



ASSESSMENT OF NEWFOUNDLAND EAST AND SOUTH COAST HERRING STOCKS TO 2006

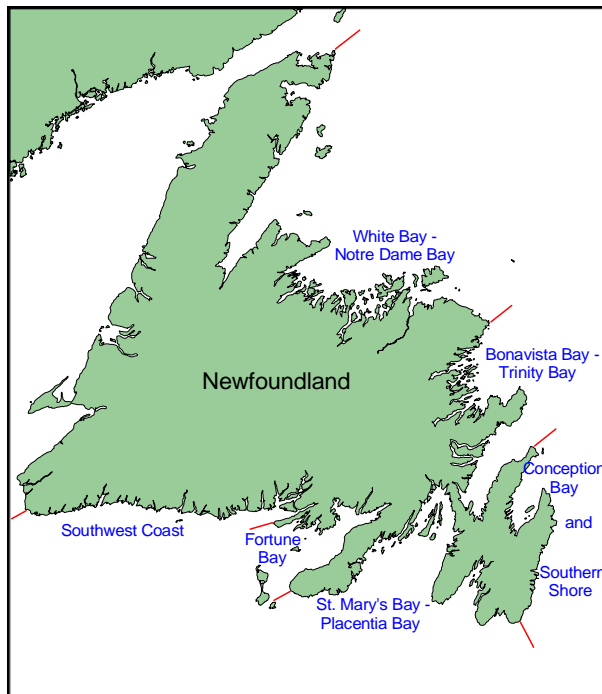
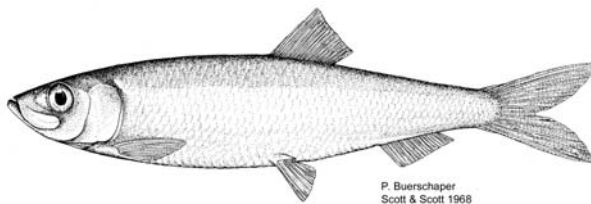


Figure 1: Area map indicating herring stock complexes within the Newfoundland and Labrador Region.

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 have averaged 5600 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 2005 – 2006 Integrated Management Plan for Herring on the East and South Coasts of Newfoundland (DFO 2005) established annual TAC's by stock area and gear sector for 2005 and 2006.

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, mean weights, and year class sizes are evaluated. In this assessment, additional details have been given for autumn spawning herring, given their increased numbers in commercial and research gill net catches in recent years.

A meeting of the Regional Advisory Process was held on November 1 and 2, 2006 in St. John's, NL to assess the status of east and south coast Newfoundland herring in support of the management of the 2007 and 2008 fisheries. Participants included DFO scientists, fisheries managers, and representatives from the provincial government and Memorial University.

SUMMARY

White Bay – Notre Dame Bay

- Reported landings increased from 265 t in 2004 to 911 t in 2005; 83% of the TAC was taken in 2005.
- A standardized performance index indicates that stock status has improved from 2002 to 2006; however, stock abundance is substantially lower than historical estimates in the 1970's.
- Short term prospects are uncertain; the 2001 year class is average and most mature year classes are average or below average compared to year classes produced since 1982. All year classes since 1982 are weak compared to historical levels.

Bonavista Bay – Trinity Bay

- Reported landings increased from 509 t in 2004 to 2639 t in 2005; 88% of the TAC was taken in 2005.
- A standardized performance index indicates that stock status has improved from 2002 to 2006; however, stock abundance is substantially lower than historical estimates in the 1970's.
- Short term prospects are positive; the 2001 year class is above average and 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 increased from 1389 t in 2004 to 1426 t in 2005; 57% of the TAC was taken in 2005.
- A standardized performance index indicates that stock status deteriorated from 2002 to 2004, improved slightly in 2005, and has remained stable from 2005 to 2006. However, stock abundance is substantially lower than historical estimates in the 1970's.
- Short term prospects are negative; the 2001 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 decreased from 2930 t in 2004 to 2653 t in 2005; 72% of the TAC was taken in 2005.
- A standardized performance index indicates that stock status deteriorated steadily from 2001 to 2004, improved slightly in 2005, and deteriorated again in 2006. However, stock abundance is substantially lower than in the late 1990's.
- Short term prospects are negative; the 2001 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.

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. In the early 1980's, the length (total length) at which 50% of fish matured was approximately 290 mm. By 2005, this decreased by 40 mm. Similarly, herring did not fully mature until age 5; now most herring are mature at age 4. Reduced growth rates can affect fecundity (number of eggs produced). For example, a one centimetre reduction in the length at which 50% of herring mature results in a 12 – 16% reduction in fecundity (Hodder 1972).

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. It has been shown (Winters and Wheeler 1987) that when good survival of young herring (i.e. recruitment) occurred through the 1960's to 1980's, it 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 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. Ocean temperatures and salinities in the early to mid 1990's were below average. Ocean temperatures have been above average since the late 1990's. Similarly, salinities have also increased since 2001 and are currently above average, potentially providing better environmental conditions for survival of young herring. However, year classes produced during the 1990's are weak in relation to the large year classes of the 1960's. The 2001 year class is average or below average in most areas. There are no estimates of recruitment beyond the 2001 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 36000 t of herring in NAFO Divs. 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. Research on recent diets and seasonal distribution of harp and hooded seals are currently underway and revised estimates of consumption should be available within the next two years (Stenson, pers. comm.).

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 2006 (Wheeler et al. in prep.). Conception Bay – Southern Shore was excluded due a lack of scientific data.

Four 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, 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 2006, twenty-seven fishers participated in the program. Data are available from 1988 to 2006 for White Bay – Notre Dame Bay and Bonavista Bay – Trinity Bay and from 1982 to 2006 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 2005. Catch rates only are available for 2006, 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 2006, 13 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 perceptions 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". To date, when asked to provide their perceptions of abundance, fishers have not been asked to define "average abundance". In 2006, information from logbooks was supplemented with data from a telephone survey. Each of 168 active fishers contacted was asked the same question to determine their perceptions of herring abundance. Logbook results were used as indices from 1996 to 2004; phone survey results were used as indices in 2005 and 2006.

The purse seine fishery questionnaire, initiated in 1996, provides a quantitative 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 2005, 20 of 28 active fishers responded. Purse seine fishers are also asked to rate their perceptions of herring abundance, on a ten point scale, similar to gill net fishers. Results are available to 2005 for White Bay – Notre Dame Bay and Bonavista Bay – Trinity Bay where there is a fall purse seine fishery. Results are available to 2006 for St. Mary's Bay – Placentia Bay where there is a winter / spring purse seine fishery. Purse seine fisher observations are not available from Fortune Bay as there is no purse seine fishery in the area.

Biological characteristics, including age compositions, mean weights (ages 4 to 10), and year class sizes were evaluated. Ecological considerations included the potential effects of changes in water temperature and salinity on recruitment.

Age compositions from research gill nets were considered to best represent population age structure and were available for each area to 2005.

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 (1995 to 2001) that can be estimated. These are the year classes that produced the 2005 population numbers at ages 4 to 10. The 2001 year class (at age 4 in 2005) is the most recent recruiting year class that can be estimated.

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.

In evaluating current vs. historical status, research gill net catch rates were compared to historical population estimates (Wheeler et al. 2001). In evaluating 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 2001 recruiting year class.

Fishery

Prior to the 2005 fishery, Fisheries and Aquaculture Management Branch formulated a new two year (2005 and 2006) integrated management plan for east and south coast Newfoundland herring. TAC’s remained the same for all areas.

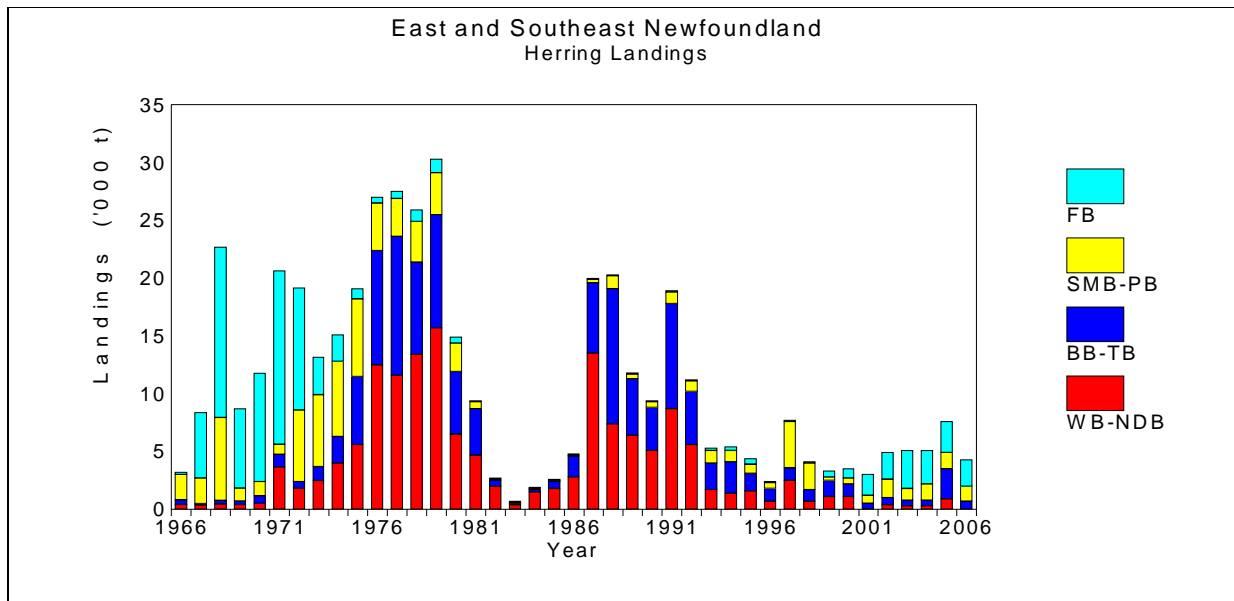


Figure 2. Herring landings by stock area, 1966 – 2006 (2006: reported landings to September).

Reported landings increased from 5100 t in 2004 to 7600 t in 2005, the highest since 1997 (Figure 2). The increased landings reflected increased effort, due to price reductions in the snow crab and shrimp fisheries. The 7600 t represented approximately 74% of the overall TAC. For 2006, landings data are available only to September.

In White Bay – Notre Dame Bay, reported landings increased from 265 t in 2004 to 911 t in 2005; 83% of the TAC was taken in 2005. The 2000 year class accounted for 38% of landing numbers, followed by the 2001 year class at 28%. As in 2004, the 2002 year class was important, and accounted for 24% of landing numbers. The age distribution was truncated, as only three year classes each accounted for greater than 5% of the landings. Spring spawners accounted for 55% of landings, a decrease of 18% from 2004.

In Bonavista Bay – Trinity Bay, reported landings increased from 509 t in 2004 to 2639 t in 2005; 88% of the TAC was taken in 2005. The 2002 year class accounted for 27% of landing numbers, followed by the 2001 year class at 25%. The age distribution was truncated as only four year classes each accounted for greater than 5% of the landings. Spring spawners accounted for 75% of landings, an increase of 14% from 2004.

In St. Mary's Bay – Placentia Bay, reported landings increased from 1389 t in 2004 to 1426 t in 2005; 57% of the TAC was taken in 2005. The 1999 year class accounted for 54% of landing numbers, followed by the 2000 year class at 13%. The 2002 and 2003 year classes accounted for a combined 16% of catch numbers. Although the 1999 year class was dominant, the age distribution was still extensive, as six year classes each accounted for greater than 5% of the landings. Spring spawners accounted for 70% of landings, an increase of 7% from 2004.

In Fortune Bay, reported landings decreased from 2930 t in 2004 to 2653 t in 2005; 72% of the TAC was taken in 2005. The 1996 year class accounted for 47% of landing numbers, followed by fish aged 11+ at 17%. The 2002 year class accounted for 8% of catch numbers. The age distribution was truncated, as only three year classes each accounted for greater than 5% of the landings. Spring spawners accounted for 80% of landings, a decrease of 17% from 2004.

ASSESSMENT

White Bay – Notre Dame Bay

Abundance Indices

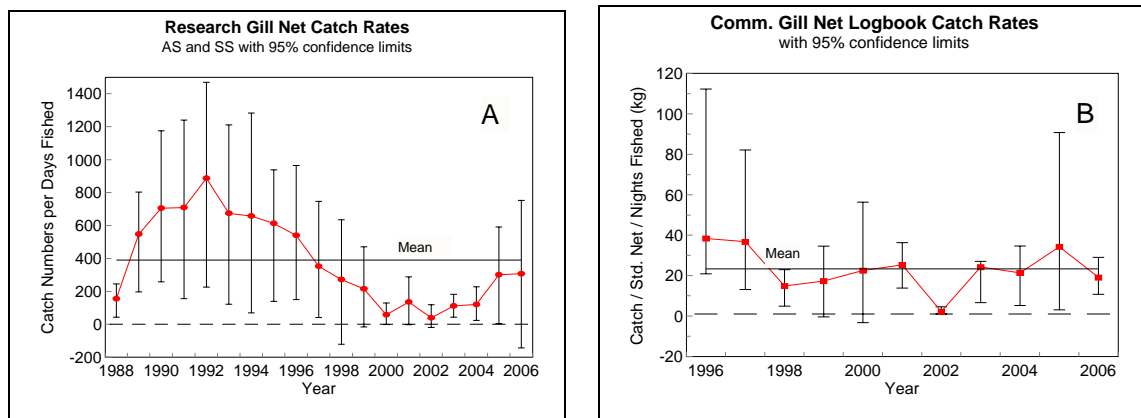


Figure 3. White Bay – Notre Dame Bay abundance indices: A) research gill net catch rates (1988 – 2006), and B) commercial gill net logbook catch rates (1996 – 2006).

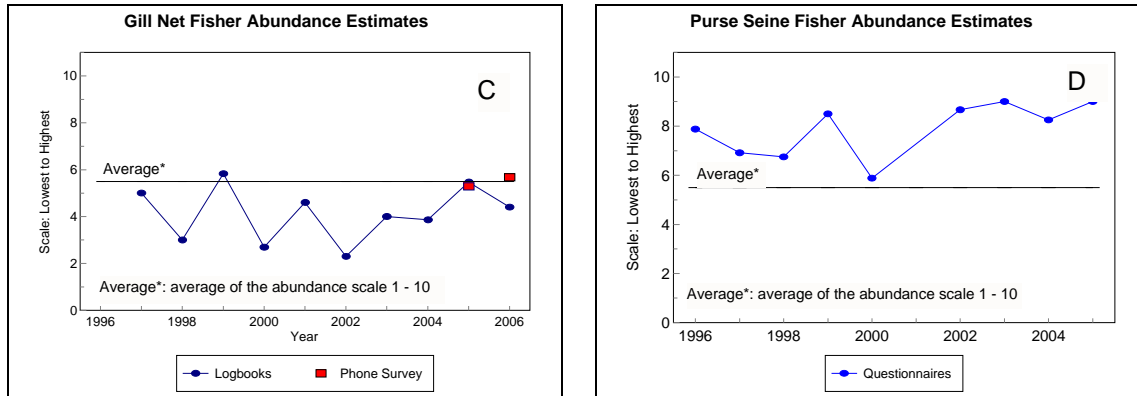


Figure 3 cont'd. White Bay – Notre Dame Bay abundance indices: C) gill net fisher abundance estimates on a ten point scale (logbooks 1996 – 2006, phone survey 2005 – 2006), and D) purse seine fisher abundance estimates on a ten point scale (1996 – 2005).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined increased, but not significantly, from 121 in 2004 to 307 in 2006 (Figure 3, Panel A). The 2006 catch rate was below average, 79% of the mean (1988 – 2006). Catch rates decreased significantly from 1992 to 2002.

Six commercial gill net logbooks were returned in 2006. Catch rates (kilograms per standard net per nights fished) decreased slightly, but not significantly, from 21.4 in 2004 to 19.6 in 2006 (Figure 3, Panel B). The 2006 catch rate was below average, 82% of the mean (1996 – 2006).

There were 40 active gill net fishers contacted in the 2006 phone survey. They indicated (on a ten point scale) that herring abundance in 2006 was average and higher than in 2005 (Figure 3, Panel C). Although perceptions of abundance were available from logbooks to 2006, sample sizes from the phone survey were larger and consequently, phone survey results were used as indices in 2005 and 2006.

Four of four active fishers responded to the purse seine questionnaire in 2005. They indicated (on a ten point scale) that herring abundance in 2005 was above average and higher than in 2004 (Figure 3, Panel D).

Biological Characteristics

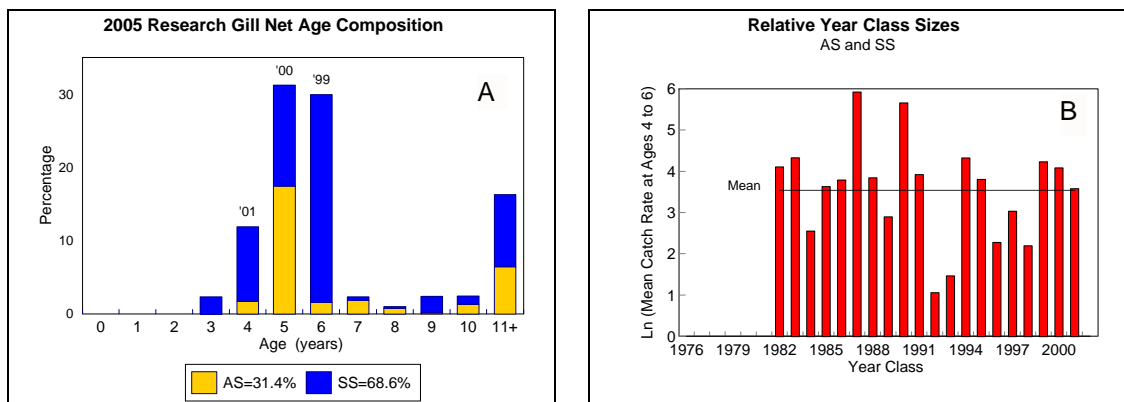


Figure 4. White Bay – Notre Dame Bay 2005 research gill net age composition (Panel A) and relative year class sizes (1982 – 2001) from research gill net catch rates at ages 4 to 6 (Panel B).

The 1999 and 2000 year classes each accounted for approximately 30% of the 2005 research gill net catch numbers (Figure 4, Panel A). The age distribution was truncated, as only three year classes each accounted for greater than 5% of the catch. However, fish aged 11+ accounted for 16% of the catch. Spring spawners accounted for 69% of the catch, an increase of 6% from 2004.

In comparison to year classes since 1982, four of seven current mature year classes (1995 to 2001) are average or below average (Figure 4, Panel B). The 2001 recruiting year class is 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

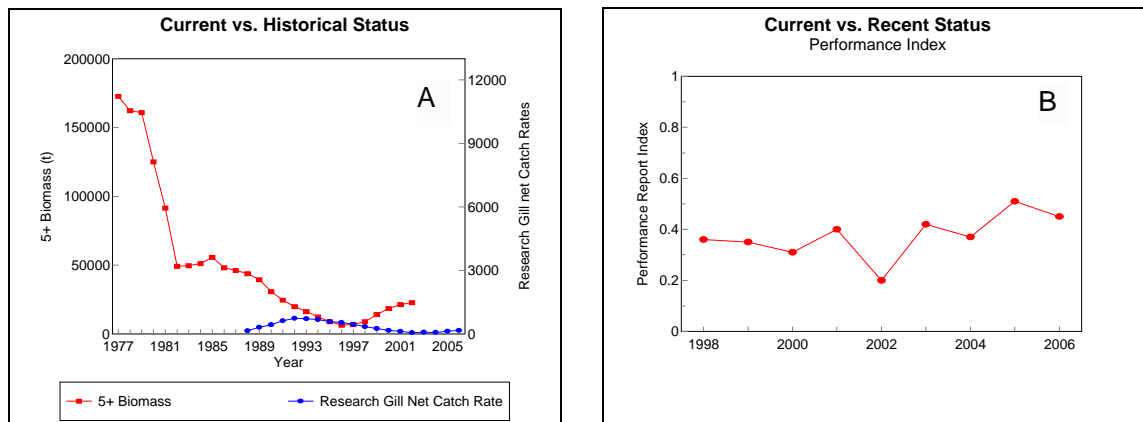


Figure 5. Comparison of research gill net catch rates and historical biomass estimates for White Bay – Notre Dame Bay (Panel A), and performance indices for 1998 to 2006 (Panel B).

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 (Figure 5, Panel A).

A standardized performance index is available for 1998 to 2006 (Figure 5, Panel B). The composite index indicates that stock status has improved from 2002 to 2006.

Short term prospects are uncertain; the 2001 year class is average and most mature year classes are average or below average compared to year classes since 1982 (Figure 4, Panel B). All year classes in the time series are weak compared to historical levels.

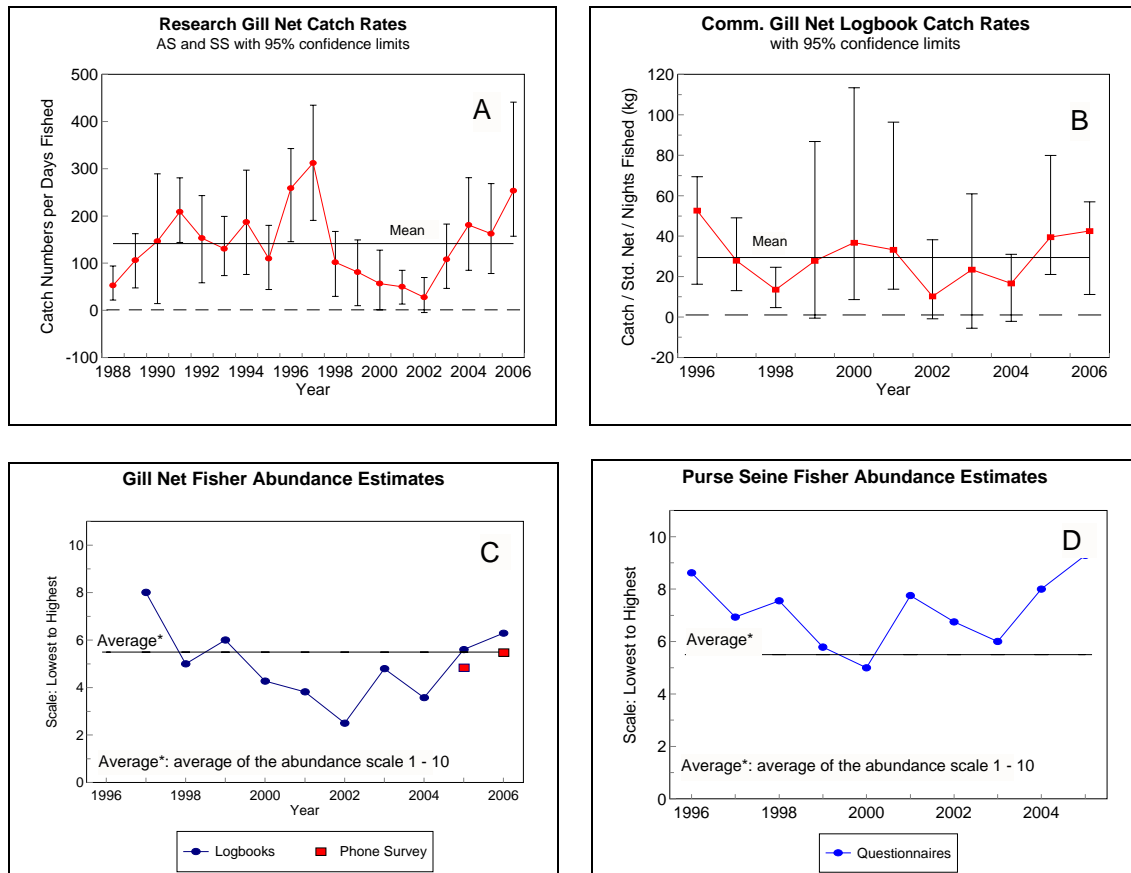
Bonavista Bay – Trinity BayAbundance Indices

Figure 6. Bonavista Bay - Trinity Bay abundance indices: A) research gill net catch rates (1988 – 2006), B) commercial gill net logbook catch rates (1996 – 2006), C) gill net fisher abundance estimates on a ten point scale (logbooks 1996 – 2006, phone survey 2005 – 2006), and D) purse seine fisher abundance estimates on a ten point scale (1996 – 2005).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined increased, but not significantly, from 181 in 2004 to 253 in 2006 (Figure 6, Panel A). The 2006 catch rate was above average, 180% of the mean (1988 – 2006). Catch rates have increased significantly from 2002 to 2006.

Six commercial gill net logbooks were returned in 2006. Catch rates (kilograms per standard net per nights fished) increased, but not significantly, from 16.6 in 2004 to 42.5 in 2006 (Figure 6, Panel B). The 2006 catch rate was above average, 145% of the mean (1996 – 2006).

There were 49 active gill net fishers contacted in the 2006 phone survey. They indicated (on a ten point scale) that herring abundance in 2006 was average and higher than in 2005 (Figure 6, Panel C). Although perceptions of abundance were available from logbooks to 2006, sample sizes from the phone survey were larger and consequently, phone survey results were used as indices in 2005 and 2006.

Seven of ten active fishers responded to the purse seine questionnaire in 2005. They indicated (on a ten point scale) that herring abundance in 2005 was above average and higher than in 2004 (Figure 6, Panel D).

Biological Characteristics

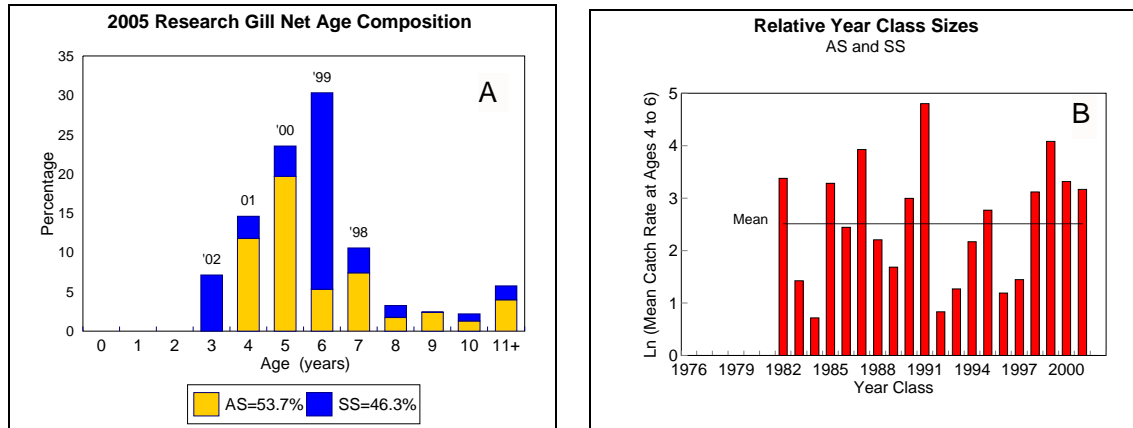


Figure 7. Bonavista Bay - Trinity Bay 2005 research gill net age composition (Panel A) and relative year class sizes (1982 – 2001) from research gill net catch rates at ages 4 to 6 (Panel B).

The 1999 and 2000 year classes accounted for approximately 30% and 25% respectively of the 2005 research gill net catch numbers (Figure 7, Panel A). The age distribution was extensive, as five year classes and fish aged 11+ each accounted for greater than 5% of the catch. Spring spawners accounted for 46% of the catch, a decrease of 8% from 2004.

In comparison to year classes since 1982, five of seven current mature year classes (1995 to 2001) are above average (Figure 7, Panel B). The 2001 recruiting year class is above 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

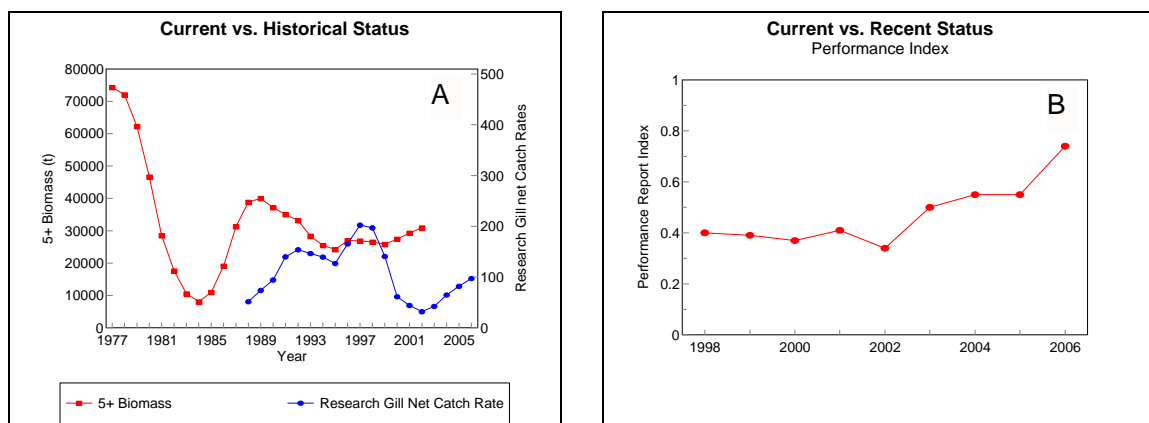


Figure 8. Comparison of research gill net catch rates and historical biomass estimates for Bonavista Bay – Trinity Bay (Panel A), and performance indices for 1998 to 2006 (Panel B).

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 (Figure 8, Panel A).

A standardized performance index is available for 1998 to 2006 (Figure 8, Panel B). The composite index indicates that stock status has improved from 2002 to 2006.

Short term prospects are positive; the 2001 year class is above average and most mature year classes are above average compared to year classes since 1982 (Figure 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

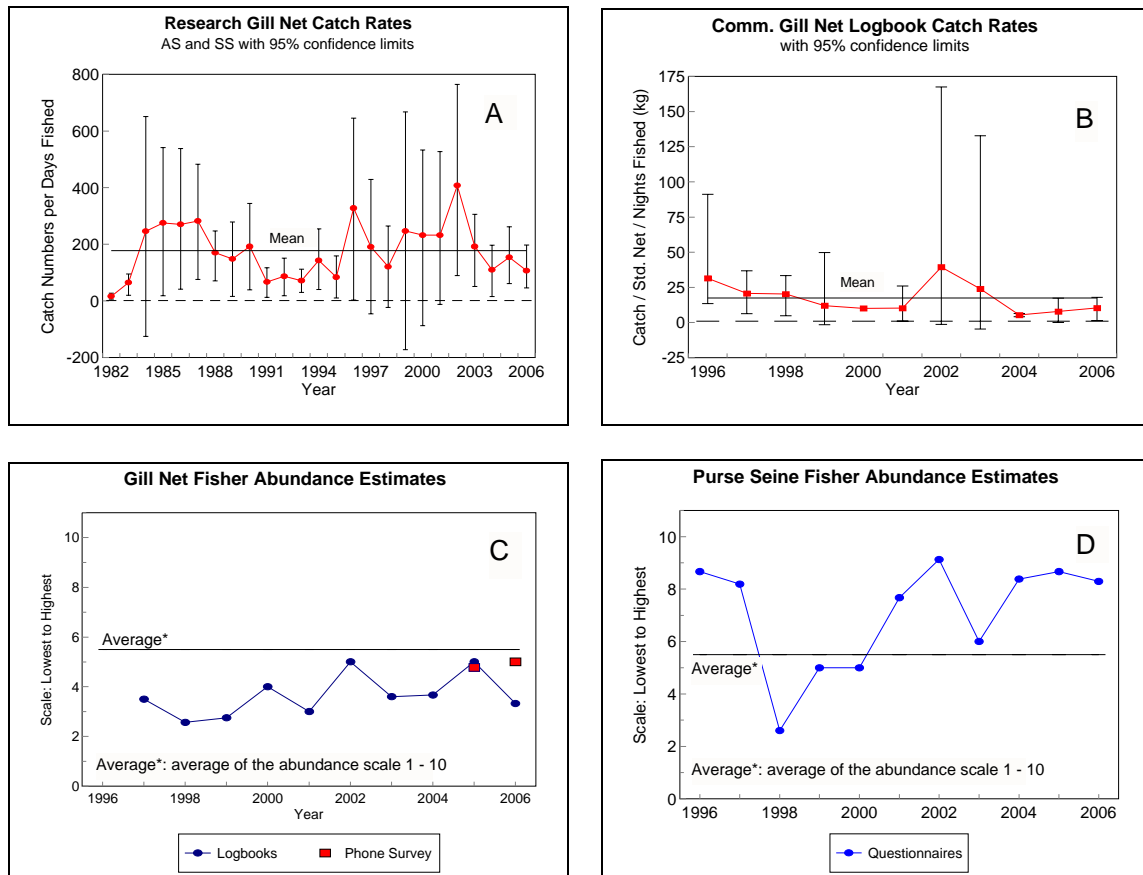


Figure 9. St. Mary's Bay - Placentia Bay abundance indices: A) research gill net catch rates (1982 – 2006), B) commercial gill net logbook catch rates (1996 – 2006), C) gill net fisher abundance estimates on a ten point scale (logbooks 1996 – 2006, phone survey 2005 – 2006), and D) purse seine fisher abundance estimates on a ten point scale (1996 – 2006).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined decreased slightly, but not significantly, from 110 in 2004 to 107 in 2006 (Figure 9, Panel A). The 2006 catch rate was below average, 60% of the mean (1982 – 2006).

Three commercial gill net logbooks were returned in 2006. Catch rates (kilograms per standard net per nights fished) increased, but not significantly, from 5.4 in 2004 to 12.7 in

2006 (Figure 9, Panel B). The 2006 catch rate was below average, 60% of the mean (1996 – 2006).

There were 22 active gill net fishers contacted in the 2006 phone survey. They indicated (on a ten point scale) that herring abundance in 2006 was below average and similar to 2005 (Figure 9, Panel C). Although perceptions of abundance were available from logbooks to 2006, sample sizes from the phone survey were larger and consequently, phone survey results were used as indices in 2005 and 2006.

Seven of nine active fishers responded to the purse seine questionnaire in 2006. They indicated (on a ten point scale) that herring abundance in 2006 was above average and similar to 2004 (Figure 9, Panel D).

Biological Characteristics

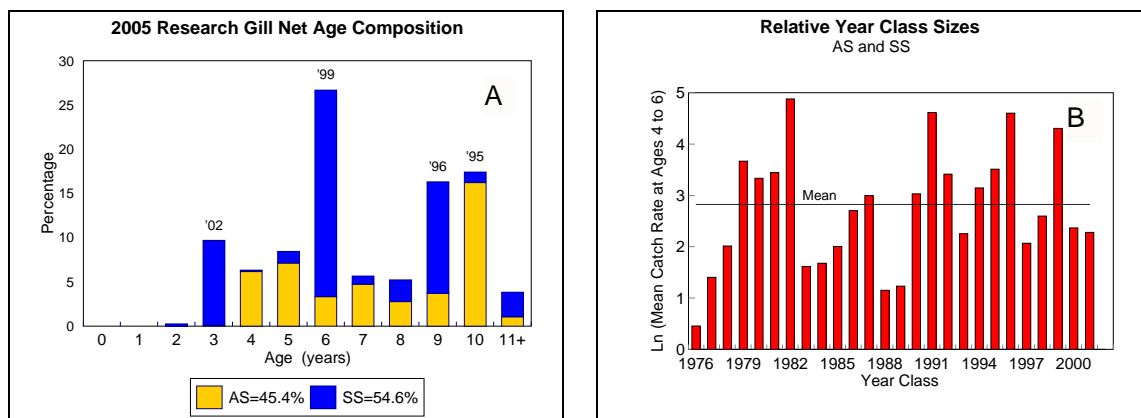


Figure 10. St. Mary's Bay - Placentia Bay 2005 research gill net age composition (Panel A) and relative year class sizes (1976 – 2001) from research gill net catch rates at ages 4 to 6 (Panel B).

The 1999 and 1995 year classes accounted for approximately 27% and 17% respectively of the 2005 research gill net catch numbers (Figure 10, Panel A). The age distribution was extensive, as eight year classes each accounted for greater than 5% of the catch. Spring spawners accounted for 55% of the catch, a decrease of 15% from 2004.

In comparison to year classes since 1976, four of seven current mature year classes (1995 to 2001) are below average (Figure 10, Panel B). The 2001 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

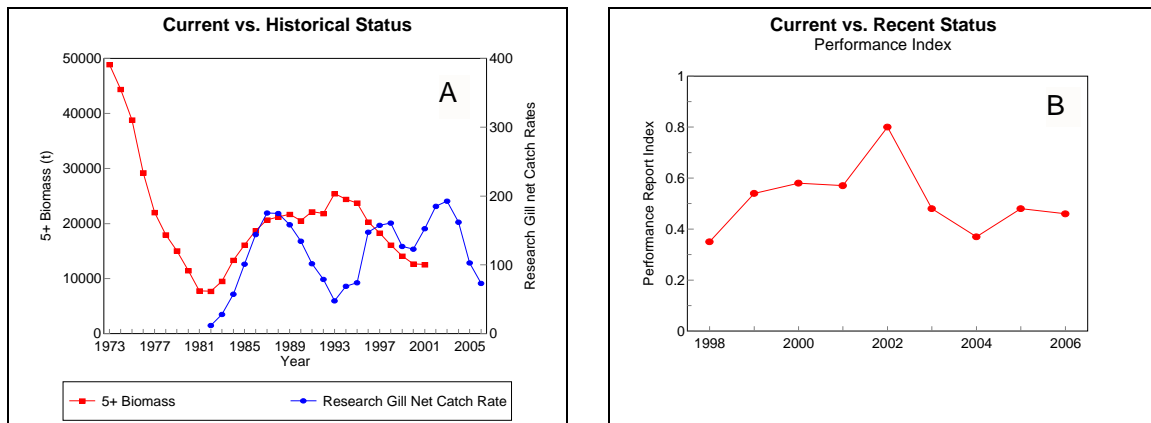


Figure 11. Comparison of research gill net catch rates and historical biomass estimates for St. Mary's Bay – Placentia Bay (Panel A), and performance indices for 1998 to 2006 (Panel B).

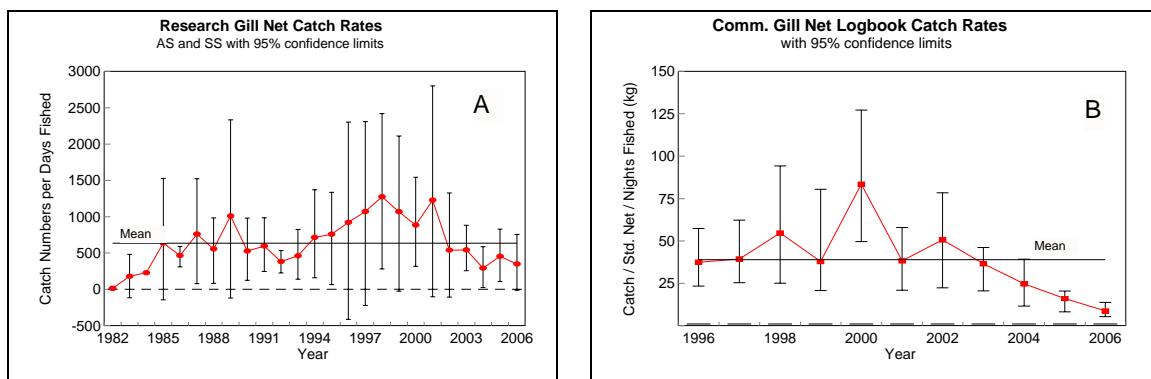
Biomass estimates are available to 2000 from an integrated catch at age analysis (Wheeler et al. 2001). A visual comparison with research gill net catch rates suggests that current abundance is substantially lower than historical estimates in the 1970's (Figure 11, Panel A).

A standardized performance index is available for 1998 to 2006 (Figure 11, Panel B). The composite index indicates that stock status deteriorated from 2002 to 2004, improved slightly in 2005, and remained stable from 2005 to 2006.

Short term prospects are negative; the 2001 year class is below average and most mature year classes are below average compared to year classes since 1976 (Figure 10, Panel B). All year classes in the time series are weak compared to historical levels.

Fortune Bay

Abundance Indices



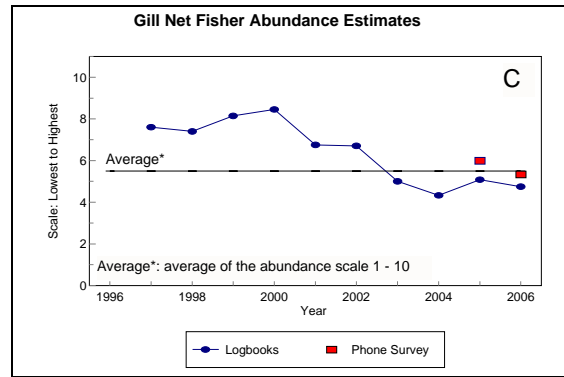


Figure 12. Fortune Bay abundance indices: A) research gill net catch rates (1982 – 2006), B) commercial gill net logbook catch rates (1996 – 2006), and C) gill net fisher abundance estimates on a ten point scale (logbooks 1996 – 2006, phone survey 2005 – 2006).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined increased slightly, but not significantly, from 291 in 2004 to 348 in 2006 (Figure 12, Panel A). The 2006 catch rate was below average, 55% of the mean (1982 – 2006).

Three commercial gill net logbooks were returned in 2006. Catch rates (kilograms per standard net per nights fished) decreased, but not significantly, from 24.6 in 2004 to 8.7 in 2006 (Figure 12, Panel B). The 2006 catch rate was below average, 22% of the mean (1996 – 2006). Catch rates decreased significantly from 2002 to 2006.

There were 57 active gill net fishers contacted in the 2006 phone survey. They indicated (on a ten point scale) that herring abundance in 2006 was average and lower than in 2005 (Figure 12, Panel C). Although perceptions of abundance were available from logbooks to 2006, sample sizes from the phone survey were larger and consequently, phone survey results were used as indices in 2005 and 2006.

Biological Characteristics

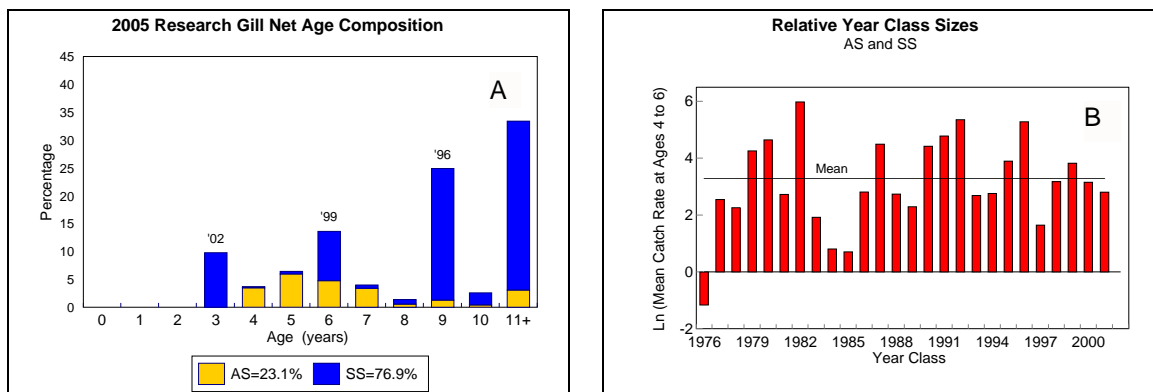


Figure 13. Fortune Bay 2005 research gill net age composition (Panel A) and relative year class sizes (1976 – 2001) from research gill net catch rates at ages 4 to 6 (Panel B).

Fish aged 11+ accounted for 33% of the 2005 research gill net catch numbers, followed by the 1996 year class at 25% (Figure 13, Panel A). The age distribution was truncated, as only four year classes each accounted for greater than 5% of the catch. Spring spawners accounted for 77% of the catch, an increase of 10% from 2004.

In comparison to year classes since 1976, four of seven current mature year classes (1995 to 2001) are average or below average (Figure 13, Panel B). The 2001 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

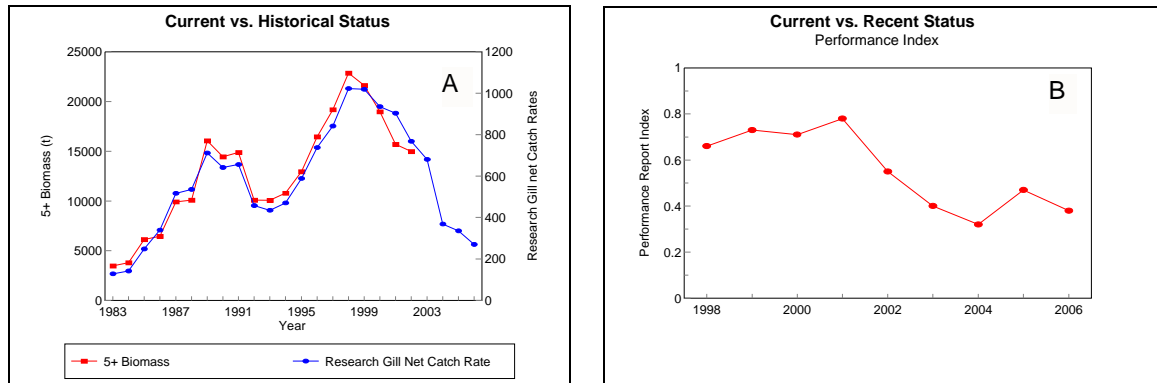


Figure 14. Comparison of research gill net catch rates and historical biomass estimates for Fortune Bay (Panel A), and performance indices for 1998 to 2006 (Panel B).

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 (Figure 14, Panel A).

A standardized performance index is available for 1998 to 2006 (Figure 14). The composite index indicates that stock status deteriorated steadily from 2001 to 2004, improved slightly in 2005 and deteriorated again in 2006.

Short term prospects are negative; the 2001 year class is below average and most mature year classes are below average compared to year classes since 1976 (Figure 13, Panel B). All year classes in the time series are weak compared to historical levels.

Sources of Uncertainty

The major uncertainty in this assessment is the inability to estimate current stock sizes and exploitation rates, and to place these estimates within an historical context. Empirical estimates of abundance would be desirable. Acoustic surveys are commonly used to produce such estimates; however, given the perceived low levels of abundance of east and south coast herring stocks, such surveys would have limited chances of success, due to the contagious nature of herring concentrations, which increases the likelihood that important concentrations would be missed.

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 the indices in these assessments are generally small resulting in higher uncertainties. A more intensive analysis of current indices is recommended before the next assessment to reduce uncertainties in the assessment. Particular concern was expressed regarding the low rate of commercial gill net logbook returns. Fishers are strongly urged to complete and return logbooks to help improve the quality of this index.

There are concerns regarding the use of perceptions of abundance from questionnaires as abundance indices, in particular with the quantification of the term “average” and the variability of its interpretation among different fishers.

Estimation of recruiting year class strength is important in evaluating the future prospects of these stocks. Recruitment data are available from one source only, the research gill net data set, and 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. In this assessment, indices were weighted subjectively based upon the perceived degree to which each data source provides an index of abundance.

CONCLUSIONS

Table 1. White Bay – Notre Dame Bay performance table to the spring of 2006.

The Fishery	Observation	
Reported Landings: 2004 - 2005	Landings increased from 265 t in 2004 to 911 t in 2005; 83% of the TAC was taken in 2005; average landings of 2800 t during 1990's; peak landings of 15,700 t in 1979.	
Total Removals: 2005	In addition to reported landings in 2005, an unknown amount of herring (considered to be less than 500 t) was caught in the gill net bait fishery; mortality from discards in the purse seine fishery, due to quota restrictions, was reported by fishers to be approximately 8 t.	
Effort: 2005 and 2006	Documented effort has declined since the 1980's; purse seine effort decreased by 95% from 1997 to 2005; gill net effort has also decreased by 83% from 1996 to 2006.	
Geographic Distribution of Fishery	The 2005 purse seine fishery, in November and December, was mostly in the Fogo Island area. The 2006 gill net fishery, from early May to late June, was mostly in Notre Dame Bay.	
Abundance Indices	Observation	Interpretation
Research Gill Net Catch Rates 1988 – 2006 (numbers / nights fished)	Increased, but not significantly, from 2004 to 2006; 2006 = 307, mean = 390, maximum = 887.	Current abundance below average.
Commercial Gill Net Catch Rates 1996 – 2006 (kg / net / nights fished)	Decreased slightly, but not significantly, from 2004 to 2006; (2006 = 6 logbooks); 2006 = 20, mean = 23, maximum = 38.	Current abundance below average.
Gill Net Fisher Observations 1996 – 2006 from logbooks 2005 – 2006 from phone surveys	Abundance in 2006 perceived to be average and higher than in 2005.	Current abundance average.
Purse Seine Fisher Observations 1996 - 2005	Abundance in 2005 perceived to be above average and higher than in 2004.	Abundance in 2005 above average.
Biological Characteristics	Observation	Interpretation
2005 Research Gill Net Age Compositions (ages 3+)	The 1999 and 2000 year classes each accounted for ~30% of the catch; 3 year classes each account for >5% of catch.	Population age structure considered to be stable due to substantial contribution of older fish.
Current Year Classes: 1995 to 2001 Series: 1982 - 2001 year classes	4 of 7 current mature year classes below average.	Most current mature year classes average or below average.
Recruitment: 2001 year class Series: 1982 to 2001 year classes	2001 year class average.	Average recruitment of the most recent estimatable year class.
Mean Weight: (ages 4 to 10) 1983 - 2005	Decreasing trend since 2002; below average in 2005 (242), mean = 255, maximum = 342.	Potential increase in fishing mortality per tonne caught.
Ecological Considerations	Observation	Interpretation
Water Temperature: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (4.02); mean = 3.67, maximum = 4.71.	Recent higher temperatures may enhance recruitment.
Water Salinity: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (31.89); mean = 31.80, maximum = 32.18	Recent higher salinities may enhance recruitment.

Stock Status	Interpretation	Evaluation	Status Definitions	
Current vs. Historical	Current abundance is substantially lower than historical estimates in the 1970's.	-	-	Concern for Current Status or Prospect
Current vs. Recent	Stock status has improved from 2002 to 2006.	+	?	Uncertainty of Interpretation
Short Term Prospects	Uncertain; average recruitment of 2001 year class; most current mature year classes are average or below average and are weak compared to historical levels.	?	+	Positive Evaluation

The standardized performance index indicates that stock status has improved from 2002 to 2006. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are uncertain; the 2001 year class is average and most mature year classes are average or below average and are weak, compared to historical levels.

Table 2. Bonavista Bay - Trinity Bay performance table to the spring of 2006.

<i>The Fishery</i>	<i>Observation</i>	
Reported Landings: 2004 - 2005	Landings increased from 509 t in 2004 to 2639 t in 2005; 88% of the TAC was taken in 2005; average landings of 2600 t during 1990's; peak landings of 12,000 t in 1977.	
Total Removals: 2005	In addition to reported landings in 2005, an unknown amount of herring (considered to be less than 300 t) was caught in the gill net bait fishery; mortality from discards in the purse seine fishery, due entirely to quota restrictions, was reported to be approximately 41 t.	
Effort: 2005 and 2006	Documented effort was less in the 1990's than in the 1980's; gill net effort has continued to decline, by 65% from 1996 to 2006; purse seine effort decreased by 73% from 2001 to 2005.	
Geographic Distribution of Fishery	The 2005 purse seine fishery, in November and December, was in the northern part of Bonavista Bay and in Northwest Arm, Trinity Bay. The 2006 gill net fishery, from mid April to late June, was distributed throughout Bonavista and Trinity Bays.	
<i>Abundance Indices</i>	<i>Observation</i>	<i>Interpretation</i>
Research Gill Net Catch Rates 1988 - 2006 (numbers / nights fished)	Increased, but not significantly, from 2004 to 2006; 2006 = 253, mean = 140, maximum = 312.	Current abundance above average.
Commercial Gill Net Catch Rates 1996 - 2006 (kg / net / nights fished)	Increased, but not significantly, from 2004 to 2006; (2006 = 6 logbooks); 2006 = 43, mean = 29, maximum = 53.	Current abundance above average.
Gill Net Fisher Observations 1996 - 2006 from logbooks 2005 - 2006 from phone surveys	Abundance in 2006 perceived to be average and higher than in 2005.	Current abundance average.
Purse Seine Fisher Observations 1996 - 2005	Abundance in 2005 perceived to be above average and higher than in 2004.	Abundance in 2005 above average.
<i>Biological Characteristics</i>	<i>Observation</i>	<i>Interpretation</i>
2005 Research Gill Net Age Compositions (ages 3+)	The 1999 and 2000 year classes each accounted for 25% - 30% of the catch; 5 year classes each account for >5% of catch.	Population age structure considered to be stable.
Current Year Classes: 1995 to 2001 Series: 1982 - 2001 year classes	5 of 7 current mature year classes above average.	Most current mature year classes above average.
Recruitment: 2001 year class Series: 1982 to 2001 year classes	2001 year class above average.	Above average recruitment of the most recent estimatable year class.
Mean Weight: (ages 4 to 10) 1983 - 2005	Stable since 2001; below average in 2005 (243) mean = 253, maximum = 335.	Potential increase in fishing mortality per tonne caught.
<i>Ecological Considerations</i>	<i>Observation</i>	<i>Interpretation</i>
Water Temperature: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (4.02); mean = 3.67, maximum = 4.71.	Recent higher temperatures may enhance recruitment.
Water Salinity: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (31.89); mean = 31.80, maximum = 32.18	Recent higher salinities may enhance recruitment.

<i>Stock Status</i>	<i>Interpretation</i>	<i>Evaluation</i>	<i>Status Definitions</i>	
Current vs. Historical	Current abundance is substantially lower than historical estimates in the 1970's.	-	-	Concern for Current Status or Prospect
Current vs. Recent	Stock status has improved from 2002 to 2006.	+	?	Uncertainty of Interpretation
Short Term Prospects	Positive; above average recruitment of 2001 year class; most current mature year classes are above average but are weak compared to historical levels.	+	+	Positive Evaluation

The standardized performance index indicates that stock status has improved from 2002 to 2006. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are positive; the 2001 year class is above average and 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 2006.

The Fishery	Observation	
Reported Landings: 2004 - 2005	Landings increased from 1389 t in 2004 to 1426 t in 2005; 57% of the TAC was taken in 2005; 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: 2005	In addition to reported landings in 2005, an unknown amount of herring (considered to be less than 150 t) was caught in the gill net bait fishery; fishers reported no discard mortality in the purse seine fishery.	
Effort: 2006	Documented effort increased from the 1980's to the 1990's; purse seine effort peaked in 2000 and has since declined by 72% from 2001 to 2006; gill net effort peaked in 1998 and has since declined by 95% from 1998 to 2006.	
Geographic Distribution of Fishery	The 2006 purse seine fishery, from January to June, was along the eastern sides of Placentia Bay and St. Mary's Bay. The 2006 gill net fishery, from early April to early June, was mostly in Placentia Bay.	
Abundance Indices	Observation	Interpretation
Research Gill Net Catch Rates 1982 – 2006 (numbers / nights fished)	Decreased slightly, but not significantly, from 2004 to 2006; 2006 = 107, mean = 177, maximum = 407.	Current abundance below average.
Commercial Gill Net Catch Rates 1996 – 2006 (kg / net / nights fished)	Increased, but not significantly, from 2004 to 2006 (2006 = 3 logbooks); 2006 = 13, mean = 17, maximum = 39.	Current abundance below average.
Gill Net Fisher Observations 1996 – 2006 from logbooks 2005 – 2006 from phone surveys	Abundance in 2006 perceived to be below average and similar to 2005.	Current abundance below average.
Purse Seine Fisher Observations 1996 – 2006	Abundance in 2006 perceived to be above average and similar to 2004.	Current abundance above average.
Biological Characteristics	Observation	Interpretation
2005 Research Gill Net Age Compositions (ages 3+)	The 1999 year class accounted for 27% of the catch; 8 year classes each account for >5% of catch.	Population age structure considered to be stable.
Current Year Classes: 1995 to 2001 Series: 1976 - 2001 year classes	4 of 7 current mature year classes below average.	Most current mature year classes below average.
Recruitment: 2001 year class Series: 1976 to 2001 year classes	2001 year class below average.	Below average recruitment of the most recent estimatable year class.
Mean Weight: (ages 4 to 10) 1983 - 2005	Increasing trend since 2002; below average in 2005 (251); mean = 269, maximum = 320.	Potential increase in fishing mortality per tonne caught.
Ecological Considerations	Observation	Interpretation
Water Temperature: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (4.02); mean = 3.67, maximum = 4.71.	Recent higher temperatures may enhance recruitment.
Water Salinity: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (31.89); mean = 31.80, maximum = 32.18	Recent higher salinities may enhance recruitment.

Stock Status	Interpretation	Evaluation	Status Definitions	
Current vs. Historical	Current abundance is substantially lower than historical estimates in the 1970's.	-	-	Concern for Current Status or Prospect
Current vs. Recent	Stock status deteriorated from 2002 to 2004, improved slightly in 2005, and remained stable from 2005 to 2006.	nil	?	Uncertainty of Interpretation
Short Term Prospects	Negative; below average recruitment of 2001 year class; most current mature year classes are below average and are weak compared to historical levels.	-	+	Positive Evaluation

The standardized performance index indicates that stock status deteriorated from 2002 to 2004, improved slightly in 2005, and remained stable from 2005 to 2006. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are negative; the 2001 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 2006.

The Fishery	Observation	
Reported Landings: 2004 - 2005	Landings decreased from 2930 t in 2004 to 2653 t in 2005; 72% of the TAC was taken in 2005; average landings of 200 t during 1990's; peak landings in 2003 (since large mobile purse seine fishery in 1960's).	
Total Removals: 2005	In addition to reported landings in 2005, an unknown amount of herring (considered to be less than 400 t) was caught in the gill net bait fishery.	
Effort: 2006	Documented effort in 1980's and 1990's was very low; gill net effort peaked in 1997 and has since declined by 93% from 1997 to 2006; 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 2300 t in 2006.	
Geographic Distribution of Fishery	The 2006 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 – 2006 (numbers / nights fished)	Increased slightly, but not significantly, from 2004 to 2006; 2006 = 348, mean = 636, maximum = 1275.	Current abundance below average.
Commercial Gill Net Catch Rates 1996 – 2006 (kg / net / nights fished)	Decreased, but not significantly, from 2004 to 2006 (2006 = 3 logbooks); 2006 = 9, mean = 39, maximum = 84.	Current abundance below average.
Gill Net Fisher Observations 1996 – 2006 from logbooks 2005 – 2006 from phone surveys	Abundance in 2006 perceived to be average and lower than in 2005.	Current abundance average.
Biological Characteristics	Observation	Interpretation
2005 Research Gill Net Age Compositions (ages 3+)	Fish aged 11+ accounted for 33% 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: 1995 to 2001 Series: 1976 - 2001 year classes	4 of 7 current mature year classes average or below average.	Most current mature year classes below average.
Recruitment: 2001 year class Series: 1976 to 2001 year classes	2001 year class below average.	Below average recruitment of the most recent estimatable year class.
Mean Weight: (ages 4 to 10) 1983 - 2005	Stable since 2000; below average in 2005 (235); mean = 259, maximum = 321.	Potential increase in fishing mortality per tonne caught.
Ecological Considerations	Observation	Interpretation
Water Temperature: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (4.02); mean = 3.67, maximum = 4.71.	Recent higher temperatures may enhance recruitment.
Water Salinity: 1983 - 2005 (at 20 m, Station 27 off St. John's)	Above average in 2005 (31.89); mean = 31.80, maximum = 32.18	Recent higher salinities may enhance recruitment.

Stock Status	Interpretation	Evaluation	Status Definitions	
Current vs. Historical	Current abundance is substantially lower than peak estimates in the late 1990's.	-	-	Concern for Current Status or Prospect
Current vs. Recent	Stock status deteriorated steadily from 2001 to 2004, improved slightly in 2005, and deteriorated again in 2006.	-	?	Uncertainty of Interpretation
Short Term Prospects	Negative; below average recruitment of 2001 year class; most current mature year classes are below average and are weak compared to historical levels.	-	+	Positive Evaluation

The standardized performance index indicates that stock status deteriorated from 2001 to 2004, improved slightly in 2005 and deteriorated again in 2006. Current abundance is substantially lower than peak estimates in the late 1990's. Short term prospects are negative; the 2001 year class is below average and most mature year classes are below average and are weak, compared to historical levels.

OTHER CONSIDERATIONS

Science Considerations

Research Recommendations

1. The research gill net catch rates are likely confounded by systematic changes in growth rates that have occurred since their inception. It is recommended that standardized estimates of year class and year effects be extracted from these data, using statistical models that permit the age-mesh size interaction to be quantified.
2. The commercial logbook abundance index suffers from very low return rates. It is recommended that return rates may be increased by sending out reminders subsequent to the initial request. It is also recommended that, should this be implemented, secondary and tertiary logbook data should be analyzed separately from that of the initial collection so as to ensure internal consistency of the full data series.
3. A variety of abundance indices are available for these stocks, some of which are data based and others which are opinion based. It is recommended that the coherence of these various indices be statistically examined so as to clarify interpretative significance and as a guide to index weighting factors.
4. Sequential population analysis is a potentially useful modeling approach to estimate current abundance and exploitation rates in relation to historic levels. Such models have not been used in recent assessments of these stocks for a variety of reasons, including low catch levels. It is recommended to re-examine the utility of these models, including variants that may be constrained by earlier acoustic estimates.

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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