NPAFC
Doc. 622
Rev.

International Salmon Research Aboard the R/V *Wakatake maru* in the Central North Pacific Ocean and Bering Sea during the Summer of 2002

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Submitted to the

NORTH PACIFIC ANADROMOUS FISH COMMISSION

by

JAPAN

October 2002

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
Tanaka, H, N. Davis, T. Onuma, M. Yamada, Y. Yamamoto, and S. Tsuchiya. 2002. International salmon research aboard the R/V *Wakatake maru* in the central North Pacific Ocean and Bering Sea during the summer of 2002. (NPAFC Doc. 622). 21 p. Hokkaido National Fisheries Research Institute, Fisheries Research Agency, 116 Katsurakoi, Kushiro 085-0802, Japan.

International Salmon Research Aboard the R/V *Wakatake maru* in the Central North Pacific Ocean and Bering Sea during the Summer of 2002

Abstract

An annual high-seas salmonid research cruise was conducted in the central North Pacific Ocean and Bering Sea from June 8 to July 21, 2002 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 0.3°C warmer than in 2001, continuing a warming trend begun in 1999. In 2002, superficial warming of the sea surface during the summer produces a shallow seasonal thermocline at 25 to 30 m, which was 10-20 m deeper than previous years. A total of 7931 salmonids was caught by longline and gillnet: 526 fish in the central North Pacific Ocean (St. 3-14) and 7405 fish in the central Bering Sea (St. 15-30). In the North Pacific Ocean, chum salmon was the most abundant species (58% of the salmonid catch), followed by coho (28%), sockeye (5.7%), steelhead trout (4.8%), pink (2.7%) and chinook salmon (0.6%). In the Bering Sea, chum salmon was the most abundant species (88% of the salmonid catch), followed by sockeye (9.3%), chinook (2.3%), and pink salmon (0.6%). The number of chum salmon caught by longline was three times larger than the previous two years. A total of 718 stomach samples was examined onboard the research vessel. Samples collected from the central North Pacific south of 46°N showed an unusually high abundance of salps in the stomach contents of chum and coho salmon. In the Bering Sea, the high abundance of euphausiids in the stomach contents of chum, sockeye, pink, and chinook salmon suggests a favorable feeding condition during this cruise. Brain and pituitary samples were obtained from 179 chum salmon for endocrine studies. Along with these samples, olfactory neurone and epithelium were collected from 46 fish to investigate genes related to homing migration. A total of 1042 salmonids (974 chum, 28 sockeye, 21 chinook salmon, 15 coho, 2 pink, and 2 steelhead trout) were released with disk tags to the North Pacific Ocean and Bering Sea. These fish included 48 chum, 18 chinook salmon, 16 sockeye, and 2 steelhead trout, which were released with archival tags.

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 from 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, including collection of data on physical oceanography, primary production, and relationships of zooplankton, salmonid, and higher trophic levels, was conducted annually in the central North Pacific Ocean and Bering Sea during summer. This document summarizes the R/V *Wakatake maru* cruise research conducted in these waters during June and July 2002.

Methods

Research Vessel and Survey Areas

The *Wakatake maru* (666 gross tons) departed Kushiro on June 8, 2002 and returned on July 21, 2002. There were 28 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, and nine operations were conducted in the 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 of the water column were collected in a manner identical to that in 2001 (Fukuwaka et al. 2000). 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 (n = 31). The conductivity, temperature, and depth sensor (CTD) was used at 5°-longitude intervals along the eastward transit and at fishing stations (n = 35). STD (Salinity Temperature Depth Profiler) was used when sea condition prevented us using CTD (n = 5). The XCTD was used at 1°-latitude intervals between fishing stations of 39°30'N to 53°30'N and at 1°-longitude intervals on the return leg from the Bering Sea (n = 41). The CTD and XCTD record data in 1-m intervals from the surface to approximately 1000 m.

Primary Production

Chlorophyll samples were collected at 19 fishing stations (St. 3-21) along a south to north transect and at 12 transit stations located at an interval of 5° longitude (Table 1). A bucket was used to collect a surface water sample of which 100-ml was filtered through a 25-mm glass-fiber filter (Whatman GF/F) using a vacuum pump (100-120 mm Hg). Filters containing the chlorophyll-a were soaked with 6 ml of N-dimethylformaide and kept in the freezer.

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 28 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 28 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 ca. 2 knots for 10 min around 23:00 hrs. Samples were fixed in 10% borax-buffered formalin in seawater. When NORPC or 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 13 stations in the central Bering Sea, outside of the U.S. EEZ (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 158 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). At eight fishing stations (St. 3-10) in the central North Pacific, the number of tans of A-gear was reduced from 19 to 17 tans, and two tans of smaller mesh size (F-gear: one tan each of 29 and 37 mm mesh size, one tan is 25 m long) were substituted in order to collect Pacific saury (*Cololabis saira*). The longline was used at 26 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 or 13) 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 trout *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 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 potential recovery of a coded-wire tag.

Non-salmonid sampling

All non-salmonid catches were identified and counted by mesh size. Body length was measured on fish, squid, and other organisms, and a few were frozen for taxonomic and ecological studies. Pacific saury were sent to the Hokkaido Fisheries Experimental Station, Kushiro, neon flying squid (*Omastrephes bartrami*) were sent to the National Research Institute of Far Seas Fisheries, Shimizu, and dead birds accidentally caught were sent to the Graduate School of Fisheries Science, Hokkaido University, Hakodate, for further examination. Salmon shark (*Lamna ditropis*) was measured for body length, sexual maturity, and the stomach contents examined. Blood, cartilage, and DNA samples collected from salmon shark were sent to the School of Aquatic and Fishery Sciences, University of Washington, Seattle, for further analysis.

Salmonid Stomach Content Examination

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). These 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.

Disk Tagging

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 (JFA) and the Fisheries Research Institute, University of Washington (FRI). 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.

Archival Tagging

Three types of externally-attached archival tags were used. One tag, used by FRI, is manufactured by Lotek Marine Technologies, Newfoundland, Canada (model LTD 1100-300; size = 8mm x 16mm x 27mm; weight in air = 5 grams; number of records = 32,768) and records temperature and depth data. Sampling interval of LTD depends on total recording time, which is referred as Time Extension Recording. The logger begins recording at a base sampling interval of 1 sample every 14.063 seconds. When its memory is full, the logger doubles its sampling interval and continues recording, overwriting every other sample in memory, and when its memory is filled at that sampling interval it doubles its sampling interval again. The process can repeat almost indefinitely. Another tag used by FRI is a Thermonchron iButton data storage device, manufactured by Dallas Semiconductor, Inc., and repackaged for fish tagging by AlphaMach, Inc. (model iB4; size = 8 mm x 16 mm x 24 mm; weight in air = 3.8 grams; number of records = 2048). The iB4 records temperature data only. A third type of archival tag is manufactured by the Little Leonard Ltd., Tokyo, Japan (model W190L-PDT; cylinderal shape = 110 mm in length and 20 mm in diameter; weight in air = 75 grams) and records swimming speed, depth, and temperature. The Number of records can be varied between 2,000,000 - 4,000,000, which depends on the variation of data. The speed sensor of the loggers consists of a propeller rotation counter (Tanaka et al. 2001). All types of tags were attached externally in the dorsal musculature of the fish anterior to the dorsal fin with stainless wires, or nickel pins.

Steelhead trout were tagged with iB4 (sampling intervals of temperature data = 4.25 hour). In the Bering Sea, we selected large maturing chum salmon considered to be of Japanese origin, and older than 0.3 age among the disk tagged fish (Urawa et al. 2000). We attached a PDT (sampling intervals of data: speed and depth = 2; temperature = 60 sec), or double tagged these chum salmon with both a LTD and iB4 (sampling intervals of temperature = 1.50 hour) to these fish. Other immature and mature chum salmon were tagged with iB4 tags. Sampling intervals of iB4 tags were set at 4.25 hour and 1.5 hour for immature and mature fish, respectively. Sockeye and chinook salmon were tagged with either a LTD or iB4 tag (sampling intervals = 4.25 hour).

Other Sampling and Research

The brain, pituitary, gonad, liver, head kidney and blood samples of chum salmon were collected for (1) molecular endocrine analysis of the spawning migration, including roles of salmon gonadotropin-releasing hormone (sGnRH) and (2) analysis of endocrinological changes of the fish during 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 was measured and a scale collected. Blood samples were collected from the caudal vasculature and centrifuged to obtain plasma samples for analyzing levels of steroid hormones. Blood clot samples were collected for determination of haplotypes based on the sequences of mitochondrial DNA. These samples were stored at –20°C. Fish were killed by decapitation, and 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. The brain of some fish was divided into six parts (olfactory bulb, telencepharon, optic tectum, hypothalamus, cerebellum, and medulla oblongata) to determine the amount of GnRH (sGnRH and cGnRH-II) and gonadotropin (GTH Iand GTH II) contents in specific areas of

the brain. Several parts of the gonads, liver and head kidneys were frozen in liquid nitrogen to measure contents of GnRH and GTH, to determine levels of mRNA encoding insulin-like growth factor I , and levels of levels of steroid hormones, respectively. Additional samples of the gonads were fixed in Bouin's solution and stored in 70% ethanol for histological analyses. In addition to the brain and pituitary samples, olfactory neurone and olfactory epithelium of some chum were collected to investigate genes related to the homing migration. All the brain, pituitary, and olfactory samples were stored at –50°C.

In the central North Pacific Ocean and Bering Sea, round samples of salmon which might be a hybrid between chum and pink salmon, and extremely slim (skinny) fish were collected.

Results and Discussion

Physical Oceanography

The 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 2 and 3 where located in the Transition Zone, an area characterized by relatively saline waters (> 34.0 psu). A vertical 34.0 psu isohaline characterizes the Subarctic Boundary, which separates subtropical and subarctic waters. The Boundary was located between 41°00'N (St. 3) and 42°N (St. 4). In 2002, the Subarctic Boundary was located near its position in 2001, which was located more northerly than in 1997-2000 years (Fukuwaka et al. 2001). However, this location is south of the boundary's position in 1991 through 1996 (Davis et al. 1996, Nagasawa et al. 1997; Ueno et al. 1998, Kawana et al. 1999, Urawa et al. 2000). 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 41°N and 46°N (between St. 3 and St. 8). 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 47°N (St. 9) and 47°30'N (St. 10). Further to the north, at 49°30'N to 50°30'N (Stations 12-13), 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 produces a shallow seasonal thermocline at 25 to 30 m, which was 10-20 m deeper than previous years (Urawa et al. 2000, Fukuwaka et al. 2001).

In 2002, average sea surface temperatures in the North Pacific were 0.3°C warmer than in 2001 (St. 1-13; 2002 mean = 9.6°C, 2001 mean = 9.3°C), continuing a warming trend begun in 1999. In the Bering Sea, sea surface temperatures in 2002 (St. 14-28; mean = 6.8°C) were 1.6°C warmer than in 2001 (mean = 5.2°C), but were almost the same in 2000 (mean = 7.0°C; Ueno et al. 1998, Kawana et al. 1999, Urawa et al. 2000, Fukuwaka et al. 2001).

Salmonid Catches

A total of 7,931 salmonids was caught by longline and gillnet: 526 fish in the central North Pacific Ocean (St. 3-14) and 7405 fish in the central Bering Sea (St. 15-30; Table 2). In the North Pacific Ocean, chum salmon was the most abundant species (58% of the salmonid catch), followed by coho (28%), sockeye (5.7%), steelhead trout (4.8%), pink (2.7%) and chinook salmon (0.6%). In the Bering Sea, chum salmon was the most abundant species

(88% of the salmonid catch), followed by sockeye (9.3%), chinook (2.3%), and pink salmon (0.6%). In 2002, the number of chum salmon caught by longline (n = 1967) was three times larger than those in 2000 (n = 628) and 2001 (n = 738), while the number caught by gillnet was slightly larger (n = 4836) than previous two years (n = 4176 in 2000 and n = 3551 in 2001).

Snout Recovery from Adipose Fin-clipped Salmonids

Twelve fin-clipped steelhead trout were caught in the central North Pacific Ocean. The snouts were salted and sent to the Auke Bay Laboratory, Juneau, AK, for dissection and potential recovery of coded-wire tags.

Non-salmonid Catches

Pacific pomfret (*Brama japonica*: n=1210) and Atka mackerel (*Pleurogrammus monopterygius*: n=378) were particularly abundant in the catch (Table 2). In addition, 173 Pacific saury, three neon flying squid, 138 other squids, three lancet fish (*Alepisaurus ferox*), two spiny dogfish (*Squalus acanthias*) and two salmon sharks were caught. Both of the salmon sharks were males (one immature, one mature). The mature male had a fresh chinook salmon (age 1.2) in its stomach. The stomach of the immature male contained Pacific saury. Other non-salmonid fishes included in the catch were lamprey fish (*Lampetra* sp.), flathead pomfret (*Taracetes asper*), goldstriped amberjack (*Seriola lalanndi*) and albacore (*Thunnus alalunga*).

Salmonid Stomach Content Examination

A total of 718 stomach samples was examined onboard the *Wakatake maru*. This total includes samples collected from 162 sockeye, 338 chum, 52 pink, 51 coho, and 92 chinook salmon, and 23 steelhead trout.

Salmon samples collected from the central North Pacific south of 46°N showed an unusually high abundance of salps in the stomach contents of chum and coho salmon. This area was characterized by warm water temperatures, and large catches of salps in the ORI net. The stomach contents of chum and coho salmon also contained the hyperiid amphipod, *Phronima sedentaria*, which uses salps to create barrels in which to live and rear their young. Another hyperiid, *Themisto pacific*, was numerous in the stomach contents of chum salmon. North of 46°N and south of the Aleutian Islands, chum salmon stomach contents contained more ctenophores, pteropods, and copepods than further south. In this area squid, *Berryteuthis anonychus*, was present in the stomachs of coho, chinook, sockeye, and pink salmon, and steelhead. Chinook salmon and steelhead were also feeding on fish, including myctophids and Atka mackerel (*Pleurogrammus monopterygius*). Young sockeye (ocean age 1) fed heavily on *Themisto.*

Examination of salmon stomach contents collected from the Bering Sea showed a variety of post-larval and juvenile fish consumed by all salmon species, particularly chum, sockeye, and pink salmon. These small fish included post-larval halibut, *Hippoglossus stenolepis*, *Atheresthes* sp., bathymasterids, juvenile Atka mackerel (*Pleurogrammus monopterygius*), and irish lords (*Hemilepidotus* spp.). The adult northern lampfish (*Stenobrachius leucopsarus*) was commonly found in the stomach contents of all salmon species, and may be a particularly important prey fish because it contains abundant lipid (T. Nomura, pers. comm. Nat. Sal. Res. Ctr., Sapporo). In the Bering Sea, the euphausiid, *Thysanoessa longipes*, is a common prey item found in the stomachs of chum, sockeye, pink, and chinook salmon. Chinook and sockeye salmon were found with large (>50 mm mantle length) *Berryteuthis anonychus* squid in their stomachs, as well as small squid (<25 mm mantle length) that may be juvenile *B. anonychus*. Small squid are also consumed by chum and pink salmon. The presence of *B. anonychus* in salmon stomachs indicates that this squid is clearly distributed in

the Bering Sea, although previously there were no records from this area (Roper et al. 1984). Other common prey organisms include *Themisto, Limacina* and *Clione* (both pteropods), copepods (*Neocalanus cristatus* CV) consumed by chum, pink, and sockeye salmon. Chum salmon had the most varied diet and were observed to also feed on ctenophores (*Beroe* sp.) medusae, (*Aglantha digitale*), and *Oikopleura* sp. The high abundance of euphausiids in the stomach contents of chum, sockeye, pink, and chinook salmon suggests a favorable feeding condition in the Bering Sea during this cruise.

Disk Tagging

A total of 1042 tagged salmonids were released to the North Pacific Ocean (n = 42) and Bering Sea (n = 1000; Table 2). The releases included 974 chum, 28 sockeye, 21 chinook, 15 coho, 2 pink salmon, and 2 steelhead trout. Of these fish, 51 salmon at St.27 and 28 were released with only JFA disk tag because we exhausted our supply of FRI disk tags at St.27. The tag release information is compiled in Fukuwaka et al. (2002).

Archival Tagging

Archival tags were attached to a total of 84 salmonids with disk tags (Table 3). In the central North Pacific Ocean, 4 sockeye, 3 immature chum, and 2 steehead trout were released with LTD or iB4 tags. In the Bering Sea, 9 chum with iB4; 36 mature chum of Japanese origin with PDT, or double tagged with a LTD and iB4; and 18 chinook and 12 sockeye salmon were released carrying a LTD or iB4 archival tag.

Other Sampling and Research

Brain and pituitary samples were collected from total 179 chum salmon at twenty-four stations (St. 05 – 28; Table 4). Olfactory neurone and epithelium were collected from 46 chum salmon at St. 06 - 14 in the North Pacific Ocean and three stations in the Bering Sea. Gonad, blood and liver samples were collected from 102 (gonad and blood) and 92 chum salmon (liver) at 20 and 17 fishing stations, respectively.

Based on external characteristics, six round samples were selected as possible hybrids of chum and pink salmon. In addition, three skinny chum salmon were collected as round samples for lipid analysis and evaluation of body condition.

Acknowledgements

We thank Captain Yuichi Murata and the officers, crew, teacher, and students of the R/V *Wakatake maru* for their cooperation in research and sample collections during the cruise.

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Table 1. Research activities conducted at each station during the *Wakatake maru* cruise in 2002.

No	St	Date	Latitude	Longitude	XBT	XCTD	CTD	Primary	NORPAC	ORI	Gillnets	Longline	Remarks
1	T-01	Jun 09	40¡00'	150¡00'E	o		o	o	o				
2	T-02	Jun 09	40¡00'	151¡00'E	o								
3	T-03	Jun 10	40¡00'	152¡00'E	o								
4	T-04	Jun 10	40¡00'	153¡00'E	o								
5	T-05	Jun 10	40¡00'	154¡00'E	o								
6	T-06	Jun 10	40¡00'	155¡00'E	o		2	o	o				STD was used due to bad weather
7	T-07	Jun 10	40¡00'	156¡00'E	o								
8	T-08	Jun 10	40¡00'	157¡00'E	o								
9	T-09	Jun 11	40¡00'	158¡00'E	o								
10	T-10	Jun 11	40¡00'	159¡00'E	o								
11	T-11	Jun 11	40¡00'	160¡00'E	o		o	o	o				
12	T-12	Jun 11	40¡00'	161¡00'E	o								
13	T-13	Jun 11	40¡00'	162¡00'E	o								
14	T-14	Jun 11	40¡00'	163¡00'E	o								
15	T-15	Jun 12	40¡00'	164¡00'E	o								
16	T-16	Jun 12	40¡00'	165¡00'E	o		o	o					
17	T-17	Jun 12	40¡00'	166¡00'E	o								
18	T-18	Jun 12	40¡00'	167¡00'E	o								
19	T-19	Jun 12	40¡00'	168¡00'E	o								
20	T-20	Jun 12	40¡00'	169¡00'E	o								
21	T-21	Jun 13	40¡00'	170¡00'E	o		o	o					
22	T-22	Jun 13	40¡00'	171¡00'E	o								
23	T-23	Jun 13	40¡00'	172¡00'E	o								
24	T-24	Jun 13	40¡00'	173¡00'E	o								
25	T-25	Jun 13	40¡00'	174¡00'E	o								
26	T-26	Jun 13	40¡00'	175¡00'E	o		o	o					
27	T-27	Jun 14	40¡00'	176¡00'E	o								
28	T-28	Jun 14	39¡45'	177¡00'E	o								
29	T-29	Jun 14	39¡30'	178¡00'E	o								
30	T-30	Jun 14	39¡15'	179¡00'E	o								
31	ST-01	Jun 14	39¡00'	180¡00'	o		o	o					
32	T-31	Jun 15	39¡30'	180¡00'		o							
33	ST-02	Jun 15	40¡00'	180¡00'			o	o					
34	T-32	Jun 15	40¡30'	180¡00'		o							
35	ST-03	Jun 15	41¡00'	180¡00'			o	o	o	o	o	o	
36	T-33	Jun 16	41¡30'	180¡00'		o							
37	ST-04	Jun 16	42¡00'	180¡00'			o	o	o	o	o	o	
38	T-34	Jun 17	42¡30'	180¡00'		o							
39	ST-05	Jun 17	43¡00'	180¡00'			o	o	o	o	o	o	
40	T-35	Jun 18	43¡30'	180¡00'		o							
41	ST-06	Jun 18	44¡00'	180¡00'			o	o	o	o	o	o	
42	T-36	Jun 19	44¡30'	180¡00'		o							
43	ST-07	Jun 19	45¡00'	180¡00'			o	o	o	o	o	o	
44	T-37	Jun 20	45¡30'	180¡00'		o							
45	ST-08	Jun 20	46¡00'	180¡00'			o	o	o	o	o	o	
46	T-38	Jun 21	46¡30'	180¡00'		o							
47	ST-09	Jun 22	47¡00'	180¡00'			2	o	o	o	o	o	STD was used due to bad weather
48	ST-10	Jun 23	47¡30'	180¡00'			2	o	o	o	o	o	STD was used due to bad weather
49	T-39	Jun 24	48¡00'	180¡00'		o							
50	ST-11	Jun 24	48¡30'	180¡00'			o	o	o	o		o	
51	T-40	Jun 25	49¡00'	180¡00'		o							
52	ST-12	Jun 25	49¡30'	180¡00'			o	o	o	o		o	
53	T-41	Jun 26	50¡00'	180¡00'		o							
54	ST-13	Jun 26	50¡30'	180¡00'			o	o	o	o		o	
55	T-42	Jun 27	51¡00'	180¡00'		o							

(continued on next page)

Table1 - continued

No	St	Date	Latitude	Longitude	XBT	XCTD	CTD	Primary	NORPAC	ORI	Gillnets	Longline	Remarks
56	ST-14	Jun 27	51°30'	180°00'			o	o	o	o		o	
57	T-43	Jun 28	52°00'	180°00'		o							
58	ST-15	Jun 28	52°30'	180°00'			o	o	o	o		o	
59	T-44	Jun 29	53°00'	180°00'		o							
60	ST-16	Jun 29	53°30'	180°00'			o	o	o	o		o	
61	T-45	Jun 30	54°00'	180°00'									
62	ST-17	Jun 30	54°30'	180°00'			o	o	o	o		o	
63	T-46	Jul 01	55°00'	180°00'									
64	ST-18	Jul 01	55°30'	180°00'			o	o	o	o	o	o	
65	T-47	Jul 02	56°00'	180°00'									
66	ST-19	Jul 02	56°30'	180°00'			o	o	o	o	o	o	
67	T-48	Jul 03	57°00'	180°00'									
68	ST-20	Jul 03	57°30'	180°00'			o	o	o	o	o	o	
69	T-49	Jul 04	58°00'	180°00'									
70	ST-21	Jul 04	58°30'	180°00'			2	o	o	o	o	o	STD was used due to bad weather
71	ST-22	Jul 05	57°30'	179°00'W			2		o	o	o	o	STD was used due to bad weather
72	ST-23	Jul 06	57°30'	178°00'W			o		o	o	o	o	
73	ST-24	Jul 07	56°30'	178°00'W			o		o	o	o	o	
74	ST-25	Jul 08	56°30'	179°00'W			o		o	o	o	o	
75	ST-26	Jul 09	56°30'	179°00'E			o		o	o	o	o	
76	ST-27	Jul 10	56°30'	178°00'E			o		o	o	o	o	
77	ST-28	Jul 11	56°30'	177°00'E			o		o	o	o	o	
78	ST-29	Jul 12	57°30'	177°00'E			o		o	o	o		
79	ST-30	Jul 13	56°30'	176°00'E			o		o	o	o		
80	T-50	Jul 14	56°00'	176°00'E		o							
81	T-51	Jul 14	55°30'	175°00'E		o		o					
82	T-52	Jul 14	55°00'	174°00'E		o							
83	T-53	Jul 14	54°30'	173°00'E		o							
84	T-54	Jul 14	54°00'	172°00'E		o							
85	T-55	Jul 15	53°30'	171°00'E		o							
86	T-56	Jul 15	53°00'	170°00'E		o		o					
87	T-57	Jul 15	52°20'	169°00'E		o							
88	T-58	Jul 15	51°40'	168°00'E		o							
89	T-59	Jul 15	51°10'	167°00'E		o							
90	T-60	Jul 15	50°40'	166°00'E		o							
91	T-61	Jul 16	50°00'	165°00'E		o		o					
92	T-62	Jul 16	49°20'	164°00'E		o							
93	T-63	Jul 16	48°40'	163°00'E		o							
94	T-64	Jul 16	48°00'	162°00'E		o							
95	T-65	Jul 16	47°30'	161°00'E		o							
96	T-66	Jul 17	46°50'	160°00'E		o		o	o				
97	T-67	Jul 17	46°10'	159°00'E		o							
98	T-68	Jul 17	45°30'	158°00'E		o							
99	T-69	Jul 17	44°50'	157°00'E		o							
100	T-70	Jul 17	44°10'	156°00'E		o							
101	T-71	Jul 18	43°30'	155°00'E		o		o	o				
102	T-72	Jul 18	42°50'	154°00'E		o							
103	T-73	Jul 18	42°10'	153°00'E		o							
104	T-74	Jul 18	41°20'	152°00'E		o							
105	T-75	Jul 18	40°40'	151°00'E		o							
106	T-76	Jul 19	40°00'	150°00'E		o		o	o				

Table 2. Salmonids, other fishes, and squid catches at each station with sea water temperature (°C), and salinity (psu) at the surface and at 100 m during the summer research cruise of *Wakatake maru*, 2002. 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 gillnet (mesh=115 mm). The number of fish tagged with disk tags and released is listed for each station.

St.	Date	North Lat.	Long.	Temperature Surface	Temperature 100 m	Salinity Surface	Salinity 100 m	Gear	No. units	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Salmonid total	Neon flying squids	Other squids	Pacific pomfret	Pacific saury	Lancet Fish	Sharks	Atka mackerel	Other fishes
03	June 15	41¡00'	180¡00'	14.5	11.40	34.25	34.23	B	30	0	0	0	0	0	0	0	0	4	59	0	0	0	0	3
								C	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
								F	2	0	0	0	0	0	0	0	0	0	0	112	0	0	0	0
								A	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
								Total		0	0	0	0	0	0	0	0	4	59	112	0	0	0	6
								Released		0	0	0	0	0	0	0								
04	June 16	42¡00'	180¡00'	11.8	9.18	33.81	33.99	B	30	0	0	0	0	0	0	0	0	0	224	0	0	0	0	0
								C	30	0	0	0	0	0	0	0	1	99	230	1	0	0	0	0
								F	2	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0
								A	17	0	0	0	2	0	0	2	2	1	139	0	0	1	0	0
								Total		0	0	0	2	0	0	2	3	100	593	33	0	1	0	0
								Released		0	0	0	0	0	0	0								
05	June 17	43¡00'	180¡00'	9.58	6.86	33.49	33.49	B	30	0	7	0	0	0	0	7	0	0	486	0	0	0	0	0
								C	30	0	4	0	2	0	0	6	0	3	33	0	0	0	0	0
								F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	17	0	0	0	1	0	1	2	0	0	30	0	0	0	0	0
								Total		0	11	0	3	0	1	15	0	3	549	0	0	0	0	0
								Released		0	0	0	0	0	0	0								
06	June 18	44¡00'	180¡00'	8.69	6.71	33.15	33.58	B	30	0	2	1	0	0	0	3	0	0	2	0	0	0	0	0
								C	30	0	7	2	7	0	1	17	0	4	6	0	0	0	0	0
								F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	17	0	0	1	3	0	4	8	0	0	1	0	1	0	0	0
								Total		0	9	4	10	0	5	28	0	4	9	0	1	0	0	0
								Released		0	0	1	0	0	0	1								

(*continued on next page*)

Table 2 - continued

St.	Date	North Lat.	Long.	Temperature Surface	Temperature 100 m	Salinity Surface	Salinity 100 m	Gear	No. units	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Salmonid total	Neon flying squids	Other squids	Pacific pomfret	Pacific saury	Lancet Fish	Sharks	Atka mackerel	Other fishes
07	June 19	45¡00'	180¡00'	7.59	7.52	33.05	33.01	B	30	0	7	0	15	0	2	24	0	0	0	0	0	0	0	0
								C	30	0	11	0	16	0	0	27	0	2	0	0	0	0	0	0
								F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	17	0	1	0	42	0	0	43	0	0	0	0	1	0	0	0
								Total		0	19	0	73	0	2	94	0	2	0	0	1	0	0	0
								Released		0	1	0	11	0	2	14								
08	June 20	46¡00'	180¡00'	7.11	4.16	32.96	33.17	B	30	0	14	1	4	0	0	19	0	0	0	0	0	0	0	0
								C	30	2	38	0	19	0	0	59	0	0	0	0	0	0	0	0
								F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	17	2	5	0	28	1	0	36	0	0	0	0	0	0	0	0
								Total		4	57	1	51	1	0	114	0	0	0	0	0	0	0	0
								Released		0	1	0	3	0	0	4								
09	June 22	47¡00'	180¡00'	7.03	3.34	32.87	33.03	B	30	0	3	1	0	0	0	4	0	0	0	0	0	0	0	0
								C	30	1	44	1	1	2	8	57	0	0	0	0	0	0	0	0
								F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	17	2	3	0	3	0	7	15	0	0	0	0	0	1	0	0
								Total		3	50	2	4	2	15	76	0	0	0	0	0	1	0	0
								Released		0	0	1	0	0	0	1								
10	June 23	47¡30'	180¡00'	6.75	3.56	32.91	33.00	B	30	0	10	0	0	0	0	10	0	0	0	0	0	0	0	0
								C	30	10	94	2	3	0	0	109	0	4	0	0	0	0	0	0
								F	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
								A	17	3	11	4	1	0	2	21	0	0	0	0	0	0	0	0
								Total		13	115	6	4	0	2	140	0	4	0	0	0	0	0	0
								Released		0	1	0	0	0	0	1								
11	June 24	48¡30'	180¡00'	6.33	3.28		33.09	B	30	0	14	0	0	0	0	14	0	1	0	0	0	0	0	0
								Released		0	5	0	0	0	0	5								
12	June 25	49¡30'	180¡00'	6.22	2.61	32.90	33.03	B	30	3	9	1	1	0	0	14	0	1	0	0	0	0	0	0
								Released		2	3	0	1	0	0	6								
13	June 26	50¡30'	180¡00'	6.67	3.25	32.84	33.15	B	30	2	15	0	0	0	0	17	0	1	0	0	0	0	1	0
								Released		0	7	0	0	0	0	7								
14	June 27	51¡30'	180¡00'	4.72	4.20	33.34	33.46	B	30	5	7	0	0	0	0	12	0	0	0	0	0	0	9	0
								Released		3	0	0	0	0	0	3								

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Table 2 - continued

St.	Date	North Lat.	Long.	Temperature Surface	Temperature 100 m	Salinity Surface	Salinity 100 m	Gear	No. units	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Salmonid total	Neon flying squids	Other squids	Pacific pomfret	Pacific saury	Lancet Fish	Sharks	Atka mackerel	Other fishes
15	June 28	52¡30'	180¡00'	4.85	4.09	33.27	33.37	B	30	2	17	0	0	0	0	19	0	0	0	0	0	0	18	0
								Released		1	7	0	0	0	0	8								
16	June 29	53¡30'	180¡00'	6.22	2.44	33.15	33.31	B	30	0	16	0	0	0	0	16	0	1	0	0	1	0	0	0
								Released		0	8	0	0	0	0	8								
17	June 30	54¡30'	180¡00'	7.04	2.63	33.06	33.34	B	30	3	249	0	0	0	0	252	0	0	0	0	0	0	0	0
								Released		2	130	0	0	0	0	132								
18	July 01	55¡30'	180¡00'	6.76	2.21	33.13	33.27	B	30	0	269	1	0	0	0	270	0	0	0	0	0	0	0	0
								C	30	22	267	3	1	1	0	294	0	0	0	0	0	0	0	0
								A	19	16	327	2	0	0	0	345	0	0	0	0	0	0	1	0
								Total		38	863	6	1	1	0	909	0	0	0	0	0	0	1	0
								Released		0	164	0	0	0	0	164								
19	July 02	56¡30'		6.79	2.22	33.17	33.27	B	30	0	37	0	0	0	0	37	0	0	0	0	0	0	0	0
								C	30	14	56	5	0	0	0	75	0	3	0	0	0	0	1	0
								A	19	11	105	1	0	1	0	118	0	0	0	0	0	0	0	0
								Total		25	198	6	0	1	0	230	0	3	0	0	0	0	1	0
								Released		0	18	0	0	0	0	18								
20	July 03	57¡30'	180¡00'	7.20	2.05	33.12	33.26	B	30	0	48	0	0	0	0	48	0	0	0	0	0	0	0	0
								C	30	8	94	2	0	0	0	104	0	0	0	0	0	0	0	0
								A	19	1	122	1	0	1	0	125	0	0	0	0	0	0	0	0
								Total		9	264	3	0	1	0	277	0	0	0	0	0	0	0	0
								Released		0	24	0	0	0	0	24								
21	July 04	58¡30'	180¡00'	6.82	2.38	33.11	33.23	B	30	0	63	0	0	0	0	63	0	0	0	0	0	0	0	0
								C	30	12	71	0	0	0	0	83	0	0	0	0	0	0	0	0
								A	19	2	141	0	0	0	0	143	0	0	0	0	0	0	0	0
								Total		14	275	0	0	0	0	289	0	0	0	0	0	0	0	0
								Released		0	34	0	0	0	0	34								
22	July 05	57¡30'	l79¡00' W	6.81	2.05	33.12	33.24	B	30	3	163	0	0	1	0	167	0	0	0	0	0	0	0	0
								C	30	40	272	4	0	5	0	321	0	0	0	0	0	0	0	0
								A	19	27	400	2	0	5	0	434	0	0	0	0	0	0	0	1
								Total		70	835	6	0	11	0	922	0	0	0	0	0	0	0	1
								Released		3	73	0	0	1	0	77								

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Table 2 – continued

St.	Date	North Lat.	Long.	Temperature Surface	Temperature 100 m	Salinity Surface	Salinity 100 m	Gear	No. units	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Salmonid total	Neon flying squids	Other squids	Pacific pomfret	Pacific saury	Lancet Fish	Sharks	Atka mackerel	Other fishes
23	July 06	57¡30'	178¡00' W	7.32	3.15	33.02	33.20	B	30	8	245	0	0	10	0	263	0	0	0	0	0	0	0	0
								C	30	46	207	5	0	57	0	315	0	3	0	0	0	0	1	0
								A	19	44	230	1	0	31	0	306	0	0	0	0	0	0	0	1
								Total		98	682	6	0	98	0	884	0	3	0	0	0	0	1	1
								Released		8	124	0	0	8	0	140								
24	July 07	56¡30'	178¡00' W	7.30	2.73	33.14	33.20	B	30	0	100	0	0	5	0	105	0	0	0	0	0	0	0	0
								C	30	21	151	1	0	7	0	180	0	0	0	0	0	0	0	0
								A	19	18	141	1	0	5	0	165	0	0	0	0	0	1	0	0
								Total		39	392	2	0	17	0	450	0	0	0	0	0	1	0	0
								Released		0	67	0	0	5	0	72								
25	July 08	56¡30'	179¡00' W	7.36	3.21	32.95	33.18	B	30	2	166	0	0	9	0	177	0	0	0	0	0	0	0	0
								C	30	19	286	3	0	12	0	320	0	1	0	0	0	0	0	1
								A	19	24	183	2	0	8	0	217	0	0	0	0	0	0	0	0
								Total		45	635	5	0	29	0	714	0	1	0	0	0	0	0	1
								Released		1	94	0	0	7	0	102								
26	July 09	56¡30'	179¡00' E	7.06	1.94	33.12	33.23	B	30	3	247	0	0	0	0	250	0	0	0	0	0	0	0	0
								C	30	30	173	2	0	0	0	205	0	2	0	0	0	0	6	0
								A	19	28	93	0	1	1	0	123	0	0	0	0	0	0	0	0
								Total		61	513	2	1	1	0	578	0	2	0	0	0	0	6	0
								Released		3	123	0	0	0	0	126								
27	July 10	56¡30'	178¡00' E	7.16	1.85	33.13	33.24	B	30	7	154	0	0	0	0	161	0	0	0	0	0	0	0	0
								C	30	46	329	1	0	2	0	378	0	5	0	0	0	0	0	0
								A	19	30	110	0	1	0	0	141	0	0	0	0	0	0	0	0
								Total		83	593	1	1	2	0	680	0	5	0	0	0	0	0	0
								Released		4	75	0	0	0	0	79								
28	July 11	56¡30'	177¡00' E	6.79	1.57	33.14	33.23	B	30	1	105	0	0	0	0	106	0	0	0	0	0	0	0	0
								C	30	45	215	1	0	1	0	262	0	3	0	0	0	1	1	0
								A	19	35	123	4	0	2	0	164	0	0	0	0	0	0	0	0
								Total		81	443	5	0	3	0	532	0	3	0	0	0	1	1	0
								Released		1	15	0	0	0	0	16								

(continued on next page)

Table2 – continued

St.	Date	North Lat.	Long.	Temperature Surface	Temperature 100 m	Salinity Surface	Salinity 100 m	Gear	No. units	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Salmonid total	Neon flying squids	Other squids	Pacific pomfret	Pacific saury	Lancet Fish	Sharks	Atka mackerel	Other fishes
29	July 13	57¡30'	177¡00' E	6.92	1.46	33.11	33.22	C	30	27	123	1	1	3	0	155	0	0	0	0	0	0	3	0
								A	19	14	80	3	0	1	0	98	0	0	0	0	0	0	0	0
								Total		41	203	4	1	4	0	253	0	0	0	0	0	0	3	0
30	July 14	56¡30'	176¡00' E	7.20	2.28	33.01	33.26	C	30	40	219	0	0	2	0	261	0	0	0	0	0	0	337	0
								A	19	38	100	0	1	0	0	139	0	0	0	0	0	0	0	0
								Total		78	319	0	1	2	0	400	0	0	0	0	0	0	337	0
								B	780	39	1967	5	20	25	2	2058	0	8	771	0	1	0	28	3
								C	630	383	2661	33	50	92	9	3228	1	129	269	1	0	1	349	3
								F	16	0	0	0	0	0	0	0	0	0	0	144	0	0	0	0
								A	383	295	2175	22	83	56	14	2645	2	1	170	0	2	3	1	3
								Total		717	6803	60	153	173	25	7931	3	138	1210	145	3	4	378	9
								Released		28	974	2	15	21	2	1042								

Table3. Summary features of 84 archival-tagged salmonids during the summer research cruise of Wakatake maru, 2002.

Station		Tag no.			FL	Age		Type of
no.	Date	JFA	FRI	Species	(mm)	F	O	archival tag
07	20.Jun	Y9064	LL5064	7	700	2	1	iB4
07	20.Jun	Y9065	LL5065	7	568	x	1	iB4
11	25.Jun	Y9072	LL5072	2	469	0	3	iB4
11	25.Jun	Y9073	LL5073	2	471	0	3	iB4
12	26.Jun	Y9077	LL5077	1	565	1	3	LTD
12	26.Jun	Y9078	LL5078	1	611	2	3	LTD
13	27.Jun	Y9089	LL5089	2	545	0	3	iB4
14	28.Jun	Y9090	LL5090	1	530	2	2	LTD
14	28.Jun	Y9092	LL5092	1	440	1	2	iB4
15	29.Jun	Y9093	LL5093	2	640	0	4	iB4
15	29.Jun	Y9094	LL5094	2	666	0	4	iB4
15	29.Jun	Y9095	LL5095	2	616	0	3	iB4
15	29.Jun	Y9096	LL5096	1	548	1	2	LTD
16	30.Jun	Y9101	LL5101	2	650	0	5	PDT
17	1.Jul	Y9231	LL5231	2	570	0	4	PDT
17	1.Jul	Y9232	LL5232	2	570	0	3	PDT
17	1.Jul	Y9239	LL5239	1	525	2	2	LTD
17	1.Jul	Y9240	LL5240	1	615	2	3	LTD
18	2.Jul	Y9399	LL5399	2	602	0	3	PDT
18	2.Jul	Y9400	LL5400	2	643	0	4	PDT
19	3.Jul	Y9405	LL5405	2	658	0	4	PDT
19	3.Jul	Y9406	LL5406	2	650	0	5	PDT
19	3.Jul	Y9407	LL5407	2	615	0	4	PDT
19	3.Jul	Y9422	LL5422	2	585	0	3	PDT
19	3.Jul	Y9423	LL5423	2	619	0	3	iB4
20	4.Jul	Y9444	LL5444	2	635	0	4	PDT
20	4.Jul	Y9445	LL5445	2	650	0	4	PDT
20	4.Jul	Y9446	LL5446	2	606	0	3	PDT
20	4.Jul	Y9447	LL5447	2	691	0	4	LTD & iB4
21	5.Jul	Y9479	LL5479	2	600	0	3	PDT
21	5.Jul	Y9480	LL5480	2	635	0	3	PDT
22	6.Jul	Y9505	LL5505	1	482	2	2	iB4
22	6.Jul	Y9506	LL5506	2	526	0	2	iB4
22	6.Jul	Y9507	LL5507	2	484	0	2	iB4
22	6.Jul	Y9508	LL5508	2	594	0	3	iB4
22	6.Jul	Y9509	LL5509	1	478	2	2	iB4
22	6.Jul	Y9510	LL5510	5	740	1	3	LTD
22	6.Jul	Y9558	LL5558	2	615	0	4	PDT
22	6.Jul	Y9559	LL5559	1	588	2	2	LTD
22	6.Jul	Y9560	LL5560	2	610	0	4	PDT
22	6.Jul	Y9561	LL5561	2	682	0	4	PDT
22	6.Jul	Y9562	LL5562	2	615	0	4	LTD & iB4

(*continued on next page*)

Table 3 - continued

Station		Tag no.			FL	Age		Type of
no.	Date	JFA	FRI	Species	(mm)	F	O	archival tag
23	7.Jul	Y9592	LL5592	1	462	2	2	iB4
23	7.Jul	Y9593	LL5593	2	493	0	3	iB4
23	7.Jul	Y9594	LL5594	2	475	0	3	iB4
23	7.Jul	Y9595	LL5595	1	507	2	3	iB4
23	7.Jul	Y9596	LL5596	1	487	2	2	iB4
23	7.Jul	Y9697	LL5697	2	611	0	4	PDT
23	7.Jul	Y9698	LL5698	2	622	0	4	PDT
23	7.Jul	Y9699	LL5699	2	616	0	4	PDT
23	7.Jul	Y9700	LL5700	5	547	x	2	iB4
23	7.Jul	Y9701	LL5701	5	595	1	2	iB4
23	7.Jul	Y9702	LL5702	5	575	1	2	iB4
23	7.Jul	Y9703	LL5703	5	610	x	2	iB4
24	8.Jul	Y9718	LL5718	5	570	1	2	LTD
24	8.Jul	Y9729	LL5729	5	650	1	3	LTD
24	8.Jul	Y9730	LL5730	5	622	1	2	LTD
24	8.Jul	Y9731	LL5731	5	789	1	3	LTD
24	8.Jul	Y9732	LL5732	5	600	1	2	LTD
24	8.Jul	Y9771	LL5771	2	620	0	4	PDT
25	9.Jul	Y9783	LL5783	5	579	1	2	LTD
25	9.Jul	Y9798	LL5798	5	562	1	2	LTD
25	9.Jul	Y9799	LL5799	5	509	x	2	LTD
25	9.Jul	Y9802	LL5802	5	546	1	2	LTD
25	9.Jul	Y9803	LL5803	5	630	1	2	LTD
25	9.Jul	Y9814	LL5814	1	503	2	2	LTD
25	9.Jul	Y9832	LL5832	5	527	1	2	LTD
25	9.Jul	Y9835	LL5835	5	664	1	3	LTD
25	9.Jul	Y9872	LL5872	2	665	0	4	PDT
25	9.Jul	Y9873	LL5873	2	628	0	4	PDT
25	9.Jul	Y9874	LL5874	2	615	0	3	PDT
25	9.Jul	Y9875	LL5875	2	670	0	4	PDT
25	9.Jul	Y9876	LL5876	2	680	0	4	LTD & iB4
25	9.Jul	Y9877	LL5877	2	650	0	4	LTD & iB4
26	10.Jul	Y1801	LL5001	2	622	0	4	LTD & iB4
26	10.Jul	Y9995	LL5995	2	640	0	3	PDT
26	10.Jul	Y9996	LL5996	2	692	0	4	PDT
26	10.Jul	Y9997	LL5997	2	625	0	3	PDT
26	10.Jul	Y9998	LL5998	1	500	2	2	LTD
26	10.Jul	Y9999	LL5999	2	618	0	3	LTD & iB4
27	11.Jul	Y1823	LL5023	1	499	1	2	LTD
27	11.Jul	Y1824	LL5024	1	508	2	2	LTD
27	11.Jul	Y1883		2	596	x	x	PDT
27	11.Jul	Y1884		2	652	0	3	PDT

Table 4. Number of tissue samples collected from chum salmon during the summer research cruise of Wakatake maru, 2002.

Station no.	Olfactory nerve	Olfactory epithelium	Brain	Pituitary	Gonad	Liver	Blood
5			7	7	7	7	7
6	2	2	2	2			
7	2	2	6	6	4	4	4
8	5	5	13	13	8	8	8
9	1	1	3	3	2	2	2
10	3	3	7	7	4	4	4
11	3	3	9	9	6	6	6
12	4	4	4	4			
13	3	3	3	3			
14	3	3	3	3			
15			8	8	8	8	8
16			7	7	7	7	7
17			10	10	10	10	10
18			6	6	6		6
19			8	8	8	8	8
20			8	8	8	8	8
21			7	7	7	7	7
22			10	10	10	10	10
23	1	1	5	5	4		4
24			8	8	8	8	8
25	8	8	8	8			
26			8	8	8	8	8
27			12	12	12	12	12
28	11	11	17	17	6	6	6
Total	46	46	179	179	133	123	133

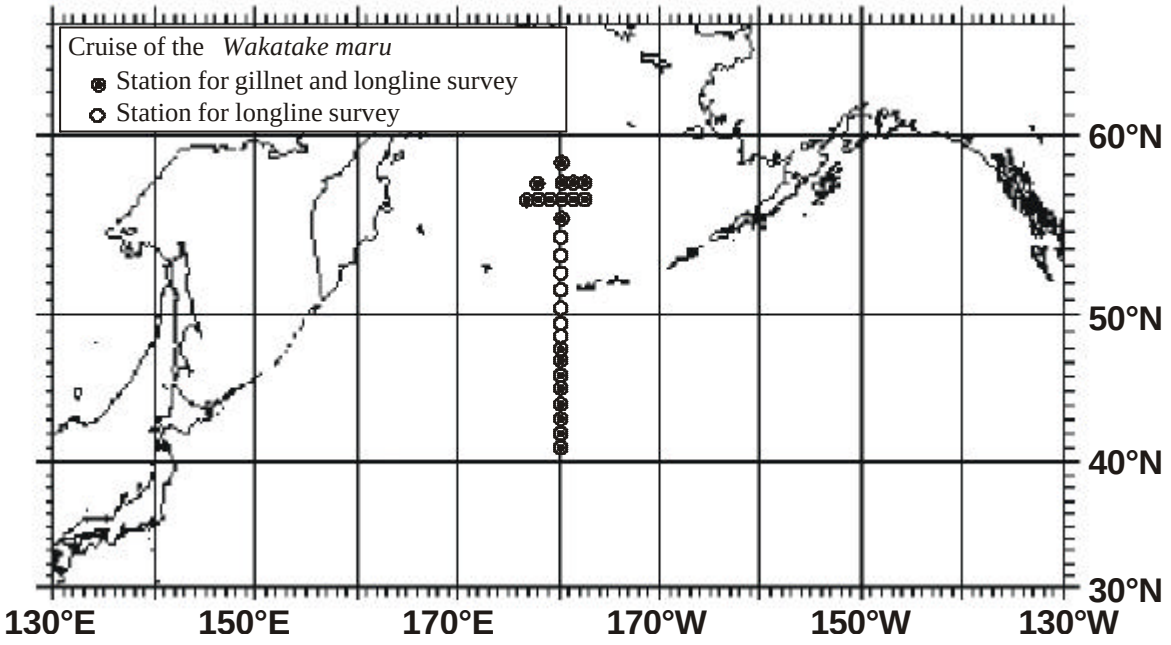

Fig. 1. Experimental fishing stations of the summer 2002 research cruise of the R/V *Wakatake maru*.