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Ocean Condition and Pacific Salmon Stock Assessment in the North Pacific Ocean, 1999

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Ocean Condition and Pacific Salmon Stock Assessment in the North Pacific Ocean, 1999

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ABSTRACT

We summarize the results of research on salmon stock assessment conducted by Japan in 1999. Mean sea surface temperature, abundance and body size of Pacific salmon in 1999 are compared to those from 1992 to 1998. Four Japanese salmon research vessels (*Oshoro maru, Hokusei maru, Hokko maru,* and *Wakatake maru*) conducted oceanographic observations, 61 gillnet (2,986 tan), 36 longline (840 hachi), and 8 hook-and-line fishing operations in the western, central, eastern North Pacific, and Bering Sea from June to August in 1999. Mean sea surface temperature in 1999 was 9.61 ˚C in the western North Pacific, 10.7 ˚C in the central North Pacific, 6.75 ˚C in the Bering Sea, 9.72 ˚C in the eastern North Pacific, and that is lower than the mean of 1992-1998. A total of 19,345 salmonids was caught by fishing operations, including 12,880 pink (66.6%), 3,459 chum (17.9%), 1,344 coho (6.9%), 1,346 sockeye (7.0%), 143 chinook (0.7%) salmon, and 173 steelhead trout (0.9%). CPUE of Pacific salmon and trout in 1999 (154 fish / 30 tan of research gillnets) was higher than the past seven-year mean (121 fish / 30 tan of research gillnets). Chum CPUE in 1999 was 70% of the past seven-year means. That was 89% of the mean for sockeye, 112% for coho, 88% for chinook, and 122% for steelhead, and that was 167% of the odd-year mean for pink. MFL of chum, sockeye, coho, chinook salmon, and steelhead trout caught in 1999 was larger than the means in the past years. That of pink was smaller than the mean.

INTRODUCTION

According to the 1999 Workplan of the North Pacific Anadromous Fish Commission (NPAFC), the Committee on Scientific Research and Statistics (CSRS) should review the results of salmon stock assessment research and the condition of salmon stocks (NPAFC 1998). This report summarizes the oceanographic conditions, abundance, and body size of salmon in the North Pacific Ocean and Bering Sea in 1999 from the salmon research conducted by Japan in the North Pacific Ocean from June to August 1999. In this report, we compared the results in 1999 with those in the previous seven-years from 1992 to 1998.

MATERIALS AND METHODS

Four Japanese salmon research vessels (*Oshoro maru, Hokusei maru, Hokko maru,* and *Wakatake maru*) conducted 61 gillnet (2,986 tan), 36 longline (840 hachi), and 8 hook-and-line fishing operations in the North Pacific Ocean and Bering Sea from June to August 1999 (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).

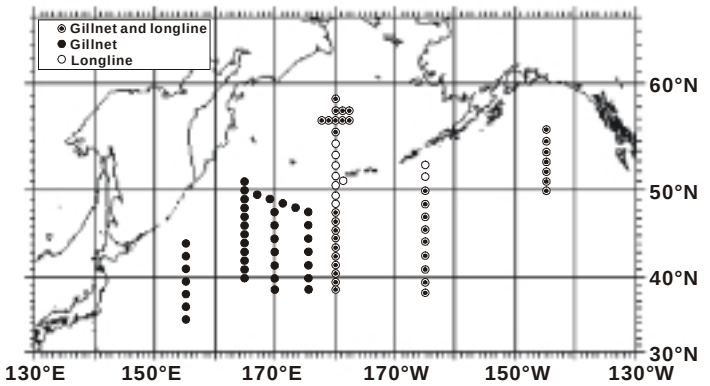

Fig. 1. Sampling locations for the Japanese salmon research vessels in the North Pacific Ocean in summer of 1999.

RESULTS AND DISCUSSION

Sea Surface Temperature

Mean sea surface temperature in the summer of 1999 was 9.61° C in the western North Pacific, 10.7° C in the central North Pacific, 6.75 ° C in the Bering Sea, and 9.72° C in the eastern North Pacific (Table 1). That was lower than the mean of 1992-1998 in each region.

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 1992-1999.

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)
92-98	10.6 ± 4.11 (192)	11.7 ± 3.59 (220)	7.52 ± 0.89 (74)	10.2 ± 1.40 (64)	10.6 ± 3.62 (550)
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)

Salmonid and Non-Salmonid Catches

A total of 19,345 salmonids was caught by fishing operations, including 12,880 pink (66.6%), 3,459 chum (17.9%), 1,344 coho (6.9%), 1,346 sockeye (7.0%), and 143 chinook salmon (0.7%), and 173 steelhead trout (0.9%) in 1999 (Appendix table 1). No

Dolly Varden was caught. Dominant non-salmonid catches included Pacific pomfret (*Brama japonica*, n = 3,970) and neon flying squid (*Ommastrephes baramii*, n = 1,858).

Salmon Abundance

CPUE of sockeye salmon was lower than the mean of the past in the Bering Sea, the eastern and western North Pacific in 1999 (Fig. 2). Sockeye salmon are mainly distributed in the Bering Sea and the eastern North Pacific in summer. In 1999, CPUE of sockeye salmon in the Bering Sea (25.5 ± 16.3 SD) was 56.9% of the past seven-year mean (44.8 ± 30.3 SD: Fig. 2). Sockeye CPUE in the eastern North Pacific (21.3 ± 19.2 SD) was 49.2% of the past mean (43.3 ± 29.7 SD). Sockeye CPUE in the western North Pacific (5.10 ± 12.2 SD) was 67.4% of the past mean (7.57 ± 21.1 SD). On the other hand, sockeye CPUE in the central North Pacific (5.95 ± 13.5 SD) was over nine times larger than the past mean (0.65 ± 4.96 SD).

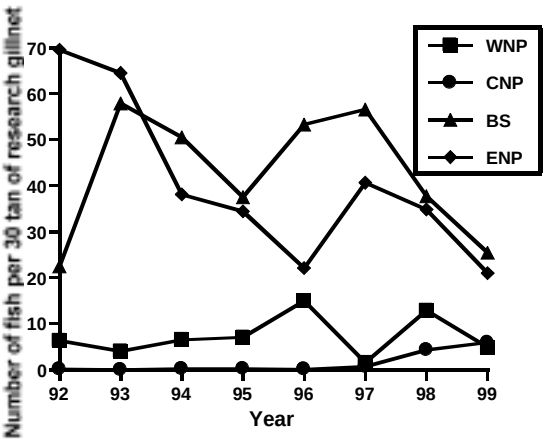

Fig.2. Number of sockeye salmon caught by 30 tan of research gillnets in summer in the North Pacific Ocean.

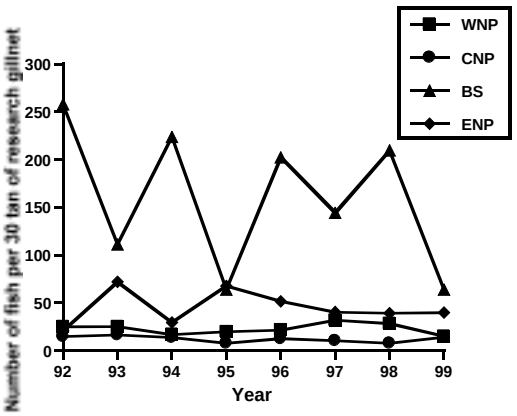

Fig. 3. Number of chum salmon caught by 30 tan of research gillnets in summer in the North Pacific Ocean.

CPUE of chum salmon was lower than the mean of the past in the western and eastern North Pacific, and the Bering Sea in 1999 (Fig. 3). Chum salmon CPUE in the western North Pacific (15.1 ± 14.9 SD) was 63.7% of the past seven-year mean (23.7 ± 12.2 SD). In the eastern North Pacific, chum CPUE (39.8 ± 31.3 SD) was 90.0% of the past seven-year mean (44.2 ± 33.4 SD). In the Bering Sea, the CPUE of chum salmon in 1999 (64.1 ± 27.9 SD) was the lowest in the 8 years and it was 37.1% of the past mean (172.9 ± 95.1 SD). In the Bering Sea, chum CPUE fluctuated and it was higher in even years than in odd years. In the central North Pacific, chum CPUE (14.2 ± 20.2 SD) was 116% of the past mean (12.2 ± 21.5 SD).

Ocean distribution of sockeye and chum salmon might shift south due to low sea surface temperature in the summer of 1999. Mean sea surface temperature was lower than the past in the Bering Sea and the central North Pacific (Table 1). Sockeye and chum salmon CPUEs were lower in the Bering Sea and higher in the central North Pacific than in the past.

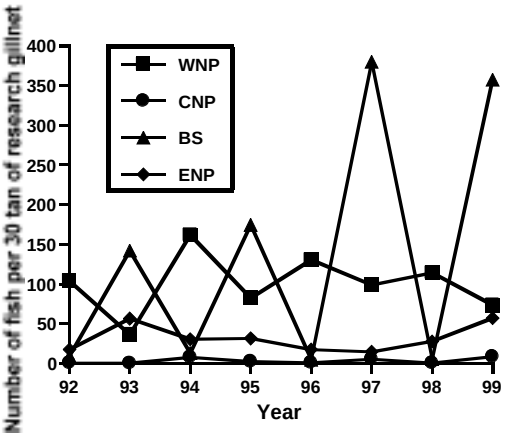

Fig. 4. Number of pink salmon caught by 30 tan of research gillnets in summer in the North Pacific Ocean.

CPUE of pink salmon in 1999 was higher than the odd-year mean in four regions of the North Pacific (Fig. 4). In the western North Pacific, odd and even year change in CPUE was

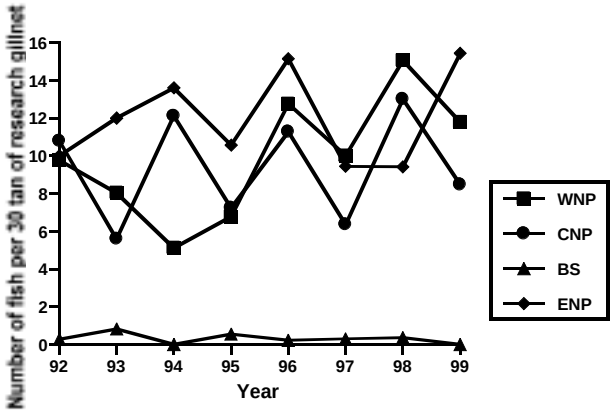

Fig. 5. Number of coho salmon caught by 30 tan of research gillnets in summer in the North Pacific Ocean.

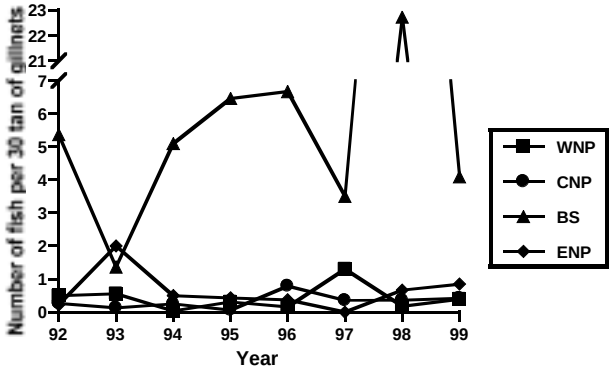

Fig. 6. Number of chinook salmon caught by 30 tan of research gillnets in summer in the North Pacific Ocean.

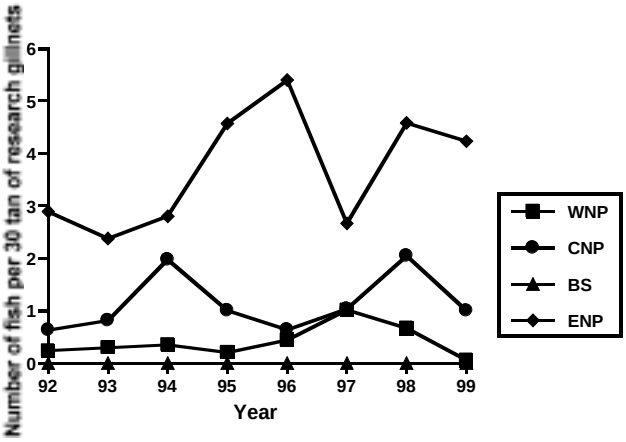

Fig. 7. Number of steelhead trout caught by 30 tan of research gillnets in summer in the North Pacific Ocean.

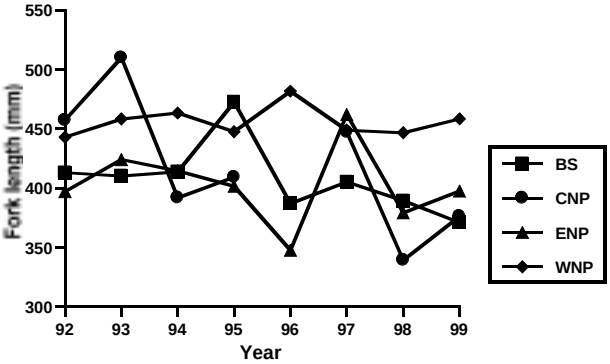

Fig. 8. Fork length of immature sockeye salmon caught by research gillnets in summer in the North Pacific Ocean.

not clear, but the pink salmon CPUE (73.5 ± 74.2 SD) in 1999 was 104.3% of the past odd-year mean (70.5 ± 121.5 SD). CPUE of pink salmon in the central North Pacific in 1999 (8.42 ± 23.7 SD) was the highest in 1992-1999. In the Bering Sea, there was a clear odd and even year change, and CPUE in 1999 (357 ± 128 SD) was 157% of the past odd-year mean (227 ± 152 SD). In the eastern North Pacific, odd and even year change was not clear, and CPUE in 1999 (57.1 ± 62.8 SD) was 170% of the past even-year mean (33.5 ± 31.2 SD).

Coho salmon are distributed in the western, central, and eastern North Pacific. Coho salmon CPUE in 1999 was 125%, 90%, and 164% of the past mean in each area, respectively (Fig. 5).

Chinook salmon are distributed abundantly in the Bering Sea and their CPUE (4.09 ± 3.23 SD) in 1999 was lower than the past mean (7.38 ± 17.3 SD: Fig. 6). Steelhead trout are distributed in the central and eastern North Pacific and their CPUE in 1999 was 90.4% and 116% of the past means, respectively (Fig. 7).

Fish Size

MFL of chum, sockeye, coho, chinook, and steelhead caught in 1999 was larger than the means in the past years. That of pink was smaller than the mean.

MFL of immature sockeye salmon in the western North Pacific of 1999 (458 mm ± 36.8 SD) was larger than in the central (376 mm ± 58.8 SD), eastern North Pacific (398 mm ± 67.7 SD), and the Bering Sea (371 mm ± 91.2 SD: Fig. 8). MFL in each area in 1999 was within the range of the past seven years, except for that in the Bering Sea. MFL of immature sockeye salmon in the Bering Sea was the smallest in the past seven years.

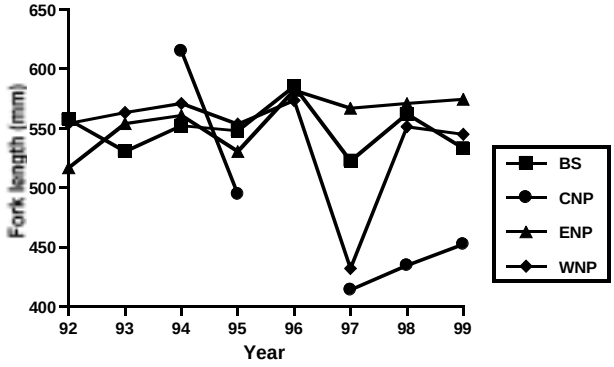

Fig. 9. Fork length of mature sockeye salmon caught by research gillnets in summer in the North Pacific Ocean.

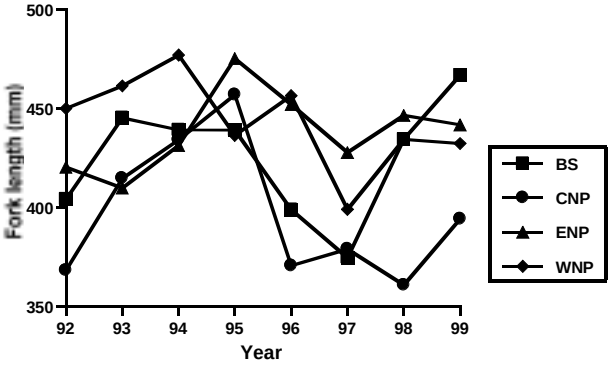

Fig. 10. Fork length of immature chum salmon caught by research gillnets in summer in the North Pacific Ocean.

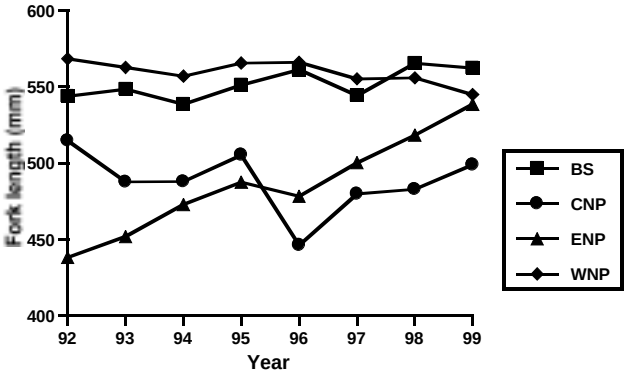

Fig. 11. Fork length of mature chum salmon caught by research gillnets in summer in the North Pacific Ocean.

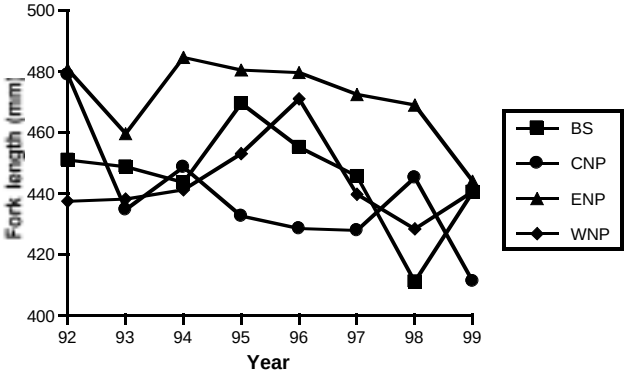

Fig. 12. Fork length of pink salmon caught by research gillnets in summer in the North Pacific Ocean.

MFL of mature sockeye salmon in the central North Pacific (452 mm ± 59.0 SD) was smaller than in the Bering Sea (533 mm ± 76.1 SD), the western (545 mm ± 44.5 SD), and the eastern North Pacific (574 mm ± 52.4 SD: Fig. 9). MFL of mature sockeye salmon in each area in 1999 was within the range of the past seven years.

MFL of immature chum salmon in 1999 in the Bering Sea (467 mm ± 32.9 SD) was larger than in the western (432 mm ± 60.9 SD), the central (394 mm ± 49.3 SD), and the eastern North Pacific (442 mm ± 52.3 SD: Fig. 10). That in 1999 was also larger than in the past seven years. In the other regions, MFL was within the range of the past seven years .

MFL of mature chum salmon in 1999 in the Bering Sea (562 mm ± 65.6 SD) was larger than in the western (545 mm ± 75.3 SD), the central (499 mm ± 104 SD), and the eastern North Pacific (539 mm ± 91.7 SD: Fig. 11). That in the western North Pacific was smaller than the past seven year means. On the other hand, in the eastern North Pacific, that in 1999 was lager than the past seven year means. In the central North Pacific and the Bering Sea, that in 1999 was within the range of the past.

MFL of pink salmon in 1999 in the central North Pacific (411 mm ± 24.0 SD) was smaller than in the Bering Sea (440 mm ± 32.1 SD), the western (440 mm ± 28.2 SD), and the eastern North Pacific (444 mm ± 29.6 SD: Fig. 12). In the central and the eastern North Pacific, MFLs were smaller than the past seven year means. In the western North Pacific and the Bering Sea, that in 1999 was within the range of the past.

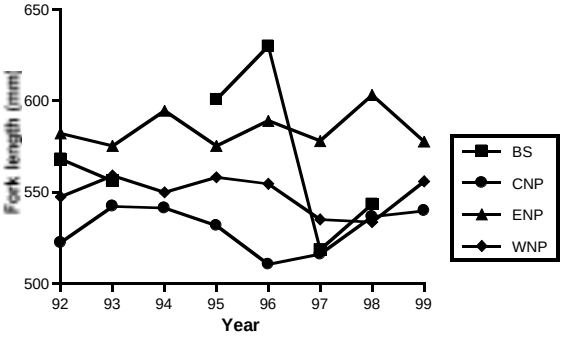

Fig. 13. Fork length of coho salmon caught by research gillnets in summer of the North Pacific Ocean.

MFL of coho salmon in 1999 in the eastern North Pacific (578 mm ± 46.3 SD) was larger than in the central (540 mm ± 46.1 SD) and the western North Pacific (556 mm ± 37.3 SD: Fig. 13). No coho salmon was caught in the Bering Sea. MFL in each region in 1999 was within the range in the past.

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

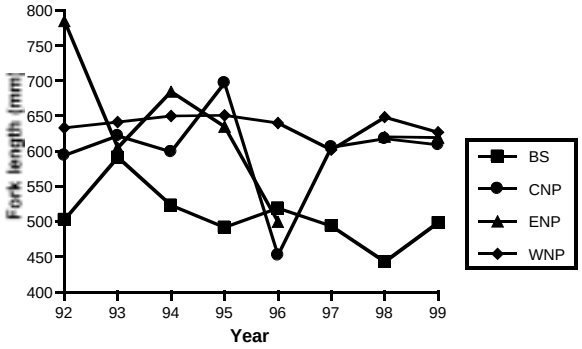

Fig. 14. Fork length of chinook salmon caught by research gillnets in summer of the North Pacific Ocean.

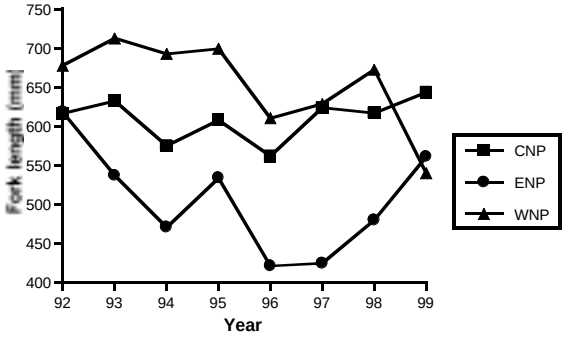

Fig. 15. Fork length of steelhead trout caught by research gillnets in summer of the North Pacific Ocean.

ACKNOWLEDGMENTS

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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. 1998. Consideration of scientific research and statistics. Annual Report 1998: 25-60.

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 1999.

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 mackerel	Salmon shark	Spiny dogfish	Blue shark	Pacific saury	Other fishes	Shear waters	Other birds	Mammals
Western North Pacific	*Hokusei maru*	Research	Jun 6-Jul 28	8	240	9	179	446	56	5	1	410	30	37	64	0	0	1	4	0	76	2	4	0
		Commercial	Jun 6-Jul 28	8	96	7	151	101	54	2	1	9	0	0	16	0	1	0	1	0	1	1	5	1
		Small-mesh	Jun 6-Jul 28	8	56	0	1	0	1	0	0	22	10	5	3	132	0	0	0	6	171	0	0	0
	Hokko maru	Research	Jun 29-Jul 10	10	297	79	92	865	157	2	0	33	53	46	81	0	4	0	43	7	133	10	3	0
		Commercial	Jun 29-Jul 10	10	170	64	65	809	192	5	2	97	0	0	34	0	1	1	77	0	1	26	4	0
		Small-mesh	Jun 29-Jul 10	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0
	Total		Jun 6-Jul 28	54	879	159	488	2221	460	14	4	571	93	88	198	132	6	2	125	21	382	39	16	1
Central North Pacific	*Hokusei maru*	Research	Jul 29-Aug 9	9	270	6	99	1	99	2	8	236	32	134	3241	0	0	2	21	0	172	0	5	0
		Commercial	Jul 29-Aug 9	9	108	4	51	1	110	4	2	93	0	1	238	0	1	1	39	0	71	0	4	2
		Small-mesh	Jul 29-Aug 9	9	63	0	0	0	1	0	0	43	1	6	4	0	0	0	0	24	169	0	0	0
	Wakatake maru	Research	Jun 16-27	10	300	108	171	159	62	6	16	217	29	9	133	0	3	1	22	57	59	22	6	0
		Commercial	Jun 16-27	10	176	11	14	16	104	5	23	316	0	2	47	0	3	3	35	0	9	36	2	0
		Small-mesh	Jun 16-23	10	14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	31	2	0	0	0
		Longline	Jun 15-30	10	300	16	32	45	5	0	2	0	0	0	64	1	0	0	5	0	2	0	0	0
	Total		Jun 15-Aug 9	67	1231	145	367	222	381	17	51	905	62	153	3727	1	7	7	122	112	484	58	17	2
Bering Sea	*Wakatake maru*	Research	Jul 5-15	11	330	280	705	3930	0	45	0	0	24	0	0	0	0	0	0	0	1	49	1	0
		Commercial	Jul 5-15	11	209	192	894	5035	1	35	0	0	0	0	0	0	0	0	0	0	1	34	11	0
		Longline	Jul 1-14	14	420	16	328	303	1	7	0	0	0	0	0	0	0	0	0	0	0	4	4	0
	Total		Jul 1-15	36	959	488	1927	9268	2	87	0	0	24	0	0	0	0	0	0	0	2	87	16	0
Eastern North Pacific	*Oshoro maru*	Research	Jun 26-Jul 15	13	387	273	516	735	199	11	55	365	77	41	24	0	1	2	35	1	102	1	1	0
		Commercial	Jun 26-Jul 15	13	208	270	128	387	270	14	61	16	0	0	21	0	1	9	32	0	87	1	2	0
		Small-mesh	Jun 26-Jul 3	13	42	0	0	0	0	0	0	1	4	2	0	0	0	0	1	19	41	0	0	0
		Longline	Jun 23-Jul 15	12	120	9	33	40	25	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		Hook&line	Jul 9-14	8		2	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total		Jun 23-Jul 15	59	757	554	677	1169	501	25	118	382	81	43	45	0	2	11	68	20	230	2	3	0
Total			Jun 6-Aug 9	216	3826	1346	3459	12880	1344	143	173	1858	260	284	3970	133	15	20	315	153	1098	186	52	3