Canadian Manuscript Report of

Fisheries and Aquatic Sciences 2119

1991

# STOCK ASSESSMENTS FOR BRITISH COLUMBIA HERRING IN 1990 AND FORECASTS OF THE POTENTIAL CATCH IN 1991

by

V. Haist and J. F. Schweigert

Biological Sciences Branch

Department of Fisheries and Oceans

Pacific Biological Station

Nanaimo, British Columbia V9R 5K6

Cat. No. Fs 97-4/12119E ISSN 0706-6473

Correct citation for this publication:

Haist, V. and J. F. Schweigert. 1991. Stock assessments for British Columbia herring in 1990 and forecasts of the potential catch in 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2119: 60 p.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

## ABSTRACT

Haist, V. and J. F. Schweigert. 1991. Stock assessments for British Columbia herring in 1990 and forecasts of the potential catch in 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2119: 60 p.

Herring stock abundance in British Columbia waters was assessed for 1990 and forecasts were made for 1991 using two analytical methods: (1) escapement model; and (2) age-structured model. Diving survey data were utilized in the escapement model wherever available.

Forecasts of pre-fishery biomass are obtained by weighting the estimates from the two models. The forecasts are for 80,800 tonnes to the northern and 105,600 tonnes to the southern stock assessment regions. These estimates represent a decrease of 23% in the northern areas and a 5% increase in the southern areas relative to the 1990 forecasts.

The recommended 1991 catch (20% of the 1991 forecast herring run) for the entire B.C. coast is 37,280 tonnes. All areas should be available to the fishery in 1991.

Key words: *Clupea harengus pallasi*, Pacific herring, stock assessment, forecasts, age-structured analysis

# RÉSUMÉ

Haist, V. and J. F. Schweigert. 1991. Stock assessments for British Columbia herring in 1990 and forecasts of the potential catch in 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2119: 60 p.

L'abondance des stocks de hareng en Colombie-Britannique a été évaluée en 1990 et des prévisions ont été faites pour 1991 à l'aide de deux méthodes d'analyse: le modèle de l'échappée et le modèle en fonction de l'âge. Des données d'études en plongée ont été utilisées dans la mesure du possible dans le modèle de l'échappée.

Les prévisions concernant la biomasse avant la pêche ont été obtenues en pondérant les estimations effectuées à l'aide des deux modèles. Les prévisions donnent 80 800 tonnes pour les stocks de la région du nord et 105 600 tonnes pour les stocks de la région du sud. Ces estimations représentent une diminution de 23% dans les secteurs du nord et une augmentation de 5% dans les secteurs du sud par rapport aux prévisions de 1990.

La prise recommandée en 1991 (20% des prévisions de remonte de hareng pour 1991) pour toute la côte de Colombie-Britannique équivaut à 37 280 tonnes. Tous les secteurs devraient être ouverts à la pêche en 1991.

Mots-clés: *Clupea harengus pallasi*, hareng du pacifique, évaluation des stocks, prévisions, analyse en fonction de l'âge

# 1. INTRODUCTION

## 1.1 GENERAL

Herring are an important component of the British Columbia commercial fishery with catch records dating from 1877. In the early 1900's the fishery was primarily for a dry salted market and catches were relatively low. During the 1930's a fishery for reduction purposes developed and catches steadily increased. Very large catches (200,000 tonnes annually), in the early 1960's in conjunction with a series of poor recruitments led to the collapse of the reduction fishery and closure in 1968. Cessation of the intensive reduction fishery resulted in a gradual recovery of stocks.

In 1972 a herring fishery for a roe product developed. These fisheries occur just prior to spawning when the fish are tightly schooled and highly aggregated. Initially the roe-fisheries were managed in-season to fixed escapement targets (Hourston 1981). This management system was untenable because of problems in obtaining accurate in-season stock estimates, uncertainty about appropriate escapement targets, and difficulty in controlling fishing effort. Since 1983, herring fisheries have been managed with a fixed quota system. Under this system catch levels are determined prior to the season based on a fixed percentage (20%) of forecast stock abundance.

In this report we present stock assessments from two analytical models which have been developed explicitly for B.C. herring: (1) an escapement model (Schweigert and Stocker 1988); and (2) an age-structured model (Fournier and Archibald 1982). Both models reconstruct stock abundance for the period 1951-1990 and forecast pre-spawning abundance for the 1991 season. Forecasts of recruit spawners are presented as poor, average, and good based on means observed historically. This report does not discuss the development and evaluation of empirical models for forecasting recruitment, as results of these studies are presented elsewhere (eg. Schweigert and Noakes 1991, Stocker and Noakes 1988).

Results in this report were presented to the PSARC (Pacific Stock Assessment Review Committee) Herring Sub-Committee in September, 1990.

## 1.2 DATA BASE

The primary data sources for the stock assessments are spawn survey data, commercial catch landing data, and age composition data from biological samples of commercial fishery, pre-fishery charter, and research catches. These data are available on computer files for the period 1951 to 1990. This time span includes the reduction fishery period to 1968 and the subsequent roe fishery period starting in the early 1970s.

Of the three data sets, the spawn data contain the largest measurement errors. We feel that the quality of spawn surveys has improved greatly over the 40 year span of these observations. This improvement is a result of increased numbers of people and vessels being involved in spawn surveys, increased attention to data measurements, increased coverage of subtidal spawnings, and increased research on estimating egg deposition from spawn observations. The consistent observations made during the 40 years of spawn surveys are the length, the width, and a measure of intensity of spawnings. The escapement model estimates absolute egg numbers from these observations and includes a width conversion to adjust for the inability to survey subtidal spawns adequately. Since 1987 an increasing number of spawn beds have been surveyed using SCUBA methods. We assume these surveys provide reasonably accurate estimates of spawn bed width and egg density and these data have been used in the escapement model where available. The age-structured model uses a spawn index which sums lengths multiplied by standardized widths and intensities.

Catch information was obtained from landing slip data. Both models use the landing slip data summed by season (seasons run from July 1 to June 30). The 1989/90 catch figures are based on hailed estimates because sales slip data were not available for timely analysis.

Age structure data are used in both models. The information from catch samples are used for years when there were commercial fisheries. Pre-fishery charter samples are used in addition to catch samples for areas with no fisheries or when catch samples do not appear to be representative. Additional data used in the age-structured model are annual average weight-at-age.

## 1.3 STOCK CONSIDERATIONS

The stock concept used for managing British Columbia herring is a compromise between biological and management considerations. Given poor or incomplete knowledge of stock structure it is prudent to manage fisheries at the level of the greatest potential stock diversity. Unfortunately, we do not feel that stock forecasts for smaller geographic regions than used in the current assessments would be accurate enough for fisheries management. Therefore, we recommend that fisheries should be spread throughout the assessment regions to prevent possible overexploitation of individual spawning groups.

Two stock groupings used for this year's assessment are modified. At the 1989 PSARC herring meeting it was decided to adopt revised boundaries for the Queen Charlotte Islands and northern west coast of Vancouver Island stock assessment regions. The current herring stock assessment regions are shown in Figures 1.1 and 1.2.

The Queen Charlotte Islands stock assessment region has been extended to include Cumshewa Inlet in the north and Louscoone Inlet in the south. The stock concept for the Prince Rupert District remains unchanged encompassing Statistical Areas 3 to 5. The central coast stock concept separates the major migratory stocks from the minor spawning populations in the mainland inlets. The areas included in the central coast assessment region are Statistical Area 7 plus Kitasu Bay in Area 6 and Kwakshua Channel in Area 8. The Strait of Georgia is separated into two stock groupings. The northern area includes all of Statistical Areas 14 to 16, 17N, and Deepwater Bay and Okisollo Channel in Area 13. The southern stock comprises Areas 17S, 18 and 19. The two stock groupings used for the west coast of Vancouver Island are southern (Areas 23 and 24) and northern (Area 25). The northern area previously included Areas 25 through 27.

Biomass estimates from the escapement model are also presented for areas outside the major assessment regions. The level of geographic aggregation used for these estimates is the section (Haist and Rosenfeld 1988).

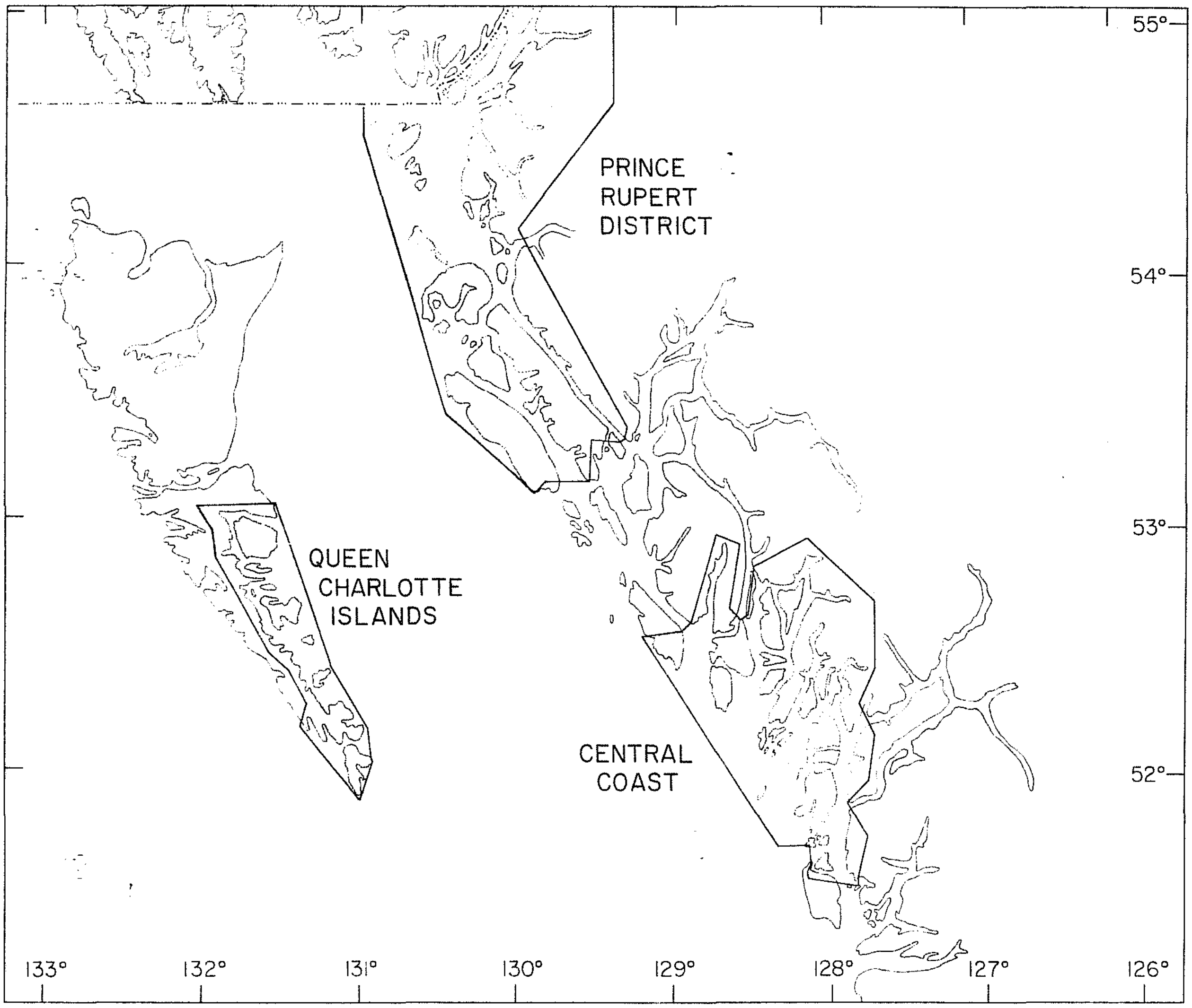


Fig. 1.1. Herring stock assessment regions in northern British Columbia.

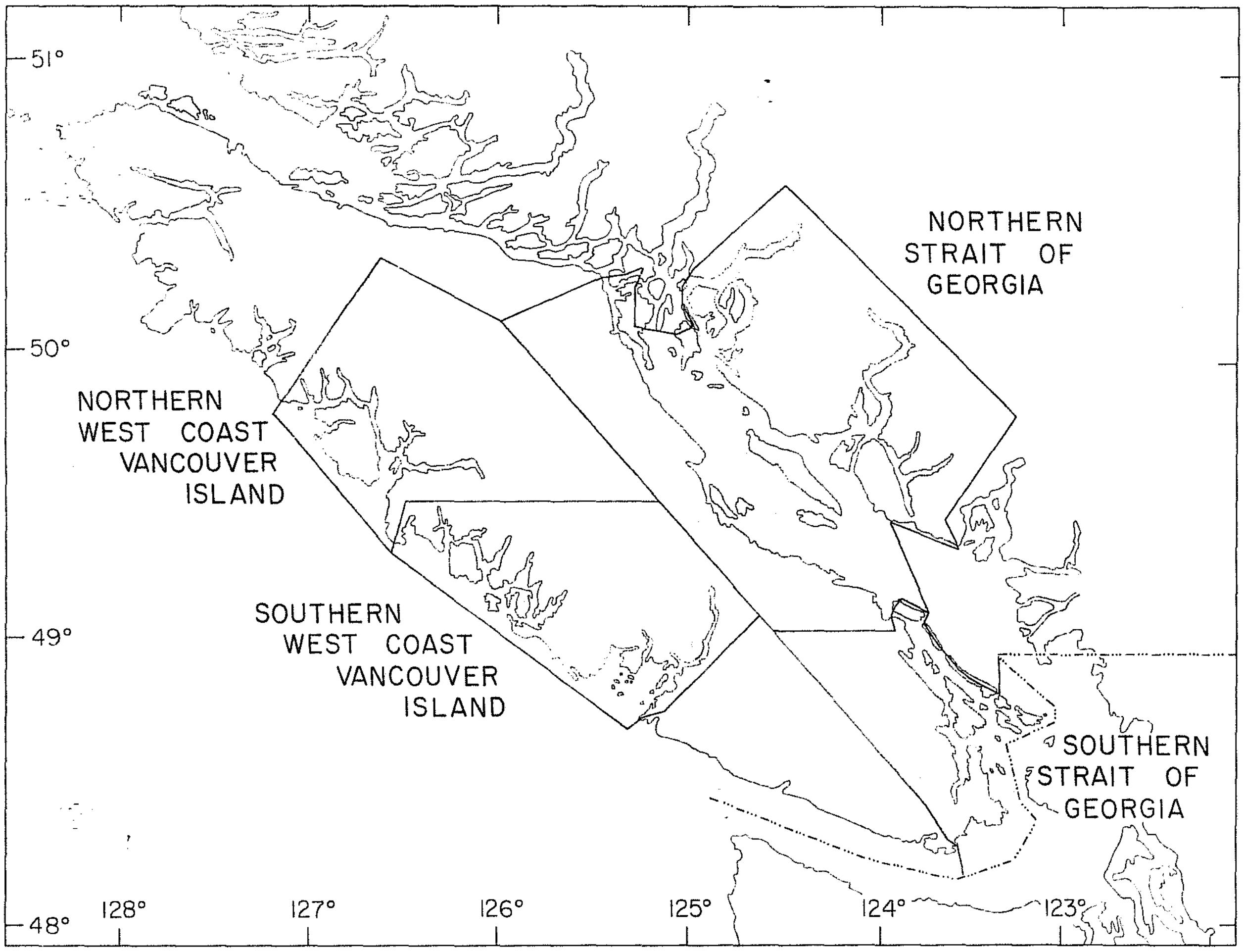


Fig. 1.2. Herring stock assessment regions in southern British Columbia.

# 2. ESCAPEMENT MODEL

## 2.1 INTRODUCTION

The escapement model, developed for the 1984 assessments (Haist et al. 1985; Schweigert and Stocker 1988), is based on information on spawn deposition and provides an empirical estimate of escapement from the fishery. For most stock assessment regions recent estimates of escapement are based on a combination of surface and SCUBA survey data. Beginning in 1987, an increasing portion of the herring spawns have been surveyed by SCUBA methods (Table 2.1).

In this year's assessment, estimates are presented for the major migratory stocks in the 7 assessment regions (Tables 2.2 and 2.3) and for the minor stocks not included in these regions (Tables 2.4 - 2.7).

## 2.2 METHODS

In the escapement model, the forecast run size is based on the estimated escapement in the previous season, growth of the fish during the current season, an average annual survival rate (0.64), and an estimate of recruitment to each stock. Recruitment is estimated for poor, average, and good levels by calculating the means of the third poorest, the middle third, and the third best recruitments observed during the historical time series from 1951-1990. Estimates of total catch (tonnes) and spawn abundance (billions of eggs) are converted to fish-at-age based on the sampling data for each area. For each area the age structure and average weight-at-age are calculated from samples available for that region. For some years no data are available for a region and information from an adjacent area is utilized in the analysis. Forecasts of repeat spawners and recruit fish are converted to forecast tonnages using average weights-at-age as outlined in Haist and Schweigert (1990). The method for estimating escapement from surface and dive survey data is described below.

### Biomass estimates

Escapement from the fishery plus total catch provides an estimate of the pre-fishery stock biomass for each assessment region. The estimated escapement for each region is derived from information on spawn deposition. Dive survey observations are used directly while surface survey observations are adjusted based on calibration equations derived from replicate surveys (Schweigert and Stocker 1988). Total egg deposition is calculated as the product of: total spawn length; observed or adjusted spawn width; and egg density as estimated from the average surface layer estimate, or average predicted egg density from quadrat observations, or average egg layer and plant densities in *Macrocystis* sp. beds. Egg deposition estimates for all spawn beds are summed within each assessment region and the total egg deposition is converted to tonnes of spawning fish based on the average estimate of 100 eggs per gram of fish.

## Surface Surveys

Estimates of spawn width and average egg layers from surface surveys are adjusted to comparable dive survey estimates. The calibration equations used for the 1990 assessment are the same as those used in last year's assessment.

The calibration equation, with parameter estimates, used to adjust surface survey spawn width estimates to comparable diver width estimates is:

ADJUSTED WIDTH = 75.275 + 0.816 SURFACE SURVEY WIDTH.

The equation used to estimate the average density of eggs (thousands per $m^2$) for each spawn from the estimate of average egg layers is:

EGGS = 202.093 + 67.345 AVERAGE SURFACE LAYERS.

Surface survey data are adjusted using the foregoing equations in all areas except for Johnstone Strait (Statistical Areas 9-13). In this area no adjustment is applied to the spawn widths as previous dive surveys in the area (Schweigert and Haegele 1988a, b) indicated that widths were accurately assessed from the surface.

## SCUBA Surveys

For SCUBA surveys spawn bed lengths are determined by exploratory raking or snorkelling and spawn bed widths estimated as the mean of all transect lengths within the spawn bed. Estimates of mean egg density are based on a two-stage sampling design (Schweigert et al. 1985, 1990). Average egg density for each spawning area is estimated as the weighted mean of the means of a series of quadrats located along each transect. For each quadrat observations are made on several variables: type of algal substrate; proportion of the quadrat covered by each algal type; number of layers of eggs on each algal type; proportion of the bottom substrate covered by eggs; and an estimate of the number of egg layers on bottom substrate. In some areas assessments are also made of the egg deposition on the giant kelp as described below.

Egg deposition for each sampling quadrat is estimated from the prediction equation described in the 1989 assessment (Haist and Schweigert 1990). Egg density for each vegetation subfraction is estimated as follows:

$$EGGS_i = 1038.5617\, L^{0.6856}\, P^{1.4189}\, V_i\, Q_j.$$

where $EGGS_i$ = estimated number of eggs in thousands per $m^2$ on vegetation type $i$,
$L$ = number of layers of eggs on algal substrate $i$,
$P$ = proportion of quadrat covered by algal substrate $i$,
$V_1$ = 1.0224 parameter for sea grasses,
$V_2$ = 1.2247 parameter for rockweed,
$V_3$ = 0.8730 parameter for flat kelp,
$V_4$ = 1.2254 parameter for other brown algae,
$V_5$ = 0.9482 parameter for leafy red and green algae,
$V_6$ = 1.0000 parameter for stringy red algae,
$Q_1$ = 0.5387 parameter for 1.00 $m^2$ quadrats,
$Q_2$ = 0.5664 parameter for 0.50 $m^2$ quadrats,
$Q_3$ = 1.0000 parameter for 0.25 $m^2$ quadrats.

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

$$EGGS = \sum_i Eggs_i\ .$$

## Eggs on Bottom and *Macrocystis*

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

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

$$EGGS/PLANT = 0.073\ LAYERS^{0.673}\ HEIGHT^{0.932}\ FRONDS^{0.703}$$

where EGGS/PLANT = total number of eggs on the *Macrocystis* plant in millions,
LAYERS = average number of egg layers on each *Macrocystis* plant,
HEIGHT = total height of the *Macrocystis* plant in metres,
FRONDS = total number of fronds per *Macrocystis* plant.

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

This information may then be combined with the estimate of the density of plants and the estimated area of the *Macrocystis* bed to obtain an estimate of the total number of eggs deposited on the kelp. This egg deposition is then added to the deposition on the understory vegetation for the area.

Enumerated Egg Samples

Samples of the algae and attached eggs from entire quadrats were collected in 1990 from the Prince Rupert District as a check on the accuracy of the egg density prediction model. This area was chosen because of concern about an apparent stock decline. A total of 54 samples were obtained. The average egg counts for the preserved samples was 298,922 eggs/$m^2$ while the average of the predictions from the statistical model is 670,704 eggs/$m^2$. The reason for this discrepancy is not clear but many of the egg samples obtained were near to hatching. We have found that this can result in underestimates of egg numbers because the egg cases begin to rupture during processing releasing the larvae. Although larvae are counted and added to the remaining eggs some larvae are lost in the sample processing.

In addition, samples were preserved for the first time in a modified form of Gilson's fluid which doesn't contain mercury. It appears that the absence of mercury in the Gilson's fluid makes the eggs more fragile resulting in increased egg rupturing even in samples which are collected earlier in the incubation period.

A comparison of egg counts from duplicate samples taken in Lambert Channel and preserved in both Gilson's fluid containing mercury and the modified non-mercuric Gilson's solution is shown in Table 2.8. A paired t-test analysis found no significant difference between egg counts from the mercuric and non-mercuric Gilson's fluid ($p>0.50$). Therefore, it appears that most of the discrepancy between model predictions and egg counts is due simply to the collection of samples which were too near to hatching and normal sampling variation.

## 2.3 RESULTS

A summary of the spawn survey coverage for the British Columbia coast from 1987 to present is presented in Table 2.1. It is evident that the majority of the spawn deposition is now being surveyed by SCUBA methods. No surface surveys were conducted in the Prince Rupert District and were conducted in only a few locations in the Queen Charlotte Islands. Due to the large number of spawn locations in the central coast about half of the spawn was surveyed by surface methods in 1990. In the Strait of Georgia and the west coast of Vancouver Island the majority of spawns were surveyed with SCUBA. Unfortunately, significant spawns in Hesquiat Harbour were not surveyed at all.

Estimates of stock abundance for the seven stock assessment regions are presented in Tables 2.2 and 2.3 and discussed in Section 4. Estimates of abundance for the minor stocks are presented in Tables 2.4 to 2.7. There are always problems in assessing stocks in more remote locations due to inadequate spawn survey coverage and a general absence of age-structure data, so absolute estimates of abundance are probably not very accurate. From the available data abundance trends for the minor stocks generally follow those of the nearby stock assessment region. The stocks in Area 2W appear healthy in relation to historical levels and could again be considered as a potential area for a roe fishery. The minor stocks in the central coast are also not surveyed with sufficient regularity to discern possible trends, but no major fishable biomasses are apparent. The Johnstone Strait stocks appear to be below the long term average based on recent surveys, but coverage may be incomplete. The stocks on the northern west coast of Vancouver Island receive intermittent survey coverage and show no clear trends. There is no large fishable biomass in this area.

Table 2.1. Kilometers of spawn surveyed by dive and surface methods for major and minor stocks on the British Columbia coast, 1987-1990.

| | 1987 | | | 1988 | | | 1989 | | | 1990 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assessment Region | Dive | Surface | Total | Dive | Surface | Total | Dive | Surface | Total | Dive | Surface | Total |
| Queen Charlotte Islands | 0.0 | 35.7 | 35.7 | 28.2 | 7.9 | 36.1 | 48.8 | 18.4 | 67.2 | 63.0 | 3.0 | 66.0 |
| Prince Rupert District | 0.0 | 83.6 | 83.6 | 55.0 | 5.7 | 60.7 | 40.1 | 0.9 | 41.0 | 47.4 | 0.0 | 47.4 |
| Central Coast | 0.0 | 86.5 | 86.5 | 32.6 | 112.7 | 145.3 | 25.1 | 105.1 | 130.2 | 73.6 | 73.9 | 147.5 |
| N. Strait of Georgia | 49.4 | 13.9 | 63.3 | 39.7 | 8.6 | 48.3 | 66.1 | 16.6 | 82.7 | 77.0 | 1.1 | 78.1 |
| S. Strait of Georgia | 25.2 | 2.2 | 27.4 | 12.6 | 5.6 | 18.2 | 24.8 | 2.3 | 27.1 | 40.5 | 0.0 | 40.5 |
| S.W.C. Vancouver Is. | 31.1 | 10.4 | 41.5 | 35.1 | 23.9 | 59.0 | 47.3 | 6.6 | 53.9 | 26.5 | 10.7 | 37.2 |
| N.W.C. Vancouver Is. | 10.7 | 19.0 | 29.7 | 0.0 | 22.6 | 22.6 | 11.6 | 11.0 | 22.6 | 4.7 | 11.2 | 15.9 |
| Other Areas | 0.0 | 173.6 | 173.6 | 0.0 | 228.5 | 228.5 | 16.1 | 153.4 | 169.5 | 32.4 | 148.1 | 180.5 |
| Coastwide Total | 116.5 | 424.8 | 541.3 | 203.4 | 415.6 | 619.0 | 279.9 | 314.4 | 594.3 | 365.1 | 248.0 | 613.1 |

Table 2.2. Estimates of spawner biomass, catch, and total stock abundance (tonnes) for the northern stock assessment regions for 1951-1990.

| | Queen Charlotte Islands | | | Prince Rupert District | | | Central Coast | | |
|---|---|---|---|---|---|---|---|---|---|
| Season | Spawners | Catch | Stock | Spawners | Catch | Stock | Spawners | Catch | Stock |
| 1950/51 | 4191 | 2847 | 7038 | 27967 | 45865 | 73832 | 20886 | 42458 | 63345 |
| 1951/52 | 3051 | 10147 | 13198 | 9957 | 52379 | 62336 | 10351 | 33195 | 43546 |
| 1952/53 | 5702 | 0 | 5702 | 14016 | 1865 | 15881 | 20187 | 768 | 20955 |
| 1953/54 | 11514 | 1786 | 13301 | 9951 | 27277 | 37228 | 16308 | 24616 | 40925 |
| 1954/55 | 5840 | 498 | 6338 | 12738 | 17806 | 30544 | 16061 | 11594 | 27655 |
| 1955/56 | 5592 | 77461 | 83053 | 12506 | 10182 | 22688 | 11557 | 43627 | 55185 |
| 1956/57 | 1495 | 21803 | 23298 | 19301 | 28035 | 47336 | 5960 | 23261 | 29221 |
| 1957/58 | 783 | 11147 | 11930 | 8514 | 4523 | 13037 | 8276 | 9849 | 18125 |
| 1958/59 | 8085 | 6828 | 14913 | 16197 | 10224 | 26421 | 7409 | 27870 | 35279 |
| 1959/60 | 7017 | 0 | 7017 | 13146 | 18476 | 31621 | 20331 | 4037 | 24368 |
| 1960/61 | 8612 | 576 | 9188 | 14482 | 42746 | 57228 | 8393 | 31704 | 40097 |
| 1961/62 | 5338 | 7632 | 12970 | 20094 | 27660 | 47754 | 22499 | 15709 | 38208 |
| 1962/63 | 4465 | 14705 | 19170 | 15151 | 40228 | 55379 | 10918 | 44054 | 54972 |
| 1963/64 | 4830 | 28882 | 33712 | 16316 | 30340 | 46655 | 11690 | 32064 | 43754 |
| 1964/65 | 1889 | 35448 | 37337 | 6278 | 44211 | 50488 | 4486 | 15670 | 20156 |
| 1965/66 | 3525 | 2746 | 6271 | 5769 | 17295 | 23065 | 4990 | 37482 | 42472 |
| 1966/67 | 942 | 213 | 1155 | 3057 | 7998 | 11055 | 8219 | 21890 | 30109 |
| 1967/68 | 817 | 80 | 897 | 6508 | 2144 | 8652 | 8973 | 1529 | 10502 |
| 1968/69 | 1799 | 0 | 1799 | 900 | 547 | 1447 | 3959 | 100 | 4058 |
| 1969/70 | 8211 | 0 | 8211 | 11904 | 1498 | 13403 | 19352 | 209 | 19561 |
| 1970/71 | 12599 | 102 | 12701 | 9685 | 3500 | 13185 | 8029 | 3614 | 11642 |
| 1971/72 | 10845 | 3972 | 14817 | 10896 | 4494 | 15390 | 8583 | 9279 | 17863 |
| 1972/73 | 11772 | 7520 | 19292 | 11112 | 1607 | 12719 | 23747 | 7799 | 31546 |
| 1973/74 | 13139 | 6318 | 19457 | 8843 | 3819 | 12663 | 19662 | 8887 | 28550 |
| 1974/75 | 11525 | 7724 | 19249 | 10572 | 1702 | 12273 | 18952 | 8739 | 27690 |
| 1975/76 | 18615 | 14116 | 32731 | 15834 | 4307 | 20141 | 30004 | 12199 | 42203 |
| 1976/77 | 18206 | 12635 | 30841 | 15617 | 8142 | 23758 | 27962 | 11106 | 39067 |
| 1977/78 | 14994 | 11726 | 26720 | 7577 | 8588 | 16165 | 16712 | 14046 | 30758 |
| 1978/79 | 12150 | 7953 | 20103 | 13730 | 4317 | 18047 | 14408 | 5 | 14413 |
| 1979/80 | 25853 | 3316 | 29169 | 17155 | 3425 | 20580 | 30389 | 538 | 30927 |
| 1980/81 | 26983 | 5631 | 32613 | 17131 | 3090 | 20221 | 32771 | 2573 | 35344 |
| 1981/82 | 22013 | 3778 | 25792 | 14917 | 1984 | 16901 | 33660 | 6370 | 40030 |
| 1982/83 | 19944 | 5597 | 25540 | 26310 | 0 | 26310 | 41185 | 5640 | 46825 |
| 1983/84 | 22150 | 4719 | 26869 | 28013 | 3761 | 31774 | 27875 | 7193 | 35068 |
| 1984/85 | 17721 | 6109 | 23830 | 31994 | 6747 | 38740 | 24676 | 5209 | 29885 |
| 1985/86 | 6719 | 3503 | 10222 | 30186 | 8679 | 38865 | 21633 | 3386 | 25019 |
| 1986/87 | 15277 | 2061 | 17338 | 38140 | 6271 | 44411 | 28714 | 3615 | 32330 |
| 1987/88 | 16771 | 32 | 16802 | 32092 | 7968 | 40060 | 48385 | 4527 | 52912 |
| 1988/89 | 25821 | 1461 | 27283 | 12931 | 8474 | 21405 | 42133 | 9442 | 51574 |
| 1989/90 | 24164 | 6678 | 30842 | 19398 | 4068 | 23466 | 42333 | 7977 | 50311 |

Table 2.3. Estimates of spawner biomass, catch, and total stock abundance (tonnes) for the southern stock assessment regions for 1951-1990.

| | Georgia Strait - North | | | Georgia Strait - South | | | WCVI - South | | | WCVI - North | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Season | Spawners | Catch | Stock | Spawners | Catch | Stock | Spawners | Catch | Stock | Spawners | Catch | Stock |
| 1950/51 | 30795 | 17787 | 48582 | 3623 | 25824 | 29447 | 6510 | 15914 | 22423 | 9345 | 5908 | 15252 |
| 1951/52 | 27928 | 17635 | 45563 | 12440 | 28084 | 40524 | 6400 | 10630 | 17030 | 1851 | 16378 | 18229 |
| 1952/53 | 33442 | 4376 | 37817 | 33092 | 3966 | 37058 | 8918 | 20 | 8938 | 13198 | 0 | 13198 |
| 1953/54 | 23291 | 20560 | 43851 | 35352 | 44284 | 79635 | 5292 | 28699 | 33991 | 4522 | 4510 | 9032 |
| 1954/55 | 30962 | 26818 | 57780 | 30895 | 41619 | 72514 | 6439 | 6041 | 12479 | 3831 | 83 | 3913 |
| 1955/56 | 13908 | 27273 | 41181 | 14745 | 44572 | 59318 | 8769 | 17098 | 25867 | 12302 | 0 | 12302 |
| 1956/57 | 12652 | 21374 | 34025 | 6817 | 38202 | 45019 | 6246 | 2600 | 8846 | 16412 | 13 | 16424 |
| 1957/58 | 8288 | 9012 | 17299 | 17174 | 11616 | 28790 | 11648 | 513 | 12161 | 5715 | 43 | 5758 |
| 1958/59 | 16095 | 34189 | 50284 | 16121 | 15765 | 31886 | 6037 | 37385 | 43422 | 4793 | 31838 | 36631 |
| 1959/60 | 20903 | 22540 | 43443 | 9267 | 43107 | 52375 | 5612 | 17652 | 23264 | 948 | 36259 | 37207 |
| 1960/61 | 17094 | 15784 | 32878 | 9186 | 30410 | 39596 | 7804 | 13489 | 21293 | 3430 | 12946 | 16376 |
| 1961/62 | 16176 | 30358 | 46534 | 5448 | 34945 | 40393 | 9024 | 15597 | 24622 | 12802 | 8087 | 20889 |
| 1962/63 | 16106 | 33746 | 49852 | 8572 | 35101 | 43673 | 8544 | 4019 | 12563 | 1537 | 14187 | 15724 |
| 1963/64 | 15319 | 36808 | 52127 | 6760 | 40179 | 46939 | 17239 | 20230 | 37469 | 7302 | 1036 | 8337 |
| 1964/65 | 13512 | 27931 | 41443 | 2567 | 19888 | 22455 | 7069 | 14063 | 21132 | 5835 | 1983 | 7818 |
| 1965/66 | 4824 | 20996 | 25821 | 2805 | 12337 | 15142 | 3377 | 8169 | 11546 | 1935 | 2673 | 4608 |
| 1966/67 | 6781 | 11157 | 17938 | 2558 | 19885 | 22444 | 2163 | 9171 | 11333 | 3568 | 5974 | 9542 |
| 1967/68 | 6969 | 966 | 7935 | 5247 | 981 | 6228 | 4105 | 0 | 4105 | 3028 | 0 | 3028 |
| 1968/69 | 9063 | 325 | 9388 | 7494 | 420 | 7914 | 5539 | 0 | 5539 | 5555 | 0 | 5555 |
| 1969/70 | 22274 | 519 | 22793 | 12870 | 365 | 13235 | 16899 | 0 | 16899 | 4813 | 0 | 4813 |
| 1970/71 | 27393 | 948 | 28341 | 10879 | 745 | 11624 | 17904 | 0 | 17904 | 6329 | 0 | 6329 |
| 1971/72 | 14022 | 6443 | 20465 | 9153 | 2368 | 11521 | 17370 | 4285 | 21655 | 9929 | 2609 | 12538 |

Table 2.3. (Cont'd.).

| | Georgia Strait - North | | | Georgia Strait - South | | | WCVI - South | | | WCVI - North | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Season | Spawners | Catch | Stock | Spawners | Catch | Stock | Spawners | Catch | Stock | Spawners | Catch | Stock |
| 1972/73 | 15205 | 6679 | 21884 | 9812 | 970 | 10781 | 6120 | 10409 | 16529 | 6053 | 7894 | 13946 |
| 1975/76 | 38858 | 8163 | 47020 | 9295 | 4075 | 13370 | 27971 | 33441 | 61412 | 4216 | 5384 | 9601 |
| 1976/77 | 47284 | 11304 | 58587 | 6001 | 6205 | 12206 | 28556 | 26453 | 55009 | 5725 | 3590 | 9315 |
| 1977/78 | 52530 | 13874 | 66404 | 13633 | 10129 | 23761 | 18760 | 18050 | 36810 | 5233 | 4695 | 9928 |
| 1978/79 | 73180 | 8638 | 81819 | 19573 | 11699 | 31273 | 27937 | 9876 | 37813 | 22912 | 8817 | 31729 |
| 1979/80 | 53805 | 4525 | 58329 | 11808 | 1294 | 13102 | 26534 | 2276 | 28810 | 8369 | 1706 | 10075 |
| 1980/81 | 32192 | 7407 | 39598 | 12152 | 4645 | 16798 | 24090 | 4928 | 29017 | 7056 | 3162 | 10218 |
| 1981/82 | 64906 | 5746 | 70652 | 7852 | 7086 | 14939 | 10921 | 3110 | 14031 | 6466 | 2377 | 8843 |
| 1982/83 | 34396 | 16220 | 50616 | 11277 | 949 | 12225 | 10921 | 6141 | 17062 | 4667 | 2434 | 7102 |
| 1983/84 | 15927 | 9869 | 25797 | 11413 | 1175 | 12588 | 16033 | 5718 | 21751 | 2668 | 858 | 3526 |
| 1984/85 | 20490 | 6239 | 26729 | 7630 | 791 | 8421 | 25889 | 178 | 26067 | 1376 | 0 | 1376 |
| 1985/86 | 55423 | 287 | 55710 | 7824 | 307 | 8131 | 28490 | 204 | 28694 | 8893 | 0 | 8893 |
| 1986/87 | 29568 | 5294 | 34861 | 9144 | 4059 | 13203 | 24254 | 13463 | 37717 | 6894 | 2471 | 9365 |
| 1987/88 | 22913 | 7500 | 30413 | 5206 | 715 | 5922 | 30036 | 9724 | 39760 | 6947 | 0 | 6947 |
| 1988/89 | 52364 | 7077 | 59441 | 4481 | 1292 | 5773 | 34002 | 13289 | 47291 | 4258 | 0 | 4258 |
| 1989/90 | 45737 | 4223 | 49960 | 13225 | 3266 | 16491 | 29620 | 9421 | 39041 | 8274 | 0 | 8274 |

Table 2.4. Estimates of the total biomass and average reduction and roe catches (tonnes) for minor stocks in the Queen Charlotte Islands for 1951-1990.

| Season | Section | | | | | Total | Section | |
|---|---|---|---|---|---|---|---|---|
| | 001 | 002 | 003 | 004 | 005 | Area 2W | 022 | 023 |
| 1950/51 | 0 | 0 | 0 | 0 | 0 | 0 | 812 | 0 |
| 1951/52 | 0 | 0 | 0 | 0 | 0 | 0 | 638 | 0 |
| 1952/53 | 0 | 0 | 776 | 160 | 0 | 936 | 1723 | 0 |
| 1953/54 | 0 | 0 | 0 | 0 | 0 | 0 | 25304 | 0 |
| 1954/55 | 0 | 0 | 0 | 0 | 0 | 0 | 19017 | 0 |
| 1955/56 | 0 | 0 | 0 | 0 | 0 | 0 | 5896 | 93 |
| 1956/57 | 0 | 0 | 148 | 0 | 0 | 148 | 1193 | 0 |
| 1957/58 | 0 | 0 | 221 | 0 | 43 | 264 | 83 | 0 |
| 1958/59 | 1675 | 1144 | 1587 | 0 | 1026 | 5432 | 11177 | 0 |
| 1959/60 | 91 | 656 | 1376 | 0 | 111 | 2234 | 3623 | 0 |
| 1960/61 | 1158 | 422 | 531 | 0 | 389 | 2500 | 4279 | 0 |
| 1961/62 | 396 | 1925 | 1665 | 0 | 311 | 4297 | 8033 | 0 |
| 1962/63 | 0 | 2411 | 0 | 0 | 0 | 2411 | 3027 | 0 |
| 1963/64 | 433 | 1403 | 760 | 192 | 168 | 2956 | 4004 | 0 |
| 1964/65 | 285 | 0 | 303 | 106 | 1481 | 2175 | 5671 | 0 |
| 1965/66 | 0 | 66 | 26 | 0 | 18 | 110 | 3792 | 0 |
| 1966/67 | 81 | 1271 | 0 | 0 | 154 | 1506 | 637 | 178 |
| 1967/68 | 0 | 6 | 110 | 0 | 77 | 193 | 273 | 0 |
| 1968/69 | 26 | 297 | 321 | 0 | 935 | 1579 | 1174 | 0 |
| 1969/70 | 0 | 423 | 373 | 0 | 805 | 1601 | 1054 | 4979 |
| 1970/71 | 0 | 170 | 825 | 0 | 589 | 1584 | 2064 | 6495 |
| 1971/72 | 0 | 467 | 489 | 0 | 1995 | 2951 | 3550 | 7400 |
| 1972/73 | 0 | 139 | 1480 | 0 | 2347 | 3966 | 1136 | 9338 |
| 1973/74 | 0 | 0 | 1364 | 0 | 3001 | 4365 | 1625 | 6270 |
| 1974/75 | 0 | 314 | 1400 | 254 | 1570 | 3538 | 2211 | 5265 |
| 1975/76 | 0 | 417 | 489 | 0 | 1857 | 2763 | 2986 | 5070 |
| 1976/77 | 0 | 302 | 669 | 221 | 2442 | 3634 | 3081 | 4184 |
| 1977/78 | 640 | 0 | 2104 | 0 | 2240 | 4984 | 4035 | 3624 |
| 1978/79 | 1292 | 53 | 692 | 110 | 875 | 3022 | 1635 | 3541 |
| 1979/80 | 1157 | 1397 | 1907 | 0 | 2310 | 6771 | 31 | 0 |
| 1980/81 | 1289 | 4097 | 2188 | 435 | 1235 | 9244 | 711 | 2077 |
| 1981/82 | 0 | 6143 | 3544 | 439 | 4101 | 14227 | 876 | 563 |
| 1982/83 | 261 | 3560 | 4165 | 550 | 5149 | 13685 | 577 | 1816 |
| 1983/84 | 580 | 2654 | 1148 | 0 | 2095 | 6477 | 2318 | 1755 |
| 1984/85 | 0 | 2242 | 909 | 38 | 1993 | 5182 | 411 | 1247 |
| 1985/86 | 0 | 1168 | 314 | 0 | 1442 | 2924 | 2816 | 974 |
| 1986/87 | 0 | 2091 | 0 | 0 | 765 | 2856 | 903 | 968 |
| 1987/88 | 721 | 4307 | 1413 | 358 | 2334 | 9133 | 425 | 0 |
| 1988/89 | 0 | 2549 | 2948 | 0 | 3773 | 9270 | 0 | 677 |
| 1989/90 | 0 | 10232 | 2117 | 0 | 2648 | 14997 | 0 | 1200 |
| Avg Biomass | 252 | 1308 | 959 | 72 | 1257 | 3848 | 3320 | 1693 |
| Avg Catch (1951-1967) | 35 | 0 | 6 | 0 | 57 | 98 | 5197 | 5 |
| Avg Catch (1972-1990) | 0 | 110 | 120 | 0 | 266 | 496 | 169 | 805 |

Table 2.5. Estimates of the total biomass and average reduction and roe catches (tonnes) for minor stocks in the Central coast for 1951-1990.

| | Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Season | 061 | 062 | 063 | 064 | 065 | 066 | 082 | 083 | 084 | Area 9 | Area 10 | Total |
| 1950/51 | 0 | 0 | 12 | 115 | 0 | 3110 | 0 | 10 | 0 | 763 | 185 | 4195 |
| 1951/52 | 0 | 0 | 0 | 101 | 211 | 0 | 2374 | 10 | 0 | 554 | 69 | 3319 |
| 1952/53 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 196 | 650 | 846 |
| 1953/54 | 0 | 181 | 0 | 808 | 223 | 58 | 309 | 994 | 0 | 2170 | 481 | 5224 |
| 1954/55 | 0 | 367 | 95 | 2925 | 2118 | 113 | 710 | 274 | 270 | 5332 | 1400 | 13604 |
| 1955/56 | 0 | 271 | 48 | 16 | 280 | 9 | 0 | 307 | 18 | 163 | 148 | 1260 |
| 1956/57 | 6610 | 149 | 22 | 53 | 1805 | 0 | 1505 | 767 | 0 | 3077 | 2170 | 16158 |
| 1957/58 | 186 | 295 | 18 | 1 | 284 | 0 | 0 | 1754 | 0 | 634 | 440 | 3612 |
| 1958/59 | 1748 | 233 | 693 | 57 | 67 | 366 | 75 | 1134 | 0 | 2870 | 1234 | 8477 |
| 1959/60 | 19 | 615 | 2521 | 249 | 1644 | 0 | 0 | 330 | 26 | 405 | 586 | 6395 |
| 1960/61 | 82 | 673 | 678 | 12 | 3666 | 0 | 289 | 457 | 0 | 1041 | 924 | 7822 |
| 1961/62 | 70 | 2298 | 90 | 0 | 5056 | 138 | 6478 | 24 | 0 | 5826 | 1556 | 21536 |
| 1962/63 | 991 | 2506 | 1282 | 180 | 65 | 0 | 2345 | 1169 | 0 | 4106 | 497 | 13141 |
| 1963/64 | 1112 | 1578 | 2117 | 0 | 934 | 31 | 1509 | 953 | 529 | 8392 | 1203 | 18358 |
| 1964/65 | 3977 | 1237 | 137 | 0 | 656 | 40 | 353 | 673 | 634 | 1486 | 315 | 9508 |
| 1965/66 | 2827 | 1966 | 597 | 277 | 37 | 147 | 3251 | 822 | 978 | 5661 | 1354 | 17917 |
| 1966/67 | 2184 | 1761 | 131 | 117 | 191 | 0 | 270 | 270 | 530 | 3184 | 3507 | 12145 |
| 1967/68 | 498 | 59 | 53 | 1 | 0 | 0 | 0 | 913 | 48 | 376 | 442 | 2390 |
| 1968/69 | 0 | 0 | 6 | 35 | 0 | 0 | 299 | 16 | 0 | 115 | 46 | 517 |
| 1969/70 | 0 | 0 | 72 | 62 | 14 | 27 | 670 | 271 | 9 | 1573 | 339 | 3037 |
| 1970/71 | 0 | 0 | 44 | 15 | 28 | 0 | 258 | 484 | 201 | 627 | 809 | 2466 |
| 1971/72 | 0 | 0 | 15 | 0 | 0 | 436 | 165 | 420 | 248 | 1037 | 1167 | 3488 |
| 1972/73 | 0 | 77 | 45 | 0 | 0 | 0 | 147 | 138 | 1190 | 3846 | 136 | 5579 |
| 1973/74 | 0 | 39 | 37 | 0 | 0 | 0 | 66 | 134 | 625 | 1045 | 302 | 2248 |
| 1974/75 | 0 | 0 | 40 | 0 | 5 | 0 | 378 | 133 | 1148 | 867 | 299 | 2870 |
| 1975/76 | 0 | 193 | 0 | 0 | 30 | 0 | 119 | 146 | 905 | 739 | 179 | 2311 |
| 1976/77 | 0 | 0 | 32 | 0 | 2 | 0 | 0 | 140 | 490 | 670 | 60 | 1394 |
| 1977/78 | 57 | 0 | 4 | 0 | 0 | 0 | 39 | 67 | 244 | 429 | 214 | 1054 |
| 1978/79 | 0 | 211 | 0 | 0 | 0 | 163 | 0 | 43 | 221 | 120 | 81 | 839 |
| 1979/80 | 0 | 0 | 0 | 0 | 0 | 581 | 0 | 150 | 0 | 320 | 246 | 1297 |
| 1980/81 | 426 | 27 | 0 | 0 | 0 | 0 | 0 | 78 | 107 | 75 | 201 | 677 |
| 1981/82 | 664 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 1017 | 741 | 2287 |
| 1982/83 | 0 | 120 | 0 | 0 | 0 | 0 | 0 | 15 | 132 | 243 | 609 | 1119 |
| 1983/84 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 273 | 58 | 700 | 1068 |
| 1984/85 | 11 | 264 | 0 | 0 | 0 | 0 | 0 | 0 | 91 | 152 | 224 | 742 |
| 1985/86 | 0 | 796 | 0 | 0 | 0 | 0 | 0 | 109 | 49 | 1702 | 584 | 3240 |
| 1986/87 | 385 | 196 | 0 | 0 | 0 | 618 | 0 | 222 | 179 | 1540 | 78 | 3218 |
| 1987/88 | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 256 | 9 | 1088 | 165 | 1586 |
| 1988/89 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 119 | 50 | 374 | 340 | 883 |
| 1989/90 | 0 | 49 | 502 | 0 | 0 | 0 | 0 | 17 | 105 | 942 | 71 | 1686 |
| Avg Biomass | 546 | 404 | 232 | 126 | 433 | 146 | 542 | 347 | 233 | 1620 | 619 | 5248 |
| Avg catch (1951-1967) | 1165 | 829 | 471 | 264 | 1013 | 144 | 1144 | 576 | 130 | 2477 | 811 | 9024 |
| Avg catch (1972-1990) | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111 | 188 | 81 | 394 |

Table 2.6. Estimates of total biomass and average reduction and roe catches (tonnes) for minor stocks in Johnstone Strait for 1951-1990.

| Season | Area 11 | Section 126 | Section 127 | Other Area 12 | Other Area 13 | Total |
|---|---|---|---|---|---|---|
| 1950/51 | 1 | 989 | 335 | 3251 | 116 | 4692 |
| 1951/52 | 4 | 2290 | 344 | 5717 | 90 | 8445 |
| 1952/53 | 0 | 202 | 258 | 1236 | 173 | 1869 |
| 1953/54 | 2 | 869 | 408 | 5102 | 80 | 6461 |
| 1954/55 | 6515 | 323 | 1073 | 1124 | 222 | 9257 |
| 1955/56 | 257 | 563 | 194 | 1089 | 518 | 2621 |
| 1956/57 | 13 | 636 | 126 | 12191 | 81 | 13047 |
| 1957/58 | 15 | 30 | 180 | 4023 | 0 | 4248 |
| 1958/59 | 144 | 3431 | 1091 | 1625 | 298 | 6589 |
| 1959/60 | 668 | 976 | 2518 | 5553 | 480 | 10195 |
| 1960/61 | 266 | 819 | 282 | 4693 | 293 | 6353 |
| 1961/62 | 781 | 112 | 749 | 9323 | 404 | 11369 |
| 1962/63 | 2187 | 591 | 1039 | 8801 | 769 | 13387 |
| 1963/64 | 129 | 446 | 5753 | 5858 | 1618 | 13804 |
| 1964/65 | 1226 | 996 | 2894 | 11028 | 3147 | 19291 |
| 1965/66 | 1171 | 292 | 2109 | 18129 | 682 | 22383 |
| 1966/67 | 252 | 140 | 998 | 10660 | 3299 | 15349 |
| 1967/68 | 7 | 50 | 152 | 2727 | 3 | 2939 |
| 1968/69 | 21 | 194 | 189 | 1509 | 168 | 2081 |
| 1969/70 | 48 | 298 | 235 | 2674 | 176 | 3431 |
| 1970/71 | 69 | 153 | 97 | 1875 | 417 | 2611 |
| 1971/72 | 31 | 1504 | 1188 | 4163 | 745 | 7631 |
| 1972/73 | 12 | 1145 | 3568 | 8850 | 276 | 13851 |
| 1973/74 | 7 | 565 | 3580 | 1742 | 290 | 6184 |
| 1974/75 | 28 | 1158 | 3285 | 1810 | 619 | 6900 |
| 1975/76 | 33 | 1207 | 2018 | 805 | 119 | 4182 |
| 1976/77 | 15 | 406 | 1721 | 1145 | 108 | 3395 |
| 1977/78 | 16 | 565 | 576 | 248 | 61 | 1466 |
| 1978/79 | 60 | 64 | 71 | 175 | 178 | 548 |
| 1979/80 | 14 | 245 | 417 | 822 | 264 | 1762 |
| 1980/81 | 9 | 192 | 287 | 460 | 1351 | 2299 |
| 1981/82 | 0 | 141 | 550 | 67 | 252 | 1010 |
| 1982/83 | 17 | 95 | 243 | 101 | 135 | 591 |
| 1983/84 | 10 | 165 | 482 | 650 | 2 | 1309 |
| 1984/85 | 0 | 415 | 940 | 129 | 228 | 1712 |
| 1985/86 | 39 | 166 | 197 | 505 | 42 | 949 |
| 1986/87 | 13 | 148 | 171 | 488 | 96 | 916 |
| 1987/88 | 7 | 257 | 396 | 900 | 1 | 1561 |
| 1988/89 | 19 | 494 | 162 | 615 | 91 | 1381 |
| 1989/90 | 0 | 385 | 563 | 61 | 150 | 1159 |
| Avg Biomass | 353 | 593 | 1036 | 3548 | 450 | 5979 |
| Avg Catch (1951-1967) | 756 | 714 | 1083 | 5966 | 530 | 9050 |
| Avg Catch (1972-1989) | 1 | 231 | 88 | 771 | 41 | 1131 |

Table 2.7. Estimates of total biomass and average reduction and roe catches (tonnes) for minor stocks for the northern west coast of Vancouver Island 1951-1990.

| | Section | | Other | Total | Section | | | Other | Total |
|---|---|---|---|---|---|---|---|---|---|
| Season | 262 | 263 | Area 26 | Area 26 | 272 | 273 | 274 | Area 27 | Area 27 |
| 1950/51 | 864 | 269 | 9 | 1142 | 622 | 1778 | 0 | 0 | 2400 |
| 1951/52 | 364 | 37 | 383 | 784 | 0 | 662 | 0 | 0 | 662 |
| 1952/53 | 2335 | 640 | 633 | 3608 | 273 | 6882 | 700 | 0 | 7855 |
| 1953/54 | 588 | 2408 | 691 | 3687 | 951 | 3156 | 342 | 1266 | 5715 |
| 1954/55 | 4203 | 889 | 180 | 5272 | 106 | 1385 | 0 | 5947 | 7438 |
| 1955/56 | 352 | 524 | 142 | 1018 | 0 | 6 | 0 | 0 | 6 |
| 1956/57 | 772 | 762 | 42 | 1576 | 0 | 772 | 0 | 0 | 772 |
| 1957/58 | 711 | 241 | 157 | 1109 | 0 | 327 | 0 | 0 | 327 |
| 1958/59 | 281 | 240 | 85 | 606 | 0 | 180 | 0 | 407 | 587 |
| 1959/60 | 2655 | 673 | 509 | 3837 | 168 | 185 | 0 | 0 | 353 |
| 1960/61 | 2710 | 1594 | 511 | 4815 | 305 | 670 | 43 | 456 | 1474 |
| 1961/62 | 1047 | 3866 | 422 | 5335 | 0 | 207 | 137 | 173 | 517 |
| 1962/63 | 3496 | 428 | 85 | 4009 | 0 | 1734 | 122 | 31 | 1887 |
| 1963/64 | 1196 | 456 | 0 | 1652 | 0 | 90 | 0 | 233 | 323 |
| 1964/65 | 724 | 1317 | 0 | 2041 | 1888 | 1801 | 50 | 11 | 3750 |
| 1965/66 | 1316 | 18 | 0 | 1334 | 213 | 56 | 0 | 862 | 1131 |
| 1966/67 | 463 | 659 | 0 | 1122 | 139 | 69 | 0 | 0 | 208 |
| 1967/68 | 61 | 0 | 0 | 61 | 0 | 208 | 0 | 240 | 448 |
| 1968/69 | 283 | 824 | 0 | 1107 | 1514 | 895 | 0 | 0 | 2409 |
| 1969/70 | 774 | 135 | 0 | 909 | 2011 | 206 | 249 | 0 | 2466 |
| 1970/71 | 741 | 646 | 0 | 1387 | 0 | 145 | 370 | 0 | 515 |
| 1971/72 | 2209 | 132 | 0 | 2341 | 0 | 69 | 424 | 0 | 493 |
| 1972/73 | 1732 | 0 | 0 | 1732 | 1799 | 788 | 349 | 0 | 2936 |
| 1973/74 | 1068 | 0 | 0 | 1068 | 0 | 526 | 0 | 0 | 526 |
| 1974/75 | 728 | 180 | 0 | 908 | 0 | 2809 | 0 | 0 | 2809 |
| 1975/76 | 575 | 0 | 0 | 575 | 12 | 402 | 221 | 0 | 635 |
| 1976/77 | 509 | 11 | 0 | 520 | 0 | 1117 | 155 | 48 | 1320 |
| 1977/78 | 0 | 0 | 0 | 0 | 3146 | 8234 | 125 | 0 | 11505 |
| 1978/79 | 0 | 0 | 0 | 0 | 3894 | 10141 | 0 | 0 | 14035 |
| 1979/80 | 0 | 0 | 0 | 0 | 8914 | 14428 | 0 | 0 | 23342 |
| 1980/81 | 0 | 0 | 0 | 0 | 0 | 6441 | 0 | 0 | 6441 |
| 1981/82 | 0 | 0 | 0 | 0 | 3576 | 4640 | 11 | 0 | 8227 |
| 1982/83 | 0 | 0 | 0 | 0 | 0 | 7642 | 0 | 0 | 7642 |
| 1983/84 | 0 | 0 | 0 | 0 | 0 | 3824 | 0 | 0 | 3824 |
| 1984/85 | 0 | 0 | 0 | 0 | 2151 | 289 | 0 | 0 | 2440 |
| 1985/86 | 0 | 0 | 0 | 0 | 0 | 3807 | 0 | 0 | 3807 |
| 1986/87 | 0 | 0 | 0 | 0 | 1967 | 2424 | 0 | 0 | 4391 |
| 1987/88 | 0 | 0 | 0 | 0 | 0 | 4868 | 0 | 0 | 4868 |
| 1988/89 | 0 | 0 | 0 | 0 | 2526 | 3122 | 0 | 0 | 5648 |
| 1989/90 | 0 | 0 | 0 | 0 | 1430 | 6335 | 0 | 0 | 7765 |
| Avg Biomass | 819 | 424 | 96 | 1339 | 940 | 2583 | 82 | 242 | 3847 |
| Avg catch (1951-1967) | 434 | 620 | 40 | 1094 | 100 | 48 | 0 | 540 | 688 |
| Avg catch (1972-1990) | 8 | 1 | 0 | 8 | 4 | 182 | 1 | 0 | 187 |

Table 2.8. Comparison of egg numbers from replicate samples using two types of Gilson's preservative.

| | | Gilson's Preservative | |
|---|---|---|---|
| Sample | Vegetation | Mercuric | Non-mercuric |
| 1 | Japweed | 91217 | 174573 |
| 2 | Leafy reds | 73578 | 81684 |
| 3 | Japweed | 473722 | 420565 |
| 4 | Japweed | 531805 | 481670 |
| 5 | Japweed | 187600 | 237944 |
| 6 | Japweed | 1071274 | 713286 |
| 7 | Sea grass | 384136 | 343485 |
| 8 | Stringy reds | 149370 | 135833 |
| 9 | Stringy reds | 226583 | 188527 |
| 10 | Leafy reds | 321028 | 216477 |
| 11 | Leafy reds | 392028 | 354375 |
| 12 | Leafy reds | 403037 | 263651 |
| 13 | Sea grass | 131086 | 128034 |
| Mean egg numbers | | 341266 | 287700 |

# 3. AGE-STRUCTURED MODEL

## 3.1 INTRODUCTION

An age-structured model, based on the error structure suggested by Fournier and Archibald (1982), has been used to assess B.C. herring stocks since 1982. Ongoing revisions to the model have made it more consistent with the life history of herring and the fisheries which are analyzed. The current version described here uses auxiliary information in the form of spawn survey data, separates catch and age composition data by gear type, and includes availability parameters to estimate partial recruitments to the spawning stock. The model includes realistic assumptions about the form of both measurement and process error. Model parameters are estimated simultaneously using a maximum likelihood method.

## 3.2 METHODS

### The Population Model

Two types of fishing gear are used commonly in B.C. herring fisheries. Seine nets are assumed to be non-selective while gillnets are selective for larger, older fish. Herring fisheries have concentrated primarily on fish which are on, or migrating to the spawning grounds. Therefore, the relative availability of age classes to non-selective gear should be equivalent to the partial recruitment of age classes to the spawning stock. The age-structured model explicitly separates availability (partial recruitment) and gear selectivity. Seine and gillnet fisheries are temporally separate so catch and age-composition are partitioned into fishing periods, separating data for the different gears. Three fishing periods are modelled. The first period encompasses all catch data prior to the spring roe-herring fisheries. This includes reduction fishery catches prior to 1968 and the winter food and bait fisheries since 1970. Most of this catch was taken by seine gear although small amounts were caught with trawl nets (which are also not size selective). The second fishing period includes all seine roe-herring catch and the third period includes all gillnet roe-herring catch.

Let $T_{ij}$ be the total number of fish in age class $j$ at the beginning of season $i$, and $\lambda_{ij}$ be the proportion of age $j$ fish which are available to the fishery. Then $N_{ij1}$, the total number of age class $j$ fish which are available at the start of period 1 in season $i$ is given by

$$N_{ij1} = \lambda_{ij} T_{ij} \qquad 3.1$$

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

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

and, for $r < p$

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

where $C_{ijr}$ is the catch of age class $j$ in season $i$ for period $r$,
$F_{ijr}$ is the fishing mortality of age class $j$ in season $i$ for period $r$,
$M_r$ is the natural mortality for period $r$,
$N_{ijr}$ is the number of fish in age class $j$ in season $i$ for period $r$,
$p$ is the number of fishing periods ($p$=3),
$n$ is the number of seasons ($n$=40),
$k$ is the number of age classes ($k$=10).

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

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

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

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

To reduce the number of parameters to be estimated assumptions are made about the availability and mortality. The availabilities are formulated to increase with age and are set to 1 for age 7 and older. For age 4 and older the availabilities are constant between years. Because the proportion of 3-year-olds which are mature appears to vary between years (Haist and Stocker 1985) and some reduction fisheries targetted on immature 2-year-olds the availability for these two age classes is parameterized with annual deviations from the average for the age class ($\overline{\lambda}_j$). Availability for ages 2 and 3 for seasons 1 to $n$-1 (only those seasons where there is age data) is

$$\lambda_{ij} = \overline{\lambda_j} + d_{ij}.$$

Deviations from average availability are not estimated for ages 2 and 3 in the final year because there is not enough information in the data to estimate these parameters. For ages 4 to 6 and ages 2 and 3 in year $n$ (and seasons where there is no age data)

$$\lambda_{ij} = \overline{\lambda_j},$$

and for ages 7 and older,

$$\lambda_{ij} = 1.$$

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

$$\ln(F_{ijr}) = a_{ir} + b_{jr}$$

where $a_{ir}$ represents the general level of fishing mortality due to fishery $r$ in season $i$, and $b_{jr}$ represents the relative vulnerability of age-class $j$ in fishery $r$. For ages greater than 7, $b_{jr}$ is fixed at $b_{7r}$. For non-selective fisheries the model is

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

The natural mortality rate is assumed constant over ages and seasons. It is fixed at 0.45 for all assessment regions.

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

$$G_{ij} = N_{ijp} \exp(-F_{ijp} - M_p)$$

and the reproductive potential ($R_i$) in season $i$ is

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

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

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

where $q$ is a spawn conversion factor and $\xi_i$ is a normally distributed random variable with mean 0 and variance $\sigma_1^2$. A standard Ricker stock-recruit relationship with multiplicative error is assumed,

$$T_{i+1,1} = \alpha R_i \exp(-\beta R_i) \exp(\xi_i), \qquad 3.4$$

where $\xi_i$ is a normally distributed random variable with mean 0 and variance $\sigma_2^2$.

For the model described above the parameters to be estimated are:

$T_{i1}$, for all seasons $i$,
$T_{1j}$, for age classes 2 to $k$,
$\overline{\lambda}_j$, for age classes 2 to 7,
$d_{ij}$, for age classes 2 and 3, for seasons 1 to $n$-1,
$a_{ir}$, for all fisheries $i,r$,
$b_{jr}$, for all selective fisheries (ie. $r$=3),
$\alpha$, $\beta$, and $q$.

The $\overline{\lambda}_j$ and $d_{ij}$ are parameterized to constrain the values of $\lambda_{ij}$ between 0 and 1. The parameters $\sigma_1^2$ and $\sigma_2^2$ are not estimated in the reconstructions, but are fixed at specified values as discussed later on. The number of parameters for each assessment region are shown in Table 3.1.

## The Objective Function

Data input to the stock reconstruction are:

$S_{ijr}$, the number of sampled fish aged $j$ in season $i$ for period $r$,

$O_{ir}$, the estimated number of fish caught in period $r$ of season $i$,
$w_{ij}$, the estimated weight at age $j$ in year $i$.
$I_i$, the estimated spawn index in year $i$,

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

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

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

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

where $C_{ir}$ is the actual number of fish caught in period $j$ in season $i$ ($C_{ir} = \sum_j C_{ijr}$) and the $\xi_i$ are independent normally distributed random variables with mean 0 and variance $\sigma_3^2$.

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

Given these stochastic assumptions, the log-likelihood function (ignoring the constant term), for the parameters $P_{ijr}$ $(P_{ijr} = C_{ijr}/C_{ir})$, $C_{ir}$, and $\sigma_3^2$ is

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

The assumptions of log-normal measurement error in the observed spawn-actual spawn relationship and log-normal process error in the spawn-recruit relationship introduce the following contributions to the log-likelihood function

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

from equation 3.3, and

$$- \sum_{i} \frac{\left(\ln(T_{i+1,1}) - \ln(R_i) - \ln(\alpha) + \beta R_i\right)^2}{2\sigma_2^2} \qquad 3.7$$

from equation 3.4. The $w_{ij}$ are assumed to be estimated without error.

The objective function described above (eqn. 3.5 + 3.6 + 3.7) incorporates both measurement (observational) and process (deviations from modelled relationships) error assumptions, with the relative magnitude of the errors related through the variance terms $\sigma_1^2$, $\sigma_2^2$, and $\sigma_3^2$, and the sample sizes $\sum_r S_{ijr}$. Because there is not enough information in the data to estimate the relative error in either the observations or processes, with the exception of scaling the $S_{ijr}$, the variance terms are not estimated but are held at fixed values. The following variances are assumed:

$$\sigma_1^2 = 0.05,$$
$$\sigma_2^2 = 0.25,$$
$$\sigma_3^2 = 0.0025.$$

These correspond to approximately a 4% average error in estimating the total number of fish caught, an 18% average error in spawn index observations, and a 45% average deviation from the spawn-recruit relationship.

The actual number of fish aged, $S_{ijr}$, could be used in the objective function, however, this may not give a realistic estimate of the precision of the proportion-at-age data. That is, the biological samples obtained may not reflect a homogeneous population. The between-load (ie. samples from different catching vessels) variability in age composition is significantly different between years, and this is related more to the spatial and temporal distribution of the fisheries than to the number of loads sampled or total fish aged. Therefore, the information in the subsamples (between load samples) which are pooled to obtain an estimate of the age composition for a given fishery is used to scale the $S_{ijr}$.

The theoretical variance of the observed proportion of fish at age $j$ ($\hat{p}_j$) for a random sample of size $S$ is:

$$\sigma_{\hat{p}_j}^2 = \frac{p_j(1 - p_j)}{S}$$

where $p_j$ is the true proportion at age $j$. An estimate of the variance of $\hat{p}_j$ is:

$$s_{\hat{p}_j}^2 = \frac{\sum_m (p_{jm} - \hat{p}_j)^2}{M - 1}$$

where $p_{jm}$ is the proportion at age $j$ in subsample $m$ and $M$ is the number of subsamples. This between-subsample variance results from the variance generated by randomly sampling an individual catch plus the variance in the true proportion at age between vessel catches. Using $\hat{p}_j$ as the best estimate for $p_j$ the theoretical sample size ($S'$) which would generate the observed variance at age $j$ is:

$$S' = \frac{\hat{p}_j(1 - \hat{p}_j)}{s_{\hat{p}_j}^2}$$

These theoretical sample sizes, calculated from the between sample variance for 4-year-old fish (Appendix Table 1), are used in the objective function.

Stock Forecasts

Forecasts of stock abundance for 1991 are calculated by assuming all natural mortality for the first period will occur prior to the fisheries. The numbers of fish at age prior to the fisheries are then the numbers estimated at the beginning of the 1990/91 season multiplied by survival for the first period and the estimated availability at age. Recruitment is calculated for three scenarios based on estimated numbers-at-age 3 for the 1951-90 time series. Poor, average, and good recruitment are calculated as the mean of the lowest 33%, the mid 33%, and the highest 33% of historic age 3 numbers.

To investigate the bias and variance of the estimated parameters, in particular, current stock estimates and stock forecasts, bootstrap techniques (Efron and Gong 1983) are applied to each of the seven data sets. The bootstrap technique involves resampling the original data set, with replacement, to generate a new data matrix which has the same statistical properties as the original data set. To resample the age composition data a two-stage procedure is used. First random subsamples are selected from the original data set, then individual fish are randomly selected from the subsample. Because there is no information about the error structure of the spawn observations or the total catch estimates these data are resampled under the same assumptions as used in the analytical model. Log-normal errors with a variance of 0.05 and 0.0025 are used for the observed spawn and the observed catch, respectively. The data for each stock grouping were resampled 100 times and reanalysed producing 100 sets of parameter estimates.

Input data used for age-structured model analysis are shown in Appendix Table 1 for all stock groupings. Where no sample data are available, but catches were taken, the catch is included with an alternate fishery where age-structure data are available. The same spawn index is used as for previous assessments. This index sums the lengths of spawnings multiplied by a width/intensity factor, standardized by section (Hay and Kronlund 1985).

## 3.3 RESULTS

Results from age-structured model stock reconstructions are shown in Appendix Table 2 for the seven stock assessment regions. Table 3.2 shows bootstrap means and standard deviations for estimated 1990 spawning biomass and forecasts of age 4 and older biomass in 1991.

For past stock assessments, and again in 1990, age-structured model estimates of spawning biomass for the northern west coast of Vancouver Island are substantially higher than those from the escapement model. While the specific reasons for this are unknown, we have identified two factors which may contribute to these differences. The first is that a significant proportion of the reduction fishery catches in Area 25 could have been fish which were destined to spawn in other locations. Tag recovery data, from taggings conducted between 1937 and 1967, showed that only half of the tags recovered in winter fisheries in Area 25 were from fish which had been tagged during the spawning period in Area 25. The remaining recoveries were primarily fish tagged in other areas on the west coast of Vancouver Island (Hourston 1981). This could result in an overestimate of the productivity of this stock. The other factor which could influence the ability of the age-structured model to obtain accurate estimates of recent spawning biomass is the lack of fisheries in recent years. There has been only one fishery in Area 25 in the past six years which limits the information content of data available for analysis. An alternate assessment has been conducted for this region using only data since 1972 (Appendix table 2.8). This limited data set suggests lower spawning abundance than the complete data set and results from this assessment are used for stock forecasts.

The differences between the estimates of 1990 spawning biomass from the stock reconstructions and the bootstrap mean estimates are generally small, with the exception of the northern west coast of Vancouver Island analysis with only post 1972 data (Table 3.2). The differences were tested using a t-test under the null hypothesis that the bootstrap mean was no different than the original estimate. For five of the data sets there was no significant difference between the two estimates. For the Queen Charlotte Islands the probability of no difference was between .05 and .02 and for the northern west coast of Vancouver Island the probability was less than .001. This supports the idea that with the limited fishery and sampling information available, age-structured assessment for this region may be biased.

Confidence limits on stock forecasts were calculated for the 1989 stock assessments using the same bootstrap techniques as this year (Haist and Schweigert 1990).

Current estimates of 1990 pre-fishery biomass are compared with these forecast confidence intervals (95%) in Table 3.3. Results are presented for only five of the assessment regions because different stock definitions were used in the 1989 assessment for the two other stocks. For four of the five assessment regions the 1990 estimate of age 4+ biomass is within the forecast 95% confidence interval. Similar comparisons of forecast confidence limits with following year estimates of abundance, conducted over the past two years, showed that 6 of 14 estimates were outside the confidence region, which is significantly higher than the expected occurrence of 1 in 20. Additional work is required to assess whether the bootstrap method provides consistent estimates of confidence limits.

Table 3.1. Number of parameters for age-structured analysis for seven assessment regions.

| | | |
|---|---|---|
| For all assessment regions: | $T_{i1}$ | 40 |
| | $T_{1i}$ | 9 |
| | $\overline{\lambda}_j$ | 7 |
| | $b_{jr}$ | 7 |
| | $\alpha, \beta, q$ | 3 |
| | Total | 66 |

| Stock Specific: | $a_{ir}$ | $d_{ij}$ | Total |
|---|---|---|---|
| Queen Charlotte Islands | 49 | 68 | 184 |
| Prince Rupert District | 67 | 78 | 212 |
| Central Coast | 58 | 76 | 201 |
| N. Strait of Georgia | 72 | 78 | 217 |
| S. Strait of Georgia | 64 | 78 | 209 |
| S. W. Coast Vancouver Is. | 50 | 70 | 187 |
| N. W. Coast Vancouver Is. | | | |
| - all years data | 42 | 62 | 171 |
| - 1972-90 data only | 29 | 36 | 111 |

Table 3.2. Bootstrap estimates of 1990 spawning biomass (tonnes) and forecast 1991 age 4, age 4+, and age 5+ biomass (tonnes) for herring stock assessment regions. The estimates for the original data sets and bootstrap means and standard deviations are also presented.

| | 1990 Spawning Biomass | 1991 Biomass Forecast | | |
|---|---|---|---|---|
| | | Age 4 | Age 4+ | Age 5+ |
| Queen Charlotte Islands | 23,918 | | 21,791 | |
| bootstrap - mean | 24,656 | 2,494 | 22,401 | 19,906 |
| - st. dev. | 3,350 | 413 | 2,894 | 2,573 |
| Prince Rupert District | 56,708 | | 54,359 | |
| bootstrap - mean | 57,174 | 9,948 | 54,774 | 44,826 |
| - st. dev. | 6,217 | 1,352 | 5,957 | 4,923 |
| Central Coast | 38,848 | | 31,659 | |
| bootstrap - mean | 39,403 | 1,957 | 32,119 | 30,161 |
| - st. dev. | 3,872 | 269 | 3,069 | 2,906 |
| Strait of Georgia | | | | |
| Northern Stock | 49,585 | | 47,419 | |
| bootstrap - mean | 50,245 | 30,413 | 47,933 | 17,520 |
| - st. dev. | 7,228 | 4,569 | 6,828 | 2,643 |
| Southern Stock | 15,768 | | 14,569 | |
| bootstrap - mean | 15,362 | 10,841 | 14,238 | 3,397 |
| - st. dev. | 2,760 | 1,961 | 2,501 | 665 |
| W. Coast Vancouver Island | | | | |
| Southern Stock | 18,552 | | 15,203 | |
| bootstrap - mean | 18,145 | 4,660 | 14,987 | 10,326 |
| - st. dev. | 2,774 | 665 | 2,203 | 1,608 |
| Northern Stock | | | | |
| (data for all years) | 21,302 | | 16,058 | |
| bootstrap - mean | 21,419 | 3,932 | 16,300 | 12,367 |
| - st. dev. | 3,269 | 1,247 | 2,619 | 1,688 |
| (1972-90 data only) | 17,880 | | 13,642 | |
| bootstrap - mean | 15,024 | 496 | 11,086 | 10,589 |
| - st. dev. | 2,986 | 1099 | 2,238 | 1,882 |

Table 3.3. Comparison of forecast and estimated 1990 age 4, age 4+, and age 5+ biomass (tonnes) for herring stock assessment regions. The forecast 95% confidence intervals are from bootstrap analyses from the 1989 assessment. The estimated values are from the 1990 age-structured model analyses. Current estimates which are outside the forecast confidence limits are marked.*

| Stock Assessment Region | 1989 Bootstrap Forecast | 1990 Estimate |
|---|---|---|
| Prince Rupert District | | |
| age 4 | 7610 - 13389 | 12445 |
| age 4+ | 40437 - 61978 | 53493 |
| age 5+ | 32260 - 49155 | 41048 |
| Central Coast | | |
| age 4 | 1259 - 2470 | 2012 |
| age 4+ | 30369 - 52106 | 45557 |
| age 5+ | 29006 - 49739 | 43546 |
| Northern Strait of Georgia | | |
| age 4 | 5377 - 10186 | 7028 |
| age 4+ | 22147 - 41472 | 26048 |
| age 5+ | 16440 - 31615 | 19020 |
| Southern Strait of Georgia | | |
| age 4 | 915 - 1954 | 1714 |
| age 4+ | 6227 - 10060 | 7800 |
| age 5+ | 5169 - 8246 | 6086 |
| Southern west coast Vancouver Is. | | |
| age 4 | 2175 - 4742 | 3327 |
| age 4+ | 11059 - 24042 | 22790 |
| age 5+ | 8769 - 19412 | 19463* |

# 4. SPAWN TRENDS, STOCK FORECASTS AND POTENTIAL CATCH

## 4.1 SPAWN TRENDS

Estimates of spawning stock biomass over the period 1972 to 1990 from the age-structured and escapement models are shown in Figures 4.1 and 4.2 for the seven major assessment regions.

For the Queen Charlotte Islands region the two models indicate similar trends in spawning stock biomass. However, the age-structured model suggests much higher peaks in abundance in the mid 1970's and the early 1980's resulting from good recruitment of the 1971, 1972 and 1977 year classes. Both models suggest a slight decrease in abundance from 1989 to 1990. The above average 1985 year class is dominant, with 5-year olds comprising 60% of the stock in 1990. The estimates of 1990 spawning biomass are 23,900 and 24,200 tonnes from age-structured and escapement model analyses, respectively.

Trends in spawn abundance from the two assessment models do not track each other very closely for the Prince Rupert Assessment region (Fig. 4.1). Age-structured model estimates of abundance are consistently higher than those from the escapement model, and for the past two years in particular the two models indicate divergent stock trends. A potential source of bias in the age-structured model could be inconsistancy in the parameterization of gillnet selectivity. This is parameterized as an age-dependent process while there has been a decrease in selectivity of younger fish (i.e., age 4 to 6) in recent years as size-at-age has decreased. This inconsistancy could lead to overestimation of stock size. A modification of the age-structured model to change gillnet selectivity from an age-selective to size-selective process is required to assess the impact of size-at-age trends on gear selectivity, and ultimately, stock estimates. Until this modification is made and evaluated, we suggest not using the age-structured model stock estimates. The escapement model estimate of 19,400 tonnes of spawners in 1990 represents an increase in stock size over the 1989 level. However, this apparent increase is also an anomaly as it implies that the abundance of repeat spawners in 1990 was greater than the escapement in 1989.

Estimates of spawning stock biomass for the central coast assessment region follow similar trends for both models (Fig. 4.1). Both models estimate spawn abundances at near historical high levels over the past three years. Currently, the strong 1985 year class is dominant with 5-year olds comprising 73% of the stock. The 1990 spawning stock biomass estimates are 38,800 and 42,300 tonnes from age-structured and escapement model analyses, respectively.

For the two Strait of Georgia assessment regions the spawning trends estimated by the two models are not very similar, with the escapement model suggesting much greater fluctuations in abundance. However, estimates of 1990 spawning biomass are similar for the two models. Both models estimate a significant increase in biomass from 1989 to 1990 for the southern stock, with 1990 estimates of 15,800 and 13,200 tonnes. Age-structured model analysis suggests a continual increase in spawning abundance since 1984 for the northern assessment region with a 1990 estimate of 49,600 tonnes. The escapement model estimate of 45,700 tonnes is lower than some of the estimated spawning biomasses during the 1980's. The 1987 year-class, which recruited to the fishery as 3-yr olds in 1990, is dominant in both assessment regions. This year class comprised 56% of the northern stock and 59% of the southern stock.

The spawning biomass for the southern west coast of Vancouver Island stock follow similar trends for the two assessment models through most of the time series, however there are periods where estimates from the two models are quite different (Fig 4.2). Both models suggest a decrease in spawn abundance from 1989 to 1990, with the age-structured model indicating a more substantial decline. The escapement model estimate for 1990 spawning biomass is 29,600 tonnes while the age-structured model estimate is 18,600 tonnes. The 1985 year class is dominant in this stock with 5-yr olds comprising 48% of the sampled fish while 3-yr olds comprised 27% of the stock.

As in past assessments, the age-structured model indicates a much greater increase in spawn abundance since the mid 1980's relative to the increase suggested by the escapement model for the northern west coast Vancouver Island assessment region. However, as suggested in Section 3, the age-structured model may be producing biased estimates for this region. The 1990 spawning biomass estimates are 8,300 tonnes and 17,900 tonnes from the escapement and age-structured models.

## 4.2 STOCK FORECASTS AND POTENTIAL CATCH

We recommend catch levels at 20% of the forecast stock biomass for those stocks that are well above CUTOFF. The 20% harvest rate is based on an analysis of stock dynamics which indicates this level will stabilize both catch and spawning biomass while foregoing minimum yield over the long term. A fixed escapement policy would theoretically produce higher yields and spawning stock stability but is not attainable at the operational level. For those stocks which are marginally above CUTOFF we recommend the following reduced catch level:

Catch = Weighted Run - CUTOFF.

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

CUTOFF levels are established at one-forth the unfished average biomass. For the seven stock assessment regions the CUTOFF levels are:

| | |
|---|---|
| Queen Charlotte Islands | 11,700 t, |
| Prince Rupert District | 12,100 t, |
| Central Coast | 10,600 t, |
| Strait of Georgia | 22,100 t, |
| W.C. Vancouver Is.-south | 15,100 t, |
| W.C. Vancouver Is.-north | 5,200 t. |

The CUTOFF level for the Queen Charlotte Islands represents a change due to the revision in the stock assessment region which now includes Louscoone and Cumshewa Inlets. The revised CUTOFF is based on the estimated unfished average biomass as determined using stock productivity parameters from age-structured analysis for the revised assessment region. However, a similar analysis for the northern west coast of Vancouver Island did not provide a consistent estimate of the unfished biomass level. The revised CUTOFF for this region is therefore based on the proportion of the total Area 25 through Area 27 spawn which occurred in Area 25 over the 1951-90 time period, and the previous CUTOFF level which had been estimated for the Area 25-27 region .

To provide an overall stock forecast we assigned subjective probabilities to the two assessment models. The age-structured model provides consistent estimates of abundance, and it would be expected that estimates from this model are relatively precise. However, it is not possible to evaluate the accuracy of this model other than by comparison of estimates with independent estimates of absolute abundance. The escapement model incorporates diving survey information on most major spawns in 1990, and we feel these direct estimates of egg deposition provide a reasonably accurate estimate of current stock size, although the estimates are probably not very precise. Hence, we used equal probabilities for the two models in most assessment regions. An exception to this is for the northern west coast of Vancouver Island where age-structured analysis appears to be biased. Consequently, we use a 80:20 weighting in favour of the escapement model for this area. In addition, we suggest not weighting the age-structured model assessment of the Prince Rupert District stocks in the weighted run forecast.

The assigned probabilities were used to weight the forecast runs obtained from each method to provide a single "weighted run" for each of the stock groupings (Table 4.1).

The forecast weighted run size to the Queen Charlotte Islands in 1991 is 23,200 tonnes assuming average recruitment. This is significantly lower than the 1990 forecast and yields a potential catch of 4,640 tonnes.

Because of the uncertainty regarding the application of the age-structured model for the Prince Rupert District we forecast a run size of 19,400 tonnes based solely on the escapement model estimate. The forecast run is comparable to last year and although significantly decreased from prior years is still well above the CUTOFF of 12,100 tonnes.

Assuming an average recruitment level, a catch of 3,880 tonnes should be available for the Prince Rupert District in 1991.

The weighted forecast for the central coast with average recruitment is 38,200 tonnes. The recommended catch for this region is 7,640 tonnes. The 1991 forecast is down slightly from levels of the previous two years because the strong 1985 year class is ageing and there is no indication of significant recruitment from the two subsequent year-classes.

The weighted forecast run to the northern Strait of Georgia in 1991 is 53,700 tonnes, and to the southern Strait of Georgia 16,100 tonnes. An average recruitment assumption would yield potential catches of 10,740 and 3,220 tonnes, respectively. Both assessment models indicate increases in stock levels for both assessment regions and stock forecasts are slightly higher than they were for 1990.

The forecasted run to the southern west coast of Vancouver Island is 25,800 tonnes for an allowable catch of 5,160 tonnes. The forecast for the northern west coast of Vancouver Island with a lower weighting on the age-structured model, is 10,000 tonnes for a recommended catch of 2,000 tonnes.

The catch levels suggested in this summary are based purely on biological considerations, reflecting the best biological analyses given the available data bases. Management of the various fisheries has practical constraints not considered in this report. As well, there are economic considerations which are beyond the scope of our analysis. Hence, the quotas ultimately adopted by DFO may differ from those suggested herein.

Table 4.1. Summary of 1991 forecast stock biomass (thousands of tonnes) from age-structured and escapement models and weighted runs for poor, average, and good recruitment levels.

| | AGE-STRUCTURED MODEL | | | | ESCAPEMENT MODEL | | | | WEIGHTED RESULTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Age | Recruitment Level | | | Age | Recruitment Level | | | Relative | Recruitment Level | | |
| Stock Assessment Regions | 4+ | Poor | Avg. | Good | 4+ | Poor | Avg. | Good | Weight | Poor | Avg. | Good |
| Queen Charlotte Islands | 21.8 | 23.0 | 25.6 | 33.0 | 17.4 | 18.3 | 20.9 | 26.4 | 50:50 | 20.6 | 23.2 | 29.7 |
| Prince Rupert District | 54.4 | 56.6 | 60.7 | 73.5 | 14.5 | 16.0 | 19.4 | 27.8 | 0:100 | 16.0 | 19.4 | 27.8 |
| Central Coast | 31.7 | 34.7 | 38.4 | 49.1 | 30.9 | 33.5 | 38.0 | 38.9 | 50:50 | 34.1 | 38.2 | 44.0 |
| Strait of Georgia - northern stock | 47.4 | 52.1 | 57.1 | 67.5 | 35.3 | 43.0 | 50.3 | 59.5 | 50:50 | 47.5 | 53.7 | 63.5 |
| southern stock[a] | 14.6 | 16.1 | 17.8 | 21.5 | 9.6 | 12.7 | 14.4 | 15.9 | 50:50 | 14.4 | 16.1 | 18.7 |
| W.C. Vancouver Island - southern stock | 15.2 | 19.1 | 22.8 | 34.3 | 21.3 | 24.8 | 28.9 | 35.7 | 50:50 | 21.9 | 25.8 | 35.0 |
| northern stock | 13.6 | 15.1 | 16.2 | 21.7 | 5.8 | 6.6 | 8.5 | 13.4 | 20:80 | 8.3 | 10.0 | 15.1 |

[a]Recruitment estimates based on data from roe fishery only.

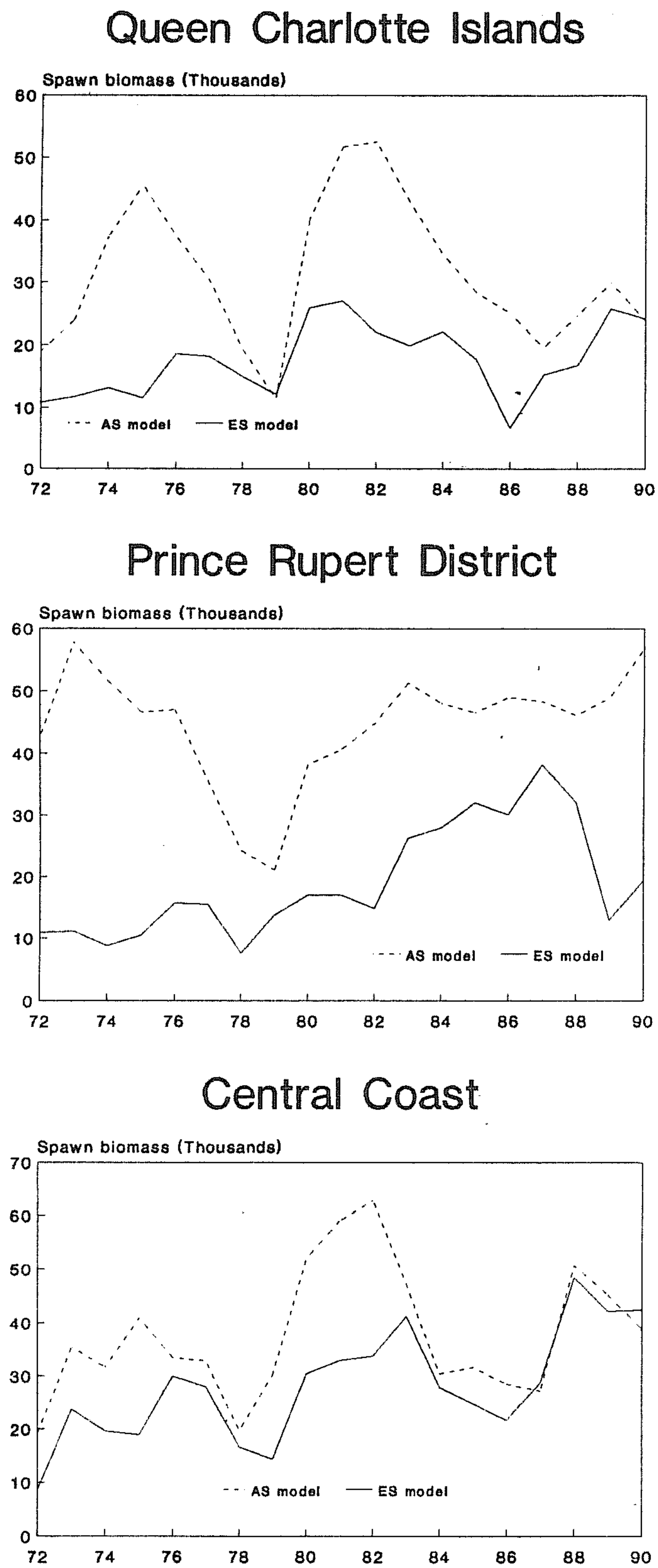


Fig. 4.1 Estimates of spawning stock biomass (1972-90) from age-structured and escapement model analyses for northern B.C. herring stock assessment regions.

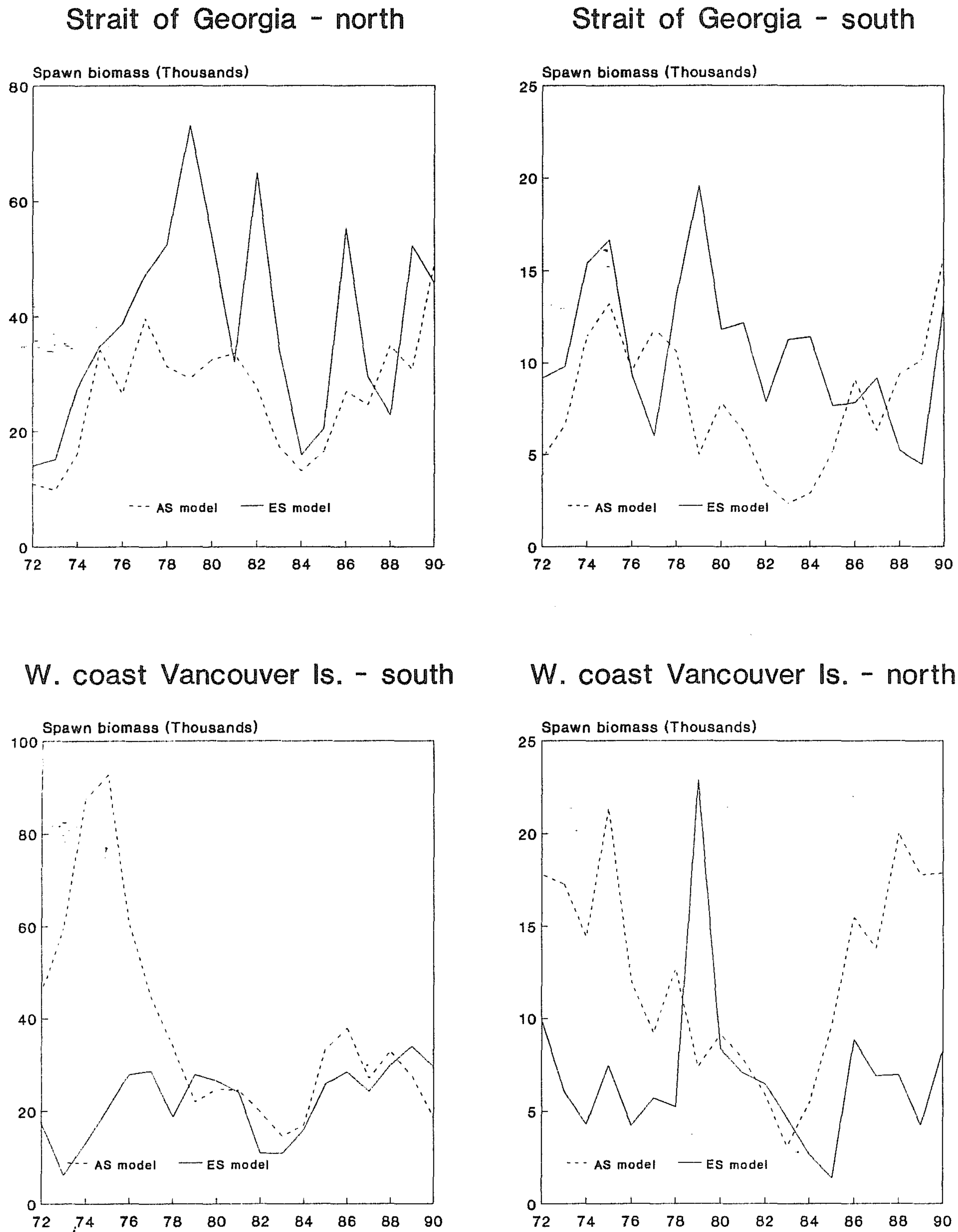


Fig. 4.2 Estimates of spawning stock biomass (1972-90) from age-structured and escapement model analyses for southern B.C. herring stock assessment regions.

## 6. REFERENCES

Doubleday, W. G. 1976. A least squares approach to analyzing catch at age data. Res. Bull. Int. Comm. Northw. Atl. Fish. 12: 69-81.

Efron, E. and G. Gong. 1983. A leisurely look at the bootstrap, the jackknife, and cross-validation. The American Statistician. 37: 36-48.

Fournier, D., and C. P. Archibald. 1982. A general theory for analyzing catch at age data. Can. J. Fish. Aquat. Sci. 39: 1195-1207.

Haegele, C. W., A. S. Hourston, R. D. Humphreys, and D. C. Miller. 1979. Eggs per unit area in British Columbia herring spawn depositions. Fish. Mar. Serv. Tech. Rep. 894: 30 p.

Haegele, C. W. and J. F. Schweigert. 1985. Estimation of egg numbers in Pacific herring spawns on giant kelp. N. Am. J. Fish. Manag. 5: 65-71.

Haegele, C. W. and J. F. Schweigert. 1990. A model which predicts Pacific herring (*Clupea harengus pallasi* ) egg deposition on giant kelp (*Macrocystis* sp.) plants from underwater observations. Can. MS Rep. Fish. Aquat. Sci. 2056: 17p.

Haist, V., and L. Rosenfeld. 1988. Definitions and codings of localities, sections and assessment regions for British Columbia herring data. Can. MS Rep. Fish. Aquat. Sci. 1994: 123 p.

Haist, V. and J. F. Schweigert. 1990. Stock assessments for British Columbia herring in 1989 and forecasts of the potential catch in 1990. Can. MS Rep. Fish. Aquat. Sci. 2049: 62 p.

Haist, V., and M. Stocker. 1985. Growth and maturation of Pacific herring (*Clupea harengus pallasi*) in the Strait of Georgia. Can. J. Fish. Aquat. Sci. 42 (Suppl. 1): 138-146.

Haist, V., M. Stocker, and J. F. Schweigert. 1985. Stock assessments for British Columbia herring in 1984 and forecasts of the potential catch in 1985. Can. Tech. Rep. Fish. Aquat. Sci. 1365: 53 p.

Hay, D. E., and A. R. Kronlund. 1987. Factors affecting the abundance and measurement of Pacific herring spawn. Can. J. Fish. Aquat. Sci. 44: 1181-1194.

Hourston, A.S. 1981. Tagging and tag recovery data for British Columbia herring, 1937-67. Can. Data Rep. Fish. Aquat. Sci. 308: vii + 276p.

Schweigert, J. F., and C. W. Haegele. 1988(a). Herring stock estimates from diving surveys of spawn for Georgia and Johnstone Straits in 1985. Can. MS Rep. Fish. Aquat. Sci. 1972: 63p.

Schweigert, J. F., and C. W. Haegele. 1988(b). Herring stock estimates from diving surveys of spawn in Georgia Strait in 1986. Can. MS Rep. Fish. Aquat. Sci. 1971: 65 p.

Schweigert, J. F., C. W. Haegele, and M. Stocker. 1985. Optimizing sampling design for herring spawn surveys in the Strait of Georgia, B.C. Can. J. Fish. Aquat. Sci. 42: 1806-1814.

Schweigert, J. F., C. W. Haegele, and M. Stocker. 1990. Evaluation of sampling strategies for Scuba surveys to assess spawn deposition by Pacific herring. N. Am. J. Fish. Manag. 10: 185-195.

Schweigert, J. F., and D. J. Noakes. 1991. Forecasting Pacific herring (*Clupea harengus pallasi*) recruitment from spawner abundance and environmental information. Proceedings of the International Herring Symposium. Univ. of Alaska Sea Grant Rep. (In press).

Schweigert, J. F., and M. Stocker. 1988. A new method for estimating Pacific herring stock size from spawn survey data and its management implications. N. Amer. J. Fish. Mgmt. 8: 63-74.

Stocker, M., and D. J. Noakes. 1988. Evaluating forecasting procedures for predicting Pacific herring (*Clupea harengus pallasi*) recruitment in British Columbia. Can. J. Fish. Aquat. Sci. 45: 928-935.

Appendix table 1.1. Age compostion and catch in numbers by fishery and season and weight at age averaged over all seasons for the Queen Charlotte Islands stock assessment region. These data are used for age-structured model analysis.

| SEASON | FISHERY | PERCENT AT AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NUMBER AGED | SAMPLE WEIGHT | CATCH (x $10^6$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950/51 | REDUCTION | 0.0 | 0.1 | 15.3 | 52.9 | 15.3 | 11.5 | 4.2 | 0.6 | 0.1 | 0.0 | 1476 | 1544 | 317.44 |
| 1951/52 | REDUCTION | 1.2 | 16.9 | 21.5 | 33.8 | 21.3 | 4.1 | 1.1 | 0.1 | 0.0 | 0.0 | 2251 | 165 | 1136.50 |
| 1953/54 | REDUCTION | 0.1 | 3.0 | 29.0 | 21.3 | 33.6 | 10.2 | 1.9 | 0.7 | 0.2 | 0.1 | 0* | 25 | 231.77 |
| 1954/55 | REDUCTION | 0.0 | 8.7 | 14.1 | 39.4 | 18.1 | 14.8 | 4.4 | 0.3 | 0.1 | 0.1 | 0* | 25 | 52.94 |
| 1955/56 | REDUCTION | 0.0 | 0.1 | 16.0 | 9.6 | 62.2 | 8.4 | 2.7 | 0.7 | 0.0 | 0.1 | 1348 | 681 | 6551.83 |
| 1956/57 | REDUCTION | 0.1 | 20.7 | 24.1 | 15.7 | 9.6 | 26.7 | 2.4 | 0.4 | 0.1 | 0.0 | 4740 | 2177 | 2092.34 |
| 1957/58 | REDUCTION | 0.0 | 81.9 | 16.4 | 1.2 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 2838 | 514 | 2146.22 |
| 1958/59 | REDUCTION | 0.0 | 1.1 | 63.2 | 28.4 | 7.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 95 | 6 | 735.74 |
| 1960/61 | REDUCTION | 0.0 | 4.2 | 32.6 | 36.0 | 24.8 | 1.3 | 0.4 | 0.2 | 0.4 | 0.0 | 0* | 25 | 59.00 |
| 1961/62 | REDUCTION | 0.0 | 3.0 | 37.6 | 41.4 | 9.6 | 6.5 | 1.6 | 0.2 | 0.0 | 0.0 | 428 | 170 | 693.85 |
| 1962/63 | REDUCTION | 0.0 | 0.4 | 50.0 | 27.1 | 18.2 | 2.1 | 2.0 | 0.0 | 0.1 | 0.1 | 804 | 411 | 1342.32 |
| 1963/64 | REDUCTION | 0.0 | 0.9 | 15.3 | 59.5 | 17.8 | 5.3 | 1.1 | 0.0 | 0.0 | 0.0 | 528 | 297 | 2515.06 |
| 1964/65 | REDUCTION | 0.0 | 1.6 | 79.8 | 11.0 | 4.4 | 2.1 | 0.9 | 0.2 | 0.0 | 0.0 | 1053 | 165 | 3424.55 |
| 1965/66 | REDUCTION | 1.7 | 18.0 | 32.2 | 16.1 | 10.2 | 7.3 | 5.8 | 4.8 | 2.0 | 1.7 | 0* | 25 | 213.13 |
| 1966/67 | REDUCTION | 0.0 | 0.9 | 67.3 | 26.5 | 2.7 | 2.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0* | 25 | 18.83 |
| 1967/68 | REDUCTION | 0.8 | 29.7 | 50.2 | 17.1 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0* | 25 | 8.48 |
| 1971/72 | ROE-SN | 0.0 | 3.0 | 32.6 | 38.3 | 16.0 | 6.1 | 2.4 | 0.9 | 0.4 | 0.1 | 1184 | 94 | 276.24" |
| 1972/73 | ROE-SN | 0.0 | 0.2 | 40.6 | 21.6 | 27.3 | 8.0 | 1.7 | 0.8 | 0.0 | 0.0 | 1726 | 914 | 524.51 |
| 1973/74 | ROE-SN | 0.0 | 0.1 | 30.5 | 40.4 | 17.7 | 9.1 | 1.9 | 0.3 | 0.1 | 0.0 | 1617 | 185 | 482.78 |
| | ROE-GN | 0.0 | 0.0 | 5.7 | 48.4 | 25.5 | 16.6 | 3.2 | 0.0 | 0.0 | 0.6 | 157 | 25 | 8.24 |
| 1974/75 | ROE-SN | 0.0 | 0.6 | 25.3 | 34.2 | 27.9 | 9.5 | 1.9 | 0.4 | 0.1 | 0.0 | 6010 | 655 | 587.13" |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 22.5 | 40.0 | 30.0 | 5.0 | 2.5 | 0.0 | 0.0 | 40 | 40 | 6.19 |
| 1975/76 | ROE-SN | 0.0 | 0.4 | 2.8 | 37.3 | 29.4 | 22.7 | 6.3 | 1.0 | 0.1 | 0.0 | 4170 | 247 | 813.57" |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 0.8 | 21.8 | 60.9 | 14.3 | 2.3 | 0.0 | 0.0 | 133 | 186 | 91.86 |
| 1976/77 | ROE-SN | 0.0 | 0.1 | 19.6 | 8.0 | 29.4 | 23.0 | 15.1 | 4.5 | 0.4 | 0.0 | 3220 | 1113 | 801.25"' |
| 1977/78 | ROE-SN | 0.0 | 0.2 | 26.2 | 17.3 | 9.5 | 26.2 | 14.1 | 5.3 | 1.0 | 0.3 | 1234 | 1932 | 620.46 |
| | ROE-GN | 0.0 | 0.0 | 0.6 | 4.8 | 11.5 | 19.4 | 39.4 | 20.0 | 3.6 | 0.6 | 165 | 126 | 129.55 |
| 1978/79 | ROE-SN | 0.0 | 5.6 | 4.4 | 31.6 | 18.7 | 21.3 | 15.1 | 2.8 | 0.4 | 0.1 | 1020 | 441 | 387.56" |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 25.1 | 25.1 | 25.1 | 20.1 | 3.5 | 0.5 | 0.5 | 199 | 65 | 128.20 |
| 1979/80 | ROE-SN | 0.0 | 0.5 | 83.2 | 4.5 | 5.4 | 2.8 | 1.9 | 1.2 | 0.6 | 0.1 | 3390 | 2427 | 222.15 |
| | ROE-GN | 0.0 | 0.0 | 3.7 | 4.5 | 40.1 | 20.8 | 22.3 | 6.9 | 1.6 | 0.1 | 938 | 1028 | 74.53 |
| 1980/81 | ROE-SN | 0.0 | 0.2 | 3.5 | 85.0 | 5.4 | 3.1 | 1.8 | 0.7 | 0.2 | 0.1 | 4943 | 489 | 331.92" |
| | ROE-GN | 0.0 | 0.0 | 0.2 | 74.8 | 8.3 | 9.4 | 4.9 | 1.9 | 0.6 | 0.0 | 905 | 339 | 121.41 |
| 1981/82 | ROE-SN | 0.0 | 0.8 | 4.5 | 4.4 | 84.6 | 2.4 | 1.6 | 0.9 | 0.5 | 0.1 | 3591 | 1725 | 185.38" |
| | ROE-GN | 0.0 | 0.0 | 0.2 | 3.4 | 88.2 | 3.4 | 2.7 | 1.1 | 0.8 | 0.2 | 526 | 341 | 99.20 |
| 1982/83 | ROE-SN | 0.0 | 4.9 | 5.2 | 3.5 | 6.9 | 72.9 | 3.9 | 1.6 | 0.9 | 0.3 | 1968 | 1609 | 317.79" |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 1.3 | 2.8 | 89.0 | 3.1 | 2.5 | 0.7 | 0.5 | 747 | 637 | 58.91 |
| 1983/84 | OTHER | 0.0 | 5.9 | 36.6 | 2.2 | 4.3 | 8.6 | 39.2 | 2.2 | 0.5 | 0.5 | 186 | 186 | 16.18 |
| | ROE-SN | 0.0 | 2.1 | 35.3 | 4.9 | 2.8 | 10.5 | 42.8 | 1.0 | 0.4 | 0.2 | 3104 | 1554 | 312.33 |
| | ROE-GN | 0.0 | 0.0 | 2.8 | 1.3 | 4.6 | 9.0 | 80.1 | 1.8 | 0.3 | 0.3 | 391 | 427 | 34.59 |
| 1984/85 | ROE-SN | 0.0 | 1.3 | 14.9 | 31.8 | 4.0 | 4.5 | 11.4 | 31.5 | 0.4 | 0.1 | 3556 | 699 | 311.61" |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 15.3 | 2.1 | 4.2 | 11.1 | 66.7 | 0.7 | 0.0 | 144 | 83 | 85.78 |
| 1985/86 | ROE-SN | 0.0 | 0.2 | 2.8 | 22.0 | 40.2 | 4.0 | 3.3 | 8.0 | 19.1 | 0.3 | 4733 | 2821 | 157.73 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 11.9 | 50.6 | 5.4 | 5.2 | 10.4 | 16.0 | 0.5 | 405 | 383 | 55.79 |
| 1986/87 | ROE-SN | 0.0 | 1.7 | 10.4 | 5.9 | 24.4 | 37.8 | 3.8 | 4.3 | 5.8 | 5.9 | 3281 | 1144 | 131.07" |
| 1987/88 | ROE-SN | 0.0 | 3.6 | 51.0 | 7.5 | 4.8 | 11.8 | 14.9 | 1.4 | 1.7 | 3.4 | 1676 | 575 | 2.56" |
| 1988/89 | ROE-SN | 0.0 | 2.3 | 17.5 | 66.3 | 4.0 | 1.6 | 3.9 | 2.8 | 0.6 | 1.0 | 3563 | 199 | 121.30" |
| 1989/90 | ROE-SN | 0.0 | 0.2 | 9.7 | 18.2 | 60.0 | 3.9 | 1.8 | 3.8 | 1.7 | 0.7 | 5055 | 409 | 411.56 |
| | ROE-GN | 0.0 | 0.0 | 0.5 | 8.3 | 43.6 | 10.2 | 8.5 | 17.1 | 8.5 | 3.2 | 433 | 397 | 75.32 |

AVERAGE WEIGHT AT AGE (gms)

| FISHERY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| REDUCTION | 11.7 | 52.0 | 84.4 | 106.6 | 125.9 | 147.7 | 156.8 | 172.1 | 147.3 | 183.5 |
| ROE-SN | 0.0 | 66.2 | 98.3 | 126.3 | 150.8 | 171.7 | 187.7 | 201.6 | 214.5 | 214.1 |
| ROE-GN | 0.0 | 0.0 | 119.8 | 141.9 | 153.5 | 171.1 | 180.2 | 192.8 | 190.8 | 198.0 |
| OTHER | 11.7 | 61.1 | 93.7 | 119.7 | 142.8 | 165.0 | 179.0 | 194.9 | 205.2 | 208.7 |

* - Age compostion from published reports.
~ - No seine roe fishery in this season. Age compostion from pre-fishery charter samples only.
" - includes catch from "other" fisheries
^ - includes catch from seine roe fisheries
' - includes catch from gillnet fisheries

Appendix table 1.2. Age compostion and catch in numbers by fishery and season and weight at age averaged over all seasons for the Prince Rupert District stock assessment region. These data are used for age-structured model analysis.

| SEASON | FISHERY | PERCENT AT AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NUMBER AGED | SAMPLE WEIGHT | CATCH ($x 10^{-6}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950/51 | REDUCTION | 0.0 | 4.3 | 18.2 | 58.5 | 10.4 | 5.6 | 2.6 | 0.3 | 0.0 | 0.0 | 4684 | 2202 | 4954.74 |
| 1951/52 | REDUCTION | 0.1 | 4.8 | 8.8 | 33.7 | 45.2 | 6.1 | 1.0 | 0.3 | 0.0 | 0.0 | 5925 | 2500 | 4392.63 |
| 1952/53 | REDUCTION | 0.0 | 1.2 | 38.1 | 23.0 | 25.4 | 11.1 | 1.0 | 0.1 | 0.0 | 0.0 | 1419 | 752 | 173.50 |
| 1953/54 | REDUCTION | 0.0 | 2.1 | 28.4 | 29.1 | 24.0 | 13.2 | 2.6 | 0.6 | 0.0 | 0.0 | 2656 | 891 | 2522.89 |
| 1954/55 | REDUCTION | 0.0 | 2.7 | 4.9 | 70.3 | 15.6 | 5.2 | 1.1 | 0.2 | 0.0 | 0.0 | 1131 | 467 | 1698.85 |
| 1955/56 | REDUCTION | 0.0 | 10.0 | 58.1 | 9.5 | 19.0 | 2.6 | 0.5 | 0.2 | 0.1 | 0.0 | 1683 | 555 | 1218.10 |
| 1956/57 | REDUCTION | 0.0 | 11.5 | 17.8 | 39.8 | 13.2 | 16.0 | 1.4 | 0.3 | 0.0 | 0.0 | 3491 | 515 | 2827.98 |
| 1957/58 | REDUCTION | 0.0 | 45.8 | 30.2 | 8.0 | 11.8 | 1.8 | 2.4 | 0.0 | 0.0 | 0.0 | 847 | 123 | 644.16 |
| 1958/59 | REDUCTION | 0.0 | 3.1 | 56.7 | 20.9 | 5.8 | 9.9 | 1.7 | 1.9 | 0.1 | 0.0 | 1741 | 349 | 1037.09 |
| 1959/60 | REDUCTION | 0.0 | 49.1 | 6.3 | 28.2 | 8.9 | 4.1 | 2.5 | 0.7 | 0.2 | 0.0 | 4206 | 337 | 2451.31 |
| 1960/61 | REDUCTION | 0.0 | 9.7 | 58.3 | 7.3 | 18.0 | 4.3 | 1.6 | 0.6 | 0.1 | 0.0 | 4300 | 763 | 4815.52 |
| 1961/62 | REDUCTION | 0.0 | 3.0 | 30.3 | 44.7 | 6.9 | 9.9 | 3.4 | 0.9 | 0.5 | 0.3 | 1845 | 752 | 2476.36 |
| 1962/63 | REDUCTION | 0.0 | 39.3 | 13.3 | 18.2 | 22.0 | 3.6 | 3.0 | 0.5 | 0.1 | 0.1 | 3415 | 433 | 4788.66 |
| 1963/64 | REDUCTION | 0.0 | 3.7 | 64.9 | 10.1 | 10.9 | 8.9 | 0.7 | 0.6 | 0.1 | 0.0 | 3400 | 1914 | 3555.87 |
| 1964/65 | REDUCTION | 0.0 | 6.0 | 13.6 | 51.0 | 8.5 | 11.0 | 8.5 | 1.0 | 0.3 | 0.1 | 3360 | 459 | 3649.12 |
| 1965/66 | REDUCTION | 0.0 | 0.0 | 5.3 | 21.4 | 23.4 | 16.3 | 19.1 | 9.7 | 3.2 | 1.6 | 435 | 59 | 1071.96 |
| 1966/67 | REDUCTION | 0.9 | 56.7 | 31.9 | 5.3 | 1.9 | 2.7 | 0.4 | 0.2 | 0.0 | 0.0 | 0* | 25 | 1225.88 |
| 1967/68 | REDUCTION | 3.2 | 33.7 | 38.5 | 18.8 | 4.4 | 0.7 | 0.3 | 0.1 | 0.3 | 0.0 | 0* | 25 | 281.72 |
| 1968/69 | OTHER | 1.3 | 29.7 | 44.5 | 20.3 | 3.8 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0* | 25 | 69.79 |
| 1969/70 | OTHER | 0.7 | 18.5 | 62.4 | 15.0 | 3.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0* | 25 | 184.71 |
| 1970/71 | OTHER | 0.0 | 6.5 | 50.4 | 29.3 | 8.0 | 4.3 | 0.8 | 0.5 | 0.2 | 0.0 | 601 | 38 | 413.67 |
| 1971/72 | ROE-SN | 0.0 | 0.0 | 5.3 | 17.9 | 64.4 | 5.9 | 3.8 | 2.4 | 0.1 | 0.1 | 714 | 209 | 278.66 |
| 1972/73 | OTHER | 0.0 | 22.9 | 47.7 | 7.8 | 13.1 | 4.6 | 2.6 | 1.3 | 0.0 | 0.0 | 153 | 14 | 35.70 |
| | ROE-SN | 0.0 | 0.3 | 33.0 | 4.4 | 30.4 | 26.6 | 3.4 | 1.3 | 0.8 | 0.0 | 797 | 662 | 94.37 |
| 1973/74 | ROE-SN | 0.0 | 0.2 | 17.9 | 53.2 | 7.4 | 16.5 | 4.4 | 0.3 | 0.2 | 0.0 | 632 | 121 | 174.36 |
| | ROE-GN | 0.0 | 0.0 | 1.0 | 39.4 | 21.2 | 34.6 | 2.9 | 1.0 | 0.0 | 0.0 | 104 | 83 | 90.07 |
| 1974/75 | OTHER | 0.0 | 1.2 | 10.5 | 15.1 | 43.0 | 14.0 | 11.6 | 2.3 | 2.3 | 0.0 | 86 | 86 | 14.18 |
| | ROE-SN | 0.3 | 1.3 | 9.4 | 22.1 | 43.0 | 11.1 | 9.6 | 2.5 | 0.6 | 0.2 | 3084 | 769 | 116.58 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 31.9 | 59.6 | 8.5 | 0.0 | 0.0 | 0.0 | 0.0 | 47 | 47 | 0.76 |
| 1975/76 | OTHER | 0.0 | 0.0 | 4.9 | 6.8 | 9.9 | 16.7 | 17.9 | 35.2 | 8.6 | 0.0 | 162 | 1661 | 30.99 |
| | ROE-SN | 0.0 | 0.0 | 0.8 | 6.9 | 31.7 | 50.1 | 7.3 | 2.4 | 0.8 | 0.0 | 713 | 654 | 204.01 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 15.8 | 57.9 | 22.8 | 3.5 | 0.0 | 0.0 | 0.0 | 57 | 57 | 17.93 |
| 1976/77 | OTHER | 0.0 | 0.4 | 23.5 | 15.7 | 22.9 | 16.6 | 10.8 | 7.4 | 2.3 | 0.4 | 511 | 276 | 61.55 |
| | ROE-SN | 0.0 | 0.1 | 16.0 | 3.7 | 22.7 | 37.8 | 15.0 | 3.3 | 0.9 | 0.5 | 1310 | 1344 | 370.40 |
| | ROE-GN | 0.0 | 0.0 | 1.1 | 2.1 | 19.9 | 54.1 | 14.6 | 6.8 | 1.4 | 0.0 | 281 | 1104 | 89.48 |
| 1977/78 | OTHER | 0.0 | 1.3 | 9.6 | 27.8 | 18.2 | 18.1 | 14.6 | 6.9 | 2.4 | 1.0 | 982 | 124 | 238.36 |
| | ROE-SN | 0.0 | 1.1 | 11.7 | 32.8 | 9.6 | 21.1 | 20.4 | 2.4 | 0.6 | 0.3 | 795 | 131 | 136.94 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 20.5 | 6.0 | 32.5 | 33.1 | 6.6 | 1.3 | 0.0 | 151 | 37 | 181.42 |
| 1978/79 | OTHER | 0.0 | 1.8 | 9.3 | 9.8 | 25.9 | 17.8 | 16.2 | 9.5 | 5.7 | 4.0 | 1435 | 856 | 118.66 |
| | ROE-SN | 0.0 | 2.7 | 18.2 | 11.5 | 29.2 | 11.5 | 18.3 | 6.5 | 1.4 | 0.8 | 958 | 1475 | 84.40 |
| | ROE-GN | 0.0 | 1.1 | 1.1 | 8.0 | 41.4 | 15.7 | 22.2 | 8.0 | 1.9 | 0.4 | 261 | 255 | 74.00 |
| 1979/80 | OTHER | 0.0 | 1.1 | 61.2 | 6.5 | 7.9 | 8.2 | 6.5 | 4.9 | 2.1 | 1.6 | 1161 | 560 | 66.18 |
| | ROE-SN | 0.0 | 0.6 | 77.9 | 7.3 | 5.1 | 3.8 | 3.5 | 1.3 | 0.4 | 0.1 | 2811 | 535 | 171.81 |
| | ROE-GN | 0.0 | 0.0 | 3.4 | 8.7 | 31.2 | 22.3 | 21.1 | 9.1 | 3.4 | 0.6 | 493 | 915 | 63.73 |
| 1980/81 | OTHER | 0.0 | 1.0 | 7.4 | 54.6 | 9.3 | 10.2 | 9.3 | 4.3 | 2.3 | 1.5 | 6524 | 1129 | 137.14 |
| | ROE-SN | 0.0 | 0.5 | 11.2 | 81.2 | 3.3 | 1.7 | 1.5 | 0.4 | 0.2 | 0.1 | 3238 | 1059 | 106.00 |
| | ROE-GN | 0.0 | 0.0 | 0.5 | 38.9 | 15.5 | 23.0 | 14.8 | 5.6 | 1.9 | 0.0 | 427 | 557 | 23.77 |
| 1981/82 | OTHER | 0.0 | 1.5 | 11.5 | 20.5 | 41.1 | 10.5 | 6.6 | 5.0 | 2.1 | 1.1 | 2669 | 555 | 138.82 |
| | ROE-SN | 0.0 | 2.7 | 18.8 | 7.4 | 66.3 | 2.8 | 1.4 | 0.4 | 0.2 | 0.0 | 1544 | 576 | 16.50 |
| 1982/83 | ROE-SN | 0.0 | 1.4 | 20.8 | 17.7 | 5.3 | 49.2 | 3.7 | 1.1 | 0.6 | 0.2 | 4583 | 1448 | 1.00 |
| 1983/84 | OTHER | 0.0 | 2.8 | 36.2 | 15.7 | 13.9 | 9.8 | 16.4 | 2.8 | 1.1 | 1.4 | 654 | 303 | 23.68 |
| | ROE-SN | 0.0 | 0.5 | 35.5 | 14.4 | 10.3 | 14.4 | 23.6 | 1.0 | 0.2 | 0.1 | 2837 | 618 | 159.00 |
| | ROE-GN | 0.0 | 0.0 | 1.0 | 2.0 | 12.9 | 21.4 | 57.4 | 3.4 | 1.2 | 0.8 | 505 | 961 | 127.31 |
| 1984/85 | OTHER | 0.0 | 15.4 | 8.2 | 25.8 | 28.2 | 11.7 | 5.4 | 4.1 | 0.8 | 0.3 | 631 | 45 | 28.24 |
| | ROE-SN | 0.0 | 0.2 | 7.8 | 54.7 | 11.9 | 6.4 | 10.6 | 8.2 | 0.1 | 0.1 | 3664 | 969 | 278.16 |
| | ROE-GN | 0.0 | 0.0 | 0.4 | 16.4 | 14.9 | 15.8 | 21.8 | 29.8 | 0.4 | 0.5 | 550 | 543 | 235.00 |
| 1985/86 | OTHER | 0.0 | 11.7 | 9.9 | 8.0 | 21.3 | 18.6 | 11.7 | 6.6 | 6.9 | 5.2 | 767 | 512 | 25.39 |
| | ROE-SN | 0.0 | 1.8 | 13.8 | 9.4 | 46.3 | 10.8 | 5.3 | 7.1 | 5.5 | 0.1 | 5655 | 4566 | 277.60 |
| | ROE-GN | 0.0 | 0.0 | 0.4 | 4.3 | 53.8 | 19.0 | 8.7 | 7.8 | 5.7 | 0.2 | 1274 | 558 | 311.02 |
| 1986/87 | ROE-SN | 0.0 | 0.9 | 38.6 | 10.2 | 6.9 | 29.9 | 5.9 | 3.5 | 2.9 | 1.2 | 4731 | 4068 | 187.95 |
| | ROE-GN | 0.0 | 0.0 | 0.6 | 3.0 | 6.9 | 55.3 | 16.1 | 8.8 | 6.0 | 3.4 | 1761 | 819 | 270.57 |
| 1987/88 | ROE-SN | 0.0 | 0.5 | 30.9 | 39.0 | 5.9 | 8.4 | 11.6 | 1.9 | 1.4 | 0.4 | 4222 | 2993 | 353.56 |
| | ROE-GN | 0.0 | 0.0 | 0.4 | 6.5 | 7.2 | 21.5 | 44.8 | 11.7 | 5.1 | 2.8 | 710 | 421 | 276.81 |
| 1988/89 | ROE-SN | 0.0 | 0.6 | 21.7 | 36.1 | 27.7 | 4.9 | 4.5 | 3.6 | 0.6 | 0.3 | 3616 | 1265 | 357.83 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 4.6 | 30.5 | 13.7 | 23.5 | 21.8 | 3.4 | 2.5 | 476 | 432 | 317.93 |
| 1989/90 | ROE-SN | 0.0 | 0.7 | 18.2 | 22.6 | 28.2 | 20.5 | 4.0 | 3.3 | 2.2 | 0.4 | 5068 | 3572 | 150.28 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 6.3 | 21.3 | 42.5 | 10.3 | 11.6 | 6.1 | 2.0 | 544 | 180 | 154.63 |

| FISHERY | AVERAGE WEIGHT AT AGE (gms) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| REDUCTION | 21.8 | 43.9 | 79.3 | 107.9 | 128.2 | 146.1 | 163.1 | 173.5 | 188.7 | 206.8 |
| ROE-SN | 8.6 | 53.1 | 84.1 | 113.6 | 137.3 | 156.2 | 170.4 | 184.0 | 192.8 | 204.8 |
| ROE-GN | 0.0 | 90.3 | 115.5 | 136.1 | 147.0 | 160.7 | 168.2 | 175.7 | 185.9 | 191.5 |
| OTHER | 17.4 | 47.0 | 80.9 | 110.0 | 132.5 | 150.7 | 165.9 | 178.0 | 187.6 | 203.0 |

Appendix table 1.3. Age compostion and catch in numbers by fishery and season and weight at age averaged over all seasons for the central coast stock assessment region. These data are used for age-structured model analysis.

| SEASON | FISHERY | PERCENT AT AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NUMBER AGED | SAMPLE WEIGHT | CATCH (x $10^6$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950/51 | REDUCTION | 0.0 | 2.4 | 28.5 | 50.6 | 12.0 | 5.1 | 1.2 | 0.1 | 0.0 | 0.0 | 5318 | 2484 | 3905.26 |
| 1951/52 | REDUCTION | 1.1 | 5.1 | 19.9 | 29.7 | 37.7 | 4.4 | 1.5 | 0.4 | 0.0 | 0.0 | 5214 | 1352 | 2954.66 |
| 1952/53 | REDUCTION | 0.4 | 9.3 | 28.0 | 23.9 | 26.5 | 10.1 | 1.3 | 0.4 | 0.0 | 0.0 | 2939 | 537 | 73.85 |
| 1953/54 | REDUCTION | 0.1 | 3.9 | 69.6 | 20.2 | 4.6 | 1.3 | 0.2 | 0.0 | 0.1 | 0.0 | 3191 | 477 | 3478.53 |
| 1954/55 | REDUCTION | 0.3 | 6.6 | 7.7 | 74.4 | 9.1 | 1.5 | 0.4 | 0.0 | 0.0 | 0.0 | 2350 | 164 | 1237.50 |
| 1955/56 | REDUCTION | 0.0 | 16.9 | 13.6 | 9.2 | 57.0 | 2.9 | 0.3 | 0.0 | 0.0 | 0.0 | 5054 | 1351 | 4136.15 |
| 1956/57 | REDUCTION | 0.0 | 16.7 | 50.7 | 10.8 | 6.2 | 14.8 | 0.7 | 0.0 | 0.0 | 0.0 | 4688 | 1703 | 2635.45 |
| 1957/58 | REDUCTION | 0.0 | 23.5 | 61.4 | 12.7 | 1.3 | 0.6 | 0.6 | 0.0 | 0.0 | 0.0 | 3743 | 847 | 1445.86 |
| 1958/59 | REDUCTION | 0.4 | 3.8 | 49.3 | 36.7 | 8.1 | 0.8 | 0.4 | 0.4 | 0.0 | 0.0 | 4996 | 1337 | 3305.21 |
| 1959/60 | REDUCTION | 0.0 | 43.5 | 23.2 | 26.5 | 5.6 | 1.1 | 0.1 | 0.1 | 0.0 | 0.0 | 1416 | 165 | 639.45 |
| 1960/61 | REDUCTION | 0.0 | 16.1 | 32.2 | 10.8 | 29.7 | 10.1 | 0.9 | 0.1 | 0.1 | 0.0 | 2799 | 1227 | 3463.55 |
| 1961/62 | REDUCTION | 0.0 | 9.7 | 57.4 | 17.9 | 2.6 | 9.9 | 2.4 | 0.1 | 0.0 | 0.0 | 808 | 146 | 1721.99 |
| 1962/63 | REDUCTION | 0.0 | 0.4 | 30.3 | 58.0 | 5.4 | 2.9 | 2.9 | 0.2 | 0.0 | 0.0 | 1087 | 885 | 4376.33 |
| 1963/64 | REDUCTION | 0.0 | 13.1 | 47.4 | 27.7 | 10.3 | 1.4 | 0.1 | 0.0 | 0.0 | 0.0 | 1258 | 198 | 3507.73 |
| 1964/65 | REDUCTION | 0.0 | 8.2 | 36.4 | 33.8 | 15.8 | 5.4 | 0.3 | 0.1 | 0.0 | 0.0 | 1750 | 684 | 1326.51 |
| 1965/66 | REDUCTION | 8.7 | 61.5 | 18.7 | 6.7 | 3.3 | 1.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0* | 25 | 5565.20 |
| 1966/67 | REDUCTION | 1.2 | 37.0 | 45.6 | 12.9 | 2.0 | 1.0 | 0.2 | 0.1 | 0.0 | 0.0 | 0* | 25 | 2538.06 |
| 1967/68 | REDUCTION | 1.8 | 32.0 | 47.2 | 16.7 | 2.1 | 0.3 | 0.0 | 0.1 | 0.0 | 0.0 | 0* | 25 | 172.48 |
| 1968/69 | OTHER | 16.1 | 27.0 | 23.2 | 22.4 | 9.5 | 1.6 | 0.1 | 0.0 | 0.0 | 0.0 | 0* | 25 | 11.56 |
| 1969/70 | OTHER | 39.5 | 32.7 | 26.9 | 0.7 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0* | 25 | 39.77 |
| 1970/71 | OTHER | 0.1 | 14.4 | 39.6 | 36.8 | 3.8 | 4.2 | 0.9 | 0.1 | 0.1 | 0.0 | 953 | 135 | 339.63 |
| 1971/72 | ROE-SN | 0.0 | 4.4 | 29.8 | 27.7 | 25.7 | 6.9 | 4.4 | 1.1 | 0.1 | 0.0 | 1837 | 598 | 762.73" |
| | ROE-GN | 0.0 | 0.0 | 0.9 | 14.9 | 65.0 | 10.6 | 7.9 | 0.6 | 0.0 | 0.0 | 329 | 503 | 8.47 |
| 1972/73 | ROE-SN | 0.0 | 1.2 | 50.5 | 18.6 | 15.5 | 11.7 | 1.9 | 0.5 | 0.2 | 0.0 | 1328 | 593 | 539.55" |
| | ROE-GN | 0.0 | 0.0 | 2.5 | 25.3 | 44.9 | 20.9 | 4.4 | 1.3 | 0.6 | 0.0 | 158 | 114 | 71.26 |
| 1973/74 | ROE-SN | 0.0 | 2.8 | 17.7 | 38.6 | 19.7 | 13.4 | 6.6 | 0.9 | 0.3 | 0.0 | 1587 | 202 | 282.57 |
| | ROE-GN | 0.0 | 0.0 | 0.4 | 22.8 | 37.7 | 24.8 | 12.3 | 1.8 | 0.2 | 0.0 | 496 | 101 | 332.81 |
| 1974/75 | ROE-SN | 0.3 | 1.2 | 32.9 | 25.4 | 27.8 | 8.6 | 3.2 | 0.7 | 0.1 | 0.0 | 8923 | 3300 | 278.78 |
| | ROE-GN | 0.0 | 0.0 | 3.3 | 25.6 | 46.2 | 16.4 | 6.4 | 2.1 | 0.0 | 0.0 | 519 | 117 | 348.42 |
| 1975/76 | ROE-SN | 0.0 | 3.0 | 11.8 | 41.2 | 20.9 | 16.8 | 4.5 | 1.5 | 0.2 | 0.0 | 5418 | 973 | 493.71 |
| | ROE-GN | 0.0 | 0.0 | 0.8 | 18.8 | 29.8 | 35.3 | 11.8 | 3.0 | 0.4 | 0.1 | 1222 | 253 | 383.45 |
| 1976/77 | OTHER | 0.0 | 1.0 | 32.8 | 18.7 | 29.8 | 8.1 | 6.6 | 3.0 | 0.0 | 0.0 | 198 | 144 | 32.75 |
| | ROE-SN | 0.0 | 0.7 | 17.4 | 22.6 | 31.8 | 16.6 | 8.5 | 1.9 | 0.4 | 0.0 | 2496 | 925 | 284.27 |
| | ROE-GN | 0.0 | 0.0 | 1.1 | 13.0 | 35.5 | 31.6 | 13.5 | 4.0 | 1.3 | 0.0 | 453 | 169 | 411.71 |
| 1977/78 | ROE-SN | 0.0 | 0.2 | 25.7 | 15.2 | 19.9 | 23.1 | 10.9 | 3.5 | 1.1 | 0.4 | 1396 | 589 | 354.31 |
| | ROE-GN | 0.0 | 0.0 | 1.3 | 8.9 | 29.6 | 38.1 | 17.7 | 3.8 | 0.5 | 0.1 | 1075 | 474 | 576.00 |
| 1979/80 | ROE-SN | 0.0 | 3.7 | 73.1 | 6.4 | 9.0 | 4.0 | 2.6 | 0.7 | 0.4 | 0.1 | 2582 | 1401 | 1.12" |
| | ROE-GN | 0.0 | 0.0 | 3.3 | 2.6 | 24.8 | 23.7 | 26.3 | 11.3 | 6.6 | 1.5 | 274 | 210 | 32.46 |
| 1980/81 | ROE-SN | 0.0 | 2.0 | 12.3 | 66.6 | 8.4 | 7.0 | 2.6 | 0.6 | 0.3 | 0.1 | 2952 | 492 | 25.75" |
| | ROE-GN | 0.0 | 0.3 | 1.5 | 50.7 | 13.6 | 15.4 | 10.6 | 5.5 | 1.8 | 0.7 | 1536 | 276 | 163.04 |
| 1981/82 | ROE-SN | 0.0 | 1.7 | 15.6 | 10.7 | 60.2 | 5.2 | 4.6 | 1.5 | 0.5 | 0.1 | 3508 | 2296 | 188.15" |
| | ROE-GN | 0.0 | 0.0 | 2.4 | 5.9 | 76.0 | 6.7 | 5.9 | 2.3 | 0.7 | 0.1 | 1337 | 301 | 287.08 |
| 1982/83 | ROE-SN | 0.0 | 0.5 | 7.0 | 15.4 | 10.8 | 57.1 | 5.0 | 3.1 | 0.7 | 0.3 | 5445 | 1082 | 154.75 |
| | ROE-GN | 0.0 | 0.0 | 0.5 | 7.2 | 13.1 | 69.4 | 5.0 | 3.9 | 0.6 | 0.3 | 1793 | 994 | 244.49 |
| 1983/84 | ROE-SN | 0.0 | 4.4 | 7.3 | 10.1 | 18.2 | 16.1 | 40.7 | 2.3 | 0.8 | 0.1 | 6294 | 2209 | 284.16" |
| | ROE-GN | 0.0 | 0.0 | 0.3 | 2.9 | 13.1 | 17.3 | 60.1 | 4.7 | 1.1 | 0.5 | 1159 | 338 | 242.25 |
| 1984/85 | ROE-SN | 0.0 | 2.7 | 37.5 | 7.5 | 8.6 | 13.1 | 11.9 | 18.2 | 0.4 | 0.1 | 5157 | 5529 | 222.13 |
| | ROE-GN | 0.0 | 0.0 | 3.2 | 5.4 | 9.4 | 19.5 | 22.5 | 38.2 | 1.0 | 0.8 | 1288 | 1407 | 143.53 |
| 1985/86 | ROE-SN | 0.0 | 3.9 | 16.4 | 40.2 | 8.6 | 6.3 | 6.7 | 6.1 | 11.3 | 0.5 | 5819 | 2074 | 163.81" |
| | ROE-GN | 0.0 | 0.0 | 1.8 | 23.9 | 12.0 | 10.0 | 16.0 | 13.2 | 22.3 | 0.8 | 1069 | 262 | 73.95 |
| 1986/87 | ROE-SN | 0.0 | 4.1 | 22.6 | 14.6 | 32.2 | 5.7 | 4.5 | 5.8 | 4.7 | 5.8 | 5038 | 2319 | 193.73 |
| | ROE-GN | 0.0 | 0.0 | 0.8 | 7.7 | 44.9 | 11.7 | 7.8 | 9.9 | 8.2 | 9.0 | 981 | 1199 | 55.71 |
| 1987/88 | ROE-SN | 0.0 | 1.1 | 67.9 | 11.7 | 6.3 | 7.1 | 1.7 | 1.5 | 1.5 | 1.2 | 5205 | 2732 | 343.86" |
| | ROE-GN | 0.0 | 0.0 | 4.2 | 10.2 | 14.8 | 27.2 | 15.2 | 7.4 | 10.1 | 10.8 | 566 | 158 | 59.81 |
| 1988/89 | ROE-SN | 0.0 | 1.3 | 4.6 | 76.2 | 9.2 | 3.6 | 2.8 | 0.8 | 0.8 | 0.8 | 5643 | 1937 | 596.32 |
| | ROE-GN | 0.0 | 0.0 | 0.3 | 27.6 | 25.1 | 17.3 | 16.5 | 5.8 | 3.7 | 3.8 | 710 | 259 | 195.14 |
| 1989/90 | ROE-SN | 0.0 | 1.0 | 5.6 | 5.1 | 72.7 | 7.5 | 3.8 | 2.9 | 0.7 | 0.8 | 6850 | 6036 | 400.82 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 1.2 | 65.1 | 16.9 | 6.3 | 7.8 | 1.1 | 1.8 | 847 | 502 | 190.50 |

| FISHERY | AVERAGE WEIGHT AT AGE (gms) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| REDUCTION | 16.1 | 43.8 | 79.8 | 104.7 | 125.6 | 138.1 | 150.4 | 156.2 | 153.5 | 179.0 |
| ROE-SN | 16.2 | 54.8 | 88.3 | 114.2 | 135.9 | 154.6 | 170.2 | 183.3 | 195.4 | 205.8 |
| ROE-GN | 0.0 | 39.3 | 114.1 | 137.9 | 149.8 | 160.9 | 170.6 | 180.4 | 186.1 | 184.3 |
| OTHER | 16.1 | 49.2 | 84.7 | 110.0 | 131.5 | 147.1 | 161.6 | 172.5 | 186.3 | 201.3 |

Appendix table 1.4. Age compostion and catch in numbers by fishery and season and weight at age averaged over all seasons for the northern Strait of Georgia stock assessment region. These data are used for age-structured model analysis.

| SEASON | FISHERY | PERCENT AT AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NUMBER AGED | SAMPLE WEIGHT | CATCH (x $10^6$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950/51 | REDUCTION | 0.1 | 3.5 | 45.5 | 38.5 | 9.5 | 2.1 | 0.6 | 0.2 | 0.0 | 0.0 | 3554 | 526 | 1733.55 |
| 1951/52 | REDUCTION | 0.1 | 13.0 | 52.2 | 26.4 | 6.8 | 1.5 | 0.1 | 0.0 | 0.0 | 0.0 | 4533 | 570 | 1857.54 |
| 1952/53 | REDUCTION | 0.4 | 12.9 | 49.7 | 30.3 | 4.8 | 1.6 | 0.3 | 0.1 | 0.0 | 0.0 | 5343 | 707 | 545.54 |
| 1953/54 | REDUCTION | 0.0 | 2.3 | 34.0 | 39.2 | 16.7 | 5.7 | 1.7 | 0.4 | 0.0 | 0.0 | 6856 | 2388 | 1934.55 |
| 1954/55 | REDUCTION | 0.0 | 5.5 | 40.9 | 44.2 | 7.7 | 1.6 | 0.1 | 0.0 | 0.0 | 0.0 | 2657 | 360 | 2903.78 |
| 1955/56 | REDUCTION | 0.0 | 9.5 | 16.4 | 28.1 | 36.9 | 7.4 | 1.2 | 0.4 | 0.1 | 0.0 | 4919 | 925 | 2587.73 |
| 1956/57 | REDUCTION | 0.0 | 0.9 | 36.8 | 25.1 | 24.3 | 11.5 | 1.3 | 0.1 | 0.0 | 0.0 | 2420 | 497 | 1848.17 |
| 1957/58 | REDUCTION | 0.0 | 6.4 | 44.3 | 23.4 | 9.5 | 9.6 | 5.8 | 0.8 | 0.1 | 0.0 | 3473 | 617 | 890.18 |
| 1958/59 | REDUCTION | 0.8 | 16.8 | 62.4 | 16.3 | 2.8 | 0.5 | 0.3 | 0.1 | 0.0 | 0.0 | 4454 | 1799 | 4185.81 |
| 1959/60 | REDUCTION | 0.0 | 14.1 | 39.7 | 39.2 | 5.8 | 0.8 | 0.3 | 0.1 | 0.0 | 0.1 | 1252 | 231 | 2428.73 |
| 1960/61 | REDUCTION | 0.0 | 21.7 | 22.8 | 30.0 | 22.0 | 3.1 | 0.4 | 0.0 | 0.0 | 0.0 | 1302 | 222 | 1771.58 |
| 1961/62 | REDUCTION | 0.0 | 13.3 | 63.4 | 12.7 | 7.2 | 2.8 | 0.6 | 0.0 | 0.0 | 0.0 | 1506 | 584 | 3439.44 |
| 1962/63 | REDUCTION | 0.0 | 20.8 | 48.3 | 24.5 | 3.4 | 1.8 | 0.9 | 0.2 | 0.0 | 0.0 | 1161 | 144 | 4278.29 |
| 1963/64 | REDUCTION | 0.0 | 5.8 | 64.7 | 26.5 | 2.3 | 0.6 | 0.1 | 0.0 | 0.0 | 0.0 | 2224 | 639 | 3714.95 |
| 1964/65 | REDUCTION | 0.2 | 14.1 | 53.3 | 28.3 | 2.7 | 1.1 | 0.3 | 0.1 | 0.0 | 0.0 | 2095 | 529 | 2668.48 |
| 1965/66 | REDUCTION | 0.0 | 19.5 | 36.8 | 23.0 | 15.9 | 3.2 | 1.6 | 0.0 | 0.0 | 0.0 | 435 | 77 | 1851.57 |
| 1966/67 | REDUCTION | 8.1 | 28.4 | 47.7 | 10.5 | 3.0 | 1.9 | 0.3 | 0.0 | 0.0 | 0.0 | 0* | 25 | 1198.37 |
| 1967/68 | REDUCTION | 13.0 | 20.0 | 50.6 | 13.0 | 2.5 | 0.6 | 0.2 | 0.1 | 0.0 | 0.0 | 0* | 25 | 103.87 |
| 1968/69 | OTHER | 18.2 | 59.4 | 19.6 | 2.4 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0* | 25 | 52.86 |
| 1969/70 | OTHER | 0.6 | 23.6 | 62.9 | 11.1 | 1.4 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0* | 25 | 51.64 |
| 1970/71 | OTHER | 0.5 | 12.9 | 42.3 | 34.4 | 6.6 | 2.8 | 0.5 | 0.0 | 0.0 | 0.0 | 1060 | 239 | 82.74 |
| 1971/72 | OTHER | 0.0 | 1.5 | 27.6 | 36.8 | 26.1 | 5.4 | 2.3 | 0.3 | 0.0 | 0.0 | 1039 | 3596 | 73.26 |
| | ROE-SN | 0.0 | 4.0 | 42.3 | 30.3 | 18.4 | 4.0 | 1.0 | 0.0 | 0.0 | 0.0 | 2773 | 265 | 518.15 |
| | ROE-GN | 0.0 | 1.1 | 12.5 | 50.2 | 28.0 | 6.5 | 1.1 | 0.4 | 0.4 | 0.0 | 279 | 214 | 0.22 |
| 1972/73 | OTHER | 0.1 | 0.5 | 23.5 | 33.0 | 26.8 | 13.9 | 1.9 | 0.3 | 0.0 | 0.0 | 3915 | 1785 | 266.29 |
| | ROE-SN | 0.0 | 4.2 | 54.9 | 21.4 | 12.9 | 6.1 | 0.5 | 0.0 | 0.0 | 0.0 | 379 | 615 | 141.70 |
| | ROE-GN | 0.0 | 0.0 | 5.5 | 27.3 | 52.7 | 10.9 | 3.6 | 0.0 | 0.0 | 0.0 | 55 | 55 | 88.52 |
| 1973/74 | ROE-GN | 0.0 | 0.0 | 3.6 | 43.1 | 33.1 | 16.9 | 2.9 | 0.3 | 0.0 | 0.0 | 661 | 320 | 204.10 |
| 1974/75 | OTHER | 1.1 | 22.1 | 60.4 | 12.3 | 2.1 | 1.4 | 0.5 | 0.0 | 0.2 | 0.0 | 439 | 15 | 65.94 |
| | ROE-SN | 1.7 | 3.5 | 57.3 | 27.0 | 7.1 | 2.6 | 0.5 | 0.2 | 0.1 | 0.0 | 3092 | 662 | 50.23 |
| | ROE-GN | 0.0 | 0.0 | 6.7 | 31.9 | 43.7 | 13.4 | 3.4 | 0.8 | 0.0 | 0.0 | 119 | 26 | 283.37 |
| 1975/76 | OTHER | 0.1 | 7.9 | 17.6 | 34.9 | 25.5 | 8.6 | 3.7 | 1.3 | 0.2 | 0.1 | 1380 | 553 | 150.55 |
| | ROE-SN | 0.0 | 13.3 | 26.3 | 43.3 | 14.1 | 2.2 | 0.3 | 0.4 | 0.0 | 0.0 | 729 | 97 | 20.92 |
| | ROE-GN | 0.0 | 0.0 | 0.5 | 39.1 | 44.0 | 12.9 | 3.0 | 0.4 | 0.1 | 0.0 | 737 | 269 | 405.21 |
| 1976/77 | OTHER | 0.0 | 3.2 | 19.7 | 24.8 | 36.9 | 14.6 | 0.6 | 0.0 | 0.0 | 0.0 | 157 | 254 | 46.34 |
| | ROE-SN | 0.1 | 3.3 | 57.8 | 20.8 | 14.4 | 3.0 | 0.4 | 0.2 | 0.0 | 0.0 | 2234 | 1269 | 370.86 |
| | ROE-GN | 0.0 | 0.0 | 3.2 | 26.1 | 48.7 | 17.2 | 4.1 | 0.6 | 0.1 | 0.0 | 1423 | 162 | 466.14 |
| 1977/78 | OTHER | 0.1 | 4.7 | 38.0 | 28.4 | 9.6 | 11.6 | 5.7 | 1.2 | 0.5 | 0.1 | 758 | 205 | 364.13 |
| | ROE-SN | 0.0 | 0.8 | 34.8 | 42.8 | 11.9 | 7.7 | 1.5 | 0.3 | 0.0 | 0.1 | 3146 | 2299 | 353.53 |
| | ROE-GN | 0.0 | 0.0 | 0.4 | 19.7 | 31.4 | 35.1 | 11.3 | 1.7 | 0.4 | 0.0 | 462 | 690 | 426.90 |
| 1978/79 | OTHER | 0.0 | 1.2 | 16.2 | 36.6 | 25.3 | 10.9 | 7.7 | 1.6 | 0.4 | 0.1 | 764 | 201 | 164.24 |
| | ROE-SN | 0.0 | 1.0 | 17.7 | 31.0 | 32.5 | 10.2 | 5.8 | 1.5 | 0.2 | 0.0 | 889 | 311 | 1.00 |
| | ROE-GN | 0.0 | 0.0 | 1.2 | 23.2 | 54.7 | 13.5 | 5.8 | 1.5 | 0.0 | 0.2 | 607 | 290 | 441.80 |
| 1979/80 | OTHER | 1.4 | 5.0 | 40.4 | 21.9 | 18.6 | 8.1 | 2.8 | 1.5 | 0.3 | 0.0 | 2101 | 1071 | 126.33 |
| | ROE-SN | 0.0 | 2.4 | 48.5 | 16.5 | 18.0 | 10.4 | 2.6 | 1.3 | 0.3 | 0.1 | 3548 | 1368 | 16.93 |
| | ROE-GN | 0.0 | 0.0 | 2.0 | 9.2 | 44.6 | 33.4 | 8.8 | 1.9 | 0.3 | 0.0 | 754 | 1139 | 215.21 |
| 1980/81 | OTHER | 0.0 | 1.8 | 40.6 | 36.5 | 13.3 | 4.7 | 2.1 | 0.5 | 0.5 | 0.0 | 655 | 212 | 26.24 |
| | ROE-SN | 0.0 | 6.8 | 36.9 | 30.5 | 11.4 | 9.7 | 3.8 | 0.6 | 0.3 | 0.0 | 7083 | 2254 | 202.01 |
| | ROE-GN | 0.0 | 0.1 | 2.2 | 18.2 | 23.0 | 37.4 | 16.1 | 2.8 | 0.3 | 0.1 | 1140 | 338 | 333.10 |
| 1981/82 | OTHER | 0.0 | 0.0 | 25.8 | 35.2 | 28.3 | 4.4 | 2.5 | 2.5 | 0.0 | 1.3 | 159 | 123 | 12.34 |
| | ROE-SN | 0.0 | 4.8 | 31.5 | 26.3 | 23.1 | 5.2 | 5.7 | 2.7 | 0.6 | 0.1 | 3304 | 1659 | 1.28 |
| | ROE-GN | 0.0 | 0.0 | 4.4 | 15.4 | 28.5 | 14.8 | 20.8 | 14.2 | 1.7 | 0.4 | 833 | 543 | 367.36 |
| 1982/83 | OTHER | 0.0 | 27.2 | 47.2 | 13.9 | 7.8 | 2.8 | 0.0 | 1.1 | 0.0 | 0.0 | 180 | 523 | 10.56 |
| | ROE-SN | 0.0 | 2.4 | 31.8 | 28.4 | 17.8 | 12.1 | 3.3 | 2.9 | 1.2 | 0.2 | 9836 | 6124 | 676.25 |
| | ROE-GN | 0.0 | 0.0 | 0.5 | 27.8 | 29.5 | 23.6 | 9.3 | 7.4 | 1.7 | 0.2 | 407 | 305 | 563.81 |
| 1983/84 | OTHER | 0.0 | 8.7 | 39.4 | 28.5 | 11.0 | 7.3 | 3.7 | 1.4 | 0.0 | 0.0 | 355 | 66 | 19.33 |
| | ROE-SN | 0.0 | 4.7 | 39.3 | 31.4 | 12.8 | 6.6 | 3.5 | 1.0 | 0.5 | 0.1 | 5747 | 1917 | 351.51 |
| | ROE-GN | 0.0 | 0.0 | 7.0 | 30.2 | 31.1 | 19.2 | 9.3 | 1.7 | 0.7 | 0.9 | 766 | 759 | 421.50 |
| 1984/85 | OTHER | 0.0 | 13.1 | 50.8 | 20.3 | 10.2 | 4.0 | 1.3 | 0.3 | 0.0 | 0.0 | 679 | 380 | 11.60 |
| | ROE-SN | 0.0 | 21.9 | 45.6 | 19.1 | 8.5 | 3.1 | 1.3 | 0.5 | 0.1 | 0.0 | 5677 | 2317 | 288.55 |
| | ROE-GN | 0.0 | 0.1 | 3.1 | 26.1 | 32.5 | 23.6 | 9.2 | 3.7 | 0.8 | 0.8 | 1096 | 650 | 237.16 |
| 1985/86 | OTHER | 0.0 | 16.3 | 48.8 | 27.9 | 2.3 | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 | 86 | 86 | 14.64 |
| | ROE-SN | 0.1 | 8.9 | 54.8 | 25.9 | 7.1 | 2.2 | 0.8 | 0.2 | 0.1 | 0.0 | 4454 | 1587 | 17.16 |
| 1986/87 | ROE-SN | 0.0 | 5.8 | 32.6 | 38.8 | 17.0 | 4.0 | 1.2 | 0.4 | 0.2 | 0.1 | 6433 | 2405 | 321.49 |
| | ROE-GN | 0.0 | 0.0 | 2.0 | 32.7 | 34.5 | 17.6 | 9.7 | 2.7 | 0.5 | 0.3 | 1277 | 652 | 145.34 |
| 1987/88 | OTHER | 0.0 | 0.0 | 45.5 | 22.7 | 22.7 | 8.0 | 1.1 | 0.0 | 0.0 | 0.0 | 88 | 88 | 4.04 |
| | ROE-SN | 0.0 | 3.8 | 57.7 | 15.6 | 16.7 | 4.7 | 1.1 | 0.3 | 0.1 | 0.0 | 4996 | 1541 | 145.97 |
| | ROE-GN | 0.0 | 0.0 | 9.1 | 14.9 | 48.1 | 19.5 | 5.5 | 2.3 | 0.4 | 0.2 | 821 | 383 | 414.24 |
| 1988/89 | ROE-SN | 0.0 | 7.1 | 19.3 | 55.4 | 9.1 | 6.9 | 1.8 | 0.3 | 0.0 | 0.0 | 4797 | 1287 | 117.28 |
| | ROE-GN | 0.0 | 0.0 | 1.6 | 40.2 | 22.0 | 25.9 | 7.8 | 2.2 | 0.4 | 0.0 | 823 | 1143 | 421.70 |
| 1989/90 | ROE-SN | 0.0 | 6.6 | 56.2 | 12.1 | 20.3 | 2.8 | 1.5 | 0.4 | 0.1 | 0.0 | 3950 | 1901 | 1.00 |
| | ROE-GN | 0.0 | 0.0 | 5.7 | 11.4 | 57.1 | 12.6 | 11.1 | 1.7 | 0.2 | 0.1 | 879 | 461 | 300.65 |

| FISHERY | AVERAGE WEIGHT AT AGE (gms) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| REDUCTION | 14.9 | 45.4 | 83.4 | 109.8 | 131.7 | 149.2 | 169.7 | 174.4 | 194.0 | 188.3 |
| ROE-SN | 15.7 | 57.0 | 82.5 | 109.8 | 130.6 | 148.6 | 164.9 | 174.4 | 174.0 | 185.7 |
| ROE-GN | 0.0 | 67.2 | 118.8 | 137.0 | 148.5 | 159.8 | 167.5 | 179.7 | 177.3 | 188.0 |
| OTHER | 16.0 | 51.9 | 84.2 | 110.5 | 132.6 | 150.4 | 167.9 | 169.8 | 175.5 | 181.0 |

Appendix table 1.5. Age compostion and catch in numbers by fishery and season and weight at age averaged over all seasons for the southern Strait of Georgia stock assessment region. These data are used for age-structured model analysis.

| | | PERCENT AT AGE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | FISHERY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NUMBER AGED | SAMPLE WEIGHT | CATCH (x $10^{-6}$) |
| 1950/51 | REDUCTION | 0.0 | 4.7 | 65.6 | 23.5 | 5.1 | 0.9 | 0.1 | 0.0 | 0.0 | 0.0 | 4262 | 1605 | 2688.26 |
| 1951/52 | REDUCTION | 0.1 | 9.3 | 58.5 | 23.7 | 6.7 | 1.2 | 0.4 | 0.1 | 0.0 | 0.0 | 4499 | 1222 | 2966.21 |
| 1952/53 | REDUCTION | 0.1 | 3.9 | 65.9 | 26.6 | 3.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 3320 | 1258 | 493.14 |
| 1953/54 | REDUCTION | 0.0 | 0.7 | 58.4 | 34.2 | 5.9 | 0.6 | 0.1 | 0.0 | 0.0 | 0.0 | 6306 | 2318 | 4668.76 |
| 1954/55 | REDUCTION | 0.0 | 3.3 | 56.4 | 33.8 | 5.7 | 0.6 | 0.1 | 0.0 | 0.0 | 0.0 | 2634 | 714 | 4115.48 |
| 1955/56 | REDUCTION | 0.0 | 4.5 | 53.8 | 29.5 | 10.4 | 1.5 | 0.2 | 0.0 | 0.0 | 0.0 | 4913 | 2414 | 4726.81 |
| 1956/57 | REDUCTION | 0.0 | 1.6 | 70.8 | 21.0 | 4.2 | 2.0 | 0.3 | 0.1 | 0.0 | 0.0 | 5059 | 2139 | 4146.45 |
| 1957/58 | REDUCTION | 0.0 | 11.3 | 63.5 | 21.0 | 2.9 | 1.0 | 0.3 | 0.1 | 0.0 | 0.0 | 3924 | 1050 | 1379.36 |
| 1958/59 | REDUCTION | 0.8 | 17.1 | 64.2 | 14.6 | 2.4 | 0.6 | 0.2 | 0.1 | 0.0 | 0.0 | 5586 | 2067 | 1946.50 |
| 1959/60 | REDUCTION | 0.0 | 4.5 | 57.2 | 35.2 | 2.5 | 0.4 | 0.1 | 0.1 | 0.0 | 0.0 | 2490 | 1351 | 4499.74 |
| 1960/61 | REDUCTION | 0.0 | 35.7 | 29.1 | 25.5 | 8.8 | 0.8 | 0.1 | 0.0 | 0.0 | 0.0 | 3049 | 620 | 3469.79 |
| 1961/62 | REDUCTION | 0.0 | 5.2 | 76.0 | 13.6 | 3.6 | 1.4 | 0.2 | 0.1 | 0.0 | 0.0 | 1697 | 412 | 3696.98 |
| 1962/63 | REDUCTION | 0.0 | 14.4 | 53.6 | 29.2 | 2.6 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 1148 | 308 | 3870.31 |
| 1963/64 | REDUCTION | 0.1 | 6.2 | 56.3 | 34.0 | 2.9 | 0.4 | 0.1 | 0.1 | 0.0 | 0.0 | 1804 | 625 | 3796.46 |
| 1964/65 | REDUCTION | 0.0 | 16.2 | 58.1 | 22.6 | 2.3 | 0.7 | 0.0 | 0.2 | 0.0 | 0.0 | 1259 | 451 | 1965.81 |
| 1965/66 | REDUCTION | 0.0 | 31.0 | 32.7 | 23.8 | 11.1 | 1.0 | 0.5 | 0.0 | 0.0 | 0.0 | 416 | 36 | 1332.91 |
| 1966/67 | REDUCTION | 13.6 | 37.4 | 33.8 | 11.2 | 2.7 | 1.0 | 0.2 | 0.0 | 0.1 | 0.0 | 0* | 25 | 2516.94 |
| 1967/68 | REDUCTION | 69.3 | 15.8 | 9.0 | 4.3 | 1.0 | 0.4 | 0.0 | 0.2 | 0.0 | 0.0 | 0* | 25 | 245.19 |
| 1968/69 | OTHER | 24.6 | 38.1 | 23.0 | 10.4 | 2.8 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0* | 25 | 60.68 |
| 1969/70 | OTHER | 0.4 | 27.4 | 57.2 | 7.8 | 5.1 | 1.0 | 1.1 | 0.0 | 0.0 | 0.0 | 0* | 25 | 38.15 |
| 1970/71 | OTHER | 0.0 | 10.6 | 33.4 | 42.1 | 8.6 | 2.8 | 2.2 | 0.3 | 0.0 | 0.0 | 359 | 162 | 64.38 |
| 1971/72 | OTHER | 0.0 | 13.8 | 33.5 | 33.8 | 15.1 | 2.7 | 1.0 | 0.1 | 0.0 | 0.0 | 2625 | 807 | 154.95 |
| | ROE-SN | 0.0 | 14.0 | 28.6 | 36.0 | 17.4 | 2.8 | 1.0 | 0.2 | 0.0 | 0.0 | 2263 | 597 | 38.49 |
| | ROE-GN | 0.0 | 5.7 | 11.1 | 45.1 | 29.4 | 7.0 | 1.6 | 0.1 | 0.0 | 0.0 | 756 | 151 | 9.59 |
| 1972/73 | OTHER | 0.0 | 3.4 | 49.6 | 21.2 | 18.6 | 5.5 | 1.1 | 0.5 | 0.1 | 0.0 | 797 | 203 | 27.12 |
| | ROE-GN | 0.0 | 0.0 | 21.3 | 31.4 | 32.5 | 11.2 | 3.0 | 0.6 | 0.0 | 0.0 | 169 | 56 | 43.63 |
| 1973/74 | OTHER | 0.0 | 17.4 | 73.3 | 8.1 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 86 | 86 | 39.04 |
| | ROE-GN | 0.0 | 0.0 | 7.3 | 40.4 | 27.7 | 16.1 | 6.4 | 2.1 | 0.0 | 0.0 | 329 | 268 | 30.21 |
| 1974/75 | ROE-SN | 0.0 | 3.9 | 50.1 | 28.6 | 8.7 | 4.3 | 3.1 | 0.9 | 0.3 | 0.0 | 2154 | 597 | 2.49" |
| | ROE-GN | 0.0 | 0.0 | 1.6 | 64.5 | 21.0 | 9.7 | 3.2 | 0.0 | 0.0 | 0.0 | 62 | 62 | 68.22 |
| 1975/76 | OTHER | 0.0 | 5.5 | 21.7 | 44.3 | 19.7 | 5.2 | 2.3 | 0.8 | 0.5 | 0.0 | 3023 | 965 | 249.87 |
| | ROE-SN | 0.0 | 9.6 | 22.1 | 35.5 | 16.0 | 5.6 | 6.1 | 3.6 | 1.3 | 0.3 | 394 | 108 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 0.7 | 41.5 | 41.5 | 11.6 | 2.7 | 2.0 | 0.0 | 0.0 | 147 | 126 | 63.84 |
| 1976/77 | OTHER | 0.6 | 4.2 | 52.5 | 21.7 | 15.2 | 3.8 | 1.3 | 0.5 | 0.2 | 0.1 | 2512 | 788 | 472.92 |
| | ROE-SN | 0.0 | 4.8 | 18.4 | 8.0 | 15.2 | 19.2 | 16.0 | 11.2 | 4.8 | 2.4 | 125 | 136 | 23.00 |
| | ROE-GN | 0.0 | 0.0 | 4.6 | 48.6 | 35.4 | 10.3 | 1.1 | 0.0 | 0.0 | 0.0 | 175 | 5 | 48.06 |
| 1977/78 | OTHER | 0.0 | 1.2 | 35.1 | 45.8 | 10.6 | 5.6 | 1.3 | 0.1 | 0.2 | 0.1 | 1709 | 391 | 819.26 |
| | ROE-SN | 0.0 | 1.1 | 40.5 | 46.2 | 7.5 | 4.3 | 0.4 | 0.0 | 0.0 | 0.0 | 279 | 132 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 1.9 | 23.1 | 24.0 | 38.5 | 12.5 | 0.0 | 0.0 | 0.0 | 104 | 433 | 57.85 |
| 1978/79 | OTHER | 0.0 | 1.9 | 18.6 | 37.8 | 29.0 | 8.0 | 3.3 | 1.0 | 0.3 | 0.1 | 4699 | 1796 | 922.01 |
| | ROE-SN | 0.0 | 2.7 | 24.0 | 35.6 | 20.2 | 7.9 | 4.0 | 3.1 | 1.3 | 1.2 | 520 | 98 | 1.00~ |
| 1979/80 | OTHER | 0.0 | 1.4 | 45.4 | 24.0 | 17.7 | 8.4 | 1.7 | 1.1 | 0.3 | 0.1 | 2842 | 1954 | 109.21 |
| | ROE-SN | 0.0 | 3.0 | 57.9 | 12.0 | 15.9 | 6.8 | 2.9 | 0.8 | 0.2 | 0.5 | 591 | 189 | 1.00~ |
| 1980/81 | OTHER | 0.0 | 3.9 | 33.3 | 33.9 | 15.9 | 9.1 | 3.2 | 0.5 | 0.1 | 0.0 | 4505 | 2225 | 390.60 |
| | ROE-SN | 0.0 | 8.6 | 38.4 | 29.9 | 10.6 | 8.8 | 2.8 | 0.6 | 0.2 | 0.0 | 648 | 255 | 1.00~ |
| 1981/82 | OTHER | 0.0 | 3.6 | 39.0 | 31.5 | 15.3 | 5.8 | 3.9 | 0.8 | 0.1 | 0.0 | 2369 | 1384 | 303.92 |
| | ROE-SN | 0.0 | 8.7 | 39.7 | 23.1 | 17.4 | 3.8 | 4.5 | 2.2 | 0.5 | 0.0 | 2096 | 1168 | 302.55 |
| 1982/83 | OTHER | 0.0 | 0.8 | 16.6 | 32.0 | 23.2 | 13.2 | 4.9 | 5.7 | 3.0 | 0.6 | 1910 | 1526 | 47.33 |
| | ROE-SN | 0.0 | 5.8 | 29.8 | 28.7 | 18.3 | 8.7 | 2.8 | 3.8 | 1.6 | 0.5 | 2126 | 975 | 22.47 |
| 1983/84 | OTHER | 0.0 | 16.2 | 30.0 | 21.9 | 18.5 | 8.3 | 3.3 | 0.9 | 0.5 | 0.4 | 1527 | 555 | 52.95 |
| | ROE-SN | 0.0 | 21.9 | 31.4 | 18.8 | 13.4 | 9.3 | 2.6 | 1.5 | 0.6 | 0.3 | 1406 | 790 | 43.55 |
| 1984/85 | OTHER | 0.0 | 33.4 | 37.1 | 18.7 | 6.7 | 2.8 | 0.9 | 0.4 | 0.1 | 0.0 | 1843 | 288 | 64.51 |
| | ROE-SN | 0.0 | 29.3 | 39.1 | 18.5 | 6.3 | 4.2 | 1.5 | 0.9 | 0.1 | 0.0 | 2155 | 693 | 12.24 |
| 1985/86 | OTHER | 0.0 | 13.1 | 59.1 | 19.7 | 6.2 | 1.4 | 0.4 | 0.1 | 0.0 | 0.0 | 777 | 156 | 27.93 |
| | ROE-SN | 0.0 | 20.8 | 59.2 | 13.8 | 4.1 | 1.3 | 0.7 | 0.1 | 0.1 | 0.0 | 1961 | 542 | 1.00~ |
| 1986/87 | OTHER | 0.0 | 21.8 | 34.7 | 31.0 | 10.0 | 1.9 | 0.5 | 0.2 | 0.0 | 0.0 | 882 | 204 | 14.91 |
| | ROE-SN | 0.0 | 27.6 | 35.8 | 28.0 | 6.4 | 1.4 | 0.6 | 0.2 | 0.0 | 0.1 | 1257 | 246 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 3.6 | 41.4 | 31.4 | 14.3 | 6.1 | 2.5 | 0.6 | 0.2 | 643 | 926 | 266.33 |
| 1987/88 | OTHER | 0.2 | 3.9 | 61.6 | 16.6 | 14.5 | 2.2 | 0.6 | 0.2 | 0.1 | 0.0 | 829 | 1087 | 65.03 |
| | ROE-SN | 0.0 | 8.0 | 72.3 | 11.1 | 7.0 | 1.0 | 0.5 | 0.0 | 0.0 | 0.0 | 922 | 494 | 1.00~ |
| 1988/89 | OTHER | 0.0 | 26.5 | 16.6 | 42.9 | 7.1 | 5.9 | 0.9 | 0.2 | 0.0 | 0.0 | 1049 | 298 | 59.24 |
| | ROE-SN | 0.0 | 18.4 | 14.1 | 47.8 | 10.5 | 7.8 | 1.0 | 0.3 | 0.0 | 0.1 | 1633 | 479 | 59.99 |
| 1989/90 | ROE-SN | 0.0 | 11.1 | 59.4 | 7.5 | 15.9 | 3.4 | 2.2 | 0.4 | 0.1 | 0.1 | 1697 | 1549 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 13.2 | 12.2 | 54.7 | 11.4 | 7.1 | 1.0 | 0.4 | 0.0 | 492 | 325 | 227.35 |

| | AVERAGE WEIGHT AT AGE (gms) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FISHERY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| REDUCTION | 13.1 | 58.5 | 93.8 | 118.6 | 143.0 | 160.3 | 173.8 | 187.2 | 193.1 | 222.2 |
| ROE-SN | 0.0 | 59.9 | 87.6 | 113.1 | 135.6 | 159.9 | 171.4 | 190.5 | 197.9 | 210.4 |
| ROE-GN | 0.0 | 59.4 | 112.8 | 139.3 | 153.1 | 167.2 | 175.8 | 175.3 | 180.8 | 213.0 |
| OTHER | 15.2 | 56.3 | 89.0 | 112.5 | 135.0 | 158.4 | 168.5 | 181.1 | 194.5 | 209.3 |

Appendix table 1.6. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the southern west coast Vancouver Island stock assessment region. These data are used for age-structured model analysis.

| SEASON | FISHERY | PERCENT AT AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NUMBER AGED | SAMPLE WEIGHT | CATCH (x $10^{-6}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950/51 | REDUCTION | 0.1 | 13.1 | 38.1 | 40.6 | 6.4 | 1.3 | 0.3 | 0.0 | 0.0 | 0.0 | 3843 | 551 | 1630.59 |
| 1951/52 | REDUCTION | 0.1 | 5.3 | 65.5 | 20.1 | 7.9 | 0.8 | 0.2 | 0.0 | 0.0 | 0.0 | 1686 | 593 | 1105.57 |
| 1952/53 | REDUCTION | 0.1 | 8.9 | 55.7 | 32.8 | 2.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 2777 | 1417 | 2.36 |
| 1953/54 | REDUCTION | 0.0 | 2.8 | 64.3 | 26.5 | 5.5 | 0.6 | 0.1 | 0.1 | 0.0 | 0.0 | 5730 | 2473 | 3086.25 |
| 1954/55 | REDUCTION | 0.0 | 16.8 | 59.4 | 19.7 | 3.4 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 2510 | 699 | 706.20 |
| 1955/56 | REDUCTION | 0.0 | 12.4 | 64.3 | 16.0 | 6.1 | 1.1 | 0.2 | 0.0 | 0.0 | 0.0 | 4653 | 2257 | 1931.15 |
| 1956/57 | REDUCTION | 0.0 | 2.7 | 71.9 | 24.8 | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 588 | 497 | 312.93 |
| 1957/58 | REDUCTION | 0.0 | 15.6 | 55.3 | 25.0 | 4.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 707 | 432 | 68.62 |
| 1958/59 | REDUCTION | 0.0 | 6.4 | 61.0 | 25.1 | 6.0 | 1.0 | 0.1 | 0.2 | 0.1 | 0.0 | 2066 | 1383 | 4315.70 |
| 1959/60 | REDUCTION | 0.0 | 26.9 | 48.2 | 19.7 | 4.1 | 0.6 | 0.4 | 0.2 | 0.0 | 0.0 | 539 | 189 | 1988.85 |
| 1960/61 | REDUCTION | 0.0 | 52.7 | 33.9 | 10.0 | 3.1 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 419 | 54 | 1719.68 |
| 1961/62 | REDUCTION | 0.0 | 5.1 | 78.2 | 12.1 | 3.7 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 751 | 386 | 1659.51 |
| 1962/63 | REDUCTION | 0.0 | 3.5 | 44.4 | 45.5 | 5.6 | 0.8 | 0.2 | 0.0 | 0.0 | 0.0 | 886 | 316 | 404.28 |
| 1963/64 | REDUCTION | 0.0 | 2.6 | 60.8 | 25.5 | 10.1 | 0.8 | 0.3 | 0.0 | 0.0 | 0.0 | 1134 | 1003 | 1989.83 |
| 1964/65 | REDUCTION | 0.0 | 2.3 | 34.7 | 49.3 | 9.8 | 3.5 | 0.4 | 0.0 | 0.0 | 0.0 | 775 | 344 | 1141.93 |
| 1965/66 | REDUCTION | 0.0 | 0.3 | 41.3 | 33.3 | 21.3 | 2.7 | 1.0 | 0.0 | 0.0 | 0.0 | 300 | 403 | 636.21 |
| 1966/67 | REDUCTION | 2.4 | 20.7 | 55.5 | 16.7 | 3.4 | 0.8 | 0.3 | 0.2 | 0.0 | 0.0 | 0* | 25 | 859.81 |
| 1971/72 | ROE-SN | 0.0 | 4.1 | 19.9 | 50.8 | 20.0 | 3.3 | 1.1 | 0.8 | 0.0 | 0.0 | 1222 | 843 | 319.50 |
| 1972/73 | ROE-SN | 0.0 | 0.9 | 32.3 | 24.1 | 31.0 | 10.1 | 1.3 | 0.3 | 0.1 | 0.0 | 1967 | 1330 | 678.19 |
| | ROE-GN | 0.0 | 0.0 | 7.9 | 22.9 | 51.8 | 13.5 | 2.9 | 1.0 | 0.2 | 0.0 | 624 | 526 | 63.80 |
| 1973/74 | ROE-SN | 0.0 | 12.1 | 45.1 | 25.7 | 11.0 | 5.0 | 1.0 | 0.1 | 0.0 | 0.0 | 3022 | 1434 | 341.88 |
| | ROE-GN | 0.0 | 0.0 | 26.1 | 30.7 | 26.1 | 13.6 | 3.4 | 0.0 | 0.0 | 0.0 | 176 | 30 | 207.72 |
| 1974/75 | ROE-SN | 0.0 | 0.7 | 46.5 | 21.9 | 14.2 | 9.4 | 5.7 | 1.4 | 0.2 | 0.0 | 6191 | 3025 | 901.22" |
| | ROE-GN | 0.0 | 0.0 | 3.0 | 30.5 | 37.9 | 21.2 | 7.1 | 0.4 | 0.0 | 0.0 | 269 | 145 | 407.98 |
| 1975/76 | ROE-SN | 0.0 | 0.1 | 7.6 | 45.5 | 20.8 | 14.4 | 8.3 | 2.8 | 0.5 | 0.0 | 7026 | 1218 | 1358.83 |
| | ROE-GN | 0.0 | 0.0 | 0.7 | 41.8 | 33.6 | 15.3 | 5.9 | 2.3 | 0.3 | 0.1 | 1238 | 125 | 932.28 |
| 1976/77 | ROE-SN | 0.0 | 0.5 | 11.8 | 32.1 | 37.5 | 12.5 | 4.1 | 1.5 | 0.2 | 0.0 | 6171 | 1298 | 1226.50" |
| | ROE-GN | 0.0 | 1.0 | 6.1 | 23.0 | 45.4 | 16.8 | 6.1 | 1.5 | 0.0 | 0.0 | 196 | 26 | 669.58 |
| 1977/78 | OTHER | 0.0 | 1.3 | 41.9 | 26.2 | 13.7 | 13.5 | 2.0 | 0.9 | 0.3 | 0.3 | 1727 | 416 | 183.29 |
| | ROE-SN | 0.0 | 0.5 | 35.1 | 18.7 | 18.6 | 20.8 | 4.8 | 1.3 | 0.2 | 0.1 | 5067 | 2353 | 381.15 |
| | ROE-GN | 0.0 | 0.0 | 1.2 | 5.3 | 20.1 | 49.6 | 17.3 | 5.8 | 0.5 | 0.2 | 417 | 84 | 730.95 |
| 1978/79 | ROE-SN | 0.0 | 0.5 | 9.9 | 39.2 | 18.5 | 16.4 | 11.9 | 2.6 | 0.8 | 0.2 | 2165 | 1149 | 411.88" |
| | ROE-GN | 0.0 | 0.0 | 1.0 | 25.1 | 27.2 | 26.3 | 18.0 | 2.1 | 0.4 | 0.0 | 518 | 214 | 263.70 |
| 1979/80 | ROE-SN | 0.0 | 3.5 | 45.0 | 11.4 | 18.2 | 9.2 | 8.4 | 3.5 | 0.7 | 0.1 | 2037 | 1241 | 146.54" |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 4.4 | 40.7 | 25.6 | 16.8 | 11.4 | 0.8 | 0.3 | 386 | 717 | 36.65 |
| 1980/81 | ROE-SN | 0.0 | 4.0 | 37.7 | 26.4 | 10.6 | 11.5 | 6.4 | 2.8 | 0.6 | 0.0 | 3162 | 1247 | 251.13" |
| | ROE-GN | 0.0 | 0.0 | 1.8 | 21.0 | 14.9 | 36.3 | 18.9 | 7.1 | 0.0 | 0.0 | 281 | 81 | 136.27 |
| 1981/82 | ROE-SN | 0.0 | 4.0 | 24.8 | 28.7 | 23.5 | 5.3 | 8.5 | 3.1 | 1.7 | 0.4 | 3930 | 2036 | 201.06" |
| | ROE-GN | 0.0 | 0.0 | 0.3 | 17.3 | 39.5 | 11.4 | 23.3 | 5.4 | 2.6 | 0.3 | 352 | 216 | 49.47 |
| 1982/83 | ROE-SN | 0.0 | 4.5 | 23.3 | 22.8 | 21.7 | 16.2 | 4.0 | 5.3 | 1.2 | 1.1 | 2761 | 1911 | 476.41 |
| 1983/84 | ROE-SN | 0.0 | 20.5 | 36.8 | 14.1 | 9.6 | 10.5 | 6.1 | 1.1 | 1.1 | 0.2 | 2903 | 1266 | 485.38 |
| 1984/85 | ROE-SN | 0.0 | 21.1 | 50.2 | 16.1 | 4.1 | 2.9 | 3.4 | 1.8 | 0.1 | 0.3 | 2341 | 603 | 15.98" |
| 1985/86 | ROE-SN | 0.0 | 4.2 | 48.8 | 27.2 | 10.3 | 3.9 | 2.7 | 2.1 | 0.7 | 0.1 | 3127 | 1073 | 16.49" |
| 1986/87 | ROE-SN | 0.0 | 15.1 | 16.0 | 35.7 | 19.0 | 8.1 | 2.9 | 1.6 | 1.2 | 0.4 | 4050 | 2121 | 1014.35 |
| 1987/88 | ROE-SN | 0.0 | 2.5 | 60.9 | 7.3 | 15.5 | 9.2 | 3.1 | 0.8 | 0.5 | 0.3 | 6293 | 4239 | 666.23 |
| | ROE-GN | 0.0 | 0.0 | 5.4 | 7.0 | 40.8 | 29.4 | 12.8 | 3.0 | 1.2 | 0.4 | 500 | 607 | 86.65 |
| 1988/89 | ROE-SN | 0.0 | 2.8 | 15.7 | 62.6 | 6.4 | 8.2 | 3.4 | 0.7 | 0.1 | 0.0 | 4969 | 3549 | 774.27 |
| | ROE-GN | 0.0 | 0.0 | 0.3 | 54.5 | 11.0 | 22.3 | 9.4 | 1.6 | 1.0 | 0.0 | 382 | 145 | 232.76 |
| 1989/90 | ROE-SN | 0.0 | 0.5 | 27.1 | 12.4 | 48.0 | 4.5 | 5.7 | 1.5 | 0.2 | 0.1 | 6294 | 5736 | 534.64 |
| | ROE-GN | 0.0 | 0.0 | 1.3 | 7.9 | 69.0 | 8.3 | 10.3 | 2.5 | 0.7 | 0.0 | 445 | 428 | 127.98 |

| FISHERY | AVERAGE WEIGHT AT AGE (gms) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| REDUCTION | 22.9 | 57.2 | 89.9 | 112.9 | 132.2 | 149.3 | 156.4 | 166.8 | 173.2 | 237.6 |
| ROE-SN | 21.0 | 63.7 | 94.5 | 124.6 | 149.7 | 170.2 | 184.2 | 194.5 | 204.1 | 206.3 |
| ROE-GN | 0.0 | 45.5 | 108.8 | 137.0 | 154.0 | 167.2 | 179.4 | 183.4 | 184.1 | 194.6 |
| OTHER | 22.6 | 60.5 | 92.5 | 119.6 | 141.7 | 160.4 | 171.7 | 188.6 | 197.5 | 206.3 |

Appendix table 1.7. Age compostion and catch in numbers by fishery and season and weight at age averaged over all seasons for the northern west coast Vancouver Island stock assessment region. These data are used for age-structured model analysis.

| SEASON | FISHERY | PERCENT AT AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NUMBER AGED | SAMPLE WEIGHT | CATCH (x $10^{-6}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950/51 | REDUCTION | 0.0 | 1.5 | 27.0 | 54.1 | 12.8 | 3.6 | 1.0 | 0.0 | 0.0 | 0.0 | 196 | 190 | 546.82 |
| 1951/52 | REDUCTION | 0.0 | 0.2 | 10.2 | 27.5 | 52.2 | 7.1 | 2.1 | 0.5 | 0.1 | 0.0 | 3236 | 3206 | 1263.43 |
| 1953/54 | REDUCTION | 0.0 | 0.0 | 46.2 | 44.2 | 6.6 | 2.7 | 0.3 | 0.0 | 0.0 | 0.0 | 364 | 21 | 494.70 |
| 1957/58 | REDUCTION | 0.0 | 9.1 | 38.9 | 30.0 | 9.7 | 6.8 | 4.1 | 1.0 | 0.2 | 0.0 | 483 | 80 | 4.98 |
| 1958/59 | REDUCTION | 0.0 | 1.4 | 24.4 | 30.3 | 25.3 | 7.6 | 5.3 | 4.3 | 1.2 | 0.3 | 1599 | 1014 | 3141.73 |
| 1959/60 | REDUCTION | 0.0 | 4.7 | 56.2 | 24.2 | 9.8 | 3.3 | 1.1 | 0.4 | 0.2 | 0.1 | 2338 | 2403 | 3724.70 |
| 1960/61 | REDUCTION | 0.0 | 21.4 | 42.7 | 30.6 | 5.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 248 | 57 | 1382.75 |
| 1961/62 | REDUCTION | 0.0 | 4.1 | 87.1 | 7.6 | 0.6 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 510 | 193 | 880.29 |
| 1962/63 | REDUCTION | 0.0 | 0.6 | 43.1 | 51.5 | 4.1 | 0.5 | 0.1 | 0.0 | 0.0 | 0.0 | 1372 | 609 | 1361.92 |
| 1963/64 | REDUCTION | 0.0 | 0.0 | 48.0 | 32.0 | 18.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 50 | 50 | 88.97 |
| 1964/65 | REDUCTION | 0.0 | 0.0 | 28.6 | 59.2 | 12.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 49 | 49 | 159.49 |
| 1965/66 | REDUCTION | 0.0 | 13.6 | 26.8 | 26.1 | 23.2 | 9.1 | 1.2 | 0.0 | 0.0 | 0.0 | 0* | 25 | 195.14 |
| 1966/67 | REDUCTION | 0.0 | 4.7 | 63.6 | 23.9 | 6.1 | 1.5 | 0.1 | 0.1 | 0.0 | 0.0 | 0* | 25 | 482.92 |
| 1971/72 | ROE-SN | 0.0 | 0.3 | 13.8 | 38.7 | 40.7 | 4.3 | 1.4 | 0.6 | 0.3 | 0.0 | 349 | 99 | 177.82 |
| 1972/73 | ROE-SN | 0.0 | 0.2 | 24.5 | 24.8 | 35.0 | 13.0 | 2.3 | 0.2 | 0.2 | 0.0 | 609 | 358 | 557.43 |
| 1973/74 | ROE-SN | 0.0 | 3.0 | 40.4 | 21.7 | 16.9 | 13.8 | 3.7 | 0.4 | 0.1 | 0.0 | 2398 | 2045 | 819.44 |
| 1974/75 | ROE-SN | 0.0 | 0.4 | 65.2 | 16.6 | 6.9 | 5.6 | 3.9 | 1.1 | 0.2 | 0.0 | 3925 | 2181 | 679.06 |
| 1975/76 | ROE-SN | 0.0 | 0.5 | 12.8 | 51.5 | 16.7 | 8.2 | 7.5 | 2.5 | 0.3 | 0.0 | 2204 | 492 | 259.12 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 15.8 | 38.2 | 21.1 | 18.4 | 6.6 | 0.0 | 0.0 | 76 | 76 | 115.02 |
| 1976/77 | ROE-SN | 0.0 | 0.9 | 19.5 | 20.3 | 33.9 | 11.3 | 8.9 | 3.7 | 1.6 | 0.0 | 575 | 1613 | 52.30 |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 8.6 | 39.5 | 18.5 | 19.8 | 9.9 | 3.1 | 0.6 | 162 | 92 | 174.14 |
| 1977/78 | OTHER | 0.0 | 1.3 | 49.2 | 16.0 | 13.8 | 16.2 | 2.5 | 0.6 | 0.3 | 0.0 | 630 | 273 | 74.55 |
| | ROE-SN | 0.0 | 1.7 | 69.0 | 13.3 | 6.4 | 5.8 | 2.2 | 1.5 | 0.1 | 0.1 | 896 | 650 | 78.36 |
| | ROE-GN | 0.0 | 0.0 | 1.1 | 2.7 | 21.8 | 41.0 | 23.4 | 8.5 | 1.1 | 0.5 | 188 | 65 | 204.38 |
| 1978/79 | ROE-SN | 0.0 | 1.2 | 18.4 | 65.0 | 8.9 | 3.4 | 2.8 | 0.2 | 0.1 | 0.1 | 1720 | 674 | 455.13 |
| | ROE-GN | 0.0 | 0.0 | 3.8 | 34.0 | 20.8 | 13.2 | 28.3 | 0.0 | 0.0 | 0.0 | 53 | 191 | 293.99 |
| 1979/80 | ROE-SN | 0.0 | 1.6 | 41.5 | 22.5 | 30.1 | 3.2 | 1.0 | 0.1 | 0.0 | 0.0 | 966 | 84 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 0.0 | 10.6 | 84.8 | 4.5 | 0.0 | 0.0 | 0.0 | 0.0 | 66 | 66 | 125.00 |
| 1980/81 | ROE-SN | 0.0 | 0.0 | 17.5 | 45.8 | 13.4 | 20.8 | 2.4 | 0.2 | 0.0 | 0.0 | 583 | 331 | 275.37 |
| 1981/82 | ROE-SN | 0.0 | 0.4 | 21.0 | 24.6 | 35.1 | 5.8 | 11.8 | 1.0 | 0.3 | 0.0 | 1116 | 790 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 0.8 | 8.2 | 46.0 | 11.9 | 29.7 | 3.1 | 0.2 | 0.0 | 511 | 426 | 176.17 |
| 1982/83 | ROE-SN | 0.0 | 2.5 | 17.8 | 16.2 | 23.2 | 26.8 | 7.0 | 6.3 | 0.2 | 0.0 | 444 | 195 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 0.4 | 14.2 | 23.8 | 44.8 | 6.5 | 9.8 | 0.4 | 0.2 | 571 | 159 | 176.62 |
| 1983/84 | ROE-SN | 0.0 | 42.0 | 44.9 | 4.5 | 1.1 | 2.3 | 3.4 | 0.6 | 1.1 | 0.0 | 176 | 369 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 1.7 | 6.7 | 18.0 | 32.6 | 31.9 | 5.4 | 3.4 | 0.3 | 595 | 464 | 55.40 |
| 1984/85 | ROE-SN | 0.0 | 18.2 | 65.7 | 7.5 | 2.4 | 2.3 | 2.4 | 1.2 | 0.2 | 0.0 | 654 | 215 | 1.00~ |
| 1985/86 | ROE-SN | 0.0 | 2.5 | 55.6 | 37.4 | 2.1 | 0.9 | 0.9 | 0.6 | 0.1 | 0.0 | 1024 | 64 | 1.00~ |
| 1986/87 | ROE-SN | 0.0 | 12.9 | 20.4 | 26.1 | 36.8 | 2.6 | 0.5 | 0.3 | 0.5 | 0.0 | 658 | 268 | 1.00~ |
| | ROE-GN | 0.0 | 0.0 | 1.8 | 24.5 | 61.8 | 5.5 | 2.2 | 2.9 | 0.9 | 0.4 | 550 | 408 | 144.31 |
| 1987/88 | ROE-SN | 0.0 | 3.1 | 61.6 | 9.5 | 10.8 | 13.6 | 0.9 | 0.3 | 0.2 | 0.0 | 1169 | 644 | 0.02 |
| 1988/89 | ROE-SN | 0.0 | 0.9 | 16.9 | 49.5 | 8.0 | 11.5 | 11.9 | 0.8 | 0.4 | 0.0 | 746 | 241 | 1.00~ |
| 1989/90 | ROE-SN | 0.0 | 0.6 | 28.5 | 12.7 | 39.0 | 4.8 | 8.3 | 5.3 | 0.6 | 0.2 | 543 | 489 | 1.00~ |

| FISHERY | AVERAGE WEIGHT AT AGE (gms) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| REDUCTION | 9.8 | 53.4 | 89.7 | 111.2 | 131.7 | 143.5 | 154.8 | 172.8 | 179.5 | 156.6 |
| ROE-SN | 0.0 | 62.6 | 92.1 | 121.3 | 146.3 | 167.3 | 179.4 | 187.3 | 195.6 | 207.0 |
| ROE-GN | 0.0 | 0.0 | 120.1 | 133.8 | 146.4 | 158.1 | 165.0 | 172.6 | 163.5 | 182.0 |
| OTHER | 9.8 | 59.3 | 91.5 | 117.3 | 140.3 | 158.1 | 171.3 | 183.0 | 190.9 | 192.6 |

Appendix table 2.1. Estimates of numbers at age, spawn and other parameters from age-structured model analysis for the Queen Charlotte Islands stock assessment region.

| Season | Estimated numbers at age ($x10^6$) for period one | | | | | | | | Spawn Index | Spawning Biomass (t) |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| 1950/51 | 1753 | 1064 | 216 | 143 | 0 | 0 | 0 | 60 | 172 | 5200 |
| 1951/52 | 1828 | 1080 | 548 | 100 | 63 | 0 | 0 | 27 | 122 | 4746 |
| 1952/53 | 2565 | 983 | 417 | 153 | 24 | 15 | 0 | 6 | 254 | 16952 |
| 1953/54 | 12910 | 1636 | 627 | 266 | 98 | 15 | 9 | 4 | 451 | 12957 |
| 1954/55 | 1620 | 8171 | 983 | 367 | 154 | 57 | 9 | 8 | 277 | 42881 |
| 1955/56 | 2153 | 1030 | 5183 | 622 | 232 | 97 | 36 | 10 | 372 | 6947 |
| 1956/57 | 706 | 623 | 296 | 719 | 48 | 18 | 8 | 4 | 71 | 1547 |
| 1957/58 | 929 | 77 | 171 | 36 | 40 | 3 | 1 | 1 | 41 | 2812 |
| 1958/59 | 1945 | 331 | 25 | 34 | 5 | 6 | 0 | 0 | 367 | 6415 |
| 1959/60 | 641 | 745 | 158 | 10 | 13 | 2 | 2 | 0 | 202 | 5410 |
| 1960/61 | 2109 | 409 | 475 | 101 | 7 | 8 | 1 | 2 | 423 | 9288 |
| 1961/62 | 2597 | 1324 | 253 | 290 | 61 | 4 | 5 | 2 | 241 | 10253 |
| 1962/63 | 5140 | 1464 | 644 | 107 | 115 | 24 | 2 | 3 | 213 | 12085 |
| 1963/64 | 1125 | 2775 | 646 | 231 | 35 | 37 | 8 | 1 | 181 | 3551 |
| 1964/65 | 3013 | 412 | 829 | 100 | 22 | 3 | 4 | 1 | 76 | 1740 |
| 1965/66 | 236 | 113 | 108 | 86 | 4 | 1 | 0 | 0 | 145 | 2601 |
| 1966/67 | 226 | 84 | 52 | 42 | 31 | 1 | 0 | 0 | 33 | 2616 |
| 1967/68 | 303 | 137 | 51 | 31 | 25 | 18 | 1 | 0 | 42 | 3580 |
| 1968/69 | 381 | 191 | 86 | 32 | 19 | 15 | 11 | 1 | 59 | 4350 |
| 1969/70 | 1139 | 243 | 122 | 55 | 20 | 12 | 10 | 8 | 237 | 7944 |
| 1970/71 | 2615 | 726 | 155 | 78 | 35 | 13 | 8 | 11 | 479 | 15296 |
| 1971/72 | 2313 | 1667 | 463 | 99 | 50 | 22 | 8 | 12 | 467 | 19016 |
| 1972/73 | 6330 | 1389 | 950 | 251 | 52 | 26 | 12 | 11 | 561 | 24093 |
| 1973/74 | 5146 | 3827 | 756 | 479 | 122 | 25 | 13 | 11 | 714 | 37276 |
| 1974/75 | 4607 | 3137 | 2225 | 420 | 261 | 66 | 14 | 13 | 571 | 45572 |
| 1975/76 | 1247 | 2795 | 1822 | 1236 | 229 | 142 | 36 | 15 | 912 | 37315 |
| 1976/77 | 1598 | 772 | 1507 | 887 | 564 | 104 | 65 | 23 | 1056 | 30495 |
| 1977/78 | 1911 | 865 | 405 | 716 | 404 | 257 | 47 | 40 | 872 | 19365 |
| 1978/79 | 758 | 1059 | 442 | 175 | 271 | 153 | 97 | 33 | 652 | 11459 |
| 1979/80 | 16648 | 466 | 533 | 180 | 59 | 91 | 51 | 44 | 1059 | 40025 |
| 1980/81 | 1215 | 10430 | 282 | 299 | 93 | 30 | 47 | 49 | 1158 | 51693 |
| 1981/82 | 522 | 763 | 6287 | 160 | 160 | 50 | 16 | 51 | 992 | 52489 |
| 1982/83 | 535 | 325 | 471 | 3776 | 94 | 94 | 29 | 39 | 805 | 42882 |
| 1983/84 | 3615 | 325 | 194 | 272 | 2129 | 53 | 53 | 39 | 837 | 34456 |
| 1984/85 | 1617 | 2190 | 193 | 111 | 152 | 1187 | 30 | 51 | 773 | 28295 |
| 1985/86 | 378 | 985 | 1268 | 104 | 57 | 77 | 605 | 41 | 319 | 25106 |
| 1986/87 | 668 | 237 | 589 | 722 | 57 | 31 | 42 | 353 | 715 | 19643 |
| 1987/88 | 5240 | 412 | 142 | 344 | 417 | 33 | 18 | 229 | 570 | 24753 |
| 1988/89 | 1729 | 3340 | 263 | 90 | 219 | 266 | 21 | 157 | 1219 | 29948 |
| 1989/90 | 820 | 1081 | 2066 | 160 | 55 | 133 | 161 | 108 | 860 | 23918 |

Estimated availability at age ( $\lambda_i$ )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.43 | 0.62 | 0.89 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Estimated relative selectivity at age for gillnet gear

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.01 | 0.21 | 0.58 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

The coefficients for the Ricker stock-recruit curve are: alpha = 1.025, beta =0.6035E-04

The estimated spawn index-escapement conversion factor is 0.263E-01

Appendix table 2.2. Estimates of numbers at age, spawn and other parameters from age-structured model analysis for the Prince Rupert District stock assessment region.

| Season | Estimated numbers at age ($x10^{-6}$) for period one 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Spawn Index | Spawning Biomass (t) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1950/51 | 6344 | 8044 | 1111 | 407 | 33 | 177 | 1 | 5 | 1058 | 12295 |
| 1951/52 | 3310 | 3385 | 3067 | 298 | 70 | 6 | 30 | 1 | 641 | 4894 |
| 1952/53 | 3424 | 1836 | 1109 | 585 | 22 | 5 | 0 | 2 | 961 | 26799 |
| 1953/54 | 7900 | 2131 | 1137 | 678 | 354 | 14 | 3 | 2 | 835 | 8560 |
| 1954/55 | 2319 | 4467 | 814 | 306 | 117 | 61 | 2 | 1 | 869 | 12169 |
| 1955/56 | 6199 | 1414 | 1992 | 294 | 89 | 34 | 18 | 1 | 951 | 36802 |
| 1956/57 | 1996 | 3406 | 811 | 1086 | 153 | 46 | 18 | 10 | 1279 | 13223 |
| 1957/58 | 3641 | 879 | 1423 | 260 | 259 | 37 | 11 | 7 | 507 | 30127 |
| 1958/59 | 7585 | 2190 | 524 | 822 | 146 | 145 | 21 | 10 | 1285 | 35165 |
| 1959/60 | 2513 | 4381 | 1251 | 284 | 425 | 75 | 75 | 16 | 1087 | 31256 |
| 1960/61 | 12742 | 1483 | 2303 | 596 | 123 | 184 | 33 | 39 | 990 | 30263 |
| 1961/62 | 6395 | 5984 | 673 | 857 | 181 | 37 | 56 | 22 | 1530 | 32100 |
| 1962/63 | 3684 | 3497 | 2977 | 293 | 329 | 69 | 14 | 30 | 783 | 24844 |
| 1963/64 | 9598 | 1865 | 1543 | 1055 | 82 | 92 | 19 | 12 | 1185 | 38329 |
| 1964/65 | 1459 | 4356 | 942 | 689 | 419 | 33 | 37 | 13 | 501 | 10841 |
| 1965/66 | 536 | 551 | 1635 | 244 | 111 | 68 | 5 | 8 | 332 | 6965 |
| 1966/67 | 886 | 294 | 234 | 539 | 61 | 28 | 17 | 3 | 222 | 7149 |
| 1967/68 | 843 | 312 | 131 | 85 | 156 | 18 | 8 | 6 | 433 | 9604 |
| 1968/69 | 1425 | 451 | 181 | 73 | 45 | 84 | 9 | 7 | 74 | 6643 |
| 1969/70 | 7293 | 895 | 275 | 108 | 43 | 27 | 49 | 10 | 886 | 25085 |
| 1970/71 | 5218 | 4561 | 556 | 169 | 66 | 26 | 16 | 36 | 716 | 32373 |
| 1971/72 | 2509 | 3191 | 2779 | 332 | 99 | 39 | 15 | 31 | 1000 | 42553 |
| 1972/73 | 4787 | 1585 | 1933 | 1644 | 193 | 57 | 22 | 27 | 730 | 57723 |
| 1973/74 | 4281 | 3012 | 995 | 1204 | 1018 | 119 | 36 | 30 | 670 | 51659 |
| 1974/75 | 2084 | 2701 | 1865 | 596 | 695 | 595 | 70 | 39 | 814 | 46556 |
| 1975/76 | 1357 | 1317 | 1688 | 1156 | 367 | 428 | 366 | 66 | 1158 | 46881 |
| 1976/77 | 2277 | 857 | 803 | 1006 | 673 | 214 | 250 | 252 | 1438 | 35489 |
| 1977/78 | 1377 | 1378 | 499 | 437 | 510 | 346 | 110 | 258 | 750 | 24289 |
| 1978/79 | 1475 | 843 | 793 | 254 | 192 | 234 | 159 | 169 | 814 | 21177 |
| 1979/80 | 12631 | 914 | 501 | 440 | 130 | 101 | 123 | 172 | 1529 | 38158 |
| 1980/81 | 2433 | 7899 | 561 | 293 | 242 | 73 | 57 | 166 | 1175 | 40598 |
| 1981/82 | 2635 | 1532 | 4881 | 339 | 173 | 143 | 43 | 132 | 1305 | 44721 |
| 1982/83 | 3168 | 1661 | 961 | 3040 | 210 | 107 | 89 | 108 | 1826 | 51259 |
| 1983/84 | 9745 | 2020 | 1059 | 613 | 1938 | 134 | 68 | 126 | 2032 | 47922 |
| 1984/85 | 1983 | 6150 | 1256 | 635 | 352 | 1130 | 78 | 113 | 2056 | 46375 |
| 1985/86 | 1912 | 1241 | 3750 | 715 | 333 | 190 | 609 | 103 | 2084 | 48995 |
| 1986/87 | 7830 | 1179 | 753 | 2106 | 365 | 175 | 100 | 376 | 2555 | 48245 |
| 1987/88 | 7437 | 4919 | 728 | 436 | 1123 | 201 | 96 | 261 | 1865 | 45997 |
| 1988/89 | 5161 | 4633 | 2977 | 402 | 214 | 575 | 103 | 183 | 1513 | 48810 |
| 1989/90 | 3785 | 3214 | 2807 | 1651 | 199 | 110 | 297 | 148 | 1742 | 56708 |

Estimated availability at age ( $\lambda_i$ )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.38 | 0.55 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Estimated relative selectivity at age for gillnet gear

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.01 | 0.14 | 0.60 | 1.00 | 0.78 | 0.78 | 0.78 | 0.78 |

The coefficients for the Ricker stock-recruit curve are: alpha = 1.258, beta =0.4407E-04

The estimated spawn index-escapement conversion factor is 0.354E-01

Appendix table 2.3. Estimates of numbers at age, spawn and other parameters from age-structured model analysis for the Central Coast stock assessment region.

| | Estimated numbers at age ($x10^{-6}$) for period one | | | | | | | | Spawn | Spawning |
|---|---|---|---|---|---|---|---|---|---|---|
| Season | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Index | Biomass (t) |
| 1950/51 | 3893 | 4764 | 840 | 337 | 0 | 0 | 14 | 72 | 834 | 14642 |
| 1951/52 | 1478 | 1646 | 1566 | 187 | 68 | 0 | 0 | 17 | 343 | 4068 |
| 1952/53 | 2332 | 510 | 413 | 186 | 17 | 6 | 0 | 2 | 629 | 9737 |
| 1953/54 | 13637 | 1470 | 311 | 249 | 111 | 10 | 4 | 1 | 487 | 8767 |
| 1954/55 | 1440 | 6827 | 475 | 67 | 48 | 22 | 2 | 1 | 553 | 28267 |
| 1955/56 | 1511 | 849 | 3595 | 232 | 32 | 23 | 10 | 1 | 394 | 8597 |
| 1956/57 | 3072 | 533 | 237 | 561 | 30 | 4 | 3 | 2 | 213 | 3763 |
| 1957/58 | 5582 | 960 | 142 | 33 | 64 | 3 | 0 | 1 | 367 | 16649 |
| 1958/59 | 6612 | 2877 | 473 | 63 | 14 | 28 | 1 | 0 | 364 | 9284 |
| 1959/60 | 1612 | 3002 | 935 | 103 | 12 | 3 | 5 | 0 | 681 | 30874 |
| 1960/61 | 2782 | 929 | 1784 | 542 | 59 | 7 | 2 | 3 | 314 | 10059 |
| 1961/62 | 8282 | 935 | 299 | 380 | 103 | 11 | 1 | 1 | 860 | 17195 |
| 1962/63 | 4035 | 4477 | 425 | 117 | 144 | 39 | 4 | 1 | 394 | 5498 |
| 1963/64 | 3825 | 1614 | 1139 | 52 | 11 | 14 | 4 | 0 | 430 | 7309 |
| 1964/65 | 1736 | 1198 | 462 | 189 | 7 | 2 | 2 | 1 | 171 | 7440 |
| 1965/66 | 1941 | 738 | 425 | 119 | 45 | 2 | 0 | 1 | 158 | 3718 |
| 1966/67 | 1516 | 286 | 173 | 41 | 8 | 3 | 0 | 0 | 322 | 6298 |
| 1967/68 | 630 | 289 | 92 | 37 | 8 | 2 | 1 | 0 | 376 | 7525 |
| 1968/69 | 693 | 345 | 166 | 51 | 20 | 4 | 1 | 0 | 172 | 6096 |
| 1969/70 | 3109 | 440 | 218 | 104 | 32 | 13 | 3 | 1 | 637 | 13848 |
| 1970/71 | 2581 | 1972 | 277 | 136 | 65 | 20 | 8 | 2 | 341 | 23085 |
| 1971/72 | 3308 | 1552 | 1157 | 158 | 77 | 37 | 11 | 6 | 435 | 19106 |
| 1972/73 | 5513 | 1893 | 765 | 510 | 67 | 33 | 16 | 7 | 964 | 35442 |
| 1973/74 | 3829 | 3249 | 1064 | 395 | 252 | 33 | 16 | 11 | 893 | 31685 |
| 1974/75 | 5135 | 2390 | 1850 | 508 | 164 | 103 | 14 | 11 | 795 | 41009 |
| 1975/76 | 2589 | 3177 | 1395 | 939 | 231 | 74 | 46 | 11 | 1426 | 33366 |
| 1976/77 | 1654 | 1592 | 1765 | 658 | 394 | 96 | 30 | 24 | 1223 | 32781 |
| 1977/78 | 2027 | 991 | 905 | 851 | 280 | 165 | 40 | 23 | 732 | 19670 |
| 1978/79 | 1488 | 1195 | 521 | 343 | 248 | 79 | 46 | 18 | 694 | 30252 |
| 1979/80 | 13948 | 949 | 762 | 332 | 218 | 158 | 50 | 41 | 1159 | 51933 |
| 1980/81 | 2488 | 8890 | 602 | 476 | 205 | 135 | 97 | 56 | 1320 | 59045 |
| 1981/82 | 2455 | 1581 | 5569 | 361 | 275 | 118 | 77 | 88 | 1302 | 62840 |
| 1982/83 | 1057 | 1534 | 970 | 3230 | 201 | 152 | 65 | 91 | 1605 | 47137 |
| 1983/84 | 877 | 662 | 939 | 564 | 1811 | 112 | 85 | 87 | 1075 | 30302 |
| 1984/85 | 3290 | 539 | 386 | 504 | 287 | 913 | 56 | 87 | 1155 | 31474 |
| 1985/86 | 1335 | 2013 | 319 | 213 | 265 | 149 | 476 | 75 | 1262 | 28414 |
| 1986/87 | 2234 | 824 | 1208 | 182 | 118 | 146 | 82 | 303 | 1160 | 27208 |
| 1987/88 | 12303 | 1381 | 490 | 684 | 100 | 65 | 80 | 212 | 1871 | 50573 |
| 1988/89 | 685 | 7612 | 834 | 283 | 386 | 56 | 36 | 164 | 1782 | 45173 |
| 1989/90 | 634 | 409 | 4354 | 434 | 139 | 188 | 28 | 98 | 1786 | 38848 |

Estimated availability at age ( $\lambda_i$ )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.50 | 0.71 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Estimated relative selectivity at age for gillnet gear

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.02 | 0.20 | 0.61 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 |

The coefficients for the Ricker stock-recruit curve are: alpha = 1.454, beta =0.5561E-04

The estimated spawn index-escapement conversion factor is 0.358E-01

Appendix table 2.4. Estimates of numbers at age, spawn and other parameters from age-structured model analysis for the northern Strait of Georgia stock assessment region.

| Season | Estimated numbers at age ($x10^6$) for period one | | | | | | | | Spawn Index | Spawning Biomass (t) |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | |
| 1950/51 | 2879 | 1375 | 326 | 65 | 0 | 0 | 0 | 27 | 2795 | 9496 |
| 1951/52 | 3458 | 1221 | 380 | 86 | 17 | 0 | 0 | 7 | 2905 | 15256 |
| 1952/53 | 3386 | 1451 | 420 | 127 | 29 | 6 | 0 | 2 | 3259 | 24224 |
| 1953/54 | 7638 | 1947 | 812 | 234 | 71 | 16 | 3 | 1 | 1850 | 15076 |
| 1954/55 | 4362 | 4362 | 643 | 260 | 75 | 23 | 5 | 1 | 2493 | 34959 |
| 1955/56 | 1775 | 1898 | 1788 | 259 | 104 | 30 | 9 | 3 | 1235 | 15953 |
| 1956/57 | 1608 | 816 | 556 | 502 | 73 | 29 | 8 | 3 | 1381 | 8003 |
| 1957/58 | 2442 | 509 | 190 | 122 | 110 | 16 | 6 | 3 | 735 | 5400 |
| 1958/59 | 6646 | 1257 | 150 | 54 | 34 | 31 | 5 | 3 | 2059 | 13416 |
| 1959/60 | 3175 | 2312 | 294 | 33 | 12 | 8 | 7 | 2 | 2044 | 16285 |
| 1960/61 | 1973 | 1301 | 746 | 92 | 10 | 4 | 2 | 3 | 1558 | 10295 |
| 1961/62 | 4734 | 929 | 400 | 221 | 27 | 3 | 1 | 1 | 1450 | 12789 |
| 1962/63 | 4745 | 1384 | 224 | 91 | 50 | 6 | 1 | 1 | 1198 | 6312 |
| 1963/64 | 4994 | 1430 | 207 | 30 | 12 | 7 | 1 | 0 | 1354 | 7840 |
| 1964/65 | 2588 | 1396 | 224 | 29 | 4 | 2 | 1 | 0 | 1439 | 11094 |
| 1965/66 | 1234 | 585 | 324 | 49 | 6 | 1 | 0 | 0 | 267 | 1714 |
| 1966/67 | 1277 | 270 | 48 | 21 | 3 | 0 | 0 | 0 | 498 | 1873 |
| 1967/68 | 307 | 127 | 32 | 5 | 2 | 0 | 0 | 0 | 556 | 3131 |
| 1968/69 | 427 | 152 | 63 | 16 | 2 | 1 | 0 | 0 | 837 | 5306 |
| 1969/70 | 1477 | 264 | 91 | 38 | 9 | 1 | 1 | 0 | 2444 | 15772 |
| 1970/71 | 1565 | 918 | 164 | 57 | 23 | 6 | 1 | 0 | 2350 | 17806 |
| 1971/72 | 1246 | 971 | 562 | 101 | 35 | 14 | 4 | 1 | 1579 | 10919 |
| 1972/73 | 1824 | 624 | 391 | 221 | 40 | 14 | 6 | 2 | 1375 | 9811 |
| 1973/74 | 2789 | 1051 | 269 | 144 | 72 | 12 | 4 | 2 | 2840 | 16090 |
| 1974/75 | 3798 | 1770 | 595 | 119 | 51 | 24 | 4 | 2 | 3808 | 34331 |
| 1975/76 | 2573 | 2342 | 996 | 271 | 44 | 18 | 9 | 2 | 3745 | 26586 |
| 1976/77 | 4444 | 1609 | 1283 | 436 | 96 | 15 | 6 | 4 | 5625 | 39688 |
| 1977/78 | 3571 | 2606 | 851 | 547 | 152 | 32 | 5 | 3 | 4586 | 31367 |
| 1978/79 | 1697 | 2048 | 1285 | 342 | 182 | 49 | 10 | 3 | 4546 | 29235 |
| 1979/80 | 2980 | 1055 | 1138 | 586 | 129 | 67 | 18 | 5 | 4473 | 32582 |
| 1980/81 | 2246 | 1842 | 625 | 618 | 293 | 64 | 33 | 11 | 3017 | 33660 |
| 1981/82 | 2018 | 1342 | 1041 | 309 | 269 | 125 | 27 | 19 | 4949 | 27570 |
| 1982/83 | 1870 | 1276 | 791 | 526 | 135 | 114 | 53 | 19 | 2946 | 17363 |
| 1983/84 | 1360 | 955 | 524 | 219 | 101 | 24 | 20 | 13 | 2202 | 13200 |
| 1984/85 | 2040 | 704 | 406 | 139 | 37 | 16 | 4 | 5 | 1970 | 16556 |
| 1985/86 | 2993 | 1150 | 334 | 135 | 33 | 8 | 4 | 2 | 4074 | 27064 |
| 1986/87 | 1788 | 1893 | 726 | 211 | 85 | 21 | 5 | 3 | 3771 | 24669 |
| 1987/88 | 5182 | 1033 | 1032 | 358 | 95 | 38 | 9 | 4 | 3299 | 35089 |
| 1988/89 | 1761 | 3193 | 566 | 445 | 123 | 31 | 12 | 4 | 5424 | 30811 |
| 1989/90 | 6997 | 1094 | 1796 | 262 | 170 | 46 | 12 | 6 | 4584 | 49585 |

Estimated availability at age ( $\lambda_i$ )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.71 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Estimated relative selectivity at age for gillnet gear

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.02 | 0.19 | 0.57 | 0.93 | 1.00 | 1.00 | 1.00 | 1.00 |

The coefficients for the Ricker stock-recruit curve are: alpha = 1.224, beta =0.6082E-04

The estimated spawn index-escapement conversion factor is 0.144

Appendix table 2.5. Estimates of numbers at age, spawn and other parameters from age-structured model analysis for the southern Strait of Georgia stock assessment region.

| | Estimated numbers at age ($x10^6$) for period one | | | | | | | | Spawn | Spawning |
|---|---|---|---|---|---|---|---|---|---|---|
| Season | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Index | Biomass (t) |
| 1950/51 | 3595 | 1121 | 230 | 46 | 0 | 0 | 1 | 7 | 285 | 8490 |
| 1951/52 | 3452 | 972 | 227 | 44 | 9 | 0 | 0 | 2 | 685 | 4299 |
| 1952/53 | 4611 | 924 | 122 | 26 | 5 | 1 | 0 | 0 | 1735 | 15295 |
| 1953/54 | 7653 | 2685 | 491 | 64 | 14 | 3 | 1 | 0 | 1774 | 13258 |
| 1954/55 | 5855 | 2786 | 500 | 86 | 11 | 2 | 0 | 0 | 1380 | 20146 |
| 1955/56 | 4723 | 1998 | 711 | 123 | 21 | 3 | 1 | 0 | 890 | 8290 |
| 1956/57 | 4247 | 1154 | 282 | 92 | 16 | 3 | 0 | 0 | 409 | 4291 |
| 1957/58 | 2085 | 542 | 113 | 24 | 8 | 1 | 0 | 0 | 895 | 5772 |
| 1958/59 | 5372 | 652 | 141 | 28 | 6 | 2 | 0 | 0 | 1074 | 10763 |
| 1959/60 | 5034 | 2470 | 201 | 42 | 9 | 2 | 1 | 0 | 504 | 10378 |
| 1960/61 | 2513 | 1320 | 398 | 30 | 6 | 1 | 0 | 0 | 602 | 6453 |
| 1961/62 | 5567 | 829 | 206 | 57 | 4 | 1 | 0 | 0 | 324 | 5090 |
| 1962/63 | 4918 | 1521 | 98 | 22 | 6 | 0 | 0 | 0 | 489 | 5115 |
| 1963/64 | 3410 | 1605 | 182 | 10 | 2 | 1 | 0 | 0 | 513 | 3736 |
| 1964/65 | 2053 | 610 | 139 | 13 | 1 | 0 | 0 | 0 | 151 | 2329 |
| 1965/66 | 1304 | 483 | 60 | 12 | 1 | 0 | 0 | 0 | 193 | 1894 |
| 1966/67 | 1171 | 475 | 58 | 6 | 1 | 0 | 0 | 0 | 138 | 1526 |
| 1967/68 | 130 | 67 | 34 | 3 | 0 | 0 | 0 | 0 | 230 | 1516 |
| 1968/69 | 144 | 42 | 22 | 11 | 1 | 0 | 0 | 0 | 346 | 2191 |
| 1969/70 | 437 | 78 | 23 | 12 | 6 | 1 | 0 | 0 | 576 | 4470 |
| 1970/71 | 551 | 262 | 47 | 14 | 7 | 4 | 0 | 0 | 491 | 3761 |
| 1971/72 | 450 | 334 | 145 | 26 | 8 | 4 | 2 | 0 | 465 | 4815 |
| 1972/73 | 590 | 235 | 155 | 64 | 11 | 3 | 2 | 1 | 455 | 6577 |
| 1973/74 | 1000 | 362 | 135 | 78 | 29 | 5 | 2 | 1 | 699 | 11485 |
| 1974/75 | 1365 | 619 | 217 | 75 | 41 | 16 | 3 | 2 | 704 | 13226 |
| 1975/76 | 995 | 865 | 370 | 116 | 37 | 22 | 8 | 2 | 541 | 9583 |
| 1976/77 | 2033 | 591 | 444 | 174 | 51 | 17 | 10 | 5 | 315 | 11825 |
| 1977/78 | 1548 | 1114 | 281 | 197 | 73 | 22 | 8 | 7 | 696 | 10638 |
| 1978/79 | 728 | 766 | 437 | 100 | 65 | 26 | 8 | 5 | 1492 | 4971 |
| 1979/80 | 809 | 333 | 199 | 110 | 25 | 16 | 6 | 3 | 746 | 7817 |
| 1980/81 | 737 | 476 | 191 | 114 | 63 | 14 | 9 | 6 | 551 | 6290 |
| 1981/82 | 540 | 366 | 201 | 80 | 48 | 26 | 6 | 6 | 206 | 3353 |
| 1982/83 | 196 | 134 | 88 | 46 | 18 | 11 | 6 | 3 | 419 | 2352 |
| 1983/84 | 309 | 112 | 66 | 43 | 23 | 9 | 5 | 4 | 466 | 2884 |
| 1984/85 | 445 | 171 | 54 | 32 | 21 | 11 | 4 | 5 | 465 | 5168 |
| 1985/86 | 785 | 260 | 98 | 31 | 18 | 12 | 6 | 5 | 476 | 9087 |
| 1986/87 | 433 | 488 | 162 | 61 | 19 | 11 | 7 | 7 | 639 | 6291 |
| 1987/88 | 1300 | 259 | 195 | 30 | 5 | 3 | 2 | 2 | 425 | 9380 |
| 1988/89 | 394 | 795 | 157 | 118 | 18 | 3 | 2 | 3 | 630 | 10163 |
| 1989/90 | 2377 | 236 | 459 | 90 | 68 | 10 | 2 | 3 | 944 | 15768 |

Estimated availability at age ( $\lambda_i$ )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.73 | 0.98 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Estimated relative selectivity at age for gillnet gear

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.03 | 0.24 | 0.63 | 1.00 | 0.68 | 0.68 | 0.68 | 0.68 |

The coefficients for the Ricker stock-recruit curve are: alpha = 0.789, beta =0.4853E-04

The estimated spawn index-escapement conversion factor is 0.880E-01

Appendix table 2.6. Estimates of numbers at age, spawn and other parameters from age-structured model analysis for the southern west coast Vancouver Island stock assessment region.

| | Estimated numbers at age ($x10^{-6}$) for period one | | | | | | | | Spawn | Spawning |
|---|---|---|---|---|---|---|---|---|---|---|
| Season | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Index | Biomass (t) |
| 1950/51 | 1234 | 992 | 147 | 30 | 0 | 0 | 0 | 7 | 475 | 3312 |
| 1951/52 | 1650 | 304 | 169 | 21 | 4 | 0 | 0 | 1 | 387 | 2153 |
| 1952/53 | 1841 | 479 | 49 | 22 | 3 | 1 | 0 | 0 | 660 | 8158 |
| 1953/54 | 3158 | 1173 | 305 | 31 | 14 | 2 | 0 | 0 | 453 | 3343 |
| 1954/55 | 1297 | 455 | 133 | 25 | 3 | 1 | 0 | 0 | 602 | 7664 |
| 1955/56 | 2169 | 505 | 184 | 52 | 10 | 1 | 0 | 0 | 597 | 4119 |
| 1956/57 | 1437 | 405 | 90 | 27 | 8 | 1 | 0 | 0 | 424 | 8326 |
| 1957/58 | 2695 | 740 | 210 | 46 | 14 | 4 | 1 | 0 | 857 | 15773 |
| 1958/59 | 4188 | 1689 | 461 | 130 | 28 | 9 | 2 | 1 | 387 | 7456 |
| 1959/60 | 1712 | 653 | 267 | 59 | 17 | 4 | 1 | 0 | 449 | 7184 |
| 1960/61 | 1302 | 374 | 158 | 58 | 13 | 4 | 1 | 0 | 396 | 7443 |
| 1961/62 | 2828 | 375 | 105 | 41 | 15 | 3 | 1 | 0 | 671 | 7891 |
| 1962/63 | 1752 | 797 | 103 | 27 | 10 | 4 | 1 | 0 | 371 | 7639 |
| 1963/64 | 3240 | 979 | 368 | 47 | 12 | 5 | 2 | 1 | 915 | 8923 |
| 1964/65 | 1232 | 1138 | 252 | 86 | 11 | 3 | 1 | 1 | 652 | 6842 |
| 1965/66 | 750 | 478 | 305 | 62 | 21 | 3 | 1 | 0 | 239 | 5243 |
| 1966/67 | 970 | 278 | 146 | 87 | 18 | 6 | 1 | 0 | 117 | 3216 |
| 1967/68 | 400 | 321 | 60 | 28 | 16 | 3 | 1 | 0 | 364 | 6269 |
| 1968/69 | 582 | 255 | 205 | 38 | 18 | 10 | 2 | 1 | 429 | 9293 |
| 1969/70 | 2388 | 371 | 163 | 130 | 24 | 11 | 7 | 2 | 959 | 21966 |
| 1970/71 | 5389 | 1523 | 237 | 104 | 83 | 15 | 7 | 5 | 1256 | 50388 |
| 1971/72 | 4294 | 3436 | 971 | 151 | 66 | 53 | 10 | 8 | 1107 | 45976 |
| 1972/73 | 5876 | 2677 | 2019 | 567 | 88 | 39 | 31 | 10 | 471 | 59562 |
| 1973/74 | 5892 | 3522 | 1485 | 1090 | 302 | 47 | 21 | 22 | 678 | 87586 |
| 1974/75 | 10466 | 3605 | 2117 | 853 | 603 | 169 | 26 | 24 | 1229 | 92704 |
| 1975/76 | 4518 | 6256 | 1997 | 1075 | 404 | 294 | 83 | 25 | 1426 | 60687 |
| 1976/77 | 2461 | 2778 | 2971 | 768 | 350 | 141 | 102 | 37 | 1558 | 44596 |
| 1977/78 | 2710 | 1428 | 1290 | 1153 | 260 | 125 | 50 | 50 | 1355 | 33988 |
| 1978/79 | 842 | 1525 | 720 | 513 | 378 | 92 | 44 | 36 | 1291 | 22042 |
| 1979/80 | 2035 | 496 | 763 | 313 | 200 | 154 | 38 | 33 | 1264 | 24858 |
| 1980/81 | 1664 | 1234 | 295 | 443 | 179 | 115 | 89 | 40 | 1272 | 24487 |
| 1981/82 | 1042 | 964 | 686 | 150 | 210 | 87 | 56 | 63 | 821 | 19802 |
| 1982/83 | 912 | 615 | 546 | 374 | 80 | 113 | 47 | 64 | 534 | 14589 |
| 1983/84 | 1577 | 473 | 284 | 247 | 169 | 36 | 51 | 50 | 799 | 17050 |
| 1984/85 | 2309 | 831 | 231 | 136 | 118 | 81 | 17 | 48 | 844 | 33522 |
| 1985/86 | 2916 | 1464 | 527 | 147 | 87 | 75 | 51 | 42 | 944 | 38046 |
| 1986/87 | 1086 | 1851 | 929 | 334 | 93 | 55 | 48 | 59 | 1138 | 27041 |
| 1987/88 | 5796 | 536 | 822 | 401 | 144 | 40 | 24 | 46 | 1617 | 32958 |
| 1988/89 | 846 | 3295 | 273 | 390 | 182 | 67 | 19 | 32 | 1365 | 27557 |
| 1989/90 | 1176 | 418 | 1522 | 108 | 137 | 67 | 25 | 19 | 1189 | 18552 |

Estimated availability at age ( $\lambda_i$ )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.72 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Estimated relative selectivity at age for gillnet gear

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.02 | 0.23 | 0.64 | 1.00 | 0.85 | 0.85 | 0.85 | 0.85 |

The coefficients for the Ricker stock-recruit curve are: alpha = 0.787, beta =0.3345E-04

The estimated spawn index-escapement conversion factor is 0.471E-01

Appendix table 2.7. Estimates of numbers at age, spawn and other parameters from age-structured model analysis for the northern west coast Vancouver Island stock assessment region.

| | Estimated numbers at age ($x10^{-6}$) for period one | | | | | | | | Spawn | Spawning |
|---|---|---|---|---|---|---|---|---|---|---|
| Season | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Index | Biomass (t) |
| 1950/51 | 1294 | 2211 | 320 | 94 | 0 | 0 | 0 | 26 | 546 | 17778 |
| 1951/52 | 632 | 712 | 1161 | 163 | 47 | 0 | 0 | 13 | 232 | 6109 |
| 1952/53 | 2187 | 306 | 193 | 248 | 34 | 10 | 0 | 3 | 614 | 14636 |
| 1953/54 | 1229 | 1395 | 195 | 123 | 158 | 22 | 6 | 2 | 483 | 14504 |
| 1954/55 | 1157 | 622 | 731 | 99 | 62 | 80 | 11 | 4 | 350 | 19068 |
| 1955/56 | 1286 | 738 | 397 | 466 | 63 | 40 | 51 | 10 | 1063 | 20057 |
| 1956/57 | 2846 | 820 | 470 | 253 | 297 | 40 | 25 | 39 | 1617 | 30213 |
| 1957/58 | 2902 | 1814 | 523 | 300 | 161 | 190 | 26 | 41 | 545 | 28167 |
| 1958/59 | 2911 | 1849 | 1156 | 333 | 191 | 103 | 121 | 42 | 492 | 7188 |
| 1959/60 | 2917 | 1281 | 402 | 176 | 50 | 29 | 15 | 24 | 80 | 2433 |
| 1960/61 | 1204 | 349 | 173 | 23 | 9 | 3 | 2 | 2 | 185 | 3370 |
| 1961/62 | 2797 | 215 | 81 | 29 | 4 | 2 | 0 | 1 | 569 | 12196 |
| 1962/63 | 1279 | 1191 | 96 | 34 | 12 | 2 | 1 | 0 | 112 | 2998 |
| 1963/64 | 1036 | 380 | 248 | 14 | 5 | 2 | 0 | 0 | 540 | 9137 |
| 1964/65 | 519 | 621 | 226 | 146 | 8 | 3 | 1 | 0 | 536 | 9461 |
| 1965/66 | 489 | 291 | 346 | 123 | 79 | 4 | 2 | 1 | 239 | 8393 |
| 1966/67 | 753 | 282 | 152 | 175 | 62 | 40 | 2 | 1 | 329 | 8030 |
| 1967/68 | 289 | 294 | 120 | 59 | 68 | 24 | 16 | 1 | 240 | 7287 |
| 1968/69 | 299 | 185 | 187 | 76 | 38 | 43 | 15 | 11 | 261 | 7839 |
| 1969/70 | 1323 | 190 | 118 | 119 | 49 | 24 | 28 | 17 | 468 | 13708 |
| 1970/71 | 2583 | 844 | 121 | 75 | 76 | 31 | 15 | 28 | 430 | 25085 |
| 1971/72 | 1849 | 1647 | 538 | 77 | 48 | 49 | 20 | 28 | 822 | 20694 |
| 1972/73 | 1542 | 1155 | 952 | 306 | 44 | 27 | 28 | 27 | 442 | 20221 |
| 1973/74 | 1787 | 852 | 561 | 440 | 141 | 20 | 13 | 25 | 241 | 16824 |
| 1974/75 | 2587 | 819 | 372 | 227 | 178 | 57 | 8 | 15 | 434 | 22646 |
| 1975/76 | 700 | 1242 | 411 | 179 | 109 | 85 | 27 | 11 | 394 | 13501 |
| 1976/77 | 745 | 414 | 642 | 186 | 75 | 42 | 33 | 15 | 443 | 10537 |
| 1977/78 | 2879 | 464 | 236 | 309 | 79 | 27 | 15 | 17 | 479 | 14359 |
| 1978/79 | 648 | 1742 | 251 | 98 | 106 | 22 | 7 | 9 | 825 | 8921 |
| 1979/80 | 1447 | 321 | 698 | 58 | 16 | 11 | 2 | 2 | 587 | 10630 |
| 1980/81 | 607 | 920 | 191 | 353 | 26 | 6 | 4 | 2 | 508 | 9019 |
| 1981/82 | 234 | 339 | 455 | 91 | 167 | 12 | 3 | 3 | 544 | 6758 |
| 1982/83 | 131 | 148 | 197 | 213 | 36 | 55 | 4 | 2 | 403 | 3765 |
| 1983/84 | 377 | 82 | 81 | 75 | 61 | 7 | 11 | 1 | 291 | 6289 |
| 1984/85 | 1828 | 239 | 49 | 39 | 32 | 22 | 3 | 4 | 188 | 11124 |
| 1985/86 | 1084 | 1165 | 152 | 31 | 25 | 20 | 14 | 5 | 487 | 18127 |
| 1986/87 | 481 | 691 | 742 | 97 | 20 | 16 | 13 | 12 | 560 | 17551 |
| 1987/88 | 1959 | 305 | 414 | 384 | 45 | 8 | 7 | 10 | 571 | 24759 |
| 1988/89 | 532 | 1249 | 195 | 264 | 245 | 29 | 5 | 11 | 251 | 20939 |
| 1989/90 | 854 | 339 | 796 | 124 | 168 | 156 | 18 | 10 | 506 | 21302 |

Estimated availability at age ( $\lambda_i$ )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.72 | 0.86 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Estimated relative selectivity at age for gillnet gear

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.01 | 0.16 | 0.47 | 0.71 | 1.00 | 1.00 | 1.00 | 1.00 |

The coefficients for the Ricker stock-recruit curve are: alpha = 0.423, beta =0.4453E-04

The estimated spawn index-escapement conversion factor is 0.354E-01