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Proceedings of the regional advisory meeting of the assessment of Estuary and Gulf of St. Lawrence northern shrimp stocks

January 27–28, 2022
Virtual meeting

Chairperson: Stéphane Plourde
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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 outlines the proceedings of the regional peer review meeting on the assessment of the Estuary and northern Gulf of St. Lawrence northern shrimp stocks. This meeting, which was held via Zoom platform (virtual meeting), on January 27-28, 2022, brought together more than 60 participants from science, academia, industry and management. 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 January 27-28, 2022 via the Zoom platform (virtual meeting), on the assessment of the Estuary and Gulf of St. Lawrence northern shrimp stocks.

The objective of the meeting was to determine whether there were any changes in the resource's status and whether management plans need to be adjusted based on the chosen conservation approach, with the ultimate goal being to provide a science advisory report on the management of Estuary and Gulf of St. Lawrence northern shrimp stocks for the 2022 and 2023 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 chairperson Stéphane Plourde welcomed the participants. He went over the scientific review's objectives and agenda as well as the role of the participants. After the participants introduced themselves, the biologist in charge of the review, Hugo Bourdages, highlighted the contributions of his collaborators. He outlined the Terms of Reference and summary of the 2020 science advisory report, stating that the conditions that seem to be causing the northern shrimp's decline, notably deep-water warming and redfish predation, are not expected to improve in the short term. In addition, the low abundance of males observed in recent years, combined with the downward trend in the size of females, point to low stock productivity.

A synopsis of the fishery management measures was given. There are four fishing areas (Estuary, Sept-Îles, Anticosti and Esquiman) and 114 licences (five provinces and seven First Nations). Each area is subject to catch monitoring through the application of a Total Allowable Catch (TAC). A reminder of the species' life cycle allows its development stages to be situated in relation to the harvesting periods and the temperature profile at depth. The data used in the assessment come from the commercial fishery (1982–2021) and the DFO research survey (1990–2021).

ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

Environmental and ecosystem considerations were presented before any details of the assessment were given. Peter Galbraith presented a summary of the temperatures observed in the three layers of water (surface, cold intermediate and deep layers) in the Gulf of St. Lawrence. Over the last few decades, deep-water temperatures have risen throughout the Gulf. In 2021, the temperatures at depths of 150 m, 200 m, 250 m and 300 m were the highest ever recorded since measurements began in 1915. The area of seabed covered by water warmer than 6 °C has increased across the Estuary and the northern Gulf of St. Lawrence. The

cold intermediate layer (CIL) was much warmer in August 2021 than in August 2020, with temperature values the highest recorded in the modern conductivity-temperature-depth (CTD) data. The Anticosti and Esquiman stocks experience warmer water at depths of 200 m and 250 m than the Sept-Îles and Estuary stocks. However, at depths of 150 m, the opposite is observed: the waters in the Anticosti and Esquiman areas are colder at this depth, due to the fact that the CIL in these regions is colder than in the Sept-Îles and Estuary areas.

Ella Guscelli's presentation focused on the biological responses of northern shrimp in the St. Lawrence Estuary to cumulative global changes, including an increase in temperatures and a reduction in pH and dissolved oxygen. The species' probability of survival and metabolic rate were examined in relation to the changes in these three environmental factors projected for 2100. When cumulative environmental changes are considered, the controlling effect of temperature and the limiting effect of dissolved oxygen on shrimp biology can be observed. On the basis of the data used in the study, survival probability drops to 40% and survivors' potential biological performance, to 40%, when shrimp are exposed to a combination of high temperatures (10 °C), low pH (7.40) and low dissolved oxygen (35% air saturation). A decline in the species' abundance could occur as a result. In addition, a decrease in the energy available for such activities as growth and reproduction could affect shrimps' size as well as their reproduction and distribution. Dissolved oxygen levels lower than those considered in the study have been observed in the Estuary (around 15% saturation) and at the heads of channels. It was also noted that the deep-water warming observed could increase shrimps' metabolism, leading to greater oxygen consumption requirements for survival.

Audrey Bourret presented the preliminary results of a study aiming to characterize the population structure and metabolic response of northern shrimp using genomics. The objectives of the study were to analyze fine-scale population structure using neutral and putative adaptive markers, to determine the genes involved in the species' metabolic response to temperature and to enhance the understanding of shrimp migratory movements using biophysical models (forthcoming). At a broad scale, two major groups were identified: (1) Flemish Cap and (2) Continental Shelf. The Continental Shelf group can be subdivided into two additional groups: (1) Arctic + Newfoundland + Gulf of St. Lawrence and (2) Scotian Shelf. Fine-scale work is underway on Gulf of St. Lawrence shrimp. It was noted that exchanges between regions may be occurring at different temporal scales. Christelle Leung presented work on the responses of individuals from three regions (Estuary, Nova Scotia and Newfoundland) to temperature changes. The preliminary results indicate that the level of gene expression is correlated with shrimps' environment of origin rather than with genetic variation. A gradual decrease (or increase) in the expression of genes associated with cellular functions was observed as a function of temperature. It was noted that environmental conditions influence the phenotype of adult individuals (cell structure).

Hugo Bourdages then discussed the northern shrimp's adaptation to environmental changes. The northern shrimp is a cold-water species. In recent years, deep-water warming and oxygen depletion have affected the distribution of the species, which is currently experiencing extreme environmental conditions. Northward migratory movements by shrimp—or even between the different stocks—to adapt to these changes were not observed. Instead, shrimp migrated locally to find more suitable conditions. These changes vary from region to region. In the Estuary, shrimp were observed to migrate from deeper waters to shallower waters to reach the CIL, with its colder and more oxygenated waters. In Sept-Îles and Anticosti, this migration involved shorter distances while, in the Esquiman area, no substantial depth-based changes in distribution were observed even though the waters are warming and oxygen levels are declining. Participants wondered whether another factor (bottom substrate, different genetics, individual size) could limit the species' response in Esquiman. In general, realized shrimp

habitat has been decreasing, particularly in the Estuary and, to a lesser degree, in Sept-Îles and Anticosti. The resulting concentrations of individuals make the species more vulnerable to predation and to the fishery and its impacts. The link between shrimp distribution and feeding was discussed, but few studies specifically address this topic.

It was further noted that water temperatures influence the development time of the eggs, which the females carry under their abdomen, and that spring hatching must be synchronized with the phytoplankton bloom to ensure high larval survival. However, warming waters and an earlier phytoplankton bloom have been observed. Since the eggs develop faster in warm water, it was postulated that shrimp would adjust the timing of maturation and spawning to ensure adequate synchronization with the phytoplankton bloom.

Changes in the ecosystem were also observed, notably an increase in deepwater redfish (*Sebastes mentella*). Redfish predation of shrimp, which increases with redfish size, appears to be a key factor in the northern shrimp's decline. The spatial overlap between the two species in summer is well known, but less certain in the other seasons. As redfish size increases, this overlap is expected to decrease. The Greenland halibut is also a predator of shrimp but is decreasing in abundance. It was noted that squid, observed in greater numbers since 2017 in the research survey, may also be a fairly important predator of shrimp.

We conclude this section by reiterating that major changes in environmental and ecosystem conditions have been observed in the Gulf of St. Lawrence. Deep waters have been warming and redfish abundance is increasing. These changes can affect the dynamics of the shrimp population through their effects on such factors as spatial distribution, growth, reproduction and trophic relationships.

COMMERCIAL FISHERY

For each area, Bourdages presented the commercial fishery indicators (landings, effort, catch per unit effort [CPUE], distribution of effort based on data from logbooks and VMS data, length frequencies, and number per unit effort (NPUE). In 2020 and 2021, preliminary landings for all the shrimp fishing areas totalled 17,845 t and 17,217 t respectively against a TAC of 17,999 t. In the past four years, the male and female NPUEs in the commercial fishery have declined in the Estuary, remained stable in Esquiman and increased in Sept-Îles and Anticosti, and are comparable to or greater than the time series average.

- It was noted that the research survey and commercial fishery do not target the same portion of the population, which partly explains the discrepancies in the data from these two sources.
- In addition, the fact that CPUE values were maintained could be related to shrimp concentrations—which make shrimp more vulnerable to the fishery—as well as to highly efficient fishing methods.
- In 2021, according to industry representatives, the numerous redfish present obstructed the Nordmore grate used in the fishery, making the fishing gear less effective.

RESEARCH SURVEY

Bourdages presented the indicators from the DFO research survey (distribution; biomass; abundance of females, males and juveniles; length frequencies). Since 2008, the research survey has shown a decreasing trend in the area in which northern shrimp are concentrated. This minimum area declined from over 50,000 km² to less than 30,000 km². Since 2012, the area of the zone trawled by the commercial fishery has also decreased, from 15,000 km² to 10,000 km². The survey data show downward trends in male and female abundance since

2005, with the estimated values for 2020 and 2021 among the lowest in the time series. The low abundance of juveniles and males observed in recent years, combined with the downward trend in the size of females, point to lower stock productivity.

- It was noted that high redfish abundance did not prevent the adequate monitoring of the shrimp population.
- Catchability in the survey probably remained the same, despite shrimp migratory movements in the water column due to water warming or in response to the presence of redfish. The survey takes account of shrimp migratory movements and distribution changes by sampling all the area occupied by each stock.

EXPLOITATION RATE

The exploitation rate index is obtained by dividing commercial catches (in numbers of shrimp) by the abundance value estimated from the research survey. Exploitation rates in the Sept-Îles, Anticosti and Esquiman areas have trended upward since 2003, with values higher than the reference period average (1990–2010). The exploitation rate in the Estuary has been variable since 2016, and the 2021 value is lower than the average (2008–2021).

- This method does not allow the absolute exploitation rate to be estimated or the index to be related to the target exploitation rates, but does make it possible to track relative changes over the years.
- Questions were raised about how changes in the TAC could affect the exploitation rate.

PRECAUTIONARY APPROACH

The precautionary approach (PA) for the Estuary and Gulf of St. Lawrence northern shrimp stocks was adopted in 2012 in accordance with the Fishery Decision-making Framework Incorporating the Precautionary Approach. The methodology used to apply the PA was summarized for participants. The main stock status indicator used in this approach declined slightly in the four fishing areas in 2021, with indicator values very close to the upper stock reference point. The Estuary, Anticosti and Esquiman stocks were in the healthy zone, while the Sept-Îles stock was in the cautious zone. In accordance with the guidelines established for the PA, projected removals (harvest levels) for 2022 were 558 t for the Estuary, 6,242 t for Sept-Îles, 5,424 t for Anticosti and 5,079 t for Esquiman.

In recent years, a discrepancy has been observed between the fishery indices and the DFO research survey indices. Although shrimp abundance indices have reached historic lows, the commercial fishery has been able to maintain the NPUE at around average levels. This discrepancy suggests that the main stock status indicator is currently overestimated due to the fact that these two information sources are given equal weight.

- It was noted that the discrepancy between the two indices widened when the stock began to decline due to an environmental change at the end of the 2000s. Subsequently, the maintenance of NPUE values in the fishery introduced an upward bias in the main indicator.
- Several participants maintained that the main indicator no longer adequately represented the stock's status.
- It was also pointed out that using numbers of shrimp rather than weight introduced a second source of bias in the PA. In the case of the decrease in the size of females, the current indicator is biased upward.

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- In addition, given the considerable variability in the Estuary, it is difficult to draw conclusions on the status of the stock in that area.
 - Although improvements in fishing methods mainly date back five or six or more years, it was the cumulative improvements since 1980 that were deemed to be significant. In addition, shrimpers' behaviour (i.e. fishing methods) was characterized as being very efficient.
 - In summary, the 2020–2021 average can no longer be compared to the reference period average (1990–2010), due to environmental changes unfavourable to shrimp (increased predation, higher deep-water temperatures), along with the decrease in the species' distribution, decline in female size, maintenance of NPUE values and higher exploitation rate. The indicator is currently overestimated and must be reviewed.

COMPLEMENTARY WORK TO ADJUST THE PRECAUTIONARY APPROACH

Work had been undertaken to formulate equivalent risk-based science advice. Marie-Julie Roux reminded participants that we were currently operating outside the environmental conditions found when the reference points and harvest control rule were defined for the PA.

Consequently, the removals determined using the existing PA were associated with an increased risk of undesirable biological and ecological consequences to shrimp stocks. In this context, we could either provide science advice that did not take account of the increased risk to shrimp stocks and the ecosystem (the status quo) or adopt an interim approach to maintain what is considered an acceptable level of risk. The latter approach would enable us to mobilize the available knowledge and information in order to adjust the science advice right away using a statistical, empirical or risk-related approach. The difference was in the proportion of uncertainty that was quantified or not in the assessment. An adjustment factor would be used and two options were available: an adjustment factor proportional to a score for the species' sensitivity to temperature or an adjustment factor proportional to the exposure to increased temperatures in each fishing area. The projected removals under each option were presented and compared to the projected removals under the PA.

- Some industry members expressed their disagreement with the use of temperature exclusively to adjust the science advice because other factors influence shrimp productivity, particularly high redfish abundance. DFO Science reiterated that, currently, these two factors were positively correlated.
- Some industry members were particularly concerned about the proposed approach for formulating the science advice, which involved reducing removals when the sum of evidence suggested that environmental conditions were unfavourable to the resource—in their view, this came out of nowhere.
- Therefore, a certain amount of discontent was noted among meeting participants, particularly industry members.
- Participants were reminded that this was an interim measure, to be used to adjust the science advice and removals in order to incorporate an equivalent risk in the management of the stocks until a new PA could be presented (possibly in 2024). Participants were told that a working group was currently reviewing the PA.
- Nevertheless, there seemed to be a consensus on the overall status of the Estuary and Gulf of St. Lawrence northern shrimp stocks.

ADDITIONAL INFORMATION: FISHING AREA CLOSURES AND BYCATCH

The fishing effort and the areas closed to protect corals and sponges did not overlap. The main bycatch species in the shrimp fishery are Greenland halibut, redfish, Atlantic cod, capelin, witch flounder, American plaice and Atlantic halibut. This bycatch makes up less than 3% of the northern shrimp catch. The proportions of Atlantic cod and American plaice have decreased, while those of redfish, Greenland halibut and witch flounder have increased.

- Participants wondered about the impact of warming on Greenland halibut, since it was a predator of northern shrimp. This topic would be addressed in the assessment of this species.

CONCLUSION

SUMMARY

The highlights were presented, and the participants commented on them. Clarifications were provided and some points were restructured.

- In the first key point on landings and the TAC in 2020 and 2021, the values provided needed to be updated, particularly in relation to the comment made on Esquiman (partial data).
- Regarding the key point on CPUE, it was decided that the comparison to the historical average should remain.
- The key point on the survey should refer to the “minimum” area. The following sentence should be removed: “This decrease was also observed in the commercial fishery.”
- It was suggested that the word “abundance” rather than “biomass” be used and “NPUE” rather than “CPUE.”
- Regarding the estimates of male and female abundance in 2020 and 2021, it was agreed that it should be stated that they were among the lowest values in the time series.
- The order of the key points was reviewed and modified in order to properly introduce the discrepancy between the two indicators (fishery and survey) and the uncertainty associated with the NPUE values.
- In the key point addressing this discrepancy, the participants agreed that it should state that harvesters had managed to maintain NPUEs at average levels at a time when shrimp abundance had reached historic lows. It should also be mentioned that this discrepancy suggests that the stock status indicator is currently overestimated due to the fact that both sources of information are given equal weight. This bullet point also allows the second-to-last bullet point to be eliminated. The term “hyperstability” should be avoided.
- For the exploitation rates in the Sept-Îles, Anticosti and Esquiman areas, the upward trend should be mentioned, specifying that this has occurred since 2003, and that rates are higher than the reference period average (1990–2010). Concerning the exploitation rate in the Estuary in 2021, it was agreed that the text should read that the rate has been variable since 2016 and lower than the average (2008–2021).
- Regarding the low abundance of juveniles and males observed in recent years and the downward trend in female size, the key point should state that this suggests lower stock productivity.

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- The key point on the main ecosystem conditions (deep-water warming, increased redfish predation) contributing to the species' decline and the fact that they will likely not improve in the short or medium term must be revised.
 - A long discussion followed on how the science advice should be worded in this peer review, given the reservations expressed about the PA (e.g. ecosystem has changed, maintenance of NPUE values) and the concerns raised over the use of the proposed interim method for adjusting the science advice. Participants were reminded of the peer review objective of facilitating discussion.
 - There was a consensus that the PA was no longer applicable or workable. Therefore, providing science advice with precise removal levels would likely be difficult. We are required by law to use the PA. However, because of the current situation and the increased risk involved, a great deal of caution must be exercised.
 - It was suggested that the text refer to the table, on which there seemed to be a consensus regarding the observations, anticipated consequences and risks. Given the unease expressed, the issue was how far to go in terms of the adjustment method.
 - It was not easy to reach a consensus on how the science advice should be worded since a number of participants seemed to be unfamiliar with the elements presented.
 - It was decided that the highlights on the PA results should be retained (projected removals, fishing areas).
 - However, the science advice must emphasize the increased risk to the sustainability of stocks associated with the bias in the main indicator, high exploitation rate, increased predation, higher deep-water temperatures and decrease in the species' distribution.
 - It was decided that the sentence suggesting that the projected removals be adjusted downward be removed, although some participants considered it to be justified.
 - Lastly, an agreement was reached on the following wording, which appeared to be acceptable to the meeting participants:

The sum of evidence (bias in the main stock status indicator, high exploitation rate, increased predation, higher deep-water temperatures and decrease in the species' distribution) demonstrates that we are currently working outside of the framework in which the precautionary approach was developed. This situation is increasing the risk to stock sustainability given the current decision rules.

The precautionary approach must be reviewed and updated between now and the next assessment.

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

Bourdages cited some recent publications¹ and briefly outlined DFO contributions as part of the Northern Shrimp strategic research plan (Appendix 3).

¹ Ouellette-Plante, J., Chabot, D., Nozères, C. and Bourdages, H. 2020. Diets of demersal fish from the CCGS Teleost ecosystemic surveys in the estuary and northern Gulf of St. Lawrence, August 2015-2017. Can. Tech. Rep. Fish. Aquat. Sci. 3383: v + 121 p.

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 16(2), e0239503.

Roux, M.-J., Duplisea, D.E., Hunter, K.L., and Rice, J. 2022. Consistent Risk Management in a Changing World: Risk Equivalence in Fisheries and Other Human Activities Affecting Marine Resources and Ecosystems. Front. Clim. 3. doi: 10.3389/fclim.2021.781559.

APPENDIX 1 – TERMS OF REFERENCE

Assessment of Estuary and Gulf of St. Lawrence Northern Shrimp Stocks

Regional Advisory Meeting – Quebec region

January 27-28, 2022

Virtual Meeting

Chairperson: Stéphane Plourde

Context

The Estuary and northern Gulf of St. Lawrence are divided in four shrimp fishing areas (SFA): Estuary (SFA 12), Sept-Îles (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 harvests based on the main stock status indicator and its position relative to the healthy, cautious and critical zone classifications.

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 2022 and 2023 fishing seasons. This advice shall include:

- Description of the biology of Gulf of St. Lawrence Northern shrimp and its distribution
- A review of population structure and responses to temperature changes of *Pandalus borealis* in the western Atlantic. The impact of these results for Gulf shrimp will also be discussed.
- A summary of oceanographic and ecosystem conditions in the Gulf
- Analysis of commercial fishery data including landings, effort, catch per unit 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 stock status indicator
- A recommendation on removals according to PA guidelines for the 2022 and 2023 fishing seasons
- Outlook for stock abundance
- Estimate bycatch during the directed Northern Shrimp fishery
- Identification and prioritization of research projects to be considered for the future

Expected Publications

- Science Advisory Report
- Research Document(s)

-
- Proceedings

Expected 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	Jan. 27	Jan. 28
Beaulieu, Jérôme	DFO – Fisheries Management	X	X
Bélanger, Michel	MAPAQ	X	X
Boudreau, Mathieu	DFO – Science	X	X
Bourdages, Hugo	DFO – Science	X	X
Bourdages, Yan	ACPG	X	X
Bourret, Audrey	DFO – Science	X	X
Bowlby, Heather	DFO – Science	X	-
Brassard, Claude	DFO – Science	X	X
Brown-Vuillemin, Sarah	UQAR	X	-
Brûlé, Caroline	DFO – Science	X	-
Bruneau, Benoît	DFO – Science	X	X
Cantin, Pierre	Fisher - Quebec	X	X
Carruthers, Erin	FFAW	X	X
Chabot, Denis	DFO – Science	X	X
Chamberland, Jean-Martin	DFO – Science	X	X
Chavaria, Caroline	DFO – Science	X	X
Couillard, Catherine	DFO – Science	X	X
Cyr, Charley	DFO – Science	X	X
Desgagnés, Mathieu	DFO – Science	-	X
Desjardins, Christine	DFO – Science	X	-
Dewland, Jennifer	PEIFA	X	X
Dubé, Sonia	DFO – Science	X	X
Duplisea, Daniel	DFO – Science	X	X
Duprey, Nick	DFO – Science	X	X
Dupuis, Dan	Fisher - Quebec	X	X
Dupuis, Vincent	Fisher - Quebec	-	X
Élément, Patrice	ACPG	X	X
Émond, Kim	DFO – Science	X	-
Galbraith, Peter	DFO – Science	X	X
Gianasi, Bruno	DFO – Science	X	X
Genge, Rendell	Fisher – NL	X	X
Grégoire, Benjamin	DFO – Science	X	-
Guscelli, Ella	UQAR	X	X
Isabel, Laurie	DFO – Science	X	X
Juillet, Cédric	DFO – Science	X	X
Lanteigne, Jean	ACAG - FRAPP	X	X
Leblanc, Léonard	Gulf Nova Scotia Fleet Planning Board	X	X
Leung, Christelle	DFO – Science	X	X
Loboda, Sarah	DFO – Science	X	-
Lussier, Jean-François	DFO – Science	X	X
MacPherson, Ian	PEIFA	X	X
Mallet, Pierre	DFO – Fisheries Management	X	X
Marquis, Marie-Claude	DFO – Science	X	X
Munro, Daniel	DFO – Science	X	-
Ouellette-Plante, Jordan	DFO – Science	X	X
Parent, Geneviève	DFO – Science	X	-
Pelletier, Claude	MAAP – NB	X	X
Plourde, Stéphane	DFO – Science	X	X
Puncher, Gregory	DFO – Science	X	X
Rondeau, Marie-Maude	DFO – Science	X	X
Roussel, Eda	ACAG – FRAPP	X	X

Name	Affiliation	Jan. 27	Jan. 28
Roux, Marie-Julie	DFO – Science	x	x
Rowsell, Nicole	Government of NL	x	-
Roy, Virginie	DFO – Science	-	x
Sainte-Marie, Bernard	DFO – Science	x	x
Sandt-Duguay, Emmanuel	AGHAMW	x	x
Senay, Caroline	DFO – Science	x	x
Sigouin, Éveline	DFO – Science	x	x
Small, Daniel	UQAR	x	x
Spingle, Jason	FFAW	x	x
Tamdrari, Hacène	DFO – Science	x	x
Thériault, Stéphane	ACAG	-	x
Tilley, Anna	Government of NL	x	x
Van Beveren, Élisabeth	DFO – Science	x	x
Weiner, Guy-Pascal	Wolastoqiyik Wahsepikuk First Nation	x	x
Watts, Taylor	Gulf Nova Scotia Fleet Planning Board	x	x

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

- Study of diets of the main groundfish - DFO (Core Program and Partnership Fund)
- Winter survey in the Laurentian channel and the northern gulf of St. Lawrence – DFO (C-68)

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)
- 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 2014–2023)
- Linking physiology to biogeography of Northern shrimp to facilitate adaptation to climate change – DFO (Strategic Program for Ecosystem-Based Research and Advice 2017-2023)
- PANOMICS: Integrating Genomics into Current and Future Spatial Management of Northern Shrimp along the Canadian Coast – DFO (Genomics Research and Development Initiative, 2019-2022)
- The Return of Groundfish to the Estuary and Northern Gulf of St. Lawrence – DFO (Partnerships Fund, 2017-2020)
- REDTANKS: understanding the environmental requirements and shrimp consumption of the redfish (*Sebastes* spp.) using tank experiments – DFO (Results Fund, 2019-2021)
- Ecosystem Approach, Shrimp Pilot Project – DFO (2019-2021)

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)

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)