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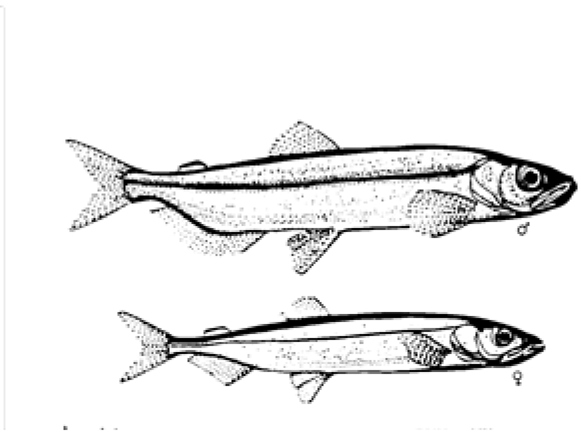
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Advisory Report 2015/036

ASSESSMENT OF CAPELIN IN SUBAREA 2 AND DIVISIONS 3KL IN 2015



Capelin (Mallotus villosus)
Image adapted from a drawing in C. E. Hollingsworth. 2002. Preface. ICES J. Mar. Sci. 59, p. 861.

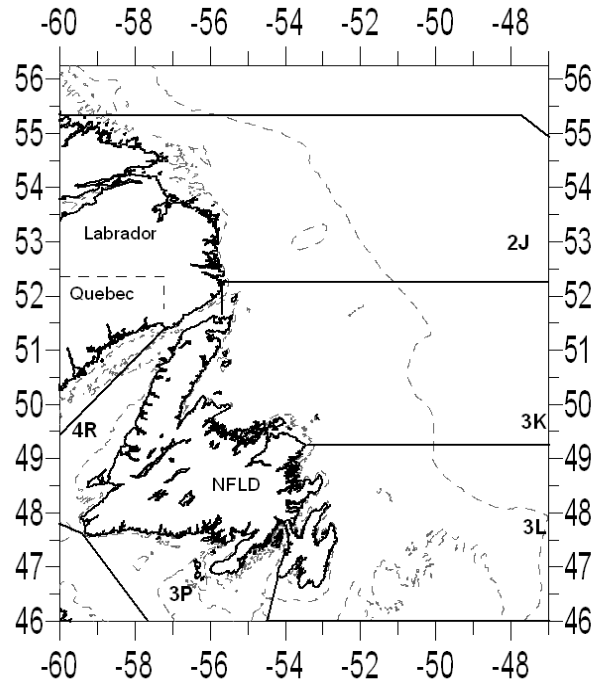


Figure 1. Capelin stock area with 100 m and 500 m contours.

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 however, 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 (Divs. 3NO), St. Pierre Bank (Subdiv. 3Ps), Gulf of St. Lawrence (Divs. 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 closer to 2,000 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 was advised for capelin stocks in the NW Atlantic. This advice has not been implemented since 2000 due to the inability to predict stock biomass.

The previous assessment for this stock was in January 2013 (DFO 2013) and included research and commercial data to 2012. Until 2001, stock status had been assessed and a stock status report produced on an annual basis, however since 2008 assessments have been conducted bi-annually. The fishery for capelin in SA2+Divs. 3KL has been managed with three-year capelin management plans from 1999 to 2008 and with single year plans from 2009 – 2011. The current (evergreen) integrated fisheries management plan commenced in April 2011 and has no fixed term.

The present review is the result of a request for science advice from the Fisheries Management (FM) Branch, Newfoundland Region prior to updating the Fisheries Management Plan for Capelin in 2015. A Regional Peer Review Process meeting was held on February 3-5, 2015 in St. John's NL to address the above request. Participants included researchers and resource 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.

SUMMARY

- Preliminary landings in 2013 and 2014 were 23,755 and 23,173 t, respectively, against a Total Allowable Catch (TAC) in Divs. 2J3KL of 22,771 t.
- Fish harvesters report increased abundance and distribution in all areas, including those that did not support a commercial fishery in 2014, with larger size (both in length and weight) and with higher fat levels. All these indicators are comparable to that observed in the 1980s.
- The 2013 and 2014 abundance indices of capelin from the spring acoustic survey were the highest values since 1990 at 53.6 and 121.9 billion respectively; about 25 % of peak values recorded in the 1980s.
- Four recruitment indices covering the year classes since 2003 were generally coherent until 2012 but have since diverged. The most recent estimates of the 2012 and 2013 cohorts in the acoustics survey were both the highest since 1996. These cohorts are expected to comprise the majority of spawners in 2015 and 2016.
- Both larval indices of abundance for the 2014 cohort were below average. Other cohorts of similar magnitude have not contributed significantly to the maturing spawner biomass.
- Fall distribution in the last 4 years is reverting to patterns more similar to those exhibited in the late 1980s than that of the last two decades, with the center of mass located further north and west.
- Spring distributions have also returned to patterns common to the 1980s with capelin more abundant in the coastal areas off the Avalon Peninsula and Trinity Bay. This represents a west and southward shift when compared to the distribution of the last 15 years.
- Capelin vertical migration patterns in the offshore remain attenuated in comparison to those of the 1980s. Since 1991 capelin have generally been found in areas of greater water depth, and in closer proximity to the bottom.
- The mean lengths and weights of capelin sampled from the commercial fishery catch in 2013 and 2014 were the largest since 1990 and similar to sizes found in the late 1980s. These increased sizes reflect a higher proportion of age 3 spawners in landings.
- The proportion of age 2 capelin found to be maturing increased from 5 % in the 1980s to a peak of 80 % in 2005. Since 2011 the proportion of age 2 maturing fish has continually declined to a low of 19 % in 2014. Delayed maturation is associated with slower growth but improved survival of age 2 capelin.
- From the early 1990s through 2010 spawning times have been delayed by as much as four weeks. Peak spawning at index sites at Bryants Cove and Bellevue Beach from 2011-2014 have occurred in early to mid-July, only two weeks later than in the 1980s.

- Stomach fullness indices from the spring acoustic survey indicate that feeding in 2014 was among the poorest in the time series. Good feeding success in 2011 was associated with increased amounts of copepods and *Oikopleura* in the spring diet and higher proportions of euphausiids in the fall.
- Survival of larvae produced in 2011 and 2012 has been 2-3 times better than that of any cohort since 2003. This two year period corresponds to one of increased zooplankton production and improved condition and feeding in adult capelin.
- Feeding and size-at-age information from the capelin acoustic survey in 2014 suggest that feeding conditions this year may not have been as favourable as from 2011-2013.
- Macrozooplankton (> 1mm) biomass returned to near-normal in 2014 after several years of above average levels. Peaks in this size fraction occurred in 2007 and 2011 coinciding with peaks in standardized recruitment indices of capelin.
- Preliminary ecosystem model estimates of consumption of capelin by fish have been increasing since 2010, which is consistent with the increasing abundance observed in the acoustic surveys. However consumption by seals, whales and seabirds have not been updated.
- Given the poorer environmental and feeding conditions seen in 2014, coupled with the below average strength of the 2014 larval cohort, and the importance of capelin as a forage species, it is suggested that a cautious approach to increasing TACs be adopted.

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, although this has started to shift back to older fish in the last two years. The short life span and highly variable recruitment offer the potential for frequent and dramatic changes in the mature biomass.

Juvenile capelin of the SA2 + Divs. 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 the major nursery areas. At maturity, during June and July, schools of adults migrate inshore to spawn on Newfoundland beaches and on demersal sites. From 1991 to 2010 the timing of peak spawning was delayed up to four weeks, with spawning taking place in July and August. These delays were attributed in part to cold water temperatures and a larger presence of younger, smaller spawners. Since 2010 capelin spawning times have been slowly shifting back toward the historic norm, with peak spawning occurring only two weeks later than it did in the 1980s. After the eggs have hatched, the larvae exit the gravel and most are carried out of the bays by surface currents.

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 1970s and was closed in Div. 3L in 1979 and in Divs. 2J3K in 1992. The peak offshore catch of 250,000 t occurred in 1976.

During the late 1970s, an inshore fishery for roe-bearing female capelin began. Throughout the 1980s, the inshore fishery usually started by mid-June in the south and finished about mid-July in the north. Since the early 1990s 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.

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 conventional 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 had 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 1980s. 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 in effect since 2006. This requirement, along with new markets for male capelin, has increased 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 steadily increased from 2004 coincident with a closure of the Barents Sea capelin fishery, but has since levelled off with the re-opening of the Barents Sea fishery in 2009 and reductions in the Newfoundland processing capacity.

In the Integrated Fisheries Management Plan for Capelin 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 Integrated Fisheries Management Plan for Capelin 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. Following a year of poor availability and catches in 2010 TACs were lowered again by 20 % in 2011. Preliminary landings in 2013 and 2014 were 23,755 and 23,173 t, respectively, against a Total Allowable Catch (TAC) in Divs. 2J3KL of 22,771 t (Fig. 2).

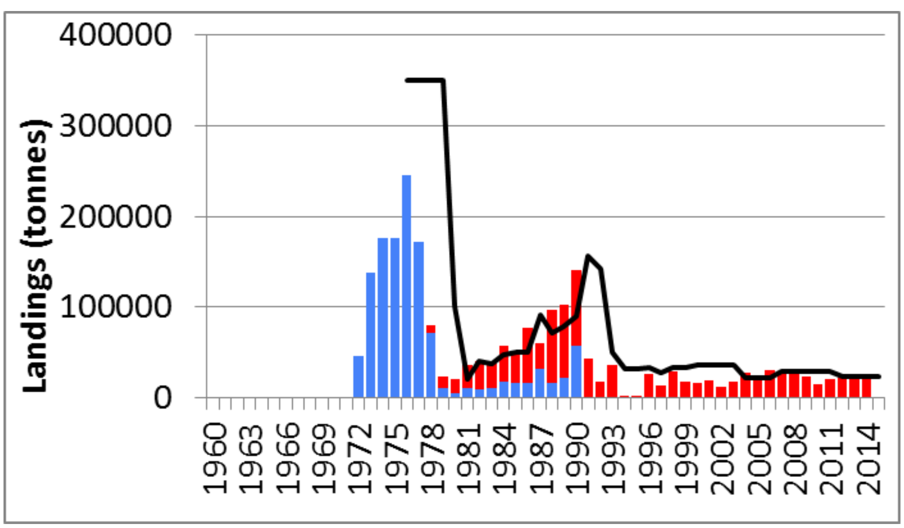


Figure 2. Inshore landings (red bars), offshore landings (blue bars) and TAC (line) for capelin in Divs. 2J3KL in 1972-2014.

Capelin landings in Notre Dame Bay and in White Bay for 2013 and 2014 have returned to levels prior to 2010, taking their full quota. During the same period landings in Conception Bay have increased with the full quota taken in 2014 for the first time since 2005 (Figure 3). Capelin landings in St. Mary's Bay and along the Southern Shore have been negligible from 1990-2008 and nil in subsequent years.

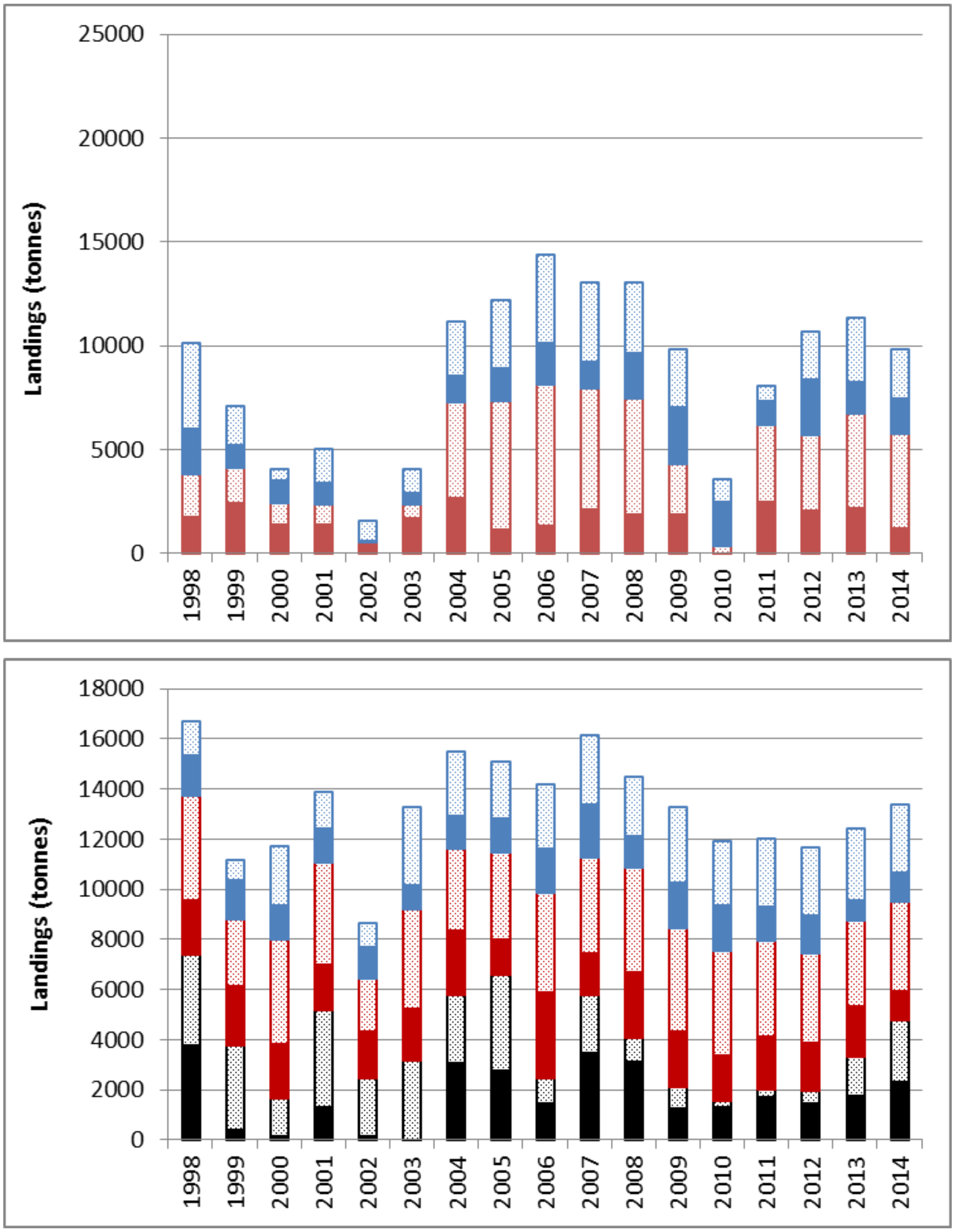


Figure 3. Trends in fixed (solid fill) and mobile (hatched fill) gear landings (t) from 1998-2014 in Division 3K [Upper panel; Notre Dame Bay (red),White Bay (blue)] and in Division 3L [lower panel: Conception Bay (black), Trinity Bay (red) and Bonavista Bay (blue)].

ASSESSMENT

The capelin fishery is targeted at spawning fish, but no estimates of spawning stock biomass are available, hence exploitation rates cannot be calculated. Absolute abundance cannot be derived from the spring acoustic survey as it only covers about one third of the potential area of distribution and is targeted toward smaller, immature fish. This assessment was therefore based on trends in the spring acoustic survey abundance, larval recruitment indices, trends in capelin distribution, biological characteristics of the stock and environmental parameters including consumption by predators and prey availability.

The sources of data considered in this stock assessment are:

1. abundance estimates and biological samples from spring offshore acoustic surveys predominantly in Div. 3L (1984-1992, 1996, 1999-2005, 2007-2014);
2. distribution from spring offshore acoustic surveys and spring and fall multi-species research vessel bottom trawl surveys in Divs. 2J3KL(1985-2014);
3. larval surface tow (2003-2014) indices from Bellevue Beach, Trinity Bay;
4. 0-group surveys of larval capelin in Trinity Bay (1982-86 and 2003-2014);
5. spawning times from Bryants Cove, Conception Bay and Bellevue Beach, Trinity Bay (1978-2014);
6. biological samples collected from the commercial inshore fishery (1981-2014);
7. spring offshore feeding (1999-2014) and fall offshore feeding (2008-2013);
8. ecosystem consumption estimates (1995-2014);
9. secondary productivity (zooplankton) indices (1999-2014).

Trends

Spring Acoustic Survey

Information from spring acoustic surveys was presented for 1988-92, 1996, 1999-2005, and 2007-14. Acoustic data collected in the early 1980s could not be treated in the same manner so was not included. Estimates from earlier years are presented in Mowbray (2013). In this assessment, 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 techniques, changes in spatial and vertical distribution patterns, and changes in the size of capelin. Abundance at age 3 was found to be well correlated with abundance at age 2 in the previous year, indicating that the survey does consistently track cohort strength in most years.

Acoustic survey abundance remains below that observed in the late 1980s. Following a period of very low abundance in the 1990s and early 2000s the abundance of capelin increased slightly during the period from 2007–2012 with a brief dip in 2010. The surveyed abundances in 2013 and 2014 were the highest levels observed since 1990 at 53.6 and 121.9 billion respectively, approximately 25 % of those recorded in the late 1980s (Fig. 4). Because the spring survey covers only a part of the stock area these are considered to be minimum abundance estimates, and may be subject to unquantified inter-annual variations due to changes in the proportion of the stock within the surveyed area.

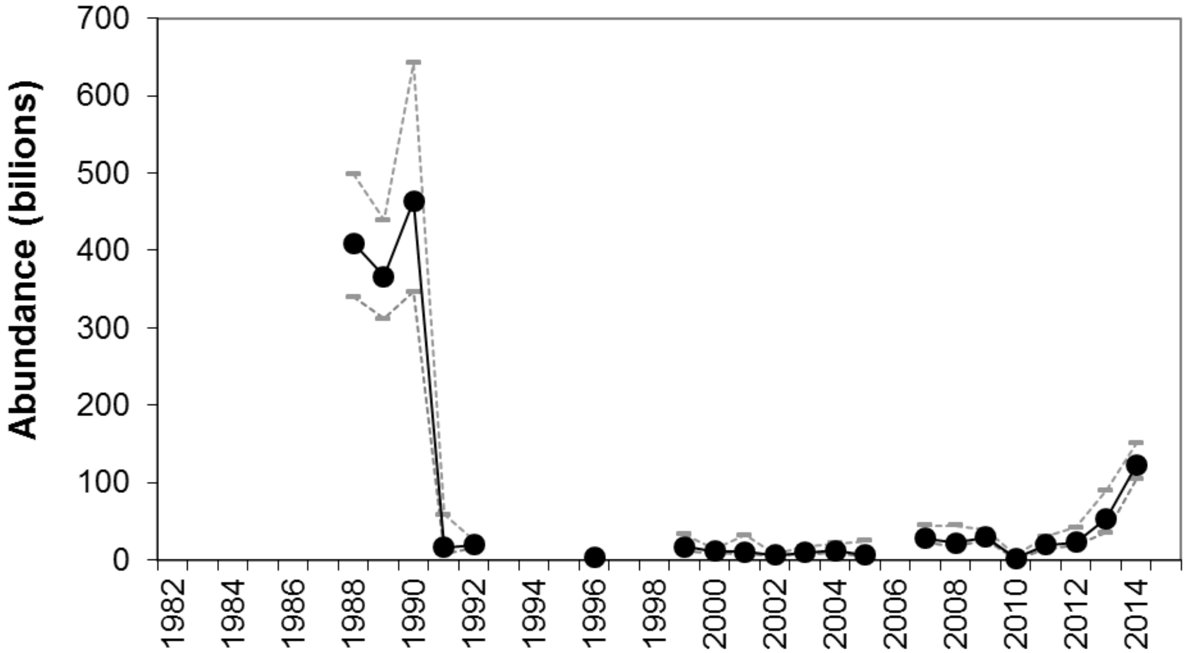


Figure 4. Index of offshore capelin abundance (line) with 95 % confidence intervals (broken lines) for an index area (mostly NAFO Div. 3L).

Larval and recruitment indices

Recruitment in capelin has been shown to be related to larval release from beaches (Carscadden el al. 2000), therefore trends from two capelin larval indices in Div. 3L are monitored. The first of these series tracks recently emerged larvae off Bellevue Beach and the surrounding area by estimating the season production from measurements at five surface tow stations sampled on alternate days throughout the larval emergence period (2003-2014). From 2002 – 2014 a second larval (0-group) survey has also been conducted in September in the central portion of Trinity Bay. This survey is directed at slightly older larvae originating from all portions of Trinity Bay and estimates mean capelin larval density from double oblique standard mesh bongo nets towed at each of 19 fixed stations (Nakashima and Mowbray 2013). Although trends in these two indices diverged between 2011 and 2012, both surveys captured the strong cohorts produced in 2007 and 2011. Both larval indices of abundance for the 2014 cohort were below average (Figure 5). Other cohorts of similar magnitude have not contributed significantly to the maturing spawner biomass.

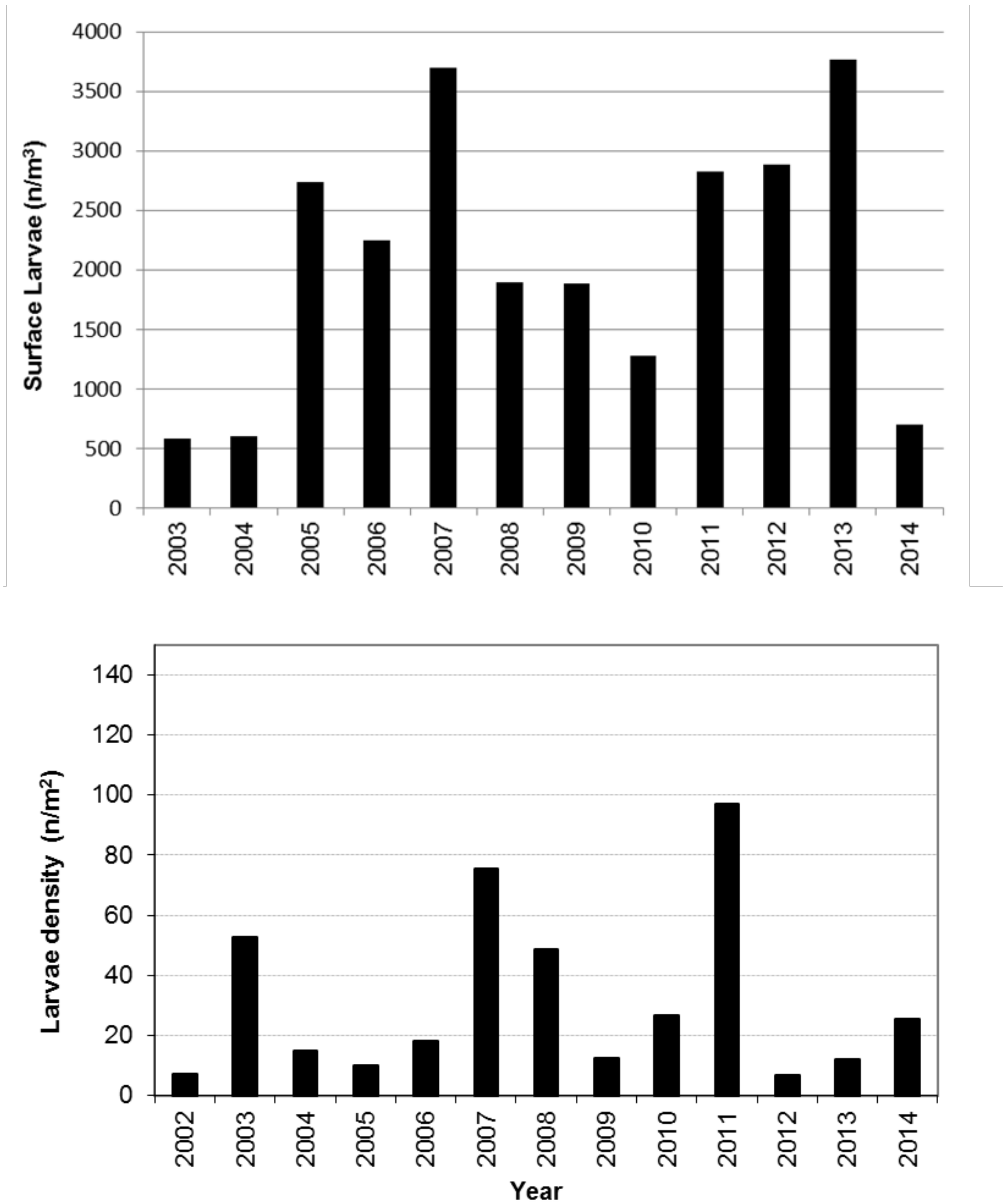


Figure 5. Larval counts from surface tows off Bellevue Beach, Trinity Bay (2003-2014; upper panel) and 0-group densities from September surveys in the central portion of Trinity Bay (2002-2014; lower panel).

Relative cohort strength from the two larval surveys are compared with indices of abundance at age one and age two from spring acoustic surveys for the 2003-2013 cohorts (Fig.6). The four recruitment indices covering the year classes since 2003 were generally coherent until 2012, but have since diverged. Differences in the abundance of the 2011 and 2012 cohorts as larvae and ages 1 and 2 may indicate better larval survival in these years. This two year period corresponds to one of increased zooplankton production and improved condition and feeding in adult capelin. The most recent estimates of the 2012 and 2013 cohorts in the acoustic survey were both the highest since 1996, and are estimated to be 3 and 5 times larger than the other cohorts produced since 2003. These cohorts are expected to comprise the majority of spawners in 2015 and 2016.

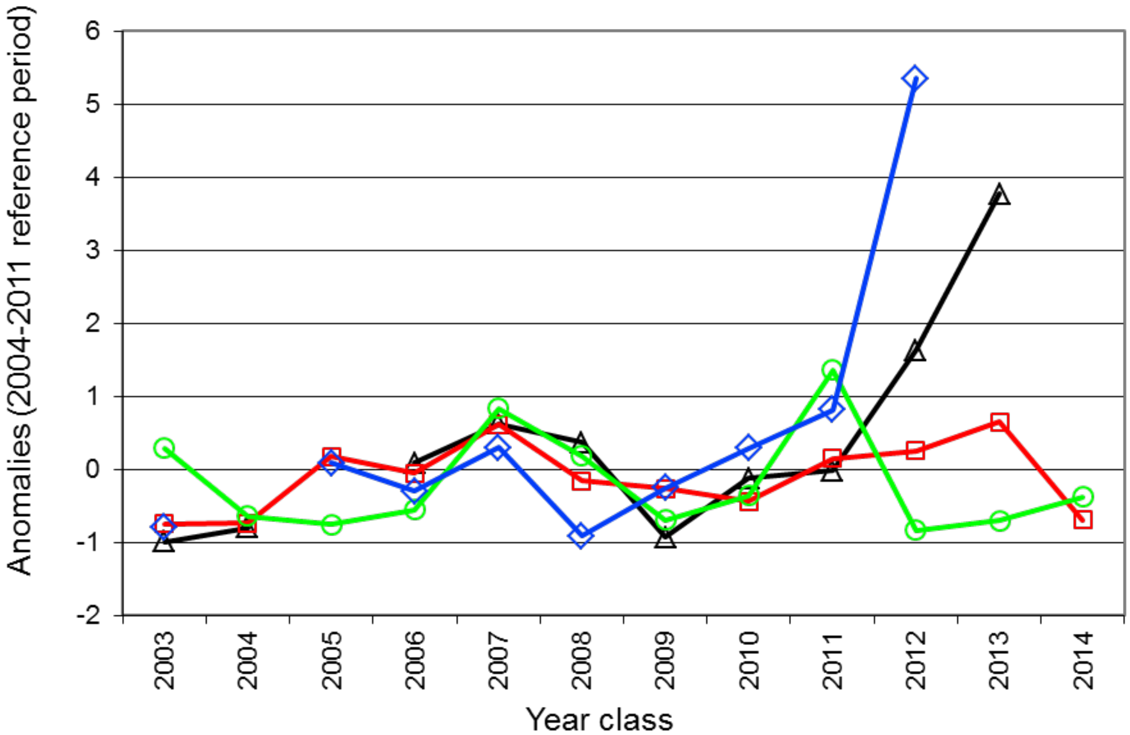


Figure 6. Standardized recruitment indices for surface tow larvae (red), Trinity Bay 0-group (green), and spring age 1 (black) and age 2 (blue) acoustic abundance estimates for the 2003-2014 year classes.

Behavioural Information

Horizontal Distribution

Spring distributions of capelin based on the acoustic survey have returned to patterns common to the late 1980s with capelin more abundant in the coastal areas off the Avalon Peninsula and Trinity Bay. This represents a west and southward shift when compared to the distribution of the last 15 years. Prior to 1991 and since 2012, high densities of capelin were spread throughout the survey area with the highest densities in the near to mid shore area of the northern Grand Bank. This pattern is the opposite of that observed from 1999 – 2011 when capelin densities on the Bank were low all over with the highest densities in deeper water strata (> 200 m) off Bonavista and along the shelf break.

During the fall of the year both immature and maturing capelin are distributed offshore in Divs. 2J3KL. The only information on fall capelin distribution comes from multi-species bottom trawl surveys. This data indicates a southerly shift in distribution starting in the early 1990s. However since 2011, the center of mass of capelin observed in the fall has shifted north and west again into Div. 2J (Fig. 7).

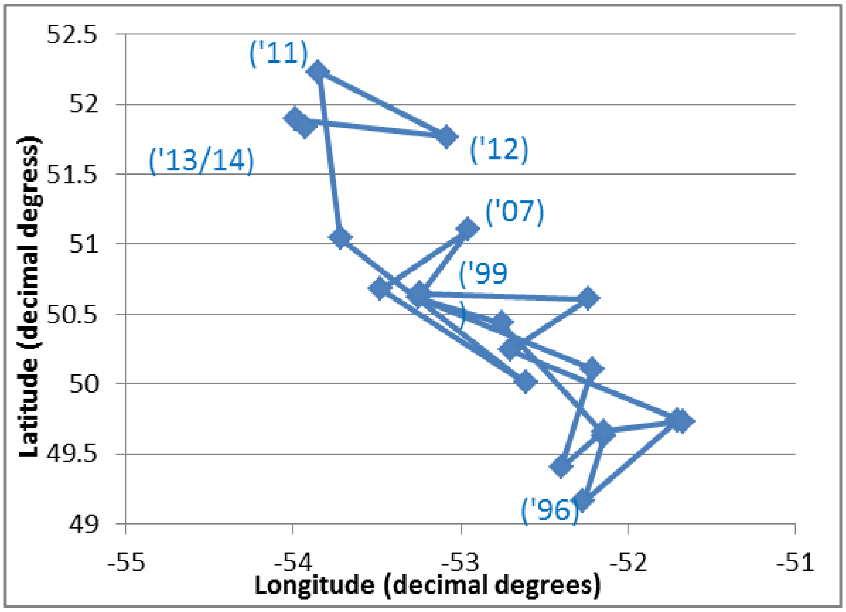


Figure 7. Center of mass of capelin captured during fall bottom trawl surveys in Div. 2J3KL (1995-2014).

Vertical Distribution

Capelin vertical migration patterns in the offshore remain attenuated in comparison to those of the 1980s. During 1991-2010 capelin were generally found in areas of greater water depth, and in closer proximity to the bottom. In the past four years capelin were once again located in shallower waters, but vertical migrations have not returned to the magnitude of those observed in the late 1980s (Fig. 8).

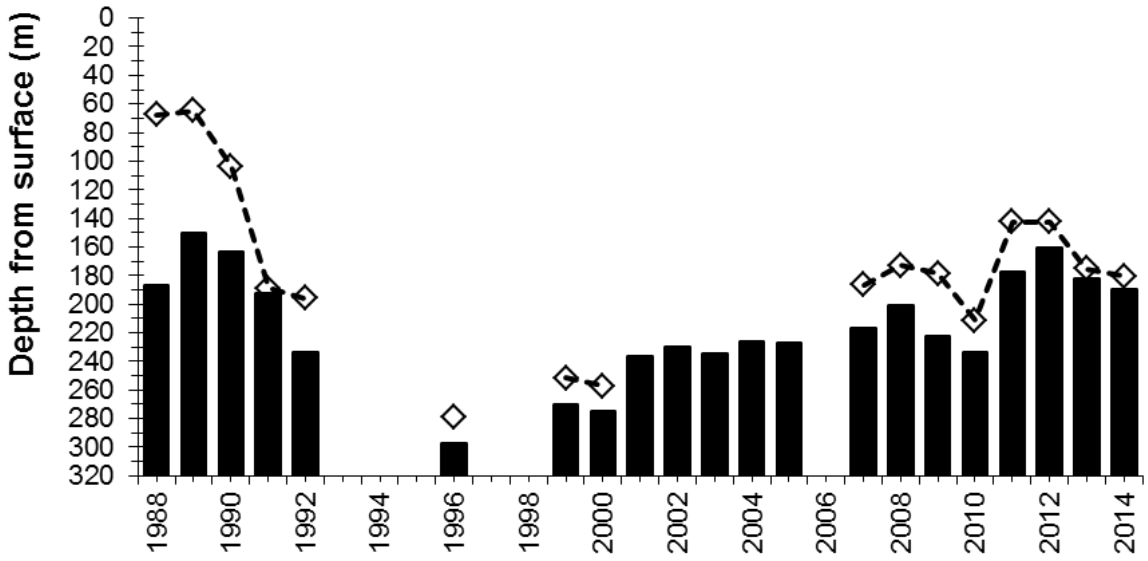


Figure 8. Mean weighted depth of capelin in the water column (diamonds) compared to mean bottom depth where capelin were found (bars) in the survey area in the spring, 1988-2014.

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) are available from 1978-2013. Bryants Cove is the only location where peak spawning has been documented before 1990. The data from Bellevue Beach, Trinity Bay is the only location where peak spawning has been documented continuously from 1990-2014.

From the early 1990s through 2010 spawning times have been delayed by as much as four weeks relative to spawning times observed in the 1980s. Peak spawning at index sites at Bryants Cove and Bellevue Beach from 2011-2014 have occurred in early to mid-July, only two weeks later than in the 1980s.

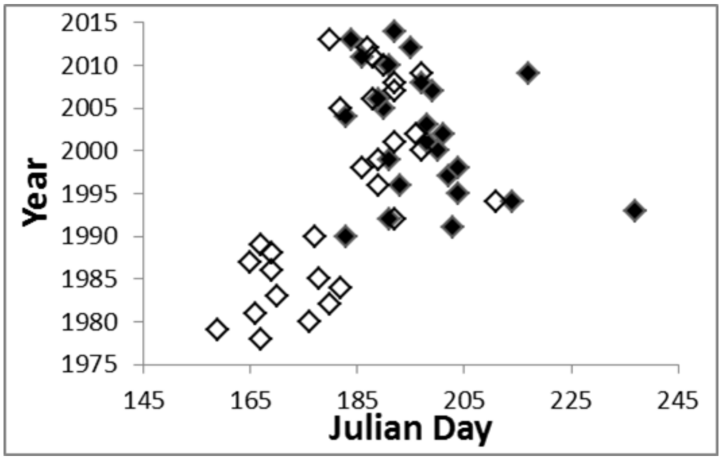


Figure 9. Peak spawning times at Bryants Cove, Conception Bay (open diamond) and Bellevue Beach, Trinity Bay (closed diamond).

Biological Information

Biological samples from the commercial inshore capelin fishery have been collected and processed since 1980. Results (excluding ages) were available to 2014 for this assessment. Mean total lengths of males and females in both Div. 3L and Div. 3K exhibit similar trends (Fig. 10). Mean lengths from 1992-2012 have been, on average, 15 to 18 mm less than those measured prior to 1992. Mean lengths in 2013 and 2014 were the highest observed since 1990.

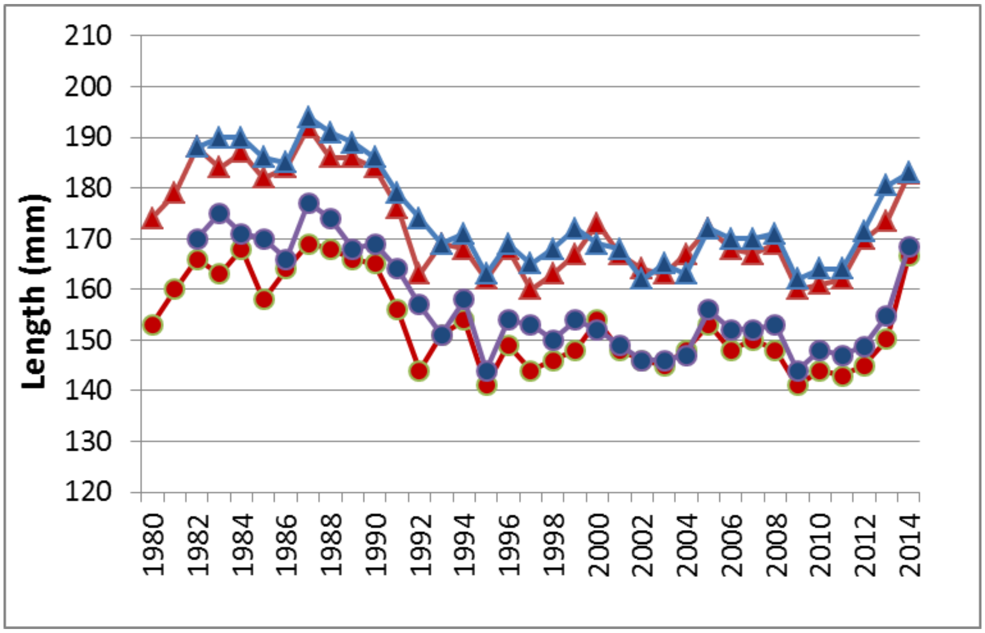


Figure 10. Mean total lengths of spawning males (triangles) and spawning females (circles) taken in the commercial fisheries in Divs. 3L (red) and 3K (blue), 1980-2014.

Although the age composition of catches was not available for 2014, information from the acoustic survey suggests that the increase in the mean size of spawners is mostly attributable to an increased proportion of older spawners (age 3 and older); a state more reflective of the late 1980s. From 1980-1991 the mean age of capelin sampled from the inshore commercial fishery varied around 3.5 years. This dropped considerably in the early 1990s with the mean age from 1995-2011 hovering around 2.6 years.

In the 1980s two year old capelin in the offshore acoustic surveys were predominantly immature. However from the early 1990s to 2011 the majority of age 2 capelin was found to be maturing (Fig. 11, upper panel). Since 2012 the proportion of maturing age two fish has again declined, although it is still higher than that observed in the 1980s.

Relative to the 1980s the size at age of capelin captured during the spring acoustic survey from 1991 – 2012 increased for age 1, 2 and 3 but decreased for age 4 fish. However, the size at age of age 3 and age 4 fish in 2013 and 2014 were the largest recorded in the past two decades (Fig. 11, bottom panel).

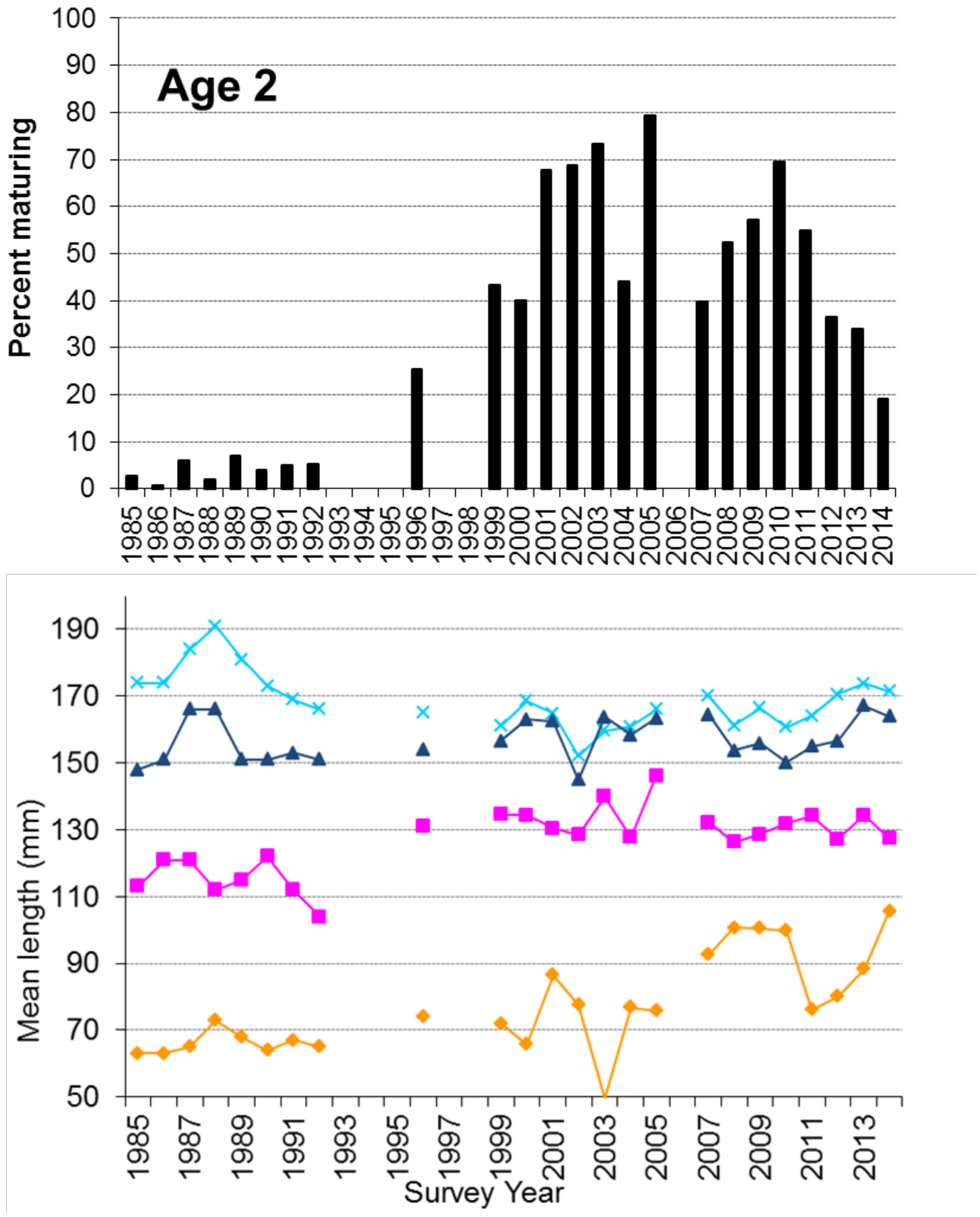


Figure 11. Proportion of two year old capelin maturing (upper panel) and mean length at age (lower panel) of capelin sampled during spring acoustic surveys 1985-2014 at age 1 (diamond), age 2 (square), age 3 (triangle) and age 4 (X).

Condition of spawning capelin was lower in the 1990s than in the 1980s (Carscadden and Frank 2002). In the spring acoustic survey in 2013 the condition of all size classes was among the highest seen since 1999, although all but one size class declined slightly in 2014 (Fig. 12).

*Figure 12. Fulton's condition (k*1000) for 1 cm length classes of capelin sampled during the spring offshore acoustic survey.*

Declines in condition in 2014 were associated with decreased stomach fullness in capelin sampled during the spring acoustic survey. Stomach fullness in 2014 was one of the lowest points in the series (Fig. 13). Feeding and size-at-age information from capelin surveyed in 2014 suggest that feeding conditions this year may not have been as favorable as in 2011-2013.

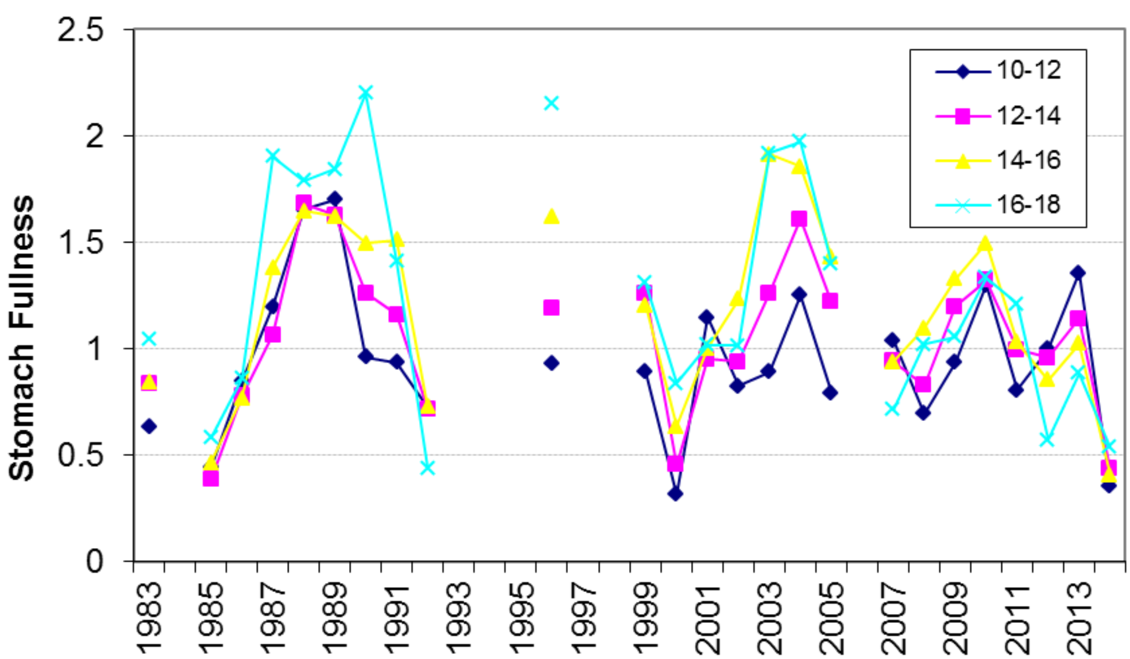


Figure 13. Mean stomach fullness by length class (cm) of capelin sampled during spring acoustic surveys 1981-2014.

Environmental/Ecosystem Considerations

The extent of the cold intermediate layer waters (CIL, < 0°C) is generally regarded as a robust index of ocean climate conditions off the eastern Canadian continental shelf. The CIL volume anomaly off the northeastern Newfoundland Shelf during fall has been below the long term (1981-2010) mean during the past 19 years but increased to above the mean in 2014 for the first time since 1994 (Fig. 14). Above normal extents of the CIL were pervasive throughout the mid-1980s and early 1990s and may be associated with later spawning and smaller sizes of capelin (Nakashima 1996).

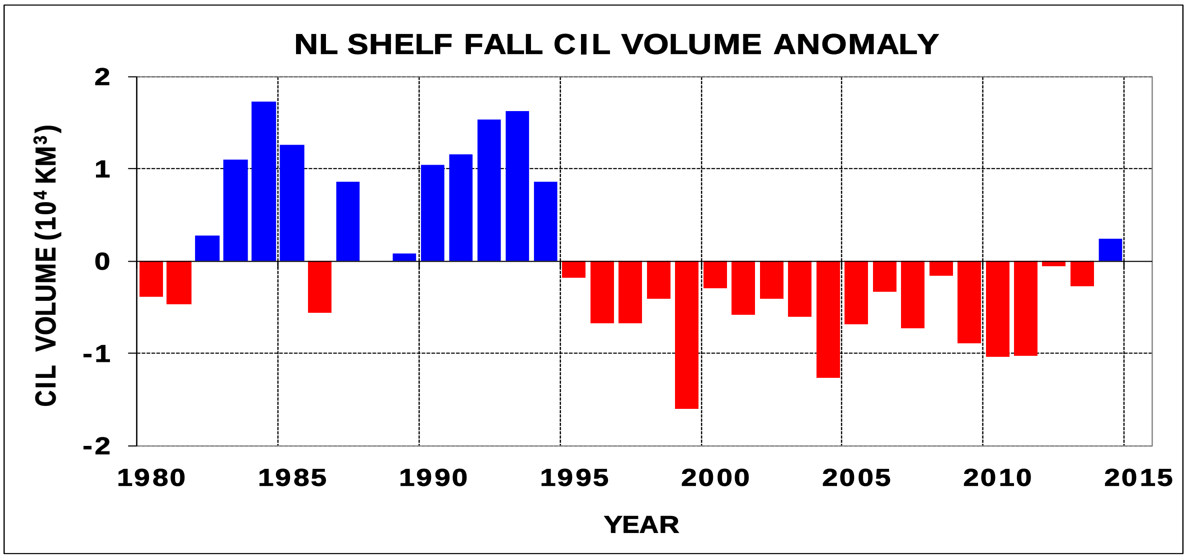


Figure 14. The Cold Intermediate Layer (CIL) volume anomalies off the northeastern Newfoundland Shelf 1980-2014.

Estimates of zooplankton biomass showed that the fraction composed of individuals < 1 mm peaked in 2002-2006 but declined in 2007 and has remained below normal through to 2014. The reciprocal pattern was evident in the large size fraction (> 1mm) with lower biomass during the first-part of the time series but transitioning to higher biomass in 2007 and remaining relatively high through 2012. The biomass of the large size fraction has returned to near average conditions in 2013-2014 (Fig. 15). Increased biomass of the large size fraction of zooplankton may confer advantages to feeding in adult capelin due to the higher energetic content compared to smaller plankton. Peaks in the biomass of the large size fraction occurred in 2007 and 2011 which coincided with peaks in standardized recruitment indices of capelin (DFO 2013).

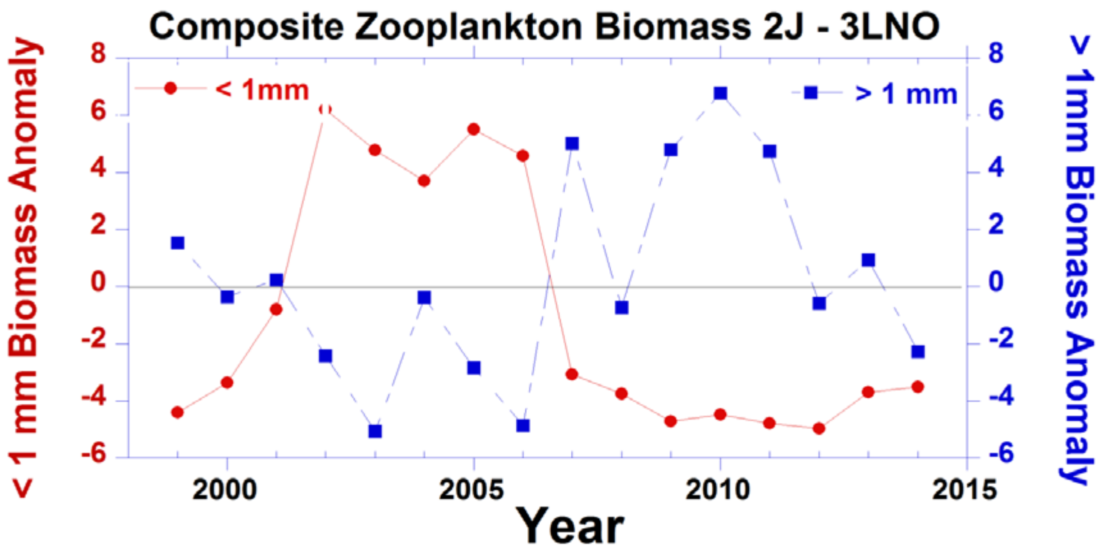


Figure 15. Time series in composite anomalies in zooplankton biomass of small (< 1mm) and large (> 1mm) size fractions from NAFO Divs. 2J to 3LNO.

Biomass indices for fish functional groups and commercial invertebrates (shrimp and crab) are available from DFO spring and fall multi-species bottom trawl surveys. According to these surveys, overall fish biomass has been increasing since 2003 (NAFO 2014). After the collapse in the early 1990s, the community structure became dominated by shellfish, but over the last 10 years it has been shifting back to a finfish dominated community (Fig. 16). Current overall fish biomass is higher than in the mid-1990s but is still well below pre-collapse levels. In terms of fish functional groups, the biomass of piscivores since 2005 is higher than the previous decade but remains lower than the 1980s. Conversely, the biomass of shrimp, which had been at record high levels in the late 1990s and 2000s, has declined since 2007 and is currently at the lowest levels since the mid 1990s.

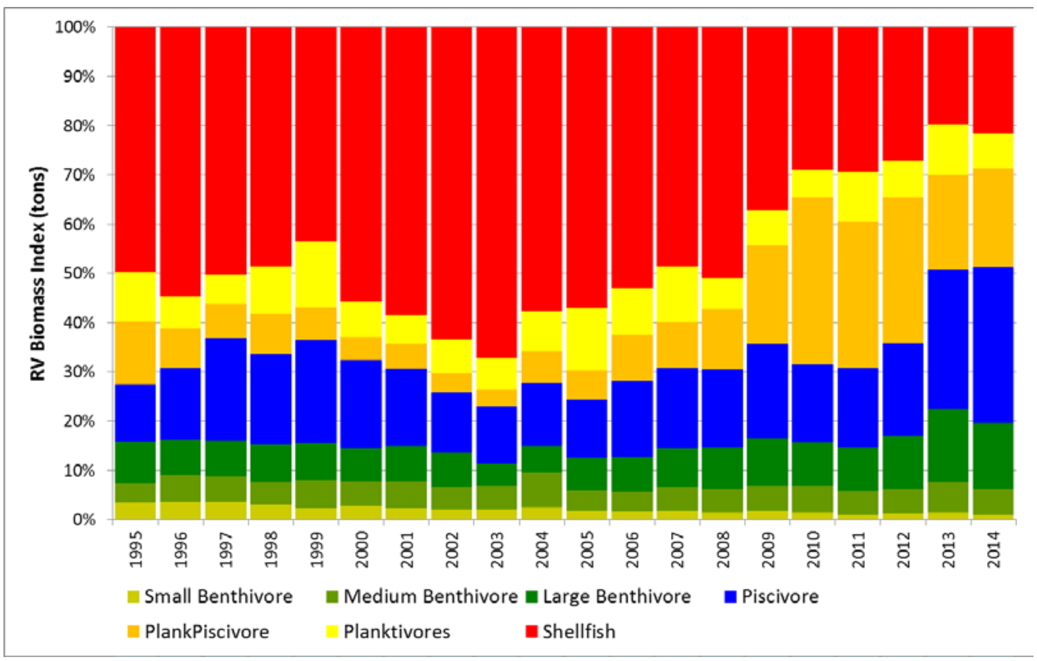


Figure 16. Community composition by functional groups based on RV Biomass indices of fish and commercial invertebrates from core strata in the fall DFO multi-species bottom trawl surveys in NAFO Divisions 2J3K.

Ecosystem level estimates of consumption of capelin by fish predators have been increasing since 2010 (Fig. 17), which is consistent with the increasing abundance observed in the acoustic surveys. These increases are due in part to increases in piscivore biomass but also to increases in the proportion of capelin in the diet of these important predators. Marine mammals are also important predators of capelin and significant amounts of capelin are consumed by harp seals in Divs. 2J3KL (Stenson 2012). However no updates on consumption estimates by seals, whales and seabirds were available at the time of this assessment.

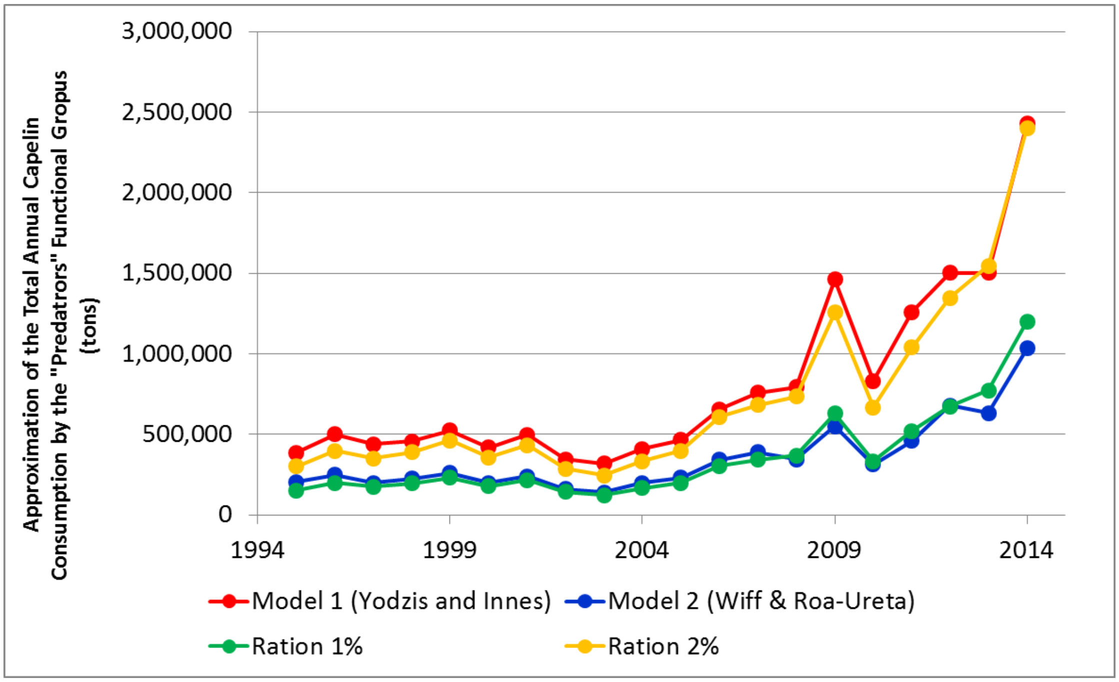


Figure 17. Approximations of capelin consumption by fish predators in NAFO divisions 2J3KL, as estimated from four different consumption models.

Given the population increases in capelin predators, and the decline in alternate prey items such as shrimp, predation pressure on capelin has most likely increased in recent years.

Sources of Uncertainty

Capelin have a short life span with only two year classes contributing the majority of the spawning biomass each year. As a result fluctuations in annual recruitment can severely affect spawning stock abundance, resulting in order of magnitude changes in abundance. Since recruitment success is environmentally driven, it is not possible to predict recruitment beyond the current year.

At present no estimates of current stock size for capelin in SA2+Divs. 3KL are available. 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 throughout the early 1990s, as well as discrepancies between the acoustic indices and other indices of abundance have never been explained.

The loss of the egg deposition and emerging larvae indices from Bellevue Beach that have been monitored since 1990 increase uncertainty in recruitment estimates.

Associated with climate change is an increase in the magnitude and frequency of anomalies in environmental parameters. Capelin can respond rapidly to such environmental changes (Buren et al. 2014). Accordingly environmental variability may increase uncertainty with regard to capelin stock dynamics.

CONCLUSIONS AND ADVICE

The 2013 and 2014 estimates of abundance from the spring acoustic survey in Div. 3L are the highest recorded since 1990. Incoming 2012 and 2013 cohorts, which will be supporting the fishery in 2015 and 2016, were 3 to 5 times larger than those seen in the acoustic index during the 2000s, although were average or below average in the larval indices.

The improvements in stock status realized in 2013 and 2014 have resulted from a combination of good larval production in 2011 and 2012 as well as increased survival of age 1 capelin. The latest biological and behavioural information indicate that the size of maturing capelin, somatic condition and age at maturation have shifted back toward those of the 1980s. Should the delays in age of first maturation persist it will result in increases in the size of capelin spawning and available to the fishery, as was observed in 2014.

Improvements in survival in 2011 and 2012 may be due in part to increases in the larger-sized zooplankton biomass as indicated by the AZMP monitoring survey, and as suggested by feeding of capelin in the spring and fall surveys. Macrozooplankton (>1mm) biomass returned to near-normal in 2014 after several years of above average levels, however spring feeding in 2014 was one of the poorest years since 1999.

Preliminary ecosystem model estimates of consumption of capelin by fish have been increasing since 2010, which is consistent with the increasing abundance of capelin observed in the acoustic surveys. Consumption by seals, whales and seabirds have not been updated**.**

Given the poorer environmental and feeding conditions seen in 2014, coupled with the below average strength of the 2014 larval cohort, and the importance of capelin as a forage species, it is suggested that a cautious approach to increasing TACs be adopted.

OTHER CONSIDERATIONS

Additional Stakeholder Perspectives

During the 2014 season, harvesters observed an abundance and size of capelin that is comparable to the mid-1980s. Placentia Bay, St. Mary’s Bay, and Conception Bay saw higher numbers of capelin than in recent years, with mobile gear in Conception Bay catching their quota and fixed gear catching 98 % of their quota. This is the first time in many years that Conception Bay has taken their quota.

Some traditional areas of the 1980s, such as St. Mary’s Bay and Placentia Bay, have seen little or no fisheries. Even though there were no landings in St. Mary’s Bay and Placentia Bay, there was an encouraging return of capelin to the bays. Harvesters from these areas saw capelin return to traditional areas but they were smaller in size and not harvestable. Lack of landings in some areas can be attributed to better economic opportunities in other fisheries within areas such as Placentia Bay and St Mary’s Bay.

Northerly areas such as Notre Dame Bay/ White Bay and the Labrador Region have shown an excellent abundance of capelin. Most of these areas caught their quota, those that did not attributed lower effort to limited quota and processing capacity.

In 2013-2014, capelin have moved to more traditional spawning times comparable to the 1980s. Most openings in 3L occurred in June. In addition to the positive sign of earlier spawning, capelin had high fat content, spawned on more beaches, and post-spawning, there were again concentrations of male capelin floating on the water. This has not been observed since the late 1980s.

Capelin in 2013-2014 were larger in weight and length, which is well documented by the collaborative efforts of harvesters and processors.

Capelin is very important to the harvesters that are involved in the NL fishery as it is an integral part of the viability of their enterprises. With the increase in size of Capelin and favourable market conditions, we expect Capelin to be an increasingly important part of fishing enterprises, as such we support increased effort placed on ensuring a healthy capelin stock for the future.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 3-5, 2015 Status of Subarea 2 and Division 3KL Capelin. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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