Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2018/013

Quebec Region

Proceedings of the regional peer review meeting on the assessment of the Estuary and Gulf of St. Lawrence shrimp stocks

January 23, 2018
Mont-Joli, Quebec

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August 2018

Canada

Foreword

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

Published by:

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

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

ISSN 1701-1280

Correct citation for this publication:

DFO. 2018. Proceedings of the regional peer review meeting of the assessment of the Estuary and Gulf of St. Lawrence shrimp stocks; January 23, 2018. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2018/013.

Aussi disponible en français :

MPO. 2018. Compte rendu de l'examen régional par des pairs sur l'évaluation des stocks de crevette nordique de l'estuaire et du golfe du Saint-Laurent; 23 janvier 2018. Secr. can. de consult. sci. du MPO, Compte rendu 2018/013.

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SUMMARY

This document contains the proceeding from the meeting held within the regional assessment process of the Estuary and Gulf of St. Lawrence Shrimp stocks. This review process was held on January 23th, 2018 at the Maurice Lamontagne Institute in Mont-Joli. This meeting gathered more than thirty-five participants from sciences to management to industry. This proceeding contains the essential parts of the presentations and discussions held and relates the recommendations and conclusions that were presented during 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 January 23, 2018, on the assessment of the Estuary and Gulf of St. Lawrence shrimp stocks.

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 scientific advice on managing the shrimp stock in the Estuary and Gulf of St. Lawrence for the 2018 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.

CONTEXT

Meeting chairperson Bernard Sainte-Marie welcomes the participants. He goes over the scientific review's objectives and agenda. After the participants introduce themselves, the biologist in charge of the review, Hugo Bourdages, highlights the contribution of his collaborators. He describes the meeting plan and the Terms of Reference. This review will be used to provide scientific advice for the 2018 fishing season. Mr. Bourdages raises two items that will be discussed in this meeting: the deterioration of the status of stocks since the last assessment and the bleak outlook given low recruitment, warming waters, and increased predation by redfish.

A synopsis of the fishery management measures is given. There are four fishing areas (Estuary, Sept-Iles, Anticosti and Esquiman) and 111 licences (five provinces and seven First Nations). Each area is subject to catch monitoring through the application of a total allowable catch (TAC). A history of the shrimp life cycle is also presented to show the harvesting periods based on development stages. The data used in the assessment come from the commercial fishery (1982–2017) and the DFO research survey (1990–2017).

ENVIRONEMENTAL AND ECOSYSTEM CONSIDERATIONS

Before getting to the heart of the assessment, Mr. Bourdages covers the environment and ecosystem. He presents a temperature profile of the bottom of the Gulf of St. Lawrence. The seafloor area with temperatures warmer than 6°C increased in the Anticosti and Esquiman channels and in the centre of the Gulf, to the detriment of seafloor habitat in the 5 to 6°C temperature range. In 2017, male and female shrimp were found at bottom temperatures that were 1°C warmer compared to the 1990 to 2016 average, whereas their depth distribution remained the same within the reference period. Highly variable surface temperatures can also impact the survival of shrimp larvae.

Denis Chabot's modelling of shrimp distribution and abundance based on the conditions of depth, temperature and dissolved oxygen (hypoxia) suggests that temperature is the main

determinant of distribution changes in shrimp stocks. However, Mr. Chabot states that his work likely underestimates the impact of hypoxia given that warming may increase shrimp's metabolism and cause it to consume more oxygen.

Participants wonder about shrimp's potential for adapting to environmental changes. It has been noted that although fall maturation and spawning take place increasingly later, the spring hatching period remains stable. Since eggs develop faster in warmer water, the hypothesis is that shrimp adjusts its spawning period to ensure a good match with the phytoplankton bloom. This adjustment's mechanisms are still unknown given factors such as potential changes in moult timing or the number of pre-spawning moults. Thus, several questions remain unanswered.

Ecosystem changes have also been observed: since 2013, there has been an increase in groundfish, especially in redfish, a shrimp predator. Redfish consumption of shrimp of the strong year-classes of 2011 to 2013 is expected to increase the pressure on shrimp stocks in the coming years.

Overall, warming water and increased predation by redfish appear to be important factors in the northern shrimp's decline. These conditions are not expected to improve in the short term.

ASSESSMENT OF THE RESOURCE

COMMERCIAL FISHERY

- Mr. Bourdages presents the commercial fishing indicators (landings, effort, CPUE, distribution and length frequency) for each area. In 2017, preliminary landings for all shrimp fishing areas were 22,431 t from a TAC of 26,732 t, a decrease of 26% since 2015. TACs were not reached in the Sept-Îles and Anticosti areas. The standardized commercial fishery catch rate has been decreasing in the four fishing areas, reaching values in 2017 that are comparable to those observed at the beginning of the 2000s.
- Participants note that the effort's spatial distribution has shrunk.
- As part of the Coral and Sponge Conservation Strategy for the Gulf, the distribution of various species was examined compared to the shrimp trawling footprint. The conclusion is that there is no overlap between the shrimp fishery and areas closed to protect coral and sponges. However, participants deem it important to continue the DFO research survey within these areas to monitor changes in shrimp stock distribution.
- Some industry members wonder about how to consider the fishery's increasing efficiency and the impact of trawl types on the fishery's male and female index. According to the biologist, this increased efficiency has impacts over the long term. Interannual variations are mainly resource-related. Furthermore, trawls exclusively select target sizes.

RESEARCH SURVEY

Mr. Bourdages presents the DFO research survey indicators (distribution, biomass, abundance and length frequency) for each area. The DFO research survey biomass index and abundance indices for males and females have been declining. Biomass and abundances in 2017 are close to the low values observed in the early 1990s. Juvenile abundance was low in 2016 and 2017 in all areas.

Northern shrimp is still widely distributed in the northern Gulf of St. Lawrence, but since 2008 the DFO survey has shown a decline in the area of shrimp concentrations. This is also observed

in the fishery, as some traditional fishing grounds have been abandoned because of the low abundance of shrimp.

EXPLOITATION RATE

The biologist presents the exploitation rate index (shrimp catches in number / shrimp abundance estimated from the research survey), which has increased and is above the series average (1990 to 2016) in each area except Anticosti, where it decreased in 2017 and is close to the average.

PRECAUTIONARY APPROACH

The methodology used for the precautionary approach is presented. The main indicator of stock status is calculated from the standardized male and female indices obtained from the summer fishery and the research survey. In 2017, according to this approach, the Estuary and Sept-Îles stocks were in the cautious area whereas Anticosti and Esquiman stocks were still in the healthy area but close to the cautious area.

- Participants ask about the differences observed, in specific areas, between the standardized indices obtained from the fishery and the survey, especially for females. Changes in the spatial distribution of catches in the fishery could partly explain these differences. Fishers focus on areas with higher abundance. Indices also show a recent tendency towards convergence.
- According to the participants, it would be appropriate to revise the management units' boundaries so that they represent the biological units of northern shrimp in the Estuary and northern Gulf. This way, the fishery and research survey indicators could be more consistent.
- Some details are provided on the indices used for the main indicator. June to August are used to estimate the commercial fishing CPUE since male and primiparous female catches will be available to the fishery the following season; this can be a good indicator of the resource's status for the following season.

Reference points were determined and guidelines were established to determine projected catches based on the main stock status indicator and its position relative to the classification zones (healthy, cautious and critical).

- It is suggested that the sampling graphic show the historical values based on the stock status indicator.

BYCATCHES

Mr. Bourdages gives an overview of the following shrimp fishery bycatches: redfish, Greenland halibut, capelin and Atlantic cod. Bycatches increased because catches of small redfish rose significantly. Bycatches represented 5% of northern shrimp catch weight in 2016 and 2017. However, the estimated catch for each bycatch species represents less than 1% of each species' biomass estimated in the DFO survey.

INTERIM YEARS

The Estuary and Gulf of St. Lawrence Northern Shrimp stock is reviewed every two years. For the interim years, an update of the following indices is planned:

- Landings

- Summer fishery CPUE (male and female)
- Abundance index from the survey (male and female)
- Main stock status indicator
- Projected harvest

RESEARCH

Mr. Bourdages cites some recent publications[1] and briefly outlines DFO contributions as part of the Northern Shrimp strategic research plan (Appendix 3).

CONCLUSION

SUMMARY

The highlights of the assessment are presented and the participants share their comments. Some facts are made clearer whereas others are restructured or will be kept only in the advice text.

- The participants insist that environmental conditions and redfish predation will continue to have a negative impact on shrimp stocks. They believe that the situation will not improve in the coming years.

RECOMMENDATION

Following the harvest guidelines established as part of the precautionary approach, the projected harvest for 2018 is 239 t for the Estuary, 4267 t for Sept-Îles, 5722 t for Anticosti, and 5508 t for Esquiman.

The outlook for northern shrimp stocks in the Estuary and Gulf of St. Lawrence is poor given low recruitment, warming water, and increased predation by redfish. In the short run, the downward trend in these stocks is expected to continue.

[1] Ouellet, P., Chabot D. Calosi, P., Orr, D. and Galbraith, P.S. 2017. Regional variations in early life stages response to a temperature gradient in the northern shrimp Pandalus borealis and vulnerability of the populations to ocean warming. J. Exp. Mar. Biol. Ecol. 497, 50-60.

Pillet, M., Dupont-Prinet, A., Chabot, D., Tremblay, R. and Audet, C. 2016. Effects of exposure to hypoxia on metabolic pathways in northern shrimp (*Pandalus borealis*) and Greenland halibut (*Reinhardtius hippoglossoides*). J. Exp. Mar. Biol. Ecol. 483, 88-96.

Stortini, C.H., Chabot, D. and Shackell, N.L. 2016. Marine species in ambient low-oxygen regions subject to double jeopardy impacts of climate change. Global Change Biology (2017) 23, 2284–2296.

Koen-Alonso, M., Favaro, C., Ollerhead, N., Benoît, H., Bourdages, H., Sainte-Marie, B., Treble, M., Hedges, K., Kenchington, E., Lirette, C., King, M., Coffen-Smout, S., and J. Murillo. 2018. Analysis of the overlap between fishing effort and Significant Benthic Areas in Canada's Atlantic and Eastern Arctic marine waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/015. xvii + 270 p.

APPENDIX 1 – TERMS OF REFERENCE

Assessment of Estuary and Gulf of St. Lawrence shrimp stocks

Regional Peer Review - Quebec Region

January 23, 2018
Mont-Joli, Qc

Chairperson: Bernard Sainte-Marie

Context

The Estuary and northern Gulf of St. Lawrence are divided in four shrimp fishing areas (SFA): Estuary (SFA 12), Sept-Iles (SFA 10), Anticosti (SFA 9) and Esquiman (SFA 8). Shrimp fishing is regulated by a number of management measures, including the setting of total allowable catches (TAC) in the four areas.

The key elements for the establishment of a precautionary approach (PA) were adopted in 2012. Reference points were determined and guidelines have been established to determine harvest based on the stock status main indicator and its position relative to healthy, cautious and critical zone classification.

Objectives

Provide scientific advice for the management of Northern Shrimp stocks in the Estuary and Gulf of St. Lawrence (SFA 8, 9, 10 and 12) for the 2018 fishing season. This advice shall include:

- Description of the biology of Gulf of St. Lawrence Northern shrimp and its distribution;
- A summary of oceanographic and ecosystem conditions in the Gulf;
- Analysis of commercial fishery data including landings, effort, catch per unit of effort and data from the commercial sampling program;
- Data analysis of the DFO research surveys in August in the estuary and northern Gulf.
- Update of the main stocks status indicator.
- A recommendation on harvest according to PA guidelines for the 2018 fishing season.
- Comment the outlook for stock abundance.
- Estimate by-catches (among others, Redfish, Turbot, Northern Cod and Capelin) during the directed fishery on Northern Shrimp.
- Identification and prioritization of research projects to be considered for the future.

Expected Publications

- CSAS Science Advisory Report on Estuary and Gulf of St. Lawrence shrimp.
- CSAS Research documents
- CSAS Proceedings summarizing discussions.

Participation

- Fisheries and Oceans Canada (DFO) (Science, and Ecosystems and Fisheries Management sectors)
- Fishing industry
- Provincial representatives
- Aboriginal Communities / Organizations

APPENDIX 2 – LIST OF PARTICIPANTS

Name	Affiliation
Beauchamps, Brittany	DFO – Science / Ottawa
Belley, Raynald	DFO – Science
Benoit, Hugues	DFO – Science
Bourdages, Hugo	DFO – Science
Brassard, Claude	DFO – Science
Brosset, Pablo	DFO – Science
Brulotte, Sylvie	DFO – Science
Bruneau, Benoît	DFO – Science
Chabot, Denis	DFO – Science
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Smith, Andrew	DFO – Science
Von Beveren, Elisabeth	DFO – Science
Weiner, Guy Pascal	Malécites Viger

APPENDIX 3 – STRATEGIC RESEARCH PLAN

DFO's contribution to the Northern Shrimp strategic research plan

Topic A. Shrimp productivity and sustainable harvesting

Sub-topic A1. The abundance of shrimp stocks in the Estuary and Gulf

- Status assessment of shrimp stocks by continued monitoring activities intended to calculate stock status indicators and determine the appropriate fishery catch shares consistent with the precautionary approach adopted in 2012 – DFO (Core Program)

Sub-topic A2. The trophic relationships between shrimp and its predators

- Description of the general structure, the trophic interactions and the effects of predation on vertebrate and invertebrate communities of the ecosystem by a mass-balance model using inverse methodology for the Estuary and northern Gulf of St. Lawrence for the period of 2011 to 2014 – DFO (Core Program) - C. Savenkoff et al.

Sub-topic A3. Environmental factors influencing shrimp productivity

- Status assessment of the physical and biochemical oceanographic environment of the Gulf of St. Lawrence by continuing the Atlantic Zone Monitoring Program to detect, monitor and foresee changes in productivity and marine environment status – DFO (Core Program)
- Vulnerability assessment of key commercial species (species selected based on their role in Northern Shrimp–Greenland Halibut trophic interactions) to climate change – DFO (Aquatic Climate Change Adaptation Services Program, 2013–2016). – C. Savenkoff, H. Bourdages, P. Galbraith, R. Larocque, M. Castonguay, J. Chassé, S. Dumont and D. Lemelin, S. Vaz (IFREMER, France).
- Assessment of synergic effects of various environmental stressors combined with acidification on the physiology, growth and survival of invertebrates that are harvested commercially in the St. Lawrence – DFO (Strategic Program for Ecosystem-Based Research and Advice 2014–2017) – D. Chabot and M. Starr.
- Linking physiology to biogeography of Northern shrimp to facilitate adaptation to climate change – DFO (Strategic Program for Ecosystem-Based Research and Advice 2017-2020) - D. Chabot, P. Caliso (UQAR) et al.

Topic B. The impacts of the fishery on the ecosystem

Sub-topic B1. Vulnerable benthic habitats and communities

- Study of the distribution, spatial structure, reproduction, ecosystem function and vulnerability to trawling of sea pen fields in the Gulf of St. Lawrence in support of the "Eastern Canadian Coral and Sponge Conservation Strategy" – DFO (Strategic Program for Ecosystem-Based Research and Advice 2014–2017) – B. Sainte-Marie, H. Bourdages, C. Couillard, R. Larocque, C. Savenkoff, M. Ouellet, G. H. Tremblay, S. Cadieux.

Sub-topic B2. Species not targeted by the fishery

- Assessment of the significance of shrimpers' bycatch by analyzing data from the At-Sea Observer Program activity monitoring – DFO (Core Program)

- Groundfish return in the Estuary and Gulf of St. Lawrence. Partnership Fund, 2017-2020.
  DFO - Yvan Lambert, Hugo Bourdages, Hughes Benoît, Denis Chabot, Daniel Duplisea, Marie-Julie Roux, Claude Savenkoff , …
  RAQ (Ressources Aquatiques Québec) – Céline Audet, Dominique Robert, Steve Plante, Pascal Sirois , Louis Bernatchez, …