FRI-UW-8815
September 1988

U.S./JAPAN COOPERATIVE HIGH SEAS SALMON RESEARCH IN 1988: SYNOPSIS OF RESEARCH ABOARD THE JAPANESE RESEARCH VESSEL *SHIN RIASU MARU*, 1 JUNE TO 22 JULY

by

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Submitted to the
International North Pacific Fisheries Commission
by the
United States National Section

September 1988

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THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Light, J. T. 1988. U.S./Japan cooperative high seas salmon research in 1988: synopsis of research aboard the Japanese research vessel *Shin Riasu maru*, 1 June to 22 July. (Document submitted to the International North Pacific Fisheries Commission.) 11 pp. FRI-UW-8815. Fisheries Research Institute, University of Washington, Seattle.

U.S./JAPAN COOPERATIVE HIGH SEAS SALMON RESEARCH IN 1988: SYNOPSIS OF RESEARCH ABOARD THE JAPANESE RESEARCH VESSEL *SHIN RIASU MARU*, 1 JUNE TO 22 JULY

ABSTRACT

Observations on fishing, tagging, and data collection are summarized for the summer salmon research cruise of the Japanese research vessel *Shin Riasu maru*. Seventy-four longline operations were performed at 33 stations in the western North Pacific Ocean southwest of 46°N latitude, 175°E longitude in June and July 1988. A total of 6,444 salmonids was caught, of which 30.6% were tagged and released. Chum (*Oncorhynchus keta*) and pink (*O. gorbuscha*) salmon were the most abundant salmonid species and chinook (*O. tshawytscha*) salmon were least abundant. Fishing effort (50 hachi) and soak time (2 hr) in morning operations exceeded evening operations (30 hachi, 1 hr soak) and resulted in morning sets catching 2.6 times as many fish as evening sets. Dropout rates were approximately 4% for all salmonids combined and were proportionately higher among larger fish, especially steelhead trout (*O. mykiss*). The non-salmonid bycatch was almost entirely composed of Pacific pomfret (*Brama japonica*). Twenty-nine adipose-clipped salmonids (28 steelhead, 1 coho [*O. kisutch*] salmon) were caught. The coho and one steelhead were captured beyond known distributional limits of North American fish of these species, but neither fish carried a coded-wire tag to confirm its origins. Recommendations for future research cruises included: 1) modifying existing scale collection methods to increase the number of non-regenerated scales in samples, 2) using a larger dipnet to help bring aboard large salmonids, 3) examining the selection criteria used to determine the fitness of a fish for tagging, and 4) improving gear and fishing strategy combinations to better accomplish research objectives.

INTRODUCTION

In accordance with the 1986 Memorandum of Understanding (MoU) on research of the International North Pacific Fisheries Commission (INPFC), in 1988 one U.S. scientist was allowed to participate in salmon research aboard the Japanese research vessel *Shin Riasu maru*. This report summarizes observations on fishing, tagging, and data collection procedures during this cruise and includes an analysis of an improved method of collecting salmonid scales for use in scale pattern studies. Results of sighting surveys for marine mammals and man-made debris are reported elsewhere (Carver 1988).

The primary objective of this cruise was to capture, tag, and release salmonids within the area of the North Pacific Ocean southwest of 46°N latitude, 175°W longitude to obtain data for determining the distribution and continent of origin of these fish. A secondary objective was to collect, in addition to the regular set of scale samples, an extra set of scales from coho (*Oncorhynchus kisutch*) and chinook (*O. tshawytscha*) salmon and steelhead trout (*O. mykiss*, formerly *Salmo gairdneri* and *Salmo mykiss*) to be used in evaluating a new technique for obtaining good quality scale specimens for scale pattern studies.

METHODS

Fishing and Tagging

Fishing and tagging equipment and procedures used aboard the *Shin Riasu maru* in 1988 were for the most part the same as those observed in 1986 (Light and LeBrasseur 1986). This year, because of the emphasis on tagging, no gillnets were used, and all fishing was conducted using surface longline gear. Both morning and evening sets were made at all stations and, at four stations, duplicate operations (2 days at the same location) were performed (Figure 1). In the evening, 30 hachi were deployed just before sunset (approximately 6:15 p.m. local time). In the morning, 50 hachi were fished, with the set beginning before sunrise (around 2:30 a.m.). Set duration was typically 15 minutes for 30 hachi and approximately 25 minutes for 50 hachi. Soak time between the end of the set and the beginning of retrieval was less variable than in 1986, and was close to 30 minutes for all operations. Retrieval lasted from slightly less than 1 hour for evening sets to over 3 hours for morning sets, but was typically 1 hour in the evening and 2 hours in the morning.

Scale Sampling

For salmonids with high rates of scale regeneration (chinook, coho, and steelhead), the routine method of sampling for scales during high seas salmon research is to remove one scale from the preferred area on each side of a sampled fish (INPFC 1987). Because a thorough examination of each scale beneath a microscope at the time of sampling is impractical, the sampled scales are often regenerated, damaged, or otherwise unsuitable for use in scale pattern studies. In experiments with adult coho in freshwater, Knudsen (1988) obtained a substantial increase in the percentage of fish with usable scales by sampling six scales from as large an area as possible on one side of each fish. Because current scale pattern studies require a large number of good quality scales from coho, chinook, and steelhead caught in the area southwest of 46° N latitude, 175°W longitude (INPFC 1987), this new method was tested as a possible alternative to standard scale collection methods for high seas samples.

The new sampling procedure was implemented on-deck during processing of the long-line mortalities, when routine biological data and standard scale samples were collected. The method involved the collection of at least six scales from one side of all coho, chinook, and steelhead that were not tagged and released. Two regular samples (one for use in this study and one for use by the Fisheries Agency of Japan) of two scales per fish, one from each side of the body, were also collected. The additional six or more scales were removed randomly from throughout the preferred area with forceps and placed on a folded slip of paper that was stored in an envelope. The scales were pulled free of the body individually in the same manner as when collecting them for immediate mounting on gummed cards (i.e., the samples were not scale scrapes).

In the laboratory, acetate impressions of the standard two-scale samples were made and examined visually to determine if the scales were suitable for measuring for scale pattern studies. When neither scale of a particular fish could be used, the additional unmounted scales for this fish were searched under a microscope for one or two suitable scales. If found, these scales were mounted on a gummed card and another set of acetate impressions was made. The new impressions were then examined, and the process was repeated until either a good scale specimen was found for a fish or the supply of unmounted scales was exhausted.

RESULTS AND DISCUSSION

Fishing

The locations of the 74 longline operations made at 33 stations during 40 days of fishing are shown in Figure 1. A total of 6,444 salmonids was landed during these operations (Table 1). Chum (*O. keta*) and pink (*O. gorbuscha*) salmon were the most abundant species in the catch and chinook salmon were least abundant. Thirty-six morning sets[1] averaged 129 fish per set (2.6 fish per hachi), while 37 evening sets averaged only 49 fish per set (1.6 fish per hachi). The captain explained that a smaller evening catch was expected, and this was the reason for fishing more hachi in the morning. A comparison of morning and evening catches is presented in Table 2. Over the entire cruise, morning effort was 1.6 times greater than in the evening. The morning hachi were fished for almost twice as long as in the evening, and the combination of these factors plus possibly a greater tendency for fish to bite in the morning resulted in approximately 2.6 times as many fish being caught during morning sets as during evening sets. Comparative catches in mornings and evenings at duplicate set stations appeared somewhat variable, but these data were not examined in detail for this report.

Dropouts

Observed dropouts (fish hooked but lost before being brought aboard) totaled 277 (4.1% of the total observed hooked fish). The greatest proportion of dropouts (as a percentage of fish landed by species) was steelhead. Of the 72 observed hooked steelhead, 10 (14%) were lost as dropouts, whereas the dropout rate for all species of Pacific salmon combined was 4%. Most of the steelhead lost as dropouts were relatively large (>750 mm, estimated). The dropout rate for all large salmonids could have been reduced if a larger dipnet were kept on hand solely for handling these difficult fish.

Bycatch

The non-salmonid bycatch was dominated by Pacific pomfret (*Brama japonica*). Landings of these fish totaled 1,519, with at least another 258 (14.5% of the total number of hooked fish) lost as dropouts. Six lancetfish (*Alepisaurus ferox*), one spiny dogfish (*Squalus acanthias*), and three Japanese squid (*Onychoteuthis borealijaponica*) were also caught, and one large (>1.5 m) squid was hooked but broke free before reaching the side of the ship. Many seabirds were entangled in the gear but were released in apparently good condition (see Carver 1988 for details).

Tagging

Of the total salmonids caught, less than one third were tagged and released during this cruise. Only 1,971 (30.6%) of 6,444 fish were tagged (Table 1)[2]. A lower percentage of the catch was tagged in the morning (28.5%) than in the evening (35.9%) (Table 2). It

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[1]Data for the morning set on 11 June was not included since fewer than 30 hachi (exact number unknown) were fished. Only 5 salmonids were caught, and only one of these was tagged.

[2]The exceptionally low tagging rate for steelhead (19.4%) is partly the result of my requesting that adipose-clipped fish be sacrificed to obtain their snouts. Some of these sacrificed fish appeared healthy and probably would have been tagged and released.

appears that while the increased amount of gear and the extended soak time in morning sets resulted in more fish being caught, the condition of some of these fish was poorer than in the evening, and this resulted in a lower tagging rate for the morning sets. The low tagging rate for all sets combined (30.6%) is somewhat lower than the 40% tagging rate reported for longline operations aboard the same vessel in 1986 (Light and LeBrasseur 1986). Hargreaves (1987) noted that only 34% of the landed catch was tagged aboard the *Hokko maru* and, after a review of the literature, he concluded that tagging rates in Japanese tagging experiments were generally lower than those for North American tagging cruises. He also suggested the Japanese might be more conservative than North American scientists in their appraisal of fish condition relative to fitness for tagging. My observations are that the Japanese are highly selective and conservative when deciding if a fish is fit for tagging. Less stringent selection criteria might increase the number of tagged fish without compromising the quality of fish released or their expected survival.

Recoveries of Adipose-Clipped Fish

Twenty-eight adipose-clipped steelhead and one adipose-clipped coho were observed in the catch (Table 3). The missing adipose fins indicate that these fish originated in North America. The single steelhead caught in the morning set on 10 June at 41°29'N latitude, 164°32'E longitude was found slightly beyond the southwestern boundary of confirmed North American steelhead distribution, but no tag was found to confirm its origin (Dahlberg et al. 1988). The 27 other adipose-clipped steelhead were caught within the confirmed range of North American steelhead (Light 1988). A single coho, captured in the morning set of 9 July at 42°32' N latitude, 168°32' E longitude, had what appeared to be a partially regenerated adipose fin. No tag was found in the snout of this fish to confirm its origin (Dahlberg et al. 1988), but if the abnormal fin were a true mark and not simply a natural deformity, then this fish almost certainly came from North America. To date, no tagged North American coho have been found this far to the west.

Fishing Strategy

A variety of important questions can be explored using research vessel operations on the high seas, but a careful consideration of research objectives is needed to properly choose gear types and fishing strategies. I suggest several possible modifications of current research vessel fishing strategies that might better address current research goals. While facilitating scheduling and providing a thorough sampling across the entire area of interest, the fixed pattern of operations across latitudes and longitudes (Figure 1) does not address the goals of tagging experiments (i.e., to tag and release as many fish as possible) because in the typical summer sampling period, most salmonids in this area are concentrated along the northern boundary (46°N). Few commercial fishing vessels were sighted in the areas fished by the *Shin Riasu maru* this year. If the concern is to catch a large number of fish for tagging to help identify the origin of fish caught by the commercial salmon fishery, then ideally longline operations should concentrate near the commercial salmon fishing fleets. If, on the other hand, information is desired on distribution and abundance of salmonids in the entire area southwest of 46°N, 175°W, then the current pattern of fishing is adequate, but *gillnets*, not longlines, should be fished, since gillnets catch far greater numbers of fish. If comparative catch-per-unit-effort data for research and commercial operations are desired, then research vessels should operate among commercial fleets with corresponding commercial gear. Each high seas research goal will require a different gear/strategy combination, and the above recommendations are offered merely to point out the need to choose the appropriate combination for addressing our current research needs.

Scale Samples

Standard sets of scale samples and an additional set of at least six scales per fish were collected along with biological data for 572 coho, 24 chinook, and 45 steelhead. In the initial survey of the scales collected by the standard method, 183 (28.5%) of the total sample of 641 salmonids were found unsuitable for measuring (Table 4). Most (83.1%) of these scales were rejected because of regeneration, and the remainder were judged unsuitable owing to human errors in collection or mounting, such as collecting scales from the wrong species, allowing glue to occlude features on the surface of the scale, mounting scales upside down or overlapping one another, etc. Steelhead scales were most frequently rejected (35.6%, all due to regeneration), followed by chinook (33.3%) and coho (27.8%). After searching through the unmounted scales of these 183 fish, acceptable scales were found for all but six, and this improved the true usable sample size from an initial 71.5% to 99.1%.

My purpose in using Knudsen's (1988) scale collection method was to improve, if possible, the effective sample size of scales for chinook, coho, and steelhead by reducing the incidence of unusable scales in the samples. Knudsen suggested that six scales be taken from the preferred area (including the anterior portion of area "B") of each fish. I did not follow his technique exactly because I often sampled more than six (but usually not more than 12) scales from each fish, but the results of the test were extremely promising. If my results can be reproduced, then by using the new method along with the standard technique, the problems associated with regenerated scales can be virtually eliminated. In addition, the human errors that further reduced the effective sample size among the standard samples can also be partially eliminated, since scale selection and mounting in the laboratory can be performed under better conditions (of the 25 samples rejected in the initial survey because of human errors, all were recovered by replacement with scales from the unmounted samples).

I recommend this method for enhancement, rather than replacement, of the currently used method because of the considerable amount of time required to find usable scales among the unmounted samples. The method takes very little extra time on deck, provided the storage envelopes are pre-numbered and contain pre-folded pieces of paper. The largest extra time investment occurs later in the laboratory, but if only a fraction of the samples must be obtained from the unmounted samples, then the benefits of this extra time investment far outweigh the costs. In summary, for scale samples collected from chinook, coho, or steelhead in the area southwest of 46°N, 175°W, where it is critical that maximum sample sizes be obtained, I highly recommend collecting extra scales to enhance the standard method.

RECOMMENDATIONS

The observations made aboard the *Shin Riasu maru* have pointed out several items for consideration in future high seas research programs. First, standard scale collection methods should be modified by collecting an unmounted sample of at least six scales from throughout the preferred area on one side of the body in addition to the regular two scales per fish (one from each side of the fish) that are mounted on gummed cards at the time of sampling. Second, a larger dipnet should be kept on hand during longline retrieval to facilitate the landing of large salmonids. Third, the criteria used to determine fish tagging fitness should be examined and modified if possible to increase the number of fish tagged and released during longline operations. Fourth, current fishing strategies should be examined to assess how well they meet research objectives.

ACKNOWLEDGMENTS

I am grateful to the Government of Japan for providing the opportunity to participate in this year's research aboard the *Shin Riasu maru.* I thank Mr. Momoru Kato of the Fisheries Agency of Japan for facilitating discussions between myself and the officers of *Shin Riasu maru* regarding our research objectives prior to departure from Miyako. I also thank Mr. Kunio Sato and the principal of the Miyako Fisheries High School for being gracious and generous hosts both in Miyako and in Kushiro. I am indebted to Captain Fukuji Sasaki and the officers, crew, and cadets aboard *Shin Riasu maru* for their hospitality and assistance throughout our time together. Finally, I thank Mr. Robert Walker of the Fisheries Research Institute for assisting with the scale analysis.

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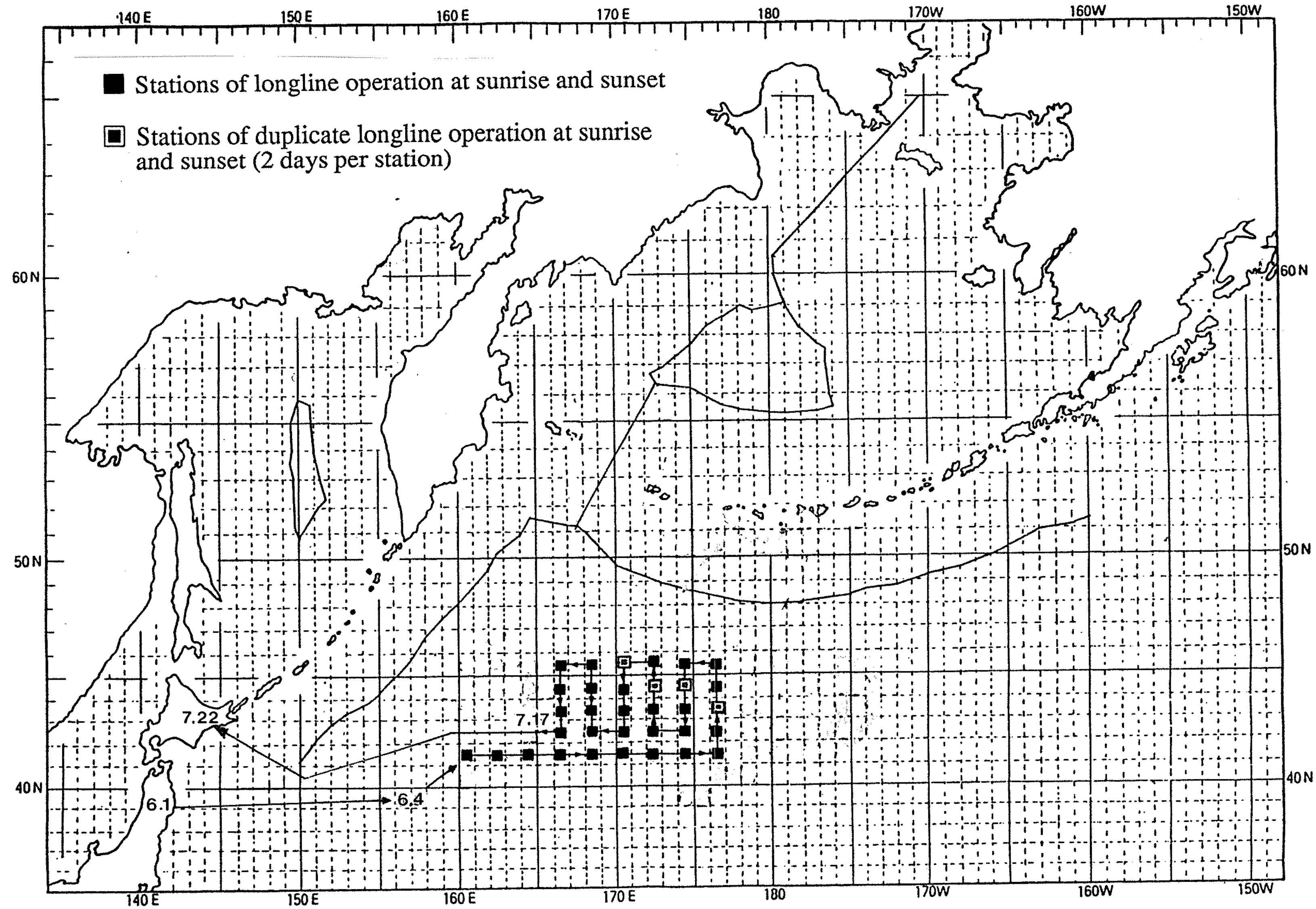

Figure 1. Cruise plan for the 1988 summer longlining cruise of the Japanese research vessel Shin Riasu Maru.

Table 1. Number and percent of fish tagged and released in all 74 longline sets during the 1988 cruise of the Japanese research vessel *Shin Riasu maru*, 1 June to 22 July.

Species	Total catch (%)	Number tagged (%)
Chum	3,700 (57.4)	1,145 (30.9)
Pink	1,676 (26.0)	511 (30.5)
Coho	816 (12.7)	243 (29.8)
Sockeye	156 (2.4)	50 (32.1)
Steelhead	62 (1.0)	12 (19.4)
Chinook	34 (0.5)	10 (29.4)
All Salmonids	6,444 (100.0)	1,971 (30.6)

Table 2. Comparison of catch and tagging rates for morning and evening longline sets made during the 1988 cruise of the Japanese research vessel *Shin Riasu maru*, 1 June to 22 July 1988.

Time of set	No. of sets	Number (%) hachi fished	Catch (% of total)	No. of fish per hachi	Number (%) tagged
Morning	36[1]	1,800 (61.9)	4,637 (72.0)	2.58	1,323 (28.5)
Evening	37	1,110 (38.1)	1,802 (28.0)	1.62	647 (35.9)
Total	73	2,910 (100.0)	6,439 (100.0)	2.21	1,970 (30.6)

[1] Data from the morning set on 11 June were not included because fewer than 30 hachi were fished (exact number unknown). Only 5 salmonids were caught, and only one of these was tagged.

Table 3. Capture locations and biological data for adipose-clipped steelhead and coho caught during the 1988 cruise of the Japanese research vessel *Shin Riasu maru*, 1 June to 22 July.

Species	Date	Time	Capture location N. latitude	E. longitude	Length (mm)	Body wt. (g)	Sex
steelhead	June 10	a.m.	41°29'	164°32'	580	2150	M
steelhead	June 13	p.m.	41°30'	168°31'	582	1740	M
steelhead	June 14	a.m.	41°27'	170°36'	812	6400	F
steelhead	June 14	a.m.	41°27'	170°36'	782	5200	F
steelhead	June 14	a.m.	41°27'	170°36'	544	1580	M
steelhead	June 14	a.m.	41°27'	170°36'	574	1700	M
steelhead	June 15	a.m.	41°23'	172°21'	572	1700	F
steelhead	June 15	a.m.	41°23'	172°21'	568	1580	F
steelhead	June 16	p.m.	41°27'	176°25'	590	1800	M
steelhead	June 16	p.m.	41°27'	176°25'	604	1940	M
steelhead	June 17	a.m.	41°27'	176°25'	568	1720	M
steelhead	June 17	a.m.	41°27'	176°25'	578	1740	M
steelhead	June 17	a.m.	41°27'	176°25'	601	1840	M
steelhead	June 17	p.m.	42°29'	176°31'	790	5100	M
steelhead	June 17	p.m.	42°29'	176°31'	568	1620	M
steelhead	June 17	p.m.	42°29'	176°31'	570	1840	M
steelhead	June 18	a.m.	42°29'	176°31'	564	1580	M
steelhead	June 18	a.m.	42°29'	176°31'	584	1800	M
steelhead	June 18	a.m.	42°29'	176°31'	596	2060	M
steelhead	June 18	p.m.	43°32'	176°31'	593	2130	F
steelhead	June 18	p.m.	43°32'	176°31'	592	2940	M
steelhead	June 21	a.m.	44°30'	176°24'	746	5150	M
steelhead	June 21	a.m.	44°30'	176°24'	740	4100	F
steelhead	June 26	p.m.	42°31'	174°38'	565	1760	F
steelhead	June 29	p.m.	44°32'	172°39'	716	3300	M
steelhead	June 30	a.m.	44°32'	172°39'	560	2040	M
steelhead	July 5	p.m.	43°32'	170°22'	510	2600	M
coho	9	a.m.	42°32'	168°32'	560	1880	M
steelhead	10	a.m.	43°28'	168°31'	842	6700	M

Table 4. Comparison of the standard[1] scale collection method used for salmonids on the high seas with an enhanced[2] version of this method designed to improve the percentage of sampled scales that are suitable for use in scale pattern studies (i.e., non-regenerated scales).

Species	Standard method				Enhanced standard nethod			
	Number of scales		Scales rejected due to:		Number of scales		Scales rejected due to:	
	Examined	Rejected	Regeneration	Other[3]	Examined	Rejected	Regeneration	Other[3]
Coho	572	159 (27.8%)	130 (81.8%)	29 (18.2%)	572	5 (0.9%)	5 (100.0%)	0
Chinook	24	8 (33.3%)	6 (75.0%)	2 (25.0%)	24	0	0	0
Steelhead	45	16 (35.6%)	16 (100.0%)	0	45	1 (2.2%)	1 (100.0%)	0
All salmonids	641	183 (28.6%)	152 (83.1%)	31 (16.9%)	641	6 (0.9%)	6 (100.0%)	0

[1]Two scales, one from the preferred area on each side of the fish, mounted on gummed cards at the time of sampling.

[2]In addition to the standard two scales per fish, an extra six or more scales are taken from throughout the preferred area on only one side of the fish, and are stored for later mounting if necessary.

[3]These scale impressions were unsuitable due to "human errors" in collection or mounting, such as collection of the wrong species, mounting scales upside down or overlapping, etc.