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2007 T/V *Oshoro-maru* Salmon Research Cruises

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Abstract

In order to clarify the oceanic structure and marine ecosystem, oceanographic observations and fishing surveys (including salmonids) were conducted in the Northwest Pacific Ocean (along 155° E), Central North Pacific Ocean (along 44° N), Bering Sea, and Chukuchi Sea. Each survey was conducted during the Cruise #178 in May, and the Cruise #180 from July to August 2007.

In May along 155° E, the Polar Front was observed in the vicinity of 43° -15'N and the Subarctic Boundary was observed in the vicinity of 39° -15'N.

Three drift gillnet surveys were conducted along 155° E in May during Cruise #178. Salmonids were collected at 42.5° N and 41° N that were in the Transition Domain. Chum salmon was more abundant at 41° N than at 42.5° N, but pink salmon was more abundant at 42.5° N. This distribution pattern is as same as those over the past six years. Pacific pomfret was dominantly caught at 38° N in the Subtropical Waters.

Each a drift gillnet and a surface longline survey, and three hook-and-line gear samplings were conducted along the 44° N between 167.5° E and 173.5° E in early July during Cruise #180-Leg 1. A total of fourteen chum, 60 pink, 29 coho, and a Chinook salmon were collected by every sampling gear. Most chum and a Chinook salmon were immature.

Except for salmonids, pacific pomfret was caught by C-gear gillnet, and a large number of pacific saury were collected by F-gear gillnet.

A total of 8 sockeye, 84 chum, 2 pink, 15 coho, and 2 Chinook salmon were collected by surface longline, hook-and-line gear, and bottom otter trawl surveys in the Bering Sea during the Cruise #180-Leg 2. ALL sockeye and pink salmon, and almost all coho salmon were collected in the southeast Bering Sea, on the other hand, 85.7% of chum salmon and all chinook salmon were collected in the northeast Bering Sea. Most sockeye salmon were adult fish. 83.3% of chum salmon collected in the southeast Bering Sea were immature, but about half of them collected in the northeast Bering Sea were matured.

No salmonids were collected by any and every sampling gear in the Chukuchi Sea during the Cruise #180-Leg 3. Sampling periods in this year were too late to collect enough salmonids samples, especially adult fish, in the Bering Sea and the Chukuchi Sea.

INTRODUCTION

The *Oshoro maru* has continued to study the oceanic structure and marine biology in the North Pacific Ocean and Bering Sea (infrequently in the Chukuchi Sea) every summer since 1953. Collected data has been published annually since 1957 (Hokkaido University, 1957-2007).

Since 1978, several transects have been repeatedly sampled to study long-term changes in the North Pacific Ocean.

The fish sampling areas including salmonids were divided roughly following three research areas during two cruises (Cruise #178 and #180) in 2007.

1. In the Northwest Pacific along the 155° E longitude line in May during Cruise #178.
2. In the Central North Pacific along the 44° N latitude line around the Emperor Seamounts in early July during Cruise #180 (Leg 1).
3. In the Bering Sea and the Chukuchi Sea from late July to early August during Cruise #180 (Leg 2,3: *Oshoro maru* 2007 International Polar Year (IPY) Research Cruise).

Primary objects for above research areas were

1. To collect oceanographic and biological data continuously along 155° E longitude line.
2. To study differences of the oceanic and ecosystem structure between the two sides of the Emperor Seamounts.
3. To collect oceanographic and biological data in the Bering Sea and Chukuchi Sea for the *Oshoro maru* research cruises during the International Polar Year (IPY) 2007-2008.

This document reports the preliminary results about those research areas during the cruises.

MATERIAL AND METHODS

Cruise Schedule and Salmon Research Area

Oceanographic observations and gillnet surveys were conducted along the 155° E from May 12 to 17 during Cruise #178. Oceanographic observations and gillnet, surface longline, and hook-and-line surveys were conducted along the 44° N latitude line in the area near the Emperor Seamounts from July 6 to 10 during Cruise #180-Leg 1. Oceanographic observations and surface longline, hook-and-line, bottom otter trawl surveys were conducted in the Bering Sea from July 24 to August 2 during Cruise #180-Leg 2 and in the Chukuchi Sea from August 6 to 13 during Cruise #180-Leg 3 (Fig. 1, Table 1).

Oceanographic Observation

Nine oceanographic observations were conducted at 45 nautical mile intervals from 44° N to 38° N along 155° E in Cruise #178, and data collected by CTD instruments were used to plot the temperature and salinity. Four oceanographic observations at salmon sampling stations were conducted from 167° 26'E to 173° 30'E along 44° N in Cruise #180-Leg 1. 35 observations in the Bering Sea and 32 observations in the Chukuchi Sea were conducted in Cruise #180-Leg 2 and 3

(Fig. 1, Table 1).

Drift Gillnet Sampling

A drift gillnet was used to collect salmonids and the other organisms at 4 stations (Figs. 1-(1), (2), Table 1). The gillnet configuration is as follows:

Net	A-Gear		C-Gear										F-Gear							Total
Mesh size (mm)	115	121	48	55	63	72	82	93	106	121	138	157	19	22	25	29	33	37	42	
Number of tan	6	6	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	49

The net comprised of 30 tans of C-Gear gillnet (non-selective varied research mesh, Takagi, 1975), 12 tans of A-Gear gillnet (commercial mesh), and 7 tans of F-Gear gillnet (special mesh). Each tan was 50m long. Gillnet gear was set in the evening, allowed to soak overnight, and retrieved the following morning. The catch was sorted and counted by species for each mesh size. Biological measurements data were recorded from a maximum 60 fishes for each species per mesh size.

Details about each operation are shown in Table 2.

Surface Longline Sampling

One surface longline sampling was operated at 44° N, 167° -28'E during Cruise #180-Leg 1. Four samplings were operated in the Bering Sea during Cruise #180-Leg 2. Three samplings were operated in the Chukuchi Sea during Cruise #180-Leg 3 (Figs. 1-(2), (3), (4), Table 1).

Ten baskets (hachi) were used except one station (used five baskets): OSSL 0706 at 67° -31'N, 168° -50'W. One basket was comprised of mainline with 34 branch lines. Main line was 127m long. Branch line with a hook attached to main line at intervals of 3m. Fishing depth was about 2m. Salted anchovies were used as bait. The catch was sorted by species and counted.

Details about each operation are shown in Table 3.

Hook-and-Line Sampling

To collect salmonids, hook-and-line gears were used along 44° N line in the Central North Pacific (three stations), in the Bering Sea (35 stations), and in the Chukuchi Sea (eight stations) during Cruise #180-Leg 1, 2, and 3 (Figs. 1-(2), (3), (4), Table 1).

Five to ten anglers were engage in the work. These samplings were mainly conducted with other observations when ship was under drifting. The catch was sorted by species and counted.

Trawl Sampling

Sixteen bottom otter trawl surveys were conducted in the Bering Sea (seven stations) and the Chukuchi Sea (nine stations) during Cruise #180-Leg 2 and 3 (Figs. 1-(3), (4), Table 1).

These surveys were conducted in daytime. Towing speed was about 4 knots. Diameter of the net mouth was ca. 5m. In order to collect salmonids, net was held on five minutes when warps were paid out 50m long from otter board and towed from surface to mid-layer in the Chukuchi

Sea.

Details about each operation are shown in Table 4.

Fish Examination for Salmonids

Salmonids were processed soon after removal from the fishing gear. Biological data were recorded per each sampling gear at every station. Biological data included fork length (F.L., mm), body weight (g), sex, and gonad weight (g). Scale samples were collected from the International North Pacific Fisheries Commission (INPFC) preferred body area (Davis et al., 1990) and placed on gummed cards for verification of species identification, and for age, growth and stock origin studies.

Additional research activities included collection of salmonids stomachs, muscle and fin tissues, blood samples, and egg samples for studies of food habits, growth, stock identification, and female-specific serum proteins.

Sockeye salmon (*Oncorhynchus nerka*), chum salmon (*O. keta*), and Chinook salmon (*O. tshawytscha*) were classified as mature or immature based on their gonad weight (Takagi, 1961, Ito et al., 1974).

RESULTS AND DISCUSSION

Details of oceanographic data and biological data collected during the cruises were published in the “*DATA RECORDE OF OCEANOGRAPHIC OBSERVATIONS AND EXPLORATORY FISHING NO. 51*” of Hokkaido University in May 2008.

Cruise #178 along the 155° E in the Northwest Pacific

Oceanographic Conditions

Temperature and salinity sections (0-500db) along the 155° E transect in Cruise #178 are shown in Figure 2.

The geographic positions of the Polar Front and the Subarctic Boundary (Dodimead et al., 1963, Favorite et al., 1976, Roden, 1991) were observed following locations in May 2007.

The Polar Front which is indicated by the vertical 4 isotherm at 100m depth observed in the vicinity of 43° -15'N, but small warm core was observed from the north of 41° -15'N in the layer between 70db and 100db. The Subarctic Boundary indicated by the vertical 34.0 psu isohaline was observed in the vicinity of 39° -15'N. This boundary will be created by the Kuroshio extension's meander.

Distribution and abundance of organisms caught by drift gillnet

The number of organisms caught by the drift gillnet at each station are shown in Table 5.

Two drift gillnet surveys (at 42.5° N and 41° N) were conducted in the Transition Domain (Dodimead et al., 1963) and one survey (at 38° N) was conducted in the Subtropical Waters during this cruise (Figs. 1, 2, Table 2). A total of 46 chum salmon, 299 pink salmon (*Oncorhynchus gorbuscha*) were collected in the Transition Domain. Chum salmon was more abundant at 41° N than at 42.5° N. On the other hand, pink salmon was more abundant at 42.5°

N than at 41° N. The distribution pattern of chum and pink salmon along 155° E in May is as same as those over the past six years (Meguro et al., 2003, 2004, 2005, 2006, 2007).

95% of organisms caught by C-gear gillnet at 42.5° N were salmonids. Pink salmon was dominant species (92.2% of C-gear) in this area. Salmonids were also caught in high ratio at 41° N. Pink salmon was dominant species (62.6% of C-gear) also in this area. Pacific pomfret (*Brama japonica*) accounted for 81% of the non-salmonids caught by C-gear at 41° N. Pacific pomfret was made up of a majority of the catch (95.5% of C-gear) but neon flying squid (*Ommastrephes bartramii*) and blue shark (*Prionace glauca*) were collected in low ratio at 38° N in the Subtropical Waters.

Biological characteristics of salmonids

A total of 20 chum salmon was collected by C-gear gillnet. Their fork lengths ranged between 490-640mm F.L. (Fig. 3), and all were mature fish. From these results, their ocean age were thought to be over 3 years (Meguro et. al., 2004).

A total of 298 pink salmon was collected by C-gear gillnet. Their fork lengths were 395.78 ± 19.59 mm (Median: 395.0mm).

Cruise #180-Leg 1 along the 44° N in the Central North Pacific

The only one gillnet survey was conducted at station “OSG 0704”: [44.0° N, 167.5° E] in early July during Cruise #180-Leg 1 owing to the bad weather. The number of organisms caught by the drift gillnet are shown in Table 6. A total of six chum salmon, 55 pink salmon, ten coho salmon (*Oncorhynchus kisutch*), and one chinook salmon were collected by the drift gillnet. Five of six chum salmon and a chinook salmon were immature fish. Fork length frequency distribution of pink salmon caught by C-gear gillnet are shown in Figure 4. Their fork lengths were 450.71 ± 25.05 mm (Median: 445.0mm).

The most non-salmonids species caught by C-gear gillnet was pacific pomfret but a large number of pacific saury (*Cololabis saira*) was collected by F-gear gillnet.

One surface longline and three hook-and-line gear samplings were conducted along the 44° N between 167.5° E and 173.5° E as substitute for the drift gillnet surveys. The catch number of salmonids by the surface longline and hook-and-line are shown in Table 7. A total of eight chum salmon, five pink salmon, and nineteen coho salmon were collected by three hook-and-line gear samplings. The fork lengths of chum salmon distributed between 430-658mm F.L. and five of eight were immature. The fork lengths of coho salmon distributed between 506-594 mm F.L. (mean \pm STD: 556.4 ± 22.23 mm, Median: 556.0mm).

Temperature and salinity data about each sampling station are shown in Appendix 1.

Cruise #180-Leg 2 in the Bering Sea and Cruise #180-Leg 3 in the Chukchi Sea

A total of eight sockeye, 84 chum, two pink, fifteen coho, and two Chinook salmon were collected by every sampling gear (Table 8). The research area in the Bering Sea is able to divide into two areas, i.e. southeast Bering Sea area and northeast Bearing Sea area. All sockeye salmon were collected in the southeast Bering Sea. Seven sockeye ranged between 499-664mm F.L. were adult fish which were collected at 56° N, 166° W. One immature sockeye collected at

56° N, 168° W was 404mm F.L.. 85.7% of chum salmon were collected in the northeast Bering Sea. The data for the fork length and maturity ratio of chum salmon collected in each two area were as follows:

Southeast Bering Sea: 438-572mm F.L., Mean \pm STD = 487.2 \pm 43.88mm, Median = 556.0mm, 83.3% immature.

Northeast Bering Sea: 487-679mm F.L., Mean \pm STD = 576.7 \pm 45.63mm, Median = 570.5mm, 53.7% immature.

Two pink salmon, which were 471mm and 500mm F.L., were collected in the southeast Bering Sea. Almost all coho salmon were also collected in the southeast Bering Sea and their fork lengths distributed between 590-675mm F.L. (Mean \pm STD: 631.7 \pm 22.80mm, Median: 632.0mm). Two immature Chinook salmon which were 612mm and 620mm F.L. were collected at 62° -55'N, 173° -15'W in the northeast Bering Sea.

No salmonids were collected by any and every sampling gear in the Chukuchi Sea during this research period.

From these results, sampling periods (late July - early August) were too late to collect enough salmonids samples, especially adult fish, in the Bering Sea and the Chukuchi Sea. We expect next year's survey that will be conducted from late June to early July in those research areas.

Temperature and salinity data about the station at which salmonids were collected are shown in Appendix 2.

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Table 1. List of salmon research stations. Positions in which multiple surveys were conducted are adopted those of oceanographic stations by deputy.

Station Name					Position		Date	
Oceanographic	Gillnet	Hook-and-Line	Surface longline	Trawl	Latitude	Longitude	S.M.T.*	T.D.**
Cruise #178								
OS 07012					44-00.1N	155-00.1E	May 11	+10h
OS 07013					43-15.1N	155-00.0E	May 12	
OS 07014	OSG 0701				42-30.7N	155-00.0E	May 13-14	
OS 07015					41-45.0N	154-59.7E	May 14	
OS 07016	OSG 0702				41-00.0N	155-00.0E	May 14-15	
OS 07017					40-15.0N	155-00.0E	May 15	
OS 07018					39-30.0N	155-00.0E	May 15	
OS 07019					38-45.0N	155-00.0E	May 16	
OS 07020	OSG 0703				38-01.2N	155-00.0E	May 16-17	
Cruise #180 - Leg 1								
OS 07035	OSG 0704		OSSL 0701		43-59.0N	167-25.6E	July 6-7	+11h
OS 07039		OSHL 0701			44-00.2N	170-29.8E	July 7	
OS 07040		OSHL 0702			44-00.3N	171-15.0E	July 8-9	
OS 07042		OSHL 0703			43-59.9N	173-30.1E	July 10	
Cruise #180 - Leg 2								
OS 07078		OSHL 0704			55-00.0N	166-00.0W	July 24	-8h
OS 07079		OSHL 0705			55-30.3N	165-59.6W	July 24	
OS 07080		OSHL 0706			55-59.9N	166-00.0W	July 25	
OS 07081		OSHL 0707			56-00.3N	166-59.7W	July 25	
OS 07082		OSHL 0708			55-59.9N	168-00.1W	July 25	
OS 07083		OSHL 0709			56-00.2N	170-00.2W	July 25	
OS 07084		OSHL 0710			56-29.9N	168-59.8W	July 26	
OS 07085		OSHL 0711	OST 0708		56-30.0N	167-59.9W	July 26	
OS 07086		OSHL 0712			56-29.9N	167-00.1W	July 26	
OS 07087		OSHL 0713			56-30.0N	166-00.1W	July 26	
OS 07088		OSHL 0714			57-00.0N	166-00.0W	July 27	
OS 07089		OSHL 0715	OSSL 0702	OST 0709, 10	57-00.1N	167-00.0W	July 27	
OS 07090		OSHL 0716			57-00.3N	167-59.7W	July 27	
OS 07091		OSHL 0717			57-00.0N	168-59.8W	July 27	
OS 07092		OSHL 0718			57-30.1N	169-00.0W	July 28	
OS 07093		OSHL 0719	OSSL 0703		57-30.0N	168-00.0W	July 28	
OS 07094		OSHL 0720			57-30.0N	167-00.3W	July 28	
OS 07095		OSHL 0721			57-30.1N	166-00.0W	July 28	
OS 07096		OSHL 0722			57-59.9N	166-00.0W	July 28	
OS 07097		OSHL 0723			58-59.9N	166-00.0W	July 29	
OS 07098		OSHL 0724			60-30.1N	168-00.0W	July 29	
OS 07099		OSHL 0725		OST 0711	62-00.0N	174-00.3W	July 30	
OS 07100		OSHL 0726		OST 0712	62-31.9N	174-38.5W	July 30	
OS 07101		OSHL 0727			62-20.1N	172-39.9W	July 31	
OS 07102		OSHL 0728	OSSL 0704	OST 0713	62-54.3N	173-16.5W	July 31	
OS 07103		OSHL 0729		OST 0714	62-38.5N	171-15.0W	July 31	
OS 07104		OSHL 0730	OSSL 0705		62-51.3N	167-21.2W	Aug. 1	
OS 07105		OSHL 0731			62-57.1N	166-45.4W	Aug. 1	
OS 07106		OSHL 0732			63-10.5N	167-30.0W	Aug. 1	
OS 07107		OSHL 0733			63-52.1N	167-45.3W	Aug. 1	
OS 07108		OSHL 0734			63-36.2N	167-00.1W	Aug. 1	
OS 07109		OSHL 0735			63-18.2N	166-15.1W	Aug. 2	
OS 07110		OSHL 0736			63-39.5N	165-36.4W	Aug. 2	
OS 07111		OSHL 0737			63-54.1N	166-12.0W	Aug. 2	
OS 07112		OSHL 0738			64-09.8N	166-49.6W	Aug. 2	

Table 1. (Continued)

Station Name					Position		Date	
Oceanographic	Gillnet	Hook-and-Line	Surface longline	Trawl	Latitude	Longitude	S.M.T.	T.D.
Cruise #180 - Leg 3								
OS 07113		OSHL 0739			66-10.7N	168-52.7W	Aug. 5	
OS 07114					66-37.9N	168-51.9W	Aug. 6	
OS 07115					67-05.0N	168-50.3W	Aug. 6	
OS 07116		OSHL 0740	OSSL 0706		67-32.4N	168-50.7W	Aug. 6	
OS 07117					67-40.2N	168-31.0W	Aug. 6	
OS 07118					67-58.0N	168-11.5W	Aug. 6	
OS 07119					67-55.8N	167-52.0W	Aug. 6	
OS 07120					68-03.6N	167-32.3W	Aug. 6	
OS 07121				OST 0715, 16	68-11.2N	167-13.6W	Aug. 6-7	
OS 07122					68-52.2N	166-48.4W	Aug. 7	
OS 07123					68-52.3N	167-50.2W	Aug. 7	
OS 07124		OSHL 0741	OSSL 0707	OST 0717, 18	68-30.6N	168-34.5W	Aug. 7-8	
OS 07125		OSHL 0742			68-52.3N	168-54.6W	Aug. 8	
OS 07126		OSHL 0743		OST 0719, 20	70-00.0N	167-59.7W	Aug. 9	
OS 07127					70-10.6N	166-13.6W	Aug. 9	
OS 07128					70-05.7N	164-57.9W	Aug. 9	
OS 07129					70-00.8N	163-41.5W	Aug. 9	-8h
OS 07130					70-24.8N	163-29.7W	Aug. 9	
OS 07131		OSHL 0744			70-29.8N	164-45.7W	Aug. 10	
OS 07132					70-34.6N	166-02.0W	Aug. 10	
OS 07133					70-39.7N	167-17.8W	Aug. 10	
OS 07134					71-04.0N	167-05.3W	Aug. 10	
OS 07135					70-58.9N	165-48.7W	Aug. 11	
OS 07136		OSHL 0745	OSSL 0708	OST 0711, 22	70-54.0N	164-34.0W	Aug. 11	
OS 07137		OSHL 0746		OST 0723	70-48.8N	163-17.7W	Aug. 11	
OS 07138					70-43.8N	162-01.9W	Aug. 11	
OS 07139					69-30.2N	166-00.0W	Aug. 12	
OS 07140					68-31.0N	168-34.9W	Aug. 12	
OS 07141					67-05.6N	168-50.6W	Aug. 13	
OS 07142					66-37.9N	168-51.7W	Aug. 13	
OS 07143					66-10.6N	168-52.1W	Aug. 13	
OS 07144					65-23.0N	168-13.8W	Aug. 13	

*S.M.T.: Ship's Mean Time.

**T.D.: Time Difference between Greenwich mean time and Ship's mean time.

Table 2. Position and research conditions of surface drift gillnet sampling at each station during the *Oshoro maru* Cruise #178 and #180-Leg 1, 2007.

Station	Date and Time (S.M.T.*1)		T.D.*2	Set Position		D.S.*3	Wr*4	Wind (Force)
	Net set	Net haul		Lat. (N)	Long. (E)			
Cruise #178								
OSG 0701	May 13 17:54-18:24	May 14 04:33-06:20	+10h	42-30.2	155-00.2	120	bc	West-5
OSG 0702	14 18:38-19:06	15 04:25-05:30		41-00.8	155-00.2	100	o	WSW-4
OSG 0703	16 17:48-18:18	17 04:29-05:29		38-00.1	154-59.6	150	c	NW-6
Cruise #180 - Leg 1								
OSG 0704	June 6 17:56-18:23	July 7 04:30-05:43	+11h	43-59.9	167-29.5	250	f	East-4

*1 S.M.T. : Ship's Mean Time.

*2 T.D. : Time Difference between Greenwich Mean Time (G.M.T.) and Ship's Mean Time (S.M.T.).

*3 D.S. : Direction of net set.

*4 Wr : Weather (bc: 25-75% clouded, o: 100% clouded, c: over 75-99% clouded, f: fog).

Table 3. Position and research conditions of surface longline sampling at each station during the *Oshoro maru* Cruise #180-Leg 1, Leg 2, and Leg 3, 2007.

Station	Date and Time (S.M.T.*1)		T.D.*2	Set Position		D.S.*3	Number of baskets	Wr*4	Wind (Force)
	Line set	Line haul		Lat.	Long.				
Cruise #180 - Leg 1									
OSSL 0701	July 7 03:55-04:14	July 7 06:14-06:32	+11h	43-59.6N	167-27.5E	110	10	r	ESE-4
Cruise #180 - Leg 2									
OSSL 0702	July 27 06:58-07:15	July 27 10:54-11:22	-8h	57-01.3N	166-55.3W	290	10	o	WNW-3
OSSL 0703	July 28 06:03-06:25	July 28 08:25-08:52		57-30.8N	168-00.1W	280	10	o	West-3
OSSL 0704	July 31 05:55-06:15	July 31 10:18-10:50		62-55.1N	173-17.0W	100	10	o	East-4
OSSL 0705	Aug. 1 05:53-06:15	Aug. 1 08:16-08:45		62-51.9N	167-18.8W	110	10	o	East-4
Cruise #180 - Leg 3									
OSSL 0706	Aug. 6 10:33-10:45	Aug. 6 13:10-13:25	-8h	67-31.2N	168-49.8W	345	5	o	NNW-4
OSSL 0707	Aug. 8 05:52-06:09	Aug. 8 10:49-11:23		68-31.5N	168-39.2W	180	10	bc	SSE-2
OSSL 0708	Aug. 11 06:00-06:24	Aug. 11 09:36-10:05		70-53.9N	164-34.3W	190	10	o	South-4

*1 S.M.T. : Ship's Mean Time.

*2 T.D. : Time Difference between Greenwich Mean Time (G.M.T.) and Ship's Mean Time (S.M.T.).

*3 D.S. : Direction of line set.

*4 Wr : Weather (r: rain, o: 100% clouded, bc: 25-75% clouded).

Table 4. Position and research conditions of bottom trawl sampling at each station during the *Oshoro maru* Cruise #180-Leg 2 and Leg 3, 2007.

Station	Date and Time of net tow (S.M.T.*)		Position		Towing direction	Bottom depth (m)	Wr**	Wind (Force)
			Lat. (N)	Long. (W)				
Cruise #180 - Leg 2								
OST 0708	July 26	12:57-13:27	56-30.3	168-06.0	270	115	b	North-3
OST 0709	July 27	11:45-11:55	57-00.1	167-00.7	270	70	o	WNW-3
OST 0710	July 27	13:08-13:28	56-55.3	167-10.7	230	73	o	West-3
OST 0711	July 30	12:02-12:32	61-59.9	174-03.7	270	65	o	SSE-2
OST 0712	July 30	16:00-16:30	62-31.4	174-31.0	270	68	o	SE-3
OST 0713	July 31	07:38-08:08	62-54.6	173-19.8	280	68	o	East-4
OST 0714	July 31	16:12-16:42	62-38.4	171-15.2	110	45	o	ESE-5
Cruise #180 - Leg 3								
OST 0715	Aug. 7	07:16-07:36	68-12.2	167-22.8	330	46	c	NNE-3
OST 0716	Aug. 7	08:44-08:49	68-18.3	167-30.2	325	43	c	NNE-2
OST 0717	Aug. 8	07:38-07:43	68-32.6	168-34.5	010	51	bc	SSW-2
OST 0718	Aug. 8	08:37-08:57	68-32.8	168-34.2	180	49	b	South-2
OST 0719	Aug. 9	07:33-07:38	69-59.5	167-59.0	190	47	f	South-5
OST 0720	Aug. 9	08:35-08:50	70-00.4	167-55.9	000	45	f	South-5
OST 0721	Aug. 11	07:33-07:38	70-51.9	164-39.4	190	33	c	SSW-5
OST 0722	Aug. 11	08:28-08:48	70-51.9	164-38.0	010	31	c	SSW-5
OST 0723	Aug. 11	13:43-14:03	70-50.1	163-14.9	020	42	bc	SSE-3

*S.M.T. : Ship's Mean Time. (Time difference from Greenwich Mean Time is -8 hours.)

** Wr : Weather (b: under 25% clouded, bc: 25-75% clouded, o: 100% clouded, c: over 75-99% clouded, f: fog).

Table 5. The number of organisms caught by drift gillnet along 155° E in the Northwest Pacific Ocean during the *Oshoro maru* Cruise # 178, 2007. (%) indicates % of total numeric catch by C-gear gillnet at each station.

Common name	Scientific name	Station					OSG 0701					OSG 0702					OSG 0703				
		Gear				Total	Gear				Total	Gear				Total					
		A	C	(%)	F		A	C	(%)	F		A	C	(%)	F						
Chum salmon	<i>Oncorhynchus keta</i>	11	6	(2.8)	0	17	15	14	(9.0)	0	29	0	0	-	0	0					
Pink salmon	<i>Oncorhynchus gorbuscha</i>	1	201	(92.2)	0	202	0	97	(62.6)	0	97	0	0	-	0	0					
Boreal clubhook squid	<i>Onychoteuthis borealijaponicus</i>	0	6	(2.8)	0	6	0	2	(1.3)	0	2	0	1	(0.6)	4	5					
Eight-armed squid	<i>Gonatopsis borealis</i>	0	0	-	1	1	0	5	(3.2)	0	5	0	0	-	0	0					
Neon flying squid	<i>Ommastrephes bartramii</i>	0	0	-	0	0	0	0	-	0	0	7	4	(2.3)	0	11					
Blue shark	<i>Prionace glauca</i>	0	0	-	0	0	0	0	-	0	0	2	3	(1.7)	0	5					
Salmon shark	<i>Lamna ditropis</i>	0	1	(0.5)	0	1	0	0	-	0	0	1	0	-	0	1					
Spiny dogfish	<i>Squalus acanthias</i>	0	1	(0.5)	0	1	0	1	(0.6)	0	1	0	0	(0.0)	0	0					
Lanternfishes	Myctophidae	0	0	-	2	2	0	0	-	2	2	0	0	(0.0)	0	0					
Pacific saury	<i>Cololabis saira</i>	0	0	-	0	0	0	0	-	0	0	0	0	-	1	1					
Pacific pomfret	<i>Brama japonica</i>	0	0	-	0	0	21	34	(21.9)	0	55	79	169	(95.5)	0	248					
Sooty shearwater	<i>Puffinus griseus</i>	0	0	-	0	0	1	2	(1.3)	0	3	0	0	-	0	0					
Short-tailed shearwater	<i>Puffinus tenuirostris</i>	4	3	(1.4)	0	7	0	0	-	0	0	0	0	-	0	0					

Table 6. The number of organisms caught by drift gillnet at [44.0° N, 167.5° E] in the Central North Pacific Ocean during the *Oshoro maru* Cruise # 180-Leg 1, 2007. (%) indicates % of total numeric catch by C-gear gillnet at each station.

		Station					OSG 0704				
Common name	Scientific name	Gear				Total					
		A	C	(%)	F						
Chum salmon	<i>Oncorhynchus keta</i>	2	4	(1.8)	0	6					
Pink salmon	<i>Oncorhynchus gorbuscha</i>	5	50	(22.8)	0	55					
Coho salmon	<i>Oncorhynchus kisutch</i>	5	5	(2.3)	0	10					
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	1	0	(0.0)	0	1					
Boreal clubhook squid	<i>Onychoteuthis borealijaponicus</i>	0	16	(7.3)	0	16					
Eight-armed squid	<i>Gonatopsis borealis</i>	0	1	(0.5)	1	2					
Spiny dogfish	<i>Squalus acanthias</i>	0	1	(0.5)	0	1					
Pacific saury	<i>Cololabis saira</i>	0	50	(22.8)	830	880					
Pacific pomfret	<i>Brama japonica</i>	66	87	(39.7)	4	157					
Smalleye squaretail	<i>Tetragonurus cuvieri</i>	0	5	(2.3)	0	5					

Table 7. The number of salmonids caught by surface longline "OSSL XXXX" and hook-and-line gear "OSHL XXXX" along the 44° N latitude line in the Central North Pacific Ocean during the *Oshoro maru* Cruise # 180-Leg 1, 2007.

	OSSL 0701	OSHL 0701	OSHL 0702	OSHL 0703	Total
Sockeye salmon	0	0	0	0	0
Chum salmon	0	1	7	0	8
Pink salmon	0	0	4	1	5
Coho salmon	0	0	17	2	19
Chinook salmon	0	0	0	0	0

Table 8. The catch number of each salmonid at each station where salmonids were collected by hook-and-line gear, surface longline, or bottom trawl survey in the Bering Sea during the *Oshoro maru* Cruise # 180-Leg 2, 2007.

	Station Name	Sampling gear	Species name					Total
			Sockeye	Chum	Pink	Coho	Chinook	
Southeast Bering Sea	OSHL 0704	Hook-and-line	0	5	1	0	0	6
	OSHL 0705	Hook-and-line	0	0	0	1	0	1
	OSHL 0706	Hook-and-line	7	4	0	5	0	16
	OSHL 0708	Hook-and-line	1	0	0	0	0	1
	OSHL 0710	Hook-and-line	0	2	1	3	0	6
	OSSL 0702	Surface longline	0	1	0	3	0	4
	OSHL 0723	Hook-and-line	0	0	0	2	0	2
	Subtotal			8	12	2	14	0
Northeast Bering Sea	OST 0711	Bottom trawl	0	40	0	0	0	40
	OSSL 0704	Surface longline	0	16	0	0	2	18
	OST 0713	Bottom trawl	0	1	0	0	0	1
	OST 0714	Bottom trawl	0	14	0	0	0	14
	OSSL 0705	Surface longline	0	1	0	0	0	1
	OSHL 0735	Hook-and-line	0	0	0	1	0	1
	Subtotal			0	72	0	1	2
Total			8	84	2	15	2	

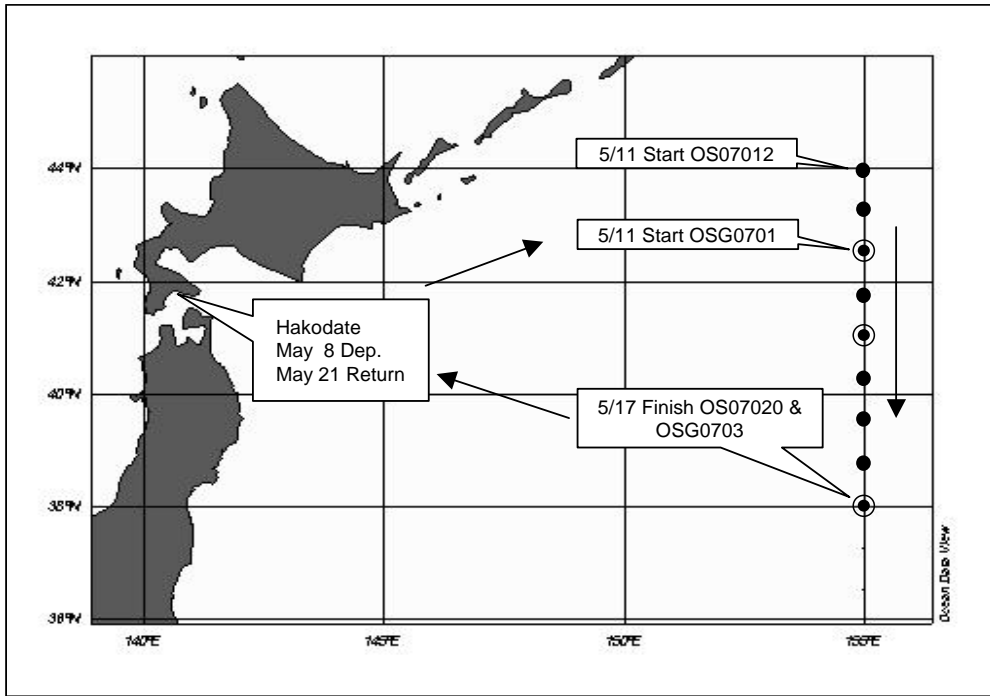


Fig.1-(1). Cruise #178.

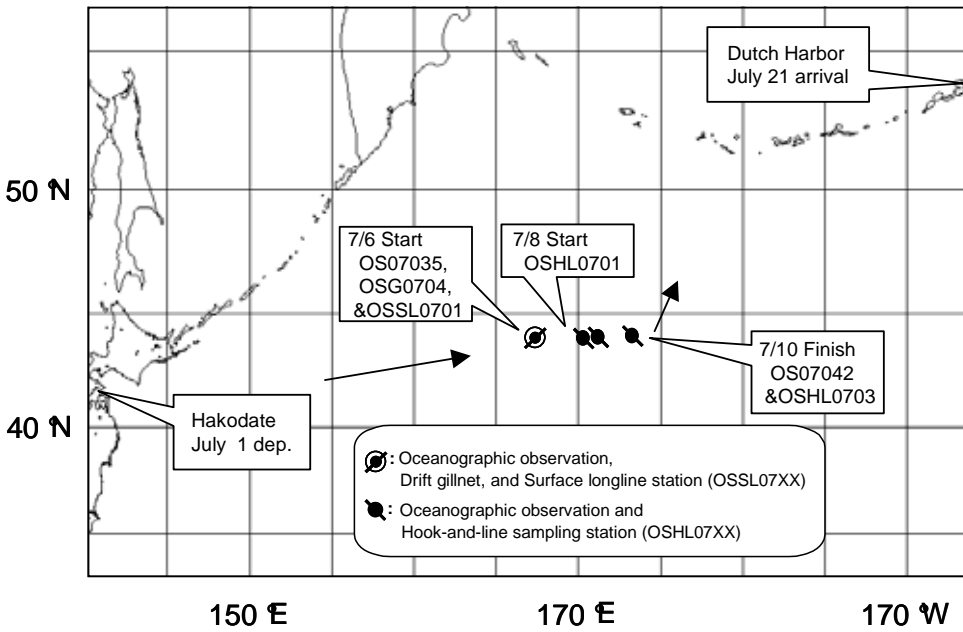


Fig.1-(2). Cruise #180-Leg 1.

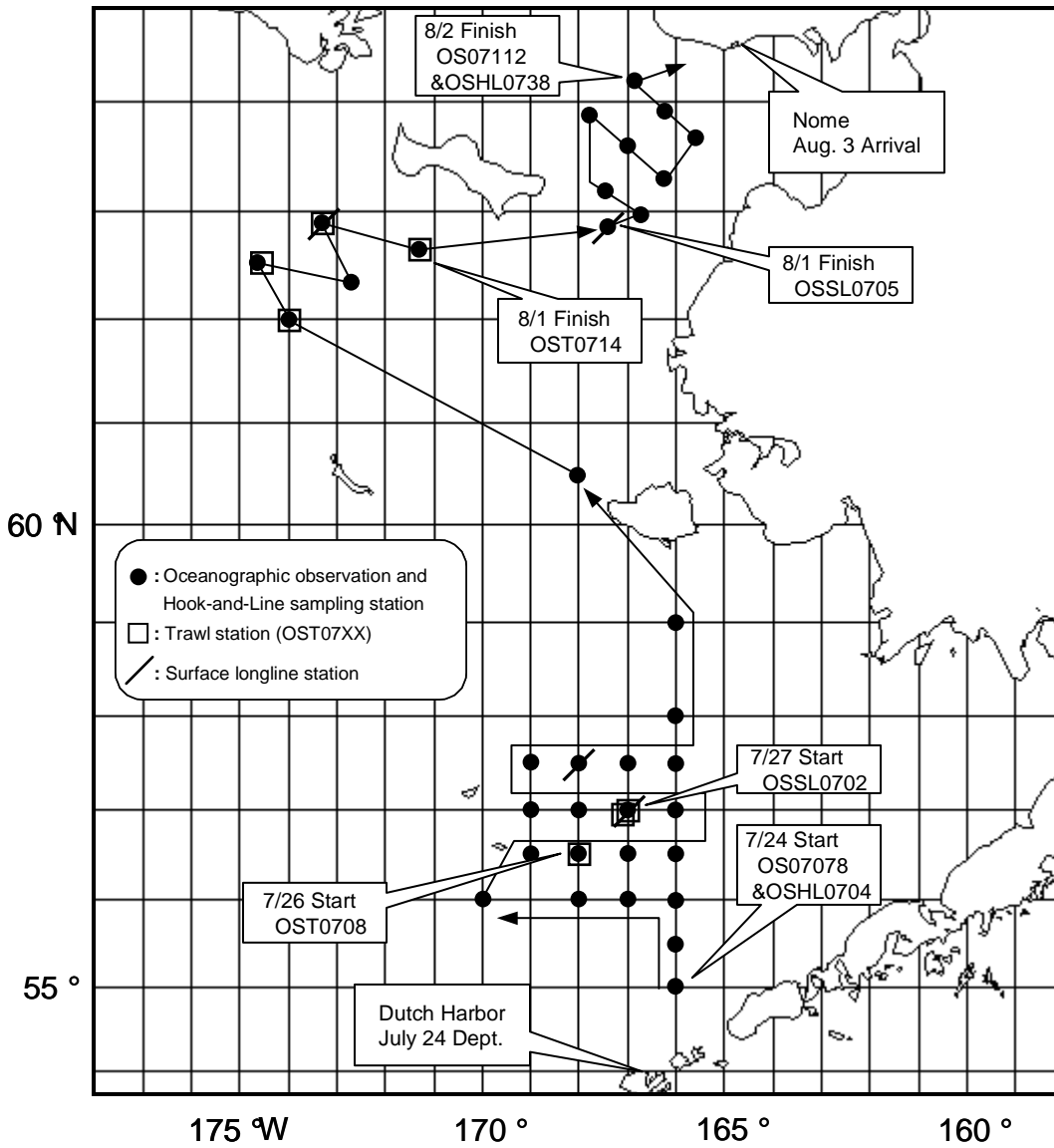


Fig.1-(3). Cruise #180-Leg 2.

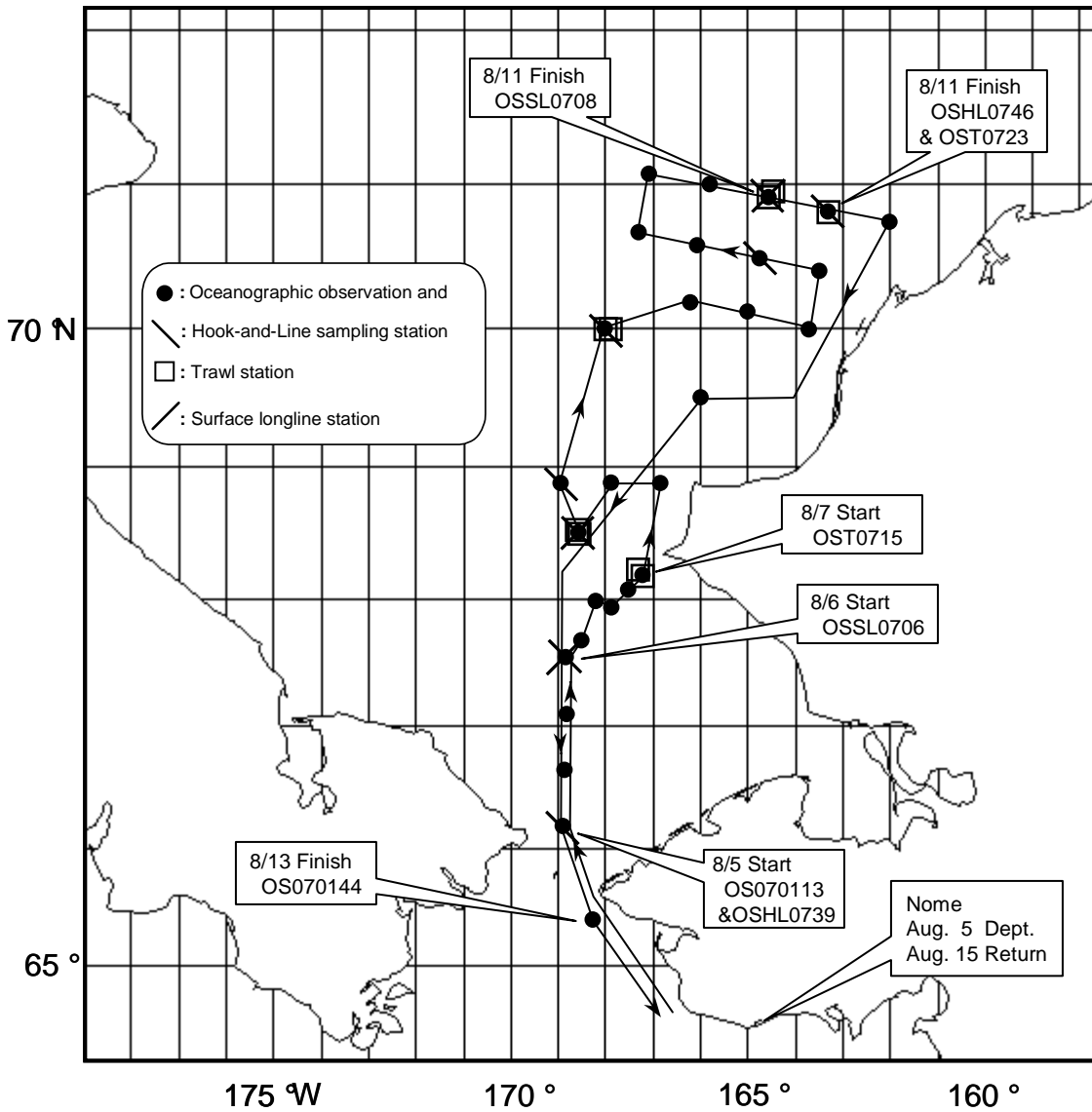


Fig.1-(4). Cruise #180-Leg 3.

Fig.1. Cruise schedule and salmon research stations during the *Oshoro maru* Cruise #178: (1) and Cruise #180-Leg 1: (2), Leg 2:(3), and Leg 3: (4) in 2007. Details about each station are shown in Table 1.

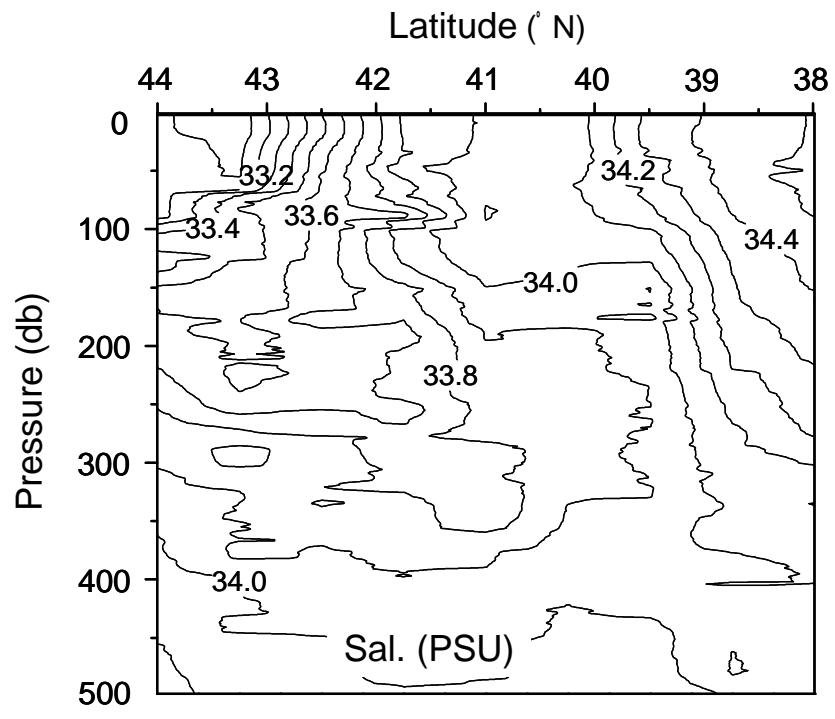
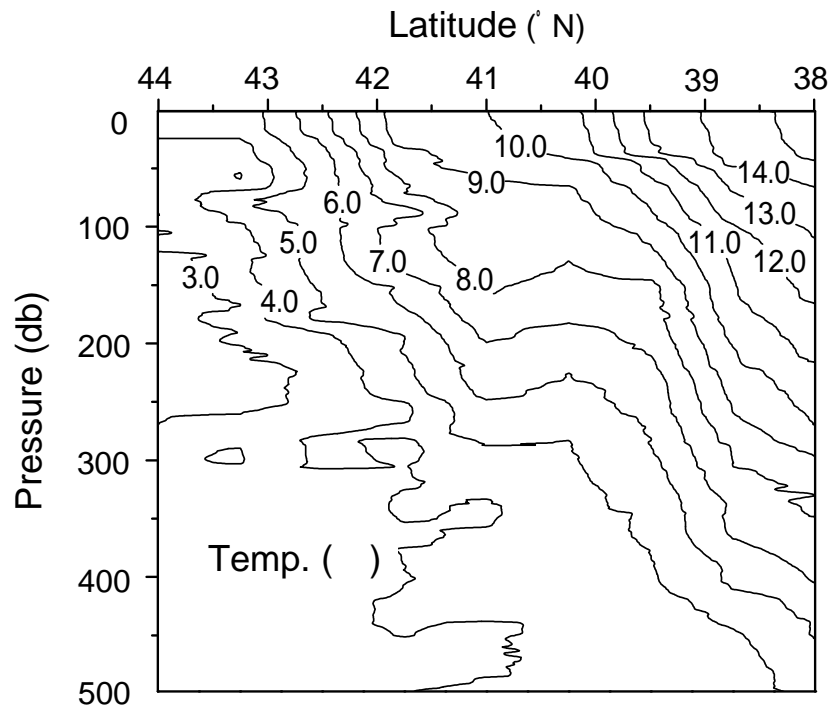


Fig. 2. Temperature and Salinity from surface to 500db pressure along the 155°E transect in the *Oshoro maru* Cruise #178, 2007.

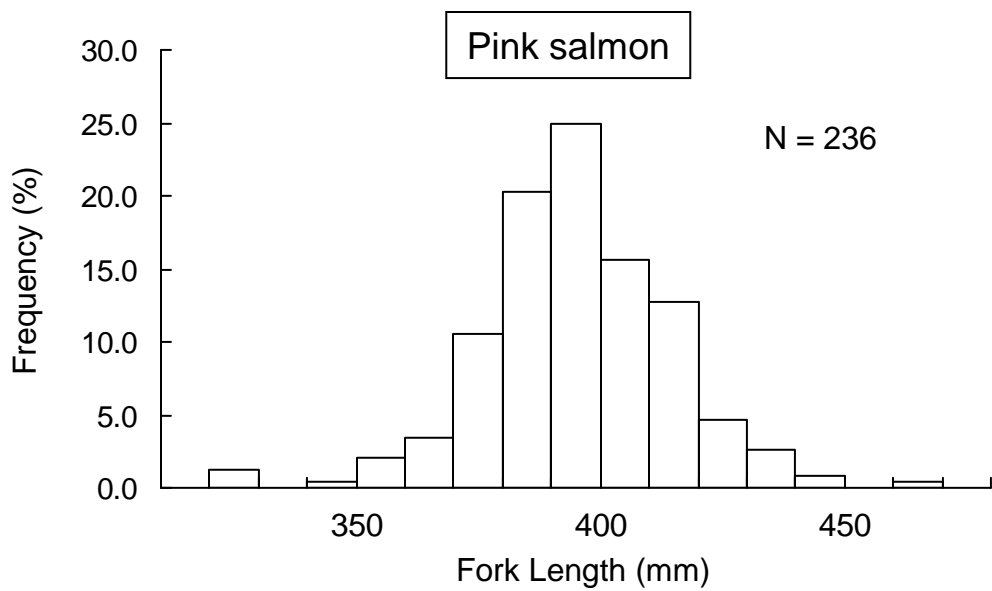
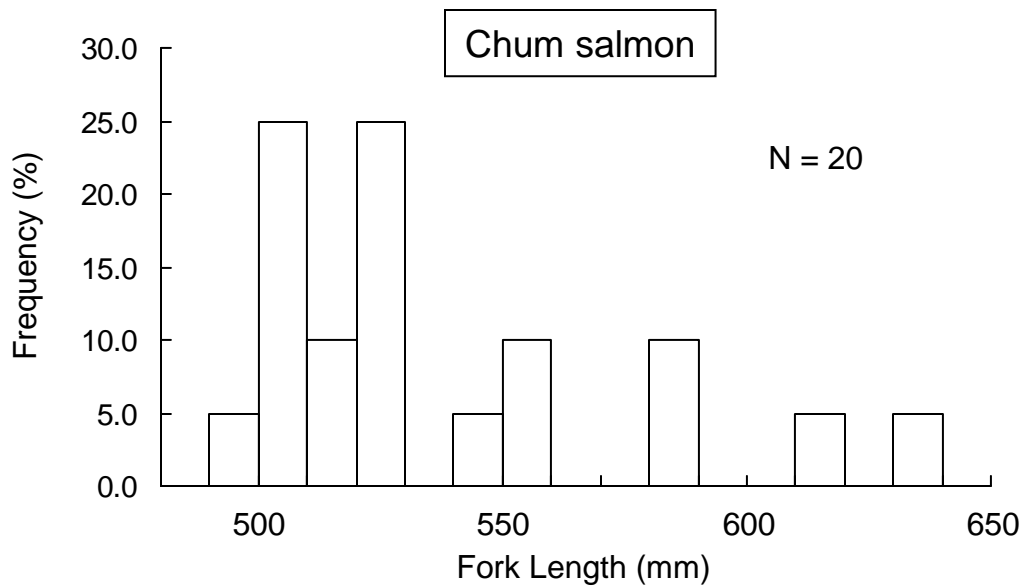


Fig. 3 Fork length frequency distribution of chum salmon and pink salmon caught by C-gear gillnet along the 155° E longitude line during the *Oshoro maru* Cruise #178 in May 2007.

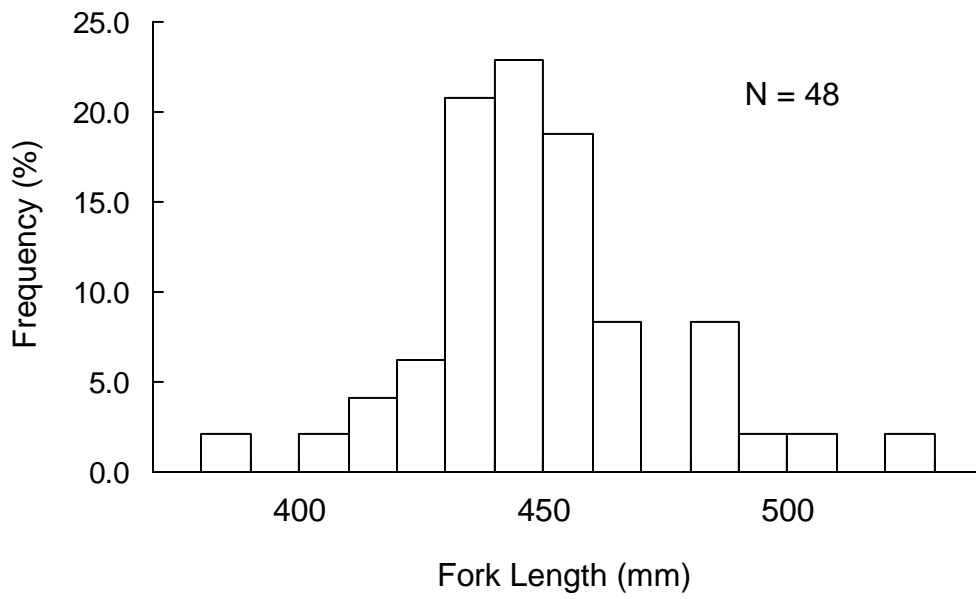


Fig. 4 Fork length frequency distribution of pink salmon caught by C-gear gillnet at station "OSG 0704": [44.0° N, 167.5° E] during the *Oshoro maru* Cruise #180-Leg 1 in early July 2007.

Appendix 1. Temperature and salinity data on the standard depth (pressure: db) at each salmon research station along the 44° N latitude line in the Central North Pacific during the *Oshoro maru* Cruise #180-Leg 1 in early July 2007.

Station: OS07035(OSSL0701)
 Latitude: 43-58.96N
 Longitude: 167-25.63E
 Depth: 5365m

Station: OS07039(OSHL0701)
 Latitude: 44-00.15N
 Longitude: 170-29.78E
 Depth: 3505m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	10.7736	32.9376
20	8.1638	33.0448
30	7.8317	33.0697
40	7.5008	33.0821
50	6.5183	33.1193
75	5.0652	33.2327
100	4.8241	33.3362
125	4.3625	33.4746
150	4.142	33.5973
175	3.9721	33.6687
200	3.7814	33.701
250	3.6652	33.7636
300	3.6413	33.8493
400	3.6963	33.9995
500	3.6258	34.1244

Press. (db)	Temp.(° C)	Salinity(PSU)
10	10.2104	32.6813
20	7.8934	32.9449
30	6.8238	32.9587
40	5.0499	33.0005
50	4.4276	33.0597
75	3.8483	33.0597
100	3.2618	33.0998
125	3.196	33.3128
150	3.1287	33.4501
175	3.0638	33.5746
200	3.283	33.6615
250	3.2804	33.756
300	3.3198	33.8421
400	3.5637	34.0589
500	3.5114	34.1531

Station: OS07040(OSHL0702)
 Latitude: 44-00.30N
 Longitude: 171-15.00E
 Depth: 6009m

Station: OS07042(OSHL0703)
 Latitude: 43-59.89N
 Longitude: 173-30.10E
 Depth: 5620m

Press. (db)	Temp.(° C)	Salinity(PSU)
0	14.86	7.432
10	8.368	32.875
20	7.638	32.94
30	7.356	32.961
40	6.974	32.958
50	5.799	32.949
75	3.535	33.014
100	3.044	33.102
125	2.949	33.345
150	2.921	33.499
175	3.022	33.605
200	3.099	33.679
250	3.254	33.818
300	3.415	33.92
400	3.465	34.061
500	3.435	34.162

Press. (db)	Temp.(° C)	Salinity(PSU)
10	10.608	32.8211
20	10.5306	32.8288
30	7.385	32.996
40	5.1956	33.0752
50	4.3236	33.1073
75	3.7089	33.1293
100	3.1581	33.0871
125	3.6132	33.383
150	3.9992	33.564
175	3.8543	33.6043
200	3.6808	33.6646
250	3.602	33.758
300	3.566	33.8291
400	3.6243	33.9986
500	3.6013	34.1159

Appendix 2. Temperature and salinity data on the standard depth (pressure: db) about the each station at which salmonids were collected in the Bering Sea during the *Oshoro maru* Cruise #180-Leg 3 from late July to early August, 2007.

Station: OS 07078 (OSHL 0704)
 Latitude: 55-00.00N
 Longitude: 166-00.03W
 Depth: 135m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	7.2581	32.1863
20	6.6704	32.2167
30	5.6884	32.3648
40	5.459	32.4632
50	5.0497	32.6376
75	3.8032	32.8856
100	3.6254	32.9638
116	3.6226	32.975

Station: OS 07079 (OSHL 0705)
 Latitude: 55-30.27N
 Longitude: 165-59.61W
 Depth: 119m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	9.2303	32.0161
20	6.0737	32.1422
30	5.7821	32.2869
40	5.1901	32.2931
50	5.0075	32.4159
75	4.2708	32.6204
100	3.6272	32.8154
101	3.6241	32.8202

Station: OS 07080 (OSHL 0706)
 Latitude: 55-59.94N
 Longitude: 166-00.04W
 Depth: 113m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	9.3599	31.8578
20	8.701	31.8548
30	5.4408	32.092
40	4.4313	32.1811
50	3.8343	32.2671
75	4.5225	32.6377
100	3.3492	32.7137
101	3.3491	32.714

Station: OS 07082 (OSHL 0708)
 Latitude: 55-59.88N
 Longitude: 168-00.05W
 Depth: 136m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	9.0185	31.8047
20	7.3326	31.8054
30	5.3706	31.8583
40	3.0587	32.0083
50	2.666	32.1835
75	3.5867	32.8042
100	3.6849	32.8584
125	3.6892	32.8599
131	3.6903	32.8603

Station: OS 07084 (OSHL 0710)
 Latitude: 56-29.91N
 Longitude: 168-59.84W
 Depth: 102m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	8.8148	31.8084
20	5.184	31.9168
30	3.8465	31.9447
40	2.308	31.9895
50	2.0834	32.1132
75	2.3349	32.259
95	2.3722	32.271

Station: OS 07089 (OSSL 0702)
 Latitude: 57-00.05N
 Longitude: 167-00.02W
 Depth: 71m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	9.5178	31.3931
20	1.4219	31.9499
30	1.3538	31.9554
40	1.3604	31.9538
50	1.3803	31.9568
65	1.4195	31.9632

Appendix 2 (Continued)

Station: OS 07097 (OSHL 0723)
 Latitude: 58-59.93N
 Longitude: 166-00.02W
 Depth: 26m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	8.1191	31.1055
20	8.036	31.11

Station: OS 07099 (OST 0711)
 Latitude: 62-00.00N
 Longitude: 174-00.25W
 Depth: 64m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	9.6155	30.8231
20	0.1581	31.6754
30	-1.0238	31.8435
40	-1.1656	31.9824
50	-1.4736	32.2581
60	-1.505	32.2966

Station: OS 07102 (OSSL 0704, OST 0713)
 Latitude: 62-54.34N
 Longitude: 173-16.54W
 Depth: 68m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	9.9833	31.0009
20	0.0345	32.0439
30	-0.7579	32.3721
40	-1.4412	32.5341
50	-1.679	32.7511
60	-1.679	32.7516

Station: OS 07103 (OST 0714)
 Latitude: 62-38.49N
 Longitude: 171-15.03W
 Depth: 41m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	11.0259	31.5362
20	0.9035	31.9266
30	-0.4611	32.1208
35	-0.2933	32.2559

Station: OS 07104 (OSSL 0705)
 Latitude: 62-51.30N
 Longitude: 167-21.21W
 Depth: 34m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	6.7705	32.0858
20	0.5378	32.5358
30	0.5363	32.5387
30	0.5363	32.5387

Station: OS 07109 (OSHL 0735)
 Latitude: 63-18.21N
 Longitude: 166-15.13W
 Depth: 21m

Press. (db)	Temp.(° C)	Salinity(PSU)
10	11.8529	30.4522
19	3.5946	31.2324