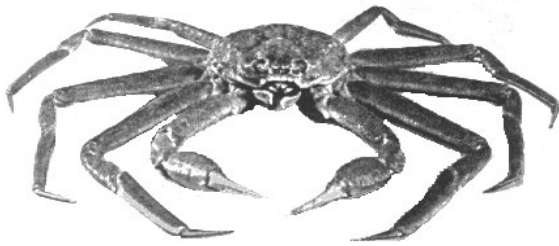




ASSESSMENT OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE (AREAS 13 TO 17, 12A, 12B, 12C AND 16A) SNOW CRAB STOCKS IN 2021



Snow Crab (Chionoecetes opilio, O. Fabricius)

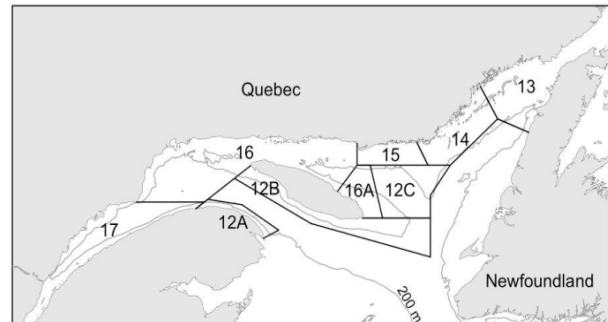


Figure 1. Snow crab management areas in the Estuary and the northern Gulf of St. Lawrence.

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. Landings for the nine fishing areas totalled 4,456 t in 2021.

The fishery targets only males with a carapace width ≥ 95 mm. White crabs (crabs that have 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 2022 quotas. A scientific peer review was conducted on February 16-18, 2022 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

- Between 2020 and 2021, the total allowable catch (TAC) decreased by 5.0% to 1,213.2 t and was reached. Landings in 2021 totalled 1,217.0 t, down 8.1% from 2020 (1,324.0 t).
- For a second consecutive year, the commercial catch per unit effort (CPUE) rose in 2021 (+11.2% from 2020 to 2021) but remained among the lowest values of the 2000–2021 period.
- Dockside sampling indicated that landings in 2021 were approximately half recruits (crabs of shell condition 1–2), representing a proportion fairly similar to the last sampling in 2019.
- The commercial abundance indicator of the post-season survey remained steady (+5.8% from 2020 to 2021) throughout the 2018–2021 period, with the lowest values seen since 2000. However, for a second year in a row, this indicator rose steadily in the southern portion of the area to near the historical average for this subregion.
- All the post-season survey abundance indicators for adolescent and adult males showed values similar to those observed in 2020. Adolescent abundance levels in the southern part of the area were at the historical average.
- The decrease in the mean weight of the spermathecal load of primiparous females and data from the post-season survey since 2020 suggest an increase in the number of primiparous females.
- The favourable thermal habitat indices for both large and small snow crabs showed a downward temporal trend over the 1990–2021 period. The values observed in 2021 are the lowest in each of the time series.
- The combined index increased by 9.1% between 2020 and 2021. Values from 2019 to 2021 were among the lowest observed throughout the 2000–2021 period.
- Indicators suggest that the biomass available to the fishery in 2022 should be similar to that available in 2021.

Outlook

- The combined index increased by 9.1% between 2020 and 2021. Values from 2019 to 2021 were among the lowest observed throughout the 2000–2021 period. The biomass available to the fishery in 2022 is expected to be similar to that of 2021.
- Given the increase in densities of primiparous females since 2020, these indicators suggest that greater caution should be exercised in establishing total allowable landings in 2022 to avoid obtaining a sex ratio that is overly biased towards females during this period of high reproductive female abundance.

Higher scenario: A 10% increase applied to total landings in 2021.

Intermediate scenario: A status quo compared to total landings in 2021.

Lower scenario: A decrease applied to total landings in 2021.

Quebec Region

Area 16

- From 2020 to 2021, the total allowable catch (TAC) decreased by 16.1% to 1,951 t, and it was reached (landings of 1,962.6 t).
- After a sharp decline over the 2016-2019 period, catch per unit effort (CPUE) for the commercial fishery is increasing (+19.4%) in 2021 for a second consecutive year, but remains below the historical average.
- Dockside sampling indicated that landings in 2021 were approximately half recruits (shell condition 1–2), representing a proportion fairly similar to the last sampling in 2019 and 2020.
- The post-season survey commercial abundance index is up (+20.9%) in 2021 after a sharp decline over the 2016-2020 period, but remains among the lowest values observed in 20 years.
- The abundance of male recruits and adolescents > 95 mm was stable in the post-season survey, while the abundance of adolescent and adult males measuring 78–95 mm increased between 2020 and 2021 and remained below the historical average.
- Monitoring of the Sainte Marguerite Bay snow crab population could not be conducted in 2021. The last survey in 2020 predicted that the biomass available to the fishery would increase from 2023-24. At the same time, the density of primiparous females was increasing sharply in 2020, suggesting a high abundance of spawning females in 2021-2023.
- The favourable thermal habitat indices for large and small crabs showed a downward temporal trend over the 1990–2021 period. The values observed in 2021 are the lowest in each of the time series.
- The combined index is up 20.0% from 2020, but remains among the lowest values in the last 20 years. This suggests that the biomass available to the fishery in 2022 should be similar to that of 2021.

Outlook

- The combined index increased (+20.0%) between 2020 and 2021 but remains among the lowest values of the last 20 years. The biomass available to the fishery in 2022 is expected to be similar to that of 2021.
- In the context of an assumed high density of reproductive females for the 2021–2023 period, these indicators suggest limiting increases in removals in 2022 to avoid obtaining a sex ratio that is overly biased towards females.

Higher scenario: A 20% increase applied to total landings in 2021.

Intermediate scenario: A 10% increase applied to total landings in 2021.

Lower scenario: A status quo compared to total landings in 2021.

Area 15

- The total allowable catch (TAC) increased by 5.0% between 2020 and 2021 to 325.5 t, and was nearly reached. Landings in 2021 were 306.0 t, up by 13.6% from 2020 (263.0 t).
- The catch per unit effort (CPUE) for the commercial fishery is stable since 2019 (+1.5% between 2020 and 2021), and the last three years' values are the lowest over the 2000-2021 period.

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- In the absence of adequate at-sea sampling program coverage for monitoring the mean carapace width (CW) of commercial males in 2021, dockside data indicate a sharp decline from 2020 to 2021 in the mean CW, which was among the lowest values for the 2000–2021 period.
- Dockside data indicate that the majority of landings (53.3%) in 2021 consisted of recruits (crabs of shell condition 1–2). This proportion increased between 2020 and 2021, while the percentage of intermediate-shell crabs declined from 45.2% to 37.9%.
- The peaks in abundance observed in 2020 in the post-season survey (particularly with respect to adult males 78–95 mm), alongside the return of indicators for 2021 to values near those seen in 2019, increase the uncertainty when comparing 2020 and 2021 values.
- Between 2020 and 2021, the commercial abundance index of the post-season survey declined significantly to the lowest value of the 2014–2021 period.
- All other post-season survey abundance indices for adolescent and adult males declined between 2020 and 2021, and only the abundance indicator for sublegal-size adolescents was above its historical average.
- According to the post-season survey, the abundance of primiparous and multiparous females is high in 2021, while the weight of the spermathecal load is decreasing.
- In 2020 and 2021, high abundances of sublegal-size adolescents and primiparous females were consistent indicators of the upcoming arrival of a pulse of recruitment.
- The combined index increased by 35.4% between 2020 and 2021, and is at the same level as the 2019 value. The 2019 to 2021 values are the lowest values observed over the 2014–2021 period.
- The available indicators suggest that the biomass available to the fishery in 2022 is expected to be less than or equal to that of 2021.

Outlook

- The combined index (CI) is among the lowest values observed in eight years (-35.4% between 2020 and 2021), with fishing yields that were, over the last three years, the lowest observed in the last two decades and a commercial abundance indicator that returned to the lowest observed value (2019). This last point is a source of uncertainty associated with using the CI to develop scenarios.
- The biomass available to the fishery in 2022 is expected to be less than or equal to that of 2021.
- Given the increase in densities of primiparous females since 2019, these indicators suggest that greater caution should be exercised in establishing total allowable landings in 2022 to avoid obtaining a sex ratio that is overly biased towards females during this period of high abundance of reproductive females.

Higher scenario: A 10% decrease applied to total landings in 2021.

Intermediate scenario: A 20% decrease applied to total landings in 2021.

Lower scenario: A more than 20% decrease applied to total landings in 2021.

Area 14

- The total allowable catch (TAC) decreased by 7.6% between 2020 and 2021 to 365.0 t, and was reached. Landings in 2021 were 362.5 t, up by 4.2% from 2020 (348.0 t).
- The catch per unit effort (CPUE) for the commercial fishery is increasing in 2021 (+30.1% between 2020 and 2021), and the last three years' values are the lowest over the 2000-2021 period.
- In the absence of adequate at-sea sampling program coverage for monitoring the mean carapace width (CW) of commercial males in 2021, dockside data indicate a decline in the mean CW since the last sampling in 2019. The mean CW in 2021 was close to the historical average.
- Dockside data indicate that the majority of landings (55.6%) in 2021 consisted of recruits (crabs of shell condition 1–2). This proportion saw a significant increase between 2019 and 2021, while the percentage of crabs with shell condition 3 and 4–5 dropped from 59.9% to 39.2% and 28.3% to 5.2%, respectively.
- All of the post-season survey abundance indices for adolescent and adult males decreased between 2020 and 2021, with a 2021 value that was among the lowest observed in the 2000–2021 period. Uncertainty remains about the validity of the indicators for 2021 compared with the last trawl survey in 2018, which signalled the arrival of a new pulse of recruitment.
- According to the post-season survey, the abundance of primiparous and multiparous females is high in 2021, while the weight of the spermathecal load remains relatively low.
- The thermal habitat indices favourable to large and small crabs showed an increasing temporal trend over the period 1990-2021.
- The combined index decreased by 34.9% between 2020 and 2021, and is at the lowest value over the 2000-2021 period.
- Indicators suggest that the biomass available to the fishery in 2022 is expected to be less than or equal to that available in 2021.

Outlook

- The combined index is at the lowest value observed over the 2000–2021 period (-34.9% between 2020 and 2021), with fishing yields that were, for the last three years, the lowest observed in the last two decades and a commercial abundance indicator that is the lowest on record. Although some uncertainty remains on the representativeness of the 2021 post-season survey in terms of the status of the resource, the biomass available to the fishery in 2022 should still be less than or equal to that available in 2021.
- Given the increase in densities of primiparous females since 2019, these indicators suggest that greater caution should be exercised in establishing total allowable landings in 2022 to avoid obtaining a sex ratio that is overly biased towards females during this period of high abundance of reproductive females.

Higher scenario: A 10% decrease applied to total landings in 2021.

Intermediate scenario: A 20% decrease applied to total landings in 2021.

Lower scenario: A more than 20% decrease applied to total landings in 2021.

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Area 13

- The total allowable catch (TAC) remained unchanged between 2020 and 2021 to 244.0 t, and was not reached. Landings in 2021 were 199.0 t, down 7.0 % from 2020 (214.0 t). The fishing season was closed 11 days early due to white crabs.
- The commercial fishery CPUE decrease between 2020 and 2021 (-26.5%) and is the lowest value observed over the 2000-2021 period.
- Dockside sampling indicates that landings consisted of a majority (59.7%) of recruits (shell condition 1-2) in 2021, which is up from 2019 (+24.4%).
- The mean carapace width of commercial males sampled at sea and dockside has decreased since the last sampling in 2019 and is among the lowest values for the 2000–2021 period.
- The commercial abundance index of the post-season survey increased between 2020 and 2021 and is now above the historical average. This increase is primarily due to the increased abundance of crabs left by the fishery (shell condition 3–5) on the north side and, to a lesser extent, the increased abundance of recruits on the south side.
- Data on spermathecal load weight in the 2019–2021 post-season surveys and densities of primiparous females in the trawl survey in 2018 suggest that the abundance of reproductive females will remain high following a peak in 2018–2019.
- The thermal habitat indices favourable to large and small crabs showed an increasing temporal trend over the period 1990-2021.
- After a sharp increase in 2020, the combined index remains stable between 2020 and 2021.
- Indicators suggest that the biomass available to the fishery in 2022 should be similar to that available in 2021.

Outlook

- The combined index remains stable in 2021 after a strong increase in 2020. The biomass available to the fishery in 2022 should be similar to that available in 2021.

Higher scenario: A 20% increase applied to total landings in 2021.

Intermediate scenario: A status quo compared to total landings in 2021.

Lower scenario: A decrease applied to total landings in 2021.

Area 16A

- The total allowable catch (TAC) decreased by 9.9% between 2020 and 2021 to 245.0 t, and was reached. Landings in 2021 were 244.2 t, down 5.0% from 2020 (257.0 t).
- The commercial fishery CPUE increase between 2020 and 2021 (+14.3%) but the 2021 value remain among the lowest observed over the 2000-2021 period.
- No indicators based on sea sampling data are available for the 2020 and 2021 fishing seasons.
- Dockside sampling indicates that landings in 2021 consisted of a majority of recruits (over half), similar to 2019 and 2020.

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- Different spatial coverage across the post-season survey created some uncertainty in the indicators for 2021.
- The commercial abundance index from the post-season survey was declining over the period 2014-2021.
- The high abundance of sublegal-size adolescents in 2020 and 2021 and of primiparous females since 2019 have been consistent indicators of an upcoming pulse of recruitment.
- The favourable thermal habitat index for small crabs showed a downward temporal trend over the 1990–2021 period.
- The combined index was declining over the 2014-2020 period, but only decreases by 4.2% between 2020 and 2021.
- This decrease suggests that the biomass available to the fishery in 2022 is expected to be less than or equal to that available in 2021.

Outlook

- The combined index was declining over the 2014-2020 period, but only decreases by 4.2% between 2020 and 2021.
- The biomass available to the fishery in 2022 should be less than or equal to that available in 2021.
- Given the high abundance of primiparous females, these indicators suggest a decrease in harvesting in 2022 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 2021.

Intermediate scenario: A 5% decrease applied to total landings in 2021.

Lower scenario: A more than 5% decrease applied to total landings in 2021.

Area 12C

- The total allowable catch (TAC) remained the same between 2020 and 2021 at 96.0 t, and was reached. Landings in 2021 were 91.0 t, up 15.2% from 2020 (79.0 t). The fishing season was closed up to 24 days early due to white crabs.
- The catch per unit effort (CPUE) for the commercial fishery is down in 2021 (-32.8%) compared to 2020 and the last three years' values are the lowest over the 2000-2021 period.
- Dockside sampling indicates that landings were about half recruits (shell condition 1-2) in 2021, which is up from 34.5% in 2019.
- The mean carapace width (CW) of commercial males sampled at sea during the fishing season was at the lowest value observed for the 2001–2021 period (103.2 mm), while the CW of males sampled dockside was at the historical average (110.3 mm).
- Different spatial coverage across the post-season survey created some uncertainty in the indicators for 2021.
- The commercial abundance index of the post-season survey declines markedly between 2020 and 2021, to the lowest values of the 2014-2021 period.

Quebec Region

- All indicators for this survey of adults and legal-size adolescents declined between 2020 and 2021, with the exception of 78–95 mm adolescents. The abundance indicator for sublegal-size adolescents was at its highest value for the 2014–2021 period. An increase in the abundance of primiparous females was also observed in 2021.
- From 2020 to 2021, increased numbers of sublegal-size adolescents and primiparous females were consistent indicators of an upcoming pulse of recruitment.
- The thermal habitat index favourable to large crabs showed a temporal decline over the period 1990-2021, and is at the lowest value of the time series in 2021.
- The combined index (CI) is decreasing between 2020 and 2021, and is at the lowest value of the 2014-2021 period. This decrease suggests that the biomass available to the fishery in 2022 is expected to be less than or equal to that in 2021.
- In the context of a very low apparent abundance in the last post-season survey, the relative difference in the CI compared with the previous year was strongly influenced by a difference of only a few crabs per trap in comparison with the previous year.

Outlook

- The combined index (CI) is at the lowest value observed in eight years, with fishing yields that were, over the last three years, the lowest seen in the last two decades and a commercial abundance indicator that is the lowest on record.
- The biomass available to the fishery in 2022 is expected to be less than or equal to that available in 2021.
- Given the increasing densities of primiparous females, these indicators suggest that great caution is needed when setting the total allowable landings in 2022 to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.
- Scientific consensus has also been reached on proposed adjustments to harvests, which—although they may be smaller than those based solely on the value of the relative change in the CI compared with the previous year—can result in a comparable or lower level of harvesting intensity in the upcoming fishing season compared with the previous season.

Higher scenario: A 20% decrease applied to total landings in 2021.

Intermediate scenario: A 30% decrease applied to total landings in 2021.

Lower scenario: A more than 30% decrease applied to total landings in 2021.

Area 12B

- A 20.0 t index fishery was introduced in 2020 but could not be conducted due to the COVID-19 pandemic. In 2021, it was renewed, and the allocation was achieved with landings of 19.0 t.
- The catch per unit effort (CPUE) of the index fishery was 14.0 kg/trap-day, while the average for the commercial fishery in the 2001–2019 period was 25.7 kg/trap-day. However, the uncertainty associated with the results from 2021 is very high.
- At-sea sampling was limited in 2021, but catches consisted mainly of recruits (shell condition 1–2) during the index fishery (87.8%). Meanwhile, dockside data indicated that the majority (72.8%) of landings from the index fishery were intermediate-shell crabs (condition 3).

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- No post-season surveys were conducted in 2020 and 2021.
- The favourable thermal habitat index for large crabs showed a downward temporal trend over the 1990–2021 period. The 2021 value was one of the lowest on record.

Outlook

- Based on the information available, the status of the resource in Area 12B cannot be assessed.

Area 12A

- The total allowable catch (TAC) decreased by 12.7% between 2020 and 2021 to 69.0 t, and it was not reached (mainly for socio-economic considerations). Landings in 2021 were 54.0 t, which corresponds to a decrease of 21.7% compared to 2020 (69.0 t).
- The catch per unit effort (CPUE) of the commercial fishery is decreasing in 2021 (-37.6% between 2020 and 2021), reaching the lowest value over the 2001–2021 period.
- At-sea sampling was limited in 2021, but the mean carapace width of commercial males sampled during the fishing season has been declining and was at the lowest value of the 2001–2021 period.
- Dockside data indicate that two-thirds of the landings were intermediate-shell crabs (category 3).
- Other than adolescent crabs with a carapace width of 78–95 mm, the numbers of which increased between 2020 and 2021 to exceed the historical average, all abundance indices from the 2021 post-season survey were among the lowest values observed across their historical series. Increased abundances of primiparous females and small males were observed in 2020 and 2021.
- The favourable thermal habitat index for large crabs showed a downward temporal trend over the 1990–2021 period.
- Between 2020 and 2021, the combined index (CI) declined by 40.8% to reach the lowest value of the 2001–2021 period.
- In the context of a very low apparent abundance in the last post-season survey, the relative difference in the CI compared with the previous year was strongly influenced by a difference of only a few crabs per trap in comparison with the previous year.
- Indicators suggest that the biomass available to the fishery in 2022 is expected to remain very low.

Outlook

- The combined index is at the lowest value on record for the 2001–2021 period (-40.8% from 2020 to 2021), with fishing yields and a post-season commercial abundance indicator that are at the lowest values observed in the last two decades. The biomass available to the fishery in 2022 is predicted to remain very low.
- Given the increasing densities of primiparous females, these indicators suggest that great caution is needed when setting the total allowable landings in 2022 to prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

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- Scientific consensus has also been reached on proposed adjustments to harvests, which—although they may be smaller than those based solely on the value of the relative change in the CI compared with the previous year—can result in a comparable or lower level of harvesting intensity in the upcoming fishing season compared with the previous season.

Higher scenario: A 20% decrease applied to total landings in 2021.

Intermediate scenario: A 30% decrease applied to total landings in 2021.

Lower scenario: A more than 30% decrease applied to total landings in 2021.

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. In 2021, 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 fishing 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 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 northern Gulf and Estuary areas was not carried out since 2019 because of the prevailing COVID-19 pandemic in 2020 and the unavailability of DFO research vessel in 2021. Thus the results of research trawl surveys updated in areas 13, 17 and 16 in 2018, 2019 and 2020 respectively, were those 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.

Assessment of the Estuary and Northern Gulf of St. Lawrence Snow Crab Stocks in 2021

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The numbers of fishing licenses and dates that fishing was allowed in 2021 are indicated in Table 1. Stocks have reached the end of the wave of recruitment to the fishery, with total landings for the nine areas in 2021 of 4,456 t, decreasing for a third consecutive year. This decrease was observed in most areas, except in areas 12C, 14 and 15 (Figure 2).

Table 1. Summary by Area of the number of licences and dates of commercial fishery in 2021. 'White crab' indicates that the fishing season ended early according to the white crab monitoring protocol in the Conservation Harvesting Plan (CHP). The fishery is closed if more than 20% of the at-sea catch is 'white crab', which are adult crabs that have recently molted.

Areas	13	14	15	16	16A	17	12A	12B	12C
Number of licences	41	19	30	51	35	36	10	6	37
Opening dates	April 24 or May 1 st	April 25 or May 2	April 7	April 1 st	April 7	March 24	March 23	March 25	April 5 or 12
Closure dates	July 28 (white crab)	August 1 st or 8	July 14	July 8	July 14	June 24	June 1 st	June 30	June 25 (white crab)

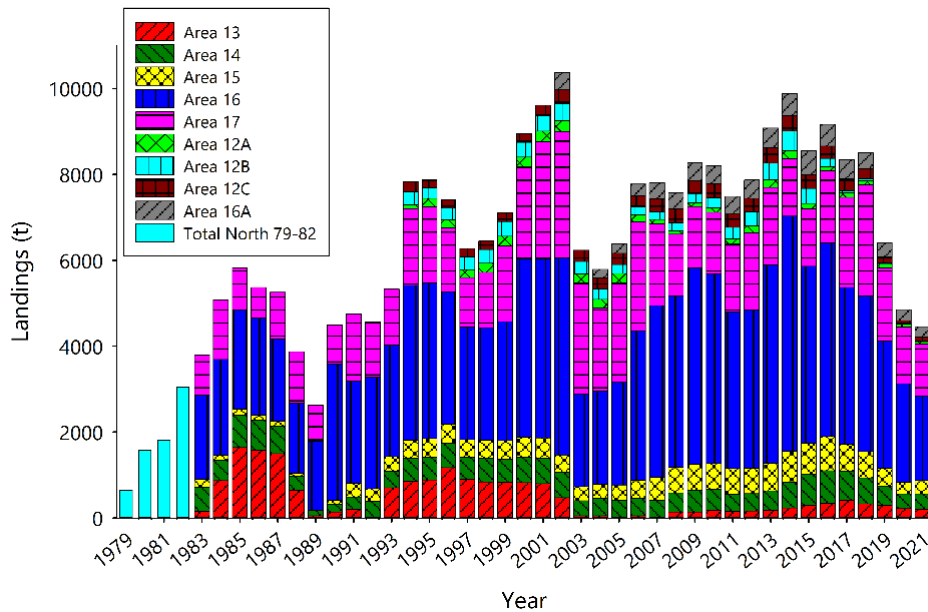


Figure 2. Snow crab landings in the Estuary and northern Gulf of St. Lawrence from 1979 to 2021. From 1979 to 1982, landings were not attributed to their area of origin.

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 (shell conditions 1 and 2), intermediate-shell crab (shell condition 3) and old-shell crab (shell 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 average NPUE from the north and south surveys in Area 13). The combined index is calculated

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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.

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

**Assessment of the Estuary and Northern Gulf
of St. Lawrence Snow Crab Stocks in 2021**

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The average size of legal-sized crabs caught at sea remains stable between 2019 and 2021. This indicator has remained below the historical average since 2014. However, the average size of commercial crabs sampled at dockside increased between 2019 and 2021 to slightly above the historical average (Figure 6).

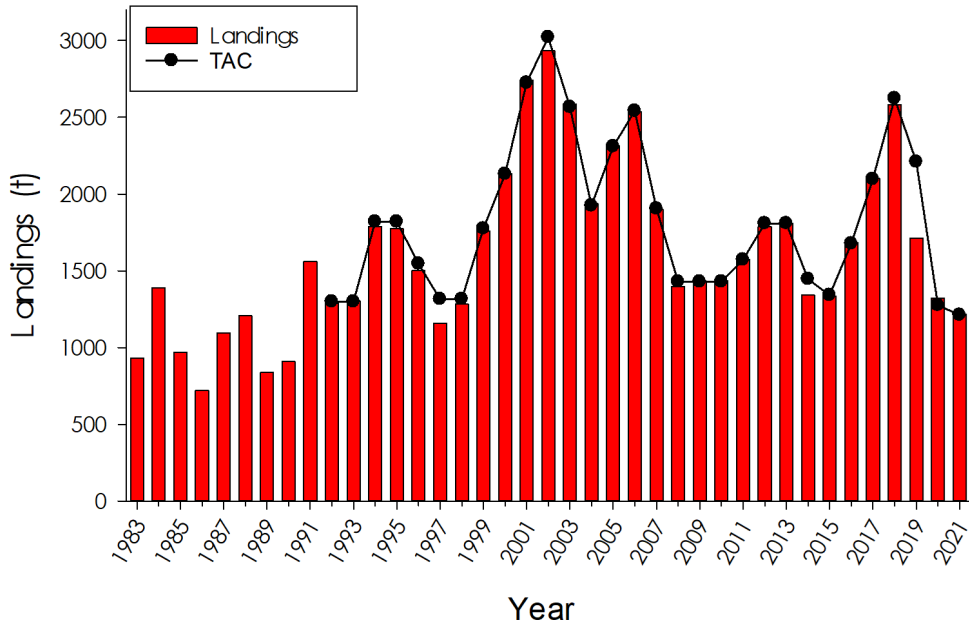


Figure 4. Annual landings and TACs in Area 17.

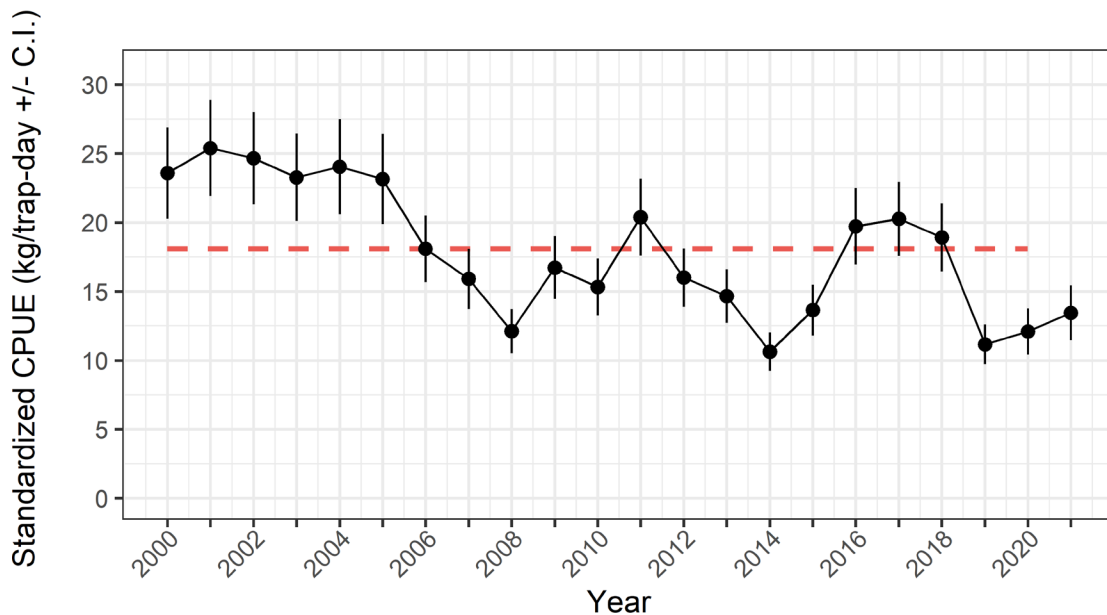


Figure 5. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 17. The dashed line shows the historical data series average (excluding the last year) which is 18.1 kg/trap per day.

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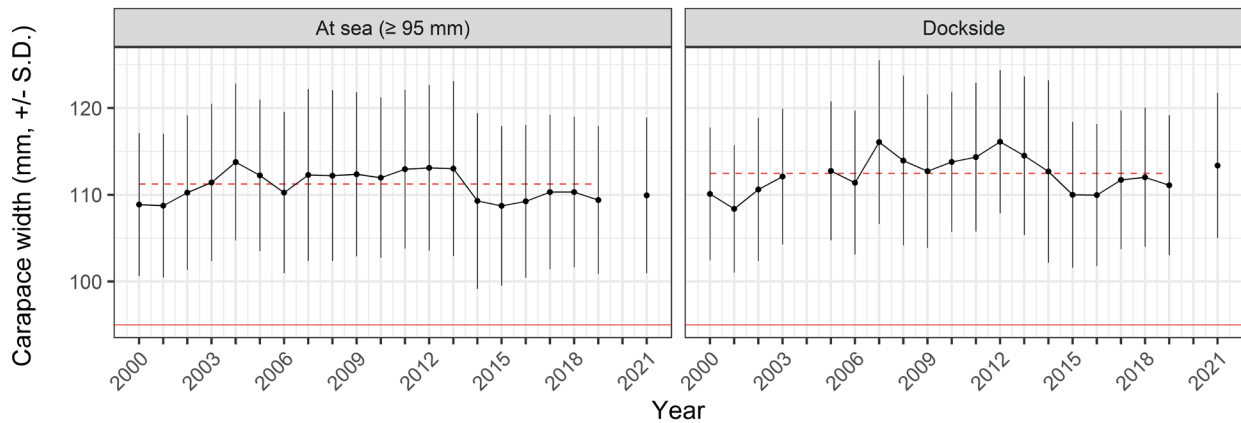


Figure 6. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 17. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 111.2 mm at sea and 112.5 mm at dock.

Fishery-independent surveys. The post-season trap survey indicated that the NPUE for adults measuring 95 mm and over remained stable over the 2018-2021 period (+5.8% between 2020 and 2021), and is below the historical average and was among the lowest values observed since 2000 (Figure 7). For a second consecutive year, this indicator rose steadily in the southern part of the area to near the historical average [2000; 2020], mainly due to an increase in recruits. However, the abundance of crabs left by the fishery on the north side has been declining, which contributes to the observed decrease in the abundance of commercial crabs in the northern part of the area (Figure 7). The NPUE values for other categories of adult and adolescent crabs are similar to those observed in 2020 for Area 17 (Figure 7). Whereas abundance levels of adolescents 78–95 mm in the southern part of the area are at the historical average [2000; 2020], they are low on the north side (Figure 7).

No scientific trawl survey was conducted in 2021 due to the unavailability of the research vessel. The scientific trawl survey conducted 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 sampled primiparous females and catch data during the post-season trap survey since 2020 suggest an increase in the number of primiparous females.

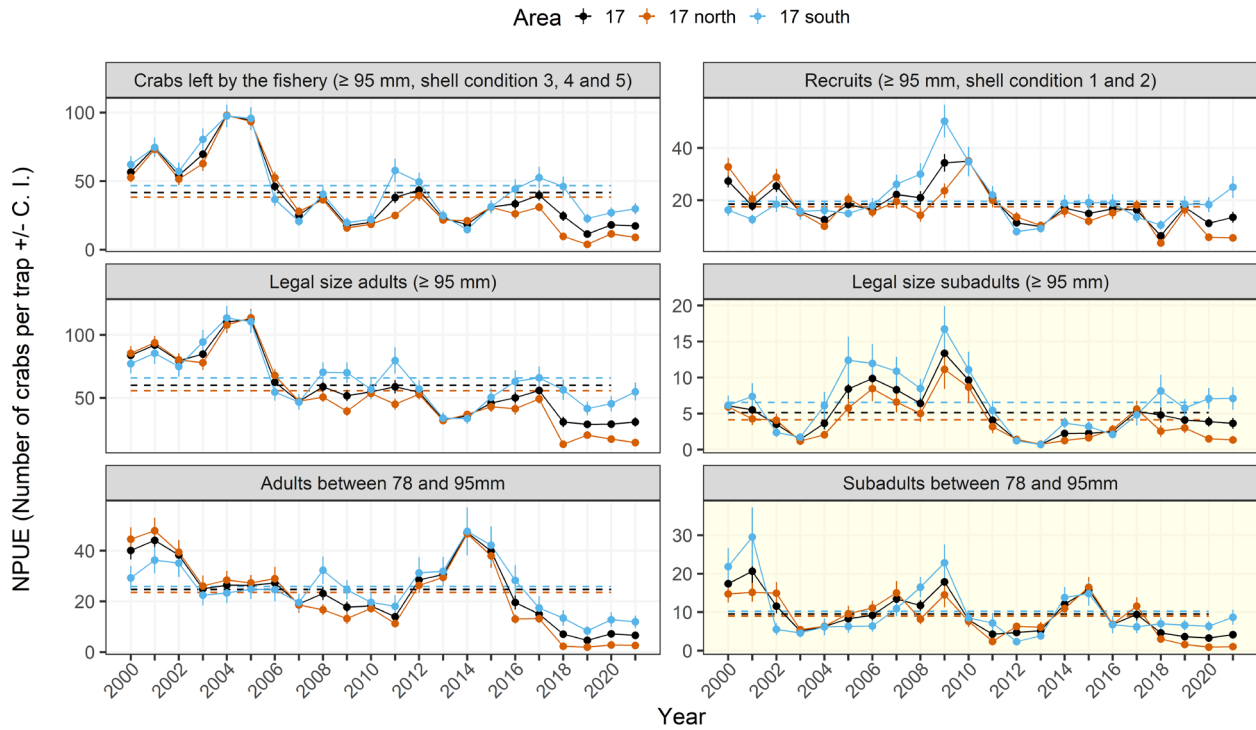


Figure 7. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 17 (black), and in each sector, Area 17 North (17N in orange) and Area 17 South (17S in blue). The dashed line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

The combined index, derived from the commercial CPUE and the post-season NPUE for adult males \geq 95 mm, increased by 9.1% between 2020 and 2021 but remained at value among the lowest values over the 2000-2021 period (Figure 8). Indicators suggest that the biomass available to the fishery in 2022 should be comparable to that in 2021.

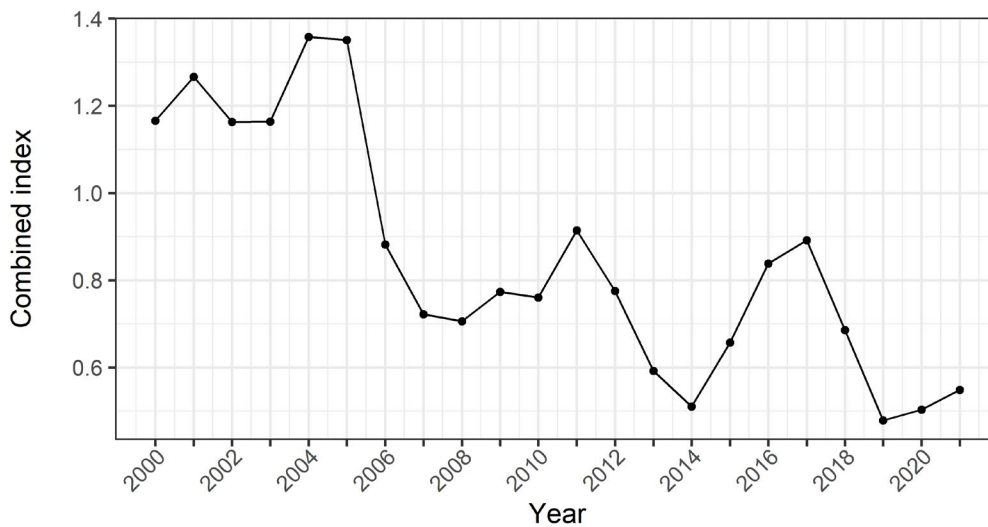


Figure 8. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 17.

Quebec Region

The thermal habitat indices favourable to adult (Figure 3A) and juvenile (Figure 3B) snow crabs in Area 17 show a decline in extent over the 1990-2021 period, which could have a negative impact on the future productivity of the stock. The values observed in 2021 are the lowest for each of the time series.

Outlook

The combined index increased by 9.1% between 2020 and 2021. The 2019-2021 values are among the lowest values observed over the 2000-2021 period. The biomass available to the fishery in 2022 is expected to be comparable to the biomass in 2021. Given the increase in densities of primiparous females since 2020, these indicators suggest that greater caution should be exercised in establishing total allowable landings in 2022 to avoid obtaining a sex ratio that is overly biased towards females during this period of high reproductive female abundance.

- *Higher scenario*: A 10% increase applied to total landings in 2021.
- *Intermediate scenario*: A status quo compared to total landings in 2021.
- *Lower scenario*: A decrease applied to total landings in 2021.

Area 16

Description of the fishery

From 2020 to 2021, the total allowable catch (TAC) decreased by 16.1% to 1,951 t, and it was reached while landings decreased by 14.7% between 2020 and 2021 to 1,962.6 t (Figure 9).

Resource status in 2021

Commercial fishery. For a second consecutive year, the standardized catch per unit effort (CPUE) increased in 2021 (+19.4%), subsequent to a steady decline between 2015 and 2019. Despite this increase, the CPUE in 2021 was below the historical average (Figure 10). Dockside sampling indicated that landings in 2021 were approximately half recruits (shell condition 1–2), representing a proportion fairly similar to that of 2019 and of 2020. The at-sea and dockside sampling data for the 2021 fishing season indicate an increase in the mean carapace width of commercial males since the last sampling (at-sea in 2020 and dockside in 2021). For data collected at sea, this value is above the historical average [1996; 2020]; for data collected dockside, it is at the historical average [1996; 2020] (Figure 11).

Fishery-independent surveys. The post-season trap survey shows that the commercial abundance index increased (+20.9%) in 2021 after a sharp decline during the 2016–2020 period but remains among the lowest values observed in 20 years (Figure 12). Although the abundance of male recruits and adolescents > 95 mm was stable in the post-season survey, the abundance of adolescent and adult males 78–95 mm increased between 2020 and 2021 while remaining below the historical average (Figure 12).

Monitoring of the snow crab population in Sainte Marguerite Bay could not be carried out in 2021. The last survey in 2020 predicted that the biomass available to the fishery would increase beginning in 2023–2024. At the same time, the density of primiparous females rose sharply in 2020, suggesting a high abundance of reproductive females in 2021–2023.

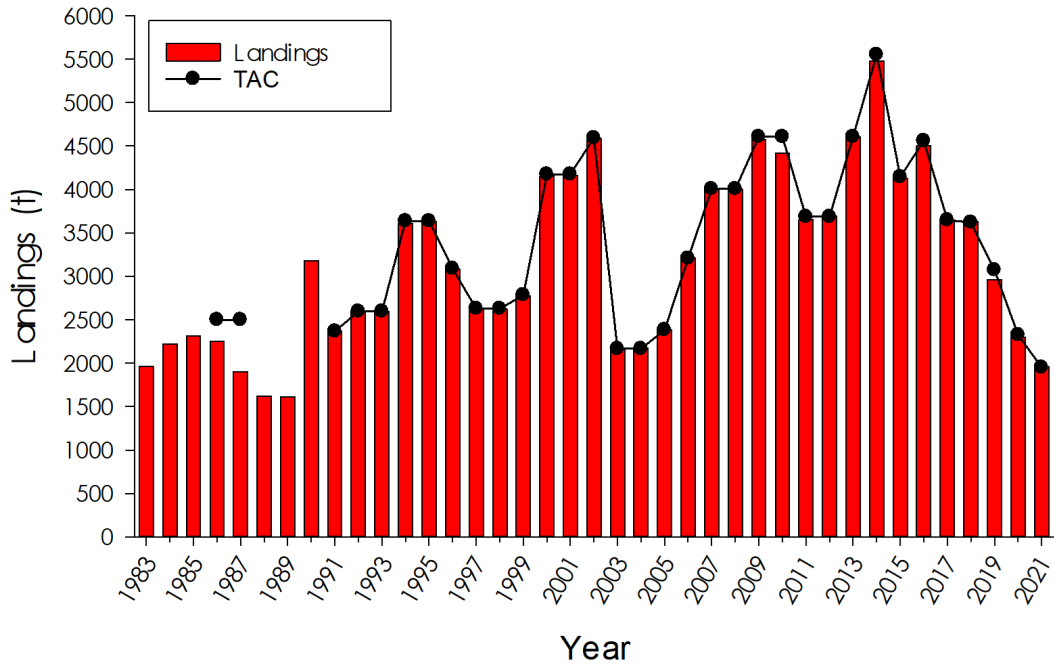


Figure 9. Annual landings and TACs in Area 16.

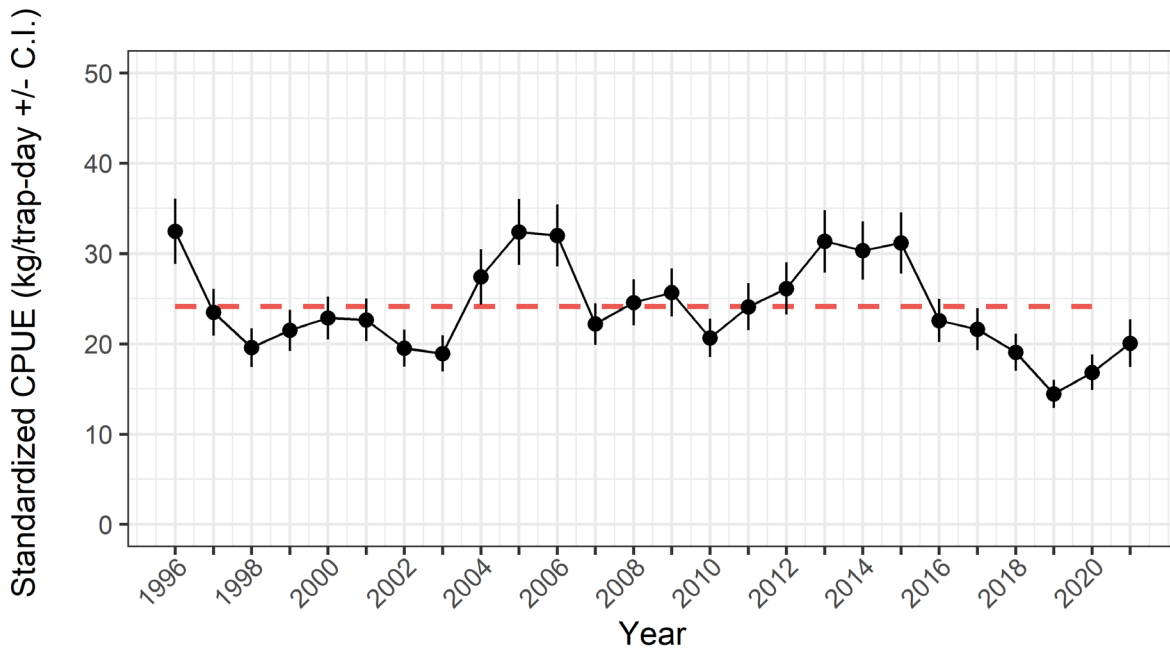


Figure 10. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 16. The dashed line shows the historical data series average (excluding the last year) which is 24.1 kg/trap per day

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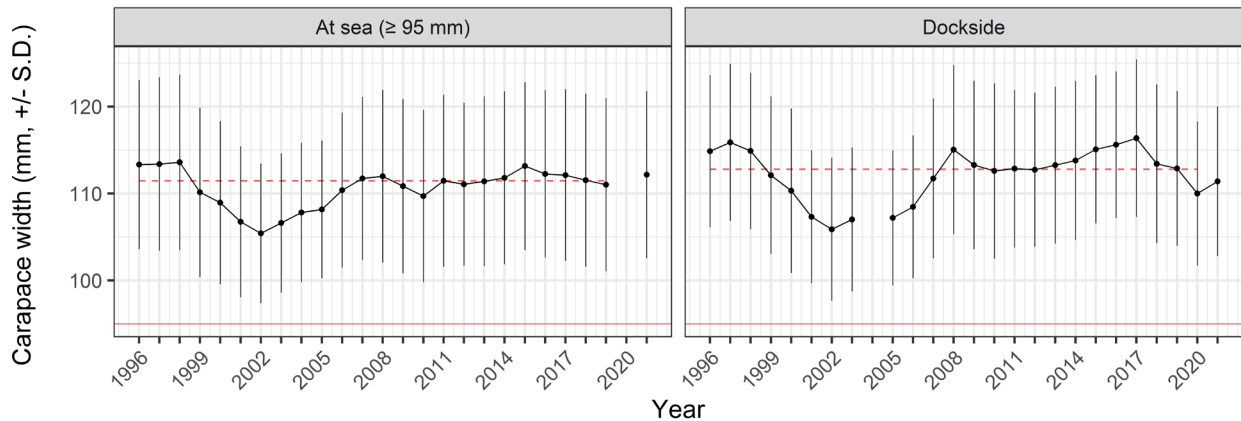


Figure 11. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 16. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 110.6 mm at sea and 112.2 mm at dock.

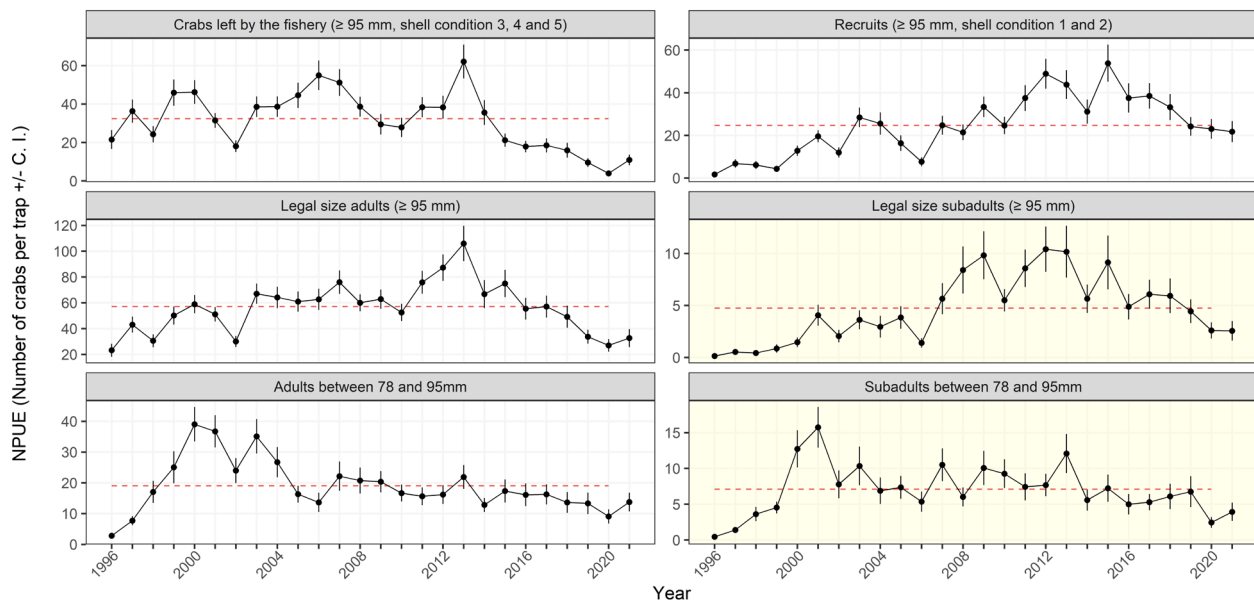


Figure 12. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 16. The dashed line shows the historical data time series average (excluding the last year).

The combined index, derived from the commercial CPUE and the post-season NPUE for adult males ≥ 95 mm, is up 20.0% from 2020, but remains among the lowest values in the last 20 years. This suggests that the biomass available to the fishery in 2022 should be similar to that of 2021 (Figure 13).

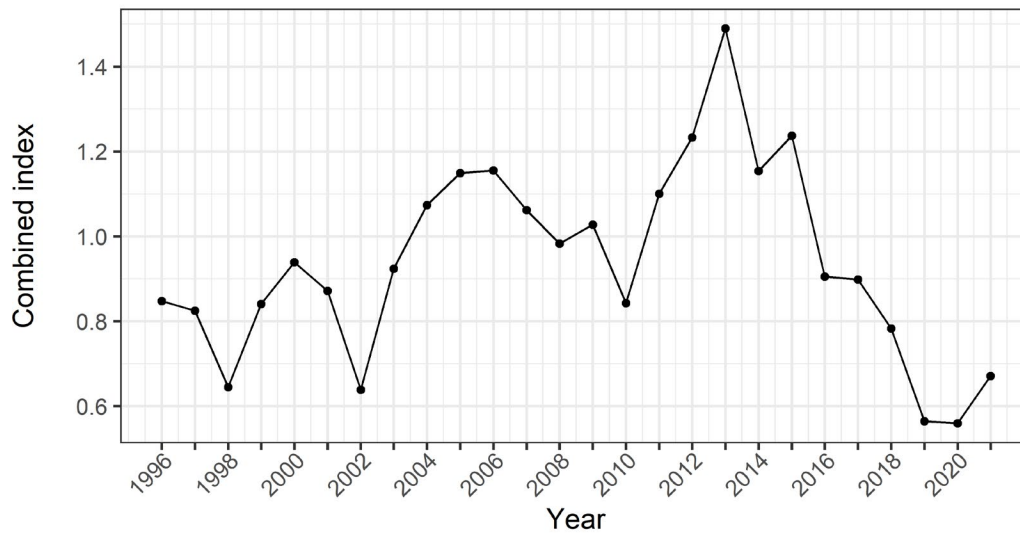


Figure 13. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 16.

The thermal habitat indices favourable to adult (Figure 3A) and juvenile (Figure 3B) snow crab in Area 16 show a decline in extent over the 1990-2021 period, which could have a negative impact on the future stock productivity. The index values observed in 2021 are the lowest for each time series.

Outlook

The combined index increased (+20.0%) between 2020 and 2021 but remains among the lowest values of the last 20 years. The biomass available to the fishery in 2022 is expected to be similar to that of 2021. In the context of an assumed high density of reproductive females for the 2021–2023 period, these indicators suggest limiting increases in removals in 2022 to avoid obtaining a sex ratio that is overly biased towards females.

- *Higher scenario:* A 20% increase applied to total landings in 2021.
- *Intermediate scenario:* A 10% increase applied to total landings in 2021.
- *Lower scenario:* A status quo compared to total landings in 2021.

Area 15

Description of the fishery

The total allowable catch (TAC) increased by 5.0% between 2020 and 2021 to 325.5 t, and was not reached. Landings increased from 263.0 t in 2020 to 306.0 t in 2021 (+13.6%), which is 94% of the TAC (Figure 14). Industry cited socio-economic reasons for not achieving the TAC, such as the closure of processing plants.

Quebec Region

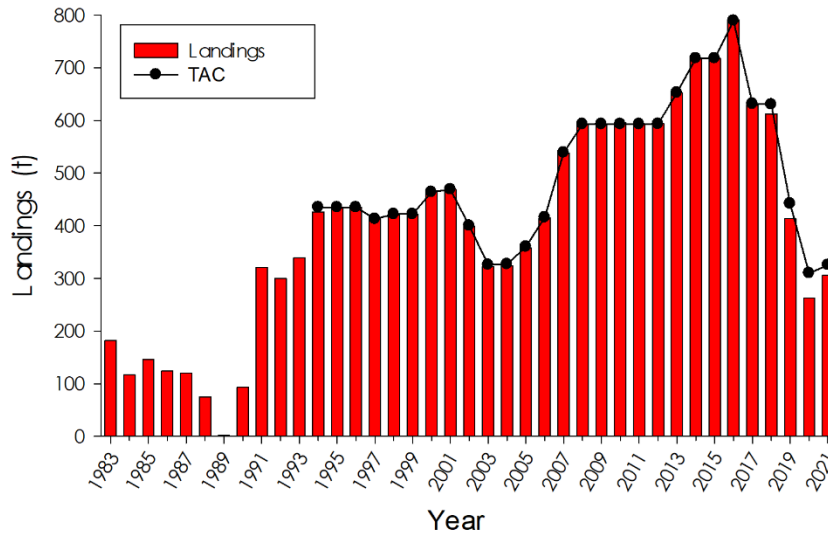


Figure 14. Annual landings and TACs in Area 15.

Resource status in 2021

Commercial fishery. The catch per unit effort (CPUE) for the commercial fishery is stable since 2019 (+1.5% between 2020 and 2021), and the last three years' values are the lowest over the 2000-2021 period (Figure 15).

The at-sea observer program, which did not take place in 2020 due to the pandemic, provided a very limited temporal and spatial coverage of Area 15 in 2021. However, the mean carapace width of commercial crabs measured at sea decreased to below the historical average, a trend that was also observed dockside (Figure 16). Dockside data indicate that the majority of landings (53.3%) in 2021 consisted of recruits (shell condition 1–2). This proportion increased between 2020 and 2021, while the percentage of intermediate-shell crabs declined from 45.2% to 37.9%.

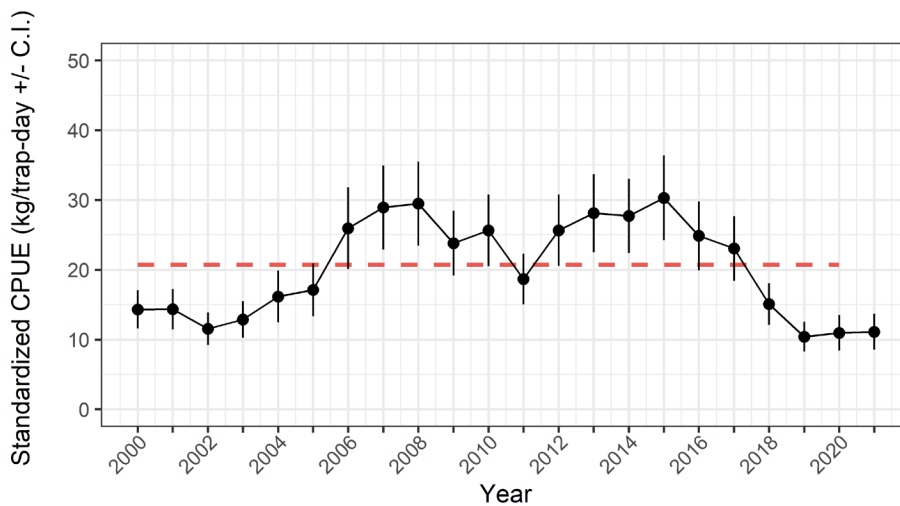


Figure 15. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 15. The dashed line shows the historical data series average (excluding the last year) which is 20.7 kg/trap per day.

Quebec Region

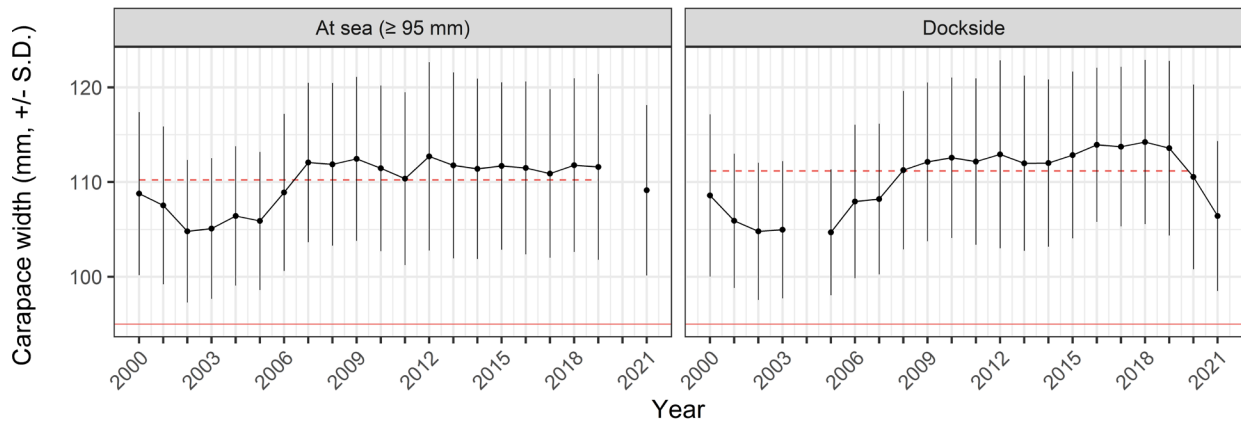


Figure 16. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 15. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 106.4 mm at sea and 111.2 mm at dock.

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 these larger traps is presented. The high abundance of adolescent and adult crabs observed in the post-season trap survey in 2020 suggested the arrival of new cohorts (Figure 17). However, in 2021, abundance levels returned to values similar to those of 2019, increasing uncertainty in the comparison of 2020 and 2021 values. The leaders of the 2021 trap survey also indicated that the strong presence of sand fleas, which feed on bait, affected crab catchability. All other abundance indices of the post-season survey for adolescent and adult males declined between 2020 and 2021, and only the abundance indicator for sublegal-size adolescents was above its historical average (Figure 17).

According to the post-season survey, the abundance of primiparous and multiparous females in 2021 was high, but the spermathecal load weight decreased. In 2020 and 2021, high abundances of sublegal-size adolescents and primiparous females were consistent indicators of the upcoming arrival of a pulse of recruitment.

The **combined index**, formed by the commercial CPUE and the NPUE of adult males ≥ 95 mm in the trap survey, declined by 35.4% between 2020 and 2021 to the same value as in 2019. Values from 2019 to 2021 were the lowest observed throughout the 2014–2021 period (Figure 18).

All indicators suggest that the biomass available to the fishery in 2022 is expected to be less than or equal to that of 2021.

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Quebec Region

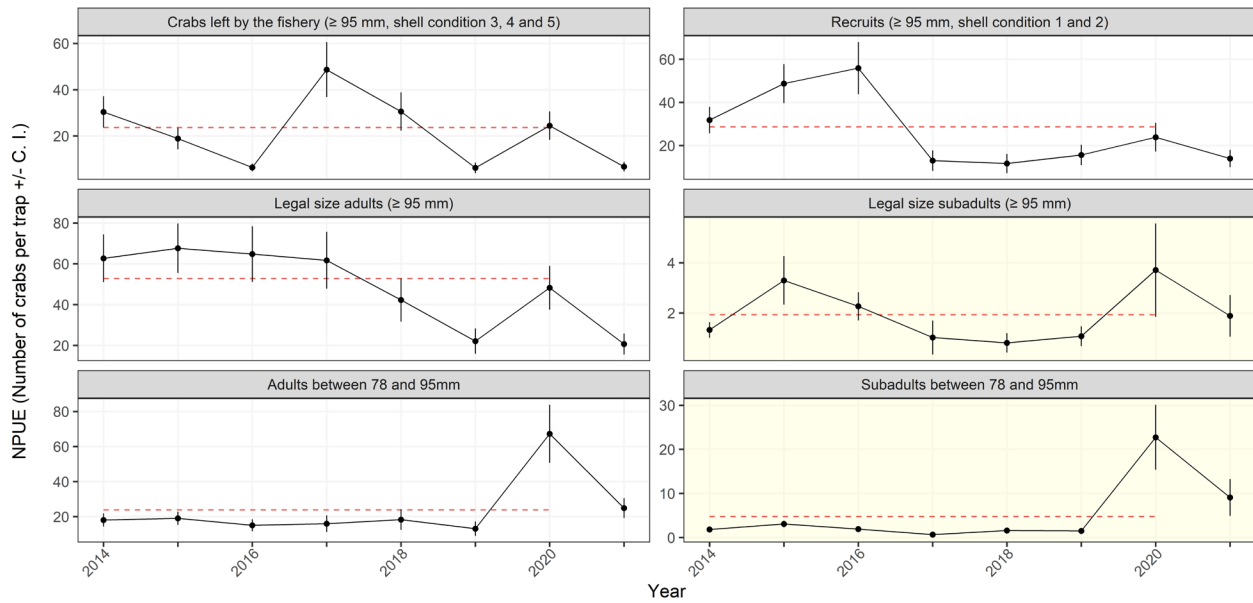


Figure 17. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 15. The dashed line shows the historical data time series average (excluding the last year).

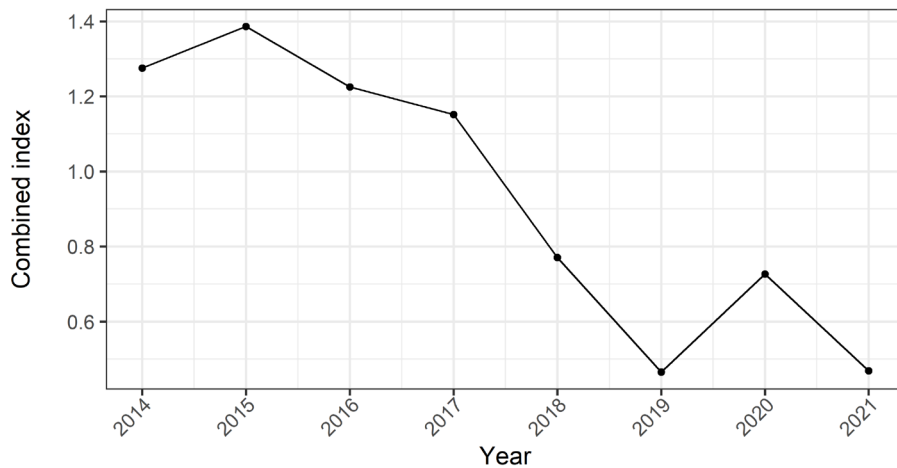


Figure 18. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 15.

Outlook

The combined index (CI) is among the lowest values observed in eight years (-35.4% between 2020 and 2021), with fishing yields that were, over the last three years, the lowest observed in the last two decades and a commercial abundance indicator that returned to the lowest observed value (2019). This last point is a source of uncertainty associated with using the CI to develop scenarios. The biomass available to the fishery in 2022 is expected to be less than or equal to that of 2021. Given the increase in densities of primiparous females since 2019, these indicators suggest that greater caution should be exercised in establishing total allowable landings in 2022 to avoid obtaining a sex ratio that is overly biased towards females during this period of high abundance of reproductive females.

Quebec Region

- *Higher scenario:* A 10% decrease applied to total landings in 2021.
- *Intermediate scenario:* A 20% decrease applied to total landings in 2021.
- *Lower scenario:* A more than 20% decrease applied to total landings in 2021.

Area 14

Description of the fishery

The total allowable catch (TAC) decreased by 7.6% between 2020 and 2021 to 365.0 t (Figure 19), and was reached. Landings in 2021 were 362.5 t (or 99.3% of the TAC), up by 4.2% from 2020 (348.0 t).

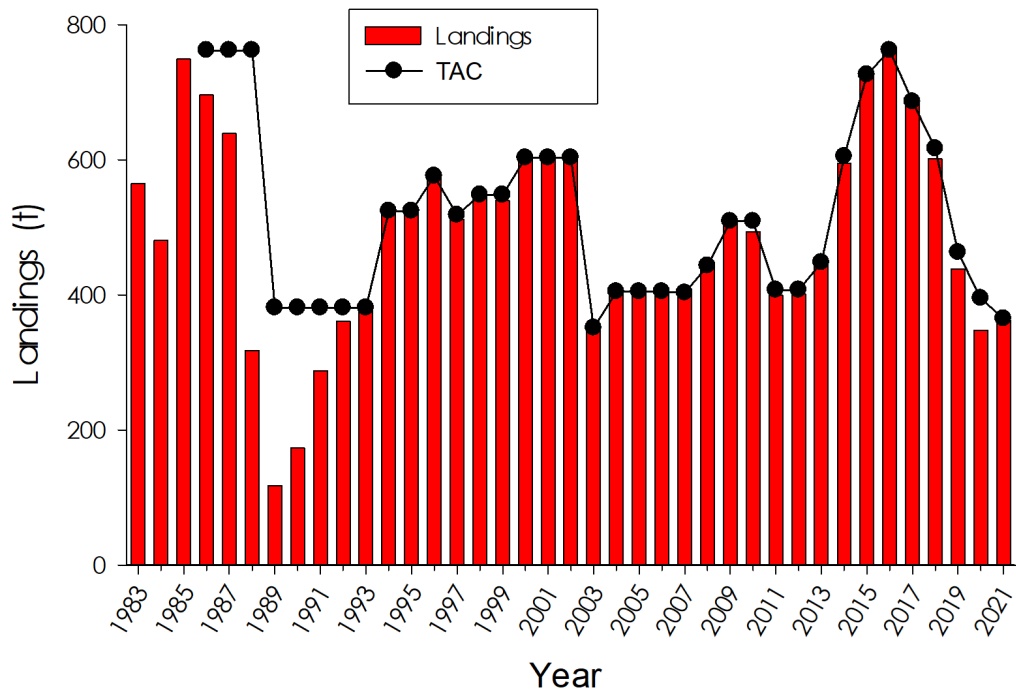


Figure 19. Annual landings and TACs in Area 14.

Resource status in 2021

Commercial fishery. The standardized catch per unit effort (CPUE) for the commercial fishery is increasing in 2021 (+30.1% between 2020 and 2021), and despite this increase, the last three years' values are the lowest over the 2000-2021 period (Figure 20). The at-sea observer program, which did not take place in 2020 due to the pandemic, provided a very limited temporal and spatial coverage of Area 14 in 2021. Both at-sea and dockside data indicate a decline in the mean carapace width since the last sampling in 2019 (Figure 21). The mean carapace width in 2021 was close to the historical average (Figure 21). Dockside data indicate that the majority of landings (55.6%) in 2021 consisted of recruits (shell condition 1–2). This proportion saw a significant increase between 2019 and 2021, while the percentage of crabs with shell condition 3 and 4–5 dropped from 59.9% to 39.2% and 28.3% to 5.2%, respectively.

Quebec Region

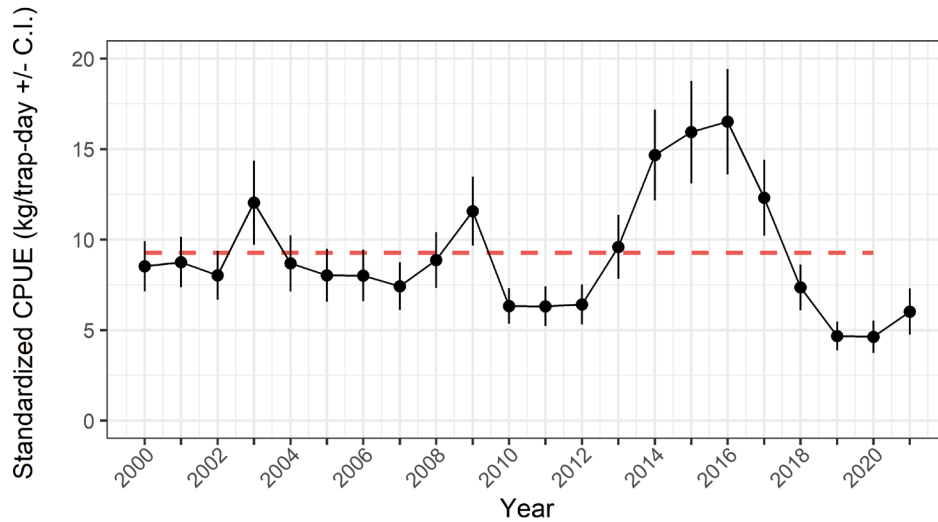


Figure 20. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 14. The dashed line shows the historical data series average (excluding the last year) which is 9.3 kg/trap per day.

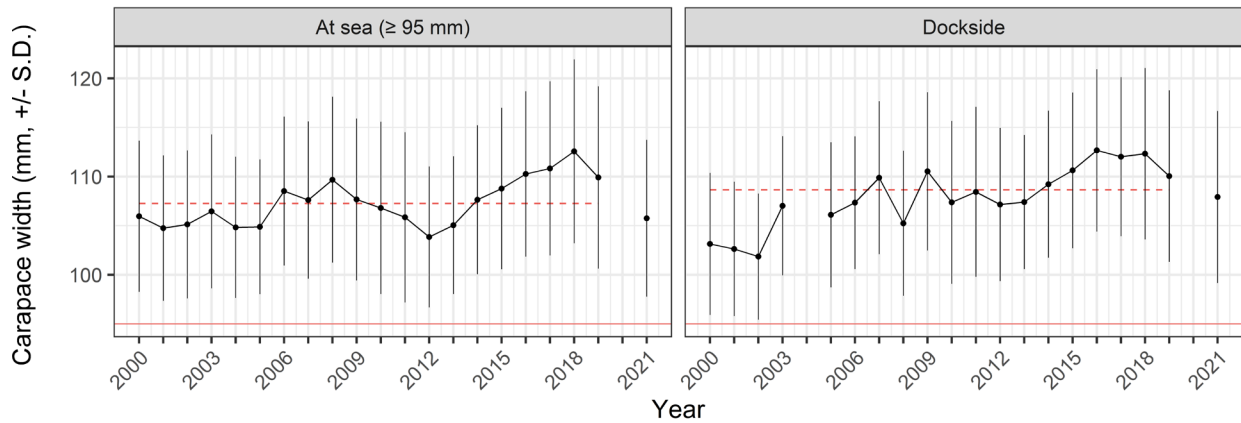


Figure 21. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 14. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 107.3 mm at sea and 108.7 mm at dock.

Fishery-independent survey. The post-season trap survey indicated that the NPUE for adults and adolescents in all categories decreased between 2020 and 2021, with 2021 values among the lowest observed since 2000 (Figure 22). The biomass of adult legal-size crabs also primarily consisted of recruits. This decrease comes after an increase in almost all indicators between 2019 and 2020. These results also diverge from the observations recorded during the last trawl survey of 2018 in this area which suggested the arrival of a new recruitment wave. Thus, uncertainty remains on the validity of the 2021 trap survey indicators.

According to the post-season survey, the abundance of primiparous and multiparous females is high in 2021, while spermathecal load weight remains relatively low.

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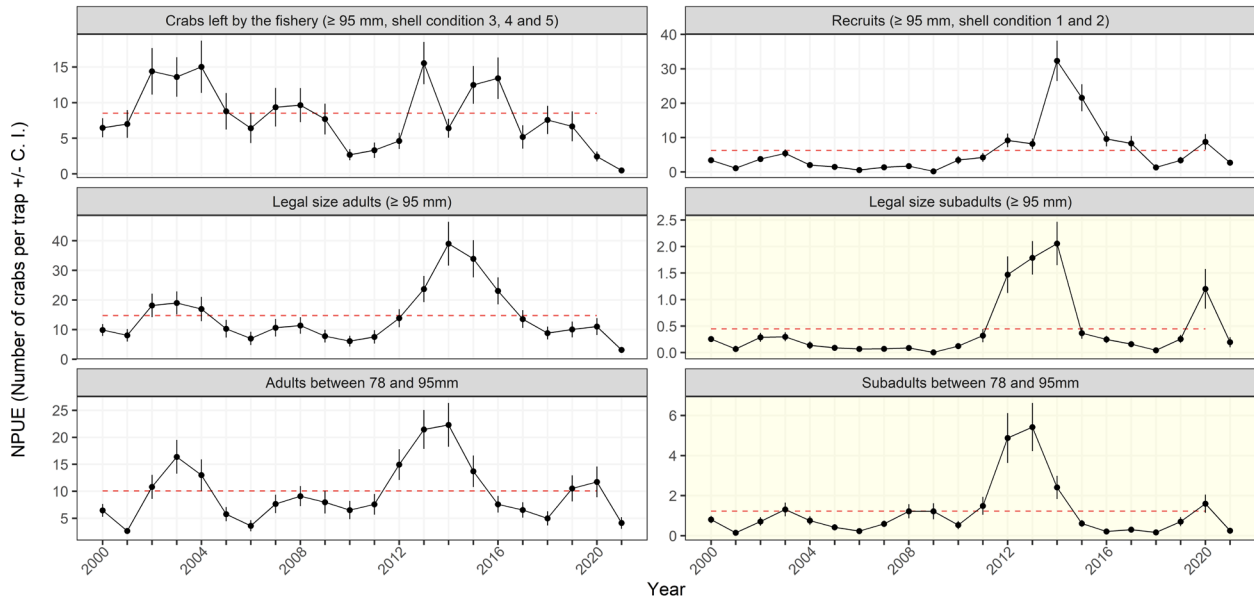


Figure 22. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 14. The dashed line shows the historical data time series average (excluding the last year).

The **combined index**, derived from the commercial CPUE and the post-season NPUE for adult males ≥ 95 mm, decreased by 34.9% between 2020 and 2021 (Figure 23), but remained at the lowest values over the 2000-2021 period, which suggests that the biomass available to the fishery in 2022 should still be less than or equal to that available in 2021.

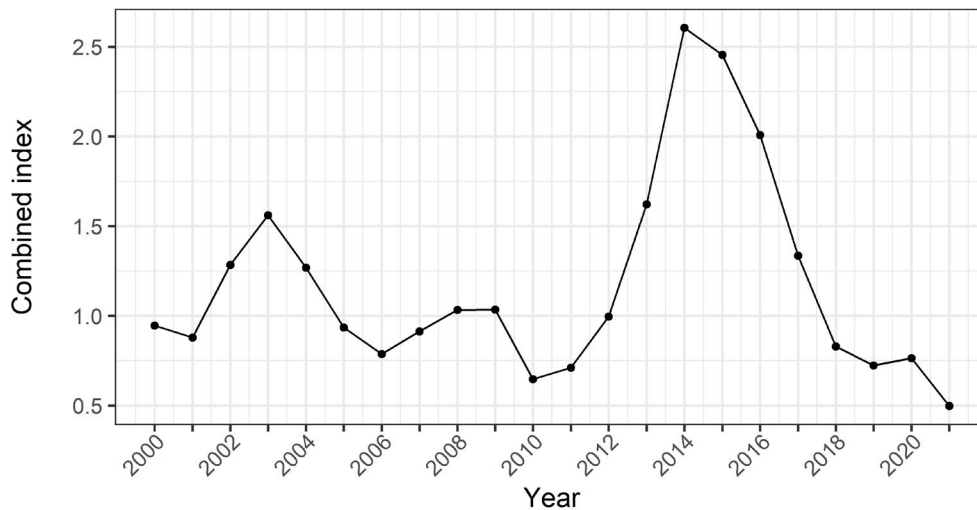


Figure 23. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 14.

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

Quebec Region

Outlook

The combined index is at the lowest value observed over the 2000–2021 period (-34.9% between 2020 and 2021), with fishing yields that were, for the last three years, the lowest observed in the last two decades and a commercial abundance indicator that is the lowest on record. Although some uncertainty remains on the representativeness of the 2021 post-season survey in terms of the status of the resource, the biomass available to the fishery in 2022 should still be less than or equal to that available in 2021.

Given the increase in densities of primiparous females since 2019, these indicators suggest that greater caution should be exercised in establishing total allowable landings in 2022 to avoid obtaining a sex ratio that is overly biased towards females during this period of high abundance of reproductive females.

- *Higher scenario:* A 10% decrease applied to total landings in 2021.
- *Intermediate scenario:* A 20% decrease applied to total landings in 2021.
- *Lower scenario:* A more than 20% decrease applied to total landings in 2021.

Area 13

Description of the fishery

The TAC remained stable to 244.0 t in 2021 and was not reached. Landings in 2021 were 199.0 t or 81.6% of the TAC (Figure 24). The failure to achieve the TAC coincides with the premature closure of the fishery 11 days before the scheduled end of the fishing season. The reason for this was that catches consisted of more than 20% white crabs (freshly moulted adults).

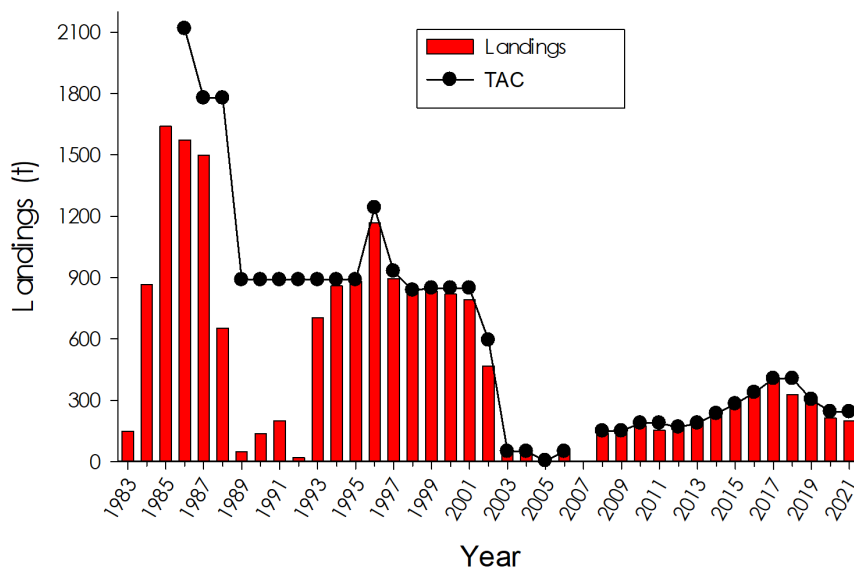


Figure 24. Annual landings and TACs in Area 13.

Resource status in 2021

Commercial fishery. The catch per unit effort (CPUE) for the commercial fishery decreased between 2020 and 2021 (-26.5%), and is the lowest value observed over the 2000-2021 period (Figure 25). From 2009 to 2014, the fishing effort was significantly higher in the southern part

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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. Dockside sampling indicates that landings consisted of a majority (59.7%) of recruits (shell condition 1-2) in 2021, which is up from 2019 (+24.4%).

The mean carapace width of commercial males sampled at sea and dockside has decreased since the last sampling in 2019 and is among the lowest values for the 2000–2021 period (Figure 26). This average size is low compared with other areas in the Gulf of St. Lawrence.

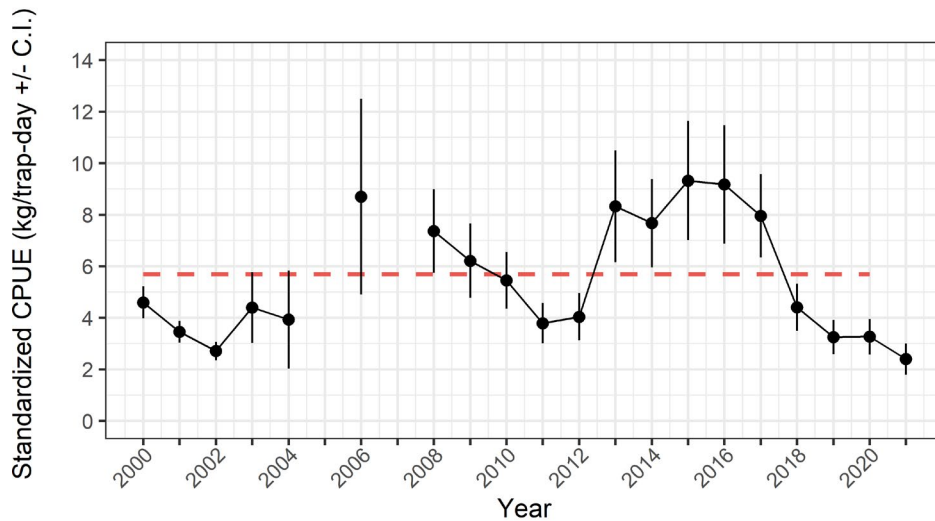


Figure 25. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 13. The dashed line shows the historical data series average (excluding the last year) which is 5.7 kg/trap per day.

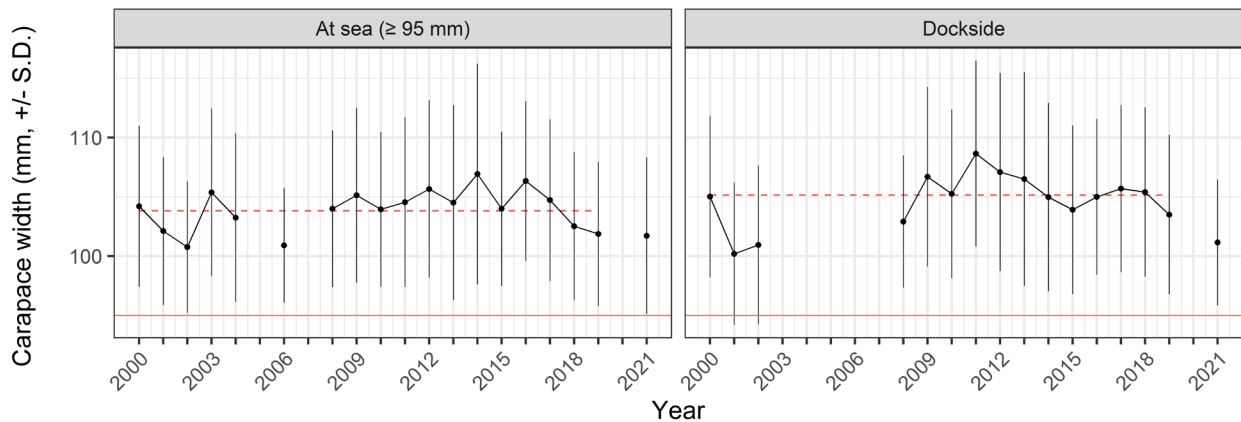


Figure 26. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 13. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 103.8 mm at sea and 105.2 mm at dock.

Fishery-independent survey. The commercial abundance index for Area 13 as a whole, incorporating the results of the post-season survey in the north and the south of the area, increased between 2020 and 2021 and is now above the historical average (Figure 27). This rise is primarily due to the increased abundance of crabs left by the fishery (shell condition 3–5)

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on the north side and, to a lesser extent, the increased abundance of recruits on the south side (Figure 27). While indices of adolescent abundance on the north shore declined between 2020 and 2021, they increased slightly on the south shore (Figure 27).

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. Data on spermathecal load weight in the 2019–2021 post-season surveys and densities of primiparous females in the trawl survey in 2018 suggest that the abundance of reproductive females will remain high following a peak in 2018–2019.

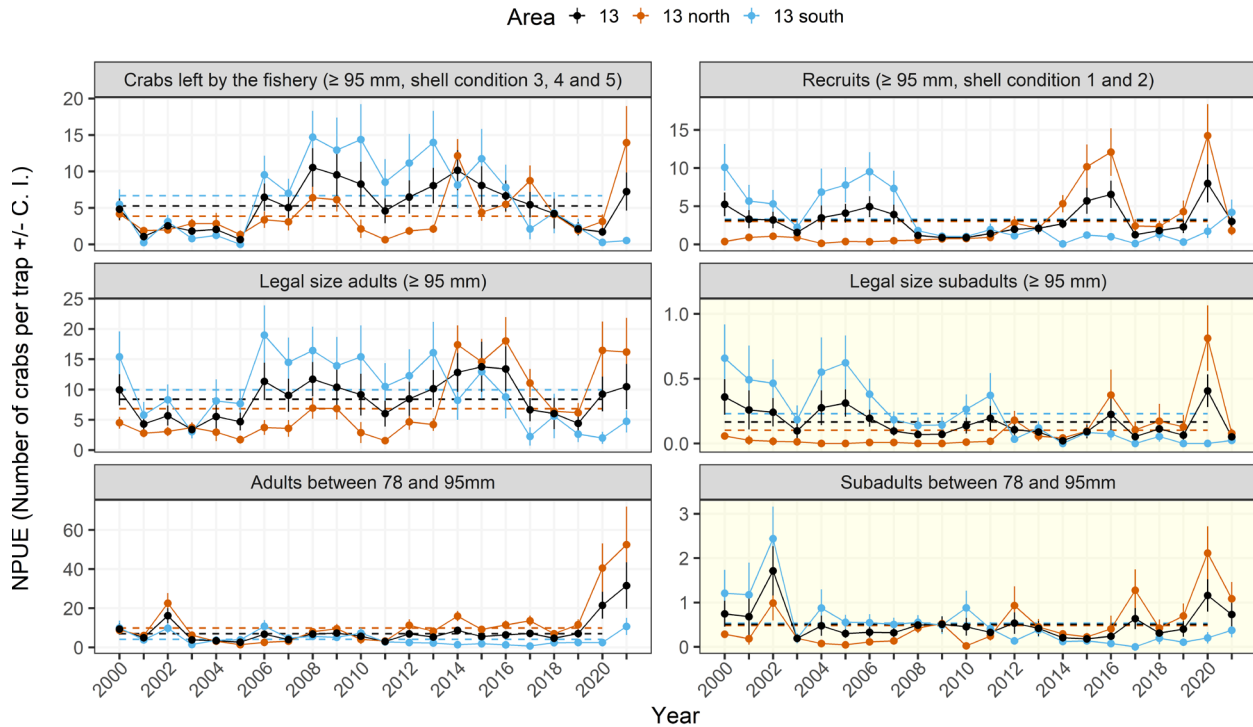


Figure 27. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 13 (black), and restricted to sub-area 13 north (orange) and sub-area 13 south (blue). The dashed line shows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

After a sharp increase in 2020, the **Combined Index**, derived from the commercial CPUE and the post-season NPUE for adult males \geq 95 mm, remains stable between 2020 and 2021 (Figure 28).

All indicators suggest that the biomass available to the fishery in 2022 is expected to be similar to that available in 2021.

The **thermal habitat indices** favourable to adult (Figure 3A) and juvenile (Figure 3B) snow crabs show an upward temporal trend in area observed over the past several decades.

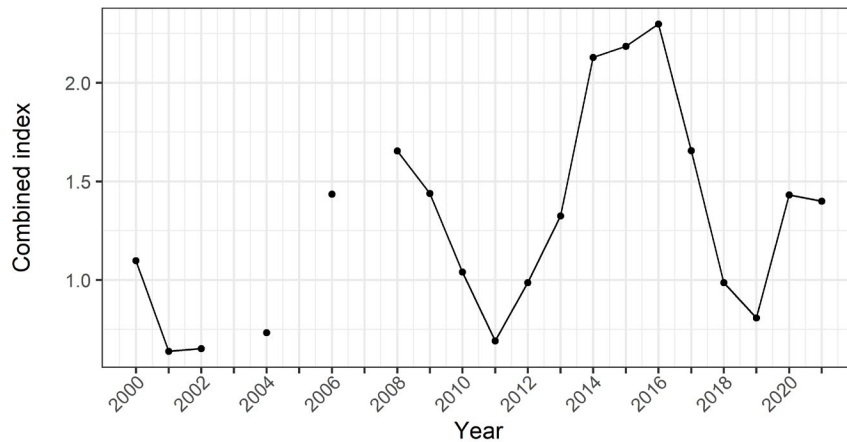


Figure 28. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 13.

Outlook

The combined index remains stable in 2021 after a strong increase in 2020. The biomass available to the fishery in 2022 should be similar to that of 2021.

- *Higher scenario:* A 20% increase applied to total landings in 2021.
- *Intermediate scenario:* A status quo compared to total landings in 2021.
- *Lower scenario:* A decrease applied to total landings in 2021.

Area 16A

Description of the fishery

The Area 16A includes two parts (north and south) separated by the Anticosti Channel. The total allowable catch (TAC) decreased by 9.9% between 2020 and 2021 to 245.0 t, and was reached. Landings in 2021 were 244.2 t, down 5.0% from 2020 (257.0 t) (Figure 29).

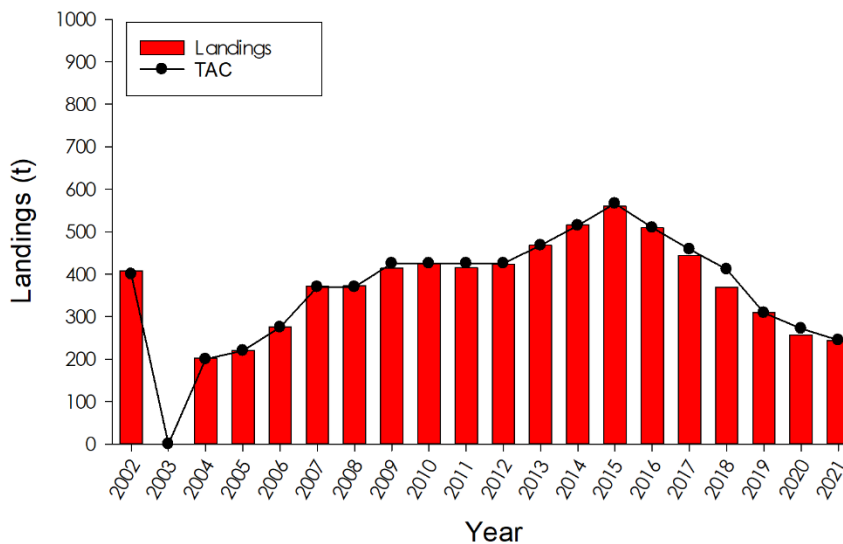


Figure 29. Annual landings and TACs in Area 16A.

Quebec Region

Resource status in 2021

Commercial fishery. Between 2020 and 2021, the standardized catch per unit effort (CPUE) in the commercial fishery increased (+14.3%) after declining for six consecutive years (Figure 30). Despite this increase, the 2021 value remains among the lowest in the series for the 2002–2021 period (Figure 30). No indicator based on at-sea sampling data is available for the 2020 and 2021 fishing seasons. Dockside sampling data in 2021 indicates that the mean size of commercial crabs is similar to what it was in 2019 and that it has returned close to the historical average after declining in 2020 (Figure 31). Dockside sampling indicates that landings in 2021 consisted of a majority of recruits (over half), similar to 2019 and 2020 (limited data in 2020 due to the pandemic context).

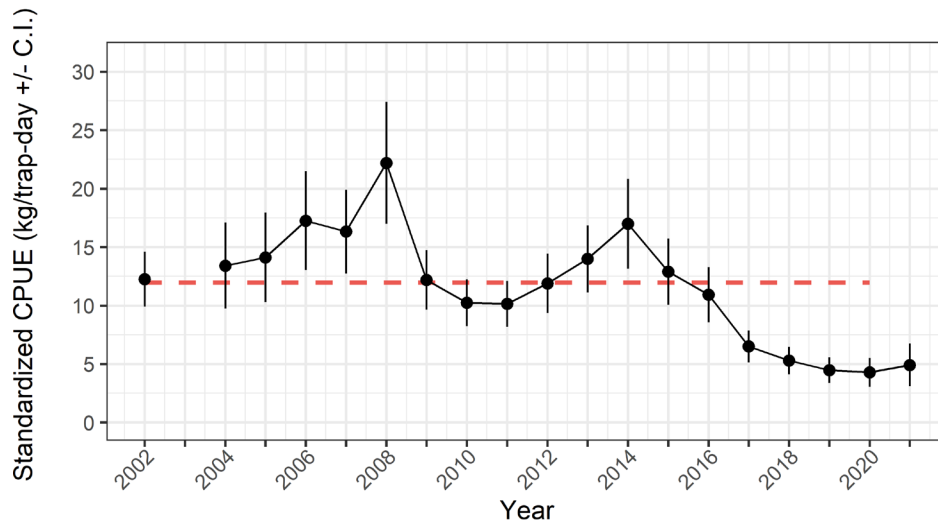


Figure 30. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 16A. The dashed line shows the historical data series average (excluding the last year) which is 12.0 kg/trap per day.

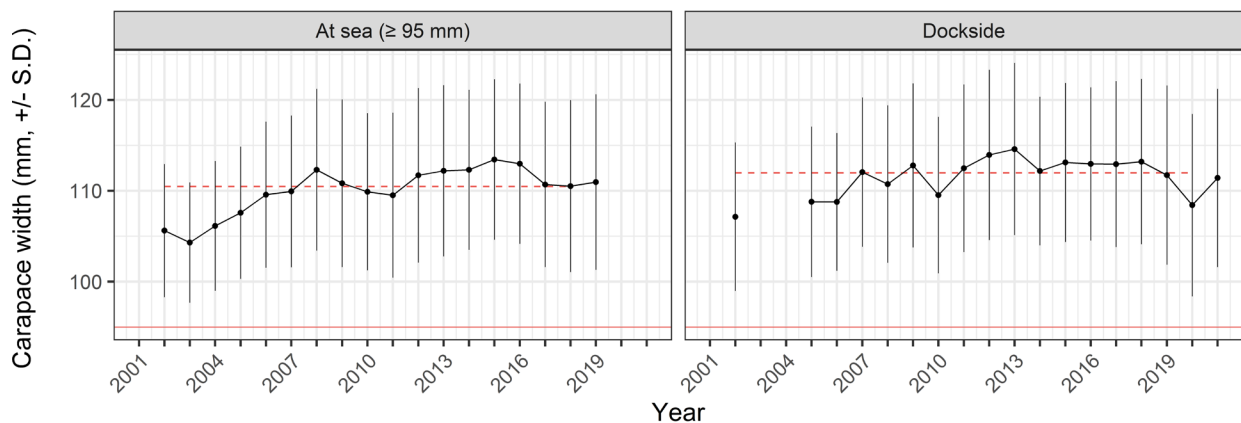


Figure 31. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 16A. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 110.5 mm at sea and 112.0 mm at dock.

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Fishery-independent survey. The sampling protocol of the post-season 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 the larger trap are presented. Only traps on the south side of the Anticosti Channel were deployed in the 2021 post-season survey, which created uncertainty in the indicators for 2021. The commercial abundance indices from the post-season survey declined over the 2014–2021 period for both recruits and crabs left by the fishery (Figure 32). Although the abundance of adolescents declined between 2020 and 2021, it remains high and well above average (Figure 32). The high abundance of sublegal-size adolescents in 2020 and 2021 and of primiparous females in the post-season surveys since 2019 have been consistent indicators of an upcoming pulse of recruitment.

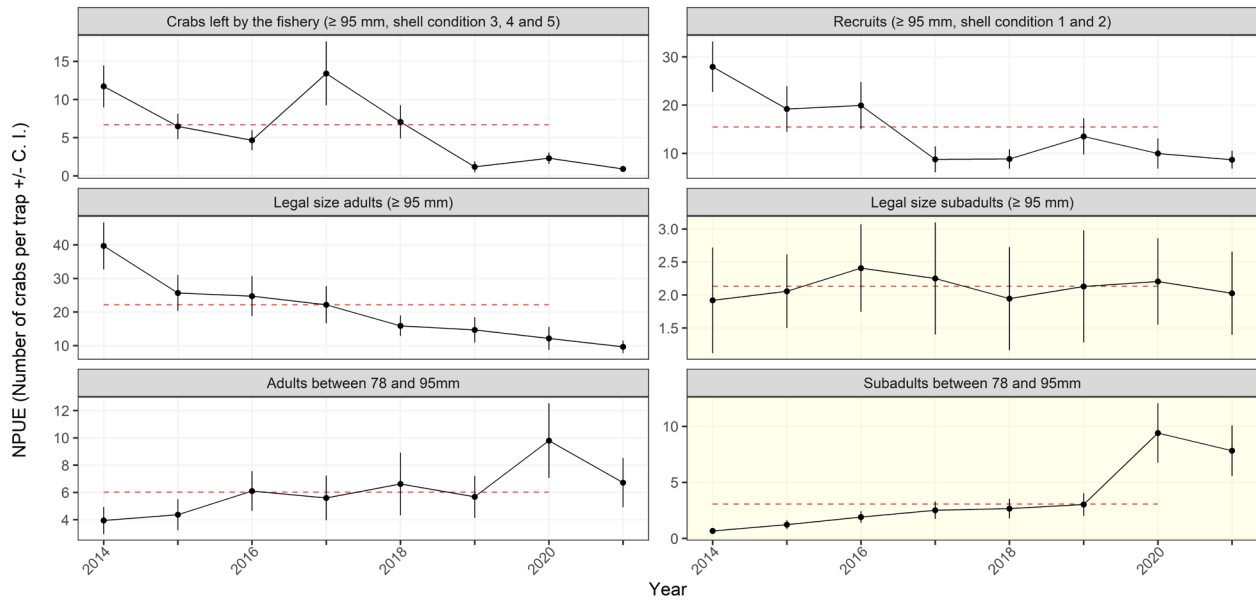


Figure 32. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 16A. The dashed line shows the historical data time series average (excluding the last year).

The combined index, derived from the commercial CPUE and the post-season NPUE for adult males \geq 95 mm, is down for the seventh consecutive year (-4.2% between 2020 and 2021; Figure 33). This slight decrease in the index suggests that the biomass available to the fishery in 2022 is expected to be less than or equal to that available in 2021.

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

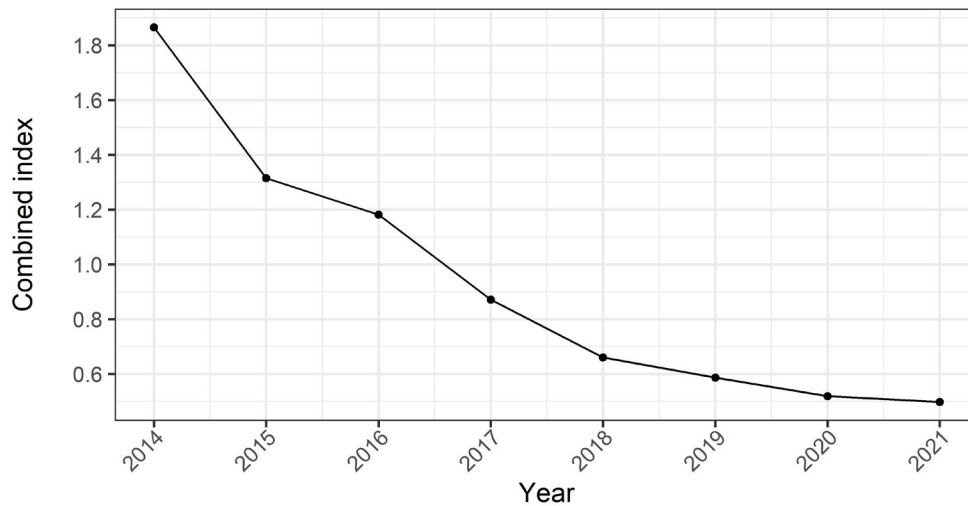


Figure 33. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 16A.

Outlook

The combined index was declining over the 2014-2020 period, but only decreases by 4.2% between 2020 and 2021. The biomass available to the fishery in 2022 is expected to be less than or equal to that available in 2021. Given the high abundance of primiparous females, these indicators suggest a decrease in harvesting in 2022 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 2021.
- *Intermediate scenario:* A 5% decrease applied to total landings in 2021.
- *Lower scenario:* A more than 5% decrease applied to total landings in 2021.

Area 12C

Description of the fishery

The Area 12C includes two parts (north and south) separated by the Anticosti Channel. The total allowable catch (TAC) remained the same between 2020 and 2021 at 96.0 t, and was reached (Figure 34). Landings in 2021 were 91.0 t, up 15.2% from 2020. The fishing season was closed on June 25, 2021, 24 days early due the high presence of white crabs (crabs that have molted recently).

Resource status in 2021

Commercial fishery. The commercial fishery is primarily concentrated in the northern part of the area, which adjoins Areas 14 and 15. The standardized catch per unit effort (CPUE) is down in 2021 (-32.8%) compared to 2020, returning to a value similar to 2019 (Figure 35) and the last three years' CPUE values are the lowest over the 2000-2021 period (Figure 35). Dockside sampling indicates that landings were about half recruits (shell condition 1-2) in 2021, which is up from 34.5% in 2019. The mean size of commercial crabs caught at sea has decreased between 2019 and 2021 and is at the lowest value observed over the 2001-2021 period, while the mean size at dockside is at the historical average for 2021 (Figure 36).

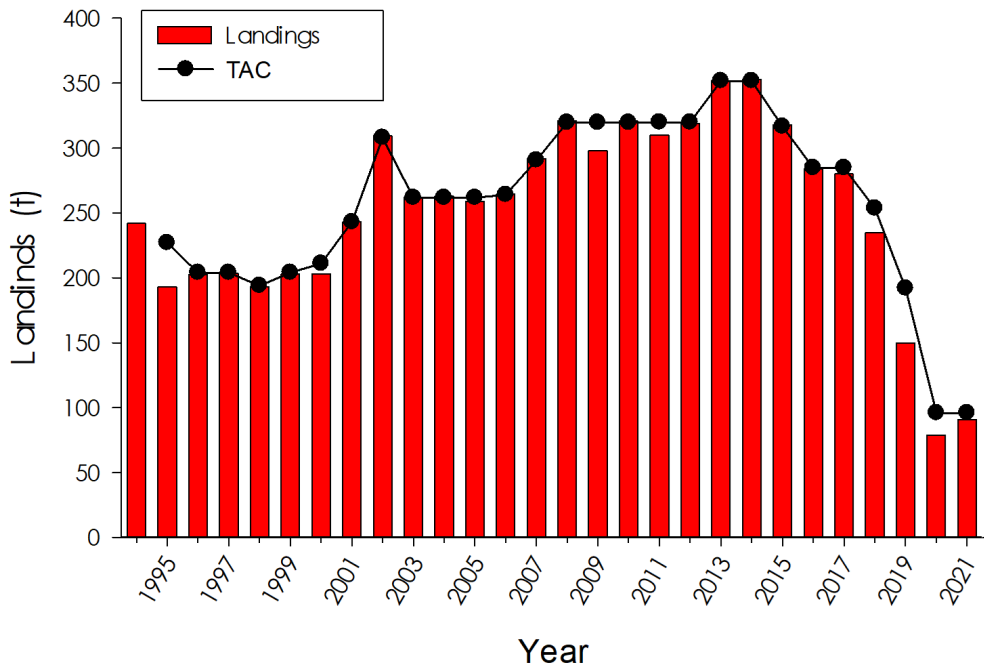


Figure 34. Annual landings and TACs in Area 12C.

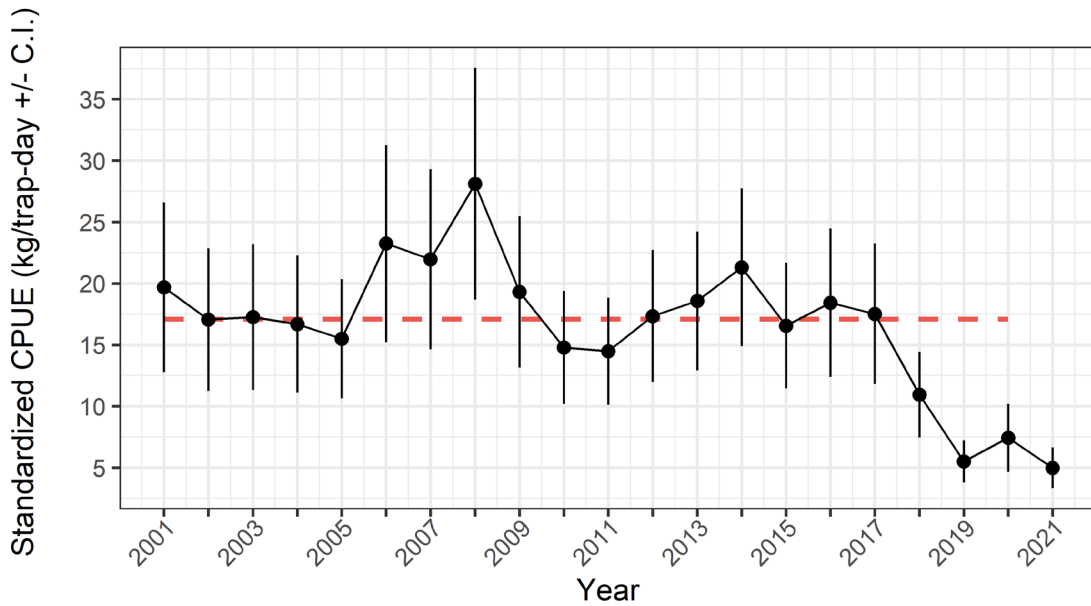


Figure 35. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12C. The dashed line shows the historical data series average (excluding the last year) which is 17.1 kg/trap per day.

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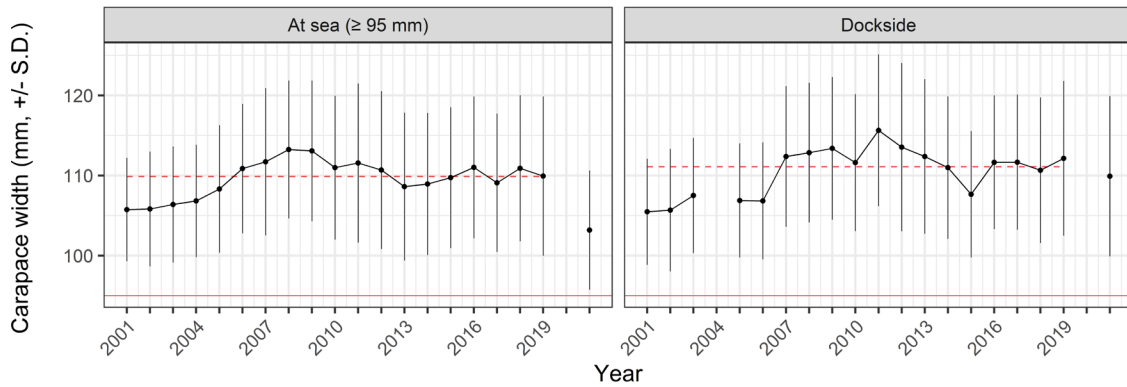


Figure 36. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 12C. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 109.9 mm at sea and 111.1 mm at dock.

Fishery-independent survey. The sampling protocol of the post-season 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. Only traps on the north side of the Anticosti Channel were deployed in the 2021 post-season survey, which created uncertainty in the indicators for 2021. All indicators for this survey (adolescents and adults), including commercial abundance indices, declined between 2020 and 2021, with the exception of 78–95 mm adolescents (Figure 37). The abundance indicator for sublegal-size adolescents was at its highest value for the 2014–2021 period (Figure 37). The abundance of primiparous females observed in the 2020 post-season survey continued to increase in 2021. From 2020 to 2021, increased numbers of sublegal-size adolescents and primiparous females were consistent indicators of an upcoming pulse of recruitment.

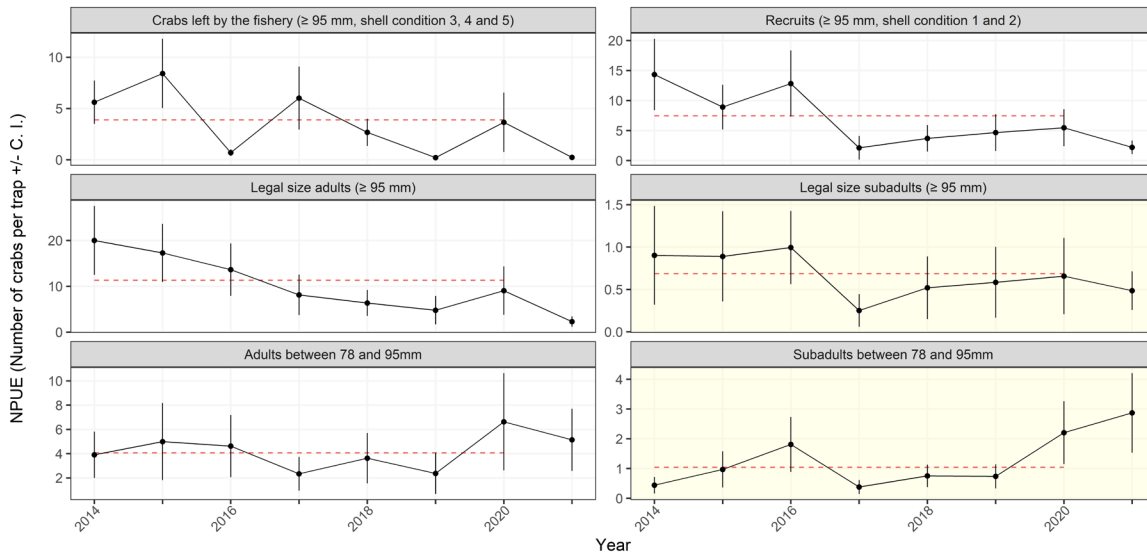


Figure 37. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 12C. The dashed line shows the historical data time series average (excluding the last year).

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The **combined index**, formed by the commercial CPUE and the NPUE of adult males ≥ 95 mm in the trap survey and which declined steadily between 2014 and 2019, declined again from 2020 to 2021 (-57.9%) following an increase between 2019 and 2020. The value for 2021 is the lowest among the values for the 2014–2021 period (Figure 38). This decrease suggests that the biomass available to the fishery in 2022 is expected to be less than or equal to that available in 2021.

The **thermal habitat index** favourable to adult snow crab in Area 12C (Figure 3A) shows a decline in extent over the 1990-2021 period, with a value in 2021 that is the lowest observed since 1990 (Figure 3A). This loss of habitat could have a negative impact on the future productivity of the stock.

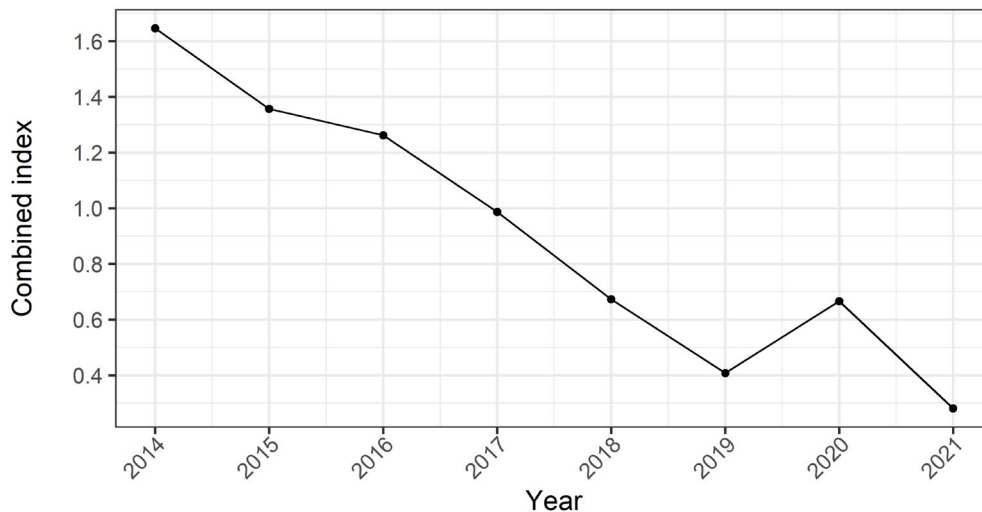


Figure 38. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 12C.

Outlook

The combined index (CI) is at the lowest value observed in eight years, with fishing yields that were, over the last three years, the lowest seen in the last two decades and a commercial abundance indicator that is the lowest on record. The biomass available to the fishery in 2022 is expected to be less than or equal to that available in 2021

Given the increasing densities of primiparous females, these indicators suggest more caution in setting the total allowable landings in 2022, and prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Scientific consensus has also been reached on proposed adjustments to harvests, which—although they may be smaller than those based solely on the value of the relative change in the CI compared with the previous year—can result in a comparable or lower level of harvesting intensity in the upcoming fishing season compared with the previous season.

- *Higher scenario:* A 20% decrease applied to total landings in 2021.
- *Intermediate scenario:* A 30% decrease applied to total landings in 2021.
- *Lower scenario:* A more than 30% decrease applied to total landings in 2021.

Area 12B

Description of the fishery

From 2010 to 2014, the total allowable catch (TAC) was gradually increased from 246 t to 468 t, a record high level. Since 2014, landings and TACs have been declining and, since 2017, have reached the lowest values in the time series (Figure 39). A 20.0 t index fishery was introduced in 2020 but could not be conducted due to the COVID-19 pandemic. In 2021, it was renewed, and the allocation was achieved with landings of 19.0 t.

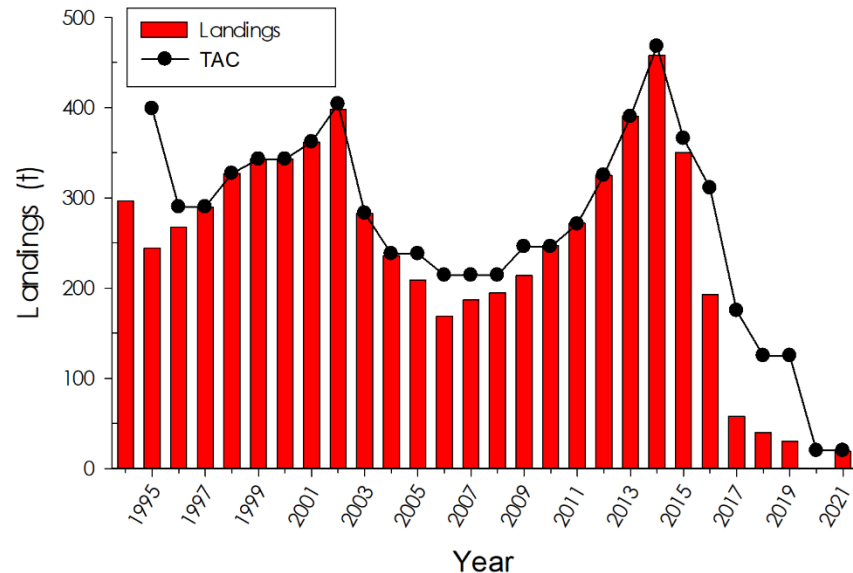


Figure 39. Annual landings and TACs in Area 12B.

Resource status in 2021

Commercial fishery. The catch per unit effort (CPUE) of the index fishery in 2021 was 14.0 kg/trap-day, while the average for the commercial fishery in the 2001–2019 period was 25.7 kg/trap-day (Figure 40). At-sea sampling coverage was limited in 2021, but catches consisted mainly of recruits (crabs of shell condition 1–2) during the index fishery (87.8%). Meanwhile, dockside data indicated that the majority (72.8%) of landings from the index fishery were intermediate-shell crabs (condition 3). Although the average size of commercial crabs measured at sea and dockside during the 2019 commercial fishery were close to their respective historical averages, both at-sea and dockside values for this indicator decreased during the 2021 index fishery (Figure 41).

Fishery-independent survey. No post-season surveys were conducted in 2020 and 2021. The most recent trap survey, conducted in 2019, indicated that the numbers per unit effort (NPUE) for adults and adolescents were near 0.

The combined index cannot be calculated since 2019 due to the absence of the post-season survey in 2020 and 2021 (Figure 42).

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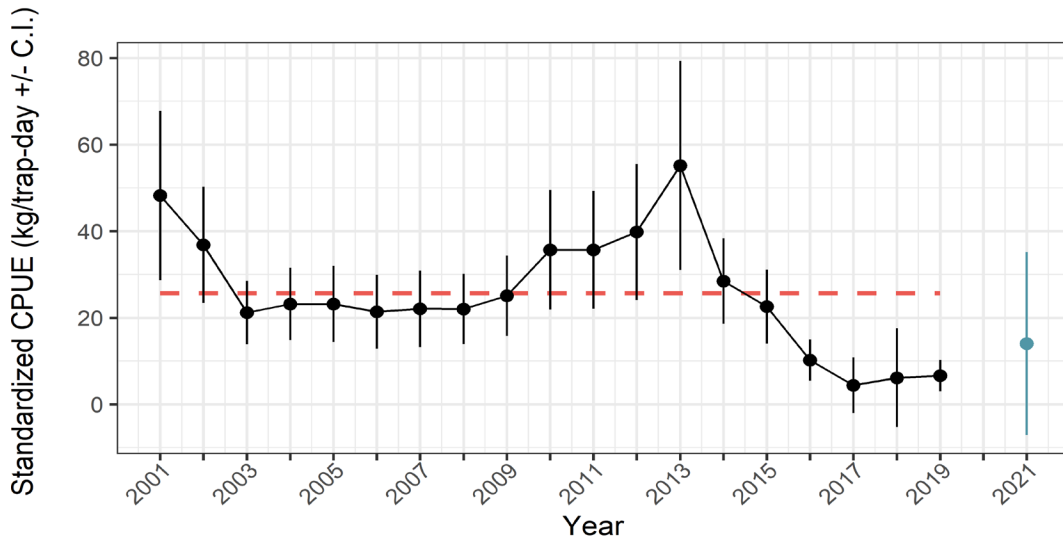


Figure 40. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12B. The red dashed line shows the historical data series average (excluding the last year) which is 25.7 kg/trap per day. The 2021 value, in blue, corresponds to a 20 t index fishery introduced in 2020, different from the traditional commercial fishery.

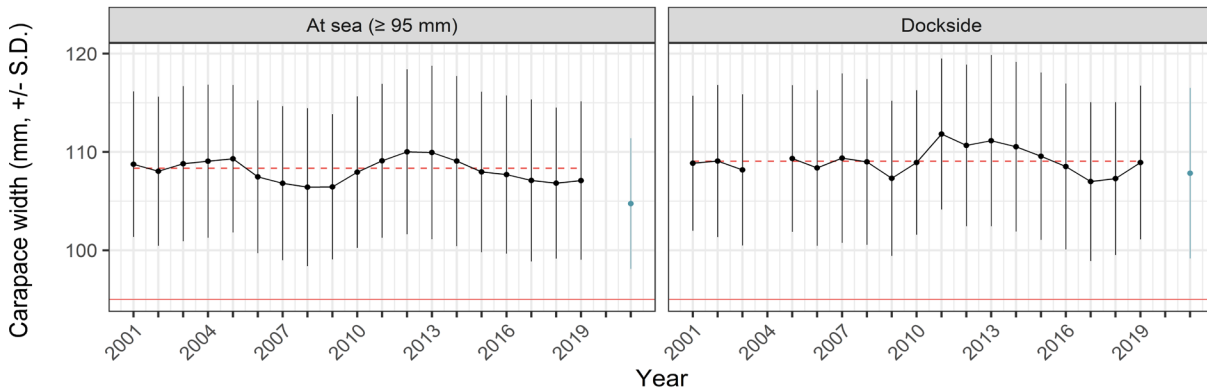


Figure 41. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 12B. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 108.3 mm at sea and 109.0 mm at dock. The 2021 value, in blue, corresponds to a 20 t index fishery introduced in 2020, different from the traditional commercial fishery.

The thermal habitat index favourable to adult snow crab in Area 12B shows a decline in extent over the 1990-2021 period, with a value in 2021 that is the lowest observed since 1990 (Figure 3A). This loss of habitat could have a negative impact on the future productivity of the stock.

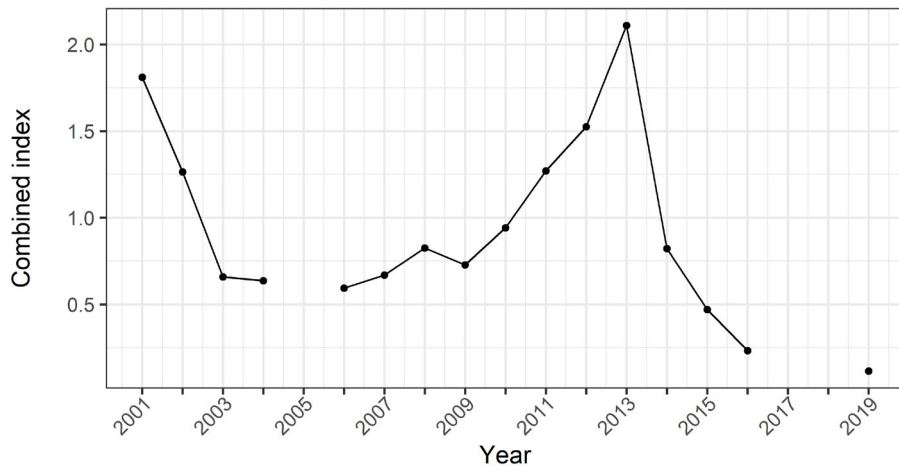


Figure 42. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 12B.

Outlook

Based on the information available, the status of the resource in Area 12B cannot be assessed.

Area 12A

Description of the fishery

The total allowable catch (TAC) decreased by 12.7% between 2020 and 2021 to 69.0 t, and it was not reached (Figure 43). Landings declined by 21.7% between 2020 and 2021, decreasing from 69.0 t to 54.0 t (78.3% of the TAC in 2021). Industry cited socio-economic reasons to explain in part why the TAC had not been reached.

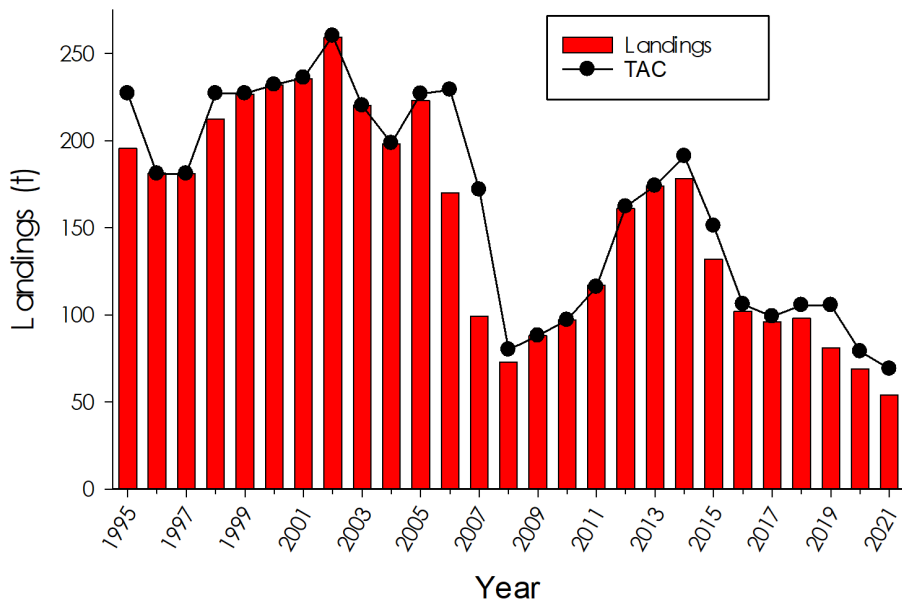


Figure 43. Annual landings and TACs in Area 12A.

Resource status in 2021

Commercial fishery. The standardized CPUE went from the highest value of the series in 2013 to the lowest value in 2021 (Figure 44). The 37.6% decrease between 2020 and 2021 occurred after some relative stability between 2017 and 2019, despite a decrease in landings since 2018. At-sea sampling coverage was limited in 2021, but the mean carapace width of commercial males sampled during the fishing season has been declining and was at the lowest value of the 2001–2021 period (Figure 45). A decrease is also observed for the average size of commercial crab landed between 2020 and 2021 (Figure 45). Dockside data indicate that two-thirds of the landings were intermediate-shell crabs (shell condition 3) a proportion that is relatively stable since 2010.

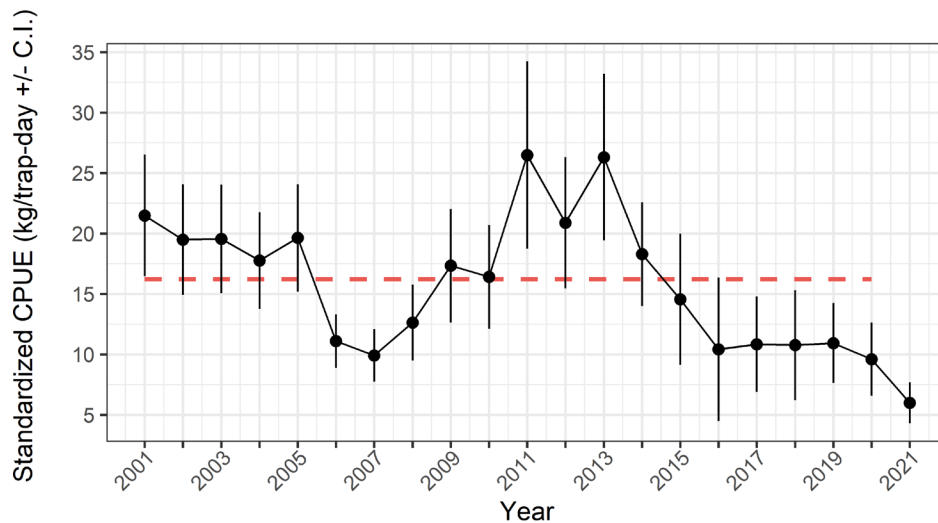


Figure 44. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12A. The dashed line shows the historical data series average (excluding the last year) which is 16.2 kg/trap per day.

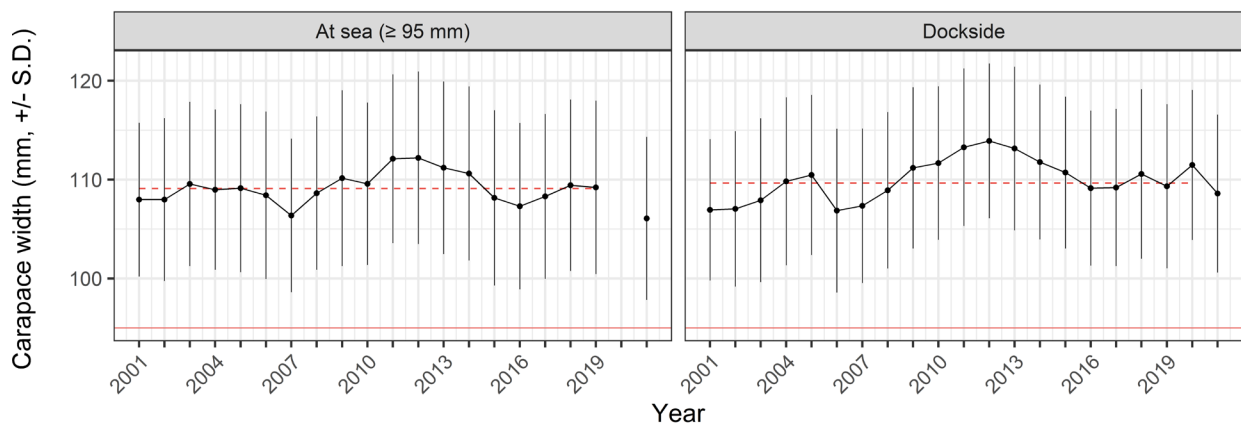


Figure 45. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 12A. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 109.1 mm at sea and 109.7 mm at dock.

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Fishery-independent survey. Other than adolescent crabs with a carapace width of 78–95 mm, the numbers of which increased between 2020 and 2021 to exceed the historical average, all abundance indices from the 2021 post-season survey were among the lowest values observed across their historical series (Figure 46). In the experimental traps, the abundance of mature females, notably primiparous females, is high in 2020 and 2021.

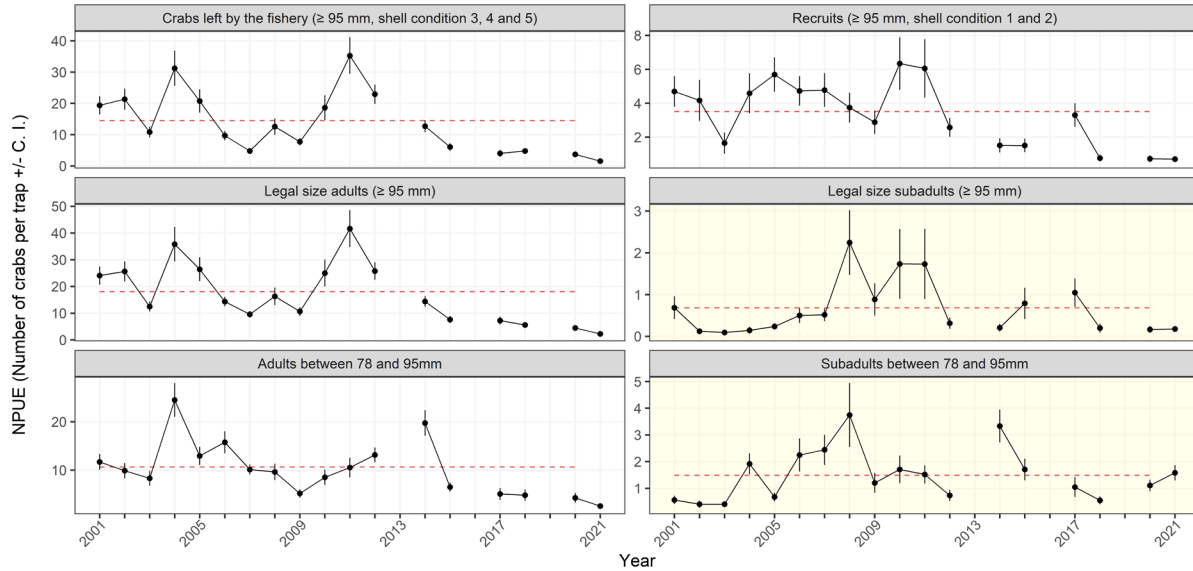


Figure 46. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 12A. The dashed line shows the historical data time series average (excluding the last 2 years).

The combined index, derived from the commercial CPUE and the post-season NPUE for adult males \geq 95 mm, has been decreasing since the 2011 peak. Between 2020 and 2021, the combined index (CI) declined by 40.8% to reach the lowest value of the time series. (Figure 47). In the context of a very low apparent abundance in the last post-season survey, the relative difference in the CI compared with the previous year was strongly influenced by a difference of only a few crabs per trap in comparison with the previous year. Despite this, indicators suggest that the biomass available to the fishery in 2022 is expected to remain very low.

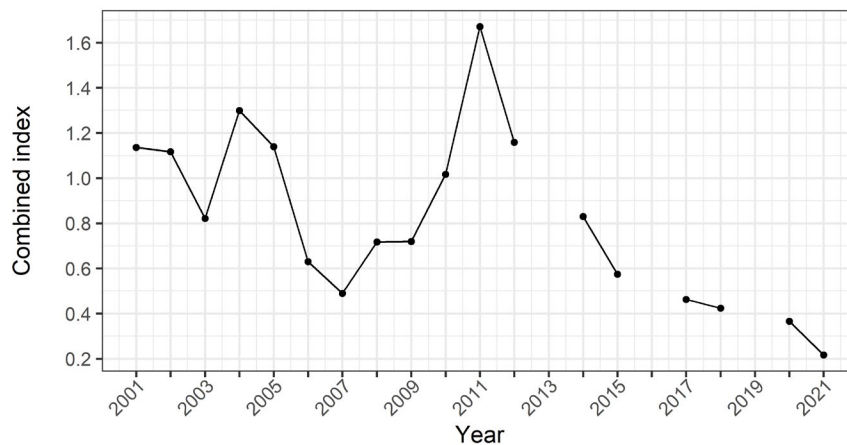


Figure 47. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the scientific trap survey for legal-size adult males in Area 12A.

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The thermal habitat index favourable to adult 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

The combined index is at the lowest value on record for the 2001–2021 period (-40.8% from 2020 to 2021), with fishing yields and a commercial abundance indicator that are at the lowest values observed in the last two decades. The biomass available to the fishery in 2022 is predicted to remain very low. Given the increasing densities of primiparous females, these indicators suggest more caution in setting the total allowable landings in 2022, and prevent an excessively biased sex ratio towards females during the recruitment of primiparous females.

Scientific consensus has also been reached on proposed adjustments to harvests, which—although they may be smaller than those based solely on the value of the relative change in the combined index compared with the previous year—can result in a comparable or lower level of harvesting intensity in the upcoming fishing season compared with the previous season.

- *Higher scenario:* A 20% decrease applied to total landings in 2021.
- *Intermediate scenario:* A 30% decrease applied to total landings in 2021.
- *Lower scenario:* A more than 30% decrease applied to total landings in 2021.

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.

OTHER 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, a warming of the surface layer and the deep water layer has been observed in the Gulf of St. Lawrence with record

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temperatures recorded during 2021 (Galbraith et al. 2022). 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 indices (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
Belley, Rénaud	DFO – Science	X	X	X
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Boucher, Jean-René	Fisher – Area 16	X	-	X
Boucher, Larry	Fisher – Area 16	X	-	-
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Couillard, Catherine	DFO – Science	X	X	X
Cyr, Charley	DFO – Science	X	X	X
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Desjardins, Christine	DFO – Science	X	X	-
Dobbin, Robert	Fisher – Area 13	-	X	X
Doucet, Marc	Fisher – Area 17	X	-	X
Dubé, Sonia	DFO – Science	X	X	X
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Galbraith, Peter	DFO – Science	X	X	X
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Gauthier, Sylvain	Fisher – Area 16	X	-	-
Gianasi, Bruno	DFO – Science	X	X	-
Gionet, Paolo	Fisher – Area 16	X	-	-
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Hawkins, Laurie	DFO – Fisheries management	-	X	-
Henry, Martin	DFO – Fisheries management	-	-	X

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Roy, Virginie	DFO – Science	X	-	-
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Sandt-Duguay, Emmanuel	AGHAMM	-	-	X
Sean, Anne-Sara	DFO – Science	X	-	X
Small, Daniel	DFO – Science	X	X	X
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St-Onge, Benoît	Pêcherie Uapan	X	-	-
Stubbert, Curtis	Fisher – LNS	X	X	X
Tamdrari, Hacène	DFO – Science	X	X	X
Tremblay, Yan	Pêcherie Uapan	X	-	-
Vallée, Simon	Fisher – Area 17	X	-	X
Vigneault, Guy	Fisher – Area 16	X	-	-

SOURCES OF INFORMATION

This Science Advisory Report is from the Regional Advisory Meeting of February 16-18, 2022 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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