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Proceedings of the regional advisory meeting on the assessment of capelin in the Estuary and Gulf of St. Lawrence (NAFO 4RST) in 2020

March 18-19, 2021
Virtual meeting

Chairperson: Rénald 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 capelin stock (NAFO 4RST) in 2020. The meeting, which was held virtually via Zoom on March 18-19, 2021, brought together roughly 50 participants from science, management, the fishing industry 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 the stocks of several exploited fish and invertebrate species in the Estuary and Gulf of St. Lawrence. Most of these stocks are assessed periodically within a regional advisory process, which is conducted at the Maurice Lamontagne Institute in Mont-Joli. This document consists of the proceedings of the meeting held on March 18-19, 2021 via the Zoom platform (virtual meeting), on the assessment of the Estuary and Gulf of St. Lawrence Capelin stock (NAFO 4RST).

The objective of the meeting was to determine whether there were any changes in the resource's status and whether adjustments were required to the management plans based on the chosen conservation approach, the ultimate goal being to provide a scientific advice on the management of the Capelin stock in the Estuary and Gulf of St. Lawrence (4RST) for the 2021 fishing season.

These proceedings report on the main points discussed in the presentations and deliberations stemming from the activities of the regional stock assessment committee. The regional review is a process open to all participants who are able to provide a critical outlook on the status of the assessed resources. Accordingly, participants from outside DFO are invited to take part in the committee's activities within the defined framework for this review (Appendices 1 and 2). The proceedings also list the recommendations made by the meeting participants.

ASSESSMENT

Meeting chairperson Rénald Belley welcomes the participants. He goes over the peer review objectives, process and the Terms of Reference. After the participants introduce themselves, Stéphane Plourde highlighted DFO's national initiative to implement an ecosystem approach to fisheries management by integrating environmental variables into single species stock assessments. The goal is to improve fisheries management decisions. This is a global shift in the approach to fisheries management in the context of climate change and to meet ecological certification, consumer demand, and international market standards. The assessment biologist, Jean-Martin Chamberland, begins his presentation by highlighting the contribution of his collaborators. Mr. Chamberland outlines the meeting's agenda (Appendix 3), and briefly reviews the summary of the latest Science Advisory Report published in 2018. Some elements on capelin ecology were discussed (taxonomy, longevity, maturity, mortality, reproduction).

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, annual landings of capelin in NAFO divisions 4RST have averaged 7,973 t. Landings for 2018, 2019 and 2020 were 8,503 t, 8,487 t and 9,848 t, respectively (data for the last two years are preliminary). Landings came primarily from the purse seine fishery in 4R, which accounted for 93% of total landings.

- Some clarifications were provided concerning the tuck seine, which is categorized as a fixed gear (as is the trap), whereas the purse seine is a mobile gear.
- It was noted that the landings from the ZIFF files also include bycatch, when required by the logbooks. Data are therefore not limited to landings from directed fisheries.

- A problem with gear coding was observed in the landings graphs. It was pointed out that some large seiner landings in 4R seemed to be missing. The biologist would make the corrections the following day.

FISHERY PERFORMANCE INDEX

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

BYCATCH FROM SHRIMPERS

Capelin is regularly caught as bycatch in the shrimp fishery. On average, an estimated 150 t of bycatch is taken annually (2000–2020). These catches are not included in official DFO statistics.

- It was specified that the estimates for 2020 were very incomplete and preliminary.
- It was noted that shrimpers were maximizing their efforts to avoid capelin. It would appear that shrimp fishing activities got off to a later start in 2020.

BIOLOGICAL INFORMATION

The biologist reviewed the biological data: size structure, Le Cren's condition index (1951), sex ratios, gonadosomatic index, length at maturity.

- In the commercial fishery, marked differences in sex ratios across regions were noted. There was some question as to what could account for these differences. It was mentioned that the commercial fishery in 4R targets mainly egg-bearing females.
- It was noted that the length at maturity (L_{50} = 108.9 mm) was estimated using data from bottom trawl surveys rather than from the commercial fishery.

CAPELIN CONSUMPTION BY DEMERSAL PREDATORS

Jordan Ouellette-Plante presented the preliminary estimates of capelin consumption by demersal predators. This approach uses cod and turbot as samplers of the environment to describe inter-annual variations in the use of capelin as a food source and to estimate a minimum level of capelin consumption. The approach was developed in 2018 after it was decided to discontinue the use of data from multi-species surveys, in order to provide a fishery-independent abundance index.

- With respect to the missing data, interpolation based on data from similar divisions and strata was suggested. For seasons not covered, it was suggested that the strata be merged to reduce gaps in data.
- It was specified that only slightly digested capelin could be measured, which would seem to exclude small capelin. It was pointed out that size could also be estimated using otoliths.
- Participants felt that the estimates of capelin consumption by cod and turbot could represent a valuable abundance index.
- Cod and turbot currently appear to be important predators. Questions were raised regarding the potential role of seals in capelin predation.
- The comparison with the work on ecosystem models done by Claude Savenkoff was found to be very interesting. There was little consistency among the results obtained, except for

the most recent period (2006–2010), which was puzzling. It was added that the same stomachs were used for the analyses. However, the methodology differed greatly, which could explain the differences. It is difficult to say which approach was more appropriate.

MULTI-SPECIES SURVEYS

Hugues Benoît and Jean-Martin Chamberland's presentation focused on research aimed at assessing the usefulness of the multi-species bottom trawl surveys (nGSL and sGSL) in providing information on the distribution, demographic composition and relative abundance of capelin in the Gulf of St. Lawrence (GSL). The results suggest that GSL capelin are found mainly in the cold intermediate layer (CIL), within which they undertake daily vertical migrations. There is some uncertainty as to whether density is horizontally homogeneous in the CIL. The results also indicate that the presence of predators reduces the catchability of capelin, although the effect is not important. Capelin in the sGSL are smaller/younger, whereas commercial-sized capelin are concentrated along the coast of Newfoundland. The survey abundance indices are similar, whether the abundance index used is based on all strata or only on those below the CIL. In terms of length frequency, surveys capture, on average, smaller capelin than the commercial fishery which targets spawning fish. Based on known life history traits and the low fishing mortality inferred for the GSL, a large proportion of the capelin targeted by the commercial fishery are likely not available to the surveys due to mortalities caused by post-spawning senescence.

In conclusion, 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. In the sGSL, the index was low in 1990s and 2000s, subsequently increasing rapidly to the highest values of the series in the 2010s. Since then, it has declined to average levels.

- It was noted that the models that use simple regression to analyze capelin abundance as a function of predator abundance are problematic in the case of species with different spatial distributions. It was therefore decided to focus on strata in which capelin are found (i.e. capelin habitat) and to examine the variations in density caused by covariates.
- Some participants felt that using only data from after 1990 does not take into consideration the period when there was a very high abundance of cod in the GSL. It may be that the significant impact of cod predation is not being taken into account. However, it was noted that there was a small amount of capelin in cod stomach contents prior to 1990, although it is still difficult to discern why (e.g. low capelin presence in the area, low catchability, avoidance of cod).
- Participants felt that the impact of cod predation was likely greater prior to 1990.
- Industry representatives (4R) believe that capelin moved closer to the coast to avoid cod during periods of high cod abundance. This could be the reason why fewer capelin are currently seen near the coast. According to the representatives, capelin are still abundant in the system.
- An inconsistency was observed between the survey data and the fishery performance index in 4R for recent years.
- It was mentioned that it would be worthwhile to invest in increasing research efforts in the northeastern part of the Gulf (Strait of Belle Isle). There was some discussion on the potential relationship between this region and the east coast of Newfoundland.

- Everyone was informed that new efforts would be made to optimize the use of acoustic data collected in the survey conducted in the nGSL in August, with a focus on capelin. It would be appropriate to coordinate efforts across regions.

AVERAGE EXPLOITATION RATE

An exercise was conducted to estimate the exploitation rate. Plausible levels for the inferred fishery exploitation rate were lower, by at least one order of magnitude, than the natural mortality (M) calculated as a function of life history traits. With respect to the stock, it is therefore unlikely that current fishing mortality of 4RST capelin has adverse effects on the population.

CAPELIN BIOMASS PREDICTION MODEL (RELATIONSHIP BETWEEN THE ENVIRONMENT AND ABUNDANCE INDICES)

The research presented by Caroline Lehoux is aimed at verifying whether the abundance indices for the GSL reflect expected variations in the population in response to environmental conditions. It also focused on improving our understanding of capelin dynamics and productivity and the environmental factors affecting these. Ms. Lehoux presented the methodology used and the results obtained. To summarize, 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 noted that mortality due to post-spawning senescence is not presently taken into account in the abundance index.
- It may be important to be able to take into account the impact of very different hydrological regimes (e.g. western Gulf vs. eastern Gulf vs. southern Gulf).
- With regard to the emergence index from the reference bay sampled in Newfoundland throughout the whole emergence season, it seems important to be able to standardize our sampling efforts (at the same biological time in relation to the hatching period).
- To improve the model, the impact of predation by mackerel and herring on capelin larvae in the southern Gulf should also be examined.

QUALITATIVE MODEL OF THE CAPELIN SYSTEM

Marie-Julie Roux gave a brief description of qualitative modelling, which focuses on the integration of knowledge and perspectives as well as on studying and understanding complex phenomena. She presented the advantages and disadvantages of this approach, which makes it possible to take into account a set of complex links when assessing the potential consequences of changes in the fishery and the environment, but which does not quantify predictions. The objectives of this new model in the context of capelin assessment are to locate the capelin stock in the ecosystem via an in-depth summary of available knowledge, identify key ecosystem components for stock productivity (abundance, condition, larval survival), and assess the potential impact on capelin of an increase/decrease in fishing in a multivariate context characterized by environmental changes.

From the results obtained, which were presented by Ms. Tasneem Elzein, it was noted that current environmental changes (increase in temperature, decrease in ice cover) have a moderately positive effect on the abundance of capelin. Other key components also affect capelin abundance, such as fishing and small pelagic zooplankton (small calanoids). However, the combined impact of different predators appeared to be neutral. A decline in the abundance

of mackerel (as a competitor) showed a significantly positive effect on capelin larval survival and a moderately positive effect on capelin abundance and condition. To conclude, the simulations carried out using the qualitative network model suggested that recent ecosystem conditions are generally favourable for capelin productivity.

- Clarifications on how the model works were provided. Some questions were raised concerning the choice of components, what would be imposed and what would not, the strength of links, scenarios explored, etc. Everyone was reminded that the use of this model would require a shift in perspective in relation to assessment models. This model provides a picture of all of the possible links between key components (and their interactions) and capelin, to which a perturbation (positive or negative) is applied and its effects observed. It is a model that explores links.
- The importance of being transparent about the premises of the model was highlighted. What the model does and does not do should also be clearly explained.
- With respect to the impact of fishing, which can be positive or negative, it would be good to have scenarios with a lower probability of fishing impact than the current scenario, considering that the significance of the impact of fishing tends to increase when there is a low presence of capelin, and vice versa (discontinuous link). This would make it possible to contrast the effect of fishing with that of predators.
- Questions were raised regarding the list of predators included in the model. What would happen if other predators were added? What would be the effect if some variables were excluded from the system? A suggestion was made to include more predators and a no-fishing scenario.
- It was noted that this type of model is already more complex than what is taken into consideration in a population model. At its core, the model is a learning tool allowing us to explore seemingly strong linkages within the system.
- Participants pointed out that this is a very valuable and highly useful tool. In addition to being visual and easy to understand, it includes a socio-economic component. It could be used upstream of the assessment to gain an understanding of the system as well as to foster interactions between various stakeholders (science, industry, management).

CONCLUSION

RESEARCH

Research priorities are as follows:

- Age determination of capelin (in progress);
- Origin determination of 1–2 year old capelin in the sGSL survey;
- Development of an acoustic index for the Teleost survey;
- Continuation of the work presented as part of this assessment: qualitative model for capelin, model relating abundance and environmental factors.

INTERIM YEAR

It is expected that the next peer review of the Estuary and Gulf of St. Lawrence capelin stock (4RST) will take place in winter 2022.

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.

- With respect to the first key point on landings, it was suggested that the percentage of landings from seine fisheries in 4R (i.e. 93%) be specified.
- 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.
- A clarification was provided concerning the key point on size structure. It is capelin targeted (not captured) by the commercial fishery that would not be available to surveys due to mortalities caused by post-spawning senescence.
- The key point on natural mortality vs. fishing mortality was reworked in order to clarify the message.
- With regard to the key point on the links between abundance indices and the environment, it should be kept in mind that recent years were less favourable.
- In the key point on the qualitative model, it was unanimously agreed that only the first sentence be kept, which states that the simulations performed using the new qualitative system model suggest that recent ecosystem conditions are generally favourable for capelin productivity.
- The key point on the abundance index was simplified by directly presenting the results. The historical background would be included in the Science Advisory Report. Participants wondered about the validity of the index, but a reminder was given that this is a relative index that relates the abundance index to ecosystem components. Additionally, it was decided not to make comparisons with the performance index in this key point.
- The key points were ordered so as to deliver a positive message. The meeting closed with the key point on the exploitation rate.

APPENDIX 1 – TERMS OF REFERENCE

Assessment of capelin in the Estuary and Gulf of St. Lawrence (NAFO 4RST) in 2020

Regional Advisory Meeting – Québec Region

March 18-19, 2021
Virtual meeting

Chairperson: Rénald Belley

Context

Capelin (*Mallotus* spp.) in the Estuary and Gulf of St. Lawrence (NAFO Divisions 4RST) were last assessed in 2018 (DFO 2018). During the evaluation, it was noted that the fishery's performance and a number of biological indices had been decreasing consistently over the past few years. The Total Allowable Catch (TAC) was subsequently lowered from 14 300 t to 9 295 t for the 2018-2019 fishing seasons. The TAC is shared in the following manner: 4ST (14%), 4R fixed (38%), 4R under 19.81 m mobile (24%), and 4R over 19.81 m mobile (24%).

The current assessment is requested by Fisheries Management to inform the development of management measures for the upcoming 2021 fishing season 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 2020 fishery.
- Analyze trends in the 4R seiner performance index.
- Present biological information on the distribution, size, maturity, and condition etc. of capelin obtained from samples from the commercial fishery and scientific surveys.
- 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

Ecosystem Approach: Environmental Effects on Stock Productivity

- Analyze trends in the bycatch of capelin caught annually in the Gulf of St. Lawrence multispecies research vessel surveys in relation to environmental conditions.
- Analyse stomach contents for two dominant demersal predators to describe their interannual variations and estimate a minimal capelin consumption level
- Assess the capelin biomass forecast model adapted from the 2J3KL capelin stock assessment for use in the 4RST stock assessment.
- Present a conceptual model and qualitative analysis of capelin stock status indicators in relation to environmental conditions, trophic interactions and commercial fishing.

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 groups
- Fishing Industry
- Academia
- Non-governmental organizations

References

DFO. 2018. Assessment of the Estuary and Gulf of St. Lawrence (Divisions 4RST) Capelin Stock in 2017. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/037.

APPENDIX 2 – LIST OF PARTICIPANTS

Name	Affiliation	March 18	March 19
Adamack, Aaron	DFO Science	x	x
Anderson, Samuel	FFAW	x	x
Barry, David	Barry Group inc.	-	x
Barry, Joe	Barry Group inc	x	x
Barry, William	Barry Group inc	x	x
Belley, Rénald	DFO Science	x	x
Benoît, Hugues	DFO Science	x	x
Boudreau, Mathieu	DFO Science	x	x
Boudreau, Mélanie	DFO Science	x	x
Bourbonnière, Jean-Patrick	DFO Science	x	x
Bourdages, Hugo	DFO Science	-	x
Brassard, Claude	DFO Science	x	x
Castonguay, Martin	DFO Science	x	-
Chabot, Denis	DFO Science	x	-
Chamberland, Jean-Martin	DFO Science	x	x
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McQuinn, Ian	DFO Science	x	x
Mowbray, Fran	DFO Science	x	x
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Ouellette-Plante, Jordan	DFO Science	x	x
Paquet, Frédéric	DFO Science	x	x
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Young, Todd	3T's Limited	x	-

APPENDIX 3 – AGENDA

Assessment of capelin in the Estuary and Gulf of St. Lawrence (NAFO 4RST) in 2020

Regional Peer Review – Québec
March 18-19, 2021

Agenda

March 18, 2021

Time	Presentation	WP[1]
8:30	Intro / participants introduce themselves (chairperson)	-
9:00	An Ecosystem Approach to Fisheries Management at DFO	-
9:15	Commercial fishery	WP1
9:45	Fishery performance index	WP1
10:00	Commercial biological data	WP1
10:30	Stomach contents: estimates of capelin consumption by two demersal predators	WP2
11:00	*Health break*	
11:30	Capelin conceptual model and qualitative analysis of stock status indicators in relation to environmental conditions, trophic interactions and commercial fishing	WP3
12:15	Capelin catches in multispecies bottom trawl surveys	WP4

March 19, 2021

Time	Presentation	WP[1]
8:30	Intro / wrap up of previous day	-
8:45	Capelin biomass forecast model	DT5
9:45	Review of science advice summary	-
10:30	*Health break*	
11:00	Review of science advice summary	-
2:00	Identification and prioritization of research projects to be considered for the future.	-

Time	Presentation	WP[1]
2:15	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	-

[1]WP: Working paper