Fisheries and Oceans Canada | Pêches et Océans Canada
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Arctic Region
Ontario and Prairie Region

Canadian Science Advisory Secretariat
Science Response 2024/017

UPDATE OF STOCK STATUS INDICATORS FOR NORTHERN SHRIMP, *PANDALUS BOREALIS*, AND STRIPED SHRIMP, *PANDALUS MONTAGUI*, IN THE EASTERN ASSESSMENT ZONE, FEBRUARY 2024

CONTEXT

Fisheries and Oceans Canada (DFO) Resource Management (RM) has requested Science advice on the status of the two species of shrimp, Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in the waters adjacent to Nunavut and Nunavik. Both species in the Eastern Assessment Zone (EAZ) were last fully assessed in 2023 (DFO 2023). Full assessments are carried out every two years with stock status updates in the intervening years. The next full assessment is scheduled for 2025. This assessment follows the framework developed in 2007 for Northern Shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007). The Limit Reference Point (LRP) was updated and an updated Upper Stock Reference point (USR) was proposed in 2020 (DFO 2020). A series of fishery-independent surveys and fishery data formed the basis of the current assessment.

This Science Response Report results from the regional peer review of February 6, 2024 on the Stock Update of Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) in the Eastern Assessment Zone and Western Assessment Zone, February 2024. (IFMP). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SCIENCE ADVICE

Status

- The *P. borealis* stock in the Eastern Assessment Zone (EAZ) is currently above the established LRP (15,800 t). Based on the proposed USR of 31,600 t, the stock would be in the Healthy zone of the Precautionary Approach (PA) Framework with a 58.8% probability.
- The *P. montagui* stock in the EAZ is currently above the established LRP (3,100 t). Based on the proposed USR of 6,100 t, the stock would be in the Healthy zone of the PA Framework with a 66.7% probability.

Trends

- Fishable biomass and spawning stock biomass indices varied without trend from 2009–2023 for both *P. borealis* and *P. montagui* in the EAZ.

Ecosystem and Climate Change Considerations

- Environmental and climate change considerations were not updated or reviewed during this Science Response Report.

- Fluctuations in the Northwest Atlantic ocean climate have potential impacts on the availability of optimal Pandalid habitat and/or predator-prey interactions in the EAZ. These potential impacts on Pandalid shrimp productivity have not yet been quantified for shrimp stocks in the EAZ or incorporated into the assessment (DFO 2023).
- *Pandalus borealis* and *P. montagui* are distributed broadly over the Northwest Atlantic Ocean. The associated assessment areas, including the EAZ, Western Assessment Zone (WAZ), and Shrimp Fishing Areas (SFAs) 4–7, are connected through larval dispersal, but rates of exchange of adults are less understood. The strong linkages between EAZ, WAZ, and SFA 4 need to be considered to interpret fluctuations in biomass within and among assessment areas, even within the same year (DFO 2023).

Stock Advice

- The assessment framework for *P. borealis* and *P. montagui* stocks in the EAZ does not provide forward-looking advice. A full stock assessment is planned in 2025.
- The spawning stock biomass index for *P. borealis* in the EAZ moved out of the Cautious zone into the proposed Healthy zone in 2023 and is currently considered to be in a healthy state.
- The spawning stock biomass index for *P. montagui* in the EAZ remained in the proposed Healthy zone in 2023 and is currently considered to be in a healthy state.

BASIS FOR ASSESSMENT

Assessment Details

Year Assessment Approach was Approved

This assessment follows the framework developed in 2007 for Northern Shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007).

Assessment Type

Interim Year Update

Most Recent Assessment Date

1. Last Full Assessment: February 2023 (DFO 2023)
2. Last Interim Year Update: January 2022 (DFO 2022)

Assessment Approach

1. Broad category: Index-based
2. Specific category: Index-based (Fishery-independent indices)

The assessment follows the framework established by DFO (2007); catch data from scientific surveys are spatially expanded to produce an abundance index for the fishable biomass (FB) and female spawning stock biomass (SSB). Both male and female shrimp with a carapace length greater than 17 mm are considered in the calculation of the FB index, while female shrimp of any size form the basis of the SSB index. A detailed description of the survey history, survey design, and biomass calculations can be found in Fulton et al. (2024).

Stock Structure Assumption

Stock overview information: For both *P. borealis* and *P. montagui*, the EAZ is a management-based stock unit and does not represent a biological unit.

Reference Points

Reference points are presented in Table 1.

Table 1. Reference points for Pandalus borealis *and* Pandalus montagui *in the Eastern Assessment Zone.*

Reference Point	Description	*Pandalus borealis*	*Pandalus montagui*
Limit Reference Point (LRP):	40% of the geometric mean of female spawning stock biomass (SSB) over the productive period (2009–2019) for EAZ, a proxy for BMSY, DFO (2020).	15,800 t	3,100 t
Upper Stock Reference (USR):	Proposed at 80% of the geometric mean of female spawning stock biomass (SSB) over the productive period (2009–2019) for EAZ, a proxy for BMSY, DFO (2020).	31,600 t	6,100 t
Removal Reference (RR):	N/A	-	-
Target (TRP):	N/A	-	-

Data

- Northern Shrimp Research Foundation (NSRF) annual trawl survey (2009–2023)
- Commercial catches from Atlantic Quota Monitoring System (AQMS)

Data changes:

- Commercial catch data for 2023 is considered incomplete as the season is not officially closed until March 31, 2024. Data were pulled on January 24, 2024.
- Commercial catch data for 2022 were updated on January 24, 2024.

ASSESSMENT

Historical and Recent Stock Trajectory and Trends – *P. borealis*

Fishery

Catch has varied without trend around 6,000 t from 1997 through 2023/24 (Figure 1a, Table 2). The total reported catch for 2023/24, based on the AQMS, as of January 24, 2024, was 6,188 t; 83.8% of the 7,383 t TAC.

Biomass

Both the FB and SSB indices varied without trend from 2009–2023. The FB in 2023 (48,216 t; Figure 2a) increased (30.6%) relative to the 2022 value but remained below both the long term mean (2009–2022; 61,213 t) and reference period mean (2009–2019; 62,849 t). The SSB in 2023 (32,659 t; Figure 1b) also increased (37.4%) relative to the 2022 value but remained below both the long term mean (2009–2022; 38,875 t) and reference period mean (2009–2019; 39,459 t).

Exploitation

Both the reported and potential exploitation rates were at or above the long term mean (2009–2022). As of January 24, 2024, the reported exploitation rate index for 2023/24 was 12.8% with 83.8% of the total allowable catch (TAC) taken (Figure 2b). Should the entire 2023/24 TAC of 7,383 t be taken, the exploitation rate index would be 15.3%.

Current Outlook

The *P. borealis* stock in the EAZ is currently above the established LRP (15,800 t) and proposed USR (Figure 2c). Should the USR be established at the proposed level of 31,600 t suggested by Fisheries and Oceans Canada's (DFO's) Science sector (i.e., 80% of the geometric mean of the SSB index; DFO 2020), the stock in 2023 would be in the Healthy zone of the PA Framework with a 58.8% probability

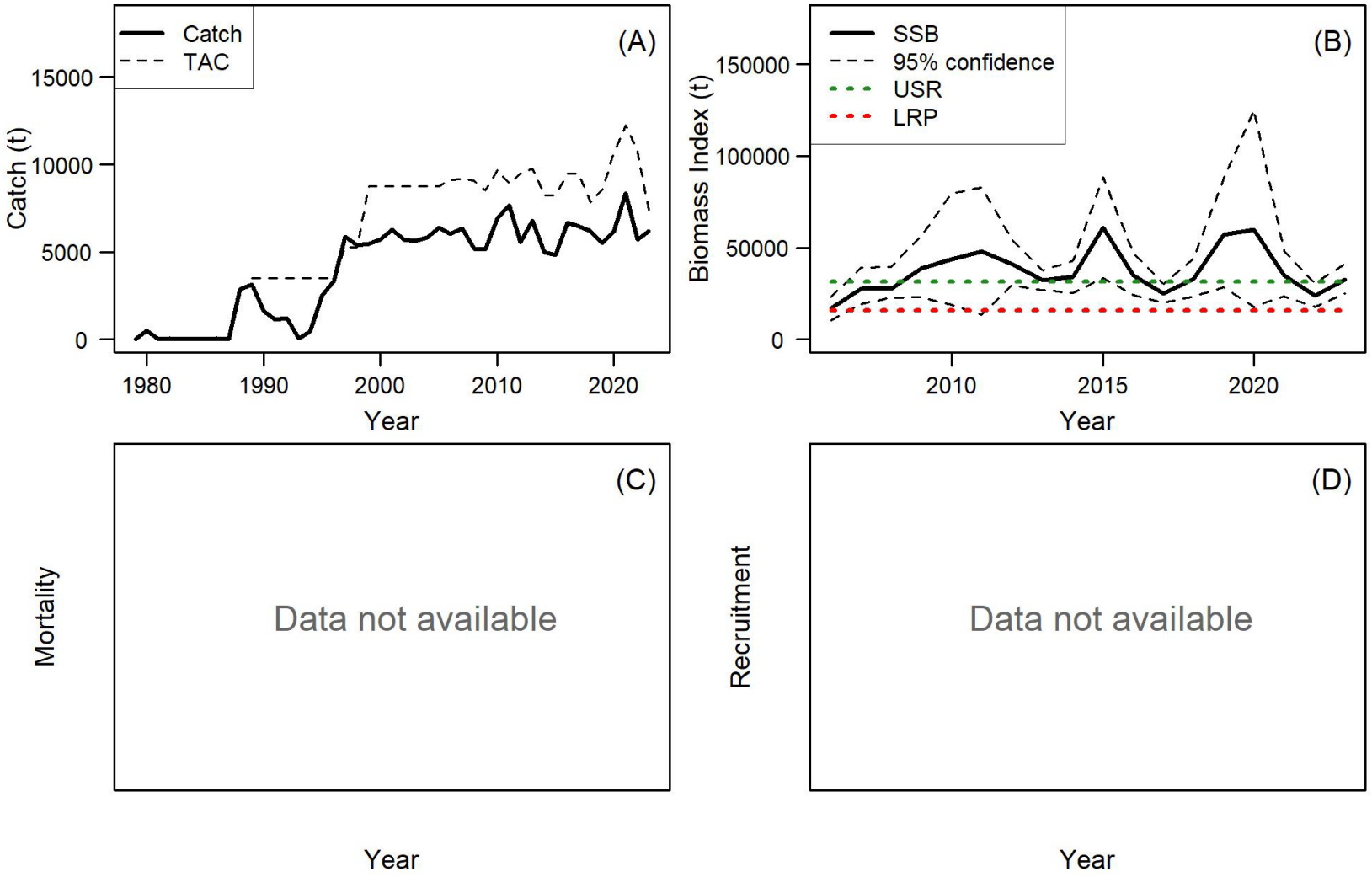

Figure 1. Pandalus borealis *in the Eastern Assessment Zone. (A; top left) Catch (as of January 24, 2024) and Total Allowable Catch (TAC), (B; top right) Spawning Stock Biomass (SSB) in relation to the Limit Reference Point (LRP; 15,800 t) and (proposed) Upper Stock Reference (USR; 31,600 t), (C; bottom left) Fishing Mortality, (D; bottom right) Recruitment.*

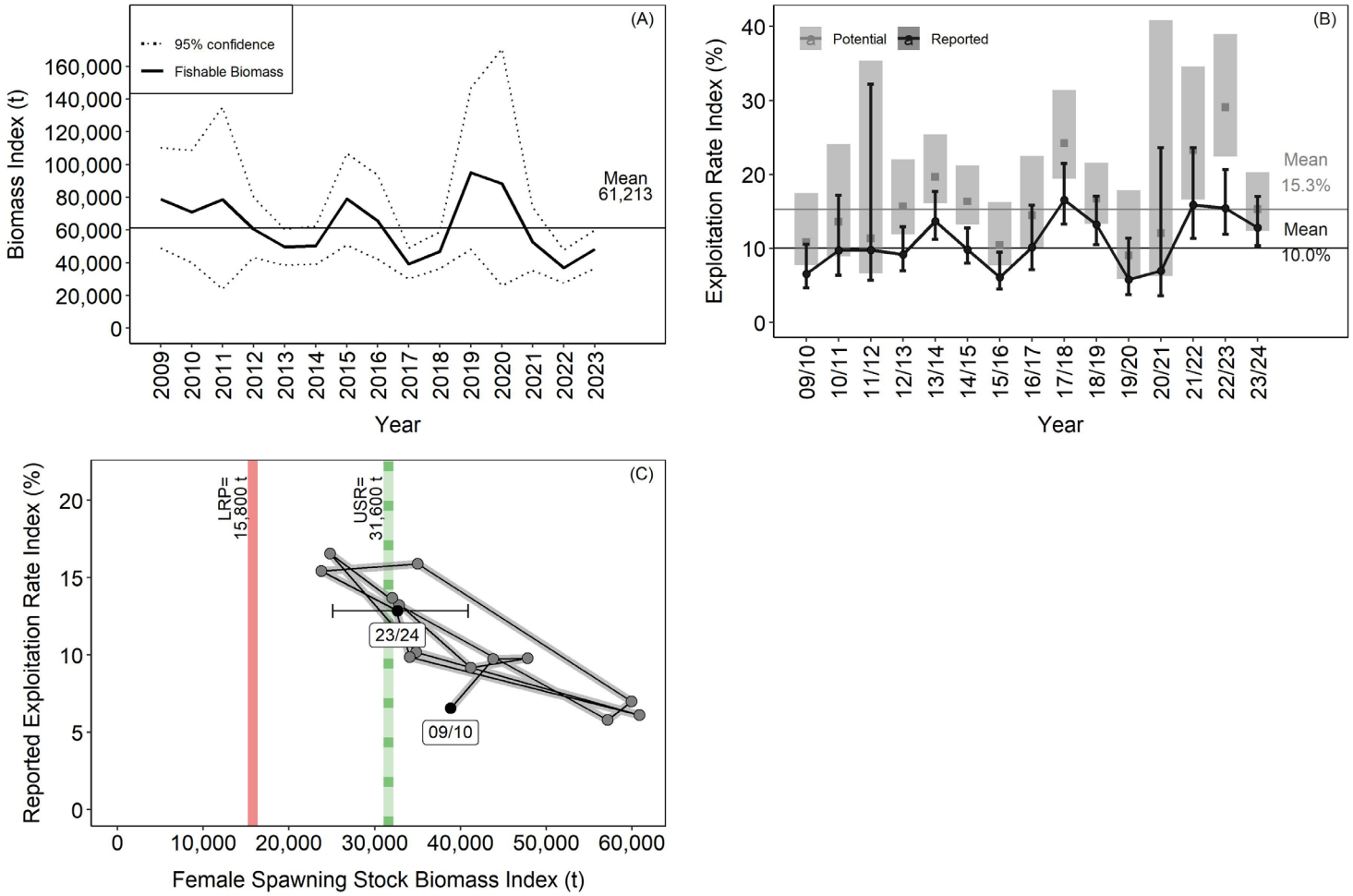

Figure 2. Pandalus borealis *in the Eastern Assessment Zone. (A; top left) Fishable Biomass Index, horizontal lines are long-term (2009–2022) geometric means. (B; top right) Exploitation rate indices for management years 2009/10–2023/24 at the reported rate based on the total catch (solid black line) and at the potential rate if the TAC was fully harvested (grey shading) as of January 24, 2024. Error bars based on bootstrapped 95% confidence ranges of the fishable biomass and horizontal lines are long-term (2009–2022) geometric means. (C: bottom left) Female spawning stock biomass (SSB) and reported exploitation rate in relation to the Limit Reference Point (LRP; 15,800 t) and (proposed) Upper Stock Reference (USR; 31,600 t).*

Historical and Recent Stock Trajectory and Trends – *P. montagui*

Biomass

Both the FB and SSB indices varied without trend from 2009–2023. The FB in 2023 (14,137 t; Figure 4a) was similar (-1.3% change) to the 2022 value and remained above both the long term mean (2009–2022; 12,525 t) and reference period mean (2009–2019; 11,715 t). The SSB in 2023 (6,829 t; Figure 3b) declined (-34.5%) relative to the 2022 value and fell below both the long term mean (2009–2022; 8,405 t) and reference period mean (2009–2019; 7,644 t).

Fishery

Total catch in 2023/24 was 173 t, 8.24% of the 2,100 t TAC (Figure 3a). Catch statistics in 2023/24 are preliminary and based on the AQMS data as of January 24, 2024.

Exploitation

As of January 24, 2024, the reported exploitation rate index for 2023/24 was 1.22% with only 8.24% of the total allowable catch (TAC) taken (Figure 4b). Should the entire 2023/24 TAC of 2,100 t be taken, the exploitation rate index would be 14.9%.

Current Outlook

Despite a decline in SSB, the *P. montagui* stock in the EAZ is currently above both the established LRP (3,100 t) and the proposed USR (6,100 t; Figure 4c). Should the USR be established at the proposed level of 6,100 t (i.e., 80% of the geometric mean of the SSB; DFO 2020), the stock in 2023 would be in the Healthy zone of the PA Framework with a 66.7% probability.

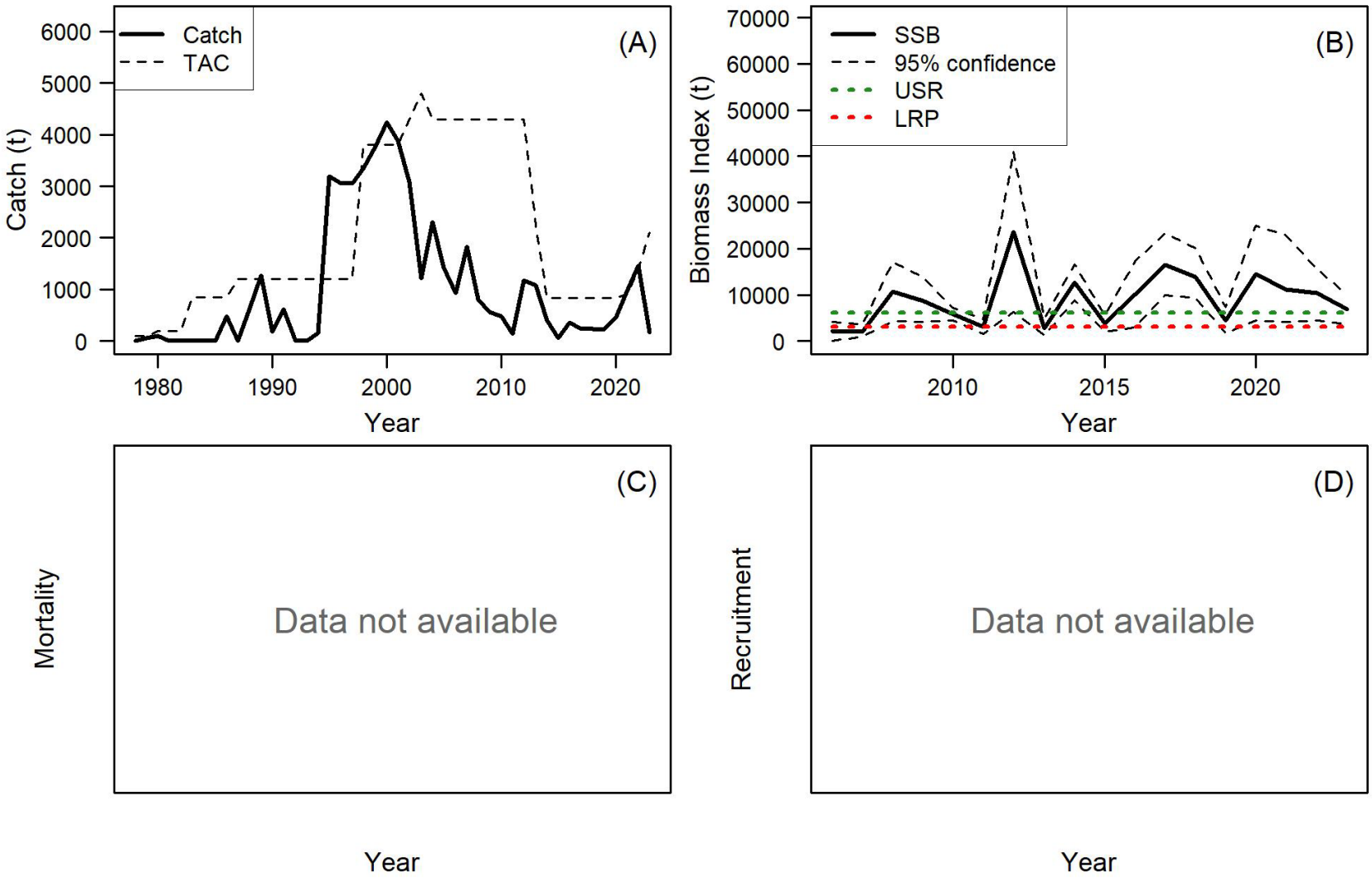

Figure 3. Pandalus montagui *in the Eastern Assessment Zone. (A; top left) Catch (as of January 24, 2024) and Total Allowable Catch (TAC), (B; top right) Spawning Stock Biomass (SSB) in relation to the Limit Reference Point (LRP; 3,100 t) and (proposed) Upper Stock Reference (USR; 6,100 t), (C; bottom left) Fishing Mortality, (D; bottom right) Recruitment.*

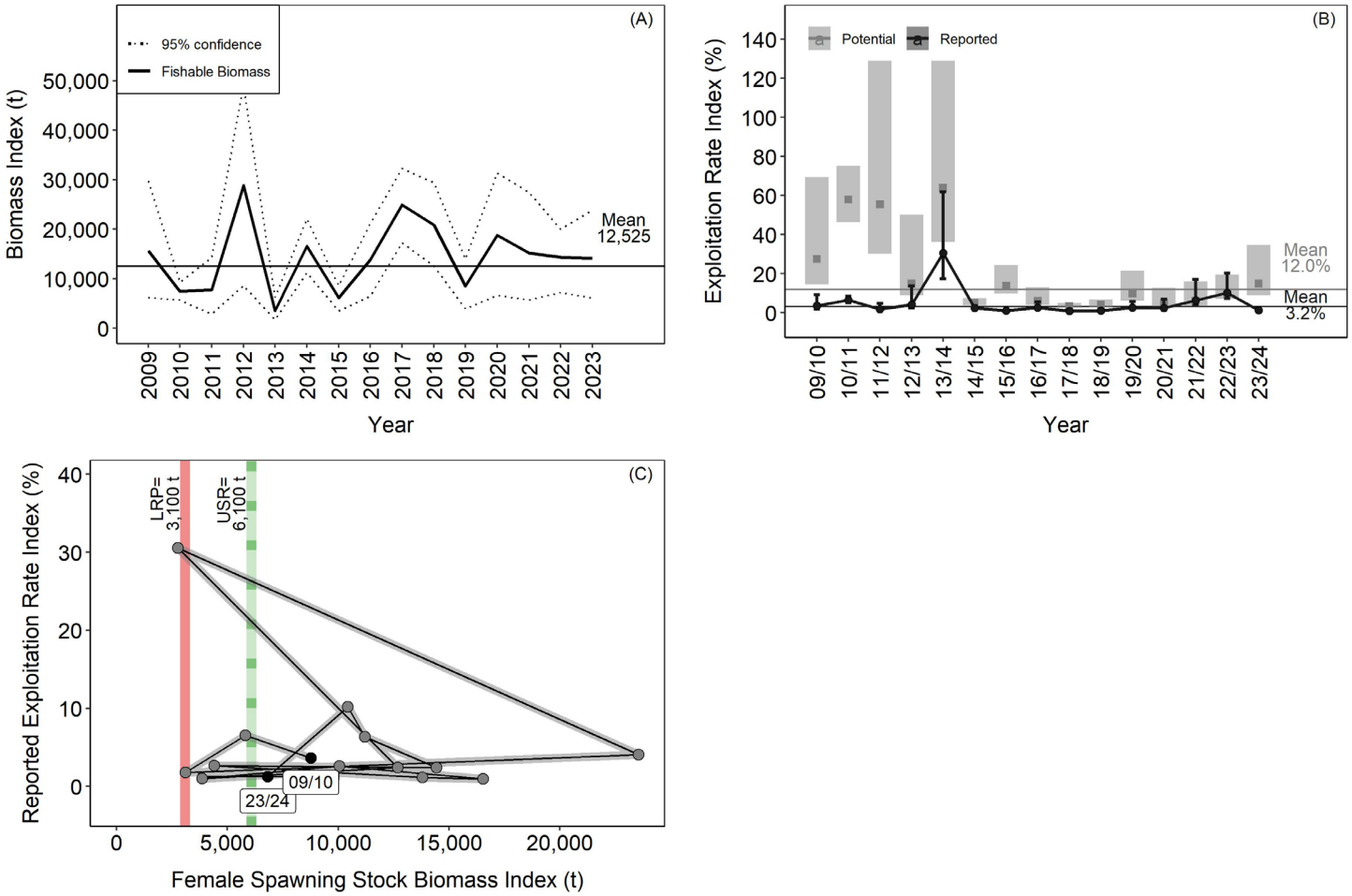

Figure 4. Pandalus montagui *in the Eastern Assessment Zone. (A: top left) Fishable Biomass Index, horizontal lines are long-term (2009–2022) geometric means. (B: top right) Exploitation rate indices for management years 2009/10–2023/24 at the reported rate based on the total catch (solid black line) and at the potential rate if the TAC was fully harvested (grey shading) as of January 24, 2024. Error bars based on bootstrapped 95% confidence ranges of the fishable biomass and horizontal lines are long-term (2009–2022) geometric means. (C: bottom left) Female spawning stock biomass (SSB) and reported exploitation rate in relation to the Limit Reference Point (LRP; 3,100 t) and (proposed) Upper Stock Reference (USR; 6,100 t).*

History of Landings

Table 2. Nominal reported catches (t) for the Eastern Assessment Zone for Pandalus borealis *and* Pandalus montagui*. Catch based on AQMS as of January 24, 2024. Catches for 2023/24 are considered preliminary.*

Year	Eastern Assessment Zone	
	P. borealis	***P. montagui***
2023/24	6,188	173
2022/23	5,691	1,460
2021/22	8,359	965
2020/21	6,165	447
2019/20	5,508	225
2018/19	6,198	234
2017/18	6,488	233
2016/17	6,667	358
2015/16	4,816	59
2014/15	4,972	401
2013/14	6,793	1,075
2012/13	5,555	1,173
2011/12	7,687	135
2010/11	6,908	483
2009/10	5,159	564
2008/09	5,184	808
2007/08	6,359	1,832
2006/07	6,028	925
2005/06	6,387	1,427
2004/05	5,842	2,301
2003/04	5,617	1,217
2002/03	5,695	3,081
2001/02	6,275	3,867
2000/01	5,718	4,238
Avg 1995–99	4,533	3,288
Avg 1990–94	904	190
Avg 1985–89	1,211	470
Avg 1979–84	93	28

Projections

Projections or simulations have not been developed for this assessment as it is index-based and data driven.

Ecosystem and Climate Change Considerations

Environmental and climate change considerations were not updated or reviewed during this Science Response Report. The following information is a summary taken from the last full assessment (Fulton et al. 2024).

It is believed that the habitat available to shrimp is shaped, to a great extent, by the oceanographic conditions present in the area. Fluctuations in the Northwest Atlantic ocean climate have potential impacts on the availability of optimal Pandalid habitat and/or predator-prey interactions in the EAZ. These potential impacts on Pandalid shrimp productivity have not yet been quantified for shrimp stocks in the EAZ or incorporated into the assessment.

Shrimp are known to be an important food source for a number of predator species, e.g., Greenland Halibut (*Reinhardtius hippoglossoides*), American Plaice (*Hippoglossoides platessoides*), Atlantic Cod (*Gadus morhua*), skates (Rajidae) and redfish (*Sebastes* spp.). The amount of shrimp consumed by these predators varies in response to predator stock size and movement within and between assessment areas. Work is ongoing to quantify the impact of these predators on the shrimp stocks in the EAZ to determine the importance of predator-prey dynamics on shrimp biomass variability over the years.

Pandalid shrimp can disperse through various mechanisms but larval dispersion with currents may be a main driver for shrimp movement (Le Corre et al. 2020). It is also known that adult shrimp can move in the water column (particularly males) and be carried away with the currents, thus this mechanism also contributes to shrimp dispersal. The two assessment areas, EAZ and WAZ, along with SFA 4 farther south and SFA 0 and SFA 1 to the north, have no physical boundaries between them and are considered interconnected. The extent of shrimp exported/imported between these areas remains unknown for both larval and adult stages, however, it could be one of the important drivers of year-to-year variability observed in any particular assessment area over time.

SOURCES OF UNCERTAINTY

Typically survey trawl length (i.e., bottom contact) is calculated using trawl sensor data to determine when each trawl starts and stops fishing. In 2023 the primary trawl sensor data were unavailable for 2/3 of the survey trawls, therefore bottom contact time was estimated for the missing trawls (52 of 173 trawls in the EAZ had their data estimated). This estimation was calculated using a regression between bottom contact times measured by CTD (Conductivity, Temperature, Depth sensor) and the primary trawl sensor for the trawls where both were measured. Although this calculation deviates from the typical approach, it is not expected to impact the outcome of the assessment.

Hudson Strait is a highly dynamic system with strong tidal currents and mixing. With speeds up to five knots, the strong currents could result in quick shifts in shrimp distribution and catchability. Shrimp could be transported great distances in a relatively short period of time in and out of the WAZ, EAZ, and SFA 4 to the south. This is most likely the cause of the wide fluctuations in biomass observed within and among assessment areas, even within the same year. Assessing only a subset of a larger population is a source of uncertainty in determining the true status of a resource.

Experimental work done by DFO in 2007 in the Resolution Island area suggests that survey results may be affected by the tidal cycle. In order to reduce the impact of the tidal currents, the surveys were conducted near neap tides as much as possible. However, the survey is conducted around the clock, so strong tidal currents would still be present and may result in either an over- or underestimate of biomass.

Trawls used in the survey are known to have a catchability coefficient 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 is known; however, the total fishery-induced mortality is

unknown (landed catch plus incidental mortality from trawling). Thus, exploitation rates are a relative index rather than absolute.

Four research vessels (Cape Ballard, Aqviq, Kinguk, Katsheshuk II) have been used throughout the time series in the EAZ. Expert opinion was that, given the similarity in the ships' dimensions and use of standardized gear, the relative catchability would be consistent among vessels. However, this assumption has not been empirically tested.

LIST OF MEETING PARTICIPANTS

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Courtney D'Aoust (written review)	DFO – Resource Management, National Capital Region
Dirk Algera	DFO – Resource Management, National Capital Region
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SOURCES OF INFORMATION

DFO. 2007. Assessment Framework for Northern Shrimp (*Pandalus borealis*) off Labrador and the northeastern coast of Newfoundland; 28-30 May 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/034.

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Aussi disponible en français :

*MPO. 2024. Mise à jour des indicateurs de l'état des stocks de crevettes nordiques (*Pandalus borealis*) et de crevettes ésopes (*Pandalus montagui*) dans la zone d'évaluation Est, février 2024. Sec. can. des avis sci. du MPO. Rép. des sci. 2024/017.*