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**Survey on Overwintering Salmonids in the North Pacific
Ocean: *Kaiyo Maru*, 5 January-29 January 1996**

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Cruise Report

to

National Marine Fisheries Service
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Survey on Overwintering Salmonids in the North Pacific Ocean: *Kaiyo Maru*, 5 January-29 January 1996

Abstract

A survey on overwintering salmonids (*Oncorhynchus* spp.) in the North Pacific Ocean (160°E-145°W, 40°N-56°N) was conducted by Japanese, Canadian, Russian, and U.S. scientists aboard the Japanese research vessel *Kaiyo Maru* from 5 January to 29 January 1996. This was the first offshore trans-Pacific survey of salmonids in the North Pacific Ocean in January. A similar survey was conducted aboard the *Kaiyo maru* in December 1992. The objectives of the January 1996 survey were to collect samples and data for (1) further clarification the winter distribution of salmon with respect to sea surface temperature, (2) evaluation of the relationships between prey availability and ocean rearing conditions in winter and the growth and mortality of salmon, and (3) comparison of mid winter habitat conditions, especially primary production and production of salmon prey organisms, to summer conditions. This report by the participating U.S. scientist presents some preliminary results of the survey.

Salmon were caught at 14 of the 22 trawl stations. The total catch of salmon during the survey was 1,346 fish (51 sockeye *O. nerka*, 767 chum *O. keta*, 439 pink *O. gorbuscha*, 57 coho *O. kisutch*, and 32 chinook *O. tshawytscha* salmon). No steelhead *O. mykiss* were caught. The majority of the catch (74%) occurred at three stations, where there were relatively large catches of chum and pink salmon. The combined results of the December 1992 and January 1996 surveys indicate that salmon in their first year at sea are distributed well offshore in winter, and that they are more abundant in offshore waters in January than in December. Because of the limited number of trawl stations sampled and the broad area covered by the survey, the relationships between salmon catches and various oceanographic and other environmental factors should be interpreted with caution. As in December 1992, salmon appeared to be distributed primarily in cool (less than 7.5°C sea surface temperature) waters in January 1996. Additional east-west transects across the entire study area, as well as transects within the Russian and U.S. 200-mile zones, are needed to further clarify winter distribution and abundance of salmon in the North Pacific Ocean.

Introduction

From 1954 to 1991, most of the high-seas research on Pacific salmon (*Oncorhynchus* spp.) was conducted during the period of operation of the historic Japanese high-seas salmon driftnet fisheries (May-July). As a result, very little is known about the ocean ecology of salmon in winter and the biological and oceanographic factors that affect their distribution, growth, and survival during this critical period. Important questions about the carrying capacity of Pacific salmon in the North Pacific Ocean, the effects of global warming on salmon during their offshore life-history phase, and recent changes in ocean distribution, abundance, age and growth, and survival of Pacific salmon necessitate the acquisition of new oceanographic and biological field data. To this end, a survey on overwintering salmonids in the North Pacific Ocean (160°E-145°W, 40°N-56°N) was conducted aboard the Japanese research vessel *Kaiyo maru* from 5 January to 29 January 1996. Canadian, Russian, and U.S. scientists (one from each country) were invited by the Fisheries Agency of Japan (FAJ) to participate in the cruise. This was the first trans-Pacific offshore survey of salmonids to be conducted in January. A similar trans-Pacific survey was conducted aboard the *Kaiyo maru* in December 1992 (Myers 1993; FAJ 1994).

The objectives of the January 1996 survey were to collect samples and data for: (1) further clarification the winter distribution of salmon with respect to sea surface temperature, (2) evaluation of relationships between prey availability and ocean rearing conditions in winter and the growth and mortality of salmon, and (3) comparison of mid winter habitat conditions, especially primary production and production of salmon prey organisms, to summer conditions. This report presents some preliminary results of the survey.

The purpose of this report is to present information on methods and some preliminary results of the survey. Data analysis and publication will be discussed among participants of the cruise, under the leadership of the chief scientist, and FAJ will publish a final report on the survey. All data collected during the cruise belongs to FAJ, and permission for use of any of the data in this report should be obtained from FAJ.

Methods

The research vessel *Kaiyo maru*, built in 1991 and owned by FAJ, is a 93 m stern trawler (gross tonnage, international: 2,942 tons). The vessel left port in Tokyo Bay, Japan, on 5 January 1996. The salmon survey was conducted from 8 January through 26 January 1996. The vessel arrived in port in Seattle, Washington, on December 29, 1996. After the survey, a post-cruise workshop on standardization of stomach content analysis techniques, which was proposed by FAJ scientists, was held at the Fisheries Research Institute (FRI), University of Washington, on 2 January 1996.

The vessel was operated by Captain Kakusuke Nakayama and 53 crew members. Scientific personnel included: Dr. Yukimasa Ishida (Chief Scientist), Dr. Yasuhiro Ueno, and Dr. Akihiro Shiimoto, National Research Institute of Far Seas Fisheries (NRIFSF), Shimizu, Japan; Dr. Shigehiko Urawa, Hokkaido Salmon Hatchery, Sapporo, Japan; John Morris, Pacific Biological Station (PBS), Nanaimo,

British Columbia, Canada; Maxim V. Koval, Kamchatka Research Institute of Fisheries and Oceanography (KamchatNIRO), Petropavlovsk, Kamchatka, Russia; and Katherine W. Myers (FRI). Four Japanese graduate students assisted in the collection of data and analysis of samples: Ayako Nishina, Tokai University; Ayumu Nakashima, Tokyo University; Kuniyuki Kodokoro, Hokkaido Tokai University; and Masakazu Morishita, Kagawa University.

Fishing Operations

The cruise plan called for fishing operations with a spider (surface rope) trawl along three north-south transects and two diagonal transects (27 stations, Fig. 1). On the north-south transects fishing was to be conducted once or twice daily depending on conditions at the stations. On the diagonal surveys, fishing was to be done only once per day.

The spider trawl used in the survey was the same net used in the December 1992 survey: 208 m long (60-m headrope, 60-m footrope, and approximately 500 m warp; Appendix Fig. 1). The cod end was made of 11-mm knotless mesh. The trawl fished from the surface to 50 m, and was towed at approximately 5 knots for 1 hour.

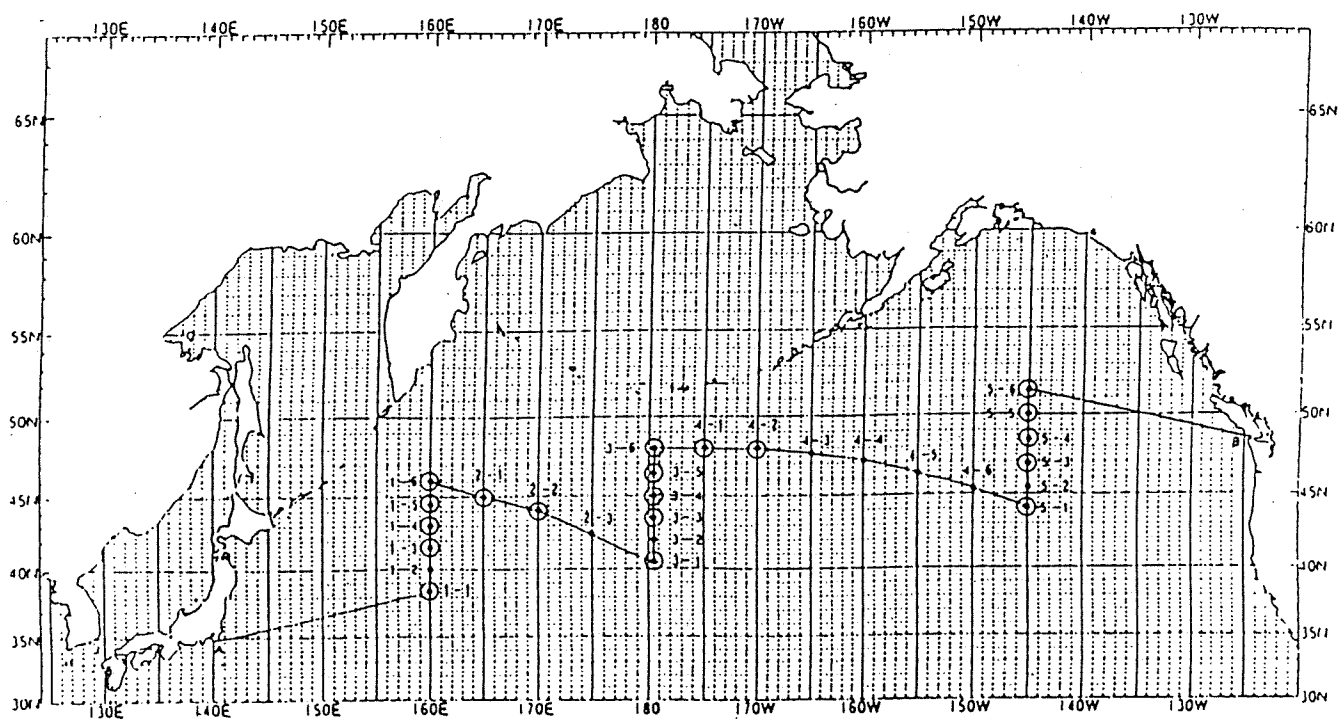


Fig. 1. Planned location of trawl and CTD stations (Fisheries Agency of Japan 1995a).

Biological Sampling

Immediately after the trawl was hauled, the catch was taken to a shipboard laboratory for biological sampling, and sorted to species. Numbers and weights of all species in the catch were determined. When individuals (non-salmonids only) were too numerous to count, the entire catch was weighed and numbers were estimated from a subsample. For Pacific salmon, body weights and fork lengths were recorded for up to 90 fish per species at each station (additional chum salmon *O. keta* were measured when catches were large), and scale samples were taken. Because of damage by the trawl net, most of the salmon did not have scales left in the preferred (International North Pacific Fisheries Commission) body area for scale sampling. In these cases, scales were collected from areas adjacent to the preferred area or from under the pectoral fin or behind the head. Two sets of scales, one for NRIFSF and one for FRI were collected. Information on scars and other abnormalities were also recorded.

Blood serum samples were collected from a subsample of the salmon catch for growth, maturity, and disease (coho salmon *O. kisutch* only) studies at FRI and Hokkaido Salmon Hatchery. Although Japanese scientists were primarily interested in collecting blood from chum salmon for maturity studies, an attempt was made to collect samples from all species, age and size groups, and transects. For each fish, species, fork length, body weight, and sample identification number were recorded on a data form, and a scale sample (usually not from the preferred body area) was collected. Blood was obtained from the caudal vein with a heparinized syringe, and centrifuged (approximately 15 minutes). The resulting plasma samples were transferred to small plastic vials, marked with the identification numbers, and stored in a shipboard freezer at -80°C. FRI's samples will be analyzed for insulin-like growth factor (IGF-1) levels.

After measuring and sampling, salmon were numbered with paper tags, sealed tightly in plastic wrap, and frozen whole (-40°C) in covered aluminum trays. When the catch of salmon was large (beyond the sample needs of NRIFSF), a sample of 15 whole salmon per species was frozen for otolith, diet, and caloric content studies at FRI. Samples of whole salmon were frozen for C and N isotope, fat, and moisture analyses at PBS. After the *Kaiyo Maru* returns to Japan, the frozen samples of Pacific salmon will be taken to the NRIFSF for further analysis. Species identification will be reconfirmed by morphological counts and measurements. Additional samples and data to be collected at the NRIFSF include:

1. sex
2. liver weight (for energetic studies)
3. gonad weight (for maturation)
4. liver sample (for glycogen content)
5. stomach contents (identification and weight)
6. otoliths (for age and growth studies)
7. heart, muscle, liver, and eye tissue (for genetic stock identification)
8. muscle sample (a small sample for isotope analysis and a large sample for water content analysis)
9. muscle sample for species identification by electrophoresis
10. parasites (for stock identification)

Samples of other species of fish and squid in the catch were also measured and frozen for later examination. Samples of mesopelagic fish (myctophiforms) were collected and frozen for studies by the U.S. National Marine Fisheries Service

(NMFS; for a reference collection of otoliths to be used for small cetacean food habits studies).

Acoustic Survey

An acoustic survey using a Feruno (FE-1282) dual beam system and paper recorder was conducted during all trawl operations to determine its effectiveness at detecting salmon.

Oceanographic Sampling

Oceanographic observations were made with a CTD either before or after fishing operations, depending on the weather. Sensors on the CTD "octopus" were used to collect data on temperature, salinity, depth, dissolved oxygen, and light intensity from 0-1,500 meters. Water samples were collected by a bucket at the surface (0 m) and by CTD Rosette sampling (2 liter bottles x 24 depths: 10, 20, 30, 40, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1,000, 1,000, 1,200, 1,300, 1,400, and 1,500 meters). In rough seas, a Seabird (Model 19) CTD, referred to in this report as SCTD, was used to collect data on temperature and salinity to a depth of 800 meters. Seawater nutrients (NO_2+NO_3 , SiO_2 , PO_4) were analyzed with an Auto-Analyzer II within a day of sampling. Chlorophyll a (0-300 m) was determined by fluorometric analysis within 24 hours. Salinities were confirmed by auto-salinometer analysis and dissolved oxygen by titration method within a day of sampling. At the CTD stations, an Ocean Color Monitor Vaouy (OCMV) was used to measure light intensity (surface to 100 m depth).

Primary production was measured by quantum sensor one or two hours after sun rise (during CTD observation) at four sampling depths (including surface). Water samples were collected using a Go-Flow water sampler (30 liter). After sampling, the seawater was put into 20 polycarbonate bottles (1 liter), and $^{13}\text{C-NaHCO}_3$, $^{15}\text{N-NaNO}_3$, and $^{15}\text{N-NH}_4\text{CL}$ was added. The bottled seawater was then incubated in a water bath for 24 hours on the deck, and filtered. The filter was preserved in the deep freezer (-40°C) for later analysis.

Zooplankton collections were taken at the fishing stations after the trawl sampling was completed. Standard NORPAC and bongo nets with attached flowmeter were used. The nets were hauled vertically from 150 meters. Zooplankton were preserved in a 10% Formalin solution (seawater).

While the vessel was underway, temperature, salinity, dissolved oxygen, chlorophyll, and zooplankton were monitored continuously using an EPCS continuous plankton measuring system. Multiple layer ultrasonic current measurements were made with an ADCP system. Vertical thermal structure (0-750 meters) was measured using an XBT at every 1 degree longitude and 30' latitude (starting at 141°E) except at trawl stations. Solar radiation was measured using a meteorological radiometer (printout every 5 minutes) throughout the survey. An APT system was used for meteorological monitoring throughout the survey.

Salmon Age Determination

After the cruise, ages of salmon were determined by the author from magnified (40x) acetate impressions of scales. Age is designated by the European method, whereby the number preceding the decimal point is the number of winters in freshwater, and the number following the decimal point is the number of winters in the ocean. By convention, all salmon are aged as one year older on January 1, even if an annulus has not formed on the scale. In this report, all salmon in their first winter at

sea are designated as ocean age .1 fish. Freshwater ages were not determined for sockeye, coho, and chinook salmon, if the scales were collected from non-preferred body areas. Because most of the scales were non-preferred, this report summarizes only ocean age data. The age data were provided by FRI to FAJ on a computer disk.

Results and Discussion

Trawl Survey

Differences in planned and actual dates and locations of the trawl stations were due primarily to gear problems, poor weather conditions, and a reduction in the number of days available for the survey because of an injured crewman (Figs. 1 and 2; Appendix Table 1). Fishing was canceled at station 1-1 because the cables on the trawl doors were tangled when the net was set. Sampling continued on schedule until 14 January, when station 2-3 was shifted to the southeast to avoid bad weather. The dateline (180°) was crossed on 14 January. No sampling was possible on the second 14 January or on 15-16 January because of bad weather. The planned 180° transect was shifted to 168°W , where sampling was conducted at six stations (3-1 to 3-6) between $41\text{-}49^\circ\text{N}$ from 17-19 January (two stations per day). On 19 January a crewman was injured while hauling the trawl. Because his injuries were not life-threatening (broken knee), the survey was continued, but the survey track was shortened so that the injured crewman could return to Japan as soon as possible. Sampling was conducted along a northeast line (one station per day, stations 4-1 to 4-3), just outside the U.S. 200-mile zone to 145°W , 56°N , and then southward along 145°W to $48\text{-}30^\circ\text{N}$ (two stations per day, stations 5-1 through 5-6). No trawl sampling was possible at station 4-2 on 21 January because of high winds and waves. The trawl survey was completed on 25 January, and the vessel arrived in Seattle on 29 January 1996.

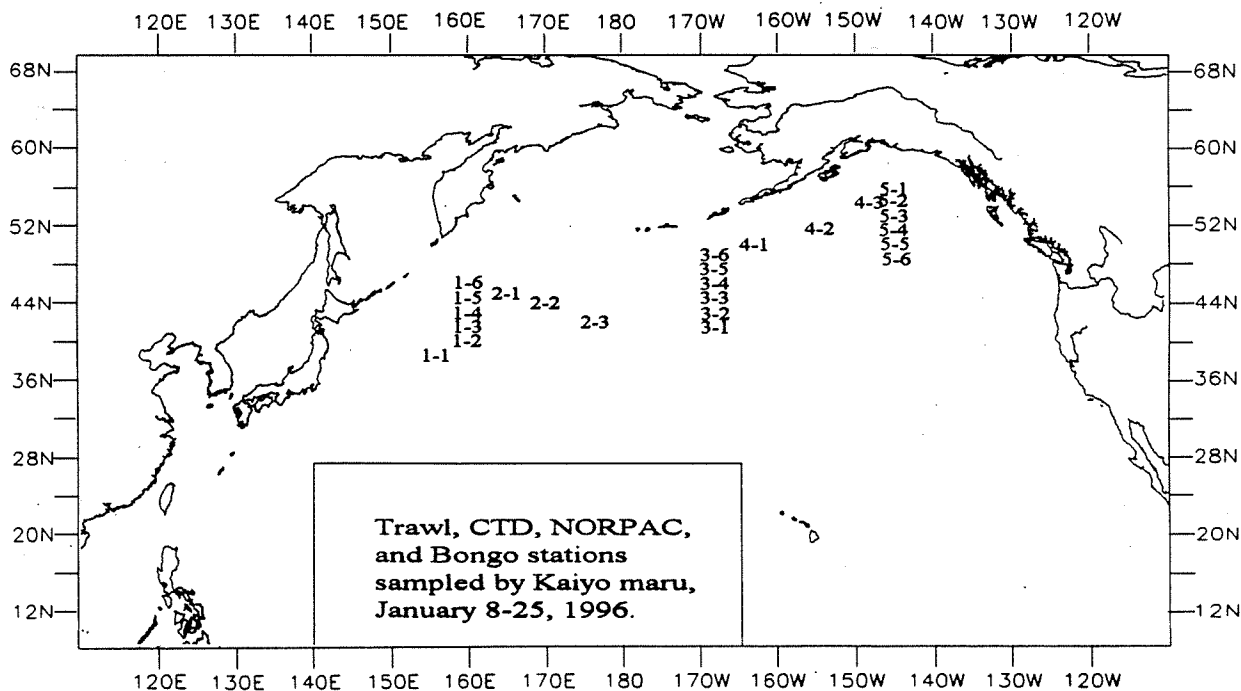


Fig. 2. Location of trawl stations, *Kaiyo maru*, January 1996.

Salmon Data and Samples

Copies of all salmonid catch and biological data forms, a computer file of the biological data, and a set of original scale cards were provided by FAJ, and are archived at FRI. In exchange, FRI provided FAJ with a computer file of age determinations for all salmon in the catch that were sampled for scales. At two stations, the salmon catch exceeded FAJ's sample size requirements, and subsamples of 15 salmon (pink salmon at station 1-5 and chum salmon at stations 1-6) were given to FRI. The samples were frozen, and will be used at FRI for bioenergetic, food habit, and growth studies.

Salmon Catch and Distribution

The total catch of salmon was 1,346 fish (51 sockeye salmon (3.8% of the total catch), 767 chum (57.0%), 437 pink (32.6%), 57 coho (4.2%), and 32 chinook (2.4%) salmon; Table 1). The majority of the catch (74%) occurred at three stations (1-5, 1-6, and 3-4), where there were large catches of chum and pink salmon.

No sockeye salmon were caught at stations in the western North Pacific Ocean (Table 1, Fig. 3). Only two sockeye salmon in their first winter at sea (ocean age .1) were caught (both at station 3-5; Table 2). There were low catches of older (ocean ages .2, .3, and .4) sockeye salmon in the central North Pacific (north of 47°30'N) and Gulf of Alaska (north of 53°N). Sockeye salmon tended to be caught in association with chum salmon. Sockeye salmon were also not abundant in offshore samples in December 1992, except for a large catch of sockeye salmon (ocean ages .0, .1, and .2) during an experimental three-hour tow at three different depths in the Gulf of Alaska (52°N, 145°W; Fisheries Agency of Japan 1994). In winter, the center of distribution of sockeye salmon (particularly the abundant Bristol Bay populations, which are the major stock-complex of sockeye salmon in the North Pacific Ocean and Bering Sea) is probably within the U.S. 200-mile zone in the Bering Sea-Aleutian Islands area and western Gulf of Alaska. Sockeye salmon, as well as the other salmon species, likely do not reach the southernmost extent of their distribution in the North Pacific Ocean until March or April. In April, maturing Bristol Bay sockeye salmon have been tagged well-offshore in areas outside of the U.S. 200-mile zone in the central North Pacific Ocean and Gulf of Alaska (e.g., Myers 1990, 1991).

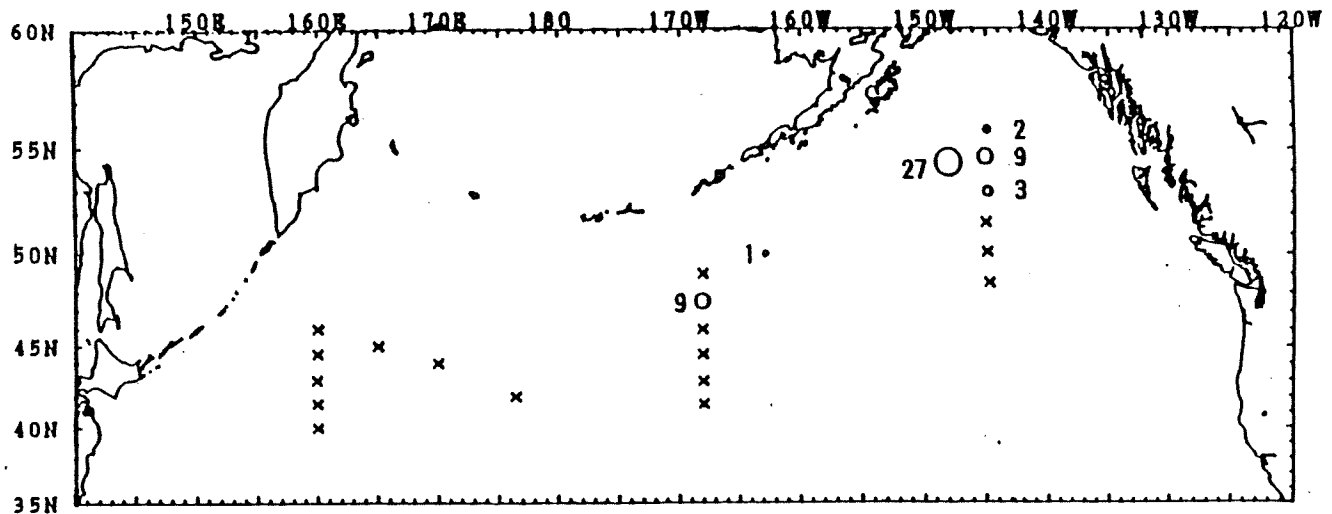


Fig. 3. Sockeye salmon catch distribution (number of fish) at trawl stations sampled by the *Kaiyo maru* in January 1996 (Fisheries Agency of Japan 1996). The size of open circles is proportional to the number of fish in the catch. x = no sockeye salmon caught.

Table 1. Catch of salmon in numbers of fish and species composition (% of total catch) by date, station (sta.), latitude (Lat.), longitude (Long.), sea surface temperature (SST; °C), and species (sock=sockeye; chin=chinook; tot. = total) during January 1996 *Kaiyo maru* survey. na = not applicable: the trawl operation at station 1-1 was canceled because of gear problems; the operation at station 4-2 was canceled because of rough seas and strong winds.

Date	Sta.	Lat.	Long.	SST	Catch					Tot.
					Sock	Chum	Pink	Coho	Chin	
8-Jan	1-1	38-34N	155-55E	11.5	na	na	na	na	na	na
9-Jan	1-2	40-07N	159-54E	10.0	0	0	0	0	0	0
10-Jan	1-3	41-32N	159-58E	8.0	0	0	0	0	0	0
10-Jan	1-4	42-58N	159-57E	6.0	0	0	0	0	0	0
11-Jan	1-5	44-31N	160-00E	4.5	0	76	127	0	4	207
					0.0%	36.7%	61.4%	0.0%	1.9%	
11-Jan	1-6	46-08N	160-02E	4.5	0	471	33	0	3	507
					0.0%	92.9%	6.5%	0.0%	0.6%	
12-Jan	2-1	44-59N	165-03E	5.5	0	2	36	0	19	57
					0.0%	3.5%	63.2%	0.0%	33.3%	
13-Jan	2-2	44-00N	170-00E	8.7	0	0	0	0	0	0
14-Jan	2-3	41-59N	176-28E	10.5	0	0	0	0	0	0
17-Jan	3-1	41-30N	168-00W	9.4	0	0	0	0	0	0
17-Jan	3-2	42-54N	168-01W	8.6	0	0	0	0	0	0
18-Jan	3-3	44-30N	168-04W	7.8	0	0	0	0	0	0
18-Jan	3-4	45-58N	168-06W	7.3	0	41	223	17	0	281
					0.0%	14.6%	79.4%	6.0%	0.0%	
19-Jan	3-5	47-30N	168-09W	6.1	9	3	5	15	0	32
					28.1%	9.4%	15.6%	46.9%	0.0%	
19-Jan	3-6	48-58N	168-07W	5.3	0	1	0	5	4	10
					0.0%	10.0%	0.0%	50.0%	40.0%	
20-Jan	4-1	50-00N	162-57W	5.1	1	5	0	3	1	10
					10.0%	50.0%	0.0%	30.0%	10.0%	
21-Jan	4-2	51-39N	154-37W	4.5	na	na	na	na	na	na
22-Jan	4-3	54-21N	148-12W	4.5	27	32	0	0	0	59
					45.8%	54.2%	0.0%	0.0%	0.0%	
23-Jan	5-1	55-47N	145-04W	4.7	2	0	0	0	0	2
					100.0%	0.0%	0.0%	0.0%	0.0%	
23-Jan	5-2	54-36N	145-11W	4.5	9	2	0	0	0	11
					81.8%	18.2%	0.0%	0.0%	0.0%	
24-Jan	5-3	53-00N	145-00W	4.6	3	20	0	0	0	23
					13.0%	87.0%	0.0%	0.0%	0.0%	
24-Jan	5-4	51-33N	145-09W	5.8	0	0	0	1	0	1
					0.0%	0.0%	0.0%	100.0%	0.0%	
25-Jan	5-5	50-04N	144-59W	6.5	0	67	15	4	1	87
					0.0%	77.0%	17.2%	4.6%	1.1%	
25-Jan	5-6	48-29N	144-48W	7.2	0	47	0	12	0	59
					0.0%	79.7%	0.0%	20.3%	0.0%	
Total					51	767	439	57	32	1346
					3.8%	57.0%	32.6%	4.2%	2.4%	

Table 2. Sockeye salmon age composition, mean fork length (mm), and mean body weight (g) by trawl station, *Kaiyo maru*, January 1996. n = number of fish. SD = standard deviation.

Sta.		Ocean Age				Total
		.1	.2	.3	.4	
3-5	n	2	7	0	0	9
	%	22	78			100
	Length	339	384			374
	SD	6	15			24
	Weight	398	589			546
	SD	103	92			121
4-1	n	0	0	1	0	1
	%			100		100
	Length			572		572
	SD					
	Weight			2200		2200
4-3	n	0	15	11	1	27
	%		56	41	4	100
	Length		444	537	498	484
	SD		19	28		51
	Weight		986	1972	1380	1402
	SD		145	373		550
5-1	n	0	0	2	0	2
	%			100		100
	Length			566		566
	SD			76		76
	Weight			2210		2210
5-2	n	0	6	3	0	9
	%		67	33		100
	Length		453	533		479
	SD		8	10		41
	Weight		1028	1903		1320
	SD		110	64		447
5-3	n	0	3	0	0	3
	%		100			100
	Length		438			438
	SD		39			39
	Weight		857			857
	SD		204			204

Chum salmon in their first winter at sea (age .1, as of January 1) were abundant at stations 1-5 and 1-6 in the western North Pacific (Table 1; Fig. 4; Table 3). In contrast, only 3 juvenile (ocean age .0) chum salmon in their first winter at sea were caught in this same area in December 1992 (Fisheries Agency of Japan 1994). The aggregations of young (age .1) chum salmon caught along the 160°E transect in January 1996 are likely Japanese and Russian stocks moving offshore from juvenile summer-fall feeding areas in the Sea of Okhotsk and northern Kurile Islands (Y. Ueno, pers. comm.). Older immature or maturing (ocean age .2 and older, as of January 1) chum salmon were often the predominant species in Gulf of Alaska catches. The Gulf of Alaska is likely a major overwintering area for ocean age .2 and older age groups of Japanese hatchery chum salmon (Y. Ishida, pers. comm.), as well as Russian and North American populations. Genetic analyses of samples collected during this cruise by Japanese scientists should further clarify the stock composition of chum salmon in these offshore areas in winter.

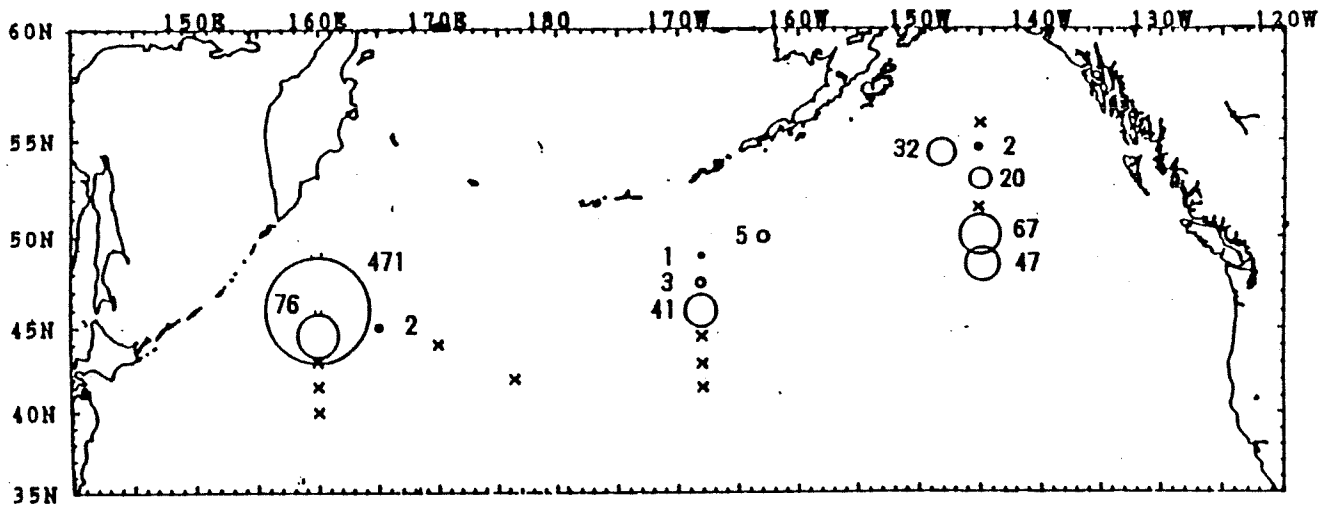


Fig. 4. Chum salmon catch distribution (number of fish) at trawl stations sampled by the *Kaiyo maru* in January 1996 (Fisheries Agency of Japan 1996). The size of open circles is proportional to the number of fish in the catch. x = no chum salmon caught.

Table 3. Chum salmon age composition, mean fork length (mm), and mean body weight (g) by trawl station, *Kaiyo maru*, January 1996. n= number of fish. SD = standard deviation.

Sta.		Age					Total
		0.1	0.2	0.3	0.4	0.5	
1-5	n	76	0	0	0	0	76
	%	100					100
	Length	233					233
	SD	15					15
	Weight	126					126
	SD	24					24
1-6	n	121	1	0	0	0	122
	%	99	1				100
	Length	228	453				230
	SD	14					25
	Weight*	129	900				141
	SD	28					100
	*n = 61						
2-1	n	2	0	0	0	0	2
	%	100					100
	Length	276					276
	SD	26					26
	Weight	218					218
	SD	74					74
3-4	N	1	35	0	0	0	36
	%	3	97				100
	Length	212	365				360
	SD		30				39
	Weight	96	473				463
	SD		102				118
3-5	N	0	0	0	3	0	3
	%				100		100
	Length				541		541
	SD				19		19
	Weight				1637		1637
	SD				217		217
3-6	N	0	0	1	0	0	1
	%			100			100
	Length			566			566
	SD						
	Weight			1960			1960
	SD						

Table 3. Chum salmon (cont'd).

Sta:		Age					Total
		0.1	0.2	0.3	0.4	0.5	
4-1	N	0	0	3	2	0	5
	%			60	40		100
	Length			544	579		558
	SD			21	4		24
	Weight			1763	2010		1862
	SD			232	127		222
4-3	N	0	11	18	2	0	31
	%		35	58	6		100
	Length		445	523	584		499
	SD		35	35	18		55
	Weight		1055	1563	2025		1413
	SD		255	260	35		381
5-2	N	0	1	1	0	0	2
	%		50	50			100
	Length		470	508			489
	SD						27
	Weight		1040	1520			1280
	SD						339
5-3	N	0	0	14	4	1	19
	%			74	21	5	100
	Length			517	547	674	532
	SD			31	34		47
	Weight			1464	1633	3730	1619
	SD			280	248		577
5-5	N	15	25	23	1	0	64
	%	23	39	36	2		100
	Length	277	385	505	580		460
	SD	13	35	51			140
	Weight	214	566	1327	2150		1273
	SD	37	177	364			914
5-6	N	0	2	34	6	0	42
	%		5	81	14		100
	Length		448	479	509		481
	SD		1	30	45		34
	Weight		900	1063	1420		1106
	SD		42	225	422		284

Pink salmon were abundant in catches in the western (between 44°-45°N, particularly station 1-5) and central (between 46-48°N, particularly station 3-4) North Pacific (Table 1, Fig. 5). Abundance of pink salmon was low at the Gulf of Alaska stations. Pink salmon were usually caught in association with chum salmon, and when pink catches were high, chum catches tended to be lower. The average size of pink salmon in the western North Pacific was smaller than in the central North Pacific (Table 4).

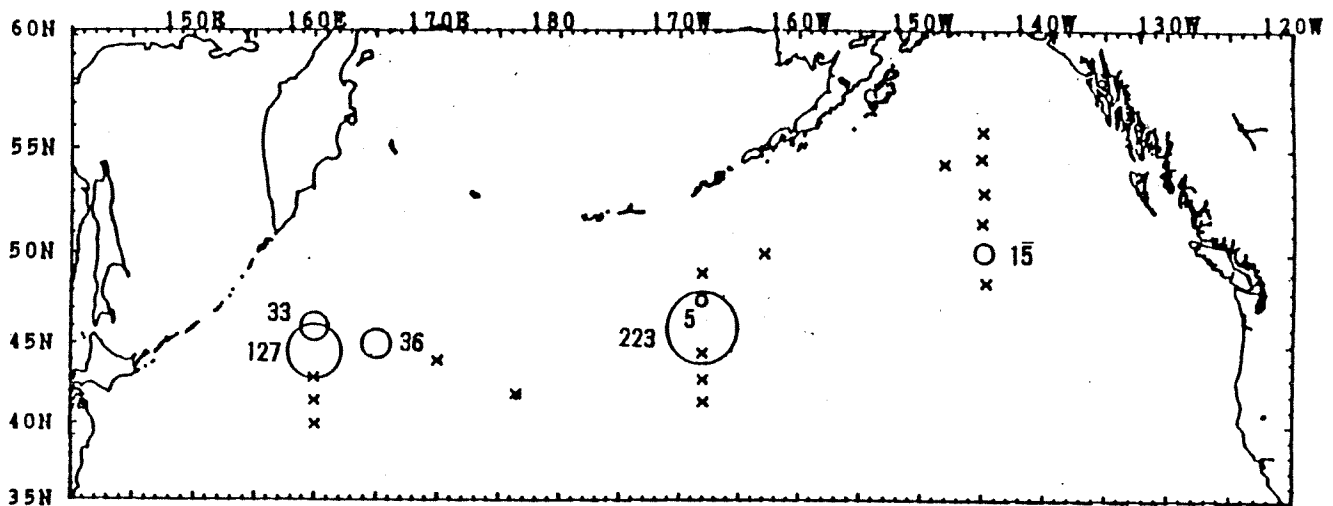


Fig. 5. Pink salmon catch distribution (number of fish) at trawl stations sampled by the *Kaiyo maru* in January 1996 (Fisheries Agency of Japan 1996). The size of open circles is proportional to the number of fish in the catch. x = no pink salmon caught.

Table 4. Pink salmon (age 0.1) mean fork length (mm) and mean body weight (g) by trawl station, *Kaiyo maru*, January 1996. n = number of fish; SD = standard deviation; WNP = western North Pacific (stations 1-5, 1-6, and 2-1 combined); CNP = central North Pacific (stations 3-4 and 3-5 combined).

	Station								
	1-5	1-6	2-1	WNP	3-4	3-5	CNP	5-5	Total
n	66	33	36	135	60	5	65	15	215
Length	250	245	265	253	266	248	265	265	265
SD	20	16	9	18	24	15	24	7	7
Weight	147	141	169	151	167	134	165	163	163
SD	41	30	17	35	43	25	42	18	18

No coho salmon were caught at stations in the western North Pacific (Table 1, Fig. 6). Catches of coho salmon in the central North Pacific and Gulf of Alaska were relatively low, although coho salmon were the predominant species in catches at three stations (3-5, 3-6, and 5-4), where catches of other species were low. Coho salmon tended to be caught in association with chum salmon, and in the central Gulf of Alaska they were caught at the more southerly stations. The average size of coho salmon in the Gulf of Alaska was larger than in the central North Pacific (Table 5).

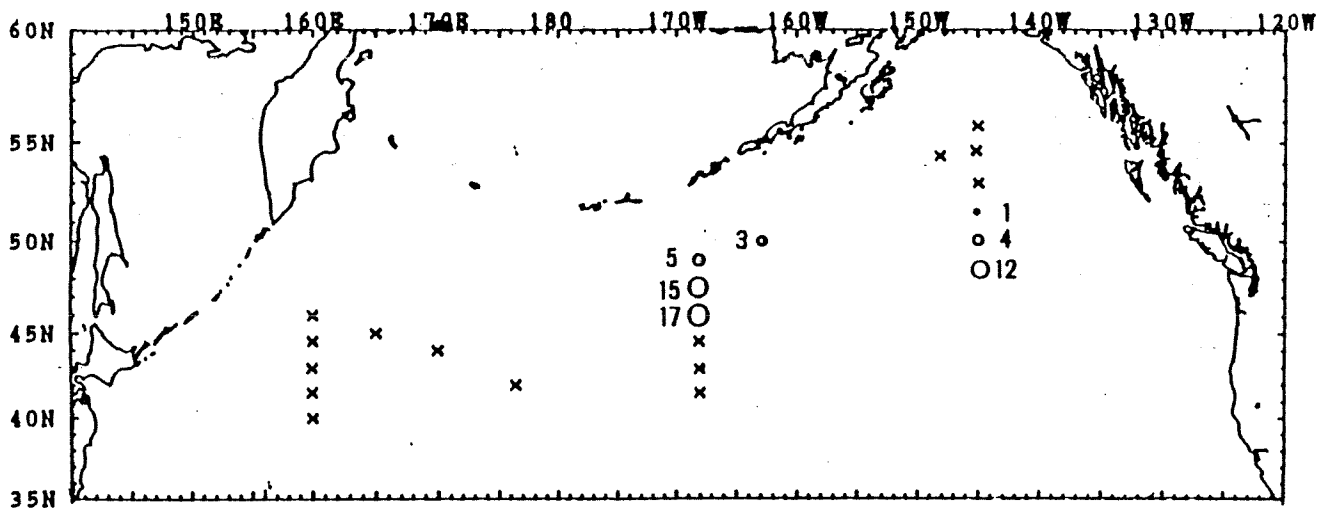


Fig. 6. Coho salmon catch distribution (number of fish) at trawl stations sampled by the *Kaiyo maru* in January 1996 (Fisheries Agency of Japan 1996). The size of open circles is proportional to the number of fish in the catch. x = no coho salmon caught.

Table 5. Coho salmon (age .1) mean fork length (mm) and mean body weight (g) by trawl station, *Kaiyo maru*, January 1996. n = number of fish; SD = standard deviation; CNP = central North Pacific (stations 3-4, 3-5, 3-6, and 4-1 combined); GOA = Gulf of Alaska (stations 5-4, 5-5, and 5-6 combined).

	Station									Total
	3-4	3-5	3-6	4-1	CNP	5-4	5-5	5-6	GOA	
n	17	15	5	3	40	1	4	12	17	57
Length	345	338	330	330	340	430	394	390	393	356
SD	18	16	19	19	17		23	38	34	34
Weight	479	445	409	409	457	950	685	695	708	532
SD	85	62	76	76	74		105	215	195	168

Table 6. Chinook salmon age composition, mean fork length (mm), and mean body weight (g) by trawl station, *Kaiyo maru*, January 1996. n= number of fish. SD = standard deviation. WNP = western North Pacific (sta. 1-5, 1-6, 2-1).

Station		Ocean age		Total
		.1	.2	
1-5	N	4	0	4
	%	100		100
	Length	293		293
	SD	18		18
	Weight	333		333
	SD	62		62
1-6	N	3	0	3
	%	100		100
	Length	282		282
	SD	20		20
	Weight	290		290
	SD	48		48
2-1	N	19	0	19
	%	100		100
	Length	287		287
	SD	18		18
	Weight	302		302
	SD	53		53
WNP	N	26	0	26
	%	100		100
	Length	288		288
	SD	17		17
	Weight	306		306
	SD	53		53
3-6	N	2	2	4
	%	50	50	100
	Length	285	521	403
	SD	6	63	141
	Weight	343	1905	1124
	SD	39	771	1006
4-1	N	1	0	1
	%	100		100
	Length	294		294
	SD			
	Weight	330		330
	SD			
5-5	N	0	1	1
	%		100	100
	Length		458	458
	SD			
	Weight		1170	1170
	SD			

As in the December 1992 *Kaiyo maru* survey, no steelhead (*O. mykiss*) were caught during the survey. It is possible that the trawl is not effective at catching steelhead, or that most steelhead leave offshore areas in winter. Most maturing and repeat-spawning adult winter-run steelhead would have left offshore areas on their return migrations by January. Although steelhead are not abundant in the North Pacific, steelhead (predominantly ocean ages .1 and .2) are routinely caught in research gillnet surveys in the central North Pacific and Gulf of Alaska in summer. Juvenile (ocean age 0.) steelhead are caught by floating gillnet along the 145°W transect in July (for example, Myers et al. 1995).

The combined results of the December 1992 and January 1996 surveys show that at least some salmonids (all species except steelhead) in their first winter at sea are distributed well offshore in December and January (Fig. 8). In addition, particularly in the western portion of the study area, juvenile chum, pink, and chinook salmon appeared to be more abundant in offshore waters in January than in December. Juvenile salmon caught in the western portion of the study area are likely fish that reared during the preceding summer in the Okhotsk Sea, Kurile Islands, and coastal areas of Kamchatka (Fig. 8, no. 1); those caught in the central portion of the study area likely reared in the Bering Sea, Aleutian Islands, and Alaska Peninsula area (Fig. 8, no. 2); and those caught in the eastern portion of the study area likely reared in shelf areas and inland waters around the perimeter of the Gulf of Alaska (Fig. 8, no. 3). The apparent grouping of juvenile salmon in the western, central, and eastern regions of the North Pacific in the first winter at sea, as shown in Fig. 8, is probably an artifact of the survey design.

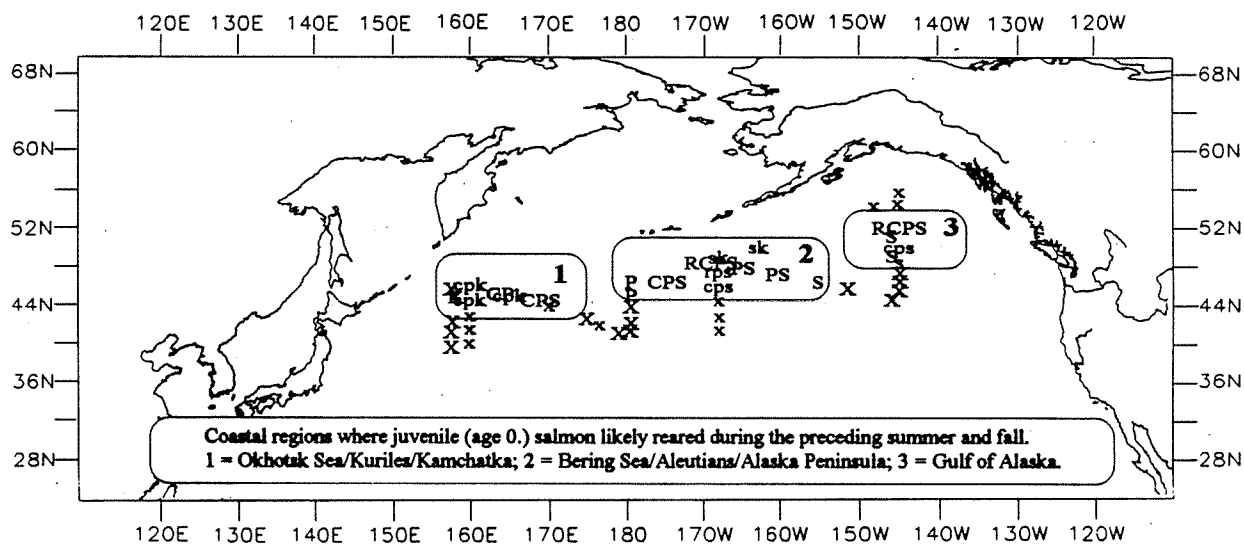


Fig. 8. Offshore distribution of juvenile salmon in December 1992 and January 1996. R = sockeye, C = chum, P = pink, S = coho, K = chinook, x = sampling, but no catch. Upper case letters = December 1992. Lower case letters = January 1996.

One of the objectives of the survey was to further clarify the winter distribution of salmon (particularly the southern limit) with respect to sea surface temperature. Because of the limited number of stations sampled and the broad area covered by the survey, the relationships between salmon catches and various oceanographic factors should be interpreted with caution. In the western North Pacific (transect 1, 160°E), the southern limit of the salmon catch was at station 3-4 (44°30'N; SST 4.5°C) for chum, pink, and chinook. These same species were caught at 5.5°C (SST) at station 2-1 (165°E, 45°N). In the central North Pacific (transect 3, 168°W), the southern limit of the salmon catch was at station 3-4 (46°N; SST 7.3°C) for pink, chum, and coho, at station 3-5 (47°30'N; SST 6.1°C) for sockeye, and at station 3-6 (49°N; SST 5.3°C) for chinook. In the central Gulf of Alaska (transect 5, 145°W), the southern limit of the sockeye salmon catch was at station 5-3 (53°N; SST 4.6°C). Chum and coho salmon were relatively abundant at the most southerly station (5-6) along this transect (48°30'N, SST 7.2°C). In general, the results were similar to those of the previous (December 1992) *Kaiyo maru* trans-Pacific survey in that all of the salmon were caught in relatively cool water (less than 7.5°C SST). Additional east-west transects across the entire study area, as well as transects within the Russian and U.S. 200-mile zones are needed to further clarify winter distribution and abundance of all species and age groups salmon in the North Pacific Ocean.

Blood Plasma for Growth Studies

Blood was collected by FRI and FAJ scientists from 98 fish (29 chum, 15 pink, 15 chinook, 26 coho, and 13 sockeye salmon) to determine if field samples from trawl-caught salmon can be used for measurement of levels of insulin-like growth factor-1 (IGF-1; Moriyama et al. 1995; Appendix Table 2). IGF-1 levels in fish plasma may provide an index of the instantaneous growth rate of salmon. Experimental studies on juvenile hatchery coho salmon in seawater show that IGF-1 levels are significantly correlated with specific growth rate and environmental conditions, e.g., temperature and photoperiod (Duan et al. 1995). This is the first field study of IGF-1 levels in salmon caught in offshore waters.

Incidental Catch

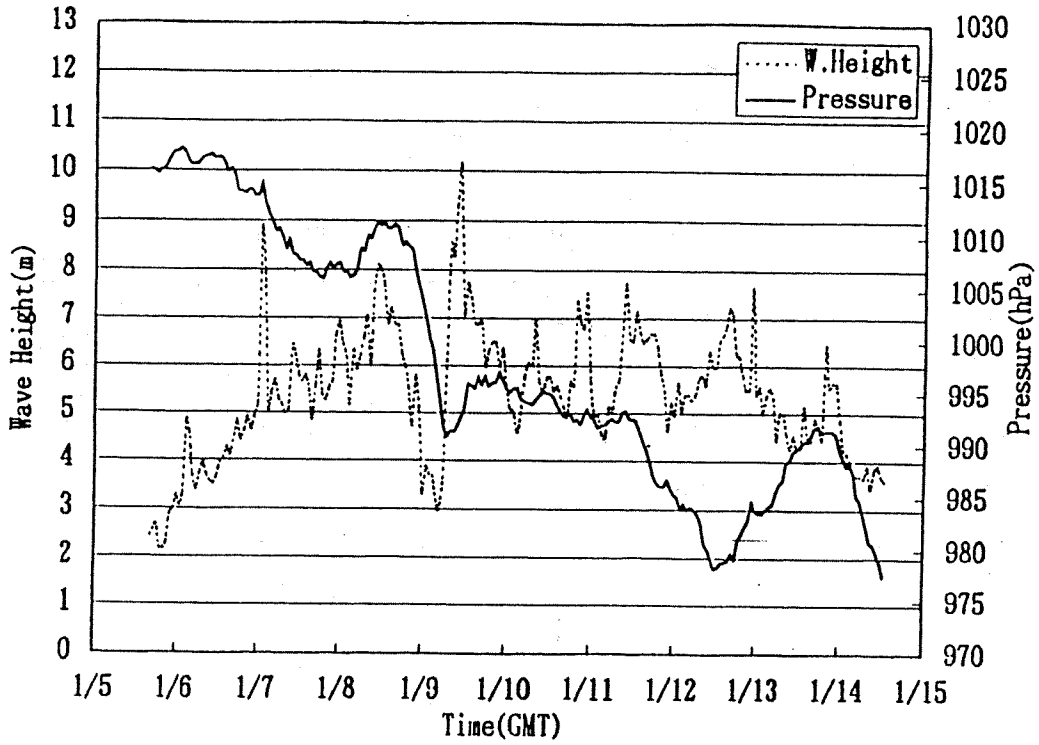
The total incidental catch was estimated at 10,349 squid, 14,935 Myctophidae, and 84 other fish (Fisheries Agency of Japan 1996). Jellyfish and salps were also common in the bycatch, but quantities were difficult to estimate because of net damage. Samples of Myctophids were collected for NMFS at two stations. No marine mammals or birds were caught by the trawl net during the survey.

Environmental and Oceanographic Data and Plankton Sampling

Environmental and oceanographic data are summarized in Figs. 9-19. Computer files of the detailed oceanographic data (pressure, temperature, salinity, oxygen, transparency, chlorophyll, and pH) were also provided on disk, and are archived at FRI. These data are summarized for each trawl station in Appendix Table 3.

ACKNOWLEDGMENTS

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北太平洋 (西経域)

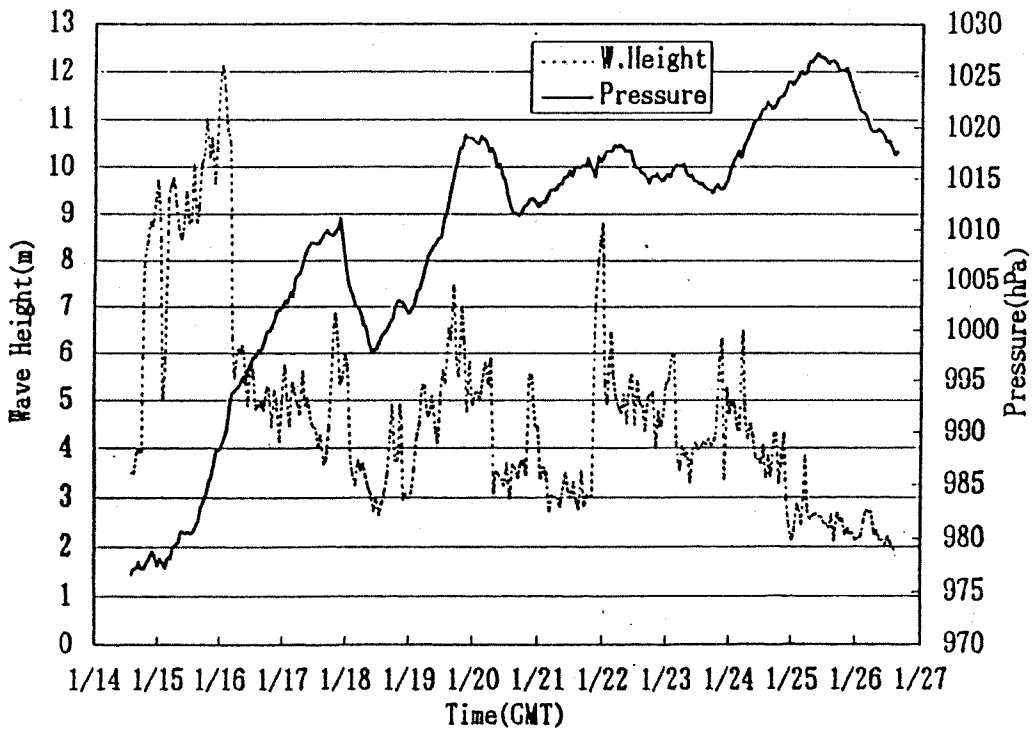
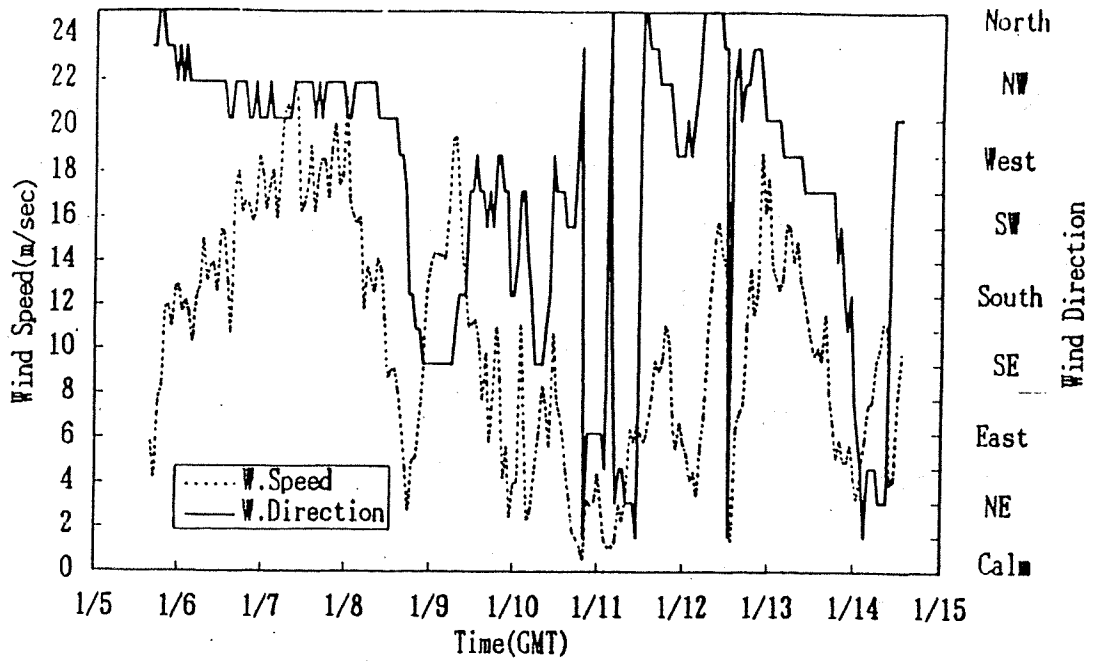


Fig. 9. Wave height (m) and atmospheric pressure (hPa) (Fisheries Agency of Japan 1996).



北太平洋 (西経域)

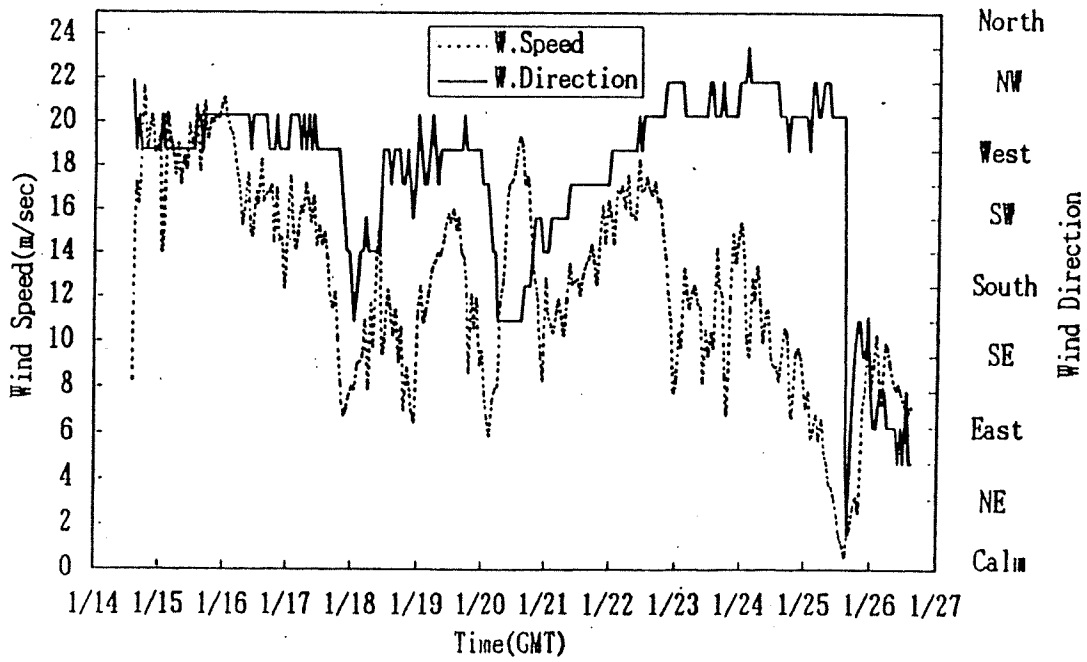


Fig. 10. Wind speed (m/sec) and wind direction (Fisheries Agency of Japan 1996).

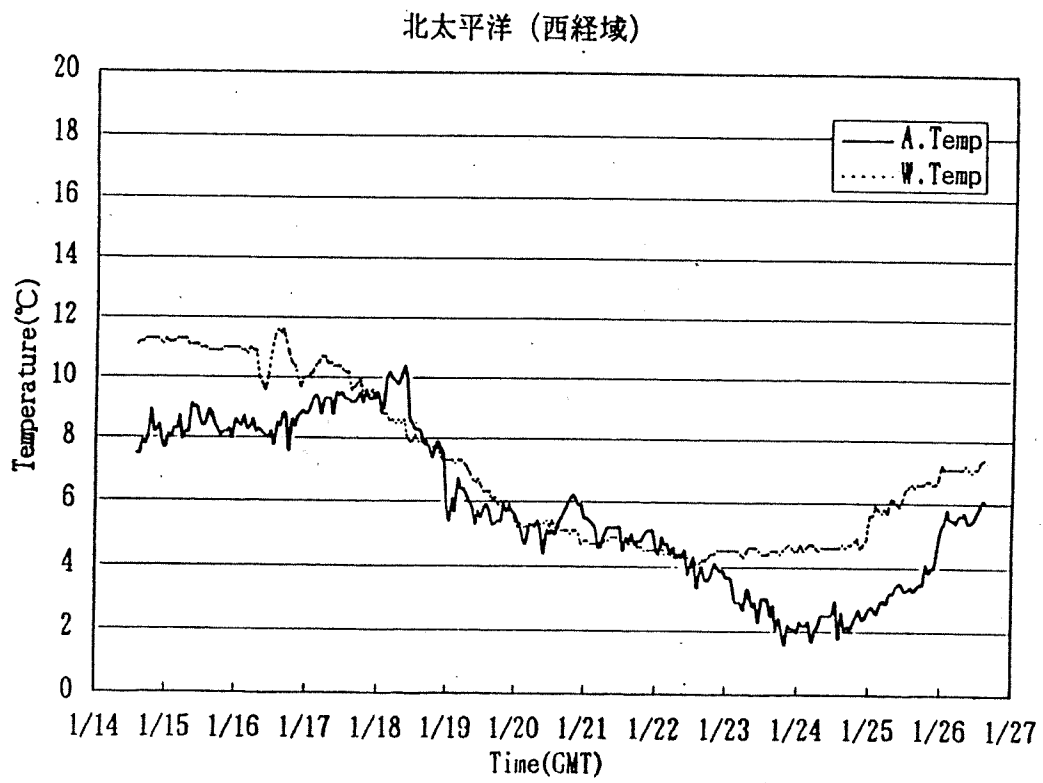
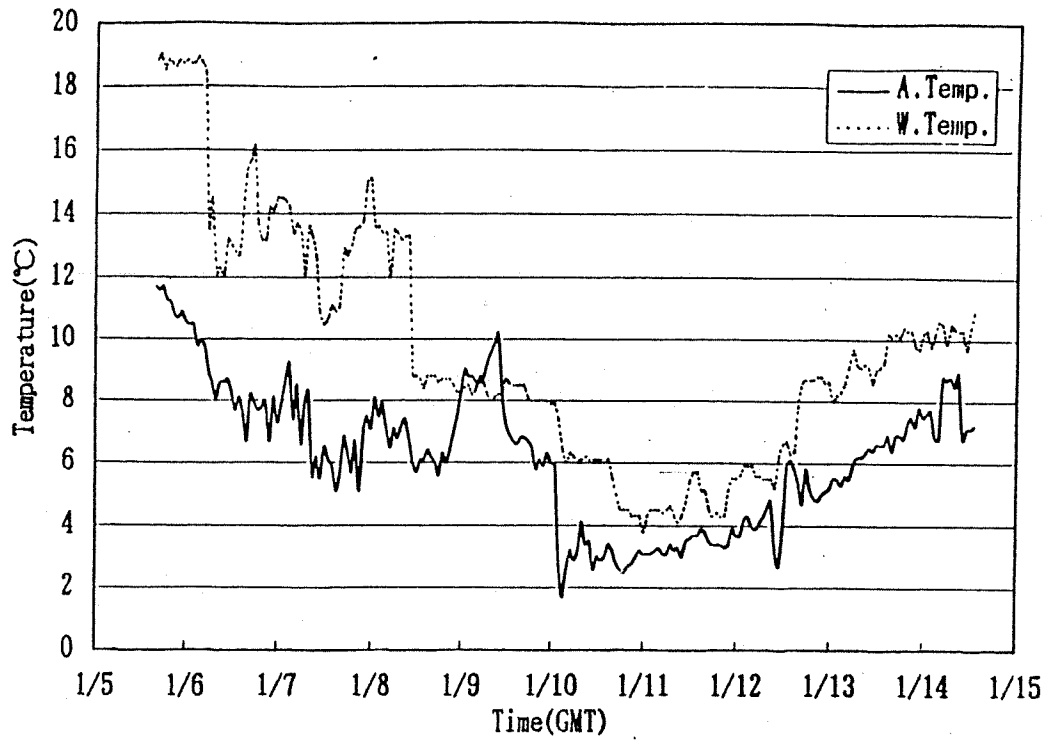


Fig. 11. Air and sea surface temperatures (Fisheries Agency of Japan 1996).

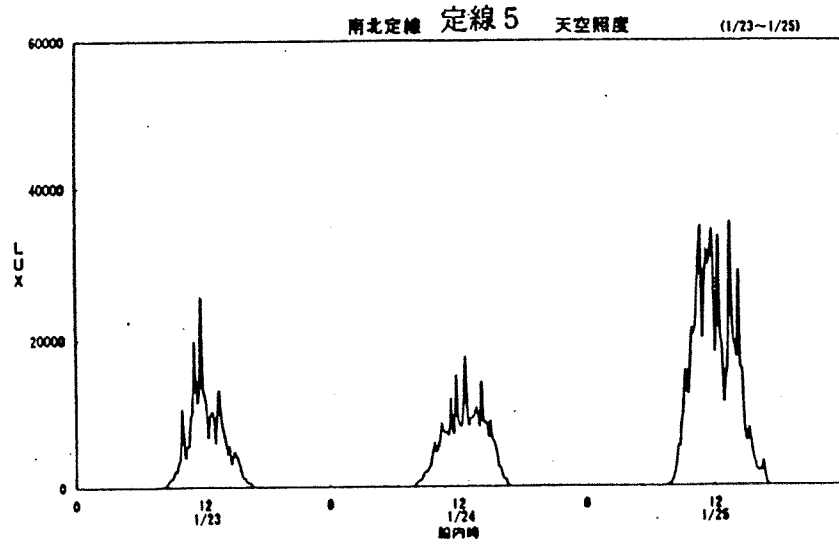
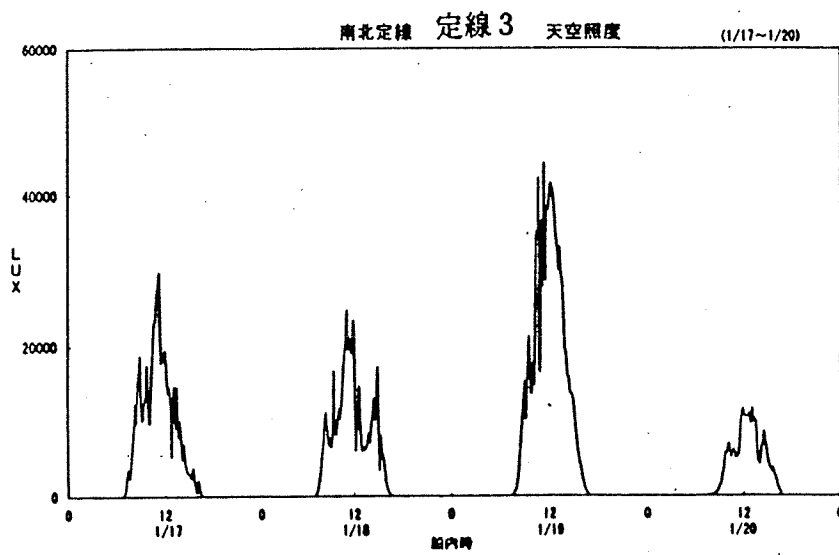
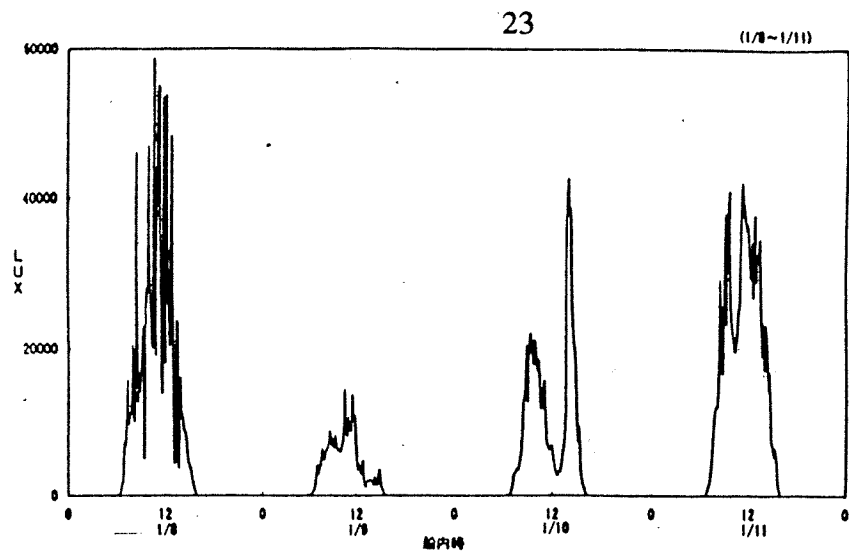


Fig. 12. Solar radiation along the three north-south transects (Fisheries Agency of Japan 1996).

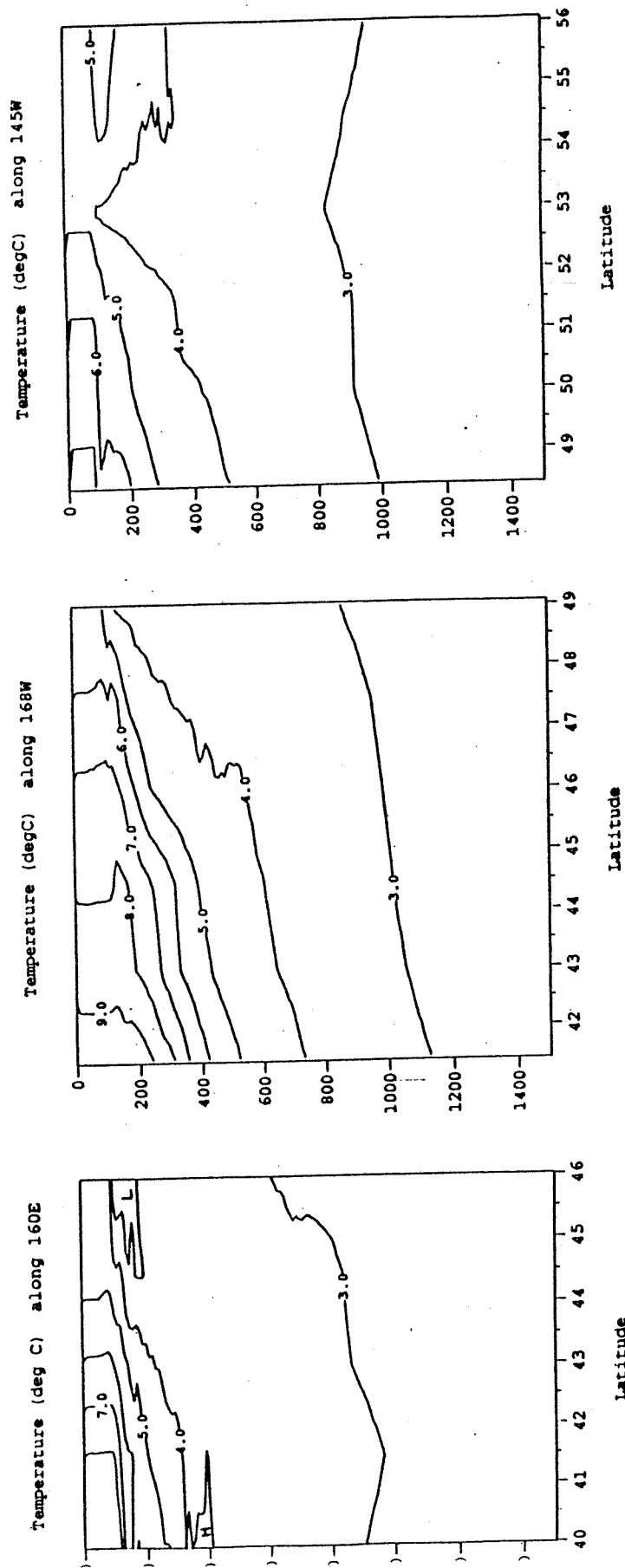


Fig. 13. Water temperatures (CTD) along the three north-south transects (Fisheries Agency of Japan 1996).

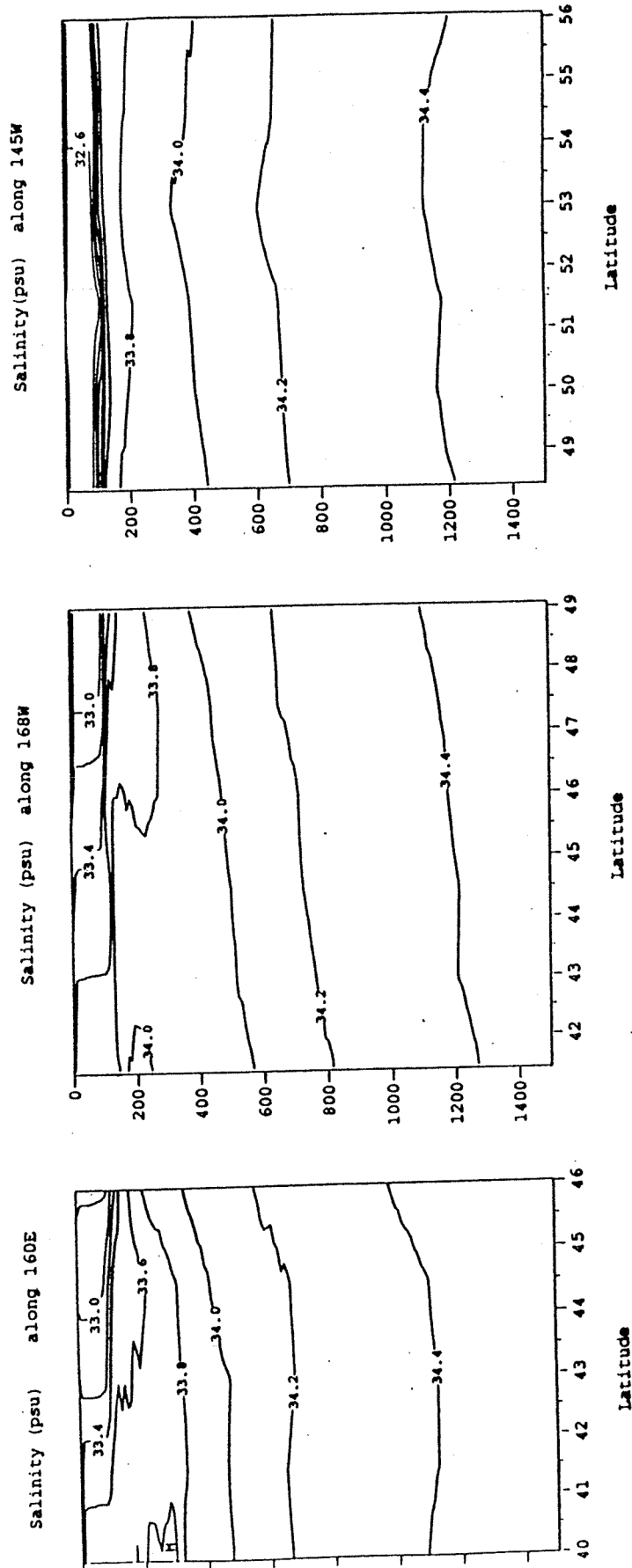


Fig. 14. Salinities (CTD) along the three north-south transects (Fisheries Agency of Japan 1996).

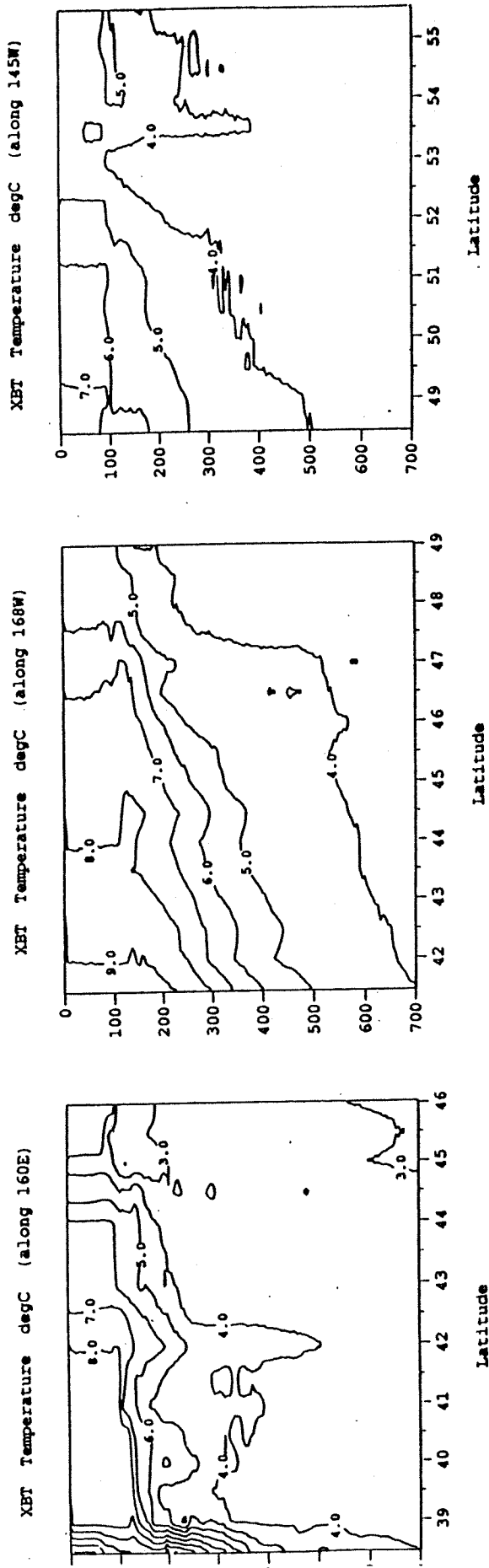


Fig. 15. Water temperatures (XBT) along the three north-south transects (Fisheries Agency of Japan 1996).

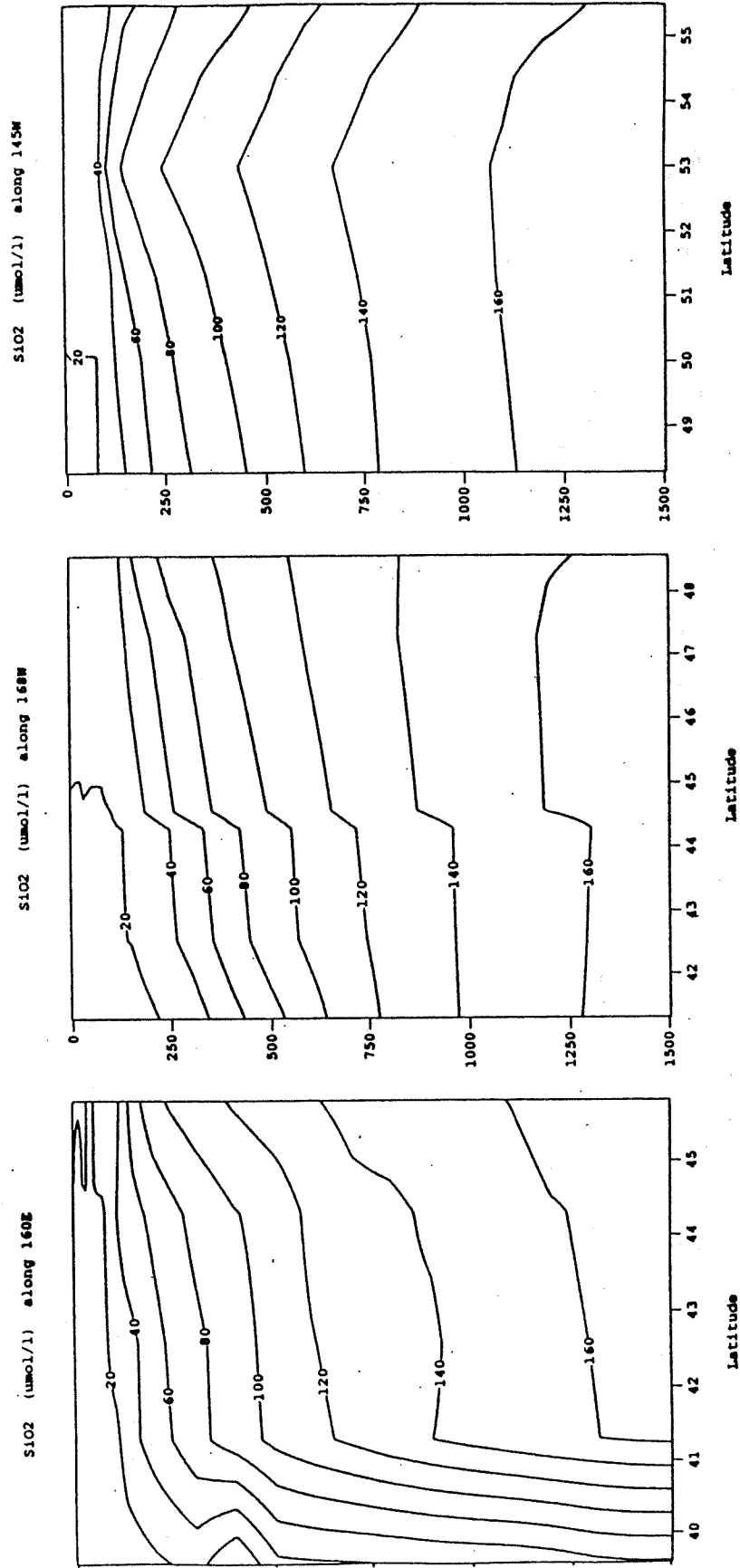


Fig. 16. SiO₂ along the three north-south transects (Fisheries Agency of Japan 1996).

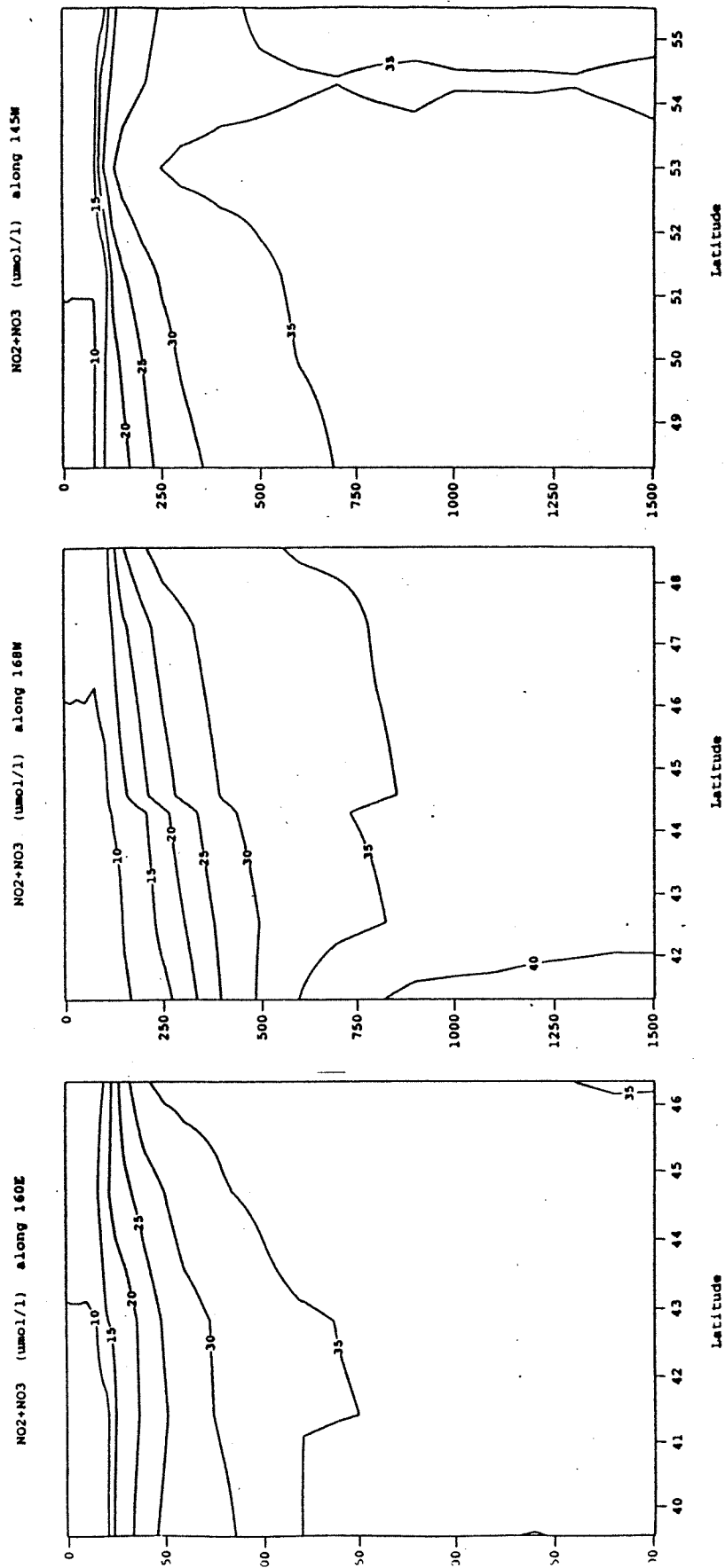


Fig. 17. NO₂ + NO₃ along the three north-south transects (Fisheries Agency of Japan 1996).

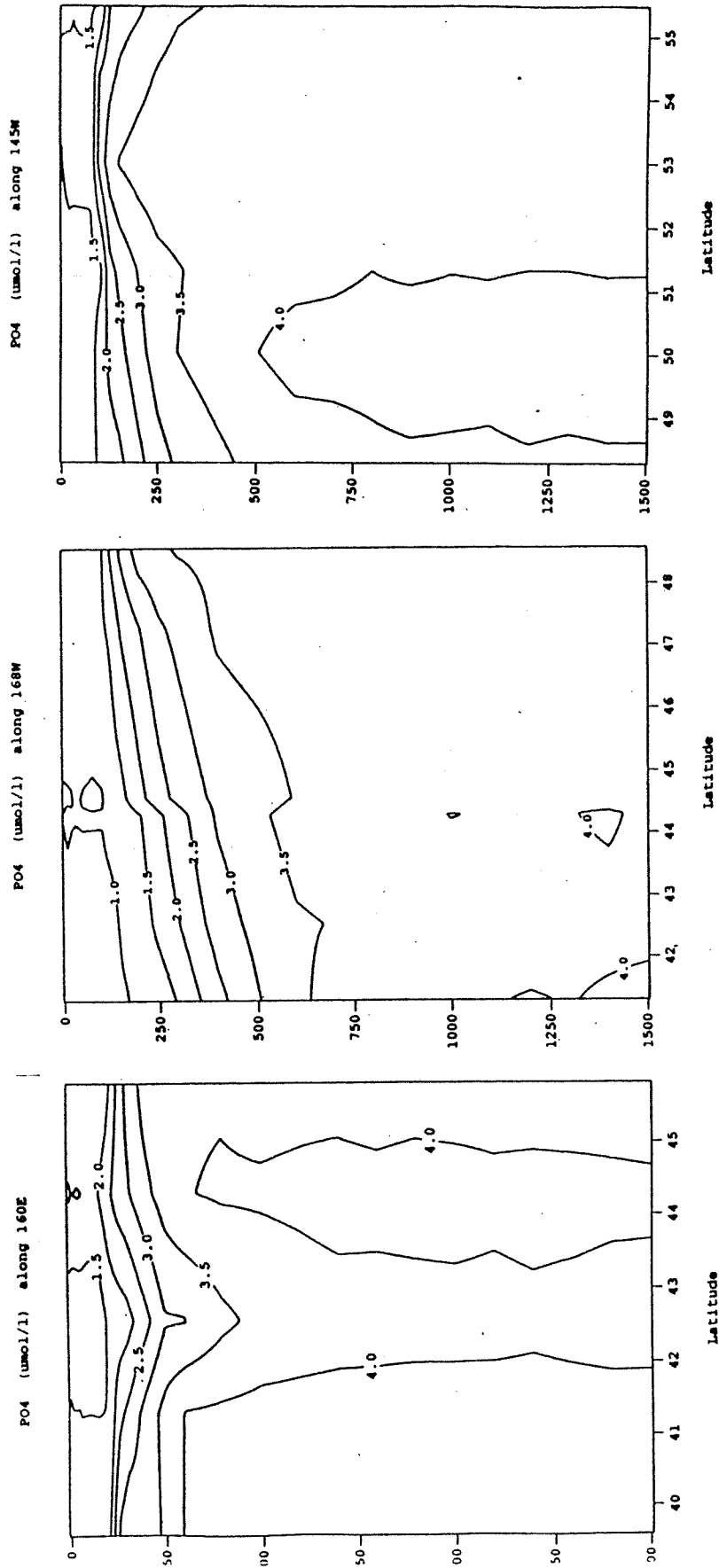


Fig. 18. PO4 along the three north-south transects (Fisheries Agency of Japan 1996).

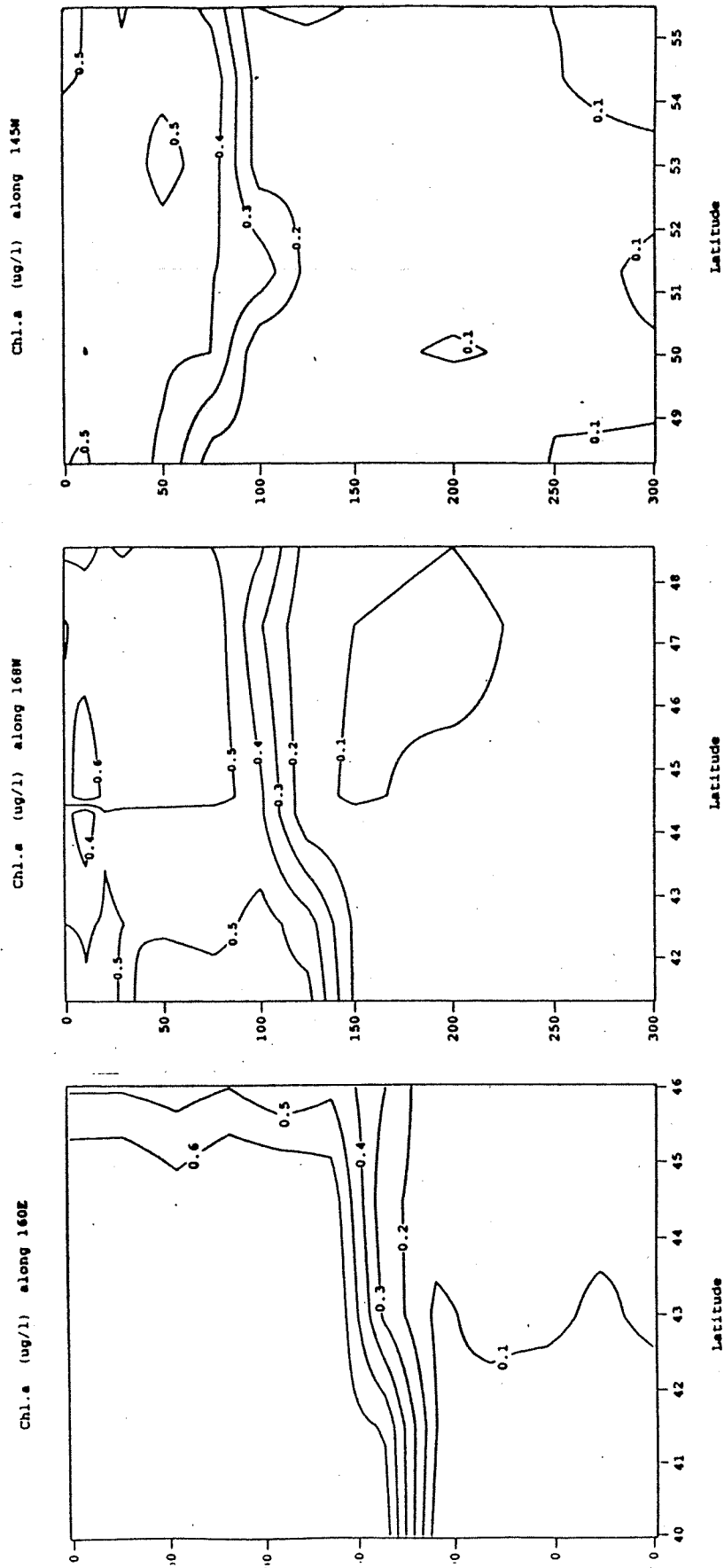
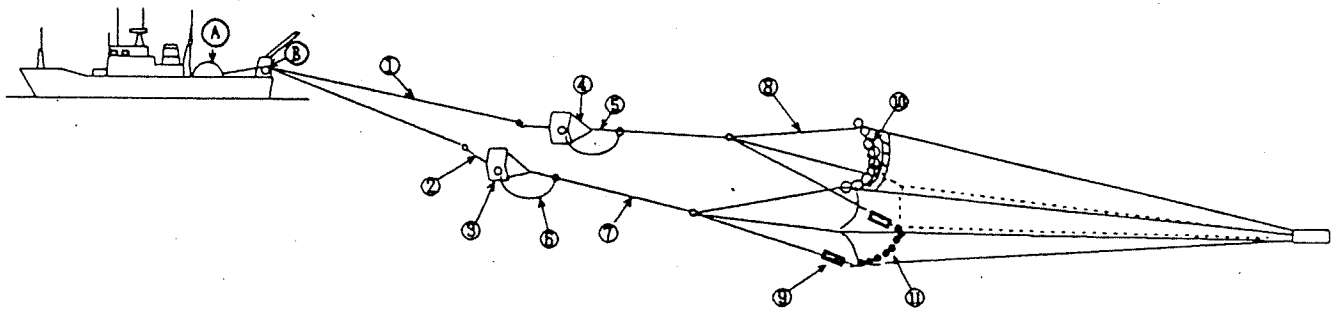
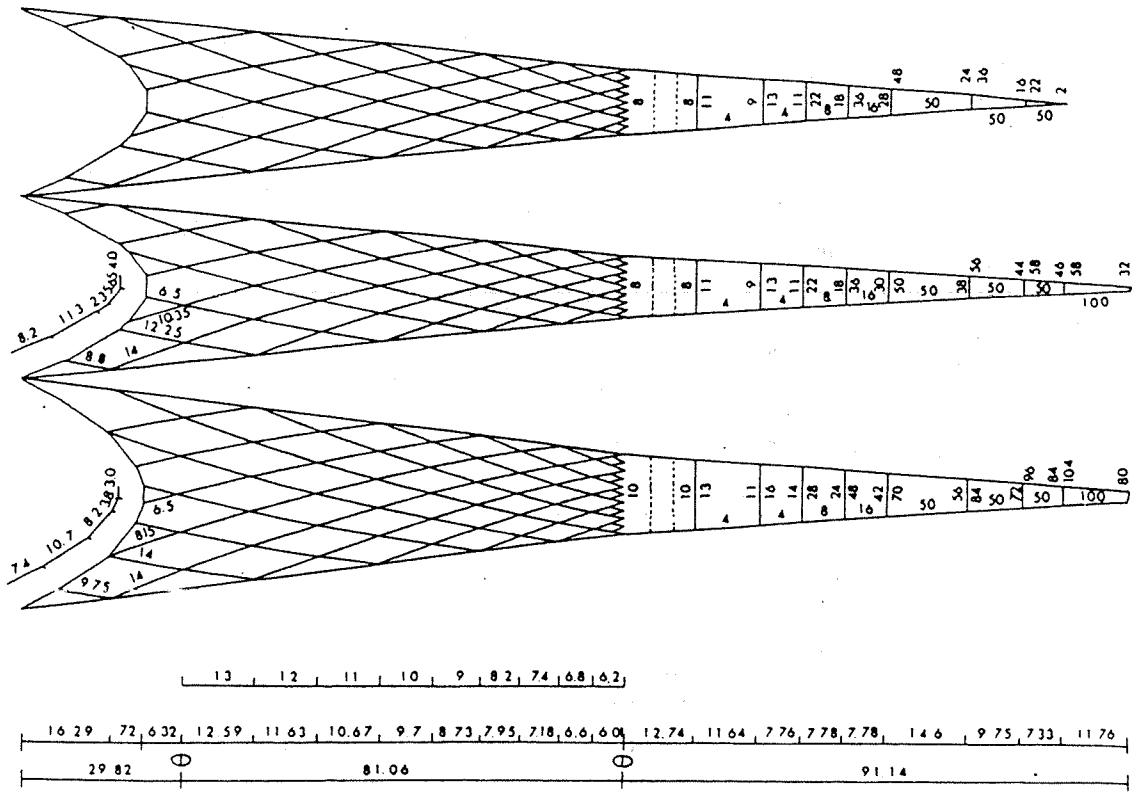


Fig. 19. Chlorophyll a ($\mu\text{g/l}$) along the three north-south transects (Fisheries Agency of Japan 1996).

REFERENCES

- Duan, C., E.M. Plisetskaya, and W.W. Dickhoff. 1995. Expression of insulin-like growth factor I in normally and abnormally developing coho salmon (*Oncorhynchus kisutch*). *Endocrin.* 136(2):446-452.
- Fisheries Agency of Japan. 1994. The research cruise for wintering salmon in the North Pacific Ocean - the second cruise report of the *Kaiyo maru* in 1992. Fisheries Agency of Japan. 163 pp.
- Fisheries Agency of Japan. 1995a. Research plan of the *Kaiyo maru* cruise in 1996 (January 5-31, 1996): survey on overwintering salmonids in the North Pacific Ocean. Tokyo, Japan. 5 pp.
- Fisheries Agency of Japan. 1995b. Summary of the report on the 1993 R/V *Kaiyo maru* juvenile salmon research. Fisheries Agency of Japan, Salmon Report Ser. No. 40:1:4.
- Fisheries Agency of Japan. 1996. Survey on overwintering salmonids in the North Pacific Ocean. Fisheries Agency of Japan. (Shipboard summary report, in Japanese.)
- Moriyama, S., W.W. Dickhoff, and E.M. Plisetskaya. 1995. Isolation and characterization of insulin-like growth factor-1 from rainbow trout, *Oncorhynchus mykiss*. *Gen. Comp. Endocrin.* 99:221-229.
- Myers, K.W. 1990. Tag returns in 1990 - United States high seas salmon tagging. (INPFC Doc.) FRI-UW-9014. Fish. Res. Inst., Univ. Washington, Seattle. 10 pp.
- Myers, K.W. 1991. Tag returns in 1991 - United States high seas salmon tagging. (INPFC Doc.) FRI-UW-9111. Fish. Res. Inst., Univ. Washington, Seattle. 9 pp.
- Myers, K.W. 1993. Japan, U.S.A., and Canada cooperative survey on overwintering salmonids in the North Pacific Ocean: *Kaiyo maru*, cruise report, 25 November-24 December 1992. FRI-UW-9301. University of Washington, Fisheries Research Institute, Box 357980, Seattle, WA 98195-7980. 15 pp. + appendices.
- Myers, K.W., R.V. Walker, N.D. Davis, W.S. Patton, K.Y. Aydin, E.K. Pikitch, and R.L. Burgner. 1995. Migrations, abundance, and origins of salmonids in offshore waters of the North Pacific - 1985. Annual Report, High Seas Salmon Research Project. National Marine Fisheries Service Contr. No. 50ABNF400001. FRI-UW-9506. Univ. Wash., Fish. Res. Inst., Box 357980, Seattle, WA 98195-7980. 84 pp.

APPENDIX



漁具名称及び規格

A トロールウインチ	① ワープ	32mm f × 400m	⑦ ハンドロープ	ワフ-ブ(TWS) 32mm f × 20m
B トップローラー	② トーイングチェーン		⑧ 網ペンネット	テリシロコロシロ-ブ(TM) 32mm f × 98m + 6m
	③ オッターボード	3.75m × 2.4m = 9.0㎡	⑨ フロントウエイト	
	④ オッターペンネット	TWS 26mm f × 13m × 2	⑩ カイト	
	⑤ 先付けワイヤー	TWS 32mm f × 2m	⑪ グランドチェーン	
	⑥ 遊びワイヤー	TWS 30mm f × 21.4m		
				注) 袖身総長+コッド長=202.02m-20m (ホリカフF8は12mm) 網口高さ 約60m、袖先間隔 約60m

Appendix Fig. 1. Diagrams showing construction and operation of spider (surface rope) trawl (Fisheries Agency of Japan 1994, 1995b).

Appendix Table 1. Date, time, and location of sampling stations (Fisheries Agency of Japan, pers. comm.).

Date SMT	Time SMT	Date GMD	Date GMT	Station	Lat.	Long.	Water Temp.	TRAWL	CTD	XBT	NORPAC NET	BONGO NET	PRIMARY PRODUCTION
0106	0649	0105	2149	X-1	3535N	14401E	18.7			○			
	1204		0106	0304	X-2	3546N	14500E	18.9		○			
	1458		0558	X-3	3557N	14600E	13.8		○				
	1816		0906	X-4	3608N	14700E	12.1		○				
	2114		1214	X-5	3619N	14800E	13.0		○				
0107	0012	0107	1512	X-6	3630N	14900E	14.0			○			
	0305		1805	X-7	3641N	15000E	16.0			○			
	0607		2107	X-8	3653N	15100E	13.3			○			
	1152		0252	X-9	3703N	15200E	14.8			○			
	1459		0559	X-10	3714N	15300E	13.4			○			
	1802		2102	X-11	3725N	15400E	13.0			○			
	2143		1213	X-12	3736N	15500E	10.5			○			
0108	0046	0108	1516	X-13	3747N	15600E	11.1			○			
	0356		1826	X-14	3758N	15700E	12.9			○			
	0704		2134	X-15	3809N	15800E	13.5			○		○	
	0803		2233	W-1	3812N	15818E	14.6			○			
	1049		0119	X-16	3819N	15900E	13.6			○			
	1435		0505	1-1	3833N	15955E	11.7	○		○			
	1747		0817	X-17	3820N	16011E	13.0			○			
	2206		1236	X-18	3900N	16000E	8.7			○			
0109	0110	0109	1540	X-19	3930N	16000E	8.8			○			
	0414		1844	X-20	4000N	16000E	8.7			○			
	0603		2033	1-2	4000N	16002E	8.8	○	○		○	○	
	0823		2253	G-1	4008N	15954E	8.8			○			
	1201		0231	X-21	4030N	16000E	8.4			○			
	1345		0415	X-22	4100N	16000E	8.4			○			
1539	0609	X-23	4130N	16000E	8.0			○					
0110	0430	0110	1830	1-3	4130N	16000E	8.0	○	○		○	○	
	0815		2215	G-2	4135N	16009E	8.0			○			
	1038		0038	X-24	4200N	16000E	7.9			○			
	1230		0230	X-25	4230N	16000E	7.1			○			
	1430		0430	1-4	4258N	16000E	5.9	○	○		○	○	
	1750		0750	X-26	4308N	16000E	6.1			○			
	2059		1059	X-27	4330N	16000E	6.1			○			
0111	0047	0111	1447	X-28	4400N	16000E	6.2			○			
	0419		1819	X-29	4430N	16000E	4.5			○			
	0442		1842	1-5	4431N	16000E	4.5	○	○		○	○	
	0828		2228	G-3	4441N	16000E	4.5			○			
	1009		0009	X-30	4500N	16000E	3.7			○			
	1207		0207	X-31	4530N	16000E	4.5			○			
	1402		0402	1-6	4558N	16000E	4.5	○	○		○	○	
	1723		0723	X-32	4608N	16002E	4.5			○			
2108	1038	X-33	4548N	16100E	4.3			○					
0112	0010	0112	1340	X-34	4536N	16200E	5.7			○			
	0305		1635	X-35	4524N	16300E	4.5			○			
	0555		1925	X-36	4512N	16400E	4.4			○			
	0838		2208	X-37	4500N	16459E	5.2			○			
	0850		2220	2-1	4500N	16500E	5.2	○	○		○	○	
	0917		2247	G-4	4500N	16501E	5.2			○			
	1429		0359	X-38	4448N	16600E	5.9			○			

Appendix Table 1. Date, time, and location of sampling stations (cont'd).

Date SMT	Time SMT	Date GMD	Date GMT	Station	Lat.	Long.	Water Temp.	TRAWL	CTD	XBT	NORPAC NET	BONGO NET	PRIMARY PRODUCTION
	1717		0647	X-39	4436N	16601E	5.5			○			
	2040		0940	X-40	4424N	16800E	5.2			○			
0113	0003		1303	X-41	4412N	16901E	6.7			○			
	0433		1733	X-42	4400N	17000E	8.7			○			
	0450		1750	2-2	4400N	17000E	8.6	○	○		○	○	
	0923		2203	G-5	4349N	17020E	8.6						○
	1136	0113	0036	X-43	4342N	17100E	7.9			○			
	1445		0345	X-44	4324N	17200E	8.6			○			
	1754		0654	X-45	4306N	17300E	9.4			○			
	2136		1006	X-46	4248N	17400E	9.1			○			
0114A	0046		1316	X-47	4230N	17500E	9.1			○			
	0416		1646	X-48	4208N	17601E	10.2			○			
	0545		1815	X-49	4159N	17625E	10.4			○			
	0558		1828	2-3	4159N	17626E	10.4	○	○		○	○	
	1023		2253	G-6	4206N	17641E	10.4						○
	1213	0114	0043	X-50	4147N	17700E	10.1			○			
	1533		0403	X-51	4125N	17800E	10.7			○			
	1951		0821	X-52	4103N	17900E	10.5			○			
0114B	0138		1338	X-53	4041N	18000W	11.2			○			
0115	1541	0116	0341	X-54	4056N	17934W	10.9			○			
	1747		0547	X-55	4051N	17900W	10.9			○			
	2115		0915	X-56	4047N	17800W	9.6			○			
0116	0044		1244	X-57	4045N	17700W	10.5			○			
	0412		1612	X-58	4044N	17600W	11.5			○			
	0732		1932	X-59	4042N	17500W	10.4			○			
	1042		2242	X-60	4040N	17400W	9.8			○			
	1349	0117	0149	X-61	4040N	17300W	10.2			○			
	1702		0502	X-62	4042N	17200W	10.7			○			
	2045		0815	X-63	4049N	17100W	10.5			○			
0117	0000		1130	X-64	4055N	17000W	10.4			○			
	0314		1444	X-65	4102N	16859W	9.8			○			
	0720		1850	X-66	4130N	16800W	9.4			○			
	0734		1904	3-1	4130N	16800W	9.4	○	○		○	○	○
	0822		1952	G-7	4130N	16800W	9.4						
	1325	0118	0035	X-67	4200N	16800W	8.9			○			
	1457		0227	X-68	4230N	16800W	8.8			○			
	1645		0415	3-2	4255N	16801W	8.6	○	○		○	○	
	2017		0747	X-69	4302N	16753W	8.6			○			
	2239		1009	X-70	4330N	16800W	8.0			○			
0118	0051		1221	X-71	4400N	16800W	8.0			○			
	0506		1636	X-72	4430N	16805W	7.8			○			
	0515		1645	3-3	4430N	16804W	7.8	○	○		○	○	
	0849		2019	G-8	4433N	16753W	7.8						○
	1054		2224	X-73	4500N	16800W	7.4			○			
	1242	0119	0012	X-74	4530N	16800W	7.4			○			
	1433		0203	3-4	4558N	16806W	7.3	○	○		○	○	
	1804		0534	X-75	4604N	16751W	7.2			○			
	2149		0849	X-76	4630N	16800W	6.8			○			
0119	0034		1134	X-77	4700N	16800W	6.5	○	○		○	○	
	0602		1702	3-5	4730N	16809W	6.1	○	○		○	○	

Appendix Table 1. Date, time, and location of sampling stations (cont'd).

Date SMT	Time SMT	Date GMD	Date GMT	Station	Lat.	Long.	Water Temp.	TRAWL	CTD	XBT	NORPAC NET	BONGO NET	PRIMARY PRODUCTION
	0900		2000	G-9	4729N	16752W	6.1						○
	0950		2050	X-78	4729N	16752W	6.1			○			
	1203		2303	X-79	4800N	16800W	5.7			○			
	1358	0120	0058	X-80	4830N	16801W	5.3			○			
	1557		0257	3-6	4858N	16807W	5.2	○	○		○	○	
	1909		0609	X-81	4902N	16755W	5.2			○			
	2216		0846	X-82	4912N	16700W	5.3			○			
0120	0055		1125	X-83	4924N	16600W	5.2			○			
	0337		1407	X-84	4936N	16500W	5.2			○			
	0552		1622	X-85	4947N	16400W	5.1			○			
	9004		1934	X-86	4959N	16300W	5.1			○			
	0920		1950	4-1	4959N	16258W	5.1	○	○		○	○	
	1001		2031	G-10	4959N	16258W	5.1						○
	1503	0121	0133	X-87	5010N	16200W	4.8			○			
	1738		0408	X-88	5022N	16100W	4.6			○			
	2007		0627	X-89	5033N	16000W	4.6			○			
	2236		0906	X-90	5045N	15900W	4.9			○			
0121	0104		1134	X-91	5056N	15800W	4.9			○			
	0330		1400	X-92	5107N	15700W	4.8			○			
	0555		0625	X-93	5119N	15600W	4.8			○			
	0821		1851	X-94	5130N	15500W	4.5			○			
	0919		1949	X-95	5138N	15439W	4.5			○			
	0930		2000	4-2	5139N	15437W	4.5	○	○		○	○	
	1008		2038	G-11	5139N	15436W	4.5						○
	1544	0122	0214	X-96	5154N	15400W	4.5			○			
	1906		0536	X-97	5216N	15300W	4.4			○			
	2302		0902	X-98	5240N	15200W	4.4			○			
0122	0229		1229	X-99	5305N	15100W	4.3			○			
	0556		1556	X-100	5330N	15000W	4.2			○			
	0933		1933	X-101	5359N	14900W	4.4			○			
	1231		2231	4-3	5421N	14812W	4.5	○	○		○	○	
	1616	0123	0216	X-102	5413N	14758W	4.5			○			
	2058		0628	X-103	5444N	14700W	4.3			○			
0123	0159		1129	X-104	5516N	14600W	4.5			○			
	0748		1718	5-1	5547N	14504W	4.4	○	○		○	○	
	1023		1953	G-12	5542N	14453W	4.4						○
	1105		2035	X-105	5541N	14454W	4.4			○			
	1208		2138	X-106	5530N	14450W	4.7			○			
	1406		2336	X-107	5500N	14500W	4.6			○			
	1551	0124	0121	5-2	5436N	14511W	4.5	○	○		○	○	
	1942		0512	X-108	5427N	14501W	4.5			○			
	2219		0749	X-109	5400N	14500W	4.6			○			
0124	0117		1047	X110	5330N	14500W	4.7			○			
	0554		1524	X-111	5300N	14500W	4.7			○			
	0603		1542	5-3	5300N	14500W	4.7	○	○		○	○	
	1019		1958	G-13	5256N	14442W	4.7						○
	1235		2105	X-112	5230N	14500W	4.6			○			
	1426		2356	X-113	5200N	14500W	5.5			○			
	1616	0125	0146	5-4	5133N	14509W	5.8	○	○		○	○	
	1939		0509	X-114	5128N	14454W	5.8			○			

Appendix Table 1. Date, time, and location of sampling stations (cont'd).

Date SMT	Time SMT	Date GMD	Date GMT	Station	Lat.	Long.	Water Temp.	TRAWL	CTD	XBT	NORPAC NET	BONGO NET	PRIMARY PRODUCTION
	2238		0808	X-115	5100N	14500W	6.9			○			
0125	0134		1104	X-116	5030N	14500W	6.1			○			
	0633		1603	5-5	5004N	14459W	6.6	○	○		○	○	
	0908		1838	X-117	4959N	14500W	6.6			○			
	0955		1925	G-14	1925N	14459W	6.6						○
	1240		2210	X-118	4930N	14500W	6.6			○			
	1431	0126	0001	X-119	4900N	14500W	7.1			○			
	1644		0214	5-6	4829N	14448W	7.1	○	○		○	○	
	2000		0530	X-120	4832N	14500W	7.1			○			
	2325		0826	X-121	4828N	14400W	7.3			○			
0126	0211		1111	X-122	4828N	14300W	7.1			○			
	0455		1355	X-123	4828N	14200W	7.4			○			
	0737		1637	X-124	4828N	14100W	7.4			○			
	1036		1936	X-125	4828N	14000W	7.7			○			
	1336		2236	X-126	4828N	13900W	8.2			○			
	1658	0127	0158	X-127	4828N	13800W	8.2			○			
	2103		0533	X-128	4828N	13700W	8.2			○			
0127	0046		0916	X-129	4828N	13600W	7.6			○			
	0431		1301	X-130	4828N	13500W	8.0			○			

Appendix Table 2. List of blood samples of salmon collected by FRI for measurement of levels of insulin-like growth factor-1 (IGF-1; Moriyama et al. 1995).

No.	Species	Date of catch	Stat.	Latitude	Longitude	Age*	(mm)	(g)
							FL	Weight
CH-1	Chum	01/11/96	1-5	44.31N	160.00E	0.1	233	125
CH-2	Chum	01/11/96	1-5	44.31N	160.00E	0.1	233	115
CH-3	Chum	01/11/96	1-5	44.31N	160.00E	0.1	256	160
CH-4	Chum	01/11/96	1-5	44.31N	160.00E	0.1	230	125
CH-5	no sample							
CH-6	Chum	01/11/96	1-5	44.31N	160.00E	0.1	262	160
CH-7	Chum	01/11/96	1-5	44.31N	160.00E	0.1	235	135
CH-8	Chum	01/11/96	1-6	45.58N	160.00E	0.2	453	900
CH-9	Chum	01/11/96	1-6	45.58N	160.00E	0.1	253	185
CH-10	Chum	01/18/96	3-4	46.03N	167.52W	0.2	410	690
CH-11	Chum	01/18/96	3-4	46.03N	167.52W	0.2	388	570
CH-12	Chum	01/18/96	3-4	46.03N	167.52W	0.2	390	525
CH-13	Chum	01/18/96	3-4	46.03N	167.52W	0.2	384	570
CH-14	Chum	01/18/96	3-4	46.03N	167.52W	0.2	404	630
CH-15	Chum	01/18/96	3-4	46.03N	167.52W	0.2	424	670
CH-16	Chum	01/19/96	3-5	47.30N	168.09W	0.4	529	1440
CH-17	Chum	01/19/96	3-5	47.30N	168.09W	0.4	530	1600
CH-18	Chum	01/19/96	3-5	47.30N	168.09W	0.4	563	1870
CH-19	Chum	01/19/96	3-6	48.58N	168.07W	0.3	566	1960
CH-20	Chum	01/20/96	4-1	50.00N	162.57W	0.3	560	1940
CH-21	Chum	01/20/96	4-1	50.00N	162.57W	0.3	552	1850
CH-22	Chum	01/20/96	4-1	50.00N	162.57W	0.3	520	1500
CH-23	Chum	01/20/96	4-1	50.00N	162.57W	0.4	582	2100
CH-24	Chum	01/20/96	4-1	50.00N	162.57W	0.4	576	1920
CH-25	Chum	01/22/96	4-3	54.21N	148.12W	0.3	498	1300
CH-26	Chum	01/22/96	4-3	54.21N	148.12W	0.3	527	1580
CH-27	Chum	01/22/96	4-3	54.21N	148.12W	0.3	508	1320
CH-28	Chum	01/22/96	4-3	54.21N	148.12W	0.3	550	1670
CH-29	Chum	01/22/96	4-3	54.21N	148.12W	0.3	552	1570
CH-30	Chum	01/22/96	4-3	54.21N	148.12W	0.2	454	1140
P-1	Pink	01/11/96	1-5	44.31N	160.00E	0.1	300	260
P-2	Pink	01/11/96	1-5	44.31N	160.00E	0.1	267	188
P-3	Pink	01/11/96	1-5	44.31N	160.00E	0.1	288	225
P-4	Pink	01/11/96	1-5	44.31N	160.00E	0.1	262	168
P-5	Pink	01/11/96	1-5	44.31N	160.00E	0.1	275	190
P-6	Pink	01/12/96	2-1	44.59N	165.03E	0.1	256	156
P-7	Pink	01/12/96	2-1	44.59N	165.03E	0.1	258	150
P-8	Pink	01/12/96	2-1	44.59N	165.03E	0.1	288	210
P-9	Pink	01/12/96	2-1	44.59N	165.03E	0.1	264	172
P-10	Pink	01/25/96	5-5	50.04N	144.59W	0.1	250	125
P-11	Pink	01/25/96	5-5	50.04N	144.59W	0.1	264	175

Appendix Table 2. Blood samples (cont'd).

No.	Species	Date of catch	Stat.	Latitude	Longitude	Age*	(mm)	(g)
							FL	Weight
P-12	Pink	01/25/96	5-5	50.04N	144.59W	0.1	261	150
P-13	Pink	01/25/96	5-5	50.04N	144.59W	0.1	268	165
P-14	Pink	01/25/96	5-5	50.04N	144.59W	0.1	261	155
P-15	Pink	01/25/96	5-5	50.04N	144.59W	0.1	273	180
K-1	Chinook	01/11/96	1-5	44.31N	160.00E	1.1	315	400
K-2	Chinook	01/11/96	1-5	44.31N	160.00E	1.1	295	360
K-3	Chinook	01/11/96	1-5	44.31N	160.00E	1.1	290	318
K-4	Chinook	01/11/96	1-5	44.31N	160.00E	1.1	272	255
K-5	Chinook	01/11/96	1-6	45.58N	160.00E	1.1	298	326
K-6	Chinook	01/11/96	1-6	45.58N	160.00E	1.1	260	236
K-7	Chinook	01/11/96	1-6	45.58N	160.00E	1.1	288	308
K-8	Chinook	01/12/96	2-1	44.59N	165.03E	1.1	292	315
K-9	Chinook	01/12/96	2-1	44.59N	165.03E	1.1	288	300
K-10	Chinook	01/12/96	2-1	44.59N	165.03E	1.1	267	245
K-11	Chinook	01/19/96	3-6	48.58N	168.07W	1.2	476	1360
K-12	Chinook	01/19/96	3-6	48.58N	168.07W	1.2	565	2450
K-13	Chinook	01/19/96	3-6	48.58N	168.07W	1.1	280	370
K-14	Chinook	01/19/96	3-6	48.58N	168.07W	1.1	289	315
K-15	Chinook	01/20/96	4-1	50.00N	162.57W	1.1	294	330
CO-1	Coho	01/18/96	3-4	46.03N	167.52W	X.1	340	490
CO-2	Coho	01/18/96	3-4	46.03N	167.52W	X.1	344	440
CO-3	Coho	01/18/96	3-4	46.03N	167.52W	X.1	338	420
CO-4	Coho	01/18/96	3-4	46.03N	167.52W	X.1	380	680
CO-5	Coho	01/18/96	3-4	46.03N	167.52W	X.1	359	510
CO-6	Coho	01/18/96	3-4	46.03N	167.52W	X.1	360	560
CO-7	Coho	01/20/96	4-1	50.00N	162.57W	X.1	340	470
CO-8	Coho	01/20/96	4-1	50.00N	162.57W	X.1	332	481
CO-9	Coho	01/20/96	4-1	50.00N	162.57W	X.1	340	480
CO-10	Coho	01/24/96	5-4	51.33N	145.09W	X.1	430	950
CO-11	Coho	01/25/96	5-5	50.04N	144.59W	X.1	386	670
CO-12	Coho	01/25/96	5-5	50.04N	144.59W	X.1	421	830
CO-13	Coho	01/25/96	5-5	50.04N	144.59W	X.1	401	660
CO-14	Coho	01/25/96	5-5	50.04N	144.59W	X.1	367	580
CO-15	Coho	01/25/96	5-6	48.29N	144.48W	X.1	393	660
CO-16	Coho	01/25/96	5-6	48.29N	144.48W	1.1	393	710
CO-17	Coho	01/25/96	5-6	48.29N	144.48W	X.1	383	670
CO-18	Coho	01/25/96	5-6	48.29N	144.48W	X.1	364	550
CO-19	Coho	01/25/96	5-6	48.29N	144.48W	X.1	348	475
CO-20	Coho	01/25/96	5-6	48.29N	144.48W	X.1	351	495
CO-21	Coho	01/25/96	5-6	48.29N	144.48W	X.1	467	1120
CO-22	Coho	01/25/96	5-6	48.29N	144.48W	X.1	427	910
CO-23	Coho	01/25/96	5-6	48.29N	144.48W	X.1	397	690
CO-24	Coho	01/25/96	5-6	48.29N	144.48W	X.1	367	580

Appendix Table 2. Blood samples (cont'd).

No.	Species	Date of catch	Stat.	Latitude	Longitude	Age*	(mm)	(g)
							FL	Weight
CO-25	Coho	01/25/96	5-6	48.29N	144.48W	X.1	352	465
CO-26	Coho	01/25/96	5-6	48.29N	144.48W	2.1	440	1020
S-1	Sockeye	01/19/96	3-5	47.30N	168.09W	X.1	335	325
S-2	Sockeye	01/19/96	3-5	47.30N	168.09W	X.2	390	570
S-3	Sockeye	01/19/96	3-5	47.30N	168.09W	X.2	390	680
S-4	Sockeye	01/19/96	3-5	47.30N	168.09W	X.2	395	660
S-5	Sockeye	01/19/96	3-5	47.30N	168.09W	X.2	372	500
S-6	Sockeye	01/19/96	3-5	47.30N	168.09W	X.2	400	670
S-7	Sockeye	01/20/96	4-1	50.00N	162.57W	X.3	572	2200
S-8	Sockeye	01/22/96	4-3	54.21N	148.12W	X.2	430	920
S-9	Sockeye	01/22/96	4-3	54.21N	148.12W	X.3	595	2850
S-10	Sockeye	01/22/96	4-3	54.21N	148.12W	X.3	514	1680
S-11	Sockeye	01/22/96	4-3	54.21N	148.12W	X.3	556	2300
S-12	Sockeye	01/22/96	4-3	54.21N	148.12W	X.3	545	1880
S-13	Sockeye	01/22/96	4-3	54.21N	148.12W	X.3	530	1960

*Number preceding decimal is number of winters in freshwater; number following decimal is number of winters in ocean. Age was determined from scales. "X" indicates that freshwater age could not be determined from non-preferred body area scales.

Appendix Table 3. Summary of oceanographic data by trawl station (Fisheries Agency of Japan, pers. comm.).

Station											
Date (GMT)											
Time											
Lat.											
Long.											
Depth											
Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO (CTD) ml/l	DO (ml/l) (実測)	SiO ₂ umol/l	NO ₂ +NO ₃ umol/l	PO ₄ umol/l	Chl-a ug/l	
Surface	0.0			34.494		6.38	5.12	8.62	1.93	0.75	
24	10.6	8.421	33.676	33.709	8.41	6.39					
23	19.1	8.424	33.675	33.705	8.42	6.37	5.00	8.60	1.86	0.69	
22	30.9	8.424	33.675	33.710	8.37	6.37	4.80	8.61	1.88	0.74	
21	39.9	8.425	33.675	33.707	8.36	6.35	4.99	8.61	1.90	0.63	
20	50.3	8.422	33.676	33.709	8.33	6.30	4.88	8.58	1.86	0.69	
19	74.7	8.427	33.677	33.708	8.37		4.36	8.58	1.92	0.67	
18	99.7	8.423	33.678	33.709	8.25	6.37	4.33	8.62	1.89	0.65	
17	126.1	6.318	33.730	33.759	7.60	5.79	9.31	17.01	3.07	0.03	
16	149.2	6.088	33.757	33.786	7.25	5.52	11.26	18.32	3.38	0.02	
15	200.2	5.669	33.807	33.842	5.74	4.42	17.12	23.50		0.07	
14	249.5	5.108	33.824	33.852	5.02	3.94	21.22	26.21	3.64	0.04	
13	301.4	4.363	33.801	33.832	4.54	3.48	26.22	26.15	4.05	0.01	
12	400.0	4.036	33.909	33.936	3.13	2.53		28.82	4.10		
11	503.3	3.872	34.030	34.059	2.04	1.72	35.85	33.50	4.17		
10	596.4	3.669	34.139	34.166	1.42	1.16	37.69	38.17	4.25		
9	703.1	3.442	34.219	34.247	1.19	0.99	39.44	38.88	4.25		
8	798.8	3.234	34.272	34.300	1.05	0.90	40.81	39.04	4.27		
7	902.2	3.021	34.324	34.349	1.05	0.96	42.83	39.67	4.27		
6	1000.6	2.833	34.362	34.388	1.03	0.90	44.43				
5	1102.3	2.671	34.401	34.425	1.08	0.75	45.95	39.82	4.28		
4	1201.6	2.540	34.431	34.457	1.13	0.81	49.69	40.07	4.30		
3	1300.3	2.392	34.462	34.486	1.23	0.89	55.63	39.75	4.28		
2	1401.4	2.297	34.481	34.506	1.33	0.97	58.79	39.77	4.27		
1	1500.2	2.211	34.504	34.525	1.46	1.06	58.98	39.97	4.23		

Station 1-3
Date (GMT) 1996/1/10
Time 3:29
Lat. 41-30.36 N
Long. 159-59.69 E
Depth 5556 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO (CTD) ml/l	DO (ml/l) (実測)	SiO ₂ umol/l	NO ₂ +NO ₃ umol/l	PO ₄ umol/l	Chl-a ug/l
Surface	0.0			33.604		6.41	14.42	8.46	1.57	0.62
23	10.2	8.162	33.562	33.595	8.38	6.37	14.08	8.24	1.50	0.63
22	18.4	8.159	33.563	33.594	8.28	6.36	14.11	8.26	1.53	0.62
21	25.8	8.167	33.562	33.596	8.38	6.35	13.94	8.25	1.49	0.69
20	48.8	8.172	33.563	33.596	8.30	6.36	14.07	8.26	1.50	0.63
19	76.3	8.179	33.564	33.597	8.30		14.01	8.32	1.49	0.66
18	99.3	8.201	33.596	33.620	8.17	6.29	14.33	8.45	1.52	0.59
17	126.6	6.462	33.712	33.755	7.30	5.51	30.35	15.19	2.35	0.10
16	149.8	6.009	33.744	33.769	6.90	5.24	37.10	17.40	2.62	0.06
15	201.0	5.063	33.724	33.760	6.14	4.57	50.46	21.40	3.23	
14	249.3	4.295	33.721	33.748	5.27	4.03	61.85	24.66	3.71	0.02
13	300.2	4.099	33.797	33.822	4.29	3.39	74.41	27.66	4.03	
12	400.0	4.036	33.928	33.958	2.92	2.23	89.70	30.94	4.10	
11	503.3	3.872	34.020	34.047	2.01	1.50	105.64	33.51	4.16	
10	596.4	3.669	34.162	34.183	1.60	1.38	115.16	34.26	4.17	
9	703.1	3.442	34.238	34.266	1.33		124.42	34.77	4.18	
8	798.8	3.234	34.291	34.312	1.22	0.86	133.06	35.16	4.18	
7	902.2	3.021	34.330	34.356	1.12	0.77	139.96	35.69	4.21	
6	1000.6	2.833	34.364	34.392	1.10	0.77	146.00	35.80	4.19	
5	1102.3	2.671	34.392	34.414	1.09	0.76	151.19	36.08	4.20	
4	1201.6	2.540	34.423	34.449	1.12	0.78	156.09	36.17	4.19	
3	1300.3	2.392	34.448	34.472	1.17	0.81	159.42	36.35	4.20	
2	1401.4	2.297	34.471	34.495	1.26	0.89	162.43	36.06	4.20	
1	1500.2	2.211	34.493	34.510	1.39	0.98	163.88	35.95	4.19	

Appendix Table 3. Oceanographic data (cont'd).

Station 1-4
 Date (GMT) 1996/1/10
 Time 15:28
 Lat. 43-07.37 N
 Long. 159-58.93 E
 Depth 5423 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO (CTD) ml/l	DO (ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			33.172		6.81	16.02	9.31	1.15	0.76
23	8.5	6.232	33.138	33.172	8.99	6.77	16.17	9.44	1.13	0.67
22	19.4	6.227	33.138	33.173	8.80	6.77	16.25	9.36	1.14	0.74
21	29.2	6.243	33.138	33.173	8.99	6.77	18.14	9.42	1.16	0.75
20	51.4	6.265	33.143	33.174	8.91	6.76	16.17	9.33	1.12	0.70
19	76.8	6.312	33.163	33.193	8.87		16.57	9.88	1.15	0.72
18	101.4	5.915	33.513	33.545	7.73	5.91	29.41	14.65	1.58	0.28
17	123.9	5.594	33.616	33.646	7.37	5.78	32.90	16.11	1.68	0.08
16	147.6	5.046	33.597	33.630	7.50	5.67	37.03	17.25	1.80	0.13
15	207.4	4.228	33.619	33.660	6.36	4.78	53.14	22.03	2.35	0.13
14	247.7	3.916	33.691	33.720	5.06	3.92	65.57	25.75	2.95	0.07
13	304.2	3.798	33.760	33.789	4.25	3.26	75.01	27.97	2.97	0.14
12	402.4	3.740	33.894	33.924	2.87	2.25	91.07	31.08	3.38	
11	497.3	3.641	34.026	34.057	1.73	1.49	107.69	33.68	3.64	
10	601.4	3.502	34.125	34.154	1.32	0.96	118.89	34.36	3.84	
9	699.7	3.352	34.209	34.236	1.04	0.74	128.08	35.12	3.80	
8	803.7	3.121	34.272	34.299	0.98	0.66	137.08	35.54	3.82	
7	901.3	2.956	34.316	34.343	0.99	0.65	137.01	35.46	3.82	
6	1000.2	2.815	34.355	34.384	1.02	0.69	148.27	37.16	3.84	
5	1098.7	2.674	34.387	34.415	1.05		153.44	35.54	3.84	
4	1202.2	2.550	34.419	34.443	1.04	0.71	157.54	38.81	3.89	
3	1300.7	2.437	34.441	34.467	1.10	0.76	160.21		3.82	
2	1404.4	2.332	34.467	34.492	1.21	0.87	163.11		3.76	
1	1507.3	2.249	34.487	34.512	1.36	0.98	163.44		3.78	

Station 1-5
 Date (GMT) 1996/1/11
 Time 3:40
 Lat. 44-30.49 N
 Long. 159-59.59 E
 Depth 5820 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO (CTD) ml/l	DO (ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.976		6.94	18.82	13.76	2.06	0.73
23	7.9	4.596	32.943	32.970	9.20	6.91		13.70	1.98	0.74
22	19.8	4.601	32.942	32.970	9.18	6.91	18.78	13.57	2.04	0.65
21	31.6	4.604	32.943	32.970	9.31	6.90	19.07	13.70	2.01	0.74
20	48.5	4.622	32.943	32.975	9.25	6.89	19.05	13.73	1.91	0.74
19	75.7	4.765	32.987	33.008	8.96	6.83	19.42	13.89	1.96	0.67
18	98.9	4.237	33.323	33.351	7.85	5.92	36.72	18.71	2.32	0.23
17	126.9	4.243	33.602	33.588	6.66	5.09	48.06	22.09	2.71	0.15
16	151.6	3.352	33.526	33.559	6.59	4.96	53.11	23.77	2.90	0.14
15	198.5	3.283	33.595	33.624	5.50	4.17	65.58	27.37	3.36	0.13
14	251.2	3.414	33.715	33.731	4.37	3.37	75.11	30.03	3.71	0.15
13	302.3	3.088	33.736	33.764	3.63	3.13	85.11	32.88	3.97	0.10
12	397.2	3.669	33.954	33.984	2.35	1.83	98.55	34.84	4.06	
11	499.1	3.872	34.105	34.117	1.79	1.29	107.78	35.84	4.07	
10	599.3	3.400	34.168	34.191	1.18	0.83	124.56	38.13	4.17	
9	698.7	3.111	34.218	34.247	0.91	0.60	135.05	38.46	4.19	
8	800.3	3.136	34.290	34.319	1.11	0.77	136.07	38.20	4.16	
7	898.9	2.931	34.329	34.357	1.06	0.73	142.84	38.42	4.20	
6	999.9	2.775	34.371	34.398	1.07	0.74	150.02	38.39	4.21	
5	1099.8	2.617	34.399	34.423	1.10	0.75	153.60	38.41	4.14	
4	1199.3	2.444	34.419	34.443	1.11	0.76	159.01	38.59	4.19	
3	1298.8	2.351	34.451	34.477	1.21	0.84	161.53	38.48	4.20	
2	1403.2	2.262	34.473	34.494	1.33	0.92	164.10	38.25	4.16	
1	1523.9	2.182	34.500	34.521	1.46	1.04	165.47	37.98	4.13	

Appendix Table 3. Oceanographic data (cont'd).

Station 1-6
 Date(GMT) 1996/1/11
 Time 15:09
 Lat. 46-07.78 N
 Long. 160-02.42 E
 Depth 5270 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.815		7.07	23.08	12.53	1.54	0.49
23	10.8	4.597	32.781	32.810	9.29	7.07	23.49	12.65	1.53	0.49
22	19.6	4.594	32.781	32.810	9.50	7.07	23.41	12.81	1.53	0.46
21	29.8	4.588	32.782	32.806	9.36	7.06	23.47	12.72	1.54	0.50
20	50.8	4.571	32.783	32.810	9.43	7.06	23.47	12.74	1.52	0.42
19	77.1	4.554	32.784	32.812	9.29	7.05	23.77	12.90	1.55	0.48
18	99.2	3.885	32.897	32.905	8.93	6.95	29.56	15.42	1.78	0.31
17	125.0	2.193	33.154	33.188	8.01	6.10	49.22	22.74	2.46	0.11
16	151.1	2.630	33.455	33.475	4.69	3.94	71.08	28.50	3.06	0.10
15	198.9	3.147	33.726	33.755	2.21	1.83	93.89	34.50	3.69	0.14
14	248.1	3.386	33.860	33.889	1.11		103.63	36.24	3.89	0.13
13	299.8	3.355	33.948	33.974	0.83	0.79	110.38		3.92	0.14
12	399.8	3.282	34.061	34.089	0.80	0.53	121.89	36.09	3.94	
11	498.1	3.158	34.159	34.188	0.71	0.46	131.41	36.04	3.81	
10	598.6	3.039	34.226	34.256	0.72	0.50	138.26	35.82	3.81	
9	695.6	2.915	34.283	34.313	0.82	0.49	144.80	35.95	3.81	
8	800.1	2.792	34.332	34.359	0.81	0.52	149.69	35.86	3.74	
7	900.0	2.674	34.371	34.400	0.86	0.56	153.83	35.60	3.79	
6	1000.2	2.543	34.406	34.433	0.96	0.66	156.90	35.44	3.73	
5	1102.7	2.426	34.431	34.458	0.94	0.67	160.41	35.43	3.73	
4	1198.0	2.319	34.459	34.486	1.05	0.67	165.98	35.82	3.71	
3	1300.9	2.231	34.483	34.509	1.38	0.96	164.18	34.98	3.63	
2	1401.0	2.155	34.504	34.530	1.49	1.05	166.79	34.60	3.63	
1	1507.3	2.085	34.521	34.545	1.51		169.44	34.69	3.60	

Station 2-1
 Date(GMT) 1996/1/12
 Time 7:20
 Lat. 44-59.74 N
 Long. 165-00.10 E
 Depth 5963 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			33.094		6.90	19.14	11.43	1.36	0.66
23	10.5	5.638	33.053	33.089	9.11	6.89	19.23	11.58	1.34	0.49
22	20.4	5.634	33.053	33.090	9.19	6.88	19.03	11.66	1.31	0.55
21	30.7	5.634	33.052	33.089	9.15	6.89	18.92	11.75	1.29	0.58
20	47.6	5.586	33.050	33.087	9.14	6.88	19.33	12.26	1.33	0.57
19	73.4	5.568	33.051	33.086	9.06	6.88	19.61	12.05	1.35	0.52
18	99.8	5.255	33.572	33.605	8.07	6.15	30.98	17.66	1.70	0.14
17	122.7	4.729	33.575	33.601	7.76	5.89	36.48	19.48	1.89	0.08
16	150.8	4.131	33.551	33.589	7.11	5.39	45.07	22.79	2.18	0.08
15	198.7	3.576	33.604	33.638	5.66	4.21	61.86	28.56	2.70	0.08
14	250.4	3.576	33.700	33.734	4.53		72.07	31.77	3.00	
13	301.9	3.621	33.796	33.823	3.59	2.72	80.93	34.40	3.20	0.08
12	398.7	3.656	33.953	33.985	2.20	1.65	98.34	37.95	3.52	
11	502.0	3.620	34.063	34.095	1.55	1.10	109.28	39.50	3.63	
10	595.3	3.412	34.142	34.174	1.17	0.85	120.88	40.79	3.71	
9	700.1	3.250	34.209	34.240	1.02	0.71	128.37	40.67	3.74	
8	797.2	3.082	34.262	34.291	0.90	0.64	135.34	40.85	3.78	
7	899.5	2.924	34.309	34.340	0.89	0.66	142.89	41.42	3.87	
6	1001.5	2.756	34.354	34.383	0.96	0.64	146.08	41.18	3.79	
5	1098.9	2.639	34.386	34.414	0.96	0.70	151.75	41.54	3.80	
4	1201.5	2.521	34.417	34.444	1.02	0.72	154.73	40.88	3.72	
3	1300.7	2.413	34.440	34.468	1.02	0.70	158.67	42.26	3.76	
2	1399.3	2.318	34.467	34.493	1.15	0.81	162.06	42.10	3.72	
1	1504.1	2.230	34.489	34.513	1.23	0.89	163.52	41.94	3.66	

Appendix Table 3. Oceanographic data (cont'd).

Station 2-2
 Date(GMT) 1996/1/13
 Time 2:43
 Lat. 44-00.16 N
 Long. 169-59.52 E
 Depth 5450 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO ₂ umol/l	NO ₂ +NO ₃ umol/l	PO ₄ umol/l	Chl-a ug/l
Surface 24	0.0			33.659		6.30	12.62	8.09	0.69	0.79
23	9.5	8.815	33.618	33.653	8.38	6.30	12.53	7.96	0.74	0.79
22	20.5	8.816	33.618	33.649	8.45	6.29	12.52	7.99	0.73	0.76
21	28.8	8.789	33.613	33.648	8.43	6.28	12.62	8.00	0.71	0.74
20	52.2	8.829	33.619	33.652	8.39	6.29	12.51	8.04	0.69	0.79
19	76.4	8.830	33.619	33.653	8.36		12.65	8.04	0.69	0.75
18	99.3	8.918	33.638	33.678	8.26	6.21	12.90	8.23	0.72	0.72
17	124.4	9.430	34.107	34.140	7.16	5.44	20.72	12.86	1.02	0.09
16	149.6	8.833	34.052	34.088	7.19	5.50	22.41	13.65	1.01	0.12
15	199.5	7.565	33.942	33.973	7.01	5.30	29.57	16.29	1.07	0.09
14	249.2	6.467	33.872	33.904	6.10	4.68	41.42	20.22	1.24	0.07
13	300.7	5.436	33.852	33.883	5.12	3.85	56.11	24.40	1.68	0.12
12	400.6	4.665	33.927	33.958	3.65	2.71	76.65	29.53	2.14	
11	501.0	4.278	34.008	34.038	2.63	1.94	91.49	32.25	2.26	
10	598.1	3.930	34.089	34.120	1.77	1.31	105.95	35.20	3.12	
9	699.7	3.695	34.170	34.201	1.35		116.64	36.31	3.30	
8	797.4	3.398	34.250	34.279	1.13	0.76	128.10	37.29	3.42	
7	899.0	3.247	34.302	34.331	1.12	0.74	133.82	37.33	3.40	
6	1000.7	3.046	34.337	34.363	1.05	0.71	140.57	37.70	3.22	
5	1100.3	2.789	34.361	34.390	0.94	0.66	147.85	38.71	3.47	
4	1201.3	2.675	34.393	34.421	0.99	0.69	152.09		3.33	
3	1300.0	2.542	34.429	34.457	1.08	0.73	156.14	38.60	2.85	
2	1400.8	2.420	34.455	34.482	1.16	0.81	158.61	38.45	3.20	
1	1507.6	2.346	34.476	34.502	1.26		159.72	38.68	3.33	

Station 2-3
 Date(GMT) 1996/1/14
 Time 3:26
 Lat. 41-58.82 N
 Long. 176-25.74 E
 Depth 5880 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO ₂ umol/l	NO ₂ +NO ₃ umol/l	PO ₄ umol/l	Chl-a ug/l
Surface 24	0.0			33.953		6.08	11.67	9.15	0.81	0.74
23	9.9	10.363	33.910	33.946	8.01	6.05	11.84	9.16	0.81	0.69
22	19.7	10.365	33.911	33.946	7.92	6.05	11.85	9.21	0.80	0.70
21	31.3	10.364	33.910	33.944	7.91	6.03	11.76	9.28	0.81	0.75
20	51.9	10.367	33.911	33.945	7.90	6.04	11.81	9.35	0.81	0.75
19	77.3	10.373	33.912	33.945	8.08	6.04	11.82	9.53	0.81	0.77
18	101.8	10.398	33.919	33.952	7.83	6.04	11.82	9.65	0.82	0.82
17	126.0	10.795	34.063	33.968	7.48	5.99	12.02	10.07	0.82	0.73
16	148.4	10.338	34.230	34.261	6.17	4.64	23.89	15.85	1.18	0.13
15	201.1	8.643	34.052	34.091	6.85	5.14	26.38	17.20	1.27	0.12
14	252.2	7.577	33.953	33.988	6.42	4.91	33.82	19.95	1.48	
13	298.8	6.556	33.903	33.939	5.87	4.36	44.89	23.83	1.78	0.14
12	399.6	5.149	33.904	33.929	4.45	3.28	66.72	30.39	2.33	
11	499.5	4.307	33.957	33.988	3.01	2.22	87.89	35.19	2.82	
10	601.6	4.173	34.085	34.111	2.11	1.54	101.72	38.03	3.01	
9	698.0	3.912	34.147	34.177	1.57	1.13	113.34	38.98	3.15	
8	799.8	3.684	34.223	34.252	1.29	0.88	123.44	40.25	3.31	
7	899.7	3.378	34.279	34.309	1.04	0.69	133.07	41.16	3.28	
6	999.8	3.148	34.325	34.354	0.96	0.68	140.38	41.52	3.31	
5	1099.9	2.923	34.363	34.391	0.93	0.61	148.52	42.09	3.35	
4	1198.9	2.746	34.396	34.425	0.90	0.60	154.36	42.13	3.45	
3	1305.5	2.585	34.424	34.453	0.96	0.62	158.25	42.10	3.35	
2	1401.0	2.478	34.446	34.475	1.02	0.66	161.56	41.97	3.35	
1	1502.8	2.372	34.470	34.499	1.11	0.74	164.85	43.14	3.45	

Appendix Table 3. Oceanographic data (cont'd).

Station 3-1
 Date(GMT) 1996/1/18
 Time 3:59
 Lat. 41-30.25 N
 Long. 168-00.14 W
 Depth 5630 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			33.817		6.24	13.04	7.19	0.80	0.58
23	11.7	9.476	33.779	33.813	8.23	6.27	13.17	7.26	0.79	0.51
22	22.0	9.473	33.778	33.812	8.24	6.27	13.16	7.31	0.77	0.56
21	30.4	9.469	33.777	33.812	8.23	6.27	13.01	7.40	0.79	0.47
20	50.2	9.471	33.777	33.811	8.31	6.25	13.28	7.49	0.83	0.59
19	75.4	9.479	33.778	33.813	7.97	6.27	13.41	7.51	0.79	
18	99.6	9.478	33.779	33.814	8.19	6.22	13.26	7.57	0.85	0.53
17	124.9	9.479	33.779	33.815	8.20	6.27	13.25	7.75	0.79	0.53
16	150.6	9.581	33.910	33.909	7.86	6.02	15.19	9.21	0.94	0.18
15	198.0	9.341	34.059	34.094	7.57	5.73	18.56	11.76	1.10	0.12
14	249.9	8.819	34.022	34.056	7.05	5.51	22.35	13.43	1.22	0.11
13	298.8	8.292	34.004	34.040	6.47	4.89	30.22	17.19	1.57	0.13
12	398.7	6.408	33.946	33.978	4.74	3.55	53.89	25.49	2.36	
11	499.6	5.237	33.969	33.999	3.56	2.65	74.03	30.97	2.97	
10	600.0	4.544	34.026	34.056	2.41	1.81	92.68	35.24	3.41	
9	700.6	4.092	34.126	34.159	1.54	1.10	110.79	38.49	3.66	
8	798.3	3.753	34.193	34.226	1.20	0.84	123.01	39.65	3.81	
7	897.6	3.466	34.255	34.285	0.83	0.53	134.03	41.21	3.91	
6	1000.9	3.206	34.307	34.337	0.73	0.44	142.18		3.95	
5	1099.5	3.008	34.348	34.376	0.71		149.53	41.87	3.98	
4	1202.7	2.827	34.384	34.412	0.63	0.39	155.78	42.80	4.02	
3	1297.8	2.690	34.410	34.437	0.58	0.32	161.10	4374.00	3.98	
2	1401.9	2.556	34.438	34.465	0.52	0.29	166.46	43.69	4.07	
1	1509.7	2.421	34.465	34.492	0.58	0.33	170.57	43.58	4.14	

Station 3-2
 Date(GMT) 1996/1/18
 Time 15:29
 Lat. 43-03.59 N
 Long. 167-53.93 W
 Depth 5510 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			33.803		6.35	17.46	7.67	0.89	0.50
23	10.7	8.598	33.612	33.646	8.47	6.34	17.10	7.69	0.88	0.49
22	18.1	8.599	33.613	33.646	8.42	6.33	16.52	7.65	0.88	0.51
21	29.8	8.595	33.613	33.647	8.44	6.33	17.33	7.70	0.89	0.50
20	49.8	8.590	33.615	33.650	8.45	6.31	17.40	7.67	0.88	0.48
19	74.4	8.592	33.616	33.651	8.48	6.30	17.05	7.66	0.87	0.46
18	100.1	8.599	33.618	33.652	8.30	6.33	16.65	7.60	0.86	0.54
17	124.4	8.624	33.626	33.659	8.40	6.30	19.61	7.57	0.87	0.45
16	148.0	8.616	33.956	33.972	7.77	5.83	20.24	10.53	1.06	0.48
15	199.5	7.970	33.919	33.949	7.40	5.59	25.35	12.45	1.25	0.12
14	250.1	7.449	33.937	33.977	6.09	4.61	37.13	46.88	1.66	0.11
13	299.5	6.598	33.902	33.934	5.42	4.18	46.59	19.71	1.99	0.12
12	398.4	5.306	33.931	33.959	3.76	2.82	71.07	26.42	2.74	
11	498.7	4.483	33.995	34.024	2.64	1.94	90.33	30.28	3.17	
10	598.2	4.136	34.078	34.107	1.88	1.33	104.33	32.57	3.45	
9	700.3	3.868	34.154	34.182	1.44	1.01	115.65	33.75	3.52	
8	800.0	3.602	34.224	34.251	1.11	0.73	125.19	34.74	3.66	
7	901.0	3.329	34.280	34.308	0.87	0.53	134.65	35.73	3.78	
6	1000.3	3.114	34.324	34.351	0.71	0.43	142.56	36.24	3.80	
5	1101.3	2.925	34.362	34.389	0.56	0.29	148.42	36.33	3.85	
4	1197.4	2.770	34.394	34.421	0.62	0.36	153.67	36.64	3.84	
3	1299.4	2.601	34.428	34.453	0.59	0.32	160.50	36.63	3.85	
2	1403.5	2.475	34.454	34.480	0.58	0.30	165.80	37.52	3.84	
1	1503.6	2.357	34.479	34.503	0.65	0.35	167.99	37.30	3.85	

Appendix Table 3. Oceanographic data (cont'd).

Station 3-3
 Date(GMT) 1996/1/19
 Time 1:41
 Lat. 44-29.67 N
 Long. 168-04.02 W
 Depth 5540 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			33.465		6.45	17.47	8.43	1.01	0.44
23	9.5	7.838	33.429	33.465	8.72	6.47	17.30	8.47	1.05	0.32
22	19.7	7.846	33.430	33.465	8.55	6.45	17.53	8.49	1.02	0.49
21	30.4	7.850	33.431	33.465	8.64	6.46	17.61	8.56	1.01	0.47
20	50.3	7.857	33.434	33.469	8.63	6.47	17.49	8.60	1.02	0.46
19	76.0	7.863	33.435	33.471	8.64	6.46	17.52	8.60	1.02	0.44
18	99.6	7.874	33.441	33.478	8.62	6.44	17.40	8.61	1.02	0.42
17	124.2	8.264	33.859	33.864	7.90	6.01	19.69	10.66	1.15	0.12
16	150.1	8.182	33.905	33.941	7.81	5.88	21.28	11.55	1.19	0.11
15	200.0	7.539	33.877	33.908	6.76	5.39	28.26	14.40	1.47	0.12
14	250.4	6.862	33.886	33.923	5.95	4.61	40.41	18.76	1.91	0.11
13	298.8	6.168	33.897	33.922	5.09	3.84	52.07	22.52	2.30	0.13
12	399.6	4.779	33.921	33.952	3.42	2.50	76.60	29.03	3.07	
11	500.7	4.342	34.012	34.042	2.35	1.74	92.48	31.74	3.41	
10	601.3	4.037	34.097	34.127	1.65	1.18	106.68	34.23	3.69	
9	698.7	3.759	34.174	34.203	1.23	0.86	118.19	34.84	3.77	
8	800.2	3.486	34.238	34.267	0.96	0.63	127.42	35.35	3.85	
7	899.2	3.265	34.283	34.309	0.79	0.50	134.35		3.92	
6	1001.0	3.039	34.331	34.358	0.75	0.44	143.38	36.93	4.01	
5	1100.8	2.853	34.369	34.396	0.65	0.40	148.24	37.07	3.97	
4	1199.8	2.725	34.396	34.424	0.71	0.39	154.11	36.89	3.98	
3	1300.9	2.580	34.426	34.453	0.65	0.34	159.73	37.35	3.98	
2	1402.1	2.450	34.455	34.479	0.75	0.40	164.13	37.27	4.07	
1	1510.8	2.330	34.478	34.504	1.06	0.70	167.16	36.77	3.89	

Station 3-4
 Date(GMT) 1996/1/19
 Time 13:16
 Lat. 46-03.63 N
 Long. 167-51.85 W
 Depth 5480 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			33.370		6.56	19.63	8.66	0.96	0.56
23										
22	19.6	7.339	33.336	33.375	8.87	6.55	19.47	8.67	0.98	0.58
21	30.2	7.349	33.346	33.380	8.64	6.55	19.79	8.65	1.04	0.57
20	50.5	7.342	33.344	33.376	8.74	6.55	19.54	8.73	0.98	0.57
19	74.4	7.388	33.354	33.388	8.90	6.53	19.51	8.58	0.95	0.57
18	100.1	7.411	33.382	33.408	8.69	6.50	19.97	8.78	0.97	0.42
17	124.8	7.294	33.787	33.815	7.82	5.91	25.65	12.54	1.22	0.12
16	148.4	7.107	33.817	33.846	7.38	5.54	30.05	14.30	1.35	0.09
15	200.8	6.185	33.813	33.843	5.98	4.66	44.04	19.01	1.86	0.12
14	251.0	5.056	33.774	33.806	5.28	4.09	57.51	23.06	2.30	
13	298.3	4.631	33.818	33.847	4.33	3.25	70.51	26.19	2.65	0.10
12	398.5	4.208	33.921	33.953	2.89	2.15	88.26	30.28	3.12	
11	500.3	4.070	34.027	34.056	2.07	1.51	101.22	32.22	3.26	
10	601.1	3.897	34.117	34.145	1.57	1.10	114.19	33.80	3.53	
9	700.8	3.618	34.186	34.214	1.23	0.83	124.57	34.36	3.67	
8	799.4	3.378	34.250	34.277	1.05	0.70	134.03	34.74	3.59	
7	900.6	3.180	34.298	34.325	0.95	0.62	142.26	35.21	3.64	
6	1000.3	2.989	34.338	34.365	0.90	0.58	148.74	35.35	3.72	
5	1100.4	2.813	34.371	34.396	0.90	0.59	153.68	35.62	3.72	
4	1201.4	2.673	34.403	34.429	0.89	0.57	160.79	35.63	3.75	
3	1299.8	2.548	34.431	34.457	0.90	0.56	163.68	35.75	3.82	
2	1399.4	2.441	34.456	34.480	0.86	0.54	167.93	35.73	3.70	
1	1505.6	2.341	34.478	34.502	0.94	0.61	170.15	35.72	3.72	

Appendix Table 3. Oceanographic data (cont'd).

Station 3-5
 Date(GMT) 1996/1/20
 Time 4:12
 Lat. 47-29:31 N
 Long. 167-52:27 W
 Depth 5421 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			33.003		6.75	22.33	11.07	1.33	0.61
23	11.7	6.089	32.979	33.006	9.15	6.75	22.18	11.11	1.33	0.55
22	19.9	6.098	32.982	33.009	9.12	6.73	22.48	11.09	1.34	0.54
21	29.5	6.091	32.979	33.007	9.01	6.77	22.53	11.03	1.34	0.57
20	51.8	6.096	32.980	33.012	9.12	6.73	22.62	11.07	1.33	0.59
19	75.5	6.178	33.001	33.031	8.90	6.71	22.82	10.81	1.33	0.57
18	100.9	6.134	33.248	33.229	8.23	6.40	27.10	12.50	1.43	0.31
17	126.2	6.321	33.651	33.655	7.48	5.77	33.91	15.30	1.59	0.12
16	147.7	5.249	33.600	33.635	6.77	5.06	45.73	19.29	2.03	0.10
15	200.4	4.590	33.709	33.736	5.64	4.21	59.73	23.38	2.48	0.07
14	248.7	4.195	33.761	33.792	4.34	3.24	73.80	27.24	2.92	0.13
13	298.1	4.063	33.813	33.844	3.58	2.70	81.82	28.97	3.13	0.11
12	398.9	3.851	33.943	33.969	2.25	1.63	100.05	32.53	3.57	
11	498.1	3.781	34.048	34.077	1.63	1.17	111.37	33.71	3.71	
10	599.5	3.635	34.144	34.173	1.25	0.88	121.96	34.05	3.77	
9	700.4	3.507	34.217	34.247	1.12	0.76	129.97	34.41	3.84	
8	799.3	3.281	34.268	34.298	0.99	0.67	138.18	35.14	3.86	
7	900.2	3.106	34.308	34.337	0.91	0.60	145.02	35.40	3.93	
6	997.1	2.922	34.345	34.374	0.89	0.58	151.35	35.38	3.90	
5	1099.1	2.772	34.379	34.407	0.87	0.56	155.58	35.11	3.88	
4	1197.7	2.635	34.413	34.402	0.81	0.52	161.59	35.69	3.89	
3	1300.6	2.525	34.437	34.463	0.80	0.49	164.74	35.70	3.96	
2	1399.6	2.405	34.462	34.486	0.87	0.55	168.93	35.70	3.96	
1	1509.5	2.287	34.487	34.512	0.99	0.64	171.15	35.70	3.94	

Station 3-6
 Date(GMT) 1996/1/20
 Time 13:55
 Lat. 49-01:63 N
 Long. 167-55:86 W
 Depth 5380 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.855		6.92	21.42	11.47	1.38	0.48
23	10.5	5.343	32.824	32.852	9.33	6.90	21.46	11.68	1.44	0.48
22	21.1	5.341	32.823	32.853	9.31	6.89	21.59	11.82	1.39	0.51
21	31.6	5.342	32.822	32.852	9.17	6.87	21.53	11.82	1.39	0.49
20	50.5	5.346	32.823	32.852	9.31	6.96	21.65	11.66	1.40	0.53
19	74.8	5.347	32.824	32.853	9.27	6.88	21.47	11.85	1.42	0.50
18	101.1	5.338	32.837	32.865	8.74	6.84	21.74	11.83	1.40	0.42
17	125.4	4.377	33.350	33.360	7.44	5.65	40.51	19.15	2.04	0.16
16	149.6	3.941	33.568	33.593	5.65		57.76	24.84	2.56	0.13
15	200.3	3.777	33.722	33.754	3.90	2.87	74.94	29.49	3.25	0.10
14	251.0	3.666	33.808	33.843	2.77	2.05	86.28	32.09	3.41	0.15
13	300.7	3.716	33.891	33.923	2.17	1.58	93.22	33.02	3.54	0.14
12	400.5	3.767	34.028	34.058	1.50	1.13	104.58	33.78	3.61	
11	499.7	3.608	34.106	34.137	1.24	0.85	114.98	34.71	3.75	
10	601.7	3.421	34.174	34.205	0.98	0.66	125.28	35.22	3.81	
9	699.5	3.263	34.237	34.268	0.90	0.59	132.69	35.39	3.80	
8	801.8	3.096	34.283	34.363	0.86	0.56	138.55	35.39	3.86	
7	900.9	2.947	34.323	34.354	0.87	0.57	143.08		3.87	
6	1004.0	2.790	34.366	34.395	0.87	0.56	148.94	35.28	3.89	
5	1101.4	2.649	34.398	34.426	0.90	0.57	153.40	35.56	3.83	
4	1199.8	2.532	34.425	34.455	0.94	0.60	159.15	35.60	3.78	
3	1300.3	2.432	34.448	34.476	1.02	0.67	160.55	35.27	3.85	
2	1403.2	2.358	34.467	34.493	1.09	0.71	164.55	35.55	3.82	
1	1507.3	2.258	34.490	34.516	1.21	0.82	166.30	35.23	3.85	

Appendix Table 3. Oceanographic data (cont'd).

Station 4-1
 Date(GMT) 1996/1/21
 Time 4:44
 Lat. 49-58.65 N
 Long. 162-58.51 W
 Depth 4949 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.677		6.95	24.57	11.21	1.16	0.52
23	9.1	5.180	32.651	32.680	9.42	6.94	24.32	11.19	1.45	0.51
22	20.4	5.179	32.652	32.679	9.26	6.93	24.61	11.20	1.46	0.48
21	29.1	5.179	32.650	32.679	9.40	6.92	24.92	11.31	1.47	0.48
20	49.7	5.181	32.652	32.679	9.40	6.94	24.62	11.20	1.45	0.50
19	74.5	5.170	32.658	32.684	9.32	6.92	24.40	11.35	1.47	0.44
18	99.6	4.818	32.894	32.905	8.83	6.72	29.09	14.19	1.69	0.22
17	126.2	4.015	33.285	33.263	5.74	4.85	50.70	22.80	2.48	0.17
16	150.4	3.740	33.582	33.613	4.56	3.38	69.98	27.69	2.94	0.14
15	200.3	3.715	33.792	33.821	2.15	1.59	89.31	32.88	3.46	0.14
14	249.6	3.666	33.873	33.899	1.55	1.15	97.81	34.78	3.64	0.12
13	300.9	3.685	33.926	33.955	1.28	0.90	103.92	35.11	3.64	0.15
12	404.5	3.618	34.038	34.068	1.03	0.70	114.50	35.16	3.68	
11	500.8	3.558	34.121	34.149	0.73	0.45	122.40	35.42	3.67	
10	600.3	3.405	34.190	34.220	0.84	0.54	131.04	35.45	3.66	
9	700.4	3.235	34.245	34.274	0.78	0.50	136.73	35.29	3.70	
8	803.0	3.061	34.289	34.322	0.78	0.49	144.05	35.58	3.74	
7	901.7	2.914	34.327	34.356	0.77	0.49	149.87	35.27	3.65	
6	997.8	2.797	34.358	34.385	0.82	0.54	153.32	35.25	3.66	
5	1100.9	2.664	34.390	34.419	0.85	0.53	156.36	35.26	3.64	
4	1200.3	2.539	34.421	34.450	0.89	0.57	161.73	35.44	3.65	
3	1299.9	2.427	34.448	34.476	0.97	0.62	165.28	35.43	3.64	
2	1402.4	2.344	34.468	34.496	1.03	0.68	166.25	35.23	3.61	
1	1508.9	2.256	34.490	34.516	1.14	0.77	170.31	35.22	3.60	

Station 4-2
 Date(GMT) 1996/1/22
 Time 5:01
 Lat. 51-38.97 N
 Long. 154-37.31 W
 Depth 4960 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.587		7.07	26.25	12.23	1.55	0.50
23	11.1	4.514	32.551	32.581	9.45	7.03	26.56	12.17	1.55	0.46
22	21.2	4.507	32.553	32.582	9.45	6.99	26.59	12.49	1.66	0.45
21	28.6	4.494	32.559	32.592	9.48	6.96	26.92	12.44	1.56	0.44
20	48.1	4.479	32.568	32.606	9.39	6.93	27.12	12.54	1.61	0.38
19	76.4	3.948	33.254	33.215	6.17	4.76	49.23	22.74	2.49	0.16
18	99.8	3.745	33.598	33.618	4.23	3.13	69.12	29.08	3.10	0.10
17	125.3	3.588	33.689	33.718	3.56	6.01	77.46	30.89	3.26	0.13
16	150.8	3.586	33.755	33.788	2.85	2.16	84.49	32.66	3.45	0.10
15	197.8	3.636	33.847	33.878	1.98	1.44	93.70	34.49	3.64	0.11
14	250.1	3.665	33.902	33.933	1.61	1.17	98.72	35.00	3.70	0.08
13	299.5	3.704	33.979	34.009	1.35	0.96	106.16	35.30	3.72	0.06
12	400.9	3.639	34.068	34.098	1.08	0.74	114.53	36.12	3.78	
11	503.3	3.518	34.147	34.177	0.93	0.60	122.26	35.73	3.79	
10	600.6	3.384	34.203	34.231	0.86	0.55	129.31	35.97	3.84	
9	698.6	3.198	34.251	34.282	0.76	0.47	139.05	36.53	3.88	
8	798.0	3.051	34.290	34.320	0.74	0.46	142.65	36.12	3.81	
7	899.6	2.929	34.325	34.356	0.73	0.45	147.20	36.18	3.80	
6	1000.7	2.807	34.358	34.387	0.74	0.45	150.65	36.25	3.82	
5	1101.3	2.668	34.393	34.420	0.77	0.48	156.86	36.26	3.82	
4	1199.8	2.565	34.420	34.446	0.80	0.48	159.74	36.19	3.83	
3	1302.1	2.460	34.443	34.468	0.88	0.56	163.30	35.98	3.78	
2	1400.7	2.362	34.466	34.492	0.98	0.63	165.66	35.89	3.74	
1	1500.8	2.266	34.489	34.514	1.11	0.74	168.27	35.78	3.73	

Appendix Table 3. Oceanographic data (cont'd).

Station 4-3
 Date(GMT) 1996/1/23
 Time 9:53
 Lat. 54-13.54 N
 Long. 147-58.25 W
 Depth 4112 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.641		7.03	25.20	12.25	1.53	0.54
23	10.7	4.627	32.607	32.637	9.45	7.01	25.19	12.49	1.54	0.53
22	20.8	4.632	32.607	32.639	9.41	7.02	25.15	12.87		0.57
21	29.7	4.633	32.607	32.638	9.34	6.99	25.45	12.63	1.55	0.51
20	48.4	4.636	32.610	32.641	9.39	6.99	24.84	12.68	1.53	0.55
19	74.1	4.687	32.630	32.659	8.74	6.94	24.90	12.74	1.55	0.53
18	101.7	5.218	33.503	33.529	5.06	3.78	49.02	23.84	2.53	0.18
17	124.2	5.118	33.743	33.770	3.95	2.92	49.02	27.20	2.91	0.14
16	150.6	4.807	33.783	33.814	3.54	2.63	58.17	28.60	3.03	0.14
15	198.2	4.281	33.823	33.851	2.62	1.94	64.51	31.54	3.31	0.14
14	250.2	3.990	33.871	33.904	1.90	1.36	76.91	33.68	3.56	0.15
13	299.4	3.750	33.912	33.944	1.53	1.10	88.66	34.75	3.70	0.13
12	400.2	3.877	34.068	34.096	0.80	0.51	97.06	35.48	3.81	
11	501.3	3.684	34.148	34.178	0.62	0.35	109.48	36.14	3.87	
10	602.8	3.422	34.206	34.236	0.59	0.33	131.64	36.28	3.91	
9	700.1	3.242	34.251	34.282	0.58		131.08	36.20	3.89	
8	803.8	3.016	34.309	34.337	0.62	0.33	137.17	36.13	3.91	
7	901.8	2.871	34.343	34.372	0.65	0.36	148.46	36.22	3.86	
6	998.7	2.741	34.373	34.403	0.69	0.40	153.18	36.45	3.98	
5	1103.1	2.635	34.398	34.426	0.74	0.44	158.18	35.98	3.90	
4	1201.7	2.529	34.423	34.452	0.80	0.48	161.03	35.73	3.88	
3	1302.6	2.427	34.447	34.474	0.89	0.52	165.65	35.43	3.81	
2	1400.1	2.324	34.472	34.498	1.00	0.63	167.77	35.72	3.78	
1	1509.4	2.237	34.493	34.518	1.10	0.71	173.02	35.58	3.81	

Station 5-1
 Date(GMT) 1996/1/24
 Time 4:16
 Lat. 55-41.85 N
 Long. 144-52.68 W
 Depth 3956 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.655		7.01	22.79	11.82	1.47	0.30
23	10.2	4.666	32.618	32.646	9.27					
22	20.5	4.661	32.617	32.646	9.38	6.94	22.86	11.92	1.47	0.50
21	29.1	4.662	32.617	32.645	9.28	6.96	23.15	11.89	1.49	0.48
20	48.9	4.664	32.618	32.646	9.31	6.95	22.70	11.85	1.45	0.50
19	75.6	4.671	32.653	32.648	8.86		22.91	11.84	1.46	0.47
18	102.9	5.729	33.546	32.680	4.52	6.80	23.53	12.37	1.53	0.38
17	124.8	5.471	33.710	33.515	4.00	3.58	47.74	23.61	2.49	0.10
16	151.1	5.215	33.780	33.734	3.47	2.93	56.61	26.71	2.78	0.09
15	201.0	4.548	33.803	33.807	2.97	2.61	62.14	28.05	2.93	0.10
14	248.7	4.142	33.830	33.833	2.39	2.20	72.28	30.46	3.19	0.14
13	300.6	4.022	33.888	33.866	1.72	1.73	83.45	32.44	3.41	0.10
12	398.9	3.844	33.985	33.923	1.05	1.27	92.12	34.06	3.55	
11	499.8	3.718	34.080	34.016	0.75	0.72	104.41	35.71	3.77	
10	599.1	3.610	34.158	34.108	0.60	0.48	116.65	36.25	3.79	
9	701.7	3.373	34.220	34.185	0.56		124.18	36.42	3.84	
8	799.7	3.216	34.259	34.247	0.59	0.29	133.38	36.32	3.85	
7	900.7	3.081	34.298	34.287	0.55	0.34	140.45	36.21	3.84	
6	996.9	2.916	34.340	34.326	0.56	0.30	147.65	36.14	3.87	
5	1100.0	2.807	34.371	34.368	0.55	0.31	152.04	36.20	3.83	
4	1200.7	2.678	34.400	34.398	0.59	0.29	156.38	36.48	3.84	
3	1300.1	2.545	34.428	34.426	0.72	0.31	159.78	36.43	3.82	
2	1398.1	2.413	34.457	34.452	0.80	0.38	163.97	36.46	3.83	
1	1508.9	2.298	34.482	34.481	0.93	0.46	169.05	36.37	3.82	

Appendix Table 3. Oceanographic data (cont'd).

Station 5-2
 Date(GMT) 1996/1/24
 Time 12:42
 Lat. 54-27.97 N
 Long. 144-59.94 W
 Depth 4124 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO ₂ umol/l	NO ₂ +NO ₃ umol/l	PO ₄ umol/l	Chl-a ug/l
Surface 24	0.0			32.676		7.02	25.77	11.17	1.54	0.51
23	10.1	4.778	32.637	32.666	9.37	6.97	25.81	11.19	1.55	0.50
22	21.1	4.775	32.636	32.666	9.24	6.97	26.18	11.12	1.55	0.48
21	31.7	4.773	32.635	32.665	9.24	6.96	26.15	11.15	1.54	0.49
20	49.6	4.775	32.636	32.666	9.30	6.97	25.62	11.26	1.57	0.47
19	74.4	4.792	32.652	32.669	9.02	6.93	25.82	11.25	1.54	0.47
18	101.0	5.325	33.467	33.471	4.98	3.89	49.67	22.15	2.54	0.15
17	125.0	5.221	33.718	33.734	3.88	2.93	58.81	25.60	2.88	0.14
16	150.7	4.855	33.785	33.808	3.36	2.49	67.75	27.45	3.07	0.14
15	199.9	4.338	33.802	33.834	2.71	2.07	77.96	29.47	3.32	0.17
14	251.5	4.202	33.890	33.901	2.01	1.44	87.91	31.86	3.56	0.11
13	302.7	4.014	33.915	33.946	1.57	0.96	95.14	32.93	3.73	0.04
12	398.3	3.944	34.036	34.066	0.88	0.58	107.71	34.01	3.87	
11	500.2	3.743	34.095	34.121	0.73	0.46	116.77	34.48	3.89	
10	602.4	3.550	34.164	34.196	0.61	0.35	128.32	34.78	3.93	
9	699.8	3.347	34.224	34.255	0.57	0.34	135.12	34.95	3.96	
8	799.9	3.163	34.274	34.302	0.56	0.32	142.42	34.69	3.93	
7	901.8	3.008	34.312	34.342	0.58	0.34	148.13	34.59	3.99	
6	1000.5	2.823	34.356	34.384	0.64	0.37	156.37	34.83	3.94	
5	1101.6	2.680	34.387	34.415	0.70	0.43	158.43	34.84	3.92	
4	1202.3	2.557	34.418	34.446	0.75	0.43	163.74	34.81	3.97	
3	1300.0	2.458	34.441	34.466	0.81	0.53	166.22	34.89	3.89	
2	1398.4	2.366	34.464	34.488	0.88	0.56	168.90	34.60	3.89	
1	1505.8	2.258	34.488	34.513	0.95	0.66	174.01	34.36	3.81	

Station 5-3
 Date(GMT) 1996/1/25
 Time 0:39
 Lat. 52-59.87 N
 Long. 144-59.78 W
 Depth 4106 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO ₂ umol/l	NO ₂ +NO ₃ umol/l	PO ₄ umol/l	Chl-a ug/l
Surface 24	0.0			32.566		7.01	30.30	12.30	1.49	0.46
23	11.8	4.769	32.532	32.559	9.41	7.00	29.01	12.20	1.58	0.46
22	20.6	4.771	32.532	32.559	9.34	6.99	29.27	12.29	1.60	0.44
21	31.5	4.777	32.531	32.558	9.24	6.99	29.33	12.49	1.60	0.54
20	49.4	4.776	32.532	32.558	9.24	6.99	29.33	12.49	1.60	0.54
19	75.2	4.775	32.548	32.563	9.08	6.97	29.00	12.57	1.60	0.45
18	101.8	3.946	33.339	33.358	5.45	4.18	28.91	12.62	1.60	0.15
17	125.2	3.847	33.626	33.651	3.63	2.83	57.81	24.40	2.71	0.18
16	151.3	3.793	33.721	33.742	2.71	2.10	74.01	29.49	3.27	0.16
15	199.7	3.713	33.831	33.854	1.71	1.30	82.82	32.12	3.53	0.12
14	249.3	3.706	33.902	33.932	1.31	0.89	93.60	34.38	3.74	0.14
13	299.0	3.715	33.955	33.986	1.03	0.69	100.86		3.86	
12	398.8	3.658	34.058	34.089	0.77	0.48	106.94	35.67	3.91	
11	500.6	3.516	34.130	34.160	0.66	0.39	117.00	35.95	3.92	
10	601.5	3.347	34.195	34.223	0.71	0.39	126.35	35.75	3.94	
9	700.7	3.165	34.256	34.284	0.65	0.36	135.15	35.72	3.93	
8	802.3	3.033	34.293	34.321	0.66	0.36	141.84		3.92	
7	900.3	2.910	34.328	34.355	0.69	0.38	148.37	35.87	3.89	
6	999.6	2.791	34.364	34.389	0.70	0.39	153.26	35.68	3.92	
5	1100.1	2.678	34.391	34.417	0.71		157.27	36.14	3.93	
4	1201.6	2.544	34.422	34.447	0.75	0.44	161.18	36.02	3.91	
3	1302.3	2.461	34.442	34.468	0.79	0.46	167.52		3.93	
2	1399.9	2.363	34.466	34.489	0.86	0.51	168.04	36.07	3.88	
1	1508.9	2.284	34.485	34.507	0.93	0.59	172.44	36.08	3.93	
							176.61	35.77	3.85	

Appendix Table 3. Oceanographic data (cont'd).

Station 5-4
 Date(GMT) 1996/1/25
 Time 13:02
 Lat. 51-29.01 N
 Long. 144-53.93 W
 Depth 4171 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.530		6.87	23.59	10.37	1.37	0.41
23	8.6	5.858	32.490	32.522	9.17	6.89	23.78	10.36	1.38	0.41
22	20.1	5.864	32.490	32.521	9.17	6.88	23.71	10.34	1.37	0.41
21	29.6	5.866	32.491	32.520	8.95	6.90	23.72	10.31	1.35	0.44
20	48.5	5.870	32.491	32.520	9.11	6.87	24.01	10.34	1.36	0.43
19	74.8	5.873	32.492	32.520	9.01	6.88	23.69	10.33	1.37	0.40
18	100.7	5.800	32.571	32.571	8.43	6.73	25.25	10.92	1.41	0.37
17	124.1	5.125	33.512	33.521	5.78	4.56	49.26	21.35	2.34	0.17
16	148.8	5.085	33.750	33.774	4.72	3.66	60.08	24.51	2.63	0.13
15	199.5	4.567	33.800	33.832	3.67	2.77	74.34	28.11	3.04	0.13
14	249.8	4.201	33.855	33.880	2.85	2.13	84.76	30.60	3.34	0.14
13	297.9	4.093	33.899	33.929	2.38	1.73	91.96	31.64	3.46	0.08
12	398.6	3.940	34.011	34.040	1.58	1.09	107.41	33.46	3.69	
11	500.6	3.733	34.098	34.127	1.08	0.73	118.97	34.64	3.84	
10	597.9	3.514	34.162	34.193	0.83	0.51	130.14	35.31	3.89	
9	699.5	3.362	34.215	34.245	0.72	0.43	137.54	35.30	3.93	
8	800.9	3.207	34.266	34.296	0.68	0.39	144.66	35.67	4.00	
7	901.1	3.037	34.312	34.340	0.67	0.36	144.89	35.63	3.94	
6	999.2	2.896	34.345	34.373	0.62	0.34	155.51	35.76	3.99	
5	1099.8	2.770	34.375	34.403	0.61	0.32	161.03	36.07	3.98	
4	1199.3	2.649	34.404	34.431	0.58	0.32	166.48	36.02	4.00	
3	1299.4	2.545	34.428	34.455	0.60	0.31	170.30	36.09	4.00	
2	1401.0	2.424	34.455	34.481	0.69	0.39	173.91	36.16	3.98	
1	1510.3	2.326	34.477	34.501	0.78	0.47	177.54	35.60	3.98	

Station 5-5
 Date(GMT) 1996/1/26
 Time 3:48
 Lat. 50-00.31 N
 Long. 144-59.50 W
 Depth 4265 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.575		6.78	19.68	9.22	1.27	0.45
23	10.1	6.753	32.535	32.565	8.84	6.76	19.97	9.25	1.27	0.40
22	18.9	6.752	32.535	32.567	8.93	6.75	19.84	9.13	1.31	0.41
21	29.9	6.755	32.536	32.567	8.81	6.76	19.86	9.23	1.30	0.41
20	50.4	6.754	32.536	32.567	8.87	6.76	19.81	9.16	1.33	0.42
19	74.9	6.754	32.536	32.568	8.78	6.74	19.85	9.18	1.31	0.40
18	99.6	5.588	33.004	33.025	8.25	6.38	26.93	14.07	1.73	0.11
17	124.0	5.391	33.415	33.464	6.70	5.20	40.68	18.63	2.14	0.11
16	149.6	5.366	33.679	33.691	5.91	4.59	48.13	21.01	2.35	0.12
15	200.2	5.126	33.807	33.836	4.47	3.42	63.25	25.27	2.83	0.09
14	250.4	4.563	33.840	33.871	3.44	2.57	76.09	28.66	3.26	0.12
13	298.7	4.268	33.881	33.912	2.85	2.10	85.65	30.51	3.50	0.11
12	399.5	4.025	33.983	34.013	1.95	1.38	100.11	33.05	3.77	
11	499.2	3.869	34.082	34.113	1.28	0.86	113.51	34.29	3.99	
10	599.4	3.625	34.152	34.183	0.97		124.87	35.07	4.15	
9	699.6	3.392	34.219	34.249	0.80	0.48	134.90	35.42	4.15	
8	800.1	3.208	34.270	34.300	0.72	0.43	142.42	35.54	4.16	
7	900.9	3.013	34.319	34.348	0.67	0.38	149.20	36.00	4.28	
6	1000.7	2.885	34.351	34.379	0.66	0.37	154.90	36.03	4.21	
5	1099.5	2.746	34.383	34.409	0.61		159.77	36.08	4.16	
4	1199.4	2.610	34.413	34.441	0.57	0.30	165.22	36.55	4.25	
3	1299.8	2.505	34.437	34.464	0.59	0.31	168.42	36.36	4.26	
2	1399.2	2.414	34.457	34.483	0.68	0.37	172.96	36.46	4.23	
1	1510.3	2.311	34.480	34.505	0.81	0.48	176.27	36.10	4.31	

Appendix Table 3. Oceanographic data (cont'd).

Station 5-6
 Date(GMT) 1996/1/26
 Time 13:17
 Lat. 48-31.54 N
 Long. 145-00.24 W
 Depth 4393 m

Bottle No.	Pres. db	Temp deg C	Salt (CTD)	Salt (実測)	DO(CTD) ml/l	DO(ml/l) (実測)	SiO2 umol/l	NO2+NO3 umol/l	PO4 umol/l	Chl-a ug/l
Surface 24	0.0			32.624		6.73	25.20	12.25	1.53	0.49
23	9.4	7.177	32.585		8.77		25.19	12.49	1.54	0.53
22	19.0	7.178	32.585	32.617	8.86	6.71	25.15	12.87		0.42
21	30.8	7.182	32.585	32.616	8.75	6.71	25.45	12.63	1.55	0.45
20	51.0	7.183	32.585	32.616	8.74	6.69	24.84	12.68	1.53	0.38
19	75.3	7.214	32.601	32.631	8.79	6.66	24.90	12.74	1.55	0.14
18	101.1	6.254	33.253	33.281	7.91	5.98	49.02	23.84	2.53	0.16
17	125.2	6.352	33.614	33.643	7.16	5.36	49.02	27.20	2.91	0.19
16	151.2	6.424	33.791	33.820	6.18	4.83	58.17	28.60	3.03	0.17
15	200.5	5.779	33.845	33.879	4.86	3.71	64.51	31.54	3.31	0.18
14	250.5	5.181	33.866	33.897	3.94	2.93	76.91	33.68	3.56	0.10
13	299.9	4.711	33.881	33.909	3.34	2.44	88.66	34.75	3.70	
12	398.1	4.298	33.952	33.984	2.44	1.78	97.06	35.48	3.81	
11	499.3	4.064	34.047	34.080	1.60	1.11	109.48	36.14	3.87	
10	599.9	3.806	34.129	34.160	1.07	0.72	131.64	36.28	3.91	
9	699.2	3.514	34.198	34.228	0.88	0.55	131.08	36.20	3.89	
8	799.9	3.309	34.254	34.284	0.74	0.44	137.17	36.13	3.91	
7	900.3	3.147	34.294	34.323	0.67	0.37	148.46	36.22	3.86	
6	997.2	2.982	34.334	34.361	0.58	0.28	153.18	36.45	3.98	
5	1100.8	2.833	34.367	34.394	0.54	0.27	158.18	35.98	3.90	
4	1200.6	2.706	34.396	34.424	0.54	0.25	161.03	35.73	3.88	
3	1300.7	2.574	34.426	34.453	0.54	0.26	165.65	35.43	3.81	
2	1398.2	2.471	34.449	34.477	0.57	0.28	167.77	35.72	3.78	
1	1512.5	2.361	34.475	34.501	0.66	0.36	173.02	35.58	3.81	