



ASSESSMENT OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE (AREAS 13 TO 17, 12A, 12B, 12C AND 16A) SNOW CRAB STOCKS IN 2020

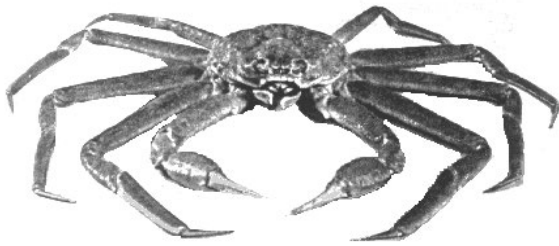


Image of a Snow Crab.

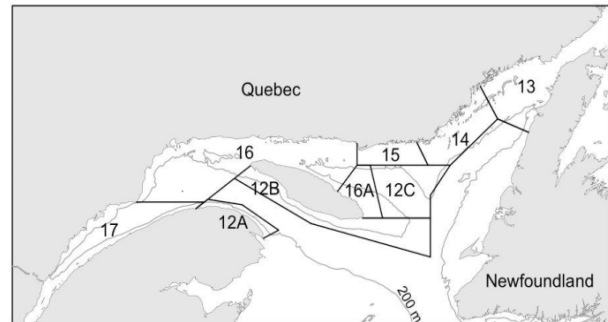


Figure 1. Snow crab management areas in the Estuary and the northern Gulf of St. Lawrence.

Context:

The snow crab fishery in the Estuary and the northern Gulf of St. Lawrence began in the late 1960s. The fishery experienced a boom from 1979 to 1985, and a management approach based on the total allowable catch (TAC) was gradually introduced between 1985 and 1995. Nine fishery management areas (13 to 17, 16A, 12A, 12B and 12C) for this species are under the responsibility of the Quebec Region (Figure 1).

Landings have varied depending on the adjusted TACs based on recruitment waves and troughs that affect the quantity of crabs available to the fishery (Figure 2). Landings for the nine fishing areas totalled 4,852 t in 2020.

The fishery targets only males with a carapace width ≥ 95 mm. White crab (crab that has recently moulted) and adolescent males may be returned to the water during the fishing season to enhance their meat yield and give them a chance to reproduce. Furthermore, since 1985, when the proportion of white crab in catches at sea exceeds 20%, the fishery is automatically closed in the affected area. This measure aims to minimize the mortality of these very fragile crabs, which will be available to the fishery the following year.

The DFO Fisheries and Aquaculture Management Branch, Quebec Region, requested a stock status assessment and a science advisory report to set the 2021 quotas. A scientific peer review was conducted on February 16-18, 2021 to assess the new relevant and available information to respond to this request. Participants included representatives from DFO Science and Fisheries and Aquaculture Management, the fishing industry and First Nations.

SUMMARY

Area 17

- From 2019 to 2020, the total allowable catch (TAC) decreased by 42.7% to 1,277 t, and it was reached (corresponding to a 22.2% decrease in landings between 2019 and 2020).
- The commercial fishery CPUE increased from 2019 to 2020 (+12.0%), but is below the historical average of the time series, at a value similar to the lowest values observed since 1991.
- No indicators based on dockside or sea sampling data are available for the 2020 fishing season (provincial COVID-19 health measures).
- The commercial abundance index of the post-season survey remained steady throughout the 2018–2020 period, with the lowest values seen since 2000. Values from both the North Shore and South Shore indicate low commercial abundance levels in 2019 and 2020.
- Abundance indices of the post-season survey for adolescents with a carapace width of between 78 and 95 mm and of 95 mm and above decreased over the 2018–2020 period. For adolescents under 95 mm in 2020, the index was the lowest in the time series (2000–2020), while the index value was slightly below the historical average for adolescents measuring 95 mm and over. No increase in recruitment to the fishery is expected in 2021.
- The decrease in the mean weight of the spermathecal load of primiparous females between 2019 and 2020 suggests an increase in the number of primiparous females.
- The two favourable thermal habitat indices for both large and small snow crabs present a downward temporal trend over the 1990–2020 period.
- The combined index increased by 7.3% between 2019 and 2020. The 2019 and 2020 values are among the lowest in the time series, however. As a whole, stock status indicators do not suggest an increase in the biomass available to the fishery in 2021.
- Scientific survey data indicate an upturn in recruitment to the fishery in the medium term.

Outlook

- The combined index increased slightly between 2019 and 2020 (+7.3%), but was among the lowest values in the time series because of the low commercial biomass in the post-season survey. As a result, no increase in the biomass available to the fishery is expected in 2021. Given the increase in primiparous female density, these indicators suggest a decrease in harvesting in 2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Higher scenario: A status quo compared to total landings in 2020.

Intermediate scenario: A 15% decrease applied to total landings in 2020.

Lower scenario: A more than 15% decrease applied to total landings in 2020.

Area 16

- The 2020 TAC of 2,326 t decreased by 25% from 2019 and was reached (landings of 2,300.3 t).

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- The catch per unit effort (CPUE) for the commercial fishery increased slightly (+16.1%) in 2020 despite decreasing over the 2016–2019 period. Despite this increase, the 2019 and 2020 values are the lowest observed since 1991.
- No indicators based on sea sampling data are available for the 2020 fishing season (provincial COVID-19 health measures).
- Dockside data are limited but indicate that landings primarily consisted of recruits and that the proportion of intermediate-shell crabs decreased between 2019 and 2020.
- All the abundance indices (adults and adolescents) in the post-season survey decreased between 2019 and 2020, and 2020 values are among the lowest observed since at least 2007.
- Based on monitoring of the Baie Sainte-Marguerite snow crab population, the biomass available to the fishery is expected to increase beginning in 2023–2024. The density of primiparous females rose sharply in 2020.
- The favourable thermal habitat index for large crabs showed a downward temporal trend over the 1990–2020 period.
- The combined index shows similar values in 2019 and 2020 (-1.2% between 2019 and 2020). The 2019 and 2020 values are the lowest in the time series that begins in 1995.
- All available indicators suggest that the biomass available to the fishery in 2021 will not be greater than that available in 2020.

Outlook

- For the second consecutive year, the combined index has remained at the lowest level in the series, and no increase is expected in the biomass available to the fishery in 2021. Given the increase in primiparous female density, these indicators suggest a decrease in harvesting in 2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Higher scenario: A status quo compared to total landings in 2020.

Intermediate scenario: A 15% decrease applied to total landings in 2020.

Lower scenario: A more than 15% decrease applied to total landings in 2020.

Area 15

- The total allowable catch (TAC) decreased by 29.9% between 2019 and 2020 to 310 t, and it was not reached. Landings in 2020 were 262.2 t, which corresponds to a decrease of 36.5% compared to landings in 2019. The start of the fishing season in 2020 was delayed by 3 weeks.
- The commercial fishery CPUE (catch per unit effort) in 2020 was similar to 2019 (+ 4.3% between 2019 and 2020), and is among the lowest values observed over the period 1985-2020.
- No indicator based on at-sea monitoring data was available for the 2020 fishing season (provincial health measures for COVID-19).
- Dockside data was limited, but showed that landings consisted mostly of recruits and crabs of intermediate shell condition in a similar proportion.

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- All post-season survey abundance indices for males, adolescents and adults were increasing between 2019 and 2020, and with the exception of the commercial portion of adults, were above their respective historical averages (limited to the period 2014-2020). The increase in biomass available to the fishery should continue in the medium term with the arrival of new cohorts.
- The mean weight of the spermathecal load of primiparous females in the 2020 post-season survey, and abundance of primiparous females in the previous post-season survey in 2019, suggested that the abundance of primiparous females was high in 2019-2020.
- The combined index increased by 56.7% between 2019 and 2020, after 4 consecutive years of decline.
- The available indicators suggest that the biomass available to fishing in 2021 will be greater than that of 2020.

Outlook

- The combined index increased between 2019 and 2020 (+ 56.7%), foreseeing a greater biomass available to fishing in 2021. However, the density of mature females, which is supposedly still high, suggest limiting the increase in harvest in 2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Higher scenario: A 30% increase applied to total landings in 2020.

Intermediate scenario: A 20% increase applied to total landings in 2020.

Lower scenario: A 10% increase applied to total landings in 2020.

Area 14

- The total allowable catch (TAC) decreased by 14.7% between 2019 and 2020 to 395 t, and it was not reached. Landings in 2020 were 348 t, which corresponds to a decrease of 20.7% compared to landings in 2019. The opening of the fishery season was delayed by 2 weeks in 2020.
- The commercial fishery CPUE (catch per unit of effort) in 2020 was similar to that of 2019 (-1.59% between 2019 and 2020), and is among the lowest values observed over the period 1985-2020 .
- No indicator based on at-sea or dockside monitoring data is available for the 2020 fishing season (provincial health measures for COVID-19).
- All post-season survey abundance indices for males, adolescents and adults increased between 2019 and 2020, except for older commercial males which are decreasing. The commercial abundance of 2020 was composed mostly of recruits in the post-season survey. The increase in the biomass available to the fishery should continue in the medium term with the arrival of new cohorts.
- No scientific trawl survey took place in 2020 (COVID-19), but the 2018 survey indicated an increase in recruitment to the fishery in the medium term.
- Data on the mean weight of spermathecal load of primiparous females during the post-season survey in 2020, and the density of primiparous females during the trawl survey in 2018 suggest that the abundance of mature females was still high in 2020 after a peak in 2018-2019.

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- The thermal habitat index favourable to large and small crabs showed an increasing temporal trend over the period 1990-2020.
- The 2020 combined index was comparable to 2018 and 2019 (+ 5.4% between 2019 and 2020), and among the lowest values observed over the period 1998-2020.
- The indicators suggest that the biomass available to the fishery in 2021 should be similar to that of 2020.

Outlook

- The combined index remains, for a second consecutive year, among the lowest values in the series. The biomass available in 2021 should be comparable to that of 2020. The expected high abundance of recruits, associated with the densities of mature females supposedly still high, suggest limiting the increase in removals in 2021 in order to limit white crab mortality and prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Higher scenario: A 10% increase applied to total landings in 2020.

Intermediate scenario: A status quo compared to total landings in 2020.

Lower scenario: A decrease compared to total landings in 2020.

Area 13

- The total allowable catch (TAC) decreased by 19.9% between 2019 and 2020 to 244 t, and it was not reached. Landings in 2020 were 213 t, which corresponds to a decrease of 29.5% compared to landings in 2019. The fishing season started with a delay of at least 2 weeks for a good part of the fleet.
- The commercial fishery CPUE (catch per unit of effort) in 2020 was similar to that of 2019 (+ 0.3% between 2019 and 2020), and was among the lowest values observed over the period 1988-2020.
- No indicator based on at-sea or dockside monitoring data was available for the 2020 fishing season (provincial health measures for COVID-19).
- All the abundance indices from the post-season survey carried out in the north of the area increased sharply between 2019 and 2020, and are above their respective historical averages. The commercial abundance of 2020 consisted mostly of recruits. All indices of the survey carried out in the south of the area have, conversely, decreased or remained stable between 2019 and 2020, and were below their historical average. The observed increase in the biomass available to the fishery is expected to continue in the medium term with the arrival of new cohorts.
- No scientific trawl survey took place in 2020 (COVID-19), but the 2018 survey indicated recruitment to the fishery in the medium term.
- Data on the mean weight of spermathecal load of primiparous females during the post-season survey in 2020, and the density of primiparous females during the trawl survey in 2018 suggest that the abundance of mature females was still high in 2020 after a peak in 2018-2019.
- The thermal habitat index favourable to large and small crabs showed an increasing temporal trend over the period 1990-2020.

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- The combined index increased sharply in 2020, after 3 consecutive years of decline (+ 44.7% between 2019 and 2020).
- The indicators suggest that the biomass available for fishing in 2021 will be higher than that of 2020.

Outlook

- The combined index increased sharply in 2020 (+ 44.7% between 2019 and 2020), after 3 consecutive years of decline. The biomass available to the fishery in 2021 will be greater than that of 2020. The expected high abundance of recruits, associated with the densities of mature females supposedly still high, suggest limiting the increase in removals in 2021 in order to limit white crab mortality and prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Higher scenario: A 20% increase applied to total landings in 2020.

Intermediate scenario: A 15% increase applied to total landings in 2020.

Lower scenario: A 5% increase applied to total landings in 2020.

Area 16A

- The total allowable catch (TAC) decreased by 12.3% between 2019 and 2020 to 272 t, and was almost reached. Landings totalled 256.7 t in 2020, which corresponds to a decrease of 17% compared to 2019. The start of the fishing season in 2020 was delayed by 4 weeks.
- The commercial fishery CPUE (catch per unit of effort) was comparable between 2019 and 2020 (-4.2% between 2019 and 2020) and the value for 2020 was the lowest since 2002.
- No indicator based on at-sea monitoring data was available for the 2020 fishing season (provincial health measures for COVID-19).
- Dockside data was limited, but indicated that landings consisted of a small majority of recruits, and the proportion of crabs with an intermediate shell condition increased between 2019 and 2020.
- The commercial abundance index from the post-season survey was declining over the period 2014-2020, with a decrease in the average size of adults observed in 2020. The indicators of this survey for adolescents and adults of carapace width less than 95 mm, were however sharply increasing between 2019 and 2020. An increase in the abundance of primiparous females was also observed in 2019. The biomass available to the fishery should increase in the medium term with the arrival of new cohorts.
- The thermal habitat index favourable to small crabs showed an increasing temporal trend over the period 1990-2020.
- The combined index was declining over the 2014-2020 period (-11.1% between 2019 and 2020). This decrease suggests that the biomass available to the fishery in 2021 will not be greater than that of 2020.

Outlook

- The combined index has decreased for a sixth consecutive year (-11.1% since 2019), and no increase in biomass available to the fishery is expected in 2021. In the presence of an increase in the density of primiparous females, these indicators suggest reducing the

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harvest in 2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Higher scenario: A status quo compared to total landings in 2020.

Intermediate scenario: A 10% decrease applied to total landings in 2020.

Lower scenario: A more than 10% decrease applied to total landings in 2020.

Area 12C

- The total allowable catch (TAC) decreased by 50% between 2019 and 2020 to 96 t, and it was not reached (in the context of COVID-19). Landings in 2020 totalled 78.9 t, which corresponds to a decrease of 47.2% compared to landings in 2019. The start of the fishing season in 2020 was delayed by 3 weeks.
- The commercial fishery CPUE (catch per unit effort) increased by 35.6% between 2019 and 2020, but the value observed in 2020 is nevertheless among the lowest observed for 25 years.
- No indicator based on at-sea or dockside monitoring data is available for the 2020 fishing season (provincial health measures for COVID-19).
- The commercial abundance index from the post-season survey is on the rise, after 5 years of consecutive decline. All the indicators of this survey (adolescents or adults, legal size or not) increased between 2019 and 2020. An increase in the abundance of primiparous females was also observed in 2020. The increase in the biomass available to the fishery is expected to increase next year and in the medium term with the arrival of new cohorts.
- The thermal habitat index favourable to large crabs showed a temporal decline over the period 1990-2020.
- The combined index increased for the first time since 2014 (+ 64.8% between 2019 and 2020). This increase suggests that the biomass available to the fishery in 2021 will be greater than that of 2020.

Outlook

- After a decrease over the period 2015-2019, the combined index increased in 2020 (+ 64.8% since 2019), which suggests an increase in the biomass available to the fishery in 2021. However, the yields from the commercial fishery in 2019 and 2020 are the lowest observed over the period 1994-2020 and the TAC was not reached for a third consecutive year. In the presence of an increase in the density of primiparous females, these indicators suggest more caution in establishing the total landings allowed in 2021, in order to prevent an excessively biased sex ratio in favour of females during the recruitment of primiparous females.

Higher scenario: A 30% increase applied to total landings in 2020.

Intermediate scenario: A 20% increase applied to total landings in 2020.

Lower scenario: A 10% increase applied to total landings in 2020.

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Area 12B

- In order to address socio-economic considerations and to enable monitoring of yields in this area, the TAC was set at 125 tonnes for 2018 and 2019 and an index fishery of 20 t was implemented in 2020.
- No snow crab fishery, commercial or scientific, was conducted in 2020.
- The fishing effort was low in 2019, with landings of 30 t.
- From 2016 onwards, the commercial fishery CPUE is at the lowest values observed since 1995.
- In 2019, the average size of legal crab caught in the commercial fishery remained similar to that of 2017 and 2018, and is below the historical average.
- Landings in 2019 consisted mostly of intermediate-shell crabs.
- The commercial abundance index of the post-season survey has been decreasing since 2013 and was close to 0 in 2018.

Outlook

- The non-attainment of the TAC, low catch rates, small size and low recruitment of snow crab suggested that stock status had not improved in 2019. The short-term outlook was not favourable.
- According to all indicators available in 2019, the biomass was very low and may not be able to support a commercial fishery.
- In the absence of data on the stock status for 2020, no new recommendation is issued for 2021.

Area 12A

- The TAC decreased by 23.7% between 2019 and 2020 to 80.5 t, and was not reached for socio-economic reasons. Landings totalled 69 t in 2020.
- The commercial fishery CPUE decrease between 2019 and 2020 (-12.3%) and is among the lowest values observed since 1995.
- No indicators based on sea sampling data are available for the 2020 fishing season (provincial COVID-19 health measures).
- Dockside data are limited but indicate that landings consisted of a strong majority of intermediate-shell crabs.
- Other than crabs with a carapace width between 78 and 95 mm (adults and adolescents), which increased between 2018 and 2020 to near the historical average, all abundance indices from the 2020 post-season survey remained rather stable compared with those in 2018 and were among the lowest values observed across their historical series. An increase in the abundance of primiparous females and small males was observed in 2020.
- The favourable thermal habitat index for large crabs showed a downward temporal trend over the 1990–2020 period.
- The combined index decreased by an average of 2.8% per year in comparison with the 2018 value, and the 2020 value was the lowest in the time series.

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- All available indicators suggest that the biomass available to the fishery in 2021 should not be greater than that available in 2020.

Outlook

- The combined index decreased by 2.8% per year on average between 2018 and 2020 to reach the lowest value in the time series, and performance during the commercial fishery in 2020 was among the lowest in 25 years. In addition, the increase in the abundance of primiparous females in 2020 suggests that a sufficient abundance of males is needed to avoid obtaining a sex ratio that is overly biased towards females during primiparous female recruitment. These indicators suggest a decrease in harvesting in 2021.

Higher scenario: A status quo compared to total landings in 2020.

Intermediate scenario: A 15% decrease applied to total landings in 2020.

Lower scenario: A more than 15% decrease applied to total landings in 2020.

INTRODUCTION

Species biology

In Canada, snow crab can be found from the southern tip of Nova Scotia to the Labrador, as well as in the Estuary and Gulf of St. Lawrence. In the Gulf of St. Lawrence, commercial-size males live at depths ranging from 50 m to 200 m, except during their winter moulting and reproductive periods, during which they migrate to shallower waters. Snow crab stop growing after the terminal moult. Males are considered adolescents (small claws) prior to the terminal moult and adults (large claws) afterwards. Adult male carapace width (CW) ranges from 40 mm to 165 mm. If they do not undergo their terminal moult earlier, males reach legal size (95 mm CW) at about 9 years of age. The proportion of males that reach the legal size is correlated with the temperature of the environment throughout their development. Snow crab recruitment is periodic or episodic and varies considerably over an 8 to 12 year cycle. The entry of recruits into the fishery can be determined by regular monitoring of landings (carapace size and condition) and the catch rate (catch per unit effort or CPUE), and is confirmed by scientific trap and trawl surveys. Global warming coupled with the upward trend in the average temperature of the deep layer could affect snow crab distribution and productivity by warming and thinning the cold intermediate layer that is their habitat.

RESOURCE ASSESSMENT

Analyses of all areas are based on fishing data from logbooks, processing plant purchase slips and dockside weighing summaries, along with catch sampling data obtained from the At-sea Observers Program and DFO samplers. Given the particular context of the prevailing pandemic, no sea sampling was conducted in the nine areas during the 2020 fishing season, while dockside sampling was possible only for areas 16, 12A, 16A and 12C (with a late start). In 2020, the industry conducted a trap-based research survey in all fishing areas (except in Area 12B, where there was no survey, and Area 13, where two independent surveys (northern and southern) were conducted), and the findings were incorporated into the stock status assessments. These trap surveys are notably used to determine the average number per unit of effort (NPUE) for each area for all legal-size adult crabs as well as the NPUE based on their seniority in the commercial population (one NPUE for crabs left by the fishery, which represent the residual commercial component, and one NPUE for new recruits) and the NPUE for adolescent crabs with a carapace width of 78 mm or more that will reach or exceed legal size

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during the next moult. Experimental traps (smaller mesh sizes) can be used to better document the proportion of younger crabs and females in the survey. The scientific trawl survey conducted every two years by Fisheries and Oceans Canada in the Lower North Shore area was not carried out in 2020 because of the prevailing COVID-19 pandemic. However, the results of research trawl surveys updated in areas 13, 17 and 16 in 2018, 2019 and 2020 respectively, were used to better assess the relative abundance of adolescent and adult crabs, males and females, as well as the position of the population in the recruitment cycle.

The numbers of fishing licences and dates that fishing was allowed in 2020 are indicated in Table 1. The 2020 fishing season began late, except in areas 17 and 12A. In the areas affected, the delay varied between two and four weeks after regulatory opening dates (Table 1). Stocks have reached the end of the wave of recruitment to the fishery, with total landings for the nine areas in 2020 decreasing for the second consecutive year. This decrease was observed in each of the areas (Figure 2).

Table 1. Summary by Area of the number of licences and dates of commercial fishery in 2020.

Areas	13	14	15	16	16A	17	12A	12B	12C
Number of licences	43	19	30	51	36	39	9	2	37
Opening dates	May 19	May 18	May 6 or 11	April 22	May 11	March 25	March 26	April 22	May 11
Closure dates	August 22	August 16	July 26	July 12	July 28	June 24	June 4	June 30	July 26

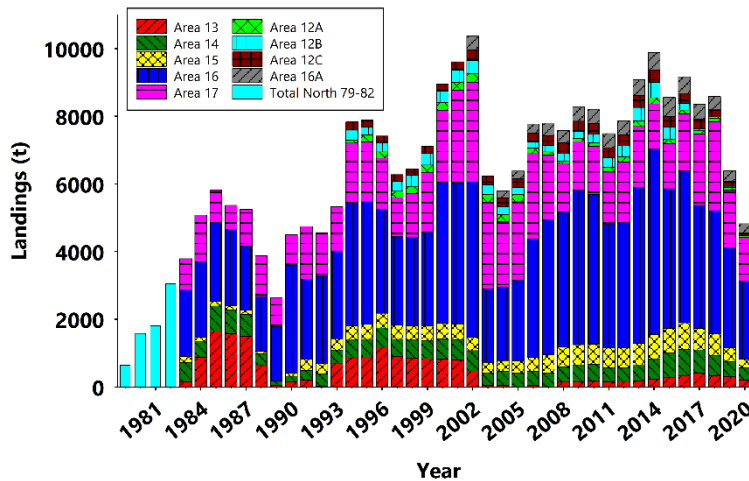


Figure 2. Snow crab landings in the Estuary and northern Gulf of St. Lawrence from 1979 to 2019. From 1979 to 1982, landings were not attributed to their area of origin.

The fishery's raw catches per unit effort (CPUE) were standardized using a linear statistical model to account for seasonal changes, gear type, soak time and fishing site. The proportion of recruits (or new crab), which can be identified by its new carapace (carapace conditions 1 and 2), intermediate-shell crab (carapace condition 3) and old-shell crab (carapace conditions 4 and 5) was determined by dockside samplers.

Since 2013, a combined index (CI) was used to obtain a better estimate of the short-term commercial biomass trend and help increase the consistency of the inter-annual recommendations for a given stock. This index is based on two biomass indices: the standardized commercial CPUE and the post-season NPUE for adult males ≥ 95 mm (the

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average NPUE from the north and south surveys in Area 13). The combined index is calculated by standardizing each of the two indices according to their respective average and standard deviation over the 2000-2012 reference period, and averaging them for the current year.

Data on the size structure of crab sampled at sea, dockside and during trap surveys, when available, were also used.

To date, data on female insemination levels, based on the average weight of spermatheca, have been collected sporadically in certain areas. The relationship between the density of females and the mean weight of the spermathecal load has already undergone careful analyses for Baie Sainte-Marguerite and is undergoing larger-scale analysis in the Estuary and northern Gulf. Large-scale preliminary results indicate a strong negative relationship between the density of primiparous females observed during the trawl surveys and the mean weight of the spermathecal load, once the size of females is accounted for. Systematic annual sampling of spermathecal loads in each area (during trap or trawl surveys) is recommended to use this parameter for assessing stock status along with a sex ratio favouring the reproductive potential of populations for different abundance levels for females in the short, medium and long term.

Outlook

The outlook for each area includes three possible scenarios for establishing the following season catches. These scenarios have been developed by taking into account an indicator combining the catch rate (standardized catch per unit effort, CPUE) from the commercial fishery of the previous year and the abundance of commercial-size adult males (number per unit effort, NPUE) from the post-season scientific survey, the uncertainty associated with this indicator, and related stock status indicators (crab carapace size and condition, expected recruitment, and levels of spermathecal load of females, if available), with the objective of ensuring sustainable resource management. The proposed changes are related to the landings of the last fishing year. The characteristics of each scenario are described below.

Higher scenario

- Greater likelihood of increased harvesting intensity for the upcoming season compared to the previous season;
- Harvest level that may result in fishing mortality exceeding the historical average;
- Harvesting pressure that may not be sustainable in the long term; and
- Likely decrease in abundance compared to the previous year if recruitment remains relatively stable or decreases.

Intermediate scenario

- Likelihood of moderate harvesting intensity for the upcoming season, similar to the previous season;
- Harvest level assumed to maintain fishing mortality close to the historical average; and
- Could maintain the stock at a level of abundance similar to the previous year.

Lower scenario

- Greater likelihood of lower harvesting intensity for the upcoming fishing season compared to the previous one;
- Cautious harvest level assumed to result in fishing mortality below the historical average; and

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- Could lead to an increase in stock abundance compared to the previous year or maintain existing biomass over a longer period of time.

Snow crab thermal habitat

Two indicators of favourable thermal habitat for snow crab are now available, one for adults and the other for juveniles. These indicators represent the area of seabed where water temperatures are between -1°C and 3°C (adults) or between 0°C and 2°C (juveniles). During the 1990 to 2020 period, a declining trend in the area of favourable thermal habitat for adult snow crab was observed in Areas 12A, 12B, 12C, 16 and 17, whereas a slight increase in the availability of favourable thermal habitat was observed in Areas 13 and 14 (Figure 3A). For juveniles, a downward trend in the area of favourable thermal habitat was seen in Area 17, but an increasing trend was observed in Areas 13, 14 and 16A (Figure 3B).

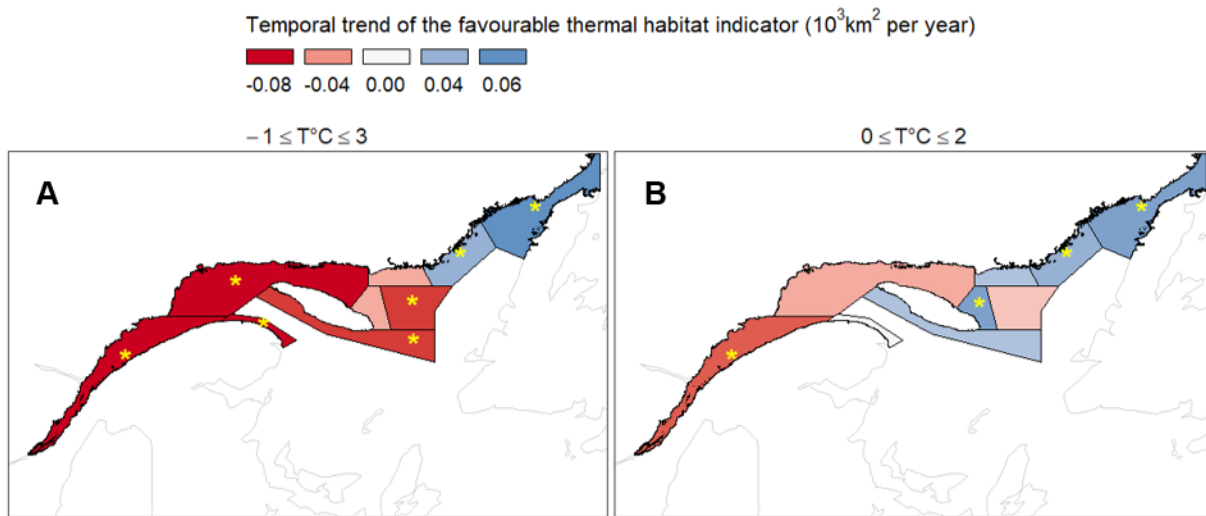


Figure 3. Temporal trends of the favourable thermal habitat indicator for adult snow crabs (A) and juvenile snow crabs (<12 mm) (B) over the 1990–2020 period. The favourable habitat indicator is the annual area of seabed where water temperatures are between -1°C and 3°C for adult crabs and between 0°C and 2°C for juvenile crabs. A negative value (in red) or positive value (in blue) associated with each area indicates a potential linear temporal trend, either increasing or decreasing (the asterisk indicates that the statistical model with a linear temporal trend was chosen over a null model, following model selection).

Area 17

Description of the fishery

In Area 17, the TAC decreased by 42.7% between 2019 and 2020 (which corresponds to a 22.2% decrease in landings between 2019 and 2020) to 1,277 t (Figure 4), and was reached (landings totalled 1,323.4 t or 103.6% of the TAC).

Resource status in 2020

Commercial fishery. The standardized CPUE increased slightly between 2019 and 2020 (+12.0%). However, the CPUE is below the historical average of the time series at a value similar to the lowest values recorded in the past 25 years (Figure 5). No indicators based on dockside or sea sampling data are available for the 2020 fishing season (provincial health measures for COVID-19). The average size of legal-sized crabs caught at sea decreased

slightly between 2018 and 2019. This indicator has remained below the historical average since 2014 (Figure 6).

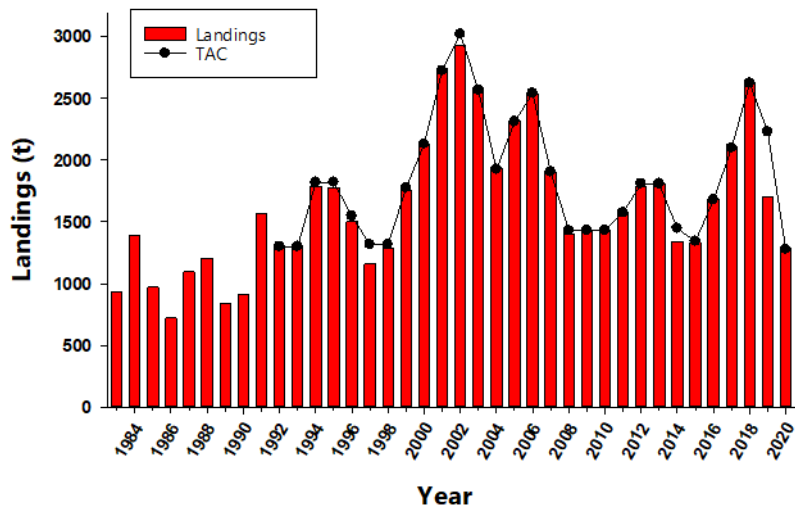


Figure 4. Annual landings and TACs in Area 17.

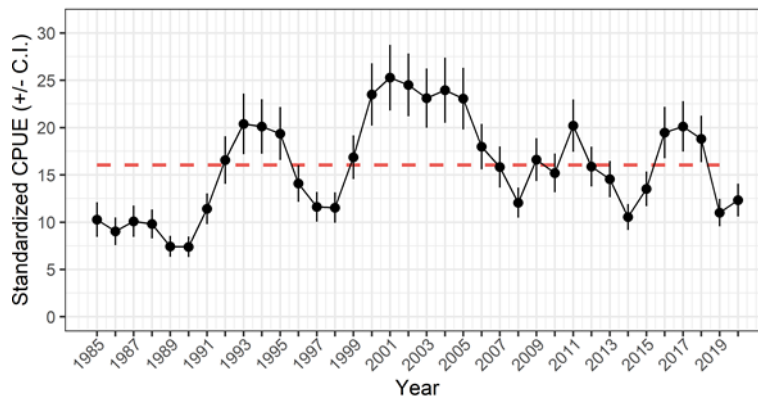


Figure 5. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 17. The dashed line shows the historical data series average (excluding the last year) which is 16.0 kg/trap per day.

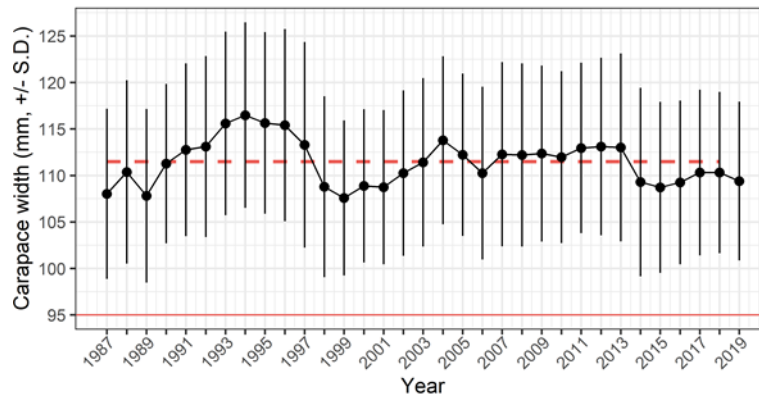


Figure 6. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 17. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 111.9 mm.

Fishery-independent surveys. The research trap survey indicated that the NPUE for adults measuring 95 mm and over remained stable over the 2018-2020 period, was below the historical average and was among the lowest values observed since 2000 (Figure 7). The NPUE for adolescents between 78 and 95 mm decreased for the third consecutive year to reach the lowest value in the time series, while the NPUE for adolescents measuring 95 mm and over was slightly under the historical average (Figure 7).

The scientific trawl survey in 2019 pointed to low recruitment in the short-term despite a high abundance of commercial-sized adults observed since 2017. The density of these reached the highest value observed on the north shore since 1995, and the second highest value observed on the south shore since the first survey of the area was conducted in 2007. However, the survey of the north shore was incomplete (48 stations out of 68). The abundance of reproductive females declined sharply in the 2017 and 2019 surveys on the north shore and in the 2019 survey on the south shore, dropping to values among the lowest in the series for both shores. However, the decrease in the mean weight of the spermathecal load of primiparous females caught during the trap survey between 2019 and 2020 suggests an increase in the number of primiparous females.

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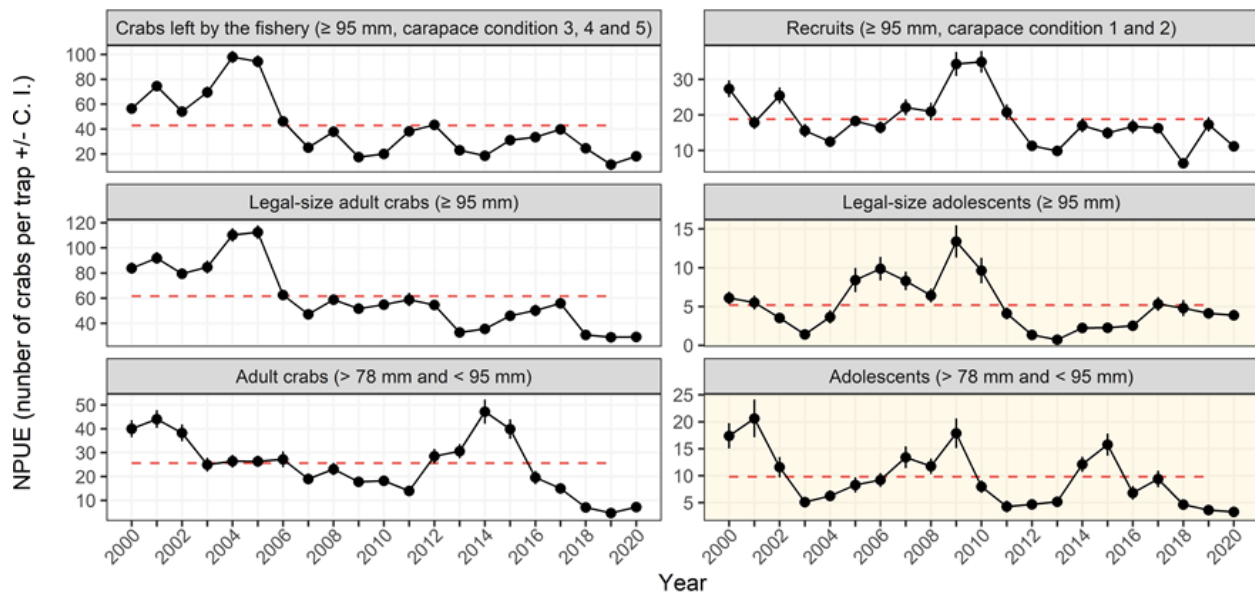


Figure 7. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 17. The dashed line shows the historical data time series average (excluding the last year).

The combined index (CI), derived from the commercial NPUE for legal-size adults in the trap survey, increased by 7.3% between 2019 and 2020 but remained at among the lowest values in the historical series. On the whole, the indicators do not suggest an increase in the biomass available to the fishery in 2021 (Figure 8).

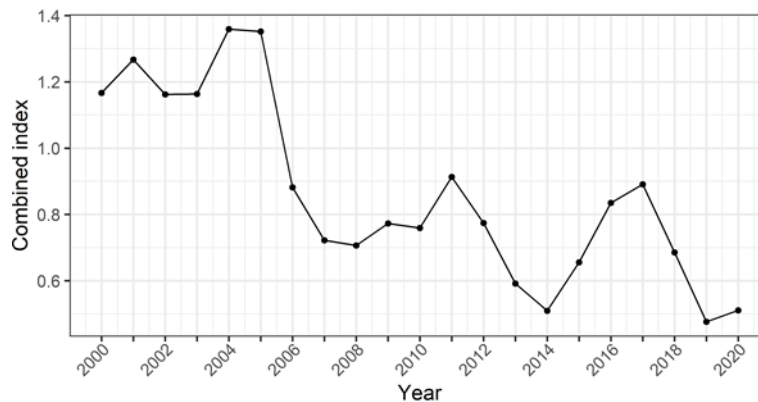


Figure 8. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 17.

The thermal habitat index favourable to adult and juvenile snow crab in Area 17 (Figure 3) shows an eroding trend in area observed over the past several decades, which could have a negative impact on the future productivity of the stock.

Outlook and conclusions

The combined index increased slightly between 2019 and 2020 (+7.3%), but was among the lowest values in the time series because of the low commercial biomass in the post-season survey. As a result, no increase in the biomass available to the fishery is expected in 2021.

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Given the increase in primiparous female density, these indicators suggest a decrease in harvesting in 2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

- *Higher scenario:* A status quo compared to total landings in 2020.
- *Intermediate scenario:* A 15% decrease applied to total landings in 2020.
- *Lower scenario:* A more than 15% decrease applied to total landings in 2020.

Area 16

Description of the fishery

In Area 16, the TAC decrease by 25% from 2019 to 2020 at 2,326 t and was reached (Figure 9).

Resource status in 2020

Commercial fishery. The standardized NPUE increased slightly in 2020 (+16.1%) following a consistent decline since 2015. Despite this increase, the 2020 NPUE is among the lowest values observed since 1990 (Figure 10). Dockside data are limited but indicate that landings primarily consisted of recruits (carapace conditions 1 and 2), while the proportion of intermediate-shell crabs (carapace condition 3) decreased between 2019 and 2020. The average size of legal-size adult crabs caught at sea decreased slightly between 2018 and 2019 to reach the historical average (Figure 11).

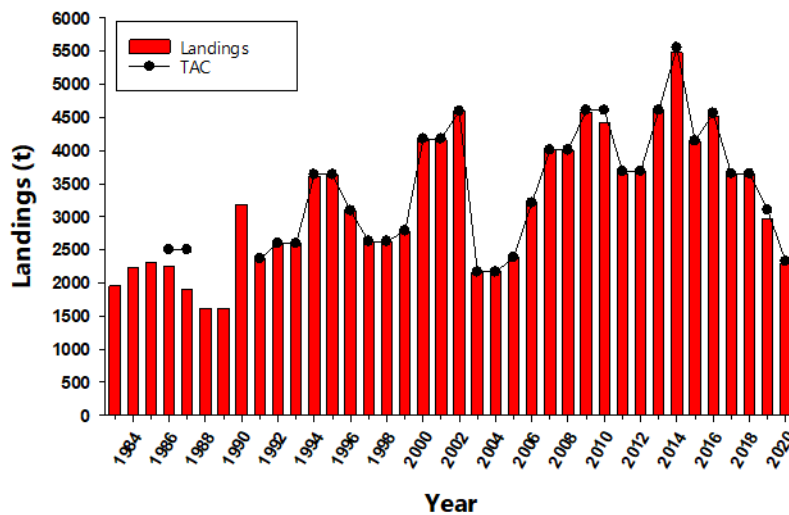


Figure 9. Annual landings and TACs in Area 16.

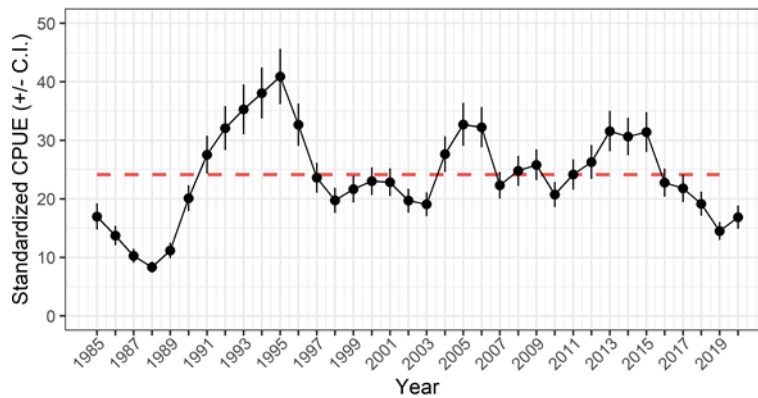


Figure 10. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 16. The dashed line shows the historical data series average (excluding the last year) which is 24.1 kg/trap per day.

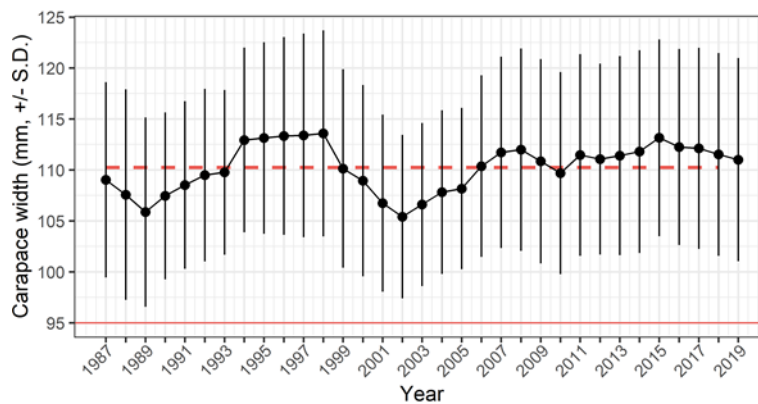


Figure 11. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 16. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 110.9 mm.

Fishery-independent surveys. The research trap survey indicates that the NPUE for all categories of adults or adolescents decreased between 2019 and 2020. Most 2020 NPUE values were among the lowest since 2007 (Figure 12). That said, the NPUE for recruits, which reached its historical high in 2015, decreased slightly in 2020 but remained similar to the historical average. The NPUE for adolescents between 78 and 95 mm, which had been relatively stable since 2016, fell sharply in 2020 (Figure 12).

Based on the results of the trawl survey conducted in Sainte-Marguerite Bay, low recruitment of legal-sized crabs is anticipated for 2021. From 2023-24 onward, recruitment is expected to increase for this population. The abundance of primiparous females in the trawl survey increased quite sharply in 2020, but the mean weight of the spermathecal load did not decrease significantly compared with 2019.

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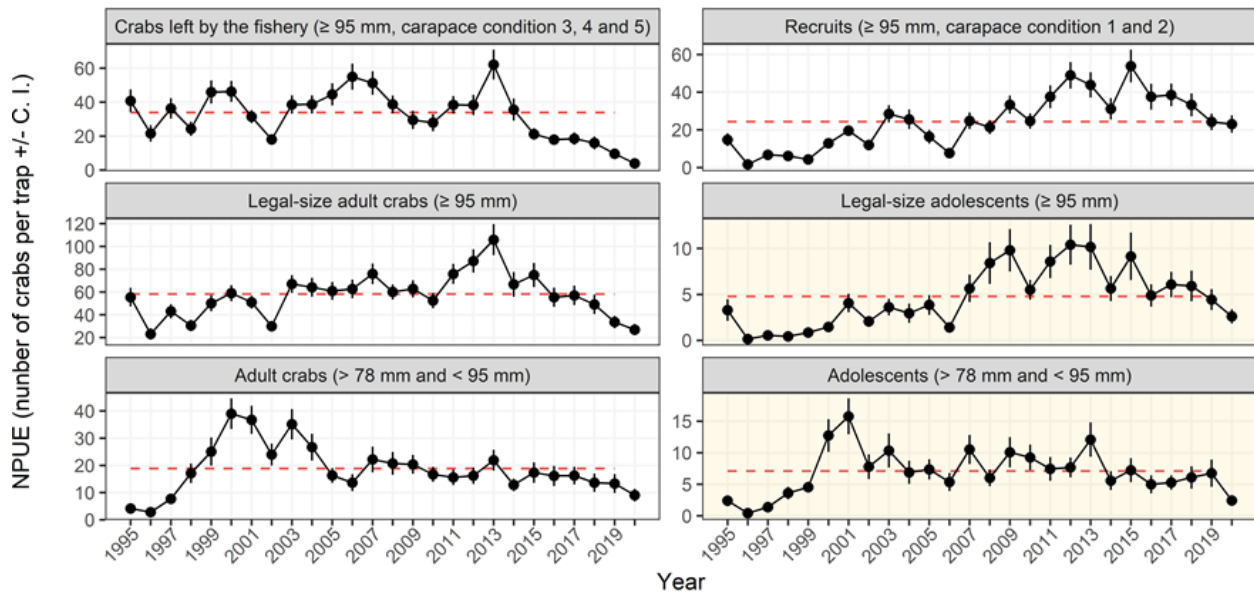


Figure 12. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 16. The dashed line shows the historical data time series average (excluding the last year).

The combined index of commercial CPUE and NPUE of adults \geq 95 mm from the post-season survey has similar values in 2019 and 2020 (-1.2%), which suggests that the biomass available to the fishery in 2021 will not be greater than in 2020 (Figure 13).

The thermal habitat index favourable to adult snow crab in Area 16 (Figure 3A) shows an eroding trend in area observed over the past several decades, which could have a negative impact on the future productivity of the stock.

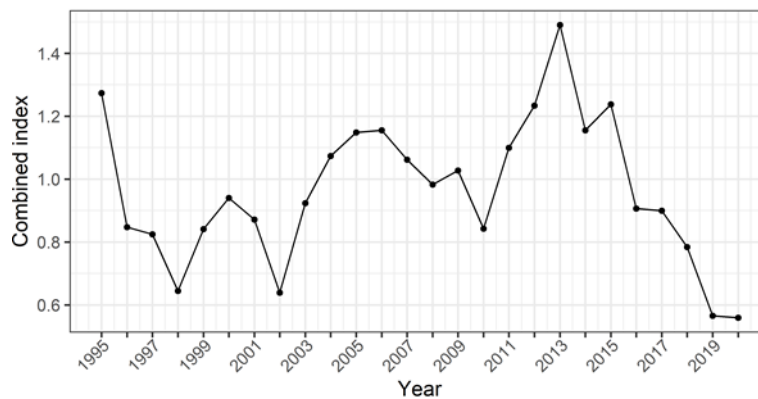


Figure 13. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 16.

Outlook and conclusions

For the second consecutive year, the combined index has remained at the lowest level in the series, and no increase is expected in the biomass available to the fishery in 2021. Given the increase in primiparous female density, these indicators suggest a decrease in harvesting in

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2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

- *Higher scenario:* A status quo compared to total landings in 2020.
- *Intermediate scenario:* A 15% decrease applied to total landings in 2020.
- *Lower scenario:* A more than 15% decrease applied to total landings in 2020.

Area 15

Description of the fishery

The TAC decreased by 29.9% between 2019 and 2020 to 310 t (Figure 14), and was not reached (262.2 t or 84.6%).

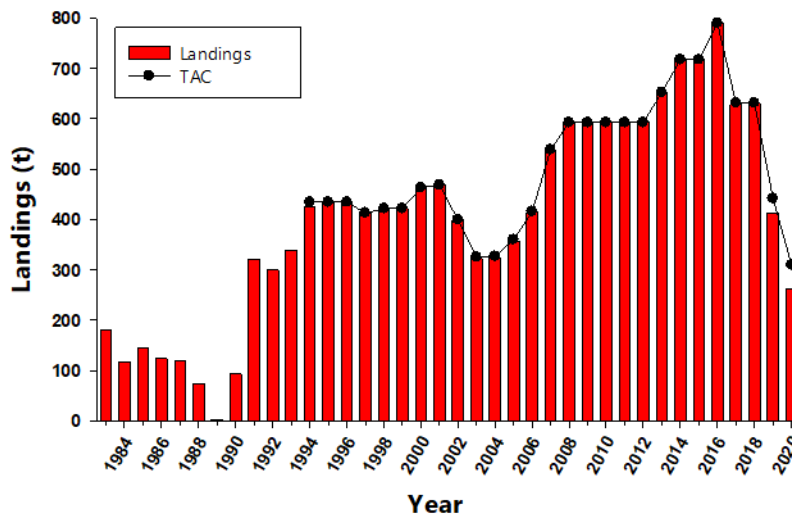


Figure 14. Annual landings and TACs in Area 15.

Resource status in 2020

Commercial fishery. The standardized CPUE increased slightly between 2019 and 2020 (+4.3%), but is still among the lowest values observed since 1985 (Figure 15). Dockside data for 2020 are limited but indicate that landings primarily consisted of recruits (carapace conditions 1 and 2), while the proportion of intermediate-shell crabs (carapace condition 3) remained similar. The average size of legal-size adult crab caught at sea during the commercial fishery has been above the historical average since 2006 (Figure 16).

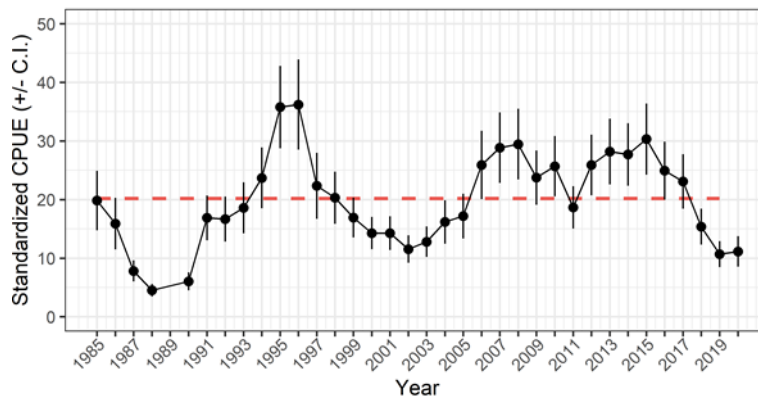


Figure 15. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 15. The dashed line shows the historical data series average (excluding the last year) which is 20.2 kg/trap per day.

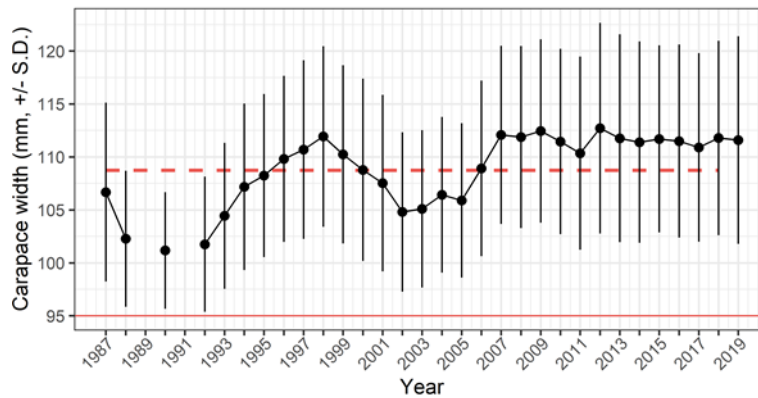


Figure 16. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 15. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 109.1 mm.

Fishery-independent survey. The protocol for trap-based research survey was changed in 2014 to allow the use of a new larger, standard conical trap of 6.5 ft diameter. Both types of traps, former and new, were being used from 2014 to 2016. Since 2017, only the larger trap is used. Since catchability with this new trap needs to be further assessed in comparison with the former traps, only the data including this new trap are presented. The research trap survey indicated an increase in the NPUE for all categories of adults and adolescents with a value significantly higher than the average for adolescents measuring 95 mm and above and adults and adolescents measuring 78 to 95 mm (Figure 17). These indicators show that the biomass available to the fishery should increase in the medium term with the expected arrival of new cohorts. Data on the weight of the spermathecal load in the 2020 post-season survey, and on the abundance of primiparous females during the 2019 post-season survey, suggest that the abundance of primiparous females was high in 2019-2020.

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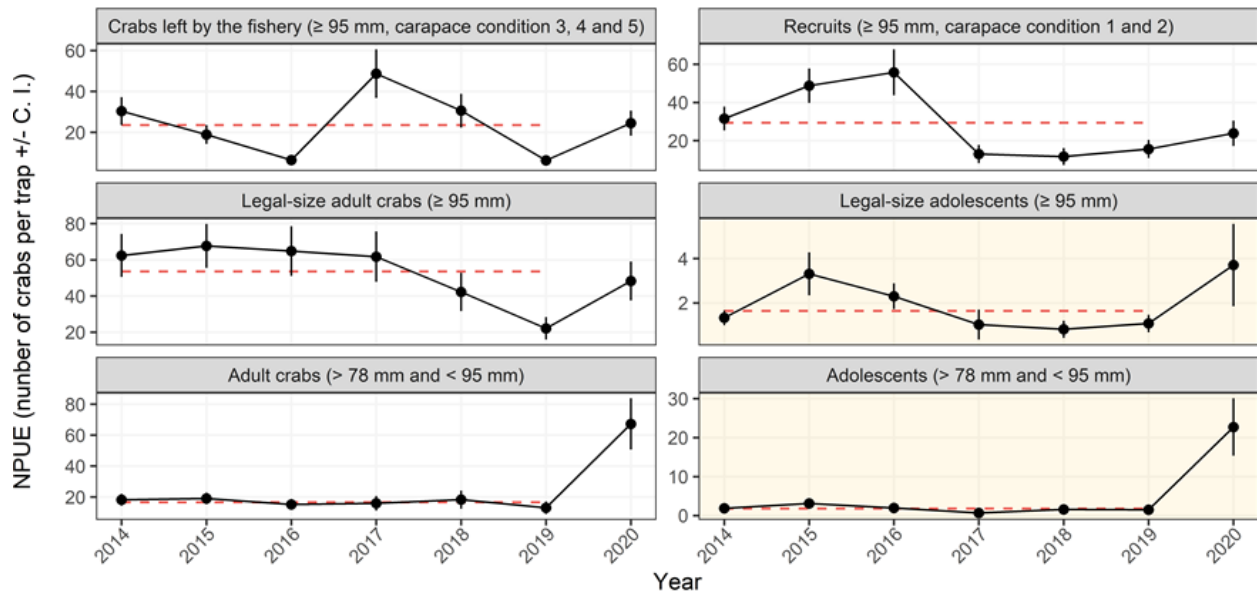


Figure 17. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 15 (with large traps). The dashed line shows the historical data time series average (excluding the last year).

The **combined index** of the commercial CPUE and NPUE of adults ≥ 95 mm from the post-season survey increased by 56.7% after 4 years of consecutive decrease. All available indicators suggest that the biomass available to the fishery will be higher in 2021 than in 2020 (Figure 18).

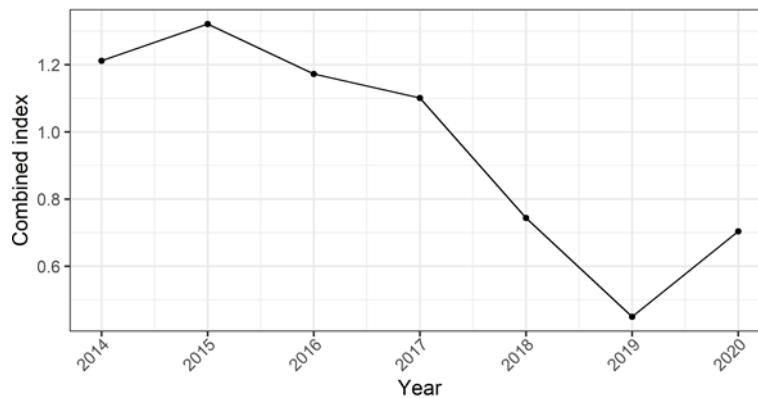


Figure 18. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 15.

Outlook and conclusions

The combined index increased between 2019 and 2020 (+ 56.7%), foreseeing a greater biomass available to fishing in 2021. However, the density of mature females, which is supposedly still high, suggest limiting the increase in harvest in 2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

- *Higher scenario*: A 30% increase applied to total landings in 2020.
- *Intermediate scenario*: A 20% increase applied to total landings in 2020.

- Lower scenario: A 10% increase applied to total landings in 2020.

Area 14

Description of the fishery

The TAC decreased by 14.7% from 2019 to 2020 to 395 t (Figure 19), and the TAC was not reached with 348 t (88.1%) landed. The industry cited socio-economic reasons for not achieving the TAC and for the two-week delay in opening the fishery.

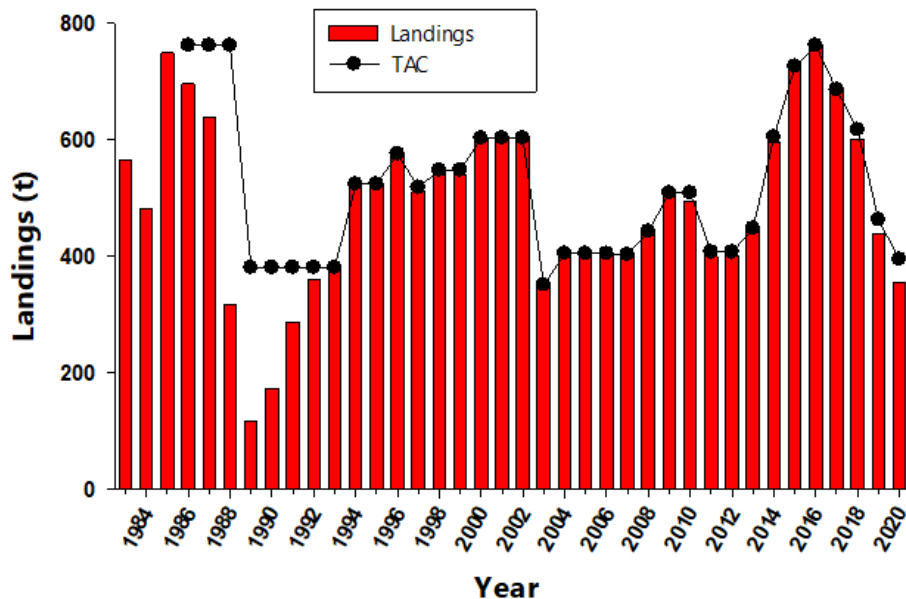


Figure 19. Annual landings and TACs in Area 14.

Resource status in 2020

Commercial fishery. The standardized NPUE decreased significantly from a historical high in 2016 to a value in 2020 that was similar to that in 2019 (-1.6%, Figure 20), and both years had the lowest recorded values since 1991. No indicators based on dockside or sea sampling data are available for the 2020 fishing season (provincial health measures for COVID-19). The average size of legal-size crab caught at sea had increased between 2012 and 2018, and was still well above the historical average despite a decrease between 2018 and 2019 (Figure 21).

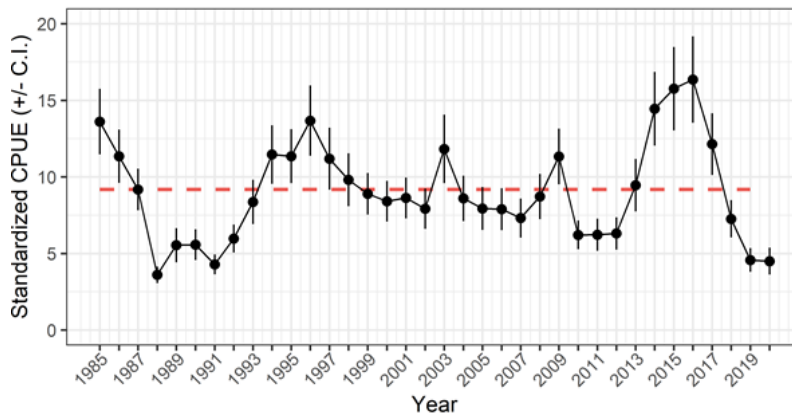


Figure 20. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 14. The dashed line shows the historical data series average (excluding the last year) which is 9.2 kg/trap per day.

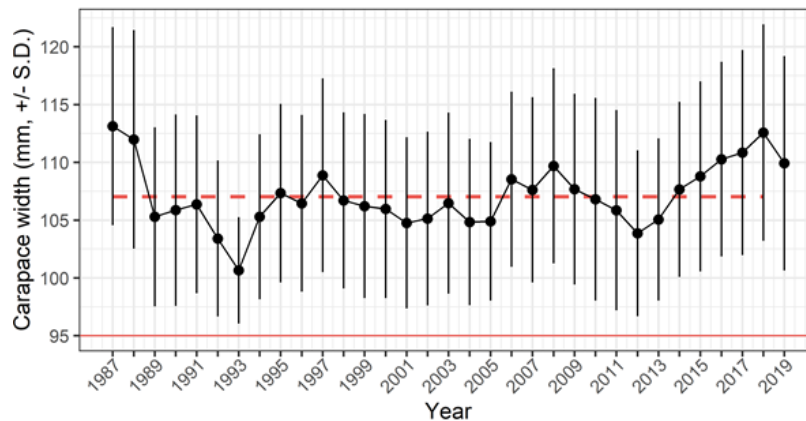


Figure 21. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 14. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 107.3 mm.

Fishery-independent survey. The research trap survey indicated that the NPUE for adults and adolescents increased between 2019 and 2020, except for crab left by the fishery (Figure 22). The biomass of adult legal-size crabs also primarily consisted of recruits. As a result of the increase between 2019 and 2020, the NPUE for adolescents was above the historical average, suggesting an increase in the commercial biomass in the medium term with the arrival of new cohorts (Figure 22). Data on the weight of the spermathecal load during the 2020 post-season survey, and on the density of primiparous females during the trawl survey in 2018, suggests that the abundance of mature females will remain high after a peak in 2018-2019.

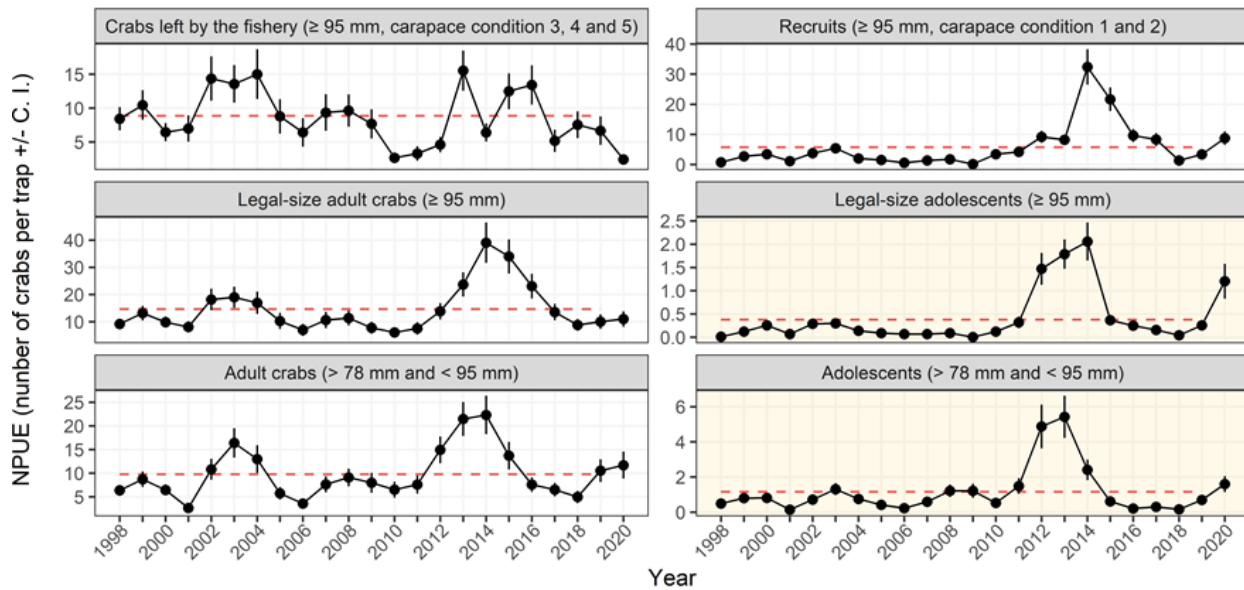


Figure 22. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 14. The dashed line shows the historical data time series average (excluding the last year).

The **combined index** of commercial CPUE and NPUE of adults \geq 95 mm from the post-season survey in 2020 is similar to 2019, with a slight increase of 5.4%, suggesting that the biomass available to the fishery will be similar in 2021 than in 2020 (Figure 23).

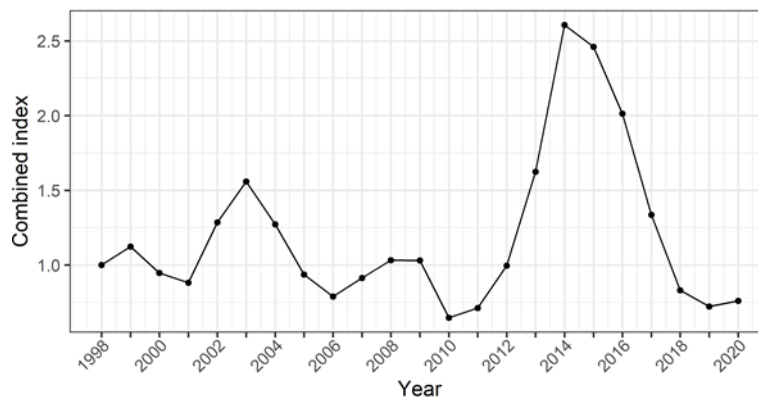


Figure 23. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 14.

The **thermal habitat index** favourable to adult and juvenile crabs shows an upward temporal trend in area observed over the past several decades (Figure 3).

Outlook and conclusions

The combined index remains, for a second consecutive year, among the lowest values in the series. The biomass available in 2021 should be comparable to that of 2020. The expected high abundance of recruits, associated with the densities of mature females supposedly still high, suggest limiting the increase in removals in 2021 in order to limit white crab mortality and

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prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

- *Higher scenario:* A 10% increase applied to total landings in 2020.
- *Intermediate scenario:* A status quo compared to total landings in 2020.
- *Lower scenario:* A decrease compared to total landings in 2020.

Area 13

Description of the fishery

The area was placed under a moratorium from 2003 to 2007 as a result of a marked decline in the biomass of legal-size crab. However, an index fishery with an annual TAC of 50 t was approved in 2003, 2004 and 2006. When the area was reopened in 2008, it was decided that precautionary, meaning low, TACs would be in effect at first and would gradually increase only if the stock indices remained positive despite harvesting. In 2020, the TAC decreased to 244 t (-19.9%) and was almost reached (landings of 213 t or 87.3%) (Figure 24). Socio-economic reasons were cited for not achieving the TAC, along with the two-week delay in opening the fishery.

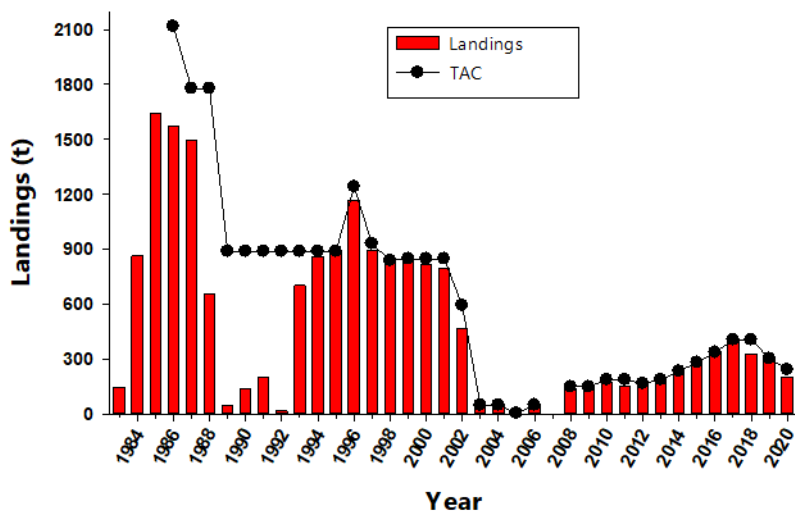


Figure 24. Annual landings and TACs in Area 13.

Resource status in 2020

Commercial fishery. The standardized 2020 NPUE was similar to the 2019 value (+0.3%) and remained one of the lowest values in the time series (Figure 25). From 2009 to 2014, the fishing effort was significantly higher in the southern part than the northern part. In 2015 and 2016, the fishing effort was divided almost equally between both parts. Since 2017, however, it has been higher in the northern part. No indicators based on dockside or sea sampling data are available for the 2020 fishing season (provincial health measures for COVID-19). In 2019, the proportion of recruits (carapace conditions 1 and 2) had decreased, while the predominant proportion consisted of intermediate-shell crabs. The average size of legal-size crab caught at sea had decreased from 2016 to 2019 with a value that was below the historical average (Figure 26). This average size is low compared with other areas in the Gulf of St. Lawrence.

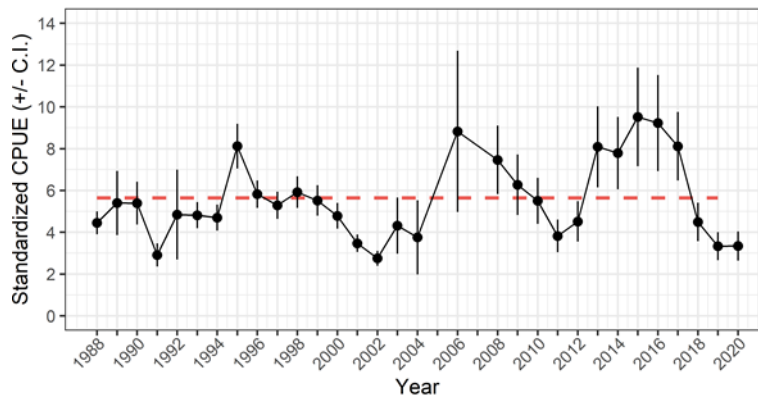


Figure 25. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 13. The dashed line shows the historical data series average (excluding the last year) which is 5.6 kg/trap per day.

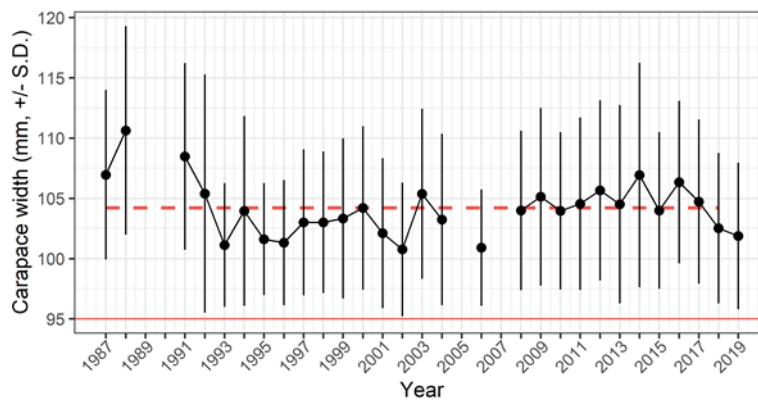


Figure 26. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 13. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 104.4 mm.

Fishery-independent surveys. The research trap surveys showed a significant increase in the NPUE in the northern part of the area (Figure 27), while a decrease or stability in the NPUE was observed in the southern portion of the area (Figure 28). A marked increase in the NPUE for legal-size adults in the northern portion of the area in 2020 can be attributed to the significant increase in recruits (Figure 27). The considerable increase in the NPUE for adolescents in the northern portion indicates that the increase in biomass should continue in the short term. That said, in the southern portion of the area, NPUE values for adolescents are below the historical average, at levels nearing 0 (Figure 28), meaning the short- and medium-term outlook in the southern portion of the area is less favourable than in the northern portion of the area.

A high abundance of 40-62 mm adolescent male crabs in the 2018 trawl survey indicated possible recruitment to the fishery in the medium term. The abundance of primiparous females observed in 2018 in the same survey was at its highest level since 1994. The mean weight of the spermathecal load of primiparous females in 2020 (post-season survey in the northern portion of the area) increased but remained low. These results indicate that the abundance of primiparous females has remained high in the area after peaking in 2018-2019.

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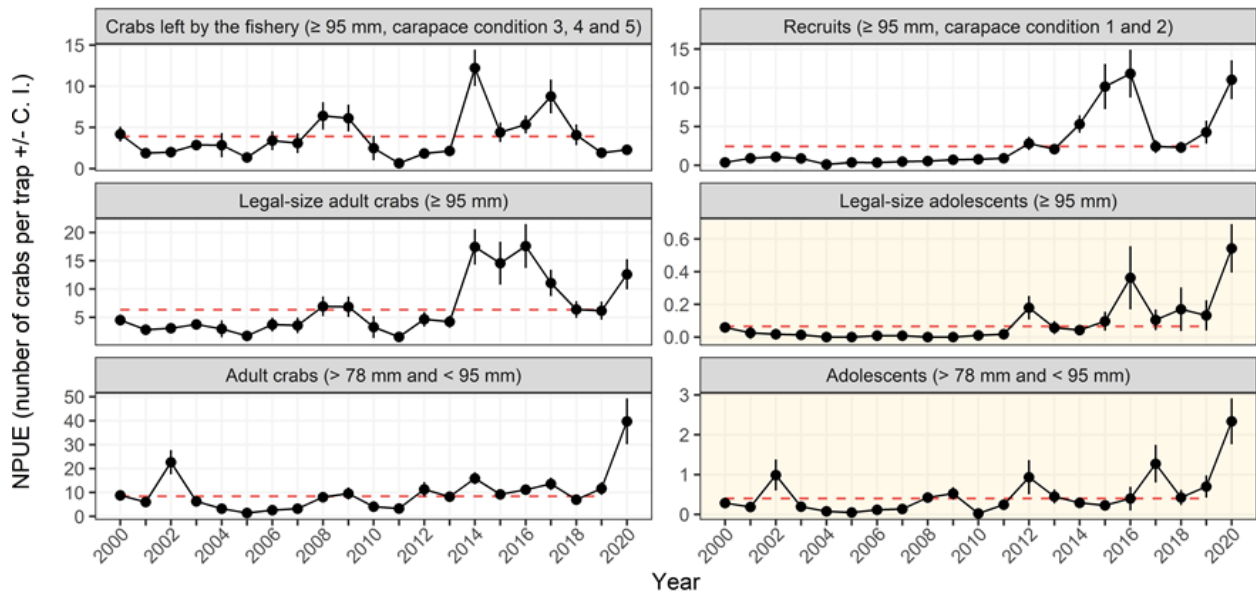


Figure 27. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in northern Area 13. The dashed line shows the historical data time series average (excluding the last year).

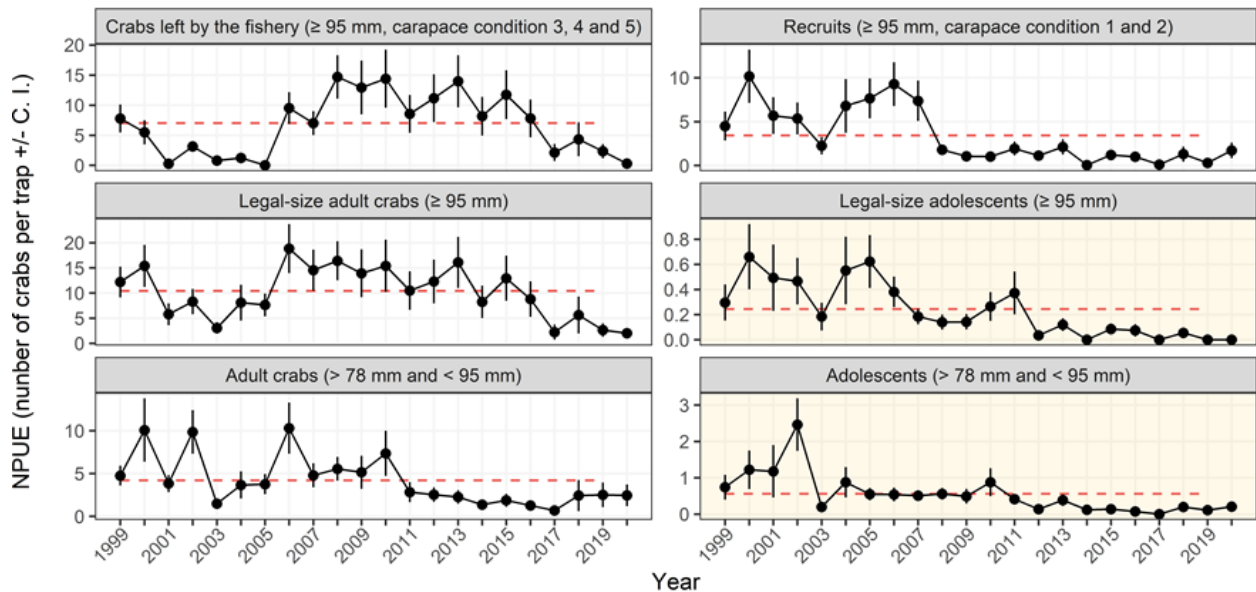


Figure 28. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in southern Area 13. The dashed line shows the historical data time series average (excluding the last year).

The combined index of the commercial CPUE and NPUE of adults \geq 95 mm from the post-season survey increased by 44.7% from 2019 to 2020, following a steady decrease in the last 3 years. The biomass available to the fishery will be higher in 2021 than in 2020, especially in the northern part of the area (Figure 29).

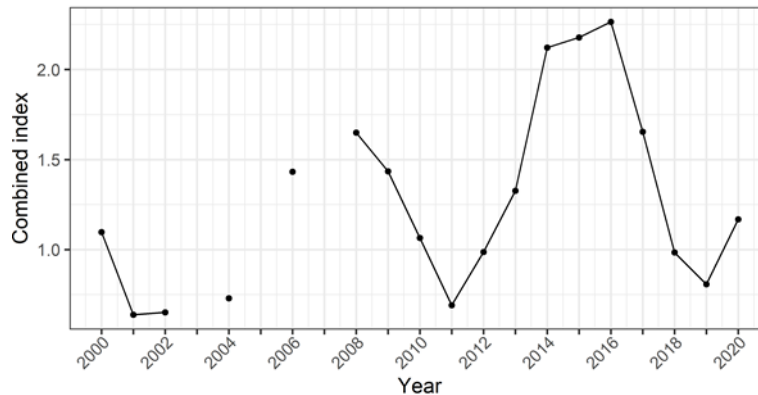


Figure 29. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 13.

The **thermal habitat index** favourable to adult and juvenile crabs shows an upward temporal trend in area observed over the past several decades (Figure 3).

Outlook and conclusions

The combined index increased sharply in 2020 (+ 44.7% between 2019 and 2020), after 3 consecutive years of decline. The biomass available to the fishery in 2021 will be greater than that of 2020. The expected high abundance of recruits, associated with the densities of mature females supposedly still high, suggest limiting the increase in removals in 2021 in order to limit white crab mortality and prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

- *Higher scenario:* A 20% increase applied to total landings in 2020.
- *Intermediate scenario:* A 15% increase applied to total landings in 2020.
- *Lower scenario:* A 5% increase applied to total landings in 2020.

Area 16A

Description of the fishery

The Area 16A includes two parts (north and south) separated by the Anticosti Channel. The TAC peaked at 566 t in 2015, then it was subsequently decreased to reach 272 t in 2020 after a decrease of 12.3% between 2019 and 2020 and was reached (Figure 30).

Resource status in 2020

Commercial fishery. The standardized CPUE increased from 2011 to 2014 and then decreased since 2015 to reach in 2020, the lowest value since the beginning of this series (Figure 31). No indicators based on sea sampling data are available for the 2020 fishing season (provincial health measures for COVID-19). Limited dockside data indicate that, based on 2019 results, landings have predominantly consisted of recruits (carapace conditions 1 and 2), which are proportionally outpacing the increasing number of intermediate-shell crabs in 2020. The average size of legal-size crab caught at sea has been decreasing since 2016 and was at the historical average starting in 2017, with a very slight increase between 2018 and 2019 (Figure 32).

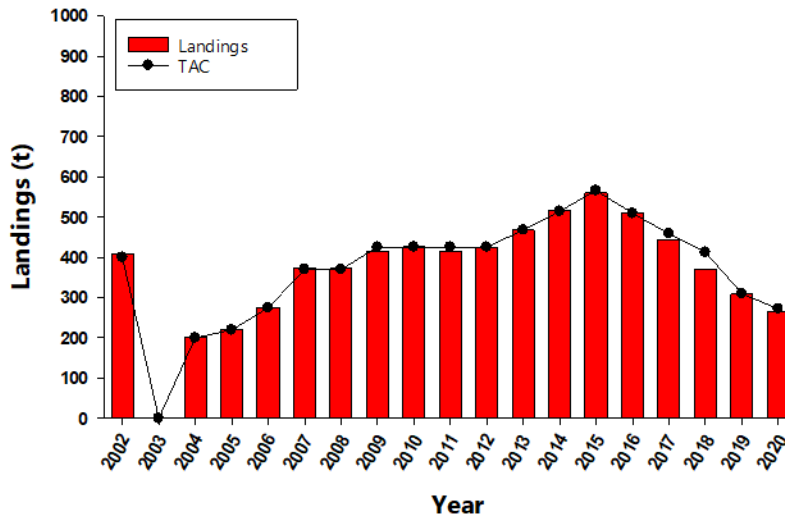


Figure 30. Annual landings and TACs in Area 16A.

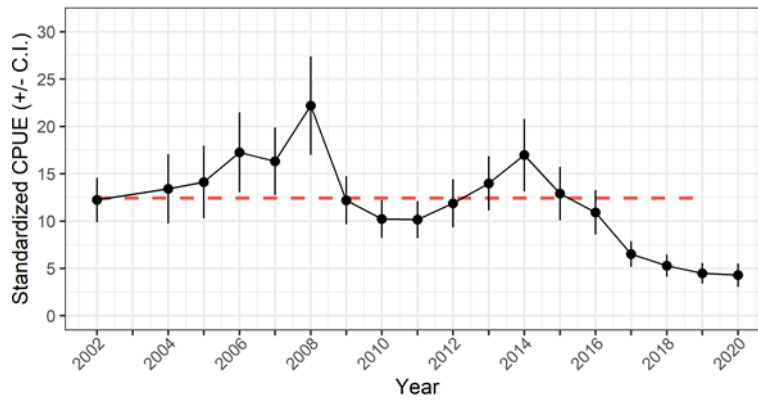


Figure 31. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 16A. The dashed line shows the historical data series average (excluding the last year) which is 12.4 kg/trap per day.

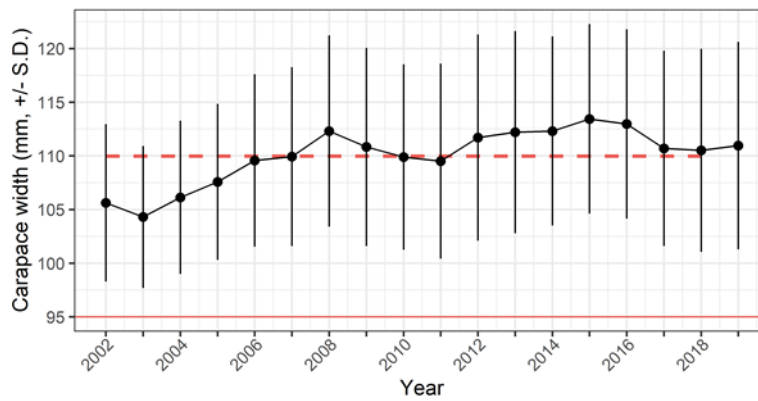


Figure 32. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 16A. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 110.5 mm.

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Fishery-independent survey. The protocol for trap-based research survey was changed in 2014 to allow the use of a new larger, standard conical trap of 6.5 ft diameter. Both types of traps, former and new, were being used from 2014 to 2016. Since 2017, only the larger trap is used. Since catchability with this new trap needs to be further assessed in comparison with the former traps, only the data including this new trap are presented. The research trap survey showed that commercial biomass was low in 2020 both for crabs left by the fishery and for recruits (Figure 33). The NPUE of adults ≥ 95 mm has decreased since the introduction of the new protocol with a yield that has decreased by more than half since 2014 (Figure 33). While NPUE values for 78–95 mm adults and adolescents remained relatively stable between 2014 and 2019, they increased sharply between 2019 and 2020 (Figure 33). The number of primiparous females rose considerably in 2019, and their relative level of abundance compared with all caught females was still high in 2020.

The combined index of commercial CPUE and NPUE of adults ≥ 95 mm from the post-season survey has been decreasing for a 6th consecutive year (-11.1% from 2019 to 2020). This decline suggests that the commercial biomass available to the fishery will be lower in 2021 than in 2020 (Figure 34).

The **thermal habitat index** favourable to juvenile crabs shows an upward temporal trend in area observed over the past several decades (Figure 3B).

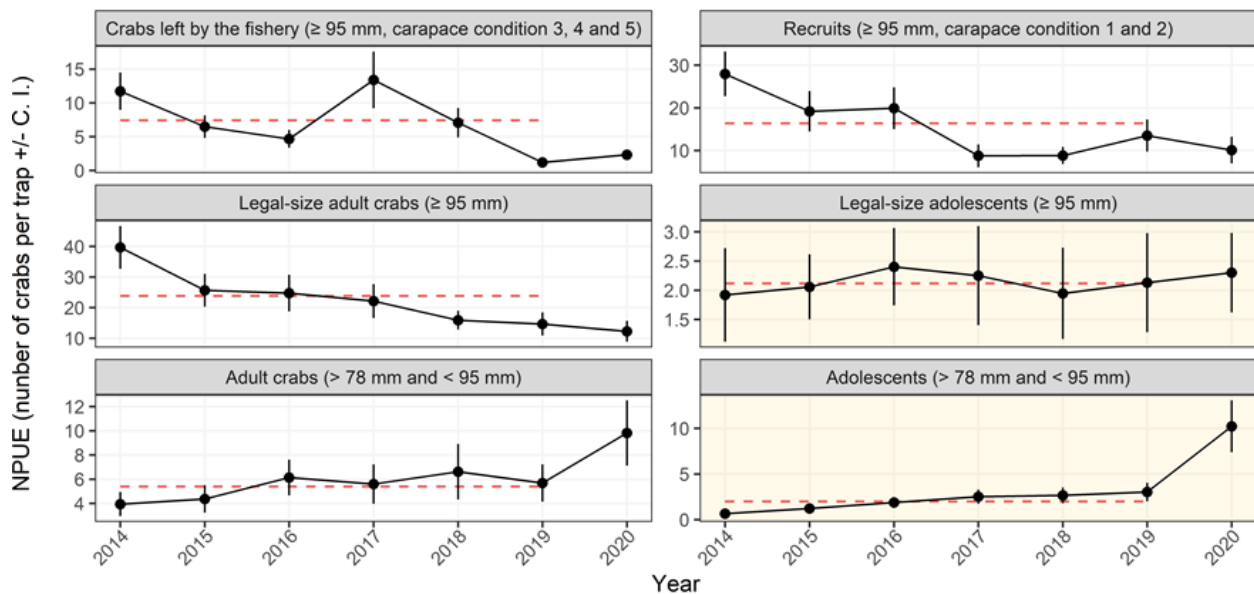


Figure 33. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 16A. The dashed line shows the historical data time series average (excluding the last year).

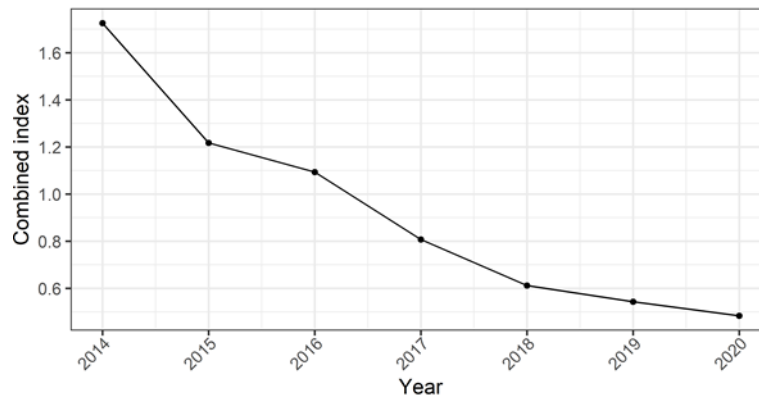


Figure 34. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 16A.

Outlook and conclusions

The combined index has decreased for a sixth consecutive year (-11.1% since 2019), and no increase in biomass available to the fishery is expected in 2021. In the presence of an increase in the density of primiparous females, these indicators suggest reducing the harvest in 2021 in order to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

- *Higher scenario*: A status quo compared to total landings in 2020.
- *Intermediate scenario*: A 10% decrease applied to total landings in 2020.
- *Lower scenario*: A more than 10% decrease applied to total landings in 2020.

Area 12C

Description of the fishery

Area 12C includes two parts (north and south) separated by the deep Anticosti Channel. The TAC peaked at 352 t in 2013 and 2014, and decreased in subsequent years. The TAC was further reduced by 50% in 2020 to 96 t and was not reached (landings of 78.9 t) (Figure 35). According to the industry, the failure to meet the TAC is largely due to the 3 week delay in the beginning of the season.

Resource status in 2020

Commercial fishery. The standardized CPUE increased (+35.6%) between 2019 and 2020, but remains among the lowest values since 1994, well below the historical average (Figure 36). The fishing effort was concentrated mainly in the northeast part of the area. No indicators based on dockside or sea sampling data are available for the 2020 fishing season (provincial health measures for COVID-19). In 2019, the proportion of recruits (carapace conditions 1 and 2) that had increased between 2017 and 2018 decreased again from 2018 to 2019. The proportion of intermediate-shell crab had increased slightly between 2018 and 2019 in landings, while the proportion of old-shelled crab (carapace conditions 4 and 5) remained stable between 2018 and 2019. In 2019, the average size of legal-size crab caught at sea was slightly above the historical average with relative stability observed since 2010 (Figure 37).

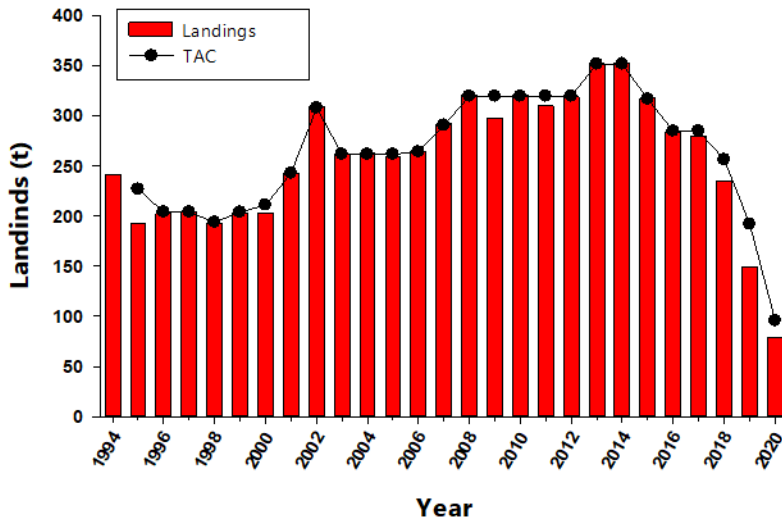


Figure 35. Annual landings and TACs in Area 12C.

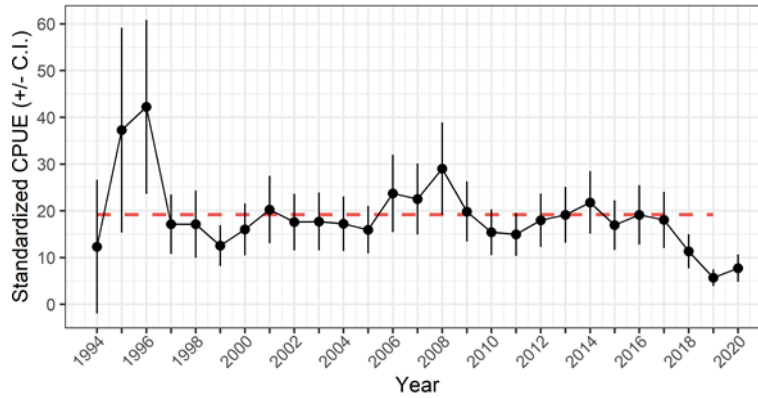


Figure 36. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12C. The dashed line shows the historical data series average (excluding the last year) which is 19.2 kg/trap per day.

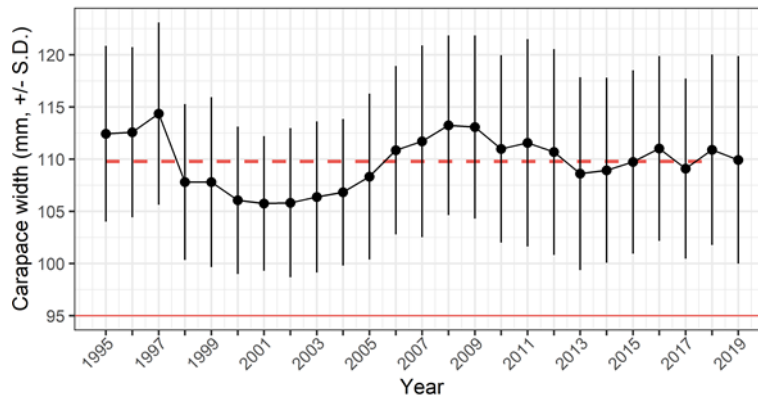


Figure 37. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 12C. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 110.2 mm.

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Fishery-independent survey. The protocol for trap-based research survey was changed in 2014 to allow the use of a new larger, standard conical trap of 6.5 ft diameter. Both types of traps, former and new, were being used from 2014 to 2016. Since 2017, only the larger trap is used. Since catchability with this new trap needs to be further assessed in comparison with the former traps, only the data including this new trap are presented. NPUE values for all adult and adolescent categories increased. NPUE values for adults measuring 95 mm and over rose for the first time since 2014, and this increase was seen both for crabs left by the fishery and for recruits (Figure 38). The NPUE for adolescents measuring 95 mm and over remained stable between 2019 and 2020, while the NPUE for 78-95 mm adolescents increased drastically (Figure 38). All of these indicators show that the biomass available to the fishery should increase in the short and medium term. An increase in the abundance of primiparous females was seen in the 2020 trap survey.

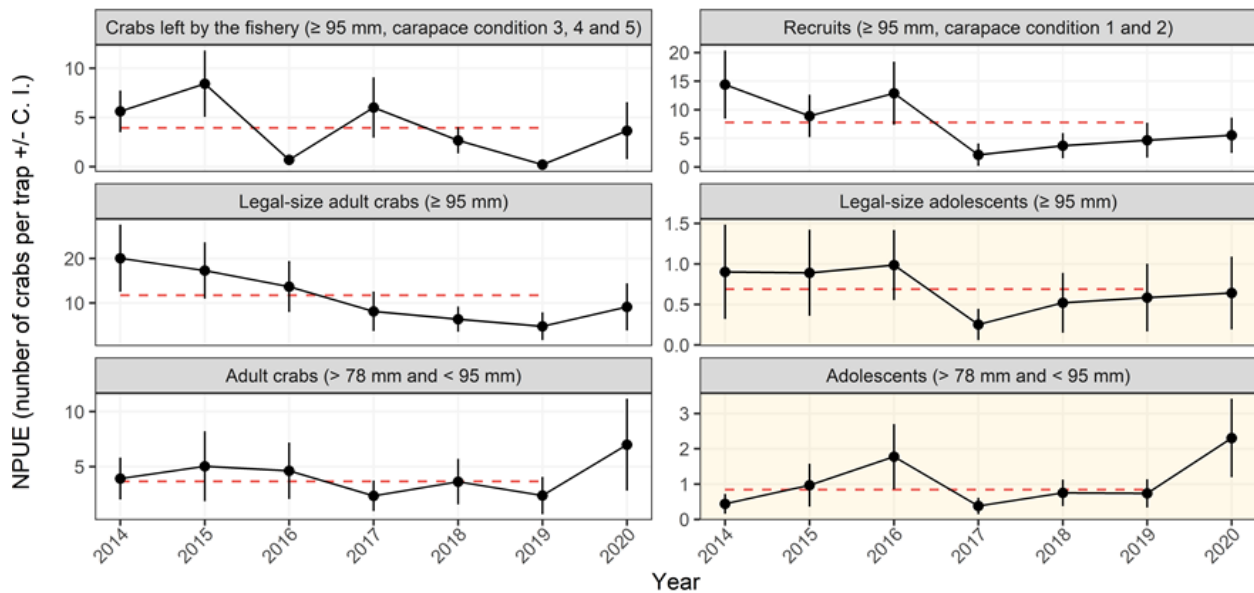


Figure 38. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 12C. The dashed line shows the historical data time series average (excluding the last year).

The combined index of commercial CPUE and NPUE of adult \geq 95 mm from the post-season survey, which has been decreasing for the past 5 years, increased between 2019 and 2020. This increase suggests that the biomass available to the fishery will be higher in 2021 than 2020 (Figure 39).

The thermal habitat index favourable to adult snow crab in Area 12C (Figure 3A) shows an eroding trend in area observed over the past several decades, which could have a negative impact on the future productivity of the stock.

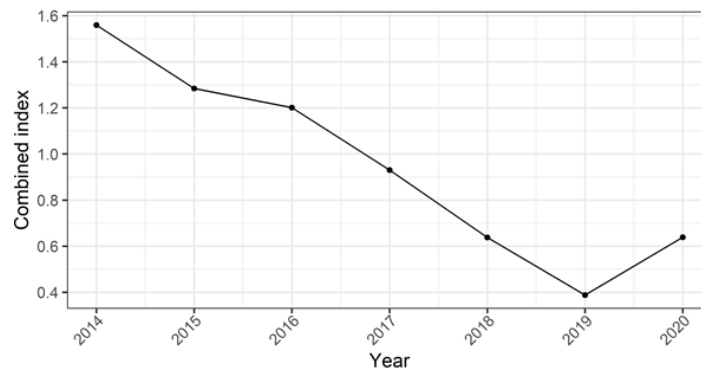


Figure 39. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 12C.

Outlook and conclusions

After a decrease over the period 2015-2019, the combined index increased in 2020 (+ 64.8% since 2019), which suggests an increase in the biomass available to the fishery in 2021. However, the yields from the commercial fishery in 2019 and 2020 are the lowest observed over the period 1994-2020 and the TAC was not reached for a third consecutive year. In the presence of an increase in the density of primiparous females, these indicators suggest more caution in establishing the total landings allowed in 2021, in order to prevent an excessively biased sex ratio in favour of females during the recruitment of primiparous females.

- *Higher scenario:* A 30% increase applied to total landings in 2020.
- *Intermediate scenario:* A 20% increase applied to total landings in 2020.
- *Lower scenario:* A 10% increase applied to total landings in 2020.

Area 12B

Description of the fishery

From 2010 to 2014, the TAC was gradually increased from 246 tonnes to 468 tonnes, a record high level. Despite a considerable decrease in the TAC, it has not been met since 2015. The TAC set for 2018 was intended to enable monitoring of snow crab yields for this stock; the stock is considered to be in poor condition but its exact status is unknown because the trap survey was not conducted in 2017 or 2018. The TAC was kept at the same level (125 t) from 2018 to 2019. In 2019, the TAC was not met, with landings totalling only 30 tonnes (Figure 40). The area has been deserted by some fishers for various reasons and fishing effort has been low, which could partly explain why the TAC was not reached. In 2020, a 20-tonne index fishery was authorized, but no commercial fishing took place.

Resource status in 2020

Commercial fishery. Given the lack of commercial and scientific fishing in 2020, it is impossible to update the indicators used to assess stock status in 2019. The standardized NPUE in 2019 was among the lowest values in the time series (8.1 kg/trap daily, while the historical average is 33.5 kg/trap daily) (Figure 41). In 2019, landings consisted primarily of intermediate-shell crabs. The proportion of recruits (carapace conditions 1 and 2) had increased slightly while old-shelled crab (carapace conditions 4 and 5) had decreased between 2018 and 2019. After a decrease between 2013 and 2018, the average size of crabs caught in the commercial fishery had

increased very slightly between 2018 and 2019, but remained relatively stable over the 2017-2019 period, and below the historical average (Figure 42).

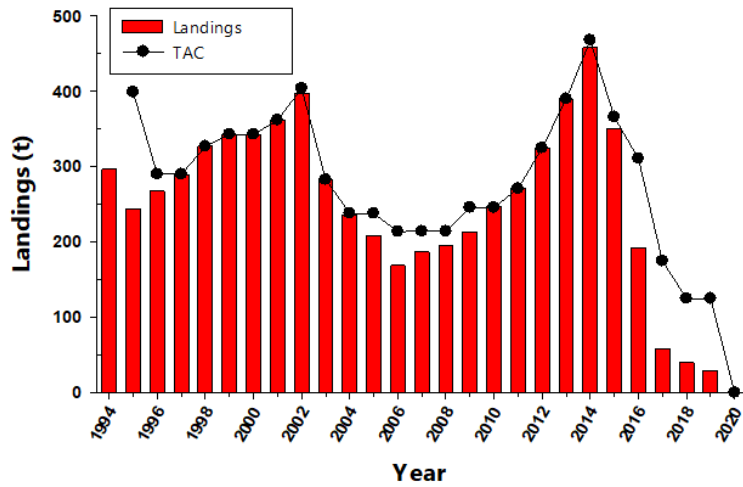


Figure 40. Annual landings and TACs in Area 12B.

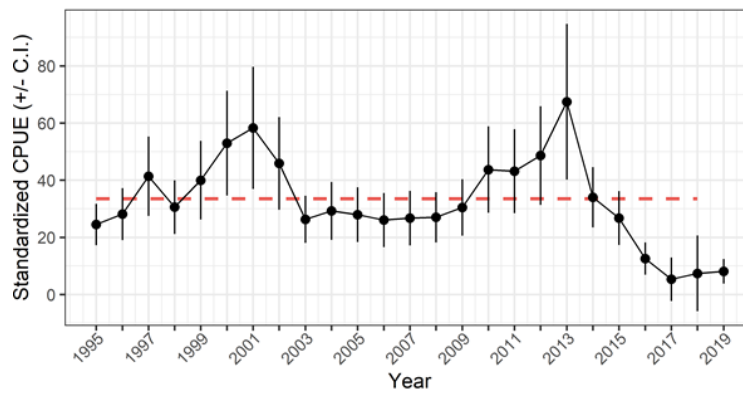


Figure 41. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12B. The dashed line shows the historical data series average (excluding the last year) which is 33.5 kg/trap per day.

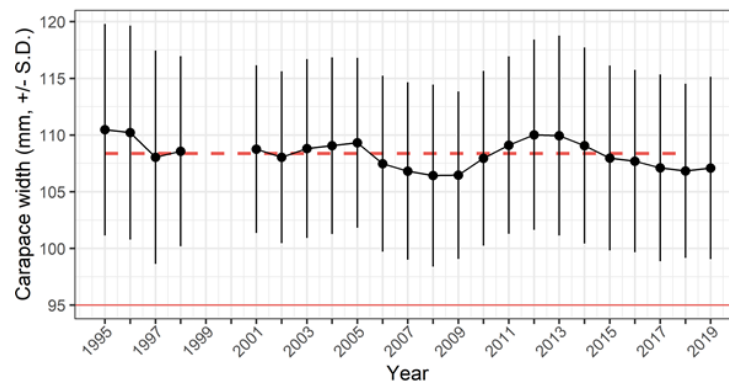


Figure 42. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 12B. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 108.7 mm.

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Fishery-independent survey. The trap-based research survey conducted since 2001 shows that the NPUE of adults and adolescents has decreased sharply since 2013 and are closed to 0 in 2019 (Figure 43). The survey was not conducted in 2017, 2018 and 2020.

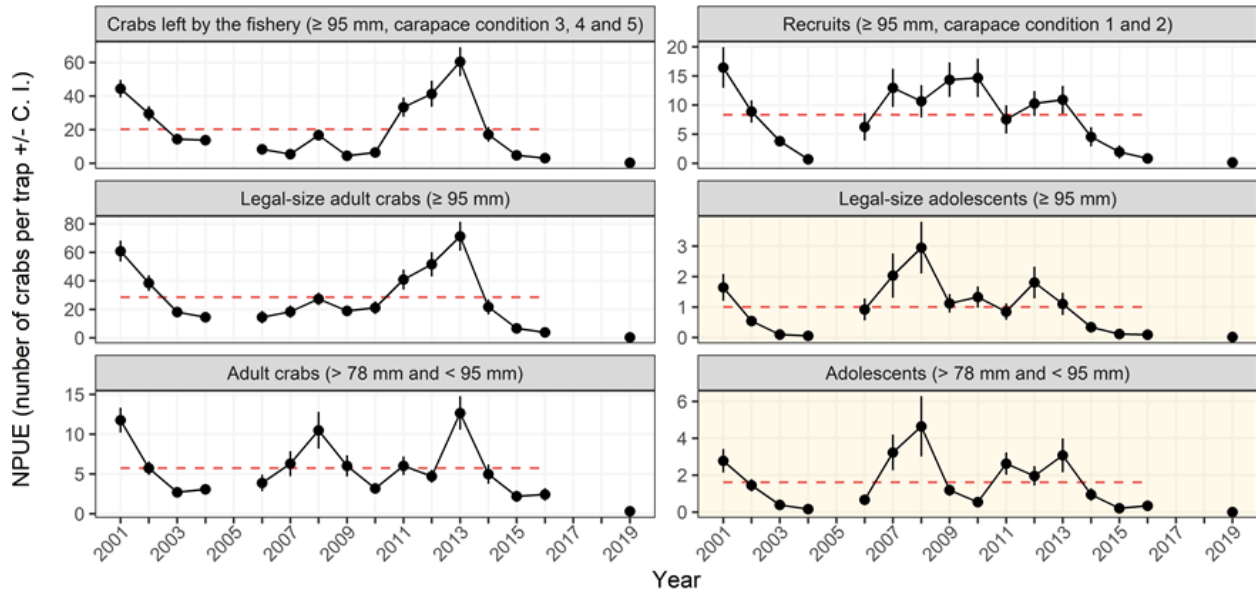


Figure 43. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 12B. The dashed line shows the historical data time series average (excluding the last 3 years).

The combined index could be calculated for 2019, but the lack of surveys in 2017 and 2018 prevents the calculation of the relative decline from the previous year (Figure 44). However, the value calculated for 2019 was the lowest value observed over the 2001-2020 time series, with a cumulative decrease of 51% since the last survey in 2016.

The thermal habitat index favourable to adult snow crab in Area 12B (Figure 3A) shows an eroding trend in area observed over the past several decades, which could have a negative impact on the future productivity of the stock.

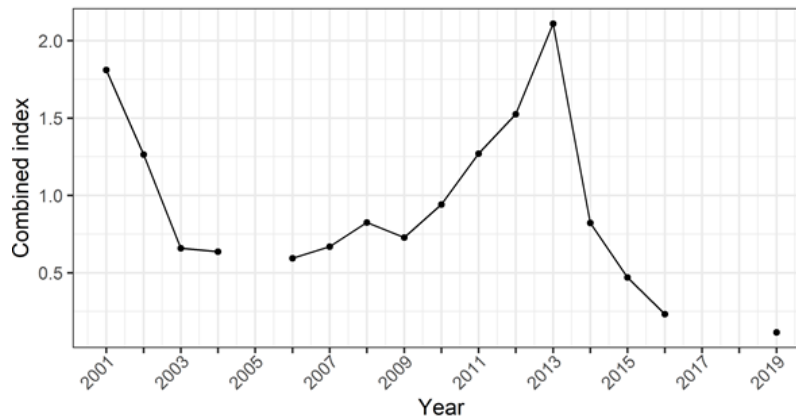


Figure 44. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 12B.

Outlook and conclusions

The non-attainment of the TAC, low catch rates, small size and low recruitment of snow crab suggested that stock status had not improved in 2019. The short-term outlook was not favourable.

According to all indicators available in 2019, the biomass was very low and may not be able to support a commercial fishery.

In the absence of data for 2020, no new recommendation is issued for 2021.

Area 12A

Description of the fishery

The TAC decreased by 23.7% from 2019 to 2020 to 80.5 t (Figure 45), and the TAC was not reached (landings of 69 t or 85.7%). Socio-economic reasons were cited for not achieving the TAC.

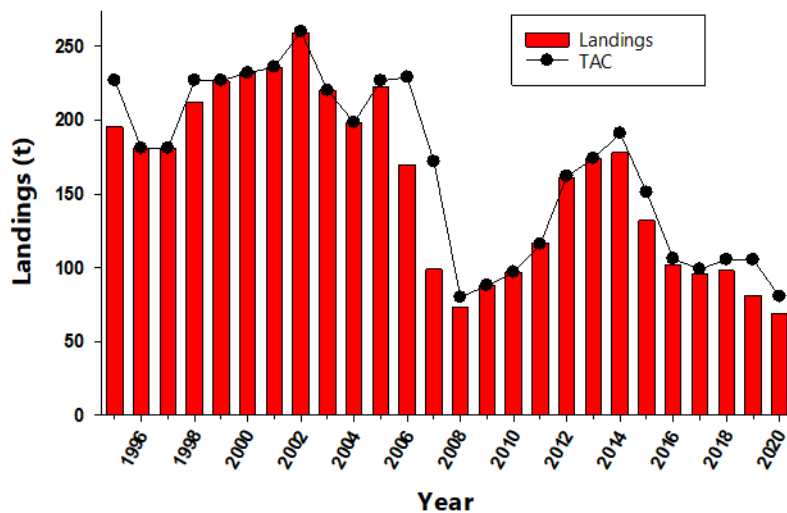


Figure 45. Annual landings and TACs in Area 12A.

Resource status in 2020

Commercial fishery. The standardized CPUE went from the highest value of the series in 2013 to the lowest value in 2020 (Figure 46). The 12.3% decrease between 2019 and 2020 occurred after some relative stability between 2017 and 2019, despite a decrease in landings from 2018 to 2020. No indicators based on sea sampling data are available for the 2020 fishing season (provincial health measures for COVID-19). Dockside data are limited but indicate that landings consisted of a strong majority of intermediate-shell crabs. The average size of crabs caught in the commercial fishery remained stable between 2018 and 2019, and was slightly above the historical average after a decrease from 2012 to 2016 (Figure 47).

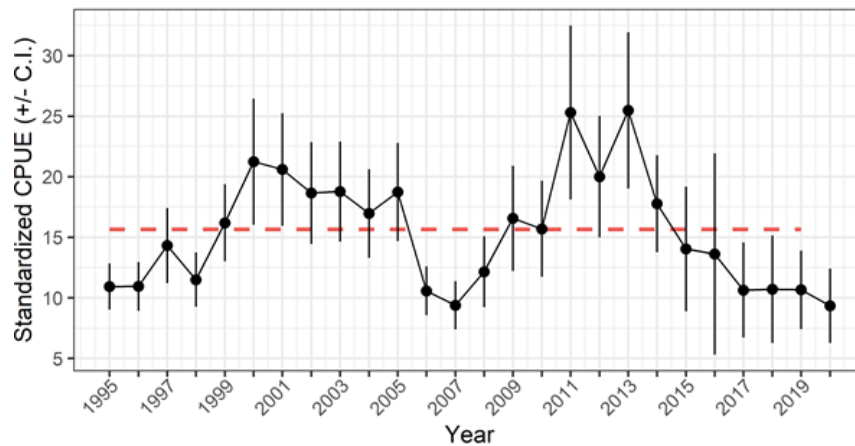


Figure 46. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12A. The dashed line shows the historical data series average (excluding the last year) which is 15.7 kg/trap per day.

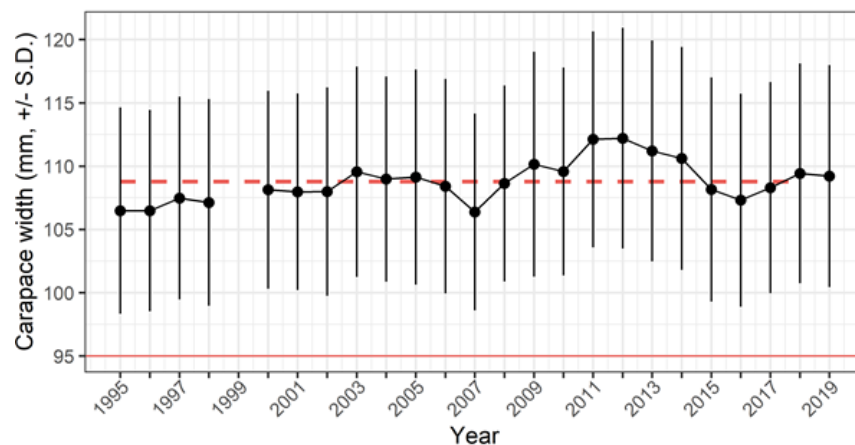


Figure 47. Average carapace width (\pm standard deviation) of legal-size male crabs caught at sea in the commercial fishery in Area 12A. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 109.0 mm.

Fishery-independent survey. The trap-based research survey, which started in 2000, was not conducted in 2013, 2016 and 2019. The 2020 survey indicated that the NPUE for 78-95 mm adults and adolescents increased but remained below the historical average (Figure 48). For the other adult and adolescent categories, NPUE values had not increased since the 2018 survey and were among the lowest values in the time series. A larger number of traps remained empty in the easternmost sector. In the experimental traps, the abundance of mature females, notably primiparous females, has been rising since 2018. This increase is also coupled with an increase in sublegal-size males in classic and experimental traps. These indicators do not suggest an increase in commercial biomass in the short term.

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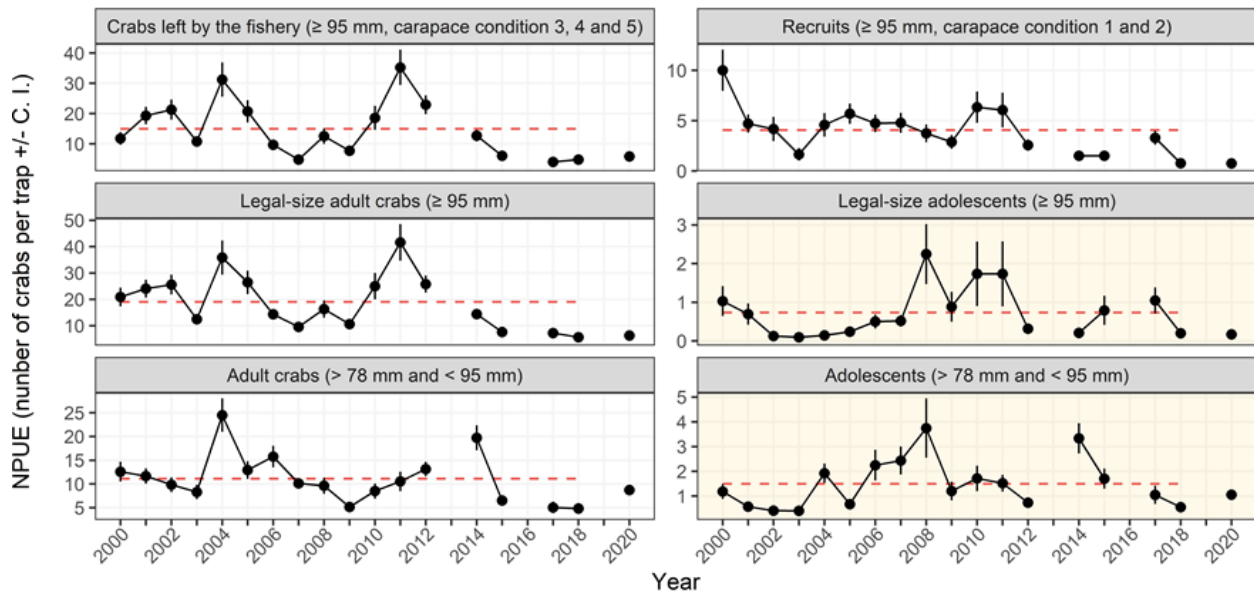


Figure 48. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 12A. The dashed line shows the historical data time series average (excluding the last 2 years).

The combined index of commercial CPUE and NPUE of adults \geq 95 mm from the post-season survey decreased by 2.7% on average per year compared to the 2018 value and is at the lowest value of the time series (Figure 49).

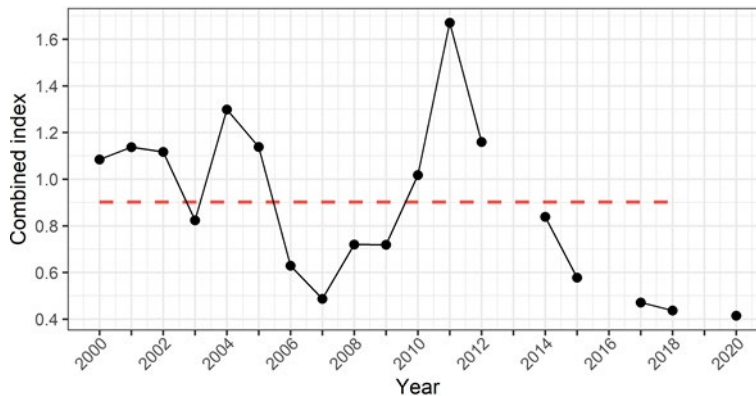


Figure 49. Combined index, derived from the annual standardized commercial NPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 12A.

The thermal habitat index favourable to adult and juvenile snow crab in Area 12A (Figure 3A) shows an eroding trend in area observed over the past several decades, which could have a negative impact on the future productivity of the stock.

Outlook and conclusions

The combined index decreased by 2.8% per year on average between 2018 and 2020 to reach the lowest value in the time series, and performance during the commercial fishery in 2020 was among the lowest in 25 years. In addition, the increase in the abundance of primiparous females in 2020 suggests that a sufficient abundance of males is needed to avoid obtaining a sex ratio

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that is overly biased towards females during primiparous female recruitment. These indicators suggest a decrease in harvesting in 2021.

- *Higher scenario*: A status quo compared to total landings in 2020.
- *Intermediate scenario*: A 15% decrease applied to total landings in 2020.
- *Lower scenario*: A more than 15% decrease applied to total landings in 2020.

Sources of Uncertainty

The quality of science advice depends mainly on the accuracy of the parameters obtained through sampling and the subsequent analyses. Information obtained from logbooks and purchase slips during the fishing season affects the accuracy of the parameters derived from these documents. For instance, abundance indices and fishing effort calculations obtained from logbooks may include errors that will affect the scientific advice provided. The selectivity and catchability of traps can vary depending on the type of trap used, its volume and mesh size, the amount and quality of bait used and soak time, which can vary with the fishing strategies employed and environmental conditions. The catchability of adolescent crab and recruits could also be affected by the abundance of intermediate-shell adult crab (condition 3) on the seafloor. The selective sorting of catches can also affect the quality of the data obtained. Finally, the availability/abundance of natural prey, such as capelin, can also influence the attractiveness of baited traps and therefore the catchability with underestimated biomass indices (CPUE and NPUE).

The abundance and condition indices and the crab size distribution obtained from the trawl and trap surveys are affected by the type of gear used and by uncertainties related to catchability variations in the different crab groups targeted. Some types of fishing gear are better suited to given seafloor areas than other types, and this factor influences the spatial coverage ultimately sampled. The biological characteristics specific to snow crab can also create sources of uncertainty that impinge on the scientific advice. For instance, the terminal moulting phase, which occurs at various sizes, affects crab condition and catchability. Natural mortality can also vary with the life cycle stage and condition of the crab.

OTHERS CONSIDERATIONS

Snow crab distribution is linked to the thickness (and temperature) of the cold intermediate layer which serves as its habitat during the benthic phase. In recent years, an increase in the temperature of the deep water layer and the surface layer has been observed in the Gulf of St. Lawrence (Galbraith et al. 2021). These warmer conditions, both above and beneath the cold intermediate layer, may lead to a reduction in the area of thermal habitat for snow crab and affect its distribution and abundance (Émond et al. 2020). A favourable thermal habitat index (see Tamdrari et al. 2012 for the method) was calculated for each fishing area based on the surface area where the bottom temperature is favourable to adult (-1°C to 3°C) and juvenile (0 à 2°C) snow crab) (Dionne et al. 2003, Sainte-Marie et al. 2005, Ouellet et Sainte-Marie 2018). The length of the early pelagic larval development stages and larval survival are related to surface water temperatures (mainly in spring and summer) just as egg incubation time and crab growth are related to water temperature on the seabed areas where they develop. It therefore seems that the distribution and productivity of snow crab stocks could be affected by the temperature in the different water layers. The effect of warming waters on crab stock productivity and distribution is a real issue. The impacts could be quite different depending on the region or area concerned and the number of years with significant warming.

LIST OF MEETING PARTICIPANTS

Name	Affiliation	Feb. 16	Feb. 17	Feb. 18
Beaulieu, Jérôme	DFO – Fisheries management	x	x	x
Bernier, Denis	DFO – Science	x	-	-
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Boucher, Larry	Fisher Area 16	-	x	-
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Doucet, Marc	Fisher Area 17	x	-	-
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Rowell, Austin	Fisher Area 12C	-	x	x
Roy, Virginie	DFO – Science	x	-	-
Sainte-Marie, Bernard	DFO – Science	x	x	x
Sandt-Duguay, Emmanuel	MMAFMA	x	x	-
Senay, Caroline	DFO – Science	x	-	x

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Vigneault, Guy	Fisher Area 16	-	x	-
Weiner, Guy-Pascal	Première nation Wolastoqiyik Wahsepiukuk	x	-	-

SOURCES OF INFORMATION

This Science Advisory Report is from the February 16-18, 2021 Regional Advisory Process on Assessment of the Estuary and northern Gulf of St. Lawrence Snow Crab stocks. 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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