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Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2019/017

Newfoundland and Labrador Region

Proceedings of the Regional Peer Review of the Status of Subarea 2 and Divisions 3KL Capelin

Meeting dates: March 7-8, 2018
Location: St. John's, NL

Chairpersons: Rick Rideout and Eugene Lee
Editor: Chelsea Boaler

Science Branch
Fisheries and Oceans Canada
PO Box 5667
St. John's, NL A1C 5X1

September 2019

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

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ISSN 1701-1280

Correct citation for this publication:

DFO. 2019. Proceedings of the Regional Peer Review of the Status of Subarea 2 and Divisions 3KL Capelin; March 7-8, 2018. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2019/017.

Aussi disponible en français :

MPO. 2019. Compte rendu de la réunion du processus régional d'examen par les pairs sur l'état du capelan de la sous-zone 2 et des divisions 3KL; du 7 au 8 mars 2018. Secr. can. de consult. sci. du MPO, Compte rendu. 2019/017.

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SUMMARY

The Regional Peer Review Process on the status of Capelin was held March 7-8, 2018, in St. John's, Newfoundland and Labrador (NL). The purpose was to assess the stock status of Capelin (*Mallotus villosus*) in Northwest Atlantic Fisheries Organization (NAFO) Subarea 2 and Divisions 3KL.

The meeting included participants from Fisheries and Oceans Canada (DFO) Science (NL Region, Gulf Region and Maritimes Region), DFO Fisheries Management (NL Region), the Provincial Department of Fisheries and Land Resources, NunatuKavut Community Council, Fish Food and Allied Workers Union, the NL fishing industry, harvesters, academia and an environmental non-governmental organization.

In addition to these Proceedings, publications to be produced from the meeting include a Science Advisory Report and a comprehensive Research Document, to be available online on the Canadian Science Advisory Secretariat website.

INTRODUCTION

The Regional Peer Review Process on the status of Capelin was held March 7-8, 2018, in St. John's, Newfoundland and Labrador (NL). The purpose was to assess the stock status of Capelin (*Mallotus villosus*) in Northwest Atlantic Fisheries Organization (NAFO) Subarea 2 and Divisions 3KL.

The meeting included participants from Fisheries and Oceans Canada (DFO) Science (NL Region, Gulf Region and Maritimes Region), DFO Fisheries Management (NL Region), the Provincial Department of Fisheries and Land Resources, NunatuKavut Community Council, Fish Food and Allied Workers Union, the NL fishing industry, harvesters, academia and an environmental non-governmental organization.

These Proceedings include an abstract and summary of discussion for each presentation. Additional information can be found in the Science Advisory Report and Research Document or from references cited therein.

PRESENTATIONS: ABSTRACTS AND DISCUSSIONS

OCEAN CLIMATE VARIABILITY ON THE NL SHELF DURING 2017

Presenter: E. Colbourne

Abstract

The North Atlantic Oscillation (NAO) Index, a key indicator of the direction and intensity of the winter wind field patterns over the Northwest Atlantic, was weakly positive during 2017. The associated atmospheric pressure fields resulted in a reduced arctic air outflow in the northwest Atlantic during the winter months resulting in near-normal winter air temperatures in many areas.

Sea ice extent across the NL Shelf between 45-55°N, although above normal during late spring, was below the long-term mean in 2017. In the inshore regions along the east and northeast coast of Newfoundland sea ice duration was up to 15-60 days longer than normal. Sea ice in these regions disappeared by mid-June which ranged from 15-45 days later than normal depending on the area.

Annual sea-surface temperature (SST) trends on the NL Shelf, while showing an increase of about 1°C since the early-1980s, were mostly below normal during 2017, driven largely by very cold spring conditions. Oceanographic data from the fall multi-species surveys in the Northwest NAFO Divisions (Divs.) 3LNO indicate bottom temperatures were about 1.2 standard deviations (SD) below normal. In Divs. 2J and 3K fall bottom temperatures continued to decrease from the record high in 2011 to about normal conditions in 2017. Observations from spring and summer Atlantic Zone Monitoring Program (AZMP) oceanographic surveys indicated that the area of cold-intermediate-layer (CIL <0°C) water overlying the continental shelf off eastern Newfoundland increased over 2016 to about 1 SD above normal, implying more extensive cold winter chilled water throughout the region.

A standardized composite climate index for the Northwest Atlantic derived from 28 time series of meteorological, ice and ocean temperature and salinity since 1950 reached a record low (cold) value in 1991. Since then it shows a warming trend that reached a peak in 2010 and thereafter decreased to mostly below normal conditions during the past four years. The 2015 value was the 7th lowest in 68 years of observations and the lowest value since 1993.

Discussion

There was discussion regarding the anomalies for the indices through time. It was highlighted that these indices can change dramatically from year to year, but these changes cannot necessarily be predicted with any amount of certainty. There were further discussions on ecosystem shifts, whereby Capelin, along with other species, have demonstrated signs of recovery up until 2014-15. The increases in Capelin biomass are not directly related to climatology data, and so it becomes a question of how much a given physical index drives Capelin abundance; the answer is that it is not one, but rather a multitude of indices that play a role within this system. The standard reference period of climate analyses is 1981-2010 and a shift in the reference period may yield different results.

OCEAN PRODUCTIVITY TRENDS IN THE NORTHWEST ATLANTIC

Presenter: G. Maillet

Abstract

Large-scale ocean colour imagery, which provide near-surface data on phytoplankton biomass, were consistent with ship-based surveys showing a decline in standing stocks of phytoplankton over the NL Shelf in recent years. In addition, timing of the spring bloom was delayed over the Region. The abundance of key functional groups of zooplankton, including a variety of small, warm and cold water copepods and non-copepod taxa, have increased substantially in recent years across the Region. At the same time, abundance of the large energy-rich calanoid copepod *Calanus finmarchicus* has declined. The shift to smaller zooplankton taxa observed in recent years has negatively impacted total zooplankton biomass levels. Evaluation of a number of physical indices based on a suite of ocean climate indicators, points towards an association with primary and secondary production indices and may represent important drivers in the ecosystem. The key physical drivers indicate reduced primary and secondary production that may have impacted transfer of energy to higher trophic levels in recent years.

Discussion

There was a short discussion surrounding the trend in zooplankton biomass (>1 mm) where the levels were low then increased dramatically for a few years before returning to comparatively low levels. There were concerns that there was a bias in gear used for sampling zooplankton; however, it was confirmed that there has been no change in the gear or sampling protocols since 1999. Additionally, all analyses were standardized through a single provider. Zooplankton biomass will be discussed further at the March AZMP meeting where all regional information will be presented, giving a broader picture of biomass fluctuations.

INFLUENCE OF PLANKTON AND ENVIRONMENT ON BIOMASS AND CONDITION OF CAPELIN: A REMOTELY-SENSED APPROACH

Presenter: C. Fuentes-Yaco

Abstract

The main objectives of this study were: 1. To analyze remotely-sensed sea-surface temperature (SST) and phytoplankton biomass (chlorophyll-a: CHL), and respectively characterize the annual thermal cycle, and the spring and autumn CHL bloom parameters. 2. To link these characteristics to indices of abundance of *Calanus finmarchicus* (copepodites C1 - C3) that are positively associated with Capelin abundance throughout the year. 3. To use Capelin (*Mallotus villosus*) data (abundance, spawning time and somatic condition) to find significant relationships

between Capelin indices and the environmental and plankton variables. The study area was located between 42° and 52°N, and depths from 50 m (adjacent to the coast) to 600 m. Persistently high and low SST and CHL separated the region into North and South of 48°N. The satellite-derived data used in the work are weekly composites for each region.

We developed indices to measure changes in the phenology of physical and biological cycles. Both of these environmental forcing variables were characterized through objective metrics such as the initiation, maximum, termination and duration of their seasonal (CHL) and annual (SST) phases. In addition, we also use an index of the temporal growth variability of *Calanus finmarchicus* (Population Development Index -PDI), defined as the proportion of copepodites C1 to C3 over the entire population expressed in percent to show the magnitude of recently produced young stages. The Capelin data were represented by the following indices: 1. Abundance index of Capelin (2 years old) from the spring NAFO 3L acoustic survey, 2. Peak spawning time of Capelin at Bellevue Beach, Newfoundland, and 3. Male Capelin (2 years old) body condition (regression of length versus weight) during spring and autumn seasons.

Multivariate methods were applied to derive statistically reliable relationships. Principal Component Analyses (PCA) were performed on each remotely-sensed derived indicator by region and season. The first three PCAs explained approximately 80% of the total variance. The capelin's characteristics showed significant statistical relationships with the ecological variables using different linear regressions models. Future research projects using remotely-sensed data should start by focusing on the physical and biological variables in the northern study area, associated with Capelin peak spawning time in Bellevue Beach. In this particular case, the multivariate analyses highlighted the importance of coupled thermal (annual cycle of SST) and primary producers (spring season cycle of CHL) amplitudes and temporal oscillations. In addition, the inter-annual variation of *Calanus* PDI anomalies matches both SST and CHL PCA amplitudes' temporal variations.

Discussion

The discussion was focused on the next steps in using the information provided to inform the assessment process. A report is currently being drafted in order to have a presentation tool for this new type of analysis. In terms of using this model in the Capelin assessment process, only timing of the spring bloom for the previous year is being analyzed, and thus would be of little use for generating predictions regarding this stock. Building on this framework, however, may help in informing the status of the stock in future years.

STRUCTURE, TRENDS, AND ECOLOGICAL INTERACTIONS IN THE MARINE COMMUNITY OF THE NEWFOUNDLAND-LABRADOR BIOREGION

Presenter: F. Mowbray on behalf of M. Koen-Alonso

Abstract

Capelin and shrimp are key forage species for finfish predators including Atlantic Cod, turbot, American Plaice, and to a lesser extent Yellowtail Flounder and Redfish, in the NL Shelves bioregion (Divs. 2J3KL3NO). Capelin was the dominant prey for finfish predators in the 1980s, while shrimp became the dominant prey after the regime shift in the early-1990s. Consistent signals of rebuilding of the groundfish community appeared in the mid-to-late 2000s and coincided with the beginning of the shellfish decline.

Diet composition from stomach contents of key predators were collected during the 2008-17 fall and spring research vessel surveys. Food consumption by the fish community was explored using different combinations of consumption models (daily ration and simple allometric models).

Ecosystem level estimates of consumption of Capelin by predatory fish have been increasing since 2010, with a slight decline in 2016 and 2017, and Capelin consumption was estimated to be around 1 million tonnes per year for 2016 and 2017. This level of predation is high relative to the past 25 years, but is low relative to the late-1980s. This increase in consumption is due to the combined effects of increased biomass of piscivorous fish, an increase in the proportion of Capelin in their diets since 2011, and a decrease in the abundance of alternative forage species like shrimp since 2013. An index of predation mortality rate on Capelin by finfish in Divs. 2J3KL, which is a function of the consumption level relative to the Capelin stock size, has increased since 2014. The current total consumption of Capelin is estimated to be three times the shrimp consumption in Divs. 2J3KL.

Discussion

There was a discussion surrounding stomach samples of Capelin predators. An increase of Capelin found in Redfish stomachs was observed mostly in Div. 3L, but also in Div. 2J. However, a participant noted that increased Capelin consumption was not observed in the Gulf Region.

A participant stated that information on marine mammal forage fish consumption would be valuable to inform the status of the Capelin stock. Currently, there is limited data on offshore seasonal seal diet. There is no way to acquire stomach content information from whales. There was concern among some participants regarding the predation pressure of seals on Capelin stocks. In response, it was noted that although predation by seals has certainly shaped ecosystems over long timeframes, seals and other marine mammals exhibit slow rates of change in population abundance due to the their longevity compared to the short lifespan of Capelin and are therefore not likely to be responsible for year to year changes in Capelin abundance. Additionally, there is a large body of evidence suggesting that Capelin abundance is driven by bottom-up processes. Consequently, seal predation information does not seem to be of high importance, as it is a top-down mechanism.

PURSUIT-DIVING SEABIRD BUFFERS REGIME SHIFT INVOLVING A THREE DECADAL DECLINE OF FORAGE FISH ABUNDANCE AND CONDITION

William A. Montevecchi, Kara Gerrow, Alejandro D. Buren, Gail Davoren, Keith Lewis, Marina W. Montevecchi, and Paul M. Regular

Presenter: W. Montevecchi

Abstract

Small pelagic fish and early life stages of fishes that are centrally positioned in food webs channel energy flow between lower and upper trophic levels. These forage fishes are instrumental in maintaining food web functionality and support a diversity of large vertebrate marine predators. A recent global analysis has indicated that a third of the standing stock biomass of forage fish is needed for seabird productivity. In the Low Arctic ecosystem of the Northwest Atlantic, Capelin (*Mallotus villosus*) is the keystone forage species for seabirds, marine mammals and large predatory fishes. In the early-1990s, the Capelin stock collapsed, exhibiting delayed spawning, distributional shifts, and decreased length, weight and age at spawning. Here we use the parental prey deliveries of pursuit-diving Common Murres (*Uria aalge*), which are Capelin specialists, at the species' largest colony as a predator-based assay to document a three-decade decline in forage fish condition (1991-2017) following the Capelin stock crash. We expected that changes in Capelin availability and condition would influence parental food deliveries, adult body mass and consequent fledgling condition. The Capelin

provisioned to chicks exhibited significant and sustained declines in condition over three decades. Despite provisioning chicks with progressively poorer quality prey, there were no apparent negative effects on either adults or fledglings, and the breeding population increased during the study period. Tracking information in a good and poor Capelin year indicated that parental murres increased foraging efforts when forage fish availability was poor, and parental body mass and fledgling condition exhibited between year differences. Over the 27-year period following a crash in its primary prey, the murres' buffering of these extreme long-term events is likely a key adaptation for the persistence of seabird populations to extended periods of forage prey scarcity.

Discussion

There was discussion on post-breeding survival of seabird parents in relation to Capelin abundance. Murre populations are increasing, and so it is assumed that parents are surviving. Such trends could be explained by drivers other than Capelin abundance, such as reduced by-catch in the gillnet fishery. There are acoustic surveys of Capelin from the University of Manitoba (Davoren lab) for this region (Div. 3K), where there have always been historically a larger cod population and large seabird colonies. More detailed studies, including genetic analyses, would be beneficial.

CAPELIN FISHERY AND DISTRIBUTION INFORMATION

Presenter: F. Mowbray

Abstract

Preliminary landings in 2015, 2016 and 2017 were 23,065 t, 27,708 t and 19,917 t, respectively, against a total allowable catch (TAC) of 28,344 t. There were no landings from southern shore and Labrador. The fishery in Notre Dame Bay did not open due to limitations in processing capacity and availability of quality fish. Capelin caught in the commercial fishery were small due to a large proportion of age 2 fish in the catch.

In 2017, the spatial distribution of Capelin observed during the spring acoustic survey was similar to the pattern common during the 1999-2011 period, with most of the Capelin biomass located along the 200 m depth contour of the shelf break and in deeper areas off Bonavista Bay. A center of gravity analysis using the fall bottom trawl data (1995-2017) found that Capelin exhibit a northern distribution when abundance is high and a southward distribution when abundance is low. In 2015-17, the center gravity of Capelin shifted south.

Discussion

There was a discussion around socio-economic factors to consider regarding the collection of commercial catch data. The Canadian Capelin fishery is largely market-driven. International markets are often filled by Capelin from Iceland and the Barents Sea before Newfoundland Capelin are available for market. Market forces are the driving force behind the Capelin fishery in Newfoundland, which is why commercial catch data are not used as an indicator for Capelin abundance. The size at age information from commercial data is usually from about a five-day window, while spawning may have happened over weeks, so commercial samples are not representative of the entire population.

Biologically, there were big changes in length and weight of Capelin after the collapse in the early-1990s. These changes are largely due to the age composition of the stock rather than an actual change in growth. Since the collapse, Capelin are spawning at younger ages (more age 2 fish vs. age 3), a change related to poor year class strength. The record proportion of capelin

maturing at age 2 is 80%. In this situation the spawning population is dominated by these young small fish. Consequently fishery removals may extract up to 30% more Capelin for a given TAC increasing fish mortality. It was noted that most of the fish that spawn die shortly thereafter (100% of males and about 75% of females).

Discussion touched on Capelin by-catch in the shrimp fishery and how by-catch data are not reliable as an abundance indicator. Shrimp fishers generally avoid Capelin while fishing as it clogs up gear; they will move into deeper water if Capelin catches are large in a set.

It was noted that during the crab fishery, sonar imagery indicated dense aggregations of Capelin south of 40^{o} and it was the most the participants had ever witnessed. Some participants suggested that these observations challenge the comprehensiveness of the spring acoustic survey and may influence one's ability to interpret the acoustic index. However, access to survey areas is variable when considering climatic conditions year-to-year. Differences in abundance across strata do not seem to vary, and so extrapolation is used to fill in information when sampling cannot be completed over the entire region.

While additional third-party imagery is valuable information, it cannot be validated at this time. Interpreting acoustic signals is subjective, which is why trawls are used to confirm acoustic information. Deriving fish abundance from acoustic signals alone is currently too risky.

CAPELIN BIOLOGICAL CHARACTERISTICS

Presenter: F. Mowbray and H. Murphy

Abstract

The sizes of Capelin landed in 2017 in both Divs. 3K and 3L were the smallest in the time-series. The small sizes recorded in the fishery were associated with an unusually high proportion of age 2 spawning Capelin in both Divs. 3L and 3K in 2017.

Similar to the previous 20 years of spring acoustic surveys, age 2 Capelin dominated the spring acoustic survey in 2017, and the age 2 abundance index was similar to that observed during the late 2000s. However, the spring acoustic abundance index of age 1, 3 and 4 Capelin were among the lowest values in the time series. Since 2015, 25-35% of age 2 Capelin surveyed in the spring acoustic survey were maturing. In 2017, the condition of the smaller size classes were similar to those observed since 2010, but condition of the largest size class was the second lowest in the time series.

A long-term data set of peak spawning times has been developed for the beaches at Bryants Cove, Conception Bay (1978-2017) and Bellevue Beach, Trinity Bay (1990-2017). For the last 3 years, spawning at these beaches has been up to 4 weeks later compared to the 1980s.

From 1991-2017, Capelin beach spawning has been monitored throughout the province by paid spawning diarists who checked their local beaches every day during the Capelin spawning period (June-August). For 2015-2017, the peak beach spawning events occurred at similar times throughout the province and lasted for similar durations, except for protracted spawning in 2016 (July 10-24, 2015; July 12-August 16, 2016; July 9-25, 2017).

Discussion

Participants discussed the differences in fish condition being observed in the fishery and DFO's surveys. Harvesters presented information that smaller, but thicker fish have been caught. Past years yielded 20-23% roe in a fish, but in 2017, 26-28% was reported, indicating healthier

condition. The spring acoustic survey found that Capelin condition did not vary significantly between 2015 and 2017.

Prey as a limiting factor for adult Capelin survival was discussed. When Capelin are in poor condition, they become susceptible to disease and predation, especially in the spring when they have just gone through their most stressful time; therefore, the spring acoustic survey is composed of survivors and may not be reflective of the condition of the whole population. More work on energy content of Capelin prey items is needed, and is an ongoing project.

Comparative discussions surrounding egg quality in salmon (i.e. lipid profile based on egg colour) presented a potential opportunity to further understand similar relationships for Capelin eggs. Capelin eggs present in different colours depending on development stage, however, it is unclear if diet (i.e. different blooms being intercepted between age 3 fish migrating from 3K and age 2 fish from 3L) also plays a role.

Discussion included spawning information from Labrador and the Gulf Region. It was highlighted that in 2016, for the first time in memory for participants, Capelin did not roll on the southern coast of Labrador. Capelin also did not spawn on the beaches in Southern Labrador in 2017. It was stated that in the Gulf Region there are fewer observations of Capelin rolling from samplers, observers at sea, and through community interviews. This is also the case in the Quebec Lower North Shore.

CAPELIN RECRUITMENT

Presenter: H. Murphy

Abstract

Two larval indices are collected by DFO in Trinity Bay. The emergent larval index (4-10 mm SL) from Bellevue Beach, Trinity Bay was related to the age 2 abundance index from the spring acoustic survey which supports previous research that identified Capelin larval survival as an important driver of recruitment. However, there is currently no relationship between the late-larval index (10-30 mm SL) in Trinity Bay and the age 2 abundance index. This may be due to changes in the survey design and Capelin spawning timing compared to the 1980s. Since 2014, the Capelin larval index at Bellevue Beach has been below average. This suggests that spawning biomass in 2018, which will be composed of the 2015 and 2016 year classes, may be smaller than average.

Discussion

Comments highlighted the need for more research to understand how larval survival from demersal sites influences recruitment. It was noted that while it is fairly rare to find a relationship between fish larval and recruitment indices, the strong relationship between the emergent larval and the age 2 recruitment indices demonstrates how important it is for Capelin larvae to get off the beach in good condition. The lack of relationship between the late-larval survey of Trinity Bay and the age 2 recruitment index was surprising. This is likely due to the change in survey design that was contracted spatially and temporally compared to the original survey in the 1980s. Flexibility in timing of the late-larval survey to take into account the late spawning of Capelin would likely improve the usefulness of this index. Using a hydrodynamic model of Trinity Bay may be useful for modeling survival of Capelin.

Capelin larval diet was dominated by the medium-sized calanoid copepod *Pseudocalanus spp.* which is in contrast to the Gulf where colder-water zooplankton species are important contributors to the Capelin larval diet.

It was recommended that salinity research completed by Memorial University be applied to field sites at Bellevue Beach to develop further understanding of the drivers of Capelin larval survival.

CAPELIN ABUNDANCE

Presenter: F. Mowbray

Abstract

The spring acoustic abundance index was 63 and 18 billion individuals in 2015 and 2017, respectively. There was no spring acoustic survey in 2016. The spring acoustic abundance index in 2017 declined 70% from the 2015 value, returning to values observed during the late-2000s.

Discussion

It was stated that the timing of the spring acoustic survey has remained the same since the 1980s despite later spawning in Capelin and a later timing of the fishery. However, the survey covers a Capelin nursery area that is composed of non-migratory immature age 1 and age 2 fish. A second survey was carried out in both 1991 and 2003 in June and there was no substantial increase in Capelin biomass.

Developing a relative fishing mortality index was discussed. To do so, the natural mortality in a given year is needed, but this is currently unknown. The spring acoustic survey contains a mix of immature and maturing fish, which adds complexity to the analysis. However, the development of Limit Reference Points and understanding the impact of the fishery on the stock were noted for future research priorities.

PREDICTING CAPELIN ABUNDANCE ON THE NEWFOUNDLAND SHELF USING INDICES OF MORTALITY AND RECRUITMENT

Presenter: K. Lewis

Abstract

In the Northwest Atlantic ecosystem, Capelin (*Mallotus villosus*) is an important commercial and forage species that occupies a key position in marine food webs by linking the energy produced by plankton to large-bodied fishes, birds, and mammals. Capelin abundance is regulated by two primary factors. First, the timing of the retreat of seasonal sea ice (t_{ice}) is hypothesized to influence adult Capelin mortality through the effect of ice melt on the spring bloom that in turn, influences zooplankton abundance, the prey of Capelin. Early t_{ice} is hypothesized to result in a mis-match between zooplankton and the spring bloom resulting in Capelin starving or being in poor condition prior to spawning in the spring. Second, recruitment of age-2 Capelin is positively related to the density of early larval Capelin. In addition, other factors that can influence Capelin abundance, but have received less support, are Capelin condition in the fall of the year before the spring acoustic survey and the abundance of prey for larval Capelin. However, when used in isolation, none of these factors predicts Capelin abundance over time. We tested the ability of linear combinations of these factors to explain Capelin abundance and develop short-term forecasting models within a Bayesian framework. The model that best explained Capelin abundance combined measures of t_{ice}, larval density, and Capelin condition. The credible interval for this model captures the point estimates of the spring acoustic survey for every year from 2003-17 except for 2013. The model predicts low Capelin abundance in 2018; this prediction will be assessed against the Capelin biomass estimate produced from the spring acoustic survey in June 2018.

Discussion

The presentation described a new model that has the potential to forecast the status of the stock, and generated a lengthy discussion regarding model inputs and uncertainty. This model uses a variety of time-lagged data. The larval data is time-lagged by 2 years, the adult fall condition is time-lagged by 1 year, and the ice data is from the current year. This model is intended to be used to create scenarios and provide an envelope of potential predictions to provide advice for management. These scenarios can be updated throughout the winter and spring as ice information becomes available from Environment Canada.

This is a 3-year project. The first year was spent identifying predictors of Capelin biomass including ice metrics, larval indices, zooplankton availability and Capelin adult condition in the fall. The next 2 years will be focused on fine-tuning the model. Currently, this model forecasts Capelin biomass (all ages) rather than just age 2. However, the larval index is only positively related to the age 2 index. A suggestion was made to forecast age 2 biomass rather than a total Capelin biomass. An additional comment was to combine commercial catches from the previous 2 years into the model. Preliminary analysis suggests the catch data will not necessarily improve the model, but this will be tested.

Discussions centered around 2010 as a year that stands out for its low Capelin biomass estimate. It is likely that the spring acoustic survey missed some of the Capelin biomass in 2010 as there were more age 3 Capelin surveyed in 2011 than predicted from the age 2 abundance in 2010. However, it was agreed that 2010 was a low year based on other independent indices. Working backwards to see how many fish should have been present in 2010 to give 2011 abundances may provide further insight.

Following the discussion, further model diagnostics were requested as follows:

For the current assessment:

- Remove years chronologically for prediction testing of model;
- Run the model with and without 2010 data included.

To do in the short-term (weeks):

- Produce equivalent r-squared values for Bayesian model;
- Look at the sensitivity of the variables.

Concerns that the prediction interval was quite wide were addressed. When predictions are being made, the intervals will always be wider than the credible intervals; the fact that a predicted value of biomass for a given year is outside the confidence interval, suggest that the model poorly captures that year.

When conducting a retrospective analysis you typically look for patterns. The predicted values were low compared to the estimate values of biomass, although there was a suggestion of a positive bias in the last 4 years.

This model will be considered for future assessments once it is further refined and additional diagnostics can be run. It will not be used to inform the current assessment.

GENERAL DISCUSSION

A discussion regarding the establishment of a Limit Reference Point for this stock highlighted that drivers of current-year abundance do not seem to be influenced by those of the previous year, and using this to develop a reference point is not valuable for this particular stock (as with other pelagic species). Some participants expressed concern over setting a Limit Reference

Point where removals by the fishery could be affected, especially as fishing mortality is not well understood.

DEVELOPMENT OF SUMMARY BULLETS

During the development of summary bullets for the Science Advisory Report (SAR), participants discussed observations from the Southern Inuit of NunatuKavut. A summary bullet was drafted but consensus on the bullet's inclusion in the SAR could not be reached by meeting participants.

CAPELIN RESEARCH RECOMMENDATIONS

- Include proportion of maturing fish in forecast model.
- Better understanding of natural and fishing mortality rates
- An understanding of the relative importance of beach and demersal spawning sites to recruitment.
- Consider extending spring acoustic survey area further south if/when possible and/or obtain Capelin samples from fishers to try and obtain more information (e.g. stock origin/ affiliation).

APPENDIX I: TERMS OF REFERENCE

STOCK ASSESSMENT OF SUBAREA 2 AND DIVISIONS 3KL CAPELIN

Regional Peer Review, Newfoundland and Labrador Region
March 7-8, 2018
St. John's, NL

Co-Chairs: Rick Rideout and Eugene Lee

Context

The status of Capelin in Subarea 2 + Divisions 3KL was last assessed in 2015. The current assessment is requested by Fisheries Management to provide the Minister with detailed advice on the status of this stock.

Objectives

A review of available information concerning the status of Subarea 2 + Divisions 3KL Capelin as follows:

- Ecosystem overview (e.g., environment, predators, prey) for SA 2 + Divs. 3KL Capelin
- Information on historical catches up to and including the 2017 fishery
- Trends in abundance from the spring acoustic survey and larval recruitment indices
- Behavioural information on occurrence, distribution, and spawning times
- Biological information on sizes, ages, maturities, condition and feeding
- Evaluation of projection methods for spawner recruitment

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Participation

- DFO Science, Newfoundland and Labrador Region and Maritimes Region
- DFO Fisheries Management, Newfoundland and Labrador Region
- Provincial Department of Fisheries and Land Resources
- Indigenous Groups
- Fish, Food and Allied Workers Union
- Non-Governmental Organizations
- Academia

References

DFO. 2015. Assessment of Capelin in Subarea 2 and Divisions 3KL in 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/036.

DFO. 2015. Proceedings of the Newfoundland and Labrador Regional Peer Review Process on the Status of Subarea (SA) 2 and Divisions 3KL Capelin and Divisions 3KL and Subdivision 3Ps Herring; February 3-5, 2015. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2015/044.

APPENIX II: AGENDA

STOCK ASSESSMENT OF SUBAREA 2 AND DIVISIONS 3KL CAPELIN

Chairs: Rick Rideout and Eugene Lee
March 7-8, 2018
Memorial Room, Northwest Atlantic Fisheries Centre

Time	Activity	Presenter
Wednesday, March 7	-	-
9:00 – 9:15	Introduction	Chairs
9:15 – 9:45	Environmental Overview	G. Maillet and E. Colbourne
9:45 – 10:00	Influence of plankton and environment on biomass and condition of Capelin	C. Fuentes-Yaco
10:00 – 10:15	*Refreshment Break*	-
10:15 – 11:15	Structure, trends and ecological interactions in the marine community of the Newfoundland-Labrador bioregion	A. Buren (presenting for M. Koen- Alonso)
11:15 - 11:45	Capelin - Seabird Interactions	B. Montevecchi
11:45 – 12:00	Assessment overview: Fishery • Landings, catch characteristics	F. Mowbray
12:00 – 1:00	*Lunch Break (lunch not provided)*	-
1:00 – 2:30	Biological Information • Distribution • Size and age structure, Maturation, condition • Feeding • Spawning times • Larval production Abundance • Div. 3L Spring acoustic survey	F. Mowbray and H. Murphy
14:30-14:45	*Refreshment break*	-
14:45 – 15:15	Predicting Capelin (*Mallotus villosus*) abundance on the Newfoundland shelf using indices of mortality and recruitment	K. Lewis
15:15 – 17:00	Discussion of drivers of Capelin abundance and potential reference points	F. Mowbray
Thursday, March 8	**-**	**-**
9:00 – 10:15	Summary of results from day 1;Unfinished discussions / Additional items; Review of SAR format; Preparation of bullets for SAR	F. Mowbray
10:15 – 10:30	*Refreshment Break*	-
10:30 – 12:00	Sources of uncertainty; Stakeholders perspectives Conclusions and Advice; Overview of other SAR sections; Research Recommendations	Chairs/ F. Mowbray

Please note all times given are approximations, schedule is subject to change.

APPENDIX III: LIST OF PARTICIPANTS

Name	Affiliation
Maxime Geoffroy	CFER/Marine Institute
Erin Dunne	DFO Resource Management, NL Region
Gary Melvin	DFO Science, Maritimes Region
Cesar Fuentes-Yaco	DFO Science, Maritimes Region
Julie Marentette	DFO Science, NCR
Rick Rideout	DFO Science, NL Region
Brad Squires	DFO Science, NL Region
Hannah Murphy	DFO Science, NL Region
Eugene Lee	DFO Science, NL Region
Frank Dawson	DFO Science, NL Region
Megan Boucher	DFO Science, NL Region
Alex Allison	DFO Science, NL Region
Meredith Schofield	DFO Science, NL Region
Ana Storch	DFO Science, NL Region
Dwight Drover	DFO Science, NL Region
Christina Bourne	DFO Science, NL Region
Paula Lundrigan	DFO Science, NL Region
Fran Mowbray	DFO Science, NL Region
Eugene Colbourne	DFO Science, NL Region
Paul Regular	DFO Science, NL Region
Brandi O'Keefe	DFO Science, NL Region
Laura Wheeland	DFO Science, NL Region
Voilaine Shikon	DFO Science, NL Region
Aaron Adamack	DFO Science, NL Region
Gary Maillet	DFO Science, NL Region
Brian Healey	DFO Science, NL Region
Alejandro Buren	DFO Science, NL Region
Keith Lewis	DFO Science, NL Region
Jennifer Higdon	DFO Science, NL Region
Jim Meade	DFO Science, NL Region (CSA Office)
Andrew Smith	DFO Science, Quebec Region
Erin Carruthers	Fish, Food and Allied Workers Union (FFAW)
Robbie Green	Harvester
Eldred Woodford	Harvester
Dennis Chaulk	Harvester
Steve Miller	Harvester
Samantha Andrews	Memorial University-Science
Craig Purchase	Memorial University-Science
Bill Montevecchi	Memorial University-Science
Shelley Dwyer	NL Department of Fisheries and Land Resources
Patricia Nash	NunatuKavut
Chelsea Boaler	Rapporteur
Victoria Neville	World Wildlife Fund Canada (WWF)