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SALMONID FOOD HABITS IN OFFSHORE WATERS OF THE GULF OF ALASKA, JUNE-JULY, 1994

by

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ABSTRACT

Preliminary information is presented from salmon feeding studies conducted in June and July, 1994 by scientists from the Fisheries Research Institute (FRI), School of Fisheries, University of Washington, in cooperation with the Faculty of Fisheries, Hokkaido University, aboard the Oshoro maru. Stomachs were collected from 650 salmonids caught in gillnet and longline gear at ten stations in the Gulf of Alaska along 50°N from 157°W to 145°W and north along 145°W from 50°N to 56°N.

Contents of 630 salmonid stomachs (127 sockeye, 167 chum, 159 pink, 122 coho, 15 chinook, and 40 steelhead) were examined. In the Subarctic Current region (along 50°N and north along 145° to 53°N) most individuals of all species except chum were feeding on squid. Chum stomachs contained unidentifiable material, pteropods, small hyperiid amphipods and fish. Further north, along the edge of the Ridge Domain, small hyperiid amphipods, small pteropods, euphausiids, copepods, and squid were the main prey of most sockeye, chum, pink, and coho salmon. No chinook were caught, and three steelhead stomachs contained fish and small amphipods.

INTRODUCTION

Scientists from the Fisheries Research Institute (FRI), School of Fisheries, University of Washington, and the Faculty of Fisheries, Hokkaido University, conducted cooperative salmon research aboard the training and research vessel T/V Oshoro maru. This report is a preliminary account of one aspect of that research; for an overview of salmon research on this year's cruise, see Walker et al. (1994).

The focus of FRI research on this cruise was on various aspects of salmon growth and ecology. Stomach contents were collected to assess the effects of oceanographic conditions, possible interactions between salmonid species and between wild and hatchery production fish, and changes from previous years. Food habits of salmonids in the Gulf of Alaska were studied on previous cruises of the Oshoro maru by scientists from Oregon State University from 1980 to 1985 (Pearcy et al. 1984, 1988). To monitor changes between years, compare with previous studies, and compare with studies in the central North Pacific (Davis 1990; Ishida et al. 1991, 1993; Nagasawa et al. 1993), a University of Washington scientist began a new series of salmonid food studies last year (Walker 1993). This report is a continuation in this series.

METHODS

Scientists on board the Oshoro maru conducted salmon research at ten stations in the Gulf of Alaska starting west along 50°N from 157°W to 145°W, then continuing north along 145°W from 50°N to 56°N (Fig. 1; Table 1). Fishing at one station was canceled due to adverse weather conditions (at 50°N, 154°W). Gillnet sampling was conducted at all 10 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. Gillnet gear was set in the evening, allowed to soak overnight, and was retrieved the following morning. Longline sampling was conducted at seven stations in the Gulf of Alaska (Table 1). Total amount of longline gear fished was 10 hachi (2 stations) or 12 hachi (5 stations), 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.

Oceanographic sampling (CTD casts and water samples for numerous chemical analyses) was conducted by Hokkaido University scientists at each station before the gillnet set and between each fishing station. In the Gulf of Alaska, gillnet stations 8-14 were in the Subarctic Current System. North of about 53°N, stations 15-17 were on the boundary between the Ridge Domain (4°C isotherm at 100m) and the Dilute Domain (33.0‰ isohaline at 100m) as defined by Favorite et al. (1976; Pearcy et al. 1988) and began to enter the edge of the Alaska Current System at the last station (Fig.2). Oceanographic data were also collected between fishing stations along 146°W, one degree further west. Here, the signature of the Ridge domain, a gradual shallow doming of cold water, was more evident (Fig. 3). Along 145°W, the depth of the 4°C isotherm rose and fell between stations. Although salinity profiles were similar at 145°W and 146°W, lower salinity water was found at slightly greater depths at 145°W. This leads to our conclusion that the 145°W fishing transect ran along the extreme eastern edge of the Ridge Domain between 53°N and 55°N, at its boundary with the Dilute Domain.

Stomach contents

Stomach contents were examined from up to 23 fish of each species from each gillnet set. Longline mortalities, though few, were also examined. The methods used were 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, megalopae, polychaetes, shrimp, isopods, and unidentified or other items. Percent volume of each prey category was estimated subjectively. Stomach content indices (SCI), a measure of stomach content weight as a percentage of total body weight, were calculated as: prey weight x 100/body weight.

RESULTS

Stomach contents

In the Gulf of Alaska, 650 stomachs (136 sockeye, 172 chum, 160 pink, 124 coho, 18 chinook, and 40 steelhead) were collected. Because of serious damage to some stomachs during removal, only 630 (127 sockeye, 167 chum, 159 pink, 122 coho, 15 chinook, and 40 steelhead) were used in stomach content analysis.

At stations located in the Subarctic Current region (along 50°N and north along 145° to 53°N), most individuals of all species except chum were feeding heavily on squid, averaging over 70% of stomach volume for most species at most stations (Table 2). Major secondary items (>5%) for non-chum species were amphipods for sockeye, and fish for pink, chinook, and steelhead. The largest volume item in chum salmon stomachs was unidentifiable material (65%); of identifiable prey items, pteropods, amphipods, and fish comprised the largest volumes.

Further north, along the eastern edge of the Ridge Domain, there was a shift in the predominant prey items in non-chum stomachs (no chinook were caught at these stations). Small hyperiid amphipods and small pteropods were common prey items for sockeye, chum, pink, and coho salmon (Table 2). Sockeye were also feeding on euphausiids, copepods, and squid; pink salmon on copepods and squid, and coho on squid. There was less unidentified material in chum stomachs (31%), but pteropods and amphipods continued to be major prey items, and euphausiids comprised 5% of the volume. Fish and small hyperiid amphipods were the only items in the three steelhead stomachs examined.

Stomach fullness also differed between the two oceanic areas. The proportion of empty stomachs was statistically different only for coho and chum salmon. Coho had a much

higher proportion of empty stomachs in the Ridge Domain (50.9% vs 9.2%; χ^2 $p<<.001$), whereas chum salmon had fewer empty stomachs at those stations (10.7% vs 26.1%; χ^2 $p<.05$). However, the amount of food in the stomach differed significantly for all species sampled in both regions. The mean fullness index and mean prey weight for coho, pink, sockeye, and steelhead were significantly less in the Ridge Domain, whereas it was greater for chum salmon.

DISCUSSION

In 1993, the Gulf of Alaska transect of the Oshoro maru was quite different from the one sampled in 1994. It trended generally southwest to northeast from 51°N, 160°W to 56°N, 142°W. The transect ran along the Ridge Domain for most of its length, entering the Alaska Current at the last few stations. Stations 14 and 15 were slightly west and east of stations 16 and 17 in 1994 and were in comparable water masses. As in 1994, the main prey of most individuals of all species were small hyperiid amphipods, small pteropods, euphausiids, copepods, and squid (Walker 1993).

In 1980 and 1981 scientists on board the Oshoro maru conducted salmon research on cruise tracks similar to that of 1994 along 145°W, and Pearcy et al. (1988) reported salmon food habits from these cruises. In both years non-chum species were also feeding heavily on squid at stations in the Subarctic Current, although in 1981 amphipods were also found in many of the stomachs examined. Contents of chum salmon stomachs were largely unidentified material, but of identified taxa hyperiid amphipods were the most abundant. In stomachs collected at Ridge Domain stations, there was a mixture of euphausiids, amphipods, and squid. Amphipods were not as abundant as in 1994, and squid were more common in stomachs in 1980 and 1981. In both 1993 and 1994 pteropods were much more prevalent as salmonid food items than in the earlier period. In 1981 there were more empty stomachs at Ridge Domain stations than at Subarctic Current stations; percent of empty stomachs was higher than in 1994. In 1980, only for coho salmon were there more empty stomachs in the Ridge Domain than in the Subarctic Current.

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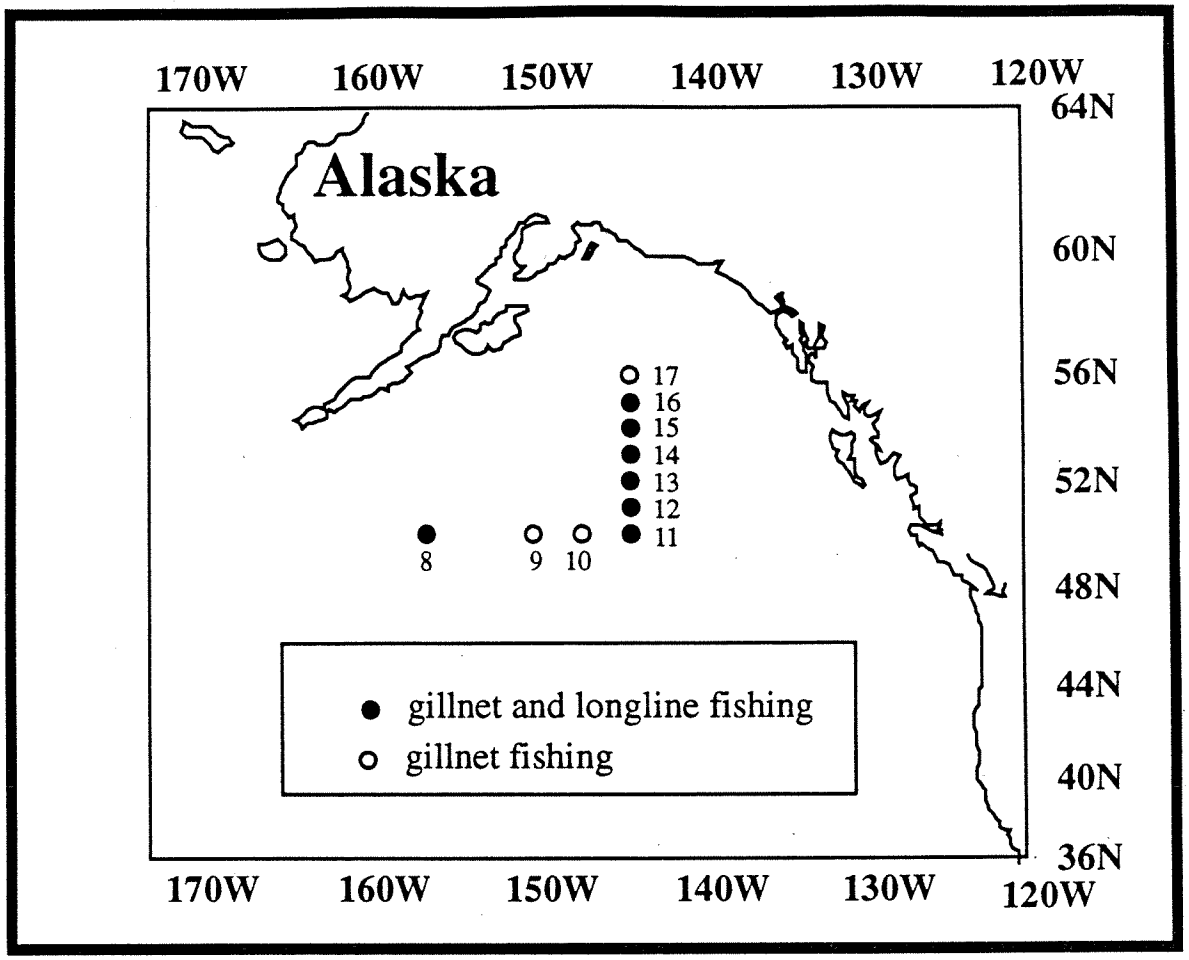

Figure 1. Location of Gulf of Alaska fishing stations, Oshoro maru cruise, 17 June to 8 July, 1994. Station numbers are those of gillnet stations.

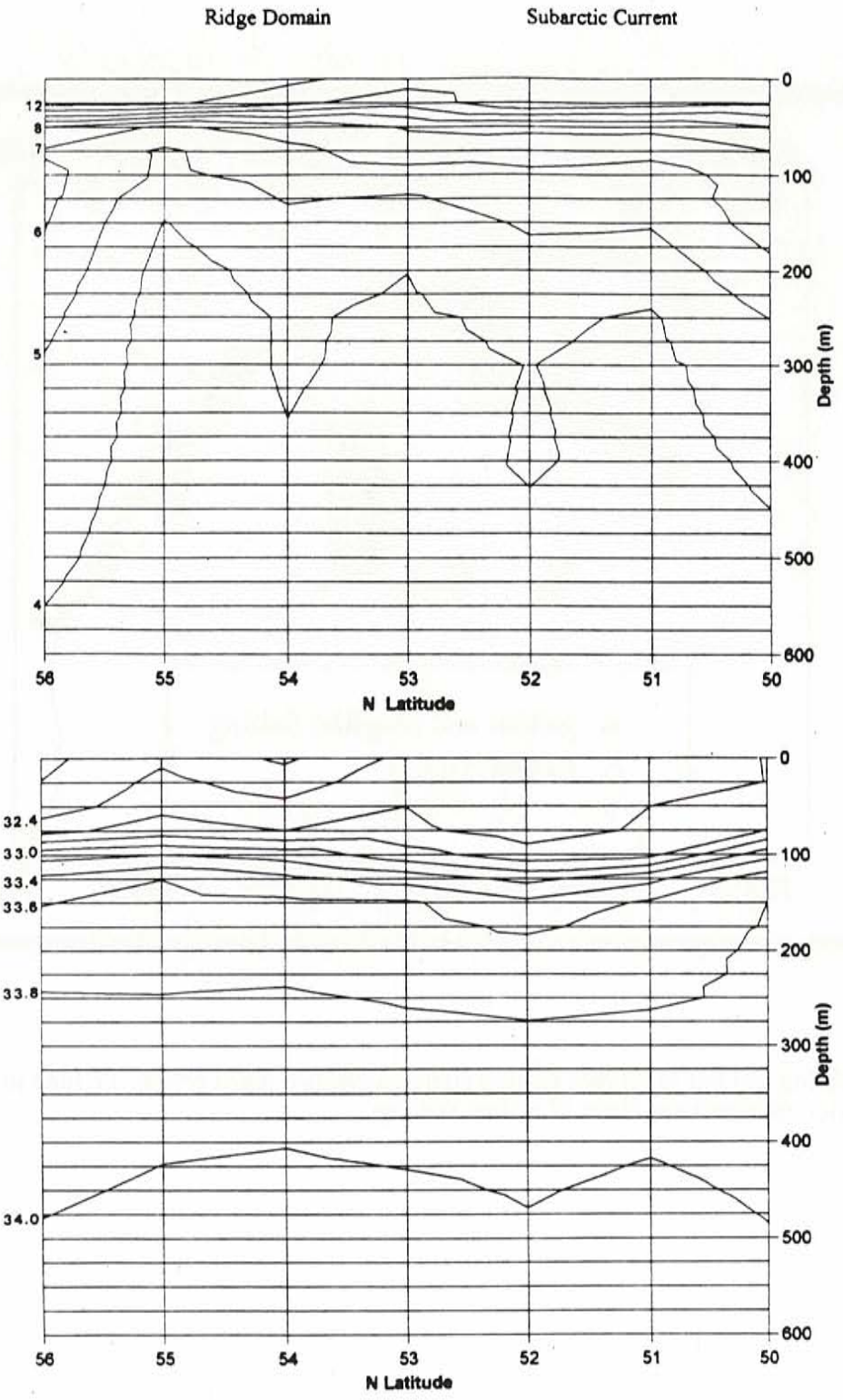

Figure 2. Vertical profiles of temperature (top, °C) and salinity (bottom, psu, practical salinity units) along a north-south transect fished during the T/V Oshoro maru cruise along 145°W longitude in the Gulf of Alaska.

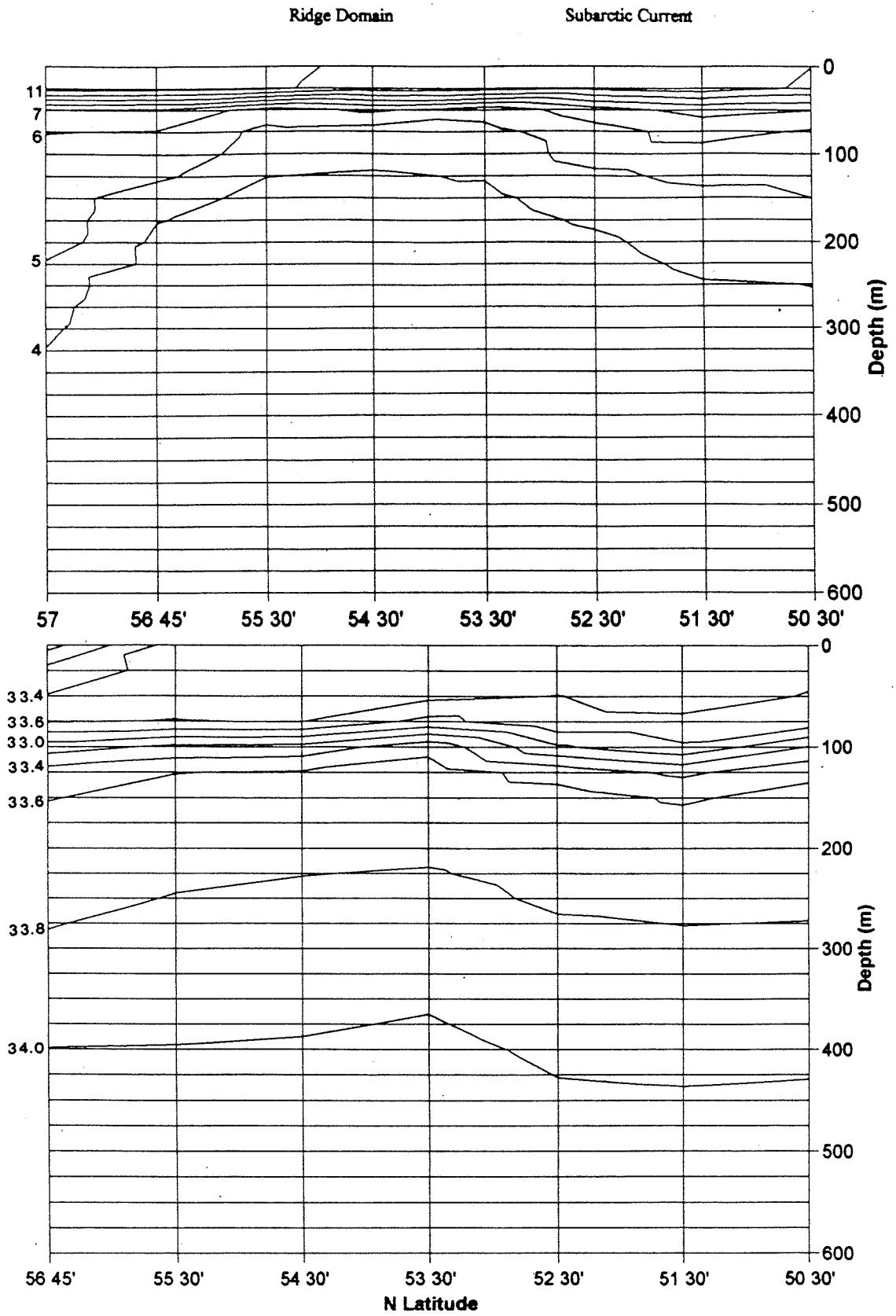

Figure 3. Vertical profiles of temperature (top, °C) and salinity (bottom, psu, practical salinity units) along a north-south transect where oceanographic observations were taken during the T/V Oshoro maru cruise along 146°W longitude in the Gulf of Alaska.

Table 1. Gulf of Alaska fishing stations of T/V Oshoro maru cruise, June-July 1994. Station numbers are those of gillnet sets. Dates are local time dates. Locations are rounded to nearest minute of latitude and longitude.

Gillnet Station	Date	Location	Gear	Sea Temperature Surface	Sea Temperature 100 m	Salinity Surface	Salinity 100 m
8	6/27-28	50°00'N, 157°00'W	Gillnet	8.3	4.6	32.6	33.4
	6/28	50°03'N, 156°56'W	Longline	8.2			
9	6/29-30	50°00'N, 151°00'W	Gillnet	8.6	5.1	32.4	33.4
10	6/30-7/1	50°00'N, 148°00'W	Gillnet	10.0	6.2	32.5	32.9
11	7/1-2	50°00'N, 144°58'W	Gillnet	10.5	6.5	32.6	33.3
	7/2	49°58'N, 144°58'W	Longline	10.2			
12	7/2-3	51°00'N, 145°00'W	Gillnet	10.6	5.6	32.5	32.7
	7/2	51°00'N, 144°55'W	Longline	10.5			
13	7/3-4	52°00'N, 145°00'W	Gillnet	11.0	5.8	32.4	32.7
	7/4	52°01'N, 145°00'W	Longline	10.9			
14	7/4-5	53°00'N, 145°00'W	Gillnet	10.5	5.5	32.5	32.9
	7/5	52°59'N, 144°49'W	Longline	10.3			
15	7/5-6	54°00'N, 145°00'W	Gillnet	11.3	5.4	32.2	33.1
	7/6	54°01'N, 145°02'W	Longline	11.3			
16	7/6-7	55°00'N, 145°00'W	Gillnet	11.5	4.8	32.4	33.2
	7/7	55°00'N, 145°06'W	Longline	11.4			
17	7/7-8	56°00'N, 145°00'W	Gillnet	11.8	6.3	32.2	33.1

Table 2. Mean percent volume of major prey categories in stomachs of salmonids, Gulf of Alaska, June-July 1994. Subarctic Current: stations 8-10 (50°N transect, 157°-148° W) and stations 11-14 (145°W transect, 50°-53°N). Ridge Domain: stations 15-17 (145°W transect, 54°-56°N). Category of "other" prey includes crab megalopae, salps, shrimp, and chaetognaths. Index of stomach fullness ranges from 0 (empty) to 4 (full). Index of stomach content weight (SCI=prey weight x 100/body weight) and mean prey weight include empty stomachs.

	Sockeye salmon		**Chum salmon**		**Pink salmon**	
Prey category	Subarctic Current	Ridge Domain	Subarctic Current	Ridge Domain	Subarctic Current	Ridge Domain
Squid	89	17	2		78	13
Fish	1	7	7	<1	4	5
Pteropods	1	10	15	22	8	25
Amphipods	8	27	10	37	2	25
Copepods	<1	10	<1	<1	1	17
Euphausiids	<1	17	<1	5	<1	2
Polychaetes		3	1	<1		
Gelatinous zooplankton			<1	2		
Other		<1		2	<1	3
Unidentified material	1	9	65	31	7	10
Number of stomachs	71	56	111	56	98	61
Number empty	8	9	29	6	26	16
% empty	11	16	26	11	27	26
Mean fullness	2.2	1.3	0.8	1.1	2.0	1.1
Mean prey weight (g)	31.5	5.1	2.8	4.4	20.3	3.2
SCI	1.52	0.31	0.23	0.32	1.23	0.21
Mean length (mm)	532	539	459	486	491	496
Mean weight (g)	2148	2092	1179	1429	1676	1530

Table 2. - continued.

	Coho salmon		Chinook salmon		Steelhead	
Prey category	Subarctic Current	Ridge Domain	Subarctic Current	Ridge Domain	Subarctic Current	Ridge Domain
Squid	99	44	79		72	
Fish		14	8		19	58
Pteropods	<1	19			5	
Amphipods		15			<1	42
Copepods						
Euphausiids		7				
Polychaetes						
Gelatinous zooplankton						
Other					<1	
Unidentified material	1	1	13		3	
Number of stomachs	65	57	15	0	34	6
Number empty	6	29	3	-	9	3
% empty	9	51	20	-	26	50
Mean fullness	2.7	0.7	2.1	-	1.7	0.7
Mean prey weight (g)	52.8	3.3	34.9	-	14.9	1.6
SCI	1.98	0.11	0.91	-	0.88	0.06
Mean length (mm)	576	608	647	-	505	601
Mean weight (g)	2812	3018	4452	-	1731	2753