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Proceedings of the Regional Advisory Meeting on the Assessment of the Gulf of St. Lawrence (4RST) Greenland halibut

February 23-24, 2021
Virtual meeting

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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.

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SUMMARY

This document outlines the proceedings of the regional peer review meeting on the assessment of the Gulf of St. Lawrence (4RST) Greenland halibut stock. This meeting, which was held virtually via Zoom on February 23-24, 2021 brought together about forty participants from science, management and industry. These proceedings detail the essential parts of the presentations and discussions held during the meeting, as well as the recommendations and conclusions made.

INTRODUCTION

The Quebec Region of Fisheries and Oceans Canada (DFO) is responsible for assessing several stocks of fish and invertebrate species harvested in the Estuary and Gulf of St. Lawrence. Most of these stocks are periodically assessed as part of a regional advisory process that is conducted at the Maurice Lamontagne Institute in Mont-Joli. This document consists of the proceedings of the meeting held on February 23-24, 2021 via the Zoom platform (virtual meeting), on the assessment of the Gulf of St. Lawrence (4RST) Greenland halibut stock.

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, with the ultimate goal being to provide a science advisory report on the management of the Gulf of St. Lawrence Greenland halibut stock (4RST) for the 2021-22 and 2022-23 fishing seasons.

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 peer review meeting 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 meeting (Appendices 1 and 2). The proceedings also list the recommendations made by the meeting participants.

ASSESSMENT

Meeting Chair Hugo Bourdages welcomed the participants. He went over the objectives of the peer review and how it would proceed, and presented the terms of reference. Attendees were then asked to introduce themselves. Before going into the details of the assessment, Mr. Bourdages noted DFO's national initiative to implement an ecosystem approach to fisheries management by incorporating environmental variables into the stock assessments. The goal is to improve fisheries management decisions.

The stock assessment biologist, Johanne Gauthier, began her presentation by recognizing the contributions made by numerous colleagues. Some data on Greenland halibut biology, habitat and distribution were presented. The Estuary and Gulf of St. Lawrence population is considered to be one of the Atlantic populations living in the warmest waters. Greenland halibut are found mainly in channels at depths ranging from 200 to 400 m. Juveniles are predominant in the Lower Estuary and north of Anticosti Island and are generally found at shallower depths than adults. Spawning occurs in winter, in the deeper portion of the Laurentian Channel southwest of Newfoundland.

Ecosystem considerations were incorporated into the presentation. In particular, it was noted that warming of the deep waters of the Gulf of St. Lawrence and oxygen depletion may lead to habitat degradation and decreased growth and increased natural mortality of Greenland halibut, which may affect their productivity. In addition, changes in community structure (high redfish abundance and low shrimp abundance) may alter competitive interactions for food resources or habitat. Current environmental conditions and climate projections suggest that the situation will continue to deteriorate.

- Participants noted the species' minimal response to environmental changes. Greenland halibut appear to stay in the same habitat despite unfavourable conditions. Participants wondered about the factors that could keep it in this habitat (e.g., prey, avoidance of

predation). It is difficult to predict how the species will adapt to ecosystem changes in the future.

FISHERY

Ms. Gauthier provided an overview of the 4RST Greenland halibut fishery. It is a fishery dominated by fixed gear, where 99% of catches are from gillnets. The commercial fishery statistics and biological data from the commercial catch sampling program were presented, as well as a description of the bycatch.

The total allowable catch (TAC) for the Gulf of St. Lawrence Greenland halibut stock was gradually reduced by 50% between the 2017–2018 and 2020–2021 fishing seasons to stand at 2,250 t. Preliminary landings for 2020–2021 totalled 1,330 t, with the fishing season ending on May 14, 2021. For the western Gulf and Esquiman areas, fishing effort and landings decreased between 2019 and 2020, reaching some of the lowest values in each of the series. The situation was different for the northern Anticosti area, which, after being abandoned from 2015 to 2017, experienced a resumption of activities. Between 2019 and 2020, effort there remained fairly stable while landings increased. From 2019 to 2020, the commercial fishery performance indices were stable for the western Gulf and Esquiman areas and increased in the northern Anticosti area. The indices for all three sectors are below the average of their respective series.

The composition of landings changed markedly between 2018 and 2019. The average size of fish decreased by 2.5 cm to 45.6 cm (average of 47.0 cm). The percentage of fish smaller than the minimum size of 44 cm increased to 30% (average of 17%). In 2018 and 2019, females made up about 85% of landings (average of 80%). As a result of the pandemic response measures, the 2020 data were incomplete.

- With regard to catch at length data from at-sea observers and dockside sampling, no information was available for Esquiman (4R) in 2020. It was hoped that this uncertainty would be included in the highlights.
- It was pointed out that the CPUE takes into account soak time (standardization). Longer soak times do not translate into larger catch rates. Soak time is believed to affect Greenland halibut quality.
- Questions were raised about the temporal breakdown of observer coverage. It appeared that the data were from coverage of the middle and end of the season.
- According to industry members, the bycatch of small Greenland halibut in the shrimp fishery is greater than what is reported. However, it was noted that the 2020 shrimping season was well covered by observers. According to some industry representatives, a comparison with the Teleost data could provide worthwhile information, although catchability is different. The comparison can be made.

DFO SURVEY AND SENTINEL FISHERY SURVEYS

According to DFO's scientific surveys and the sentinel fisheries program, the abundance and biomass indices for Greenland halibut generally showed a downward trend from the late 2000s to 2019. These indices increased slightly between 2019 and 2020 but were well below the peaks of the 2000s. This increase was caused by the arrival of the strong 2018 cohort. This cohort is growing at a normal rate and could begin recruiting to the fishery in 2024. The cohorts expected to recruit to the fishery in 2021 and 2022 are of average to low abundance.

- There is consistency between the abundance indices from surveys and the fishery performance index.

- With regard to the graph of length frequency in 4R, the participants wondered about the impact of the small sample size.
- The size frequency data corroborate the finding that the growth rate is higher in 4S (Anticosti). A higher dissolved oxygen level was observed in 4S as well.
- Questions were raised about the decrease in Greenland halibut biomass and size in 4R (Esquiman), which could be related to the warming of deep waters.
- Participants wondered about possible changes in the strong 2018 cohort. The situation appears promising, but only time will tell.

EXPLOITATION RATE

The relative exploitation rate (ratio between landings and biomass of fish over 40 cm) was presented by fishing area and for the Gulf as a whole (4RST). For the Gulf, the exploitation rate index decreased between 2019 and 2020 and remained close to the series average.

- It was noted that the biomass of fish over 40 cm was relatively stable over the past four years. According to this indicator, the stock is currently in the cautious zone. A number of participants feel that a decrease in the exploitation rate is necessary to move out of this zone.
- Industry members indicated that a drop in the exploitation rate could, however, jeopardize the viability of this fishery.

NEW SERIES OF INDICES COMBINING THE NORTHERN GULF OF ST. LAWRENCE (NGSL) AND SOUTHERN GULF OF ST. LAWRENCE (SGSL) SURVEYS

Hugues Benoît's presentation focused on recent re-analyses of comparative fishing experiments undertaken in the nGSL in 1990. They have made it possible to extend the series of surveys back to 1984 and combine it with the sGSL series. The aim is to harmonize the time series through a calibration that takes into account changes in vessels, fishing gear and protocols that could affect catchability. The catches can therefore be corrected by calibration factors. Yihao Yin presented the method for estimating relative catch efficiency using binomial and beta-binomial models.

This broader geographic scope covering a longer period provided new information on the distribution of the GSL Greenland halibut stock. The results indicate that, in the late 1980s, when abundance was low, Greenland halibut were concentrated in the St. Lawrence Estuary. As abundance increased in the 1990s, densities expanded eastward along the Laurentian Channel and at the heads of the Anticosti and Esquiman channels, as well as in Chaleur Bay and the Cape Breton Trough. The recent decline in abundance has resulted in a more pronounced decrease in stock density in the eastern part of the range. Overall, this pattern is consistent with the extension and contraction of the geographic range as a function of density, with the St. Lawrence Estuary serving as the core of the Greenland halibut distribution.

- Participants wondered what might explain the difference in the exploitation rate proxy before and after 1990. It appears that Greenland halibut were more concentrated in the estuary prior to 1990 and that there was a greater percentage of other gear involved in this fishery.
- The results clearly show what appear to be refuge areas for small fish in the southern Gulf, which would be an overflow area when recruitment is high in the northern Gulf.
- It was confirmed that there was no fishery south of Cap Gaspé.

- This new series (1984–2020) represents a further step toward incorporating an ecosystem approach to stock assessment.

IMPACTS OF CLIMATE CHANGE ON 4RST GREENLAND HALIBUT

Daniel Duplisea's presentation discussed an empirical model that suggests that surplus production of the Greenland halibut stock decreases with increasing bottom water temperature. According to this general relationship, with the increased warming of bottom waters observed since 2010, we can expect a decline in stock productivity. Although the general predictions of the empirical model involve a degree of uncertainty which makes their specificities somewhat uncertain, the overall trajectory is robust. The productivity outlook for this stock is not encouraging. It is unlikely that a reduction in catches will be sufficient to slow the long-term decline.

- Participants wondered about the minimum biomass that would enable the stock to rebound should environmental conditions become favourable again.
- According to one expert, it seems unlikely that conditions will improve in the future. The contribution of the warm Gulf Stream waters will remain substantial. The general trend remains one of warming.
- However, it is impossible to assess the Greenland halibut's capacity to adapt to future conditions.
- It was noted, however, that warming may benefit warm-water species. It is the fisheries' capacity to adapt to ecosystem changes that will be tested.
- This modelling was said to be a step forward in incorporating environmental variables into stock assessments.

PRECAUTIONARY APPROACH

Ms. Gauthier issued a brief reminder about the precautionary approach. With this approach, the indicator stabilized between 2017 and 2020 and is halfway between the limit reference point and the upper stock reference, in the cautious zone.

- The Science Sector proposed a new upper stock reference (USR) at a precautionary approach working group meeting in the winter of 2020. The working group agreed on this USR (37,740 t) in February 2020.
- No decision rules for adjusting catches exist at present.

INTERIM YEAR

The Greenland halibut stock assessment is conducted every two years. The monitoring indicators for the interim year are landings and abundance indices from the DFO survey. A stock assessment during an interim year may be triggered by a decrease of more than 30% in the biomass index of fish larger than 40 cm (DFO survey) when this biomass is in the cautious or critical zones defined by the precautionary approach.

PUBLICATIONS

An overview of recent publications on Greenland halibut was provided:

- Integrated management tools for sustainable exploitation of Greenland halibut throughout eastern Canada 2015-2018. NSERC-Strategic – Laval University, ISMER, UQAC, DFO, Bernatchez, L., Audet, C., Tremblay, Sirois, P., and Lambert, Y.
- Carrier, E., Ferchaud. A.-L., Normandeau, E., Sirois, P. and Bernatchez, L. 2020. Estimating the contribution of Greenland Halibut (*Reinhardtius hippoglossoides*) stocks to nurseries by means of genotyping-by-sequencing: Sex and time matter. Evol. Appl. 2020; 00:1–13.
- Ghinter, L., Lambert, Y. and Audet, C. 2021. Juvenile Greenland halibut (*Reinhardtius hippoglossoides*) growth in the context of rising temperature in the Estuary and Gulf of St. Lawrence. Fish. Res. 233.
- Ghinter, L., Lambert, Y. and Audet, C., 2019. Influence of sex on growth of juvenile Greenland halibut (*Reinhardtius hippoglossoides*) in the Estuary and Gulf of St. Lawrence. Fish. Res. 219.
- Duplisea, D.E, Roux, M-J., Hunter, K.L., and Rice, J. 2021.Fish harvesting advice under climate change: a risk-equivalent empirical approach. PloS one.
- Duplisea, D.E, Roux, M-J., Hunter, K.L., and Rice, J. 2021.Considering climate change in fisheries management advice for cold-water adapted Greenland halibut (*Reinhardtius hippoglossoides*) in the Gulf of Saint Lawrence, Canada. Pages 225–236 in: Bahri, T., Vasconcellos, M, Welch, D., Johnson, J., Perry, R.I., Ma, X., Sharma, R. (eds.) “Adaptive management of fisheries in response to climate change.” Fisheries and Agricultural Organisation of the United Nations, Rome. Fisheries Technical Paper 667.

REVIEW OF TERMS OF REFERENCE

The objectives of the terms of reference were briefly reviewed to ensure that they had been properly covered by the review and incorporated into the science advice. The sources of uncertainty section was reviewed. Some additions were proposed:

- The resumption of the redfish trawl fishery is a concern in terms of a potential increase in Greenland halibut bycatch.
- Changes observed in the ecosystem (e.g., warming of deep waters, decrease in oxygen concentrations, change in community structure) could affect stock productivity.

These additions could be addressed in the other considerations section. The sources of uncertainty section should be reserved for data uncertainties.

The research priorities were said to include the following issues:

- Determination of length at sexual maturity for Greenland halibut in the Gulf of St. Lawrence through a histological study. This study is ongoing.
- Spatiotemporal modelling of length at maturity incorporating a classification error to identify the population structure and changes in the life history of Greenland halibut in the Northwest Atlantic.
- Study on the effect of ocean temperatures, oxygen levels and acidification on the Greenland halibut’s physiology and hypoxia tolerance.
- Tagging study to improve knowledge of movements, vertical migrations, mortality, etc. Examination of possible options (spaghetti, acoustic, satellite tags). Interest in a larger-scale genetic study as well.

CONCLUSION

HIGHLIGHTS AND RECOMMENDATIONS

The highlights were presented, and the participants commented on them. Comments having to do with stylistic rewording are not reported.

- In terms of the fishery performance highlight, the participants agreed that the index was stable for the western Gulf and Esquiman areas and increasing for the northern Anticosti area.
- With respect to the composition of landings, the highlight will be reworked in the sub-group. It was also suggested that it be specified that, in 2020, the data were partial but not indicative of change.
- In the scientific survey highlight, the consensus was that the strong 2018 cohort could (rather than should) begin recruiting to the fishery in 2024.
- As for the exploitation rate, it was simply mentioned that it decreased between 2019 and 2020 and remained close to the series average, without area-specific details.
- In the highlight on ecosystem changes, it is worth mentioning that changes in community structure could increase interspecific competition for food and habitat. It was pointed out that the situation is not likely to improve in the future.
- A few clarifications were provided to the last highlight to properly reflect the participants' vision in a manner that is more consistent with the precautionary approach. This highlight was expanded on with the indication that unfavourable environmental conditions could be factors that influence the trajectory of stock abundance.
- Overall, industry representatives shared a less pessimistic view of the stock status. They emphasized that further reductions in exploitation rates could jeopardize the viability of this fishery. This concern could be discussed at the Advisory Committee meeting.

The participants' **conclusion** is as follows:

According to the precautionary approach under development, the stock status indicator was on a downtrend with a decline of over 60% between 2008 and 2017, moving from the healthy zone to the cautious zone. The indicator stabilized from 2017 to 2020 and is midway between the limit reference point and the upper stock reference point. Under these conditions, a reduction in catches below recent levels could reduce the exploitation rate and help increase the stock. However, the unfavorable environmental conditions for Greenland halibut that prevail in the Gulf of St. Lawrence could be determining factors in the trajectory of the stock's abundance.

APPENDIX 1 – TERMS OF REFERENCE

Assessment of the Gulf of St. Lawrence (4RST) Greenland halibut

Regional Advisory Meeting - Quebec Region

February 23-24, 2021
Virtual Meeting

Chairperson: Hugo Bourdages

Context

The Gulf of St. Lawrence (4RST) Greenland halibut (turbot) fishery is conducted by inshore fixed-gear fleets from Quebec and the west coast of Newfoundland. This fishery is subject to several management measures including a total allowable catch (TAC).

The current assessment is requested by the Fisheries Management Branch to provide detailed advice on the status of 4RST Greenland halibut in order to inform management decisions for this stock for the upcoming management cycle.

Objectives

Provide scientific advice on Greenland halibut stock status in NAFO Divisions 4RST. This advice shall include:

- Description of the biology of Greenland halibut and its distribution;
- An oceanographic and environmental overview for the stock area.
- Analysis of the commercial fishing data including landings, fishing effort, catch per unit effort, length composition, and Greenland halibut by-catches in other fisheries;
- Analysis of data from the DFO annual research trawl survey and mobile sentinel fisheries program;
- An assessment of current biomass, exploitation rate, and biological characteristics (including length composition, age at maturity, and distribution). To the extent possible, these variables will be describe in relation to historic observations.
- A presentation of the stock status in relation to the reference points of the precautionary approach in development;
- Analysis of by-catch from directed fisheries for Greenland halibut
- Perspectives for 2021 and 2022 based on available indicators;
- The determination of the process to provide advice during the interim years, including a description of conditions that may warrant a full stock assessment during these interim years;
- Highlight major sources of uncertainty in the assessment.
- Identification and prioritization of research projects to be considered for the future.

Expected Publications

- Science Advisory Report on the Greenland halibut in the Gulf of St. Lawrence (4RST)
- Proceedings
- Research Document

Expected Participation

- Fisheries and Oceans Canada (DFO) (Science and Fisheries Management sectors)
- Fishing industry

- Provincial representatives
- Indigenous Groups

APPENDIX 2 – LIST OF PARTICIPANTS

Name	Affiliation	February 23	February24
Bélanger, Michel	MAPAQ	x	x
Benoit, Hugues	DFO – Science	x	x
Bermingham, Tom	DFO – Science	x	x
Bernier, Denis	DFO – Science	x	x
Bois, Samantha	ACPG	x	-
Boucher, Jean-René	RPPNG/OPFGQ	x	x
Boudreau, Mathieu	DFO – Science	x	-
Bourdages, Hugo	DFO – Science	x	x
Bourbonnière, Jean-Patrick	DFO – Science	x	-
Brassard, Claude	DFO – Science	x	x
Chabot, Denis	DFO – Science	x	-
Chamberland, Jean-Martin	DFO – Science	x	x
Chlebak, Ryan	DFO – Science Ottawa	x	x
Cyr, Charley	DFO – Science	x	x
Denis, Marcel	ACPG	x	x
Desgagnés, Mathieu	DFO – Science	x	-
Dobbin, Shannon	Fisher	x	x
Dubé, Sonia	DFO – Science	x	x
Dubé, Frank	Fisher	-	x
Dugas, Franky	Fisher	x	x
Duplisea, Daniel	DFO – Science	x	x
Dupuis, Mario	RPPNG	x	x
Dwyer, Shelley	DFO – Fisheries Management - NL	x	x
Gauthier, Johanne	DFO – Science	x	x
Hardy, Magaly	DFO – Fisheries Management Québec	x	x
Hébert, Denyse	DFO – Fisheries Management Québec	x	x
Karbowski, Chelsey	Oceans North Canada	x	x
Langelier, Serge	AMIK	x	x
Lapierre, Daniel	DFO – Fisheries Management Gulf	x	x
Laurie, Isabel	DFO – Science	x	x
Lussier, Jean-François	DFO – Science	x	-
Marquis, Marie-Claude	DFO – Science	x	x
Martin, Lucas	ISMER/UQAR	x	x
Méthot, Chantal	DFO – Science	-	x
Nicolas, Pierre	OPFGQ	x	x
Ouellette-Plante, Jordan	DFO – Science	x	x
Parent, Geneviève	DFO – Science	x	x
Pond, Nancy	DFO – Fisheries Management - NL	x	x
Pomerleau, Corinne	DFO – Science	x	-
Plourde, Stéphane	DFO – Science	x	-
Roux, Marie-Julie	DFO – Science	x	x
Sandt-Duguay, Emmanuel	AGHAMM	x	-
Senay, Caroline	DFO – Science	x	x
Simard, Émilie	DFO – Science	x	x
Spingle, Jason	FFAW/UniFor	x	x
Tilley, Anna	Province of NL	x	x
Tremblay, Yan	UAPAN	x	-