Juvenile Herring Surveys: Methods and Data Base

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ABSTRACT

Thompson, M., C. Hrabok, D.E. Hay, J. Schweigert, C. Haegele, and B. Armstrong. 2003. Juvenile herring surveys: methods and data base. Can. Manuscr. Rep. Fish. Aquat. Sci. 2651: 31p.

Juvenile Pacific herring (*Clupea pallasi*) surveys were conducted from 1990 to 2001 in the Strait of Georgia and Johnstone Strait. Usually two or more surveys were made each year in late spring and early fall, between May and October. The survey sampling design consisted of ten core transects positioned throughout the Strait of Georgia. Each transect had between three and five sampling 'stations' where purse seine sets were made. On each transect, the stations started at the shore, with each station about one km apart extending out towards the channel. The exact co-ordinates of each station were known, and fishing was conducted on exactly the same locations in all surveys. The ten transects were sampled in all years, but additional transects and stations were added in some years. These additional transects and stations were used to address specific inquiries, such as the prevalence of herring in mid-Strait waters or distribution north of the Strait of Georgia. Catches were examined on deck and subsamples were fixed in seawater formalin for later analysis in the laboratory. This included counts and measurements of juvenile herring and salmonids along with other species. In addition plankton samples were taken with small-mesh bongo nets. All sampling data were entered into a relational database (Access©). This report describes the sampling methodology, methods of catch quantification, and the design of the database.

RÉSUMÉ

Thompson, M., C. Hrabok, D.E. Hay, J. Schweigert, C. Haegele, and B. Armstrong. 2003. Juvenile herring surveys: methods and data base. Can. Manuscr. Rep. Fish. Aquat. Sci. 2651: 31p.

Nous avons effectué des relevés du hareng du Pacifique juvénile (*Clupea pallasi*) de 1990 à 2001 dans les détroits de Georgia et de Johnstone au rythme de deux ou plus par année, soit à la fin du printemps (mai) et au début de l'automne (octobre). Le plan d'échantillonnage comprenait dix transects de base répartis dans le détroit de Georgia. Chaque transect comptait de trois à cinq stations d'échantillonnage à la seine coulissante. La première station de chaque transect était toujours située sur la rive, et les autres suivaient à environ un kilomètre d'intervalle en direction du chenal. Puisque nous connaissions les coordonnées exactes de chaque station, nous avons échantillonné chaque année aux mêmes endroits sur les dix transects. Nous avons ajouté des transects et des stations au cours de certaines années pour étudier des questions précises, comme le nombre de harengs dans le milieu du détroit de Georgia ou leur distribution au nord de ce même détroit. Nous avons analysé les prises à bord des bateaux; cela comprenait le dénombrement et la mesure de harengs et salmonidés juvéniles et d'autres espèces. De plus, nous avons conservé des sous-échantillons dans une solution d'eau salée et de formaldéhyde pour analyse ultérieure en laboratoire. Nous avons également prélevé des échantillons de plancton à l'aide de filets à petites mailles de type bongo. Toutes les données d'échantillonnage ont été entrées dans une base de données relationnelle (Access©). Ce rapport décrit les méthodes d'échantillonnage et de quantification des prises ainsi que la structure de la base de données.

INTRODUCTION

Purse seine surveys to determine the distribution and abundance of juvenile herring in the Strait of Georgia have been conducted annually since 1990, except for 1995. The surveys were conducted in the spring (May and June) and late summer (September and October). Additional mid-summer surveys occurred in some years. In general, all surveys consisted of purse seining on the ten core transects, each with about 3-5 sampling stations, but additional transects were added in some years (Figs. 1 and 2). In 1997 and 1998 the surveys were extended to include southern and northern Johnstone Strait (Fig. 3). Sampling locations and methodology were consistent in all years since 1991 when the sampling gear changed from hand seining to purse seining.

The main objective of the juvenile herring surveys was to estimate the density and relative abundance of the juvenile herring population in the Strait of Georgia as a potential predictor of recruitment. In British Columbia, most herring join the sexually maturing population at age-3, so the number of age-3 fish is an approximate estimate of recruitment (Hay and McCarter 1999). Sometimes this age group represents a large proportion of the population – as much as 50% in some years. Current stock assessment methods (Schweigert 2002) concentrate on estimating the numbers and biomass of fish *after* they have joined the spawning stock. Present methods do not provide reliable estimates of recruitment of 3-year-olds *before* they join the adult component of the population. The initial purpose of these surveys was to examine the relative abundance of juvenile herring as a potential predictor of annual recruitment into the spawning population. In addition to recruitment prediction, the surveys have also contributed to a better understanding of the distribution, abundance and ecological role of herring in the Strait of Georgia and Johnstone Strait.

The purpose of this report is to provide (1) a definitive description of the field sampling methods, including the times and places of all purse-seine activity, (2) document the methods of catch sampling, both in the field and laboratory, and (3) describe the structure of the resulting database.

METHODS

The surveys started with hand seining from small open vessels in 1990. In 1991 they were conducted by purse seine vessels, WALKER ROCK, KETA, or TAHLOK. Since 1996, the surveys have been conducted from the 13.7m vessel Walker Rock. Crew sizes have varied over the years depending on the method and vessel used (Table 1).

Since 1990, one to four surveys were performed each year. Each survey would perform the ten core transects plus any additional locations that were deemed useful to address inquires about prevalence of juvenile herring in mid-Strait waters or distribution north of the Strait of Georgia. Spring surveys (cruise 1) were carried out between late May to early July. Fall surveys (cruise 2) were carried out between early September to mid-October. Four surveys were performed in 1990 and 1991 with all being performed between May and October. A single survey was performed in the fall of 1998.
The ten core transects range from Active Pass in the south to Cortes Island in the north of the Strait of Georgia. Additional transects have stretched the study area from

Plumper Sound in the south of the Strait of Georgia, north to Codrington Point in the Johnstone Strait.

In 1990 the surveys were limited to a relatively few areas but expanded in 1991. Since 1991, ten core transects were established at approximately equal intervals around the perimeter of the Strait of Georgia (Table 2, Figs. 1 and 2). The transects were located based on either 'open coast' or 'channel sites' (Haegele 1997). 'Open coast' transects (1, 3, 5, 9 and 11) were located perpendicular to shore and consisted of five stations approximately one km apart. 'Channel' transects (2, 4, 6, 8 and 10) were located across channels with the outer stations about 360m from high water ranging from 3 to 400m deep. Table 2 provides approximate bathymetry data attained from CHS charts in Arcview©. Each transect consisted of a mid-channel station, and one station between each outer and mid-channel station for a total of five stations. Channel stations were also about one km apart (Haegele 1997). Every attempt was made to sample on station; however, weather and tidal conditions resulted in some variation of fishing positions. Database latitude and longitude positions do not reflect this slight variation. Table 3 provides a summary of all sampling types and locations.

Sampling began after dusk as herring rise in the water column to feed on plankton at night (Haegele 1997). Plankton sampling was conducted first, followed by seining, which was completed by dawn.

SEINING OPERATIONS

In 1990, cruises 1 and 2 used a 75m long by 20m deep hand seine net deployed from a 6.1m skiff, whereas, cruises 3 and 4 were conducted using a 400m long by 27m deep purse seine net. Subsequent to 1990, all sets were made with the same gear: deep purse seine net (220m long by 27m deep) with an estimated fished area of $3851 m^2$. All three net sizes had knot-less marquisette web that retained fish >3 cm long (Haegele 1995). Table 1 shows the type of vessel and net fished in each location over the study years. All purse seine sets were conducted using the same methods. Sets were conducted with the net open to the tidal direction. Under windy conditions, sets were made so that the boat was downwind from the seine bunt to prevent the net from collapsing. Inshore sets were conducted so that the open side of the ¾ set was along the shoreline (Haegele 1997; Hanson and Armstrong 1996). A skiff was deployed to tow the fishing vessel away from the net when windy or strong tidal conditions prevailed. All sets were performed 'blind' or conducted without acoustical or other indications of presence/absence of herring in the area.

BIOLOGICAL SAMPLE PROCESSING

In general, all fish landed on deck were examined. In the event of large catches (greater than 100 kg), subsamples were placed in a 40kg tote for detailed examination of species composition. The remainder of the catch was released with the number of fish estimated in number of 40kg totes. A minimum of two totes were retained from each large set conducted between 1990 and 1994. From 1996 to present, only one tote was sampled when the catches were large. A catch total and species total was then calculated from the retained subsample. A catch number for each species was calculated by using the following equation when a subsample was taken.

(Catch / Mean weight of species) * Total catch weight

where:
Catch = total number of a specific species caught
Mean weight of species = average weight (g) of specific species caught
Total catch weight = sum weight (g) of all species caught

Sampled catches were immediately separated into herring, salmonids or other species. Salmonids were identified to species, labelled and preserved in a 3.7% formaldehyde and seawater solution. Other fish species were identified, recorded and released. Table 4 shows the species composition of all fish and invertebrates captured.

For each catch an estimated sample size of 200 juvenile herring (age groups 0+ and 1+) was preserved when possible. Larger, older herring, ages 2+ or greater were preserved in the same manner. On deck, herring ages were determined based on distinct differences in length among the three main groups of herring: age 0+, age 1+ and ages 2+ and older. The following table shows the spring and fall herring length/age divisions used for ageing (Hanson and Armstrong 1996).

Age	Spring (May – July)	Fall (September - October
0+	<72mm	<114mm
1+	73 to 161mm	115 to 161mm
2+	>162mm	>162mm

Maximum sample sizes of 20 juvenile salmon were preserved when possible. When the required number of species was not met, the total catch would be preserved and labelled 'ALL'. When a sufficiently large catch occurred, a 'SAMPLE' consisting of 200 juvenile herring as well as 20 salmonids of each species was retained. These designations allowed for easier processing in the lab.

PLANKTON SAMPLING

Since 1991, plankton samples have been collected using a 19cm diameter bongo net with a 350 micron mesh. In 1990, cruise 4 used a 57cm diameter net (these data are not included in the database). The volume of seawater filtered through the nets was measured using a General Oceanics® model 2030R flowmeter. Plankton was usually collected just prior to dusk using a stepped oblique tow. The bongo nets were lowered to 20 m and raised 1 m every 15 seconds with an electric winch. In shallow water, the bongo nets were lowered to 10 m and raised every 30 seconds. During plankton tows, a vessel speed of five knots was used while circling the station.

In 1996 plankton tows were only conducted at 2 stations (#2 and #4) along each transect (Hanson and Armstrong 1996). Prior to and after 1996, plankton was collected from most stations along each transect (Table 3). After 1996, only a few of the yearly plankton samples were analysed due to financial constraints. Plankton samples were preserved in a 3.7% seawater formaldehyde solution.

LABORATORY SAMPLING

Preserved fish were transported to the Pacific Biological Station for analysis. Prior to analysis, the samples were soaked overnight under running tap water to flush away excessive formalin. Herring, salmon and occasionally other species were then measured for length (mm) and weight (g). Herring were measured for standard lengths (tip of snout to end of hypural plate) and salmon for fork lengths (tip of snout to tail fork). Weight was measured to the nearest tenth of a gram for both species. Several fish identification keys were used to assist in the identification of juvenile salmonids and other species (Hanson and Armstrong 1996; Hart 1973; Lamb and Edgell 1986; Pollard et al. 1997). Table 4 provides a listing of all species captured.

Laboratory analyses of plankton and the contents of fish stomachs were conducted by DFO technical staff from 1990 until 1994 and by contract (AMC Technical Services Ltd.) from 1996 to present. Sampling methods were consistent over time, but prior to 1996, copepods were lumped together and subsequently have been identified to the species level.

A volumetric splitter was used to reduce the sample size to a point where organisms could be conveniently counted and identified in a counting tray using a stereo microscope. The sample was successively split in half to a target size of approximately 300 organisms for counting. The procedure for splitting plankton samples is shown in Fig. 4.

Stomachs of some of the preserved fish were analysed for content. Stomachs were rated for fullness (empty, trace, half full and full) and state of digestion (fresh, partly, mostly, and complete) and contents identified (Table 5) and counted (Haegele 1997).

DATABASE DESIGN

The data were compiled into eight main tables. The data tables were as follows: Dates, Catch, Gut, Plankton, Herring, and Other Species. Latitude/Longitude and Species are two other data tables that were included into the database to provide additional reference information.

DATES:

This data table consists of fields that list all transects (TRAN) and stations (STN) for each seine and plankton set for each survey. Figures 1, 2 and 3 show all transect locations. In 1990 and 1991 four surveys were performed. Each subsequent year, excluding 1995 and 1998, two surveys were conducted. No surveys were performed in 1995 and a single spring survey was performed in 1998. The spring survey of 1999 was a limited outing of seven transects creating a small data set containing only herring measurement data. Table 3 shows the complete sampling synopsis for all years.

The "Dates" table contains times and locations for both plankton and purse seining sampling. A primary key field called CATCHID was created to link all relevant fishing log data to catch, gut, plankton, herring and other species data tables. This primary key provides a unique value for each field, thus providing a link between all related data in each data table. CATCHID was created as a 10-digit sequential number by combining the 4-digit year, 1-digit cruise, 3-digit transect and the 2-digit station numbers (i.e. 1996100502 = year 1996, cruise 1, transect 5, station 2). The creation of this primary key also decreased the repetition of common data among data tables – such as year, cruise, date, month, day, transect and station information. Day of year (DOY) information was intentionally removed from the CATCHID primary key due to several plankton tows being performed a day before or after the catch seines (due to bad weather or time constraints). Therefore the DOY could not be used as a common referential linkage between all the data tables.

CATCH:

The "Catch" data table refers to all fish and significant invertebrate species caught at each station. If no fish were caught, that station was not included in this data table. The SPECIES heading is a 4-letter abbreviation of species caught. Table 4 shows the full species names. Number (NO) is the total count of fish caught and the weight (WT) for these fish in grams (g).

A summary of all data tables with relation to year and survey is shown in Table 3. Highlighted cells represent gut and/or herring sampling that do not have corresponding catch data. To obtain a gut or herring sample, a corresponding catch date should have been provided. Unfortunately, a few samples do not contain the required corresponding catch information and these have been bolded in Table 3. This should be taken into account when comparing catch, gut and herring data together since some gut/herring data can appear without corresponding catch information.

GUT:

Captured fish subsamples (SPECIES) were analysed for stomach content, species (GUTSPECIES) and amount of content (COUNT). These fish included herring (0+, 1+ and 2+), trout, chinook, chum, coho, pink and sockeye salmon. The stomachs of ten 0+ and ten 1+ herring from each transect, when available, were retained for content analysis (Haegele and Armstrong 1997, 1998, 1999, 2000, 2001). Table 5 provides a complete list of plankton species analysed from stomach contents.

The fullness of the stomachs (FULL) was recorded using the following scale:

- 0 = empty
- 1 = trace
- 2 = half full
- 3 = full

The state of the stomach contents (STATE) was recorded using the following scale:

- 1 = fresh
- 2 = partly digested
- 3 = mostly digested
- 4 = totally digested

Two gaps in original data will have an impact on gut analysis, as error exists in matching gut content to fish capture:

1. Gut samples were not taken in 1994, 1997, 1998 and 1999. The gut data collected for 1996, 2000 and 2001 data were missing station numbers. The CATCHID primary key then had to be altered to allow some transects to have a default station number of zero. These transects are 1-6, 8-11, 14-16, 19-22, 25, 36, and 37 (bolded default station numbers are shown in Table 2).

2. Original gut data for 1990 and 1991 were labelled as having a cruise number of 1 or 2, when there were four surveys performed for both years. Stations 1,2,3,4 and 5 were visited during all four surveys so it is not possible to associate samples with their corresponding surveys. Catch data showed a few unique stations that were sampled in cruises 3 and 4 and changes were made to the original gut data accordingly (i.e. Transect 2, stations 11 through 16). Wherever possible, dates were taken from the catch data to correspond with survey and transect information to fill missing data.

PLANKTON:

Most plankton samples were collected using a 19 cm diameter bongo net with a 350 micron mesh. The only exception to this was 1990 cruise 4 when a 57 cm diameter bongo was used instead. These data have been excluded from the data set. Beginning flow (FLOWB) and end flow (FLOWE) were recorded from the General Oceanics® model 2030R flowmeter. The following formula is used to calculate the volume of water filtered (VOL) in m^3:

V=(A*F*K)/999,999
where:
V = volume of water filtered through plankton net (m^3)
A = area of net opening (0.0283 m^2)
F = number of revolutions recorded by flowmeter (FLOWE – FLOWB)
K = high speed rotor constant of 7.0 cm rotor (26,873)
999,999 = six-digit counter readout

Initial separations of plankton samples were screened using 1000 or 250 micron sieves. Volumetric splits (SPLIT) were performed to reduce large samples into subsequent subsamples for quicker processing. The resulting wet weight of the subsample was taken and recorded (WT) in grams (g). Figure 4 shows a diagram of plankton sample splits.

Number (NO) is the number of plankters of a specific species or group within the plankton sample per m^3. Scientific names, common names and abbreviations (SPECIES) are shown in Table 5.

Plankton samples were organised into eight phyla and separated into 23 corresponding categories as seen in Table 5. Starting in 1996, copepods were further separated into genus and species whenever possible. Therefore within the plankton data table, since 1996, copepods have been totalled for each sample (referred to as COPE) as well as having their own species headings and totals.

There are two other species abbreviations that are composed of a total from other groups. Barnacles (BARN) are a sum of *Cirripedia cyprids* (CIRC) and *Cirripedia nauplii* (CIRN). Crabs (CRAB) are a sum of crab megalopia (CRAM) and crab zoea (CRAZ).
From 1990 to 1994, ophistobranch (PTER) or prosobranch (PROS) gastropods data were recorded individually. Both *Clione sp.* and *Limacina sp.* ophistobranch gastropods (PTER) have been combined with prosobranch gastropods (PROS) under gastropods (GAST) since 1996.

HERRING:

From 1990 to 1994, herring were recorded as herring adult (HERA) and herring juvenile (HERJ). Since 1996, herring were recorded as HER0+, HER1+ and HER2+ depending on their size class. To produce a cohesive database, HERJ were changed to HER0+ and HERA were changed to their corresponding year class of HER1+ or HER2+ based on size-at-age histograms.

Juvenile herring were weighed (WT) to the nearest tenth of a gram (g) and standard length measured (LEN) to the nearest millimetre (mm). Juvenile herring age is a calendar day (DOY) determined by assuming a date of birth of April 1 (day 90). Day of capture is found on the "Dates" data table (DATE).

AGE 0+ = day of capture - 90
AGE 1+ = (day of capture + 365) - 90
AGE 2+ = (day of capture + 730) - 90

OTHER SPECIES:

"Other Species" is a data table composed of fish species other than herring that were measured and weighed. These include capelin, trout, chum, coho, sockeye, pink and chinook salmon. Salmonids were measured to fork length in millimetres (mm) while capelin were measured to standard length in millimetres (mm). Both were weighed to the nearest tenth of a gram (g). When recorded, the method of preservation (PRESERVE) was included. Freezing and a diluted seawater formaldehyde solution were the only two methods of preservation used during the surveys.

SPECIES:

This data table is an informational component for the six main data tables. "Species" provides family and category (FAM_CAT) groupings as well as common and scientific names for all species of fish and plankton captured during this study. Additional notes (NOTES) are provided for many species regarding life stage or age class separations. Within the database, both fish and plankton species lists (Tables 4 and 5) are combined to allow for easier relationship connections.

LATITUDE/LONGITUDE:

As with the "Species" data table, the "latitude and longitude" data table is an informational component for the six main data tables. This data set provides all decimal degree latitude (LAT_N) and longitude (LONG_W) information for every transect (TRAN) and station (STN) covered during the Juvenile Herring Survey. Statistical Area, section and location code (LOCCODE) are designations based on Pacific herring stock assessment areas (Haist and Rosenfeld 1988). Figures 1, 2 and 3 show all stations sampled during the juvenile herring survey. Figure 5 shows the statistical areas within the Strait of Georgia and lower Johnstone Strait.

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Table 1. Summary of research surveys showing the year and month (YEAR, MONTH) of each survey, as well as the corresponding survey number (cruise #) and vessel used. The captain columns indicate the initials of the captains: Doug Miller (DM) and Bob Armstrong (BA). The two seine methods (seine method are shown). Three net sizes were used (net size) which resulted in three different areas of total fishing area.

Year	Month	Cruise #	Vessel	Captain	Seine Method	Net Size	Net Area Fished
1990	May-June	1	land-based	DM	hand	75m by 20m	448m2
1990	June-July	2	land-based	DM	hand	75m by 20m	448m2
1990	August	3	KETA	DM	purse	400m by 27m	12,732m2
1990	October	4*	KETA	DM	purse	400m by 27m	12,732m2
1991	May-June	1	TAHLOK	DM	purse	220m by 27m	3851m2
1991	July	2	TAHLOK	DM	purse	220m by 27m	3851m2
1991	Aug.-Sept.	3	KETA	DM	purse	220m by 27m	3851m2
1991	October	4	KETA	DM	purse	220m by 27m	3851m2
1992	June	1	TAHLOK	DM	purse	220m by 27m	3851m2
1992	September	2	KETA	DM	purse	220m by 27m	3851m2
1993	June	1	TAHLOK	DM	purse	220m by 27m	3851m2
1993	September	2	KETA	DM	purse	220m by 27m	3851m2
1994	June	1	TAHLOK	DM	purse	220m by 27m	3851m2
1994	September	2	KETA	DM	purse	220m by 27m	3851m2
1996	June	1	WALKER ROCK	BA	purse	220m by 27m	3851m2
1996	September	2	WALKER ROCK	BA	purse	220m by 27m	3851m2
1997	June	1	WALKER ROCK	BA	purse	220m by 27m	3851m2
1997	September	2	WALKER ROCK	BA	purse	220m by 27m	3851m2
1998	Sept.-Oct.	1	WALKER ROCK	BA	purse	220m by 27m	3851m2
1999	June	1	WALKER ROCK	BA	purse	220m by 27m	3851m2
1999	Sept.-Oct.	2	WALKER ROCK	BA	purse	220m by 27m	3851m2
2000	June	1	WALKER ROCK	BA	purse	220m by 27m	3851m2
2000	Sept.-Oct.	2	WALKER ROCK	BA	purse	220m by 27m	3851m2
2001	June	1	WALKER ROCK	BA	purse	220m by 27m	3851m2
2001	Sept.-Oct.	2	WALKER ROCK	BA	purse	220m by 27m	3851m2

*Some sets on cruise 4 in 1990 used hydro acoustics to locate herring concentrations.

Table 2. Juvenile herring sampling locations showing transect names (TRANNAME) with all transects (TRAN) and station numbers (STN) used during the survey. The statistical areas (STATAREA), subareas (SECTION), location code (LOCCODE) are all geographical units associated with herring spawn assessment areas. The latitude (LAT) and longitude (LONG), in decimal degrees are indicated for each transect. Depth intervals (DEPTH) in metres were based on reference of the transect positions to Canadian Hydrographic charts. Bolded cells represent the default station 0's to correct for gut data omissions.

TRANNAME	TRAN	STN	STATAREA	SECTION	LOCCODE	LAT	LONG	DEPTH
Clarke Rock	**1**	**0**	**17**	**172**	**1563**			
Clarke Rock	1	1	17	172	1563	49.22357	-123.943	10-20
Clarke Rock	1	2	17	172	1563	49.23333	-123.932	50-100
Clarke Rock	1	3	17	172	1563	49.23665	-123.922	100-200
Clarke Rock	1	4	17	172	1563	49.237	-123.912	100-200
Clarke Rock	1	5	17	172	1563	49.238	-123.902	200-300
Clarke Rock	1	6	17	172	1563	49.24885	-123.89	200-300
Clarke Rock	1	7	17	172	1563	49.27142	-123.839	400-500
Clarke Rock	1	8	17	172	1563	49.29108	-123.795	400-500
Clarke Rock	1	9	17	172	1563	49.31052	-123.753	300-400
Yellow Point	**2**	**0**	17	**173**	**1771**			
Yellow Point	2	1	17	173	1771	49.04243	-123.747	5-10
Yellow Point	2	2	17	173	1771	49.048	-123.722	50-100
Yellow Point	2	3	17	173	1771	49.0558	-123.722	30-50
Yellow Point	2	4	17	173	1771	49.06	-123.708	50-100
Yellow Point	2	5	17	173	1771	49.06583	-123.698	30-50
Yellow Point	2	11	17	173	1771	49.025	-123.627	30-50
Yellow Point	2	12	17	173	1771	48.92333	-123.658	100-200
Yellow Point	2	13	17	173	1771	48.92333	-123.658	100-200
Yellow Point	2	14	17	173	1771	48.92333	-123.658	100-200
Yellow Point	2	15	17	173	1771	48.87283	-123.405	30-50
Yellow Point	2	16	17	173	1771	48.79217	-123.247	10-20
Bowser	**3**	**0**	**14**	**143**	**825**			
Bowser	3	1	14	143	825	49.45167	-124.68	5-10
Bowser	3	2	14	143	825	49.45917	-124.672	30-50
Bowser	3	3	14	143	825	49.46667	-124.663	50-100
Bowser	3	4	14	143	825	49.476	-124.657	100-200
Bowser	3	5	14	143	825	49.482	-124.651	50-100
Bowser	3	6	14	143	825	49.47798	-124.609	100-200
Bowser	3	7	14	143	825	49.488	-124.56	100-200
Bowser	3	8	14	143	825	49.49705	-124.511	200-300
Bowser	3	9	14	143	825	49.50687	-124.461	100-200
Henry Bay	**4**	**0**	**14**	**142**	**1871**			
Henry Bay	4	1	14	142	1871	49.59333	-124.875	20-30
Henry Bay	4	2	14	142	1871	49.601	-124.845	20-30
Henry Bay	4	3	14	142	1871	49.59833	-124.853	30-50
Henry Bay	4	4	14	142	1871	49.598	-124.866	30-50
Henry Bay	4	5	14	142	1871	49.60198	-124.833	2-5
Henry Bay	4	11	14	142	1871	49.517	-124.805	50-100
French Creek	**5**	**0**	**14**	**143**	**834**			
French Creek	5	1	14	143	834	49.34833	-124.35	15-20
French Creek	5	2	14	143	834	49.35332	-124.338	50-100
French Creek	5	3	14	143	834	49.3575	-124.327	50-100
French Creek	5	4	14	143	834	49.368	-124.323	100-200
French Creek	5	5	14	143	834	49.373	-124.317	200-300

Table 2 (Cont'd)

TRANNAME	TRAN	STN	STATAREA	SECTION	LOCCODE	LAT	LONG	DEPTH
French Creek	5	5	14	143	834	49.373	-124.317	200-300
French Creek	5	7	14	143	834	49.38928	-124.257	300-400
French Creek	5	8	14	143	834	49.40948	-124.216	300-400
French Creek	5	11	14	143	834	49.34417	-124.307	50-100
Trincomali Channel	**6**	**0**	**17**	**173**	**938**			
Trincomali Channel	6	1	17	173	938	48.85492	-123.43	20-30
Trincomali Channel	6	2	17	173	938	48.862	-123.423	30-50
Trincomali Channel	6	3	17	173	938	48.86667	-123.417	30-50
Trincomali Channel	6	4	17	173	938	48.873	-123.407	30-50
Trincomali Channel	6	5	17	173	938	48.87665	-123.407	50-100
Trincomali Channel	6	11	17	173	938	49.9615	-124.872	50-100
Trincomali Channel	6	12	17	173	938	49.96017	-124.811	100-200
Trincomali Channel	6	13	17	173	938	49.89	-124.7	100-200
Oyster River	7	1	14	141	821	49.87602	-125.11	0-2
Oyster River	7	2	14	141	821	49.87602	-125.11	0-2
Oyster River	7	3	14	141	821	49.87602	-125.11	0-2
Oyster River	7	4	14	141	821	49.87602	-125.11	0-2
Oyster River	7	5	14	141	821	49.87602	-125.11	0-2
Smelt Bay	**8**	**0**	**13**	**135**				
Smelt Bay	8	1	13	135	771	50.03583	-125	30-50
Smelt Bay	8	2	13	135	771	50.0456	-125.016	50-100
Smelt Bay	8	3	13	135	771	50.05413	-125.03	15-20
Smelt Bay	8	4	13	135	771	50.036	-125	30-50
Atrevida Reef	**9**	**0**	**15**	**152**	**858**			
Atrevida Reef	9	1	15	152	858	49.91642	-124.659	20-30
Atrevida Reef	9	2	15	152	858	49.91202	-124.673	100-200
Atrevida Reef	9	3	15	152	858	49.90832	-124.686	100-200
Atrevida Reef	9	4	15	152	858	49.901	-124.675	100-200
Atrevida Reef	9	5	15	152	858	49.913	-124.668	50-100
Cape Cockburn	**10**	**0**	**16**	**162**	**906**			
Cape Cockburn	10	1	16	162	906	49.66953	-124.198	50-100
Cape Cockburn	10	2	16	162	906	49.662	-124.218	200-300
Cape Cockburn	10	3	16	162	906	49.65082	-124.242	300-400
Cape Cockburn	10	4	16	162	906	49.642	-124.255	300-400
Cape Cockburn	10	5	16	162	906	49.642	-124.278	200-300
Secret Cove	**11**	**0**	**16**	**163**	**889**			
Secret Cove	11	1	16	163	889	49.53498	-123.977	30-50
Secret Cove	11	2	16	163	889	49.53165	-123.995	100-200
Secret Cove	11	3	16	163	889	49.52833	-124.014	100-200
Secret Cove	11	4	16	163	889	49.527	-124.04	20-30
Secret Cove	11	5	16	163	889	49.523	-124.06	200-300
Plumper Sound	12	1	18	182	1012	48.80298	-123.266	10-20
Plumper Sound	12	2	18	182	1012	48.81	-123.254	50-100
Plumper Sound	12	3	18	182	1012	48.81657	-123.241	20-30
Crofton	13	1	17	173	965	48.85688	-123.615	5-10
Crofton	13	2	17	173	965	48.86032	-123.584	100-200
Crofton	13	3	17	173	965	48.86345	-123.559	20-30
Mistaken Island	**14**	**0**	**14**	**143**	**1546**			
Mistaken Island	14	1	14	143	1546	49.32322	-124.222	20-30
Mistaken Island	14	2	14	143	1546	49.32	-124.231	100-200
Mistaken Island	14	3	14	143	1546	49.31498	-124.243	20-30

Table 2 (Cont'd)

TRANNAME	TRAN	STN	STATAREA	SECTION	LOCCODE	LAT	LONG	DEPTH
Qualicum Beach	**15**	**0**	**14**	**143**	**810**			
Qualicum Beach	15	1	14	143	810	49.35833	-124.448	15-20
Qualicum Beach	15	2	14	143	810	49.367	-124.281	200-300
Qualicum Beach	15	3	14	143	810	49.377	-124.448	50-100
Qualicum Bay	**16**	**0**	**14**	**143**	**1815**			
Qualicum Bay	16	1	14	143	1815	49.40998	-124.623	5-10
Qualicum Bay	16	2	14	143	1815	49.417	-124.612	20-30
Qualicum Bay	16	3	14	143	1815	49.424	-124.602	50-100
Komas Bluff	17	1	14	142	837	49.585	-124.786	15-20
Komas Bluff	17	2	14	142	837	49.591	-124.773	50-100
Komas Bluff	17	3	14	142	837	49.598	-124.76	50-100
Homby Island	18	1	14	142	819	49.552	-124.714	15-20
Homby Island	18	2	14	142	819	49.562	-124.718	20-30
Homby Island	18	3	14	142	819	49.571	-124.723	20-30
Marina Island	**19**	**0**	**13**	**135**	**796**			
Marina Island	19	1	13	135	796	50.0893	-125.056	>0
Marina Island	19	2	13	135	796	50.09415	-125.075	100-200
Marina Island	19	3	13	135	796	50.101	-125.083	100-200
Savary Island	**20**	**0**	**15**	**152**	**854**			
Savary Island	20	1	15	152	854	49.94842	-124.78	20-30
Savary Island	20	2	15	152	854	49.955	-124.783	100-200
Savary Island	20	3	15	152	854	49.96155	-124.789	100-200
Texada Island	**21**	**0**	**16**	**163**	**872**			
Texada Island	21	1	16	163	872	49.71493	-124.375	30-50
Texada Island	21	2	16	163	872	49.7433	-124.38	200-300
Texada Island	21	3	16	163	872	49.76818	-124.383	15-20
Bargain Bay	**22**	**0**	**16**	**163**	**883**			
Bargain Bay	22	1	16	163	883	49.60372	-124.036	15-20
Bargain Bay	22	2	16	163	883	49.6	-124.05	30-50
Bargain Bay	22	3	16	163	883	49.59665	-124.067	100-200
Trail Bay	23	1	29	292	870	49.448	-123.731	0-2
Trail Bay	23	2	29	292	870	49.442	-123.743	100-200
Trail Bay	23	3	29	292	870	49.436	-123.753	100-200
Gower Point	24	1	28	280	1346	49.39548	-123.564	2-5
Gower Point	24	2	28	280	1346	49.38833	-123.572	100-200
Gower Point	24	3	28	280	1346	49.37917	-123.581	100-200
Gower Point	24	4	28	280	1346	49.36052	-123.64	50-100
Gower Point	24	5	28	280	1346	49.34397	-123.676	200-300
Gower Point	24	6	28	280	1346	49.32053	-123.734	200-300
Thrasher Rock	**25**	**0**	**29**	**291**	**1887**			
Thrasher Rock	25	1	29	291	1887	49.11888	-123.681	20-30
Thrasher Rock	25	2	29	291	1887	49.1272	-123.657	30-50
Thrasher Rock	25	3	29	291	1887	49.156	-123.576	200-300
Thrasher Rock	25	4	29	291	1887	49.18403	-123.503	300-400
Thrasher Rock	25	5	29	291	1887	49.2134	-123.42	200-300
Spratt Bay	26	1	15	152	910	49.74347	-124.508	20-30
Westview	27	1	15	152	909	49.82435	-124.53	15-20
Stuart Island	28	1	13	136	783	50.3467	-125.147	20-30
Francis Bay	29	1	16	163	16	50.34882	-125.04	10-20
Redonda Bay	30	1	15	152	15	50.26003	-124.969	30-50
Cortes Island	31	1	15	152	850	50.21373	-124.998	100-200
Evans Bay	32	1	13	136	790	50.18737	-125.088	30-50

Table 2 (Cont'd)

TRANNAME	TRAN	STN	STATAREA	SECTION	LOCCODE	LAT	LONG	DEPTH
Village Bay	33	1	13	136	1623	50.15993	-125.187	20-30
Drew Harbour	34	1	13	135	1470	50.0991	-125.193	20-30
Qualicum-offshore	35	1	14	143	1815	49.45208	-124.523	200-300
Qualicum-offshore	35	2	14	143	1815	49.43875	-124.461	200-300
Cape Lazo	**36**	**0**	**14**	**142**	**814**			
Cape Lazo	36	1	14	142	814	49.74827	-124.931	15-20
Cape Lazo	36	2	14	142	814	49.77568	-124.865	100-200
Cape Lazo	36	3	14	142	814	49.80592	-124.803	200-300
Cape Lazo	36	4	14	142	814	49.8358	-124.74	100-200
Fraser River	**37**	**0**	**29**	**291**	**1352**			
Fraser River	37	1	29	291	1352	49.20618	-123.293	5-10
Fraser River	37	2	29	291	1352	49.23342	-123.284	2-5
Fraser River	37	3	29	291	1352	49.27597	-123.161	0-2
Fraser River	37	4	29	291	1352	49.28272	-123.179	10-20
Fraser River	37	5	29	291	1352	49.14487	-123.291	10-20
Bute Inlet	99	2	13	134	781	50.4722	-125.107	
Tribune Point	101	1	12	123	703	50.64303	-126.483	20-30
Maple Cove	102	1	12	123	1385	50.67857	-126.464	20-30
Gilford Bay	103	1	12	123	1385	50.65683	-126.384	50-100
Doctor Islets	104	1	12	123	12	50.6556	-126.289	20-30
Bones Bay	105	1	12	123	691	50.59185	-126.357	20-30
Codrington Point	106	1	12	124	742	50.90427	-126.811	20-30
Cartwright Bay	107	1	12	124	742	50.8822	-126.776	20-30
Boyer Bay	108	1	12	124	12	50.8729	-126.707	30-50
Harry Bay	109	1	12	123	1944	50.83985	-126.641	50-100
Shawl Bay	110	1	12	126	758	50.852	-126.56	30-50
Sointula Bay	111	1	12	121	681	50.63642	-127.035	20-30
Port McNeill	112	1	12	121	681	50.59218	-127.068	20-30
Mitchell Bay	113	1	12	121	1935	50.62747	-126.852	20-30
Bauza Cove	114	1	12	123	677	50.54387	-126.819	5-10
Growler Cove	115	1	12	123	698	50.54203	-126.633	30-50
Boat Bay	116	1	12	123	698	50.52272	-126.555	20-30
Naka Creek	117	1	12	121	716	50.48087	-126.47	20-30
Forward Bay	118	1	12	121	716	50.5256	-126.388	20-30
Stimpson Reef	119	1	12	121	716	50.50635	-126.243	20-30
Blenkinsop Bay	120	1	12	121	716	50.48303	-126.007	20-30
Vere Cove	121	1	13	131	763	50.39095	-125.777	30-50
Shorter Point	122	1	13	131	1402	50.41057	-125.73	30-50
Loughborough-E	123	1	13	133	774	50.4672	-125.581	20-30
Loughborough-W	124	1	13	133	774	50.46885	-125.604	30-50
Loughborough-mid	125	1	13	133	774	50.468	-125.593	100-200
Bickley Bay	126	1	13	131	1141	50.44785	-125.397	20-30
Shoal Bay	127	1	13	131	1141	50.46033	-125.363	20-30
Frederick Arm	128	1	13	136	775	50.47647	-125.259	30-50
Richard Point	129	1	17	172	1376	50.49968	-125.356	30-50
Fanny Bay	130	1	14	142	829	50.528	-125.395	20-30
Young Passage	131	1	13	131	13	50.35412	-125.355	20-30
Hemming Bay	132	1	13	131	13	50.39342	-125.369	10-20
Otter Cove	133	1	13	131	13	50.32523	-125.449	10-20
Kanish Bay	134	1	13	132	800	50.25835	-125.337	30-50
Deepwater Bay	135	1	13	132	766	50.17485	-125.336	20-30
Lawrence Point	201	1	13	134	781	50.45533	-125.1	50-100

Table 2 (Cont'd)

TRANNAME	TRAN	STN	STATAREA	SECTION	LOCCODE	LAT	LONG	DEPTH
Amor Point	205	1	13	134	781	50.53207	-125.001	30-50
Francis Bay	207	1	16	163	16	50.34615	-125.03	10-20
Lawrence Point	208	1	13	134	781	50.4523	-125.1	50-100
Owen Point	210	1	14	142	829	50.4552	-125.308	2-5
Cape Lazo	213	1	14	142	814	49.6867	-124.84	5-10
Chrome Island	214	1	14	142	1519	49.47397	-124.683	2-5
Unknown Location	999							

Table 3. Summary of catch (c), gut (g), plankton (p) and herring (h) sampling for all years and surveys (CR) of the juvenile herring survey (1990 to 2001). Bolded cells represent gut and/or herring samples that were processed without reference to catch data. Location (TRANNAME), transect number (TRAN), and station (STN) names are shown for all sampling locations.

			1990				**1991**				**1992**		**1993**		**1994**		**1996**	
TRANNAME	TRAN	STN	CR1	CR2	CR3	CR4	CR1	CR2	CR3	CR4	CR1	CR2	CR1	CR2	CR1	CR2	CR1	CR2
Clarke Rock	1	1	cgph	cgph	cph		cgph	cgph	cph	cph	cgph	cgp	cgph	cgph	cph	cph	ch	ch
Clarke Rock	1	2	cgph	cgph	cph		cgph	cgph	cp	cph	cgph	cgp	cgph	cgph	cph	cph	cph	cph
Clarke Rock	1	3	cgp	cgph	cph		cgph	cgph	cph	cp	cgph	cgp	cgph	cgph	cph	cp	ch	ch
Clarke Rock	1	4	gp	cgph	cph		cgph	cgph	cph	cp	cgph	cgp	cph	cgph	cph	cp	cph	cp
Clarke Rock	1	5	p	cgph	cph		cgph	cph	p	cp	cgph	cg	cph	cp	cph	cp	c	c
Clarke Rock	1	6																
Clarke Rock	1	7																
Clarke Rock	1	8																
Clarke Rock	1	9																
Yellow Point	2	1	cgph	cgph	cph		cgph	cgph	cph	cph	cgph	cgph	cgph	cgph	cph	cph	ch	ch
Yellow Point	2	2	cgp	cgph	cph		cgph	cgph	p	cph	cgph	cgph	cgph	cgph	cph	cph	cph	cph
Yellow Point	2	3	cgp	cgph	cph		cgph	cgph	p	cph	cgph	cgph	cph	cgph	cph	cph	ch	ch
Yellow Point	2	4	cgp	cgph	cph		cgph	cgph	cph	cph	cgph	cgph	cph	cgph	cph	cph	cph	cp
Yellow Point	2	5	cgh	cgph	cph		cgph	cgph	cph	cph	cgph	cgph	cgph	cgph	cph	cph	ch	ch
Yellow Point	2	11				cgh												
Yellow Point	2	12				cgh												
Yellow Point	2	13				cgh												
Yellow Point	2	14				cgh												
Yellow Point	2	15				cgh												
Yellow Point	2	16				cgh												
Bowser	3	1	cgph	cgph	cp		cgph	cgph	cph		cgph	cgph	cgph	cgph	cph	cp	ch	ch
Bowser	3	2	cgph	cgph	cph	ch	cgph	cgph	cph		cgph	cp	cgph	cgp	cph	cph	cph	cph
Bowser	3	3	cgp	**gp**	cph	ch	cgph	cph	cp		cgph	cgp	cph	cgp	cph	cph	ch	ch
Bowser	3	4	cgph	**gp**	cph		cgph	cph	cp		cgph	cgp	cgph	cgp	cph	cph	cph	cph
Bowser	3	5	cgph	cgph	cph		cgph	cph	cp		cgph	cgph	cgph	cgp	cph	cph	ch	ch
Bowser	3	6																
Bowser	3	7																
Bowser	3	8																
Bowser	3	9																
Henry Bay	4	1	cgph	cph	p		cgph	cgph	p	cph	cgph	cp	cgph	cgph	cph	cp	ch	ch
Henry Bay	4	2	cgph	cph	p		cgph	cgph	cph	cph	cgph	cp	cgph	cgph	cph	cph	cph	cph
Henry Bay	4	3	cgph	cph	p		cgph	cgph	cph	cph	cgph	cgph	cgph	cgph	cph	cph	ch	ch
Henry Bay	4	4	cgph	cgp	p	ch	cgph	cgph	cph	cph	cgph	cgph	cph	cgph	cph	cph	cph	cph
Henry Bay	4	5	cgph	cp	p		cgp	cgph	cp	cph	cgph	cgph	cgph	cgph	cph	cph	ch	ch
Henry Bay	4	11				cgh												

Table 3 (Cont'd)

			1990				1991				1992		1993		1994		1996	
TRANNAME	TRAN	STN	CR1	CR2	CR3	CR4	CR1	CR2	CR3	CR4	CR1	CR2	CR1	CR2	CR1	CR2	CR1	CR2
French Creek	5	1	g p	c g p h	c p	c h	g p	c p h			c p	c g p h	c g p h	c g p h	c p h	c p h	c h	c h
French Creek	5	2	g p	c g p h	c p		g p	c p			c g p h	c g p h	c g p h	c g p	c p h	c p	c p h	c p
French Creek	5	3	g p	c g p h	c p	c	p	c p			c g p h	c g p h	c g p h	c g p	c p h	p	c h	c
French Creek	5	4		c g p h	c p		g p	c p h			c g p h	c p	c g p h	c g p	c p h	c p	c p h	c p
French Creek	5	5		g p	c p		c g p	p			c g p h	c g p	c p h	c g p	c p h	c p	c h	c
French Creek	5	6																
French Creek	5	7																
French Creek	5	8																
French Creek	5	11				c g h												
Trincomali Channel	6	1					c g p h	c p h	c p		c g p h	c g p h	c g p h	c p h	p	c p h	c h	c h
Trincomali Channel	6	2					c g p h	c p h	c p		c g p h	c p	c g p h	c g p	c p h	c p h	c p h	c p
Trincomali Channel	6	3					c g p h	c p h	c p		c g p h	c g p h	c p h	c g p	c p	c p h	c h	c h
Trincomali Channel	6	4					c g p h	c p h	c p		c p h	c p	c g p h	c g p h	c p h	c p h	c p h	c p h
Trincomali Channel	6	5					c g p h	c g p h	c p h		c g p h	c g p h	c g p h	c g p h	c p	c p h	c h	c h
Trincomali Channel	6	11				c g h												
Trincomali Channel	6	12				c g h												
Trincomali Channel	6	13				c g h												
Oyster River	7	1					c		c g h									
Oyster River	7	2					c g											
Oyster River	7	3					c g		c g h									
Oyster River	7	4					c g		c g h									
Oyster River	7	5					c		c g h									
Smelt Bay	8	1					c g p h	c g p	c p h	c p h	c g p h	c g p h	p	c g p h	c p h	c p h	c h	c h
Smelt Bay	8	2					c g p h	c g p h	c p h	c p h	c g p h	c g p h	p	c g p h	c p h	c p h	c p h	c p h
Smelt Bay	8	3					c g p h	c g p h	c p h	c p h	c g p h	c g p h	c g p h	c g p h	c p h	c p h	c h	c p h
Smelt Bay	8	4					c g p h	c g p	c p h	c p h	c g p h	c g p h	c p h	c g p h	c p h	c p h	c p h	c h
Atrevida Reef	9	1					c g p	c g p h	c p h		c g p h	c g p h	c g p h	c g p	c p h	c p h	c h	c h
Atrevida Reef	9	2					c g p h	c g p h	c p h		c g p h	c g p h	c p h	c g p	c p h	c p h	c p h	c p
Atrevida Reef	9	3					c g p h	c g p h	c p h		c g p h	c g p h	c p h	c g p	c p h	c p h	c h	c
Atrevida Reef	9	4					g p	c g p h	c p h		c g p h	c g p h	c g p h	c p	c p h	c p h	c p h	c p
Atrevida Reef	9	5					p	c g p	c p h		c g p h	c g p	c p h	c g p	c p h	c p h	c h	c
Cape Cockburn	10	1					c g p	c g p h	c p h		c g p h		c g p h	c g p h	c p h	c p h	c h	c h
Cape Cockburn	10	2					c p	p	p		c g p h		c p h	c g p h	c p h	c p h	c p h	c p h
Cape Cockburn	10	3					c g p	p	p		c g p h		c g p h	c g p	c p h	c p h	c	c h
Cape Cockburn	10	4					c p	g p	c p		c g p		c g p h	c g p	c p h	c p h	c p	c p h
Cape Cockburn	10	5					c g p h	c g p h	c p		c g p		c g p h	c g p h	c p h	c p h	c h	c h
Secret Cove	11	1					c g p h	c g p h	c p h	c p h			p	c g p	c p h	p	c h	c h

Table 3 (Cont'd)

			1990				1991				1992		1993		1994		1996	
TRANNAME	TRAN	STN	CR1	CR2	CR3	CR4	CR1	CR2	CR3	CR4	CR1	CR2	CR1	CR2	CR1	CR2	CR1	CR2
Secret Cove	11	2					c g p h	c g p h	c p h	c p h			p	c g p	c p h	p	c p h	c p h
Secret Cove	11	3					c g p h	c g p h	c p h	c p h			p	c g p	c p h	p	c h	c h
Secret Cove	11	4					c g p h	c g p h	c p h	c p h				c g p	c p h	p	c h	c p h
Secret Cove	11	5					c g p h	c p h	c p	c p				c g p	c p h	p h	c p h	c h
Unknown Location	999	1										h						
Unknown Location	999	2										h						

			1997		1998	1999		2000		2001	
TRANNAME	TRAN	STN	CR1	CR2	CR1	CR1	CR2	CR1	CR2	CR1	CR2
Clarke Rock	1	1	c p h	c p	c p h		c p h	c p h	c p h	p	c p h
Clarke Rock	1	2	c p h	c p	c p h		c p h	p	c p h	p	c p h
Clarke Rock	1	3	c p h	c p	c p h		c h	p	c p h	p	c p h
Clarke Rock	1	4							c h	p	c p h
Clarke Rock	1	5						c h	c h	p	c p h
Clarke Rock	1	6					c h		c h		c h
Clarke Rock	1	7					c		c h		c
Clarke Rock	1	8					c		c h		c
Clarke Rock	1	9					c		c h		c g h
Yellow Point	2	1	c p h	c p	c p h		c p h	c p h	c p h	c p h	c p h
Yellow Point	2	2						c h	c h	c p h	c p h
Yellow Point	2	3	c p h	c p	c p h		c p h	c p h	c p h	c p h	c p h
Yellow Point	2	4						c h	c h	c p h	c p h
Yellow Point	2	5	c h	c	c p h		c p h	c p h	c p h	c p h	c p h
Bowser	3	1	c p h	c p	c p h		c p	c p h	c p h	c p h	c p h
Bowser	3	2	c p h	c p	c p h		c p h	c p h	c p h	c p h	c p h
Bowser	3	3	c p h	c p	c p h		c p h	c p h	c p h	c p h	c p h
Bowser	3	4						c h	c h	c p h	c p h
Bowser	3	5							c h	c p h	c p h
Bowser	3	6					c h		c h		c h
Bowser	3	7					c h		c h		c h
Bowser	3	8					c h		c h		c h
Bowser	3	9					c p h		c h		c h
Henry Bay	4	1	c h	c			c p h				c p h
Henry Bay	4	2							c h		c h
Henry Bay	4	3	c p h	c p	c p h		c p h		c h		c p h
Henry Bay	4	4									
Henry Bay	4	5	c p h	c p	c p h		p		c h		
French Creek	5	1	c h	c	c h		c p h	c p h	c p h	c p h	c p h

Table 3 (Cont'd)

TRANNAME	TRAN	STN	1997 CR1	1997 CR2	1998 CR1	1999 CR1	1999 CR2	2000 CR1	2000 CR2	2001 CR1	2001 CR2
French Creek	5	2	c h	c	c		c p h	c p h	c p h	c g p h	c p h
French Creek	5	3	c h	c	c		c p h	c p h	c p h	c p h	c p h
French Creek	5	4						c h	c h	c h	c h
French Creek	5	5						c h	c h	c h	c h
French Creek	5	6					c h		c h		c h
French Creek	5	7					c h		c h		c h
French Creek	5	8					c h		c		c p h
Trincomali Channel	6	1	c h	c	c h		c p h		c h		c p h
Trincomali Channel	6	2							c h		c p h
Trincomali Channel	6	3	c h	c	c h		c p h		c h		c p h
Trincomali Channel	6	4							c h		c p h
Trincomali Channel	6	5	c h	c	c h		c p h		c h		c p h
Smelt Bay	8	1	c p h	c p	c p h		c p h	c p h	c p h	c p	c p h
Smelt Bay	8	2	c p h	c p	c p h		c p h	c p h	c p h	c p h	c p h
Smelt Bay	8	3			c h		c p h	c p h	c p h	c g p h	c p h
Smelt Bay	8	4	c p h	c p							
Atrevida Reef	9	1	c p h	c p	c p h		c p h	c p h	c p h	c p h	c p h
Atrevida Reef	9	2	c p h	c p	c p		c p h	c h	c h	c p h	c h
Atrevida Reef	9	3	c p h	c p	c p h		c p h	c p h	c p h	c g p h	c p h
Atrevida Reef	9	4						c h	c h	c h	c h
Atrevida Reef	9	5			h			c p h	c p h	c h	c p h
Cape Cockburn	10	1	c h	c	c h		c p h	p	c p h	c p h	c p h
Cape Cockburn	10	2			h				c h	c h	c h
Cape Cockburn	10	3	c h	c	c h		c p h	p	c p h	c p h	c p h
Cape Cockburn	10	4							c h	c g	c h
Cape Cockburn	10	5	c h	c	c		c p h	p	c p h	c p	c p h
Secret Cove	11	1	c p h	c p	c p h		c h	c h	c h	c g p h	c p h
Secret Cove	11	2	c p h	c p	c p h		c h	c h	c h	c h	c h
Secret Cove	11	3	c p h	c p	c p h		c h	c h	c h	c p h	c p h
Secret Cove	11	4						c h	c h	c h	c h
Secret Cove	11	5						c h	c h	c g p h	c p
Plumper Sound	12	1	c h	c	c h		c h		c h		c h
Plumper Sound	12	2	c h	c	c h		c h		c h		c h
Plumper Sound	12	3	c h	c	c h				c h		c h
Crofton	13	1	c h	c	c h				c h		c h
Crofton	13	2	c h	c	c h				c h		c h
Crofton	13	3	c h	c	c h				c h		c h
Mistaken Island	14	1	c h	c	c h				c h		c h

Table 3 (Cont'd)

TRANNAME	TRAN	STN	1997 CR1	1997 CR2	1998 CR1	1999 CR1	1999 CR2	2000 CR1	2000 CR2	2001 CR1	2001 CR2
Mistaken Island	14	2	c h	c					c h		c h
Mistaken Island	14	3	c h	c	c h				c h		c h
Qualicum Beach	15	1	c h	c	c h				c h		c h
Qualicum Beach	15	2	c h	c					c		c h
Qualicum Beach	15	3	c h	c					c h		c h
Qualicum Bay	16	1	c h	c	c				c h		c h
Qualicum Bay	16	2	c h	c					c h		c h
Qualicum Bay	16	3	c h	c					c h		c h
Komas Bluff	17	1	c h	c							
Komas Bluff	17	2	c h	c							
Komas Bluff	17	3	c h	c							
Homby Island	18	1	c h	c							
Homby Island	18	2	c h	c							
Homby Island	18	3	c h	c							
Marina Island	19	1	c h	c	c h				c h		c h
Marina Island	19	2	c h	c	c h				c h		c h
Marina Island	19	3	c h	c					c h		c h
Savary Island	20	1	c h	c	c h				c h		c h
Savary Island	20	2	c h	c					c h		c h
Savary Island	20	3	c h	c	c h				c h		c h
Texada Island	21	1	c h	c	c h		c h		c h		c h
Texada Island	21	2	c h	c	c h		c h		c h		c h
Texada Island	21	3	c h	c	c h		c h		c h		
Bargain Bay	22	1	c h	c	c h				c h		c h
Bargain Bay	22	2	c h	c	c h				c h		c h
Bargain Bay	22	3	c h	c	c h				c h		c h
Trail Bay	23	1	c h	c							
Trail Bay	23	2	c h	c							
Trail Bay	23	3		c							
Gower Point	24	1	c h		c h						
Gower Point	24	2	c h		c h						
Gower Point	24	3	c h		c h						
Gower Point	24	4			c h						
Gower Point	24	5			c h						
Gower Point	24	6			c						
Thrasher Rock	25	1			c h				c h		c h
Thrasher Rock	25	2			c h				c h		c g h
Thrasher Rock	25	3			c h				c h		c h

Table 3 (Cont'd)

TRANNAME	TRAN	STN	1997 CR1	1997 CR2	1998 CR1	1999 CR1	1999 CR2	2000 CR1	2000 CR2	2001 CR1	2001 CR2
Thrasher Rock	25	4			c				c p h		c p
Thrasher Rock	25	5					p				
Spratt Bay	26	1			c h						
Westview	27	1			c h						
Stuart Island	28	1			c h						
Francis Bay	29	1			c h						
Redonda Bay	30	1			c h						
Cortes Island	31	1			c h						
Evans Bay	32	1			c h						
Village Bay	33	1			c h						
Drew Harbour	34	1			c h						
Qualicum-offshore	35	1			c h						
Qualicum-offshore	35	2			c						
Cape Lazo	36	1					c h		c h		c h
Cape Lazo	36	2					c p h		c p h		c
Cape Lazo	36	3					c h		c h		c h
Cape Lazo	36	4					c h		c h		c p h
Fraser River	37	1								c g p h	c p
Fraser River	37	2								c p h	c p
Fraser River	37	3									c
Fraser River	37	4									c g p h
Fraser River	37	5									c h
Bute Inlet	99	2						c p h			
Tribune Point	101	1			c p h		c h				
Maple Cove	102	1			c h		c h				
Gilford Bay	103	1			c h		c h				
Doctor Islets	104	1			c h		c p h				
Bones Bay	105	1			c h		c				
Codrington Point	106	1			c p h		c h				
Cartwright Bay	107	1			c h		c h				
Boyer Bay	108	1			c h		c h				
Harry Bay	109	1			c h		c p h				
Shawl Bay	110	1			c h						
Sointula Bay	111	1			c p h						
Port McNeill	112	1			c h						
Mitchell Bay	113	1			c h						
Bauza Cove	114	1			c h		c p h				
Growler Cove	115	1			c		c h				

Table 3 (Cont'd)

			1997		1998	1999		2000		2001	
TRANNAME	TRAN	STN	CR1	CR2	CR1	CR1	CR2	CR1	CR2	CR1	CR2
Boat Bay	116	1			c p h		c h				
Naka Creek	117	1			c h		c p h				
Forward Bay	118	1			c h		c h				
Stimpson Reef	119	1			c h		c h				
Blenkinsop Bay	120	1			c h		c p				
Vere Cove	121	1			c p h		c h				
Shorter Point	122	1			c h		c h				
Loughborough-E	123	1			c h		c h				
Loughborough-W	124	1			c h		c p				
Loughborough-mid	125	1			c h		c h				
Bickley Bay	126	1			c p h		c h				
Shoal Bay	127	1			c h		c h				
Frederick Arm	128	1			c		c p h				
Richard Point	129	1			c		c h				
Fanny Bay	130	1			c						
Young Passage	131	1			c p		c h				
Hemming Bay	132	1			c		c h				
Otter Cove	133	1			c						
Kanish Bay	134	1			c		c h				
Deepwater Bay	135	1			c		c p h				
Lawrence Point	201	1				h					
Amor Point	205	1				h					
Francis Bay	207	1				h					
Lawrence Point	208	1				h					
Owen Point	210	1				h					
Cape Lazo	213	1				h					
Chrome Island	214	1				h					

Table 4. List of all fish and invertebrate species captured during the juvenile herring survey. Family name (FAMILY), species abbreviation (SPECIES), common name and scientific names included (note some SPECIES are a combination of several kinds of fish). Notes regarding life stage or size-class provided for all fish and invertebrates caught.

FAMILY	SPECIES	COMMON_NAME	SCIENTIFIC_NAME	NOTES
Engraulidae	ANCH	Northern Anchovy	*Engraulis mordax mordax*	Any size
Osmeridae	CAPE	Capelin	*Mallotus villosus*	Any size
Salmonidae	CHIN	Chinook Salmon	*Oncorhynchus tshawytscha*	Unspecified age group
Salmonidae	CHIA	Chinook Adult	*Oncorhynchus tshawytscha*	2nd or later ocean year
Salmonidae	CHIJ	Chinook Juvenile	*Oncorhynchus tshawytscha*	1st ocean year
Salmonidae	CHUM	Chum Salmon	*Oncorhynchus keta*	Unspecified age group
Salmonidae	CHUA	Chum Adult	*Oncorhynchus keta*	2nd or later ocean year
Salmonidae	CHUJ	Chum Juvenile	*Oncorhynchus keta*	1st ocean year
Salmonidae	COHO	Coho Salmon	*Oncorhynchus kisutch*	Unspecified age group
Salmonidae	COHA	Coho Adult	*Oncorhynchus kisutch*	2nd or later ocean year
Salmonidae	COHJ	Coho Juvenile	*Oncorhynchus kisutch*	1st ocean year
Squalidae	DOGF	Dogfish	*Squalus acanthias*	Any size
Zoarcidae	EELP	Eelpout	*Bothrocara molle*	Any size
Pleuronectidae	FLAT	Flatfish	*Parophyrus vetulus, Lepidopsetta bilineata, Platichthys stellatus, Citharichthys stigmaens*	Any size
Gobiidae	GOBY	Goby	*Coryphopterus nicholsi*	Any size
Hexagrammidae	GREE	Greenling	*Hexagrammos sp.*	Any size
Pholidae	GUNN	Gunnel	*Apodichthys flavidus, Pholis laeta*	Any size
Gadidae	HAKA	Hake Adult	*Merluccius productus*	2nd or later year of life
Gadidae	HAKJ	Hake Juvenile	*Merluccius productus*	In year of birth
Clupeidae	HER0	0+ Herring	*Clupea pallasi*	In year of birth
Clupeidae	HER1	1+ Herring	*Clupea pallasi*	In year after birth
Clupeidae	HER2	2+ Herring	*Clupea pallasi*	2nd or later year of life
	JELL	Jellyfish		Any size
Petromyzoniformes	LAMP	Lamprey	*Lampetra sp.*	Any size
Hexagrammidae	LINA	Lingcod Adult	*Ophiodon elongatus*	2nd year or later year of life
Hexagrammidae	LINJ	Lingcod Juvenile	*Ophiodon elongatus*	In year of birth
Scombridae	MACK	Mackerel	*Scomber japonicus*	Any size
Batrachoididae	MIDS	Midshipman	*Porichthys notatus*	Any size
Gadidae	PCOD	Pacific Cod	*Gadus macrocephalus*	Any size
Salmonidae	PINK	Pink Salmon	*Oncorhynchus gorbuscha*	Unspecified age group
Salmonidae	PINA	Pink Adult	*Oncorhynchus gorbuscha*	2nd or later ocean year
Salmonidae	PINJ	Pink Juvenile	*Oncorhynchus gorbuscha*	1st ocean year
Syngnathidae	PIPE	Pipefish	*Syngnathus griseolineatus*	Any size
Agonidae	POAC	Poacher	*Agonus acipenserinus*	Any size
Gadidae	POLA	Pollock Adult	*Theragra chalcogramma*	2nd year or later year of life
Gadidae	POLJ	Pollock Juvenile	*Theragra chalcogramma*	In year of birth
Stichaeidae	PRIC	Snake Prickleback	*Lumpenus sagitta*	Any size
Squalidae	RATF	Ratfish	*Hydrolagus colliei*	Any size
Scorpaenidae	ROCA	Rockfish Adult	*Sebastes sp.*	Older than juvenile
Scorpaenidae	ROCJ	Rockfish Juvenile	*Sebastes sp.*	In year of birth
Anoplopomatidae	SABJ	Sablefish Juvenile	*Anoplopoma fimbria*	In year of birth
Trichodontidae	SANF	Sandfish	*Trichodon trichodon*	Any size
Ammodytidae	SANL	Sandlance	*Ammodytes hexapterus*	Any size
Clupeidae	SARD	Pacific Sardine	*Sardinops sagax*	2nd year or later year of life
Cottidae	SCUL	Sculpin	*Leptocottus armatus*	Any size
Embiotocidae	SHIN	Shiner Perch	*Cymatogaster aggregata*	Any size
	SHRI	Shrimp		Any size
Osmeridae	SMEA	Smelt Adult	*Hypomesus pretiosus, Thaleichthys pacificus*	2nd year or later year of life
Osmeridae	SMEJ	Smelt Juvenile	*Mallotus villosus, Hypomesus pretiosus*	In year of birth
Salmonidae	SOCK	Sockeye Salmon	*Oncorhynchus nerka*	Unspecified age group
Salmonidae	SOCA	Sockeye Adult	*Oncorhynchus nerka*	2nd year or later year of life
Salmonidae	SOCJ	Sockeye Juvenile	*Oncorhynchus nerka*	1st ocean year
Decapoda	SQUI	Squid	*Loligo opalescens, Gonatus fabricii*	Any size
Gasterosteidae	STIC	Stickleback	*Gasterosteus aculeatus*	Any size
Gadidae	TOMC	Pacific Tomcod	*Microgadus proximus*	Any size
Salmonidae	TROU	Trout	*Oncorhynchus mykiss, Oncorhynchus clarki clarki*	Any size
Aulorhynchidae	TUBE	Tubesnout	*Aulorhynchus flavidus*	Any size
Anarhichadidae	WOLF	Wolfeel	*Anarrhichthys ocellatus*	Any size

Table 5. List of all plankton species captured and stomach contents analysed during juvenile herring survey. Basic grouping (CATEGORY), species abbreviation (SPECIES), common and scientific names included (note some SPECIES are a grouping of several plankters). Notes provide information regarding life stage or explanation of animal sampled.

CATEGORY	SPECIES	COMMON_NAME	SCIENTIFIC_NAME	NOTES
Copepods	ACLA	Calanoid	*Acartia clausi*	
Copepods	ADIV	Calanoid	*Aetidius divergens*	
Copepods	ALON	Calanoid	*Acartia longimeres*	
Amphipods	AMPH	Amphipods		Mostly gammarid and hyperiid with some caprellid
Copepods	APAC	Calanoid	*Aetidius pacificus*	
Bamacle	BARN	Bamacle	*Cirripedia cyprids, Cirripedia nauplii*	
Copepods	CABD	Calanoid	*Centropages abdominates*	
Copepods	CALA	Calanoid	*Calanus sp.*	
Copepods	CANG	Cyclopoid	*Corycaeus anglicus*	
Copepods	CCOL	Calanoid	*Canadacia columbiae*	
Copepods	CGRA	Calanoid	*Chiridius gracilis*	
Bamacle	CIRC	Bamacle	*Cirripedia cyprids*	
Bamacle	CIRN	Bamacle	*Cirripedia nauplii*	
Cladocerans	CLAD	Cladocerans		
Copepods	CMAR	Calanoid	*Calanus marshallae*	
Medusae	COEL	Medusae		
Copepods	COPE	Copepods		
Copepods	CPAC	Calanoid	*Calanus pacificus*	
Crab	CRAB	Crab		
Crab	CRAM	Crab		Megalopia
Crab	CRAZ	Crab		Zoea
Copepods	CYCL	Cyclopoid		
	DIAT	Diatoms		
Copepods	EBUN	Calanoid	*Eucalanus bungii*	
Echinoderm	ECHI	Echinoderm		
Ectoprocts	ECTO	Ectoprocts		
Miscellaneous	EGGS	Pelagic Eggs		
Copepods	EJAP	Calanoid	*Euchaeta japonica*	
Copepods	ELON	Calanoid	*Epilabidocera longipedata*	
Euphausiid	EUPA	Euphausiid		Post-nauplii
Euphausiid	EUPH	Euphausiid	*Euphausia pacifica*	Any size
Euphausiid	EUPL	Euphausiid		Nauplii
Copepods	EURY	Calanoid	*Eurytemora sp.*	
Mollusca	GAST	Gastropods	*Clione sp. and Limacina sp.*	Both prosobranch and ophistobranch
Miscellaneous	INLA	Unidentified Invertebrate		
Insects	INSE	Insects		
Isopods	ISOP	Isopods		
Larvaceans	LARV	Larvaceans		
Copepods	MONS	Monstrilloid	*Monstrilla sp.*	
Copepods	MPAC	Calanoid	*Metridia pacifica*	
Crustecean nauplii	NAUP	Crustecean		
Copepods	OBOR	Calanoid	*Oncaea borealis*	
Copepods	OITH	Cyclopoid	*Oithona sp.*	
Ostracods	OSTR	Ostracods		
Mollusca	PELE	Pelecypods		Pelagic clams
Copepods	PMIN	Calanoid	*Pseudocalanus minutus*	
Polychaetes	POLY	Polychaetes		Free swimming segmented worms
Copepods	PPAR	Calanoid	*Paracalanus parvus*	
Mollusca	PROS	Prosobranch gastropods		Small pelagic snails
Mollusca	PTER	Pteropods	*Clione sp. and Limacina sp.*	Ophistobranch gastropods
Siphonophores	SIPH	Siphonophores		
Copepods	SMIN	Calanoid	*Scolecithricella minor*	
Copepods	TDIS	Calanoid	*Tortanus discaudatus*	
Teleosts	TELA	Teleosts		
Thaliaceans	THAL	Thaliaceans		

Table 5 (Cont'd)

CATEGORY	SPECIES	COMMON NAME	SCIENTIFIC NAME	NOTES
Copepods	TISB	Cyclopoid	*Tisbe sp.*	
Copepods	UCAL	Unidentified Calanoid		
Copepods	UCYC	Unidentified Cyclopoid		
Copepods	UHAR	Unidentified Harpacticoids		

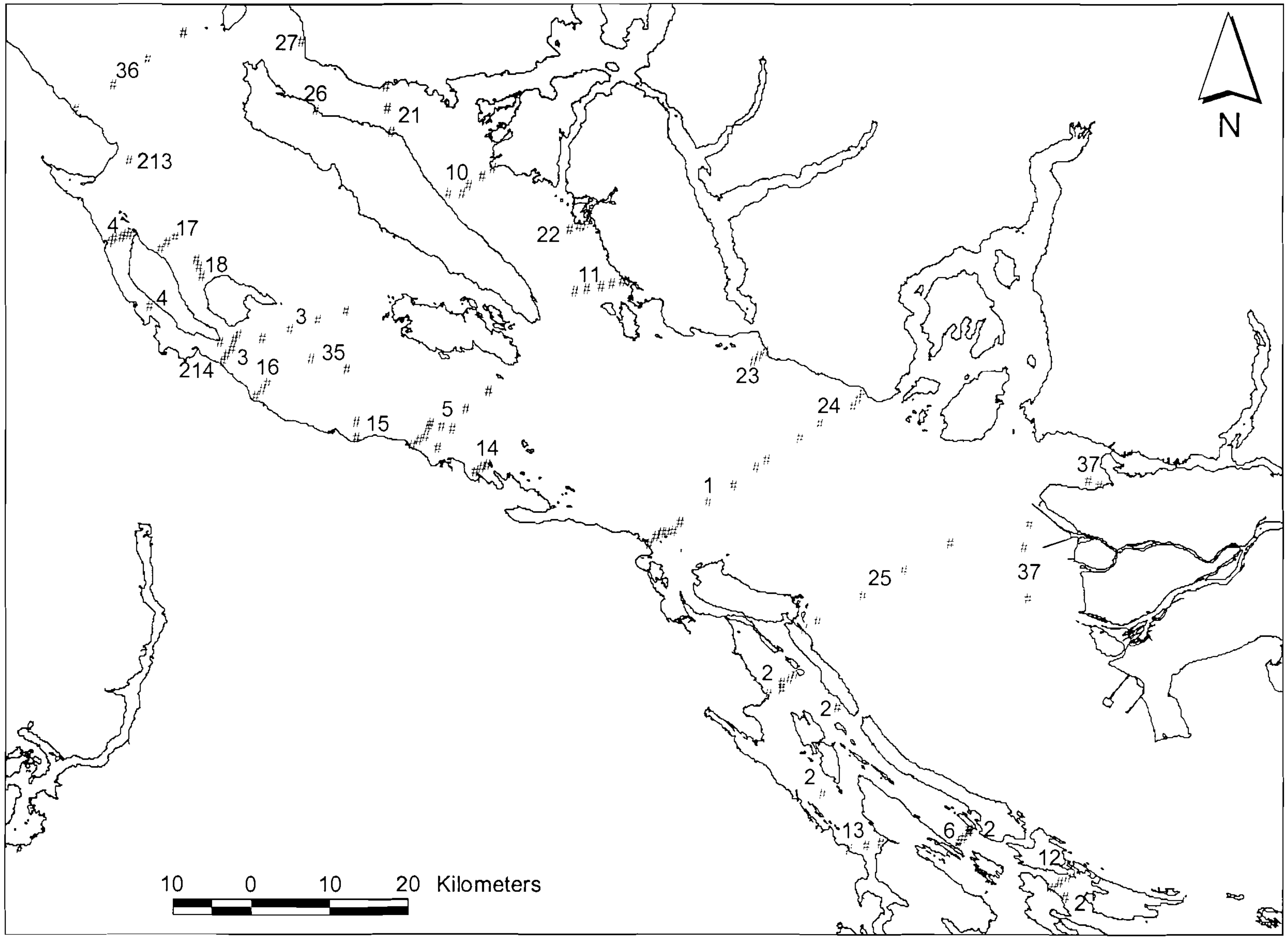

Fig. 1. Lower strait of Georgia juvenile herring stations along with transect locations (numbers).

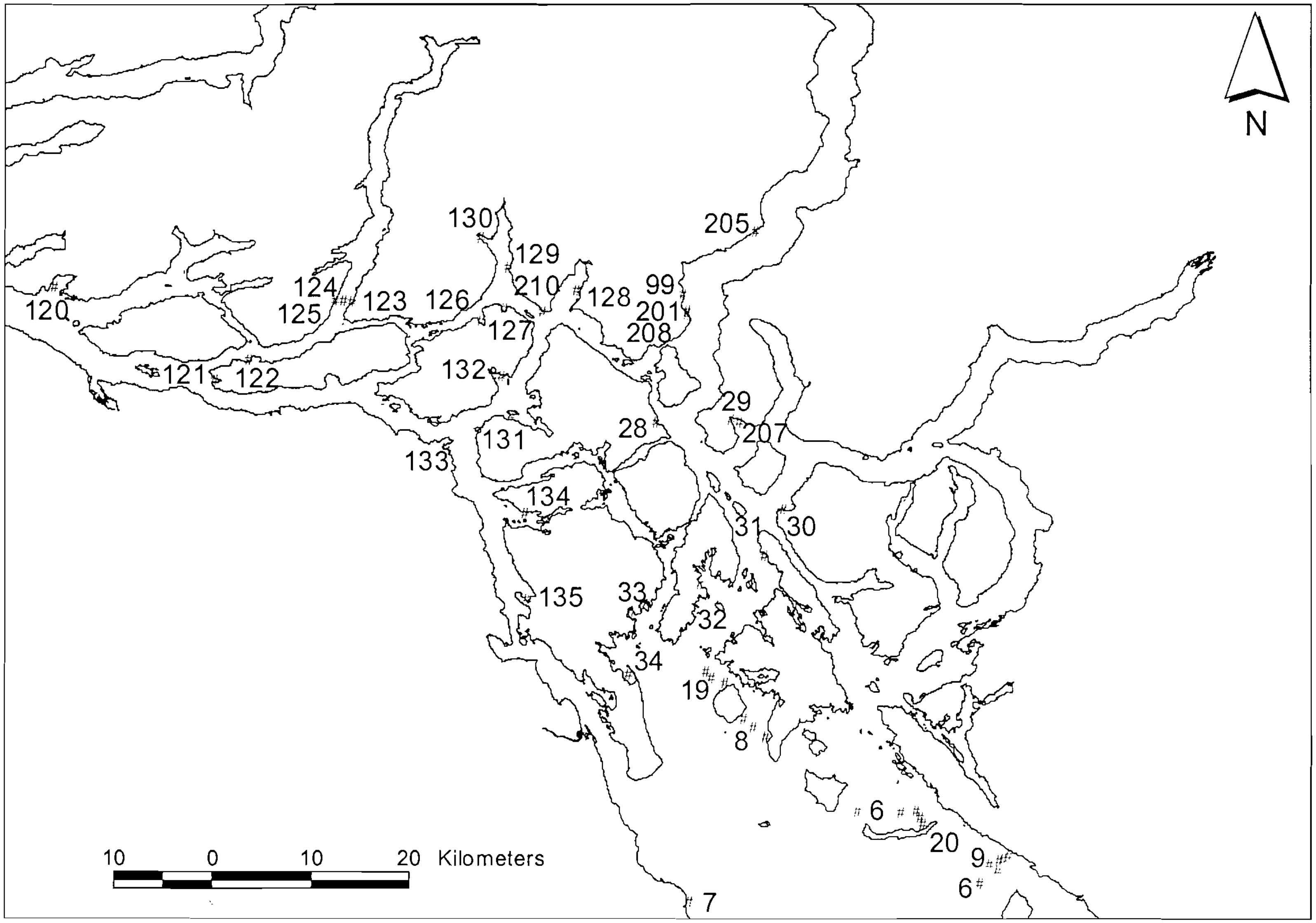

Fig. 2. Upper Strait of Georgia and Lower Johnstone Strait juvenile herring stations along with transect locations (numbers).

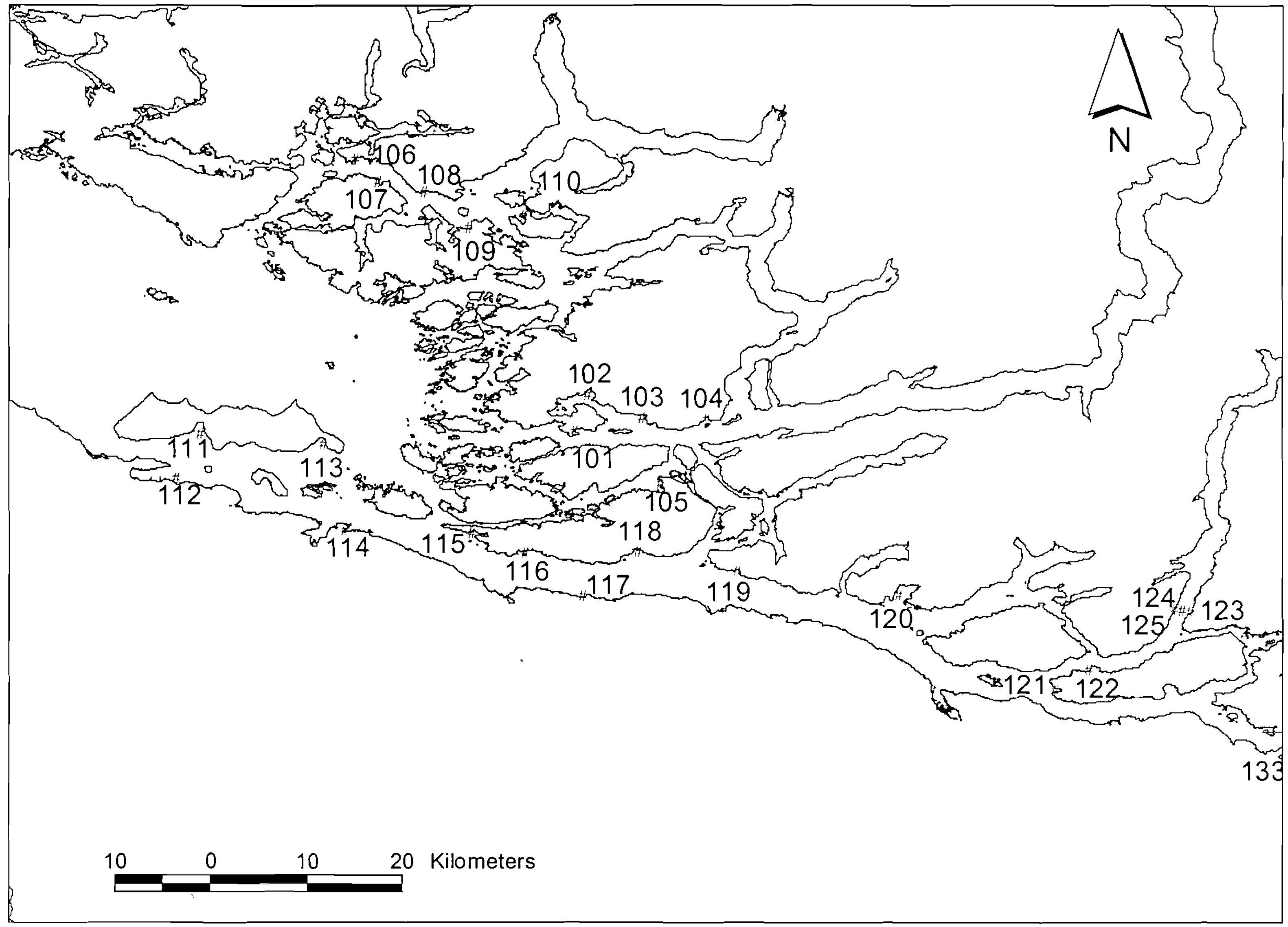

Fig. 3. Upper Johnstone Strait juvenile herring stations along with transect locations (numbers).

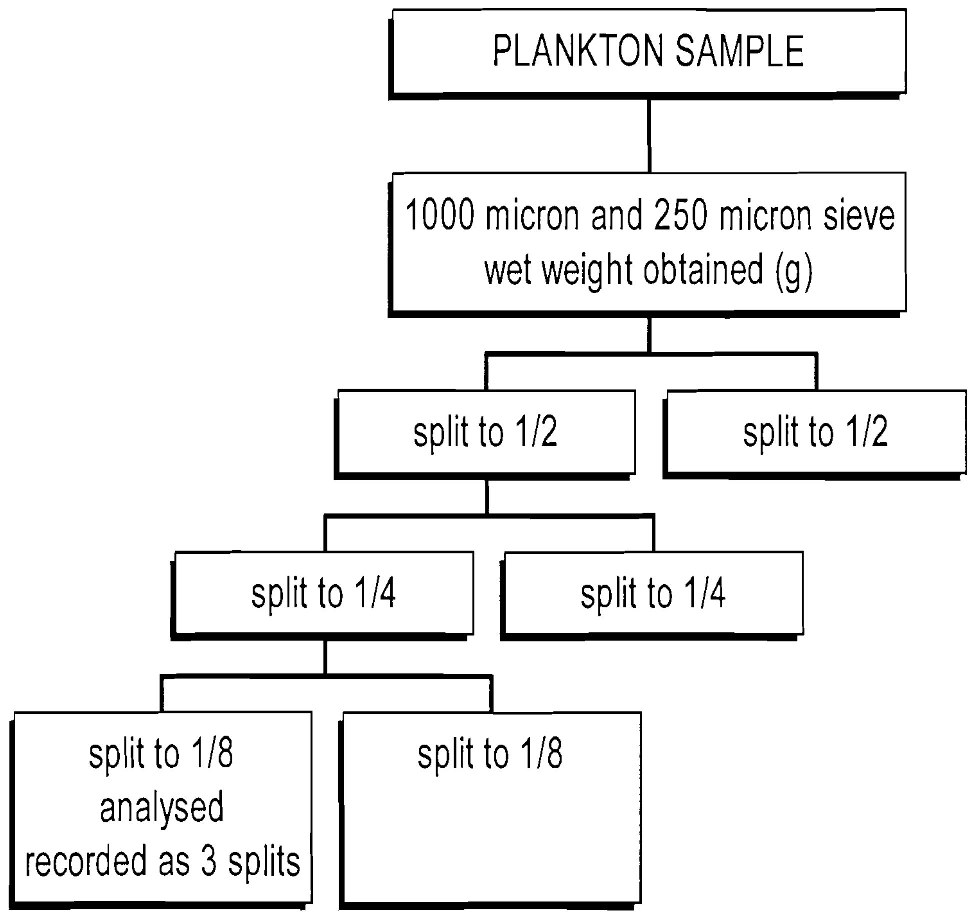

Fig. 4. Plankton tow organization chart showing how a plankton sample was analyzed. This chart shows the third split being analyzed.

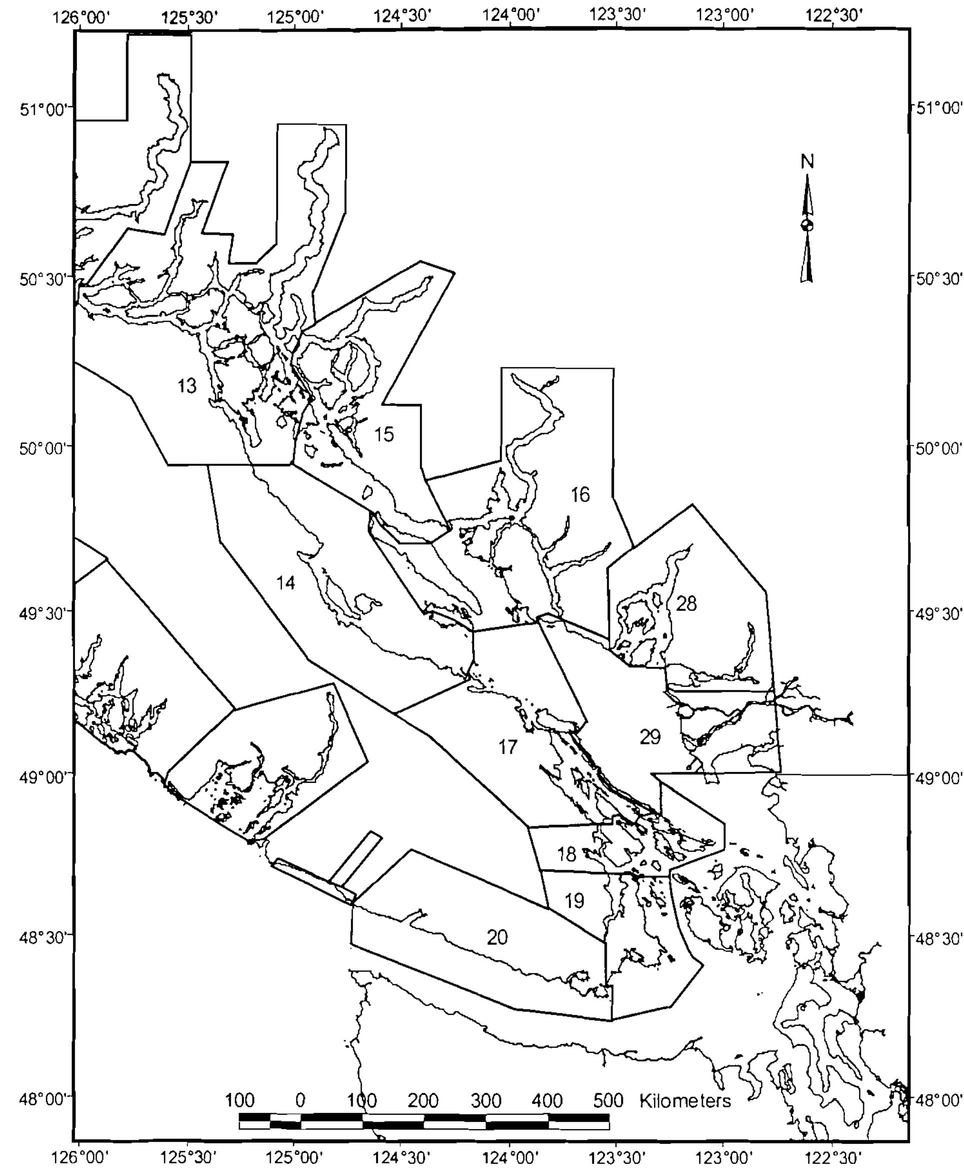

Fig. 5. Statistical areas of the Strait of Georgia and Johnstone Strait based on herring stock assessment areas.