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Proceedings for the regional peer-review meeting on Science Advice on Limit Reference Points for Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Western and Eastern Assessment Zones

Meeting dates: May 12–13, 2020

Location: Virtual Meeting

Chairperson: David Boguski

Editors: Jessica Mai and Chelsey Lumb

Freshwater Institute
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, Manitoba R3T 2N6

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 Canadian Science Advisory Secretariat (CSAS) regional peer-review meeting was held on May 12–13, 2020 via Teleconference/WebEx to establish Limit Reference Points (LRPs) for the Precautionary Approach (PA) framework for the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ) Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) fisheries. The objectives of the meeting were to establish new LRPs for Northern and Striped shrimp in the WAZ, update existing LRPs for Northern and Striped shrimp in the EAZ, and propose Upper Stock Reference points (USRs) for both fisheries in the WAZ and EAZ. LRPs are established by Fisheries and Oceans Canada (DFO) Science sector and are reference points required by DFO Resource Management to establish the USRs and the harvest control rules (HCRs) in consultation with Science, co-management partners, provincial and territorial governments, and industry.

The existing LRPs for the EAZ are based on 30% of the mean spawning stock biomass (SSB) index for Northern and Striped shrimp. LRPs for the WAZ have not been previously established due to changes in survey conditions, which reset the data series. Discussions during the meeting focused on establishing LRPs in the WAZ and updating the LRPs in the EAZ. Discussions emphasized the relatively short time series of data currently available, fluctuations in stock biomass, recovery potential, and a lack of environmental and biological data contributing to the understanding of shrimp productivity. These factors, in concert with guidance from DFO's PA policy, support the use of LRPs of 40% of the mean SSB for the EAZ and WAZ and provide a more precautionary approach to support sustainability based on the best available scientific information.

The meeting included participants from regional and national DFO Science and Resource Management sectors, Nunavik Marine Region Wildlife Board, Nunavut Wildlife Management Board, and Concordia University. This report summarizes the relevant discussions from the meeting and presents recommended revisions to be made to the associated research document. The Proceedings, Research Document, and Science Advisory Report (SAR) resulting from this science advisory meeting will be published on the [DFO Canadian Science Advisory Secretariat \(CSAS\) website](#).

INTRODUCTION

Fisheries and Oceans Canada (DFO) Resource Management has requested DFO Science to establish a Limit Reference Point (LRP) consistent with the Precautionary Approach (PA) framework for both Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in the Western Assessment Zone (WAZ) and the Eastern Assessment Zone (EAZ). The objectives of the meeting were to establish new LRPs for Northern and Striped shrimp in the WAZ, update existing LRPs for Northern and Striped shrimp in the EAZ, and propose Upper Stock Reference Points (USRs) for both shrimp fisheries in the WAZ and EAZ (Appendix 1). LRPs are established by DFO Science and are reference points required by DFO Resource Management to develop the USR and the harvest control rules (HCRs), in consultation with Science, co-management partners, provincial and territorial governments, and industry.

The Canadian Science Advisory Secretariat (CSAS) regional peer-review meeting was held on May 12–13, 2020 via Teleconference and WebEx and generally followed the agenda in Appendix 2. Participants included staff from regional and national DFO Science and Resource Management, the Nunavik Marine Region Wildlife Board, Nunavut Wildlife Management Board, and Concordia University (Appendix 3).

OPENING DISCUSSION

The Chair welcomed participants to the meeting and reviewed the Terms of Reference (Appendix 1) and objectives of the meeting. A draft working paper was circulated to participants prior to the meeting for review and comments. Comments were compiled from the reviewers and used to guide discussions and ensure all participants' questions and/or concerns were addressed. If accepted, the working paper would be updated and published as a CSAS Research Document to support the final conclusions and advice resulting from this review in the CSAS Science Advisory Report (SAR).

Participants were reminded that everyone at the meeting was expected to participate and to contribute fully to the discussions over the next two meeting days. Participants were encouraged to ask questions and raise concerns during the meeting. Jessica Mai and Chelsey Lumb (DFO Science) were identified as the rapporteurs for the meeting and participants were reminded to speak slowly and clearly in order to accurately document the discussions. The Proceedings, Research Document, and SAR resulting from this science advisory meeting will be published on the [DFO Canadian Science Advisory Secretariat \(CSAS\) website](#).

PRESENTATIONS

REQUEST FOR PEER REVIEWED SCIENCE INFORMATION AND ADVICE

Presenter: Courtney D'Aoust

DFO Science was requested by DFO Resource Management (National Capital Region) to provide advice to establish LRPs consistent with the PA framework. The CSAS regional peer-review meeting was held to: establish new LRPs for Northern and Striped shrimp in the WAZ, update existing LRPs for Northern and Striped shrimp in the EAZ, and propose USRs for both fisheries in the WAZ and the EAZ. LRPs are required, as per DFO's PA framework, in order to manage fisheries based on the best available science in setting Total Allowable Catches (TACs) and developing harvest control rules (HCRs) for these stocks. LRPs are established by DFO Science. USRs and HCRs are then established by Resource Management, in consultation with Science, co-management partners, provincial and territorial governments, and industry. The

establishment of LRPs and HCRs are required to maintain Marine Stewardship Counsel (MSC) certification for shrimp stocks in the WAZ. The WAZ is entirely within the Nunavut Settlement Area and Nunavik Marine Region. The information will also be used for the evergreen Northern Shrimp Integrated Fisheries Management Plan (IFMP).

There were no questions or comments following the presentation.

INFORMATION IN SUPPORT OF THE ESTABLISHMENT OF THE PRECAUTIONARY APPROACH FRAMEWORK FOR NORTHERN SHRIMP (*PANDALUS BOREALIS*) AND STRIPED SHRIMP (*PANDALUS MONTAGUI*) STOCKS IN THE WESTERN ASSESSMENT ZONE AND UPDATING THE EXISTING LIMIT REFERENCE POINTS FOR THE EASTERN ASSESSMENT ZONES

Presenter: Wojciech Walkusz

The PA is a general philosophy used to manage threats of serious or irreversible harm where there is scientific uncertainty. The PA provides options for the stock to be in one of three zones: Critical, Cautious, or Healthy. These zones are delineated by an LRP and a USR. The USR divides the Healthy and Cautious Zones; it is the stock level threshold below which the removal rate is reduced (DFO 2006). The LRP is the stock level below which productivity is sufficiently impaired to cause serious harm (Critical Zone) to the resource but above the level where the risk of extinction becomes a concern. DFO has committed to implementing a PA framework in the management of Northern and Striped shrimp fisheries in the WAZ and to updating the existing LRPs in the EAZ.

Northern and Striped shrimp are protandrous hermaphrodites, beginning life as males for the first three years and then becoming mature females for the remainder of their lives. Shrimp have a pelagic larval stage, spending three to four months passive in the water column, which can lead to large dispersal distances. Northern Shrimp are found in the Northwest Atlantic from Baffin Bay in the north to the Gulf of Maine in the south. Striped Shrimp are found from Davis Strait in the north to the Bay of Fundy in the south. Shrimp are considered harvestable once their carapace length (CL) exceeds 17 mm, which occurs at approximately three years of age. Therefore, most of the fishable biomass consists of females. Both species are believed to feed on zooplankton and dead organic matter that is deposited on the bottom (carrion), thus playing an important role in energy transfer. Northern and Striped shrimp are important prey items for several species (Atlantic Cod [*Gadus morhua*], Greenland Halibut [*Reinhardtius hippoglossoides*], Harp Seals [*Phoca groenlandica*]), particularly when the availability of high-energy prey fish is low.

Data were collected annually through the joint DFO-Northern Shrimp Research Foundation (NSRF) shrimp survey conducted in the WAZ (2014 to 2019) and the EAZ (2009 to 2019). Three biomass indices were calculated: total biomass (all individuals collected in a catch, regardless of size), fishable biomass (all individuals, regardless of sex, greater than 17 mm CL), and female spawning stock biomass (SSB; all females in the catch). Total and fishable biomass indices are used to set the TAC, and SSB is used for the PA framework.

The commercial fisheries usually take place from July to November each year. The TAC is set annually, through a consultative process, based on the previous year's assessment. Stocks in the WAZ are co-managed with the Nunavut Wildlife Management Board and Nunavik Marine Regional Wildlife Board. In the WAZ, Northern Shrimp are a bycatch species, with Striped Shrimp being the primary targeted stock. In the EAZ, Striped Shrimp are bycatch and Northern Shrimp are the targeted stock.

Existing PA reference points for EAZ shrimp were based on a relatively short data series of three years (2006 to 2008) and were developed for Shrimp Fishing Area (SFA) 2, not for the geographic area of the EAZ. Now that eleven years of data are available, there is sufficient survey data to update the reference points. Reference points have not been established for the WAZ before due to substantial changes in the survey conditions, which reset the data series. However, sufficient survey data is now available (2014–2019) to establish a PA framework. Northern and Striped shrimp stocks in the EAZ and WAZ exhibit relatively large interannual biomass variability. It is suspected that there is only one population of Northern Shrimp and one population of Striped Shrimp inhabiting both assessment zones. LRPs based on 30% of the geometric mean of SSB and USRs based on 80% of the geometric mean of SSB were presented for the four shrimp stocks.

DISCUSSION

The draft working paper was sent to participants prior to the meeting for their review and comments. Comments were compiled from reviews and discussed during the meeting.

A participant asked about the effects of the proposed LRP updates on managing the shrimp stocks. The proposed LRP updates would shift the reference points to be more precautionary, so action would be taken sooner if biomass decreases. The same participant noted that there appear to be similar biomass patterns among the four shrimp stocks and wondered if it may be due to a similar general underlying ecological process or due to sampling efficiency. The author suggested that there may be large-scale habitat effects influencing biomass, such as reduction in habitat due to temperature change or lower stock production.

It was noted that the proposed reference points are acceptable as short-term proxies. The proposed LRPs were developed using an approach similar to those used in Newfoundland and Labrador (NL) Region. However, in recent years there have been internal concerns that the DFO PA policy was not followed in the NL Region PA and may be ineffective. A participant suggested moving towards incorporating environmental parameters rather than only stock indices and using more of a modeling approach to assess stocks. The current survey was designed to assess shrimp stocks only; it is not a multi-species survey. The only environmental data currently available are water temperature and salinity. DFO is working with partners to develop a multi-species survey, independent of the shrimp assessment survey, to better understand environmental and biological factors that influence shrimp stocks. Environmental conditions that influence shrimp biomass and growth are not available. There was agreement that the proposed LRPs may be used in the short-term, until new data become available to update the reference points. However, the term “proxy” should not be used when referring to the LRPs as it remains unclear how long it may take to update them. A participant noted that the working paper did not indicate that the proposed reference points are for short-term use but supports the use of the proposed LRPs for temporary purposes, until more information becomes available.

Predator Sampling

A participant found that in NL predator densities were comparable between surveys. The participant wondered if the same type of predator information (e.g., Atlantic Cod, Greenland Halibut) could be used from the NSRF surveys or other surveys to estimate predation. It was explained that the survey conducted by NSRF mainly assesses shrimp. Fish species are recorded as batch weights and size structure data are not collected. It was noted that the size of the predator is important in determining predation pressure. Stomach content analyses indicate certain fish size classes prey more on shrimp than others. In order to estimate predation pressure, predator size would be required. Another participant asked if the grate was used on

the trawl net during the NSRF survey. Since the grate is not used on the trawl net, the potential predators (e.g., Greenland Halibut) should be relatively well sampled regardless of their size distribution. The author noted that the main predators in the area are skates (*Raja* spp.), grenadiers (*Macrouridae*) and Greenland Halibut. Another participant asked if Arctic Cod (*Boreogadus saida*) affected shrimp stocks and noted they can be caught as bycatch in large quantities. Arctic Cod do not feed on mature shrimp but may prey on larval shrimp thus affecting recruitment. Larval shrimp have been found in Arctic Cod stomach contents. A participant suggested the author elaborate on these limitations in the working paper.

Selecting LRPs and Productive Biomass Periods

Participants asked questions regarding the appropriateness of using 30% of the geometric mean of SSB to select LRPs and whether they should be selected based on productive periods of time. A 30% LRP was used to develop the original PA framework for the EAZ based on the “*Proceedings of the Precautionary Approach Workshop on Canadian Shrimp and Prawn Stocks and Fisheries*” (DFO 2009b). At the workshop multiple approaches were discussed and it was decided 30% of biomass at maximum sustainable yield (B_{MSY}) was an acceptable rule. It also concluded that SSB over a productive period may be used as an appropriate proxy for B_{MSY} in Arctic shrimp fisheries. The Northwest Atlantic Fisheries Organization (NAFO) used 30% B_{MSY} to develop an LRP for Northern Shrimp in SFA 1. Also, NL Region developed their initial shrimp PA framework using an LRP defined as 30% of the geometric mean of the SSB index over a productive period.

The PA workshop on shrimp and prawns recommended that a PA framework be established during productive periods of the stock. However, with the limited amount of data (years) available for shrimp stocks in the WAZ and the EAZ, and the variability of the biomass indices over time, it is difficult to determine productivity. In NL Region, LRPs were developed based on a time period when shrimp stock biomass increased, which was considered a productive period, which justified 30% LRPs. However, the NL Region time series did not have the same fluctuation in biomass estimates as the Central and Arctic Region time series. The DFO PA policy (2009a) suggests the use of 40% of B_{MSY} (or a proxy) for LRPs in cases where insufficient stock-specific information is available to base reference points. There was a discussion about whether it is relevant to determine a productive period before establishing LRPs. There may be a period of high shrimp biomass but that may not mean an area is productive; shrimp could be transported from other areas. In the WAZ and the EAZ, there is currently no evidence that biomass has been sampled during a productive period, which should be indicated in the working paper. In the absence of a biomass model, the best approach would be to use the information available and to recommend future research possibilities.

A participant pointed out there is some evidence of Northern and Striped shrimp productivity since the stocks have been able to withstand exploitation rates above 10% in recent years. There was a discussion about the use of potential exploitation rate (TAC/fishable biomass) rather than relative exploitation rate (catch/fishable biomass) in the figures presented in the working paper. Exploitation rate is relative because the absolute biomass is unknown. The catchability of the trawl is unknown but is likely less than one. The actual exploitation rate of stocks is less than it appears to be because fishable biomass is larger than estimated from the survey. To know absolute exploitation rates, catchability of fishable biomass would have to be 100% (shrimp with CL bigger than 17mm), when calculating exploitation rates catchability of females is 100%. Therefore, it should be stated that relative exploitation rates were used and the catchability of the trawl is unknown. A participant added that using the word “index” in the presentation and working paper indicates exploitation rates are relative rather than absolute.

Biomass Calculations to Estimate Biomass at MSY

There was a concern from a participant about the calculation of B_{MSY} to determine the LRP. Currently the LRPs are calculated using the mean female SSB of all data points (years) for each stock. A participant referenced that in the “*Proceedings of the Precautionary Approach Workshop on Canadian Shrimp and Prawn Stocks and Fisheries*” (DFO 2009b) a few options were provided to calculate B_{MSY} when an estimate is not available. One option is using mean biomass over a productive period, which is not known in this case. Another option is using 50% of the maximum biomass as a proxy for B_{MSY} to calculate the LRP and USR. Participants were hesitant to use this option because of the variability observed in stock biomass and because stocks are heavily influenced by the environment and potential (not yet quantified) biomass exchange with neighboring areas. Using 50% maximum biomass may be more appropriate for fish stocks that have more stable biomass over time than do shrimp stocks.

Another participant suggested that since the shrimp survey occurs concurrently with the commercial fisheries, years with high exploitation rates may have artificially lower biomass estimates due to fishery removal. Rather than using the full time series to calculate mean SSB, they suggested omitting values from years when the exploitation rate is greater than 10% and using the remaining values to calculate mean SSB for the reference points. This would remove years with abnormal exploitation rates. This approach may be applied annually. This suggestion was discussed but not adopted by the group. A participant cautioned that Northern Shrimp can undergo large fluctuations in productivity in a short time so MSY may not be static.

Concerns with Changing LRP Values

A participant found a statement in the DFO PA policy (2009a) indicating that a 40% LRP aligned with international policy. By using 40% LRPs, it would allow DFO to react sooner if stocks were to decline, particularly in cases with limited biological and environmental data. There was a discussion about the merits of continuing with 30% LRPs rather than 40% LRPs. Changing the LRPs may lead to questions about the validity and application in other shrimp fisheries. Changing the LRP to 40% may retroactively result in past biomass values falling within the Cautious or Critical zones and a rebuilding plan may then be required. There was also concern that if LRPs changed from 30% to 40% there would be a relatively smaller (narrower) Cautious Zone. This may create a situation where there is less time for Management to react before the stock reaches the Critical Zone and could potentially require more changes in management approaches. The author agreed to recalculate the LRPs for both species, in both assessment zones, to show the differences between LRPs at 30% and 40% of the mean SSB, and 50% of maximum biomass. The author conducted this analysis in the evening and presented the findings on Day 2 (see “Justification for Change in LRP Calculation” section below).

It was clarified that LRPs are based on biological criteria and are established by DFO Science through a peer-review scientific process (DFO 2009a), whereas USRs and HCRs are developed by DFO Resource Management in consultation with Science and stakeholders. The Minister considers recommended USRs and HCRs and implements these components based on a holistic perspective. The role of participants at this meeting is to present the best available scientific information and advice for a sustainable fishery. The advice is not based on socio-economic considerations.

Survey Clarification

A participant asked about the size selectivity of the trawling gear used in the shrimp survey, as the total biomass and fishable biomass values were similar. The trawl net uses a mesh size of 12.7 mm; anything smaller goes through the mesh. The mesh size and gear are consistent with those used by commercial fishers. The participant asked if the catch composition consists

mainly of females and some males. The total biomass values consist of male and female shrimp, regardless of size. Fishable biomass includes all individuals greater than 17 mm CL, regardless of sex. SSB includes all female biomass.

A participant wondered why total exploitation rates were used rather than female exploitation rates because female SSB is used to assess stock status. The approach used for the WAZ and the EAZ is consistent with the approach used in NL Region. In the Maritimes Region, dockside sampling is conducted during the fishing season to establish stock composition (size composition and sex ratio), making it possible to estimate female exploitation rates. Stock composition data are not available for the WAZ and the EAZ. The TAC for each year is established using the previous year's assessment biomass estimates. It is assumed that biomass will not change in the next year when the TAC is set. In an ideal scenario, a spring survey would be conducted to determine biomass indices in the current year, which would allow for the most reliable TAC. However, considering the environmental conditions in the fishing ground (ice cover and short fishing time window), the only time to survey the stock is during the active fishing season. Shrimp in the WAZ and the EAZ are consistently fished every year, during the ice-free season (usually July to November). In the future, consideration of data on environmental conditions along with biological data is encouraged when determining LRPs.

A participant asked about the use of geometric means to calculate reference points rather than arithmetic means. Geometric means are generally used in PA frameworks to assess stock status. Arithmetic means have traditionally been used to assess trends.

Privacy Issues

A participant brought up a concern regarding the fact that some of the data presented may not meet privacy requirements. There was a discussion about whether the data presented sufficiently met the rule of three/five (number of commercial entities involved in the fishery that can allow for data disclosure). Although, the rule of five is encouraged whenever feasible, the rule of three has been used in publications and industry is aware of its use. It was decided that since the rule of three has been previously used in fisheries publications that it is not an issue at this time. A participant made a note to look into the rule for future shrimp assessments.

IFMP Review

It was generally agreed by all participants that the proposed reference points are for short-term use and should be updated when more information becomes available. No timeline was set to review the reference points, but it was agreed that regular reviews are necessary as new information becomes available. A participant asked about when the IFMP will be reviewed and updated. The IFMP for the WAZ and the EAZ is considered an evergreen document. If new reference points are developed, or if the Minister decides to change reference points the IFMP would be updated accordingly.

Justification for Change in LRP Calculation

The working paper author presented the calculations for LRPs that he prepared in the evening following the Day 1 meeting. Participants discussed using 30% or 40% of the mean SSB (proxy for B_{MSY}) over a given time series, or 50% of the maximum biomass (or mean of the top productive years) to calculate the LRPs in the WAZ and EAZ. New tables and figures were developed to compare the different LRP scenarios and to facilitate discussions during the meeting.

A participant clarified that NAFO uses a modeling approach to assess Northern Shrimp in SFA 1, which generates an estimate of B_{MSY} . The DFO (2009b) Workshop Proceedings, states that a 30% B_{MSY} is currently being used as a reference point by NAFO. Adopting a 30% LRP in the

Central and Arctic Region would be consistent with NAFO and how shrimp fisheries are managed in NL Region. However, the use of a 30% LRP is not fully supported because of the limited scientific information available for these particular stocks. Furthermore, an LRP of 40% of B_{MSY} is suggested by the DFO PA policy (DFO 2009b) in instances of data deficiency and uncertainty. Establishing LRPs based on 40% of the mean SSB (proxy for B_{MSY}) for the WAZ and the EAZ may be the best way forward based on the information available, recent decreases in stock productivity, and concerns about the use of 30% LRPs in other regions.

A participant wondered why 30% LRPs were still being considered. It was stated that other shrimp fisheries, such as those in SFA 4, 5, and 6, use 30% LRP. If 40% LRPs are used in the WAZ and the EAZ, which border SFA 4, the approach may be viewed as somewhat controversial by the stakeholders.

There was a discussion about the variability in Striped Shrimp biomass in the EAZ. A participant noted the biomass estimates bounce between the Critical and Cautious Zones and asked whether it could be related to survey estimates. Biomass variability may be related to habitat expansion/contraction or temperature variability, but the effects of these factors remain unknown. The variable distribution of shrimp result in occasional large catches and variable biomass estimates over time. Striped Shrimp were mainly caught as bycatch in the EAZ, where Northern Shrimp is the target species.

The discussion went on to justify using 40% LRPs over 30% LRPs. Other SFAs have longer data sets and can justify using 30% LRPs, while the WAZ and EAZ have shorter data sets, large fluctuations in biomass, and a lack of stock trends. Furthermore, the stocks in the WAZ and EAZ appear to recover from a 40% LRP, below which point recovery of the stocks are unknown. It was stated by participants that the development of LRPs should be based on science and should not be influenced by outside factors.

A participant noted that by changing the LRPs to 40%, the Cautious Zone appeared narrower. If DFO Resource Management is concerned about the size of the Cautious Zone, there is opportunity to review the USR and HCR with co-management partners and stakeholders in order to allow more time for management action/mitigation, as appropriate.

A participant asked if a stock were to enter the Critical Zone, whether the fishery would then close. Another participant noted that in the HCRs for the Exclusive Economic Zone, as per the IFMP, the fishery does not close if the stock enters the Critical Zone, but rather the exploitation rate is lowered. It was stated that there may be a single population of Northern Shrimp and Striped Shrimp moving between the WAZ and EAZ. The author pointed out that Striped Shrimp are the more targeted species in the WAZ and Northern Shrimp are the targeted species in the EAZ, which may balance the stock for each species. The TAC for Striped Shrimp in the EAZ has never been fully realized, so it has not driven the dynamics of stock biomass. A participant remarked that when the DFO PA policy guidance was first developed, the LRP was the stop-fishing point but it quickly evolved. No definitive answer was provided at the time. From further discussions (following the peer review meeting), it was noted that there are regional and fishery differences in the determination of the exploitation rate within a Critical Zone. A participant highlighted that insufficient stock-specific information, including a short time-series of data and poorly defined productivity levels, are important risk factors to consider in this fishery's ability to recover from a decision to continue exploitation at a lower rate.

A participant wondered why the female biomass was used in calculations, when the values are so variable, rather than total biomass; total biomass eventually becomes female biomass. It was explained, for shrimp, female biomass can be used as a proxy for B_{MSY} (DFO 2009b) and that NAFO calculates B_{MSY} based on female SSB. The Quebec Region combines male and female

biomass to predict the fishable biomass for the next season. They find that male biomass has been found to be a better predictor of fishable biomass for the next season.

When the PA framework for the EAZ was initially established using 30% LRPs, the reference points were based on three years of data, the geographic area of SFA 2, and a different survey range. It was recommended by a former DFO Biologist that the initial EAZ PA framework be revised as soon as possible. Now there are eleven years of data available but due to high variability and a lack of trends in the biomass, the stock behaviour is not necessarily better understood than when LRPs were first established. The participants noted the decision to use 40% LRPs would be a more precautionary and appropriate approach given the limitations of the data and the decline observed in other shrimp stocks. It was mentioned that other shrimp fisheries have moved towards a dynamic LRP, which follows the pattern of the stock. Since the WAZ and EAZ have limited biological and environmental information available for shrimp, the LRP remains fixed. The PA framework can be revised in the future when more data on variables affecting WAZ and EAZ shrimp stocks become available.

Species Identification Concerns

A participant flagged a potential identification issue for past and future shrimp surveys. Recently, the DFO Maritimes Region has identified *Dichelopandalus leptocerus* in their catch records. This species looks very similar to *Pandalus montagui*, with few discernable differences (e.g., number of spines on the head and angle of stripes). It is not known to what extent, if any, this species is found in the WAZ or EAZ, and if misidentification has occurred. *Dichelopandalus leptocerus* has not been observed in shrimp surveys for SFA 4, which borders the WAZ and the EAZ. Participants concluded that it is unlikely they are present in the WAZ or the EAZ at this time, but it was noted for future awareness.

SCIENCE ADVISORY REPORT REVIEW

Participants were asked to assist in drafting the contents of the “Summary” and “Sources of Uncertainty” sections in the SAR document. Participants were encouraged to participate in the discussions when forming the bullet points and the Chair regularly conducted a roundtable to ensure consensus. As a group, the participants reviewed and edited each bullet. All participants accepted the contents in the “Summary” and “Sources of Uncertainty” sections.

The existing LRPs for the EAZ have not been updated since 2009, despite the changes to the geographic extent of the shrimp fishing area, survey range, and availability of stock data. The working paper discussed throughout this meeting contrasts the existing and newly established LRPs for the WAZ and EAZ based on the best available scientific information. Discussions highlighted the lack of stock-specific information, the unknown stock recovery potential below 40% LRP, high variability in shrimp productivity, and insufficient information on the environmental and biological variables influencing shrimp productivity. Therefore, there was no strong opposition by participants in following the DFO PA policy guidelines in establishing LRPs based on 40% of the mean SSB (proxy for B_{MSY}) for Northern and Striped shrimp fisheries in the WAZ and EAZ. The proposed USRs remain at 80% of the mean SSB (proxy for B_{MSY}), as suggested by DFO PA policy but will be established by DFO Resource Management in consultation with Science, co-management partners, provincial and territorial governments, and industry.

The proposed reference points are based on the best available scientific information and constitute advice to Management for a sustainable shrimp fishery. Participants agreed the PA reference points for the WAZ and EAZ should be re-examined when a population model is

developed or relationships between stock productivity and environmental or ecosystem factors are sufficiently developed to inform stock assessments.

CONCLUDING REMARKS

The participants agreed the author will update the working paper to reflect the results of the meeting discussions and use the draft to fill in the context section of the CSAS SAR. Participants agreed that the working paper should be adopted as a CSAS Research Document and, with minor changes, the author can re-circulate the updated document to all participants for final review. The rapporteurs agreed to draft the CSAS Proceedings quickly to help the authors to finish the SAR and Research Document. All documents (i.e., SAR, Proceedings, Research Document) will be distributed to meeting participants and are considered confidential until published. The advice is time sensitive and needed for an upcoming meeting with DFO Resource Management, co-managers, and key stakeholders.

The Chair thanked everyone for their active participation at the meeting and the meeting was adjourned.

REFERENCES CITED

- DFO. 2006. [A Harvest Strategy Compliant with the Precautionary Approach](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023.
- DFO. 2009a. [A Fishery Decision-Making Framework Incorporating the Precautionary Approach](#) [online]. [accessed June 2020].
- DFO. 2009b. [Proceedings of the Precautionary Approach Workshop on Shrimp and Prawn Stocks and Fisheries; November 26-27, 2008](#). DFO Can. Sci. Advis. Sec. Proceed. Ser. 2008/031.

APPENDIX 1. TERMS OF REFERENCE

Science Advice on Limit Reference Points for Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Western and Eastern Assessment Zones

Regional Peer Review – Central & Arctic Region

May 12–13, 2020

Virtual meeting

Chairperson: Dave Boguski

Context

Fisheries and Oceans Canada (DFO) Resource Management has requested Science to establish a Limit Reference Point (LRP) consistent with the Precautionary Approach (PA) framework for both Northern Shrimp (*Pandalus montagui*) and Striped Shrimp (*P. borealis*) in order to determine the point below which serious harm may be occurring to the stock (i.e., the Critical Zone).

The LRP is required in order to manage fisheries based on the best available science in setting Total Allowable Catches (TACs) and to support the development of harvest control rules for these stocks to ensure the sustainability of the fishery. The LRP is established by DFO Science and is a required reference point so that the Upper Stock Reference Point (USR) and harvest decision rules can then be established by DFO Resource Management in consultation with co-management partners, provincial and territorial governments, industry, and DFO Science.

Since the reorganization of surveys conducted in the Central and Arctic Region in 2014, the joint DFO-Northern Shrimp Research Foundation survey has covered the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ) survey areas at the same time annually with the same ship and gear (DFO 2020). LRPs for the WAZ were developed in 2013, however, the restart of the time series means they are no longer valid (DFO 2018). Data points acquired since the new survey began will therefore be used to establish new reference points for the WAZ. Reference points will also be updated with the same proxies for the EAZ since the original points were calculated from only three surveys (Siferd 2015), which also no longer correspond to the assessment area boundaries (DFO 2019).

Objectives

The objectives of the peer-review are to:

- establish new LRPs for Northern and Striped shrimp in the WAZ;
- update existing LRPs for Northern and Striped shrimp in the EAZ; and,
- propose USRs for both fisheries in the WAZ and EAZ.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Expected Participation

- Fisheries and Oceans Canada (DFO) (Science and Resource Management sectors)

-
- Nunavut Wildlife Management Board
 - Nunavik Marine Region Wildlife Board
 - Academics
 - Other invited experts

References

- DFO. 2018. [Update of stock status indicators for Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Western and Eastern Assessment Zones, February 2018](#). DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/012.
- DFO. 2019. [Assessment of Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Eastern and Western Assessment Zones, February 2019](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/011.
- DFO. 2020. [Update of stock status indicators for Northern Shrimp, *Pandalus borealis*, and Striped Shrimp, *Pandalus montagui*, in the Western and Eastern Assessment Zones, January 2020](#). DFO Can. Sci. Advis. Sec. Sci. Resp. 2020/014. (Erratum: February 2020)
- Siferd, T.D. 2015. [2015 Assessment of Northern Shrimp \(*Pandalus borealis*\) and Striped Shrimp \(*Pandalus montagui*\) in the Eastern and Western Assessment Zones \(SFAs Nunavut, Nunavik and Davis Strait\)](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2015/010. v + 70 p.

APPENDIX 2. LIST OF PARTICIPANTS

| Name | Organization/Affiliation |
|---------------------------|-------------------------------------------------------|
| Christi Friesen | DFO – Fisheries Management, Central and Arctic Region |
| Courtney D'Aoust | DFO – Resource Management, National Capital Region |
| Chantelle Sawatzky | DFO – Science, Central and Arctic Region |
| David Boguski (Chair) | DFO – Science, Central and Arctic Region |
| Kevin Hedges | DFO – Science, Central and Arctic Region |
| Chelsey Lumb (Rapporteur) | DFO – Science, Central and Arctic Region |
| Jessica Mai (Rapporteur) | DFO – Science, Central and Arctic Region |
| Joclyn Paulic | DFO – Science, Central and Arctic Region |
| Justin Shead | DFO – Science, Central and Arctic Region |
| Ross Tallman | DFO – Science, Central and Arctic Region |
| Wojciech Walkusz | DFO – Science, Central and Arctic Region |
| Manon Cassista Da-Ros | DFO – Science, Maritimes Region |
| Brittany Beauchamp | DFO – Science, National Capital Region |
| Susan Thompson | DFO – Science, National Capital Region |
| Katherine Skanes | DFO – Science, Newfoundland and Labrador Region |
| Krista Baker | DFO – Science, Newfoundland and Labrador Region |
| Hugo Bourdages | DFO – Science, Quebec Region |
| Eric Pedersen | Concordia University – Biology |
| Frankie Jean-Gagnon | Nunavik Marine Region Wildlife Board |
| Amber Giles | Nunavut Wildlife Management Board |

APPENDIX 3. MEETING AGENDA

Science Advice to Establish Limit Reference Points for Northern and Striped shrimp fisheries in the Western and Eastern Assessment Zones

CSAS Peer Review Meeting Agenda

Chair: David Boguski, DFO Science

Rapporteurs : Jessica Mai and Chelsey Lumb, DFO Science

TUESDAY MAY 12, 2020

| | | |
|------------------|---------------------------------------------------------------------------|----------------------|
| 9:00 – 9:15 am | Introductions and Roundtable | David Boguski |
| 9:15 – 9:30 am | CSAS Peer Review Process | Joclyn Paulic (CSAS) |
| 9:30 – 9:45 am | Terms of Reference Overview | David Boguski |
| 9:45 – 10:00 am | Presentation - Management of Shrimp Fishery | Courtney D'Aoust |
| 10:00 – 11:00 am | Presentation - Shrimp and Fishery History Overview and Review | Wojciech Walkusz |
| 11:00 – 12:00 pm | LUNCH | |
| 12:00 – 2:00 pm | Presentation - Research Document Methods, Results, and Conclusions Review | Wojciech Walkusz |

WEDNESDAY MAY 13, 2020

| | | |
|------------------|-------------------------------------------------|---------------|
| 9:00 – 9:30 am | Roundtable and Recap from Day 1 | David Boguski |
| 9:30 – 10:30 am | Key Uncertainties and Knowledge Gaps Discussion | David Boguski |
| 10:30 – 11:00 am | Draft Science Advisory Report | David Boguski |
| 11:00 – 12:00 pm | LUNCH | |
| 12:00 – 1:30 pm | Draft Science Advisory Report | David Boguski |
| 1:30 – 2:00 pm | Final Remarks and Next Steps | David Boguski |