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SUMMARY OF COOPERATIVE U.S.-JAPAN HIGH SEAS SALMONID RESEARCH ABOARD THE JAPANESE RESEARCH VESSEL OSHORO MARU, 1993

by

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ABSTRACT

Preliminary information is presented from salmon research conducted in June and July, 1993 by a scientist from the Fisheries Research Institute (FRI), University of Washington, aboard the Oshoro maru in cooperation with the Faculty of Fisheries, Hokkaido University. The research was focussed on various aspects of salmon growth and ecology. Sixteen stations were fished along two transects: along 180° between 36°N and 43°N, and in the Gulf of Alaska generally southwest to northeast from 51°N, 160°W to 56°N, 142°W. Variable mesh gillnet took 82 salmonids from 39° to 43° N along 180°, and took 2,574 salmonids in the Gulf of Alaska. Two coho salmon were caught with longline gear, tagged, and released at 42°N, 180°. Sixty-two salmonids were caught with longline gear in the Gulf of Alaska, and of these 54 were tagged and released. One chum salmon tagged in the Gulf of Alaska was recovered in Cook Inlet, Alaska. Coded-wire tags were found in two coho lacking adipose fins caught in the Gulf of Alaska at 55°13'N, 146°W; the fish were released from hatcheries near Anchorage and Juneau, Alaska. Stomachs of 46 chum salmon caught along 180° contained copepods and well-digested unidentifiable material, while 25 coho stomachs contained squid and large pteropods; one steelhead stomach contained squid. In the Gulf of Alaska, 442 stomachs (104 sockeye, 101 chum, 105 pink, 81 coho, 27 chinook, and 24 steelhead) were collected. Small hyperiid amphipods, euphausiids, small pteropods, copepods, and squid were the main prey of most individuals of all species. Muscle samples collected from 38 fish (16 sockeye, 18 chum, 3 pink and 1 coho) in the Gulf of Alaska will be dried to determine moisture content as an indirect measure of the condition of the fish; results will be reported later. Five whole salmon (two coho and three pink salmon) will also be analyzed later for caloric content.

INTRODUCTION

Scientists from the University of Washington have been allowed to conduct fisheries and oceanographic research aboard the training and research vessel T/V Oshoro maru, and in 1988 the Faculty of Fisheries, Hokkaido University, and the College of Ocean and Fishery Sciences, University of Washington, signed a sister school agreement. In 1993 the Faculty of Fisheries accepted a proposal for a scientist from the Fisheries Research Institute (FRI), University of Washington, to conduct salmon research aboard the Oshoro maru. This report is a preliminary account of that research, and does not cover research conducted by Hokkaido University scientists and students.

The focus of FRI research on this cruise was on various aspects of salmon growth and ecology. Scale samples were collected for growth studies and for comparison with scales collected in the same areas in the past. Stomach contents and samples and data related to condition factors, such as moisture content of muscle tissue and weight and length data, were collected to assess the effect of oceanographic conditions, possible interactions between salmonid species and between wild and hatchery production, and changes from previous years.

METHODS

The Oshoro maru departed Hakodate on June 4, 1993, and arrived in Seattle on July 9, 1993. Salmon research was conducted along two transects: at eight stations along 180° between 36°N and 43°N, and at eight stations in the Gulf of Alaska along a generally southwest-northeast transect from 51°N, 160°W to 56°N, 142°W (Fig. 1; Table 1). Fishing at three stations was cancelled due to weather conditions (one at 35°N, 180°, and two in the Gulf of Alaska at 52°49'N, 152°00'W and 53°38'N, 150°00'W). Oceanographic sampling (CTD casts and water samples for numerous chemical analyses) was conducted by Hokkaido University scientists at each station before gillnet set and between each station. The Subarctic Boundary as defined by Favorite et al. (1976; vertical 34‰ isohaline, which corresponds closely to the location of the 34‰ isohaline at 100m) and Roden (1991; outcrop of 33.8‰ isohaline) was crossed at about 42°N.

Gillnet sampling

Gillnet sampling was conducted at all 16 stations. Total amount of gillnet gear used was 49 tans (19 tans of commercial mesh, 30 tans of research mesh; each tan is 50 m long), with mesh sizes ranging from 48 to 157 mm (Table 2). Gillnet gear was set in the evening, allowed to soak overnight, and was retrieved the following morning.

Longline sampling

Longline sampling was conducted at five stations along 180° and at six stations in the Gulf of Alaska (Table 1). Total amount of longline gear fished was 10 hachi at each station, each hachi consisting of 34 hooks and gangions attached to 127 m of mainline. Longlines were set in the early morning, fished for one and one-half to two and one-half hours, and retrieved after retrieval of the gillnet.

Tagging

All viable fish caught on longlines were tagged with 1/2" and 3/4" red and white Petersen disk tags and released. Tags provided by FRI were used in addition to Fisheries Agency of Japan (FAJ) tags, in order to test whether presence of a North American return address would improve return of tags by U.S. and Canadian fishermen.

Fish lacking adipose fins

By prior arrangement with FAJ, heads were collected from salmonids lacking adipose fins. Heads were frozen aboard the Oshoro maru and taken to FRI in Seattle, where they were salted and sent to Auke Bay Laboratory, U.S. National Marine Fisheries Service (NMFS), for examination for coded-wire tags.

Scale sampling

Scale samples were collected by Oshoro maru personnel from all longline-caught fish and from up to 30 fish of each species caught in each mesh size of gillnet gear used in each set.

Stomach contents

Stomach contents were examined from up to 15 fish of each species from each gillnet set. The methods followed those of Davis (1990) and Ishida et al. (1991). Stomachs were removed from the esophagus to the pyloric valve. The fullness of each stomach was estimated on a scale from zero to four, and the degree of digestion of the contents was rated on a scale of three stages (fresh, medium, well-digested). Each stomach was weighed to the nearest gram, the contents removed, and the empty stomach reweighed. The difference in weights was used as the weight of the contents. The contents were examined visually without magnification and classified to the following major prey categories: fish, squid, copepods, euphausiids, amphipods, pteropods,

appendicularia, chaetognaths, gelatinous zooplankton, mysids, zoea, polychaetes, shrimp, isopods, and unidentified materials. Percent volume of each prey category was estimated subjectively.

Condition factors and caloric contents

Muscle samples were collected from salmon in the Gulf of Alaska to determine moisture content. Water content of muscle is inversely related to fat content and is an indirect measure of the condition of the fish. A transverse section approximately 2-3 cm thick was taken from just behind the pectoral fins. Moisture samples were weighed to the nearest gram, frozen, and taken to FRI for drying in a drying oven. Length and weight data were also copied for use in estimating condition from weight per length ratios. A few whole salmon were collected and frozen for later caloric content analysis at FRI.

RESULTS AND DISCUSSION

Gillnet sampling

Along 180°, 82 salmonids (56 chum, 25 coho, 1 steelhead) were caught at five stations from 39° to 43° N (Table 3). In the Gulf of Alaska, 2,574 salmonids (1,117 sockeye, 559 chum, 592 pink, 219 coho, 59 chinook, and 28 steelhead; Table 3) were caught at eight stations.

Longline sampling and tagging

Two coho salmon were caught, tagged, and released at station 7 (42°N, 180°). Sixty-two salmonids were caught in the Gulf of Alaska (7 sockeye, 30 chum, 3 pink, 15 coho, 2 chinook, and 5 steelhead), and of these 54 (6 sockeye, 26 chum, 3 pink, 13 coho, 1 chinook, and 5 steelhead) were tagged and released (Table 4).

One recovery has been reported from the tag releases thus far in 1993. A chum salmon tagged at station 13 was recovered by a commercial fisherman in Cook Inlet, Alaska on July 30 (Ogura 1993).

Fish lacking adipose fins

Seven heads were collected from salmonids lacking adipose fins (Table 5): three steelhead, two coho, and two pink salmon. All were caught in the Gulf of Alaska. Snouts from these salmonids were sent to the Auke Bay Laboratory, NMFS for detection of coded-wire tags that may have been present. None of the steelhead and pink salmon were found to contain coded wire tags. The two coho were caught at 55°13'N, 146°W and contained tags from Bird Creek near Anchorage, Alaska and Gastineau Channel near Juneau, Alaska (Dahlberg et al. 1993).

One steelhead trout lacking the adipose fin was caught on longline gear at station 13 (54°27'N, 147°58'W). It was tagged with disc tags KK1043 (FAJ) and EE0043 (FRI) and released, because of the relatively low probability that it contained a coded-wire tag (see Table 6 in Dahlberg et al. 1992).

Scale collection

Acetate impressions of scale cards collected by Oshoro maru personnel were made at FRI during the Seattle port call. Accompanying biological data sheets were also copied. Scale samples will be analyzed later. By request of the Pacific Salmon Commission (PSC), Vancouver, biological data and scale cards of sockeye salmon were also copied for the PSC.

Stomach contents

Because of damage to some stomachs during removal, accurate estimates of stomach fullness and content weight were not always possible. In this report, only

frequency of occurrence (proportion of non-empty stomachs containing each prey category) is presented (Table 6). A future report will contain data on prey weight and estimated percent composition of each prey category.

Along 180°, 72 stomachs were examined (46 chum, 25 coho, 1 steelhead). Chum stomachs contained copepods and well-digested unidentifiable material, while coho stomachs contained squid and large pteropods. The steelhead stomach contained squid (Table 6).

In the Gulf of Alaska, 442 stomachs (104 sockeye, 101 chum, 105 pink, 81 coho, 27 chinook, and 24 steelhead) were collected. (Of these, fifty stomachs from stations 9, 10, and 12 in the Gulf of Alaska were frozen and will be analyzed later.) Small hyperiid amphipods, euphausiids, small pteropods, copepods, and squid were the main prey of most individuals of all species (Table 6).

Condition factors and caloric contents

Muscle samples were collected from 38 fish (16 sockeye, 18 chum, 3 pink and 1 coho; Table 7) in the Gulf of Alaska to determine moisture content. The samples will be dried and results will be reported later. Five whole salmon (two coho and three pink salmon) will also be analyzed later for caloric content (Table 7).

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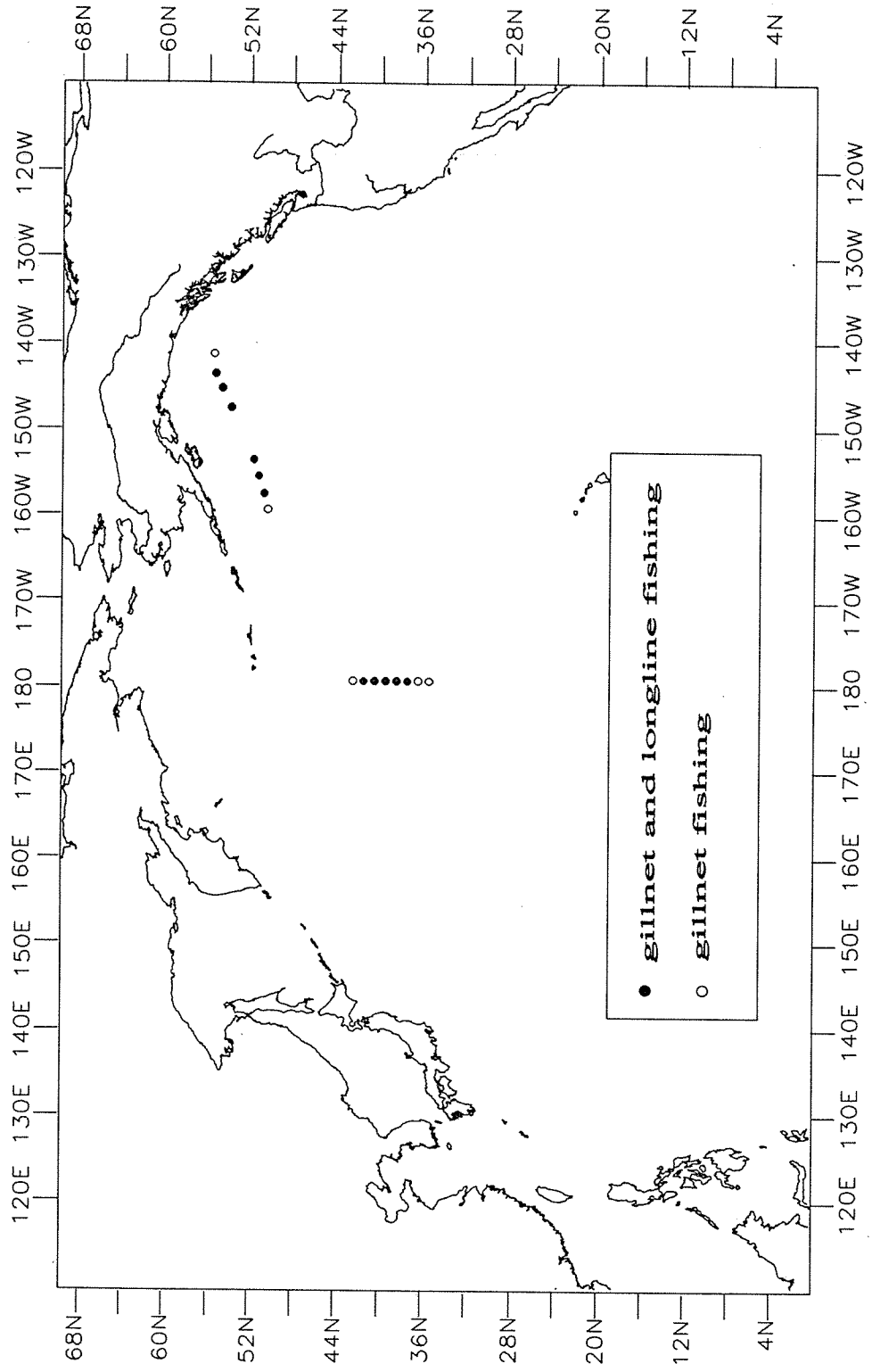

Figure 1. Location of fishing stations, Oshoro maru cruise, 4 June to 9 July, 1993.

Table 1. Fishing stations of T/V Oshoro maru cruise, June-July 1993

Station	Date	Location	Gear	Sea Temperature		Salinity	
				Surface	100 m	Surface	100 m
1	6/10-11	36°00'N, 179°59'W	Gillnet	16.8	12.9	34.5	34.4
2	6/11-12	36°59'N, 179°59'W	Gillnet	15.3	11.8	34.3	34.3
3	6/12-13	38°00'N, 179°59'W	Gillnet	14.6	12.6	33.6	34.4
	6/13	38°01'N, 179°48'W	Longline	14.6			
4	6/13-14	39°00'N, 179°58'W	Gillnet	12.7	10.1	33.3	34.2
	6/14	38°56'N, 179°58'E	Longline	12.6			
5	6/14-15	40°00'N, 180°00'	Gillnet	13.5	10.8	34.3	34.2
	6/15	40°04'N, 179°55'E	Longline	13.6			
6	6/15-16	41°00'N, 180°00'	Gillnet	13.9	10.1	34.0	34.1
	6/16	41°02'N, 179°56'E	Longline	12.8			
7	6/16-17	42°00'N, 180°00'	Gillnet	11.1	9.1	34.0	33.8
	6/17	42°08'N, 180°00'	Longline	11.1			
8	6/18	43°00'N, 180°00'	Gillnet	10.7	8.2	33.4	33.9
9	6/28	51°00'N, 160°00'W	Gillnet	7.8	3.8	31.5	32.8
10	6/28-29	51°20'N, 158°00'W	Gillnet	8.2	4.3	31.9	33.5
	6/29	51°21'N, 157°58'W	Longline	8.1			
11	6/29-30	51°40'N, 156°00'W	Gillnet	8.4	4.0	32.5	33.1
	6/30	51°41'N, 155°55'W	Longline	8.2			
12	6/30-7/1	52°00'N, 154°00'W	Gillnet	8.8	4.1	32.5	33.1
	7/1	52°03'N, 153°54'W	Longline	8.7			
13	7/2-3	54°26'N, 147°59'W	Gillnet	9.7	4.0	31.9	33.0
	7/3	54°27'N, 147°58'W	Longline	10.0			
14	7/3-4	55°13'N, 146°00'W	Gillnet	10.6	4.3	32.1	33.0
	7/4	55°13'N, 145°56'W	Longline	10.6			
15	7/4-5	56°00'N, 144°00'W	Gillnet	11.6	5.4	32.4	32.8
	7/5	56°01'N, 143°53'W	Longline	11.8			
16	7/5-6	56°00'N, 142°00'W	Gillnet	12.0	5.2	32.3	32.6

Table 2. Arrangement of gillnet mesh sizes and amount of each mesh size fished from the T/V Oshoro maru, June-July, 1993. (1 tan = 50 m.)

Commercial or Research (A) (C)	Mesh Size (mm)	Amount (no. of tans)
A	115	10
C	48	3
C	93	3
C	157	3
C	106	3
C	63	3
C	121	3
C	72	3
C	138	3
C	82	3
C	55	3
A	121	9
Total		49

Table 3. Salmonid catch of T/V Oshoro maru by commercial (A) and research (C) gillnets, June-July, 1993. SST = sea surface temperature (°C).

Sta.	Date	Location	SST	Gear	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total
180° transect:											
1	6/11	36°00'N	16.8	A	0	0	0	0	0	0	0
		179°59'W		C	0	0	0	0	0	0	0
				A+C	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2	6/12	36°59'N	15.3	A	0	0	0	0	0	0	0
		179°59'W		C	0	0	0	0	0	0	0
				A+C	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	6/13	38°00'N	14.6	A	0	0	0	0	0	0	0
		179°59'W		C	0	0	0	0	0	0	0
				A+C	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	6/14	39°00'N	12.7	A	0	0	0	0	0	0	0
		179°58'W		C	0	1	0	0	0	0	1
				A+C	**0**	**1**	**0**	**0**	**0**	**0**	**1**
5	6/15	40°00'N	13.5	A	0	0	0	0	0	0	0
		180°00'		C	0	1	0	0	0	0	1
				A+C	**0**	**1**	**0**	**0**	**0**	**0**	**1**
6	6/16	41°00'N	13.9	A	0	0	0	0	0	0	0
		180°00'		C	0	12	0	0	0	0	12
				A+C	**0**	**12**	**0**	**0**	**0**	**0**	**12**
7	6/17	42°00 'N	11.1	A	0	3	0	7	0	0	10
		180°00'		C	0	12	0	5	0	0	17
				A+C	**0**	**15**	**0**	**12**	**0**	**0**	**27**
8	6/18	43°00'N	10.7	A	0	0	0	6	0	1	7
		180°00'		C	0	27	0	7	0	0	34
				A+C	**0**	**27**	**0**	**13**	**0**	**1**	**41**
180° transect subtotal:				A	0	3	0	13	0	1	17
				C	0	53	0	12	0	0	65
				Subtotal	**0**	**56**	**0**	**25**	**0**	**1**	**82**

continued

Table 3. Gillnet salmonid catch by T/V Oshoro maru, June-July, 1993. (continued)

Sta.	Date	Location	SST	Gear	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total
Gulf of Alaska transect:											
9	6/28	51°.00'N	7.8	A	11	5	3	2	3	1	25
		160°00'W		C	49	131	22	3	1	2	208
				A+C	**60**	**136**	**25**	**5**	**4**	**3**	**233**
10	6/29	51°20'N	8.2	A	28	1	5	7	4	3	48
		158°00'W		C	32	59	12	2	1	2	108
				A+C	**60**	**60**	**17**	**9**	**5**	**5**	**156**
11	6/30	51°40'N	8.4	A	31	4	5	1	4	1	46
		156°00'W		C	45	33	25	7	1	2	113
				A+C	**76**	**37**	**30**	**8**	**5**	**3**	**159**
12	7/1	52°00'N	8.8	A	50	1	3	13	28	0	95
		154°00'W		C	78	26	15	6	14	7	146
				A+C	**128**	**27**	**18**	**19**	**42**	**7**	**241**
13	7/3	54°26'N	9.7	A	125	4	25	18	1	2	175
		147°59'W		C	84	77	75	18	1	3	258
				A+C	**209**	**81**	**100**	**36**	**2**	**5**	**433**
14	7/4	55°13'N	10.6	A	198	3	42	61	1	1	306
		146°00'W		C	134	95	108	48	0	3	388
				A+C	**332**	**98**	**150**	**109**	**1**	**4**	**694**
15	7/5	56°00'N	11.6	A	86	6	37	17	0	0	146
		144°00'W		C	65	95	113	7	0	0	280
				A+C	**151**	**101**	**150**	**24**	**0**	**0**	**426**
16	7/6	56°00'N	12	A	72	0	21	6	0	1	100
		142°00'W		C	29	19	81	3	0	0	132
				A+C	**101**	**19**	**102**	**9**	**0**	**1**	**232**
Gulf of Alaska transect subtotal:				A	601	24	141	125	41	9	944
				C	516	535	451	94	18	19	1,633
				Subtotal	**1,117**	**559**	**592**	**219**	**59**	**28**	**2,574**
Cruise grand total:				A	601	27	141	138	41	10	958
				C	516	588	451	106	18	19	1,698
				Total	**1,117**	**615**	**592**	**244**	**59**	**29**	**2,656**

Table 4. Longline salmonid catch and tagging by T/V Oshoro maru, June-July, 1993. SST = sea surface temperature (°C).

Sta.	Date	Location	SST		Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total
3	6/13	38°01'N	14.6	Catch	0	0	0	0	0	0	0
		179°48'W		Tagged	0	0	0	0	0	0	0
4	6/14	38°56'N	12.6	Catch	0	0	0	0	0	0	0
		179°58'E		Tagged	0	0	0	0	0	0	0
5	6/15	40°04'N	13.6	Catch	0	0	0	0	0	0	0
		179°55'E		Tagged	0	0	0	0	0	0	0
6	6/16	41°02'N	12.8	Catch	0	0	0	0	0	0	0
		179°56'E		Tagged	0	0	0	0	0	0	0
7	6/17	42°08'N	11.1	Catch	0	0	0	2	0	0	2
		180°00'		Tagged	0	0	0	2	0	0	2
10	6/29	51°21'N	8.1	Catch	0	8	0	3	0	0	11
		157°58'W		Tagged	0	7	0	3	0	0	10
11	6/30	51°41'N	8.2	Catch	1	3	1	1	0	2	8
		155°55'W		Tagged	1	3	1	1	0	2	8
12	7/1	52°03'N	8.7	Catch	2	1	2	3	1	1	10
		153°54'W		Tagged	2	1	2	3	1	1	10
13	7/3	54°27'N	10.0	Catch	2	10	0	4	1	2	19
		147°58'W		Tagged	1	9	0	2	0	2	14
14	7/4	55°13'N	10.6	Catch	2	8	0	4	0	0	14
		145°56'W		Tagged	2	6	0	4	0	0	12
15	7/5	56°01'N	11.8	Catch	0	0	0	0	0	0	0
		143°53'W		Tagged	0	0	0	0	0	0	0
	Total	**Catch**			**7**	**30**	**3**	**15**	**2**	**5**	**62**
	Total	**Tagged**			**6**	**26**	**3**	**15**	**1**	**5**	**56**

Table 5. Salmonids with missing or damaged adipose fins. Catch location and biological data.

Species	Sta.	Date	Position	Length (mm)	Weight (gm)	Sex	Gonad Wt. (gm)	Gear
Steelhead	10	6/29	51°20'N 158°00'W	590	1820	F	13	A115
Steelhead	12	7/1	52°00'N 154°00'W	522	1380	M	3	C093
Steelhead	13	7/3	54°26'N 147°59'W	622	2540	F	38	C121
Steelhead*	13	7/3	54°27'N 147°58'W	580				B
Coho	14	7/4	55°13'N 146°00'W	618	2580	F	37	A115
Coho	14	7/4	55°13'N 146°00'W	650	3400	F	150	A115
Pink	15	7/5	56°00'N 144°00'W	512	1760	F	185	C106
Pink**	16	7/6	56°00'N 142°00'W	460	1120	M	18	C093

* This fish was caught on longline gear, tagged, and released.
** This fish was missing only part of adipose fin.

Table 6. a. Frequency of occurrence (proportion of non-empty stomachs containing each prey category) of major prey categories in stomachs of sockeye salmon.

Prey category	180° transect	Western Gulf of Alaska 160°-154°W	Eastern Gulf of Alaska 148°-142°W
Pteropods		.38	.40
Hyperiid amphipods		.71	.49
Gammarid amphipods			.17
Copepods		.38	.55
Euphausiids		.48	.45
Squid		.38	.28
Fish		.14	.08
Polychaetes			.21
Gelatinous zooplankton			.02
Other			
Unidentified material		.14	.34
Number of stomachs	0	32	56
number empty		11	9

Table 6. b. Frequency of occurrence of major prey categories in stomachs of chum salmon.

Prey category	180° transect	Western Gulf of Alaska 160°-154°W	Eastern Gulf of Alaska 148°-142°W
Pteropods	.09	.38	.52
Hyperiid amphipods	.06	.54	.62
Gammarid amphipods		.08	.05
Copepods	.37	.21	.26
Euphausiids		.21	.24
Squid	.03		.10
Fish	.11		.07
Polychaetes			.07
Gelatinous zooplankton	.03		.26
Other			.02
Unidentified material	.89	.88	.50
Number of stomachs	45	26	54
number empty	10	2	12

Table 6. c. Frequency of occurrence of major prey categories in stomachs of pink salmon.

Prey category	180° transect	Western Gulf of Alaska 160°-154°W	Eastern Gulf of Alaska 148°-142°W
Pteropods		.64	
Hyperiid amphipods		.81	.52
Gammarid amphipods		.10	.76
Copepods		.55	.29
Euphausiids		.42	.83
Squid		.03	.52
Fish		.03	.19
Polychaetes			.10
Gelatinous zooplankton			.02
Other		.03	
Unidentified material		.19	.17
Number of stomachs	0	35	55
number empty		4	13

Table 6. d. Frequency of occurrence of major prey categories in stomachs of coho salmon.

Prey category	180° transect	Western Gulf of Alaska 160°-154°W	Eastern Gulf of Alaska 148°-142°W
Pteropods	.79	.06	.27
Hyperiid amphipods	.05	.72	.37
Gammarid amphipods		.06	.10
Copepods		.28	.20
Euphausiids	.05	.56	.40
Squid	.58	.50	.50
Fish	.16		.07
Polychaetes			
Gelatinous zooplankton			.03
Other	.05		.10
Unidentified material	.26	.17	.13
Number of stomachs	25	30	51
number empty	6	12	21

Table 6. e. Frequency of occurrence of major prey categories in stomachs of chinook salmon.

Prey category	180° transect	Western Gulf of Alaska 160°-154°W	Eastern Gulf of Alaska 148°-142°W
Pteropods		.07	
Hyperiid amphipods		.14	.50
Gammarid amphipods			
Copepods		.07	
Euphausiids		.29	.50
Squid		.50	.50
Fish		.21	
Polychaetes			
Gelatinous zooplankton			
Other		.07	
Unidentified material		.14	
Number of stomachs	0	23	4
number empty		9	2

Table 6. f. Frequency of occurrence of major prey categories in stomachs of steelhead trout.

Prey category	180° transect	Western Gulf of Alaska 160°-154°W	Eastern Gulf of Alaska 148°-142°W
Pteropods		.38	
Hyperiid amphipods		.38	
Gammarid amphipods			
Copepods		.12	.25
Euphausiids		.12	
Squid	1.00	.12	.75
Fish		.62	.25
Polychaetes			
Gelatinous zooplankton			
Other			.25
Unidentified material		.12	.25
Number of stomachs	1	15	8
number empty	0	7	4

Table 7. Muscle samples taken for moisture content analysis and whole fish taken for caloric content analysis.

Station	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total
Moisture samples:							
10	3	0	0	0	0	0	3
11	4	2	0	0	0	0	6
12	5	1	0	0	0	0	6
13	2	6	1	0	0	0	9
14	2	3	1	1	0	0	7
15	0	4	1	0	0	0	5
16	0	2	0	0	0	0	2
Total	16	18	3	1	0	0	38
Whole fish samples:							
13	0	0	2	2	0	0	4
15	0	0	1	0	0	0	1
Total	0	0	3	2	0	0	5