SUMMARY OF 1988 HERRING STOCK ASSESSMENT

by

V. Haist and J. Schweigert

Department of Fisheries and Oceans
Fisheries Research Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

Submitted to the

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

by the

CANADIAN NATIONAL SECTION

September 1988

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER: Haist, V. and J. Schweigert. 1988. Summary of the 1988 herring stock assessment. 7 p. (Document sumbitted to the Annual Meeting of the International North Pacific Fisheries Commission, Tokyo, Japan, November 1988.) 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 1988 assessment and 1989 forecasts. Both models utilize the 38 year time series of catch, spawn deposition, and sampling information available from the commercial fishery and pre-fishery and research samples.

The escapement model is based on estimates of egg deposition obtained from annual surveys of all major herring spawns. Historically spawn surveys have been conducted from the surface, using grappling hooks and underwater viewers, to obtain estimates of spawn width and intensity of egg deposition. Surface survey methods underestimate spawn width and do not provide consistent estimates of intensity. Since 1985 dive methods have replaced the traditional surface methods for surveying many spawns. In 1988, most major spawns were surveyed using diver methods; these surveys should provide consistent estimates of spawn width and intensity. Egg deposition estimates are converted to estimates of spawners-at-age using age composition and fecundity data from the bio-sampling data base.

The age-structured model, a modified version of the model described in Fournier and Archibald (1982), has been used to assess B.C. herring stocks since 1982. The model incorporates auxillary information in the form of spawn index data, separates catch-at-age data by gear type, and includes an availability term to model partial recruitment to the spawning stock. The model includes realistic assumptions about the form of both measurement and process error. A maximum likelihood method is used to simultaneously estimate all model parameters.

Stock assessments and forecasts for 1989 have been conducted for 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 Kitasu 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 19. 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 a dry salted market 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 October to February. 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 1979; for 1988 data are hailed catches) and quotas (since 1983) in thousands of tonnes are shown:

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Queen Charlotte Islands										
Roe Catch	8.7	3.4	6.4	5.3	8.1	5.0	6.3	3.6	2.0	0.3
Roe Quota						4.6	5.0	3.8	1.4	0
Prince Rupert District										
Roe Catch	2.5	2.7	1.4	0.1	0	3.5	6.5	8.3	6.1	8.3
Roe Quota						4.0	5.0	6.4	5.4	7.5
Central Coast										
Roe Catch	0	0.5	2.6	6.3	5.6	7.2	5.2	3.3	3.6	4.5
Roe Quota						6.6	4.1	2.3	3.4	3.7
Strait of Georgia										
Roe Catch	6.8	3.3	7.1	8.9	16.4	10.2	6.2	0.2	9.1	7.9
Roe Quota					11.7	11.6	4.7	0	8.1	6.4
West Coast Vancouver Island										
Roe Catch	19.3	4.5	8.8	6.1	8.7	6.7	0.2	0.2	15.9	9.7
Roe Quota					4.5	4.5	0	0	9.4	8.1
Total Coast										
Roe Catch	37.3	14.4	26.3	26.5	38.8	32.6	24.4	15.6	36.7	30.7
Roe Quota					28.0	31.3	18.8	12.5	27.7	25.8

STOCK TRENDS

Herring abundance along the B.C. coast increased in 1988. This increase is the result of very good recruitment to the central coast stock and average recruitment levels to the other B.C. herring stocks. The following discussion of stock trends and 1987 spawning biomass are based on the weighted escapement estimates of both assessment methods.

NORTH COAST STOCKS

The Queen Charlotte Islands and Central Coast stocks had 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 and had then steadily declined through 1987. An exceptionally good recruitment to the Central Coast has reversed this trend for this stock. The 3-year-old cohort, recruiting to the spawning stock in 1988, appears to be one of the best in the historical time series. The 1988 weighted spawning biomass of 45,400 tonnes represents a 73% increase over the 1987 spawn level.

The 1985 year-class, recruiting to the Queen Charlotte Islands stock as 3-year-olds in 1988, is average in size relative to historic recruitment levels. This year-class has halted the steady stock decline in this area and the 1988 estimated spawning biomass of 16,100 tonnes represents a 5% increase over the 1987 spawn level.

The stock in the Prince Rupert District continues to remain near historically high levels. The estimated spawning biomass for 1988 is 36,000 tonnes, a level it has maintained over the past six years. The 1981 and 1984 year-classes which recruited to the fishery in 1984 and 1987, were well above average levels and the 1985 year-class which recruited to the fishery in 1988 was average in size. This succession of good recruitment should maintain the abundance of this stock for a few more years.

SOUTH COAST STOCKS

The two analytical assessment models produce substantially different estimates of 1988 spawning biomass for the two Strait of Georgia herring stocks. Age-structured model analysis suggests there is a major increase in both stocks over 1987 levels, due to above average recruitment in 1988. Spawning biomass estimates obtained from escapement model analysis suggest a slight decrease from 1987 spawn levels for both stocks. Because there is no objective method to determine the relative accuracy of the analytical models we assign an equal probability to both models to obtain weighted stock estimates. The weighted spawning biomass estimate for the northern and southern Strait of Georgia stocks in 1988 was 33,600 and 10,200 tonnes, respectively.

Results from both assessment models suggest a slight increase in spawning biomass for the southern west coast of Vancouver Island stock in 1988. The estimate of 28,000 tonnes of spawners represents a 15% increase over 1987 spawn levels. Age-structured model analysis continues to suggest a substantial increase in northern west coast Vancouver Island stocks over the period 1983 to 1988. This trend, and estimates of current spawning biomass, appears overly high given spawning estimates from diver spawn surveys and in-season hydroacoustic surveys. For this reason, escapement model estimates are weighted higher than age-structured model estimates to obtain one overall stock forecast (Table 1). The weighted spawning stock estimate for the northern west coast of Vancouver island in 1988 is 16,600 tonnes, a similar level to the 1987 estimate.

STOCK FORECASTS FOR 1989

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 average biomass, as estimated using computer simulations. CUTOFF levels have been revised this year based on more recent stock productivity parameters. The following CUTOFF levels were estimated:

Queen Charlotte Islands	10,600 tonnes
Prince Rupert District	12,100 tonnes
Central Coast	10,600 tonnes
Strait of Georgia	22,100 tonnes
W.C. Vancouver Island - South	15,100 tonnes
W.C. Vancouver Island - North	8,700 tonnes

The weighted run forecast for the Queen Charlotte Islands for 1989 with average recruitment is 15,400 tonnes (Table 1). Given the fishery closure in 1988 and the continued low stock abundance, the poor recruitment scenario of 13,700 tonnes may be more reasonable.

The Prince Rupert District weighted run of 37,600 tonnes with average recruitment is down slightly from 1988 forecasts. Recruitment to this stock continues to average or better levels and has maintained the spawning stock at historic high levels since 1983.

The central coast stock is forecast at 48,500 tonnes with average recruitment, a substantial increase over the forecast for 1988.

The weighted run for the northern Strait of Georgia is 41,200 tonnes and for the southern Strait of Georgia 12,600 tonnes assuming average recruitment. Good recruitments would see 50,900 and 15,200 tonnes in the northern and southern areas, respectively.

The weighted average runs to the west coast of Vancouver Island stocks are 31,800 and 18,900 tonnes for the southern and northern areas, respectively. Another good recruitment in both areas could see stock levels of 41,700 and 26,300 tonnes in the south and north.

SUMMARY

For the 1988 herring stock assessments two assessment methods were used: (1) an escapement model; and (2) an age-structured model. Both methods use a 38-year time series of catch, spawn deposition, and age composition data. 1988 has seen a slight increase in the coastwide abundance of herring. The 1988 estimated escapement was 185,000 tonnes coastwide. The Prince Rupert District spawning stock is currently close to the maximum levels observed historically. The Central Coast herring stock increased substantially in 1988 due to a high abundance of recruit fish. Herring stocks in the Queen Charlotte Islands continue to be at low levels, although the major decline in these stocks observed from 1983 through 1987 appears to have been halted. Spawning biomass in all four south coast herring stocks in 1988 were similar to 1987 levels.

REFERENCES

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

Haist, V., J. F. Schweigert, and D. Fournier. 1987. Stock assessments for British Columbia herring in 1986 and forecasts of the potential catch in 1987. Can. MS Rep. Fish. Aquat. Sci. 1929: 63 p.

Haist, V., J. F. Schweigert, and M. Stocker. 1985. Stock assessments for British Columbia herring in 1985 and forecasts of the potential catch in 1985. Can. MS Rep. Fish. Aquat. Sci. 1889: 48 p.

Schweigert, J. F. and M. Stocker. 1988. Escapement model for estimating Pacific herring stock size from spawn survey data and its management implications. N. Am. J. Fish. Manag. 8: 63-74.

Table 1. Summary of 1989 predicted stock biomass (1000t) from age-structured and escapement models and weighted runs for poor, average, and good recruitment levels.

	AGE STRUCTURED MODEL				ESCAPEMENT MODEL				WEIGHTED RESULTS			
		Stock + recruitment				Stock + recruitment				Stock with recruitment		
	AGE 4+	Poor	Avg.	Good	AGE 4+	Poor	Avg.	Good	Rel Weight	Poor	Avg.	Good
Queen Charlotte Islands	16.2	17.1	19.1	26.4	9.6	10.3	11.7	17.4	50:50	13.7	15.4	21.9
Prince Rupert District	41.7	43.6	47.1	59.4	23.9	25.2	28.1	35.5	50:50	34.4	37.6	47.5
Central Coast	45.1	48.3	52.0	61.9	38.2	41.0	44.9	55.3	50:50	44.7	48.5	58.6
Strait of Georgia												
northern stock	42.0	46.2	51.5	61.2	17.2	24.9	30.8	40.6	50:50	35.6	41.2	50.9
southern stock	13.9	15.4	16.9	20.6	3.7	7.1	8.3	9.7	50:50	11.3	12.6	15.2
West Coast of Vancouver Is.												
southern stock	24.6	28.5	32.8	44.6	22.4	26.4	30.7	38.7	50:50	27.5	31.8	41.7
northern stock[a]	33.0	34.7	38.7	44.8	9.0	11.1	14.0	21.7	20:80	15.8	18.9	26.3

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