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Stock Assessment for British Columbia Herring in 2003 and Forecasts of the Potential Catch in 2004

Évaluation de 2003 des stocks de hareng de la Colombie-Britannique et prévisions des prises potentielles en 2004

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Abstract

Herring stock abundance in British Columbia waters was assessed for 2003 and forecasts were made for 2004 using an age structured assessment model for the major stock assessment regions and an escapement model for the minor stocks in Areas 2W and 27. These models have been applied to assess herring abundance since 1984. As in the 2002 assessment, changes to the analytical model were introduced to account for temporal change in the spawn index. A fixed spawn conversion or catchability factor was applied for the dive survey era beginning in 1988 and a free fitted parameter was estimated for the earlier surface survey period. In addition, a year specific logistic function was introduced to model the availability of fish on the spawning grounds. In addition, the effect of a range of penalty weights on a series of indicators was investigated and the penalty weight was increased on the spawn data and decreased on the catch-age data for the final assessment. The effects on overall biomass levels was minimal except for the Queen Charlotte Islands where it resulted in a slight decrease in abundance over the time series. All available biological data on total harvest, spawn deposition, and age and size composition of the spawning runs were used to determine current abundance levels. No significant problems were evident in the extent and comprehensiveness of the data collections. However, a number of samples from the Strait of Georgia were not aged due to resource limitations. All available data were included in and summarized from an Access database. Coastwide, the estimated pre-fishery stock biomass for all assessment regions in 2003 was 246,000 tonnes based on the age-structured model which represents a 28% increase over the 2002 abundance level. This increase reflects increased abundance in the south coast stocks particularly the Strait of Georgia. However, abundance in the three northern stocks also increased slightly as a result of a good recruiting 2000 year-class.

The estimated harvestable surplus in 2004 (20% of the 2004 forecast herring run) based on forecast abundance to the five assessment regions is 53,020 tonnes for the B.C. coast assuming average recruitment to all areas. However, since consensus on stock levels for each assessment region may change as a result of PSARC review of these data, forecast run sizes, and harvestable surpluses, are subject to change.

Résumé

On a utilisé un modèle structuré par âge pour déterminer l’abondance des principaux stocks de hareng dans les eaux de la Colombie-Britannique en 2003 et pour faire des prévisions pour 2004, tandis que un modèle d’échappement à été utilisé pour les petits stocks des zones 2W et 27. Ces modèles sont utilisés à cette fin depuis 1984. Comme pour l’évaluation de 2002, des changements ont été apportés au modèle analytique de sorte à tenir compte du changement temporel dans l’indice de fraie : on a appliqué un facteur fixe de conversion de l’indice de fraie ou de capturabilité à la série de données recueillies en plongée depuis 1988 et on a estimé un paramètre librement ajusté pour la période précédente de relevés en surface. On a aussi introduit une fonction logistique par année pour modéliser la disponibilité du poisson dans les frayères et on a examiné l’effet d’une gamme de poids de pénalité sur une série d’indicateurs; dans l’évaluation finale, on a accru le poids de pénalité appliqué aux données sur la ponte et réduit celui appliqué aux données sur les prises par âge, ce qui a permis d’établir que l’effet sur les niveaux de biomasse globaux était minime, sauf dans le cas des îles de la Reine-Charlotte, où cela a mené à une légère baisse de l’abondance dans la série chronologique. Toutes les données biologiques disponibles sur les prises totales, la ponte et la composition par âge et par taille des reproducteurs ont été utilisées pour déterminer les niveaux d’abondance actuels. Aucun problème important n’était évident dans l’étendue et la représentativité des séries de données. Par contre, l’âge d’un certain nombre d’échantillons prélevés dans le détroit de Georgia n’a pas été établi à cause des ressources limitées. Toutes les données disponibles ont été saisies dans une base de données Access, puis résumées. À l’échelle de la côte, la biomasse estimative des stocks dans toutes les zones évaluées avant qu’ils soient pêchés en 2003 s’élevait à 246 000 t d’après le modèle structuré par âge, ce qui représente une augmentation de 28 % par rapport à 2002. Cette augmentation reflète un accroissement de l’abondance chez les stocks de la côte sud, en particulier celui du détroit de Georgia. L’abondance chez les trois stocks du nord a légèrement augmenté aussi grâce au recrutement de la classe d’âge 2000, assez abondante.

Pour l’ensemble de la côte de la Colombie-Britannique, l’excédent pêchable en 2004 (20 % du nombre prévu de reproducteurs en 2004) estimé d’après l’abondance prévue dans les cinq zones d’évaluation se chiffre à 53 020 t dans l’hypothèse d’un recrutement moyen dans toutes les zones. Toutefois, étant donné que l’on pourrait changer d’idée quant au niveau d’abondance du stock dans chaque zone d’évaluation à la suite de l’examen des données par le CEESP, le nombre prévu de reproducteurs et les excédents pêchables pourraient changer.

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1. INTRODUCTION

Herring have been one of the most important components of the British Columbia commercial fishery over the past century with catch records dating from 1877. The fishery has evolved from a dry salted product in the early 1900s, to a reduction fishery in the 1930s that collapsed in the late 1960s as a result of environmental change and excessive harvesting. After a four year closure, the current roe fishery began in 1972. Roe fisheries occur just prior to spawning when the fish are highly aggregated and very vulnerable to exploitation. Since 1983, herring roe fisheries have been managed with a fixed quota system. Under this system, harvest levels are determined prior to the season based on a fixed percentage (20%) of forecast stock size. In addition, threshold biomass or Cutoff levels were introduced in 1986 to restrict harvest during periods of reduced abundance.

In previous reports, stock assessments were presented for two analytical models developed explicitly for British Columbia herring populations: (1) a modification of the escapement model described by Schweigert and Stocker (1988); and (2) a modification of the age-structured model described by Fournier and Archibald (1982). In 2002, the age-structured model was adopted as the primary assessment tool and escapement model estimates are provided only for minor stocks in Areas 2W and 27. Stock abundance estimates are developed for the period 1951-2003 and forecast pre-spawning abundance for the 2004 season are presented. Forecasts of upcoming run size are based on the combination of estimates of surviving repeat spawners and newly recruiting spawners which are presented as poor, average, and good, based on historic recruitment levels.

1.1. STOCK CONSIDERATIONS

The stock concept used for managing British Columbia herring is based on current knowledge of stock structure that is necessarily incomplete. Given incomplete knowledge of population structure, it is prudent to manage fisheries to ensure maintenance of the greatest potential biological diversity in all regions. Additionally, stock forecasts for smaller geographic regions than those used in the current assessments are not accurate enough for fisheries management. Therefore, fisheries should continue to focus on the major aggregations within each assessment region to minimize the potential over-exploitation of any smaller, spatially discrete spawning groups. In the 2003 spawning season, the research study using a combination of coded wire tagging and micro-satellite DNA analysis to further investigate stock structure of British Columbia herring was continued. Preliminary results of these studies are presented in separate reports (Schweigert and Flostrand 2000, Flostrand and Schweigert 2002, 2003, Beacham et al. 2001, 2002).

The stock groupings used for the current assessments are identical to those used since 1993 (Fig. 1.). The Queen Charlotte Islands stock assessment region includes most of Statistical Area 2E, spanning from Cumshewa Inlet in the north to Louscoone Inlet in the south. The Prince Rupert District stock assessment region encompasses Statistical Areas 3 to 5. The Central Coast assessment region separates the major migratory stocks from the minor spawning populations in the mainland inlets. The Central Coast assessment region includes Statistical Area 7 plus Kitasu Bay in Area 6 and Kwakshua Channel in Area 8. The Strait of Georgia stock assessment region includes all of Statistical Areas 14 to 19, 28, 29, and Deepwater Bay and Okisollo Channel in Area 13. The west coast of Vancouver Island assessment region encompasses Statistical Areas 23 to 25. Haist and Rosenfeld (1988) outline current geographical stock boundaries.

Abundance estimates are not presented for other areas outside of the major assessment regions that may support additional small herring runs, because both the spawn survey and catch data are incomplete for many of these areas. Therefore, presentation of stock estimates could lead to erroneous conclusions regarding either absolute abundance or stock trends. Recent attempts to conduct a complete age-structured assessment for Areas 2W and 27 have been unsuccessful because of incomplete data. An escapement model estimate of current stock abundance is available for these areas but no forecast of abundance in the coming year is possible.

1.2. DATA BASE

The primary data sources for the stock assessments are spawn survey data, commercial catch landing data, and age composition data from biological samples of commercial fishery, pre-fishery charter, and research catches. These data are available in an Access database for the period 1951 to 2003. This time span includes the reduction fishery period to 1968 and the subsequent roe fishery period that began in 1972.

Of the three data sets, the spawn data contain the largest measurement errors. While the quality of spawn surveys has generally improved over the 53 year span of these data, due to increased effort and better quality control of the surveys, there are occasional problems with equipment and weather which may hamper data completeness or accuracy in some years. The consistent observations made during all years of surveys are the total length, the average width, and a measure of egg density for each spawning site. Since 1987 an increasing number of egg beds have been assessed using Scuba rather than traditional surface survey methods. We assume all surveys provide accurate estimates of spawn bed width and egg density. These data have been used in developing the spawn index where available. All major herring spawning beds were surveyed in 2003. Many of the minor spawning beds outside the assessment areas were also surveyed by Scuba in 2003.

Catch information was obtained from landing slips or monitoring of plant offload data. Historically, landing slip data were summed by fishery season (seasons run from July 1 to June 30). Beginning in 1997/98 season, roe catch figures are based on verified plant offload weights, a result of the introduction of the individual vessel quota ('pool fishery') system for all fisheries except the Strait of Georgia and Prince Rupert gillnet fisheries. Since the 1998/99 season, verified plant offload weights are available for all food and roe fisheries coastwide. The spawn-on-kelp (SOK) fishery includes a total of 46 licensed operators that were allocated 3000 tons (2722 tonnes) in 2003 for use in open and closed pond operations. For assessment purposes, it is assumed that the 100 tons (91 tonnes) of herring allocated to each closed pond operator are removed from the population as egg production or mortality (Shields et al. 1985). A similar assumption of 35 tons (32 tonnes) is made for open pond operations. These data are treated as an additional seine removal. Allocations to all SOK fisheries since its inception in 1975 have been tabulated and are included in the current analysis.

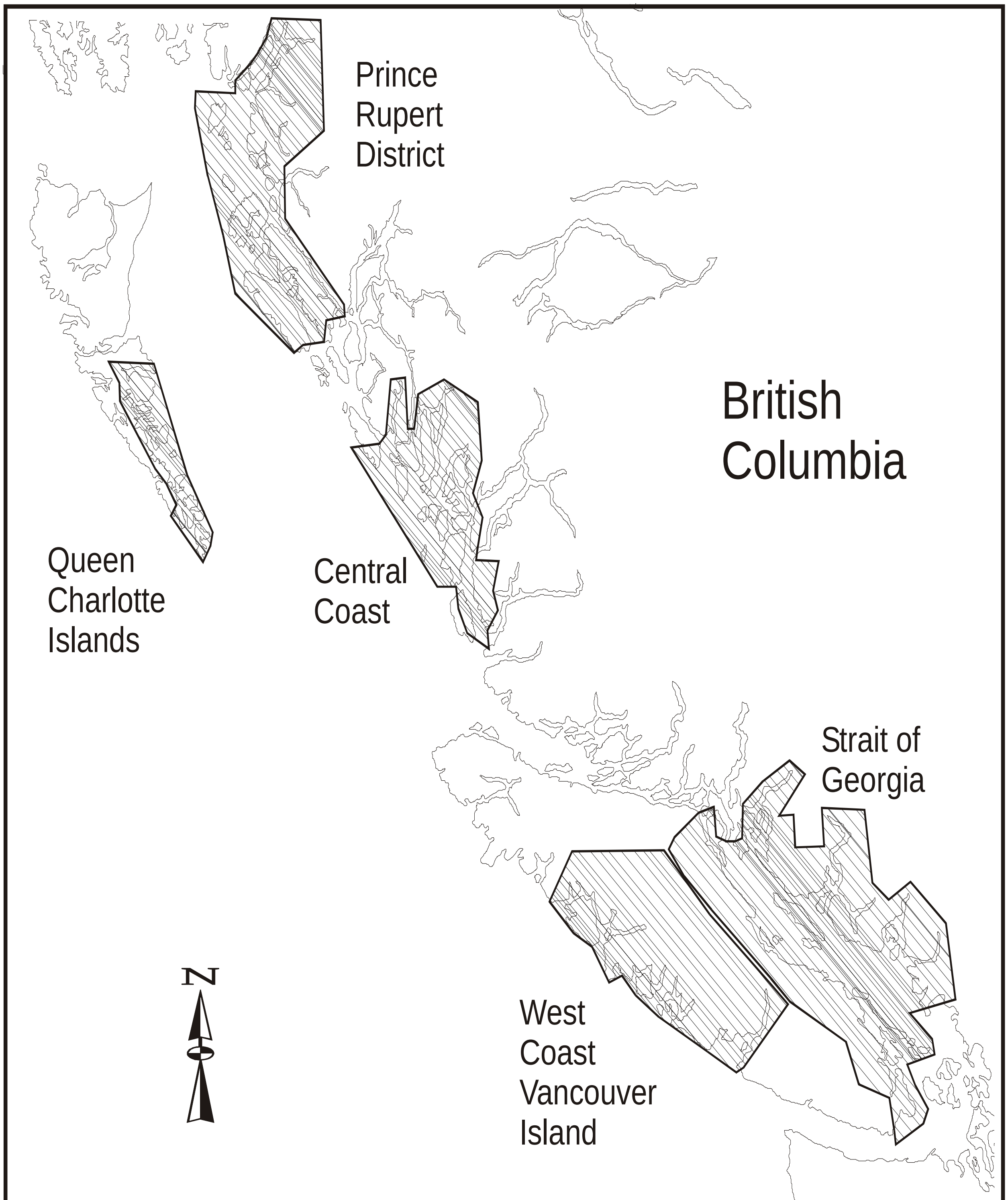

Figure 1. Pacific herring major stock assessment regions in British Columbia.

Age structure data are used in both assessment models. The information from catch samples is used for years when there were commercial fisheries. Pre-fishery charters began in 1975 and these samples are used in addition to samples taken from the catch, particularly in areas with no fisheries, or when catch samples are few in number or not representative of the entire catch. Additional data used in both models are annual estimates of the mean weight-at-age. During the

2002/03 season a total of 407 herring samples (100 roe, 8 food, 241 test fishery and 53 miscellaneous others) were collected and processed compared to 392 in the previous year. Of the roe and test fishery samples, 21 were taken in the Queen Charlotte Islands assessment area (another 11 from Area 2W), 30 in the Prince Rupert area, 59 in the Central Coast, 120 in the Strait of Georgia, and 76 on the west coast of Vancouver Island. The current level of sampling coverage is adequate to estimate age composition and mean weight at age for assessment analysis. However, it should be noted that due to resource constraints and new equipment the ageing laboratory was unable to process 51 of the samples collected during the 2003 season.

In the current assessment we continue to use the year of life convention for ageing adopted in the 1991 assessment. Fish which were previously named age 3 are now referred to as the 2^+ age class. In a few instances the text refers to age class 2^{++} which indicates all fish that are age 2^+ and older.

2. SPAWN INDEX

2.1 INTRODUCTION

The spawn index estimation was referred to as the escapement model in previous assessments. It provides the auxiliary information for tuning the age-structured model. It was first developed for the 1984 assessments (Haist et al. 1985; Schweigert and Stocker 1988), and provides an empirical estimate of the escapement from the fishery based on egg deposition information. For most stock assessment regions, recent estimates of escapement are based on a combination of surface and Scuba survey data. Scuba surveys have been used routinely since 1987 and an increasing proportion of the herring spawning beds have been surveyed using this technique. Scuba surveys have been found to be superior to surface surveys for spawn assessment because they provide more accurate estimates of both spawn bed width and the intensity of egg deposition. A summary of the recent spawn survey coverage for the British Columbia coast is presented below. As a result of reductions in DFO resources and the consequent contracting of diving surveys to industry, there was again virtually no DFO effort directed to surface surveys in 2003, particularly outside of the assessment regions. Limited surface surveys were conducted in area 2W and in Johnstone Strait using HCRS funded contractors. All areas did receive good Scuba survey coverage. Coastwide, there was a modest increase in the total length of spawn surveyed by Scuba and surface surveys relative to 2002. The difference is attributable to increases in spawn bed length in the Queen Charlotte Islands, the Strait of Georgia, and the west coast of Vancouver Island

Summary of the kilometres of herring spawning beds surveyed by Scuba and surface methods for major and minor stocks on the British Columbia coast in recent years, 2000-2003.

	2000			2001			2002			2003		
Assessment Region	Scuba	Surface	Total	Scuba	Surface	Total	Scuba	Surface	Total	Scuba	Surface	Total
Queen Charlotte Is.	26.6	0.0	26.6	40.2	0.0	40.2	14.8	0.0	14.8	14.6	14.5	29.1
Prince Rupert District	73.8	0.0	73.8	98.9	0.0	98.9	63.5	0.0	63.5	70.2	0.0	70.2
Central Coast	97.6	0.7	98.3	99.3	0.0	99.3	107.2	16.3	123.5	94.9	0.0	94.9
Strait of Georgia	152.5	1.3	153.8	173.5	0.0	173.5	143.7	5.3	149.0	231.3	3.1	234.4
W.C. Vancouver Is.	40.7	0.0	40.7	35.0	0.0	35.0	41.3	0.0	41.3	50.9	0.0	50.9
Other Areas	30.3	42.2	72.5	18.3	37.6	55.9	44.0	32.7	66.7	23.8	60.5	84.3
Coastwide Total	421.5	44.2	465.7	465.2	37.6	502.8	414.5	42.1	456.6	485.7	78.1	563.8

2.2 METHODS

The spawn index provides an estimate of the total egg deposition in each assessment region. The total egg deposition is an amalgamation of estimates of total number of eggs based on surface surveys, dive surveys of the algal and bottom substrate, and surveys of the giant kelp, *Macrocystis* sp., and attached eggs. The methods adopted for deriving total egg deposition are detailed below.

Surface Surveys

Since the late 1920s, there have been organized efforts to assess the amount of herring eggs deposited throughout the British Columbia coast as an indicator of stock abundance. The parameters which have been monitored consistently are total length of each spawning bed measured parallel to the shoreline, the average width of each spawning bed, and an estimate of intensity of the spawn deposition. Prior to 1981, intensity was estimated subjectively on either a 1-5 or 1-9 scale of light to heavy (Hay and Kronlund 1987). Subsequently, intensity of egg deposition was recorded as the number of egg layers observed on each of several types of algal substrate. Beginning in 1987 an increasing proportion of the spawning beds have been surveyed using Scuba techniques as outlined below.

To provide a consistent coastwide assessment of total egg deposition throughout the time period from 1951-2003, it was necessary to intercalibrate the surface and Scuba surveys of egg deposition. Initially, the intercalibration took the form of linear equations that converted the surface survey estimates of spawning bed width and egg layers to comparable Scuba estimates (Schweigert and Stocker 1988). However, the data available for this intercalibration were limited in time and space to particular spawning beds over the course of a few years. As Scuba surveys of the spawning beds became widespread, an extensive database of estimates of the dimensions of herring spawning beds in most areas of the coast became available and a new procedure for calibrating the width of herring spawning beds estimated by surface surveys was proposed (Schweigert et al. 1993). The methodology consisted of defining spawn pools that were a grouping of herring spawning locations which were geographically adjacent and probably geomorphologically similar. Hence, diver width estimates developed for such a 'pool' were felt to be characteristic of all herring locations within that pool. For the small number of locations which could not be assigned to a pool, the median width for the herring section (Haist and Rosenfeld 1988) was used to adjust width estimates for the herring location. The median width was preferable to the mean because of the non-normal distribution of the spawn width estimates. Any pools for which fewer than 25 observations of width existed were also adjusted using the section median. For the rare instances where no median estimate was available at the section level, the median width for the assessment region was applied to calculate spawn area. The long term median spawn width for each pool, was then applied to each surface survey record to estimate a ‘diver’ width and combined with the estimated surface length, to determine the total area of egg deposition for each spawning bed.

To estimate egg density, it was assumed that surface and Scuba survey estimates of the number of egg layers in a spawning bed were equivalent. The database of 5111 observations of egg density per square meter from laboratory egg counts of Scuba surveyed quadrat samples was used to develop a predictive model of egg density from egg layers:

$$Eggs / m^2 = 14.698 + 212.218\ Layers$$

The relationship is statistically significant ($P<0.001$). Total egg deposition for each egg bed is then estimated from the product of total spawning bed area, and egg density predicted from the average surface egg layer estimate.

At present no methods exist for adjusting surface survey data in most areas outside the major assessment regions except in a few locations such as Johnstone Strait (Statistical Areas 9-13) where some dive surveys have been conducted. These surveys indicated that no adjustments are required for the spawn widths in Johnstone Strait because widths are very narrow and appear to be accurately assessed from the surface in this area (Schweigert and Haegele 1988a, b).

Scuba Surveys

For Scuba surveys, spawning bed lengths are determined by exploratory grabs with a spawn drag, rake or snorkelling to define the limits of the areas of egg deposition. A systematic sampling regime is employed whereby transects are set across the egg bed perpendicular to shore at 350 m intervals. Corresponding spawning bed widths are estimated as the mean of all transect lengths within the spawning bed. Estimates of mean egg density are based on a two-stage sampling design (Schweigert et al. 1985, 1990). Average egg density for each spawning bed is estimated, as the weighted mean of the means of a series of quadrats located along each transect, where the weighting is based on the length of each transect. For each quadrat, observations are made on several variables: type of algal substrate; proportion of the quadrat covered by each algal type; number of layers of eggs on each algal type; proportion of the bottom substrate covered by eggs; and an estimate of the number of egg layers on the bottom substrate. In some areas, assessments are also made of the egg deposition on the giant kelp as described in a following section.

Egg deposition for each sampling quadrat is estimated from the predictive equation described in the 1989 assessment (Haist and Schweigert 1990, Schweigert 1993). Egg density for each vegetation subfraction is estimated as follows using non-linear regression (P<0.0001):

$$Eggs_{ij} = 1033.6694\ L_{ij}^{0.7137}\ P_{ij}^{1.5076}\ V_{ij}\ Q_j.$$

where

$Eggs_{ij}$ = estimated number of eggs in thousands per m^2 on vegetation type *i* in quadrat *j*

L_{ij} = number of layers of eggs on algal substrate *i* in quadrat *j*,
P_{ij} = proportion of quadrat covered by algal substrate *i* in quadrat *j*,
V_{1j} = 0.9948 parameter for sea grasses in quadrat *j*,
V_{2j} = 1.2305 parameter for rockweed in quadrat *j*,
V_{3j} = 0.8378 parameter for flat kelp in quadrat *j*,
V_{4j} = 1.1583 parameter for other brown algae in quadrat *j*,
V_{5j} = 0.9824 parameter for leafy red and green algae in quadrat *j*,
V_{6j} = 1.0000 parameter for stringy red algae in quadrat *j*,
Q_1 = 0.5668 parameter for 1.00 m^2 quadrats,
Q_2 = 0.5020 parameter for 0.50 m^2 quadrats,
Q_3 = 1.0000 parameter for 0.25 m^2 quadrats.

Total egg density (thousands of eggs per m^2) for each quadrat is then estimated by summing the egg density estimates over the vegetation types,

$$Eggs_j = \sum_i eggs_{ij}.$$

Beginning in 1988 samples of algae and the attached eggs from entire quadrats were collected and processed to evaluate model predictions of egg density relative to sample egg counts. Due to funding shortfalls, no samples have been collected since 1997 and model predictions of egg numbers per sample quadrat are assumed to be unbiased for use in the assessment of egg density.

Eggs on Bottom and *Macrocystis*

Eggs on rock are estimated from the product of the proportion of the quadrat covered by eggs, number of egg layers, and 340,000 eggs/m^2 (Haegele *et al*. 1979). Eggs on rock also includes eggs on other inorganic substrata as well as egg deposition on very short (1-2 cm) red algae, calcareous encrusting algae, worm tubes, logs, etc. Total egg density for each quadrat is the sum of eggs on vegetation plus eggs on rock.

In some northerly areas such as the Queen Charlotte Islands and the Prince Rupert District, a significant proportion of the total egg deposition can occur on the giant kelp, *Macrocystis* sp., with smaller amounts in some localities on the Central Coast and west coast of Vancouver Island. The approach we have adopted for routine Scuba surveys follows that outlined by Haegele and Schweigert (1985). The Scuba transects which are used to assess egg density on understory vegetation are also used to enumerate *Macrocystis* plants and fronds within 1 m on either side of the transect line. An egg prediction equation has been developed (Haegele and Schweigert 1990) to estimate egg numbers for an individual plant:

$$Eggs/Plant = 0.073\ Layers^{0.673}\ Height^{0.932}\ Fronds^{0.703}$$

where

Eggs/Plant = total number of eggs on the *Macrocystis* plant in millions,
Layers = average number of egg layers on each *Macrocystis* plant,
Height = total height of the *Macrocystis* plant in metres,
Fronds = total number of fronds per *Macrocystis* plant.

This equation estimates the number of eggs occurring on a plant of a specific height with a certain number of fronds and egg layers. In practice, the synoptic Scuba survey estimates only the average number of egg layers per plant, the average plant height, and the average number of fronds per plant along each transect. These quantities are used in the above equation to estimate the total egg numbers per plant for each transect. These estimates are averaged across transects to obtain an average number of eggs per plant for the entire *Macrocystis* bed.

This information may then be combined with the estimate of the density of plants and the estimated area of the *Macrocystis* bed to obtain an estimate of the total number of eggs deposited on the kelp:

$$Total\ Eggs\ on\ Macrocystis = Eggs\ Plant^{-1} \bullet Plants\ m^{-2}$$

This egg deposition is then added to the estimated eggs on the understory vegetation to determine a total egg deposition for that spawn pool.

Biomass Estimates for Minor Stocks

Biological sampling data and spawn surveys for the minor stocks in Areas 2W and 27 have been intermittent, making age-structured analysis difficult. Alternatively, escapement from the fishery from egg deposition surveys, plus total catch can be used to provide an estimate of the pre-fishery spawning stock biomass for these areas. A harvest rule of 10% of the estimated biomass in the previous year has been in place for several years for these minor stock areas. The following relationship may be used to estimate pre-fishery biomass for each area (Schweigert 1993), if all pertinent data are available:

$$B_j = C_j + Eggs_j \bullet \left(\frac{\sum_{3}^{10} P_{ij} W_{ij}}{\sum_{3}^{10} P_{ij} F_{ij} SR_{ij}} \right)$$

where

B_j = total pre-fishery mature biomass in tonnes in year *j*,
C_j = total catch in tonnes in year *j,*
$Eggs_j$ = total egg deposition in billions in year *j*,
P_{ij} = proportion of fish at age *i* in year *j* in the spawning run,
F_{ij} = fecundity of females of age *i* in year *j*,
SR_{ij} = sex ratio or proportion of females at age *i* in year *j*,
W_{ij} = mean weight of fish at age *i* in year *j* in tonnes.

However, estimates of fecundity, age composition, and mean weight at age are not available each year so a simpler method is used to estimate biomass from the estimate of total egg deposition. Total egg deposition estimates for all spawning beds from all three types of survey (surface, dive, and kelp) are summed within each area and the total egg deposition is converted to tonnes of spawning fish based on an estimate of 100 eggs per gram of herring on average (Hay 1985). The total catch is obtained from sales slip information or verified plant landed weight data and added to the escapement to determine current biomass. Estimates of mature biomass for Areas 2W and 27 based on this analysis are presented in Table 2.1.

Table 2.1. Estimates of spawning stock biomass, catch and pre-fishery stock abundance (tonnes) for the minor stocks in areas 27 for 1971-2003.

	Spawn (mt)				Catch (mt)				Total
Season	Surface	Macro	Dive	Total	Seine	Gillnet	Other	Total	Stock
19501	1,955.24			1,955.24					1,955.24
19512	484.38			484.38					484.38
19523	4,618.03			4,618.03					4,618.03
19534	2,646.44			2,646.44	1,919.89			1,919.89	4,566.33
19545	574.87			574.87	5,938.70			5,938.70	6,513.58
19556	1.47			1.47					1.47
19567	184.03			184.03					184.03
19578	38.62			38.62					38.62
19589	60.47			60.47	407.22			407.22	467.69
19590	223.95			223.95					223.95
19601	168.99			168.99	1,149.06			1,149.06	1,318.05
19612	101.62			101.62	173.05			173.05	274.67
19623	407.30			407.30	30.75			30.75	438.05
19634	0.00			0.00	322.55			322.55	322.55
19645	2,516.54			2,516.54	769.08			769.08	3,285.62
19656	81.73			81.73	951.48			951.48	1,033.21
19667	46.24			46.24	51.42			51.42	97.66
19678	141.68			141.68					141.68
19689T	2,198.42			2,198.42					2,198.42
19690	2,433.72			2,433.72					2,433.72
19701	290.00			290.00					290.00
19712	250.29			250.29					250.29
19723	2,578.17			2,578.17					2,578.17
19734	0.00			0.00	507.91	18.33		526.25	526.25
19745	1,606.18			1,606.18					1,606.18
19756	210.44			210.44		78.62		78.62	289.06
19767	638.19		0.00	638.19					638.19
19778	3,595.03			3,595.03	74.98	75.12	0.00	150.10	3,745.13
19789	6,908.61			6,908.61	422.13	270.40	0.00	692.53	7,601.13
19790	14,419.06			14,419.06		519.26	0.00	519.26	14,938.32
19801	1,828.32			1,828.32		670.95	0.00	670.95	2,499.27
19812	4,136.53			4,136.53	238.49	332.09	0.00	570.58	4,707.11
19823	2,500.47			2,500.47		162.93	91.00	253.93	2,754.41
19834	3,004.22			3,004.22		170.71	182.00	352.71	3,356.93
19845	370.26		887.62	1,257.88			182.00	182.00	1,439.88
19856	47.10	284.64	2,865.78	3,197.52			96.00	96.00	3,293.52
19867	952.33			952.33			364.00	364.00	1,316.33
19878	1,612.23			1,612.23			364.00	364.00	1,976.23
19889	1,684.74	122.10	2,560.22	4,367.06			364.00	364.00	4,731.06
19890	3,565.45	37.96	1,450.65	5,054.06			246.00	246.00	5,300.06
19901	2,011.68	11.15	1,107.60	3,130.43	0.09		246.00	246.09	3,376.53
19912	55.30	613.94	1,938.09	2,607.33	335.43		364.00	699.43	3,306.76
19923	1,394.34	2,536.51	1,468.55	5,399.40		366.85	364.00	730.85	6,130.25
19934		1,967.85	3,052.01	5,019.86		344.55	246.00	590.55	5,610.41
19945		559.20	1,654.22	2,213.42	87.57		455.01	542.58	2,756.00
19956		14.41	1,244.48	1,258.88			364.02	364.02	1,622.90
19967		61.77	1,657.36	1,719.13			96.00	96.00	1,815.13
19978		214.65	1,791.13	2,005.78			273.00	273.00	2,278.78
19989		153.05	425.32	578.37			96.00	96.00	674.37
19990			1,118.60	1,118.60			96.00	96.00	1,214.60
20001			178.40	178.40			96.00	96.00	274.40
20012		100.68	719.62	820.31			32.00	32.00	852.31
20023		140.56	652.23	792.79			64.00	64.00	856.79

Table 2.2. Estimates of spawning stock biomass, catch, and pre-fishery stock abundance (tonnes) for the minor stocks in area 2W for 1950-51 to 2002-03.

	Spawn (mt)				Catch (mt)				Total
Season	Surface	Macro	Veg	Total	Seine	Gillnet	Other	Total	Stock
19523	202.90			202.90					202.90
19567	3.82			3.82	105.83			105.83	109.65
19578	156.88			156.88					156.88
19589	1,915.96			1,915.96					1,915.96
19590	1,569.27			1,569.27					1,569.27
19601	558.49			558.49					558.49
19612	1,715.31			1,715.31					1,715.31
19623	1,436.26			1,436.26					1,436.26
19634	968.87			968.87	312.49			312.49	1,281.35
19645	439.48			439.48	1,251.27			1,251.27	1,690.75
19656	23.51			23.51	172.37			172.37	195.87
19667	261.65			261.65					261.65
19678	72.62			72.62					72.62
19689	593.04			593.04					593.04
19690	576.86			576.86					576.86
19701	603.53			603.53					603.53
19712	1,010.77			1,010.77					1,010.77
19723	1,603.60			1,603.60	705.73			705.73	2,309.33
19734	1,674.84			1,674.84	403.25			403.25	2,078.09
19745	1,153.98			1,153.98	449.34			449.34	1,603.31
19756	826.10			826.10			68.00	68.00	894.10
19767	1,174.40			1,174.40				0.00	1,174.40
19778	831.97			831.97	574.68			574.68	1,406.66
19789	494.02			494.02	690.59			690.59	1,184.61
19790	2,114.38			2,114.38					2,114.38
19801	1,811.18			1,811.18	770.26		91.00	861.26	2,672.44
19812	4,781.24			4,781.24	1,225.32			1,225.32	6,006.56
19823	4,869.26			4,869.26	2,518.17			2,518.17	7,387.44
19834	2,522.18			2,522.18					2,522.18
19845	1,719.33			1,719.33	199.47			199.47	1,918.80
19856	683.72			683.72					683.72
19867	988.92			988.92					988.92
19878	3,380.16			3,380.16					3,380.16
19889	2,718.92			2,718.92					2,718.92
19890	2,787.76		7,570.52	10,358.28	2,271.92			2,271.92	12,630.21
19901	355.53	170.74	2,309.67	2,835.94	2,558.29			2,558.29	5,394.23
19912		169.14	3,374.66	3,543.81	1,283.54			1,283.54	4,827.35
19923	0.61	12.54	61.56	74.72	1,305.66			1,305.66	1,380.39
19934		17.13	192.45	209.58					209.58
19978		13.70	376.19	389.89	179.63			179.63	569.52
19990		145.60	119.01	264.61					264.61
20001			30.97	30.97					30.97
20012		13.39	120.73	134.12	0.00				134.12
20023	1,461.95			1,461.95					1,461.95

3. AGE-STRUCTURED MODEL

3.1. INTRODUCTION

An age-structured model, based on the error structure suggested by Fournier and Archibald (1982), has been used to assess B.C. herring stocks since 1982. Ongoing revisions to the model have made it more consistent with the life history of herring and the fisheries that are analyzed. The current version uses auxiliary information in the form of spawning escapement data, separates catch and age composition data by gear type, and includes availability parameters to estimate partial recruitment to the spawning stock. Model parameters are estimated simultaneously using a maximum likelihood method. The model has used estimates of spawning stock biomass as the abundance or 'spawn index' for parameter estimation beginning in 1994 (Schweigert and Fort 1994). Recent changes to the model have been described previously (Schweigert 2001). The model is implemented in the C^{++} programming language using AD model builder software (Otter Research Ltd, 2001).

3.2. METHODS

Data Sources

The input data for the age-structured analysis differs from recent years. Beginning in 2002, spawn index and catch at age estimates are derived from an Access database (funding provided by the Herring Conservation and Research Society (HCRS) that has been developed over the past few years. The process for amalgamating data in space and time differs from that in previous assessments but overall spawn index estimates and numbers of fish caught do not differ markedly from the earlier assessments (Appendix 1).

The Population Model

Purse seines and gillnets are the two types of fishing gear commonly used in B.C. herring fisheries. Seine nets are assumed to be non-selective for herring while gillnets are selective for larger, older fish. Herring fisheries have concentrated primarily on fish which are on, or migrating to the spawning grounds. Therefore, the relative availability of age-classes to non-selective gear should be equivalent to the partial recruitment of age-classes to the spawning stock. The age-structured model explicitly separates availability (partial recruitment) and gear selectivity. Seine and gillnet fisheries are usually temporally separate so catch and age-composition are partitioned into fishing periods, separating data for the different gears. Three fishing periods are modelled as follows. In this and previous assessments, the first period encompassed all catch prior to the spring roe herring fisheries. This included reduction fishery catches prior to 1968 and the winter food and bait fisheries since 1970. Most of this catch was taken by seine gear although small amounts were caught with trawl nets (which are also assumed to be non-size selective). The second fishing period includes all seine roe herring catch and the third period includes all gillnet roe herring catch. Beginning with the 2002 assessment, the Access database summarizes catch-at-age data by periods (May-Sept., Oct.-Dec., Jan.-April) that differ slightly from the earlier approach. However, the catch-at-age data are still tabulated into reduction and roe fishery periods consistent with the previous methodology for further analysis.

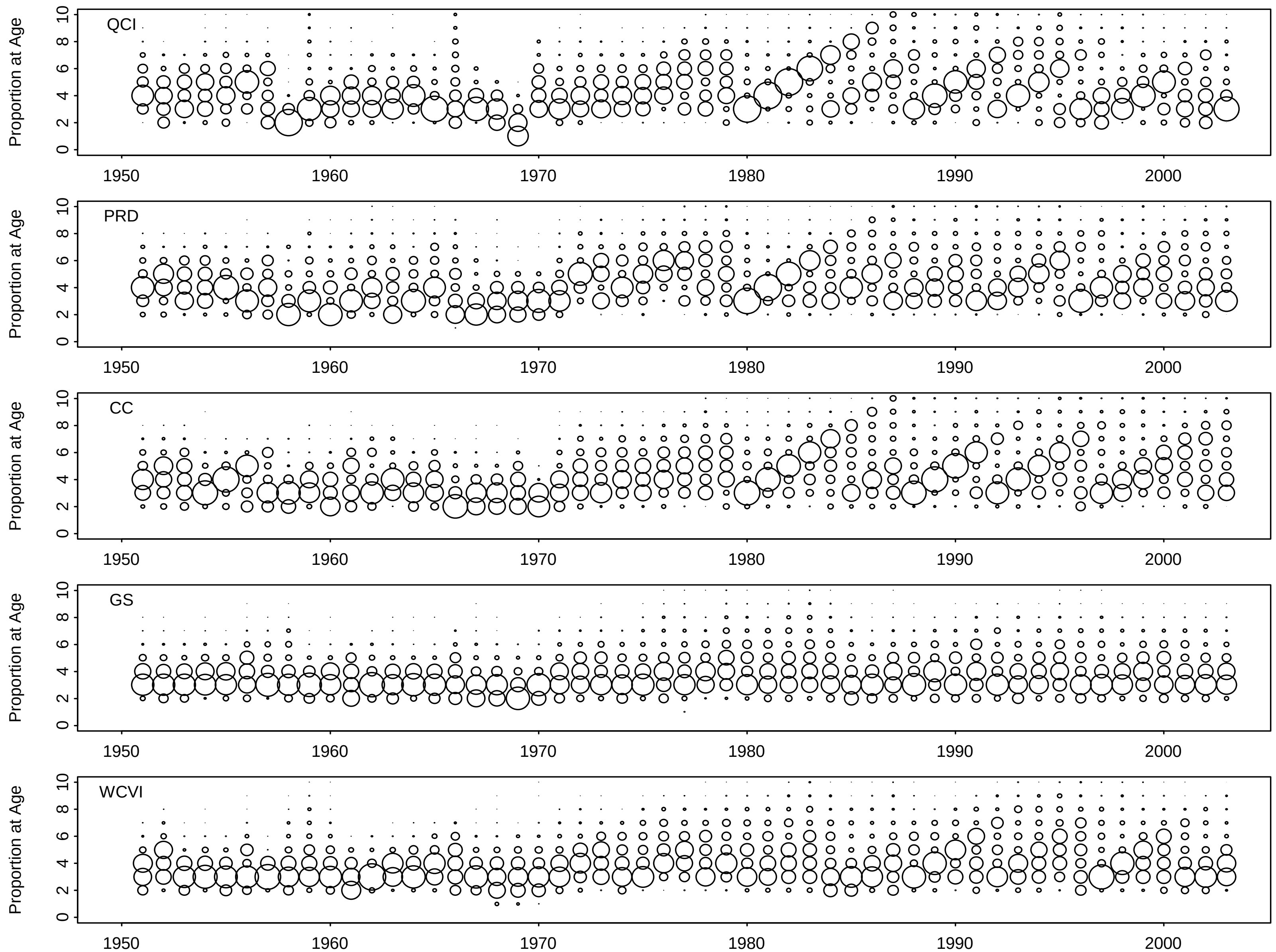

Figure 3.0. Age composition estimates for five major assessment regions from 1951-2003.

In the population model for each assessment region, let T_{ij} be the total number of fish in age class *j* at the beginning of season *i*, where season is equivalent to year, and λ_{ij} be the proportion of age *j* fish which are available to the fishery. Then N_{ij1}, the total number of age class *j* fish which are available at the start of period 1 in season *i* is given by

$$N_{ij1} = \lambda_{ij} T_{ij} \text{, where } 0 \langle \lambda_{ij} \langle 1 \qquad 3.1$$

To model the fishing process, a form of the catch equations which models fishing and natural mortality as continuous processes over time period *r*, is used:

$$C_{ijr} = \frac{F_{ijr}}{F_{ijr} + M_r}\left(1 - \exp\left(-F_{ijr} - M_r\right)\right) N_{ijr},$$

and, for $r < p$

$$N_{ijr+1} = N_{ijr} \exp\left(-F_{ijr} - M_r\right),$$

where

C_{ijr}	is the catch of age class *j* in season *i* for period *r*,
F_{ijr}	is the fishing mortality of age class *j* in season *i* for period *r*,
M_r	is the natural mortality for period *r*,
N_{ijr}	is the number of fish in age class *j* in season *i* for period *r*,
i	is the number of seasons (*n*=53),
j	is the number of fishing periods (*p*=3),
k	is the number of age classes (*k*=9).

$N_{i+1,j+1,1}$ is defined by equation 3.1 where for $j+1 < k$

$$T_{i+1,j+1} = N_{ijp} \exp\left(-F_{ijp} - M_p\right) + T_{ij}\left(1 - \lambda_{ij}\right) \exp \sum_r - M_r \qquad 3.2$$

In the model the last age class, *k*, accumulates all fish aged *k* and older, so for $j+1=k$ equation 3.2 is replaced by

$$T_{i+1,k} = N_{i,k-1,p} \exp\left(-F_{i,k-1,p} - M_p\right) + T_{i,k-1}\left(1 - \lambda_{i,k-1}\right) \exp\left(\sum_r - M_r\right)$$
$$+ N_{ikp} \exp\left(-F_{ikp} - M_p\right) + T_{ik}\left(1 - \lambda_{ik}\right) \exp\left(\sum_r - M_r\right).$$

To reduce the number of parameters to be estimated, assumptions are made about the form of the availabilities and mortalities. In previous assessments, the availabilities were formulated to increase with age and were set to 1 for age 6+ and older. For age 3+ to 5+ the availabilities were constant between years, that is,

$$\lambda_{ij} = \lambda^{\bullet}{}_{j},$$

The proportion of age 2^+ fish which are mature appears to vary among years (Haist and Stocker 1985) and some reduction fisheries targeted on immature 1^+ fish. Therefore, the availability for these two age classes was estimated separately for each year for which there is age-composition data, with the exception of the final year. In the final year, the availability for age 1+ and 2+ fish was set equal to the average over all years in the time series.

In the current assessment, a modified logistic equation is fit for each year over all age classes to reduce the large number of availability parameters that were estimated in previous assessments:

$$\lambda_{ij} = \frac{1}{1 + \exp(-\delta(j - \gamma_i))}$$

For the selective gillnet fishery (i.e. fishing period 3), fishing mortality is separated into age selectivity and fishing intensity components. Following Doubleday (1976),

$$\ln\left(F_{ij3}\right) = \alpha_{i3} + b_j \qquad 3.2a$$

where α_{i3} represents the general level of fishing mortality due to the gillnet fishery in season *i*, and b_j represents the relative selectivity of the gear for age-class *j*. The b_j are parameterized such that age selectivity is modelled as a function of annual average weights-at-age. A modified logistic equation is used,

$$b_{ij} = \frac{1}{1 + \exp(\rho - \tau g_{ij}^{\omega})}$$

where g_{ij} is $\log_e$ of the geometric mean weight-at-age *j* in year *i*. The b_{ij} replace the b_j in equation 3.2a.

For non-selective fisheries (i.e. fishing periods 1 and 2) only fishing intensity parameters are estimated, that is

$$\ln\left(F_{ijr}\right) = a_{ir}.$$

As in recent assessments, an average natural mortality parameter, $M_{\bullet}$, is estimated. It is assumed that most of the natural mortality occurs following spawning and over the course of the summer and early winter prior to the first fishery (period 1). Little or no natural mortality is assumed during the course of the roe fisheries (periods 2 and 3) which occur over a roughly 2 week period at the end of the year. Hence, various proportions of the annual natural mortality for the three fishing periods is modelled as,

$$M_1 = 0.95M_{\bullet}$$
$$M_2 = M_3 = 0.025M_{\bullet}$$

Additional structure is built into the model through the inclusion of annual spawn data (spawn index, I_i). Spawning occurs at the end of the season so the number of spawners at age *j* in season *i* (G_{ij}) is estimated by

$$G_{ij} = N_{ijp} \exp\left(-F_{ijp} - M_r\right) \qquad \text{where} \qquad j>1$$

and the spawning stock biomass, which is assumed to be proportional to egg production, in season *i*,(R_i) is

$$R_i = \sum_j w_{ij} G_{ij},$$

where w_{ij} is the average weight-at-age *j* in season *i*. The errors in the spawn index observations (I_i) are assumed to be multiplicative so that

$$I_i = q\, R_i \exp(\xi_i), \qquad 3.3$$

where *q* is a spawn conversion factor and ξ_i is a normally distributed random variable with mean 0 and variance σ_1^2. For the model described above the parameters to be estimated are:

- T_{i1}, for all seasons *i*,
- T_{ij}, for age classes 1+ to *k* in the first year,
- λ_{ij}, from the logistic equation for ages 1+ to 8+, for seasons 1 to n-1,
- α_{ir}, for all fisheries *i,r*,
- $\delta, \gamma_i, \rho, \tau, \omega, M_{\bullet}$ and ***q*.**

The $\lambda_j^{\bullet}$ and λ_{ij} are parameterized to constrain their values between 0 and 1. The parameter σ_1^2 is not estimated in the reconstructions, but is fixed as discussed later on.

The Objective Function

Data input to the stock reconstruction are:

S_{ijr}, the number of sampled fish aged *j* in season *i* for period *r*,
O_{ir}, the estimated number of fish caught in period *r* of season *i*,
I_i, the estimated escapement biomass or spawn index in season *i*,
w_{ij}, the mean weight-at-age *j* in season *i*,
g_{ij}, the $\log_e$ of the geometric mean weight-at-age *j* in season *i*.

The error structure suggested by Fournier and Archibald (1982) for the observations S_{ijr} and O_{ir} is used:

1) the S_{ijr} are obtained from ageing random samples of fish from the catch (and there are no ageing errors, i.e. a multinominal sampling distribution).

2) the error structure for the estimated number of fish caught (O_{ir}) is log-normal. That is,

$$O_{ir} = C_{ir} \exp(\xi_i),$$

where C_{ir} is the actual number of fish caught in period *r* in season *i* ($C_{ir} = \sum_j C_{ijr}$) and the ξ_i are independent normally distributed random variables with mean 0 and variance σ_3^2.

3) the random variables S_{ijr} and O_{ir} are independent.

Given these stochastic assumptions, the log-likelihood function (ignoring the constant term), for the parameters P_{ijr} $(P_{ijr} = C_{ijr} / C_{ir}), C_{ir}$, and σ_3^2 is

$$\sum_{ijr} S_{ijr} \ln(P_{ijr}) - \sum_{ir} \frac{(\ln(O_{ir}) - \ln(C_{ir}))^2}{2\sigma_3^2} \qquad 3.5$$

The assumption of log-normal measurement error in the observed spawn-actual spawn relationship introduces the following contribution to the log-likelihood function:

$$-\sum_i \frac{(\ln(I_i) - \ln(q R_i))^2}{2\sigma_1^2} \qquad 3.6$$

The w_{ij} and g_{ij} are assumed to be estimated without error.

The objective function described above (eqn. 3.5 & 3.6) incorporates measurement error in the proportion at age data, the total catch data and the spawn index data, with the relative magnitude of the errors related through the variance terms σ_1^2, σ_3^2, and the sample sizes $\sum_r S_{ijr}$.

Because there is not enough information in the data to estimate the relative error in these observations, the variance terms are not estimated but are held at fixed values. In previous assessments, the following variances were assumed:

σ_1^2 = 0.025,
σ_3^2 = 0.0025,

These correspond to approximately a 4% coefficient of variation in estimates of the total number of fish caught and an 15% coefficient of variation in spawn index observations. However, it is not possible to estimate the variance directly. Therefore, in the current assessment, the sensitivity of the stock reconstructions to the relative penalty weights or variances assumed in the analysis were investigated in some detail.
The contribution to the objective function from the lack of fit for the age composition data for a fishery in period *r* in season *i* is:

$$V_{ir} = \sum_r S_{ijr} \ln P_{ijr} - \sum_r S_{ijr} \ln\left(\frac{S_{ijr}}{\sum_r S_{ijr}}\right)$$

The second term in this equation is a constant. Inclusion of this term allows comparison of the contribution to the lack of fit for the age composition data for each fishery. If the predicted and observed proportion at age data were identical, the V_{ir} would be zero.

To facilitate an assessment of the lack of model fit to the age composition data the standard deviates of the observed versus predicted proportions-at-age (Z_{ijr}) are also calculated:

$$Z_{ijr} = \frac{S_{ijr} - \left(\sum_r S_{ijr}\right) P_{ijr}}{\sqrt{S_{ijr}\left(1 - \frac{S_{ijr}}{\sum_r S_{ijr}}\right)}}$$

Penalty Weights

In recent assessments a penalty weight of 20 (corresponding to a variance of approximately .025) was applied to the spawn data, and a penalty weight of 200 (corresponding to a variance of approximately .0025) was applied to the catch at age data. Because the true variance of the data is unknown a reasonable approximation to the variance is generally assumed in setting the penalty weights. Although the age-structured model does not appear to be particularly sensitive to the choice of penalty weights, ongoing concern about the retrospective performance of the model indicated the need for a more detailed analysis. In support of the current assessment a series of runs were conducted for each stock using a variety of combinations of penalty weights for the spawn and age-structure data, respectively. The penalty weights examined were 2, 20, 100, 200, and 1000 corresponding to variances ranging from approximately 0.25 to 0.0005. For each set of model fits, either the spawn or catch-age penalty weight was fixed at 100 and the other penalty weight was varied as indicated above. The results of these analyses are presented below:

Queen Charlotte Islands

Spawn=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	3520	0.417	9669	0.47	10801
200	3475	0.410	9285	0.49	10482
100	3490	0.398	8741	0.53	10000
20	3093	0.255	7509	0.89	9496
2	2409	0.000	7788	1.48	11739

Catch=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	5422	0.365	7821	0.78	8628
200	3893	0.390	7868	0.57	9088
100	3490	0.398	8741	0.53	10000
20	2784	0.360	12368	0.61	15035
2	2416	0.000	5914	1.49	24354

Prince Rupert District

Spawn=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	7344	0.282	35639	0.61	36186
200	7228	0.274	35520	0.64	36208
100	6445	0.302	32201	0.60	29133
20	6791	0.217	36118	0.79	38555
2	6039	0.000	34190	1.05	44872

Catch=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	9933	0.197	35893	0.86	37731
200	7745	0.253	36245	0.69	37449
100	6445	0.302	32201	0.60	29133
20	6492	0.285	32914	0.61	32934
2	6173	0.323	27379	0.59	25785

Central Coast

Spawn=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	4044	0.225	31119	0.64	31071
200	3949	0.215	31353	0.67	31562
100	3852	0.203	31576	0.70	32110
20	3379	0.107	32239	0.90	35491
2	2556	0.000	25612	1.05	31246

Catch=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	6016	0.201	28208	0.74	27761
200	4377	0.217	30696	0.68	30617
100	3852	0.203	31576	0.70	32110
20	3096	0.101	31752	0.89	35393
2	2713	0.000	14690	1.10	15373

Strait of Georgia

Spawn=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	6144	0.494	149775	1.49	103590
200	6050	0.490	151479	1.52	105109
100	5962	0.486	153363	1.54	106832
20	5631	0.456	162664	1.59	116392
2	7249	0.222	145545	2.19	116405

Catch=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	7394	0.481	156266	1.61	108921
200	6259	0.484	156282	1.55	109079
100	5962	0.486	153363	1.54	106832
20	5611	0.491	138736	1.52	94951
2	5492	0.496	124838	1.50	83485

W.C. Vancouver Island

Spawn=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	4622	0.439	35113	0.96	28956
200	4460	0.434	34971	0.96	28918
100	4762	0.434	34339	0.90	28421
20	3788	0.388	33367	1.02	28010
2	2823	0.234	32437	0.98	27499

Catch=100	Objective Function	Natural Mortality	Current Biomass	Spawn Conversion q	Forecast Biomass 3+
1000	8052	0.439	31470	0.74	26594
200	5109	0.439	33387	0.88	27466
100	4762	0.434	34339	0.90	28421
20	3222	0.380	34339	1.28	29417
2	3521	0.146	22263	2.29	20734

Based on these results, it appears that penalty weights of 100 and 100 for the spawn and catch-age data may be more appropriate than the current 20 and 200. Effectively this provides for slightly greater emphasis on the spawn data and slightly reduced emphasis on the catch-age data. The modest improvement in the retrospective pattern described in the next section supports this approach.

4. STOCK TRENDS AND ABUNDANCE FORECASTS

4.1 STOCK TRENDS

Estimates of pre-fishery stock biomass over the period 1951 to 2003 from three alternative age-structured models and the estimated spawn index are shown in Figures 4.1 and 4.2 for the five major coastal regions. The model used in last year's assessment with a spawn catchability parameter, q, equal to 1 for the dive survey era and q estimated for the surface era prior to 1988, is presented as the 2q model. In addition, this model is fit with a logistic function to estimate annual availability or selectivity assuming the current penalty weights of 20 and 200 for the spawn and catch-age data, respectively. Finally, the results from this model are presented assuming an annually estimated availability but with penalty weights of 100 and 100 for the spawn and catch-age data.

Residual and Retrospective Analysis

The model estimate of the population egg production from equation 3.3 can be compared to the observed egg deposition and residuals reviewed for lack of model fit. The results of this comparison are shown in Figures 4.3 and 4.4 for the five major stocks. Similarly, a comparison between the observed age composition and that determined by the model is presented for the three fishing periods and the five major stocks in Figures 4.5 to 4.9.

A retrospective analysis for the herring age-structured model with the new penalty weighting is presented for each of the major herring stocks in Figures 4.10 and 4.11. The plots show the stock trajectory determined for each of the past ten years beginning in 1994 demonstrating the impact of additional data on model performance relative to the current assessment of stock trajectory. A comparison of the abundance forecasts for 2003 from 2002 is also presented in Table 4.1 together with the assessment of current abundance.

4.2 STOCK FORECASTS

Forecasts of stock abundance for 2004 are calculated in two ways. First, the numbers of fish at age prior to the fisheries are the numbers estimated at the beginning of the 2003/04 season multiplied by survival for the first period and the estimated availability at age. Recruitment is based on the survival and availability of the age 1+ fish estimated for the previous season. This recruitment is added to the estimated returning adults to project total abundance. Likelihood profiles for the predicted total biomass are determined and presented in Fig. 4.12 and 4.13. The profile likelihoods provide an approximation of expected recruitment based on the abundance of age 1+ fish the previous year in comparison to the point estimates of historical poor, average, and good recruitment described below. Secondly, as in previous assessments, recruitment is also calculated for three scenarios based on estimated numbers-at-age 2^+ for the 1951-2003 time series. Poor, average, and good recruitment levels are calculated as the mean of the lowest 33%, the mid 33%, and the highest 33% of the estimate of historic age 2^+ abundance. These three recruitment estimates are then added to the projected adult biomass in 2004 to provide abundance forecasts. The point estimates for these three levels of recruitment are plotted with the likelihood profiles in Fig. 4.12 and 4.13 for each stock.

4.3. POTENTIAL HARVEST

Management Considerations

The Pacific Science Advice Review Committee (PSARC) has reviewed the biological basis for target exploitation rate, considering both the priority of assuring conservation of the resource and allowing sustainable harvesting opportunities (Schweigert and Ware 1995). The review concluded that 20% is an appropriate exploitation rate for those stocks that are well above Cutoff or minimum spawning biomass threshold levels (PSARC 1995). The 20% harvest rate is based on an analysis of stock dynamics which indicates this level will stabilize both catch and spawning biomass while foregoing minimum yield over the long term (Hall et al. 1988, Zheng et al. 1993). A fixed escapement policy would theoretically produce higher yields and spawning stock stability but is not attainable at the operational level. For those stocks which are marginally above Cutoff the following reduced catch level is recommended:

Catch = Forecast Run - Cutoff.

This will provide for smaller fisheries in areas where the 20% harvest rate would bring the escapement down to levels below the Cutoff.

Cutoff levels have been established through a stock-recruitment curve or bootstrapping of the observed recruitment time series. Changes in model structure have historically resulted in a parallel change in Cutoff level. To minimize confusion, in 1995 the Subcommittee recommended that a fixed Cutoff level should be established for each stock based on the long-term production characteristics in relation to current environmental conditions and that this Cutoff level need not be re-evaluated on an ongoing basis. The Cutoff levels for the five major stocks are:

	1992/93 Cutoff[a]	1994/95 Cutoff	1996/97 Cutoff	**2003/04 Cutoff[c]**
Queen Charlotte Islands	11700	10700	10700	**10700**
Prince Rupert District[b]	12100	12100	12100	**12100**
Central Coast	10600	18800	17600	**17600**
Strait of Georgia	22100	21200	21200	**21200**
W.C. Vancouver Island	20300	18800	18800	**18800**

[a] - Cutoff level based on simulation model with stock-recruitment relationship, and two assessment areas on the WCVI.

[b] - Because of the poor performance of the age-structured model in this region in the past the Cutoff has not been recalculated using the bootstrap approach but is based on a stock-recruitment relationship.

[c] – A Cutoff of 14,000 tonnes was proposed for the Central Coast in 1998. Uncertainty about ASM performance in 1998 resulted in retention of the existing Cutoff.

The history of catch forecasts, recommended quotas, and actual harvests since the introduction of the Cutoff in 1986 is presented in Table 4.2.

Table 4.1. The abundance forecast from 2002 of 2003 run size (tonnes) showing the observed abundance and recruitment from the assessment model. Recruitment categories are in parentheses and are defined in Section 4.2.

Management Region	2002 Forecast of 2003 Biomass	2003 Observed Biomass	2003 Validated Roe Catch*	2003 Escapement
Queen Charlotte Islands	7,200 (average)	7,900 (good)	0	7,000
Prince Rupert	31,660 (average)	33,100 (good)	4,000	28,200
Central Coast	25,260 (average)	24,700 (good)	2,600	21,000
Strait of Georgia	130,010 (good)	153,200 (good)	20,400	132,800
West Coast Vancouver Island	30,030 (poor)	31,700 (good)	3,500	27,700
Total Coast	224,160	250,600	30,500	216,700

*includes test fish catch

Table 4.2. Stock biomass forecast, recommended yield, actual roe fishery quota, and roe catches (tonnes x 1000) since 1986.

		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999[d]	2000[d]	2001[d]	2002[d]	2003
QCI [f]	Forecast[a]		15.3	12.1	13.7	35.3	23.2	18.1	17.7	12.4	7.7	6.7	11.0	19.8	28.2	15.1	8.7	14.0	7.2
	Rec. Yield[b]		2.2	0.0	2.7	7.1	4.6	3.6	3.5	1.0	0.0	0.0	0.3	4.0	5.6	3.0	0.0	2.8	0.0
	Roe Quota	3.8	1.4	0.0	0.9	5.5	4.7	3.3	3.0	0.0	0.0	0.0	0.0	1.6	3.0	1.4	0.0	0.4	0.0
	Roe Catch[c]	3.6	2.0	0.3	1.4	9.0	7.0	3.8	4.0	0.3	0.0	0.0	0.0	1.4	3.0	1.8	0.0	0.7	0.0
PRD	Forecast[a]		32.1	43.8	42.6	23.3	19.4	30.5	55.1	34.1	21.9	21.2	36.1	34.0	24.4	37.0	23.2	34.1	31.7
	Rec. Yield[b]		6.4	8.7	8.5	4.7	3.9	6.1	11	6.8	4.4	4.2	7.2	6.8	4.9	7.4	4.6	6.8	6.3
	Roe Quota	6.4	5.4	7.5	7.3	3.5	2.6	4.2	5.4	4.9	2.3	2.4	5.5	5.5	2.0	4.1	2.5	4.2	3.5
	Roe Catch[c]	8.3	6.1	7.9	8.5	4.9	3.5	5.0	6.3	4.7	2.1	3.1	5.5	3.2	2.1	4.3	2.9	4.5	3.7
CC	Forecast[a]		23.0	23.8	48.5	43.2	38.2	37.7	70.1	69.8	54.4	25.8	20.7	44.5	43.4	47.0	36.8	25.4	25.3
	Rec. Yield[b]		4.6	4.8	9.7	8.6	7.6	7.5	14.0	14.0	10.9	5.2	3.1	8.9	8.7	9.4	7.4	5.1	5.0
	Roe Quota	2.3	3.3	3.7	7.8	7.4	6.2	5.3	7.8	10.3	8.5	3.2	1.4	7.8	6.9	6.3	5.2	2.8	2.1
	Roe Catch[c]	3.3	3.6	4.5	9.5	8.4	8.9	8.3	10.5	11.9	9.6	4.3	3.6	8.6	7.5	7.4	6.1	3.3	2.2
SG	Forecast[a]		53.0	46.7	49.4	55.2	69.8	59.2	91.8	97.4	69.5	63.4	77.2	72.7	78.9	84.7	82.6	103.1	130.0
	Rec. Yield[b]		10.6	9.3	9.9	11.0	14.0	11.8	18.3	19.5	13.9	12.7	15.5	14.5	15.8	16.9	16.5	20.6	26.0
	Roe Quota	0.0	8.0	6.4	7.4	7.1	9.1	9.7	11.0	14.4	11.9	10.8	13.2	13.0	11.5	13.2	13.9	16.2	16.8
	Roe Catch[c]	0.2	9.1	7.5	7.4	7.9	10.6	12.5	13.1	16.7	12.5	13.6	15.4	12.7	11.8	14.0	15.0	17.3	17.8
WCVI [g]	Forecast[a]		48.3	39.6	52.6	35.9	33.9	29.1	NA[h]	36.3	20.8	21.4	24.1	40.1	39.6	21.5	14.6	22.4	30.0
	Rec. Yield[b]		9.7	7.9	10.5	7.2	6.8	5.8	3.4[h]	7.3	2.0	2.0	4.8	8.0	7.9	2.7	0.0	3.6	6.0
	Roe Quota	0.0	9.4	8.1	10.3	7.2	6.7	2.9	2.7	5.0	1.3	0.9	3.7	7.5	5.1	1.1	0.0	0.4	2.9
	Roe Catch[c]	0.2	15.9	9.7	13.4	9.9	8.6	3.7	5.6	6.0	2.0	0.8	6.7	7.0	4.4	1.6	0.0	0.8	3.0
Coast	Forecast	0.0	171.7	166.0	206.8	192.9	184.5	174.6	234.7	250.0	174.3	138.5	169.1	211.1	214.5	205.3	165.9	199.0	224.2
	Rec. Yield	0.0	33.5	30.7	41.3	38.6	36.9	34.8	50.2	48.6	31.2	24.1	30.9	42.2	42.9	39.4	28.5	38.9	43.3
	Roe Quota	12.5	27.5	25.7	33.7	30.7	29.3	25.4	29.9	34.6	24.0	17.3	23.8	35.4	28.5	26.1	21.6	24.0	25.3
	Roe Catch	15.6	36.7	29.9	40.2	40.1	38.6	33.3	39.5	39.6	26.1	21.8	31.1	32.9	28.8	29.1	24.0	26.6	26.7

[a] PSARC stock forecast used to derive recommended yield;
[b] PSARC recommended yield, includes allocations to non-roe fisheries;
[c] Roe catch includes all test fishery catches;
[d] Catch in 1999 through 2002 were the dockside validated catch;
[e] In 1983, the quota for North of Cape Caution was 11.8 tonnes;
[f] In 1983, 1985, 1990, 1991, 1992 and 1993 catch for QCI included both areas 2E and 2W;
[g] Includes Area 27 catch in 1983 & 1984 but excludes it in 1992, 1993, 1994, 1995 following removal from assessment region;
[h] No consensus on stock status, recommended that catch not exceed 1992 level.

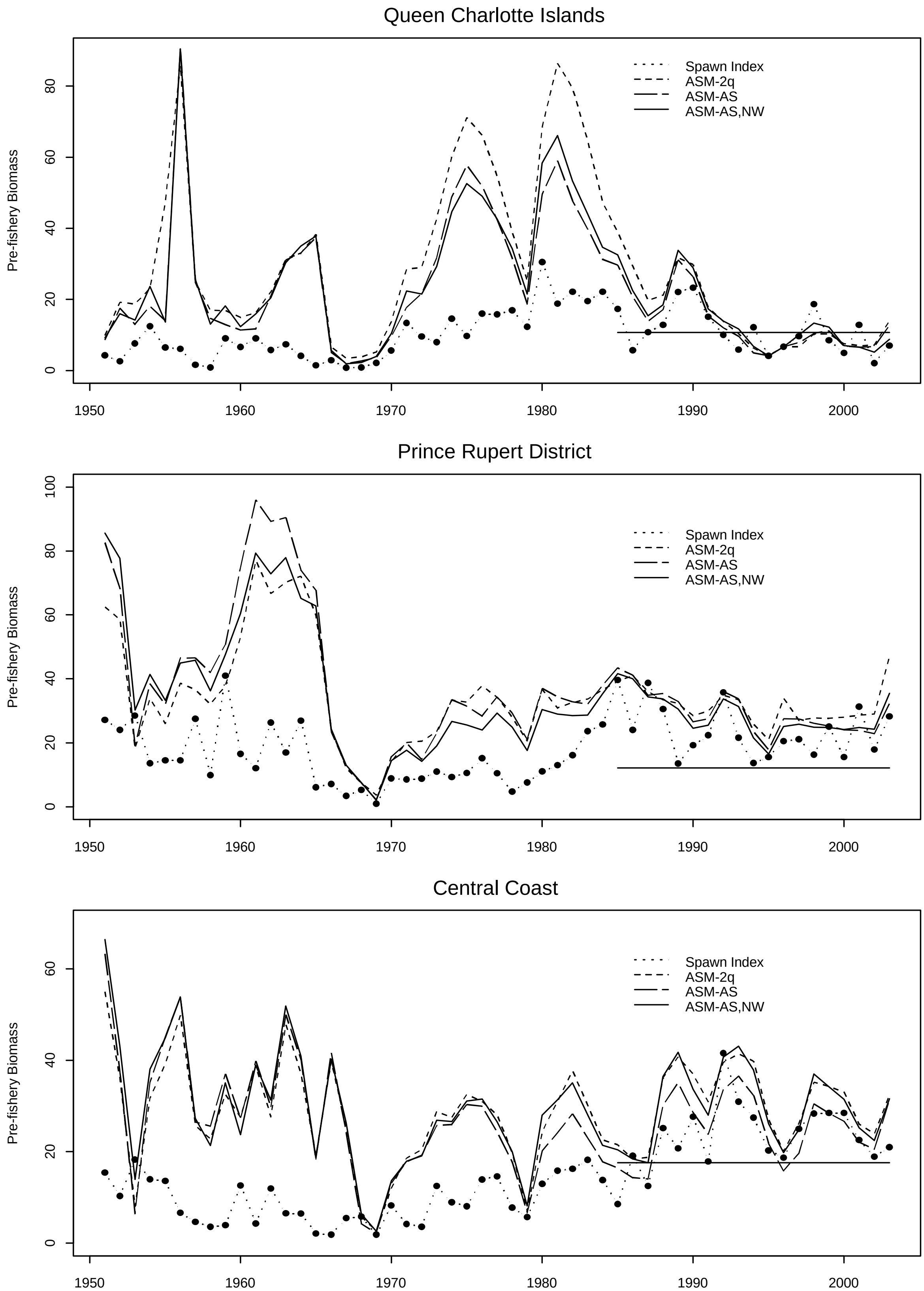

Figure 4.1. Estimates of pre-fishery spawning stock biomass (tonnes x 1000) from age-structured model (ASM) analyses for northern B.C. herring stock assessment regions, 1951-2003, assuming annual selectivity curves and alternate weighting schemes. Horizontal line indicates the Cutoff level.

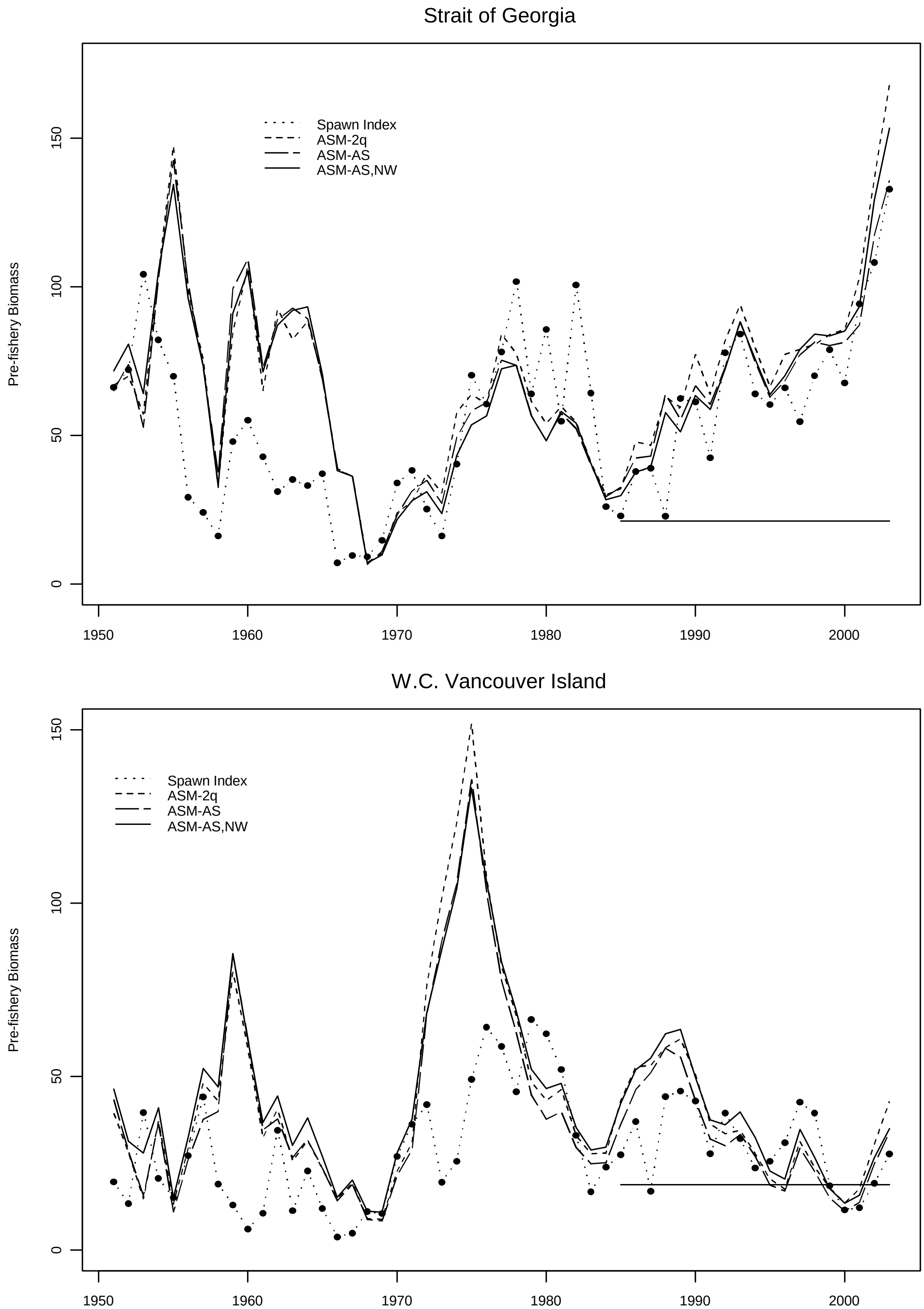

Figure 4.2. Estimates of pre-fishery spawning stock biomass (tonnes x 1000) from age-structured model (ASM) analyses for southern B.C. herring stock assessment regions, 1951-2003, assuming annual selectivity curves and alternate weighting schemes. Horizontal line indicates the Cutoff level.

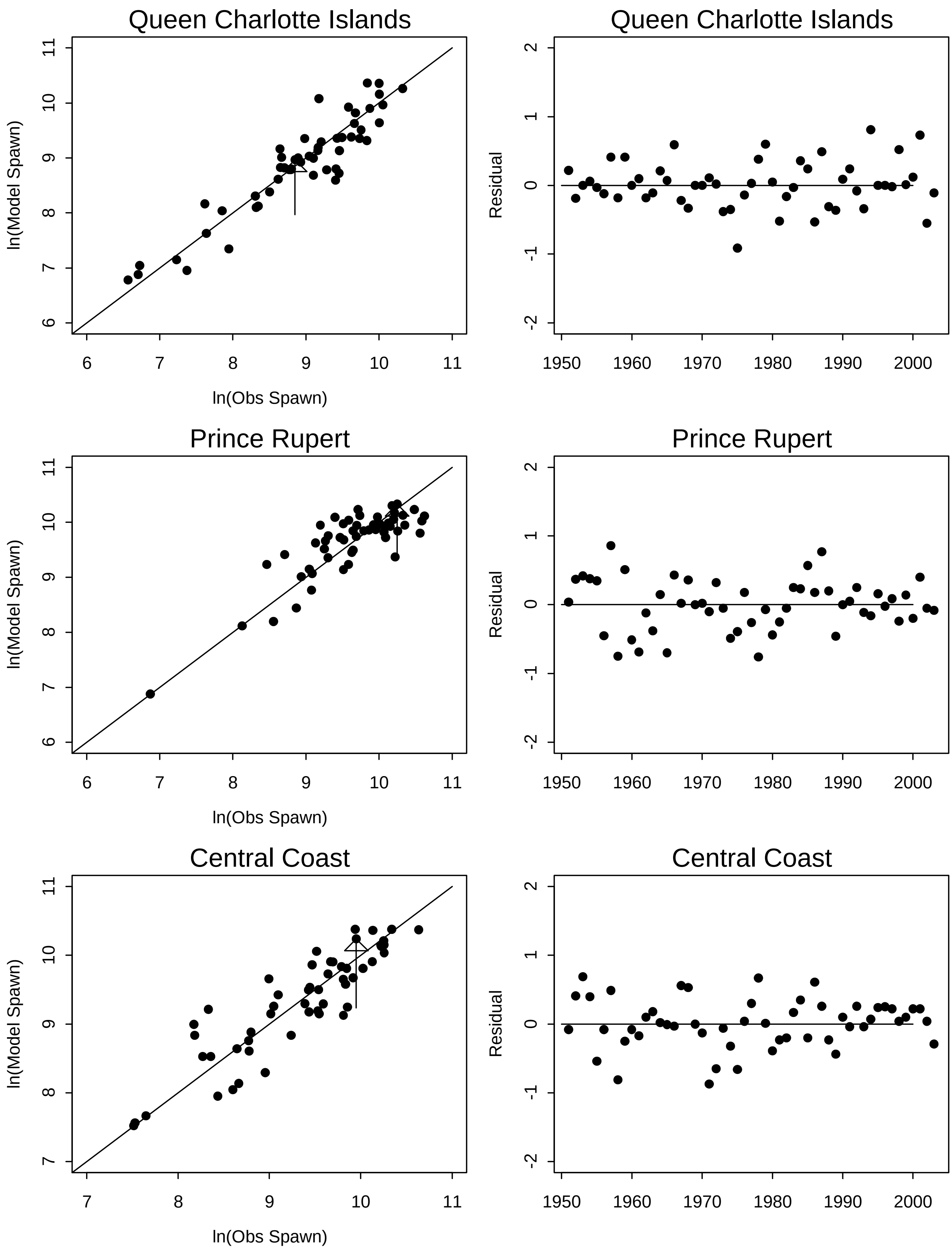

Figure 4.3. The residuals from the observed spawn - true spawn relationship for the northern assessment regions. The arrow indicates the most recent data point.

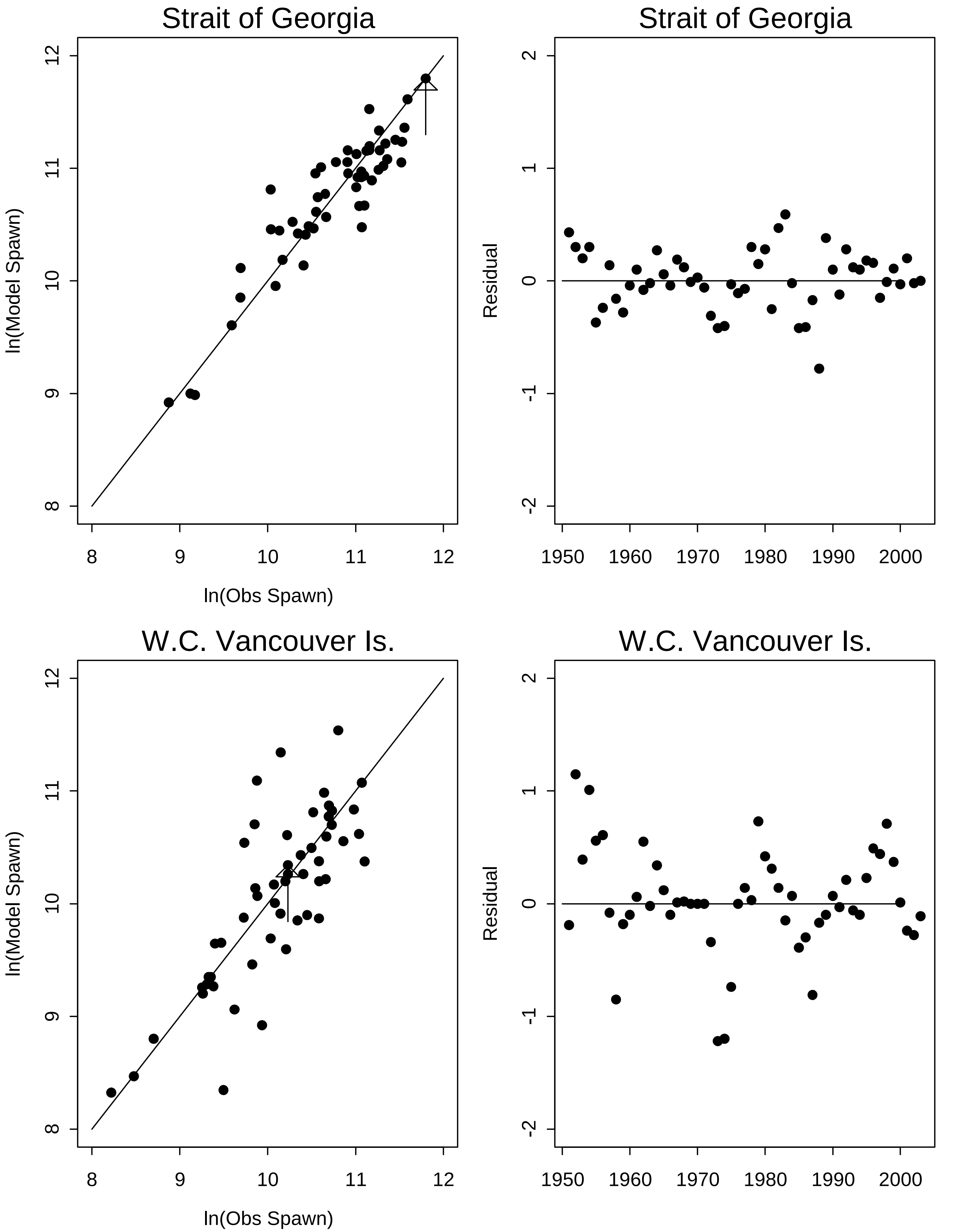

Figure 4.4. The residuals from the observed spawn - true spawn relationship for the southern assessment regions. The arrow indicates the most recent data point.

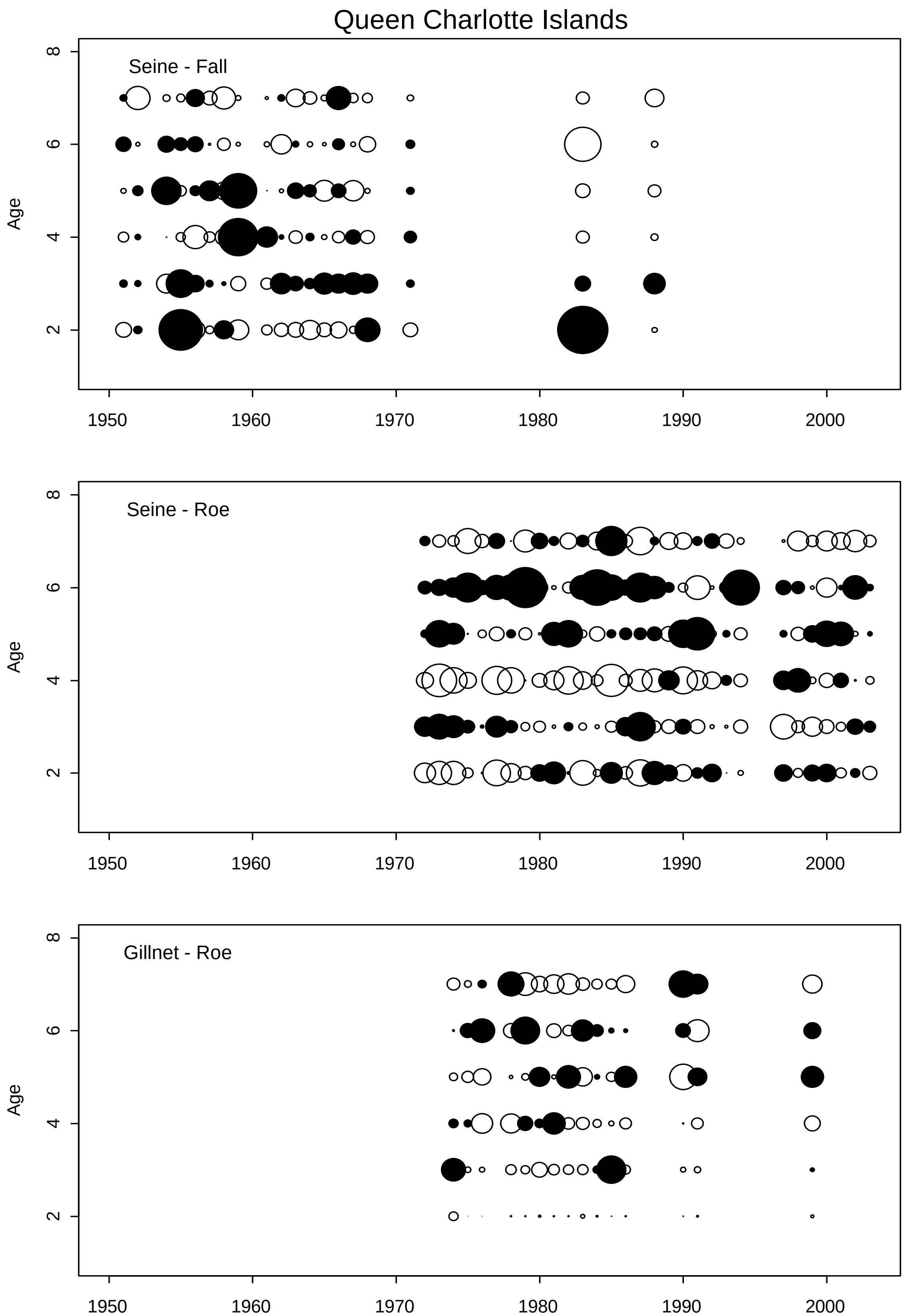

Figure 4.5. Residuals from the age-structured model fit to the catch-at-age data by year and fishing period for the Queen Charlotte Islands. Filled circles indicate positive residuals and open circles are negative residuals.

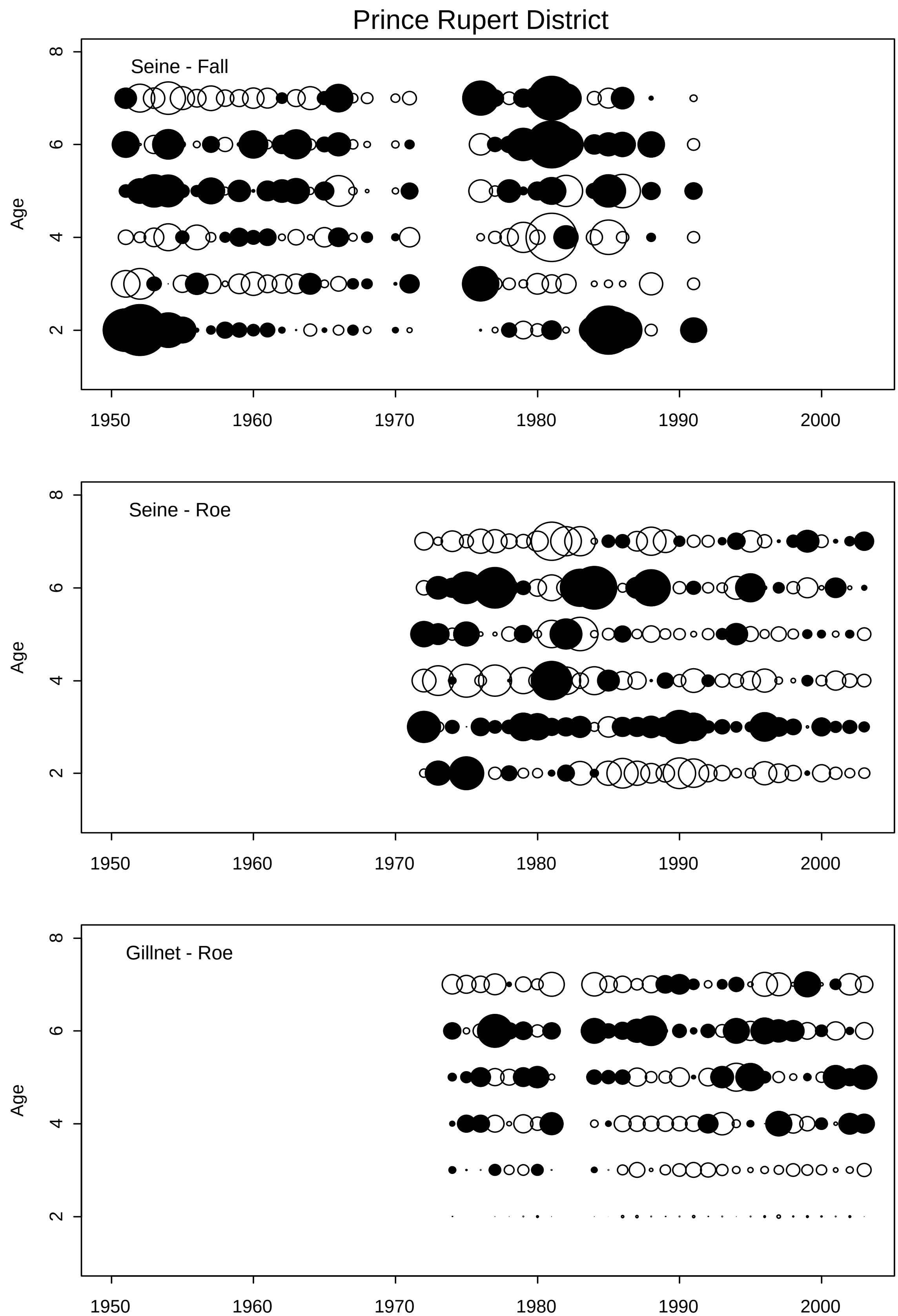

Figure 4.6. Residuals from the age-structured model fit to the catch-at-age data by year and fishing period for the Prince Rupert District. Filled circles indicate positive residuals and open circles are negative residuals.

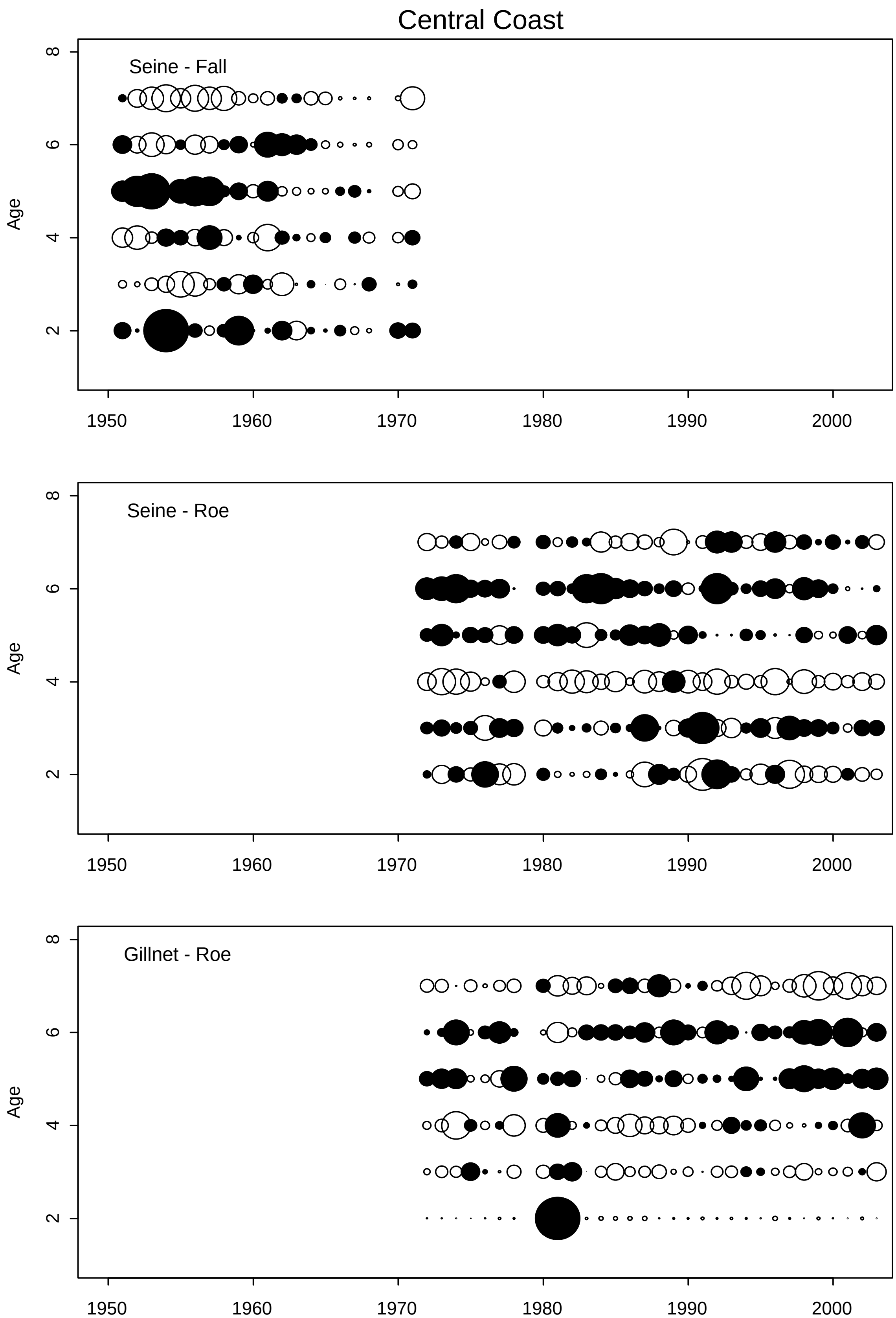

Figure 4.7. Residuals from the age-structured model fit to the catch-at-age data by year and fishing period for the Central Coast. Filled circles indicate positive residuals and open circles are negative residuals.

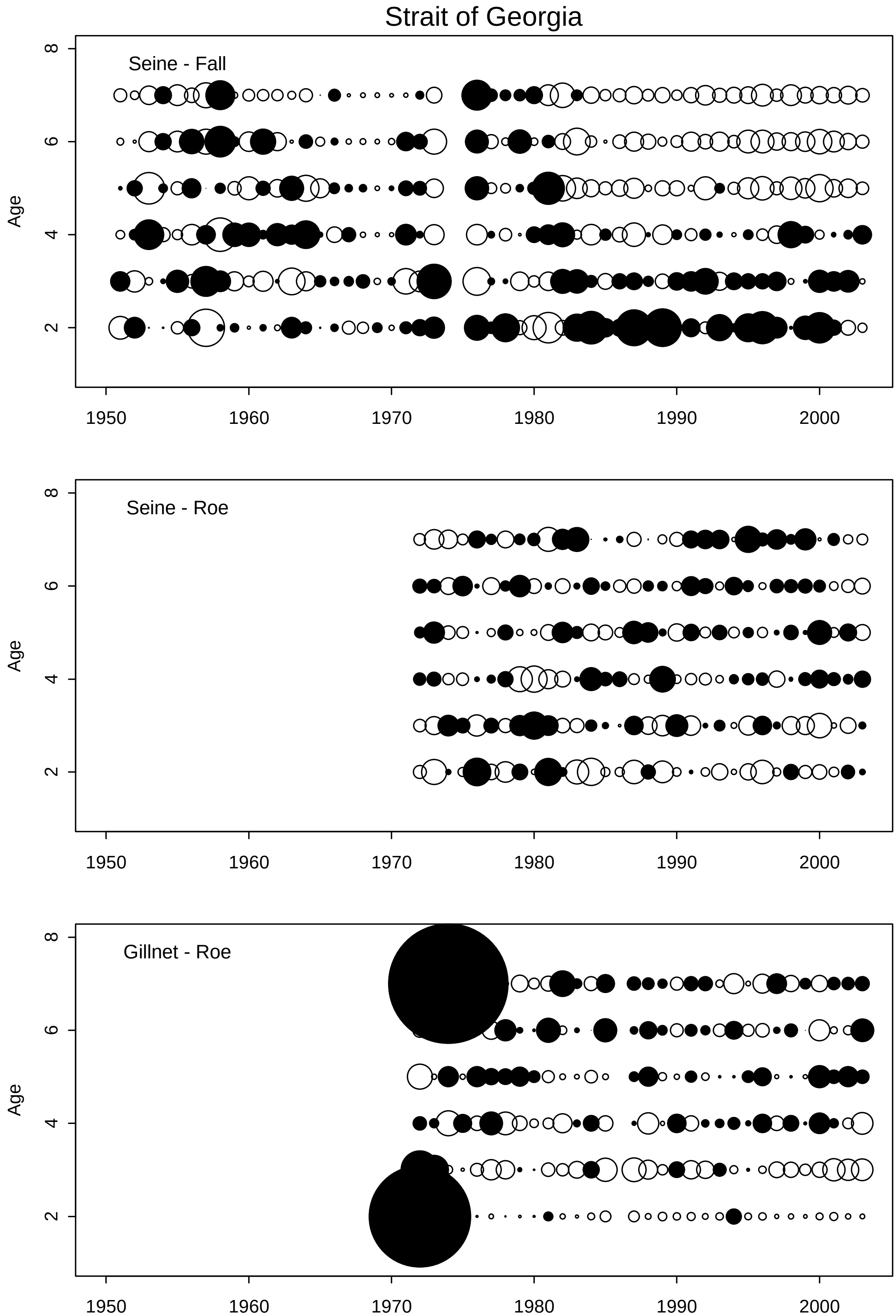

Figure 4.8. Residuals from the age-structured model fit to the catch-at-age data by year and fishing period for the Strait of Georgia. Filled circles indicate positive residuals and open circles are negative residuals.

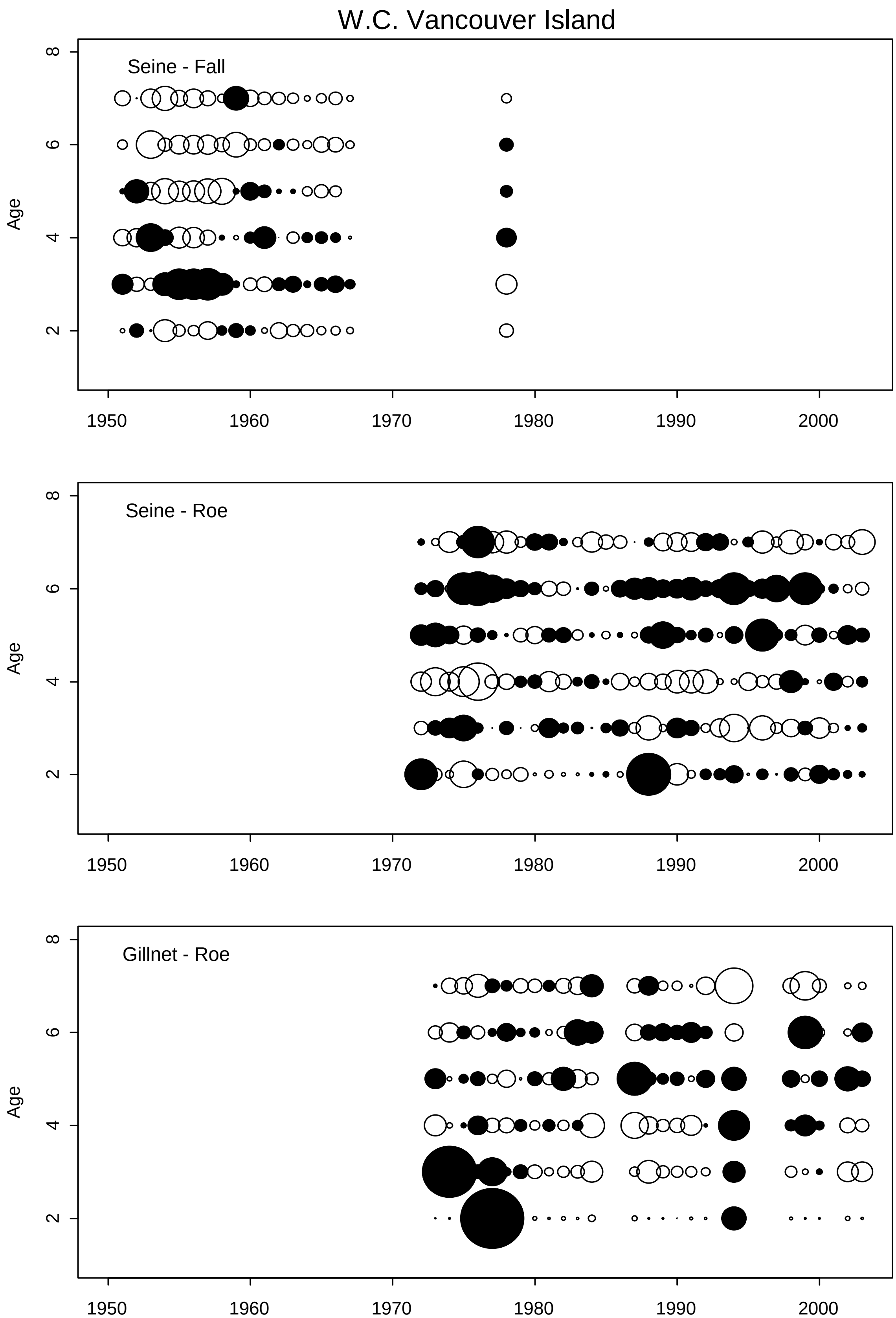

Figure 4.9. Residuals from the age-structured model fit to the catch-at-age data by year and fishing period for the west coast of Vancouver Island. Filled circles indicate positive residuals and open circles are negative residuals.

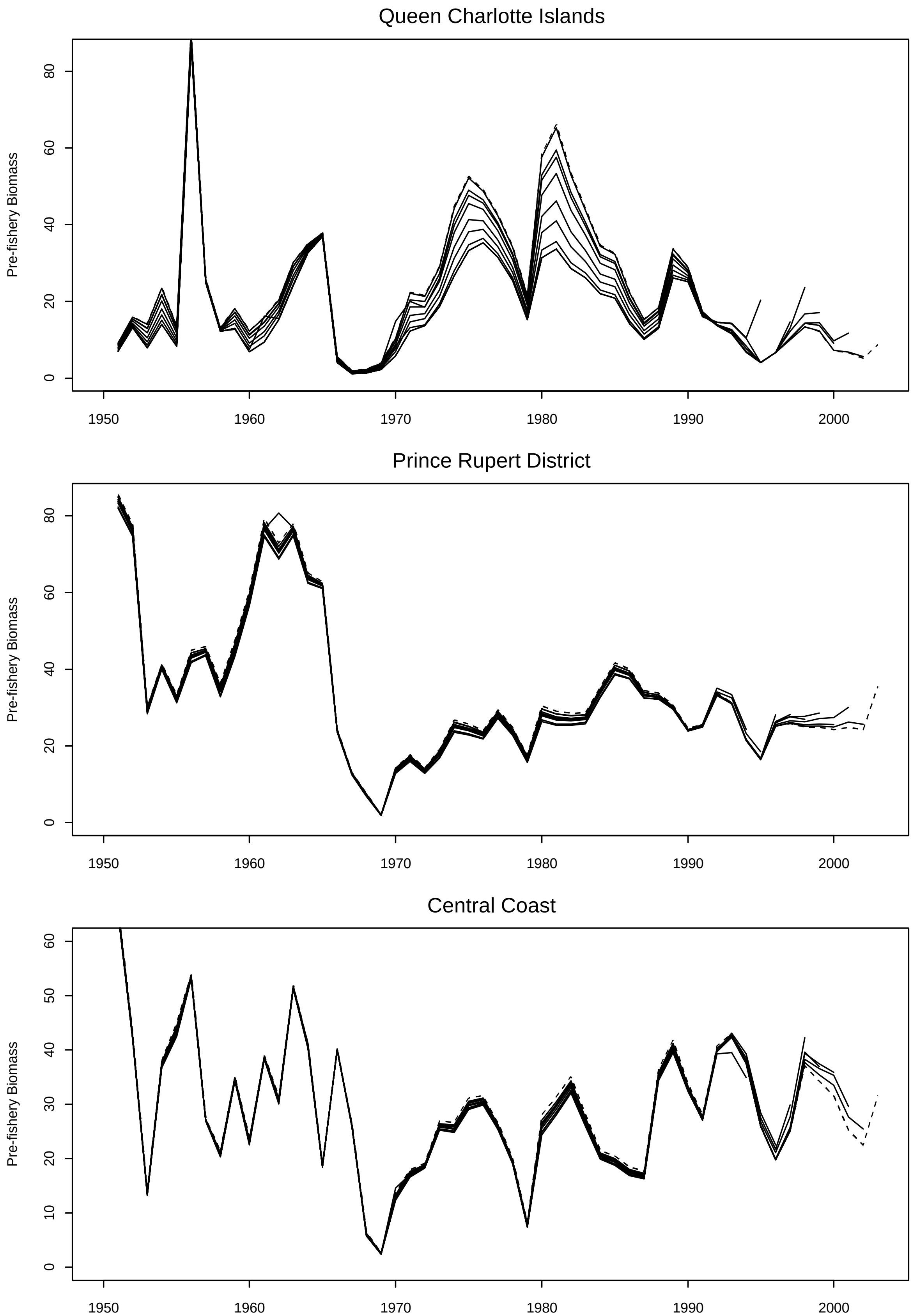

Figure 4.10. Retrospective analysis of estimated spawning biomass (tonnes x 1000) for northern B.C. herring stocks from 1951-2003. Dashed line indicates the most recent assessment.

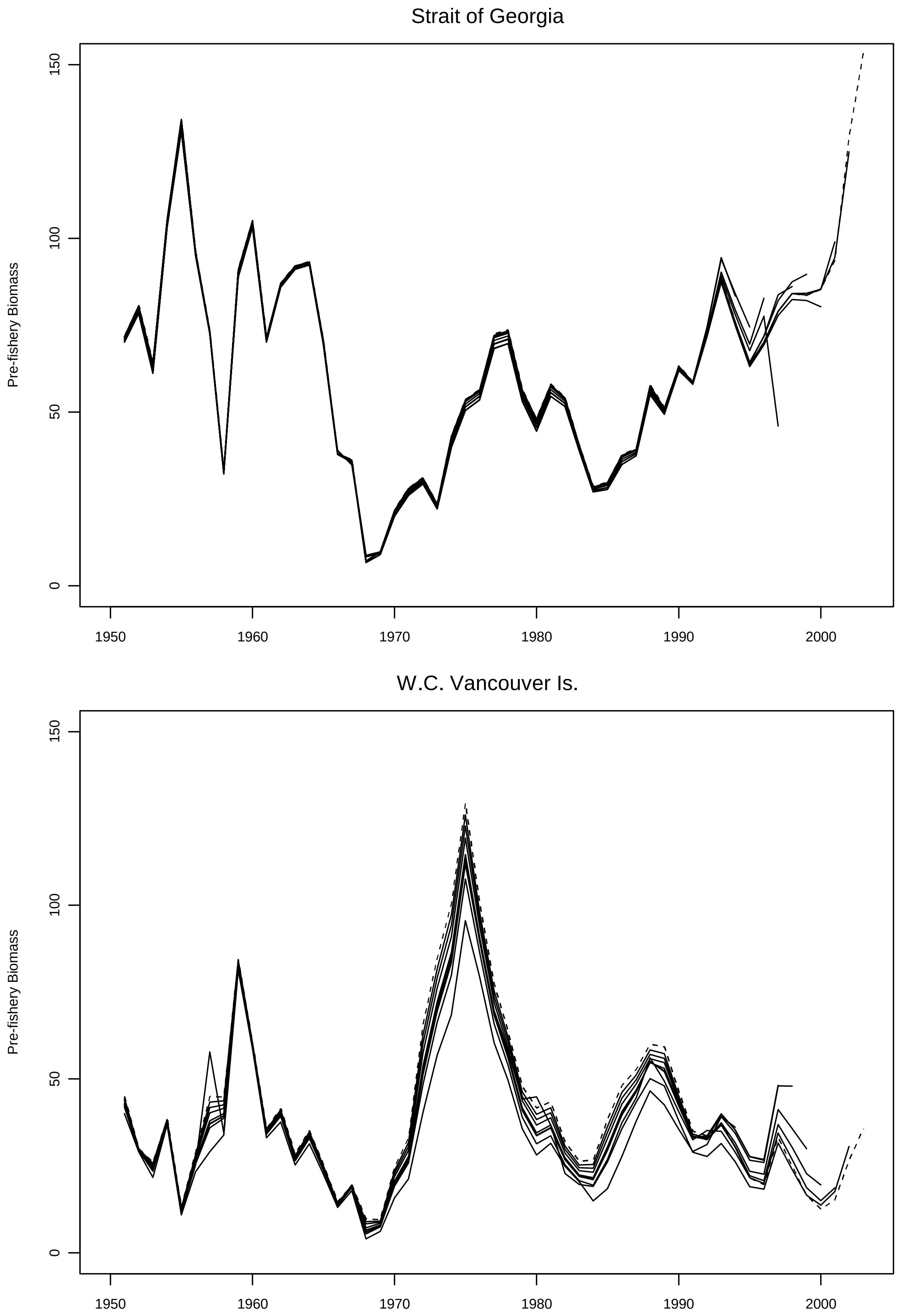

Figure 4.11. Retrospective analysis of estimated spawning biomass (tonnes x 1000) for southern B.C. herring stocks from 1951-2003. Dashed line indicates the most recent assessment.

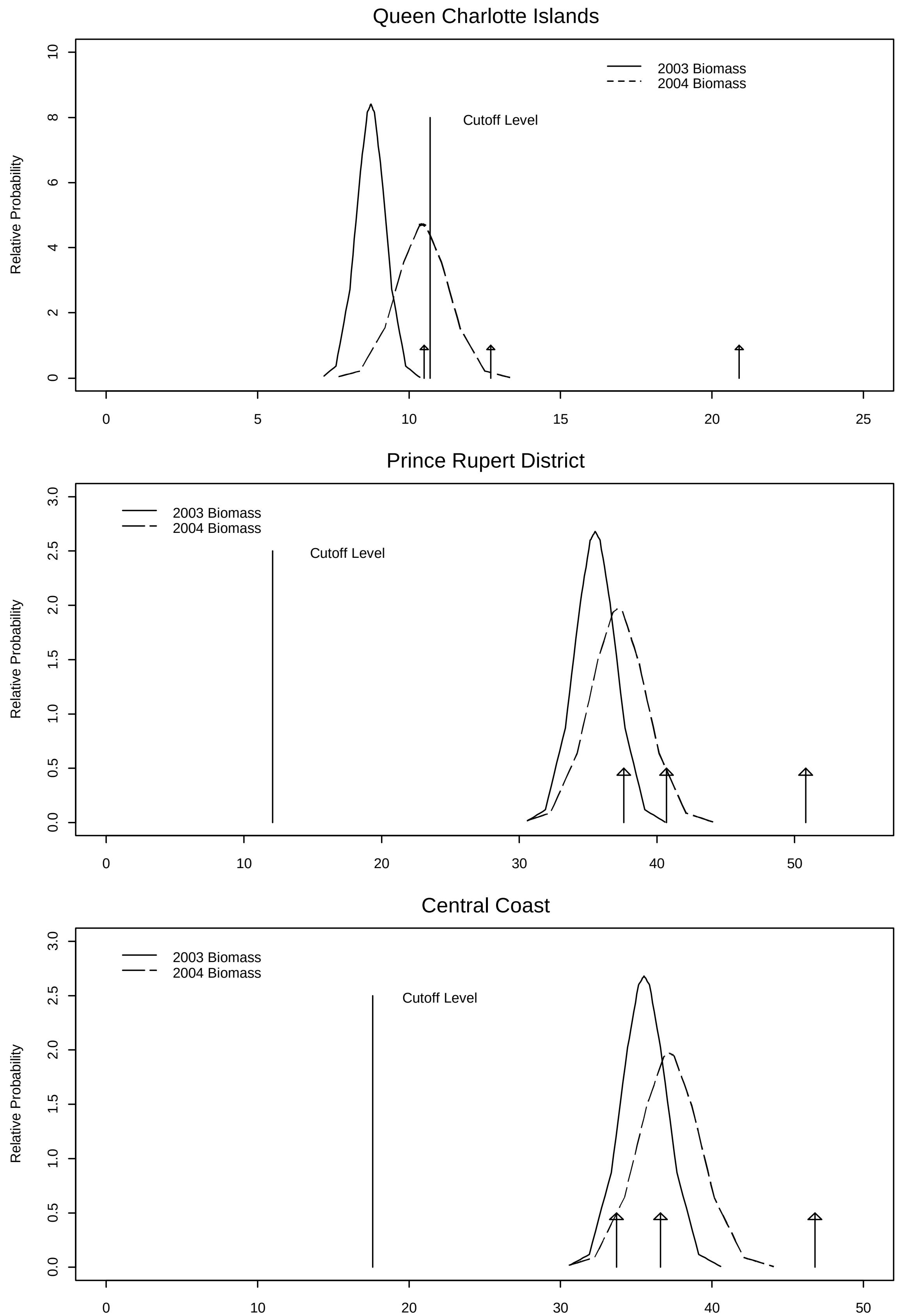

Figure 4.12. Estimated Bayesian profile likelihood distributions for current and forecast pre-fishery biomass for the northern stock assessment regions.

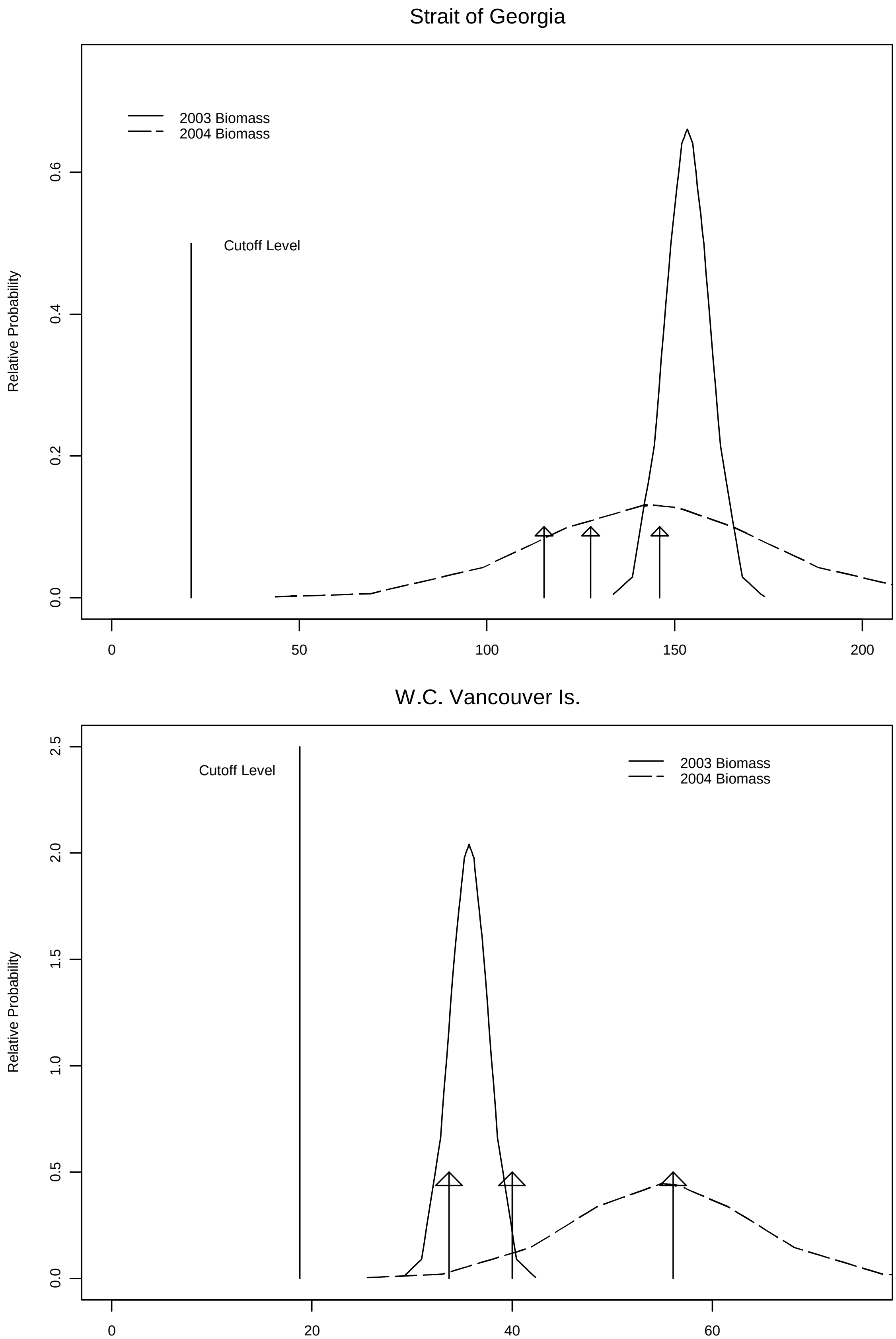

Figure 4.13. Estimated Bayesian profile likelihood distributions for current and forecast pre-fishery biomass for the southern stock assessment regions.

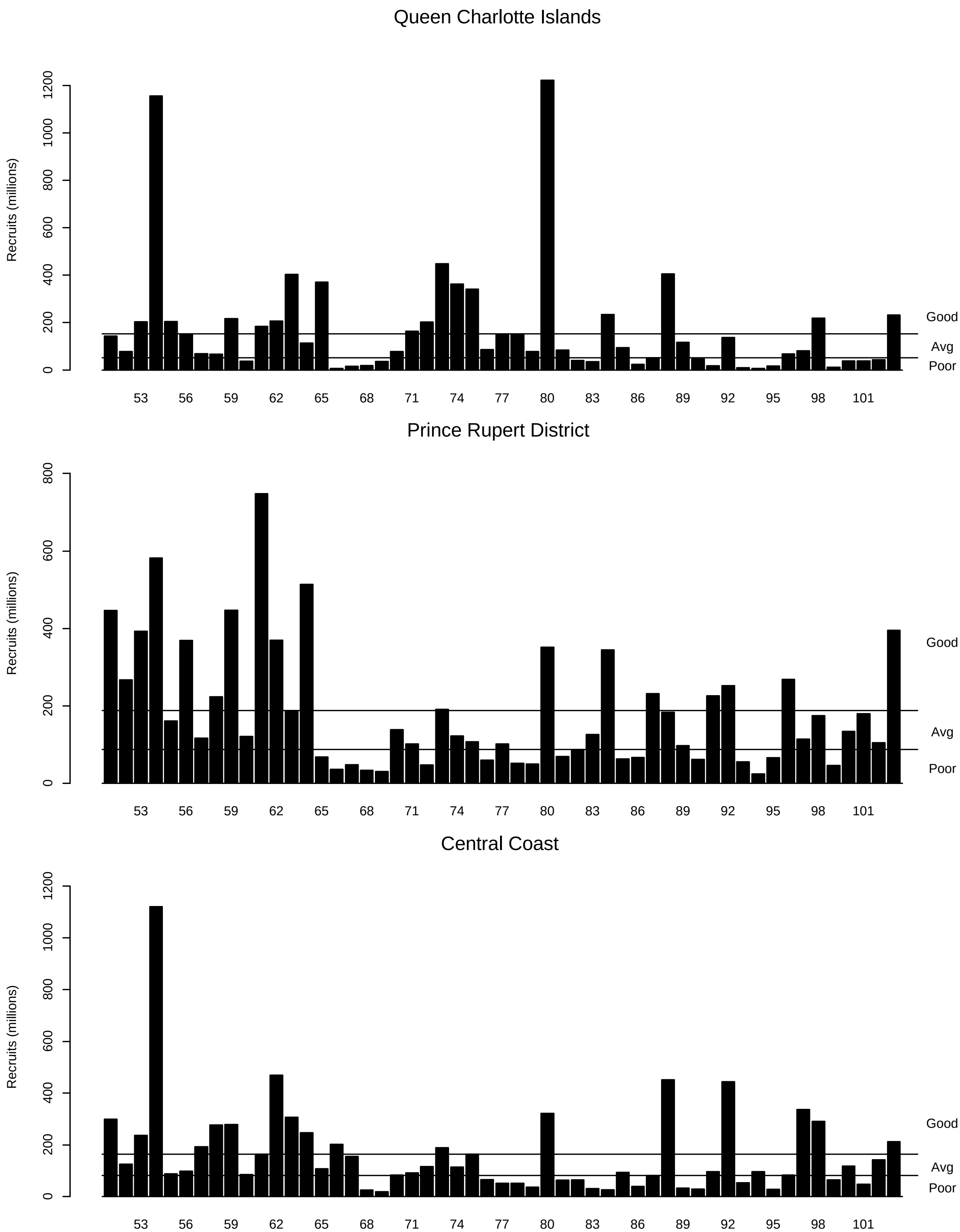

Figure 4.14. Estimates of abundance of recruiting age 2^+ year-classes from age-structured analysis for northern B.C. herring stock assessment regions, 1951-2003. The horizontal lines delimit poor, average, and good recruitment categories and are the 33 and 66 percentiles of the cumulative frequency distribution.

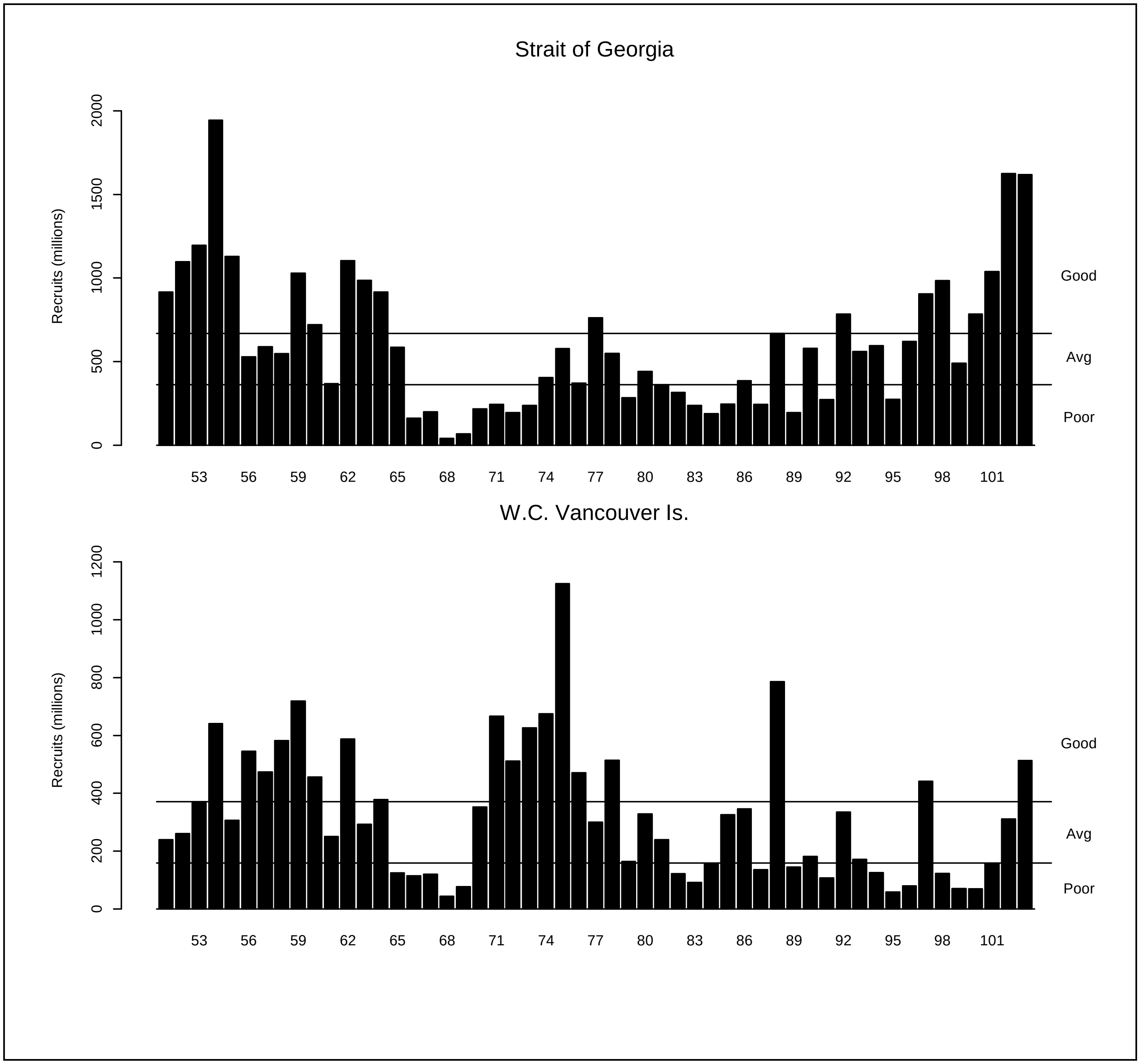

Figure 4.15. Estimates of abundance of recruiting age 2^+ year-classes from age-structured analysis for southern B.C. herring stock assessment regions, 1951-2003. The horizontal lines delimit poor, average, and good recruitment categories and are the 33 and 66 percentiles of the cumulative frequency distribution.

Queen Charlotte Islands

The stock reconstruction for the Queen Charlotte Islands region indicates peaks in abundance during the mid-1950s, 1970s, and 1980s followed by a recent protracted decline (Fig. 4.1). Similar trends in stock biomass are evident from all three versions of the catch-age model. Residuals from the spawn and age composition data do not indicate any major lack of fit to the model in recent years (Fig. 4.3, 4.5). The retrospective analysis for this stock suggests considerable uncertainty about abundance levels during the 1970s and 1980s with a general tendency to under estimate abundance relative to the current assessment. However, in recent years there is an indication that the revised model has a small tendency for optimistic forecasts of abundance (Fig. 4.10)

The profile likelihood indicates that abundance in 2003 was between 8 and 10,000 tonnes and projections for 2004 are anticipated to be slightly higher (Fig. 4.12). The forecast biomass is expected to be very close to the Cutoff level of 10,700 tonnes for this assessment region. A poor recruitment would bring the stock to just below the Cutoff level while an average recruitment would bring the biomass to just above this level. Recruitment to this stock has been generally poor for the past decade with only one good year-class in 1995 although indications are that the 2000 year-class that recruited this year is also good (Fig. 4.14). The spawning run was composed primarily of recruits with age 3 fish constituting 70% of the spawners (Appendix 1.1). The forecast run size to the Queen Charlotte Islands in 2004 is 10.500 tonnes with a poor recruitment and 12,700 tonnes with an average recruitment (Table 4.3).

Prince Rupert District

The stock reconstruction for the Prince Rupert District indicates minor fluctuations in abundance since the rebuilding of the stock in the early 1970s with a relatively stable level since the early 1980s (Fig. 4.1). Similar trends in stock biomass are observed for all three catch-age models. Residuals from the spawn data indicate a good fit to the model (Fig. 4.3). The age composition data does not indicate any major lack of fit to the model in recent years although there are some large residuals from the fall food fishery samples in the early 1980s (Fig. 4.6). The retrospective analysis for this stock indicates some minor variations in estimated abundance during part of the time series although it is much improved over recent assessments. In recent years the model abundance forecasts have been slightly higher than suggested by the current assessment (Fig. 4.10).

The profile likelihood indicates that abundance in 2003 was between 30 and 40,000 tonnes and projections for 2004 are anticipated to be of a similar magnitude (Fig. 4.12). Both these levels are well above the Cutoff of 12,100 tonnes for this assessment region. Recruitment to this stock has been consistent, with good year-classes occurring roughly ever 4 years since 1980 and indications are that the recruitment in 2003 was good (Fig. 4.14). The spawning run consisted of over 50% age 2+ recruits (Appendix 1.1). The forecast run size to the Prince Rupert District in 2004 with average recruitment is 40,710 tonnes resulting in a potential harvest of 8,140 tonnes (Table 4.3).

Central Coast

The stock reconstruction for the Central Coast indicates moderate fluctuations in abundance since the rebuilding of the stock in the early 1970s with a slightly increasing trend to the mid-1990s (Fig. 4.1). The fluctuations appear to be associated with the recruitment of strong year-classes. Virtually identical trends in stock biomass are observed with the new weighting and last year's model. However, these are more optimistic than the model with annual availability estimates and the old weighting. Residuals from the spawn data indicate good fit to the model (Fig. 4.3). The age composition data also do not indicate any major lack of fit to the model in recent years although there are some larger residuals for the gillnet fishery early in the time series (Fig. 4.7). The retrospective analysis for this stock indicates little or no variation in estimated abundance during the entire time series. There are only slight indications of over forecasting in recent years relative to the current assessment (Fig. 4.10).

The profile likelihood indicates that abundance in 2003 was between 30 and 40,000 tonnes and projections for 2004 are anticipated to be slightly higher (Fig. 4.12). The projected abundance remains well above the Cutoff of 17,600 tonnes for this assessment region. Recruitment to this stock has been characterized by intermittent strong year-classes with the last good ones being 1994 and 1995 (Fig. 4.14). The recruiting 2000 year-class was good, accounting for 40% of the spawning run (Appendix 1.1). The forecast run size to the Central Coast in 2004 with average recruitment is 36,600 tonnes, resulting in a potential harvest of 7,300 tonnes.

Strait of Georgia

The Strait of Georgia herring stock remains the most productive on the coast. Stock reconstruction for the Strait of Georgia indicates that abundance has increased steadily since the fishery closure of the mid-1980s (Fig. 4.2). Very similar trends in stock biomass are observed using all three versions of the catch-age model although the 2q model used in last year's assessment results in the highest abundance estimates in recent years. Residuals from the spawn data indicate good fit to the model particularly since the early 1990s (Fig. 4.4). The age composition data does not indicate any major lack of fit to the model over the time series although there are two very large gillnet residuals at the beginning of the time series and some large residuals for the fall food fishery since the mid-1970s (Fig. 4.8).The retrospective analysis for this stock indicates little or no variation in estimated abundance during most of the time series, and no consistent indication of over or under forecasting relative to the current assessment (Fig. 4.11).

The profile likelihood indicates that abundance in 2003 was between 140 and 170,000 tonnes and projections for 2004 are anticipated to be slightly lower (Fig. 4.13). The projected abundance remains well above the Cutoff of 21,200 tonnes for this assessment region. Recruitment to this stock has been characterized by consistent strong year-classes every second or third year since the mid-1980s (Fig. 4.15). The recruiting 2000 year-class along with the 1999 appear to be among the largest ever observed in this assessment region accounting for 46% and 34% of the spawning run in 2003 (Appendix 1.1). The forecast run size to the Strait of Georgia in 2004 with average recruitment is 127,600 tonnes resulting in a potential harvest of 25,520 tonnes.

West Coast Vancouver Island

Abundance in the west coast of Vancouver Island assessment region has fluctuated dramatically from the historic high of the mid-1970s to the recent depressed levels (Fig. 4.2). As with most of the other stocks, very similar trends in stock biomass are observed for all three versions of the catch-age model. Residuals from the spawn data indicate a reasonable fit to the model with larger residuals than most of the other areas (Fig. 4.4). The age composition residuals indicate a good fit throughout the time series with only a few large residuals during the gillnet fisheries of the late-1970s (Fig. 4.9). The retrospective analysis for this stock indicates substantial variation in estimated abundance during the 1970s and 1980s with a slight tendency to overestimate abundance relative to the most recent assessment in the last few years (Fig. 4.11).

The profile likelihood indicates that abundance in 2003 was between 30 and 40,000 tonnes and projections for 2004 are poorly determined but are anticipated to be somewhat higher (Fig. 4.13). The projected abundance is well above the Cutoff of 18,800 tonnes for this assessment region, and indicates that the rebuilding trend observed the past few years is continuing. Recruitment to this stock has been characterized by periods of good and bad recruitment prior to 1980. Subsequently, average or better year-classes have been intermittent occurring about every 4-5 years (Fig. 4.15). The recruiting 2000 year-class appears to be good accounting for 39% of the spawning run (Appendix 1.1). The forecast run size to the west coast of Vancouver Island in 2004 with average recruitment, is 40,00 tonnes resulting in a potential harvest of 8,000 tonnes.

Minor Stocks

A forecast of run size is not available for the minor stocks in Area 27. However, based on recent harvesting policy for this area, a quota of no more than 10% of the estimated 2003 biomass is recommended. The estimated spawning biomass of 857 tonnes in 2003 (Table 2.1), yields a maximum potential harvest of 86 tonnes for the area.

Similarly, the limited spawn assessment in Area 2W indicated a biomass of 1462 tonnes in 2003, resulting in a potential harvest of 146 tonnes for 2004 (Table 2.2)

Table 4.3. Summary of 2004 abundance forecast, Cutoff levels, and potential harvest given poor, average, and good age 2^+ recruitment for each of the assessment regions. The 95% confidence interval for the profile likelihood is also presented.

Assessment	Abundance Forecast			P.L.	Cutoff	Potential Harvest		
Region	Poor	Avg	Good	95% C.I.	Level	Poor	Avg	Good
Queen Charlotte Is.	10.54	12.74	20.95	9.0-12.0	10.7	0.00	2.04*	4.20
Prince Rupert	37.57	40.71	50.81	33.8-40.9	12.1	7.51	8.14	10.16
Central Coast	33.70	36.57	46.81	29.8-35.7	17.6	6.74	7.31	9.36
Georgia Strait	125.3	137.6	156.4	138.9-157.5	21.2	25.05	27.53	31.27
W.C. Vancouver Is.	33.75	39.98	56.11	40.0-71.4	18.8	6.75	8.00	11.22

* Available harvest is the forecast-Cutoff to maintain stock at or above the Cutoff level.

5. SIZE AT AGE TRENDS

Interannual changes in growth rate of herring can have significant impacts on the size at age and consequently on the estimates of stock productivity and availability to the harvesting sectors. Recent concerns about declining size of herring in the late 1990s have ameliorated but no obvious trends in size at age are evident from recent data (Fig. 5.1). Size at age trends continue to be of interest and since 1999 have been incorporated into the management decision making process to adjust the potential harvest based on the proportion of the stock catchable by the gillnet sector.

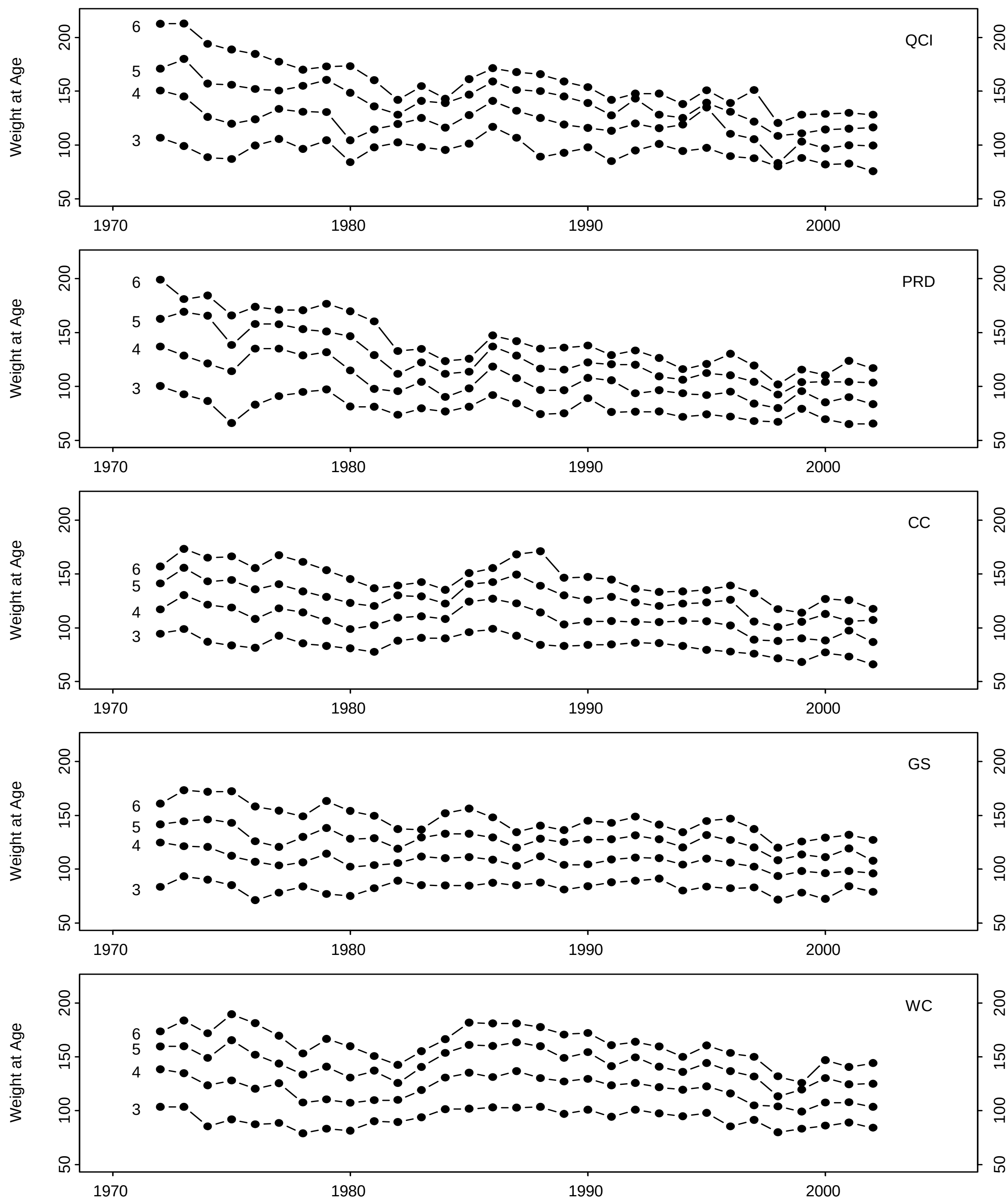

Figure 5.1. Estimates of weight-at-age (g) for 3-6 year old herring from 1951-2003 for the five major assessment regions.

ACKNOWLEDGEMENTS

Chuck Fort and Peter Midgley updated the catch, biological sampling and spawn survey data bases and reviewed all 2003 assessment data. Howard Stiff provided programming support for the Access databases used to summarize the assessment data series. Database upgrades and ongoing maintenance has been funded by the Herring Conservation and Research Society (HCRS). The HCRS through the test fishing program also funded the collection of spawn survey information and biological samples coastwide

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7. APPENDICES

Appendix 1.1. Age composition and catch by season, fishery and gear type for the Queen Charlotte Islands stock assessment region. These data are used for the age-structured model analysis.

			PERCENT AT AGE												CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	(tonnes)	(millions)
19501	Seine	Jan-Apr	0.00	0.07	15.31	52.91	15.31	11.52	4.20	0.61	0.07	0.00	89.7	1,476	2,847	31.744
19512	Seine	Jan-Apr	1.92	24.77	20.96	29.67	17.98	3.71	0.93	0.07	0.00	0.00	78.4	2,251	10,147	122.347
19534	Seine	Jan-Apr	0.06	2.90	29.02	21.28	33.66	10.19	1.93	0.71	0.19	0.06	77.1	0 *	1,786	23.168
19545	Seine	Oct-Dec	0.00	8.74	14.08	39.42	18.06	14.85	4.37	0.29	0.10	0.10	94.1	0 *	99	1.047
	Seine	Jan-Apr	0.00	8.74	14.08	39.42	18.06	14.85	4.37	0.29	0.10	0.10	94.1	0 *	1,136	12.066
19556	Seine	Jan-Apr	0.00	0.15	16.02	9.64	62.17	8.38	2.74	0.74	0.00	0.15	118.2	1,348	77,681	657.044
19567	Seine	Jan-Apr	0.07	20.71	24.66	15.96	9.38	26.29	2.37	0.44	0.11	0.00	103.3	4,423	23,711	227.806
19578	Seine	Oct-Dec	0.00	81.58	16.68	1.26	0.18	0.14	0.14	0.00	0.00	0.00	52.1	2,769 +	721	13.844
	Seine	Jan-Apr	0.00	81.98	16.24	1.29	0.20	0.16	0.12	0.00	0.00	0.00	51.8	2,475	10,426	201.343
	Seine	May-Sep	0.00	81.58	16.68	1.26	0.18	0.14	0.14	0.00	0.00	0.00	52.1	2,769 +	19	0.357
19589	Seine	Oct-Dec	0.00	1.05	63.16	28.42	7.37	0.00	0.00	0.00	0.00	0.00	92.8	95 +	199	2.140
	Seine	Jan-Apr	0.00	1.05	63.16	28.42	7.37	0.00	0.00	0.00	0.00	0.00	92.8	95 +	6,828	73.560
19601	Seine	Jan-Apr	0.00	4.21	32.63	36.00	24.84	1.26	0.42	0.21	0.42	0.00	97.7	0 *	576	5.901
	Seine	May-Sep	0.00	4.21	32.63	36.00	24.84	1.26	0.42	0.21	0.42	0.00	97.7	0 *	77	0.789
19612	Seine	Jan-Apr	0.00	2.57	38.97	44.12	5.88	7.35	0.74	0.37	0.00	0.00	114.0	272 +	7,632	66.952
19623	Seine	Jan-Apr	0.00	0.37	50.00	27.11	18.16	2.11	1.99	0.00	0.12	0.12	109.5	804	14,705	134.232
	Seine	May-Sep	0.00	0.37	50.00	27.11	18.16	2.11	1.99	0.00	0.12	0.12	109.5	804 +	275	2.508
19634	Seine	Jan-Apr	0.00	1.02	15.92	60.00	16.53	5.31	1.22	0.00	0.00	0.00	113.9	490	28,600	251.046
	Seine	May-Sep	0.00	1.02	15.92	60.00	16.53	5.31	1.22	0.00	0.00	0.00	113.9	490 +	131	1.154
	Trawl	Jan-Apr	0.00	1.02	15.92	60.00	16.53	5.31	1.22	0.00	0.00	0.00	113.9	490 +	46	0.401
19645	Seine	Jan-Apr	0.00	1.71	82.31	10.25	3.63	1.34	0.55	0.20	0.00	0.00	101.5	1,019	35,304	348.556
	Seine	May-Sep	0.00	1.67	81.75	10.30	4.02	1.47	0.59	0.20	0.00	0.00	102.0	1,019 +	145	1.419
19656	Seine	Jan-Apr	0.00	18.36	32.77	16.38	10.40	7.45	5.89	4.92	2.07	1.75	130.7	0 *	2,746	21.016
19667	Seine	Jan-Apr	0.00	0.88	67.25	26.49	2.65	2.72	0.00	0.00	0.00	0.00	113.0	0 *	213	1.883
19678	Seine	Jan-Apr	0.00	29.95	50.57	17.23	2.25	0.00	0.00	0.00	0.00	0.00	94.9	0 *	80	0.843
19701	Seine	Jan-Apr	0.00	6.50	50.40	29.30	8.00	4.30	0.80	0.50	0.20	0.00	118.1	0 *	102	0.861
19712	Seine	Jan-Apr	0.00	3.59	34.24	40.98	12.30	5.57	2.14	0.77	0.35	0.06	142.1	1,184	3,972	27.954
19723	Seine	Jan-Apr	0.00	0.20	32.91	18.91	32.99	11.77	2.10	1.13	0.00	0.00	140.7	1,726	7,520	49.735
19734	Seine	Jan-Apr	0.00	0.12	27.40	41.39	17.67	10.64	2.32	0.40	0.06	0.00	126.8	1,215	6,191	47.881
	Gillnet	Jan-Apr	0.00	0.00	5.73	48.41	25.48	16.56	3.18	0.00	0.00	0.64	153.8	157 +	127	0.824
19745	Seine	Jan-Apr	0.00	0.62	27.82	36.04	24.53	8.53	1.94	0.40	0.12	0.00	132.8	6,010	7,602	60.181
	Seine	May-Sep	0.00	0.13	33.28	45.41	13.55	5.29	1.72	0.46	0.17	0.00	116.3	3,026 +	17	0.147
	Gillnet	Jan-Apr	0.00	0.00	0.00	22.50	40.00	30.00	5.00	2.50	0.00	0.00	169.3	40 +	105	0.619
19756	Seine	Jan-Apr	0.00	0.30	2.98	44.51	31.53	15.24	4.61	0.76	0.06	0.00	155.4	4,055	11,939	82.499
	Seine	May-Sep	0.00	0.44	2.81	36.87	29.25	23.18	6.41	0.96	0.07	0.00	151.8	4,055 +	374	2.466
	Other	Jan-Apr	0.00	0.44	2.81	36.87	29.25	23.18	6.41	0.96	0.07	0.00	151.8	4,055 +	341	2.247
	Gillnet	Jan-Apr	0.00	0.00	0.00	0.75	21.80	60.90	14.29	2.26	0.00	0.00	196.2	133 +	1,802	9.186
19767	Seine	Jan-Apr	0.00	0.05	18.42	9.26	36.66	22.74	9.92	2.64	0.31	0.00	159.1	3,178	11,125	73.628
	Seine	May-Sep	0.00	0.09	19.67	8.12	29.70	22.91	14.66	4.44	0.41	0.00	157.1	3,178 +	21	0.132
	Other	Jan-Apr	0.00	0.09	19.67	8.12	29.70	22.91	14.66	4.44	0.41	0.00	157.1	3,178 +	1,365	8.687
	Gillnet	Jan-Apr	0.00	0.00	0.00	2.53	16.61	39.71	27.08	11.55	2.17	0.36	196.6	277 +	1,489	7.575
19778	Seine	Jan-Apr	0.00	0.16	22.75	17.10	11.34	33.12	13.29	2.03	0.17	0.05	146.4	1,172	9,172	62.947
	Other	Jan-Apr	0.00	0.17	26.28	17.24	9.56	26.54	14.08	4.95	0.94	0.26	147.5	1,172 +	819	5.554
	Gillnet	Jan-Apr	0.00	0.00	0.00	4.17	11.81	20.14	38.89	20.14	4.17	0.69	196.9	144 +	2,553	12.967
19789	Seine	Oct-Dec	0.00	6.22	4.91	32.53	18.23	20.31	14.19	3.06	0.44	0.11	149.9	916 +	50	0.336
	Seine	Jan-Apr	0.00	7.06	5.39	32.35	18.23	20.80	12.45	3.08	0.51	0.13	148.9	779	5,817	39.078
	Other	Jan-Apr	0.00	6.22	4.91	32.53	18.23	20.31	14.19	3.06	0.44	0.11	149.9	916 +	1,001	6.679
	Gillnet	Jan-Apr	0.00	0.00	0.00	28.24	25.88	27.06	15.29	3.53	0.00	0.00	160.1	170 +	2,086	13.028
19790	Seine	Jan-Apr	0.00	0.69	83.10	4.49	5.44	2.58	1.79	1.22	0.60	0.09	97.1	2,986	2,106	22.050
	Other	Jan-Apr	0.00	1.74	83.71	4.18	4.46	2.49	1.54	1.15	0.65	0.07	93.5	4,015 +	1,001	10.704
	Gillnet	Jan-Apr	0.00	0.00	6.50	4.56	44.47	19.36	19.58	4.20	1.34	0.00	157.6	518	1,210	7.739
19801	Seine	Jan-Apr	0.00	0.42	3.05	85.37	5.13	3.08	1.92	0.68	0.21	0.14	116.3	5,551	3,888	32.912
	Seine	May-Sep	0.00	1.33	3.92	88.65	2.94	1.73	0.69	0.35	0.23	0.17	112.7	1,735 +	39	0.342
	Other	Jan-Apr	0.00	0.54	3.69	84.91	5.08	2.79	1.75	0.71	0.28	0.24	117.0	6,336 +	910	7.778
	Gillnet	Jan-Apr	0.00	0.00	0.30	72.00	8.55	9.84	5.88	2.84	0.60	0.00	141.9	790	1,705	11.930
19812	Seine	Jan-Apr	0.00	0.45	3.26	3.50	87.61	2.19	1.34	0.95	0.57	0.12	127.2	3,526	2,353	18.420
	Seine	May-Sep	0.00	0.85	4.68	4.48	84.32	2.47	1.53	0.99	0.54	0.14	128.0	3,526 +	18	0.138
	Other	Jan-Apr	0.00	0.85	4.68	4.48	84.32	2.47	1.53	0.99	0.54	0.14	128.0	3,526 +	1,001	7.821
	Gillnet	Jan-Apr	0.00	0.00	0.21	3.35	89.10	3.35	2.31	1.05	0.42	0.21	141.9	477	1,407	9.918
19823	Seine	Jan-Apr	0.00	4.14	4.21	3.02	5.75	77.05	3.65	1.33	0.70	0.14	148.7	1,425	4,601	30.942
	Seine	May-Sep	0.00	4.88	5.23	3.51	6.86	72.87	3.91	1.58	0.91	0.25	146.9	1,968 +	67	0.457
	Other	Jan-Apr	0.00	4.88	5.23	3.51	6.86	72.87	3.91	1.58	0.91	0.25	146.9	1,968 +	1,001	6.815
	Gillnet	Jan-Apr	0.00	0.00	0.00	1.19	2.38	90.32	2.72	2.38	0.51	0.51	158.5	589	929	5.860
19834	Seine	Jan-Apr	0.00	2.09	36.57	4.17	2.64	9.56	43.33	1.11	0.35	0.17	126.1	3,484	4,054	31.997
	Seine	May-Sep	0.00	2.70	36.39	4.54	2.87	10.10	41.76	1.12	0.34	0.17	125.5	3,484 +	58	0.459
	Other	Jan-Apr	0.00	2.70	36.39	4.54	2.87	10.10	41.76	1.12	0.34	0.17	125.5	3,484 +	1,001	7.976
	Gillnet	Jan-Apr	0.00	0.00	2.81	1.28	4.60	8.95	80.05	1.79	0.26	0.26	154.6	391 +	535	3.459
19845	Seine	Jan-Apr	0.00	0.12	8.63	25.14	3.52	3.93	12.79	45.24	0.53	0.10	146.4	3,099	4,581	27.888
	Seine	May-Sep	0.00	0.10	8.15	24.49	3.51	3.95	12.94	46.22	0.54	0.10	165.5	2,025 +	35	0.209
	Other	Jan-Apr	0.00	1.32	14.93	31.83	4.05	4.50	11.36	31.47	0.45	0.08	148.1	3,556 +	1,001	6.758
	Gillnet	Jan-Apr	0.00	0.00	8.30	24.48	2.90	4.56	12.45	46.89	0.41	0.00	155.0	241 +	1,493	9.632
19856	Seine	Jan-Apr	0.00	0.16	2.00	21.05	37.46	3.69	3.28	8.88	23.03	0.43	165.5	4,462	2,613	15.278
	Trawl	Jan-Apr	0.00	0.31	2.80	10.56	37.58	8.70	9.63	11.18	17.70	1.55	163.5	322	0	0.000 ~
	Other	Jan-Apr	0.00	0.22	2.83	21.27	40.02	4.33	3.68	8.23	19.03	0.40	165.5	5,055 +	1,001	6.048
	Gillnet	Jan-Apr	0.00	0.00	0.00	12.73	53.42	4.04	5.28	9.01	15.22	0.31	159.7	322 +	890	5.576
19867	Seine	Jan-Apr	0.00	1.78	9.60	4.90	24.93	38.44	3.88	4.36	5.86	6.24	158.6	2,916	2,028	12.787
	Seine	May-Sep	0.00	1.74	10.42	5.85	24.35	37.76	3.84	4.33	5.79	5.91	157.2	3,281 +	33	0.210
	Other	Jan-Apr	0.00	1.74	10.42	5.85	24.35	37.76	3.84	4.33	5.79	5.91	157.2	3,281 +	1,001	6.366

Appendix 1.1. Age composition and catch by season, fishery and gear type for the Queen Charlotte Islands stock assessment region. These data are used for the age-structured model analysis.

			P E R C E N T A T A G E										Mean	Number	C A T C H	
Season	**Gear**	**Fishery**	**0+**	**1+**	**2+**	**3+**	**4+**	**5+**	**6+**	**7+**	**8+**	**9++**	**Weight**	**Aged**	**(tonnes)**	**(millions)**
19878	Seine	Jan-Apr	0.00	3.64	51.01	7.52	4.77	11.75	14.86	1.37	1.67	3.40	123.6	1,676	0	0.000 ~
	Seine	May-Sep	0.00	1.34	41.98	5.34	3.24	14.50	22.71	1.91	1.72	7.25	136.5	524 +	32	0.232
	Trawl	Jan-Apr	0.00	1.33	68.11	11.63	1.66	6.98	6.64	1.33	1.66	0.66	105.4	301	0	0.000 ~
	Other	Jan-Apr	0.00	3.29	53.62	8.14	4.30	11.03	13.61	1.37	1.67	2.98	120.8	1,977 +	1,000	8.277
19889	Seine	Jan-Apr	0.00	3.43	5.12	85.99	3.74	0.18	0.77	0.47	0.08	0.22	119.2	2,996	1,449	11.972
	Seine	May-Sep	0.00	1.27	31.75	45.90	4.03	2.55	7.00	4.81	1.06	1.63	117.4	1,414 +	13	0.108
	Other	Jan-Apr	0.00	2.27	17.46	66.35	4.01	1.57	3.90	2.78	0.62	1.04	120.5	3,563 +	824	6.839
19890	Seine	Jan-Apr	0.00	0.14	10.61	6.53	78.55	2.43	0.33	0.85	0.34	0.23	133.9	4,769	5,542	39.649
	Other	Jan-Apr	0.00	0.22	9.64	18.17	60.02	3.94	1.84	3.82	1.70	0.65	134.8	5,053 +	915	6.789
	Gillnet	Jan-Apr	0.00	0.00	0.51	8.18	44.50	9.97	8.44	17.39	8.44	2.56	149.6	391 +	1,170	7.821
19901	Seine	Jan-Apr	0.00	5.60	4.25	10.74	33.21	33.99	3.68	2.00	4.70	1.84	127.8	2,448	3,899	30.506
	Trawl	Jan-Apr	0.00	1.06	4.26	8.51	21.28	46.81	4.26	6.38	4.26	3.19	143.0	94	0	0.000 ~
	Other	Jan-Apr	0.00	6.55	4.14	10.60	28.50	38.70	3.71	1.92	3.99	1.90	130.3	3,481 +	1,001	7.684
	Gillnet	Jan-Apr	0.00	0.00	0.00	2.27	22.44	43.47	9.66	7.10	10.23	4.83	151.9	352 +	543	3.576
19912	Seine	Jan-Apr	0.00	1.05	30.50	4.25	8.27	4.46	48.40	2.42	0.14	0.52	143.2	3,228	2,524	16.695
	Trawl	Jan-Apr	0.00	1.08	54.84	9.68	2.15	15.05	11.83	3.23	2.15	0.00	115.6	93	0	0.000 ~
	Other	Jan-Apr	0.00	0.72	38.96	5.06	8.19	12.53	30.20	2.41	0.63	1.29	134.2	3,321 +	583	4.343
19923	Seine	Jan-Apr	0.00	0.04	2.79	67.33	4.25	4.68	9.73	9.95	0.87	0.36	124.2	2,755	2,699	21.742
	Trawl	Jan-Apr	0.00	1.75	4.68	59.65	5.85	6.43	11.70	7.02	2.34	0.58	125.9	171	0	0.000 ~
	Other	Jan-Apr	0.00	0.39	3.50	60.31	4.51	6.08	12.05	11.54	1.21	0.41	128.3	3,883 +	883	6.883
	Gillnet	Jan-Apr	0.00	0.00	0.00	2.27	22.44	43.47	9.66	7.10	10.23	4.83	151.9	352 +	0	0.002
19934	Seine	Jan-Apr	0.00	5.50	5.50	5.63	40.75	12.87	14.48	11.13	3.49	0.67	130.5	746	299	2.291
	Trawl	Jan-Apr	0.00	7.08	2.36	5.42	53.30	8.49	6.60	8.49	7.31	0.94	133.0	424	0	0.000 ~
	Other	Jan-Apr	0.00	6.39	3.77	5.11	49.67	10.04	9.80	10.23	4.26	0.73	129.0	1,643 +	1,092	8.467
19945	Seine	Jan-Apr	0.00	14.35	15.82	2.32	4.43	37.55	9.70	8.02	5.27	2.53	134.8	474	0	0.000 ~
19956	Seine	Jan-Apr	0.10	10.76	53.81	9.30	3.24	3.34	15.57	2.40	1.15	0.31	102.8	957	0	0.000 ~
19967	Seine	Jan-Apr	0.00	22.64	26.17	33.41	5.23	1.52	4.44	5.36	0.85	0.37	97.5	1,643	0	0.000 ~
	Other	Jan-Apr	0.00	22.64	26.17	33.41	5.23	1.52	4.44	5.36	0.85	0.37	97.5	1,643 +	214	2.194
19978	Seine	Jan-Apr	0.00	0.16	58.12	27.55	9.74	2.53	0.48	0.40	0.63	0.40	87.9	1,263	1,372	15.597
	Other	Jan-Apr	0.00	0.37	54.12	27.91	11.60	2.69	0.66	1.22	1.10	0.33	87.8	2,716 +	818	9.322
19989	Seine	Jan-Apr	0.00	3.78	2.18	64.88	16.88	8.04	2.75	0.66	0.41	0.42	105.9	2,516	2,859	26.998
	Other	Jan-Apr	0.00	4.29	2.31	63.99	17.21	8.11	2.54	0.64	0.40	0.52	105.8	2,516 +	819	7.742
	Gillnet	Jan-Apr	0.00	0.00	0.67	30.78	22.80	29.12	9.98	2.66	1.33	2.66	131.4	601	473	3.596
19990	Seine	Jan-Apr	0.00	3.71	17.36	3.72	60.60	8.26	5.19	0.39	0.61	0.16	108.4	2,057	1,822	17.023
	Other	Jan-Apr	0.00	4.98	18.51	3.91	59.07	7.95	4.51	0.42	0.47	0.19	107.5	2,150 +	910	8.468
20001	Seine	Jan-Apr	0.00	15.26	31.65	22.32	5.06	20.92	3.05	1.39	0.26	0.09	97.0	1,147	0	0.000 ~
	Other	Jan-Apr	0.00	15.26	31.65	22.32	5.06	20.92	3.05	1.39	0.26	0.09	97.0	1,147 +	408	4.207
20012	Seine	Jan-Apr	0.00	20.84	22.90	25.47	12.99	3.11	12.83	1.36	0.43	0.08	93.6	2,572	706	7.543
	Other	Jan-Apr	0.00	20.46	25.49	24.00	12.54	2.92	12.61	1.43	0.44	0.10	94.7	2,942 +	910	9.608
20023	Seine	Jan-Apr	0.00	0.09	69.92	16.94	5.87	3.28	1.09	2.23	0.44	0.13	95.4	2,284	0	0.000 ~
20023	Other	Jan-Apr	0.00	0.09	69.92	16.94	5.87	3.28	1.09	2.23	0.44	0.13	95.4	2,284 +	910	9.536

NOTE: * No biosample data available. Age composition and mean weight assigned from published reports.

+ Age composition calculated from biosample data aggregated from adjacent sections and/or fishery periods, by gear type.

~ No fishery openings this season. Age composition and mean weight obtained from pre-fishery charter biosamples.

Appendix 1.2. Age composition and catch by season, fishery and gear type for the Prince Rupert District stock assessment region. These data are used for the age-structured model analysis.

Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	CATCH (tonnes)	CATCH (millions)
			PERCENT AT AGE													
19501	Seine	Oct-Dec	0.03	5.19	18.96	57.83	10.05	5.42	2.27	0.20	0.06	0.00	91.5	3,524	27,192	297.109
	Seine	Jan-Apr	0.09	1.72	15.86	60.43	11.38	6.21	3.79	0.43	0.00	0.09	95.8	1,160	18,674	195.022
19512	Seine	Oct-Dec	0.09	5.32	9.32	33.19	45.08	5.66	0.91	0.40	0.03	0.00	121.7	3,498	42,613	350.112
	Seine	Jan-Apr	0.00	3.96	8.08	34.32	45.41	6.84	1.19	0.16	0.04	0.00	115.7	2,427	9,650	83.415
	Seine	May-Sep	0.05	4.76	8.81	33.65	45.22	6.14	1.03	0.30	0.03	0.00	119.2	5,925 +	116	0.976
19523	Seine	Oct-Dec	0.00	1.46	38.05	28.90	26.40	4.99	0.21	0.00	0.00	0.00	114.7	481	401	3.491
	Seine	Jan-Apr	0.00	1.07	38.17	20.04	24.95	14.29	1.39	0.11	0.00	0.00	107.7	938	1,465	13.601
19534	Seine	Oct-Dec	0.00	0.38	22.98	31.95	27.13	14.48	2.52	0.56	0.01	0.00	114.3	2,138	26,692	232.215
	Seine	Jan-Apr	0.00	8.88	47.88	19.11	13.51	6.76	3.28	0.58	0.00	0.00	83.9	518	584	6.969
19545	Seine	Jan-Apr	0.00	2.25	4.08	70.30	15.80	6.01	1.34	0.22	0.00	0.00	105.2	1,131	17,806	167.544
19556	Seine	Oct-Dec	0.00	10.04	58.11	9.51	18.95	2.55	0.53	0.18	0.12	0.00	83.6	1,683 +	1,602	19.164
	Seine	Jan-Apr	0.00	8.99	59.62	9.14	18.79	2.65	0.66	0.07	0.07	0.00	84.6	1,357	8,580	101.455
19567	Seine	Oct-Dec	0.00	18.02	19.80	35.57	12.24	13.25	0.90	0.22	0.00	0.00	93.8	3,172 +	820	9.056
	Seine	Jan-Apr	0.00	3.83	19.26	42.33	13.46	19.05	1.61	0.41	0.05	0.00	104.8	2,784	19,753	182.450
	Seine	May-Sep	0.00	0.00	7.11	44.95	37.16	9.17	1.38	0.23	0.00	0.00	106.7	436	7,461	69.921
	Trawl	Jan-Apr	0.00	4.08	21.43	52.04	12.24	10.20	0.00	0.00	0.00	0.00	88.3	98	0	0.000 ~
19578	Seine	Oct-Dec	0.00	58.55	24.14	6.24	7.24	0.80	3.02	0.00	0.00	0.00	62.7	497 +	1,270	20.260
	Seine	Jan-Apr	0.00	58.55	24.14	6.24	7.24	0.80	3.02	0.00	0.00	0.00	62.7	497 +	667	10.640
	Seine	May-Sep	0.00	58.55	24.14	6.24	7.24	0.80	3.02	0.00	0.00	0.00	62.7	497 +	2,586	41.259
19589	Seine	Oct-Dec	0.00	1.64	62.11	19.52	5.96	7.16	2.05	1.54	0.01	0.00	98.0	1,592 +	1,629	16.406
	Seine	Jan-Apr	0.00	2.88	61.03	19.34	5.06	7.96	1.81	1.85	0.06	0.00	97.5	1,454	5,629	57.722
	Seine	May-Sep	0.00	1.17	62.96	19.29	6.19	6.74	2.21	1.44	0.56	0.00	98.7	1,592 +	2,899	29.047
	Trawl	Jan-Apr	0.00	3.39	58.98	20.35	5.15	8.73	1.44	1.88	0.06	0.00	97.5	1,592 +	66	0.674
19590	Seine	Oct-Dec	0.00	62.74	8.21	20.55	5.57	1.63	1.10	0.08	0.12	0.00	64.7	1,549	3,125	49.715
	Seine	Jan-Apr	0.00	66.74	7.43	18.52	4.46	1.48	0.94	0.22	0.22	0.00	61.5	1,617	12,513	218.740
	Seine	May-Sep	0.00	5.00	3.26	51.30	20.22	10.65	7.39	1.96	0.22	0.00	115.5	460	2,297	19.897
	Trawl	Oct-Dec	0.00	59.38	7.49	23.25	6.10	2.21	1.17	0.22	0.19	0.00	64.7	3,166 +	72	1.110
	Trawl	Jan-Apr	0.00	59.38	7.49	23.25	6.10	2.21	1.17	0.22	0.19	0.00	64.7	3,166 +	468	7.238
19601	Seine	Oct-Dec	0.00	13.33	69.22	4.76	9.50	2.44	0.44	0.25	0.06	0.00	80.6	1,729	14,879	183.842
	Seine	Jan-Apr	0.00	8.10	60.17	6.91	18.06	4.38	1.74	0.43	0.20	0.00	93.8	2,174	24,244	278.906
	Seine	May-Sep	0.00	10.08	59.51	7.23	17.13	4.07	1.43	0.42	0.13	0.00	93.9	3,903 +	350	4.012
	Trawl	Jan-Apr	0.00	10.25	60.16	7.07	16.63	3.97	1.38	0.41	0.13	0.00	86.7	3,903 +	3,273	37.756
19612	Seine	Oct-Dec	0.00	6.70	32.01	38.46	7.44	11.41	2.23	0.74	0.74	0.25	106.6	403 +	633	5.938
	Seine	Jan-Apr	0.00	6.70	32.01	38.46	7.44	11.41	2.23	0.74	0.74	0.25	106.6	403 +	25,352	237.877
	Seine	May-Sep	0.00	6.70	32.01	38.46	7.44	11.41	2.23	0.74	0.74	0.25	106.6	403 +	346	3.243
	Trawl	Oct-Dec	0.00	6.05	30.85	38.31	7.66	11.69	3.43	0.60	1.01	0.40	109.0	496 +	296	2.714
	Trawl	Jan-Apr	0.00	6.05	30.85	38.31	7.66	11.69	3.43	0.60	1.01	0.40	109.0	496 +	1,033	9.474
19623	Seine	Oct-Dec	0.00	76.33	15.42	4.46	3.10	0.28	0.35	0.06	0.00	0.00	55.5	1,267	9,769	199.178
	Seine	Jan-Apr	0.00	38.55	15.20	21.58	17.43	3.27	3.61	0.21	0.06	0.10	96.9	1,921	29,142	350.900
	Seine	May-Sep	0.00	60.74	16.33	12.62	7.12	1.42	1.69	0.01	0.00	0.07	74.6	3,188 +	736	11.819
	Trawl	Oct-Dec	0.00	41.59	13.61	17.25	21.11	3.14	2.79	0.41	0.06	0.03	80.9	3,188 +	123	1.526
	Trawl	Jan-Apr	0.00	41.59	13.61	17.25	21.11	3.14	2.79	0.41	0.06	0.03	80.9	3,188 +	457	5.653
19634	Seine	Oct-Dec	0.00	2.51	71.43	11.94	7.88	5.04	0.85	0.35	0.00	0.00	84.2	1,644	14,887	170.573
	Seine	Jan-Apr	0.00	1.29	48.47	10.21	19.65	17.00	1.48	1.38	0.40	0.11	89.9	1,697	13,180	135.777
	Seine	May-Sep	0.00	2.89	67.52	11.86	10.20	6.38	0.60	0.43	0.11	0.02	80.8	3,341 +	1,282	14.960
	Trawl	Oct-Dec	0.00	3.26	65.07	10.15	11.10	8.98	0.69	0.60	0.12	0.03	85.8	3,341 +	44	0.519
	Trawl	Jan-Apr	0.00	3.26	65.07	10.15	11.10	8.98	0.69	0.60	0.12	0.03	85.8	3,341 +	537	6.254
19645	Seine	Oct-Dec	0.00	9.22	19.05	45.55	10.13	10.34	4.75	0.71	0.22	0.03	127.7	805	5,435	40.840
	Seine	Jan-Apr	0.00	4.99	13.41	53.55	9.70	9.66	7.23	1.03	0.37	0.06	118.0	2,088	12,851	99.593
	Seine	May-Sep	0.00	6.54	15.87	50.81	10.48	9.83	5.18	0.95	0.34	0.77	124.0	2,893 +	25,924	191.386
19656	Seine	Oct-Dec	0.00	0.00	5.29	21.38	23.45	16.32	19.08	9.66	3.22	1.61	137.3	0 *	3,312	24.120
	Seine	Jan-Apr	0.00	0.00	5.29	21.38	23.45	16.32	19.08	9.66	3.22	1.61	137.3	0 *	9,151	66.643
	Seine	May-Sep	0.00	0.00	5.29	21.38	23.45	16.32	19.08	9.66	3.22	1.61	137.3	0 *	4,831	35.181
	Trawl	Jan-Apr	0.00	0.00	5.29	21.38	23.45	16.32	19.08	9.66	3.22	1.61	137.3	0 *	1	0.007
19667	Seine	Oct-Dec	0.00	57.22	32.31	5.37	1.88	2.70	0.41	0.20	0.00	0.00	65.7	0 *	4,379	66.650
	Seine	Jan-Apr	0.00	57.22	32.31	5.37	1.88	2.70	0.41	0.20	0.00	0.00	65.7	0 *	2,338	35.588
	Seine	May-Sep	0.00	57.22	32.31	5.37	1.88	2.70	0.41	0.20	0.00	0.00	65.7	0 *	1,280	19.484
19678	Seine	Oct-Dec	0.00	34.87	39.74	19.40	4.59	0.73	0.26	0.14	0.27	0.00	77.9	0 *	53	0.678
	Seine	Jan-Apr	0.00	34.87	39.74	19.40	4.59	0.73	0.26	0.14	0.27	0.00	77.9	0 *	1,084	13.902
19678	Seine	May-Sep	0.00	34.87	39.74	19.40	4.59	0.73	0.26	0.14	0.27	0.00	77.9	0 *	932	11.953
19690	Seine	Jan-Apr	0.00	18.67	62.91	15.11	3.12	0.03	0.08	0.08	0.00	0.00	81.6	0 *	1,330	16.304
19701	Seine	Jan-Apr	0.00	5.79	45.91	31.35	9.51	5.05	1.63	0.59	0.15	0.00	92.2	673	3,418	37.076
	Seine	May-Sep	0.00	5.79	45.91	31.35	9.51	5.05	1.63	0.59	0.15	0.00	92.2	673 +	82	0.894
19712	Seine	Jan-Apr	0.00	0.00	5.32	17.93	64.43	5.88	3.78	2.38	0.14	0.14	161.3	714	4,490	27.842
	Gillnet	Jan-Apr	0.00	0.00	0.96	39.42	21.15	34.62	2.88	0.96	0.00	0.00	168.2	104 +	4	0.023
19723	Seine	Oct-Dec	0.00	3.89	35.37	4.95	27.58	23.05	3.26	1.26	0.63	0.00	133.3	950 +	16	0.123
	Seine	Jan-Apr	0.00	0.61	33.23	4.45	30.09	26.25	3.38	1.26	0.74	0.00	137.9	950	1,524	10.454
	Seine	May-Sep	0.00	3.89	35.37	4.95	27.58	23.05	3.26	1.26	0.63	0.00	133.3	950 +	67	0.499
19734	Seine	Jan-Apr	0.00	0.16	17.88	53.16	7.44	16.46	4.43	0.32	0.16	0.00	132.2	632	2,300	17.401
	Gillnet	Jan-Apr	0.00	0.00	0.96	39.42	21.15	34.62	2.88	0.96	0.00	0.00	168.2	104 +	1,519	9.034
19745	Seine	Jan-Apr	0.20	0.35	4.42	26.83	51.39	9.06	6.31	1.26	0.18	0.00	124.1	1,704	1,691	12.357
	Other	Jan-Apr	0.32	1.29	9.40	21.92	42.97	11.20	9.65	2.46	0.63	0.16	131.2	3,170 +	204	1.555
	Gillnet	Jan-Apr	0.00	0.00	0.00	31.91	59.57	8.51	0.00	0.00	0.00	0.00	140.9	47 +	11	0.076
19756	Seine	Oct-Dec	0.00	0.00	1.60	6.86	27.66	43.89	9.26	8.46	2.29	0.00	172.2	875 +	564	3.278
	Seine	Jan-Apr	0.00	0.00	0.90	7.22	32.25	49.73	7.47	1.74	0.70	0.00	169.6	713	3,466	20.451
	Other	Jan-Apr	0.00	0.00	1.60	6.86	27.66	43.89	9.26	8.46	2.29	0.00	172.2	875 +	409	2.375
	Gillnet	Jan-Apr	0.00	0.00	0.00	15.79	57.89	22.81	3.51	0.00	0.00	0.00	154.0	57 +	276	1.793

Appendix 1.2. Age composition and catch by season, fishery and gear type for the Prince Rupert District stock assessment region. These data are used for the age-structured model analysis.

Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	CATCH (tonnes)	CATCH (millions)
						PERCENT AT AGE										
19767	Seine	Oct-Dec	0.00	0.08	13.52	6.40	24.30	35.92	14.53	4.01	0.80	0.43	154.2	1,821 +	296	1.895
	Seine	Jan-Apr	0.00	0.13	21.43	3.97	20.78	34.28	14.49	3.18	1.29	0.45	151.9	1,765	6,309	41.462
	Seine	May-Sep	0.00	0.16	18.12	7.08	22.73	31.85	13.84	4.45	1.32	0.44	149.8	1,821 +	31	0.204
	Other	Jan-Apr	0.00	0.16	18.12	7.08	22.73	31.85	13.84	4.45	1.32	0.44	149.8	1,821 +	682	4.552
	Gillnet	Jan-Apr	0.00	0.00	1.07	2.14	19.93	54.09	14.59	6.76	1.42	0.00	166.9	281 +	1,494	8.948
	Gillnet	May-Sep	0.00	0.00	1.07	2.14	19.93	54.09	14.59	6.76	1.42	0.00	166.9	281 +	12	0.072
19778	Seine	Oct-Dec	0.00	1.66	7.66	32.30	17.60	16.98	13.46	6.21	2.48	1.66	151.1	483	2,263	14.977
	Seine	Jan-Apr	0.00	1.35	12.58	34.86	9.09	19.63	18.84	2.66	0.67	0.32	147.2	812	2,202	14.957
	Seine	May-Sep	0.00	1.73	12.50	38.39	9.35	18.12	15.88	2.73	0.92	0.38	147.1	1,295 +	68	0.469
	Trawl	Oct-Dec	0.00	1.36	10.03	31.95	13.18	19.41	17.48	4.37	1.43	0.79	150.3	1,396 +	1,024	6.814
	Trawl	Jan-Apr	0.00	0.99	2.97	20.79	19.80	25.74	20.79	7.92	0.99	0.00	167.6	101	0	0.000 ~
	Other	Jan-Apr	0.00	1.36	10.03	31.95	13.18	19.41	17.48	4.37	1.43	0.79	150.3	1,396 +	819	5.450
	Gillnet	Jan-Apr	0.00	0.00	0.00	20.53	5.96	32.45	33.11	6.62	1.32	0.00	167.1	151 +	3,031	18.142
19789	Seine	Oct-Dec	0.00	1.42	9.81	10.85	25.36	19.39	17.10	8.63	4.73	2.71	152.3	777	971	6.314
	Seine	Jan-Apr	0.00	2.91	9.88	12.21	32.17	13.57	21.32	5.81	1.74	0.39	158.5	516	1,411	8.905
	Seine	May-Sep	0.00	2.19	14.84	11.37	28.12	14.72	17.26	6.93	2.94	1.62	151.3	1,732 +	10	0.063
	Trawl	Oct-Dec	0.00	2.04	9.07	10.37	27.96	15.37	15.37	8.52	7.04	4.26	147.9	540	690	4.664
	Trawl	Jan-Apr	0.00	2.04	9.07	10.37	27.96	15.37	15.37	8.52	7.04	4.26	147.9	540	0	0.000 ~
	Other	Jan-Apr	0.00	2.16	13.47	11.14	28.08	14.88	16.81	7.31	3.92	2.24	150.5	2,272 +	910	6.048
	Gillnet	Jan-Apr	0.00	0.00	0.00	8.25	41.24	18.56	22.68	7.56	1.72	0.00	168.4	291 +	1,236	7.338
19790	Seine	Oct-Dec	0.00	1.82	62.62	6.88	6.93	7.57	5.81	5.21	2.12	1.04	108.2	1,049	460	4.238
	Seine	Jan-Apr	0.00	1.69	85.42	4.98	2.89	2.29	1.69	0.70	0.30	0.05	90.0	2,010	1,641	18.223
	Trawl	Oct-Dec	0.00	1.59	73.25	7.18	5.79	4.99	3.78	2.12	0.91	0.39	99.0	4,389 +	278	2.806
	Trawl	Jan-Apr	0.00	0.00	47.95	12.33	10.96	16.44	1.37	5.48	4.11	1.37	123.9	73	0	0.000 ~
	Other	Jan-Apr	0.00	1.59	73.25	7.18	5.79	4.99	3.78	2.12	0.91	0.39	99.0	4,389 +	910	9.190
	Gillnet	Jan-Apr	0.00	0.00	4.98	7.66	35.25	19.92	19.54	8.43	3.45	0.77	162.2	261 +	1,046	6.449
19801	Seine	Oct-Dec	0.00	1.13	7.37	53.52	10.15	10.64	8.82	4.51	2.45	1.40	124.7	3,068	733	5.870
	Seine	Jan-Apr	0.03	0.57	10.08	82.32	3.36	1.46	1.55	0.32	0.19	0.13	98.7	3,156	1,051	10.652
	Trawl	Oct-Dec	0.00	1.07	7.67	56.82	8.62	9.09	9.02	3.68	2.37	1.66	119.0	3,095	949	7.928
	Trawl	Jan-Apr	0.00	1.07	7.21	55.35	8.89	9.56	9.66	4.17	2.36	1.74	121.0	3,095	0	0.000 ~
	Other	Jan-Apr	0.01	0.96	8.75	66.19	6.94	6.27	5.79	2.63	1.42	1.03	112.3	10,887 +	728	6.484
	Gillnet	Jan-Apr	0.00	0.00	0.37	39.18	16.42	23.13	14.55	4.48	1.87	0.00	149.7	268 +	356	2.378
19812	Seine	Oct-Dec	0.00	0.83	14.25	24.70	45.73	6.01	3.80	3.07	1.13	0.49	128.5	1,143	794	6.481
	Seine	Jan-Apr	0.00	4.57	11.84	7.15	71.51	2.93	1.41	0.35	0.23	0.00	106.5	853	170	1.593
	Trawl	Oct-Dec	0.00	2.34	11.99	19.03	39.60	10.11	6.80	6.60	2.13	1.39	132.6	1,283	1,021	7.686
	Trawl	Jan-Apr	0.00	2.34	11.85	18.08	40.14	10.37	6.94	6.24	2.42	1.64	132.6	1,283	0	0.000 ~
	Other	Jan-Apr	0.00	1.99	14.56	15.09	51.11	7.30	4.58	3.27	1.39	0.71	119.6	3,970 +	728	6.086
19823	Seine	Jan-Apr	0.00	1.35	20.82	17.74	5.26	49.16	3.73	1.13	0.59	0.22	117.7	4,583	0	0.000 ~
	Other	Jan-Apr	0.00	1.35	20.82	17.74	5.26	49.16	3.73	1.13	0.59	0.22	117.7	4,583 +	773	6.565
19834	Seine	Oct-Dec	0.00	1.83	34.08	15.42	15.21	10.14	19.68	3.04	0.20	0.41	97.1	493	87	0.900
	Seine	Jan-Apr	0.00	0.43	32.79	11.18	9.48	17.31	27.38	0.95	0.33	0.14	106.6	3,118	1,679	15.337
	Seine	May-Sep	0.00	0.72	36.17	14.18	10.77	13.79	22.65	1.27	0.28	0.17	102.7	3,611 +	6	0.055
	Trawl	Oct-Dec	0.00	0.93	36.45	14.29	10.74	13.57	21.95	1.30	0.42	0.34	102.3	3,772 +	54	0.529
	Trawl	Jan-Apr	0.00	5.59	42.86	16.77	9.94	8.70	6.21	1.86	3.73	4.35	93.4	161	0	0.000 ~
	Other	Jan-Apr	0.00	0.93	36.45	14.29	10.74	13.57	21.95	1.30	0.42	0.34	102.3	3,772 +	728	7.116
	Gillnet	Jan-Apr	0.00	0.00	0.99	1.98	12.87	21.39	57.43	3.37	1.19	0.79	147.7	505	1,880	12.731
19845	Seine	Oct-Dec	0.00	17.10	8.92	20.45	30.67	12.83	4.46	4.28	0.93	0.37	86.0	538	48	0.556
	Seine	Jan-Apr	0.00	0.33	7.91	50.78	11.15	6.74	12.95	9.81	0.19	0.16	108.4	4,214	3,070	27.724
	Seine	May-Sep	0.00	2.15	7.95	50.48	14.31	7.07	10.01	7.61	0.27	0.17	108.3	4,752 +	70	0.662
	Trawl	Oct-Dec	0.00	2.31	7.95	50.46	14.58	7.09	9.74	7.41	0.27	0.17	105.8	4,752 +	83	0.787
	Other	Jan-Apr	0.00	2.31	7.95	50.46	14.58	7.09	9.74	7.41	0.27	0.17	105.8	4,752 +	728	6.884
	Gillnet	Jan-Apr	0.00	0.00	0.36	16.36	14.91	15.82	21.82	29.82	0.36	0.55	147.9	550	3,476	23.500
19856	Seine	Oct-Dec	0.00	1.77	12.72	10.13	44.29	9.00	5.23	8.78	7.96	0.11	139.2	3,554 +	130	0.937
	Seine	Jan-Apr	0.00	1.75	12.79	10.09	44.41	9.10	5.23	8.69	7.83	0.11	133.1	5,655	3,823	27.523
	Seine	May-Sep	0.00	1.69	13.34	9.55	46.09	10.53	5.26	7.46	5.98	0.10	137.1	5,655 +	105	0.778
	Trawl	Oct-Dec	0.00	12.11	11.13	9.48	27.58	16.27	9.30	5.81	5.02	3.30	137.9	1,635	47	0.343
	Trawl	Jan-Apr	0.00	12.11	11.13	9.48	27.58	16.27	9.30	5.81	5.02	3.30	137.9	1,635	0	0.000 ~
	Other	Jan-Apr	0.00	4.07	13.17	9.45	42.07	12.03	6.17	6.80	5.42	0.81	135.2	7,290 +	728	5.384
	Gillnet	Jan-Apr	0.00	0.00	0.38	4.09	54.02	18.86	8.71	7.65	6.06	0.23	147.0	1,320	4,573	31.100
19867	Seine	Oct-Dec	0.00	0.60	38.78	9.59	7.26	29.94	5.84	3.59	3.09	1.33	117.1	2,977 +	47	0.398
	Seine	Jan-Apr	0.00	0.45	39.37	9.51	7.32	29.04	5.78	3.72	3.34	1.47	117.1	4,049	2,100	17.695
	Seine	May-Sep	0.00	1.06	36.99	9.81	7.06	32.66	6.01	3.21	2.31	0.89	117.1	2,977 +	52	0.448
	Other	Jan-Apr	0.00	0.87	39.44	10.15	6.77	29.47	5.82	3.42	2.82	1.24	116.1	4,828 +	728	6.271
	Gillnet	Jan-Apr	0.00	0.00	0.50	2.67	6.37	55.23	16.65	9.37	6.07	3.14	150.4	1,855	4,071	27.067
19878	Seine	Oct-Dec	0.00	0.52	35.53	36.87	5.23	7.15	11.18	1.59	1.43	0.49	100.3	3,076 +	23	0.229
	Seine	Jan-Apr	0.00	0.52	35.53	36.87	5.23	7.15	11.18	1.59	1.43	0.49	100.3	3,076	3,550	35.399
	Seine	May-Sep	0.00	0.45	30.98	38.94	5.97	8.35	11.53	1.95	1.45	0.38	102.6	4,206 +	56	0.542
	Trawl	Jan-Apr	0.00	0.26	13.73	41.19	11.92	11.14	11.92	4.40	4.15	1.30	109.5	386	0	0.000 ~
	Other	Jan-Apr	0.00	0.44	29.53	39.13	6.47	8.58	11.56	2.16	1.68	0.46	103.2	4,592 +	728	7.056
	Gillnet	Jan-Apr	0.00	0.00	0.24	4.97	4.59	20.02	48.56	13.52	5.31	2.78	157.2	710	4,340	27.459
19889	Seine	Oct-Dec	0.00	0.21	25.24	29.11	30.29	4.94	4.83	4.40	0.64	0.32	105.0	931 +	42	0.403
	Seine	Jan-Apr	0.00	0.70	19.15	41.92	25.84	4.00	4.19	3.39	0.46	0.36	104.1	2,893	3,686	35.672
	Other	Jan-Apr	0.00	0.61	21.68	36.14	27.68	4.92	4.48	3.57	0.64	0.28	104.2	3,616 +	728	6.986
	Gillnet	Jan-Apr	0.00	0.00	0.00	5.11	30.02	13.98	22.91	21.87	3.66	2.46	149.3	476	4,745	31.739
19890	Seine	Jan-Apr	0.00	0.63	20.05	21.02	29.59	18.95	3.90	3.41	2.08	0.37	120.7	4,215	2,295	19.231
	Seine	May-Sep	0.00	0.14	14.00	25.59	26.19	24.51	3.85	3.58	1.99	0.14	120.9	5,068 +	32	0.263
	Other	Jan-Apr	0.00	0.65	18.15	22.55	28.24	20.52	4.01	3.31	2.15	0.41	119.7	5,068 +	728	6.080
	Gillnet	Jan-Apr	0.00	0.00	0.00	6.25	21.32	42.46	10.29	11.58	6.07	2.02	146.7	544	2,361	16.100

Appendix 1.2. Age composition and catch by season, fishery and gear type for the Prince Rupert District stock assessment region. These data are used for the age-structured model analysis.

			PERCENT AT AGE										Mean	Number	CATCH	
Season	**Gear**	**Fishery**	**0+**	**1+**	**2+**	**3+**	**4+**	**5+**	**6+**	**7+**	**8+**	**9++**	**Weight**	**Aged**	**(tonnes)**	**(millions)**
19901	Seine	Jan-Apr	0.00	1.07	51.92	9.89	11.11	15.82	7.04	1.23	0.91	1.03	98.8	2,529	1,348	13.642
	Seine	May-Sep	0.00	0.55	40.80	10.75	16.94	17.49	11.29	1.82	0.00	0.36	108.1	549 +	19	0.172
	Trawl	Jan-Apr	0.00	17.05	28.41	5.68	22.73	6.82	6.82	0.00	2.27	10.23	110.2	88	0	0.000 ~
	Other	Jan-Apr	0.00	1.28	47.62	9.41	12.81	15.57	9.43	1.62	0.90	1.35	102.1	4,208 +	819	8.020
	Gillnet	Jan-Apr	0.00	0.00	0.00	4.26	18.67	31.44	31.33	6.66	4.37	3.28	144.5	916	2,143	14.832
19912	Seine	Jan-Apr	0.00	0.19	45.84	29.44	6.36	5.42	7.73	3.60	0.74	0.67	96.6	4,265	1,377	14.161
	Seine	May-Sep	0.00	0.70	24.97	53.31	5.57	5.34	5.23	3.95	0.46	0.46	96.2	861 +	3	0.027
	Trawl	Jan-Apr	0.00	14.10	21.79	20.94	8.97	18.80	6.41	4.70	1.28	2.99	108.5	234	0	0.000 ~
	Other	Jan-Apr	0.00	1.07	38.90	36.36	6.05	6.05	6.71	3.49	0.64	0.73	96.9	4,499 +	819	8.456
	Gillnet	Jan-Apr	0.00	0.00	0.32	13.21	9.13	23.52	25.35	19.66	3.97	4.83	145.5	931	3,797	26.100
19923	Seine	Jan-Apr	0.00	0.04	6.28	56.22	21.93	4.18	4.46	4.86	1.59	0.44	103.4	3,262	2,204	20.895
	Seine	May-Sep	0.00	0.40	21.17	25.83	39.41	4.26	3.73	3.20	1.73	0.27	101.3	751 +	5	0.046
	Trawl	Jan-Apr	0.00	6.59	31.87	31.32	22.53	2.75	3.85	1.10	0.00	0.00	91.4	182	0	0.000 ~
	Other	Jan-Apr	0.00	0.40	11.64	43.72	29.86	3.97	4.37	4.21	1.50	0.33	103.6	4,209 +	819	7.906
	Gillnet	Jan-Apr	0.00	0.00	0.00	8.32	40.54	9.53	18.52	13.29	8.19	1.61	134.1	745	4,112	30.661
19934	Seine	Jan-Apr	0.00	0.47	3.34	10.44	54.82	20.19	4.55	4.05	1.50	0.64	108.9	6,643	2,364	21.475
	Trawl	Jan-Apr	0.00	3.61	4.64	27.84	38.66	20.10	2.58	1.55	1.03	0.00	106.1	194	0	0.000 ~
	Other	Jan-Apr	0.00	0.75	4.89	13.73	48.57	22.32	4.11	3.67	1.43	0.53	107.6	6,837 +	920	8.550
	Gillnet	Jan-Apr	0.00	0.00	0.00	3.15	18.85	48.99	11.78	11.14	4.86	1.24	132.6	899	2,324	17.614
19945	Seine	Jan-Apr	0.08	3.82	12.91	5.38	9.57	49.66	13.84	2.46	1.44	0.82	113.1	3,532	706	6.242
	Other	Jan-Apr	0.07	3.18	15.31	6.76	11.26	43.18	15.74	2.43	1.27	0.80	111.4	4,396 +	1,183	10.622
	Gillnet	Jan-Apr	0.00	0.00	0.12	1.18	16.98	34.79	39.39	4.13	1.89	1.53	131.4	848	1,355	10.311
19956	Seine	Jan-Apr	0.00	1.08	65.37	8.94	2.82	4.26	11.72	5.19	0.37	0.26	89.0	2,697	0	0.000 ~
	Other	Jan-Apr	0.00	1.08	65.37	8.94	2.82	4.26	11.72	5.19	0.37	0.26	89.0	2,697 +	1,092	12.264
	Gillnet	Jan-Apr	0.00	0.00	0.78	4.11	5.68	25.83	32.68	26.42	3.13	1.37	133.8	511	3,086	23.053
19967	Seine	Jan-Apr	0.00	1.30	22.79	53.63	8.01	2.52	4.93	4.74	1.85	0.22	88.5	2,698	0	0.000 ~
	Other	Jan-Apr	0.00	1.30	22.79	53.63	8.01	2.52	4.93	4.74	1.85	0.22	88.5	2,698 +	942	10.642
	Gillnet	Jan-Apr	0.00	0.00	0.16	19.49	11.57	13.95	20.29	20.60	11.09	2.85	133.4	631	5,541	41.550
19978	Seine	Jan-Apr	0.00	0.19	33.18	21.98	36.29	4.44	1.42	1.09	1.28	0.14	83.2	2,116	0	0.000 ~
	Other	Jan-Apr	0.00	0.19	33.18	21.98	36.29	4.44	1.42	1.09	1.28	0.14	83.2	2,116 +	910	10.943
	Gillnet	Jan-Apr	0.00	0.00	0.65	3.05	43.07	20.52	9.89	11.28	7.02	4.53	127.9	1,082	3,217	25.158
19989	Seine	Jan-Apr	0.00	0.93	3.39	51.17	20.68	17.76	2.92	0.47	1.17	1.52	105.5	856	511	4.849
	Other	Jan-Apr	0.00	0.99	5.52	41.05	20.35	24.71	4.42	1.05	0.87	1.05	103.4	1,720 +	1,001	9.684
	Gillnet	Oct-Dec	0.00	0.00	0.00	10.82	16.50	49.51	13.45	4.58	1.94	3.19	125.8	721 +	1	0.007
	Gillnet	Jan-Apr	0.00	0.00	0.00	11.18	16.22	48.98	13.23	4.72	2.20	3.46	126.1	721	1,858	14.716
19990	Seine	Jan-Apr	0.00	1.73	24.93	8.36	35.72	14.21	12.13	2.01	0.41	0.49	95.8	3,972	1,404	13.925
	Other	Jan-Apr	0.00	1.94	27.97	9.59	28.50	12.54	16.26	2.24	0.50	0.45	95.5	3,972 +	1,001	10.482
	Gillnet	Jan-Apr	0.00	0.00	0.12	2.10	23.06	20.47	42.17	9.37	1.11	1.60	133.7	811	3,030	22.657
20001	Seine	Jan-Apr	0.00	0.53	28.84	25.30	5.65	23.85	9.15	5.34	1.14	0.22	103.9	2,285	1,012	9.743
	Other	Jan-Apr	0.00	1.81	42.75	20.99	5.42	15.40	6.71	5.92	0.89	0.12	89.8	5,188 +	1,001	11.146
	Gillnet	Jan-Apr	0.00	0.00	0.29	5.58	9.33	32.40	20.67	25.58	5.29	0.87	134.3	1,040	3,811	28.369
20012	Seine	Oct-Dec	0.00	5.18	19.99	36.74	18.99	3.93	9.56	3.51	1.79	0.30	90.3	5,577 +	1	0.009
	Seine	Jan-Apr	0.00	7.21	19.39	32.03	20.34	4.16	11.12	3.83	1.60	0.33	93.0	3,678	2,061	22.159
	Other	Jan-Apr	0.00	5.18	19.99	36.74	18.99	3.93	9.56	3.51	1.79	0.30	90.3	5,577 +	910	10.083
	Gillnet	Jan-Apr	0.00	0.00	0.11	7.05	20.25	11.72	27.42	15.81	15.36	2.28	143.2	879	2,432	16.982
20023	Seine	Oct-Dec	0.00	0.18	68.20	11.58	11.95	3.72	1.63	1.47	0.59	0.67	86.5	477 +	5	0.066
	Seine	Jan-Apr	0.00	0.07	53.06	13.44	14.53	9.54	2.97	4.24	1.47	0.68	95.3	2,925	1,446	15.169
	Other	Jan-Apr	0.00	0.22	57.38	12.95	14.68	7.71	2.24	3.11	1.10	0.61	88.2	4,918 +	910	10.322
	Gillnet	Jan-Apr	0.00	0.00	0.34	4.60	37.13	25.98	10.57	12.30	5.29	3.79	136.6	870	2,562	18.760

NOTE: * No biosample data available. Age composition and mean weight assigned from published reports.
+ Age composition calculated from biosample data aggregated from adjacent sections and/or fishery periods, by gear type.
~ No fishery openings this season. Age composition and mean weight obtained from pre-fishery charter biosamples.

Appendix 1.3. Age composition and catch by season, fishery and gear type for the Central Coast stock assessment region. These data are used for the age-structured model analysis.

			PERCENT AT AGE										Mean	Number	CATCH	
Season	**Gear**	**Fishery**	**0+**	**1+**	**2+**	**3+**	**4+**	**5+**	**6+**	**7+**	**8+**	**9++**	**Weight**	**Aged**	**(tonnes)**	**(millions)**
19501	Seine	Oct-Dec	0.00	2.68	28.09	50.52	12.28	5.17	1.20	0.06	0.00	0.00	109.2	3,175	15,508	141.986
	Seine	Jan-Apr	0.06	2.25	31.20	49.36	11.23	4.84	1.06	0.01	0.00	0.00	107.9	2,143	26,950	250.936
19512	Seine	Jan-Apr	0.25	4.61	20.10	29.98	38.50	4.56	1.55	0.40	0.04	0.02	112.7	5,214	33,072	290.690
	Seine	May-Sep	1.11	5.12	19.85	29.75	37.71	4.45	1.52	0.44	0.04	0.02	112.3	5,214 +	123	1.091
19523	Seine	Jan-Apr	0.43	7.65	28.02	24.49	27.28	10.25	1.40	0.48	0.00	0.00	104.9	2,939	768	7.304
19534	Seine	Oct-Dec	0.15	7.31	69.86	17.41	3.99	1.06	0.15	0.00	0.08	0.00	63.6	1,327	6,389	100.473
	Seine	Jan-Apr	0.00	1.72	72.02	21.04	3.91	1.10	0.15	0.00	0.06	0.00	76.2	1,739	18,119	243.703
	Seine	May-Sep	0.07	4.04	69.18	20.52	4.63	1.34	0.16	0.00	0.07	0.00	71.1	3,066 +	109	1.531
19545	Seine	Oct-Dec	0.29	9.94	6.32	77.40	5.10	0.48	0.48	0.00	0.00	0.00	85.4	826	2,559	28.033
	Seine	Jan-Apr	0.00	1.31	5.42	80.39	11.08	1.56	0.25	0.00	0.00	0.00	99.8	1,524	9,035	90.856
19556	Seine	Oct-Dec	0.10	13.79	13.63	11.05	58.24	2.85	0.25	0.10	0.00	0.00	91.4	2,408	22,335	208.767
	Seine	Jan-Apr	0.00	7.39	12.21	8.70	67.86	3.36	0.43	0.00	0.00	0.04	114.2	2,614	21,018	178.311
	Seine	May-Sep	0.04	16.97	13.60	9.12	56.99	2.89	0.34	0.04	0.00	0.02	105.4	5,022 +	275	2.606
19567	Seine	Oct-Dec	0.00	52.32	42.90	3.83	0.55	0.27	0.14	0.00	0.00	0.00	60.1	732	1,788	29.756
	Seine	Jan-Apr	0.00	3.59	52.30	13.98	8.33	20.79	0.98	0.03	0.00	0.00	93.9	3,890	21,002	211.756
	Seine	May-Sep	0.00	23.13	49.84	9.53	5.03	11.85	0.59	0.02	0.00	0.00	79.6	4,622 +	470	5.669
19578	Seine	Oct-Dec	0.00	40.38	49.69	8.01	1.33	0.17	0.42	0.00	0.00	0.00	61.5	2,106	4,928	79.258
	Seine	Jan-Apr	0.00	5.67	73.61	17.35	1.50	1.22	0.65	0.00	0.00	0.00	73.8	1,472	4,454	60.180
	Seine	May-Sep	0.00	47.57	42.11	7.27	2.01	0.42	0.62	0.00	0.00	0.00	64.8	3,578 +	467	8.141
19589	Seine	Oct-Dec	0.17	5.25	49.47	35.94	7.43	0.61	0.57	0.55	0.01	0.00	83.4	2,169	10,774	125.789
	Seine	Jan-Apr	0.00	0.74	47.39	40.66	9.62	0.72	0.52	0.35	0.00	0.00	88.2	2,594	17,096	192.788
19590	Seine	Oct-Dec	0.00	42.87	24.11	26.16	5.59	1.10	0.08	0.08	0.00	0.00	62.1	1,269	3,397	54.675
	Seine	Jan-Apr	0.00	41.51	23.53	27.72	5.86	1.22	0.08	0.08	0.00	0.00	63.7	1,313 +	640	10.054
19601	Seine	Oct-Dec	0.00	64.30	28.81	3.34	2.30	1.25	0.00	0.00	0.00	0.00	51.4	479	956	18.581
	Seine	Jan-Apr	0.00	4.30	32.64	12.80	36.63	12.48	0.94	0.16	0.05	0.00	100.6	2,302	30,641	302.709
	Seine	May-Sep	0.00	16.18	32.43	10.82	29.70	9.92	0.79	0.11	0.04	0.00	91.1	2,781 +	104	1.136
	Trawl	May-Sep	0.00	16.18	32.43	10.82	29.70	9.92	0.79	0.11	0.04	0.00	91.1	2,781 +	4	0.042
19612	Seine	Oct-Dec	0.00	7.65	54.80	20.82	2.85	11.39	2.31	0.18	0.00	0.00	94.1	562 +	677	7.197
	Seine	Jan-Apr	0.00	3.73	51.28	25.17	2.80	13.99	2.80	0.23	0.00	0.00	99.6	429	14,942	150.045
	Seine	May-Sep	0.00	7.65	54.80	20.82	2.85	11.39	2.31	0.18	0.00	0.00	94.1	562 +	90	0.954
19623	Seine	Oct-Dec	0.00	0.36	30.27	58.03	5.25	2.86	3.02	0.21	0.00	0.00	100.6	1,052 +	124	1.232
	Seine	Jan-Apr	0.00	0.35	30.14	58.19	5.18	2.86	3.07	0.21	0.00	0.00	100.6	1,052	43,930	436.570
19634	Seine	Oct-Dec	0.00	14.03	46.96	27.37	10.09	1.45	0.09	0.00	0.00	0.00	91.1	1,169 +	3,214	35.288
	Seine	Jan-Apr	0.00	4.88	43.06	35.48	14.65	1.80	0.13	0.00	0.00	0.00	103.4	778	28,288	273.620
	Seine	May-Sep	0.00	14.03	46.96	27.37	10.09	1.45	0.09	0.00	0.00	0.00	91.1	1,169 +	165	1.808
	Trawl	Jan-Apr	0.00	14.03	46.96	27.37	10.09	1.45	0.09	0.00	0.00	0.00	91.1	1,169 +	228	2.507
19645	Seine	Oct-Dec	0.00	14.07	37.58	31.01	12.10	5.03	0.18	0.03	0.00	0.00	114.4	1,750 +	1,562	14.266
	Seine	Jan-Apr	0.00	3.62	35.16	37.44	17.59	5.77	0.39	0.03	0.00	0.00	122.3	1,652	12,630	101.310
	Seine	May-Sep	0.00	8.49	36.46	33.62	15.63	5.41	0.33	0.06	0.00	0.00	111.9	1,750 +	1,477	12.553
19656	Seine	Oct-Dec	0.00	67.32	20.43	7.33	3.60	1.13	0.19	0.00	0.00	0.00	71.9	0 *	16,217	225.703
	Seine	Jan-Apr	0.00	67.32	20.43	7.33	3.60	1.13	0.19	0.00	0.00	0.00	71.9	0 *	19,101	265.835
	Seine	May-Sep	0.00	67.32	20.43	7.33	3.60	1.13	0.19	0.00	0.00	0.00	71.9	0 *	2,163	30.107
19667	Seine	Oct-Dec	0.00	37.40	46.19	13.10	2.04	1.02	0.17	0.07	0.01	0.00	87.0	0 *	2,910	33.432
	Seine	Jan-Apr	0.00	37.40	46.19	13.10	2.04	1.02	0.17	0.07	0.01	0.00	87.0	0 *	17,206	197.668
	Seine	May-Sep	0.00	37.40	46.19	13.10	2.04	1.02	0.17	0.07	0.01	0.00	87.0	0 *	1,774	20.378
19678	Seine	Oct-Dec	0.00	32.53	48.02	17.02	2.11	0.25	0.00	0.06	0.00	0.00	89.8	0 *	497	5.535
	Seine	Jan-Apr	0.00	32.53	48.02	17.02	2.11	0.25	0.00	0.06	0.00	0.00	89.8	0 *	309	3.439
	Seine	May-Sep	0.00	32.53	48.02	17.02	2.11	0.25	0.00	0.06	0.00	0.00	89.8	0 *	722	8.043
19690	Seine	Jan-Apr	0.00	54.02	44.42	1.16	0.40	0.00	0.00	0.00	0.00	0.00	73.9	0 *	209	2.832
19701	Seine	Jan-Apr	0.06	12.04	39.34	39.20	4.11	4.33	0.72	0.06	0.13	0.00	108.2	953	3,614	32.684
19712	Seine	Jan-Apr	0.00	3.54	28.25	27.13	27.01	7.57	5.17	1.26	0.08	0.00	120.5	1,763	9,143	74.425
	Gillnet	Jan-Apr	0.00	0.00	2.27	18.18	61.36	11.36	6.82	0.00	0.00	0.00	159.6	44 +	137	0.855
19723	Seine	Jan-Apr	0.00	0.97	48.51	18.90	16.23	12.72	2.02	0.47	0.19	0.00	125.2	1,239	6,664	52.842
	Seine	May-Sep	0.00	1.21	49.64	18.40	15.98	12.11	2.02	0.48	0.16	0.00	124.7	1,239 +	22	0.178
	Gillnet	Jan-Apr	0.00	0.00	4.04	28.28	43.43	21.21	2.02	1.01	0.00	0.00	152.8	99 +	1,113	7.288
19734	Seine	Jan-Apr	0.00	2.94	20.26	42.18	18.05	10.26	5.42	0.71	0.18	0.00	129.5	1,515	3,621	28.835
	Gillnet	Jan-Apr	0.00	0.00	0.42	22.36	38.82	24.47	12.24	1.69	0.00	0.00	158.5	474	5,267	33.230
19745	Seine	Jan-Apr	0.18	0.99	48.84	22.87	19.00	5.33	2.25	0.48	0.04	0.02	119.5	8,923	3,343	31.457
	Gillnet	Jan-Apr	0.00	0.00	4.27	26.40	45.60	15.73	5.60	2.40	0.00	0.00	152.8	375 +	5,395	35.308
19756	Seine	Jan-Apr	0.00	2.18	11.33	41.86	21.86	16.69	4.31	1.52	0.24	0.02	124.4	5,418	6,198	50.662
	Gillnet	Jan-Apr	0.00	0.00	0.86	18.72	30.18	35.12	11.56	3.02	0.44	0.09	162.0	1,222	6,213	38.357
19767	Seine	Jan-Apr	0.00	0.70	17.01	23.32	31.11	17.06	8.70	1.72	0.34	0.05	136.6	2,606	4,201	30.702
	Gillnet	Jan-Apr	0.00	0.00	1.10	13.02	35.54	31.57	13.47	3.97	1.32	0.00	167.7	453	6,904	41.171
19778	Seine	Jan-Apr	0.00	0.19	28.64	16.47	21.54	21.13	8.68	2.56	0.59	0.20	129.6	1,391	4,723	37.629
	Seine	May-Sep	0.00	0.18	29.21	16.70	21.83	20.76	8.28	2.38	0.50	0.17	124.6	1,391 +	46	0.369
	Other	Jan-Apr	0.00	0.22	25.59	15.24	19.99	23.15	10.86	3.52	1.08	0.36	134.7	1,391 +	182	1.352
	Gillnet	Jan-Apr	0.00	0.00	0.83	8.45	32.10	38.26	16.57	3.21	0.44	0.15	162.1	886	9,277	56.466
19789	Seine	Oct-Dec	0.00	5.70	4.40	31.50	18.70	21.30	15.10	2.80	0.40	0.10	151.8	0 *	0	0.001
	Seine	May-Sep	0.00	5.70	4.40	31.50	18.70	21.30	15.10	2.80	0.40	0.10	151.8	0 *	5	0.031
	Other	Jan-Apr	0.00	5.70	4.40	31.50	18.70	21.30	15.10	2.80	0.40	0.10	151.8	0 *	91	0.600
19790	Seine	Oct-Dec	0.06	5.59	69.33	6.94	9.48	4.51	2.87	0.72	0.42	0.09	91.4	3,345 +	10	0.111
	Seine	Jan-Apr	0.06	5.59	69.33	6.94	9.48	4.51	2.87	0.72	0.42	0.09	91.4	3,345	0	0.000 ~
	Other	Jan-Apr	0.06	5.59	69.33	6.94	9.48	4.51	2.87	0.72	0.42	0.09	91.4	3,345 +	91	0.995
	Gillnet	Jan-Apr	0.00	0.00	5.36	0.89	34.82	21.43	18.75	11.61	6.25	0.89	157.9	112 +	528	3.347
19801	Seine	Jan-Apr	0.00	1.88	14.92	68.45	7.06	4.98	1.95	0.44	0.29	0.04	101.3	5,210	263	2.570
	Seine	May-Sep	0.00	3.78	14.57	63.82	7.83	6.03	2.80	0.67	0.36	0.13	99.2	5,210 +	6	0.063
	Other	Jan-Apr	0.00	3.78	14.57	63.82	7.83	6.03	2.80	0.67	0.36	0.13	99.2	5,210 +	91	0.917
	Gillnet	Jan-Apr	0.00	0.28	1.47	47.46	12.43	15.35	12.78	6.94	2.48	0.82	142.5	1,418	2,304	15.892

Appendix 1.3. Age composition and catch by season, fishery and gear type for the Central Coast stock assessment region. These data are used for the age-structured model analysis.

			P E R C E N T A T A G E										Mean	Number	C A T C H	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged	(tonnes)	(millions)
19812	Seine	Jan-Apr	0.00	0.61	11.52	10.17	66.35	5.52	4.26	1.26	0.30	0.00	131.9	2,300	2,258	17.116
	Seine	May-Sep	0.00	0.61	11.52	10.17	66.35	5.52	4.26	1.26	0.30	0.00	131.9	2,300 +	0	0.003
	Other	Jan-Apr	0.00	1.68	15.62	10.72	60.21	5.19	4.56	1.45	0.48	0.09	122.2	3,508 +	91	0.745
	Gillnet	Jan-Apr	0.00	0.00	2.88	6.96	76.07	7.38	5.17	1.20	0.33	0.01	141.3	1,242	4,112	29.155
19823	Seine	Jan-Apr	0.00	0.58	7.06	13.65	11.15	58.16	5.32	3.13	0.64	0.31	134.7	5,445	2,061	15.154
	Other	Jan-Apr	0.00	0.53	7.00	15.43	10.82	57.10	5.03	3.10	0.73	0.26	133.2	5,445 +	273	2.050
	Gillnet	Jan-Apr	0.00	0.00	0.56	7.56	13.82	68.06	5.22	3.93	0.62	0.23	146.7	1,703	3,579	24.422
19834	Seine	Jan-Apr	0.00	2.29	5.47	7.67	17.73	17.04	47.03	1.93	0.69	0.14	128.0	6,294	3,589	28.383
	Other	Jan-Apr	0.02	4.35	7.31	10.12	18.16	16.14	40.72	2.26	0.83	0.10	127.1	6,294 +	273	2.148
	Gillnet	Jan-Apr	0.00	0.00	0.27	2.69	12.49	16.84	61.49	4.63	1.07	0.53	145.1	1,092	3,582	24.536
19845	Seine	Jan-Apr	0.00	0.61	28.72	8.11	9.89	17.28	14.48	20.15	0.49	0.26	136.5	3,690	2,915	20.337
	Other	Jan-Apr	0.00	2.75	37.85	7.56	8.43	12.87	11.77	18.20	0.44	0.13	130.2	5,422 +	273	2.097
	Gillnet	Jan-Apr	0.00	0.00	3.78	6.27	9.37	20.63	23.57	35.09	0.85	0.44	161.3	1,507	2,294	14.082
19856	Seine	Oct-Dec	0.00	4.00	16.21	39.67	8.61	6.41	6.74	6.12	11.63	0.62	135.0	5,995 +	30	0.224
	Seine	Jan-Apr	0.00	0.94	14.64	41.12	10.95	5.12	6.40	6.55	13.85	0.43	138.7	3,983	2,173	16.047
	Trawl	Jan-Apr	0.00	4.00	16.21	39.67	8.61	6.41	6.74	6.12	11.63	0.62	135.0	5,995 +	7	0.054
	Other	Jan-Apr	0.00	4.00	16.21	39.67	8.61	6.41	6.74	6.12	11.63	0.62	135.0	5,995 +	214	1.585
	Gillnet	Jan-Apr	0.00	0.00	2.01	21.83	14.45	7.98	14.53	14.47	24.18	0.56	155.5	1,020	1,176	7.676
19867	Seine	Jan-Apr	0.00	4.13	20.03	13.26	32.77	5.60	5.06	6.71	5.11	7.33	143.9	3,614	2,695	18.225
	Other	Jan-Apr	0.00	4.99	22.77	14.49	31.67	5.63	4.48	5.73	4.58	5.67	137.6	5,134 +	214	1.555
	Gillnet	Jan-Apr	0.00	0.00	0.82	7.75	44.85	11.72	7.85	9.89	8.15	8.97	165.2	981	920	5.571
19878	Seine	Jan-Apr	0.00	0.82	65.84	12.35	6.16	8.30	1.73	1.71	1.68	1.40	107.5	4,159	3,539	31.909
	Seine	May-Sep	0.00	0.81	65.96	12.42	6.14	8.29	1.66	1.73	1.66	1.34	110.9	2,835 +	18	0.162
	Other	Jan-Apr	0.00	1.14	67.92	11.67	6.28	7.12	1.68	1.46	1.50	1.23	103.4	5,194 +	273	2.639
	Gillnet	Jan-Apr	0.00	0.00	4.39	10.69	15.27	27.48	13.74	7.06	9.73	11.64	162.2	524	970	5.978
19889	Seine	Jan-Apr	0.00	0.84	3.72	79.59	8.59	2.79	2.28	0.60	0.87	0.71	112.1	4,321	6,531	61.253
	Other	Jan-Apr	0.00	1.28	4.61	76.21	9.16	3.58	2.80	0.74	0.80	0.82	109.5	5,642 +	273	2.492
	Gillnet	Jan-Apr	0.00	0.00	0.32	29.13	25.73	17.31	14.72	5.34	3.72	3.72	147.9	618	2,911	19.680
19890	Seine	Jan-Apr	0.00	0.81	3.55	5.07	74.01	7.47	3.93	3.48	0.81	0.85	131.1	6,843	5,305	39.561
	Other	Jan-Apr	0.00	0.96	5.60	5.06	72.67	7.47	3.77	2.95	0.75	0.77	127.9	6,843 +	273	2.134
	Gillnet	Jan-Apr	0.00	0.00	0.00	1.03	68.15	16.46	5.46	6.48	1.10	1.32	144.7	806	3,046	20.978
19901	Seine	Jan-Apr	0.00	1.76	16.48	7.41	6.52	56.72	6.70	2.34	1.70	0.36	133.9	7,107	7,097	52.412
	Other	Jan-Apr	0.03	2.03	18.81	6.75	6.19	55.54	6.37	2.34	1.48	0.46	131.0	7,107 +	455	3.474
	Gillnet	Jan-Apr	0.00	0.00	0.56	2.41	6.30	69.81	9.44	7.04	3.52	0.93	154.7	540	1,806	11.673
19912	Seine	Jan-Apr	0.00	0.94	60.91	10.17	2.47	2.95	19.02	2.03	0.79	0.72	107.2	7,264	7,251	66.620
	Other	Jan-Apr	0.00	2.01	58.38	11.40	2.74	3.44	18.75	2.13	0.61	0.54	105.4	7,264 +	455	4.315
	Gillnet	Jan-Apr	0.00	0.00	6.87	6.96	4.42	6.98	60.93	9.67	2.99	1.19	155.5	1,119	1,111	6.991
19923	Seine	Jan-Apr	0.00	3.37	7.06	63.75	9.66	1.85	2.41	10.22	1.24	0.43	112.3	6,939	8,478	75.838
	Other	Jan-Apr	0.00	2.88	6.70	64.08	9.69	2.02	2.57	10.47	1.12	0.47	111.4	8,751 +	455	4.084
	Gillnet	Jan-Apr	0.00	0.00	0.20	45.74	14.12	5.43	5.88	25.47	2.48	0.67	138.9	781	2,038	14.682
19934	Seine	Jan-Apr	0.00	0.87	18.91	7.17	56.09	7.93	2.09	3.02	3.51	0.42	118.7	6,174	9,757	81.704
	Other	Jan-Apr	0.00	1.16	21.05	8.48	53.20	7.51	2.03	2.72	3.52	0.33	115.9	7,308 +	455	3.925
	Gillnet	Jan-Apr	0.00	0.00	1.73	5.09	66.34	12.30	3.27	4.00	6.51	0.77	133.8	1,951	2,122	15.809
19945	Seine	Jan-Apr	0.00	0.58	5.12	22.95	9.25	49.46	6.30	2.18	2.34	1.81	127.0	8,932	8,131	64.167
	Other	Jan-Apr	0.00	0.77	6.06	23.46	9.32	48.00	6.35	2.00	2.29	1.75	124.8	9,592 +	637	5.105
	Gillnet	Jan-Apr	0.00	0.00	0.23	8.93	8.00	64.84	10.67	1.79	2.23	3.31	137.4	1,267	1,451	10.565
19956	Seine	Jan-Apr	0.00	12.82	18.28	5.03	16.68	7.26	31.17	5.89	1.57	1.31	124.2	4,087	3,897	32.478
	Other	Jan-Apr	0.00	11.91	19.89	5.77	16.53	6.93	30.32	5.80	1.48	1.37	117.8	5,601 +	1,001	8.494
	Gillnet	Jan-Apr	0.00	0.00	0.39	1.55	18.33	11.88	53.07	10.48	1.97	2.33	146.4	566	402	2.743
19967	Seine	Jan-Apr	0.00	2.20	56.77	15.70	3.46	6.65	4.27	8.66	1.70	0.58	94.3	5,235	3,276	34.713
	Other	Jan-Apr	0.00	2.13	56.65	16.89	3.62	6.14	3.99	8.49	1.54	0.55	92.7	6,870 +	1,183	12.756
	Gillnet	Jan-Apr	0.00	0.00	1.36	2.92	6.23	22.76	19.26	38.33	7.20	1.95	143.5	514	344	2.401
19978	Seine	Jan-Apr	0.00	0.52	30.62	41.30	7.99	2.46	6.42	5.30	4.48	0.90	97.1	1,339	7,963	81.986
	Other	Jan-Apr	0.00	0.52	36.42	42.50	8.42	2.36	3.07	3.01	2.92	0.78	89.2	6,571 +	1,183	13.268
	Gillnet	Jan-Apr	0.00	0.00	0.44	13.09	12.55	8.50	18.31	16.51	22.13	8.46	140.4	1,031	639	4.483
19989	Seine	Jan-Apr	0.00	0.39	8.47	40.02	34.44	7.61	2.15	2.79	2.60	1.53	99.8	5,005	6,449	63.286
	Other	Jan-Apr	0.00	0.78	8.79	42.78	34.15	6.51	1.62	2.12	1.94	1.32	98.7	5,005 +	1,092	11.063
	Gillnet	Jan-Apr	0.00	0.00	0.13	15.27	45.02	17.80	6.24	5.31	5.44	4.78	128.8	753	1,524	11.833
19990	Seine	Jan-Apr	0.00	0.20	17.26	10.45	33.08	28.77	6.39	1.44	1.16	1.25	110.1	4,527	6,803	58.874
	Other	Jan-Apr	0.00	0.35	19.11	10.82	34.72	26.20	5.81	1.17	0.91	0.91	109.6	4,527 +	1,274	11.625
	Gillnet	Jan-Apr	0.00	0.00	0.44	2.04	40.44	41.61	10.36	1.61	0.88	2.63	133.0	685	1,077	8.093
20001	Seine	Jan-Apr	0.01	2.11	7.09	24.84	12.46	25.26	21.37	5.12	1.18	0.57	117.5	3,070	5,950	49.818
	Other	Jan-Apr	0.02	2.54	7.70	27.04	11.71	26.57	18.82	4.10	0.86	0.63	112.9	4,415 +	889	7.875
	Gillnet	Jan-Apr	0.00	0.00	0.00	4.87	5.75	52.75	28.13	7.12	1.13	0.25	135.3	800	517	3.822
20012	Seine	Jan-Apr	0.00	4.71	33.86	9.81	15.67	6.41	19.55	8.17	1.56	0.26	98.5	3,164	2,894	29.155
	Other	Jan-Apr	0.00	4.79	34.80	9.87	16.85	5.67	18.56	7.95	1.29	0.23	95.7	6,456 +	980	10.235
	Gillnet	Jan-Apr	0.00	0.00	0.60	5.95	20.83	7.54	47.02	16.47	1.39	0.20	128.6	504	399	3.099
20023	Seine	Jan-Apr	0.00	0.09	30.97	24.46	9.95	12.93	5.79	11.12	3.98	0.72	104.9	2,212	2,299	21.911
	Other	Jan-Apr	0.00	0.43	46.74	24.13	6.81	8.30	3.88	6.71	2.50	0.51	94.5	5,289 +	1,071	11.338
	Gillnet	Jan-Apr	0.00	0.00	0.43	3.57	11.14	25.73	11.24	33.08	12.32	2.49	143.2	925	289	2.021

NOTE: * No biosample data available. Age composition and mean weight assigned from published reports.
+ Age composition calculated from biosample data aggregated from adjacent sections and/or fishery periods, by gear type.
~ No fishery openings this season. Age composition and mean weight obtained from pre-fishery charter biosamples.

Appendix 1.4. Age composition and catch by season, fishery and gear type for the Strait of Georgia stock assessment region. These data are used for the age-structured model analysis.

Season	Gear	Fishery	PERCENT AT AGE 0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	CATCH (tonnes)	CATCH (millions)
19501	Seine	Oct-Dec	0.03	4.32	58.19	28.93	6.71	1.40	0.30	0.10	0.02	0.00	99.6	7,816	42,180	424.795
	Seine	Jan-Apr	0.06	4.40	32.64	48.59	10.65	2.76	0.62	0.23	0.06	0.00	103.6	1,774 +	1,226	11.828
	Seine	May-Sep	0.04	3.46	61.00	26.57	7.12	1.25	0.43	0.12	0.00	0.00	99.5	7,816 +	393	3.923
19512	Seine	Oct-Dec	0.11	14.85	55.11	21.73	6.50	1.32	0.28	0.08	0.01	0.00	93.0	8,839	44,896	492.871
	Seine	Jan-Apr	0.16	21.32	49.53	21.11	6.19	1.52	0.11	0.05	0.00	0.00	91.8	8,839 +	423	4.847
	Seine	May-Sep	0.03	5.73	55.51	29.95	7.19	1.34	0.20	0.05	0.00	0.00	97.0	8,839 +	527	5.222
	Trawl	Jan-Apr	0.00	0.00	50.26	36.79	9.84	2.59	0.52	0.00	0.00	0.00	115.6	193	0	0.000 ~
19523	Seine	Oct-Dec	0.10	1.72	54.76	38.77	3.97	0.52	0.07	0.10	0.00	0.00	87.1	3,810	3,750	41.452
	Seine	Jan-Apr	0.14	3.79	65.35	27.05	2.97	0.62	0.07	0.00	0.00	0.00	81.0	5,220	3,966	48.795
	Seine	May-Sep	0.17	2.60	55.66	37.08	3.71	0.63	0.09	0.07	0.00	0.00	84.6	9,030 +	442	5.059
	Trawl	Oct-Dec	0.00	1.58	63.29	30.79	3.68	0.66	0.00	0.00	0.00	0.00	88.4	760	29	0.326
	Trawl	Jan-Apr	0.00	5.91	67.27	23.62	2.60	0.60	0.00	0.00	0.00	0.00	78.0	999	225	2.888
19534	Seine	Oct-Dec	0.00	1.12	53.97	36.36	6.83	1.38	0.27	0.06	0.01	0.00	96.0	9,693	57,443	595.913
	Seine	Jan-Apr	0.00	2.17	43.19	41.52	8.91	3.32	0.70	0.18	0.01	0.00	94.5	3,618 +	619	6.600
	Seine	May-Sep	0.00	1.78	22.05	37.29	26.45	8.79	2.98	0.60	0.07	0.00	119.9	3,374	7,692	62.447
	Trawl	Jan-Apr	0.00	1.36	52.67	36.83	7.07	1.66	0.33	0.08	0.01	0.00	95.7	9,788 +	14	0.142
19545	Seine	Oct-Dec	0.00	3.92	56.38	33.92	5.18	0.52	0.09	0.00	0.00	0.00	98.5	4,028	50,604	503.361
	Seine	Jan-Apr	0.00	3.50	22.26	60.88	11.00	2.22	0.15	0.00	0.00	0.00	85.6	896	13,825	161.566
	Seine	May-Sep	0.00	4.65	49.87	38.62	5.95	0.82	0.10	0.00	0.00	0.00	94.5	4,924 +	4,207	43.919
	Trawl	Oct-Dec	0.00	4.65	50.12	38.35	5.99	0.80	0.10	0.00	0.00	0.00	95.8	4,994 +	5	0.054
	Trawl	Jan-Apr	0.00	8.57	57.14	25.71	8.57	0.00	0.00	0.00	0.00	0.00	84.7	70	0	0.000 ~
19556	Seine	Oct-Dec	0.00	4.07	52.03	30.65	11.30	1.65	0.29	0.00	0.00	0.00	97.4	3,783	44,043	451.810
	Seine	Jan-Apr	0.00	4.10	14.20	29.99	41.94	7.87	1.37	0.43	0.09	0.02	109.1	4,816	26,375	243.982
	Seine	May-Sep	0.00	0.13	9.76	43.52	26.32	17.07	2.44	0.64	0.00	0.13	125.5	779	1,462	11.648
	Trawl	Oct-Dec	0.00	5.52	58.00	26.95	8.19	1.05	0.29	0.00	0.00	0.00	93.7	1,050	182	1.944
	Trawl	Jan-Apr	0.00	18.62	44.38	24.62	10.24	1.91	0.23	0.00	0.00	0.00	85.7	2,197	0	0.000 ~
19567	Seine	Oct-Dec	0.00	0.73	64.78	20.31	9.37	4.25	0.51	0.04	0.00	0.00	96.2	4,691	44,241	460.767
	Seine	Jan-Apr	0.00	1.42	64.96	21.83	7.50	3.97	0.31	0.00	0.00	0.00	95.7	826	8,202	84.577
	Seine	May-Sep	0.00	3.46	18.92	40.97	25.30	9.95	1.08	0.11	0.11	0.11	129.9	925	7,165	55.146
	Trawl	Jan-Apr	0.12	2.24	71.93	14.15	4.60	5.66	0.94	0.24	0.00	0.12	91.7	848	0	0.000 ~
19578	Seine	Oct-Dec	0.00	10.67	60.24	20.45	3.60	3.20	1.64	0.15	0.04	0.00	88.8	3,085	11,745	133.517
	Seine	Jan-Apr	0.00	9.97	61.67	16.52	4.36	3.66	3.24	0.49	0.09	0.00	90.1	1,850	6,982	84.814
	Seine	May-Sep	0.00	9.00	60.10	21.06	3.99	3.20	2.30	0.30	0.05	0.00	88.9	4,935 +	1,206	13.597
	Trawl	Jan-Apr	0.00	12.72	73.29	11.64	1.88	0.45	0.01	0.01	0.00	0.00	74.8	527	695	9.491
	Gillnet	Jan-Apr	0.00	24.49	53.06	18.37	0.00	2.04	0.00	2.04	0.00	0.00	76.1	49	0	0.000 ~
19589	Seine	Oct-Dec	0.74	13.95	66.31	15.95	2.34	0.39	0.21	0.10	0.01	0.00	83.5	7,169	47,601	575.751
	Seine	Jan-Apr	0.86	14.21	65.57	16.41	2.29	0.39	0.21	0.06	0.01	0.00	82.4	7,215 +	146	1.770
	Seine	May-Sep	0.00	25.55	57.59	10.98	3.72	1.52	0.27	0.29	0.09	0.00	79.4	1,506	1,897	23.636
	Trawl	Jan-Apr	1.52	19.81	59.43	18.10	1.14	0.00	0.00	0.00	0.00	0.00	70.9	525	0	0.000 ~
	Gillnet	Oct-Dec	0.00	24.49	53.06	18.37	0.00	2.04	0.00	2.04	0.00	0.00	76.1	49 +	381	5.002
19590	Seine	Oct-Dec	0.00	6.80	54.12	35.60	2.93	0.36	0.09	0.07	0.00	0.02	98.1	3,323	67,866	685.617
	Seine	Jan-Apr	0.00	23.34	50.24	24.15	2.11	0.00	0.16	0.00	0.00	0.00	79.8	617	149	1.863
	Trawl	Oct-Dec	0.00	10.10	51.47	34.80	3.07	0.36	0.10	0.08	0.00	0.03	95.7	3,940 +	23	0.237
19601	Seine	Oct-Dec	0.00	40.17	30.91	22.59	5.84	0.50	0.00	0.00	0.00	0.00	88.0	2,248	25,847	303.907
	Seine	Jan-Apr	0.00	31.62	24.51	25.79	16.10	1.87	0.11	0.00	0.00	0.00	80.6	1,145	9,335	115.270
	Seine	May-Sep	0.00	0.16	28.79	22.54	26.29	19.56	2.35	0.31	0.00	0.00	114.2	639	9,119	79.855
	Trawl	Oct-Dec	0.00	38.75	35.27	19.59	6.24	0.15	0.00	0.00	0.00	0.00	85.8	689	1,328	15.472
	Trawl	Jan-Apr	0.00	38.75	35.27	19.59	6.24	0.15	0.00	0.00	0.00	0.00	85.8	689 +	586	6.822
19612	Seine	Oct-Dec	0.00	9.92	71.21	12.79	4.02	1.72	0.33	0.00	0.00	0.00	88.8	2,824	53,725	602.612
	Seine	Jan-Apr	0.00	13.01	67.90	10.71	5.23	2.56	0.60	0.00	0.00	0.00	87.8	2,824 +	36	0.412
	Seine	May-Sep	0.00	9.42	71.71	13.00	3.96	1.57	0.32	0.02	0.00	0.00	88.8	2,824 +	10,747	120.280
	Trawl	Oct-Dec	0.00	9.56	71.49	12.85	4.11	1.59	0.35	0.04	0.00	0.00	89.0	2,824 +	785	8.818
	Trawl	Jan-Apr	0.00	9.56	71.49	12.85	4.11	1.59	0.35	0.04	0.00	0.00	89.0	2,824 +	9	0.106
19623	Seine	Oct-Dec	0.00	13.94	52.76	29.55	3.49	0.19	0.04	0.04	0.00	0.00	86.6	1,596	56,900	651.147
	Seine	Jan-Apr	0.00	31.58	47.44	15.39	2.88	1.78	0.72	0.35	0.00	0.00	82.2	1,874 +	5,014	71.016
	Seine	May-Sep	0.00	16.74	51.99	27.11	3.19	1.26	0.49	0.10	0.00	0.00	83.3	1,874 +	6,685	78.835
	Trawl	Oct-Dec	0.00	16.73	53.03	26.51	2.73	0.65	0.25	0.10	0.00	0.00	84.5	2,014 +	200	2.372
	Trawl	Jan-Apr	0.00	16.73	53.03	26.51	2.73	0.65	0.25	0.10	0.00	0.00	84.5	2,014 +	47	0.562
19634	Seine	Oct-Dec	0.00	4.30	63.37	29.55	2.20	0.47	0.05	0.07	0.00	0.00	103.4	3,255	65,538	626.573
19634	Seine	Jan-Apr	0.06	5.19	60.54	31.14	2.58	0.40	0.03	0.06	0.00	0.00	105.7	3,255 +	878	8.440
	Seine	May-Sep	0.00	3.41	49.27	36.83	6.34	3.17	0.73	0.24	0.00	0.00	99.2	410	10,153	102.385
	Trawl	Oct-Dec	0.06	5.41	60.55	30.91	2.58	0.40	0.03	0.06	0.00	0.00	103.4	3,255 +	105	1.016
	Trawl	Jan-Apr	0.06	5.41	60.55	30.91	2.58	0.40	0.03	0.06	0.00	0.00	103.4	3,255 +	208	2.011
19645	Seine	Oct-Dec	0.00	20.04	54.60	22.98	2.07	0.28	0.00	0.03	0.00	0.00	103.0	2,555	39,050	388.413
	Seine	Jan-Apr	0.00	20.49	50.36	25.51	2.46	1.14	0.23	0.00	0.00	0.00	104.3	2,939 +	5,453	54.899
	Seine	May-Sep	0.00	16.35	55.51	25.09	2.26	0.77	0.67	0.04	0.00	0.00	104.0	2,939 +	3,266	31.893
	Trawl	Oct-Dec	0.00	14.53	56.86	25.79	2.14	0.61	0.03	0.03	0.00	0.00	104.3	2,939 +	36	0.349
	Trawl	Jan-Apr	0.00	14.53	56.86	25.79	2.14	0.61	0.03	0.03	0.00	0.00	104.3	2,939 +	14	0.132
19656	Seine	Oct-Dec	0.00	17.20	38.00	25.14	15.88	2.65	1.13	0.00	0.00	0.00	120.4	529	27,909	231.771
	Seine	Jan-Apr	0.00	17.20	38.00	25.14	15.88	2.65	1.13	0.00	0.00	0.00	120.4	529 +	4,216	35.012
	Seine	May-Sep	0.00	17.20	38.00	25.14	15.88	2.65	1.13	0.00	0.00	0.00	120.4	529 +	1,165	9.673
	Trawl	Oct-Dec	0.00	17.20	38.00	25.14	15.88	2.65	1.13	0.00	0.00	0.00	120.4	529 +	25	0.211
	Trawl	Jan-Apr	0.00	17.20	38.00	25.14	15.88	2.65	1.13	0.00	0.00	0.00	120.4	529 +	18	0.146
19667	Seine	Oct-Dec	0.00	36.90	45.72	12.18	3.21	1.59	0.29	0.05	0.06	0.00	91.6	0 *	28,090	306.795
	Seine	Jan-Apr	0.00	36.90	45.72	12.18	3.21	1.59	0.29	0.05	0.06	0.00	91.6	0 *	1,694	18.499
	Seine	May-Sep	0.00	36.90	45.72	12.18	3.21	1.59	0.29	0.05	0.06	0.00	91.6	0 *	1,193	13.031
	Trawl	Oct-Dec	0.00	36.90	45.72	12.18	3.21	1.59	0.29	0.05	0.06	0.00	91.6	0 *	1	0.008
	Trawl	Jan-Apr	0.00	36.90	45.72	12.18	3.21	1.59	0.29	0.05	0.06	0.00	91.6	0 *	65	0.707

Appendix 1.4. Age composition and catch by season, fishery and gear type for the Strait of Georgia stock assessment region. These data are used for the age-structured model analysis.

			PERCENT AT AGE												CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	(tonnes)	(millions)
19678	Seine	Oct-Dec	0.00	30.37	50.62	14.68	3.04	0.88	0.18	0.23	0.00	0.00	94.8	0 *	1,031	10.881
	Seine	Jan-Apr	0.00	30.37	50.62	14.68	3.04	0.88	0.18	0.23	0.00	0.00	94.8	0 *	58	0.616
	Seine	May-Sep	0.00	30.37	50.62	14.68	3.04	0.88	0.18	0.23	0.00	0.00	94.8	0 *	700	7.390
	Trawl	Jan-Apr	0.00	30.37	50.62	14.68	3.04	0.88	0.18	0.23	0.00	0.00	94.8	0 *	101	1.061
19690	Seine	Oct-Dec	0.00	25.64	60.32	9.49	3.27	0.72	0.56	0.00	0.00	0.00	95.5	0 *	1	0.007
	Seine	Jan-Apr	0.00	25.64	60.32	9.49	3.27	0.72	0.56	0.00	0.00	0.00	95.5	0 *	220	2.299
	Trawl	Jan-Apr	0.00	25.64	60.32	9.49	3.27	0.72	0.56	0.00	0.00	0.00	95.5	0 *	0	0.004
	Gillnet	Jan-Apr	0.00	25.64	60.32	9.49	3.27	0.72	0.56	0.00	0.00	0.00	95.5	0 *	22	0.230
19701	Seine	Oct-Dec	0.35	12.33	40.03	36.36	7.12	2.82	0.92	0.07	0.00	0.00	114.8	1,419	588	5.118
	Seine	Jan-Apr	0.43	13.36	41.17	34.74	7.01	2.58	0.67	0.04	0.00	0.00	113.9	1,419 +	857	7.672
	Seine	May-Sep	0.35	12.33	40.03	36.36	7.12	2.82	0.92	0.07	0.00	0.00	114.8	1,419 +	66	0.577
	Trawl	Oct-Dec	0.35	12.33	40.03	36.36	7.12	2.82	0.92	0.07	0.00	0.00	114.8	1,419 +	95	0.828
	Trawl	Jan-Apr	0.35	12.33	40.03	36.36	7.12	2.82	0.92	0.07	0.00	0.00	114.8	1,419 +	4	0.032
	Gillnet	Oct-Dec	0.00	4.58	11.75	46.61	28.49	6.77	1.49	0.20	0.10	0.00	140.1	1,004 +	40	0.286
	Gillnet	Jan-Apr	0.00	4.58	11.75	46.61	28.49	6.77	1.49	0.20	0.10	0.00	140.1	1,004 +	44	0.311
19712	Seine	Oct-Dec	0.06	12.78	32.57	33.30	16.53	3.36	1.21	0.12	0.06	0.00	126.0	2,340	1,017	8.277
	Seine	Jan-Apr	0.00	5.69	32.75	36.27	19.69	4.21	1.29	0.09	0.01	0.00	113.1	7,062	7,240	63.276
	Seine	May-Sep	0.01	4.41	29.73	34.98	23.32	6.08	1.39	0.09	0.01	0.00	117.3	9,402 +	98	0.815
	Trawl	Jan-Apr	0.01	8.60	34.61	33.23	18.40	3.79	1.17	0.17	0.02	0.00	114.9	9,402 +	0	0.002
	Gillnet	Jan-Apr	0.00	5.92	11.45	45.25	28.69	6.90	1.65	0.14	0.00	0.00	139.8	1,004	456	3.275
19723	Seine	Oct-Dec	0.00	3.37	50.48	20.94	18.35	5.39	0.91	0.45	0.11	0.00	120.6	1,071	256	2.082
	Seine	Jan-Apr	0.08	1.98	36.48	29.31	20.75	10.01	1.24	0.14	0.01	0.00	130.3	4,643	5,161	41.003
	Seine	May-Sep	0.09	3.35	39.83	27.62	19.68	7.90	1.15	0.33	0.05	0.00	124.1	5,714 +	167	1.351
	Trawl	Oct-Dec	0.10	1.89	31.61	30.52	23.07	11.01	1.51	0.26	0.03	0.00	130.6	5,777 +	1	0.008
	Trawl	Jan-Apr	0.10	1.89	31.61	30.52	23.07	11.01	1.51	0.26	0.03	0.00	130.6	5,777 +	0	0.000
	Gillnet	Oct-Dec	0.00	0.00	17.41	30.36	37.50	11.16	3.13	0.45	0.00	0.00	133.4	224 +	6	0.048
	Gillnet	Jan-Apr	0.00	0.00	17.41	30.36	37.50	11.16	3.13	0.45	0.00	0.00	133.4	224 +	2,057	15.421
19734	Seine	Jan-Apr	0.00	16.29	60.29	17.53	4.19	1.47	0.11	0.11	0.00	0.00	77.8	884 +	842	10.833
	Seine	May-Sep	0.00	16.29	60.29	17.53	4.19	1.47	0.11	0.11	0.00	0.00	77.8	884 +	62	0.795
	Trawl	Jan-Apr	0.00	16.83	61.15	17.24	3.42	1.23	0.14	0.00	0.00	0.00	72.2	731	5	0.064
	Gillnet	Jan-Apr	0.00	0.00	3.74	43.04	32.01	17.56	3.21	0.43	0.00	0.00	157.1	924	3,095	19.692
19745	Seine	Oct-Dec	1.00	5.07	54.83	26.49	7.34	3.17	1.50	0.44	0.18	0.00	97.1	5,685 +	218	2.243
	Seine	Jan-Apr	0.36	3.87	57.31	27.80	7.04	2.49	0.77	0.23	0.13	0.00	98.1	5,685	575	5.995
	Seine	May-Sep	1.00	5.07	54.83	26.49	7.34	3.17	1.50	0.44	0.18	0.00	97.1	5,685 +	55	0.564
	Trawl	Oct-Dec	1.00	5.07	54.83	26.49	7.34	3.17	1.50	0.44	0.18	0.00	97.1	5,685 +	1	0.006
	Other	Jan-Apr	1.00	5.07	54.83	26.49	7.34	3.17	1.50	0.44	0.18	0.00	97.1	5,685 +	204	2.102
	Gillnet	Jan-Apr	0.00	0.00	4.88	46.34	32.32	12.80	3.05	0.61	0.00	0.00	150.1	164 +	5,331	35.526
19756	Seine	Oct-Dec	0.06	7.34	23.01	40.08	20.31	5.57	2.38	0.79	0.43	0.04	122.7	3,494	4,313	35.358
	Seine	Jan-Apr	0.00	5.95	20.35	46.41	19.28	5.46	1.60	0.71	0.20	0.04	109.9	2,254	834	7.166
	Seine	May-Sep	0.03	7.45	21.69	41.20	20.01	5.53	2.57	1.04	0.40	0.07	119.8	5,748 +	28	0.238
	Trawl	Oct-Dec	0.03	7.28	21.54	41.65	19.99	5.44	2.59	1.01	0.39	0.07	120.3	5,918 +	3	0.021
	Trawl	Jan-Apr	0.03	7.28	21.54	41.65	19.99	5.44	2.59	1.01	0.39	0.07	120.3	5,918 +	86	0.711
	Other	Jan-Apr	0.03	7.28	21.54	41.65	19.99	5.44	2.59	1.01	0.39	0.07	120.3	5,918 +	205	1.704
	Gillnet	Jan-Apr	0.00	0.00	0.54	42.00	43.88	10.28	2.70	0.40	0.20	0.00	148.8	786	6,975	46.818
19767	Seine	Oct-Dec	0.62	6.52	56.39	19.55	12.05	3.06	0.95	0.66	0.19	0.01	107.2	1,828	616	5.836
	Seine	Jan-Apr	0.06	3.39	52.68	22.31	16.46	3.70	0.86	0.42	0.03	0.09	105.5	3,200	8,257	78.397
	Seine	May-Sep	0.36	3.76	52.98	21.04	15.51	4.16	1.25	0.62	0.20	0.12	106.5	5,028 +	25	0.236
	Trawl	Oct-Dec	0.36	3.76	52.98	21.04	15.51	4.16	1.25	0.62	0.20	0.12	106.5	5,028 +	73	0.683
	Trawl	Jan-Apr	0.36	3.76	52.98	21.04	15.51	4.16	1.25	0.62	0.20	0.12	106.5	5,028 +	802	7.534
	Other	Jan-Apr	0.36	3.76	52.98	21.04	15.51	4.16	1.25	0.62	0.20	0.12	106.5	5,028 +	569	5.343
	Gillnet	Jan-Apr	0.00	0.00	3.50	27.75	47.32	16.68	4.08	0.54	0.15	0.00	150.3	1,658	7,736	51.507
19778	Seine	Oct-Dec	0.06	2.53	36.75	40.07	9.39	7.18	3.08	0.56	0.35	0.03	110.2	1,984	10,648	96.197
	Seine	Jan-Apr	0.00	0.42	34.65	42.60	13.62	7.09	1.22	0.32	0.00	0.08	105.6	3,516	3,919	36.641
	Seine	May-Sep	0.06	2.25	36.56	39.10	10.46	7.84	2.83	0.57	0.27	0.06	106.3	5,500 +	30	0.287
	Trawl	Oct-Dec	0.03	1.31	35.05	42.37	11.19	7.52	1.95	0.34	0.15	0.08	107.9	5,891 +	1,792	16.618
	Trawl	Jan-Apr	0.03	1.31	35.05	42.37	11.19	7.52	1.95	0.34	0.15	0.08	107.9	5,891 +	296	2.746
	Other	Jan-Apr	0.03	1.31	35.05	42.37	11.19	7.52	1.95	0.34	0.15	0.08	107.9	5,891 +	546	5.063
	Gillnet	Oct-Dec	0.00	0.00	0.37	20.33	30.50	36.04	10.91	1.48	0.37	0.00	148.9	541 +	63	0.425
	Gillnet	Jan-Apr	0.00	0.00	0.37	20.33	30.50	36.04	10.91	1.48	0.37	0.00	148.9	541	7,253	48.694
19789	Seine	Oct-Dec	0.00	1.62	17.91	38.42	27.23	8.82	4.77	1.01	0.15	0.08	126.5	2,433	10,046	79.075
	Seine	Jan-Apr	0.00	3.01	23.91	33.51	25.54	7.92	3.91	1.48	0.43	0.29	117.7	2,095	54	0.461
	Seine	May-Sep	0.00	2.25	20.19	36.76	25.68	8.39	4.95	1.27	0.31	0.20	120.8	4,528 +	71	0.587
	Trawl	Oct-Dec	0.00	1.04	17.08	39.67	29.98	8.28	2.76	1.04	0.07	0.07	125.5	1,341	2,734	21.790
	Trawl	Jan-Apr	0.00	2.34	21.31	33.82	29.30	8.39	3.55	0.56	0.48	0.24	121.0	1,239	607	5.018
	Other	Jan-Apr	0.00	2.11	19.98	36.69	27.50	8.16	3.95	1.11	0.31	0.18	123.2	7,108 +	364	2.954
	Gillnet	Oct-Dec	0.00	0.00	1.15	23.14	54.68	13.77	5.54	1.53	0.00	0.19	153.5	523 +	7	0.048
	Gillnet	Jan-Apr	0.00	0.00	1.25	22.00	55.02	14.11	5.74	1.66	0.00	0.21	153.8	523	6,818	44.171
19790	Seine	Oct-Dec	0.30	2.02	42.12	22.71	18.78	9.35	2.56	1.54	0.47	0.15	114.6	3,063	1,188	10.051
	Seine	Jan-Apr	0.00	4.54	41.60	20.45	20.27	9.00	2.55	1.29	0.25	0.05	100.2	7,664	903	9.224
	Seine	May-Sep	0.15	4.03	43.30	19.97	19.34	8.73	2.59	1.42	0.37	0.11	102.3	10,727 +	52	0.514
	Trawl	Oct-Dec	0.00	3.30	46.70	22.21	15.90	8.60	2.01	1.29	0.00	0.00	108.4	698	242	2.234
	Trawl	Jan-Apr	0.00	3.31	49.04	22.17	14.65	7.90	1.78	1.15	0.00	0.00	107.1	785 +	254	2.373
	Other	Jan-Apr	0.06	3.58	46.53	19.04	17.66	9.09	2.32	1.29	0.31	0.11	104.8	11,512 +	273	2.606
	Gillnet	Oct-Dec	0.00	0.00	1.52	9.89	44.49	34.22	8.75	0.76	0.38	0.00	148.7	263 +	0	0.001
	Gillnet	Jan-Apr	0.00	0.00	1.52	9.89	44.49	34.22	8.75	0.76	0.38	0.00	148.7	263 +	3,177	21.367
	Gillnet	May-Sep	0.00	0.00	1.52	9.89	44.49	34.22	8.75	0.76	0.38	0.00	148.7	263 +	2	0.017

Appendix 1.4. Age composition and catch by season, fishery and gear type for the Strait of Georgia stock assessment region. These data are used for the age-structured model analysis.

Season	Gear	Fishery	PERCENT AT AGE 0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	CATCH (tonnes)	(millions)
19801	Seine	Oct-Dec	0.00	4.38	33.94	34.26	14.82	8.57	3.14	0.66	0.21	0.02	116.5	6,355	4,152	34.800
	Seine	Jan-Apr	0.00	6.17	34.93	30.73	11.93	10.58	4.58	0.67	0.37	0.04	99.9	12,461	2,133	19.819
	Seine	May-Sep	0.00	4.80	38.21	36.28	10.06	7.77	2.22	0.46	0.15	0.03	96.4	18,816 +	79	0.813
	Trawl	Oct-Dec	0.26	4.36	39.15	29.90	13.16	7.76	3.57	1.13	0.61	0.09	111.0	1,147	501	4.510
	Trawl	Jan-Apr	0.26	4.36	39.15	29.90	13.16	7.76	3.57	1.13	0.61	0.09	111.0	1,147 +	121	1.087
	Other	Jan-Apr	0.02	7.86	37.75	30.48	11.48	8.21	3.21	0.71	0.26	0.04	106.0	19,963 +	409	3.860
	Gillnet	Jan-Apr	0.00	0.09	2.19	18.16	22.98	37.37	16.05	2.81	0.26	0.09	152.1	1,140	5,067	33.319
19812	Seine	Oct-Dec	0.00	5.36	39.98	31.38	14.07	4.96	3.31	0.83	0.06	0.06	121.1	3,876	3,337	27.503
	Seine	Jan-Apr	0.00	7.65	37.90	23.33	19.46	4.51	4.57	2.11	0.40	0.06	104.8	5,332	3,324	30.103
	Seine	May-Sep	0.00	3.86	35.45	28.47	21.36	4.56	4.30	1.74	0.22	0.04	106.8	9,208 +	74	0.690
	Trawl	Oct-Dec	0.00	2.19	46.35	30.29	15.51	2.74	1.64	0.91	0.00	0.36	119.5	548	414	3.464
	Trawl	Jan-Apr	0.00	2.19	46.35	30.29	15.51	2.74	1.64	0.91	0.00	0.36	119.5	548 +	101	0.843
	Other	Jan-Apr	0.00	5.74	37.68	27.80	17.93	4.66	4.14	1.65	0.32	0.08	112.4	9,756 +	455	4.049
	Gillnet	Jan-Apr	0.00	0.00	4.60	15.77	30.37	15.82	20.42	11.58	1.03	0.41	150.9	589	5,583	37.004
	Gillnet	May-Sep	0.00	0.00	4.58	15.96	30.56	15.11	20.88	11.71	0.85	0.34	151.6	589 +	0	0.001
19823	Seine	Oct-Dec	0.00	3.37	34.06	30.39	16.43	8.12	2.93	3.00	1.43	0.26	116.0	5,296	632	4.809
	Seine	Jan-Apr	0.00	3.36	31.41	28.72	17.68	11.49	3.16	2.78	1.16	0.24	113.5	13,007	7,798	69.556
	Seine	May-Sep	0.00	10.91	42.05	22.39	12.44	7.63	1.95	1.76	0.72	0.14	109.6	18,303 +	57	0.568
	Trawl	Oct-Dec	0.00	1.59	19.36	35.99	17.54	12.07	3.87	5.01	3.87	0.68	144.1	439	115	0.797
	Trawl	Jan-Apr	0.00	1.59	19.36	35.99	17.54	12.07	3.87	5.01	3.87	0.68	144.1	439	0	0.000 ~
	Trawl	May-Sep	0.00	1.59	19.36	35.99	17.54	12.07	3.87	5.01	3.87	0.68	144.1	439 +	2	0.017
	Other	Jan-Apr	0.00	4.41	33.16	28.53	16.64	9.91	2.97	2.85	1.27	0.26	115.3	18,742 +	272	2.359
	Gillnet	Jan-Apr	0.00	0.00	0.49	27.76	29.48	23.59	9.34	7.37	1.72	0.25	152.8	407	8,613	56.381
19834	Seine	Oct-Dec	0.21	19.24	36.34	21.19	13.02	6.01	2.80	0.64	0.34	0.22	108.4	3,634	444	3.882
	Seine	Jan-Apr	0.00	4.70	40.35	31.85	11.86	6.31	3.10	1.27	0.44	0.11	103.8	7,318	4,137	41.098
	Seine	May-Sep	0.15	10.57	39.21	27.00	12.16	6.30	3.13	0.95	0.39	0.14	105.9	10,952 +	88	0.843
	Trawl	Oct-Dec	0.12	11.35	38.18	26.45	12.59	6.62	3.17	0.95	0.41	0.16	106.6	10,952 +	113	1.056
	Trawl	Jan-Apr	0.12	11.35	38.18	26.45	12.59	6.62	3.17	0.95	0.41	0.16	106.6	10,952 +	214	2.011
	Other	Jan-Apr	0.12	11.35	38.18	26.45	12.59	6.62	3.17	0.95	0.41	0.16	106.6	10,952 +	182	1.708
	Gillnet	Jan-Apr	0.00	0.00	7.14	30.29	30.95	19.05	9.39	1.59	0.66	0.93	142.9	756	6,039	42.246
19845	Seine	Oct-Dec	0.00	32.93	37.34	18.72	6.75	2.89	0.91	0.34	0.11	0.00	101.9	2,528	409	3.904
	Seine	Jan-Apr	0.00	23.09	43.51	19.33	8.62	3.55	1.27	0.55	0.07	0.00	90.8	8,187	2,770	29.011
	Seine	May-Sep	0.00	24.05	45.04	18.72	7.69	2.83	1.19	0.42	0.05	0.01	90.3	10,715 +	88	0.975
	Trawl	Oct-Dec	0.00	25.68	43.11	18.61	7.60	3.21	1.20	0.51	0.06	0.01	93.7	10,799 +	20	0.218
	Trawl	Jan-Apr	0.00	25.68	43.11	18.61	7.60	3.21	1.20	0.51	0.06	0.01	93.7	10,799 +	246	2.630
	Other	Jan-Apr	0.00	25.68	43.11	18.61	7.60	3.21	1.20	0.51	0.06	0.01	93.7	10,799 +	182	1.943
	Gillnet	Oct-Dec	0.00	0.09	3.10	26.09	32.48	23.63	9.22	3.74	0.82	0.82	147.4	1,096 +	0	0.002
	Gillnet	Jan-Apr	0.00	0.09	3.10	26.09	32.48	23.63	9.22	3.74	0.82	0.82	147.4	1,096	3,495	23.718
19856	Seine	Oct-Dec	0.00	14.33	62.24	17.57	4.40	1.27	0.17	0.02	0.00	0.00	103.3	1,390	209	2.004
	Seine	Jan-Apr	0.01	9.76	55.76	24.98	6.45	2.06	0.80	0.12	0.08	0.00	94.7	6,773	178	1.844
	Seine	May-Sep	0.05	13.71	56.73	21.10	5.75	1.79	0.70	0.12	0.06	0.00	95.2	8,163 +	40	0.426
	Trawl	Oct-Dec	0.05	13.71	56.73	21.10	5.75	1.79	0.70	0.12	0.06	0.00	95.2	8,163 +	46	0.481
	Trawl	Jan-Apr	0.05	13.71	56.73	21.10	5.75	1.79	0.70	0.12	0.06	0.00	95.2	8,163 +	120	1.257
	Gillnet	Oct-Dec	0.00	0.00	2.50	35.62	33.44	16.51	8.49	2.60	0.57	0.26	145.1	1,920 +	0	0.000
19867	Seine	Oct-Dec	0.10	23.34	34.77	30.50	8.84	1.75	0.46	0.23	0.00	0.00	104.8	1,148	104	0.984
	Seine	Jan-Apr	0.03	2.73	32.98	38.23	19.76	4.32	1.22	0.45	0.19	0.10	97.6	7,957	3,133	32.258
	Seine	May-Sep	0.03	11.92	35.91	34.11	13.52	3.16	0.96	0.27	0.08	0.05	94.2	9,105 +	41	0.431
	Trawl	Jan-Apr	0.03	11.82	33.27	35.95	14.21	3.23	0.99	0.34	0.11	0.05	98.6	9,105 +	76	0.768
	Gillnet	Jan-Apr	0.00	0.00	3.01	38.33	32.48	15.47	7.35	2.55	0.60	0.21	145.3	1,920	5,998	41.166
19878	Seine	Oct-Dec	0.41	6.52	64.47	14.59	11.38	1.81	0.55	0.15	0.11	0.00	106.4	1,632	357	3.386
	Seine	Jan-Apr	0.00	2.35	52.89	17.58	20.29	5.27	1.31	0.21	0.10	0.00	104.0	6,338	1,475	13.516
	Seine	May-Sep	0.07	4.82	61.90	14.59	13.99	3.51	0.87	0.18	0.06	0.00	99.7	7,970 +	33	0.333
	Trawl	Oct-Dec	0.06	4.74	61.47	14.71	14.27	3.60	0.90	0.19	0.06	0.00	100.5	7,970 +	83	0.826
	Trawl	Jan-Apr	0.06	4.74	61.47	14.71	14.27	3.60	0.90	0.19	0.06	0.00	100.5	7,970 +	279	2.773
	Gillnet	Jan-Apr	0.00	0.00	9.20	14.81	47.81	20.09	5.27	2.24	0.34	0.22	144.4	891	5,988	41.461
19889	Seine	Oct-Dec	0.00	26.15	17.44	42.75	6.77	5.90	0.82	0.16	0.00	0.00	109.1	1,252	728	6.660
	Seine	Jan-Apr	0.00	12.31	15.17	51.91	10.87	7.93	1.48	0.27	0.04	0.03	104.6	6,517	1,446	13.339
	Seine	May-Sep	0.01	12.64	17.97	51.78	8.95	6.86	1.47	0.28	0.03	0.01	102.2	7,769 +	56	0.547
	Trawl	Oct-Dec	0.01	12.64	17.97	51.78	8.95	6.86	1.47	0.28	0.03	0.01	102.2	7,769 +	134	1.308
	Trawl	Jan-Apr	0.01	12.64	17.97	51.78	8.95	6.86	1.47	0.28	0.03	0.01	102.2	7,769 +	86	0.844
	Gillnet	Jan-Apr	0.00	0.00	1.60	40.43	21.42	26.02	7.99	2.26	0.28	0.00	140.3	823	5,919	42.236
19890	Seine	Oct-Dec	0.00	6.68	58.62	12.72	17.67	2.26	2.05	0.00	0.00	0.00	101.3	928	75	0.736
	Seine	Jan-Apr	0.00	10.09	57.87	8.23	17.43	3.59	2.27	0.40	0.07	0.06	100.2	5,915	96	0.936
	Seine	May-Sep	0.00	7.51	56.71	11.25	19.33	2.97	1.81	0.34	0.06	0.01	97.4	6,843 +	62	0.632
	Gillnet	Jan-Apr	0.00	0.00	8.93	11.71	56.04	12.10	9.44	1.41	0.30	0.06	141.6	1,371	7,886	55.630
19901	Seine	Oct-Dec	0.00	13.89	31.24	38.58	7.67	7.42	1.04	0.16	0.00	0.00	107.5	698	371	3.440
	Seine	Jan-Apr	0.00	3.82	21.09	44.52	10.27	16.08	2.48	1.47	0.24	0.03	109.4	5,291	1,141	10.217
	Seine	May-Sep	0.00	10.74	23.31	39.87	8.80	13.78	2.05	1.27	0.17	0.02	108.1	5,989 +	58	0.541
	Trawl	Oct-Dec	0.00	10.74	23.31	39.87	8.80	13.78	2.05	1.27	0.17	0.02	108.1	5,989 +	122	1.133
	Gillnet	Jan-Apr	0.00	0.00	1.29	28.15	17.20	40.11	7.27	4.69	1.20	0.09	146.0	1,087	9,410	64.461
19912	Seine	Oct-Dec	0.00	3.96	67.09	17.24	9.27	1.31	0.56	0.56	0.00	0.00	103.6	641	639	6.140
	Seine	Jan-Apr	0.00	3.62	53.63	14.96	17.44	4.04	5.34	0.59	0.38	0.00	105.6	5,036	3,725	34.318
	Seine	May-Sep	0.00	4.95	56.44	14.07	15.80	3.22	4.63	0.58	0.28	0.02	104.1	5,677 +	57	0.550
	Trawl	Oct-Dec	0.00	4.95	56.44	14.07	15.80	3.22	4.63	0.58	0.28	0.02	104.1	5,677 +	128	1.229
	Gillnet	Jan-Apr	0.00	0.00	6.33	14.88	43.63	11.72	18.91	2.65	1.45	0.43	147.6	1,169	8,870	60.081
19923	Seine	Oct-Dec	0.00	26.95	31.11	31.47	6.97	2.56	0.26	0.58	0.11	0.00	98.6	973	516	5.272
	Seine	Jan-Apr	0.00	11.22	39.18	33.15	7.57	5.77	1.37	1.63	0.06	0.06	101.3	5,445	4,396	42.070
	Seine	May-Sep	0.00	16.80	36.80	31.55	6.87	5.28	1.20	1.32	0.14	0.03	99.6	6,418 +	96	0.968
	Gillnet	Jan-Apr	0.00	0.00	11.47	40.02	16.98	21.61	4.08	5.40	0.22	0.22	137.9	907	8,733	63.326

Appendix 1.4. Age composition and catch by season, fishery and gear type for the Strait of Georgia stock assessment region. These data are used for the age-structured model analysis.

			PERCENT AT AGE												CATCH	
Season	**Gear**	**Fishery**	**0+**	**1+**	**2+**	**3+**	**4+**	**5+**	**6+**	**7+**	**8+**	**9++**	**Mean Weight**	**Number Aged**	**(tonnes)**	**(millions)**
19934	Seine	Oct-Dec	0.00	5.65	50.00	25.43	16.30	1.52	1.09	0.00	0.00	0.00	101.3	460	866	8.549
	Seine	Jan-Apr	0.02	3.72	42.96	26.98	19.34	3.70	2.65	0.53	0.13	0.00	97.2	5,969	5,138	52.868
	Seine	May-Sep	0.02	4.74	42.74	26.61	18.59	3.81	2.69	0.65	0.14	0.00	97.4	6,429 +	71	0.730
	Gillnet	Jan-Apr	0.00	0.07	3.65	25.26	44.78	15.21	7.83	2.42	0.62	0.16	133.7	1,201	11,572	86.661
19945	Seine	Oct-Dec	0.00	20.87	27.81	36.05	10.01	4.44	0.68	0.11	0.00	0.02	102.9	1,130	604	5.865
	Seine	Jan-Apr	0.00	7.09	21.21	37.04	18.67	11.51	2.92	1.13	0.35	0.08	110.4	5,754	4,362	38.990
	Seine	May-Sep	0.00	11.65	22.69	35.69	16.39	9.89	2.37	0.93	0.29	0.10	107.9	6,884 +	33	0.306
	Gillnet	Jan-Apr	0.00	0.00	2.10	27.82	38.15	24.14	5.10	2.10	0.30	0.30	139.6	927	8,190	58.655
19956	Seine	Oct-Dec	0.49	29.31	46.92	11.70	8.84	1.78	0.87	0.08	0.00	0.00	85.9	1,662	397	4.650
	Seine	Jan-Apr	0.06	9.29	47.72	15.20	15.88	6.74	3.87	0.86	0.27	0.11	98.2	8,243	7,434	73.620
	Seine	May-Sep	0.08	14.92	48.51	13.72	13.62	5.27	3.01	0.61	0.19	0.07	95.1	9,905 +	10	0.106
	Trawl	Oct-Dec	0.08	14.92	48.51	13.72	13.62	5.27	3.01	0.61	0.19	0.07	95.1	9,905 +	39	0.406
	Gillnet	Jan-Apr	0.00	0.00	4.05	15.87	44.53	22.08	10.30	2.11	0.84	0.21	138.2	544	6,233	45.214
19967	Seine	Oct-Dec	3.29	9.71	54.01	21.40	5.31	5.27	2.24	1.24	0.14	0.16	88.1	7,667 +	279	3.120
	Seine	Jan-Apr	0.00	5.52	51.35	24.45	6.54	7.43	2.84	1.70	0.12	0.04	88.8	7,297	9,390	96.287
	Seine	May-Sep	0.65	8.74	52.26	22.45	5.78	6.09	2.41	1.42	0.13	0.07	91.7	7,667 +	7	0.071
	Gillnet	Jan-Apr	0.00	0.00	4.74	17.85	16.43	31.91	17.06	8.53	2.53	0.95	136.7	633	6,148	44.974
19978	Seine	Oct-Dec	0.00	3.96	48.07	40.23	6.40	0.91	0.34	0.08	0.00	0.00	86.1	1,288	954	11.072
	Seine	Jan-Apr	0.02	2.93	47.03	31.80	12.25	2.90	2.14	0.70	0.21	0.03	86.8	5,837	5,755	66.260
	Trawl	Jan-Apr	0.00	7.01	45.19	37.03	8.16	1.14	0.98	0.16	0.33	0.00	74.3	613	0	0.000 ~
	Gillnet	Jan-Apr	0.00	0.00	1.54	26.20	28.32	15.61	18.69	7.13	1.54	0.96	130.4	519	6,895	52.858
19989	Seine	Oct-Dec	0.17	12.18	27.78	43.23	13.39	2.74	0.37	0.13	0.00	0.00	91.2	1,297	1,811	19.847
	Seine	Jan-Apr	0.00	4.27	22.82	44.94	18.55	6.58	1.88	0.78	0.13	0.06	96.6	4,953	5,082	50.852
	Seine	May-Sep	0.03	7.18	25.52	41.65	17.73	5.66	1.50	0.58	0.10	0.05	94.8	6,250 +	5	0.058
	Trawl	Jan-Apr	0.00	5.49	31.87	30.77	21.98	7.69	1.10	0.00	1.10	0.00	92.3	91	0	0.000 ~
	Gillnet	Jan-Apr	0.00	0.00	2.15	29.31	36.72	21.05	6.70	3.35	0.60	0.12	130.8	836	6,837	52.248
	Gillnet	May-Sep	0.00	0.00	2.15	29.31	36.72	21.05	6.70	3.35	0.60	0.12	130.8	836 +	1	0.005
19990	Seine	Oct-Dec	0.00	21.28	50.13	16.62	8.71	2.38	0.88	0.00	0.00	0.00	74.9	1,077	1,252	16.641
	Seine	Jan-Apr	0.10	9.67	35.49	19.32	23.85	8.80	2.12	0.35	0.28	0.02	90.8	7,412	6,636	71.998
	Gillnet	Jan-Apr	0.00	0.00	1.08	13.93	44.67	28.49	9.45	1.97	0.40	0.00	134.4	1,179	10,425	77.334
20001	Seine	Oct-Dec	0.00	9.66	51.94	27.98	5.52	3.51	1.25	0.00	0.13	0.00	95.6	797	1,423	14.897
	Seine	Jan-Apr	0.00	4.80	42.65	30.65	9.52	9.19	2.52	0.55	0.09	0.02	97.3	4,558	7,275	74.770
	Gillnet	Jan-Apr	0.00	0.00	3.39	17.98	25.60	34.61	15.06	2.65	0.41	0.29	133.4	1,027	11,042	82.770
20012	Seine	Oct-Dec	0.00	4.96	61.42	26.19	5.93	0.97	0.32	0.11	0.00	0.11	87.0	928	1,328	15.265
	Seine	Jan-Apr	0.00	6.59	49.18	27.04	12.45	2.35	1.99	0.40	0.00	0.00	87.7	4,475	9,299	106.015
	Gillnet	Jan-Apr	0.00	0.00	5.83	20.78	30.42	17.69	21.01	3.54	0.49	0.24	131.8	915	7,986	60.800
20023	Seine	Oct-Dec	0.00	2.80	44.16	42.29	8.41	2.10	0.23	0.00	0.00	0.00	91.9	428	1,696	18.466
	Seine	Jan-Apr	0.00	3.15	46.39	34.35	10.54	3.89	1.01	0.55	0.11	0.00	87.6	5,264	10,670	121.786
	Gillnet	Jan-Apr	0.00	0.00	2.90	20.50	31.91	23.60	9.86	7.35	2.90	0.97	132.1	517	8,010	60.630

NOTE: * No biosample data available. Age composition and mean weight assigned from published reports.
+ Age composition calculated from biosample data aggregated from adjacent sections and/or fishery periods, by gear type.
~ No fishery openings this season. Age composition and mean weight obtained from pre-fishery charter biosamples.

Appendix 1.5. Age composition and catch by season, fishery and gear type for the West Coast Vancouver Island stock assessment region. These data are used for the age-structured model analysis.

			PERCENT AT AGE												CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	(tonnes)	(millions)
19501	Seine	Oct-Dec	0.10	15.78	39.08	37.78	5.35	1.56	0.26	0.05	0.05	0.00	96.8	1,927	7,670	79.266
	Seine	Jan-Apr	0.00	10.19	36.69	43.89	7.69	1.25	0.30	0.00	0.00	0.00	99.3	2,112	14,151	143.353
19512	Seine	Oct-Dec	0.11	6.62	61.99	20.85	9.27	0.89	0.27	0.00	0.00	0.00	98.9	996	8,251	83.215
	Seine	Jan-Apr	0.00	0.33	12.08	27.32	50.77	6.88	2.08	0.48	0.06	0.00	123.8	3,897	18,757	146.019
19523	Seine	Jan-Apr	0.16	11.77	57.76	28.08	1.67	0.50	0.05	0.00	0.00	0.00	82.4	3,764	20	0.242
19534	Seine	Oct-Dec	0.05	1.61	61.40	29.42	6.70	0.59	0.12	0.12	0.00	0.00	95.6	3,655	23,534	245.938
	Seine	Jan-Apr	0.00	4.43	65.53	24.81	4.06	0.83	0.21	0.04	0.04	0.04	87.2	2,439	9,675	109.814
19545	Seine	Oct-Dec	0.06	19.64	57.81	18.59	3.27	0.64	0.00	0.00	0.00	0.00	87.6	1,723	4,650	53.117
	Seine	Jan-Apr	0.00	10.86	65.09	20.01	3.47	0.52	0.05	0.00	0.00	0.00	80.9	754	1,473	18.369
19556	Seine	Oct-Dec	0.00	13.43	67.98	14.82	3.09	0.50	0.16	0.02	0.00	0.00	87.4	3,730	15,310	175.972
	Seine	Jan-Apr	0.00	9.21	49.51	19.28	17.88	3.68	0.11	0.11	0.22	0.00	87.2	923	1,787	20.496
19567	Seine	Oct-Dec	0.00	2.86	71.84	24.69	0.41	0.20	0.00	0.00	0.00	0.00	86.4	490 +	1,690	19.549
	Seine	Jan-Apr	0.00	2.74	71.92	24.81	0.35	0.18	0.00	0.00	0.00	0.00	86.4	588 +	915	10.586
	Seine	May-Sep	0.00	2.72	71.94	24.83	0.34	0.17	0.00	0.00	0.00	0.00	86.4	588 +	8	0.088
19578	Seine	Jan-Apr	0.00	15.18	54.28	25.87	3.98	0.47	0.17	0.04	0.01	0.00	76.8	1,480	513	6.766
	Seine	May-Sep	0.00	13.04	52.03	25.41	5.47	2.30	1.35	0.34	0.07	0.00	78.3	1,480 +	43	0.551
19589	Seine	Oct-Dec	0.00	3.26	45.21	29.96	14.51	3.46	1.82	1.45	0.33	0.00	92.2	2,843	55,196	588.911
	Seine	Jan-Apr	0.00	3.28	19.68	23.88	26.94	9.15	7.94	6.52	1.99	0.62	99.6	751	13,845	136.204
	Gillnet	Jan-Apr	0.00	10.00	58.10	9.50	19.00	2.60	0.50	0.20	0.10	0.00	97.6	0 *	182	1.868
19590	Seine	Oct-Dec	0.00	8.92	54.85	23.26	8.64	2.81	0.95	0.35	0.14	0.07	95.7	2,846	53,911	563.328
	Seine	Jan-Apr	0.00	8.92	54.85	23.26	8.64	2.81	0.95	0.35	0.14	0.07	95.7	2,846	0	0.000 ~
19601	Seine	Oct-Dec	0.00	38.31	37.97	19.15	4.41	0.17	0.00	0.00	0.00	0.00	85.5	590 +	16,711	195.384
	Seine	Jan-Apr	0.00	38.31	37.97	19.15	4.41	0.17	0.00	0.00	0.00	0.00	85.5	590 +	9,679	113.162
	Seine	May-Sep	0.00	38.31	37.97	19.15	4.41	0.17	0.00	0.00	0.00	0.00	85.5	590 +	44	0.520
19612	Seine	Oct-Dec	0.00	4.82	82.29	9.63	2.41	0.86	0.00	0.00	0.00	0.00	93.2	1,163 +	5,951	63.821
	Seine	Jan-Apr	0.00	5.32	80.46	10.07	3.10	1.05	0.00	0.00	0.00	0.00	92.8	1,117	17,710	190.890
	Trawl	Jan-Apr	0.00	4.82	82.29	9.63	2.41	0.86	0.00	0.00	0.00	0.00	93.2	1,163 +	24	0.253
19623	Seine	Oct-Dec	0.00	1.99	43.18	48.71	5.16	0.75	0.21	0.00	0.00	0.00	101.3	1,862 +	3,184	31.449
	Seine	Jan-Apr	0.00	2.47	41.39	49.75	5.41	0.71	0.27	0.00	0.00	0.00	101.0	1,633	15,022	148.723
19634	Seine	Oct-Dec	0.00	1.64	60.61	25.86	10.83	0.77	0.29	0.00	0.00	0.00	103.4	1,107 +	2,952	28.550
	Seine	Jan-Apr	0.00	0.95	65.05	22.91	10.00	0.85	0.25	0.00	0.00	0.00	101.0	769	18,313	182.208
19645	Seine	Oct-Dec	0.00	2.78	34.38	48.44	10.07	3.99	0.35	0.00	0.00	0.00	122.5	576 +	68	0.553
	Seine	Jan-Apr	0.00	2.78	34.37	48.44	10.07	3.99	0.35	0.00	0.00	0.00	122.5	576	10,397	84.858
	Seine	May-Sep	0.00	2.78	34.37	48.44	10.07	3.99	0.35	0.00	0.00	0.00	122.5	576 +	5,582	45.559
19656	Seine	Oct-Dec	0.00	13.59	26.83	26.12	23.17	9.07	1.23	0.00	0.00	0.00	137.0	0 *	4,299	31.377
	Seine	Jan-Apr	0.00	13.59	26.83	26.12	23.17	9.07	1.23	0.00	0.00	0.00	137.0	0 *	6,471	47.228
	Seine	May-Sep	0.00	13.59	26.83	26.12	23.17	9.07	1.23	0.00	0.00	0.00	137.0	0 *	73	0.535
19667	Seine	Oct-Dec	0.00	12.86	60.28	20.52	4.84	1.15	0.18	0.01	0.02	0.00	114.9	0 *	2,965	25.811
	Seine	Jan-Apr	0.00	12.86	60.28	20.52	4.84	1.15	0.18	0.01	0.02	0.00	114.9	0 *	9,794	85.253
	Seine	May-Sep	0.00	12.86	60.28	20.52	4.84	1.15	0.18	0.01	0.02	0.00	114.9	0 *	2,385	20.760
19701	Seine	Jan-Apr	0.00	5.77	44.57	36.95	7.85	2.77	1.62	0.46	0.00	0.00	132.8	433	0	0.000 ~
19712	Seine	Jan-Apr	0.00	3.66	19.01	50.10	21.81	3.39	1.23	0.79	0.03	0.00	135.3	1,482	6,894	51.001
19723	Seine	Jan-Apr	0.00	0.21	25.15	23.05	35.64	13.81	1.89	0.17	0.08	0.00	139.1	2,556	16,766	117.326
	Gillnet	Jan-Apr	0.00	0.00	8.81	23.56	51.44	12.23	3.06	0.72	0.18	0.00	159.4	556	1,537	9.642
19734	Seine	Jan-Apr	0.00	5.71	43.66	22.09	15.14	10.96	2.32	0.12	0.00	0.00	114.9	5,221	12,394	109.083
	Gillnet	Jan-Apr	0.00	0.00	29.87	27.92	27.92	10.39	3.90	0.00	0.00	0.00	133.5	154 +	3,940	29.517
19745	Seine	Jan-Apr	0.02	0.44	51.61	19.95	12.00	8.70	5.71	1.38	0.18	0.00	124.6	10,038	17,798	142.327
	Trawl	Jan-Apr	0.02	0.60	53.85	19.75	11.36	8.01	4.96	1.28	0.17	0.01	122.5	10,038 +	0	0.004
	Other	Jan-Apr	0.02	0.60	53.85	19.75	11.36	8.01	4.96	1.28	0.17	0.01	122.5	10,038 +	136	1.111
	Gillnet	Jan-Apr	0.00	0.00	2.90	32.37	36.51	19.92	7.88	0.41	0.00	0.00	169.0	241 +	8,310	49.159
19756	Seine	Jan-Apr	0.00	0.20	8.31	48.06	19.79	12.97	7.65	2.57	0.43	0.00	140.0	9,230	22,820	162.893
	Trawl	Jan-Apr	0.00	0.47	14.55	54.46	18.78	6.10	5.16	0.47	0.00	0.00	131.6	213	0	0.000 ~
	Other	Jan-Apr	0.00	0.21	8.99	47.10	19.78	12.80	8.02	2.67	0.42	0.00	140.1	9,443 +	204	1.456
	Gillnet	Jan-Apr	0.00	0.00	0.68	41.72	34.00	14.77	5.92	2.50	0.33	0.08	150.2	1,199	16,005	106.418
19767	Seine	Jan-Apr	0.00	0.39	11.51	32.16	38.00	12.43	3.89	1.42	0.16	0.03	136.7	6,684	17,463	126.700
	Gillnet	Jan-Apr	0.00	0.60	3.61	17.47	43.37	16.87	11.14	5.12	1.51	0.30	154.2	332 +	12,556	81.452
	Gillnet	May-Sep	0.00	0.60	3.61	17.47	43.37	16.87	11.14	5.12	1.51	0.30	154.2	332 +	24	0.154
19778	Seine	Oct-Dec	0.00	0.00	31.00	23.75	15.00	22.50	4.25	1.50	1.00	1.00	127.3	400	303	2.379
	Seine	Jan-Apr	0.00	0.77	39.43	18.78	16.78	18.80	4.14	1.10	0.17	0.04	109.2	7,454	7,615	67.761
19778	Seine	May-Sep	0.00	0.80	41.49	19.07	15.66	17.60	3.85	1.18	0.23	0.11	111.9	7,854 +	7	0.066
	Trawl	Oct-Dec	0.00	0.80	41.63	19.02	15.66	17.52	3.85	1.18	0.23	0.11	111.8	7,898 +	51	0.456
	Trawl	Jan-Apr	0.00	0.80	41.63	19.02	15.66	17.52	3.85	1.18	0.23	0.11	111.8	7,898 +	3	0.023
	Trawl	May-Sep	0.00	0.80	41.63	19.02	15.66	17.52	3.85	1.18	0.23	0.11	111.8	7,898 +	11	0.101
	Gillnet	Jan-Apr	0.00	0.00	1.42	5.45	21.33	49.05	17.54	4.74	0.24	0.24	157.6	422	14,755	93.615
19789	Seine	Oct-Dec	0.00	0.81	13.91	50.09	14.23	10.79	7.94	1.60	0.52	0.11	124.5	3,689 +	70	0.563
	Seine	Jan-Apr	0.00	1.07	14.94	51.51	13.82	9.87	7.04	1.43	0.26	0.06	123.1	3,689	10,473	86.211
	Seine	May-Sep	0.00	0.81	13.91	50.09	14.23	10.79	7.94	1.60	0.52	0.11	124.5	3,689 +	4	0.032
	Trawl	Oct-Dec	0.00	0.81	13.91	50.09	14.23	10.79	7.94	1.60	0.52	0.11	124.5	3,689 +	9	0.073
	Gillnet	Jan-Apr	0.00	0.00	1.05	24.79	28.57	23.74	18.07	3.15	0.42	0.21	161.5	476	8,138	50.388
19790	Seine	Jan-Apr	0.00	7.13	37.93	13.75	20.24	8.99	8.11	3.14	0.48	0.23	110.8	3,735	1,682	14.641
	Seine	May-Sep	0.00	6.21	43.91	15.58	20.00	6.37	5.30	2.20	0.35	0.08	108.2	3,735 +	0	0.000
	Gillnet	Jan-Apr	0.00	0.00	0.00	5.31	52.51	22.35	12.01	7.26	0.28	0.28	163.6	358 +	2,300	14.061
19801	Seine	Jan-Apr	0.00	3.89	32.52	33.31	10.62	13.65	4.07	1.51	0.37	0.05	116.1	5,026	5,008	44.277
	Seine	May-Sep	0.00	2.83	27.39	22.26	14.13	17.84	8.83	4.77	1.41	0.53	133.6	566	2	0.015
	Other	Jan-Apr	0.00	4.62	37.17	28.31	9.93	12.00	5.19	2.05	0.58	0.16	114.1	5,026 +	46	0.403
	Gillnet	Jan-Apr	0.00	0.00	1.78	21.00	14.95	36.30	18.86	7.12	0.00	0.00	148.6	281 +	3,079	20.725
19812	Seine	Jan-Apr	0.00	4.32	24.84	28.55	22.53	5.50	7.92	3.73	2.04	0.58	120.4	4,775	2,370	19.713
	Seine	May-Sep	0.00	3.27	23.96	27.41	26.05	5.45	9.51	2.72	1.36	0.27	115.9	4,775 +	2	0.013
	Gillnet	Jan-Apr	0.00	0.00	0.70	12.02	44.25	11.67	27.53	3.31	0.35	0.17	137.0	574	3,115	22.741

Appendix 1.5. Age composition and catch by season, fishery and gear type for the West Coast Vancouver Island stock assessment region. These data are used for the age-structured model analysis.

			PERCENT AT AGE												CATCH	
Season	**Gear**	**Fishery**	**0+**	**1+**	**2+**	**3+**	**4+**	**5+**	**6+**	**7+**	**8+**	**9++**	**Mean Weight**	**Number Aged**	**(tonnes)**	**(millions)**
19823	Seine	Jan-Apr	0.00	3.83	19.37	23.62	23.39	16.69	4.60	5.45	1.50	1.55	131.3	3,188	6,141	45.840
	Gillnet	Jan-Apr	0.00	0.00	0.35	14.19	23.82	44.83	6.48	9.81	0.35	0.18	137.8	571	2,434	17.662
19834	Seine	Jan-Apr	0.00	23.09	37.97	13.00	8.86	9.48	5.52	0.88	1.00	0.19	114.9	3,079	5,718	49.965
	Gillnet	Jan-Apr	0.00	0.00	1.68	6.72	17.98	32.61	31.93	5.38	3.36	0.34	154.9	595	858	5.540
19845	Seine	Jan-Apr	0.00	6.28	48.74	22.86	6.40	5.12	6.21	3.47	0.37	0.55	120.1	2,995	177	1.352
	Seine	May-Sep	0.00	20.47	53.62	14.22	3.71	2.74	3.17	1.70	0.13	0.23	109.0	2,995 +	1	0.008
19856	Seine	Oct-Dec	0.00	3.78	50.45	29.70	8.29	3.13	2.24	1.76	0.58	0.07	121.5	4,151 +	1	0.005
	Seine	Jan-Apr	0.00	3.86	48.16	27.50	10.68	3.83	2.92	2.21	0.74	0.11	124.3	2,847	203	1.633
19867	Seine	Jan-Apr	0.00	16.21	16.21	36.29	18.16	7.70	2.56	1.38	1.15	0.34	130.8	3,480	13,463	102.956
	Trawl	Jan-Apr	0.00	26.98	26.03	28.57	13.65	1.59	0.95	1.90	0.32	0.00	93.9	315	0	0.000 ~
	Gillnet	Jan-Apr	0.00	0.00	1.82	24.55	61.82	5.45	2.18	2.91	0.91	0.36	171.3	550	2,471	14.431
19878	Seine	Jan-Apr	0.00	1.60	63.80	7.41	14.70	8.38	2.75	0.65	0.48	0.23	127.5	4,883	8,276	67.129
	Trawl	Jan-Apr	0.00	3.03	59.09	19.70	15.15	3.03	0.00	0.00	0.00	0.00	92.9	66	0	0.000 ~
	Gillnet	Jan-Apr	0.00	0.00	5.38	7.10	41.29	28.60	12.90	3.01	1.29	0.43	166.9	465	1,448	8.674
19889	Seine	Jan-Apr	0.00	3.06	14.96	61.92	7.11	8.47	3.45	0.79	0.17	0.07	126.4	4,178	9,774	77.304
	Trawl	Jan-Apr	0.00	0.00	14.29	63.10	10.71	9.52	2.38	0.00	0.00	0.00	127.4	84	0	0.000 ~
	Gillnet	Jan-Apr	0.00	0.00	0.20	54.50	11.00	22.30	9.40	1.60	1.00	0.00	151.0	382 +	3,515	23.274
19890	Seine	Jan-Apr	0.00	0.46	26.32	11.72	48.79	4.89	5.99	1.53	0.27	0.03	139.4	3,720	7,890	56.611
	Gillnet	Jan-Apr	0.00	0.00	1.35	7.87	68.99	8.31	10.34	2.47	0.67	0.00	155.6	445	1,959	12.593
19901	Seine	Jan-Apr	0.00	6.15	19.13	22.02	10.60	35.06	2.99	3.39	0.64	0.02	130.8	5,715	6,299	47.096
	Other	Jan-Apr	0.00	6.59	21.41	21.11	10.67	33.10	3.01	3.43	0.66	0.03	132.0	7,311 +	273	2.069
	Gillnet	Jan-Apr	0.00	0.00	3.26	6.84	12.70	64.50	6.84	8.14	6.52	0.00	175.5	307 +	2,336	13.308
19912	Seine	Jan-Apr	0.00	1.47	43.29	10.77	14.97	6.62	18.95	2.42	1.26	0.26	132.2	4,290	3,086	23.337
	Trawl	Jan-Apr	0.00	3.45	31.03	20.69	26.44	2.30	10.34	2.30	2.30	1.15	105.6	87	0	0.000 ~
	Other	Jan-Apr	0.00	1.69	48.04	10.74	13.42	5.87	16.70	2.09	1.22	0.23	128.7	6,162 +	273	2.122
	Gillnet	Jan-Apr	0.00	0.00	6.29	13.49	30.76	13.85	29.86	2.88	2.52	0.36	154.2	556	627	4.066
19923	Seine	Jan-Apr	0.00	3.46	26.25	39.83	7.14	8.29	4.57	8.71	1.08	0.66	126.9	4,705	5,612	44.244
	Other	Jan-Apr	0.00	3.87	27.66	40.82	6.88	7.53	4.09	7.66	0.92	0.56	124.3	5,524 +	273	2.196
19934	Seine	Jan-Apr	0.00	3.85	18.47	22.30	31.82	8.69	6.19	6.58	1.84	0.27	125.3	6,196	5,332	42.481
	Trawl	Oct-Dec	0.00	3.00	22.74	24.13	30.04	8.00	5.00	5.26	1.58	0.24	124.7	6,274 +	0	0.001
	Trawl	Jan-Apr	0.00	6.41	25.64	37.18	12.82	12.82	3.85	0.00	1.28	0.00	92.4	78	0	0.000 ~
	Trawl	May-Sep	0.00	0.79	26.11	29.11	26.58	7.91	5.38	2.85	1.11	0.16	97.1	632	1	0.008
	Other	Jan-Apr	0.00	3.00	22.74	24.13	30.04	8.00	5.00	5.26	1.58	0.24	124.7	6,274 +	273	2.190
	Gillnet	Jan-Apr	0.00	0.16	5.65	32.10	54.84	5.32	1.13	0.65	0.16	0.00	131.1	620	706	5.381
19945	Seine	Jan-Apr	0.00	1.02	13.98	21.55	19.83	27.32	7.46	4.66	3.26	0.93	139.0	5,392	1,947	14.006
	Trawl	Oct-Dec	0.00	1.17	13.32	25.60	20.52	25.29	6.44	4.02	2.89	0.75	135.6	7,086 +	1	0.005
	Trawl	May-Sep	0.00	2.57	34.57	29.07	10.02	13.75	4.52	3.93	1.57	0.00	105.9	574	3	0.029
	Other	Jan-Apr	0.00	1.17	13.32	25.60	20.52	25.29	6.44	4.02	2.89	0.75	135.6	7,086 +	637	4.699
19956	Seine	Jan-Apr	0.00	17.06	22.43	12.83	15.22	12.76	14.03	3.39	1.42	0.86	119.3	5,394	790	6.607
	Trawl	Oct-Dec	0.00	14.66	22.14	12.66	19.38	12.53	13.75	2.82	1.25	0.81	119.5	8,255 +	1	0.006
	Trawl	May-Sep	0.00	14.66	22.14	12.66	19.38	12.53	13.75	2.82	1.25	0.81	119.5	8,255 +	0	0.000
	Other	Jan-Apr	0.00	14.66	22.14	12.66	19.38	12.53	13.75	2.82	1.25	0.81	119.5	8,255 +	728	6.093
19967	Seine	Jan-Apr	0.00	3.65	70.44	8.47	4.17	5.11	4.02	3.18	0.63	0.32	98.6	6,539	6,656	67.506
	Other	Jan-Apr	0.01	3.23	69.98	8.14	4.10	6.01	4.44	3.22	0.56	0.32	100.4	8,540 +	728	7.249
19978	Seine	Jan-Apr	0.00	2.40	21.91	61.07	6.56	2.75	2.40	1.65	0.98	0.29	99.1	6,098	5,449	55.784
	Other	Jan-Apr	0.00	2.49	22.75	59.49	6.52	2.75	2.95	1.79	1.01	0.26	98.7	7,055 +	364	3.689
	Gillnet	Jan-Apr	0.00	0.00	0.86	41.37	10.51	10.55	14.67	12.41	6.33	3.29	138.6	899	1,550	11.177
19989	Seine	Jan-Apr	0.00	1.35	21.66	23.61	39.90	8.54	2.64	1.27	0.70	0.33	110.5	4,341	3,590	33.366
	Seine	May-Sep	0.00	1.44	21.90	24.90	38.57	8.09	2.66	1.49	0.63	0.32	106.2	5,562 +	0	0.000
	Other	Jan-Apr	0.00	1.44	21.90	24.90	38.57	8.09	2.66	1.49	0.63	0.32	106.2	5,562 +	455	4.285
	Gillnet	Jan-Apr	0.00	0.00	0.82	9.98	60.36	18.46	5.32	3.35	1.48	0.24	135.7	1,043	963	7.098
19990	Seine	Jan-Apr	0.00	5.97	25.15	19.61	17.87	25.60	3.66	1.19	0.74	0.21	115.1	6,613	1,356	11.965
	Other	Jan-Apr	0.00	6.68	24.61	19.79	17.36	25.78	3.70	1.19	0.68	0.20	112.7	6,888 +	364	3.229
	Gillnet	Jan-Apr	0.00	0.00	1.28	7.52	27.04	52.80	6.24	2.56	2.24	0.32	145.2	625	700	4.823
20001	Seine	Jan-Apr	0.00	7.02	45.66	20.20	8.38	7.57	9.44	1.32	0.21	0.21	105.3	2,352	0	0.000 ~
	Other	Jan-Apr	0.00	7.02	45.66	20.20	8.38	7.57	9.44	1.32	0.21	0.21	105.3	2,352 +	364	3.456
20012	Seine	Jan-Apr	0.00	4.14	51.73	22.77	9.91	3.00	4.36	3.73	0.36	0.00	103.0	2,200	433	4.204
	Other	Jan-Apr	0.00	7.02	53.62	22.92	7.48	2.82	3.17	2.64	0.30	0.02	96.6	4,957 +	546	5.651
	Gillnet	Jan-Apr	0.00	0.00	0.00	10.28	28.79	15.33	20.56	22.43	2.24	0.37	152.3	535	388	2.550
20023	Seine	Jan-Apr	0.00	1.13	38.68	39.13	14.95	2.87	1.45	0.88	0.79	0.11	105.7	4,310	2,571	24.343
	Other	Jan-Apr	0.11	1.81	41.23	38.41	13.26	2.54	1.17	0.79	0.62	0.08	103.1	5,317 +	455	4.413
	Gillnet	Jan-Apr	0.00	0.00	2.61	17.43	31.86	19.84	9.82	12.83	5.01	0.60	146.7	499	945	6.444

NOTE: * No biosample data available. Age composition and mean weight assigned from published reports.
+ Age composition calculated from biosample data aggregated from adjacent sections and/or fishery periods, by gear type.
~ No fishery openings this season. Age composition and mean weight obtained from pre-fishery charter biosamples.

Appendix 1.6. Age composition and catch by season, fishery and gear type for the Area 27 stock assessment region. These data are used for the age-structured model analysis.

Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	CATCH (tonnes)	CATCH (millions)
			PERCENT AT AGE													
19534	Seine	Jan-Apr	0.03	2.56	62.55	28.12	5.74	0.69	0.19	0.08	0.02	0.02	92.9	6,361 +	1,920	20.667
19545	Seine	Oct-Dec	0.00	2.77	35.29	52.50	7.55	1.48	0.33	0.08	0.00	0.00	99.0	1,412	5,939	58.757
	Seine	Jan-Apr	0.00	6.80	34.77	49.72	6.94	1.42	0.28	0.07	0.00	0.00	96.7	1,412	0	0.000 ~
19589	Seine	Jan-Apr	0.00	4.12	44.71	27.63	14.44	3.90	2.45	2.06	0.58	0.11	93.3	3,594 +	407	4.366
19601	Seine	Jan-Apr	0.00	38.31	37.97	19.15	4.41	0.17	0.00	0.00	0.00	0.00	85.5	590 +	1,149	13.434
19612	Seine	Jan-Apr	0.00	4.82	82.29	9.63	2.41	0.86	0.00	0.00	0.00	0.00	93.2	1,163 +	173	1.856
19623	Seine	Jan-Apr	0.00	1.99	43.18	48.71	5.16	0.75	0.21	0.00	0.00	0.00	101.3	1,862 +	31	0.304
19634	Seine	Jan-Apr	0.00	1.33	59.98	26.04	11.56	0.83	0.25	0.00	0.00	0.00	103.7	1,202 +	323	3.110
19645	Seine	Jan-Apr	0.00	2.51	31.20	46.10	14.62	4.60	0.42	0.28	0.28	0.00	125.8	718 +	769	6.113
19656	Seine	Oct-Dec	0.00	13.59	26.83	26.12	23.17	9.07	1.23	0.00	0.00	0.00	137.0	0 *	125	0.913
	Seine	Jan-Apr	0.00	13.59	26.83	26.12	23.17	9.07	1.23	0.00	0.00	0.00	137.0	0 *	826	6.032
19667	Seine	Jan-Apr	2.43	20.71	55.46	16.68	3.43	0.80	0.26	0.19	0.04	0.00	106.7	0 *	51	0.482
19701	Seine	Jan-Apr	0.00	19.86	30.14	40.41	4.79	2.05	1.37	0.68	0.68	0.00	131.8	146	0	0.000 ~
19734	Seine	Jan-Apr	0.00	8.03	43.12	23.94	13.56	8.83	2.23	0.22	0.04	0.02	111.3	5,389 +	508	4.562
	Gillnet	Jan-Apr	0.00	8.03	43.12	23.94	13.56	8.83	2.23	0.22	0.04	0.02	111.3	5,389 +	18	0.165
19756	Gillnet	Jan-Apr	0.00	0.00	1.03	41.48	32.92	15.35	6.05	2.80	0.30	0.07	149.7	1,355 +	79	0.525
19778	Seine	Jan-Apr	0.00	0.81	41.60	18.95	15.70	17.59	3.84	1.17	0.23	0.11	111.8	7,925 +	75	0.670
	Gillnet	Jan-Apr	0.00	0.00	1.42	5.45	21.33	49.05	17.54	4.74	0.24	0.24	157.6	422 +	75	0.477
19789	Seine	Jan-Apr	0.00	0.82	13.88	50.49	14.19	10.61	7.80	1.59	0.50	0.11	124.1	3,769 +	422	3.401
	Gillnet	Jan-Apr	0.00	0.00	0.93	27.43	27.61	23.32	17.35	2.80	0.37	0.19	159.6	536 +	270	1.695
19790	Seine	Jan-Apr	0.00	7.17	82.08	8.96	1.43	0.00	0.00	0.36	0.00	0.00	84.3	279	0	0.000 ~
	Gillnet	Jan-Apr	0.00	6.28	46.56	15.12	18.71	5.93	4.93	2.07	0.32	0.07	106.6	4,014 +	519	4.873
19801	Seine	Jan-Apr	0.00	2.08	13.73	60.33	8.74	13.59	1.53	0.00	0.00	0.00	113.6	721	0	0.000 ~
	Gillnet	Jan-Apr	0.00	4.30	34.23	32.33	9.78	12.20	4.73	1.79	0.50	0.14	114.0	5,747 +	671	5.884
19812	Seine	Jan-Apr	0.00	0.60	30.57	8.73	47.59	4.07	7.53	0.75	0.15	0.00	118.6	664	238	2.011
	Gillnet	Jan-Apr	0.00	0.00	0.63	11.62	44.58	11.77	27.63	3.30	0.31	0.16	137.7	637 +	332	2.411
19823	Seine	Jan-Apr	0.00	3.96	20.79	31.68	10.89	28.71	0.00	3.96	0.00	0.00	108.4	101	0	0.000 ~
	Other	Jan-Apr	0.00	4.23	22.50	22.13	21.59	17.97	4.32	5.35	1.03	0.88	127.9	3,289 +	91	0.712
	Gillnet	Jan-Apr	0.00	0.00	0.31	13.52	22.73	47.00	5.99	9.98	0.31	0.15	138.0	651 +	163	1.181
19834	Other	Jan-Apr	0.00	21.73	37.22	13.58	9.16	10.04	5.91	1.07	1.07	0.23	116.1	3,079 +	182	1.567
	Gillnet	Jan-Apr	0.00	0.00	0.00	4.17	42.13	16.67	33.33	2.55	1.16	0.00	154.2	432	171	1.107
19845	Other	Jan-Apr	0.00	20.47	53.62	14.22	3.71	2.74	3.17	1.70	0.13	0.23	109.0	2,995 +	182	1.670
19856	Seine	Jan-Apr	0.00	2.21	23.62	63.47	2.58	1.48	1.85	2.58	2.21	0.00	136.5	271	0	0.000 ~
	Other	Jan-Apr	0.00	3.69	48.80	31.77	7.94	3.03	2.22	1.81	0.68	0.07	122.4	4,422 +	96	0.784
19867	Seine	Jan-Apr	0.00	17.02	27.66	15.96	35.46	1.06	0.00	1.06	0.35	1.42	131.2	282	0	0.000 ~
	Other	Jan-Apr	0.00	15.66	17.74	33.06	21.73	6.67	2.32	1.39	1.00	0.41	131.1	5,305 +	364	2.776
19878	Seine	Jan-Apr	0.00	2.16	62.53	11.05	6.20	15.36	1.62	0.81	0.00	0.27	121.3	371	0	0.000 ~
	Other	Jan-Apr	0.00	2.55	61.03	7.92	14.35	10.07	2.72	0.73	0.42	0.22	123.7	7,896 +	364	2.943
19889	Seine	Jan-Apr	0.00	0.21	12.66	57.51	8.15	8.37	11.37	1.29	0.43	0.00	151.3	466	0	0.000 ~
	Other	Jan-Apr	0.00	0.21	12.66	57.51	8.15	8.37	11.37	1.29	0.43	0.00	151.3	466 +	364	2.406
19890	Seine	Jan-Apr	0.00	1.84	22.68	14.25	39.63	5.83	7.13	7.78	0.65	0.22	158.0	926	0	0.000 ~
	Other	Jan-Apr	0.00	1.84	22.68	14.25	39.63	5.83	7.13	7.78	0.65	0.22	158.0	926 +	246	1.557
19901	Seine	Oct-Dec	0.01	6.71	22.27	20.52	10.65	32.59	2.99	3.50	0.73	0.03	131.8	7,680 +	0	0.001
	Seine	Jan-Apr	0.27	8.94	39.30	8.94	10.30	22.49	2.71	4.88	2.17	0.00	128.4	369	0	0.000 ~
	Other	Jan-Apr	0.01	6.71	22.27	20.52	10.65	32.59	2.99	3.50	0.73	0.03	131.8	7,680 +	246	1.867
19912	Seine	Jan-Apr	0.00	1.30	66.59	13.39	4.27	3.20	7.11	1.42	1.90	0.83	130.0	844	335	2.580
	Other	Jan-Apr	0.00	3.48	71.21	11.21	3.40	2.91	5.04	0.99	1.28	0.50	116.9	1,410 +	364	3.115
19923	Seine	Jan-Apr	0.00	11.30	35.79	38.93	5.02	1.57	1.41	5.02	0.31	0.63	108.5	637	0	0.000 ~
	Other	Jan-Apr	0.00	11.30	35.79	38.93	5.02	1.57	1.41	5.02	0.31	0.63	108.5	637 +	364	3.356
	Gillnet	Jan-Apr	0.00	0.00	3.28	53.28	14.09	7.92	7.53	11.58	0.97	1.35	146.6	518	367	2.502
19934	Seine	Jan-Apr	0.00	1.48	31.75	24.55	30.90	5.50	2.12	2.86	0.53	0.32	119.5	945	0	0.000 ~
	Other	Jan-Apr	0.00	1.48	31.75	24.55	30.90	5.50	2.12	2.86	0.53	0.32	119.5	945 +	246	2.059
	Gillnet	Jan-Apr	0.00	0.00	1.28	19.40	61.19	9.81	3.41	3.84	0.43	0.64	140.4	469	345	2.455
19945	Seine	Jan-Apr	0.00	1.29	6.83	30.93	27.19	25.26	5.28	1.55	1.29	0.39	130.6	776	88	0.670
	Trawl	May-Sep	0.00	1.68	6.37	35.29	24.37	24.65	4.13	1.33	1.61	0.56	131.3	1,428 +	0	0.000
	Other	Jan-Apr	0.00	1.68	6.37	35.29	24.37	24.65	4.13	1.33	1.61	0.56	131.3	1,428 +	455	3.465
19956	Seine	Jan-Apr	0.00	10.19	24.60	7.91	20.91	17.75	14.76	3.16	0.35	0.35	120.9	569	0	0.000 ~
	Trawl	May-Sep	0.00	10.19	24.60	7.91	20.91	17.75	14.76	3.16	0.35	0.35	120.9	569 +	0	0.000
	Other	Jan-Apr	0.00	10.19	24.60	7.91	20.91	17.75	14.76	3.16	0.35	0.35	120.9	569 +	364	3.011
19967	Seine	Jan-Apr	0.00	4.01	76.83	7.32	1.57	4.01	4.70	1.57	0.00	0.00	89.9	574	0	0.000 ~
	Other	Jan-Apr	0.00	4.01	76.83	7.32	1.57	4.01	4.70	1.57	0.00	0.00	89.9	574 +	96	1.068
19978	Seine	Jan-Apr	0.00	1.39	38.89	48.61	4.86	0.35	2.78	2.43	0.69	0.00	90.8	288	0	0.000 ~
	Other	Jan-Apr	0.00	2.45	23.38	59.06	6.46	2.66	2.94	1.81	0.99	0.25	98.4	7,343 +	273	2.775
19989	Seine	Jan-Apr	0.00	7.76	28.03	33.82	24.87	4.08	0.53	0.53	0.26	0.13	86.9	760	0	0.000 ~
	Other	Jan-Apr	0.00	7.76	28.03	33.82	24.87	4.08	0.53	0.53	0.26	0.13	86.9	760 +	96	1.104
19990	Seine	Jan-Apr	0.00	2.30	54.36	24.20	9.65	7.50	1.23	0.15	0.46	0.15	89.9	653	0	0.000 ~
	Other	Jan-Apr	0.00	2.30	54.36	24.20	9.65	7.50	1.23	0.15	0.46	0.15	89.9	653 +	96	1.068
20001	Seine	Jan-Apr	0.00	6.63	20.92	35.71	12.76	12.24	9.69	1.02	0.51	0.51	91.7	196	0	0.000 ~
	Other	Jan-Apr	0.00	6.99	43.76	21.39	8.71	7.93	9.46	1.30	0.24	0.24	104.3	2,548 +	96	0.921
20012	Seine	Jan-Apr	0.00	7.49	62.74	15.63	10.06	0.64	2.36	0.86	0.21	0.00	96.7	467	0	0.000 ~
	Other	Jan-Apr	0.00	7.49	62.74	15.63	10.06	0.64	2.36	0.86	0.21	0.00	96.7	467 +	32	0.331
20023	Seine	Jan-Apr	0.00	0.52	51.13	37.09	6.24	3.99	0.17	0.69	0.17	0.00	104.9	577	0	0.000 ~
	Other	Jan-Apr	0.00	0.52	51.13	37.09	6.24	3.99	0.17	0.69	0.17	0.00	104.9	577 +	64	0.610

NOTE: * No biosample data available. Age composition and mean weight assigned from published reports.
+ Age composition calculated from biosample data aggregated from adjacent sections and/or fishery periods, by gear type.
~ No fishery openings this season. Age composition and mean weight obtained from pre-fishery charter biosamples.

Appendix 1.7. Age composition and catch by season, fishery and gear type for the Area 2W stock assessment region. These data are used for the age-structured model analysis.

Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Mean Weight	Number Aged	CATCH (tonnes)	CATCH (millions)
			PERCENT AT AGE													
19567	Seine	Jan-Apr	0.07	20.00	25.34	16.22	9.41	25.92	2.46	0.47	0.11	0.00	104.2	4,506 +	106	1.016
19634	Seine	Jan-Apr	0.00	1.02	15.92	60.00	16.53	5.31	1.22	0.00	0.00	0.00	113.9	490 +	312	2.743
19645	Seine	Jan-Apr	0.00	1.59	80.07	10.20	5.14	1.78	0.84	0.37	0.00	0.00	104.0	1,069 +	1,251	12.030
19656	Seine	Jan-Apr	1.67	18.05	32.22	16.11	10.23	7.33	5.79	4.84	2.04	1.72	128.8	0 *	172	1.338
19723	Seine	Jan-Apr	0.00	0.16	38.08	21.42	26.62	10.93	1.93	0.80	0.05	0.00	144.7	1,867 +	706	4.878
19734	Seine	Jan-Apr	0.00	0.61	31.47	38.54	17.89	8.36	2.58	0.49	0.06	0.00	126.9	1,627 +	403	3.178
	Gillnet	Jan-Apr	0.00	50.98	11.11	5.88	15.69	5.88	9.15	1.31	0.00	0.00	101.0	153	0	0.000 ~
19745	Seine	Jan-Apr	0.00	0.63	26.50	34.13	27.01	9.18	2.05	0.41	0.09	0.00	130.8	6,384 +	449	3.436
19756	Seine	Jan-Apr	0.00	23.71	6.70	41.24	23.71	4.64	0.00	0.00	0.00	0.00	139.8	194	0	0.000 ~
	Other	Jan-Apr	0.00	1.51	2.99	37.07	29.00	22.33	6.12	0.92	0.07	0.00	151.2	4,249 +	68	0.450
19778	Seine	Jan-Apr	0.00	0.15	23.63	18.15	9.48	28.96	13.11	5.04	1.26	0.22	150.5	1,350 +	575	3.819
19789	Seine	Jan-Apr	0.00	1.49	18.84	22.95	16.23	22.95	13.81	1.87	1.12	0.75	151.9	536	691	4.546
19790	Seine	Jan-Apr	0.00	0.37	76.03	13.11	4.49	3.37	1.87	0.00	0.75	0.00	108.8	267	0	0.000 ~
19801	Seine	Jan-Apr	0.00	4.98	1.87	66.92	11.97	6.35	5.02	1.79	0.84	0.26	132.9	1,232	770	5.808
	Other	Jan-Apr	0.00	4.51	3.77	67.99	11.90	5.72	3.90	1.41	0.67	0.13	133.0	1,487 +	91	0.684
19812	Seine	Jan-Apr	0.00	0.02	53.90	2.31	34.93	3.91	2.55	2.02	0.23	0.13	139.5	1,654	1,225	9.099
19823	Seine	Jan-Apr	0.00	0.50	1.52	68.64	3.59	20.49	2.37	1.43	0.83	0.64	151.9	3,356	2,518	16.808
19834	Seine	Jan-Apr	0.00	6.45	1.61	0.60	35.28	2.42	51.01	1.81	0.60	0.20	166.2	496	0	0.000 ~
19845	Seine	Jan-Apr	0.00	0.40	0.67	5.80	2.56	13.75	1.62	74.39	0.67	0.13	212.3	742	199	0.940
19856	Seine	Jan-Apr	0.00	0.82	0.27	11.48	11.75	5.46	20.77	7.38	41.53	0.55	205.2	366	0	0.000 ~
19867	Seine	Jan-Apr	0.00	22.14	61.32	0.25	1.27	1.27	1.27	8.14	1.02	3.31	112.0	393	0	0.000 ~
19878	Seine	Jan-Apr	0.00	1.79	74.01	19.31	0.26	0.53	0.66	0.79	1.65	0.99	114.1	1,512	0	0.000 ~
19889	Seine	Jan-Apr	0.00	0.49	3.42	76.06	15.88	0.49	0.49	0.98	0.81	1.38	137.6	1,228	0	0.000 ~
19890	Seine	Jan-Apr	0.00	0.19	1.71	2.28	80.41	13.18	0.46	0.18	0.70	0.90	168.1	2,353	2,272	13.608
19901	Seine	Jan-Apr	0.00	0.50	6.46	0.89	1.84	68.91	19.83	0.72	0.45	0.39	173.3	1,795	2,558	14.762
19912	Seine	Jan-Apr	0.00	1.48	6.34	13.44	1.37	2.79	60.55	12.46	0.55	1.04	183.5	1,830	1,284	6.994
19923	Seine	Jan-Apr	0.00	0.76	11.71	16.46	13.53	1.91	4.57	44.54	5.67	0.84	156.7	2,574	1,306	7.985
19934	Seine	Jan-Apr	0.00	5.32	12.23	43.62	14.89	9.57	2.13	5.85	5.32	1.06	145.6	188	0	0.000 ~
19978	Seine	Jan-Apr	0.00	18.50	34.75	23.10	18.68	2.62	0.63	1.53	0.18	0.00	120.8	1,108	180	1.487
19989	Seine	Jan-Apr	0.00	15.60	32.38	28.09	14.30	7.28	1.56	0.52	0.26	0.00	116.8	769	0	0.000 ~
19990	Seine	Jan-Apr	0.00	14.77	63.64	18.18	0.00	2.27	0.00	1.14	0.00	0.00	85.0	88	0	0.000 ~
20001	Seine	Jan-Apr	0.00	4.37	8.48	40.62	24.42	12.08	6.94	2.06	0.51	0.51	153.2	389	0	0.000 ~
20012	Seine	Jan-Apr	0.00	28.69	23.83	4.77	21.64	9.72	6.86	2.67	1.53	0.29	130.5	1,049	0	0.000 ~
20023	Seine	Jan-Apr	0.00	0.65	82.00	8.86	1.03	4.20	1.12	1.31	0.47	0.37	111.1	1,072	0	0.000 ~

NOTE: * No biosample data available. Age composition and mean weight assigned from published reports.
+ Age composition calculated from biosample data aggregated from adjacent sections and/or fishery periods, by gear type.
~ No fishery openings this season. Age composition and mean weight obtained from pre-fishery charter biosamples.

Appendix 2.1. Estimates of numbers at age, spawning stock biomass (SB), spawn index (SI), estimated spawn-observed spawn residuals (RES), and other parameters from age-structured analysis for the Queen Charlotte Is. stock assessment region.

	Estimated numbers at age (x10-5) for period 1											
Season	1+	2+	3+	4+	5+	6+	7+	8+	9+	SB	SI	RES
1950/51	1145	1432	1034	233	140	66	0	0	0	6366	4213	0.22
1951/52	3309	767	923	550	115	69	32	0	0	5838	2578	-0.19
1952/53	17210	2030	265	225	130	27	16	8	0	14159	7555	0.00
1953/54	3040	11556	1363	178	151	87	18	11	5	21860	12408	0.06
1954/55	2277	2038	7630	875	114	97	56	12	10	12375	6437	-0.03
1955/56	1123	1529	1368	5071	552	70	60	34	14	12795	6042	-0.12
1956/57	1455	683	434	194	669	73	9	8	6	1983	1592	0.41
1957/58	5844	662	85	34	15	50	5	1	1	1836	815	-0.18
1958/59	740	2166	76	8	3	1	4	0	0	11157	8981	0.41
1959/60	2736	370	1021	36	4	1	1	2	0	12368	6599	0.00
1960/61	3087	1837	248	685	24	2	1	0	2	15226	8981	0.10
1961/62	6045	2065	1206	162	447	16	2	1	1	12836	5730	-0.18
1962/63	1730	4024	1226	547	70	192	7	1	1	15307	7297	-0.11
1963/64	5683	1143	2192	480	204	26	71	2	1	6222	4104	0.21
1964/65	222	3708	518	418	76	32	4	11	0	2397	1378	0.07
1965/66	377	58	238	25	20	4	2	0	1	2921	2824	0.59
1966/67	277	161	25	102	11	9	2	1	0	1662	710	-0.22
1967/68	545	185	105	15	60	6	5	1	1	2164	833	-0.33
1968/69	1146	366	123	67	10	38	4	3	1	3889	2075	0.00
1969/70	2431	770	245	83	45	6	26	3	3	10405	5552	0.00
1970/71	3015	1632	517	165	56	30	4	17	4	22218	13291	0.11
1971/72	6706	2022	1093	346	110	37	20	3	14	17515	9542	0.02
1972/73	5431	4484	1281	611	189	60	20	11	9	21721	7960	-0.38
1973/74	5108	3633	2840	675	307	95	30	10	10	38418	14510	-0.35
1974/75	1290	3417	2322	1675	392	178	55	17	12	44922	9686	-0.91
1975/76	2268	862	2161	1359	968	226	103	32	17	34619	15986	-0.14
1976/77	2263	1520	561	1202	691	483	112	51	24	28573	15717	0.03
1977/78	1159	1508	922	288	593	335	233	54	36	21718	16885	0.38
1978/79	18267	768	879	448	129	261	146	101	39	12548	12236	0.60
1979/80	1252	12230	491	426	175	49	97	54	52	54099	30455	0.05
1980/81	594	837	7926	309	241	94	26	52	57	59547	18823	-0.52
1981/82	526	398	545	4884	182	134	51	14	59	48610	22159	-0.16
1982/83	3523	351	255	339	3003	110	79	30	43	37487	19470	-0.03
1983/84	1424	2330	215	151	197	1735	63	45	42	29016	22120	0.36
1984/85	350	945	1427	125	86	112	978	36	49	25432	17232	0.24
1985/86	760	233	579	789	66	44	57	499	43	18006	5679	-0.53
1986/87	6033	509	152	330	426	35	24	30	288	12297	10751	0.49
1987/88	1735	4043	331	87	181	233	19	13	174	17423	12814	-0.31
1988/89	685	1164	2668	211	55	115	148	12	119	31488	22031	-0.36
1989/90	276	457	746	1676	132	34	72	93	82	21274	23263	0.09
1990/91	2069	183	271	400	856	66	17	35	85	11884	15061	0.24
1991/92	137	1368	105	134	192	401	30	8	55	10831	9990	-0.08
1992/93	83	91	839	57	72	103	215	16	33	8165	5801	-0.34
1993/94	257	55	52	400	27	34	48	100	23	5394	12149	0.81
1994/95	1002	166	31	28	217	15	18	26	67	4061	4061	0.00
1995/96	1194	673	111	21	19	146	10	12	62	6646	6646	0.00
1996/97	3257	801	452	75	14	13	98	7	50	9760	9576	-0.02
1997/98	176	2183	530	297	49	9	8	64	37	11104	18673	0.52
1998/99	602	117	1316	296	164	27	5	5	56	8383	8475	0.01
1999/00	585	388	58	544	118	59	9	2	19	4364	4925	0.12
2000/01	648	382	196	22	206	44	22	3	8	6138	12757	0.73
2001/02	3521	428	242	123	14	129	28	14	7	3524	2029	-0.55
2002/03	196	2309	222	95	47	5	49	11	8	7832	6985	-0.11

Estimated average availability at age (Si): 0.14 0.54 0.91 0.99 1.00 1.00 1.00 1.00 1.00

Estimated average relative selectivity at age for gillnet fisheries: 0.01 0.04 0.26 0.61 0.84 1.00 1.00 1.00 1.00

Spawn index-escapement conversion factor, pre-dive era (q) is 0.53

Estimated instantaneous natural mortality rate is 0.398

Appendix 2.2. Estimates of numbers at age, spawning stock biomass (SB), spawn index (SI), estimated spawn-observed spawn residuals (RES), and other parameters from age-structured analysis for the Prince Rupert District stock assessment region.

	Estimated numbers at age (x10-5) for period 1											
Season	1+	2+	3+	4+	5+	6+	7+	8+	9+	SB	SI	RES
1950/51	3558	4467	6900	1067	403	221	0	0	0	39672	27149	0.04
1951/52	5171	2673	2415	2694	409	155	85	0	0	25274	24047	0.37
1952/53	7612	3925	1640	819	855	130	49	27	0	28391	28468	0.42
1953/54	2130	5818	2950	1213	605	632	96	36	20	14067	13535	0.38
1954/55	4834	1610	3165	574	206	102	107	16	9	15489	14482	0.35
1955/56	1680	3685	1093	1206	196	70	35	36	9	34708	14533	-0.45
1956/57	3232	1166	2195	644	710	116	41	21	27	17783	27518	0.86
1957/58	6206	2234	446	735	215	237	39	14	16	31751	9882	-0.75
1958/59	1602	4474	1467	291	480	140	155	25	19	37323	40961	0.51
1959/60	11769	1208	2927	908	180	296	87	96	27	41979	16545	-0.51
1960/61	5294	7483	622	1490	462	92	151	44	63	36558	12059	-0.69
1961/62	2580	3693	3267	248	593	184	36	60	42	45168	26329	-0.12
1962/63	8663	1877	2116	1795	136	325	101	20	56	37678	16981	-0.38
1963/64	996	5138	837	928	787	60	143	44	33	35207	26919	0.15
1964/65	637	678	2638	418	463	393	30	71	39	18554	6055	-0.70
1965/66	632	362	219	812	128	142	121	9	34	7032	7105	0.43
1966/67	1094	480	226	79	276	44	48	41	15	5061	3386	0.02
1967/68	528	338	132	62	22	76	12	13	15	5502	5197	0.36
1968/69	1806	301	193	75	35	12	43	7	16	1469	965	0.00
1969/70	1355	1382	231	148	58	27	9	33	18	13100	8814	0.02
1970/71	649	1014	970	161	103	40	19	7	35	14205	8480	-0.10
1971/72	2492	475	639	600	99	64	25	12	26	9718	8774	0.32
1972/73	1596	1906	360	407	310	51	33	13	19	17469	10959	-0.05
1973/74	1404	1219	1416	255	288	219	36	23	23	22895	9244	-0.49
1974/75	787	1073	906	956	161	180	137	22	29	23720	10565	-0.39
1975/76	1331	602	808	649	680	114	128	98	36	19278	15199	0.18
1976/77	679	1018	460	597	413	424	71	80	83	20532	10425	-0.26
1977/78	649	517	703	266	323	222	226	38	87	15449	4734	-0.76
1978/79	4607	494	357	377	128	151	102	105	58	12393	7600	-0.07
1979/80	911	3516	355	210	211	70	83	56	89	26075	11001	-0.44
1980/81	1136	690	2467	236	132	130	43	51	89	25216	12939	-0.25
1981/82	1653	867	503	1690	157	86	85	28	91	25804	16108	-0.05
1982/83	4506	1262	635	356	1193	111	61	60	84	27844	23575	0.25
1983/84	819	3446	954	473	265	888	83	45	107	30921	25667	0.23
1984/85	877	626	2551	680	326	175	557	52	96	34151	39606	0.57
1985/86	3045	664	443	1741	445	197	93	296	78	30621	24055	0.18
1986/87	2405	2314	466	280	1012	250	107	50	203	27362	38673	0.77
1987/88	1272	1834	1677	314	169	568	133	57	135	25026	30519	0.20
1988/89	806	967	1270	1067	178	80	239	56	81	21355	13487	-0.46
1989/90	2963	610	648	782	578	76	29	88	50	19127	19209	0.00
1990/91	3302	2258	432	418	475	326	40	16	73	21219	22340	0.05
1991/92	725	2518	1632	291	264	286	182	22	50	27760	35773	0.25
1992/93	321	553	1834	1143	175	139	136	86	34	24180	21594	-0.11
1993/94	862	245	393	1210	686	82	52	51	45	15949	13613	-0.16
1994/95	3518	657	173	248	713	366	33	21	38	13244	15486	0.16
1995/96	1499	2685	477	117	159	437	207	18	33	20980	20487	-0.02
1996/97	2285	1143	1982	340	76	84	209	99	25	19338	21078	0.09
1997/98	603	1745	852	1423	205	30	18	44	26	20778	16271	-0.24
1998/99	1755	460	1299	614	952	118	5	3	11	21681	25033	0.14
1999/00	2357	1341	343	914	418	600	67	3	8	18872	15478	-0.20
2000/01	1379	1796	962	233	569	245	299	33	5	20896	31277	0.40
2001/02	5194	1050	1299	663	149	277	105	128	16	18834	17868	-0.05
2002/03	323	3954	741	861	407	80	119	45	62	30595	28216	-0.08

Estimated average availability at age (Si): 0.13 0.61 0.94 0.98 1.00 1.00 1.00 1.00 1.00

Estimated average relative selectivity at age for gillnet fisheries: 0.00 0.01 0.16 0.44 0.71 1.00 1.00 1.00 1.00

Spawn index-escapement conversion factor, pre-dive era (q) is 0.66

Estimated instantaneous natural mortality rate is 0.268

Appendix 2.3. Estimates of numbers at age, spawning stock biomass (SB), spawn index (SI), estimated spawn-observed spawn residuals (RES), and other parameters from age-structured analysis for the Central Coast stock assessment region.

	Estimated numbers at age (x10-5) for period 1											
Season	1+	2+	3+	4+	5+	6+	7+	8+	9+	SB	SI	RES
1950/51	1619	2996	3906	716	292	85	0	0	0	24027	15390	-0.08
1951/52	3040	1253	1393	1248	223	91	26	0	0	9822	10295	0.41
1952/53	13739	2360	542	324	275	49	20	6	0	13153	18237	0.69
1953/54	1146	11205	1905	425	253	214	38	16	5	13452	13967	0.40
1954/55	1284	879	4292	355	74	44	37	7	3	33383	13564	-0.54
1955/56	2990	979	553	2610	215	45	27	23	6	10270	6626	-0.08
1956/57	3790	1924	242	105	491	41	8	5	5	4062	4607	0.49
1957/58	3875	2762	564	40	17	77	6	1	2	11513	3549	-0.81
1958/59	1090	2783	1244	229	16	7	31	3	1	7219	3909	-0.25
1959/60	2289	852	1303	334	59	4	2	8	1	19718	12615	-0.08
1960/61	6144	1641	591	903	231	41	3	1	6	7229	4265	-0.17
1961/62	3821	4688	653	142	209	53	9	1	2	15598	11948	0.10
1962/63	3128	3066	3012	319	68	100	25	4	1	7816	6485	0.18
1963/64	1830	2467	1443	532	49	10	15	4	1	9076	6464	0.02
1964/65	2584	1074	580	285	104	10	2	3	1	3051	2097	-0.01
1965/66	4700	2015	452	96	42	15	1	0	1	2754	1863	-0.03
1966/67	1434	1553	160	29	6	3	1	0	0	4450	5434	0.56
1967/68	307	251	272	28	5	1	0	0	0	4882	5790	0.53
1968/69	1021	185	152	164	17	3	1	0	0	2638	1837	0.00
1969/70	1139	833	151	124	134	14	3	1	0	13422	8230	-0.13
1970/71	1470	919	663	120	98	107	11	2	1	14314	4156	-0.87
1971/72	2342	1159	617	426	77	63	68	7	2	9818	3572	-0.65
1972/73	1408	1885	759	288	189	34	28	30	4	19048	12447	-0.06
1973/74	2018	1134	1330	463	168	109	20	16	19	17723	8924	-0.32
1974/75	806	1641	876	816	235	76	48	9	15	22355	8060	-0.66
1975/76	639	653	1244	567	445	118	37	23	12	19107	13893	0.04
1976/77	637	515	469	779	283	195	49	15	14	15493	14619	0.30
1977/78	457	514	374	288	401	127	84	21	13	5716	7749	0.67
1978/79	3944	363	327	148	63	49	13	8	3	8070	5676	0.01
1979/80	777	3218	296	265	120	51	39	10	9	27369	12958	-0.39
1980/81	796	634	2613	238	204	89	37	28	14	28670	15845	-0.23
1981/82	378	648	510	2020	167	122	45	19	22	28618	16238	-0.20
1982/83	315	305	498	371	1332	105	72	27	24	22164	18217	0.17
1983/84	1172	256	237	357	245	827	63	43	30	14015	13795	0.35
1984/85	499	945	184	150	205	127	406	31	36	14973	8498	-0.20
1985/86	1002	401	682	117	89	117	70	224	37	14851	19061	0.61
1986/87	5555	811	298	462	77	57	74	44	165	13800	12493	0.26
1987/88	400	4517	622	200	292	48	35	46	129	31681	25134	-0.23
1988/89	362	324	3427	444	136	193	31	23	115	32087	20708	-0.44
1989/90	1184	289	228	2245	256	72	96	16	69	25097	27629	0.10
1990/91	5480	961	217	154	1411	149	40	53	47	18652	17833	-0.04
1991/92	659	4444	707	132	88	774	79	21	53	31931	41559	0.26
1992/93	1199	531	3184	465	84	54	468	48	45	32125	30917	-0.04
1993/94	350	960	369	2014	276	47	28	238	47	25544	27468	0.07
1994/95	1030	275	626	222	1147	150	24	14	145	15888	20272	0.24
1995/96	4183	832	192	351	117	582	73	12	78	14485	18665	0.25
1996/97	3592	3370	581	118	211	69	342	43	52	20079	24999	0.22
1997/98	800	2910	2498	392	79	136	44	218	61	27230	28363	0.04
1998/99	1454	643	1989	1512	233	45	72	23	147	25632	28464	0.10
1999/00	596	1176	465	1262	913	135	21	33	79	22836	28484	0.22
2000/01	1764	481	827	287	748	521	74	11	61	18167	22552	0.22
2001/02	2632	1426	342	497	169	431	295	42	41	18196	18917	0.04
2002/03	161	2125	1036	230	329	110	276	189	53	27917	20993	-0.29

Estimated average availability at age (Si): 0.15 0.66 0.96 1.00 1.00 1.00 1.00 1.00 1.00

Estimated average relative selectivity at age for gillnet fisheries: 0.00 0.03 0.19 0.50 0.76 1.00 1.00 1.00 1.00

Spawn index-escapement conversion factor (q) is 0.70

Estimated instantaneous natural mortality rate is 0.203

Appendix 2.4. Estimates of numbers at age, spawning stock biomass (SB), spawn index (SI), estimated spawn-observed spawn residuals (RES), and other parameters from age-structured analysis for the Strait of Georgia stock assessment region.

	Estimated numbers at age (x10-5) for period 1											
Season	1+	2+	3+	4+	5+	6+	7+	8+	9+	SB	SI	RES
1950/51	18365	9213	3333	752	161	71	0	0	0	28077	66143	0.43
1951/52	20508	11049	3652	902	200	43	19	0	0	35096	72112	0.30
1952/53	32017	12055	3621	913	224	50	11	5	0	55995	104220	0.20
1953/54	18662	19577	6963	2017	508	124	28	6	3	39842	82141	0.30
1954/55	9228	11341	8859	1649	456	115	28	6	2	66142	69854	-0.37
1955/56	10085	5320	3944	2728	506	140	35	9	3	24257	29202	-0.24
1956/57	9269	5918	1595	820	560	104	29	7	2	13723	24126	0.14
1957/58	17271	5503	1854	296	149	102	19	5	2	12390	16149	-0.16
1958/59	12816	10341	1960	406	64	32	22	4	1	41211	47864	-0.27
1959/60	6669	7249	3863	689	143	22	11	8	2	37348	55082	-0.04
1960/61	19674	3698	2401	1185	211	44	7	3	3	25352	42864	0.10
1961/62	16965	11097	1193	695	342	61	13	2	2	21905	31078	-0.07
1962/63	16039	9907	3199	240	138	68	12	3	1	23297	35135	-0.01
1963/64	9932	9203	2657	644	48	28	14	2	1	16465	33117	0.27
1964/65	3782	5872	2646	415	98	7	4	2	0	22939	37116	0.06
1965/66	4095	1620	1274	549	86	20	2	1	1	4890	7153	-0.04
1966/67	3390	1994	205	122	52	8	2	0	0	5240	9619	0.18
1967/68	1258	400	236	24	14	6	1	0	0	5297	9128	0.12
1968/69	3634	692	193	113	12	7	3	0	0	9702	14644	-0.01
1969/70	4022	2191	400	111	65	7	4	2	0	21665	33953	0.02
1970/71	3227	2461	1333	243	67	39	4	2	1	26555	38180	-0.06
1971/72	4025	1967	1452	783	143	40	23	2	2	22448	25165	-0.31
1972/73	6703	2405	938	641	339	61	17	10	2	16116	16191	-0.42
1973/74	9564	4100	1344	409	246	127	23	6	4	39494	40354	-0.40
1974/75	6119	5849	2446	706	201	118	76	13	6	47553	70208	-0.03
1975/76	12566	3748	3518	1382	331	84	48	31	8	44342	60511	-0.11
1976/77	9097	7692	2192	1744	584	125	31	17	14	54648	78113	-0.07
1977/78	4712	5545	4259	1073	742	223	45	11	11	49398	101735	0.30
1978/79	7315	2866	2937	1986	433	264	74	15	7	36172	63915	0.14
1979/80	5986	4470	1585	1312	740	144	83	23	7	42403	85679	0.28
1980/81	5270	3661	2634	895	677	355	67	38	14	45862	54754	-0.25
1981/82	3958	3189	2027	1389	421	292	147	28	22	41163	100611	0.47
1982/83	3177	2392	1720	1015	649	175	117	59	20	23198	64243	0.59
1983/84	4172	1908	1151	633	280	157	32	22	15	17383	26054	-0.02
1984/85	6529	2491	931	450	164	56	30	6	7	22802	22890	-0.42
1985/86	4046	3902	1328	414	146	39	12	6	3	37385	37844	-0.41
1986/87	11077	2474	2364	803	251	88	24	7	5	30249	38905	-0.17
1987/88	3216	6754	1394	1200	338	85	23	6	3	49872	22813	-0.78
1988/89	9569	1965	3958	733	538	133	29	8	3	43072	62432	0.37
1989/90	4495	5845	1154	2160	335	217	49	11	4	55467	61239	0.10
1990/91	12914	2755	3547	669	1088	146	89	20	6	47779	42468	-0.12
1991/92	9240	7907	1636	1946	317	448	54	33	10	59180	77802	0.27
1992/93	9879	5646	4579	864	868	121	160	19	15	74736	84050	0.12
1993/94	4541	5981	3229	2414	395	348	44	58	12	58158	63917	0.09
1994/95	10223	2757	3378	1637	1004	127	97	12	20	50577	60317	0.18
1995/96	14920	6221	1570	1750	705	379	42	32	11	55884	65984	0.17
1996/97	16041	9030	3433	814	806	280	140	16	16	62830	54640	-0.14
1997/98	7917	9748	4960	1742	358	285	85	43	10	69685	70018	0.00
1998/99	12530	4828	5583	2639	805	136	69	21	13	68977	78766	0.13
1999/00	16985	7639	2761	2991	1273	331	45	23	11	67875	67643	0.00
2000/01	28385	10311	4317	1455	1340	394	75	10	8	73818	94255	0.24
2001/02	36170	17350	5887	2272	626	465	107	20	5	106303	108173	0.02
2002/03	34422	22101	9964	3160	1130	247	158	36	9	138771	132782	-0.04

Estimated average availability at age (Si): 0.13 0.80 1.00 1.00 1.00 1.00 1.00 1.00 1.00

Estimated average relative selectivity at age for gillnet fisheries: 0.00 0.02 0.19 0.50 0.79 1.00 1.00 1.00 1.00

Spawn index-escapement conversion factor, pre-dive era (q) is 1.53

Estimated instantaneous natural mortality rate is 0.489

Appendix 2.5. Estimates of numbers at age, spawning stock biomass (SB), spawn index (SI), estimated spawn-observed spawn residuals (RES), and other parameters from age-structured analysis for the west coast of Vancouver Island stock assessment region.

	Estimated numbers at age (x10-5) for period 1											
Season	1+	2+	3+	4+	5+	6+	7+	8+	9+	SB	SI	RES
1950/51	4385	2397	2910	436	112	49	0	0	0	24612	19597	-0.19
1951/52	5762	2611	937	1093	164	42	19	0	0	4389	13310	1.15
1952/53	9900	3706	1166	139	150	22	6	3	0	27984	39571	0.39
1953/54	5035	6414	2400	755	90	97	15	4	2	7802	20648	1.01
1954/55	8597	3066	1364	332	104	12	13	2	1	8966	15112	0.56
1955/56	7732	5454	1675	731	178	55	7	7	1	15320	27183	0.61
1956/57	9003	4740	2367	698	305	74	23	3	4	49745	44114	-0.08
1957/58	11121	5816	2949	1459	430	188	46	14	4	46434	18986	-0.85
1958/59	7400	7198	3742	1896	938	277	121	29	12	16229	12979	-0.18
1959/60	4390	4560	1627	506	253	125	37	16	5	6911	6015	-0.10
1960/61	10460	2507	649	160	49	25	12	4	2	10334	10556	0.06
1961/62	4734	5880	627	148	36	11	6	3	1	20722	34470	0.55
1962/63	5918	2924	2230	216	51	13	4	2	1	11972	11245	-0.02
1963/64	1992	3789	1243	612	59	14	3	1	1	16862	22761	0.34
1964/65	1819	1251	1427	395	194	19	4	1	1	11008	11891	0.12
1965/66	1865	1145	450	406	112	55	5	1	0	4286	3722	-0.10
1966/67	970	1199	527	98	85	23	11	1	0	4963	4813	0.01
1967/68	1192	434	232	97	18	16	4	2	0	11200	11029	0.02
1968/69	5451	772	281	150	63	12	10	3	2	10895	10465	0.00
1969/70	10302	3532	500	182	97	41	8	7	3	28017	26912	0.00
1970/71	7896	6675	2288	324	118	63	27	5	6	37693	36206	0.00
1971/72	9671	5116	4324	1482	210	76	41	17	7	61416	41857	-0.34
1972/73	10440	6261	3208	2529	864	122	45	24	14	68425	19481	-1.22
1973/74	17488	6751	3739	1680	1304	444	63	23	20	87841	25540	-1.20
1974/75	7299	11247	3973	2080	891	680	231	33	22	106967	49149	-0.74
1975/76	4640	4709	6655	2146	1052	447	340	116	27	67171	64200	0.00
1976/77	7954	3004	2935	3226	835	387	163	124	52	53017	58679	0.14
1977/78	2555	5146	1814	1396	1374	333	152	64	69	46272	45607	0.03
1978/79	5096	1649	3062	971	574	478	108	49	43	33394	66397	0.73
1979/80	3716	3292	956	1502	379	203	165	37	32	42557	62308	0.42
1980/81	1920	2398	2066	589	875	209	110	90	38	39911	52014	0.31
1981/82	1416	1221	1391	1156	297	422	98	52	60	29839	33047	0.14
1982/83	2458	911	741	808	622	145	195	45	52	20280	16771	-0.15
1983/84	5209	1571	482	354	351	259	59	80	40	23066	23872	0.07
1984/85	5349	3264	823	240	171	169	124	28	57	42151	27437	-0.39
1985/86	2089	3463	2108	531	155	110	109	80	55	51710	36971	-0.30
1986/87	12360	1353	2236	1360	343	100	71	70	87	39432	16858	-0.81
1987/88	2238	7861	696	1048	620	156	45	32	71	52628	44193	-0.17
1988/89	2819	1446	4678	384	564	332	83	24	55	50323	45735	-0.10
1989/90	1661	1809	821	2461	193	277	162	41	39	39929	42887	0.07
1990/91	5215	1070	1040	439	1281	100	143	84	41	28595	27736	-0.03
1991/92	2655	3347	599	541	220	626	48	69	60	32123	39476	0.21
1992/93	1966	1716	2046	349	310	125	356	27	74	33927	32061	-0.06
1993/94	909	1258	977	1142	195	173	70	199	56	26099	23656	-0.10
1994/95	1231	579	695	520	595	100	88	36	130	20190	25496	0.23
1995/96	6845	796	352	401	300	343	58	51	96	18953	30902	0.49
1996/97	1923	4417	485	212	241	180	206	35	88	27373	42573	0.44
1997/98	1109	1227	2326	244	106	121	90	103	62	19310	39419	0.71
1998/99	1079	707	635	1102	110	40	40	30	55	12840	18498	0.37
1999/00	2458	691	370	306	494	47	15	15	32	11485	11553	0.01
2000/01	4813	1585	405	204	160	249	23	8	24	15450	12113	-0.24
2001/02	7930	3116	1011	256	129	101	157	15	20	25290	19154	-0.28
2002/03	9100	5131	1966	628	156	76	59	92	20	31000	27684	-0.11

Estimated average availability at age (Si): 0.09 0.75 0.99 1.00 1.00 1.00 1.00 1.00 1.00

Estimated average relative selectivity at age for gillnet fisheries: 0.00 0.03 0.30 0.67 0.89 1.00 1.00 1.00 1.00

Spawn index-escapement conversion factor, pre-dive era (q) is 0.96

Estimated instantaneous natural mortality rate is 0.434

Appendix 3. 2004 recruitment forecast for West Coast Vancouver Island and Strait of Georgia herring. Ron Tanasichuk, Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C.

The recruitment forecast is made using the methodology described in Tanasichuk (2002). It has two parts. The first forecasts the proportion of age 3 (recruit fish) in the incoming prespawning biomass. It is based on the linear relationship between the proportion of age 2+ herring trawled during August off the southwest coast of Vancouver Island and the proportion of age 3 fish “observed” by the age-structured herring stock assessment model (Schweigert 2003) in the prefishery biomass during the subsequent spring prefishery season. (The working aging convention is that birthdays occur at spawning time (March). JMP (2002) is used for regression analyses. Proportion data are transformed using the logit transformation (Sokal and Rohlf 1995). Predictive regressions are re-expressed as geometric mean regressions (GMR) because both variables were measured with error (Ricker 1973). The regression is updated annually as new data appear.

The second part of the methodology consists of calculating the number of incoming age 3 recruits using the forecasted proportion age 3 from the regression and the number of returning adults (age 4 and older) forecasted by the stock assessment model. Number of age 3 fish in the (R_t) prefishery biomass is estimated as:

$$(1) \quad R_t = (N_t \bullet (1 - p_t)^{-1}) - N_t,$$

where N_t is the number of age 4 and older fish forecasted to be in the prefishery biomass and p is the proportion of age 3 fish forecasted from the offshore survey and t is prefishery year.

Data collection

Data for the 2004 forecasts are from the offshore hake hydroacoustic survey done over August 6-11, 2003 using the R/V W. E. Ricker equipped with a midwater trawl. The southwest coast of Vancouver Island (Appendix Fig. 3.1) was surveyed intensively. Over 480 n.m. were steamed in the 2-1/2 days (August 9-11) allocated for the herring survey. Herring distributions were very unusual. Historically, pre-recruit herring concentrate on Swiftsure Bank whereas recruits and adults are distributed over 40 Mile and Finger Banks and on the Southwest Corner. This summer, pre-recruit fish were found at the Southwest Corner and adults were in one immense school on Swiftsure Bank. Pacific hake (*Merluccius productus*) were found on 40 Mile and Swiftsure Banks at depths shallower than they have ever been observed since summer herring surveys began in 1985.

Herring were collected in 11 of the 15 midwater tows made. Fish were sampled from the eight tows where catch exceeded 100 kg. The catch was weighed. One-hundred and fifty fish were subsampled from each tow. Standard length (mm) was measured for all fish. In addition, for the first 25 fish, total mass (g) was measured and stomach contents were described and stomach volume was measured (mL). For most tows, scales from the first 100 fish were removed for aging by the Aging Laboratory at the Pacific Biological Station.

Identification of age 2+ (recruit) herring

Fish were assigned to age 2+ or not age 2+ using the methods described in Tanasichuk (2002). Age-length data were pooled over tows and stratified by 2 mm length intervals. For the pooled data, the proportion of fish at age *j* in length interval *l* was estimated as:

$$(2) \quad P_{j,l} = N_{j,l} \bullet N_l^{-1}.$$

Number of fish at age 2+ in each tow (N_{2+}) was then estimated as:

$$(3) \quad N_{2+} = \sum_{i=120}^{240} P_{2+,l} \bullet N_l \, .$$

Proportion of age 2+ fish in a sample in a given tow was estimated by dividing N_{2+} by the number of fish sampled. Appendix Fig. 3.2 shows the assignment of fish to age 2+ or not age 2+ for the 2003 survey. Appendix Table 3.1 presents catch information for the 2003 survey and the proportion of age 2+ fish estimated for each tow. Tows 101 and 108 were excluded because, based on length ranges, these fish were assumed to be too small to be recruiting to the 2004 spawning biomass. The mean proportion of age 2+ fish, weighted by CPUE, was 0.09.

Retrospective analyses of recruitment forecasts

Incoming recruitment categories are assumed for all other B.C. herring stocks because there is no forecasting methodology developed for them. Recruitments are classified as Poor, Average or Good. Boundaries between Poor and Average, and Average and Good recruitments, are calculated as the 33 and 66 percentiles respectively of the cumulative frequency distributions of the forecast year-specific age 2+ abundance time series from the stock assessment model. By convention, recruitment to a B. C. herring stock is assumed to be Average. Poor or Good recruitments are assumed after a recruitment time series indicates a persistent (3-year trend) of one of those states of recruitment. The stock assessment model estimates recruit biomasses associated with the recruitment categories. The biomass for the recruitment category chosen by the Pelagics Subcommittee is added to the forecasted biomass of returning adults to generate the forecast of prefishery biomass.

Appendix Table 3.2 shows a retrospective analysis of the recruitment forecasts for WCVI herring. The regression statistics for the forecasts are not presented because they have been stable since the 1992 forecasting year and the methodology has been accepted by the Pelagics Subcommittee. The 2003 forecasted recruitment category was Poor and the observed, based on the stock assessment model estimate, was Good. The recruitment forecast has been correct in 8 of 11 years. The convention used to forecast recruitment for other B.C. herring populations would have been correct in 2 of 11 years.

The utility of recruitment forecasting for Strait of Georgia herring is being pursued as recommended by Pelagics Subcommittee based on Tanasichuk (2002). Appendix 3.3 presents the regression statistics relating observed proportion age 2+ in the trawl samples to age 3 fish observed in the Strait of Georgia prefishery biomass during the subsequent spring. Standard errors for the forecasted proportion age 3 ($\hat{S}_y$) were calculated using the equation given by Sokal and Rohlf (1995), where,

$$(4)\quad \hat{S}_y = \sqrt{S^2_{y \bullet x}\left[1 + \frac{1}{n} + \frac{\left(X_i - \overline{X}\right)^2}{\sum x^2}\right]}$$

and $S^2{}_{Y \bullet X}$ is the error mean square for the regression, n is the number of data pairs used to estimate the regression, X_i is the trawled proportion age 2+ for the forecast, and Σx^2 is the sum of the squared deviations for X. Regression parameter estimates are stable over time. Observed proportion age 3 was within the 95% confidence interval for all nine years evaluated retrospectively.

Appendix 3.4 gives the results of the retrospective analysis of the recruitment forecasts made using the methodology. Results show that the forecasts were accurate in seven of the nine years. The error for 1996 and 1998 forecasts appears to be due to an inaccurate forecast of proportion age 3. The conventional Average recruitment assumption would have been accurate in two of the nine years.

2003 recruitment forecast

Results of the 2003 offshore survey suggest that 0.09 of the number of fish trawled were age 2+. Consequently, using the regression based on data to the 2003 fishing season inclusive, 0.10 of the fish in the WCVI 2004 prefishery biomass are forecasted to be age 3. The stock assessment model forecast of the number of age 4 and older fish in the 2004 prefishery biomass is $2440 \bullet 10^{-5}$. Therefore, the forecasted number of age 3 herring is $271 \bullet 10^{-5}$. The current breakpoints between Poor/Average and Average/Good recruitments are $779 \bullet 10^{-5}$ and $1833 \bullet 10^{-5}$ fish respectively. Consequently, recruitment for WCVI herring in 2004 is forecast to be Poor.

The recruitment forecast for the Strait of Georgia is Average. The forecasted proportion of age 3 fish in the 2004 Strait of Georgia prefishery biomass is 0.20. The RASM forecast for number of age 4 and older fish is $11337 \bullet 10^{-5}$ and the forecasted number of age 3 fish is $2834 \bullet 10^{-5}$. The current breakpoints between Poor/Average and Average/Good recruitments are $1742 \bullet 10^{-5}$ and $3300 \bullet 10^{-5}$ fish respectively.

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Appendix Table 3.1. Tow information, herring catch, proportion of age 2+ herring from midwater trawl tows along the southwest coast of Vancouver Island, 2003. Subareas are defined in Appendix Fig. 3.1.

Tow	Day	Month	Subarea	Catch (kg)	CPUE ($kg \bullet m^{-3}$)	Prop. Age 2+
101	10	8	9	271	7 E-5	0.40
104	10	8	9	2000	0.0028	0.03
105	10	8	9	1273	0.0018	0.23
106	10	8	9	2727	0.0149	0.09
108	11	8	3	675	0.0025	0.16
109	11	8	3	521	0.0010	0.40
110	11	8	9	4090	0.0168	0.06
111	11	8	9	1364	0.0079	0.11

Appendix Table 3.2. Retrospective recruitment forecasts for WCVI herring, 1993-2003. Numbers of fish - • 10^{-5}. All observed estimates are age-structured model output and are multiplied by forecast year-specific survival and forecast year-specific and age -specific availability to generate prefishery estimates. Recruitment distribution breakpoints for Poor/Average (p=0.33) and Average/Good (p=0.67) are from age 2+ time series for the 1992-2003 forecasts. APE – absolute percent error, $\left((observed - forecasted) \bullet observed^{-1}\right) \bullet 100$.

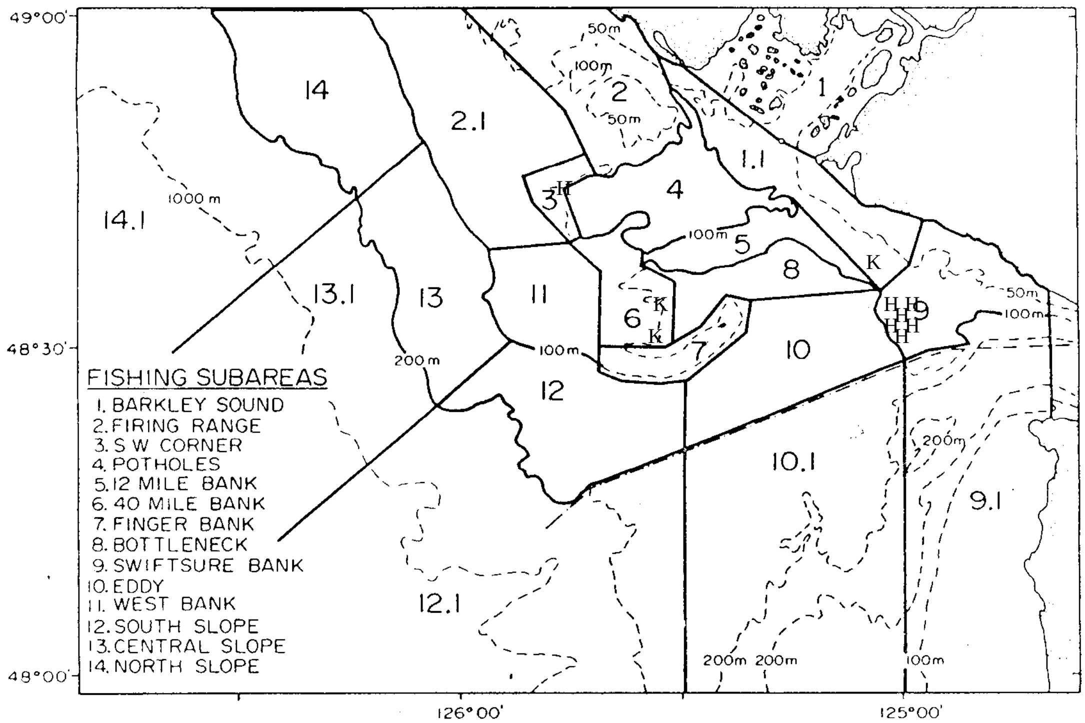
	Proportion age 3		**Forecast**		Observed		Proportion age 3		**No. age 4++**			
Season	Forecast	Observed	Number	Category	Number	Category	Residual	APE	Observed	Forecast	Residual	APE
1993	0.16	0.29	331	Poor	785	Poor	-0.13	0.81	1928	1737	191	0.10
1994	0.27	0.25	665	Poor	521	Poor	0.02	0.07	1718	1798	-80	0.05
1995	0.30	0.16	576	Poor	249	Poor	0.14	0.47	1586	1343	243	0.15
1996	0.26	0.25	434	Poor	444	Poor	0.01	0.04	1346	1234	111	0.08
1997	0.37	0.71	759	Average	3102	Good	-0.34	0.92	1284	1292	-8	0.01
1998	0.19	0.25	736	Average	1018	Average	-0.06	0.32	3586	3136	450	0.13
1999	0.13	0.21	460	Poor	691	Poor	-0.08	0.62	2335	3082	-747	0.32
2000	0.54	0.31	2261	Good	452	Poor	0.23	0.43	1370	1926	-556	0.41
2001	0.46	0.48	1021	Average	993	Average	-0.02	0.04	1042	1199	-157	0.15
2002	0.74	0.52	4353	Good	1741	Good	0.22	0.30	1343	1529	-187	0.14
2003	0.16	0.56	456	Poor	2493	Good	0.40	2.53	1929	2393	-106	0.17
Mean							0.04	0.59			-109	0.16

Appendix Table 3.3. Retrospective analysis of recruitment forecasting regressions for Strait of Georgia herring. Regression statistics are for regressions based on all data up and including the year of trawling. Regressions were used to forecast proportion age 3 fish in year x+1 based on trawled proportion age 2+ in year x. Forecasted proportion and 95% CL for the prediction for year+1 appear in the entry for year x+1. For example, the regression statistics for 1993 appearing in the entry for 1993 were calculated using all data pairs to 1993 inclusive. This regression was used with the trawled proportion age 2+ (0.27) for 1994 to predict that the proportion age 3 in the 1995 prefishery biomass would be 0.38. The observed proportion age 3 was 0.23. Regression analyses began with five years of data because smaller sample sizes were considered to be inadequate. β, α - predictive regression slope and intercept respectively. β′, α′ - GMR regression slope and intercept respectively.

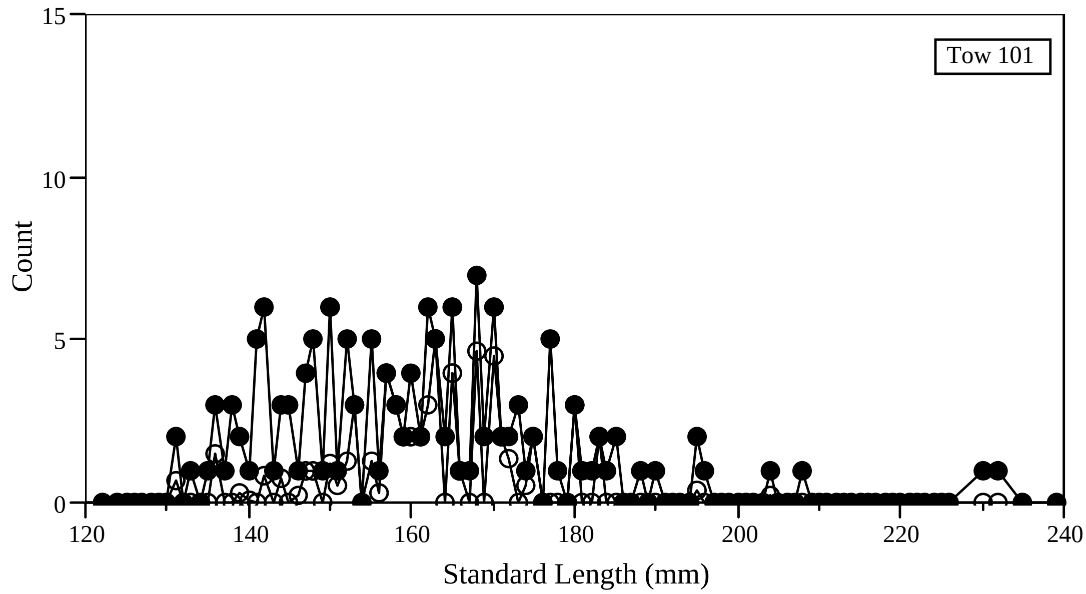
Year	Prop. Age		Regression statistics									Lower		Upper
	Trawled (Year)	Obs. (Year+1)	β	s_β	P	β′	α	s_α	p	α′	R^2	95% CL	**Estimate**	95% CL
1986	0.19	0.26												
1987	0.46	0.61												
1988	0.25	0.20												
1989	0.25	0.47												
1990	0.10	0.24	0.80	0.410	0.15	1.06	0.30	0.561	0.62	0.63	0.56			
1991	0.62	0.51	0.59	0.264	0.09	0.79	0.01	0.334	0.99	0.19	0.56			
1992	0.16	0.36	0.54	0.235	0.07	0.75	0.01	0.312	0.98	0.23	0.52			
1993	0.24	0.39	0.54	0.217	0.05	0.76	0.03	0.283	0.92	0.26	0.51			
1994	0.27	0.23	0.53	0.229	0.05	0.81	-0.06	0.293	0.86	0.23	0.44	0.17	0.38	0.65
1995	0.25	0.40	0.53	0.218	0.04	0.81	-0.03	0.274	0.91	0.26	0.42	0.14	0.34	0.63
1996	0.34	0.48	0.55	0.206	0.03	0.83	0.01	0.251	0.96	0.30	0.44	0.20	0.43	0.70
1997	0.19	0.48	0.49	0.213	0.04	0.84	0.02	0.264	0.95	0.37	0.35	0.12	0.29	0.55
1998	0.14	0.26	0.51	0.195	0.02	0.82	0.02	0.251	0.92	0.37	0.39	0.08	0.24	0.51
1999	0.42	0.41	0.49	0.180	0.02	0.79	-0.02	0.224	0.92	0.30	0.38	0.26	0.52	0.78
2000	0.38	0.44	0.49	0.169	0.01	0.78	-0.02	0.205	0.92	0.28	0.39	0.24	0.48	0.73
2001	0.61	0.51	0.46	0.144	0.01	0.71	-0.04	0.170	0.82	0.19	0.42	0.37	0.65	0.85
2002	0.17	0.48	0.40	0.154	0.02	0.72	-0.06	0.186	0.76	0.30	0.31	0.11	0.28	0.51
2003	0.09											0.11	0.20	0.57

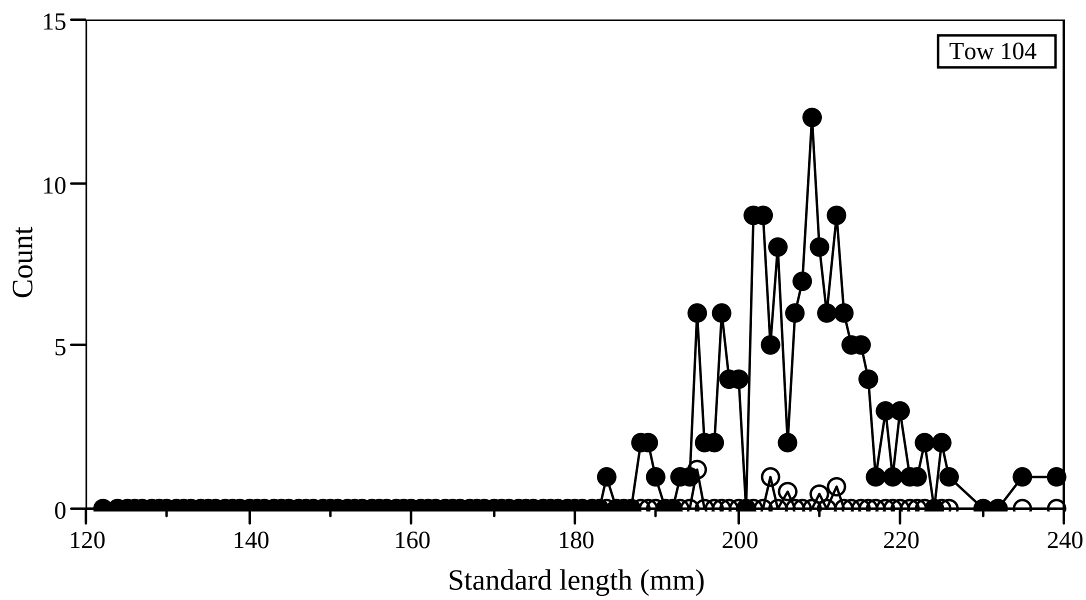
Appendix Table 3.4. Retrospective recruitment forecasts for Strait of Georgia herring, 1995-2003. Numbers of fish - • 10^{-5}. All observed estimates are age-structured model output and are multiplied by $e^{-M} \bullet \lambda$ (age-independent and year-dependent survival • age-and year-dependent availability) to generate prefishery estimates. Recruitment distribution breakpoints (Poor/Average, p=0.33) and (Average/Good, p=0.67) were estimated from age 2+ time series for each of the 1995-2003 forecasts. APE – absolute percent error, $\left((observed - forecasted) \bullet observed^{-1}\right) \bullet 100$.

	Proportion age 3		Forecast		Observed		Proportion age 3		No. age 4++			
Season	Forecast	Observed	Number	Category	Number	Category	Residual	APE	Observed	Forecast	Residual	APE
1995	0.38	0.23	2827	Average	1699	Average	-0.15	65	4864	4613	251	5
1996	0.34	0.40	1910	Average	4442	Good	0.06	15	3354	3708	-354	11
1997	0.43	0.48	3602	Good	5343	Good	0.05	10	3981	4775	-794	20
1998	0.29	0.48	2329	Average	4156	Good	0.19	40	4267	5703	-1436	34
1999	0.24	0.26	1567	Average	2305	Average	0.02	8	6051	4961	1090	18
2000	0.52	0.41	5139	Good	3388	Good	-0.11	27	4227	4743	-516	12
2001	0.48	0.44	3854	Good	5053	Good	-0.04	9	5572	4176	1396	25
2002	0.65	0.51	11634	**Good**	8046	Good	-0.14	27	6410	6264	146	2
2003	0.28	0.48	3499	Good	10788	Good	0.20	42	10203	8997	1206	12
Mean							0.01	0.27			110	0.15

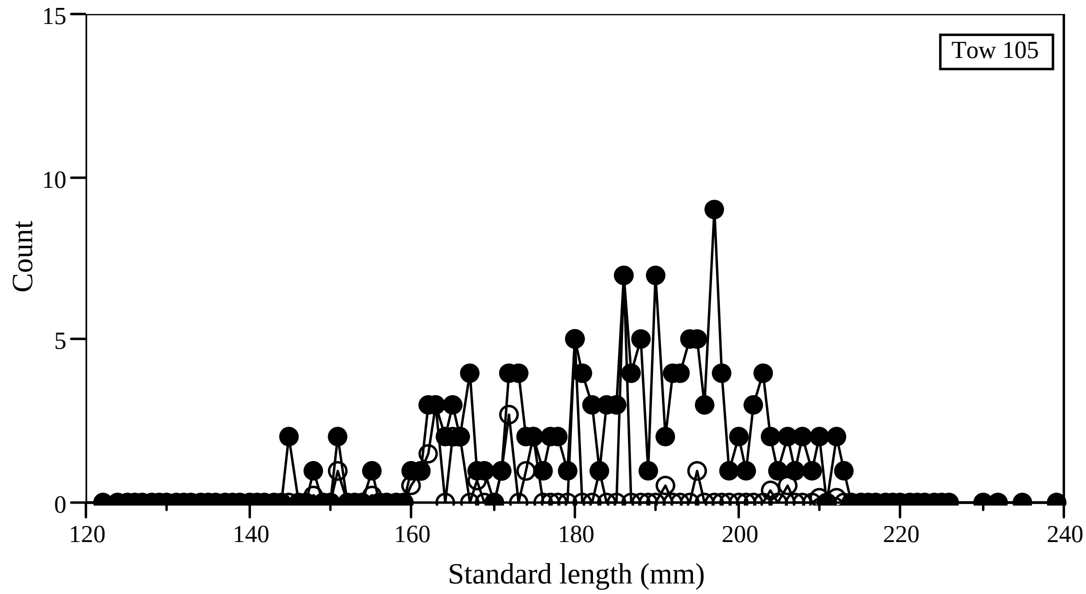


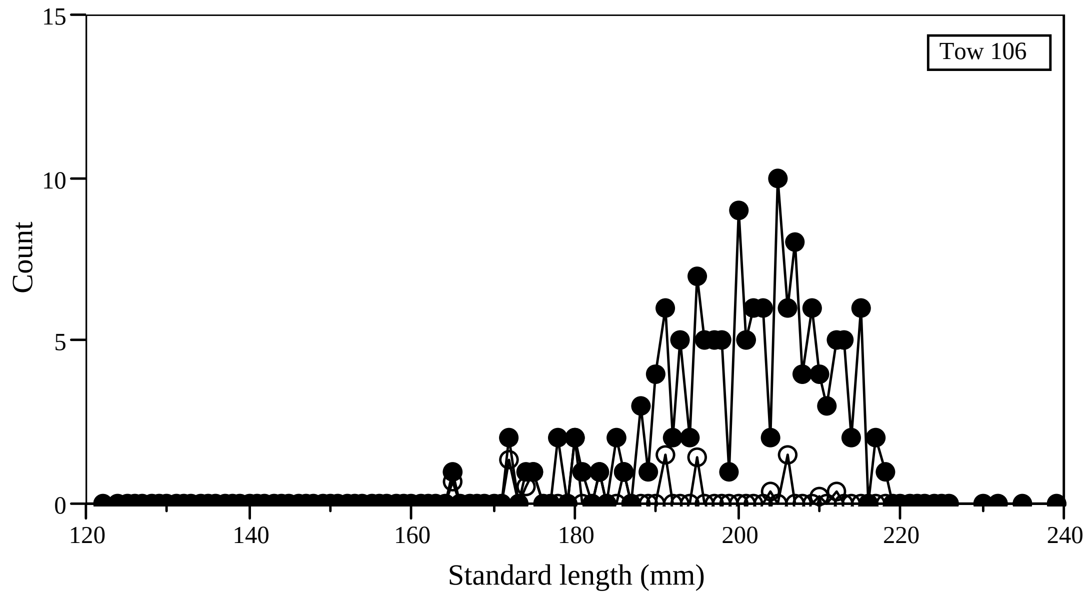
Appendix Fig. 3.1. Laperouse study area. Outlined letters show herring (H) and hake (K) concentrations for August 9 –11, 2003 herring survey.



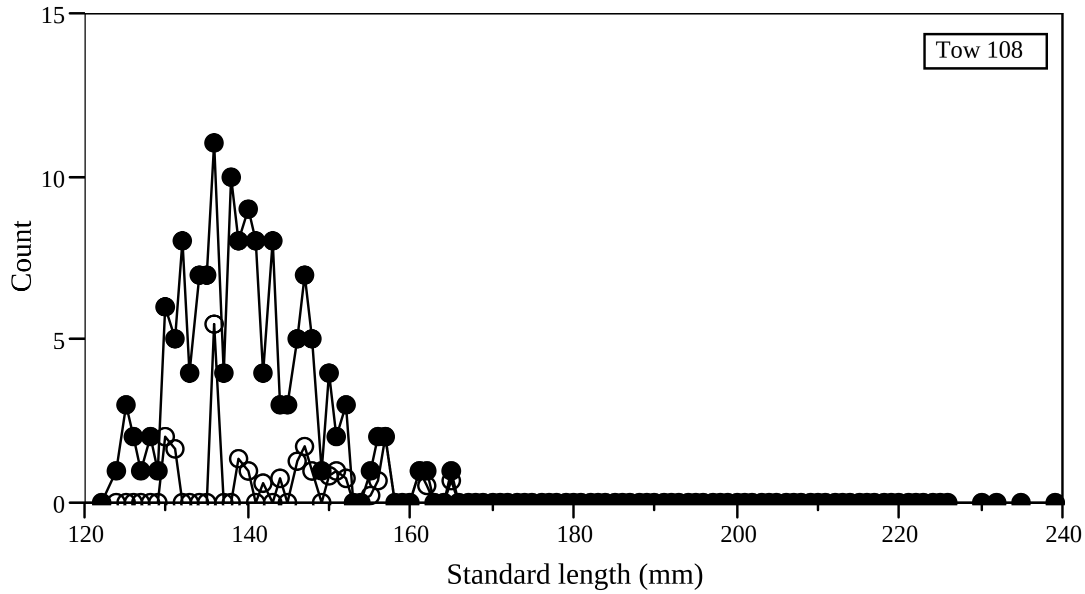


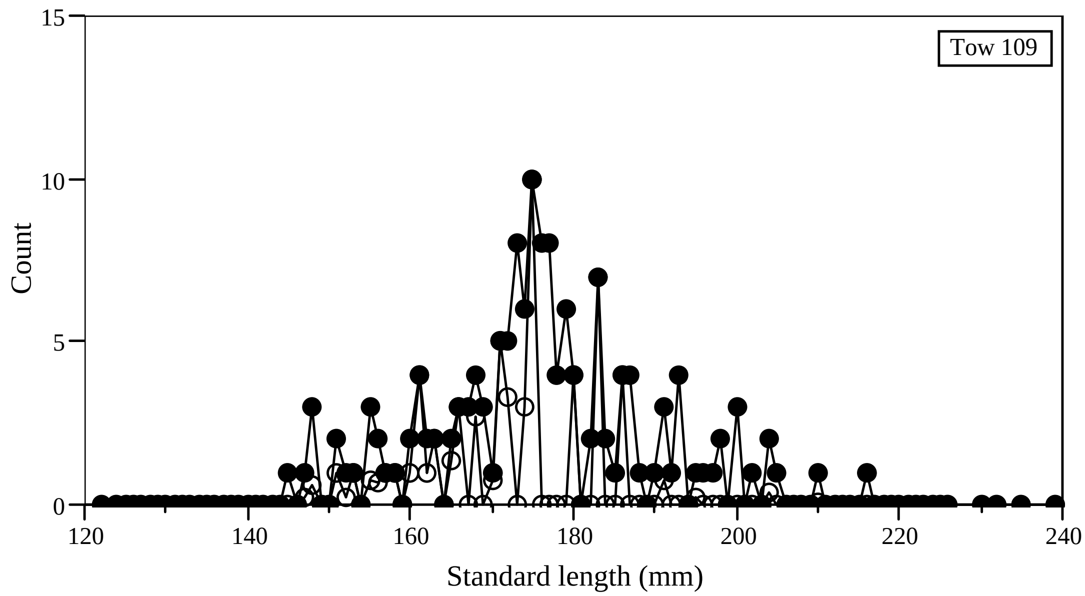
Appendix Fig. 3.2. Length-frequencies for herring trawled during the 2003 offshore herring survey. Open circles indicate fish presumed to be age 2+.



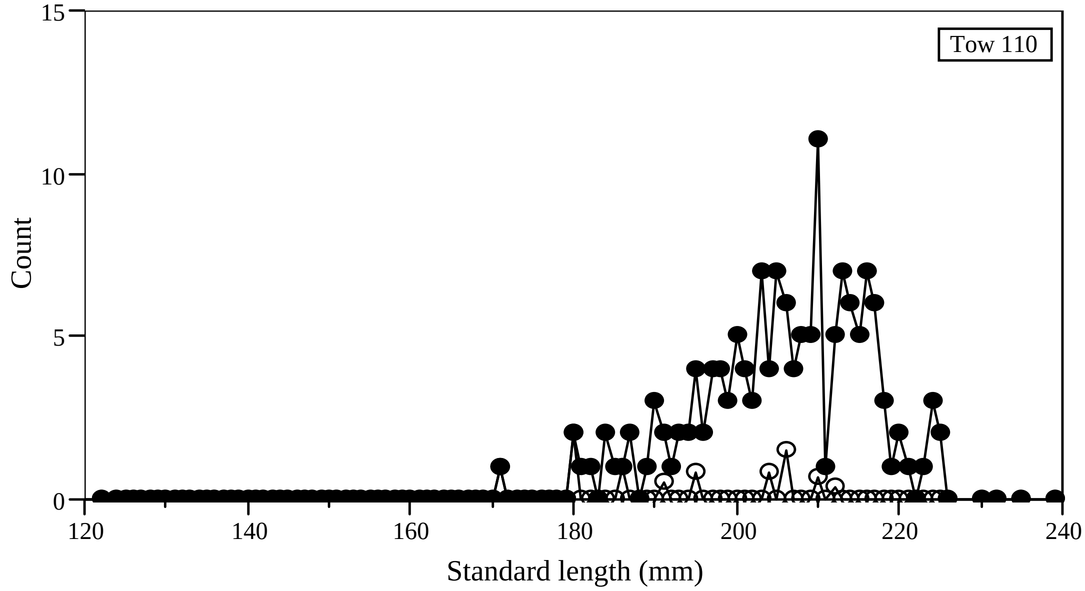


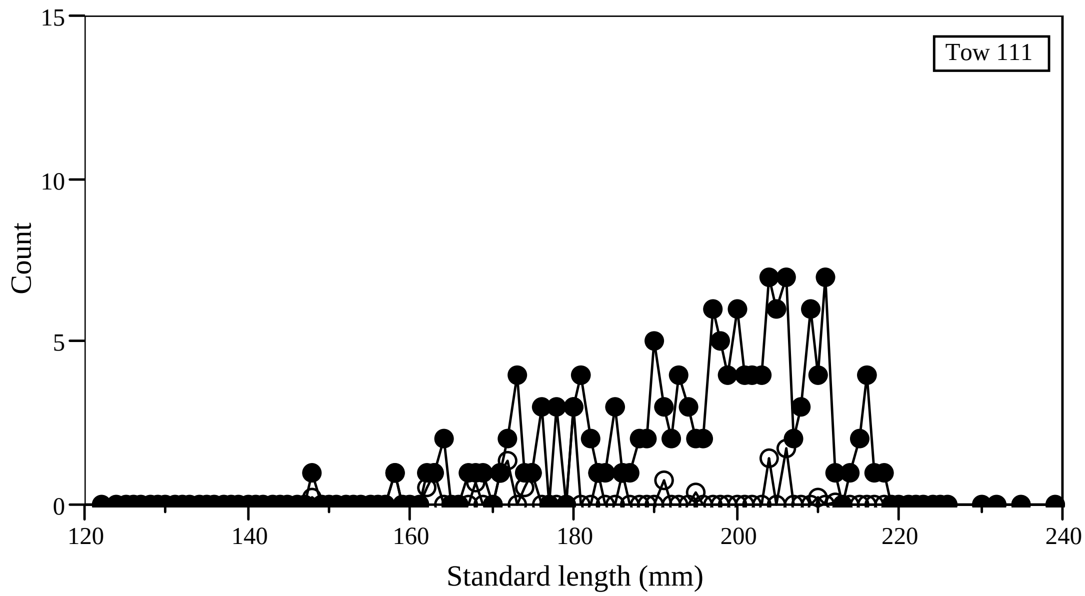
Appendix Fig. 3.2 cont.



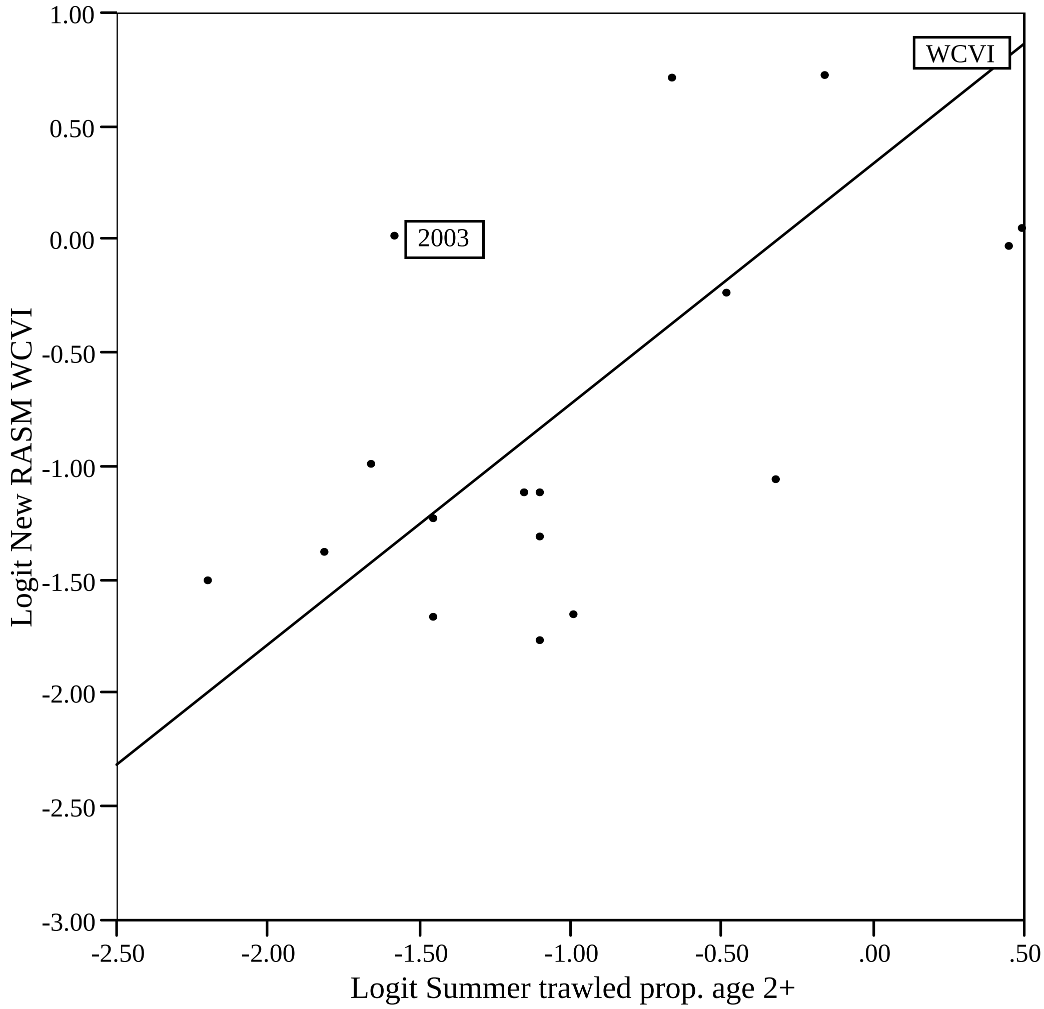


Appendix Fig. 3.2 cont.

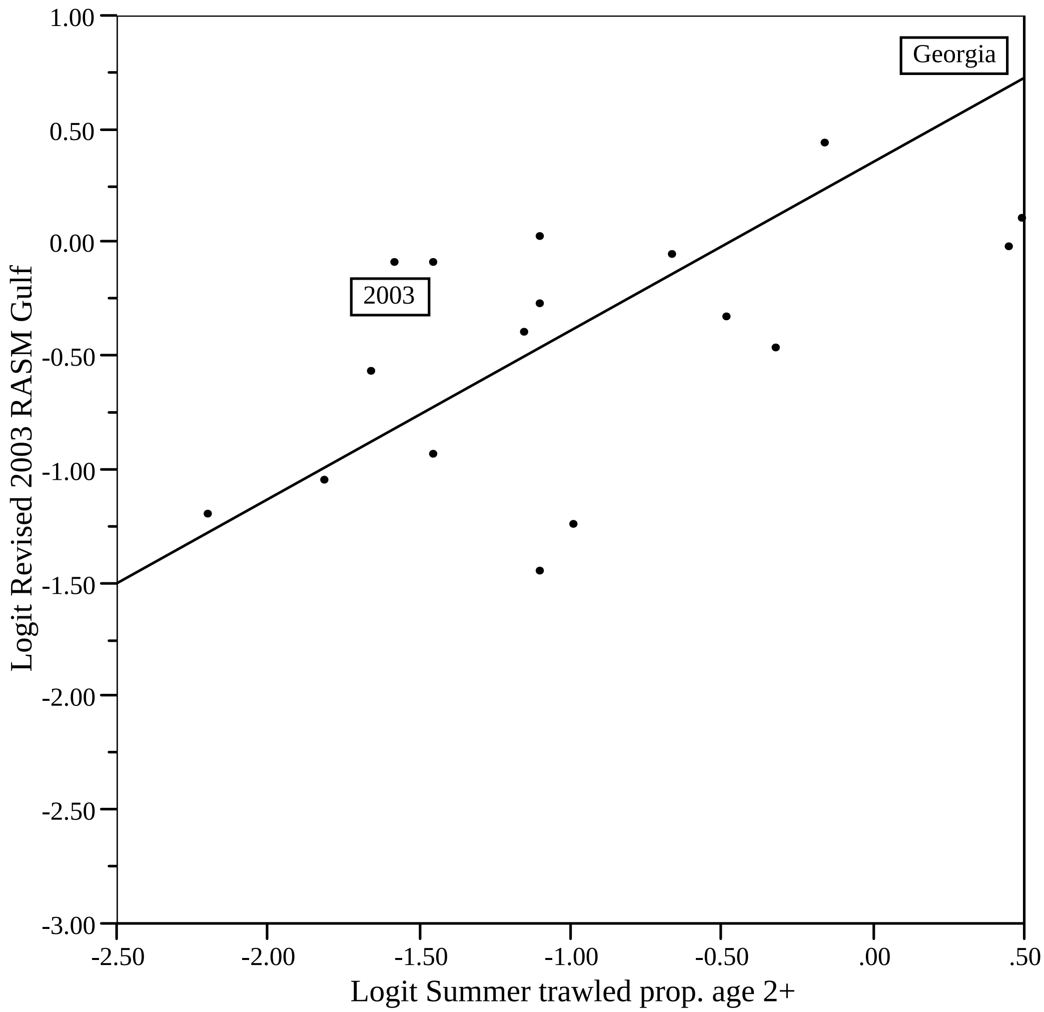




Appendix Fig. 3.2 cont.



Appendix Fig. 3.3. Scatterplot of logit observed proportion age 3 against logit trawled proportion age 2+ for WCVI herring. Line is GMR regression used to forecast recruitment for 2003 where y'=1.09•x'+0.32, p=0.01, adjusted R^2=0.32. 2003 – trawled and observed data pair for 2003 fishing season.



Appendix Fig. 3.4. Scatterplot of logit observed proportion age 3 against logit trawled proportion age 2+ for Strait of Georgia herring. Line is GMR regression used to forecast recruitment for 2003 where y'=0.72•x+0.30, p=0.02, adjusted R^2=0.27. 2003 – trawled and observed data pair for 2003 fishing season.

Appendix 4. 2004 recruitment forecast for West Coast Vancouver Island and Strait of Georgia herring. Ron Tanasichuk, Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C.

The recruitment forecast is made using the methodology described in Tanasichuk (2002). It has two parts. The first forecasts the proportion of age 3 (recruit fish) in the incoming prespawning biomass. It is based on the linear relationship between the proportion of age 2+ herring trawled during August off the southwest coast of Vancouver Island and the proportion of age 3 fish "observed" by the age-structured herring stock assessment model (Schweigert 2003) in the prefishery biomass during the subsequent spring prefishery season. (The working aging convention is that birthdays occur at spawning time (March)). JMP (2002) is used for regression analyses. Proportion data are transformed using the logit transformation (Sokal and Rohlf 1995). Predictive regressions are re-expressed as geometric mean regressions (GMR) because both variables were measured with error (Ricker 1973). The regression is updated annually as new data appear.

The second part of the methodology consists of calculating the number of incoming age 3 recruits using the forecasted proportion age 3 from the regression and the number of returning adults (age 4 and older) forecasted by the stock assessment model. Number of age 3 fish in the (R_t) prefishery biomass is estimated as:

$$(1) \quad R_t = (N_t \bullet (1 - p_t)^{-1}) - N_t,$$

where N_t is the number of age 4 and older fish forecasted to be in the prefishery biomass and p is the proportion of age 3 fish forecasted from the offshore survey and t is prefishery year.

<u>Data collection</u>

Data for the 2004 forecasts are from the offshore hake hydroacoustic survey done over August 6-11, 2003 using the R/V W. E. Ricker equipped with a midwater trawl. The southwest coast of Vancouver Island (Appendix Fig. 1) was surveyed intensively. Over 480 n.m. were steamed in the 2-1/2 days (August 9-11) allocated for the herring survey. Herring distributions were very unusual. Historically, pre-recruit herring concentrate on Swiftsure Bank whereas recruits and adults are distributed over 40 Mile and Finger Banks and on the Southwest Corner. This summer, pre-recruit fish were found at the Southwest Corner and adults were in one immense school on Swiftsure Bank. Pacific hake (*Merluccius productus*) were found on 40 Mile and Swiftsure Banks at depths shallower than they have ever been observed since summer herring surveys began in 1985.

Herring were collected in 11 of the 15 midwater tows made. Fish were sampled from the eight tows where catch exceeded 100 kg. The catch was weighed. One-hundred and fifty fish were subsampled from each tow. Standard length (mm) was measured for all fish. In addition, for the first 25 fish, total mass (g) was measured and stomach contents were described and stomach volume was measured (mL). For most tows, scales from the first 100 fish were removed for aging by the Aging Laboratory at the Pacific Biological Station.

Identification of age 2+ (recruit) herring

Fish were assigned to age 2+ or not age 2+ using the methods described in Tanasichuk (2002). Age-length data were pooled over tows and stratified by 2 mm length intervals. For the pooled data, the proportion of fish at age *j* in length interval *l* was estimated as:

$$(2) \quad P_{j,l} = N_{j,l} \bullet N_l^{-1}.$$

Number of fish at age 2+ in each tow (N_{2+}) was then estimated as:

$$(3) \quad N_{2+} = \sum_{i=120}^{240} P_{2+,l} \bullet N_l \, .$$

Proportion of age 2+ fish in a sample in a given tow was estimated by dividing N_{2+} by the number of fish sampled. Appendix Fig. 2 shows the assignment of fish to age 2+ or not age 2+ for the 2003 survey. Appendix Table 1 presents catch information for the 2003 survey and the proportion of age 2+ fish estimated for each tow. Tows 101 and 108 were excluded because, based on length ranges, these fish were assumed to be too small to be recruiting to the 2004 spawning biomass. The mean proportion of age 2+ fish, weighted by CPUE, was 0.09.

Retrospective analyses of recruitment forecasts

Incoming recruitment categories are assumed for all other B.C. herring stocks because there is no forecasting methodology developed for them. Recruitments are classified as Poor, Average or Good. Boundaries between Poor and Average, and Average and Good recruitments, are calculated as the 33 and 66 percentiles respectively of the cumulative frequency distributions of the forecast year-specific age 2+ abundance time series from the stock assessment model. By convention, recruitment to a B.C. herring stock is assumed to be Average. Poor or Good recruitments are assumed after a recruitment time series indicates a persistent (3-year trend) of one of those states of recruitment. The stock assessment model estimates recruit biomasses associated with the recruitment categories. The biomass for the recruitment category chosen by the Pelagics Subcommittee is added to the forecasted biomass of returning adults to generate the forecast of prefishery biomass.

Appendix Table 2 shows a retrospective analysis of the recruitment forecasts for WCVI herring. The regression statistics for the forecasts are not presented because they have been stable since the 1992 forecasting year and the methodology has been accepted by the Pelagics Subcommittee. The 2003 forecasted recruitment category was Poor and the observed, based on the stock assessment model estimate, was Good. The recruitment forecast has been correct in 8 of 11 years. The convention used to forecast recruitment for other B.C. herring populations would have been correct in 2 of 11 years.

The utility of recruitment forecasting for Strait of Georgia herring is being pursued as recommended by Pelagics Subcommittee based on Tanasichuk (2002). Appendix Table 3 presents the regression statistics relating observed proportion age 2+ in the trawl samples to age 3 fish observed in the Strait of Georgia prefishery biomass during the subsequent spring. Standard errors for the forecasted proportion age 3 ($\hat{S}_y$) were calculated using the equation given by Sokal and Rohlf (1995), where,

$$(4)\quad \hat{S}_y = \sqrt{S^2_{y \bullet x}\left[1 + \frac{1}{n} + \frac{(X_i - \overline{X})^2}{\sum x^2}\right]}$$

and $S^2_{Y \bullet X}$ is the error mean square for the regression, n is the number of data pairs used to estimate the regression, X_i is the trawled proportion age 2+ for the forecast, and Σx^2 is the sum of the squared deviations for X. Regression parameter estimates are stable over time. Observed proportion age 3 was within the 95% confidence interval for all nine years evaluated retrospectively.

Appendix Table 4 gives the results of the retrospective analysis of the recruitment forecasts made using the methodology. Results show that the forecasts were accurate in seven of the nine years. The error for 1996 and 1998 forecasts appears to be due to an inaccurate forecast of proportion age 3. The conventional Average recruitment assumption would have been accurate in two of the nine years.

2003 recruitment forecast

Results of the 2003 offshore survey suggest that 0.09 of the number of fish trawled were age 2+. Consequently, using the regression based on data to the 2003 fishing season inclusive, 0.10 of the fish in the WCVI 2004 prefishery biomass are forecasted to be age 3. The stock assessment model forecast of the number of age 4 and older fish in the 2004 prefishery biomass is $2440 \bullet 10^{-5}$. Therefore, the forecasted number of age 3 herring is $271 \bullet 10^{-5}$. The current breakpoints between Poor/Average and Average/Good recruitments are $779 \bullet 10^{-5}$ and $1833 \bullet 10^{-5}$ fish respectively. Consequently, recruitment for WCVI herring in 2004 is forecast to be Poor.

The recruitment forecast for the Strait of Georgia is Average. The forecasted proportion of age 3 fish in the 2004 Strait of Georgia prefishery biomass is 0.20. The RASM forecast for number of age 4 and older fish is $11337 \bullet 10^{-5}$ and the forecasted number of age 3 fish is $2834 \bullet 10^{-5}$. The current breakpoints between Poor/Average and Average/Good recruitments are $1742 \bullet 10^{-5}$ and $3300 \bullet 10^{-5}$ fish respectively.

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Sokal, R. R. and F. J. Rohlf. 1995. Biometry. 3rd edition. W. H. Freeman and Co. New York, NY. 887p.

Tanasichuk, R. W. 2002. An evaluation of a recruitment forecasting procedure for Strait of Georgia herring. PSARC Working Paper P2002-01. 24p.

Appendix Table 1. Tow information, herring catch, proportion of age 2+ herring from midwater trawl tows along the southwest coast of Vancouver Island, 2003. Subareas are defined in Appendix Fig. 1.

Tow	Day	Month	Subarea	Catch (kg)	CPUE ($kg \cdot m^{-3}$)	Prop. Age 2+
101	10	8	9	271	7 E-5	0.40
104	10	8	9	2000	0.0028	0.03
105	10	8	9	1273	0.0018	0.23
106	10	8	9	2727	0.0149	0.09
108	11	8	3	675	0.0025	0.16
109	11	8	3	521	0.0010	0.40
110	11	8	9	4090	0.0168	0.06
111	11	8	9	1364	0.0079	0.11

Appendix Table 2. Retrospective recruitment forecasts for WCVI herring, 1993-2003. Numbers of fish - $\bullet 10^{-5}$. All observed estimates are age-structured model output and are multiplied by forecast year-specific survival and forecast year-specific and age -specific availability to generate prefishery estimates. Recruitment distribution breakpoints for Poor/Average (p=0.33) and Average/Good (p=0.67) are from age 2+ time series for the 1992-2003 forecasts. APE – absolute percent error, $\left((observed - forecasted)\bullet observed^{-1}\right)\bullet 100$.

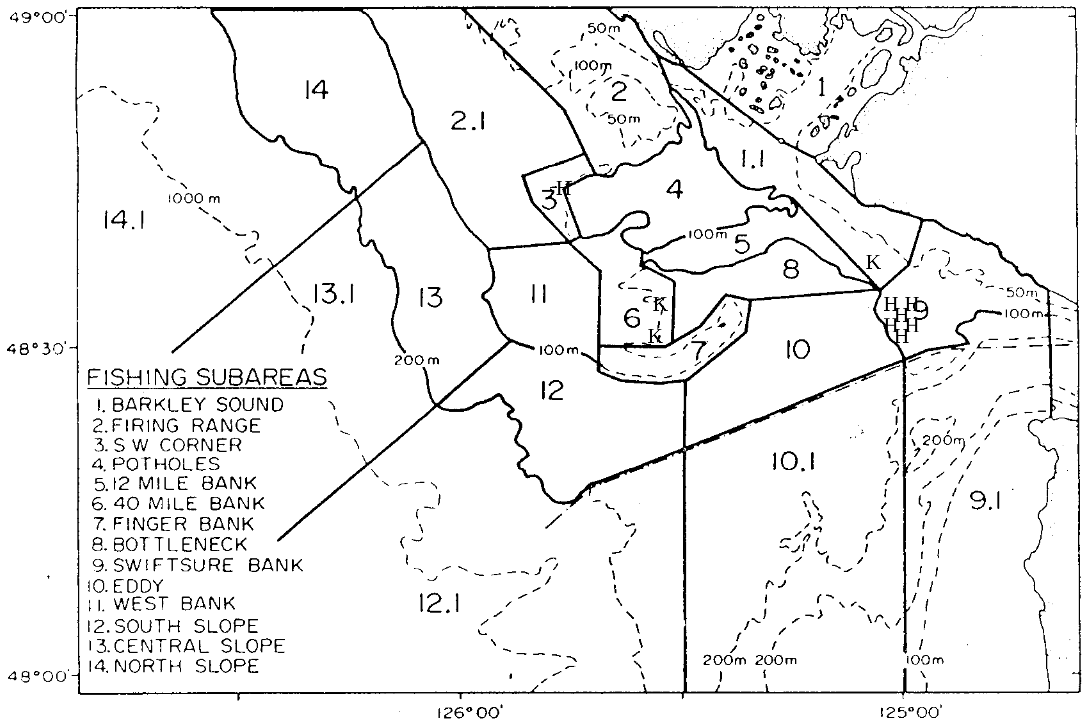
	Proportion age 3		**Forecast**		Observed		Proportion age 3		**No. age 4++**			
Season	Forecast	Observed	Number	Category	Number	Category	Residual	APE	Observed	Forecast	Residual	APE
1993	0.16	0.29	331	Poor	785	Poor	-0.13	0.81	1928	1737	191	0.10
1994	0.27	0.25	665	Poor	521	Poor	0.02	0.07	1718	1798	-80	0.05
1995	0.30	0.16	576	Poor	249	Poor	0.14	0.47	1586	1343	243	0.15
1996	0.26	0.25	434	Poor	444	Poor	0.01	0.04	1346	1234	111	0.08
1997	0.37	0.71	759	Average	3102	Good	-0.34	0.92	1284	1292	-8	0.01
1998	0.19	0.25	736	Average	1018	Average	-0.06	0.32	3586	3136	450	0.13
1999	0.13	0.21	460	Poor	691	Poor	-0.08	0.62	2335	3082	-747	0.32
2000	0.54	0.31	2261	Good	452	Poor	0.23	0.43	1370	1926	-556	0.41
2001	0.46	0.48	1021	Average	993	Average	-0.02	0.04	1042	1199	-157	0.15
2002	0.74	0.52	4353	Good	1741	Good	0.22	0.30	1343	1529	-187	0.14
2003	0.16	0.56	456	Poor	2493	Good	0.40	2.53	1929	2393	-106	0.17
Mean							0.04	0.59			-109	0.16

Appendix Table 3. Retrospective analysis of recruitment forecasting regressions for Strait of Georgia herring. Regression statistics are for regressions based on all data up and including the year of trawling. Regressions were used to forecast proportion age 3 fish in year x+1 based on trawled proportion age 2+ in year x. Forecasted proportion and 95% CL for the prediction for year+1 appear in the entry for year x+1. For example, the regression statistics for 1993 appearing in the entry for 1993 were calculated using all data pairs to 1993 inclusive. This regression was used with the trawled proportion age 2+ (0.27) for 1994 to predict that the proportion age 3 in the 1995 prefishery biomass would be 0.38. The observed proportion age 3 was 0.23. Regression analyses began with five years of data because smaller sample sizes were considered to be inadequate. β, α - predictive regression slope and intercept respectively. β', α' - GMR regression slope and intercept respectively.

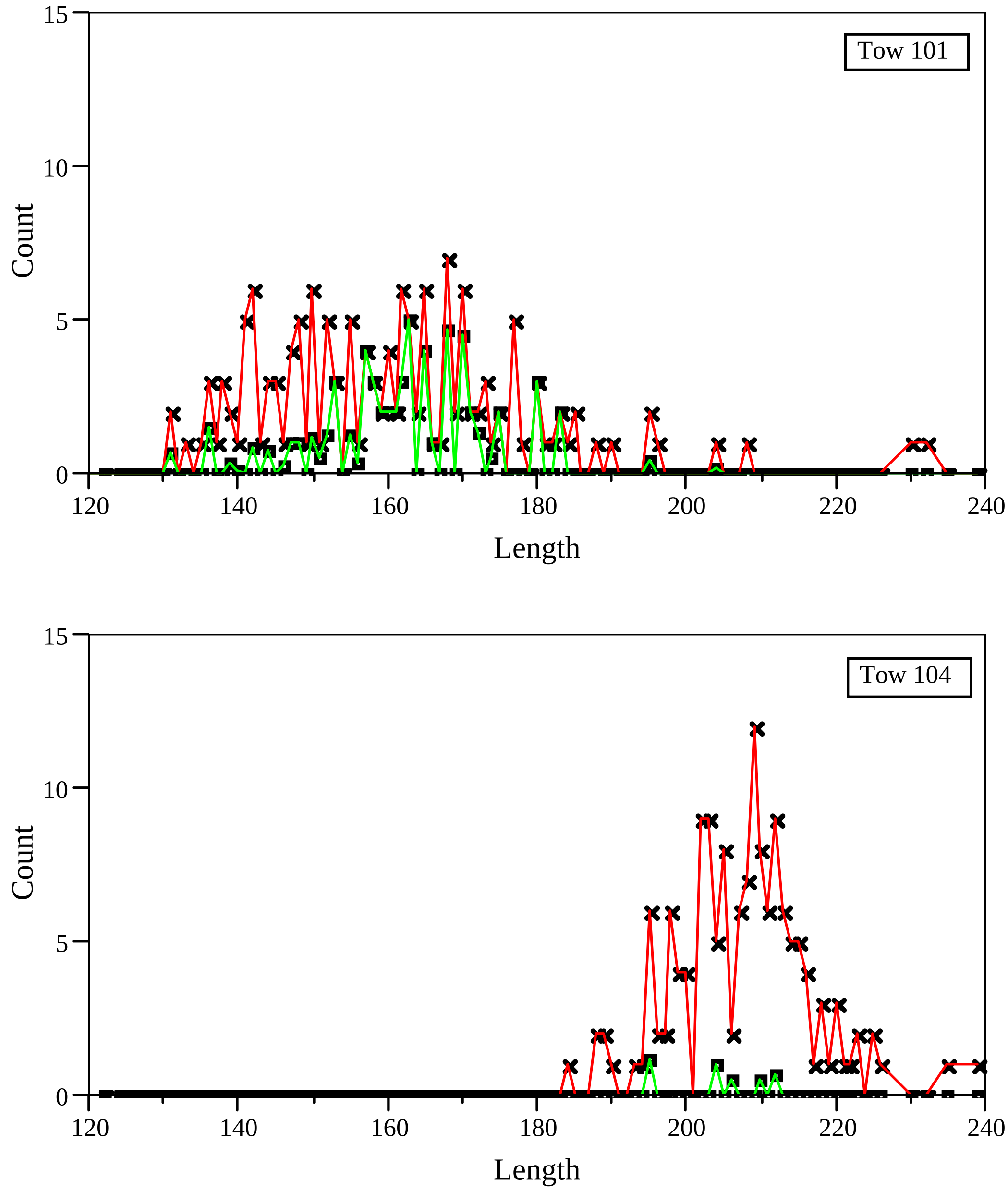
Year	Prop. Age		Regression statistics									Lower		Upper
	Trawled (Year)	Obs. (Year+1)	β	s_β	P	β'	α	s_α	p	α'	R^2	95% CL	**Estimate**	95% CL
1986	0.19	0.26												
1987	0.46	0.61												
1988	0.25	0.20												
1989	0.25	0.47												
1990	0.10	0.24	0.80	0.410	0.15	1.06	0.30	0.561	0.62	0.63	0.56			
1991	0.62	0.51	0.59	0.264	0.09	0.79	0.01	0.334	0.99	0.19	0.56			
1992	0.16	0.36	0.54	0.235	0.07	0.75	0.01	0.312	0.98	0.23	0.52			
1993	0.24	0.39	0.54	0.217	0.05	0.76	0.03	0.283	0.92	0.26	0.51			
1994	0.27	0.23	0.53	0.229	0.05	0.81	-0.06	0.293	0.86	0.23	0.44	0.17	0.38	0.65
1995	0.25	0.40	0.53	0.218	0.04	0.81	-0.03	0.274	0.91	0.26	0.42	0.14	0.34	0.63
1996	0.34	0.48	0.55	0.206	0.03	0.83	0.01	0.251	0.96	0.30	0.44	0.20	0.43	0.70
1997	0.19	0.48	0.49	0.213	0.04	0.84	0.02	0.264	0.95	0.37	0.35	0.12	0.29	0.55
1998	0.14	0.26	0.51	0.195	0.02	0.82	0.02	0.251	0.92	0.37	0.39	0.08	0.24	0.51
1999	0.42	0.41	0.49	0.180	0.02	0.79	-0.02	0.224	0.92	0.30	0.38	0.26	0.52	0.78
2000	0.38	0.44	0.49	0.169	0.01	0.78	-0.02	0.205	0.92	0.28	0.39	0.24	0.48	0.73
2001	0.61	0.51	0.46	0.144	0.01	0.71	-0.04	0.170	0.82	0.19	0.42	0.37	0.65	0.85
2002	0.17	0.48	0.40	0.154	0.02	0.72	-0.06	0.186	0.76	0.30	0.31	0.11	0.28	0.51
2003	0.09											0.11	0.20	0.57

Appendix Table 4. Retrospective recruitment forecasts for Strait of Georgia herring, 1995-2003. Numbers of fish - • 10^{-5}. All observed estimates are age-structured model output and are multiplied by $e^{-M} \bullet \lambda$ (age-independent and year-dependent survival • age-and year-dependent availability) to generate prefishery estimates. Recruitment distribution breakpoints (Poor/Average, p=0.33) and (Average/Good, p=0.67) were estimated from age 2+ time series for each of the 1995-2003 forecasts. APE – absolute percent error, $((observed - forecasted) \bullet observed^{-1}) \bullet 100$.

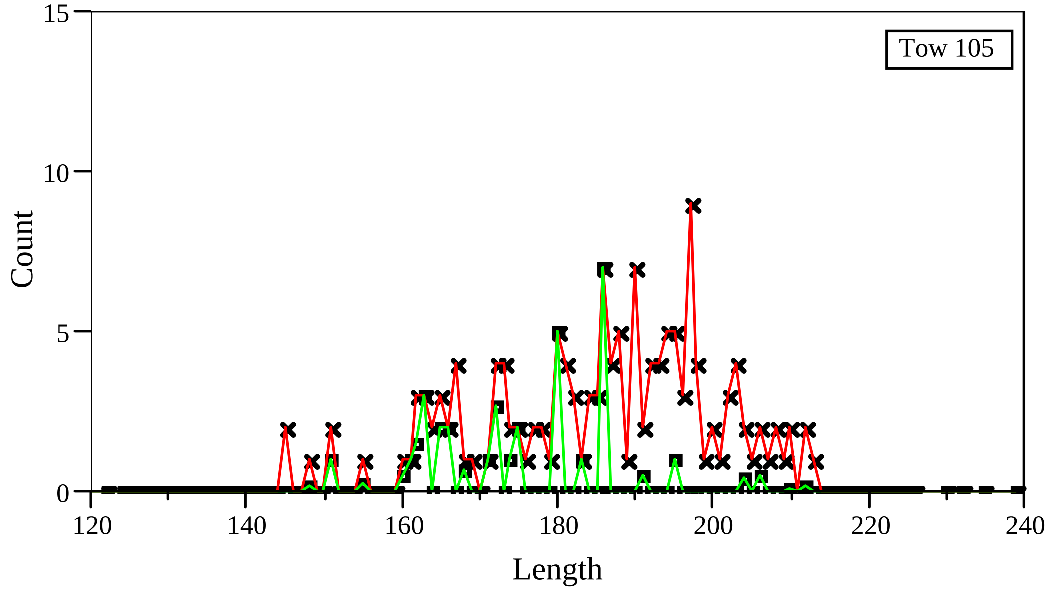
	Proportion age 3		Forecast		Observed		Proportion age 3		No. age 4++			
Season	Forecast	Observed	Number	Category	Number	Category	Residual	APE	Observed	Forecast	Residual	APE
1995	0.38	0.23	2827	Average	1699	Average	-0.15	65	4864	4613	251	5
1996	0.34	0.40	1910	Average	4442	Good	0.06	15	3354	3708	-354	11
1997	0.43	0.48	3602	Good	5343	Good	0.05	10	3981	4775	-794	20
1998	0.29	0.48	2329	Average	4156	Good	0.19	40	4267	5703	-1436	34
1999	0.24	0.26	1567	Average	2305	Average	0.02	8	6051	4961	1090	18
2000	0.52	0.41	5139	Good	3388	Good	-0.11	27	4227	4743	-516	12
2001	0.48	0.44	3854	Good	5053	Good	-0.04	9	5572	4176	1396	25
2002	0.65	0.51	11634	Good	8046	Good	-0.14	27	6410	6264	146	2
2003	0.28	0.48	3499	Good	10788	Good	0.20	42	10203	8997	1206	12
Mean							0.01	0.27			110	0.15

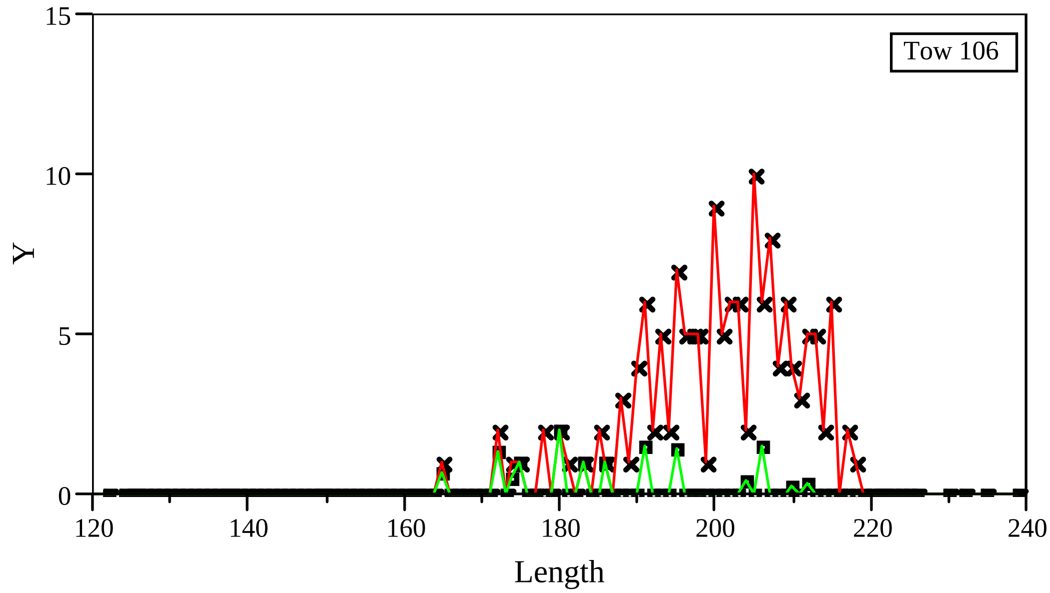


Appendix Fig. 1. Laperouse study area. Outlined letters show herring (H) and hake (K) concentrations for August 9 –11, 2003 herring survey.

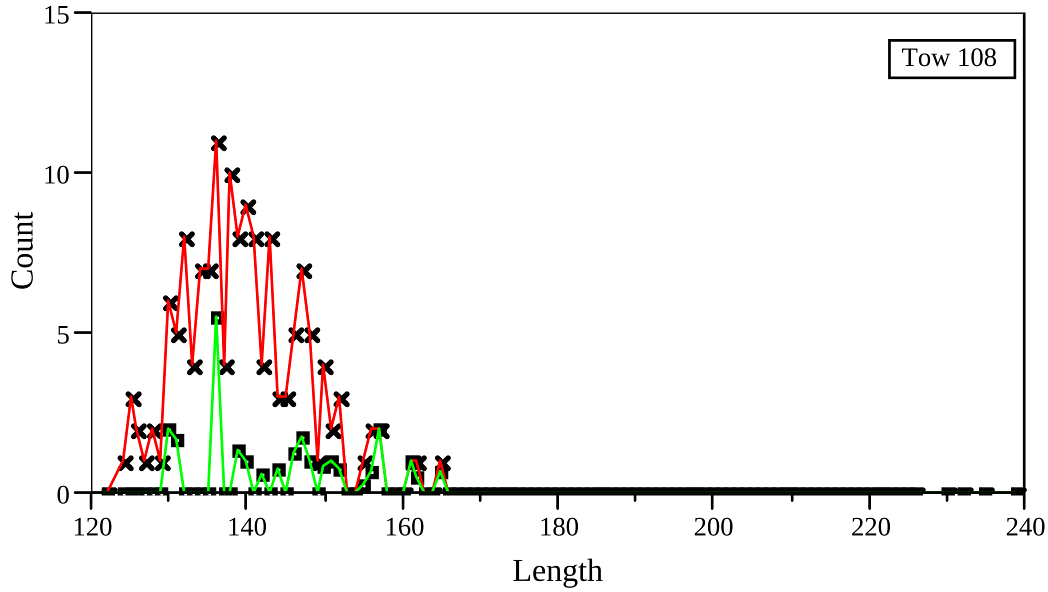


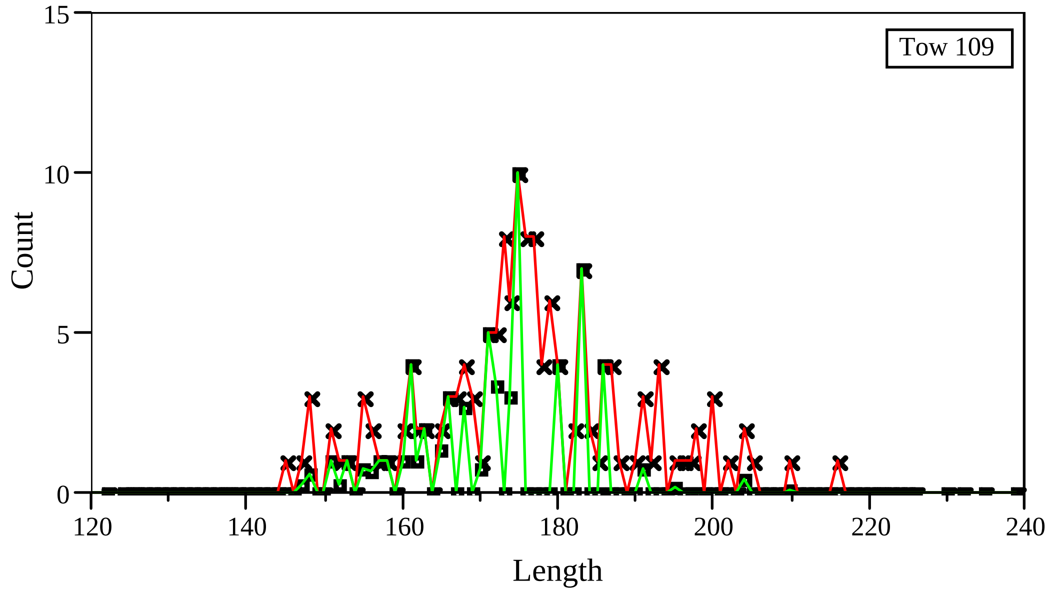
Appendix Fig. 2. Length-frequency histograms for herring trawled during the 2003 offshore herring survey. Squares indicate fish presumed to be age 2+.



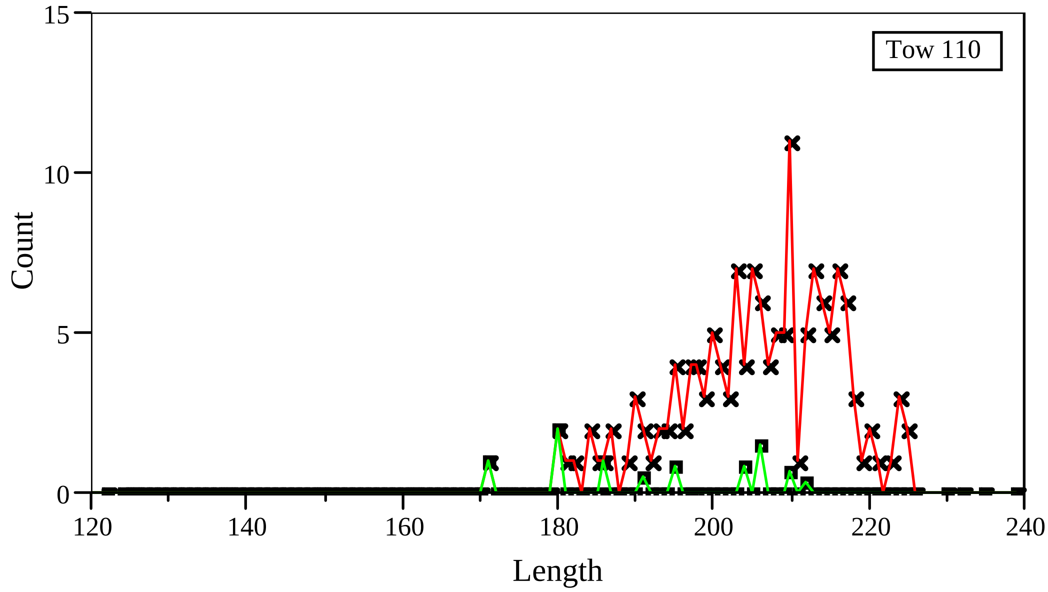


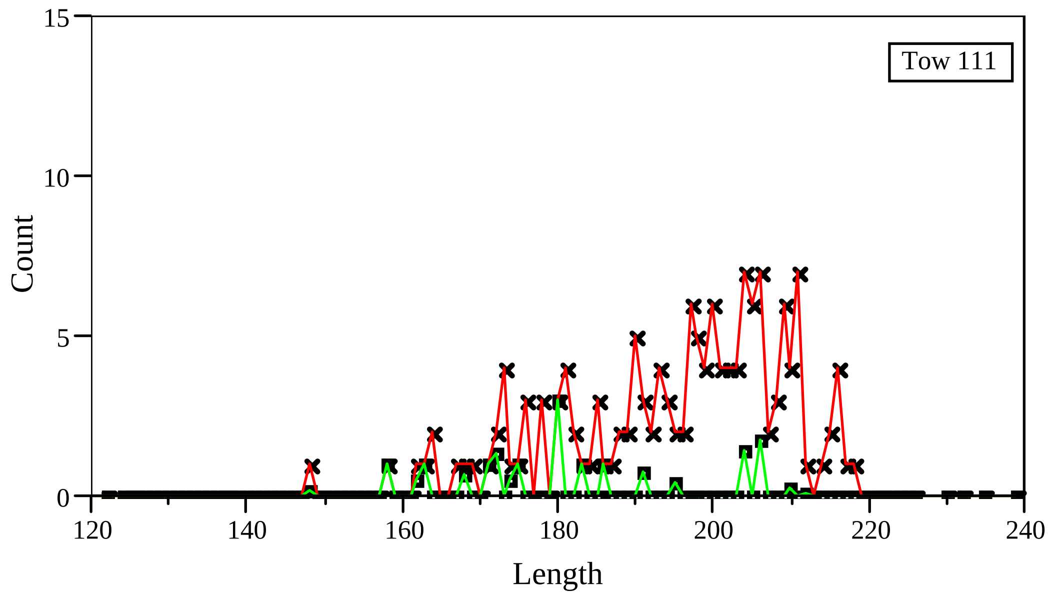
Appendix Fig. 2 cont.



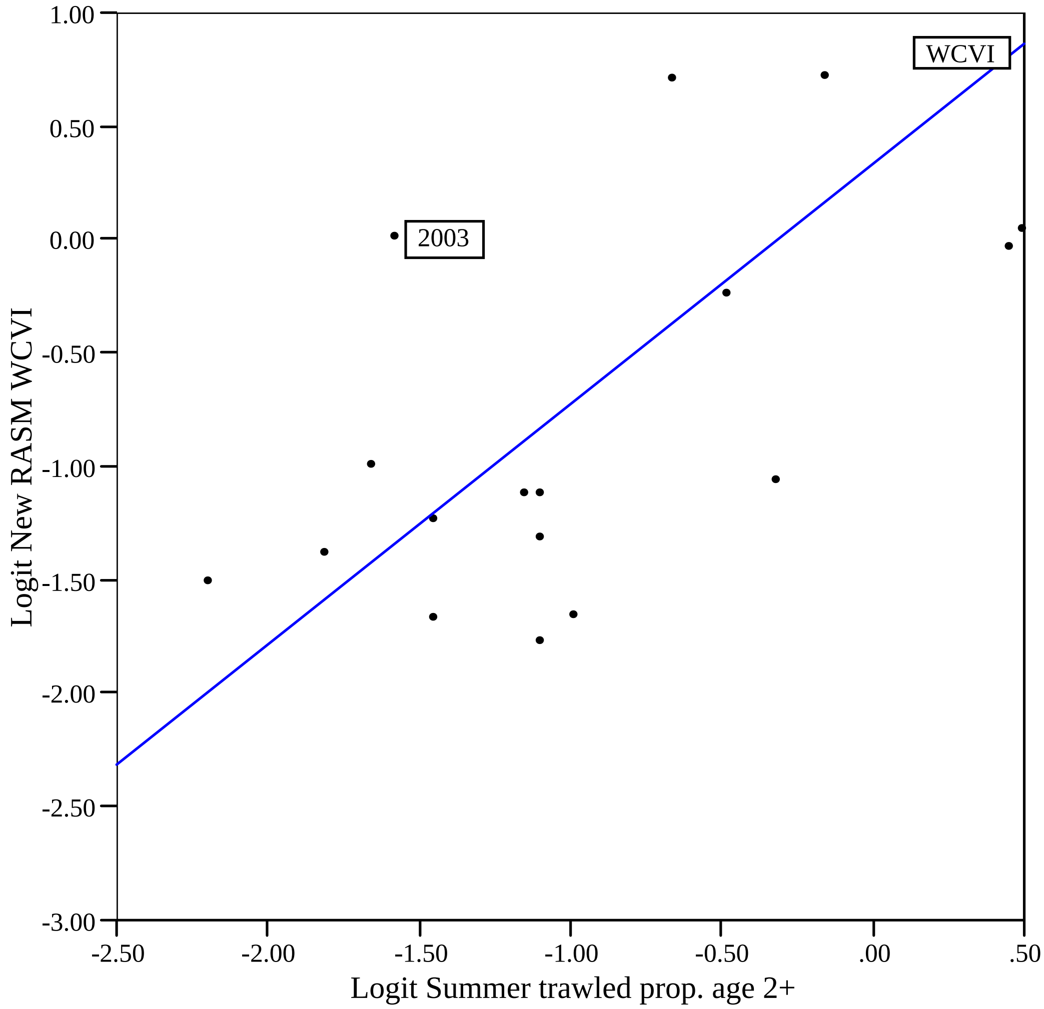


Appendix Fig. 2 cont.

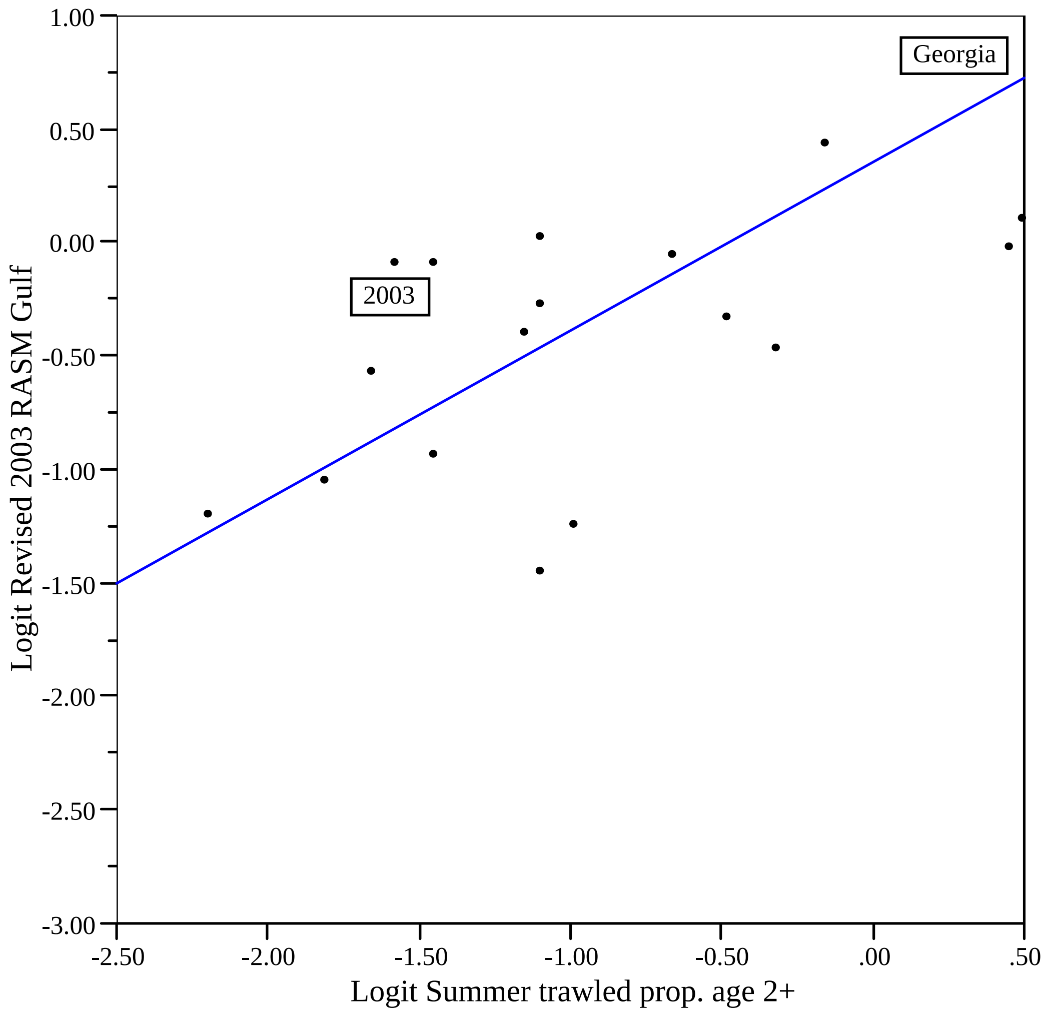




Appendix Fig. 2 cont.



Appendix Fig. 3. Scatterplot of logit observed proportion age 3 against logit trawled proportion age 2+ for WCVI herring. Line is GMR regression used to forecast recruitment for 2003 where y'=1.09•x'+0.32, p=0.01, adjusted R^2=0.32. 2003 – trawled and observed data pair for 2003 fishing season.



Appendix Fig. 4. Scatterplot of logit observed proportion age 3 against logit trawled proportion age 2+ for Strait of Georgia herring. Line is GMR regression used to forecast recruitment for 2003 where y'=0.72•x+0.30, p=0.02, adjusted R^2=0.27. 2003 – trawled and observed data pair for 2003 fishing season.