

**Ocean Condition and Pacific Salmon Stock Assessment
in the North Pacific Ocean, 2000**

by

Masa-aki Fukuwaka and Yukimasa Ishida

Hokkaido National Fisheries Research Institute, Fisheries Agency of Japan

Submitted to the

NORTH PACIFIC ANADROMOUS FISH COMMISSION

by

JAPAN

November 2000

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Fukuwaka, M, and Y. Ishida. 2000. Ocean condition and Pacific salmon stock assessment in the North Pacific Ocean, 2000. (NPAFC Doc. 481). Hokkaido National Fisheries Research Institute, Fisheries Agency of Japan, 116 Katsurakoi, Kushiro 085-0802, Japan. 9 p.

Ocean Condition and Pacific Salmon Stock Assessment in the North Pacific Ocean, 2000

Masa-aki Fukuwaka, and Yukimasa Ishida,

Hokkaido National Fisheries Research Institute, Fisheries Agency of Japan

ABSTRACT

We summarize results of researches on salmon stock assessment conducted by Japan in summer of 2000. Four Japanese salmon research vessels (*Oshoro maru*, *Hokusei maru*, *Shoyo maru*, and *Wakatake maru*) conducted oceanographic observations, 56 gillnet (2,717 tans), 40 longline (959 hachi), 3 hook-and-line fishing operations in the western, the central, the eastern North Pacific, and the Bering Sea from June to August. Mean sea surface temperature, abundance and body size of Pacific salmon in 2000 are compared to those from 1992 to 1999. Mean sea surface temperature in 2000 was 12.6°C in the western North Pacific, 8.49°C in the central North Pacific, 7.69°C in the Bering Sea, 9.89°C in the eastern North Pacific. A total of 12,231 salmonids was caught, including 6,758 chum (55.3%), 2,851 pink (23.3%), 1,544 sockeye (12.6%), 612 coho (5.0%), 315 chinook salmon (2.6%), and 151 steelhead trout (1.2%). CPUEs of chum, pink, sockeye, and coho salmon in 2000 were in low levels in 1992-2000 in the North Pacific Ocean. In the Bering Sea, CPUE of pink salmon in 2000 was the lowest in 1992-2000. In that regions, CPUE of chum salmon was the lowest in even-years in 1992-2000. CPUEs of chinook salmon and steelhead trout were higher than the mean in 1992-1999. No common trend in annual changes of mean fork lengths of salmonids was observed.

INTRODUCTION

According to the 2000 Work Plan of the North Pacific Anadromous Fish Commission (NPAFC), the Committee on Scientific Research and Statistics (CSRS) should review results of salmon stock assessment research and the condition of salmon stocks (NPAFC 1999). This report summarizes the oceanographic conditions, abundance, and body size of salmon in the North Pacific Ocean and Bering Sea in 2000 from the salmon research conducted by Japan in the North Pacific Ocean from June to August 2000. In this report, we compared results in 2000 with those in the previous eight years from 1992 to 1999.

MATERIALS AND METHODS

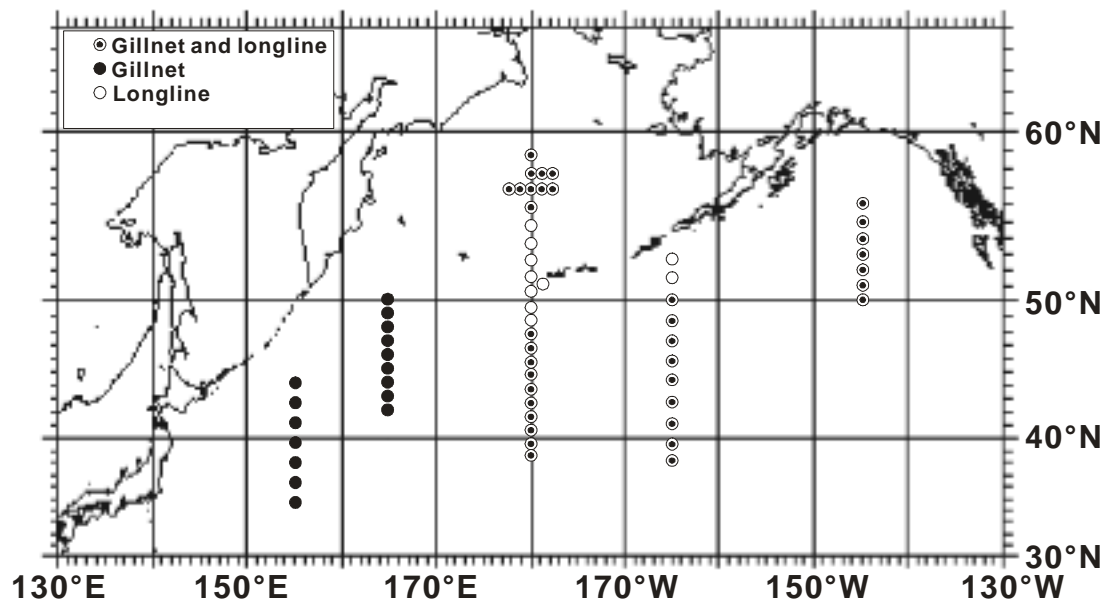


Fig. 1. Sampling locations for Japanese salmon research vessels in the North Pacific Ocean in summer of 2000.

Four Japanese salmon research vessels (*Oshoro maru*, *Hokusei maru*, *Shoyo maru*, and *Wakatake maru*) conducted 56 gillnet (2,717 tans), 40 longline (959 hachi), and 3 hook-and-line fishing operations in the North Pacific Ocean and Bering Sea from June to August 2000 (Fig. 1). We divided the research area to 4 regions: the western North Pacific (38-51° N, 150-170° E), the central North Pacific (38-52° N, 170° E-170° W), the Bering Sea (52-59° N, 170° E-170° W), and the eastern North Pacific (38-56° N, 170-140°W). To examine abundance of salmon, mean numbers of fish caught by 30 tans of non-selective research gillnets (CPUEs) were calculated (Takagi 1975). For body size of salmon, mean fork length (MFL) of fish caught by non-selective research gillnets was calculated. Maturity of salmon was determined from gonad weight (Takagi, 1961; Ito et al., 1974; Okazaki 1984).

RESULTS AND DISCUSSION

Sea Surface Temperature

Mean sea surface temperature in the summer of 2000 was 12.6°C in the western North Pacific, 8.49°C in the central North Pacific, 7.69 °C in the Bering Sea, and

Table 1. Mean sea surface temperature (°C), standard deviation, and number of observations in parentheses by regions in the North Pacific Ocean in the summer of 1992-2000.

Year	Western North Pacific	Central North Pacific	Bering Sea	Eastern North Pacific	Whole research area
1992	8.98 ± 4.13 (38)	10.6 ± 3.46 (38)	6.61 ± 0.53 (11)	9.56 ± 0.68 (9)	9.38 ± 3.61 (96)
1993	11.0 ± 3.50 (27)	11.0 ± 2.94 (32)	7.50 ± 0.56 (11)	9.36 ± 1.30 (8)	10.8 ± 3.22 (78)
1994	12.9 ± 4.99 (29)	12.3 ± 4.72 (32)	7.08 ± 0.59 (11)	10.4 ± 1.10 (10)	11.5 ± 4.62 (82)
1995	11.6 ± 4.14 (30)	11.6 ± 2.81 (32)	7.80 ± 0.70 (11)	9.78 ± 1.62 (7)	10.9 ± 3.42 (80)
1996	9.98 ± 2.71 (25)	12.4 ± 3.18 (33)	7.87 ± 0.56 (9)	9.62 ± 0.99 (9)	10.7 ± 3.08 (76)
1997	9.22 ± 1.79 (20)	11.6 ± 3.55 (31)	8.41 ± 0.64 (10)	12.2 ± 0.43 (9)	10.5 ± 2.93 (70)
1998	10.8 ± 4.39 (23)	11.2 ± 3.84 (22)	7.51 ± 1.14 (11)	9.98 ± 1.11 (12)	10.2 ± 3.65 (68)
1999	9.61 ± 3.63 (18)	10.7 ± 4.22 (19)	6.75 ± 0.60 (11)	9.72 ± 2.82 (13)	9.47 ± 3.61 (61)
92-99	10.6 ± 4.08 (210)	11.6 ± 3.65 (239)	7.42 ± 0.89 (85)	10.1 ± 1.73 (77)	10.5 ± 3.64 (611)
2000	12.6 ± 7.14 (21)	8.49 ± 2.78 (22)	7.69 ± 1.25 (25)	9.89 ± 1.74 (26)	9.39 ± 4.40 (96)

9.89°C in the eastern North Pacific (Table 1). That was lower than the mean of 1992-

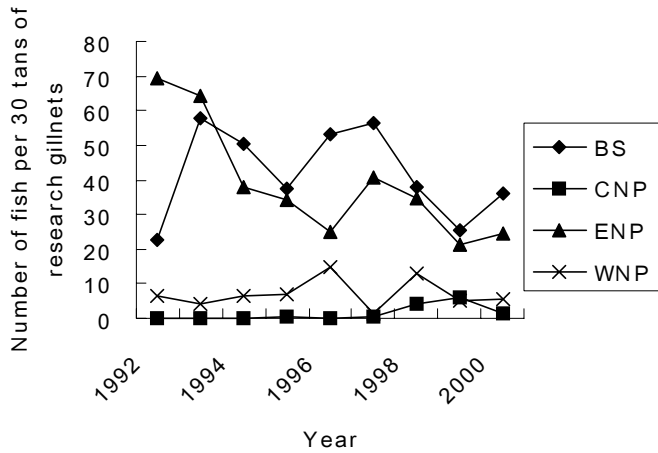


Fig. 2. Number of sockeye salmon caught by 30 tans of research gillnets in summer of 1992-2000 in the North Pacific Ocean.

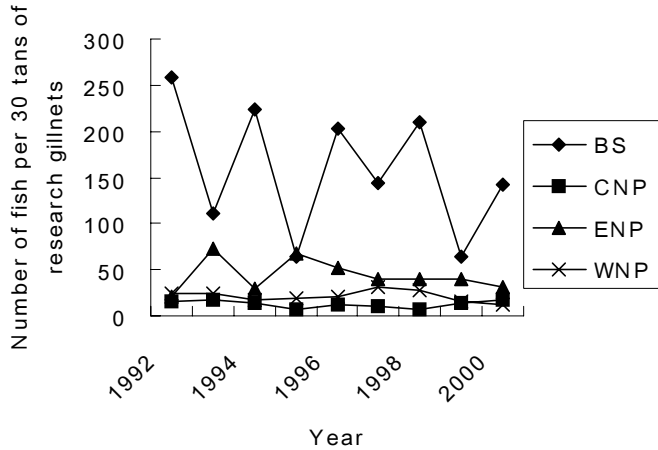


Fig. 3. Number of chum salmon caught by 30 tans of research gillnets in summer of 1992-2000 in the North Pacific Ocean.

salmon are mainly distributed in the Bering Sea and the eastern North Pacific in summer. In 2000, CPUE of sockeye salmon in the Bering Sea ($36.1 \pm \text{SD } 53.3$) was

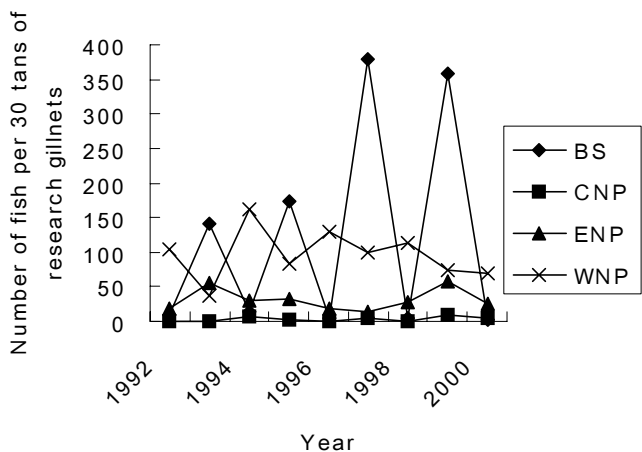


Fig. 4. Number of pink salmon caught by 30 tans of research gillnets in summer of 1992-2000 in the North Pacific Ocean.

1999 in the central North Pacific, the Bering Sea, and the eastern North Pacific. In the western North Pacific, mean sea surface temperature in 2000 was higher than mean in 1992-1999.

Salmonid and Non-Salmonid Catches

A total of 12,231 salmonids was caught using drift gillnet, longline, and hook-and-line, including 6,758 chum (55.3%), 2,851 pink (23.3%), 1,544 sockeye (12.6%), 612 coho (5.0%), and 315 chinook salmon (2.6%), and 151 steelhead trout (1.2%) in 2000 (Appendix table 1). No Dolly Varden was caught. Dominant non-salmonid catches included 1,130 Pacific pomfret (*Brama japonica*).

Salmon Abundance

CPUEs of chum, pink, sockeye, and coho salmon in 2000 were in low levels in 1992-2000 in the North Pacific Ocean.

CPUE of sockeye salmon in the summer of 2000 was higher than in the last year, but was in a low level in 1992-2000 (Fig. 2). Sockeye salmon CPUE in the eastern North Pacific ($24.7 \pm \text{SD } 19.8$) was 62.4% of the mean in 1992-1999 ($39.6 \pm \text{SD } 29.4$). Sockeye CPUE in the western North Pacific ($5.67 \pm \text{SD } 14.9$) was 77.0% of the mean in 1992-1999 ($7.36 \pm \text{SD } 20.5$). On the other hand, sockeye CPUE in the central North Pacific ($1.60 \pm \text{SD } 2.33$) was larger than the mean in 1992-1999 ($1.07 \pm \text{SD } 6.27$).

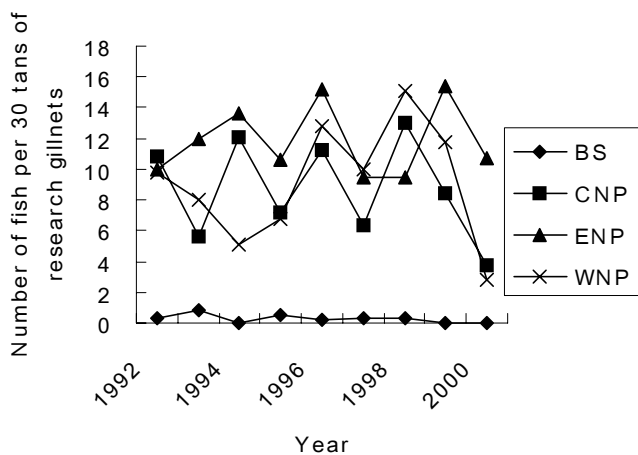


Fig. 5. Number of coho salmon caught by 30 tans of research gillnets in summer of 1992-2000 in the North Pacific Ocean.

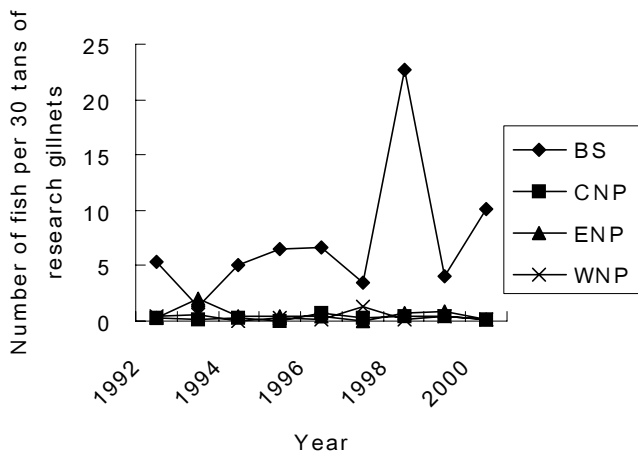


Fig. 6. Number of chinook salmon caught by 30 tans of research gillnets in summer of 1992-2000 in the North Pacific Ocean.

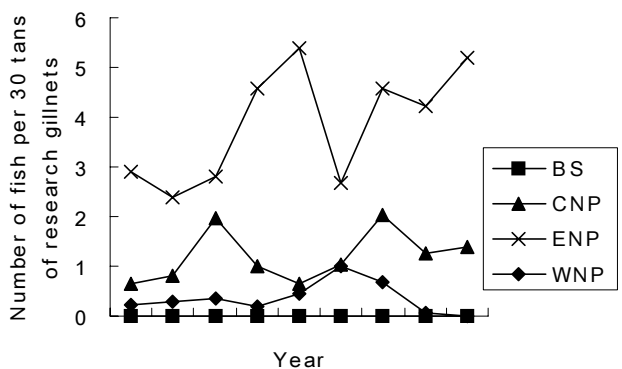


Fig. 7. Number of steelhead trout caught by 30 tans of research gillnets in summer of 1992-2000 in the North Pacific Ocean.

CPUE of chum salmon in 2000 was lower than the mean in 1992-1999 in the western, eastern North Pacific, and the Bering Sea (Fig. 3). Chum salmon CPUE in the western North Pacific ($11.8 \pm \text{SD } 16.1$) was 51.3% of the mean in 1992-1999 ($22.9 \pm \text{SD } 25.6$). In the eastern North Pacific, chum CPUE ($31.2 \pm \text{SD } 30.4$) was 71.6% of the mean in 1992-1999 ($43.5 \pm \text{SD } 33.1$). In the Bering Sea, the CPUE of chum salmon in 2000 ($142 \pm \text{SD } 60.1$) was lower than the mean in 1992-1999 ($159 \pm \text{SD } 96.5$) and the lowest in even years. In the Bering Sea, chum CPUE was higher in even years than in odd years. In the central North Pacific, chum CPUE ($17.3 \pm \text{SD } 20.8$) was 140% of the mean in 1992-1999 ($12.4 \pm \text{SD } 21.4$).

CPUE of pink salmon in 2000 was lower than the even-year mean in the western North Pacific and the Bering Sea (Fig. 4). In the western North Pacific, pink salmon CPUE in 2000 ($70.0 \pm \text{SD } 93.0$) was 55.4% of the mean in even-years in 1992-1998 ($126 \pm \text{SD } 180$). CPUE of pink salmon in the central North Pacific in 2000 ($4.70 \pm \text{SD } 3.69$) was 186% of the mean in even-years in 1992-1999 ($2.53 \pm \text{SD } 11.6$). In the Bering Sea, there was a clear odd and even year change, and CPUE in 2000 ($2.18 \pm \text{SD } 1.96$) was the lowest in odd-years in 1992-2000. In the eastern North Pacific, odd and even year change was not clear, and CPUE in 2000 ($26.2 \pm \text{SD } 35.5$) was 110% of the past even-year mean ($23.9 \pm \text{SD } 15.3$).

Coho salmon are distributed in the western, central, and eastern North Pacific. Coho salmon CPUE

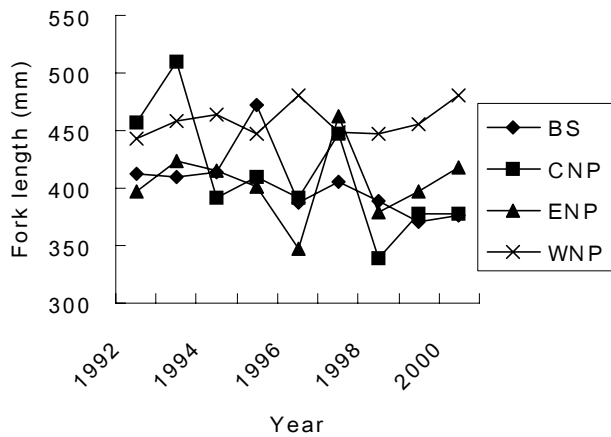


Fig. 8. Mean fork length of immature sockeye salmon caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

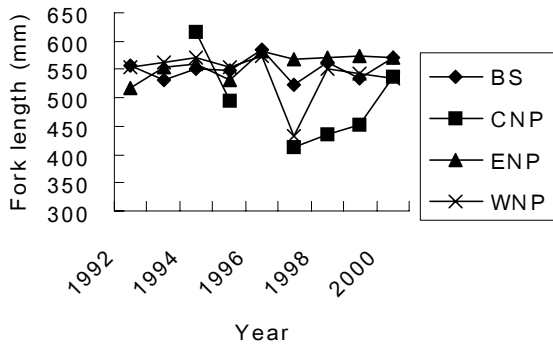


Fig. 9. Mean fork length of mature sockeye salmon caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

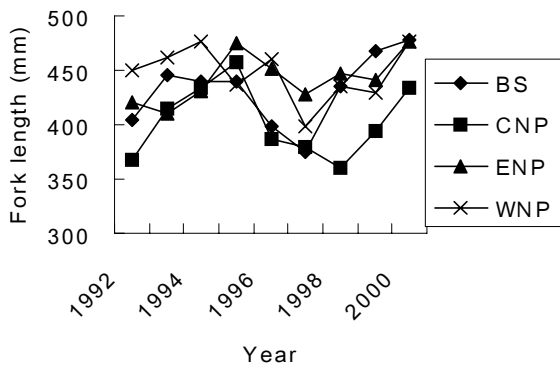


Fig. 10. Mean fork length of immature chum salmon caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

in 2000 was 29.7% of the mean in 1992-1999 in the western North Pacific, 39.8% in the central North Pacific, and 89.3% in the eastern North Pacific (Fig. 5).

Chinook salmon are distributed in the Bering Sea and their CPUE ($10.2 \pm SD 13.7$) in 2000 was higher than the mean in 1992-1999 ($6.95 \pm SD 16.3$; Fig. 6). Steelhead trout are distributed in the central and eastern North Pacific and their CPUE in 2000 was 125% of the mean in 1992-1999 in the central North Pacific and 139% in the eastern North Pacific (Fig. 7).

Fish Size

MFL of immature sockeye salmon in summer of 2000 was larger than the mean in 1992-1999 in the central, the eastern, and the western North Pacific (Fig. 8). That was $376 \pm SD 81.7$ mm in the Bering Sea, $377 \pm SD 66.2$ mm in the central North Pacific, $418 \pm SD 82.9$ mm in the eastern North Pacific, and $480 \pm SD 72.6$ mm in the western North Pacific in summer of 2000.

MFL of mature sockeye salmon in summer of 2000 was larger than the mean in 1992-1999 in the Bering Sea, the central, and the eastern North Pacific (Fig. 9). That was $570 \pm SD 59.1$ mm in the Bering Sea, $539 \pm SD 23.5$ mm in the central North Pacific, $572 \pm SD 45.4$ mm in the eastern North Pacific, and $534 \pm SD 33.0$ mm in the western North Pacific in summer of 2000.

MFL of immature chum salmon in summer of 2000 was larger than the mean in 1992-1999 in every region in the North Pacific Ocean (Fig. 10). That was $477 \pm SD 51.9$

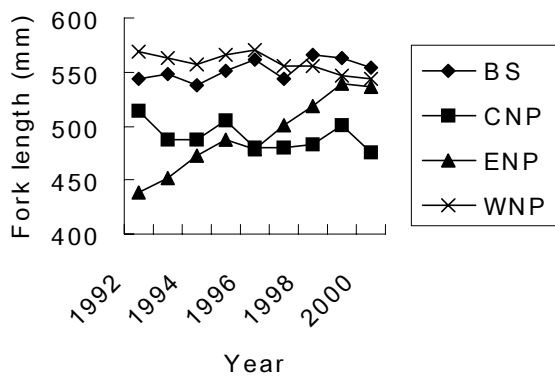


Fig. 11. Mean fork length of mature chum salmon caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

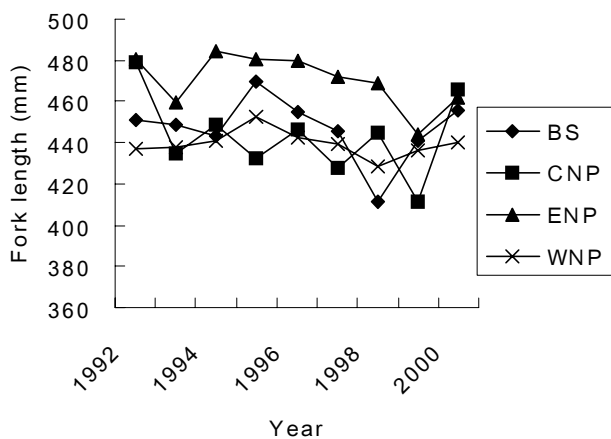


Fig. 12. Mean fork length of pink salmon caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

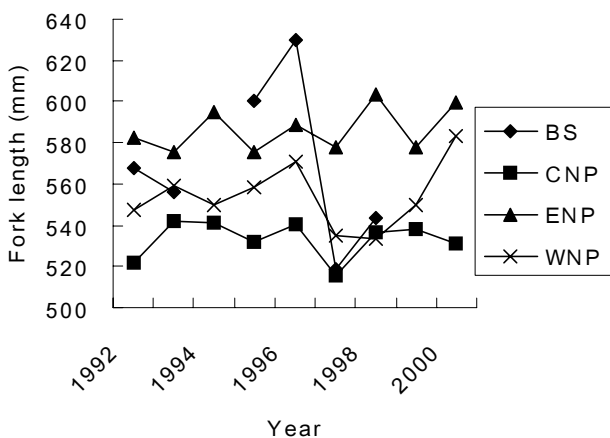


Fig. 13. Mean fork length of coho salmon caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

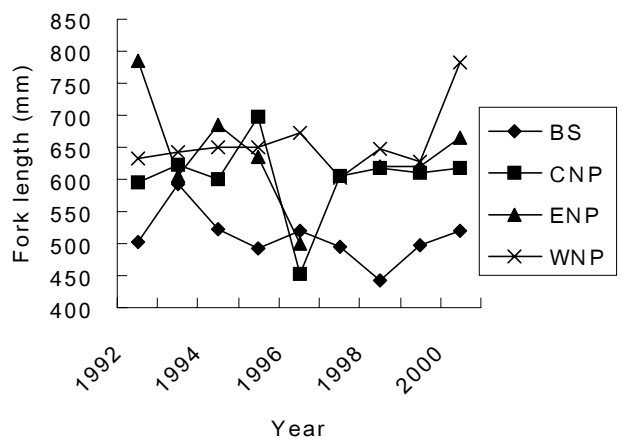


Fig. 14. Mean fork length of chinook salmon caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

mm in the Bering Sea, $433 \pm \text{SD } 57.4$ mm in the central North Pacific, $477 \pm \text{SD } 54.2$ mm in the eastern North Pacific, and $476 \pm \text{SD } 61.4$ mm in the western North Pacific in summer of 2000.

MFL of mature chum salmon in summer of 2000 was larger than the mean in 1992-1999 in the Bering Sea and the eastern North Pacific, while that was smaller in the central and the western North Pacific (Fig. 11). That was $553 \pm \text{SD } 53.1$ mm in the Bering Sea, $475 \pm \text{SD } 42.6$ mm in the central North Pacific, $536 \pm \text{SD } 43.6$ mm in the eastern North Pacific, and $543 \pm \text{SD } 35.3$ mm in the western North Pacific in summer of 2000.

MFL of pink salmon in summer of 2000 was larger than the mean in 1992-1999 in the Bering Sea, the central, and the western North Pacific (Fig. 12). That was $455 \pm \text{SD } 38.6$ mm in the Bering Sea, $466 \pm \text{SD } 32.4$ mm in the central North Pacific, $462 \pm \text{SD } 44.3$ mm in the eastern North Pacific, and $440 \pm \text{SD } 31.0$ mm in the western North Pacific in summer of 2000.

MFL of coho salmon in summer of 2000 was smaller than

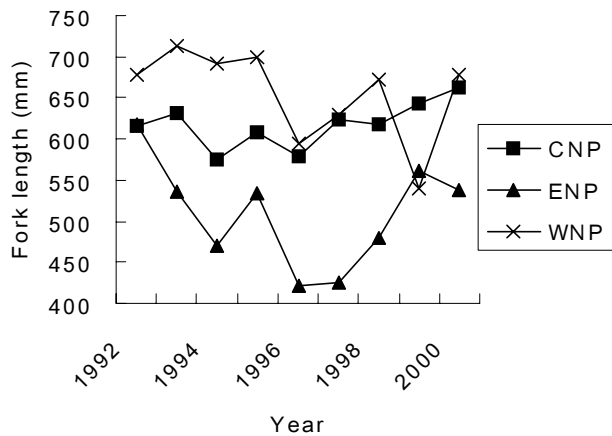


Fig. 15. Mean fork length of steelhead trout caught by research gillnets in summer of 1992-2000 in the North Pacific Ocean.

the mean in 1992-1999 in the central and the western North Pacific (Fig. 13). That was $531 \pm \text{SD } 44.1$ mm in the central North Pacific, $600 \pm \text{SD } 50.6$ mm in the eastern North Pacific, and $583 \pm \text{SD } 49.1$ mm in the western North Pacific in summer of 2000. In the Bering Sea, no coho salmon was caught.

No clear change in MFL was observed for chinook salmon and steelhead trout due to small number of samples (Fig. 14 and Fig. 15).

ACKNOWLEDGMENTS

We thank Capt. S. Yamaguchi of the *Oshoro maru*, Capt. T. Meguro of the *Hokusei maru*, Capt. Y. Hayasaka of the *Wakatake maru*, Capt. K. Kubota of the *Shoyo maru*, and the officers and crew of these vessels for their careful collection of data and samples. We thank S. Ito for his help in age determination.

REFERENCES

- Ito, J., K. Takagi, and S. Ito. 1974. The identification of maturing and immature chinook salmon, *Oncorhynchus tshawytscha* (Walbaum) in the offshore stage and some related information. Far Seas Fish. Res. Lab. Bull. 11: 67-75.
- North Pacific Anadromous Fish Commission. 1999. Consideration of scientific research and statistics. Annual Report 1999: 34-63.
- Okazaki, T. 1984. Age composition, growth, sex ratio and gonad development of *Salmo gairdneri* and *Salmo mykiss* in the North Pacific. Japan. J. Ichthyol. 31(1): 23-37.
- Takagi, K. 1961. The seasonal change of gonad weight of sockeye and chum salmon in the North Pacific Ocean, especially with reference to mature and immature fish. Bull. Hokkaido Reg. Fish. Res. Lab. 23:17-34.
- Takagi, K. 1975. A non-selective salmon gillnet for research operations. Int. North Pac. Fish. Comm. Bull. 32:13-41.

Appendix table 1. Numbers of Pacific salmon and other organisms caught by the Japanese salmon research vessels in summer of 2000.

Region	Research Vessel	Gillnet or other gear	Date	Operation	Tan/hachi	Sock/eye	Chum	Pink	Coho	Chi-nook	Steel head	Flying sq.	Gonate sq.	Club hook sq.	Pacific pomfret	Atka mack erel	Salmon shark	Spiny dogfish	Blue shark	Pacific saury	Other fishes	Shear waters	Other birds	Mamals	
Western North Pacific	<i>Hokusei maru</i>	Research	Jun 7-Aug 8	13	390	0	138	789	40	1	0	361	3	263	813	0	1	0	128	4	528	0	4	0	
		Commercial	Jun 7-Aug 8	13	156	0	210	146	36	0	0	19	0	1	9	0	2	0	49	0	366	0	3	1	
		Small-mesh	Jun 7-Aug 8	13	91	0	1	1	0	0	0	13	0	232	102	0	0	0	3	459	294	0	0	0	
	<i>Shoyo maru</i>	Research	Jun 15-Jun 22	8	240	119	109	682	20	1	0	0	6	5	0	0	1	0	0	0	2	12	0	0	
		Commercial	Jun 15-Jun 22	8	152	180	186	583	22	0	2	0	0	0	0	0	1	1	0	0	0	12	2	0	
	Total		Jun 7-Aug 8	21	1029	299	644	2201	118	2	2	393	9	501	924	0	5	1	180	463	1190	24	9	1	
Central North Pacific	<i>Wakatake maru</i>	Research	Jun 13-23	10	300	16	173	47	37	1	14	2	16	32	30	0	2	4	3	1	5	1	1	0	
		Commercial	Jun 13-23	10	178	2	66	35	66	3	15	4	0	0	8	0	1	0	2	0	2	0	1	0	
		Small-mesh	Jun 13-18	6	12	0	0	0	0	0	0	0	0	1	3	0	0	0	0	9	0	0	0	0	
		Longline	Jun 12-26	14	419	12	79	4	13	0	3	0	0	3	12	0	0	0	1	0	2	0	0	0	
		Total		Jun 12-26	24	909	30	318	86	116	4	32	6	16	36	53	0	3	4	6	10	9	1	2	0
Bering Sea	<i>Wakatake maru</i>	Research	Jul 1-13	11	330	397	1556	24	0	112	0	0	5	0	0	1	0	0	0	0	1	33	6	0	
		Commercial	Jul 1-13	11	361	131	2467	13	0	168	0	0	0	0	0	0	0	0	0	0	0	2	23	0	0
		Longline	Jun 27-Jul 12	14	420	25	1111	2	0	24	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0
		Total		Jun 27-Jul 13	25	1111	553	5134	39	0	304	0	0	5	0	0	3	0	0	0	0	3	58	6	0
Eastern North Pacific	<i>Oshoro maru</i>	Research	Jun 21-Jul 15	14	390	316	397	332	139	1	66	0	122	62	51	0	1	2	0	0	3	0	8	0	
		Commercial	Jun 21-Jul 15	14	227	346	248	183	220	2	51	0	1	1	87	0	1	9	0	0	1	0	4	2	
		Small-mesh	Jun 21-Jul 7	14	42	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	19	0	0	0	
		Longline	Jun 22-Jul 13	12	120	0	17	9	14	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	
		Hook & line	Jul 4- Jul 10	3		0	0	1	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total		Jun 21-Jul 15	29	779	662	662	525	378	5	117	0	127	64	153	0	2	11	0	0	23	0	12	2	
Total			Jun 7-Aug 6	99	3828	1544	6758	2851	612	315	151	399	157	601	1130	3	10	16	186	473	1225	83	29	3	