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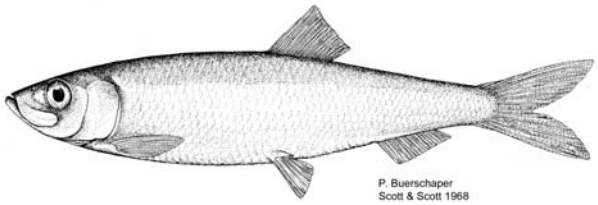
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Advisory Report 2008/049

ASSESSMENT OF NEWFOUNDLAND EAST AND SOUTH COAST HERRING STOCKS TO 2008



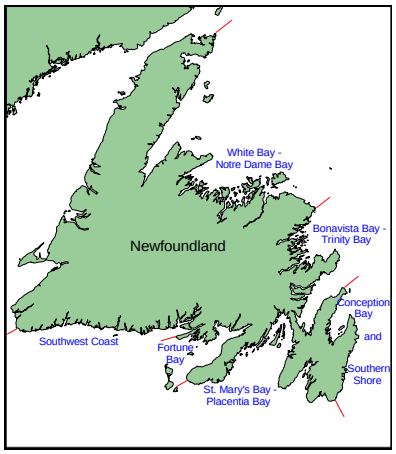


Figure 1: Area map indicating herring stock complexes within the Newfoundland and Labrador Region.

Context

There are five herring stocks distributed along the east and south coasts of Newfoundland: White Bay-Notre Dame Bay, Bonavista Bay-Trinity Bay, Conception Bay - Southern Shore, St. Mary's Bay-Placentia Bay, and Fortune Bay. In addition, herring occur along the southwest coast; the affinities of these herring are uncertain.

Total annual landings in the last five years (to 2007) have averaged 6400 t. Fishing seasons are area and gear dependent. Principal gears include: purse seines, bar seines, traps, and gill nets. TAC management was established in 1977. The 2007–08 Integrated Management Plan for Herring on the East and South Coasts of Newfoundland (DFO 2007) established annual TAC's by stock area and gear sector for 2007 and 2008.

Stock assessments are conducted bi-annually in support of the bi-annual integrated fishery management plan. Since 2002, performance reports, including evaluation of abundance indices and biological characteristics, have been used to assess the current status and future prospects of each stock. Abundance indices include: research gill net catch rates, commercial gill net catch rates, gill net fisher observations, and purse seine fisher observations. Biological characteristics, including age compositions and year class sizes are evaluated. Additional details have been given for autumn spawning herring, given their increased numbers in commercial and research gill net catches in some areas in recent years.

A meeting of the Regional Advisory Process was held on November 3-5, 2008 in St. John's, NL to assess the status of east and south coast Newfoundland herring in support of the management of the 2009 and 2010 fisheries. Participants included DFO scientists, fisheries managers, and representatives from the provincial government, Memorial University, the Marine Institute, the Fish Food and Allied Workers Union, and the Fisheries Resource Conservation Council.

SUMMARY

White Bay-Notre Dame Bay

- Reported landings increased from 309 t in 2006 to 362 t in 2007; 21% of the TAC was taken in 2007.
- A standardized performance index indicates that stock status has improved from 2002 to 2008; however, stock abundance is substantially lower than historical estimates in the 1970's.
- Short term prospects are uncertain; the 2003 year class is below average and equal numbers of mature year classes are above or below average compared to year classes produced since 1982. However, all year classes since 1982 are weak compared to historical levels.

Bonavista Bay-Trinity Bay

- Reported landings increased from 1904 t in 2006 to 2777 t in 2007; 69% of the TAC was taken in 2007.
- A standardized performance index indicates that stock status improved from 2002 to 2007 but deteriorated in 2008; stock abundance is substantially lower than historical estimates in the 1970's.
- Short term prospects are uncertain; the 2003 year class is below average but most mature year classes are above average compared to year classes produced since 1982. However, all year classes since 1982 are weak compared to historical levels.

St. Mary's Bay-Placentia Bay

- Reported landings decreased from 1528 t in 2006 to 759 t in 2007; 30% of the TAC was taken in 2007.
- A standardized performance index indicates that stock status has deteriorated slightly from 2005 to 2008; stock abundance is substantially lower than historical estimates in the 1970's.
- Short term prospects are negative; the 2003 year class is below average and most mature year classes are below average compared to year classes produced since 1976. All year classes since 1976 are weak compared to historical levels.

Fortune Bay

- Reported landings increased from 2340 t in 2006 to 2448 t in 2007; 77% of the TAC was taken in 2007.
- A standardized performance index indicates that stock status deteriorated steadily from 2001 to 2004, improved slightly in 2005, deteriorated again in 2006, and has remained stable from 2006 to 2008. However, stock abundance is lower than peak estimates in the mid to late 1980's.
- Short term prospects are negative; the 2003 year class is below average and most mature year classes are average or below average compared to year classes produced since 1976.

BACKGROUND

Species Biology

Herring (*Clupea harengus*) are distributed in the northwest Atlantic from Cape Hatteras to southern Labrador. They are a schooling species that undertake extensive seasonal migrations in coastal waters. Historically, stocks within the Newfoundland and Labrador region have been characterized by the predominance of spring-spawning herring; however, in recent years, autumn spawning herring have formed an increasing component of the catch in most areas.

Growth rates declined through the 1990's and have remained below average in all areas. Length and age to maturity have also changed. Length at 50% maturity was variable but relatively stable for the 1965-89 year classes. However, there was a downward trend from 1990 to 1996. The length at 50% maturity of the 1996 year class (230 mm) was approximately 15% lower than that of the 1988 year class (272 mm). Length at 50% maturity showed an upward trend for year classes to 2002 but was still below average. Age at 50% maturity was also variable but relatively stable for the 1963-92 year classes. There was a downward trend from 1994 to 1998. The age at 50% maturity of the 1998 year class (2.45 years) was approximately 32% lower than that of the 1992 year class (3.60 years). The age at 50% maturity of the 2002 year class increased but was still below average (Wheeler et al. in press).

Herring within the Newfoundland region are at the northern extent of their geographic range. Ideal conditions seldom exist and consequently strong recruitment is very sporadic. Winters and Wheeler (1987) observed that good survival of young herring (i.e. recruitment) was largely influenced by suitable environmental conditions, principally warm over-wintering water temperatures and high salinities prior to spawning.

Large year classes of herring produced in 1968 and 1969 supported most of the stocks through the 1970's. The moderately large 1982 year class allowed stocks to rebuild in the 1980's. Since then, the 1987 and 1996 year classes have been of moderate strength, but in some areas only. However, year classes produced during the 1990’s are weak in relation to the large year classes of the 1960’s. The 2003 year class is below average in all areas. There are no estimates of recruitment beyond the 2003 year class.

Herring are important prey for many species including other fish, sea birds and marine mammals. Quantitative information on the predation of herring is available only for seals. Hammill and Stenson (2000) estimated that in 1996, harp, hooded, grey and harbour seals consumed 36,000 t of herring in NAFO Div. 2J3KL, an area encompassing all east and southeast Newfoundland herring stocks, except Fortune Bay. The vast majority of this consumption (31,000 t) was due to harp seals with hooded seals accounting for slightly less than 5,000 t.

Methodology to Describe Stock Status

Of the five herring stocks in the coastal waters of east and south Newfoundland, four were assessed to the spring of 2008 (Wheeler et al. 2008). Conception Bay–Southern Shore was excluded due a lack of scientific data.

Five series of abundance indices were evaluated for each of the herring stocks including: research gill net catch rates, commercial gill net catch rates, gill net fisher observations from

logbooks, gill net fisher observations from telephone surveys, and purse seine fisher observations.

The research gill net program, initiated in 1982, provides standardized age disaggregated abundance indices independent of the commercial fishery. Each year, commercial fishers are contracted to provide catch rate data and biological samples of their catch. In 2008, twenty-six fishers participated in the program. Data are available from 1988 to 2008 for White Bay–Notre Dame Bay and Bonavista Bay–Trinity Bay and from 1982 to 2008 for St. Mary's Bay–Placentia Bay and Fortune Bay. Catch rates at age for spring and autumn spawning herring (numbers per nights fished) are available up to and including 2007. Catch rates only are available for 2008, as biological samples have not yet been processed.

The commercial gill net logbook program, initiated in 1996, provides a time series of standardized catch per unit effort data from the commercial gill net and bait fisheries. Each year, logbooks are sent to approximately 2800 licensed fishers and/or bait permit holders in the Newfoundland and Labrador region. The return of logbooks is voluntary and the numbers returned are generally very low. In 2008, 30 logbooks were returned (to October) and, depending upon the area fished, most returns were from winter/spring/early summer fisheries.

In addition to recording their catch, fishers who complete and return commercial gill net logbooks are asked to provide their observations of herring abundance. Specifically, they are asked "on a scale of 1 to 10, with 1 being the lowest and 10 being the highest, how abundant were herring in your fishing area in the current (and previous) year". During the 2006 RAP, concerns were expressed that opinion-based abundance indices, as derived from fisher's observations of herring abundance, may be confounded by differing reference periods from which current year estimates are compared. To address this concern, a new cumulative index was calculated comparing the current year perception of abundance with the previous year perception of abundance.

The gill net telephone survey, initiated in 2006, provides observations of abundance from a larger sample of fishers than the gill net logbooks. In 2008, 142 active fishers were contacted. In 2006, logbook results were used as indices from 1996 to 2004; phone survey results were used as indices in 2005 and 2006. In 2008, observations of abundance from gill net logbooks and gill net telephone surveys were considered as separate indices. In assessing observations of abundance, it was assumed that observations of all active fishers were equal, regardless of their level of effort. Catch data from this survey have been used to estimate bait landings in 2007 and 2008.

The purse seine fishery questionnaire, initiated in 1996, provides a qualitative evaluation of biological and fishery related information from herring purse seine fishers. Each year, attempts are made to contact all active fishers by phone after the purse seine fishery. Response rates are high for most areas and years; in 2007, 20 of 23 active fishers responded. Purse seine fishers are also asked to rate their observations of herring abundance, on a ten point scale, similar to gill net fishers. Results are available to 2007 for White Bay–Notre Dame Bay and Bonavista Bay–Trinity Bay where there is a fall purse seine fishery. Results are available to 2008 for St. Mary's Bay–Placentia Bay where there is a winter/spring purse seine fishery. There is no purse seine fishery in Fortune Bay. The cumulative index was calculated for observations of abundance from gill net logbooks, gill net telephone surveys, and purse seine questionnaires.

Biological characteristics, including age compositions and year class sizes were evaluated. Age compositions from research gill nets were considered to best represent population age structure and were available for each area to 2007. Estimates of relative year class size were derived

from mean research gill net catch rates at ages four, five, and six. For each area, there are seven mature year classes (1997-2003) that can be estimated. These year classes produced the 2007 population numbers at ages 4-10. The 2003 year class (at age 4 in 2007) is the most recent recruiting year class that can be estimated.

As recommended during the 2006 RAP, an analytical analysis of population size was attempted in 2008 using the adaptive (ADAPT) framework (Gavaris 1988). The combination of large mean square residuals, large relative errors of parameter estimates, and strong year and/or cohort residual patterns indicated that the model fits of the ADAPT calibrations, by stock area and spawning type, were unreliable and did not provide a true indicator of current population levels.

For each stock area, current stock status and future prospects were summarized in a performance report. Observations on abundance indices, biological characteristics, and ecological considerations, were interpreted and then evaluated using the traffic light method (Caddy 1998). This method uses a system of red (-), yellow (?), and green (+) lights to categorize indicators as 'cause for concern', 'uncertain', or 'positive'. **In this assessment, 'uncertain' was defined as 'uncertainty of an interpretation', rather than precautionary uncertainty.**

To evaluate current vs. historical status, research gill net catch rates were compared to historical population estimates (Wheeler et al. 2001). To evaluate current vs. recent status, trends in stock status were examined based upon a standardized evaluation of all abundance indices and age composition data (range of mature age groups). Short term prospects were described by evaluating the strength of the mature year classes and of the 2003 recruiting year class.

Fishery

Prior to the 2007 fishery, Fisheries and Aquaculture Management Branch formulated a new two year (2007 and 2008) integrated management plan for east and south coast Newfoundland herring. TAC's increased 55% for White Bay–Notre Dame Bay and 33% for Bonavista Bay–Trinity Bay, remained the same for St. Mary's Bay–Placentia Bay, and decreased 14% for Fortune Bay.

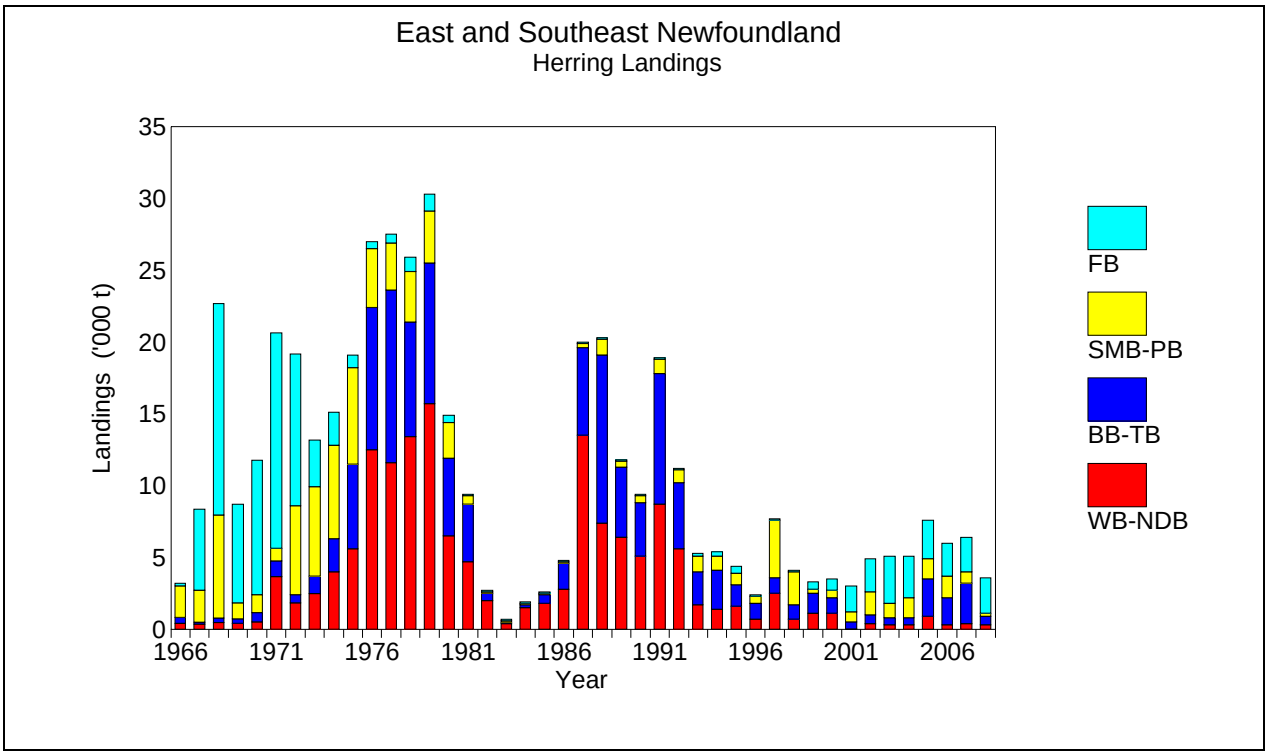


Figure 2. Herring landings by stock area, 1966–2008 (2008: reported landings to October).

Reported landings increased from 6400 t in 2006 to 6700 t in 2007 (Fig. 2) due to an increased fishery in Bonavista Bay–Trinity Bay. The 6700 t represented approximately 54% of the overall TAC. For 2008, landings data are available only to October.

In White Bay–Notre Dame Bay, reported landings increased from 309 t in 2006 to 362 t in 2007; 21% of the TAC was taken in 2007. The 2002 year class accounted for 39% of landing numbers, followed by the 2001 year class at 32%. Spring spawners accounted for 77% of landing numbers, an increase of 22% from 2006.

In Bonavista Bay–Trinity Bay, reported landings increased from 1904 t in 2006 to 2777 t in 2007; 69% of the TAC was taken in 2007. The 2001 year class accounted for 32% of landing numbers, followed by the 2002 and 2000 year classes at 23% and 22% respectively. Spring spawners accounted for 65% of landing numbers, an increase of 22% from 2006.

In St. Mary's Bay–Placentia Bay, reported landings decreased from 1528 t in 2006 to 759 t in 2007; 30% of the TAC was taken in 2007. The 2000 year class accounted for 42% of landing numbers, followed by fish aged 11+ at 23%. Spring spawners accounted for only 10% of landing numbers, a decrease of 38% from 2006.

In Fortune Bay, reported landings increased from 2340 t in 2006 to 2448 t in 2007; 77% of the TAC was taken in 2007. Fish age 11+ accounted for 61% of landing numbers, followed by the 2002 year class at 23%. Spring spawners accounted for 92% of landing numbers, a decrease of 2% from 2006.

ASSESSMENT

White Bay-Notre Dame Bay

Abundance Indices

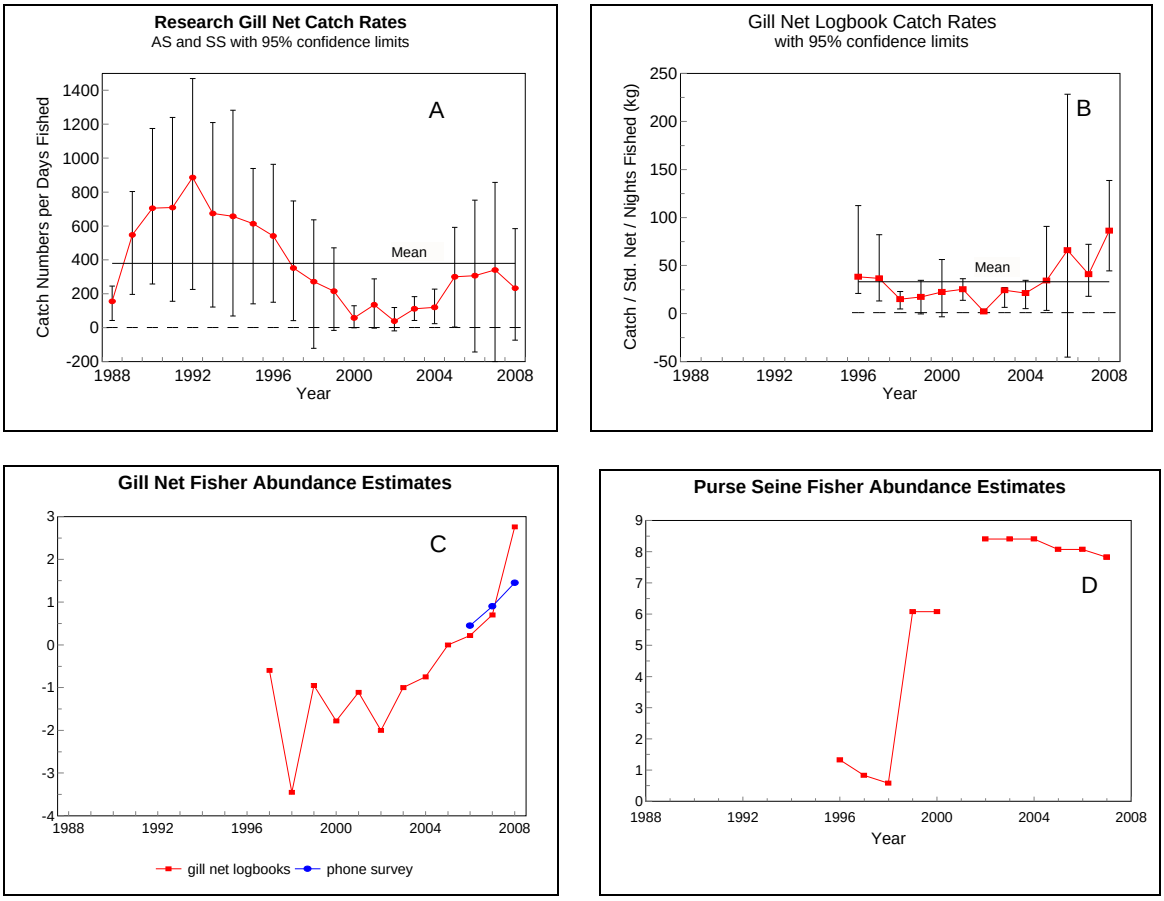


Figure 3. White Bay-Notre Dame Bay abundance indices: A) research gill net catch rates (1988-2008), and B) commercial gill net logbook catch rates (1996–2008), C) gill net fisher abundance estimates on a cumulative index (logbooks 1997–2008, phone survey 2006–08), and D) purse seine fisher abundance estimates on a cumulative index (1996–2007).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined decreased, but not significantly, from 307 in 2006 to 233 in 2008 (Fig. 3, Panel A). The 2008 catch rate was below average, 61% of the mean (1988-2008). Catch rates decreased significantly from 1992 to 2002.

Eight commercial gill net logbooks were returned in 2008. Catch rates (kilograms per standard net per nights fished) increased, but not significantly, from 65.9 in 2006 to 86.2 in 2008 (Fig. 3, Panel B). The 2008 catch rate was above average, 261% of the mean (1996-2008) and the highest in the time series. Fishers indicated (cumulative index) an increasing trend in abundance in the past five years and abundance in 2008 was higher than in 2007 (Fig. 3, Panel C).

There were 32 active gill net fishers contacted in the 2008 telephone survey. They indicated (cumulative index) an increasing trend in abundance since the survey began in 2006 and abundance in 2008 was higher than in 2007 (Fig. 3, Panel C).

Both active fishers responded to the purse seine questionnaire in 2007. They indicated (cumulative index) a decreasing trend in abundance in the past five years and abundance in the fall of 2007 was slightly lower than in 2006 (Fig. 3, Panel D).

Biological Characteristics

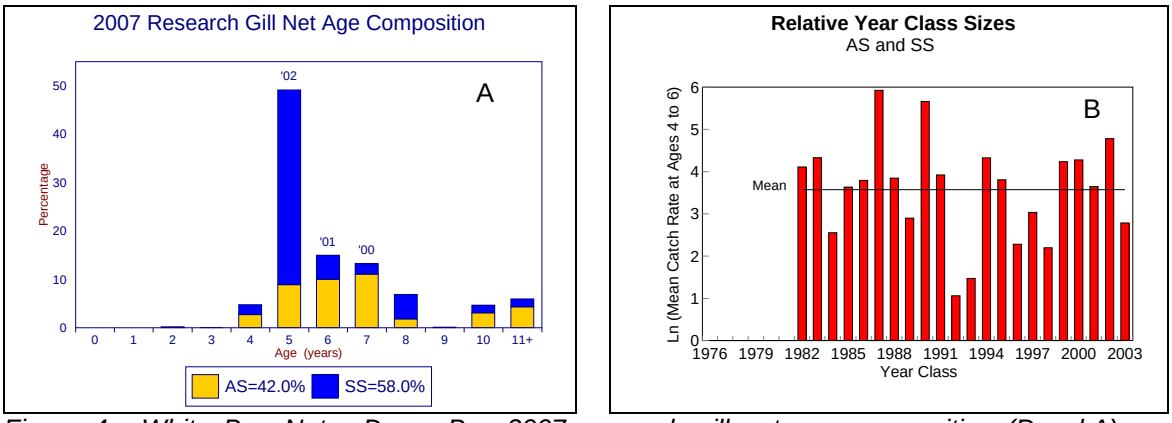


Figure 4. White Bay–Notre Dame Bay 2007 research gill net age composition (Panel A) and relative year class sizes (1982–2003) from research gill net catch rates at ages 4 to 6 (Panel B).

The 2002 and 2001 year classes accounted for 49% and 15% respectively of the 2007 research gill net catch numbers (Fig. 4, Panel A). The age distribution was extensive, as five year classes (including fish age 11+) each accounted for greater than 5% of the catch. Spring spawners were 58% of the catch, an increase of 9% from 2006.

In comparison to year classes since 1982, three of seven current mature year classes (1997 to 2003) are above average, three are below average, and one is average (Fig. 4, Panel B). The 2003 recruiting year class is below average. All year classes in this time series are weak in relation to the strong year classes of the late 1960's (Wheeler et al. 2001).

Current Status and Short Term Prospects

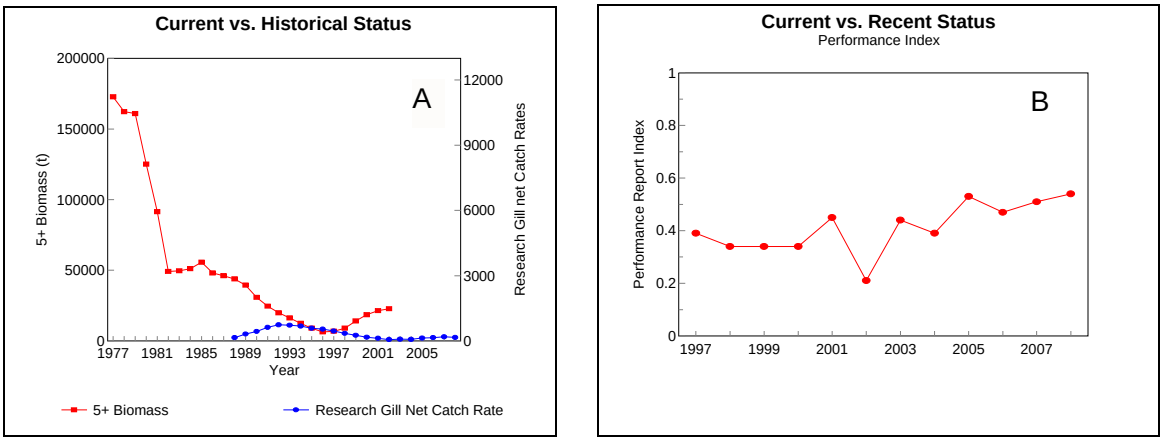


Figure 5. Comparison of research gill net catch rates and historical biomass estimates for White Bay-Notre Dame Bay (Panel A), and performance indices for 1997 to 2008 (Panel B).

Biomass estimates are available to 2001 from an integrated catch at age analysis (Wheeler et al. 2001). A visual comparison with research gill net catch rates suggests that current abundance is substantially lower than historical estimates in the 1970's (Fig. 5, Panel A).

A standardized performance index is available for 1997 to 2008 (Fig. 5, Panel B). The composite index indicates that stock status has improved from 2002 to 2006.

Short term prospects are uncertain; the 2003 year class is below average and equal numbers of mature year classes are above average or below average compared to year classes since 1982 (Fig. 4, Panel B). All year classes in the time series are weak compared to historical levels.

Bonavista Bay-Trinity Bay

Abundance Indices

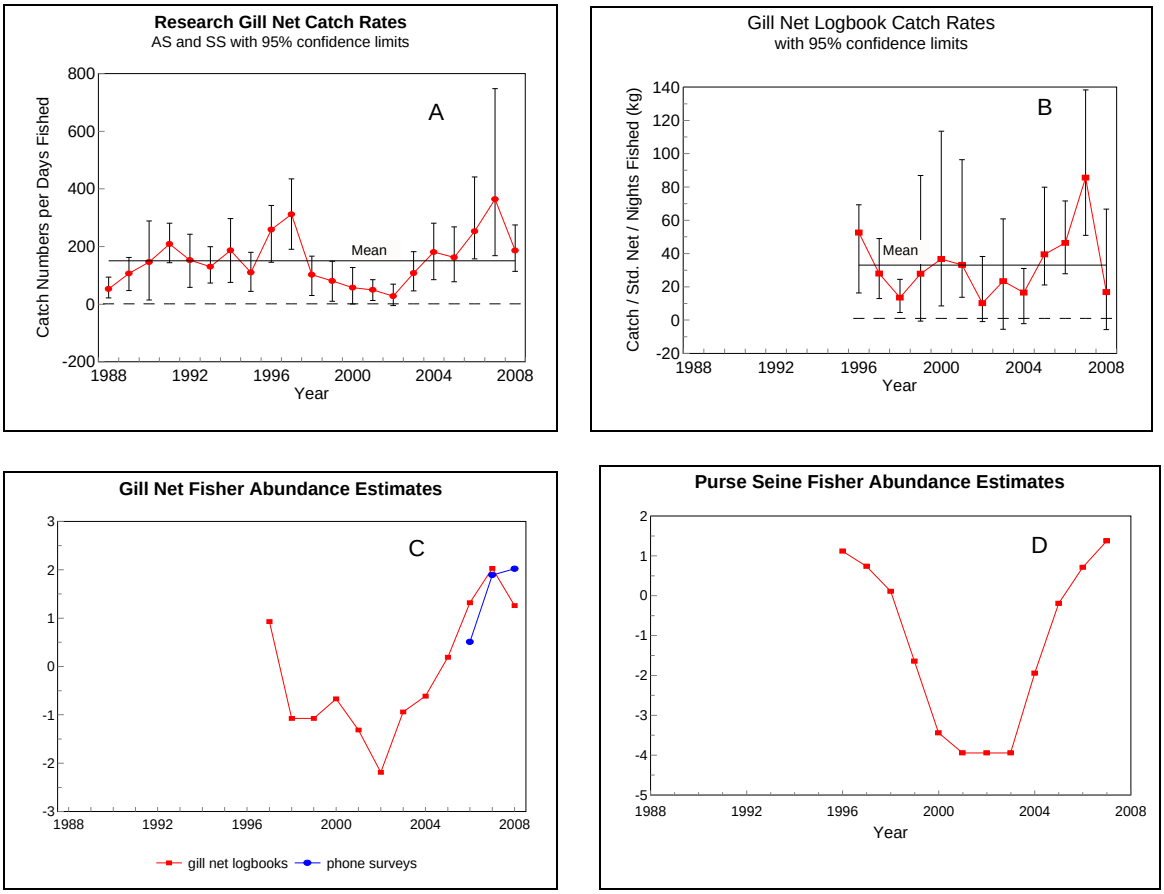


Figure 6. Bonavista Bay - Trinity Bay abundance indices: A) research gill net catch rates (1988-2008), B) commercial gill net logbook catch rates (1996–2008), C) gill net fisher abundance estimates on a cumulative index (logbooks 1996–2008, phone survey 2006–08), and D) purse seine fisher abundance estimates on a cumulative index (1996–2007).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined decreased, but not significantly, from 253 in 2006 to 186 in 2008 (Fig. 6, Panel A). The 2008 catch rate was above average, 124% of the mean (1988-2008). Catch rates have increased significantly from 2002 to 2007.

Three commercial gill net logbooks were returned in 2008. Catch rates (kilograms per standard net per nights fished) decreased, but not significantly, from 46.4 in 2006 to 16.8 in 2008 (Fig. 6, Panel B). The 2008 catch rate was below average, 55% of the mean (1996-2008). Fishers indicated (cumulative index) an increasing trend in abundance in the past five years and abundance in 2008 was lower than in 2007 (Fig. 6, Panel C).

There were 43 active gill net fishers contacted in the 2008 telephone survey. They indicated (cumulative index) an increasing trend in abundance since the survey began in 2006 and abundance in 2008 was higher than in 2007 (Fig. 6, Panel C).

Fifteen of eighteen active fishers responded to the purse seine questionnaire in 2007. They indicated (cumulative index) an increasing trend in abundance in the past five years and abundance in the fall of 2007 was higher than in 2006 (Fig. 6, Panel D).

Biological Characteristics

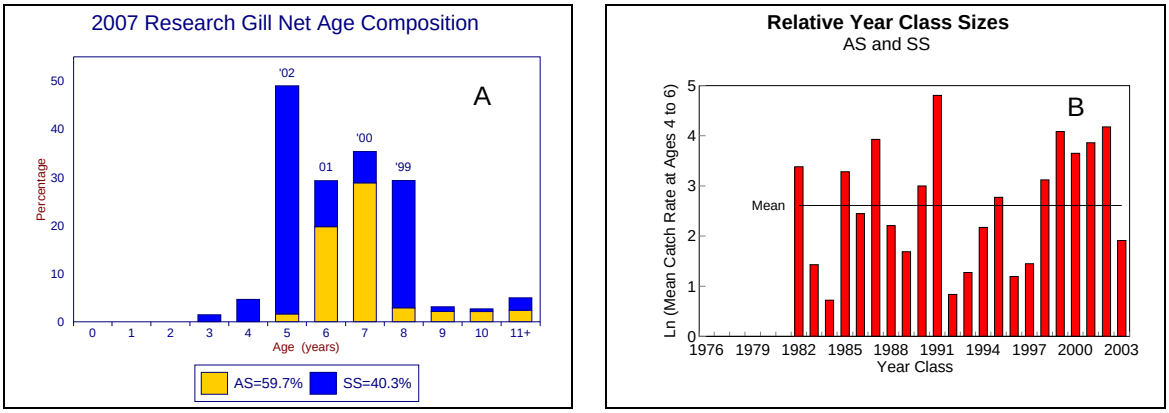


Figure 7. Bonavista Bay - Trinity Bay 2007 research gill net age composition (Panel A) and relative year class sizes (1982-2003) from research gill net catch rates at ages 4 to 6 (Panel B).

The 2002 and 2000 year classes accounted for 49% and 35% respectively of the 2007 research gill net catch numbers (Fig. 7, Panel A). The age distribution was extensive, as five year classes (including fish aged 11+) each accounted for greater than 5% of the catch. Spring spawners were 40% of the catch, a decrease of 15% from 2006.

In comparison to year classes since 1982, five of seven current mature year classes (1997 to 2003) are above average (Fig. 7, Panel B). The 2003 recruiting year class is below average. All year classes in this time series are weak in relation to the strong year classes of the late 1960's (Wheeler et al. 2001).

Current Status and Short Term Prospects

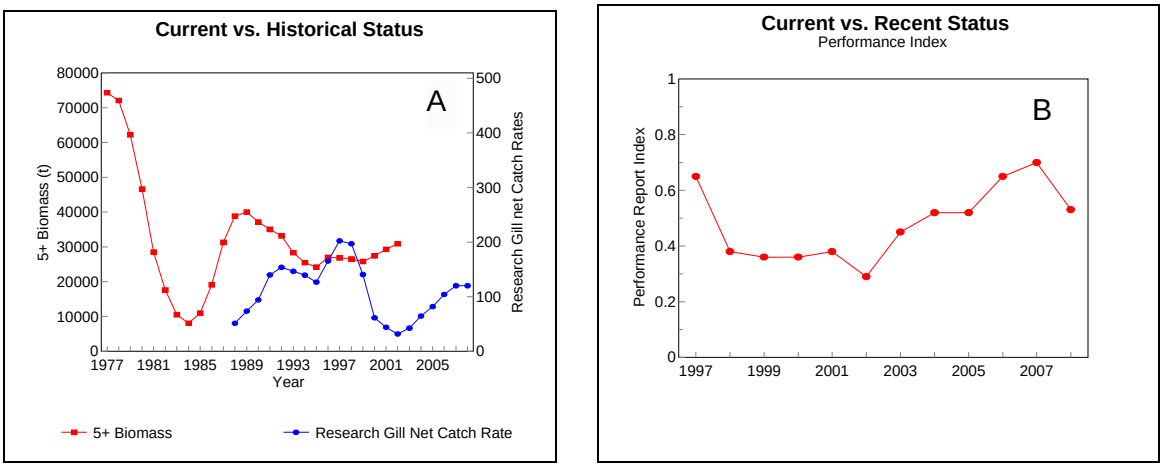


Figure 8. Comparison of research gill net catch rates and historical biomass estimates for Bonavista Bay-Trinity Bay (Panel A), and performance indices for 1997 to 2008 (Panel B).

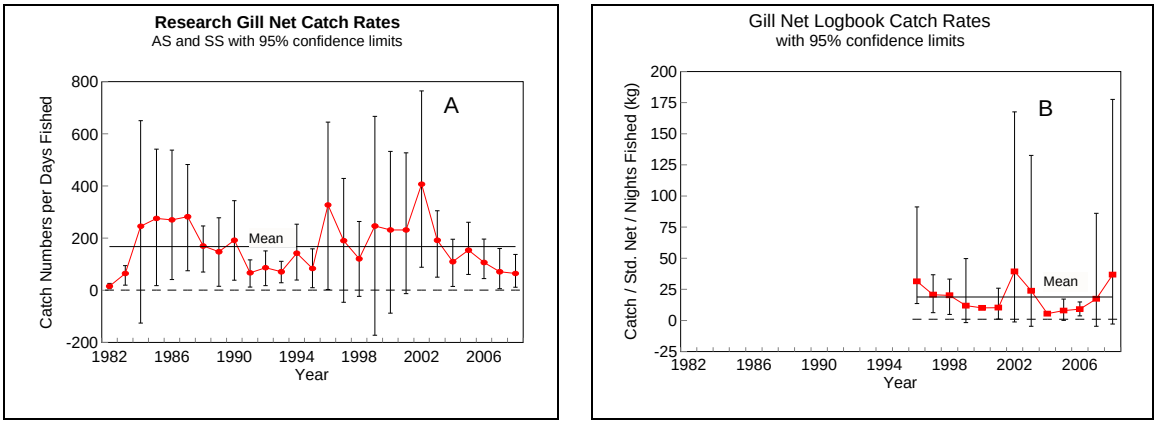
Biomass estimates are available to 2001 from an integrated catch at age analysis (Wheeler et al. 2001). A visual comparison with research gill net catch rates suggests that current abundance is substantially lower than historical estimates in the 1970's (Fig. 8, Panel A).

A standardized performance index is available for 1997-2008 (Fig. 8, Panel B). The composite index indicates that stock status improved from 2002 to 2007 and deteriorated in 2008.

Short term prospects are uncertain; the 2003 year class is below average but most mature year classes are above average compared to year classes since 1982 (Fig. 7, Panel B). However, all year classes in the time series are weak compared to historical levels.

St. Mary's Bay-Placentia Bay

Abundance Indices



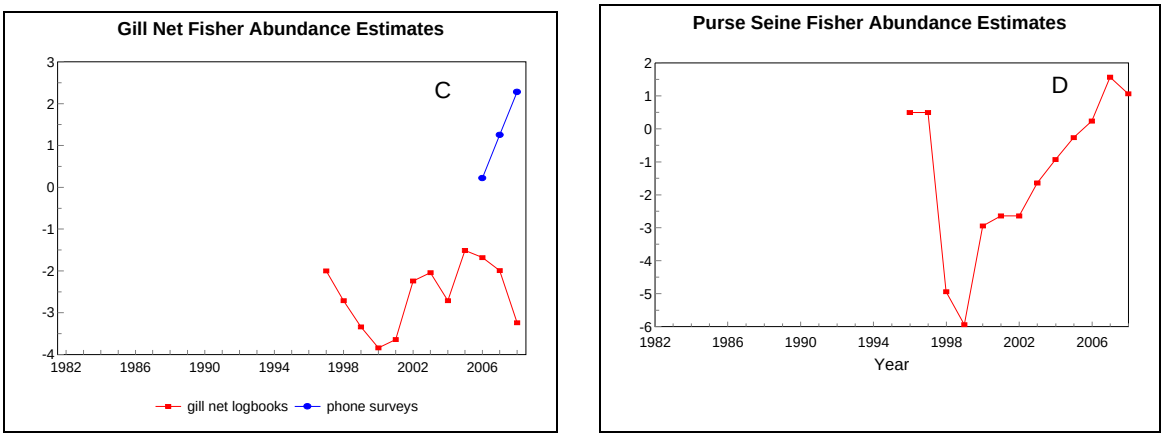


Figure 9. St. Mary's Bay - Placentia Bay abundance indices: A) research gill net catch rates (1982-2008), B) commercial gill net logbook catch rates (1996-2008), C) gill net fisher abundance estimates on a cumulative index (logbooks 1996-2008, phone survey 2006-2008), and D) purse seine fisher abundance estimates on a ten point scale (1996-2008).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined decreased, but not significantly, from 107 in 2006 to 29 in 2008 (Fig. 9, Panel A). The 2008 catch rate was below average, 17% of the mean (1982-2008) and the second lowest in the time series.

Seven commercial gill net logbooks were returned in 2008. Catch rates (kilograms per standard net per nights fished) increased, but not significantly, from 9.14 in 2006 to 36.8 in 2008 (Fig. 9, Panel B). The 2008 catch rate was above average, 196% of the mean (1996-2008) and the second highest in the time series. Fishers indicated (cumulative index) a decreasing trend in abundance in the past five years and abundance in 2008 was lower than in 2007 (Fig. 9, Panel C).

There were 17 active gill net fishers contacted in the 2008 telephone survey. They indicated (cumulative index) an increasing trend in abundance since the survey began in 2006 and abundance in 2008 was higher than in 2007 (Fig. 9, Panel C).

Both active fishers responded to the purse seine questionnaire in 2008. They indicated (cumulative index) an increasing trend in abundance in the past five years and abundance in the spring of 2008 was lower than in 2007 (Fig. 9, Panel D).

Biological Characteristics

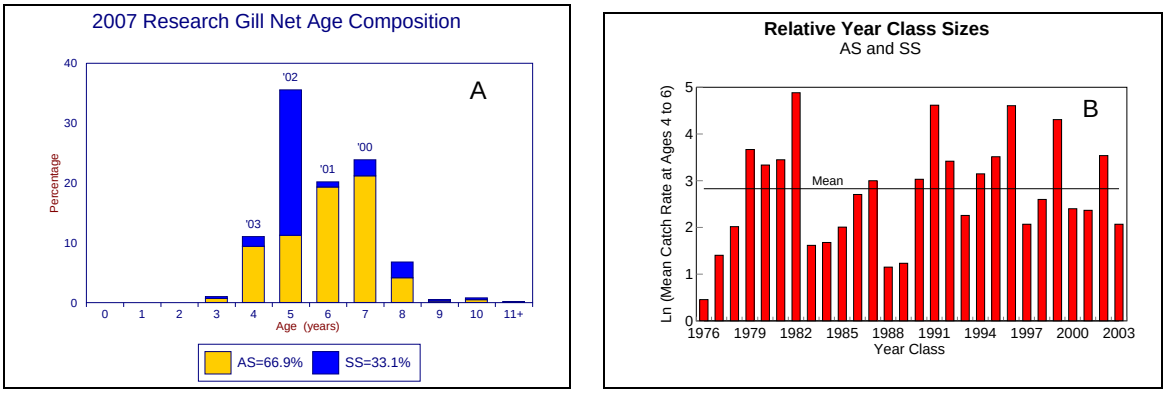


Figure 10. St. Mary's Bay - Placentia Bay 2007 research gill net age composition (Panel A) and relative year class sizes (1976-2003) from research gill net catch rates at ages 4 to 6 (Panel B).

The 2002 and 2000 year classes accounted for 36% and 24% respectively of the 2007 research gill net catch numbers (Fig. 10, Panel A). The age distribution was extensive, as five year classes (including fish age 11+) each accounted for greater than 5% of the catch. Spring spawners were 33% of the catch, a decrease of 41% from 2006.

In comparison to year classes since 1976, five of seven current mature year classes (1997 to 2003) are below average (Fig. 10, Panel B). The 2003 recruiting year class is below average. All year classes in this time series are weak in relation to the strong year classes of the late 1960's (Wheeler et al. 2001).

Current Status and Short Term Prospects

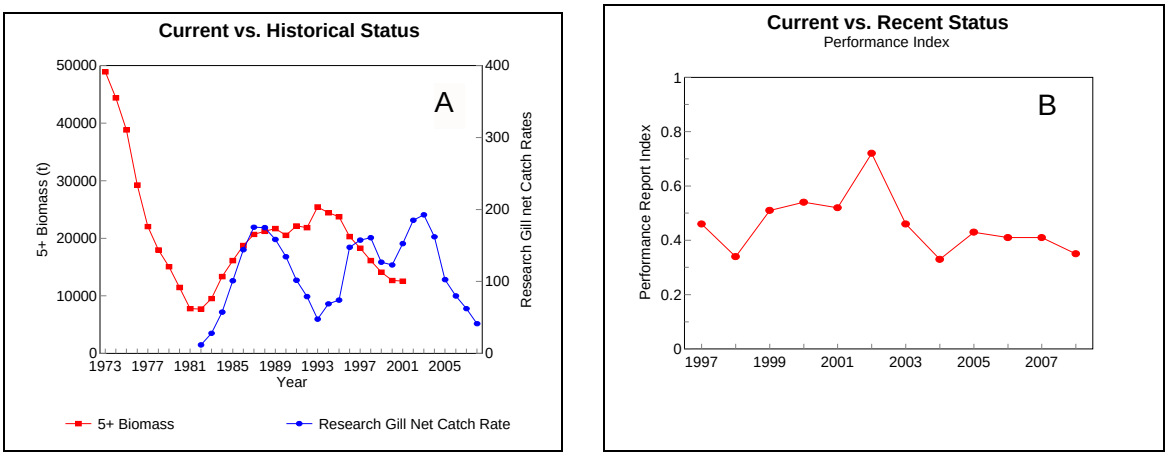


Figure 11. Comparison of research gill net catch rates and historical biomass estimates for St. Mary's Bay-Placentia Bay (Panel A), and performance indices for 1997 to 2008 (Panel B).

Biomass estimates are available to 2000 from an integrated catch at age analysis (Wheeler et al. 2001). A visual comparison with research gill net catch rates suggests that current abundance is substantially lower than historical estimates in the 1970's (Fig. 11, Panel A).

A standardized performance index is available for 1997 to 2008 (Fig. 11, Panel B). The composite index indicates that stock status deteriorated slightly from 2005 to 2008.

Short term prospects are negative; the 2003 year class is below average and most mature year classes are below average compared to year classes since 1976 (Fig. 10, Panel B). All year classes in the time series are weak compared to historical levels.

Fortune Bay

Abundance Indices

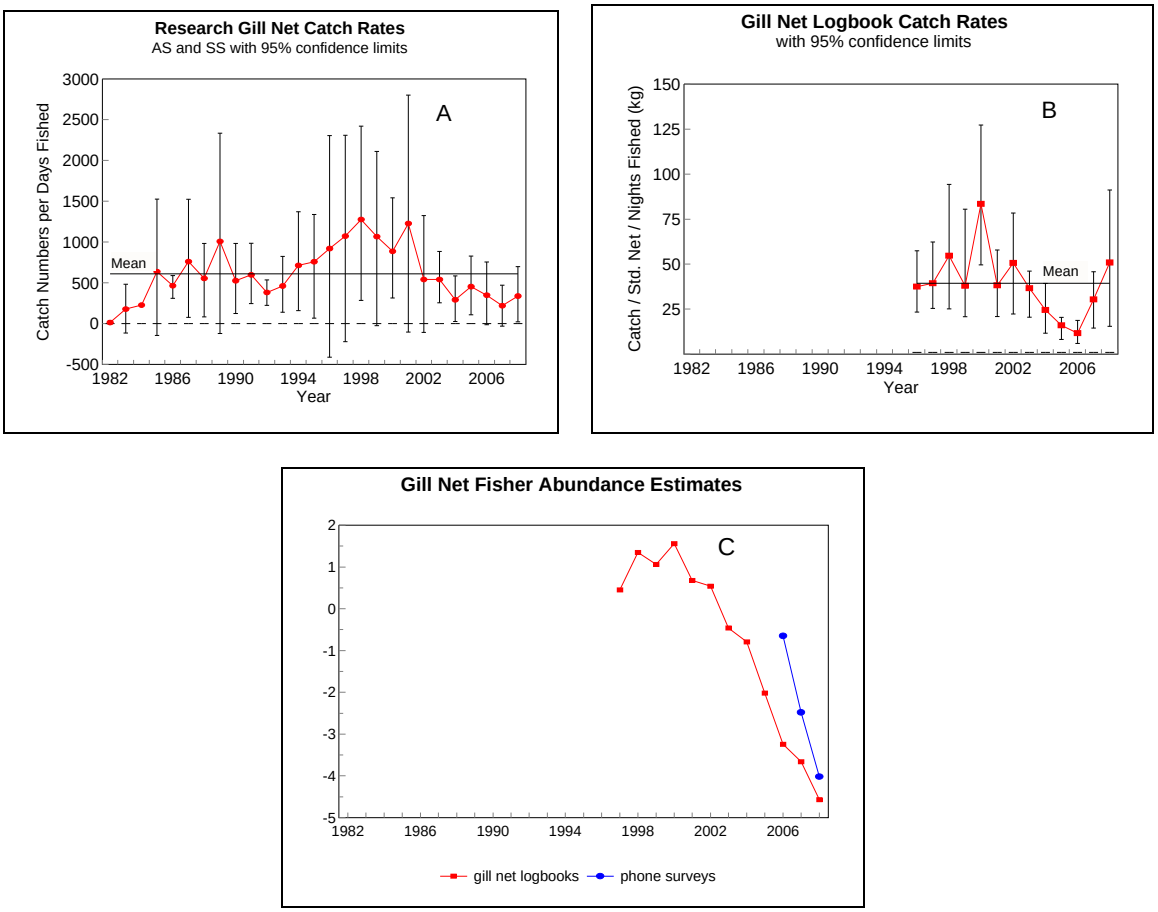


Figure 12. Fortune Bay abundance indices: A) research gill net catch rates (1982-2008), B) commercial gill net logbook catch rates (1996-2008), and C) gill net fisher abundance estimates on a cumulative index (logbooks 1996-2008, phone survey 2006-2008).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined decreased, but not significantly, from 348 in 2006 to 338 in 2008 (Fig. 12, Panel A). The 2008 catch rate was below average, 56% of the mean (1982-2008).

Twelve commercial gill net logbooks were returned in 2008. Catch rates (kilograms per standard net per nights fished) increased, but not significantly, from 11.6 in 2006 to 50.9 in 2008 (Fig. 12, Panel B). The 2008 catch rate was above average, 129% of the mean (1996-2008). Fishers indicated (cumulative index) a decreasing trend in abundance in the past five years and abundance in 2008 was lower than in 2007 (Fig. 12, Panel C).

There were 50 active gill net fishers contacted in the 2008 telephone survey. They indicated (cumulative index) a decreasing trend in abundance since the survey began in 2006 and abundance in 2008 was lower than in 2007 (Fig. 12, Panel C).

Biological Characteristics

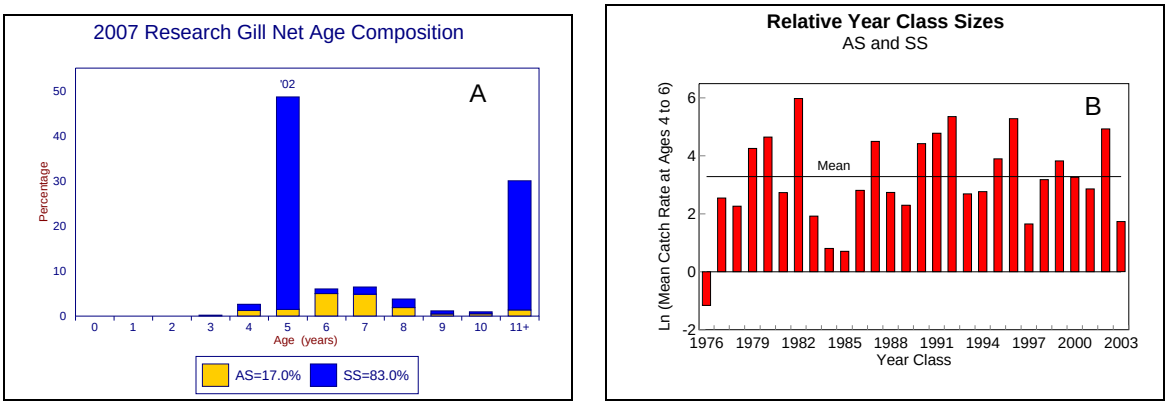


Figure 13. Fortune Bay 2007 research gill net age composition (Panel A) and relative year class sizes (1976-2003) from research gill net catch rates at ages 4 to 6 (Panel B).

The 2002 year class and fish age 11+ accounted for 49% and 30% respectively of the 2007 research gill net catch numbers (Fig. 13, Panel A). The age distribution was truncated, as only four year classes (including fish age 11+) each accounted for greater than 5% of the catch. Spring spawners were 83% of the catch, an increase of 7% from 2006.

In comparison to year classes since 1976, five of seven current mature year classes (1997-2003) are average or below average (Fig. 13, Panel B). The 2003 recruiting year class is below average. All year classes in this time series are weak in relation to the strong year classes of the late 1960's (Wheeler et al. 2001).

Current Status and Short Term Prospects

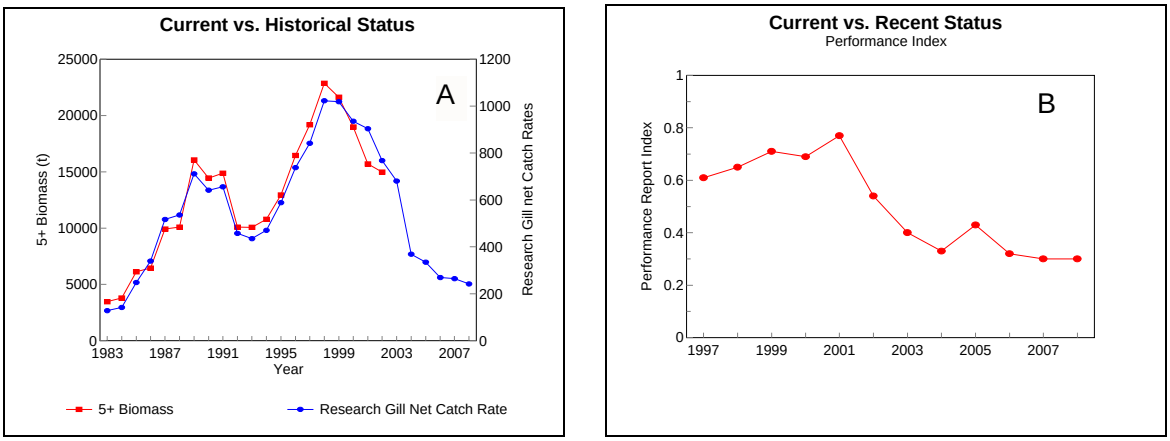


Figure 14. Comparison of research gill net catch rates and historical biomass estimates for Fortune Bay (Panel A), and performance indices for 1997 to 2008 (Panel B).

Biomass estimates are available to 2001 from a research gill net catchability analysis (Wheeler et al. 2001). A visual comparison with research gill net catch rates suggests that current abundance is substantially lower than peak estimates in the late 1990's (Fig. 14, Panel A).

A standardized performance index is available for 1997 to 2008 (Fig. 14, Panel B). The composite index indicates that stock status deteriorated from 2001 to 2006, but has remained stable from 2006 to 2008.

Short term prospects are negative; the 2003 year class is below average and most mature year classes are average or below average compared to year classes since 1976 (Fig. 13, Panel B).

Sources of Uncertainty

The major uncertainty in this assessment continues to be the inability to estimate current stock sizes and exploitation rates, and to place these estimates within an historical context. Models which depend upon catch at age are difficult to calibrate due to low catch levels in some areas and years. Such models are further complicated due to uncertainties in the catch at age. Bait landings, which account for a large portion of the catch in some areas and years, are not included in official catch statistics for most years. Estimates of landings by purse seine fishers are higher than official statistics in some areas and years. Dead discards from the purse seine fishery are also not included in estimates of total removals.

The evaluation of trends within abundance indices is dependent, among other things, upon the uncertainties associated with each index. Due to the limited fishery and research data, sample sizes for most indices in these assessments, with the exception of the gill net fisher index from telephone surveys, are generally small resulting in higher uncertainties. This was evident in examining residual patterns from ADAPT calibrations.

There continues to be concerns regarding a methodology to quantify the observations of abundance by gill net and purse seine fishers contacted during telephone surveys.

Estimation of recruiting year class strength is important in evaluating the future prospects of these stocks. Recruitment data are available from the research gill net series, but these may be biased by systematic changes in growth. Strong year classes are normally seen across stock areas and quickly become dominant in most data sources. However, it is more difficult to predict the future prospects of weak and moderately strong year classes.

Standardization of performance reports requires the combination of several indices. As in past assessments, indices were weighted subjectively based upon the perceived degree to which each data source represents abundance trends.

CONCLUSIONS

Table 1. White Bay-Notre Dame Bay performance table to the spring of 2008.

The Fishery	***Observation***	
Reported Landings: 2006 - 2007	Landings increased from 309 t in 2006 to 362 t in 2007; 21% of the TAC was taken in 2007; average landings of 2800 t during 1990's; peak landings of 15,700 t in 1979.	
Total Removals: 2007	In addition to reported landings in 2007, approximately 600 t were estimated to have been taken for bait purposes; fishers reported no discard mortality in the purse seine fishery.	
Effort: 2007 and 2008	Documented effort has declined since the 1980's; purse seine effort decreased by 80% from 1997 to 2007; gill net effort has also decreased by 82% from 1996 to 2008.	
Geographic Distribution of Fishery	The 2007 purse seine fishery, in November and December, was mostly in the Fogo Island area. The 2008 gill net fishery, from early May to early July, was mostly in Notre Dame Bay.	
Abundance Indices	***Observation***	***Interpretation***
Research Gill Net Catch Rates 1988-2008 (numbers / nights fished)	Decreased, but not significantly, from 2006 to 2008; 2008 = 233, mean = 380, maximum = 887.	Current abundance below average.
Commercial Gill Net Catch Rates 1996-2008 (kg / net / nights fished)	Increased, but not significantly, from 2006 to 2008; (2008 = 8 logbooks); 2008 = 86, mean = 33, maximum = 86.	Current abundance above average.
Gill Net Fisher Observations 1996-2008 from logbooks	16 observations in 2008; increasing trend in abundance over past 5 years; 2008 higher than 2007.	Increasing trend in abundance.
Gill Net Fisher Observations 2006-2008 from telephone surveys	32 observations in 2008; increasing trend in abundance since telephone survey began in 2006; 2008 higher than 2007.	Increasing trend in abundance.
Purse Seine Fisher Observations 1996 - 2007	2 observations in 2007; decreasing trend in abundance over past 5 years; 2007 slightly lower than 2006.	Decreasing trend in abundance.
Biological Characteristics	***Observation***	***Interpretation***
2007 Research Gill Net Age Compositions (ages 3+)	The 2002 and 2001 year classes accounted for 49% and 15% respectively of the catch; 5 year classes each account for >5% of catch.	Population age structure considered to be stable.
Current Year Classes: 1997 to 2003 Series: 1982 - 2003 year classes	3 of 7 current mature year classes above average, 3 below average, and 1 average.	Equal numbers of mature year classes above and below average.
Recruitment: 2003 year class Series: 1982 to 2003 year classes	2003 year class below average.	Below average recruitment of the most recent estimatible year class.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Historical	Current abundance is substantially lower than historical estimates in the 1970's.	-
Current vs. Recent	Stock status improved from 2002 to 2008.	+
Short Term Prospects	Uncertain; below average recruitment of 2003 year class; equal numbers of current mature year classes are above and below average but are weak compared to historical levels.	?

Status Definitions	
-	Concern for Current Status or Prospect
?	Uncertainty of Interpretation
+	Positive Evaluation

The standardized performance index indicates that stock status improved from 2002 to 2008. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are uncertain; the 2003 year class is below average and equal numbers of mature year classes are above and below average but are weak, compared to historical levels.

Table 2. Bonavista Bay - Trinity Bay performance table to the spring of 2008.

The Fishery	***Observation***	
Reported Landings: 2006 - 2007	Landings increased from 1904 t in 2006 to 2777 t in 2007; 69% of the TAC was taken in 2007; average landings of 2600 t during 1990's; peak landings of 12,000 t in 1977.	
Total Removals: 2007	In addition to reported landings in 2007, approximately 550 t were estimated to have been taken for bait purposes; fishers reported no discard mortality in the purse seine fishery.	
Effort: 2007 and 2008	Documented effort has increased in the purse seine fishery in recent years and peaked in 2007; gill net effort decreased by 93% from 1996 to 2008.	
Geographic Distribution of Fishery	The 2007 purse seine fishery, in November and December, was in the northern part of Bonavista Bay and in Northwest Arm and the southern part of Trinity Bay. The 2008 gill net fishery, from mid April to late June, was distributed throughout Bonavista and Trinity Bays.	
Abundance Indices	***Observation***	***Interpretation***
Research Gill Net Catch Rates 1988-2008 (numbers / nights fished)	Decreased, but not significantly, from 2006 to 2008; 2008 = 186, mean = 150, maximum = 365.	Current abundance above average.
Commercial Gill Net Catch Rates 1996-2008 (kg / net / nights fished)	Decreased, but not significantly, from 2006 to 2008; (2008 = 3 logbooks); 2008 = 17, mean = 33, maximum = 86.	Current abundance below average.
Gill Net Fisher Observations 1996-2008 from logbooks	13 observations in 2008; increasing trend in abundance over past 5 years; 2008 lower than 2007.	Increasing trend in abundance.
Gill Net Fisher Observations 1996-2008 from telephone surveys	41 observations in 2008; increasing trend in abundance since telephone survey began in 2006; 2008 higher than 2007.	Increasing trend in abundance.
Purse Seine Fisher Observations 1996 - 2007	15 observations in 2007; increasing trend in abundance over past 5 years; 2008 higher than 2007.	Increasing trend in abundance.
Biological Characteristics	***Observation***	***Interpretation***
2007 Research Gill Net Age Compositions (ages 3+)	The 2002 and 2000 year classes accounted for 49% and 35% respectively of the catch; 5 year classes each account for >5% of catch.	Population age structure considered to be stable.
Current Year Classes: 1997 to 2003 Series: 1982 - 2003 year classes	5 of 7 current mature year classes above average.	Most current mature year classes above average.
Recruitment: 2003 year class Series: 1982 to 2003 year classes	2003 year class above average.	Below average recruitment of the most recent estimatible year class.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Historical	Current abundance is substantially lower than historical estimates in the 1970's.	-
Current vs. Recent	Stock status improved from 2002 to 2007 but deteriorated in 2008.	+
Short Term Prospects	Uncertain; below average recruitment of 2003 year class; most current mature year classes are above average but are weak compared to historical levels.	?

Status Definitions	
-	Concern for Current Status or Prospect
?	Uncertainty of Interpretation
+	Positive Evaluation

The standardized performance index indicates that stock status improved from 2002 to 2007 but deteriorated in 2008. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are uncertain; the 2003 year class is below average but most mature year classes are above average but weak, compared to historical levels.

Table 3. St. Mary's Bay-Placentia Bay performance table to the spring of 2008.

The Fishery	***Observation***	
Reported Landings: 2006 - 2007	Landings decreased from 1528 t in 2006 to 759 t in 2007; 30% of the TAC was taken in 2007; average landings of 1200 t during 1990's; peak landings of 4000 t in 1997 (since large mobile purse seine fishery in 1960's).	
Total Removals: 2007	In addition to reported landings in 2007, approximately 150 t were estimated to have been taken for bait purposes; fishers reported no discard mortality in the purse seine fishery.	
Effort: 2008	Documented effort increased from the 1980's to the 1990's; purse seine effort peaked in 2000 and has since declined by 79% from 2001 to 2008; gill net effort peaked in 1998 and has since declined by 73% from 1998 to 2008.	
Geographic Distribution of Fishery	The 2008 purse seine fishery, from April to June, was along the eastern sides of Placentia Bay and St. Mary's Bay. The 2008 gill net fishery, from early April to early June, was mostly in Placentia Bay.	
Abundance Indices	***Observation***	***Interpretation***
Research Gill Net Catch Rates 1982-2008 (numbers / nights fished)	Decreased, but not significantly, from 2006 to 2008; 2008 = 29, mean = 168, maximum = 407.	Current abundance below average.
Commercial Gill Net Catch Rates 1996-2008 (kg / net / nights fished)	Increased, but not significantly, from 2006 to 2008 (2008 = 7 logbooks); 2008 = 37, mean = 19, maximum = 39.	Current abundance above average.
Gill Net Fisher Observations 1996-2008 from logbooks	10 observations in 2008; decreasing trend in abundance over past 5 years; 2008 lower than 2007.	Decreasing trend in abundance.
Gill Net Fisher Observations 1996-2008 from telephone surveys	15 observations in 2008; increasing trend in abundance since telephone survey began in 2006; 2008 higher than 2007.	Increasing trend in abundance.
Purse Seine Fisher Observations 1996-2008	2 observations in 2008; increasing trend in abundance over past 5 years; 2008 lower than 2007.	Increasing trend in abundance.
Biological Characteristics	***Observation***	***Interpretation***
2007 Research Gill Net Age Compositions (ages 3+)	The 2002 and 2000 year classes accounted for 36% and 24% respectively of the catch; 5 year classes each account for >5% of catch.	Population age structure considered to be stable.
Current Year Classes: 1997 to 2003 Series: 1976 - 2003 year classes	5 of 7 current mature year classes below average.	Most current mature year classes below average.
Recruitment: 2003 year class Series: 1976 to 2003 year classes	2003 year class below average.	Below average recruitment of the most recent estimatible year class.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Historical	Current abundance is substantially lower than historical estimates in the 1970's.	-
Current vs. Recent	Stock status deteriorated slightly since 2005.	-
Short Term Prospects	Negative; below average recruitment of 2003 year class; most current mature year classes are below average and are weak compared to historical levels.	-

Status Definitions	
-	Concern for Current Status or Prospect
?	Uncertainty of Interpretation
+	Positive Evaluation

The standardized performance index indicates that stock status deteriorated from 2002 to 2004, improved slightly in 2005, and deteriorated slightly from 2005 to 2008. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are negative; the 2003 year class is below average and most mature year classes are below average and are weak, compared to historical levels.

Table 4. Fortune Bay performance table to the spring of 2008.

The Fishery	***Observation***	
Reported Landings: 2006 - 2007	Landings increased from 2340 t in 2006 to 2448 t in 2007; 77% of the TAC was taken in 2007; average landings of 200 t during 1990's; peak landings in 2003 (since large mobile purse seine fishery in 1960's).	
Total Removals: 2007	In addition to reported landings in 2007, approximately 450 t were estimated to have been taken for bait purposes.	
Effort: 2008	Documented effort in 1980's and 1990's was very low; gill net effort peaked in 1997 and has since declined by 81% from 1997 to 2008; there is no purse seine fishery in Fortune Bay. The current fishery is primarily by bar seines and traps for which no effort information is available. However, combined bar seine and trap landings have increased from 0 t in 1998 to 2440 t in 2008.	
Geographic Distribution of Fishery	The 2008 spring bar seine fishery was concentrated in the Long Harbour area; the gill net fishery, from early April to mid June, was distributed throughout Fortune Bay.	
Abundance Indices	***Observation***	***Interpretation***
Research Gill Net Catch Rates 1982-2008 (numbers / nights fished)	Decreased, but not significantly, from 2006 to 2008; 2008 = 338, mean = 610, maximum = 1275.	Current abundance below average.
Commercial Gill Net Catch Rates 1996-2008 (kg / net / nights fished)	Increased, but not significantly, from 2006 to 2008 (2008 = 12 logbooks); 2008 = 60, mean = 39, maximum = 84.	Current abundance above average.
Gill Net Fisher Observations 1996-2008 from logbooks	16 observations in 2008; decreasing trend in abundance over past 5 years; 2008 lower than 2007.	Decreasing trend in abundance.
Gill Net Fisher Observations 1996-2008 from telephone surveys	47 observations in 2008; decreasing trend in abundance since telephone survey began in 2006; 2008 lower than 2007.	Decreasing trend in abundance.
Biological Characteristics	***Observation***	***Interpretation***
2007 Research Gill Net Age Compositions (ages 3+)	The 2002 year class and fish aged 11+ accounted for 49% and 30% respectively of the catch; 4 year classes each account for >5% of the catch.	Population age structure considered to be stable due to substantial contribution of older fish.
Current Year Classes: 1997 to 2003 Series: 1976 - 2003 year classes	5 of 7 current mature year classes average or below average.	Most current mature year classes average or below average.
Recruitment: 2003 year class Series: 1976 to 2003 year classes	2003 year class below average.	Below average recruitment of the most recent estimatible year class.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Historical	Current abundance is lower than peak estimates in the late 1990's.	-
Current vs. Recent	Stock status deteriorated steadily from 2001 to 2004, improved slightly in 2005, deteriorated again in 2006, and has remained stable from 2006 to 2008.	-
Short Term Prospects	Negative; below average recruitment of 2003 year class; most current mature year classes are below average.	-

Status Definitions	
-	Concern for Current Status or Prospect
?	Uncertainty of Interpretation
+	Positive Evaluation

The standardized performance index indicates that stock status deteriorated from 2001 to 2004, improved slightly in 2005, deteriorated again in 2006, and remained stable from 2006 to 2008. Current abundance is substantially lower than peak estimates in the mid to late 1980's. Short term prospects are negative; the 2003 year class is below average and most mature year classes are below average.

OTHER CONSIDERATIONS

A manuscript has been accepted for publication titled “Temporal changes in growth, maturation, and condition of spring-spawning Atlantic herring (*Clupea harengus*) and the potential implications for fisheries management in Newfoundland waters” (Wheeler et al. 2008). It concludes that length and age at maturation decreased for spring-spawning herring in Newfoundland waters during the late 1980s and early 1990s. The changes were probably induced by a combination of environmental factors and fishing mortality. This maturation decline happened similarly for males and females and for fish from northern and southern regions. Growth rates and body condition (for a given size and age) also declined during the same period. The results do not support the hypothesis that maturation changes were due to phenotypic plasticity, and therefore by default support the hypothesis that these populations have evolved a different maturation projectory.

Regardless of the cause, fisheries managers should exercise caution before considering a reduction in the minimum commercial size for herring. When set in the early 1970s, the minimum size was designed to protect all two year old and most three year old herring from commercial exploitation. Recent studies (Ernande et al. 2004) have shown that evolutionary changes in maturation are minimized when the minimum allowable size is set such that immature individuals are mostly below the size limit. It has also been suggested that earlier maturation may negatively influence reproductive potential, as smaller females produce fewer offspring than larger ones and also produce offspring of poorer quality (Murawski et al. 2001; Berkeley et al. 2004; Hutchings 2005).

Management Considerations

Performance reports provide a review of stock status and a visual description of stock status; however, they do not provide absolute estimates of abundance.

Management should consider the impact of recent catch levels when formulating management plans.

Management should also consider the impact of slower growth and earlier age to maturity and their potential contribution to higher exploitation on the existing weak year classes.

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ISSN 1480-4913 (Printed)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2009. Assessment of Newfoundland East and South Coast Herring Stocks to 2008. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/049.