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Preliminary Findings of the International Year of the Salmon Pan-Pacific Winter High Seas Expedition Onboard the F/V *Northwest Explorer* during April 3–17, 2022

by

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Abstract

The objective of the 2022 International Year of the Salmon Pan-Pacific Winter High Seas Expedition was to demonstrate the utility of an international pan-Pacific winter ecosystem survey to understand how increasingly extreme climate variability in the North Pacific Ocean and the associated changes in the physical environment influence the abundance, distribution, migration, and growth of Pacific salmon and surrounding species. The 2022 Expedition included five vessels that were deployed during January–April of 2022 into the North Pacific Ocean. The F/V *Northwest Explorer* covered the central North Pacific Ocean, and sampling occurred within an area of approximately 240,000 km^2, between April 3 and April 17 (AK Date), 2022. An international research team of six scientists from the US and Canada participated on the F/V *Northwest Explorer* and the Chief Scientist during the survey was Jim Murphy. Funding for this portion of the 2022 Expedition was provided by the North Pacific Research Board and the government of the United States. In total, 633 salmon were caught during surface trawl operations during the survey, including: 388 chum salmon, 3 coho salmon, 222 sockeye salmon, 18 pink, and 2 Chinook salmon. This report provides an overview of the samples collected and some preliminary results from the survey.

Keywords: Pacific salmon, North Pacific Ocean, international collaboration, winter salmon ecology

Introduction

The 2022 International Year of the Salmon Pan-Pacific Winter High Seas Expedition was an international collaborative effort between Canada, Japan, the Republic of Korea, the Russian Federation and the United States of America. The 2022 Expedition is the largest ever multinational survey to study salmon in the North Pacific Ocean during the winter and builds on previous International Year of the Salmon (IYS) Expeditions into the Gulf of Alaska in 2019 and 2020 (Pakhomov et al. 2019, Somov et al. 2020). With changing climate and associated anomalous events in the North Pacific Ocean progressively exposing salmon to conditions outside normal climate cycles, these expeditions offer important insights which can help further our understanding of changing ocean conditions and their effects on salmon in the open ocean.

To date, significant resources have been invested in attempts to better understand and manage the freshwater phase of the salmon life cycle to maximize salmon productivity. Despite these research efforts, we still struggle to predict and understand inter-annual fluctuations in salmon productivity. We need to understand the physical, chemical and biological drivers of salmon growth and survival in the ocean to fully address current management challenges. The IYS 2019, 2020 and 2022 Expeditions have begun to address this gap in knowledge regarding the ocean phase of the salmon life cycle and have offered excellent opportunities for collaborating multilaterally with salmon-producing countries across the North Pacific to build knowledge that can improve our ability to manage and sustain salmon into the future.

The 2022 Expedition was carried out between January and April of 2022 and involved five research vessels and covered the Central and Eastern North Pacific Ocean. The overall objective of the 2022 Expedition is to demonstrate the utility of an international pan-Pacific winter ecosystem survey to understand how increasingly extreme climate variability in the North Pacific Ocean and the associated changes in the physical environment influence the abundance, distribution, migration, and growth of Pacific salmon and surrounding species. The specific sub-objectives of the 2022 Expedition were as follows:

1. Determine species and stock-specific ocean distributions and relative abundances, and condition of juvenile, immature/mature Pacific salmon within the study area, and factors/mechanisms controlling them;
2. Document the spatial and temporal variation in physical and biological oceanographic conditions;
3. Document the distribution, condition, and standing stocks of zooplankton, and nekton that serve as the prey base for Pacific salmon and associated marine fishes;
4. Demonstrate the ability to effectively collaborate across the five NPAFC parties and our partners to conduct integrated ecosystem research that will support the sustainable management of salmon in a rapidly changing North Pacific Ocean.

This report summarizes the preliminary results of the 2022 IYS Expedition during the F/V *Northwest Explorer* survey. A more detailed report from each vessel will be compiled into an NPAFC Technical Report and published before the end of 2022. All participants agreed that all data collected as part of the 2022 IYS Expedition will be made publicly available.

Materials and Methods

The key methodological approach was to conduct an international survey of salmon and the epipelagic ecosystems in the offshore regions of the North Pacific Ocean (NPO) by deploying survey vessels at key times and areas to provide a seasonal picture of the distribution, migration and ecology of salmon and associated species in the high seas. The survey design included concurrent surveys between January–April 2022 within the Central and Eastern North Pacific Ocean (Figure 1).

An ecosystem survey utilizing a surface trawl to capture overwintering salmon was conducted in the central NPO of the IYS 2022 Pan-Pacific Winter High Seas Expedition survey area (Figure 1) from April 3–17 (AK date) on board the F/V *Northwest Explorer*. This vessel covered approximately 240,000 km^2 of the overall survey area. This portion of the 2022 IYS Expedition was supported with funding support by the North Pacific Research Board and the government of the United States. Four scientists from US and two from Canada participated onboard the F/V *Northwest Explorer* (Table 1).

The cruise plan is outlined in NPAFC Doc. 2051 and detailed sampling protocols are outlined in NPAFC Doc. 1995. The survey onboard the F/V *Northwest Explorer* was conducted during a single leg starting and ending in Dutch Harbor, Alaska. The survey area was sampled from east to west along six primary transects with four to five stations spaced approximately 60nm apart along each transect (Figure 1). The stations sampled by the F/V *Northwest Explorer* were originally planned for the R/V *TINRO*, but due to complications associated with gaining permission to conduct research in the US waters, the US EEZ was not sampled by the R/V *TINRO*. All operations were conducted during daylight hours due to the limited number of scientists that the F/V *Northwest Explorer* could carry (n = 6). Two primary stations were planned for each sampling day and mid-water trawls were conducted as time and weather conditions permitted. A total of 22 stations with 22 surface trawl sets, 22 CTD casts, 18 bongo tows, and three mid-water trawl sets for micronekton were completed during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

The typical survey stations conducted during both daytime and nighttime consisted of:

1. CTD casts to 250 m depth
2. Plankton net(s): vertical Bongo net to 250 m depth
3. Surface trawl towed at approximately 4 knots for one hour in the top 38 m of the water column
4. Hydroacoustic measurements throughout the full survey area
5. Mid-water trawl sets as time and weather conditions permit

1. CTD Deployment and Processing

A CTD (SeaBird Instruments SBE19+) cast was completed at each station and all data were logged internally and downloaded to a laptop after each cast. The CTD sampled the water column to a depth of 250 m at each station or the best estimation of the depth based the wire angle. The CTD was deployed with a spectra line marked at 250m to with a crane winch and a maximum line speed of approximately 0.6 m/s. Instruments on the CTD included: temperature and conductivity (TC) sensors, a Photosynthetically Active Radiation (PAR) sensor (Bioshpherical/Licor), a chlorophyll-a fluorometer (WET Labs ECO-AFL/FL), and a turbidity meter (WET Labs, ECO-NTU). Unfortunately, the CTD was not configured correctly and the temperature and salinity data collected during the survey were not considered to be reliable. The tubbing used to keep the salinity sensor from drying out during storage was left on the CTD during deployment. Sensors not associated with the TC sensor (PAR, turbidity, and chl-a fluorescence) are unlikely to be impacted by this configuration error. The spatial distribution of SST during the survey was based on modeled satellite data from Copernicus Marine Services (https://marine.copernicus.eu/) and SST estimates at each station was based on the NOAA OISSTv2 high resolution dataset (Reynolds et al. 2007) provided by the NOAA PSL, Boulder, Colorado, USA, from their website at https://psl.noaa.gov.

2. Plankton Net Deployment and Processing

A vertical 60-cm diameter bongo net was towed from approximately 250 m to the surface to sample zooplankton and ichthyoplankton during the survey. The tow depth of the bongo net was approximated by the line out and the line angle. The retrieval rate of the bongo net was approximately 0.6 m/s. The bongo net included two 250 micron mesh nets. Samples from the first bongo net was preserved in 5% buffered formalin, while samples from the second net were size-fractionated to 4000 µm, 2000 µm, 1000 µm, 500 µm and 250 µm for stable isotope and energy density analysis.

3. Surface Trawl Deployment and Processing

Surface trawl operations were conducted with a Cantrawl 400/601 rope trawl (Cantrawl Pacific Ltd.), 5m alloy trawl doors from Nor'eastern Trawl Systems, and 55m wire rope bridals. The main warp length was set to 200m for most of the survey, but increased to 256m during the survey to increase stability of the doors during higher sea states. Two A4 and one A5 Polyform buoys were added to the wingtips and one A4 Polyform buoy was added to the center of the headrope to help keep the trawl headrope near the surface during surface trawl tows. The trawl was configured to sample in the deeper habitats of the central NPO by adding tom weights (300 lbs) to the wingtips of the foot rope and by increasing the chain setbacks (0, 10' and 15' for the top, middle, and bottom bridals, respectively) than is typically used to sample shallow habitats for juvenile salmon in the northern Bering Sea. Trawl dimensions were monitored during each tow with a Simrad FS70 net sounder except for stations where seas states were too large to effectively deploy the net sounder without tangling with the surface buoys. All surface trawl tows were one hour in. Catch-per-unit-effort (CPUE) was estimated from the catch of each species and the area swept by the trawl (km^2), which was calculated from the horizontal opening of the net sonar (average opening used during stations sampled without a net sonar) and the distance sampled from GPS positions at the start and end of each trawl tow. The survey area was estimated to be 240,000 km^2 by drawing a simple polygon around station coordinates in ArcMap. Although estimates of the survey area should be calculated from the survey design, this was assumed to provide a reasonable approximation to the true survey area as the exact details of the survey design were not available.

All biological data were recorded in an electronic catch logging system developed by the Alaska Fisheries Science Center, known as the Catch Logger for Acoustic and Midwater Surveys (CLAMS). Trawl catches were sorted by species and all salmon and up to 50 individuals from non-salmon species were processed for biological data at each station.

A specimen number (barcode number) was assigned to all biological samples that was unique to an individual fish. Biological data were not collected from salmon that were identified as a 'washdown' samples from the previous trawl set, but 'washdown' catches were added to the catch record from the previous trawl set. Up to four scales were collected from each salmon that had scale samples that could reasonably be collected (no scales were collected from pink salmon). Scales were placed onto 40 position gum cards and scales for up to 10 fish were included on each card. The scale card, position (1–10), and body region (preferred and non-preferred regions) of the scale collection were electronically entered into CLAMS. Duplicate caudal fin clips were placed onto Whatman cards from all salmon captured during the survey, except for two 'washdown' salmon and due to a few minor sample processing errors. Information on the survey, station, species, and barcode numbers were added to each Whatman card to track individual specimen data. Heads or whole bodies of salmon were collected from all salmon captured during the survey with the exception of 'washdown' salmon. Duplicate pre-dorsal muscle tissue samples, as well as stomachs, livers, and gonads were also collected from up to 30 individual salmon by species at each station (the sample size was reduced to 20 during the survey).

A Fish Fatmeter (DISTELL FFM-692, with a sensor head width of 10cm) was used to estimate percent lipid in the muscle tissue of salmon. Fatmeter measurements were not planned for the survey, but measurements were collected during the second half of the survey (stations 11-22) once we knew we had a Fatmeter onboard the survey. Fatmeter measurements were typically collected from all salmon at stations 11–22, except for one station when the battery failed and two stations where there was a misunderstanding of collection protocols. Three independent measurements of muscle lipid were collected on one side of large salmon (pre-dorsal, dorsal, and post-dorsal measurements). Only one or two measurements were possible on smaller salmon to ensure lipid measurements were collected from non-overlapping regions of the body. Internal Fatmeter calibrations were provided by the manufacture for sockeye, coho, and Chinook salmon and lipid estimates for each of these species were based on their species-specific calibrations. Calibrations were not available for chum salmon and therefore sockeye salmon calibrations were used to estimate percent lipid in chum salmon. Significant difference in estimates of percent lipid were not observed when applying species-specific calibrations and therefore we believe the sockeye salmon calibrations should provide a reasonable approximation for lipid levels in chum salmon. Station averages were estimated for trawl events where fatmeter values were collected from at least three fish, with the exception of Chinook salmon where where we allowed a minimum sample size of two fish. Exponential models were fitted to the average weight and average percent lipid for chum and sockeye salmon at each station (the two species that were consistently captured during the survey) to describe energy allocation patterns of salmon.

4. Hydroacoustic Measurements

Raw acoustic data from the ship's SIMRAD ES80 38 kHz system were recorded during the survey and all data were uploaded to NPAFC at the end of the survey.

5. Midwater Trawl Deployment and Processing

All midwater trawl deployments used the same trawl configuration as surface trawl deployments, but polyform buoys were not added to the headrope. All midwater deployments were 0.25 hr in duration and the ship's main trawl warp was adjusted to sample midwater acoustic layers. Station, catch, and specimen data were recorded in CLAMS using the same protocols as surface trawl operations. Voucher samples of rare species were frozen whole for species verification and museum collections at the University of Alaska, Fairbanks.

6. Sample Data Entry and Organization

All data collected on the 2022 IYS Expedition will be made publicly available on the shortest feasible timescale.

Preliminary Findings

A total of 22 stations were sampled during the 2022 IYS Expedition survey aboard the F/V *Northwest Explorer* (Table 2, Figure 1). All station data and time values were based on UTC values. A CTD cast and a surface trawl were completed at each station, but bongo tows were not completed at four stations due to inclement weather. Three midwater tows were conducted to sample acoustic layers. The average satellite derived SST was 4.86 °C and the average upper 10 m chl-a fluorescence was 0.87 mg/m^3 during the survey (Table 3, Figure 2).

Average surface trawl dimensions were 34 m vertical and 52 m horizontal with an average footrope depth of approximately 36 m (Table 4). The depth of the net sounder during surface tows is assumed to be approximately 2 m based on previous measurements for this trawl. All surface trawl tows were one hour in duration. Average distance trawled during surface trawl operations was 7.6 $km^{2,}$ the average tow speed was 4.11 knots, and the average effort was 0.39 km^2.

Average mid-water trawl dimension were 23 m vertical and 72 m horizontal (Table 5). Headrope depth during midwater tow ranged from 235 m to 402 m, with an average distance trawled of 1.55 km^2, an average speed of 3.34 knots and an average effort of 0.11 km^2.

The catch and catch rates of salmon by species and station during the survey are shown in Table 6 and Figures 3–5). A total of 633 salmon were caught during surface trawl operations, including: 388 chum salmon (*Oncorhynchus keta*), 222 sockeye salmon (*O. nerka*), 18 pink salmon (*O. gorbuscha*), three coho salmon (*O. kisutch*), and two Chinook salmon (*O. tshawytscha*). Surface trawl effort was relatively stable during the survey and therefore catch rates (n/km^2) of salmon varied with the catch at each station. Chum salmon had the highest average catch rate (43.58), followed by sockeye salmon (25.48), pink salmon (1.98), coho salmon (0.32), and Chinook salmon (0.2). The abundance of salmon within the survey area (within the depths sampled by the surface trawl, upper 36 m) was estimated by expanding the catch rates of salmon by the approximate survey area of 240,000 km^2. Survey abundance estimates for each species of salmon were: 10,460 thousand chum salmon, 6,116 thousand sockeye salmon, 476 thousand pink salmon, 76 thousand coho salmon, and 49 thousand Chinook salmon.

The most abundant non-salmon fish species were threespine stickleback (*Gasterosteus aculeatus*) (n = 5,737). Although threespine stickleback were caught at multiple stations, their largest catches occurred at stations 2, 3, and 16. The most abundant species of squid was minimal armhook squid (*Berryteuthis anonychus or Okutani anonycha*) (n = 3,449). Nearly all minimal armhook squid were captured at station 22. Myctophid fish species were the most abundant fish species group captured during midwater tows, with a total catch of 955 northern lampfish (*Stenobrachius leucopsarus*), 183 northern flashlightfish (*Protomyctophum thompsoni*), 176 California headlightfish (*Diaphus theta*), and 59 blue lanternfish (*Tarletonbeania crenularis*) (Table 8).

Individual lengths and weights were collected from a total of 626 salmon and a summary of the length frequency distribution and length-weight relationships for chum and sockeye are shown in Figures 6–9. Biological samples were collected from a total of 624 salmon and a summary of these collections are included in Table 9.

Fatmeter values of lipid in the pre-dorsal muscle tissue of salmon were used to evaluate the condition of salmon and add insight into how salmon were allocating energy to storage within the survey area (Figure 10–12). Maturation, stock, age, and location all contribute to the variation in lipid levels at the individual fish level (Figures 10); however, the average weight of chum and sockeye salmon at a station provided a reasonably good predictor of the average pre-dorsal muscle lipid (Figure 11). Exponential models explained 94% and 82% of the station level variance in lipid levels of chum and sockeye salmon, respectively (Figure 11). Chinook salmon had the highest percent lipid of all salmon species, and sockeye salmon had higher lipid than chum salmon at a given weight. The maturation state of salmon may be an important contributor to the variation of lipid at the individual fish level as average percent lipid by station was relatively consistent with average weight. The maturation state of salmon may also be an important component in the relationship between average weight and average lipid as the proportion of maturing fish increases with size and age. An improved understanding of how the lipid content in salmon varies by species, region, time, weight, maturation, stock, and age will improve our understanding of how salmon are responding to changes in ocean conditions.

Acknowledgements

We wish to thank the captain and crew of the F/V *Northwest Explorer* for their exceptional support of the survey and their willingness to complete the survey on such such short notice. We would also like to thank Kevin Siwikie and Skip Mckinnell for their assistance with satelitte SST data.

Tables

Table 1. Name and affiliation of scientific crew members during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*. AFSC—Alaska Fisheries Science Center, Auke Bay Laboratories, Juneau, AK; NPAFC—North Pacific Anadromous Fish Commission, Vancouver, BC; UBC—University of British Columbia, Vancouver, BC; NPRB—North Pacific Research Board, Anchorage, AK.

Name (Last, First)	Title	Date Embark	Date Disembark	Affiliation
Murphy, Jim	Chief Scientist	4/1/2022	4/20/2022	AFSC
Dimond, Andrew	Fish Biologist	4/1/2022	4/20/2022	AFSC
Sheridan, Tommy	Commissioner	4/1/2022	4/20/2022	NPAFC
Price, Elliott	Zooplankton Ecologist	4/1/2022	4/20/2022	UBC
Lerner, Jake	Fish Biologist	4/1/2022	4/20/2022	UBC
Baker, Matt	Science Director	4/1/2022	4/9/2022	NPRB

Table 2. Station date, location, and sampling events during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*. Station information is based on the CTD date, time, and location.

Station	Date (UTC)	Time (UTC)	Latitude	Longitude	CTD	Bongo	Surface Trawl	Midwater Trawl
1	4/3/2022	20:44	53.60	-163.06	Yes	Yes	Yes	No
2	4/4/2022	16:11	52.67	-163.16	Yes	Yes	Yes	No
3	4/5/2022	0:49	51.70	-163.14	Yes	Yes	Yes	No
4	4/5/2022	16:05	50.67	-163.05	Yes	Yes	Yes	No
5	4/6/2022	0:44	49.65	-163.04	Yes	Yes	Yes	No
6	4/6/2022	16:04	49.16	-165.14	Yes	Yes	Yes	Yes
7	4/7/2022	2:50	50.14	-165.18	Yes	Yes	Yes	No
8	4/7/2022	16:03	51.16	-165.22	Yes	Yes	Yes	No
9	4/8/2022	0:10	52.17	-165.23	Yes	Yes	Yes	No
10	4/8/2022	16:02	53.31	-165.32	Yes	Yes	Yes	Yes
11	4/11/2022	16:05	51.90	-167.29	Yes	Yes	Yes	No
12	4/12/2022	1:35	50.85	-167.36	Yes	Yes	Yes	No
13	4/12/2022	16:05	49.90	-167.32	Yes	Yes	Yes	Yes
14	4/13/2022	3:16	48.82	-167.29	Yes	Yes	Yes	No
15	4/13/2022	16:04	48.48	-169.43	Yes	Yes	Yes	No
16	4/14/2022	0:09	49.48	-169.45	Yes	Yes	Yes	No
17	4/14/2022	16:40	49.19	-171.60	Yes	No	Yes	No
18	4/15/2022	18:36	48.68	-173.67	Yes	No	Yes	No
19	4/16/2022	16:39	50.21	-171.62	Yes	Yes	Yes	No
20	4/17/2022	1:13	51.21	-171.52	Yes	Yes	Yes	No
21	4/17/2022	16:35	50.46	-169.52	Yes	No	Yes	No
22	4/18/2022	1:32	51.51	-169.54	Yes	No	Yes	No

Table 3. Sea surface temperature (SST) from satelitte data and average upper 10m chl-a fluoresence from a CTD (SBE-19+) during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*. SST values were estimated from NOAA's Optimally Interpolated Sea Surface Temperature (OISSTv2) dataset (Reynolds et al. 2007).

Station	OISST (°C)	Fluorescence (mg/m^3)
1	3.78	0.43
2	3.96	0.82
3	4.60	0.61
4	5.22	0.86
5	5.76	0.80
6	5.75	0.99
7	5.08	0.77
8	4.51	0.69
9	3.87	0.75
10	3.68	0.68
11	3.92	0.81
12	4.67	0.66
13	5.80	1.18
14	6.36	1.03
15	6.07	0.82
16	5.79	0.76
17	5.44	0.70
18	5.09	0.48
19	4.56	0.85
20	4.33	0.68
21	4.69	0.86
22	4.32	2.94
Average	4.86	0.87

Table 4. Surface trawl date, time, location (north latitude and west longitude in decimal degrees), duration, speed, effort, net dimensions, and trawl warp length during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

Station	Trawl Date (UTC)	Trawl Time (UTC)	Trawl Start Latitude (DD)	Trawl Start Longitude (DD)	Trawl End Latitude (DD)	Trawl End Longitude (DD)	Trawl Duration (hr)	Distance Trawled (km)	Average Speed (knots)	Average Effort (km^2)	Vertical Net Spread (m)	Horizontal Net Spread (m)	Assumed Headrope Depth (m)	Trawl Warp (m)
1	4/3/2022	00:21	53.62	-162.97	53.69	-163.00	1	7.38	3.99	0.34	31.77	46.64	2.00	200
2	4/4/2022	18:31	52.66	-163.13	52.60	-163.06	1	8.53	4.60	0.43	32.34	50.25	2.00	200
3	4/5/2022	02:56	51.68	-163.12	51.63	-163.05	1	7.31	3.95	0.37	32.90	50.96	2.00	200
4	4/5/2022	18:03	50.63	-163.04	50.56	-163.02	1	8.01	4.32	0.41	32.47	50.79	2.00	200
5	4/6/2022	03:04	49.60	-163.03	49.53	-163.00	1	8.20	4.43	0.42	31.98	50.95	2.00	200
6	4/6/2022	18:13	49.16	-165.14	49.23	-165.12	1	6.90	3.73	0.35	33.58	51.15	2.00	200
7	4/7/2022	04:44	50.16	-165.18	50.22	-165.19	1	7.52	4.06	0.38	33.80	50.93	2.00	200
8	4/7/2022	17:59	51.18	-165.23	51.25	-165.25	1	7.67	4.14	0.39	33.30	50.79	2.00	200
9	4/8/2022	02:02	52.19	-165.23	52.25	-165.26	1	6.97	3.76	0.36	34.55	51.05	2.00	200
10	4/8/2022	17:55	53.32	-165.33	53.37	-165.37	1	6.72	3.63	0.35	36.19	51.67	2.00	200
11	4/11/2022	18:18	51.89	-167.31	51.82	-167.32	1	7.15	3.86	0.37	38.74	51.49	2.00	200
12	4/12/2022	03:24	50.83	-167.36	50.77	-167.32	1	7.15	3.86	0.36	36.08	50.80	2.00	200
13	4/12/2022	18:26	49.90	-167.32	49.84	-167.30	1	6.69	3.61	0.34	38.06	50.28	2.00	200
14	4/13/2022	05:12	48.81	-167.31	48.79	-167.39	1	6.78	3.66	0.36	37.54	52.51	2.00	200
15	4/13/2022	18:02	48.50	-169.43	48.56	-169.46	1	7.72	4.17	0.42	35.27	54.99	2.00	225
16	4/14/2022	02:23	49.48	-169.48	49.47	-169.58	1	7.61	4.11	0.41	34.36	53.90	2.00	242
17	4/14/2022	18:38	49.17	-171.57	49.11	-171.51	1	7.97	4.30	0.41			2.00	256
18	4/15/2022	20:46	48.69	-173.65	48.75	-173.57	1	8.50	4.59	0.44			2.00	256
19	4/16/2022	19:04	50.23	-171.62	50.31	-171.62	1	8.71	4.70	0.45			2.00	256
20	4/17/2022	03:28	51.20	-171.48	51.19	-171.37	1	7.78	4.20	0.43	31.40	55.31	2.00	256
21	4/17/2022	18:31	50.48	-169.49	50.56	-169.47	1	8.60	4.64	0.44			2.00	256
22	4/18/2022	03:13	51.53	-169.49	51.57	-169.40	1	7.71	4.16	0.42	32.52	54.07	2.00	256
Average								7.62	4.11	0.39	34.27	51.59	2.00	218

Table 5. Midwater trawl date, time, location (north latitude and west longitude in decimal degrees), duration, average speed, average net dimensions, average headrope depth, and average trawl warp length during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

Station	Trawl Date (UTC)	Trawl Time (UTC)	Trawl Start Lat. (DD)	Trawl Start Lon. (DD)	Trawl End Lat. (DD)	Trawl End Lon. (DD)	Trawl Duration (hr)	Distance Trawled (km)	Average Speed (knots)	Effort (km^2)	Vertical Net Spread (m)	Horizontal Net Spread (m)	Headrope Depth (m)	Trawl Warp (m)
6	4/6/2022	20:43	49.31	-165.17	49.32	-165.17	0.25	1.54	3.32	0.11	25.78	74.44	402	1188
10	4/482022	18:47	53.32	-165.33	53.42	-165.37	0.25	1.63	3.52	0.11	20.70	70.20	235	817
13	4/12/2022	20:40	49.73	-167.26	49.72	-167.26	0.25	1.47	3.18	0.11	21.60	72.10	288	841
Average								1.55	3.34	0.11	22.69	72.25	308	949

Table 6. Total surface trawl catch in numbers and weight (kg) by species during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

Species Group	Common name	Scientific name	Total Catch (n)	Total Catch (kg)
Salmon	Chum salmon	*Oncorhynchus keta*	388	389.75
	Sockeye salmon	*O. nerka*	222	209.10
	Pink salmon	*O. gorbuscha*	18	9.43
	Coho salmon	*O. kisutch*	3	1.00
	Chinook salmon	*O. tshawytscha*	2	3.01
	Sub Total		633	612.29
Non-salmon	Threespine stickleback	*Gasterosteus aculeatus*	5,737	16.15
	Capelin	*Mallotus villosus*	9	0.12
	North Pacific Daggertooth	*Anotopterus nikparini*	6	0.82
	Black rockfish	*Sebastes melanops*	2	4.39
	Brokenline lampfish	*Lampanyctus jordani*	1	0.02
	Sub Total		5,755	21.50
Squid	Minimal armhook squid	*Okutania anonycha*	3,449	67.50
	Shortarm gonate squid	*Gonatus kamtschaticus*	5	0.55
	Sub Total		3,454	68.05
Jellyfish	Water jellyfish	*Aequorea sp.*	566	86.15
	Northern sea nettle	*Chrysaora melanaster*	103	17.44
	Fried egg jellyfish	*Phacellophora camtchatica*	73	23.94
	Moon jellyfish	*Aurelia sp.*	19	3.33
	Salp unidentified	*Salpidea*	3	0.05
	Sub Total		765	130.90

Table 7. Surface trawl catch and catch-per-unit-effort (CPUE) of salmon in numbers by species during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

	Catch					CPUE (n/km^2)				
Station	Pink Salmon	Chum Salmon	Sockeye Salmon	Coho Salmon	Chinook Salmon	Pink Salmon	Chum Salmon	Sockeye Salmon	Coho Salmon	Chinook Salmon
1	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
2	0	8	17	0	0	0.00	18.67	39.68	0.00	0.00
3	0	3	8	0	0	0.00	8.06	21.48	0.00	0.00
4	0	1	2	0	0	0.00	2.46	4.92	0.00	0.00
5	0	23	8	0	0	0.00	55.06	19.15	0.00	0.00
6	2	32	11	0	0	5.66	90.62	31.15	0.00	0.00
7	0	3	10	0	0	0.00	7.83	26.10	0.00	0.00
8	0	3	8	0	0	0.00	7.70	20.54	0.00	0.00
9	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
10	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
11	0	1	8	0	0	0.00	2.72	21.74	0.00	0.00
12	0	11	12	0	0	0.00	30.28	33.04	0.00	0.00
13	1	26	8	0	0	2.97	77.31	23.79	0.00	0.00
14	0	8	28	0	0	0.00	22.47	78.66	0.00	0.00
15	0	25	12	0	0	0.00	58.85	28.25	0.00	0.00
16	3	36	10	1	0	7.31	87.75	24.37	2.44	0.00
17	2	55	25	0	0	4.87	133.80	60.82	0.00	0.00
18	8	79	9	0	0	18.26	180.28	20.54	0.00	0.00
19	1	5	5	1	2	2.23	11.13	11.13	2.23	4.45
20	1	19	36	1	0	2.33	44.18	83.70	2.33	0.00
21	0	2	3	0	0	0.00	4.51	6.76	0.00	0.00
22	0	48	2	0	0	0.00	115.19	4.80	0.00	0.00
Total	18	388	222	3	2					
Average						1.98	43.58	25.48	0.32	0.20

Table 8. Total midwater trawl catch in numbers and weight (kg) by species during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

Species Group	Common name	Scientific name	Total Catch (n)	Total Catch (kg)
Myctophid	Northern lampfish	*Stenobrachius leucopsarus*	955	3.549
	Northern flashlightfish	*Protomyctophum thompsoni*	183	0.224
	California headlightfish	*Diaphus theta*	176	1.399
	Blue lanternfish	*Tarletonbeania crenularis*	59	0.147
	Lanternfish unident.	*Myctophidae*	7	0.004
	Sub Total		1,380	5.323
Other Fish	Pacific viperfish	*Chauliodus macouni*	17	0.082
	Walleye pollock	*Gadus chalcogrammus*	6	6.400
	Slender barracudina	*Lestidiops ringens*	2	0.031
	Lowcrest hatchetfish	*Argropelecus sladeni*	1	0.004
	White barracudina	*Arctozenus risso*	1	0.027
	Larval Rex sole	*Glyptocephalus zachiris*	1	0.002
	Sub Total		28	6.546
Squid	Fiery armhook squid	*Gonatus pyros*	1	0.027
	Gonatus kamtschaticus	*Gonatus kamtschaticus*	1	0.043
	Sub Total		2	0.070
Jellyfish	Unidentified salp.	*Salpidea*	46	0.560
	Helmet jellyfish	*Perhiphylla sp.*	36	0.167
	Water jellyfish	*Aequorea sp.*	8	1.012
	Northern sea nettle	*Chrysaora melanaster*	6	1.766
	Fried egg jellyfish	*Phacellophora camtchatica*	5	1.166
	Sub Total		101	4.671

Table 9. Salmon specimens collected during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

Station	Pink salmon	Chum salmon	Sockeye salmon	Coho salmon	Chinook salmon
Caudal fin clips	18	382	219	3	2
Scales	0	382	176	3	2
Whole fish	0	3	50	1	0
Heads	18	380	171	2	2
Muscle tissue (AFSC)	18	257	154	2	2
Muscle tissue (UBC)	18	257	154	2	2
Stomachs	16	253	151	2	2
Livers	18	257	154	2	2
Gonads	18	256	148	2	2
Fatmeter	16	264	132	3	2

Figures

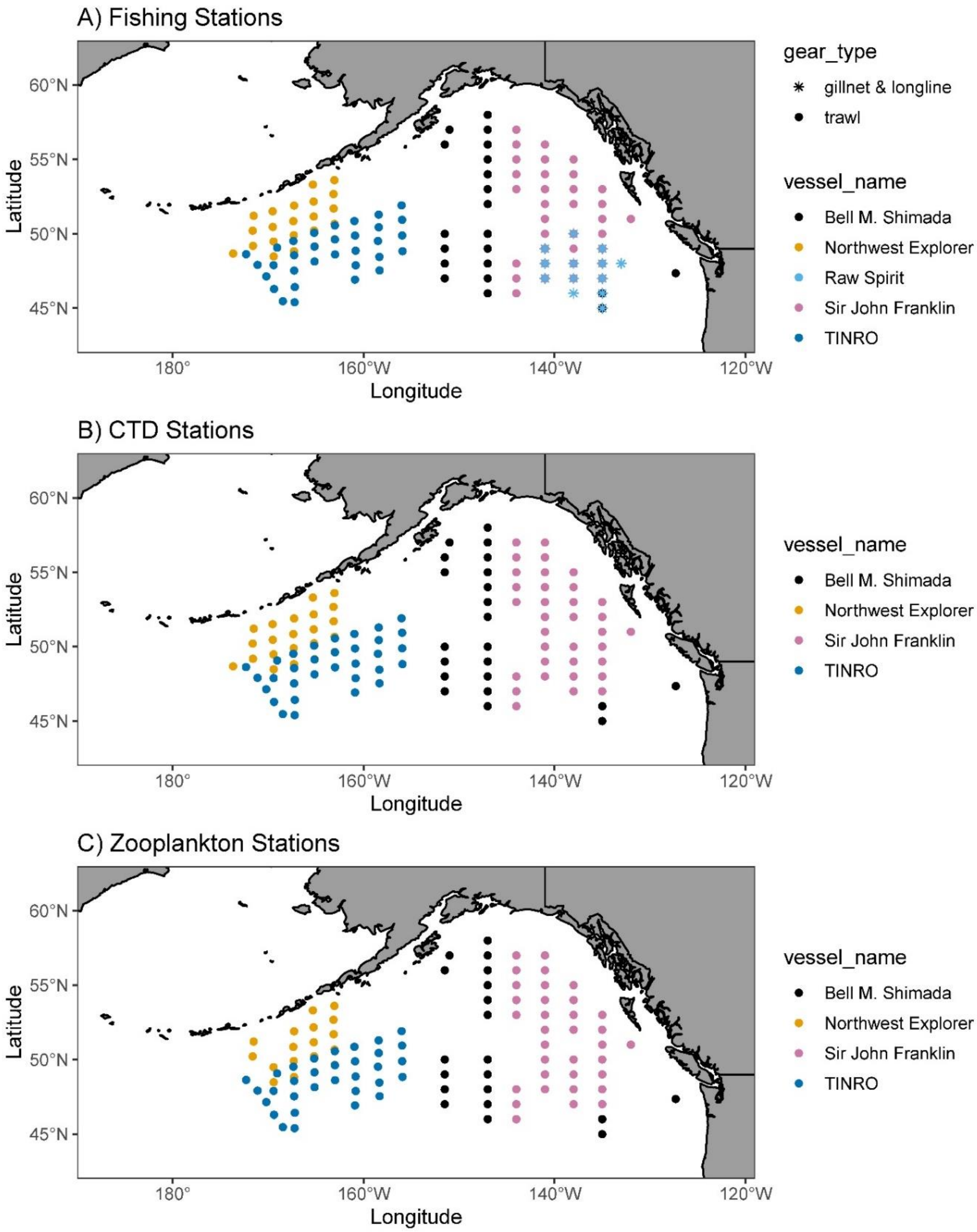

Figure 1. Fishing (surface trawl, gillnet, and longline), CTD, and zooplankton (bongo) stations during the 2022 International Year of the Salmon Expeditions.

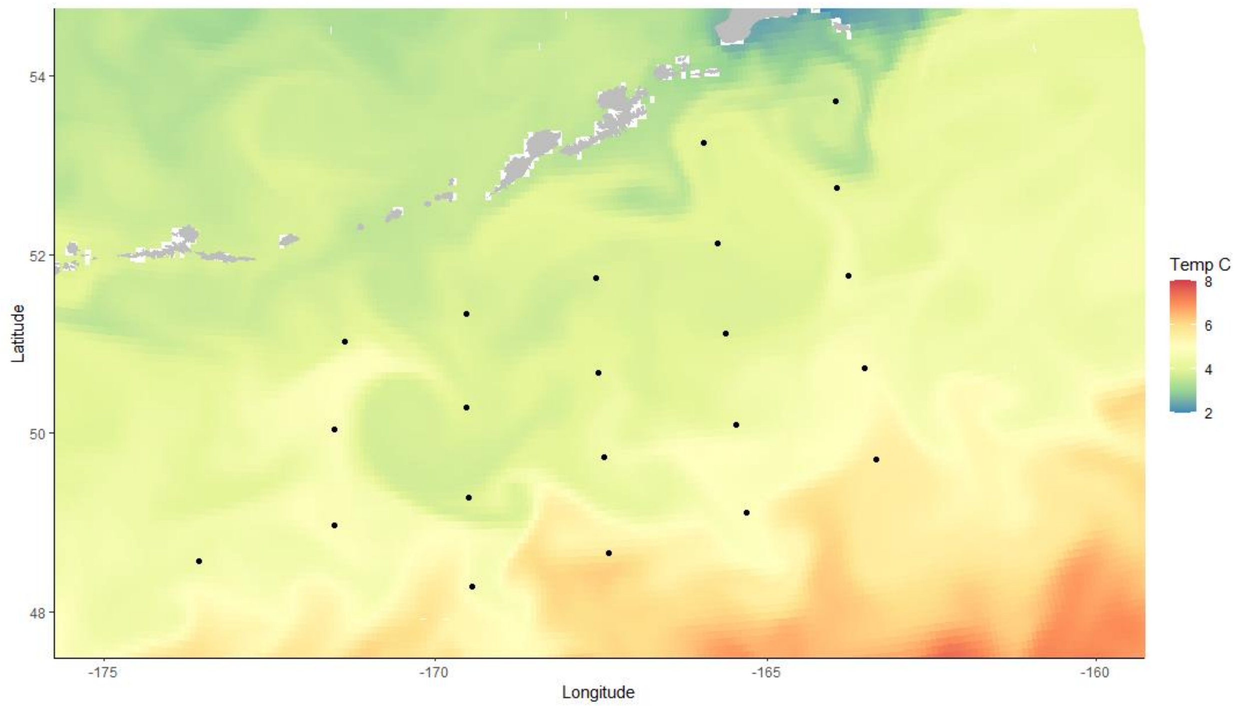

Figure 2. Sea surface temperatures (April 18th, 2022) and station locations sampled during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*. Sea surface temperature data provided by Copernicus Marine Services (available at https://marine.copernicus.eu/).

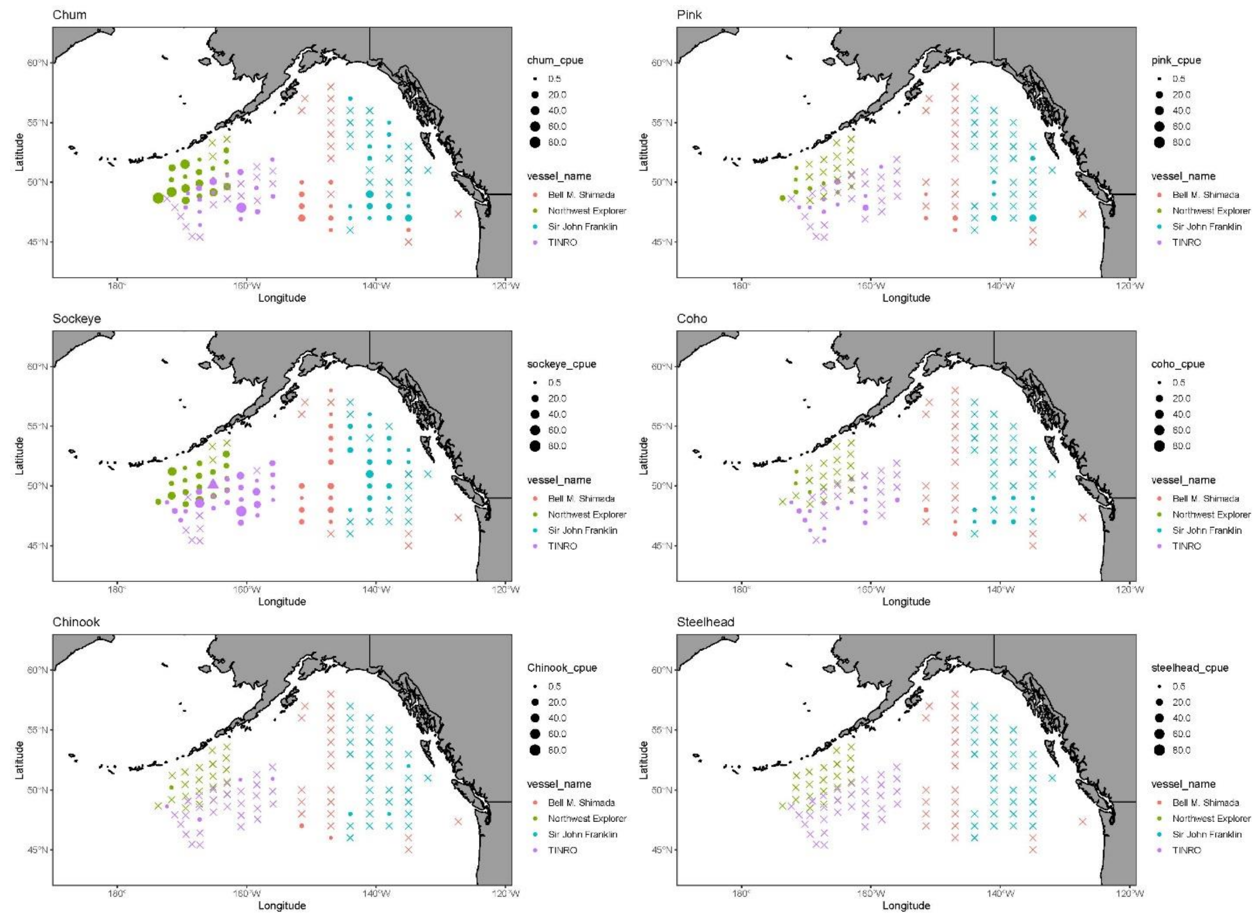

Figure 3. Surface trawl catch rates of salmon during the 2022 International Year of the Salmon Expeditions.

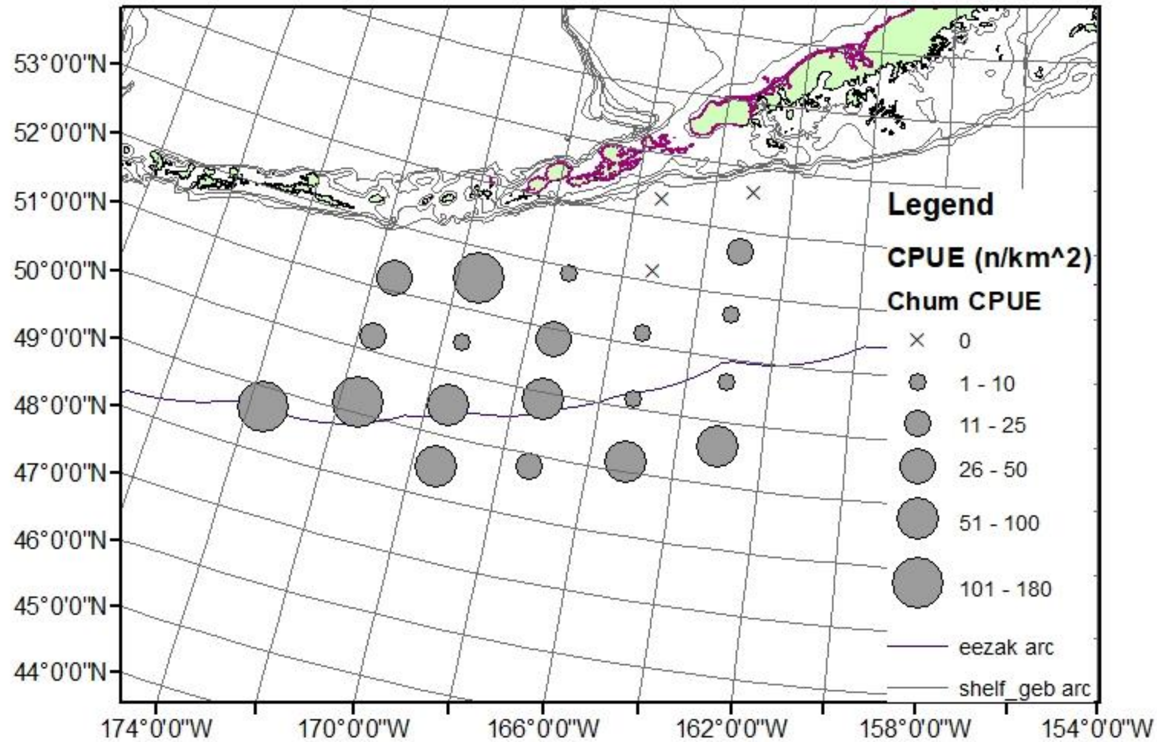

Figure 4. Surface trawl catch rates (n/km^2) of chum salmon during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

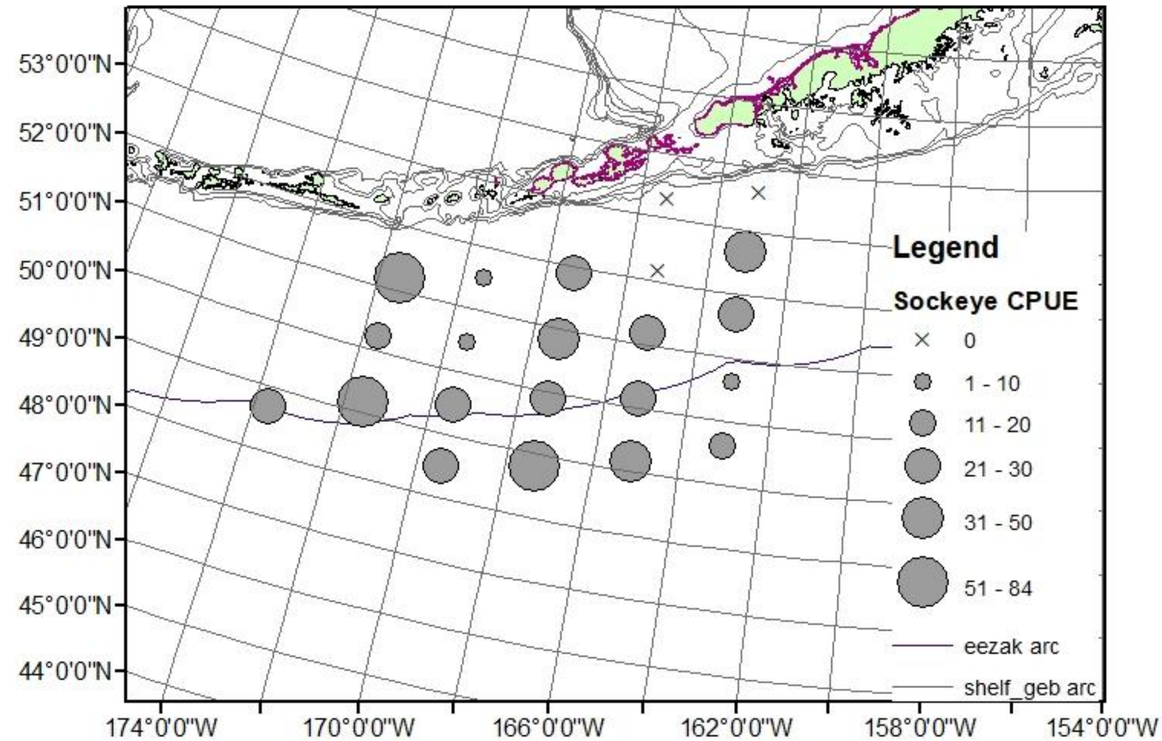

Figure 5. Surface trawl catch rates (n/km^2) of sockeye salmon during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

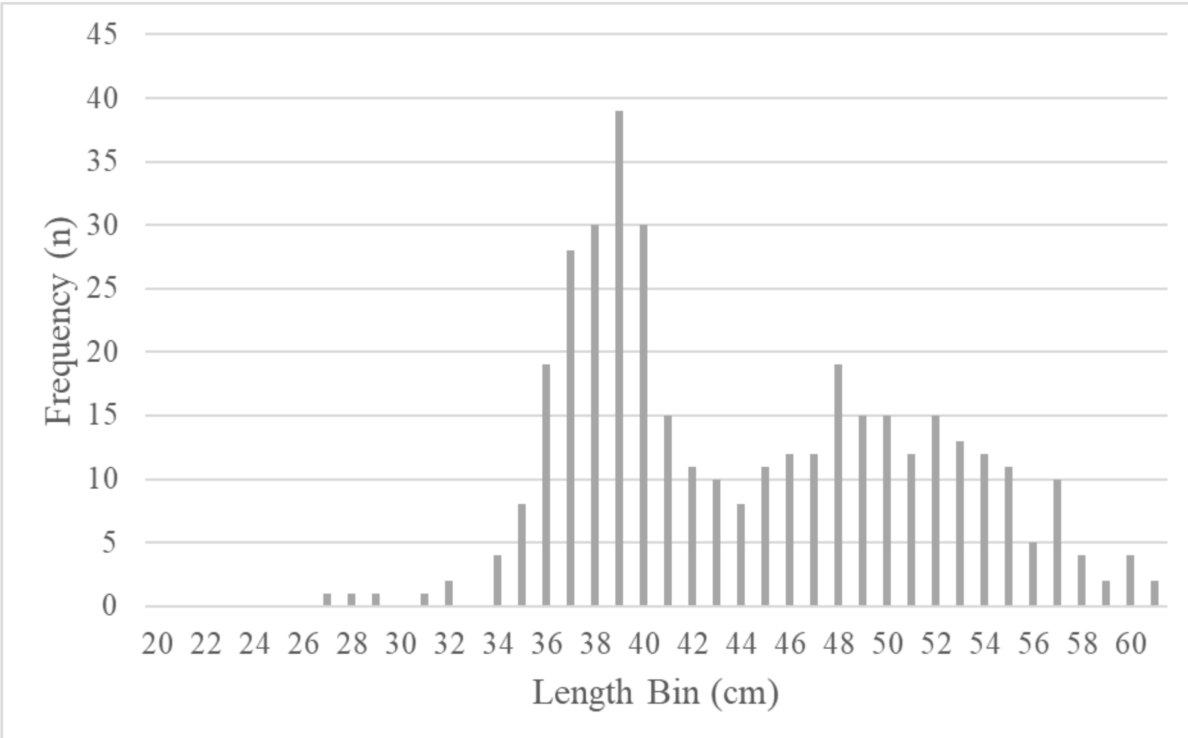

Figure 6. Length frequency distribution of chum salmon captured during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

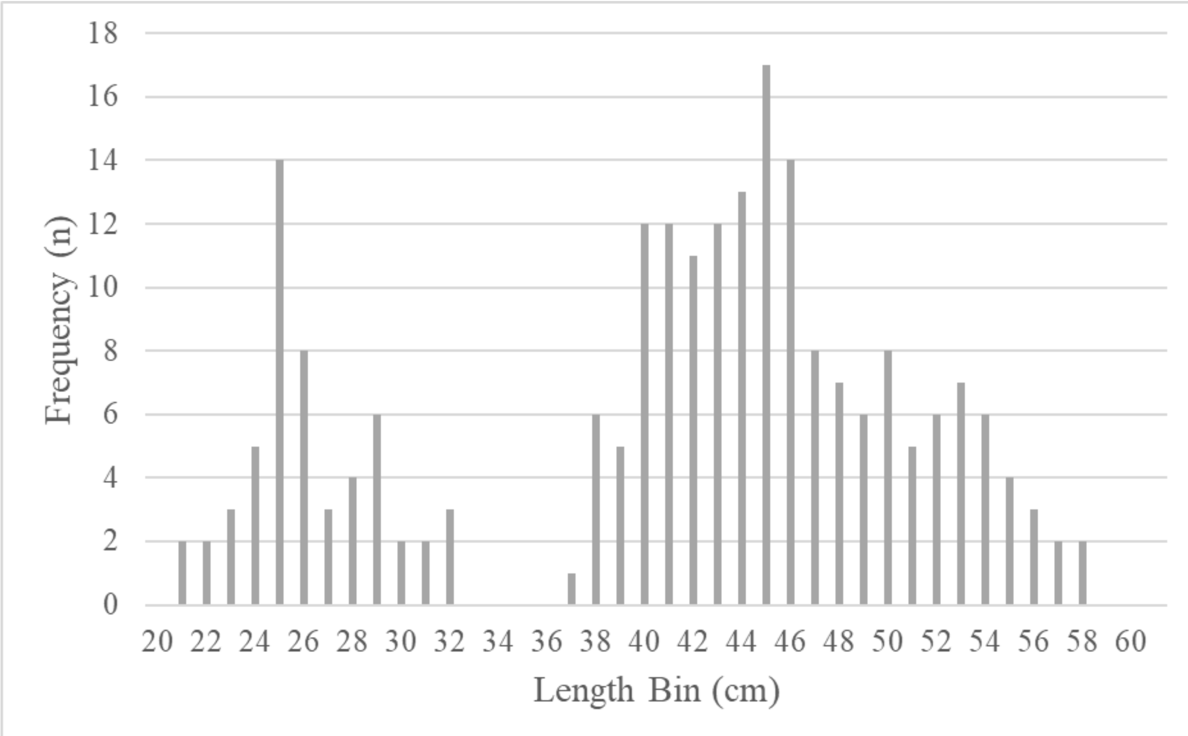

Figure 7. Length frequency distribution of sockeye salmon captured during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

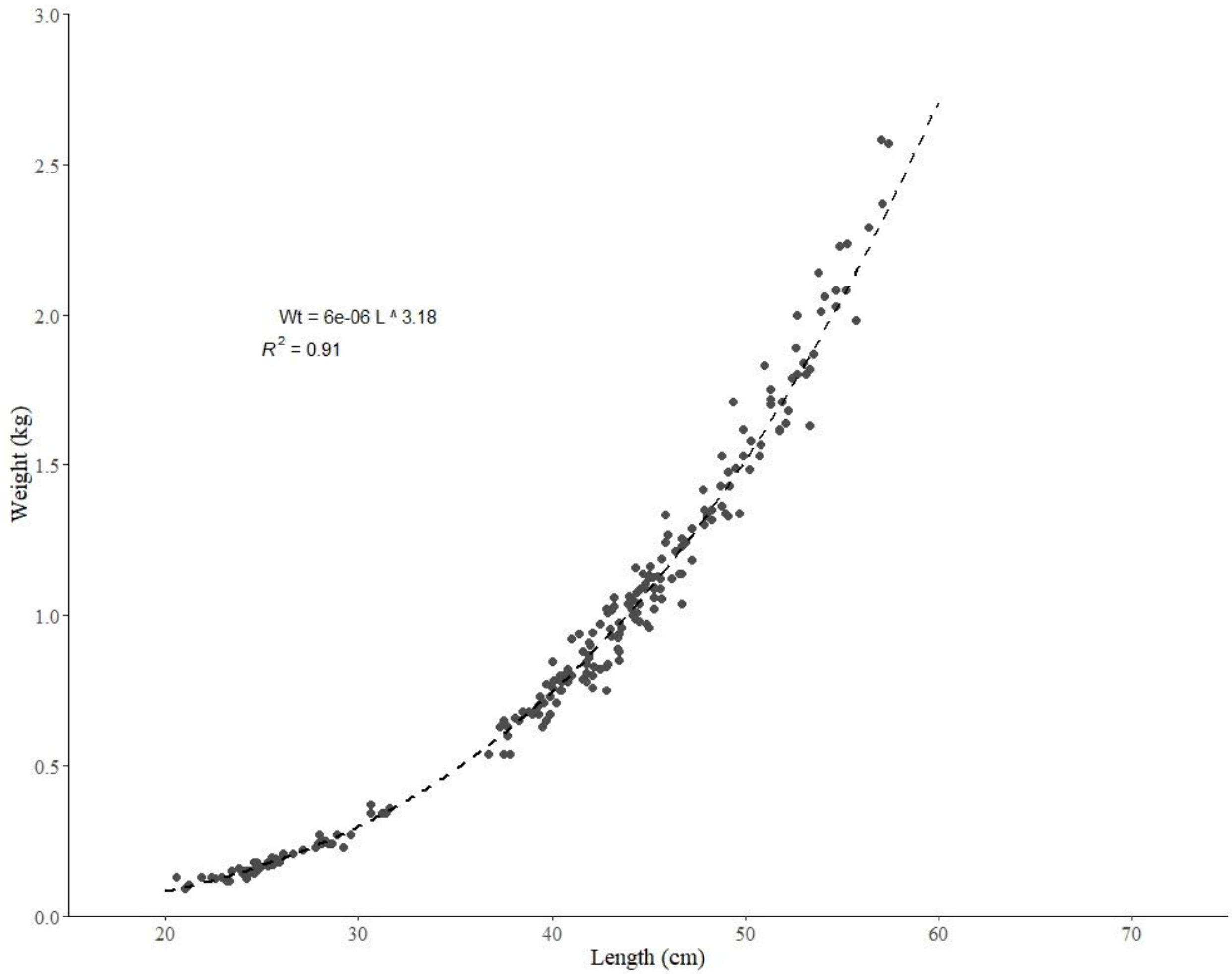

Figure 8. The relationship between length and weight of sockeye salmon captured during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

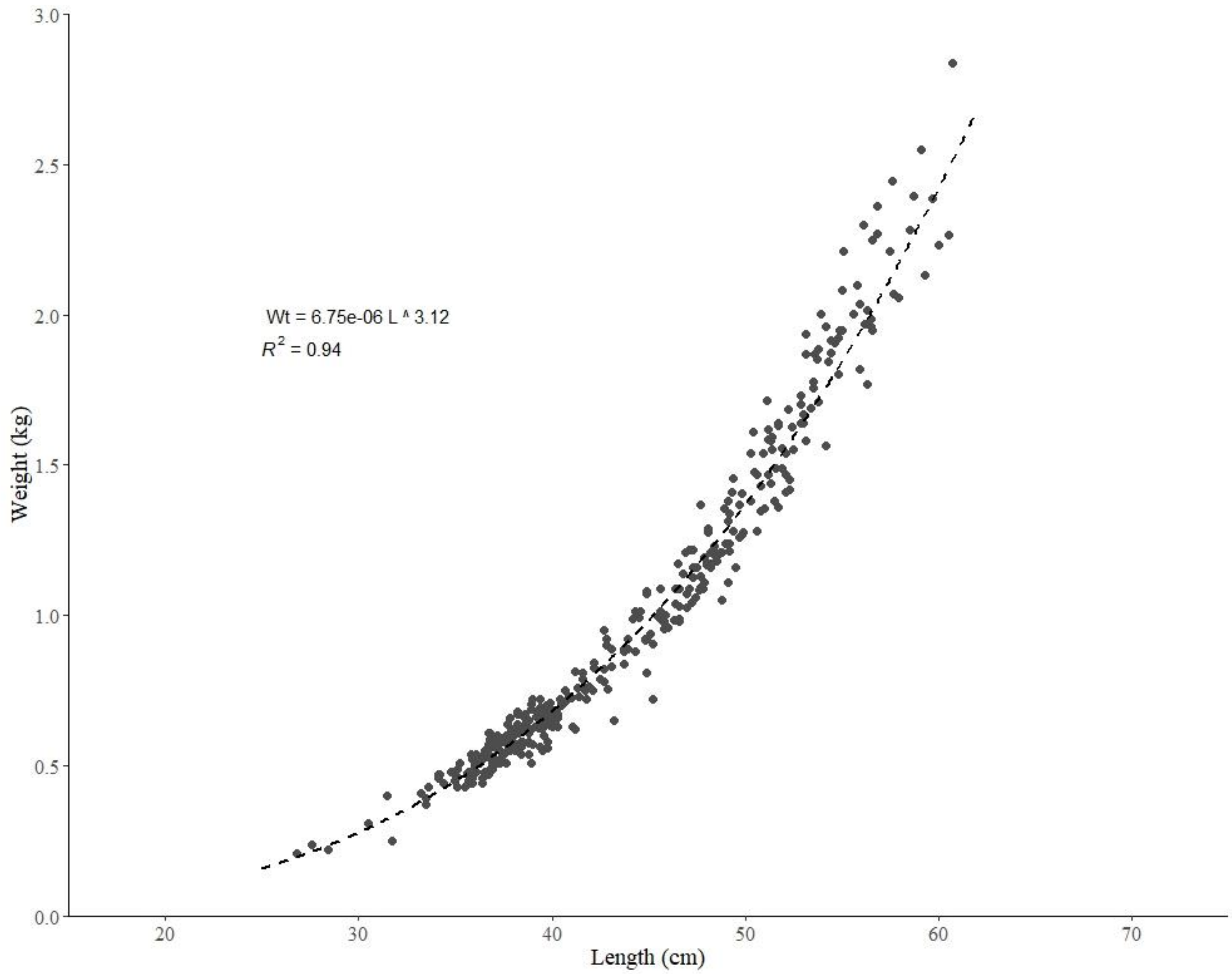

Figure 9. The relationship between length and weight of chum salmon captured during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

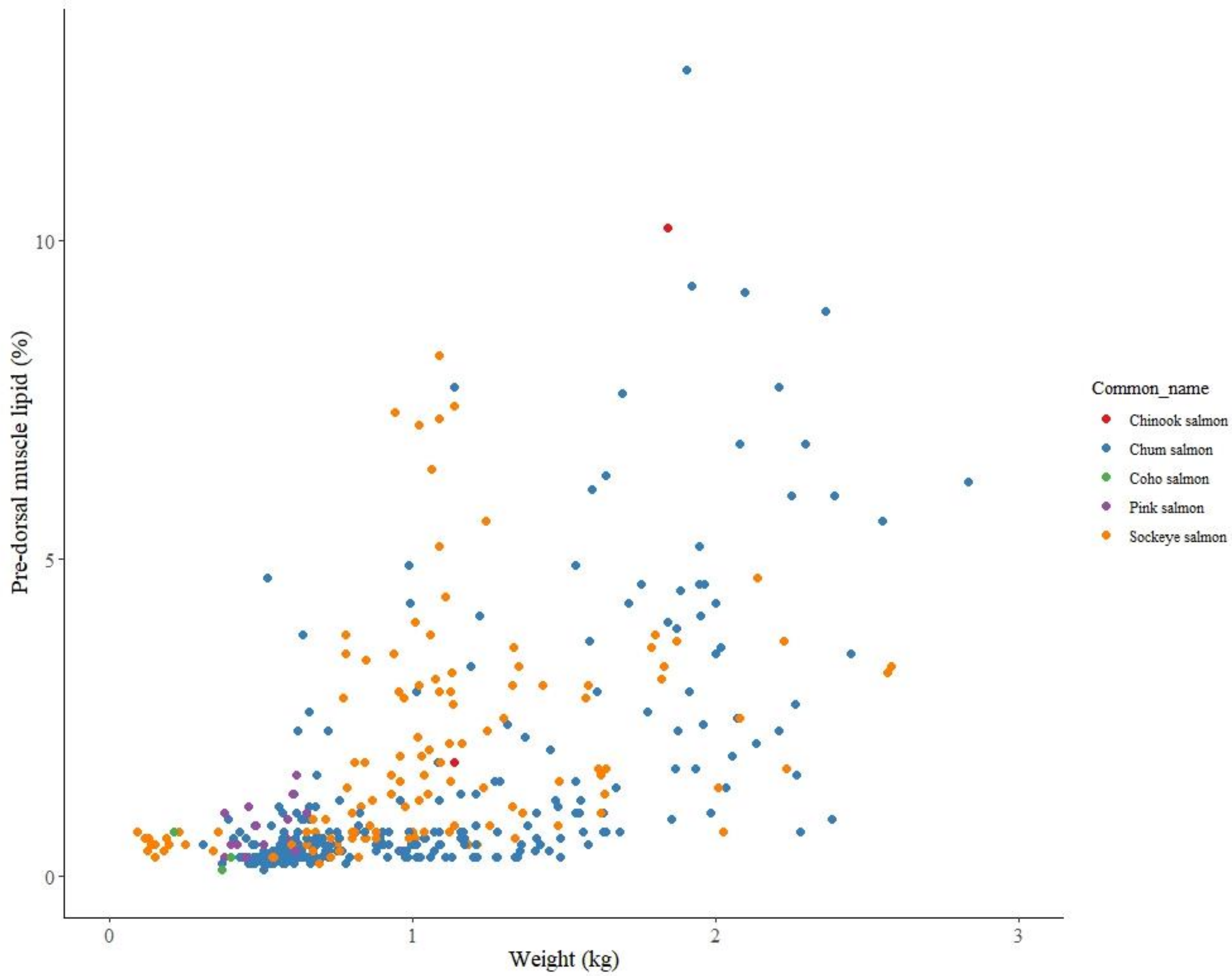

Figure 10. The relationship weight and pre-dorsal muscle lipid of salmon captured during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

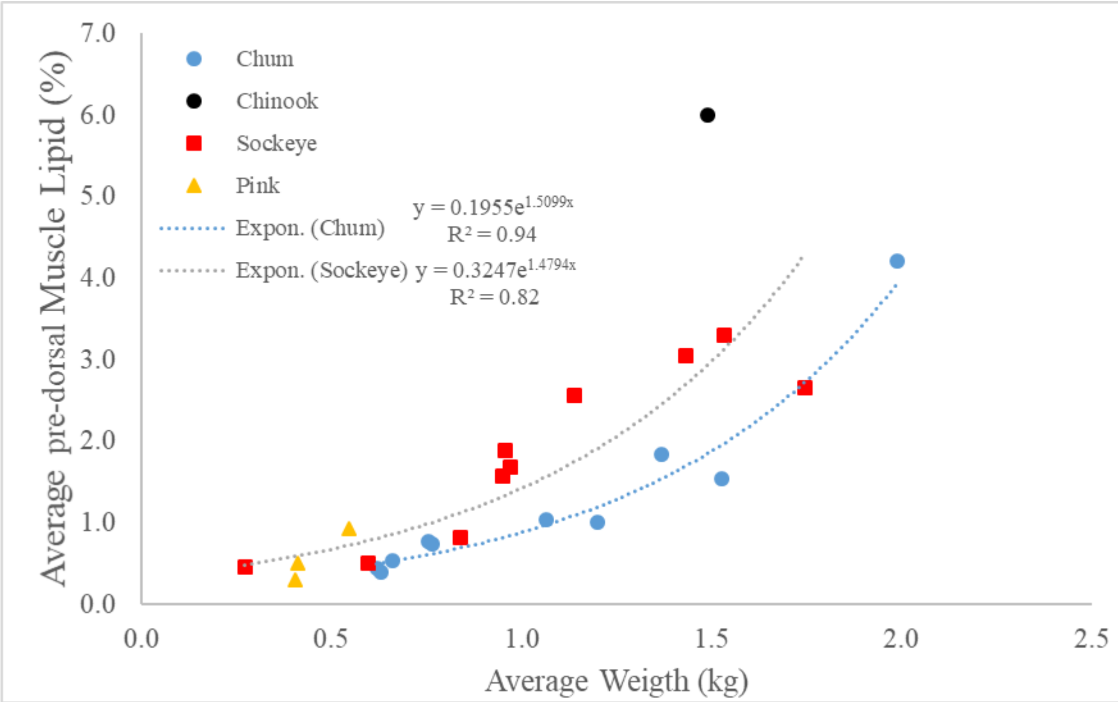

Figure 11. The relationship between average weight and average pre-dorsal muscle lipid by station of salmon captured during the 2022 International Year of the Salmon Expedition aboard the F/V *Northwest Explorer*.

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