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Results of 2019 Salmon Research by the *Oshoro maru*

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, T/V *Oshoro maru* conducted oceanographic observations and fishing surveys in the western North Pacific (along the 155°E longitude line). The survey was conducted during the Cruise #071 in May 2019. Oceanographic observations and a drift gillnet surveys were conducted along the 155°E during the Cruise #071.

We were able to conduct three gillnet surveys at three different stations, whereas only one survey was conducted in 2018. A total of 721 salmonids was caught by the survey, including 699 pink, 21 chum and one coho salmon. Other species such as steelhead and sockeye salmon were not caught during the cruise. The fork lengths (F.L.) of pink salmon collected by C-gear gillnet were all adult fish ranging between 308-497 mm. To collect salmon samples including fresh salmon blood, otoliths and various tissues extensively four hook-and-line gear samplings were conducted during the Cruise #071.

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.

Salmon researches were conducted during a cruise in May 2019: the *Oshoro maru* Cruise #071 in the Western North Pacific.

Primary salmon research objectives during a cruise 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 10th May 2019 to start the Cruise #071. Oceanographic observations, gillnet surveys, surface long-line and hook-and-line samplings were conducted along the 155°E longitude between 43°59.5'N and 40°16'N latitude from 14th to 17th, and returned to Hakodate on 21st May.

[Table 1, 2, Fig.1]

Oceanographic observation

Twelve oceanographic observations were conducted from 44°N to 38°48'N along the 155°E longitude line. [Table 3, Fig.1.1] 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 sectioned diagram on temperature and salinity during the Cruise #071. [Fig.2.1, 2.2]

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	181	121	48	55	63	72	82	93	106	121	138		157
OSG1901~3	Number of tan	3	3	3	3	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). F-Gear gillnet (special mesh) was not used this year. 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

Two surface long-line researches were conducted to collect salmonids during the Cruise #071. [Fig.1, Table 2]

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, otoliths and various tissues, hook-and-line gears were used at four research stations during the Cruise #071. [Fig.1, Table 2].

Three to ten anglers were engaged 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. Otoliths were also extracted for analysis of the hatch code.

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 pink salmon (*Oncorhynchus gorbuscha*) 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 #071 in May 2019

Oceanographic Conditions

Temperature and salinity sections (0-500db) along the 155°E longitude line are shown in Figure. 2.1, 2.2.

The Polar Front indicated by the vertical 4°C isotherm appears to sit without conspicuous shift from the last year (Sato, T., K. Sakaoka, Y. Kajiwara, K. Imai, N. Hoshi, M. Ohwada, Y. Inagaki, and S. Takagi., 2018) in the vicinity of 44°30'N [Fig.2.1]. The Subarctic Boundary indicated by the vertical 34.0psu isohaline is also seen with little positional difference from the last year (Sato et al., 2018) [Figure. 2.2].

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 stations during the Cruise #071 are shown in Table 4.

Three drift gillnet survey was conducted along the 155°E in the Subarctic Waters during the Cruise #071 in May 2019. [Fig.1, Tables 1]. A total of fifteen chum salmon (*Oncorhynchus keta*), and 696 pink salmon (*Oncorhynchus gorbuscha*) were collected by C-gear gillnet during the cruise #071. Comparing CPUE value of pink salmon caught in OSG1901 to OSG1801, the value this year is higher than the last year (Sato et al., 2018). Non-salmonid fish 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.3.

333 pink salmon out of the total 696 by C-gear gillnet were measured. Their F.L. ranged between 308-497 mm. Mean \pm SD of them was 391.8 ± 14.8 mm, and median was 392 mm. Comparing these values to these last year, we can see that the size of pink salmon caught this year is bigger than last year (Sato et al., 2018).

Surface Long-line Research and Hook-and-Line Samplings (Cruise#071)

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

By surface long-line and hook-and-line gear, a total of four chum, 153 pink and one sockeye salmon were collected at 155°E research line during the Cruise #071

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Table 1. Position and research conditions of surface drift gillnet sampling at each station during the *Oshoro maru* Cruise #071, 2019.

Station	Date and Time (S.M.T.*1)				T.D.*2	Set Position		D.S.*3	bottom depth(m)	Wr*4	Wind (force)	S.T.*5 (°C)
	Net set		Net haul			Lat.	Long.					
OSG 1901	May 14	1750-1808	May 15	0452-0603	+10h	43-17.0N	155-04.1 E	330	>5000	o	NNW-5	7.2
OSG 1902	May 15	1821-1838	May 16	0453-0555	+10h	41-45.8N	154-59.9N	300		c	WNW-6	8.4
OSG 1903	May 16	1747-1803	May 17	0455-0555	+10h	40-15.9N	155-00.0N	210		o	North-3	11.9

Table 2. Position and research conditions of surface long-line and hook-and-line sampling at each station during the *Oshoro maru* Cruise #071, 2019.

Station	Date and Time (S.M.T.*1)				T.D.*2	Set Position		D.S.*3	Number of baskets	bottom depth(m)	Wr*4	Wind (force)	S.T.*5 (°C)
	Line set		Line haul			Lat.	Long.						
Cruise #071													
OSSL1901	May 15	0420-0430	May 15	0641-0725	+10h	43-14.2N	155-05.1E	290	10		bc	NW-5	6.7
OSSL1902	May 16	0419-0427	May 16	0625-0710	+10h	41-44.1N	154-57.4E	300	10	5460	f	WNW-4	9.1
OSHL1901	May 13	0600	May 14	0400	+10h	43-59.5N	154-59.7E	-	-	-	o	North-6	3.3
OSHL1902	May 14	1130	May 15	0330	+10h	43-15.2N	155-00.0E	-	-	-	o	NNW-5	7.2
OSHL1903	May 15	2100	May 16	0330	+10h	41-47.8N	154-57.1E	-	-	-	o	WNW-5	8.5
OSHL1904	May 16	1915	May 17	0330	+10h	40-14.5N	155-00.7E	-	-	-	o	North-3	11.8

Table 3. List of oceanographic station during the *Oshoro maru* Cruise #071, 2019.

Station	Date and Time (S.M.T.*1)			T.D.*2	Set Position		Remark CTD	CTD depth(db)
					Lat.	Long.		
Cruise #071								
OS 19023	May 13	1545		+10h	43-59.7N	154-59.1E	Sea-Bird SBE 9	5000
OS 19024	May 14	1200		+10h	43-15.5N	155-00.1E	Sea-Bird SBE 9	5000
OS 19025	May 14	1700		+10h	43-16.3N	155-03.6E	Sea-Bird SBE 9	200
OS 19026	May 15	1210		+10h	42-30.0N	155-00.1E	Sea-Bird SBE 9	1000
OS 19027	May 15	1950		+10h	41-47.6N	154-56.9E	Sea-Bird SBE 9	200
OS 19028	May 15	2110		+10h	41-48.0N	154-57.1E	Sea-Bird SBE 9	3000
OS 19029	May 16	1135		+10h	41-00.0N	155-00.2E	Sea-Bird SBE 9	1000
OS 19030	May 16	1915		+10h	40-14.5N	155-00.7E	Sea-Bird SBE 9	200
OS 19031	May 16	2040		+10h	40-15.0N	155-02.3E	Sea-Bird SBE 9	3000
OS 19032	May 17	1120		+10h	39-30.7N	155-00.4E	Sea-Bird SBE 9	1000
OS 19033	May 17	1815		+10h	38-45.6N	155-00.1E	Sea-Bird SBE 9	3000
OS 19034	May 17	2135		+10h	38-48.0N	155-00.8E	Sea-Bird SBE 9	200

*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, r: rain, d: drizzle).

*5 S.T. : Surface temperature

Table 4. The number of organisms caught by drift gillnet during the *Oshoro maru* Cruise # 071, in May 2019. CPUE and (%) indicate numerical catch per tan and percentage of total catch by C-gear gillnet at the station, respectively.

		Station		OSG 1901				OSG 1902				OSG 1903			
Common name	Scientific name	Gear	C		A	Total	C		A	Total	C		A	Total	
			CPUE	(%)			CPUE	(%)			CPUE	(%)			
Sockeye salmon	<i>Oncorhynchus nerka</i>		0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	
Chum salmon	<i>Oncorhynchus keta</i>		1	0.0 (0.2)	2	3	14	0.5 (4.8)	4	18	0	0.0 (0.0)	0	0	
Pink salmon	<i>Oncorhynchus gorbuscha</i>		431	14.4 (98.6)	3	434	265	8.8 (91.4)	0	265	0	0.0 (0.0)	0	0	
Coho salmon	<i>Oncorhynchus kisutch</i>		0	0.0 (0.0)	0	0	1	0.0 (0.3)	0	1	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	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	
Tufted Puffin	<i>Fratercula cirrhata</i>		1	0.0 (0.2)	0	1	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	
Ancient murrelet	<i>Synthliboramphus antiquus</i>		2	0.1 (0.5)	0	2	0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	
Boreal clubhook squid	<i>Onychoteuthis borealijaponica</i>		2	0.1 (0.5)	0	2	9	0.3 (3.1)	0	9	1	0.0 (1.2)	0	1	
Boreopacific gonate squid	<i>Gonatopsis borealis</i>		0	0.0 (0.0)	0	0	1	0.0 (0.3)	0	1	0	0.0 (0.0)	0	0	
Salmon shark	<i>Lamna ditropis</i>		0	0.0 (0.0)	1	1	0	0.0 (0.0)	1	1	1	0.0 (1.2)	2	3	
Japanese scaled sardine	<i>Sardinops melanostictus</i>		0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	1	0.0 (1.2)	2	3	
Pacific pomfret	<i>Brama japonica</i>		0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	22	0.7 (26.8)	4	26	
Chub mackerel	<i>Scomber japonicus</i>		0	0.0 (0.0)	0	0	0	0.0 (0.0)	0	0	57	1.9 (69.5)	0	57	

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 # 071, 2019.

Station Name	Sampling gear	Species name						Total
		Sockeye	Chum	Pink	Coho	Chinook	Steelhead	
Cruise #071								
OSSL 1901	Surface longline	0	0	7	0	0	0	7
OSSL 1902	Surface longline	0	1	18	0	0	0	19
OSHL 1901	Hook-and-line	1	1	18	0	0	0	20
OSHL 1902	Hook-and-line	0	0	80	0	0	0	80
OSHL 1903	Hook-and-line	0	2	30	0	0	0	32
OSHL 1904	Hook-and-line	0	0	0	0	0	0	0
Total		1	4	153	0	0	0	158

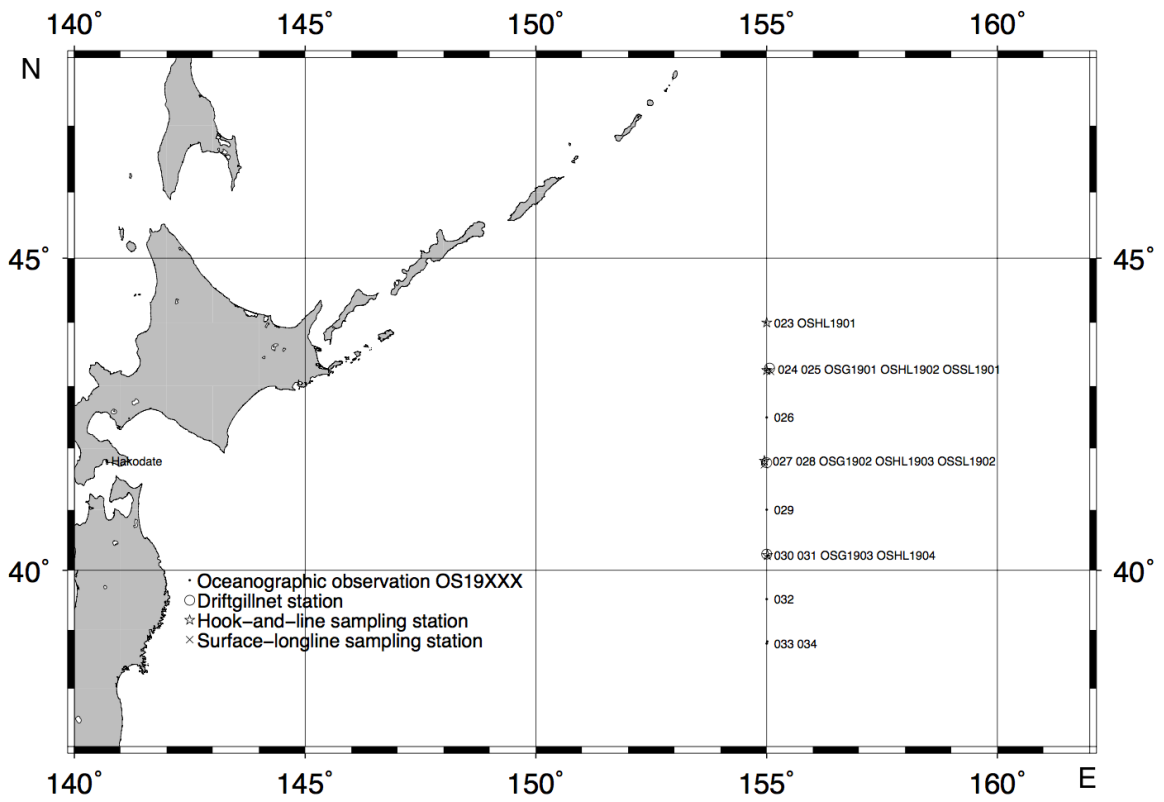


Fig. 1. Salmon research stations during the Oshoro maru Cruise # 071

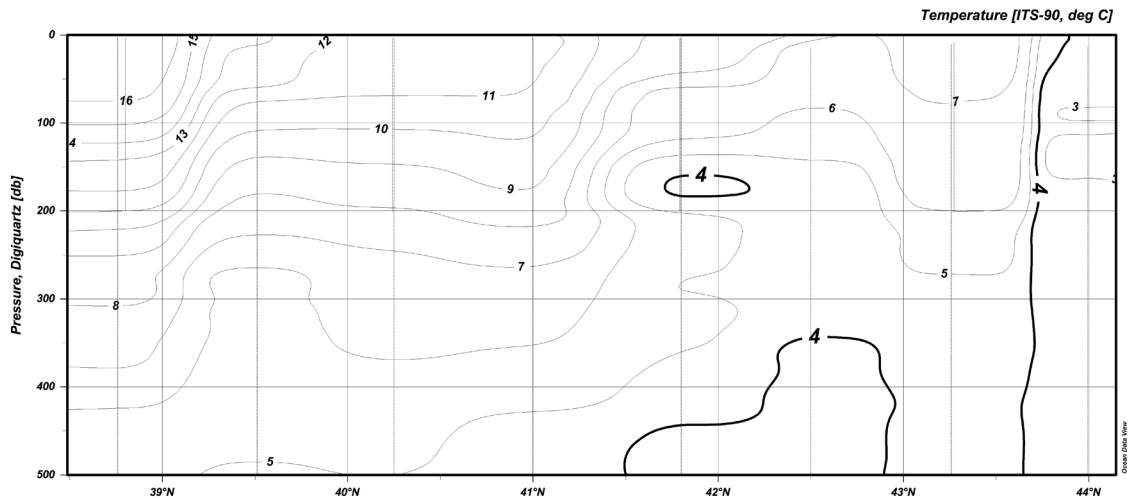


Fig. 2.1. Cross section of temperature from surface to 500 db pressure along the 155°E during the *Oshoro maru* Cruise #071 in May, 2019. (Drawn by Ocean Data View ver.4.7.10)

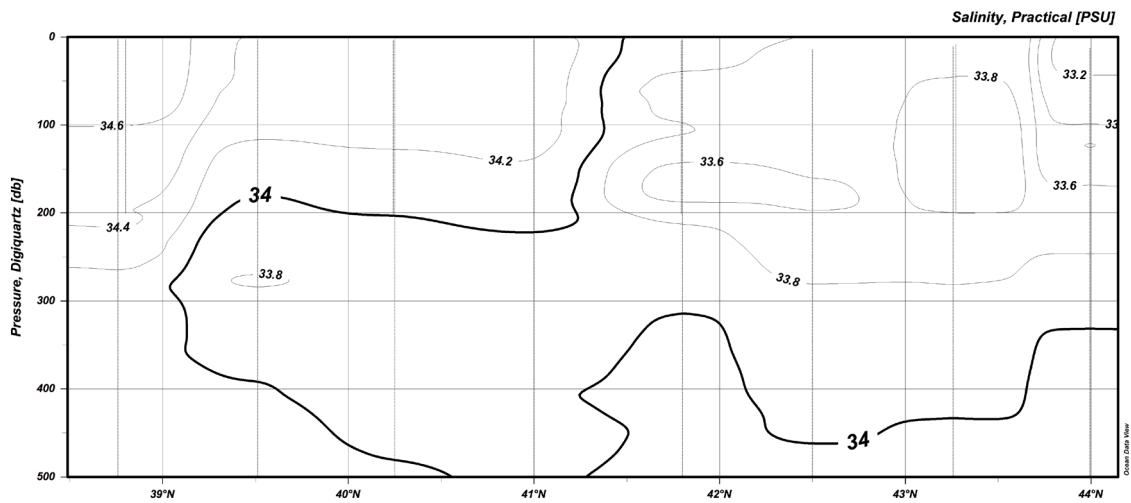


Fig. 2.2. Cross section of salinity from surface to 500 db pressure along the 155°E during the *Oshoro maru* Cruise #071 in May, 2019. (Drawn by Ocean Data View ver.4.7.10)

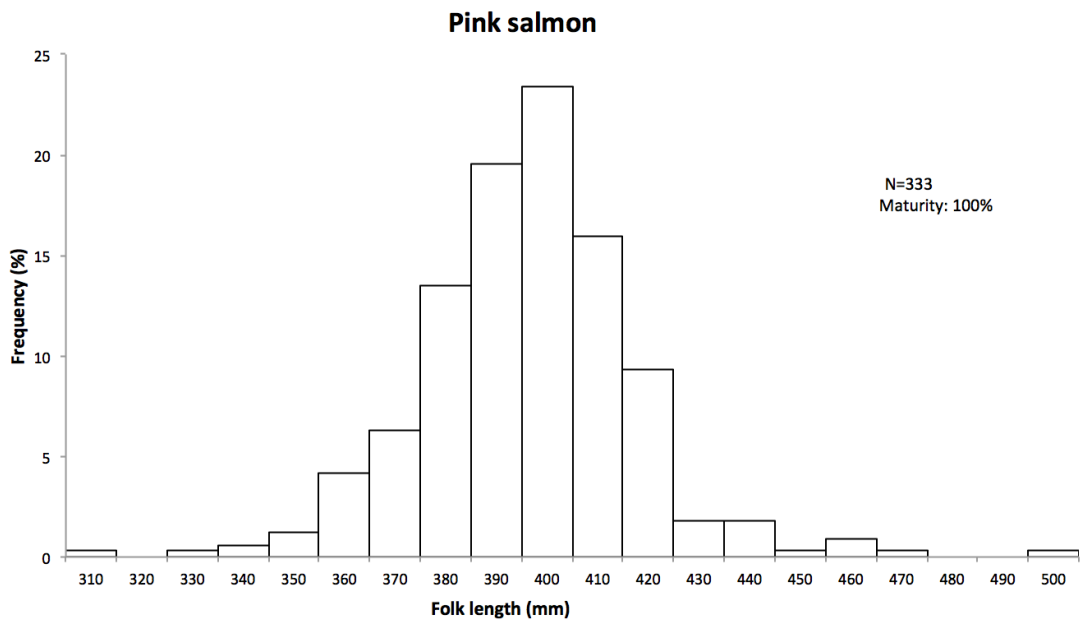


Fig. 3. Fork length frequency of pink salmon caught by C-gear gillnet along the 155°E during the *Oshoro maru* Cruise #071 in May, 2019.