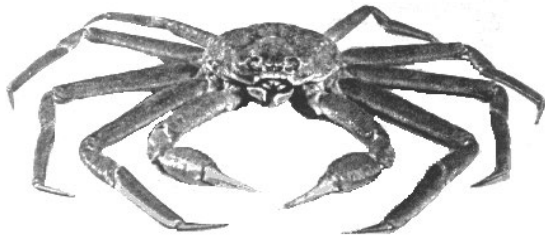




ASSESSMENT OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE (AREAS 13-17, 12A, 12C AND 16A) SNOW CRAB STOCKS IN 2022



Chionoecetes opilio (Fabricius, 1788)

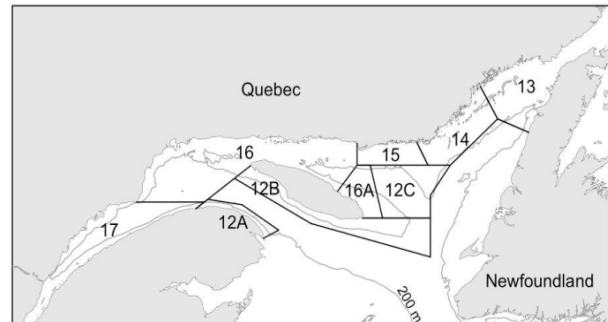


Figure 1. Snow crab management areas in the Estuary and the northern Gulf of St. Lawrence.

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).

Annual landings have varied depending on the adjusted TACs based on recruitment waves and troughs that affect the quantity of crabs available to the fishery. In 2022, a moratorium was imposed on snow crab fishing in Area 12B. Landings for the eight fishing areas totalled 4,553 t in 2022.

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 2023 quotas. A scientific peer review was conducted on February 15-17, 2023 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

- The total allowable catch (TAC) in 2022 was similar to that in 2021 (1,202.8 t, down 0.9%), and was reached. Landings in 2022 totalled 1,211.6 t, representing a 0.4% decrease from 1,217.0 t in 2021.
- Between 2021 and 2022, the standardized commercial catch per unit effort (CPUE) declined slightly (-2.5%) and is currently below the historical average [2000; 2021].
- The carapace width of legal-size crabs sampled at sea increased between 2021 and 2022, and is above the historical average [2000; 2021].
- According to dockside sampling data, recruits made up more than half of landings in 2022, a trend observed since 2018.
- The commercial abundance index derived from the post-season survey rose significantly between 2021 and 2022 and is slightly below the historical average [2000; 2021]. This increase is observed throughout the fishing area, with recruit abundance above the historical average [2000; 2021]. The abundance of legal- and sublegal-size adolescent males declined in the southern part of the fishing area but increased in the northern part—in both cases, to below the respective historical average [2000; 2021].
- According to the post-season survey, the abundance of primiparous females has been increasing since 2020, while the spermathecal load weight has been decreasing since 2019.
- Indicators of favourable thermal habitat for large and small crabs showed a downward temporal trend during the 1990-2022 period.
- The combined index, derived from the commercial CPUE and the number per unit effort (NPUE) obtained from the post-season survey, rose by 26.6 % in 2022, suggesting that the biomass available to the fishery in 2023 will be greater than in 2022.

Outlook

- The combined index increased between 2021 and 2022, suggesting that the biomass available to the fishery in 2023 will be greater than that in 2022.
- Given the expected high abundance of recruits, associated with densities of mature females that are still high, it is suggested that the increase in removals in 2023 be limited to prevent increased white crab mortality and to avoid obtaining a sex ratio that is overly biased towards females.

Higher scenario: A 25% increase relative to total landings in 2022.

Intermediate scenario: A 15% increase relative to total landings in 2022.

Lower scenario: A 5% increase relative to total landings in 2022.

Area 16

- The total allowable catch (TAC) in 2022, which was increased to 2,236.9 t from 2021, was reached. Landings in 2022 totalled 2,252.0 t (+14.7% between 2021 and 2022).
- The standardized commercial catch per unit effort (CPUE) increased in 2022 (+9.8%) for the third consecutive year, and is slightly below the historical average [1996; 2021].

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- The carapace width of legal-size crabs sampled at sea was down slightly, but is close to the historical average [1996; 2021].
- According to dockside sampling data, crabs with a carapace condition of 1-2 (recruits) made up roughly one half of landings in 2022, a proportion that has been fairly stable since 2019.
- According to the 2022 post-season survey, the abundance indices for both adult and adolescent males increased between 2021 and 2022, with a marked increase in sub-legal size adults. The mean carapace width of adult and adolescent male crabs caught in this survey with standard traps declined and is below the historical average [1996; 2021].
- The abundance of females in the post-season survey is still high in the western part of the area.
- According to the data obtained in the 2022 scientific trawl survey in Sainte-Marguerite Bay, primiparous female recruitment will likely decrease over the next few years, while recruitment to the commercial fishery should increase. However, the average size of adult males is declining and early terminal moulting (i.e. before crabs reach legal size) is increasingly frequent, representing significant losses for the commercial fishery, particularly from 2019 to 2022.
- The indicators of favourable thermal habitat for large and small crabs showed a downward temporal trend over the period [1990; 2022].
- The combined index, derived from the commercial CPUE and the number per unit effort (NPUE) obtained from the post-season survey, increased for a second year (+23.1%), suggesting that the biomass available to the fishery in 2023 should be greater than in 2022.

Outlook

- The combined index increased between 2021 and 2022 (+23.1%), which suggests that the biomass available to the fishery in 2023 should be greater than in 2022.
- Given the expected high abundance of recruits, associated with densities of mature females that are still high, it would be a good idea to limit the increase in removals in 2023 to prevent increased white crab mortality and to avoid obtaining a sex ratio that is overly biased towards females.

Higher scenario: A 25% increase relative to total landings in 2022.

Intermediate scenario: A 15% increase relative to total landings in 2022.

Lower scenario: A 5% increase relative to total landings in 2022.

Area 15

- In 2022, the total allowable catch (TAC) was reduced to 243.2 t, representing a 25.3% decrease relative to 2021, and was fully fished. Landings in 2022 totalled 237.0 t, a 22.5% decline from 306.0 t in 2021.
- The commercial catch per unit effort (CPUE) declined between 2021 and 2022 (-6.8%). The values in the last four years are the lowest for the period [2000; 2022].
- The carapace width of legal-size crabs sampled at sea is decreasing and is currently below the historical average [2000; 2021].

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- According to dockside sampling data, recruits made up slightly over half of landings in 2022, a proportion that has been increasing since 2019.
- All abundance indices obtained from the post-season survey showed an upward trend between 2021 and 2022 for both adolescent and adult males, and the 2022 values were above their respective historical averages [2014; 2021]. The mean carapace width of adult and adolescent male crabs caught with standard traps, which has fallen below the historical average between 2017 and 2020, has increased since 2020 but remains below the historical average [2000; 2021].
- The experimental traps used in the post-season survey indicate a high density of primiparous females in the last four years. All indicators point to increasing levels of recruitment to the commercial fishery, and this trend is expected to continue in the short and medium term.
- The combined index, derived from the commercial CPUE and the number per unit effort (NPUE) from the post-season survey, increased sharply between 2021 and 2022. This suggests that the biomass available to the fishery in 2023 should be greater than that in 2022.

Outlook

- The combined index, which had declined to one of the lowest values recorded since 2014, increased sharply between 2021 and 2022, due to a significant increase in the abundance of commercial-size crabs—which consisted of recruits and crabs left by the fishery in equal proportions—in the 2022 post-season survey. The biomass available to the fishery in 2023 is expected to be greater than that in 2022.
- Since CPUE values from the last four years were the lowest in the time series, caution is recommended in increasing removals.

Higher scenario: A 45% increase relative to total landings in 2022.

Intermediate scenario: A 35% increase relative to total landings in 2022.

Lower scenario: A 25% increase relative to total landings in 2022.

Area 14

- In 2022, the total allowable catch (TAC) was reduced to 309.9 t, a 15.1% decrease in relation to 2021, and was reached. Landings in 2022 totalled 310.7 t, down 14.3% from 362.5 t in 2021.
- Between 2021 and 2022, the commercial catch per unit effort (CPUE) increased by 20.2%, remaining slightly below the historical average [2000; 2021].
- The carapace width of legal-size crabs sampled at sea decreased and is below the historical average [2000; 2021].
- According to dockside data, landings in 2022 primarily consisted of intermediate-shell crabs, followed closely by recruits.
- According to the post-season survey data, the abundance of adult legal-size male crabs increased between 2021 and 2022, due to an increase in the number of commercial crabs left by the fishery. Recruit abundance declined during the same period. The average size of adult male crabs caught with standard traps has been declining since 2016 and is below the

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historical average [2000; 2021], while the abundance of adult sublegal-size males increased sharply between 2021 and 2022. The abundance of primiparous and multiparous females is declining, while the spermathecal load weight is increasing.

- The 2022 scientific trawl survey conducted in the eastern part of Areas 13 and 14, in the Lower North Shore area, points to a high density of primiparous and multiparous females and sublegal-size males.
- The combined index, derived from the commercial CPUE and the number per unit effort (NPUE) from the post-season survey, rose sharply between 2021 and 2022, indicating that the biomass available to the fishery will likely be greater in 2023 than in 2022.

Outlook

- The combined index rose sharply between 2021 and 2022, indicating that the biomass available to the fishery in 2023 should be greater than in 2022 and consist mainly of crabs left by the fishery.
- In light of the decline in the abundance of recruits and legal-size adolescents observed in the 2022 post-season survey, it is recommended that caution be exercised when increasing removals.

Higher scenario: A 35% increase relative to total landings in 2022.

Intermediate scenario: A 25% increase relative to total landings in 2022.

Lower scenario: A 15% increase relative to total landings in 2022.

Area 13

- Between 2021 and 2022, the total allowable catch (TAC) decreased by 18.7% to 198.3 t, and was reached. Landings in 2022 totalled 188.0 t, down 5.5% from 199 t in 2021.
- Between 2021 and 2022, the commercial catch per unit effort (CPUE) increased by 45.5% and is currently below the historical average [2000; 2021].
- Dockside sampling of legal-size crabs showed a decrease in the carapace width between 2021 and 2022 to values below the historical average [2000; 2021]. The 2022 values are at 2002 pre-moratorium levels.
- According to the dockside sampling data, landings consisted primarily of recruits for the second consecutive year.
- The commercial abundance index derived from the post-season survey rose between 2021 and 2022 and is now above the average for the last three years [2019; 2021]. This upward trend reflects the increasing abundance of recruits in the northern part of the fishing area. The average size of adult males caught with standard traps has been declining since 2016 and is below the historical average [2000; 2021]. The abundance of sublegal-size adult males rose significantly in the northern part of the area between 2021 and 2022. The abundance of primiparous and multiparous females declined, while the spermathecal load weight increased.
- The 2022 scientific trawl survey in the eastern part of Areas 13 and 14, in the Lower North Shore, points to a high density of primiparous and multiparous females and sublegal-size males.

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- Between 2021 and 2022, the combined index, derived from the commercial CPUE and the number per unit effort (NPUE) from the post-season survey, increased sharply. The biomass available to the fishery in 2023 is expected to be greater than that in 2022.

Outlook

- Between 2021 and 2022, the combined index increased. The biomass available to the fishery in 2023 is expected to be greater than that in 2022.
- Given the reliance of the commercial fishery on recruits and the smaller carapace width of the crabs caught in the post-season survey, it is suggested that caution be exercised in setting the TACs during the resumption of the recruitment pulse to prevent increased white crab mortality.

Higher scenario: A 20% increase relative to total landings in 2022.

Intermediate scenario: A 10% increase relative to total landings in 2022.

Lower scenario: Status quo relative to total landings in 2022.

Area 16A

- The total allowable catch (TAC) remained the same in 2021 and 2022, at 245 t, and was fully fished in 2022, with landings of 244.3 t.
- The commercial catch per unit effort (CPUE) increased between 2021 and 2022 (+33.9%), although the 2022 value remained below the historical average [2002; 2021].
- The carapace width of legal-size crabs sampled at sea has remained stable since the last time sampling took place (2019), and is still above the historical average [2002; 2019].
- According to dockside sampling data, recruits have accounted for slightly over half of landings since 2018.
- According to the 2022 post-season survey data, the abundance of legal-size crabs, which primarily consist of recruits, is increasing. Although the abundance of crabs left by the fishery increased between 2021 and 2022, it still remains very low. The mean carapace width of male crabs caught in this survey with standard traps declined, and was below the historical average [2002; 2021].
- Data from the experimental traps used in the post-season survey indicate a high density of primiparous females in the last four years. According to all the indicators, recruitment to the commercial fishery is likely increasing and this is expected to continue over the short and medium term.
- The indicator of favourable thermal habitat for small crabs showed an upward temporal trend during the 1990-2022 period, while that for large crabs declined slightly during the same period.
- The combined index, derived from the commercial CPUE and the number per unit effort (NPUE) from the post-season survey, increased for the first time since 2014. The large increase between 2021 and 2022 suggests that the biomass available to the fishery in 2023 will be greater than in 2022.

Outlook

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- The combined index, after declining during the 2014-2021 period, rose sharply between 2021 and 2022, suggesting that the biomass available to the fishery will increase in 2023. However, commercial fishery yields are still low and the abundance of crabs left by the fishery was very low.
- Given the commercial fishery's reliance on recruits, caution should be exercised in increasing removals during the resumption of the recruitment pulse, to prevent increased white crab mortality.

Higher scenario: A 30% increase relative to total landings in 2022.

Intermediate scenario: A 20% increase relative to total landings in 2022.

Lower scenario: A 10% increase relative to total landings in 2022.

Area 12C

- The total allowable catch (TAC) in 2022 was reduced to 71.5 t from 2021, and was not reached. Landings in 2022 totalled 66.0 t.
- The commercial catch per unit effort (CPUE) increased between 2021 and 2022 (+17.1%), but the 2022 value remains among the lowest in the time series [2001; 2021].
- The carapace width of legal-size crabs sampled at sea increased, but remained below the historical average [2001; 2021].
- According to dockside sampling data, the proportion of recruits increased between 2021 and 2022. In 2022, landings were made up mostly of recruits.
- Different spatial coverage in the post-season surveys created some uncertainty in the indicators for 2021 and 2022. The difference in NPUE95 (legal-size adults) between 2021 and 2022 was +42.5% without adjusting for the differences in the protocol, but -23.7% when the transects sampled in the two years were compared. The abundance of commercial-size adults in 2022 remained very low. The mean carapace width of male crabs caught in the post-season survey with regular conical traps is stable, but below the historical average [2001; 2021].
- The indicator of favourable thermal habitat for large crabs showed a downward temporal trend during the 1990-2022 period.
- The value of the combined index, derived from the commercial CPUE and the number per unit effort (NPUE) from the post-season survey, in 2022 was among the lowest observed since the time series began in 2014.

Outlook

- Given the uncertainty created by the difference in the spatial coverage in the post-season surveys in 2021 and 2022, the combined index will not be used as the main reference for recommendations.
- Standardized CPUE values increased by 17.1% between 2021 and 2022, while the difference in NPUE95 values between the two years was calculated at -23.7%, based on the transects sampled in the two years. The biomass available to the fishery in 2023 could remain at a level similar to that in 2022.

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- Given the heavy reliance of the commercial fishery on recruits and the smaller carapace width of the crabs caught in the post-season survey, caution should be exercised in setting the TACs during the resumption of the recruitment pulse.

Higher scenario: A 10% increase relative to total landings in 2022.

Intermediate scenario: Status quo relative to total landings in 2022.

Lower scenario: A 10% decrease relative to total landings in 2022.

Area 12A

- In 2022, the total allowable catch (TAC) was reduced to 43.1 t, representing a 37.5% decrease relative to 2021, and was fully fished. Landings in 2022 totalled 43.0 t, a 20.4% decline from 54.0 t in 2021.
- The commercial catch per unit effort (CPUE), which reached its lowest value in the time series in 2021, increased in 2022 and is below the historical average [2001; 2021].
- The carapace width of legal-size crabs sampled at sea and at dockside was down between 2021 and 2022 and is below the historical average [2001; 2021].
- According to dockside sampling data, intermediate-shell crabs made up more than half of landings in 2022, a trend observed since 2004.
- According to the post-season survey data, the commercial abundance index increased between 2021 and 2022, after a steady decline since 2011, but remains among the lowest in the time series [2001; 2021]. The abundance of primiparous females remains high in 2022.
- Indicators of favourable thermal habitat for large crabs showed a downward temporal trend during the 1990-2022 period.
- The combined index, derived from the commercial CPUE and the number per unit effort (NPUE) from the post-season survey, reached its lowest value in 2021 and is increasing between 2021 and 2022, indicating that the biomass available to the fishery will likely be greater in 2023 than in 2022.

Outlook

- The combined index, which reached its lowest value in 2021, increased between 2021 and 2022, suggesting that the biomass available to the fishery in 2023 will be greater than that in 2022.
- However, the biomass and abundance indices are at very low levels. In addition, the density of mature females is still high. All the indicators point to the need to exercise caution when establishing harvest levels for 2023.

Higher scenario: A 10% increase relative to total landings in 2022.

Intermediate scenario: Status quo relative to total landings in 2022.

Lower scenario: A 10% decrease relative to total landings in 2022.

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 arrival of recruitment 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 post-season trap survey and scientific trawl surveys. Legal-size adult crabs that have moulted recently—recruits—can be identified from their bright orange shell and iridescence (carapace condition 1 and 2). As crabs age after the terminal moult, their carapace gradually turns brown and loses its iridescence, and their claws become worn (carapace condition 3 to 5). 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 dockside samplers. In 2022, the industry conducted after the fishing season a trap-based research survey in all fishing areas (Area 14 to 17, 12A, 12C and 16A), as well as in 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 surveys normally conducted every two years by DFO in the northern Gulf and Estuary areas did not take place in 2020 because of the prevailing COVID-19 pandemic and in 2021 due to the unavailability of DFO research vessel. In 2022, the scientific trawl survey was carried out on the Lower North Shore, east of Area 14 and in the northern part of Area 13. Thus the results of research trawl surveys on the Lower North Shore and in Sainte Marguerite Bay in Area 16 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 licenses and dates that fishing was allowed in 2022 are indicated in Table 1. Stocks have reached the end of the wave of recruitment to the fishery, with total landings in 2022 of 4,553.0 t. This decrease was observed in most areas, except in areas 12C, 14 and 15 (Figure 2).

Assessment of the Estuary and Northern Gulf of St. Lawrence Snow Crab Stocks in 2022

Quebec Region

Table 1. Summary by Area of the number of licences and dates of commercial fishery in 2022.

Areas	13	14	15	16	16A	17	12A	12B	12C
Number of licences	41	19	30	51	35	36	10	Moratorium	37
Opening dates	May 7 or 15	May 2 or 9	April 4	April 4	April 4 or 11	March 25	March 31	-	April 4 or 11
Closure dates	August 12 or 20	August 7 or 14	July 10	July 10	July 10 or 17	June 24	June 9	-	June 26 or July 17

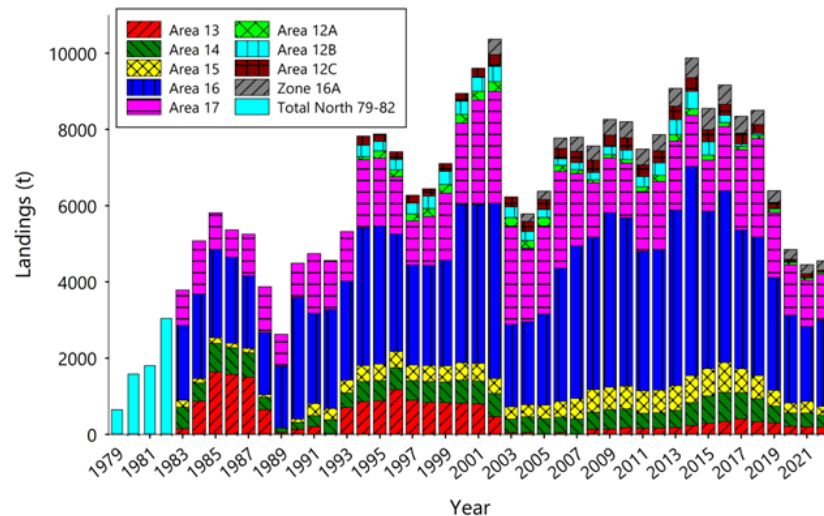


Figure 2. Snow crab landings in the Estuary and northern Gulf of St. Lawrence from 1979 to 2022. From 1979 to 1982, landings were not attributed to their area of origin.

The fishery’s raw catches per unit effort (CPUE) were standardized using a linear statistical model to account for seasonal changes, fishing 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 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 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 post-season 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.

Snow crab thermal habitat

Two indicators of favourable thermal habitat for snow crab are now available, one for adults and the other for juveniles (<12 mm). 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 2021 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 Areas 16 and 17, but an increasing trend was observed in Areas 13, 14 and 16A (Figure 3B).

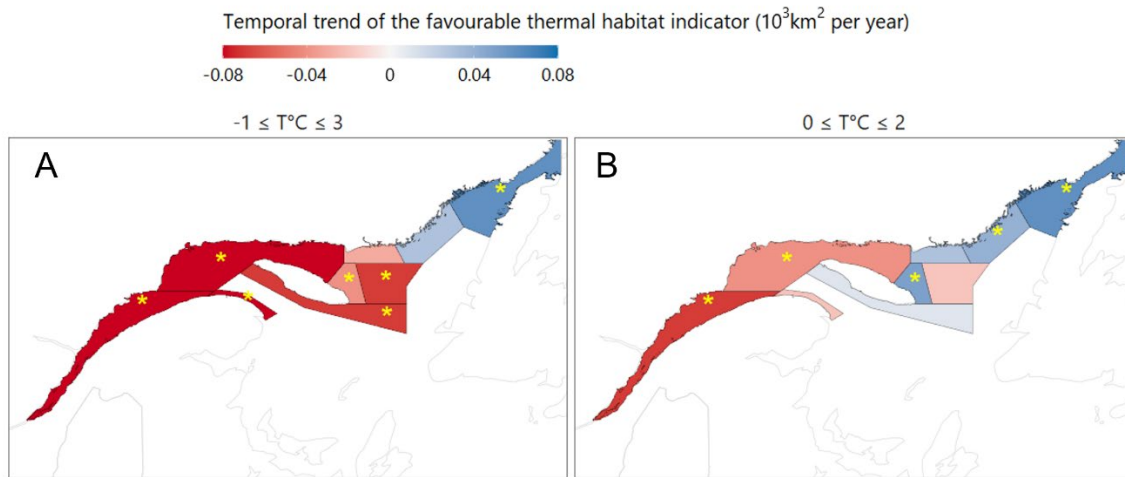


Figure 3. Temporal trends of the favourable thermal habitat indices for adult snow crabs (A) and juvenile snow crabs (<12 mm) (B) over the 1990–2020 period. The favourable habitat index is the annual area of seabed where water temperatures are between -1°C and 3°C for adult crabs and between 0°C and 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 total allowable catch (TAC) stood at 1,202.8 t (Figure 4), down 0.9% from the 2021 level. Landings decreased by only 0.4% between 2021 and 2022, reaching 1,211.6 t or 100.7% of the TAC.

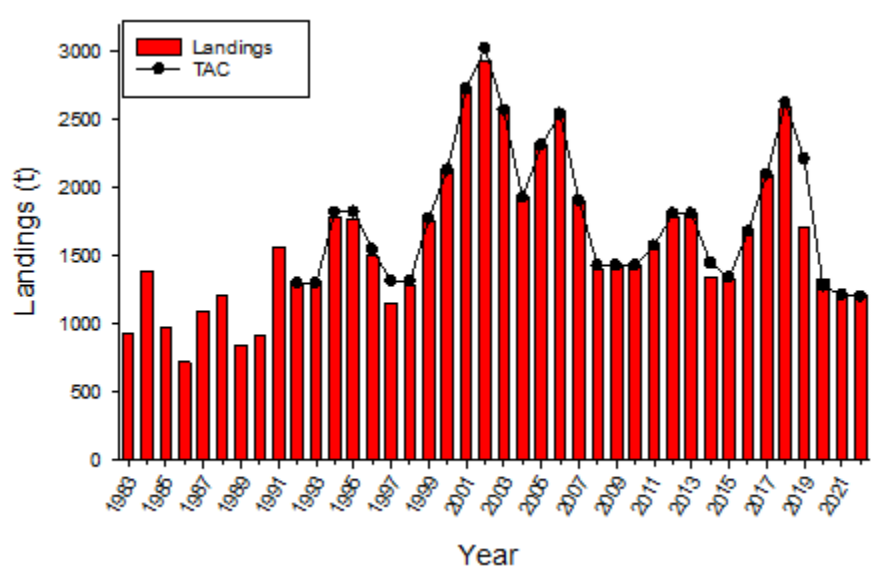


Figure 4. Annual landings and TACs in Area 17.

Resource status in 2022

Commercial fishery. Between 2021 and 2022, the standardized commercial catch per unit effort (CPUE) declined slightly (-2.5%) and is currently below the historical average (Figure 5). According to dockside sampling data, recruits made up more than half of landings in 2022, a trend observed since 2018.

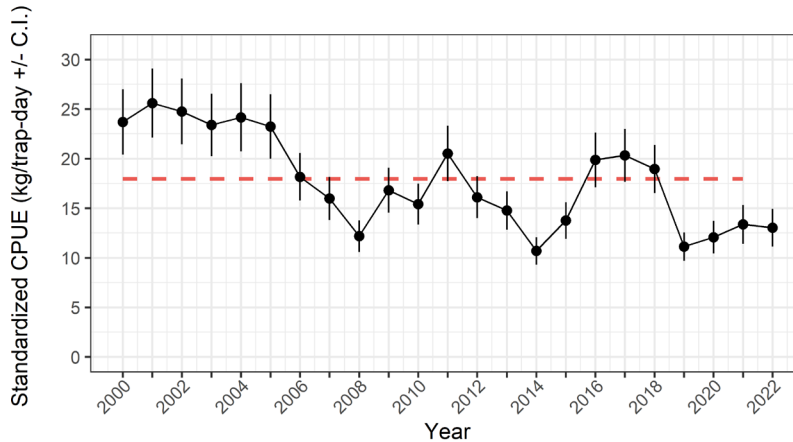


Figure 5. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 17. The dashed line shows the historical data series average (excluding the last year) which is 18.0 kg/trap per day.

The average size of legal-size crabs sampled at sea increased between 2021 and 2022, and is above the historical average. The average size of commercial crabs sampled at dockside is stable between 2019 and 2021 to slightly above the historical average (Figure 6).

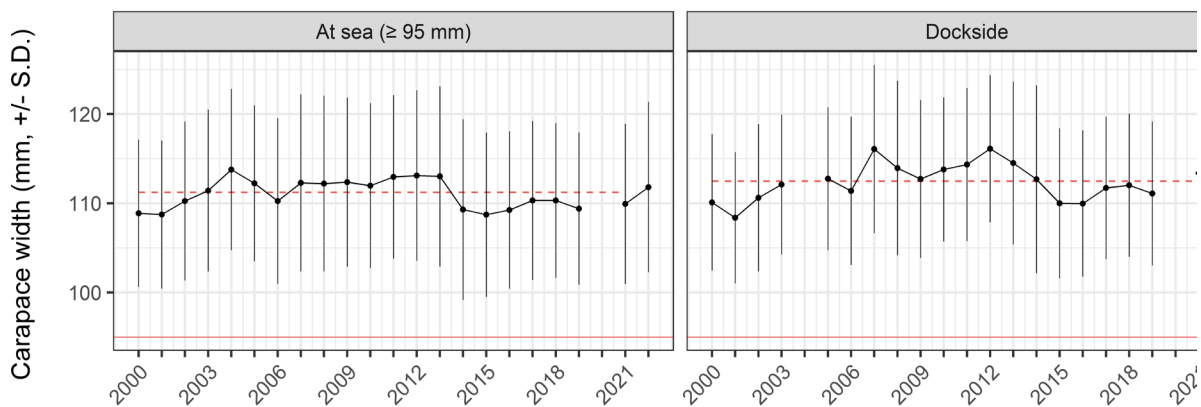


Figure 6. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 17. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 111.2 mm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

Fishery-independent surveys. Based on the post-season survey, the abundance of the different categories of adults increased between 2021 and 2022, with the abundance of recruits (adults \geq 95 mm, carapace condition 1 and 2) showing values above the historical average in 2022, unlike the other categories of crab (Figure 7). These increases in the abundance of adults is observed on both sides of the area. However, the abundance of legal- and sublegal-size

adolescents (78-95 mm) declined between 2021 and 2022 on the south side, but increased on the north side (Figure 7).

The mean weight of the spermathecal load of primiparous females caught during the post-season survey has been declining since 2019, whereas the abundance of primiparous females has been increasing since 2020.

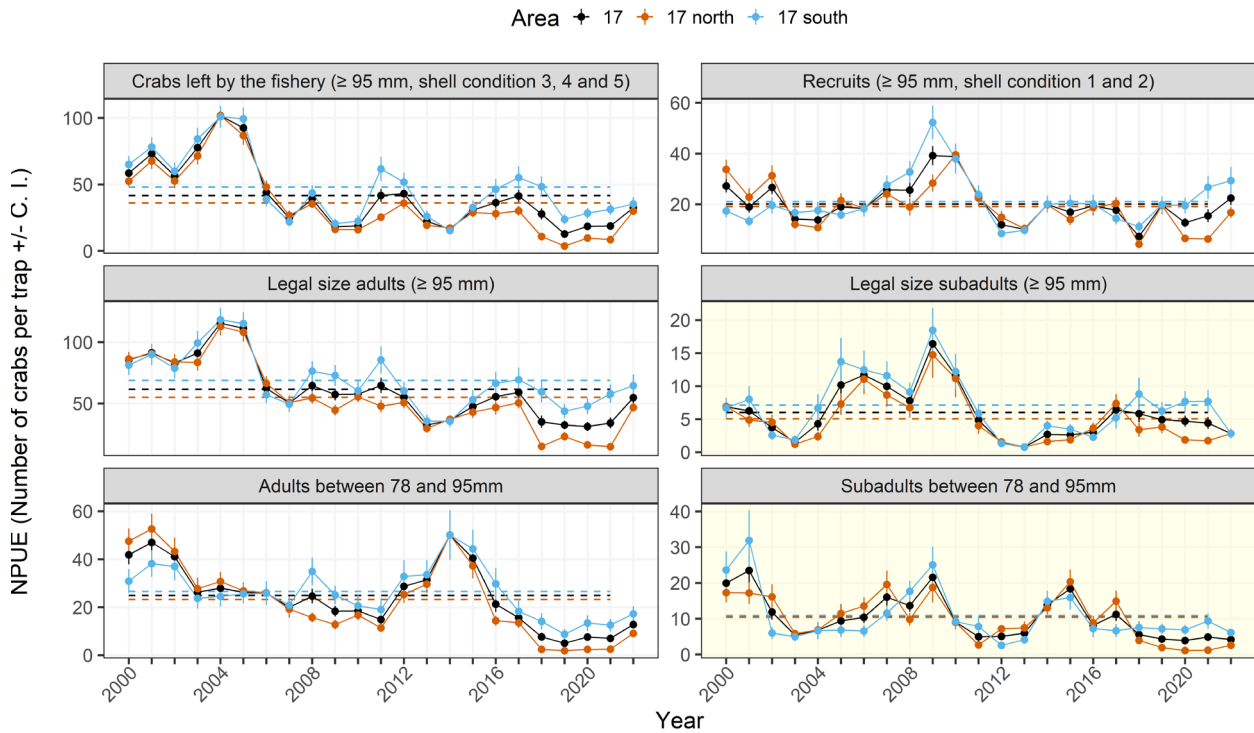


Figure 7. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 17 (black), and in each sector, Area 17 North (17N in orange) and Area 17 South (17S in blue). The dashed line 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 ≥ 95 mm, increased by 26.6% between 2021 and 2022 (Figure 8). Indicators suggest that the biomass available to the fishery in 2023 will be greater than in 2022.

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.

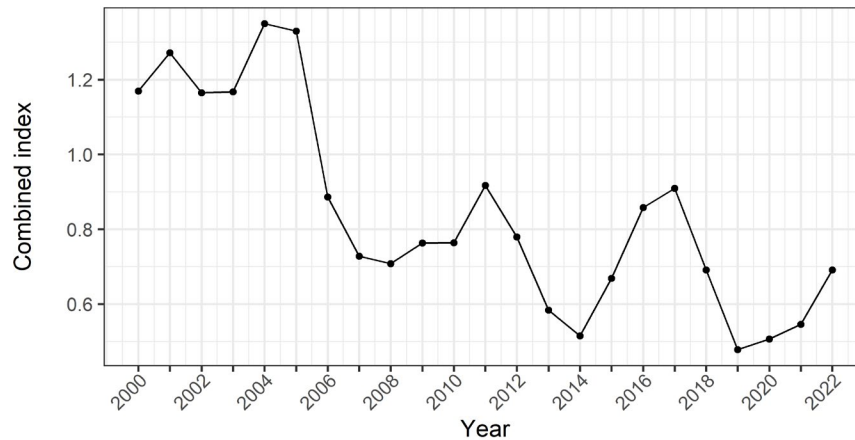


Figure 8. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 17.

Outlook

The combined index increased between 2021 and 2022, suggesting that the biomass available to the fishery in 2023 will be greater than that in 2022. Given the expected high abundance of recruits, associated with densities of mature females that are still high, it is suggested that the increase in removals in 2023 be limited to prevent increased white crab mortality and to avoid obtaining a sex ratio that is overly biased towards females.

Higher scenario: A 25% increase applied to total landings in 2022.

Intermediate scenario: A 15% increase applied to total landings in 2022.

Lower scenario: A 5% increase applied to total landings in 2022.

Area 16

Description of the fishery

The total allowable catch (TAC) in 2022, which was increased to 2,236.9 t from 2021 (+14.6%), was reached. Landings in 2022 totalled 2,252.0 t (+14.7% between 2021 and 2022) (Figure 9).

Resource status in 2022

Commercial fishery. For a third consecutive year, the standardized catch per unit effort (CPUE) increased in 2022 (+9.8%), subsequent to a steady decline between 2015 and 2019. The CPUE in 2022 is slightly below the historical average (Figure 10). Dockside sampling indicated that landings in 2022 were approximately half recruits (shell condition 1–2), representing a proportion fairly similar to that observed since 2019.

The at-sea sampling data in 2022 indicate a slightly decrease in the mean carapace width of commercial males, while dockside sampling data show an increase between 2021 and 2022. In both cases, the 2022 values are similar to their respective historical averages (Figure 11).

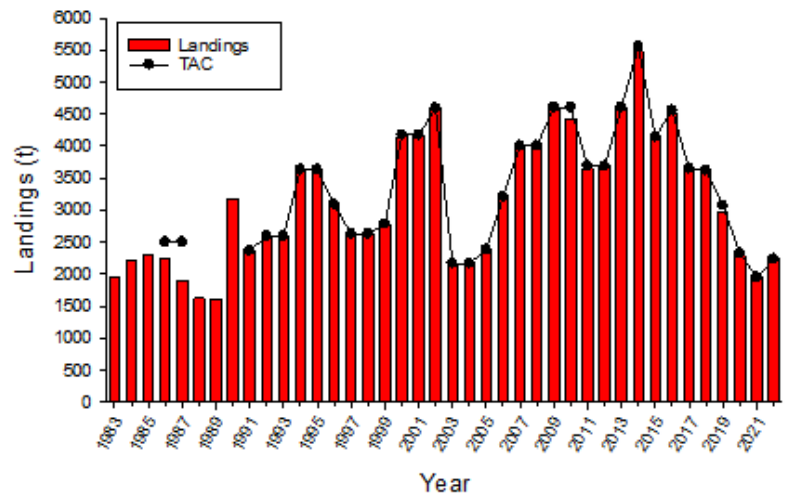


Figure 9. Annual landings and TACs in Area 16.

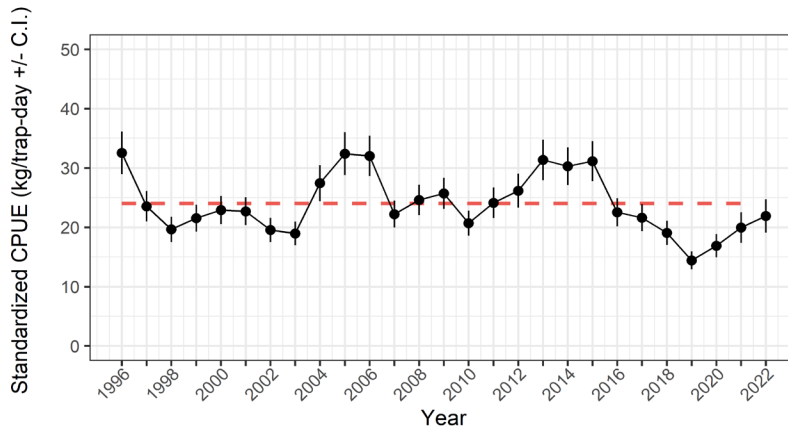


Figure 10. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 16. The dashed line shows the historical data series average (excluding the last year) which is 24.0 kg/trap per day.

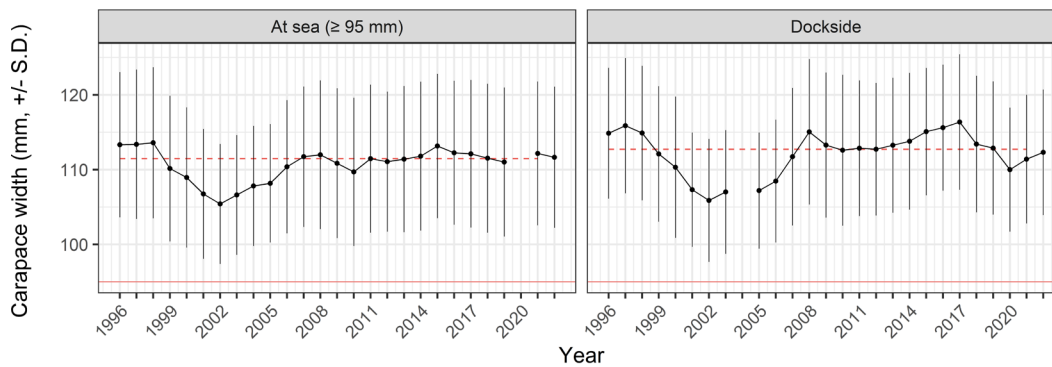


Figure 11. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 16. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 111.5 mm at sea and 112.7 mm at dock.

Fishery-independent surveys. The post-season survey shows that all the abundance indicators for adult and adolescent crab increased between 2021 and 2022 (Figure 12). The commercial abundance index increased for the second consecutive year (+43.5% between 2021 and 2022), after a sharp decline during the 2016-2020 period (Figure 12). In 2022, the abundance of recruits and of sublegal adults (78-95 mm) was above their respective historical averages (Figure 12). The mean carapace width of adult and adolescent male crabs caught in this survey with standard traps declined and is below the historical average [1996; 2021].

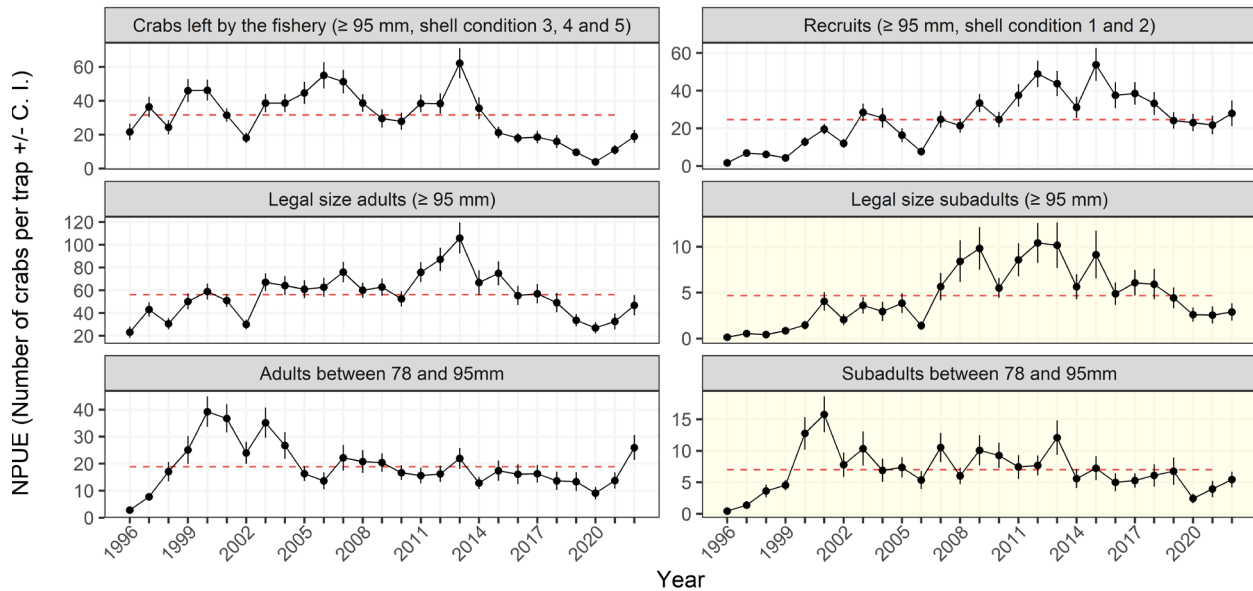


Figure 12. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 16. The dashed line shows the historical data time series average (excluding the last year).

Monitoring of the snow crab population in Sainte Marguerite Bay was not carried out in 2021. Based on the 2022 survey, the density of primiparous females should decrease over the coming years, while the density of adult males is expected to increase. However, the frequency of premature terminal moulting (the terminal moult is the one that occurs before crabs reach legal size) was high between 2019 and 2022, which represents a considerable commercial loss. The high frequency of premature terminal moulting creates uncertainty related to the strength of the next wave of recruitment to the fishery.

The **combined index**, derived from the commercial CPUE and the post-season NPUE for adult males \geq 95 mm, increased by 23.1% between 2021 and 2022, suggesting that the biomass available to the fishery in 2023 should be greater than in 2022 (Figure 13).

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 1990-2022 period, which could have a negative impact on the future stock productivity.

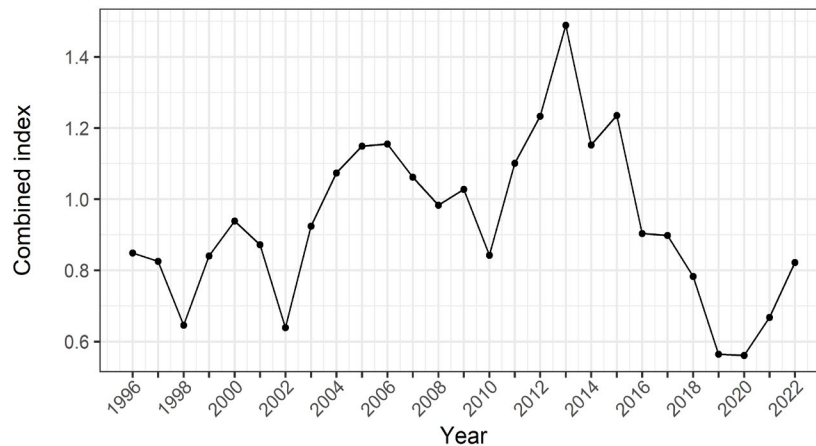


Figure 13. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 16.

Outlook

The combined index increased between 2021 and 2022 (+23.1%), which suggests that the biomass available to the fishery in 2023 should be greater than in 2022. Given the expected high abundance of recruits, associated with densities of mature females that are still high, it would be a good idea to limit the increase in removals in 2023 to prevent increased white crab mortality and to avoid obtaining a sex ratio that is overly biased towards females.

Higher scenario: A 25% increase relative to total landings in 2022.

Intermediate scenario: A 15% increase relative to total landings in 2022.

Lower scenario: A 5% increase relative to total landings in 2022.

Area 15

Description of the fishery

In 2022, the total allowable catch (TAC) was reduced to 243.2 t, representing a 25.3% decrease relative to 2021, and was fully fished. Landings in 2022 totalled 237.0 t, a 22.5% decline from 306.0 t in 2021 (Figure 14).

Resource status in 2022

Commercial fishery. The catch per unit effort (CPUE) for the commercial fishery has been relatively stable since 2019 (+6.8% between 2021 and 2022), and the last four years' values are the lowest over the 2000-2022 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 in 2021.

In 2022, the average carapace width of legal-size crabs sampled at sea is decreasing and is currently below the historical average, a trend also observed dockside (Figure 16). According to dockside sampling data, recruits (shell condition 1–2) made up the majority (63.8%) of landings in 2022, a proportion that has been increasing since 2019, while intermediate-shell crabs declined from 37.9% to 33.5% between 2021 and 2022.

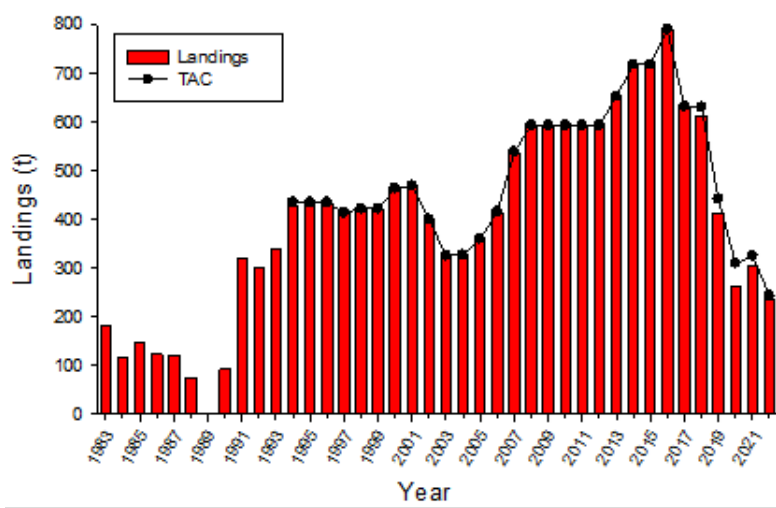


Figure 14. Annual landings and TACs in Area 15.

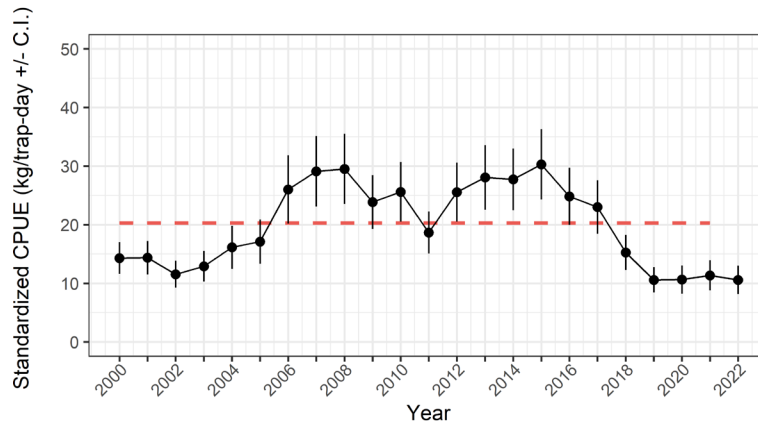


Figure 15. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 15. The dashed line shows the historical data series average (excluding the last year) which is 20.3 kg/trap per day.

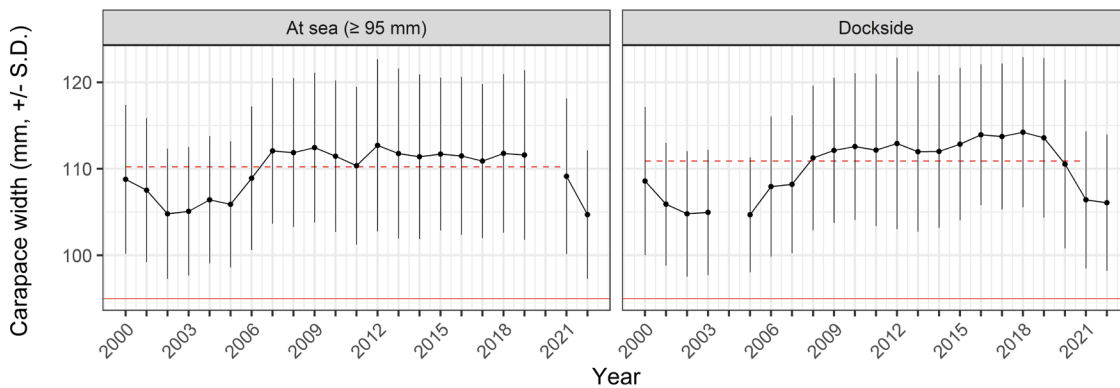


Figure 16. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 15. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 110.2 mm at sea and 110.9 mm at dock.

Fishery-independent survey. 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, a catchability problem encountered during the post-season survey in 2021 associated with the strong presence of amphipods increased the uncertainty surrounding the interpretation of values from that year. All abundance indices obtained from the post-season survey showed an upward trend between 2021 and 2022 for both adolescent and adult males, and the 2022 values were above their respective historical averages (Figure 17). The mean carapace width of adult and adolescent male crabs caught with standard traps, which has fallen below the historical average between 2017 and 2020, has increased since 2020 but remains below the historical average [2000; 2021].

According to the post-season survey, the abundance of primiparous and multiparous females is still high, and has been for 4 years. Meanwhile, the weight of the spermathecal load of primiparous females increased between 2021 and 2022. All the indicators confirm the arrival of a wave of recruitment.

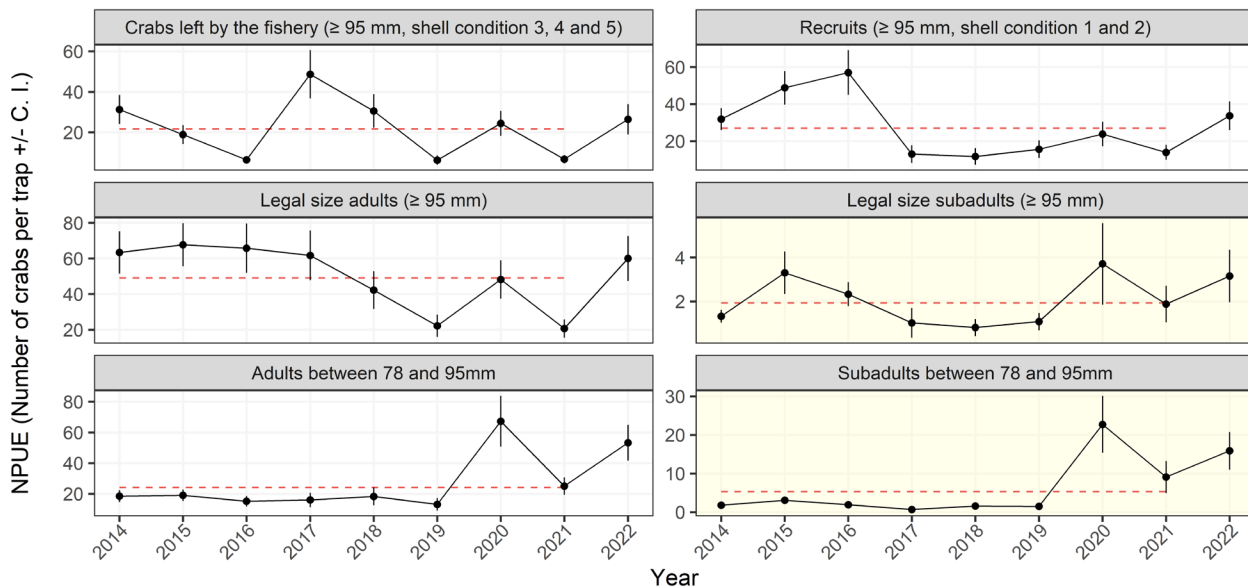


Figure 17. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 15. The dashed line shows the historical data time series average (excluding the last year).

The **combined index**, derived from the commercial CPUE and the post-season NPUE for adult males \geq 95 mm, increased by 75.3% between 2021 and 2022 (Figure 18). All indicators suggest that the biomass available to the fishery in 2023 should be greater than in 2022.

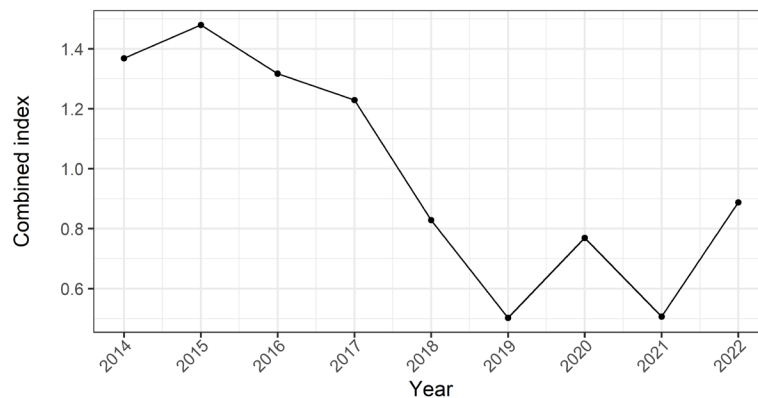


Figure 18. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 15.

Outlook

The combined index, which had declined to one of the lowest values recorded since 2014, increased sharply between 2021 and 2022, due to a significant increase in the abundance of commercial-size crabs—which consisted of recruits and crabs left by the fishery in equal proportions—in the 2022 post-season survey. The biomass available to the fishery in 2023 is expected to be greater than that in 2022. Since CPUE values from the last four years were the lowest in the time series, caution is recommended in increasing removals.

Higher scenario: A 45% increase relative to total landings in 2022.

Intermediate scenario: A 35% increase relative to total landings in 2022.

Lower scenario: A 25% increase relative to total landings in 2022.

Area 14

Description of the fishery

In 2022, the total allowable catch (TAC) was reduced to 309.9 t, a 15.1% decrease in relation to 2021, and was reached. Landings in 2022 totalled 310.7 t, down 14.3% from 362.5 t in 2021 (Figure 19). The presence of sea ice in the west of the area delayed the start of the fishing season by 3 weeks in this sector.

Resource status in 2022

Commercial fishery. Between 2021 and 2022, the standardized¹ commercial catch per unit effort (CPUE) increased by 20.2%, remaining in 2022 below the historical average (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 in 2021. At-sea and dockside sampling data show a decrease in the mean carapace width of commercial crabs between 2021 and 2022, with values remaining below their respective historical averages (Figure 21). Dockside data show that in 2022 landings consisted mainly (54.9%) of intermediate-shell crabs, closely followed by recruits (crabs with carapace condition 1 and 2). However, an inconsistency was noted between the proportion of crabs with carapace condition 4 and 5 in the dockside samples (0.3%) and the corresponding proportion in the at-sea samples (40.1%), which could point to high grading by

¹The standardized CPUE in Area 14 is calculated solely from fishing trips involving the use of Japanese traps, which are smaller than the standard conical traps. See the “Sources of Uncertainty” section.

fishers. However, during the review it was agreed that this inconsistency is very likely due to the low spatial and seasonal coverage of the at-sea sampling that has been conducted in recent years.

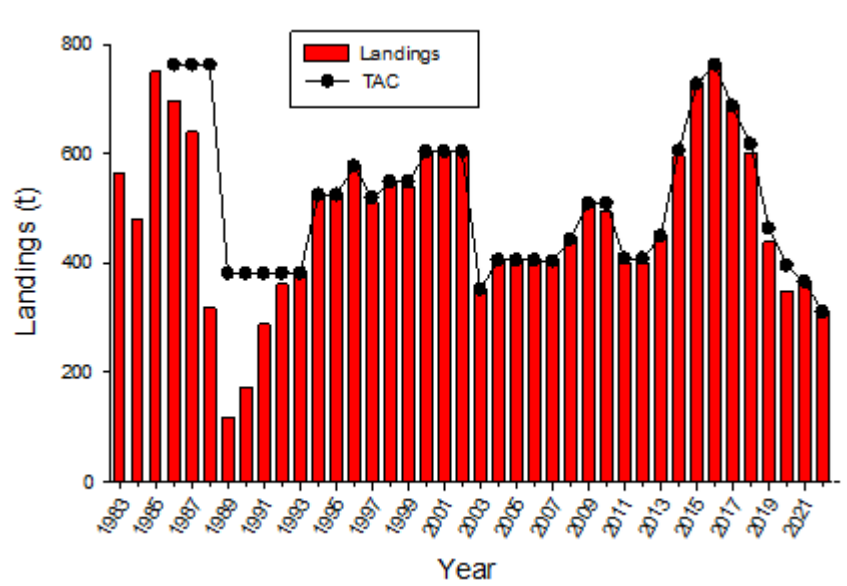


Figure 19. Annual landings and TACs in Area 14.

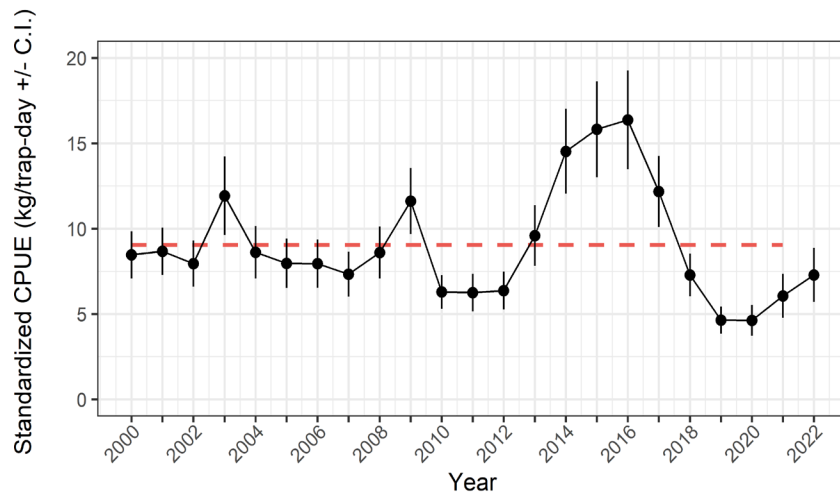


Figure 20. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 14. The dashed line shows the historical data series average (excluding the last year) which is 9.1 kg/trap per day.

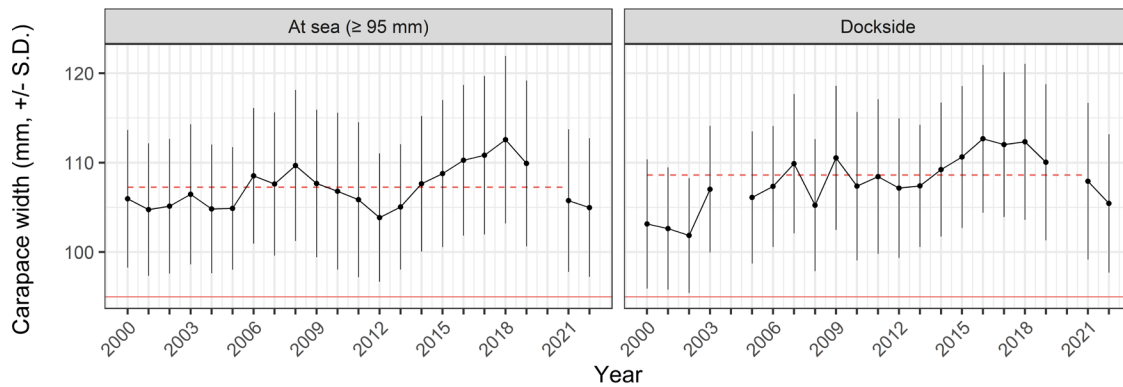


Figure 21. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 14. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 107.3 mm at sea and 108.6 mm at dock.

Fishery-independent survey. The protocol for the trap survey was modified in 2019 to allow the use of a new, larger trap, that is, a standard conical trap 6.5 feet in diameter. From 2019 to 2021, the two types of trap, old and new, were used; however, since 2022, only the large traps have been used. Since the catchability of the new trap compared to the old trap needs to be assessed more accurately, only the data obtained with the new trap are presented. The post-season survey shows that the abundance per unit effort (NPUE) of legal-size adults increased between 2021 and 2022, because of the increase in crabs left by the fishery (legal-size crabs with carapace condition 3, 4 and 5), whereas the number of recruits (legal-size crabs with carapace condition 1 and 2) declined during the same period (Figure 22). The number of legal-size adolescents also decreased between 2021 and 2022, while the number of sublegal-size adolescents (78-95 mm) increased (Figure 22). The average size of adult male crabs caught with standard traps has been declining since 2016 and is below the historical average [2000; 2021], while the abundance of adult sublegal-size males increased sharply between 2021 and 2022.

According to the post-season survey, the abundance of primiparous and multiparous females is declining after high abundance in recent years, while the spermathecal load weight is increasing between 2020 and 2022.

The scientific trawl survey was not carried out in 2020 or 2021. In 2022, 32 conventional stations were successfully sampled with a beam trawl in the eastern portion of Area 14 and the north side of Area 13. The survey documented a high density of spawning females (primiparous and multiparous) and of sublegal-size males, adolescents and adults. These results confirm the resumption of the snow crab abundance cycle observed during post-season surveys in the sector.

The **combined index**, derived from the commercial CPUE and the post-season NPUE for adult males ≥ 95 mm, increased by 39.7% between 2021 and 2022 (Figure 23), suggesting that the biomass available to the fishery in 2023 should be greater than in 2022.

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

**Assessment of the Estuary and Northern Gulf of
St. Lawrence Snow Crab Stocks in 2022**

Quebec Region

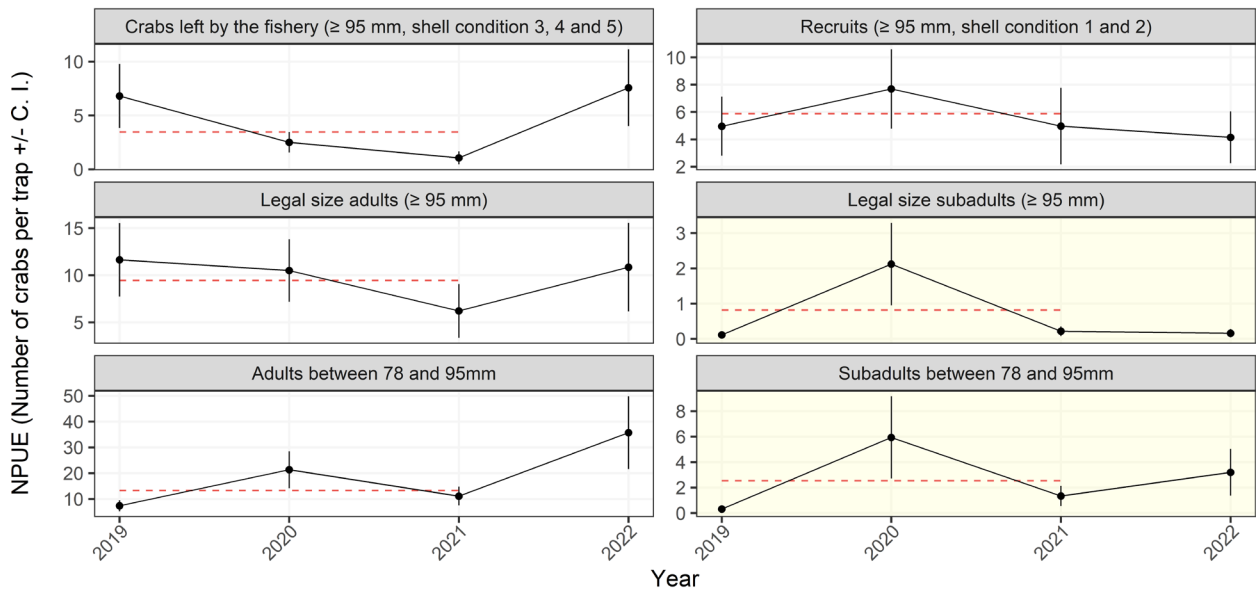


Figure 22. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 14. The dashed line shows the historical data time series average (excluding the last year).

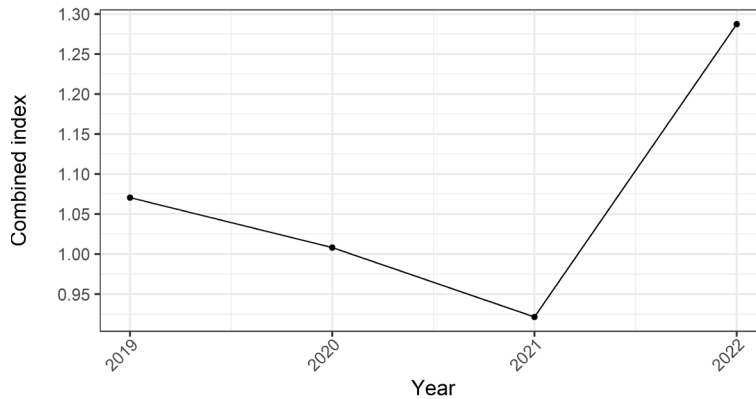


Figure 23. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 14.

Outlook

The combined index rose sharply between 2021 and 2022, indicating that the biomass available to the fishery in 2023 should be greater than in 2022 and consist mainly of crabs left by the fishery.

In light of the decline in the abundance of recruits and legal-size adolescents observed in the 2022 post-season survey, it is recommended that caution be exercised when increasing removals.

Higher scenario: A 35% increase relative to total landings in 2022.

Intermediate scenario: A 25% increase relative to total landings in 2022.

Lower scenario: A 15% increase relative to total landings in 2022.

Area 13

Description of the fishery

Between 2021 and 2022, the total allowable catch (TAC) decreased by 18.7% to 198.3 t, and was reached. Landings in 2022 totalled 188.0 t or 94.8% of the TAC), down 5.5% from 199.0 t in 2021 (Figure 24).

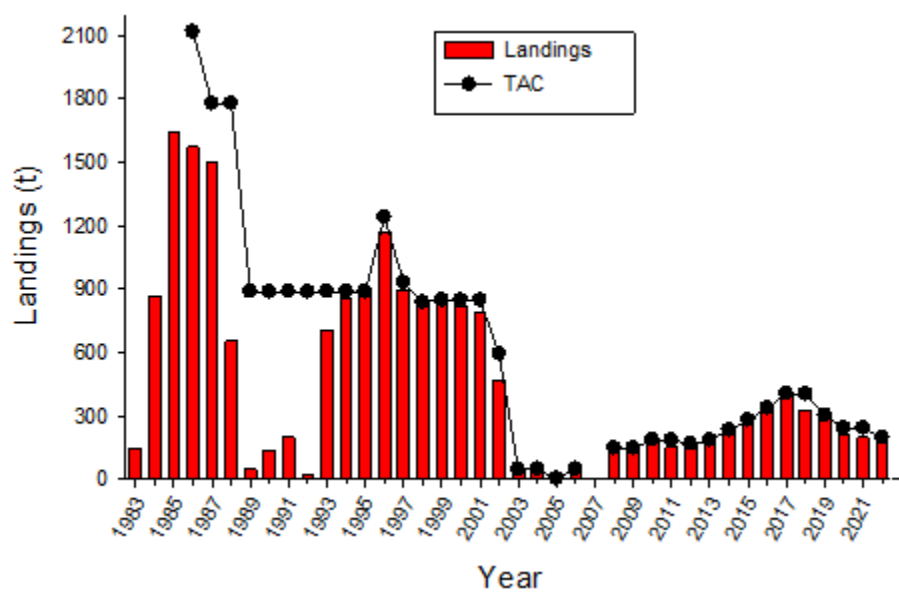


Figure 24. Annual landings and TACs in Area 13.

Resource status in 2022

Commercial fishery. Between 2021 and 2022, the standardized² commercial catch per unit effort (CPUE) increased by 45.5% and is currently below the historical average (Figure 25). Fishing effort was significantly higher on the south side than on the north side of the area from 2009 to 2014 and was split almost equally between the two sides in 2015 and 2016. Fishing effort has been greater on the north side since 2017. Dockside sampling shows that in 2022 landings consisted mainly (56.9%) of recruits (crabs with carapace condition 1 and 2), a proportion similar to that in 2021.

The average size of commercial males in at-sea and dockside samples decreased between 2021 and 2022 and is among the lowest values for the period 2000-2022, and close to the pre-moratorium values observed in 2002 (Figure 26). It should be noted that the average size of male snow crabs in Area 13 is small compared to that in the other areas of the Gulf of St. Lawrence.

² The standardized CPUE in Area 13 is calculated solely from fishing trips involving the use of Japanese traps, which are smaller than the standard conical traps. See the “Sources of Uncertainty” section.

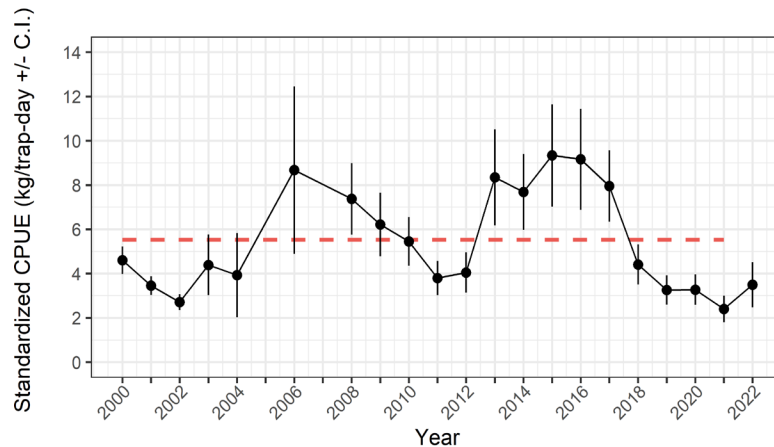


Figure 25. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 13. The dashed line shows the historical data series average (excluding the last year) which is 5.5 kg/trap per day.

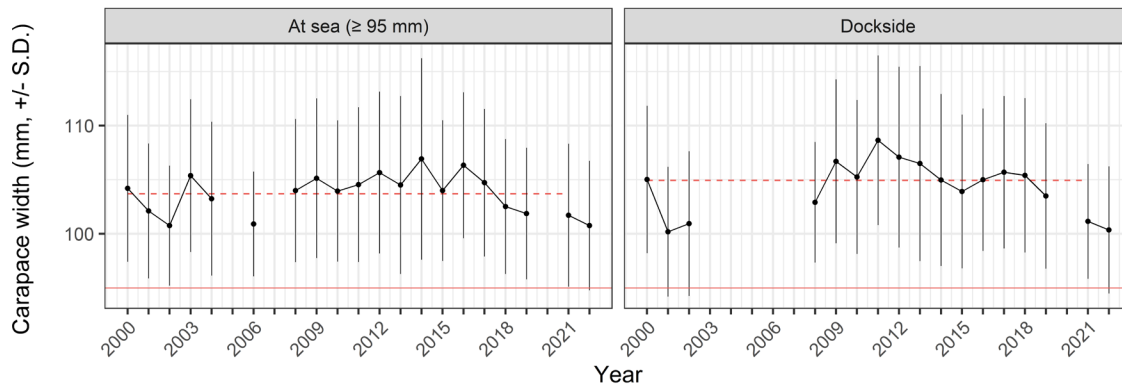


Figure 26. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 13. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 103.7 mm at sea and 105.0 mm at dock.

Fishery-independent surveys. The protocol for the trap survey on the north side was modified in 2019 to allow the use of a new, larger trap, that is, a standard conical trap 6.5 feet in diameter. From 2019 to 2021, the two types of trap, old and new, were used; however, since 2022, only the large traps have been used. Since the catchability of the new trap compared to the old trap needs to be assessed more accurately, only the data obtained with the new trap will be combined with the data from the southern part of the area. 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 2021 and 2022 and is now above the average of the last three years [2019;2021] (Figure 27). This rise is primarily due to the increased abundance of recruits (adults with shell condition 1–2) on the north side and, to a lesser extent, the increased abundance of crabs left by the fishery (shell condition 3–5) on the south side (Figure 27). The abundance index of legal-size adolescents declined slightly between 2021 and 2022, whereas the abundance of adolescents with a carapace width of 78 to 95 mm increased significantly in the northern part of the area (Figure 27). The average size of adult males caught with standard traps has been declining since 2016 and is below the historical average [2000;2021].

Whereas the abundance of primiparous females in experimental traps has been declining since 2020, the weight of the spermathecal load of primiparous females sampled during post-season surveys has been on the rise since 2019.

Area 13

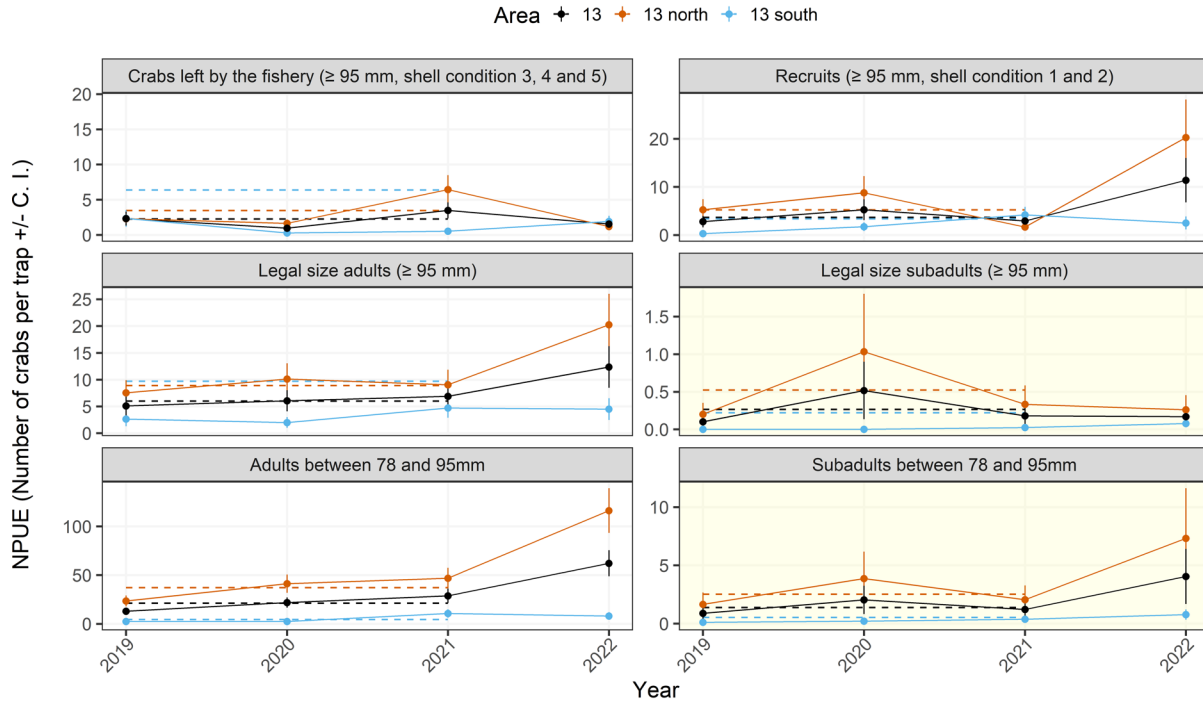


Figure 27. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 13 (black), and restricted to sub-area 13 north (orange) and sub-area 13 south (blue). The dashed line shows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

The scientific trawl survey was not conducted in 2020 or 2021. In 2022, 32 conventional stations were sampled successfully with a beam trawl in the eastern sector of Area 14 and the northern part of Area 13. The survey documented a high density of spawning females (primiparous and multiparous) and of sublegal-size males, adolescents and adults. These results confirm the resumption of the snow crab abundance cycle observed during post-season surveys in Area 13.

The **combined index**, derived from the commercial CPUE and the post-season NPUE for adult males \geq 95 mm, increased by 62.8% between 2021 and 2022 after a sharp decline between 2020 and 2021 (Figure 28). All indicators suggest that the biomass available to the fishery in 2023 should be greater than in 2022.

The **thermal habitat indices** favourable to adult (Figure 3A) and juvenile (Figure 3B) snow crabs show an upward temporal trend in area observed between 1990 and 2022.

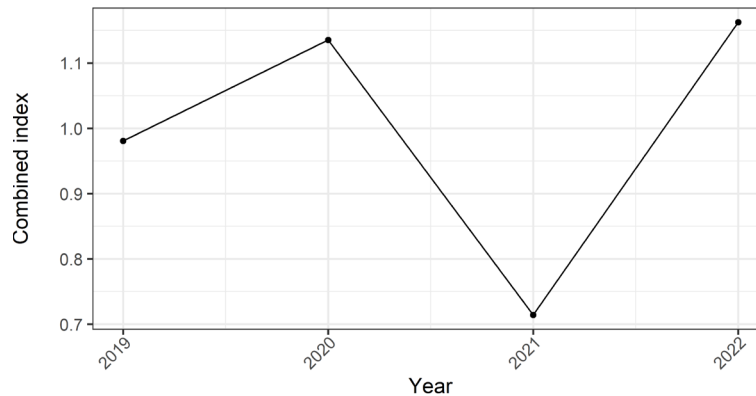


Figure 28. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 13.

Outlook

Between 2021 and 2022, the combined index increased. The biomass available to the fishery in 2023 is expected to be greater than that in 2022.

Given the reliance of the commercial fishery on recruits and the smaller carapace width of the crabs caught in the post-season survey, it is suggested that caution be exercised in setting the TACs during the resumption of the recruitment pulse to prevent increased white crab mortality.

Higher scenario: A 20% increase relative to total landings in 2022.

Intermediate scenario: A 10% increase relative to total landings in 2022.

Lower scenario: Status quo relative to total landings in 2022.

Area 16A

Description of the fishery

The total allowable catch (TAC) remained the same in 2021 and 2022, at 245 t, and was fully fished in 2022, with landings of 244.3 t (Figure 29).

Resource status in 2022

Commercial fishery. The standardized³ commercial catch per unit effort (CPUE) increased between 2021 and 2022 (+33.9%), although the 2022 value remained below the historical average (Figure 30). No indicator based on at-sea sampling data was available for the 2020 and 2021 fishing seasons.

In 2022, the carapace width of legal-size crabs sampled at sea has remained stable since the last time sampling took place, in 2019, and is still above the historical average (Figure 31). The dockside sampling data indicate that the average size of commercial crabs decreased between 2021 and 2022, and is below the historical average (Figure 31). In 2022, landings consisted mainly of recruits (more than 50%), a similar proportion since 2018 despite the limited data available in 2020 due to the pandemic.

³ The standardized CPUE in Area 16A is calculated solely from fishing trips involving the use of Japanese traps, which are smaller than the standard conical traps. See the “Sources of Uncertainty” section.

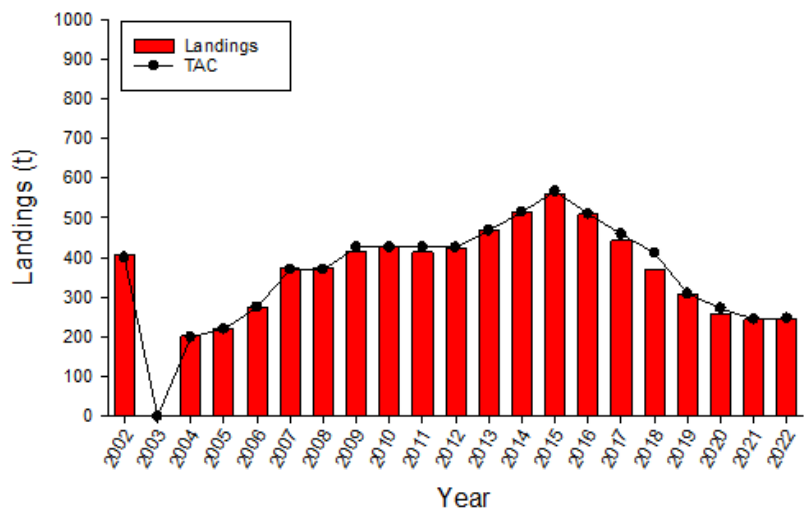


Figure 29. Annual landings and TACs in Area 16A.

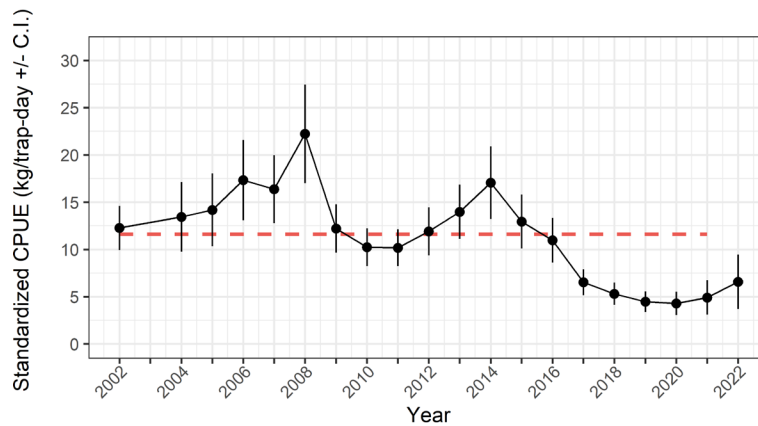


Figure 30. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 16A. The dashed line shows the historical data series average (excluding the last year) which is 11.6 kg/trap per day.

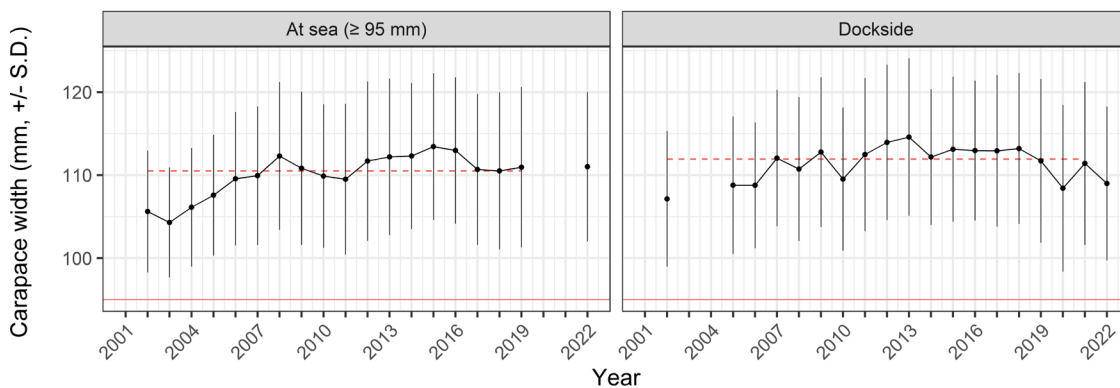


Figure 31. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 16A. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 110.5 mm at sea and 111.9 mm at dock.

Fishery-independent survey. Area 16A encompasses two sectors (north and south) separated by the Anticosti Channel. 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 and trends between 2021 and 2022. The commercial abundance index from the post-season survey increased between 2021 and 2022, mainly because of the marked increase in recruits (legal-size crabs with carapace condition 1 and 2) and, to a lesser extent, because of crab left by the fishery (Figure 32). The abundance of adolescents increased between 2021 and 2022, and remains high, well above the average value (Figure 32). Despite the difference in post-season survey coverage from one year to the next, the increases in crab abundance between 2021 and 2022 are still seen when only the data from transects sampled annually are compared. This indicates that the increase in abundance is probably not due to a difference in coverage but rather to an increase in the crab population. The mean carapace width of male crabs caught in this survey with standard traps declined, and was below the historical average [2002; 2021]. Data from the experimental traps in the post-season survey indicate a high density of primiparous females in the last four years. According to all the indicators, recruitment to the commercial fishery is likely increasing and this is expected to continue over the short and medium term.

The combined index, derived from the commercial CPUE and the post-season NPUE for adult males ≥ 95 mm, increased for the first time since 2014 (+58,5% between 2021 and 2022; Figure 33). This increase suggests that the biomass available to the fishery in 2023 will be greater than in 2022.

The **thermal habitat indices** favourable to small crabs showed an upward temporal trend during the 1990-2022 period (Figure 3B), while that for large crabs declined slightly during the same period (Figure 3A).

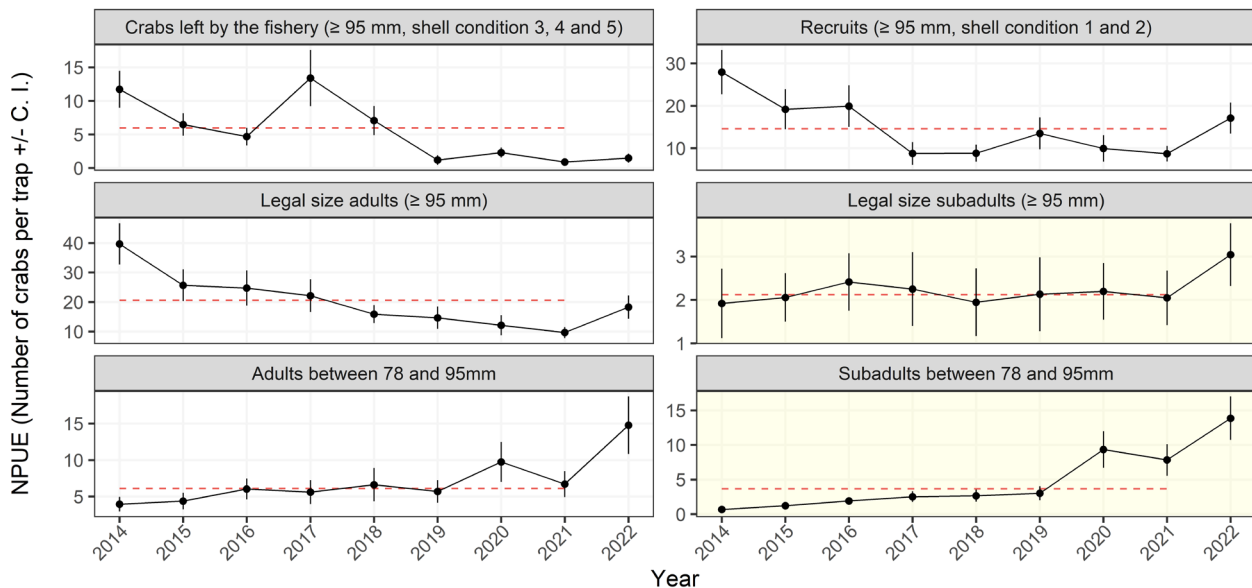


Figure 32. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 16A. The dashed line shows the historical data time series average (excluding the last year).

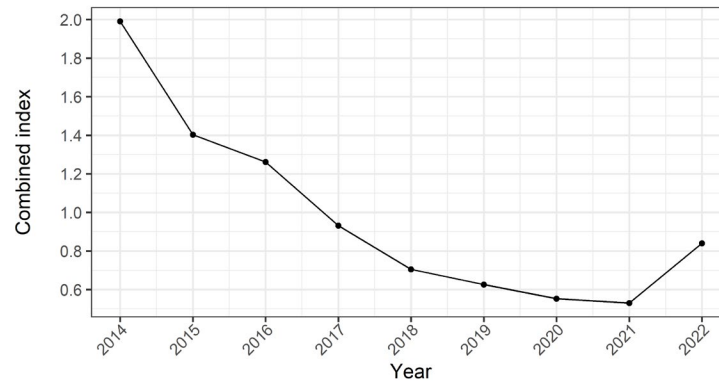


Figure 33. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 16A.

Outlook

The combined index, after declining during the 2014-2021 period, rose sharply between 2021 and 2022, suggesting that the biomass available to the fishery will increase in 2023. However, commercial fishery yields are still low and the abundance of crabs left by the fishery was very low.

Given the commercial fishery's reliance on recruits, caution should be exercised in increasing removals during the resumption of the recruitment pulse, to prevent increased white crab mortality.

Higher scenario: A 30% increase relative to total landings in 2022.

Intermediate scenario: A 20% increase relative to total landings in 2022.

Lower scenario: A 10% increase relative to total landings in 2022.

Area 12C

Description of the fishery

In 2022, the total allowable catch (TAC) was reduced to 71.5 t, a 25.5% decrease in relation to 2021, and was not reached. Landings in 2022 totalled 66.0 t, down 27.5% from 2021 (Figure 34).

Resource status in 2022

Commercial fishery. Area 12C encompasses two sectors (north and south) separated by the Anticosti Channel. The commercial fishery is primarily concentrated in the northern part of the area, which adjoins Areas 14 and 15. The standardized commercial catch per unit effort (CPUE) increased between 2021 and 2022 (+17.1%), after reaching its lowest value in 2021 (Figure 35). Standardized CPUE values for the last 4 years are the lowest in the time series [2001;2022] (Figure 35).

The mean size of commercial crabs caught at sea has increased between 2021 and 2022, while the mean size at dockside has decreased (Figure 36). In both cases, mean size of commercial crabs in 2022 are below their respective historical averages (Figure 36). Dockside sampling indicates that landings were more than half recruits (legal adult crabs shell condition 1–2) in 2022, which is increasing since 2019.

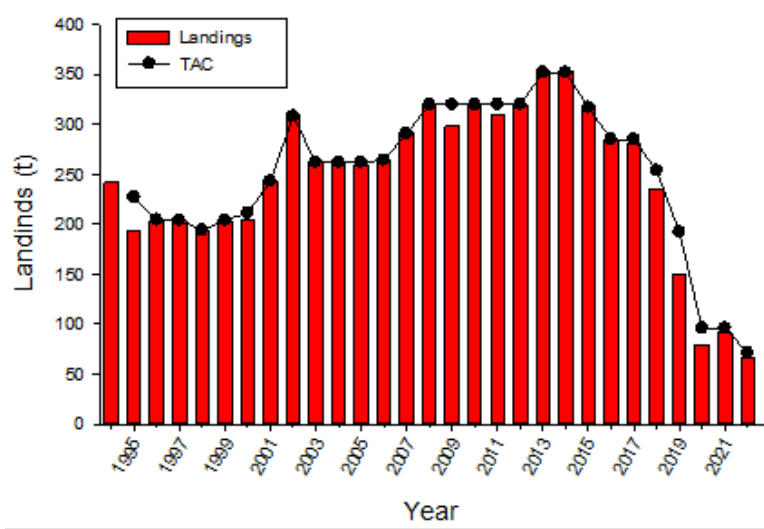


Figure 34. Annual landings and TACs in Area 12C.

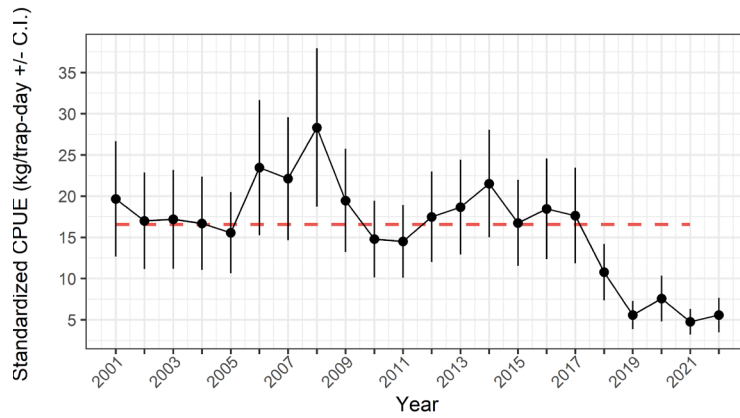


Figure 35. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12C. The dashed line shows the historical data series average (excluding the last year) which is 16.6 kg/trap per day.

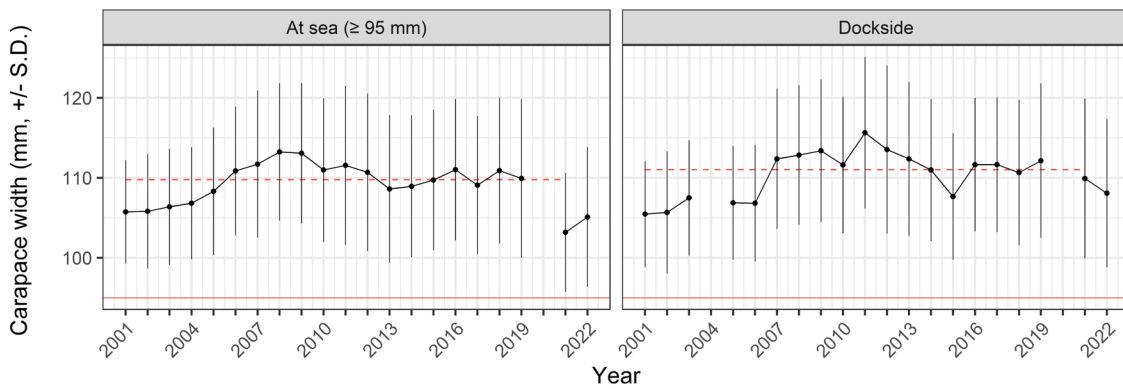


Figure 36. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 12C. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 109.8 mm at sea and 111.0 mm at dock.

Fishery-independent survey. Whereas during the post-season survey in 2021, traps were deployed solely on the north side of the Anticosti Channel, in 2022 they were once again deployed north and south of the fishing area. The difference in the spatial coverage of the post-season survey between 2021 and 2022 created some uncertainty in the indicators. The difference in the number of legal-size adults per unit effort (NPUE95) between 2021 and 2022 is +42.5% with no adjustment for the difference in spatial coverage, and -23.7% when only the 10 transects sampled in 2021 and 2022 are considered. The abundance values for commercial crabs, recruits and crabs left by the fishery remain low in 2022, below their respective historical averages, regardless of whether all the transects are considered or only the transects sampled every year (Figure 37). In contrast, the abundance of adults and sublegal-size adolescents increased between 2021 and 2022 (Figure 37). The mean carapace width of male crabs caught in the post-season survey with regular conical traps is stable, but below the historical average [2001; 2021].

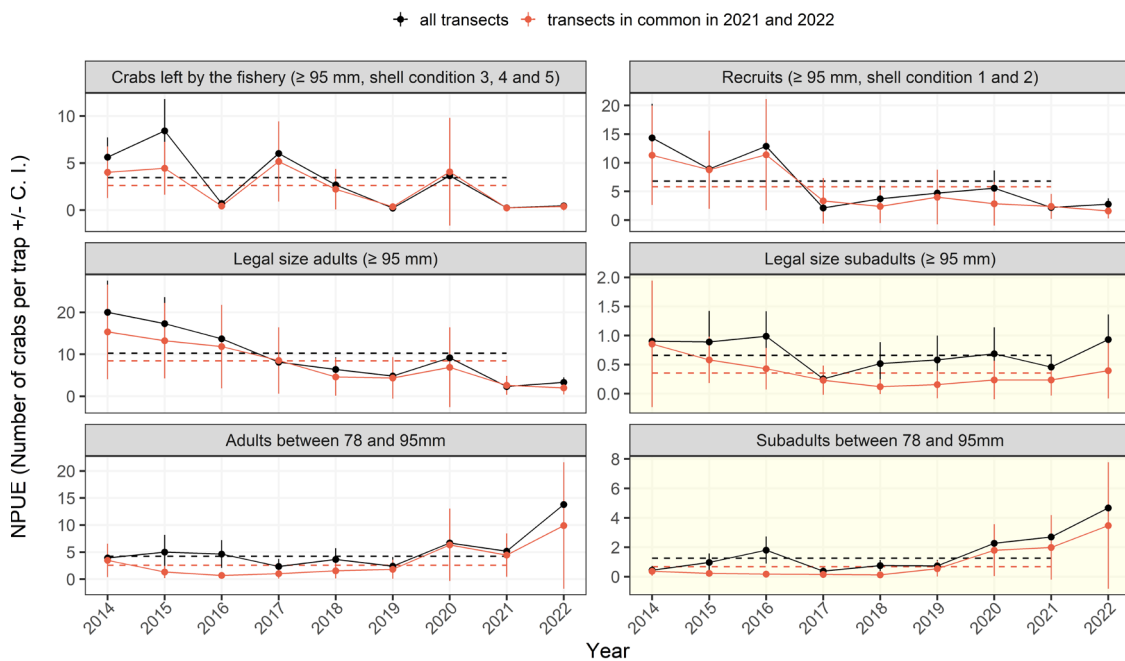


Figure 37. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 12C. Values calculated from all the transects conducted north and south of the fishing area annually (in black), and values calculated from the transects conducted north of the area only (in orange). The dashed line shows the historical data time series average (excluding the last year).

The **combined index** is formed by the commercial CPUE and the NPUE of adult males ≥ 95 mm in the trap survey. The value of this indicator for 2022 is the lowest among the values for the 2014–2022 period (Figure 38).

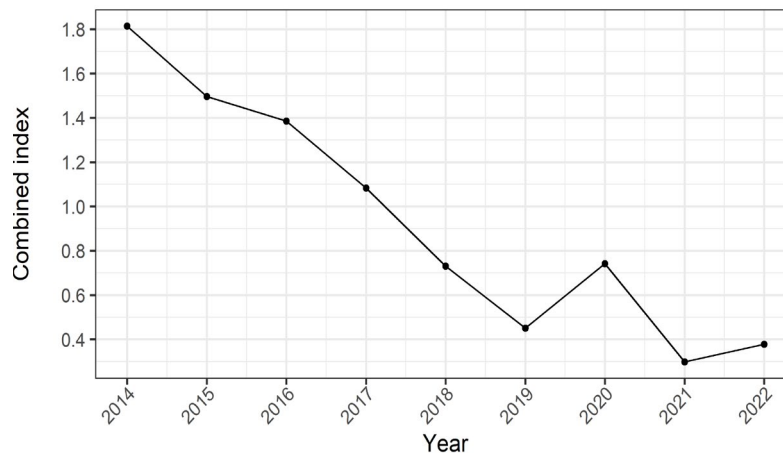


Figure 38. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 12C.

The **thermal habitat index** favourable to adult snow crabs shows a downward temporal trend over the past several decades (Figure 3A). This loss of habitat could have a negative impact on the future stock productivity.

Outlook

Given the uncertainty created by the difference in the spatial coverage in the post-season surveys in 2021 and 2022, the combined index will not be used as the main reference for recommendations.

Standardized CPUE values increased by 17.1% between 2021 and 2022, while the difference in NPUE95 values between the two years was calculated at -23.7%, based on the transects sampled in the two years. The biomass available to the fishery in 2023 could remain at a level similar to that in 2022.

Given the heavy reliance of the commercial fishery on recruits and the smaller carapace width of the crabs caught in the post-season survey, caution should be exercised in setting the TACs during the resumption of the recruitment pulse.

Higher scenario: A 10% increase relative to total landings in 2022.

Intermediate scenario: Status quo relative to total landings in 2022.

Lower scenario: A 10% decrease relative to total landings in 2022.

Area 12A

Description of the fishery

Between 2021 and 2022, the total allowable catch (TAC) decreased by 37.5% to 43.1 t, and was reached (Figure 39). Landings in 2022 totalled 43.0 t, a 20.4% decline from 54.0 t in 2021.

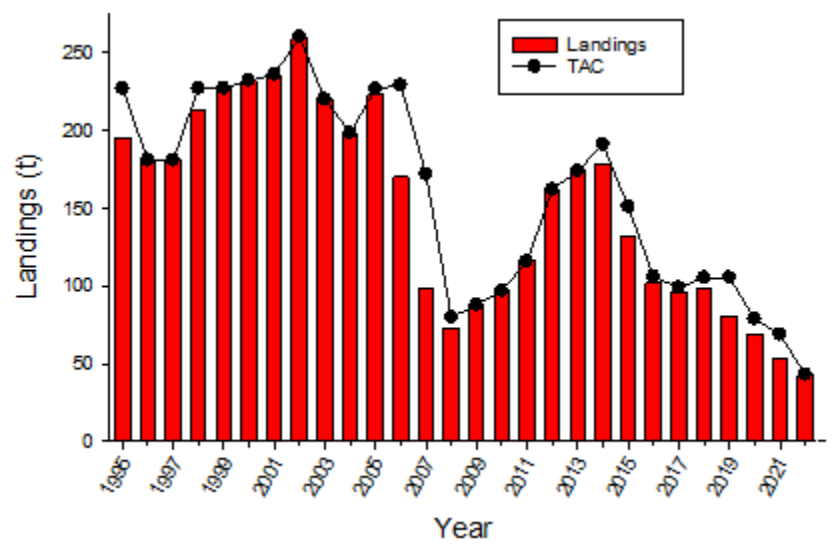


Figure 39. Annual landings and TACs in Area 12A.

Resource status in 2022

Commercial fishery. The standardized commercial catch per unit effort (CPUE), which reached its lowest value in the time series in 2021, increased between 2021 and 2022 (+58,2%; Figure 40). The CPUE value in 2022 is similar to that in 2020, and remains below the historical average [2001;2021] (Figure 40).

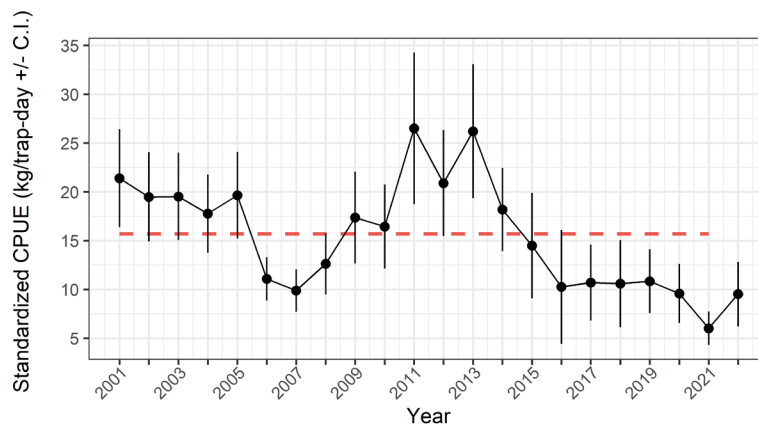


Figure 40. Standardized annual CPUE (\pm 95% confidence interval) in the commercial fishery in Area 12A. The dashed line shows the historical data series average (excluding the last year) which is 15.7 kg/trap per day.

At-sea sampling coverage has been limited for several years, which has created some uncertainty around the analysis of these data. The carapace width of commercial male crabs sampled at sea and at dockside was down between 2021 and 2022 and is for the second year below their respective historical averages [2001; 2021] (Figure 41). Dockside data indicate that a majority of the landings were intermediate-shell crabs, a proportion that is relatively stable since 2004.

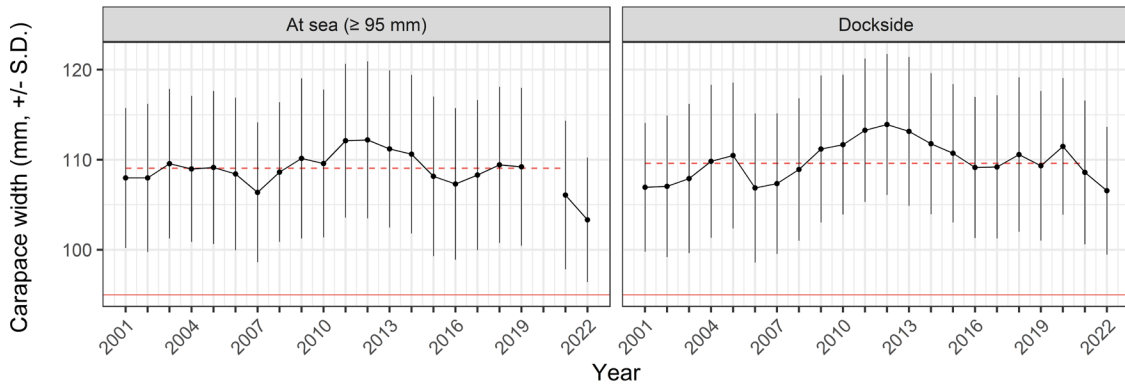


Figure 41. Average carapace width (\pm standard deviation) of legal-size male crabs measured at sea in the commercial fishery and at dockside in Area 12A. The solid line shows the legal size at 95 mm and the dashed line shows the historical data series average (excluding the last year) which is 109.1 mm at sea and 109.6 mm at dock.

Fishery-independent survey. The post-season survey in 2022 indicates that the abundance of commercial crabs increased slightly between 2021 and 2022, following a steady decline since 2011. This increase is observed for both recruits (crabs with carapace condition 1 and 2) and crabs left by the fishery (crabs with carapace condition 3, 4 and 5; Figure 42). Despite this small increase, the abundance of legal-size crabs in 2022 was among the lowest values in the series and well below the historical average [2001;2021]. Whereas the abundance of legal-size adolescents declined between 2021 and 2022, the abundance of sublegal-size adolescents (78-95 mm) remained stable and close to the historical average (Figure 42). The abundance of mature females, particularly primiparous females, was high in 2022, and has been high since 2020.

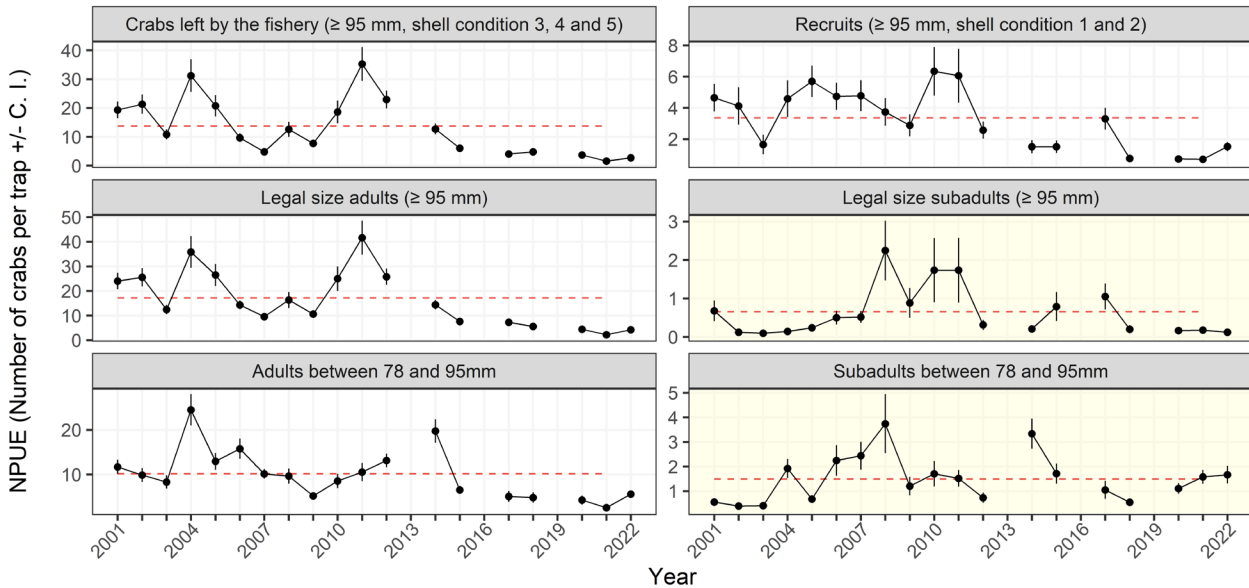


Figure 42. Annual catch rate (NPUE) (\pm 95% confidence interval) of different categories of adult (white background) and adolescent (yellow background) crabs from the post-season survey in Area 12A. The dashed line shows the historical data time series average (excluding the last year).

The **combined index**, derived from the commercial CPUE and the post-season NPUE for adult males ≥ 95 mm, which has been decreasing since the 2011 peak, increased by 65.3% between 2021 and 2022 (Figure 43). Indicators suggest that the biomass available to the fishery in 2023 will be greater than in 2022. Although the combined index increased, the 2022 value is the second lowest in the time series [2001;2022]. All indicators suggest that the biomass available to the fishery in 2023 should be greater than in 2022.

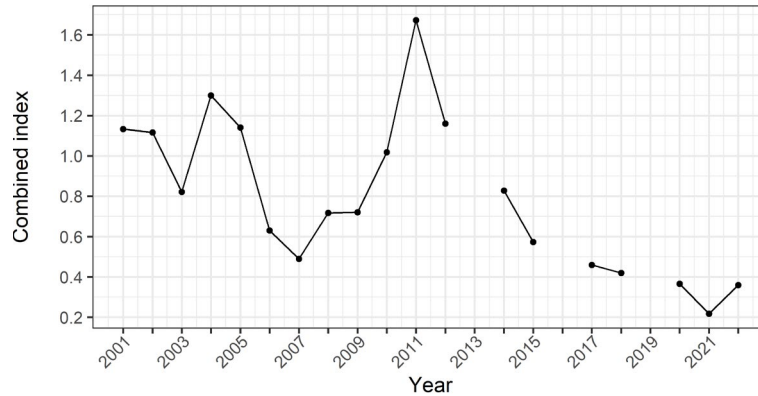


Figure 43. Combined index, derived from the annual standardized commercial CPUE and the annual NPUE from the post-season survey for legal-size adult males in Area 12A.

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

Outlook

The combined index, which reached its lowest value in 2021, increased between 2021 and 2022, suggesting that the biomass available to the fishery in 2023 will be greater than that in 2022.

However, the biomass and abundance indices are at very low levels. In addition, the density of mature females is still high. All the indicators point to the need to exercise caution when establishing harvest levels for 2023.

Higher scenario: A 10% increase relative to total landings in 2022.

Intermediate scenario: Status quo relative to total landings in 2022.

Lower scenario: A 10% decrease relative to total landings in 2022.

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 as well as 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.

The standardization approach used for the commercial CPUE index was initially developed in 2003 (Bourdages and Dufour 2003) and a few adjustments were made in 2006 (DFO 2007). Since then, the CPUE standardization method has not been modified despite changes observed in the fishing season (start and length of season) and in the type of traps used by most fishers or by a large proportion of new fishers in certain fishing areas over the past two decades. For example, for areas 14, 13 and 16A, only fishing trips involving the use of Japanese traps, which are smaller than the standard conical ones, are considered in the calculation of standardized CPUE indices, despite the increased use of conical traps over time. In addition, for areas where the two types of trap are taken into account in the calculation, the standardized CPUE value, an estimate derived through statistical modelling, appears not to be supported by the raw data. In order to process the different biases observed in the analysis methods, a review of the standardized CPUE is imperative and is currently under way.

OTHER CONSIDERATIONS

During summer, the 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 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. 15	Feb. 16	Feb. 17
Beaudin-Gauthier, Jérôme	Fisher area 16	X	-	-
Beaudry-Sylvestre, Manuelle	DFO – Science	X	-	-
Belley, Rénaud	DFO – Science	X	X	X
Bennett, Lottie	DFO – Science	X	X	X
Bernier, Denis	DFO – Science	X	-	-
Bois, Samantha	ACGP	X	-	X
Boudreau, Sophie	DFO – Science	X	X	X
Bouchard, Donald	Essipit First Nation	-	-	X
Boucher, Jean-René	Area 16	X	X	X
Boucher, Larry	Fisher area 16	X	-	-
Boula, Dominique	DFO – Fisheries management	X	X	X
Bourassa, Luc	Consultant	X	X	X
Bourdages, Hugo	DFO – Science	X	-	-
Brûlé, Caroline	DFO – Science	-	X	-
Buffitt, Shawn	LNSFA	X	X	-
Chabot, Denis	DFO – Science	X	X	X
Couillard, Catherine	DFO – Science	-	X	X
Cyr, Charley	DFO – Science	X	X	X
Dennis, Olivia	Province of Newfoundland	X	X	X
Desjardins, Christine	DFO – Science	-	-	X
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Dubé, Sonia	DFO – Science	X	X	X
Duplisea, Daniel	DFO – Science	X	X	-
Émond, Kim	DFO – Science	X	X	X
Galbraith, Peter	DFO – Science	X	X	-
Gianasi, Bruno	DFO – Science	X	-	X
Gosselin, Claude	Fisher area 17	X	-	X
Guénard, Guillaume	DFO – Science	X	X	X
Joncas, Jean-Richard	Fisher Lower North Shore	-	X	-
Juillet, Cédric	DFO – Science	X	X	X
Lacasse, Olivia	DFO – Science	X	X	X
Langelier, Serge	AMIK	X	X	X
Lavallée, Dean	Fisher Lower North Shore	X	-	-
Leclerc, Caroline	DFO – Fisheries management	-	X	X
Lees, Kirsty	DFO – Science	X	X	X
Léonard, Pierre	Essipit First Nation	X	-	X
Lévesque, Isabelle	DFO – Science	X	X	X
Loboda, Sarah	DFO – Science	X	X	X
Marcoux, Guylaine	DFO – Fisheries management	X	X	X
Martin, Henri	DFO – Fisheries management	-	X	-
Monger, Julie	LNSFA	X	X	-
Monger, Marc	Fisher Lower North Shore	X	X	-
Munro, Daniel	DFO – Science	X	-	-
Nadeau, Paul	LNSFA	X	X	-
Pinette, Majoric	Pessamit First Nation	X	X	X
Poirier, Serge	Fisher area 16	X	-	-
Ransom, Glen	Fisher Lower North Shore	X	X	-
Roy, Marie-Josée	DFO – Fisheries management	X	X	X
Sainte-Marie, Bernard	DFO – Science	X	X	X
Sandt-Duguay, Emmanuel	AGHAMW	-	-	X

**Assessment of the Estuary and Northern Gulf of
St. Lawrence Snow Crab Stocks in 2022**

Quebec Region

Name	Affiliation	Feb. 15	Feb. 16	Feb. 17
Sigouin, Evelyne	AGHAMW	x	x	x
Senay, Caroline	DFO – Science	x	-	-
Stubbert, Curtis	Fisher Lower North Shore	x	x	-
Tamdrari, Hacène	DFO – Science	x	x	x
Vallée, Simon	Fisher area 17	-	-	x
Vigneault, Guy	Shipek	x	x	-

SOURCES OF INFORMATION

This Science Advisory Report is from the regional peer review meeting of February 15-17, 2023 on the Assessment of the Estuary and northern Gulf of St. Lawrence Snow Crab stocks (zones 12A, 12C, 13, 14, 15, 16, 16A and 17). Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

- Bourdages, H., and Dufour, R. 2003. [Standardized CPUE indice development for the estuary and northern gulf of St. Lawrence snow crab](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2003/116.
- DFO. 2007. [Assessment of the Estuary and Northern Gulf of St. Lawrence \(Areas 13 to 17 and 12A, 12B and 12C\) Snow Crab Stocks in 2006](#). DFO Can. Sci. Advis. Sec., Sci. Advis. Rep. 2007/017.
- DFO. 2022. [Assessment of the Estuary and Northern Gulf of St. Lawrence \(Areas 13 to 17, 12A, 12B, 12C and 16A\) Snow Crab Stocks in 2021](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2022/040.
- Dionne, M., Sainte-Marie, B., Bourget, E. and Gilbert, D. 2003. Distribution and habitat selection of early benthic stages of snow crab *Chionoecetes opilio*. Mar. Ecol.-Prog. Ser.. 259:117-128.
- Dufour, R. and Dallaire, J.-P. 2003. [Status of snow crab populations in the St. Lawrence Estuary and the Northern Gulf of St. Lawrence from 1999 to 2001](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2003/048.
- Émond, K., Sainte-Marie, B., and Bêty, J. 2020. Long-term trends and drivers of larval phenology and abundance of dominant brachyuran crabs in the Gulf of St. Lawrence (Canada). Fish. Oceanogr. 29:185-200.
- Galbraith, P.S., Chassé, J., Dumas, J., Shaw, J.-L., Caverhill, C., Lefavre, D. and Lafleur, C. 2022. [Physical Oceanographic Conditions in the Gulf of St. Lawrence during 2021](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2022/034. iv + 83 p.
- Lambert, J. et Dallaire, J.P. 2016. [État des principaux stocks de crabe des neiges de l'estuaire et du nord du golfe du Saint-Laurent en 2014 \(zones 13, 14, 15, 16 et 17\)](#). Secr. can. de consult. sci. du MPO. Doc. de rech. 2016/082.
- Ouellet, P. and Sainte-Marie, B. 2018. Vertical distribution of snow crab (*Chionoecetes opilio*) pelagic stages in the Gulf of St. Lawrence (Canada) and effect of temperature on development and survival. ICES J. Mar. Sci. 75 : 773–784.
- Sainte-Marie, B., Sévigny, J.-M. and Carpentier, M. 2002. Interannual variability of sperm reserves and fecundity of primiparous females of the snow crab (*Chionoecetes opilio*) in relation to sex ratio. Can. J. Fish. Aquat. Sci. 59: 1932-1940.

Quebec Region

- Sainte-Marie, B., Dufour, R., Bourassa, L., Chabot, D., Dionne, M., Gilbert, D., Rondeau, A. and Sévigny, J.-M. 2005. [Critères et propositions pour une définition des unités de production du crabe des neiges \(*Chionoecetes opilio*\) dans l'estuaire et le nord du golfe du Saint-Laurent](#). Secr. can. de consult. sci. du MPO. Doc. de rech. 2005/059.
- Tamdrari, H., Castonguay, M., Brêthes, J.-C., Galbraith, P.S., and Duplisea, D. 2012. The dispersal pattern and behaviour of Atlantic cod (*Gadus morhua*) in the northern Gulf of St. Lawrence: results from tagging experiments. Can. J. Fish. Aquat. Sci.69 : 112-121.

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