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Science

Sciences

Newfoundland and Labrador Region

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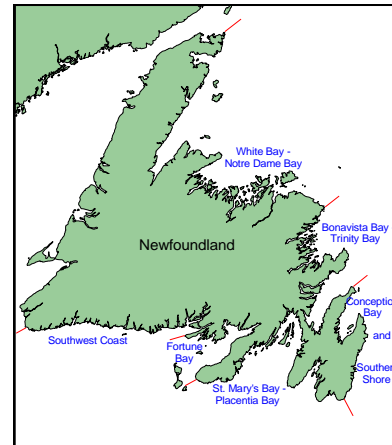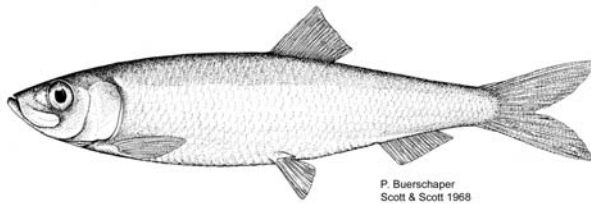# ASSESSMENT OF NEWFOUNDLAND EAST AND SOUTH COAST HERRING STOCKS TO 2009

P. Buerschaper
Scott & Scott 1968

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 2008) have averaged 6700 t. Fishing seasons are area and gear dependent. Principal gears include: purse seines, tuck seines, bar seines, traps, and gill nets. TAC management was established in 1977. The 2009 Integrated Management Plan for Herring on the East and South Coasts of Newfoundland (DFO 2009) established annual TAC's by stock area and gear sector for 2009.

Stock assessments were conducted bi-annually from 2002 to 2008 in support of bi-annual integrated fishery management plans. 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 from November 25-27, 2009 in St. John's, NL. The purpose of the meeting was two-fold: 1) to review the current state of scientific knowledge on the population dynamics of the stocks and to provide a framework to assess the stocks for a five year period from 2010-2014, and 2) to assess the status of the stocks in support of the management of the 2010 and 2011 fisheries. Participants included DFO scientists, technical staff, and fisheries managers, and representatives from the provincial government, Memorial University, the Marine Institute, and the Fish Food and Allied Workers Union.

SUMMARY

- Reported landings in 2008 were 7600 t, 61% of the overall TAC. TACs were not taken in any of the four assessed stock areas due primarily to limited markets and the resulting impacts on some gear sectors.

White Bay-Notre Dame Bay

- Reported landings increased from 362 t in 2007 to 714 t in 2008; 42% of the TAC was taken in 2008.
- A standardized performance index indicates that stock status improved from 2002 to 2005 and has remained stable since then; however, stock abundance remains at a low level compared to historical estimates in the 1970's.
- Short term prospects are uncertain; the 2004 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.
- The status of this stock has not changed since the 2008 assessment.

Bonavista Bay-Trinity Bay

- Reported landings remained the same in 2008 as in 2007, at 2800 t; 71% of the TAC was taken in 2008.
- A standardized performance index indicates that stock status improved from 2002 to 2007 but deteriorated in 2008 and again in 2009; stock abundance remains at a low level compared to historical estimates in the 1970's.
- Short term prospects are uncertain; the 2004 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.
- The status of this stock has deteriorated since the 2008 assessment.

St. Mary's Bay-Placentia Bay

- Reported landings increased from 759 t in 2007 to 1148 t in 2008; 50% of the TAC was taken in 2008.
- A standardized performance index indicates that stock status deteriorated from 2001 to 2004, and has remained stable since 2005; stock abundance remains at a low level compared to historical estimates in the 1970's.
- Short term prospects are negative; the 2004 year class is below average and most mature year classes are below average and are weak compared to historical levels.
- The status of this stock has not changed since the 2008 assessment.

Fortune Bay

- Reported landings increased from 2448 t in 2007 to 2550 t in 2008; 80% of the TAC was taken in 2008.
- A standardized performance index indicates that stock status deteriorated from 2001 to 2006, and has remained stable since then; stock abundance is lower than peak estimates in the late 1990's.
- Short term prospects are negative; the 2004 year class is below average and most mature year classes are average or below average.

- The status of this stock has not changed since the 2008 assessment.

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. 2009).

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.   The 2000 – 2002 year classes currently dominate in most areas. However, year classes produced during the 1990's and 2000's are weak in relation to the large year classes of the 1960's. The 2004 year class, estimated from research gill net catch rates in 2008 only, is below average in all areas. There are no estimates of recruitment beyond the 2004 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 2009 (Wheeler et al. in prep.). 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 from telephone surveys.

The spring 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 2009, twenty-seven fishers participated in the program. Data are available from 1988 to 2009 for White Bay–Notre Dame Bay and Bonavista Bay–Trinity Bay and from 1982 to 2009 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 2008. Catch rates only are available for 2009, 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 2200 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 2009, 37 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, 5½ being average, and 10 being the highest, how abundant were herring in your fishing area in the current year compared to the previous year". A cumulative index is calculated for each stock to compare current year observations of abundance with previous years. This index is based primarily upon observations during the spring.

The gill net telephone survey, initiated in 2006, provides a cumulative index of abundance from a larger sample of fishers than the gill net logbooks. In 2009, 147 active fishers were contacted. In assessing observations of abundance, it is assumed that observations of all active fishers are equal, regardless of their level of effort. This index is based primarily upon observations during the spring and summer. Catch data from this survey have been used to estimate bait landings from 2007 - 2009.

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 2008, 25 of 28 active fishers responded. Purse seine fishers are also asked to provide their observations of herring abundance, on a ten point scale, similar to gill net fishers. Observations are available during the fall to 2008 for White Bay–Notre Dame Bay and Bonavista Bay–Trinity Bay and during the winter/spring to 2009 for St. Mary's Bay–Placentia Bay. 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 2008. 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 (1998-2004) that can be estimated. These year classes produced the 2008 population numbers at ages 4-10. The 2004 year class (at age 4 in 2008) is the most

recent recruiting year class that can be estimated. Although the recruiting year class is based upon catch rate data at age 4 in the most recent year only, the relative strength of that year class does not often change when catch rate data at ages 5 and 6 are included.

Reported landings are provided annually by Policy and Economics Branch. It was noted during the 2008 assessment that estimates of herring caught for use as bait were included in annual landings from 1970 to 1995 but have not been included since then. In 2009, mean bait catches per fisher from the 2007 and 2008 gill net telephone surveys, were used to estimate bait catches from 1996 to 2006. Catch at age matrices were revised to include bait catch estimates from 1996 to 2008, and also to include estimates of dead discards for the purse seine fishery during the same period.

An analytical analysis of population size using the adaptive (ADAPT) framework (Gavaris 1988) was attempted in 2009 with the revised catch at age matrices. The model, as formulated, did not provide reliable estimates of population sizes.   A preliminary survey-based analysis (SURBA) (Cook 1997) was also attempted to estimate relative stock sizes. These models require further evaluation to determine their utility in providing management advice.

For each stock area, current stock status and future prospects were summarized in a performance report. Observations on abundance indices, and biological characteristics, 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 2004 recruiting year class.

Fishery

TACs for the 2008 fishery remained unchanged from 2007 as the fishery was regulated by a two year (2007 and 2008) integrated management plan formulated by Fisheries and Aquaculture Management Branch.
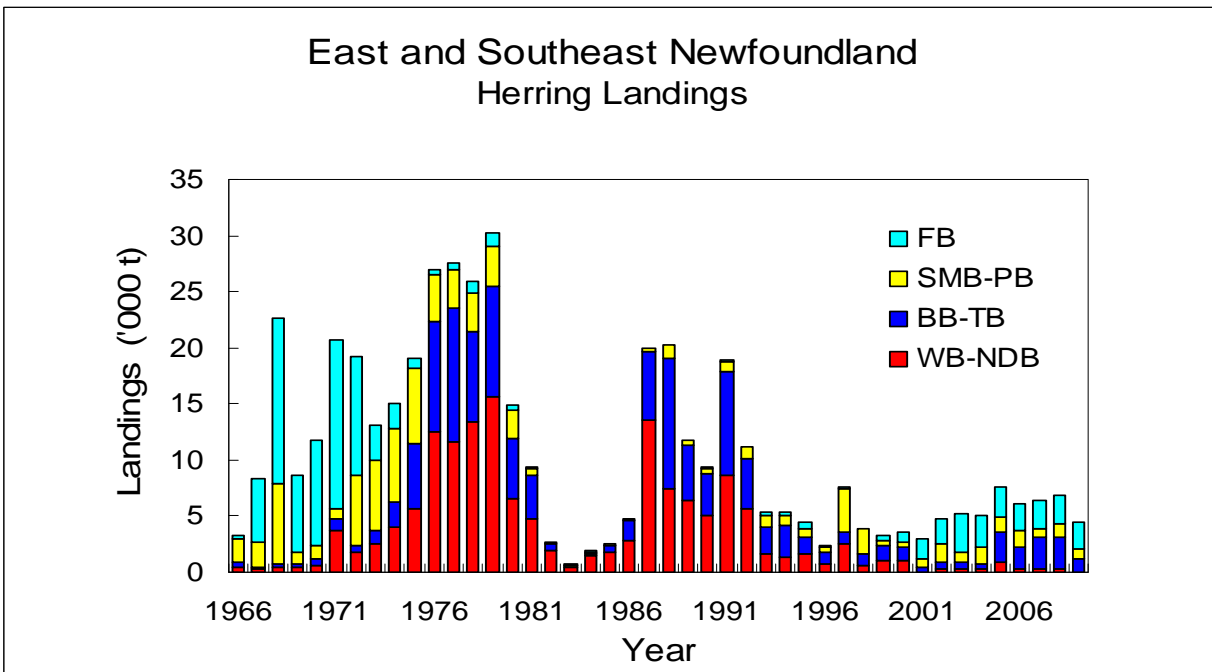
East and Southeast Newfoundland
Herring Landings

Figure 2. Reported herring landings by stock area, 1966–2009 (2009: reported landings to October).

Reported landings increased from 6600 t in 2007 to 7600 t in 2008 (Fig. 2). The 7600 t represented approximately 61% of the overall TAC. The TAC was not taken due to limited overall markets and the resulting impacts on some gear sectors for which there were few if any buyers. For 2009, landings data are available only to October.

In the context of this report, reported landings are those recorded by Policy and Economics Branch. Catches include estimates of herring used as bait, and dead discards in the purse seine fishery.

In White Bay–Notre Dame Bay, reported landings increased from 362 t in 2007 to 714 t in 2008; 42% of the TAC was taken in 2008. The 2001 year class accounted for 34% of catch numbers, followed by the 2000 year class at 27%. Autumn spawners accounted for 58% of catch numbers, an increase of 3% from 2007.

In Bonavista Bay–Trinity Bay, reported landings remained the same in 2008 as in 2007, at 2800 t; 71% of the TAC was taken in 2008. The 2001 year class accounted for 32% of catch numbers, followed by the 2002 year class at 23%. Spring spawners accounted for 53% of catch numbers, a decrease of 11% from 2007.

In St. Mary's Bay–Placentia Bay, reported landings increased from 759 t in 2007 to 1148 t in 2008; 50% of the TAC was taken in 2008. The 2000 year class accounted for 41% of catch numbers, followed by the 2001 year class at 25%. Autumn spawners accounted for 84% of catch numbers, a decrease of 5% from 2007.

In Fortune Bay, reported landings increased from 2448 t in 2007 to 2550 t in 2008; 80% of the TAC was taken in 2008. Fish age 11+ accounted for 46% of catch numbers, followed by the 2002 year class at 43%. Spring spawners accounted for 93% of catch numbers, a decrease of 1% from 2007.
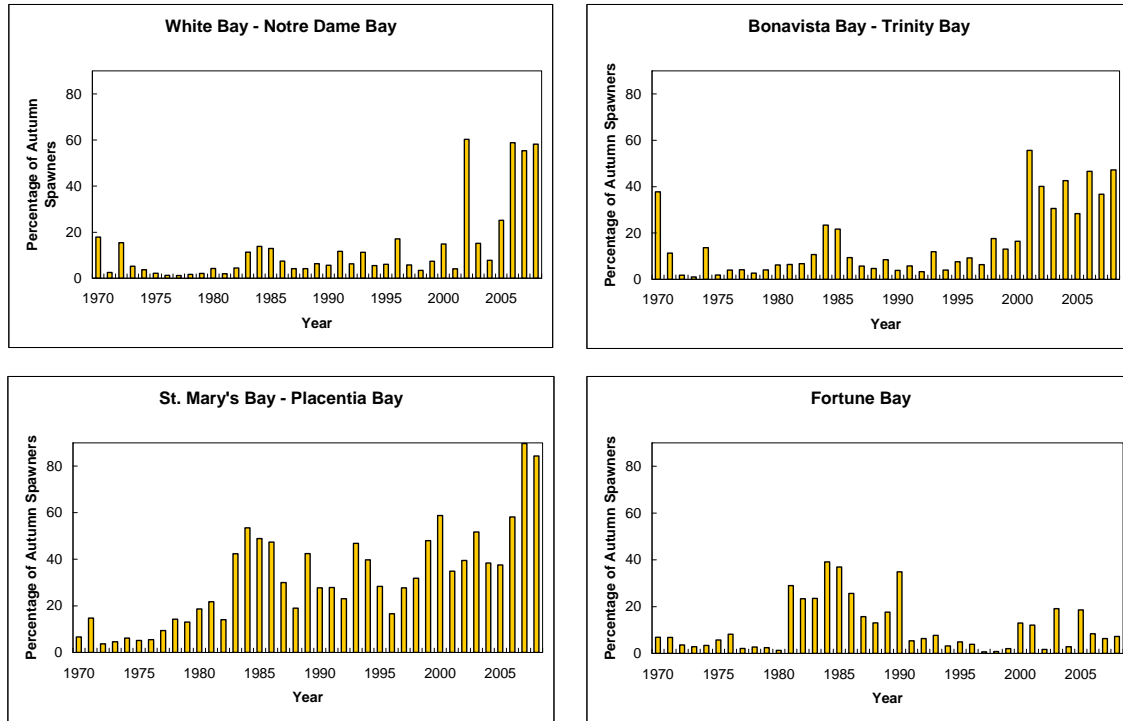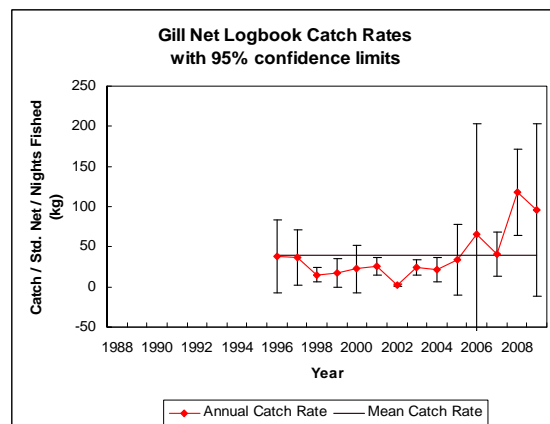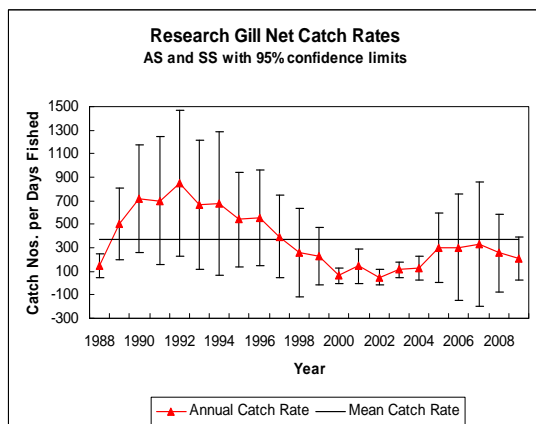
Figure 3. Percentage of autumn spawners in the reported landings, by stock area, 1970 – 2008.

The percentage of autumn spawners in reported landings has increased substantially in recent years in all areas except Fortune Bay.

ASSESSMENT / ANALYSIS

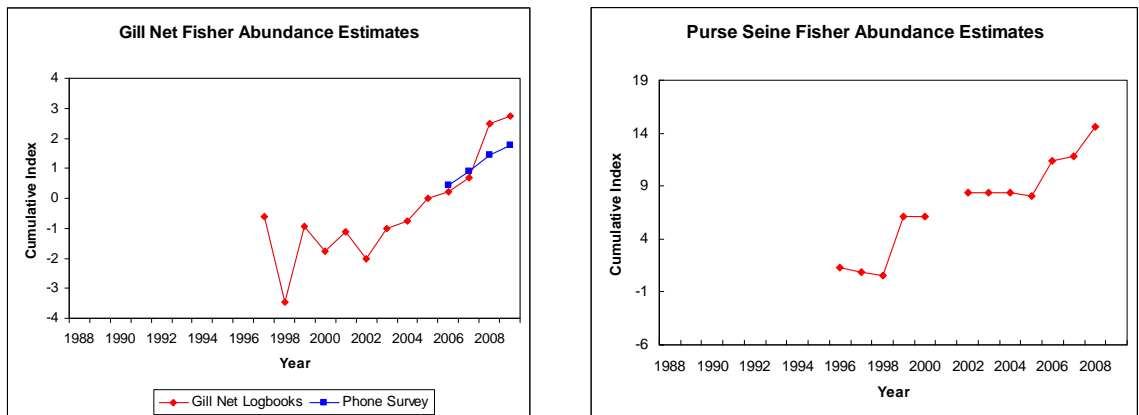## White Bay-Notre Dame Bay

Abundance Indices

Figure 4. White Bay-Notre Dame Bay abundance indices: top left) research gill net catch rates (1988-2009), top right) commercial gill net logbook catch rates (1996–2009), bottom left) gill net fisher abundance estimates on a cumulative index (logbooks 1997–2009, telephone survey 2006–09), and bottom right) purse seine fisher abundance estimates on a cumulative index (1996–2008).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined decreased, but not significantly, from 233 in 2008 to 218 in 2009 (Fig. 3, top left). The 2009 catch rate was below average, 57% of the mean (1988-2009). Catch rates decreased significantly (95% CL) from 1992 to 2002.

Twelve commercial gill net logbooks were returned in 2009. Catch rates (kilograms per standard net per nights fished) decreased, but not significantly, from 117.9 in 2008 to 96.4 in 2009 (Fig. 3, top right). The 2009 catch rate was above average, 242% of the mean (1996-2009) and the second highest in the time series. Fishers indicated (cumulative index) an increasing trend in abundance in the past seven years and abundance in 2009 was higher than in 2008 (Fig. 3, bottom left).

There were 37 active gill net fishers contacted in the 2009 telephone survey. They indicated (cumulative index) an increasing trend in abundance since the survey began in 2006 and abundance in 2009 was higher than in 2008 (Fig. 3, bottom left).

Seven of seven active fishers responded to the purse seine questionnaire in 2008. They indicated (cumulative index) an increasing trend in abundance in the past three years and abundance in the fall of 2008 was higher than in 2007 (Fig. 3, bottom right).
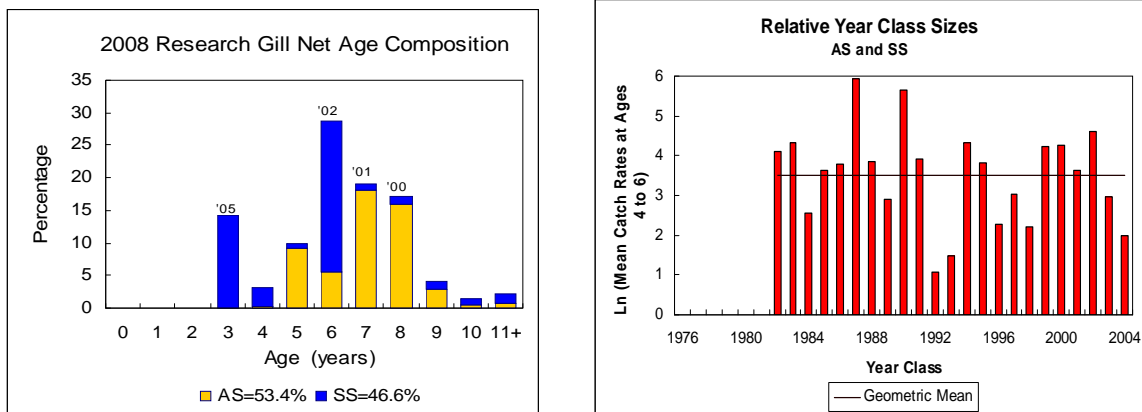
Biological Characteristics

Figure 5. White Bay–Notre Dame Bay 2008 research gill net age composition (left panel) and relative year class sizes (1982–2004) from research gill net catch rates at ages 4 to 6 (right panel).

The 2002 and 2001 year classes accounted for 29% and 19% respectively of the 2008 research gill net catch numbers (Fig. 4, left panel). The age distribution was extensive, as five year classes (including fish age 11+) each accounted for greater than 5% of the catch. Autumn spawners were 53% of the catch, an increase of 11% from 2007.

In comparison to year classes since 1982, four of seven current mature year classes (1998 to 2004) are above average (Fig. 4, right panel). The 2004 recruiting year class, based upon 2008 catch rates only, 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).

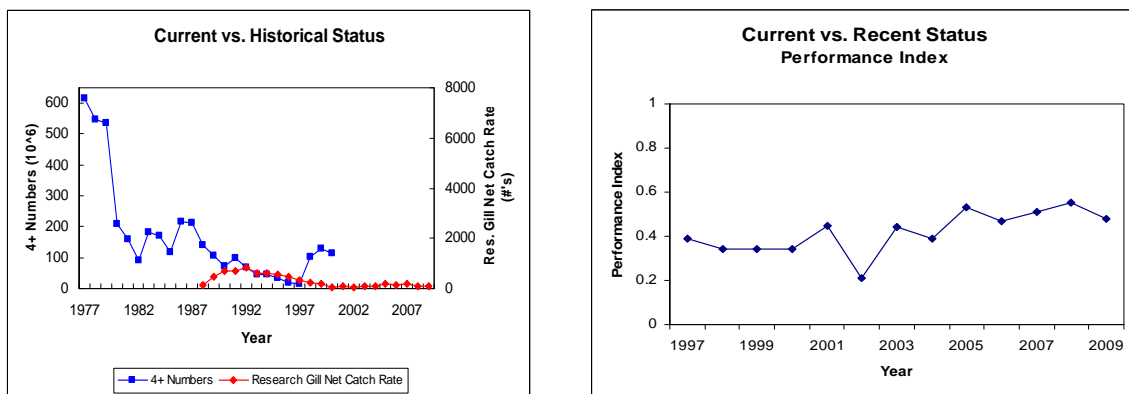Current Status and Short Term Prospects

Figure 6. Comparison of research gill net catch rates and historical population estimates for White Bay-Notre Dame Bay (left panel), and performance indices for 1997 to 2009 (right panel).

Population 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, left panel).

A standardized performance index is available for 1997 to 2009 (Fig. 5, right panel). The composite index indicates that stock status improved between 2002 and 2005 and has remained stable since then.

Short term prospects are uncertain; the 2004 year class is below average but most mature year classes are above average compared to year classes produced since 1982 (Fig. 4, right panel). However, all year classes since 1982 are weak compared to historical levels.

Assessment results are summarized in the following performance table (Table 1).

Table 1. White Bay-Notre Dame Bay performance table to the spring of 2009.

The Fishery	Observation	
Reported Landings: 2007 - 2008	Reported landings increased from 362 t in 2007 to 714 t in 2008; 42% of the TAC was taken in 2008; average landings of 2800 t during 1990's; peak landings of 15,700 t in 1979.	
Total Removals: 2008	In addition to reported landings in 2008, approximately 475 t were estimated to have been taken for bait purposes; fishers reported approximately 3 t of discard mortality in the purse seine fishery.	
Effort: 2008 and 2009	Documented purse seine effort decreased by 75% from 1997 to 2008; documented gill net effort decreased by 80% from 1996 to 2009.	
Geographic Distribution of Fishery	The 2008 purse seine fishery, in November and December, was mostly in the Fogo Island area. The 2009 gill net fishery, from early May to early July, was mostly in Notre Dame Bay.	
Abundance Indices	**Observation**	**Interpretation**
Research Gill Net Catch Rates 1988-2009 (numbers / nights fished)	Decreased, but not significantly, from 2008 to 2009; 2009 = 218, mean = 373, maximum = 887.	Current abundance below average.
Commercial Gill Net Catch Rates 1996-2009 (kg / net / nights fished)	Decreased, but not significantly, from 2008 to 2009; (2009 = 12 logbooks); 2009 = 96, mean = 40, maximum = 118.	Current abundance above average.
Gill Net Fisher Observations 1996-2009 from logbooks	21 observations in 2009; increasing trend in abundance over past 7 years; 2009 higher than 2008.	Increasing trend in abundance.
Gill Net Fisher Observations 2006-2009 from telephone surveys	37 observations in 2009; increasing trend in abundance since telephone survey began in 2006; 2009 higher than 2008.	Increasing trend in abundance.
Purse Seine Fisher Observations 1996 - 2008	7 observations in 2008; increasing trend in abundance over past 3 years; 2008 higher lower than 2007.	Increasing trend in abundance.
Biological Characteristics	**Observation**	**Interpretation**
2008 Research Gill Net Age Compositions (ages 3+)	The 2002 and 2001 year classes accounted for 29% and 19% respectively of the catch; 5 year classes each account for >5% of catch.	Population age structure considered to be stable.
Current Year Classes: 1998 to 2004 Series: 1982 - 2004 year classes	4 of 7 current mature year classes above average.	Most mature year classes above average.
Recruitment: 2004 year class Series: 1982 to 2004 year classes	2003 year class below average.	Below average recruitment of the most recent estimatible year class.

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 improved from 2002 to 2005 and has remained stable since then.	**+**	**?**	Uncertainty of Interpretation
Short Term Prospects	Uncertain; below average recruitment of 2004 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 improved from 2002 to 2005 and has remained stable since then. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are uncertain; the 2004 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.
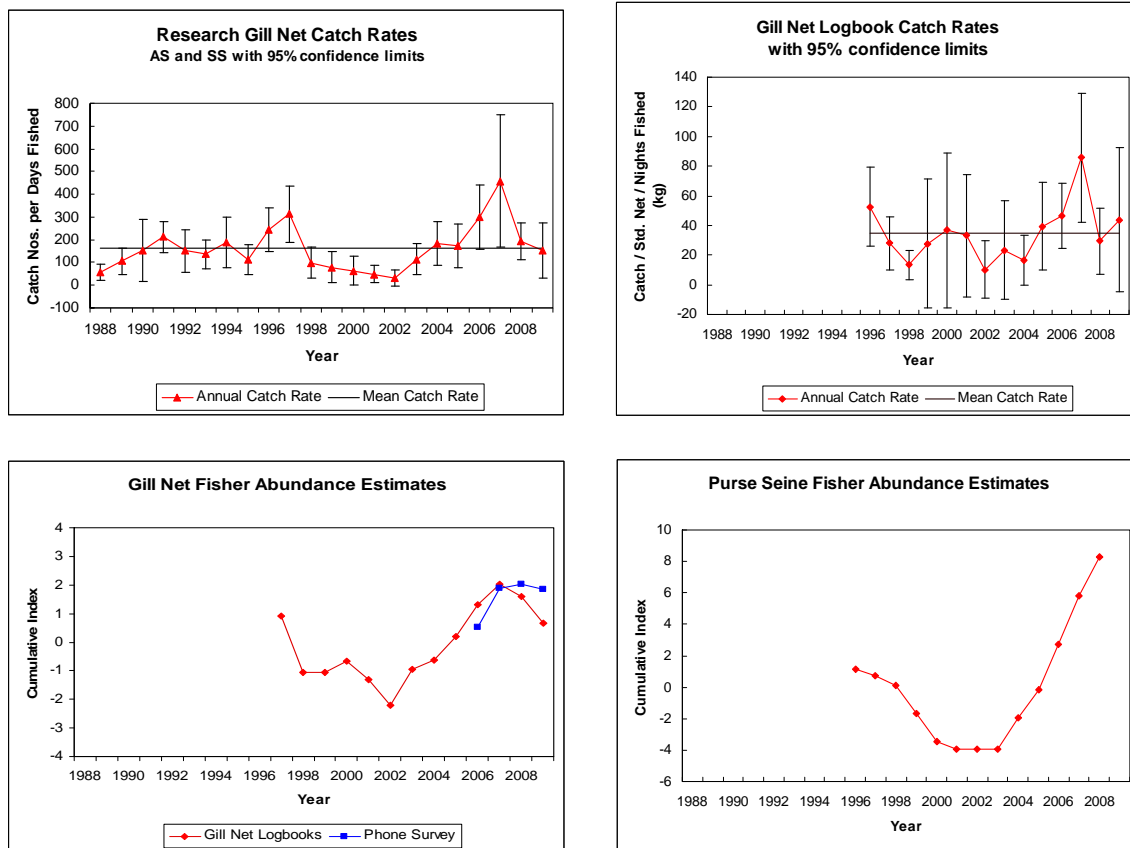
Bonavista Bay-Trinity Bay

Abundance Indices

Figure 7. Bonavista Bay - Trinity Bay abundance indices: top left) research gill net catch rates (1988-2009), top right) commercial gill net logbook catch rates (1996–2009), bottom left) gill net fisher abundance estimates on a cumulative index (logbooks 1996–2009, phone survey 2006–09), and bottom right) purse seine fisher abundance estimates on a cumulative index (1996–2008).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined decreased, but not significantly, from 186 in 2008 to 147 in 2009 (Fig. 6, top left). The 2009 catch rate was below average, 91% of the mean (1988-2009). Catch rates increased significantly (95% CL) from 2002 to 2007.

Ten commercial gill net logbooks were returned in 2009. Catch rates (kilograms per standard net per nights fished) increased, but not significantly, from 29.4 in 2008 to 43.7 in 2009 (Fig. 6, top right). The 2009 catch rate was above average, 126% of the mean (1996-2009). Fishers indicated (cumulative index) a decreasing trend in abundance in the past two years and abundance in 2009 was lower than in 2008 (Fig. 6, bottom left).

There were 44 active gill net fishers contacted in the 2009 telephone survey. They indicated (cumulative index) little or no change in abundance over the last two years (Fig. 6, bottom left).

Fifteen of eighteen 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 fall of 2008 was higher than in 2007 (Fig. 6, bottom right).
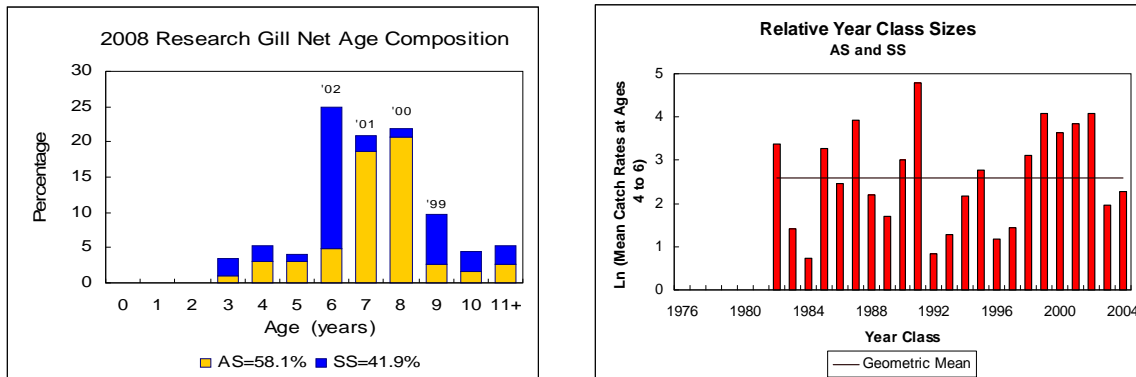
Biological Characteristics

Figure 8. Bonavista Bay - Trinity Bay 2008 research gill net age composition (left panel) and relative year class sizes (1982-2004) from research gill net catch rates at ages 4 to 6 (right panel).

The 2002 and 2000 year classes accounted for 25% and 22% respectively of the 2008 research gill net catch numbers (Fig. 7, left panel). The age distribution was extensive, as seven year classes (including fish aged 11+) each accounted for greater than 5% of the catch. Autumn spawners were 58% of the catch, a decrease of 2% from 2007.

In comparison to year classes since 1982, five of seven current mature year classes (1998 to 2004) are above average (Fig. 7, right panel). The 2004 recruiting year class, based upon 2008 catch rates only, 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).
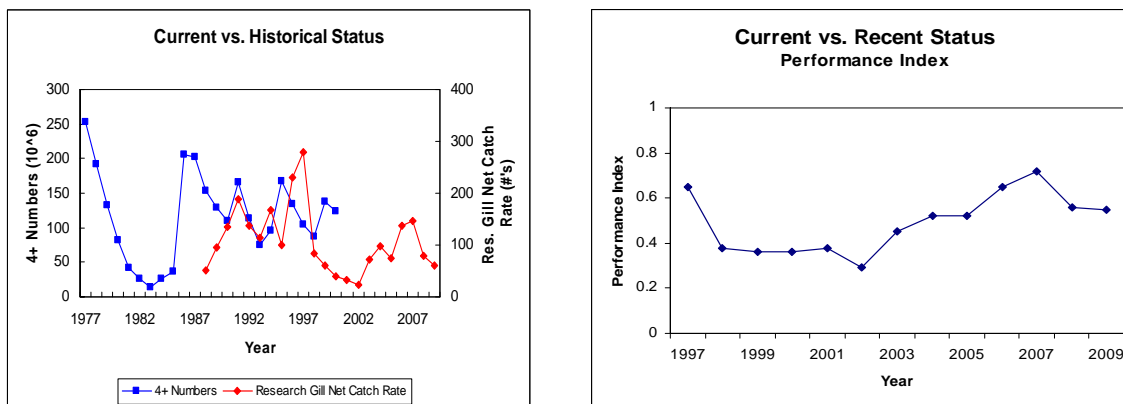
Current Status and Short Term Prospects

Figure 9. Comparison of research gill net catch rates and historical population estimates for Bonavista Bay-Trinity Bay (left panel), and performance indices for 1997 to 2009 (right panel).

Population 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, left panel).

A standardized performance index is available for 1997-2009 (Fig. 8, right panel). The composite index indicates that stock status improved from 2002 to 2007 but deteriorated in 2008 and again in 2009.

Short term prospects are uncertain; the 2004 year class is below average but most mature year classes are above average compared to year classes produced since 1982 (Fig. 7, right panel). However, all year classes since 1982 are weak compared to historical levels.

Assessment results are summarized in the following performance table (Table 2).

Table 2. Bonavista Bay - Trinity Bay performance table to the spring of 2009.

The Fishery	Observation	
Reported Landings: 2008 – 2009	Reported landings remained the same in 2008 as in 2007, at 2800 t; 71% of the TAC was taken in 2008; average landings of 2600 t during 1990's; peak landings of 12,000 t in 1977.	
Total Removals: 2008	In addition to reported landings in 2008, approximately 450 t were estimated to have been taken for bait purposes; fishers reported approximately 8 t of discard mortality in the purse seine fishery.	
Effort: 2008 and 2009	Documented purse seine effort decreased by 77% from 2001 to 2008; documented gill net effort decreased by 69% from 1996 to 2009.	
Geographic Distribution of Fishery	The 2008 purse seine fishery, in November and December, was in the northern part of Bonavista Bay and in the western arms of Trinity Bay. The 2009 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 1988-2009 (numbers / nights fished)	Decreased, but not significantly, from 2008 to 2009; 2009 = 147, mean = 153, maximum = 365.	Current abundance below average.
Commercial Gill Net Catch Rates 1996-2009 (kg / net / nights fished)	Increased, but not significantly, from 2008 to 2009; (2009 = 10 logbooks); 2009 = 44, mean = 35, maximum = 86.	Current abundance above average.
Gill Net Fisher Observations 1996-2009 from logbooks	17 observations in 2009; decreasing trend in abundance over past 2 years; 2009 lower than 2008.	Decreasing trend in abundance.
Gill Net Fisher Observations 1996-2009 from telephone surveys	44 observations in 2009; increasing trend in abundance from 2006 to 2007; no change from 2007 to 2009.	No change in abundance.
Purse Seine Fisher Observations 1996 – 2008	15 observations in 2008; increasing trend in abundance over past 5 years; 2008 higher than 2007.	Increasing trend in abundance.
Biological Characteristics	**Observation**	**Interpretation**
2008 Research Gill Net Age Compositions (ages 3+)	The 2002 and 2000 year classes accounted for 25% and 22% respectively of the catch; 7 year classes each account for >5% of catch.	Population age structure considered to be stable.
Current Year Classes: 1998 to 2004 Series: 1982 – 2004 year classes	5 of 7 current mature year classes above average.	Most current mature year classes above average.
Recruitment: 2004 year class Series: 1982 to 2004 year classes	2004 year class below average.	Below average recruitment of the most recent estimatible year class.

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 improved from 2002 to 2007 but deteriorated in 2008 and again in 2009.	**+**	**?**	Uncertainty of Interpretation
Short Term Prospects	Uncertain; below average recruitment of 2004 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 improved from 2002 to 2007 but deteriorated in 2008 and again in 2009. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are uncertain; the 2004 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.
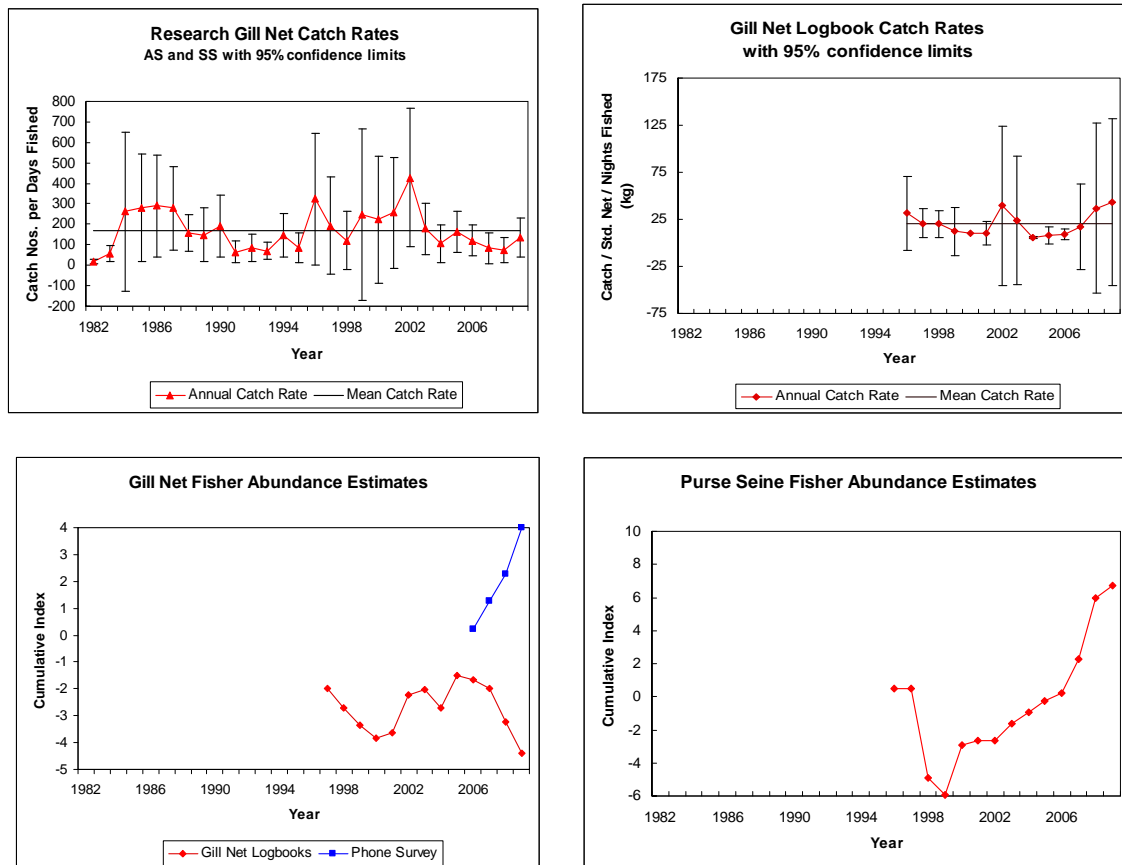
St. Mary's Bay-Placentia Bay

Abundance Indices

Figure 10. St. Mary's Bay - Placentia Bay abundance indices: top left) research gill net catch rates (1982-2009), top right) commercial gill net logbook catch rates (1996-2009), bottom left) gill net fisher abundance estimates on a cumulative index (logbooks 1996-2009, phone survey 2006-2009), and bottom right) purse seine fisher abundance estimates on a cumulative index (1996–2009).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined increased, but not significantly, from 65 in 2008 to 127 in 2009 (Fig. 9, top left). The 2009 catch rate was below average, 74% of the mean (1982-2009).

Three commercial gill net logbooks were returned in 2009. Catch rates (kilograms per standard net per nights fished) increased, but not significantly, from 36.8 in 2008 to 42.7 in 2009 (Fig. 9, top right). The 2009 catch rate was above average, 117% of the mean (1996-2009) and the highest in the time series. Fishers indicated (cumulative index) a decreasing trend in abundance in the past four years and abundance in 2009 was lower than in 2008 (Fig. 9, bottom left).

There were 19 active gill net fishers contacted in the 2009 telephone survey. They indicated (cumulative index) an increasing trend in abundance since the survey began in 2006 and abundance in 2009 was higher than in 2008 (Fig. 9, bottom left).

Four of four active fishers responded to the purse seine questionnaire in 2009. They indicated (cumulative index) an increasing trend in abundance in the past seven years and abundance in the spring of 2009 was higher than in 2008 (Fig. 9, Panel D).
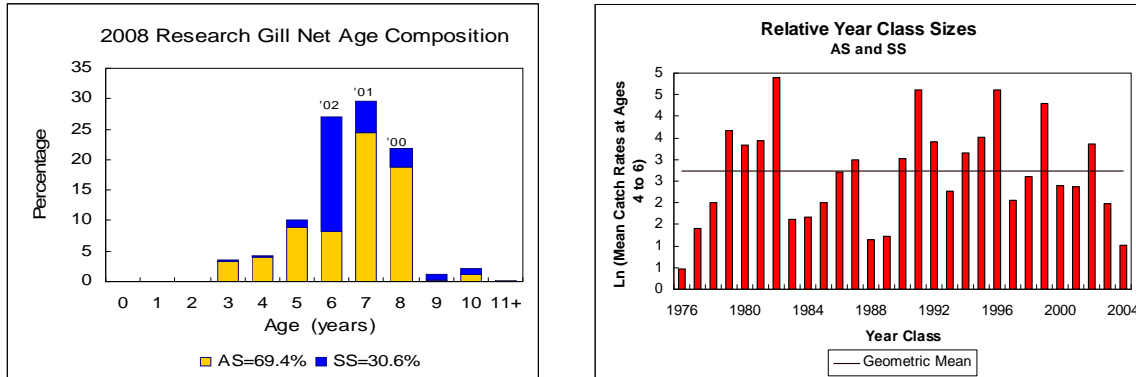
Biological Characteristics

Figure 11. St. Mary's Bay - Placentia Bay 2008 research gill net age composition (left panel) and relative year class sizes (1976-2004) from research gill net catch rates at ages 4 to 6 (right panel).

The 2001 and 2002 year classes accounted for 30% and 27% respectively of the 2008 research gill net catch numbers (Fig. 10, left panel). The age distribution was truncated, as four year classes (including fish age 11+) each accounted for greater than 5% of the catch. Autumn spawners were 69% of the catch, an increase of 2% from 2007.

In comparison to year classes since 1976, five of seven current mature year classes (1998 to 2004) are below average (Fig. 10, right panel). The 2004 recruiting year class, based upon 2008 catch rates only, 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).

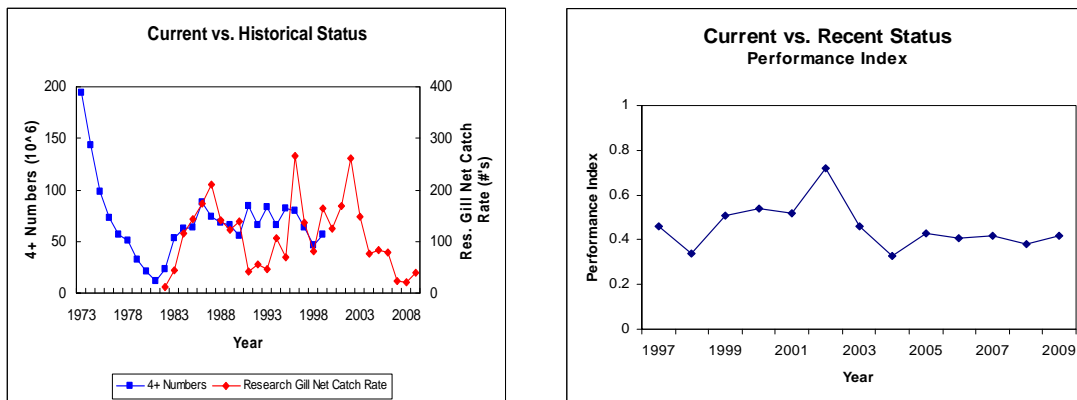Current Status and Short Term Prospects

Figure 12. Comparison of research gill net catch rates and historical population estimates for St. Mary's Bay-Placentia Bay (left panel), and performance indices for 1997 to 2009 (right panel).

Population 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, left panel).

A standardized performance index is available for 1997 to 2009 (Fig. 11, right panel). The composite index indicates that stock status deteriorated from 2001 to 2004, improved slightly in 2005, and has remained stable from 2005 to 2009.

Short term prospects are negative; the 2004 year class is below average and most mature year classes are below average compared to year classes since 1976 (Fig. 10, right panel). All year classes in the time series are weak compared to historical levels.

Assessment results are summarized in the following performance table (Table 3).

Table 3. St. Mary's Bay-Placentia Bay performance table to the spring of 2009.

The Fishery	Observation	
Reported Landings: 2007 - 2008	Reported landings increased from 759 t in 2007 to 1148 t in 2008; 50% of the TAC was taken in 2008; 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: 2008	In addition to reported landings in 2008, approximately 125 t were estimated to have been taken for bait purposes; fishers reported approximately 3 t of discard mortality in the 2009 purse seine fishery.	
Effort: 2009	Documented purse seine effort decreased by 68% from 2000 to 2009; documented gill net effort decreased by 90% from 1998 to 2009.	
Geographic Distribution of Fishery	The 2009 purse seine fishery, in June, was along the eastern side of St. Mary's Bay. The 2009 gill net fishery, from early March to early June, was mostly in Placentia Bay.	
Abundance Indices	**Observation**	**Interpretation**
Research Gill Net Catch Rates 1982-2009 (numbers / nights fished)	Increased, but not significantly, from 2008 to 2009; 2009 = 127, mean = 173, maximum = 407.	Current abundance below average.
Commercial Gill Net Catch Rates 1996-2009 (kg / net / nights fished)	Increased, but not significantly, from 2008 to 2009 (2009 = 3 logbooks); 2009 = 43, mean = 21, maximum = 43.	Current abundance above average.
Gill Net Fisher Observations 1996-2009 from logbooks	7 observations in 2009; decreasing trend in abundance over past 4 years; 2009 lower than 2008.	Decreasing trend in abundance.
Gill Net Fisher Observations 1996-2009 from telephone surveys	19 observations in 2009; increasing trend in abundance since telephone survey began in 2006; 2009 higher than 2008.	Increasing trend in abundance.
Purse Seine Fisher Observations 1996-2009	4 observations in 2009; increasing trend in abundance over past 7 years; 2008 lower than 2007.	Increasing trend in abundance.
Biological Characteristics	**Observation**	**Interpretation**
2008 Research Gill Net Age Compositions (ages 3+)	The 2001 and 2002 year classes accounted for 30% and 27% respectively of the catch; 4 year classes each account for >5% of catch.	Population age structure not considered to be stable.
Current Year Classes: 1998 to 2004 Series: 1976 – 2004 year classes	5 of 7 current mature year classes below average.	Most current mature year classes below average.
Recruitment: 2004 year class Series: 1976 to 2004 year classes	2004 year class below average.	Below average recruitment of the most recent estimatible year class.

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 2001 to 2004 and has remained stable since 2005.	**-**	**?**	Uncertainty of Interpretation
Short Term Prospects	Negative; below average recruitment of 2004 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 has remained stable from 2005 to 2009. However, current abundance is substantially lower than historical estimates in the 1970's. Short term prospects are negative; the 2004 year class is below average and most mature year classes are below average and are weak, compared to historical levels.
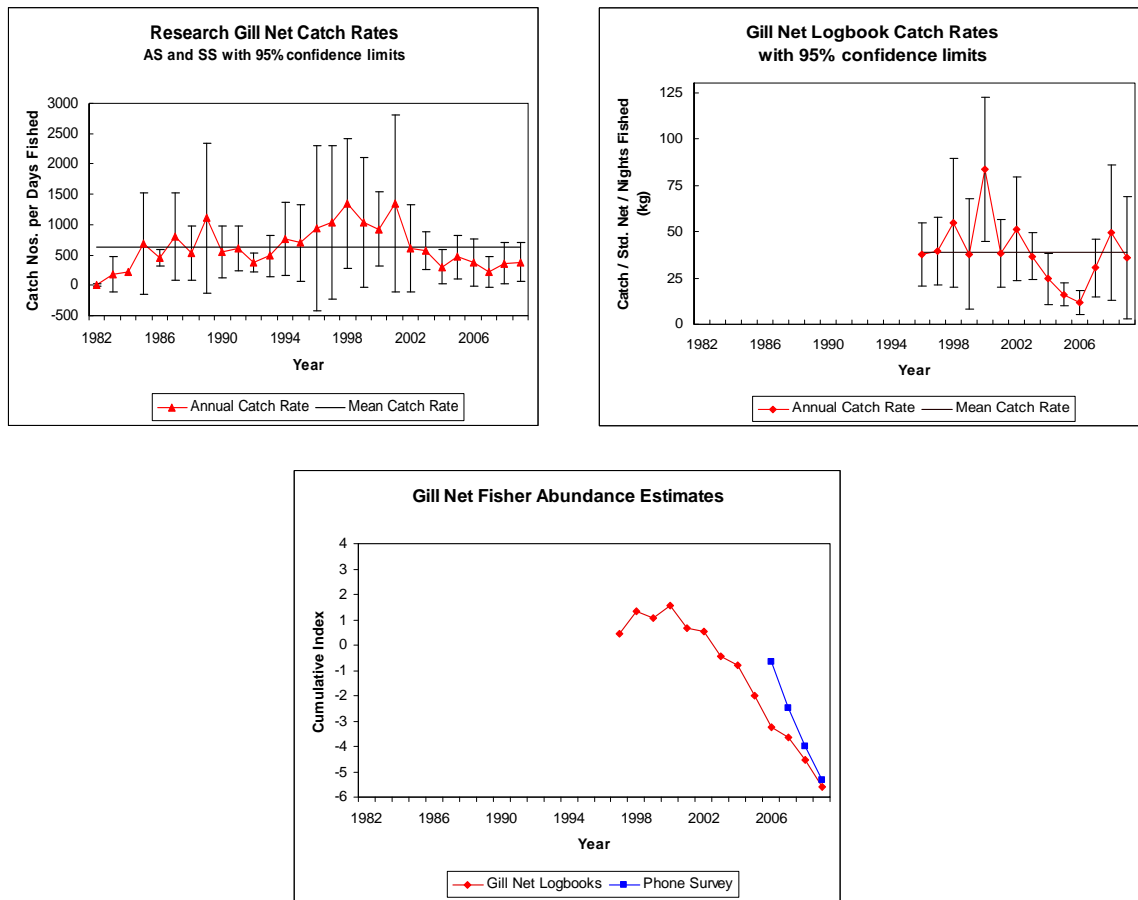
Fortune Bay

Abundance Indices

Figure 13. Fortune Bay abundance indices: top left) research gill net catch rates (1982-2009), top right) commercial gill net logbook catch rates (1996-2009), and bottom centre) gill net fisher abundance estimates on a cumulative index (logbooks 1996-2009, phone survey 2006-2009).

Research gill net catch rates (fish per days fished) of spring and autumn spawners combined increased, but not significantly, from 338 in 2008 to 375 in 2009 (Fig. 12, top left). The 2009 catch rate was below average, 60% of the mean (1982-2009).

Twelve commercial gill net logbooks were returned in 2009. Catch rates (kilograms per standard net per nights fished) decreased, but not significantly, from 49.3 in 2008 to 35.8 in 2009 (Fig. 12, top right). The 2009 catch rate was slightly below average, 84% of the mean (1996-2009). Fishers indicated (cumulative index) a decreasing trend in abundance in the past nine years and abundance in 2009 was lower than in 2008 (Fig. 12, bottom centre).

There were 47 active gill net fishers contacted in the 2009 telephone survey. They indicated (cumulative index) a decreasing trend in abundance since the survey began in 2006 and abundance in 2009 was lower than in 2008 (Fig. 12, bottom centre).
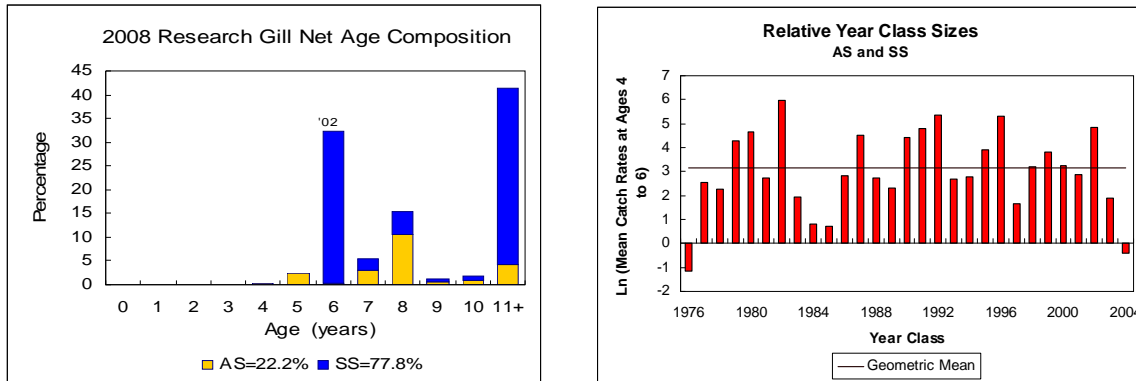
Biological Characteristics

Figure 14. Fortune Bay 2008 research gill net age composition (left panel) and relative year class sizes (1976-2004) from research gill net catch rates at ages 4 to 6 (right panel).

Fish aged 11+ and the 2002 year class accounted for 41% and 32% respectively of the 2008 research gill net catch numbers (Fig. 13, left panel). 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 78% of the catch, a decrease of 5% from 2007.

In comparison to year classes since 1976, five of seven current mature year classes (1997-2003) are average or below average (Fig. 13, right panel). The 2004 recruiting year, based upon 2008 catch rates only, 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).
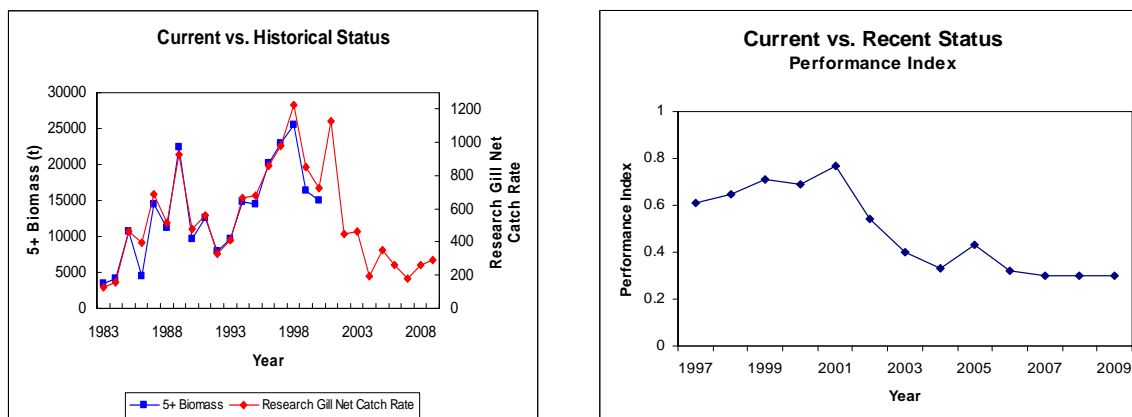
Current Status and Short Term Prospects

Figure 15. Comparison of research gill net catch rates and historical biomass estimates for Fortune Bay (left panel), and performance indices for 1997 to 2009 (right panel).

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, left panel).

A standardized performance index is available for 1997 to 2009 (Fig. 14, right panel). The composite index indicates that stock status deteriorated from 2001 to 2004, improved slightly in 2005, deteriorated again in 2006, and has remained stable from 2006 to 2009.

Short term prospects are negative; the 2004 year class is below average and most mature year classes are average or below average compared to year classes since 1976 (Fig. 13, right panel).

Assessment results are summarized in the following performance table (Table 4).

Table 4. Fortune Bay performance table to the spring of 2009.

The Fishery	Observation	
Reported Landings: 2007 - 2008	Reported landings increased from 2448 t in 2007 to 2550 t in 2008; 80% of the TAC was taken in 2008; average landings of 200 t during 1990's; peak landings in 2003 (since large mobile purse seine fishery in 1960's).	
Total Removals: 2008	In addition to reported landings in 2008, approximately 400 t were estimated to have been taken for bait purposes.	
Effort: 2009	Documented effort in 1980's and 1990's was very low; gill net effort peaked in 1997 and has since declined by 73% from 1997 to 2009; 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 2355 t in 2009.	
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 1982-2009 (numbers / nights fished)	Increased, but not significantly, from 2008 to 2009; 2009 = 375, mean = 623, maximum = 1275.	Current abundance below average.
Commercial Gill Net Catch Rates 1996-2009 (kg / net / nights fished)	Decreased, but not significantly, from 2008 to 2009 (2009 = 12 logbooks); 2009 = 36, mean = 39, maximum = 84.	Current abundance below average.
Gill Net Fisher Observations 1996-2009 from logbooks	20 observations in 2009; decreasing trend in abundance over past 9 years; 2009 lower than 2008.	Decreasing trend in abundance.
Gill Net Fisher Observations 1996-2009 from telephone surveys	47 observations in 2009; decreasing trend in abundance since telephone survey began in 2006; 2009 lower than 2008.	Decreasing trend in abundance.
Biological Characteristics	**Observation**	**Interpretation**
2008 Research Gill Net Age Compositions (ages 3+)	Fish aged 11+ and the 2002 year class accounted for 41% and 32% respectively of the catch; 4 year classes each account for >5% of the catch.	Population age structure not considered to be stable.
Current Year Classes: 1998 to 2004 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: 2004 year class Series: 1977 to 2004 year classes	2004 year class below average.	Below average recruitment of the most recent estimatible year class.

Stock Status	Interpretation	Evaluation	Status Definitions	
Current vs. Historical	Current abundance is lower than peak estimates in the late 1990's.	**-**	**-**	Concern for Current Status or Prospect
Current vs. Recent	Stock status deteriorated from 2001 to 2004, improved slightly in 2005, deteriorated again in 2006, and has remained stable from 2006 to 2009.	**-**	**?**	Uncertainty of Interpretation
Short Term Prospects	Negative; below average recruitment of 2004 year class; most current mature year classes are average or below average.	**-**	**+**	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 2009. Current abundance is substantially lower than peak estimates in the mid to late 1990's. Short term prospects are negative; the 2004 year class is below average and most mature year classes are average or below average.

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 and estimates of mortality. Estimates of dead discards in the purse seine fishery (1996 – 2008) and estimates of herring caught for use as bait (1996 – 2008) were added to the catch at age matrices this year. However, population sizes still could not be accurately estimated using ADAPT.

The percentage of autumn-spawning herring has increased substantially in commercial and research gill net catches in three of four stock areas in recent years. It is uncertain what impact this has had on the main index of abundance (research gill net catch rates), as the research gill net program is designed primarily to provide catch rates of spring-spawning herring.

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 becomes particularly evident in their resulting residual patterns in ADAPT calibrations. Further evaluation of indices is required to explore for divergent trends before inclusion in the model.

There continues to be concerns regarding how to quantify the observations of abundance of gill net and purse seine fishers in estimating current abundance.

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 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, as in the past, indices were weighted subjectively based upon the perceived degree to which each data source provides an index of abundance.

The inability to estimate population sizes has precluded (to date) the calculation of stock status zones and reference points. This severely limits the implementation of the precautionary approach in fisheries management decisions.

ADDITIONAL STAKEHOLDER PERSPECTIVES

<u>Harvesters Perspectives</u>

Harvesters acknowledge the high level of collaboration between science and industry in collecting information for assessing NL herring stocks. However, all of the indices are partially or completely dependent on commercial fishing activity and while that data is essential in assessing the stocks, it should only be one piece in the puzzle. Commercial activity is influenced by price and market conditions, TAC levels and fleet allocation issues and as a consequence, used alone, those indices can result in inaccurate estimates.

Harvesters feel that data provided by a series of acoustic surveys would fill in the data vacuum (fisheries independent data) that currently exists. By having fisheries dependant and fisheries independent data available for stock assessments, estimates of recruitment, mortality and biomass would be far more accurate.   Harvesters feel that data from acoustic surveys would increase their level of confidence in stock estimates and would help ensure harvest levels are adequate from both a biological and an economic perspective.

Not being able to obtain an adequate market and price and, for some fleets, not having enough quota are the reasons for the uncaught TAC's in recent years. Good science is necessary to developing a long term conservation harvesting plan (CHP) and good long term markets cannot be developed without that CHP. In preparation for the next assessment there must be an acoustic survey conducted on NL Herring Stocks.

CONCLUSIONS

<u>White Bay-Notre Dame Bay</u>

The status of this stock has not changed since the 2008 assessment. The stock improved from 2002 to 2005 and has remained stable since then. However, current abundance is substantially lower than historical estimates in the 1970's.

Short term prospects are uncertain; the 2004 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.

<u>Bonavista Bay-Trinity Bay</u>

The status of this stock has deteriorated since the 2008 assessment. The stock improved from 2002 to 2007 but deteriorated in 2008 and again in 2009. Current abundance is substantially lower than historical estimates in the 1970's.

Short term prospects are uncertain; the 2004 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

The status of this stock has not changed since the 2008 assessment. The stock deteriorated from 2001 to 2004 and has remained stable since 2005. Current abundance is substantially lower than historical estimates in the 1970's.

Short term prospects are negative; the 2004 year class is below average and most mature year classes are below average and are weak, compared to historical levels.

Fortune Bay

The status of this stock has not changed since the 2008 assessment. The stock deteriorated between 2001 and 2006 and has remained stable since then. Current abundance is substantially lower than peak estimates in the late 1990's.

Short term prospects are negative; the 2004 year class is below average and most mature year classes are average or below average.

OTHER CONSIDERATIONS

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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FOR MORE INFORMATION

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