

# **Integrated Pelagic Ecosystem Survey on the Vancouver Island Continental Shelf, June 15 - July 15, 2019**

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INTEGRATED PELAGIC ECOSYSTEM SURVEY ON THE VANCOUVER ISLAND  
CONTINENTAL SHELF, JUNE 15 - JULY 15, 2019

by

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## ABSTRACT

Boldt, J., Anderson, E., King, J., Dennis-Bohm, H., Zubkowski, T., and Flostrand, L. 2020. Integrated Pelagic Ecosystem Survey on the Vancouver Island Continental Shelf, June 15 -July 15, 2019. Can. Tech. Rep. Fish. Aquat. Sci. 3339: vii + 85 p.

Fisheries and Oceans Canada (DFO) mandates and policies require the development and application of an ecosystem based approach to fisheries management as well as cumulative risk assessments. Required to meet these mandates is a comprehensive understanding of factors that affect the distribution and abundance of fish and prey species, trophic structure, predator-prey dynamics, and species interdependencies. The Integrated Pelagic Ecosystem Survey (IPES) is the only broad-scale pelagic ecosystem survey in the Pacific Region that collects this type of information. The goal of the IPES survey is to understand factors affecting the distribution, abundance, and food web linkages of pelagic fish species, such as Pacific Herring and juvenile Pacific Salmon. To accomplish this goal, we conducted a random stratified survey with 8 strata on the north and west continental shelf of Vancouver Island in 2017, 2018, and 2019. The IPES survey provides comprehensive biological sampling and stomach analyses of all caught species, along with physical and biological oceanographic sampling. The survey produces data required for ecosystem monitoring and modelling, data for SARA-listed species, and supports both DFO's State of the Pacific Ocean reporting and the State of the Salmon program. This report summarizes the IPES survey design, methods, and results from the 2019 survey. The majority of sample catch weight per unit effort (CPUE) comprised Pacific Herring, North Pacific Spiny Dogfish, Chum Salmon, Pink Shrimp, Coho Salmon, Pink Salmon, and Chinook Salmon. Pacific Herring dominated biomass estimates and were the most frequently sampled species. Of the juvenile Pacific Salmon species sampled, Chum and Coho Salmon had the highest biomass estimates and, along with Chinook Salmon, were encountered more frequently than Pink or Sockeye Salmon. The dominant invertebrate CPUEs comprised Pink Shrimp and Water Jellyfish. Pyrosomes, which were observed in 2017 and 2018 for the first time in BC waters were not encountered in 2019. Fish diet analyses indicated that the most common prey items were Euphausiids, fish, and crab larvae. Data generated from the survey supports research into linkages between oceanographic conditions and fish abundance or community composition, Pacific Salmon and other fish ocean ecology, forecasting adult fish returns, and food-web dynamics.



## RÉSUMÉ

Boldt, J., Anderson, E., King, J., Dennis-Bohm, H., Zubkowski, T., and Flostrand, L. 2020. Integrated Pelagic Ecosystem Survey on the Vancouver Island Continental Shelf, June 15 - July 15, 2019. Can. Tech. Rep. Fish. Aquat. Sci. 3339: vii + 85 p.

Les mandats et les politiques de Pêches et Océans Canada (MPO) exigent l'élaboration et l'application d'une approche écosystémique de la gestion des pêches ainsi que des évaluations des risques cumulatifs. Pour remplir ces mandats, il est nécessaire de bien comprendre les facteurs qui influent sur la répartition et l'abondance des poissons et des proies, la structure trophique, la dynamique prédateur-proie et les interdépendances des espèces. Les relevés intégrés des écosystèmes pélagiques (RIEP) sont la seule étude à grande échelle de l'écosystème pélagique dans la région du Pacifique qui recueille ce type d'information. Le but des RIEP est de comprendre les facteurs ayant une incidence sur la distribution, l'abondance et les liens du réseau trophique des espèces de poissons pélagiques, comme le hareng du Pacifique et le saumon du Pacifique jeune. Pour atteindre cet objectif, nous avons effectué un relevé aléatoire stratifié de huit strates sur le plateau continental nord et ouest de l'île de Vancouver en 2017, 2018 et 2019. Les RIEP fournissent des échantillonnages biologiques complets et des analyses d'estomac de toutes les espèces capturées, ainsi que des échantillonnages océanographiques physiques et biologiques. Ils génèrent les données nécessaires à la surveillance et à la modélisation de l'écosystème, les données sur les espèces inscrites sur la liste de la LEP et appuient les rapports du MPO sur l'état de l'océan Pacifique et le programme sur l'état du saumon. Le présent rapport résume la conception, les méthodes et les résultats des RIEP de 2019. La majorité des échantillons de prises par unité d'effort (PUE) comprenaient du hareng du Pacifique, de l'aiguillat commun du Pacifique Nord, du saumon kéta, de la crevette rose, du saumon coho, du saumon rose et du saumon quinnat. Le hareng du Pacifique dominait les estimations de la biomasse et était l'espèce la plus souvent échantillonnée. Parmi les espèces de saumon du Pacifique, le saumon kéta et le saumon coho avaient les estimations les plus élevées de la biomasse et, tout comme le saumon quinnat, étaient présents plus fréquemment que le saumon rose et le saumon sockeye. Les prises PUE d'invertébrés dominants comprenaient les crevettes roses et les méduses. Les pyrosomes, qui avaient été observés pour la première fois dans les eaux de la Colombie-Britannique en 2017 et en 2018, ne l'ont pas été en 2019. Les analyses du régime alimentaire des poissons ont indiqué que les proies les plus courantes étaient les euphausiacés, les poissons et les larves de crabe. Les données générées par les relevés appuient la recherche sur les liens entre les conditions océanographiques et l'abondance ou la composition des communautés de poissons, le saumon du Pacifique et d'autres espèces de poissons, la prévision des montaisons de poissons adultes et la dynamique de la chaîne alimentaire.

# 1 INTRODUCTION

In British Columbia (BC), Canada, the Vancouver Island (VI) continental shelf (< 200 m) is a productive ecosystem found off the island's west and north coasts from Juan de Fuca Strait in the south, northward through the Scott Islands and eastward to include southern Queen Charlotte Sound (QCS, Figure 1). Off the west coast, the continental shelf ecosystem is the northern extent of the California Current upwelling system, with a typical northern boundary around Brooks Peninsula (Figure 1). The ecosystem supports important First Nations, commercial, and recreational fisheries, namely for Pacific Salmon (*Onchorhynchus* spp.) and Pacific Herring (*Clupea pallasii*).

The region has been a focus for pelagic fish research surveys for decades. Most notable were the 1) Pacific Sardine (*Sardinops sagax*) ecology trawl survey conducted annually in July/August from 1997-2010, which was then adapted to the annual nighttime pelagic ecosystem trawl survey 2010-2014 (DFO 2012; Flostrand et al. 2015), 2) the annual juvenile Pacific Salmon trawl surveys conducted in June/July 1998-2015 (for example see Welch et al. 2003), and 3) the annual La Perouse acoustic-trawl pelagic fish and ecosystem survey conducted during 2011-2015 (Boldt et al. 2016). The Pacific Sardine ecology trawl survey conducted sub-surface trawls (15 m headrope depths) along transects during the daytime from 1997-2005, then during the nighttime from 2006 to 2009. In 2010, the survey was redesigned as a nighttime pelagic ecosystem survey, with nighttime surface (4 m headrope depths) trawling using a random stratified survey design instead of transects. The juvenile Pacific Salmon surveys conducted daytime surface trawling (0 m, 15 m and 30 m headrope depths) along transects. The La Perouse acoustic-trawl survey included the collection of acoustic data along parallel transects in a core survey area; acoustic echosign was verified using a midwater trawl net and cameras to collect biological samples.

The DFO Pelagic Integrated Ecosystem Science (PIES) team was formed to address challenges and implement collaborative monitoring and integrated research plans on pelagic ecosystems in BC. Challenges included limited resources and vessel time; therefore, one recommendation was to combine multiple surveys while trying to address all survey goals and objectives. The three above-mentioned surveys were integrated into the Integrated Pelagic Ecosystem Survey (IPES; King et al. 2019c), initiated in July 2017, and repeated in July 2018 and 2019. The nighttime pelagic ecosystem and the juvenile Pacific Salmon surveys have been integrated and the La Perouse acoustic-trawl survey has been partly integrated. The three surveys previously deployed the same trawl gear, with some overlaps in survey timing and locations that provided an opportunity for collaborative research. The goal of the IPES is to understand factors affecting the distribution, abundance, and food web linkages of pelagic fish species, such as juvenile Pacific Salmon and Pacific Herring. To accomplish this goal, specific objectives of the survey are to: 1) examine species distribution, composition, and abundance; 2) collect morphometric data, diet data, and biological samples; 3) examine the prey environment by sampling zooplankton (vertical bongo net hauls) and conducting oceanographic monitoring (temperature, salinity, fluorescence). The IPES is currently the only broad-scale pelagic ecosystem survey in the Pacific Region, providing comprehensive biological sampling and stomach content analyses of all caught species, along with physical and biological oceanographic sampling. The survey produces data required for ecosystem monitoring and modelling, data for SARA-listed species (e.g., Tope Sharks, *Galeorhinus galeus*), and supports State of the Pacific Ocean reporting and

the State of the Salmon program of DFO. Data generated from the survey support research into linkages between oceanographic conditions and fish abundance and community composition, Pacific Salmon ocean ecology and forecasting adult returns and trophic-level dynamics. The objectives of this report are to summarize methods used and data collected during the 2019 IPES to address research goals. Methods used and data collected in 2017 and 2018 were previously summarized in (King et al. 2019c).

## 2 METHODS

### 2.1 Survey Area and Design

The survey was conducted on the continental shelf, west and north of Vancouver Island, between the 50 and 200 m isobaths (Figure 1).

#### 2.1.1 Survey strata and blocks

A random, stratified survey design was used. The survey area was divided into 8 distinct strata, based on bathymetry (50-100; 100-200 m) and known ecosystem distinctions (Figure 1). The survey area was divided into a contiguous grid of 4 km<sup>2</sup> blocks, representing possible trawl tow locations. For each survey year, random blocks were selected within each stratum, with the number of blocks based on stratum area so that the total number of blocks was about 70 (i.e. the estimated total number of stations that could be completed given the number of fishing days available) (Table 1). Within a stratum, an equal number of tows with the headrope at 0 m (surface) and at 15 m were selected. The total number of blocks to be selected was estimated by the number of total fishing days available and assuming 6 tows per day.

### 2.2 Vessel and Fishing Gear

In 2019, the survey was conducted on the *M.V. Nordic Pearl*, a 35 m stern trawler. Tows were conducted with a two-bridle LFS 7742 mid-water trawl net (LFS Net Systems, Bellingham, USA; Appendix A Table A.1, Appendix A Figure A.1) with a codend liner. The front end consists of a 252 foot headline of 5/8 inch coated spectra rope. The next section is diamond mesh 512 inch of 13 mm, and 10 mm synthetic rope. A tapered net body consists of 256 inch, 128 inch, 64 inch, 32 inch, 16 inch, 8 inch, and then 4 inch meshes. The intermediate section of the net is 4 inch mesh with 1 in-8 strand riblines. The codend has a 4 inch web with a 1/2 inch (12.7 mm) stretched mesh insert. The vessel was equipped with a Scanmar Trawl Sensor system (with some Marport sensors) to provide real-time doorspread values and a Scanmar Trawleye to provide real-time headline depth or footrope depths.

The LFS 7742 Midwater trawl was setup on the *M.V. Nordic Pearl* using a dual door leg hookup: a door leg from the top of the door was directly connected to the top link of the net and a bottom door leg directly to the bottom link of the net. Two large chain clumps, approximately 330 lbs

each, were placed on the lower wingtips, one on each side to increase the weight of the bottom of the net. There was an adjustable setback hookup system in place, meaning on surface tows there was a reduced setback of approximately 18 chain links (Viking Links on the setback chain hooked together), and at 15 m depth tows, the setback was increased to 36 chain links (full chain length, Viking Links unhooked). There were 2 Marport wingtip spread sensors placed after the setback chain where the net begins with the wingtips (one sensor on each side). Three scotchmen A4 floats were attached during surface tows to visually see the net at the surface. One A4 float was placed on each wingtip, at the 4th splice from the kite where the 13 mm twine meets the headline, and one A4 float was attached to the kite at the center of the headrope. The A4 floats were only used on the surface tows. The *M.V. Nordic Pearl* uses a 3rd wire connected to the center of the kite to increase lift at both surface and 15 m depth tows. The trawl doors used were Thyboron type 15, 4.5 m<sup>2</sup> pelagic doors, with a door spread sensor in each door (Thyboron Trawl door, Thyboron, Denmark). For surface tows, 90 fathoms (164 m) of warp were used and at 15 m depth tows, 110 fathoms (201 m) of warp were used.

## **2.3 Fishing Operations**

### **2.3.1 Time and duration of tows**

To provide a continuous time series for both the former juvenile Pacific Salmon survey (fishing conducted during daytime hours) and the former nighttime pelagic ecosystem survey (fishing conducted during nighttime hours), each selected block was fished once during daytime hours and a second time during nighttime hours. Fishing operations began at approximately 16:00 and ended at approximately 04:00 the following day. The net was towed at 4 to 5 knots for a target duration of 20 minutes (with a minimum acceptable tow duration of 10 minutes; note the minimal acceptable tow duration was shortened from 15 minutes in 2018 to 10 minutes in 2019 to minimize the frequency of anomalously large catches). 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.

### **2.3.2 Other data recorded during tows**

Vessel speed, direction, bottom depth, weather conditions (Appendix B Table B.1), vertical net opening, and trawl door spread were recorded for each tow. A RBR concerto data logger (RBR Ltd, Ottawa, ON) recording conductivity, temperature, depth, salinity and dissolved oxygen at 1 second intervals (1 Hz), was mounted inside a protective housing and attached to the top of the trawl net along the port rib line of the first belly of the lengthening piece. In addition, two RBR duet data loggers (RBR Ltd., Ottawa, ON) recording depth at 30 second intervals (0.033 Hz) were also mounted inside protective housings with one attached to the kite at the center of the headrope and one attached to the center of the footrope using stainless steel shackles. These sensors were attached to the net by the deck crew at the start of each day, and retrieved by the crew at the end of the day for downloading by science crew. During the second half of the survey, sensors were left on the net for the remainder of the survey. The vertical net opening was calculated from the difference in the headrope and footrope depth sensors after the doors were

locked. The horizontal net opening was calculated from the door spread and the net dimensions (Appendix A Table A.1) using trigonometry.

## 2.4 Acoustic Transects

In 2019, continuous acoustic data were collected and recorded during daylight hours when fishing was not occurring (i.e., between approximately 06:30 and 15:00). Acoustic data were collected with a SIMRAD EK60 scientific echo sounder operating at 38 kHz and 120 kHz. Data were collected along predetermined parallel transects, which were selected based on DFO's biennial Pacific Hake (*Merluccius productus*) survey and spaced 10 nautical miles apart (Figure 2; Edwards et al. 2018). Data were collected from the 50 m to the 1,500 m isobath. Although there were no trawl tows conducted to verify species composition of the echosign, the echosign patterns and trawl catches from this standardized survey were used to determine the spatial distribution of euphausiids, coastal pelagic fish (primarily Pacific Herring), and Pacific Hake. Previous surveys have validated echosigns for these three taxonomic groupings.

## 2.5 Oceanographic Data

Within each selected block, a vertical conductivity-temperature-depth (CTD) cast was conducted with a Seabird SBE 25 CTD profiler (Sea-Bird Scientific, Seattle, USA) to 250 m or to within 10 m of the bottom. One CTD cast was conducted per block, unless blocks were located next to each other and sampling time was limited. In addition, seawater samples for nitrate, phosphate, and silicate were collected with a Niskin bottle at 10 m from the surface, placed in acid-washed glass test tubes and frozen. Seawater for chlorophyll *a* (chl *a*) estimation were filtered with GF/F glass fibre filter disks. Filter disks were then placed in polypropylene scintillation vials and frozen. Seawater and chl *a* samples were sent for analyses at DFO's Institute of Ocean Sciences, Sidney, BC.

## 2.6 Zooplankton Sampling

Within each selected block, vertical zooplankton tows were conducted to approximately 250 m or within 10 m of the bottom with two paired 60 cm diameter, 253  $\mu\text{m}$  Nitex zooplankton nets mounted in a bongo-drum style black frame. Zooplankton tows were conducted immediately following the CTD cast. A RBR duet<sup>3</sup> data logger (RBR Ltd., Ottawa, ON) collecting depth was attached to the bongo frame at the start of each survey, and retrieved periodically and at the end of each survey to estimate velocity and depth of the net. A flowmeter was attached inside one net to record the water volume sampled. Zooplankton collected from the flow meter-side net were preserved in 10% formalin and sent to the zooplankton laboratory at DFO's Institute of Ocean Sciences, for species classification and enumeration (Mackas et al. 2001, 2007; Galbraith and Young 2019). Zooplankton collected from the net without the flowmeter were sorted into four size fractions by successively sieving through 8.0, 1.7, 1.0, and 0.25 mm screens. Each size fraction was individually frozen in a pre-weighed Ziploc bag for future stable isotopes, bomb calorimetry, and proximate analyses.

## **2.7 Catch Processing**

At the end of each trawl, the net was retrieved and the catch dumped into a hopper in the fish processing lab for sorting on a conveyor belt. Large catches were randomly subsampled prior to sorting. The catch was sorted to the lowest taxonomic group possible. Juvenile Pacific Salmon (<300 mm total length) were recorded separately from adult Pacific Salmon. The total catch (or the subsample) of each species or taxonomic group, was weighed to the nearest 0.1 kg using a large capacity, motion-compensating electronic balance (Marel Model M1100, 60 kg capacity). For catches of a species or taxonomic group which totalled less than 0.01 kg, “trace” weight was recorded. Where practical, the number of individuals was recorded. Catch weights of jellyfish species were also recorded.

## **2.8 Biological Sampling**

Time permitting, all fish species captured were measured for length (nearest mm) and weight (nearest 0.01 g) if the specimen was large enough to be accurately weighed using a benchtop electronic scale (Marel Model M1100, 3 kg capacity) and stomach contents recorded. For each species, a target number of 50 randomly selected specimens per tow were sampled, with 10 random specimens selected for stomach content analyses. If the catch count was less than the target number, all specimens in that tow were sampled. Additional biological sampling occurred for Pacific Salmon, Pacific Herring, Pacific Sardine and Eulachon (*Thaleichthys pacificus*), as outlined below. When collected, tissue for genetic stock identification was stored on Whatman paper. All sharks were sampled as per DFO survey sampling protocol (Appendix D). The bell diameters (nearest mm) of intact jellyfish specimens were recorded.

### **2.8.1 Pacific Salmon**

Biological sampling was done separately for juvenile and adult Pacific Salmon. The target number of juvenile or adult Pacific Salmon specimens per tow was 10, and an additional 20 specimens with only length and weight recorded. Full biological samples included: measuring fork length and weight, collecting otoliths, taking a caudal fin clip for genetic stock identification, noting if the adipose fin was clipped (denoting hatchery released fish), retaining heads if a coded wire tag (CWT) was detected with a CWT wand, analyzing stomach contents, collecting whole body or muscle tissue (as per below).

### **2.8.2 Pacific Herring**

The target number of specimens per tow was 100. An additional 100 specimens were frozen for subsequent length and weight measurements and scale collections for age determination in the laboratory. On the vessel, full biological samples included: measuring standard length and weight, analyzing stomach contents, and collecting whole body or muscle tissue (as per below).

### **2.8.3 Pacific Sardine**

The target number of specimens per tow was 100. Full biological samples included recording fork length, weight, sex, and maturity stage (Appendix C Table C.1). An additional 100 specimens were to be frozen for laboratory stomach analyses. No stomachs were sampled at sea, therefore if catches of Pacific Sardine were less than the target number, all specimens were to be frozen for laboratory analyses.

### **2.8.4 Eulachon**

The target number of specimens per tow was 50. Full biological sampling included measuring standard length and weight, collecting a caudal fin clip for genetic stock identification, analyzing stomach contents, and collecting whole body or muscle tissue (as per below).

### **2.8.5 Other fish**

For all other species, the target number of specimens per tow was 50. Full biological sampling included measuring length (standard for smelt species, fork or total for other species) and weight, analyzing stomach contents, and collecting whole body or muscle tissue (as per below).

## **2.9 Stomach Contents Sampling**

Stomach contents were analyzed for the first 10 random specimens or for all specimens for catches with fewer than 10 individuals. The target sample size for stomachs analysed per species per stratum was 30. Stomach content sampling followed the recommended at-sea protocol for DFO Pacific Region surveys (King et al. 2018):

1. The stomach was removed from the anterior end of the oesophagus to the pyloric sphincter.
2. Empty stomachs were identified and recorded.
3. Any specimens with everted, regurgitated stomachs, or in-net feeding were identified, recorded and rejected for further sampling.
4. The bolus was removed from pyloric and cardiac parts of the stomach to petri dish and prey taxa were sorted.
5. Prey were identified to lowest taxonomic level that the sampler was comfortable with using their naked eye or a hand lens.
6. The volume of prey categories were measured to the nearest 0.1 cm<sup>3</sup> using a volume measuring tool made of plexiglass (see Figure 5, King et al. 2018). The tool has a ruler (mm) embedded on one side of a trench that is 1 cm wide and 1 cm deep. Prey items were

placed in the trench, and packed such that they filled the trench evenly and did not extend past 1 cm high. Once packed, the volume (cm<sup>3</sup>) was measured as the length along the ruler and recorded. Digestion state for each prey category was estimated as Fresh, Partial, or Well digested as per King et al. (2018).

Once stomach contents were enumerated, the empty stomach was placed back in the fish body. Up to five whole bodies per tow were frozen for future energy density estimation, after which, if there were additional specimens, muscle tissue was frozen for future stable isotope analyses.

## 2.10 Biomass Estimates

Design-based biomass estimates were produced for each juvenile Pacific Salmon species (based on daytime fishing events) and for Pacific Herring (based on nighttime fishing events). The annual biomass estimate ( $B$ ) is the sum of the product of catch per unit effort densities (CPUE; kg·km<sup>3</sup>) and the volume (km<sup>3</sup>) of each stratum across  $m$  strata:

$$B = \sum_{i=1}^m V_i \delta_i$$

where  $\delta_i$  is the mean CPUE density (kg·km<sup>3</sup>) for stratum  $i$

$V_i$  is the volume (km<sup>3</sup>) of the upper 30 m of stratum  $i$

and  $m$  is the number of strata.

Individual CPUE values were adjusted for catchability, prior to analysis. Catchability for juvenile Pacific Salmon was assumed to be 0.4 (Volvenko 2003) and 1.0 for Pacific Herring. When calculating CPUE, if net opening data were not available, the survey mean width (m) or height (m) at that depth was used instead. Variance of the annual biomass estimate was estimated as per Thompson (1992):

$$\sigma^2 = \sum_{i=1}^m V_i (V_i - v_i) \frac{s^2}{n_i}$$

where  $V_i$  is the volume (km<sup>3</sup>) of the upper 30 m of stratum  $i$

$v_i$  is the total swept volume (km<sup>3</sup>) of tows in stratum  $i$

$n_i$  is the total number of tows in stratum  $i$

$s^2$  is the sample variance of  $\delta_i$  from stratum  $i$

and  $m$  is the number of strata.



## 3 RESULTS

### 3.1 Fishing Operations

The survey was divided into two legs: June 15, 2019 to June 30, 2019; and June 30, 2019 to July 15, 2019. The first 4 days were used for loading, training, and conducting sampling for another project and the IPES survey began on June 19. Weather prevented fishing and oceanographic sampling on 4 days. In total there were 26 fishing days, with 11 during the first leg and 13 during the second leg. A total of 134 tows were completed, of which 134 were useable. As in 2017 and 2018, an average of 5 tows per day were completed. Bridge log data for each tow (e.g., locations, times, depths, etc.) are reported in Table E.1.

A total of 68 survey blocks were successfully fished during the day, and 66 during the night (Table 1, Figure 3). Weather or high densities of marine mammals precluded all blocks being fished in both day and night, but a minimum of 66 blocks were fished successfully during both day and night. Fishing effort was distributed across strata such that the percentage of successful tows was between 83.3% and 100% of each stratum's target blocks (Table 1).

#### 3.1.1 Gear Sensors

Net mensuration data from the Scanmar and Marport trawl sensors were collected. These sensors typically do not always work when the net is towed at the surface. There were, therefore, some spurious values while trawling at the surface; wingspread, headline (for 15 m tows) or footrope (for 0 m tows), and doorspread values were sometimes unavailable. Vertical net mouth opening dimensions were calculated using data from RBR duet sensors mounted on the headrope and footrope. The headrope sensor failed partway through the second leg of the survey, so for tows with missing sensor data, tow depth-specific averages were used for vertical net mouth opening values (i.e., an average value for surface tows or 15 m depth tows; Table E.1).

### 3.2 Acoustic Transects

During daylight hours, acoustic backscatter data, attributed to coastal pelagic species were collected. There was a technical issue with the 38 kHz transducer (a quadrant wire was disconnected inside of the transducer cable); therefore, options for data analyses will need to be explored and data were not available prior to the publication of this report.

### 3.3 Oceanographic Data

Oceanographic data from CTD casts, including Niskin bottle samples for nitrate, phosphate, silicate, and chl *a*, were processed, analyzed, and archived in the Ocean Sciences Data Inventory at the Fisheries and Oceans Institute of Ocean Sciences. CTD casts and Niskin bottle

sampling were conducted in 58 blocks (85% of the blocks that were successfully fished either during the day or the night), with depths of CTD casts ranging from 50-190 m (Table F.1).

### 3.4 Zooplankton Samples

Vertical zooplankton tows were conducted in 58 blocks where CTD casts were completed (Table F.1) at depths ranging from 50-190 m (Appendix Table F.1). Formalin-preserved zooplankton samples are being enumerated at the Institute of Ocean Sciences and data will be archived in the DFO zooplankton database. Frozen zooplankton samples are being processed at the Pacific Biological Station and results are not reported here.

### 3.5 Catch Composition

Catch composition for each tow is presented in Table G.1. Sixty-eight species or taxonomic groups were identified, of which 49 were vertebrates (Table 2), and 19 were invertebrates (Table 3). The mean catch weight per tow was 191 kg, with species-specific total catches ranging from 0 - 19,621 kg for each usable tow (Table G.1). The total survey catch weight from usable tows was 25,555 kg (Tables 2 and 3), excluding species for which only count data were collected (e.g., sharks).

For each species captured during the survey, the number of tows in which the species occurred, total catch weight, maximum catch weight, and mean catch weight per tow for usable tows were calculated (Tables 2 & 3). Pacific Herring dominated the catches and represented 77% of the total survey catch weight; there was one very large catch (approximately 10,000 kg), three catches >1,000 kg, and nine catches approximately 200 kg or more. Pacific Herring were also the most frequently caught species; they were present in 50% of tows. North Pacific Spiny Dogfish (*Squalus suckleyi*) had the second highest catch weight (6% of total survey catch weight); however, they were encountered in only 10% of the tows, and the majority of the species' total catch weight was captured in two tows of 1,150 kg and 244 kg (Table G.1).

Approximately 68% of the remaining catch weight was comprised of 6 species or groups (in relative order of contribution): Chum Salmon (*Oncorhynchus keta*), Pink Shrimp (Smooth) (*Pandalus jordani*), Coho Salmon (*Oncorhynchus kisutch*), Pink Salmon (*Oncorhynchus gorbuscha*), Chinook Salmon (*Oncorhynchus tshawytscha*), and, Pacific Hake (*Merluccius productus*) (catches of salmon includes both adults and juveniles; Tables 2-3). These species were encountered in 36%, 3%, 38%, 25%, 44%, 9% of tows, respectively. Pink Shrimp were only encountered in 4 tows; however, there was one large catch of 705 kg (Table 3). Other frequently encountered fish species or groups were Flatfishes (*Pleuronectiformes* spp.) (43% of tows), Rockfishes (*Sebastes* spp.) (41%), and Walleye Pollock (*Theragra chalcogramma*) (31%) (Table 2). The most frequently encountered invertebrate species or groups were Water Jellyfish (*Hydromedusa* spp.) (37% of tows), Jellyfish (*Cnidaria* spp.) (33%), and Lion's Mane Jellyfish (*Cyanea capillata*) (32%) (Table 3).

## **3.6 Biological Samples**

### **3.6.1 Samples**

Biological samples were collected from 45 species or groups and included 7,930 individual specimens (Table 4). Sample sizes and statistics of length and weight are presented in Table 4 for each species sampled.

### **3.6.2 Length and Weight**

Length frequencies and length-weight relationships were examined for species with at least 100 individuals measured (Figures 4-12). Length frequency plots for Pacific Salmon (Figures 5-9), illustrate that this survey encounters both juveniles (<300 mm) and adults, with a higher proportion of juvenile specimens. Pacific Herring standard lengths ranged from 103 to 236 mm, with a mean length of 173 mm (Table 4). Based on lengths, three or four size classes of Pacific Herring are sampled by this survey; however, this does not imply the same number of age classes, since there is overlap in lengths among age classes (Figure 4). Eulachon lengths ranged from 85 to 188 mm, with the majority being between 150 and 175 mm (Figure 10). Lengths of North Pacific Spiny Dogfish were between 251 mm and 1,080 mm (Figure 11). Most Opalescent Inshore Squid (*Doryteuthis opalescens*) mantle lengths were between 80 mm and 114 mm (Figure 12). Water jellyfish bell diameters were 39 to 141 mm (Figure 13).

## **3.7 Stomach Content Samples**

A total of 1,596 stomach specimens were processed at sea from 25 species (Table 5). Of the stomachs examined, on average 21% were empty (Table 5). Pacific Salmon species diets were examined in 96-100% of the tows in which they were caught. The numbers of fish examined for diet were 189, 237, 245, 161, 33 for Chinook, Chum, Coho, Pink, and Sockeye Salmon, respectively. Pacific Herring were sampled in 72% (48 tows) of the tows in which they were caught and 445 fish were sampled. For all but four species, diets were examined in 2-100% of the tows in which they were caught and numbers of fish ranged from 1 to 106. Other species were either released alive (e.g., many North Pacific Spiny Dogfish) or were too small to examine diets at sea. Subsamples of small fish such as young of the year Walleye Pollock and juvenile Rockfishes were frozen for later laboratory analyses.

### **3.7.1 Diet Summaries**

The most frequently consumed prey items across predators were Euphausiids (in 34% of the stomachs examined), true crabs (19%), and teleosts (~17%) (Table 6). Most teleost prey were unidentifiable to species (11%), but the most frequently occurring species was Pacific Herring (4%), with small amounts of Flatfishes, Lanternfishes (*Myctophidae* spp.), Rockfishes, Smelts

(*Osmeridae* spp.), and Sturgeon Poachers (*Podothecus accipenserinus*) (Table 6). Teleost prey that contributed the largest average volume to diets were Pacific Herring and Rockfishes.

### 3.8 Biomass Estimates

In 2019, biomass estimates of Pacific Herring (sampled at night) and juvenile Pacific Salmon species (sampled in daylight) were generally similar to previous years (King et al. 2019c), with a few exceptions (Table 7). The biomass of Pacific herring was 98,217 t (CV=0.58; Table 7) which is similar to the estimate in 2017 (92,175 t), but almost 3 times the biomass observed in 2018 (34,562 t). The juvenile salmon species with the highest biomass in 2017 and 2019 was Chum Salmon (128.2 and 25.5 t, respectively); in 2018, their biomass was 11.92 t. In 2019, the juvenile salmon species with the second highest biomass was Coho Salmon, 17.9 t (Table 7), compared to 36.0 t in 2018 and 79.3 t in 2017 (King et al. 2019c). Biomass estimates of juvenile Chinook Salmon were similar among years, varying between 8 and 10 t (Table 7; King et al. (2019c). The juvenile Sockeye Salmon biomass estimate in 2019 (4.4 t) was slightly higher than previous years (1.6 t in 2017 and 0.8 t in 2018; King et al. 2019c). Finally, biomass estimates of juvenile Pink Salmon were low for all years during 2017-2019. The few juvenile Pink Salmon that were caught in 2019 were caught at night, resulting in a daytime biomass estimate of 0 t (Table 7). Juvenile Pink Salmon biomass was also low in 2017 (0.29 t) and 2018 (2.1 t) (King et al. 2019c). In 2019, biomass CVs for juvenile Pacific Salmon species and Pacific Herring ranged from 0.25 for Chinook Salmon to 0.72 for Sockeye Salmon (Table 7).

## 4 DISCUSSION

The IPES data generated in 2017-2019 cover physical and biological oceanographic conditions, fish abundance and composition of the pelagic community, along with comprehensive sampling and stomach content analyses of all caught species. With a combination of day and night time fishing, the IPES extends long-term time series of relative abundance for juvenile Pacific Salmon, Pacific Herring, and other important pelagic fish species. If Pacific Sardine re-establish high migratory rates into Canadian waters to feed in summer, the IPES will provide documentation and also extend the long-term time series of that species' relative abundance. Acoustic data on Pacific Herring and Pacific Hake distributional patterns have also been reported in the State of the Pacific Ocean report (Boldt et al. 2019). IPES 2017-2019 relative catch rates and condition of juvenile Pacific Salmon have extended a 20-year time series off the west coast of Vancouver Island and have been reported in State of the Pacific Ocean reports (King and Tucker 2018; King et al. 2019a) and in the Fraser River Sockeye Salmon Forecasting Supplement (MacDonald et al. 2019). It is important to maintain the long-term time series of juvenile Pacific Salmon relative abundance along the continental shelf, since linking IPES survey results to similar surveys from Oregon north to the Gulf of Alaska and Bering Sea provide indication of broad-scale responses to regional drivers (King et al. 2019b). The IPES also provides the opportunity to document unusual occurrences, such as the unprecedented, and broad-scale Pyrosome bloom in 2017, reduced bloom in 2018, and return to an absence of Pyrosomes in 2019 (IPES data reported in Brodeur et al. 2018 and; Boldt and Chandler 2019). Other interesting results include abundant juvenile Rockfish catches in 2018 and 2019 (Boldt and Chandler 2019). IPES is conducted

annually and is a key platform supporting ecosystem research and empirical-based linkages of climate and ocean variability to fish abundance or community composition, which is fundamental to ecosystem-based fisheries management.

## **5 ACKNOWLEDGEMENTS**

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## 7 FIGURES

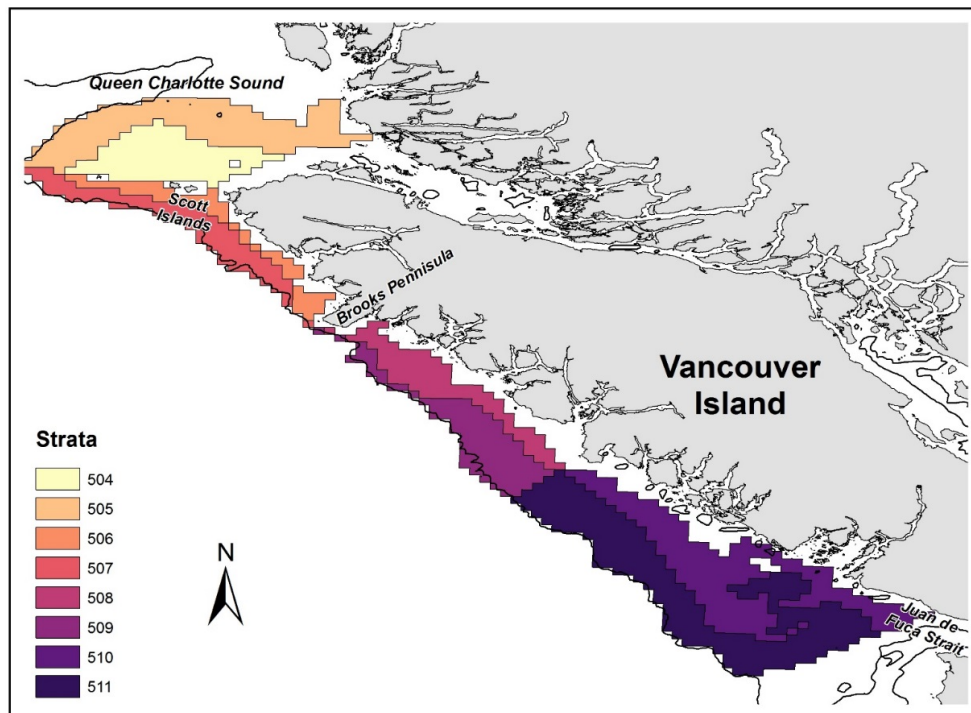


Figure 1. Survey area and strata for the Integrated Pelagic Ecosystem Survey on the Vancouver Island continental shelf.



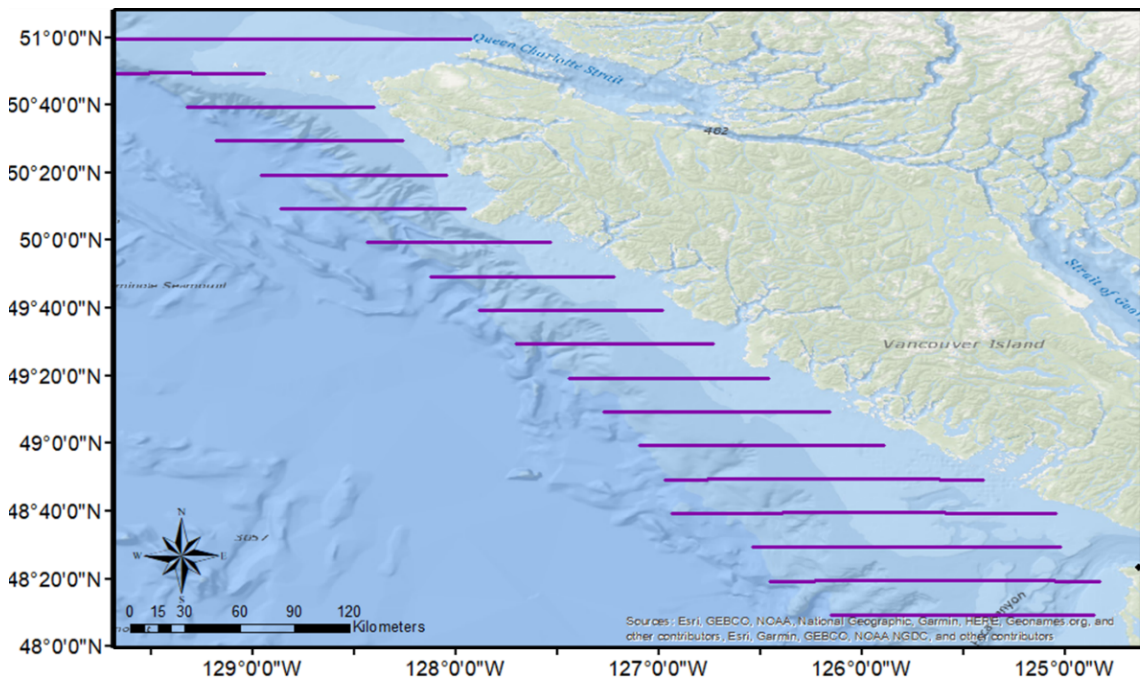


Figure 2. Transects for acoustic data collection during non-fishing hours for the 2019 Integrated Pelagic Ecosystem Survey, based on DFO's Pacific Hake survey acoustic transects.

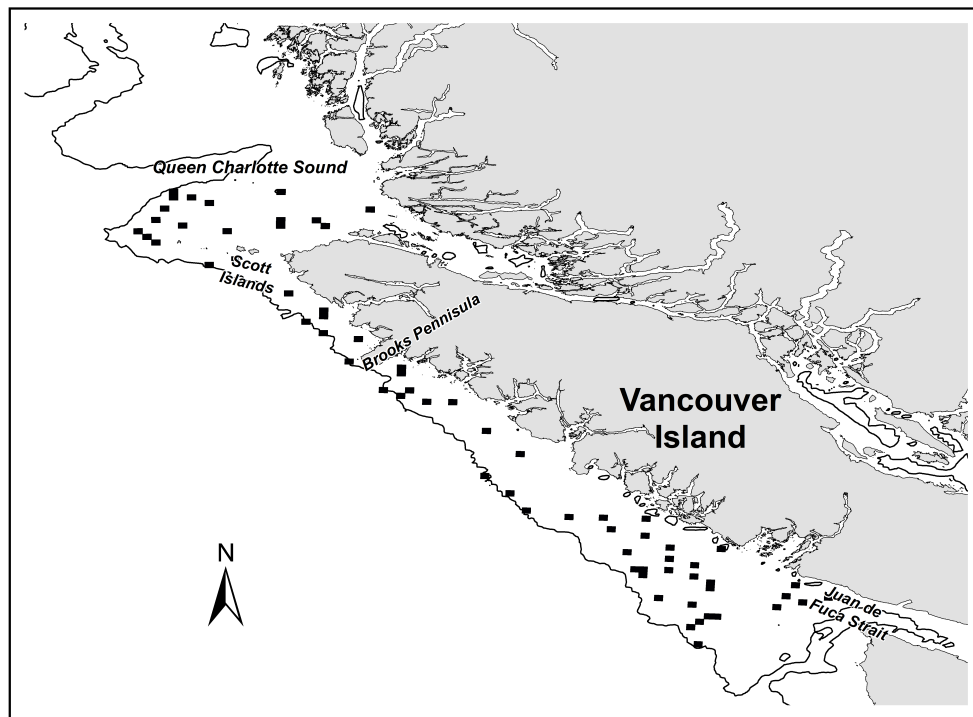


Figure 3. Blocks fished during the June 15, 2019 to July 15, 2019 Integrated Pelagic Ecosystem Surveys on the Vancouver Island continental shelf. The 200 m isobath is shown with a black line.

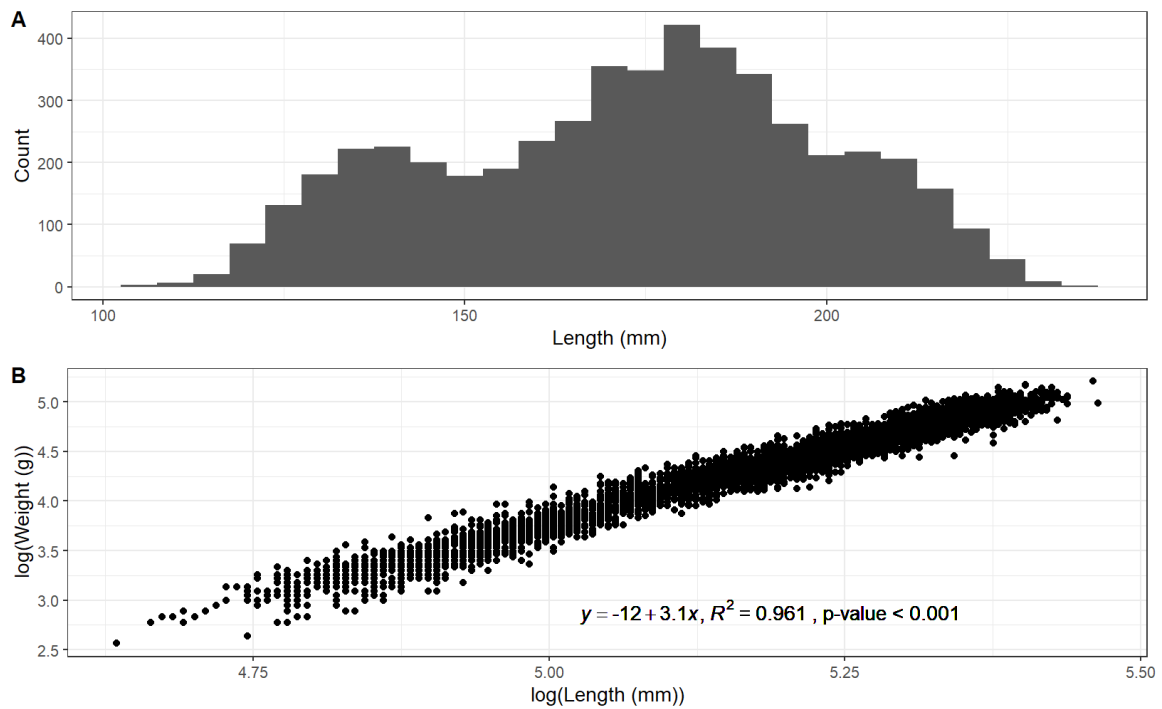


Figure 4. Pacific Herring (*Clupea pallasii*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

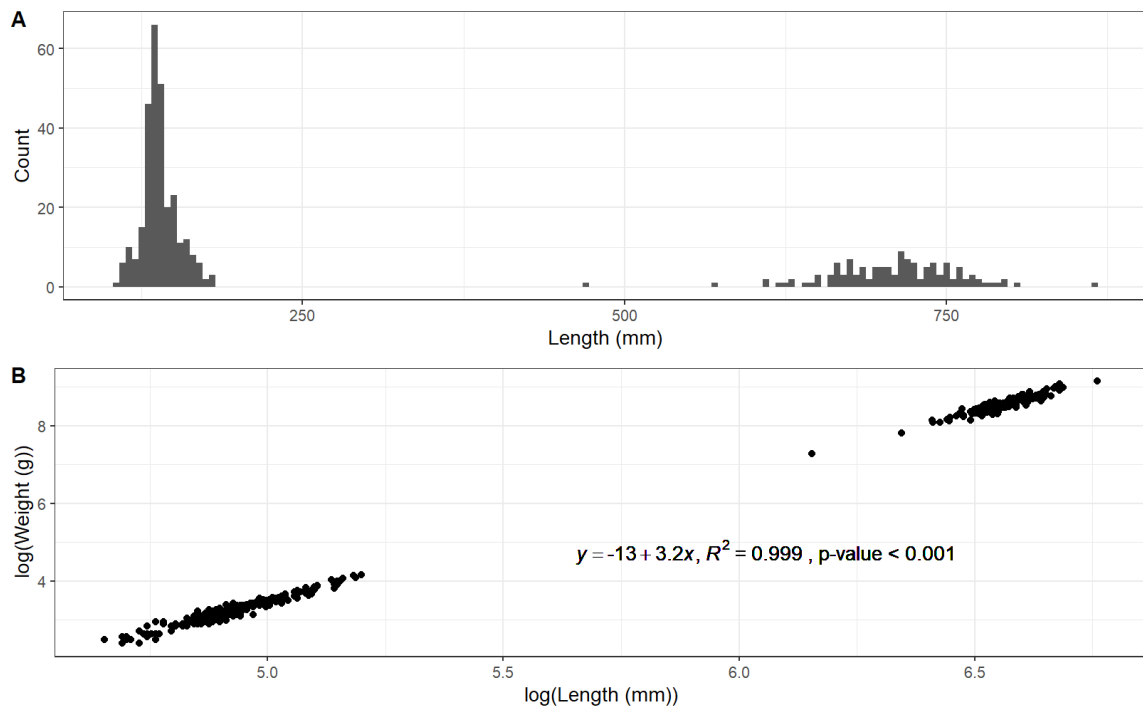


Figure 5. Chum salmon (*Oncorhynchus keta*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

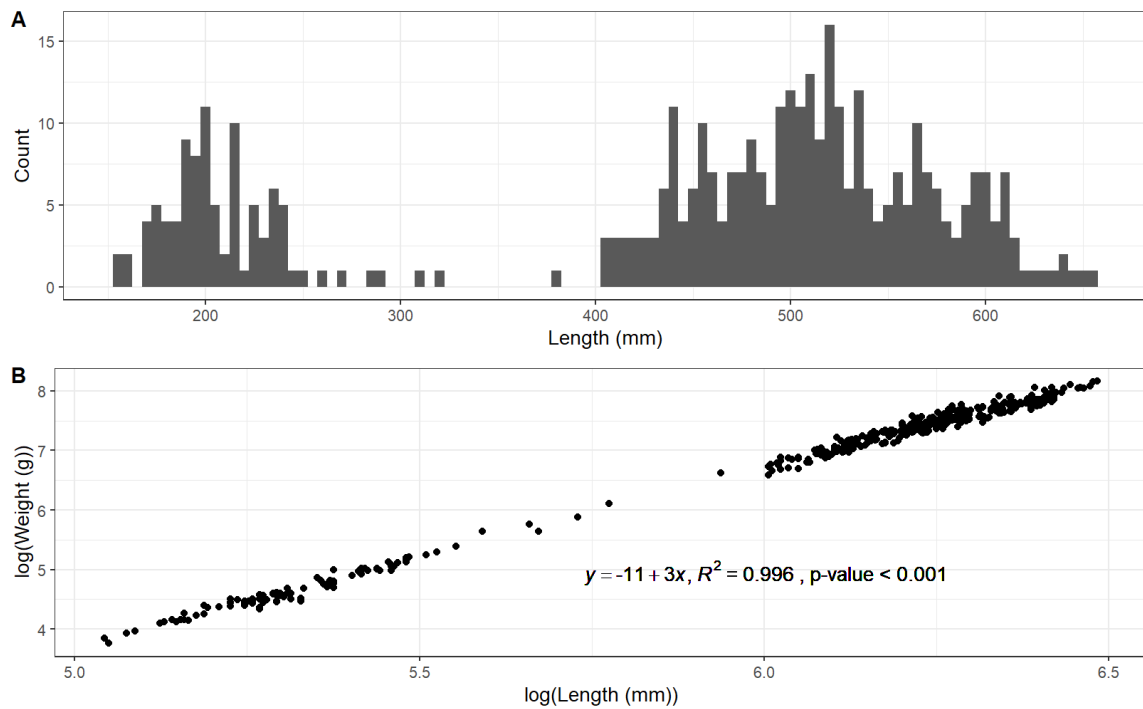


Figure 6. Coho salmon (*Oncorhynchus kisutch*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

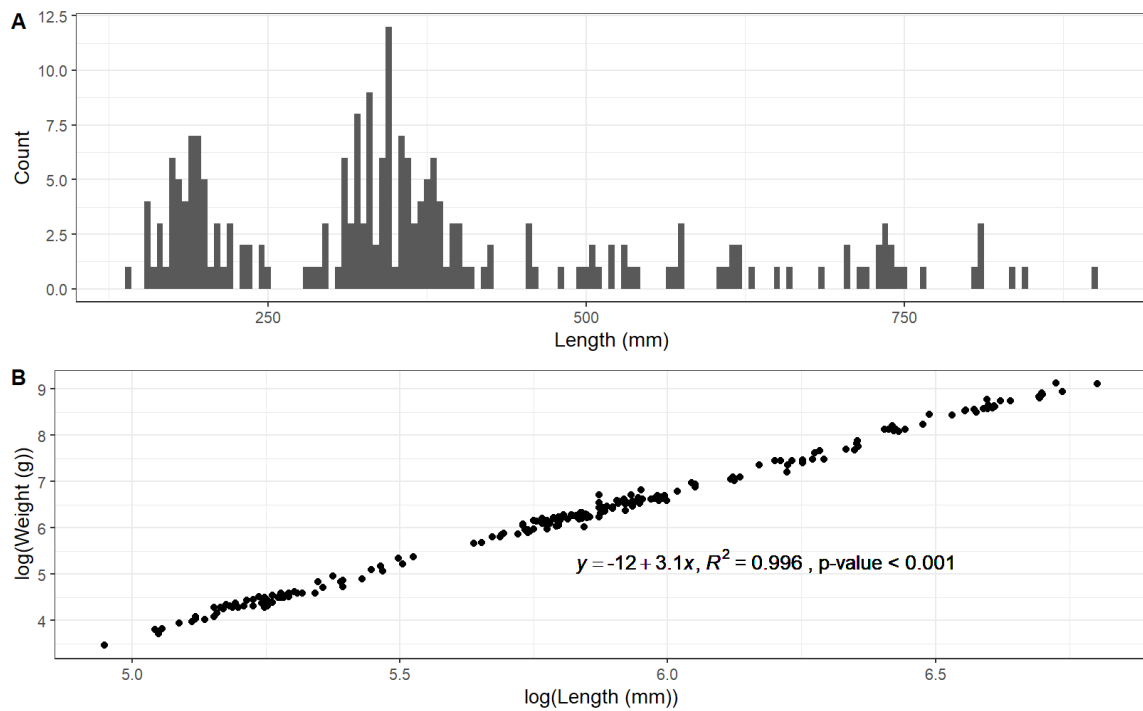


Figure 7. Chinook salmon (*Oncorhynchus tshawytscha*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

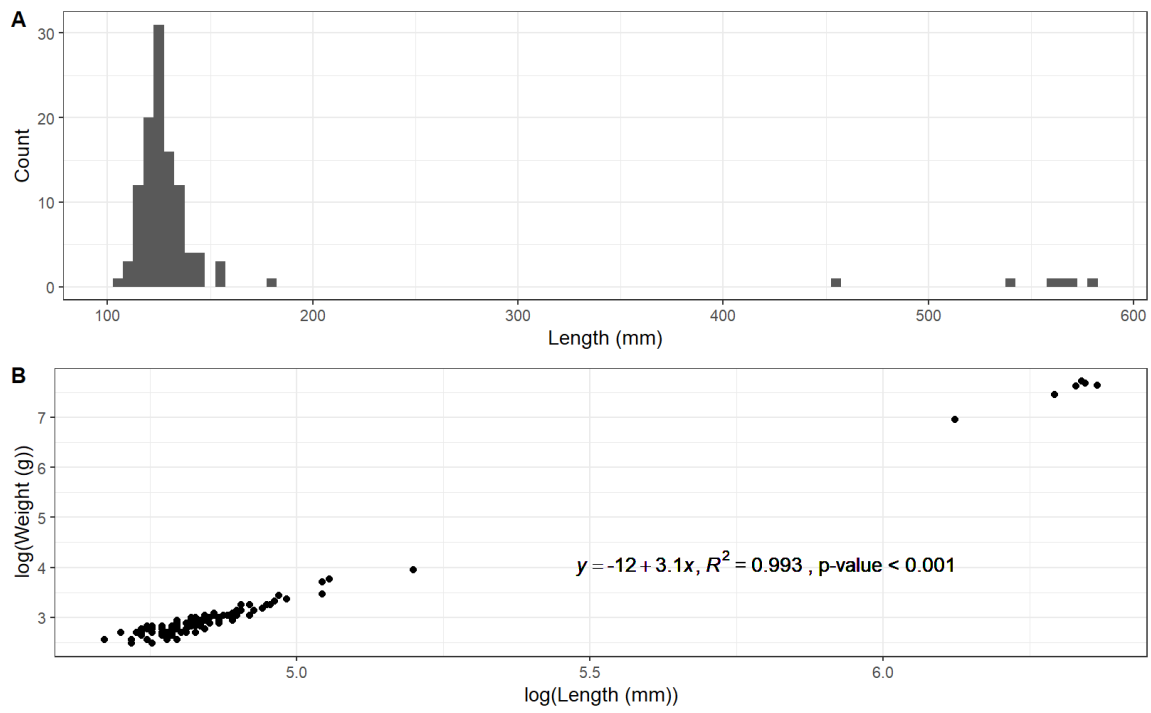


Figure 8. Sockeye salmon (*Oncorhynchus nerka*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

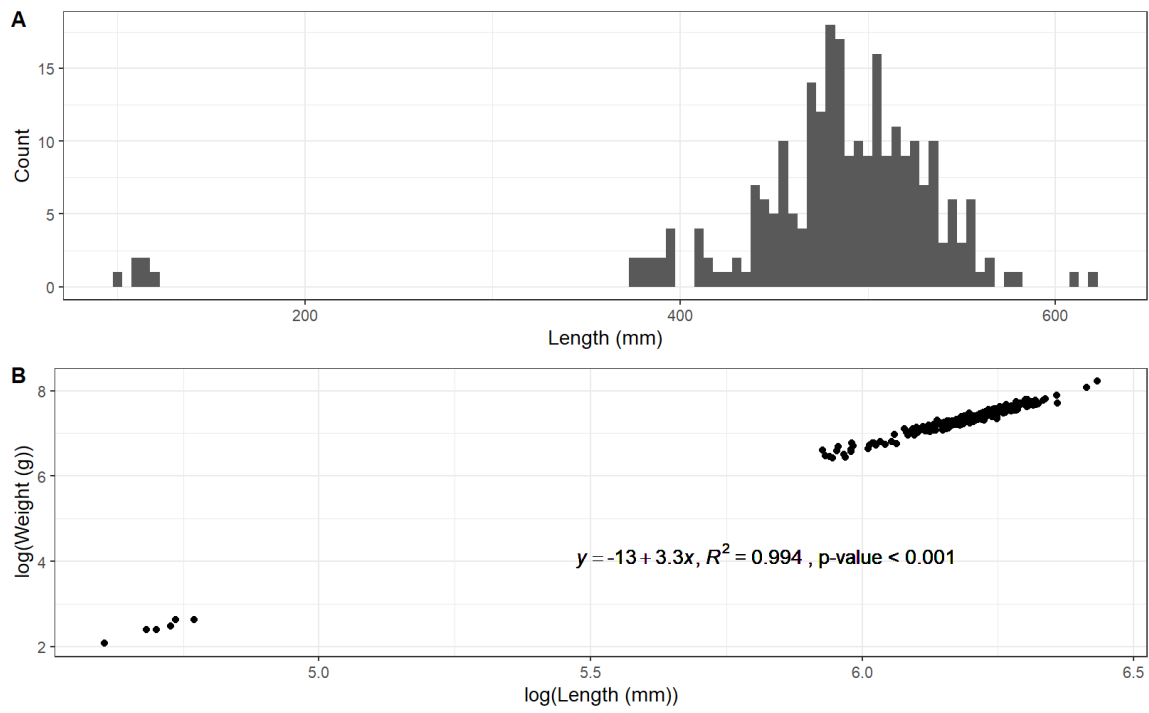


Figure 9. Pink salmon (*Oncorhynchus gorbuscha*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).



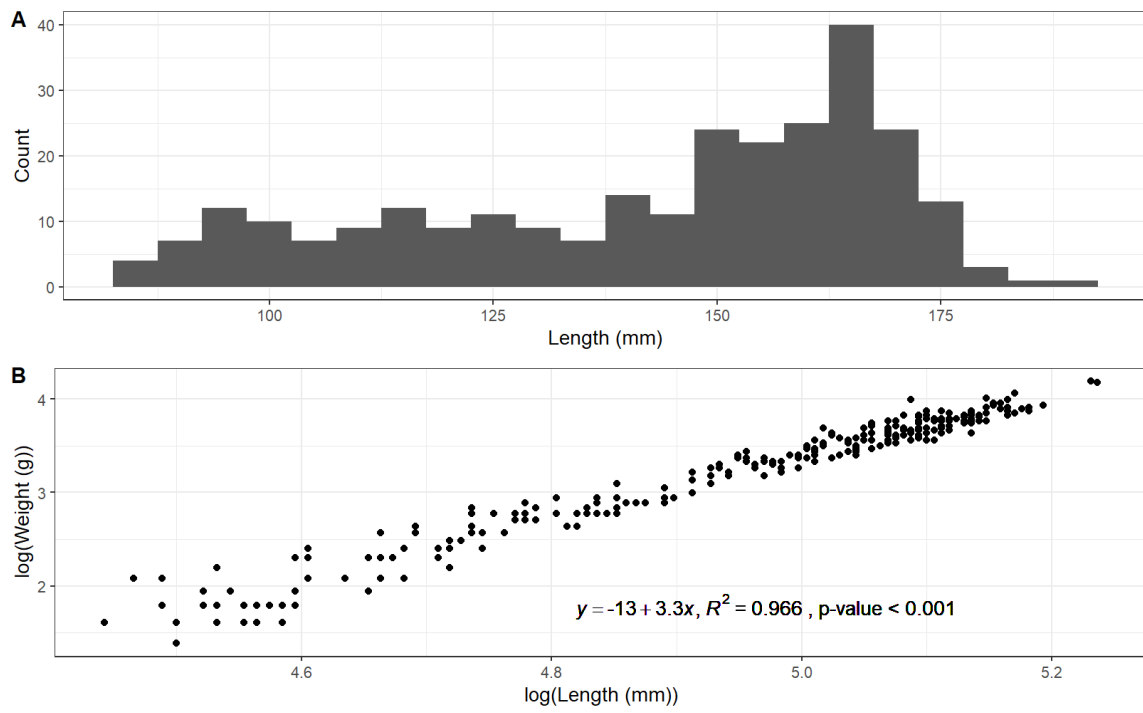


Figure 10. Eulachon (*Thaleichthys pacificus*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

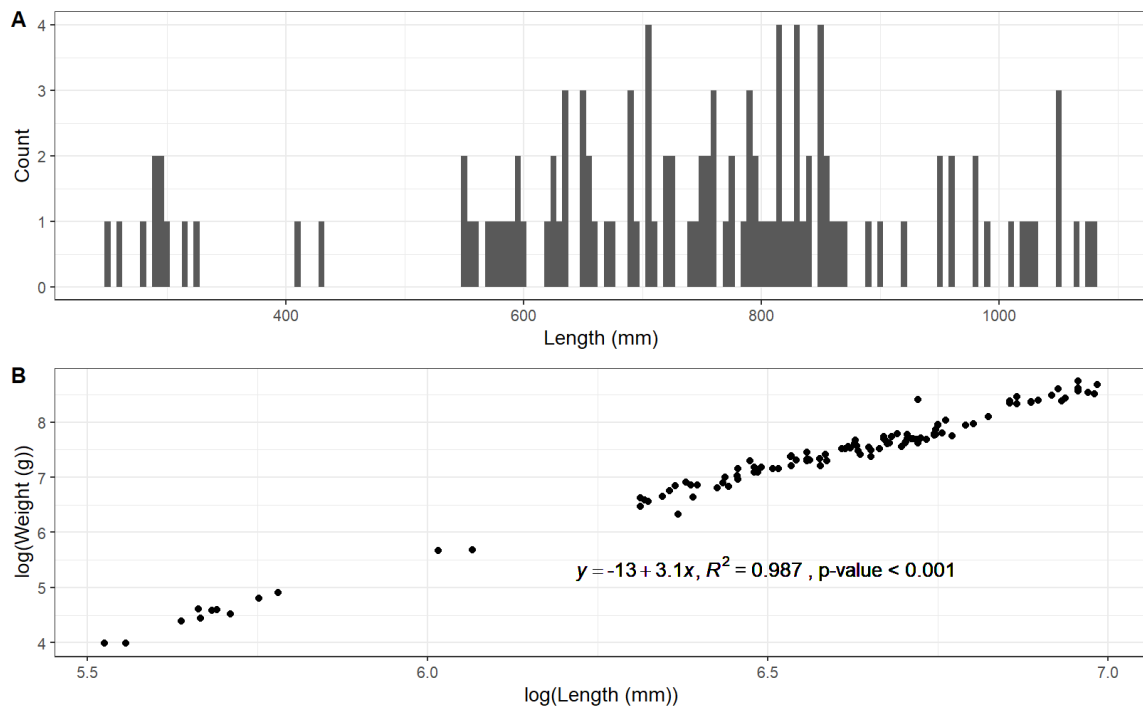


Figure 11. North Pacific spiny dogfish (*Squalus suckleyi*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

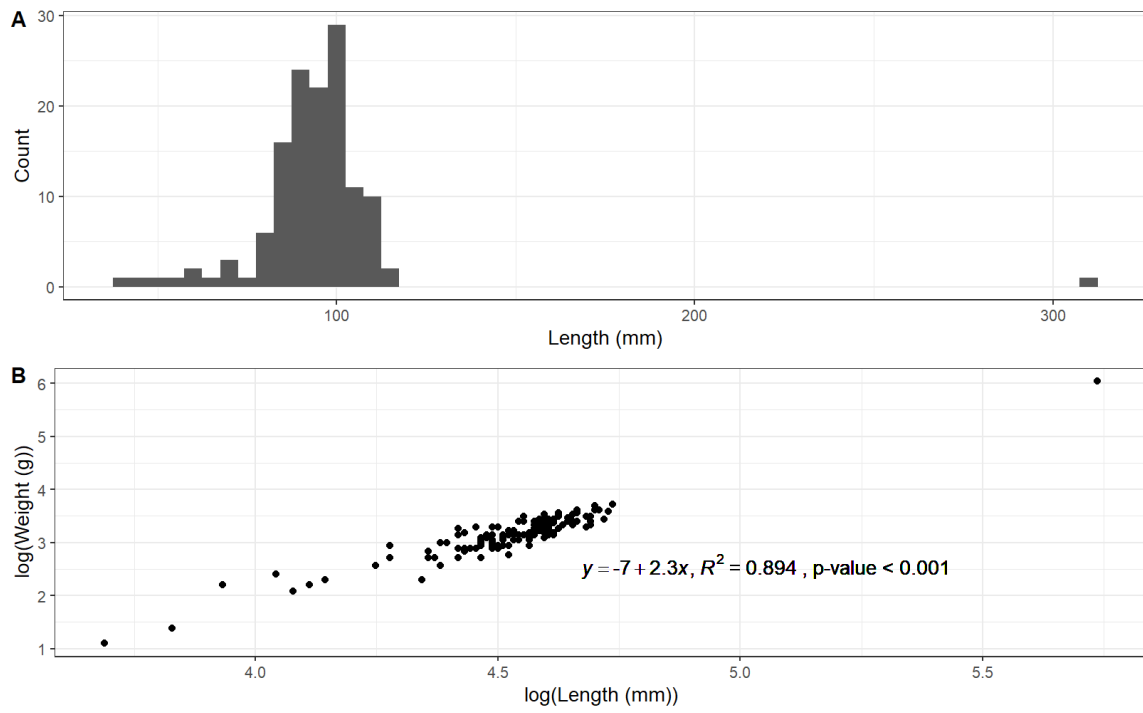


Figure 12. Opalescent inshore squid (*Doryteuthis opalescens*) length frequency plots as sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019 (A). Double log-transformed length-weight regression with outliers removed, using a Bonferroni outlier test (B).

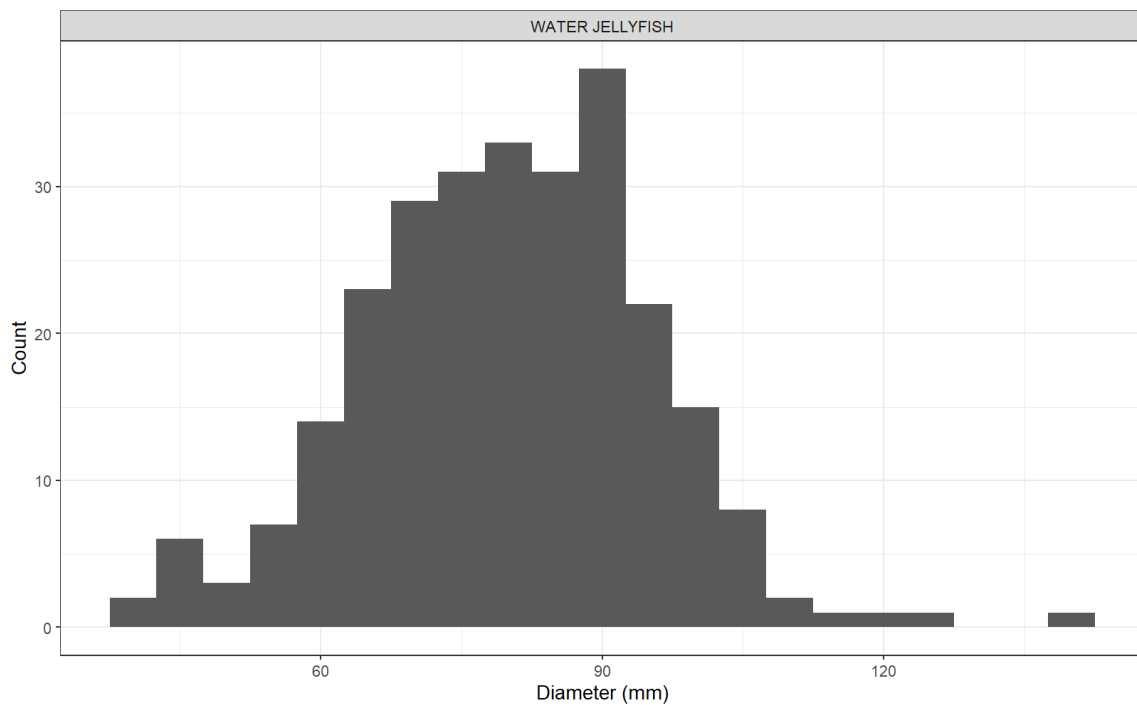


Figure 13. Bell diameter frequency plot (5 mm size bins) for specimens, with more than 100 individual measurements, sampled during the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15, 2019 to July 15, 2019.

## 8 TABLES

Table 1. Survey strata, strata sizes, target number of blocks to sample, and actual blocks sampled during the Integrated Pelagic Ecosystem Survey June 15 to July 15, 2019 aboard the *M. V. Nordic Pearl*. Actual bottom depths during the survey may differ from the depth (bathymetry for strata designation) of any given block; actual tow depth during the survey may differ from the targeted depth.

Stratum		Stratum Size			Target No. Blocks			No. Blocks Successfully Fished		
Location	Bottom Depth Range (m)	Total Blocks	Proportion	0 m	15 m	Total	0 m	15 m	Total	Proportion
<b>2019 Daytime</b>										
504	QCS 50-100	98	0.098	3	3	6	3	3	6	0.088
505	QCS 100-200	153	0.153	5	5	10	5	5	10	0.147
506	NWVI 50-100	52	0.052	2	2	4	2	2	4	0.059
507	NWVI 100-200	84	0.084	3	3	6	3	3	6	0.088
508	CWVI 50-100	79	0.079	3	3	6	3	3	6	0.088
509	CWVI 100-200	93	0.093	3	3	6	3	2	5	0.074
510	SWVI 50-100	190	0.189	7	7	14	8	5	13	0.191
511	SWVI 100-200	254	0.252	9	9	18	9	9	18	0.265
TOTAL		1003	1.000	35	35	70	36	32	68	1.000
<b>2019 Nighttime</b>										
504	QCS 50-100	98	0.098	3	3	6	3	3	6	0.091
505	QCS 100-200	153	0.153	5	5	10	5	5	10	0.152
506	NWVI 50-100	52	0.052	2	2	4	2	2	4	0.061
507	NWVI 100-200	84	0.084	3	3	6	3	3	6	0.091
508	CWVI 50-100	79	0.079	3	3	6	3	3	6	0.091
509	CWVI 100-200	93	0.093	3	3	6	3	2	5	0.076
510	SWVI 50-100	190	0.189	7	7	14	8	4	12	0.182
511	SWVI 100-200	254	0.252	9	9	18	9	8	17	0.258
TOTAL		1003	1.000	35	35	70	36	30	66	1.000

Table 2. All captured vertebrate fish species (or taxonomic group), ordered by total catch weight, showing number of tows in which the species occurred, total catch weight, maximum catch weight, and mean catch weight per tow for usable tows from the Integrated Pelagic Ecosystem Survey, June 15 to July 15, 2019 aboard the *M. V. Nordic Pearl*. Zero catch indicates specimens could not be weighed accurately with Marel platform scale.

Common Name	Scientific Name	Tows	Total	Max	Mean
Pacific herring	<i>Clupea pallasii</i>	67	19620.88	9847.40	292.85
North pacific spiny dogfish	<i>Squalus suckleyi</i>	14	1492.70	1150.00	106.62
Chum salmon	<i>Oncorhynchus keta</i>	48	832.86	109.57	17.35
Coho salmon	<i>Oncorhynchus kisutch</i>	51	676.04	124.30	13.26
Pink salmon	<i>Oncorhynchus gorbuscha</i>	34	475.63	96.33	13.99
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	59	291.63	24.84	4.94
Pacific hake	<i>Merluccius productus</i>	12	283.73	152.60	23.64
Jack mackerel	<i>Trachurus symmetricus</i>	4	115.61	80.74	28.90
Rockfishes	<i>Sebastes</i>	55	44.17	22.37	1.03
Eulachon	<i>Thaleichthys pacificus</i>	24	21.75	9.75	0.95
Sockeye salmon	<i>Oncorhynchus nerka</i>	12	14.24	2.39	1.19
Whitebait smelt	<i>Allosmerus elongatus</i>	3	8.81	8.74	2.94
American shad	<i>Alosa sapidissima</i>	2	5.36	5.36	5.36
Pacific sanddab	<i>Citharichthys sordidus</i>	10	5.25	1.34	0.52
Black rockfish	<i>Sebastes melanops</i>	8	3.24	1.24	0.46
Walleye pollock	<i>Theragra chalcogramma</i>	42	2.82	2.46	0.18
Widow rockfish	<i>Sebastes entomelas</i>	1	1.82	1.82	1.82
Wolf eel	<i>Anarrhichthys ocellatus</i>	30	1.80	0.45	0.09
Shortbelly rockfish	<i>Sebastes jordani</i>	2	1.71	1.64	0.86
Yellowtail rockfish	<i>Sebastes flavidus</i>	3	1.63	0.89	0.82
Northern anchovy	<i>Engraulis mordax</i>	2	1.47	1.42	0.74
Greenstriped rockfish	<i>Sebastes elongatus</i>	1	1.24	1.24	1.24
Slender sole	<i>Lyopsetta exilis</i>	2	0.51	0.42	0.26
Silvergray rockfish	<i>Sebastes brevispinis</i>	11	0.37	0.20	0.12
Copper rockfish	<i>Sebastes caurinus</i>	1	0.36	0.36	0.36
Lanternfish	<i>Tarletonbeania</i>	1	0.28	0.28	0.28
Arrowtooth flounder	<i>Reinhardtius stomias</i>	2	0.19	0.15	0.10
Flatfishes	Pleuronectiformes	57	0.15	0.08	0.02
Steelhead	<i>Oncorhynchus mykiss</i>	1	0.15	0.15	0.15
Prowfish	<i>Zaprora silenus</i>	7	0.14	0.03	0.02
Sablefish	<i>Anoplopoma fimbria</i>	2	0.10	0.07	0.05
Pacific sardine	<i>Sardinops sagax</i>	3	0.09	0.06	0.04
Canary rockfish	<i>Sebastes pinniger</i>	5	0.07	0.07	0.07
Codfishes	Gadidae	13	0.05	0.03	0.02
Pacific lamprey	<i>Lampetra tridentata</i>	1	0.02	0.02	0.02
Sanddabs	<i>Citharichthys</i>	4	0.01	0.01	0.01
Larval fish	Larval fish	13	0.00		
Top shark	<i>Galeorhinus galeus</i>	8	0.00		

Common Name	Scientific Name	Tows	Total	Max	Mean
Smelts	Osmeridae	7	0.00		
Lumpfishes and snailfishes	Cyclopteridae	5	0.00		
Pacific tomcod	<i>Microgadus proximus</i>	4	0.00		
Sturgeon poacher	<i>Podothecus accipenserinus</i>	4	0.00		
Ocean sunfish	<i>Mola mola</i>	3	0.00		
Pacific sand lance	<i>Ammodytes hexapterus</i>	3	0.00		
Blue shark	<i>Prionace glauca</i>	2	0.00		
Darkblotched rockfish	<i>Sebastes crameri</i>	2	0.00		
Greenlings	Hexagrammidae	2	0.00		
Northern spearnose poacher	<i>Agonopsis vulsa</i>	1	0.00		
Unknown fish	Unknown fish	1	0.00		
	Total vertebrates		23906.88		



Table 3. All captured invertebrate species (or taxonomic group), ordered by total catch weight, showing number of tows in which the species occurred, total catch weight, maximum catch weight, and mean catch weight per tow for usable tows from the Integrated Pelagic Ecosystem Survey, June 15 to July 15, 2019 aboard the *M. V. Nordic Pearl*. Zero catch indicates specimens could not be weighed accurately with Marel platform scale.

Common Name	Scientific Name	Tows	Total	Max	Mean
Pink shrimp (smooth)	<i>Pandalus jordani</i>	4	724.34	704.93	241.45
Water jellyfish	<i>Aequorea</i>	49	245.40	30.48	5.22
Jellyfish	Scyphozoa	44	192.05	14.73	4.68
Euphausiids	Euphausiacea	26	149.43	41.00	7.47
Lions mane jellyfish	<i>Cyanea capillata</i>	43	124.83	10.14	2.97
Moon jellyfish	<i>Aurelia labiata</i>	28	114.72	28.16	4.10
Pacific sea nettle	<i>Chrysaora fuscescens</i>	20	37.67	6.52	1.88
Fried egg jellyfish	<i>Phacellophora camtschatica</i>	17	24.98	5.99	1.56
Opalescent inshore squid	<i>Doryteuthis opalescens</i>	29	19.61	8.31	0.78
Boreal clubhook squid	<i>Onychoteuthis borealijaponicus</i>	6	11.17	6.26	2.23
Dinner plate jellyfish	<i>Solmissus</i>	3	2.83	1.88	0.94
Comb jellyfish	Ctenophora	10	0.66	0.42	0.13
Salps	Salpida	1	0.04	0.04	0.04
Sea butterfly	<i>Corolla</i>	2	0.02	0.02	0.02
Calyropsis spp.	Calyropsis	1	0.00		
Isopods	Isopoda	1	0.00		
Siphonophorae	Siphonophorae	1	0.00		
Squids	Teuthida	1	0.00		
True crabs	Brachyura	1	0.00		
	Total invertebrates		1647.75		

Table 4. Sample size and statistics of lengths and weights for each species (listed alphabetically) sampled during the Integrated Pelagic Ecosystem Survey, June 15 to July 15, 2019 aboard the *M. V. Nordic Pearl*. (Sampled = number of tows, Measured = number of lengths, Weighed = number of weights).

Species	Sampled	Measured	Length (mm)			Weighed	Weight (g)		
			Min	Max	Mean		Min	Max	Mean
American Shad	1	1	240	240	240.0	1	141	141	141
Arrowtooth Flounder	2	3	142	251	184.3	3	16	112	57.3
Black Rockfish	6	6	189	382	253.3	6	102	920	317.3
Blue Shark	2	2	1560	1670	1615.0	0			
Boreal Clubhook Squid	3	36	149	270	218.0	36	113	488	280.5
Chinook Salmon	59	216	141	900	378.7	216	32	9210	1263.2
Chum Salmon	48	412	105	863	311.8	412	11	9420	1630.6
Coho Salmon	51	396	155	654	443.0	396	43	3512	1388
Comb Jellyfish	5	52	21	70	31.3	0			
Copper Rockfish	1	1	282	282	282.0	1	385	385	385
Dinner Plate Jellyfish	1	1	223	223	223.0	0			
Eulachon	20	279	85	188	141.8	279	4	66	28.8
Flatfishes	1	3	132	149	139.7	3	16	25	20
Fried Egg Jellyfish	4	5	71	301	186.8	0			
Greenstriped Rockfish	1	1	299	299	299.0	1	340	340	340
Jack Mackerel	4	65	316	534	493.7	65	355	1890	1393.9
Jellyfish	1	5	37	67	53.6	0			
Lions Mane Jellyfish	12	27	56	458	212.5	0			
Moon Jellyfish	15	69	62	407	275.2	0			
North Pacific Spiny Dogfish	14	118	251	1080	732.2	116	54	6260	2037.6
Northern Anchovy	2	2	148	152	150.0	2	37	38	37.5
Ocean Sunfish	1	1	240	240	240.0	0			
Opalescent Inshore Squid	18	262	21	310	70.1	134	3	420	27.5
Pacific Hake	9	88	318	591	485.5	88	213	1469	753.4
Pacific Herring	58	5002	103	236	172.7	5002	12	183	74.9
Pacific Lamprey	1	1	208	208	208.0	1	19	19	19
Pacific Sanddab	10	64	56	305	184.6	63	1	278	82.7
Pacific Sardine	2	3	144	150	146.7	3	31	34	32.7
Pacific Sea Nettle	7	8	137	535	381.2	2	214	591	402.5
Pink Salmon	34	254	100	622	479.5	254	8	3734	1528.6
Prowfish	3	3	75	121	105.0	3	3	33	21
Rockfishes	1	34	39	59	49.7	0			
Sablefish	2	3	98	193	143.7	3	10	75	36.7
Shortbelly Rockfish	1	26	160	204	174.5	26	45	99	56.8
Slender Sole	2	3	170	353	246.3	3	27	424	171.3
Sockeye Salmon	12	114	107	581	148.9	114	12	2251	117.4
Steelhead	1	1	235	235	235.0	1	126	126	126
Tope Shark	8	8	163	1790	907.8	0			
Walleye Pollock	1	10	284	313	296.4	10	195	291	235.2
Water Jellyfish	21	268	39	141	79.9	1	20	20	20
Whitebait Smelt	2	63	87	131	104.4	63	5	22	10.8
Widow Rockfish	1	1	504	504	504.0	1	1765	1765	1765
Wolf Eel	5	11	365	561	469.1	11	16	118	61.4

Table 5. Number of samples (tows), number of stomachs examined, number empty stomachs, and percentage of stomachs that were empty for species sampled (listed alphabetically) during the Integrated Pelagic Ecosystem Survey, June 15 to July 15, 2019 aboard the *M.V. Nordic Pearl*.

<b>Species</b>	<b>Number of Tows</b>	<b>Number of Stomachs</b>	<b>Number of Empty Stomachs</b>	<b>Percent Empty Stomachs</b>
American Shad	1	1	1	100
Arrowtooth Flounder	2	3	1	33
Black Rockfish	5	5	0	0
Chinook Salmon	58	189	14	7
Chum Salmon	48	237	18	8
Coho Salmon	49	245	17	7
Copper Rockfish	1	1	1	100
Eulachon	20	106	61	58
Jack Mackerel	4	18	1	6
North Pacific Spiny Dogfish	2	16	7	44
Northern Anchovy	2	2	0	0
Pacific Hake	9	44	5	11
Pacific Herring	48	445	122	27
Pacific Sanddab	10	41	14	34
Pink Salmon	34	161	7	4
Prowfish	3	3	0	0
Sablefish	2	3	0	0
Shortbelly Rockfish	1	10	3	30
Slender Sole	2	3	0	0
Sockeye Salmon	12	33	5	15
Steelhead	1	1	0	0
Walleye Pollock	1	10	0	0
Whitebait Smelt	2	11	3	27
Widow Rockfish	1	1	0	0
Wolf Eel	3	7	1	14

Table 6. Prey items identified in the stomach contents of species sampled (listed alphabetically) during the Integrated Pelagic Ecosystem Survey, June 15 to July 15, 2019 aboard the *M.V. Nordic Pearl*. The average prey volume is in cm<sup>3</sup> and the count of stomachs is the number of stomachs examined.

<b>Species</b>	<b>Prey Species</b>	<b>Average Prey Volume</b>	<b>Count of Stomachs</b>
Arrowtooth Flounder	Euphausiids	0.15	2
Black Rockfish	True Crabs	0.76	2
Black Rockfish	Unid. Remains	0.58	4
Chinook Salmon	Pacific Herring	34.34	27
Chinook Salmon	Pink Shrimp (Smooth)	21.60	1
Chinook Salmon	Rockfishes	10.47	13
Chinook Salmon	Euphausiids	5.92	44
Chinook Salmon	Unid. Fishes	3.41	76
Chinook Salmon	Unid. Remains	2.84	14
Chinook Salmon	Squids	2.66	5
Chinook Salmon	True Crabs	2.64	48
Chinook Salmon	Flatfishes	0.80	2
Chinook Salmon	Smelts	0.70	3
Chinook Salmon	Unidentified Plankton	0.20	1
Chinook Salmon	Sturgeon Poacher	0.01	1
Chum Salmon	Unkn. Marine Organics	13.73	9
Chum Salmon	Unid. Remains	4.87	151
Chum Salmon	Rockfishes	4.05	2
Chum Salmon	Jellyfish	1.00	13
Chum Salmon	Euphausiids	0.88	71
Chum Salmon	Unid. Fishes	0.32	5
Chum Salmon	Mysids	0.29	7
Chum Salmon	True Crabs	0.24	7
Chum Salmon	Amphipods	0.23	7
Chum Salmon	Invertebrates	0.14	6
Coho Salmon	Pacific Herring	47.97	32
Coho Salmon	Euphausiids	18.93	85
Coho Salmon	True Crabs	8.77	117
Coho Salmon	Rockfishes	7.95	20
Coho Salmon	Squids	5.75	2
Coho Salmon	Unid. Fishes	5.25	68
Coho Salmon	Unid. Remains	4.10	8
Coho Salmon	Lanternfishes	2.00	1
Coho Salmon	Segmented Worms	0.30	1
Coho Salmon	Amphipods	0.23	8
Coho Salmon	Invertebrates	0.10	2
Coho Salmon	Mysids	0.01	1
Eulachon	Euphausiids	0.28	43

Table 6. continued.

<b>Species</b>	<b>Prey Species</b>	<b>Average Prey Volume</b>	<b>Count of Stomachs</b>
Eulachon	Unid. Remains	0.01	1
Eulachon	Unidentified Plankton	0.01	1
Jack Mackerel	True Crabs	1.46	4
Jack Mackerel	Unid. Fishes	1.19	6
Jack Mackerel	Euphausiids	0.78	13
Jack Mackerel	Unid. Remains	0.01	1
North Pacific Spiny Dogfish	Rockfishes	240.00	1
North Pacific Spiny Dogfish	Euphausiids	10.29	7
North Pacific Spiny Dogfish	Unid. Remains	5.00	1
North Pacific Spiny Dogfish	Unkn. Marine Organics	3.00	1
Northern Anchovy	True Crabs	0.60	1
Northern Anchovy	Unid. Remains	0.01	1
Pacific Hake	Pacific Herring	36.00	1
Pacific Hake	Shortbelly Rockfish	34.00	1
Pacific Hake	Unid. Fishes	16.50	1
Pacific Hake	Euphausiids	6.23	36
Pacific Hake	Unid. Remains	3.20	1
Pacific Hake	Jellyfish	0.01	1
Pacific Herring	Euphausiids	2.39	155
Pacific Herring	Unid. Fishes	0.95	4
Pacific Herring	True Crabs	0.87	14
Pacific Herring	Salps	0.65	12
Pacific Herring	Unidentified Plankton	0.53	7
Pacific Herring	Unid. Remains	0.29	143
Pacific Herring	Unkn. Marine Organics	0.02	3
Pacific Herring	Amphipods	0.01	2
Pacific Sanddab	Jellyfish	2.60	5
Pacific Sanddab	Bivalve Molluscs	2.50	1
Pacific Sanddab	Euphausiids	0.93	7
Pacific Sanddab	Unid. Fishes	0.10	1
Pacific Sanddab	Amphipods	0.10	1
Pacific Sanddab	Mysids	0.01	1
Pacific Sanddab	Unid. Remains	0.01	13
Pink Salmon	Rockfishes	33.80	2
Pink Salmon	Euphausiids	11.46	74
Pink Salmon	True Crabs	9.76	106
Pink Salmon	Squids	4.00	1

Table 6. continued.

<b>Species</b>	<b>Prey Species</b>	<b>Average Prey Volume</b>	<b>Count of Stomachs</b>
Pink Salmon	Unkn. Marine Organics	3.10	1
Pink Salmon	Unid. Fishes	2.56	18
Pink Salmon	Unid. Remains	2.27	14
Pink Salmon	Amphipods	1.60	7
Pink Salmon	Unidentified Plankton	1.00	1
Pink Salmon	Invertebrates	0.25	4
Pink Salmon	Pandalid Shrimp	0.20	1
Pink Salmon	Polychaete Worms	0.10	1
Prowfish	Euphausiids	0.40	1
Prowfish	Unidentified Plankton	0.30	1
Prowfish	Segmented Worms	0.10	1
Prowfish	Unid. Remains	0.10	1
Sablefish	Unid. Fishes	0.80	1
Sablefish	Unid. Remains	0.70	3
Shortbelly Rockfish	Euphausiids	0.76	7
Slender Sole	Euphausiids	0.27	3
Sockeye Salmon	Euphausiids	5.77	3
Sockeye Salmon	True Crabs	1.07	15
Sockeye Salmon	Amphipods	0.50	1
Sockeye Salmon	Invertebrates	0.42	5
Sockeye Salmon	Mysids	0.10	1
Sockeye Salmon	Unidentified Plankton	0.10	1
Sockeye Salmon	Unid. Remains	0.06	2
Sockeye Salmon	Unid. Fishes	0.01	1
Steelhead	Unid. Fishes	2.00	1
Steelhead	Euphausiids	0.40	1
Walleye Pollock	Euphausiids	9.25	10
Whitebait Smelt	True Crabs	0.20	6
Whitebait Smelt	Unid. Remains	0.15	2
Widow Rockfish	Euphausiids	2.60	1
Wolf Eel	Flatfishes	0.80	1
Wolf Eel	Unid. Remains	0.65	4
Wolf Eel	Invertebrates	0.40	1
Wolf Eel	Unid. Fishes	0.20	1
Wolf Eel	True Crabs	0.10	2
Wolf Eel	Amphipods	0.01	4

Table 7. Biomass estimates in tonnes (coefficient of variance (CV), standard error (SE), 95% confidence intervals (CI) for the upper 30 m pelagic layer for juvenile Pacific Salmon (daytime tows only) and Pacific Herring (nighttime tows only) during the Integrated Pelagic Ecosystem Survey, June 15 to July 15, 2019, aboard the *M.V. Nordic Pearl*. If estimated lower confidence interval (CI) was negative, it is reported as zero.

<b>Species</b>	<b>Biomass (t)</b>	<b>CV</b>	<b>SE</b>	<b>Lower CI (t)</b>	<b>Upper CI (t)</b>
Chinook Salmon	8.32	0.25	0.26	4.19	12.46
Chum Salmon	25.50	0.64	1.99	0.00	57.61
Coho Salmon	17.85	0.45	0.97	2.24	33.46
Pink Salmon	0.00		0.00	0.00	0.00
Sockeye Salmon	4.41	0.72	0.38	0.00	10.62
Pacific Herring	98217.00	0.58	6966.82	0.00	209150.46

**APPENDIX A Net utilized during the 2019 Integrated Pelagic Ecosystem Survey**

Table A.1. Net specifications for the LFS 7742 mid-water Trawl Net used during the Integrated Pelagic Ecosystem Survey aboard the *M. V. Nordic Pearl*, June 15 to July 15, 2019.

Part	Size	Material
<b>Rigging</b>		
Doors	4 m <sup>2</sup>	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
<b>Net Frame</b>		
Head Line	102.83 m (56.2 fm)	5/8 inch coated Spectra Rope
<b>Foot Rope</b>		
Foot Rope	102.83 (56.2 fm)	9/16 inch coasted Spectra rope with 13 mm chain
<b>Web</b>		
Mesh incl. Codend	3.8 cm (1.5 inch)	Knotted nylon
Codend Liner	12.7 mm (0.5 inch) stretched	210/20 knotless liner



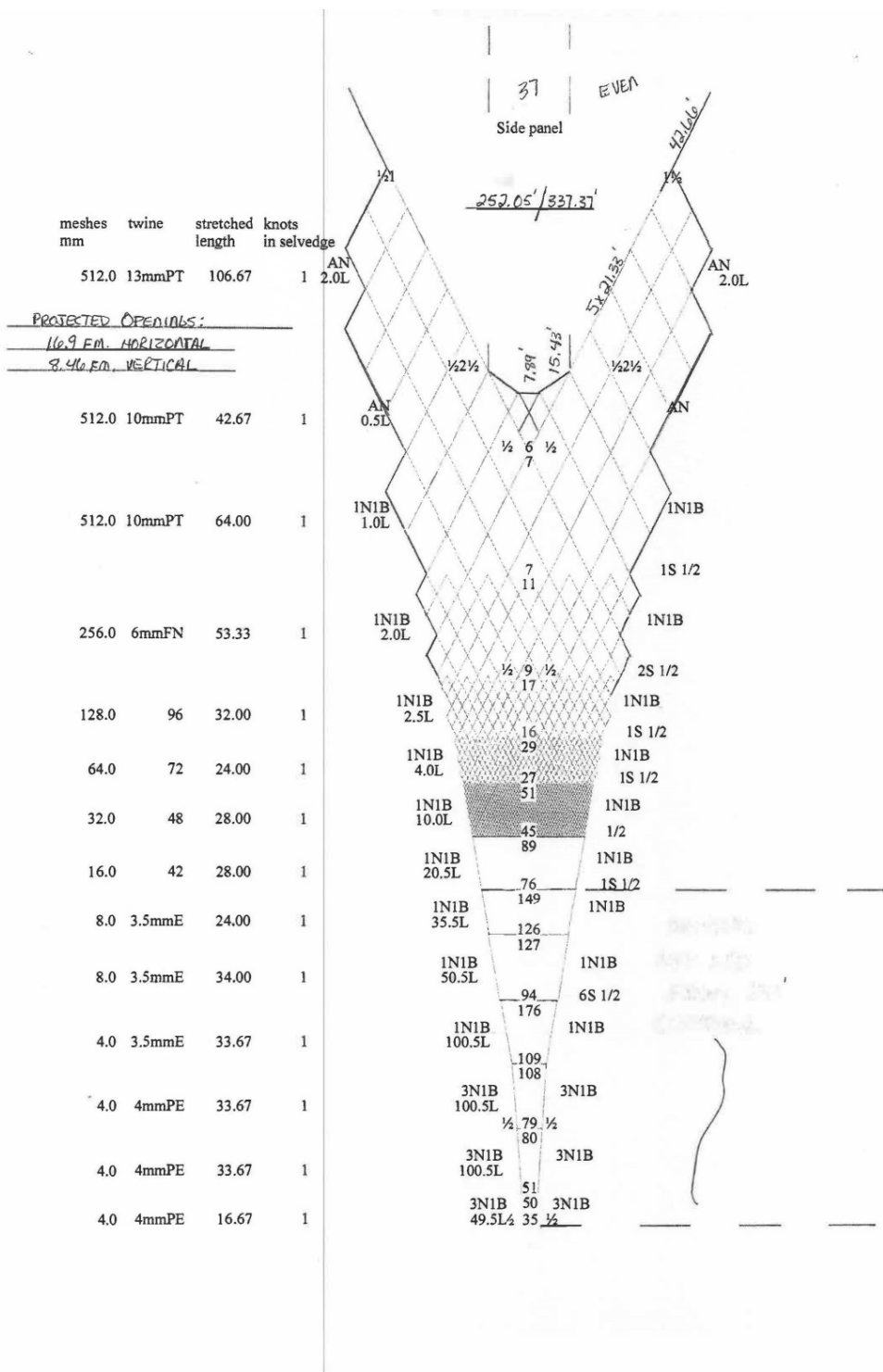


Figure A.1. Diagram of LFS 7742 mid-water Trawl Net used during the Integrated Pelagic Ecosystem Survey, June 15 to July 15, 2019, aboard the *M.V. Nordic Pearl*.

## APPENDIX B The Beaufort Scale

Table B.1. The Beaufort Scale used to describe weather conditions.

Force	Description	Wind Speed (knots)	Sea State
0	Calm	<1	Sea like mirror
1	Light Air	1-3	Ripples; no foam crests
2	Light Breeze	4-6	Small wavelets
3	Gentle Breeze	7-10	Crests breaking
4	Moderate Breeze	11-16	Whitecaps
5	Fresh Breeze	17-21	Moderate waves - spray
6	Strong Breeze	22-27	Large waves
7	Moderate Gale	28-33	Sea heaps up
8	Fresh Gale	34-40	Moderately high waves
9	Strong Gale	41-47	High waves; spray
10	Whole Gale	48-55	Overhanging crests; sea white
11	Storm	56-63	Exceptionally high waves
12	Hurricane	64-118	Sea white

## APPENDIX C Sardine Maturity Convention

Table C.1. Description of maturity stages for Pacific sardine maturity determination.

<b>Code</b>	<b>Appearance</b>	<b>Maturity</b>	<b>Description</b>
1	torpedo-shaped	F - immature	Clearly Immature: oocytes not visible, ovary is very small, translucent/clear, and thin but with rounded edges (torpedo shape).
2	oocytes not visible	F - intermediate	Intermediate: Individual oocytes are not visible to unaided eye (no visible yolk or hydrate oocytes in the ovaries) and ovary is not clearly immature. Includes possible maturing and regressed ovaries.
3	oocytes visible	F - active	Active: Yoliked oocytes visible, any size or amount as long as you can see them by the unaided eye in ovaries. This includes the smaller opaque oocytes (around 0.4-0.5 mm) to the large yellowish oocytes (about 0.6-0.8mm). If hydrated oocytes are also present
4	hydrated oocytes	F - mature	Hydrated oocytes present, yoliked oocytes may, or not, also be seen; any amount of hydrated oocytes (large and transparent) qualifies for this class from few to many or even if loose or "oozing/running" from ovary.
5	knife-shaped	M - immature	Clearly Immature: testes is very small, knife-shaped, translucent/clear, thin with a flat ventral edge
6	no milt present	M - intermediate	Intermediate: no milt evident and is not clearly immature; includes maturing or regressed testes
7	milt present	M - mature	Milt is present: either oozing from pore, in the duct, or when testes is cut with a knife
8	unknown	unknown	Unknown

## APPENDIX D Shark Sampling Protocol for use on DFO Research Surveys

### DFO SHARK SAMPLING PROTOCOL

When handling live sharks be careful. They will normally calm down when their eyes are covered.

#### FOR LIVE OR DEAD SHARKS:

##### 1. TAKE PHOTOS (ONE PER SPECIES PER TOW)

Side views of:

- whole shark alongside measuring tape
- head & gill openings
- tail fin

Ventral views of:

- claspers of males

#### TO KEEP TRACK OF PHOTOS

Include a piece of paper in the photo with:

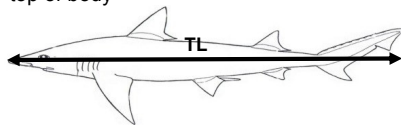
- Species
- Tow

##### 2. RECORD LENGTHS

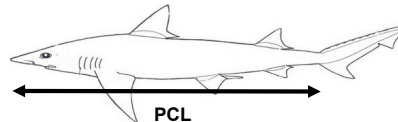
- Total length: tip of snout to tip of upper lobe of caudal fin with fin in a straight line with top of body

AND

- Pre-caudal length: tip of snout to caudal fin



Move upper lobe downwards so that it is in line with top of body

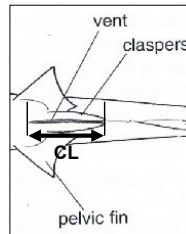


##### 3. RECORD SEX

- Males have claspers associated with pelvic fin

#### IF TIME PERMITS ALSO RECORD:

- Clasper length (CL) and note if they are rigid or red



- OR • Females do not have claspers

##### 4. COLLECT DNA TISSUE SAMPLE

- clip 1 cm of tissue from any fin tip
- place in vials with ethanol and record vial number

#### FOR DEAD SHARKS (Can be subsampled if > 20 sharks in tow):

##### 5. PRESENCE AND SAMPLING OF PUPS

- number of pups

#### IF TIME PERMITS RECORD OR COLLECT:

- total length (cm) of pups
- muscle tissue from pups (see 7 below)—can be subsampled if there are >10 pups
- Pup numbers can be Mother's fish number + P1, P2, etc.

##### 6. SAMPLE AND RECORD STOMACH CONTENTS

- Sort and identify to lowest taxonomic group you feel confident with
- For each prey group or item measure a) volume (L) and/or length (mm)
- For each prey group or item record digestion state as Fresh, Partial or Well

##### 7. COLLECT MUSCLE TISSUE

- the size of an ice cube (about 1 cm<sup>3</sup>)
- freeze in a small ziploc provided and label

#### LABEL ALL FROZEN SAMPLES

- Species
- Fish number (P1, P2 etc if pups)
- Date collected
- Tow number

**APPENDIX E Bridge Data from the 2019 Integrated Pelagic Ecosystem Survey**

Table E.1. Bridge log information for trawl tows from the Integrated Ecosystem Pelagic Survey aboard the *M. V. Nordic Pearl*, June 15 to July 15, 2019. Beaufort Scale code for sea state definitions are provided above.

	1	2	3	4	5	6	7	8
Event Number	19	22	23	26	27	28	29	30
Date	2019-06-19	2019-06-19	2019-06-19	2019-06-19	2019-06-20	2019-06-20	2019-06-21	2019-06-21
Stratum	504	505	505	505	504	505	504	504
Block Number	10788	10912	11168	11168	10788	10912	10783	10908
Start Time (PDT)	16:32	18:33	20:44	22:33	00:52	02:17	15:56	17:19
Duration (min)	21	21	20	22	21	21	21	20
Start Latitude	50°59'4 N	51°0'54 N	51°2'57 N	51°5'5 N	50°58'55 N	51°0'57 N	50°58'54 N	51°1'14 N
Start Longitude	128°11'9 W	128°10'30 W	127°53'27 W	127°49'39 W	128°10'45 W	128°10'12 W	128°27'18 W	128°27'34 W
End Latitude	50°57'45 N	50°59'32 N	51°4'1 N	51°3'40 N	50°57'44 N	51°0'14 N	50°57'26 N	51°0'2 N
End Longitude	128°9'14 W	128°12'38 W	127°51'37 W	127°51'15 W	128°8'49 W	128°12'30 W	128°25'49 W	128°25'42 W
Distance Towed (km)	3.30	3.54	2.92	3.22	3.14	3.00	3.22	2.89
Direction of Tow (deg)	137	224	46	215	133	243	147	131
Vessel Speed (km/h)	9.6	8.9	8.5	9.1	9.2	8.9	9.4	8.5
Swell Height (m)	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5
Beaufort Scale	4	2	3	3	2	2	3	3
Cloud Cover (Bottom Depth (m))	82	145	150	107	77	142	97	100
Net Opening Height (m)	15.7				16.2			
Net Opening Width (m)	40.1	41.8	41.6	39.2	38.9	42.5	40.1	42.6
Door Spread (m)	71.7	74.8	74.3	70.0	69.6	75.9	71.5	76.2
Target Headrope Depth (m)	0	15	15	15	0	15	0	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	9	10	11	12	13	14	15	16
Event Number	33	36	37	38	39	42	45	48
Date	2019-06-21	2019-06-21	2019-06-22	2019-06-22	2019-06-22	2019-06-22	2019-06-22	2019-06-22
Stratum	505	505	504	504	504	505	505	505
Block Number	11533	11533	10908	10783	11275	11398	11521	11396
Start Time (PDT)	19:43	22:24	00:06	01:11	15:36	17:13	18:43	20:27
Duration (min)	20	22	21	22	20	20	20	20
Start Latitude	51°9'38 N	51°11'50 N	51°1'17 N	50°58'46 N	51°7'42 N	51°7'36 N	51°9'58 N	51°9'45 N
Start Longitude	128°23'50 W	128°27'28 W	128°27'35 W	128°27'43 W	128°54'58 W	128°58'33 W	129°5'39 W	129°5'14 W
End Latitude	51°10'46 N	51°10'52 N	51°0'11 N	50°57'38 N	51°6'1 N	51°8'49 N	51°11'11 N	51°8'46 N
End Longitude	128°25'44 W	128°25'13 W	128°25'43 W	128°25'40 W	128°53'35 W	129°0'41 W	129°7'45 W	129°7'31 W
Distance Towed (km)	3.06	3.19	2.77	3.18	3.50	3.37	3.34	3.24
Direction of Tow (deg)	313	124	128	131	153	312	313	236
Vessel Speed (km/h)	8.8	9.0	8.1	9.1	10.2	10.1	9.7	9.5
Swell Height (m)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Beaufort Scale	2	2	3	3	3	3	2	2
Cloud Cover (Bottom Depth) (m)	193	196	97	96	110	126	153	150
Net Opening Height (m)	42.1	40.1	42.6	15.9	42.1	19.5	40.4	13.9
Net Opening Width (m)	75.3	71.7	76.2	67.4	75.3	37.4	72.1	36.5
Door Spread (m)	15	15	15	0	15	0	15	0
Target Headrope Depth (m)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes



Tow	17	18	19	20	21	22	23	24
Event Number	49	50	51	52	53	56	59	62
Date	2019-06-22	2019-06-22	2019-06-23	2019-06-23	2019-06-23	2019-06-23	2019-06-23	2019-06-23
Stratum	504	505	505	505	505	505	504	504
Block Number	11275	11398	11521	11396	11145	10894	10772	10772
Start Time (PDT)	22:40	23:53	00:55	02:04	16:01	17:57	19:37	22:26
Duration (min)	21	21	20	20	21	20	21	21
Start Latitude	51° 7'24 N	51° 7'46 N	51° 9'44 N	51° 9'30 N	51° 5'24 N	51° 1'12 N	50° 58'59 N	50° 59'17 N
Start Longitude	128° 54'23 W	128° 58'9 W	129° 5'8 W	129° 5'33 W	129° 11'43 W	129° 15'3 W	129° 5'19 W	129° 5'35 W
End Latitude	51° 6'46 N	51° 8'44 N	51° 10'33 N	51° 8'35 N	51° 4'10 N	50° 59'41 N	50° 57'41 N	50° 58'40 N
End Longitude	128° 52'21 W	129° 0'14 W	129° 7'18 W	129° 7'54 W	129° 9'36 W	129° 12'47 W	129° 3'28 W	129° 3'40 W
Distance Towed (km)	2.63	3.01	2.95	3.23	3.36	3.64	3.25	2.52
Direction of Tow (deg)	116	306	301	238	133	134	138	117
Vessel Speed (km/h)	7.6	8.9	8.6	9.7	9.8	10.5	9.4	7.3
Swell Height (m)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Beaufort Scale	3	3	3	3	2	2	2	2
Cloud Cover (Bottom Depth) (m)	103	122	151	145	157	163	106	107
Net Opening Height (m)		19.9		20.7	15.0	15.3		
Net Opening Width (m)	42.1	38.7	41.8	38.9	39.6	39.1	42.5	46.2
Door Spread (m)	75.2	69.2	74.7	69.5	70.6	69.9	76.0	82.5
Target Headrope Depth (m)	15	0	15	0	0	0	15	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	25	26	27	28	29	30	31	32
Event Number	63	64	65	68	69	72	73	74
Date	2019-06-23	2019-06-24	2019-06-24	2019-06-24	2019-06-24	2019-06-24	2019-06-24	2019-06-25
Stratum	505	505	506	505	505	505	505	506
Block Number	10894	11145	10394	10518	10642	10642	10518	10394
Start Time (PDT)	23:51	01:00	15:51	17:18	18:17	22:28	23:25	00:35
Duration (min)	21	21	21	21	20	21	20	21
Start Latitude	50° 59'8 N	51° 3'21 N	50° 50'41 N	50° 52'43 N	50° 54'41 N	50° 56'45 N	50° 54'35 N	50° 50'25 N
Start Longitude	129° 12'31 W	129° 12'2 W	129° 15'1 W	129° 15'35 W	129° 18'46 W	129° 22'8 W	129° 18'39 W	129° 15'14 W
End Latitude	51° 0'9 N	51° 4'41 N	50° 51'60 N	50° 53'59 N	50° 55'36 N	50° 55'57 N	50° 53'22 N	50° 51'48 N
End Longitude	129° 15'2 W	129° 10'4 W	129° 13'13 W	129° 17'37 W	129° 20'45 W	129° 19'56 W	129° 16'40 W	129° 13'54 W
Distance Towed (km)	3.49	3.36	3.22	3.33	2.87	2.98	3.26	3.00
Direction of Tow (deg)	303	43	41	315	306	120	134	31
Vessel Speed (km/h)	10.3	9.8	9.3	9.7	8.4	8.7	9.4	8.4
Swell Height (m)	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5
Beaufort Scale	2	2	2	2	1	2	2	2
Cloud Cover (Bottom Depth) (m)	147	152	107	100	144	163	141	115
Net Opening Height (m)	17.0	16.7	44.4	15.1	40.9	42.6	17.0	42.8
Net Opening Width (m)	37.7	36.3	79.2	56.6	73.3	76.1	35.3	76.4
Door Spread (m)	67.3	64.8	15	101.1	15	15	63.1	15
Target Headrope Depth (m)	0	0	15	0	15	15	0	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	33	34	35	36	37	38	39	40
Event Number	75	78	81	84	85	86	87	88
Date	2019-06-25	2019-06-25	2019-06-25	2019-06-25	2019-06-26	2019-06-26	2019-06-26	2019-06-26
Stratum	507	506	504	504	506	507	507	506
Block Number	9900	10028	10652	10652	10028	9900	8788	8913
Start Time (PDT)	15:55	18:22	20:34	22:34	00:27	01:55	15:48	16:46
Duration (min)	20	20	21	20	21	21	21	21
Start Latitude	50° 41'47" N	50° 43'42" N	50° 54'41" N	50° 54'40" N	50° 45'54" N	50° 43'45" N	50° 22'11" N	50° 24'22" N
Start Longitude	128° 51'33" W	128° 41'16" W	128° 44'55" W	128° 44'56" W	128° 43'10" W	128° 51'37" W	128° 10'54" W	128° 9'57" W
End Latitude	50° 42'58" N	50° 45'9" N	50° 55'48" N	50° 55'58" N	50° 44'7" N	50° 42'21" N	50° 23'33" N	50° 26'8" N
End Longitude	128° 53'11" W	128° 42'46" W	128° 47'14" W	128° 47'16" W	128° 43'16" W	128° 52'53" W	128° 9'16" W	128° 10'16" W
Distance Towed (km)	2.92	3.32	3.43	3.64	3.32	2.99	3.21	3.30
Direction of Tow (deg)	319	324	307	311	182	210	37	353
Vessel Speed (km/h)	8.6	9.7	9.9	10.6	9.6	8.9	9.3	9.5
Swell Height (m)	0.2	0.2	0.5	0.2	1.0	0.5	0.2	0.1
Beaufort Scale	2	3	3	3	3	2	1	1
Cloud Cover (Bottom Depth) (m)	190	117	92	93	78	150	147	109
Net Opening Height (m)	16.2	15.2	16.0	17.5	16.1	17.6	45.4	41.5
Net Opening Width (m)	38.5	39.7	35.8	36.5	37.2	37.7	81.0	74.1
Door Spread (m)	68.9	0	64.0	65.3	66.4	67.4	15	15
Target Headrope Depth (m)	0	0	0	0	0	0	15	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	41	42	43	44	45	46	47	48
Event Number	91	94	95	96	97	100	103	106
Date	2019-06-26	2019-06-26	2019-06-26	2019-06-26	2019-06-27	2019-06-27	2019-06-27	2019-06-27
Stratum	507	507	506	507	506	507	507	507
Block Number	9284	9284	8913	8788	8292	8413	8661	8661
Start Time (PDT)	18:50	22:25	23:59	00:55	15:49	17:45	19:43	22:27
Duration (min)	21	21	21	21	20	20	20	15
Start Latitude	50°30'50 N	50°33'3 N	50°26'30 N	50°23'54 N	50°14'33 N	50°15'57 N	50°19'57 N	50°22'2 N
Start Longitude	128°21'4 W	128°24'26 W	128°11'8 W	128°10'3 W	127°54'23 W	128°8'13 W	128°14'24 W	128°17'46 W
End Latitude	50°31'37 N	50°31'49 N	50°25'34 N	50°22'12 N	50°14'31 N	50°16'52 N	50°20'59 N	50°20'59 N
End Longitude	128°23'9 W	128°22'32 W	128°8'57 W	128°9'49 W	127°57'8 W	128°10'29 W	128°16'17 W	128°16'21 W
Distance Towed (km)	2.86	3.19	3.10	3.16	3.28	3.19	2.93	2.56
Direction of Tow (deg)	300	135	123	174	268	302	310	139
Vessel Speed (km/h)	8.5	9.3	9.1	9.2	9.8	9.4	8.5	10.0
Swell Height (m)	0.2	0.2	0.2	0.2	1.0	1.0	1.0	1.2
Beaufort Scale	1	1	1	1	3	3	4	3
Cloud Cover (Bottom Depth (m)	141	156	97	116	91	220	200	190
Net Opening Height (m)		40.9	41.8	41.3	16.1	16.9	18.7	10.1
Net Opening Width (m)	43.7				38.5	34.6	39.7	37.7
Door Spread (m)	77.9	73.0	74.6	73.7	69.0	62.0		67.5
Target Headrope Depth (m)	15	15	15	15	0	0	0	0
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	49	50	51	52	53	54	55	56
Event Number	107	108	109	112	113	116	117	118
Date	2019-06-27	2019-06-28	2019-06-28	2019-06-28	2019-06-28	2019-06-28	2019-06-29	2019-06-29
Stratum	507	506	508	508	507	507	508	508
Block Number	8413	8292	7547	7672	7791	7791	7672	7547
Start Time (PDT)	23:31	01:30	15:49	17:24	19:02	22:27	00:35	02:13
Duration (min)	21	20	21	15	21	21	16	21
Start Latitude	50° 17'39 N	50° 14'35 N	50° 0'15 N	50° 2'26 N	50° 4'55 N	50° 7'2 N	50° 2'45 N	50° 0'7 N
Start Longitude	128° 10'49 W	127° 54'21 W	127° 38'4 W	127° 37'56 W	127° 58'14 W	128° 1'35 W	127° 4'14 W	127° 38'12 W
End Latitude	50° 16'32 N	50° 14'40 N	50° 1'19 N	50° 3'10 N	50° 6'6 N	50° 5'50 N	50° 2'42 N	50° 1'21 N
End Longitude	128° 8'45 W	127° 57'5 W	127° 40'14 W	127° 39'51 W	128° 0'12 W	127° 59'53 W	127° 39'16 W	127° 40'12 W
Distance Towed (km)	3.22	3.26	3.24	2.67	3.23	3.00	2.15	3.30
Direction of Tow (deg)	129	272	306	299	313	136	91	312
Vessel Speed (km/h)	9.3	9.9	9.5	10.7	9.3	8.7	8.4	9.5
Swell Height (m)	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5
Beaufort Scale	3	3	2	2	3	3	3	3
Cloud Cover (Bottom Depth) (m)	178	91	81	64	120	195	64	82
Net Opening Height (m)	20.0	17.6	43.8	18.0	37.5	39.2	16.6	42.1
Net Opening Width (m)	35.8	37.4	78.4	40.4	67.1	70.0	75.4	75.2
Door Spread (m)	63.9	66.9	78.4	72.2	67.1	70.0	75.4	75.2
Target Headrope Depth (m)	0	0	15	0	15	15	0	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	57	58	59	60	61	62	63	64
Event Number	119	122	125	128	129	130	131	134
Date	2019-06-29	2019-06-29	2019-06-29	2019-06-29	2019-06-29	2019-06-30	2019-07-01	2019-07-01
Stratum	511	511	511	511	511	511	510	510
Block Number	3699	4197	4446	4446	4197	3699	4451	4076
Start Time (PDT)	15:45	17:57	19:21	22:18	23:22	00:49	16:08	19:01
Duration (min)	21	20	21	20	20	22	21	20
Start Latitude	48° 51'52" N	49° 0'37" N	49° 5'0" N	49° 7'6" N	49° 2'35" N	48° 53'38" N	49° 6'32" N	48° 58'2" N
Start Longitude	126° 11'36" W	126° 17'35" W	126° 20'43" W	126° 23'41" W	126° 20'31" W	126° 14'12" W	126° 7'33" W	126° 6'47" W
End Latitude	48° 53'7" N	49° 1'48" N	49° 6'11" N	49° 6'8" N	49° 1'27" N	48° 52'19" N	49° 6'18" N	48° 59'46" N
End Longitude	126° 13'28" W	126° 19'28" W	126° 22'31" W	126° 21'38" W	126° 18'18" W	126° 12'2" W	126° 4'50" W	126° 6'45" W
Distance Towed (km)	3.25	3.17	3.09	3.09	3.41	3.61	3.33	3.21
Direction of Tow (deg)	313	312	313	123	126	130	95	358
Vessel Speed (km/h)	9.3	9.2	9.0	9.1	10.2	10.0	9.6	9.4
Swell Height (m)	0.2	0.2	0.2	0.5	0.5	0.2	1.0	0.7
Beaufort Scale	1	1	2	2	2	2	2	2
Cloud Cover (Bottom Depth) (m)	120	116	106	108	123	126	59	77
Net Opening Height (m)	15.0					17.0	15.5	17.4
Net Opening Width (m)	38.0	39.9	40.1	40.9	40.9	37.2	38.7	54.8
Door Spread (m)	68.1	71.2	71.5	73.0	73.3	66.4	69.2	97.7
Target Headrope Depth (m)	0	15	15	15	15	0	0	0
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	65	66	67	68	69	70	71	72
Event Number	137	138	139	142	145	148	149	150
Date	2019-07-01	2019-07-02	2019-07-02	2019-07-02	2019-07-02	2019-07-02	2019-07-02	2019-07-03
Stratum	510	510	509	508	509	509	508	509
Block Number	4076	4451	7047	7173	7170	7170	7173	7047
Start Time (PDT)	22:34	00:57	15:57	17:24	19:06	22:21	23:32	00:44
Duration (min)	16	16	20	21	20	20	20	20
Start Latitude	48° 57'54 N	49° 6'30 N	49° 51'32 N	49° 53'55 N	49° 55'25 N	49° 55'1 N	49° 53'58 N	49° 53'52 N
Start Longitude	126° 6'50 W	126° 7'37 W	127° 41'41 W	127° 37'59 W	127° 45'14 W	127° 47'48 W	127° 37'58 W	127° 40'3 W
End Latitude	48° 59'7 N	49° 6'21 N	49° 52'31 N	49° 54'58 N	49° 55'32 N	49° 55'6 N	49° 55'26 N	49° 52'17 N
End Longitude	126° 6'60 W	126° 5'38 W	127° 39'38 W	127° 35'57 W	127° 47'53 W	127° 44'54 W	127° 36'8 W	127° 40'10 W
Distance Towed (km)	2.28	2.43	3.05	3.12	3.18	3.47	3.49	2.92
Direction of Tow (deg)	353	95	52	50	273	87	38	182
Vessel Speed (km/h)	8.9	9.6	9.2	9.1	9.3	10.3	10.3	8.5
Swell Height (m)			0.2	0.5	0.5	0.5	0.5	
Beaufort Scale	2	2	1	1	1	1	1	
Cloud Cover (Bottom Depth) (m)	79	61	183	84	165	173	85	131
Net Opening Height (m)	17.9	15.5	17.7	15.4	17.6	15.2	17.4	17.4
Net Opening Width (m)	40.4	41.5	38.2	40.3	39.2	36.7	37.0	37.5
Door Spread (m)	72.3	74.2	68.3	71.9	70.1	65.4	66.0	67.2
Target Headrope Depth (m)	0	0	0	0	0	0	0	0
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	73	74	75	76	77	78	79	80
Event Number	151	154	157	160	161	162	163	166
Date	2019-07-03	2019-07-03	2019-07-03	2019-07-03	2019-07-03	2019-07-04	2019-07-04	2019-07-04
Stratum	509	508	508	508	508	509	509	509
Block Number	6307	6928	6925	6925	6928	6307	4935	5307
Start Time (PDT)	15:42	17:55	19:38	22:21	23:31	01:31	15:44	17:30
Duration (min)	20	20	20	20	16	21	20	20
Start Latitude	49°38'19 N	49°49'20 N	49°51'27 N	49°50'31 N	49°50'22 N	49°40'22 N	49°14'19 N	49°20'59 N
Start Longitude	127°6'28 W	127°18'33 W	127°29'24 W	127°31'36 W	127°21'17 W	127°8'27 W	126°56'20 W	127°6'9 W
End Latitude	49°39'43 N	49°50'31 N	49°49'57 N	49°50'39 N	49°50'32 N	49°39'19 N	49°15'38 N	49°22'7 N
End Longitude	127°8'5 W	127°20'44 W	127°29'4 W	127°29'17 W	127°19'26 W	127°6'43 W	126°58'13 W	127°7'51 W
Distance Towed (km)	3.23	3.42	2.79	2.79	2.24	2.87	3.37	2.95
Direction of Tow (deg)	321	309	171	84	81	132	315	314
Vessel Speed (km/h)	9.6	10.1	8.2	8.3	8.8	8.5	9.9	8.7
Swell Height (m)	0.2	0.5	0.5	0.2	0.2	0.5	1.0	1.0
Beaufort Scale	1	1	1	1	1	1	2	3
Cloud Cover (Bottom Depth (m)	116	76	76	81	76	116	174	163
Net Opening Height (m)		15.0			16.6		17.4	
Net Opening Width (m)	41.1	39.4	43.0	41.1	37.5	43.2	38.7	42.5
Door Spread (m)	73.5	70.5	76.7	73.6	67.1	77.0	69.2	76.0
Target Headrope Depth (m)	15	0	15	15	0	15	0	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes



Tow	81	82	83	84	85	86	87	88
Event Number	169	172	173	174	175	178	183	184
Date	2019-07-04	2019-07-04	2019-07-04	2019-07-05	2019-07-05	2019-07-05	2019-07-05	2019-07-06
Stratum	508	508	509	509	511	511	511	511
Block Number	5811	5811	5307	4935	4442	4562	4562	4442
Start Time (PDT)	19:32	22:16	00:00	01:21	15:44	17:48	22:25	00:13
Duration (min)	20	20	20	20	20	21	21	21
Start Latitude	49°29'26 N	49°31'45 N	49°22'53 N	49°16'18 N	49°6'40 N	49°7'58 N	49°7'44 N	49°6'27 N
Start Longitude	126°55'49 W	126°54'8 W	127°5'58 W	126°59'17 W	126°33'38 W	126°50'21 W	126°50'1 W	126°36'25 W
End Latitude	49°30'37 N	49°30'19 N	49°21'31 N	49°15'11 N	49°6'36 N	49°9'15 N	49°9'3 N	49°5'44 N
End Longitude	126°54'5 W	126°54'15 W	127°7'16 W	126°57'5 W	126°36'13 W	126°52'6 W	126°51'55 W	126°33'60 W
Distance Towed (km)	3.03	2.65	2.98	3.38	3.15	3.19	3.36	3.24
Direction of Tow (deg)	42	181	211	126	266	317	315	113
Vessel Speed (km/h)	8.9	7.8	8.8	10.0	9.3	9.5	9.7	10.0
Swell Height (m)	1.0	1.0	1.0	1.0	0.5	0.5	1.0	1.0
Beaufort Scale	3	2	3	3	2	1	1	1
Cloud Cover (Bottom Depth (m))	110	91	157	168	131	175	174	133
Net Opening Height (m)	42.6	41.3	42.3	18.9	42.5	16.2	9.6	42.5
Door Spread (m)	76.1	73.9	75.6	40.4	75.8	40.4	38.7	42.5
Target Headrope Depth (m)	15	15	15	0	15	0	0	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	89	90	91	92	93	94	95	96
Event Number	185	188	191	194	195	196	197	200
Date	2019-07-06	2019-07-06	2019-07-06	2019-07-06	2019-07-06	2019-07-06	2019-07-07	2019-07-07
Stratum	510	510	510	510	510	510	511	511
Block Number	3829	3579	3329	3329	3579	3329	3326	3325
Start Time (PDT)	15:47	17:26	19:03	22:21	23:32	00:31	15:50	17:19
Duration (min)	20	20	21	21	20	20	21	20
Start Latitude	48° 55'32 N	48° 51'30 N	48° 45'52 N	48° 45'51 N	48° 49'17 N	48° 53'36 N	48° 45'15 N	48° 46'60 N
Start Longitude	125° 57'55 W	125° 58'27 W	125° 58'32 W	125° 58'41 W	125° 57'28 W	125° 58'12 W	126° 5'25 W	126° 8'51 W
End Latitude	48° 54'18 N	48° 50'17 N	48° 45'51 N	48° 45'44 N	48° 50'49 N	48° 55'3 N	48° 46'22 N	48° 45'42 N
End Longitude	125° 56'20 W	125° 56'38 W	125° 55'53 W	125° 56'1 W	125° 57'25 W	125° 56'50 W	126° 7'9 W	126° 10'9 W
Distance Towed (km)	2.99	3.16	3.23	3.28	2.85	3.17	2.97	2.89
Direction of Tow (deg)	137	133	88	92	359	29	312	212
Vessel Speed (km/h)	8.8	9.3	9.5	9.7	8.5	9.5	8.8	8.5
Swell Height (m)	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5
Beaufort Scale	2	2	3	3	3	3	3	3
Cloud Cover (Bottom Depth (m)	62	74	83	82	76	65	112	128
Net Opening Height (m)	17.2	16.3			17.0	18.9		
Net Opening Width (m)	40.4	41.3	44.2	44.2	37.5	39.9	42.3	40.3
Door Spread (m)	72.3	73.8	78.9	78.8	67.2	71.4	75.6	72.0
Target Headrope Depth (m)	0	0	15	15	0	0	15	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	97	98	99	100	101	102	103	104	105
Event Number	201	202	203	204	205	208	211	214	215
Date	2019-07-07	2019-07-07	2019-07-07	2019-07-07	2019-07-08	2019-07-08	2019-07-08	2019-07-08	2019-07-09
Stratum	511	511	511	511	511	510	510	510	510
Block Number	3201	3201	3325	3326	3207	3457	3835	3835	3457
Start Time (PDT)	19:19	22:17	23:11	00:03	15:45	17:22	19:34	22:25	00:30
Duration (min)	20	21	20	20	20	20	21	15	20
Start Latitude	48° 42'52" N	48° 42'55" N	48° 45'12" N	48° 45'52" N	48° 43'24" N	48° 47'4" N	48° 54'56" N	48° 54'56" N	48° 46'56" N
Start Longitude	126° 5'2" W	126° 5'11" W	126° 8'37" W	126° 8'26" W	125° 45'60" W	125° 48'43" W	125° 35'29" W	125° 35'14" W	125° 48'43" W
End Latitude	48° 43'36" N	48° 43'31" N	48° 45'58" N	48° 45'34" N	48° 43'55" N	48° 48'21" N	48° 55'1" N	48° 55'4" N	48° 48'14" N
End Longitude	126° 6'52" W	126° 7'7" W	126° 10'31" W	126° 5'55" W	125° 48'32" W	125° 46'51" W	125° 37'54" W	125° 36'60" W	125° 47'17" W
Distance Towed (km)	2.63	2.61	2.73	3.13	3.25	3.29	2.96	2.17	2.97
Direction of Tow (deg)	299	293	299	98	285	41	270	274	34
Vessel Speed (km/h)	7.8	7.7	8.1	9.2	9.6	9.7	8.5	8.6	8.8
Swell Height (m)	1.5	1.0	1.0	1.0	1.0	1.0	0.5	0.5	1.0
Beaufort Scale	3	3	3	3	2	1	1	1	1
Cloud Cover (Bottom Depth (m))	120	120	130	127	164	63	87	95	60
Net Opening Height (m)	44.9	43.7	42.6	42.0	18.4	17.6	41.8	39.6	17.6
Door Spread (m)	80.2	78.1	76.2	75.0	68.7	72.9	74.7	70.6	70.8
Target Headrope Depth (m)	15	15	15	15	0	0	15	15	0
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	106	107	108	109	110	111	112	113	114
Event Number	216	217	220	223	226	227	228	229	232
Date	2019-07-09	2019-07-09	2019-07-09	2019-07-09	2019-07-09	2019-07-09	2019-07-10	2019-07-10	2019-07-10
Stratum	511	511	511	510	511	511	510	510	510
Block Number	3207	2592	2843	3094	2592	2843	3094	2335	2959
Start Time (PDT)	01:43	15:33	17:06	18:21	22:08	23:12	00:37	15:51	18:24
Duration (min)	15	21	20	20	12	20	15	20	20
Start Latitude	48° 44'29" N	48° 30'45" N	48° 35'34" N	48° 39'14" N	48° 30'38" N	48° 35'41" N	48° 39'7" N	48° 27'7" N	48° 40'20" N
Start Longitude	125° 45'44" W	125° 14'15" W	125° 14'5" W	125° 10'11" W	125° 13'56" W	125° 13'42" W	125° 8'36" W	125° 39'27" W	125° 42'57" W
End Latitude	48° 43'37" N	48° 31'36" N	48° 36'37" N	48° 40'22" N	48° 31'13" N	48° 36'32" N	48° 40'21" N	48° 28'41" N	48° 39'10" N
End Longitude	125° 47'9" W	125° 16'39" W	125° 12'15" W	125° 8'11" W	125° 15'10" W	125° 11'54" W	125° 8'7" W	125° 39'48" W	125° 41'4" W
Distance Towed (km)	2.38	3.35	2.97	3.23	1.86	2.70	2.33	2.93	3.16
Direction of Tow (deg)	225	296	46	47	303	52	12	349	131
Vessel Speed (km/h)	9.5	9.9	8.9	9.5	9.1	8.0	9.3	8.7	9.4
Swell Height (m)	1.0	0.5	0.5	0.5	0.5	0.5	1.0	2.0	2.0
Beaufort Scale	1	2	2	1	2	4	4	4	4
Cloud Cover (Bottom Depth (m))	115	137	121	90	138	118	80	113	145
Net Opening Height (m)	20.4	15.7	16.7	16.1	18.2	19.6	19.1	18.2	18.2
Net Opening Width (m)	38.0	40.1	38.7	39.2	37.7	36.9	40.3	40.3	40.3
Door Spread (m)	68.0	71.6	69.1	70.1	67.5	65.7	71.8	71.9	72.0
Target Headrope Depth (m)	0	0	0	0	0	0	0	0	0
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	115	116	117	118	119	120	121	122	123
Event Number	233	236	237	238	239	242	245	246	247
Date	2019-07-10	2019-07-10	2019-07-10	2019-07-11	2019-07-11	2019-07-11	2019-07-11	2019-07-11	2019-07-12
Stratum	511	510	510	511	510	511	511	510	511
Block Number	3084	2959	2335	2334	2582	2703	2703	2582	2334
Start Time (PDT)	19:31	22:16	23:57	15:42	17:00	18:55	22:20	23:50	01:08
Duration (min)	21	21	19	20	20	20	10	20	20
Start Latitude	48° 41'22 N	48° 40'9 N	48° 29'15 N	48° 27'12 N	48° 31'53 N	48° 35'3 N	48° 36'16 N	48° 31'50 N	48° 29'19 N
Start Longitude	125° 42'48 W	125° 42'33 W	125° 39'8 W	125° 40'30 W	125° 48'17 W	125° 59'31 W	126° 0'57 W	125° 49'42 W	125° 43'22 W
End Latitude	48° 42'12 N	48° 38'54 N	48° 27'39 N	48° 27'33 N	48° 33'21 N	48° 34'55 N	48° 35'20 N	48° 33'8 N	48° 28'12 N
End Longitude	125° 40'36 W	125° 41'1 W	125° 39'25 W	125° 42'41 W	125° 48'51 W	126° 2'6 W	126° 0'57 W	125° 48'55 W	125° 41'44 W
Distance Towed (km)	3.11	2.99	2.98	2.77	2.83	3.18	1.73	2.61	2.89
Direction of Tow (deg)	57	138	184	281	343	264	178	19	133
Vessel Speed (km/h)	9.2	8.9	9.8	8.5	8.5	9.4	10.2	7.9	8.6
Swell Height (m)	1.7	1.7	2.0	1.5	1.5	1.5	1.0	1.5	1.5
Beaufort Scale	3	4	4	2	3	2	2	2	2
Cloud Cover (Bottom Depth (m)	150	65	100	109	88	113	120	88	102
Net Opening Height (m)	43.8	21.5	20.1	49.1	43.2	18.4	19.1	43.7	42.8
Door Spread (m)	78.4	39.6	37.4	87.9	77.2	37.7	39.1	78.0	76.5
Target Headrope Depth (m)	15	0	0	15	15	0	0	15	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	124	125	126	127	128	129	130	131	132
Event Number	248	251	252	255	256	257	258	261	264
Date	2019-07-12	2019-07-12	2019-07-12	2019-07-12	2019-07-12	2019-07-12	2019-07-13	2019-07-13	2019-07-13
Stratum	511	511	511	511	511	511	511	510	510
Block Number	2208	2082	1708	1708	2082	2208	2720	2848	2850
Start Time (PDT)	15:45	17:07	18:27	22:24	23:37	01:21	15:43	17:46	19:19
Duration (min)	20	20	20	20	21	21	20	20	20
Start Latitude	48° 27'2" N	48° 25'6" N	48° 18'28" N	48° 16'30" N	48° 23'7" N	48° 25'1" N	48° 34'6" N	48° 34'46" N	48° 34'11" N
Start Longitude	125° 44'59" W	125° 47'43" W	125° 46'13" W	125° 45'47" W	125° 48'40" W	125° 44'57" W	125° 7'18" W	124° 54'15" W	124° 51'10" W
End Latitude	48° 25'8" N	48° 24'9" N	48° 16'42" N	48° 18'4" N	48° 24'44" N	48° 26'31" N	48° 34'6" N	48° 34'48" N	48° 35'0" N
End Longitude	125° 45'0" W	125° 49'48" W	125° 45'52" W	125° 45'58" W	125° 48'45" W	125° 45'17" W	125° 4'45" W	124° 57'10" W	124° 49'14" W
Distance Towed (km)	3.53	3.11	3.30	2.90	3.00	2.83	3.13	3.60	2.84
Direction of Tow (deg)	178	233	170	353	355	349	87	268	54
Vessel Speed (km/h)	10.4	10.1	9.7	8.7	8.9	8.4	9.2	10.6	8.4
Swell Height (m)	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5
Beaufort Scale	1	1	1	1	1	2	1	1	1
Cloud Cover (Bottom Depth (m))	115	145	173	180	153	135	102	75	75
Net Opening Height (m)	15.2	18.6	18.5	18.4	20.1	18.8	43.2	43.7	42.5
Net Opening Width (m)	40.6	40.8	40.3	37.9	38.4	39.1	77.0	78.1	75.8
Door Spread (m)	72.6	72.9	72.0	67.7	68.6	69.9	15	15	15
Target Headrope Depth (m)	0	0	0	0	0	0	15	15	15
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tow	133	134
Event Number	267	268
Date	2019-07-13	2019-07-13
Stratum	511	510
Block Number	2720	2848
Start Time (PDT)	22:22	23:59
Duration (min)	20	10
Start Latitude	48° 34'8 N	48° 34'48 N
Start Longitude	125° 7'25 W	124° 54'23 W
End Latitude	48° 34'25 N	48° 34'48 N
End Longitude	125° 5'15 W	124° 55'41 W
Distance Towed (km)	2.72	1.61
Direction of Tow (deg)	76	267
Vessel Speed (km/h)	8.1	9.5
Swell Height (m)	0.5	0.5
Beaufort Scale		
Cloud Cover (Bottom Depth (m))	105	72
Net Opening Height (m)		
Net Opening Width (m)	42.1	40.9
Door Spread (m)	75.3	73.2
Target Headrope Depth (m)	15	15
Usable	Yes	Yes

## APPENDIX F Oceanographic Data from the 2019 Integrated Pelagic Ecosystem Survey

Table F.1. Bridge log information for CTD casts and vertical zooplankton tows on the Integrated Pelagic Ecosystem Survey aboard the *M.V. Nordic Pearl*, June 15 to July 15, 2019.

Date	Stratum	Block	CTD			Bongo		
			Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)
19-Jun-19	504	10788	17:22	57	50	17:40	56	50
19-Jun-19	505	11168	21:31	126	120	21:47	124	120
21-Jun-19	504	10908	18:03	100	95	18:18	100	95
21-Jun-19	505	11533	20:27	196	190	20:40	197	190
22-Jun-19	504	11275	16:21	94	90	16:30	94	85
22-Jun-19	505	11398	17:57	138	135	18:08	138	135
22-Jun-19	505	11521	19:28	193	185	19:38	200	190
23-Jun-19	504	10772	20:24	87	85	20:32	87	85
23-Jun-19	505	10894	18:41	147	140	18:50	147	140
23-Jun-19	505	11145	16:49	141	135	16:59	142	135
24-Jun-19	505	10642	19:00	170	165	19:08	170	165
24-Jun-19	506	10394	16:39	87	85	16:45	87	85
25-Jun-19	504	10652	21:18	77	70	21:26	85	80
25-Jun-19	506	10028	19:13	77	75	19:20	77	75
25-Jun-19	507	9900	16:44	167	160	16:57	170	165
26-Jun-19	506	8913	17:36	88	85	17:43	87	85
26-Jun-19	507	9284	19:33	154	150	19:41	154	150
27-Jun-19	506	8292	16:35	82	80	16:43	78	75
27-Jun-19	507	8413	18:45	177	175	18:54	177	170
27-Jun-19	507	8661	20:27	187	185	20:36	187	180
28-Jun-19	507	7791	19:49	127	125	19:57	124	120
28-Jun-19	508	7547	16:35	75	75	16:41	74	70
29-Jun-19	511	3699	16:46	120	115	16:54	119	115
29-Jun-19	511	4197	18:39	122	120	18:47	123	120
29-Jun-19	511	4446	20:03	106	105	20:09	105	100
01-Jul-19	510	4076	20:01	70	65	20:07	69	65
01-Jul-19	510	4451	17:00	55	50	17:07	55	60
02-Jul-19	508	7173	18:09	60	55	18:15	65	60
02-Jul-19	509	7047	16:44	118	115	16:50	123	120
02-Jul-19	509	7170	19:55	163	160	20:02	175	170
03-Jul-19	508	6925	20:20	72	70	20:25	73	70
03-Jul-19	508	6928	18:38	73	75	18:43	73	70
03-Jul-19	509	6307	16:25	114	115	16:33	113	110
04-Jul-19	508	5811	20:14	94	95	20:20	94	90
04-Jul-19	509	4935	16:28	165	165	16:35	165	160
04-Jul-19	509	5307	18:11	164	165	18:18	162	150
05-Jul-19	509	4937	19:59	139	140	20:09	144	140



Table F.1. Bridge log information for CTD casts and vertical zooplankton tows on the Integrated Pelagic Ecosystem Survey aboard the *M. V. Nordic Pearl*, June 15 to July 15, 2019. (continued)

Date	Stratum	Block	CTD			Bongo		
			Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)	Start Time (PDT)	Bottom Depth (m)	Gear Depth (m)
05-Jul-19	511	4442	16:28	135	135	16:35	133	130
05-Jul-19	511	4562	18:32	172	170	18:40	170	165
06-Jul-19	510	3329	19:49	75	75	19:55	75	70
06-Jul-19	510	3579	18:08	73	70	18:14	73	70
06-Jul-19	510	3829	16:28	64	65	16:36	64	60
07-Jul-19	511	3326	16:39	115	115	16:46	115	110
08-Jul-19	510	3457	18:04	53	50	18:09	52	50
08-Jul-19	510	3835	20:19	95	95	20:25	93	90
08-Jul-19	511	3207	16:29	115	115	16:35	110	105
09-Jul-19	510	3094	19:03	56	55	19:08	56	50
09-Jul-19	511	2592	16:21	115	115	16:28	115	110
09-Jul-19	511	2843	17:47	105	105	17:53	105	100
10-Jul-19	510	2335	16:37	95	95	16:43	95	90
10-Jul-19	511	3084	20:15	170	170	20:24	168	160
11-Jul-19	510	2582	17:48	81	75	17:53	81	70
11-Jul-19	511	2703	19:39	118	110	19:45	120	110
12-Jul-19	511	1708	19:11	174	165	19:18	174	165
12-Jul-19	511	2208	16:31	137	130	16:36	137	130
13-Jul-19	510	2848	18:31	60	55	18:35	60	50
13-Jul-19	510	2850	20:00	60	55	20:04	60	50
13-Jul-19	511	2720	16:25	110	105	16:31	114	105

## APPENDIX G Catch Data from the 2019 Integrated Pelagic Ecosystem Survey

Table G.1. Catch (kg) of species (or taxonomic groups where species identification could not be made with certainty) captured during the Integrated Pelagic Ecosystem Survey *M.V. Nordic Pearl*, June 15 to July 15, 2019.

	Tow													
Event Number	19	22	23	26	27	28	29	30	33	36	37	38	39	42
American Shad														
Arrowtooth Flounder					0.04									
Black Rockfish	0.25		0.10											
Blue Shark														
Boreal Clubhook Squid														
Calycoptis Spp.														
Canary Rockfish	2.27		6.99		0.41			0.69	5.41			11.09		
Chinook Salmon			9.17		0.03		6.33					0.07	0.95	
Chum Salmon														
Codfishes														
Coho Salmon			0.06		2.36		0.03							
Comb Jellyfish														
Copper Rockfish														
Darkblotched Rockfish														
Dinner Plate Jellyfish														
Eulachon				0.12				1.88	0.58					
Euphausiids										5.03				
Flatfishes						0.06								
Fried Egg Jellyfish						1.24								
Greenlings						0.08								0.05
Greenstriped Rockfish														
Isopods														
Jack Mackerel														
Jellyfish										4.02	2.34		11.53	2.56
Lanternfish														
Lions Mane Jellyfish										4.29			7.43	6.80
Lumpfishes And Snailfishes														
Moon Jellyfish							0.47							0.36
North Pacific Spiny Dogfish														
Northern Anchovy														
Northern Spearnose					0.05									
Poacher														
Ocean Sunfish														
Opalescent Inshore Squid	0.14				1.70		0.12							0.08
Pacific Hake														
Pacific Herring	5.32		0.50	826.75	84.18	3.62	11.23				1.26		23.78	
Pacific Lamprey														
Pacific Sand Lance														
Pacific Sanddab						0.46					1.34		0.90	

Tow	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Event Number</b>	<b>19</b>	<b>22</b>	<b>23</b>	<b>26</b>	<b>27</b>	<b>28</b>	<b>29</b>	<b>30</b>	<b>33</b>	<b>36</b>	<b>37</b>	<b>38</b>	<b>39</b>	<b>42</b>
Pacific Sardine														
Pacific Sea Nettle							0.20							
Pacific Tomcod														
Pink Salmon												0.01		
Pink Shrimp (Smooth)														
Prowfish													0.03	0.03
Rockfishes														
Sablefish														
Salps														
Sanddabs														
Sea Butterfly														
Shortbelly Rockfish														
Silvergray Rockfish														
Siphonophorae														
Slender Sole														
Smelts														
Sockeye Salmon			1.30											
Squids														
Steelhead														
Sturgeon Poacher														
Tope Shark														
True Crabs														
Unidentified Larvae														
Unknown Fish														
Walleye Pollock														
Water Jellyfish	1.20													
Whitebait Smelt														
Widow Rockfish														
Wolf Eel														
Yellowtail Rockfish	9.18	0	18.12	829.07	88.73	5.50	18.38	0.69	7.29	13.92	4.94	35.93	19.94	9.80
<b>TOTAL</b>														

	Tow	15	16	17	18	19	20	21	22	23	24	25	26	27	28
<b>Event Number</b>	<b>45</b>	<b>48</b>	<b>49</b>	<b>50</b>	<b>51</b>	<b>52</b>	<b>53</b>	<b>56</b>	<b>59</b>	<b>62</b>	<b>63</b>	<b>64</b>	<b>65</b>	<b>68</b>	
American Shad															
Arrowtooth Flounder					0.15										
Black Rockfish															
Blue Shark															
Boreal Clubhook Squid															
Calycoopsis Spp.															
Canary Rockfish															
Chinook Salmon				0.09		9.61		0.09							7.64
Chum Salmon				10.27		0.07		6.01				0.10			
Codfishes				0.02											
Coho Salmon															
Comb Jellyfish															
Copper Rockfish															
Darkblotched Rockfish															
Dinner Plate Jellyfish															
Eulachon											0.53				
Euphausiids					41.00	3.86						25.17			
Flatfishes															
Fried Egg Jellyfish								2.75							
Greenlings															
Greenstriped Rockfish															
Isopods															
Jack Mackerel															
Jellyfish	5.75	8.19	1.51	2.93	2.16	0.43	6.79	1.59	1.77	1.59		0.80	1.90	1.74	
Lanternfish															
Lions Mane Jellyfish															
Lumpfishes And Snailfishes	8.80	7.51	2.49	3.42	4.51	7.42	10.14	4.64	1.69	0.48	2.41	0.98	0.71	1.64	
Moon Jellyfish														0.61	
North Pacific Spiny Dogfish															
Northern Anchovy															
Northern Spearnose															
Poacher															
Ocean Sunfish															
Opalescent Inshore Squid				0.08				0.03			0.06				0.40
Pacific Hake															
Pacific Herring															
Pacific Lamprey				0.13							0.47	0.08			
Pacific Sand Lance															
Pacific Sanddab															
Pacific Sardine															
Pacific Sea Nettle															
Pacific Tomcod															0.08

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Tow	45	48	49	50	51	52	53	56	59	62	63	64	65	68
Pink Salmon				0.08										
Pink Shrimp (Smooth)											18.88	0.53		
Prowfish				0.02		0.02						0.01		
Rockfishes														
Sablefish														
Salps														
Sanddabs														
Sea Butterfly														
Shortbelly Rockfish														
Silvergray Rockfish								0.01						
Siphonophorae														
Slender Sole														
Smelts														
Sockeye Salmon				0.09										
Squids														
Steelhead														
Sturgeon Poacher														
Tope Shark														
True Crabs														
Unidentified Larvae														
Unknown Fish														
Walleye Pollock														
Water Jellyfish														
Whitebait Smelt														
Widow Rockfish														
Wolf Eel														
Yellowtail Rockfish														
TOTAL	14.55	15.70	4.00	17.13	47.82	21.41	16.93	12.25	6.33	2.07	22.35	27.67	3.30	11.42



	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Tow	69	72	73	74	75	78	81	84	85	86	87	88	91	94
Event Number														
Pink Salmon														
Pink Shrimp (Smooth)														
Prowfish														
Rockfishes														
Sablefish														
Salps														
Sanddabs														
Sea Butterfly														
Shortbelly Rockfish														
Silvergray Rockfish														
Siphonophorae														
Slender Sole														
Smelts														
Sockeye Salmon														
Squids														
Steelhead														
Sturgeon Poacher														
Tope Shark														
True Crabs														
Unidentified Larvae														
Unknown Fish														
Walleye Pollock														
Water Jellyfish														
Whitebait Smelt														
Widow Rockfish														
Wolf Eel														
Yellowtail Rockfish														
TOTAL	3.78	38.70	88.47	45.55	118.17	214.33	17.88	46.84	573.84	277.25	24.29	59.48	14.71	56.83



Tow	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Event Number	95	96	97	100	103	106	107	108	109	112	113	116	117	118
American Shad														
Arrowtooth Flounder					0.16			0.11		0.45				
Black Rockfish														
Blue Shark						2.37	2.24					6.26	0.25	
Boreal Clubhook Squid														
Calyropsis Spp.														
Canary Rockfish					0.94		3.54	23.15	6.42	0.39	9.51	5.24	2.41	2.63
Chinook Salmon	4.07	14.50	14.68	4.34			104.76	1.37	25.90		5.45	74.94	83.93	109.57
Chum Salmon														
Codfishes														
Coho Salmon			11.62		4.83		11.22	7.37	47.24	0.10	7.68	5.90	20.64	16.12
Comb Jellyfish														
Copper Rockfish								0.36						
Darkblotched Rockfish														
Dinner Plate Jellyfish														
Eulachon	0.15						16.32	1.97				3.94		0.21
Euphausiids														
Flatfishes														
Fried Egg Jellyfish					0.83				0.47	0.71	0.29		0.42	
Greenlings														
Greenstriped Rockfish														
Isopods														
Jack Mackerel														
Jellyfish			1.09		1.22			0.69				3.94		
Lanternfish														
Lions Mane Jellyfish		0.08		0.78	2.10	0.21	8.40							
Lumpfishes And Snailfishes														
Moon Jellyfish	0.98	0.16	1.53					1.54	4.32	28.16	11.24	6.82	3.35	5.52
North Pacific Spiny Dogfish														
Northern Anchovy														
Northern Spearnose														
Poacher														
Ocean Sunfish														
Opalescent Inshore Squid			0.56					8.31		3.25	0.05		0.59	
Pacific Hake	13.94	6.80				47.47	1.96					38.66		
Pacific Herring	60.42	35.75		1127.24	1.94	0.73	0.42	30.77			0.21	139.96	54.62	99.11
Pacific Lamprey												0.02		
Pacific Sand Lance														
Pacific Sanddab														
Pacific Sardine														
Pacific Sea Nettle														
Pacific Tomcod														

	Tow	43	44	45	46	47	48	49	50	51	52	53	54	55	56
<b>Event Number</b>	<b>95</b>	<b>96</b>	<b>97</b>	<b>100</b>	<b>103</b>	<b>106</b>	<b>107</b>	<b>108</b>	<b>109</b>	<b>112</b>	<b>113</b>	<b>116</b>	<b>117</b>	<b>118</b>	
Pink Salmon				8.36			11.68		11.04			2.82	11.70	21.14	
Pink Shrimp (Smooth)															
Prowfish															
Rockfishes		0.08					0.86								
Sablefish															
Salps															
Sanddabs															
Sea Butterfly															
Shorbelly Rockfish	1.64	0.07													
Silvergray Rockfish															
Siphonophorae															
Slender Sole															
Smelts															
Sockeye Salmon		1.17						1.04							
Squids															
Steelhead				0.15											
Sturgeon Poacher															
Tope Shark															
True Crabs															
Unidentified Larvae															
Unknown Fish															
Walleye Pollock									2.80	14.86	9.61				
Water Jellyfish															
Whitebait Smelt											1.82				
Widow Rockfish									0.02		0.45		0.02	0.04	
Wolf Eel															
Yellowtail Rockfish															
<b>TOTAL</b>	<b>77.13</b>	<b>46.93</b>	<b>45.23</b>	<b>1132.36</b>	<b>20.53</b>	<b>62.08</b>	<b>160.54</b>	<b>77.82</b>	<b>98.21</b>	<b>47.92</b>	<b>46.31</b>	<b>288.50</b>	<b>177.93</b>	<b>254.34</b>	

	Tow	57	58	59	60	61	62	63	64	65	66	67	68	69	70
<b>Event Number</b>	<b>119</b>	<b>122</b>	<b>125</b>	<b>128</b>	<b>129</b>	<b>130</b>	<b>131</b>	<b>134</b>	<b>137</b>	<b>138</b>	<b>139</b>	<b>142</b>	<b>145</b>	<b>148</b>	
American Shad															
Arrowtooth Flounder															
Black Rockfish									1.24						
Blue Shark															
Boreal Clubhook Squid															
Calycoopsis Spp.						0.07									
Canary Rockfish							7.12	10.66	24.84	2.70					
Chinook Salmon			0.83					0.20	79.37	6.57	0.03	11.28			
Chum Salmon															
Codfishes															
Coho Salmon							10.50	13.27	95.32	11.11	1.62	9.80	9.68	10.01	
Comb Jellyfish		0.10													
Copper Rockfish															
Darkblotched Rockfish															
Dinner Plate Jellyfish							0.37								
Eulachon									1.65						
Euphausiids				9.75	2.12	0.24									
Flatfishes		2.00		1.00		0.46									7.02
Fried Egg Jellyfish		1.40							1.10			5.99			
Greenlings															
Greenstriped Rockfish															
Isopods															
Jack Mackerel															
Jellyfish					0.20	0.46	3.09	0.67		1.18	14.37	3.31	12.47	4.87	
Lanternfish															
Lions Mane Jellyfish							2.30				1.45		3.38	3.47	
Lumpfishes And Snailfishes															
Moon Jellyfish							4.17				6.87	2.33	5.00	7.40	
North Pacific Spiny Dogfish						0.59									
Northern Anchovy															
Northern Spearnose															
Poacher															
Ocean Sunfish															
Opalescent Inshore Squid							0.12	2.33	0.33	0.06					0.42
Pacific Hake									4.70						
Pacific Herring									652.53	28.76					
Pacific Lamprey															
Pacific Sand Lance															
Pacific Sanddab															
Pacific Sardine															
Pacific Sea Nettle															0.06
Pacific Tomcod															

	Tow	57	58	59	60	61	62	63	64	65	66	67	68	69	70
<b>Event Number</b>	<b>119</b>	<b>122</b>	<b>125</b>	<b>128</b>	<b>129</b>	<b>130</b>	<b>131</b>	<b>134</b>	<b>137</b>	<b>138</b>	<b>139</b>	<b>142</b>	<b>145</b>	<b>148</b>	
Pink Salmon							10.35	15.60	1.79	49.14	10.33	39.26	18.95		
Pink Shrimp (Smooth)															
Prowfish															
Rockfishes					0.18										
Sablefish											0.09		0.01	0.01	
Salps															
Sanddabs															
Sea Butterfly															
Shortbelly Rockfish															
Silvergray Rockfish	0.20				0.16										
Siphonophorae															
Slender Sole															
Smelts															
Sockeye Salmon									0.05	2.10	2.39				
Squids															
Steelhead															
Sturgeon Poacher															
Tope Shark															
True Crabs															
Unidentified Larvae															
Unknown Fish															
Walleye Pollock			0.02	0.07						0.01	0.05		0.01	0.01	
Water Jellyfish	1.34	2.60	4.64	1.26											
Whitebait Smelt															
Widow Rockfish															
Wolf Eel		0.05													
Yellowtail Rockfish						0.89									
<b>TOTAL</b>	<b>1.54</b>	<b>6.15</b>	<b>5.49</b>	<b>12.08</b>	<b>2.32</b>	<b>3.05</b>	<b>27.85</b>	<b>37.48</b>	<b>876.69</b>	<b>52.29</b>	<b>75.72</b>	<b>45.43</b>	<b>69.81</b>	<b>52.16</b>	

	Tow	71	72	73	74	75	76	77	78	79	80	81	82	83	84
<b>Event Number</b>	<b>149</b>	<b>150</b>	<b>151</b>	<b>154</b>	<b>157</b>	<b>160</b>	<b>161</b>	<b>162</b>	<b>163</b>	<b>166</b>	<b>169</b>	<b>172</b>	<b>173</b>	<b>174</b>	
American Shad															
Arrowtooth Flounder															
Black Rockfish															
Blue Shark															
Boreal Clubhook Squid															
Calycoopsis Spp.															
Canary Rockfish															
Chinook Salmon	0.54		1.27	0.15	0.73			0.53			4.45	3.25			
Chum Salmon	17.71	35.04		1.53	0.08	7.27			5.59			6.22			5.08
Codfishes															0.03
Coho Salmon	0.33	14.14	1.79	3.79		11.15					0.35	7.28			
Comb Jellyfish															
Copper Rockfish															
Darkblotched Rockfish															
Dinner Plate Jellyfish															
Eulachon								1.19				0.33	8.28		0.13
Euphausiids															
Flatfishes			0.01												
Fried Egg Jellyfish										1.32					
Greenlings															
Greenstriped Rockfish															
Isopods															
Jack Mackerel															
Jellyfish		10.79	7.74	14.73		13.20		14.01	7.48	12.96					0.28
Lanternfish									1.17						
Lions Mane Jellyfish															
Lumpfishes And Snailfishes	0.88	0.10	3.05	3.78							0.79				
Moon Jellyfish															
North Pacific Spiny Dogfish	3.04	2.04			11.48	3.41									
Northern Anchovy															
Northern Spearnose															
Poacher															
Ocean Sunfish															
Opalescent Inshore Squid															
Pacific Hake							152.6					0.88			
Pacific Herring	229.52	19.40				12.26	9847.4	0.17			0.08	38.51	2.20		0.23
Pacific Lamprey															
Pacific Sand Lance															
Pacific Sanddab															
Pacific Sardine															
Pacific Sea Nettle															1.42
Pacific Tomcod															

	Tow	71	72	73	74	75	76	77	78	79	80	81	82	83	84
<b>Event Number</b>	<b>149</b>	<b>150</b>	<b>151</b>	<b>154</b>	<b>157</b>	<b>160</b>	<b>161</b>	<b>162</b>	<b>163</b>	<b>166</b>	<b>169</b>	<b>172</b>	<b>173</b>	<b>174</b>	
Pink Salmon	5.15	90.50	6.01		1.44	4.40						1.56			
Pink Shrimp (Smooth)															
Prowfish															
Rockfishes		0.12		0.01		0.06		0.06	22.37	0.59	0.01	0.07	0.05	0.05	3.12
Sablefish															
Salps															
Sanddabs															
Sea Butterfly															
Shortbelly Rockfish															
Silvergray Rockfish															
Siphonophorae															
Slender Sole															0.09
Smelts															
Sockeye Salmon	1.76			0.03											
Squids															
Steelhead															
Sturgeon Poacher															
Tope Shark															
True Crabs															
Unidentified Larvae															
Unknown Fish															
Walleye Pollock			0.01	0.01		0.01					0.01				
Water Jellyfish			0.32	0.46	30.48			0.79			10.30	2.40	2.06	5.42	
Whitebait Smelt															
Widow Rockfish															
Wolf Eel				0.03	0.09			0.10	0.04	0.08					
Yellowtail Rockfish															
<b>TOTAL</b>	<b>258.93</b>	<b>172.13</b>	<b>20.20</b>	<b>24.52</b>	<b>44.30</b>	<b>51.76</b>	<b>10000.0</b>	<b>16.85</b>	<b>36.65</b>	<b>14.95</b>	<b>15.99</b>	<b>61.92</b>	<b>12.68</b>	<b>14.29</b>	

	Tow	85	86	87	88	89	90	91	92	93	94	95	96	97	98
<b>Event Number</b>	<b>175</b>	<b>178</b>	<b>183</b>	<b>184</b>	<b>185</b>	<b>188</b>	<b>191</b>	<b>194</b>	<b>195</b>	<b>196</b>	<b>197</b>	<b>200</b>	<b>201</b>	<b>202</b>	
American Shad															
Arrowtooth Flounder															
Black Rockfish															
Blue Shark															0.05
Boreal Clubhook Squid															
Calycoopsis Spp.															
Canary Rockfish															
Chinook Salmon					0.61			7.48	7.16						
Chum Salmon									0.07						
Codfishes															
Coho Salmon															
Comb Jellyfish		0.01													
Copper Rockfish															
Darkblotched Rockfish															
Dinner Plate Jellyfish															
Eulachon															0.01
Euphausiids															
Flatfishes	0.01			0.01	0.03			0.01							
Fried Egg Jellyfish															
Greenlings															
Greenstriped Rockfish			1.24												
Isopods															
Jack Mackerel															
Jellyfish															
Lanternfish															
Lions Mane Jellyfish															
Lumpfishes And Snailfishes															
Moon Jellyfish					1.08		0.25								
North Pacific Spiny Dogfish															
Northern Anchovy															
Northern Spearnose															
Poacher															
Ocean Sunfish															
Opalescent Inshore Squid					0.06										
Pacific Hake															
Pacific Herring									0.06	3.87	9.70	7.24			
Pacific Lamprey															
Pacific Sand Lance															
Pacific Sanddab									0.20	0.18					
Pacific Sardine									0.03						
Pacific Sea Nettle	3.01	1.42	1.24	0.34	0.34	1.01	0.16	0.58	0.23			5.63			5.68
Pacific Tomcod															

	Tow	85	86	87	88	89	90	91	92	93	94	95	96	97	98
<b>Event Number</b>	<b>175</b>	<b>178</b>	<b>183</b>	<b>184</b>	<b>185</b>	<b>188</b>	<b>191</b>	<b>194</b>	<b>195</b>	<b>196</b>	<b>197</b>	<b>200</b>	<b>201</b>	<b>202</b>	
Pink Salmon															
Pink Shrimp (Smooth)															
Prowfish															
Rockfishes	0.17	9.30	1.28	0.34	0.03	0.05	0.01	0.02	0.01	0.02	0.78	0.57	1.99	0.03	
Sablefish															
Salps															
Sanddabs															
Sea Butterfly															
Shortbelly Rockfish															
Silvergray Rockfish															
Siphonophorae															
Slender Sole															
Smelts															
Sockeye Salmon															
Squids															
Steelhead															
Sturgeon Poacher															
Tope Shark															
True Crabs															
Unidentified Larvae															
Unknown Fish															
Walleye Pollock					0.01				0.01						
Water Jellyfish	4.64	0.82	4.01	1.00	16.77	3.11	4.80	9.44	1.92	2.13	8.76	2.72	0.78	3.83	
Whitebait Smelt									0.01						
Widow Rockfish															
Wolf Eel	0.03							0.05					0.38	0.01	
Yellowtail Rockfish					0.74										
<b>TOTAL</b>	<b>7.86</b>	<b>11.55</b>	<b>7.77</b>	<b>1.69</b>	<b>19.66</b>	<b>4.18</b>	<b>5.29</b>	<b>21.44</b>	<b>12.11</b>	<b>16.80</b>	<b>9.54</b>	<b>8.92</b>	<b>3.15</b>	<b>9.61</b>	





Tow	99	100	101	102	103	104	105	106	107	108	109	110	111	112
Event Number	203	204	205	208	211	214	215	216	217	220	223	226	227	228
Pink Salmon						7.28			4.85	1.35	6.28			19.22
Pink Shrimp (Smooth)						704.93								
Prowfish														
Rockfishes	0.07	0.41	0.08	0.01			0.30							
Sablefish														
Salps														
Sanddabs														
Sea Butterfly														
Shortbelly Rockfish														
Silvergray Rockfish														
Siphonophorae														
Slender Sole														
Smelts														
Sockeye Salmon										2.08				
Squids														
Steelhead														
Sturgeon Poacher														
Tope Shark														
True Crabs														
Unidentified Larvae														
Unknown Fish														
Walleye Pollock				0.07			0.04						2.46	
Water Jellyfish	0.62	1.43	7.72	13.08	3.00		23.14							
Whitebait Smelt						8.74	0.06							
Widow Rockfish														
Wolf Eel							0.07				0.12			
Yellowtail Rockfish	4.57	7.20	7.88	13.33	7.55	788.79	25.16	885.77	259.25	11.03	36.20	725.04	20.68	34.10
TOTAL														

	Tow	113	114	115	116	117	118	119	120	121	122	123	124	125	126
<b>Event Number</b>	<b>229</b>	<b>232</b>	<b>233</b>	<b>236</b>	<b>237</b>	<b>238</b>	<b>239</b>	<b>242</b>	<b>245</b>	<b>246</b>	<b>247</b>	<b>248</b>	<b>251</b>	<b>252</b>	
American Shad															
Arrowtooth Flounder															
Black Rockfish															
Blue Shark															
Boreal Clubhook Squid															
Calycoopsis Spp.															
Canary Rockfish					12.40										
Chinook Salmon	0.56									6.45				0.31	
Chum Salmon		0.55													
Codfishes															
Coho Salmon	4.48				3.78			0.09			12.97	11.43			0.42
Comb Jellyfish															
Copper Rockfish															
Darkblotched Rockfish															
Dinner Plate Jellyfish															
Eulachon				0.11											
Euphausiids															
Flatfishes															
Fried Egg Jellyfish															
Greenlings															
Greenstriped Rockfish															
Isopods															
Jack Mackerel								1.92							
Jellyfish					0.36										
Lanternfish															
Lions Mane Jellyfish															
Lumpfishes And Snailfishes															
Moon Jellyfish															
North Pacific Spiny Dogfish		0.31		10.20					24.69					2.81	
Northern Anchovy															
Northern Spearnose															
Poacher															
Ocean Sunfish															
Opalescent Inshore Squid			0.02												
Pacific Hake															
Pacific Herring															
Pacific Lamprey										6.23	5.43	7.54			
Pacific Sand Lance					1911.56										
Pacific Sanddab															
Pacific Sardine															0.13
Pacific Sea Nettle															
Pacific Tomcod							0.27	0.91							

	Tow	113	114	115	116	117	118	119	120	121	122	123	124	125	126
<b>Event Number</b>	<b>229</b>	<b>232</b>	<b>233</b>	<b>236</b>	<b>237</b>	<b>238</b>	<b>239</b>	<b>242</b>	<b>245</b>	<b>246</b>	<b>247</b>	<b>248</b>	<b>251</b>	<b>252</b>	
Pink Salmon	3.20			3.56						1.99					
Pink Shrimp (Smooth)															
Prowfish															
Rockfishes							0.29	0.01	0.02		0.05	0.48	0.13		
Sablefish								0.03					0.07		
Salps							0.04								
Sanddabs													0.01		
Sea Butterfly							0.02								
Shortbelly Rockfish															
Silvergray Rockfish															
Siphonophorae															
Slender Sole															
Smelts															
Sockeye Salmon															
Squids															
Steelhead															
Sturgeon Poacher															
Tope Shark															
True Crabs															
Unidentified Larvae															
Unknown Fish															
Walleye Pollock															
Water Jellyfish		6.17	23.40				1.89	0.50	1.49			2.19	4.10		
Whitebait Smelt															
Widow Rockfish															
Wolf Eel							0.03								
Yellowtail Rockfish															
<b>TOTAL</b>	<b>8.24</b>	<b>7.03</b>	<b>23.42</b>	<b>127.21</b>	<b>1932.08</b>	<b>0.27</b>	<b>1151.92</b>	<b>3.27</b>	<b>31.46</b>	<b>6.94</b>	<b>41.03</b>	<b>11.48</b>	<b>5.80</b>	<b>4.72</b>	

	Tow	127	128	129	130	131	132	133	134	135
<b>Event Number</b>	<b>252</b>	<b>255</b>	<b>256</b>	<b>257</b>	<b>258</b>	<b>261</b>	<b>264</b>	<b>267</b>	<b>268</b>	
American Shad										
Arrowtooth Flounder										
Black Rockfish										
Blue Shark										
Boreal Clubhook Squid										
Calyopsis Spp.										
Canary Rockfish										
Chinook Salmon		4.62			6.94	0.85	15.54	18.03		
Chum Salmon										
Codfishes										
Coho Salmon					11.69	24.38	39.52	124.30	2.41	
Comb Jellyfish	0.42									
Copper Rockfish										
Darkblotched Rockfish										
Dinner Plate Jellyfish										
Eulachon			0.17		0.03					
Euphausiids										
Flatfishes										
Fried Egg Jellyfish										
Greenlings										
Greenstriped Rockfish										
Isopods										
Jack Mackerel								80.74		
Jellyfish										
Lanternfish										
Lions Mane Jellyfish										
Lumpfishes And Snailfishes										
Moon Jellyfish		0.02								
North Pacific Spiny Dogfish		6.31	4.88		4.02					
Northern Anchovy										
Northern Spearnose										
Poacher										
Ocean Sunfish										
Opalescent Inshore Squid										
Pacific Hake			0.71							
Pacific Herring		198.10	1082.33	12.44				20.40	35.89	
Pacific Lamprey										
Pacific Sand Lance										
Pacific Sanddab										
Pacific Sardine										
Pacific Sea Nettle			0.25			6.52			2.50	
Pacific Tomcod										

	Tow	127	128	129	130	131	132	133	134	135
<b>Event Number</b>	<b>252</b>	<b>255</b>	<b>256</b>	<b>257</b>	<b>258</b>	<b>261</b>	<b>264</b>	<b>267</b>	<b>268</b>	
Pink Salmon					5.73	0.67	1.59	96.33	2.27	
Pink Shrimp (Smooth)										
Prowfish										
Rockfishes	0.13	0.02								
Sablefish	0.07									
Salps										
Sanddabs										
Sea Butterfly										
Shortbelly Rockfish										
Silvergray Rockfish										
Siphonophorae										
Slender Sole										
Smelts										
Sockeye Salmon										
Squids										
Steelhead										
Sturgeon Poacher										
Tope Shark										
True Crabs										
Unidentified Larvae										
Unknown Fish										
Walleye Pollock										
Water Jellyfish	4.10	0.24				0.40				
Whitebait Smelt										
Widow Rockfish										
Wolf Eel								0.03		
Yellowtail Rockfish										
<b>TOTAL</b>	<b>4.72</b>	<b>204.94</b>	<b>1092.71</b>	<b>21.67</b>	<b>28.38</b>	<b>32.82</b>	<b>56.65</b>	<b>339.80</b>	<b>43.07</b>	