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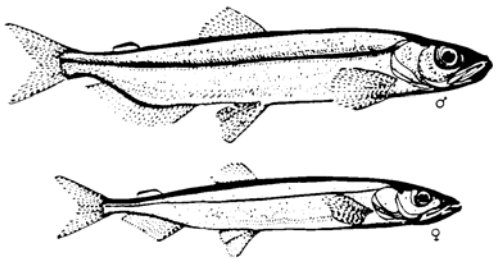
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Advisory Report 2008/054

ASSESSMENT OF CAPELIN IN SA2+DIV. 3KL IN 2008



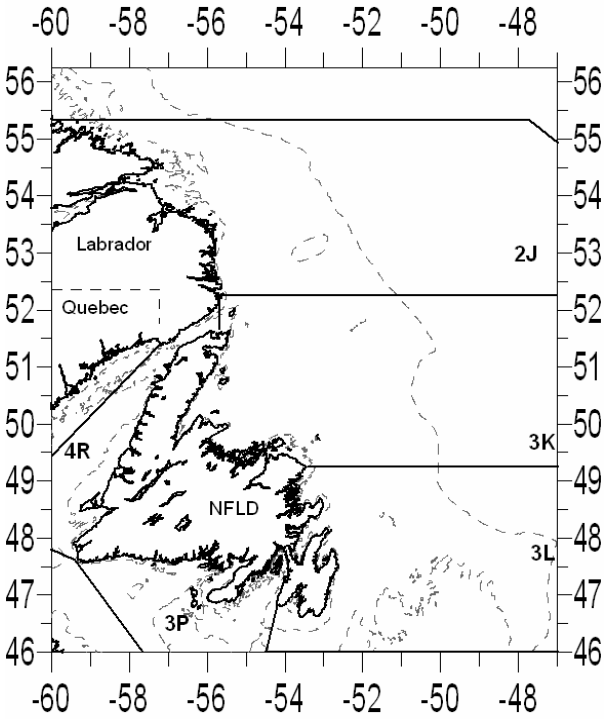


Figure 1: Capelin stock area with 100 m and 500 m contours.

Context :

Capelin (Mallotus villosus) is a small pelagic schooling species with major populations occurring in the Northwest Atlantic, in waters around Iceland, in the Barents Sea and in the northern Pacific.

Prior to 1992, capelin in NAFO SA2 + Div. 3K and in Div. 3L were treated as two separate stocks, but as a result of accumulated evidence, scientists recommended in 1992 that capelin in these areas be considered one stock complex. Four other recognized capelin stocks occurring in Canadian waters are the Southeast Shoal (Div. 3NO), St. Pierre Bank (Div. 3Ps), Gulf of St. Lawrence (Div. 4RST), and the Scotian Shelf (Div.4W).

Historical catches of capelin for food, fertilizer, and bait in Newfoundland have not exceeded 25,000 t. An offshore foreign fishery for capelin occurred in the 1970s with a peak catch of 250,000 t in 1976. The offshore fishery was closed in Div. 3L in 1979 and in Divs. 2J3K in 1992. An inshore fishery started in Divs. 3KL in the late 1970s with peak landings of about 80,000 t from 1988-90. Recent landings have been close to 30,000 t.

Capelin are eaten by many predators including seals, whales, cod, Greenland halibut, salmon and seabirds and are considered a key forage species. Because of its prominent position in the ecosystem a conservative approach to their management has been adopted. Since 1979 a conservative exploitation rate not to exceed 10% of the projected spawning biomass has been advised for capelin stocks in the Northwest Atlantic.

The last analytical assessment for this stock was in 2000 (DFO 2000). Until 2001, stock status had been assessed and a stock status report produced on an annual basis. The fishery for capelin in SA2+Div 3KL

has been managed with three-year capelin management plans since 1999.

The present review is the result of a request for science advice from the Fisheries and Aquaculture Management (FAM) Branch, Newfoundland Region prior to the formulation of the Integrated Capelin Management Plan for 2009-11.

A meeting of the Regional Advisory Process was held on November 5, 2008 in St. John's NL to address the above request. Participants included researchers and fisheries managers from the Department of Fisheries and Oceans; representatives from the Newfoundland and Labrador provincial government and the Fish, Food and Allied Workers Union; fish harvesters; and faculty and graduate students from Memorial University and the Marine Institute.

SUMMARY

- Preliminary landings for 2008 in Div. 3KL are 28,216 t, similar to the TAC of 28,344 t.
- Interest in the fishery has increased in recent years partly related to higher prices associated with the recent closure of the Barents Sea capelin fishery (2004-08).
- The size and age of capelin continue to reflect changes that occurred in the early 1990s, that is, smaller and younger capelin contributing to the spawning biomass.
- The proportion of maturing two year olds observed in a spring acoustic survey has increased since the mid-1990's.
- Fish harvesters have observed an increase in capelin abundance from 2006-08.
- Abundance, estimated from the spring acoustic survey in Div. 3L has increased from 2007-08; however, these estimates are considerably less than acoustic abundances observed in 1988-90.
- Egg deposition in Bellevue Beach in 2007 was the fifth highest since 1990.
- Larval emergence from Bellevue Beach in 2007 was the fourth highest since 1990.
- Spawning times continue to be about four weeks later than observed prior to 1991.
- Capelin are not undertaking diurnal migrations to the extent observed in the 1980s.

INTRODUCTION

Species Biology

Adult fish range in size from about 12 to 23 cm with males being larger than females. Historically, the spawning populations were composed of mainly three and four year old fish. Since the early 1990s, spawning populations have consisted predominantly of two and three year old fish. The short life span and variable recruitment offer the potential for frequent and dramatic changes in mature biomass.

Juvenile capelin of the SA2 + Div. 3KL stock can be found both in major bays and in offshore waters although the northern Grand Bank and Northeast Newfoundland Shelf are thought to be major nursery areas. At maturity, schools of adults migrate inshore to spawn on Newfoundland beaches and demersally during June and July. The amount of off-beach spawning has been

assumed to be variable from year-to-year. Since 1991 spawning has been delayed up to four weeks with spawning taking place in July and August. After the eggs have hatched, the larvae exit the gravel and most are carried rapidly out of the bays by surface currents.

The average size of mature capelin continues to be smaller than observed during the 1980's.

In summary, capelin biology and behaviour continue to reflect the patterns observed during the 1990's. The dramatic shifts, first observed in the early 1990's, appeared to be linked with below normal seawater temperatures; however, the changes continue to persist despite higher seawater temperatures since the mid-1990's.

Fishery

Historically, capelin were fished domestically on spawning beaches for food, bait and fertilizer (annual harvest estimated at about 25,000 t). A directed foreign offshore fishery began in the early 1970's and was closed in Div. 3L in 1979 and in Div. 2J3K in 1992. The peak offshore catch of 250,000 t occurred in 1976 (Fig. 2).

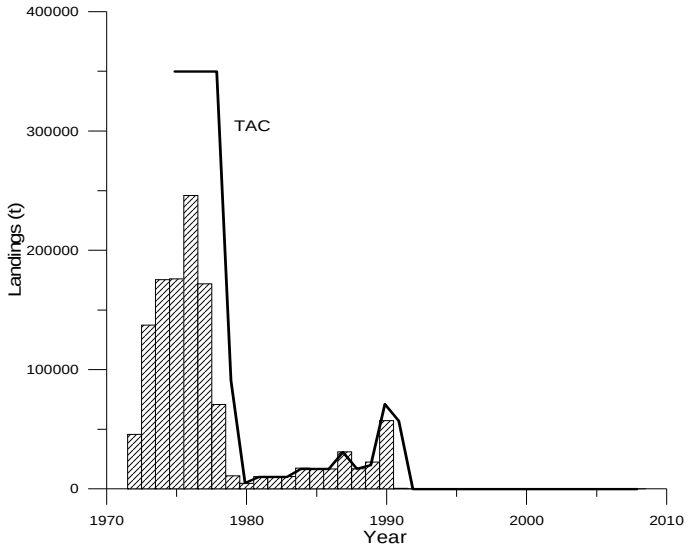


Figure 2: Offshore landings (bars) and TAC (line) for Divs. 2J3KL in 1972-2008.

During the late 1970's, an inshore fishery for roe-bearing female capelin began. Throughout the 1980's, the inshore fishery usually started by mid-June in the south and finished about mid-July in the north. Since the early 1990's the inshore fishery has operated mainly in July and at times, especially in Div. 3K, in early August. Peak inshore landings of approximately 80,000 t occurred in 1988-90. Landings from 2006-08 have been at or slightly higher than the current Total Allowable Catch (TAC) (Fig. 3).

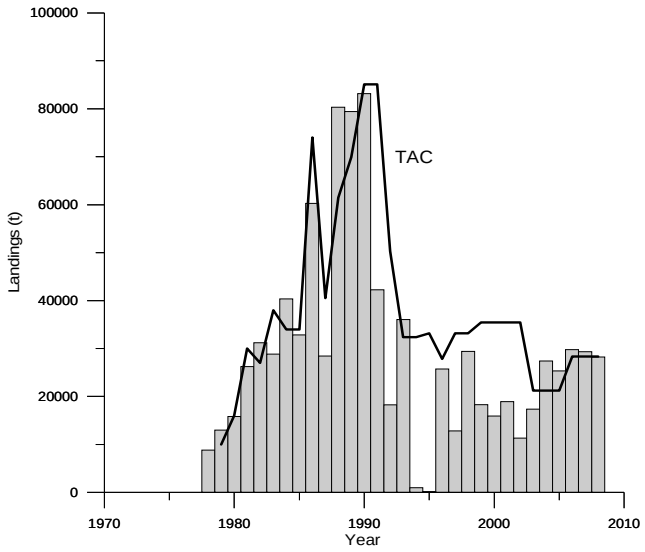


Figure 3: Inshore landings (bars) and TAC (line) for Div. 3KL in 1978-2008.

The inshore fishery has been prosecuted by capelin traps, purse seines and, to a lesser extent, beach seines. Since 1998, modified beach seines, called "tuck seines" have been deployed because capelin stayed in deep water and were unavailable to capelin traps and beach seines. The use of tuck seines or capelin traps has varied from location to location. The majority of the inshore landings in recent years comes from purse seines and tuck seines.

The primary market for frozen roe-bearing female capelin in Japan is limited and the demand for quality is high. Inshore TACs have been tied to market constraints until the late 1990s. Discarding at sea and dumping of capelin, predominantly males which are unsuitable for the Japanese market, were major concerns in the 1980's. In recent years, several management measures and access to other markets have mitigated these concerns. Monitoring capelin quality prior to opening the fishery and relatively short fisheries (two to three days) have significantly reduced at-sea discarding. A condition of provincial processing licenses requiring full utilization of capelin has been instituted since 2006. This requirement along with new markets for male capelin have improved the utilization of male capelin.

In 1994 and 1995, the average size of female capelin in most areas was too small to meet a conservation criterion of 50 count / kg. (sea run) in the capelin management plan. As a result, the fishery either did not open or opened for only a short time and catches were low. In 1996, this size criterion was removed.

Landings from 1996-2003 were less than the TAC as a result of reduced fishing effort due to low prices, small females, and lack of interest by processors. Interest in the capelin fishery has steadily increased since 2004 coincident with a closure of the Barents Sea capelin fishery.

In the Integrated Capelin Management Plan for 2003-05, there was a 40% reduction in TACs attributed to uncertainty around the status of capelin at the time and its role in cod recovery. In the current Integrated Capelin Management Plan for 2006-08, TACs were increased by 33%; at the time there were indications that capelin status was improving based on observations of capelin in northern portions of the stock area, an increase in the size of spawners, and indications of more and earlier beach spawning.

ASSESSMENT

There are no reliable estimates of current spawning biomass for the entire stock. The assessment is therefore based on trends in indices, behavioural changes, and biological descriptors.

The sources of data for consideration are as follows:

1) abundance estimates, distribution maps, and biological samples from spring offshore acoustic surveys predominantly in Div. 3L 1984-92, 1996, 1999-2005, 2007-08,
2) egg deposition index (1990-2007) and larval emergence index (1990-96, 1998-2007) from Bellevue Beach, Trinity Bay,
3) trawlable biomass estimates (1995-2007) and probability occurrence index (1981-2007) from DFO fall multi-species research vessel bottom trawl surveys in Div. 2J3KL,
4) spawning times from two capelin beaches 1978-2008, and
5) biological samples collected from the commercial inshore fishery 1981-2007.

Trends

Spring Acoustic Survey

Information from spring acoustic surveys was available for 1988-92, 1996, 1999-2005, and 2007-08. Estimates of capelin numbers, including 95% confidence limits, were calculated using a simulation technique that incorporated variability over time associated with advances in hydro-acoustic technology and calibration, changes in spatial distribution patterns, and changes in the size of capelin (Mowbray 2008). At this time, acoustic survey data from 1984 to 1987 could not be processed in the same way in order to extend the time series back in time. A slight increase in abundance has occurred in the last two years (Fig. 4); however, abundance remains substantially lower than in 1988-90. Information from this survey does not consider changes in survey design, surveyed area, vessels, fishing gears, and migration timing which may further complicate analyses and interpretation. The spring survey covers only a part of the stock area and as such these are considered to be minimum abundance estimates.

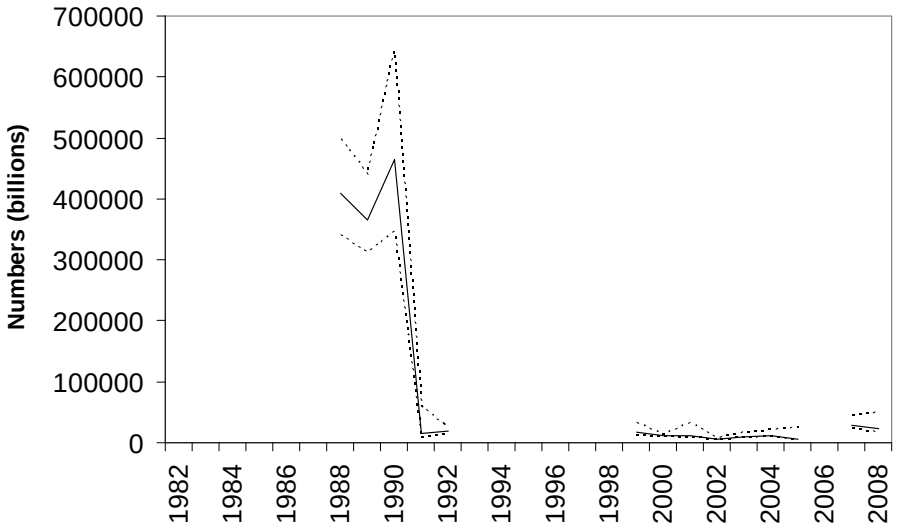


Figure 4: Simulated spring offshore abundance estimates (line) with 95% confidence intervals (broken lines) for an index area comparable to Div.3L.

Egg and Larval Studies

Trends in two indices from a single capelin spawning beach at Bellevue Beach in Trinity Bay, Div. 3L were evaluated. Egg deposition is based on the amount of stage I-II eggs (viable eggs less than 36 hours old) per cm^2 of beach gravel (Nakashima and Slaney 2001). Egg deposition in 2007 was higher than the long-term average (Fig. 5). If egg deposition is considered a proxy for spawner abundance, then spawning abundance in 2007 was the fifth highest in the series.

Annual estimates of larval capelin emerging from beach gravel at Bellevue Beach were available from 1990 to 2007 except for 1997. Larvae were enumerated from plankton tows over the intertidal zone at every high tide (Nakashima and Slaney 2001). Larval release from beaches has been shown to be related to recruitment in capelin (Carscadden el al. 2000). If so then the 2007 year class which is one of the highest in the series should be relatively abundant as two-year olds in 2009 and the 2006 year class which was one of the lowest in the series should be relatively weak as three-year olds in 2009 (Fig. 5).

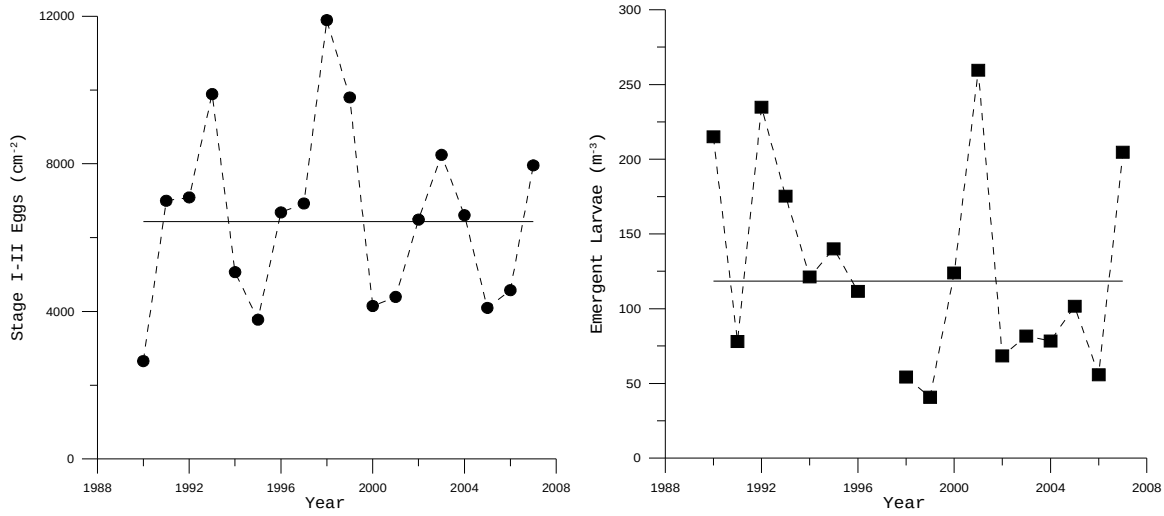


Figure 5: Egg deposition (circles) from 1990-2007 and larval emergence (squares) from 1990-96, 1998-2007 for Bellevue Beach, Trinity Bay. The solid line represents the average egg deposition and average larval emergence, respectively.

The egg deposition and larval emergence indices are from a single capelin beach and may not reflect what is occurring throughout the stock area. There are no similar indices from other beaches for corroboration.

Fall Multi-species Surveys

Estimates of capelin biomass from bottom fishing sets conducted during the fall multi-species survey in 2J3KL using the Campellen trawl were available from 1995 to 2007. The trawlable biomass of capelin has been increasing from 1996 to 2007 (Fig. 6). This trend cannot be compared to data collected prior to 1995 because of the difference in catchability of capelin by the Campellen trawl in the recent period and the Engels trawl used previously. Moreover, year to year changes in the age at which capelin are fully recruited to this survey indicate

considerable inter-annual variation in capelin availability. Consequently, trawlable biomass estimates do not necessarily reflect annual biomass.

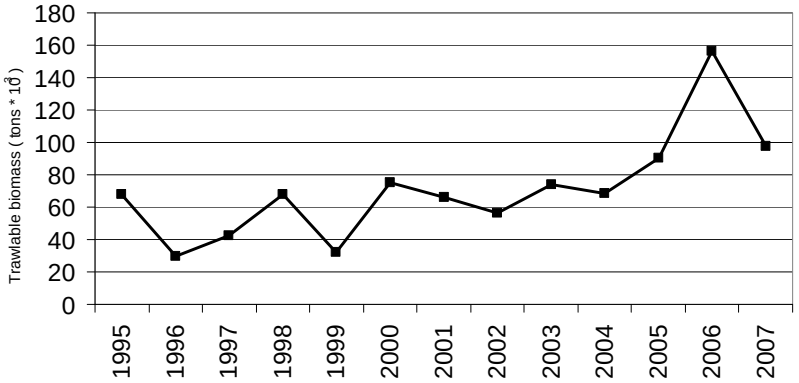


Figure 6. Trawlable biomass of capelin from the fall multi-species bottom trawl survey in 2J3KL.

Behavioural Information

Occurrence

The occurrence (presence-absence) of capelin in fishing sets from the fall multispecies bottom trawl surveys was analyzed using Kriged probability of occurrence (Grégoire et al. 2002). The probability occurrence index from 1981-1994 using the Engels trawl shows an increasing trend compared to the 1995-2007 period that shows variation around a constant and higher level (Fig. 7). The two time series could not be reconciled. The Campellen trawl has a higher catchability for small capelin compared to the Engels trawl. In addition, capelin tend to be closer to the bottom since the 1990s and this behavioural change may have increased the probability of capturing capelin using a bottom trawl.

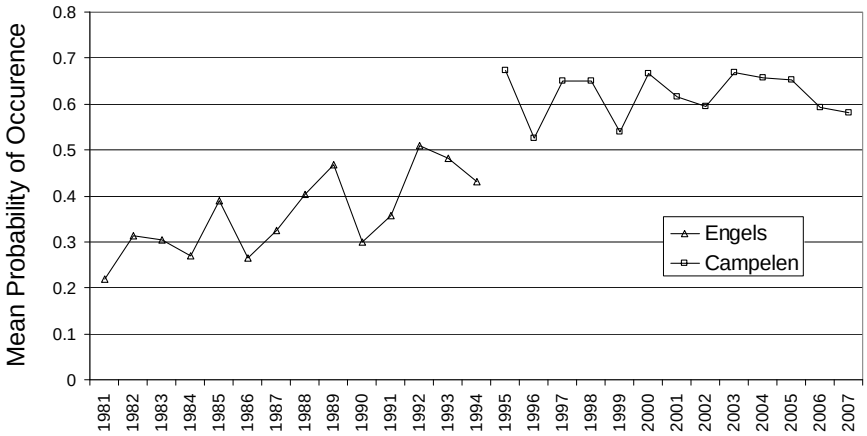


Figure 7. Mean probability of occurrence of capelin for the Engels trawl (diamonds) and Campellen trawl (circles).

Horizontal Distribution

Distribution maps of capelin predominantly in Div 3L based on acoustic data from spring surveys in 1988-92, 1996, 1999-2005, and 2007-08 were examined. From 1988-90, capelin were well distributed throughout the survey area and the densities were relatively high. In 1991 capelin were encountered at very low densities in a few areas only; however, half the area was not surveyed due to ice cover. From 1992 to 2005 capelin were sparsely distributed and densities remained at low levels. In 2007 and 2008, densities increased, especially in northern areas of Div. 3L. Despite this increase, recent densities and distributions are more comparable to the 1990's than the 1980's.

Vertical Distribution

Vertical distribution, as measured from the spring acoustic surveys, shows that capelin in Div. 3L are remaining close to the bottom (Fig. 8) and are not undergoing diurnal migrations as observed in the 1980s.

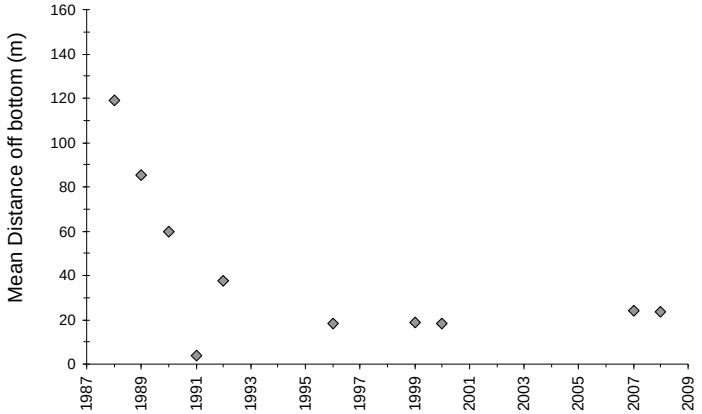


Figure 8. Mean distance off the bottom of capelin aggregations in Div. 3L in the spring.

Spawning Time

A time series consisting of the annual date of peak spawning was available for two beaches (Fig. 9). The data from Bryants Cove, Conception Bay (Div. 3L) were from 1978-2007 and is the only location where peak spawning has been documented before 1990. Observations were also available for 12 of 18 years from 1990-2007. The data from Bellevue Beach, Trinity Bay is the only location where peak spawning has been documented continuously from 1990-2008. Observations from 1991-2007 from four other spawning beaches in White Bay, Notre Dame Bay, Bonavista Bay, and Conception Bay mirrored the trend of peak spawning reported for Bryants Cove and Bellevue Beach. These data show that beach spawning by capelin continues to be about 4 weeks later than observed historically.

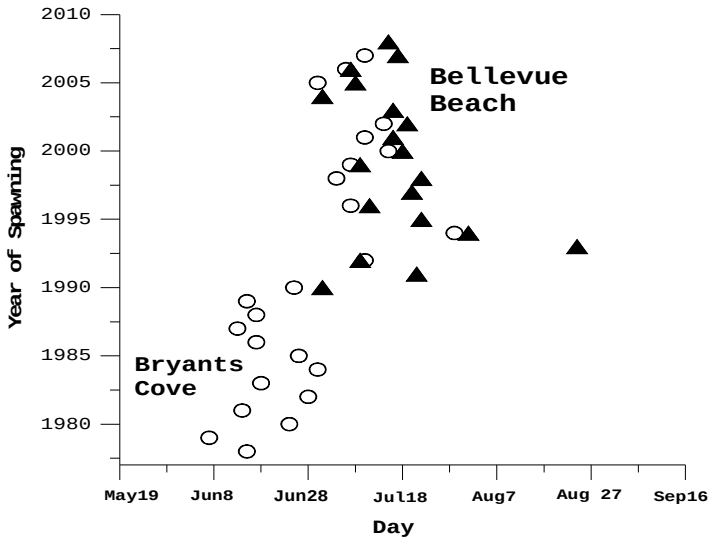


Figure 9: Peak spawning times at Bryants Cove, Conception Bay (open circles) and Bellevue Beach, Trinity Bay (closed triangles).

Biological Information

Biological samples from the commercial inshore capelin fishery have been collected and processed since the early 1980s. Results were available to 2007 for this assessment. Mean total lengths of males and females in both Div. 3L and Div. 3K describe similar trends (Fig. 10). Mean lengths since 1992 have been, on average, 15 to 18 cm less than those measured prior to 1992. Mean weights depicted a similar trend being about 5 grams less since 1992.

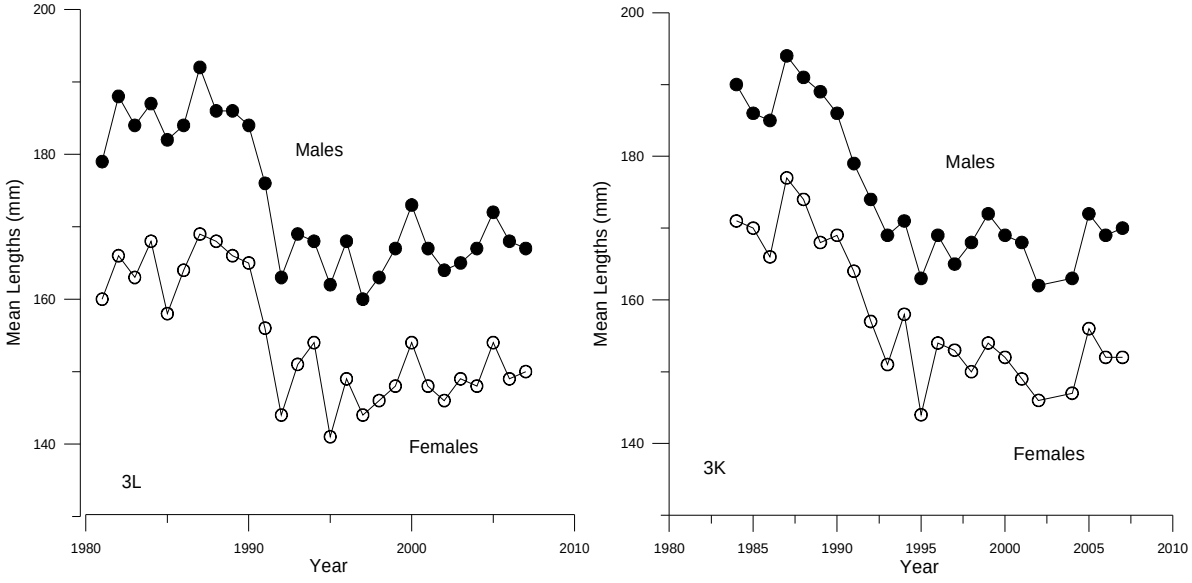


Figure 10: Mean total lengths of males (closed circles) and females (open circles) in Divs. 3L and 3K.

Mean ages of biological samples from the inshore commercial fishery have been younger since 1992 compared to the 1980s (Fig. 11). From 1980-1991 the spawning biomass was predominantly comprised of three and four year-old fish. Since 1992 the spawning biomass has been dominated by two and three year-old fish.

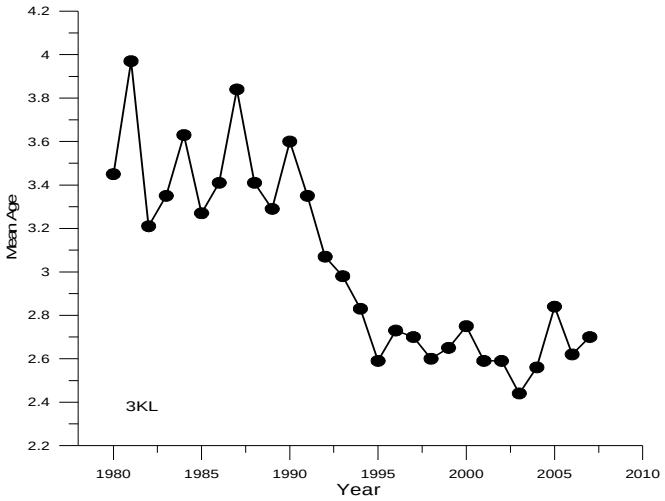


Figure 11: Mean age of mature capelin (sexes combined) in Div. 3KL.

The biological information from commercial sampling indicates that mature capelin continue to be smaller and younger than fish sampled prior to 1992.

Biological samples collected during the spring acoustic survey in recent years have a higher proportion of mature two-year olds. In the 1980's two year old capelin in the offshore were predominantly immature. Since 1996 a higher proportion of mature two year olds have been evident in the spring acoustic survey sampling. These observations are consistent with the increase in the proportion of mature two year olds observed in the commercial inshore fishery since the mid-1990's.

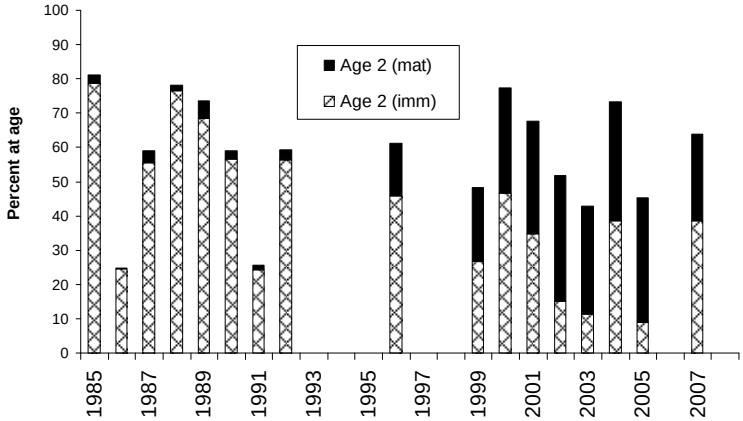


Figure 12: Proportion of mature two year old capelin in the spring survey.

Sources of Uncertainty

There are no estimates of current stock size for capelin in SA2+Div.3KL. As a result the impact of current catches on spawning biomass cannot be evaluated.

Beginning in 1991 and continuing throughout the 1990s, acoustic densities of capelin offshore have been substantially lower than densities recorded during the 1980s. At the same time, other indicators of abundance, most notably those collected inshore during the spawning season, did not decline to the degree that would have been predicted from the acoustic estimates. The abrupt decline in offshore acoustic densities between 1990 and 1991, the continuing low offshore acoustic densities, and the discrepancies between the acoustic indices and other indices have never been explained.

ADDITIONAL STAKEHOLDER PERSPECTIVES

Since 2006, fish harvesters have observed an increase in capelin abundance, comparable to abundances observed in the 1980's. During this time, TACs have generally been harvested in a very short time, indicative of good catch rates. Fish harvesters conducting other fisheries such as crab and shrimp are reporting increased occurrences of capelin which also indicate higher abundances.

CONCLUSIONS AND ADVICE

The indicators examined during this assessment show that many of the changes reported in the 2001 Stock Status Report (DFO 2001) related to capelin biology and behaviour have persisted from 1992-2007 and are likely to continue. There are no recent estimates of abundance available for the entire stock, however a spring acoustic survey covering an index area had estimated abundances that are considerably lower than those derived in the late 1980's. Because of the uncertainty of the level of exploitation on this stock and the importance of capelin as a key forage species, caution is advised.

Increases in the offshore abundance of capelin in 2007 and 2008 from spring acoustic surveys complement observations by fish harvesters that abundance has been increasing since 2006. Further, egg deposition at Bellevue Beach was above average in 2007 indicating higher abundance of mature capelin compared to 2005 and 2006. Larval emergence from Bellevue Beach was above average in 2007 indicating that the 2007 year class as two year olds in 2009 may be relatively strong and below average in 2006 indicating that the 2006 year class as three year olds will be relatively weak. It remains to be seen whether these positive signs in recent years will continue or become part of the variation oscillating around the trend of generally low offshore abundances observed since the early 1990's.

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