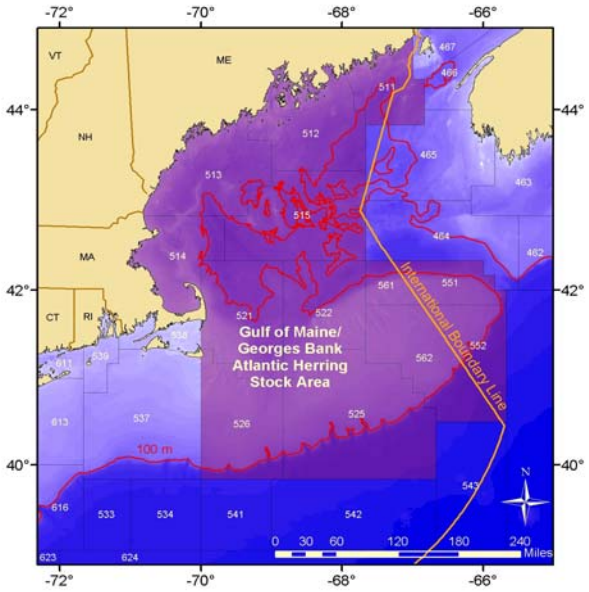
Fisheries and Oceans Canada | Pêches et Océans Canada
NOAA FISHERIES NATIONAL MARINE FISHERIES SERVICE

**Transboundary Resources Assessment Committee**

**Status Report 2009/04**

# GULF OF MAINE-GEORGES BANK HERRING STOCK COMPLEX




***Summary***

- Combined Canada and USA herring landings increased from 106,000 mt in 2005 to 116,000 mt in 2006, then declined to 90,000 mt in 2008.

- Stock biomass (2+, January 1) increased steadily from about 111,600 mt in 1982 to almost 830,000 mt in 1997, fluctuated without trend since then, and was estimated to be 652,000 mt at the beginning of 2008. This is below $B_{msy}$ (670,600 mt).

- Recruitment at Age 2 from the 2004 and 2006 year classes appear weaker than the long-term (1967-2005) average of 2.3 billion fish. The 2005 year class abundance estimate is above average abundance at 3.3 billion fish.

- Fishing mortality (Age 2+) declined to 0.14 in 1993 and has remained stable at about 0.16 from 2002 onwards (Figure 1). Estimated fishing mortality in 2008 was 0.14. This is below $F_{msy}$ (0.27).

**Landings, 2+ Biomass (thousands mt); Recruits (millions)**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Avg[1] | Min[1] | Max[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Canada Landed* | 18.6 | 17.1 | 24.8 | 13.4 | 9.0 | 20.6 | 12.6 | 12.9 | 30.9 | 6.4 | 23.1 | 6.4 | 44.1 |
| *USA Landed* | 110.6 | 108.8 | 120.0 | 93.2 | 100.8 | 94.4 | 93.3 | 103.1 | 81.7 | 83.6 | 80.6 | 33.2 | 123.6 |
| *Total Landed* | 129.1 | 125.9 | 144.8 | 106.6 | 109.8 | 115.0 | 105.9 | 116.0 | 112.6 | 90.0 | 103.7 | 44.6 | 144.8 |
| | | | | | | | | | | | | | |
| *2+ Biomass* | 735 | 854 | 790 | 670 | 674 | 711 | 684 | 690 | 697 | 652 | 529 | 112 | 1,294 |
| | | | | | | | | | | | | | |
| *Age 2 Recruits* | 1032 | 3828 | 1033 | 1275 | 2739 | 3775 | 1616 | 1318 | 3252 | 265 | 2268 | 265 | 8758 |
| | | | | | | | | | | | | | |
| *Fishing Mortality* | 0.19 | 0.16 | 0.20 | 0.17 | 0.17 | 0.17 | 0.16 | 0.17 | 0.17 | 0.14 | 0.37 | 0.14 | 0.80 |
| | | | | | | | | | | | | | |
| *Exploitation Rate* | 0.16 | 0.13 | 0.16 | 0.14 | 0.14 | 0.14 | 0.13 | 0.14 | 0.14 | 0.12 | 0.28 | 0.12 | 0.50 |

[1] 1978-2008 for landings (thousands mt)
1967-2008 for 2+ biomass (thousands mt), recruitment (millions) and F(2+)

## *Fishery*

**Combined Canada/USA landings.** Combined Canada/USA landings averaged 90,000 mt during 1978-1994 (Figure 1). Landings increased during 1995-2001, averaging 133,000 mt, and peaking at 145,000 mt in 2001. Landings declined slightly during 2002-2005, and averaged 109,000 mt. During 1978-2005, the USA accounted for about 76% of the total landings, but during the most recent decade, this percentage increased to about 85%.

**Canadian landings.** Landings by Canada averaged about 27,000 mt during 1978-1994, declined to an average of 19,000 mt during 1995-2001, and declined further to 14,000 mt during 2002-2005. Landing from 2006-2008 average 16,800 mt although landings in 2007 peaked at 31,000 mt. Canadian landing have been dominated by the New Brunswick weir fishery.

**USA landings.** Landings by the United States averaged about 62,300 mt during 1978-1994, increased to an average of 103,000 mt during 1995-2001, and declined to an average of 95,000 mt during 2002-2005. Landings since 2005 have averaged 89,000 mt. During 1978-1982, USA landings were about equally split between the weir fisheries and purse seines. During 1983-1992, most USA landings were taken by purse seines but subsequently single mid-water and paired mid-water trawling have dominated the landings, with purse seining accounting for only about 10-15% of the total USA landings during 2000-2005. Since 2005 purse seining has increased while pair and single midwater trawling has decreased with pair trawling accounting for 56%, single midwater trawling 12% and purse seine 26%.

## *Harvest Strategy and Reference Points*

The Atlantic herring 2006 TRAC recommended that a strategy be adopted to maintain a low to neutral risk of exceeding the fishing mortality limit reference point, and that when stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding. A Fox surplus production model estimated $F_{msy}$ = 0.27, MSY = 178,374 mt, and $B_{msy}$ = 670,600 mt. Yield per recruit reference points (proxies for $F_{msy}$) were estimated as: $F_{0.1}$=0.21, and $F_{40\%}$=0.20.

## *State of Resource*

The state of the resource was based on results from an age-structured, analytical assessment which used fishery catch statistics and biological samples to characterize the size and age

composition of the catches during 1967 to 2008. Even though this was an update assessment, the suite of indices used was re-evaluated. All formulations showed similar trends in stock size but differed in scale. The final formulation was selected, with some difficulty, to balance various data sources and their uncertainty, and was calibrated to trends in abundance from the NMFS spring and fall bottom trawl surveys. In addition, a revised landings at age was applied, as recommended in the benchmark. This resulted in changes to biomass estimates that will be reviewed in more detail at the next benchmark.

Retrospective analyses were used to detect any patterns to overestimate - or underestimate - fishing mortality, biomass and recruitment relative to the terminal year estimates. A significant retrospective pattern was detected in this assessment in overestimating SSB relative to the current estimate (averaging + 42%/year, and ranging between 14-56%) and this is a concern (Figure 2). The pattern has persisted for several years and is expected to continue in the future.

**Stock biomass (2+, January 1)** increased steadily from about 111,600 mt in 1982 to almost 830,000 mt in 1997, fluctuated without trend since then, and was estimated to be 650,700 mt at the beginning of 2008. This is below $B_{msy}$ (670,600 mt). Biomass increases in the late 1990s were due to improved recruitment, especially from two very large year classes, 1994 and 1998 (Figure 3). Weights-at-age in the population declined in the late 1980s but have remained steady since 1995.

**Recruitment** (at Age 2) markedly improved in the late 1980s with several moderate year classes and three large year classes (1994 cohort: 6.3 billion; 1998 cohort: 3.8 billion; and the 2002 cohort: 3.8 billion). Recruitment from the 2004 and 2006 year classes appear weaker than the long-term (1967-2005) average of 2.3 billion fish. The 2005 year class abundance estimate is above average abundance at 3.3 billion fish.

**Fishing mortality (Age 2+)** declined from peak values above 0.7 in the 1970s to an average of 0.4 during the mid-late 1980s (Figure 1). Fishing mortality declined to 0.14 in 1993 and has remained stable at about 0.16 from 2002 onwards (Figure 1). Estimated fishing mortality in 2008 was 0.14. This is below $F_{msy}$ (0.27).

### *Productivity*

Age structure, spatial distribution, and fish growth reflect changes in the productive potential of the stock complex. The **population age structure** shows an increase in abundance of ages 6+ in 1995, remaining relatively constant since then, consistent with lowered exploitation. Increasing abundance of older fish in the landings-at-age and future surveys would help to confirm this pattern. **Spatial distribution** patterns of herring in recent NMFS fall bottom trawl surveys (1998-2008) were similar to patterns observed in the 1960s, prior to the collapse of the offshore stock component. Declines in **weights-at-age** are a factor in limiting increases in the population biomass. On balance, however, the productive potential of the herring stock complex has improved in recent years.

### *Outlook*

An outlook is provided in terms of the consequences on SSB and for landings in 2009, 2010 and 2011 of fishing at the current F=0.14. Additional projections will be run at various Fs as

required by management. Although uncertainty in stock size and recruitment generates uncertainty in forecast results, a formal risk analysis was not undertaken due to the significant retrospective pattern in SSB and the difficulty and uncertainty in selecting the final model formulation. Nevertheless, the forecasts are considered useful for general management guidance.

The projections assumed that recruitment of the 2009-2011 year classes was equal to the recent 10-year average (2.0 billion fish at Age 2) (Figures 3 and 4). A fishing mortality of F=0.14 in 2009 generates a landings of 82,403 mt and an SSB in 2009 of 460,343 mt, a decline of about 11%. Continuing to fish at F=0.14 in both 2010 and 2011 produces annual landings of 81,154 mt and 82,625 mt, respectively, and results in a slight decline in SSB in 2011 to 444,532 mt.

| | 2+ Biomass | SSB | Landings | F |
|---|---|---|---|---|
| **2009** | 694.3 | 460.3 | 82.4 | 0.14 |
| **2010** | 683.8 | 440.0 | 81.2 | 0.14 |
| **2011** | 692.2 | 444.5 | 82.6 | 0.14 |

### *Special Considerations*

The 2005 year class dominated landings in 2006 and 2007 at ages 1 and 2 respectively, and landings over the next several years are therefore dependent on the magnitude of the 2005 year class, which still has high uncertainty.

The retrospective pattern in SSB that has persisted in the last several assessments is an issue and will continue to be investigated in the next benchmark. Ignoring the retrospective pattern in biomass could increase the risk of not meeting conservation objectives.

Analysis of predator consumption and mortality, as well as the use of a larval index to estimate SSB, were discussed. It was considered possible to incorporate these into the assessment, and they will be investigated further at the next benchmark.

Ongoing issues with aging will be addressed further to determine the age at which adequate resolution is achieved. Additional otolith exchanges, workshops and development of common protocols are encouraged.

### *Source Documents*

Overholtz, W.J., and J.S. Link. 2007. Consumption Impacts by Marine Mammals, Fish and Seabirds on the Gulf of Maine-Georges Bank Atlantic Herring (*Clupea harengus*) Complex During the Years 1977-2002. ICES Journal of Maine Science, 64:83-96.

Overholtz, W.J., L.D. Jacobson, G.D. Melvin, M. Cieri, M. Power, D. Libby, and K. Clark. 2004. Stock Assessment of the Gulf of Maine-Georges Bank Atlantic Herring Complex, 2003. Northeast Fisheries Science Center Reference Document 04-06, 290 p.

TRAC. 2006. Gulf of Maine-Georges Bank Herring Stock Complex. TRAC Status Report 2006/01.

### *Correct Citation*

TRAC. 2009. Gulf Of Maine-Georges Bank Herring Stock Complex. TRAC Status Report 2009/04.

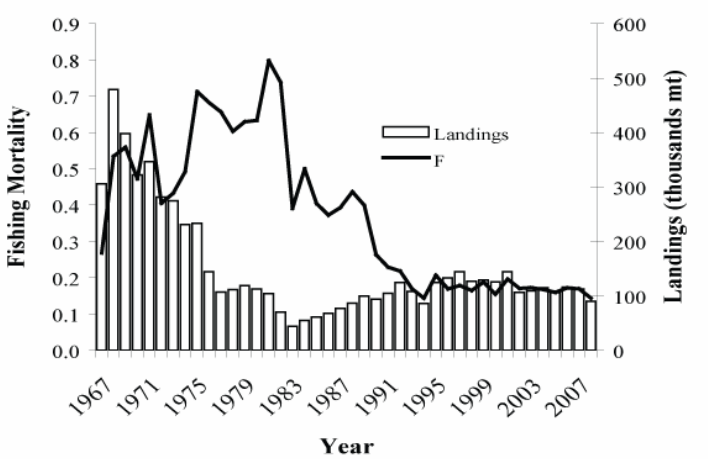



Figure 1. Gulf of Maine/Georges Bank Atlantic herring landings and Age 2+ fishing mortality.

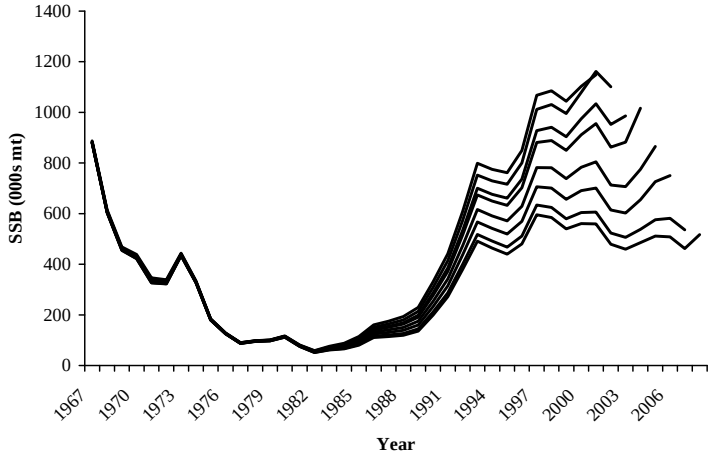



Figure 2. Retrospective pattern of Gulf of Maine/Georges Bank Atlantic herring spawning stock biomass.

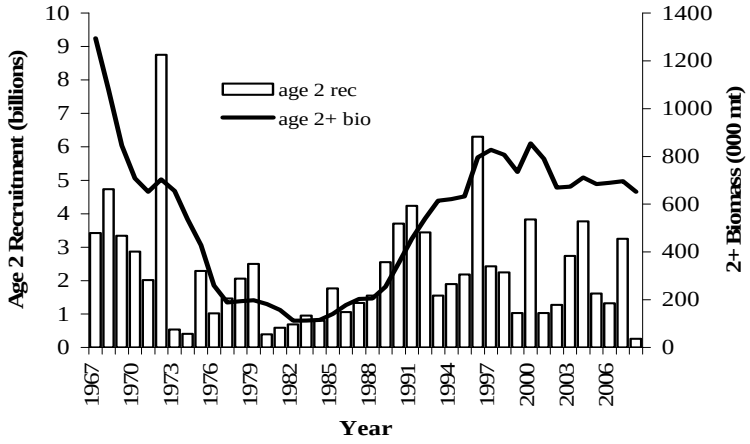



Figure 3. Gulf of Maine/Georges Bank Atlantic herring Age 2+ biomass and Age 2 recruitment.

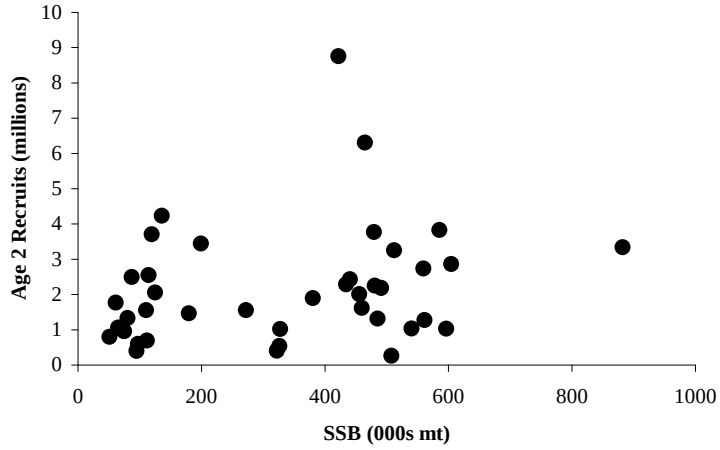



Figure 4. Gulf of Maine/Georges Bank Atlantic herring SSB and Age 2 recruitment.