Juvenile Pacific Salmon (*Oncorhynchus* spp.) Trawl Survey on the South Coast of British Columbia, March 1 to March 13, 2012

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2024

JUVENILE PACIFIC SALMON (*ONCORHYNCHUS* SPP.) TRAWL SURVEY ON THE SOUTH COAST OF BRITISH COLUMBIA, MARCH 1 TO MARCH 13, 2012

by

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ABSTRACT

Jung, Y., Tabata, A.M., Flynn, K.L., Zubkowski, T.B., and King, J.R. 2024. Juvenile Pacific Salmon (*Oncorhynchus* spp.) Trawl Survey on the South Coast of British Columbia, March 1 to March 13, 2012. Can. Data Rep. Fish. Aquat. Sci. 1412: vi + 33 p.

Fisheries and Oceans Canada (DFO) conducted a surface trawl survey from March 1 to March 13, 2012 on the *CCGS W.E. Ricker*. This study targeted juvenile Pacific Salmon (*Oncorhynchus* spp.) in southern British Columbia (BC). There were 4,375 individuals caught from 15 species in 55 tows. Pacific Herring was the most abundant species with 61% of the total catch. Juvenile salmon species caught in decreasing abundance by count were: Coho Salmon, Chinook Salmon, Sockeye Salmon and Chum Salmon, with catch distribution varying by species. Biological samples for genetic stock composition, otoliths, and coded wire tags were returned to the Pacific Biological Station (DFO, Nanaimo, BC). Associated information on the physical oceanography (57 locations), water samples for chemistry and chlorophyll *a* along with zooplankton samples (56 locations) were returned to the Institute of Ocean Sciences (DFO, Sidney, BC).

RÉSUMÉ

Jung, Y., Tabata, A.M., Flynn, K.L., Zubkowski, T.B., and King, J.R. 2024. Juvenile Pacific Salmon (*Oncorhynchus* spp.) Trawl Survey on the South Coast of British Columbia, March 1 to March 13, 2012. Can. Data Rep. Fish. Aquat. Sci. 1412: vi + 33 p.

Pêches et Océans Canada a effectué un relevé au chalut de surface entre mars 1 to mars 13, 2012 sur le *CCGS W.E. Ricker*. Cette étude ciblait le saumon du Pacifique juvénile (*Oncorhynchus* spp.) dans le sud de la Colombie-Britannique (C.-B.). 4,375 individus de 15 espèces ont été capturés au cours de 55 traits. Le hareng du Pacifique était l'espèce la plus abondante avec 61% de la prise totale. Les espèces de saumon juvénile capturées par ordre décroissant d'abondance par comptage étaient les suivantes: saumon coho juvéniles, saumon quinnat juvéniles, saumon rouge juvéniles et saumon kéta juvéniles, avec la répartition des prises variait selon les espèces. Les échantillons biologiques pour la composition génétique des stocks, les otolithes, et les micromarques magnétisées codées ont été retournés à la Station biologique du Pacifique (MPO, Nanaimo, C.-B.). Les informations associées sur l'océanographie physique (57 sites) les échantillons d'eau pour la chimie et la chlorophylle *a* ainsi que les échantillons de zooplancton (56 sites) ont été retournés à l'Institut des sciences de la mer (MPO, Sidney, C.-B.).

1 INTRODUCTION

Fisheries and Oceans Canada (DFO) conducted a trawl survey, targeting juvenile Pacific Salmon (*Oncorhynchus* spp.) from March 01 to March 13, 2012 on the *CCGS W.E. Ricker*. The main objectives of this survey were:

1. to determine the abundance, condition, distribution, and genetic stock composition of juvenile Pacific Salmon present off the north and west coast of Vancouver Island;
2. the associated physical oceanography; and
3. the distribution and biomass of zooplankton.

This survey was part of an ongoing suite of surveys which was led by the High Seas Salmon Program at the Pacific Biological Station, Nanaimo, British Columbia (BC) in support of research on Pacific Salmon ocean ecology. These surveys have been conducted annually since 1997 (Welch et al., 2002), initially from the Gulf of Alaska to the southern continental shelf of BC, albeit with differences in location, survey area and timing each year. This data report documents the biological, oceanographic, and zooplankton data and samples collected.

2 METHODS

2.1 SURVEY LOCATIONS

Fishing, oceanographic, and zooplankton sampling occurred off the north and west coast of Vancouver Island, including Queen Charlotte Strait, Queen Charlotte Sound, and Juan de Fuca Strait (Figure 1).

2.2 FISHING OPERATIONS

The *CCGS W.E. Ricker* deployed a Cantrawl model 250 midwater trawl net (approximately 90 m long x 30 m wide x 15 m high; (Cantrawl Nets Ltd., Richmond, Canada; Appendix Table A and Appendix Figure B). This three-bridle midwater net had a codend liner with 12.7 mm mesh (stretched) to retain smaller species. On this survey, the mean trawl net opening was 34 m wide by 13 m high, or an area of 442 m^2.

Tow speed averaged 8.7 km/hr, and varied between 5.4 to 11.7 km/hr speed over ground, depending on the wind, tide, and current. The target headrope depths were 0 m, 15 m, and 30 m. Warp length ranged from 150 m to 175 m (Appendix C). Tow duration was 15-30 min, with the time starting when the Jet 5 m^2 trawls doors were locked and the net started fishing. Tows were considered unusable if the net was fishing incorrectly, either due to weather or mechanical error, or the tow duration was less than 15 minutes.

2.3 CATCH PROCESSING

All fish were sorted to species and counted. The catch of juvenile Pacific Salmon by species (number of fish) was divided by swept volume to calculate catch per unit effort (CPUE). Fish caught during unusable tows were still processed for lengths and weights, but were not included in CPUE estimates.

2.4 BIOLOGICAL SAMPLING

All salmon species were measured for fork length (mm) and weight (g), sex determined, and presence of sea lice recorded. Pacific Salmon were separated into juveniles and adults based on their fork lengths. All Pacific Salmon species that were < 300 mm in length were considered juveniles, except for Chinook Salmon whose length threshold as juveniles was < 200 mm. Additional collections included: fin clips for genetic stock identification (GSI), additional salmon tissues for molecular identification of pathogens, muscle tissue for energy density estimation, stable isotope analyses or proximate analyses, otoliths, adipose fin status (i.e., clipped vs. non-clipped), and coded wire tags (CWTs). Other fish species were measured for length (mm) and weight (g) as time permitted.

2.5 OCEANOGRAPHY

A Sea-Bird 911plus CTD (conductivity-temperature-depth; Sea-Bird Scientific, Bellevue, WA) was used for oceanographic profiles at 57 locations (Figure 1, Appendix D). A Niskin bottle at 10 m from the surface was used for nutrient and chlorophyll (chl *a*) collections. Seawater samples for nitrate, phosphate, and silicate were placed in acid-washed glass test tubes and frozen. Seawater samples for chl *a* estimation were filtered with 25 mm GF/F (glass fibre filter) disks under vacuum, not exceeding 5 inHg (inch of mercury, a unit of measurement for pressure). Filter disks were then placed in polypropylene scintillation vials and frozen. Both the nutrient and chl *a* samples were frozen and maintained at -18°C. Nutrient and chl *a* samples were sent for analyses at the Institute of Ocean Sciences (DFO, Sidney, BC).

2.6 ZOOPLANKTON

At 56 locations (Figure 1, Appendix D), vertical tows to sample zooplankton were conducted to approximately 250 m or within 10 m of the bottom with two 60 cm diameter, 253 μm mesh nets mounted in a bongo-drum style frame, one of which was equipped with a flow meter. Zooplankton collected from one bongo net were preserved in 10% formalin and sent to the zooplankton laboratory at the Institute of Ocean Sciences (DFO, Sidney, BC) for species enumeration. The zooplankton sample from the other bongo net was sorted into four size fractions by successively sieving through 8.0, 1.7, 1.0, and 0.25 mm screens. Individual size fractions were frozen for future stable isotope, energy density, or proximate analyses and sent to the Pacific Biological Station (DFO, Nanaimo, BC) for processing or archiving.

3 RESULTS

3.1 FISHING OPERATIONS

This survey conducted 56 trawl net tows off the north and west coast of Vancouver Island (Figure 1, Appendix C) with 55 trawls completed successfully. There was 1 unusable tow due to problems with equipment deployment and is identified by Usable = N in Appendix C.

3.2 CATCH COMPOSITION

The Total catch for the survey from usable tows was 4,375 fish, with 67 (or 2%) juvenile Pacific Salmon. Detailed catch composition for each tow is included in Appendix E. For each species captured during the survey, the number of tows in which the species was present, total catch count, maximum tow catch count, and mean tow catch count in usable tows is presented in Table 1. The top three abundant species caught by count were: Pacific Herring (n=2,659), Threespine Stickleback (n=780), then Pacific Sand Lance (n=380; Table 1). Juvenile Pacific Salmon species caught, in order of abundance by count, were: Coho Salmon, Chinook Salmon, Sockeye Salmon and Chum Salmon. Juvenile Pink Salmon were not caught in the survey. The survey targeted juvenile Pacific Salmon, but the catch of adult Pacific Salmon was higher than expected.

The location and catch per unit effort (CPUE, count/km^3) of juvenile salmon is shown in Figure 2. Juvenile Chinook Salmon were caught exclusively in the Quatsino Inlet. Juvenile Coho Salmon were abundant throughout Juan de Fuca Strait, but at no other locations. Juvenile Chum Salmon were the least abundant salmon species, caught primarily in Juan de Fuca Strait. Juvenile Sockeye Salmon were the second least abundant salmon species, caught off Estevan Point, on the West Coast Vancouver Island.

3.3 BIOLOGICAL SAMPLES

Samples were collected for GSI (n=336), otoliths (n=334), pathogen analyses (n=28), energy density and stable isotope analyses (n=333). CWTs (n=27) when present and detected were retained. These biological samples are located at the Pacific Biological Station, DFO (Nanaimo, BC).

3.4 LENGTH AND WEIGHT

Length frequencies and length-weight relationships are presented for juvenile Chinook Salmon in Figure 3 and Coho Salmon species in Figure 4. The Juvenile Chum Salmon and Sockeye Salmon figures are excluded due to insufficient sample data. Double log transformed length-weight regressions coefficients were similar in Chinook Salmon and Coho Salmon. A larger coefficient typically represents better condition, whereas a smaller coefficient typically represents

worse condition. Lengths and weights of 13 species for all the tow were recorded (Table 2). The length frequencies for species with greater than 50 length measurements (Pacific Herring, Threespine Stickleback and Pacific Sand Lance) are presented in Figure 5.

Within juvenile Pacific Salmon, Coho Salmon had the largest maximum length (284 mm) and weight (246 g), whereas Chinook Salmon had the smallest maximum length (174 mm) and weight (58 g).

3.5 OCEANOGRAPHY

CTD casts and water samples were completed at 57 sites with cast depths ranging from 27 m to 500 m (Appendix D). Oceanographic data from the CTD casts and nutrient analysis of the water samples are archived online within the Water Properties Data Inventory (Institute of Ocean Sciences, DFO, Sidney, BC) under cruise number 201203.

3.6 ZOOPLANKTON

Vertical bongo tows were conducted at 56 stations to depths ranging from 25 m to 150 m (Appendix D). Zooplankton enumeration data are archived in the zooplankton database (Institute of Ocean Sciences, DFO, Sidney, BC) under cruise number 201203.

4 DISCUSSION

This juvenile Pacific Salmon trawl survey collected valuable information on the distribution, abundance, condition, and genetic stock composition for juvenile Pacific Salmon off the north and west coast of Vancouver Island. Overall, juvenile Coho Salmon and juvenile Chinook Salmon were most abundant, whereas juvenile Sockeye Salmon were second least abundant and juvenile Chum Salmon were least abundant. Juvenile Pink Salmon were not caught. Distributions varied by species and life stage. This survey data supplements historic juvenile Pacific Salmon surveys that have been reported in Fisheries and Oceans Canada's State of the Pacific Ocean, and are being incorporated into longer term and broader scope research projects.

5 REFERENCES

Welch, D.W., Morris, J.F.T., and Demers, E. 2002. *CCGS W.E. Ricker* Gulf of Alaska salmon survey, March - April, 1997. Can. Data Rep. Fish. Aquat. Sci. 1101: 19 p.

6 ACKNOWLEDGEMENTS

We would like to thank the Captain Scott Doan, Fishing Master Les Han and crew of the *CCGS W.E. Ricker*. Marc Trudel was the High Seas Salmon Program Lead in 2012, Tyler Zubkowski was Chief Scientist on this survey. We appreciate the expertise of additional science staff who participated in the survey, in particular Hugh Maclean who conducted all oceanographic sampling and Lana Fitzpatrick who reviewed the report.

7 FIGURES

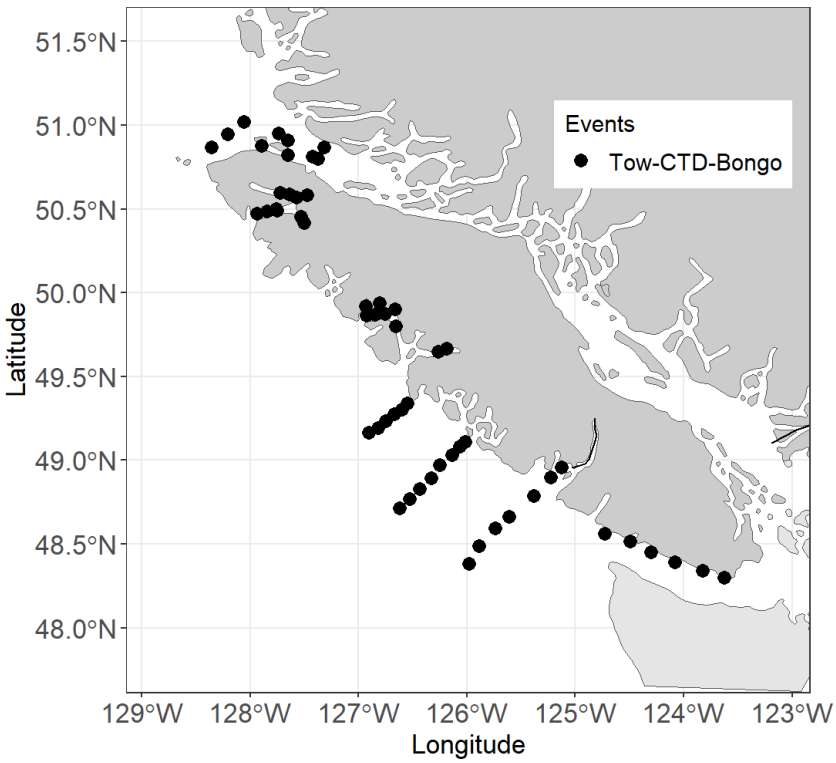

Figure 1. Location of survey events (fishing tows, CTD casts and zooplankton bongo casts) during the juvenile Pacific Salmon trawl survey from March 01 to March 13, 2012 on the *CCGS W.E. Ricker*.

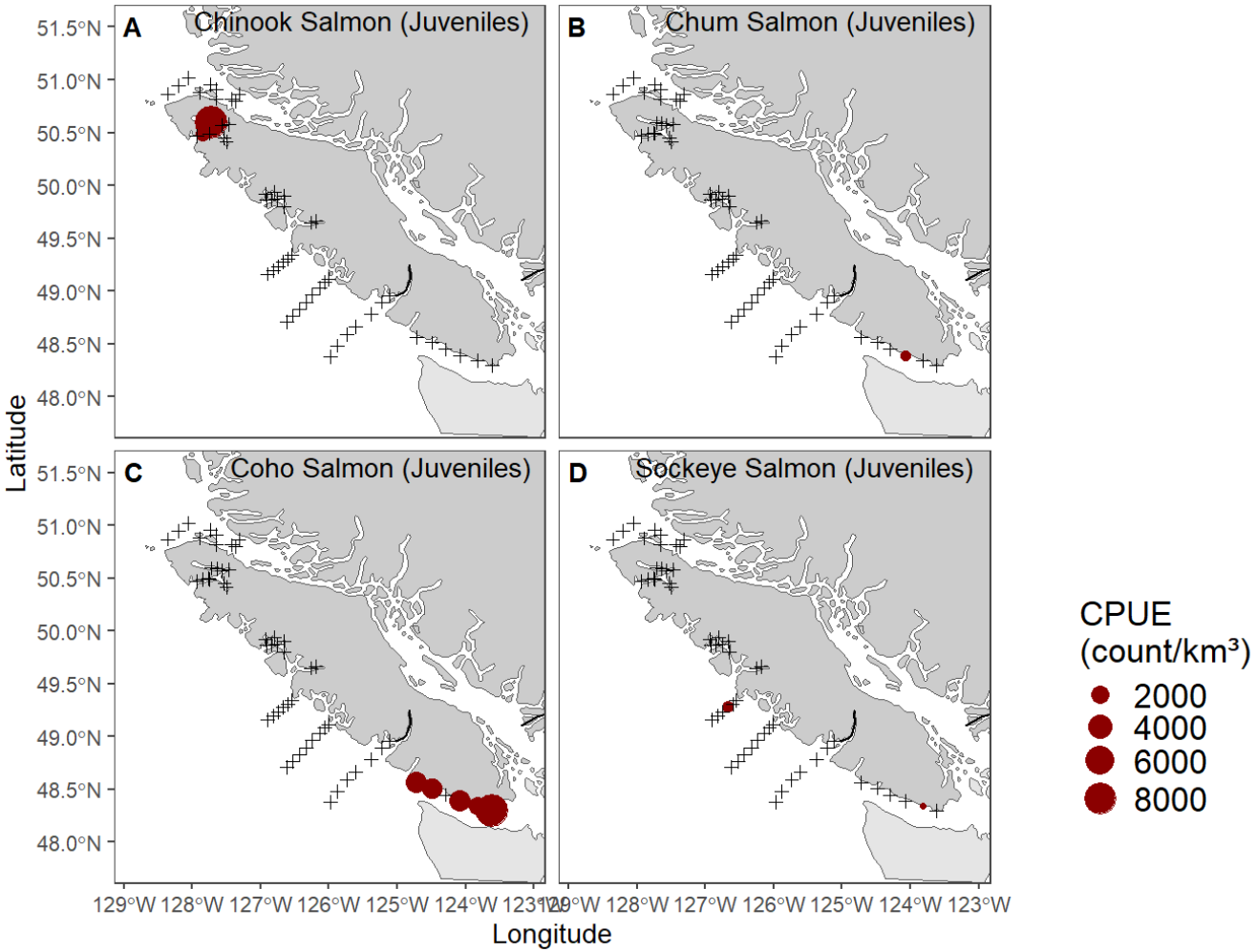

Figure 2. Juvenile Pacific Salmon (*Oncorhynchus* spp.) catch (count) per unit effort (CPUE; count/km^3) for each tow. Circles are proportional to maximum abundance, and zero catches are shown with a cross (+).

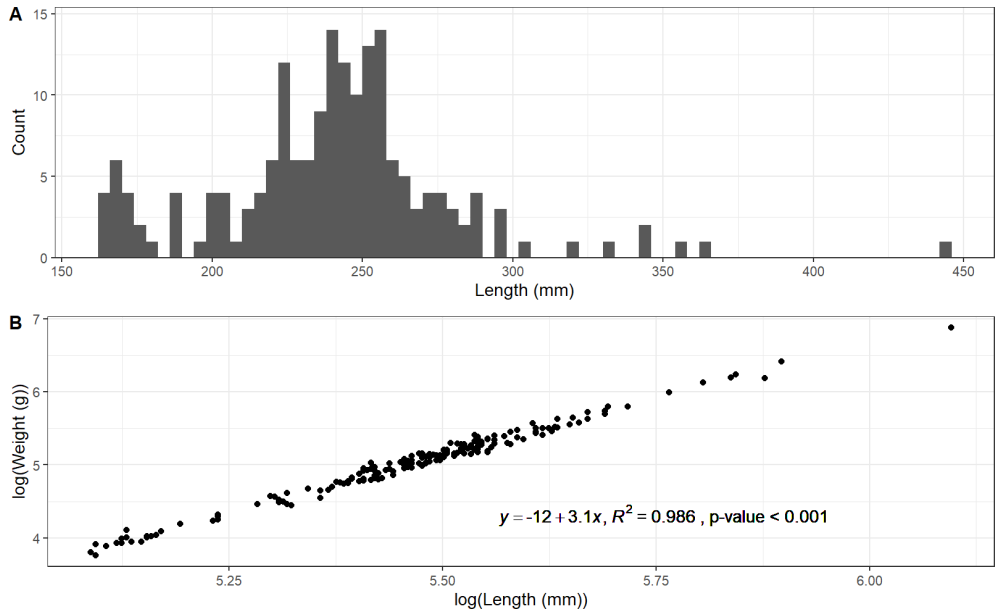

Figure 3. **A.** Chinook Salmon (*Oncorhynchus tshawytscha*) length frequency plot as sampled during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012. **B.** Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test.

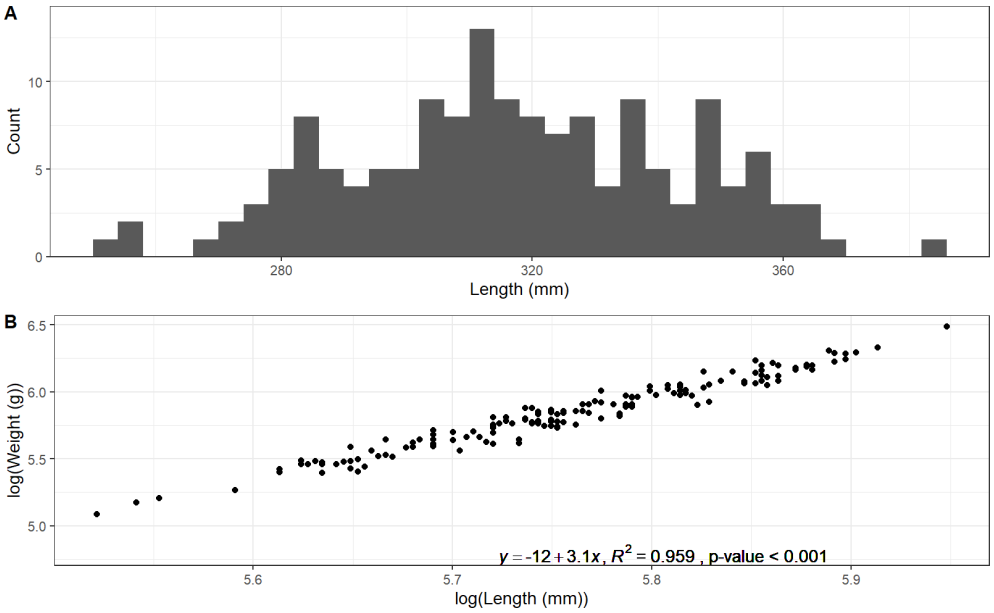

Figure 4. **A.** Coho Salmon (*Oncorhynchus kisutch*) length frequency plot as sampled during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012. **B.** Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test.

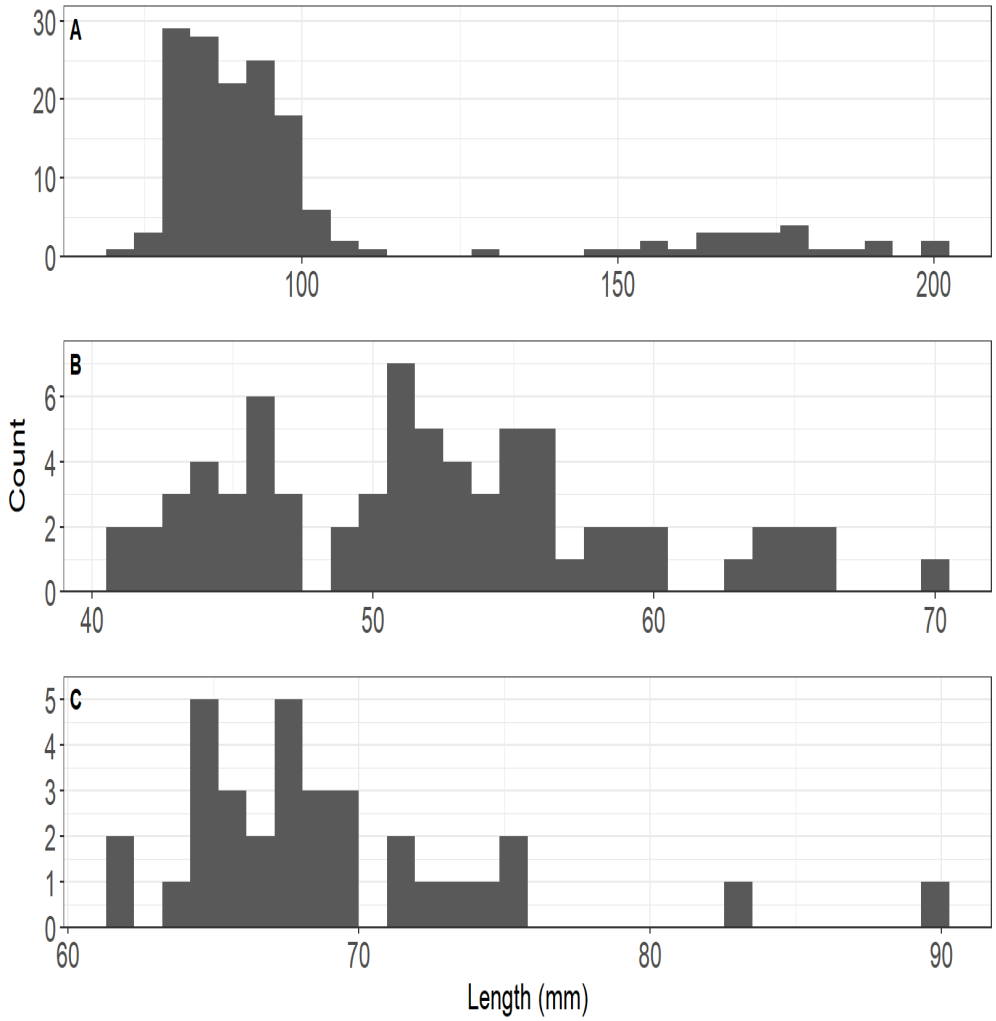

Figure 5. Length (mm) frequency plots for common species sampled (n>50 samples) during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012. **A.** Pacific Herring (*Clupea pallasii*), length = Fork Length, **B.** Threespine Stickleback (*Gasterosteus aculeatus*), length = Total Length, **C.** Pacific Sand Lance (*Ammodytes personatus*), length = Total Length.

8 TABLES

Table 1. All captured species (or taxonomic group), ordered by total catch count, showing number of tows in which the species occurred, total catch count, maximum catch count, and mean catch count per tow for usable tows during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012.

Common Name	Scientific Name	Tows	Count	Max	Mean
Pacific Herring	*Clupea pallasii*	9	2,659	2,549	295
Threespine Stickleback	*Gasterosteus aculeatus*	5	780	758	156
Pacific Sand Lance	*Ammodytes personatus*	2	380	377	190
Coho Salmon (Adults)	*Oncorhynchus kisutch*	6	172	58	29
Chinook Salmon (Adults)	*Oncorhynchus tshawytscha*	22	167	36	8
Opalescent Inshore Squid	*Doryteuthis opalescens*	4	127	115	32
Coho Salmon (Juveniles)	*Oncorhynchus kisutch*	5	42	17	8
Chinook Salmon (Juveniles)	*Oncorhynchus tshawytscha*	4	22	17	6
Soft Sculpin	*Psychrolutes sigalutes*	2	10	9	5
Rockfishes	*Sebastes*	6	8	2	1
Pacific Spiny Lumpsucker	*Eumicrotremus orbis*	2	2	1	1
Sockeye Salmon (Juveniles)	*Oncorhynchus nerka*	2	2	1	1
Chum Salmon (Juveniles)	*Oncorhynchus keta*	1	1	1	1
Moon Jellyfish	*Aurelia*	1	1	1	1
Pile Perch	*Rhacochilus vacca*	1	1	1	1
Spotted Ratfish	*Hydrolagus colliei*	1	1	1	1
Comb Jellyfish	*Ctenophora*	11			

Table 2. Lengths and weights for each species (arranged descending by the number of length measurements for each by species) sampled during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012. Tows = number of tows wth species present or caught. Type = Type of length measurement (FL = Fork Length, TL = Total Length, SL = Standard Length, ML = Mantle Length, BD = Bell Diameter). Measured = number of length measurements. Weighed = number of weight measurements. Counts may include fish that were caught in unusable tows, and may not reflect total counts used to estimate CPUE.

		Length (mm)					Weight (g)			
Common Name	Tows	Type	Measured	Min	Max	Mean	Weighed	Min	Max	Mean
Coho Salmon	6	FL	214	250	397	326	151	162	656	353
Chinook Salmon	25	FL	190	162	497	248	183	43	970	177
Pacific Herring	9	FL	160	72	201	102				
Threespine Stickleback	5	TL	72	41	70	52				
Pacific Sand Lance	2	TL	33	62	90	69				
Opalescent Inshore Squid	4	ML	32	25	49	32				
Soft Sculpin	2	TL	10	30	45	37				
Rockfishes	6	TL	8	22	98	43				
Sockeye Salmon	2	FL	2	197	245	221	2	78	155	116
Chum Salmon	1	FL	1	236	236	236	1	124	124	124
Moon Jellyfish	1	BD	1	195	195	195				
Pile Perch	1	FL	1	70	70	70				
Spotted Ratfish	1	TL	1	286	286	286				

APPENDIX A CANTRAWL 250 NET SPECIFICATIONS

Table A.1. Net specifications for the CanTrawl 250 net used during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012.

Part	Size	Material
Doors	2 m^2	Jet
Door Legs	12.2 m (6.67 fm)	1 inch Spectra rope
Bridles	45.72 m (25 fm)	5/8 Wire Rope
Head Line	76.2 m (41.7 fm)	1 1/8 inch Tenex
Foot Rope	76.2 (41.7 fm)	1/2 chain
Mesh incl. Codend	3.8 cm (1.5 inch)	Knotted nylon
Codend Liner	12.7 mm (0.5 inch)	210/20 knotless liner

APPENDIX B CANTRAWL 250 NET DIAGRAM

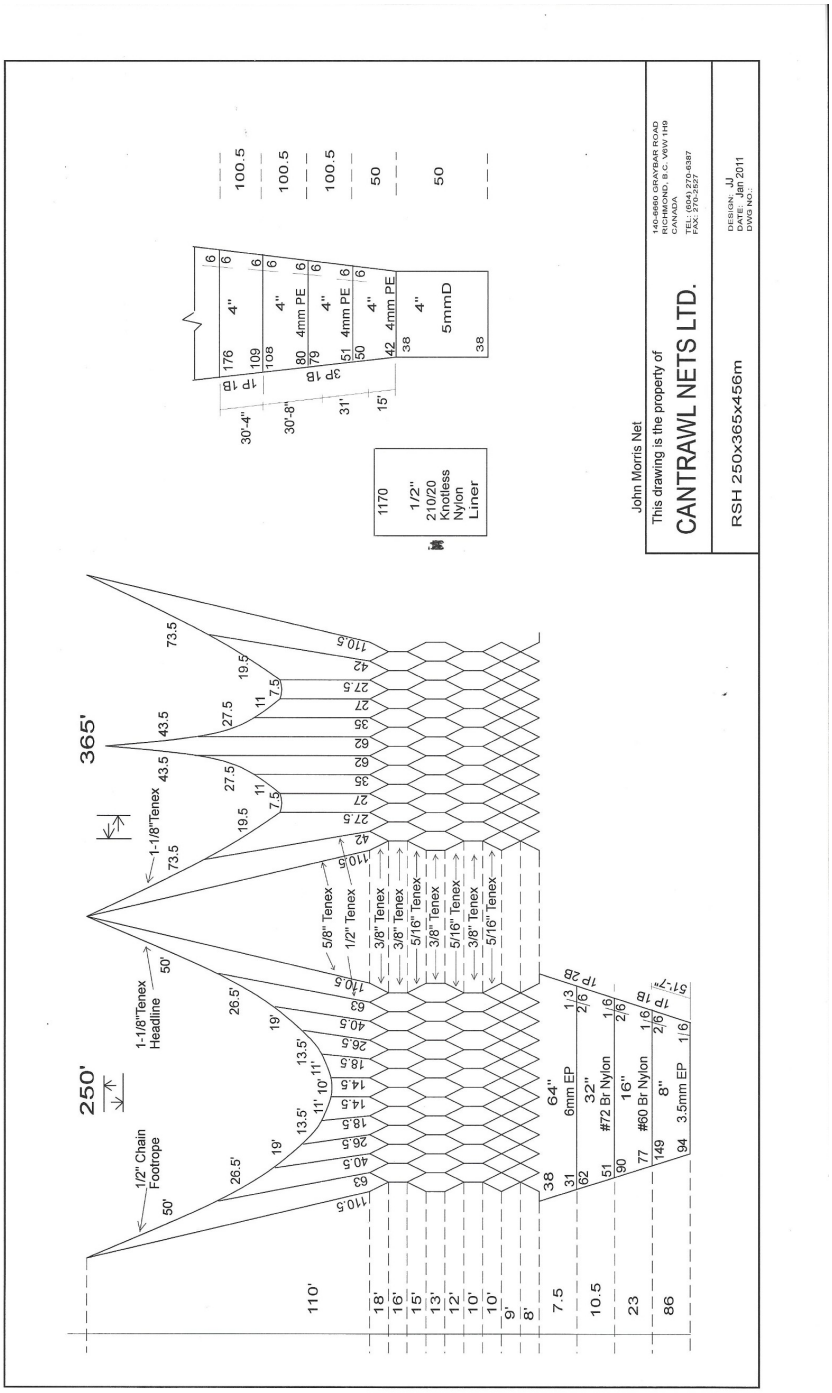

Figure B.1. Net diagram for CanTrawl 250 trawl net used during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012.

APPENDIX C TRAWL BRIDGE LOG DATA

Table C.1. Bridge log information for trawl tows during the juvenile Pacific Salmon trawl survey aboard the *CCGS W.E. Ricker*, March 01 to March 13, 2012.

Station Name	JF01	JF02	JF03	JF04	JF05	JF06
Tow	1	2	3	4	5	6
Date (Pacific)	2012-03-02	2012-03-02	2012-03-02	2012-03-02	2012-03-02	2012-03-02
Start Time (Pacific)	07:43:00	09:31:00	11:24:00	13:35:00	15:12:00	17:06:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	30	30	30	30
Start Latitude	48° 17' 56" N	48° 20' 20" N	48° 23' 28" N	48° 26' 53" N	48° 30' 43" N	48° 33' 43" N
Start Longitude	123° 37' 08" W	123° 49' 23" W	124° 04' 44" W	124° 18' 00" W	124° 29' 17" W	124° 43' 19" W
End Latitude	48° 18' 32" N	48° 20' 53" N	48° 24' 25" N	48° 28' 05" N	48° 31' 34" N	48° 33' 54" N
End Longitude	123° 40' 52" W	123° 44' 42" W	124° 08' 49" W	124° 21' 29" W	124° 33' 18" W	124° 46' 48" W
Direction of Tow (deg)	284	80	289	297	287	274
Vessel Speed (km/h)	9.4	11.7	10.6	9.6	10.4	8.5
Distance Towed (km)	4.72	5.85	5.33	4.89	5.24	4.28
Net Opening Height (m)	15	17	13	15	14	14
Net Opening Width (m)	29	35	32	40	33	34
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	0	15	0	30	0	15
Start Bottom Depth (m)	138	139	102	108	118	95
End Bottom Depth (m)	141	124	106	114	119	98
Usable	Y	Y	Y	Y	Y	Y

Station Name	IVI01	IVI02	VI01	VI02	VI03	VI04
Tow	7	8	9	10	11	12
Date (Pacific)	2012-03-03	2012-03-03	2012-03-03	2012-03-03	2012-03-03	2012-03-03
Start Time (Pacific)	07:29:00	08:52:00	10:41:00	12:49:00	14:28:00	16:21:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	30	30	30	30
Start Latitude	48° 57' 14" N	48° 53' 46" N	48° 47' 06" N	48° 39' 40" N	48° 35' 24" N	48° 29' 02" N
Start Longitude	125° 07' 12" W	125° 13' 26" W	125° 22' 48" W	125° 36' 32" W	125° 44' 13" W	125° 52' 52" W
End Latitude	48° 55' 48" N	48° 52' 08" N	48° 45' 43" N	48° 38' 06" N	48° 34' 08" N	48° 28' 23" N
End Longitude	125° 10' 05" W	125° 15' 40" W	125° 25' 34" W	125° 38' 28" W	125° 47' 31" W	125° 56' 06" W
Direction of Tow (deg)	233	223	233	219	240	253
Vessel Speed (km/h)	8.7	8.1	8.3	7.4	9.3	8.3
Distance Towed (km)	4.39	4.07	4.22	3.74	4.65	4.19
Net Opening Height (m)	12	12	12	16	14	14
Net Opening Width (m)	37	34	34	37	34	34
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	0	15	0	30	0	15
Start Bottom Depth (m)	99	101	97	191	67	123
End Bottom Depth (m)	92	88	102	59	77	136
Usable	Y	Y	Y	Y	Y	Y

Station Name	VI05	VI06	VI07	VI08	VI09	VI10
Tow	13	14	15	16	17	18
Date (Pacific)	2012-03-03	2012-03-04	2012-03-04	2012-03-04	2012-03-04	2012-03-04
Start Time (Pacific)	17:46:00	07:50:00	09:18:00	10:47:00	12:31:00	14:05:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	30	30	30	30
Start Latitude	48° 22' 48" N	48° 42' 43" N	48° 46' 05" N	48° 49' 34" N	48° 53' 31" N	48° 58' 05" N
Start Longitude	125° 58' 26" W	126° 37' 01" W	126° 31' 30" W	126° 25' 59" W	126° 19' 34" W	126° 14' 42" W
End Latitude	48° 21' 50" N	48° 44' 02" N	48° 47' 10" N	48° 50' 49" N	48° 54' 29" N	48° 59' 24" N
End Longitude	125° 55' 16" W	126° 33' 25" W	126° 28' 08" W	126° 22' 23" W	126° 16' 59" W	126° 11' 10" W
Direction of Tow (deg)	114	61	64	62	61	60
Vessel Speed (km/h)	8.5	10.0	9.1	9.8	7.2	9.8
Distance Towed (km)	4.30	5.06	4.57	4.93	3.63	4.93
Net Opening Height (m)	13	13	13	12	15	13
Net Opening Width (m)	35	34	34	35	39	32
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	0	0	15	0	30	0
Start Bottom Depth (m)	489	1184	386	190	151	117
End Bottom Depth (m)	600	639	274	178	135	89
Usable	Y	Y	Y	Y	Y	Y

Station Name	VI11	VI12	EP07	IVI03	IVI04	EP01
Tow	19	20	21	22	23	24
Date (Pacific)	2012-03-04	2012-03-04	2012-03-05	2012-03-05	2012-03-05	2012-03-06
Start Time (Pacific)	15:31:00	16:28:00	07:51:00	15:30:00	17:47:00	07:27:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	30	30	30	30
Start Latitude	49° 01’ 52" N	49° 04’ 55" N	49° 06’ 36" N	49° 39’ 47" N	49° 38’ 53" N	49° 20’ 20" N
Start Longitude	126° 08’ 10" W	126° 03’ 43" W	126° 00’ 36" W	126° 11’ 10" W	126° 15’ 32" W	126° 32’ 53" W
End Latitude	49° 03’ 04" N	49° 05’ 10" N	49° 06’ 18" N	49° 39’ 04" N	49° 38’ 35" N	49° 18’ 47" N
End Longitude	126° 05’ 17" W	126° 00’ 14" W	125° 57’ 00" W	126° 14’ 42" W	126° 19’ 12" W	126° 35’ 35" W
Direction of Tow (deg)	57	84	97	253	263	228
Vessel Speed (km/h)	8.1	8.3	8.7	8.9	8.7	8.7
Distance Towed (km)	4.13	4.24	4.41	4.48	4.44	4.35
Net Opening Height (m)	13	12	14	12	12	12
Net Opening Width (m)	34	32	34	31	35	32
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	15	0	0	0	0	0
Start Bottom Depth (m)	70	57	770	358	350	54
End Bottom Depth (m)	56	50	418	365	289	87
Usable	Y	Y	Y	Y	Y	Y

Station Name	EP02	EP03	EP04	EP05	EP06	IVI05
Tow	25	26	27	28	29	30
Date (Pacific)	2012-03-06	2012-03-06	2012-03-06	2012-03-06	2012-03-06	2012-03-07
Start Time (Pacific)	08:48:00	10:41:00	12:50:00	14:59:00	17:02:00	07:30:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	30	30	30	30
Start Latitude	49° 18’ 07" N	49° 16’ 30" N	49° 14’ 02" N	49° 11’ 35" N	49° 09’ 43" N	49° 47’ 56" N
Start Longitude	126° 35’ 56" W	126° 40’ 12" W	126° 44’ 35" W	126° 49’ 08" W	126° 53’ 56" W	126° 39’ 11" W
End Latitude	49° 16’ 05" N	49° 14’ 46" N	49° 11’ 56" N	49° 09’ 36" N	49° 07’ 59" N	49° 50’ 28" N
End Longitude	126° 33’ 00" W	126° 37’ 05" W	126° 41’ 38" W	126° 46’ 30" W	126° 51’ 22" W	126° 39’ 40" W
Direction of Tow (deg)	137	131	137	139	136	354
Vessel Speed (km/h)	10.2	9.8	10.6	9.6	8.9	9.3
Distance Towed (km)	5.17	4.96	5.30	4.89	4.48	4.70
Net Opening Height (m)	12	12	12	13	12	12
Net Opening Width (m)	36	31	32	33	34	32
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	0	0	0	0	0	0
Start Bottom Depth (m)	97	118	124	143	190	128
End Bottom Depth (m)	98	116	125	138	182	192
Usable	Y	Y	Y	Y	Y	Y

Station Name	IVI06	IVI07	IVI08	IVI09	IVI10	IVI11
Tow	31	32	33	34	35	36
Date (Pacific)	2012-03-07	2012-03-07	2012-03-07	2012-03-07	2012-03-07	2012-03-07
Start Time (Pacific)	09:04:00	10:49:00	12:55:00	14:35:00	16:02:00	16:52:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	30	30	30	30
Start Latitude	49° 54’ 00" N	49° 52’ 16" N	49° 56’ 13" N	49° 52’ 05" N	49° 51’ 50" N	49° 55’ 05" N
Start Longitude	126° 39’ 29" W	126° 45’ 18" W	126° 48’ 18" W	126° 50’ 53" W	126° 55’ 12" W	126° 55’ 48" W
End Latitude	49° 51’ 47" N	49° 54’ 36" N	49° 54’ 14" N	49° 51’ 29" N	49° 54’ 00" N	49° 57’ 40" N
End Longitude	126° 39’ 43" W	126° 47’ 35" W	126° 47’ 24" W	126° 54’ 54" W	126° 55’ 44" W	126° 56’ 02" W
Direction of Tow (deg)	184	328	164	257	351	357
Vessel Speed (km/h)	8.1	10.2	7.6	9.6	8.0	9.4
Distance Towed (km)	4.13	5.11	3.82	4.89	4.06	4.80
Net Opening Height (m)	14	11	16	12	12	12
Net Opening Width (m)	33	32	39	32	36	33
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	15	0	30	0	15	0
Start Bottom Depth (m)	183	261	217	236	238	284
End Bottom Depth (m)	200	222	226	198	275	206
Usable	Y	Y	Y	Y	Y	Y

Station Name	IVI12	IVI13	IVI14	IVI15	IVI16	IVI17
Tow	37	38	39	40	41	42
Date (Pacific)	2012-03-08	2012-03-08	2012-03-08	2012-03-08	2012-03-08	2012-03-09
Start Time (Pacific)	10:28:00	12:04:00	13:19:00	14:51:00	16:51:00	08:57:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	15	18	30	15	30	15
Start Latitude	50° 28’ 19" N	50° 29’ 06" N	50° 29’ 49" N	50° 29’ 28" N	50° 24’ 54" N	50° 34’ 08" N
Start Longitude	127° 55’ 52" W	127° 50’ 35" W	127° 45’ 29" W	127° 44’ 42" W	127° 30’ 00" W	127° 34’ 12" W
End Latitude	50° 28’ 16" N	50° 28’ 34" N	50° 30’ 40" N	50° 29’ 42" N	50° 27’ 07" N	50° 34’ 55" N
End Longitude	127° 53’ 53" W	127° 49’ 05" W	127° 41’ 53" W	127° 43’ 37" W	127° 31’ 41" W	127° 35’ 35" W
Direction of Tow (deg)	93	120	70	71	334	312
Vessel Speed (km/h)	9.4	6.7	8.9	5.4	9.1	8.7
Distance Towed (km)	2.37	2.02	4.46	1.35	4.57	2.17
Net Opening Height (m)	12	15	13	20	12	14
Net Opening Width (m)	34	36	33	44	33	35
Warp Length (m)	150	150	150	175	150	150
Target Headrope Depth (m)	0	15	0	60	15	0
Start Bottom Depth (m)	193	173	127	107	146	128
End Bottom Depth (m)	202	128	109	117	188	122
Usable	N	Y	Y	Y	Y	Y

Station Name	IVI18	IVI19	IVI20	IVI21	QCSD01	QCSD02
Tow	43	44	45	46	47	48
Date (Pacific)	2012-03-09	2012-03-09	2012-03-09	2012-03-09	2012-03-10	2012-03-10
Start Time (Pacific)	10:30:00	11:42:00	13:21:00	15:40:00	12:19:00	13:47:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	15	30	30	30
Start Latitude	50° 35’ 35" N	50° 35’ 13" N	50° 34’ 55" N	50° 27’ 11" N	50° 52’ 01" N	50° 56’ 42" N
Start Longitude	127° 43’ 01" W	127° 38’ 02" W	127° 28’ 05" W	127° 31’ 48" W	128° 21’ 18" W	128° 12’ 22" W
End Latitude	50° 35’ 17" N	50° 34’ 37" N	50° 34’ 48" N	50° 25’ 23" N	50° 53’ 46" N	50° 58’ 26" N
End Longitude	127° 39’ 40" W	127° 35’ 06" W	127° 29’ 53" W	127° 30’ 25" W	128° 17’ 31" W	128° 09’ 43" W
Direction of Tow (deg)	98	108	264	153	54	44
Vessel Speed (km/h)	7.8	7.0	8.3	7.4	10.9	8.9
Distance Towed (km)	3.94	3.59	2.09	3.74	5.50	4.44
Net Opening Height (m)	15	15	12	15	13	14
Net Opening Width (m)	35	36	34	37	35	37
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	15	30	0	30	0	15
Start Bottom Depth (m)	88	115	72	189	47	66
End Bottom Depth (m)	108	134	77	159	46	69
Usable	Y	Y	Y	Y	Y	Y

Station Name	QCSD03	QCST01	QCST02	QCST03	QCST04	QCST05
Tow	49	50	51	52	53	54
Date (Pacific)	2012-03-10	2012-03-11	2012-03-11	2012-03-11	2012-03-11	2012-03-11
Start Time (Pacific)	15:31:00	07:40:00	09:46:00	11:34:00	13:38:00	15:21:00
Net	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250	CanTrawl 250
Duration (min)	30	30	30	30	30	27
Start Latitude	51° 01’ 05" N	50° 52’ 37" N	50° 57’ 07" N	50° 54’ 22" N	50° 49’ 16" N	50° 48’ 47" N
Start Longitude	128° 03’ 14" W	127° 53’ 17" W	127° 44’ 10" W	127° 38’ 56" W	127° 39’ 00" W	127° 25’ 26" W
End Latitude	51° 02’ 46" N	50° 51’ 47" N	50° 56’ 10" N	50° 53’ 24" N	50° 48’ 32" N	50° 50’ 28" N
End Longitude	128° 00’ 40" W	127° 49’ 59" W	127° 42’ 22" W	127° 36’ 50" W	127° 35’ 42" W	127° 22’ 59" W
Direction of Tow (deg)	44	112	131	126	109	43
Vessel Speed (km/h)	8.5	8.1	5.4	5.9	8.1	9.4
Distance Towed (km)	4.35	4.11	2.72	3.06	4.07	4.28
Net Opening Height (m)	14	14	14	14	15	13
Net Opening Width (m)	31	31	37	34	38	32
Warp Length (m)	150	150	150	150	150	150
Target Headrope Depth (m)	0	0	15	0	30	0
Start Bottom Depth (m)	155	205	288	431	370	179
End Bottom Depth (m)	158	261	467	403	430	163
Usable	Y	Y	Y	Y	Y	Y

Station Name	QCST06	QCST07
Tow	55	56
Date (Pacific)	2012-03-11	2012-03-11
Start Time (Pacific)	16:48:00	18:08:00
Net	CanTrawl 250	CanTrawl 250
Duration (min)	30	30
Start Latitude	50° 51’ 54" N	50° 48’ 00" N
Start Longitude	127° 18’ 58" W	127° 22’ 08" W
End Latitude	50° 49’ 52" N	50° 46’ 48" N
End Longitude	127° 20’ 10" W	127° 25’ 59" W
Direction of Tow (deg)	201	244
Vessel Speed (km/h)	8.0	10.0
Distance Towed (km)	4.04	5.07
Net Opening Height (m)	13	13
Net Opening Width (m)	34	32
Warp Length (m)	150	150
Target Headrope Depth (m)	15	0
Start Bottom Depth (m)	152	207
End Bottom Depth (m)	151	358
Usable	Y	Y

APPENDIX D CTD CASTS AND ZOOPLANKTON TOWS

Table D.1. CTD casts and vertical bongo tow times and depths during the juvenile Pacific Salmon trawl survey from March 01 to March 13, 2012 on the *CCGS W.E. Ricker*.

				CTD			BONGO		
Date	Station	Latitude	Longitude	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)
2012-03-02	JF01	48° 17' 42" N	123° 36' 00" W	08:01	155	145	07:16	160	150
2012-03-02	JF02	48° 20' 06" N	123° 48' 07" W	10:01	118	108	09:11	120	110
2012-03-02	JF03	48° 23' 02" N	124° 02' 56" W	11:59	102	95	11:06	101	91
2012-03-02	JF04	48° 26' 10" N	124° 15' 54" W	14:05	102	92	13:16	98	88
2012-03-02	JF05	48° 30' 29" N	124° 27' 50" W	15:46	108	100	14:54	113	103
2012-03-02	JF06	48° 33' 18" N	124° 42' 18" W	17:34	101	90	16:46	102	92
2012-03-03	IVI01	48° 57' 47" N	125° 06' 32" W	08:02	95	85	07:10	95	85
2012-03-03	IVI02	48° 54' 25" N	125° 12' 36" W	09:24	96	86	08:35	95	85
2012-03-03	VI01	48° 47' 49" N	125° 21' 47" W	11:14	88	78	10:22	89	79
2012-03-03	VI02	48° 40' 30" N	125° 35' 42" W	13:16	184	175	12:27	200	150
2012-03-03	VI03	48° 35' 49" N	125° 42' 50" W	15:02	64	55	14:09	64	54
2012-03-03	VI04	48° 29' 02" N	125° 51' 18" W	16:47	116	105	15:55	115	105
2012-03-03	VI05	48° 21' 43" N	125° 54' 50" W	19:31	522	250	18:44	531	150
2012-03-04	VI06	48° 42' 11" N	126° 38' 17" W	08:00	1,200	500	07:29	1,200	150
2012-03-04	VI07	48° 45' 40" N	126° 32' 38" W	09:45	475	250	08:57	475	150
2012-03-04	VI08	48° 49' 19" N	126° 27' 07" W	11:16	200	190	10:27	200	150
2012-03-04	VI09	48° 52' 55" N	126° 20' 31" W	13:01	153	140	12:11	159	149
2012-03-04	VI10	48° 57' 29" N	126° 15' 40" W	14:36	118	110	13:46	123	113
2012-03-04	VI11	49° 01' 37" N	126° 09' 14" W	16:06	68	58	15:14	73	63
2012-03-04	VI12	49° 05' 13" N	126° 00' 58" W	18:44	46	40	17:51	52	42
2012-03-05	EP07	49° 06' 47" N	127° 01' 52" W	07:59	770	250	07:12	800	150
2012-03-05	IVI03	49° 40' 01" N	126° 09' 36" W	15:53	361	250	15:08	366	150
2012-03-05	IVI04	49° 38' 38" N	126° 19' 48" W	19:41	281	250	18:57	287	150
2012-03-06	EP01	49° 21' 00" N	126° 31' 48" W	08:02	32	27	07:10	35	25
2012-03-06	EP02	49° 18' 54" N	126° 36' 18" W	09:19	85	75	08:27	86	76
2012-03-06	EP03	49° 16' 59" N	126° 40' 52" W	11:12	113	105	10:20	114	104
2012-03-06	EP04	49° 14' 42" N	126° 45' 07" W	13:21	119	110	12:28	125	115
2012-03-06	EP05	49° 12' 22" N	126° 49' 37" W	15:28	141	130	14:37	148	138
2012-03-06	EP06	49° 10' 16" N	126° 54' 07" W	17:26	184	175	16:40	190	150
2012-03-07	IVI05	49° 47' 20" N	126° 38' 49" W	07:59	126	115	07:10	130	120

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Date	Station	Latitude	Longitude	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)
2012-03-07	IVI06	49° 54' 47" N	126° 39' 25" W	09:41	60	50	08:49	61	51
2012-03-07	IVI07	49° 51' 36" N	126° 44' 20" W	11:14	221	210	10:28	215	150
2012-03-07	IVI08	49° 54' 00" N	126° 47' 17" W	13:06	225	215	12:21	230	150
2012-03-07	IVI09	49° 52' 23" N	126° 50' 31" W	15:35	239	230	14:14	240	150
2012-03-07	IVI10	49° 51' 22" N	126° 55' 44" W	16:21	239	230	15:35	231	150
2012-03-07	IVI11	49° 57' 54" N	126° 56' 10" W	18:38	189	180	17:52	193	150
2012-03-08	IVI12	50° 28' 19" N	127° 57' 07" W	10:55	144	135	10:06	147	137
2012-03-08	IVI13	50° 29' 28" N	127° 51' 07" W	12:08	60	50	11:15	59	49
2012-03-08	IVI14	50° 29' 35" N	127° 46' 16" W	13:44	182	172	12:58	180	150
2012-03-08	IVI15	50° 29' 17" N	127° 45' 36" W	15:24	103	90	14:34	102	92
2012-03-08	IVI16	50° 27' 00" N	127° 31' 37" W	19:01	187	175	18:13	188	150
2012-03-09	IVI17	50° 33' 50" N	127° 33' 32" W	09:26	123	113	08:37	123	113
2012-03-09	IVI18	50° 35' 53" N	127° 44' 17" W	11:01	79	70	10:09	79	69
2012-03-09	IVI19	50° 35' 13" N	127° 39' 07" W	12:13	111	100	11:23	111	101
2012-03-09	IVI20	50° 35' 10" N	127° 27' 00" W	13:58	59	50	13:06	65	55
2012-03-09	IVI21	50° 27' 43" N	127° 32' 20" W	16:02	186	175	15:19	188	150
2012-03-10	QCSD01	50° 51' 00" N	128° 23' 20" W	12:55	43	35	12:02	46	35
2012-03-10	QCSD02	50° 55' 48" N	128° 13' 12" W	14:25	45	35	13:30	52	42
2012-03-10	QCSD03	51° 00' 29" N	128° 04' 52" W	16:00	135	125	15:10	145	135
2012-03-10	T07	50° 49' 19" N	129° 13' 59" W	08:01	109	100			
2012-03-11	QCST01	50° 52' 55" N	127° 54' 25" W	07:10	180	170	07:19	179	150
2012-03-11	QCST02	50° 57' 14" N	127° 44' 28" W	09:14	354	130	09:26	336	150
2012-03-11	QCST03	50° 54' 22" N	127° 39' 14" W	10:48	436	250	11:14	438	150
2012-03-11	QCST04	50° 49' 41" N	127° 40' 59" W	13:01	334	250	13:17	355	150
2012-03-11	QCST05	50° 48' 22" N	127° 26' 31" W	14:56	108	100	15:03	120	110
2012-03-11	QCST06	50° 52' 52" N	127° 18' 54" W	16:18	118	110	16:28	114	104
2012-03-11	QCST07	50° 46' 41" N	127° 26' 49" W	18:55	346	250	19:08	350	150

APPENDIX E CATCH DATA

Table E.1. Catch (counts) of species (or taxonomic groups where species identification could not be made with certainty) captured during the juvenile Pacific Salmon trawl survey from March 01 to March 13, 2012 on the *CCGS W.E. Ricker*. "0" count means present but not counted.

Tow	1	2	3	4	5	6	7	8	9	10	11
Station ID	JF01	JF02	JF03	JF04	JF05	JF06	IVI01	IVI02	VI01	VI02	VI03
Chinook Salmon (Adults)		7	4	25	12	36	6	6	1	5	1
Chinook Salmon (Juveniles)											
Chum Salmon (Juveniles)			1								
Coho Salmon (Adults)	25	35	26		27	58					
Coho Salmon (Juveniles)	17	7	6		6	6					
Sockeye Salmon (Juveniles)		1									
Comb Jellyfish	0										
Moon Jellyfish											
Opalescent Inshore Squid				115							
Pacific Herring											
Pacific Sand Lance				377							
Pacific Spiny Lumpsucker		1									
Pile Perch											
Rockfishes											2
Soft Sculpin	9										
Spotted Ratfish											
Threespine Stickleback	6	12	2								
TOTAL	57	63	39	517	45	100	6	6	1	5	3

Tow	14	15	16	17	18	20	21	23	24	26	27
Station ID	VI06	VI07	VI08	VI09	VI10	VI12	EP07	IVI04	EP01	EP03	EP04
Chinook Salmon (Adults)						17				1	
Chinook Salmon (Juveniles)											
Chum Salmon (Juveniles)											
Coho Salmon (Adults)											
Coho Salmon (Juveniles)											
Sockeye Salmon (Juveniles)										1	
Comb Jellyfish	0		0		0		0		0		0
Moon Jellyfish											
Opalescent Inshore Squid											
Pacific Herring								4			
Pacific Sand Lance									3		
Pacific Spiny Lumpsucker						1					
Pile Perch											
Rockfishes		2		1	1		1				
Soft Sculpin											
Spotted Ratfish											
Threespine Stickleback											
TOTAL	0	2	0	1	1	18	1	4	3	2	0

Tow	28	29	30	31	33	35	36	38	39	40	43
Station ID	EP05	EP06	IVI05	IVI06	IVI08	IVI10	IVI11	IVI13	IVI14	IVI15	IVI18
Chinook Salmon (Adults)					9	2	3	15	3	1	
Chinook Salmon (Juveniles)								1	1		17
Chum Salmon (Juveniles)											
Coho Salmon (Adults)								1			
Coho Salmon (Juveniles)											
Sockeye Salmon (Juveniles)											
Comb Jellyfish	0	0								0	
Moon Jellyfish											
Opalescent Inshore Squid										2	
Pacific Herring	1		2	2	2					28	33
Pacific Sand Lance											
Pacific Spiny Lumpsucker											
Pile Perch				1							
Rockfishes											
Soft Sculpin											
Spotted Ratfish								1			
Threespine Stickleback			758								
TOTAL	1	0	760	3	11	2	3	18	4	31	50

Tow	44	46	47	48	50	55
Station ID	IVI19	IVI21	QCSD01	QCSD02	QCST01	QCST06
Chinook Salmon (Adults)		2	4	5	2	
Chinook Salmon (Juveniles)	3					
Chum Salmon (Juveniles)						
Coho Salmon (Adults)						
Coho Salmon (Juveniles)						
Sockeye Salmon (Juveniles)						
Comb Jellyfish			0			
Moon Jellyfish			1			
Opalescent Inshore Squid	5	5				
Pacific Herring	2549	38				
Pacific Sand Lance						
Pacific Spiny Lumpsucker						
Pile Perch						
Rockfishes			1			
Soft Sculpin						1
Spotted Ratfish						
Threespine Stickleback						2
TOTAL	2557	45	6	5	2	3