SUBMISSION TO THE

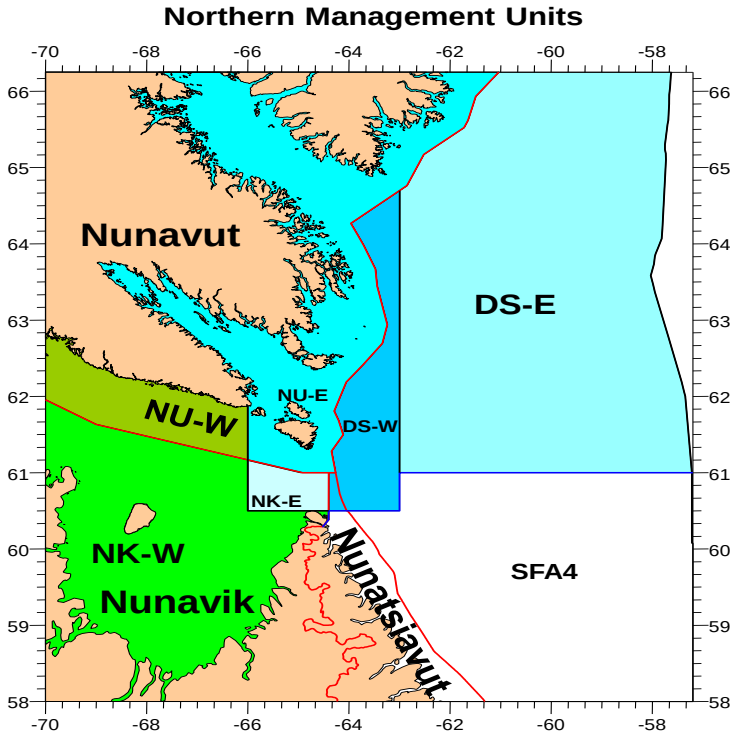
NUNAVUT WILDLIFE MANAGEMENT BOARD AND NUNAVIK MARINE REGION WILDLIFE BOARD

FOR

Information: **Decision: X** **Recommendation: X**

Issue: Precautionary Approach Framework for Northern (*Pandalus borealis*) and Striped (*P. montagui*) Shrimp in the Western and Eastern Assessment Zones

Map:
Blue areas – Eastern Assessment Zone
Green areas – Western Assessment Zone



Northern shrimp (*Pandalus borealis*)

Striped shrimp (*Pandalus montagui*)

Background

Two shrimp species (*P. borealis* and *P. montagui*) occur in the Northern shrimp fishery that takes place in the Davis Strait and eastern Hudson Strait. This fishery is managed according to two distinct stock assessment zones, the Western Assessment Zone (WAZ) and Eastern Assessment Zone (EAZ). These zones extend partly into the Nunavut Settlement Area (NSA) and partly into the Nunavik Marine Region (NMR) (see Map).

Further to the briefing note provided for information to the Nunavut Wildlife Management Board (NWMB) and the Nunavik Marine Region Wildlife Board (NMRWB) (the Boards) in December 2020, the Northern Precautionary Approach Working Group (NPAWG) continues its work to develop recommendations on a Precautionary Approach (PA) Framework for *P. montagui* and *P. borealis* stocks in the WAZ and EAZ, respectively (Appendix 1). A complete PA framework would include reference points and harvest decision rules (HDRs).

Development of a PA Framework for these stocks will serve to guide fisheries management decisions and contribute to sustainable management of the resource in these areas. In addition, efforts to develop a PA Framework for *P. montagui* in the WAZ, specifically developing a Limit Reference Point (LRP) and a Target Reference Point (TRP)), are directly related to conditions for Marine Stewardship Council (MSC) certification of this fishery.

Implementation of reference points for *P. borealis* and *P. montagui* in the WAZ and EAZ, respectively, is targeted for the 2021-22 fishery.

Progress to Date

Consistent with the *Fishery Decision-Making Framework Incorporating the Precautionary Approach* (DFO, 2006), DFO Science conducted a peer review process to establish LRP for shrimp stocks in the WAZ and update pre-existing LRPs for stocks in the EAZ. Results of the 2020 Canadian Science Advisory Secretariat (CSAS) process are at Appendix 2. LRPs are considered implemented and are not subject to Board decision.

Through a series of working group sessions held from November 2020 to February 2021, the NPAWG has made progress towards development of additional reference points for these stocks. Work will continue in February 2021 on this component of the PA Framework with the intent to finalize a report of NPAWG outcomes and recommendations in early March.

NPAWG outcomes and recommendations will be presented at the Northern Shrimp Advisory Committee meeting on March 9, 2021 (limited to EAZ stocks, WAZ stocks not discussed). At the time of this submission, a report from the NPAWG was not yet available. An addendum to this briefing note will present information to support Board decision making as it relates to a PA Framework for stocks in the WAZ and EAZ.

Next Steps

Work to develop HDRs, is intended to follow the development of recommendations on reference points. HDRs will provide details on harvest rates and other management procedures prescribed relative to stock status. Development of HDRs will include discussion of season-bridging protocols for allocations to Nunavut and Nunavik fishing interests in these zones.

Notably, development of HDRs are not a requirement for MSC certification of this shrimp fishery.

Summary of the Request

To support Board decision making as it relates to a PA Framework for stocks in the WAZ and EAZ, an addendum to this briefing note will be submitted in the coming weeks that will include a report of NPAWG outcomes and recommendations.

In order to fully or partially implement a PA Framework (including but not limited to reference points) for the 2021-22 fishery, advice on the following matters is requested as soon as possible:

Western Assessment Zone:

1. Decisions on reference points for *P. borealis* and *P. montagui* in the WAZ, respectively.*

Eastern Assessment Zone:

1. Decisions on reference points for *P. borealis* and *P. montagui* in the NU/NK E management units.*

2. Recommendations on reference points for *P. borealis* and *P. montagui* within the offshore Davis Strait management units.*

**Decisions and recommendations on reference points from NWMB and NMRWB must be compatible such that a common reference point is established the stock for the entire assessment zone.*

Prepared by: Courtney D'Aoust, Fisheries Resource Management, Fisheries and Oceans Canada

Appendices

APPENDIX 1 – [SUMMARY] DFO. 2020. Science Advice on Limit Reference Points for Northern Shrimp (*Pandalus Borealis*) and Striped Shrimp (*Pandalus Montagui*) in the Eastern and Western Assessment Zones. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/053.

APPENDIX 2 – FULL PUBLICATION: DFO. 2020. Science Advice on Limit Reference Points for Northern Shrimp (*Pandalus Borealis*) and Striped Shrimp (*Pandalus Montagui*) in the Eastern and Western Assessment Zones. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/053.

Appendix 1

SCIENCE ADVICE ON LIMIT REFERENCE POINTS FOR NORTHERN SHRIMP (*PANDALUS BOREALIS*) AND STRIPED SHRIMP (*PANDALUS MONTAGUI*) IN THE EASTERN AND WESTERN ASSESSMENT ZONES

Canadian Science Advisory (Science Advisory Report 2020/053)

SUMMARY

- The Precautionary Approach (PA) Framework for the Eastern Assessment Zone (EAZ) was established in 2009 on the basis of 3 years of survey data and the results of the *Precautionary Approach Workshop on Canadian Shrimp and Prawn Stocks and Fisheries* (DFO 2009b). The Western Assessment Zone (WAZ) PA Framework was deferred because of changes to the survey design in 2014 that reset the survey time series. The goals of this meeting were to establish the Limit Reference Point (LRP) and propose Upper Stock Reference Points (USR) for the WAZ and update the existing reference points for the EAZ.
- LRPs for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) in both the WAZ and EAZ are newly established as 40%, and the proposed USRs as 80%, of the geometric mean of the spawning stock biomass (SSB) index. These calculations are consistent with guidance in the DFO PA Policy.
- In the WAZ, the newly established LRPs for Northern Shrimp (4,100 t) and Striped Shrimp (12,300 t) are based on a 6-year time series (2014–2019). Similarly, a newly proposed upper stock reference (USR) is provided for each species (8,200 and 24,600 t, respectively).
- In the EAZ, the updated LRP for Northern Shrimp (increase to 15,800 from 6,800 t) and the proposed USR (increase to 31,600 from 18,200 t) are based on an 11-year time series (2009–2019). Re-calculation of the LRP and proposed USR for Striped Shrimp in the EAZ resulted in 3,100 t (increase from 2,300 t) and 6,100 t (no change), respectively.
- The LRPs and proposed USRs are based on the best available scientific information, but do not incorporate environmental or ecosystem factors into their calculations. Information pertaining to these metrics are lacking.
- 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.

Date: February 4, 2021

Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Central and Arctic Region

Canadian Science Advisory Secretariat
Science Advisory Report 2020/053

SCIENCE ADVICE ON LIMIT REFERENCE POINTS FOR NORTHERN SHRIMP (*PANDALUS BOREALIS*) AND STRIPED SHRIMP (*PANDALUS MONTAGUI*) IN THE EASTERN AND WESTERN ASSESSMENT ZONES

*Top: Northern Shrimp (*Pandalus borealis*)*
*Bottom: Striped Shrimp (*Pandalus montagui*)*
Photo: Fisheries Oceans Canada, Newfoundland and Labrador Region.

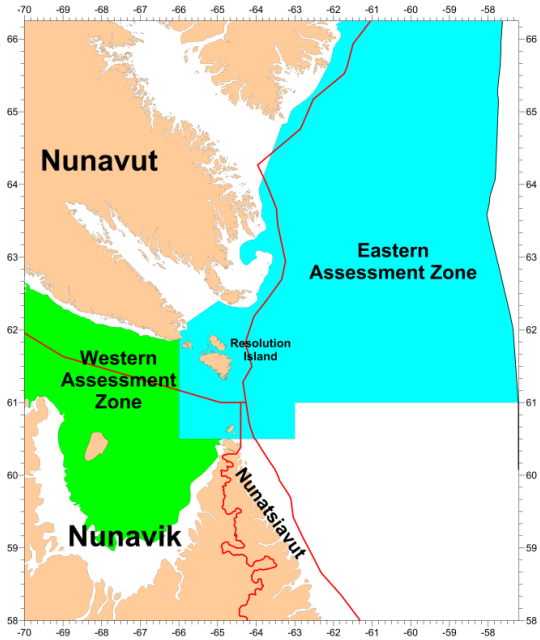


Figure 1. Eastern and Western Assessment Zones for shrimp fisheries in Arctic Region. Boundaries of the Nunavut, Nunavik and Nunatsiavut land claim areas are shown in red.

Context:

Fisheries and Oceans Canada's Fishery Decision-Making Framework Incorporating the Precautionary Approach describes a framework where reference points and harvest decision rules are used to make fisheries management decisions. The limit reference point (LRP) represents the stock status below which serious harm is likely occurring to the stock. The LRP is established based on biological criteria by Fisheries and Oceans Canada (DFO) Science. The Upper Stock Reference (USR) divides the Healthy Zone from the Cautious Zone and is established by DFO Resource Management in consultation with co-management partners, provincial and territorial governments, industry, and DFO Science, to enact harvest decision rules.

*Since the reorganization of the Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) surveys conducted in the 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 annually with the same ship and gear (DFO 2020a). LRPs for the WAZ were developed in 2013, however, the restart of the time series in 2014 means they are no longer valid (DFO 2018a). 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 for the EAZ since the original points were calculated from only three surveys (Siferd 2015), which no longer correspond to the assessment area boundaries (DFO 2019a).

DFO Resource Management has requested that Science establish LRPs consistent with the Precautionary Approach (PA) framework for Northern Shrimp and Striped Shrimp in order to determine the point below which serious harm may be occurring to the stock (i.e., the Critical Zone), and propose an USR. This Science Advisory Report is from the May 12–13, 2020 Meeting on Science Advice on Limit Reference Points for Northern Shrimp, Pandalus borealis, *and Striped Shrimp,* Pandalus montagui*, in the Eastern and Western Assessment Zones. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.*

SUMMARY

- The Precautionary Approach (PA) Framework for the Eastern Assessment Zone (EAZ) was established in 2009 on the basis of 3 years of survey data and the results of the *Precautionary Approach Workshop on Canadian Shrimp and Prawn Stocks and Fisheries* (DFO 2009b). The Western Assessment Zone (WAZ) PA Framework was deferred because of changes to the survey design in 2014 that reset the survey time series. The goals of this meeting were to establish the Limit Reference Point (LRP) and propose an Upper Stock Reference point (USR) for the WAZ and update the existing reference points for the EAZ.
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- The LRPs and proposed USRs are based on the best available scientific information, but do not incorporate environmental or ecosystem factors into their calculations. Information pertaining to these metrics are lacking.
- 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.

BACKGROUND

Canadian Precautionary Approach Framework and Limit Reference Points

In 2009, Fisheries and Oceans Canada (DFO) published the Sustainable Fisheries Framework that provides the basis for ensuring Canadian fisheries are conducted in a manner which supports conservation and sustainability. The framework is comprised of a number of policies for the conservation and sustainable use of fisheries resources including "A Fishery Decision-Making Framework Incorporating the Precautionary Approach" (DFO 2009a). The Precautionary

Approach (PA) Policy applies where decisions on harvest strategies or harvest rates for a stock are taken to determine Total Allowable Catch (TAC) or other measures to control harvests. This is the case for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) stocks.

There are three components to the general decision framework for the PA:

1. Reference points and stock status zones;
2. Harvest strategy and harvest decision rules; and,
3. The need to take into account uncertainty and risk when developing reference points and developing and implementing decision rules.

The first component of the PA framework, reference points and status zones, is the subject of this advisory report. The PA is divided into three stock status zones: the Healthy, Cautious and Critical Zones (Figure 2). The Upper Stock Reference (USR) divides the Healthy Zone from the Cautious Zone and the Limit Reference Point (LRP) divides the Cautious Zone from the Critical Zone.

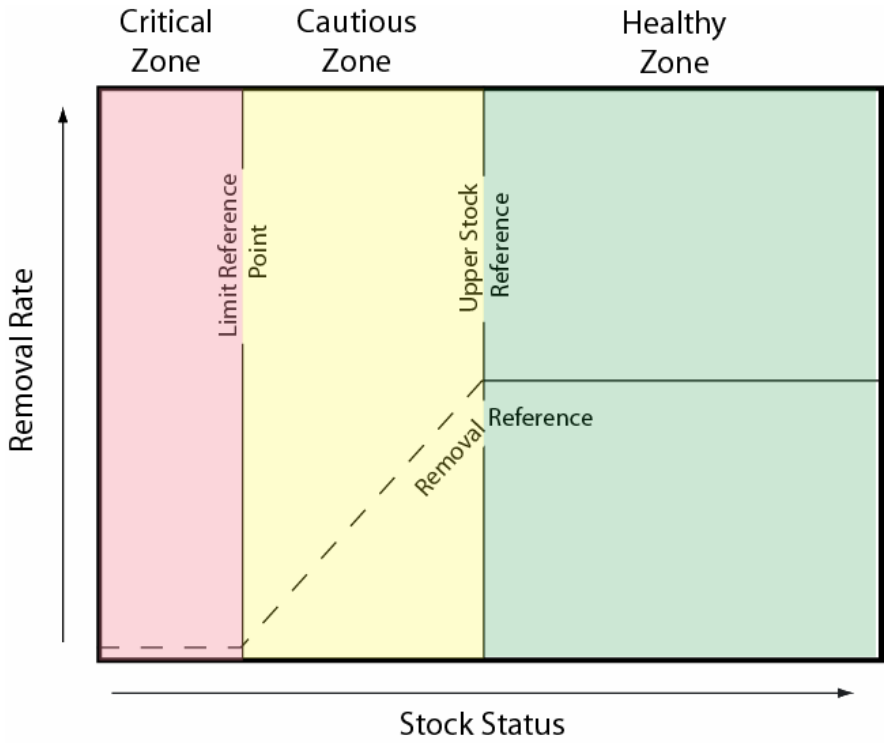

Figure 2. Elements of DFO's PA framework (from DFO 2009a).

The LRP is defined as the stock status *below which serious harm is being done to the stock*. However, a challenge in setting an LRP is identifying the threshold of where and when '*serious harm*' occurs to the stock. This threshold is approximated based on the best available information, below which validation is exactly the situation to be avoided. LRPs are based on biological criteria and are established by DFO Science. In the Critical Zone, conservation/biological considerations are meant to be the primary drivers for management decision-making (as opposed to socio-economic factors) and there is to be no tolerance for preventable declines as the primary goal is to rebuild the stock out of the critical zone. Management actions pertaining to this zone are to promote stock growth and removals are to be kept to the lowest possible level regardless of the stock trajectory.

When establishing an LRP, the guidelines advise choosing a stock metric that can account for changing productivity, generally the spawning stock biomass. An LRP should be determined by accounting for periods of high and low productivity over as long a time-series as possible, and based on the best information available on stock biology and fishery characteristics while acknowledging limitations of the data. However, in some cases there may be insufficient information on which to base choices of stock-specific precautionary reference points and harvest rules. In these instances, DFO has a guideline of 40% LRP and 80% USR. The PA Policy states:

> "In cases where insufficient stock-specific information is available, these reference points may be considered as the best available guidance for management and for assessing the stock in relation to sustainability. Actual reference points for a stock may use other metrics and be set lower or higher than these references but should be demonstrably appropriate for the stock and be consistent with the intent of the PA."

Furthermore, while reference points should be reviewed periodically, neither the timeframe nor the triggers for review are specified in the PA Policy. Given that reference points have not been previously proposed for Northern Shrimp and Striped Shrimp in the Western Assessment Zone (WAZ; Figure 1) and that the current reference points in the Eastern Assessment Zone (EAZ) have been in place since 2009 (DFO 2009b), Resource Management has requested a review of the LRPs, and their rationales, to be carried out for these stocks.

Species Biology

Northern Shrimp is found in the Northwest Atlantic from Baffin Bay to the Gulf of Maine, while Striped Shrimp is found from Davis Strait south to the Bay of Fundy.

Both species of shrimp are protandric hermaphrodites. They function as males early in their lives then change sex and reproduce as females for the remainder of their lives. Females usually produce eggs once a year in the late summer-fall and carry them, attached to their abdomen, through the winter until the spring, when they hatch. Newly hatched shrimp spend three to four months as pelagic larvae. At the end of this period they settle at the bottom and take up the life style of the adults.

Recent research by Le Corre (2019, 2020) on the connectivity of management units via shrimp larval drift found that virtually the entire population of Northern Shrimp along the Canadian Atlantic coast (from Baffin Bay to the Scotian Shelf) is connected through larval drift processes with variable retention success in a given management zone. Also, larval drift was found to promote genetic homogeneity in areas with strong currents (Jorde et al. 2015). These findings improved our understanding of recruitment mechanisms and may in the future help to inform management of Canadian shrimp stocks.

Shrimp lifespan is uncertain but shrimp in the north are thought to live five to eight years. Growth rates and maturation are likely slower in the northern populations.

Fishery

The fishery began in the late 1970s in what is known as shrimp fishing area (SFA) 1. Exploratory fishing expanded into what is now the Davis Strait-East management unit (previously known as SFA 2) and then to areas southeast of Resolution Island in Hudson Strait. Quotas in these areas were based on fishery performance and not scientific survey data. In the mid-1990s, the fishery moved southeast of Resolution Island in SFA 2, where the main fishery

remains to date. Implementation of the Nunavut Agreement in 1999 shifted the main fishery east of the Nunavut Settlement Area.

Currently, the fishery in the EAZ and WAZ is managed by a TAC which is divided into individual quotas for 17 offshore licence holders and special allocations for Nunavut and Nunavik fishing interests. Changes to the management of the fishery in what were SFAs 2 and 3 created new SFAs and Management Units beginning with the 2013/14 fishing season (Figure 2). Nunavut Wildlife Management Board (NWMB) and Nunavik Marine Region Wildlife Board (NMRWB) advise on the allocation of quotas to Nunavut and Nunavik fishing interests, respectively. All fishing to date has been conducted by large vessels (> 100' overall length) with 100% At-Sea-Observer coverage.

Fishing gear in the EAZ and WAZ consists of single and, more recently, twin shrimp trawls requiring a minimum codend mesh size of 40 mm and separator grate (maximum 28 mm bar spacing). Since 2003, the management year has been April 1 to March 31. The fishing season is limited by the extent of sea ice, and is conducted between May and December in most years.

Northern Shrimp has been the main commercial species throughout the history of the shrimp fishery in this area. Historically, most of the harvest of Striped Shrimp occurred as by-catch in the directed Northern Shrimp fishery. Directed fishing for Striped Shrimp has become more important especially with quotas available in the Nunavut-West and Nunavik-West management units beginning with the 2013/14 fishing season.

Fishery catch per unit effort (CPUE) data are not considered to reflect stock status. Commercial fishing locations are not broadly distributed; fishing vessels target areas of high density. A mix of two shrimp species are disproportionally caught in the fishery and the composition of the two species in the catch determines which species is designated as directed, which biases CPUE calculations. Throughout the history of the fishery, economic factors (e.g., fuel prices, market price of shrimp) have influenced when and where the species are caught. In the EAZ, commercial vessel performance has changed over the years to target each species to achieve cleaner catches of just one species. Renewed effort in the WAZ is relatively recent. In some years, cleaner catches can be similarly achieved in the WAZ, however that varies in relation to the distribution of the two species.

ASSESSMENT

This is an assessment of LRPs for both Northern Shrimp and Striped Shrimp in the EAZ and WAZ (Figure 1). These two species have overlapping distributions, particularly in the Resolution Island area, resulting in an overlap of their fisheries. The total removal, both directed catch and by-catch, of each species is considered in the assessment.

DFO plans and the Northern Shrimp Research Foundation (NSRF) conducts annual surveys of the EAZ (Resolution Island Study Area; RISA-W, RISA-E and SFA 2EX) and WAZ (SFA 3) survey areas (Figure 3). Both species in the EAZ and WAZ were last assessed in 2019 (DFO 2019a) and updated in 2020 (DFO 2020a). Survey data in the EAZ are available for the period of 2006–2019, however, the first three years are not considered comparable with the rest of the series because of poor trawl performance, incomplete sampling coverage, and inconsistent timing, vessels, and gear (DFO 2018a). Therefore the first three years of data are excluded, and only 2009–2019 data are evaluated for the EAZ.

The WAZ (Figure 1) was surveyed biennially by DFO from 2007–2013. However, results could not be combined with the EAZ survey results because the surveys used different gear and occurred at different times of year. This prevented a comprehensive evaluation of the

distributions of shrimp and a more practical look at broader stock assessment over a larger spatial scale. In 2014, the NSRF was commissioned to take over the survey of the WAZ so that it is sampled in conjunction with the EAZ as a means to maintain consistent methods among management units. This action started a new time series for the WAZ. In 2019, the WAZ was surveyed for the sixth year in the new time series. The advice contained herein marks the first occasion that LRPs have been developed in the WAZ.

Fishable and female spawning stock biomass (SSB) indices from scientific surveys form the basis of this assessment. Fishable biomass is based on male and female shrimp from the surveys with a carapace length greater than 17 mm; this represents shrimp that are large enough to be retained in commercial trawls. SSB is based on all female shrimp from the surveys regardless of size. Fishery data are used to determine the observed exploitation rate index, calculated as catch from the reporting records (Canadian Atlantic Quota Report; CAQR) divided by the fishable biomass index from the same year. The potential exploitation rate index is calculated to represent the exploitation rate if the entire TAC is taken. Bootstrapped 95% confidence intervals are included for each of the indices.

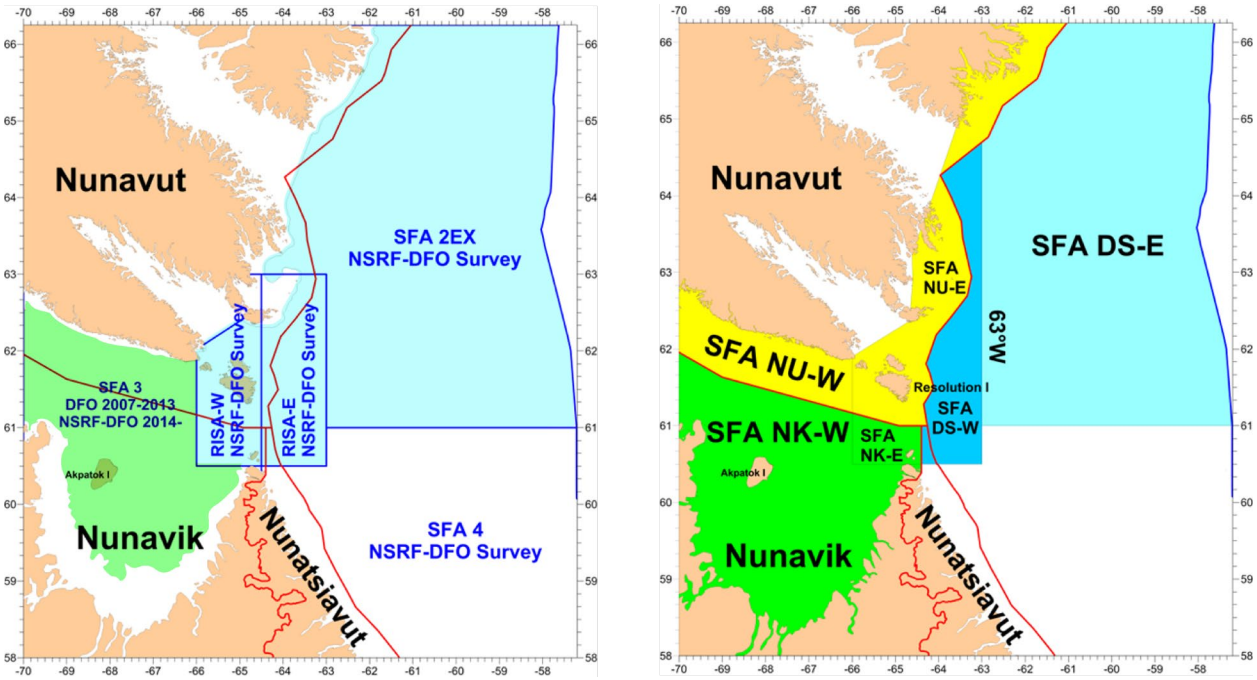

Figure 3. Locations of NSRF survey areas (left panel) within the Eastern (blue) and Western (green) Assessment Zones and the management units (right panel) referred to in this report. Shrimp Fishing Area (SFA), Exploratory (EX), Resolution Island Study Area (RISA), East (E), West (W), Nunavut (NU), Nunavik (NK) and Davis Strait (DS). Red lines show the borders of the Nunavut, Nunatsiavut and Nunavik Land Claims Areas.

For each assessment zone and shrimp fishery an LRP based on 30% and 40% of the SSB index was explored (Walkusz and Atchison 2020). Currently, a 30% LRP is being applied as a reference point by the Northwest Atlantic Fisheries Organization (NAFO) for the Northern Shrimp stock in SFA 1, which is adjacent to the EAZ. This was noted but not considered in-depth during a two-day workshop in 2008 among DFO-Science, DFO-Resource Management, co-management partners and stakeholders in an attempt to establish LRPs in these shrimp fisheries (2009b). Additionally, LRPs and the USRs were adopted at 30% and 80%, respectively, of the geometric mean of female SSB for both Northern and Striped Shrimp in

other southern SFAs. The SSB was deemed to be a suitable proxy for B_{MSY}. The contributing factors leading to the use of 30 and 80% were three years of survey data (2006–2008) in Shrimp Fishing Area 2, and that it was consistent with the approach taken by NAFO. LRPs have since gone unchanged in the EAZ (Siferd 2015).

Adopting a 30% LRP as part of the 2020 process would be consistent with NAFO approach and how shrimp fisheries are managed in the Newfoundland and Labrador Region. However, the use of a 30% LRP is unsubstantiated for the WAZ and EAZ based on the best available scientific information for these particular fisheries (Walkusz and Atchison 2020). Furthermore, an LRP of 40% is suggested in the DFO PA Policy (DFO 2009a) for instances of data deficiency and uncertainty. Establishing LRPs based on 40% average SSB for the WAZ and the EAZ was determined to be the best way forward based on the information available and recent decreases in stock productivity in southern SFAs (e.g., SFAs 4–6, DFO 2019b; SFAs 13–15, DFO 2019c). Uncertainty remains with respect to biomass variability as it relates to environmental conditions (e.g., temperature). Patchy shrimp population distributions have led to occasional large catches and fluctuations and increased variance in biomass estimates for each of the assessment zones in different years. 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 indices and a lack of stock trends. Furthermore, Striped Shrimp in the EAZ appear to have recovered from biomass levels equivalent to an SSB level near the 40% LRP; below this point the ability of the stocks to recover is unknown (DFO 2020b). Similarly, it is not known to what extent Northern Shrimp can recover from below their lowest recorded biomass levels (comparatively higher than Striped Shrimp in the EAZ). 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 that the initial EAZ PA framework be revised as soon as possible (DFO 2020b). One of the potential options would be to move to a dynamic LRP, which follows the pattern of the stock. Since information on shrimp stocks is limited in the WAZ and EAZ, a fixed LRP is recommended. The PA framework may be revised in the future when more data on variables affecting shrimp stocks in the WAZ and EAZ become available.

The recommended reference points follow DFO's PA Policy (2009a) and include new data to update existing LRPs in the EAZ and establish new LRPs in the WAZ. The geometric mean of SSB was used as a proxy for B_{MSY}. Furthermore, this framework suggests a starting point for calculating USRs. Accordingly, the LRPs and proposed USRs were calculated at 40% and 80%, respectively, of the geometric mean of SSB for both Northern and Striped Shrimp (Figures 4 and 5).

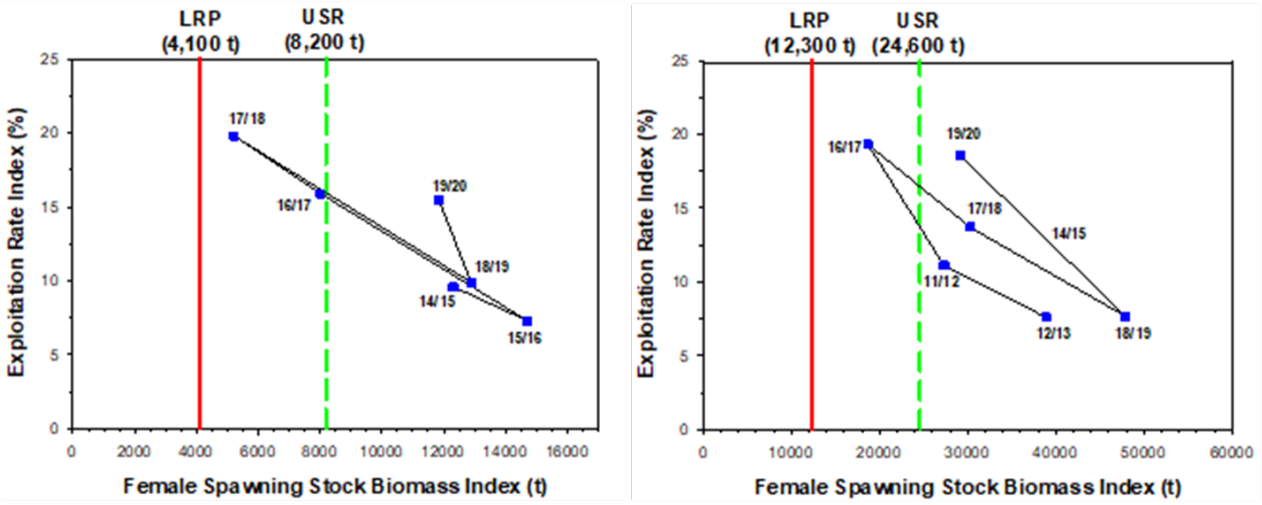

Figure 4. Newly established LRPs for Northern Shrimp (left) and Striped Shrimp (right) in the WAZ. The LRP (red line) is calculated as 40% of the geometric mean of the SSB index and the proposed USR (dashed green line) calculated as 80% of the geometric mean of the SSB index. Blue symbols are annual stock status values, numbers indicate the fishing season.

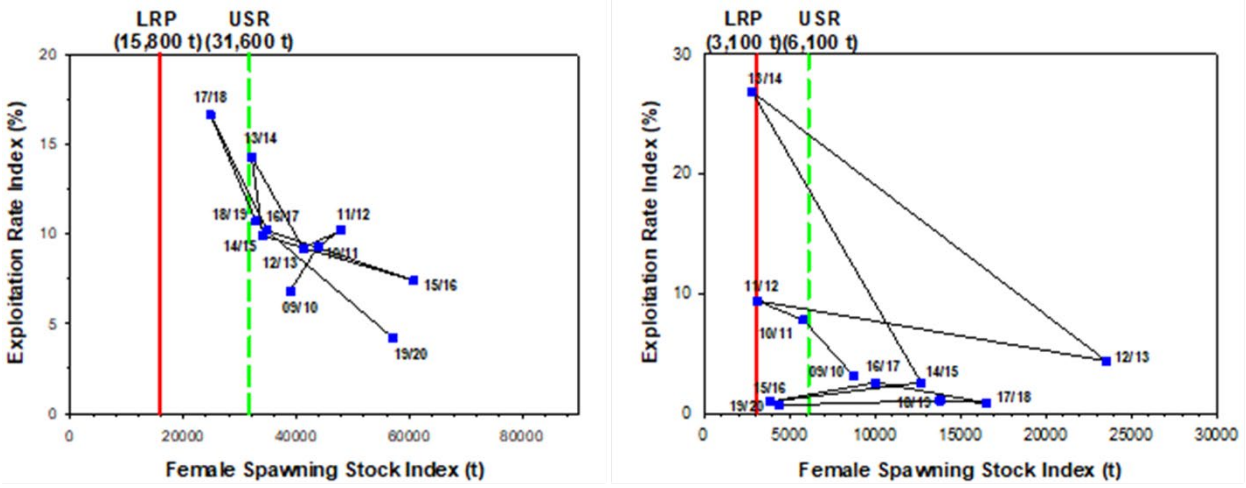

Figure 5. Updated LRPs for Northern Shrimp (left) and Striped Shrimp (right) in the EAZ. The LRP (red line) is calculated as 40% of the geometric mean of the SSB index and the proposed USR (dashed green line) calculated as 80% of the geometric mean of the SSB index. Blue symbols are annual stock status values, numbers indicate the fishing season.

Sources of Uncertainty

The sources of uncertainty that were not quantitatively incorporated into the establishment of LRPs for Northern and Striped Shrimp stocks in the WAZ and EAZ, include:

- Despite having data on temperature preferences of the two shrimp species, the distribution, availability and dynamics of preferred habitats is lacking. Future efforts should focus on moving towards an Ecosystem Approach to Fisheries Management to address knowledge gaps and drivers of stock variability, such as: larval drift related to the connectivity between management zones (stocks), habitat spatiotemporal variability, and ecosystem linkages

(e.g., predator-prey interactions, oceanographic drivers). The lack of environmental information contributes to uncertainty.

- Given the short time series and the lack of observed trends, it is not feasible to identify periods of high productivity upon which to base reference points (as suggested in the DFO PA Policy).
- Trawls used in the survey are known to have a catchability less than one but the exact value is unknown. Therefore, the survey is an index of biomass and not an absolute estimate of the total biomass.
- Catch data are known; however, the total fishery-induced mortality is unknown (landed catch plus incidental mortality from trawling). Exploitation rates are a relative index rather than absolute.
- Survey of all stocks is completed in the middle of the fishing season. It is uncertain how much of the TAC has already been taken while the survey is ongoing. Results may be confounded by the timing of the survey and the concurrent level of harvest.
- It is uncertain to what extent these stocks have the capacity to recover from low levels of biomass. High biomass variability exhibited in these stocks can lead to their positioning within the proposed Cautious Zone of this PA framework. A longer time series and a better understanding of the drivers of stock variability may inform recovery potential.
- The stocks' natural mortality, including multi-species linkages, is currently unknown.
- Factors that may cause shrimp productivity to change are poorly understood within the WAZ and EAZ. For example, it is uncertain to what extent larval drift exists between these assessment zones, and to what extent shrimp productivity is impacted by their movements.
- Stocks of both species in both assessment zones exhibit relatively large inter-annual variability in biomass and no trends have been observed. The drivers leading to this variability are poorly understood.
- Northern and Striped Shrimp have populations spanning both assessment zones and their relative distributions are likely to change inter-annually. The stock structure of each species within and between assessment zones is unresolved. For example, it is possible there are multiple populations of the same species within a single assessment zone.
- DFO has recently discovered that a portion of what was previously identified as *P. montagui* from the Gulf and Scotian Shelf (Division 3PS) are in fact *Dichelopandalus leptocerus*. There remains uncertainty about whether this species has recently migrated to this area or may have been misidentified for several years. The same may be true in more northern areas including the WAZ and EAZ.

CONCLUSIONS AND ADVICE

The work described here represents new and updated science advice on reference points for the Northern and Striped Shrimp fisheries in the WAZ and EAZ. The advice is based on a traditional approach of calculating SSB from shrimp trawl surveys, and explores a time series of fishery-independent data. Data used to assess these fisheries are limited and highly variable, and currently no trends in stock status have been observed. Striped Shrimp in the EAZ have demonstrated an ability to recover from 40% of the SSB, the LRP, below which the ability of these stocks to recover is uncertain. Therefore, we recommend a PA consistent with DFO (2009a) that reflects insufficient stock-specific information: 40% LRP and 80% USR, with

respect to the geometric mean SSB index. These reference points represent the best available scientific information and constitute advice to management for assessing the stock in relation to sustainability.

In the WAZ, the newly established LRP and the proposed USR for Northern Shrimp and Striped Shrimp are based on a 6-year time series (2014–2019; Table 1). In the EAZ, the updated LRP and the proposed USR for Northern Shrimp and Striped Shrimp are based on an 11-year time series (2009–2019; Table 1).

Table 1. Established Limit Reference Points (LRPs) and proposed Upper Stock Reference points (USRs) for Northern Shrimp and Striped Shrimp in the Western Assessment Zone and Eastern Assessment Zone. Spawning stock biomass is reported in tonnes. Previous reference points are provided in parentheses.

Species	Western Assessment Zone		Eastern Assessment Zone	
	LRP	USR	LRP	USR
Northern Shrimp (*Pandalus borealis*)	4,100	8,200	15,800 (from 6,800)	31,600 (from 18,200)
Striped Shrimp (*Pandalus montagui*)	12,300	24,600	3,100 (from 2,300)	6,100 (no change)

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.

OTHER CONSIDERATIONS

In general, management of key forage species, such as shrimp, under an ecosystem approach, requires the adoption of a conservative approach with lower fishing mortality reference points and higher biomass reference points than would be considered under a single species management approach.

In cases where insufficient stock-specific information is available, DFO's PA Policy (2009a) suggests reference points that may be considered as the best available guidance for management and for assessing the stock in relation to sustainability. The 40% LRP and 80% USR provided as guidance are the results of reviews and meta-analyses across a wide variety of fish stocks. However, it is uncertain to what extent this standard can be applied to shrimp fisheries. Here, 40% LRP and 80% USR of the geometric mean SSB index have been used to inform reference points for shrimp fisheries in the WAZ and EAZ without demonstrable validation of stock productivity. Indeed, most larvae released in any management area end up as functioning adults in another management area (in other words, most adults in any management area originated elsewhere; Le Corre et al. 2020). This in and of itself is evidence that the SSB index within an individual management area does not provide a defensible measure of the future health within any individual management area.

The PA reference points in both the WAZ and EAZ are based on the best available scientific information and need to be re-evaluated with new and/or alternative methodologies when data are available to corroborate the advice contained herein. Actual reference points for a stock may use other metrics and be set lower or higher than these references but should be justified for the

stock and consistent with the intent of the PA. Ideally, more robust LRPs and associated PA frameworks should be considered by Science and Resource Management when additional data are available.

LIST OF MEETING 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 an 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

SOURCES OF INFORMATION

This Science Advisory Report is from the May 12–13, 2020 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. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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Le Corre, N., Pepin, P., Burmeister, A., Walkusz, W., Skanes, K., Wang, Z., Brickman, and D., Snelgrove. P.V.R. 2020. Larval connectivity of Northern Shrimp (*Pandalus borealis*) in the northwest Atlantic. Can. J. Fish. Aqua. Sci. 77 : 1332–1347.

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THIS REPORT IS AVAILABLE FROM THE:

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ISSN 1919-5087

Correct Citation for this Publication:

DFO. 2020. Science Advice on Limit Reference Points for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in the Eastern and Western Assessment Zones. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/053.

Aussi disponible en français :

*MPO. 2020. Avis scientifique sur les points de référence limites pour la crevette nordique (*Pandalus borealis*) et la crevette ésope (*Pandalus montagui*) dans les zones d'évaluation est et ouest. Secr. can. de consult. sci. du MPO, Avis sci. 2020/053.*

December 3, 2020

To: Derek Mahoney, Chair - Northern Precautionary Approach Working Group (NPAWG)
From: Alastair O'Rielly, Northern Coalition
Brian Burke, Nunavut Fisheries Association
RE: Northern Precautionary Approach Working Group (NPAWG)

Good day Derek,

The Northern Coalition (NC) and Nunavut Fisheries Association (NFA) are writing this letter in response to the November 30th meeting of the Northern Precautionary Approach Working Group (NPAWG) and specifically the CSAS document and advice discussed at this meeting. Combined the NC and NFA represent all commercial fishing interests in Canada's Eastern Arctic, a group of Indigenous-owned companies that hold seven of the 17 offshore shrimp licenses, 100% of the shrimp allocations in the Western Assessment Zone (WAZ) and 65.9% of the shrimp allocations in the Eastern Assessment Zone (EAZ). From an economic perspective, these EAZ and WAZ allocations are extremely important to the viability of our members, especially given the recent reductions in allocations in Shrimp Fishing Areas (SFAs) 4 and 5.

From our joint perspective, any discussion and recommendations of the NPAWG must be cognisant of the respective Land Claims Agreements and the critical role of the Wildlife Management Boards.

The CSAS advice seeks to move the Limit Reference Points (LRP) for all shrimp stocks in the Eastern and Western Assessment Zones from 30% of the mean spawning stock biomass (SSB) to 40% of the SSB, a 1/3 increase in the LRP, predicated on inadequate science information and a presumption that this increase could provide for earlier and more effective response measures to reductions in the SSB.

The correspondence to you from Mr. Bruce Chapman of the Canadian Association of Prawn Producers (CAPP) provides a thoughtful and well articulated critique of the proposed shift in the LRP for stocks in the EAZ and WAZ shrimp areas. We generally concur with the perspective contained in this letter and look forward to receiving further information from the Department on use of 40% LRPs in other relevant shrimp stocks throughout the North Atlantic. From our perspective, the most relevant stocks would be those in the SFA 1 to 7 complex, all of which we understand utilize LRPs set at 30% of the SSB.

The assertion that the risks of stock decline in the North are greater than in southern stocks is implausible. SFA 4, 5 and 6 have all experienced precipitous declines in biomass in recent years. SFA 5 has seen a 43.6% decline over the past two years. We do not understand that there is evidence to suggest that a 40% LRP for these stocks would have produced a more expeditious management response that could have arrested these reductions. It is

generally recognized that neither the unprecedented growth in shrimp biomass levels during the 1990s, nor the dramatic declines of recent years are correlated with fishery removal levels.

Survey variability for *Pandalus borealis* and *montagui* in the EAZ and WAZ areas are extreme and may not necessarily reflect interannual biomass variability. Application of a 40% LRP for these stocks, particularly given extreme shifts in biomass indices, holds the potential risk of inducing a series of dramatic oscillations in management responses which are unlikely to mitigate stock declines, would prove very disruptive to fishing operations and potentially undermine the credibility of Canada's resource management regime. Based on the information and materials provided thus far, we see no benefits to an arbitrary shift in the LRP for these stocks.

This approach by the Arctic region to implement restrictions on fishing activity which are inconsistent with DFO's decisions in other regions is reflective of recent decisions and recommendations made on several other issues, most recently the Arctic region's opposition to a 5% increase in the 0A/0B turbot quotas and revisions to the turbot conversion factor to be consistent with changes in the south. Both NC and NFA strongly oppose this inequity in approach for different regions, particularly when dealing with the same stock complexes, which is also contrary to DFO's stated goal of regional consistency.

The CSAS document also recommends a very significant increase in the LRP and USR for the EAZ based on additional years of data. For both the EAZ and WAZ we have some concerns regarding the potential setting of LRPs and USRs at periods of high stock levels, which may not be sustainable in the long-term, thus impacting negatively on future allocation levels, as witnessed in SFA 6.

We also note concern with the composition of the meeting attendees at the May 12-13, 2020 meeting on Science Advice on Limit Reference Points for Northern Shrimp and Striped Shrimp in the Western and Eastern Assessment Zones. Other than the respective Nunavut and Nunavik Management Board representatives, the meeting was dominated by representation from the Arctic region and the only non-DFO attendee was a recent DFO Science employee. Having other academic and industry science and technical participation would be appropriate.

Moving the LRP to 40% was presented as a 'fait accompli' further to the outcome of the May 2020 Canadian Science Advisory Secretariat meeting. We note that the Research Document 2020/072 dated November 2020 states on page iv that "The intent of this document is to serve as a source of supporting information to provide advice to DFO Resource Management, consistent with the Department's PA Framework in support of the sustainable management of these fisheries." Your presentation at the Working Group meeting indicated that the CSAS process is not an advisory function with respect to the setting of Limit Reference Points but has de facto decision-making authority within DFO's PA Framework.

Finally, we are very appreciative of the work of DFO Science and the challenges in monitoring and analyzing an extremely dynamic marine environment with a dearth of critical biological and environmental data. However, the recommended move to increase the LRP for EAZ and WAZ Shrimp does not appear to be based "on biological criteria', nor can it be demonstrably linked to "stock status below which serious harm is likely occurring to the stock."

As discussed, we request that the next meeting of the NPAWG include the full group and a fulsome discussion on these issues.

Sincerely,

Alastair O'Rielly
Executive Director, Northern Coalition

Brian Burke
Executive Director, Nunavut Fisheries Association

cc: Arran McPherson – Assistant Deputy Minister, Ecosystems and Oceans Science
Sylvie Lapointe – Assistant Deputy Minister, Fisheries and Harbour Management
David Whorley – Chair, Northern Shrimp Advisory Committee (NSAC)
Adam Burns – Director General, Fisheries Management
Courtney D'Aoust – Fisheries and Aquaculture Management Officer, DFO
Daniel Shewchuk, Chair – Nunavut Wildlife Management Board (NWMB)
Robert Moshenko, A/Chair - Nunavik Marine Region Wildlife Board (NMRWB)
Jason Akearok, Executive Director, NWMB
Janelle Kennedy, Executive Director, NMRWB
Bruce Chapman – Canadian Association of Prawn Producers (CAPP)

Good afternoon:

Before our NPAWG session tomorrow, I thought that it would be useful to recap our discussions and to provide an assessment of where we are in our work with respect to key elements in development of a Precautionary Approach (PA) Framework. In addition, I can report on discussions I have had internally with my DFO colleagues and management. My hope is that this update will help to focus our discussions tomorrow and give indication of what we might be able to accomplish in our remaining time before reporting to NSAC, and providing information to the Nunavut Wildlife Management Board and the Nunavik Marine Region Wildlife Board (the Boards).

As chair of this working group, I would first thank each of you for your participation in the group and for your flexibility in making yourself available, particularly as times have shifted for a number of our meetings. I have tried to guide discussions in a way that promoted open dialogue, with my ultimate goal being a consensus recommendation to NSAC. I believe that would be the best outcome for all involved. However, while consensus is a worthwhile goal, working groups like NPAWG are not a decision-making bodies. At the conclusion of our work, the Minister, in keeping with co-management processes with the Boards, will take decisions on the PA Framework for shrimp fisheries in the Eastern Assessment Zone (EAZ) and the Western Assessment Zone(WAZ). These decisions will, therefore, be informed by either consensus recommendations or the various views of our group.

Limit Reference Points (LRP)

As discussed in detail in our early sessions, the LRP for shrimp stocks in the EAZ and WAZ are established by DFO Science through peer-review, in accordance with DFO's PA policy. While our work as NPAWG is limited to non-LRP elements of the PA, I took from our discussions and from written submissions from working groups members that there are general concerns related to the uncertainties associated with EAZ and WAZ shrimp stocks. These concerns were partly reflected in members' calls for a review, in the near term, of these LRPs. I will address the idea of such a review later in this note.

Upper Stock Reference (USR)

The bulk of our discussions to this point have centered around USRs and the variability of stock status for shrimp in these areas. The data points that collectively produce this variability represent our best available science and, therefore, our clearest expression of stock status. However, given influences beyond fishing mortality and the lack of trends that can be derived from relatively limited time series, some NPAWG members felt that measures should be taken to mitigate the effects of this variability. These measures included the suggestion of a USR established at 70% of the geometric mean of SSB, where averaging of multiple (2 or 3 year) stock status data points would be used to determine stock status relative to established

reference points. DFO Science has been clear that stock status needs to be represented as a single data point rather than an average. In reaction to this position, some working group members then proposed that a USR not be developed and instead the NPAWG focus on a target reference point (TRP) to satisfy Marine Stewardship Council (MSC) certification conditions. These measures would effectively reduce, or eliminate, the potential for stocks to enter a defined cautious zone, which industry members have stated is significantly harmful to product marketability.

From DFO's perspective, stock status is exclusively within our Science sector's area of responsibility and a single-year value is the clearest expression of that status for a given point in time. Additionally, USRs are an integral part of DFO's PA policy, primarily serving as a point sufficiently above the LRP "to provide an opportunity for the management system to recognize a declining stock status and sufficient time for management actions to have effect". In keeping with DFO's PA policy, the USR is critical is defining the boundary between the Healthy and Cautious zones and DFO continues to report in this context through the annual Sustainability Survey for Fisheries.

It is true that DFO does manage some fisheries for which USRs are not in place, including in the WAZ. However, it is a policy priority for the Department to establish complete PA Frameworks for Canada's fisheries that include a USR. The establishment of a TRP without an accompanying (or dual purpose) USR would represent a departure from this priority. This would be particularly pertinent in the EAZ where a USR has been in place for a number of years.

For these reasons, I believe a recommendation from NPAWG to move forward without USRs is unlikely to be accepted by the Minister. The development, however, of a distinct TRP in addition to a USR could be a productive effort for this group in my view.

Harvest Control Rules (HCRs)

Secondary to reference points has been NPAWG's consideration of HCRs for shrimp fisheries in the EAZ and WAZ. I note that HCRs are not an outstanding MSC condition for these fisheries. In my experience, the development of HCRs is best to follow the establishment of reference points, so that the potential impacts of their application can be assessed relative to defined biomass values. It is my feeling that we are unlikely to revisit the HCRs for EAZ and/or contemplate the development of HCRs for the WAZ in our time remaining before the March 9, 2021, meeting of NSAC.

Review Provision

Given the limited time series and uncertainty surrounding the stocks in the EAZ and WAZ, many group members stated a strong preference for the PA to be reviewed in the near-term (i.e., 2-5 years). Members suggested the benefit of doing so with the aid of additional survey and, preferably, incremental science work that could provide some information related to environmental and ecological influences on these stocks.

From discussions I have had and from my own perspective, an expiry date on a PA Framework is unlikely to be supported by DFO decision-makers. Further, there could be implications for MSC certification in the event a PA Framework (including reference points) is not in place. A review after a certain time period may be a better way to proceed rather than a predefined expiry. In the very short-term, I do not believe the knowledge of these stocks is likely to sufficiently increase to the extent that we could expect any difference in the outcome of a similar process to what we are now undertaking. For this reason, I would suggest that NPAWG recommend a review of reference points (and any additional components of a PA Framework) in 4 or 5 years (i.e., in 2025 or 2026).

NPAWG may wish to consider the usefulness of establishing a committee to undertake this review and ultimately consider the merit of modifying the PA framework. Such a group would likely best be composed of DFO and non-DFO members. Associated with the notion of available data, NPAWG may also wish to emphasize the need for additional science to improve environmental knowledge as part of its report to NSAC and the Boards.

Path Forward

As I see it, tomorrow's (February 5) meeting will be important in determining if there is basis to continue the NPAWG process of developing elements of a PA framework for these stocks. If that proves the case, I believe we could plan 1-2 additional sessions before turning our focus to the development of a report.

Once again, thanks for your participation in NPAWG sessions. I look forward to our coming discussions.

Regards,

Derek Mahoney

From: Brian Burke
To: Jason Akearok
Cc: Amber Giles; Denis Ndeloh
Subject: FW: NPAWG update Feb 4 / GTAPN mise a jour 4 fév
Date: Friday, February 5, 2021 10:43:31 AM
Attachments: DMahoney_Letter_to_NPAWG_Feb_4_2021_English.DOCX

Good morning,

Due to the late sending of this note and its content, which dismisses any suggestions made by stakeholders in favour of a dictated DFO approach to PA in the WAZ and EAZ, NFA has boycotted today's NPAWG meeting.

It is my understanding that DFO intends to make a submission on the NPAWG to the NWMB for its March meeting. From a NFA perspective, this late date does not provide adequate time for us to prepare and submit a detailed paper on our views regarding the PA approach in the WAZ and EAZ. However, if DFO does make a submission for decision at the upcoming meeting which is based on the approach outlined in this note from the NPAWG Chair, this is an approach which does not have the support of NFA or any other industry participants in the WAZ and EAZ shrimp fisheries. As such, we would ask for the opportunity to provide input at the March meeting and request a call for written submissions take place for the following meeting.

As per our prior NFA and industry correspondence on this critical issue, we entered into the "working group" process in good faith with the belief that, as a working group, reasonable approaches that do not impact on the stock status but do take into account the potential socio-economic impacts on industry would be fully considered, leading to a negotiated consensus agreement on the way forward. Unfortunately, this does not appear to be the case and rather than being coopted by our participation in the "working group" being seen as acceptance, we have taken the decision to, for the present time at least, remove ourselves from this flawed process.

As with other issues impacting the Nunavut fishery, it is our view that the NWMB has a very strong decision and recommendation making role and mandate, and we look forward to the NWMB exercising this authority for the benefit of Nunavut and Nunavummiut.

Regards,

Brian Burke
Executive Director
Nunavut Fisheries Association (NFA)
Tel: (709) 351-7263

From: D'Aoust, Courtney <Courtney.D'aoust@dfo-mpo.gc.ca>
Sent: February 4, 2021 5:17 PM
To: D'Aoust, Courtney <Courtney.D'aoust@dfo-mpo.gc.ca>

Subject: NPAWG update Feb 4 / GTAPN mise a jour 4 fév

Sent on behalf of Derek Mahoney, Chair, Northern Precautionary Approach Working Group (NPAWG)

Good afternoon, please find attached a **note from the Chair** in regards to tomorrow's discussion. A copy is also available in the NPAWG Dropbox.

Session Title	**Objectives**	**Sub-group(s) to attend**	**Date & Time**
USR 3: EAZ & WAZ stocks	Discuss reference points (Borealis + Montagui)	WAZ & EAZ	**Friday February 5** 9 AM – 11 AM EST (2 hours) Join Zoom Meeting https://zoom.us/j/93998895525?pwd=clpnYWVRQkZkUzdvYTVrTFFMTDcvZz09 Meeting ID: 939 9889 5525 Passcode: 761300 1-855-703-8985 Canada Toll-free **interpretation not available*

Thank you.

****

Envoyé de la part de Derek Mahoney, Président, Groupe de travail sur l'approche de précaution du Nord (GTAPN)

Bonjour, veuillez trouver ci-joint une **note du président** concernant la discussion de demain. Une copie est également disponible au Dropbox GTAPN.

Titre de la session	**Objectifs**	**Sous-groupe(s) à assister**	**Date et heure**
PRS 3: stocks ZEE & ZEO	Discuter les points de références (Borealis + Montagui)	ZEO & ZEE	**Vendredi le 5 février** 09h00 – 11h00 heure de l'est (2 heures) Rejoindre la réunion Zoom https://zoom.us/j/93998895525?pwd=clpnYWVRQkZkUzdvYTVrTFFMTDcvZz09 ID de la réunion: 939 9889 5525 Passcode: 761300 1-855-703-8985 Canada gratuit **interprétation non disponible*

Merci.

Courtney D'Aoust
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