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Proceedings of the Regional Advisory Meeting on the Stock status in 2020 and fishery advice for 2021 for Snow Crab from the Southern Gulf of St. Lawrence

Meeting dates: February 10-11, 2021
Location: 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

A regional peer review meeting to assess the status of the snow crab (*Chionoecetes opilio*) stock in the southern Gulf of St. Lawrence (sGSL) biological unit (management areas 12, 12E, 12F and 19) was held on February 10 and 11, 2021. These proceedings provide a summary of the discussions that took place at the meeting, which was held virtually. In addition to these proceedings, additional publications to be produced from this meeting include a Science Advisory Report and a Research Document. All publications will be made available online on the Canadian Science Advisory Secretariat (CSAS) website.

INTRODUCTION

To respond to the Department of Fisheries and Oceans (DFO) Fisheries Management's request for science advice, DFO's Gulf Region Science Branch undertakes an annual peer review of the status of the snow crab (*Chionecetes opilio*) stock in the southern Gulf of St. Lawrence (sGSL) biological unit (management areas 12, 12E, 12F and 19). This year, the meeting was held virtually on February 10 and 11, 2021, with simultaneous translation. Some data, working documents and presentations were made available in advance so that participants could examine them thoroughly and submit their comments and questions before the meeting via a feedback form. Obtaining comments beforehand optimizes meeting time and allows discussions to be focussed on the main presentations, the answers to the reviewers' questions, the comments received and the finalization of the science advice. Aside from the comments received from the two external reviewers, no feedback forms were submitted before the meeting.

PROCEEDINGS

TERMS OF REFERENCE (TOR)

The 2020-2021 ToR were reviewed, and a few differences relative to the previous year were highlighted. In addition, modifications to the process, which involved reducing the list of participants to those with greater expertise and stronger contributions, were noted

Discussion

One participant said that he would like to have access to the list of people who were not invited to participate in the process this year compared to last year, commenting that industry participation in the process was crucial. In particular, he noted that money from the industry had funded the scientific research and that industry people deserved more appreciation. Another participant asked if other First Nations had been invited this year but did not show up today. Another participant pointed out that representatives of the provinces had not been invited and thought that they would make an important contribution to the discussion. He would like provincial representatives to be put back on the participants' list. One participant remarked that he would have liked to have been informed of this change before the meeting.

The chair of the meeting and the Department of Fisheries and Oceans (DFO) Science team noted that the list of participants would be included in the meeting proceedings and that experts had not been not removed from the list, but that areas of expertise had been selected instead. Changes to Canadian Science Advisory Secretariat (CSAS) processes and procedures include an emphasis on smaller groups and targeted groups of experts. Although this had resulted in a smaller number of participants this year than in previous years, DFO believed that it had made wise decisions that would result in a good meeting. This year, DFO had invited science advisors from the Aboriginal Aquatic Resource and Oceans Management (AAROM) Program.

PRESENTATIONS

Environmental conditions in the southern Gulf of St. Lawrence (sGSL)

Presenter: Joël Chassé

Discussion

The following comments were made by meeting participants:

- The discussion centered on various aspects potentially influenced by temperature. Long-term warming trends suggest that the snow crab's preferred habitat has shrunk in recent years. These results are noteworthy, particularly when compared with the survey results.
- In recent reporting in the media on the warming of the waters of the Gulf, the situation was described as extremely worrisome for snow crab. Participants wondered about the effect of the warmer water on females' reproductive cycles and crab survival. It was pointed out that an experiment exposing females to higher temperatures had been conducted. Normally, females have a two-year cycle, but this could be reduced to one year with a temperature increase of one or two degrees. If most crabs had a two-year cycle and have now gone to a one-year cycle, this would be positive for recruitment in the short term. However, it is not known whether the cycle had become shorter in the sGSL and no egg sampling took place in 2020.
- A request was made to clarify the phrase "fairly cold winters." It was explained that the average air temperature has increased by roughly 2 °C in 100 years and that there is a direct correlation between this temperature and the water temperature in the Gulf. The average winter temperature in the Gulf as a whole is -7.3 °C and winters that are colder than average have some positive effects on crab habitat.
- It was noted that the survey data were obtained at the end of summer (late September), when the water is warmer and the entire water column may be well mixed due to the onset of the storm season.
- A question was raised about the possible correlation between biomass and temperature. Although this relationship had not been studied, productivity will ultimately influence biomass, and higher temperatures would affect the larval stages. The DFO Science team said that it was working on a population model and a fecundity model. Given current warming trends (particularly in marginal fishing areas), the Science team is curious to find out if trends differ in the various management areas. One of the reviewers brought up the point that habitat measurements may not reflect the actual condition of the habitat in a given year and that this could be linked to the catchability or redistribution of animals. The Science team was said to be focusing more on spatial models at this time.

2020 fishery data

Presenter: Amélie Rondeau

Discussion

A participant remarked that a correction was required to the data for management area 19.

2020 trawl survey data

Presenter: Amélie Rondeau

Discussion

Participants had no comments.

Follow-up on issues raised during the 2020 review – relocation of survey stations

Presenter: Tobie Surette

Discussion

Participants made a few comments on this subject:

- Last year, a participant had suggested that concentrating the sampling effort in areas with a more trawlable bottom would bias stock abundance. This year, the relocation of stations was cited as a potential source of bias; this drift had been occurring for some time. However, this drift does not explain what had been observed in the last two years with regard to bias. It should be noted that catch rates should be lower in less trawlable areas.
- For the 2021 survey, it was suggested that a subset of fixed stations be randomly selected from all the 2013 survey stations (i.e., 50 to 100 stations distributed throughout the Gulf). These fixed stations would provide a baseline for comparison with the relocatable stations over time. One reviewer supported this approach, which incorporates the advantages of both fixed and moveable stations. However, another reviewer observed that, for a survey to be representative from year to year, it must be consistent (i.e., either random or fixed). He explained that diverging from either method would result in inconsistencies in the survey over time. The question of whether the use of fixed stations from the 2013 survey would introduce bias was also raised. The DFO Science team noted that its statistical model had been developed for use with fixed stations and recognized that relocating stations would affect the confidence of observations. The team also indicated that, in 2012-2013, some new stations had been used, resulting in a rate of rejected tows of 20%, which decreased to 10% in subsequent years. Using a subsample of the 2013 fixed stations would allow us to determine whether the results obtained with these fixed stations would be similar to those obtained with the current model. Using only a subset of the stations would provide a rejection rate of roughly 13%, which would be more acceptable from a practical standpoint.
- The external reviewers were asked what procedures they would use if a tow was unacceptable. One said that he would randomize all the stations each year in each stratum and suggested to the DFO Science team that it take a subset of stations and randomize them each year. The other reviewer reported using a sampling method employing fixed stations. The location of the stations was adjusted and finetuned over time by trying a station several times before moving to an alternate station; the use of the fixed model was maintained to ensure that the bias was the same every year and to prevent inconsistencies.

Follow-up on issues raised during the 2020 review – use of catch per unit effort (CPUE) as a biomass index

Presenter: Amélie Rondeau

Discussion

The DFO Science team would take account of the reviewers' comments with regard to this section.

Follow-up on issues raised during the 2020 review – review of issues in recent surveys

Presenter: Tobie Surette

Discussion

The participants discussed the points raised:

- Several points were discussed that could explain the difference between the 2018 and 2019 catches: differences between survey vessels, trawl wingspread, duration of the passive phase, trawl behaviour, net mesh size and the different types of bottoms trawled, as well as certain unidentified factors that could influence the catchability of certain sizes of crab. The closure of fishing areas to protect North Atlantic right whales was also covered.
- The DFO Science team noted that it had standardized catches by the trawl swept area (wingspread data) and that it had experienced some problems with the acoustic monitoring sensors on older vessels (in 2018 and 2019). Although the swept area of these tows was still estimated, it was associated with a greater degree of uncertainty.
- The presenter remarked on the considerable increase in the abundance of certain size ranges, which seemed unusual. This result is worrisome and warrants further investigation. In general, the larger the crab, the easier it is to catch. The 30-40% increase observed in the catch of sub-legal adolescent crabs and mature females was not found in commercial-size crabs, a difference that could be linked to fishery effects, although there are no data elucidating these effects. Therefore, it is difficult to understand why this increase fell off abruptly in legal-size crabs.
- The DFO Science team observed that knowing what was happening with the bottom trawl on the seabed was critical and that cameras could be used for this. An effort would also be made to better control the passive phase.
- The hypothesis related to net behaviour and the biological behaviour of crabs was discussed. If the net digs deeper into the sediment during the passive phase, this would increase the quantity of small crabs in particular, which would explain the significantly higher numbers of smaller crabs in the net.
- The Science team noted that mesh size was measured to ensure that data were comparable from year to year. It also remarked that a vessel's power and tonnage could influence trawl behaviour—and therefore catchability—even when the towing speed remained constant from survey to survey. However, the team expected the bias to change more gradually and to be reduced in legal-size crabs. This observation reflects the commercial fishery's selectivity.

Potential overestimation of commercial biomass in 2020

Presenter: Marcel Hébert

Discussion

Following the comments by reviewers and the most recent analyses conducted, the DFO Science team reassessed the results, which suggest that biomass was overestimated in 2019 and 2020 relative to the 2018 results.

The participants discussed the presentation and the scenarios presented:

- Several participants suggested that CPUE values not be used to draw the conclusion that biomass was overestimated. Indeed, CPUE values are generally not used for this and in 2020 they were affected by management area closures resulting from the presence of North Atlantic right whales.

- Some participants agreed that caution must be exercised in 2021, particularly if residual biomass was also overestimated. The comment was also made that we must be circumspect in making changes to the protocol (including the passive phase), since too many changes could make it even more difficult to identify problems.
- The Science team explained that there have always been adjustments to the protocol to some extent. The goal was not to eliminate the passive phase but rather to control it. A retroactive standardization process was currently under way.
- The presenter reported that, according to the indicators, fishery indicators had declined in all management areas (i.e., decrease in CPUE values in all areas). Fishing effort was the highest it had been since 1987 and was distributed throughout the Gulf. Survey, biomass and landings-based indicators were all very similar. The presenter noted that it would be risky to maintain the same exploitation rate.
- Several participants remarked that the use of the Leslie analysis per se was not appropriate.
- A participant suggested that other options and other types of analyses should be explored. Several new indicators do not correspond with the proposed hypotheses and he was not convinced that the passive phase was the problem.
- A participant suggested that the effect of the breeding season on fishing effort be examined.
- The DFO Science team stressed that this was the second year that the survey showed a jump in biomass and the long-term consequences must be considered. It recommended that caution be exercised and that a correction of at least 15% (15-40%) be made to the estimated commercial biomass to protect the stock. The majority of the industry participants were not comfortable with this advice.
- The question arose whether mortality was perhaps underestimated, and the Science team noted that this was one of the main hypotheses.
- The possibility of crabs migrating from region to region was discussed but does not seem to be a valid hypothesis based on the tagging data.
- The Science team asked participants for their opinion on the status of the stock. Some noted that catches were declining and that the legal-size crab were smaller. A number of participants had been affected by management area closures resulting from the presence of North Atlantic right whales and believed that these closures were why the quota was not achieved. Some shared concerns over a possible decline in biomass and were in favour of further analysis, but believed that the stock was still healthy.
- The majority of the industry participants did not appreciate getting certain key information at the last minute. The Science team acknowledged that it had been caught off guard by these last-minute findings and had conducted analyses non-stop up to the day before the meeting.

Review of the main points of the February 10, 2021 presentations and proposed options

Presenter: Amélie Rondeau

Discussion

Participants made the following comments:

- The DFO Science team reminded everyone that it strives to provide the best science advice possible with the information available and that it would be irresponsible to disregard these

indicators suggesting that biomass is overestimated for a second year. The main goal is to answer a specific question on fisheries management and to protect the stock.

- The team reviewed the indicators suggesting that biomass was overestimated in 2019-2020, noting that the cumulative effect of all these indicators could have an impact on the stock assessment.
- Some industry members would like to have access to the external reviewers' comments. Generally, these comments are shared with participants during the meeting, but participants are encouraged to approach reviewers with questions and/or comments. The Science team opened the floor to the reviewers. The reviewers confirmed that the quality of the crab survey was high and praised this discussion. The survey period was ideal since the data were available in advance for this meeting. The Science team had done an excellent job and its relationship with the industry was admirable.
- The reviewers were in favour of trying out different analyses. They recommended that the passive phase be re-examined; that the bias resulting from surveying on more trawlable sections of the seabed, which probably results in a gradual increase in biomass, be minimized; and that the possible overestimation of biomass during the last two surveys (which had already been pointed out by the Science team) be examined. There appears to be a factor in the survey that has not been identified or quantified but is a source of significant bias and uncertainties associated with the time series. The absence of residual biomass and the natural mortality rate of 35-40%, which seems high, were also discussed. The reviewers did not think that a natural mortality rate of 40% was reasonable.
- Most of the industry representatives agreed that there were major issues with uncertainties, but were not comfortable with using an overestimation of biomass to explain these uncertainties. Although it was presumed that the numbers were overestimated by 15%, we are not sure exactly how much and no specific cause has been found. The Science team agreed with this but noted that 15% was probably a minimum value.
- The industry agreed that the closure of management areas to protect North Atlantic right whales had disrupted the fishery a great deal and believed that it was the main reason for the quota not being achieved. In addition, it felt that the passive phase had been corrected but that an effort should be made to better understand the behaviour of the trawl on the seabed (cameras), as well as to try to explain the high mortality rate (also seen in previous years); the scarcity of old crabs is well within the average of the last five years and is not worrisome. In addition, some still wondered about the crab movements mentioned on the previous day.
- The DFO Science team reiterated that it did not think that crab migration could explain the overestimation. Studies have demonstrated that crabs do not move much, and it would require the migration of the entire eastern Nova Scotia stock to the sGSL to explain the abundance of crab. One of the external reviewers showed participants the biomass data for the area around Cape Breton and confirmed that no increase in biomass had occurred in this adjacent system.
- Industry participants asked for the results on bycatch species and for the data from other surveys (e.g., multi-species surveys). The Science team had examined the data on other species and had observed changes in some species' abundance. Many problems had occurred with the September multi-species survey in the last two years, making the data less reliable.

- The DFO Science team proposed the hypothesis of an increase in the fishing mortality of recruits. The timing of the survey from year to year and the warming of the water, which could affect the migration of legal-size crab, were also mentioned by a member of the Science team. However, on the basis of what is known about crab movements, the team did not believe that the hypothesis based on crab migration was plausible, or that it was sufficient to create a bias for the entire Gulf. A team member also noted that, in 2019, tropical storm Dorian had occurred, which caused a 7 °C increase in water temperature in a two-day period, which persisted for several weeks. The hypothesis was put forward that this could have caused a thermal shock and, in turn, an increase in mortality.
- Since all the participants had the same objective, which was to protect the resource, it would be wise to recommend a total allowable catch (TAC) that reflected these unknown factors. The Science team mentioned that it may be time to discuss a new snow crab assessment framework.
- The Science team proposed some statements and asked participants if they were strongly opposed to them. It also stressed the importance of separating biases and uncertainties. Most participants were not comfortable with supporting or opposing these statements. One external reviewer suggested looking at the data before drawing any conclusions.

Working document: review

Presenter: DFO team

Discussion

The DFO team suggested to the external reviewers that they specifically address certain figures or data that are important in their view.

- The exploitation rate, survey efficiency, and residual biomass were discussed.
- Some industry members thought that a 40% mortality rate was high but conceivable. Four factors were mentioned that could explain higher mortality (illegal fishing, natural or discard mortality, immigration, and overestimation). Participants questioned why this discrepancy seems to have increased in recent years.
- There was a significant increase in female abundance in 2019 and 2020 that cannot be explained by biological factors. Although this trend was also observed in small crabs, it was absent in commercial-size crabs. The industry acknowledges that this is difficult to explain but it is not comfortable applying the same bias to legal-size crabs.
- The DFO Science team presented a new risk analysis that incorporates the uncertainties. The reviewers supported this analysis and recommended further exploration by adjusting the bias and mortality. This analysis is much more conservative since it incorporates the uncertainties. A reviewer asked the industry members what exploitation rate would be too high. According to the industry, to remain in the healthy zone, based on the precautionary approach, the stock must not fall below B_{lim} (exploitation rate of roughly 45%). The Science team added that the exploitation rate chosen also depends on recruitment. The team was confident that biomass was overestimated in 2019 and 2020 and proposed that using F_{lim} be considered. Industry participants did not support this approach.
- The DFO Science team and the external reviewers supported a simulation that takes account of uncertainties (range of 0-30%).
- A consensus could not be reached, and a draft version of the Science Advisory Report could not be prepared.

APPENDIX 1. TERMS OF REFERENCE

Stock status in 2020 and fishery advice for 2021 for Snow Crab from the Southern Gulf of St. Lawrence

Regional Advisory Meeting – Gulf Region

February 10 and 11, 2021
Virtual meeting

Chairperson: Mark LaFlamme

Context

In support of DFO Ecosystems and Fisheries Management request for advice, DFO Science Branch Gulf Region undertakes a peer review of the stock status of the snow crab (*Chionoecetes opilio*) biological unit of the southern Gulf of St. Lawrence (management areas 12, 12E, 12F and 19).

Objectives

Develop science advice for the management of the snow crab fishery for the southern Gulf of Saint Lawrence biological unit for the 2021 fishing season. The following considerations and items will be on the agenda for this peer review meeting.

- Present for each of the four management areas in the southern Gulf (12, 12E, 12F, 19):
    - Available commercial fishery statistics for the 2020 fishing season (landings, effort, catch per unit of effort),
- Present the following estimates based on the post-fishery directed snow crab trawl survey for the extended polygon of 20 to 200 fathoms (defined in 2014) for 2020 and previous years:
    - the exploitable commercial biomass (adult male crab of carapace width >= 95 mm, residual and recruitment) for the southern Gulf biological unit and for each of the four management areas (12, 12E, 12F and 19) within the southern Gulf biological unit,
    - male recruitment abundances,
    - the female spawning stock abundance,
    - male and female size frequency distributions by maturity stage,
    - the total annual mortality of commercial-sized adult male crab.
- Perform a risk analysis of catch options for the 2021 fishing season, including projections with uncertainty of the predicted adult male commercial biomass for the 2022 fishing season. This risk analysis will be prepared for the southern Gulf biological unit, relative to the reference points (limit, upper reference), and according to the agreed decision rule.
- Present the information on the environmental factors which may influence the abundance and population dynamic of the snow crab stock of the southern Gulf of St. Lawrence.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Expected Participation

- Fisheries and Oceans Canada (DFO) (Ecosystems and Oceans Science, and Ecosystems and Fisheries Management)
- Stakeholders
- External experts
- Aboriginal Aquatic Resource and Ocean Management (AAROM)

APPENDIX 2. LIST OF MEETING PARTICIPANTS

Nom	Affiliations
Adam Cook	DFO Science - Maritimes
Alan Dwyer	DFO FAM - Antigonish
Amélie Rondeau	DFO Science - Gulf
Steve Lapierre	Groupe de pêcheurs zone 12F Inc.
Carter Hutt	PEI Snow Crab Fisherman Association
Craig Knickle	Mi'kmaq Confederacy of PEI
Daniel Desbois	Association des crabiers Gaspésiens inc.
Darrell Mullowney	DFO Science - Newfoundland and Labrador
Devin Ward	North Shore Micmac District Council (Anquotum Resource Management)
Emmanuel Saindt-Duguay	Mi’gmaq and Maliseet Fisheries Management Association (MMAFMA)
Jean Lanteigne	Fédération régionale acadienne des pécheurs professionnels (FRAPP)
Jean-François Landry	DFO Science - Gulf
Jillian Arany	Confederacy of Mailand Mi’kmaq
Joel Chassé	DFO Science - Gulf
Josiane Massiera	DFO FAM - Gulf
Laura Ramsay	Prince Edward Island Fishermen’s Association (PEIFA)
Leonard LeBlanc	Gulf Nova Scotia Fleet Planning Board
Luc Haché	Association interprovinciale des crabiers zone 12E
Marcel Hébert	DFO Science - Gulf
Martin Noël	Association des pêcheurs professionnels crabiers acadiens (APPCA)
Mathieu Noël	The Maritime Fishermen’s Union Inc.
Matthew Hardy	DFO Science - Gulf
Mikio Moriyasu	DFO Science - Gulf
Paul Boudreau	Regroupement des pêcheurs professionnels des Iles-de-la-Madeleine
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