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CCGS W.E. Ricker Gulf of Alaska Salmon Survey, March 1997

by

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ABSTRACT

A survey of the distribution of juvenile salmon nearing the end of their first winter of life in the northern Gulf of Alaska was conducted from March 11 to April 3, 1997. Over a broad area of the northern Gulf almost no salmon were found. It is unclear how much of the absence of salmon from this large area of the Gulf of Alaska in 1997 was a result of the markedly reduced levels of abundance of all species of salmon that subsequently returned to Alaska later in the summer. The available evidence does not, however, point to a westward displacement of salmon in the spring out of the study region because of elevated ocean temperatures; surface temperatures were within 1°C of average in March and April, although they were much higher than average by June. When data from this survey are combined with previously reported Japanese survey results for the Kaiyo Maru in December 1992 and January 1995 and a previous Canadian survey conducted in March 1995, the data suggest that juvenile salmon do not utilize the northern regions of the Gulf of Alaska in the spring. As previous Fall surveys have found juvenile salmon almost exclusively confined to the continental shelf between British Columbia and Kodiak, Alaska, our findings suggest that most juvenile salmon migrate westward of Kodiak Alaska before eventually turning south and migrating offshore. The exact timing and westward extent of the juvenile migration on the shelf needs to be clarified in order to better understand the ocean biology of Pacific salmon, and establish the times and regions where changes in ocean climate can affect them.

INTRODUCTION

A survey of the distribution of juvenile salmon completing the end of their first year of life in the ocean was conducted using a pelagic rope trawl on the *CCGS W.E. Ricker* in the Gulf of Alaska. This report details the findings of our survey from March 11 to April 3, 1997. The spring survey had the following objectives:

1) to establish the distribution and abundance of juvenile pink, chum, and sockeye salmon in the central Gulf of Alaska near the end of their first year of life in the ocean and establish their offshore migration path;
2) to collect detailed oceanographic measurements on the Alaska Coastal Current in March on transects across the shelf off the Queen Charlotte Islands and

Kodiak Island; and

3) to collect detailed oceanographic measurements across the Gulf of Alaska to define the structure of the Alaskan Gyre in the spring.

Fig. 1 shows the track for the *W.E. Ricker* March, 1997 survey. It consisted of an out-bound northwest leg from the Queen Charlotte Islands to Cape Chiniak, Alaska, followed by a southern leg from the Trinity Islands off Kodiak Island to 49° 30'N, 140°W in the eastern North Pacific, and then an eastward leg to Cape Scott, Vancouver Island. Included on this survey track were three detailed oceanographic and fishing transects on the continental shelf off the Queen Charlotte Islands and Kodiak Island where the stations were spaced at approximately 2.5 km intervals. A total of 90 oceanographic stations and 49 fishing tows (Tables 1 and 2) were completed.

METHODS

Ship, fishing gear, and fishing operations

The CCGS W.E. Ricker is a 1,104 gross tonnes stern trawler, 58 m in length, 9.5 m in beam, and powered by a 2,500 H.P. model AH 40 Akasaka diesel engine. The model 400/580 mid-water trawl, manufactured by Cantrawl Pacific Ltd., Richmond, B.C. measures 200 m in length, and has front-end section of hexagonal mesh made with 3/8" and 5/16" Tenex rope, a body made up of 64", 32", 16", 8", and 4" polypropelene sections, an intermediate section of 3" polypropelene, and a 1 1/2" nylon codend lined with 1/4" mesh. The trawl was typically towed within 5m of the surface at 5 knots under good sea conditions, and achieved a measured mouth opening of approximately 28 m horizontal by 16 m vertical (as measured by a ScanMar trawl eye) with the following configuration: 100m 1 1/4" warp, three 240m 5/8" bridles per side attached at a double hook-up to 5m Suberkrub mid-water doors, 20" diameter Scotsman at each wing tip, approximately 750 lb. of chain on each side, and a 5 m canvas kite for additional lift attached to the headrope. At a few stations (Table1), the W.E. Ricker towed the trawl to a maximum of depth of 100m by paying out more warp. In cases where more than one depth for the headrope is reported in Table 1, the trawl was fished for periods of equal duration at several depths to ensure that the lack of salmon evident in near-surface waters was not due to their distribution at greater depth.

Oceanographic sampling

At all stations CTD casts were made to within 5m of bottom or to 600m maximum depth using both a Guildline (serial # 53977) and a Seabird SBE19 (serial # 1031) CTD mounted together. XBT casts with T-5 probes were conducted at those stations (Table 2) where sea state prohibited CTD operations. A continuous log was recorded of sea surface salinity and temperature from the ship's SAIL loop. Surface seawater samples from the ship's SAIL loop were taken at every station as a check on the accuracy of the CTDs and the salinity probe within the SAIL loop.

Shelf stations off Queen Charlotte and Kodiak Islands were spaced at approximately 2.5 km intervals to obtain detailed cross-shelf profiles of temperature, salinity, and nutrients at depth. At these stations water samples were drawn from Nisken bottles clamped at 25 m depth intervals on the co-axial CTD cable. Nitrate and phosphate samples were collected in acid-washed glass test tubes and stored frozen; silicate samples were collected in acid-washed plastic test tubes and similarly stored; and O^{18} and barium samples were collected in high density polyproplylene scintillation vials and stored at room temperature. O^{18} and barium samples will be used as tracers in an attempt to define sources of fresh water contributions to the Alaskan Coastal Current.

Surface seawater samples at all stations were drawn from the ship's pumped sea water system for subsequent measurement of nitrate, phosphate, silicate, O^{18}, barium, and salinity levels, and a 330 ml seawater sample was filtered on an ashed GF/F Whatman glass fiber filter, folded in half, wrapped in aluminum foil and frozen for subsequent measurement of chlorophyll *a* and phytoplankton stable isotope ratios. In addition, bongo tows for zooplankton were conducted at most fishing stations.

Acoustic Doppler Current Profiler (ADCP)

An acoustic Doppler current profiler (ADCP), RD Industries, frequency 150 kHz, was run continuously to measure velocities and direction of currents with depth along the survey track. The ADCP data was logged with Transect ver.1.82

software.

ADCP analyses can be obtained from Dr. Andreas Münchow, Rutgers University, New Brunswick, New Jersey. E-mail: *ANDREAS@IMCS.RUTGERS.EDU*

Zooplankton sampling

Oblique tows to 150 m were conducted with 57 cm diameter Bongo nets made of 253 micron nitex mash. The net was retrieved at a vertical speed of 0.3 m/sec while being towed at 2 knots after reaching the target depth. Most bongo tows were completed within 20 minutes from the time of initial deployment.

Zooplankton samples from the codend of the flowmeter net were preserved in 10% formalin and sent to the Institute of Ocean Sciences for species identification and enumeration. The data can be obtained from Dr. David Mackas, Plankton Productivity, Institute of Ocean Sciences, P.O. Box 6000, 9860 West Saanich Road, Sydney, British Columbia, Canada. V8L 4B2. Tel: 250-363-6442 FAX: 250-363-6479 Email: mackas@ios.bc.ca. Zooplankton from the other net were sorted into three sizes factions by successively sieving through 1.7mm, 1.0 mm , and 250 micron screens. The three fractions were weighed wet, dried at 60°C for 48 hours, re-weighed, and stored for future C^{14} and N^{15} isotope analysis.

Zooplankton Net Comparison

Bongo, NORPAC, and SCOR zooplankton nets were sequentially fished at a series of stations near 50°N, 145°W in the eastern North Pacific in order to provide a calibration of the extensive time series of zooplankton data collected at station P from the 1950s to 1980s, a period when changes in zooplankton nets occurred. A total of 8 replicates were completed (Table 4), where a replicate consisted of three consecutive vertical hauls from 150 m to the surface with the Bongo, NORPAC, and SCOR nets at the same station. The net pay-out and retrieval rates were 0.7m/sec and 1.0 m/sec, respectively. All replicate samples were taken within ±3 hours of local noon.

Data from the replicate sampling can be obtained from Dr. David Mackas, Plankton Productivity, Institute of Ocean Sciences, P.O. Box 6000, 9860 West

Saanich Road, Sydney, British Columbia, Canada. V8L 4B2. Tel: 250-363-6442 FAX: 250-363-6479 Email: mackas@ios.bc.ca

RESULTS

Table 1 provides a summary of salmon catches at each tow station on the March 1997 survey. Only 10 salmon were caught during the survey, including four age .1 juvenile sockeye salmon, three age .1 juvenile chinook salmon, and three age .2 and age .3 immature sockeye salmon. (Ages are indicated as ".1" for juveniles since we adopt the convention that the birthdate is January 1, although a full year in the ocean was not yet completed.) No age .1 juvenile pink, chum, and coho salmon were caught. The chinook were caught on the continental shelf near Kodiak, Alaska, and all sockeye were caught off the shelf in the central Gulf of Alaska.

Table 2 provides a listing of the CTD and XBT casts conducted at each oceanographic stations. CTD and XBT cast #s run sequentially, but do not correspond to station #s because for some stations repeated casts were conducted. XBT #2 was inadvertently not assigned a station #.

The CTD, XBT, and Sail data has been archived under survey # 9705 and can be obtained from Mr Robin Brown, Oceanographic Data Manager, Institute of Ocean Sciences, P.O. Box 6000, 9860 West Saanich Road, Sydney, British Columbia, Canada. V8L 4B2. Tel: 250-363-6378 Fax: 250-363-6746 E-mail: rmbrown@ios.bc.ca

Table 3 reports the biological data collected from each salmon. All salmon were labeled with the cruise identifier "HS9705", where HS stands for High Seas and "9705" is the identifier for the March survey, and then sequentially numbered by tow, species code, and sample number. For example, fish # HS9705-31-124-1 refers to tow 31, the species code "124" for chinook salmon, and the sample number "1". We used the following codes from Canadian Department of Fisheries and Oceans' Salmon Stock Assessment database: 108, pink salmon; 112, chum salmon; 115, coho salmon; 118, sockeye salmon; 124, chinook salmon; and 128, steelhead salmon.

Body weights were measured in the laboratory, and do not include stomach contents. One juvenile chinook, HS9705-32-124-1, was examined for stomach contents at sea and discarded, and its weight estimate determined at sea is not reported.

Ages are represented by the notation *i.j*, where *i* is the number of fresh water years, and *j* is the number of ocean years. An x is used to indicate cases where an age could not be confidently determined.

Stomach content weights were determined in the laboratory, and the relative composition of major taxonomic groups was estimated visually. For one juvenile chinook (HS9705-32-124-1) and one immature sockeye salmon (HS9705-68-118-1) stomach contents were examined at sea and an accurate weight was not obtained. These weights are reported as "NA".

Table 4 provides estimates of zooplankton abundances from bongo tows. Total dry weights from one codend are reported, as well as dry weights for three size fractions: large zooplankton (>1.7 mm), medium-size zooplankton (>1.0 mm), and small zooplankton (>0.250 mm).

Table 5 provides a record of the replicate sampling operations. Zooplankton abundance estimates are not presented here but can be obtained from Dr. David Mackas (address as noted above).

DISCUSSION

This survey showed that over a broad area of the northern Gulf of Alaska between the Queen Charlotte Islands and Kodiak Island, first ocean year juvenile pink, chum and sockeye salmon were absent in March of 1997. These first ocean year pink, chum, and sockeye salmon must have either moved off the continental shelf of British Columbia and central Alaska or moved westward of Kodiak Island sometime between November and early March, since none were caught on the continental shelf off on two transects off Kodiak Island and one transect off the Queen Charlotte Islands. In contrast, three first ocean year chinook were caught in shallow waters on the continental shelf off Kodiak Island.

This survey also indicated that by March juvenile sockeye salmon are wintering along with older sockeye in the Gulf of Alaska, since four age .1 juvenile sockeye, ranging in size from 26.3 to 29.4 cm in fork length (Table 2), were caught on one tow near 51° N, 145° W , and three age .2 and .3 sockeye were caught on three tows along the southeastern tack from Kodiak to 49°N, 140°W. Further sampling in this region of the eastern North Pacific, which was necessary to strengthen this association, was unfortunately cut short because of severe weather and resulting damage to the trawl.

A comparison of catches with two Japanese surveys by the *R/V Kaiyo Maru* in December, 1992 (FAJ 1993) and January 1996 (Ueno 1996), and with a previous Canadian survey aboard the *F/V Anita J* in March 1995, demonstrates that first ocean year juvenile salmon are well offshore during the winter and spring (Fig. 3a-d). However, when catches for the two sets of surveys are overlaid, the data suggest that the majority of juvenile salmon in the winter and spring are distributed in the south-central Gulf of Alaska, and do not appear to occur in significant numbers above approximately 52°N (roughly, the latitude of the southern tip of the Queen Charlotte Islands).

It is unclear how much of the absence of salmon from the large area of the northern Gulf of Alaska in 1997 was a result of the markedly reduced levels of abundance of all species of salmon that subsequently returned to Alaska later in the summer. The available evidence does not, however, point to a westward displacement of salmon in the spring out of the study region because of elevated ocean temperatures; surface temperatures were within 1°C of average in March and April, although they were much higher than average by June.

Recent Canadian and United States surveys give little indication of juvenile salmon moving off the continental shelf for areas between southern British Columbia and Kodiak Island in either the summer or fall. This suggests that juvenile salmon may move well to the west of Kodiak Island before moving south and offshore in the winter and spring period, and then moving back east in the Subarctic Current. With recent declines in marine survival of Pacific salmon stocks returning to specific regions of North America, it is important to establish those areas of the coastal and offshore ocean where salmon stocks with different

trends in stock abundance co-exist. Events occurring in these areas of the ocean could not be responsible for such differences in survival, and knowledge of these areas simplifies the task of identifying where the changes in marine survival are occurring.

As previous Fall surveys have found juvenile salmon almost exclusively confined to the continental shelf between British Columbia and Kodiak, Alaska, our findings suggest that most juvenile salmon migrate westward of Kodiak before eventually turning south and migrating offshore. The exact timing and westward extent of the juvenile migration on the shelf needs to be clarified in order to better understand the ocean biology of Pacific salmon, and establish the times and regions where changes in ocean climate can affect them.

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Ueno, Y; Ishida, Y; Shiomoto, A; Urawa, S; Myers, K.W.; Morris, J; and Koval, M.V. 1996. Summary of wintering salmon research aboard the research vessel Kaiyo-Maru in January 1996. NPAFC Doc. 213. 20 p.

Table 1. Summary of salmon catches at each tow position on the W.E. Ricker survey to the Gulf of Alaska, March, 1997; Cruise ID # 9705.

station #	transect	date	start time	start position	duration hh:mm	Headrope depth (m)	Juvenile sockeye Age x.1	Immature sockeye Age x.2, x.3	Juvenile chinook Age x.1
2	Moresby I	14-Mar-96	8:32	52.987 °N 132.478 °W	0:29	17	0	0	0
3	Moresby I	14-Mar-96	10:37	52.933 °N 132.561 °W	0:33	14.8	0	0	0
4	Moresby I	14-Mar-96	12:53	52.893 °N 132.683 °W	0:30	18	0	0	0
5	Moresby I	14-Mar-96	15:15	52.852 °N 132.803 °W	0:30	19	0	0	0
11	Trans Gulf of Alaska to Kodiak	15-Mar-96	8:32	53.380 °N 135.678 °W	0:30	12	0	0	0
12	Trans Gulf of Alaska to Kodiak	15-Mar-96	12:28	53.378 °N 136.178 °W	0:59	24,14.7,4.3	0	0	0
13	Trans Gulf of Alaska to Kodiak	15-Mar-96	16:05	53.362 °N 136.453 °W	0:30	3.6	0	0	0
14	Trans Gulf of Alaska to Kodiak	15-Mar-96	17:06	53.328 °N 136.385 °W	0:29		0	0	0
17	Trans Gulf of Alaska to Kodiak	16-Mar-97	8:02	53.778 °N 138.263 °W	0:30	3.6,5.5	0	0	0
18	Trans Gulf of Alaska to Kodiak	16-Mar-97	13:41	53.955 °N 138.822 °W	0:30	5.3	0	0	0
19	Trans Gulf of Alaska to Kodiak	16-Mar-97	16:42	54.088 °N 138.975 °W	0:30	3.6	0	0	0
20	Trans Gulf of Alaska to Kodiak	17-Mar-97	7:55	54.740 °N 141.470 °W	2:27	3.6, 20,40,60,80	0	0	0
21	Trans Gulf of Alaska to Kodiak	17-Mar-97	13:58	55.002 °N 142.148 °W	1:03	4.6, 25.5	0	0	0
22	Trans Gulf of Alaska to Kodiak	17-Mar-97	16:42	55.128 °N 142.600 °W	0:29	5.6	0	0	0
25	Trans Gulf of Alaska to Kodiak	18-Mar-97	6:37	55.410 °N 145.143 °W	1:02	10, 25	0	0	0
27	Trans Gulf of Alaska to Kodiak	18-Mar-97	15:53	55.667 °N 146.012 °W	1:32	8,25,50,75	0	0	0
28	Trans Gulf of Alaska to Kodiak	19-Mar-97	16:09	56.177 °N 150.070 °W	0:45	5	0	0	0
31	Cape Chiniak	20-Mar-97	6:26	57.160 °N 152.212 °W	0:32	3.9	0	0	1
32	Cape Chiniak	20-Mar-97	8:05	57.085 °N 152.197 °W	0:30	3.6	0	0	1
33	Cape Chiniak	20-Mar-97	9:42	57.023 °N 152.162 °W	0:31	5.8	0	0	0
34	Cape Chiniak	20-Mar-97	12:08	56.902 °N 151.978 °W	0:31	5	0	0	0
36	Cape Chiniak	20-Mar-97	14:38	56.823 °N 151.830 °W	0:30	8.5	0	0	0
37	Cape Chiniak	20-Mar-97	16:08	56.767 °N 151.748 °W	0:30	10	0	0	0
41	Cape Chiniak to Trinity Islands	22-Mar-97	12:34	57.582 °N 152.010 °W	0:28	3.7	0	0	1
42	Cape Chiniak to Trinity Islands	22-Mar-97	16:58	57.132 °N 152.178 °W	0:30	3.6	0	0	0
43	Sitinak Island	23-Mar-97	6:15	56.333 °N 153.648 °W	0:30	3.6	0	0	0
44	Sitinak Island	23-Mar-97	7:48	56.283 °N 153.541 °W	0:34	4.6	0	0	0
45	Sitinak Island	23-Mar-97	9:22	56.252 °N 153.410 °W	0:31	7	0	0	0
47	Sitinak Island	23-Mar-97	11:12	56.212 °N 153.313 °W	0:31	5	0	0	0
48	Sitinak Island	23-Mar-97	12:57	56.192 °N 153.223 °W	0:30	4.1	0	0	0
49	Sitinak Island	23-Mar-97	14:42	56.178 °N 153.147 °W	0:30	7	0	0	0
50	Sitinak Island	23-Mar-97	16:28	56.158 °N 153.067 °W	0:30	9.1	0	0	0
53	to Hechy Seamount, Gulf of Alaska	24-Mar-97	6:20	54.623 °N 152.252 °W	0:30	10	0	0	0
54	to Hechy Seamount, Gulf of Alaska	24-Mar-97	9:00	54.467 °N 152.207 °W	0:30	3.7	0	0	0
55	to Hechy Seamount, Gulf of Alaska	24-Mar-97	11:17	54.352 °N 152.187 °W	0:29	3.6	0	0	0

Table 1 continued.

station #	transect	date	start time	start position		duration hh:mm	Headrope depth (m)	Juvenile sockeye Age x.1	Immature sockeye Age x.2, x.3	Juvenile chinook Age x.1
56	to Hechy Seamount, Gulf of Alaska	24-Mar-97	13:49	54.202 ° N	152.142 ° W	0:30	3.6	0	0	0
57	to Hechy Seamount, Gulf of Alaska	24-Mar-97	15:44	54.118 ° N	152.138 ° W	0:29	3.6	0	0	0
58	to Hechy Seamount, Gulf of Alaska	24-Mar-97	17:01	54.023 ° N	152.142 ° W	0:30	3.6	0	0	0
61	towards 50°,150°W	25-Mar-97	6:15	52.712 ° N	151.312 ° W	0:30	5	0	1	0
62	towards 50°,150°W	25-Mar-97	9:03	52.545 ° N	151.138 ° W	0:57	3.5	0	0	0
63	towards 50°,150°W	25-Mar-97	13:30	52.290 ° N	150.950 ° W	0:30	7.5	0	0	0
64	towards 50°,150°W	25-Mar-97	15:43	52.180 ° N	150.935 ° W	0:29	9	0	0	0
65	towards 50°,150°W	25-Mar-97	17:06	52.092 ° N	150.875 ° W	0:27	8	0	0	0
68	towards 50°,150°W	26-Mar-97	6:15	50.740 ° N	150.255 ° W	0:30	7.5	4	1	0
69	towards 50°,150°W	26-Mar-97	9:50	50.662 ° N	150.245 ° W	0:31	6	0	0	0
74	towards 49.5°,140°W	28-Mar-97	13:00	48.803 ° N	143.003 ° W	0:24	6	0	0	0
76	towards 49.5°,140°W	29-Mar-97	7:15	49.530 ° N	141.415 ° W	1:00	8.5	0	1	0
77	towards 49.5°,140°W	29-Mar-97	15:35	49.543 ° N	141.282 ° W	1:00	13.7	0	0	0
78	towards 49.5°,140°W	29-Mar-97	17:14	49.548 ° N	141.118 ° W	0:27	13.7	0	0	0
						totals		4	3	3

Table 2. Oceanographic stations, W.E. Ricker Survey to the Gulf of Alaska, March, 1997; Cruise # 9705.

station #	transect	date	time	latitude	longitude	bottom depth	Guildline sn 53977 CTD #	T-5 probe XBT #
1	Queen Charlotte Is. (west coast)	13-Mar-97	16:01:59	51.5430 °N	130.0598 °W	250	2	
2	Moresby I	14-Mar-97	6:19:51	52.9992 °N	132.4552 °W	176	3	
3	Moresby I	14-Mar-97	9:26:18	52.9407 °N	132.5113 °W	860	4,5	
4	Moresby I	14-Mar-97	11:37:55	52.9010 °N	132.6427 °W	1350	6	
5	Moresby I	14-Mar-97	13:47:23	52.8610 °N	132.7703 °W	1538	7	
6	Moresby I	14-Mar-97	16:01:25	52.8228 °N	132.8918 °W	>2000	8	
7	Moresby I	14-Mar-97	17:33:11	52.8473 °N	133.0703 °W	>2000	9	
8	Moresby I	14-Mar-97	19:06:17	52.8920 °N	133.2990 °W	1590	10	
9	Moresby I	14-Mar-97	23:54:01	53.0652 °N	134.2458 °W	>2000	11	
10	Trans Gulf of Alaska to Kodiak	15-Mar-97	4:32:21	53.2495 °N	135.1818 °W	>2000	12	
11	Trans Gulf of Alaska to Kodiak	15-Mar-97	7:14:18	53.3692 °N	135.6043 °W	>2000	13	
12	Trans Gulf of Alaska to Kodiak	15-Mar-97	11:03:43	53.4240 °N	136.1455 °W	>2000	14	
13	Trans Gulf of Alaska to Kodiak	15-Mar-97	15:09:41	53.3668 °N	136.4617 °W	>2000	15	
14	Trans Gulf of Alaska to Kodiak	15-Mar-97	18:01:16	53.2995 °N	136.3140 °W	>2000	16	
15	Trans Gulf of Alaska to Kodiak	15-Mar-97	23:08:25	53.5087 °N	137.1592 °W	>2000	19	
16	Trans Gulf of Alaska to Kodiak	16-Mar-97	3:06:16	53.6478 °N	137.7610 °W	>2000	20	
17	Trans Gulf of Alaska to Kodiak	16-Mar-97	6:59:46	53.7785 °N	138.2875 °W	>2000	21	
18	Trans Gulf of Alaska to Kodiak	16-Mar-97	14:53:08	54.0002 °N	138.7907 °W	>2000	22	
19	Trans Gulf of Alaska to Kodiak	16-Mar-97	17:31:39	54.1402 °N	138.9757 °W	>2000	23	
20	Trans Gulf of Alaska to Kodiak	17-Mar-97	6:58:12	54.7232 °N	141.3700 °W	>2000	24	
21	Trans Gulf of Alaska to Kodiak	17-Mar-97	13:02:52	54.9937 °N	142.1345 °W	>2000	25	
22	Trans Gulf of Alaska to Kodiak	17-Mar-97	17:51:43	55.1622 °N	142.6603 °W	>2000	26	
23	Trans Gulf of Alaska to Kodiak	17-Mar-97	21:58:25	55.2893 °N	143.5022 °W	>2000	27	
24	Trans Gulf of Alaska to Kodiak	18-Mar-97	2:23:55	55.4563 °N	144.3862 °W	>2000	28	
25	Trans Gulf of Alaska to Kodiak	18-Mar-97	8:06:49	55.5195 °N	145.2370 °W	>2000	29	
26	Trans Gulf of Alaska to Kodiak	18-Mar-97	13:31:00	55.7017 °N	146.1107 °W	>2000	30	
27	Trans Gulf of Alaska to Kodiak	18-Mar-97	18:46:05	55.6102 °N	146.0010 °W	>2000	31	
28	Trans Gulf of Alaska to Kodiak	18-Mar-97	22:39:47	55.7652 °N	146.7913 °W	>2000	32	
30	Trans Gulf of Alaska to Kodiak	19-Mar-97	20:53:15	56.3550 °N	150.6157 °W	>2000	33	
31	Cape Chiniak	20-Mar-97	7:18:13	57.0990 °N	152.1907 °W	80	34	
32	Cape Chiniak	20-Mar-97	8:59:19	57.0375 °N	152.1690 °W	70	35	
34	Cape Chiniak	20-Mar-97	11:18:34	56.9173 °N	151.9693 °W	81	36	

Table 2 continued.

station #	transect	date	time	latitude	longitude	bottom depth	Guildline sn 53977 CTD #	T-5 probe XBT #
35	Cape Chiniak	20-Mar-97	12:57:24	56.8523 °N	151.9577 °W	86	37	
36	Cape Chiniak	20-Mar-97	14:03:44	56.8338 °N	151.8455 °W	86	38	
37	Cape Chiniak	20-Mar-97	15:28:07	56.7832 °N	151.7760 °W	177	39	
38	Cape Chiniak	20-Mar-97	16:57:26	56.7412 °N	151.6833 °W	787	40	
39	Cape Chiniak	20-Mar-97	18:52:27	56.6398 °N	151.5383 °W	1500	41	
40	Cape Chiniak	20-Mar-97	20:52:09	56.5545 °N	151.3918 °W	>2000	42	
41	Cape Chiniak to Trinity Islands	22-Mar-97	13:27:11	57.5398 °N	152.0002 °W	67	43	
42	Cape Chiniak to Trinity Islands	22-Mar-97	17:47:39	57.1043 °N	152.2508 °W	78	44	
43	Sitinak Island	23-Mar-97	5:03:36	56.3502 °N	153.6772 °W	67	45	
44	Sitinak Island	23-Mar-97	7:15:59	56.2858 °N	153.5600 °W	69	46	
45	Sitinak Island	23-Mar-97	8:51:24	56.2582 °N	153.4275 °W	82	47	
46	Sitinak Island	23-Mar-97	10:10:43	56.2155 °N	153.3567 °W	180	48	
47	Sitinak Island	23-Mar-97	10:47:58	56.2167 °N	153.3297 °W	255	49	
48	Sitinak Island	23-Mar-97	12:05:28	56.1858 °N	153.2487 °W	1000	50	
49	Sitinak Island	23-Mar-97	13:48:34	56.1775 °N	153.1640 °W	1600	51	
50	Sitinak Island	23-Mar-97	15:30:22	56.1617 °N	153.0878 °W	1567	52	
51	Sitinak Island	23-Mar-97	21:03:36	55.6667 °N	152.7417 °W	>2000	53	
52	to Hecht Seamount, Gulf of Alaska	24-Mar-97	1:02:17	55.1960 °N	152.4930 °W	>2000	54	
53	to Hecht Seamount, Gulf of Alaska	24-Mar-97	5:31:49	54.6567 °N	152.2417 °W	>2000	55	
54	to Hecht Seamount, Gulf of Alaska	24-Mar-97	8:04:11	54.4742 °N	152.1933 °W	>2000	56	
55	to Hecht Seamount, Gulf of Alaska	24-Mar-97	10:28:50	54.3580 °N	152.1745 °W	>2000	57	
56	to Hecht Seamount, Gulf of Alaska	24-Mar-97	13:02:43	54.2042 °N	152.1308 °W	>2000	58	
57	to Hecht Seamount, Gulf of Alaska	24-Mar-97	14:58:05	54.1240 °N	152.1392 °W	>2000	59	
58	to Hecht Seamount, Gulf of Alaska	24-Mar-97	18:11:42	53.9880 °N	152.1678 °W	>2000	60	
59	to Hecht Seamount, Gulf of Alaska	24-Mar-97	22:02:27	53.5912 °N	151.9343 °W	>2000	61,62	
60	towards 50°N, 150 °W	25-Mar-97	2:03:12	53.1297 °N	151.6223 °W	>2000	63	
61	towards 50°N, 150 °W	25-Mar-97	5:28:13	52.7542 °N	151.3435 °W	>2000	64	
62	towards 50°N, 150 °W	25-Mar-97	8:04:20	52.5592 °N	151.1497 °W	>2000	65	
63	towards 50°N, 150 °W	25-Mar-97	12:31:42	52.3033 °N	150.9498 °W	>2000	66	
64	towards 50°N, 150 °W	25-Mar-97	14:53:21	52.1868 °N	150.9278 °W	>2000	67	
65	towards 50°N, 150 °W	25-Mar-97	18:17:29	52.0165 °N	150.8010 °W	>2000	68	
66	towards 50°N, 150 °W	25-Mar-97	22:01:27	51.6247 °N	150.6402 °W	>2000	69	

Table 2 continued.

station #	transect	date	time	latitude	longitude	bottom depth	Guildline sn 53977 CTD #	T-5 probe XBT #
67	towards 50°N, 150 °W	26-Mar-97	2:02:11	51.1297 °N	150.3992 °W	>2000	70	
68	towards 50°N, 150 °W	26-Mar-97	5:33:08	50.7413 °N	150.2475 °W	>2000	71	
69	towards 50°N, 150 °W	26-Mar-97	9:01:36	50.6615 °N	150.2625 °W	>2000	72	
no station #	towards 50°N, 150 °W	27-Mar-97	13:13:00	49.4333 °N	147.3830 °W	>2000		2
70	towards 49.5°N, 140 °W	27-Mar-97	15:37:00	49.3333 °N	147.0083 °W	>2000		3
71	towards 49.5°N, 140 °W	27-Mar-97	20:53:00	49.1292 °N	145.9017 °W	>2000		5
72	towards 49.5°N, 140 °W	28-Mar-97	2:10:00	48.9867 °N	145.0000 °W	>2000		6
73	towards 49.5°N, 140 °W	28-Mar-97	7:30:00	48.8967 °N	144.0000 °W	>2000		7
74	towards 49.5°N, 140 °W	28-Mar-97	12:30:00	48.7983 °N	143.0433 °W	>2000		8
75	towards 49.5°N, 140 °W	28-Mar-97	18:37:00	48.9917 °N	142.0000 °W	>2000		9
76	towards 49.5°N, 140 °W	29-Mar-97	8:46:41	49.5653 °N	141.2763 °W	>2000	73	
77	towards 49.5°N, 140 °W	29-Mar-97	18:24:00	49.5455 °N	141.0065 °W	>2000	74	
78	towards 49.5°N, 140 °W	29-Mar-97	23:07:32	49.6700 °N	140.0088 °W	>2000	75	
79	to Tucker Seamount	30-Mar-97	3:52:15	49.7670 °N	139.0085 °W	>2000	76	
80	to Tucker Seamount	30-Mar-97	8:55:30	49.8785 °N	138.0027 °W	>2000	77	
81	to Tucker Seamount	30-Mar-97	16:00:00	49.9333 °N	137.0000 °W	>2000		10
82	to Tucker Seamount	30-Mar-97	20:00:00	50.0000 °N	136.0000 °W	>2000		11, 12
83	to Triangle I.	31-Mar-97	0:23:00	50.0083 °N	135.0000 °W	>2000		13
84	to Triangle I.	31-Mar-97	4:24:00	50.1983 °N	134.0000 °W	>2000		14
85	to Triangle I.	31-Mar-97	8:35:00	50.2453 °N	133.0000 °W	>2000	78	15
86	to Triangle I.	31-Mar-97	12:59:06	50.3458 °N	132.0065 °W	>2000	79	
87	to Triangle I.	31-Mar-97	17:32:20	50.4280 °N	131.0153 °W	>2000	80	
88	to Triangle I.	31-Mar-97	22:24:57	50.5355 °N	130.0115 °W	>2000	81	
89	westcoast Vancouver I.	1-Apr-97	3:20:40	50.6482 °N	129.0012 °W	1040	82	
90	westcoast Vancouver I.	1-Apr-97	5:23:01	50.6960 °N	128.6080 °W	130	83	

Table 3. Biological data for each fish on the W.E. Ricker survey, Gulf of Alaska, March, 1997; cruise # 9705.

fish #	species	fl (mm)	body wt (g)	age	sex	stomach contents wet wt (g)	stomach contents % body wt	description of stomach contents
HS9705-31-124-1	chinook	232	152.44	x.1	F	0.238	0.16	small amount of unidentified, well-digested remains
HS9705-32-124-1	chinook	286	NA	x.1	M	NA	NA	100 % fish remains (two larval caplien), < 1g
HS9705-41-124-1	chinook	234	145.30	x.1	F	0.864	0.59	60% herring larvae (C. sprattus) , 40% hyperiid amphipods
HS9705-61-118-1	sockeye	506	1404.39	1.2	F	31.165	2.22	80% squid, 15% euphausiids, 5% hyperiid amphipods
HS9705-68-118-1	sockeye	475	1063.40	1.1	F	NA	NA	100% euphausiids, <1 g
HS9705-68-118-2	sockeye	270	172.36	1.0	F	0.000	0.00	
HS9705-68-118-3	sockeye	263	175.22	1.0	F	0.000	0.00	
HS9705-68-118-4	sockeye	282	207.93	1.1	F	0.000	0.00	
HS9705-68-118-5	sockeye	294	238.16	x.x	M	0.000	0.00	
HS9705-76-118-1	sockeye	438	901.85	0.2	M	1.171	0.13	20% euphausiids, 70% hyperiid amphipods, 10% calanoid amphipods

Table 4. Estimated zooplankton abundances from Bongo tows, W.E. Ricker survey, Gulf of Alaska, March, 1997; Cruise # 9705.

station	start latitude	start longitude	date mm/dd/yy	start time hh:mm	tow direction	duration hh:mm	target depth m	volume sieved cubic m	dry weight of size factions g / 1000 m^3 >0.250 mm	>1.0 mm	>1.7mm	total
2	52.9992 °N	132.4552 °W	3/14/97	7:43	270º	0:19	150	2570	0.227	0.032	0.150	0.409
3	52.9403 °N	132.5118 °W	3/14/97	10:11	300º	0:07	150	1094	0.073	0.022	0.057	0.152
4	52.9010 °N	132.6427 °W	3/14/97	12:25	350º	0:10	150	NA	NA	NA	NA	NA
6	52.8228 °N	132.8918 °W	3/14/97	15:39	10º	0:10	150	1309	0.170	0.017	1.690	1.876
11	53.3692 °N	135.6043 °W	3/15/97	7:43	10º	0:12	150	NA	NA	NA	NA	NA
12	53.4240 °N	136.1455 °W	3/15/97	11:31	240º	0:12	150	NA	NA	NA	NA	NA
13	53.3668 °N	136.4617 °W	3/15/97	15:38	310º	0:09	150	941	0.342	0.070	0.657	1.069
14	53.2995 °N	136.3140 °W	3/15/97	18:29	285º	0:10	150	1499	0.128	0.020	0.451	0.599
17	53.7785 °N	138.2875 °W	3/16/97	7:36	225º	0:08	150	1900	0.093	0.000	0.883	0.976
18	54.0002 °N	138.7907 °W	3/16/97	14:33	15º	0:15	150	1561	0.153	0.045	0.859	1.056
19	54.1402 °N	138.9757 °W	3/16/97	18:06	180º	0:10	150	1773	0.065	0.019	1.303	1.388
20	54.7232 °N	141.3700 °W	3/17/97	7:29	85º	0:09	150	2205	0.085	0.044	0.000	0.129
21	54.9937 °N	142.1345 °W	3/17/97	13:30	130º	0:15	150	1005	0.169	0.040	1.749	1.958
22	55.1622 °N	142.6603 °W	3/17/97	17:33	105º	0:13	150	1939	0.051	0.003	1.073	1.126
25	55.5195 °N	145.2370 °W	3/18/97	8:40	230º	0:10	150	1461	0.052	0.036	0.569	0.657
26	55.7017 °N	146.1107 °W	3/18/97	14:02	290º	0:18	150	2335	0.081	0.003	1.037	1.122
27	55.6102 °N	146.0010 °W	3/18/97	18:20	320º	0:13	150	2149	0.049	0.020	0.771	0.839
29	56.1283 °N	150.1317 °W	3/19/97	17:20	0º	0:13	150	1480	0.104	3.611	0.000	3.715
31	57.0990 °N	152.1907 °W	3/20/97	7:43	300º	0:07	60	939	0.181	0.019	0.611	0.812
32	57.0375 °N	152.1690 °W	3/20/97	9:18	300º	0:06	60	1560	0.094	0.003	0.581	0.677
34	56.9173 °N	151.9693 °W	3/20/97	11:40	300º	0:08	60	1094	0.128	0.037	0.908	1.073
35	56.8523 °N	151.9577 °W	3/20/97	13:21	30º	0:05	60	905	0.146	0.027	2.619	2.791
37	56.7832 °N	151.7760 °W	3/20/97	17:35	80º	0:11	150	1777	0.106	0.009	1.408	1.523
39	56.6398 °N	151.5383 °W	3/20/97	19:27	310º	0:10	150	2367	0.112	0.006	0.802	0.919
40	56.5545 °N	151.3918 °W	3/20/97	21:40	345º	0:10	150	2058	0.221	0.047	1.909	2.176
41	57.5398 °N	152.0002 °W	3/22/97	13:33	180º	0:07	50	698	0.602	0.009	0.120	0.731
42	57.1043 °N	152.2508 °W	3/22/97	18:00	180º	0:07	60	1325	0.056	0.002	1.700	1.757
43	56.3502 °N	153.6772 °W	3/23/97	5:11	45º	0:06	55	948	0.462	0.011	0.597	1.070
44	56.2858 °N	153.5600 °W	3/23/97	7:25	330º	0:06	60	1087	0.197	0.107	0.099	0.403
45	56.2582 °N	153.4275 °W	3/23/97	8:57	300º	0:08	80	1270	0.220	0.000	0.082	0.302
46	56.2155 °N	153.3567 °W	3/23/97	10:18	340º	0:13	150	1835	0.215	0.009	0.614	0.837
48	56.1858 °N	153.2487 °W	3/23/97	12:28	50º	0:11	150	1664	0.156	0.006	0.338	0.500
49	56.1775 °N	153.1640 °W	3/23/97	14:08	45º	0:17	150	2644	0.081	0.010	0.847	0.937
50	56.1617 °N	153.0878 °W	3/23/97	15:58	55º	0:13	150	2386	0.112	0.012	1.197	1.321
54	54.4742 °N	152.1933 °W	3/24/97	8:29	30º	0:15	150	1823	0.053	0.071	2.525	2.649
55	54.3580 °N	152.1745 °W	3/24/97	10:48	20º	0:13	150	1899	0.087	0.065	1.579	1.731
56	54.2042 °N	152.1308 °W	3/24/97	13:21	25º	0:13	150	1642	0.054	0.022	2.157	2.233
57	54.1240 °N	152.1392 °W	3/24/97	15:17	34º	0:12	150	1502	0.128	0.083	1.902	2.112
58	53.9880 °N	152.1678 °W	3/24/97	18:33	25º	0:16	150	1783	0.073	0.026	2.690	2.789
62	52.5592 °N	151.1497 °W	3/25/97	8:31	330º	0:11	150	1463	0.118	0.067	3.571	3.755
63	52.3033 °N	150.9498 °W	3/25/97	12:52	135º	0:11	150	1733	0.095	0.170	1.832	2.096

Table 4 continued.

station	start latitude	start longitude	date mm/dd/yy	start time hh:mm	tow direction	duration hh:mm	target depth m	volume sieved cubic m	dry weight of size factions g / 1000 m^3 >0.250 mm	>1.0 mm	>1.7mm	total
64	52.1868 °N	150.9278 °W	3/25/97	15:14	305º	0:13	150	1932	0.113	0.099	1.850	2.062
65	52.0165 °N	150.8010 °W	3/25/97	18:38	270º	0:17	150	2629	0.122	0.102	2.989	3.214
69	50.6615 °N	150.2625 °W	3/26/97	9:22	160º	0:10	150	1765	0.102	0.181	2.137	2.420

Table 5. Replicate sampling to compare zooplankton abundance estimates with Bongo, Scor and Norpac nets; cruise # 9705.

date	location		gear	replicate#	flowmeter reading	start time	end time	time	depth	wire angle	wire-out
29-Mar-97	49.5653 °N	141.2763 °W	Norpac	1	1220	9:25	9:40	0:15	150	30	170
29-Mar-97	49.5653 °N	141.2763 °W	Scor	1	1930	9:41	9:55	0:14	150	20	160
29-Mar-97	49.5653 °N	141.2763 °W	Bongo	1	1122	10:02	10:17	0:15	150	21	161
29-Mar-97	49.5653 °N	141.2763 °W	Norpac	2	1375	10:30	10:45	0:15	150	17	157
29-Mar-97	49.5653 °N	141.2763 °W	Scor	2	1235	10:45	10:55	0:10	150	15	155
29-Mar-97	49.5653 °N	141.2763 °W	Bongo	2	1327	10:55	11:03	0:08	150	15	155
29-Mar-97	49.5653 °N	141.2763 °W	Scor	3	1715	11:10	11:21	0:11	150	22	167
29-Mar-97	49.5653 °N	141.2763 °W	Norpac	3	2340	11:23	11:35	0:12	150	10	153
29-Mar-97	49.5653 °N	141.2763 °W	Bongo	3	1186	11:36	11:47	0:11	>144	0	>144
29-Mar-97	49.5653 °N	141.2763 °W	Norpac	4	1740	12:00	12:25	0:25	140	0	>140
29-Mar-97	49.5653 °N	141.2763 °W	Scor	4	3490	12:27	12:40	0:13	NA	15	>155
29-Mar-97	49.5653 °N	141.2763 °W	Bongo	4	1825	13:17	13:25	0:08	140	0	140
29-Mar-97	49.5653 °N	141.2763 °W	Scor	5	1855	13:41	13:56	0:15	140	0	140
29-Mar-97	49.5653 °N	141.2763 °W	Norpac	5	1050	13:58	14:07	0:09	140	0	140
29-Mar-97	49.5653 °N	141.2763 °W	Bongo	5	1900	14:11	14:19	0:08	121	30	140
29-Mar-97	49.5653 °N	141.2763 °W	Scor	6	1960	14:22	14:30	0:08	135	15	140
29-Mar-97	49.5653 °N	141.2763 °W	Norpac	6	1070	14:31	14:42	0:11	140	0	140
29-Mar-97	49.5653 °N	141.2763 °W	Bongo	6	1000	14:43	14:53	0:10	137	12	140
29-Mar-97	49.5653 °N	141.2763 °W	Norpac	7	1225	14:53	15:02	0:09	115	35	140
29-Mar-97	49.5653 °N	141.2763 °W	Scor	7	1167	15:03	15:10	0:07	130	22	140
29-Mar-97	49.5653 °N	141.2763 °W	Bongo	7	1440	15:13	15:21	0:08	138	10	140
30-Mar-97	49.8785 °N	138.0027 °W	Scor	8	1925	10:35	10:48	0:13	149	33	178
30-Mar-97	49.8785 °N	138.0027 °W	Norpac	8	2383	10:55	11:08	0:13	151	33	180
30-Mar-97	49.8785 °N	138.0027 °W	Bongo	8	2145	11:17	11:30	0:13	156	12	160

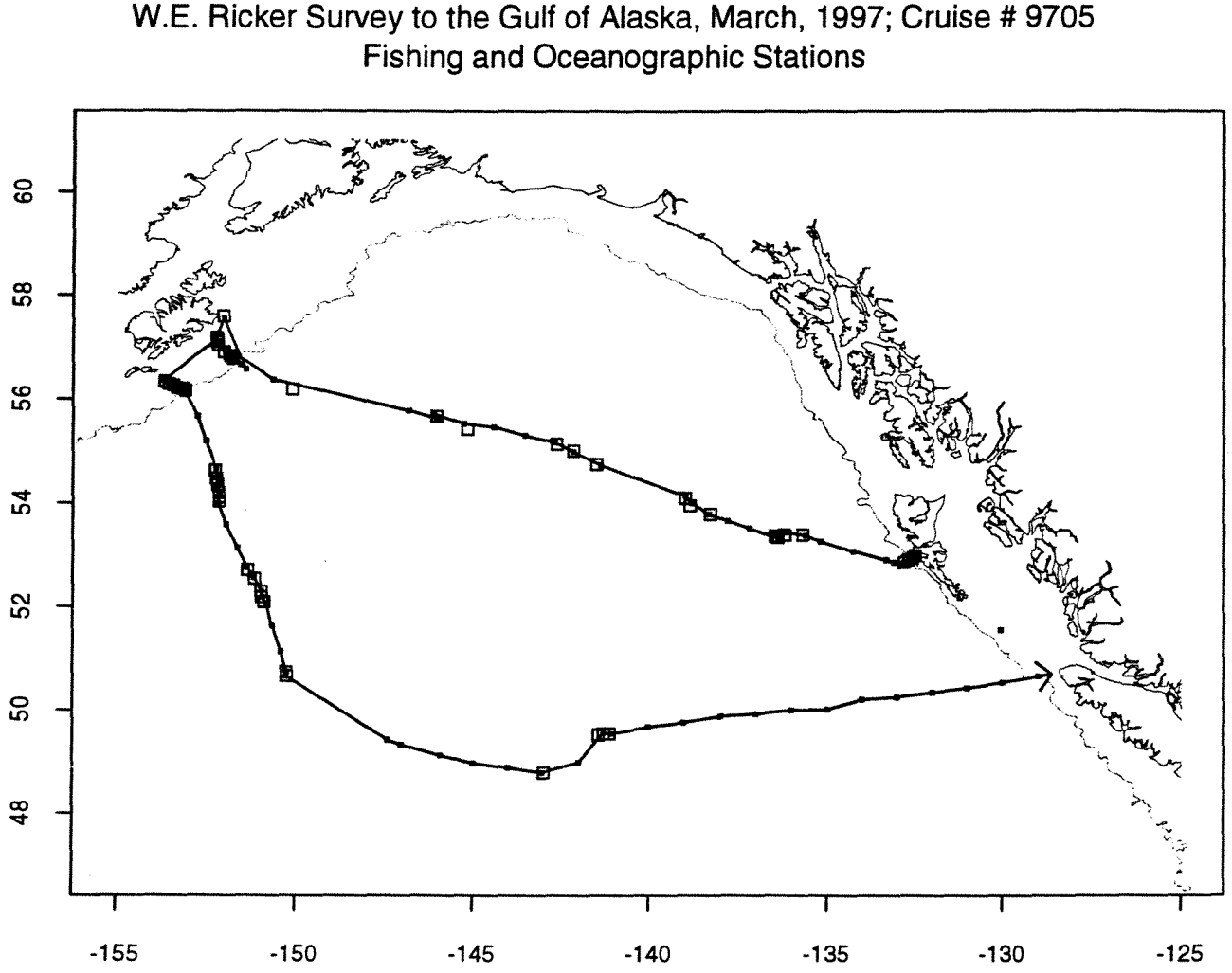

Fig. 1. Survey track for the *C.C.G.S. W. E. Ricker* to the Gulf of Alaska, March, 1997. Filled squares (■) along the survey track represent oceanographic stations, and open squares (□) represent the location of fishing stations.

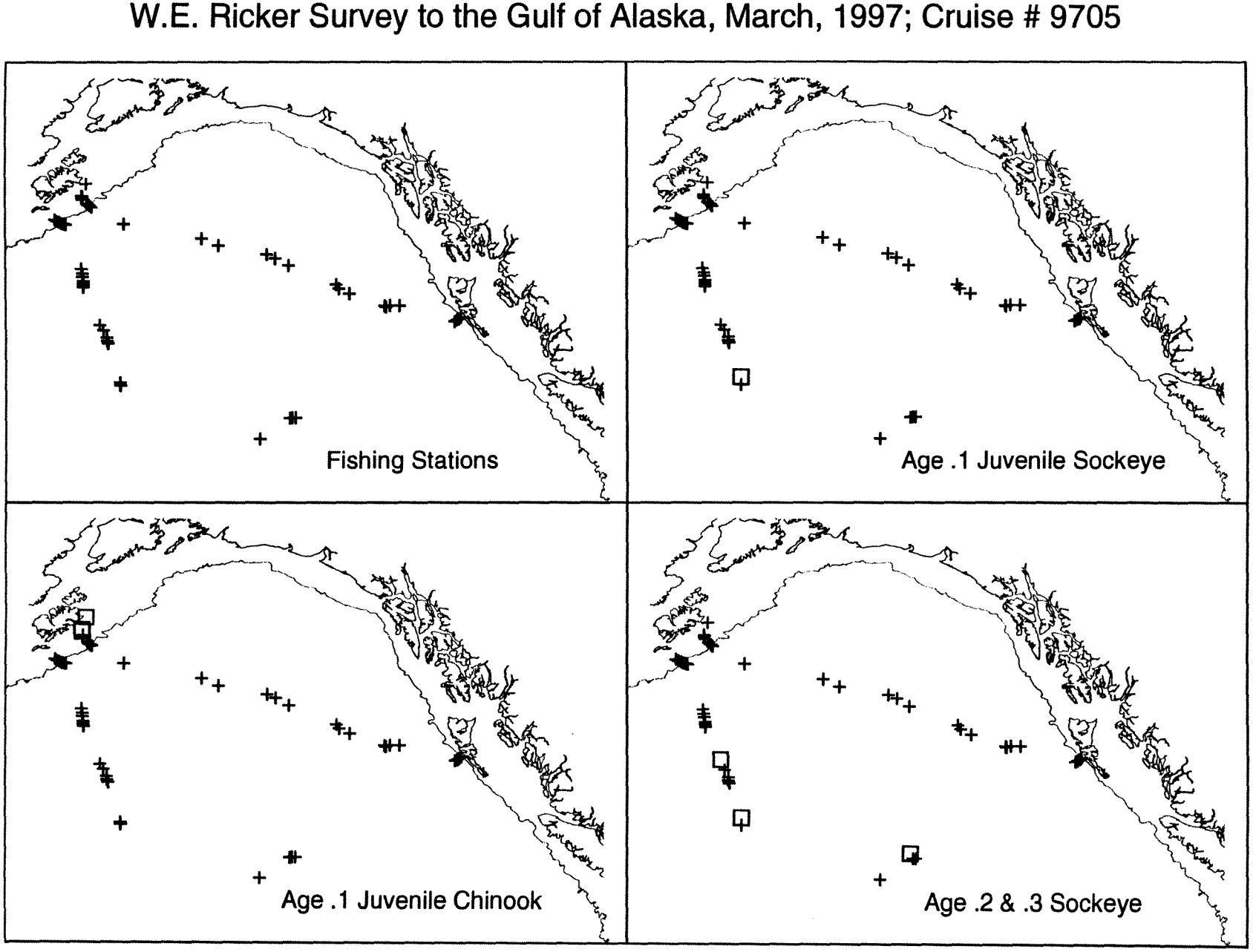

Fig. 2 (a-d). Salmon catches at each station on the *CCGS W.E. Ricker* survey in March, 1997. For Fig. 2a crosses (+) represent fishing stations and in Figs. 2b-d, crosses represent fishing stations where no salmon were caught. Open squares (□) show locations where salmon were caught.

Comparison of December-March Juvenile Salmon Catches

Japanese and Canadian Surveys, 1992 to 1997

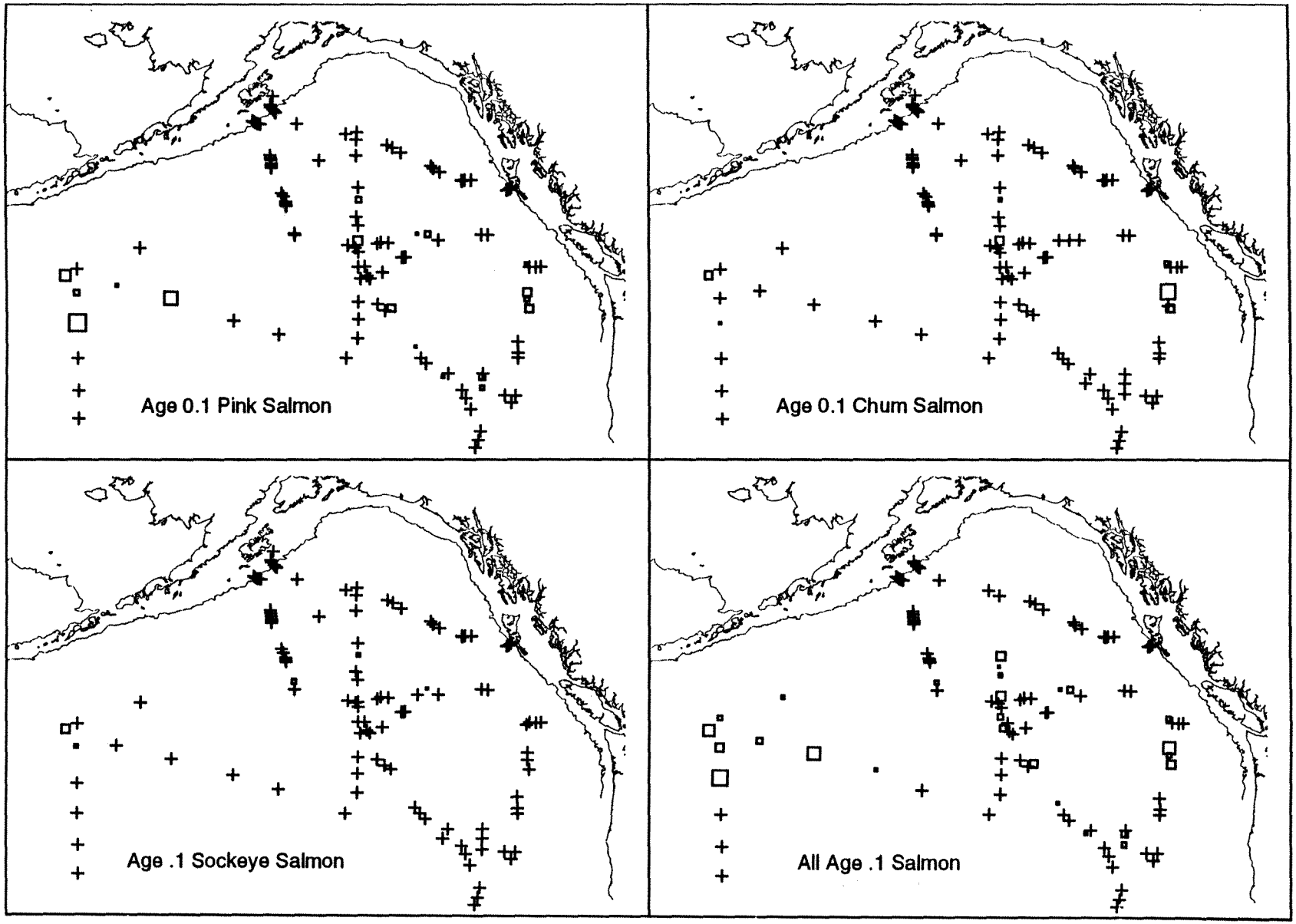

Fig. 3 (a-d). Comparison of combined December-March juvenile salmon catches for Japanese and Canadian surveys to the Gulf of Alaska from 1992-97. These include *the R/V Kaiyo Maru*, December, 1992 survey; the *R/V Kaiyo Maru*, January, 1996 survey; the *F/V Anita J*, March, 1995 survey; and the *C.C.G.S. W.E. Ricker*, March, 1997 survey. Crosses (+) represent fishing stations where no age .1 juvenile salmon were caught. Open squares (□) show locations where age .1 juvenile salmon were caught; symbol size is proportional to the log-transformed CPUE . For Fig. 3d., the inserted label, "All Age .1 Salmon", means the combined catches for age .1 juvenile pink, chum, and sockeye salmon.