

SUMMARY OF 1987 HERRING STOCK ASSESSMENT

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| INPFC |
| DOCUMENT |
| Serial 3216 |
| Rev. No. |

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Submitted to the
INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION
by the
CANADIAN NATIONAL SECTION
September 1987

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER: Haist, V. and J. Schweigert. 1987. Summary of the 1987 herring stock assessment. 9 p. (Document submitted to the Annual Meeting of the International North Pacific Fisheries Commission, Vancouver, B.C., October 1987.) Department of Fisheries and Oceans, Biological Sciences Branch, Pacific Biological Station, Nanaimo, B.C., Canada, V9R 5K6

INTRODUCTION

The herring stock assessment group has standardized its methods by using two stock assessment models to reconstruct historic stock levels and forecast run sizes for B.C. herring stocks during the last several years (eg. Haist et al. 1987). These methods, the age-structured model (Fournier and Archibald 1982), and the escapement model (Schweigert and Stocker 1987), have again been used for the 1987 assessment and 1988 forecasts with some minor changes to both models. Both models utilize the 37 year time series of catch, spawn deposition, and sampling information available from the commercial fishery and pre-fishery and research samples.

The escapement model uses dive survey data since 1985 wherever it is available. In 1987, most of the south coast spawnings were surveyed by the synoptic dive survey using fishery officer dive teams. In addition, a comprehensive dive survey including sample collection and subsequent egg counts was completed in the Queen Charlotte Islands. The advantages of the dive survey data are that it increases our confidence in the stock estimates by eliminating the need for the intermediate steps of data adjustment which are required for the surface survey information. In addition, by incorporating age structure into the model we separate the effects of growth and recruitment components on annual production. Hence, the forecast of recruitment is based on the historic estimates of the numbers of three-year-old fish in the spawning biomass while the estimates of returning adults includes the effects of growth.

Modifications to the age-structured model include redefining the availability equations and using information in the subsamples to determine age-composition sample sizes. In addition, we have used bootstrap techniques to investigate the variability and bias in forecast stock biomass.

Stock assessments and forecasts for 1988 have been conducted for the usual seven major migratory stocks using both assessment methods. For the Queen Charlotte Islands, the areas included in the stock assessment region are the inlets and bays from Selwyn Inlet in the north to Skincuttle Inlet in the south. The Prince Rupert stock assessment region includes all of B.C. Statistical Areas 3 to 5. In the central coast, we attempt to separate the major migratory stock from the non-migratory inlet stocks. For this area, the stock assessment region includes Statistical Area 7 plus Kitsu Bay and Kwakshua Channel. In the south coast, both the Strait of Georgia and west coast of Vancouver Island are separated into two stock assessment regions. The northern Strait of Georgia stock encompasses Statistical Areas 14 to 16 plus Area 17N and parts of Area 13, while the southern stock includes Area 17S and Areas 18 and 20. On the West coast of Vancouver Island, the southern stock comprises Areas 23 and 24, while the northern stock includes Areas 25 to 27.

CATCH TRENDS

Herring in British Columbia waters have supported commercial fisheries since 1877, although reliable records of place, date, and quantity caught are available only since 1950. There was a fishery for the dry salted market in the Orient from 1904-1934, with catches up to 85,000 tonnes in a year. A reduction fishery, mainly by purse seining followed (1935-1967). Fish were taken during their inshore spawning migrations from November to March. Very large catches of 200,000 tonnes annually in the early 1960s followed by a series of poor recruitments led to the collapse of the reduction fishery, with a closure in 1968. Cessation of the intensive reduction fishery resulted in a gradual recovery of stocks. The roe herring fishery began in 1971. Herring are now caught on or near the spawning grounds by both gillnets and purse seines. Roe herring landings have averaged 28,000 tonnes for the last five years.

The roe fishery first came under quota regulations in 1983. Prior to this, guidelines of anticipated roe catches were given. Roe catches (since 1978) and quotas (since 1983) in thousands of tonnes are shown:

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|-------------------------|------|------|------|------|------|------|------|------|------|------|
| Queen Charlotte Islands | | | | | | | | | | |
| Roe Catch | 12.5 | 8.7 | 3.4 | 6.4 | 5.3 | 8.1 | 5.0 | 6.3 | 3.6 | 1.7 |
| Roe Quota | | | | | | | 4.6 | 5.0 | 3.8 | 1.4 |
| Prince Rupert District | | | | | | | | | | |
| Roe Catch | 5.1 | 2.5 | 2.7 | 1.4 | 0.1 | 0 | 3.5 | 6.5 | 8.3 | 5.6 |
| Roe Quota | | | | | | | 4.0 | 5.0 | 6.4 | 5.4 |
| Central Coast | | | | | | | | | | |
| Roe Catch | 14.0 | 0 | 0.5 | 2.6 | 6.3 | 5.6 | 7.2 | 5.2 | 3.3 | 3.2 |
| Roe Quota | | | | | | | 6.6 | 4.1 | 2.3 | 3.4 |
| Strait of Georgia | | | | | | | | | | |
| Roe Catch | 11.5 | 6.8 | 3.3 | 7.1 | 8.9 | 16.4 | 10.2 | 6.2 | 0.2 | 9.1 |
| Roe Quota | | | | | | 11.7 | 11.6 | 4.7 | 0 | 8.1 |
| West Coast | | | | | | | | | | |
| Vancouver Island | | | | | | | | | | |
| Roe Catch | 20.0 | 19.3 | 4.5 | 8.8 | 6.1 | 8.7 | 6.7 | 0.2 | 0.2 | 15.6 |
| Roe Quota | | | | | | 4.5 | 4.5 | 0 | 0 | 9.4 |
| Total Coast | | | | | | | | | | |
| Roe Catch | 63.1 | 37.3 | 14.4 | 26.3 | 26.5 | 38.8 | 32.6 | 24.4 | 15.6 | 35.2 |
| Roe Quota | | | | | | 28.0 | 31.3 | 18.8 | 12.5 | 27.7 |

STOCK TRENDS

Herring abundance along the B.C. coast decreased slightly in 1987. This decrease resulted from below average recruitment to all areas except the Prince Rupert District. Spawning biomass estimates (tonnes) from 1951 to 1987 are shown in Fig. 1 and 2 for both age-structured and escapement model analyses. The following discussion of stock trends and 1987 spawning biomass are based on the weighted escapement estimates of both assessment methods, unless otherwise stated.

NORTH COAST STOCKS

The Queen Charlotte Islands and Central Coast stocks have been declining since the early 1980s as the extraordinarily large 1977 year-classes moved through the fisheries. Both stocks had reached historically high levels during this period. However, the decline has been less severe in the Central Coast stock (Fig. 1). There has been no significant recruitment to the Queen Charlotte Islands stock since 1980, except for the 1981 year-class which is now supporting the fishery. The year classes recruiting at age 3 in both 1986 and 1987 are among the poorest on record. The 1987 weighted spawning biomass of 15,100 tonnes is down slightly from the previous year, although estimates from the escapement model indicate an increase in spawn. This discrepancy in the stock trend between the two assessment methods may result because the comprehensive dive survey, which was conducted in this area for the first time in 1987, provides a more accurate and complete estimate of total spawning area. The absence of significant recruitment in 1987 and the disappearance of the 1977 year-class will almost certainly bring the stock to a level where a fishery closure is indicated to allow stock rebuilding.

The rate of decline in the Central Coast stock has been halted by an average recruitment in the 1982 year-class. The 1987 spawning stock biomass was estimated at 24,000 tonnes, down marginally from the previous year. This stock remains well above the CUTOFF level but its trend will require special attention over the next few years.

The stock in the Prince Rupert District continues to remain near historically high levels. The estimated spawning biomass for 1987 is 40,800 tonnes, a level it has maintained over the past four years. The 1981 and 1984 year-classes which recruited to the fishery in 1984 and 1987, were well above average levels and should maintain the abundance of this stock for a few more years.

SOUTH COAST STOCKS

The four herring stocks which can support roe fisheries on the South Coast all declined steadily from 1981 to 1985 due to a series of years of below average recruitment. A combination of fisheries closures and above-average recruitment in 1986 caused a sharp increase in spawning levels. However, recruitment in 1987 was below average and caused a slight drop in stock sizes relative to 1986 levels. The estimated spawning biomass for the northern and southern Strait of Georgia stocks in 1987 was 32,300 and 9,700 tonnes, respectively, for a total of 42,000 tonnes.

The spawning stock biomass on the west coast of Vancouver Island followed a similar pattern although the increase in 1986 was less dramatic. The 1987 spawning biomass estimates of 21,100 tonnes in the south and 15,500 tonnes in the north are down from 1986 levels as a result of below average recruitments and large catches, particularly in the southern stock. The spawning stock estimates from the two assessment models track each other very well since 1982, the first year of dive spawn surveys, for the southern west coast Vancouver Island stock (Fig. 2). However, recent spawning trends for the northern stock are very different for the two models. Dive surveys have been conducted on most of the major spawns in this area since 1984, so we feel the escapement model estimates of spawning biomass are fairly accurate.

STOCK FORECASTS FOR 1988

The two stock assessment models used for the herring assessment rely on different sources of information to derive their stock estimates. The escapement model relies most strongly on the estimates of spawn deposition while the age-structured model relies primarily on the estimates of catch at age data from each population. As such they provide two essentially independent estimates of population abundance. Beginning with the 1986 assessment the two models were assigned an equal weighting or given an equal probability of providing the best or most accurate forecast for stock biomass in any particular area unless we felt one of the models provided more reliable current stock estimates. For the current analysis the only suspect stock assessment is the age-structured model analysis for the northern west coast of Vancouver Island, so we have given the escapement model estimates a higher weighting in this area (Table 1). Recruitment forecasts are based on the historic estimates of age 3 biomass. Poor, average, and good recruitment are the mean of the lowest third, the mid third, and the highest third of the historic estimates.

We continue to recommend a 20% annual harvest rate for Pacific herring. In addition, we recommend that areas be closed to commercial fishing when stock forecasts are below CUTOFF levels. CUTOFF levels are

established at one-fourth of the unfished equilibrium biomass, as estimated using computer simulations. For the seven areas as defined in Haist et al. (1985), the following CUTOFF levels were estimated:

| | |
|-------------------------------|---------------|
| Queen Charlotte Islands | 13,100 tonnes |
| Prince Rupert District | 8,900 tonnes |
| Central Coast | 11,100 tonnes |
| Strait of Georgia - North | 14,600 tonnes |
| Strait of Georgia - South | 6,200 tonnes |
| W.C. Vancouver Island - South | 15,400 tonnes |
| W.C. Vancouver Island - North | 6,000 tonnes |

The weighted run forecast for the Queen Charlotte Islands for 1988 with average recruitment is 13,000 tonnes (Table 1). Given the small fishery in 1987 and the absence of any appreciable recruitment in the last several years, the poor recruitment scenario of 11,250 tonnes appears more reasonable. However, even assuming average recruitment the forecast run size is below the CUTOFF of 13,100 tonnes for this area.

The Prince Rupert District weighted run of 38,150 tonnes with average recruitment is up from 1987 forecasts. There have been indications of continuing good recruitments in this area and so the stock continues to maintain itself at above average levels.

The central coast stock is forecast at 23,800 tonnes with average recruitment, down slightly from 1987 but still relatively healthy.

The weighted run for the northern Strait of Georgia is 36,300 tonnes and for the southern Strait of Georgia 11,650 tonnes assuming average recruitment. Good recruitments would see 46,850 and 19,600 tonnes in the northern and southern areas, respectively.

The weighted average runs to the west coast of Vancouver Island stocks are 23,000 and 16,560 tonnes for the southern and northern areas, respectively. Another good recruitment in both areas could see stock levels of 33,000 and 25,260 tonnes in the south and north.

SUMMARY

For the 1987 herring stock assessments two assessment methods were used: (1) an escapement model; and (2) an age-structured model. Both methods use a 37-year time series of catch, spawn deposition, and age composition data. 1987 has seen a slight decline in the coastwide abundance of herring, the result of below average recruitment to all areas except the Prince Rupert District. The 1987 estimated escapement was 158,500 tonnes coastwide. The Prince Rupert District spawning stock is currently close to the maximum levels observed historically. Both the

Queen Charlotte Islands and Central Coast stocks continue to decline from the high levels observed in 1981, however the trend is more severe in the Queen Charlotte Islands. Spawning biomass in all four south coast herring stocks was down from 1986 levels, primarily the result of below average recruitment. These stocks are, however, still above the low levels of 1983 and 1984 which led to fishery closures.

The weighted run forecast for 1988, assuming average recruitment, is 161,160 tonnes for the entire B.C. coast. All stocks, with the exception of that in the Queen Charlotte Islands, are forecast well above CUTOFF levels, even under the poor recruitment scenario. The forecast for the Queen Charlotte Islands stock, assuming average recruitment is 13,000 tonnes which is marginally below the CUTOFF.

REFERENCES

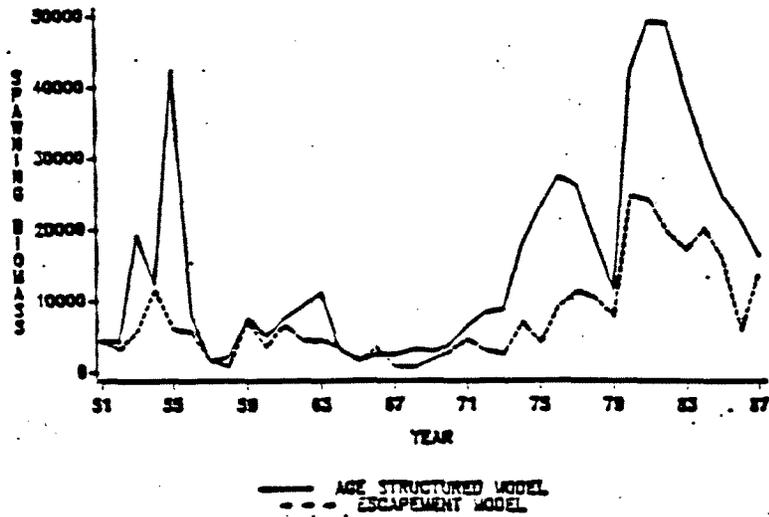
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Table 1. Summary of 1988 forecast stock biomass (1000 t) from age-structured and escapement models and weighted runs for poor, average, and good recruitment levels.

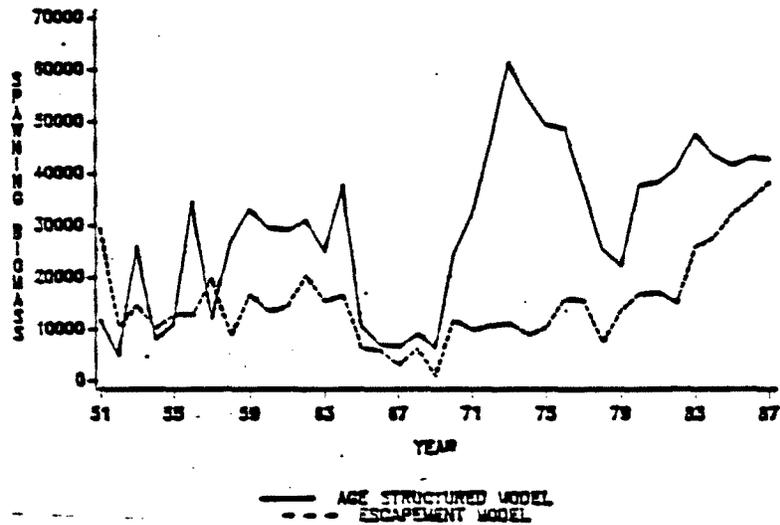
| | Age-structured model | | | | Escapement model | | | | Rel. weight | Weighted results | | |
|---|----------------------|------|------|------|---------------------|------|------|------|-------------|------------------------|-------|-------|
| | Stock + recruitment | | | | Stock + recruitment | | | | | Stock with recruitment | | |
| | Age 4+ | Poor | Avg. | Good | Age 4+ | Poor | Avg. | Good | | Poor | Avg. | Good |
| Queen Charlotte Islands | 12.2 | 13.1 | 15.0 | 22.9 | 8.8 | 9.4 | 11.0 | 19.0 | 50:50 | 11.25 | 13.00 | 20.65 |
| Prince Rupert District | 39.1 | 41.1 | 44.5 | 57.0 | 27.6 | 28.8 | 31.8 | 41.7 | 50:00 | 34.95 | 38.15 | 49.35 |
| Central Coast | 16.9 | 19.8 | 22.9 | 30.8 | 18.5 | 21.1 | 24.7 | 35.9 | 50:50 | 20.45 | 23.80 | 33.35 |
| Strait of Georgia northern stock | 31.6 | 35.8 | 41.2 | 50.1 | 18.9 | 25.2 | 31.4 | 43.6 | 50:50 | 30.50 | 36.30 | 46.85 |
| southern stock ^a | 7.7 | 9.2 | 11.0 | 13.9 | 5.5 | 8.2 | 9.7 | 12.5 | 50:50 | 8.70 | 10.35 | 13.20 |
| West Coast of Vancouver Island southern stock | 14.8 | 18.5 | 22.6 | 33.8 | 15.7 | 19.0 | 23.4 | 32.6 | 50:50 | 18.75 | 23.00 | 33.20 |
| northern stock | 27.9 | 29.7 | 33.6 | 39.1 | 7.4 | 9.2 | 12.3 | 21.8 | 20:80 | 13.30 | 16.56 | 25.26 |

^aRecruitment estimates based on data from roe fishery only.

SKINCUTLE - SELWYN



PRINCE RUPERT DISTRICT



CENTRAL COAST

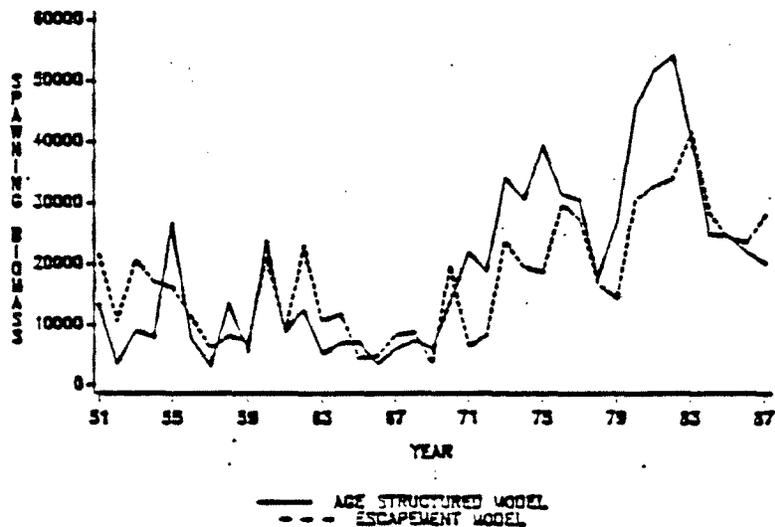
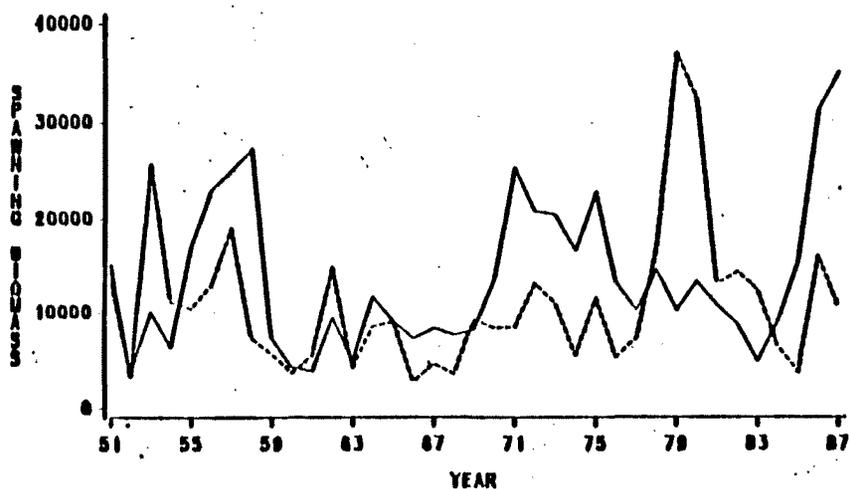


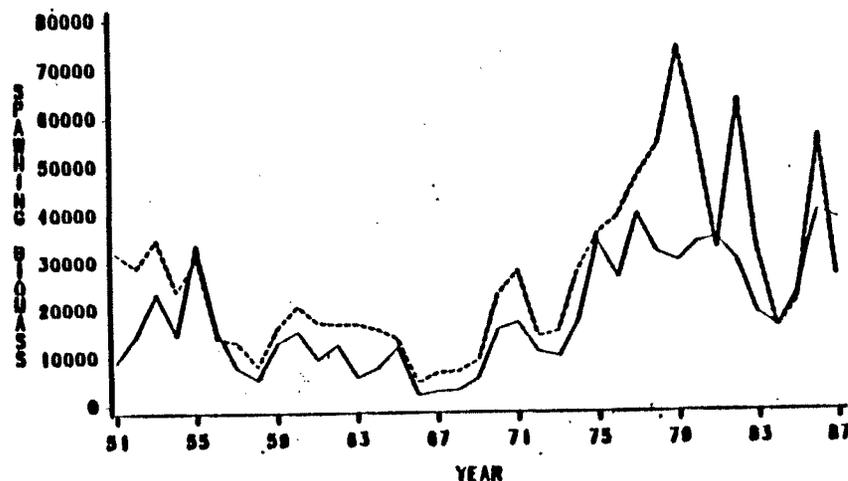
Fig. 1. Spawning biomass estimates (tonnes) from age-structured model and escapement model analysis for northern B.C. herring stock assessment regions.

WEST COAST VANCOUVER ISLAND – NORTH



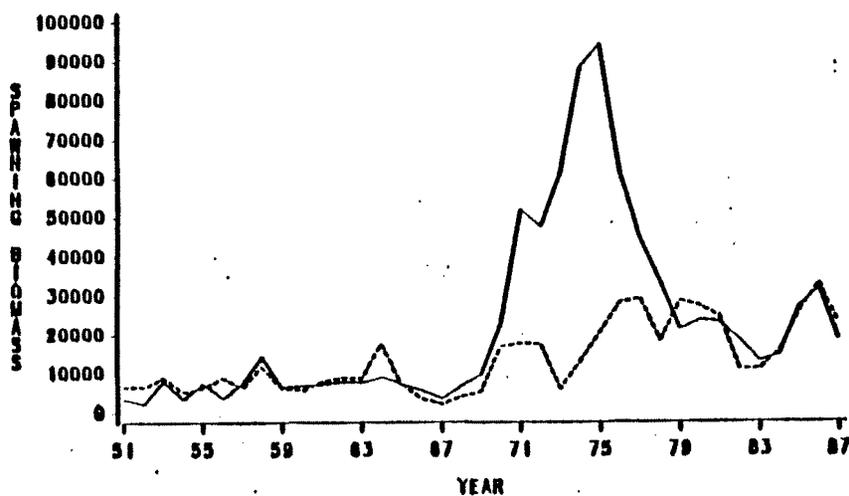
— AGE STRUCTURED MODEL
 - - - ESCAPEMENT MODEL

STRAIT OF GEORGIA – NORTH



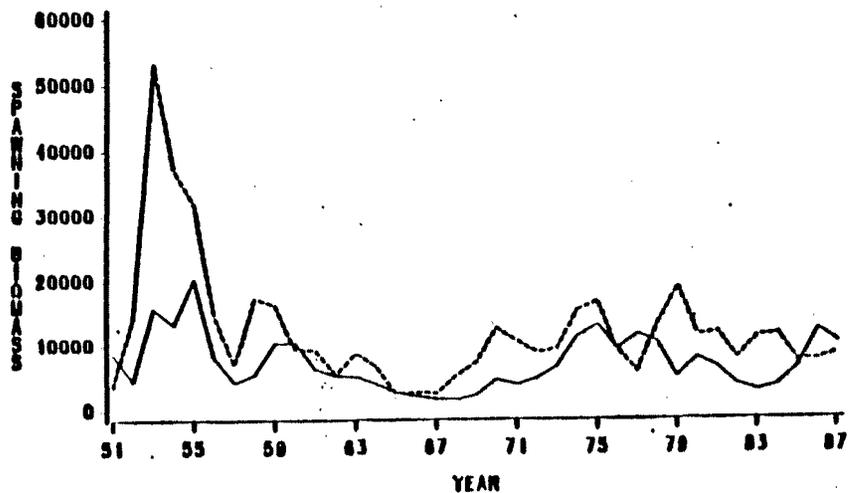
— AGE STRUCTURED MODEL
 - - - ESCAPEMENT MODEL

WEST COAST VANCOUVER ISLAND – SOUTH



— AGE STRUCTURED MODEL
 - - - ESCAPEMENT MODEL

STRAIT OF GEORGIA – SOUTH



— AGE STRUCTURED MODEL
 - - - ESCAPEMENT MODEL

Fig. 2. Spawning biomass estimates (tonnes) from age-structured model and escapement model analysis for southern B.C. herring stock assessment regions.