



ASSESSMENT OF NORTHERN SHRIMP, *Pandalus borealis*, AND STRIPED SHRIMP, *Pandalus montagui*, IN THE EASTERN AND WESTERN ASSESSMENT ZONES, FEBRUARY 2019



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

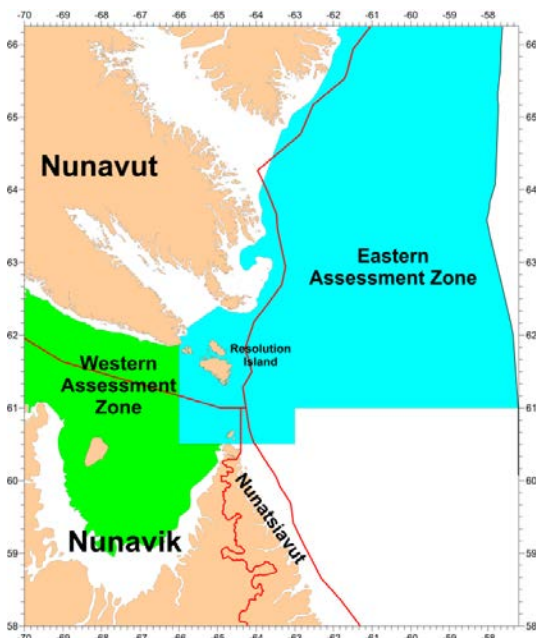


Figure 1. Eastern and Western Assessment Zones. Boundaries of the Nunavut, Nunavik and Nunatsiavut land claims areas are shown in red.

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 and Western Assessment Zones (EAZ and WAZ) were last assessed in 2017 (DFO 2017) and updated in 2018 (DFO 2018). Full assessments are carried out every two years with stock status updates in the intervening years.

The EAZ and WAZ were adopted in 2011 (DFO 2011) as the basis for setting Total Allowable Catch (TAC) for each species within the management areas adjacent to Nunavut. In the 2013/14 fishing season, a new management system was implemented with three new Shrimp Fishing Areas (SFAs), Nunavut, Nunavik and Davis Strait, established to reflect the three jurisdictions present within this area. These new SFAs were further subdivided into management units which fall entirely within either the EAZ or WAZ.

This assessment follows the framework developed in 2007 for Northern Shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007). A series of fishery-independent surveys and fishery data formed the basis of the current assessment.

This Science Advisory Report is from the February 12-14, 2019 Northern and Striped Shrimp Assessment. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

SUMMARY

- The assessment includes 2018 survey biomass indices, fishery data, and fishery exploitation rate indices for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) from the Eastern and Western Assessment Zones (EAZ and WAZ).

Eastern Assessment Zone *Pandalus borealis*

- Total catch varied without trend around 6,000 t from 1997 through 2018/19.
- The fishable biomass index was below the long-term mean (62,412 \pm 13,735 t) in both 2017 and 2018. It increased by 19.6% (from 39,198 t in 2017), to 46,900 t in 2018.
- The female spawning stock biomass (SSB) index was below the long-term mean (38,592 \pm 9,688 t) in both 2017 and 2018. It increased by 32.4% (from 24,800 t in 2017), to 32,842 t in 2018.
- The reported exploitation rate index has varied without trend since 2007/08 and in 2018/19 was slightly above the long-term mean of 10.4 \pm 2.7% with 64% of the TAC taken. Based on the 2018/19 TAC of 7,840 t, the potential exploitation rate index was 16.7%.
- The resource is currently in the Healthy Zone within the [Integrated Fisheries Management Plan Precautionary Approach \(IFMP PA\) framework](#).

Eastern Assessment Zone *Pandalus montagui*

- Total catch in 2018/19 was 150 t, 18% of the 840 t TAC.
- The fishable biomass index was above the long-term mean (13,952 \pm 6,677 t). It decreased by 16.3% (from 24,957 t in 2017) to 20,895 t in 2018.
- The female spawning stock biomass (SSB) index was above the long-term mean (9,787 \pm 6,062 t). It decreased by 16.5% (from 16,537 t in 2017) to 13,806 t in 2018.
- The reported exploitation rate index for 2018/19 was 0.7% with 18% of the TAC taken. Based on the 2018/19 TAC of 840 t, the potential exploitation rate index was 4.0%. Over the last three years, the resource remained in the healthy zone. Previously the resource has shown wide fluctuations year to year in the female SSB index. As a result, caution is advised when setting the TAC.

Western Assessment Zone *Pandalus borealis*

- Total catch was 1,307 t in 2018/19, which is 63% of the 2,080 t TAC.
- The fishable biomass index increased in 2018 to the level above the long-term mean (18,462 \pm 6,476 t). It increased by 101.0% (from 10,487 t in 2017) to 21,088 t in 2018.
- The female SSB index increased in 2018 to the level above the long-term mean (10,063 \pm 3,484 t). It increased by 147% (from 5,216 t in 2017) to 12,884 t in 2018.
- The reported exploitation rate index for 2018/19 was 6.2% with 63% of the TAC taken. Based on the 2018/19 TAC of 2,080 t, the potential exploitation rate index was 9.9%.
- The resource is currently not assessed with a PA framework.

Western Assessment Zone *Pandalus montagui*

- Total catch was 5,530 t in 2018/19, which is 90% of the 6,138 t TAC.
- The fishable biomass index was above the long-term mean (52,228 \pm 18,493t). It increased by 77.7% (from 44,915 t) to 79,835 t in 2018.

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- The SSB index was above the long-term mean (28,799 ±9,980 t). It increased by 57.8% (from 30,305 t in 2017) to 47,834 t in 2018.
- The reported exploitation rate index for 2018/19 was 6.9% with 90% of the TAC taken. Based on the 2018/19 TAC of 6,138 t, the potential exploitation rate index was 7.7%.
- The resource is currently not assessed with a PA framework.

BACKGROUND

Species Biology

Northern Shrimp (*Pandalus borealis*) is found in the Northwest Atlantic from Baffin Bay to the Gulf of Maine, while Striped Shrimp (*P. montagui*) is found from Davis Strait south to the Bay of Fundy. Both species have preferred depth and temperature ranges. *Pandalus montagui* prefers cooler water (-1 to 2°C) than *P. borealis* (0 to 4°C). In the assessment area, these cooler waters tend to occur at shallower depths. The bulk of the biomass of *P. borealis* is located at depths of 300–500 m, while *P. montagui* occur mainly at depths of 200–500 m. Northern Shrimp are associated with soft substrates whereas Striped Shrimp prefer harder bottoms. Since these two species' thermal preference and depth overlap, they are often found occupying the same locations.

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. Both species migrate upwards into the water column during the night. The migration consists mainly of males and smaller females. Shrimp are opportunistic feeders on or near the sea floor and in the water column. 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. *Pandalus* shrimp are important forage species.

Fishery

The fishery is managed by a TAC which is divided into quotas for the 17 offshore license holders and special allocations for Nunavut and Nunavik interests. Changes to the management of the fishery in what were shrimp fishing areas (SFAs) 2 and 3 created new SFAs and Management Units beginning with the 2013/14 fishing season (Figure 2). The 17 offshore license holders have access to fishing grounds in Davis Strait. Their quota is further subdivided by enterprise allocation with each receiving a 1/17 share per license. Nunavut and Nunavik each have quotas that can be fished anywhere within either of their two land claims areas. Nunavut also has quota that can be fished within management unit Davis Strait-East. Nunavut Wildlife Management Board (NWMB) and Nunavik Marine Region Wildlife Board (NMRWB) manage the sub-allocation of their quotas. All fishing to date has been conducted by large vessels with 100% observer coverage.

Fishing gear consists of single and, more recently, twin shrimp trawls requiring a minimum codend mesh size of 40 mm and Nordmøre 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.

Pandalus borealis has been the main commercial species throughout the history of the shrimp fishery in this area. Historically, most of the harvest of *P. montagui* occurred as by-catch in the directed *P. borealis* fishery. Directed fishing for *P. montagui* has become more important especially

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with new quotas available in areas Nunavut-West and Nunavik-West beginning with the 2013/14 fishing season.

The fishery began in the late 1970s in SFA 1. Exploratory fishing expanded into what is now Davis Strait-East management unit (previously 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 Land Claims Agreement in 1999 shifted the main fishery east of the Nunavut Settlement Area.

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 is targeted in the fishery and the composition of the two species in the catch determines which species is designated as directed, which biases CPUE calculations. Over the time period 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 both *P. borealis* and *P. montagui* 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.

Survey data, since the last full assessment, comes from the 2017 and 2018 Northern Shrimp Research Foundation (NSRF) surveys of the EAZ (Resolution Island Study Area (RISA)-W, RISA-E and SFA 2EX) and WAZ (SFA 3) survey areas (Figure 2). Survey data in the EAZ are available for the period of 2005–2018, however, the first two years are not considered comparable with the rest of the series because of incomplete coverage and operational issues; thus only 2008–2018 data are evaluated for the EAZ.

The WAZ (Figure 2) was surveyed biennially by DFO from 2007–2013. Because the WAZ was surveyed by a different ship and gear and at a different time of year, it could not be combined with the survey results of the EAZ. This prevented a comprehensive evaluation of the distributions of shrimp and a more practical look at broader stock implications. 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 address these issues. This action started a new time series for the WAZ. In 2018, the WAZ was surveyed for the fifth year in the new time series. Assessment of the status of the whole population within a PA framework will be undertaken in the near future.

The assessment follows the framework established by DFO (2007). Fishable and female spawning stock biomass (SSB) indices from scientific surveys form the basis of the assessment. Fishable biomass is based on male and female shrimp from the surveys with a carapace length greater than 17 mm. SSB is based on all female shrimp from the surveys regardless of size. The recruitment index was removed from the assessment starting in 2017 as too few recruitment-sized shrimp are caught in the trawl codend during the survey to produce a meaningful index. 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 was calculated assuming the entire TAC was taken. Bootstrapped 95% confidence intervals are included for each of the indices.

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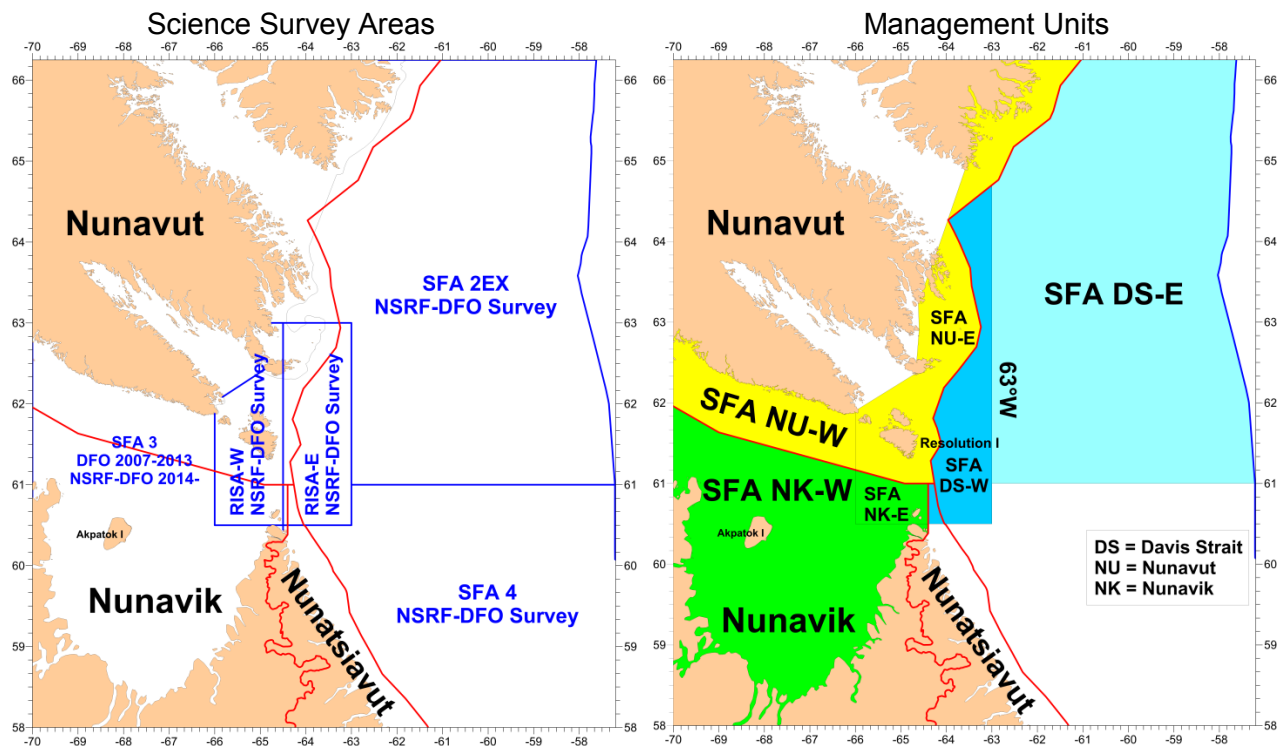


Figure 2. Location of the northern survey areas (left panel) within the Eastern and Western Assessment Zones (Figure 1) and the management units (right panel) referred to in this report. Shrimp Fishing Area (SFA), Exploratory (EX), Resolution Island Study Area (RISA), East (E), West (W), Nunavut (NU), Nunavik (NK) and Davis Strait (DS). Red line shows the borders of the Nunavut, Nunatsiavut and Nunavik Land Claims Areas.

For this assessment, resource status in the EAZ was evaluated within the PA framework (DFO 2006). Reference points were set (DFO 2009) and an IFMP is in place for shrimp in the EAZ. The Limit Reference Point (LRP) is 30% and the Upper Stock Reference (USR) is 80% of the geometric mean of SSB for 2006–2008. Reference Points for the WAZ were developed with the same proxies and adopted at the 2012 Zonal Advisory Process (DFO 2012). They are, however, no longer applicable because 2014 was the start of a new survey time series.

The WAZ was surveyed biennially with the Greenland Institute of Natural Resources’ research vessel *Paamiut* using a Cosmos trawl from 2007–2013. The EAZ was surveyed with the commercial fishing vessels *Cape Ballard* from 2005 to 2011 and *Aqviq* in 2012 and 2013. Both the EAZ and WAZ were surveyed by the commercial fishing vessel *Kinguk* in 2014. In 2015, the commercial fishing vessel *Katsheshuk II* was used, while in the last three years (2016-18) the survey was completed again with the *Aqviq*. A standard Campelen trawl was used to sample the EAZ in 2006 and 2007. In 2008, to improve coverage and reduce the incidence of tear-ups in the RISA survey area, a modified Campelen trawl was developed (Siferd and Legge 2014) and first used. That same year, a standard Campelen trawl was used in the SFA 2EX survey area. The modified Campelen trawl has been used on all NSRF surveys in the EAZ (since 2008) and WAZ (since 2014). There has been no standardization between the Cosmos and the Campelen surveys.

Two additional aspects when interpreting the trawl survey data are worth noting. The first is the strong tidal currents in Hudson Strait, with speeds up to five knots, which could result in quick shifts in shrimp distribution and catchability. The second is that the near-bottom average water temperatures in the WAZ in 2016 and 2017 were the lowest in the survey time series, which might

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have influenced the spatial distribution of the resource in the area and translate into biomass variability in the coming years.

In 2018, on order to protect coral and sponges habitats, the Government of Canada implemented a Marine Conservation Closure in the proximity of Resolution Island. This closure, referred to as the Hatton Basin Conservation Area, has impacted the allocation of the sampling stations visited during the NSRF survey. As a consequence, five deep water strata were removed in the EAZ (three in RISA East, two in SFA2Ex), while another 2 had their areas reduced (both in RISA East). Overall the survey area of the EAZ has been reduced by 11.6%. The Hatton Basin Closure did not impact station allocation in the WAZ. The re-analysis of the shrimp biomass using the revised area (removal/reduction of strata due to Hatton Basin Closure implementation) has shown minimal impact on the past years' results. Fishable biomass was lower by $\bar{x} = 1.3\%$ (range: 0.8-1.5%) and $\bar{x} = 0.1\%$ (range: 0.0-0.2%) for *P. borealis* and *P. montagui*, respectively. Spawning stock biomass was lower by $\bar{x} = 1\%$ (range: 0.5-1.8%) and $\bar{x} = 0.1\%$ (range: 0.0-0.2%) for *P. borealis* and *P. montagui*, respectively. Thus, considering negligible impact of the closure on biomass indices, it has been determined that there is no need to revise the Reference Points of the Precautionary Approach Framework in the EAZ.

Eastern Assessment Zone – *P. borealis*

Fishery

Catch has varied without trend around 6,000 t from 1997 through 2018/19 (Figure 3). The total reported catch for 2018/19, based on the Canadian Atlantic Quota Report (CAQR), as of December 18, 2018, was 5,000 t, 64% of the TAC (7,840 t).

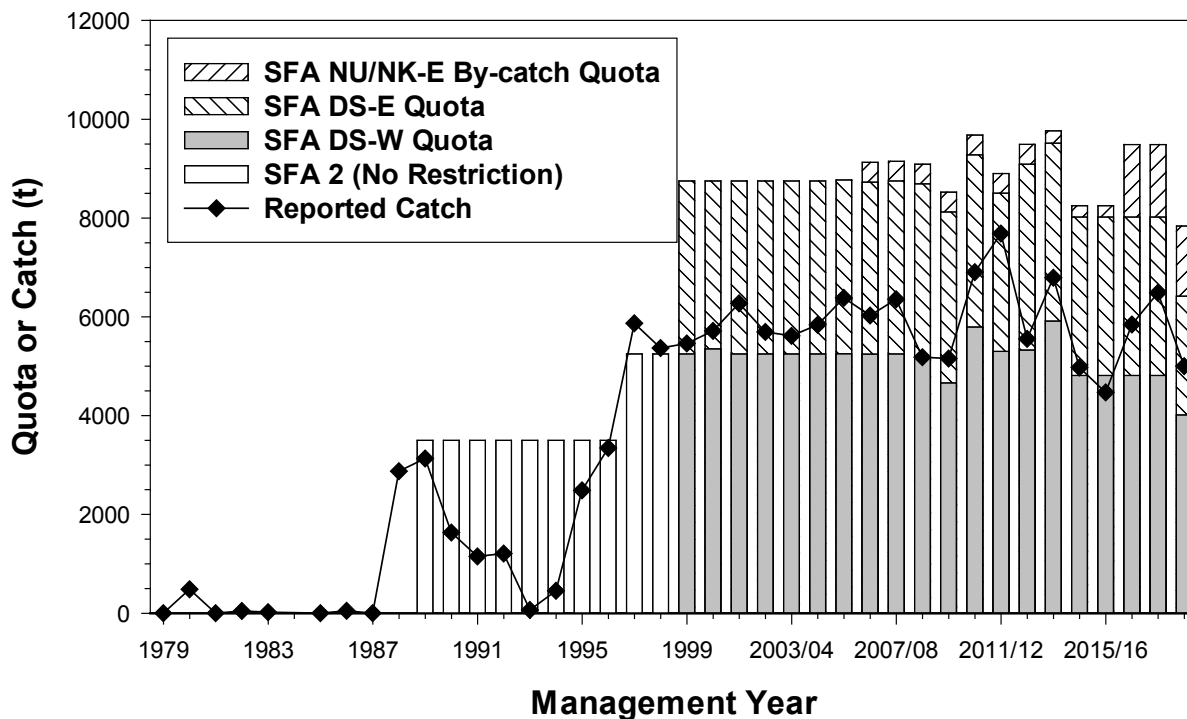


Figure 3. Eastern Assessment Zone *Pandalus borealis* TAC and catch reported by the Canadian Atlantic Quota Report (CAQR). CAQR records may be incomplete for 2018/19 (data as of December 18, 2018).

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Biomass

The fishable biomass index was below the long-term mean (62,412 t) in both 2017 and 2018. It increased by 19.6% (from 39,198 t in 2017), to 46,900 t in 2018 (Figure 4a). The female spawning stock biomass (SSB) index was below the long-term mean (38,592 t) in both 2017 and 2018. It increased by 32.4% (from 24,800 t in 2017), to 32,842 t in 2018 (Figure 4b).

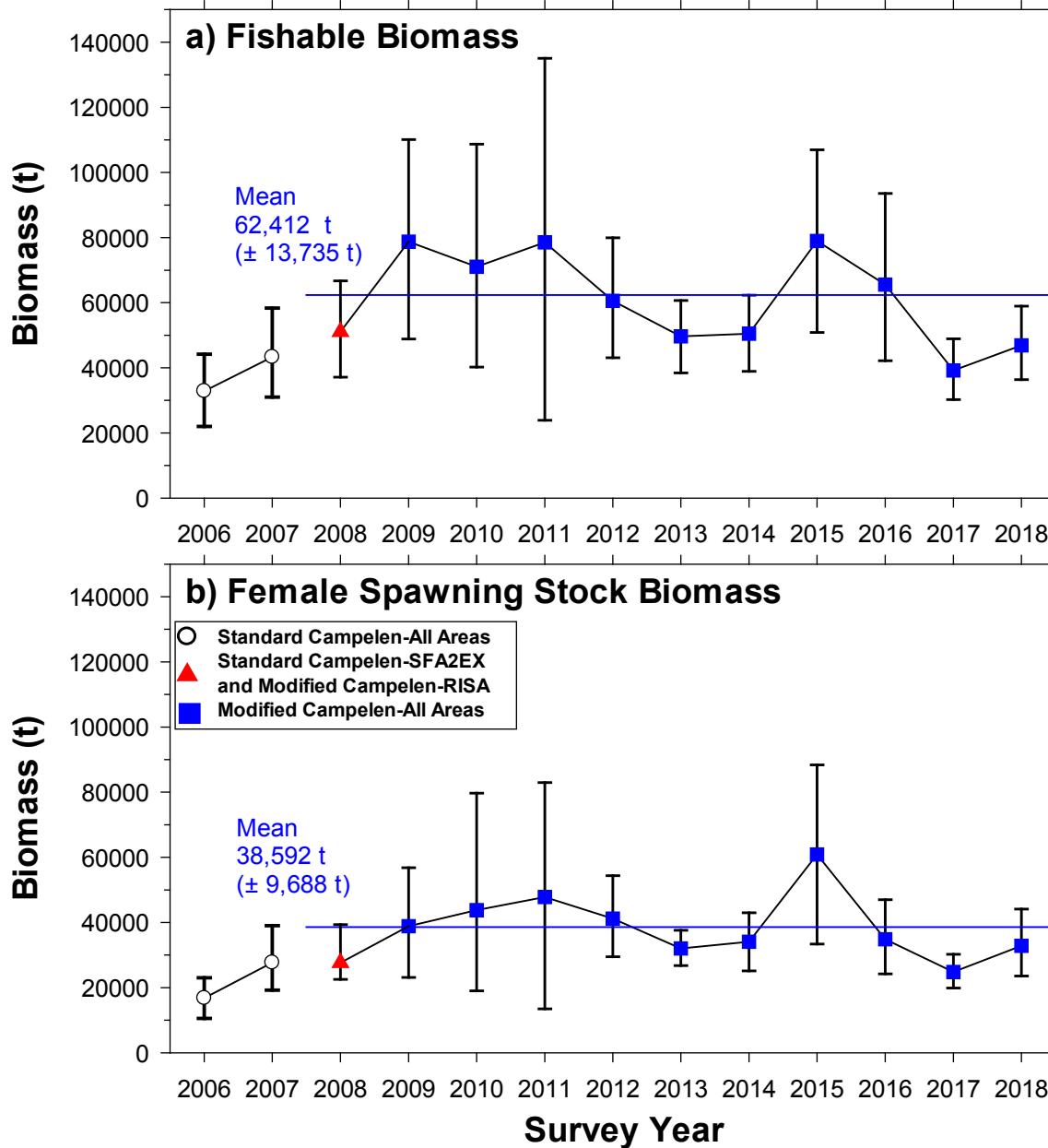


Figure 4. The Eastern Assessment Zone fishable and female spawning stock biomass indices of *Pandalus borealis* for the survey years 2006–2018. The first two years of survey data (2006–2007) are not considered to be comparable with the rest of the series because of poor trawl performance around Resolution Island. Error bars are 95% confidence ranges.

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Exploitation

The reported exploitation rate index (Figure 5a) has varied without trend since 2007/08 and in 2018/19 was slightly above the long-term mean of 10.4% with 64% of the TAC taken. Based on the 2018/19 TAC of 7,840 t, the potential exploitation rate index was 16.7% (Figure 5b).

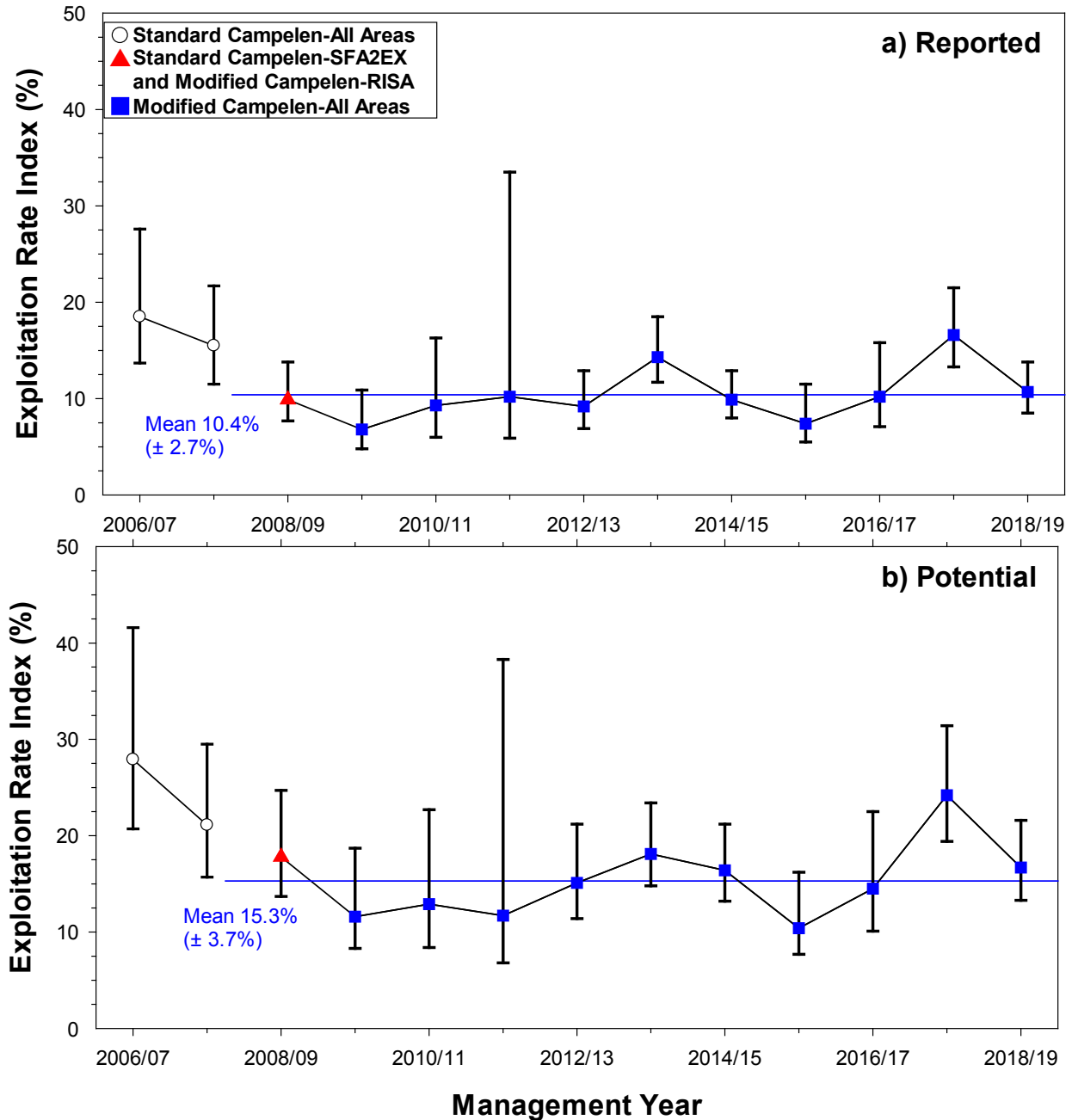


Figure 5. The Eastern Assessment Zone *Pandalus borealis* exploitation rate indices for a) the reported rate based on the catch taken and b) the potential rate if the TAC assigned to the zone was taken. The first two years of survey data (2006–2007) are not considered to be comparable with the rest of series because of poor trawl performance around Resolution Island. Error bars are 95% confidence ranges.

Current Outlook

The 2018/19 female SSB is currently well within the Healthy Zone of the IFMP PA Framework (Figure 6). There is very little chance of transgressing the Upper Stock Reference.

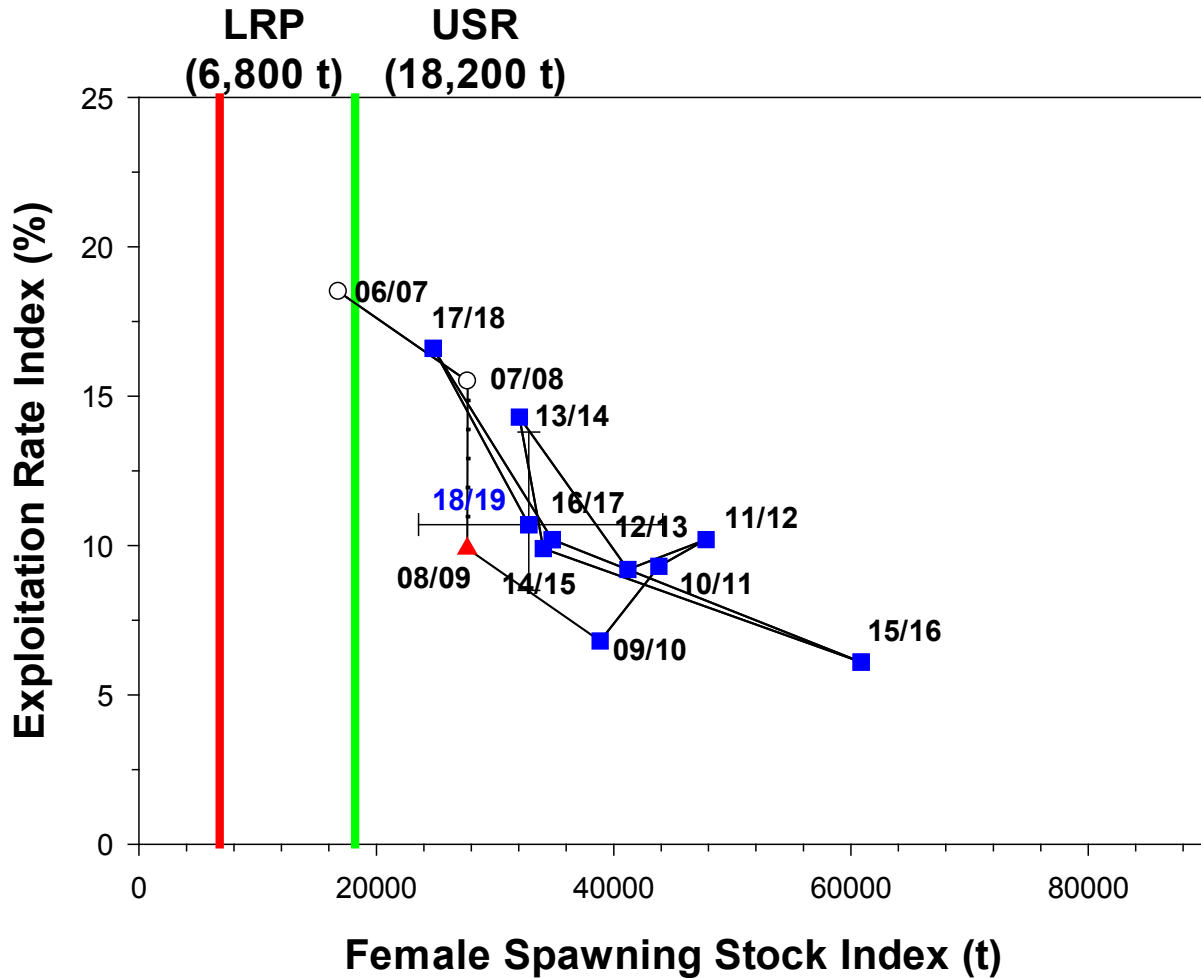


Figure 6. The Eastern Assessment Zone trajectory of *Pandalus borealis* female spawning stock biomass and exploitation rate indices in relation to its reference points. USR=Upper stock reference and LRP=limit reference point are 80% and 30% respectively of the geometric mean of the SSB index (2006–2008 in SFA 2). Error bars around the 2018/19 data point are 95% confidence ranges.

Eastern Assessment Zone – *P. montagui*

Fishery

Total catch in 2018/19 was 150 t, 18% of the 840 t TAC (Figure 7). Catch statistics in 2018/19 are preliminary and based on the CAQR data as of December 18, 2018.

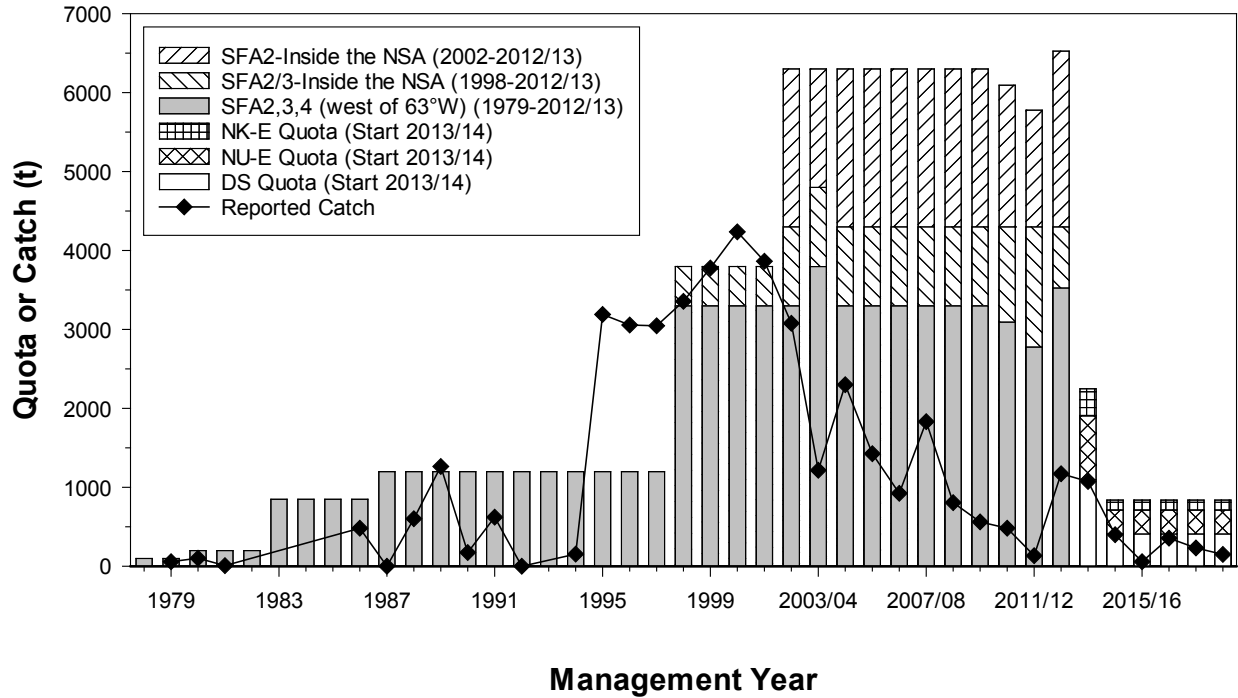


Figure 7. Eastern Assessment Zone *Pandalus montagui* TAC and catch reported in the Canadian Atlantic Quota Report (CAQR). CAQR records may be incomplete for 2018/19 (data as of December 18, 2018).

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Biomass

Biomass indices have fluctuated widely from 2011 to 2018 making the interpretation of stock status challenging. The fishable biomass index was above the long-term mean (13,952 t). It decreased by 16.3% (from 24,957 t in 2017) to 20,895 t in 2018 (Figure 8a). The female spawning stock biomass (SSB) index was above the long term mean (9,787 t). It decreased by 16.5% (from 16,537 t in 2017) to 13,806 t in 2018 (Figure 8b). The fluctuations in biomass indices are likely a result from a resource transfer across management boundaries rather than local dynamics within a population.

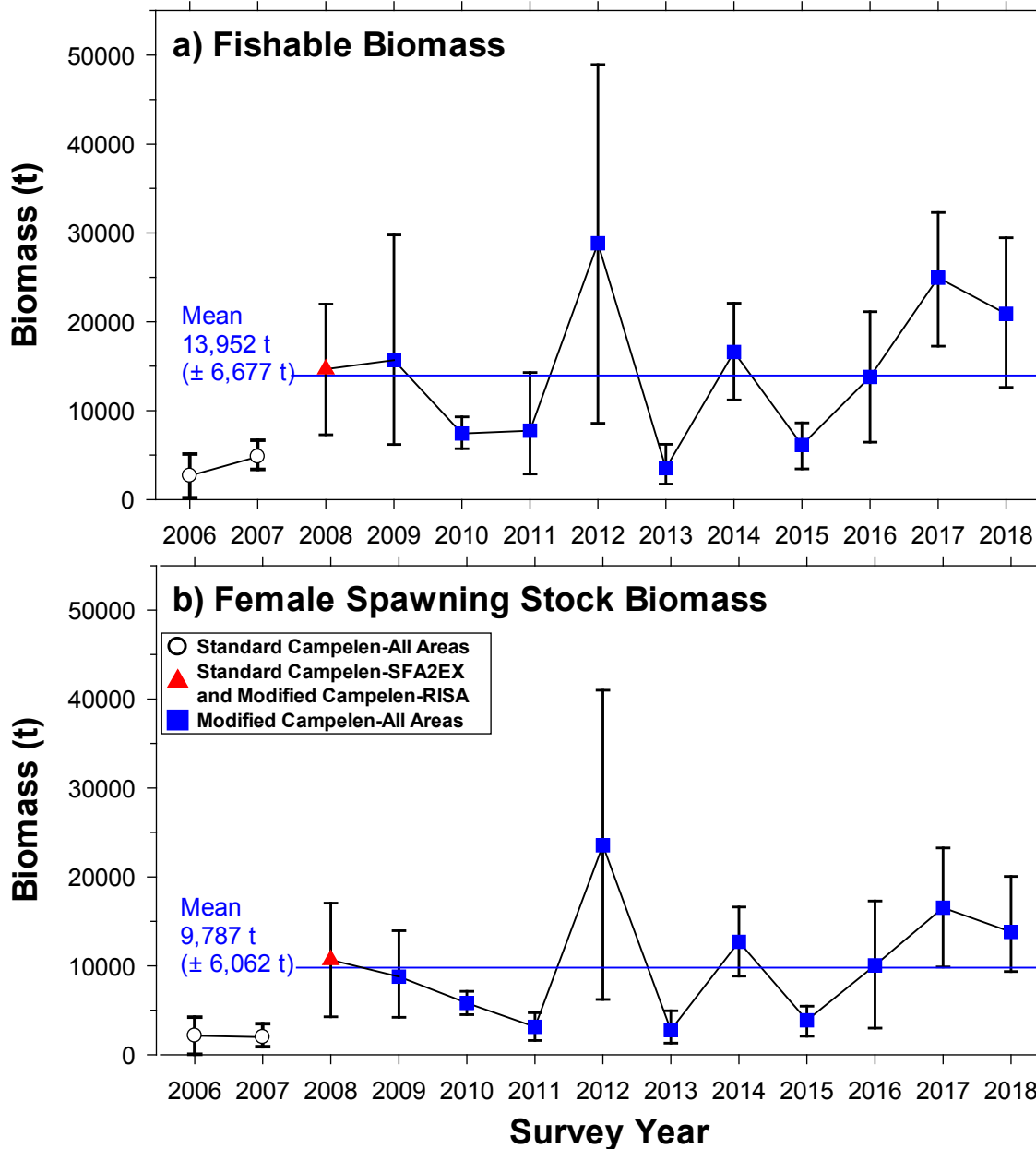


Figure 8. The Eastern Assessment Zone *Pandalus montagui* fishable and female spawning stock biomass indices for the survey years 2006–2018. Error bars are 95% confidence ranges.

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Exploitation

The reported exploitation rate index for 2018/19 was 0.7% with 18% of the TAC taken (Figure 9a). Based on the 2018/19 TAC of 840 t, the potential exploitation rate index was 4.0% (Figure 9b).

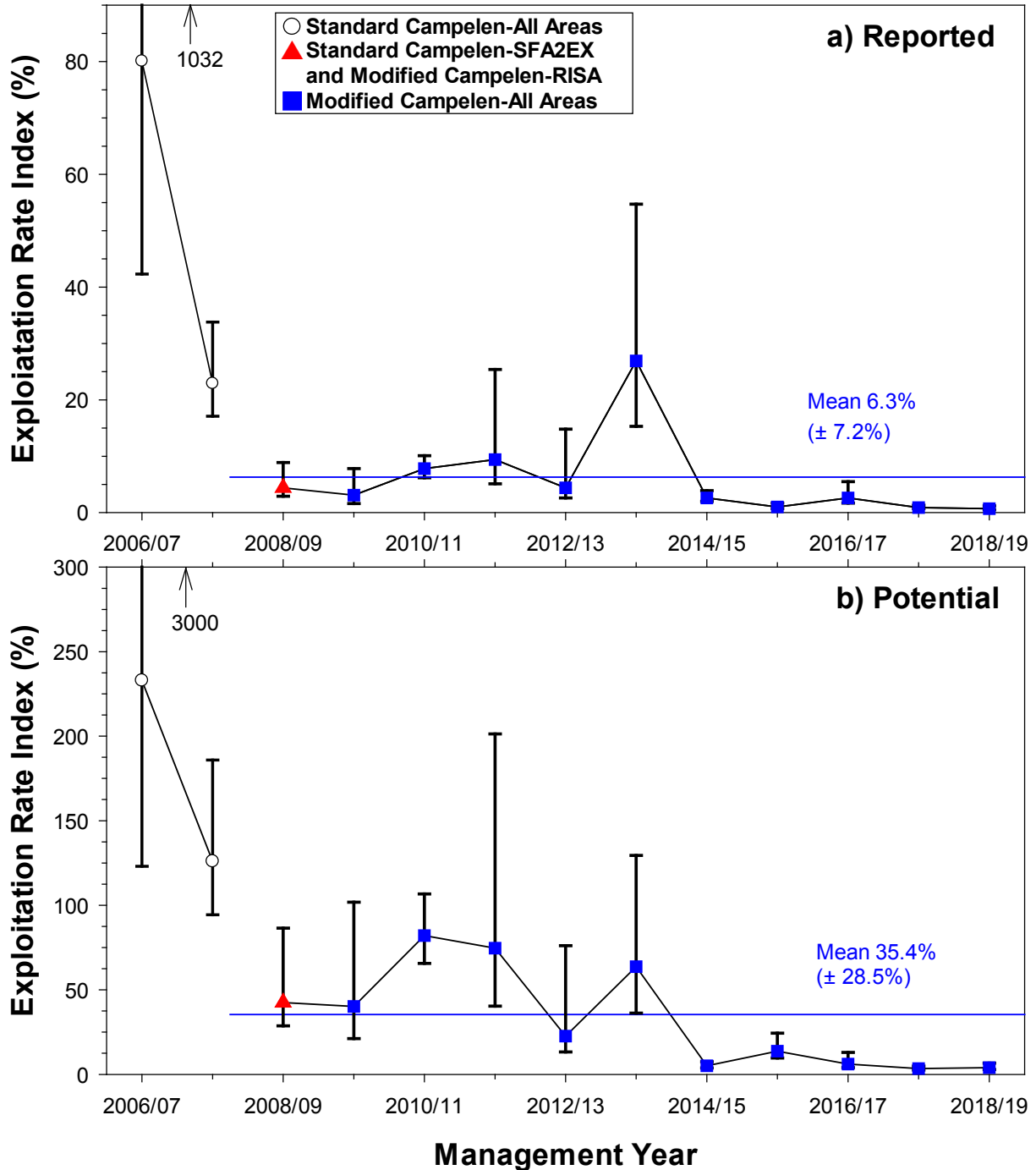


Figure 9. The Eastern Assessment Zone *Pandalus montaguui* exploitation rate indices for a) the reported rate, based on the catch taken and b) the potential rate if the TAC was taken. Error bars are 95% confidence ranges. Upper confidence limit for 2006/07 is shown numerically.

Current Outlook

Over the last three years, the resource remained in the healthy zone. Previously the resource has shown wide fluctuations year to year in the female SSB index (Figure 10). As a result, caution is advised when setting the TAC.

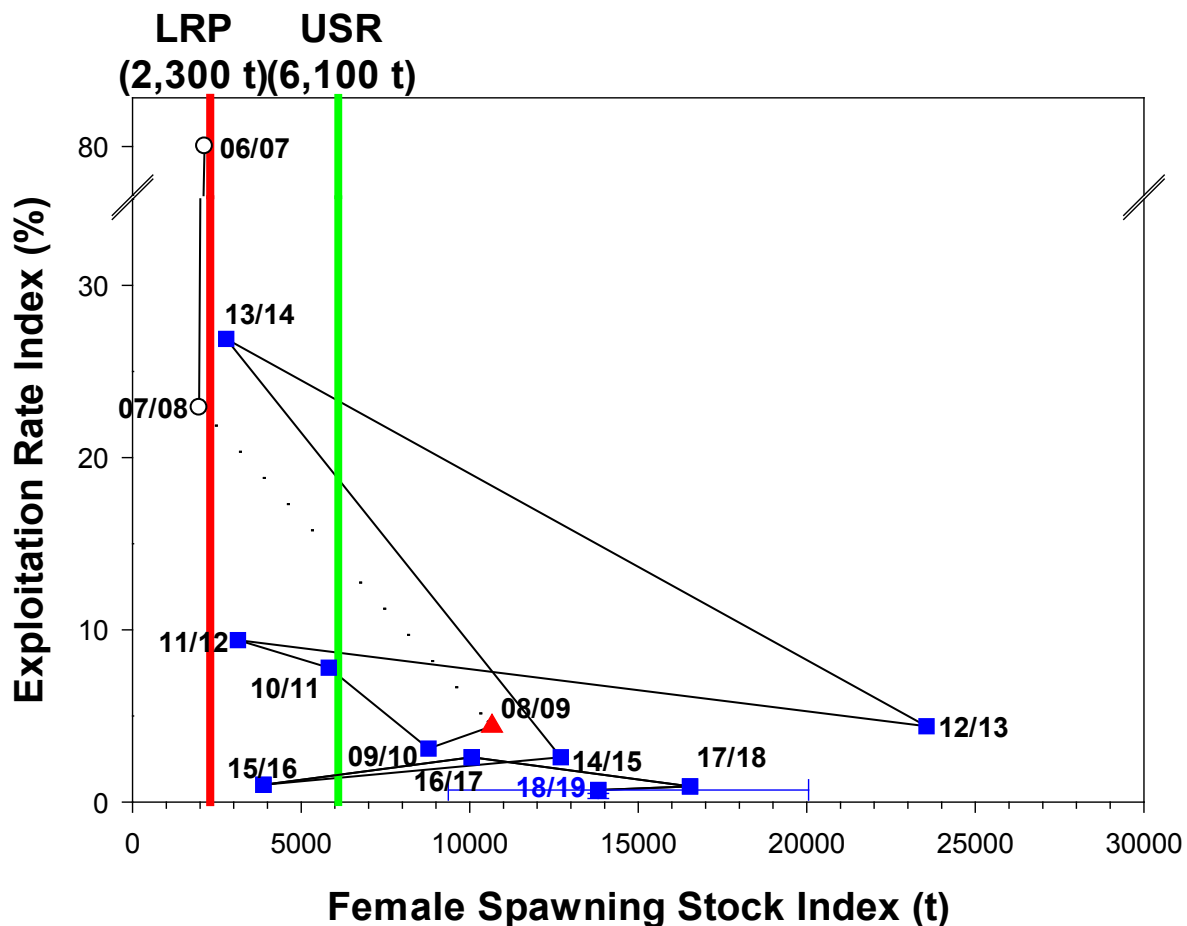


Figure 10. The Eastern Assessment Zone trajectory of *Pandalus montagui* female spawning stock biomass and exploitation rate indices in relation to its reference points. USR=Upper stock reference and LRP=limit reference point are 80% and 30% respectively of the geometric mean of the SSB index (2006–2008 in SFA 2). Error bars are 95% confidence ranges.

Western Assessment Zone – *P. borealis*

Fishery

With the implementation of new management areas in the north, quotas for directed fishing were established for the first time for the 2013/14 fishing year at 1,500 t (Figure 11). The TAC was increased to 2,080 t for 2014/15 and has been maintained at this level. The total reported catch for 2018/19, based on the CAQR, as of December 18, 2018, was 1,307 t in 2018/19, which is 63% of the 2,080 t TAC.

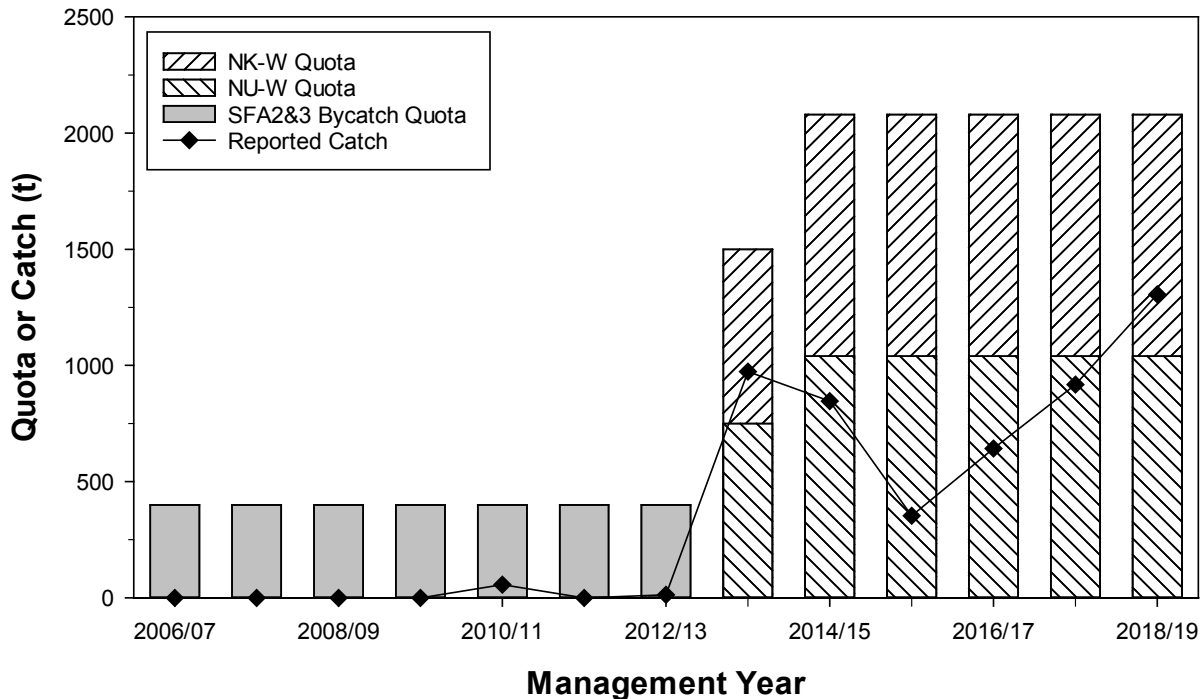


Figure 11. The Western Assessment Zone *Pandalus borealis* TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR) for 2018/19 and observer records prior to 2013/14. Catch records from CAQR as of December 18, 2018.

Biomass

The 2014 survey began a new time series, not directly comparable with previous surveys because no trawl standardization between the DFO/Cosmos and NSRF-DFO/Campelen surveys had taken place. Thus, the 2018 survey was the fifth survey in the new time series. Both the fishable biomass and SSB indices varied without a trend. The fishable biomass index increased in 2018 to the level above the long-term mean (18,462 t). It increased by 101.0% (from 10,487 t in 2017) to 21,088 t in 2018 (Figure 12a). The female SSB index increased in 2018 to the level above the long-term mean (10,063 t). It increased by 147% (from 5,216 t in 2017) to 12,884 t in 2018 (Figure 12b).

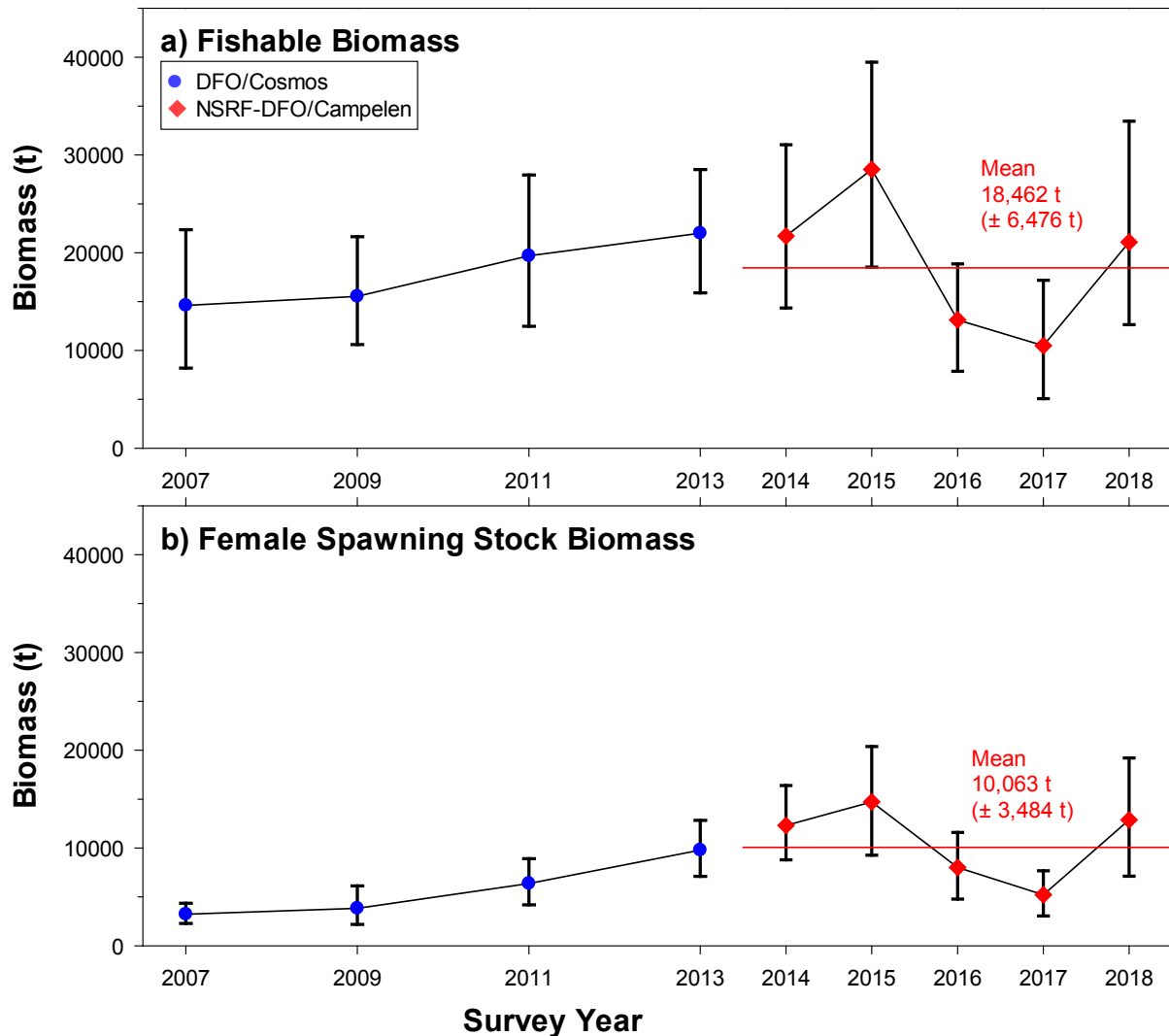


Figure 12. Western Assessment Zone *Pandalus borealis*, a) fishable biomass and b) female spawning stock biomass indices for the four DFO/Cosmos surveys (blue diamonds). The 2014–2018 NSRF-DFO/Campelen surveys (red diamonds) represent the new time series for the WAZ. Error bars are 95% confidence ranges.

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Exploitation

The reported exploitation rate index for 2018/19 was 6.2% with 63% of the TAC taken (Figure 13a). Based on the 2018/19 TAC of 2,080 t, the potential exploitation rate index was 9.9% (Figure 13b).

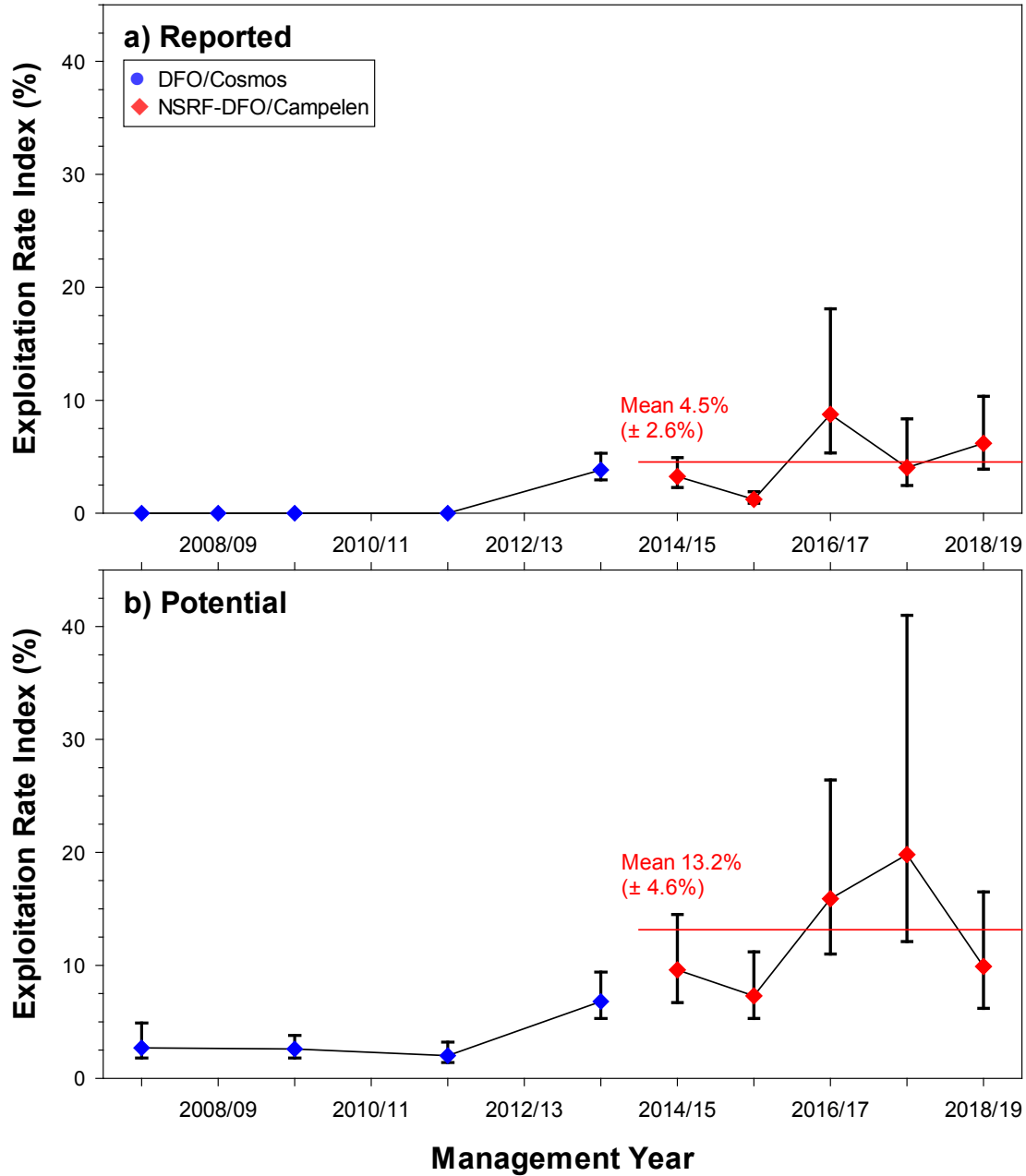


Figure 13. The Western Assessment Zone *Pandalus borealis* exploitation rate indices for the a) reported rate, based on the Canadian Atlantic Quota Report catch and the b) potential rate if the entire TAC assigned to the zone was taken. Included are four DFO/Cosmos surveys (blue diamonds), and the 2014–2018 NSRF-DFO/Campelen surveys (red diamonds) represent the new time series for the WAZ. Error bars are 95% confidence ranges.

Current Outlook

Considering the variability in the assessed *P. borealis* biomass, the current outlook for the resource remains unknown. In the WAZ, the resource is currently not assessed under a PA framework, however work is underway to establish the PA framework within the next two years.

Western Assessment Zone – *P. montagui*

Fishery

With the implementation of new management areas in the north, quotas for directed fishing were established for the first time for the 2013/14 fishing year at 5,000 t (Figure 14). The TAC was increased to 5,860 t for 2014/15, and increased further to 6,138 t in 2015/16 and has been maintained at this level (Figure 14). The total reported catch for 2018/19, based on the CAQR, as of December 18, 2018, was 5,530 t, 90% of the TAC.

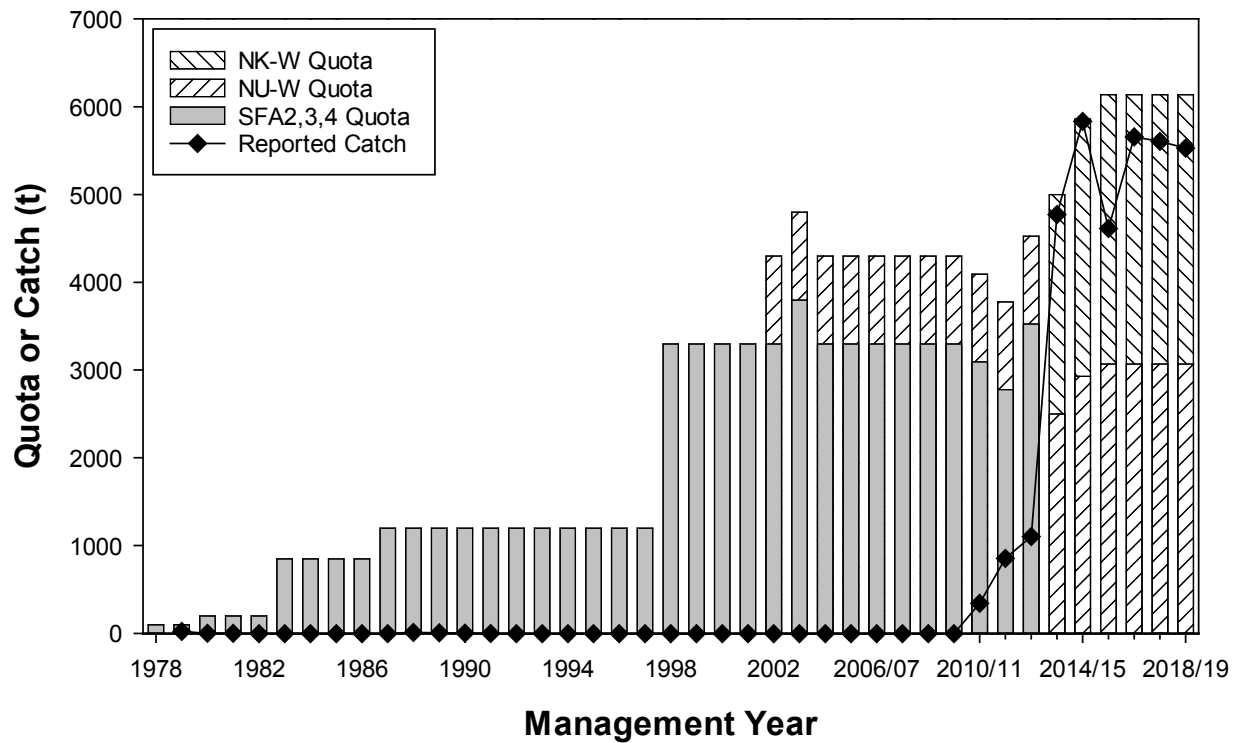


Figure 14. The Western Assessment Zone *Pandalus montagui* TAC and catch recorded in the Canadian Atlantic Quota Report (CAQR) for 2018/19 and observer records prior to 2013/14. Catch records from CAQR as of December 18, 2018.

Biomass

The 2014 survey began a new time series, not directly comparable with previous surveys because there was no trawl standardization between the DFO/Cosmos and NSRF-DFO/Campelen surveys. Thus, the 2018 survey was the fifth survey in the new time series. The fishable biomass index was above the long-term mean (52,228 t). It increased by 77.7% (from 44,915 t) to 79,835 t in 2018 (Figure 15a). The SSB index was above the long-term mean (28,799 t). It increased by 57.8% (from 30,305 t in 2017) to 47,834 t in 2018 (Figure 15b).

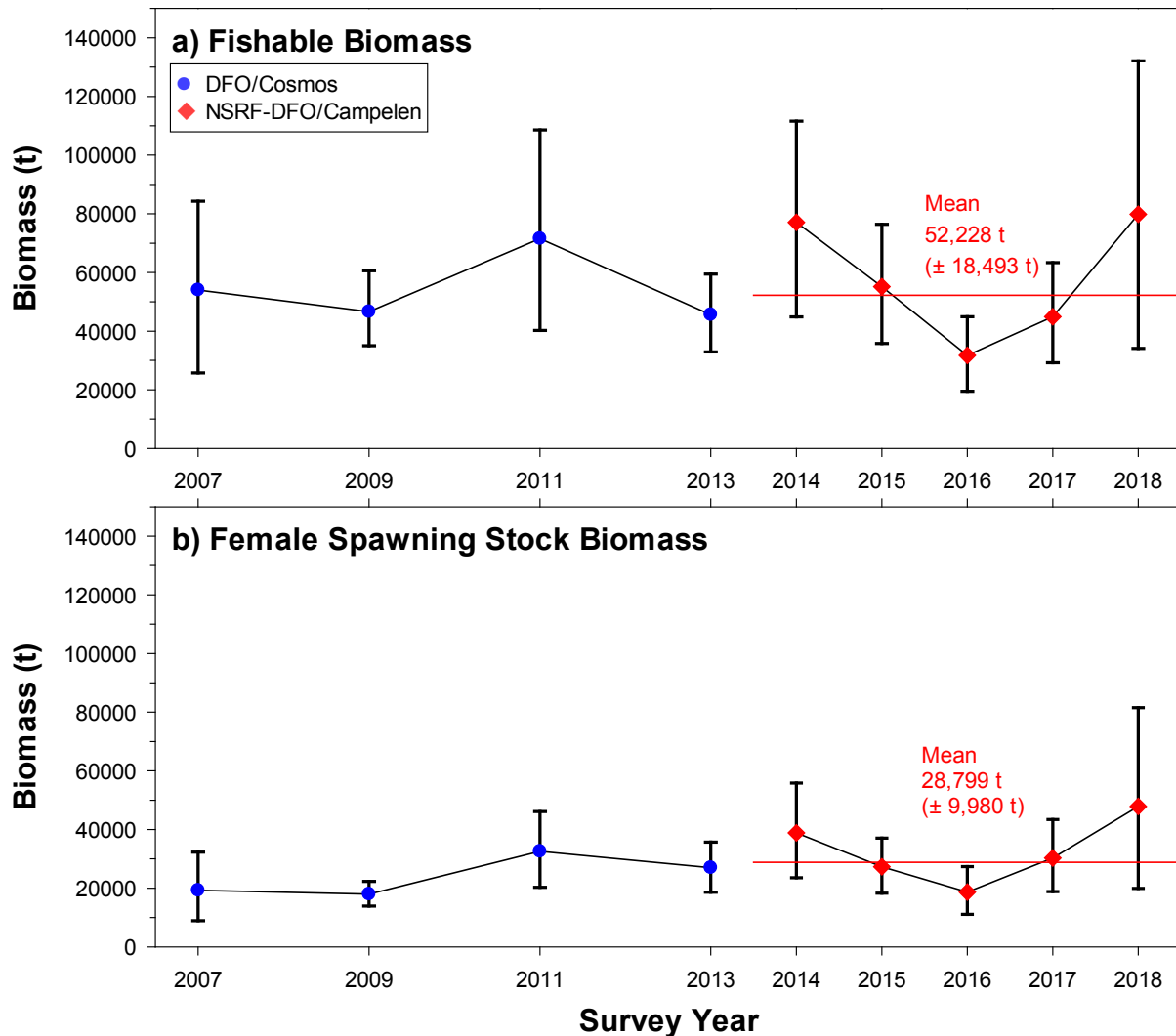


Figure 15. Western Assessment Zone *Pandalus montagui*, a) fishable biomass and b) female spawning stock biomass indices. Included are four DFO/Cosmos surveys (blue diamonds), and the 2014–2018 NSRF-DFO/Campelen survey (red diamonds) which represents the new time series. Error bars are 95% confidence ranges.

Exploitation

The reported exploitation rate index for 2018/19 was 6.9% with 90% of the TAC taken (Figure 16a). Based on the 2018/19 TAC of 6,138 t, the potential exploitation rate index was 7.7% (Figure 16b).

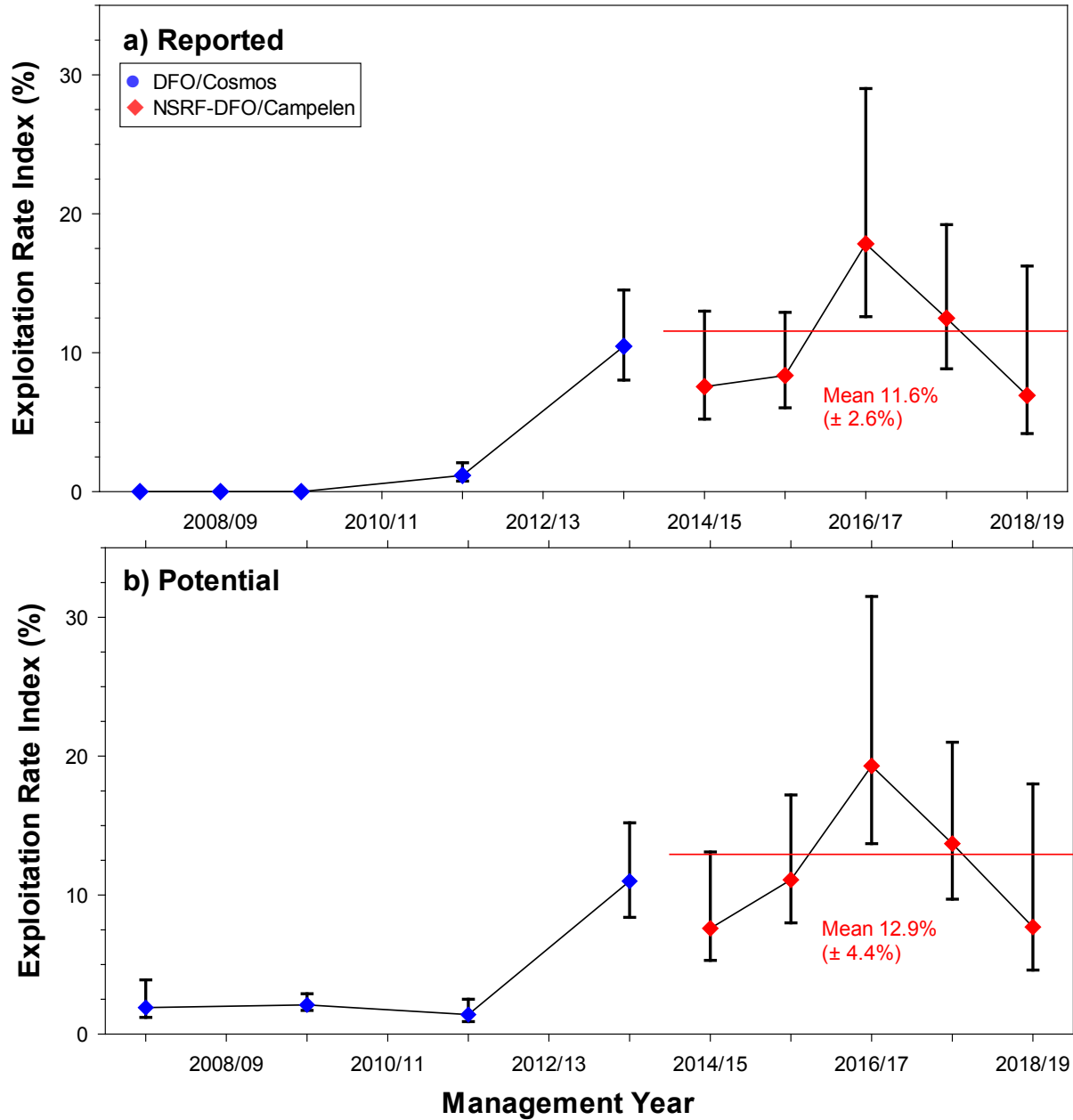


Figure 16. The Western Assessment Zone *Pandalus montagu* exploitation rate indices for the a) reported rate, based on the Canadian Atlantic Quota Report catch and the b) potential rate if the entire TAC assigned to the zone was taken. Included are four DFO/Cosmos surveys (blue diamonds), and the 2014–2018 NSRF-DFO/Campelen surveys (red diamonds) represent the new time series for the WAZ. Error bars are 95% confidence ranges.

Current Outlook

Considering the variability in the assessed *P. montagui* biomass, the current outlook for the resource remains unknown. In the WAZ, the resource is currently not assessed under a PA framework, however work is underway to establish the PA framework within the next two years.

Sources of Uncertainty

Hudson Strait is a highly dynamic system with strong tidal currents and mixing. 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 the most likely cause of the wide fluctuations in biomass seen in these areas. 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. Surveys from 2006–2008 were all conducted at the height of the spring tide, while the 2009–2018 surveys were conducted at neap tides to minimize the tidal effect. Regardless, the survey is conducted over a 24-hour period so strong tidal currents would still be present and may result in either an over- or underestimate of biomass.

The survey in the WAZ represents a new data series beginning in 2014 and is now an annual survey. The WAZ is now being surveyed with the same ship and trawl, conducted at the same time of year as the survey of the EAZ thus removing issues identified previously about comparing populations in the two assessment zones.

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 is 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.

The validity of the PA reference points used in this assessment for the EAZ is somewhat questionable. Estimates from only three surveys were used to calculate the reference points and it is uncertain how the biomass during this period relates to B_{MSY} . In addition, the reference points no longer correspond to the assessment area and the first two surveys are no longer considered comparable with the remainder of the time series.

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 commonality of the ships' dimensions, relative catchability would be consistent among vessels. However, this was not empirically tested.

Additionally, drivers of stock variability are poorly understood and research is needed into foraging (e.g., zooplankton biomass estimates), predation (e.g., gut contents of shrimp predators), shrimp ageing, and ecosystem tracers (e.g., stable isotopes and fatty acids in various food chain elements).

CONCLUSIONS AND ADVICE

Eastern Assessment Zone – *P. borealis*

The resource is currently in the Healthy Zone within the IFMP PA framework. Based on the 2018/19 TAC of 7,840 t, the potential exploitation rate index was 16.7%.

Eastern Assessment Zone – *P. montagui*

Based on the 2018/19 TAC of 840 t, the potential exploitation rate index was 4.0%. Over the last three years, the resource remained in the healthy zone. Previously the resource has shown wide fluctuations year to year in the female SSB index. As a result, caution is advised when setting the TAC.

Western Assessment Zone – *P. borealis*

The current outlook of the resource remains unknown. In the WAZ, the resource is currently not assessed under a PA framework, however work is underway to establish a PA framework within the next two years. Based on the 2018/19 TAC of 2,080 t, the potential exploitation rate index was 9.9%.

Western Assessment Zone – *P. montagui*

The current outlook of the resource remains unknown. In the WAZ, the resource is currently not assessed under a PA framework, however work is underway to establish a PA framework within the next two years. Based on the 2018/19 TAC of 6,138 t, the potential exploitation rate index was 7.7%.

MANAGEMENT CONSIDERATIONS

In general, management of key forage species such as shrimp, under an ecosystem approach, requires adoption of a conservative approach with lower fishing mortality reference points and higher biomass reference points than those that would be adopted under a single species management approach. Keeping the exploitation rate at or below the base of 15% for the Healthy Zone of the IFMP PA framework is thought to be conservative and leaves sufficient forage in the water for predators.

The PA reference points in the EAZ should be viewed with caution and most likely need to be re-evaluated. Reference points were based on the former shrimp fishing areas (SFA2 and SFA3) which are different than the current assessment zones; thus, the biomass levels used to define the reference points may no longer be appropriate. In addition, the survey time series that were used to determine the reference points are much shorter than in other SFAs. For the EAZ, the time series included two years of data which is now not considered comparable with the rest of the series. The status of shrimp within the WAZ is no longer represented by the former reference points established in 2013 (DFO 2013) because these reference points were based on survey results that are not comparable to the new time series that began in 2014. The 2018 survey in the WAZ was the fifth in the new time series. This data set may be adequate to establish new reference points. Evaluation of new reference points should be considered by Science and Resource Management in the coming years.

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SOURCES OF INFORMATION

This Science Advisory Report is from the February 12-14, 2019 Northern and Striped Shrimp Assessment. 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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