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Proceedings of the Regional Peer Review Meeting on the Assessment of the Estuary and Gulf of St. Lawrence (Divisions 4RST) Capelin Stock

April 20-21, 2022
Virtual meeting

Chairperson: Rénaud Belley
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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.

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SUMMARY

This document contains the proceedings of the regional peer review meeting on the assessment of the Estuary and Gulf of St. Lawrence (4RST) capelin stock. The review, which was conducted on April 20 and 21, 2022, via Zoom (virtual meeting), brought together about forty participants from science, industry, management, and environmental non-governmental organizations. These proceedings describe the highlights of the meeting presentations and discussions and outline the recommendations and conclusions resulting from the review.

INTRODUCTION

The Quebec Region of Fisheries and Oceans Canada (DFO) is responsible for assessing a number of fish and invertebrate stocks exploited in the Estuary and Gulf of St. Lawrence. Most of the stocks are periodically assessed as part of a regional peer review process held at the Maurice Lamontagne Institute in Mont-Joli. This document constitutes the proceedings of the Estuary and Gulf of St. Lawrence (4RST) capelin stock assessment meeting held virtually via Zoom on April 20-21, 2022.

The purpose of this review was to determine whether changes had occurred in the status of the resource that required adjustments to the management plan based on the conservation approach adopted. The ultimate objective was to provide science advice for the management of Estuary and Gulf of St. Lawrence (4RST) capelin stock for the 2022 and 2023 fishing seasons.

These proceedings report on the main points discussed in the presentations and deliberations resulting from the activities of the regional stock assessment committee. Regional peer reviews are a process open to any participant who is able to provide a critical outlook on the status of the assessed resources. Consequently, participants from outside DFO are invited to take part in the committee's activities within the defined Terms of Reference for this review (Appendices 1 and 2). The proceedings also set out the recommendations made by the meeting participants.

ASSESSMENT

Meeting Chair Régnald Belley welcomed the participants. He went over the science review process and objectives as well as the role of the participants. The terms of reference and agenda (Appendix 3) were presented.

The assessment biologist, Mathieu Boudreau, opened his presentation by highlighting the support given by various collaborators and briefly reviewed the summary of the most recent science advisory report (DFO 2021). Several elements of the ecology of capelin were addressed, e.g. distribution, longevity, maturity, mortality, spawning, and interannual variation in biomass. It was clarified that information contained in the science advisory report would provide answers to the media question regarding an earlier opening date for the capelin fishery in the Charlevoix region. According to the eCapelin citizen science tool, the capelin spawning season runs from late April to early May in the Upper Estuary and continues in the east and north as far as the Strait of Belle Isle from June to August.

COMMERCIAL FISHERY IN DIVISIONS 4RST

The background of the commercial fishery in 4RST and landings were presented by division, type of fishing gear, and unit area. Temporal patterns of the fishery were also presented. Since 2000, total landings of capelin in the Estuary and Gulf of St. Lawrence (NAFO Divisions 4RST) have averaged 8,068 t. In 2020 and 2021, the annual total allowable catch (TAC) was 9,295 t, and preliminary landings totalled 10,281 t and 9,934 t, respectively. These landings came primarily from the seine fishery in 4R.

- Some clarifications were given on the potential reasons for the years of low landings (few markets, competition with Europe, small capelin size, strong presence of ice).
- It was noted that landings are closely linked to the Asian market demand, and the time window for making catches is very limited.
- Some participants felt that the TAC is limiting in this fishery.

FISHERY PERFORMANCE INDEX

Mr. Boudreau briefly presented the model used to obtain a standardized performance index for the commercial purse seine and tuck seine fisheries in 4R. The performance index for seiners in NAFO area 4R increased between 2004 and 2010, subsequently fluctuating above the historical series average.

- It was made clear that the TAC was not taken into consideration in the model.
- It was also pointed out that this index should not in any way be considered an indicator of stock status, given the improvements to the capelin fishery (e.g. technology, vessel length), which undoubtedly affect fishing capacity and efficiency. These changes represent sources of uncertainty and must be addressed before presenting the performance index.
- According to Science, there is no relationship between this index and percentage of TAC landed.
- According to an industry representative, two factors may account for the improvement in the capelin fishery: the market price of capelin and capelin abundance. Fishers confirmed that the abundance of capelin is very high.

BYCATCH FROM SHRIMPERS

Capelin is regularly caught as bycatch in the shrimp fishery. On average, an estimated 144 t of bycatch is taken annually (2000–2021). However, the amount of bycatch has declined in recent years.

- Some meeting participants attributed this decline to a decrease in the fishing effort of shrimpers.
- It was specified that the estimates for 2021 were very incomplete and preliminary, particularly for Esquiman. The graphs in the research document may be updated.
- It was noted that these bycatches are not included in official DFO statistics.
- In recent years, bycatch of capelin by shrimpers has occurred mainly in the Estuary.
- It was noted that shrimp fishing activities on the west coast of Newfoundland appeared to have had a later start in 2021. Fishing depths also seem to have varied.
- Moreover, there were no observers in the Estuary in 2020 (due to the pandemic), which would explain the lack of bycatch.

BIOLOGICAL DATA

The biologist reviewed the biological data: size structure (fishery and survey), mean length, Le Cren's condition index (1951), sex ratios, and gonadosomatic index. The condition index for males and females caught in NAFO Divisions 4R and 4S in 2021 was above the average of the 1984–2021 historical series. Fish in the southern Gulf of St. Lawrence (sGSL) are smaller (likely immature) compared to those in the northern Gulf of St. Lawrence (nGSL).

- A suggestion was made to weight the size structure by subregion in order to provide a clearer picture.
- It was pointed out that data on the age of capelin would be very useful.
- It was mentioned that it would be useful to link the condition index to the gonadosomatic index in order to better interpret the condition index.

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- With respect to the gonadosomatic index, some participants felt that it would be appropriate to consider only samples from pre-spawn capelin. The current index represents capelin sampled from the fishery, including fish at the pre- and post-spawning stages. Participants were reminded that this index does not reflect stock status. The index would benefit from being categorized by time period, class size, etc. Lastly, concerns were raised about the actual usefulness of this index.
 - The size structure derived from the *Teleost* survey showed a disconnect between the northern and southern Gulf. The southern Gulf was considered to represent a potential nursery.

RELATIVE ABUNDANCE INDEX

Previous work focused on assessing the usefulness of multispecies bottom trawl surveys (nGSL and sGSL) in estimating the relative abundance of capelin in the Gulf of St. Lawrence. An update was made to incorporate 2020 and 2021 into the model. The results indicated that the relative abundance index of the nGSL survey was high and increased slightly throughout the 1990s. The index declined to its lowest values in the first half of the 2000s, before gradually increasing to a peak in 2011. It decreased to relatively low levels thereafter, and in 2020 and 2021, it was below the long-term average. In the sGSL, the index was low in the 1990s and 2000s, subsequently increasing rapidly to the highest values of the series in the 2010s. Since then, it has remained above the long-term average. Other work has shown that variations in relative abundance indices of capelin based on bottom trawl surveys were associated with environment-related variations in the condition of capelin over the last two years, consistent with the hypothesis of bottom-up regulation of capelin survival and cohort strength.

- It was specified that the model takes into account depths associated with temperatures colder than 3°C (up to 175 m / 0–100 fathoms, including inshore strata). For the time being, there is no additional information on the cold intermediate layer (CIL). The survey abundance indices are fairly similar, whether the abundance index used is based on core strata or only on CIL strata.
- Since 2010, the increased abundance in the sGSL has been attributed to a suspected decrease in habitat quality in the nGSL rather than to an increase in habitat quality in the sGSL. This is the most plausible hypothesis at the moment. Additional work will provide clarity on the situation.
- Thus, up until the late 1990s during the cold period, capelin abundance indices were higher in the nGSL than in the sGSL. Subsequent to a transition period in the 2000s and the warming that began in the 2010s, there has been a reversal of trends in the nGSL vs. the sGSL. Potential reasons for this reversal are differences in productivity and feeding-related migrations, given that these are 1- to 2-year-old fish that need to feed for their first breeding. Work on otolith microchemistry will shed light on exchanges between regions and the movement of capelin.

FISHING MORTALITY

An exercise was conducted to estimate fishing mortality. Approximations of fishing mortality rates from 1997 to 2021 were likely much lower than the natural mortality rates typical of short-lived forage species like capelin.

- It was emphasized that this exercise should be viewed as a risk analysis that provides a general sense of the impact of the fishery on capelin biomass. Refinements could potentially be made, particularly with respect to the stages and ages considered.

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- The choice of using herring catchability ($q=0.0045$) for capelin was questioned. Some participants felt that the highest catchability ($q=0.01$) should be considered in order to be as conservative as possible, especially given that catchability in the sGSL is higher.
 - The calculations were redone based on two scenarios, using low catchability coefficients ($q=0.0045$ for the nGSL and $q=0.01$ for the sGSL) and high catchability coefficients ($q=0.01$ for the nGSL and $q=0.1$ for the sGSL). A one-year lag between the biomass estimated in a given year and availability to the fishery in the following year was also considered by subtracting a portion of the natural mortality.
 - It was observed that even with more conservative values, it is still unlikely that the fishery affects the abundance of the resource. Fishing mortality remains very low compared to natural mortality.
 - Industry believes that the capelin fishery is one of the most stable fisheries.
 - Questions were raised about using the sGSL biomass in the calculations despite the fact that it will not be available to the fishery. Participants reiterated that a previous exercise that excluded the biomass did not produce any worrisome results.
 - A suggestion was made to raise the risk of local depletion in the sources of uncertainty, especially on the west coast of Newfoundland where the fishery is concentrated.
 - All sources of uncertainty associated with this model should be noted in the science advisory report and research document.

EMPIRICAL MODEL OF VARIATIONS IN LANDINGS

An empirical model of variations in landings was included in this year's assessment. The premises of the model, response variable (landing in 4RS), and predictor variables were presented. Variables that were considered were the timing of ice retreat, anomaly of abundance indices, mean length anomaly, and average price per kilogram. Several models were tested. The selected model had one of the lowest AICs and significant bootstrap results and was robust to the missing years. It also considered the effect of the ice retreat and abundance in the sGSL. The effect of these variables in 2022 should result in landings comparable to the maximums observed between 2011 and 2021.

- It was clarified that this is a model that predicts fishing opportunity, not landings. Some participants questioned the relevance of this type of model in a stock assessment, even if it seems useful from a management perspective.
- Participants felt that the performance (or effort) index should be considered among the predictor variables. It was noted that the aim of excluding a portion of the time series was to avoid confusing two very different periods of effort.
- Others felt that the TAC should also be considered a predictor variable.
- According to Industry, the average price may also have a major impact depending on the year.
- Fleet capacity is likely another predictor variable to be considered.
- Participants agreed that the model is not perfect, as it only provides an explanation for half of what is observed. Based on the feedback from participants, it seems that additional analyses will be necessary.
- As a result, the model will not be used this year.

IMPORTANCE OF CAPELIN IN THE DIETS OF COD AND GREENLAND HALIBUT

Previous work provided estimates of capelin consumption by demersal predators. This approach used cod and turbot as samplers of the environment to describe interannual variations in the use of capelin as a food source and to estimate a minimum level of capelin consumption.

- It was proposed that these estimates be viewed in terms of the probability of capelin presence (occurrence). As a result, it was suggested that cod and turbot be used as samplers of the presence of capelin in the ecosystem. These predators also provide greater coverage compared to trawls.
- Cod and turbot currently appear to be important predators. There was some question as to the importance of redfish in capelin predation.
- Since it had previously been accepted that these estimates of capelin consumption by cod and turbot could provide information on the capelin stock status, they were considered in the composite indices.

STOCK STATUS COMPOSITE INDICES

Three composite indices synthesizing several indicators were developed to provide a perspective on the stock status relative to its status in the medium to long term. Of these composite indices, an index combining five independent indices of 4RST capelin stock status (nGSL and sGSL abundance indices, percentage in weight of capelin in the diets of two key predators, and timing of the last ice retreat) has varied around the 1990–2021 long-term average since 2016.

- Participants agreed to exclude indices that include landings and the TAC.
- It was noted that the effect of the timing of the last ice retreat on the stock was well documented. In addition, the condition index could potentially substitute for the timing of the last ice retreat.
- According to participants, redfish should be considered in the same way as cod and turbot.
- With regard to the missing years for stomach content data (2010 to 2014), participants wondered about the best way to infer values. Suggestions included applying the average of the anomalies from the previous two years (2008–2009). This needs to be given some thought.
- Questions were raised about how to interpret the composite index graph, especially from a management perspective.
- A suggestion was made to move forward with this approach and use the index that does not consider commercial fishery data (landings, TAC). Some refinements may potentially be made.

CONCLUSION

SUMMARY AND OUTLOOK

The key points of the assessment were presented by the assessment biologist, and some changes were proposed by participants. Comments concerning stylistic rewording were not reported.

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- In the first key point on landings, a suggestion was made to specify that these were preliminary landings (2020 and 2021) and to mention the annual TAC.
 - It was decided that the breakdown of landings by division and subdivision would not be included in the summary.
 - Information on the spawning season was only retained in the science advisory report.
 - Regarding the performance index for seiners in 4R, there was consensus that the index fluctuated above the time series average, following the increase that occurred between 2004 and 2010.
 - For the biological data, it was decided that only the key point on the condition index would be kept, considering its impact on the post-winter survival of capelin. It was specified that in 2021, this index was above the historical average (1984–2021).
 - The key point on the abundance index of the nGSL and sGSL trawl surveys was reviewed, and north and south were distinguished. Information on the difference in size between capelin in the nGSL vs. the sGSL was added.
 - The key point on approximations of fishing mortality rates between 1997 and 2021 was reworked by comparing them to natural mortality rates typical of short-lived forage species like capelin.
 - The key point on the empirical model was omitted because it was not used in this assessment.
 - It was also decided not to include the key point on capelin consumption by cod and turbot.
 - For the key point on composite indices, only the index for which there seemed to be consensus among participants will be discussed, without going into more detail. This index includes five independent indices of 4RST capelin stock status (nGSL and sGSL abundance indices, percentage in weight of capelin in the diets of two key predators, and timing of the last ice retreat).
 - The last key point, which is the recommendation, was simplified. Participants preferred to refer to harvest levels as opposed to TAC. After discussion, it was agreed that the harvest levels attained over the last decade are unlikely to pose a risk to the 4RST capelin stock in 2022.
 - As a result, participants agreed on this wording:

Available evidence (low approximations of fishing mortality and the composite index around the long-term average) indicate that any of the harvest levels attained over the last decade are unlikely to pose a risk to the 4RST capelin stock in 2022.

RESEARCH

Research priorities are as follows:

- Age determination of capelin in the GSL;
- Development of an acoustic abundance index in the GSL; and
- Identification of the origin/distribution of capelin in different regions of the GSL (using otolith microchemistry).

Note: Given the very short timeframe for writing the science advisory report and the research document, it is expected that they will be reviewed by a committee. The following individuals

volunteered to be a part of this committee: Stéphane Plourde, Mathieu Boudreau, Aaron Adamack and Jean-Martin Chamberland. Other participants may also join.

REFERENCES CITED

DFO. 2021. [Assessment of the Estuary and Gulf of St. Lawrence \(Divisions 4RST\) Capelin Stock in 2020](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2021/027.

APPENDIX 1 – TERMS OF REFERENCE

Assessment of the Estuary and Gulf of St. Lawrence (Divisions 4RST) Capelin Stock

Regional Peer Review – Québec Region

April 20-21, 2022
Virtual meeting

Chairperson: Régnald Belley

Context

Capelin (*Mallotus* spp.) in the Estuary and Gulf of St. Lawrence (NAFO Divisions 4RST) was last assessed in 2020 (DFO 2021). During the evaluation, it was noted that the fishery's performance increased in 2018 and then decreased in 2019 and 2020. The relative abundance indices from the survey in the southern Gulf of St. Lawrence were slightly above average for the years 2018 to 2020, while the abundance indices in the northern Gulf were at low levels and below the average for the past 3 years. The total allowable catch (TAC) having been reduced from 14 300 t to 9295 t during the 2018-2019 fishing seasons, has been maintained at 9 295 t for the 2020 and 2021 seasons. The TAC is distributed as follows: 4ST (14%), 4R fixed (38%), 4R shorter than 19.81 m mobile (24%) and 4R longer than 19.81 m mobile (24%).

The current assessment is requested by Fisheries Management to inform the development of management measures for the 2022 and 2023 fishing seasons based on the best available science.

Objectives

Data from the Commercial Fishery and Scientific Surveys:

- Review information on historical catches up to and including the 2021 fishery;
- Update of the 4R seiner performance index;
- Update of the biological information on the distribution, size, maturity, and condition etc. of capelin obtained from samples from the commercial fishery and scientific surveys;
- Update of the abundance indices of capelin caught annually in the Gulf of St. Lawrence multispecies research vessel surveys;
- Present estimates of fishing mortality order of magnitude compared to natural mortality (historical perception);
- The identification and prioritization of research projects to be considered for the future;
- The determination of the process to provide advice during the interim years, including a description of conditions that may warrant a full stock assessment earlier than originally planned.

New elements to assess stock status:

- Presentation of a combined index of stock state;
- Predictive empirical relationship of landings.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Expected Participation

- Fisheries and Oceans Canada (DFO): Ecosystems and Oceans Science, and Ecosystems and Fisheries Management
- Newfoundland and Labrador Department of Fisheries and Land Resources
- Indigenous Communities / Organizations
- Fishing Industry
- Academia
- Environmental Non-governmental Organizations

References

DFO. 2021. [Assessment of the Estuary and Gulf of St. Lawrence \(Divisions 4RST\) Capelin Stock in 2020](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2021/027.

APPENDIX 2 – LIST OF PARTICIPANTS

Name	Affiliation	April 20	April 21
Adamack, Aaron	DFO Science	X	X
Barry, Joe	Groupe Barry	X	-
Barry, William	Groupe Barry	X	X
Beaudoin, Tony	Fisher Lower North Shore	X	X
Belley, Rénaud	DFO Science	X	X
Bernier, Denis	DFO Science	X	X
Boudreau, Mathieu	DFO Science	X	X
Boudreau, Mélanie	DFO Science	X	X
Boudreau, Sophie	DFO Science	X	X
Bourdages, Hugo	DFO Science	X	X
Byrne, Vanessa	Government NL	X	X
Cawthray, Jenness	DFO Fisheries management - Ottawa	X	X
Chamberland, Jean-Martin	DFO Science	X	X
Cogliati, Karen	DFO Science	X	X
Croussette, Yolaine	DFO Fisheries management – Québec	X	-
Cyr, Charley	DFO Science	X	X
Desrosiers, Brigitte	DFO Science	X	X
Dubé, Sonia	DFO Science	X	X
Dunne, Erin	DFO Fisheries management – NL	X	X
Duplisea, Daniel	DFO Science	X	X
Emond, Kim	DFO Science	X	X
Fequet, Ross	Fisher Lower North Shore	X	X
Girard, Linda	DFO Science	X	X
Hawkins, Laurie	DFO Fisheries management - NL	X	X
Joyce, Michael	FFAW	X	-
Jubenville, Isabelle	Oceana Canada	X	X
Lehoux, Caroline	DFO Science	X	X
Mowbray, Fran	DFO Science	X	X
Murphy, Hannah	DFO Science	X	X
Nadeau, Paul	LNSFA	X	X
Ouellette-Plante, Jordan	DFO Science	X	X
Paquet, Frédéric	DFO Science	X	X
Pellerin, Mathieu	DFO Fisheries management – Québec	X	X
Plourde, Stéphane	DFO Science	X	X
Rousseau, Shani	DFO Science	X	X
Scarratt, Michael	DFO Science	-	X
Smith, Andrew	DFO Science	X	X
Spingle, Jason	FFAW	X	-
Thibault, Cynthia	Comité ZIP Côte-Nord	X	X
Van Beveren, Elisabeth	DFO Science	X	X

APPENDIX 3 – AGENDA

Assessment of capelin in the Estuary and Gulf of St. Lawrence (4RST)

Regional Peer Review – Quebec Region April 20-21, 2022

Agenda

Day 1 – April 20, 2022

Time (EST)	Topic
9:00	Chairperson's introduction and presentation of participants
9:20	Terms of Reference
9:25	Summary of the last Science Advisory Report
9:30	Introduction and landings
10:00	Performance index of seiner in 4R
10:30	Bycatch in the shrimp fishery
10:40	Commercial and biological (<i>Teleost</i> survey) sampling
11:10	<i>Break (lunch)</i>
11:40	Relative abundance index
12:10	Order of magnitude of fishing mortality
12:40	Empirical model of variations in landings
1:25	Importance of capelin in cod and Greenland halibut diet

Day 2 – April 21, 2022

Time (EST)	Topic
9:00	Summary of day 1
9:15	Composite index of stock status
10:00	Review of science advisory summary
11:30	<i>Break (lunch)</i>

Time (EST)	Topic
12:00	Identification and prioritization of research projects to be considered for the future
12:15	Process during interim years
12:30	Committee for the review of the research document and the Science Advisory Report
12:40	Conclusion