Juvenile Pacific Salmon (*Oncorhynchus* spp.) Trawl Survey on the South Coast of British Columbia, June 10 to June 14, 2018

Yeongha Jung, Amy M. Tabata, Kelsey L. Flynn, Tyler B. Zubkowski, and Jackie R. King

Pacific Biological Station
Fisheries and Oceans Canada
3190 Hammond Bay Road
Nanaimo, British Columbia
V9T 6N7, Canada

2024

Canadian Data Report of Fisheries and Aquatic Sciences 1407

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

Canadian Data Report of Fisheries and Aquatic Sciences

Data reports provide a medium for filing and archiving data compilations where little or no analysis is included. Such compilations commonly will have been prepared in support of other journal publications or reports. The subject matter of the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries management, technology and development, ocean sciences, and aquatic environments relevant to Canada.

The correct citation appears above the abstract of each report. Each report is abstracted in the data base *Aquatic Sciences and Fisheries Abstracts*.

Data reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-25 in this series were issued as Fisheries and Marine Service Data Records. Numbers 26-160 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Data Reports. The current series name was changed with report number 161.

Rapport statistique canadien des sciences halieutiques et aquatiques

Les rapports statistiques servent de base à la compilation des données de classement et d'archives pour lesquelles il y a peu ou point d'analyse. Cette compilation aura d'ordinaire été préparée pour appuyer d'autres publications ou rapports. Les sujets des rapports statistiques reflètent la vaste gamme des intérêts et politiques de Pêches et Océans Canada, notamment la gestion des pêches, la technologie et le développement, les sciences océaniques et l'environnement aquatique, au Canada.

Le titre exact figure au haut du résumé de chaque rapport. Les rapports à l'industrie sont résumés dans la base de données *Résumés des sciences aquatiques et halieutiques*.

Les rapports statistiques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement d'origine dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 25 de cette série ont été publiés à titre de Records statistiques, Service des pêches et de la mer. Les numéros 26-160 ont été publiés à titre de Rapports statistiques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom de la série a été modifié à partir du numéro 161.

Canadian Data Report of
Fisheries and Aquatic Sciences 1407

2024

JUVENILE PACIFIC SALMON (*ONCORHYNCHUS* SPP.) TRAWL SURVEY ON THE SOUTH COAST OF BRITISH COLUMBIA, JUNE 10 TO JUNE 14, 2018

by

Yeongha Jung, Amy M. Tabata, Kelsey L. Flynn, Tyler B. Zubkowski, and Jackie R. King

Pacific Biological Station
Fisheries and Oceans Canada, 3190 Hammond Bay Road
Nanaimo, British Columbia, V9T 6N7, Canada

Cat. No. Fs97-13/1407E-PDF ISBN 978-0-660-74087-4 ISSN 1488-5395

Correct citation for this publication:

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, June 10 to June 14, 2018. Can. Data Rep. Fish. Aquat. Sci. 1407: vi + 28 p.

CONTENTS

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, June 10 to June 14, 2018. Can. Data Rep. Fish. Aquat. Sci. 1407: vi + 28 p.

Fisheries and Oceans Canada (DFO) conducted a surface trawl survey from June 10 to June 14, 2018 on the *CFV Sea Crest*. This study targeted juvenile Pacific Salmon (*Oncorhynchus* spp.) in southern British Columbia (BC). There were 1,917 individuals caught from 16 species in 27 tows. juvenile Chum Salmon was the most abundant species with 37% of the total catch. Juvenile salmon species caught in decreasing abundance by count were: Chum Salmon, Sockeye Salmon, Pink Salmon, Coho Salmon and Chinook Salmon, with catch distribution varied based on 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 (12 locations), water samples for chemistry and chlorophyll *a* along with zooplankton samples (13 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, June 10 to June 14, 2018. Can. Data Rep. Fish. Aquat. Sci. 1407: vi + 28 p.

Pêches et Océans Canada a effectué un relevé au chalut de surface entre juin 10 to juin 14, 2018 sur le *CFV Sea Crest*. Cette étude ciblait le saumon du Pacifique juvénile (*Oncorhynchus* spp.) dans le sud de la Colombie-Britannique (C.-B.). 1,917 individus de 16 espèces ont été capturés au cours de 27 traits. Le saumon kéta juvéniles était l'espèce la plus abondante avec 37% de la prise totale. Les espèces de saumon juvénile capturées par ordre décroissant d'abondance par comptage étaient les suivantes: saumon kéta juvéniles, saumon rouge juvéniles, saumon rose juvéniles, saumon coho juvéniles et saumon quinnat 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 (12 sites) les échantillons d'eau pour la chimie et la chlorophylle *a* ainsi que les échantillons de zooplancton (13 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.) in Johnstone and Queen Charlotte Straits and southern Queen Charlotte Sound from June 10 to June 14, 2018 on the *CFV Sea Crest*. The main objectives of this survey were:

1. to determine the abundance, condition, distribution, and genetic stock composition of juvenile Pacific Salmon present in Johnstone Strait and Queen Charlotte Strait;
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 Basin and Coastal-Scale Interactions Program at the Pacific Biological Station, Nanaimo, British Columbia (BC) in support of research on Pacific Salmon ocean ecology. This survey augments annual summer and fall surveys that have been conducted annually between 1997-2017 from the Gulf of Alaska to the southern continental shelf (Welch et al. 2002), albeit with differences in location and timing in each year. This survey focused on Johnstone Strait, Queen Charlotte Strait and southern Queen Charlotte Sound to investigate a new scientific hypothesis related to food availability before, during and after juvenile salmon migrate northwards through Johnstone Strait (McKinnell et al. 2014). 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 east coast of Vancouver Island, including Johnstone Strait, southern Queen Charlotte Sound and Queen Charlotte Strait (Figure 1).

2.2 FISHING OPERATIONS

The *CFV Sea Crest* deployed a coastal LFS 7742 trawl net (Figure A, Appendix A), manufactured by LFS Trawl (LFS Net Systems, Bellingham, USA). This two-bridle midwater net has a codend liner (12.7 mm stretched) to retain smaller species. The LFS 7742 trawl net was designed to have a net opening of 30 m wide by 15 m high, or an area of 450 m^2 (Figure B, Appendix B). The net was towed at 4 to 5 knots (7.4 - 9.3 km/hr) for a target duration of 20 minutes.The start time and location of the tow was recorded when the doors were locked, and the end time and location when the retrieval of the doors was initiated. The target headrope

depths were 0 m (surface) and 15 m (depth). Two A-6 floats 86.4 cm x 118.1 cm (34” x 46.5”) were attached to the headrope for surface tows.

Tow speed averaged 8.6 km/hr, and varied between 5.6 to 13.5 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 50 m to 100 m (Appendix C). Tow duration was 13-28 minutes, with the time starting when Thyborøn Type 15 VF 4.5 m^2 mid water 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. Juvenile Pacific Salmon catch by species (number of fish) were 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 divided into juveniles and adults based on their fork lengths. All Pacific Salmon species that were < 300 mm in length were considered juveniles, except for Coho Salmon whose length threshold as juveniles was < 350 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 12 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 13 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 30 trawl net tows in Johnstone Strait and Queen Charlotte Strait (Figure 1, Appendix C) with 27 trawls completed successfully. There were 3 unusable tows due to problems with equipment deployment and are identified by Usable = N in Appendix C.

3.2 CATCH COMPOSITION

Total catch for the survey from usable tows was 1,917 fish, with 1,631 (or 85%) 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 juvenile Chum Salmon (n=713), juvenile Sockeye Salmon (n=565), then juvenile Pink Salmon (n=282; Table 1). Juvenile Pacific Salmon species caught, in order of abundance by count, were: Chum Salmon, Sockeye Salmon, Pink Salmon, Coho Salmon and Chinook Salmon. The survey targeted juvenile Pacific Salmon so the catches of adult Pacific Salmon should be interpreted with care.

The location and catch per unit effort (CPUE, count/km^3) of juvenile salmon is shown in Figure 2. Juvenile Chinook Salmon and Coho Salmon were least abundant and were encountered in Johnstone Strait and in more northerly tows in Queen Charlotte Strait and in southern Queen Charlotte Sound. Juvenile Chum Salmon were abundant throughout the survey area. Juvenile Pink Salmon were the moderately abundant salmon species, caught throughout the survey area. Juvenile Sockeye Salmon were captured throughout the survey area, with exceptionally high abundance in northern Queen Charlotte Strait.

3.3 BIOLOGICAL SAMPLES

Samples were collected for GSI (n=488), otoliths (n=439). CWTs (n=11) 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 Pacific Salmon species in Figures 3 to 7. Double log transformed length-weight regressions coefficients were larger and similar in Chinook Salmon, Coho Salmon and Chum Salmon. Pink Salmon Salmon had a slightly smaller coefficient. Juvenile Sockeye Salmon had a smaller coefficient. A larger coefficient typically represents better condition, whereas a smaller coefficient typically represents worse condition. Lengths and weights of 10 species were recorded from all tows (Table 2). The length frequencies for species with greater than 50 length measurements (Pacific Herring, Sablefish and Opalescent Inshore Squid) are presented in Figure 8.

Within juvenile Pacific Salmon, Coho Salmon had the largest maximum length (167 mm) and weight (55 g), whereas Pink Salmon had the smallest maximum length (111 mm) and weight (13 g).

3.5 OCEANOGRAPHY

CTD casts and water samples were completed at 12 sites with cast depths ranging from 50 m to 150 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 201893.

3.6 ZOOPLANKTON

Vertical bongo tows were conducted at 13 stations to depths ranging from 50 m to 250 m (Appendix D). Zooplankton enumeration data are archived in the zooplankton database (Institute of Ocean Sciences, DFO, Sidney, BC) under cruise number 201893.

4 DISCUSSION

This juvenile Pacific Salmon trawl survey collected valuable information on distribution, abundance, condition, and genetic stock composition for juvenile Pacific Salmon in Johnstone Strait, Queen Charlotte Strait and southern Queen Charlotte Sound. Overall, juvenile Chum Salmon and juvenile Sockeye Salmon were most abundant, whereas juvenile Chinook Salmon were least abundant. 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

McKinnell, S., Curchitser, E., Groot, K., Kaeriyama, M., and Trudel, M. 2014. Oceanic and atmospheric extremes motivate a new hypothesis for variable marine survival of Fraser River sockeye salmon. Fish. Oceanogr. 23: 322-341.

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 Nathan Dobie and crew of the *CFV Sea Crest*. Jackie King was Chief Scientist on the survey. We appreciate the expertise of additional science staff who participated in the survey, particularly Jasmine Wietzke who conducted all oceanographic sampling and Lana Fitzpatrick who reviewed the report.

7 FIGURES

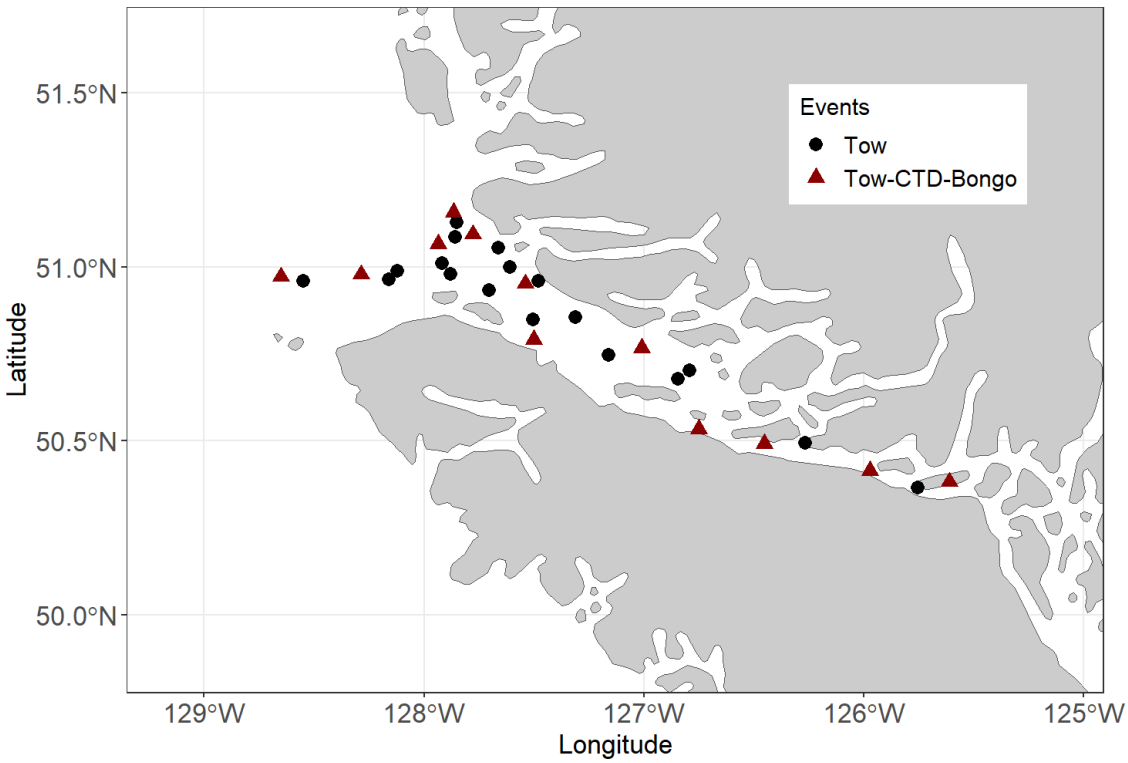

Figure 1. Location of survey events (fishing tows, CTD casts and zooplankton bongo casts) during the juvenile Pacific Salmon trawl survey from June 10 to June 14, 2018 on the *CFV Sea Crest*.

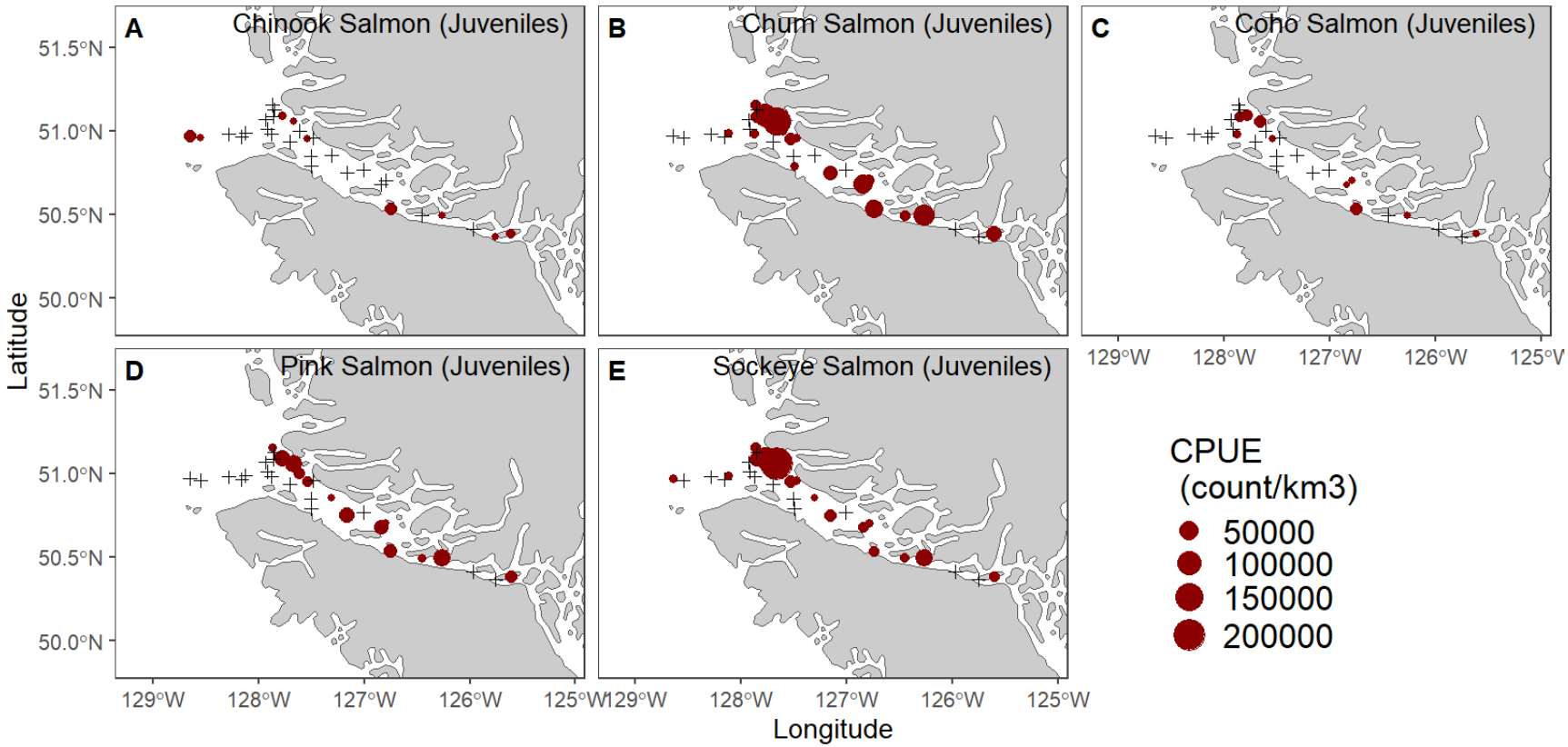

Figure 2. Juvenile Pacific Salmon (*Oncorhynchus spp.*) catch (count) per unit effort (CPUE; count/km^3) for each tow. Circles are proportional to maximum abundance, and zero catches are shown with a cross (+). **A.** Chinook Salmon (Juveniles), **B.** Chum Salmon (Juveniles), **C.** Coho Salmon (Juveniles),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

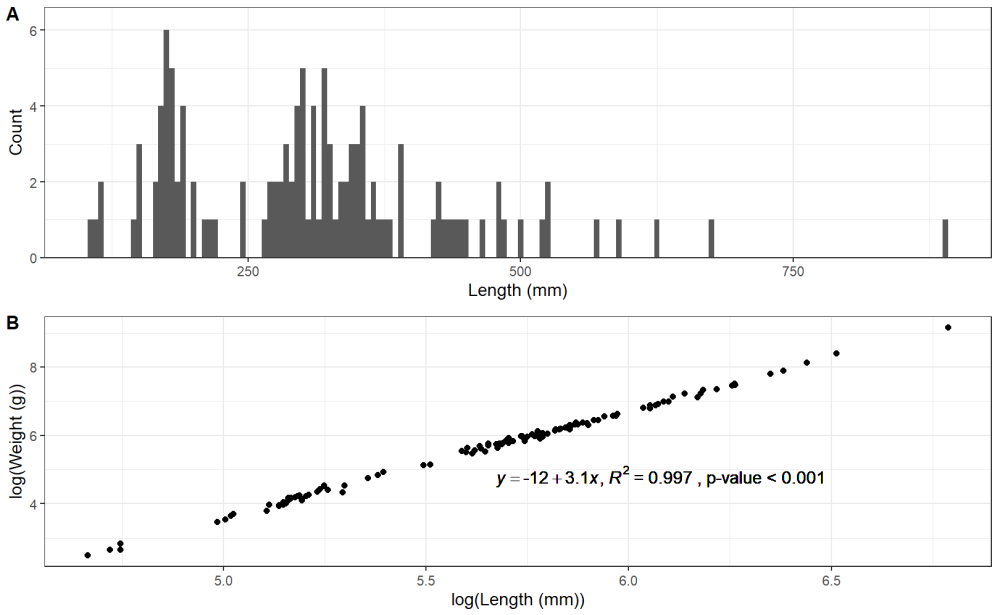

Figure 3. **A.** Chinook Salmon (*Oncorhynchus tshawytscha)*) length frequency plot as sampled during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018. **B.** Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test.

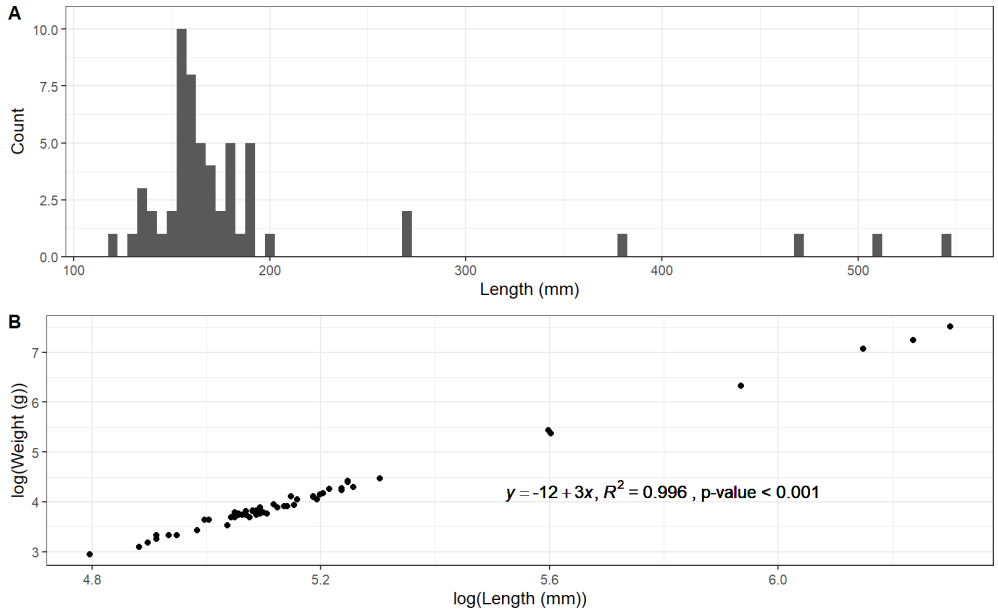

Figure 4. **A.** Coho Salmon (*Oncorhynchus kisutch*) length frequency plot as sampled during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018. **B.** Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test.

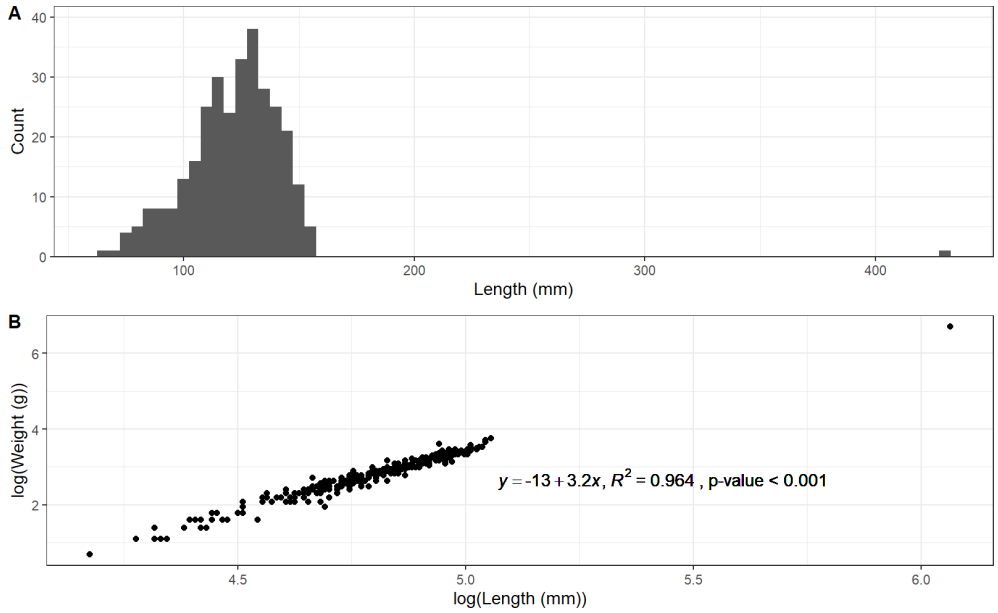

Figure 5. **A.** Chum Salmon (*Oncorhynchus keta*) length frequency plot as sampled during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018. **B.** Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test.

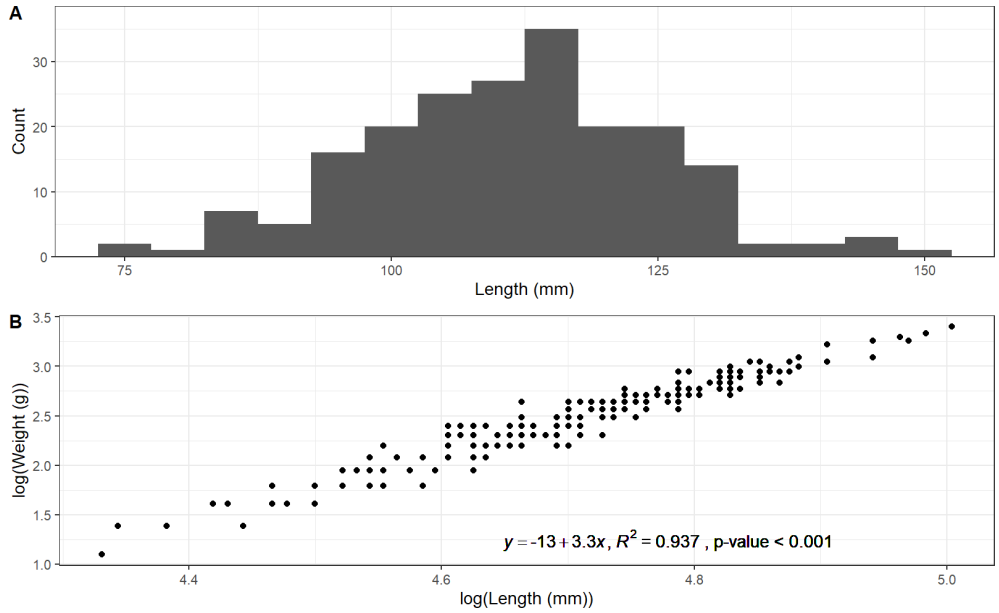

Figure 6. **A.** Pink Salmon (*Oncorhynchus gorbusha*) length frequency plot as sampled during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018. **B.** Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test.

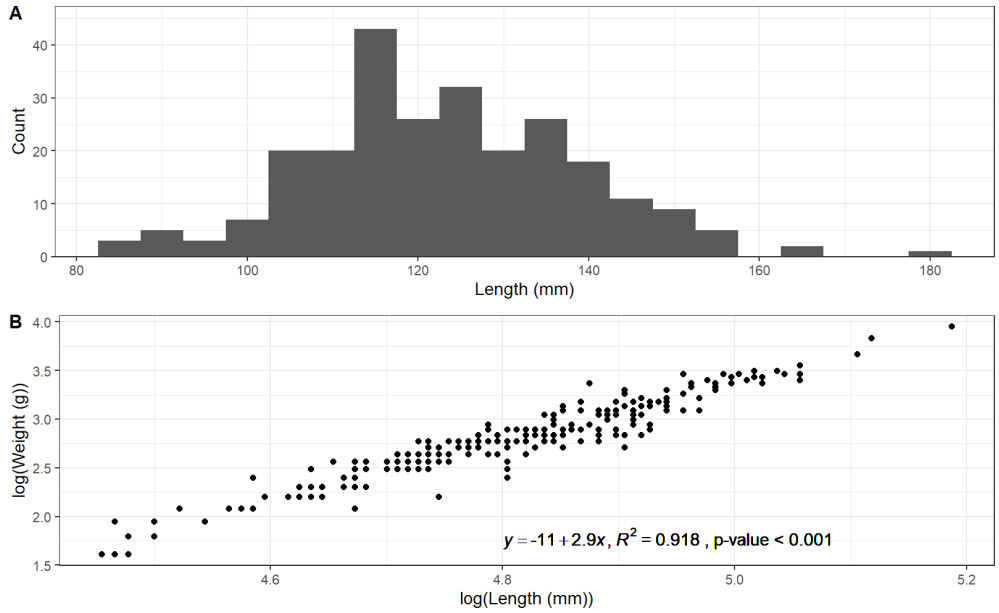

Figure 7. **A.** Sockeye Salmon (*Oncorhynchus nerka*) length frequency plot as sampled during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018. **B.** Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test.

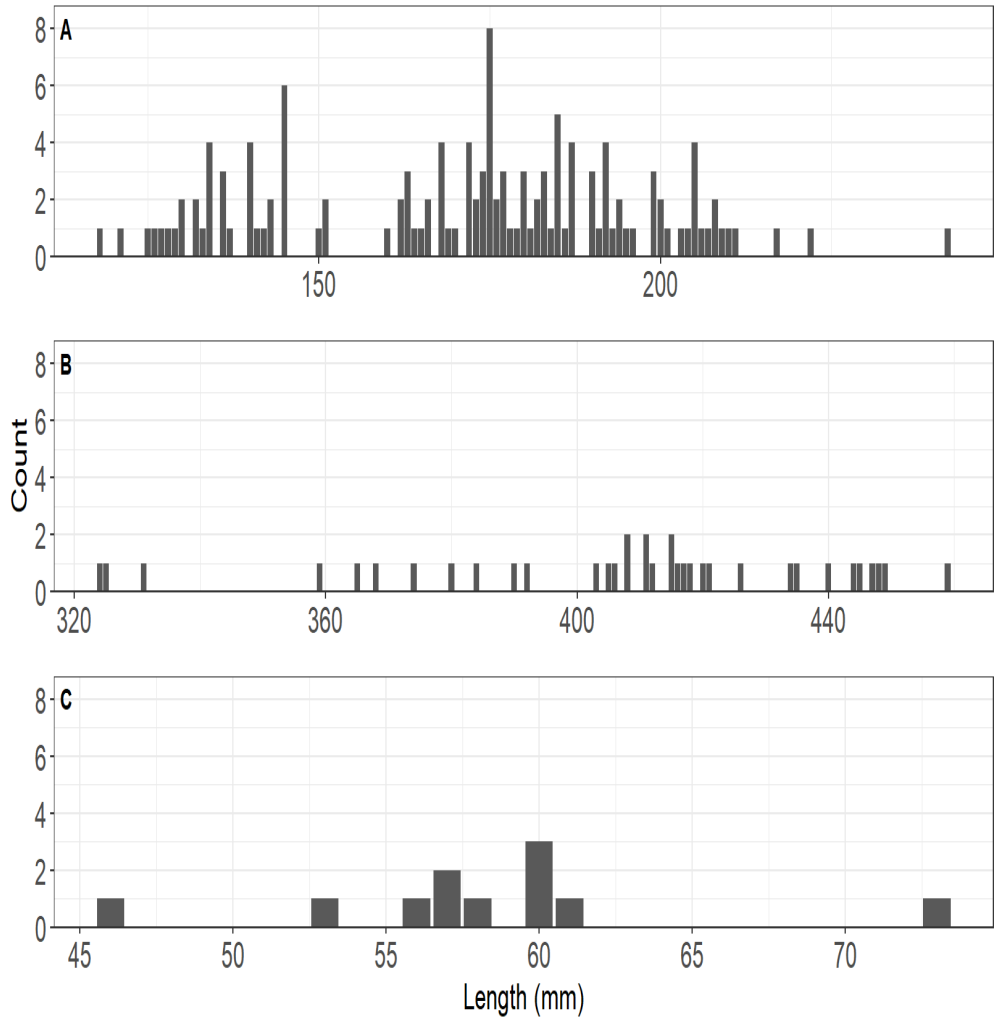

Figure 8. Length (mm) frequency plots for common species sampled (n>50 samples) during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018. **A.** Pacific Herring (*Clupea pallasii*), length = Standard Length, **B.** Sablefish (*Anoplopoma fimbria*), length = Fork Length, **C.** Opalescent Inshore Squid (*Doryteuthis opalescens*), length = Mantle 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 *CFV Sea Crest*, June 10 to June 14, 2018.

Common Name	Scientific Name	Tows	Count	Max	Mean
Chum Salmon (Juveniles)	*Oncorhynchus keta*	14	713	179	51
Sockeye Salmon (Juveniles)	*Oncorhynchus nerka*	14	565	260	40
Pink Salmon (Juveniles)	*Oncorhynchus gorbuscha*	11	282	68	26
Pacific Herring	*Clupea pallasii*	11	147	78	13
Chinook Salmon (Adults)	*Oncorhynchus tshawytscha*	15	88	35	6
Coho Salmon (Juveniles)	*Oncorhynchus kisutch*	9	45	15	5
Chinook Salmon (Juveniles)	*Oncorhynchus tshawytscha*	8	26	13	3
Sablefish	*Anoplopoma fimbria*	5	17	5	3
Opalescent Inshore Squid	*Doryteuthis opalescens*	1	11	11	11
Moon Jellyfish	*Aurelia*	15	5	3	2
Lions Mane	*Cyanea capillata*	8	4	1	1
Coho Salmon (Adults)	*Oncorhynchus kisutch*	4	4	1	1
Walleye Pollock	*Gadus chalcogrammus*	3	4	2	1
North Pacific Spiny Dogfish	*Squalus suckleyi*	1	3	3	3
Sea Nettle	*Chrysaora fuscescens*	6	2	1	1
Chum Salmon (Adults)	*Oncorhynchus keta*	1	1	1	1
Water Jellyfish	*Aequorea*	24			
Fried Egg Jellyfish	*Phacellophora camtschatica*	2			
Comb Jellyfish	*Ctenophora*	1			

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 *CFV Sea Crest*, June 10 to June 14, 2018. Tows = number of tows. 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
Chum Salmon	18	FL	313	65	430	122	311	2	816	20
Sockeye Salmon	17	FL	256	81	179	123	256	3	52	17
Pink Salmon	13	FL	202	76	149	111	202	3	30	13
Pacific Herring	14	SL	132	118	242	172	132	8	135	55
Chinook Salmon	20	FL	122	106	888	310	120	6	9,450	594
Coho Salmon	12	FL	58	121	545	189	58	19	1,837	137
Sablefish	6	FL	36	324	459	406	36	292	870	624
Opalescent Inshore Squid	1	ML	11	46	73	58	11	3	13	7
Walleye Pollock	3	FL	4	45	487	162	4	1	870	219
North Pacific Spiny Dogfish	1	TL	3	462	600	541	3	331	961	703

APPENDIX A NET SPECIFICATIONS

Table A.1. Net specifications for the LFS 7742 net used during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018.

Part	Size	Material
Doors	4.5 m^2	Thyboron Type 15
Door Legs	12.2 m (6.67 fm)	1 inch Spectra rope
Bridles	45.72 m (25 fm)	3/4 inch TS2P Spectra Rope
Head Line	102.83 m (56.2 fm)	5/8 inch coated Spectra Rope
Foot Rope	102.83 m (56.2 fm)	9/16 inch coated Spectra with 13 mm 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 NET DIAGRAM

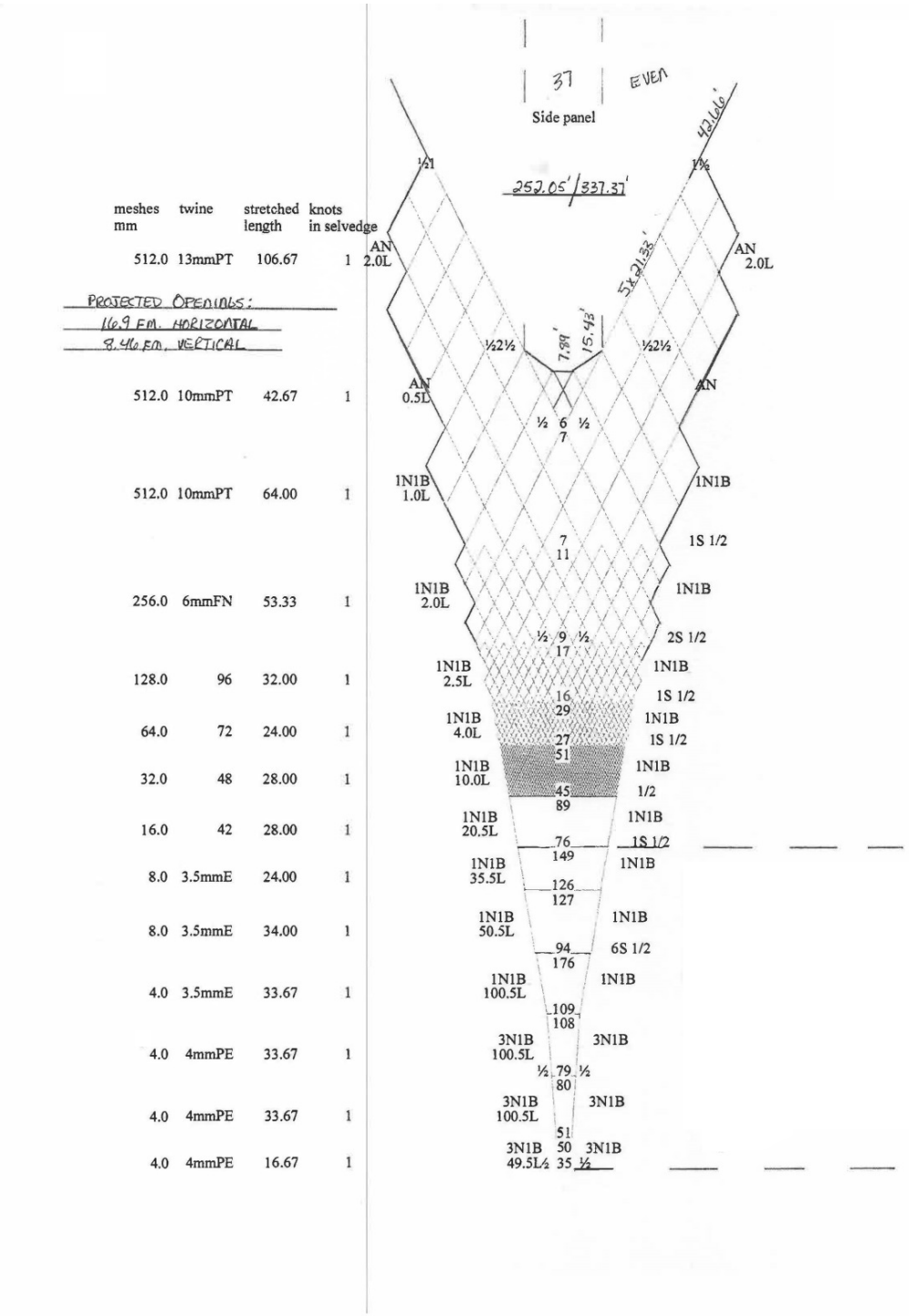

Figure B.1. Net diagram for LFS7742 trawl net used during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018.

APPENDIX C TRAWL BRIDGE LOG DATA

Table C.1. Bridge log information for trawl tows during the juvenile Pacific Salmon trawl survey aboard the *CFV Sea Crest*, June 10 to June 14, 2018.

Station Name	JS01	JS02	JS03	JS04	JS05	QCSD01
Tow	1	2	3	4	5	6
Date (Pacific)	2018-06-10	2018-06-10	2018-06-10	2018-06-10	2018-06-10	2018-06-11
Start Time (Pacific)	09:16:00	10:40:00	13:10:00	15:55:00	17:31:00	07:40:00
Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Duration (min)	20	22	20	20	20	20
Start Latitude	50° 22' 55" N	50° 21' 58" N	50° 24' 50" N	50° 29' 38" N	50° 29' 31" N	50° 58' 19" N
Start Longitude	125° 36' 40" W	125° 45' 22" W	125° 58' 16" W	126° 15' 54" W	126° 27' 07" W	128° 39' 00" W
End Latitude	50° 22' 23" N	50° 22' 34" N	50° 24' 00" N	50° 29' 17" N	50° 29' 56" N	50° 57' 00" N
End Longitude	125° 39' 04" W	125° 42' 25" W	125° 55' 34" W	126° 13' 16" W	126° 29' 46" W	128° 38' 24" W
Direction of Tow (deg)	251	73	116	102	284	163
Vessel Speed (km/h)	9.1	9.6	10.7	9.6	9.6	7.6
Distance Towed (km)	5.57	6.70	6.61	5.91	5.96	4.65
Net Opening Height (m)	12.0	12.0	11.5	12.0	12.0	11.0
Net Opening Width (m)	32	32	32	32	32	32
Warp Length (m)	75	75	100	50	75	100
Target Headrope Depth (m)	0	30	19	0	0	12
Start Bottom Depth (m)	155	133	188	320	373	66
End Bottom Depth (m)	264	182	74	273	394	56
Usable	Y	Y	Y	Y	N	Y

Station Name	QCSD02	QCSD03	QCSD04	QCSD05	QCSD06	QCSD07
Tow	7	8	9	10	11	12
Date (Pacific)	2018-06-11	2018-06-11	2018-06-11	2018-06-11	2018-06-11	2018-06-11
Start Time (Pacific)	08:47:00	10:19:00	11:52:00	12:56:00	14:10:00	15:21:00
Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Duration (min)	20	20	20	20	16	20
Start Latitude	50° 57’ 32" N	50° 58’ 44" N	50° 57’ 54" N	50° 59’ 20" N	50° 58’ 44" N	51° 07’ 44" N
Start Longitude	128° 32’ 56" W	128° 17’ 06" W	128° 09’ 29" W	128° 07’ 16" W	127° 52’ 41" W	127° 51’ 07" W
End Latitude	50° 57’ 40" N	50° 57’ 32" N	50° 58’ 23" N	50° 58’ 52" N	50° 57’ 43" N	51° 03’ 00" N
End Longitude	128° 30’ 11" W	128° 15’ 32" W	128° 06’ 54" W	127° 58’ 52" W	127° 51’ 54" W	127° 50’ 06" W
Direction of Tow (deg)	86	142	75	95	206	28
Vessel Speed (km/h)	9.6	8.5	9.3	8.7	7.6	8.0
Distance Towed (km)	5.91	5.30	5.74	5.43	3.83	4.91
Net Opening Height (m)	10.5	10.0	10.0	12.0	12.0	12.0
Net Opening Width (m)	32	32	32	32	32	32
Warp Length (m)	75	100	50	75	75	75
Target Headrope Depth (m)	16	33	18	0	0	0
Start Bottom Depth (m)	63	73	59	77	101	145
End Bottom Depth (m)	78	74	46	41	50	132
Usable	Y	Y	Y	Y	Y	Y

Station Name	QCSD08	QCSD09	QCST01	QCST02	QCST03	QCST04
Tow	13	14	15	16	17	18
Date (Pacific)	2018-06-11	2018-06-11	2018-06-12	2018-06-12	2018-06-12	2018-06-12
Start Time (Pacific)	16:40:00	18:08:00	07:01:00	09:14:00	10:46:00	12:45:00
Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Duration (min)	28	20	20	22	20	20
Start Latitude	51° 03’ 58" N	51° 00’ 36" N	50° 47’ 28" N	50° 51’ 00" N	50° 56’ 02" N	50° 57’ 32" N
Start Longitude	127° 56’ 02" W	127° 55’ 05" W	127° 30’ 07" W	127° 30’ 18" W	127° 42’ 11" W	127° 28’ 48" W
End Latitude	51° 01’ 59" N	50° 59’ 42" N	50° 48’ 11" N	50° 51’ 22" N	50° 56’ 46" N	50° 57’ 32" N
End Longitude	127° 56’ 02" W	127° 56’ 53" W	127° 32’ 20" W	127° 32’ 35" W	127° 43’ 48" W	127° 30’ 22" W
Direction of Tow (deg)	180	231	296	283	305	268
Vessel Speed (km/h)	7.8	8.0	8.9	7.2	7.0	5.6
Distance Towed (km)	6.87	4.94	5.44	5.00	4.35	3.46
Net Opening Height (m)	10.0	10.0	12.0	10.7	12.7	12.0
Net Opening Width (m)	32	32	32	32	32	32
Warp Length (m)	75	85	75	75	75	100
Target Headrope Depth (m)	25	18	0	16	38	0
Start Bottom Depth (m)	153	120	352	142	511	102
End Bottom Depth (m)	139	99	278	84	478	66
Usable	Y	Y	Y	Y	Y	N

Station Name	QCST05	QCST06	QCST07	QCSD10	QCSD11	QCSD12
Tow	19	20	21	22	23	24
Date (Pacific)	2018-06-13	2018-06-13	2018-06-13	2018-06-13	2018-06-13	2018-06-13
Start Time (Pacific)	06:55:00	08:48:00	09:57:00	13:01:00	15:25:00	16:27:00
Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Duration (min)	23	21	17	22	16	21
Start Latitude	50° 57’ 07" N	50° 59’ 56" N	51° 03’ 18" N	51° 05’ 38" N	51° 05’ 13" N	51° 09’ 25" N
Start Longitude	127° 32’ 20" W	127° 36’ 36" W	127° 39’ 47" W	127° 46’ 37" W	127° 51’ 25" W	127° 52’ 01" W
End Latitude	50° 59’ 02" N	51° 01’ 48" N	51° 04’ 05" N	51° 06’ 43" N	51° 06’ 40" N	51° 10’ 59" N
End Longitude	127° 34’ 30" W	127° 36’ 54" W	127° 41’ 06" W	127° 48’ 11" W	127° 52’ 34" W	127° 52’ 01" W
Direction of Tow (deg)	324	354	313	320	333	1
Vessel Speed (km/h)	11.3	9.8	7.4	7.4	11.1	8.3
Distance Towed (km)	7.98	6.37	3.93	5.07	5.57	5.44
Net Opening Height (m)	12.0	11.9	12.0	12.0	12.0	11.0
Net Opening Width (m)	32	32	32	32	32	32
Warp Length (m)	75	75	75	75	100	100
Target Headrope Depth (m)	0	15	0	0	0	16
Start Bottom Depth (m)	134	181	138	104	118	112
End Bottom Depth (m)	170	178	139	90	118	123
Usable	Y	Y	Y	Y	Y	Y

Station Name	QCST08	QCST09	QCST10	QCST11	QCST12	JS06
Tow	25	26	27	28	29	30
Date (Pacific)	2018-06-14	2018-06-14	2018-06-14	2018-06-14	2018-06-14	2018-06-14
Start Time (Pacific)	07:52:00	09:38:00	11:13:00	13:26:00	15:26:00	17:00:00
Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Duration (min)	20	20	20	20	20	13
Start Latitude	50° 51’ 18" N	50° 44’ 49" N	50° 46’ 01" N	50° 42’ 11" N	50° 40’ 41" N	50° 32’ 02" N
Start Longitude	127° 18’ 36" W	127° 09’ 40" W	127° 00’ 32" W	126° 47’ 28" W	126° 50’ 38" W	126° 45’ 00" W
End Latitude	50° 50’ 10" N	50° 45’ 58" N	50° 45’ 22" N	50° 40’ 52" N	50° 38’ 17" N	50° 31’ 41" N
End Longitude	127° 17’ 28" W	127° 11’ 20" W	126° 58’ 41" W	126° 46’ 41" W	126° 50’ 20" W	126° 44’ 06" W
Direction of Tow (deg)	147	317	119	159	175	124
Vessel Speed (km/h)	7.4	8.5	7.6	7.8	13.5	5.7
Distance Towed (km)	4.57	5.30	4.67	4.82	8.30	2.35
Net Opening Height (m)	12.0	10.7	12.0	12.0	12.0	12.0
Net Opening Width (m)	32	32	32	32	32	32
Warp Length (m)	75	75	100	75	100	75
Target Headrope Depth (m)	0	15	0	5	0	0
Start Bottom Depth (m)	137	172	175	167	150	434
End Bottom Depth (m)	132	200	176	140	150	405
Usable	Y	Y	Y	Y	Y	N

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 June 10 to June 14, 2018 on the *CFV Sea Crest*.

				CTD			BONGO		
Date	Station	Latitude	Longitude	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)
2018-06-10	JS01	50° 22' 56" N	125° 34' 35" W	08:21	223	150	08:39	230	120
2018-06-10	JS03	50° 24' 20" N	125° 57' 18" W	14:19	144	140	14:27	145	130
2018-06-10	JS05	50° 30' 32" N	126° 30' 50" W	18:26	395	150	18:43	380	250
2018-06-11	QCSD01	50° 57' 58" N	128° 40' 42" W	06:59	68	60	07:06	68	50
2018-06-11	QCSD03	50° 57' 32" N	128° 14' 52" W	11:08	62	50	11:11	57	50
2018-06-11	QCSD08	51° 01' 25" N	127° 55' 55" W	17:35	135	125	17:39	135	120
2018-06-12	QCST01	50° 47' 54" N	127° 33' 32" W	07:57	352	150	08:08	356	250
2018-06-13	QCSD10	51° 05' 19" N	127° 46' 36" W	11:22	102	90	11:27	102	90
2018-06-13	QCSD12	51° 11' 37" N	127° 51' 24" W	17:13	114	105	17:19	117	105
2018-06-13	QCST05	50° 59' 51" N	127° 35' 11" W	07:49	115	105	07:59	180	170
2018-06-14	JS06	50° 31' 01" N	126° 39' 23" W	17:57	424	150	18:06	454	250
2018-06-14	QCST08	50° 51' 43" N	127° 20' 31" W				07:09	139	130
2018-06-14	QCST10	50° 45' 16" N	126° 57' 44" W	12:01	161	150	12:09	164	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 June 10 to June 14, 2018 on the *CFV Sea Crest*. "0" means present but not counted.

Tow	1	2	3	4	6	7	8	9	10	11	12
Station ID	JS01	JS02	JS03	JS04	QCSD01	QCSD02	QCSD03	QCSD04	QCSD05	QCSD06	QCSD07
Chinook Salmon (Adults)					4	1	1	3	2	6	6
Chinook Salmon (Juveniles)	4	1		1	13	1					
Chum Salmon (Adults)					1						
Chum Salmon (Juveniles)	42			124					2	3	
Coho Salmon (Adults)											
Coho Salmon (Juveniles)	1			1						2	
Pink Salmon (Juveniles)	16			68							
Sockeye Salmon (Juveniles)	9			67	2				2		
Comb Jellyfish							0				
Fried Egg Jellyfish											
Lions Mane		0					0		1		1
Moon Jellyfish	0	0	0	0	0		0		0		
North Pacific Spiny Dogfish											
Opalescent Inshore Squid											
Pacific Herring	2	78					21		2		
Sablefish							4				5
Sea Nettle							0	0			
Walleye Pollock	1	2									
Water Jellyfish	0	0	0	0	0		0	0	0	0	0
TOTAL	75	81	0	261	20	2	26	3	9	11	12

Tow	13	14	15	16	17	19	20	21	22	23	24
Station ID	QCSD08	QCSD09	QCST01	QCST02	QCST03	QCST05	QCST06	QCST07	QCSD10	QCSD11	QCSD12
Chinook Salmon (Adults)		16	35	1	1	2			5	1	4
Chinook Salmon (Juveniles)						2		1	3		
Chum Salmon (Adults)											
Chum Salmon (Juveniles)			3			28	2	179	128	16	6
Coho Salmon (Adults)				1		1					
Coho Salmon (Juveniles)						2		15	14	8	
Pink Salmon (Juveniles)						13	14	42	48		2
Sockeye Salmon (Juveniles)						29	4	260	114	36	8
Comb Jellyfish											
Fried Egg Jellyfish					0						0
Lions Mane						1	1				0
Moon Jellyfish		0				2	3	0	0		
North Pacific Spiny Dogfish					3						
Opalescent Inshore Squid						11					
Pacific Herring				2	6	10	4	9			10
Sablefish	1	2									5
Sea Nettle			0		1				1	0	
Walleye Pollock									1		
Water Jellyfish	0	0	0		0	0	0	0	0	0	0
TOTAL	1	18	38	4	11	101	28	506	314	61	35

Tow	25	26	27	28	29
Station ID	QCST08	QCST09	QCST10	QCST11	QCST12
Chinook Salmon (Adults)					
Chinook Salmon (Juveniles)					
Chum Salmon (Adults)					
Chum Salmon (Juveniles)		30		12	138
Coho Salmon (Adults)	1				1
Coho Salmon (Juveniles)				1	1
Pink Salmon (Juveniles)	1	32		1	45
Sockeye Salmon (Juveniles)	1	18		2	13
Comb Jellyfish					
Fried Egg Jellyfish					
Lions Mane				0	
Moon Jellyfish			0	0	0
North Pacific Spiny Dogfish					
Opalescent Inshore Squid					
Pacific Herring	3				
Sablefish					
Sea Nettle					
Walleye Pollock					
Water Jellyfish	0	0	0		0
TOTAL	6	80	0	16	198