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A COMPARISON OF ESTIMATED AND REPORTED CATCHES OF STEELHEAD BY JAPANESE HIGH SEAS COMMERCIAL SALMON FISHERIES, 1981-1986

by

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ABSTRACT

Steelhead catch and effort data from Japanese high seas salmon research vessels were used in combination with commercial (landbased and mothership) effort data to estimate the average number of steelhead caught by the Japanese high seas commercial salmon fleets in 1981-1986. These estimates were then compared to the reported catch of the landbased fleet and the observed catch of the mothership fleet (mothership fleets do not officially record or report the number of steelhead taken within U.S. waters) to evaluate the accuracy of the reported catches. For the mothership fishery, the observed landings were consistently lower than the estimated landings. In 1984-1986, the average number of steelhead returned to motherships for sampling by U.S. foreign fishery observers was only 28% of the estimated average. Reported catches for the landbased fishery also tended to be below estimates, although in some years or months the reported landings exceeded the estimates. Overall, average reported catches for the landbased fishery in 1981-1986 were 89% of the expected average catches. Because research vessel effort was generally lower and more widely-dispersed than commercial effort, and because steelhead abundance was low overall, the estimates derived from the research vessel data may not have been suitably comparable. However, the consistently low catches reported by the mothership fishery in 1984-1986 suggests that observed steelhead catches by this fishery may not be reliable.

INTRODUCTION

In 1983, the United States Section of the International North Pacific Fisheries Commission (INPFC) requested that all steelhead caught incidental to salmon during fishing operations of the mothership salmon fleets within the U.S. EEZ be returned to the motherships for collection or sampling by U.S. foreign fishery observers. From 1984 through 1986 all steelhead returned to the motherships were frozen whole and later shipped to the United States for detailed biological sampling. The Japanese commercial landbased salmon fishery also catches steelhead, and these catches have been reported annually to the INPFC since 1981. Early estimates of expected steelhead catches by the mothership fleet (Robert L. Burgner, Fisheries Research Institute, personal communication) indicated that the reported[1] landings from the mothership fishery were lower than expected. In an attempt to evaluate the reliability of the reported commercial catches, this report compares reported steelhead catches by the mothership fishery (1984-1986) and the landbased fishery (1981-1986) with estimated catches for these fisheries derived from a combination of CPUE data (catch-per-unit-effort; fish per tan of commercial-mesh gillnet) from Japanese research vessels operating in the same areas as the two fleets and known effort expended by the commercial fleets in each year steelhead catch data were available.

[1] "Reported" catch by the mothership fishery refers to those steelhead taken during fishing operations within the U.S. 200-mile limit that were returned to motherships for sampling by U.S. foreign fishery observers. Mothership fleets do not officially record or report the number of steelhead taken within U.S. waters.

SOURCES OF DATA

Research vessel catch and effort data were provided on computer tape by the Fisheries Agency of Japan (FAJ). Mothership and landbased effort data were also provided on computer tape by FAJ. Catch data for the landbased fishery were obtained from FAJ publications (1982-1987). Mothership catch data for steelhead were obtained from unpublished reports by United States salmon fishery observers aboard motherships in 1984-1986.

METHODS AND RESULTS

Mothership Fishery

For motherships, I used unweighted[2] average CPUE values (i.e., an average of the mean CPUE values in each year) from research vessels operating in the mothership area over a 5-year period (1981-1985), stratified by 1 degree latitude X 5 degree longitude areas, by month (June, July), and by 10-day period (days 1-10, 11-20, and 21-31 of each month). Catch estimates were then derived by combining these CPUE values with total commercial effort (stratified in the same way) for the three years (1984-1986) that steelhead were returned to the motherships for sampling. A catch comparison for months and years is presented in Table 1. In June of each year, few fish were returned to the motherships, and no catch was expected. In July, the observed catch represented between 10% and 55% of the expected landings (28% overall). The mothership fleets expended greater effort than research vessels in most times and areas, and as a result, the commercial fleets often landed fish where research vessel CPUE was zero.

In 1984 and 1986, direct catch estimates were possible because research vessels operated in the same time-area strata where landings by motherships were reported. Results of the mothership effort data applied to research vessel CPUE data in these strata indicated that in 1984 approximately 3,100 steelhead should have been landed[3], whereas 214 were reported (Table 2). In the two strata where both commercial and research vessels operated in 1986, no steelhead were caught by research vessels whereas 41 steelhead were caught by the mothership fleet (Table 2). The small number of strata (8) available precluded a statistical comparison of the mean CPUE between commercial and research vessels in 1984, but the large differences between estimated and reported catches in strata where steelhead were landed suggest that in this year some steelhead were overlooked in the mothership catches. Research vessels made only a few sets in the mothership area in 1985, and in the areas fished by both commercial and research vessels, no steelhead were caught.

Landbased Fishery

Reported catches of steelhead by the landbased driftnet fishery were available for 1981[4] through 1986. Both weighted and unweighted average CPUE values were calculated from research vessel data for 1981-1985 (stratified by 2° latitude X 5° longitude areas, by month, and by 10-day period), and estimated catches were derived by multiplying these values by the reported commercial landbased effort in the same time-area strata. Prior to 1986, the length of a tan of gillnet was not uniform and varied between 30 and 45 m. I used standardized (1 tan = 45 m) effort data for 1984 and 1985 in this analysis, but this was not possible for the 1981-1983 data.

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[2]Unweighted average CPUE values were virtually identical to weighted (i.e., pooled catch in all years divided by pooled effort averages).

[3]This is considered a minimum estimate, since motherships landed steelhead in areas where there was no research vessel effort for comparison.

[4]In 1981, reported catches were derived by expanding the reported catches of 139 of the 207 licensed vessels.

Catch comparisons for years and months are presented in Table 3. The average reported catch for the entire 6-year period (19,311) was approximately 10% less than either of the estimates (21,591 unweighted, 21,301 weighted). Reported catches exceeded estimates in 1982, 1983 and 1984 by as much as 163% (range = 108% to 163%), but in 1981, 1985 and 1986 the reported catches were only 51% to 70% of the estimated catches.

It is important to note that while in some years the estimated and reported total catch figures were similar, among months there were often substantial differences between these figures. For example, in 1982 the overall total reported catch was close to both unweighted and weighted estimates, but the reported catch for May of that year was well below both of the estimates (Table 3). In June, reported catches were slightly higher than estimated catches, and in July the reported landings were nearly double the estimates. Monthly differences were also apparent in 1984, but in this year the reported catch in May was much higher and in July much lower than the estimated catch.

To examine the differences in greater detail, and to make comparisons as direct as possible, I calculated direct estimates of expected catch in all strata (years, months, and 10-day periods in each 2° latitude X 5° longitude area) where both research and commercial vessels operated (Table 4). Results from the 68 time-area combinations where overlap occurred indicated that direct estimates were nearly double the reported landings. However, mean CPUE values from research and commercial vessels for the same 68 strata (Table 5) were not found to be significantly different at the 5% level (Wilcoxon nonparametric paired-sample *t* - test, P = .17).

DISCUSSION

The disparities between estimated catches based on research vessel catch data and catches reported by the two commercial fleets in the above analysis suggest that either steelhead were overlooked in the commercial catches, or that the research and commercial catch statistics were not directly comparable. The first explanation is difficult to assess, but the second might be approached by calculating catch estimates for salmon and comparing these to reported salmon catches to determine whether the differences are on the same order as for steelhead.

The use of research vessel catch statistics to estimate commercial catches does present problems due to differences in intensity (amount of gear or area of coverage) of fishing by the research and commercial fisheries, and the low and probably variable abundance of steelhead in the areas fished. Estimated catches were based on the assumption that research vessel CPUE values averaged over a number of years in given time-area strata were representative of what might be expected in those strata in any given year. If, however, steelhead were not randomly distributed in the areas fished, or if their abundance was highly variable from year to year, month to month, or even day to day, then application of CPUE averages from several years to a single year might not have accurately estimated catches[5]. In addition, research vessel CPUE data were not available every year for each time-area stratum.

Research vessel effort in a given time-area combination was generally much lower than the commercial effort, and because steelhead abundance (reflected by CPUE) was low overall, the difference of even a few steelhead caught in a single research vessel operation would dramatically alter CPUE values. If research vessels fished in an area where steelhead were especially abundant, then for that time-area combination the CPUE would be abnormally high. When applied to the commercial effort in that stratum, such high CPUE values would result in extremely high estimated

[5]Some insight into the variability in steelhead CPUE for research vessels can be gained by comparing the July CPUE values in the motherships area over the years 1981-1985 (see Appendix A).

catches, and this may account for the large differences between estimated and reported catches seen above.

Direct catch estimates, where possible, provided more precise clues to how applicable the multi-year averages were in any single year. Results showed that for the mothership and land-based driftnet fisheries, direct catch estimates were frequently higher than reported catches. No trends were apparent in landbased fishery catches, except for low reported catches in recent years, but mothership catches do appear to be consistently lower than estimates. This evidence, based on the most complete and detailed data available, indicates that under-reporting of steelhead by the mothership fishery cannot be ruled out as a possible explanation for the apparent differences between the numbers of steelhead returned to the motherships for sampling by U.S. foreign fishery observers, and the expected catches derived from research vessel data.

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Table 1. Comparison of estimated[1] catch with reported[2] catch for steelhead taken by Japanese commercial salmon mothership fleets, 1984-1986.

Year	Month	Total Catch	
		Estimated	Reported
1984	June	0	6
	July	1,332	390
		1,332	396
1985	June	0	2
	July	699	381
		699	383
1986	June	0	13
	July	1,137	103
		1,137	116
Grand Total		3,168	895

[1]Estimated from mothership effort and average (1981-1985, unweighted) steelhead CPUE data (fish per tan of commercial-mesh gillnet) from Japanese research vessels operating in the same time-area strata as the mothership fleets.

[2]"Reported" catch refers to the number of steelhead taken during fishing operations within the U.S. 200-mile limit that were returned to the motherships for sampling by U.S. foreign fishery observers. The mothership fishery does not officially record or report the numbers of steelhead caught in U.S. waters.

Table 2. Comparison of reported and estimated steelhead catches for times and areas where both motherships and research vessels operated in July, 1984 and 1986.

Year	Month	10-day period	INPFC 1°X5° area	Total Catch Estimated[1]	Total Catch Reported[2]
1984	July	1	E7052	0	0
			7051	0	0
			6552	0	0
			6551	0	0
			6550	0	0
		2	7050	1,253	83
			7049	1,657	130
			7048	181	1
				3,091	214
1986	July	1	7050	0	11
			7049	0	30
				0	41

[1]Estimated from Japanese research vessel CPUE (fish/tan of commercial-mesh gillnet) multiplied by mothership effort (tans).

[2]"Reported" catch refers to the number of steelhead taken during fishing operations within the U.S. 200-mile limit that were returned to the motherships for sampling by U.S. foreign fishery observers. The mothership fishery does not officially record or report the numbers of steelhead caught within U.S. waters.

Table 3. Comparison of estimated catch with reported catch for steelhead taken during fishing operations of the Japanese landbased driftnet salmon fishery, 1981 to 1986.

Year	Month	Total Catch		
		Estimated[1]		Reported[2]
1981	May	6,716[3]	8,073[4]	64[5]
	June	21,067	20,355	17,561[5]
	July	5,053	5,053	5,413[5]
		32,836	33,481	23,038[5]
1982	May	7,390	8,807	4,839
	June	13,033	11,584	13,697
	July	4,352	4,352	8,167
		24,775	24,743	26,703
1983	May	5,800	7,015	8,842
	June	7,306	6,132	14,135
	July	4,582	4,575	5,934
		17,688	17,772	28,911
1984[6]	May	3,703	3,720	6,495
	June	6,403	5,862	7,518
	July	2,282	2,282	879
		12,388	11,864	14,892
1985[6]	May	---	---	---
	June	19,688	18,783	8,166
	July	8,017	8,008	5,906
		27,705	26,791	14,072
1986[6]	May	---	---	---
	June	12,942	11,990	7,327
	July	1,213	1,213	922
		14,155	13,203	8,249
Grand Average		21,591	21,301	19,311

[1]Based on average CPUE data for steelhead caught by fishing operations of Japanese research vessels in the same times and areas, 1981-1985.

[2]Reported annually by the landbased fishery.

[3]Based on 1981-1985 unweighted average CPUE values (i.e., yearly CPUE means averaged to provide a single mean value in each time-area strata).

[4]Based on 1981-1985 weighted average CPUE values (i.e., pooled catch and effort across all years in each time-area strata).

[5]Expanded from reported catches for 139 of 207 licensed vessels.

[6]Catch estimates based on standardized (1 tan = 45 m) commercial effort.

Table 4. Comparison of reported catch with direct[1] estimates of catch for steelhead taken during fishing operations of the Japanese landbased driftnet salmon fishery, 1981 to 1985.

Year	Month	10-day period	INPFC 2° X 5° area	Total Catch	
				Estimated	Reported
1981[2]	May	1	E4470	0	2
			4270	396	4
			4265	0	0
			4255	0	0
		2	4260	0	0
	June	1	4265	0	11
		3	4265	2,856	297
			4255	0	0
	July	1	4260	0	91
				3,252	405
1982	May	1	4470	2,341	309
			4270	2,689	28
			4255	0	4
		2	4470	4,579	865
			4270	1,069	82
			4265	3,104	28
			4260	0	17
		3	4265	0	309
			4260	290	57
			4255	308	17
			4060	16	0
			4055	0	8
	June	1	4255	99	85
			4050	0	0
		2	4265	2,527	1,038
			4250	0	0
		3	4255	0	5
	July	1	4255	0	10
			4250	0	0
				17,022	2,862
1983	May	1	4270	183	61
		2	4470	639	1,912
			4270	1,302	628
			4260	541	182
			4255	0	0
		3	4470	0	2,637
	June	1	4055	0	0
		2	4255	0	51
			4245	0	0
		3	4265	2,498	1,729
			4260	0	1,548
			4255	0	102

Table 4. Comparison of reported catch with direct[1] estimates of catch for steelhead taken during fishing operations of the Japanese landbased driftnet salmon fishery, 1981 to 1985- continued.

Year	Month	10-day period	INPFC 2° X 5° area	Total Catch Estimated	Total Catch Reported
	July	1	4265	3,556	1,945
			4255	0	36
				8,719	10,831
1984[3]	May	2	4270	843	959
			4265	542	390
		3	4265	572	1,335
			4260	0	170
			4255	140	54
			4060	388	233
	June	1	4265	0	902
			4260	331	345
			4255	0	417
			4250	32	6
			4050	0	0
		2	4260	1,527	543
			4255	165	63
		3	4265	589	188
			4260	757	97
				5,886	5,702
1985[3]	June	1	4255	0	3
			4045	0	1
		2	4270	15,449	1,630
			4265	427	684
			4260	20	8
			4250	2	1
		3	4260	0	17
	July	1	4270	1,999	2,060
		2	4270	228	901
			4070	0	0
			4265	0	707
				18,125	6,719
	Grand Total			53,004	26,519
	Grand Average			10,601	5,304

[1]Direct estimates based on Japanese research vessel CPUE (fish/tan of commercial-mesh gillnet) multiplied by landbased commercial fleet effort (tans) in the same time-area strata.

[2]Reported catch figures for 1981 were expanded from reported landings of 139 of the 207 licensed vessels.

[3]Catch estimates based on standardized (1 tan = 45 m) commercial effort.

Table 5. Comparison of commercial and research vessel catch per unit effort (CPUE, fish per tan of commercial-mesh gillnet) for steelhead caught in the area of the Japanese landbased driftnet salmon fishery, 1981 to 1985.

Year	Month	10-day period	INPFC 2° X 5° area	CPUE[1] Research	CPUE[1] Commercial
1981[2]	May	1	E4470	0	.000013
			4270	.009804	.000099
			4265	0	0
			4255	0	0
		2	4260	0	0
	June	1	4265	0	.000494
		3	4265	.019608	.002039
			4255	0	0
	July	1	4260	0	.002349
1982	May	1	4470	.019608	.002588
			4270	.039216	.000408
			4255	0	.012121
		2	4470	.019608	.003704
			4270	.039216	.000408
			4265	.023529	.000212
			4260	0	.000340
		3	4265	0	.002505
			4260	.003922	.000772
			4255	.009804	.000542
			4060	.009804	0
			4055	0	.008081
	June	1	4255	.002451	.002113
			4050	0	0
		2	4265	.014706	.006040
			4250	0	0
		3	4255	0	.000615
	July	1	4255	0	.001579
			4250	0	0
1983	May	1	4270	.009804	.003268
		2	4470	.003268	.009772
			4270	.029412	.014186
			4260	.006536	.002197
			4255	0	0
		3	4470	0	.015622
	June	1	4055	0	0
		2	4255	0	.001414
			4245	0	0
		3	4265	.029412	.020356
			4260	0	.007346
			4255	0	.001539
	July	1	4265	.026144	.014291
			4255	0	.000800

Table 5. Comparison of commercial and research vessel catch per unit effort (CPUE, fish per tan of commercial-mesh gillnet) for steelhead caught in the area of the Japanese landbased driftnet salmon fishery, 1981 to 1985 - continued.

Year	Month	10-day period	INPFC 2° X 5° area	CPUE[1] Research	CPUE[1] Commercial
1984[3]	May	2	4270	.025063	.028507
			4265	.008333	.005999
		3	4265	.004167	.009726
			4260	0	.001239
			4255	.002778	.001071
			4060	.009804	.005884
	June	1	4265	0	.009363
			4260	.002778	.002896
			4255	0	.002194
			4250	.004098	.000758
			4050	0	0
		2	4260	.009804	.003486
			4255	.002451	.000936
		3	4265	.006536	.002088
			4260	.009804	.001256
1985[3]	June	1	4255	0	.001299
			4045	0	.000010
		2	4270	.062295	.006573
			4265	.003922	.006289
			4260	.003268	.001284
			4250	.001631	.000770
		3	4260	0	.001662
	July	1	4270	.009615	.009909
		2	4270	.004808	.018966
			4070	0	0
			4265	0	.008336
			Mean[4]	.0072	.0039
			S.D.	.0119	.0057
			n	68	68

[1]Based on actual catch and effort data for times and areas where both research and commercial vessels operated in each year.

[2]Commercial CPUE based on catch figures expanded from 139 of the 207 licensed vessels.

[3]Catch estimates based on standardized (1 tan = 45 m) commercial effort.

[4]Means not significantly different at the 5% level (Wilcoxon non-parametric paired-sample *t*-test, P = .17).

APPENDIX A. Variability in Japanese research vessel catch-per-unit-effort (CPUE, steelhead per tan of commercial-mesh gillnet) in the area of the Japanese mothership commercial salmon fishery (170°E-175°E), July, 1981-1985.

°N Latitude[1]	Year	CPUE (x 10,000) Day 1-10	CPUE (x 10,000) Day 11-20
48-49	1981	294	98
	1982	392	*
	1983	*[2]	0[3]
	1984	*	686
	1985	196	122
47-48	1981	98	485
	1982	294	686
	1983	*	1,366
	1984	*	829
	1985	392	2,913
46-47	1981	294	1,019
	1982	588	684
	1983	*	1,176
	1984	*	2,059
	1985	4,615	2,330

[1]Data not shown for the mothership area between 50° and 54°N due to low or inconsistant catch or effort over the years examined.

[2]No effort.

[3]Effort, no catch.