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Results of 2000 Salmon Research Cruise of the *Shoyo maru*

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Abstract

The salmon research cruise of the R/V *Shoyo maru* of the Fisheries Agency of Japan was conducted along 165° E from 50° to 43° N in June 13 - July 26, 2000, for stock assessment and carrying capacity estimation in the western North Pacific. The survey included oceanographic observation, sampling of zooplankton, fishing of salmon and other fishes using drift gillnet. Number of salmon caught by 8 sets of drift net was 1,904. It includes 1,265 pink, 298 sockeye, 296 chum, 42 coho, 2 steelhead, and 1 chinook. CPUEs of coho, chum, and pink salmon in 2000 was lower than in the past 8 years. Fish sizes of sockeye, chum, and coho salmon were larger than in past 8 surveys by R/V *Hokko maru*. Samples and data will be analyzed in the Hokkaido National Fisheries Research Institute, National Salmon Resources Center, National Fisheries Research Institute for Far Sea Fisheries, and Hokkaido Tokai University.

Introduction

The R/V *Hokko maru* of the Hokkaido National Fisheries Research Institute (HNFRI) continued the salmon research cruise in summer in the western North Pacific from 1992 to 1999 (Ishida et al. 1999, Kawasaki et al. 1999). In 2000, the *Shoyo maru* of the Fisheries Agency of Japan surveyed in that region instead of the *Hokko maru*. The *Shoyo maru*, *Wakatake maru*, *Oshoro maru*, and *Hokusei maru* researched to assess conditions of Pacific salmon stocks and ocean distribution of Japanese chum salmon stocks in summer in the North Pacific. All of these surveys by Japanese salmon research vessels include fishing of salmon using non-selective research gillnets, oceanographic observation, and zooplankton sampling. Another major objective of the *Shoyo maru* survey is to estimate carrying capacity of salmon in the western North Pacific.

Methods

1. Period and area of the *Shoyo maru* salmon survey

The *Shoyo maru* surveyed in June 13 – June 26, 2000, in the western North Pacific. Eight stations were set at 1°-latitude intervals along 165° E from 50° N to 43° N (Fig. 1).

2. Oceanographic observation

At 8 stations, sea surface temperature and transparency were measured using a mercury thermometer and a Secchi disk. Salinity, water temperature, and concentration of dissolved oxygen from 0 to 1500 m were measured using a CTD probe. Surface water was

sampled to measure salinity using AUTOSAL. At the midpoints between survey stations, salinity, and temperature from 0 to 1000 m were measured by an XCTD probe.

3. Zooplankton samplings

At 8 stations, zooplankton was sampled in nighttime by vertical towing of a remodeled NORPAC net from 150 m depth to the surface and by horizontal towing (10 min at 2 knot) of an ORI net (0.69 mm mesh) under the sea surface. An ORI net was towed obliquely to sample large zooplankton from 200 m depth to the surface and from 50 m to the surface. Sampled zooplankton will be examined in the laboratory.

4. Fishing of salmon and other fishes

At 8 stations, drift gillnet was used to catch salmon and other fishes. The net was consisted of 30 tan of non-selective research gillnet (48, 55, 72, 82, 93, 106, 121, 138, and 157 mm mesh size; 3 tans of each mesh size; 1 tan is 50 m long) and 19 tans of commercial gillnet (115 mm mesh size). The net was set at 16:00 and retrieved at 04:00 in Japan Standard Time.

Number of organisms caught by drift gillnet was counted by species and by mesh sizes. Catch per unit effort (CPUE) was calculated as number of fish caught by 30 tans of research gillnets. Fork length, body weight, and gonad weight of maximum 60 fish by salmon species were measured. Scales were collected from the INPFC preferred area. Fork or total, length of maximum 30 non-salmonids was measured.

5. Sampling of tissues or whole salmon

To study food habit of salmon, 495 stomachs from salmon caught by research gillnet were fixed and preserved in 10% buffered formalin. Stomach contents will be examined in the HNFRI and the Hokkaido Tokai University. Twenty pink and chum salmon were frozen to measure carbon and nitrogen stable isotope concentrations in the HNFRI.

To study food habit of seabirds in the Hokkaido University, 14 shearwaters, 1 tufted puffin, and 1 horned puffin were frozen.

Results and Discussion

1. Oceanographic environment

A thermocline was observed at about 50 m depth in the vertical section along 165°E (Fig. 2). At northern stations from 47°N to 50°N, the dichothermal structure, the minimum water temperature near 100 m depth under the thermocline, was observed.

Low salinity water (< 33.0 psu) was distributed near the surface at 47-49°N. A halocline was near 150 m depth at stations on 47°N-50°N. The depth of halocline was consistent with the depth of lower layer of the minimum temperature water.

Sea surface temperature was lower than that in surveys in the past 8 years, especially in 47-49°N. That might be due to the earlier research period than in the past.

2. Fishing of salmonids and other fishes

1) Summary of fishing operations

Number of organisms caught by 8 sets of drift gillnets is 1,947, including 1,904 salmonids (98% of total organisms) (Table 1). That includes 1,265 (65%) pink, 298 (15.3%) sockeye, 296 (15.2%) chum, 42 (2.2%) coho, 1 chinook salmon, and 2 steelhead trout. No fin-clipped salmonids were caught.

Non-salmonid organisms including 2 salmon shark (*Lamna ditropis*), 1 spiny dogfish (*Squalus acanthias*), 1 smalleye squaretail (*Tetragonurus cuvieri*), 1 Atka mackerel (*Pleurogrammus monoptyerygius*), 25 shearwaters (Procellariidae), 1 horned puffin (*Fratercula corniculata*), 1 tufted puffin (*Lunda cirrhata*), 6 boreopacific gonate squid (*Gonatopsis borealis*), and 5 boreal clubhook squid (*Onychoteuthis borealijaponica*), were caught incidentally. Frying squid, Pacific pomfret, blue shark, Pacific saury, that have commonly caught in the past surveys, were not found (Ishida et al. 1999).

2) Abundance of salmon

CPUEs of salmonids, especially coho, chum, and pink salmon, were less than the past 8 surveys (Table 1). Chum CPUE (14 fish) was about a half of mean CPUE in 1992-1999. Pink CPUE (85 fish) was the least in even-years in 1992-2000. Although these results might be due to earlier survey period and lower SST than in past 8 years, the abundance of salmonids in 2000 might decrease from the last year in the western North Pacific.

2) Body size of salmon

Mean body sizes of sockeye, chum, and coho salmon in 2000 were near or larger than in the past surveys (Table 3). Mean body size of pink salmon in 2000 was smaller than in other years.

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Table 1. Numbers of salmon and other organisms caught during the *Shoyo maru* salmon research cruise in 2000. C: research gillnet (30 tans; 48-157 mm), A: commercial gillnet (19 tans; 115 mm).

| St | Date | Lat. | Long. | SST | Gear | Tan | Sockeye | Chum | Pink | Coho | Chinook | Steel-head | Gonate sq. | Club-hook sq. | Salmon shark | Spiny dogfish | Other fishes | Shearwaters | Other birds |
|-------|--------|------|---------|-----|------|-----|---------|------|-------|------|---------|------------|------------|---------------|--------------|---------------|--------------|-------------|-------------|
| 2 | Jun 15 | 5000 | 16500 E | 5.0 | C | 30 | 41 | 40 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| | | | | | A | 19 | 48 | 83 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Jun 16 | 4900 | 16500 E | 4.5 | C | 30 | 58 | 15 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 |
| | | | | | A | 19 | 115 | 41 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 4 | Jun 17 | 4800 | 16500 E | 4.4 | C | 30 | 16 | 11 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| | | | | | A | 19 | 14 | 34 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 5 | Jun 18 | 4700 | 16500 E | 5.1 | C | 30 | 3 | 13 | 108 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| | | | | | A | 19 | 3 | 17 | 176 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 6 | Jun 19 | 4600 | 16500 E | 7.4 | C | 30 | 0 | 4 | 165 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | A | 19 | 0 | 1 | 121 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Jun 20 | 4500 | 16500 E | 8.1 | C | 30 | 0 | 11 | 145 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | | | | | A | 19 | 0 | 1 | 104 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Jun 21 | 4400 | 16500 E | 7.9 | C | 30 | 0 | 8 | 180 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| | | | | | A | 19 | 0 | 2 | 114 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 9 | Jun 22 | 4300 | 16500 E | 9.8 | C | 30 | 0 | 8 | 62 | 13 | 0 | 0 | 5 | 4 | 1 | 0 | 0 | 0 | 0 |
| | | | | | A | 19 | 0 | 7 | 24 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | | | | C | 240 | 118 | 110 | 682 | 20 | 1 | 0 | 6 | 5 | 1 | 0 | 2 | 13 | 0 |
| | | | | | A | 152 | 180 | 186 | 583 | 22 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 12 | 2 |
| Total | | | | | | 392 | 298 | 296 | 1,265 | 42 | 1 | 2 | 6 | 5 | 2 | 1 | 2 | 25 | 2 |

Table 2. Number of salmon per 30 tans of research gillnets at 43-50°N, 165°E in the western North Pacific.

| Year | Sockeye | Chum | Pink | Coho | Chinook | Steelhead | Total |
|-------|---------|------|------|------|---------|-----------|-------|
| 1992 | 27 | 22 | 102 | 19 | 1.5 | 0.5 | 180.0 |
| 1993 | 11 | 45 | 16 | 10 | 1.3 | 0.3 | 92.2 |
| 1994 | 12 | 11 | 311 | 12 | 0 | 0.4 | 355.7 |
| 1995 | 11 | 23 | 61 | 16 | 0.5 | 0.1 | 120.5 |
| 1996 | 16 | 21 | 167 | 8 | 0.1 | 0.6 | 222.5 |
| 1997 | 2 | 20 | 102 | 11 | 1.1 | 1.4 | 145.1 |
| 1998 | 21 | 31 | 157 | 17 | 0.4 | 1.1 | 234.3 |
| 1999 | 10 | 12 | 109 | 20 | 0.3 | 0 | 158.9 |
| 92-99 | 14 | 23 | 128 | 14 | 0.7 | 0.6 | 188.8 |
| 2000 | 15 | 14 | 85 | 3 | 0.1 | 0 | 122.9 |

Table 3. Mean fork length (FL; mm) and body weight (BW; g) of salmon caught by research gillnets in salmon research cruises along 165°E in the western North Pacific. Standard deviations are in parentheses. N: number of measured fish.

| Year | Sockeye | | | Chum | | | Pink | | | Coho | | | Chinook | | | Steelhead | | |
|------|----------|------------|-----|----------|------------|-----|----------|------------|------|----------|------------|-----|----------|-------------|----|-----------|-------------|----|
| | FL | BW | N | FL | BW | N | FL | BW | N | FL | BW | N | FL | BW | N | FL | BW | N |
| 1992 | 493 (79) | 1662 (822) | 214 | 438 (56) | 1015 (443) | 190 | 457 (28) | 1066 (507) | 638 | 544 (37) | 1973 (451) | 153 | 619 (30) | 3025 (509) | 12 | 669 (83) | 3108 (886) | 4 |
| 1993 | 484 (64) | 1476 (694) | 102 | 516 (89) | 1961 (990) | 451 | 479 (33) | 1408 (379) | 128 | 561 (40) | 2359 (559) | 104 | 631 (28) | 3296 (453) | 13 | 694 (14) | 3250 (227) | 3 |
| 1994 | 520 (74) | 1956 (884) | 174 | 508 (78) | 1719 (747) | 132 | 451 (25) | 1133 (218) | 1379 | 541 (34) | 1920 (406) | 102 | – | – | 0 | 700 (81) | 3520 (953) | 5 |
| 1995 | 497 (73) | 1686 (771) | 206 | 480 (96) | 1547 (890) | 244 | 484 (32) | 1464 (285) | 557 | 558 (36) | 2360 (457) | 127 | 652 (88) | 3834 (1651) | 5 | 744 | 4750 | 1 |
| 1996 | 525 (64) | 1984 (914) | 366 | 485 (96) | 1574 (870) | 263 | 471 (28) | 1351 (292) | 1315 | 554 (67) | 2109 (496) | 79 | 640 | 3400 | 1 | 610 (95) | 2250 (794) | 5 |
| 1997 | 441 (55) | 1103 (520) | 28 | 423 (91) | 1079 (881) | 184 | 446 (29) | 1160 (232) | 937 | 532 (43) | 1918 (518) | 93 | 614 (39) | 2889 (447) | 10 | 621 (114) | 2623 (1353) | 12 |
| 1998 | 497 (73) | 1716 (830) | 288 | 468 (84) | 1302 (849) | 429 | 439 (23) | 986 (191) | 1120 | 527 (33) | 1792 (366) | 134 | 649 (79) | 3863 (1797) | 4 | 674 (118) | 3519 (2086) | 10 |
| 1999 | 503 (59) | 1761 (727) | 79 | 487 (81) | 1574 (868) | 86 | 446 (26) | 1166 (235) | 793 | 549 (34) | 2108 (411) | 154 | 630 (20) | 3550 (450) | 2 | – | – | 0 |
| 2000 | 534 (44) | 2095 (501) | 118 | 512 (71) | 1716 (760) | 109 | 442 (24) | 976 (191) | 636 | 567 (45) | 2339 (576) | 20 | 764 | 7000 | 1 | – | – | |

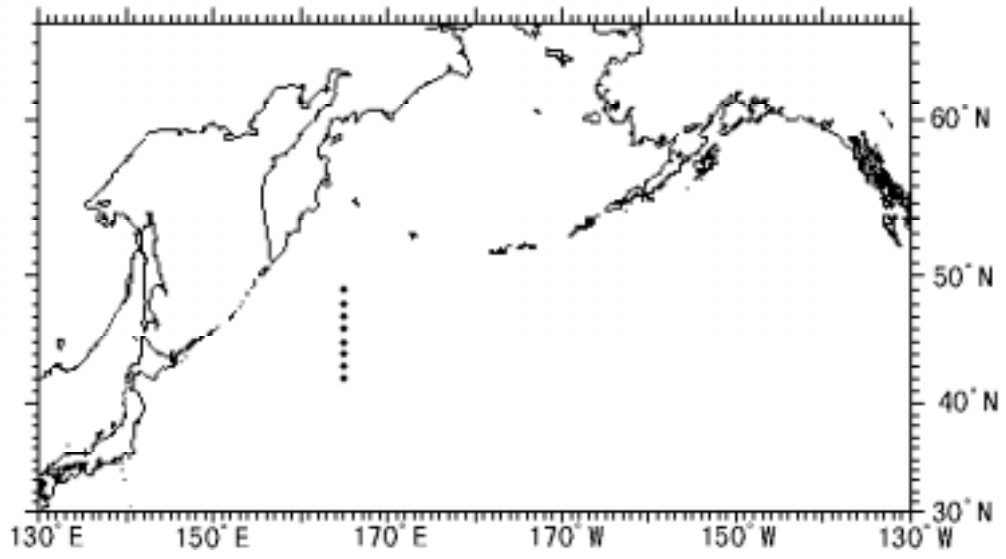


Fig. 1. Map of sampling stations for the 2000 salmon research cruise of the *Shoyo maru* in the western North Pacific.

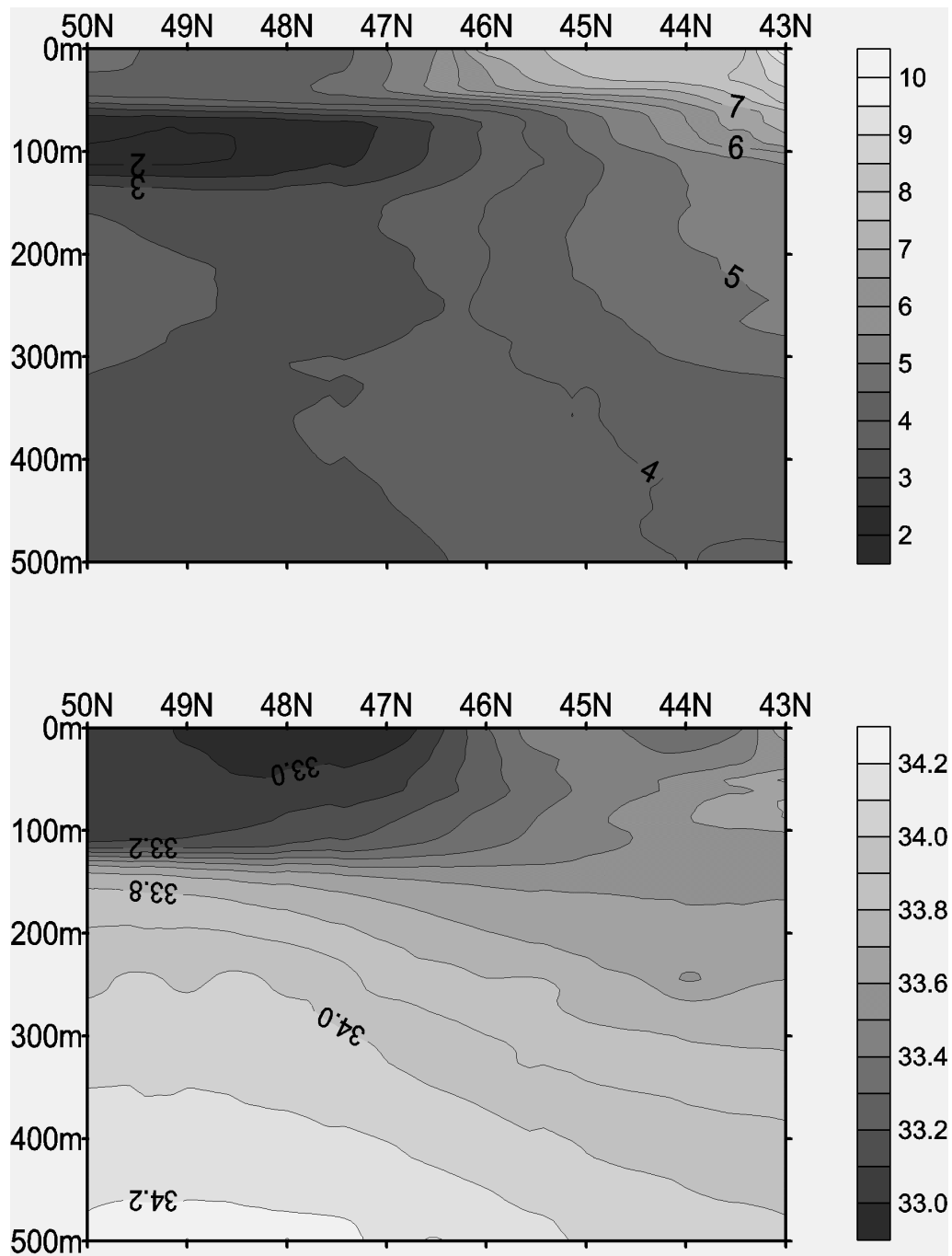


Fig. 2. Vertical profiles of water temperature (upper; °C) and salinity (lower; psu) along 165°E in the western North Pacific.

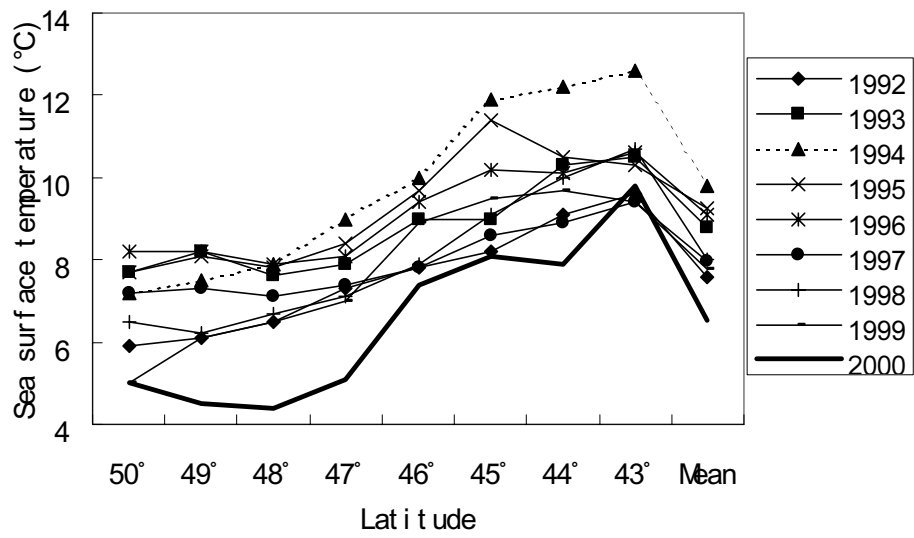


Fig. 3. Sea surface temperature observed in salmon research cruises along 165°E in the western North Pacific in June-July 1992-2000.