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by

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Abstract

In order to accumulate oceanographic and biological data (including salmonids) and to clarify the oceanic structure and marine ecosystem, the T/V *Oshoro maru* conducted oceanographic observations and fishing surveys in the western North Pacific (along the 155°E longitude line and 47°N 160°E). The survey was conducted during the Cruise #025 in May, and the Cruise #026-Leg2 June to July 2016.

Eleven oceanographic observations and three drift gillnet surveys were conducted along the 155°E during the Cruise #025 in May. The Polar Front was observed in the vicinity of 44°N which were shifted north than the location in previous years and the Subarctic Boundary was located in the north side of 41°N also shifted north rather than last year. A total of 474 salmonids was caught by gillnet surveys, including 439 Pink, 32 Chum, two Steelhead and one Sockeye salmon. Pink salmon was the dominant species. The fork lengths (F.L.) of chum salmon collected by C-gear gillnet ranged between 454-586 mm F.L., and those of pink salmon ranged between 300-430 mm F.L., 90.6% of chum salmon caught along 155°E were adult fish.

To collect salmon samples extensively and to collect fresh salmon blood and various tissues, three hook-and-line gear samplings were conducted during the Cruise #026-Leg2. Almost all of caught by these gears were Pink salmon. A total of eight Chum, and 237 Pink salmon were collected during the Cruise #026-Leg2.

Keywords: salmon, gillnet, 155°E longitude line

INTRODUCTION

The *Oshoro maru* has continued to study the oceanic structure and marine biology in the North Pacific Ocean every summer and Bering Sea (infrequently in the Chukuchi Sea) almost every summer since 1953. Collected data has been published annually since 1957 (Hokkaido University, 1957-2016).

Salmon researches were conducted during a cruise in May 2016: the *Oshoro maru* Cruise #025 in the western North Pacific and in June to July 2016: the *Oshoro maru* Cruise #026-Leg2 in the western North Pacific.

Primary salmon research objects during two cruises were

1. To collect oceanographic and biological data continuously along 155°E longitude line in May.
2. To collect salmon samples as extensively as possible during the cruises periods in order to study their food habits, growth and stock identification etc.

This document reports the preliminary results about those researches during the cruise.

MATERIAL AND METHODS

Survey Area and Cruise Schedule

The *Oshoro maru* (1,998 gross ton) departed Hakodate on May 12, 2016 and started the Cruise #025. Oceanographic observations, gillnet surveys, surface long-line and hook-and-line samplings were conducted along the 155°E longitude between 44°N and 38°-45°N latitude from May 14 to 18, and returned to Hakodate on May 23. The Cruise #026-Leg2 was started on June 19 when she left Tokyo. Salmon research activities were conducted from June 22 to July 9, and returned to Hachinohe on July 15. Oceanographic observations and hook-and-line samplings were conducted. [Table 1, 2, Fig.1]

Oceanographic observation

Eleven oceanographic observations were conducted from 44°N to 37°-15'N along the 155°E longitude line. [Table 3, Fig.1] The temperature and salinity data at each station were collected by using CTD. Temperature and salinity data from surface to 500db along the 155°E longitude line were used to plot temperature and salinity sections about each transect during the Cruise #025. [Fig.2] Three oceanographic observations at salmon sampling stations were conducted in the Cruise #026-Leg2. [Table 3, Fig.1]

Drift Gillnet Research

One set of a drift gillnet was used to collect salmonids and the other organisms at the station along the 155°E longitude line. [Fig.1, Table1] The gillnet configuration at the station was as follows:

Stations	net	A-Gear		C-gear										Total
	Mesh size (mm)	112	115	48	55	63	72	82	93	106	121	138	157	
OSG1601-3	Number of tan	6	6	3	3	3	5	6	5	3	3	3	3	49

The net was total 49 tans which comprised of 37 tans of C-Gear gillnet (non-selective varied research mesh, Takagi, 1975) and 12 tans of A-Gear gillnet (commercial mesh). This year not using F-Gear gillnet (special mesh). Each tan was 50 m long. Gillnet gear was set in the evening, allowed to soak overnight, and retrieved the following morning. The catch was sorted and counted by mesh size and species. The Catch per Unit Effort (CPUE) values of C-Gear gillnet by species at each station was calculated as catch number per one tan of C-Gear gillnet.

Details about each gillnet operation are shown in Table 1.

Surface Long-line Research

Three surface long-line researches were conducted to collect salmonids from the 43°-19'N to 42-30°N along the 155°E longitude line during the Cruise #025. [Fig.1]

The long-line consisted of 20 or 30 baskets (hachi). One basket was 110.68 m long with 49 hooks baited with Japanese common squid (*Todarodes pacificus*). The catch was sorted by species and counted.

Details about each surface long-line operation are shown in Table 2.

Hook-and-Line Sampling

To collect fresh salmon blood and various tissues, hook-and-line gears were used at seven research stations during the Cruise #025 and the Cruise #026-Leg2 [Fig.1].

Three to ten anglers were engage in the work. Those samplings were conducted mainly around the same time that oceanographic observation was operating. The catch was sorted by species and counted.

Details about each hook-and-line operation are shown in Table 2.

Fish Examination

The Catch was processed soon after removal from the fishing gear. Biological data were recorded per each sampling gear at every station. Biological data for salmonids consisted of 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. For the salmon which had a clipped fin, its snout was removed, salted, and frozen for later potential recovery of the coded-wire tag (CWT) by researchers at NOAA NMFS, Auke Bay Laboratories (ABL).

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 (*Oncorhynchus keta*) and steelhead (*Oncorhynchus mykiss*) were classified as mature or immature based on their gonad weight (Takagi, 1961).

Body length and body weight were determined for non-salmonid fish, squid, and other organisms up to a maximum of 30 per species by mesh size. A few were frozen for taxonomic and ecological studies.

RESULTS AND DISCUSSION

Along the 155°E Longitude Line: during the Cruise #025 in May 2016

Oceanographic Conditions

Temperature and salinity sections (0-500db) along the 155°E longitude line transect are shown in Figs. 2 and 3.

The geographic positions of the Polar Front and the Subarctic Boundary along the 155°E longitude line transect (Dodimead et al., 1963; Favorite et al., 1976; Roden, 1991) were observed following locations in May 2016.

The Polar Front which is indicated by the vertical 4°C isotherm at 100 db observed in the vicinity south of 44°N, it was shifted north than the location in previous years. The Subarctic Boundary indicated by the vertical 34.0 psu isohaline was observed in the north side of 41°N also shifted north slightly rather than last year.

Distribution and Abundance of Organisms Caught by Drift Gillnet

The numbers of organisms caught by drift gillnet and the CPUE values of C-gear gillnet at the station along the 155°E longitude line are shown in Table 4.

Three drift gillnets survey were conducted along the 155°E during the cruise #025 in May 2016. Two drift gillnet surveys (OSG1601,OSG1602) was conducted in the Subarctic Waters and one drift gillnet (OSG1603) survey was conducted in southern of the Subarctic Boundary [Fig. 1, Tables 1]. A total of one sockeye salmon (*Oncorhynchus nerka*), 32 chum salmon (*O. keta*), 439 pink salmon (*O. gorbuscha*) and two steelhead (*O. mykiss*) were collected at 43°-01.9'N (OSG1601) and 42°-01.7'N (OSG1602). The CPUE value of pink salmon was high at these position. Non-salmonid fishes caught by C-gear gillnet were also shown in Table 4.

Biological Characteristics of Salmonids

F.L. frequency distributions of pink salmon caught by C-gear gillnet along the 155°E are shown in Fig. 4.

A total of 13 chum salmon were collected by C-gear gillnet. Their F.L. ranged between 454-582 mm. Mean \pm SD of them was 522.4 ± 38.6 mm, and median of them was 524.0 mm. Mature fish occupied 92.3%.

A total of 438 pink salmon were collected by C-gear gillnet (238 Pink salmon were measured). Their F.L. ranged between 300-430 mm. Mean \pm SD of them was 376.7 ± 24.5 mm, and median was 378 mm.

Surface Long-line Research and Hook-and-Line Samplings

The catch number of salmonids at each station by hook-and-line gear and surface long-line is shown in Table 5.

A total of 24 chum and 774 pink salmon were collected by surface long-line and hook-and-line gear at 155°E research line during the Cruise #025 (OSSL1601-03, OSHL1601-04) and the Cruise #026 (OSHL1605-07).

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Table 1. Position and research conditions of surface drift gillnet sampling at each station during the *Oshoro maru* Cruise #025, 2016.

Station	Date and Time (S.M.T.*1)				T.D.*2	Set Position		D.S.*3	bottom depth(m)	Wt*4	Wind (Force)	S.T.*5 (°C)
	Net set		Net haul			Lat.	Long.					
OSG 1601	May 15	1939-2000	May 16	0533-0647	+10h	43-01.9N	155-00.7 E	290	5345	o	East-4	7.4
OSG 1602	May 16	1903-1925	May 17	0453-0553	+10h	42-01.7N	154-59.6 E	290	5400	o	SE-4	7.6
OSG 1603	May 18	1812-1832	May 19	0458-0620	+10h	38-44.7N	154-57.6 E	215	5740	bc	SSE-5	14.4

Table 2. Position and research conditions of surface long-line and hook-and-line sampling at each station during the *Oshoro maru* Cruise #025 and #026-Leg2, 2016.

Station	Date and Time (S.M.T.*1)				T.D.*2	Set Position		D.S.*3	Number of baskets	bottom depth(m)	Wt*4	Wind (Force)	S.T.*5 (°C)
	Line set		Line haul			Lat.	Long.						
Cruise #025													
OSSL1601	May 15	1023-1040	May 15	1356-1450	+10h	43-18.7N	155-00.1N	180	20	5445	f	ENE-3	5
OSSL1602	May 16	0440-0505	May 16	0726-0845	+10h	43-04.5N	154-58.6E	80	30	5353	c	ENE-4	7.3
OSSL1603	May 16	1222-1240	May 16	1534-1615	+10h	42-30.5N	155-00.2E	270	20	5140	o	East-5	8.2
OSHL1601	May 14	2000	May 15	0400	+10h	43-59.9N	154-59.9E	-	-	5295	f	NNE-2	3.9
OSHL1602	May 15	2100	May 16	0340	+10h	43-01.7N	154-57.3E	-	-	5314	c	ENE-4	7.5
OSHL1603	May 16	2020	May 17	0330	+10h	41-59.5N	154-57.8E	-	-	5419	o	ESE-4	7.8
OSHL1604	May 17	2030	May 18	0000	+10h	40-14.9N	154-59.8E	-	-	5563	bc	ESE-5	12.9
Cruise #026													
OSHL1605	Jun. 22	2000	Jun. 22	2145	+10h	43-11.9N	153-19.9E	-	-	5266	bc	East-5	9.4
OSHL1606	Jun. 25	2230	Jun. 26	0300	+10h	46-54.1N	159-55.1E	-	-	5171	f	SSW-4	5.7
OSHL1607	Jul. 7	2125	Jul. 8	0330	+10h	47-00.5N	160-00.0E	-	-	5164	bc	West-3	7.4

Table 3. List of oceanographic station during the *Oshoro maru* Cruise #025 and #026-Leg2 2016.

Station	Date and Time (S.M.T.*1)		T.D.*2	Set Position		Remark	CTD depth(db)
				Lat.	Long.		
Cruise #025							
OS 16029	May 14	2000	+9h	43-59.9N	155-00.2E	Sea-Bird SBE 9	5300
OS 16032	May 15	1055	+10h	43-16.0N	155-00.3E	Sea-Bird SBE 9	5500
OS 16033	May 15	2100	+10h	43-01.7N	154-57.3E	Sea-Bird SBE 9	5300
OS 16035	May 16	1302	+10h	42-29.6N	154-57.7E	Sea-Bird SBE 9	5200
OS 16036	May 16	2027	+10h	41-59.5N	154-57.8E	Sea-Bird SBE 9	5400
OS 16038	May 17	1333	+10h	41-00.0N	155-00.2E	Sea-Bird SBE 9	5500
OS 16039	May 17	2038	+10h	40-14.9N	154-59.8E	Sea-Bird SBE 9	5500
OS 16041	May 18	0810	+10h	39-29.9N	154-59.9E	Sea-Bird SBE 9	5600
OS 16042	May 18	1533	+10h	38-45.0N	155-00.0E	Sea-Bird SBE 9	5700
OS 16044	May 19	1204	+10h	38-00.2N	154-59.9E	Sea-Bird SBE 9	6000
OS 16045	May 19	1922	+10h	37-15.0N	155-00.0E	Sea-Bird SBE 9	5700
Cruise #026-Leg2							
OS 16066	Jun 22	1738	+10h	43-11.7N	153-19.7E	Sea-Bird SBE 9	300
OS16084	Jun 28	0145	+10h	47-00.1N	160-00.1E	Sea-Bird SBE 9	800
OS 16132	July 08	1519	+10h	47-00.0N	160-00.0E	Sea-Bird SBE 9	5200

*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 or line set.

*4 Wr. : Weather (bc:25-74%clouded, c: 75-99% clouded, o: 100% clouded, f: fog).

*5 S.T. : Surface temperature

Table 4. The number of organisms caught by drift gillnet during the *Oshoro maru* Cruise # 025, in May, 2016. CPUE and (%) indicate numerical catch per tan and percentage of total catch by C-gear gillnet at the station, respectively.

		OSG 1601				OSG 1602				OSG 1603			
Common name	Scientific name	C		A	Total	C		A	Total	C		A	Total
		CPUE	(%)			CPUE	(%)			CPUE	(%)		
Sockeye salmon	<i>Oncorhynchus nerka</i>	1	0.0 (0.5)	0	1	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0
Chum salmon	<i>Oncorhynchus keta</i>	1	0.0 (0.5)	2	3	12	0.4 (4.7)	17	29	0	0.0 (0.0)	0	0
Pink salmon	<i>Oncorhynchus gorbuscha</i>	204	6.8 (96.2)	0	204	234	7.8 (91.4)	1	235	0	0.0 (0.0)	0	0
Coho salmon	<i>Oncorhynchus kisutch</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0
Steelhead	<i>Oncorhynchus mykiss</i>	0	0.0 (0.0)	0	0	2	0.1 (0.8)	0	2	0	0.0 (0.0)	0	0
Tufted Puffin	<i>Fratercula cirrhata</i>	0	0.0 (0.0)	0	0	1	0.0 (0.4)	0	1	0	0.0 (0.0)	0	0
Boreal clubhook squid	<i>Onychoteuthis borealijaponica</i>	4	0.1 (1.9)	0	4	5	0.2 (2.0)	0	5	2	0.1 (1.0)	0	2
Boreopacific gonate squid	<i>Gonatopsis borealis</i>	2	0.067 (0.9)	0	2	1	0.0 (0.4)	0	1	0	0.0 (0.0)	0	0
Horned puffin	<i>Fratercula corniculata</i>	0	0.0 (0.0)	0	0	1	0.033 (0.4)	0	1	0	0.0 (0.0)	0	0
Neon flying squid	<i>Ommastrephes bartramii</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	11	0.367 (5.7)	14	25
Pacific pomfret	<i>Brama japonica</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	172	5.733 (89.6)	109	281
Albacore tuna	<i>Thunnus alalunga</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	0	0.0 (0.0)	1	1
Blue shark	<i>Prionace glauca</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	6	0.2 (3.1)	2	8
Shortfin mako shark	<i>Isurus oxyrinchus</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	0	0.0 (0.0)	1	1
Salmon shark	<i>Lamna ditropis</i>	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	1	0.033 (0.5)	0	1

Table 5. The catch number of each salmonid at each station where salmonids were collected by hook-and-line gear, surface long-line in the *Oshoro maru* Cruise # 025 and #026-Leg2, 2016.

Station Name	Sampling gear	Species name									Total
		Sockeye	Chum	Pink	Coho	Chinook	Stellhead	D.immutabilis	B.J.Hilgendorf	Scomber	
Cruise #025											
OSSL 1601	Surface longline	0	8	23	0	0	0	0	0	0	31
OSSL 1602	Surface longline	0	4	159	0	0	0	2	0	0	165
OSSL 1603	Surface longline	0	1	17	0	0	0	0	0	0	18
OSHL 1601	Hook-and-line	0	1	9	0	0	0	0	0	0	10
OSHL 1602	Hook-and-line	0	2	100	0	0	0	0	0	0	102
OSHL 1603	Hook-and-line	0	0	226	0	0	0	0	0	0	226
OSHL 1604	Hook-and-line	0	0	3	0	0	0	0	3	4	10
Cruise #026-Leg2											
OSHL 1605	Hook-and-line	0	0	2	0	0	0	0	0	0	2
OSHL 1606	Hook-and-line	0	0	4	0	0	0	0	0	0	4
OSHL 1607	Hook-and-line	0	8	231	0	0	0	0	0	0	239
Total		0	24	774	0	0	0	2	3	4	807

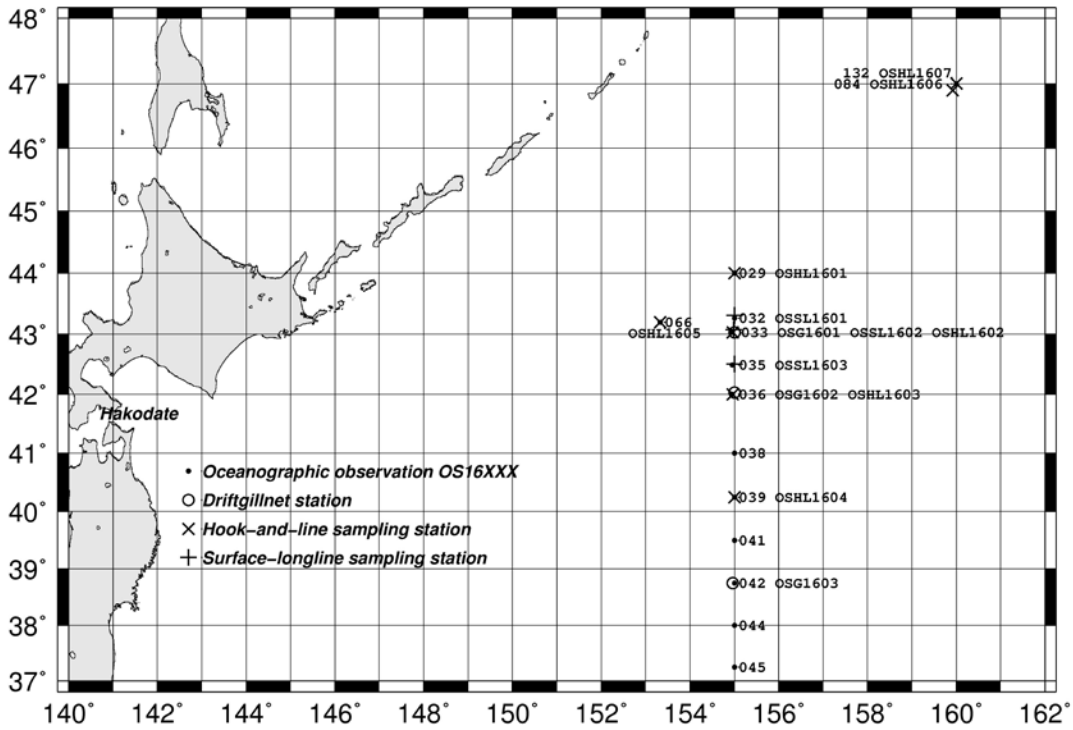


Fig. 1. Salmon research stations during the *Oshoro maru* Cruise # 025 and #026-Leg2, 2016. Details about each station are shown in Table 1.-2.-3.

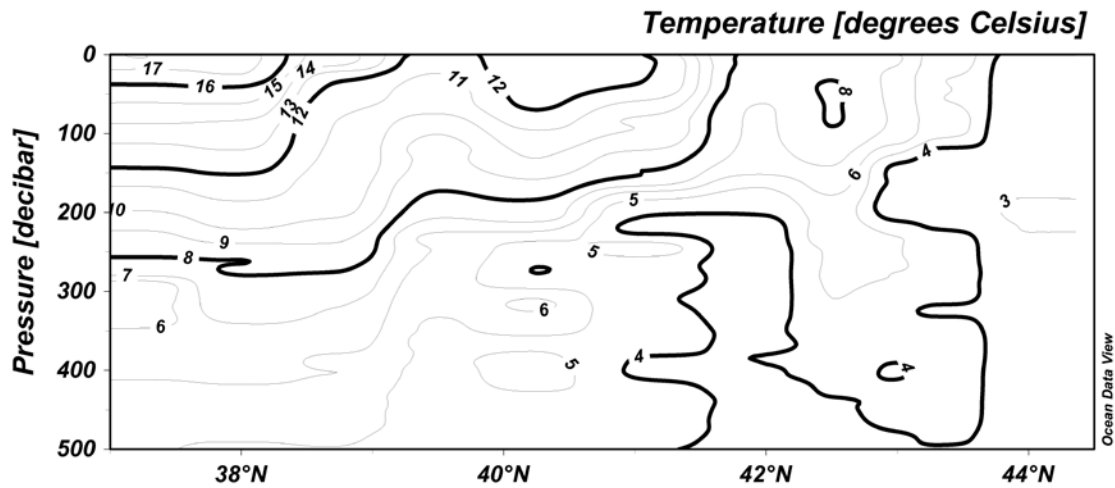


Fig. 2. Temperature from surface to 500 db pressure along the 155°E transect during the *Oshoro maru* Cruise #025 in May, 2016.

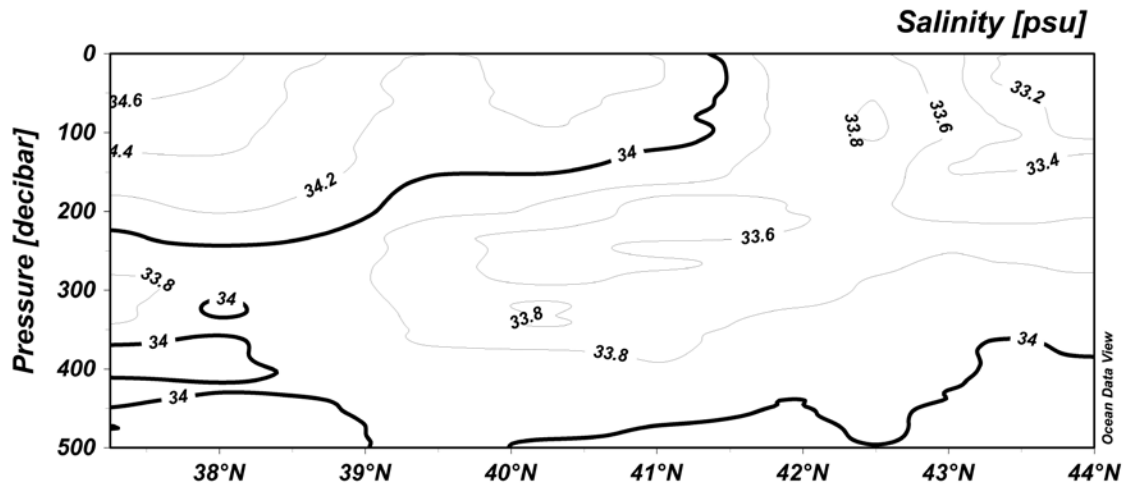


Fig. 3. Salinity from surface to 500 db pressure along the 155°E transect during the Oshoro maru Cruise #025 in May, 2016.

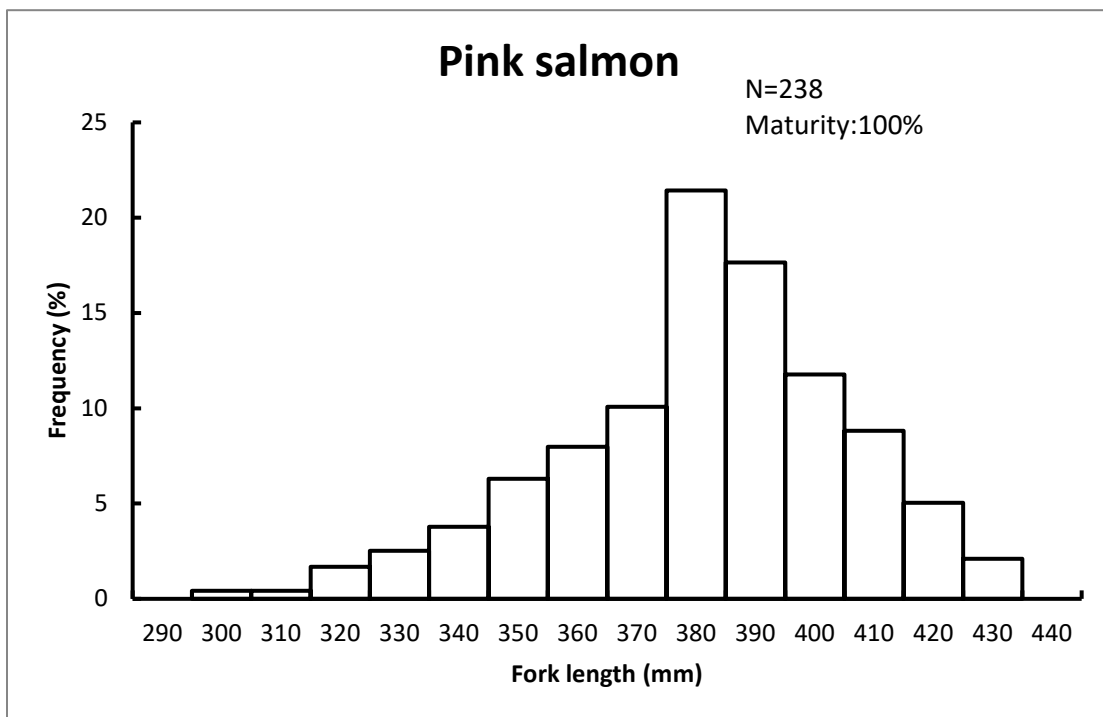


Fig. 4. Fork length frequency of pink salmon caught by C-gear gillnet along the 155°E during the Oshoro maru Cruise #025 in May, 2016.