

NPAFC

Doc. 1044

Rev. _____

Rev. Date: _____

The 2007 Summer Japanese Salmon Research Cruise of the R/V *Hokko maru*

by

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Submitted to the

NORTH PACIFIC ANADROMOUS FISH COMMISSION

by

Japan

October 2007

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Morita, K., S. Sato, M. Kagaya, Y. Katayama, Y. Goda, T. Chiba, and K. Makino. 2007. The 2007 summer Japanese salmon research cruise of the R/V Hokko maru. NPAFC Doc. 1044. 8 pp. (Available at <http://www.npafc.org>)

The 2007 Summer Japanese Salmon Research Cruise of the R/V *Hokko maru*

Abstract: A summer high-seas research cruise to investigate biology of Pacific salmon was conducted in the Bering Sea from 25 June to 17 July (first leg) and from 20 July to 9 August (second leg) onboard the Japanese research vessel *Hokko maru*. Research cruise activities included the collection of data on oceanography, zooplankton, micronekton, salmonid fishes, and other organisms. A total of 8,041 salmonids were caught by trawl and angling: 3,415 fishes in the first leg and 4,626 fishes in the second leg. In the first leg, chum salmon was the most abundant species (82.8%), followed by pink (11.3%), chinook (3.2%), and sockeye salmon (2.9%). In the second leg, chum salmon was the most abundant species (84.1%), followed by sockeye (12.4%), chinook (3.1%), pink (0.3%), and coho salmon (0.02%). Salmonids were measured for fork length, body and gonad weight, lipid content by fat meter, sexed, and removed scales for age determination. Isotope, genetic, otolith, stomach contents, lipid samples were obtained for future studies.

Introduction

Japanese research vessels have monitored the stock condition of Pacific salmon (*Oncorhynchus* spp.) since 1952 (Ishida and Ogura, 1992). Several interesting findings have found from analyses of data collected during these surveys (e.g., Ishida *et al.*, 1993; Ogura and Ito, 1994; Shiimoto *et al.*, 1997; Welch *et al.*, 1998; Ishida *et al.*, 2002). The new R/V *Hokko maru* was launched in 2004 and it was her first salmon research cruise in the North Pacific. The main objective of this research program is to explore the biology of salmonids in the offshore areas. Routine observations have included the collection of data on physical oceanography, primary production, and the trophic interactions among zooplankton, salmonids, and organisms at higher trophic levels, and analysis of the genetic structure of salmon populations in the ocean. In addition, the transfer experiment from saltwater to freshwater was conducted to examine the endocrinological changes in chum salmon. This document summarizes the research cruise conducted by the R/V *Hokko maru* in the Bering Sea during summer 2007.

Survey Area

The R/V *Hokko maru* departed from Kushiro, Japan, on 25 June 2007 and visited Dutch Harbor, Alaska, on 17 July 2007 (first leg); the *Hokko maru* departed Dutch Harbor 20 July 2007 and returned to Kushiro on 9 August 2007 (second leg). A total of 54 trawling were conducted at 37 stations during the cruise (Fig. 1 and Table 1). Thirty-two trawling were conducted during the first leg, and 22 trawling were conducted during the second leg. All fishing stations were located in the Bering Sea.

Temperature and Salinity Sampling

A salinity, temperature, and depth sensor (STD) was used at final fishing station of leg 1 and each fishing station of leg 2. The STD recorded data at 1-m intervals from the surface to a maximum of approximately 500 m.

Zooplankton and Micronekton Sampling

Macro-zooplankton were sampled with a remodeled NORPAC net (0.45 m ring diameter, 1.93 m net length, 0.33 mm mesh size) at each fishing station of leg 2. The NORPAC net was towed vertically from 150 m to the surface. A calibrated flow meter was attached to the opening of these nets in a position slightly off-center. The NORPAC net samples were fixed in 10% borax-buffered formalin.

Large macro-zooplankton were collected at 9 fishing stations using an BONGO net (2 rings, 0.7 m diameter, 4.1 m in overall length, 0.335 mm mesh size). The net was towed obliquely along the stern of the vessel from 100 m to the surface at a speed of approximately 1.5 knots around 21:00 hrs. Samples were fixed in 10% borax-buffered formalin in seawater.

Transfer Experiment from SW to FW

A transfer experiment from saltwater to freshwater was conducted during this cruise. A total of 177 Pacific salmon were angled, and 32 chum salmon caught in healthy condition were used for the transfer experiment. These chum salmon were placed in a 1,000 L tank and were transferred from saltwater to freshwater. Gill, blood, gonad and stomach samples were collected to examine the endocrinological changes during the experiment.

Fish Collection

A surface trawl was used for experimental fishing operations to collect salmonids and other pelagic fish at each fishing station (Fig. 1, Table 1). The trawl was towed at the speed of 5 knots at the surface layer from the surface to approximately 30 m depth for one hour in daytime. In the first leg, the trawl was also towed at the speed of 5 knots at the mid-water layer from approximately 10-30 m depth to 40-60 m depth for one hour in daytime. The height and the width of the mouth of trawl was c.a. 30 and 40 m, respectively, the length was 152 m, and the cod end of the net was lined with a net of mesh size 17.5 mm. In addition, hooks and lines were used to collect live fish for the transfer experiment from saltwater to freshwater.

A total of 8,041 salmonids (8,245 kg) was caught by trawl and angling: 3,415 fishes in the first leg and 4,626 fishes in the second leg (Table 1). In the first leg, chum salmon (*Oncorhynchus keta*) was the most abundant species (82.8%), followed by pink (*O. gorbuscha*; 11.3%), chinook (*O. tshawytscha*; 3.2%), and sockeye salmon (*O. nerka*; 2.9%). In the second leg, chum salmon was the most abundant species (84.1%), followed by sockeye (12.4%), chinook (3.1%), pink (0.3%), and coho salmon (0.02%).

Two strange salmon having abnormally large scales were caught (Fig. 2). These two fish were counted as chum salmon, but may be hybrid species.

In addition, 15,459 non-salmonid fishes (115.6 kg), many squids (57.2 kg), and jellyfish (394.3 kg) were caught with the trawl (Table 1). Walleye pollock (*Theragra chalcogramma*; $n = 9,658$, 7.4 kg) and Atka mackerel (*Pleurogrammus monopterygius*; $n = 5,530$, 44.2 kg), and smooth lump sucker (*Aptocyclus ventricosus*; $n = 99$, 60.3 kg) were particularly abundant in the catch. Most walleye pollock and Atka mackerel were small juveniles.

Fish Measurement

Salmonids were processed soon after removal from the fishing gear. The catch was sorted by species and counted. Biological data were recorded from a maximum of 120 individuals per species caught in each trawl. Biological data included fork length (mm), body weight (10 g), sex, gonad weight (0.1 g) and lipid content. The presence of visceral adhesions was also recorded. Body and gonad weight were measured using the Marine scale (POLS, Iceland). Lipid contents were measured by the Distell fatmeter (Distell, Scotland). Samples of one scale (pink salmon), two scales (sockeye, chum, coho, and chinook salmon) were collected for age determination and back calculation of growth. When possible, scales were collected from the preferred body area identified by the International North Pacific Fisheries Commission for scale sampling (INPFC; Davis *et al.*, 1990).

Samples of salmon body from each species were collected for analyses of stable isotope analysis. Samples of chum and pink salmon body were collected for analyses of lipid content. The isotope and lipid samples were frozen and carried to Hokkaido National Fisheries Research Institute (HNFRI) and National Salmon Resources Center (NASREC), respectively, for a further examination in a laboratory. A part of pectoral fin of chum and chinook salmon and otoliths of chum salmon were collected for genetic stock identification and for detection of thermal marks on the otolith. Fixed fin samples in ethanol and dried otoliths were sent to NASREC. Stomach samples were collected from all species of salmon. A maximum 20 stomachs for each species at each trawl was fixed in 10% borax-buffered formalin for further examination in a laboratory and carried to HNFRI.

Acknowledgements

We thank Captain Sadaaki Danno, officers, and crew of the R/V *Hokko maru* for their cooperation in the research and collection of samples during the cruise. This work was supported by the Promotion Program for International Resources Surveys of the Fisheries Agency of Japan.

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Table 1. Catches of sockeye salmon (SO), chum salmon (CH), pink salmon (PK), coho salmon (CO), chinook salmon (CN), Atka mackerel (AM), walleye pollock (WP), smooth lump sucker (SL), and other fishes (OF) along with the sea surface temperature (SST, °C) at each station during the R/V *Hokko maru* cruise in 2007 summer. J-gear, surface trawl (depth 0 m to ca. 30 m); J*-gear, mid-water trawl (depth ca. 10–30 m to 40–60 m); O-gear, hook and line.

St.	Date	Location		SST	Gear	Pacific salmon						AM	WP	SL	OF	
						SO	CH	PK	CO	CN	Total					
H00-1	6/30	54.7°N	177.2°	E	6.9	J*	0	3	5	0	0	8	0	0	0	0
H00-2	6/30	54.8°N	177.5°	E	7	J*	0	12	13	0	0	25	0	0	0	0
W18S	7/1	55.5°N	180.0°		6.2	J	2	50	21	0	0	73	20	0	0	0
W18M	7/1	55.5°N	180.0°		6.5	J*	2	40	18	0	0	60	0	0	4	1
W19M	7/2	56.5°N	180.0°		6.4	J*	0	8	0	0	0	8	0	0	2	0
W19S	7/2	56.5°N	180.0°		6.7	J	3	101	47	0	3	154	0	0	0	0
W20S	7/3	57.5°N	180.0°		6.6	J	3	36	37	0	1	77	0	0	5	0
W20M	7/3	57.4°N	180.0°		6.7	J*	2	35	22	0	3	62	0	0	13	0
W21M	7/4	58.4°N	179.9°	W	6.8	J*	0	21	0	0	0	21	0	0	5	0
W21S	7/4	58.4°N	179.9°	W	6.7	J	9	82	40	0	19	150	0	0	0	0
W22S	7/5	57.5°N	179.0°	W	6.7	J	12	212	31	0	4	259	0	0	1	0
W22M	7/5	57.5°N	179.0°	W	6.8	J*	0	4	0	0	0	4	0	0	4	0
W23M	7/6	57.5°N	178.0°	W	7	J*	0	107	3	0	4	114	0	0	0	0
W23S	7/6	57.6°N	178.1°	W	7.4	J	3	159	34	0	4	200	0	0	0	0
W24S	7/7	56.5°N	178.1°	W	6.8	J	4	96	11	0	7	118	89	0	0	0
W24M	7/7	56.5°N	177.9°	W	7.1	J*	0	32	0	0	5	37	1000	0	1	0
W25S	7/8	56.5°N	178.9°	W	6.9	J	1	134	9	0	5	149	55	0	3	1
W25M	7/8	56.5°N	179.0°	W	7.3	J*	0	3	0	0	0	3	0	0	3	0
W26M	7/9	56.4°N	179.0°	E	6.9	J*	0	2	1	0	0	3	0	0	2	0
W26S	7/9	56.5°N	178.9°	E	7	J	9	341	9	0	3	362	6	0	0	1
W27S	7/10	56.5°N	178.1°	E	7.3	J	9	328	11	0	2	350	0	0	0	0
W27M	7/10	56.5°N	178.0°	E	7.4	J*	0	8	2	0	0	10	0	0	5	0
W28M	7/11	56.5°N	177.1°	E	7.9	J*	0	1	0	0	1	2	0	0	12	0
W28S	7/11	56.5°N	177.9°	E	7.9	J	5	84	5	0	4	98	0	0	4	0
W29S	7/12	57.6°N	176.9°	E	7.4	J	9	262	7	0	4	282	0	0	5	0
W29M	7/12	57.5°N	177.0°	E	7.5	J*	0	0	0	0	0	0	0	0	8	0
W30M	7/13	57.5°N	176.1°	E	7.3	J*	0	1	0	0	0	1	0	0	14	0
W30S	7/13	57.5°N	176.1°	E	7.4	J	6	76	6	0	3	91	+	0	1	0
W31S	7/14	56.4°N	176.1°	E	8	J	6	151	11	0	16	184	0	0	3	0
W31M	7/14	56.4°N	176.1°	E	8.3	J*	0	18	0	0	0	18	0	0	2	0

—Table 1. continued—

St.	Date	Location		SST	Gear	Pacific salmon						AM	WP	SL	OF	
						SO	CH	PK	CO	CN	Total					
W21S-2	7/15	58.5°N	180.0°	8.2	J	3	190	5	0	4	202	6	0	1	0	
W21S-3	7/15	58.5°N	180.0°	8.4	J	0	146	1	0	3	150	4	0	1	1	
1 st leg	7/1–7/15	Bering Sea				O	7	86	35	0	13	141	0	0	0	0
H03	7/22	53.3°N	177.7°	W	6.3	J	17	65	4	0	86	0	0	0	0	
H04	7/22	54.1°N	170.4°	W	8.2	J	21	100	2	1	2	126	0	0	0	6
H05	7/23	55.1°N	170.4°	W	9	J	183	321	1	0	3	508	0	0	0	0
H06	7/23	56.1°N	170.2°	W	8.4	J	32	361	3	0	0	396	0	0	0	0
H07	7/24	58.1°N	174.9°	W	9.6	J	0	87	0	0	0	87	0	8500	0	0
H08	7/25	57.0°N	174.8°	W	8.4	J	125	872	2	0	1	1000	0	0	0	0
H09	7/25	56.1°N	175.2°	W	9.3	J	25	128	1	0	3	157	0	791	0	3
H10	7/26	54.1°N	175.2°	W	9.3	J	12	127	0	0	6	145	0	13	0	7
H11	7/26	53.9°N	174.9°	W	9.3	J	12	40	2	0	70	124	0	7	0	7
H12	7/27	53.1°N	175.2°	W	9.3	J	6	42	0	0	25	73	0	0	0	7
H15	7/28	52.6°N	179.9°	E	7	J	0	59	0	0	1	60	18	0	0	19
H16	7/28	53.6°N	179.9°	E	9.4	J	6	49	0	0	4	59	1	0	0	24
H17	7/29	54.6°N	180.0°	E	9.6	J	5	117	0	0	5	127	258	95	0	14
H18	7/29	55.6°N	179.9°	E	9.6	J	9	30	0	0	2	41	2908	0	0	4
H19	7/30	56.6°N	180.0°	E	9.3	J	7	151	0	0	10	168	112	0	0	4
H20	7/30	57.4°N	179.9°	W	9.7	J	22	145	0	0	3	170	299	0	0	0
H21	7/31	58.4°N	180.0°		9.9	J	47	247	0	0	3	297	0	+	0	4
H26.	7/31	59.4°N	178.9°	W	9.8	J	31	347	1	0	3	382	0	0	0	+
H22	8/1	55.9°N	175.1°	E	10.6	J	6	320	0	0	1	327	235	0	0	11
H23	8/2	55.1°N	174.9°	E	10.5	J	1	64	0	0	0	65	516	252	0	31
H24	8/2	54.2°N	175.0°	E	10.4	J	1	76	0	0	0	77	3	0	0	23
H25	8/3	53.1°N	174.9°	E	9.8	J	3	102	0	0	2	107	0	0	0	4
2 nd leg	7/22–8/3	Bering Sea				O	4	40	0	0	0	0	0	0	0	0
Total							670	6718	400	1	252	8041	5530	9658	99	172

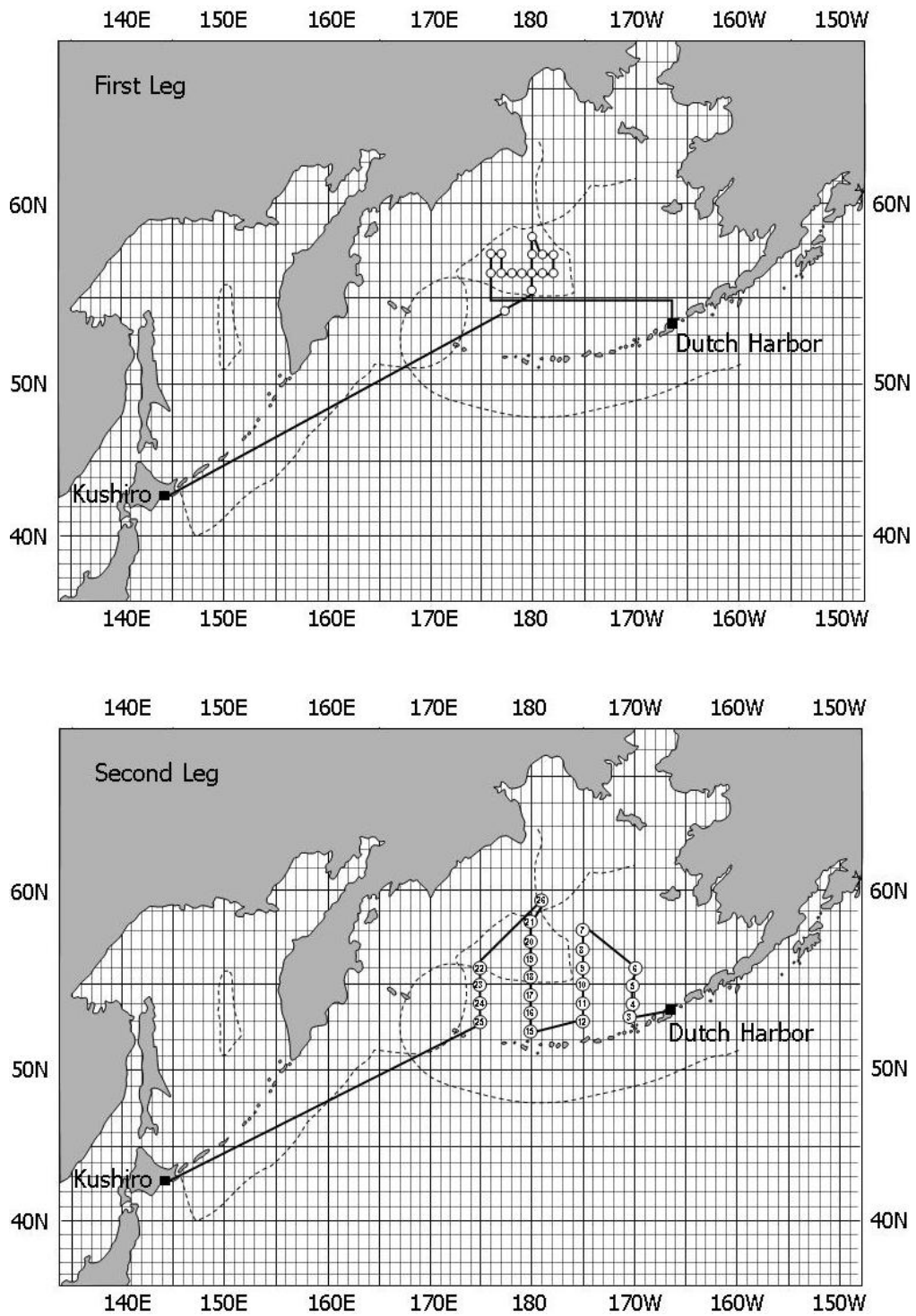


Fig. 1. The survey area of the R/V *Hokko maru* cruise during summer 2007. Upper panel: first leg, lower panel: second leg.



Fig. 2. A strange salmon having abnormally large scales caught in the Bering Sea (fork length = 314 mm).