Strait of Georgia Groundfish Bottom Trawl Survey, March 14 – 24, 2012

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Abstract

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A bottom trawl survey of the Strait of Georgia was conducted on the fisheries research vessel C.C.G.S. *W.E. Ricker* between March 14 and March 24, 2012. The Strait of Georgia is the only ecosystem within British Columbia that is not routinely surveyed by the DFO groundfish synoptic bottom trawl survey program. This survey was the first fully comprehensive bottom trawl survey in the Strait of Georgia and the objective was to investigate the feasibility of conducting a synoptic survey of all demersal fish species available to bottom trawling in this area, as well as to collect biological samples of selected species including stomach contents. A total of 110 survey blocks were examined, with 51 blocks successfully fished. The mean catch per tow was 286 kg, and the total catch for the survey from usable tows was 14,595 kg. In total, 73 species of fish and 61 taxonomic groups of invertebrates were identified. Spotted Ratfish, Pacific Hake, Slender Sole, English Sole, and North Pacific Spiny Dogfish were the most frequently encountered fish species, all of which were captured in at least 85% of the tows. The fish species that comprised 70% of the total survey catch (kg) included (in relative order of contribution): English Sole, North Pacific Spiny Dogfish, Spotted Ratfish, Walleye Pollock and Shiner Perch. Biological data, including individual length, weight, sex, and diet composition were collected from 46 different species of fish. Oceanographic data and net geometry data were also collected, including water temperature, depth, headrope height, and trawl door spread.

Résumé

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Un relevé au chalut de fond du détroit de Georgie a été effectué sur le NGCC de recherche scientifique halieutique *W.E. Ricker* entre les 14 et 24 mars 2012. Le détroit de Georgie est le seul écosystème de la Colombie-Britannique dans lequel des relevés ne sont pas régulièrement effectués par le programme de relevé synoptique au chalut de fond du poisson démersal du MPO. L'étude était le premier relevé au chalut de fond complet réalisé dans le détroit de Georgie. Elle visait à examiner la faisabilité d'une étude synoptique de toutes les espèces de poisson démersal exposées au chalut de fond dans la zone ainsi qu'à prélever des échantillons biologiques de certaines espèces, notamment des contenus stomacaux. Au total, les relevés ont porté sur 110 blocs, dont 51 ont fait l'objet d'une pêche. Les prises moyennes par coup de filet s'élevaient à 286 kg et, au total les prises du relevé issues de coups de filets utilisables atteignaient 14 595 kg. En tout, 73 espèces issues de 61 groupes taxonomiques d'invertébrés ont été identifiées. Les espèces les plus couramment trouvées étaient la chimère d'Amérique, le merlu du Pacifique, la plie mince, le carlottin anglais et l'aiguillat commun du Pacifique Nord, qui se retrouvaient dans au moins 85 % des coups de filet. Les espèces de poissons qui composaient 70 % des prises totales de l'étude (en kg) étaient (par ordre relatif d'importance) : le carlottin anglais, l'aiguillat commun du Pacifique Nord, la chimère d'Amérique, la goberge de l'Alaska et la perche-méné. Des données biologiques, notamment la longueur, le poids, le sexe et la composition du régime alimentaire des individus, ont été recueillies pour 46 espèces de poisson. Des données océanographiques et géométriques ont également été collectées, notamment la température de l'eau, la profondeur, la longueur de la ralingue supérieure et le déploiement des panneaux de chalut.

Introduction

The Strait of Georgia is a semi-enclosed marine basin between the mainland of British Columbia and Vancouver Island, Canada (Figure 1). Commercial and recreational groundfish fisheries have been conducted in the Strait of Georgia since the late 19th century. Currently, Strait of Georgia groundfish fisheries are limited in scope compared to historic exploitation levels and to other areas in British Columbia. In 2001, a National Stock Assessment Review (DFO 2001) recommended that fishery-independent indices of relative abundance be developed for all species exposed to fishing. In the Pacific region, groundfish synoptic bottom trawl surveys were designed (Sinclair et al. 2003) to provide these fishery-independent abundance indices for as many benthic and near-benthic fish species as possible, while obtaining supporting biological samples from selected species. Groundfish synoptic bottom trawl surveys have been conducted in the outer coastal waters off British Columbia since 2003. The 2012 Strait of Georgia groundfish synoptic bottom trawl survey represents the first comprehensive bottom trawl survey in the Canadian portion of the Georgia Basin. This survey was also used to collect groundfish diet composition data in order to address gaps in ecosystem research in the Strait of Georgia. It is anticipated that this survey will be conducted every 3- 5 years.

Methods

Vessel and Fishing Gear

The fishing vessel for the survey was the Canadian Coast Guard Ship (CCGS) *W.E. Ricker*, a 57.3 m stern trawler used for fisheries research. Bottom trawl tows were conducted using a Yankee 36 Trawl net connected to 1,135 kg U.S.A. Jet doors and equipped with a hard bottom footrope (Appendix Table A-1 and Appendix Figure A-1). This is a smaller net than used in other groundfish synoptic surveys and was used to minimize catch of depleted species and to permit a smaller area of deployment for fishing events. Much of the Strait of Georgia is untrawlable due to underwater cables, and a smaller net makes area of tow selection more feasible. The trawl net was equipped with a Simrad ITI Trawl System that provided realtime net depth, doorspread and wingspread values. These data allowed us to continually monitor the net during fishing.

Survey Area and Design

The survey area consisted of the Canadian portion of the Georgia Basin between Saturna Island and the southern end of Discovery Passage, from a latitude of approximately 48° 54’ N to a latitude of 50° 02’ N (Figure 1).

Available data for planning purposes

Sinclair et al. (2003) recommended using the time series of groundfish commercial bottom trawl catch data for planning purposes when developing a synoptic survey of a new area. However, commercial bottom trawling has been limited in the Strait of Georgia since about 1990 with limited information on discards, so there was little commercial data available. Three previous multi-species bottom trawl surveys had occurred in portions of the Strait of Georgia: in 2003, Fisheries and Oceans Canada conducted a pilot survey in the Canadian portion of the Georgia Basin aboard a small research trawler (Greg Workman, unpublished data), while in 1997 and 2001, the Washington Department of Fish and Wildlife conducted transboundary synoptic surveys which included Canadian waters in the southern portion of the Georgia Basin (Palsson

et al. 2003). These research surveys provided some insight into species composition that might be expected in bottom trawl tows, as well as allowing us to select appropriate depth strata.

Depth strata and survey blocks

We followed the random, depth stratified design recommended for coastwide synoptic surveys by Sinclair et al. 2003.

Based on bathymetry as well as data from previous research surveys in the area, the survey area was divided into four distinct depth strata (Table 1, Figure 1). The survey area was further divided into a contiguous grid of 4 km^2 blocks, representing possible tow locations (Stanley et al. 2004), with the stratum area determined by counting the number of blocks in each stratum. For the 2012 survey, a stratified random sample of blocks was drawn, with the target proportion of successfully fished blocks per stratum determined relative to the area of each stratum (Table 1), as per the Option Two allocation scheme described in Sinclair et al. (2003).

The number of randomly selected blocks must necessarily be greater than the target number of successful tows per stratum, as a proportion of the blocks will be unfishable. As this was the first such survey in the Strait of Georgia, it was not possible to estimate the proportion of fishable tows per stratum. Therefore, primary and secondary survey blocks were randomly selected from the sampling frame, with each set distributed over the full extent of the sampling frame, following a similar method to that used in 2004 for the West Coast Vancouver Island synoptic survey, where the sampling frame would be traversed twice as each set of blocks was completed (Workman et al. 2008). In future Strait of Georgia synoptic surveys, the per-stratum failure/rejection rate from the 2012 and subsequent surveys can be used to determine an appropriate number of blocks to select that will achieve the desired sampling frequency in each stratum.

Fishing Operations

Duration of tows and vessel track line

The target duration of each tow was 20 minutes, towed at 2.8 – 3.0 knots, with a minimum acceptable tow duration of 15 minutes, and is consistent with the other synoptic surveys (e.g. Stanley et al. 2004). Start time of the tow was when the footrope reached the bottom and the head rope collapsed to the correct height, as measured by the real-time net sensor. Nineteen minutes after the start of the tow, we retrieved the net. Retrieval was done one minute early because slack in the warps creates a lag of about one minute before the net leaves the bottom. End time of the tow was when the footrope left the bottom, or if the net collapsed or stopped moving during a hang-up.

A bottom contact sensor (HOBO pendant logger) was attached to the footrope of the net during tows to record tilt angles as the net was dragged along the seafloor. This sensor, mounted in a protective housing, was attached to the net at the start of each day, and removed for downloading at the end of the day. The bottom contact sensor provided additional (after the fact) estimates of the time the net was in contact with the bottom.

A GPS unit continuously recorded the vessel speed, direction, and location, forming the trackline. The vessel track from the first stable bottom contact to bottom lift-off, as recorded by the net sensor, was recorded as the tow location.

Selection and rejection of survey blocks

As with any bottom trawl survey, tows were not attempted on grounds known to be unsuitable for bottom trawling, or on grounds determined to be unsuitable based on inspection (of charts and/or depth sounder trace). We relied on the knowledge and experience of the fishing master to reject unsuitable blocks based on "prior knowledge" or following "inspection", and such blocks were permanently removed from the sampling frame, as per the rationale provided by Stanley et al. (2007).

For the remaining randomly selected blocks, the fishing master attempted to complete a 20 minute tow through the centre of the block, usually following a depth contour. However, where the bottom topography made this difficult or impossible, the fishing master would trawl wherever he felt he could obtain a successful result. A successful tow was defined as one which achieved at least 15 minutes of total bottom time, with a trawl track of which at least half was within the survey block. A failed tow was defined as one where a "hang-up" (snagging of the net on bottom) caused the net to collapse or stop moving, or where there was damage to the net that would significantly affect the catch. Failed tows in a particular block could be repeated at the fishing master's discretion, but if the fishing master determined that no further tows would be possible in the block, the block was rejected "after one or more attempts to fish" and was permanently removed from the sampling frame.

Each of the survey blocks randomly selected for the survey was assigned a status in the sampling frame corresponding to rejection of the survey block for various reasons (and permanent removal from the sampling frame), or acceptance of the block due to successful fishing (Appendix Table B-1).

Other data recorded during tows

In addition to the start and end times and positions for the tow, we recorded vessel speed, bottom depth, weather conditions (Appendix Table B-2), tide, net mouth height, and trawl door spread for each tow.

Oceanographic Data

Two Seabird Electronics devices were attached to the trawl net to record oceanographic data for each tow. A Seabird Electronics model 39 (SBE39) recording instrument was attached to the wingtip of the trawl net on the headrope to record temperature and pressure (depth) at five second intervals. A Seabird Electronics model 19plus (SBE19) SeaCAT Profiler Conductivity-Temperature-Depth probe (CTD) was mounted inside a protective housing and attached via a mesh bag to the top of the trawl net behind the center of the headrope to record temperature, pressure (depth), salinity, and dissolved oxygen at 10 second intervals. 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.

Catch Processing

At the end of each tow, the net was retrieved and the catch dumped into a hopper in the fish processing lab. Large catches were randomly subsampled prior to sorting. The catch was sorted on a conveyer system to the lowest taxonomic group possible. 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/M2000, 60 kg capacity). For catches of a species or taxonomic group which totalled less than 0.1 kg, we recorded "trace" instead of a weight. Where practical, the number of individuals was recorded.

Biological Sampling

One of the objectives of the groundfish synoptic bottom trawl surveys is to collect comprehensive biological samples (length, length-sex, and length-sex-weight-maturity-age) from a wide range of species. An additional objective of the Strait of Georgia Survey was to collect diet composition data from as many species as possible. In order to improve sampling logistics, two separate biological sampling protocols were used to achieve these objectives, and are described in detail in Appendix C. In addition, if any sharks were captured (other than North Pacific Spiny Dogfish, *Squalus suckleyi*), the shark sampling protocol would apply (Appendix D).

The main biological sampling protocol was applied to all tows except the first tow of the day, the tow hauled aboard immediately after lunch, and the final tow of the day. In addition, the main biological sampling protocol applied to all tows on the first day of each leg of the survey. Under the main biological sampling protocol, length or length-sex samples were collected from all species captured, subject to species-specific minimum catch criteria. In addition, length, sex, and weight, or length, sex, weight, maturity and age structures were collected from certain species from each tow, subject to a predetermined species ranking, species-specific minimum catch criteria, and dominance in the tow. The maximum sample size required was approximately 25 – 30 specimens, with the exception of Bocaccio, where all individuals were to be sampled if possible, and Pacific Cod, where a length-stratified age sample of up to approximately 60 specimens was required.

The stomach sampling protocol was applied to the first tow of the day, the tow hauled aboard immediately after lunch, and the final tow of the day, except on the first day of each leg of the survey. Under the stomach sampling protocol, length, sex, weight and stomach content information were collected from as many species as possible in the selected tow, starting with the most abundant species in the tow, and working through the catch to the least abundant species as time permitted. An overall target for the survey was at least 200 stomach specimens per species for species captured in at least 10 tows. If skates or Lingcod were captured during these sets, ageing structures would also be collected. Stomach contents were identified to the lowest taxonomic level possible. For each species and taxonomic group in the stomach contents, the volume was estimated to the nearest cubic centimetre (cc) and the digestion state was estimated as “fresh,” “half digested,” “three-quarters digested,” or “fully digested.” A single stomach could have one or several different types of prey at different stages of digestion.

Diet Analyses

Diet analyses were conducted with empty stomachs and stomachs containing unidentifiable material excluded. Three measures of importance were calculated for each prey item for species sampled in at least 10 fishing events. Percent frequency occurrence (%FO) was the percentage of stomachs containing that prey item. The proportion of contents (%C) was the mean percentage of the prey item volume to the individual stomach total volume. The total volume importance (%V) was the percentage ratio of the total prey volume to the total stomach content volume consumed by that species. These three measures of importance were combined to calculate an overall index of Relative Importance (RI) for each prey item as per King and Beamish (2000) such that:

$$RI = \%FO \times (\%C + \%V)$$

The RI relates how many fish eat that prey item, how much of a prey item an individual fish eats, and how much that prey contributes to the total amount of food consumed by all fish examined. RI ranges from zero (i.e. prey item not present) to 20,000 (i.e. a monodiet with 100% for all three measures). For easier comparison, RI was expressed as a percentage (%RI) and as

three-way plots to indicate which measure of diet was most influential in determination of %RI (Cortes 1997). Only prey items that occurred in at least 2% of the stomachs examined were included in these plots.

Biomass Index

Swept area biomass estimates were obtained following Stanley et al. (2004) and Workman et al. (2008) for each finfish species with greater than 0.5 kg of catch from a usable tow. Estimates were computed in R 2.10.1 (R Development Core Team 2009).

CPUE Density

Catch per unit of effort (CPUE) densities, δ_{yi} (kg/m^2) were obtained as follows:

$$(1) \qquad \delta_{yi} = \frac{1}{n_{yi}} \sum_{j=1}^{n_{yi}} \frac{C_{yij}}{D_{yij} w_{yij}}$$

where C_{yij} is the catch (kg) in tow j, stratum i, year y; D_{yij} is the distance travelled (km) for tow j, stratum i, year y; w_{yij} is the net width or door spread (km) for tow j, stratum i, year y; and n_{yi} is the number of tows in stratum i, year y. $D_{yij}\, w_{yij}$ is the swept area for tow j, stratum i, year y. When the distance travelled (D_{yij}) was not available, the code estimated the distance travelled as the product of the difference between start and end of bottom contact time (tow duration) and the tow speed. When bottom contact times were not available, end of gear deployment and beginning of gear retrieval were used. When net width or door spread (w_{yij}) was not available, the mean doorspread for the survey was used.

Annual Biomass Estimate

The annual biomass estimate (B_y) is the sum of the product of CPUE densities and the area of each stratum across m strata:

$$(2) \qquad B_y = \sum_{i=1}^{m} \delta_{yi} A_i = \sum_{i=1}^{m} B_{yi} \ ,$$

where δ_{yi} is the mean CPUE density (kg/m^2) for stratum i, year y; A_i is the area (m^2) of stratum i; B_{yi} is the biomass (kg) for stratum i, year y; and m is the number of strata.

Error Distribution and Survey Precision

Bootstrapping was used to estimate the uncertainty of the biomass estimates (Efron 1982). One thousand bootstrap replicates with replacement were made on the survey data to provide bias corrected 95% confidence limits.

Relative error (RE) was defined as the coefficient of variation (CV) of the distribution of the 1000 bootstrapped estimates for each biomass estimate (Workman et al. 2008). This is the Observation Error, an estimate of sampling variance caused by variation among catch rates within the set of observations from one survey year, and is used as a proxy for the overall relative error of the survey (Stanley et al. 2007).

Stanley et al. (2004) used the RE as a measure of precision, or the capability of a survey to track changes in a population over time, and suggested the following standards:

- Excellent: < 0.2
- Good: 0.2 – 0.3
- Adequate: 0.3 – 0.4

- Poor: 0.4 – 0.6
- Very poor: > 0.6

Workman et al. (2008) have specified that generating biomass indices with RE < 0.2 is one of the design objectives of the synoptic surveys. We provide estimates of RE based on the 1000 bootstrapped biomass estimates for finfish species with greater than 0.5 kg of catch from a usable tow.

Results

Fishing

We divided the survey into two legs of five days (March 14 – 18) and six days (March 19 – 24). We were able to fish on all survey days, resulting in a total of 11 fishing days. We conducted a total of 53 tows, of which 51 were successful. On average, we were able to conduct about 5 successful tows per day. Bridge log data for each tow is contained in Appendix Table E-1.

A total of 110 survey blocks were examined, with 51 blocks successfully fished (Table 1, Figure 2). In Stratum 1, we successfully fished seven blocks (the target number of blocks: 14% of the total) and rejected 14 blocks. In Stratum 2, we successfully fished eight blocks (three less than the target: 16% of the total, compared to the target of 22% of the tows) and rejected 18 blocks. In Stratum 3, we successfully fished 16 blocks (one more than the target: 31% of the total compared to the target of 30%) and rejected 12 blocks. In Stratum 4, we successfully fished 20 blocks (three more than the target: 39% compared to the target of 34%) and rejected 15 blocks. Recall that blocks were assigned to strata based on the mean charted depth for the block. For some blocks, the actual depth towed in the field resulted in a depth range for that tow that was outside of the range for the stratum to which that block was assigned; however, the assignment of blocks to strata was not changed based on actual depths towed.

The final status of the 2012 sampling frame therefore includes 110 survey blocks examined with 51 blocks successfully fished, 31 blocks rejected prior to fishing based on the fishing master's knowledge (typically due to presence of cables), 27 blocks rejected based on on-ground inspection, and one location rejected after a failed fishing attempt (Figure 2).

Future surveys may benefit from consideration of the proportion of successfully fished to rejected blocks, as well as consideration of the proportion of successfully fished to target proportion in each stratum. In particular, additional effort may be required in Stratum 2 to obtain the desired proportion of tows. Future surveys will likely see an improvement in the number of successful tows per day, as considerable time during the first leg of the survey was spent inspecting grounds, and the inspected blocks that were deemed unfishable have been permanently removed from the sampling frame.

Catch Composition

Catch composition for each tow is presented in Appendix Table E-2. One hundred thirty-four species or taxonomic groups of fishes and invertebrates were identified, of which 73 were fishes and 61 were invertebrates. The mean catch weight per tow was 286 kg, with catches ranging from 36 – 1587 kg for each usable tow. The total catch for the survey from usable tows was 14,595 kg.

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 is presented in Table 2. Approximately 70% of the total survey catch (in kg) was comprised of five

species (in relative order of contribution): English Sole, North Pacific Spiny Dogfish, Spotted Ratfish, Walleye Pollock and Shiner Perch (Table 2). However, Shiner Perch was not frequently encountered, as only eight tows captured this species. Spotted Ratfish, Pacific Hake, Slender Sole, English Sole, and North Pacific Spiny Dogfish were the most frequently encountered fish species, all of which were captured in at least 85% of the tows (Table 2). Anemones (Acinaria), Schoolmaster Gonate Squid (*Berryteuthis magister*), and Sidestripe Shrimp (*Pandalopsis dispar*) were the most abundant and frequently encountered invertebrate species by both weight and number of tows.

Biological Sampling

Samples

A total of 556 biological samples were collected from 46 fish species, which included 9914 individual specimens (Table 3). Sample size, statistics of length and weight, and sex proportion are presented in Table 4 for each species sampled.

Length and Sex

Length frequencies are presented for fish species where at least 100 specimens were measured (Figure 3 to Figure 6). Differences in sex ratio or differences in sex-specific size were apparent for some species. Overall, more and larger female Pacific Hake were captured and for both males and females, there was a distinct bimodal length distribution (Table 4, Figure 3). These modes correspond to age 1 and age 2 based on size-at-age data from Strait of Georgia Pacific Hake since 1997 (King, unpub. data). Male Spotted Ratfish were more frequent than females; females were slightly larger than males (Table 4, Figure 3). Mean length of female Slender Sole was larger than that for males, and slightly more females were captured (Table 4, Figure 3). The mean length of female English Sole was larger than mean length for males, and more females were captured (Table 4, Figure 4). The length distributions for both male and female Walleye Pollock were bimodal (Figure 4), corresponding to age 0 and age 1 through 5 based on size-at-age data collected elsewhere in British Columbia waters (King, unpub. data). The mean length of female Flathead Sole was larger than mean length for males, and more females were captured (Table 4, Figure 5). The mean length of female Pacific Sanddab was larger than the mean length for males (Figure 5). More male Splitnose Rockfish were captured than females (Table 4, Figure 5). More and larger female Greenstriped Rockfish were captured than males (Table 4, Figure 5). The mean length of male Plainfin Midshipmen was larger than for females, and slightly more males were captured (Table 4, Figure 6). More female Blackbelly eelpouts were captured than males (Table 4, Figure 6). The mean length of female Southern Rock Sole was larger than that for males, and slightly more females were captured (Table 4, Figure 6).

Stomach Samples and Diet Analyses

A total of 115 stomach samples were collected from 25 fish species (Table 5). Of the 2259 individual specimens examined, 2131 had usable stomachs (stomachs were not everted). Of the usable stomachs, 49 % were empty, and 42 % contained identifiable prey. The remainder contained unidentifiable prey items, which are generally items too digested to retain identifiable features. Detailed stomach contents for each predator species are presented in Table 6. We were able to obtain stomach samples from at least 10 tows for six species with cumulative sample sizes of at least 199 specimens: Spotted Ratfish, North Pacific Spiny Dogfish, Slender Sole, English Sole, Pacific Hake and Walleye Pollock (Table 5). These six species were

present in the highest number of tows for the survey, and were among the top seven species by total catch weight (Table 2); the number of tows with stomach analyses represented over 20% of the tows in which each species were captured. Shiner Perch was also one of the top seven species by total catch weight, but was caught in only eight tows during the survey; the two Shiner Perch tows with large catches (107 and 760 kg) were not designated stomach sample tows.

The diet of Spotted Ratfish was dominated by sea urchins (%RI=25.8%); many Spotted Ratfish ate this prey item, most of the total prey eaten was comprised of sea urchins, and when consumed, sea urchins accounted for over 80% of the stomach contents (Figure 7). The diet of North Pacific Spiny Dogfish was heavily dominated by teleosts, in particular, Pacific Herring when teleosts were identified to species. Together, unidentified fishes (%RI=32.4%); and Pacific Herring (%RI=11.0%) occurred in over 65% of the North Pacific Spiny Dogfish stomachs; teleosts were generally consumed in large quantities and accounted for over 90% of stomach contents (Figure 7). The diet of Slender Sole was dominated by amphipods (%RI=30.9%) which occurred in almost half of the stomachs and accounted for over 90% of stomach contents (Figure 7). The diet of English Sole was dominated by Polychaetes (%RI=16.1%) and tube worms (%RI=11.8%), each consumed by about 20-30% of the fish, comprising most of the stomach contents, and consumed in moderate quantities (Figure 7). The diet of Pacific Hake was dominated by Shrimp (%RI=15.6%) and euphausiids (%RI=15.5%), both consumed by at least 30% of the fish, comprising over 90% stomach contents, but consumed only in small quantities (Figure 7). The diet of Walleye Pollock was dominated by euphausiids (%RI=16.1%) and amphipods (%RI=9.3%); although these prey items were at least 85% of the stomach contents, they were consumed in small quantities and by less than 30% of the fish (Figure 7).

Biomass Estimates

The swept area estimates (as well as the trawl door spread and distance towed) used to estimate species biomass (for finfish only) for each tow are included with the bridge log data in Appendix Table E-1. Biomass estimates and the relative errors (RE) associated with those estimates are presented in Table 7 for all fish species with a catch weight of greater than 0.5 kg from a usable tow. The top five most abundant species in the Strait of Georgia, based on biomass estimates, are English Sole (RE=0.4), North Pacific Spiny Dogfish (RE=0.1), Spotted Ratfish (RE=0.1), Walleye Pollock (RE=0.4), and Flathead Sole (RE=0.5). However, it is important to note that the RE for three of these species was greater than the 0.2 (excellent) threshold for precision, although only Flathead Sole exceeded RE=0.4 (adequate precision).

Of the 73 species of fish captured, there were 26 species that were captured in at least 10 tows, or 20% of the survey tows. Of these species, only six had RE values <0.2 (excellent precision): Spotted Ratfish, North Pacific Spiny Dogfish, Brown Cat Shark, Dover Sole, Longnose Skate, and Pacific Hake (Table 7). An additional 10 species which met the 10-tow criteria had RE values in the 0.2 – 0.4 range (good to adequate precision).

Gear and Oceanographic Sensors

Oceanographic data from the Seabird SBE39 and SBE19plus are archived in the GFBio database at the Pacific Biological Station. In addition, modal bottom temperature is included with the bridge log data in Appendix Table E-1. Data from the Simrad ITI trawl system was collected throughout the survey, but the data were of poor quality; data collection appeared sporadic and there were many spurious values. Doorspread data, where available, are archived in GFBio. Data from the GPS on vessel position, direction, and speed, and data from the

bottom contact sensor were incorporated into the bridge log data in Appendix Table E-1, and are archived in GFBio.

Discussion

There are several areas within the Strait of Georgia which do not present trawlable bottom habitat, namely due to underwater cables, shipping lanes or navy firing ranges. This survey provided opportunity to investigate survey blocks, and several were rejected as unfishable and were permanently removed from the sampling frame. Future surveys will therefore likely see an improvement in the number of successful tows per day, and will benefit from considering this survey's proportion of successfully fished tows to target proportion in each stratum. Of the 26 species of fish captured in at least 20% of the survey tows, six had relative error values <0.2, which is considered excellent precision and one of the design objectives of synoptic surveys (Workman et al. 2008). Ten additional species of fish had relative error values in the 0.2 – 0.4 range, which is considered good to adequate precision. Another objective of this bottom trawl survey was analyse groundfish diet composition data in order to address gaps in ecosystem research in the Strait of Georgia. The designation of three tows per day as diet sampling tows did not impede the logistics of the survey and provided comprehensive diet samples for groundfish in the Strait of Georgia.

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Table 1. Depth strata utilized during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

	Depth Stratum		Stratum Size		Target No. Tows	Blocks examined	Successful Tows*	
	(m)	(fm)	Total Blocks	Proportion			No.	Proportion
1	10 – 75	5 – 41	169	0.14	7	21	7	0.14
2	75 – 150	41 – 82	258	0.22	11	26	8	0.16
3	150 – 250	82 – 137	364	0.30	15	28	16	0.31
4	250 – 500	137 – 273	403	0.34	17	35	20	0.39
		Total	1194	1.00	50	110	51	1.00

* Note that the number of successful tows per stratum is based on the stratum to which blocks were assigned prior to the survey. Actual towed depths during the survey may differ from the charted depth of any given block.

Table 2. All captured species, 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 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

Common Name	Scientific name	No. Tows	Catch (kg)		
			Total	Max	Mean
English Sole	*Parophrys vetulus*	48	2,615.2	597.4	54.5
North Pacific Spiny Dogfish	*Squalus suckleyi*	48	2,271.5	177.6	47.3
Spotted Ratfish	*Hydrolagus colliei*	50	2,250.0	164.8	45.0
Walleye Pollock	*Theragra chalcogramma*	44	2,083.7	452.2	47.4
Shiner Perch	*Cymatogaster aggregata*	8	947.7	759.6	118.5
Slender Sole	*Lyopsetta exilis*	49	775.7	220.9	16.2
Pacific Hake	*Merluccius productus*	49	590.8	138.6	13.1
Pacific Cod	*Gadus macrocephalus*	14	387.7	315.3	27.7
Southern Rock Sole	*Lepidopsetta bilineata*	12	372.8	195.9	33.9
Flathead Sole	*Hippoglossoides elassodon*	22	335.8	193.7	15.3
Starry Flounder	*Platichthys stellatus*	4	235.6	171.9	58.9
Plainfin Midshipman	*Porichthys notatus*	20	191.9	67.5	10.7
Dover Sole	*Microstomus pacificus*	41	187.8	34.6	4.6
Pacific Sanddab	*Citharichthys sordidus*	6	163.7	97.2	27.3
Rex Sole	*Glyptocephalus zachirus*	35	51.4	9.9	1.6
Arrowtooth Flounder	*Reinhardtius stomias*	26	51.2	11.9	2.0
Longnose Skate	*Raja rhina*	32	50.3	8.6	1.7
Blackbelly Eelpout	*Lycodes pacificus*	27	47.4	16.1	3.0
American Shad	*Alosa sapidissima*	21	29.9	5.8	1.4
Pacific Herring	*Clupea pallasii*	21	26.4	7.3	1.6
Eelpouts	*Zoarcidae*	3	24.6	19.3	12.3
Greenstriped Rockfish	*Sebastes elongatus*	14	22.4	5.9	1.6
Lingcod	*Ophiodon elongatus*	5	20.9	12.0	4.2
Splitnose Rockfish	*Sebastes diploproa*	13	20.0	7.8	1.5
Brown Cat Shark	*Apristurus brunneus*	26	19.0	2.3	0.8
Eulachon	*Thaleichthys pacificus*	12	12.0	3.5	1.1
Big Skate	*Raja binoculata*	7	11.3	3.8	1.6
Chinook Salmon	*Oncorhynchus tshawytscha*	6	10.9	5.0	1.8
Bluntnose Sixgill Shark	*Hexanchus griseus*	1	9.4	9.4	9.4
Petrale Sole	*Eopsetta jordani*	9	9.1	3.7	1.0
Shortspine Thornyhead	*Sebastolobus alascanus*	15	8.2	1.7	0.6
Pile Perch	*Rhacochilus vacca*	3	7.3	4.3	2.4
Snake Prickleback	*Lumpenus sagitta*	5	6.1	4.0	2.0
Quillback Rockfish	*Sebastes maliger*	4	5.5	3.2	1.4
Sablefish	*Anoplopoma fimbria*	5	5.4	2.3	1.1
Pacific Staghorn Sculpin	*Leptocottus armatus*	11	5.2	3.1	0.6
Black Eelpout	*Lycodes diapterus*	22	5.1	1.3	0.4
Pacific Tomcod	*Microgadus proximus*	3	3.4	2.7	1.7
Copper Rockfish	*Sebastes caurinus*	2	2.4	1.3	1.2
Sand Sole	*Psettichthys melanostictus*	1	2.4	2.4	2.4
Threadfin Sculpin	*Icelinus filamentosus*	1	2.2	2.2	2.2
Sailfin Sculpin	*Nautichthys oculofasciatus*	1	1.7	1.7	1.7
Butter Sole	*Isopsetta isolepis*	1	1.4	1.4	1.4
Northern Smoothtongue	*Leuroglossus schmidti*	17	1.2	0.4	0.2
Rougheye Rockfish	*Sebastes aleutianus*	1	1.2	1.2	1.2
Blackfin Poacher	*Bathyagonus nigripinnis*	18	1.2	0.5	0.2
Kelp Greenling	*Hexagrammos decagrammus*	1	0.5	0.5	0.5
Anchovies	*Engraulidae*	3	0.3	0.3	0.1
Yelloweye Rockfish	*Sebastes ruberrimus*	1	0.2	0.2	0.2
Lampreys	*Petromyzontidae*	4	0.2	0.2	0.2
Dwarf Wrymouth	*Cryptacanthodes aleutensis*	5	0.2	0.2	0.1
Pacific Sardine	*Sardinops sagax*	1	0.1	0.1	0.1
Giant Wrymouth	*Cryptacanthodes giganteus*	1	0.1	0.1	0.1
Whitebait Smelt	*Allosmerus elongatus*	1	0.0	0.0	0.0
Showy Snailfish	*Liparis pulchellus*	1	0.0	0.0	0.0
Speckled Sanddab	*Citharichthys stigmaeus*	1	0.0	0.0	0.0
Sculpins	*Cottidae*	4	0.0	0.0	0.0
Slim Sculpin	*Radulinus asprellus*	1	0.0	0.0	0.0
Northern Lampfish	*Stenobrachius leucopsarus*	9	0.0	0.0	0.0
Spinyhead Sculpin	*Dasycottus setiger*	6	0.0	0.0	0.0
Darkfin Sculpin	*Malacocottus zonurus*	4	0.0	0.0	0.0
Pacific Lamprey	*Lampetra tridentata*	1	0.0	0.0	0.0
Blackmouth Eelpout	*Lycodapus fierasfer*	1	0.0	0.0	0.0
Pallid Eelpout	*Lycodapus mandibularis*	1	0.0	0.0	0.0
Shortfin Eelpout	*Lycodes brevipes*	1	0.0	0.0	0.0
Sticklebacks	*Gasterosteidae*	1	0.0	0.0	0.0

Table 2 (Continued).

Common Name	Scientific name	No. Tows	Catch (kg) Total	Max	Mean
Whitebarred Prickleback	*Poroclinus rothrocki*	1	0.0	0.0	0.0
Roughspine Sculpin	*Triglops macellus*	1	0.0	0.0	0.0
Poachers	*Agonidae*	1	0.0	0.0	0.0
Northern Spearnose Poacher	*Agonopsis vulsa*	1	0.0	0.0	0.0
Sturgeon Poacher	*Podothecus accipenserinus*	1	0.0	0.0	0.0
Smootheye Poacher	*Xeneretmus leiops*	1	0.0	0.0	0.0
Pygmy Poacher	*Odontopyxis trispinosa*	1	0.0	0.0	0.0
Anemone	*Actiniaria*	21	247.0	55.4	13.7
Schoolmaster Gonate Squid	*Berryteuthis magister*	36	138.1	16.3	3.8
Sidestripe Shrimp	*Pandalopsis dispar*	44	92.4	21.3	2.1
Plumose Anemone	*Metridium*	11	61.3	38.7	5.6
Dungeness Crab	*Cancer magister*	12	61.1	23.9	5.1
Squids	*Teuthida*	4	30.8	11.0	10.3
Pink Shrimp (Smooth)	*Pandalus jordani*	5	10.7	6.2	2.7
Inshore Tanner Crab	*Chionoecetes bairdi*	20	10.3	2.4	0.7
Mud Star	*Ctenodiscus crispatus*	10	8.0	6.3	1.6
Sand Star	*Luidia foliolata*	7	7.9	2.1	1.1
Sweet Potato Sea Cucumber	*Molpadia intermedia*	9	7.1	5.5	2.4
Brown Box Crab	*Lopholithodes foraminatus*	5	4.9	1.2	1.0
Prawn	*Pandalus platyceros*	17	3.9	2.6	0.4
Tanner Crabs	*Chionoecetes*	9	3.6	1.4	0.5
Opalescent Inshore Squid	*Loligo opalescens*	5	2.7	1.2	0.7
Pink Shrimp	*Pandalus borealis*	11	2.6	1.9	0.7
Heart Urchins	*Atelostomata*	17	2.4	1.2	0.4
Sponges	*Porifera*	6	2.2	1.1	0.4
Sunflower Starfish	*Pycnopodia helianthoides*	2	2.2	1.3	1.1
Glass Shrimp	*Pasiphaea pacifica*	19	1.5	1.4	0.8
Rosy Tritonia	*Tritonia diomedea*	1	1.3	1.3	1.3
Box Crabs	*Lopholithodes*	2	1.1	0.7	0.6
Sea Whip	*Balticina septentrionalis*	4	0.9	0.5	0.4
Basket Star	*Gorgonocephalus eucnemis*	1	0.7	0.7	0.7
Mediaster	*Mediaster*	1	0.6	0.6	0.6
Northern Crangon	*Crangon alaskensis*	16	0.5	0.3	0.2
Vermillion Starfish	*Mediaster aequalis*	6	0.5	0.3	0.2
Pink Shrimp (Flexed)	*Pandalus goniurus*	2	0.4	0.4	0.4
Polychaete Worms	*Polychaeta*	3	0.3	0.3	0.3
Turban Snails	*Turbinidae*	1	0.2	0.2	0.2
Crangons	*Crangon*	2	0.2	0.2	0.2
Smoothskin Octopus	*Benthoctopus leioderma*	6	0.1	0.1	0.1
Sea Urchins	*Echinacea*	1	0.0	0.0	0.0
Pacific Bobtail Squid	*Rossia pacifica*	4	0.0	0.0	0.0
Shrimp (Eualus Sp.)	*Eualus*	5	0.0	0.0	0.0
Common Two-Spined Crangon	*Neocrangon communis*	15	0.0	0.0	0.0
Rock Snails	*Muricidae*	5	0.0	0.0	0.0
Decorator Crabs	*Oregonia*	5	0.0	0.0	0.0
Sea Mouse	*Aphrodita*	3	0.0	0.0	0.0
Humpback Shrimp	*Pandalus hypsinotus*	3	0.0	0.0	0.0
Whelks	*Buccinidae*	2	0.0	0.0	0.0
California Armina	*Armina californica*	2	0.0	0.0	0.0
Starfish	*Asteroidea*	2	0.0	0.0	0.0
Sea Cucumbers	*Holothuroidea*	2	0.0	0.0	0.0
Coonstripe Shrimp	*Pandalus danae*	2	0.0	0.0	0.0
Squat Lobster	*Munida quadrispina*	2	0.0	0.0	0.0
Adams Spiny Margarite	*Cidarina cidaris*	1	0.0	0.0	0.0
Peanutworms	*Sipuncula*	1	0.0	0.0	0.0
Pale Moonsnail	*Euspira pallida*	1	0.0	0.0	0.0
True Whelks (Buccinum)	*Buccinum*	1	0.0	0.0	0.0
Slender Admete	*Admete gracilior*	1	0.0	0.0	0.0
Yoldias	*Yoldiidae*	1	0.0	0.0	0.0
Broad Yoldia	*Megayoldia thraciaeformis*	1	0.0	0.0	0.0
Soft Sea Cucumber	*Pseudostichopus mollis*	1	0.0	0.0	0.0
Isopods	*Isopoda*	1	0.0	0.0	0.0
Shrimp	*Dendrobranchiata*	1	0.0	0.0	0.0
Common Argid	*Argis alaskensis*	1	0.0	0.0	0.0
Deepsea Eualid	*Eualus biunguis*	1	0.0	0.0	0.0
Hermit Crabs	*Paguroidea*	1	0.0	0.0	0.0
Alaskan Hermit	*Pagurus ochotensis*	1	0.0	0.0	0.0
Redclaw Crab	*Chorilia longipes*	1	0.0	0.0	0.0

Table 3. Number of samples and number of recorded or collected biological attributes for each species sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

Species Common Name	No. Samples	No. Specimens	No. Sexes	No. Lengths				
				Fork Length	Standard Length	Total Lengths	2nd Dorsal	Total
Cartilaginous fish								
Bluntnose Sixgill Shark	1	1	1	--	--	1	--	1
Brown Cat Shark	25	92	91	--	--	92	--	92
North Pacific Spiny Dogfish	41	1015	1015	--	--	1015	--	1015
Big Skate	7	15	15	--	--	15	--	15
Longnose Skate	31	76	76	--	--	76	--	76
Spotted Ratfish	45	1465	1465	--	--	--	1465	1465
Roundfish								
American shad	21	81	58	81	--	--	--	81
Chinook salmon	6	9	9	9	--	--	--	9
Pacific Cod	14	55	55	55	--	--	--	55
Pacific Hake	38	1539	1540	1539	--	--	--	1539
Pacific Tomcod	2	22	15	22	--	--	--	22
Walleye Pollock	28	633	633	633	--	--	--	633
Sablefish	5	6	6	6	--	--	--	6
Lingcod	5	59	59	59	--	--	--	59
Non-commercial roundfish								
Northern Smoothtongue	3	58	0	--	58	--	--	58
Plainfin Midshipman	3	102	42	--	--	102	--	102
Eelpouts	1	30	0	--	--	30	--	30
Black Eelpout	5	98	0	--	--	98	--	98
Blackbelly Eelpout	8	275	45	--	--	275	--	275
Kelp Greenling	1	6	6	6	--	--	--	6
Threadfin Sculpin	1	36	0	--	--	36	--	36
Pacific Staghorn Sculpin	1	27	0	--	--	27	--	27
Blackfin Poacher	1	19	0	--	--	19	--	19
Pelagics								
Pacific Herring	9	207	106	--	207	--	--	207
Eulachon	9	157	106	--	157	--	--	157
Shiner Perch	4	309	309	309	--	--	--	309
Pile Perch	1	23	0	23	--	--	--	23
Rockfish								
Rougheye Rockfish	1	1	1	1	--	--	--	1
Copper Rockfish	2	11	11	11	--	--	--	11
Splitnose Rockfish	13	112	112	112	--	--	--	112
Greenstriped Rockfish	14	103	103	103	--	--	--	103
Quillback Rockfish	4	12	12	12	--	--	--	12
Yelloweye Rockfish	1	1	1	1	--	--	--	1
Shortspine Thornyhead	14	64	64	--	--	64	--	64
Flatfish								
Pacific Sanddab	4	100	100	--	--	100	--	100
Arrowtooth Flounder	6	66	66	66	--	--	--	66
Petrale Sole	9	14	13	--	--	14	--	14
Rex Sole	12	265	265	--	--	265	--	265
Flathead Sole	11	262	262	--	--	262	--	262
Butter Sole	1	7	7	--	--	7	--	7
Southern Rock Sole	11	102	102	--	--	102	--	102
Slender Sole	47	1064	1063	--	--	1064	--	1064
Dover Sole	40	506	506	--	--	506	--	506
English Sole	47	755	755	--	--	755	--	755
Starry Flounder	2	48	48	--	--	48	--	48
Sand Sole	1	5	5	--	--	5	--	5
Total	**556**	**9913**	**9148**	**3048**	**422**	**4978**	**1465**	**9913**

Table 3. (Continued.)

Species Common Name	No. Maturities	No. Weights	No. DNA	No. Age Structures				
				Otoliths	Dorsal Fin	Pectoral Fin	Dorsal Spine	Total
Cartilaginous fish								
Bluntnose Sixgill Shark	--	1	--	--	--	--	--	--
Brown Cat Shark	--	55	--	--	--	--	--	--
North Pacific Spiny Dogfish	479	917	--	--	--	--	479	479
Big Skate	--	14	--	--	--	--	--	--
Longnose Skate	--	54	--	--	--	--	--	--
Spotted Ratfish	--	558	--	--	--	--	--	--
Roundfish								
American shad	--	31	--	--	--	--	--	--
Chinook salmon	--	7	--	--	--	--	--	--
Pacific Cod	29	46	--	--	29	--	--	29
Pacific Hake	432	1055	--	482	--	--	--	482
Pacific Tomcod	--	--	--	--	--	--	--	--
Walleye Pollock	300	596	--	--	--	300	--	300
Sablefish	4	4	--	4	--	--	--	4
Lingcod	56	59	--	--	44	--	--	44
Non-commercial roundfish								
Northern Smoothtongue	--	--	--	--	--	--	--	--
Plainfin Midshipman	--	42	--	--	--	--	--	--
Eelpouts	--	--	--	--	--	--	--	--
Black Eelpout	--	--	--	--	--	--	--	--
Blackbelly Eelpout	--	45	--	--	--	--	--	--
Kelp Greenling	--	--	--	--	--	--	--	--
Threadfin Sculpin	--	--	--	--	--	--	--	--
Pacific Staghorn Sculpin	--	--	--	--	--	--	--	--
Blackfin Poacher	--	--	--	--	--	--	--	--
Pelagics								
Pacific Herring	--	24	--	--	--	--	--	--
Eulachon	--	--	--	--	--	--	--	--
Shiner Perch	--	96	--	--	--	--	--	--
Pile Perch	--	--	--	--	--	--	--	--
Rockfish								
Rougheye Rockfish	1	1	1	1	--	--	--	1
Copper Rockfish	8	11	--	11	--	--	--	11
Splitnose Rockfish	88	108	--	88	--	--	--	88
Greenstriped Rockfish	62	101	--	62	--	--	--	62
Quillback Rockfish	12	12	--	12	--	--	--	12
Yelloweye Rockfish	--	--	--	--	--	--	--	--
Shortspine Thornyhead	4	55	--	49	--	--	--	49
Flatfish								
Pacific Sanddab	--	77	--	--	--	--	--	--
Arrowtooth Flounder	31	51	--	31	--	--	--	31
Petrale Sole	--	11	--	--	--	--	--	--
Rex Sole	65	116	--	65	--	--	--	65
Flathead Sole	68	120	--	68	--	--	--	68
Butter Sole	--	--	--	--	--	--	--	--
Southern Rock Sole	75	89	--	75	--	--	--	75
Slender Sole	431	782	--	431	--	--	--	431
Dover Sole	177	341	--	177	--	--	--	177
English Sole	320	589	--	319	--	--	--	319
Starry Flounder	19	48	--	19	--	--	--	19
Sand Sole	--	5	--	--	--	--	--	--
Total	**2661**	**6121**	**1**	**1894**	**73**	**300**	**479**	**2746**

Table 4. Sample size (n), statistics of length and weight, and sex proportion for each species sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

Species Common Name	n	length (cm)			weight (g)			sex proportion	
		min	max	mean	min	max	mean	males	females
Cartilaginous fish									
Bluntnose Sixgill Shark	1	132.0	132.0	132.0	9000	9000	9000.0	0.00	1.00
Brown Cat Shark	92	17.0	55.5	35.1	14	572	175.0	0.59	0.41
North Pacific Spiny Dogfish	1015	23.5	110.0	59.7	55	6650	1018.4	0.54	0.46
Big Skate	15	19.0	78.5	35.5	41	3378	725.2	0.53	0.47
Longnose Skate	76	18.0	87.0	42.5	42	4142	626.8	0.57	0.43
Spotted Ratfish	1465	7.5	47.0	30.0	6	1105	419.4	0.56	0.44
Roundfish									
American shad	81	20.0	42.0	29.2	230	770	389.5	0.55	0.45
Chinook salmon	9	3.0	72.0	25.3	334	4924	1183.3	0.43	0.57
Pacific Cod	55	24.5	74.5	56.9	142	5602	2087.6	0.42	0.58
Pacific Hake	1540	9.5	73.5	24.5	4	3092	161	0.36	0.64
Pacific Tomcod	22	14.0	21.0	16.9	--	--	--	0.13	0.87
Walleye Pollock	633	2.7	53.0	28.6	4	1165	233.7	0.48	0.52
Sablefish	6	30.0	51.0	43.8	241	1256	797.3	0.83	0.17
Lingcod	59	2.2	60.5	23.7	62	2130	205.3	0.44	0.56
Non-commercial roundfish									
Northern Smoothtongue	58	6.0	13.0	9.1	--	--	--	--	--
Plainfin Midshipman	102	10.0	27.0	19.5	8	202	84.0	0.53	0.47
Eelpouts	30	10.0	22.0	17.2	--	--	--	--	--
Black Eelpout	98	11.0	24.0	19.5	--	--	--	--	--
Blackbelly Eelpout	275	9.0	23.0	16.3	6	30	15.7	0.24	0.76
Kelp Greenling	6	16.0	28.0	20.7	--	--	--	0.17	0.83
Threadfin Sculpin	36	15.0	25.0	20.6	--	--	--	--	--
Pacific Staghorn Sculpin	27	14.0	28.0	20.2	--	--	--	--	--
Blackfin Poacher	19	7.0	17.0	14.2	--	--	--	--	--
Pelagics									
Pacific Herring	207	8.0	23.0	17.1	4	170	90.8	0.46	0.54
Eulachon	157	13.0	21.0	17.5	--	--	--	0.54	0.46
Shiner Perch	309	8.0	15.0	11.0	10	28	18.0	0.43	0.57
Pile Perch	23	15.0	23.0	17.2	--	--	--	--	--
Rockfish									
Rougheye Rockfish	1	40.0	40.0	40.0	1134	1134	1134.0	0.00	1.00
Copper Rockfish	11	16.0	30.0	22.5	68	438	209.5	0.45	0.55
Splitnose Rockfish	112	6.0	34.5	18.3	2	714	159	0.64	0.36
Greenstriped Rockfish	103	10.0	32.5	24.1	12	530	207.6	0.42	0.58
Quillback Rockfish	12	15.5	38.5	26.7	62	1218	433	0.42	0.58
Yelloweye Rockfish	1	23.0	23.0	23.0	--	--	--	1.00	0.00
Shortspine Thornyhead	64	6.0	32.5	18.9	1	478	109	0.59	0.41
Flatfish									
Pacific Sanddab	100	16.0	37.5	27.3	51	818	268.2	0.48	0.52
Arrowtooth Flounder	66	21.5	56.0	35.5	76	1322	433.6	0.33	0.67
Petrale Sole	14	32.0	410.0	63.8	430	907	610.5	0.46	0.54
Rex Sole	265	7.0	51.0	24.1	18	1184	134.8	0.42	0.58
Flathead Sole	262	12.0	39.0	24.3	18	446	154.3	0.42	0.58
Butter Sole	7	26.0	32.0	28.1	--	--	--	0.14	0.86
Southern Rock Sole	102	16.0	41.0	25.4	44	838	188.6	0.47	0.53
Slender Sole	1064	9.0	29.0	20.4	4	198	58.4	0.44	0.56
Dover Sole	506	16.5	46.5	29.1	40	856	224.0	0.45	0.55
English Sole	755	10.5	44.5	30.0	10	1010	244.2	0.31	0.69
Starry Flounder	48	22.0	48.5	32.7	124	1658	456.3	0.71	0.29
Sand Sole	5	30.0	41.5	34.6	280	744	467.6	0.00	1.00

Table 5. Number of samples, number of specimens examined, number usable stomachs (not everted), and proportion (%) of stomachs that were empty or contained unidentified and identifiable prey for species sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

Predator Name	No. Samples	No. Specimens	No. Usable	Proportion of Stomachs (%)		
				Empty	Unidentified Remains	Identifiable Prey
Spotted Ratfish	15	362	360	33.9	24.2	41.9
Pacific Hake	11	336	234	51.7	3.4	44.9
Slender Sole	14	335	334	62.0	5.4	32.6
North Pacific Spiny Dogfish	16	299	299	46.8	4.0	49.2
English Sole	15	205	205	42.9	5.9	51.2
Walleye Pollock	10	199	195	42.1	6.7	51.3
Dover Sole	9	118	118	22.9	16.9	60.2
Pacific Sanddab	2	59	59	52.5	10.2	37.3
Plainfin Midshipman	1	42	42	85.7	11.9	2.4
Greenstriped Rockfish	3	41	27	55.6	3.7	40.7
Pacific Cod	3	36	34	5.9	0.0	94.1
Rex Sole	2	27	27	11.1	7.4	81.5
Blackbelly Eelpout	1	25	25	80.0	4.0	16.0
Shiner Perch	1	25	25	92.0	8.0	0.0
Flathead Sole	1	25	25	88.0	0.0	12.0
Starry Flounder	1	25	25	100.0	--	--
Pacific Herring	1	24	24	41.7	25.0	33.3
Lingcod	1	24	24	87.5	0.0	12.5
Arrowtooth Flounder	1	18	18	88.9	0.0	11.1
Splitnose Rockfish	2	8	5	100.0	--	--
Southern Rock Sole	1	8	8	87.5	0.0	12.5
Petrale Sole	1	6	6	100.0	--	--
Sand Sole	1	5	5	40.0	20.0	40.0
Chinook salmon	1	4	4	0.0	0.0	100.0
Copper Rockfish	1	3	3	100.0	--	--
Total	115	2259	2131	48.5	9.1	42.4

Table 6. Prey items identified in the stomach contents of species sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012. N *is the number of occurrences of each prey type,* %FO *is the frequency of occurrence among all stomachs with identifiable prey,* cc *is the average volume (cm^3) of identifiable prey in each stomach,* %V *is the total volume importance, or proportion of total volume of identifiable prey accounted for by each prey type, and* %C *is the mean proportion of the total identifiable contents of each stomach accounted for by each prey type.*

Spotted Ratfish

Prey Item	N	%FO	cc	%V	%C
Sea urchins	81	39.7	1.3	47.3	83.5
Amphipods	33	16.2	0.4	5.2	39.3
Unid. Fishes	16	7.8	1.1	7.4	67.4
Polychaete worms	12	5.9	1.6	8.3	87.1
Bivalve molluscs	12	5.9	0.7	3.7	85.0
Unidentified worm	11	5.4	2.4	11.8	68.6
Peanutworms	7	3.4	1.8	5.5	69.4
Shrimp	5	2.5	1.3	2.9	56.1
True crabs	5	2.5	0.3	0.7	68.0
Tube worms	4	2.0	0.2	0.3	100.0
Sea cucumbers	3	1.5	0.4	0.5	40.4
Glass Shrimps	3	1.5	2.2	2.9	61.6
Invertebrates	3	1.5	1.2	1.6	46.0
Pink Shrimp	2	1.0	0.3	0.3	13.7
Decapods	2	1.0	0.3	0.3	55.0
Euphausiids	2	1.0	0.4	0.4	55.4
Cephalopods	2	1.0	0.8	0.7	61.5
Squat lobster	1	0.5	1.0	0.4	100.0

North Pacific Spiny Dogfish

Prey Item	N	%FO	cc	%V	%C
Unid. Fishes	80	48.8	9.0	39.1	93.5
Pacific Herring	31	18.9	13.5	22.9	93.6
Shrimp	10	6.1	3.2	1.7	66.5
Euphausiids	7	4.3	0.5	0.2	85.8
Squids	6	3.7	11.5	3.8	78.8
Pacific Hake	5	3.0	19.4	5.3	100.0
Cephalopods	3	1.8	2.1	0.3	46.5
Schoolmaster gonate squid	2	1.2	59.0	6.4	92.9
Codfishes	2	1.2	35.0	3.8	89.2
Shiner Perch	2	1.2	13.0	1.4	98.4
Unidentified worm	2	1.2	6.0	0.7	90.0
Jellyfish	2	1.2	1.0	0.1	100.0
Polychaete worms	2	1.2	0.8	0.1	83.3
Tanner crabs	1	0.6	200.0	10.9	100.0
English Sole	1	0.6	20.0	1.1	100.0
Arrowtooth Flounder	1	0.6	15.0	0.8	100.0
Fish eggs	1	0.6	9.0	0.5	100.0
Slender Sole	1	0.6	5.0	0.3	31.2
Sidestripe Shrimp	1	0.6	4.0	0.2	100.0
Spotted Ratfish	1	0.6	3.0	0.2	14.2
Decapods	1	0.6	3.0	0.2	100.0
Amphipods	1	0.6	0.1	0.0	16.6
Peanutworms	1	0.6	1.0	0.1	3.2

Table 6. (Continued)

Slender Sole					
Prey Item	**N**	**%FO**	**cc**	**%V**	**%C**
Amphipods	58	48.7	0.4	29.3	97.7
Euphausiids	20	16.8	1.4	33.3	88.7
Shrimp	13	10.9	0.7	11.8	92.9
Ophiuroidea	5	4.2	0.1	0.7	71.7
Bivalve molluscs	4	3.4	0.8	3.9	60.6
Unid. Fishes	2	1.7	2.6	6.3	100.0
Sidestripe Shrimp	2	1.7	1.8	4.3	100.0
Decapods	2	1.7	1.5	3.7	66.6
Invertebrates	2	1.7	0.3	0.6	100.0
Fish eggs	2	1.7	0.1	0.2	100.0
Platyhelminthes	2	1.7	0.1	0.2	100.0
True crabs	1	0.8	1.0	1.2	33.3
Polychaete worms	1	0.8	1.0	1.2	83.3
Pacific Herring	1	0.8	1.0	1.2	100.0
Green alga	1	0.8	0.5	0.6	100.0
Copepods	1	0.8	0.5	0.6	100.0
Squids	1	0.8	0.5	0.6	50.0
Unidentified worm	1	0.8	0.1	0.1	100.0

English Sole					
Prey Item	**N**	**%FO**	**cc**	**%V**	**%C**
Polychaete worms	53	32.7	1.2	34.3	63.9
Tube worms	37	22.8	1.2	24.2	78.9
Bivalve molluscs	33	20.4	0.6	9.8	49.7
Peanutworms	16	9.9	3.0	24.8	65.3
Unidentified worm	10	6.2	0.7	3.5	87.5
Ophiuroidea	5	3.1	0.1	0.3	9.5
Gammaridea	2	1.2	0.8	0.8	63.5
Euphausiids	2	1.2	0.7	0.7	83.3
Sea mouse	2	1.2	0.6	0.6	51.0
Sea cucumbers	1	0.6	2.0	1.0	100.0
Amphipods	1	0.6	0.1	0.1	9.0

Table 6. (Continued)

Pacific hake

Prey Item	N	%FO	cc	%V	%C
Shrimp	35	30.4	1.4	8.7	94.2
Euphausiids	32	27.8	1.6	9.5	86.9
Unid. Fishes	17	14.8	3.7	11.4	89.4
Pacific Herring	5	4.3	17.4	15.7	93.3
Thysanoessa spinifera	5	4.3	3.3	3.0	100.0
Glass Shrimp	4	3.5	3.5	2.5	100.0
Crustaceans	4	3.5	0.6	0.4	100.0
Lanternfishes	2	1.7	6.5	2.3	92.9
Sidestripe Shrimp	2	1.7	5.5	2.0	100.0
Amphipods	2	1.7	0.8	0.3	100.0
Walleye Pollock	1	0.9	200.0	36.1	100.0
Squids	1	0.9	15.0	2.7	93.7
Northern Smoothtongue	1	0.9	12.0	2.2	100.0
Pacific Hake	1	0.9	9.0	1.6	100.0
Pink Shrimp	1	0.9	6.0	1.1	100.0
Invertebrates	1	0.9	2.0	0.4	40.0
Decapods	1	0.9	0.3	0.1	100.0

Walleye Pollock

Prey Item	N	%FO	cc	%V	%C
Euphausiids	35	28.9	0.8	21.7	89.7
Amphipods	22	18.2	0.9	15.1	86.8
Invertebrates	15	12.4	0.7	7.7	76.2
Copepods	11	9.1	1.0	8.0	100.0
Glass Shrimp	10	8.3	2.6	19.8	80.4
Crustaceans	6	5.0	0.8	3.8	68.1
Fish eggs	5	4.1	0.2	0.6	100.0
Shrimp	4	3.3	2.5	7.6	96.4
Unid. Fishes	4	3.3	0.5	1.4	27.5
Pandalid shrimp	2	1.7	5.5	8.3	78.6
Sidestripe Shrimp	2	1.7	2.0	3.0	41.4
Decapods	2	1.7	1.0	1.5	50.0
Northern Smoothtongue	1	0.8	1.0	0.8	66.6
Thysanoessa gregaria	1	0.8	0.5	0.4	100.0
Gammaridea	1	0.8	0.3	0.2	100.0

Dover Sole

Prey Item	N	%FO	cc	%V	%C
Polychaete worms	63	72.4	1.2	83.1	86.8
Tube worms	8	9.2	0.6	4.8	26.1
Bivalve molluscs	6	6.9	0.1	0.8	44.4
Jellyfish	3	3.4	2.3	7.4	27.7
Unidentified worm	2	2.3	1.3	2.6	52.2
Peanutworms	2	2.3	0.3	0.6	56.5
Amphipods	1	1.1	0.5	0.5	100.0
Ophiuroidea	1	1.1	0.1	0.1	2.4

Pacific Cod

Prey Item	N	%FO	cc	%V	%C
Unid. Fishes	24	58.5	7.4	28.1	84.8
Pacific Herring	6	14.6	54.0	51.2	100.0
Shrimp	6	14.6	2.1	1.9	23.6
Walleye Pollock	1	2.4	50.0	7.9	100.0
Slender Sole	1	2.4	30.0	4.7	100.0
Herrings	1	2.4	22.0	3.5	61.1
Shiner Perch	1	2.4	14.0	2.2	60.8
Green alga	1	2.4	3.0	0.5	85.7

Table 6. (Continued)

Rex Sole

Prey Item	N	%FO	cc	%V	%C
Polychaete worms	19	70.4	0.8	85.1	90.9
Peanutworms	3	11.1	0.5	8.6	55.7
Invertebrates	2	7.4	0.2	2.3	100.0
True crabs	1	3.7	0.5	2.9	38.4
Bivalve molluscs	1	3.7	0.1	0.6	50.0
Euphausiids	1	3.7	0.1	0.6	16.6

Pacific Sanddab

Prey Item	N	%FO	cc	%V	%C
Unid. Fishes	5	22.7	2.9	22.8	84.0
Decapods	3	13.6	3.0	14.2	100.0
Pink Shrimp	2	9.1	1.3	3.9	100.0
Ophiuroidea	2	9.1	0.8	2.4	40.4
Pacific Herring	1	4.5	10.0	15.7	100.0
Pacific Hake	1	4.5	8.0	12.6	100.0
Amphipods	1	4.5	5.0	7.9	100.0
Peanutworms	1	4.5	4.0	6.3	100.0
Northern anchovy	1	4.5	3.0	4.7	100.0
Glass Shrimp	1	4.5	2.5	3.9	100.0
Proboscis worm	1	4.5	2.0	3.1	100.0
Bivalve molluscs	1	4.5	0.5	0.8	100.0
Shrimp	1	4.5	0.5	0.8	100.0
Euphausiids	1	4.5	0.5	0.8	100.0

Greenstriped Rockfish

Prey Item	N	%FO	cc	%V	%C
Amphipods	10	90.9	0.5	81.8	100.0
Octopus	1	9.1	1.0	18.2	100.0

Pacific Herring

Prey Item	N	%FO	cc	%V	%C
Euphausiids	4	44.4	1.4	32.4	100.0
Decapods	3	33.3	3.0	52.9	100.0
Crangons	2	22.2	1.3	14.7	50.0

Chinook salmon

Prey Item	N	%FO	cc	%V	%C
Unid. Fishes	3	75.0	0.8	11.9	100.0
Pacific Herring	1	25.0	17.0	88.1	100.0

Blackbelly Eelpout

Prey Item	N	%FO	cc	%V	%C
Bivalve molluscs	2	50.0	0.1	50.0	75.0
Copepods	1	25.0	0.1	25.0	100.0
Polychaete worms	1	25.0	0.1	25.0	100.0

Table 6. (Continued)

Lingcod

Prey Item	N	%FO	cc	%V	%C
Unid. Fishes	3	100.0	0.7	100.0	100.0

Flathead Sole

Prey Item	N	%FO	cc	%V	%C
Glass Shrimp	1	33.3	3.0	42.9	100.0
Amphipods	1	33.3	2.5	35.7	100.0
Thysanoessa spinifera	1	33.3	1.5	21.4	100.0

Sand Sole

Prey Item	N	%FO	cc	%V	%C
Unid. Fishes	2	100.0	4.5	100.0	100.0

Arrowtooth Flounder

Prey Item	N	%FO	cc	%V	%C
Unid. Fishes	2	100.0	4.0	100.0	100.0

Southern Rock Sole

Prey Item	N	%FO	cc	%V	%C
Polychaete worms	1	100.0	0.5	100.0	100.0

Plainfin Midshipman

Prey Item	N	%FO	cc	%V	%C
Euphausiids	1	100.0	0.3	100.0	100.0

Table 7. Biomass estimates for fish species from the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012. Biomass estimates are calculated for fish species with at least one usable tow which yielded > 0.5 kg of catch, and are ordered by the number of tows which captured each species. Bootstrap bias corrected confidence intervals and CVs are based on 1000 random draws with replacement, and the bootstrap CV is used as proxy for the overall relative error (RE) of the survey.. Biomass estimates associated with RE <0.2 are considered to have excellent precision.

Common Name	No. Tows	Biomass (t)	Bootstrapped Biomass (t)	Lower Bound Bootstrapped Biomass (t)	Upper Bound Bootstrapped Biomass (t)	Bootstrap CV (RE)
Spotted Ratfish	50	1,923.6	1,918.2	1,465.5	2,395.2	0.1
Pacific Hake	49	538.3	539.2	312.9	848.2	0.2
Slender Sole	49	825.6	810.8	395.0	1,378.0	0.3
North Pacific Spiny Dogfish	48	1,926.4	1,939.1	1,416.1	2,472.5	0.1
English Sole	48	4,833.9	4,874.3	1,710.3	9,585.6	0.4
Walleye Pollock	44	1,791.0	1,740.3	603.8	3,067.5	0.4
Dover Sole	41	140.6	141.4	91.2	199.7	0.2
Rex Sole	35	70.6	70.6	30.2	122.4	0.3
Longnose Skate	32	44.1	44.2	25.6	67.1	0.2
Blackbelly Eelpout	27	122.7	122.8	16.3	299.2	0.7
Brown Cat Shark	26	13.0	13.1	8.5	18.7	0.2
Arrowtooth Flounder	26	46.5	46.3	21.8	75.0	0.3
Black Eelpout	22	3.1	3.0	1.1	5.3	0.4
Flathead Sole	22	1,422.1	1,405.4	102.3	3,974.8	0.8
American Shad	21	24.9	24.7	13.6	39.6	0.3
Pacific Herring	21	28.1	28.4	14.9	42.7	0.3
Plainfin Midshipman	20	223.5	218.6	75.7	424.7	0.4
Shortspine Thornyhead	15	5.4	5.4	2.8	8.5	0.3
Greenstriped Rockfish	14	25.8	25.7	11.6	41.6	0.3
Pacific Cod	14	517.9	512.2	39.6	1,396.5	0.8
Splitnose Rockfish	13	17.8	18.0	4.3	35.3	0.4
Eulachon	12	11.4	11.5	4.7	19.3	0.3
Southern Rock Sole	12	397.4	403.1	45.4	853.9	0.5
Pacific Staghorn Sculpin	11	6.2	6.2	1.0	12.9	0.5
Petrale Sole	9	7.4	7.4	2.6	13.3	0.4
Shiner Perch	8	916.5	899.2	89.2	2,339.9	0.7
Big Skate	7	32.6	33.0	4.5	80.7	0.6
Pacific Sanddab	6	291.4	295.9	37.9	563.2	0.5
Chinook Salmon	6	10.6	10.4	1.8	21.3	0.5
Sablefish	5	3.8	3.8	0.6	8.0	0.5
Lingcod	5	20.7	20.3	1.7	45.3	0.6
Snake Prickleback	5	28.4	28.6	0.4	81.3	0.9
Starry Flounder	4	368.6	373.8	40.2	783.8	0.5
Quillback Rockfish	4	6.8	7.0	0.0	16.0	0.6
Pile Perch	3	6.9	6.9	0.0	15.9	0.6
Pacific Tomcod	3	3.4	3.4	0.0	8.4	0.7
Copper Rockfish	2	2.1	2.1	0.0	4.2	0.6
Threadfin Sculpin	1	1.8	1.9	0.0	5.5	0.9
Sailfin Sculpin	1	1.8	1.8	0.0	5.5	0.9
Butter Sole	1	9.1	9.0	0.0	27.2	0.9
Kelp Greenling	1	0.4	0.4	0.0	1.2	0.9
Bluntnose Sixgill Shark	1	8.0	7.9	0.0	24.0	0.9
Sand Sole	1	2.9	2.9	0.0	8.7	1.0
Rougheye Rockfish	1	0.9	0.8	0.0	2.7	1.0

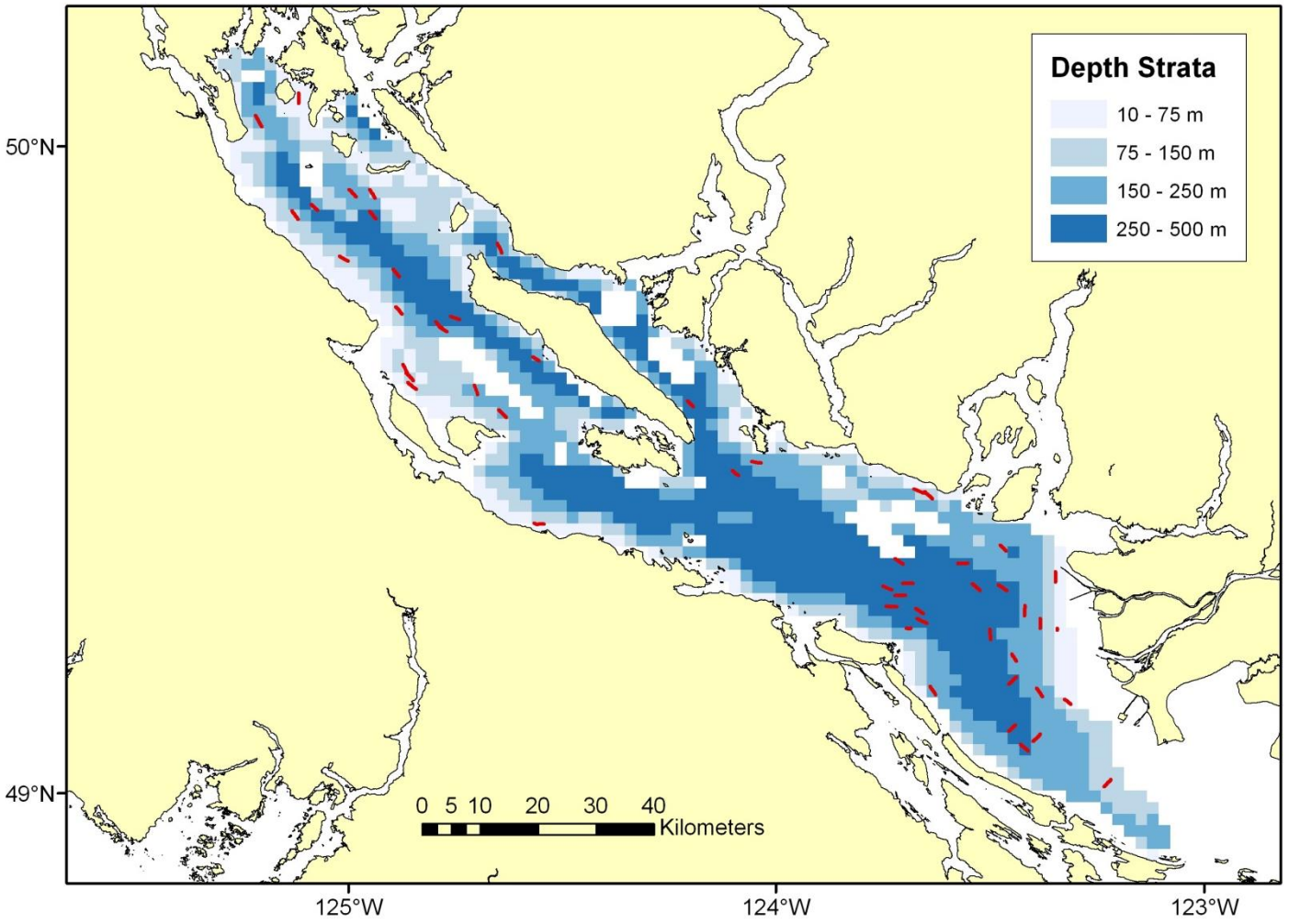


Figure 1. Survey area, depth strata, and tow locations (red lines) for the 2012 Strait of Georgia Synoptic Survey, March 14 – 24, 2012.

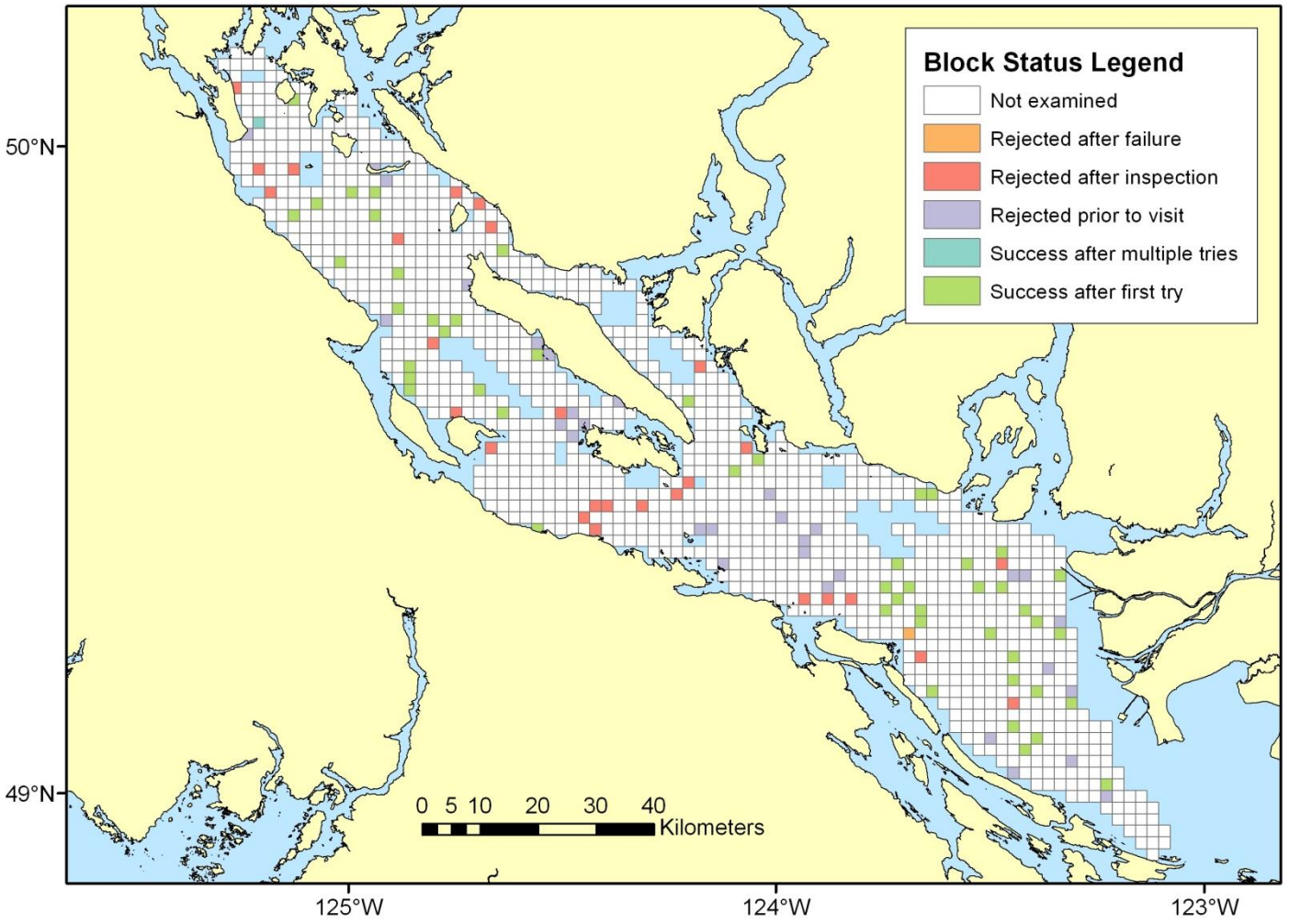


Figure 2. Final status of the Strait of Georgia sampling frame following the 2012 Synoptic Survey, March 14 – 24, 2012. Rejected blocks will be permanently removed from the sampling frame.

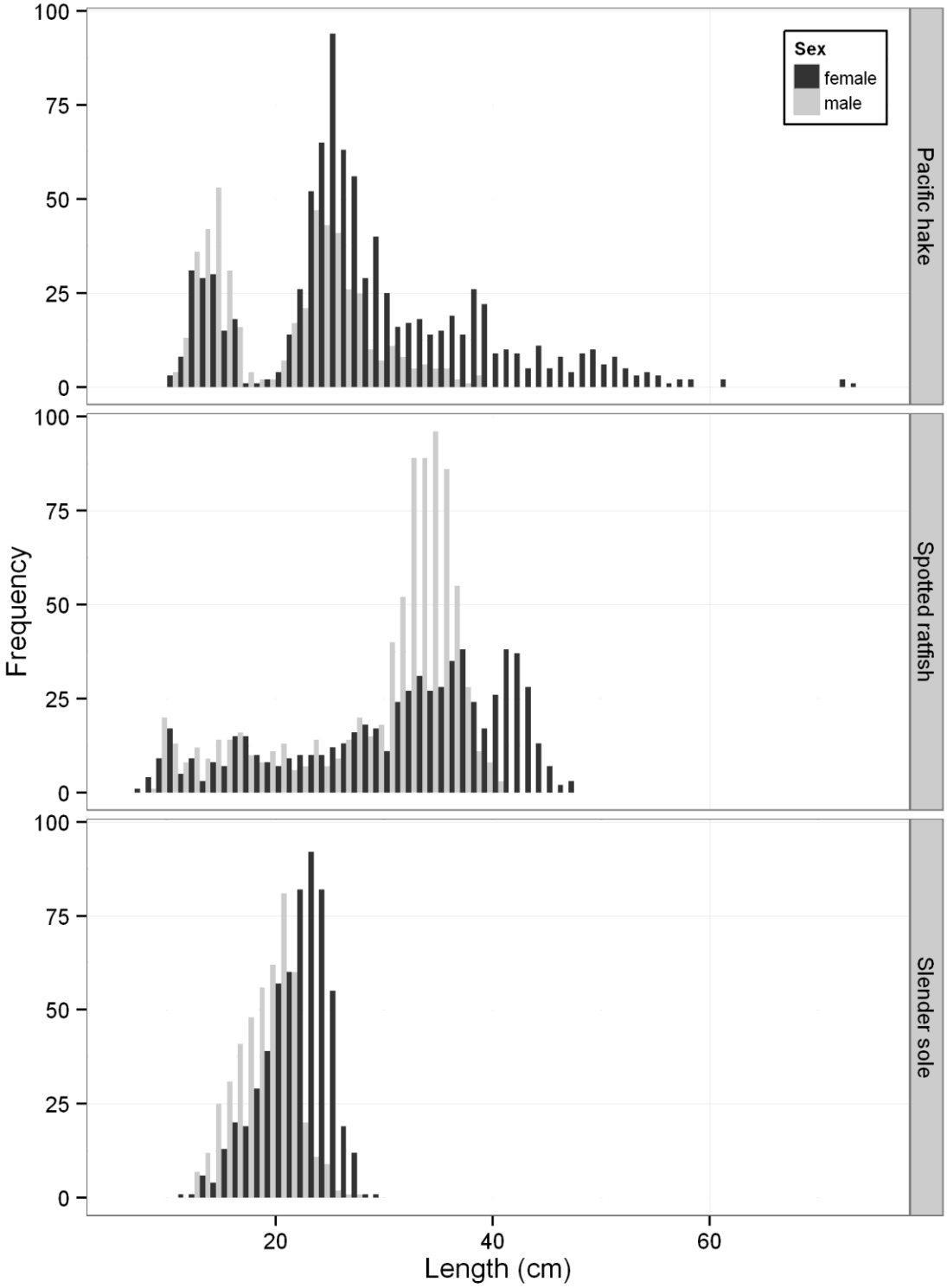


Figure 3. Length frequency for Pacific Hake, Spotted Ratfish, and Slender Sole sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

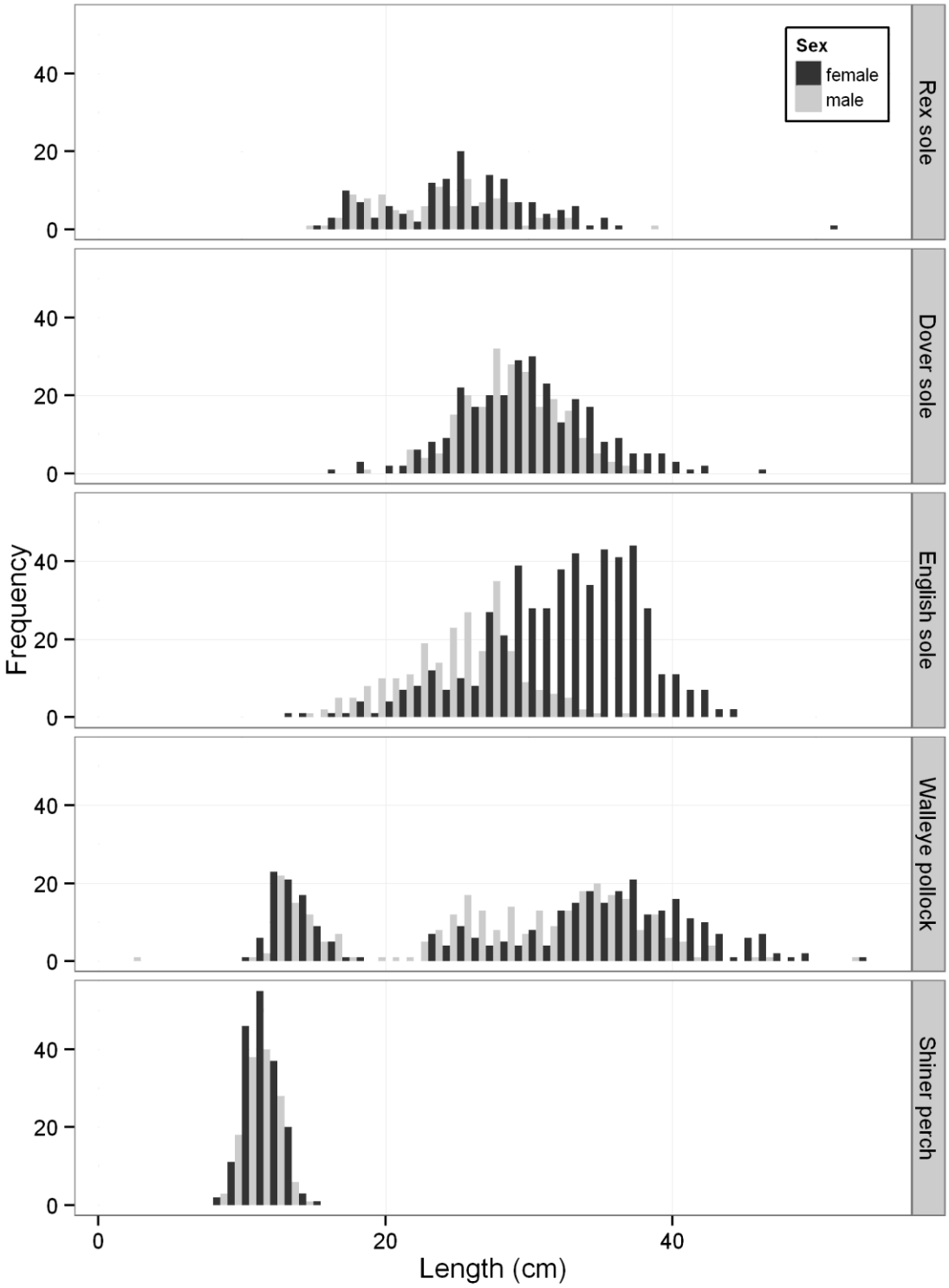


Figure 4. Length frequency for Rex Sole, Dover Sole, English Sole, Walleye Pollock, and Shiner Perch sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

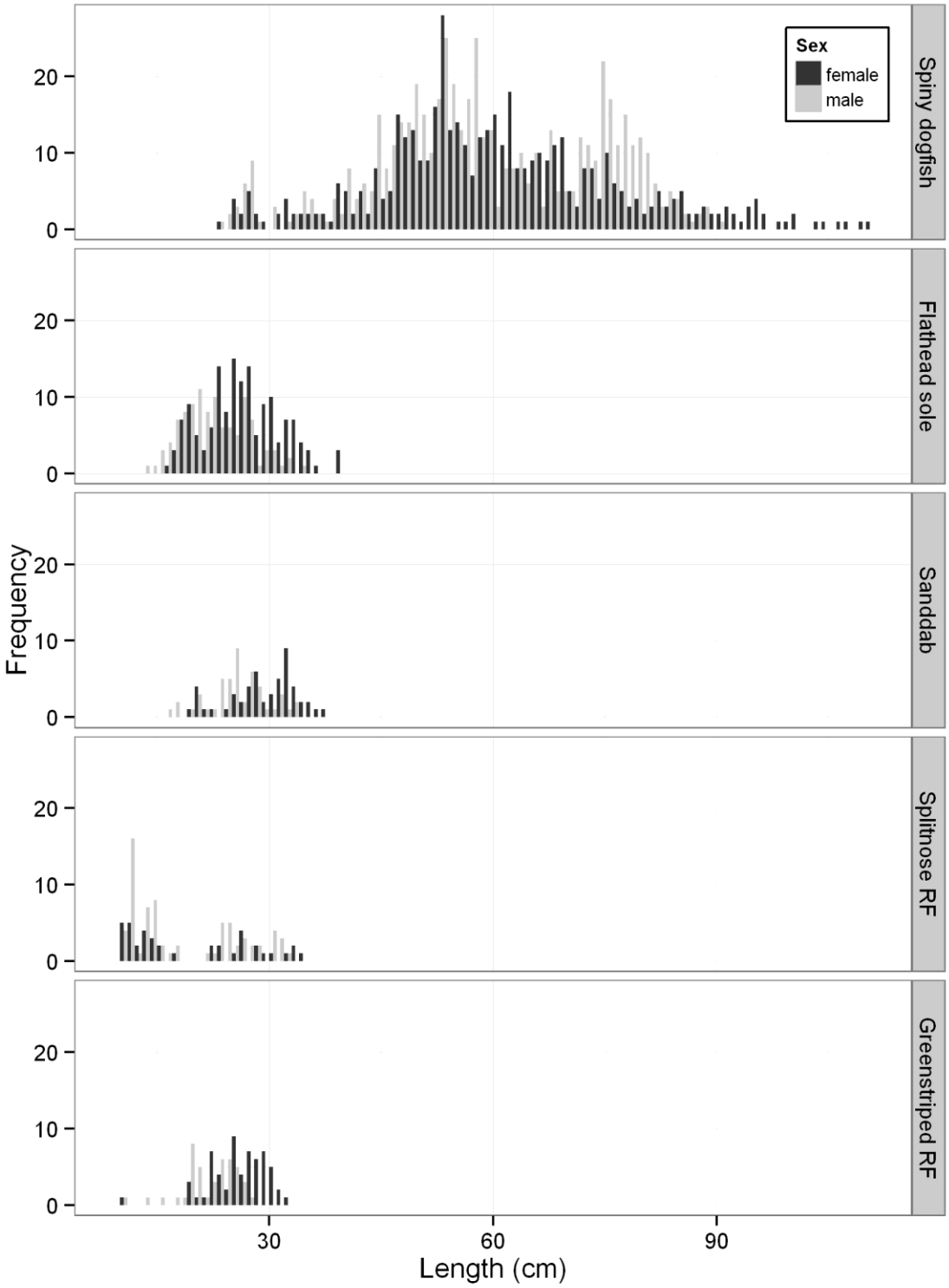


Figure 5. Length frequency for North Pacific Spiny Dogfish, Flathead Sole, Pacific Sanddab, Splitnose Rockfish, and Greenstriped Rockfish sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

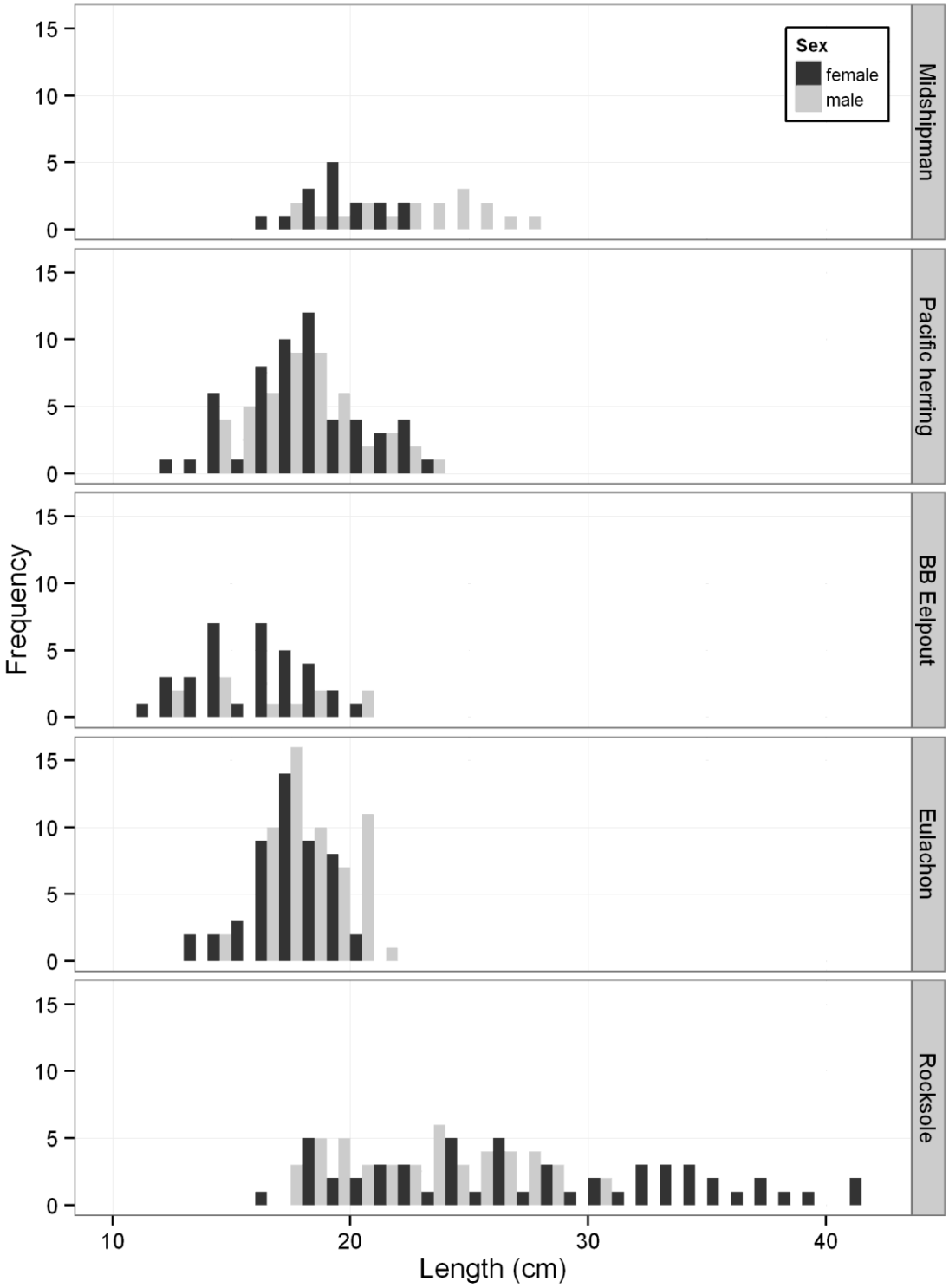


Figure 6. Length frequency for Plainfin Midshipman, Pacific Herring, Blackbelly Eelpout, Eulachon, and Southern Rocksole sampled during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

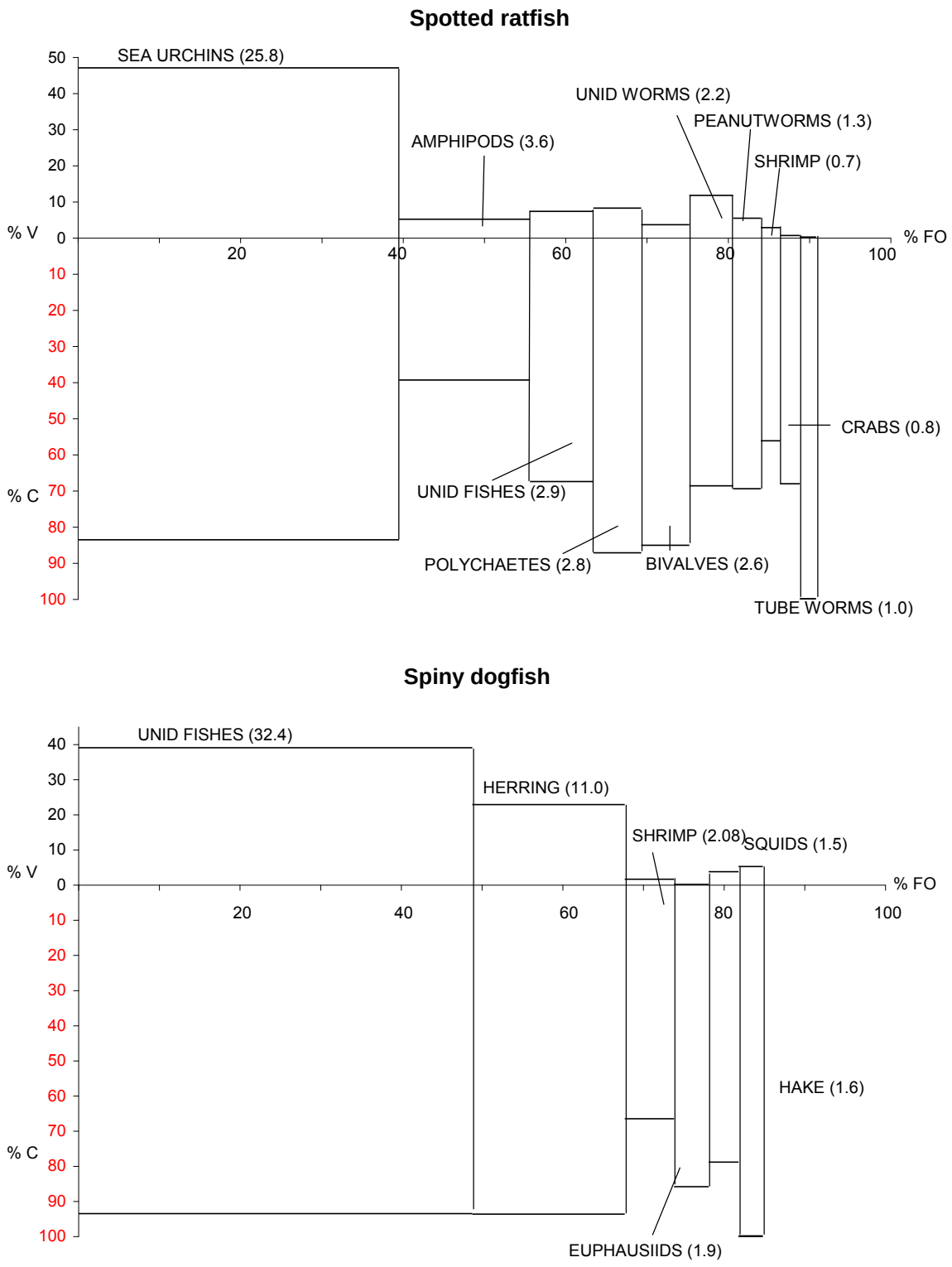
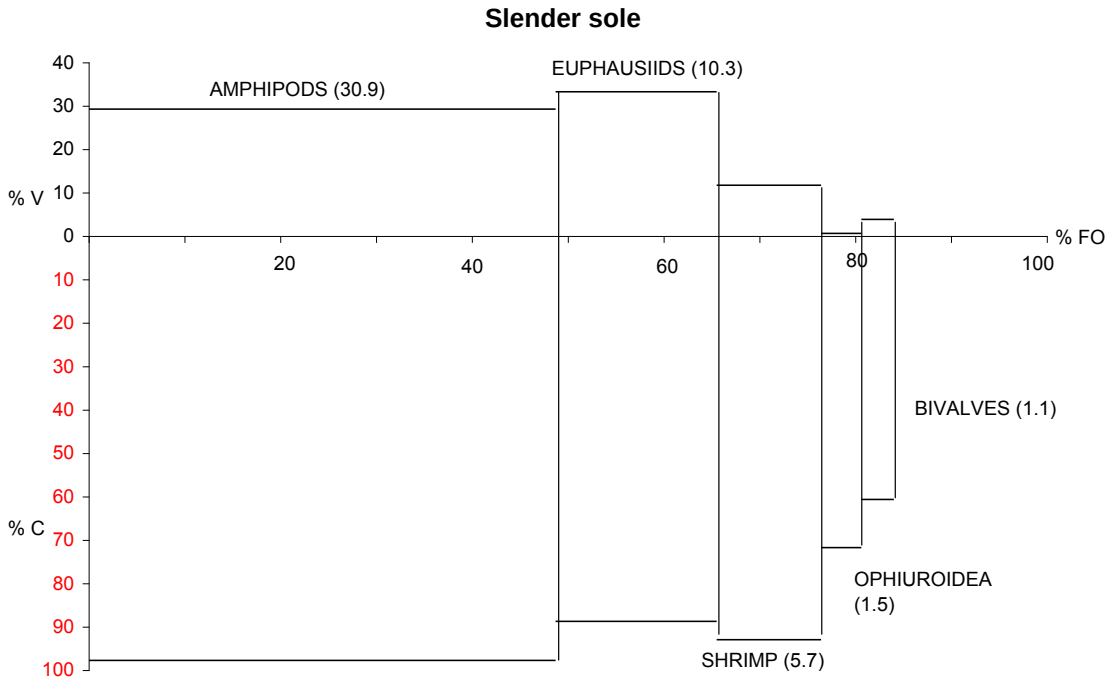


Figure 7. Three-way box plots of percentage frequency of occurrence (%FO), percent total volume (%V) and percent contents (%C) for prey items occurring in at least 2% of the stomachs examined for each species with samples from at least 10 fishing events. The area contained by each box represents overall relative importance of that prey item, with the index of relative importance value in parenthesis.



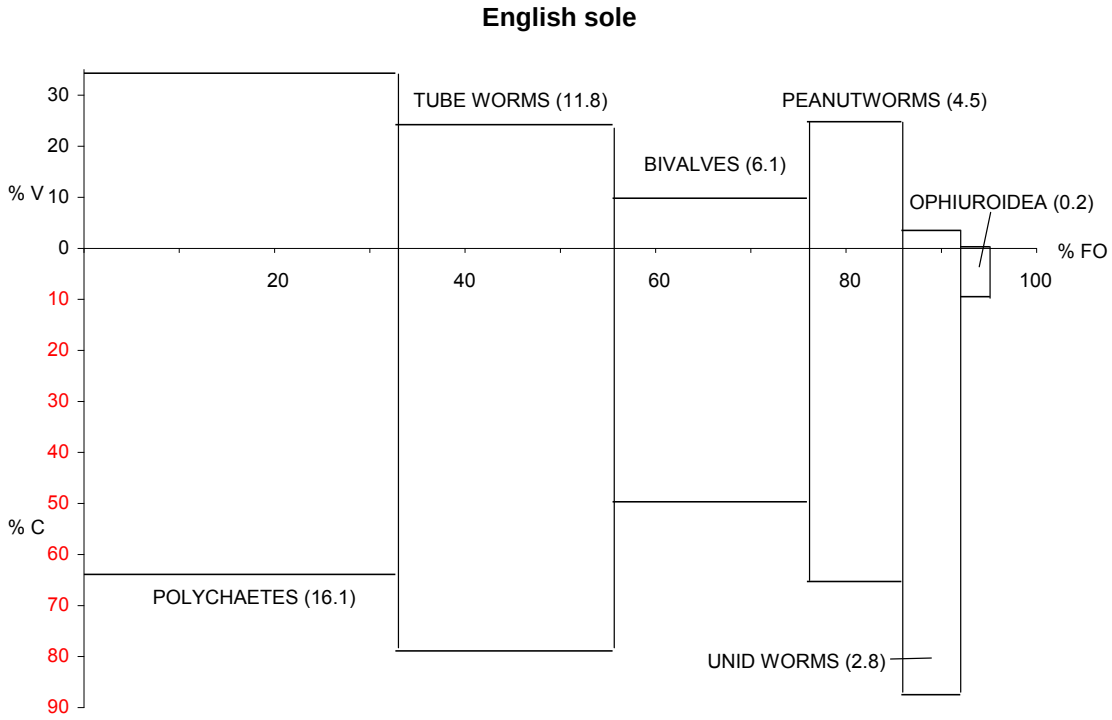
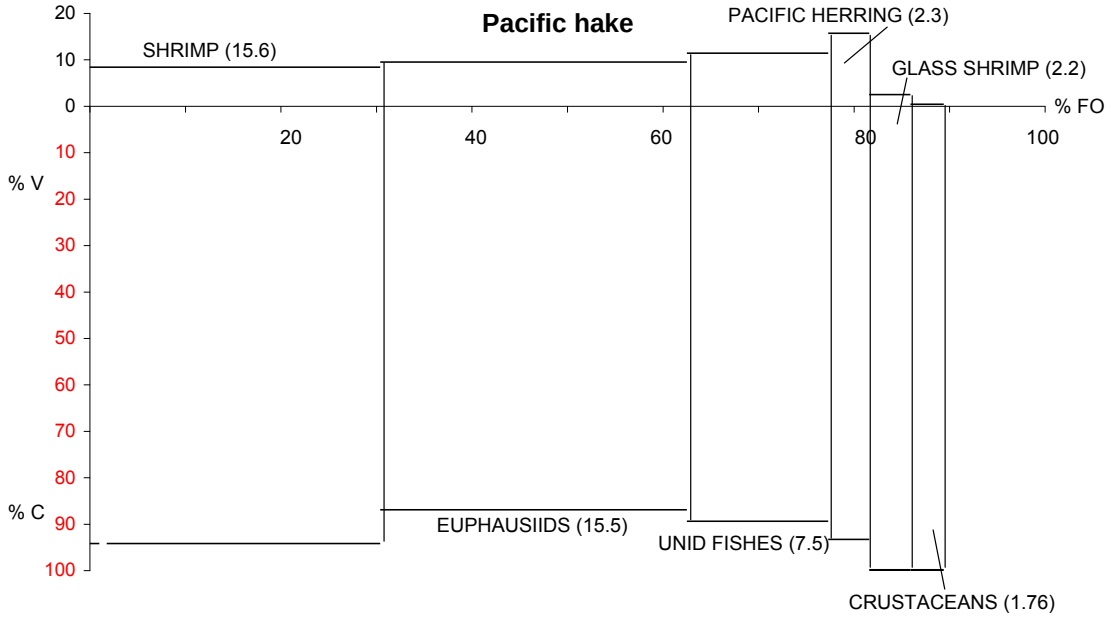


Figure 7. (Continued.)



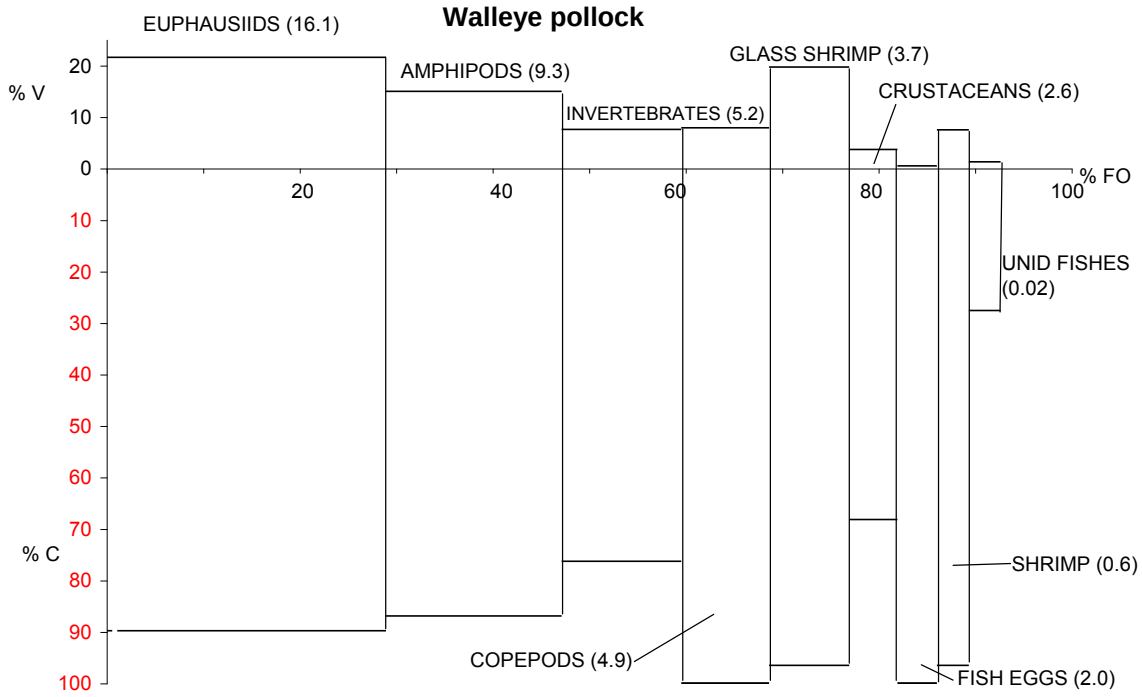
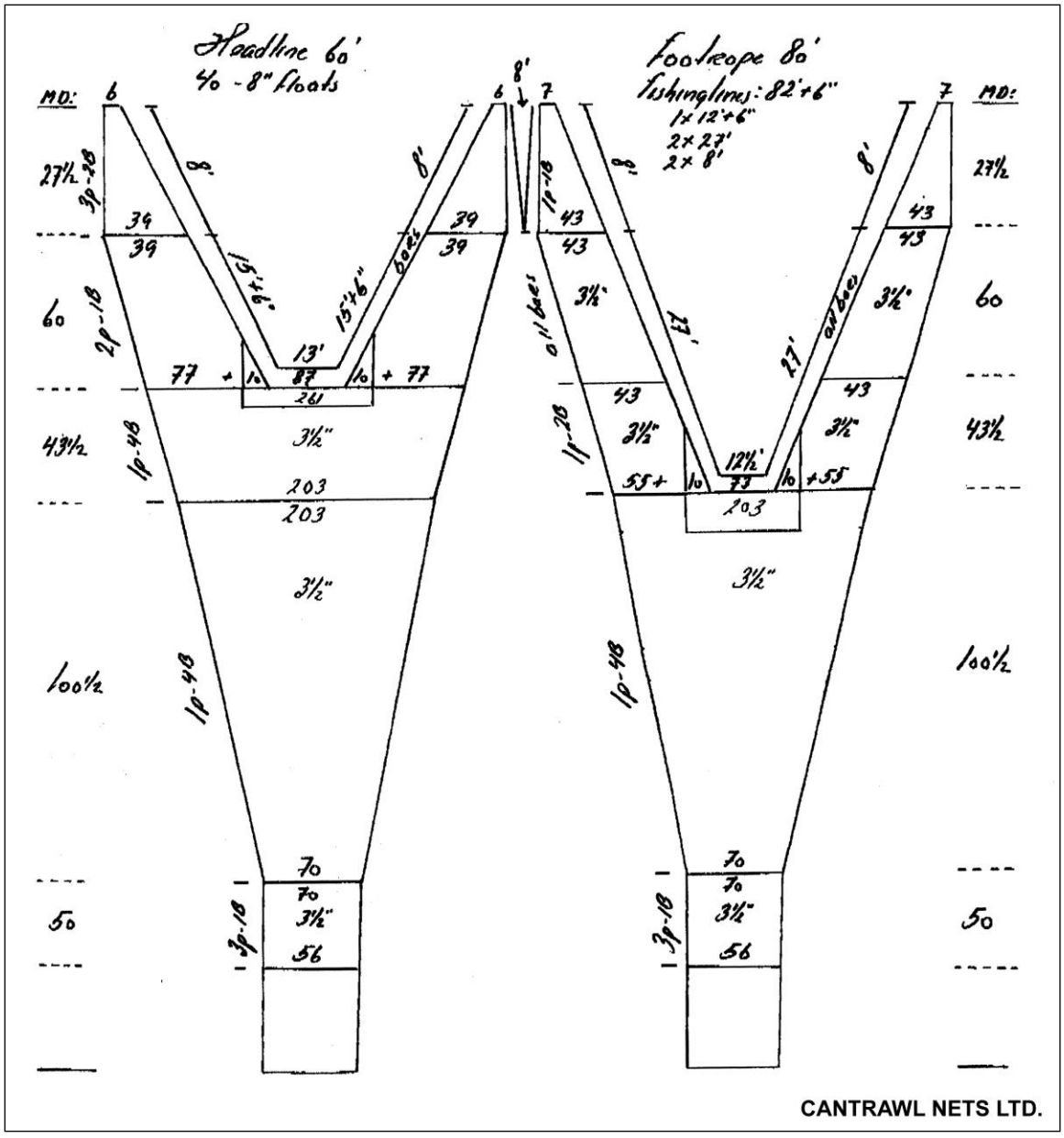


Figure 7. (Continued.)

Appendix A. Nets utilized during the 2012 Strait of Georgia Synoptic Survey

Appendix Table A-1. Net specifications for the Yankee 36 bottom trawl net used during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

Part	Size	Material
Rigging		
Doors	1135 kg each	USA Jet Model P (in HSMA 1250 kg)
Door Legs	13.7 m (7.5 fm)	
Sweep Lines	18.3 m (10 fm)	
Bridles	18.3 m (10 fm)	
Net Frame		
Head Line	18.3 m (60')	22 mm corkline or 24 mm Polysteel rope with 40 20 cm (8") plastic floats.
Fishing Line	25.4 m (82' 6")	9 mm longlink chain.
Bolsch Line	26.1 m (85')	22 mm (7/8") polypropylene rope
Foot Rope		
Foot Rope	24.4 m (80')	16 mm (5/8 in) chain
Bosom Section	3.7 m (12')	41 cm (16 in) rubber rollers with 15 cm (6 in) rubber discs, spacers and toggles
Bunt & Wing Sections	5.2 m (17') & 2.4 m (8')	36 cm (14 in) rubber half eggs and 15 x 20 cm (6 x 8 in) rubber spacers
Web		
Mesh, including Codend	89 mm (3.5")	3.5 mm, polyethylene
Codend Liner	25 mm	knotless braided nylon web



Appendix Figure A-1. Dimensions of Yankee 36 Trawl Net used during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012. Dimensions given are number of meshes and distance in feet and inches.

Appendix B. Code Tables

Appendix Table B-1. Possible status codes for fishing blocks within the sampling frame. Once blocks are designated as "rejected" for any reason, they are permanently removed from the sampling frame

Status Code	Description
0	Unknown status
1	Rejected based on prior knowledge
2	Rejected based on on-ground inspection
3	Rejected after last attempt failed
4	Not rejected but last attempt failed
5	Successfully fished after multiple attempts
6	Successfully fished on first attempt
7	Rejected for unknown reason
8	Successfully fished after unknown number of attempts
9	Block not fished but remains in sampling frame

Appendix Table B-2. The Beaufort Scale

Beaufort 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. Biological sampling protocols and criteria utilized during the 2012 Strait of Georgia Synoptic Survey.

One of the objectives of the groundfish synoptic bottom trawl surveys is to collect comprehensive biological samples (length, length-sex, and length-sex-weight-maturity-age) from a wide range of species. An additional objective of the Strait of Georgia Survey was to collect diet composition data from as many species as possible. As both objectives require intensive and time consuming sampling efforts, two separate biological sampling protocols were used in order to avoid "backlog" situations, where sampling for one tow is not completed before the next tow is brought on board. Specific tows were designated for length-sex-maturity-age sampling (the "Main" biological sampling protocol), while other tows were designated for diet composition (the "Stomach" sampling protocol).

Main biological sampling protocol

This sampling protocol is utilized on all groundfish synoptic surveys. For the 2012 Strait of Georgia Synoptic Survey, this sampling protocol was applied to all tows except the first tow of the day, the tow hauled aboard immediately after lunch, and the final tow of the day. These tows were designated for diet composition sampling. Diet composition samples were not taken on the first day of each leg, to allow for staff orientation to species identification and sampling logistics.

Prior to the survey, all species which we anticipated capturing were ranked on a scale of 0 to 3, according to the type and intensity of biological sampling required (Appendix Table C-1). Note that the rank of each species may differ between different synoptic surveys. Rank 0 species were those for which no age or weight data was required: generally non-commercial species, or commercial species that were expected to be captured only rarely. Rank 1 species were species of special concern such as Boaccio, or commercially exploited species that we expected to encounter infrequently but from which we wanted to collect age structures if we encountered a significant catch. Rank 2 species were commercially exploited species that are assessed using age structured models. Rank 3 species were minor commercial species or other species of interest that were expected to be encountered in large numbers.

In general, length samples, or length-by-sex samples, were collected from all species captured, subject to species-specific minimum catch criteria (Appendix Table C-1 and Appendix Table C-2). In addition, weight data was collected whenever practical, for example, when individual halibut or skate were sorted and discarded. If any large sharks were captured, the shark sampling protocol would apply (Appendix D).

Collection of aging structures (A) was associated with collection of length (L), sex (S), weight (W) and reproductive maturity (M) data, and such samples were designated LSWMA . The selection of LSWMA samples was based on species Rank, species-specific minimum criteria, and dominance (by numbers) in the tow (Appendix Table C-1 and Appendix Table C-2). Dominance was based on the number of specimens of each species captured in a tow, and implied a minimum catch of 25 individuals. In general, LSWMA samples were collected from all Rank 1 species as long as the number caught met a species-specific minimum criterion. LSWMA samples were also collected from the two most dominant Rank 2 species, and if there were only a few Rank 1 species being sampled for age structures, structures were also collected from either the next most dominant Rank 2 species or the most dominant Rank 3 species. Lastly, if no LSWMA sample was being collected from Rank 3 species, one LSW sample was collected from the most dominant rank 3 species in the catch.

The maximum sample size required was approximately 25 – 30 specimens, with the exception of Bocaccio, where all individuals were to be sampled if possible, and Pacific Cod, where a length-stratified age sample of up to approximately 60 specimens was required.

Stomach sampling protocol

The stomach sampling protocol was applied to the first tow of the day, the tow hauled aboard immediately after lunch, and the final tow of the day, except on the first day of each leg of the survey. Length, sex, weight and stomach contents were collected from as many species as possible in the stomach sampling tow, starting with the most abundant species in the tow, and working through the catch to the least abundant species as time permitted. If skates or Lingcod were captured during these sets, ageing structures would also be collected. If any large sharks were captured, the shark sampling protocol would apply (Appendix D).

Stomach contents were identified to the lowest taxonomic level possible. For each species and taxonomic group in the stomach contents, the volume was estimated to the nearest cubic centimetre (cc) and the digestion state was estimated as “fresh”, “half digested”, or “fully digested.” A single stomach could have one or several different types of prey, or prey at different stages of digestion.

As for the main sampling protocol, the maximum sample size required was approximately 25 – 30 specimens.

Types of Length Measurement

A variety of different types of length measurement are required for different species or groups of species.

Total length is measured for species without a forked tail, or for species with an asymmetric forked tail (Appendix Figure C-1). It is measured from the tip of the snout in a straight line to the posterior end of the caudal fin. Total length is used for dogfish, sharks, skates, most flatfish, thornyheads, eelpouts, and sculpins.

Fork length is measured for species with a forked tail (Appendix Figure C-1). It is measured from the tip of the snout in a straight line to the posterior end of the shortest caudal rays in the centre of the fork. Fork length is used for rockfishes, Sablefish, Lingcod, Pacific Cod, Pacific Hake, Walleye Pollock, Pacific Tomcod, Pacific Halibut and Arrowtooth Flounder. Note that fork length is measured in addition to total length for large sharks (Appendix D).

Standard length is measured from the tip of the snout in a straight line to the midlateral posterior edge of the hypural plate (in fish with a hypural plate) or to the posterior end of the vertebral column (in fish lacking a hypural plate) (Appendix Figure C-1). Standard length is used for most pelagic species (smelts, herring, anchovy).

Additional length measurements may be collected for certain species. For example, for ratfish, length is measured from the snout to the posterior edge of the second dorsal fin, while for grenadiers, length is measured from the snout to the anterior insertion of the anal fin. Interdorsal space and pre-caudal length may be collected for large sharks (Appendix D).

Types of Age Structure

In general, the following age structures are collected from groundfish species:

- Otoliths: flatfish, rockfish, many roundfish
- 1st dorsal fin: Pacific Cod

- 2nd dorsal fin: Lingcod
- Left pectoral fin: Walleye Pollock and Pacific Tomcod
- 2nd dorsal spine: North Pacific Spiny Dogfish
- Vertebrae: skate and sharks other than North Pacific Spiny Dogfish

Appendix Table C-1. Ranks, biological sampling criteria, and special instructions. Note: L and LS are Length and Length-by-Sex samples, respectively. LSW and LSWMA are Length-Sex-Weight, and Length-Sex-Weight-Maturity-Age samples, respectively.

Cartilaginous fish				
Rank	**Species**	**Minimum for L or LS**	**Minimum for Age Samples**	**Special Instructions**
*	Large sharks	1	*	Follow large shark protocol
0	Skates and small sharks other than dogfish	1	n/a	Freeze Brown Cat Sharks, geen eye sharks
2	North Pacific Spiny Dogfish	5	25	LSWMA following dominant catch rules
3	Spotted Ratfish	5	25	LSW following dominant catch rules (no age structures); freeze 20 of each sex per 5cm size interval

Roundfish				
Rank	**Species**	**Minimum for L or LS**	**Minimum for Age Samples**	**Special Instructions**
0	Salmon, shad, mackerel	1	n/a	save salmon head if adipose fin is clipped
1	Pacific Cod	1	5	LSWMA if > 5 specimens from random sample (n ≤ 60); length stratified age sample: 1 fin per 1cm size interval
1	Lingcod	1	5	LSWMA if > 5 specimens
1	Sablefish	n/a	1	LSWMA for all
2	Walleye Pollock, Pacific Hake	5	25	LSWMA following dominant catch rules
3	Pacific Tomcod	5	25	LSW or LSWMA following dominant catch rules

Non-commercial roundfish				
Rank	**Species**	**Minimum for L or LS**	**Minimum for Age Samples**	**Special Instructions**
0	Wolf Eel, prowfish, large sculpins, greenling	1	n/a	L only and release alive; LS if dead or if can be sexed externally
0	Eelpouts, poachers, small sculpins, other small non-commercial fish	10	n/a	L only, if workload permits
3	Grenadiers, Pacific Flatnose	1	25	LSW or LSWMA following dominant catch rules

Pelagics				
Rank	**Species**	**Minimum for L or LS**	**Minimum for Age Samples**	**Special Instructions**
0	Eulachon, smelts, Pacific Herring, Sand Lance, Sardine	5	n/a	L only

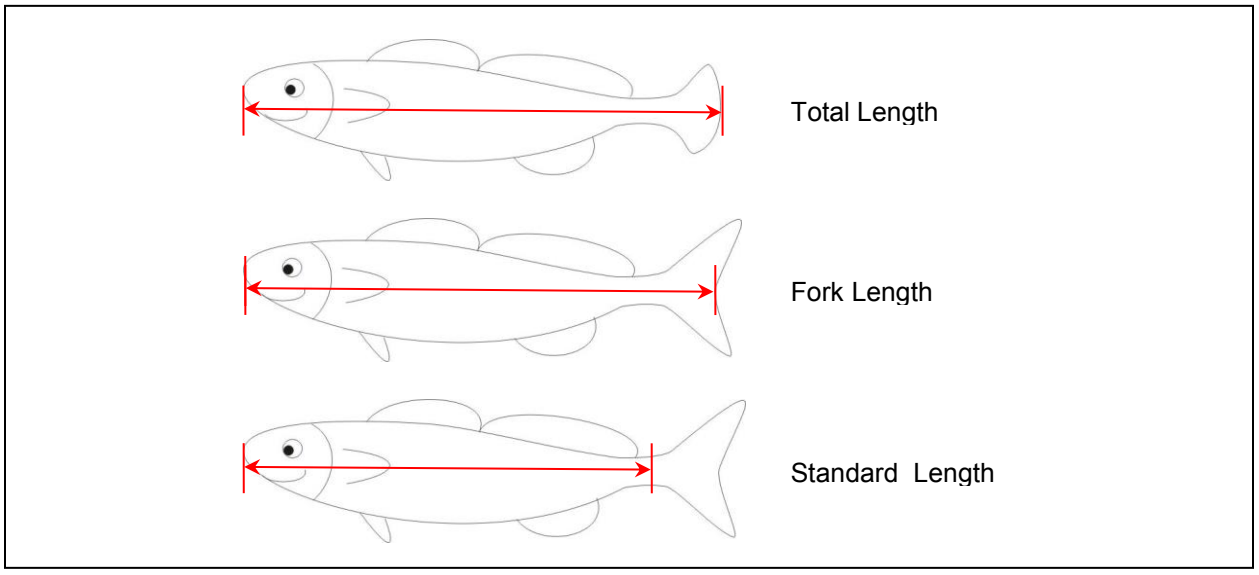
Rockfish				
Rank	**Species**	**Minimum for L or LS**	**Minimum for Age Samples**	**Special Instructions**
1	Bocaccio, Shortraker, Yelloweye, Copper, Quillback, Canary Rockfish	n/a	1	LSWMA for all; for Boccacio sample all specimens even if n > 25.
1	Rougheye and Yellowtail Rockfish	n/a	1	LSWMA for all; DNA sample
1	All other rockfish and thornyheads	1	5	LSWMA if > 5 specimens

Flatfish				
Rank	**Species**	**Minimum for L or LS**	**Minimum for Age Samples**	**Special Instructions**
0	Pacific Halibut	1	n/a	
1	Petrale Sole, Rock Sole	1	5	LSWMA if > 5 specimens
1	Butter Sole, Slender Sole, Curlfin Sole, Sand Sole, Starry Flounder	1	20	LSWMA if > 20 specimens
2	Dover Sole, English Sole	1	25	LSWMA following dominant catch rules
2	Arrowtooth Flounder	5	25	LSWMA following dominant catch rules
3	Flathead Sole, Rex Sole, Pacific Sanddab	5	25	LSW or LSWMA following dominant catch rules

Notes: Unless otherwise specified, sample size (n) is approximately 25-30 specimens.
Collect LSW instead of LS wherever practical and collect L from any large/rare/unusual species not listed here.

Appendix Table C-2. Main sample selection protocol by Species Ranking for the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012. Note: L and LS are Length and Length-by-Sex samples, respectively. LSW and LSWMA are Length-Sex-Weight, and Length-Sex-Weight-Maturity-Age samples, respectively.

Rank	Protocol	Details
0	0	L or LS only
1	1	Collect a LSWMA sample for all Rank 1 species where the catch is greater than the minimum for age samples; otherwise collect LS or LSW.
2	2a	Collect LSWMA samples for the first and second most dominant Rank 2 species where the catch is greater than the minimum for age samples
	2b	If there are <10 Rank 1 specimens, collect one LSWMA sample for the next most dominant Rank 2 species where the catch is greater than the minimum for age samples (but do not sample the same species from the same stratum on the same day). Keep sampling Rank 2 species until there are a total of 400 LSWMA specimens sampled.
	2c	Collect LS or LSW for any remaining Rank 2 species where the catch is greater than the minimum for length samples.
3	3a	If 2b does not apply, collect one LSMWA sample for the most dominant Rank 3 species where the catch is greater than the minimum
	3b	If 2b applies, collect one LSW sample for the most dominant Rank 3 species (but do not sample the same species from the same stratum on the same day).
	3c	Collect LS for any remaining Rank 3 species where the catch is greater than the minimum for length samples.



Appendix Figure C-1. Common length types for fish species sampled during synoptic surveys.

Appendix D. Shark Sampling Protocol for use on DFO Research Surveys

In order of priority:

FOR LIVE OR DEAD SHARKS:

1. TAKE PHOTOS

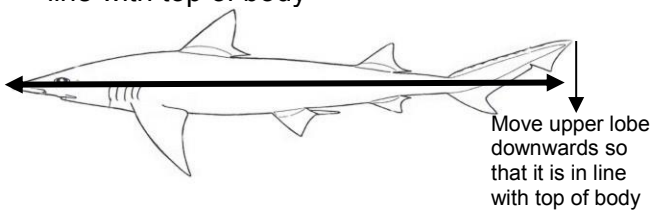
Side views of:
- whole shark alongside measuring tape
- head & gill openings
- tail fin

Ventral views of:
- claspers of males

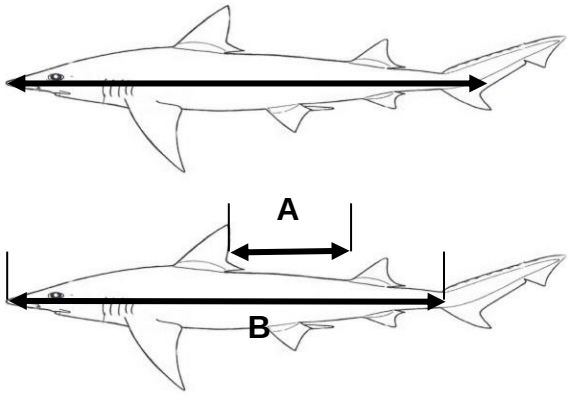
LABEL ALL FROZEN SAMPLES
- species
- date collected
- vessel name
- cruise identification
- tow number
- general location
- collector

2. RECORD LENGTH ***AND***

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



Fork length: tip of snout to fork in caudal fin



IF TIME PERMITS ALSO RECORD:

A: interdorsal space (if two fins are present)

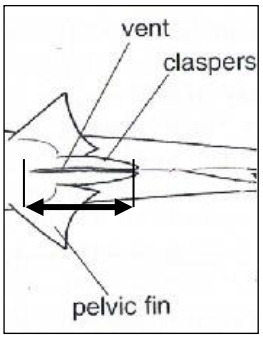
B: pre-caudal length

3. RECORD SEX ***OR***

Males have claspers associated with pelvic fin

Record clasper length and note if they are rigid or red

Females do not have claspers



FOR DEAD SHARKS ONLY:

Determine the presence of pups and record:
- number of pups
- sex of pups
- total length and fork length of pups

IF TIME PERMITS COLLECT:
- muscle tissue from pups (see 4 below)
- vertebrae from pups (see 5 below)

ALTERNATIVELY FREEZE AND LABEL ALL PUPS

4. COLLECT DNA TISSUE SAMPLE
- clip 1 cm square of tissue from any fin tip
- place in ethanol (preferred) or simply freeze in a Ziploc (label with information)

WHOLE SPECIMEN REQUESTS (please freeze whole shark; label with information)
1. Brown Cat Shark (up to 25 individuals) from trawls > 500 fathoms (900 m)
2. Potential Green Eye Shark – need to verify all identifications with actual specimens
3. Big Eye Thresher Shark – these are large sharks; at the very least keep vertebrae for ageing determination

FOR DEAD SHARKS ONLY:
items 1-4 above and *In order of priority*:

5. COLLECT TISSUE SAMPLE FOR CONTAMINANT ANALYSES
- muscle sample from posterior base of the dorsal fin at body attachment area
- size of an ice cube
- freeze in a Ziploc (label with information)

6. COLLECT VERTEBRAE FOR AGE DETERMINATION
- remove backbone starting from just behind the gill slits

Total length of shark	Length of backbone to collect
< 1 m	10 cm
1-3 m	20 cm
3-6 m	40 cm
> 6 m	60 cm

- retain all tissue associated with backbone; do not scrape vertebrae cartilage
- freeze in Ziploc (label with information)

7. RECORD AND SAMPLE STOMACH CONTENTS
- estimate total volume (Litres)
- freeze sample (or subsample) in a Ziploc (label with information) or record stomach contents

8. COLLECT LIVER SAMPLE FOR FAT CONTENT AND STABLE ISOTOPE ANALYSES
- size of an ice cube
- wrap in tinfoil and freeze in a Ziploc (label with information)

BASKING SHARKS

*These sharks are listed under SARA as Endangered. As such, if you capture a **live Basking Shark** complete 1-4 if possible, with priority of returning the shark to the water as soon as possible. Immediately call Dr. Jackie King (250-756-7176) or Maria Surry (250-756-7317) to report a live Basking Shark capture; depending on location we may be able to re-locate the shark for satellite tag application.*

FOR DEAD BASKING SHARKS ONLY:

- items 1-8 above and *In order of priority*:

9. COLLECT BLOOD SAMPLE FOR REPRODUCTIVE HORMONES ANALYSES
- from the caudal vein collect 5-10 mL of blood (cut the tail off)
- freeze in a jar, plastic vial or Ziploc (label with information)

10. COLLECT GILL RAKERS FOR PLANKTON-SIZE MODELING
- remove an entire (or a portion of) gill raker
- freeze in a bag (label with information)

Appendix E. Raw data from the 2012 Strait of Georgia Synoptic Survey

Appendix Table E-1. Bridge log information for bottom trawl tows from the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012. Depth Strata and Beaufort Scale code definitions are provided in Appendix B.

Tow Number	1	2	3	4	5	6	7	8
Date	March 14	March 14	March 14	March 14	March 14	March 15	March 16	March 16
Block Number	6045	6273	6389	6503	6740	7426	8532	8995
Location	South Gabriola	South Gabriola	29 Middle West	29 Middle West	29 Middle West	Mccall/halibut Bank	Cape Lazo	Cape Lazo
GMU Minor Area	29	29	29	29	29	29	14	14
DFO Statistical Area	29 - 2	17 - 11	29 - 2	29 - 2	29 - 3	29 - 2	14 - 9	14 - 12
Depth Stratum	3	4	4	4	4	2	2	3
Start Time (PDT)	9:45	13:17	15:00	16:38	18:26	7:09	7:12	9:45
Duration(min)	9	20	20	20	20	20	21	20
Start Position								
North Latitude	49° 10.808'	49° 12.985'	49° 13.953'	49° 14.973'	49° 16.418'	49° 23.189'	49° 37.452'	49° 40.947'
West Longitude	123° 39.288'	123° 41.871'	123° 40.621'	123° 42.321'	123° 29.811'	123° 35.345'	124° 47.958'	124° 41.631'
End Position								
North Latitude	49° 10.766'	49° 12.868'	49° 13.85'	49° 14.49'	49° 16.48'	49° 23.649'	49° 36.684'	49° 41.555'
West Longitude	123° 38.665'	123° 40.424'	123° 39.136'	123° 40.958'	123° 31.224'	123° 36.67'	124° 47.02'	124° 42.864'
Distance Towed (km)	0.77	1.78	1.77	1.89	1.73	1.82	1.82	1.87
Vessel Speed (km/h)	5.1	5.3	5.4	5.5	5.2	5.4	5.3	5.6
Tow Direction (°T)	092	093	092	114	270	294	138	304
Bottom Depth (m)	252	387	385	389	270	132	87	243
Bottom Temperature (°C)	8.61	8.68	8.54	8.72	8.78	7.51	8.15	8.53
Tide	--	Ebb	Ebb	Ebb	Low Slack	Slack	Slack	Flood
Beaufort Scale	7	5	4	4	3	4	3	4
Cloud Cover (%)	100	100	100	100	100	100	100	90
Mouth Height (m)	--	1.3	3.8	3.7	1.2	1.5	1.3	1.8
Door Spread (m)	--	60.7	64.4	68.9	67.6	65.9	58.5	62
Swept Area (m^2)	47304	108046	113988	130221	116948	119938	106470	115940
Total Catch (kg)	77.08	152.2	281.69	214.91	565.16	35.91	578.13	239.79
Usable	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table E-1. (Continued.)

Tow Number	9	10	11	12	13	14	15	16
Date	March 16	March 16	March 16	March 17	March 17	March 17	March 17	March 17
Block Number	9111	9221	9566	11049	11282	11049	10249	10367
Location	West Texada	Cape Lazo	West Cape Lazo		Cortes Island		West Cape Lazo	
GMU Minor Area	16	14	14	13	13	13	14	14
DFO Statistical Area	14 - 12	14 - 13	14 - 13	13 - 14	13 - 15	13 - 14	14 - 13	15 - 2
Depth Stratum	4	2	4	3	1	3	3	3
Start Time (PDT)	12:00	13:57	16:15	7:26	9:02	12:08	14:50	16:36
Duration(min)	20	20	20	20	20	20	20	20
Start Position								
North Latitude	49° 42.446'	49° 43.636'	49° 46.314'	50° 1.136'	50° 3.898'	50° 0.916'	49° 53.676'	49° 54.763'
West Longitude	124° 41.343'	124° 48.935'	124° 48.043'	125° 6.85'	125° 1.127'	125° 6.677'	125° 0.415'	124° 54.711'
End Position								
North Latitude	49° 42.098'	49° 42.895'	49° 47.082'	50° 2.209'	50° 2.974'	50° 1.761'	49° 52.953'	49° 54.025'
West Longitude	124° 39.887'	124° 48.047'	124° 48.975'	125° 7.545'	125° 1.239'	125° 7.342'	124° 59.386'	124° 53.732'
Distance Towed (km)	1.87	1.75	1.81	1.77	1.72	1.76	1.82	1.81
Vessel Speed (km/h)	5.6	5.2	5.4	5.4	5.4	5.3	5.5	5.4
Tow Direction (°T)	107	139	319	334	181	330	134	136
Bottom Depth (m)	304	129	326	251	88	247	313	239
Bottom Temperature (°C)	8.72	8.19	8.74	8.72	8.24	8.72	8.73	8.71
Tide	High Slack	Ebb	Ebb	Ebb	Low Slack	Flood	High Slack	Ebb
Beaufort Scale	4	4	4	2	2	3	4	2
Cloud Cover (%)	80	40	60	100	80	70	40	100
Mouth Height (m)	5.5	1.7	1.4	1.5	1.5	2.1	4.5	2.3
Door Spread (m)	61.8	--	63	57.9	51.9	55.1	58.5	59.7
Swept Area (m^2)	115566	107510	114030	102483	89268	96976	106470	108057
Total Catch (kg)	264.36	459.2	196.92	183.87	613.22	141.06	188.09	77.25
Usable	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

Appendix Table E-1. (Continued.)

Tow Number	17	18	19	20	21	22	23	24
Date	March 18	March 18	March 18	March 18	March 19	March 19	March 19	March 19
Block Number	8326	7757	7640	6734	6276	7427	6511	6858
Location	Malaspina Strait	17 Central	17 Central	Mccall/halibut Bank	29 Middle West	Mccall/halibut Bank	29 Middle West	Cape Roger Curtis
GMU Minor Area	16	17	17	29	29	29	29	29
DFO Statistical Area	16 - 18	17 - 11	17 - 11	29 - 2	29 - 3	29 - 2	29 - 3	29 - 3
Depth Stratum	4	3	4	4	4	2	4	3
Start Time (PDT)	8:07	10:05	12:01	16:28	9:25	11:57	13:48	15:07
Duration(min)	20	20	20	20	20	20	20	18
Start Position								
North Latitude	49° 33.412'	49° 27.021'	49° 26.69'	49° 17.401'	49° 11.979'	49° 23.361'	49° 13.765'	49° 17.943'
West Longitude	124° 8.339'	123° 58.027'	124° 2.621'	123° 40.311'	123° 36.47'	123° 35.291'	123° 28.352'	123° 25.208'
End Position								
North Latitude	49° 32.694'	49° 27.245'	49° 26.035'	49° 16.806'	49° 12.574'	49° 22.652'	49° 14.482'	49° 17.306'
West Longitude	124° 7.291'	123° 59.476'	124° 1.528'	123° 39.062'	123° 37.67'	123° 34.229'	123° 29.407'	123° 24.326'
Distance Towed (km)	1.77	1.8	1.8	1.88	1.83	1.77	1.83	1.6
Vessel Speed (km/h)	5.5	5.4	5.4	5.6	5.4	5.5	5.6	5.4
Tow Direction (°T)	133	280	129	122	303	132	312	134
Bottom Depth (m)	368	201	392	263	380	132	313	230
Bottom Temperature (°C)	8.96	8.41	8.92	8.33	8.52	7.73	8.45	8.18
Tide	Ebb	Low Slack	Flood	High Slack	Ebb	Flood	Flood	Flood
Beaufort Scale	1	1	1	2	4	4	4	4
Cloud Cover (%)	50	90	90	10	75	100	100	100
Mouth Height (m)	4	3.2	1.7	4.8	5.6	1.3	1.8	2.6
Door Spread (m)	--	62.7	62.2	61.9	62.7	55.8	64.9	63.7
Swept Area (m^2)	108738	112860	111960	116372	114741	98766	118767	101920
Total Catch (kg)	93.5	46.02	162.11	188.95	225.92	50.87	170.74	59.18
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table E-1. (Continued.)

Tow Number	25	26	27	28	29	30	31	32
Date	March 19	March 19	March 20	March 20	March 20	March 20	March 20	March 20
Block Number	6513	6171	6058	6285	6633	6052	5824	5594
Location	29 Middle West	Sandheads	Sandheads	Sandheads	Sandheads	29 Middle West	Sandheads	29 Middle West
GMU Minor Area	29	29	29	29	29	29	29	29
DFO Statistical Area	29 - 3	29 - 3	29 - 3	29 - 3	29 - 3	29 - 3	29 - 4	29 - 4
Depth Stratum	4	3	1	3	1	4	3	4
Start Time (PDT)	16:34	18:03	7:09	9:42	10:58	13:31	15:14	16:09
Duration(min)	20	20	19	20	19	20	15	20
Start Position								
North Latitude	49° 14.267'	49° 9.821'	49° 8.836'	49° 12.142'	49° 15.048'	49° 10.201'	49° 7.057'	49° 5.584'
West Longitude	123° 25.874'	123° 20.347'	123° 17.921'	123° 22.275'	123° 17.584'	123° 27.47'	123° 24.057'	123° 24.193'
End Position								
North Latitude	49° 13.649'	49° 10.81'	49° 9.791'	49° 11.174'	49° 14.085'	49° 9.219'	49° 7.732'	49° 4.963'
West Longitude	123° 24.682'	123° 20.205'	123° 17.932'	123° 22.401'	123° 17.67'	123° 27.418'	123° 24.613'	123° 25.33'
Distance Towed (km)	1.77	1.82	0.26	1.77	1.78	1.8	1.42	1.79
Vessel Speed (km/h)	5.5	5.6	5.2	5.5	5.4	5.6	5.7	5.6
Tow Direction (°T)	124	001	355	181	179	174	327	226
Bottom Depth (m)	276	168	75	234	64	299	228	262
Bottom Temperature (°C)	8.29	7.42	7.41	7.37	7.39	8.57	7.48	7.62
Tide	Flood	Ebb	Flood	Ebb	Ebb	Low Slack	Flood	Flood
Beaufort Scale	4	4	5	5	5	4	5	5
Cloud Cover (%)	100	100	100	80	80	90	80	60
Mouth Height (m)	1.7	1.5	1.3	1.5	1.2	2	1.8	1.3
Door Spread (m)	60.6	64.4	56.1	64.9	56.8	64.1	--	--
Swept Area (m^2)	107262	117208	14586	114873	101104	115380	87236	109967
Total Catch (kg)	270.36	86.46	701.34	305.72	1585.65	102.66	517.76	487.16
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table E-1. (Continued.)

Tow Number	33	34	35	36	37	38	39	40
Date	March 20	March 21	March 21	March 21	March 21	March 21	March 21	March 21
Block Number	5481	5369	4567	5021	4905	5134	5472	6161
Location	Apex	Apex	E. Mayne Island	E. Valdes	E. Valdes	E. Valdes	E. Valdes	29 Middle West
GMU Minor Area	29	29	18	17	17	17	17	29
DFO Statistical Area	29 - 4	29 - 6	18 - 1	29 - 4	29 - 4	29 - 4	29 - 5	29 - 2
Depth Stratum	3	1	2	3	4	4	3	4
Start Time (PDT)	18:01	7:17	9:06	10:50	12:27	13:28	14:59	16:38
Duration(min)	19	19	20	21	20	19	20	20
Start Position								
North Latitude	49° 3.58'	49° 2.53'	48° 55.495'	49° 0.161'	48° 58.616'	49° 1.232'	49° 5.314'	49° 11.667'
West Longitude	123° 20.754'	123° 16.589'	123° 11.922'	123° 21.378'	123° 23.299'	123° 24.728'	123° 36.456'	123° 37.625'
End Position								
North Latitude	49° 4.413'	49° 3.16'	48° 54.843'	48° 59.514'	48° 59.312'	49° 0.605'	49° 4.476'	49° 11.143'
West Longitude	123° 21.477'	123° 17.645'	123° 13.037'	123° 22.494'	123° 24.303'	123° 25.846'	123° 35.759'	123° 36.29'
Distance Towed (km)	1.76	1.27	1.79	1.73	1.73	1.76	1.75	1.78
Vessel Speed (km/h)	5.4	5.5	5.6	5.4	5.4	5.5	5.4	5.6
Tow Direction (°T)	326	308	224	224	312	225	147	117
Bottom Depth (m)	196	77	131	235	258	303	201	390
Bottom Temperature (°C)	7.33	7.27	7.33	8.36	8.44	8.56	8.23	8.56
Tide	Flood	Ebb	Ebb	Ebb	Flood	Flood	Flood	Flood
Beaufort Scale	6	3	3	4	3	4	4	4
Cloud Cover (%)	70	50	40	50	20	70	80	40
Mouth Height (m)	1.4	1.3	1.7	1.4	2.1	3.3	1.5	5.8
Door Spread (m)	--	--	--	64.3	64.9	65.1	58	64.1
Swept Area (m^2)	108124	78021	109967	111239	112277	114576	101500	114098
Total Catch (kg)	497.86	443.34	113.44	100.39	67.31	71.83	178.98	210.6
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table E-1. (Continued.)

Tow Number	41	42	43	44	45	46	47	48
Date	March 21	March 22	March 22	March 22	March 23	March 23	March 23	March 23
Block Number	6505	10139	10369	9805	10132	9676	9109	8647
Location	29 Middle West	Grant Reef		Westview	West Cape Lazo	West Cape Lazo	Cape Lazo	Cape Lazo
GMU Minor Area	29	14	14	16	14	14	14	14
DFO Statistical Area	29 - 2	14 - 13	15 - 2	15 - 1	14 - 13	14 - 13	14 - 12	14 - 9
Depth Stratum	4	4	2	3	2	2	4	1
Start Time (PDT)	18:03	7:09	8:04	11:09	9:42	11:18	13:07	14:51
Duration(min)	19	20	20	20	19	19	20	20
Start Position								
North Latitude	49° 14.942'	49° 51.807'	49° 54.605'	49° 48.966'	49° 52.158'	49° 48.611'	49° 42.152'	49° 37.355'
West Longitude	123° 37.822'	124° 51.027'	124° 51.68'	124° 33.82'	125° 2.154'	124° 56.579'	124° 43.494'	124° 47.724'
End Position								
North Latitude	49° 15.004'	49° 52.601'	49° 53.781'	49° 48.041'	49° 52.983'	49° 48.105'	49° 41.404'	49° 38.224'
West Longitude	123° 39.289'	124° 51.832'	124° 50.995'	124° 33.298'	125° 2.965'	124° 55.352'	124° 42.494'	124° 48.331'
Distance Towed (km)	1.78	1.73	1.7	1.78	1.77	1.74	1.78	1.74
Vessel Speed (km/h)	5.5	5.4	5.3	5.5	5.5	5.4	5.5	5.5
Tow Direction (°T)	270	324	149	157	325	119	136	332
Bottom Depth (m)	382	264	167	256	126	105	262	84
Bottom Temperature (°C)	8.72	8.57	8.53	8.92	8.05	7.95	8.6	7.85
Tide	Ebb	High Slack	Ebb	Ebb	Ebb	Ebb	Flood	Flood
Beaufort Scale	3	3	4	6	3	2	3	3
Cloud Cover (%)	10	60	40	100	50	50	20	20
Mouth Height (m)	2.4	1.7	1.4	1.4	1.3	1.3	1.9	2.3
Door Spread (m)	65.8	63.1	--	63.9	59.5	52.9	61.8	59.3
Swept Area (m^2)	117124	109163	104438	113742	105315	92046	110004	103182
Total Catch (kg)	252.03	109.12	154.54	152.23	565.64	612.46	179.72	564
Usable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table E-1. (Continued.)

Tow Number	49	50	51	52	53
Date	March 23	March 23	March 24	March 24	March 24
Block Number	8417	8423	8195	8773	7048
Location	Cape Lazo	Hornby Island	Hornby Island	West Texada	Qualicum-parksville
GMU Minor Area	14	14	14	16	14
DFO Statistical Area	14 - 9	14 - 12	14 - 6	16 - 21	14 - 4
Depth Stratum	1	3	3	3	1
Start Time (PDT)	16:19	18:24	7:13	8:47	11:08
Duration(min)	20	20	21	20	19
Start Position					
North Latitude	49° 35.824'	49° 35.964'	49° 33.54'	49° 38.386'	49° 22.819'
West Longitude	124° 46.602'	124° 38.345'	124° 35.13'	124° 30.068'	124° 30.998'
End Position					
North Latitude	49° 36.494'	49° 35.031'	49° 32.766'	49° 37.815'	49° 22.683'
West Longitude	124° 47.728'	124° 37.907'	124° 34.03'	124° 28.879'	124° 29.558'
Distance Towed (km)	1.83	1.77	1.95	1.75	1.8
Vessel Speed (km/h)	5.6	5.5	5.6	5.5	5.6
Tow Direction (°T)	309	160	134	123	095
Bottom Depth (m)	86	167	178	336	70
Bottom Temperature (°C)	7.78	8.64	8.65	8.55	7.68
Tide	Flood	Flood	Ebb	Ebb	Ebb
Beaufort Scale	2	2	4	1	2
Cloud Cover (%)	10	5	0	0	0
Mouth Height (m)	1.2	1.3	1.4	4.6	2.2
Door Spread (m)	59.1	60.3	--	--	--
Swept Area (m^2)	108153	106731	119797	107510	110581
Total Catch (kg)	269	386.87	137.75	62.11	403.21
Usable	Yes	Yes	Yes	Yes	Yes

Appendix Table E-2. Catch composition (kg) for major species or taxonomic group captured during the 2012 Strait of Georgia Synoptic Survey aboard the CCGS W.E. Ricker, March 14 – 24, 2012.

	Catch (kg)													
Tow Number	**1***	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12***	**13**	**14**
Fish Species														
Cartilaginous fish														
Bluntnose Sixgill Shark	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Brown Cat Shark	--	0.6	1.32	1.52	0.47	--	--	0.48	0.18	Trace	0.74	--	--	1.7
North Pacific Spiny Dogfish	14.69	82.68	33.5	88.93	118.3	1.84	5.98	51.96	177.56	115.3	61.6	58.26	10.56	56.7
Big Skate	0.7	--	--	--	--	--	0.4	--	--	--	--	--	1.94	--
Longnose Skate	--	--	--	1.06	1.16	--	3.04	0.26	1.32	1.76	2.54	6.66	--	2.84
Spotted Ratfish	39.01	36.34	113.05	45.98	90.16	3.77	94.62	123.88	52.9	20	83.32	36.3	3.24	39.34
Total cartilaginous fish	54.4	119.62	147.87	137.49	210.09	5.61	104.04	176.58	231.96	137.06	148.2	101.22	15.74	100.58
Roundfish														
American shad	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chinook salmon	--	--	--	--	--	--	2.78	--	--	--	--	--	0.5	--
Pacific Cod	--	--	--	--	--	--	24.45	--	--	4.24	--	--	1.84	--
Pacific Hake	17.92	9.04	16.68	10.04	7.66	9.32	1.3	26.52	7.18	35.92	7.06	0.76	Trace	0.62
Pacific Tomcod	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Walleye Pollock	--	--	1.42	--	306.66	1.33	0.83	3.08	5.2	0.42	6.12	35.7	--	8.82
Sablefish	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lingcod	--	--	--	--	--	--	--	--	--	--	--	14.94	1.4	--
Total roundfish	17.92	9.04	18.1	10.04	314.32	10.65	29.36	29.6	12.38	40.58	13.18	51.4	3.74	9.44
Non-commercial roundfish														
Northern Smoothtongue	--	--	--	Trace	Trace	--	--	--	--	--	--	--	--	--
Plainfin Midshipman	--	--	--	--	--	0.98	67.51	--	0.06	7.1	--	--	11.72	--
Eelpouts	--	--	--	--	--	--	--	--	--	19.26	--	--	5.34	--
Black Eelpout	--	0.02	--	--	0.3	--	--	--	--	--	0.16	--	--	--
Blackbelly Eelpout	--	--	--	--	--	0.26	6.46	0.26	0.06	--	Trace	--	--	--
Snake Prickleback	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--
Kelp Greenling	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Threadfin Sculpin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pacific Staghorn Sculpin	--	--	--	--	--	0.16	--	--	--	--	--	--	Trace	Trace
Blackfin Poacher	0.2	--	--	--	--	--	--	0.28	0.12	0.46	Trace	Trace	--	--
Total non-commercial roundfish	0.2	0.02	0	0	0.3	1.4	73.97	0.54	0.24	26.82	0.16	0	17.46	0
Pelagics														
Pacific Herring	--	--	--	--	--	0.49	4.15	--	--	0.72	--	--	2.82	--
Eulachon	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shiner Perch	--	--	--	--	--	--	20.16	--	--	--	--	--	23.16	--
Pile Perch	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total pelagics	0	0	0	0	0	0.49	24.31	0	0	0.72	0	0	25.98	0

Tow 1 and tow 12 were not usable tows.

Appendix Table E-2. (Continued)

	Catch (kg)													
Tow Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Fish Species (cont.)														
Rockfish														
Rougheye Rockfish	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper Rockfish	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Splitnose Rockfish	1.14	--	--	--	--	--	--	7.76	0.08	3.44	--	0.64	--	--
Greenstriped Rockfish	--	--	--	--	--	1.12	0.41	--	--	3.26	--	--	--	--
Quillback Rockfish	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Yelloweye Rockfish	--	--	--	--	--	--	--	--	--	--	--	4.72	--	--
Shortspine Thornyhead	0.44	Trace	0.77	0.16	0.69	--	--	--	--	--	--	--	--	--
Total Rockfish	1.58	0	0.77	0.16	0.69	1.12	0.41	7.76	0.08	6.7	0	5.36	0	0
Flatfish														
Pacific Sanddab	--	--	--	--	--	--	0.64	--	--	--	--	--	--	--
Arrowtooth Flounder	--	0.5	1.6	0.82	1.04	--	--	4.2	--	0.46	0.68	0.98	--	0.52
Petrale Sole	--	--	--	--	0.92	--	--	--	--	--	3.72	--	--	--
Rex Sole	--	--	0.3	0.28	--	--	2.27	--	0.14	0.42	--	0.18	Trace	0.4
Flathead Sole	0.1	--	0.23	--	--	--	0.3	--	--	1.34	--	--	42.94	--
Butter Sole	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Southern Rock Sole	--	--	--	--	--	--	2.19	--	--	0.5	--	--	195.86	--
Slender Sole	--	0.34	0.39	0.14	1.82	4.85	58.85	5.76	3.7	220.87	1.64	7.66	80.1	7.58
Dover Sole	--	6.18	34.6	22.04	3.68	--	--	1	1.96	--	2.68	1.38	--	2.78
English Sole	--	6.74	11.5	4.24	7.02	2.45	277.94	3.94	0.74	1.96	1.74	2.96	48.5	6.72
Starry Flounder	--	--	--	--	--	--	--	--	--	--	--	--	171.9	--
Sand Sole	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total flatfish	0.1	13.76	48.62	27.52	14.48	7.3	342.19	14.9	6.54	225.55	10.46	13.16	539.3	18
Other fish	0	0	0	Trace	Trace	Trace	0.02	0.01	0	0.47	Trace	0.01	1.74	Trace
Total fish	**74.2**	**142.44**	**215.36**	**175.21**	**539.88**	**26.57**	**574.3**	**229.39**	**251.2**	**437.9**	**172**	**171.15**	**603.96**	**128.02**
Invertebrate Species														
Anemone	--	--	55.44	35.24	22	Trace	Trace	--	0.9	--	11.22	6.3	4.04	1.22
Plumose anemone	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sand star	--	--	--	--	--	0.31	--	--	--	--	--	--	--	--
Mud star	--	--	--	--	--	0.09	--	Trace	0.12	--	1.06	0.26	Trace	6.26
Sweet potato sea cucumber	--	--	--	--	--	--	--	--	--	--	--	--	--	1.58
Squids	--	--	--	--	--	--	--	8.86	10.9	--	11.04	--	--	--
Schoolmaster gonate squid	1.84	8.64	10.3	3.76	1.26	0.32	--	--	--	--	--	1.64	--	1.74
Smooth Pink Shrimp	--	--	--	--	--	--	2.62	--	--	--	--	--	0.98	--
Sidestripe Shrimp	0.35	0.34	0.31	0.4	0.64	4.91	--	1.1	1.24	21.3	1.6	2.14	--	1.4
Dungeness crab	--	--	--	--	--	1.86	--	--	--	--	--	--	--	--
Inshore tanner crab	--	--	--	--	--	1.16	--	--	--	--	--	--	--	--
Other invertebrates	0.69	0.78	0.28	0.3	1.38	0.69	1.21	0.44	--	Trace	Trace	2.38	4.24	0.84
Total invertebrates	**2.88**	**9.76**	**66.33**	**39.7**	**25.28**	**9.34**	**3.83**	**10.4**	**13.16**	**21.3**	**24.92**	**12.72**	**9.26**	**13.04**
Total catch	**77.08**	**152.2**	**281.69**	**214.91**	**565.16**	**35.91**	**578.13**	**239.79**	**264.36**	**459.2**	**196.92**	**183.87**	**613.22**	**141.06**

Appendix Table E-2. (Continued)

	Catch (kg)													
Tow Number	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Fish Species														
Cartilaginous fish														
Bluntnose Sixgill Shark	9.42	--	--	--	--	--	--	--	--	--	--	--	--	--
Brown Cat Shark	0.37	0.66	1.5	--	2.34	0.42	1.14	--	0.11	--	--	--	--	--
North Pacific Spiny Dogfish	90.44	28.6	39	12.98	92.08	32.33	112.78	1.35	57.42	3.86	35.3	11.94	6.58	16.72
Big Skate	--	--	--	--	--	--	--	--	--	--	--	--	3.76	--
Longnose Skate	0.96	0.84	--	--	1.6	--	1.04	--	1.04	0.4	--	Trace	Trace	0.62
Spotted Ratfish	63.15	13.28	11.79	9.46	23.6	104.7	45.35	--	44.36	9.74	85.26	22.76	8.16	46.5
Total cartilaginous fish	164.34	43.38	52.29	22.44	119.62	137.4	160.31	1.35	102.93	14	120.56	34.7	18.5	63.84
Roundfish														
American shad	--	--	0.44	1.26	--	0.58	--	0.53	2.95	0.62	1.12	0.46	0.36	1.5
Chinook salmon	--	--	--	--	--	--	--	--	--	--	--	5.04	--	--
Pacific Cod	--	1.32	--	--	--	--	--	1.92	--	--	--	3.56	--	--
Pacific Hake	0.77	3.99	8.59	5.4	13.89	3.54	30.46	6.15	5.06	2.78	3.06	0.14	2.11	2.06
Pacific Tomcod	--	--	--	--	--	--	--	--	--	--	--	--	Trace	--
Walleye Pollock	4.45	0.24	1.54	--	--	37.57	1.18	0.62	9.1	2.68	116.9	12.14	8.16	187.8
Sablefish	1.08	--	--	--	--	--	0.83	--	--	--	--	--	--	--
Lingcod	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total roundfish	6.3	5.55	10.57	6.66	13.89	41.69	32.47	9.22	17.11	6.08	121.08	21.34	10.63	191.36
Non-commercial roundfish														
Northern Smoothtongue	--	--	--	0.14	--	0.19	--	--	Trace	0.42	--	--	--	Trace
Plainfin Midshipman	--	--	--	0.12	--	--	--	1.74	--	--	--	--	3.74	--
Eelpouts	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Black Eelpout	--	--	Trace	--	0.14	Trace	0.28	Trace	0.6	--	0.94	Trace	--	Trace
Blackbelly Eelpout	--	--	--	--	Trace	--	--	1.91	Trace	--	--	--	13.44	0.2
Snake Prickleback	--	--	--	--	--	--	--	--	--	--	--	--	4	--
Kelp Greenling	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Threadfin Sculpin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pacific Staghorn Sculpin	0.21	--	--	--	--	--	--	--	--	--	--	--	0.36	0.28
Blackfin Poacher	Trace	--	--	Trace	Trace	0.14	--	Trace	--	--	--	--	Trace	Trace
Total non-commercial roundfish	0.21	0	0	0.26	0.14	0.33	0.28	3.65	0.6	0.42	0.94	0	21.54	0.48
Pelagics														
Pacific Herring	--	Trace	--	--	--	Trace	--	0.56	--	--	--	0.14	0.08	0.2
Eulachon	--	--	--	--	--	--	--	--	--	--	0.5	0.56	0.3	3.46
Shiner Perch	--	--	--	--	--	--	--	--	--	--	--	--	1.94	--
Pile Perch	--	--	--	--	--	--	--	0.78	--	--	--	--	--	--
Total pelagics	0	0	0	0	0	0	0	1.34	0	0	0.5	0.7	2.32	3.66
Rockfish														
Rougheye Rockfish	--	--	--	--	--	--	--	--	--	--	1.22	--	--	--

Appendix Table E-2. (Continued)

	Catch (kg)													
Tow Number	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Fish Species (cont.)														
Rockfish(cont.)														
Copper Rockfish	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Splitnose Rockfish	--	0.24	0.55	--	--	0.39	--	0.04	--	--	--	--	--	--
Greenstriped Rockfish	--	--	--	--	--	--	--	2.68	0.34	--	--	--	--	--
Quillback Rockfish	--	--	--	--	--	--	--	3.18	--	--	--	--	--	--
Yelloweye Rockfish	--	--	--	--	--	--	--	0.21	--	--	--	--	--	--
Shortspine Thornyhead	--	--	--	--	0.42	0.64	--	--	0.72	0.36	1.74	--	--	0.26
Total Rockfish	0	0.24	0.55	0	0.42	1.03	0	6.11	1.06	0.36	2.96	0	0	0.26
Flatfish														
Pacific Sanddab	--	--	--	--	--	--	--	--	--	--	--	--	19.12	--
Arrowtooth Flounder	8.29	--	--	--	--	--	--	0.41	--	--	0.34	0.18	--	1.02
Petrale Sole	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rex Sole	--	Trace	--	0.28	--	0.32	0.12	0.45	--	0.68	0.26	7.72	3.5	0.32
Flathead Sole	--	--	--	0.2	--	--	--	0.8	--	--	0.26	3	193.66	1.08
Butter Sole	--	--	--	--	--	--	--	--	--	--	--	--	1.38	--
Southern Rock Sole	Trace	--	--	--	--	--	--	--	--	--	--	--	5.08	0.54
Slender Sole	0.23	9.68	--	1.92	0.58	1.51	0.36	10.22	2.24	3.02	3.8	3.3	0.49	15.92
Dover Sole	0.98	1.38	4.91	3.8	1.86	1.46	17.7	0.8	1.88	0.28	2.4	1.72	0.5	0.94
English Sole	1.93	3.46	--	4.22	1	2.17	0.62	4.16	5.88	3.24	3.5	11.66	375.28	20.38
Starry Flounder	--	--	--	--	--	--	--	--	--	--	--	--	21.54	--
Sand Sole	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total flatfish	11.43	14.52	4.91	10.42	3.44	5.46	18.8	16.84	10	7.22	10.56	27.58	620.55	40.2
Other fish	0	Trace	Trace	Trace	Trace	0	Trace	Trace	0	0	0	0.02	0.1	Trace
Total fish	**182.28**	**63.69**	**68.32**	**39.78**	**137.51**	**185.9**	**211.86**	**38.51**	**131.7**	**28.08**	**256.6**	**84.34**	**673.64**	**299.8**
Invertebrate Species														
Anemone	0.56	--	15.69	--	6.02	--	8.04	--	33.88	22.86	11.14	--	--	3.02
Plumose anemone	--	--	--	--	--	--	--	1.52	--	--	--	--	2.18	--
Sand star	--	--	--	--	--	--	--	1.39	--	--	--	0.38	1.58	--
Mud star	Trace	--	--	--	--	--	--	--	--	--	--	--	--	--
Sweet potato sea cucumber	--	--	--	--	--	--	Trace	--	--	0.03	--	--	Trace	--
Squids	Trace	--	--	--	--	--	--	--	--	--	--	--	--	--
Schoolmaster gonate squid	3.94	9.74	5.96	2.2	16.34	2.34	5.4	0.49	2.98	1.6	2.1	--	--	1.2
Smooth Pink Shrimp	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sidestripe Shrimp	0.19	2.72	0.98	0.68	1.18	0.38	0.46	8.8	2.18	2	0.26	1.48	2.68	1.7
Dungeness crab	--	--	--	0.74	--	--	--	--	--	--	--	--	21.26	--
Inshore tanner crab	--	--	2.38	1.14	--	--	0.16	0.07	Trace	0.88	0.26	--	Trace	--
Other invertebrates	1.12	1.1	0.17	1.48	1.06	0.3	Trace	0.09	Trace	3.73	Trace	0.26	Trace	Trace
Total invertebrates	**5.81**	**13.56**	**25.18**	**6.24**	**24.6**	**3.02**	**14.06**	**12.36**	**39.04**	**31.1**	**13.76**	**2.12**	**27.7**	**5.92**
Total catch	**188.09**	**77.25**	**93.5**	**46.02**	**162.11**	**189**	**225.92**	**50.87**	**170.74**	**59.18**	**270.36**	**86.46**	**701.34**	**305.72**

Appendix Table E-2. (Continued)

	Catch (kg)													
Tow Number	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**
Fish Species														
Cartilaginous fish														
Bluntnose Sixgill Shark	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Brown Cat Shark	--	0.2	--	--	--	--	--	0.37	0.32	0.7	Trace	1.82	0.52	--
North Pacific Spiny Dogfish	--	65.74	4.64	10.6	1.1	--	2.93	19.84	22.78	23.79	19.88	90.42	169.18	5.5
Big Skate	--	--	--	--	--	2.54	0.22	0.18	--	--	--	--	--	--
Longnose Skate	2.38	--	0.24	0.46	--	--	--	0.25	2.87	0.13	8.58	--	0.48	0.56
Spotted Ratfish	1.62	10	31.84	30.8	12.96	4.36	39.2	43.72	13.36	29.7	39.88	70.86	33.16	77.71
Total cartilaginous fish	4	75.94	36.72	41.86	14.06	6.9	42.35	64.36	39.33	54.32	68.34	163.1	203.34	83.77
Roundfish														
American shad	--	1.1	--	5.8	0.72	0.26	1.3	2.33	2.62	2.11	0.38	--	--	--
Chinook salmon	0.54	--	--	--	--	--	--	--	--	--	--	--	--	--
Pacific Cod	--	--	13.38	--	--	--	3.01	3.27	--	--	--	--	--	--
Pacific Hake	0.17	6.51	0.78	1.98	Trace	--	Trace	6.26	4.73	6.58	7.62	6.16	3.3	3.18
Pacific Tomcod	2.72	--	--	--	--	0.72	--	--	--	--	--	--	--	--
Walleye Pollock	7.47	4.16	452.24	416.54	393.92	31.34	1.84	11.07	9.2	0.67	0.74	0.69	1.86	0.28
Sablefish	--	--	--	--	--	--	--	--	--	0.3	--	2.31	0.84	--
Lingcod	--	--	--	1.98	--	--	--	--	--	--	--	--	--	--
Total roundfish	10.9	11.77	466.4	426.3	394.64	32.32	6.15	22.93	16.55	9.66	8.74	9.16	6	3.46
Non-commercial roundfish														
Northern Smoothtongue	--	--	0.14	0.1	--	--	--	Trace	Trace	Trace	Trace	0.15	0.09	--
Plainfin Midshipman	2.55	--	--	--	--	1.48	--	--	--	Trace	--	--	--	0.05
Eelpouts	--	--	--	--	Trace	--	--	--	--	--	--	--	--	--
Black Eelpout	--	1.26	0.14	--	--	--	--	Trace	0.09	0.62	--	0.08	0.3	--
Blackbelly Eelpout	16.13	0.42	0.1	--	Trace	Trace	0.09	--	--	Trace	Trace	--	--	--
Snake Prickleback	1.7	--	--	--	--	--	--	--	--	--	--	--	--	--
Kelp Greenling	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Threadfin Sculpin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pacific Staghorn Sculpin	0.59	--	0.08	--	--	0.18	--	--	--	--	--	--	--	--
Blackfin Poacher	--	--	--	--	--	--	--	--	--	--	Trace	--	--	0.06
Total non-commercial roundfish	20.97	1.68	0.46	0.1	0	1.66	0.09	0	0.09	0.62	0	0.23	0.39	0.11
Pelagics														
Pacific Herring	2.72	--	0.16	Trace	--	2.3	0.78	0.21	--	Trace	--	--	--	--
Eulachon	--	--	1.8	1.14	1.12	--	0.84	0.62	1.43	0.25	--	--	--	--
Shiner Perch	759.59	--	--	--	--	0.14	--	--	--	--	--	--	--	--
Pile Perch	4.25	--	--	--	--	--	--	--	--	--	--	--	--	--
Total pelagics	766.56	0	1.96	1.14	1.12	2.44	1.62	0.83	1.43	0.25	0	0	0	0
Rockfish														
Rougheye Rockfish	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix Table E-2. (Continued)

	Catch (kg)													
Tow Number	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**
Fish Species (cont.)														
Rockfish(cont.)														
Copper Rockfish	1.12	--	--	--	--	--	--	--	--	--	--	--	--	--
Splitnose Rockfish	--	--	--	--	--	--	--	--	--	--	0.74	--	--	2.3
Greenstriped Rockfish	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Quillback Rockfish	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Yelloweye Rockfish	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shortspine Thornyhead	--	0.85	--	0.2	--	--	--	--	--	--	0.52	0.4	0.42	--
Total Rockfish	2.12	0.85	0	0.2	0	0	0	0	0	0	1.26	0.4	0.42	2.3
Flatfish														
Pacific Sanddab	38.89	--	--	--	0.12	97.22	--	--	--	--	--	--	--	--
Arrowtooth Flounder	--	--	--	0.62	--	1.24	--	0.56	0.36	0.52	11.94	1.12	0.46	--
Petrale Sole	--	--	0.84	0.44	0.48	0.5	--	--	--	--	--	0.79	--	--
Rex Sole	7.3	0.42	1.78	2.22	0.58	0.74	0.2	0.33	--	0.14	0.12	0.29	0.12	--
Flathead Sole	31.25	--	--	--	--	7.6	2.4	0.21	0.09	0.35	4.82	--	--	--
Butter Sole	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Southern Rock Sole	--	--	--	--	--	0.92	1.88	--	--	--	--	--	--	--
Slender Sole	--	2.06	0.22	0.94	0.1	Trace	0.68	1.19	1.1	0.32	67.64	0.63	0.44	7.1
Dover Sole	--	2.28	4.16	6.4	3.54	3.78	--	2.84	3.28	2.86	0.78	19.22	12.48	1.92
English Sole	597.41	2.56	0.4	0.4	80.62	278.2	56.58	--	1.32	0.53	2.52	9.6	9.84	2.04
Starry Flounder	42.16	--	--	--	--	--	--	--	--	--	--	--	--	--
Sand Sole	--	--	--	--	--	2.38	--	--	--	--	--	--	--	--
Total flatfish	717.01	7.32	7.4	11.02	85.44	392.5	61.74	5.13	6.15	4.72	87.82	31.65	23.34	11.06
Other fish	0.03	0	Trace	0	0	0	Trace	Trace	Trace	Trace	Trace	0	0	Trace
Total fish	**1521.59**	**97.56**	**512.94**	**480.62**	**495.26**	**435.9**	**111.95**	**93.25**	**63.55**	**69.57**	**166.16**	**204.54**	**233.49**	**100.7**
Invertebrate Species														
Anemone	--	Trace	--	--	--	--	--	--	--	--	0.46	0.67	14.6	--
Plumose anemone	38.72	--	0.64	2.08	--	3.24	0.5	3.85	--	--	--	--	--	--
Sand star	--	--	2.14	1.54	--	--	0.54	--	--	--	--	--	--	--
Mud star	--	--	--	--	--	--	--	--	--	--	--	--	--	Trace
Sweet potato sea cucumber	--	Trace	--	Trace	--	--	--	--	--	Trace	--	--	Trace	--
Squids	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Schoolmaster gonate squid	--	4.38	0.54	0.44	--	--	--	2.03	2.6	1.36	8.16	4.15	2.64	6.61
Smooth Pink Shrimp	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sidestripe Shrimp	--	0.72	0.92	1.48	0.26	1.34	0.1	0.76	1.16	0.9	2.64	0.4	1.14	1.48
Dungeness crab	23.88	--	0.54	0.76	2.34	2.66	--	0.5	--	--	0.66	--	--	--
Inshore tanner crab	1.46	Trace	--	Trace	--	--	--	--	--	--	--	--	Trace	0.21
Other invertebrates	Trace	Trace	0.04	0.24	Trace	0.24	0.35	Trace	Trace	Trace	0.9	0.84	0.16	0.12
Total invertebrates	**64.06**	**5.1**	**4.82**	**6.54**	**2.6**	**7.48**	**1.49**	**7.14**	**3.76**	**2.26**	**12.82**	**6.06**	**18.54**	**8.42**
Total catch	**1585.65**	**102.66**	**517.76**	**487.16**	**497.86**	**443.3**	**113.44**	**100.39**	**67.31**	**71.83**	**178.98**	**210.6**	**252.03**	**109.12**

Appendix Table E-2. (Continued)

	Catch (kg)											
Tow Number	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**Total for all Tows**
Fish Species												
Cartilaginous fish												
Bluntnose Sixgill Shark	--	--	--	--	--	--	--	--	--	--	--	9.42
Brown Cat Shark	Trace	1.2	--	--	0.28	--	--	--	--	--	--	18.96
North Pacific Spiny Dogfish	28.35	32.98	174.18	73.24	24.64	0.5	--	110.52	14.32	26.45	3.6	2344.42
Big Skate	--	--	--	--	--	--	--	--	--	--	2.24	11.98
Longnose Skate	4.48	--	--	1.3	4.24	--	--	2.5	--	1.32	--	56.93
Spotted Ratfish	20.3	91.23	118.28	12.9	113.56	164.8	11.84	49.6	12.49	19.79	1.37	2325.34
Total cartilaginous fish	53.13	125.41	292.46	87.44	142.72	165.3	11.84	162.62	26.81	47.56	7.21	4767.05
Roundfish												
American shad	0.39	--	--	--	--	--	--	3.08	--	--	--	29.91
Chinook salmon	--	--	1.58	--	--	--	0.44	--	--	--	--	10.88
Pacific Cod	--	--	--	315.3	1.84	6.6	--	4.94	--	--	2.02	387.69
Pacific Hake	32	8.94	17.42	38.3	10.34	1.84	--	138.6	74.7	2.04	--	609.47
Pacific Tomcod	--	--	--	--	--	--	--	--	--	--	--	3.44
Walleye Pollock	3.19	0.3	21.48	0.54	5.12	1.96	1.01	0.96	--	0.81	--	2119.35
Sablefish	--	--	--	--	--	--	--	--	--	--	--	5.36
Lingcod	--	--	--	5.14	--	--	0.34	--	--	--	12.04	35.84
Total roundfish	35.58	9.24	40.48	359.28	17.3	10.4	1.79	147.58	74.7	2.85	14.06	3201.94
Non-commercial roundfish												
Northern Smoothtongue	Trace	--	--	--	--	--	--	--	--	Trace	--	1.23
Plainfin Midshipman	2.95	Trace	--	1.56	--	63.94	15.4	10.42	0.05	--	0.48	191.85
Eelpouts	--	--	--	--	--	--	--	--	--	--	--	24.6
Black Eelpout	--	--	--	--	--	--	--	Trace	0.19	Trace	--	5.12
Blackbelly Eelpout	1.12	0.28	Trace	Trace	--	2.68	3.6	Trace	Trace	--	0.42	47.43
Snake Prickleback	--	--	--	--	--	--	Trace	Trace	--	--	--	6.1
Kelp Greenling	--	--	--	--	--	--	--	--	--	--	0.53	0.53
Threadfin Sculpin	--	--	--	--	--	--	--	--	--	--	2.19	2.19
Pacific Staghorn Sculpin	--	--	--	--	--	--	0.21	--	--	--	3.14	5.21
Blackfin Poacher	--	--	Trace	--	Trace	--	--	Trace	Trace	0.13	--	1.39
Total non-commercial roundfish	4.07	0.28	0	1.56	0	66.62	19.21	10.42	0.24	0.13	6.76	285.65
Pelagics												
Pacific Herring	--	--	--	2.56	--	7.26	0.58	--	--	--	0.65	26.38
Eulachon	--	--	--	--	--	Trace	--	--	--	--	--	12.02
Shiner Perch	--	--	--	--	--	34.74	106.89	--	--	--	1.03	947.65
Pile Perch	--	--	--	--	--	--	--	--	--	--	2.22	7.25
Total pelagics				2.56		42	107.47				3.9	993.3
Rockfish												
Rougheye Rockfish	--	--	--	--	--	--	--	--	--	--	--	1.22

Appendix Table E-2. (Continued)

	Catch (kg)											
Tow Number	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**Total for all Tows**
Fish Species (cont.)												
Rockfish(cont.)												
Copper Rockfish	--	--	--	--	--	--	--	--	--	--	1.29	2.41
Splitnose Rockfish	2.69	0.92	--	--	0.8	--	--	0.03	--	--	--	21.76
Greenstriped Rockfish	3.03	0.44	0.4	5.88	--	2.42	0.78	1.32	0.07	--	0.27	22.42
Quillback Rockfish	--	--	--	1.32	--	--	--	--	--	--	0.03	5.53
Yelloweye Rockfish	--	--	--	--	--	--	--	--	--	--	--	4.93
Shortspine Thornyhead	--	--	--	--	--	--	--	--	--	--	--	8.59
Total Rockfish	5.72	1.36	0.4	7.2	0.8	2.42	0.78	1.35	0.07	0	1.59	66.86
Flatfish												
Pacific Sanddab	--	--	--	--	--	--	--	--	--	--	7.69	163.68
Arrowtooth Flounder	--	--	5.56	4.18	0.48	--	--	3.1	1.01	--	--	52.19
Petrale Sole	--	--	0.82	0.62	--	--	--	--	--	--	--	9.13
Rex Sole	0.38	--	9.94	5.06	--	0.42	0.36	--	--	--	3.56	51.6
Flathead Sole	0.75	--	--	--	--	5.96	35.12	0.58	--	--	2.87	335.91
Butter Sole	--	--	--	--	--	--	--	--	--	--	--	1.38
Southern Rock Sole	--	--	--	0.56	--	4.62	0.28	--	--	--	160.35	372.78
Slender Sole	27.88	6.5	16.06	46.26	4	41.68	19.05	50.26	27.26	0.61	14.38	783.33
Dover Sole	--	1.06	1	1.14	2.54	--	--	0.44	1.55	1.03	--	189.21
English Sole	8.59	0.88	198.54	96.6	2.66	220	59.15	0.3	--	2.57	172.93	2618.19
Starry Flounder	--	--	--	--	--	--	--	--	--	--	--	235.6
Sand Sole	--	--	--	--	--	--	--	--	--	--	--	2.38
Total flatfish	37.6	8.44	231.92	154.42	9.68	272.7	113.96	54.68	29.82	4.21	361.78	4815.38
Other fish	0.16	Trace	0	0	Trace	Trace	Trace	0	Trace	0	0.07	2.63
Total fish	**136.26**	**144.73**	**565.26**	**612.46**	**170.5**	**559.5**	**255.05**	**376.65**	**131.64**	**54.75**	**395.37**	**14132.8**
Invertebrate Species												
Anemone	--	--	--	--	--	--	--	--	--	--	--	253.3
Plumose anemone	--	--	--	--	--	0.5	5.99	--	--	--	2.11	61.33
Sand star	--	--	--	--	--	--	--	--	--	--	--	7.88
Mud star	--	--	--	--	Trace	--	--	0.44	--	--	--	8.23
Sweet potato sea cucumber	5.51	--	--	--	--	--	--	--	--	--	--	7.12
Squids	--	--	--	--	--	--	--	--	--	--	--	30.8
Schoolmaster gonate squid	0.69	3.86	0.38	--	8.2	0.62	--	5.8	2.46	2.89	--	141.6
Smooth Pink Shrimp	--	--	--	--	--	0.88	6.18	Trace	--	--	--	10.66
Sidestripe Shrimp	7.83	1.54	--	--	0.84	Trace	--	3.02	3.21	3.7	--	94.86
Dungeness crab	1.37	--	--	--	--	--	--	--	--	--	4.52	61.09
Inshore tanner crab	0.39	0.7	--	--	--	0.2	0.59	0.4	--	0.32	--	10.32
Other invertebrates	2.49	1.4	--	--	0.18	2.32	1.19	0.56	0.44	0.45	1.21	35.67
Total invertebrates	**18.28**	**7.5**	**0.38**	**0**	**9.22**	**4.52**	**13.95**	**10.22**	**6.11**	**7.36**	**7.84**	**722.86**
Total catch	**154.54**	**152.23**	**565.64**	**612.46**	**179.72**	**564**	**269**	**386.87**	**137.75**	**62.11**	**403.21**	**14855.7**