Pacific salmon was conducted in the central North Pacific Ocean and the Bering Sea from 9 June to 21 July 2004 onboard the Japanese research vessel *Wakatake maru*. Research cruise activities included the collection of data on oceanography, primary production, zooplankton, salmonid fishes, and other organisms. A total of 6,510 salmonids was caught by longline and gillnet: 685 fishes in the central North Pacific Ocean and 5,825 fishes in the central Bering Sea. In the North Pacific Ocean, coho and chum salmon were the most abundant species (40.4% and 39.6%, respectively), followed by pink salmon (9.6%), sockeye salmon (4.2%), steelhead trout (3.9%), and chinook salmon (2.2%). In the Bering Sea, chum salmon was the most abundant species (76.4%), followed by pink (9.9%), sockeye (9.7%), chinook (3.7%), and coho salmon (0.3%). A total of 872 samples of salmonid stomach contents was examined onboard the research vessel. Brain, pituitary, and blood samples were obtained from 100 chum salmon for endocrine studies. There were 717 salmon (30 sockeye, 573 chum, 31 pink, 50 coho, and 33 chinook salmon) tagged with disk tags and released in the North Pacific Ocean and the Bering Sea. From among fish released with disk-tags, 22 sockeye, 85 chum, 19 pink, and 32 chinook salmon were released carrying one of three different archival tags.

## Introduction

Since 1991, the Japanese research vessel *Wakatake maru* has been collecting data on the biology of Pacific salmon (*Oncorhynchus* spp.) and the oceanography of the central North Pacific Ocean and the Bering Sea (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). Several scientific papers have resulted from analyses of data collected during these surveys (*e.g.*, Tadokoro *et al.* 1996; Shiimoto *et al.* 1997; Walker *et al.* 2000; Friedland *et al.* 2001; Ishida *et al.* 2002; Shiimoto *et al.* 2002). The main objective of this research program is to monitor the stock condition of salmonids. Routine observations have included the collection of data on physical oceanography, primary production, and the trophic interactions among zooplankton, salmonids, and organisms at higher trophic levels. Other studies have included using archival data tags to study salmon habitat and movement patterns, monitoring the endocrinological changes that occur in salmon during migration, and analysis of the genetic structure of salmon populations in the ocean. Moreover, because the *Wakatake maru* belongs to the Education Bureau of Hokkaido prefecture, this research program provides an opportunity for students to learn about high-seas salmon research. This document summarizes the research cruise conducted by the R/V *Wakatake maru* in the central North Pacific Ocean and the Bering Sea during summer 2004.

## Survey Area

The R/V *Wakatake maru* departed from Kushiro, Japan, on 9 June 2004 and returned to Kushiro on 21 July 2004. A total of 104 observation stations including 29 fishing stations were visited during the cruise (Fig. 1 and Table 1). Nineteen fishing stations were located between 41°00'N and 58°30'N latitude, at 180° longitude. In addition, ten fishing stations were located in the international waters of the central Bering Sea. Oceanographic data were collected at each fishing station, between stations, and en route to and from the fishing area.

## Temperature and Salinity Sampling

The collection method of seawater temperature and salinity data has remained the same since 1999 (Kawana *et al.* 1999, Urawa *et al.* 2000, Fukuwaka *et al.* 2001, Tanaka *et al.* 2002, Fukuwaka *et al.* 2003). An expendable bathythermograph (XBT) recorded data in 1-m increments from the surface to 780 m at 1°-longitude intervals on the outbound, eastward transit at 40°N and at 1°-latitude intervals between fishing stations (n = 51). A conductivity, temperature, and depth sensor (CTD) was used at 5°-longitude intervals along the eastward transit and at fishing stations (n = 39). An expendable CTD (XCTD) was used at 1°-longitude intervals on the return leg from the Bering Sea (n = 26). The CTD and XCTD recorded data at 1-m intervals from the surface to a maximum of approximately 1000 m.

The relative position of oceanographic domains were identified along the 180° transect according to the seawater characteristics described by Dodimead *et al.* (1963) and Favorite *et al.* (1976). Stations ST01 and ST02 were located in the Transition Zone, an area characterized by relatively saline waters (> 34.0 psu). A vertical, 34.0-psu isohaline characterized the Subarctic Boundary, which separates subtropical and subarctic waters. The boundary was located between 40°N (ST02) and 41°N (ST03). In 2004, the Subarctic Boundary was located at the same latitude observed in 1997, 1998, 2000, and 2003. However, the boundary was located 1° latitude south of this position in 1991-1996, 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).

The southern limit of the Transition Domain is the Subarctic Boundary, whereas the northern limit is delineated by cold water (< 4°C) below a depth of 100 m in the central North Pacific. The Transition Domain was located between 40°N and 46°N (between ST02 and ST08). The Subarctic Current—an eastward-flowing surface current of cool, low-salinity waters—was located between 46°N (ST08) and 48°30'N (ST11) and was identified by cold water (~3.5°C) at an approximate depth of 125 m. Further to the north (49°30'-50°30'N, ST12-13) low salinity surface waters (< 32.8 psu, at <50 m) indicated these stations were located in the westward-flowing Alaska current. Station 14 (ST14) 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°N (ST15 through ST31) were located in the Bering Sea. The central Bering Sea is characterized by a seasonally-stratified water column, where warm surface water (< 30 m) overlays a cold water pool (30 m to approximately 200 m), which is produced by cooling and mixing during the previous winter.

In 2004, the average sea surface temperature of the North Pacific and the Bering Sea increased by 0.28°C and 0.03°C above the average temperature observed in 2003 (ST03-14: 2003 mean = 7.81°C, 2004 mean = 8.09°C; ST15-31: 2003 mean = 7.72°C, 2004 mean = 7.75°C).

## Primary Production and Zooplankton Sampling

Seawater was sampled by hand with a bucket and using Niskin bottles, attached to the CTD at 33 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 microfibre filter (Whatman GF/F) and two nuclepore track-etch membranes (Whatman, 2 µm and 10 µm) using a vacuum pump (100-150 mm Hg). This provided 3 × 7 chlorophyll samples at each station. Filters containing chlorophyll-a were stored in the freezer. In addition, a water sample (20 ml) 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.

Macro-zooplankton was collected with a remodeled NORPAC net at 35 stations (ring diameter, 0.45 m; net length, 1.93 m; mesh size, 0.33 mm; Table 1). NORPAC tows at fishing stations were conducted at night at approximately 24:00 h. Otherwise, tows were conducted at whatever time of day the ship arrived on station. The net was towed vertically from a depth of 150 m to the surface. A calibrated flow meter was attached slightly off-center to the opening of the net. The net samples were fixed in seawater containing 10% borax-buffered formalin. In addition, large macro-zooplankton were collected at night at approximately 23:00 h with an Ocean Research Institute (ORI) net equipped with a calibrated flow meter at 29 stations (diameter, 1.60 m; overall length, 7.5 m; mesh size, 0.67 mm; Table 1). The ORI net was towed at speeds of 1.5-2.0 kts along the side of the vessel at the sea surface for 10 min. Samples from the ORI net were fixed in seawater containing 10% borax-buffered formalin. If the sample volume collected by the ORI net was greater than the capacity of the storage bottle, the total volume was measured, and a sub-sample of the ORI net was retained.

## Fish Collection

Salmonid and other pelagic fishes were collected by gillnet and longline (Fig. 1). The gillnet was used at eight stations in the central North Pacific Ocean and at 14 stations in the central Bering Sea, outside of the U.S. EEZ (Fig. 1, Table 1). The gillnet was set at 16:00 h in the afternoon (Local Mean Time [LMT], GMT+12) and retrieved at 04:00 h 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 sizes, one tan was 50 m long) combined with panels of a commercial-mesh gillnet (A-gear: 19 tans of 115 mm mesh size, one tan was 50 m long). At six fishing stations (ST03-08) in the central North Pacific, the number of tans of A-gear was reduced from 19 to 17 tans, and two tans of a smaller mesh size (F-gear: one tan each of 29 and 37 mm mesh sizes, one tan was 25 m long) were substituted to collect

Pacific saury (*Cololabis saira*). A 3.32-km longline was set 30 min before sunset and hauled 30 min after sunset (LMT) at 29 fishing stations. The longline comprised 30 hachi baited with salted Japanese anchovy (*Engraulis japonicus*). Each hachi was 110.68 m long and contained 49 hooks.

A total of 6,510 salmonid fishes was caught with the longline and gillnet: 685 fish in the central North Pacific Ocean (ST03-14) and 5,825 fish in the central Bering Sea (ST15-31) (Table 2). In the North Pacific Ocean, coho (*O. kisutch*) and chum salmon (*O. keta*) were the two most abundant species (40.4% and 39.6%), followed by pink salmon (*O. gorbuscha*; 9.6%), sockeye salmon (*O. nerka*; 4.2%), steelhead trout (*O. mykiss*; 3.9%), and chinook salmon (*O. tshawytscha*; 2.2%). In the Bering Sea, chum salmon was the most abundant species (76.4% of the salmonid catch), followed by pink (9.9%), sockeye (9.7%), chinook (3.7%), and coho salmon (0.3%).

In addition, 2,146 non-salmonid fishes and 165 squids were caught with the longline and gillnet. Pacific saury (n = 1,023), Pacific pomfret (*Brama japonica*; n = 1,000), and Atka mackerel (*Pleurogrammus monopterygius*; n = 106) were particularly abundant in the catch (Table 2). Sharks included salmon shark (*Lamna ditropis*; n = 3), spiny dogfish (*Squalus acanthias*; n = 6), and blue shark (*Prionace glauca*; n = 1). Other fishes in the catch included longnose lancetfish (*Alepisaurus ferox*; n = 2), North Pacific pelagic armorhead (*Pentaceros wheeleri*; n = 2), black rockfish (*Sebastes melanops*; n = 1), prowlfish (*Zaprora silenus*; n = 1), and ragfish (*Icosteus aenigmaticus*; n = 1). No walleye pollock (*Theragra chalcogramma*) were captured. Squids in the catch included neon flying squid (*Ommastrephes bartrami*; n = 40), eight-armed squid (*Gonatopsis borealis*; n = 79), boreal clubhook squid (*Onychoteuthis borealijaponica*; n = 45), and shortarm gonate squid (*Gonatus kamtschaticus* [*middendorffi*]; n = 1).

## Fish Measurement

Salmonids were processed soon after removal from the fishing gear. For each gillnet mesh size, the catch was sorted by species and counted. Biological data were recorded from a maximum of 60 individuals per species caught in each mesh size (number of mesh sizes = 11 or 13) and from a maximum of 60 individuals per species caught by longline. Biological data included fork length (FL, mm), body weight (BW, g), sex, and gonad weight (GW, g). The presence of external injuries and visceral adhesions was also recorded (Nagasawa *et al.* 1997). Samples of one scale (pink salmon), two scales (sockeye, chum, coho, and chinook salmon, and steelhead trout), and a scale scrape sample (steelhead trout) were collected for age determination and back calculation of growth. When possible, scales were collected from the preferred body area identified by the International North Pacific Fisheries Commission for scale sampling (INPFC; Davis *et al.* 1990).

Salmonids were checked for the presence of clipped fins, the possibility of hybridization, and the incidence of diseases. A total of 19 adipose fin-clipped salmonids was caught (16 steelhead trout, 2 chinook, and 1 pink salmon). The snouts of these fishes were removed, salted, and sent to the Auke Bay Laboratory (National Marine Fisheries Service, NOAA), Juneau, AK, for dissection and potential recovery of coded-wire tags. A total of 105 potential hybrids was caught (104 pink × chum, 1 sockeye × chum). The livers of potential hybrids and 44 controls (23 pink, 17 chum, and 4 sockeye) were

collected for DNA analysis and frozen. The liver samples were sent to scientists at Hokkaido University, Hakodate, Japan. In addition, 24 unusual fish (23 black-spotted fish, 1 flabby fish) and three potentially diseased fish were caught. Unusual fishes were kept as round samples and frozen. Tissues from potentially diseased salmon were removed and fixed with 10% formalin (in freshwater). Samples of unusual or diseased salmon were sent to scientists at the National Salmon Resources Center, Sapporo, Japan.

The non-salmonid catch was identified and counted by mesh size. Body length of non-salmonid fishes, squid, and other organisms was measured, and a few individuals were frozen for taxonomic and ecological studies. Pacific saury was frozen and sent to the Hokkaido Fisheries Experimental Station, Kushiro; neon flying squid was frozen and sent to the National Research Institute of Far Seas Fisheries, Shimizu; and birds were frozen and sent to Hokkaido University, Hakodate, for further examination. Body length of salmon sharks was measured, and sexual maturity determined. Blood, cartilage, gonads, snout, and DNA samples of muscle tissue were sent to scientists at the University of Washington, Seattle, WA, USA.

### 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 and from the commercial-mesh gillnet (C- and 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 the weight of the stomach contents obtained by subtraction. The stomach contents were examined using a binocular microscope and separated into several prey categories as described by Ueno *et al.* (1998). The percent volume in each prey category was estimated by eye. During the cruise, a total of 872 samples of stomach contents was examined. This total includes samples collected from 159 sockeye, 261 chum, 197 pink, 96 coho, and 133 chinook salmon, and 26 steelhead trout.

Common salmon prey organisms included squid (subadult *Berryteuthis anonychus*, and juveniles of several unidentified species), fish, including juvenile Atka mackerel, post-larval halibut (*Hippoglossus stenolepis*), *Atheresthes* sp., bathymasterids, Irish lord (*Hemilepidotus* spp.), and adult northern lampfish (*Stenobranchius leucopsarus*). Common zooplankton prey included hyperiid amphipods (*Themisto pacifica*, *Primno abyssalis*, *Hyperoche medusarum*, *Hyperia medusarum*, and *Phronima sedentaria*), euphausiids, *Thysanoessa longipes*, pteropods (*Limacina helicina* and *Clione limacina*), and copepods (*Neocalanus cristatus* CV). Chum salmon had the most varied diet and were observed to also feed on ctenophores (*Beroe* sp.) medusae, (*Aglantha digitale*), and *Oikopleura* sp.

### Chum Salmon Brain and Blood Sample Collection

Brain and pituitary samples were collected from 100 chum salmon at stations ST10-31. Olfactory epithelia were collected from 30 fish at stations ST10-22, and blood samples were collected from 74 fish at stations ST10-22.

Brain, pituitary, and blood samples were collected for (i) an immunohistochemical analysis of the neuroendocrine principles released during the spawning migration, (ii) the determination of the role of neuromodulators such as salmon gonadotropin-releasing hormone (sGnRH), and (iii) an analysis of the endocrinological changes occurring in salmon during the spawning migration from the Bering Sea to Japan. Chum salmon caught in healthy condition were placed in a recovery tank soon after they were detached from the longline. After measuring FL and BW and collecting a scale sample, blood samples were collected from the caudal vasculature. Blood samples were centrifuged to separate the plasma for later determination of steroid hormones levels. Plasma samples were stored at  $-20^{\circ}\text{C}$ . Gonad weight was obtained to calculate the gonadosomatic index (GSI;  $\text{GW}/\text{BW} \times 100$ ).

To understand the organization of sGnRH neurons and to examine the association of sGnRH neurons with other neurons, brain and pituitary tissue samples were removed from chum salmon and immersed in fixatives containing (i) 4% paraformaldehyde (PFA) in 0.01 M phosphate-buffered saline (PBS), (ii) 4% PFA and 0.02% picric acid in 0.01 M PBS, or (iii) 4% PFA and 0.08% picric acid in 0.01 M PBS. These tissue samples were stored at  $4^{\circ}\text{C}$ . Some of the brain samples were divided into six parts (olfactory bulb, telencephalon, optic tectum, hypothalamus, cerebellum, and medulla oblongata), frozen in liquid nitrogen along with the olfactory epithelium and the pituitary, and stored at  $-50^{\circ}\text{C}$ . These brain tissues were collected to determine the GnRH and gonadotropin content of specific areas of the brain and to investigate genes that control the homing migration.

## Release of Tagged Salmon

*Disk tagging:* Live salmon caught in healthy condition were put into a recovery tank soon after removal from the longline. Each fish was tagged with two disk tags, one issued by the Fisheries Agency of Japan (FAJ) and one by the Fisheries Research Institute, University of Washington (FRI). Both disk tags were placed on one plastic cinch strap and attached to the fish in an area anterior to the dorsal fin. The fork length was measured and two scales were collected before the fish was released to the sea. A total of 717 disk-tagged salmonids was released into the North Pacific Ocean ( $n = 134$ ) and the Bering Sea ( $n = 717$ ; Table 2). Releases consisted of 30 sockeye, 573 chum, 31 pink, 50 coho, and 33 chinook salmon.

*Archival tagging:* Three types of archival tags were used. First, a CTD tag manufactured by Star-Oddi, Reykjavik, Iceland, recorded seawater temperature and salinity, and the depth of fish movement (model DST CTD; size,  $15 \times 46$  mm; weight in air, 19 g; number of records, 43,582 per sensor). Second, an LTD tag manufactured by Lotek Marine Technologies, Newfoundland, Canada, was used to record seawater temperature and depth of the fish (model LTD 1100-300; size,  $8 \times 16 \times 27$  mm; weight in air, 5 g; number of records, 32,768). Third, an ibutton tag manufactured by Dallas Semiconductor, Inc. and repackaged for fish tagging by Alpha Mach, Inc., Quebec, Canada, was used to record seawater temperature (model iB4; size,  $8 \times 16 \times 24$  mm; weight in air, 3.8 g; number of records, 2048). Archival tags were attached externally with nickel pins to the dorsal musculature of the fish anterior to the dorsal fin.

A total of 158 salmon was released with archival tags in the North Pacific Ocean ( $n = 10$ ) and the Bering Sea ( $n = 148$ ; Table 3). Releases included 22 sockeye, 85 chum,

19 pink, and 32 chinook salmon.

*Archival tag recovery:* One pink salmon tagged during the evening longline retrieval was recovered the following morning at the same location during the gillnet operation (ST23, ibutton tag number: W148, disk tag numbers: NN0373 and MM2373).

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**Table 1.** Research activities conducted at each station during the R/V *Wakatake maru* cruise in 2004.

St.	Location	Physical Oceanography			Primary production	Zooplankton		Fishing	
		XBT	XCTD	CTD		NORPAC	ORI	Gillnet	Longline
T01	40°00'N 150°00'E	○		○	○	○			
T02	40°00'N 151°00'E	○							
T03	40°00'N 152°00'E	○							
T04	40°00'N 153°00'E	○							
T05	40°00'N 154°00'E	○							
T06	40°00'N 155°00'E	○		○	○	○			
T07	40°00'N 156°00'E	○							
T08	40°00'N 157°00'E	○							
T09	40°00'N 158°00'E	○							
T10	40°00'N 159°00'E	○							
T11	40°00'N 160°00'E	○		○	○	○			
T12	40°00'N 161°00'E	○							
T13	40°00'N 162°00'E	○							
T14	40°00'N 163°00'E	○							
T15	40°00'N 164°00'E	○							
T16	40°00'N 165°00'E	○		○	○				
T17	40°00'N 166°00'E	○							
T18	40°00'N 167°00'E	○							
T19	40°00'N 168°00'E	○							
T20	40°00'N 169°00'E	○							
T21	40°00'N 170°00'E	○		○	○				
T22	40°00'N 171°00'E	○							
T23	40°00'N 172°00'E	○							
T24	40°00'N 173°00'E	○							
T25	40°00'N 174°00'E	○							
T26	40°00'N 175°00'E	○		○	○				
T27	40°00'N 176°00'E	○							
T28	39°45'N 177°00'E	○							
T29	39°30'N 178°00'E	○							
T30	39°15'N 179°00'E	○							
ST01	39°00'N 180°00'	○		○	○				
T31	39°30'N 180°00'	○							
ST02	40°00'N 180°00'			○	○				
T32	40°30'N 180°00'	○							
ST03	41°00'N 180°00'			○	○	○	○	○	○
T33	41°30'N 180°00'	○							
ST04	42°00'N 180°00'			○	○	○	○	○	○
T34	42°30'N 180°00'	○							
ST05	43°00'N 180°00'			○	○	○	○	○	○
T35	43°30'N 180°00'	○							
ST06	44°00'N 180°00'			○	○	○	○	○	○
T36	44°30'N 180°00'	○							
ST07	45°00'N 180°00'			○	○	○	○	○	○
T37	45°30'N 180°00'	○							
ST08	46°00'N 180°00'			○	○	○	○	○	○
T38	46°30'N 180°00'	○							
ST09	47°00'N 180°00'			○	○	○	○	○	○
ST10	47°30'N 180°00'			○	○	○	○	○	○
T39	48°00'N 180°00'	○							
ST11	48°30'N 180°00'			○	○	○	○		○
T40	49°00'N 180°00'	○							
ST12	49°30'N 180°00'			○	○	○	○		○
T41	50°00'N 180°00'	○							

—Table 1. continued—

St.	Location	Physical Oceanography			Primary production	Zooplankton		Fishing	
		XBT	XCTD	CTD		NORPAC	ORI	Gillnet	Longline
ST13	50°30' N 180°00'			○	○	○	○		○
T42	51°00' N 180°00'	○							
ST14	51°30' N 180°00'			○	○	○	○		○
T43	52°00' N 179°40' W	○							
ST15	52°30' N 180°00'			○	○	○	○		○
T44	53°00' N 180°00'	○							
ST16	53°30' N 180°00'			○	○	○	○		○
T45	54°00' N 180°00'	○							
ST17	54°30' N 180°00'			○	○	○	○		○
T46	55°00' N 180°00'	○							
ST18	55°30' N 180°00'			○	○	○	○	○	○
T47	56°00' N 180°00'	○							
ST19	56°30' N 180°00'			○	○	○	○	○	○
T48	57°00' N 180°00'	○							
ST20	57°30' N 180°00'			○	○	○	○	○	○
T49	58°00' N 180°00'	○							
ST21	58°30' N 180°00'	○			○	○	○	○	○
ST22	57°30' N 179°00' W			○		○	○	○	○
ST23	57°30' N 178°00' W			○		○	○	○	○
ST24	56°30' N 178°00' W			○		○	○	○	○
ST25	56°30' N 179°00' W			○		○	○	○	○
ST26	56°30' N 179°00' E			○		○	○	○	○
ST27	56°30' N 178°00' E			○		○	○	○	○
ST28	56°30' N 177°00' E			○		○	○	○	○
ST29	57°30' N 177°00' E			○		○	○	○	○
ST30	57°30' N 176°00' E			○		○	○	○	○
ST31	56°30' N 176°00' E			○		○	○	○	○
T50	56°00' N 176°00' E		○						
T51	55°30' N 175°00' E		○	○	○				
T52	55°00' N 174°00' E		○						
T53	54°30' N 173°00' E		○						
T54	54°00' N 172°00' E		○						
T55	53°30' N 171°00' E		○						
T56	53°00' N 170°00' E		○	○	○				
T57	52°20' N 169°00' E		○						
T58	51°40' N 168°00' E		○						
T59	51°10' N 167°00' E		○						
T60	50°40' N 166°00' E		○						
T61	50°00' N 165°00' E		○	○	○				
T62	49°20' N 164°00' E		○						
T63	48°40' N 163°00' E		○						
T64	48°00' N 162°00' E		○						
T65	47°30' N 161°00' E		○						
T66	46°50' N 160°00' E		○	○	○	○			
T67	46°10' N 159°00' E		○						
T68	45°30' N 158°00' E		○						
T69	44°50' N 157°00' E		○						
T70	44°10' N 156°00' E		○						
T71	43°30' N 155°00' E		○	○	○	○			
T72	42°50' N 154°00' E		○						
T73	42°10' N 153°00' E		○						
T74	41°20' N 152°00' E		○						
T75	40°40' N 151°00' E		○						
T76	40°00' N 150°00' E			○	○	○			

**Table 2.** Catches of sockeye salmon (SO), chum salmon (CH), pink salmon (PK), coho salmon (CO), chinook salmon (CN), steelhead trout (ST), Pacific pomfret (PP), Pacific saury (PS), Atka mackerel (AM), sharks (SH), other fishes (OF), and squids (SQ) along with the sea surface temperature (SST, °C) at each station during the R/V *Wakatake maru* cruise in 2004. B-gear, surface longline; C-gear, salmon research gillnet (meshes = 48, 55, 63, 72, 82, 93, 106, 121, 138, and 157 mm); F-gear, small mesh research gillnet (meshes = 29 and 37 mm); A-gear, commercial-mesh gillnet (115-mm). The number of fish tagged with disk tags and released is listed for each station.

St.	Date	Location	SST	Gear	No. unit	Pacific salmon																
						SO	CH	PK	CO	CN	ST	Total	PP	PS	AM	SH	OF	SQ				
ST03	2004/6/16	41°00'N 180°00'	12.0	B	30	0	1	0	0	0	0	0	1	123	0	0	0	0	0	0		
				C	30	0	1	0	1	0	0	0	2	40	0	0	0	0	0	0	39	
				F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				A	17	0	1	0	1	0	0	0	2	29	0	0	0	1	1	0	0	21
				Total		0	3	0	2	0	0	0	5	192	0	0	0	1	1	0	0	60
				Release		0	1	0	0	0	0	0	1									
ST04	2004/6/17	42°00'N 180°00'	11.5	B	30	0	7	0	5	0	0	0	12	55	0	0	0	0	1	0		
				C	30	0	3	1	8	0	0	0	12	164	109	0	1	1	0	0	12	
				F	2	0	0	0	0	0	0	0	0	0	0	637	0	0	0	0	0	
				A	17	0	0	0	15	0	0	1	16	201	0	0	0	0	0	0	6	
				Total		0	10	1	28	0	1	40	420	746	0	0	1	1	1	1	18	
				Release		0	5	0	4	0	0	0	9									
ST05	2004/6/18	43°00'N 180°00'	10.2	B	30	0	8	4	16	0	0	0	28	52	0	0	0	0	1	0		
				C	30	0	4	2	24	0	0	0	30	158	41	0	0	0	0	0	7	
				F	2	0	0	0	0	0	0	0	0	0	236	0	0	0	0	0	0	
				A	17	0	1	1	32	0	1	35	110	0	0	1	1	0	1	1	1	
				Total		0	13	7	72	0	1	93	320	277	0	0	1	1	1	1	8	
				Release		0	6	4	12	0	0	22										
ST06	2004/6/19	44°00'N 180°00'	8.8	B	30	0	3	0	4	0	0	0	7	17	0	0	0	0	0	1		
				C	30	0	15	5	9	0	0	0	29	31	0	0	0	0	0	0	8	
				F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				A	17	0	2	4	21	0	3	30	17	0	0	1	1	0	0	0	0	
				Total		0	20	9	34	0	3	66	65	0	0	0	1	1	0	0	9	
				Release		0	3	0	3	0	0	6										
ST07	2004/6/20	45°00'N 180°00'	7.8	B	30	0	3	1	6	0	0	10	2	0	0	0	0	0	0			
				C	30	0	50	2	15	0	2	69	0	0	0	1	1	0	0	11		
				F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				A	17	0	0	4	15	0	4	23	1	0	0	2	2	0	0	0		
				Total		0	53	7	36	0	6	102	3	0	0	3	0	0	0	0	11	
				Release		0	2	1	5	0	0	8										

—Table 2. continued—

St.	Date	Location	SST	Gear	No. unit	Pacific salmon													
						SO	CH	PK	CO	CN	ST	Total	PP	PS	AM	SH	OF	SQ	
ST08	2004/6/21	46°00'N 180°00'	7.0	B	30	0	10	2	12	1	3	28	0	0	0	0	0	0	
				C	30	0	58	6	16	4	5	89	0	0	1	0	0	6	
				F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				A	17	2	1	1	28	1	3	36	0	0	0	1	1	0	0
				Total		2	69	9	56	6	11	153	0	0	1	1	1	0	6
Release		0	9	1	10	1	0	21											
ST09	2004/6/22	47°00'N 180°00'	6.5	B	30	0	5	1	2	1	9	0	0	0	0	0	0		
				C	30	3	19	5	4	3	0	34	0	0	0	0	1	3	
				A	19	0	4	7	10	2	1	24	0	0	0	0	0	0	
				Total		3	28	13	16	6	1	67	0	0	0	0	0	1	3
				Release		0	5	1	2	1	0	9							
ST10	2004/6/23	47°30'N 180°00'	6.8	B	30	0	3	0	2	0	5	0	0	0	0	1	0		
				C	30	7	25	8	4	1	1	46	0	0	0	0	0	1	
				A	19	3	6	6	16	2	1	34	0	0	0	0	0	0	
				Total		10	34	14	22	3	2	85	0	0	0	0	1	1	
				Release		0	2	0	2	0	0	4							
ST11	2004/6/24	48°30'N 180°00'	6.9	B	30	0	7	2	10	0	1	20	0	0	0	0	1		
				Release		0	3	1	8	0	0	12							
ST12	2004/6/25	49°30'N 180°00'	6.9	B	30	0	1	0	1	0	2	0	0	0	0	1			
				Release		0	1	0	1	0	0	2							
ST13	2004/6/26	50°30'N 180°00'	6.9	B	30	4	10	0	0	0	1	15	0	0	0	1			
				Release		3	6	0	0	0	0	9							
ST14	2004/6/27	51°30'N 180°00'	5.8	B	30	10	23	4	0	0	37	0	0	1	0	0			
				Release		10	20	2	0	0	0	32							
ST15	2004/6/28	52°30'N 180°00'	5.3	B	30	3	12	1	0	0	16	0	0	14	0	0			
				Release		3	12	1	0	0	0	16							
ST16	2004/6/29	53°30'N 180°00'	5.7	B	30	3	47	3	1	0	54	0	0	6	0	0			
				Release		1	35	2	1	0	0	39							
ST17	2004/6/30	54°30'N 180°00'	6.6	B	30	0	33	1	0	1	35	0	0	0	0	0			
				Release		0	20	1	0	1	0	22							

—Table 2. continued—

St.	Date	Location	SST	Gear	No. unit	Pacific salmon													
						SO	CH	PK	CO	CN	ST	Total	PP	PS	AM	SH	OF	SQ	
ST18	2004/7/1	55°30'N 180°00'	7.8	B	30	0	30	5	0	0	0	0	35	0	0	0	0	0	0
				C	30	11	150	24	0	6	0	0	191	0	0	0	0	1	6
				A	19	14	89	23	0	5	0	131	0	0	0	0	0	0	0
				Total		25	269	52	0	11	0	357	0	0	0	0	0	1	6
				Release		0	15	2	0	0	0	17							
ST19	2004/7/2	56°30'N 180°00'	8.2	B	30	1	23	3	0	6	0	33	0	0	0	0	0	0	
				C	30	11	136	33	0	6	0	186	0	0	0	1	0	0	6
				A	19	14	134	37	0	2	0	187	0	0	0	0	0	0	0
				Total		26	293	73	0	14	0	406	0	0	1	0	0	0	6
				Release		1	9	2	0	6	0	18							
ST20	2004/7/3	57°30'N 180°00'	7.7	B	30	4	73	9	0	0	0	86	0	0	0	0	0	0	
				C	30	17	106	38	0	6	0	167	0	0	0	0	0	0	0
				A	19	18	95	12	0	10	0	135	0	0	0	0	1	0	0
				Total		39	274	59	0	16	0	388	0	0	0	0	0	1	0
				Release		3	45	5	0	0	0	53							
ST21	2004/7/4	58°30'N 180°00'	8.5	B	30	0	15	4	0	17	0	36	0	0	0	0	0	0	
				C	30	21	92	47	0	8	0	168	0	0	0	0	0	0	0
				A	19	17	104	40	0	5	0	166	0	0	0	0	0	0	0
				Total		38	211	91	0	30	0	370	0	0	0	0	0	0	0
				Release		0	5	4	0	9	0	18							
ST22	2004/7/5	57°30'N 179°00'W	8.2	B	30	0	50	4	1	11	0	66	0	0	0	0	0	0	
				C	30	12	118	21	0	49	0	200	0	0	0	0	0	0	6
				A	19	20	124	28	0	21	0	193	0	0	0	0	0	0	0
				Total		32	292	53	1	81	0	459	0	0	0	0	0	0	6
				Release		0	29	1	1	9	0	40							
ST23	2004/7/6	57°30'N 178°00'W	8.5	B	30	2	46	2	0	2	0	52	0	0	0	0	0	0	
				C	30	37	134	46	2	7	0	226	0	0	0	0	0	0	2
				A	19	30	102	47	0	7	0	186	0	0	0	0	0	0	0
				Total		69	282	95	2	16	0	464	0	0	0	0	0	0	2
				Release		2	32	1	0	1	0	36							

—Table 2. continued—

St.	Date	Location	SST	Gear	No. unit	Pacific salmon														
						SO	CH	PK	CO	CN	ST	Total	PP	PS	AM	SH	OF	SQ		
ST24	2004/7/7	56°30'N 178°00'W	8.6	B	30	1	144	0	0	2	0	147	0	0	0	0	0	0	0	
				C	30	23	219	9	0	5	0	256	0	0	0	0	0	0	10	
				A	19	21	120	21	2	10	0	174	0	0	0	0	0	0	0	
				Total		45	483	30	2	17	0	577	0	0	0	0	0	0	0	10
				Release		1	87	0	0	1	0	89								
ST25	2004/7/8	56°30'N 179°00'W	8.6	B	30	2	105	2	0	3	0	112	0	0	0	0	0	0		
				C	30	21	330	4	0	3	0	358	0	0	0	0	0	0		
				A	19	29	118	16	3	9	0	175	0	0	0	0	0	0		
				Total		52	553	22	3	15	0	645	0	0	0	0	0	0	6	
				Release		2	63	2	0	2	0	69								
ST26	2004/7/9	56°30'N 179°00'E	7.6	B	30	1	159	0	0	0	0	160	0	0	0	0	0	0		
				C	30	20	338	4	0	0	0	362	0	0	11	0	0	2		
				A	19	10	147	12	0	0	0	169	0	0	0	1	0	1		
				Total		31	644	16	0	0	0	691	0	0	11	1	0	3		
				Release		0	101	0	0	0	0	101								
ST27	2004/7/10	56°30'N 178°00'E	7.7	B	30	3	34	0	0	1	0	38	0	0	0	0	0	0		
				C	30	16	262	6	0	0	0	284	0	0	15	1	0	0		
				A	19	13	93	6	0	0	0	112	0	0	0	0	0	0		
				Total		32	389	12	0	1	0	434	0	0	15	1	0	0		
				Release		2	23	0	0	1	0	26								
ST28	2004/7/11	56°30'N 177°00'E	7.5	B	30	0	17	0	0	1	0	18	0	0	0	0	0	0		
				C	30	26	178	8	1	1	0	214	0	0	50	0	0	6		
				A	19	18	49	11	1	0	0	79	0	0	1	0	0	0		
				Total		44	244	19	2	2	0	311	0	0	51	0	0	6		
				Release		0	10	0	0	1	0	11								
ST29	2004/7/12	57°30'N 177°00'E	8.1	B	30	1	8	0	0	0	0	9	0	0	0	0	0	0		
				C	30	11	44	7	0	3	0	65	0	0	1	0	0	1		
				A	19	7	42	10	2	1	0	62	0	0	0	0	0	0		
				Total		19	94	17	2	4	0	136	0	0	1	0	0	1		
				Release		1	6	0	0	0	0	7								

—Table 2. continued—

St.	Date	Location	SST	Gear	No. unit	Pacific salmon																	
						SO	CH	PK	CO	CN	ST	Total	PP	PS	AM	SH	OF	SQ					
ST30	2004/7/13	57°30'N 176°00'F	8.4	B	30	0	11	0	0	0	0	0	0	11	0	0	0	0	0	0			
				C	30	23	40	8	1	0	0	0	0	0	72	0	0	0	0	0	0		
				A	19	2	15	7	1	4	0	0	0	0	29	0	0	0	0	0	0	0	
				Total		25	66	15	2	4	0	0	0	0	112	0	0	0	5	0	0	0	0
				Release		0	9	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0
ST31	2004/7/14	56°30'N 176°00'F	8.7	B	30	1	23	0	1	0	0	0	0	25	0	0	0	0	0	0			
				C	30	64	155	2	0	0	1	0	0	0	222	0	0	0	0	0	0	1	
				A	19	17	86	16	0	4	0	0	0	0	123	0	0	0	0	0	0	0	
				Total		82	264	18	1	5	0	0	0	0	370	0	0	0	0	0	0	0	1
				Release		1	9	0	1	0	0	0	0	0	11	0	0	0	0	0	0	0	0
Total				B	870	36	911	48	61	46	5	1107	249	0	21	0	4	3					
				C	660	323	2477	286	85	103	8	3282	393	150	84	3	2	133					
				F	12	0	0	0	0	0	0	0	0	873	0	0	0	0					
				A	406	235	1333	309	147	83	14	2121	358	0	1	7	1	29					
				Total		594	4721	643	293	232	27	6510	1000	1023	106	10	7	165					
Release		30	573	31	50	33	0	717	0	0	0	0	0	0	0	0							



**Table 3.** Archival tag releases in the central North Pacific Ocean and the Bering Sea during the R/V *Wakatake maru* cruise in 2004. FAJ, Fisheries Agency of Japan; FRI, Fisheries Research Institute, University of Washington. One pink salmon, shown in bold lettering, was recovered the following day at the same location it was released.

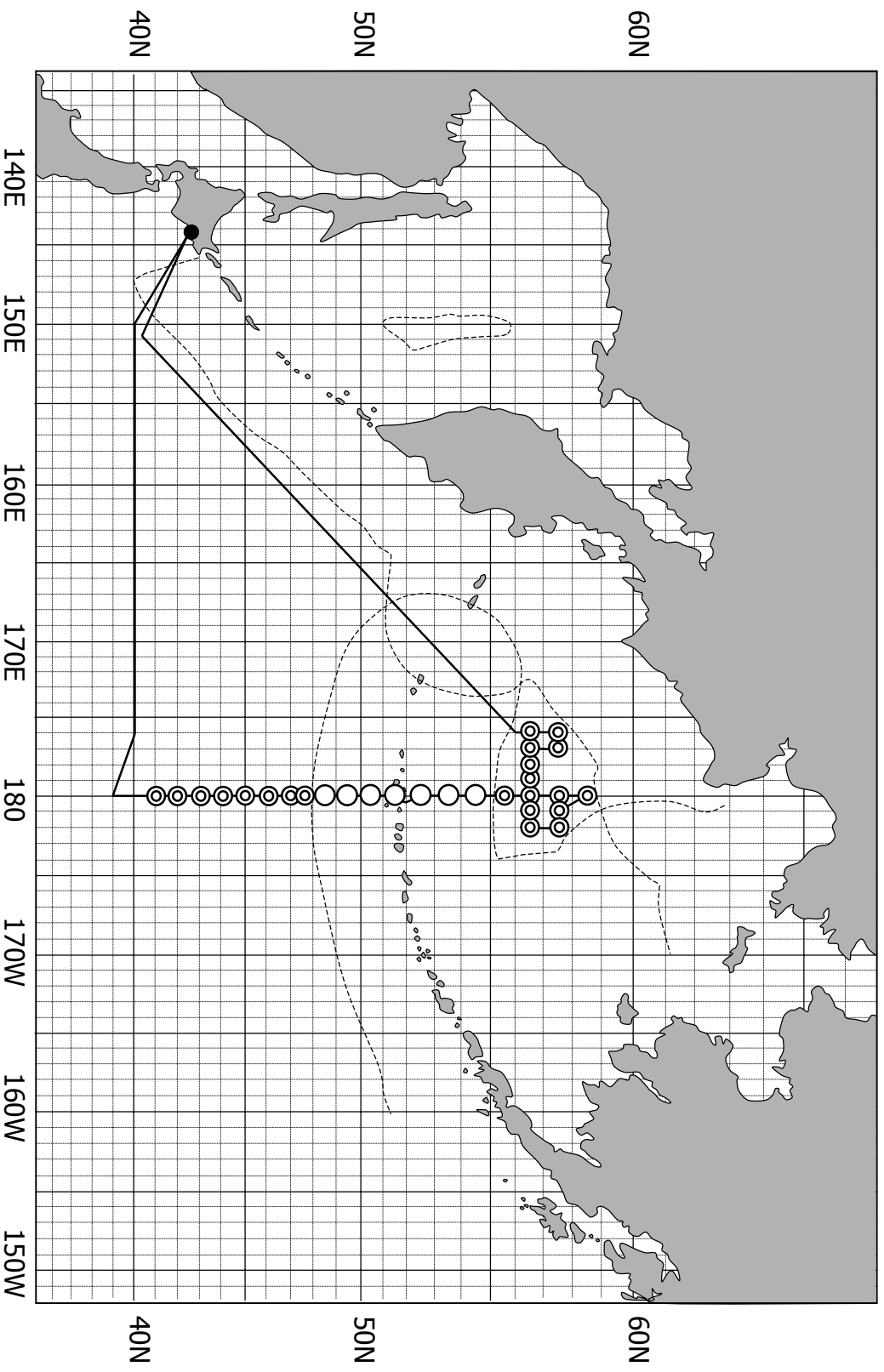
St.	Type of archival tag	Archival tag number	Disk tag number		Species	Fork length (mm)	Age	
			FRI	FAJ			Fresh	Ocean
ST19	CTD	1360	NN0232	MM2232	chinook	730	X	X
ST13	CTD	1361	NN0096	MM2096	sockeye	608	1	3
ST13	CTD	1363	NN0101	MM2101	sockeye	640	2	3
ST15	CTD	1364	NN0139	MM2139	chum	640	0	5
ST17	CTD	1365	NN0210	MM2210	chum	623	0	4
ST18	CTD	1366	NN0225	MM2225	chum	595	0	4
ST20	CTD	1367	NN0263	MM2263	chum	649	0	4
ST20	CTD	1369	NN0264	MM2264	chum	652	0	5
ST22	CTD	1373	NN0320	MM2320	chum	630	0	4
ST22	CTD	1375	NN0326	MM2326	chum	599	0	4
ST23	CTD	1376	NN0363	MM2363	chum	575	0	3
ST23	CTD	1378	NN0380	MM2380	chum	660	0	4
ST24	CTD	1379	NN0421	MM2421	chum	591	0	4
ST25	CTD	1380	NN0508	MM2508	chum	578	0	4
ST25	CTD	1381	NN0509	MM2509	chum	650	0	4
ST14	ibutton	W118	NN0133	MM2133	pink	480	0	1
ST14	ibutton	W119	NN0136	MM2136	pink	453	0	1
ST15	ibutton	W120	NN0152	MM2152	pink	446	0	1
ST16	ibutton	W121	NN0158	MM2158	pink	453	0	1
ST16	ibutton	W122	NN0159	MM2159	pink	427	0	1
ST17	ibutton	W123	NN0206	MM2206	pink	488	0	1
ST18	ibutton	W124	NN0221	MM2221	pink	445	0	1
ST13	ibutton	W125	NN0097	MM2097	sockeye	476	2	2
ST14	ibutton	W126	NN0105	MM2105	sockeye	479	2	2
ST14	ibutton	W127	NN0106	MM2106	sockeye	463	1	2
ST15	ibutton	W128	NN0137	MM2137	sockeye	465	0	2
ST08	ibutton	W129	NN0051	MM2051	chinook	653	1	3
ST15	ibutton	W130	NN0151	MM2151	sockeye	459	1	2
ST19	ibutton	W131	NN0235	MM2235	chinook	598	2	2
ST19	ibutton	W132	NN0238	MM2238	chinook	600	1	2
ST21	ibutton	W133	NN0303	MM2303	chinook	398	1	1
ST21	ibutton	W134	NN0305	MM2305	chinook	325	1	1
ST21	ibutton	W135	NN0306	MM2306	chum	549	X	X
ST21	ibutton	W136	NN0308	MM2308	chinook	522	1	2
ST18	ibutton	W137	NN0230	MM2230	pink	454	0	1
ST19	ibutton	W138	NN0234	MM2234	pink	453	0	1
ST19	ibutton	W139	NN0239	MM2239	chum	646	0	4
ST19	ibutton	W140	NN0241	MM2241	pink	468	0	1
ST20	ibutton	W141	NN0250	MM2250	pink	454	0	1
ST20	ibutton	W142	NN0251	MM2251	chum	603	0	4
ST20	ibutton	W143	NN0266	MM2266	pink	432	0	1
ST20	ibutton	W144	NN0265	MM2265	pink	467	0	1
ST21	ibutton	W145	NN0304	MM2304	pink	435	0	1
ST21	ibutton	W146	NN0311	MM2311	pink	450	0	1
ST22	ibutton	W147	NN0355	MM2355	pink	452	0	1
<b>ST23</b>	<b>ibutton</b>	<b>W148</b>	<b>NN0373</b>	<b>MM2373</b>	<b>pink</b>	<b>459</b>	<b>0</b>	<b>1</b>
ST22	ibutton	W149	NN0358	MM2358	chum	637	0	4
ST23	ibutton	W150	NN0377	MM2377	sockeye	576	2	2
ST25	ibutton	W151	NN0504	MM2504	pink	516	0	1
ST25	ibutton	W152	NN0523	MM2523	pink	526	0	1
ST28	ibutton	W153	NN0687	MM2687	chum	719	0	5
ST28	ibutton	W154	NN0688	MM2688	chum	564	0	3
ST22	ibutton	W155	NN0343	MM2343	chinook	558	1	2

—Table 3. continued—

St.	Type of archival tag	Archival tag number	Disk tag number		Species	Fork length (mm)	Age	
			FRI	FAJ			Fresh	Ocean
ST21	ibutton	W156	NN0309	MM2309	chinook	584	1	2
ST21	ibutton	W157	NN0310	MM2310	chinook	382	1	1
ST21	ibutton	W158	NN0314	MM2314	chinook	546	1	3
ST22	ibutton	W159	NN0359	MM2359	chinook	578	1	2
ST23	ibutton	W160	NN0392	MM2392	sockeye	450	2	2
ST24	ibutton	W161	NN0435	MM2435	sockeye	477	2	2
ST25	ibutton	W162	NN0490	MM2490	sockeye	489	2	2
ST26	ibutton	W163	NN0556	MM2556	chum	432	0	2
ST26	ibutton	W164	NN0625	MM2625	chum	432	0	2
ST26	ibutton	W165	NN0630	MM2630	chum	435	0	2
ST26	ibutton	W166	NN0645	MM2645	chum	399	0	2
ST27	ibutton	W167	NN0663	MM2663	chum	541	X	3
ST27	ibutton	W168	NN0666	MM2666	sockeye	481	1	2
ST27	ibutton	W169	NN0668	MM2668	chum	437	0	2
ST27	ibutton	W170	NN0671	MM2671	chum	468	0	3
ST27	ibutton	W171	NN0676	MM2676	sockeye	489	1	2
ST27	ibutton	W172	NN0681	MM2681	chum	462	0	2
ST28	ibutton	W173	NN0683	MM2683	chum	428	0	2
ST28	ibutton	W174	NN0684	MM2684	chum	420	0	2
ST28	ibutton	W175	NN0690	MM2690	chum	511	0	3
ST28	ibutton	W176	NN0693	MM2693	chum	425	0	2
ST29	ibutton	W177	NN0694	MM2694	chum	516	0	3
ST29	ibutton	W178	NN0695	MM2695	chum	431	0	2
ST29	ibutton	W179	NN0696	MM2696	chum	608	0	4
ST29	ibutton	W180	NN0697	MM2697	chum	552	0	3
ST29	ibutton	W181	NN0698	MM2698	chum	534	0	3
ST29	ibutton	W182	NN0699	MM2699	chum	454	0	2
ST29	ibutton	W183	NN0700	MM2700	sockeye	498	1	2
ST30	ibutton	W184	NN0701	MM2701	chum	500	0	3
ST30	ibutton	W185	NN0702	MM2702	chum	588	0	3
ST30	ibutton	W186	NN0703	MM2703	chum	545	0	3
ST30	ibutton	W187	NN0704	MM2704	chum	557	0	3
ST30	ibutton	W188	NN0705	MM2705	chum	741	0	4
ST30	ibutton	W189	NN0706	MM2706	chum	624	0	3
ST30	ibutton	W190	NN0707	MM2707	chum	556	0	4
ST30	ibutton	W191	NN0708	MM2708	chum	510	0	3
ST30	ibutton	W192	NN0709	MM2709	chum	586	0	4
ST09	LTD	5917	NN0074	MM2074	chinook	720	X	3
ST14	LTD	5927	NN0122	MM2122	sockeye	473	1	2
ST15	LTD	5936	NN0138	MM2138	sockeye	449	1	2
ST16	LTD	5941	NN0170	MM2170	sockeye	491	1	2
ST16	LTD	5942	NN0189	MM2189	chum	611	0	4
ST17	LTD	5952	NN0192	MM2192	chum	504	0	3
ST17	LTD	5956	NN0195	MM2195	chum	620	0	4
ST17	LTD	5963	NN0198	MM2198	chum	588	0	3
ST17	LTD	5970	NN0199	MM2199	chum	600	0	4
ST17	LTD	5979	NN0200	MM2200	chum	631	0	3
ST17	LTD	5980	NN0209	MM2209	chum	521	0	3
ST18	LTD	5981	NN0224	MM2224	chum	614	0	4
ST19	LTD	5985	NN0233	MM2233	chum	589	0	4
ST19	LTD	5987	NN0236	MM2236	chinook	686	1	2
ST19	LTD	5991	NN0237	MM2237	chum	635	0	4
ST19	LTD	5996	NN0240	MM2240	sockeye	617	1	3

—Table 3. continued—

St.	Type of archival tag	Archival tag number	Disk tag number		Species	Fork length (mm)	Age	
			FRI	FAJ			Fresh	Ocean
ST19	LTD	5998	NN0242	MM2242	chinook	598	1	2
ST17	LTD	6358	NN0197	MM2197	chinook	689	1	3
ST19	LTD	7429	NN0243	MM2243	chinook	582	X	2
ST19	LTD	7430	NN0245	MM2245	chum	605	0	3
ST20	LTD	7431	NN0249	MM2249	sockeye	577	2	2
ST20	LTD	7432	NN0277	MM2277	sockeye	556	X	X
ST20	LTD	7433	NN0278	MM2278	sockeye	520	2	2
ST20	LTD	7434	NN0286	MM2286	chum	572	0	3
ST20	LTD	7435	NN0299	MM2299	chum	588	0	4
ST21	LTD	7436	NN0302	MM2302	chinook	591	X	2
ST21	LTD	7437	NN0307	MM2307	chinook	576	1	2
ST21	LTD	7438	NN0313	MM2313	chum	574	0	4
ST21	LTD	7439	NN0315	MM2315	chinook	630	1	2
ST21	LTD	7440	NN0317	MM2317	chum	622	0	4
ST22	LTD	7441	NN0321	MM2321	chinook	561	X	2
ST22	LTD	7442	NN0322	MM2322	chinook	633	1	3
ST22	LTD	7444	NN0323	MM2323	chinook	545	1	2
ST22	LTD	7445	NN0324	MM2324	chum	566	0	4
ST22	LTD	7446	NN0327	MM2327	chum	611	0	3
ST22	LTD	7447	NN0328	MM2328	chinook	613	1	3
ST22	LTD	7448	NN0329	MM2329	chum	634	0	4
ST22	LTD	7449	NN0330	MM2330	chum	562	0	3
ST22	LTD	7450	NN0341	MM2341	chinook	605	X	2
ST22	LTD	7451	NN0342	MM2342	chinook	529	1	2
ST23	LTD	7453	NN0360	MM2360	chinook	626	1	2
ST23	LTD	7454	NN0376	MM2376	chum	543	0	3
ST23	LTD	7455	NN0391	MM2391	chum	644	0	4
ST24	LTD	7456	NN0396	MM2396	chum	573	0	3
ST24	LTD	7457	NN0400	MM2400	chinook	593	1	2
ST24	LTD	7458	NN0401	MM2401	chum	554	0	3
ST24	LTD	7459	NN0404	MM2404	chum	642	0	4
ST24	LTD	7460	NN0405	MM2405	chum	666	0	3
ST25	LTD	7461	NN0486	MM2486	chum	535	0	4
ST25	LTD	7464	NN0510	MM2510	chinook	610	1	2
ST25	LTD	7465	NN0521	MM2521	chinook	552	X	2
ST25	LTD	7466	NN0522	MM2522	sockeye	520	1	2
ST25	LTD	7467	NN0541	MM2541	chum	583	0	3
ST26	LTD	7468	NN0557	MM2557	chum	624	0	4
ST26	LTD	7469	NN0562	MM2562	chum	641	0	4
ST26	LTD	7470	NN0577	MM2577	chum	621	0	4
ST26	LTD	7471	NN0578	MM2578	chum	620	0	4
ST26	LTD	7473	NN0581	MM2581	chum	640	0	4
ST26	LTD	7474	NN0629	MM2629	chum	590	0	4
ST26	LTD	7475	NN0633	MM2633	chum	606	0	4
ST26	LTD	7476	NN0638	MM2638	chum	636	0	4
ST26	LTD	7477	NN0644	MM2644	chum	655	0	4
ST27	LTD	7478	NN0660	MM2660	chum	490	0	3
ST27	LTD	7479	NN0667	MM2667	chum	637	X	X
ST27	LTD	7480	NN0670	MM2670	chum	615	0	3
ST27	LTD	7481	NN0672	MM2672	chinook	646	X	X
ST28	LTD	7482	NN0685	MM2685	chum	511	0	3
ST28	LTD	7484	NN0686	MM2686	chinook	710	X	3



**Fig. 1.** The survey area of the R/V *Wakatake maru* cruise during summer 2004. Single circles indicate longline fishing stations, double circles indicate station locations where longline and gillnet fishing operations were conducted.