

East and Southeast Newfoundland Atlantic Herring

Background

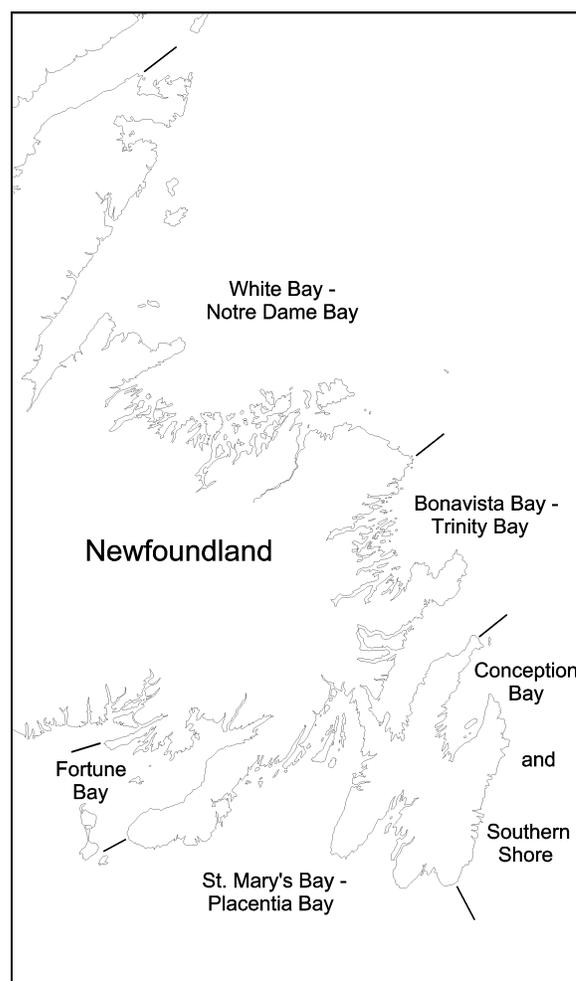
Herring (*Clupea harengus*) are distributed in the northwest Atlantic from Cape Hatteras to southern Labrador.

There are five herring stocks distributed along the east and southeast 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).

These herring migrate extensively on an annual basis through the coastal waters from near shore spawning grounds to feeding areas throughout the bays and returning to overwinter in deep coastal inlets.

Historically, the stocks have supported commercial food and bait fisheries. The fishery along the northeast coast developed in the mid 1970's and peaked during the late 1970's as a result of increased markets due to the collapse of the North Sea herring fishery. The fisheries in all stock areas were closed in the early 1980's due to declining stock sizes but were reopened in the mid 1980's with the recruitment of the 1982 year class. Although controlled by TAC's, the fisheries since then have been largely driven by market availability and in most years quotas have not been taken.

Separate stock status reports have been prepared within this document for all areas except Conception Bay - Southern Shore, due to the limited commercial fishery and lack of scientific data.



Summary

- The mature biomass (age 5+) estimate for east and southeast Newfoundland herring stocks decreased from 89,700 t in 1998 to 83,100 t in 2000.
- Most stocks are at low levels relative to peak levels in the 1970's.
- Year classes produced during the 1990's are generally small, contributing to the overall decline in abundance.

- Caution should be exercised when applying the stock status classification system for management of these stocks.

Species biology

Historically, most of these stocks have been characterized by the predominance of spring-spawning herring; however, autumn spawning herring now form a substantial part of the population in St. Mary's Bay - Placentia Bay. Growth is most rapid at earlier ages, herring at age 4 being an average of 27 cm in length and at age 10, 35 cm. The herring are fully mature by age 5 and can live in excess of 11 years.

Herring within the Newfoundland region are at the northern extent of their geographic range. Good survival of young herring (ie. recruitment) in these stocks is largely influenced by suitable environmental conditions, principally warm overwintering water temperatures and high salinities prior to spawning. Ideal conditions seldom exist and consequently strong recruitment is very sporadic. Large year classes of herring produced in the late 1960's supported the stocks through the 1970's. There was poor survival of all year classes until 1982 and since then only the 1987 year class has been of moderate strength. Ocean temperatures in the early to mid 1990's were below average and year classes produced during this period were weak. Ocean temperatures since 1997 have been warmer and similar to the long-term average; however, little information is yet available on the strength of year classes produced during this period.

Herring are important as a prey for many species including other fish, sea birds and marine mammals. Quantitative information on consumption of herring is available only

for seals. Hammill and Stenson (2000) estimated that, in 1996, seals consumed 36,000 t of herring in NAFO Div. 2J3KL, an area encompassing four of the five Newfoundland herring stocks, excluding Fortune Bay. From 1990 to 1996, it was estimated that the consumption of herring by seals in Atlantic Canada increased by 40%. Most of the herring consumed by seals are <30 cm in length.

Estimation of Stock Sizes

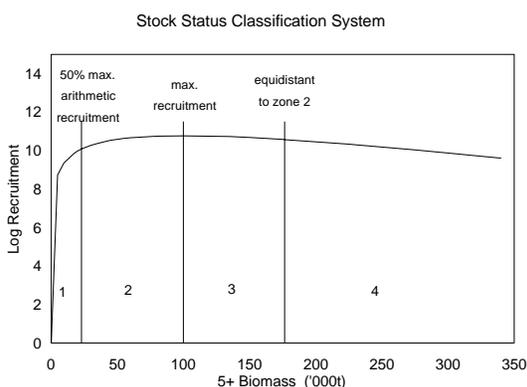
Three series of abundance indices were available for each of the herring stock areas including: research gill net catch rates and acoustic survey biomass estimates extending back to the early 1980's, and commercial gill net catch rates commencing in 1996. Gill net fisher and purse seine fisher observations were also available since 1996. These were derived from questionnaires in which fishers were asked to rate herring abundance on a scale of one to ten, with one being the lowest and ten being the highest.

The research gill net catch rates and acoustic survey biomass estimates were used to estimate population sizes from catch at age data in a sequential population model, ie. integrated catch at age analysis (ICA) (Patterson 1998) similar to the last assessment. However, due to low fishing mortalities, input parameters for the model, such as years of separable constraint had to be changed for White Bay - Notre Dame Bay and St. Mary's Bay - Placentia Bay.

The commercial gill net catch rates, gill net fisher observations, and purse seine fisher observations were not used in this analysis but were used to qualitatively assess stock status.

Population estimates were derived for all areas except Fortune Bay where catch levels and associated fishing mortalities were too low to allow for sequential population analysis. Consequently, as in the last assessment of these stocks, the current stock size for Fortune Bay was estimated using a research gill net catchability coefficient.

The stock status classification system, which links exploitation rates to recruitment estimates at given spawning stock levels, was again used in this assessment. Stock status zones are defined along environmentally based stock-recruit curves.



Zone	Stock Status	F	Type of Fishery
1	Very Poor	0.00 - 0.05	Scientific
2	Poor to Moderate	0.05 - 0.10	Restricted
3	Moderate to Good	0.10 - 0.20	Commercial
4	Good to Very Good	≥ 0.20	Accelerated

Figure 1. Description of the stock status classification system.

A risk analysis was conducted for all areas to determine the probability of projected mature biomass estimates being less than reference levels in the stock status classification system.

White Bay - Notre Dame Bay

The Fishery

Landings in 1999 were 1050 t, 97% of which were taken by purse seines during the fall, and mostly from the eastern portion of the stock area.

The commercial fishery was dominated by age 4 and 5 herring (1995 and 1994 year classes) which accounted for 85% (numbers) of the landings. The 1991 year class, which had been dominant until 1997, accounted for less than 5% of the landings in 1999.

Landings and TAC's ('000 t)

Year	1989	1990	1991	1992	1993	1994
TAC	14	16.5	13.5	13.5	13.5	13.5
Landings	6.4	5.1	8.5	5.7	1.7	1.4

Year	1995	1996	1997	1998	1999	2000
TAC	1.2	1.6	4.9	2.5	2.5	2.5
Landings	1.6	0.6	2.2	0.7	1.0	-

1995-1999 provisional landings

Resource Status

Research gill net catch rates have decreased continuously since 1992; catch rates in 2000 (sample size = 6) were the lowest in the 13 year time series and were 94% lower than the peak in 1992. Similar to the commercial fishery, the 1994 and 1995 year classes dominated in the research gill nets, accounting for 75% of the catch in 1999.

The age 5+ biomass estimated from the most recent acoustic survey in the fall of 1998 was 1600 t. The previous acoustic estimate in 1994 was 1100 t.

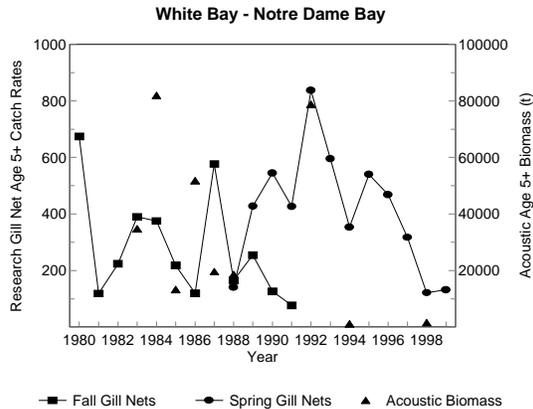


Figure 2. Abundance indices for White Bay – Notre Dame Bay.

However, the 1995 year class (at age 3) dominated in the 1998 acoustic survey and the total biomass estimate from the survey was 19,500 t. There was also evidence of recruitment of the 1997 and 1998 year classes in the survey.

Commercial gill net catch rates have decreased continuously from 1996 to 2000 and are currently (sample size = 5) 94% lower than in 1996. These same gill net fishers indicated that herring abundance was well below average in 2000.

Purse seine fishers (sample size = 2) indicated that herring abundance was well above average in 1999 but much lower than when they first started fishing herring.

The mature biomass estimate for 2000 from the sequential population model was 22,700 t, a slight increase since 1998.

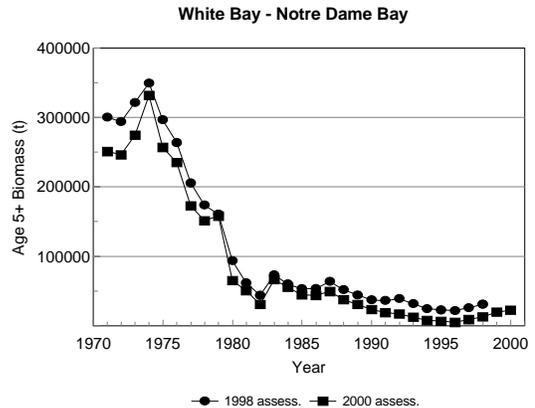


Figure 3. Comparison of age 5+ biomass estimates for White Bay – Notre Dame Bay from current and previous assessment.

Recruitment continued to be poor. The dominant 1994 year class was estimated from the sequential population analysis to be 70% of the strength of the moderately strong 1982 year class. The 1995 year class was only 35% of the strength of the 1982 year class.

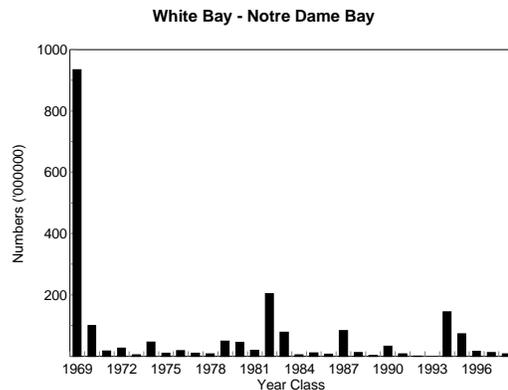


Figure 4. Estimates of recruitment of spring spawning herring at age 2 for White Bay – Notre Dame Bay.

Outlook

With the exception of one indicator (purse seine fisher observations), all indices show that this stock continues to be low in abundance. The current analysis indicates

that the stock should be classified in zone 1 of the stock status classification system.

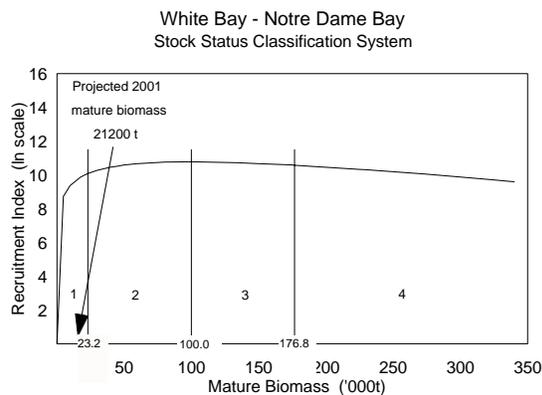


Figure 5. Stock status classification system and projected mature biomass for White Bay – Notre Dame Bay.

The stock continues to be at a low level relative to peak levels in the mid 1970's due to poor recruitment through the 1980's and 1990's. Although the 1994 and 1995 year classes are currently dominant, they are not large year classes. Pre-recruit estimates of the 1997 and 1998 year classes indicate that they are not large.

F	Year	Catch (t)	Probability Mature Biomass < Zone 2
~0.00	2001	<100	46%
	2002	<100	44%
0.05	2001	1300	52%
	2002	1180	53%

Risk analysis indicates that with 2001 and 2002 catches in the order of 1300 t and 1180 t respectively, there is greater than 50% probability that the mature stock biomass will remain in zone 1 of the stock status classification system. This probability decreases by approximately 7% if catches are less than 100 t.

Bonavista Bay - Trinity Bay

The Fishery

Landings in 1999 were 1430 t, with approximately 56% taken by purse seines in a fall fishery in both bays. A spring bar seine fishery in both bays accounted for 30% of the landings.

The commercial fishery was dominated by age 8 herring (1991 year class) which accounted for approximately 45% (numbers) of the landings. This year class has dominated in the fishery since 1995.

Landings and TAC's ('000 t)

Year	1989	1990	1991	1992	1993	1994
TAC	6.9	23.4	10.0	10.0	10.0	10.0
Landings	4.9	3.7	9.1	4.7	2.9	2.7

Year	1995	1996	1997	1998	1999	2000
TAC	1.0	1.4	1.6	2.5	2.5	2.5
Landings	1.4	1.1	1.1	1.0	1.4	-

1995-1999 provisional landings

Resource Status

Research gill net catch rates have decreased continuously since 1997; catch rates in 2000 (sample size = 8) were the lowest in the 13 year time series and were 85% lower than the peak in 1997. Similar to the commercial fishery, the 1991 year class dominated in the research gill nets, accounting for 55% of the catch in 1999. The 1994 and 1995 year classes accounted for 20% and 30% of the catch respectively.

The age 5+ biomass estimated from an acoustic survey in the fall of 1999 was 10,400 t. This was a decrease from the previous acoustic estimate (31,200 t) in 1996.

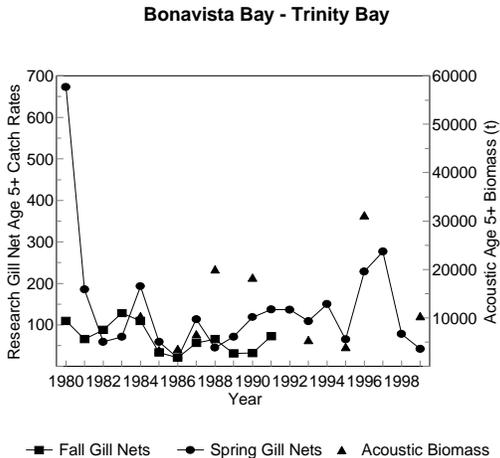


Figure 6. Abundance indices for Bonavista Bay – Trinity Bay.

However, the 1997 year class (at age 2) dominated in the 1999 acoustic survey and the total biomass from the survey was 22,700 t. There was also evidence of recruitment of the 1998 and 1999 year classes in the survey.

Commercial gill net catch rates decreased from 1996 to 1998 and increased from 1998 to 2000 and are currently (sample size = 7) similar to the peak in 1996. These same gill net fishers indicated that herring abundance was average in 2000.

Purse seine fishers (sample size = 14) indicated that herring abundance was above average in 1999 but somewhat lower than when they first started fishing herring.

The 2000 mature biomass estimate from the sequential population model was 30,900 t, an increase since 1998.

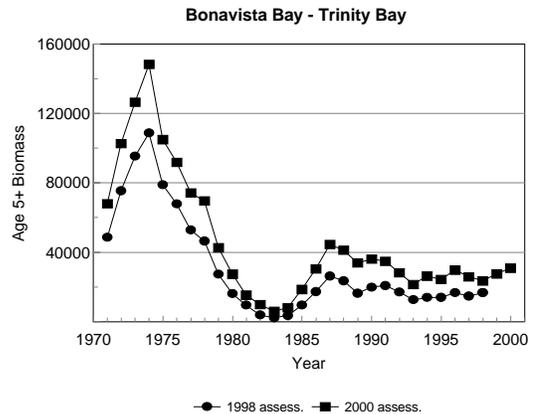


Figure 7. Comparison of age 5+ biomass estimates for Bonavista Bay – Trinity Bay from current and previous assessment.

The 1991 year class, estimated to be approximately 60% of the strength of the 1982 year class, continues to dominate. The 1995 year class is estimated to be 39% the strength of the 1982 year class.

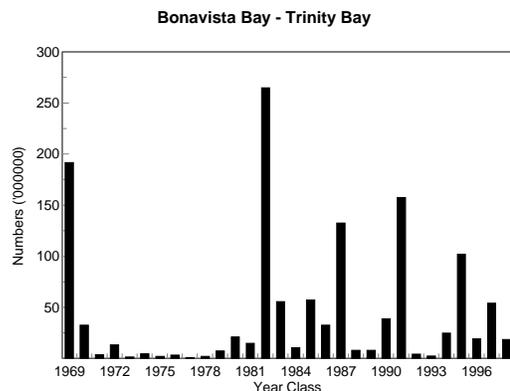


Figure 8. Estimates of recruitment of spring spawning herring at age 2 for Bonavista Bay – Trinity Bay.

Outlook

Abundance indices for this stock provide mixed signals. Research gill net catch rates and acoustic biomass estimates indicate that the stock is declining in abundance. Commercial gill net catch rates and

observations of fishers are more positive. The current analysis indicates that this stock should be classified in zone 4 of the stock status classification system.

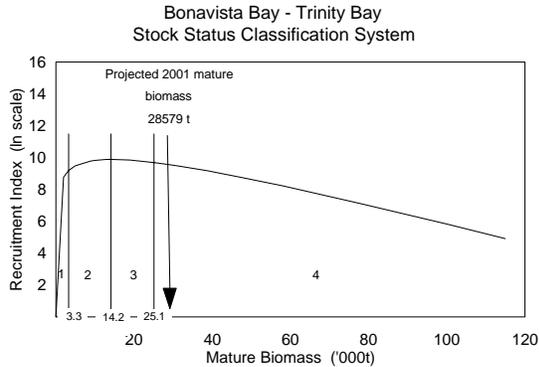


Figure 9. Stock status classification system and projected mature biomass for Bonavista Bay – Trinity Bay.

However, the stock is still at a low level relative to peak levels in the mid 1970's. Although the 1991 and 1995 year classes have dominated in the 1990's, they are not strong year classes. Pre-recruit estimates of the 1998 and 1999 year classes also indicate that they are not large.

F	Year	Catch (t)	Probability Mature Biomass < Zone 4
0.1	2001	2430	27%
	2002	2020	32%
0.2	2001	4650	32%
	2002	3580	40%

Risk analysis indicates that with 2001 and 2002 catches of 4650 t and 3580 t respectively, there is a 32% - 40% probability that the mature stock biomass will decrease to zone 3 within the stock status classification system. By reducing catches to approximately 2000 t, this probability would be reduced by 8%.

St. Mary's Bay - Placentia Bay

The Fishery

Landings in 1999 were 330 t, 99% of which were taken by purse seine during the late winter and spring in Placentia Bay.

The commercial fishery was dominated by age 8 herring (1991 year class), which accounted for approximately 40% (numbers) of the landings. This year class has dominated the commercial fishery since 1995.

Landings and TAC's ('000 t)

Year	1989	1990	1991	1992	1993	1994
TAC	1.5	1.5	1.5	1.5	1.5	1.5
Landings	0.4	0.5	1.0	0.9	1.2	1.0

Year	1995	1996	1997	1998	1999	2000
TAC	1.1	0.7	6.6	2.0	2.0	2.0
Landings	0.8	0.5	3.9	2.3	0.3	-

1995-1999 provisional landings

Resource Status

Research gill net catch rates decreased from 1996 to 1998 and increased from 1998 to 2000 (sample size = 5); Unlike the commercial fishery, the 1996 year class dominated in the research gill nets, accounting for approximately 30% of the catch in 1999. The 1991 and 1995 year classes each accounted for approximately 15% of the catch.

The age 5+ biomass estimated from an acoustic survey in the early spring of 2000 was 1900 t. This was a decrease from the previous acoustic estimate (10,700 t) in 1998.

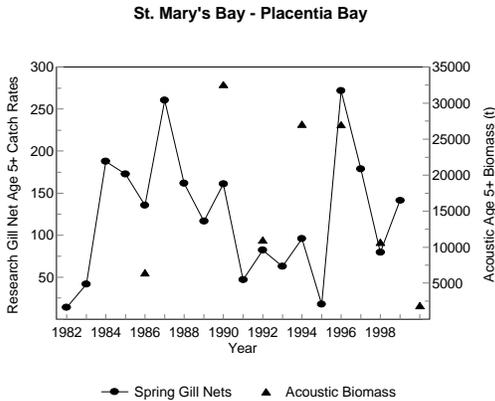


Figure 10. Abundance indices for St. Mary's Bay – Placentia Bay.

The 1995 year class (at age 5) dominated in the 2000 acoustic survey. There was limited evidence of recruitment of the 1996 year class in the survey.

Commercial gill net catch rates have decreased continuously from 1996 to 2000 and are currently (sample size = 1) 68% lower than in 1996. This same gill net fisher indicated that herring abundance was well below average in 2000.

A single purse seine fisher who fished in 2000 indicated that herring abundance was average but much lower than when he first started fishing herring.

The mature biomass estimate for 2000 from the sequential population model was 14,500 t, similar to the mature biomass from the 1998 assessment (14,800 t) of the stock.

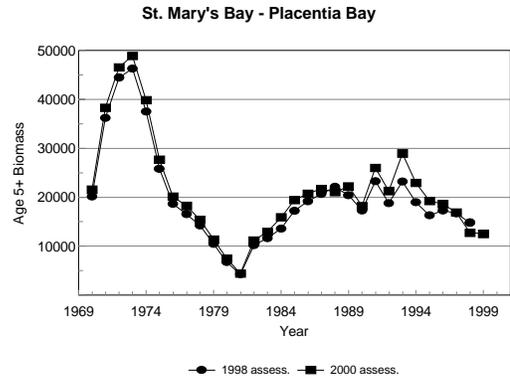


Figure 11. Comparison of age 5+ biomass estimates for St. Mary's Bay – Placentia Bay from current and previous assessment.

The 1991 year class, dominant in the commercial fishery, was estimated to be of similar strength to the 1982 year class. The 1995 and 1996 year classes, dominant in the acoustic survey and research gill nets respectively, were each estimated to be approximately 60% the strength of the 1982 year class.

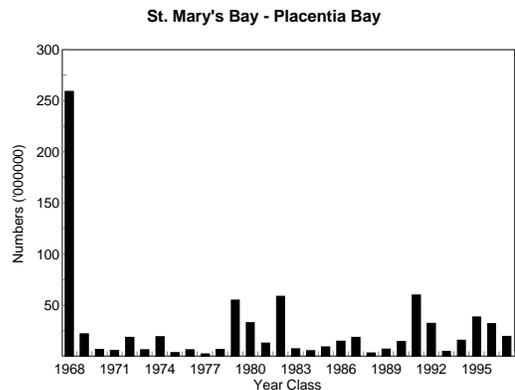


Figure 12. Estimates of recruitment of spring and autumn spawning herring at age 2 for St. Mary's Bay – Placentia Bay.

Outlook

With the exception of research gill net catch rates in St. Mary's Bay, all indices show that this stock is at a similar or lower level than in 1998. The current analysis indicates that

the stock should be classified in zone 3 of the stock status classification system.

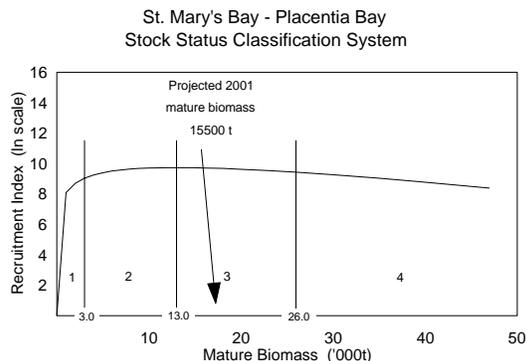


Figure 13. Stock status classification system and projected mature biomass for St. Mary's Bay – Placentia Bay.

The stock is at a moderate level relative to peak levels in the early 1970's. However, there is no evidence of strong recruitment of recent year classes.

F	Year	Catch (t)	Probability Mature Biomass < Zone 3	Probability Mature Biomass < Zone 4
0.1	2001	1380	29%	82%
	2002	1300	34%	85%
0.2	2001	2620	38%	86%
	2002	2200	46%	88%

Risk analysis indicates that with 2001 and 2002 catches in the order of 1380 and 1300 t, there is a 29% to 34% probability that the mature stock biomass would decrease to zone 2 within the stock status classification system. This increases by 8 - 12% with catches of 2620 t and 2200 t. With any of the above catch levels, there is greater than 80% probability that the mature stock biomass would not increase to zone 4.

Fortune Bay

The Fishery

Landings in 1999 were 455 t, 74% of which were taken by bar seine during the spring, primarily in Long Harbour.

The commercial fishery was dominated by age 7 herring (1992 year class), which accounted for approximately 50% (numbers) of the landings. Fish aged 11+, which had been dominant until 1997, still accounted for 30% of the landings.

Landings and TAC's ('000 t)

Year	1989	1990	1991	1992	1993	1994
TAC	1.5	1.5	1.5	1.5	1.5	1.5
Landings	0.1	<0.1	0.1	0.1	0.2	0.3

Year	1995	1996	1997	1998	1999	2000
TAC	1.5	0.5	5.4	5.4	5.4	5.4
Landings	0.5	0.1	0.1	<0.1	0.5	-

1995-1999 provisional landings

Resource Status

Research gill net catch rates peaked in 1998 and decreased in 1999 and 2000; catch rates in 2000 (sample size = 3) were 42% lower than in 1998 but were still high relative to other stock areas. Similar to the commercial fishery, the 1992 year class dominated in the research gill nets, accounting for 29% of the catch in 1999. Fish aged 11+ and the 1991 year class accounted for 27% and 19% of the catch respectively. There was also evidence of the recruitment of the 1996 year class.

The age 5+ biomass estimated from an acoustic survey in the early spring of 1999 was 12,400 t, a decrease from the previous acoustic estimate (15,700 t) in 1997.

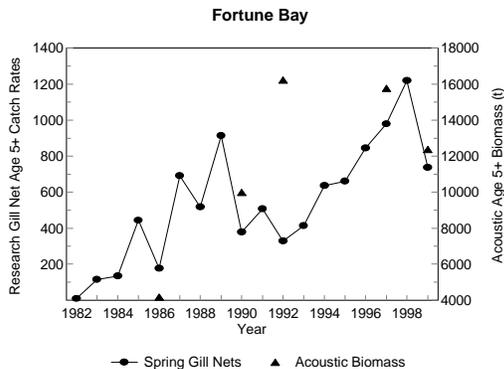


Figure 14. Abundance indices for Fortune Bay.

However, the 1996 year class (at age 3) dominated in the 1999 acoustic survey; the total biomass estimate for the survey was 30,400 t. There was no evidence of recruitment of more recent year classes in the survey.

Commercial gill net catch rates have fluctuated at high levels from 1996 to 2000 and are currently (sample size = 4) at the highest level in the five year time series. These same gill net fishers indicated that herring abundance was well above average in 2000.

The 2000 age 5+ biomass estimate from the research gill net catchability analysis was 15,000 t, a decrease since the 1998 assessment (27,300 t) of the stock.

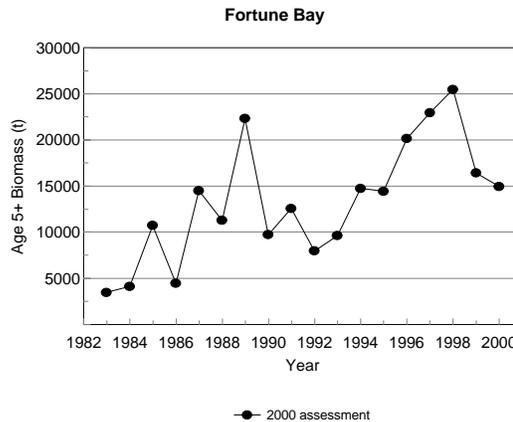


Figure 15. Age 5+ biomass estimate for Fortune Bay from the current assessment.

This decrease is consistent with the decrease in research gill net catch rates, because it is calculated directly from research gill net catch rates.

Outlook

Abundance indices for this stock provide mixed signals. Research gill net catch rates and the acoustic biomass estimate indicate that mature biomass has declined in abundance since the last assessment. Commercial gill net catch rates and observations of fishers are more positive. The current analysis indicates that in 2000 the stock should be classified in zone 3 of the stock status classification system.

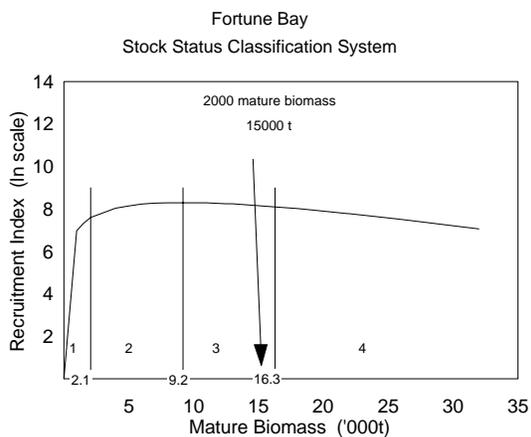


Figure 16. Stock status classification system and mature biomass estimate for Fortune Bay.

Fish aged 11+ continue to contribute significantly to the spawning biomass and there has been very limited fishing mortality.

Year	Catch (t)	Probability Mature Biomass < Zone 3	Probability Mature Biomass < Zone 4
2001	1000	32%	62%
2002	1000	35%	64%
2001	2000	36%	64%
2002	2000	43%	68%

Risk analysis indicates that with 2001 and 2002 catches in the order of 1000 - 2000 t, there is a 32% to 43% probability that the mature stock biomass would decrease to zone 2 within the stock status classification system. With either of the above catch levels, there is greater than 60% probability that the mature stock biomass would not increase to zone 4.

Sources of Uncertainty

The accurate prediction of trends from abundance indices is dependent, among other things, upon the sample size within the index; the smaller the sample size, the greater the variability in the result. Sample sizes are generally low indicating that variability in the indices is probably high.

Accurate commercial catch data is required for the sequential population model. There is reported concern about the extent of unreported gill net catches (bait and domestic use) relative to the total commercial landings, in particular for St. Mary's Bay - Placentia Bay and Fortune Bay.

The sequential population model is sensitive to the manner in which fishing mortality is applied to plus groups, ie. older fish which cannot be accurately aged. For stocks in which a large proportion of the catch consists of these older fish, the fishing mortality applied to these groups can affect historical population estimates.

Natural mortality is assumed to be constant over time in the sequential population model. If natural mortality increased in recent years, current population estimates would be reduced.

Management Considerations

The stock status classification system has been used for the management of these stocks since the mid 1990's. It was introduced to provide a method to reduce fishing mortality if a stock was estimated to be below an optimal level. This has been achieved in recent years as fishing mortalities have been kept low due to the combined effects of the stock status

classification system and poor markets. However, during this period, recruitment has continued to be poor and consequently, most stocks remain at low levels. Although risk analysis indicates minimal differences between the recommended lower and upper fishing mortalities, caution should be exercised when applying the stock status classification system until recruitment improves and stocks begin to increase.

For More Information

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