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Stock Assessment and Management Advice for the British Columbia Herring Stocks: 2010 Assessment and 2011 Forecasts

Évaluation du stock et avis sur la gestion des stocks de harengs de la Colombie-Britannique : évaluation 2010 et prévisions 2011

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ABSTRACT

Herring stock abundance in British Columbia (B.C.) waters are assessed for 2010 and forecasts were made for 2011 using the herring catch-age model (HCAMv2), developed for the 2008 assessment (and revised in 2009). B.C. herring stocks are managed as five major and two minor stock areas. Accordingly, catch and survey information is collected independently for each of these seven areas and science advice is provided on the same scale. All available biological data on spawn deposition and age and size composition of the spawning stocks, as well as commercial harvest data, were used to determine current abundance levels. Herring abundance has remained relatively stable over the past few years, with no substantial changes in 2010. The total estimated pre-fishery biomass for the major assessment regions for 2010 is 84,656 metric tonnes (t), broken down as follows: Haida Gwaii (QCI 2E) – 6,046 t, Prince Rupert District (PRD) – 19,039 t, Central Coast (CC) – 7,974 t, Strait of Georgia (SOG) – 48,262 t, and west coast of Vancouver Island (WCVI) – 3,335 t . Pre-fishery biomass estimates for 2009 and 2008 are 103,470 t and 95,076 t, respectively. Recruitment of the 2007 year class in 2010 was poor for HG, CC, SOG and WCVI, while recruitment in PRD was average. Pre-fishery biomass for the minor stock areas for 2010 and recruitment of the 2007 year class in 2010 were estimated as 7,593 t with good recruitment for Area 2W and 998 t with poor recruitment for Area 27.

Stock projections for 2011 indicate reduced abundance and poor recruitment in three major stock areas. Implementation of the herring harvest control rule (HCR) advises the following stocks will not support a commercial harvest: HG, WCVI, and CC. Spawning stock biomass for two of the five major stock areas is forecast to be above the biomass cutoff level for 2011. Based on a 20% harvest rate and application of the recruitment forecasting rules, the estimated maximum available harvest of B.C. herring for 2011 is 3,834 t for the PRD stock (assuming average recruitment) and 13,777 t for the SOG (assuming good recruitment). The HCR for the minor stock areas assumes average recruitment, in developing the stock biomass forecast, and recommends a 10% harvest rate. Following application of these rules, the recommended maximum available harvest for the minor stocks in 2011 is: 253 t in Area 2W (based on the 2010 spawn index) and 94 t in Area 27.

RÉSUMÉ

On a procédé à l'évaluation de l'abondance des stocks de harengs dans les eaux de la Colombie-Britannique (C.-B.) en 2010 et à l'établissement des prévisions pour 2011 à l'aide du modèle de captures à l'âge de harengs (MCAHv2) mis au point pour l'évaluation de 2008 (et révisé en 2009). Les stocks de harengs de la C.-B. sont gérés selon cinq principales zones d'évaluation des stocks et deux zones secondaires. Par conséquent, les données sur les prises et provenant de relevés sont recueillies de façon indépendante pour chacune de ces sept zones et l'avis scientifique est donné selon la même échelle. Toutes les données biologiques disponibles sur la ponte et sur la composition selon l'âge et la taille des stocks reproducteurs, ainsi que les données sur les prises commerciales, ont été utilisées afin de déterminer les niveaux d'abondance actuels. L'abondance du hareng est demeurée relativement stable au cours des dernières années, sans changements importants en 2010. La biomasse totale estimée avant la pêche pour les principales zones d'évaluation pour 2010 est de 84 656 tonnes métriques (t), répartie comme suit : Haida Gwaii (HG 2E) – 6 046 t, district de Prince Rupert (DPR) 19 039 t, côte centrale (CC) – 7 974 t, détroit de Georgia (DG) 48 262 t et côte ouest de l'île de Vancouver (COIV) – 3 335 t. Les estimations de biomasse avant la pêche pour 2009 et 2008 sont de 103 470 t et de 95 076 t, respectivement. Le recrutement de la classe d'âge de 2007 a été médiocre en 2010 pour les zones HG, CC, DG et COIV, tandis que le recrutement pour la zone DPR a été moyen. La biomasse avant la pêche pour les stocks des zones secondaires pour 2010 et le recrutement de la classe d'âge de 2007 en 2010 ont été estimés comme étant de 7 593 t avec un bon recrutement pour la zone 2W et de 998 t avec un recrutement médiocre pour la zone 27.

Les projections relatives aux stocks pour 2011 indiquent une abondance réduite et un recrutement médiocre pour trois des zones principales de stocks. La mise en œuvre de la règle de limitation de l'exploitation (RLE) pour le hareng établit que les stocks suivants ne supporteront pas la pêche commerciale : HG, COIV et CC. La biomasse des stocks reproducteurs pour deux des cinq zones principales devrait se situer au-dessus du niveau limite de la biomasse pour 2011. En supposant un taux de captures de 20 p. 100 et l'application des règles de prévision du recrutement, l'estimation du maximum disponible pour les captures de harengs de la C.-B. pour 2011 est de 3 834 t pour les stocks du DPR (en supposant un recrutement moyen) et de 13 777 t pour le DG (en supposant un bon recrutement). La RLE pour les zones secondaires de stocks repose sur un recrutement moyen, par l'élaboration de prévisions pour la biomasse des stocks, et recommande un taux de captures de 10 p. 100. Suivant l'application de ces règles, le maximum de captures disponible recommandé pour les stocks secondaires en 2011 est de 253 t dans la zone 2W (en fonction de l'indice du frai de 2010) et de 94 t dans la zone 27.

EXECUTIVE SUMMARY

B.C. herring stocks are managed as five major and two minor stock areas. Accordingly, catch and survey information is collected independently for each of these seven areas and science advice is provided on the same scale. The 2010 stock assessment for the B.C. herring fishery was carried out using a version of a herring catch-age model (HCAMv2), developed and approved for the 2008 assessment (Schweigert and Haist, 2008). The approach involves fitting this catch-age model to the time series of commercial catch data, spawn index and proportions-at-age data within a Bayesian estimation framework. Model outputs for the time series include estimates of recruitment (3 year old fish), numbers at age, spawning stock biomass and pre-fishery forecasts of biomass, as well as estimates of natural mortality, fishing mortality and fishery selectivity by gear type. Biomass estimates represent median estimates from the marginal posterior distributions. Catch advice, presented in the form of decision tables, is based on application of the herring harvest control rule (HCR) to model forecasts of repeat spawners and posterior distributions of recruitment under assumptions of poor, average and good recruitment. For the Strait of Georgia and West Coast Vancouver Island stocks, recruitment forecasts are based on results from the summer off-shore trawl survey. For the Queen Charlotte Islands, Prince Rupert District and Central Coast stocks, recruitment forecast rules are applied based on recent stock trends. For the two minor stocks, the recruitment forecast rule is to assume an average recruitment.

MAJOR STOCK AREAS:

Comparisons of 2009 and 2010 **model estimates** of spawning stock biomass are presented below.

Haida Gwaii (QCI 2E)

The estimated spawning biomass for 2010 is approximately 6,000 t, a reduction in biomass from the 2009 model estimate (~7,000 t, Cleary et al. 2009). Model estimates of recruitment for this stock have alternated between poor and average over the last 10-years, with 2010 estimated as poor. For the Haida Gwaii stock, the recruitment forecast rule denotes poor recruitment, thus the forecast biomass for 2011 is ~4,100 t. This stock continues to remain below cutoff (10,700 t). Following the herring harvest control rule, the science recommendation is for no commercial harvest in this area.

Prince Rupert District

The estimated spawning biomass for 2010 is approximately 19,000 t, an increase in biomass from the 2009 model estimate (15,000 t, Cleary et al. 2009). Model estimates of recruitment for this stock have alternated between poor and average over the last 10-years, with the occasional good year. Recruitment for 2010 was estimated to be average. For the Prince Rupert District stock, the recruitment forecast rule denotes average recruitment, thus the forecast biomass for 2011 is ~19,000 t. This stock is above cutoff (12,100). Following the herring harvest control rule, the maximum available harvest, based on a 20% harvest rate, is ~3,800 t.

Central Coast

The estimated spawning biomass for 2010 is approximately 8,000 tonnes, a decline in biomass from the 2009 model estimate (~10,000 t, Cleary et al. 2009). Model estimates of recruitment for this stock have alternated between poor and average over the last 10-years, with one good recruitment year in 2003. Recruitment for 2010 was estimated to be poor. For the Central Coast stock, the recruitment forecast rule denotes poor recruitment, thus forecast

biomass for 2011 is ~6,400 t. This stock is below cutoff (17,600 t). Following the herring harvest control rule, the science recommendation is for no commercial harvest in this area.

Strait of Georgia

The estimated spawning biomass for 2010 is approximately 48,000 tonnes, representing no change from the 2009 model estimate (Cleary et al. 2009). Model estimates of recruitment to this stock have alternated between average and good over the last 10-years, with poor recruitment in 2008 and 2010. Results from the summer off-shore trawl survey predict recruitment for 2011 will be good, thus the forecast biomass for 2011 is ~69,000 t. This stock is above cutoff (21,200 t). Following the herring harvest control rule, the maximum available harvest, based on a 20% harvest rate, is ~13,700 tonnes.

West Coast Vancouver Island

The estimated spawning biomass for 2010 is approximately 3,300 t, a decline in biomass from the 2009 model estimate (~5,000 t, Cleary et al. 2009). Model estimates of recruitment for this stock have been poor for the majority of the past 10-years. Recruitment in 2010 was poor. Results from the summer off-shore trawl survey predict recruitment for 2011 will be average. This stock is below cutoff (18,800 t). Following the herring harvest control rule, the science recommendation is for no commercial harvest in this area.

MINOR STOCK AREAS:

Area 2W

The estimated spawning biomass for 2010 is approximately 7,600 t, an increase in biomass from the 2009 model estimate (~5,700 t, Cleary et al. 2009). Recruitment in 2009 and 2010 was good. The recruitment forecast rule denotes average recruitment, however biomass forecasts for 2011 were unavailable this year. The maximum available harvest, based on a 10% harvest rate of the 2010 spawn index, is ~250 t.

Area 27

The estimated spawning biomass for 2010 is approximately 1,000 t, down slightly from the 2009 model estimate (~1,600 t, Cleary et al. 2009). Model estimates of recruitment to this stock were poor in 2008, good in 2009 and poor in 2010. The recruitment forecast rule denotes average recruitment, thus the forecast biomass for 2011 is ~900 tonnes. The maximum available harvest, based on a 10% harvest rate, is ~90 tonnes.

1. INTRODUCTION

The objectives of this paper are two-fold: (1) to present the 2010 stock assessment and forecasts for 2011 and (2) to provide a detailed description of the current assessment model and decision rules, bringing together model descriptions and equations previously reported in Haist and Schweigert (2006), Schweigert and Haist (2007), Schweigert et al. (2009), Christensen et al. (2009) and Cleary et al. (2009).

B.C. herring are currently managed as five major and two minor stock areas. Accordingly, catch and survey information is collected independently for each of these seven areas and science advice is provided on the same scale. Since the early 1980's, a statistical catch-age model has been used to provide stock assessment advice for the major stock areas (Haist and Stocker 1984). In 2006 the catch-age model was termed the herring catch age model (HCAM, Haist and Schweigert 2006), used for the 2006 and 2007 stock assessments. A modified version, HCAMv2, was used in the 2008 and the current year's assessments (modifications to HCAM are documented in Christensen et al. 2009). During the 2008 assessment, Schweigert et al. (2009) determined that the time series of survey data for the minor stock areas was sufficiently long enough to implement a catch-age assessment, rather than using the escapement model from past years (Schweigert 2001). Thus, the HCAMv2 model is now implemented for all seven stock areas. However, it should be noted that decision rules for determining the CSAP Science recommended catch differ between major and minor stock areas (see Section 0).

2. B.C. HERRING STOCKS

The geographic boundaries used to delineate the B.C. herring stock assessment regions have remained consistent since 1993. Boundaries and locations of the major stock and minor stock areas are identified in Figure 1. The Haida Gwaii (HG) or Queen Charlotte Islands (QCI) 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 (PRD) stock assessment region encompasses Statistical Areas 03 to 05. The Central Coast (CC) assessment region separates the major migratory stocks from the minor spawning populations in the mainland inlets. The Central Coast assessment region includes Statistical Area 07 plus Kitasu Bay in Area 06, Kwakshua Channel in Section 085 and Fitz Hugh Sound in Section 086. The Strait of Georgia (SOG) stock assessment region includes all of Statistical Areas 14 to 19, 28, and 29 (excluding Section 293), Deepwater Bay and Okisollo Channel, both in Section 132, and Section 135. The west coast of Vancouver Island (WCVI) assessment region encompasses Statistical Areas 23 to 25. The minor stocks include all of Area 27 and Area 2W (excluding Louscoone Inlet in Section 006). Current geographic stock boundaries are outlined in Midgley (2003), although note that SOG sections 280 and 291 do not appear as they were added in 2006.

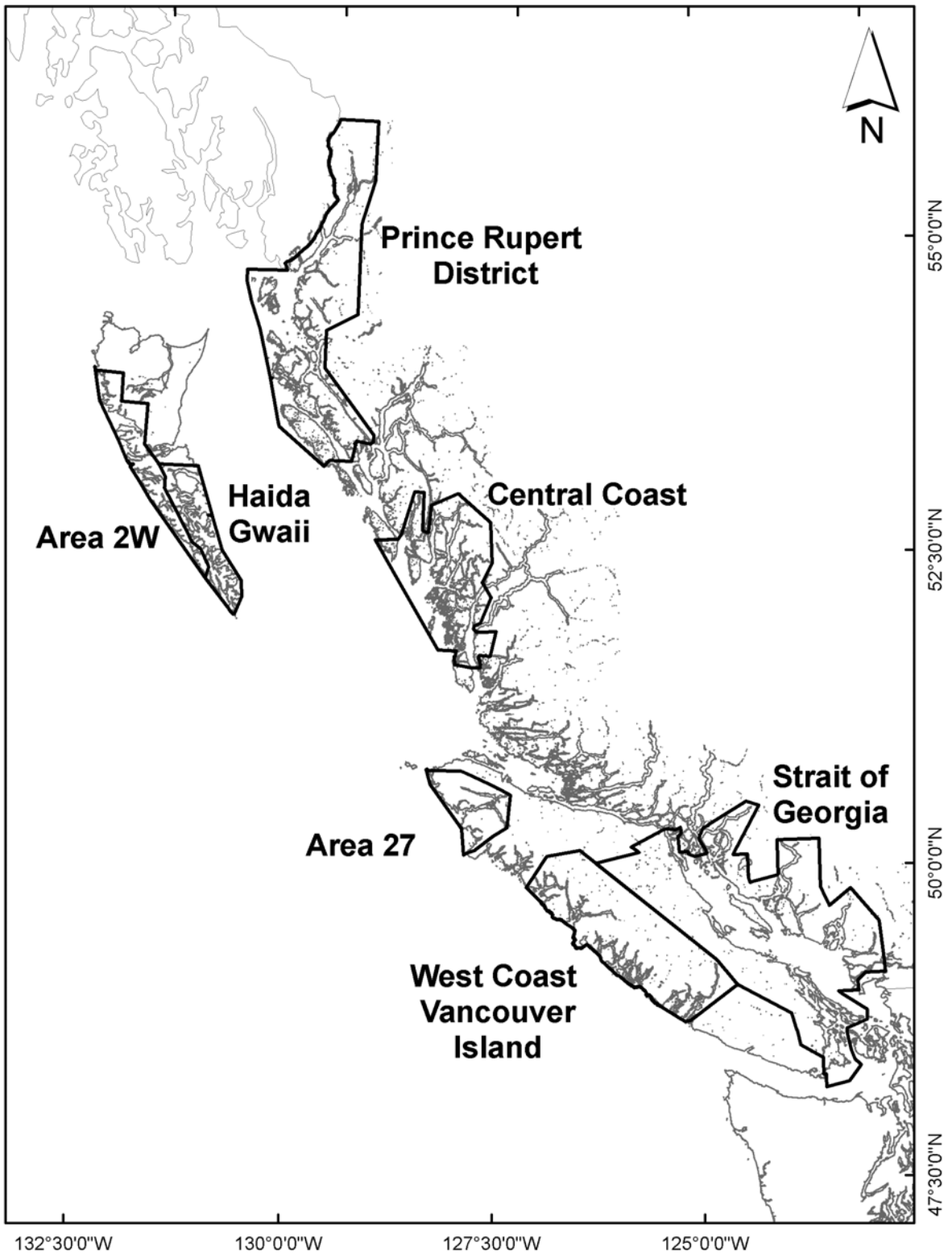


Figure 1. B.C. herring major stock areas: Haida Gwaii (HG or QCI 2E), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SOG), West Coast Vancouver Island (WCVI), and minor stock areas: Area 2W and Area 27.

3. DATA

The herring assessment model is driven by three sources of data: commercial catch landings, a spawn survey index and age composition data. Each of these times series of data represent the collective efforts of the herring industry, First Nations and DFO Science and FAM. For the purposes of stock assessment, we include fishery and survey data from 1951 onwards. These time series are stored in a MS Access database, referred to as the HSA or herring stock assessment fisheries database. Catch and biological information is also collected from the "minor" herring fisheries (food & bait, special use, spawn-on-kelp) and a database is currently being developed to incorporate these data.

COMMERCIAL CATCH DATA

Catch information is 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 the 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 which remained open fisheries. Beginning in the 1998/99 season, verified plant offload weights are available for all food and roe fisheries coast-wide.

The history of commercial herring catches for the major assessment areas are presented in Figure 2. Following from application of the herring harvest control rule (HCR, section 0) beginning in 1986, the major stock areas were closed to commercial fishing in the following years: HG: 1987, 1995-1997, 2001 and 2003-2010, CC: 2008-2010, SOG: 1986, and WCVI: 1986, 2001 and 2006-2010. Commercial landings from the spawn-on-kelp (SOK) fishery are not included in the model as catch because there is no basis for verifying mortality imposed on the population. Instead, beginning with the 2006 assessment, the validated landed weight of SOK product is used to estimate the egg removal from the spawning grounds and these data are converted to ones of fish equivalents based on data provided in Shields et al. (1985). These estimates are then added to the estimated spawning biomass for each area over the course of the SOK fishery from 1975 to present. Landings from the minor herring fisheries (food & bait, special use) are based on landing slip data or more recently logbook information.

The time series of commercial catch data is divided into three periods: fishing period 1 or the winter period, which primarily represents the reduction fishery (1951-1968) and more recently fall food fisheries, fishing period 2, representing the roe seine fishery (1972-present), and fishing period 3 which represents the roe gillnet fishery (1972-present). The history of catches by fishing period is presented in Figure 3.

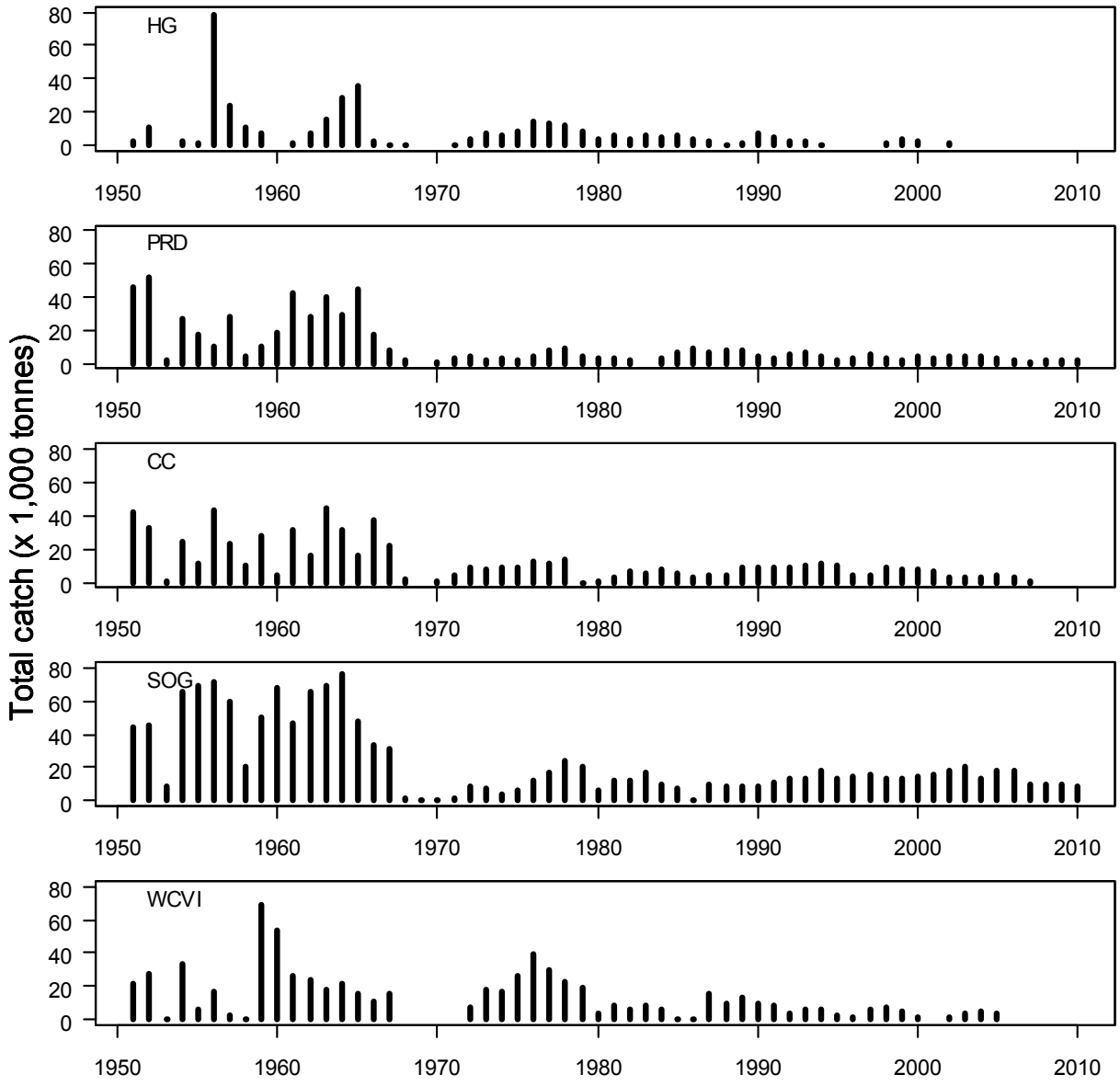


Figure 2. Estimated total catch from all fisheries except spawn-on-kelp for each major stock area from 1951-2010. Haida Gwaii (HG or QCI 2E), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SOG), and West Coast Vancouver Island (WCVI).

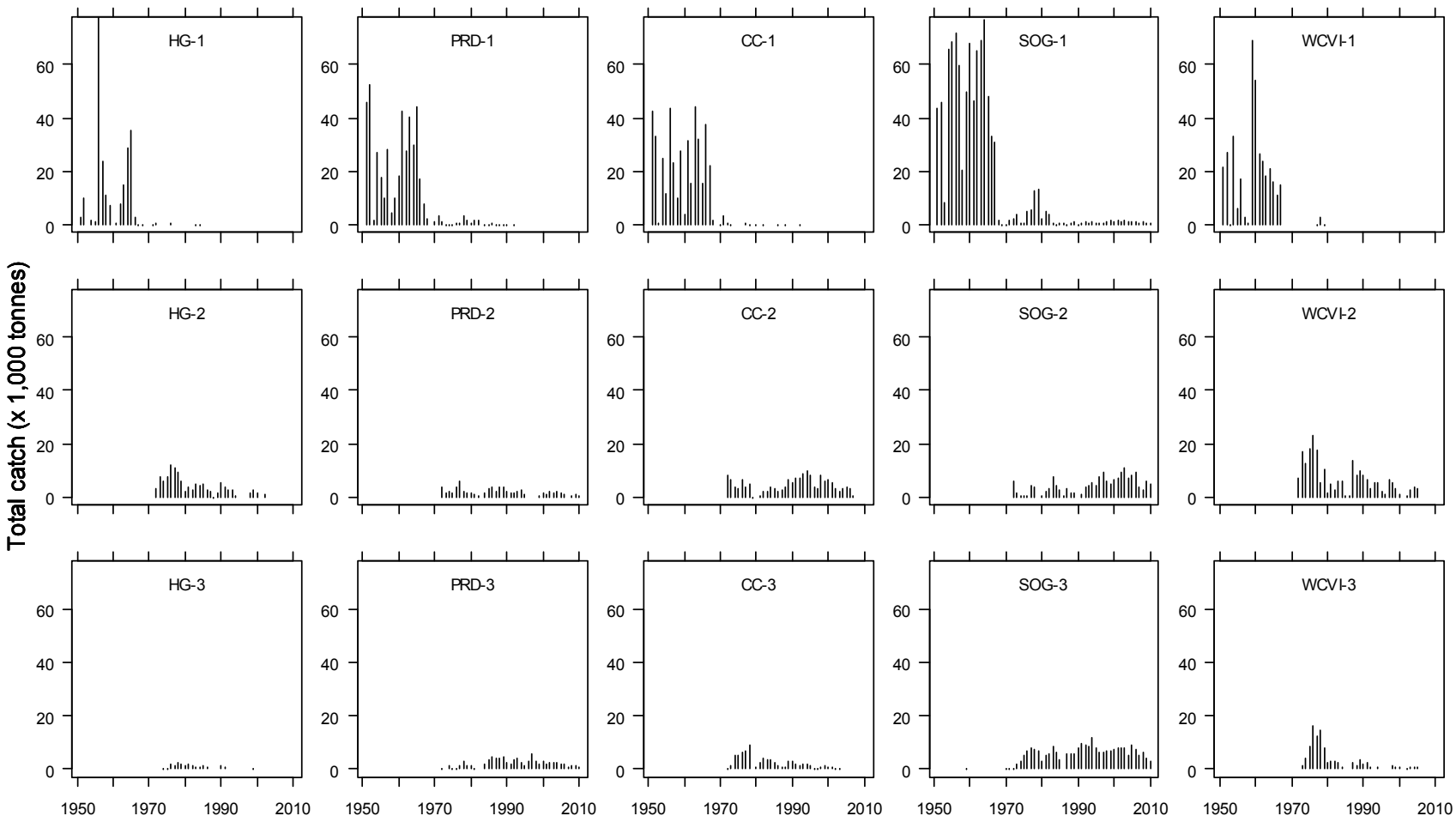
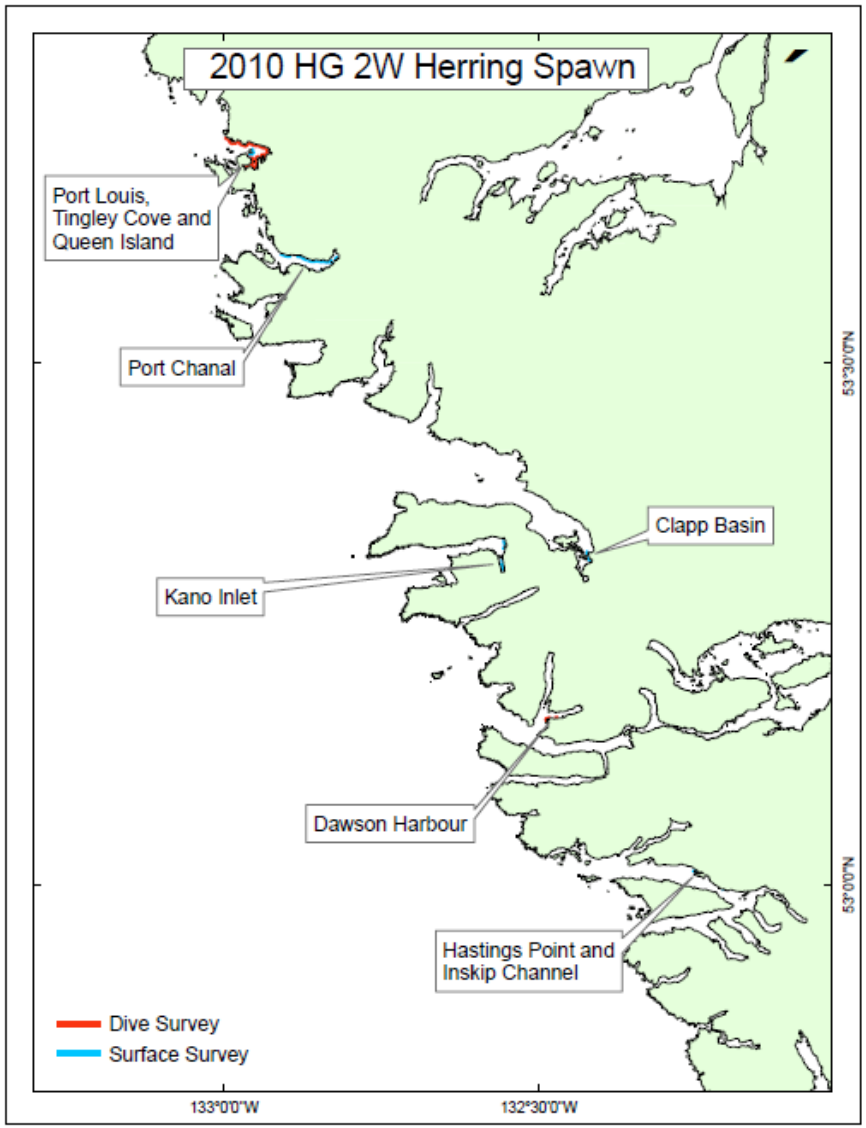


Figure 3. Estimated total catch by fishing period for each major stock area from 1951-2010 (excludes spawn-on-kelp fishery). Upper row- Fishing period 1 – primarily seine and reduction fisheries, except recent years in SOG which represent food and bait/ special use fisheries; Middle row- Fishing period 2 (seine roe fishery); Bottom row- Fishing period 3 (gillnet roe fishery). Haida Gwaii (HG or QCI 2E), Prince Rupert District (PRD), Central Coast (CC), Strait of Georgia (SOG), and West Coast Vancouver Island (WCVI).

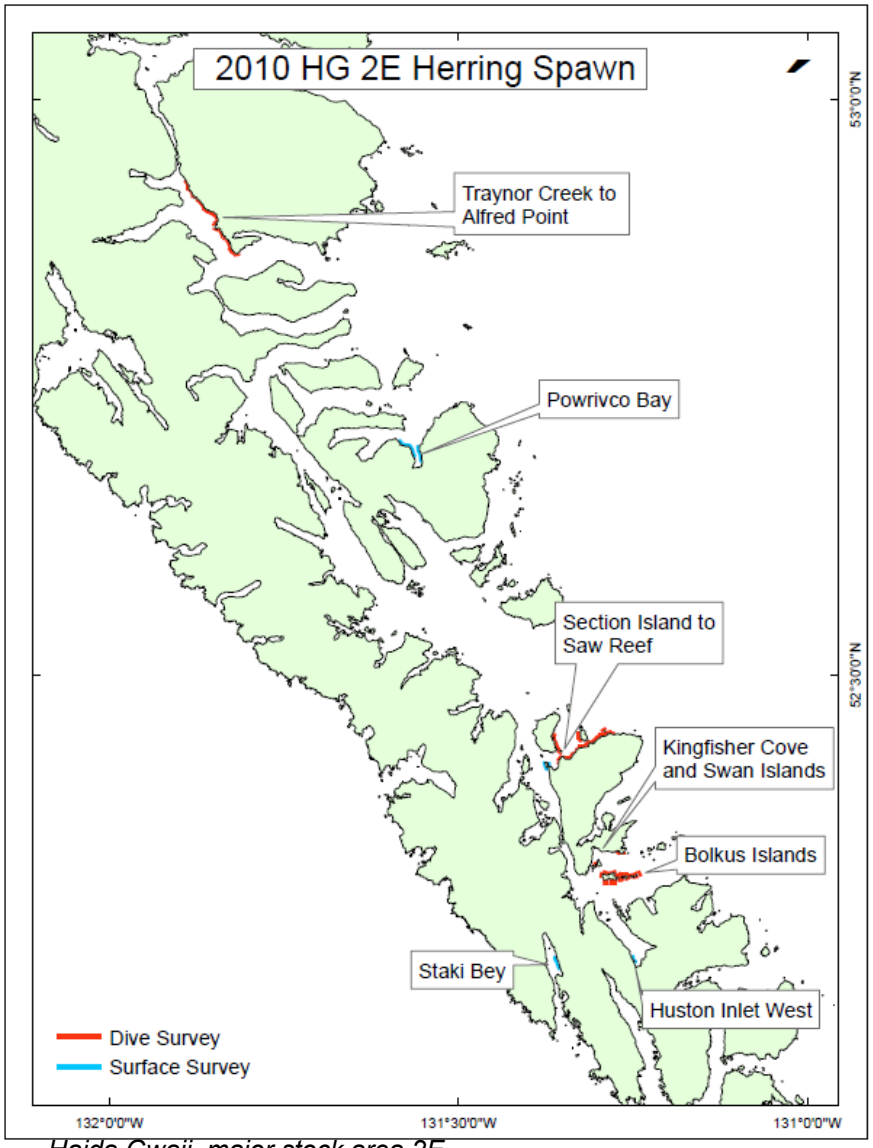
3.2 SPAWN DATA (SURVEY INDEX)

Herring spawn surveys have been conducted throughout the B.C. coast beginning in the 1930s. In years prior to 1988, spawn surveys were conducted from the surface either by walking the beach at low tide or using a drag from a skiff to estimate the shoreline length and width of spawn. Egg layers were sampled visually and are used to calculate egg densities following the methods of Schweigert (2001). Beginning in 1988, herring spawn surveys using SCUBA methods were introduced and became coastwide within a couple of years initially being conducted by DFO staff but eventually through contract divers hired through the test fishing program. Prior to the Larocque ruling, the test fishing program was funded through an allocation of fish by industry. In years since the 2006 Larocque ruling, the availability of resources to conduct dive surveys in all areas has been reduced. For the 2010 survey, dive surveys were conducted in all major and minor assessment regions, with the exception of Area 2W where snorkeling and surface survey methods were also used. As in earlier years, a few minor spawning beds outside the main assessment areas were surveyed by SCUBA or surface methods where resources permitted.

Figure 4 shows locations of spawning beds in 2010 for the major and minor stock areas. Table 1 summarizes spawning information (spawn length, spawn width and egg density) from 2008-2010. Egg density estimates are used to calculate a fishery independent estimate of herring spawners (in units of fish biomass), referred to as the spawn survey index (Schweigert 2001). The time series of survey index, from 1951-2010, for each of the major stock areas is shown in Figure 5.

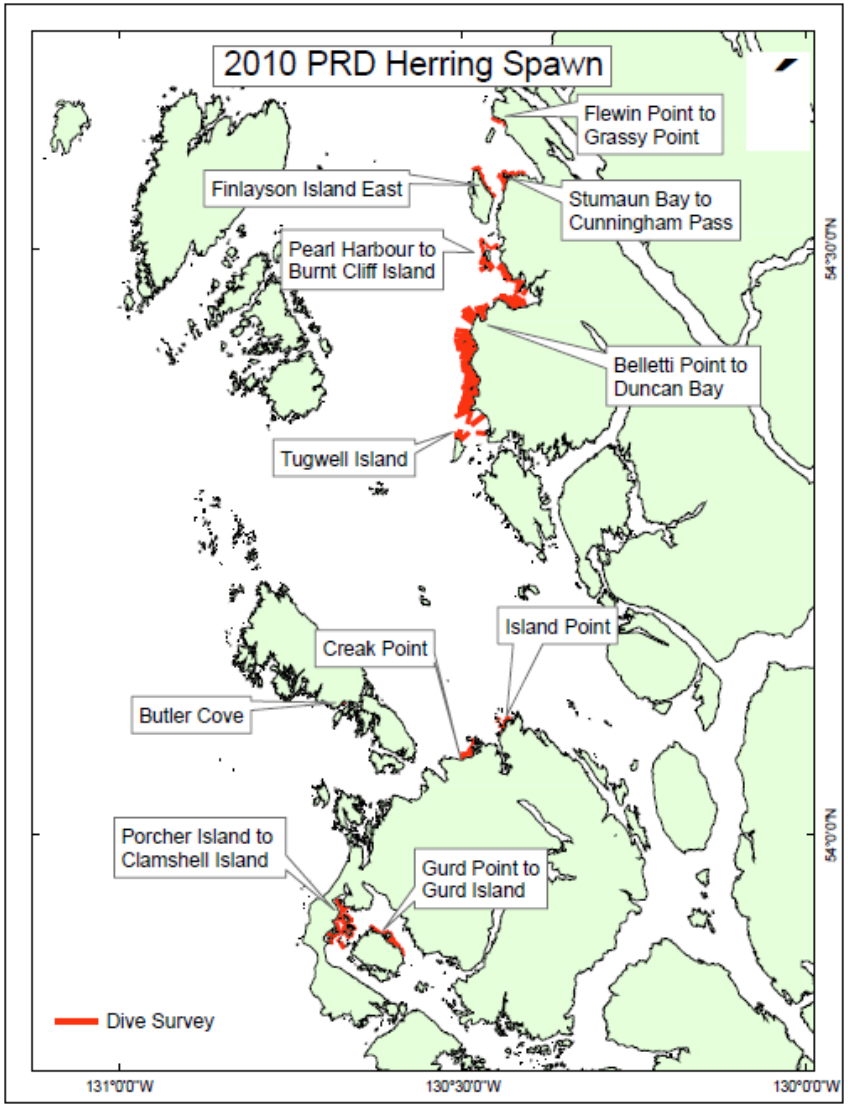


Haida Gwaii, minor stock area 2W

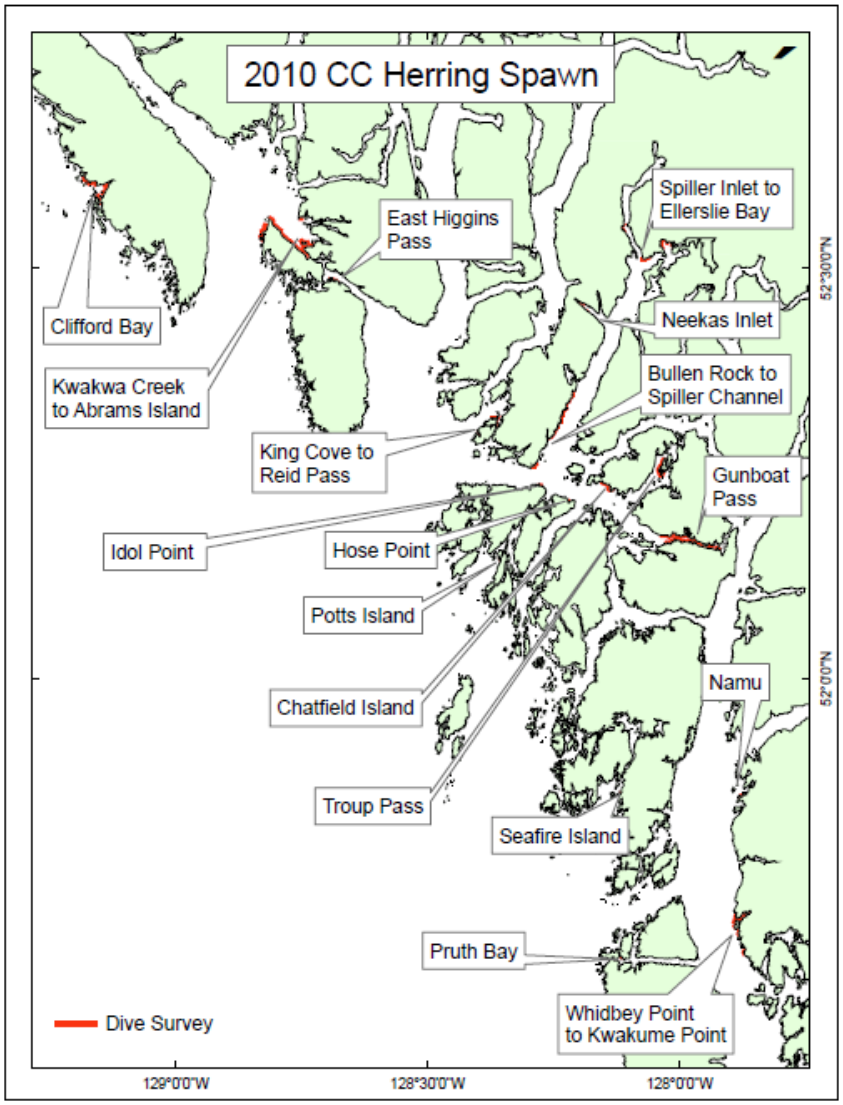


Haida Gwaii, major stock area 2E

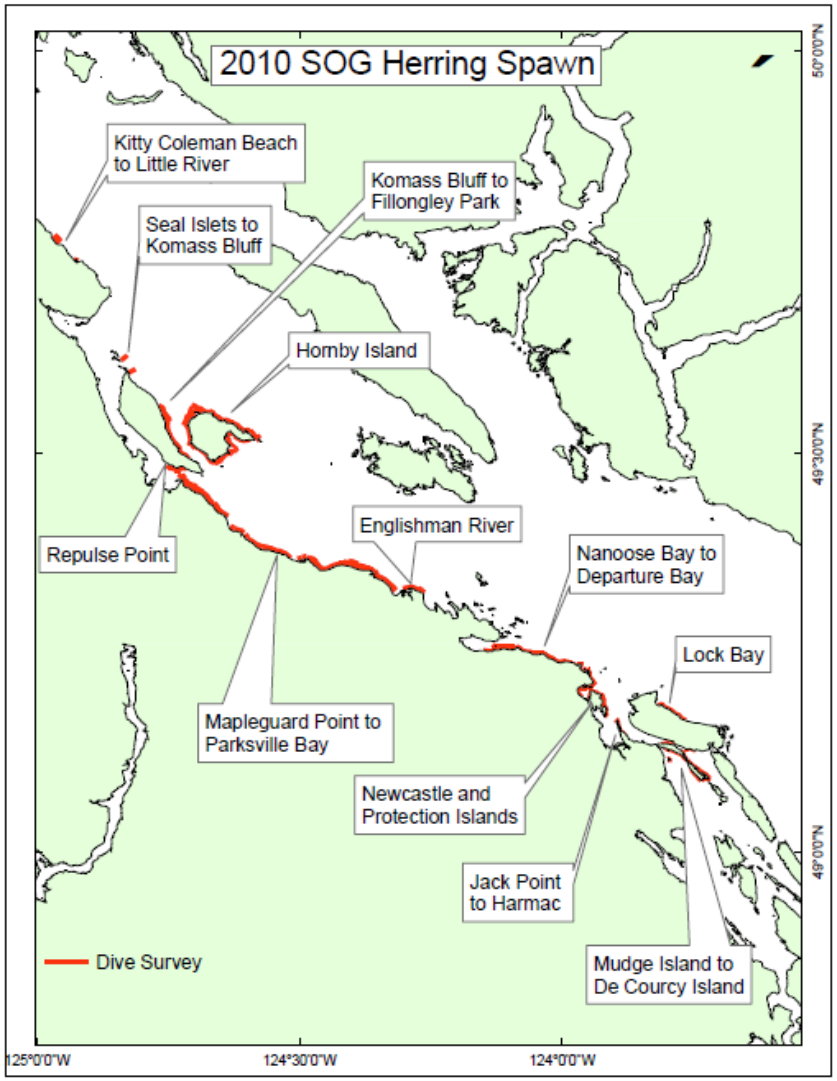
Figure 4. Herring spawning bed locations for the 2010 survey year. Red lines denote locations surveyed by SCUBA; blue lines denote surface methods.



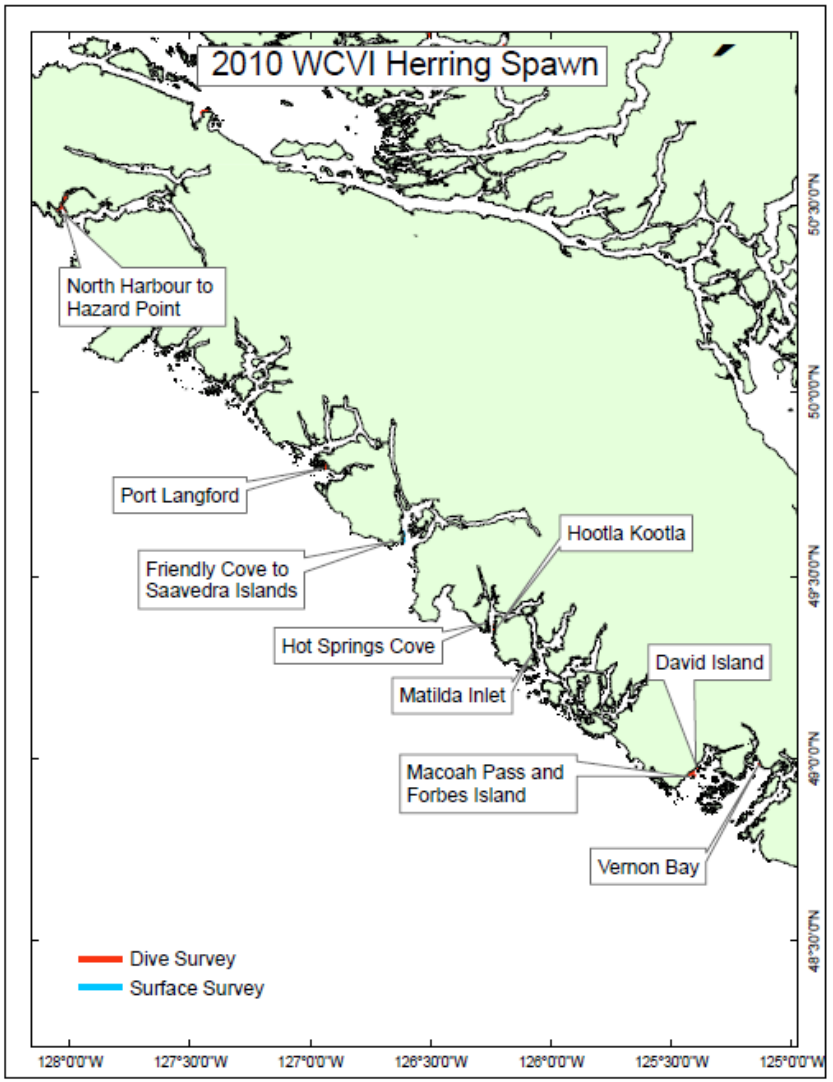
Prince Rupert District (PRD), major stock area



Central Coast (CC), major stock area



Strait of Georgia (SOG), major stock area includes Area 27



West Coast of Vancouver Island (WCVI), major stock area

Table 1. Summary of spawning information: spawn length, spawn width and average number of egg layers from recent years. Bold values represent 2010 data.

	Total spawn length (m)		Average spawn width (m)		Average # egg layers	
Stock	Dive	Surface	Dive	Surface	Dive	Surface
HG (QCI 2E)	**27,670** (42,470)* (23,770)^	**6,000** (7,919)*	**75** (46)* (43)^	**19** (15)*	**0.6** (0.6)*	**1.4** (1.1)*
PRD	**57,950** (32,360)* (49,910)^		**139** (158)* (109)^		**0.6** (0.3)* (0.7)^	
CC	**86,290** (70,730)* (30,390)^		**43** (31)* (35)^		**0.6** (1.1)* (0.8)^	
SOG	**147,040** (144,460)* (122,930)^	(3,050)^	**84** (111)* (86)^	(11)^	**1.1** (0.8)* (1.3)^	(0.5)^
WCVI	**10,850** (32,340)* (21,300)^	**6,205**	**116** (152)* (95)^	**50**	**0.6** (1.0)* (0.5)^	**2.6**
Area 2W	**10,690** (9,750)*	**13,800** (17,195)* (15,950)^	**42** (40)*	**23** (15)* (19)^	**1.61** (1.01)*	**1.75** (0.50)* (2.11)^
Area 27	**11,270** (11,730)* (3,300)^		**32** (25)* (59)^		**0.60** (0.78)* (1.97)^	

* (2009)
^ (2008)

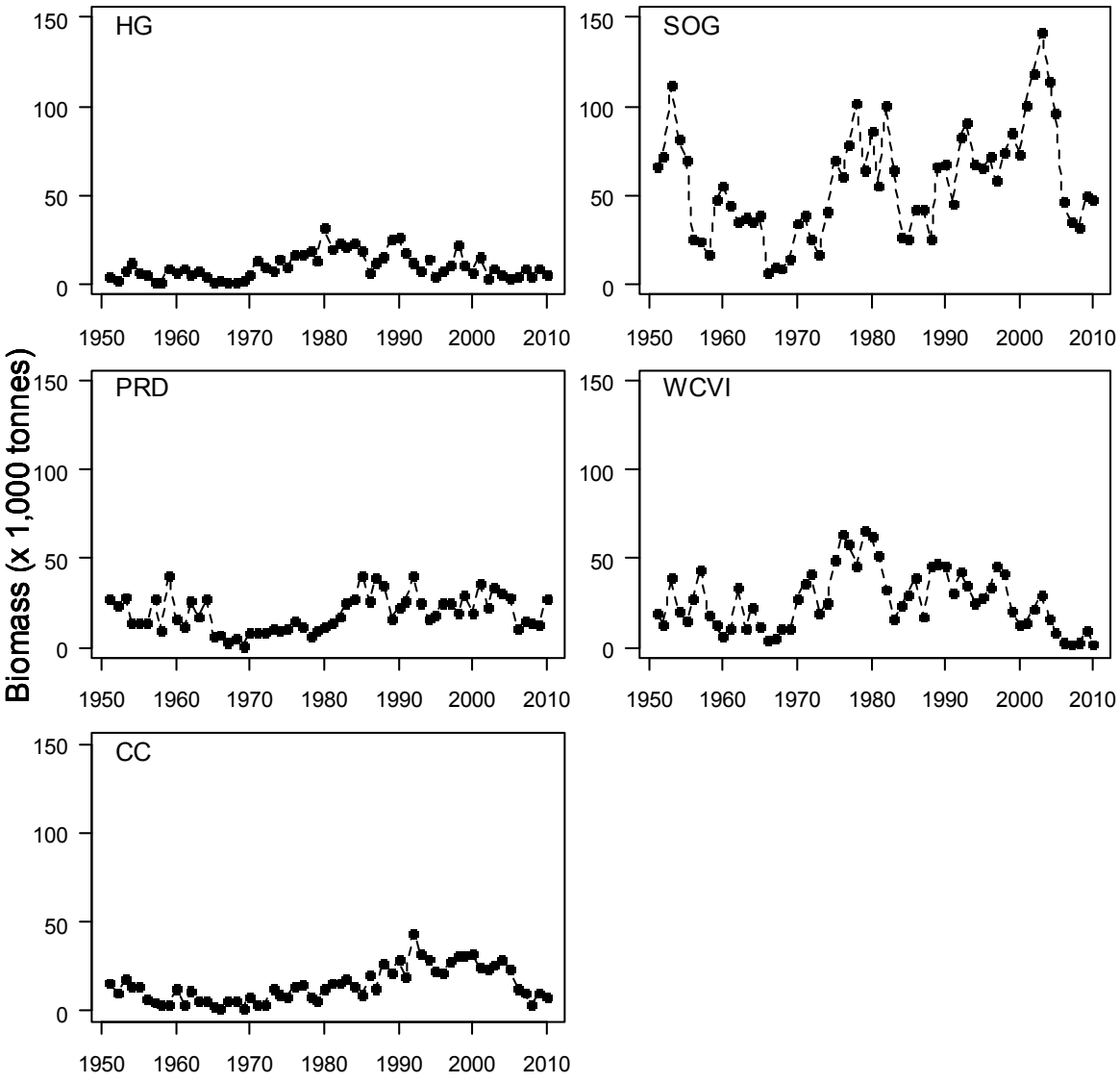


Figure 5. Spawn survey index for the major stock areas from 1951-2010.

3.3 BIOLOGICAL SAMPLES

Biological samples are collected from both the commercial catch and through the test fishery program. Beginning in 1975, test fishery charters were intended to supplement biological samples in areas where catch samples are low or not representative of the entire stock, or in areas where fisheries are closed. Prior to 2006, test fishery charters were funded through an allocation of fish to the test program, however this has since ceased and the program is now fully funded by DFO. Through a contract with DFO, the Herring Conservation and Research Society (HCRS) sub-contracts a number of vessels to collect biological samples. Industry also conducts pre-season test sets for roe-quality testing (in open areas only) and supplementary biological samples are provided as part of this program. The following data are collected for all biological samples: fish length, weight, age, sex, and maturity. Subsequently,

these sources of data are combined and information on weight-at-age and proportion-at-age become input data for the assessment model.

During the 2009/10 season a total of 213 biological samples were collected, of which 127 were collected from the test fishery, 55 were collected from the roe fishery, 16 from the food & bait fishery, 6 from SOK operations, and 8 from the summer trawl research survey (Table 2). Spatial distribution of the biosamples collected in 2009/10 is presented in Figure 6 and Figure 7 for the North Coast and South Coast stocks, respectively. Note that each "sample" collected is comprised of approximately 100 fish. A summary of biological samples collected from commercial and test fishery charters from 2002/03-2009/10 is presented in Table 3.

Table 2. Summary of biological samples collected and processed from all sources from the 2009/10 herring season.

	Commercial samples				
Stock	Roe fishery	SOK fishery	F&B	Test fishery	Research
HG (QCI 2E)				12	
PRD	22	3		22	
CC				26	
SOG	33		14	37	
WCVI				23	4
Area 2W		1		6	
Area 27		3			
Other Areas[1]			2	1	4
Total	55	6	16	127	8

[1]Other Areas = F&B – Section 131, Test – Section 102, Research – Section 121

Table 3. Summary of biological samples collected and processed from commercial catch and test fishery charters from 2002/03-2009/10.

Fishing season	Commercial fishery samples	Charter and research samples	Total[1]
2002/03	120	287	407
2003/04	79	222	301
2004/05[2]	83	191	274
2005/06	46	164	210
2006/07	114	85	199
2007/08	116	103	219
2008/09	87	136	223
2009/10	78	135	213

[1] One-sample ≈ 100 fish.

[2] DFO ageing lab implemented an annual cap for the Pelagics group, which is now set at 28,400 fish..

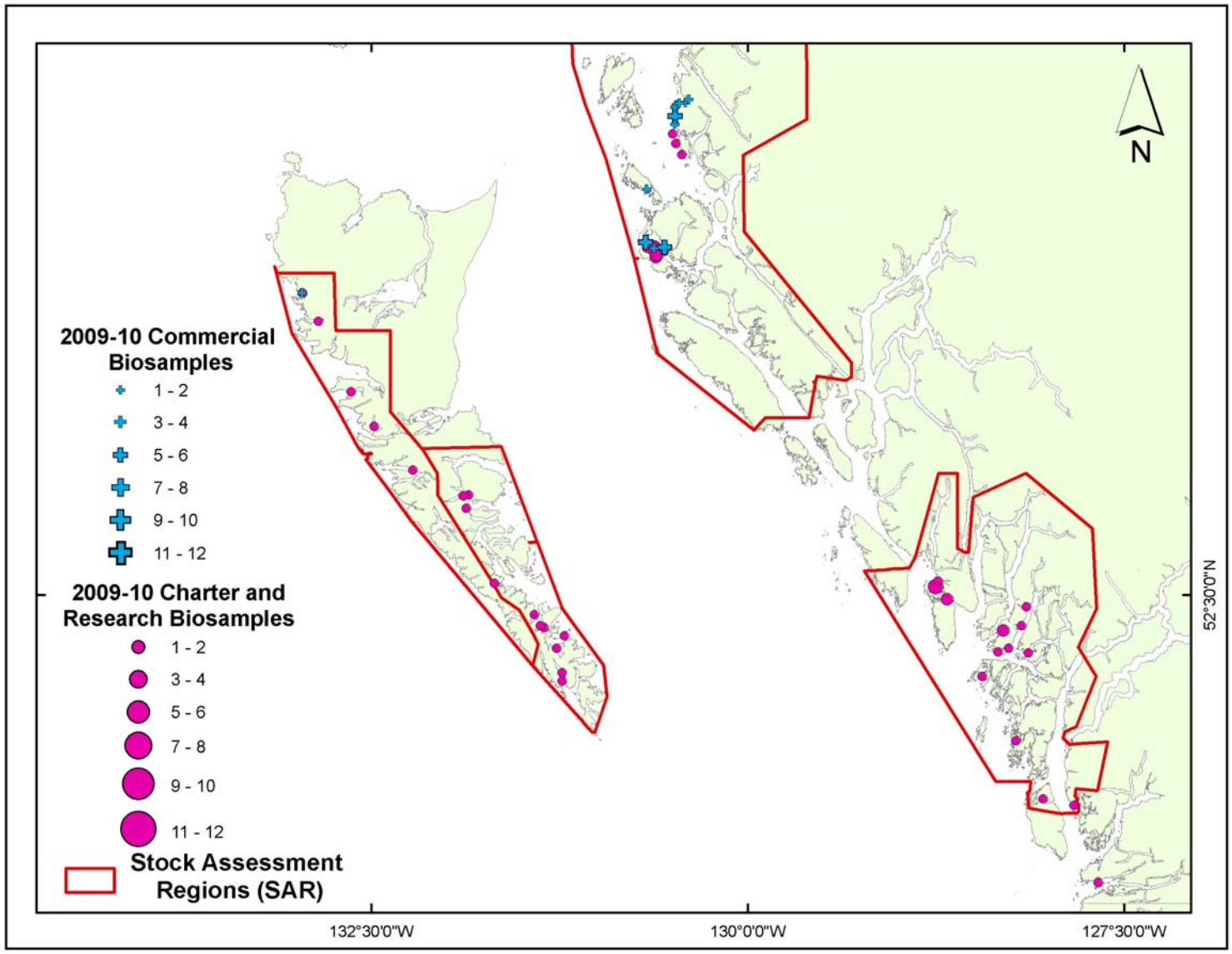


Figure 6. Spatial distribution of biosample collections in 2009/10 for the North Coast stocks.

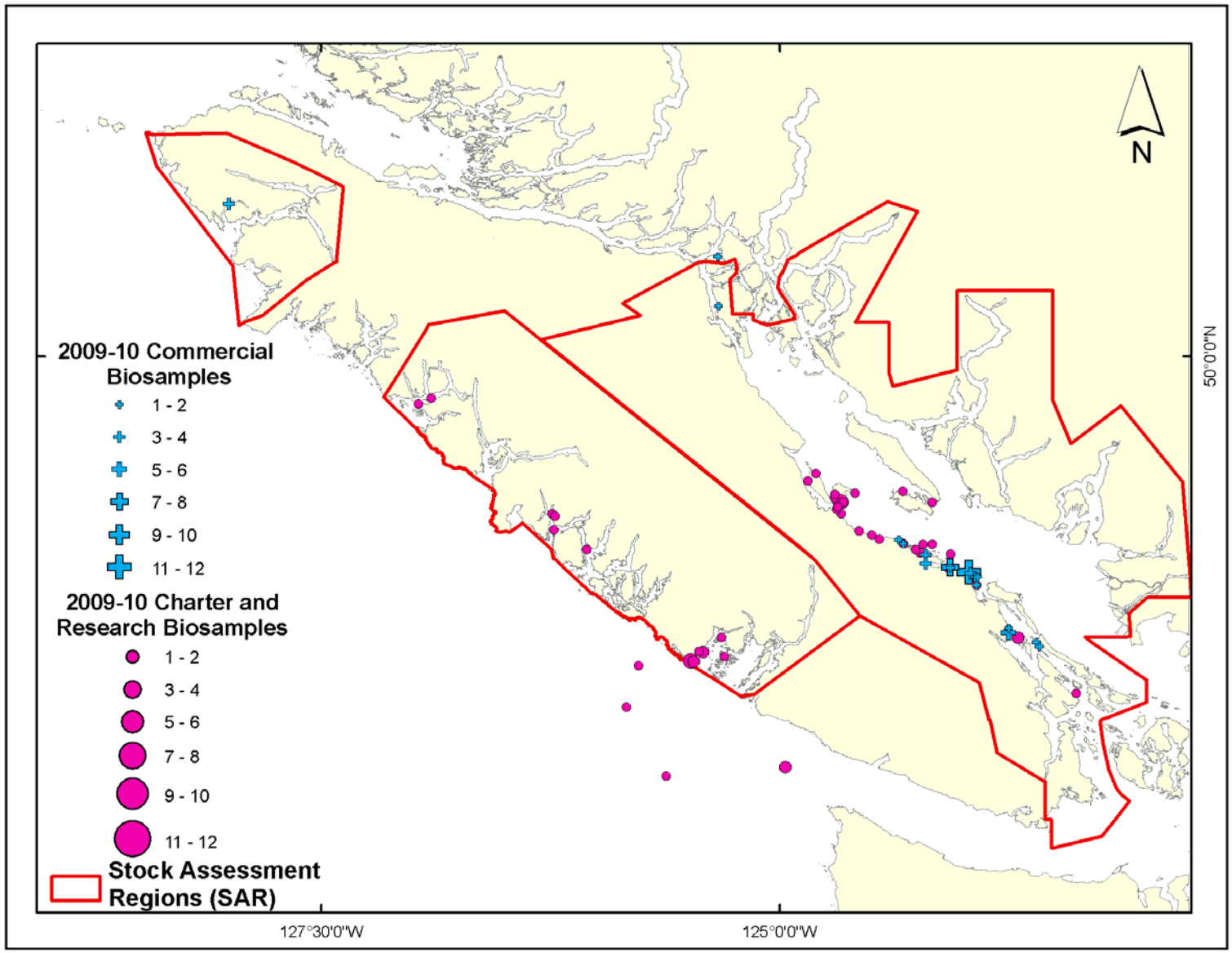


Figure 7. Spatial distribution of biosample collections in 2009/10 for the South Coast stocks.

3.3.1 Age composition data

Ageing data, through the reading of fish scales, are collected from the biological samples taken from the commercial fisheries and test fishery charters. Age composition data is used to determine proportions-at-age and is an essential source of input data to the herring stock assessment model. Percent age composition for each area by year and gear-type are included in Appendix Tables 1.1 to 1.7. Observed proportions-at-age for each of the five major stock areas from 1951-2010 are presented in Figure 8.

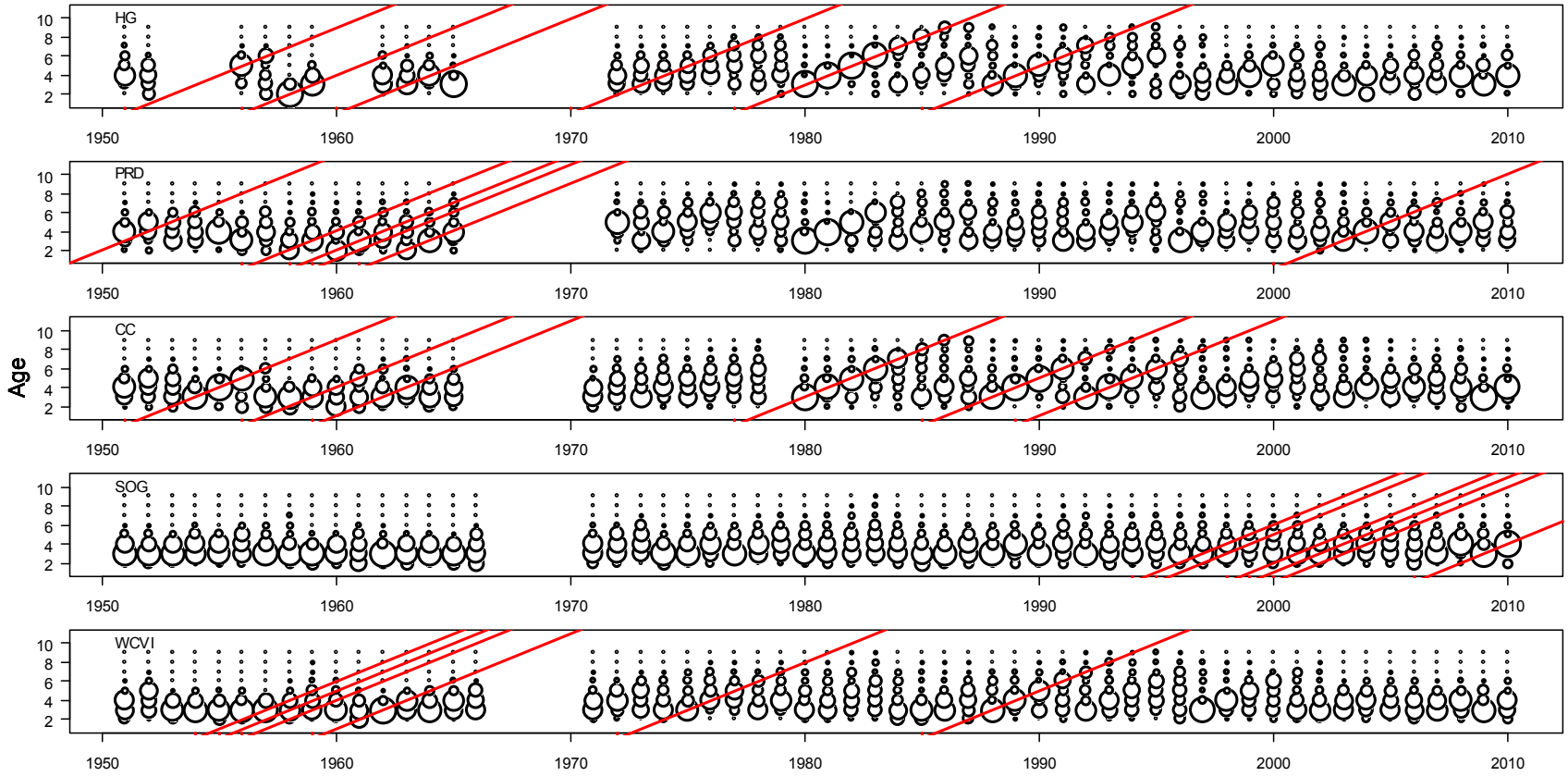


Figure 8. Bubble plots represent observed age proportions for the five major stock assessment regions from 1951-2010. Red lines identify a number of strong year classes, defined as years with the top 10% of model-predicted age-3 recruits.

Above average or strong year classes are represented by diagonal red lines. These cohorts are named for their year of hatch (i.e., age 0). For example, the 1977 year class is strongly visible in the northern stocks, HG, PRD and CC, recruiting to the spawning stock and fishery as 3-year olds in 1980. Several strong year classes appear in the WCVI stock, for example: the 1985, 1989 and 1994 year classes, recruiting as 3-year olds in 1988, 1992 and 1997, respectively. In the most recent years, 2006 appears to be a strong year class for HG, CC, SOG and WCVI, recruiting to the spawning stock and fishery in 2009.

Proportion-at-age bubble plots are a useful tool for tracking cohort strength within a given stock area, however, it is important to avoid drawing conclusions about the size of cohorts across stocks because each bubble plot is scaled to the number of fish within each stock. Furthermore, red lines in Figure 8 identify years with the top 10% of model-predicted age-3 recruits but they don't necessarily identify all years considered to be strong year classes (e.g., PRD 1977 is not included, nor is the 2004 year class – considered to be strong coastwide).

3.3.2 Weight-at-age

From the mid-1970s until the present, there has been a measureable decline in weight-at-age for all ages in all major stock areas (Figure 9). Samples collected during the 2009/10 fishing year indicate weights-at-age that are among the lowest on record (Figure 10- blue circles). This declining weight-at-age may be attributed to any number of factors, including: fishing effects (i.e., gear selectivity), environmental effects (changes in ocean productivity), or it may even be attributed to changes in sampling protocols (shorter time frame over which samples are collected). Declining weight-at-age has been observed in all five of the major stocks, and despite area closures over the last 10-years, has continued to occur in the HG and WCVI stocks. Although the direct cause of this decline is still to be investigated, this trend has been observed in B.C. and U.S. waters, from California to Alaska (Schweigert et al. 2002), and merits further research.

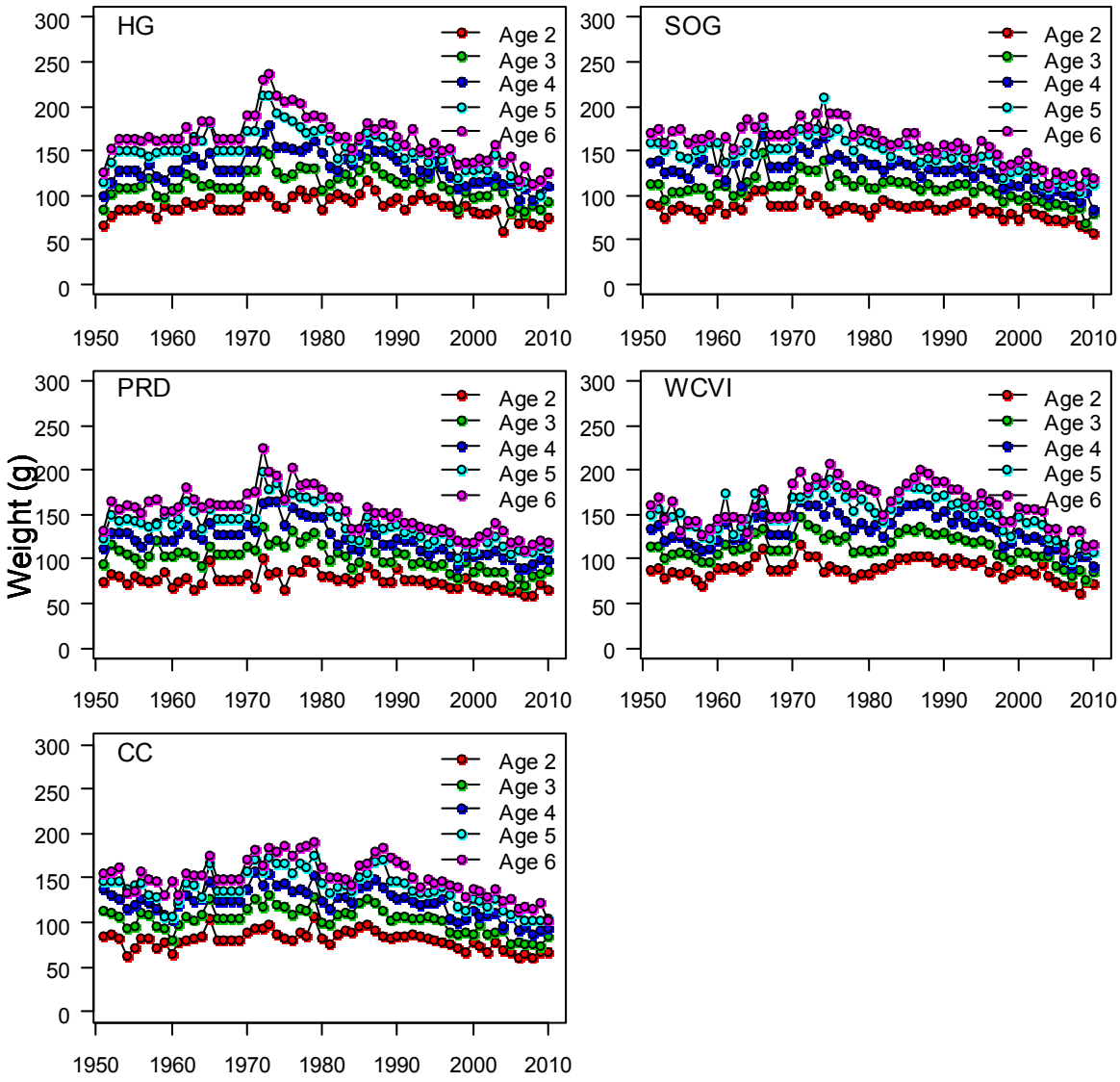


Figure 9. Time series of mean weight-at-age (in grams) for herring ages 2-6 for all major stock areas. Note that data extrapolation methods were used to fill in weight-at-age data for years following the reduction fishery closure (1967-1970).

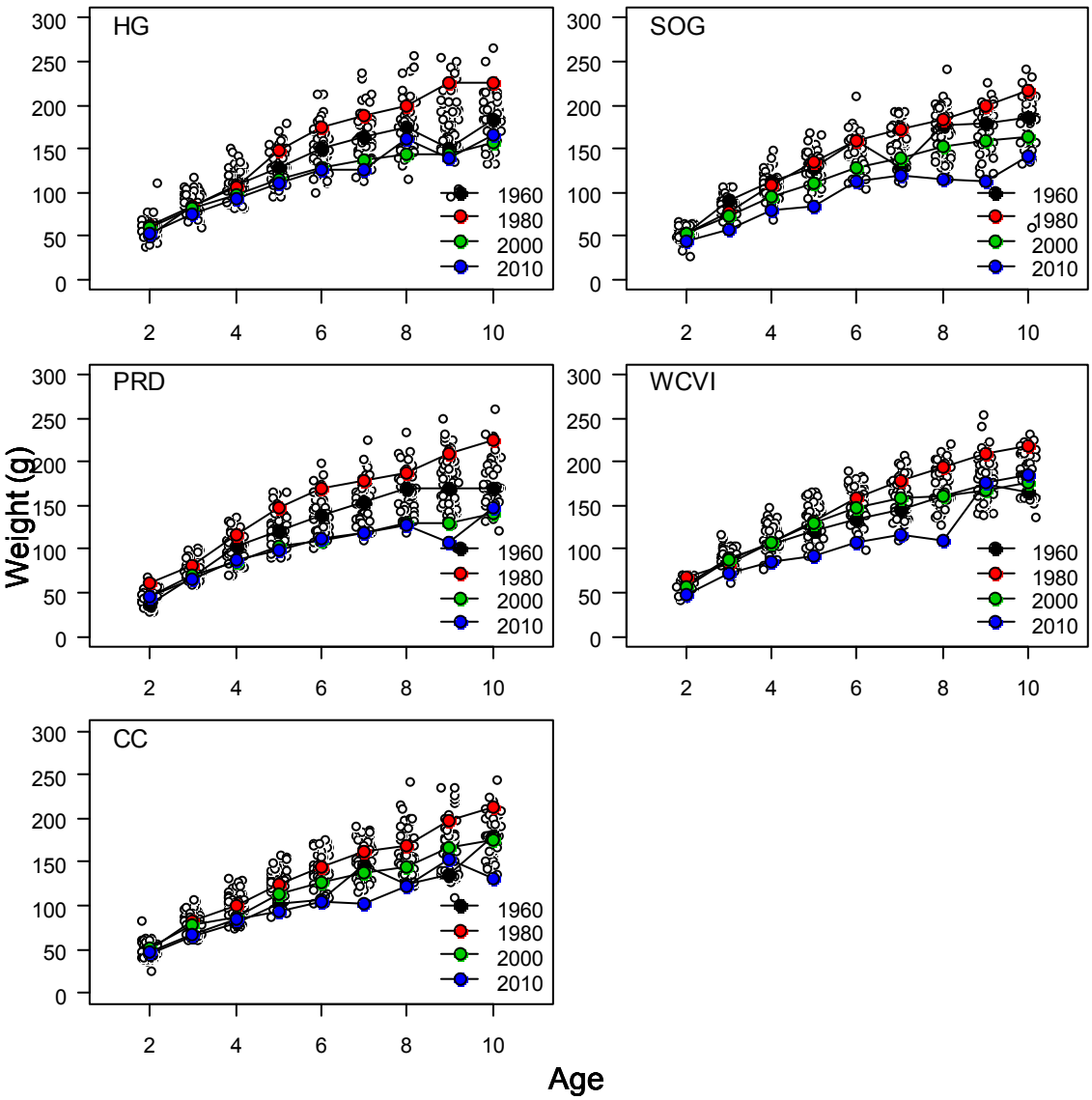


Figure 10. Mean weight versus age for all years from 1951-2010. Open circles represent mean weight for ages 2-10 for years 1951-2010. Coloured circles (black, red, green and blue) show 20-year increments of mean weight for each age.

4. METHODS

Input data and a complete description of the herring catch age model (HCAMv2) are provided in Appendices A and B, respectively. Additional details on model choice can be found in Christensen et al. (2009) and Haist and Schweigert (2006) while management of the B.C. herring fishery is summarized in Stocker (1993).

Overall, this year's assessment uses the same modelling approach as was reviewed and approved for the 2008 herring stock assessment (Schweigert and Haist, 2008). A number of small changes have been made to the HCAM model code since 2008. For the purposes of documentation, these are listed below:

1) Code adjustment to ensure all period 2 age samples are included, even for years in which there was no roe seine fishery (2009 WP, Cleary et al. 2009);
2) Code adjustment to the bounds of the fishing mortality rate (2009 WP, Cleary et al. 2009);
3) Code adjustment to the spawner residuals component of the likelihood function;
4) Code adjustment to correct use of prior for estimating natural mortality;
5) Removal of derived age samples from 1967-1970 in all areas and in some earlier years where no biosamples were available, particularly in HG. During the coastwide closure 1967-1970, age length keys were developed to estimate age composition but these were felt to be unreliable.
6) Exclusion of a number of age samples collected, mostly during period 1 since 1971 that were associated with very small commercial catches < 50 tonnes and were felt to be insufficient to provide accurate age structure estimates.

Points 3 and 4 were identified and adjusted by J.S. Cleary and V. Haist whilst preparing for the Herring Stock Assessment Workshop held June 17-18th, 2010. Points 5 and 6, age-composition exclusion criteria, came out of the workshop discussions. Results presented in the 2010 assessment reflect these adjustments to the HCAMv2 model.

4.1 MODELLING APPROACH

The general odeling approach used in the herring stock assessment is to fit a catch-age model to a time series of commercial catch data, spawn index and proportions-at-age data within a Bayesian estimation framework. The objective function contains four likelihood components related to: 1) age composition, 2) commercial catch, 3) spawn data, and 4) prior distributions for model parameters. The model allows parameters to be estimated using Bayesian estimation procedures whereby marginal posteriors are approximated using the Markov Chain Monte Carlo (MCMC) routines built into AD Model Builder (Otter Research, 2000). Posterior samples were drawn systematically every 1,000 iterations from a chain of length 2,000,0000, resulting in a sample of 2,000 points for all major and minor stock areas.

Model runs were examined for convergence using visual inspection of the trace plots. Where possible, we provide comparisons between the mode of the posterior distribution, MPD, also equivalent to the maximum likelihood estimate (MLE), and median estimates from the marginal posterior distributions. Catch advice is based on application of the herring HCR to model forecasts calculated from the posterior distributions under assumptions of poor, average and good recruitment.

4.2 PARAMETER ESTIMATION

A significant component of model implementation is parameter estimation. The 2010 implementation of HCAMv2 estimates 136 parameters plus fishing mortality parameters for each period-year combination, for a total of 212, 237, 249, 277 and 224 parameters for the HG, PRD, CC, SOG and WCVI stocks, respectively. During parameter estimation, the model also generates predicted values of commercial catch, spawning biomass, and age composition. A comprehensive description of parameter estimation and model equations is provided in Appendix B.

For the purposes of gauging model fit and precision of the parameter estimation procedure, the results section includes a number of comparisons between observed and predicted indices, as well as distributions of parameter estimates (and priors where applicable).

4.3 PRIORS

Model priors are an integral component of the Bayesian estimation procedure and are based on existing knowledge of parameter values and/or herring biology, derived either from previous studies or expert opinion. In the 2009 implementation of the HCAMv2, we include priors for estimating average or total mortality, deviations in natural mortality, deviations in recruitment and steepness. The prior for steepness also includes upper and lower bounds, as defined by the Beverton-Holt stock recruitment relationship. Prior distributions are described in Table 4.

Table 4. Prior distributions for model parameters for all major and minor stock areas.

Parameter	Prior density	Range[2]	Mean	Median	SD
Average natural mortality rate	normal	-	0.45	-	0.2
Residual deviations in average natural mortality rate	normal	-	0.0	-	0.1
Recruitment deviations	normal on a log scale	-	0.0	-	0.8
Steepness[1]	lognormal	(0.2 -0.99)	0.67	-	0.17
Initial fishing mortality	lognormal	-	0.3945	0.3166	-

[1] Hilborn, pers. comm. with Schweigert, comparable to Myers *et al.* (1999) estimate of 0.74 for Atlantic herring. Note this prior should be changed to a beta distribution to naturally bound steepness between 0.2 and 1.0.

[2] Steepness is the only parameter with a bounded prior. Upper and lower bounds are used during the estimation procedure for other parameters but they are not related to model priors, thus are not included in Table 4.

Remaining "free" parameters, R_0, q_1, ψ, are assumed to be uniformly distributed, although the range of some of these uniform distributions may be restricted using upper and lower bounds (e.g. $q_2 \sim U[0.3,1.2]$).

4.4 RETROSPECTIVE ANALYSIS

A retrospective analysis is used to examine the sensitivity of estimates of pre-fishery biomass to the addition or removal of new data (for the major stock areas). The retrospective analysis includes the successive removal of 10-years of data. Warning signs include persistent over- or under-estimation of pre-fishery biomass.

4.5 ABUNDANCE FORECASTS

The assessment model includes a component for forecasting herring abundance for the upcoming fishing year. The forecast of pre-fishery biomass, referred to as 'forecast run', is calculated as:

Forecast run = predicted spawning biomass of fish age 4 and older in year $t=T+1$

+ predicted recruitment of age 3 fish in year $t=T+1$

For each stock, forecasts are calculated under each assumption of poor, average and good recruitment (Section 0). Equations describing these calculations appear in Appendix B.

4.6 RECRUITMENT FORECAST RULES

Independent estimates of recruitment for the WCVI and SOG stocks are based on offshore survey data collected during the summer prior to the recruitment of age 3 fish to the spawning population. Recruitment forecasting methods have been consistently applied since 1999/2000 for the WCVI stock (Tanasichuk 2000) and in 2005/06 for the SOG stock (Tanasichuk 2002). Comparable methods for the HG, CC and PRD stocks are not available, thus assumed recruitment is based on the following precautionary rules:

1. If the pre-fishery biomass was below cutoff in the previous year, then assume POOR recruitment for the forecast.
2. If the pre-fishery biomass was above cutoff in the previous year and recruitment has been GOOD in the previous two years, then assume GOOD recruitment for the forecast.
3. If Rule 1 or Rule 2 DO NOT APPLY then assume AVERAGE recruitment for the forecast.

The calculation of area-specific cutoffs is described in Section 0. For all assumptions of recruitment, recommended harvest rates follow the rules outlined in Section 0.

4.7 HARVEST CONTROL RULE

A formal harvest control rule (HCR) has been used to provide advice for the management of major B.C. herring stocks since 1986 (Stocker 1993). The herring HCR has three components:

1. Reference point
2. Harvest rates
3. Decision rules

These are the same three components identified within the DFO Harvest Strategy Compliant with the Precautionary Approach (DFO 2006), a key component of the Sustainable Fisheries Framework (SFF 2009).

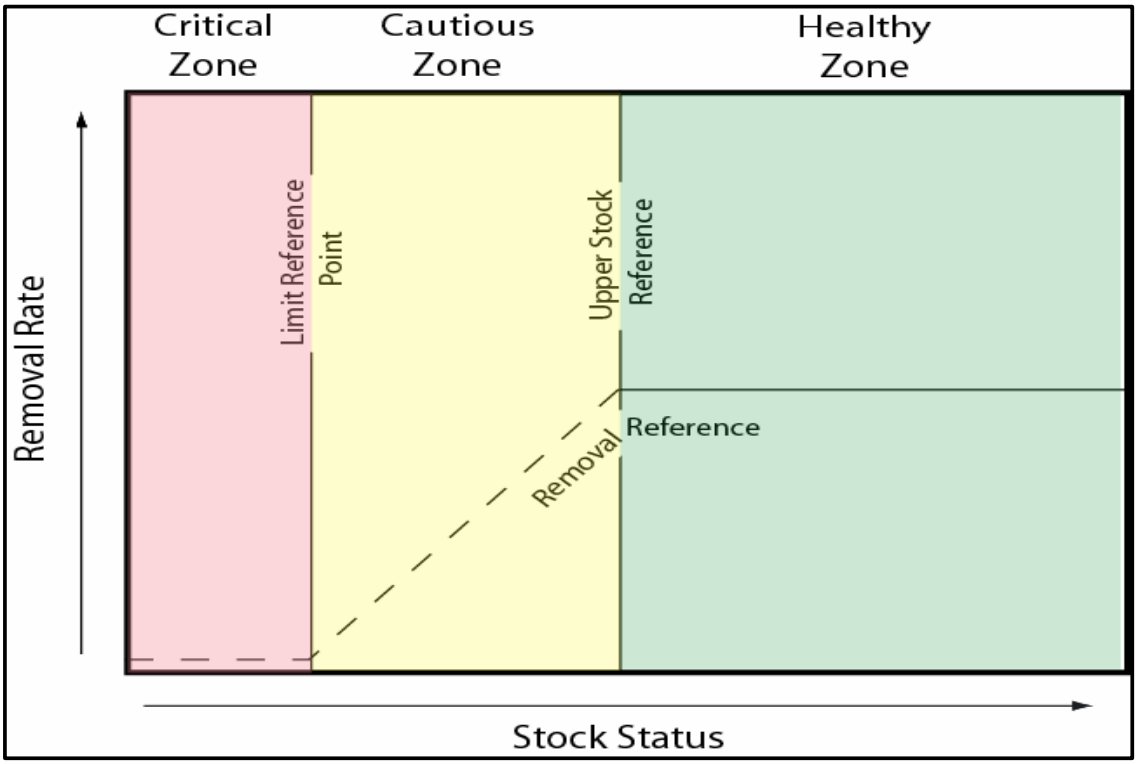


Figure 11. The DFO Harvest Strategy compliant with the Precautionary Approach.

In Figure 11, the limit reference point, defined as $0.4B_{MSY}$, separates the critical and cautious stock zones while the upper stock reference point, defined as $0.8B_{MSY}$, separates the cautious and healthy stock zones. The removal reference defines the maximum acceptable removal rate which is constant in the healthy zone, reduced in the cautious zone and negligible (little or no targeted catch) in the critical zone. This harvest strategy is intended to keep the removal rate moderate when stock status is healthy, promote rebuilding when stock status is low and ensure a low risk of serious or irreversible harm.

Figure 12 shows the harvest control rule for B.C. herring stocks. The main differences between these figures are the "width" of the cautious zone and the existence of only a lower reference point, the cutoff ($0.25B_0$), for the herring HCR.

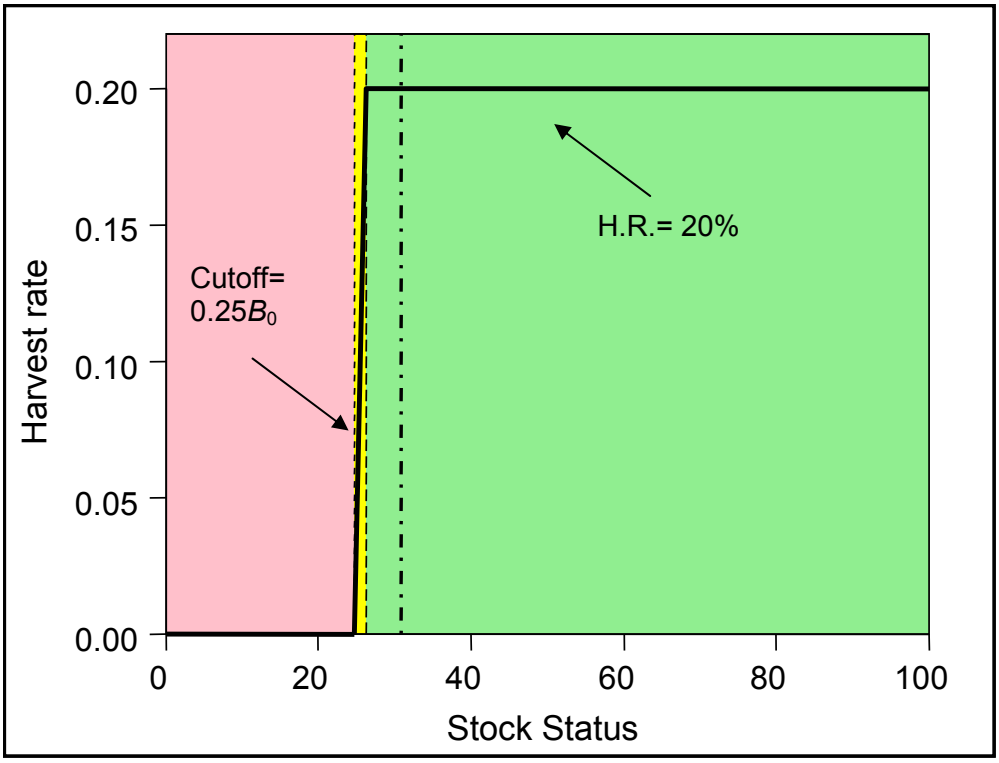


Figure 12. Harvest control rule for B.C. herring stocks, where stock status is defined as a percentage of the estimated virgin biomass. The left-hand dashed line represents the cutoff value for a given stock ($0.25B_0$), i.e., the stock level below which the harvest rate, H.R., is zero. The right-hand dashed line represents the stock level below which the H.R. is reduced below 20%. The dash-dot line is the biological reference point B_{MSY} (biomass at maximum sustainable yield). Note this figure was produced using a generic operating model.

We recognize that evaluating compliance of the current herring HCR with the DFO harvest strategy is a necessary next step. We intend to carry out this comparison using a simulation framework in the context of a management strategy evaluation (MSE).

4.7.1 Reference points

Based on previous work by Haist et al. (1986) and Hall et al. (1988), the recommended reference point or cutoff for the herring HCR is $0.25B_0$. These simulation studies indicate this minimum spawning stock biomass is adequate to sustain each population during natural reductions in stock productivity. For each major stock area, the cutoff is intended to ensure a minimum spawning biomass of 25% of the estimated unfished biomass (B_0). A similar reference point criterion is also used in managing the Pacific sardine fishery (PFMC 1998).

Because of the way they are defined, herring cutoffs are considered commercial fishing thresholds and not conservation thresholds and are thus thought to be more conservative than the default Limit Reference Point of $0.4B_{MSY}$ included in the DFO harvest control rule (DFO 2006). However, as previously mentioned, to ensure compliance of the herring HCR with the DFO Harvest Strategy and the Precautionary Approach, an evaluation of these and alternate reference points in a simulation framework is planned for the near future.

Estimates of unfished biomass used in the calculation of current cutoff levels were calculated using simulation methods, either using a stock recruitment relationship or by bootstrap sampling of the historic recruitment time series. Cutoff values used in this years' assessments, and all assessments from 1997-present year, are based on 1996/97 estimates of unfished biomass. That is, the "current" cutoff values listed in Table 5 have been fixed for over 10-years. In other words, the cutoff level currently used in the herring HCR is a static benchmark based on 1996 estimates of B_0. Revised estimates of unfished biomass and biological reference points will be developed in future simulation work.

Table 5. Current and historic cutoff levels incorporated into the B.C. herring harvest control rule for the major stock areas.

	Cutoff levels			
	1992/93[a]	1994/95[b]	1996/97[c]	**Current**
HG (QCI 2E)	11,700	10,700	10,700	**10,700**
PRD	12,100	12,100	12,100	**12,100**
CC	10,600	18,800	17,600	**17,600**
SOG	22,100	21,200	21,200	**21,200**
WCVI	20,300	18,800	18,800	**18,800**

[a] Cutoff levels based on simulation model with stock recruitment relationship and two assessment areas on the WCVI (Schweigert and Fort 1994).

[b] Cutoff levels revised (Schweigert et al 1995).

[c] Cutoff levels revised (Schweigert et al 1997).

4.7.2 Harvest rates

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 unpublished manuscript, PSARC H95:2). The review concluded that 20% is an appropriate exploitation rate for those major stock areas that are well above cutoff levels of 25% of the estimated unfished biomass. The recommended 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).

In the case of minor stock areas, data-limitations present a challenge in providing reliable estimates of unfished biomass, required for the calculation of stock-specific cutoffs. Consequently, the PSARC recommended harvest rate of 10% is applied to the forecasted biomass level for each minor stock area.

4.7.3 Decision rules

The herring harvest control rule (HCR) was first implemented for the major stock areas in 1983 as a fixed harvest rate of 20% and was augmented with a fishing threshold or cutoff in 1986 (Stocker 1993). Since inception, the rule has remained unchanged, however modifications have been made to model estimates of unfished biomass and consequently to stock-specific cutoff levels (Table 5).

For the major stock areas, the harvest control rule combines both constant exploitation rate and constant escapement policies (Figure 12), allowing for smaller fisheries in areas where

the 20% harvest rate would bring the escapement down to levels below the cutoff. The rule operates as follows:

If the forecast run is less than the cutoff:

The area is closed to all commercial harvest (allowable harvest = 0)

Analogous to the critical zone in Figure 11

If the forecast run is greater than the cutoff

A commercial harvest is permitted and the H.R. is based on the following rules:

If the forecast run – 0.20 x forecast run is greater than the cutoff

A 20% H.R. is applied

Analogous to the healthy zone in Figure 11

If the forecast run – 0.20 x forecast run is less than the cutoff

A reduced H.R. equivalent to: forecast run – cutoff is applied

This represents the constant escapement portion of the rule.

Analogous to the cautious zone in Figure 11 but is operationally narrow as is shown in Figure 12.

In the case of the minor stock areas, the decision to allow for a commercial harvest has been at the discretion of Fisheries Management. In years where a commercial harvest is permitted, a harvest rate of 10% is applied to the forecasted biomass for the area.

5 RESULTS

The results section contains two subsections: Model estimates (0) and Catch advice (0); where the former includes figures and descriptions of leading (model-estimated) parameters and the latter includes decision tables for catch advice, with pre-fishery biomass and available harvest presented under three recruitment scenarios: poor, average and good.

5.1 MODEL ESTIMATES

5.1.1 Catch: observed vs. predicted

In the herring assessment, we assume commercial catch to be known with a high degree of certainty. This assumption is confirmed by plotting observed and predicted catch (Figure 13) and by examining the residuals (not shown).

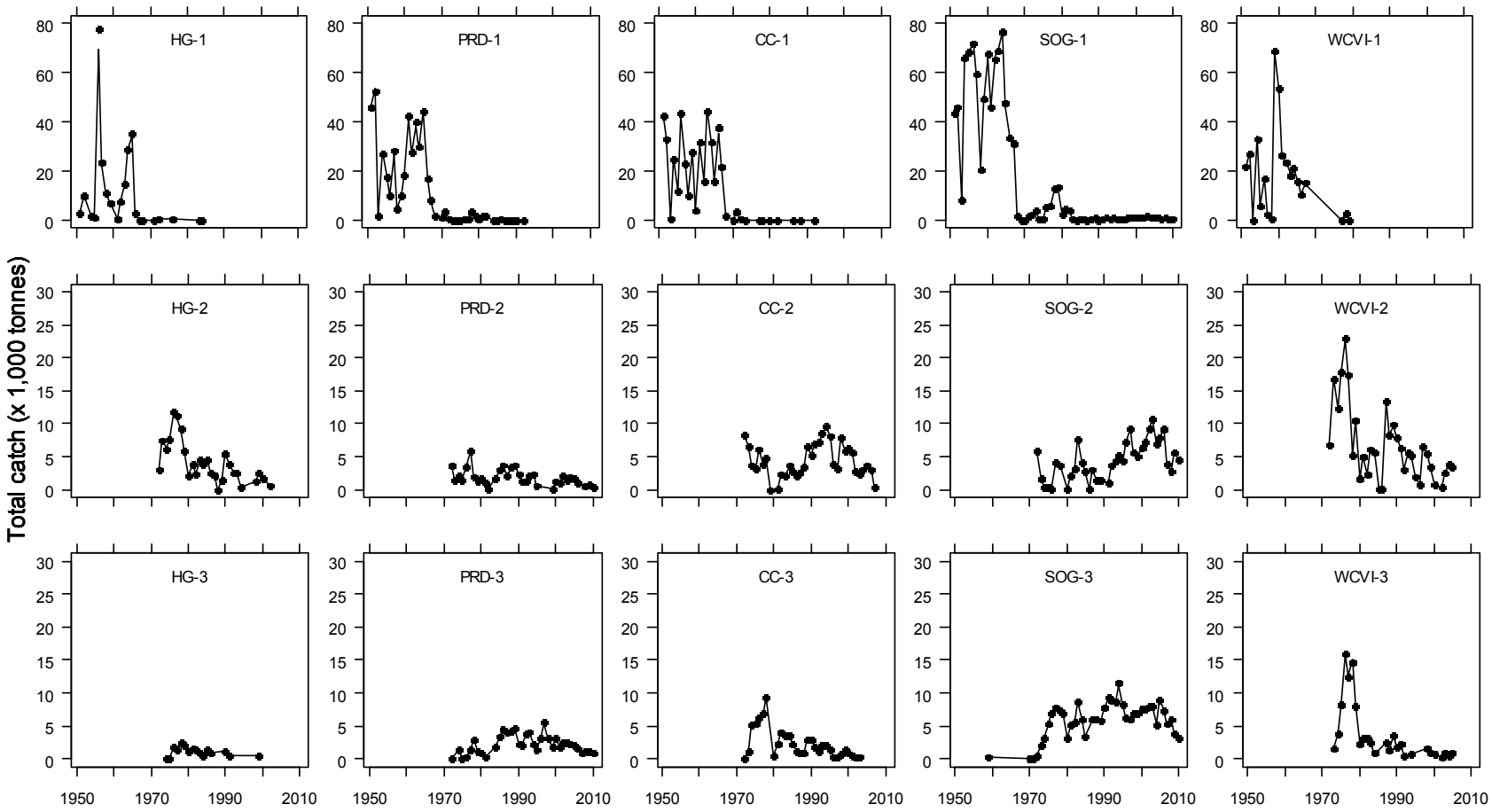


Figure 13. Observed (circles) and model predicted catch (lines) by fishing period from 1951-2010. Upper row- Fishing period 1 – primarily seine and reduction fisheries, except recent years in SOG which represent food and bait/ special use fisheries; Middle row- Fishing period 2 (seine roe fishery); Bottom row- Fishing period 3 (gillnet roe fishery). Note range in y-axis differs for fishing period 1 (vs. periods 2 and 3).

5.1.2 Spawn index: observed vs. predicted

Time series of estimated spawning stock biomass (SSB) fitted to observed spawn index for all major stock areas are shown in Figure 14. An examination of the residuals provides the basis for assessing the fit of the model to the available data. We compare model estimates of population egg production (estimated spawning stock biomass, SSB) to the observed egg deposition (observed spawn index) and calculate the by-year differences, the residuals, as log (observed) – log (predicted), adjusted for differences in *q* (spawn index proportionality coefficient) for the five major stocks. For all stocks, residuals range from -1 to +1, with a few exceptions in the earlier years, e.g., PRD for 1960s-1970s. In recent years, model estimated spawning biomass is closely fitted to the spawn index, although there are a higher proportion of negative residuals in years preceding the surface surveys (pre-1988). In particular, the SOG and PRD stocks show a run of negative residuals from the late 1980s through mid 2000s, translating to overestimates in stock biomass (SSB). Currently we are unsure of the reason for this switch, however, reasons for serial correlation in these estimates will be examined in future work.

The spawn index proportionality coefficient, *q*, is used to relate spawn observed during the survey to the total amount of spawn in each area (i.e., *q* is the proportion of the total spawn estimated to have been identified). In years prior to 1988, when surface survey was the primary survey method, *q* is estimated as a free parameter in the model (see Appendix B) and from 1988-present we make the precautionary assumption that q=1 (i.e., we assume to observe all spawning events).

The formulation of *q* used in the assessment is recognized to be conservative. Alternative methods for estimating *q* have been examined in past assessments and are shown to have a large impact on variability in the estimation of management parameters, such as B_0. Future work will examine alternate methods for estimating *q*.

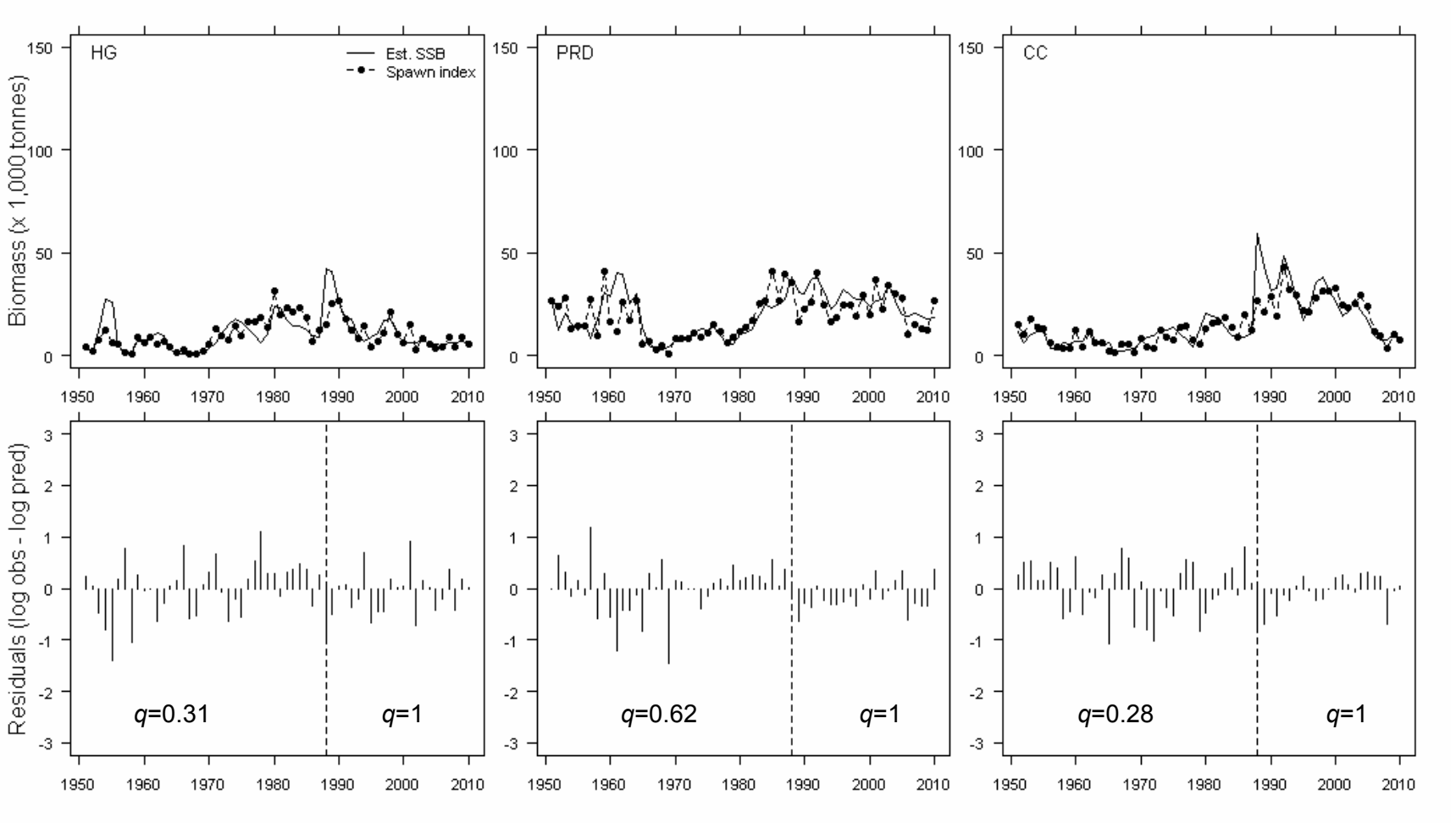


Figure 14. HG, PRD and CC

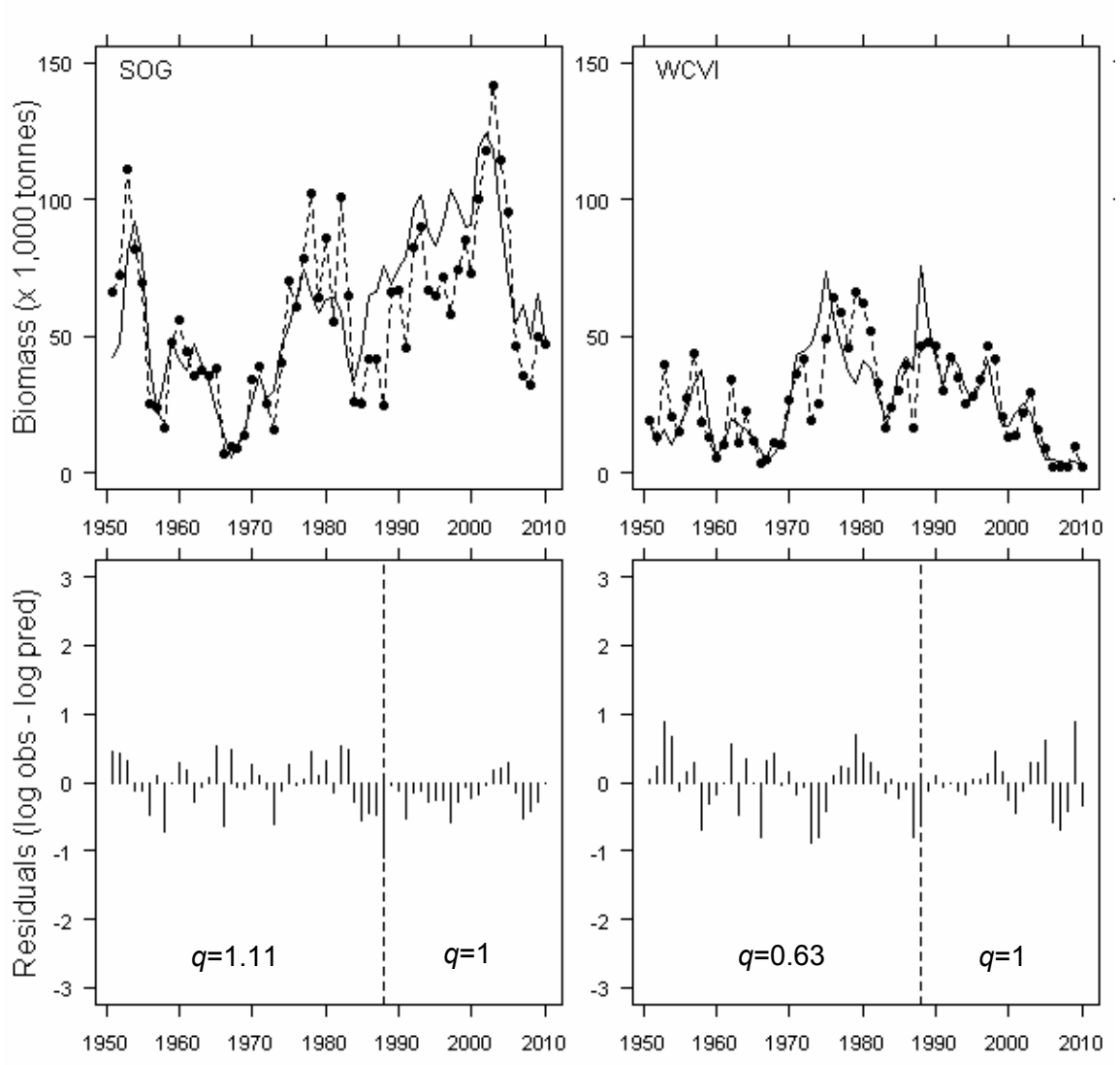


Figure 14. SOG and WCVI

Figure 14. Time series of estimated spawning stock biomass (SSB) fitted to observed spawn index for all major stock areas. Residuals of this relationship appear in the bottom plots. Note that residuals are calculated as log (observed) – log (predicted), with values adjusted for differences in q *(spawn index proportionality coefficient). Vertical dashed line in residual plots indicates 1988, the year the spawn survey switched from surface to dive survey. In years prior to 1988,* q *is estimated, whereas from 1988-present* q *is assumed to be 1. Values of* q *appear at the bottom of each residual plot.*

5.1.3 Age composition: observed vs. predicted

We used standardized Pearson's residuals to summarize the fit of the age-structured model to the observed proportion-at-age data. Residuals are presented in Figure 15 for each of the five major stocks over time (broken down by fishing period). Positive residuals (blue) indicate the model is under-estimating age proportions for a given year/period, negative residuals (green) indicate an overestimation. There is no evidence of persistent over or underestimation of age composition in any area for any of the three fishing periods indicating reasonable agreement between the observed data and model predictions of age composition. A few larger positive (blue) residuals remain in each area and require further investigation.

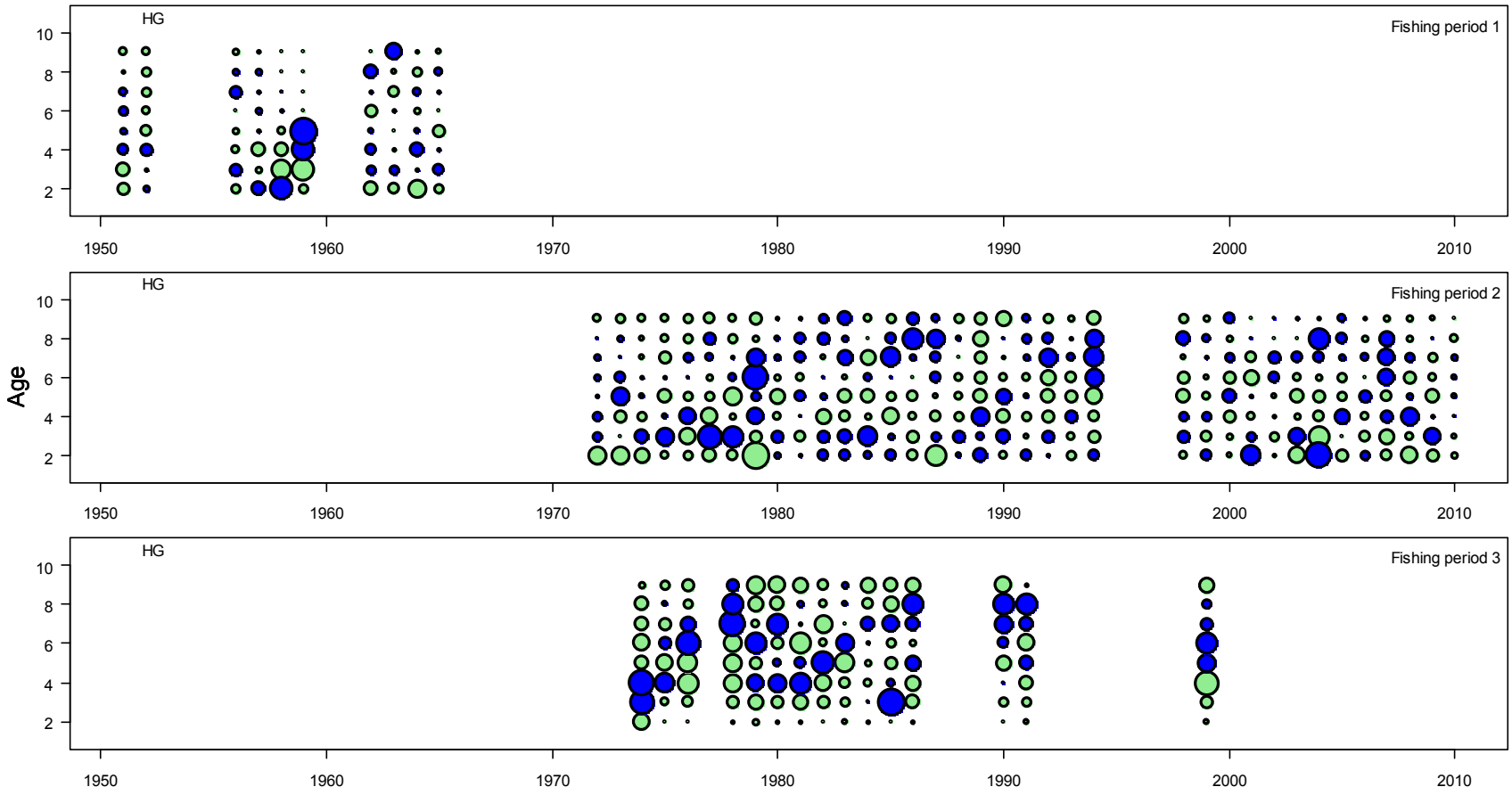

HG
Fishing period 1
HG
Fishing period 2
HG
Fishing period 3
Age
2
4
6
8
10
1950
1960
1970
1980
1990
2000
2010

Figure 15. HG

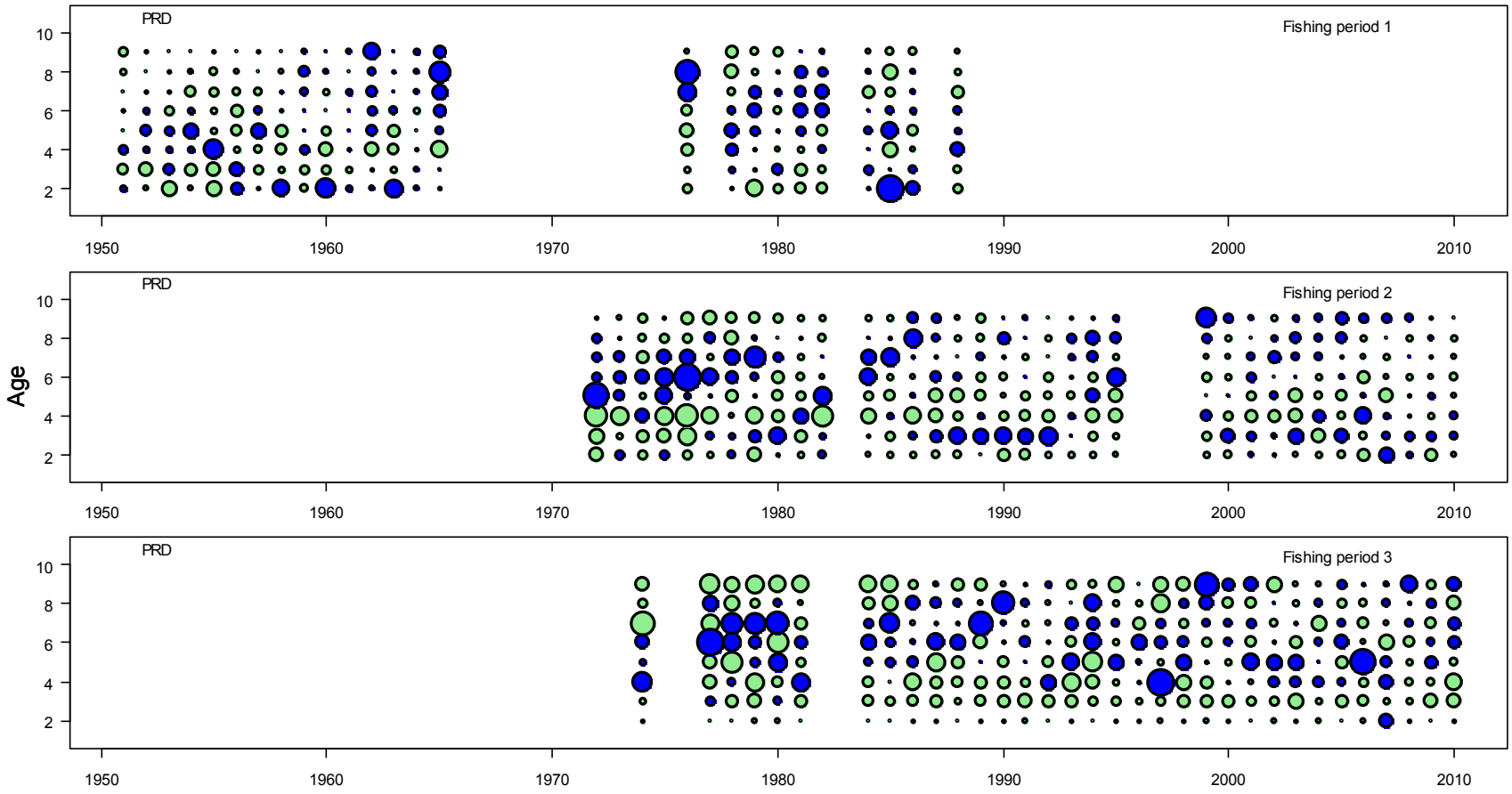


Figure 15. PRD

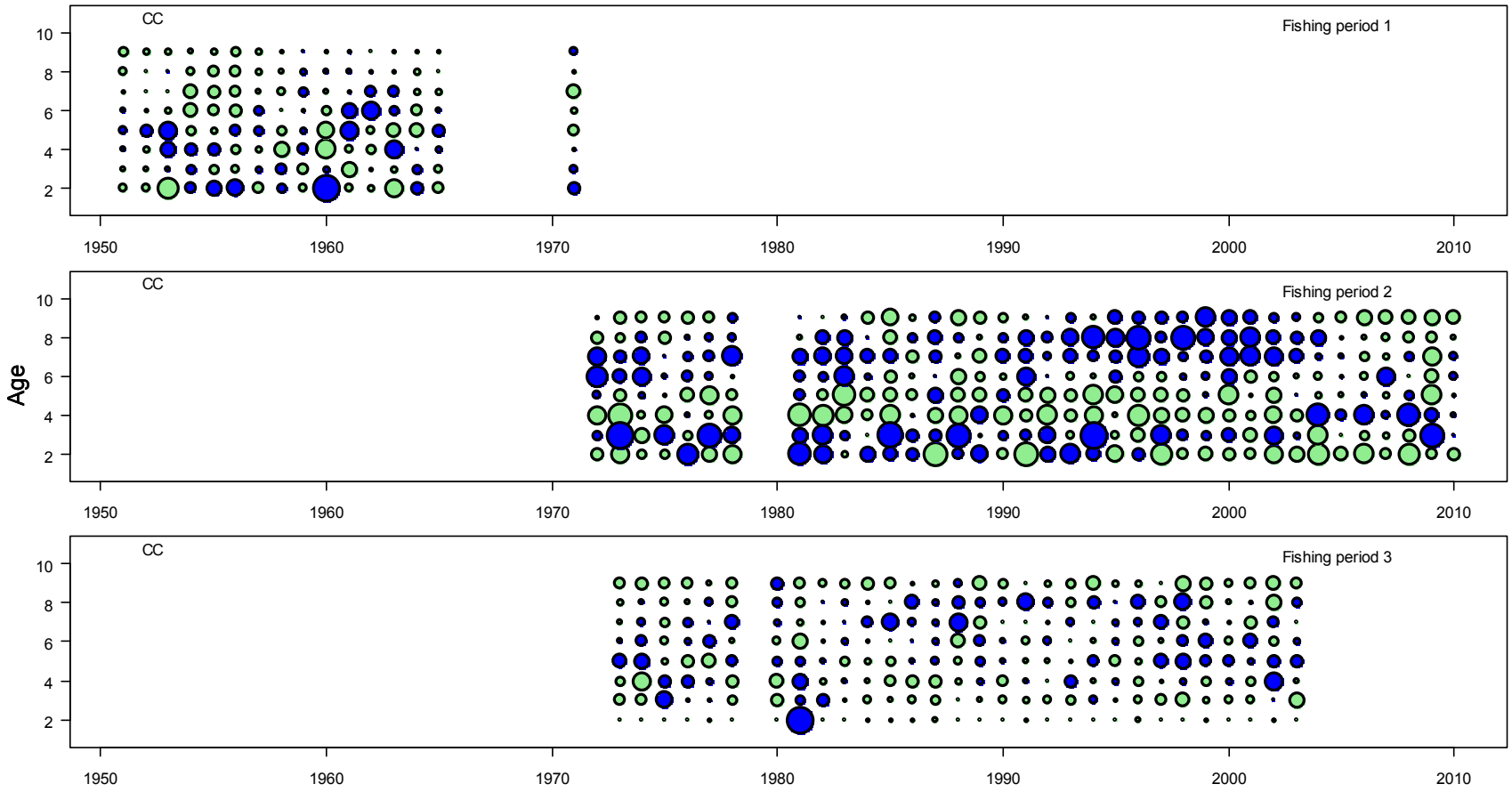

CC
Fishing period 1
CC
Fishing period 2
CC
Fishing period 3
Age
10
8
6
4
2
1950
1960
1970
1980
1990
2000
2010

Figure 15. CC

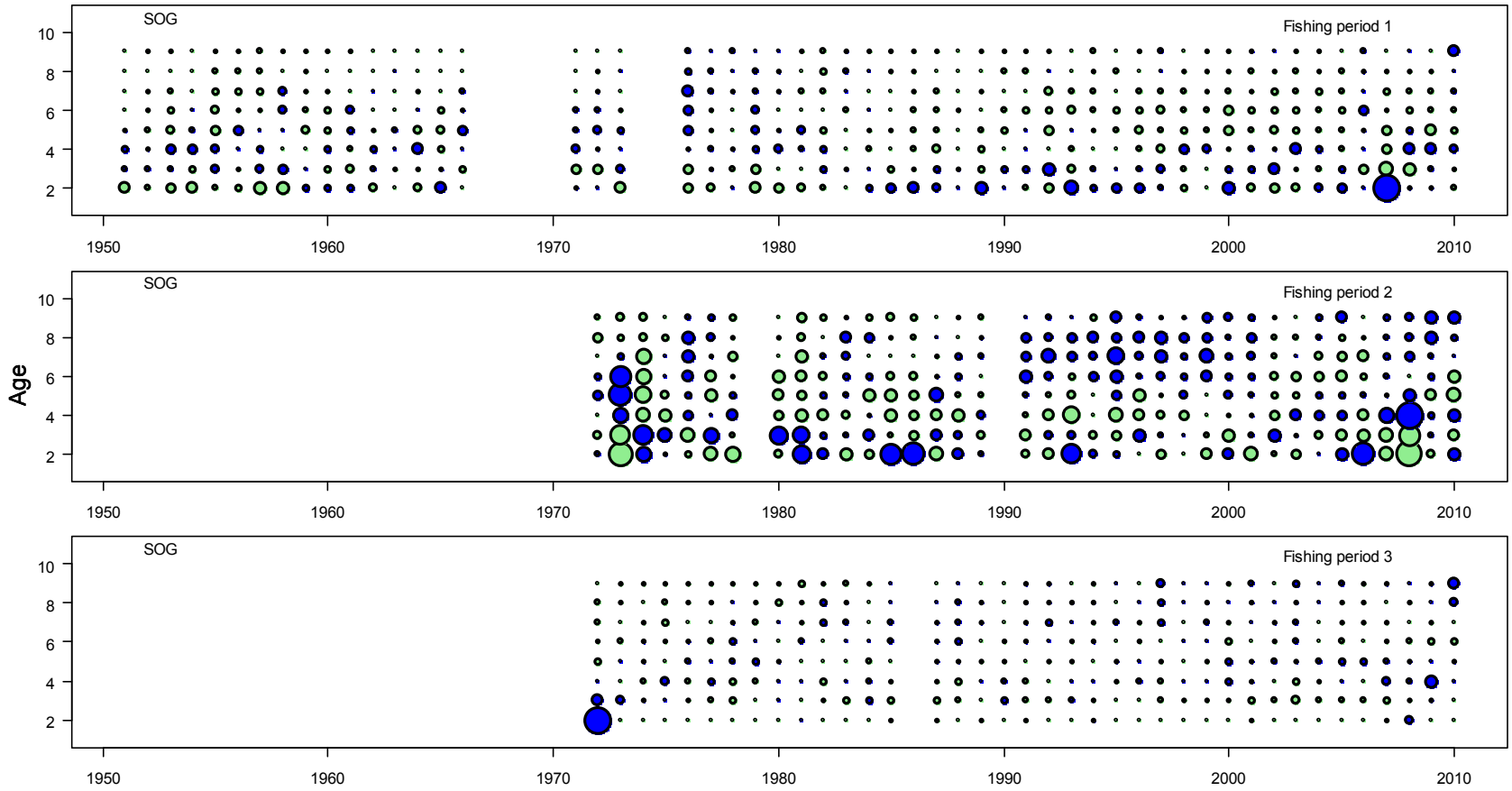


Figure 15. SOG

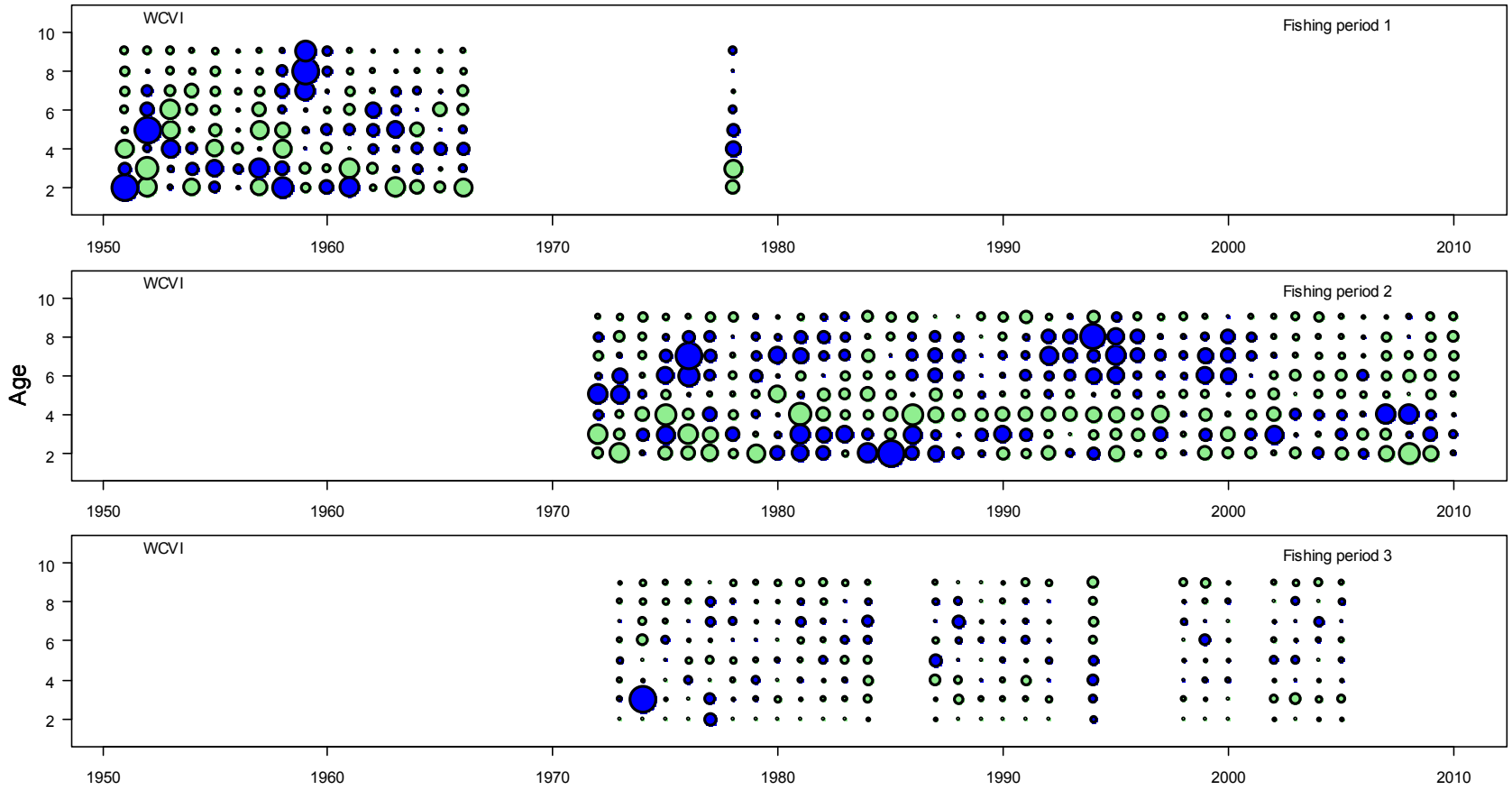
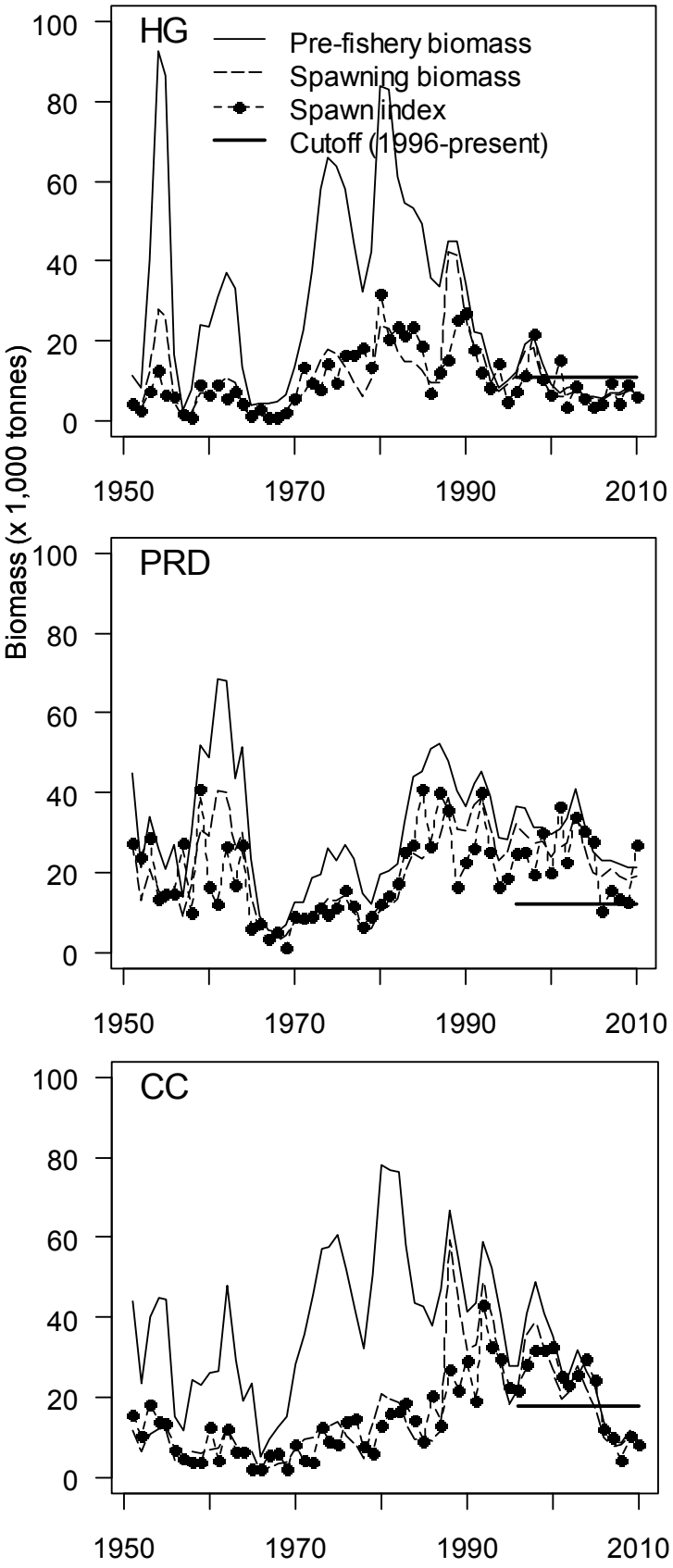


Figure 15. WCVI

Figure 15. Bubble plots of Pearson residuals for the proportions-at-age calculated between observed and model-predicted proportions-at-age for each fishing period from 1951-2010. Positive residuals appear in blue, negative residuals in green.

5.1.4 Biomass estimates

Spawning stock biomass in 2010 was estimated as follows: HG – 6,046 tonnes, PRD – 19,221 tonnes, CC – 7,974 tonnes, SOG – 48,037 tonnes and WCVI – 3,335 tonnes. Time series of model estimates of pre-fishery biomass for the minor stock areas are presented in Figure 16.


HG
Pre-fishery biomass
Spawning biomass
Spawn index
Cutoff (1996-present)
PRD
CC
Biomass (x 1,000 tonnes)
0
20
40
60
80
100
1950
1970
1990
2010

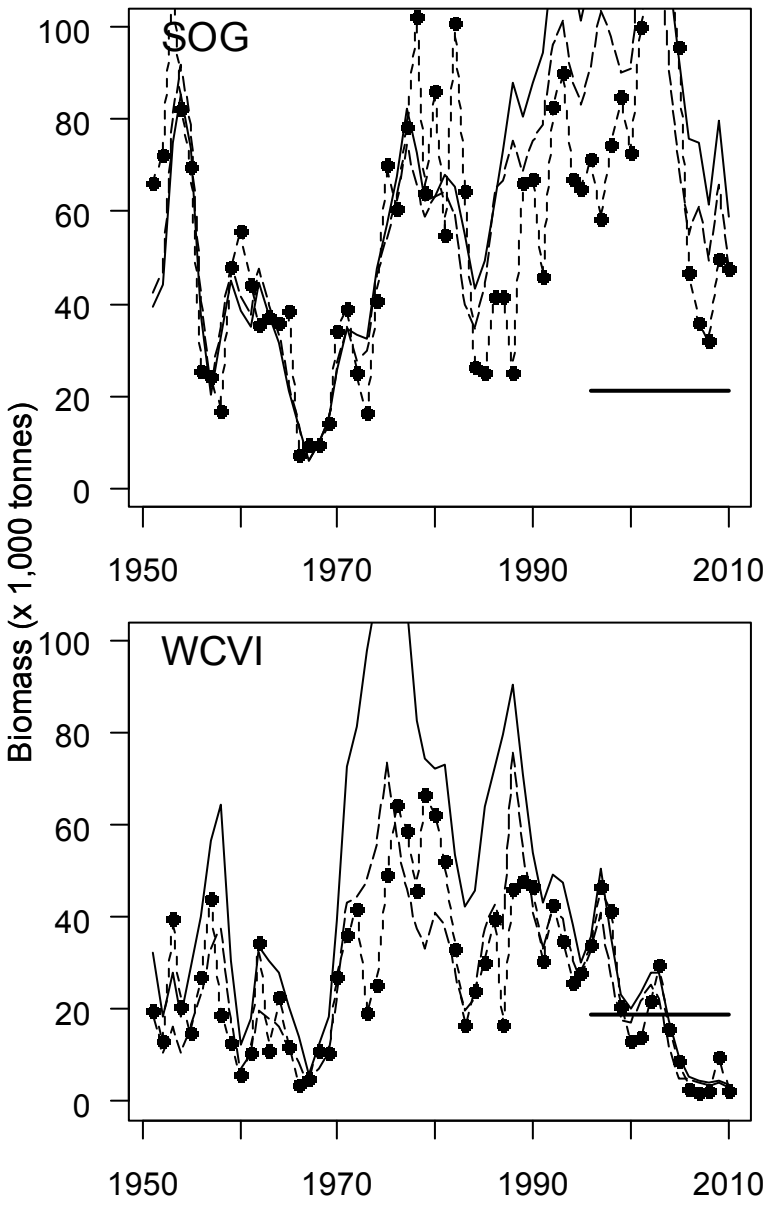


Figure 16. Estimates of pre-fishery stock biomass with comparisons to estimated spawning biomass, spawn index and harvest cutoff levels for all major stock areas.

5.1.5 Recruitment

Recruitment of age 3 fish is estimated as the number of age 3 fish recruited to the stock at the beginning of year *t*. Recruitment is categorized as poor, average or good, and model estimates of recruitment are calculated as average of the lower 33%, middle 33% and upper 33% of the number of age 3 fish over the entire time series. Numbers of recruits and the poor-average and average-good recruitment category divisions (0.33 and 0.66 quantiles) are presented for each major stock area in Figure 17. With the addition of each year of data, these category divisions change slightly to reflect our updated view of poor, average and good

recruitment. The HG (QCI 2E) stock alternates between poor and average recruitment (over the past 10-years), with poor recruitment occurring in 2010. Poor recruitment was also observed for the CC stock, while the PRD stock demonstrated average recruitment. Both the SOG and WCVI stocks showed poor recruitment in 2010. For all stock areas, the 2009 recruitment forecasts were accurate for 2010, in other words, for all stocks the 2009 forecasted recruitment was realized in 2010.

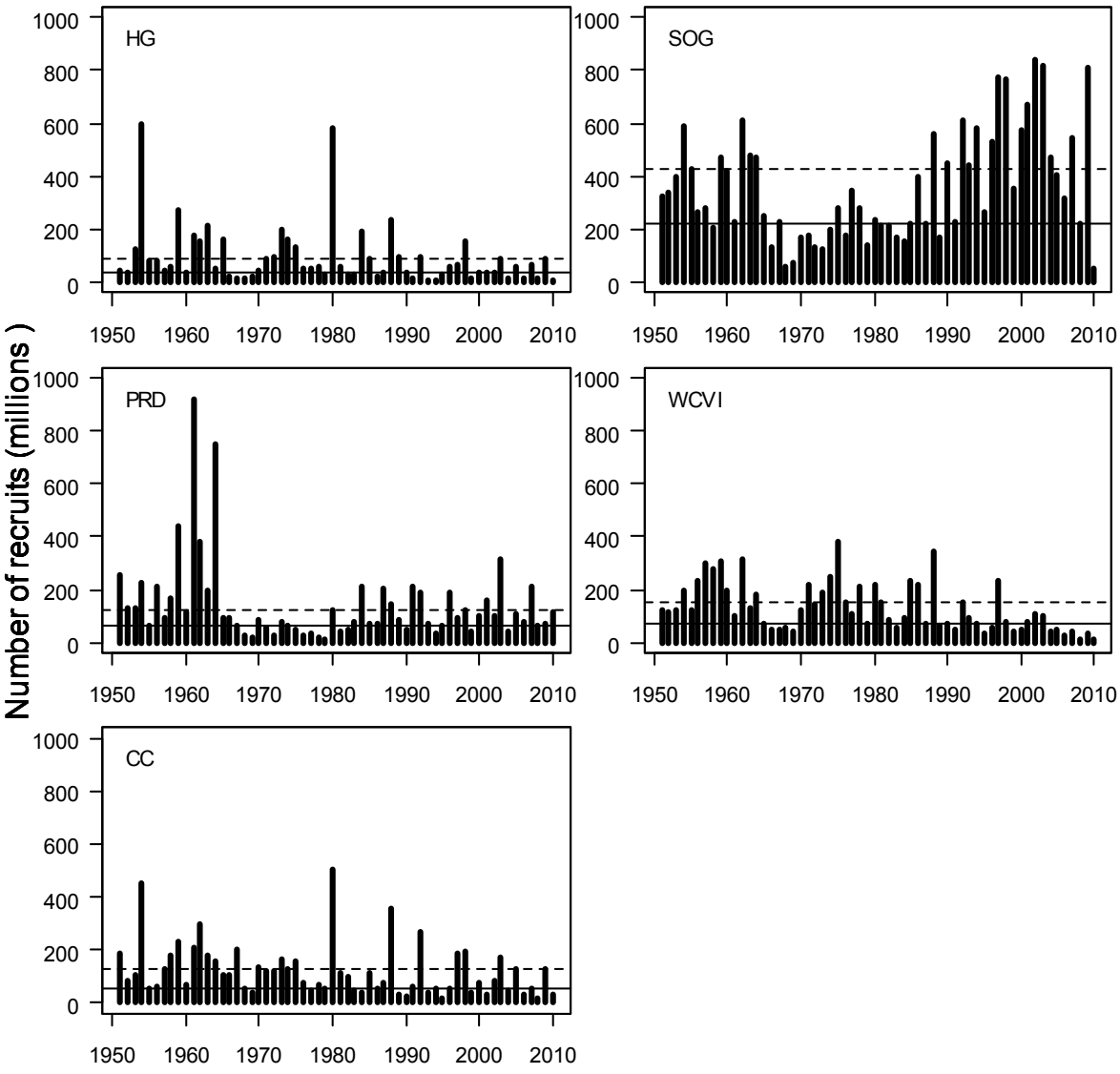


Figure 17. Estimated number of age 3 fish recruiting to the stock in each of the major stock assessment areas. Upper dashed lines represent division between good and average categories of recruitment, lower solid lines represent division between average and poor recruitment. Divisions were calculated as the 0.33 and 0.66 quantiles of the historic numbers of age 3 fish across all years. Recruitment categories for 2010 are as follows: HG- poor; PRD- average; CC- poor; SOG- poor; WCVI- poor.

5.1.6 Gillnet selectivity

Fishery selectivity is estimated separately for all three fishing periods using three different logistic equations (see Appendix B, Model description and documentation). Figure 18 shows the selectivity function for the roe gillnet fishery, estimated using a weight-based logistic function. The average selectivity curves (thick lines) imply that on average herring are not fully-selected to the gillnet fishery until age 8-9. Based on the way the fishery operates, we would expect herring to be fully selected at a younger age, i.e., 6-years, thus future work should examine adjustments to parameters of the selectivity function to more closely reflect operations of the gillnet fishery. For the SOG stock, the observed declines in selectivity at older ages are the result of lower observed fish weight for ages 9-10 than for ages 7-8. Future work should also include comparisons of gillnet and seine selectivity functions to determine whether differences between these functions is reasonable and accurately reflects fishery operations.

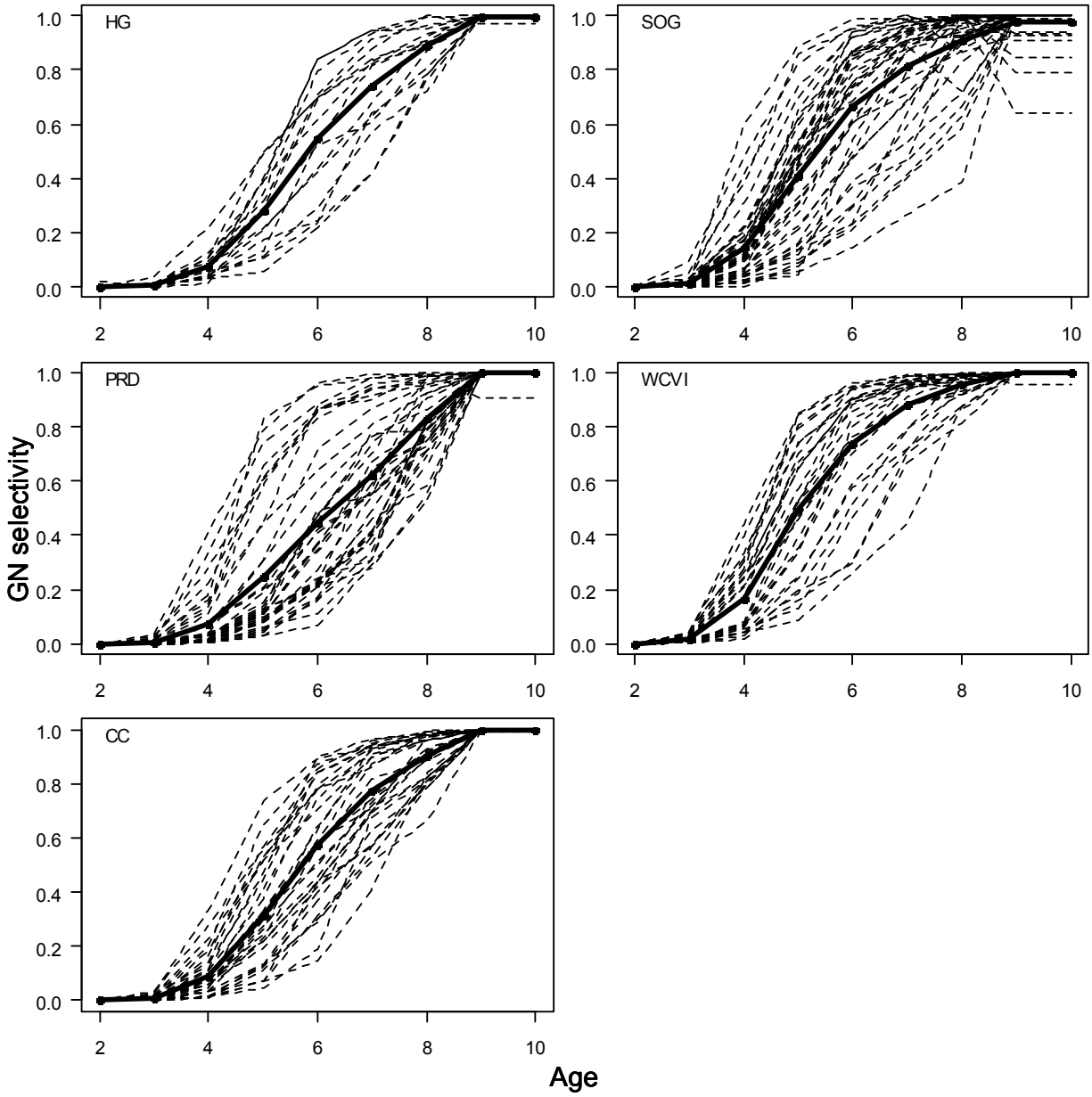


Figure 18. Fishery selectivity for the roe gillnet fishery, estimated using a weight-based logistic function. Each line represents one-year in the time series with average selectivity over all years indicated by the thick black line.

5.1.7 Fishing mortality

From the observed catch, the model estimates the rate of fishing that produced the observed catch, also known as the instantaneous fishing mortality rate. These rates are presented in Figure 19. Historical trends in *F* reflect the intensive fishing of the reduction period, while later *F* values reflect the comparatively low catch rates of recent years.

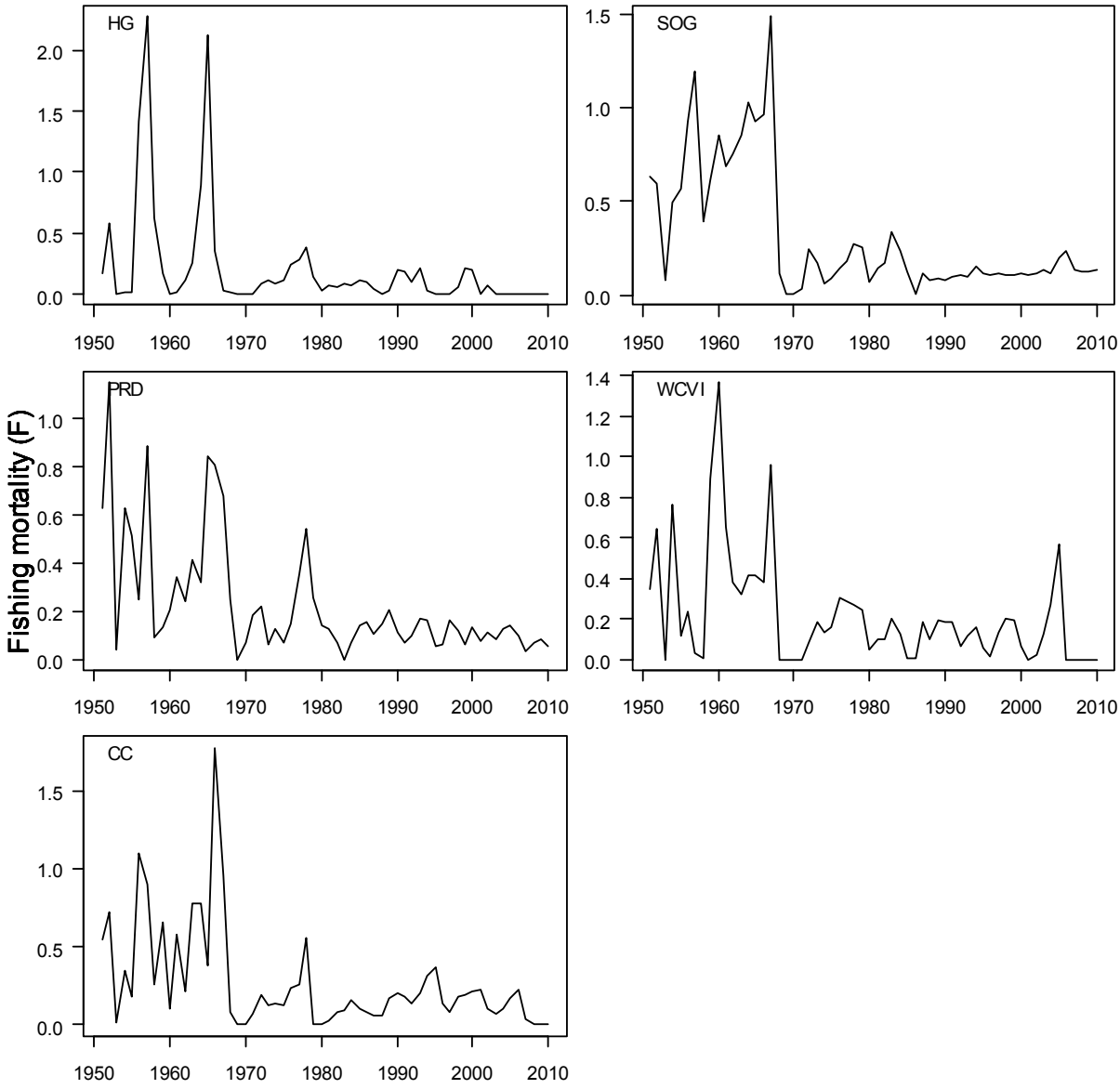


*Figure 19. Estimates of annual instantaneous fishing mortality (*F*) for major B.C. herring stocks from 1951-2010. Estimates of fishing mortality for 2010 are as follows: HG- 0.0; PRD- 0.06; CC- 0.0; SOG- 0.13; WCVI- 0.0.*

5.1.8 Natural mortality

Over the years, a number of different methods have been explored for estimating natural mortality for herring stocks, including: fixed and estimated values for constant *M*, age-dependent *M*, and most recently, annual estimates of *M* using a 'random walk' in the estimation procedure (see Appendix B, Model description and documentation). Using this method, natural mortality is shown to be increasing in all major stocks (Figure 20), with the highest observed rates in areas closed to fishing: HG, CC and WCVI. Further investigation into the mechanisms responsible for increasing trends in model estimates of natural mortality is required. Contributing factors may

include: reductions in food availability, changes or increases in predator communities, or they could be the result of model misspecification.

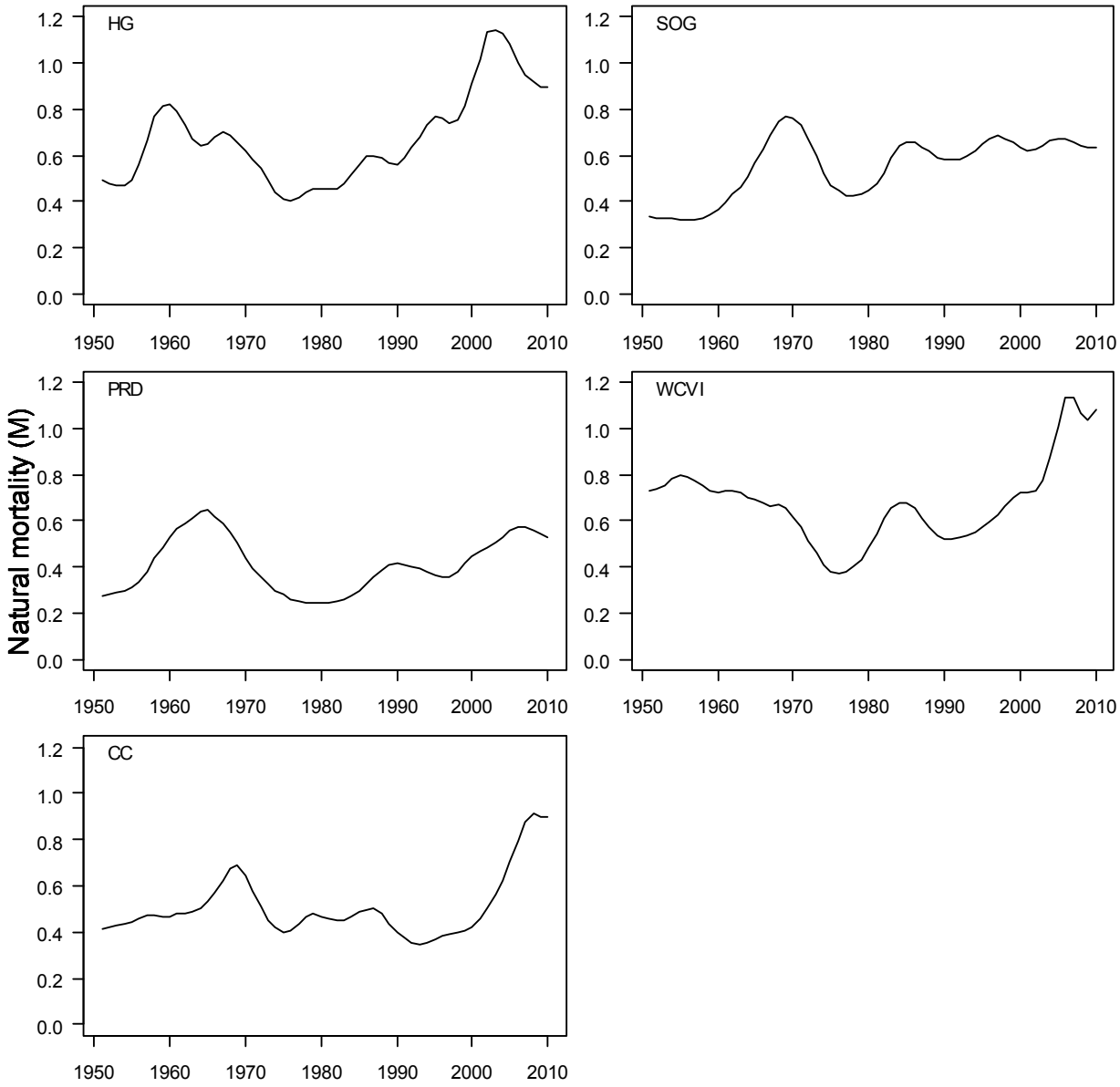


*Figure 20. Estimate of the annual instantaneous natural mortality rate (*M*) for the B.C. herring stocks from 1951-2010, calculated using a random walk approach. Estimates of natural mortality for 2010 are as follows: HG- 0.89; PRD- 0.53; CC- 0.9; SOG- 0.63; WCVI- 1.08.*

Part of the difficulty in differentiating between whether model estimates of high natural mortality are an accurate reflection of herring biology in a 'low productivity' regime or whether the estimation procedure for *M* is capturing noise from other parameters (resulting in increased values of *M*) arises from parameter confounding. For example, parameters such as *F* and *h* (steepness) can be confounded with natural mortality, meaning that when we make a change to one of these parameters this change can be detected in the others. For the 2009 assessment (Cleary et al. 2009) we ran a number of simulations to test the response of changes in *M*, *F* and

h, and found, as expected, a high degree of response in *h* when changes were made to *M*, and vice versa. However, we found little effects on *F*. The lack of trade-off between *M* and *F* is likely the result of model assumptions about catch and biomass, specifically that we have absolute estimates of both (commercial catch is known with high certainty and *q*=1 from 1988 to present). These tests confirmed a degree of confounding among these three parameters, although they do not allow us to confirm whether high *M* values accurately reflect the current productivity regime. Future work will explore the effects of: (1) estimating time-invariant *M*, (2) constraining the year-to-year rate of change in *M* (reducing the variance), (3) fixing *h* at 0.74 (as per Myers et al. 1999) and (4) estimating *h* across all stocks.

5.1.9 Parameter estimation

Marginal posterior distributions are available for all parameters estimated using MCMC routines. We have included posterior distributions (Figure 21) and trace lines (Figure 22) for key model parameters and derived variables which are used for providing science advice on each stock. Median values of the marginal posterior distributions (vertical black dashed lines) are used in calculating pre-fishery forecast biomass and available catch, presented in Table 6.

Ideally, we like to see smooth posterior distributions, such as the posterior distributions for average recruitment and steepness for the WCVI stock. These posterior samples follow a normal distribution and it is clear that there is no interference of the parameter bounds during the parameter estimation procedure. In most cases, the maximum posterior density (MPD) and median of the marginal posterior distributions are similar, as indicated by the high degree of overlap between the solid green and black dashed lines.

Model estimates of steepness (median of the posterior distribution) for all stocks are: HG=0.76, PRD=0.54, CC=0.80, SOG=0.68 and WCVI=0.69.

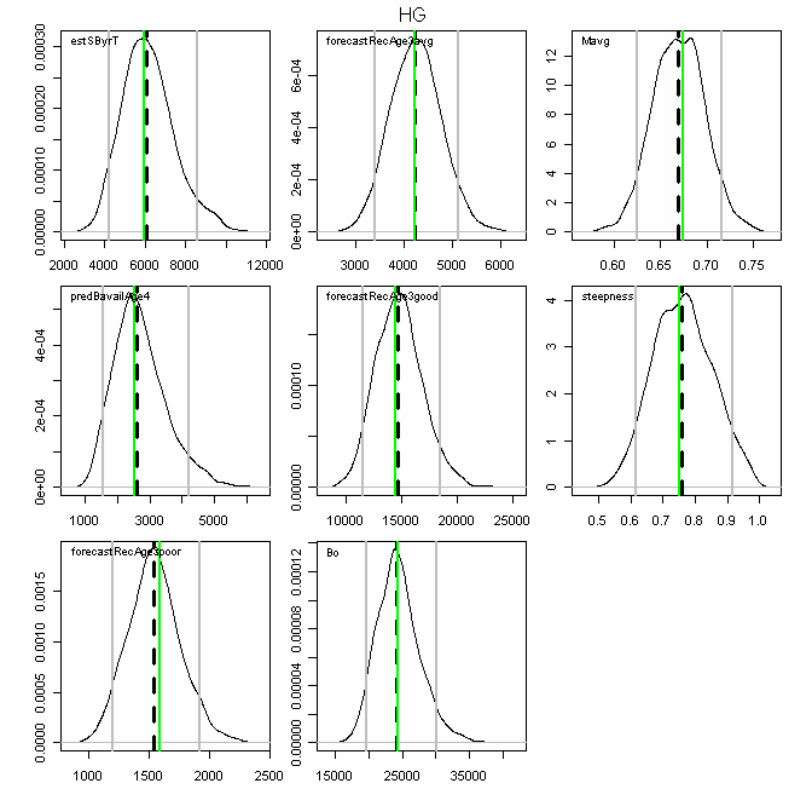


Figure 21. HG

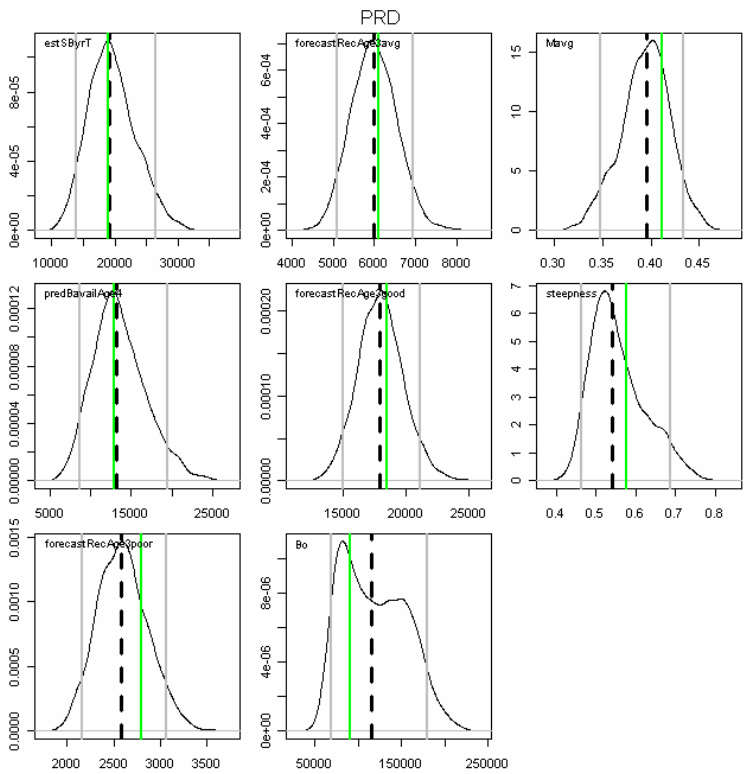


Figure 21. PRD

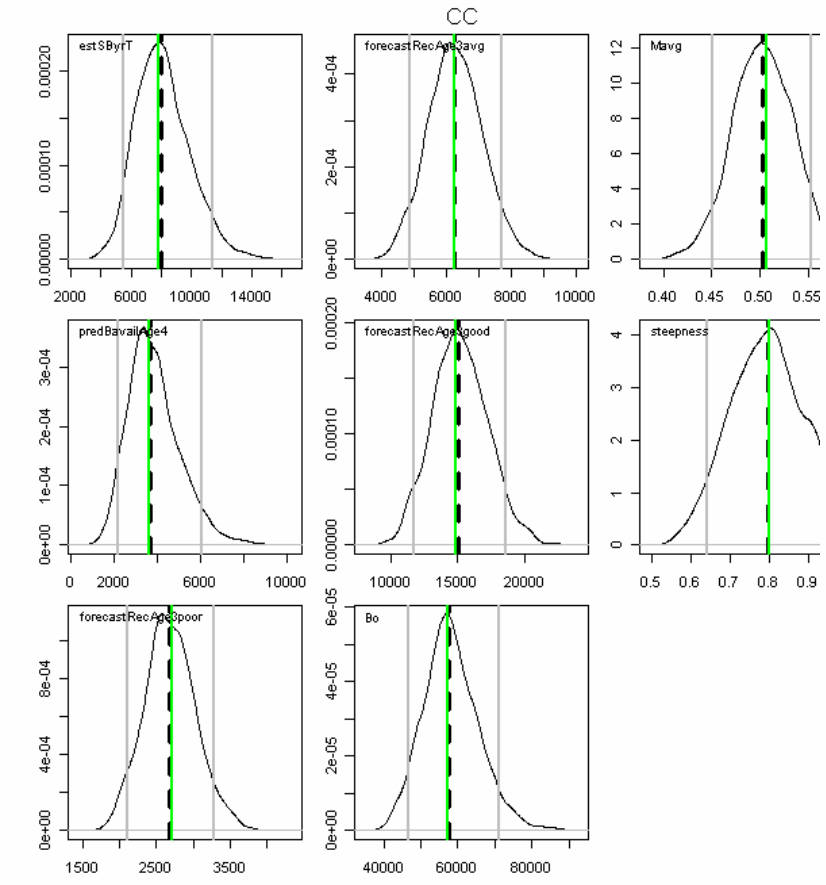


Figure 21. CC

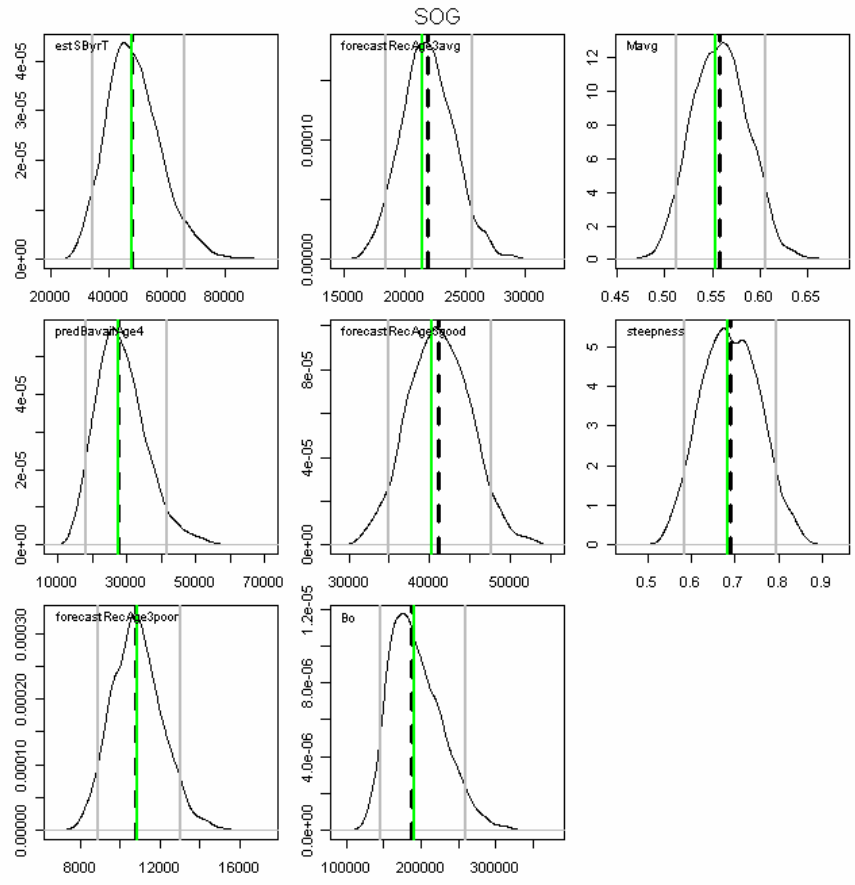


Figure 21. SOG

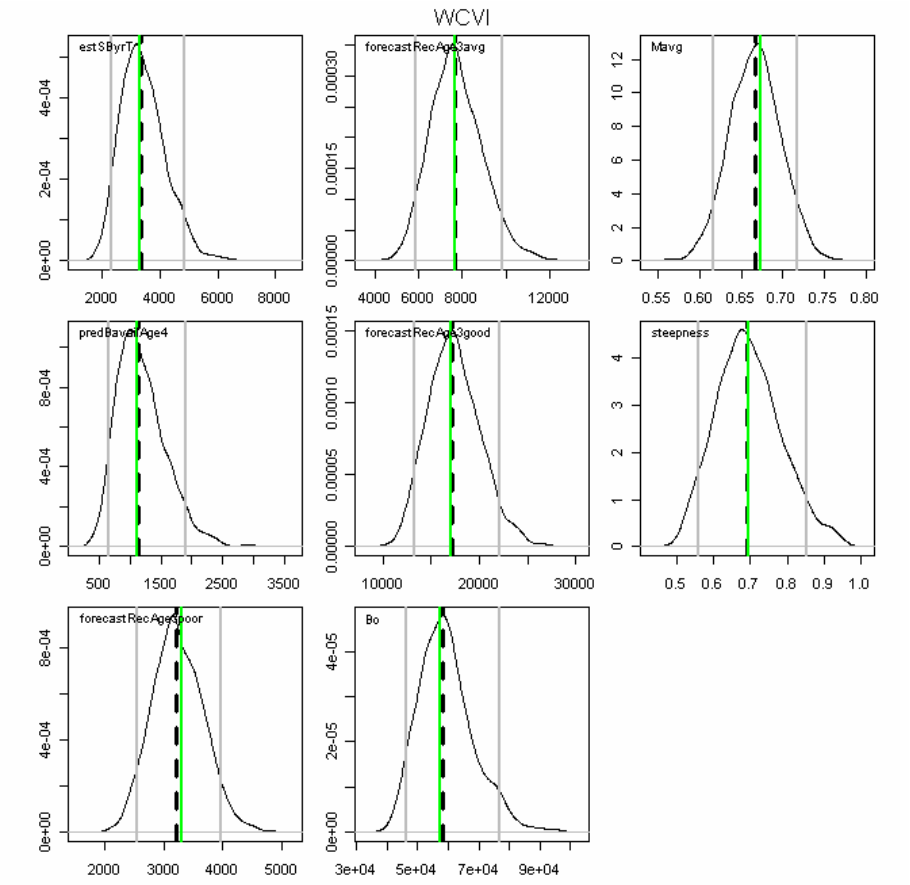


Figure 21. WCVI

Figure 21. Marginal posterior distributions for key parameters of the 2010 assessment, shown for the five major stock areas. Black trend lines outline the marginal posterior distribution for each parameter, vertical black dashed lines represents median posterior values while solid green lines represent MPD estimates. Gray vertical lines denote the 5% and 95% quantiles of the posterior distribution. Estimated parameters include: unfished biomass (B_0), average natural morality (Mavg), and steepness. The other five distributions are key derived variables used for providing science advice to management. These include: estimated spawning biomass in the final year (estSByrT), predicted availability of age 4 and older fish (in biomass, predBavailAge4), and forecast recruitment of age 3 fish under estimates of poor, average and good recruitment (forecastRecAge3poor, forecastRecAge3avg and forecastRecAge3good).

Model runs were examined for convergence through visual inspection of MCMC trace plots (Figure 22). For the HG, CC and WCVI stocks, convergence was apparent for all parameters with a chain length of 2 million. For PRD and SOG stocks we found evidence of non-convergence in the estimation of steepness (h) and unfished biomass (B_0). In attempts to resolve these issues, we ran additional chains up to 20 million iterations. These extra long chains did improve the appearance of the trace plots, and it is likely that additional iterations, up to 50 million, would lead to convergence in all parameters. However, time did not permit these additional simulations.

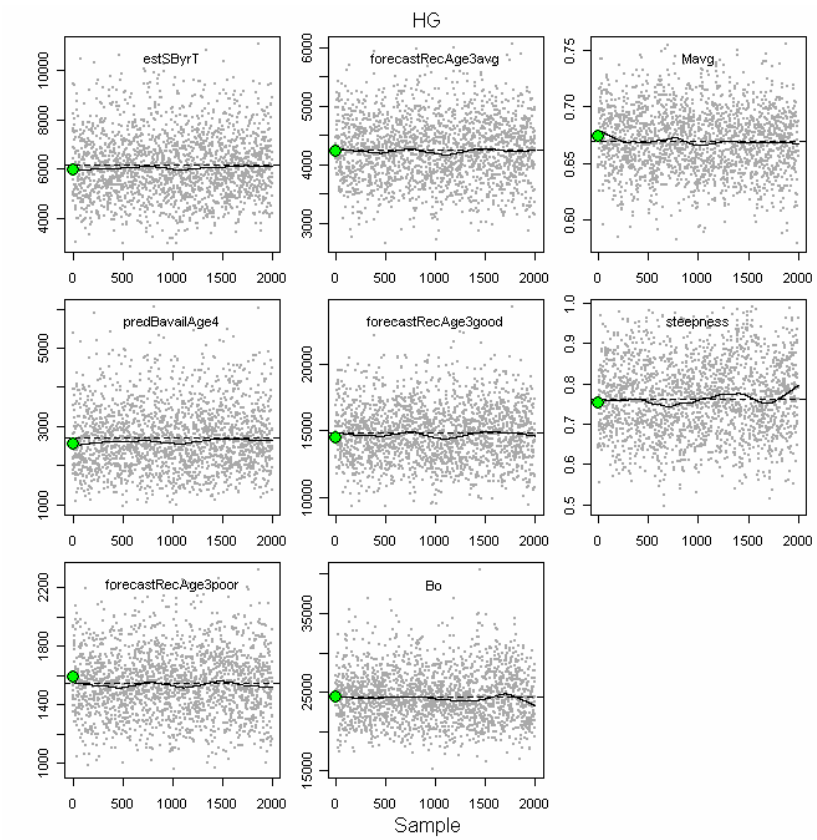


Figure 22. HG

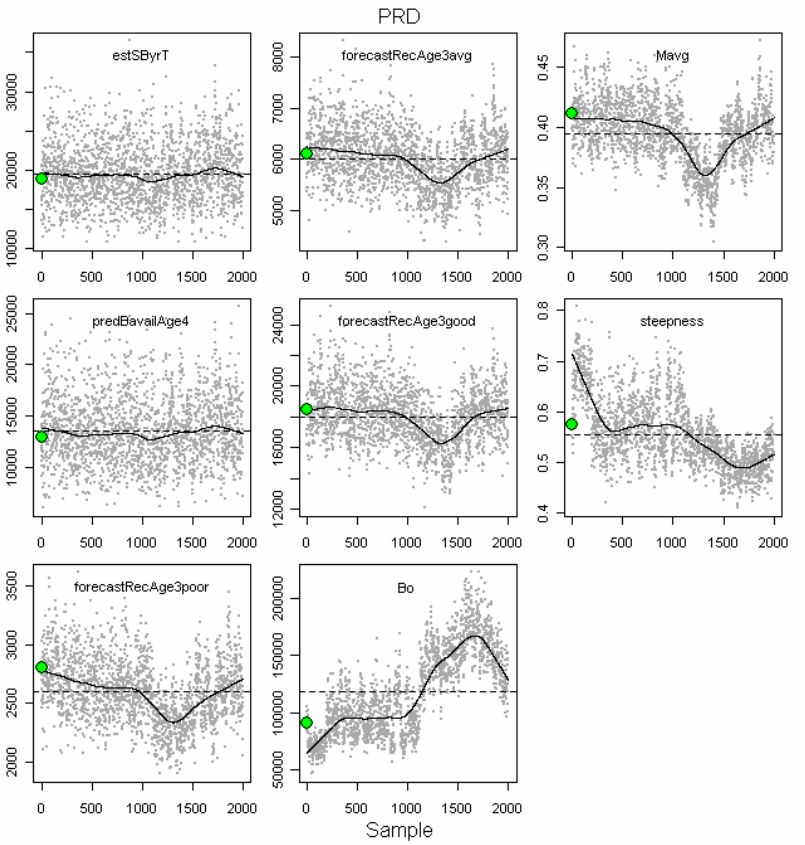


Figure 22. PRD

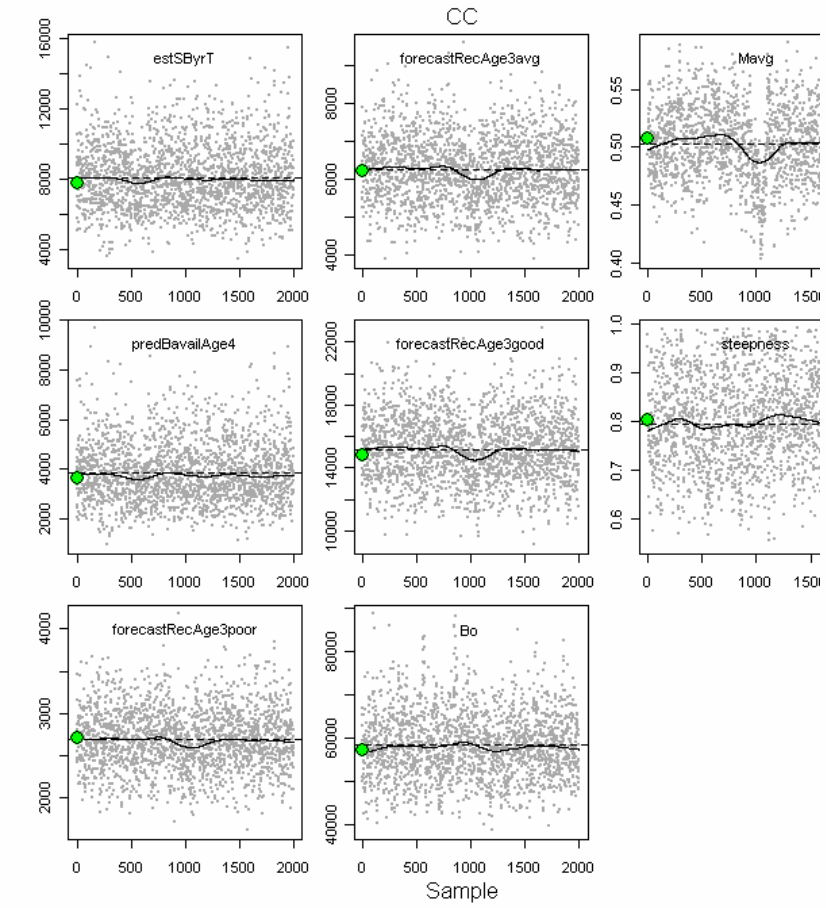


Figure 22. . CC

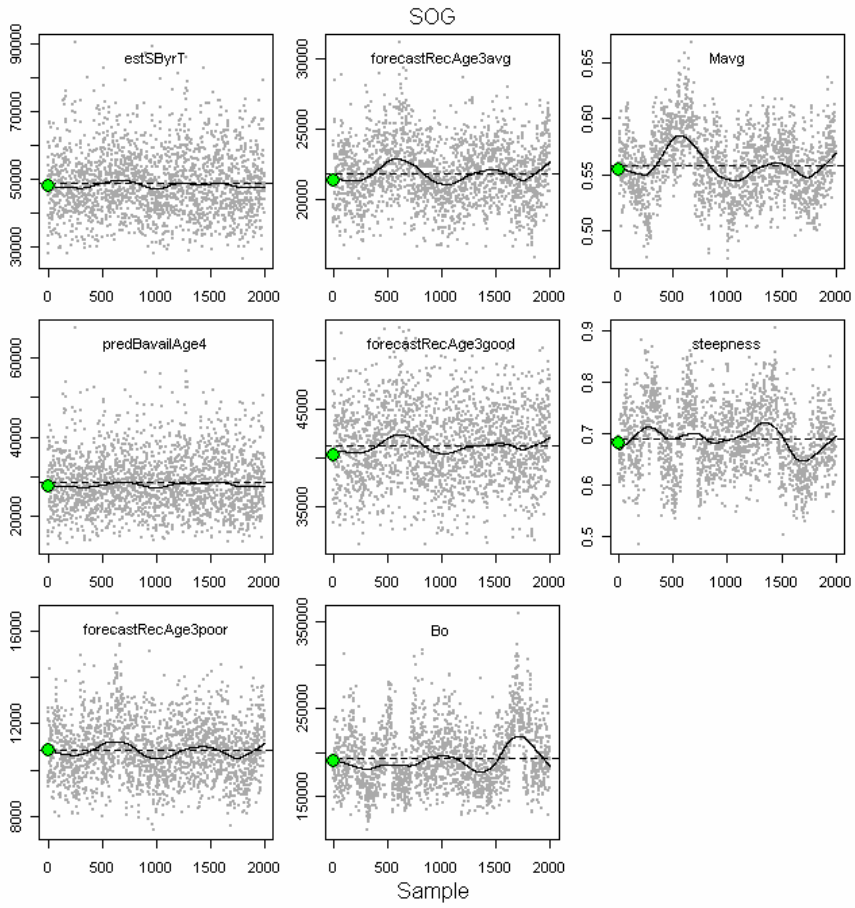


Figure 22.. SOG

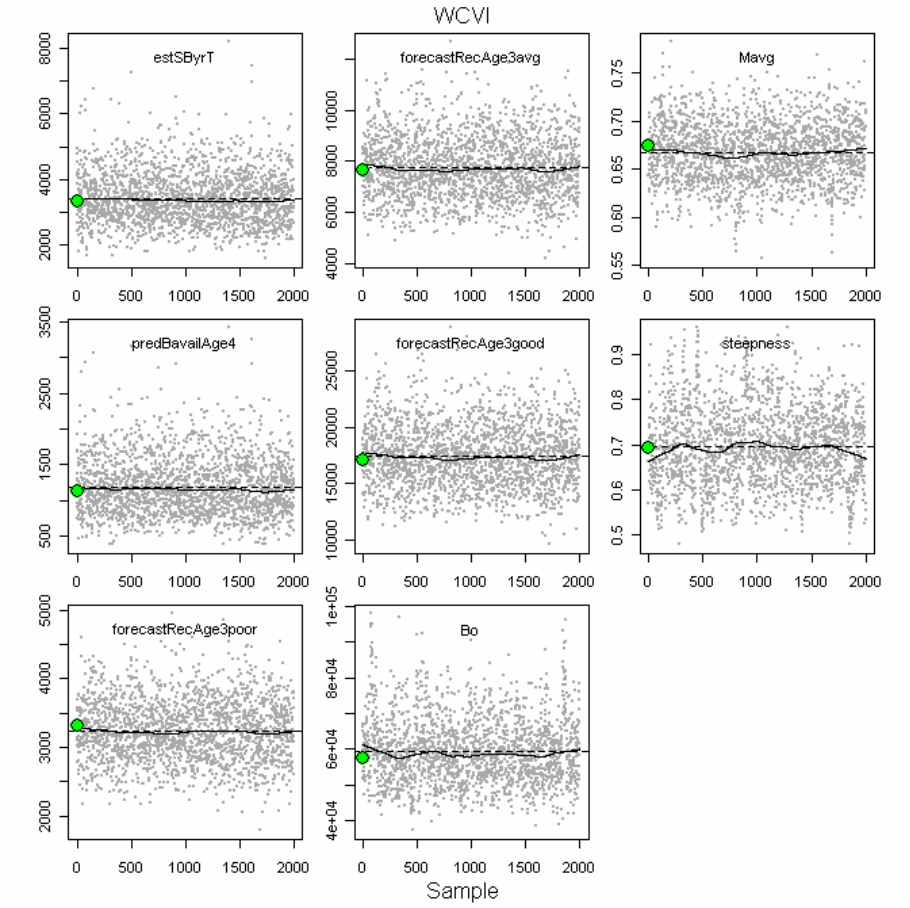


Figure 22 . WCVI

Figure 22. MCMC trace plots for key parameters of the 2010 assessment, shown for the five major stock areas. Black trend lines were generated using a locally-weighted polynomial regression (lowess smoother) and reflect average behaviour across posterior samples. Green points represent MPD estimates, which also correspond to the MLE of each parameter. See Figure 21 caption for parameter and variable descriptions.

5.1.10 Retrospective analysis

A retrospective analysis was conducted for each of the major herring stocks to examine the sensitivity of pre-fishery biomass to the addition of new data (Figure 23). Only maximum likelihood estimates (MLEs) were used for these analyses. These figures show the pre-fishery biomass for each year since 1999, demonstrating the effect of additional data on model performance relative to the estimates from the stock trajectory in the final year. For HG and WCVI stocks, incidences of over- and under-estimation of pre-fishery biomass occur with the same frequency, and thus appear to be unbiased. The PRD and CC stocks show a positive retrospective bias for most years of the analysis, while the SOG stock demonstrates a negative bias for years 1999-2002. In terms of precautionary fisheries management, a persistent positive bias warrants further investigation as it can lead to the stock being subject to a higher harvest rate than is recommended under the herring harvest control rule. Although the cause of these biases is currently unknown, it should be noted that the magnitude of these retrospective biases is much smaller than has been previously observed, prior to the implementation of the HCAMv2 model (Haist and Schweigert 2006, Schweigert et al. 2009).

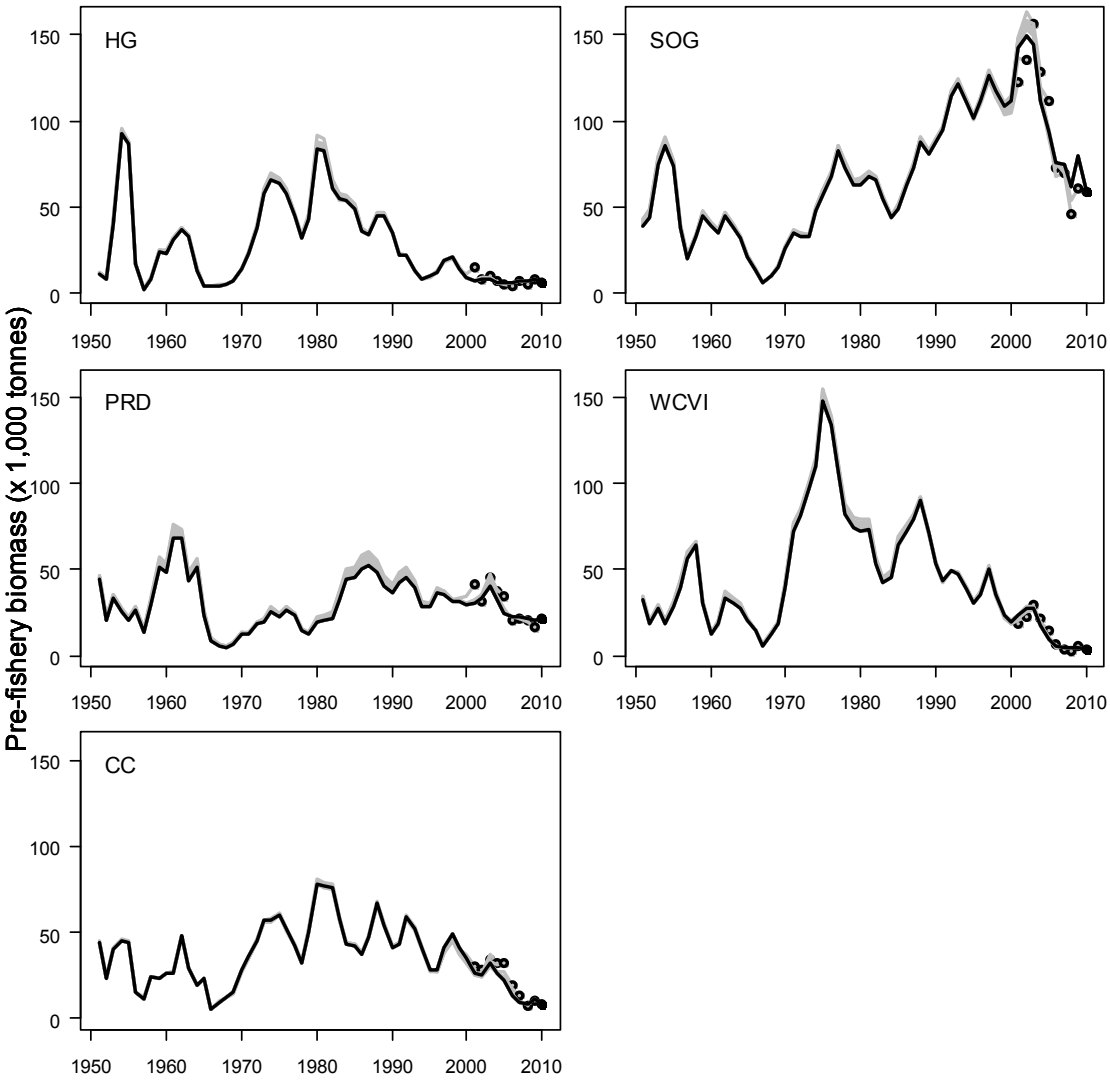


Figure 23. Retrospective maximum likelihood estimates of pre-fishery biomass for the five major stock areas (2001-2010). Black line and solid black circle represent the complete time series. Gray lines and gray filled circles denote terminal year estimates for the reconstruction.

5.2 CATCH ADVICE

Catch advice is provided in the form of a decision table, with pre-fishery biomass and available harvest presented for three recruitment scenarios: poor, average and good. Similar results were obtained using both estimation procedures, however, Table 6 includes only those calculated using median values of the marginal posterior distributions. Time series of model estimates of pre-fishery biomass are presented in Figure 16, and include comparisons of spawning biomass, spawn index and cutoff levels.

Table 6. Estimated spawning stock biomass (2010) and pre-fishery forecast and available harvest for 2011 calculated using median values from the posterior distributions for the major stock areas.

			Pre-fishery Forecast Biomass			Available Harvest			
	2010 SSB	2011 age 4	Poor	Average	Good	Cutoff	Poor	Average	Good
HG	6,046	2,599	**4,140**	6,830	17,340	10,700	below cutoff	below cutoff	3,468
PRD	19,039	13,090	15,757	**19,172**	31,472	12,100	3,151	3,834	6,294
CC	7,974	3,701	**6,374**	9,940	18,768	17,600	below cutoff	below cutoff	1,168
SOG	48,262	28,056	38,669	49,570	**68,886**	21,200	7,734	9,914	13,777
WCVI	3,335	1,130	4,339	**8,778**	18,372	18,800	below cutoff	below cutoff	below cutoff

6 STOCK ASSESSMENT FOR MINOR STOCK AREAS

6.1 MODEL ESTIMATES

Abundance estimates for the minor stock areas, Area 2W and Area 27, were obtained using the HCAMv2 assessment model. Because of data limitations for these minor stocks, the time series for analysis is restricted to the period of 1978-2010. For the most part, the model is parameterized in the same way as was used for the major stock areas. However, there are a few minor differences which are described in Appendix B.

As per the 2008 and 2009 assessments, pre-fishery spawning biomass was estimated assuming one spawn index proportionality coefficient for Area 2W (q) and two for Area 27 (q_1, q_2). For Area 2W, q= 0.49 and for Area 27, q_1= 1.03 and q_2= 1.0.

Update (post-CSAP meeting):

In 2010 the authors encountered a number of difficulties fitting HCAMv2 to the A2W time series of spawn index. This was primarily the result of 'missing years of spawn', a phenomena that has not appeared in the other BC herring stocks (major or minor). Area 2W parameter estimates from HCAMv2 (i.e., q) are included in this document for the purposes of comparisons with previous years. We recognize these values will likely change with further updates to the model (to cope with missing years of spawn).

No 2011 forecast of mature stock biomass for Area 2W is available from the stock assessment model. Given that there is no other currently available information to assess this stock, the 2010 spawn index was used to estimate the 2011 pre-fishery mature stock biomass stock.

6.1.1 Biomass estimates

Spawning stock biomass in 2010 was estimated as 7,593 tonnes (A2W) and 998 tonnes (A27). Time series of model estimates of pre-fishery biomass for the minor stock areas are presented in Figure 24.

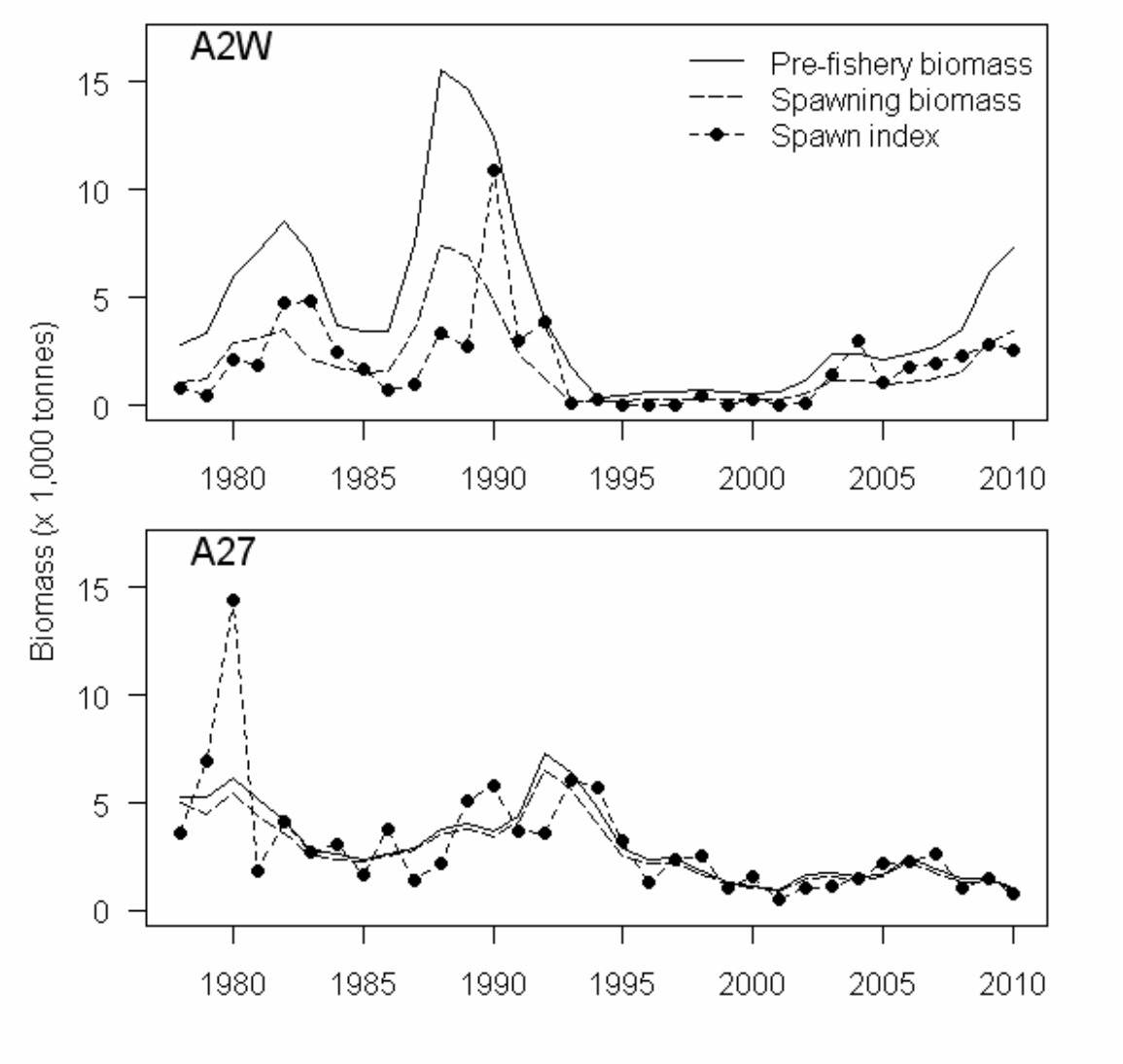


Figure 24. Estimates of pre-fishery spawning stock biomass, estimated spawning biomass and spawn index for the minor stock areas.

6.1.2 Recruitment

Following the same approach used with the major stock areas, recruitment of age 3 fish is estimated as the number of age 3 fish recruited to the stock at the beginning of year *t*. Recruitment is categorized as poor, average or good, and model estimates of recruitment are calculated as mean of the lower 33%, middle 33% and upper 33% of the number of age 3 fish over the entire time series. Numbers of recruits and the poor-average and average-good recruitment category divisions (0.33 and 0.66 quantiles) are presented for the minor stock areas in Figure 25. With the addition of each year of data, these category divisions change slightly to reflect our updated view of poor, average and good recruitment. Based on this year's information, Area 2W showed good recruitment for 2010 while for Area 27 recruitment was poor.

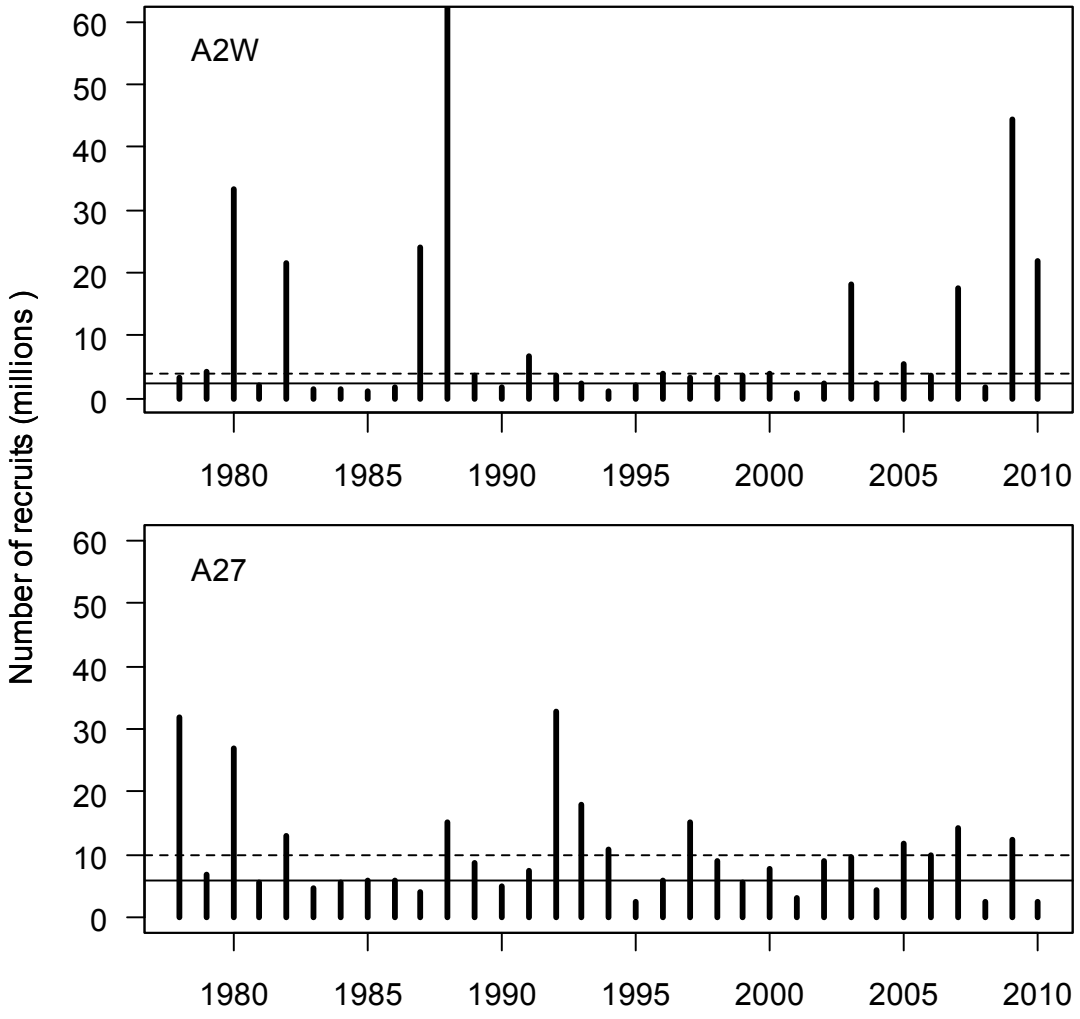


Figure 25. Estimated number of age 3 fish recruiting to the stock for the minor stock assessment areas (A2W and A27). Upper dashed lines represent division between good and average categories of recruitment, lower solid lines represent division between average and poor recruitment. Divisions were calculated as the 0.33 and 0.66 quantiles of the historic numbers of age 3 fish across all years.

6.2 CATCH ADVICE

Catch advice is provided in the form of a decision table, with pre-fishery biomass and available harvest presented for three recruitment scenarios: poor, average and good. Results presented in Table 7 are calculated using median values of the marginal posterior distributions. Cutoff values are not available for the minor stock areas and instead available harvest represents a 10% harvest rate. Recruitment forecasting rules for the minor stock areas (section 0) specify average recruitment, regardless of forecast stock biomass.

Table 7. Estimated spawning stock biomass (2010) and pre-fishery forecast and available harvest for 2011 calculated using median values from the posterior distributions for the minor stock areas.

			Pre-fishery Forecast Biomass				Available Harvest		
	2010 SSB	2011 age 4	Poor	Average	Good	Cutoff	Poor	Average[1]	Good
A2W	7,593[2]	4,723[2]	-	2,532[3]	-	NA	-	253[3]	-
A27	998	342	601	935	1,695	NA	60	94	170

[1] Current decision rule: Assume average recruitment for all minor stock areas.

[2] From HCAMv2.

[3] No 2011 forecast of mature stock biomass for Area 2W is available from the stock assessment model. Given that there is no other currently available information to assess this stock, the 2010 spawn index was used to estimate the 2011 pre-fishery mature stock biomass.

7 OUTSTANDING ISSUES

Following the completion of this year's herring stock assessment, we feel there are a number of areas which require further investigation. Some of these areas of uncertainty were also discussed at the Herring Stock Assessment workshop held on June 17-18, 2010. Future research will:

1. Re-evaluate cutoff levels for the major stock areas and update estimates of unfished biomass for all stock areas. This should include review of fishing thresholds applied to other herring populations and other species with similar life histories.
2. Explore alternate formulations for estimating *q*.
3. Improve our understanding of the relationship between natural mortality and steepness in order to determine whether high observed values of *M* and *h* are biologically reasonable for the B.C. herring stocks.
4. Explore different methods of recruitment forecasting.
5. Explore modelling effects from varying spawn-on-kelp mortality, ideally in association with acquiring accurate SOK fishery data.
6. Explore additional methods of defining natural mortality, including: (1) estimating time-invariant *M*, (2) constraining the year-to-year rate of change in *M* (reducing the variance) and (3) fixing *h* at 0.74 (as per Myers et al. 1999).
7. Explore the impacts of estimating steepness across all stocks.

We feel these uncertainties represent important areas of research for B.C. herring stocks. They are however complex issues and need to be examined in the context of the entire management system. Future work will include the development of *candidate* operating models for use in the context of a management strategy evaluation.

ACKNOWLEDGEMENTS

The authors would like to thank Charles Fort and Kristen Daniel for their continued efforts in error checking, reviewing and updating the catch, spawn survey and biological sampling databases. We would also like to acknowledge Howard Stiff for providing programming support for the MS Access database used to summarize the assessment data time series.

Funding for the test fishing and spawn survey programs was provided by DFO through Larocque relief funds through a contract to the HCRS. The herring industry provided additional biological samples for the SOG and PRD stock areas through a modified roe testing program.

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APPENDIX A INPUT AND OUTPUT DATA

Appendix 1.1. Age composition and catch by season, fishery and gear type for Haida Gwaii (QCI 2E) 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	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	0	+	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-	0.00	81.58	16.68	1.26	0.18	0.14	0.14	0.00	0.00	0.00	52.1	0	+	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	0	+	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	0	+	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-	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	0	+	7,711	67.645
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-	0.00	0.37	50.00	27.11	18.16	2.11	1.99	0.00	0.12	0.12	109.5	0	+	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		28,617	251.193
	Seine	May-	0.00	1.02	15.92	60.00	16.53	5.31	1.22	0.00	0.00	0.00	113.9	0	+	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	0	+	46	0.401
19645	Seine	Jan-Apr	0.00	1.85	80.28	11.38	4.06	1.41	0.65	0.36	0.00	0.00	100.5	1,115		35,304	351.154
	Seine	May-	0.00	1.97	77.40	12.74	4.93	1.61	0.81	0.54	0.00	0.00	100.4	0	+	145	1.442
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	0	+	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-	0.00	0.13	33.28	45.41	13.55	5.29	1.72	0.46	0.17	0.00	116.3	0	+	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	0	+	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-	0.00	0.44	2.81	36.87	29.25	23.18	6.41	0.96	0.07	0.00	151.8	0	+	374	2.466
	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	0	+	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-	0.00	0.09	19.67	8.12	29.70	22.91	14.66	4.44	0.41	0.00	157.1	0	+	21	0.132
	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	0	+	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
	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	0	+	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	0	+	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
	Trawl	Oct-Dec	0.00	6.22	4.91	32.53	18.23	20.31	14.19	3.06	0.44	0.11	149.9	0	+	65	0.436
	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	0	+	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
	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-	0.00	1.33	3.92	88.65	2.94	1.73	0.69	0.35	0.23	0.17	112.7	0	+	39	0.342
	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-	0.00	0.85	4.68	4.48	84.32	2.47	1.53	0.99	0.54	0.14	128.0	0	+	18	0.138
	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-	0.00	4.88	5.23	3.51	6.86	72.87	3.91	1.58	0.91	0.25	146.9	0	+	67	0.457
	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-	0.00	2.70	36.39	4.54	2.87	10.10	41.76	1.12	0.34	0.17	125.5	0	+	58	0.459
	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	0	+	535	3.459

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

Appendix 1.1. Age composition and catch by season, fishery and gear type for the Haida Gwaii (QCI 2E) 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)	
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-	0.00	0.10	8.15	24.49	3.51	3.95	12.94	46.22	0.54	0.10	165.5	0	+	35	0.209	
	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	0	+	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	~
	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	0	+	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-	0.00	1.74	10.42	5.85	24.35	37.76	3.84	4.33	5.79	5.91	157.2	0	+	33	0.210	
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-	0.00	1.34	41.98	5.34	3.24	14.50	22.71	1.91	1.72	7.25	136.5	0	+	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	~
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-	0.00	1.27	31.75	45.90	4.03	2.55	7.00	4.81	1.06	1.63	117.4	0	+	13	0.108	
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	
	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	0	+	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	~
	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	0	+	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	~
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	~
	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	0	+	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	~
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	~
19978	Seine	Jan-Apr	0.00	0.23	55.83	27.55	10.64	2.70	0.51	1.11	1.04	0.39	86.8	2,327		2,093	24.012	
19989	Seine	Jan-Apr	0.00	3.71	2.16	65.00	16.83	8.03	2.78	0.67	0.41	0.41	105.9	1,943		2,500	23.604	
	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		736	5.602	
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		1,765	16.491	
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	~
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	7.544	
20023	Seine	Jan-Apr	0.00	0.08	68.16	18.33	6.43	3.24	1.13	2.10	0.40	0.12	96.7	2,472		0	0.000	~
20034	Seine	Jan-Apr	0.00	29.35	2.37	50.65	8.76	4.02	2.60	1.42	0.59	0.24	91.5	845		0	0.000	~
20045	Seine	Jan-Apr	0.00	1.30	46.29	15.66	28.57	3.90	2.37	1.22	0.46	0.23	93.9	1,309		0	0.000	~
20056	Seine	Jan-Apr	0.00	19.07	10.10	42.78	9.40	15.15	2.81	0.42	0.00	0.28	83.3	713		0	0.000	~
20067	Seine	Jan-Apr	0.00	1.10	45.24	14.29	20.88	5.86	10.26	2.20	0.18	0.00	93.5	546		0	0.000	~
20078	Seine	Jan-Apr	0.00	9.35	7.39	63.37	7.61	8.59	1.85	1.63	0.00	0.22	87.5	920		0	0.000	~
20089	Seine	Jan-Apr	0.00	0.10	64.31	7.58	22.13	1.99	2.89	0.40	0.50	0.10	79.0	1,003		0	0.000	~
20090	Seine	Jan-Apr	0.00	3.82	6.86	63.08	6.07	16.65	1.76	1.27	0.29	0.20	98.0	1,021		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

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)
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-	0.05	4.76	8.81	33.65	45.22	6.14	1.03	0.30	0.03	0.00	119.2	0	+	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	0	+	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	0	+	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-	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	0	+	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	0	+	667	10.640
	Seine	May-	0.00	58.55	24.14	6.24	7.24	0.80	3.02	0.00	0.00	0.00	62.7	0	+	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	0	+	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-	0.00	1.17	62.96	19.29	6.19	6.74	2.21	1.44	0.56	0.00	98.7	0	+	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	0	+	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-	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	0	+	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	0	+	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-	0.00	10.08	59.51	7.23	17.13	4.07	1.43	0.42	0.13	0.00	93.9	0	+	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	0	+	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	0	+	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	0	+	25,352	237.877
	Seine	May-	0.00	6.70	32.01	38.46	7.44	11.41	2.23	0.74	0.74	0.25	106.6	0	+	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	0	+	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	0	+	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-	0.00	60.74	16.33	12.62	7.12	1.42	1.69	0.01	0.00	0.07	74.6	0	+	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	0	+	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	0	+	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-	0.00	2.89	67.52	11.86	10.20	6.38	0.60	0.43	0.11	0.02	80.8	0	+	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	0	+	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	0	+	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-	0.00	6.54	15.87	50.81	10.48	9.83	5.18	0.95	0.34	0.77	124.0	0	+	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-	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-	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

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

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)	
19678	Seine	May-	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-	0.00	5.79	45.91	31.35	9.51	5.05	1.63	0.59	0.15	0.00	92.2	0	+	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	0	+	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	0	+	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-	0.00	3.89	35.37	4.95	27.58	23.05	3.26	1.26	0.63	0.00	133.3	0	+	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	0	+	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	
	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	0	+	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	0	+	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	
	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	0	+	276	1.793	
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	0	+	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-	0.00	0.16	18.12	7.08	22.73	31.85	13.84	4.45	1.32	0.44	149.8	0	+	31	0.204	
	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	0	+	1,494	8.948	
	Gillnet	May-	0.00	0.00	1.07	2.14	19.93	54.09	14.59	6.76	1.42	0.00	166.9	0	+	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-	0.00	1.73	12.50	38.39	9.35	18.12	15.88	2.73	0.92	0.38	147.1	0	+	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	0	+	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	~
	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	0	+	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-	0.00	2.19	14.84	11.37	28.12	14.72	17.26	6.93	2.94	1.62	151.3	0	+	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	~
	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	0	+	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	0	+	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	~
	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	0	+	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	~
	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	0	+	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	~
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	~
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-	0.00	0.72	36.17	14.18	10.77	13.79	22.65	1.27	0.28	0.17	102.7	0	+	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	0	+	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	~
	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-	0.00	2.15	7.95	50.48	14.31	7.07	10.01	7.61	0.27	0.17	108.3	0	+	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	0	+	83	0.787	
	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	

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

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)	
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	0	+	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-	0.00	1.69	13.34	9.55	46.09	10.53	5.26	7.46	5.98	0.10	137.1	0	+	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	~
	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	0	+	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-	0.00	1.06	36.99	9.81	7.06	32.66	6.01	3.21	2.31	0.89	117.1	0	+	52	0.448	
	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	0	+	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-	0.00	0.45	30.98	38.94	5.97	8.35	11.53	1.95	1.45	0.38	102.6	0	+	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	~
	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	0	+	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	
	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-	0.00	0.14	14.00	25.59	26.19	24.51	3.85	3.58	1.99	0.14	120.9	0	+	32	0.263	
	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	
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-	0.00	0.55	40.80	10.75	16.94	17.49	11.29	1.82	0.00	0.36	108.1	0	+	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	~
	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-	0.00	0.70	24.97	53.31	5.57	5.34	5.23	3.95	0.46	0.46	96.2	0	+	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	~
	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-	0.00	0.40	21.17	25.83	39.41	4.26	3.73	3.20	1.73	0.27	101.3	0	+	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	~
	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	~
	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	
	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	~
	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	~
	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	~
	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		3,945	30.856	
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		256	2.426	
	Gillnet	Jan-Apr	0.00	0.00	0.00	11.17	16.23	48.99	13.23	4.72	2.20	3.46	126.1	721		1,877	14.863	
19990	Seine	Jan-Apr	0.00	1.70	24.62	8.21	36.56	14.42	11.61	1.98	0.40	0.50	98.8	3,972		1,239	12.203	
	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		3,076	23.002	
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	9.740	
	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		1,906	14.186	
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	0	+	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	
	Gillnet	Jan-Apr	0.00	0.00	0.11	7.11	20.37	11.69	27.39	15.79	15.28	2.26	142.0	1,059		2,432	16.995	
20023	Seine	Oct-Dec	0.00	0.79	67.83	13.49	11.10	3.13	1.52	1.15	0.48	0.51	85.1	0	+	5	0.068	
	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	
	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	18.758	
20034	Seine	Oct-Dec	0.00	0.91	1.98	69.32	11.20	10.06	4.20	0.91	1.27	0.16	93.7	0	+	11	0.116	
	Seine	Jan-Apr	0.00	0.88	1.76	69.88	10.58	9.88	4.45	0.97	1.39	0.19	96.0	2,155		1,909	19.886	
	Gillnet	Jan-Apr	0.00	0.00	0.09	21.84	13.52	36.88	15.40	4.92	4.74	2.60	134.5	1,117		2,192	16.303	

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

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)
20045	Seine	Jan-Apr	0.00	0.75	26.86	8.94	45.29	9.23	6.00	2.02	0.51	0.42	91.1	2,972	1,750	18.938
	Gillnet	Jan-Apr	0.00	0.00	0.00	0.80	46.42	18.04	25.86	5.84	1.33	1.72	134.5	754	2,050	15.237
20056	Seine	Jan-Apr	0.00	1.45	16.34	44.33	8.80	22.99	3.90	1.60	0.45	0.15	87.1	2,001	957	10.981
	Gillnet	Jan-Apr	0.00	0.00	0.00	2.77	7.19	59.82	15.23	13.61	1.38	0.00	128.7	577	1,661	12.941
20067	Seine	Jan-Apr	0.00	3.69	48.50	21.99	10.66	3.01	9.84	1.23	0.96	0.14	71.6	732	0	0.000 ~
	Gillnet	Jan-Apr	0.00	0.08	0.90	3.26	16.94	8.79	51.30	12.21	5.29	1.22	127.5	1,228	969	7.606
20078	Seine	Jan-Apr	0.00	1.50	9.82	56.89	13.82	10.45	2.18	4.24	0.75	0.36	93.3	2,526	513	5.498
	Gillnet	Jan-Apr	0.00	0.00	0.08	10.53	8.52	18.71	9.02	43.36	6.43	3.34	128.3	1,197	1,148	8.951
20089	Seine	Jan-Apr	0.00	0.08	23.78	14.00	45.78	7.70	5.72	1.28	1.59	0.08	100.8	2,586	713	7.077
	Gillnet	Jan-Apr	0.00	0.00	0.11	2.19	44.42	20.46	15.75	5.80	10.07	1.20	126.1	914	1,286	10.196
20090	Seine	Jan-Apr	0.00	0.79	36.94	31.67	8.83	16.83	3.03	1.33	0.21	0.37	87.3	2,412	475	5.434
	Gillnet	Jan-Apr	0.00	0.00	0.00	2.19	8.30	56.75	16.72	9.00	3.58	3.46	132.2	867	1,010	7.633

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

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-	1.11	5.12	19.85	29.75	37.71	4.45	1.52	0.44	0.04	0.02	112.3	0	+	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-	0.07	4.04	69.18	20.52	4.63	1.34	0.16	0.00	0.07	0.00	71.1	0	+	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-	0.04	16.97	13.60	9.12	56.99	2.89	0.34	0.04	0.00	0.02	105.4	0	+	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-	0.00	23.13	49.84	9.53	5.03	11.85	0.59	0.02	0.00	0.00	79.6	0	+	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-	0.00	47.57	42.11	7.27	2.01	0.42	0.62	0.00	0.00	0.00	64.8	0	+	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	0	+	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-	0.00	16.18	32.43	10.82	29.70	9.92	0.79	0.11	0.04	0.00	91.1	0	+	104	1.136
	Trawl	May-	0.00	16.18	32.43	10.82	29.70	9.92	0.79	0.11	0.04	0.00	91.1	0	+	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	0	+	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-	0.00	7.65	54.80	20.82	2.85	11.39	2.31	0.18	0.00	0.00	94.1	0	+	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	0	+	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	0	+	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-	0.00	14.03	46.96	27.37	10.09	1.45	0.09	0.00	0.00	0.00	91.1	0	+	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	0	+	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	0	+	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-	0.00	8.49	36.46	33.62	15.63	5.41	0.33	0.06	0.00	0.00	111.9	0	+	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-	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-	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-	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	0	+	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-	0.00	1.21	49.64	18.40	15.98	12.11	2.02	0.48	0.16	0.00	124.7	0	+	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	0	+	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	0	+	5,395	35.308

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

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)	
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-	0.00	0.18	29.21	16.70	21.83	20.76	8.28	2.38	0.50	0.17	124.6	0	+	46	0.369	
	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-	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	
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	0	+	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	~
	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	0	+	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-	0.00	3.78	14.57	63.82	7.83	6.03	2.80	0.67	0.36	0.13	99.2	0	+	6	0.063	
	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	
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-	0.00	0.61	11.52	10.17	66.35	5.52	4.26	1.26	0.30	0.00	131.9	0	+	0	0.003	
	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	
	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	
	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	
	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	0	+	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	0	+	7	0.054	
	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	
	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-	0.00	0.81	65.96	12.42	6.14	8.29	1.66	1.73	1.66	1.34	110.9	0	+	18	0.162	
	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	
	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	
	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	
	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	
	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	
	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	
	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	
	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	
	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	
	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	0.57	31.97	41.69	8.77	2.55	5.02	4.40	4.08	0.96	90.0	4,825		12,670	134.718	
	Gillnet	Jan-Apr	0.00	0.00	0.50	14.82	14.10	8.79	17.60	15.74	20.76	7.69	140.4	1,031		800	5.675	
19989	Seine	Jan-Apr	0.00	0.38	8.39	39.74	34.48	7.66	2.21	2.88	2.72	1.55	100.2	3,861		6,125	59.905	
	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	17.33	10.45	32.95	28.80	6.40	1.45	1.17	1.26	112.6	4,527		6,394	55.294	
	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		972	7.304	
20001	Seine	Jan-Apr	0.01	2.12	7.10	24.85	12.46	25.25	21.35	5.12	1.17	0.57	117.5	3,070		5,613	47.004	
	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	3.823	

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

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)	
20012	Seine	Jan-Apr	0.00	4.14	33.85	10.20	16.51	5.90	19.75	8.00	1.35	0.29	96.5	5,894	2,894	29.510	
	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	21.910	
	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	2.020	
20034	Seine	Jan-Apr	0.00	1.27	6.44	65.95	16.06	2.98	3.46	1.74	1.67	0.43	96.1	2,094	2,988	30.990	
20045	Seine	Jan-Apr	0.00	0.50	33.48	16.62	34.91	9.13	1.96	1.74	1.09	0.58	88.5	5,728	3,778	41.595	
20056	Seine	Jan-Apr	0.00	0.84	10.82	56.17	10.59	16.51	3.51	0.77	0.60	0.19	86.7	5,835	3,072	35.945	
20067	Seine	Jan-Apr	0.29	1.32	29.35	20.47	29.70	9.33	7.73	1.35	0.38	0.08	86.3	2,343	398	4.586	
20078	Seine	Jan-Apr	0.00	9.76	9.89	44.65	12.47	16.67	2.98	2.91	0.54	0.14	80.1	1,476	0	0.000	~
20089	Seine	Jan-Apr	0.00	2.13	73.14	10.94	8.45	2.38	2.24	0.28	0.36	0.07	71.3	2,815	0	0.000	~
20090	Seine	Jan-Apr	0.00	1.67	15.74	64.97	5.41	7.69	2.07	2.12	0.08	0.24	84.2	2,458	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

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										Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)	
19501	Seine	Oct-Dec	0.03	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	0	+	1,226	11.828	
	Seine	May-	0.04	3.46	61.00	26.57	7.12	1.25	0.43	0.12	0.00	0.00	99.5	0	+	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	21.00	49.73	21.23	6.21	1.51	0.11	0.05	0.00	0.00	92.5	0	+	438	5.011	
	Seine	May-	0.03	5.99	55.50	29.71	7.17	1.34	0.20	0.05	0.00	0.00	96.6	0	+	551	5.472	
	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	0.11	1.74	54.75	38.76	3.97	0.52	0.07	0.10	0.00	0.00	85.9	3,810		3,757	41.534	
	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-	0.17	2.67	55.64	37.01	3.71	0.63	0.09	0.07	0.00	0.00	84.1	0	+	447	5.124	
	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	0	+	619	6.600	
	Seine	May-	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	0	+	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-	0.00	4.65	49.87	38.62	5.95	0.82	0.10	0.00	0.00	0.00	94.5	0	+	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	0	+	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	14.29	29.97	41.88	7.86	1.36	0.43	0.09	0.02	109.0	4,908		26,375	244.079	
	Seine	May-	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-	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-	0.00	9.00	60.10	21.06	3.99	3.20	2.30	0.30	0.05	0.00	88.9	0	+	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	0	+	146	1.770	
	Seine	May-	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	0	+	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	0	+	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	31.84	24.60	25.78	15.85	1.83	0.11	0.00	0.00	0.00	80.0	1,188		9,335	115.878	
	Seine	May-	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	0	+	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	0	+	36	0.412	
	Seine	May-	0.00	9.42	71.70	13.00	3.96	1.57	0.32	0.02	0.00	0.00	88.8	0	+	10,801	120.882	
	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	0	+	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	0	+	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	47.43	15.38	2.89	1.77	0.71	0.35	0.00	0.00	81.8	0	+	5,014	71.025	
	Seine	May-	0.00	16.95	51.64	26.95	3.50	1.26	0.48	0.10	0.00	0.00	82.8	0	+	6,685	79.351	
	Trawl	Oct-Dec	0.00	17.03	52.56	26.28	3.13	0.66	0.24	0.09	0.00	0.00	83.8	0	+	200	2.392	
	Trawl	Jan-Apr	0.00	17.03	52.56	26.28	3.13	0.66	0.24	0.09	0.00	0.00	83.8	0	+	47	0.567	
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	

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

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										Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)
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	0	+	878	8.440
	Seine	May-	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	0	+	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	0	+	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	0	+	5,453	54.899
	Seine	May-	0.00	16.35	55.51	25.09	2.26	0.77	0.67	0.04	0.00	0.00	104.0	0	+	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	0	+	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	0	+	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		27,914	231.812
	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	0	+	4,216	35.012
	Seine	May-	0.00	17.20	38.00	25.14	15.88	2.65	1.13	0.00	0.00	0.00	120.4	0	+	1,165	9.675
	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	0	+	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	0	+	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	*	1,812	19.789
	Seine	May-	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
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	*	1,034	10.909
	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-	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	*	23	0.243
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	0	+	857	7.672
	Seine	May-	0.35	12.33	40.03	36.36	7.12	2.82	0.92	0.07	0.00	0.00	114.8	0	+	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	0	+	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	0	+	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	0	+	42	0.303
	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	0	+	44	0.315
	Gillnet	May-	0.00	4.58	11.75	46.61	28.49	6.77	1.49	0.20	0.10	0.00	140.1	0	+	3	0.023
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-	0.01	4.41	29.73	34.98	23.32	6.08	1.39	0.09	0.01	0.00	117.3	0	+	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	0	+	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-	0.09	3.35	39.83	27.62	19.68	7.90	1.15	0.33	0.05	0.00	124.1	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	856	11.013
	Seine	May-	0.00	16.29	60.29	17.53	4.19	1.47	0.11	0.11	0.00	0.00	77.8	0	+	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	0	+	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-	1.00	5.07	54.83	26.49	7.34	3.17	1.50	0.44	0.18	0.00	97.1	0	+	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	0	+	1	0.006
	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	0	+	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-	0.03	7.45	21.69	41.20	20.01	5.53	2.57	1.04	0.40	0.07	119.8	0	+	28	0.238

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

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										Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)	
19756	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	0	+	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	0	+	86	0.711	
	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-	0.36	3.76	52.98	21.04	15.51	4.16	1.25	0.62	0.20	0.12	106.5	0	+	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	0	+	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	0	+	802	7.534	
	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-	0.06	2.13	36.39	39.51	10.55	7.78	2.72	0.54	0.26	0.06	106.5	0	+	35	0.329	
	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	0	+	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	0	+	296	2.746	
	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	0	+	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-	0.00	2.25	20.19	36.76	25.69	8.38	4.95	1.27	0.31	0.20	121.2	0	+	72	0.591	
	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	
	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	0	+	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	4.56	41.63	20.44	20.25	8.99	2.55	1.29	0.25	0.05	100.0	7,825		903	9.229	
	Seine	May-	0.16	4.15	43.47	19.89	19.22	8.66	2.57	1.41	0.37	0.11	101.9	0	+	52	0.515	
	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	0	+	254	2.373	
	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	0	+	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	0	+	3,177	21.367	
	Gillnet	May-	0.00	0.00	1.52	9.89	44.49	34.22	8.75	0.76	0.38	0.00	148.7	0	+	2	0.017	
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	30.74	11.93	10.58	4.58	0.67	0.37	0.04	99.8	12,548		2,133	19.820	
	Seine	May-	0.00	4.84	38.20	36.22	10.07	7.78	2.23	0.47	0.15	0.03	98.6	0	+	80	0.826	
	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	0	+	121	1.087	
	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	104.6	5,576		3,324	30.103	
	Seine	May-	0.00	3.84	35.71	28.39	21.30	4.51	4.25	1.72	0.22	0.04	107.4	0	+	75	0.700	
	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	0	+	101	0.843	
	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-	0.00	0.00	4.58	15.96	30.56	15.11	20.88	11.71	0.85	0.34	151.6	0	+	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	113.3	13,279		7,798	69.557	
	Seine	May-	0.00	10.85	42.19	22.38	12.42	7.61	1.95	1.75	0.72	0.14	110.3	0	+	58	0.571	
	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-	0.00	1.59	19.36	35.99	17.54	12.07	3.87	5.01	3.87	0.68	144.1	0	+	2	0.017	
	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-	0.15	10.59	39.19	26.99	12.17	6.31	3.13	0.95	0.39	0.14	106.0	0	+	90	0.858	
	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	0	+	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	0	+	214	2.011	
	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	90.6	8,379		2,770	29.011	

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

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										Mean	Number	CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged	(tonnes)	(millions)
19845	Seine	May-	0.00	24.03	45.30	18.55	7.64	2.81	1.18	0.43	0.05	0.01	90.6	0 +	90	1.002
	Trawl	Oct-Dec	0.00	25.60	43.51	18.41	7.53	3.18	1.19	0.51	0.06	0.01	93.2	0 +	20	0.219
	Trawl	Jan-Apr	0.00	25.60	43.51	18.41	7.53	3.18	1.19	0.51	0.06	0.01	93.2	0 +	246	2.645
	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	0 +	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	55.78	24.96	6.44	2.06	0.80	0.12	0.08	0.00	94.4	6,953	178	1.845
	Seine	May-	0.05	13.72	56.90	20.95	5.72	1.80	0.68	0.12	0.06	0.00	94.7	0 +	41	0.430
	Trawl	Oct-Dec	0.05	13.72	56.90	20.95	5.72	1.80	0.68	0.12	0.06	0.00	94.7	0 +	46	0.484
	Trawl	Jan-Apr	0.05	13.72	56.90	20.95	5.72	1.80	0.68	0.12	0.06	0.00	94.7	0 +	120	1.263
	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	0 +	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	97.4	8,055	3,133	32.258
	Seine	May-	0.03	11.96	35.91	34.10	13.50	3.13	0.96	0.27	0.08	0.05	94.8	0 +	43	0.452
	Trawl	Jan-Apr	0.03	11.89	33.42	35.83	14.15	3.19	0.99	0.34	0.11	0.05	98.4	0 +	76	0.769
	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	6,423	1,475	13.516
	Seine	May-	0.06	4.77	61.78	14.70	14.04	3.53	0.88	0.18	0.06	0.00	99.8	0 +	34	0.343
	Trawl	Oct-Dec	0.06	4.69	61.35	14.81	14.30	3.63	0.91	0.19	0.06	0.00	100.4	0 +	83	0.826
	Trawl	Jan-Apr	0.06	4.69	61.35	14.81	14.30	3.63	0.91	0.19	0.06	0.00	100.4	0 +	279	2.775
	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	104.4	6,610	1,446	13.339
	Seine	May-	0.01	12.66	18.07	51.78	8.90	6.79	1.46	0.28	0.03	0.01	101.8	0 +	56	0.551
	Trawl	Oct-Dec	0.01	12.66	18.07	51.78	8.90	6.79	1.46	0.28	0.03	0.01	101.8	0 +	134	1.312
	Trawl	Jan-Apr	0.01	12.66	18.07	51.78	8.90	6.79	1.46	0.28	0.03	0.01	101.8	0 +	86	0.846
	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-	0.00	7.51	56.71	11.25	19.33	2.97	1.81	0.34	0.06	0.01	97.4	0 +	65	0.663
	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	107.4	698	372	3.442
	Seine	Jan-Apr	0.00	3.83	21.09	44.51	10.27	16.07	2.48	1.47	0.24	0.03	109.1	5,291	1,144	10.242
	Seine	May-	0.00	10.74	23.31	39.87	8.80	13.78	2.05	1.27	0.17	0.02	108.1	0 +	61	0.567
	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	0 +	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	4.17	70.00	15.26	8.56	1.12	0.45	0.45	0.00	0.00	102.5	890	916	8.886
	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-	0.00	4.96	57.49	13.77	15.39	3.10	4.44	0.56	0.27	0.02	103.9	0 +	60	0.573
	Trawl	Oct-Dec	0.00	4.96	57.49	13.77	15.39	3.10	4.44	0.56	0.27	0.02	103.9	0 +	128	1.231
	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	5,540	4,396	42.070
	Seine	May-	0.00	16.64	36.82	31.52	6.85	5.40	1.21	1.38	0.14	0.03	99.5	0 +	97	0.972
	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
19934	Seine	Oct-Dec	0.00	7.53	51.43	24.01	14.52	1.61	0.90	0.00	0.00	0.00	99.0	558	957	9.662
	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-	0.02	4.92	42.98	26.47	18.40	3.78	2.65	0.64	0.14	0.00	97.3	0 +	72	0.735
	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	109.9	5,754	4,362	38.991
	Seine	May-	0.00	11.65	22.69	35.69	16.39	9.89	2.37	0.93	0.29	0.10	107.9	0 +	36	0.336
	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-	0.08	14.92	48.51	13.72	13.62	5.27	3.01	0.61	0.19	0.07	95.1	0 +	11	0.121
	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	0 +	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

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

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										Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)
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	0	+	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-	0.65	8.74	52.26	22.45	5.78	6.09	2.41	1.42	0.13	0.07	91.7	0	+	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	2.10	28.16	29.30	14.83	17.07	6.12	1.64	0.79	125.7	1,398		9,785	75.940
19989	Seine	Oct-Dec	0.17	12.30	27.77	43.17	13.35	2.74	0.37	0.13	0.00	0.00	91.3	1,297		1,471	16.123
	Seine	Jan-Apr	0.00	4.23	22.78	45.02	18.55	6.58	1.88	0.78	0.13	0.06	100.0	3,192		4,976	49.748
	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		6,850	52.349
19990	Seine	Oct-Dec	0.00	21.12	50.16	16.69	8.74	2.39	0.89	0.00	0.00	0.00	75.0	1,077		1,156	15.363
	Seine	Jan-Apr	0.10	9.62	35.44	19.34	23.92	8.81	2.12	0.36	0.28	0.02	92.2	5,042		6,454	69.961
	Gillnet	Jan-Apr	0.00	0.00	1.08	14.00	44.71	28.42	9.40	1.99	0.39	0.00	134.4	1,179		7,594	56.373
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		7,276	74.777
	Gillnet	Jan-Apr	0.00	0.00	3.32	18.08	25.60	34.42	15.05	2.78	0.46	0.29	133.4	1,027		7,683	57.592
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	106.016
	Gillnet	Jan-Apr	0.00	0.00	5.58	21.25	30.62	17.31	20.59	3.92	0.50	0.23	131.8	915		7,986	60.707
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		1,701	18.517
	Seine	Jan-Apr	0.01	2.67	42.62	36.58	12.64	4.03	0.93	0.41	0.10	0.00	87.2	7,293		10,600	121.507
	Gillnet	Jan-Apr	0.00	0.00	2.29	22.23	31.51	23.72	9.98	7.15	2.55	0.57	131.1	1,311		8,083	61.493
20034	Seine	Oct-Dec	0.00	11.24	30.77	40.04	14.00	3.55	0.39	0.00	0.00	0.00	83.1	507		1,360	16.360
	Seine	Jan-Apr	0.00	2.90	25.39	41.55	22.29	5.65	1.54	0.43	0.25	0.00	83.1	1,707		7,019	79.434
	Gillnet	Jan-Apr	0.00	0.00	1.73	21.37	37.01	23.99	11.75	2.51	1.49	0.14	124.0	1,185		5,226	41.623
20045	Seine	Oct-Dec	0.05	9.02	31.32	28.33	20.85	7.92	1.94	0.44	0.10	0.03	87.9	0	+	1,332	15.161
	Seine	Jan-Apr	0.00	4.00	23.82	31.66	28.26	8.73	2.30	0.85	0.28	0.09	95.6	3,174		7,929	82.945
	Gillnet	Jan-Apr	0.00	0.00	0.79	12.47	46.19	25.12	10.31	3.68	1.26	0.18	131.1	773		8,954	68.338
20056	Seine	Oct-Dec	0.33	23.94	30.74	23.55	11.94	7.31	1.88	0.83	0.31	0.01	79.8	0	+	1,373	17.941
	Seine	Jan-Apr	0.07	17.00	24.96	24.50	18.89	11.01	2.44	0.88	0.21	0.03	80.8	4,195		9,308	110.245
	Gillnet	Jan-Apr	0.00	0.00	0.69	12.90	33.91	33.26	15.08	3.24	0.85	0.08	129.8	810		7,277	56.068
20067	Seine	Oct-Dec	0.00	2.66	48.04	26.57	12.82	5.96	3.01	0.68	0.23	0.03	84.9	0	+	672	7.770
	Seine	Jan-Apr	0.00	1.71	48.41	27.05	12.84	5.93	3.12	0.71	0.20	0.02	83.9	5,809		3,865	45.134
	Gillnet	Jan-Apr	0.00	0.00	4.80	13.95	28.09	27.34	19.06	5.14	1.36	0.26	125.2	2,645		5,286	42.169
20078	Seine	Oct-Dec	0.12	15.45	10.56	55.62	14.50	2.89	0.61	0.12	0.12	0.00	74.8	933		1,136	14.517
	Seine	Jan-Apr	0.00	0.25	7.14	65.12	16.73	6.27	3.01	1.20	0.25	0.04	88.0	2,761		6,046	68.731
	Gillnet	Jan-Apr	0.00	0.01	1.24	41.78	23.94	17.99	10.43	3.29	1.28	0.05	111.0	1,866		2,752	24.624
20089	Seine	Oct-Dec	0.00	0.69	73.58	15.82	7.88	1.64	0.29	0.09	0.01	0.00	65.0	0	+	547	8.708
	Seine	Jan-Apr	0.00	0.47	66.60	14.39	12.67	4.08	1.15	0.40	0.24	0.00	74.8	2,967		5,685	76.005
	Gillnet	Jan-Apr	0.00	0.00	4.79	7.18	53.14	18.93	11.29	3.31	1.25	0.11	122.7	877		3,937	32.095
20090	Seine	Oct-Dec	2.02	11.13	6.03	73.12	5.69	3.09	0.58	0.21	0.10	0.01	72.2	0	+	540	7.396
	Seine	Jan-Apr	0.00	2.42	2.00	75.58	6.48	9.81	2.43	0.89	0.20	0.20	84.0	5,383		4,540	50.162
	Gillnet	Jan-Apr	0.00	0.00	0.13	19.59	6.38	49.78	13.86	6.63	2.68	0.94	132.3	923		3,244	24.292

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

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										Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)	
19501	Seine	Oct-Dec	0.10	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	0	+	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	0	+	915	10.586	
	Seine	May-	0.00	2.72	71.94	24.83	0.34	0.17	0.00	0.00	0.00	0.00	86.4	0	+	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-	0.00	13.04	52.03	25.41	5.47	2.30	1.35	0.34	0.07	0.00	78.3	0	+	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	0	+	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	0	+	9,679	113.162	
	Seine	May-	0.00	38.31	37.97	19.15	4.41	0.17	0.00	0.00	0.00	0.00	85.5	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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-	0.00	2.78	34.37	48.44	10.07	3.99	0.35	0.00	0.00	0.00	122.5	0	+	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-	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-	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	0	+	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	0	+	0	0.004	
	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	0	+	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	~
	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	0	+	12,556	81.452	
	Gillnet	May-	0.00	0.60	3.61	17.47	43.37	16.87	11.14	5.12	1.51	0.30	154.2	0	+	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	
	Seine	May-	0.00	0.80	41.49	19.07	15.66	17.60	3.85	1.18	0.23	0.11	111.9	0	+	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	0	+	51	0.456	

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

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										Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)	
19778	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	0	+	3	0.023	
	Trawl	May-	0.00	0.80	41.63	19.02	15.66	17.52	3.85	1.18	0.23	0.11	111.8	0	+	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	0	+	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-	0.00	0.81	13.91	50.09	14.23	10.79	7.94	1.60	0.52	0.11	124.5	0	+	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	0	+	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-	0.00	6.21	43.91	15.58	20.00	6.37	5.30	2.20	0.35	0.08	108.2	0	+	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	0	+	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-	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	
	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	0	+	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-	0.00	3.27	23.96	27.41	26.05	5.45	9.51	2.72	1.36	0.27	115.9	0	+	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	
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-	0.00	20.47	53.62	14.22	3.71	2.74	3.17	1.70	0.13	0.23	109.0	0	+	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	0	+	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	0	+	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	
	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	0	+	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	~
	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	
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	0	+	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-	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	
	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	0	+	1	0.005	
	Trawl	May-	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	
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	0	+	1	0.006	
	Trawl	May-	0.00	14.66	22.14	12.66	19.38	12.53	13.75	2.82	1.25	0.81	119.5	0	+	0	0.000	
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	
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	
	Gillnet	Jan-Apr	0.00	0.00	0.73	40.09	10.72	10.19	16.92	12.39	6.06	2.90	138.6	899		2,633	18.989	
19989	Seine	Jan-Apr	0.00	1.39	21.95	23.61	39.60	8.41	2.67	1.29	0.73	0.33	110.5	4,341		3,407	31.759	
	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	6.91	26.22	20.46	17.47	23.66	3.24	1.09	0.72	0.21	111.0	5,592		926	8.409	

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

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										Mean	Number	CATCH		
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged	(tonnes)	(millions)	
19990	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	4.822	
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	~
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	
	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	38.66	39.14	14.95	2.87	1.45	0.88	0.79	0.11	105.7	4,309	2,571	24.342	
	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	6.443	
20034	Seine	Jan-Apr	0.00	1.32	13.73	52.30	22.60	7.34	1.89	0.51	0.27	0.03	104.1	2,956	3,861	37.108	
	Gillnet	Jan-Apr	0.00	0.00	0.79	28.37	24.41	25.04	14.58	3.80	2.22	0.79	137.2	631	593	4.324	
20045	Seine	Jan-Apr	0.00	1.09	33.21	23.84	27.65	9.92	3.45	0.60	0.12	0.12	100.5	1,653	3,373	33.572	
	Gillnet	Jan-Apr	0.00	0.00	0.80	10.80	49.80	23.80	10.60	3.80	0.20	0.20	127.5	500	896	7.030	
20056	Seine	Jan-Apr	0.00	15.08	37.26	33.54	7.89	5.37	0.78	0.09	0.00	0.00	78.8	1,154	0	0.000	~
20067	Seine	Jan-Apr	0.00	1.16	50.33	35.05	10.96	1.83	0.66	0.00	0.00	0.00	78.3	602	0	0.000	~
20078	Seine	Jan-Apr	0.00	5.22	24.64	54.01	11.50	3.09	0.77	0.58	0.10	0.10	82.8	1,035	0	0.000	~
20089	Seine	Jan-Apr	0.00	2.43	66.41	15.64	12.71	2.27	0.55	0.00	0.00	0.00	79.6	1,810	0	0.000	~
20090	Seine	Jan-Apr	0.00	11.49	31.43	45.70	5.72	4.79	0.76	0.11	0.00	0.00	78.6	1,836	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

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.

			PERCENT AT AGE										Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)	
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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	0	+	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	~
	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	0	+	163	1.181	
19834	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	
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	~
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	~
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	~
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	~
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	~
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	0	+	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	~
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	
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	~
	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	~
	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-	0.00	1.68	6.37	35.29	24.37	24.65	4.13	1.33	1.61	0.56	131.3	0	+	0	0.000	
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-	0.00	10.19	24.60	7.91	20.91	17.75	14.76	3.16	0.35	0.35	120.9	0	+	0	0.000	
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	~
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	~
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	~
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	~
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	~
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	~
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	~
20034	Seine	Jan-Apr	0.00	1.30	21.50	54.15	19.69	1.04	1.55	0.78	0.00	0.00	98.1	386		0	0.000	~
20045	Seine	Jan-Apr	0.00	0.56	54.19	24.02	12.85	7.26	0.56	0.56	0.00	0.00	81.1	179		0	0.000	~
20067	Seine	Jan-Apr	0.00	1.10	46.14	30.91	15.89	3.53	2.21	0.22	0.00	0.00	75.5	453		0	0.000	~
20078	Seine	Jan-Apr	0.00	1.64	3.28	59.56	21.86	12.02	1.37	0.27	0.00	0.00	82.7	366		0	0.000	~
20089	Seine	Jan-Apr	0.00	1.26	62.66	10.21	20.00	3.22	2.52	0.00	0.14	0.00	80.9	715		0	0.000	~
20090	Seine	Jan-Apr	0.00	5.40	12.59	55.40	8.99	12.95	2.16	2.52	0.00	0.00	81.3	278		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

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.

			PERCENT AT AGE									Mean	Number		CATCH	
Season	Gear	Fishery	0+	1+	2+	3+	4+	5+	6+	7+	8+	9++	Weight	Aged		(tonnes)	(millions)	
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	0	+	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	0	+	312	2.743	
19645	Seine	Jan-Apr	0.00	1.89	76.05	12.53	5.92	1.89	1.03	0.69	0.00	0.00	102.3	0	+	1,251	12.232	
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	0	+	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	0	+	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	0	+	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	~
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	0	+	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	
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	19.50	31.34	24.01	18.53	3.34	0.85	2.18	0.27	0.00	121.0	1,108		359	2.967	
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	1.03	73.49	15.31	3.39	3.69	1.15	1.33	0.36	0.24	111.3	1,652		0	0.000	~
20034	Seine	Jan-Apr	0.00	7.24	9.74	71.71	7.50	1.71	1.58	0.26	0.00	0.26	124.5	760		0	0.000	~
20045	Seine	Jan-Apr	0.00	0.36	26.68	8.63	58.76	4.04	0.54	0.81	0.00	0.18	122.7	1,113		0	0.000	~
20056	Seine	Jan-Apr	0.00	10.75	13.98	17.63	6.88	44.95	3.44	1.72	0.65	0.00	132.4	465		0	0.000	~
20067	Seine	Jan-Apr	0.00	0.31	57.89	11.30	6.50	3.25	18.58	1.55	0.46	0.15	102.9	646		0	0.000	~
20078	Seine	Jan-Apr	0.00	34.08	1.68	41.90	8.38	2.79	2.23	8.38	0.00	0.56	99.6	179		0	0.000	~
20089	Seine	Jan-Apr	0.00	2.58	72.48	2.46	12.16	2.21	2.46	2.21	2.95	0.49	102.7	814		0	0.000	~
20090	Seine	Jan-Apr	0.30	8.25	31.48	35.98	2.70	9.45	2.10	5.40	2.55	1.80	118.7	667		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

Table 2.1. Estimated numbers at age, spawning stock biomass (SB), spawn index (SI), residuals (RES), and other model estimated parameters for the Haida Gwaii (QCI 2E) stock assessment region. Age notation refers to age at beginning of fishery.

	Estimated numbers at age (x 10,000)											
Season	2	3	4	5	6	7	8	9	10	SB	SI	RES
1950/51	1,417	1,066	988	211	120	39	10	4	3	10,739	4,213	0.22
1951/52	5,104	857	592	489	96	52	17	4	3	7,830	2,578	0.04
1952/53	23,862	3,027	359	155	88	14	7	2	1	38,396	7,555	-0.47
1953/54	3,307	14,877	1,887	224	97	55	9	4	2	88,321	12,408	-0.81
1954/55	3,186	2,057	9,157	1,146	135	58	33	5	4	82,475	6,437	-1.4
1955/56	1,951	1,941	1,247	5,519	687	81	35	20	5	15,813	6,042	0.19
1956/57	3,246	1,056	650	215	565	53	6	2	2	2,304	1,592	0.78
1957/58	15,800	1,491	171	21	2	3	0	0	0	7,394	815	-1.05
1958/59	2,239	6,717	292	11	1	0	0	0	0	22,102	8,981	0.25
1959/60	10,075	975	2,540	92	3	0	0	0	0	21,576	6,599	-0.03
1960/61	8,273	4,432	429	1,117	40	1	0	0	0	28,762	8,981	-0.01
1961/62	10,965	3,759	1,997	191	494	18	1	0	0	34,652	5,730	-0.65
1962/63	2,479	5,232	1,662	799	71	174	6	0	0	30,892	7,297	-0.29
1963/64	8,238	1,242	2,263	592	244	20	47	2	0	12,640	4,104	0.03
1964/65	1,258	4,091	379	354	55	17	1	3	0	3,728	1,378	0.16
1965/66	746	573	541	6	1	0	0	0	0	3,916	2,824	0.83
1966/67	814	369	229	163	2	0	0	0	0	4,033	710	-0.58
1967/68	1,163	402	179	109	76	1	0	0	0	4,484	833	-0.53
1968/69	2,132	583	200	89	53	37	0	0	0	6,200	2,075	0.06
1969/70	3,988	1,109	303	104	46	28	19	0	0	12,746	5,552	0.32
1970/71	4,315	2,149	597	163	56	25	15	10	0	21,297	13,291	0.68
1971/72	8,454	2,405	1,195	331	90	31	14	8	6	32,624	9,542	-0.07
1972/73	6,681	4,874	1,315	599	151	39	13	6	6	47,714	7,960	-0.64
1973/74	5,031	4,052	2,756	659	262	61	15	5	4	56,900	14,510	-0.21
1974/75	2,061	3,220	2,485	1,568	343	128	29	7	4	53,786	9,686	-0.56
1975/76	1,812	1,360	2,040	1,467	853	177	64	14	6	42,771	16,374	0.19
1976/77	2,211	1,203	848	1,136	698	353	69	25	8	30,449	16,408	0.54
1977/78	1,043	1,447	731	447	506	268	126	24	11	19,620	18,371	1.09
1978/79	22,985	665	840	346	155	141	64	28	8	32,601	13,649	0.28
1979/80	2,426	14,404	380	389	106	37	29	12	7	76,695	31,904	0.28
1980/81	1,182	1,538	8,973	228	196	42	14	10	6	73,764	20,294	-0.14
1981/82	1,047	750	956	5,344	125	87	16	5	6	54,652	23,593	0.31
1982/83	7,617	661	468	580	3,147	71	44	8	5	46,433	21,391	0.38
1983/84	3,819	4,704	400	272	321	1,671	37	22	7	46,407	23,439	0.47
1984/85	1,128	2,275	2,733	222	143	162	823	17	14	40,662	18,625	0.37
1985/86	1,625	642	1,256	1,416	105	63	70	337	12	30,490	6,847	-0.34
1986/87	10,835	894	346	645	687	49	29	32	157	29,663	12,289	0.27
1987/88	4,235	5,944	480	179	321	333	24	14	90	42,533	15,245	-1.03
1988/89	1,572	2,353	3,302	267	99	178	185	13	57	41,263	25,201	-0.49
1989/90	765	893	1,322	1,819	144	53	94	97	37	26,203	27,058	0.03
1990/91	4,483	434	484	657	795	56	19	32	44	16,765	17,998	0.07
1991/92	460	2,476	228	231	279	305	20	6	24	17,863	12,376	-0.37
1992/93	548	243	1,251	107	100	114	122	8	12	9,919	8,152	-0.2
1993/94	1,699	275	114	524	39	34	37	39	6	7,196	14,293	0.69
1994/95	3,199	819	131	53	240	18	15	17	20	9,050	4,701	-0.66
1995/96	3,715	1,480	379	61	25	111	8	7	17	11,469	7,377	-0.44
1996/97	8,162	1,738	692	177	28	12	52	4	11	17,595	11,215	-0.45
1997/98	617	3,890	828	330	84	14	6	25	7	18,204	21,649	0.17
1998/99	2,001	289	1,763	354	132	32	5	2	12	10,387	10,610	0.02
1999/2000	2,396	880	118	630	108	32	6	1	1	6,511	6,698	0.03
2000/01	2,678	954	323	38	171	26	7	1	0	6,199	15,195	0.9
2001/02	7,008	966	344	116	14	62	10	3	1	6,677	3,257	-0.72
2002/03	1,227	2,245	292	94	28	3	13	2	1	7,579	8,801	0.15
2003/04	4,518	393	719	93	30	9	1	4	1	5,578	5,668	0.02
2004/05	1,060	1,467	128	233	30	10	3	0	2	5,470	3,614	-0.41
2005/06	4,657	358	496	43	79	10	3	1	1	5,065	4,097	-0.21
2006/07	740	1,707	131	182	16	29	4	1	1	6,465	9,436	0.38
2007/08	5,541	286	660	51	70	6	11	1	1	6,318	4,213	-0.41
2008/09	661	2,205	114	263	20	28	2	4	1	7,459	8,935	0.18
2009/10	1,627	270	901	47	107	8	11	1	2	5,948	6,091	0.02

Estimated gillnet selectivity at age (averaged over all years):

2	3	4	5	6	7	8	9	10
0.0	0.0	0.1	0.3	0.6	0.7	0.9	1.0	1.0

Spawn index proportionality coefficient (pre-1988): 0.32

Table 2.2. Estimated numbers at age, spawning stock biomass (SB), spawn index (SI), residuals (RES), and other model estimated parameters for the Prince Rupert District stock assessment region. Age notation refers to age at beginning of fishery.

	Estimated numbers at age (x 10,000)										
Season	2	3	4	5	6	7	8	9	10	SB	SI	RES
1950/51	3,166	4,530	6,030	935	358	172	54	31	43	43,718	27,149	0
1951/52	3,383	2,266	2,399	2,412	268	65	18	3	2	20,505	24,047	0.63
1952/53	5,475	2,335	947	617	353	18	2	0	0	33,068	28,468	0.32
1953/54	1,547	4,096	1,710	680	433	240	12	1	0	25,174	13,535	-0.15
1954/55	5,428	1,087	2,126	670	190	77	24	1	0	20,282	14,482	0.14
1955/56	2,468	3,790	586	903	214	41	10	2	0	26,045	14,533	-0.11
1956/57	4,778	1,715	2,301	315	417	81	12	2	0	13,451	27,518	1.19
1957/58	12,304	3,007	694	611	51	35	3	0	0	28,539	9,882	-0.59
1958/59	3,465	7,837	1,794	390	320	24	15	1	0	49,304	40,961	0.29
1959/60	28,734	2,095	4,362	927	184	133	9	4	0	46,354	16,545	-0.56
1960/61	12,441	16,466	1,051	1,937	355	58	33	2	1	64,650	12,059	-1.21
1961/62	6,371	6,787	7,218	377	545	72	8	3	0	64,070	26,329	-0.42
1962/63	25,811	3,461	3,231	3,048	137	163	17	1	0	41,060	16,981	-0.41
1963/64	3,162	13,401	1,417	1,063	770	24	19	1	0	48,112	26,919	-0.11
1964/65	3,478	1,608	5,650	503	306	167	4	2	0	22,129	6,055	-0.82
1965/66	2,282	1,692	527	1,273	73	24	6	0	0	8,576	7,105	0.28
1966/67	940	1,144	577	125	196	6	1	0	0	5,319	3,386	0.02
1967/68	573	488	418	152	22	20	0	0	0	4,819	5,197	0.55
1968/69	2,579	322	241	184	58	7	5	0	0	6,525	965	-1.44
1969/70	1,669	1,559	194	146	111	35	4	3	0	12,097	8,814	0.16
1970/71	655	1,065	955	115	82	59	17	2	1	11,932	8,480	0.13
1971/72	2,049	433	643	531	58	36	22	5	1	14,279	8,774	-0.02
1972/73	1,671	1,422	267	339	266	28	17	10	3	17,672	10,959	-0.01
1973/74	1,130	1,204	983	175	218	170	18	11	8	21,574	9,244	-0.38
1974/75	635	836	851	633	97	118	91	9	10	20,635	10,949	-0.16
1975/76	885	480	612	597	439	67	81	62	13	22,640	15,587	0.1
1976/77	387	678	346	403	381	276	42	50	46	15,665	11,589	0.17
1977/78	347	298	460	193	197	177	125	18	42	9,405	6,164	0.05
1978/79	2,896	268	204	249	78	65	51	32	13	9,382	9,195	0.45
1979/80	985	2,247	186	114	115	31	23	17	13	16,545	11,937	0.15
1980/81	1,183	769	1,629	117	57	50	13	9	11	18,368	14,087	0.21
1981/82	1,838	919	564	1,116	73	31	25	6	8	21,382	17,186	0.25
1982/83	4,968	1,422	690	411	789	49	20	15	8	31,930	25,247	0.24
1983/84	1,626	3,824	1,094	531	317	607	38	15	18	39,354	27,041	0.1
1984/85	1,659	1,231	2,829	783	362	202	352	18	14	37,461	41,028	0.56
1985/86	4,972	1,231	882	1,906	499	209	100	138	10	41,192	26,638	0.04
1986/87	3,794	3,587	852	557	1,089	268	106	49	71	44,178	39,905	0.37
1987/88	2,364	2,658	2,453	553	328	582	133	51	54	38,585	35,444	-0.08
1988/89	1,347	1,607	1,738	1,502	310	154	224	51	35	30,808	16,379	-0.63
1989/90	5,635	894	1,020	1,020	789	123	50	58	22	30,274	22,679	-0.29
1990/91	5,025	3,719	570	610	576	406	58	22	34	36,949	25,811	-0.36
1991/92	1,819	3,338	2,421	353	356	318	203	27	24	38,680	40,145	0.04
1992/93	864	1,221	2,202	1,545	195	164	131	73	15	31,443	25,071	-0.23
1993/94	1,745	584	801	1,352	868	83	54	38	20	22,901	16,589	-0.32
1994/95	4,878	1,191	384	492	781	460	33	20	17	25,272	18,516	-0.31
1995/96	2,303	3,383	815	257	316	484	268	17	18	32,300	24,854	-0.26
1996/97	3,099	1,612	2,365	562	168	176	251	123	14	29,336	25,037	-0.16
1997/98	1,070	2,164	1,123	1,620	339	72	46	46	16	27,165	19,420	-0.34
1998/99	2,736	731	1,473	750	1,008	183	18	5	1	27,754	29,745	0.07
1999/2000	4,534	1,806	479	940	464	572	100	7	2	23,774	19,694	-0.19
2000/01	2,842	2,903	1,129	286	502	229	236	28	2	26,488	36,684	0.33
2001/02	9,119	1,783	1,788	670	163	245	109	96	12	27,341	22,449	-0.2
2002/03	1,298	5,609	1,056	998	341	70	81	31	19	34,960	34,007	-0.03
2003/04	3,357	785	3,316	602	508	134	20	19	10	26,596	30,493	0.14
2004/05	2,414	1,978	449	1,793	303	212	34	3	3	19,903	27,956	0.34
2005/06	6,802	1,380	1,091	236	839	131	65	4	1	19,119	10,251	-0.62
2006/07	1,957	3,818	756	573	120	358	42	15	1	20,687	15,562	-0.28
2007/08	2,351	1,104	2,154	425	311	56	156	14	3	19,100	13,553	-0.34
2008/09	3,657	1,343	623	1,186	226	151	23	45	4	17,988	12,684	-0.35
2009/10	2,266	2,127	766	345	615	104	62	8	12	18,866	26,988	0.36

Estimated gillnet selectivity at age (averaged over all years):

2	3	4	5	6	7	8	9	10
0.00	0.01	0.07	0.25	0.45	0.62	0.83	1.00	1.00

Spawn index proportionality coefficient (pre-1988): 0.62

Table 2.3. Estimated numbers at age, spawning stock biomass (SB), spawn index (SI), residuals (RES), and other model estimated parameters for the Central Coast stock assessment region. Age notation refers to age at beginning of fishery.

	Estimated numbers at age (x 10,000)										
Season	2	3	4	5	6	7	8	9	10	SB	SI	RES
1950/51	3,445	4,637	4,898	835	321	95	34	19	21	42,136	15,390	0.27
1951/52	4,152	2,154	2,141	1,722	236	77	21	7	8	22,490	10,295	0.5
1952/53	17,346	2,558	913	646	397	44	13	3	2	38,298	18,237	0.54
1953/54	2,294	11,296	1,651	585	411	251	28	8	3	43,085	13,967	0.15
1954/55	2,583	1,427	5,629	676	204	127	72	8	3	42,369	13,564	0.14
1955/56	5,521	1,626	819	2,985	336	97	59	33	5	14,326	6,626	0.51
1956/57	7,781	3,198	559	173	431	36	9	5	3	11,120	4,607	0.4
1957/58	9,495	4,403	975	95	19	33	2	0	0	22,982	3,549	-0.59
1958/59	3,040	5,724	2,170	402	34	6	10	1	0	21,921	3,904	-0.44
1959/60	8,510	1,778	2,204	570	78	5	1	1	0	24,830	12,615	0.6
1960/61	12,865	5,273	1,030	1,204	297	39	3	0	1	25,332	4,265	-0.5
1961/62	7,604	7,452	2,056	280	246	49	6	0	0	45,670	11,948	-0.06
1962/63	6,753	4,570	3,865	937	115	93	18	2	0	27,552	6,485	-0.17
1963/64	4,875	3,848	1,650	916	160	15	11	2	0	18,173	6,464	0.25
1964/65	4,660	2,731	1,349	375	148	20	2	1	0	22,198	2,097	-1.08
1965/66	10,510	2,620	1,200	476	111	38	5	0	0	4,966	1,863	0.3
1966/67	2,729	5,030	391	48	8	1	0	0	0	8,948	5,434	0.78
1967/68	1,853	1,311	1,207	48	4	0	0	0	0	11,495	5,790	0.59
1968/69	6,778	935	629	554	21	2	0	0	0	13,914	1,837	-0.74
1969/70	5,907	3,409	471	316	279	11	1	0	0	26,253	8,230	0.12
1970/71	5,290	3,103	1,785	246	165	145	6	0	0	33,701	4,156	-0.81
1971/72	7,040	2,935	1,651	916	122	80	70	3	0	35,221	3,572	-1.01
1972/73	4,919	4,189	1,564	750	376	48	31	27	1	46,924	12,434	-0.05
1973/74	5,982	3,116	2,485	824	362	176	22	15	13	46,333	8,852	-0.37
1974/75	2,790	3,929	1,979	1,390	382	142	66	8	10	49,636	8,037	-0.54
1975/76	1,885	1,862	2,554	1,171	686	168	60	28	8	37,826	13,849	0.28
1976/77	2,610	1,250	1,174	1,444	516	245	54	18	11	29,791	14,613	0.57
1977/78	2,170	1,687	773	640	632	178	79	17	9	16,922	7,747	0.5
1978/79	20,172	1,356	978	339	166	76	16	7	2	48,181	5,779	-0.84
1979/80	4,593	12,516	841	607	210	103	47	10	6	74,132	13,012	-0.46
1980/81	3,997	2,873	7,825	524	368	122	58	26	9	70,808	15,919	-0.21
1981/82	1,731	2,532	1,816	4,863	309	190	54	23	13	66,622	16,333	-0.13
1982/83	1,548	1,103	1,593	1,105	2,762	168	98	27	17	49,994	18,482	0.29
1983/84	4,438	982	690	964	634	1,508	90	51	22	34,574	14,185	0.39
1984/85	2,167	2,770	592	390	509	309	704	39	30	35,560	8,850	-0.11
1985/86	3,260	1,328	1,645	326	201	252	149	335	32	32,562	20,342	0.81
1986/87	14,600	1,977	784	916	174	104	129	76	186	41,230	12,827	0.11
1987/88	1,280	8,833	1,158	433	477	88	52	65	131	59,140	26,916	-0.79
1988/89	931	790	5,288	657	231	242	44	26	99	43,069	21,561	-0.69
1989/90	2,390	598	482	2,955	314	96	89	16	45	31,662	28,980	-0.09
1990/91	9,745	1,594	380	281	1,555	144	40	37	25	33,070	19,183	-0.54
1991/92	1,503	6,662	1,004	211	139	709	62	17	26	48,836	43,274	-0.12
1992/93	1,899	1,048	4,322	583	112	70	337	28	19	40,271	32,392	-0.22
1993/94	745	1,333	684	2,495	301	52	31	134	18	28,308	29,432	0.04
1994/95	2,097	519	843	369	1,179	129	20	11	54	17,594	22,348	0.24
1995/96	6,941	1,435	315	421	158	458	47	7	22	22,590	21,646	-0.04
1996/97	7,221	4,696	897	175	215	77	219	22	13	35,691	28,255	-0.23
1997/98	1,589	4,862	3,002	532	99	115	40	111	18	38,656	31,503	-0.2
1998/99	2,764	1,061	2,966	1,604	261	45	44	15	44	32,075	31,813	-0.01
1999/2000	1,306	1,835	661	1,668	816	122	17	11	13	26,784	32,652	0.2
2000/01	3,206	849	1,107	357	822	373	52	7	9	19,488	25,109	0.25
2001/02	7,073	2,011	487	554	165	356	155	21	6	21,304	23,147	0.08
2002/03	2,058	4,248	1,137	251	268	77	159	67	11	27,661	25,679	-0.07
2003/04	6,157	1,171	2,322	586	124	127	35	72	35	22,063	29,407	0.29
2004/05	1,831	3,283	591	1,080	260	54	55	15	46	17,502	24,158	0.32
2005/06	3,176	896	1,473	233	397	93	19	20	22	9,715	12,051	0.22
2006/07	1,142	1,420	358	499	72	119	28	6	12	7,839	9,857	0.23
2007/08	7,753	476	579	142	194	28	46	11	7	7,911	3,971	-0.69
2008/09	1,760	3,112	191	232	57	78	11	18	7	10,521	10,183	-0.03
2009/10	1,469	714	1,263	77	94	23	32	5	10	7,813	8,075	0.03

Estimated gillnet selectivity at age (averaged over all years):

2	3	4	5	6	7	8	9	10
0.00	0.01	0.09	0.32	0.58	0.77	0.90	1.00	1.00

Spawn index proportionality coefficient (pre-1988): 0.28

Table 2.4. Estimated numbers at age, spawning stock biomass (SB), spawn index (SI), residuals (RES), and other model estimated parameters for the Strait of Georgia stock assessment region. Age notation refers to age at beginning of fishery.

	Estimated numbers at age (x 10,000)											
Season	2	3	4	5	6	7	8	9	10	SB	SI	RES
1950/51	10,033	6,392	2,634	603	149	52	18	6	3	38,049	66,143	0.45
1951/52	11,685	6,687	2,542	881	200	49	17	6	3	42,597	72,376	0.43
1952/53	16,197	7,833	2,734	882	303	69	17	6	3	72,469	111,307	0.32
1953/54	12,310	11,531	5,183	1,772	571	196	45	11	6	82,771	82,141	-0.11
1954/55	7,561	8,412	5,348	2,126	722	233	80	18	7	71,154	69,854	-0.12
1955/56	8,447	5,153	3,730	2,064	815	277	89	31	10	36,568	25,667	-0.46
1956/57	6,331	5,571	1,688	948	518	204	69	22	10	19,744	24,126	0.1
1957/58	13,486	4,071	1,453	306	169	92	36	12	6	31,578	16,911	-0.73
1958/59	12,405	9,206	1,931	615	129	71	39	15	8	43,243	47,864	0
1959/60	7,015	8,204	3,652	642	192	38	21	12	7	37,288	55,709	0.3
1960/61	19,464	4,441	2,693	949	165	49	10	5	5	33,738	44,326	0.17
1961/62	15,810	11,999	1,472	718	250	44	13	3	3	42,739	35,574	-0.29
1962/63	16,299	9,437	3,817	375	181	63	11	3	1	35,933	37,381	-0.07
1963/64	9,123	9,339	2,689	844	82	40	14	2	1	29,919	35,954	0.08
1964/65	5,200	4,944	2,283	485	150	15	7	2	1	20,186	38,390	0.54
1965/66	9,291	2,678	1,242	441	93	29	3	1	1	12,326	7,211	-0.64
1966/67	2,782	4,430	554	186	65	14	4	0	0	5,391	9,647	0.48
1967/68	3,200	1,217	645	49	16	6	1	0	0	9,045	9,442	-0.06
1968/69	7,317	1,493	511	263	20	7	2	0	0	13,943	14,039	-0.1
1969/70	7,359	3,386	686	234	120	9	3	1	0	23,777	34,163	0.26
1970/71	5,516	3,438	1,574	318	108	55	4	1	1	32,106	38,921	0.09
1971/72	4,923	2,648	1,608	728	147	50	26	2	1	24,822	25,139	-0.09
1972/73	7,162	2,455	1,099	591	259	51	17	9	1	27,002	16,191	-0.62
1973/74	9,384	3,884	1,182	467	224	96	19	6	4	41,693	40,571	-0.13
1974/75	5,510	5,566	2,265	596	219	103	44	9	5	48,830	70,211	0.26
1975/76	10,765	3,428	3,412	1,268	241	75	34	14	4	57,171	60,642	-0.05
1976/77	8,484	6,831	2,066	1,795	570	98	30	13	7	67,206	78,562	0.05
1977/78	4,266	5,465	4,036	1,071	770	214	35	11	7	58,743	102,115	0.45
1978/79	7,305	2,739	3,044	1,989	423	251	64	10	5	52,973	64,266	0.09
1979/80	6,527	4,662	1,541	1,524	852	165	95	24	6	57,049	85,991	0.31
1980/81	6,793	4,166	2,898	932	852	449	86	49	15	57,686	55,121	-0.15
1981/82	5,730	4,181	2,397	1,576	444	369	189	35	27	53,465	100,987	0.53
1982/83	5,488	3,362	2,262	1,182	708	172	139	70	23	35,964	64,575	0.48
1983/84	8,344	3,011	1,625	866	345	183	38	29	18	30,893	26,227	-0.27
1984/85	15,162	4,364	1,443	647	241	78	41	8	10	39,996	25,247	-0.56
1985/86	8,491	7,784	2,096	605	216	65	20	10	4	58,318	41,575	-0.44
1986/87	20,823	4,405	4,014	1,079	311	111	34	10	7	59,932	41,737	-0.47
1987/88	6,182	10,984	2,208	1,817	389	85	24	6	3	75,456	24,976	-1.11
1988/89	15,991	3,320	5,739	1,047	737	139	28	7	3	69,020	66,052	-0.04
1989/90	8,114	8,860	1,792	2,903	444	273	48	9	3	75,319	67,152	-0.11
1990/91	21,440	4,548	4,928	950	1,285	163	94	16	4	78,970	45,830	-0.54
1991/92	15,681	11,967	2,478	2,470	396	447	51	28	6	96,228	82,714	-0.15
1992/93	20,746	8,708	6,387	1,211	1,003	136	146	16	11	101,602	90,198	-0.12
1993/94	9,807	11,393	4,580	3,074	500	363	45	47	8	87,883	67,144	-0.27
1994/95	20,074	5,249	5,826	2,098	1,128	135	88	9	10	83,034	64,899	-0.25
1995/96	30,130	10,412	2,614	2,677	817	392	43	28	6	91,322	71,326	-0.25
1996/97	30,035	15,260	4,958	1,156	1,032	267	121	13	10	103,772	58,232	-0.58
1997/98	13,818	15,056	7,149	2,149	432	305	70	30	5	97,767	74,616	-0.27
1998/99	21,915	7,012	7,304	3,220	824	129	58	9	4	90,021	85,095	-0.06
1999/2000	24,983	11,331	3,461	3,372	1,315	278	37	14	3	90,788	72,688	-0.22
2000/01	30,932	13,162	5,659	1,625	1,401	401	70	7	3	118,921	100,248	-0.17
2001/02	30,158	16,495	6,640	2,702	664	478	114	19	3	123,919	117,864	-0.05
2002/03	17,757	16,034	8,245	3,080	1,132	197	118	22	3	117,777	141,651	0.18
2003/04	15,466	9,270	7,801	3,692	1,216	396	40	15	5	92,682	114,352	0.21
2004/05	12,412	7,930	4,492	3,561	1,565	446	135	10	5	70,656	95,643	0.3
2005/06	21,267	6,286	3,729	1,954	1,324	449	97	24	3	54,921	46,752	-0.16
2006/07	8,316	10,726	2,826	1,498	647	335	71	10	1	61,424	35,865	-0.54
2007/08	30,440	4,278	5,225	1,317	606	167	59	8	1	49,282	32,103	-0.43
2008/09	1,958	15,977	2,133	2,313	507	164	27	6	0	65,604	49,909	-0.27
2009/10	14,554	1,033	7,936	1,023	926	151	34	4	0	47,918	47,480	-0.01

Estimated gillnet selectivity at age (averaged over all years):

2	3	4	5	6	7	8	9	10
0.00	0.02	0.14	0.41	0.67	0.82	0.91	0.97	0.97

Spawn index proportionality coefficient (pre-1988): 1.11

Table 2.5. Estimated numbers at age, spawning stock biomass (SB), spawn index (SI), residuals (RES), and other model estimated parameters for the west coast of Vancouver Island stock assessment region. Age notation refers to age at beginning of fishery.

	Estimated numbers at age (x 10,000)											
Season	2	3	4	5	6	7	8	9	10	SB	SI	RES
1950/51	7,059	3,617	3,730	544	148	52	20	9	7	29,993	19,597	0.04
1951/52	7,914	3,338	1,297	1,131	162	44	15	6	5	17,034	13,310	0.22
1952/53	12,006	3,651	882	239	202	29	8	3	2	25,940	39,571	0.89
1953/54	8,304	5,668	1,723	416	113	95	14	4	2	17,015	20,648	0.66
1954/55	15,473	3,655	1,290	253	59	16	14	2	1	26,821	15,112	-0.11
1955/56	19,674	6,924	1,429	466	91	21	6	5	1	36,883	27,183	0.16
1956/57	17,598	8,815	2,416	429	138	27	6	2	2	52,485	44,114	0.29
1957/58	19,302	8,116	3,953	1,066	189	61	12	3	2	59,873	18,986	-0.68
1958/59	12,590	9,075	3,797	1,844	497	88	28	6	2	28,553	12,979	-0.32
1959/60	6,765	5,799	2,061	537	251	67	12	4	1	11,514	6,015	-0.18
1960/61	20,179	3,064	912	146	36	17	4	1	0	16,869	10,556	0
1961/62	8,293	9,244	607	101	15	4	2	0	0	31,395	34,470	0.56
1962/63	10,979	3,909	3,057	161	26	4	1	0	0	28,344	11,245	-0.46
1963/64	4,400	5,236	1,388	908	47	8	1	0	0	25,891	22,761	0.34
1964/65	3,155	2,141	1,818	392	252	13	2	0	0	19,189	11,891	-0.01
1965/66	3,113	1,551	764	533	113	73	4	1	0	13,337	3,722	-0.81
1966/67	3,592	1,548	562	228	157	33	21	1	0	5,627	4,813	0.31
1967/68	2,590	1,751	329	67	26	18	4	2	0	11,649	11,029	0.41
1968/69	7,115	1,331	900	169	34	13	9	2	1	17,319	10,465	-0.04
1969/70	11,990	3,699	692	468	88	18	7	5	2	36,868	26,912	0.15
1970/71	7,499	6,450	1,990	372	252	47	10	4	3	68,437	36,206	-0.17
1971/72	9,275	4,226	3,635	1,122	210	142	27	5	4	70,515	41,857	-0.06
1972/73	11,549	5,507	2,373	1,938	590	110	74	14	5	75,346	19,481	-0.89
1973/74	16,901	7,225	3,044	1,146	887	266	50	34	9	89,580	25,540	-0.79
1974/75	6,500	11,184	4,410	1,660	564	415	123	23	19	117,731	49,149	-0.41
1975/76	4,796	4,432	7,039	2,422	779	256	188	56	19	91,647	64,222	0.11
1976/77	9,034	3,284	2,739	3,647	927	261	84	61	24	73,669	58,679	0.24
1977/78	3,165	6,123	2,011	1,385	1,562	343	94	30	30	59,467	45,607	0.2
1978/79	9,848	2,107	3,844	1,137	565	454	84	22	14	52,833	66,397	0.69
1979/80	7,146	6,332	1,237	1,985	436	174	132	24	10	65,021	62,308	0.42
1980/81	4,268	4,403	3,841	732	1,111	224	87	66	17	61,290	52,063	0.3
1981/82	2,923	2,468	2,438	2,016	349	498	96	37	35	44,880	33,047	0.16
1982/83	5,442	1,588	1,304	1,232	956	148	202	36	27	31,419	16,771	-0.16
1983/84	13,761	2,797	745	548	471	346	52	71	22	36,423	23,872	0.04
1984/85	12,507	6,920	1,269	300	208	176	129	19	34	59,760	30,010	-0.22
1985/86	4,090	6,365	3,514	643	152	106	89	65	27	68,018	39,514	-0.08
1986/87	18,799	2,134	3,315	1,827	334	79	55	46	48	59,805	16,858	-0.8
1987/88	3,258	10,095	1,012	1,345	690	124	29	20	35	75,867	46,242	-0.5
1988/89	3,642	1,835	5,316	492	621	315	56	13	25	54,391	47,718	-0.13
1989/90	2,360	2,116	981	2,520	213	256	128	23	15	41,654	46,464	0.11
1990/91	7,565	1,388	1,142	478	1,156	96	114	57	17	32,576	30,456	-0.07
1991/92	4,563	4,447	740	536	206	471	38	45	29	43,211	42,687	-0.01
1992/93	3,583	2,681	2,498	395	277	105	239	19	38	39,681	34,728	-0.13
1993/94	1,716	2,080	1,443	1,254	195	136	52	117	28	30,671	25,625	-0.18
1994/95	2,840	981	1,093	693	577	87	60	23	64	26,577	28,057	0.05
1995/96	12,553	1,602	533	574	361	300	45	31	45	32,849	33,986	0.03
1996/97	4,435	6,928	869	285	305	192	159	24	40	41,107	46,490	0.12
1997/98	2,399	2,354	3,320	379	121	129	81	67	27	26,884	41,556	0.44
1998/99	2,888	1,226	1,091	1,364	145	38	35	20	21	17,543	20,390	0.15
1999/2000	4,646	1,425	552	446	507	51	11	9	11	17,087	13,267	-0.25
2000/01	6,384	2,254	670	249	190	203	20	4	8	21,875	13,955	-0.45
2001/02	6,389	3,094	1,092	325	121	92	98	10	6	25,166	22,086	-0.13
2002/03	2,927	3,068	1,468	510	147	52	38	40	6	22,331	29,750	0.29
2003/04	3,453	1,339	1,308	582	185	45	14	9	11	11,976	15,844	0.28
2004/05	2,428	1,425	471	384	159	43	9	2	3	4,949	9,075	0.61
2005/06	3,498	868	379	89	39	9	1	0	0	4,841	2,705	-0.58
2006/07	1,166	1,129	280	122	29	13	3	0	0	4,146	2,089	-0.69
2007/08	3,075	376	364	90	39	9	4	1	0	3,840	2,548	-0.41
2008/09	1,272	1,058	129	125	31	14	3	1	0	4,085	9,876	0.88
2009/10	2,083	451	375	46	44	11	5	1	1	3,321	2,373	-0.34

Estimated gillnet selectivity at age (averaged over all years):

2	3	4	5	6	7	8	9	10
0.00	0.02	0.17	0.49	0.74	0.88	0.95	1.00	1.00

Spawn index proportionality coefficient (pre-1988): 0.63

APPENDIX B MODEL DESCRIPTION AND DOCUMENTATION

The herring catch-age model consists of five major components: (1) data, (2) model initialization, (3) model dynamics, (4) the likelihood function and (5) forecasts. We have broken the description of the assessment model into these five components and use a series of tables to document model equations. Symbols and their definitions are defined in Table 3 of Appendix B. The model assumes each of the major and minor stock areas are independent from each other, although the majority of parameter start-values and bounds are common across stocks (described throughout).

Table 3. Notation for the herring catch-age model (HCAMv2).

Symbol	Description
	Indices and Index Ranges
a	age class index, where a = 1 corresponds to actual age k
A	plus age class (A = 8, which corresponds to ages 9 and up)
k	youngest age in the model (k = 2)
k'	age of maturity/ recruitment to the fishery ($k' = 3$)
K	oldest age in the model (K = 10)
n	number of age classes (n = 9)
p	fishing period, where p = 1 corresponds to winter, p = 2 to seine, and p = 3 to gillnet
p'	total number of fishing periods ($p' = 3$)
t	year index
t'	first year of catch and survey data (1951, t' = 1)
T'	final year of surface survey (1987, T' = 37)
$T'+1$	first year of dive survey (1988, $T'+1$ = 38)
T	final year (2009, T = 59)
	Data
$C_{t,p}$	observed catch biomass (metric tonnes) in period p of year t
I_t	observed spawn survey index in year t
$\tilde{N}^S_{t,p}$	number of age samples processed in year t
$P_{t,p,a}$	observed proportion of fish at age a in period p of year t (test fishery + commercial samples combined)
$w_{t,a}$	observed mean weight-at-age a in year t (test fishery + commercial samples combined)
$w'_{t,a}$	geometric mean weight-at-age a in year t (test fishery + commercial samples combined)

Parameters (fixed)

q_2	spawn index proportionality coefficient, $q_2 = 1$ for $t > T'$
λ_a	proportion of age *a* fish available to the fishery, constant across all years (λ_2 =0.25, λ_3 =0.90, $\lambda_{a>3}$ =1)
σ_h^2	variance of the steepness, *h*
σ_R^2	variance of recruitment deviations, d^R

Parameters (derived)

α, β, h	parameters of the stock recruitment relationship
a_{50}	age at 50% vulnerability to the fishing gear
d_t^M	mortality deviations in year *t*
d_t^R	recruitment deviations in year *t*
$\varepsilon^{process}$	process error in number of ageing samples, $N_{t,p}^S$
$F'_{t,a}$	fishing mortality rate for fish of age *a* in year *t*
κ	initial fishing mortality rate for $t < t'$
q_1	spawn index proportionality constant for $t \le T'$
ψ	average natural mortality rate in year $t = t'$
$\sigma_{a_{50}}$	standard deviation in a_{50} (parameter of selectivity function)

State Variables

B_t	biomass in year *t*
B_t^S	spawning stock biomass in year *t*
$\hat{C}_{t,p,a}$	model estimated catch-at-age *a* by period *p* and year *t*
$F_{t,p}$	instantaneous fishing mortality by period *p* and year *t*
M_t	instantaneous natural mortality in year *t*
$\overline{M}$	average natural mortality rate
$N_{t,a}$	number of fish of age *a* at the beginning of year *t*
$N'_{t,p,a}$	number of fish of age *a* at the beginning of period *p* of year *t* that are available to the fishery
$\hat{P}_{t,p,a}$	model estimated proportion of fish at age *a* in period *p* of year *t*

R_0	unfished recruitment
R_t	recruitment in year *t*
$s_{t,p,a}$	selectivity to the fishery at age *a* in period *p* of year *t*

B.1. MODEL INITIALIZATION

Model initialization assumes equilibrium conditions with a constant level of fishing (κ) in years prior to the first year of the analysis ($t < t'$, pre-1951). To initialize the age structure of the model, we must first calculate the relative proportion of fish in each of the age groups ($a = k$ to K–1) for years $t = t'-n$ (subtracting one year for each age group). This means the model is initialized to t = 1942. Equations used to initialize the population are laid out in Table 4 and Table 5.

Table 4. Population initialization

$$N_{t'-n-1,a} = R_0 \times \tilde{N}_a \quad \text{(T4.1)}$$

$$\tilde{N}_{a=k} = \exp(-M_{a=k}) \quad \text{(T4.2)}$$

$$\tilde{N}_{a>k} = \tilde{N}_{a-1} \times \exp(-M_a) \quad \text{(T4.3)}$$

$$\tilde{N}_{a=K} = \tilde{N}_{a=K} \Big/ \left(1-\exp(-M_{a=K})\right) \quad \text{(T4.4)}$$

$$B^S_{t'-n-1} = \sum N_{t,a} w'_{t,a} \lambda_a \quad \text{(T4.5)}$$

$$N_{t+1,a} = N_{t,a}\lambda_a \exp(-M_{t,a} - F_t) + N_{t,a}\left(1-\lambda_a\right)\exp(-M_{t,a}) \quad \text{(T4.6)}$$

$$B_{t>t',a} = \sum N_{t,a}\lambda_{t,a} w_{t,a} \quad \text{(T4.7)}$$

In the year prior to population initialization, $t = t'-n-1$, numbers at age, $N_{t'-n-1,a}$ (T4.1), are calculated by multiplying the relative proportion of fish in each age group, $\tilde{N}_a$ (T4.2–T4.4), by the unfished recruitment, R_0 (Table 5). From here, we set $N_{t'-n,a} = N_{t'-n-1,a}$ and derive numbers at age for years $t'-n$ to t' by calculating the spawning biomass, $B^S_{t,a}$ (T4.5), and subsequent recruits, R_t (T5.1). We then add new recruits, R_t, to numbers at age, N_{t-1}, in the previous year. Natural mortality (M_t), availability (λ_a), and weight-at-age ($w_{t,a}$) for this initialization step are equivalent to those values used in t', i.e. $M_{t>t'} = M_{t'}$. In the final steps (T4.6-T4.7), we subtract from the initial population the effects of natural mortality, M_t, and initial fishing mortality, κ, and then calculate the corresponding biomass, B_t.

Table 5. Stock-recruitment relationship

$$R_{t,a} = \frac{\alpha B_t}{\beta + B_t} \exp\left(d_t^R - 0.5\sigma_R^2\right) \quad \text{(T5.1)}$$

$$\alpha = R_0 \frac{4h}{(5h-1)} \quad \text{(T5.2)}$$

$$\beta = B_0 \frac{(1-h)}{(5h-1)} \quad \text{(T5.3)}$$

$$B_0 = R_0 \left(\sum_{a=1}^{A} \left(\lambda_a w_{t',a} \exp\left(\sum_{a=1}^{A} - M_{t',a} \right) \right) + \lambda_A w_{t',a=A} \exp\left(\sum_{a=1}^{A} - M_{t',a} \right) \left(1 - \exp\left(- M_{t',a=A}\right)\right)^{-1} \right) \quad \text{(T5.4)}$$

Model initialization also includes calculation of fishery selectivity, $s_{t,\,p,\,a}$, and natural mortality, M_t. Selectivity is modelled for each fishing period using variations of the logistic equation (T6.1 and T6.2). Time-varying natural mortality (T6.3 and T6.4) is apportioned across fishing periods as a fraction of annual mortality (T6.5 and T6.6), with annual deviations, d_t^M, modelled using a random walk. The 2006 implementation of the HCAM model included estimation of annual availability/ maturity, λ_a, however, in the 2008 and 2009 assessments a fixed availability schedule is used. Average natural mortality rate, $\overline{M}$, is also calculated (T6.7).

Table 6. Fishery selectivity and natural mortality

$$s_{t,\,p\le 2,\,a} = 1 / 1 + \exp\left(-\sigma_{a_{50}}\left(a - a_{50}\right)\right) \quad \text{(T6.1)}$$

$$s_{t,\,p=3,\,a} = 1 \Big/ \left(1 + \exp\left(a_{50} - \sigma_{a_{50}} w'_{t,a} \exp\left(0.2\, d^{GN}\right)\right)\right) \quad \text{(T6.2)}$$

$$M_{t=t'} = \psi \quad \text{(T6.3)}$$

$$M_{t>t'} = \exp(d_t^M)\, M_{t-1} \quad \text{(T6.4)}$$

$$M_{t,\,p=1} = 0.90 M_t \quad \text{(T6.5)}$$

$$M_{t,\,p>1} = 0.05 M_t \quad \text{(T6.6)}$$

$$\overline{M} = \sum_{t=t'}^{T} M_t \Big/ \left((T - t' + 1)(K - k + 1)\right) \quad \text{(T6.7)}$$

B.2. POPULATION AND FISHING DYNAMICS

After the model initialization step, the model estimates these variables: available numbers at age $N'_{t,a}$ and total numbers at age $N_{t,a}$, both estimated by year and period (T7.1–T7.5), estimated spawning biomass, (T7.6), catch, $\hat{C}_{t,p,a}$, and age composition, $\hat{P}_{t,p,a}$. Catch is predicted using the discrete catch equation (T7.7) and is assumed to be known with great certainty, thus differences between observed and predicted catch are assumed to follow a log normal distribution with a mean of 0 and standard deviation of 0.005. In this calculation, fishing mortality, $F'_{t,a}$ (T7.8), is estimated as a free parameter. Fitted proportions at age, $\hat{P}_{t,p,a}$, are estimated using predicted catch (T7.9). This implementation of the HCAMv2 assumes no ageing error.

Table 7. Population and fishing dynamics

$$N'_{t,p=1,a} = \lambda_a N_{t,a} \quad \text{(T7.1)}$$

$$N'_{t,p>1,a} = \exp\left(-M_{t,p} - F_{t,p}\right) N'_{t,p,a} \quad \text{(T7.2)}$$

$$N_{t+1,a+1} = N'_{t,p=p'+1,a} + \left(1-\lambda_a\right)\exp\left(-M_t\right) N_{t,a} \quad \text{(T7.3)}$$

$$N_{t+1,a+1} = N'_{t,p=p'+1,a} + \left(1-\lambda_a\right)\exp\left(-M_t\right) N_{t,a} + N'_{t,p=p'+1,a=K} + \left(1-\lambda_{a=K}\right)\exp\left(-M_t\right) N_{t,a=K} \quad \text{(T7.4)}$$

$$N_{t,a=K} = R_t \quad \text{(T7.5)}$$

$$B_t^S = \sum_{a=k}^{K} N'_{t,p=p'+1,a} w_{t,a} \lambda_a \quad \text{(T7.6)}$$

$$\hat{C}_{t,p,a} = \exp\left(-M_{t,p}\right) s_{t,p,a} F'_{t,p} N'_{t,p,a} \quad \text{(T7.7)}$$

$$F_{t,p,a} = -\ln\left(s_{t,p,a} F'_{t,p}\right) \quad \text{(T7.8)}$$

$$\hat{P}_{t,p,a} = \hat{C}_{t,p,a} \Big/ \sum_{a=k}^{K} \hat{C}_{t,p,a} \quad \text{(T7.9)}$$

B.3. LIKELIHOODS

The final component of the estimation procedure is the objective function. Table 8 summarizes the likelihoods components and Table 9 the associated priors related to: 1) age composition with process error, 2) commercial catch and 3) the spawn index.

Table 8. Negative log likelihoods

Age composition data

$$-\ln(L) = N^S_{t,p} \ln\left(\hat{P}_{t,p,a}\right) - N^S_{t,p} \ln\left(P_{t,p,a}\right) \quad \text{(T8.1)}$$

$$-\ln(L) = 0.5 \sum_{t,p,a} \ln\left(r_{t,p,a}\right) - \sum_{t,p,a} \ln\left[\exp\left[\frac{-\left(P_{t,p,a} - \hat{P}_{t,p,a}\right)^2}{2r_{t,p,a} \big/ N^S_{t,p}} \right] + 0.01 \right] \quad \text{(T8.2)}$$

$$\text{where } r_{t,p,a} = \left(1 - P_{t,p,a}\right) P_{t,p,a} + \left(0.01 \big/ T - t' + 1\right) \quad \text{(T8.3)}$$

$$N^S_{t,p} = \frac{1}{1/\tilde{N}^S_{t,p} + 1/\varepsilon^{process}} \quad \text{(T8.4)}$$

Catch

$$-\ln(L) = \frac{\sum_{t=t'}^{T} \ln\left(C_{t,p,a} \big/ \hat{C}_{t,p,a} \right)}{2\sigma_C^2} \quad \text{(T8.5)}$$

Spawn index data

$$-\ln(L) = \frac{\sum_{t=}^{T} \ln\left(I_t \big/ qB_t \right)}{2\sigma_t^2} \quad \text{(T8.6)}$$

Table 9. Prior contributions to the objective function

Average natural mortality rate	
$\frac{\left(\overline{M}-0.45\right)}{2\sigma_{\overline{M}}^2}$	(T9.1)
Deviations in average natural mortality rate	
$\frac{d_t^M}{2\sigma_M^2}$	(T9.2)
Recruitment deviations	
$\left(T-t'\right)\ln\left(\sigma_R\right)+\sum_{t=t'+1}^{T}\left[\frac{\left(d_t^R\right)^2}{2\sigma_R^2}\right]$	(T9.3)
Steepness	
$\frac{\left(h-0.5\right)}{2\sigma_h^2}$	(T9.4)
Initial fishing mortality	
$\ln\left(\kappa\right)-\frac{0.5\left(\ln\left(\kappa\right)-\ln\left(0.3166\right)\right)^2}{\left(0.6633\right)^2}$	(T9.5)