Ecosystem-Based Juvenile Pacific Salmon (Oncorhynchus spp.) Survey on the North Coast of British Columbia, October 6-16, 2020

Erika D. Anderson, Jackie R. King, Tyler B. Zubkowski

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

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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.

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ECOSYSTEM-BASED JUVENILE PACIFIC SALMON (*ONCORHYNCHUS* SPP.) SURVEY ON THE NORTH COAST OF BRITISH COLUMBIA, OCTOBER 6-16, 2020

by

Erika D. Anderson, Jackie R. King, and Tyler B. Zubkowski

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

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ABSTRACT

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Fisheries and Oceans Canada conducted an ecosystem-based survey from October 6-16, 2020 on the *CCGS Sir John Franklin*. This study targeted juvenile Pacific Salmon from Queen Charlotte Sound to Dixon Entrance.

There were 26 species sampled in 1741 kg of catch, with 25% Pacific Salmon caught by weight. Overall, Opalescent Inshore Squid (45%) and Moon Jellyfish (26%) were the most abundant species by weight. Lengths and weights were recorded for 17 species, including all 5 Pacific Salmon species (*Oncorhynchus* spp.). Juvenile Chum Salmon were the most abundant Pacific Salmon species with large catches, particularly in Hecate Strait, and only 2% containing empty stomachs. Pink Salmon were the most widespread species, whereas juvenile Sockeye Salmon were localized in northern Dixon Entrance. Both juvenile Pink Salmon and Sockeye Salmon were primarily feeding on euphausiids and amphipods. Juvenile Coho Salmon were less abundant and were caught in Dixon Entrance and Hecate Strait, to a lesser amount. Juvenile Coho Salmon had 47% empty stomachs and the widest variety of prey in their stomach contents. Only three Chinook Salmon were caught. The only Chinook Salmon with stomach contents contained Squid.

Biological samples for genetic stock composition and energy density are at the Pacific Biological Station, Fisheries and Oceans Canada (Nanaimo, BC) for laboratory analysis. Associated information on the physical oceanography and zooplankton composition was collected from 21 stations, and will be analysed at the the Institute of Ocean Sciences, Fisheries and Oceans Canada (Sidney, BC).

In addition, gear optimization occurred for the 2022 Pan-Pacific High Seas Expedition. The protocols for the offshore LFS 1142 trawl net, MOCNESS (Multiple Opening and Closing Net with Environmental Sensing System), oblique zooplankton tows, and CTD rosette deployment using the Launch and Recovery System (LARS) were tested.

RÉSUMÉ

Anderson, E.D., King, J.R. and Zubkowski, T.B. 2021. Ecosystem-Based Juvenile Pacific Salmon (*Oncorhynchus* spp.) Survey on the North Coast of British Columbia, October 6-16, 2020. Can. Data Rep. Fish. Aquat. Sci. 1331: vi + 36 p.

Pêches et Océans Canada a mené une étude écosystémique du 6 au 16 octobre 2020 sur le *NGCC Sir John Franklin*. Cette étude ciblait les saumons du Pacifique juvéniles de la région de Queen Charlotte Sound jusqu'à l'entrée Dixon.

Il y avait 26 espèces capturées pour un poids total de 1741 kg, dont 45% étaient attribués aux calmars opales, et 26% aux méduses lunaires, 25% aux saumons du Pacifique, et 4% autres. Les longueurs et les poids ont été enregistrés pour 17 espèces, dont les 5 espèces de saumon du Pacifique (*Oncorhynchus* spp.). Le saumon kéta juvénile était l'espèce de saumon du Pacifique la plus abondante, les prises étaient particulièrement élevées dans le détroit d'Hécate, avec seulement 2% des estomacs vides. Le saumon rose juvénile était les espèces plus largement distribué, tandis que le saumons rouge juvéniles était localisés au nord de l'entrée Dixon. Le saumon rose et le saumon rouge juvéniles se nourrissaient principalement d'euphausiacés et d'amphipodes. Le saumon coho juvénile était capturé dans l'entrée Dixon et le détroit d'Hécate. Le saumon coho juvénile avait 47% de vides les estomacs et la plus grande variété de proies dans leur contenu stomacal. Seulement trois saumons quinnat ont été capturés, et un seul stomac a contenu des calmars.

Les échantillons biologiques pour la composition génétique des populations et la densité énergétique se trouvent à la Station de Biologie du Pacifique de Pêches et Océans Canada (Nanaimo, C.-B.) pour fin d'analyses en laboratoire. Des informations sur l'océanographie physique et la composition du zooplancton ont été recueillies auprès de 21 stations, et seront analysées à l'Institut des Sciences de la Mer de Pêches et Océans Canada (Sidney, C.-B.).

De plus, nous avons optimisé les engins d'échantillonnages en vue de l'expédition Pan-Pacifique en haute mer prévue pour 2022. Les protocoles pour le filet de chalut océanique LFS 1142, le MOCNESS (filet à ouverture et fermeture multiples avec un système de détection de l'environnement), ainsi que les câbles de zooplancton obliques et déploiement de rosettes CTD utilisant le système de lancement et de récupération (LARS) ont été testés.

1 INTRODUCTION

Fisheries and Oceans Canada conducted an ecosystem-based survey, targeting juvenile Pacific Salmon (*Oncorhynchus* spp.) from October 6 to 16, 2020 on the *CCGS Sir John Franklin*. The main objectives of this surveys were:

1. to determine the abundance, condition, distribution, and genetic stock composition of juvenile Pacific Salmon present from Queen Charlotte Strait to Dixon Entrance in the fall, and
2. to optimize the offshore LFS 1142 trawl net setup and deployment and oceanographic sampling protocols for the new fisheries research vessel, the *CCGS Sir John Franklin* in preparation for the 2022 Pan-Pacific High Seas Expedition of the North Pacific Anadromous Fisheries Commission (NPAFC).

This survey supports research into linkages between oceanographic conditions, fish abundance and community composition, Pacific Salmon ocean ecology and forecasting adult returns. This data report documents the biological, oceanographic, zooplankton, and nekton data and samples collected during the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020.

2 MATERIALS AND METHODS

2.1 SURVEY LOCATIONS

Fishing (Figure 1), oceanographic (Figure 2) and zooplankton sampling (Figure 3) occurred west of Triangle Island and in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance.

2.2 FISHING OPERATIONS

The vessel deployed two mid water trawl nets: the offshore LFS 1142 trawl net and coastal LFS 7742 trawl net (Appendix A, manufactured by LFS Trawl (LFS Net Systems, Bellingham, USA). Both trawl nets are two-bridle mid water nets, and have codend liners to retain smaller species (offshore LFS 1142 codend liner is 11 mm and coastal LFS 7742 codend liner is 12.7 mm). The offshore LFS 1142 trawl net was designed for High Seas Expeditions, and has never been deployed from the *CCGS Sir John Franklin*. Equipment set up was incorporated into this survey because gear testing was cancelled due to COVID-19 restrictions. The codend was left open for the offshore LFS 1142 trawl net gear optimization. The main difference between the offshore LFS 1142 trawl net and coastal LFS 7742 trawl net is that the offshore LFS 1142 trawl net was designed to have a larger net opening. The offshore LFS 1142 trawl net opening was designed to be 46 m wide by 30 m high (A. Somov 2020), or an area of 1380 m^2. The coastal 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 A.4). Actual net openings varied; therefore, height and width dimensions were recorded for each tow and used in the calculation of catch per swept volume (Figures 5 to 9).

Two chain clumps were attached to the footrope with approximately 340 kg (750 lbs) and 204 kg (450 lbs) per chain clump for the offshore LFS 1142 trawl net and coastal LFS 7742 trawl net respectively. Thyborøn Type 15 VF, 4.5 m^2 mid water doors (730 kg each) with Scanmar SS4 door sensors, were used with both nets. A Simrad FS70 was used as a third wire trawl sonar to the monitor net opening in real time, and Scanmar SS4 clump sensors were attached near the wing tips. In addition, RBR duet^3 temperature and depth sensors (RBR Ltd., Ottawa, ON, Canada) were attached to the headrope and footrope to record depth every 30 seconds. The vertical net opening was plotted over time to show the net opening and depth in order to improve consistency between tows.

Tow speed varied between 6.1 to 9.6 km/hour (3.3 and 5.2 knots) speed over ground, depending on the wind, tide, and current, in order to reach the target headrope depth. 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 sixth blue knot on headrope for surface tows. Warp length ranged from 190-200 m for surface tows, and 227 to 243 m for 15 m headrope depth tows (Appendix B). Target tow duration was 15-20 min once the trawls doors were locked and the net fishing.

2.3 BIOLOGICAL SAMPLES

All shark species were released alive after identification and length measurements. The remaining species were sorted by species or taxonomic group, then the individuals measured for length and weight. Stomachs were analysed at sea following an established protocol (King et al. 2018). For each species in the tow, up to five whole bodies and five muscle tissues were collected for energy density and stable isotope analyses. Additional collection for Pacific Salmon species included: fin clips for genetic stock identification, otoliths, and adipose fin status, and coded wire tags (CWTs).

2.4 OCEANOGRAPHY

A 24 bottle rosette with Sea-bird 911 CTD (Sea-bird Electronics Bellevue Washington, USA), was deployed to 10 m above bottom for the first two stations. The Niskin bottles were sampled for nutrients, chlorophyll a (chl a), and trace metals using ligand analysis. Unfortunately, the cable on the Launch and Recovery System (LARS) failed on the third CTD rosette deployment so a standalone Sea-bird 25 CTD was used for water profiles thereafter. Surface water was collected for chlorophyll and nutrient analyses for the remainder of the survey. Seawater samples for nitrate, phosphate, and silicate were placed in acid-washed glass test tubes and frozen. Seawater for chl a estimation were filtered with GF/F glass fibre filter disks. Filter disks were then placed in polypropylene scintillation vials and frozen. Both the chlorophyll and nutrient samples were frozen and maintained at -80℃. Seawater and chl a samples were sent for analyses at the Institute of Ocean Sciences, Fisheries and Oceans Canada (Sidney, BC).

2.5 ZOOPLANKTON AND NEKTON SAMPLING

At zooplankton stations (Figure 3), vertical tows were conducted to approximately 250 m or within 10 m of the bottom with two 60 cm diameter, 253 micrometer mesh nets mounted in a bongo-drum style frame. Zooplankton collected from the flow meter side were preserved in 10% formalin and sent to the zooplankton laboratory at the Institute of Ocean Sciences, Fisheries and Oceans Canada (Sidney, BC) for species classification and enumeration. The remaining zooplankton sample 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, and proximate analyses.

Two additional oblique bongo tows were completed at the offshore stations (CS01, T01). The vessel speed was controlled to allow a 45 degree wire angle to increase the volume of water sampled. Oblique zooplankton tows were a method under consideration for the 2022 Pan-Pacific High Seas Expedition.

The MOCNESS nekton sampling gear was deployed at three stations (CS01, MT08, Mason53) from the starboard side of the vessel. The vessel speed was controlled to allow a 45 degree angle on the wire. A net was open during descent to 300-500 m, depending on the starting bottom depth. Five additional strata were sampled during ascent, with the depth strata depending on the maximum depth and acoustic signals.

3 RESULTS

3.1 FISHING OPERATIONS

This survey completed 6 offshore LFS 1142 trawl net tows for gear setup (4 with the codend open; 2 with the codend closed) and 21 coastal LFS 7742 trawl net tows (Appendix B). Although four offshore LFS 1142 trawl net adjustment tows were done with the codend open to avoid the capture of fish, a 4.6 m male Common Thresher Shark (*Alopias vulpinus*) was captured, and released alive from the first tow (Figure 4). The last coastal LFS 7742 trawl net tow of the survey was aborted in Queen Charlotte Strait due to equipment failure of the third wire winch. Subsequent tows were cancelled.

The offshore LFS 1142 mouth opening averaged 24 m high by 54 m wide, or an area of 1296 m^2. This opening is slightly smaller than to the expected net area opening of 30 m high by 46 m wide, or an area of 1380 m^2 (A. Somov 2020). The coastal LFS 7742 trawl net averaged 16 m high by 48 m wide, or an area of 768 m^2, during surface tows on this survey. This mouth area is similar to a previous survey on the *FV Sea Crest* where the coastal LFS 7742 trawl net mouth opening averaged 19 m high by 41 m wide at the surface, or area of (779 m^2; (E. D. Anderson 2019)). All catch per unit effort (CPUE) reported here are standardized by swept volume to standardize catch values.

3.2 CATCH COMPOSITION

For each of 26 species captured during the survey, the number of tows in which the species was present, total catch weight, maximum catch weight, and mean catch weight per tow for usable tows is presented in Table 1. The most abundance species caught by weight were Opalescent Inshore Squid, primarily caught in one set (785 kg), Moon Jellyfish (447 kg), then Chum Salmon (384 kg; Table 1). All species of juvenile Pacific Salmon were caught. The order of abundance by weight was Chum Salmon, Coho Salmon, Pink Salmon, Sockeye Salmon, and Chinook Salmon. Total catch for the survey from usable tows was 1741 kg, with 443 kg or 25% Pacific Salmon. Detailed catch composition for each tow is included in Appendix D.

Chum Salmon were abundant in the northern portion the survey area, with the highest catches within Hecate Strait (Figure 5). Pink Salmon had the second highest abundance by count and were found throughout the survey area, except offshore (Figure 6). Juvenile Sockeye Salmon were strongly localized in the northern area of Dixon Entrance (Figure 7). Coho Salmon were primarily caught throughout Dixon Entrance, with lesser numbers in Hecate Strait (Figure 8). Finally, there was only one Chinook Salmon caught during a usable tow in Hecate Strait (Figure 9; not including the two Chinook Salmon caught during the aborted tow in Queen Charlotte Strait).

3.3 BIOLOGICAL SAMPLES

Samples were collected for DNA stock composition (322), otoliths (322), energy density (259), stable isotope analysis (170), and coded wire tags (3). These biological samples are located at the Pacific Biological Station, Fisheries and Oceans Canada (Nanaimo, BC) awaiting laboratory analysis.

3.4 LENGTH AND WEIGHT

Length frequencies and length-weight relationships are presented for Pacific Salmon species in Figures 10 to 14. Double log transformed length-weight regressions coefficients were similar for all Pacific Salmon species, except Coho Salmon. The relationship between length and weight in juvenile Coho Salmon was more variable, with a smaller slope (Figure 13). Lengths and weights of 17 species were recorded, with all five Pacific Salmon species represented (Table 2) Coho Salmon had the largest mean length (302 mm) and weight (333 g), whereas Pink Salmon had the smallest mean length (193 mm) and weight (68 g) of the Pacific Salmon species. These size differences are expected given the different life histories of Pacific Salmon species. For example, juvenile Pink Salmon migrate to the marine environment in their first year, whereas juvenile Coho Salmon migrate later and some individuals remain in the coastal environment (Quinn 2018).

3.5 STOMACH CONTENTS

Stomachs of 415 individual fish, from 10 species, were analysed at sea (Table 3). Chinook Salmon (67%) and Coho Salmon (47%) had the highest percentage of empty stomachs, whereas Chum Salmon (2%) had the lowest percentage of empty stomach within Pacific Salmon species. Pink Salmon (38%) and Sockeye Salmon (21%) had intermediate percentages of empty stomachs (Table 3).

Juvenile Pacific Salmon showed species-specific differences in their prey items (Table 4). Juvenile Chum Salmon primarily had unidentified remains within their stomachs. Jellyfish and Squid are digested quickly; therefore, unidentified remains may represents those prey species. Juvenile Coho Salmon showed the widest range of prey species. The most common prey within juvenile Pink Salmon and Sockeye Salmon stomachs were amphipods and euphausiids. The only Chinook Salmon with stomach contents contained Squid (Table 4).

3.6 OCEANOGRAPHY

CTD casts and water samples were completed at 21 sites with cast depths ranging from 52 m to 2100 m (Appendix C). Samples were collected for nutrients and chlorophyll, primarily at surface with some limited ligand sampling at depth during the CTD rosette operations. The LARS was used to launch the rosette with the Seabird 911 CTD for the first two stations (CS01, T01). Thereafter, a standalone Seabird 25 CTD was deployed. Oceanographic data from the CTD rosette and standalone CTD casts, including water samples for nitrate, phosphate, silicate, and chl a, are being processed, analyzed, and will be archived online within the Water Properties Data Inventory.

3.7 ZOOPLANKTON

Vertical bongo tows were conducted at 21 stations to depths ranging from 56 m to 250 m (Appendix C). Formalin-preserved zooplankton samples will be identified and enumerated at the Institute of Ocean Sciences, Fisheries and Oceans Canada (Sidney, BC). Data will be archived in the zooplankton database. Fractionated zooplankton samples are frozen at the Pacific Biological Station, Fisheries and Oceans Canada (Nanaimo, BC).

In preparation for the 2022 Pan-Pacific High Seas Expedition, three MOCNESS and two oblique bongo tows were completed. Both techniques were deployed under calm sea conditions off the *CCGS Sir John Franklin*. The MOCNESS did not close nets between all depth strata in the first two tows. This failure to release was likely due to the attachment point not being properly aligned. The attachment point was realigned, and all strata were successfully sampled in the subsequent tow.

3.8 ACOUSTIC DATA

Acoustic data was collected throughout the survey with the drop keel deployed, for analysis at the Institute of Ocean Sciences, Fisheries and Oceans Canada (Sidney, BC).

4 DISCUSSION

This ecosystem-based juvenile Pacific Salmon survey collected valuable information on distribution, abundance, condition, and genetic stock composition (GSI) for juvenile Pacific Salmon in the north coast of British Columbia. Overall, juvenile Chum Salmon and Pink Salmon were most abundant, whereas Chinook Salmon were least abundant. Distributions and stomach contents varied by species. We collected physical oceanographic water profiles, and zooplankton abundance and composition associated with the Pacific Salmon caught. As it becomes available, the data from laboratory analysis (i.e. GSI, energy density, zooplankton composition) will be integrated into the survey data. These catch data, along with condition and GSI data, supplement historic juvenile Pacific Salmon surveys in these areas and will be reported in Fisheries and Oceans Canada State of the Pacific Ocean report and the annual Fraser River Sockeye Forecasting Supplement (B. L. MacDonald and Selbie 2020).

The offshore LFS 1142 trawl net was deployed for the first time on the *CCGS Sir John Franklin* with success. The setup and deployment procedure for this gear can be applied to the Pan-Pacific High Seas Expedition. Three MOCNESS and two oblique bongo tows were successfully conducted off the starboard in calm waters. The LARS was successfully used deploy the CTD rosette at two stations.

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7 FIGURES

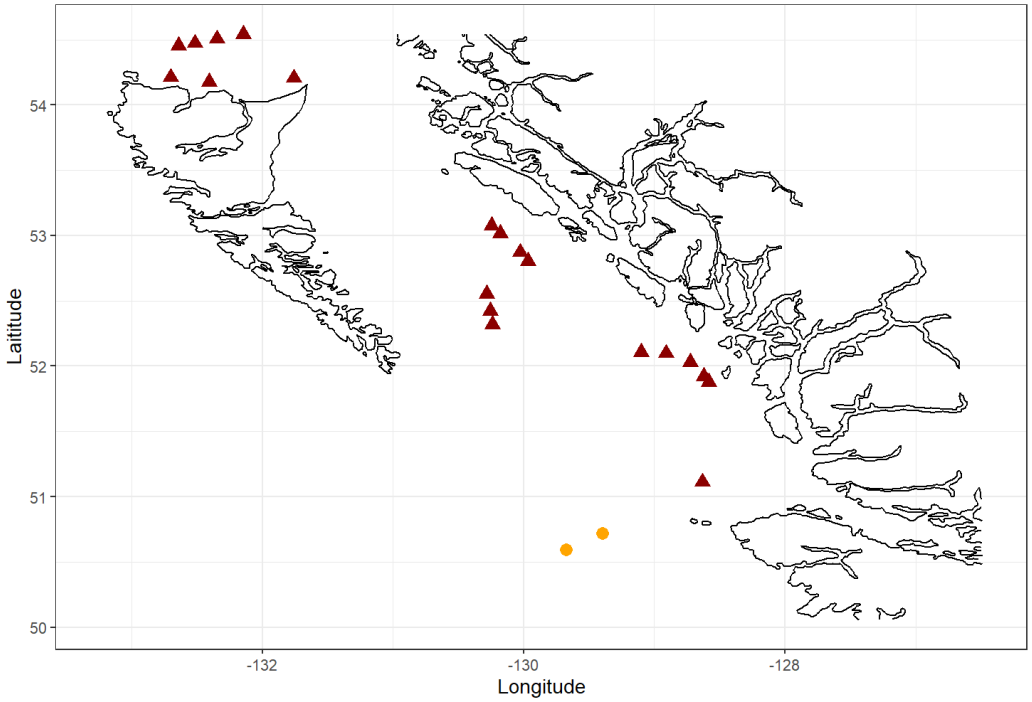

Figure 1. Fishing tow locations during the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*. The offshore LFS 1142 trawl net (orange circles) was used for 2 tows and the coastal LFS 7742 trawl net (red triangles) was used for 20 tows. Net testing and aborted tows are not shown.

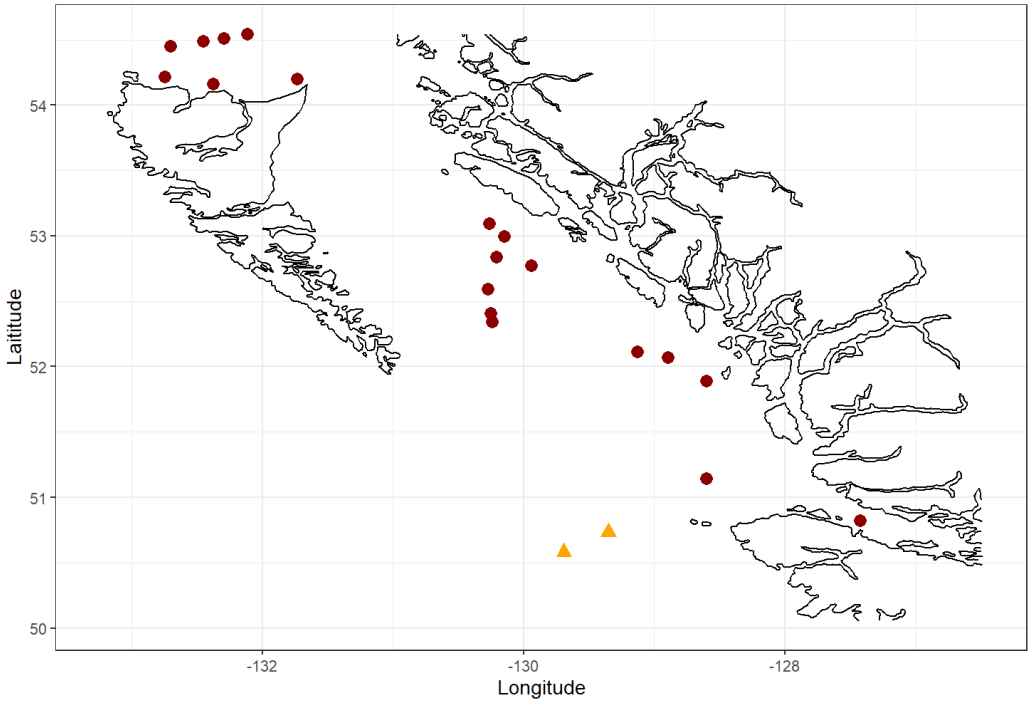

Figure 2. Oceanographic sampling locations during the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*. There were 19 Seabird 25 CTD casts (red circles) and 2 Seabird 911 rosette casts (orange triangles).

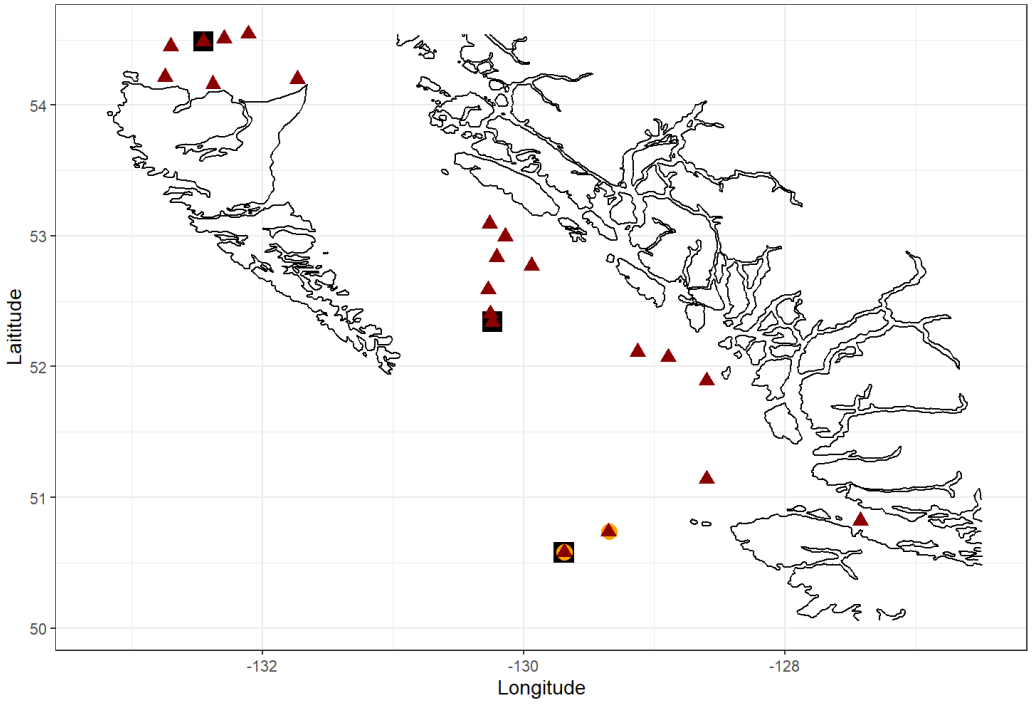

Figure 3. Zooplankton sampling locations during the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*. There were 21 vertical bongo tows (red triangles), 2 oblique tows (yellow circles) and 3 MOCNESS tows (black squares).

Figure 4. Common Thresher Shark (*Alopias vulpinus*) captured during gear optimization of the offshore LFS 1142 trawl net (despite the open cod end). This 4.6 m male shark was released alive (photo credit T. Zubkowski).

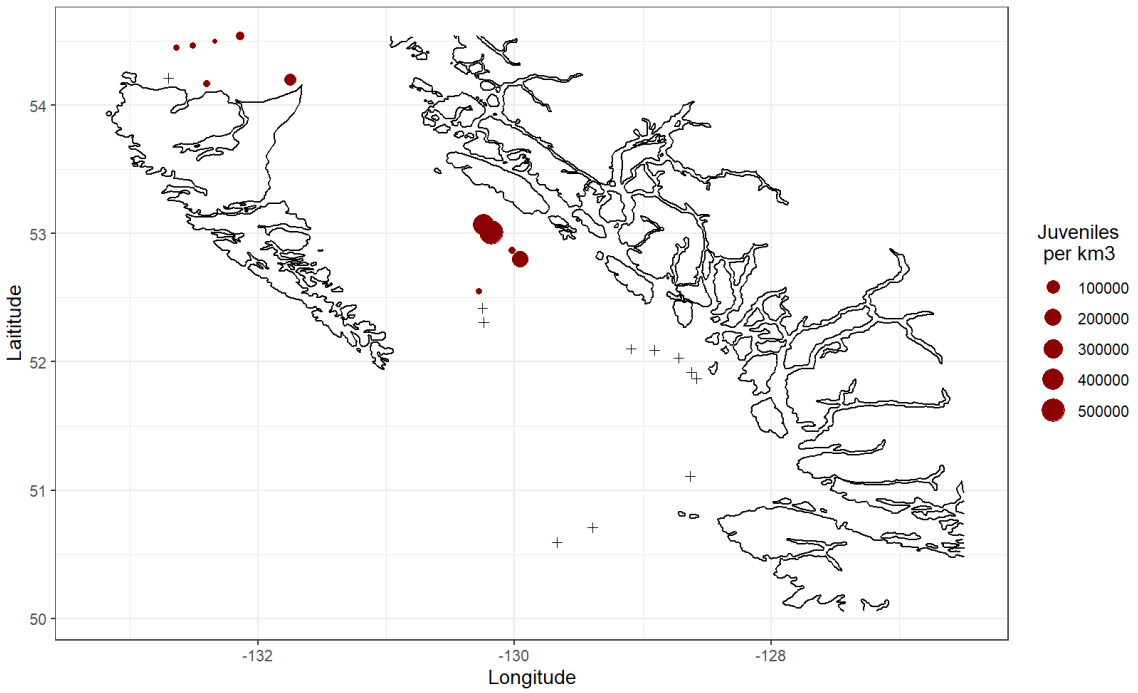

Figure 5. Juvenile Chum Salmon (*Oncorhynchus keta*) catch per km^3 per tow. Red circles are proportional to catch abundance, and zero catches are shown with a cross (+).

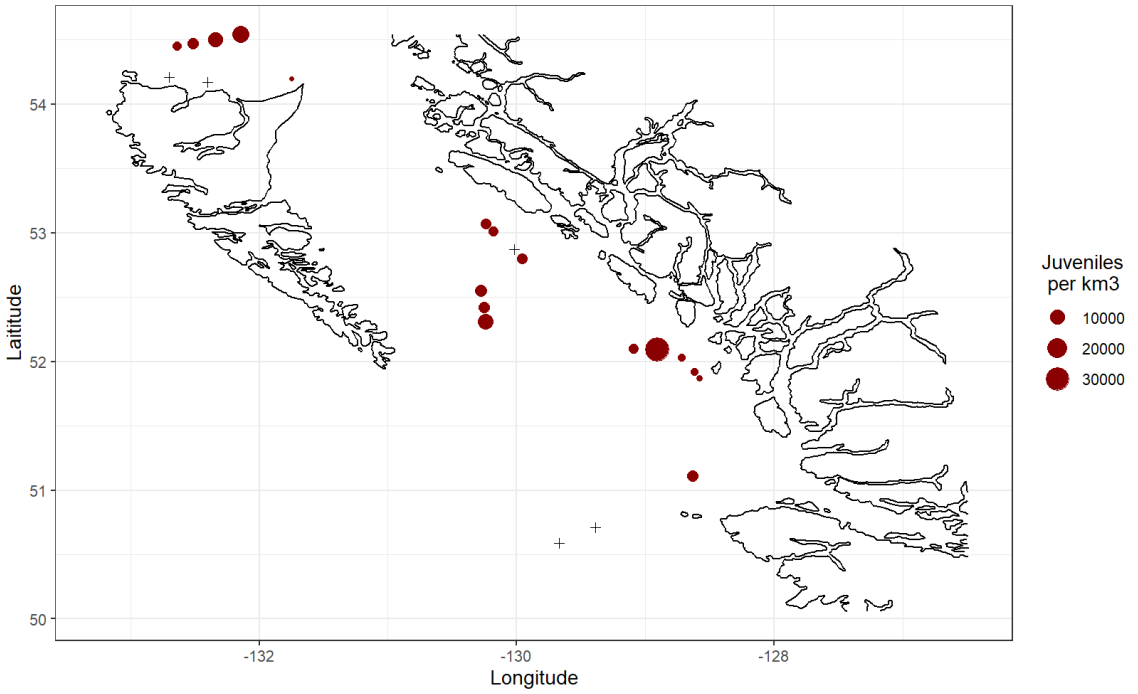

Figure 6. Juvenile Pink Salmon (*Oncorhynchus gorbusha*) catch per km^3 per tow. Red circles are proportional to catch abundance, and zero catches are shown with a cross (+).

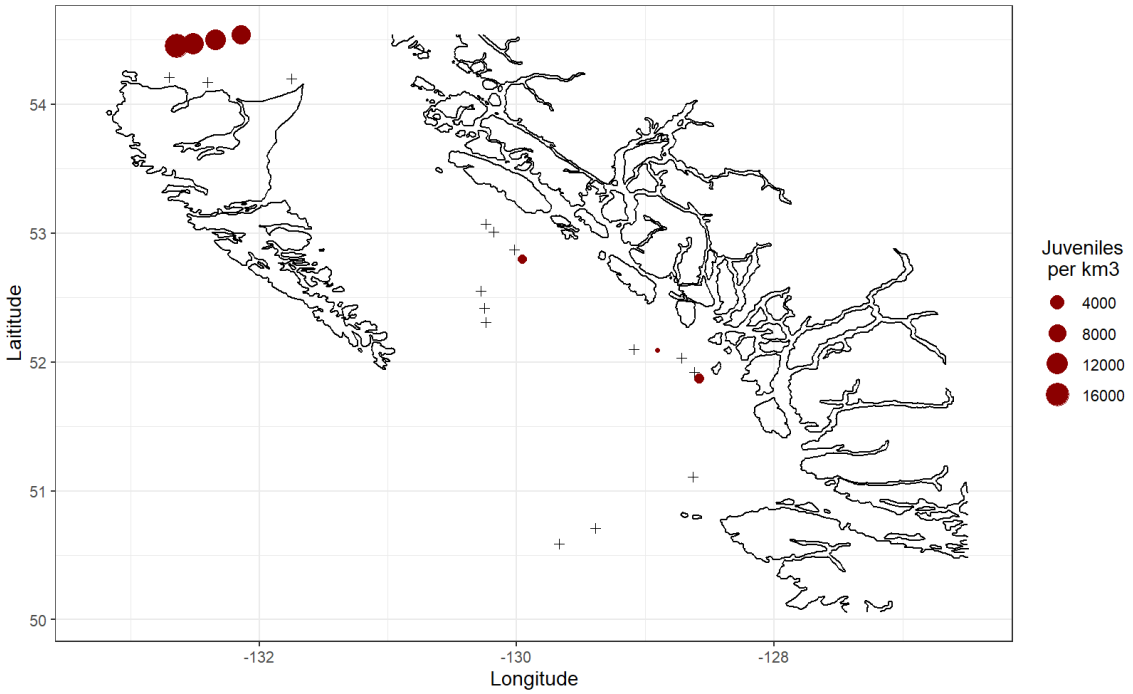

Figure 7. Juvenile Sockeye Salmon (*Oncorhynchus nerka*) catch per km^3 per tow. Red circles are proportional to catch abundance, and zero catches are shown with a cross (+).

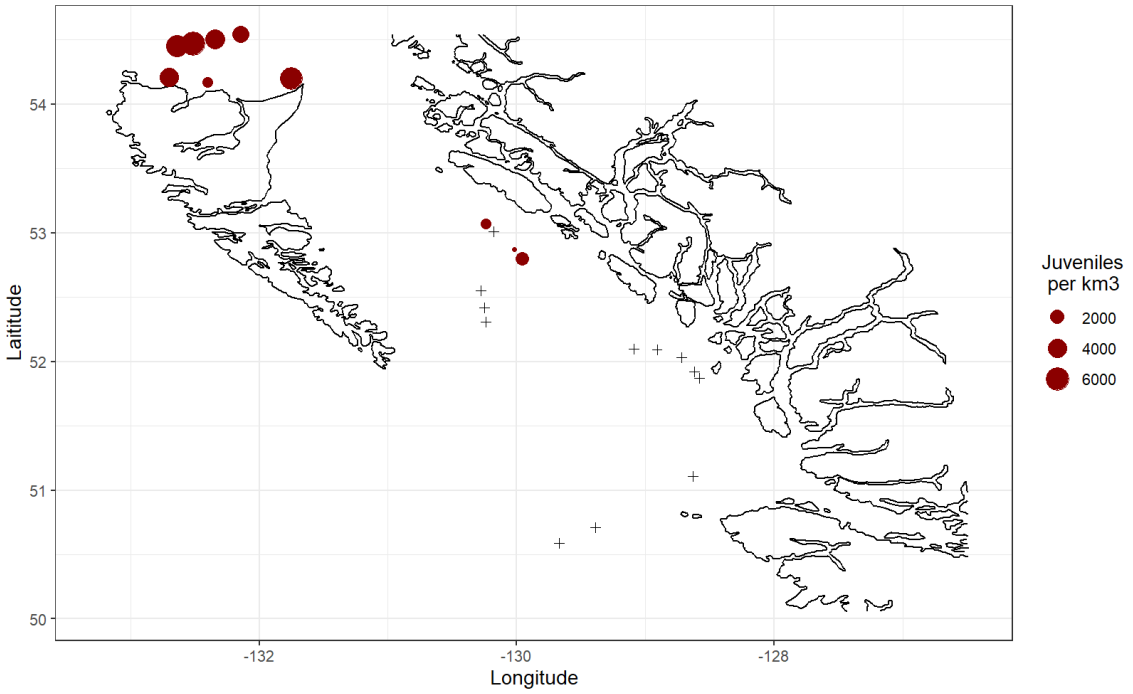

Figure 8. Juvenile Coho Salmon (*Oncorhynchus kitsutch*) catch per km^3 per tow. Red circles are proportional to catch abundance, and zero catches are shown with a cross (+).

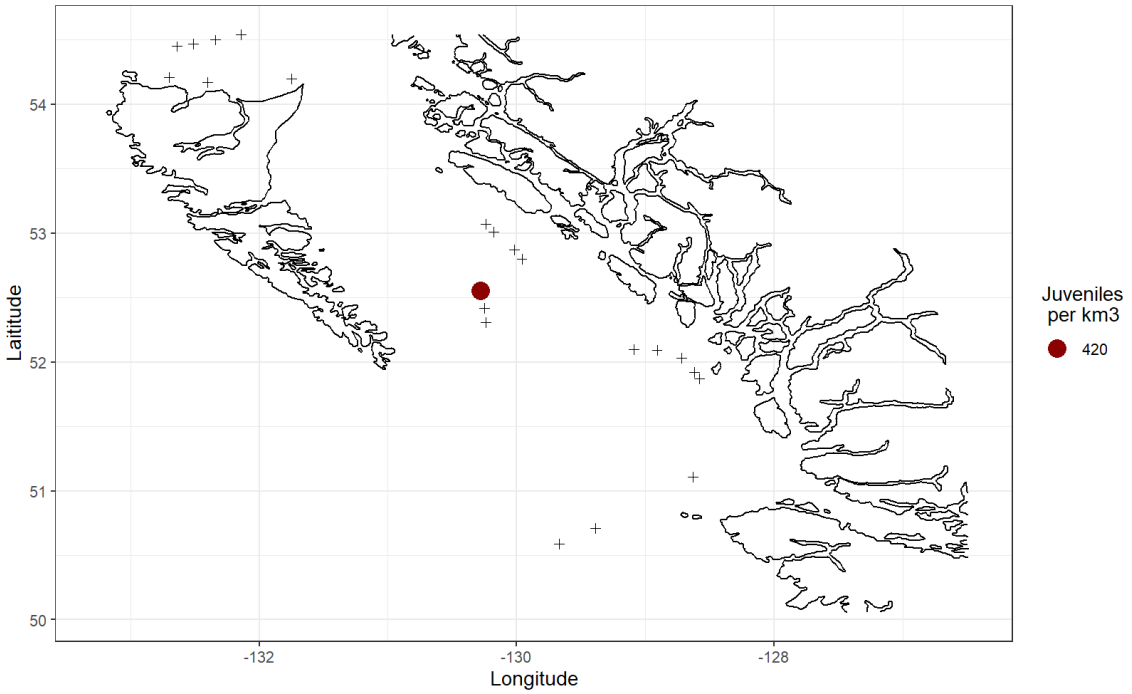

Figure 9. Juvenile Chinook Salmon (*Oncorhynchus tschawytscha*) catch per km^3 per tow. Red circles are proportional to catch abundance, and zero catches are shown with a cross (+).

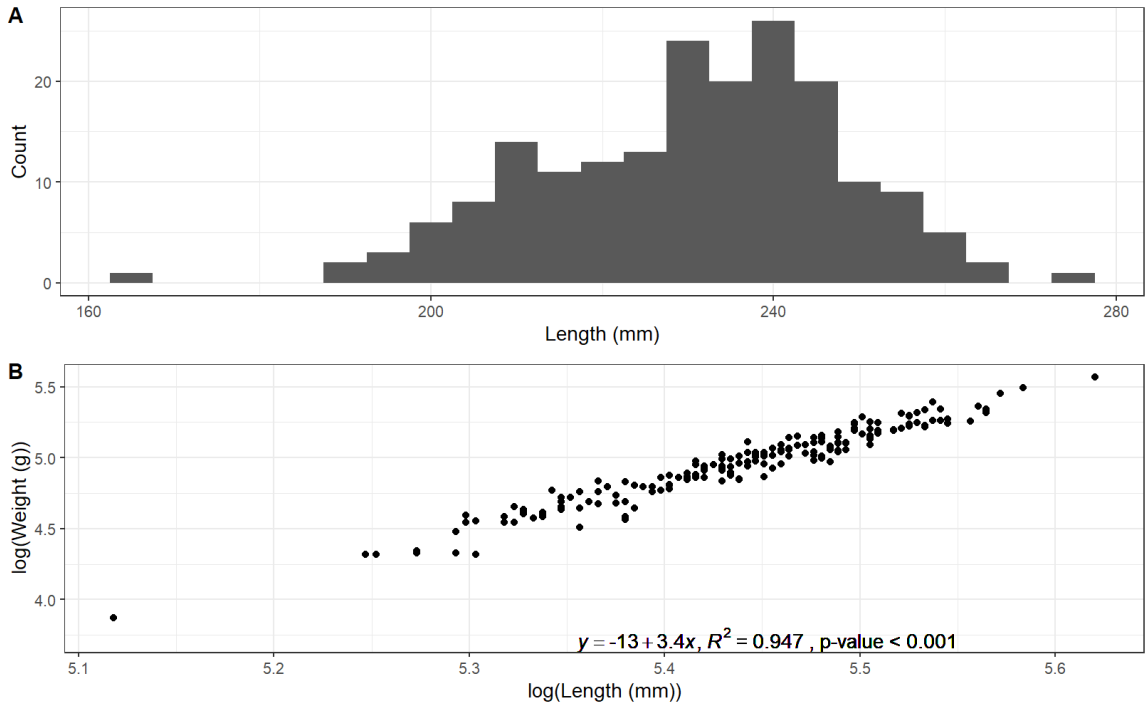

Figure 10. Juvenile Chum Salmon (*Oncorhynchus keta*) length frequency plot as sampled during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

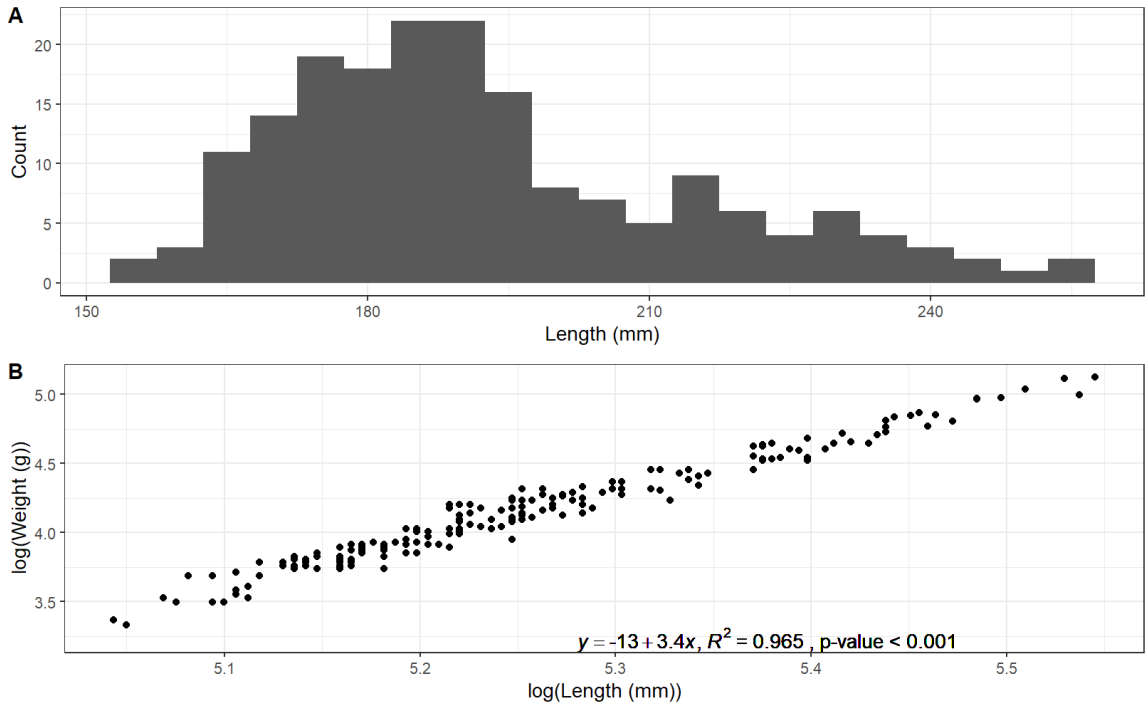

Figure 11. Juvenile Pink Salmon (*Oncorhynchus gorbusha*) length frequency plot as sampled during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

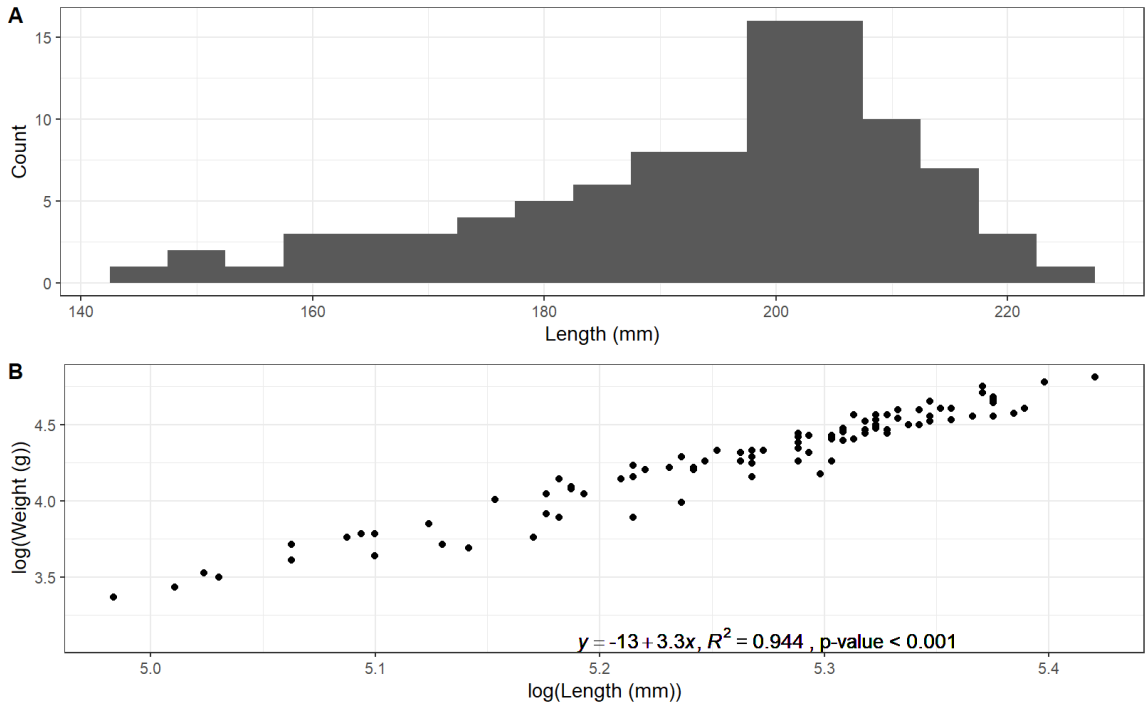

Figure 12. Juvenile Sockeye Salmon (*Oncorhynchus nerka*) length frequency plot as sampled during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

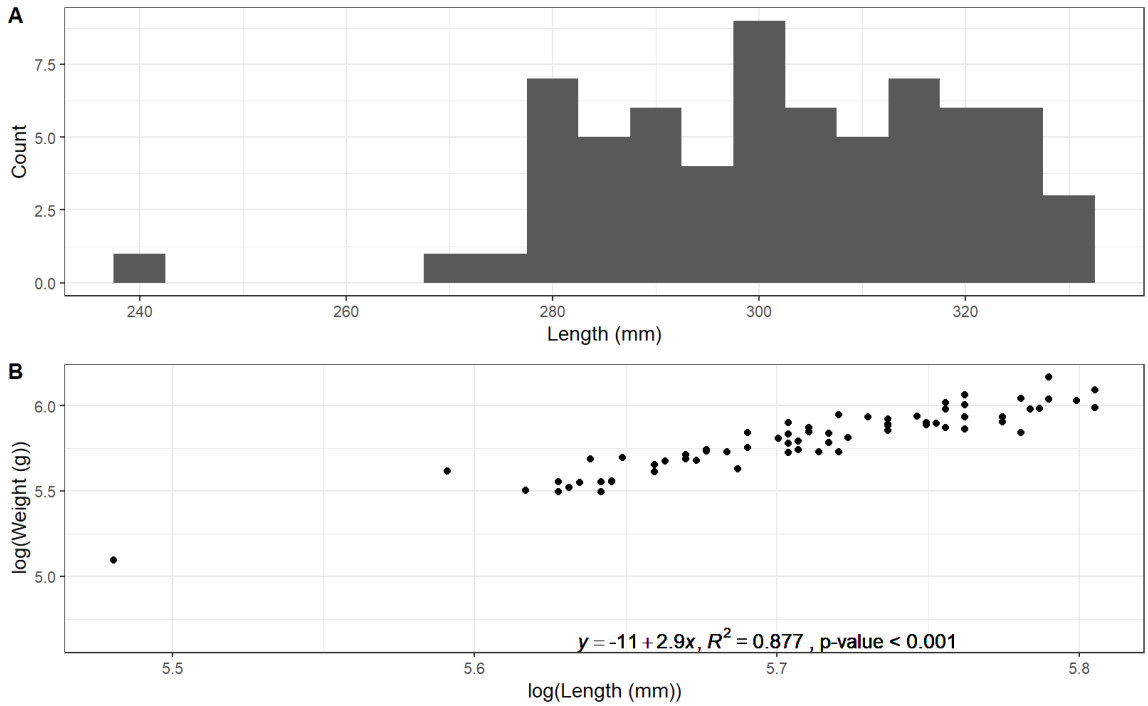

Figure 13. Juvenile Coho Salmon (*Oncorhynchus kisutch*) length frequency plot as sampled during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

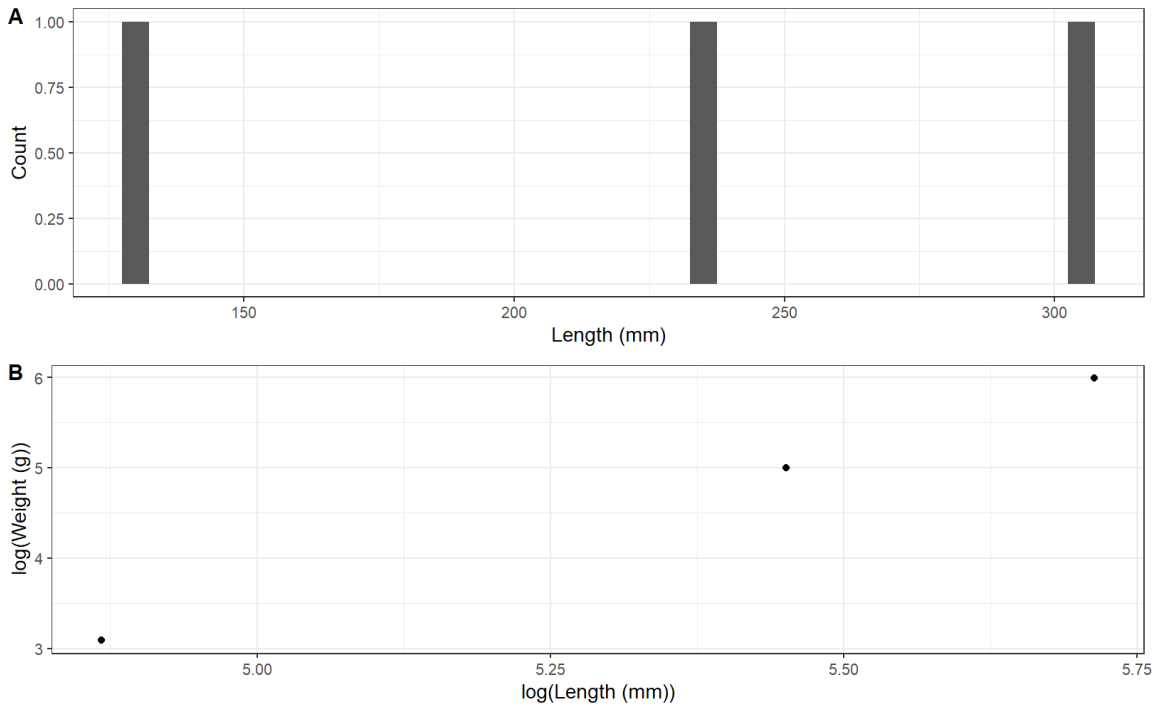

Figure 14. Juvenile Chinook Salmon (*Oncorhynchus tshawytscha)*) length frequency plot as sampled during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test. No linear equation is included since there were so few caught. (B).

8 TABLES

Table 1. All captured species (or taxonomic group), ordered by total catch weight (in grams), showing number of tows in which the species occurred, total catch weight, maximum catch weight, and mean catch weight per tow for usable tows during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020. Blank weights indicate specimens which could not be weighed accurately (either released alive or too small).

Common Name	Scientific Name	Tows	Total	Max	Mean
Opalescent Inshore Squid	Doryteuthis opalescens	8	784838	746000	130806
Moon Jellyfish	Aurelia	8	446750	332460	55844
Chum Salmon	Oncorhynchus keta	12	384332	162858	32028
Coho Salmon	Oncorhynchus kisutch	10	35887	12793	3589
Water Jellyfish	Aequorea	10	27460	10790	2746
Pacific Herring	Clupea pallasii	10	22297	13985	2230
Pink Salmon	Oncorhynchus gorbuscha	17	13941	3490	820
Sockeye Salmon	Oncorhynchus nerka	7	8262	3110	1180
Sablefish	Anoplopoma fimbria	4	6370	4450	1592
Ocean Sunfish	Mola mola	1	4850	4850	4850
Euphausiids	Euphausiacea	1	3860	3860	3860
Lions Mane	Cyanea capillata	1	710	710	710
Chinook Salmon	Oncorhynchus tshawytscha	1	430	430	430
Pacific Saury	Cololabis saira	2	200	150	100
Salps	Thaliacea	2	180	100	90
Bering Sea Nettle	Chrysaora melanaster	1	160	160	160
Dover Sole	Microstomus pacificus	1	80	80	80
Spectacular Corolla	Corolla spectabilis	1	75	75	75
Ragfish	Icosteus aenigmaticus	1	70	70	70
Northern Rock Sole	Lepidopsetta polyxystra	1	60	60	60
Rockfishes	Sebastes	2	25	25	25
Blue Shark	Prionace glauca	2			
Codfishes	Gadidae	1			
Flatfishes	Pleuronectiformes	1			
Northern Spearnose Poacher	Agonopsis vulsa	1			
Rex Sole	Glyptocephalus zachirus	1			

Table 2. Lengths and weights for each species (arranged descending by the number of length measurements for each by species) sampled during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020. (Tows = number of tows, Measured = number of length measurements, Weighed = number of weight measurements).

		Length (mm)				Weight (g)			
Species	**Tows**	**Measured**	**Min**	**Max**	**Mean**	**Weighed**	**Min**	**Max**	**Mean**
Opalescent Inshore Squid	7	300	18	66	39	24	1	9	3
Chum Salmon	13	190	167	741	235	190	48	5238	188
Pink Salmon	18	185	151	256	193	185	28	168	68
Pacific Herring	10	142	179	294	220	142	42	182	104
Sockeye Salmon	8	99	105	226	193	99	26	123	75
Coho Salmon	11	70	240	332	302	70	163	477	333
Moon Jellyfish	8	54	120	401	300	9	854	2334	1607
Sablefish	4	44	226	267	249	44	108	171	139
Water Jellyfish	1	8	195	256	219				
Blue Shark	2	6	850	1410	1048				
Chinook Salmon	2	3	130	303	222	3	22	400	190
Pacific Saury	2	3	229	285	259	3	48	83	67
Lions Mane	1	1	225	225	225				
Northern Spearnose Poacher	1	1	75	75	75	1	2	2	2
Ocean Sunfish	1	1	340	340	340	1	4850	4850	4850
Ragfish	1	1	195	195	195	1	65	65	65
Flatfish	1	1	175	175	175	1	56	56	56

Table 3. Number of tows with stomach samples (Tows), number of stomachs examined (Stomachs), number of empty stomachs (empty), and percentage of empty stomachs for each species (Percent), arranged descending by number of tows, during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020.

Species	Tows	Stomachs	Empty	Percent
Pink Salmon	18	117	44	38
Chum Salmon	13	95	2	2
Coho Salmon	11	59	28	47
Pacific Herring	10	64	17	27
Sockeye Salmon	8	48	10	21
Sablefish	4	24	11	46
Chinook Salmon	2	3	2	67
Pacific Saury	2	3	0	0
Ragfish	1	1	1	100
Rock Sole	1	1	1	100

Table 4. Prey items (Prey) identified in the stomach contents of predator species (Species) sampled (alphabetical by Species) during during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020. Volume is average volume in cm^3; Count is the number of stomachs observed with each prey.

Species	Prey	Volume	Count
Chinook Salmon	Squids	20.00	1
Chum Salmon	Unid. Remains	0.47	91
Chum Salmon	Jellyfish	0.30	1
Chum Salmon (Adults)	Squids	12.10	2
Chum Salmon (Adults)	Unid. Remains	6.00	2
Coho Salmon	Pacific Herring	10.25	2
Coho Salmon	Cephalopods	8.00	1
Coho Salmon	Threespine Stickleback	5.00	1
Coho Salmon	Unid. Fishes	2.48	5
Coho Salmon	Rockfishes	2.30	1
Coho Salmon	True Crabs	2.00	6
Coho Salmon	Squids	1.11	7
Coho Salmon	Euphausiids	0.98	5
Coho Salmon	Octopus	0.90	2
Coho Salmon	Unid. Plankton	0.17	3
Coho Salmon	Unid. Remains	0.15	2
Coho Salmon	Amphipods	0.09	8
Pacific Herring	Flatfishes	0.70	1
Pacific Herring	Gastropods	0.60	1
Pacific Herring	Euphausiids	0.56	16
Pacific Herring	Unid. Fishes	0.17	3
Pacific Herring	Misc. Non-Marine	0.10	1
Pacific Herring	Unid. Plankton	0.10	5
Pacific Herring	Unid. Remains	0.09	16
Pacific Herring	Amphipods	0.07	6
Pacific Herring	Invertebrate Remains	0.01	2
Pacific Saury	Invertebrate Remains	0.30	1
Pacific Saury	Unid. Fishes	0.10	3
Pacific Saury	Unid. Remains	0.10	1
Pink Salmon	Squids	1.30	1
Pink Salmon	Unid. Fishes	0.34	3
Pink Salmon	True Crabs	0.13	3
Pink Salmon	Euphausiids	0.11	27
Pink Salmon	Amphipods	0.08	36
Pink Salmon	Invertebrate Remains	0.06	8
Pink Salmon	Unid. Remains	0.06	16
Sablefish	Unid. Fishes	4.55	2
Sablefish	Pandalid Shrimp	3.07	3
Sablefish	Squids	2.80	1
Sablefish	Unid. Remains	0.90	1
Sablefish	True Crabs	0.44	5

Species	Prey	Volume	Count
Sablefish	Polychaete Worms	0.40	1
Sablefish	Jellyfish	0.10	1
Sablefish	Euphausiids	0.00	1
Sockeye Salmon	Euphausiids	0.54	9
Sockeye Salmon	Amphipods	0.26	23
Sockeye Salmon	Unid. Fishes	0.20	1
Sockeye Salmon	Unid. Remains	0.17	3
Sockeye Salmon	Jellyfish	0.11	2
Sockeye Salmon	Pandalid Shrimp	0.10	1
Sockeye Salmon	Unid. Plankton	0.05	5
Sockeye Salmon	Copepods	0.01	1
Sockeye Salmon	True Crabs	0.01	1

APPENDIX A NET SPECIFICATIONS

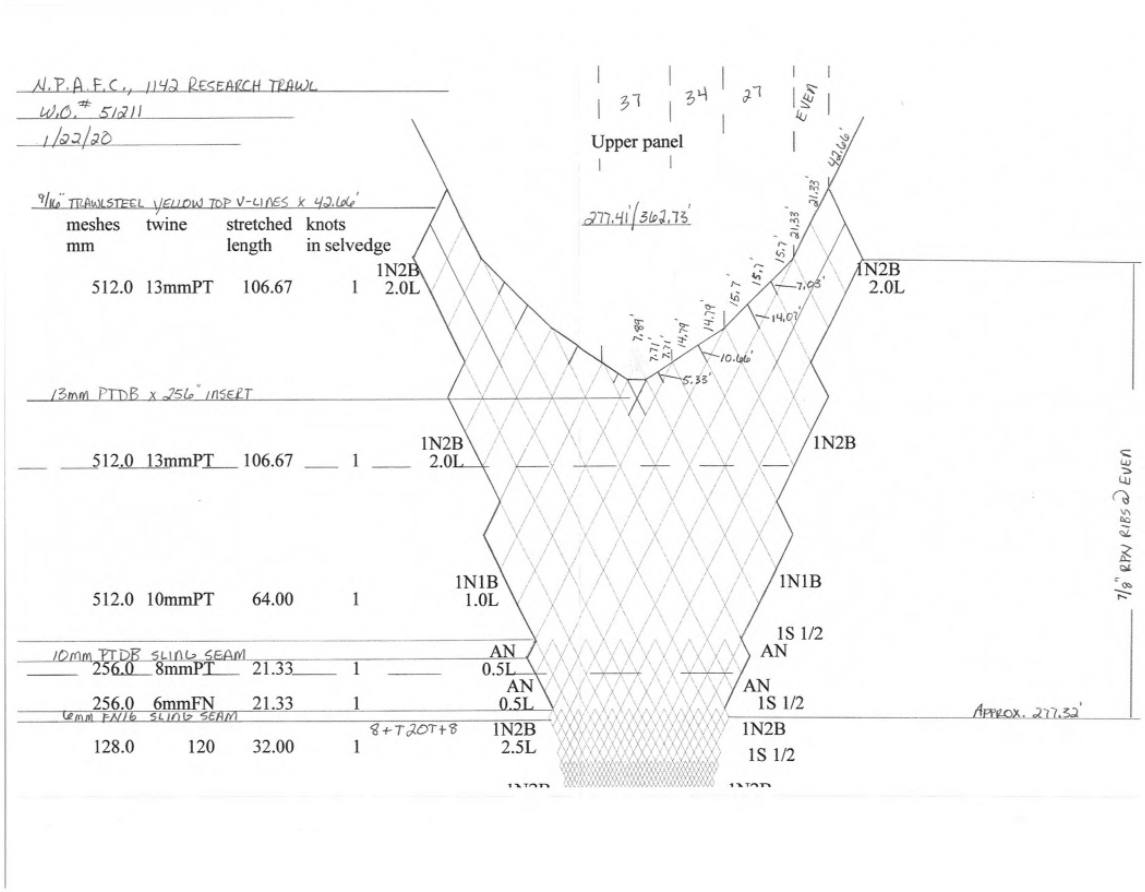

Figure A.1. Net specifications (upper view) for the offshore LFS 1142 trawl net used on the the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*.

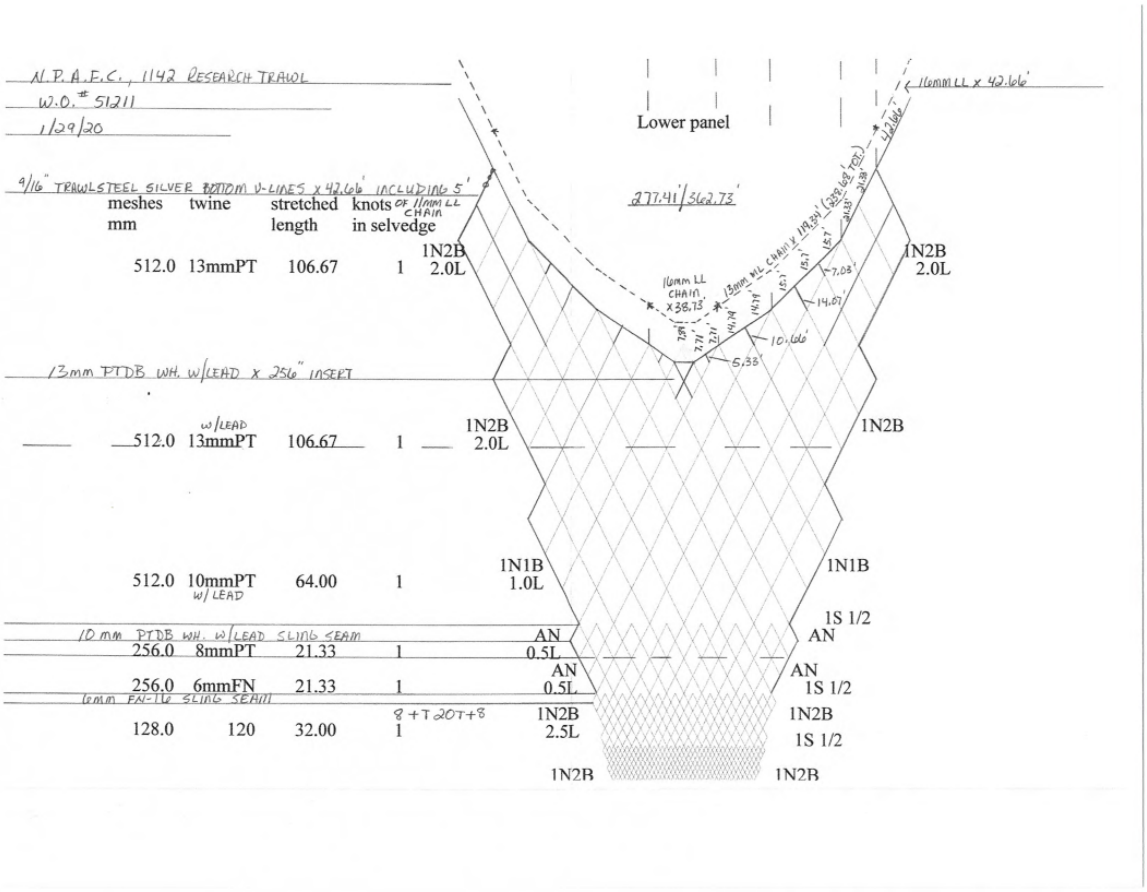

Figure A.2. Net specifications (lower view) for the offshore LFS 1142 trawl net used on the the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*.

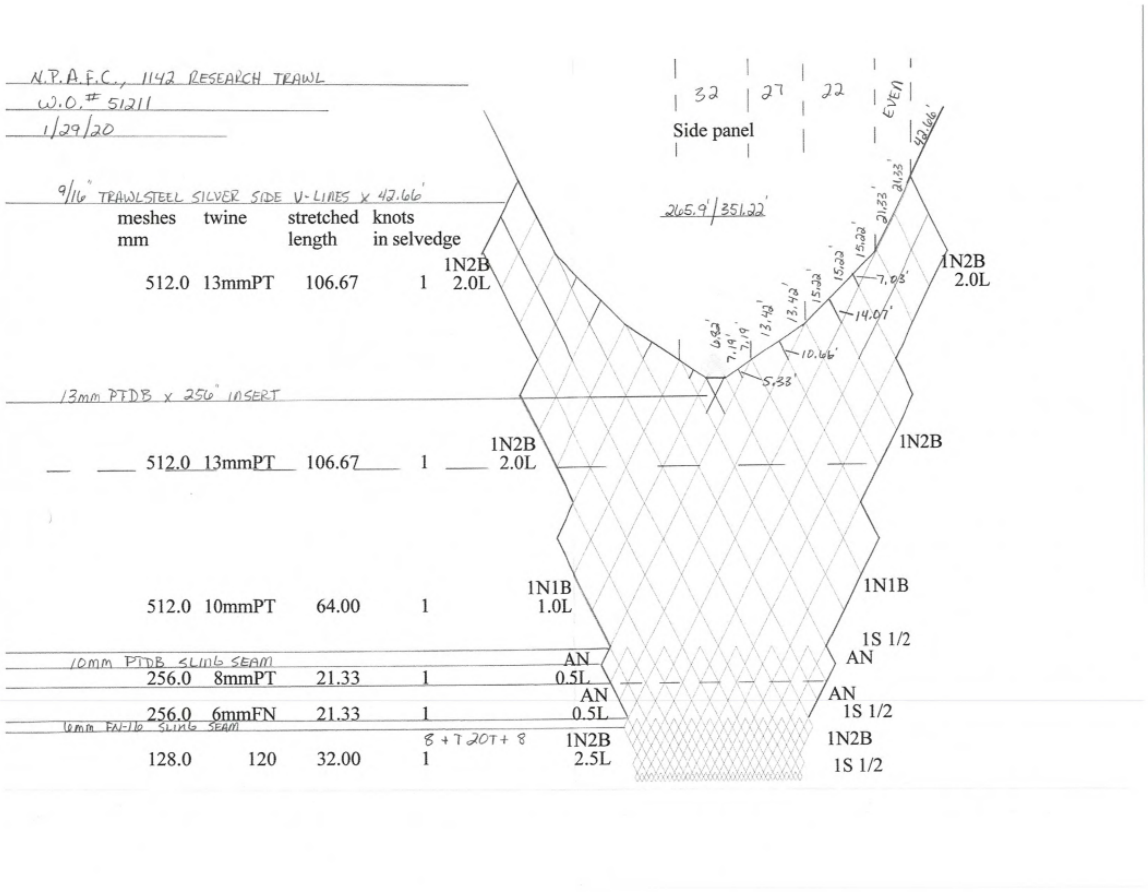

Figure A.3. Net specifications (side view) for the offshore LFS 1142 trawl net used on the the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*.

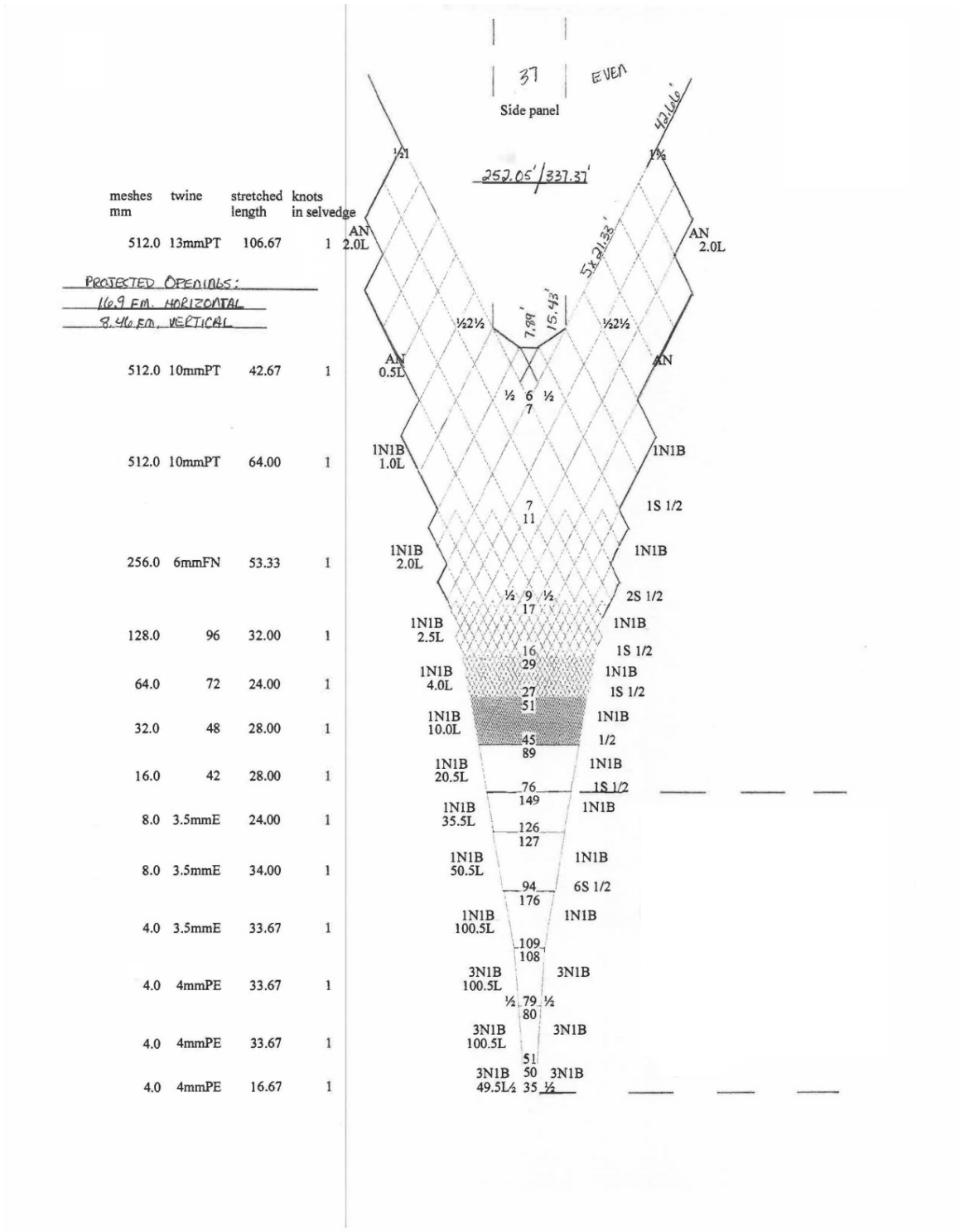

Figure A.4. Net specifications (side view only) for the coastal LFS 7742 trawl net the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*.

APPENDIX B TRAWL BRIDGE LOG DATA

Table B.1. Bridge log information for trawl tows during the ecosystem-based juvenile Pacific Salmon survey aboard the *CCGS Sir John Franklin*, October 6 to 16, 2020.

Tow Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Event Number	1	3	4	9	10	11	15
Date	2020-10-07	2020-10-07	2020-10-07	2020-10-08	2020-10-08	2020-10-09	2020-10-09
Station ID	Test1	Test2	Test3	CS01	CS01	T01	CS08
Trawl Net	LFS 1142	LFS 1142	LFS 1142	LFS 1142	LFS 1142	LFS 1142	LFS 7742
Start Time (PDT)	9:32	15:07	16:32	13:46	15:21	8:10	14:30
Duration (min)	28	25	10	17	21	20	19
Start Latitude	49°4'20	49°27'11	49°29'50	50°36'37	50°35'36	50°42'57	51°6'46
Start Longitude	126°29'12	127°7'02	127°11'19	129°40'35	129°40'23	129°23'41	128°37'47
End Latitude	49°4'20	49°28'24	49°30'28	50°35'24	50°34'13	50°43'42	51°8'06
End Longitude	126°32'40	127°8'53	127°11'50	129°41'41	129°41'52	129°21'41	128°36'12
Direction of Tow (deg)	270	315	332	210	214	60	37
Vessel Speed (km/h)	9.3	7.4	7.4	9.3	8.9	8.3	9.4
Distance Towed (km)	4.22	3.19	1.33	2.61	3.12	2.72	3.06
Net Opening Height (m)	24	24	25	21	25	24	17
Net Opening Width (m)	48	56	58	56	51	56	41
Warp Length (m)	200	193	193	199	193	190	194
Door Spread (m)	74	78	74.5	85	79	78	86
Target Headrope Depth (m)	0	0	0	0	0	0	0
Average Headrope Depth (m)	14	4.7	6	0	0	0	0
Start Bottom Depth (m)	130	146	154	2025	2072	1684	110
End Bottom Depth (m)	134	147	155	2084	2117	1061	130
Usable	N	N	N	N	Y	Y	Y

Tow Number	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Event Number	22	25	26	33	36	37	42	43
Date	2020-10-10	2020-10-10	2020-10-10	2020-10-11	2020-10-11	2020-10-11	2020-10-12	2020-10-12
Station ID	MT08	H01	H02	DE01	DE03	DE04	DE07	Mason53
Trawl Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Start Time (PDT)	9:38	12:43	14:25	8:04	13:45	15:53	8:18	9:29
Duration (min)	21	19	19	19	20	17	20	20
Start Latitude	52°19’10	52°25’22	52°33’05	54°12’21	54°10’33	54°12’43	54°27’20	54°28’22
Start Longitude	130°14’24	130°15’22	130°16’52	131°45’25	132°24’17	132°42’12	132°38’31	132°31’00
End Latitude	52°20’34	52°26’40	52°34’35	54°12’29	54°11’39	54°12’55	54°27’26	54°28’48
End Longitude	130°14’36	130°15’23	130°16’57	131°47’54	132°25’34	132°44’09	132°35’37	132°28’14
Direction of Tow (deg)	355	360	358	275	326	280	87	75
Vessel Speed (km/h)	8.3	7.8	8.1	8	8.3	8.1	9.6	9.3
Distance Towed (km)	2.63	2.42	2.78	2.71	2.47	2.15	3.15	3.1
Net Opening Height (m)	18	17	17	16	17	17	17	16
Net Opening Width (m)	44	44	50	51	45	48	47	47
Warp Length (m)	194	196	194	190	193	192	192	194
Door Spread (m)	84	87	83	89	85	87	87	80
Target Headrope Depth (m)	0	0	0	0	0	0	0	0
Average Headrope Depth (m)	0	1	8	5	0	0	0	0
Start Bottom Depth (m)	371	331	260	93	97	151	362	366
End Bottom Depth (m)	367	325	246	110	98	188	364	362
Usable	Y	Y	Y	Y	Y	Y	Y	Y

Tow Number	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Event Number	47	50	55	56	59	60	65	66
Date	2020-10-12	2020-10-12	2020-10-13	2020-10-13	2020-10-13	2020-10-13	2020-10-14	2020-10-14
Station ID	DE08	DE09	HN01	HN02	HN03	HN04	HS03	HS02
Trawl Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Start Time (PDT)	13:10	15:25	8:09	9:21	12:18	13:23	7:51	10:12
Duration (min)	19	19	20	21	19	22	20	20
Start Latitude	54°30’23	54°32’23	53°4’39	53°0’60	52°52’19	52°48’19	52°6’17	52°5’56
Start Longitude	132°20’41	132°8’39	130°14’49	130°10’51	130°1’40	129°58’01	129°5’55	128°54’35
End Latitude	54°30’35	54°32’44	53°3’32	52°59’49	52°51’08	52°47’07	52°5’50	52°4’41
End Longitude	132°18’34	132°6’52	130°13’45	130°9’45	130°0’35	129°56’32	129°3’57	128°54’08
Direction of Tow (deg)	81	71	150	150	151	143	110	168
Vessel Speed (km/h)	7.6	6.1	6.9	7.4	7.2	8	8	6.9
Distance Towed (km)	2.32	2.03	2.38	2.51	2.51	2.76	2.4	2.38
Net Opening Height (m)	17	18	16	16	14	17	13	17
Net Opening Width (m)	44	45	47	48	48	49	53	49
Warp Length (m)	196	193	193	194	227	197	233	195
Door Spread (m)	82	79	86	87	87	86	95	87
Target Headrope Depth (m)	0	0	0	0	15	0	15	0
Average Headrope Depth (m)	0	0	0	0	15	0.6	12	0
Start Bottom Depth (m)	356	238	205	218	252	255	120	181
End Bottom Depth (m)	355	224	209	223	253	255	134	170
Usable	Y	Y	Y	Y	Y	Y	Y	Y

Tow Number	**24**	**25**	**26**	**27**
Event Number	69	70	73	76
Date	2020-10-14	2020-10-14	2020-10-14	2020-10-15
Station ID	HS01	QCSD01	QCSD02	QCST01
Trawl Net	LFS 7742	LFS 7742	LFS 7742	LFS 7742
Start Time (PDT)	12:21	14:00	15:19	7:45
Duration (min)	20	20	19	05
Start Latitude	52°1’47	51°55’11	51°52’40	50°49’15
Start Longitude	128°43’25	128°37’25	128°35’06	127°25’24
End Latitude	52°1’20	51°53’53	51°51’33	50°48’50
End Longitude	128°41’09	128°36’51	128°33’50	127°23’58
Direction of Tow (deg)	108	165	145	114
Vessel Speed (km/h)	8.3	7.4	7.8	
Distance Towed (km)	2.73	2.5	2.54	1.86
Net Opening Height (m)	14	14	14	
Net Opening Width (m)	54	50	52	
Warp Length (m)	243	243	237	
Door Spread (m)	93	94	97	
Target Headrope Depth (m)	15	15	15	0
Average Headrope Depth (m)	19	19	19	
Start Bottom Depth (m)	174	131	124	
End Bottom Depth (m)	159	131	119	
Usable	Y	Y	Y	N

APPENDIX C CTD CASTS AND ZOOPLANKTON TOWS

Table C.1. CTD casts and vertical bongo tow times and depths during the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*.

		CTD			BONGO		
Date	**Station**	**Start Time (PDT)**	**Bottom Depth (m)**	**Gear Depth (m)**	**Start Time (PDT)**	**Bottom Depth (m)**	**Gear Depth (m)**
2020-10-08	CS01	7:38	2107	2100	10:13	2107	250
2020-10-09	T01	9:28	934	924	10:24	850	250
2020-10-09	CS08	16:09	135	125	16:24	135	125
2020-10-10	MT08	7:17	365	355	7:42	365	250
2020-10-10	H01	10:51	337	327	12:00	338	250
2020-10-10	H02	15:39	242	232	15:18	244	234
2020-10-10	H03	17:54	227	217	18:12	228	218
2020-10-11	DE01	7:20	66	52	7:10	66	56
2020-10-11	DE03	12:47	90	80	12:58	89	79
2020-10-11	DE04	17:50	187	177	17:34	188	178
2020-10-12	DE07	7:08	355	345	7:33	355	250
2020-10-12	Mason53	10:43	361	351	10:24	361	250
2020-10-12	DE08	13:58	355	345	14:19	356	250
2020-10-12	DE09	16:29	239	229	16:11	226	216
2020-10-13	HN01	7:22	203	193	7:36	203	193
2020-10-13	HN02	10:28	225	215	10:10	225	215
2020-10-13	HN04	14:10	254	244	14:27	254	244
2020-10-14	HS03	7:04	141	131	7:17	139	119
2020-10-14	HS02	11:09	158	158	10:55	168	158
2020-10-14	QCSD01	14:43	129	119	14:53	129	119
2020-10-15	QCST01	7:22	197	197	7:06	207	195

APPENDIX D CATCH DATA

Table D.1. Catch (kg) of species (or taxonomic groups where species identification could not be made with certainty) captured during the ecosystem-based juvenile Pacific Salmon survey from October 6 to 16, 2020 on the *CCGS Sir John Franklin*. Species with no weights (released alive or too small) are not included in this table.

Tow	5	6	7	8	9	10	11	12	13	14	15
Event Number	**10**	**11**	**15**	**22**	**25**	**26**	**33**	**36**	**37**	**42**	**43**
Bering Sea Nettle											0.16
Chinook Salmon						0.43					
Chum Salmon			8.22			0.52	24.88	1.38		0.83	1.24
Coho Salmon							3.90	0.79	2.54	4.53	5.26
Dover Sole		0.08									
Euphausiids		3.86									
Lions Mane										0.71	
Moon Jellyfish		7.64	332.46							0.78	
Northern Rock Sole											
Ocean Sunfish			4.85								
Opalescent Inshore Squid			746.00								
Pacific Herring			0.09	2.18	1.27	0.19	0.81				
Pacific Saury								0.15			
Pink Salmon			0.70	1.22	0.44	0.64	0.13			0.57	1.32
Ragfish									0.07		
Rockfishes		0.02									
Sablefish							4.45	1.35	0.43		
Salps											
Sockeye Salmon										3.11	2.00
Spectacular Corolla		0.08									
Water Jellyfish	2.79	4.46					0.34	0.52	10.79	3.22	1.54
TOTAL	2.79	16.14	1092.32	3.40	1.71	1.78	34.51	4.19	13.83	13.75	11.52

Tow	16	17	18	19	20	21	22	23	24	25	26
Event Number	**47**	**50**	**55**	**56**	**59**	**60**	**65**	**66**	**69**	**70**	**73**
Bering Sea Nettle											
Chinook Salmon											
Chum Salmon	0.19	3.10	113.86	162.86	1.48	65.77					
Coho Salmon	2.17	1.82	12.79		0.44	1.64					
Dover Sole											
Euphausiids											
Lions Mane											
Moon Jellyfish					5.98			1.64	19.50	9.36	69.39
Northern Rock Sole					0.06						
Ocean Sunfish											
Opalescent Inshore Squid						7.83	0.25		0.06	17.50	13.20
Pacific Herring			0.90	13.98	0.26	2.51	0.11				
Pacific Saury		0.05									
Pink Salmon	1.50	2.18	0.38	0.18		0.47	0.30	3.49	0.16	0.16	0.10
Ragfish											
Rockfishes											
Sablefish	0.14										
Salps								0.08	0.10		
Sockeye Salmon	1.59	1.34				0.08		0.00			0.14
Spectacular Corolla											
Water Jellyfish	2.51	1.06					0.23				
TOTAL	8.10	9.55	127.93	177.02	8.22	78.30	0.89	5.21	19.82	27.02	82.83