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JAPANESE OCEAN SALMON RESEARCH

SYNOPSIS OF OBSERVATIONS ABOARD SHIN RIASU MARU, 11 JUNE TO 20 JULY 1986.

by

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INTRODUCTION

In accordance with cooperative research efforts of the three member nations of the INPFC (Japan, the United States, and Canada), in 1986 United States, Canadian and Japanese scientists participated in fishing for anadromous fish in the west-central North Pacific Ocean to collect data for determination of their continent of origin. This report summarizes observations on fishing, tagging, and data collection procedures, as well as results of sighting surveys for marine mammals and man-made debris conducted while the vessel was in transit to and from fishing stations.

The Japan Marine Resource Research Center (JMRRC) chartered, on behalf of the Japanese Fisheries Agency (JFA), the SHIN RIASU MARU, a training vessel operated by the Miyako Fisheries High School, to sample and tag salmon in international waters. The ship departed Miyako June 11 and returned to Kushiro in northern Japan July 20. The Japanese and Canadian observers left SHIN RIASU July 2 via the TOKO MARU, a JFA fisheries inspection vessel, which was in transit to Kushiro.

Fishing was conducted at the stations shown in Figure 1. During the first part of the cruise (11 June to 3 July) both longlines and gillnets were fished in the area between 168° and 175°E longitude and 42° to 47°N latitude which includes part of the Japanese landbased salmon fishing zone. Oceanographic observations were made at each fishing station and at eight additional positions between the last fishing station and Japan. During the second part of the cruise (4 July to 20 July) repeat gillnet sets were made at five stations in an area south of the Rat Island group of the Aleutian Island chain. No longlines were fished in this area.

In addition to observing the fishing and tagging operations and conducting sighting surveys we attempted to :-

i) collect scale samples

ii) retain all untagged steelhead for shipment to Seattle for further biological analyses

iii) examine the catch for fin-clipped fish and retain the heads of those with a missing adipose for checking for coded-wire tags

iv) videotape fishing and sampling procedures

v) monitor catch per unit effort

vi) weigh fresh and frozen salmon gonads to determine weight loss associated with freezing and defrosting.

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MARINE MAMMAL AND DEBRIS SURVEY

Methods

Observations were made from the bridge (7 m from the water to eye level) or from the flying bridge (9 m above the water). Marine mammals and debris

were usually sighted abeam or ahead of the ship but were occasionally detected abaft. Binoculars (7 X 30) were used to identify and estimate the size of the animals and objects. For each sighting, the distance from the observer to the item and the azimuth from the ship's heading to the item were estimated and recorded with the time of sighting. Geographic coordinates were observed on the ship's satellite navigation system and recorded for each sighting together with the prevailing weather by a crew member which allowed for an uninterrupted survey. In estimating the relative abundance of sighted objects a transect of 50m was assumed. Thus, 1km^2 surveyed is represented by a 20km distance traversed times a 50m transect width.

Results

i) Marine mammals

A total of 1,308 nautical miles (2424km) was surveyed during 109 hours of effort over a period of 27 days. The majority of the effort was expended during Beaufort 1 (34.3%) and 2 (40.5%) sea conditions (Table 1).

During the survey 162 marine mammals were seen. Almost all of the animals could be identified to type (porpoise, whale, seal, etc.) and 111 (69%) could be identified to species (Table 2). The most common animals were porpoise (70%) (mostly Dall's porpoise, Phocoenoides dalli), northern fur seals (Callorhinus ursinus, 13%), and killer whales (Orcinus orca, 5%). Two sperm whales (Physeter macrocephalus), two humpback whales (Megaptera novaeangliae), and one Steller's sea lion (Eumetopias jubatus) were also seen.

The marine mammals encountered during this cruise were usually moving away from the vessel, and it often seemed as though they were fleeing after being

startled by the passage of the ship. On two occasions the animals appeared to actively seek out the ship, once when two Dall's porpoise rode the pressure wave at the ship's bow and, once when two humpback whales repeatedly surfaced, dove, and rolled beside the ship as it drifted.

ii) Marine debris

Floating industry-related objects were sighted on 96 occasions (Table 3). Of these objects, 60% were plastic (styrofoam or other plastic material), 26% were wood, 7% were metal, and 5% were glass. Fiber materials (cardboard, rope, etc.) were rarely encountered. No net debris was seen. The majority of the debris was seen between 40°N and 47°N latitude in the area where most (90%) of the effort was expended. The density of objects was greatest in the area between 40° and 42°N latitude, (Table 4), and within this latitudinal band the frequency of sightings decreased with increasing distance from shore (Japan). No debris was seen between 47° and 52°N.

Sea conditions were a major factor governing sighting frequencies. The majority of the sightings were made when seas were relatively calm (Beaufort 1-2). Whenever seas were rough enough for whitecaps to form, few marine mammals or debris were seen. Most of the objects seen (56%) were within 50 m of the ship.

FISHING

i) Longline Operations

Thirty hachi were fished during each longline operation. Each hachi consisted of a 138 m main line supported by ten white wooden floats

distributed evenly along its length. There were 49 single-barbed hooks per hachi, each attached to a 1 m gangion separated from the next gangion by approximately 1.5 m. A radio buoy and two lighted buoys were attached to one end of the gear (the end first retrieved), and a small 20 cm x 30 cm red float was attached to the terminal end. The longlines were set at dawn or dusk and soaked for about 30 min before retrieval. The gear was set downwind, and retrieved against the wind.

As the line was retrieved, hooked fish were dip-netted from the water and placed onto a foam rubber mat and dehooked. If a fish bled heavily or the hook was too deep in the mouth to reach or the fish was in poor condition, it was retained for later sampling. If in good condition, the fish was put into a flowing seawater live box (wooden, 1 m^2 x .5 m deep) to await tagging.

During tagging, the fish were netted from the live box and put into a u-shaped trough where they were identifed to species, measured for fork length, and two sets of scales collected from the preferred area for USA and Japanese scientists, respectively. The tag, a plastic two-color (red and white) disk tag, was threaded with a plastic lock-strap and inserted anterior to the dorsal fin. The fish was then carried to the side and released.

Sampled fish (mortalities) were processed after the longline retrieval was completed. The fish were sorted to species and laid on the deck where two sets of scales were taken. If scales could not be collected from the desired area an alternate position was selected and recorded. Due to the speed with which fish samples were processed it is possible that some non-preferred scales were taken without being recorded. In addition, the length, weight (gonad and body weight)and sex of the fish were recorded. All weights were measured with a Japanese beam balance. When finished, the fish were cleaned

and rinsed in seawater before being stored in the freezer. Prior to freezing, one set of gills was removed and the body cavity was lightly salted.

In 23 longline operations, 1,632 salmonids (Appendix Table 1) and approximately 566 pomfret were caught. Forty-one percent of the salmon were tagged and released alive. The number and percent of each species in the total catch and the number and percent tagged were as follows:

Species	Total No. Caught	(%)*	Total No. Tagged	(%)**
Sockeye	57	(4)	30	(53)
Chum	722	(44)	320	(44)
Pink	163	(10)	64	(39)
Coho	634	(39)	232	(37)
Chinook	28	(2)	19	(68)
Steelhead	28	(2)	11	(39)
Total	1,632		676	

*Percent of total catch, all species.
**Percent of total catch, each species.

The average maximum soak time (first hachi in to last out) was 128 min, and ranged from 95 to 151 min. The minimum soak (last in to first out) lasted an average of 42 min and ranged from 30 to 51 min.

When an evening and morning longline set were made at the same station (8 of the 15 stations), the average catch of the morning set was approximately one-third higher than the evening set. For example, of the 980 salmon caught at these eight stations, 380 (39%) were caught in the evening, and 600 (61%) were taken during morning operations. The average catch per hachi was approximately 2.4 fish.

Counts were made of the total number of salmonids caught for each 10 hachi

during a standard set of 30 to observe the distribution of the fish. If the fish were distributed randomly then the catch for each grouping of 10 hachi would be approximately equal, i.e., each would have one third of the total catch. It was found that the second and third groups of 10 hachi caught more salmonids than the first in 9 out of 12 morning sets observed; in the evening sets, the first and second groups of hachi had fewer fish than the last. Overall, the third group of 10 hachi caught 33% more salmonids than the first and 9% more than the second. The bias of catch in favor of the third group precludes the attempt to infer fish distributions, random or aggregated. By way of explanation it was apparent that there was a difference of up to 60 minutes soaking between the first 10 hachi and the last 10. Thus there is an obvious relation between the duration of the soak and the catch. A further observation essential to obtaining salmon for tagging is to determine if the condition of the fish deteriorates with duration of soak.

Hooked fish were sometimes lost as they were being brought aboard. The rate of these longline "dropouts" varied according to sea conditions and species, but was primarily dependent upon the skill of the net handler. Some individuals were adept at landing fish, while others sometimes lost their catch in the mildest weather. Most dropouts occurred when the net handler failed to get the net under the fish just as it was being lifted from the water. Less effort was made to recover the pomfret catch than the salmon.

ii) Gillnet operations

At the first seven gillnet stations, 100 tans of monofilament gillnet (70 tans commercial mesh, 30 tans research mesh), (1 tan = 47 m) were fished in

conjunction with longlines. The nets were attached end to end with the different meshes arranged as shown below:

50 tans commercial nets	30 tans research nets	20tans comm. nets

This end set last and retrieved first

115 55 82 138 72 121 63 106 157 93 48
mesh size (mm)

The nets were set at approximately 5PM local time as the ship moved downwind and allowed to soak until the following morning after the longline was retrieved. Time for setting the gillnets averaged 19 minutes, the soak time averaged 13 h 19 min, and retrieval averaged 49 min.

Approximately thirty fish of each species caught were sampled as above. All salmon were gutted, lightly salted and frozen.

The total gillnet catch of 2,787 salmonids (Appendix table 2) was comprised of 37% coho, 33% chum, 17% sockeye and 7% pink and approximately 3% each of chinook and steelhead. Chinook were slightly more abundant than steelhead (89 chinook vs. 71 steelhead). An adipose-clipped coho was caught by commercial mesh in the gillnet set of 25 June at 44°30'N, 171°28'E. The nose was removed from this fish to check for the presence of a coded-wire tag.

Thirty tans of gear (research mesh only) were fished at the repeat-set gillnet stations off the Rat Islands. Gillnet sets made on consecutive days were noticeably different with respect to the daily catch and catch per unit effort (CPUE, fish per tan). The greatest difference in CPUE of sockeye occurred at 51°28'N, 178°30'E (exact positions of the two sets were slightly

different; see Appendix Table 3). The July 7 set produced two fish (.07 fish per tan) and the July 8 catch was 38 fish (1.27 fish/tan). The highest CPUE for sockeye (3.9 fish/tan) occurred at the July 9 station. Chum CPUE was equally variable on consecutive days (Appendix Table 4). For example, from July 5 to July 6 at 50°30'N, 179°30'E, the CPUE decreased by 77%.

Sockeye and chum were caught most frequently in the 63 to 106 mm mesh nets. The highest overall sockeye catch (and CPUE) was in the 93 mm mesh (165 fish, 3.0 fish/tan), and the most effective experimental mesh size for chum was 63 mm (5.5 fish/tan). Mean length from a subsample of 300 sockeye and chum was 430 mm and 394 mm respectively.

Dropouts were more common during gillnet retrieval than during longline operations. Salmonids were less susceptible to dropout than some of the other species such as pollock, pomfret, and Atka mackerel that were caught in the gillnets (see discussion of bycatch below). Large salmon and steelhead were often lightly entangled in the net and dropped free when the net was lifted from the water. If the fish were caught on the forward face of the net (the side where, when lifted during retrieval, the net formed a cradle to catch the loose fish), these dropouts could be saved. Otherwise, except for a few picked up by means of a treble-hooked gaff, they were lost. This ship did not have a "dropout" net stationed aft of the gillnet that is used on some commercial vessels. The speed of the retrieval and the condition of the sea surface were also important in determining the incidence of dropouts. When the net was being taken in very rapidly, or the seas were rough, or both, more fish broke free of the net than during slower retrievals and/or in good sea conditions.

Several species of marine birds, fish, and invertebrates were taken

incidentally to salmon during fishing operations (Table 5). The numbers of fish and squid reported are conservative because they only represent those that were landed. Some species, especially pomfret, pollock, and Atka mackerel, were prone to dropout. For example, during the gillnet retrieval of June 29th, an estimated one-fourth to one-third of the pomfret catch fell free of the net. The bycatch was greater with gillnets than with longlines. Red squid (Gonatus magister) were almost always present in the bycatch. They were most numerous in the smaller (48 - 63 mm) mesh sections of the research gillnet. Japanese squid (Onychoteuthis borealijaponica) were less abundant but were taken with both longlines and gillnets. A single flying squid (Ommastrephes bartrami) was caught by commercial mesh gillnet on 27 June at 42°29'N, 171°30'E (sea surface temp. = 10.6°C). The pomfret catch was large and relatively few salmonids were taken at this station. Occasionally lancetfish (Alepisaurus ferox) and spiny dogfish (Squalus acanthias) were also taken. The seabirds most frequently found entangled in gillnets were tufted puffins (Lunda cirrhata). Three Laysan's albatross (Diomedea immutabilis) and a single storm petrel (Oceanodroma furcata) were hooked by longline gear. These were released alive. No marine mammals were caught in the fishing gear.

Eighteen of the total catch of 99 steelhead were missing the adipose fin. The snouts of these fish were saved to check for the presence of coded-wire tags. All gillnet-caught steelhead and the longline-caught steelhead that were not tagged and released were frozen whole for shipment to Seattle for further processing. Steelhead were the largest salmonid caught. It appeared that their size contributed to the high frequency of dropouts for this species in both gear types.

iii)Fresh vs. Defrosted Gonad Weight Comparison

Gonads from 14 male and 14 female salmon (species was not recorded) were weighed fresh and again, following refreezing and defrosting, for three subsequent times. Each weighing was performed with the same balance. The balance was wetted and tared before each weighing, and in all cases the tare weight was 1.5 g (samples weighed by the crew on deck were not adjusted for wet-pan weight). After the first defrosting, the gonads were initially weighed in the bag to check against fresh weights before any fluid was lost, then weighed out of the bag.

In general, ovaries lost little fluid between freezings, whereas testes fluid loss increased with each freezing-defrosting. Female gonads lost about 1.2% of their weight between each weighing (Table 6). Male gonads lost from 2.3% to 4% of their weight with each weighing. The differences between fresh weight and the first defrost weight while in the bag were not large (no more than ±0.5 g). These differences may be solely due to the accuracy of the hand balance. Any weight loss was through fluid loss, and this was evidenced by the fluid left in the bags after removing the gonads. Since the weights of the gonads after first defrosting were not greatly different from fresh weights, and since the weight differences increased with successive freeze-thaws, the best results will come about through weighing freshly defrosted gonads from fish that have been frozen only once. The maximum weight loss for an individual fish's gonads (from fresh weight to the final defrosting) was 20% for females (5 g to 4 g), and 24.6% for males (36.5 g to 27.5 g). The smallest percent change was zero percent for females (accounting for 36% of the total sample), and 4.6% for males.

Catch data provided by the chief scientist aboard the SHIN RIASU MARU are shown as Appendix Tables 1, 2, 3 and 4.

Table 1. Sighting survey effort (in hours and minutes) by sea surface conditions during the 1986 salmon research cruise of the SHIN RIASU MARU.

Date	Beaufort Number						Total		
	0	1	2	3	4	5	Effort	nmi	Area Covered* (km^2)
6-12		8:00					8:00	107.2	5.36
6-13			2:37	2:19			4:56	62.6	3.13
6-14				2:06	2:00		4:06	48.8	2.44
6-15			6:14				6:14	72.4	3.62
6-17					1:15	1:15	2:30	28.5	1.43
6-19				3:35			3:35	40.0	2.00
6-20			4:00				4:00	45.5	2.28
6-21		3:35					3:35	41.9	2.10
6-22		8:07					8:07	99.6	4.98
6-23		4:07					4:07	46.4	2.32
6-24			2:13	2:13			4:26	50.7	2.54
6-25			3:34				3:34	39.3	1.96
6-26				4:15	0:21		4:36	55.8	2.79
6-27		6:26					6:26	66.7	3.34
6-28	0:59	1:26	1:32				3:57	47.3	2.36
6-29			1:42	1:41			3:23	40.0	2.00
7-01			1:40				1:40	19.7	0.99
7-02				3:00			3:00	37.3	1.86
7-03			1:37	1:01			2:38	29.3	1:46
7-04				0:27	0:27		0:54	8.5	0.42
7-06			1:00				1:00	11.2	0.56
7-10			1:58				1:58	43.9	2.20
7-12			3:01				3:01	35.9	1.80
7-15			4:46				4:46	53.1	2.66
7-16		1:41	3:29				5:10	61.2	3.06
7-17		1:03	3:42				4:45	59.1	2.96
7-18		3:07	1:11	0:41			4:59	56.6	2.83

*Assuming a 50 m transect width.

Table 2. Summary of marine mammals seen in the North Pacific Ocean while conducting sighting surveys aboard the Japanese salmon research vessel SHIN RIASU MARU, June-July 1986.

Date	Common name and total number seen								Total Effort (hrs and min)
	Dall's Porpoise	Northern Fur Seal	Killer Whale	Steller's Sea Lion	Sperm Whale	Humpback Whale	Unident. Dolphin	Unident. Whale	
6-12	11	4		1				2	8:00
6-13	28		5						4:56
6-14	6	1							4:06
6-15	2	2					4	3	6:14
6-17			Nothing Seen						2:30
6-19			Nothing Seen						3:35
6-20							5		4:00
6-21			2		2		5	2	3:35
6-22	7		1				2		8:07
6-23		1							4:07
6-24			Nothing Seen						4:26
6-25							3		3:34
6-26		1							4:36
6-27	9	10					9		6:26
6-28	5	1					5		3:57
6-29			Nothing Seen						3:23
7-01			Nothing Seen						1:40
7-02			Nothing Seen						3:00
7-03			Nothing Seen						2:38
7-04			Nothing Seen						:54
7-06			Nothing Seen						1:00
7-10	3								1:58
7-11						2*			0
7-12	2	1							3:01
7-15								3	4:46
7-16			Nothing Seen						5:10
7-17	7						4		4:45
7-18			Nothing Seen						4:59
Total	80	21	8	1	2	2	37	10	109:23

*Observed while the vessel was drifting.

Table 3. Description of objects observed adrift on the surface of the North Pacific Ocean, June-July 1986.

Material	Object	Number Seen
Plastic	bag	1
	bottle	2
	cooler lid	1
	float	15
	foamrubber	1
	fragment	21
	plate	2
	sheet	20
	unidentified	1
Wood	block	4
	board	4
	box	1
	bucket	1
	dowel	1
	log	9
	stump	1
Glass	bottle	4
Fiber	cardboard	1
	webbing	1
Metal	can	2
	float	3

Table 4. Latitudinal distribution of the distance and area surveyed and the estimated density of plastic objects observed on the surface of the North Pacific Ocean in June-July 1986.

Lat. (°N)	Distance Surveyed (nmi)	Area Surveyed* (km2)	Total No. of Objects Observed No.	Objects per nmi X 100	No. of objects seen 0-50m from ship	Density of objects** (No. per km2)	No. of Plastic Objects Seen 0-50m from ship (%)	Density of Plastic Objects** (No. per km2)
51-52	18.0	0.9	0	0	0	0	0	0
50-51	81.5	4.1	0	0	0	0	0	0
49-50	0	0	-	-	-	-	-	-
48-49	16.9	0.8	0	0	0	0	0	0
47-48	12.4	0.6	0	0	0	0	0	0
46-47	233.0	11.7	8	3.43	6	0.51	1(17)	0.09
45-46	119.0	5.9	6	5.04	4	0.68	3(75)	0.51
44-45	199.8	10.0	10	5.00	5	0.50	1(20)	0.10
43-44	161.7	8.1	12	7.42	4	0.49	2(50)	0.25
42-43	223.4	11.2	13	5.82	8	0.71	5(63)	0.45
41-42	72.0	3.6	0	0	6	1.67	6(100)	1.67
40-41	169.8	8.5	47	27.68	21	2.47	15(71)	1.76

*Using a transect width of 50 m.
**Assuming all objects larger than 2.5 x 2.5 x 2.5 cm were seen within the transect.

Table 5. Comparison of total daily catch, catch per mesh size, and CPUE (fish per tan) of chum taken during repeat gillnet operati ons in the North Pacific Ocean, July 1986.

Mesh Size (mm)	Date of Retrieval 7-05	7-06	7-07	7-08	7-09	7-10	7-11	7-12	7-13	7-14	Total Catch	CPUE
48	0	1	0	0	0	0	0	0	0	0	1	.033
55	8	1	3	5	1	4	5	6	1	0	34	1.133
63	52	16	11	29	14	17	6	5	8	7	165	5.500
72	4	5	4	26	5	13	8	8	16	5	94	3.133
82	17	2	8	27	10	0	0	3	4	1	72	2.400
93	23	5	10	12	5	2	2	0	5	2	66	2.200
106	32	2	0	3	4	4	1	3	2	4	55	1.833
121	5	1	2	2	0	1	0	2	1	1	15	.500
138	0	0	3	0	0	0	0	1	2	1	7	.233
157	0	0	2	1	1	0	0	1	2	0	7	.233
Total Catch	141	33	43	105	40	41	22	29	41	21	516	1.720
CPUE	4.70	1.10	1.43	3.50	1.33	1.37	.73	.97	1.37	.70	1.72	

Table 6. List of animals caught incidentally to salmon by gillnet and longline fishing operations in the North Pacific Ocean in June and July, 1986.

Name	Number
SQUID	
Japanese squid (*Onychoteuthis borealijaponica*)	55
Red Squid (*Gonatus magister*)	278
FISH	
Atka mackerel (*Pleurogrammus monopterygius*)	42
Lancetfish (*Alepisaurus ferox*)	4
Pacific pollock (*Theragra chalcogramma*)	561
Pacific pomfret (*Brama japonica*)	863
Ragfish (*Icosteus aenigmaticus*)	1
Skilfish (*Erilepis zonifer*)	1
Salmon shark (*Lamna ditropis*)	1
Spiny dogfish (*Squalus acanthias*)	7
SEABIRDS	
Common murre (*Uria aalge*)	1
Fork-tailed storm petrel (*Oceanodroma furcata*)	1
Horned puffin (*Fratercula corniculata*)	2
Laysan albatross (*Diomedea immutabilis*)	3
Short-tailed shearwater (*Puffinus tenuirostris*)	6
Sooty shearwater (*Puffinus griseus*)	1
Tufted puffin (*Lunda cirrhata*)	16

Table 7. Weight comparison of fresh and defrosted gonads from chum, sockeye, and pink salmon collected in the North Pacific Ocean, June-July 1986.

Sex	Fish number	Fresh weight (g)	Defrosted weight (g) 1	2	3	4	Percent change (max.-min.)
Female	1	9.0	9.0	9.0	9.0	9.0	0
"	2	11.5	11.5	11.5	11.0	11.0	4.4
"	3	6.5	6.5	6.5	6.5	6.5	0
"	4	7.0	7.0	7.0	7.0	6.5	7.1
"	5	6.5	6.5	6.5	6.5	6.0	7.7
"	6	6.0	6.0	6.0	6.0	6.0	0
"	7	9.5	9.5	9.0	9.5	9.5	0
"	8	9.5	9.5	9.5	9.0	9.0	5.3
"	9	7.5	7.5	7.0	6.5	7.0	6.7
"	10	5.0	5.0	5.0	4.0	4.5	20.0
"	11	6.0	6.0	5.5	5.5	5.5	8.3
"	12	12.0	12.0	12.0	12.0	11.5	4.2
"	13	9.0	9.0	9.0	9.0	9.0	0
"	14	8.0	7.5	7.5	8.0	8.0	6.2
	Mean	8.1	8.0	7.9	7.8	7.8	3.7
	S.D.	+2.1	+2.1	+2.1	+2.2	+2.1	
Male	1	13.5	13.5	13.0	12.5	12.5	7.4
"	2	35.0	35.0	34.0	32.5	30.0	14.3
"	3	91.0	91.0	85.0	80.5	77.5	14.8
"	4	36.5	36.0	34.0	30.5	27.5	24.6
"	5	19.5	19.0	19.0	18.0	17.5	10.3
"	6	25.0	25.5	24.5	23.5	21.0	16.0
"	7	40.0	40.5	39.5	37.5	33.5	16.2
"	8	40.0	42.5	42.0	41.0	41.0	6.2
"	9	22.0	22.5	22.0	21.5	21.0	4.6
"	10	64.5	64.0	63.0	60.5	59.0	8.5
"	11	65.5	63.5	64.0	60.0	60.0	8.4
"	12	54.0	52.5	52.0	52.0	52.0	3.7
"	13	83.0	76.5	77.5	75.0	75.0	9.6
"	14	22.0	22.5	22.0	21.5	21.0	4.6
	Mean	44.2	43.2	42.2	40.5	39.2	11.3
	S.D.	+24.7	+23.4	+22.8	+21.8	+21.8	

Appendix Table 1. Summary of salmon and steelhead caught during longline operations of the SHIN RIASU MARU in the North Pacific Ocean, June-July, 1986.

Date	Lat. (xN)	Long. (xE)	Station No.	Sea Surface Temp. (xC)	Catch (Number Tagged) Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total
6-16	42x27'	168x26'	1	6.4	0	3 (2)	18 (7)	12 (7)	3 (2)	1 (1)	37 (19)
6-17	42x27'	168x26'	1	6.4	1	9 (4)	17 (6)	18 (4)	3 (3)	0	48 (17)
6-19	43x30'	168x31'	2	5.2	1	6 (3)	2 (1)	2 (1)	0	0	11 (5)
6-19	44x27'	168x32'	3	5.2	5 (4)	28 (11)	21 (9)	12 (7)	2 (2)	0	68 (33)
6-20	44x27'	168x32'	3	5.2	3 (1)	13 (8)	2 (1)	6 (2)	4 (1)	3 (1)	31 (14)
6-21	45x29'	168x31'	4	5.3	7 (3)	30 (16)	36 (15)	6 (3)	3 (3)	1 (1)	83 (41)
6-21	46x30'	168x31'	5	5.9	14 (8)	73 (30)	1 (1)	0	0	0	88 (39)
6-22	46x30'	168x31'	5	5.9	25 (13)	151 (67)	14 (4)	0	0	0	190 (84)
6-23	46x32'	171x32'	6	6.3	1 (1)	28 (10)	2	21 (8)	0	6 (4)	58 (23)
6-23	45x30'	171x30'	7	6.8	0	10 (4)	1	3 (1)	1 (1)	0	15 (6)
6-24	45x30'	171x30'	7	6.8	0	46 (21)	2	23 (5)	2	5 (2)	78 (28)
6-25	44x30'	171x28'	8	7.3	0	28 (9)	33 (13)	181 (66)	3 (2)	0	245 (90)
6-25	43x30'	171x30'	9	9.2	0	3	1	5 (2)	0	0	9 (2)
6-26	43x30'	171x30'	9	9.2	0	3 (1)	4	4 (1)	1 (1)	0	12 (3)
6-27	42x29'	171x30'	10	10.6	0	0	1 (1)	15 (4)	0	0	16 (5)
6-27	42x31'	174x32'	11	11.6	0	2 (2)	0	42 (16)	0	0	44 (18)
6-28	42x31'	174x32'	11	11.6	0	10 (2)	0	64 (30)	0	1 (1)	75 (33)
6-29	43x33'	174x32'	12	8.4	0	16 (7)	2 (2)	36 (9)	0	0	54 (18)
6-30	44x30'	174x30'	13	8.1	0	30 (11)	0	18 (4)	1	1	50 (15)
7-01	44x30'	174x30'	13	8.1	0	62 (25)	0	61 (16)	0	1	124 (41)
7-02	45x31'	174x30'	14	7.6	0	100 (51)	3 (1)	48 (21)	1 (1)	2 (0)	154 (74)
7-02	46x29'	174x29'	15	6.9	0	39 (23)	3 (3)	20 (13)	3 (2)	4	69 (41)
7-03	46x29'	174x29'	15	6.9	0	32 (13)	0	37 (12)	1 (1)	3 (1)	73 (27)
					57 (30)	722 (320)	163 (64)	634 (232)	28 (19)	28 (11)	1632 (676)

Appendix Table 2. Summary of salmon and steelhead caught during gillnet operations of the SHIN RIASU MARU in the North Pacific Ocean, June-July, 1986.

Date	Lat. (°N)	Long. (xE)	Station No.	Sea Surface Temp. (°C)	Catch						
					Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total
6-19	43°30'	168°31'	2	5.2	6	70	14	11	3	7	111
6-21	45°29'	168°31'	4	5.3	70	112	105	43	24	2	356
6-23	46°32'	171°32'	6	6.3	12	62	5	219	28	26	352
6-25	44°30'	171°28'	8	7.3	0	26	49	359	6	13	453
6-27	42°29'	171°30'	10	10.6	0	4	2	54	2	4	66
6-29	43°33'	174°32'	12	8.4	0	90	5	141	4	9	249
7-02	45°31'	174°30'	14	7.6	0	43	5	205	7	8	268
7-05	50°30'	179°30'	16-1	7.1	35	141	1	0	0	0	177
7-06	50°30'	179°29'	16-2	7.1	50	33	0	1	1	0	85
7-07	51°28'	178°30'	17-1	5.9	2	43	0	1	0	0	46
7-08	51°22'	178°22'	17-2	6.5	38	105	0	0	2	0	145
7-09	51°30'	177°29'	18-1	6.5	118	40	2	1	2	0	163
7-10	51°29'	177°27'	18-2	7.4	57	41	2	1	1	0	102
7-11	50°30'	177°31'	19-1	8.6	16	22	1	1	4	0	44
7-12	50°30'	177°30'	19-2	8.1	18	29	0	0	0	1	48
7-13	50°29'	175°32'	20-1	8.3	16	41	0	3	2	0	62
7-14	50°30'	175°29'	20-2	8.3	33	21	0	2	3	1	60
					471	923	191	1042	89	71	2787

Appendix Table 3. Comparison of total daily catch, catch per mesh size, and CPUE (fish per tan) of sockeye taken during repeat gil lnet operations in the North Pacific Ocean, July 1986.

Mesh Size (mm)	Date of Retrieval										Total Catch	CPUE
	7-05	7-06	7-07	7-08	7-09	7-10	7-11	7-12	7-13	7-14		
48	0	0	0	0	2	2	0	0	0	0	4	.133
55	1	2	0	2	4	1	0	0	0	0	10	.333
63	4	8	1	8	25	6	1	0	0	0	53	1.767
72	5	8	0	4	23	4	0	1	0	1	46	1.533
82	6	6	0	5	14	19	1	8	2	4	65	2.167
93	8	8	0	7	24	12	3	4	7	17	90	3.000
106	9	6	1	6	20	12	8	1	1	9	73	2.433
121	2	11	0	2	2	1	2	2	5	0	27	.900
138	0	0	0	1	3	0	1	2	1	1	9	.300
157	0	1	0	3	1	0	0	0	0	1	6	.200
Total Catch	35	50	2	38	118	57	16	18	16	33	383	1.277
CPUE	1.17	1.67	.07	1.27	3.93	1.90	.53	.60	.53	1.10	1.28	

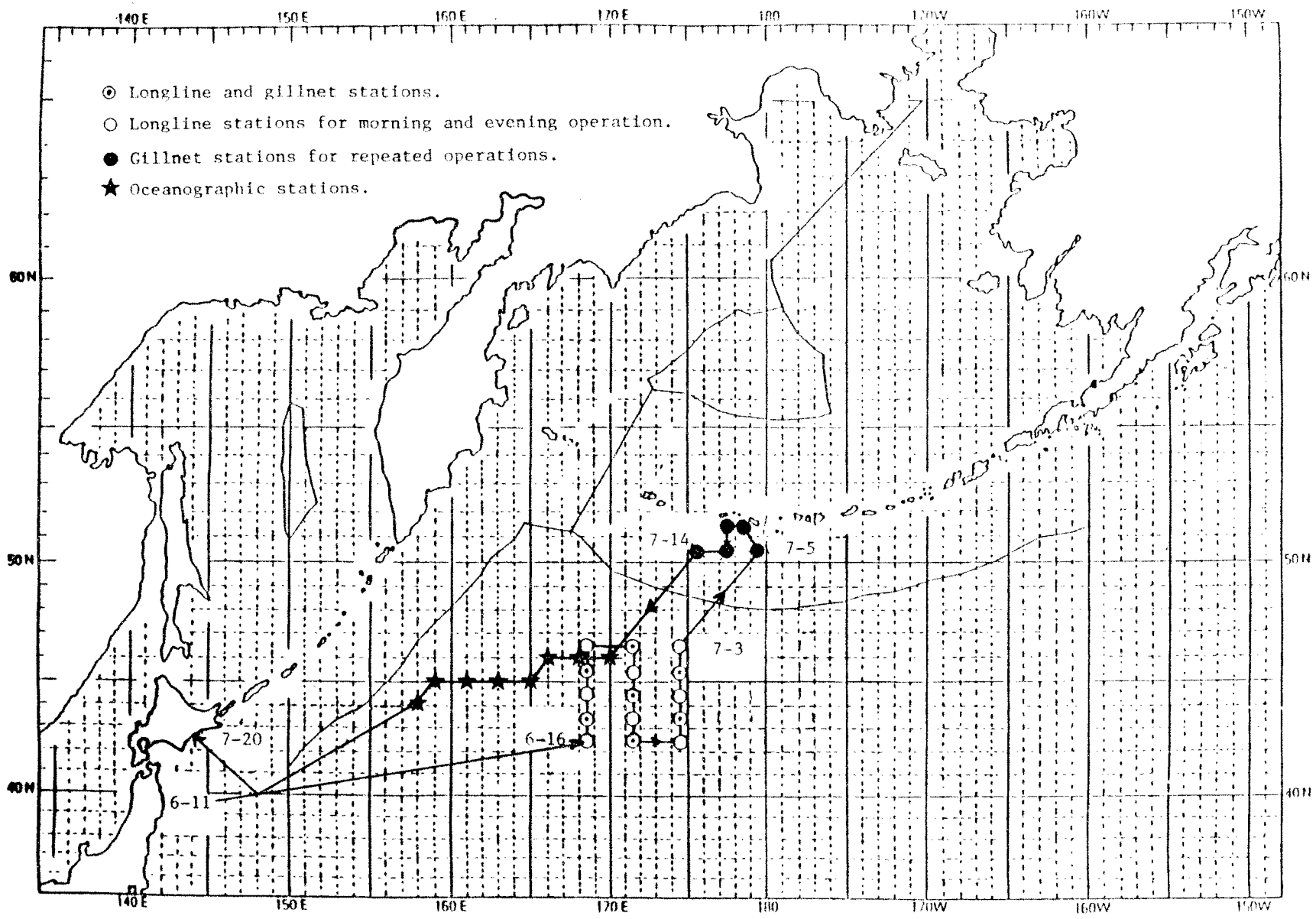

Figure 1. 1986 summer cruise of the Japanese salmon research vessel Shin Riasu Maru.