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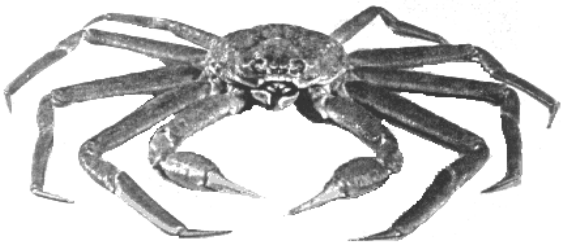
Canadian Science Advisory Secretariat
Quebec Region **Science Advisory Report 2019/047**

ASSESSMENT OF THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE (AREAS 13 TO 17, 12A, 12B, 12C AND 16A) SNOW CRAB STOCKS IN 2018



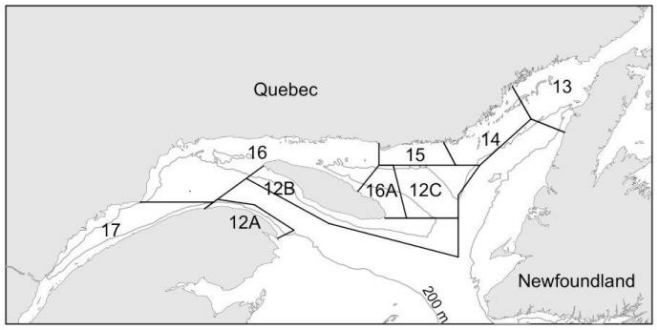


Figure 1. Snow crab management areas in the Estuary and the northern Gulf of St. Lawrence.

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 TAC (total allowable catch) 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 in the Estuary and northern Gulf of St. Lawrence (Figure 1).

Landings have varied depending on the adjusted TACs based on recruitment waves and troughs that affect the quantity of crabs available to the fishery (Figure 2). Landings for the nine fishing areas totalled 8,502 t in 2018.

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

The DFO Fisheries and Aquaculture Management Branch, Quebec Region, requested a stock status assessment and a science advisory report to set the 2019 quotas. A scientific peer review was conducted on February 12 and 14, 2019 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

- In 2018, all stocks in the northern Gulf of St. Lawrence (areas 13, 14, 15, 16, 17, 16A, and 12A, B, C) showed a decline in commercial biomass compared to 2017. Recruits (legal-size males that have moulted in the last one or two years) dominated the landings in areas 17, 16, 15 and 16A and showed a relative increase in the other areas in 2018 (except Area 12B). A decrease in the abundance of adolescents ≥ 78 mm suggests low recruitment to the fishery in 2019 in areas 12A, 13 (Quebec) and 14. Recruitment in areas 12A and 12B could depend on productivity in adjacent areas in the coming years. The absence of post-season trap surveys in Area 12B and specific conditions observed in Area 17 during this survey increase the uncertainty regarding the expected strength of recruitment in these areas.
- The purpose of conservation is to maintain an adequate male reproductive biomass in order to ensure the recovery or maintenance of the population in a given area. Recommendations assume that the natural mortality rate will be the same in 2019 as in previous years.
- The protocol for establishing the outlook for each area has been defined for this stock assessment and set out as a preamble to the summary for each area in the section below.

Outlook

- The outlook for each area includes three possible scenarios for establishing the 2019 TAC. These scenarios have been developed by taking into account an indicator combining the commercial catch per unit effort (CPUE) and the number per unit effort (NPUE) of commercial-size adult males from the post-season scientific survey, the uncertainty associated with this indicator, and related stock status indicators (crab carapace size and condition, expected recruitment), with the objective of ensuring sustainable resource management. 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.

Ecosystem considerations

- Since 1990, the estimated area of favourable thermal habitat for snow crab (between -1°C and 3°C) was the lowest in 2015 for fishing areas 12A, 12C and 16A, and in 2016 for areas 12B, 16 and 17. In contrast, 2017 and 2018 showed near-average estimated areas of favourable thermal habitat in all fishing areas.

Area 17

- The TAC increased by 25% to 2,623 t from 2017 to 2018, and it was reached.
- The commercial CPUE decreased from 2017 to 2018 after three years of consecutive increases. It remains above the historical average of the time series.
- Landings were mostly made up of recruits, with the proportion of “intermediate-shell” crabs declining for a fourth consecutive year.
- The average size of crabs caught in the commercial fishery in 2017 and 2018 was similar and is just below the historical average.
- The commercial abundance index of the 2018 post-season survey was down sharply after four years of increases and below the average. The extent of the decline observed for the north shore was much more marked than for the south shore.
- The abundance of adolescents ≥ 78 mm in the post-season survey decreased between 2017 and 2018 and is below the average. However, trends differ between the two shores, with adolescents falling sharply in the survey on the north shore, with the 2018 value being the lowest observed to date, while they are up on the south shore compared with 2017, at a value just below the average.
- The last scientific trawl survey conducted in 2017 on the north and south shore predicted good recruitment until 2018, and then a subsequent decline in recruitment by 2020.
- The marked and unexpected decrease in the NPUE of all crab size categories in the post-season survey on the north shore, and only for this sub-area, is a significant source of uncertainty as to the reality of the decreases observed on the north shore in this survey between 2017 and 2018.
- The combined index (CI), derived from overall CPUE and NPUE in the fishing area, is down 25% from the 2017 value, which suggests that the biomass available to the fishery will be lower in 2019 than in 2018.

Outlook:

- The sharp decline in the combined index (CI) suggests that harvest should be reduced in 2019. However, given the uncertainty in the results of the post-season survey on the north shore and that stock status is likely to be better than the CI indicates, the decrease in the CI between 2017 and 2018 is used as a lower scenario.

  Higher scenario: A 5% decrease in the TAC compared with 2018.

  Intermediate scenario: A 15% decrease in the TAC compared with 2018.

Lower scenario: A more than 25% decrease in the TAC compared with 2018.

Area 16

- The 2018 TAC was similar to the 2017 TAC of 3,648 t and it was reached.
- The commercial CPUE has been declining since a high CPUE period was observed in 2013–2015 and it was below the historical average in 2018.
- Landings consisted mostly of recruits. The proportion of recruits increased for the third consecutive year, while that of intermediate-shell crabs decreased.
- The average size of landed crabs in the commercial fishery decreased between 2017 and 2018 and is just above the average.
- With the exception of 2015, the commercial abundance index of the post-season survey has been declining since 2013, when the highest value in the series was observed. The 2018 value was the lowest since 2002.
- The abundance of adolescents ≥ 78 mm in the post-season survey has increased slightly since 2017 and is at the average level, which does not suggest a significant increase in recruitment for 2019.
- The CI decreased by 13% compared with 2017, which suggests that less biomass will be available to the fishery in 2019 than in 2018.
- Monitoring of the snow crab population in Sainte-Marguerite Bay suggests that recruitment, in terms of legal crab numbers associated with the 2007 recruitment wave, will decrease from 2018 for about three years, before the positive effect of the 2015–2016 wave is felt. Good recruitment of legal males is anticipated from 2022–2023.

Outlook:

- The 13% decrease in the CI, in a context where fishing recruitment is expected to decline until 2021, suggests that the TAC should be reduced in 2019.

  Higher scenario: A 10% decrease in the TAC compared with 2018.

  Intermediate scenario: A 20% decrease in the TAC compared with 2018.

  Lower scenario: A more than 20% decrease in the TAC compared with 2018.

Area 15

- The TAC remained the same in 2018 at 631.7 t, and was reached.
- The commercial fishery CPUE declined for a third consecutive year and is now below the historical series average. Landings mainly consisted of recruits, whose proportion increased for a second consecutive year, while that of intermediate-shell crabs decreased.
- The average size of crabs caught in the commercial fishery increased slightly between 2017 and 2018. These at-sea measurement values have been fairly stable for the past 10 years and are among the highest in history.
- The commercial abundance index of the post-season survey has decreased over the past three years, with a marked decrease between 2017 and 2018.

- The abundance of adolescents ≥ 78 mm has been relatively stable in the post-season survey over the past five years.
- The CI is down 29% from the 2017 value. This was the third consecutive decline. This decline in the index suggests that there will be less biomass available to the fishery in 2019 than in 2018.

Outlook:

- A third decline in the CI in a context where recruitment to the fishery is expected to remain low in the short term suggests that the TAC should be reduced in 2019.

Higher scenario: A 25% decrease in the TAC compared with 2018.

Intermediate scenario: A 30% decrease in the TAC compared with 2018.

Lower scenario: A more than 30% decrease in the TAC compared with 2018.

Area 14

- The TAC decreased by 10% in 2018 to 617.3 t. It was almost reached.
- The commercial fishery CPUE declined sharply for the second consecutive year and is below the historical average in 2018. Landings consisted primarily of intermediate-shell crab in 2018.
- The average size of crabs caught in the commercial fishery shows a strong upward trend between 2012 and 2018, with the last year being among the highest values.
- The commercial abundance index of the post-season survey has declined significantly over the past four years, to below the historical average in 2018.
- The abundance of adolescents ≥ 78 mm has remained low and fairly stable in the post-season survey over the past four years, which suggests that recruitment to the fishery will not increase in 2019.
- The CI decreased by 38% from 2017 to 2018. This is the fourth consecutive decline, which suggests that the biomass available for fishing in 2019 will be lower than in 2018.

Outlook:

- A significant decrease (38%) in the CI with no indication of improved recruitment suggests that the TAC should be reduced in 2019.

Higher scenario: A 25% decrease in the TAC compared with 2018.

Intermediate scenario: A 35% decrease in the TAC compared with 2018.

Lower scenario: A more than 35% decrease in the TAC compared with 2018.

Area 13

- The TAC remained unchanged at 406 t, and was not reached (landings of 328.8 t).
- After several years of relatively high values, the commercial fishery CPUE declined sharply from 2017 to 2018, and is below the historical average in 2018. Landings consisted primarily of intermediate-shell crab in 2018.

- Average size of crabs caught in the commercial fishery decreased over the past two years to below the historical average in 2018. It should be noted that the decrease in the average size of crabs caught in the commercial fishery could be associated with the lack of at-sea sampling on the south side, and a northward shift in fishing effort covered by the At-Sea Observer Program.
- The commercial abundance index of the post-season survey on the north side of the area declined sharply for a second consecutive year and is at the level of the historical average in 2018. The 2018 value for the south side of the area is up from the previous year, but remains below the historical average, and is among the lowest values in the historical series.
- The abundance of adolescents ≥ 78 mm remained low and stable in the post-season survey, which does not suggest a significant increase in the recruitment to the fishery in 2019.
- The CI decreased by 42% from 2017 to 2018. The biomass available to the fishery in 2019 could be lower than in 2018.

Outlook:

- The significant decrease (42%) in the CI, while recruitment is expected to remain low, suggests decreasing the TAC in 2019. In the presence of a stock harvested at a lower intensity than neighbouring fishing areas since its reopening, the area's CI value was used as a reference for the lower scenario, which reflects this specific aspect.

  Higher scenario: A 25% decrease in the TAC compared with 2018.

  Intermediate scenario: A 35% decrease in the TAC compared with 2018.

  Lower scenario: A more than 45% decrease in the TAC compared with 2018.

Area 16A

- The TAC decreased by 10% to 412.9 t in 2018, and it was not reached (landings of 369 t). The fishery was closed as of July 14, 2018, due to an increase in the proportion of white crab in catches.
- The commercial fishery CPUE decreased for a fourth year. The 2018 CPUE is the lowest since the series began in 2004. Landings consisted of a large majority of recruits in 2018.
- The average size of crabs caught in the commercial fishery remained stable between 2017 and 2018, and is at the historical average.
- The commercial abundance index of the post-season survey has declined significantly over the past four years.
- The abundance of adolescents ≥ 78 mm remained low and relatively stable in the post-season survey between 2017 and 2018, which does not suggest an increase in recruitment to the fishery in 2019.
- The CI was down for the fourth consecutive year (24% decrease from 2017 to 2018). This decline in the index suggests that there will be less biomass available to the fishery in 2019 than in 2018.

Outlook:

- The 24% decrease in the CI, which was the fourth consecutive one, suggests that the TAC should be reduced in 2019, in a context where recruitment is expected to remain stable and/or low.

  Higher scenario: A 25% decrease in the TAC compared with the 2018.

  Intermediate scenario: A 30% decrease in the TAC compared with the 2018.

  Lower scenario: A more than 30% decrease in the TAC compared with the 2018.

Area 12C

- The TAC decreased by 10% to 256.4 t, and was not reached (landings of 235 t).
- The commercial fishery CPUE is down for the second consecutive year. The CPUE in 2018 is among the lowest values observed in 25 years. Landings consisted primarily of intermediate-shell crab, and they declined between 2016 and 2018.
- The average size of crabs caught in the commercial fishery remained close to the historical averages at sea and dockside in 2018.
- The commercial abundance index of the post-season survey decreased significantly over the past four years.
- The abundance of adolescents ≥ 78 mm remained low and fairly stable in the post-season survey between 2014 and 2018, which does not suggest an increase in recruitment to the fishery in 2019.
- The CI decreased for a fourth consecutive year, with a 26% decrease from 2017 to 2018. This decline in the index suggests that there will be less biomass available to the fishery in 2019 than in 2018.

Outlook:

- The 26% drop in the CI, during a period of stable and low recruitment, suggests that the TAC should be reduced in 2019.

  Higher scenario: A 25% decrease in the TAC compared with the 2018.

  Intermediate scenario: A 30% decrease in the TAC compared with the 2018.

  Lower scenario: A more than 30% decrease compared with the 2018.

Area 12B

- The 2018 TAC was intended to enable monitoring of snow crab yields for this stock, which is considered to be in poor condition, but whose exact status is uncertain due to the absence of post-season surveys in 2017 and 2018.
- The TAC decreased by 28.6% between 2017 and 2018 to 125 t. The TAC was not reached, with landings of only 40 t. The area has been neglected by some fishers for various reasons and fishing effort has not been high, which may partly explain why the TAC has not been met.
- The CPUE increased slightly, but is the second-lowest value in the historical series.

- Landings consisted primarily of intermediate-shell crabs.
- The average size of crabs caught in the commercial fishery remained similar to that of 2017 and is among the lowest values observed since the beginning of the historical series.
- A significant increase in the favourable thermal habitat available in the area was observed between 2016 and 2018.

Outlook:

- The non-attainment of the TAC, low catch rates, small size and low recruitment of snow crab suggest that stock status did not improve in 2018. Given the uncertainty about the exact status of the biomass in this area, it is impossible to make specific recommendations.
- It is recommended that harvest be set at the lowest level possible for monitoring of the area, further to a consultation between the fishing industry and Fisheries and Oceans Canada (Ecosystem and Fisheries Management sector).

Area 12A

- The TAC was increased by 7% to 105.5 t from 2017 to 2018, and it was reached.
- The commercial fishery CPUE remained similar in 2018 to that of 2017 and is among the lowest values observed.
- Landings consisted primarily of intermediate-shell crab.
- The average size of crabs caught in the commercial fishery increased between 2017 and 2018, and is above the average.
- All abundance indices from the 2018 post-season survey are declining or fairly stable and are among the lowest values observed in the historical series. In particular, the abundance of adolescents ≥ 78 mm declined between 2017 and 2018, suggesting a decline in recruitment in 2019.
- The CI decreased by 7% compared with the 2017 value. The biomass available to the fishery in 2019 could be lower than in 2018.

Outlook:

- The slight decline in the CI suggests that the TAC should be reduced in 2019 compared with 2018:

  Higher scenario: Status quo of the TAC compared with 2018.

  Intermediate scenario: A 7% decrease in the TAC compared with 2018.

  Lower scenario: A more than 10% decrease in the TAC compared with 2018.

INTRODUCTION

Species biology

In Canada, snow crab can be found from the southern tip of Nova Scotia to halfway up the Labrador coast, 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. Male carapace width (CW) ranges from 40 mm to 165 mm after the terminal moult. 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 and specifically recent years' upward trend in the average temperature of the deep layer could affect snow crab distribution and productivity by warming.

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 2018, 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 surveys help determine the average NPUE (numbers per unit effort) of legal-size crab by area and the NPUE of adolescent crab with a carapace more than 78 mm wide that will reach or exceed legal size during the next moult. The results of the trawl research surveys conducted in 2016, 2017 and 2018 in areas 13, 16 and 17 were used to calculate an adolescent or adult crab abundance index.

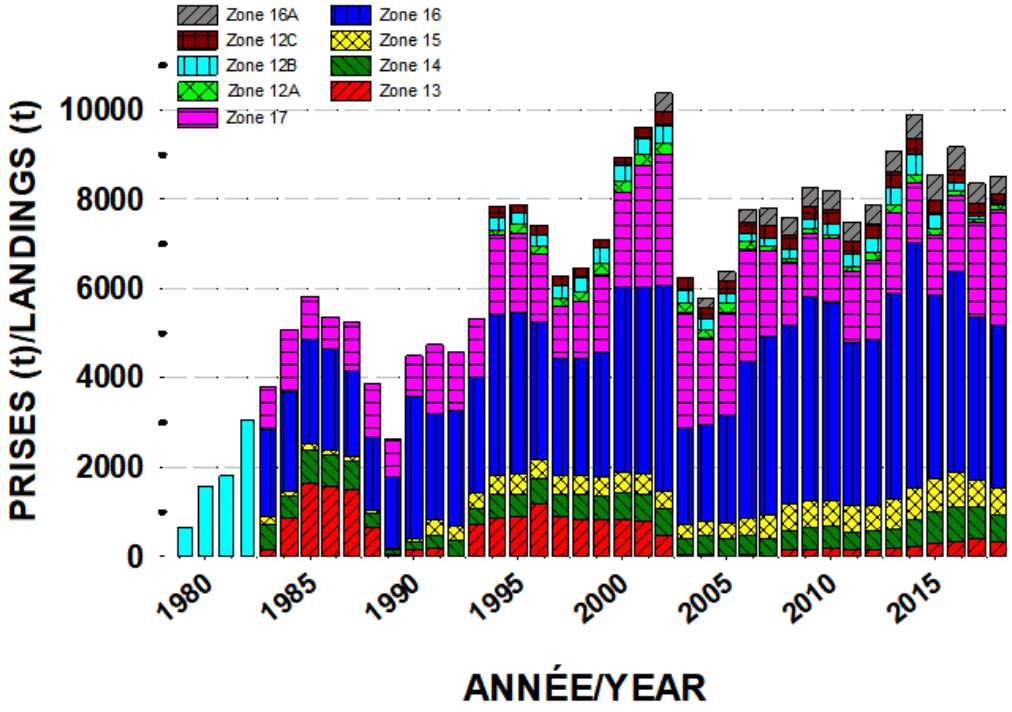


Figure 2. Snow crab landings in the Estuary and northern Gulf of St. Lawrence from 1979 to 2018. From 1979 to 1982, landings were not attributed to their area of origin.

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

Since 2013, a combined index was introduced 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 post-season NPUE for adult males ≥ 95 mm (the average NPUE from the north and south surveys in Area 13) and the standardized commercial CPUE. The combined index is calculated by standardizing each of the two indices according to their respective average and standard deviation over the 2000 to 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 were also used.

To date, data on female insemination levels have been collected sporadically in certain areas. Annual systematic sampling of each area is recommended so this parameter can be used for stock status assessments because it is a measure of primiparous female mating success and the relative abundance of large adult males.

Area 17

Description of the fishery

In Area 17, 21 fishers hold regular licences in Group A (88% of the TAC) and 20 fishers hold special licences in Group B (12% of the TAC). The TAC increased by 25% between 2017 and 2018 to 2,623 t and was reached (Figure 3). The 2018 fishing season opened on March 27 and closed on June 22.

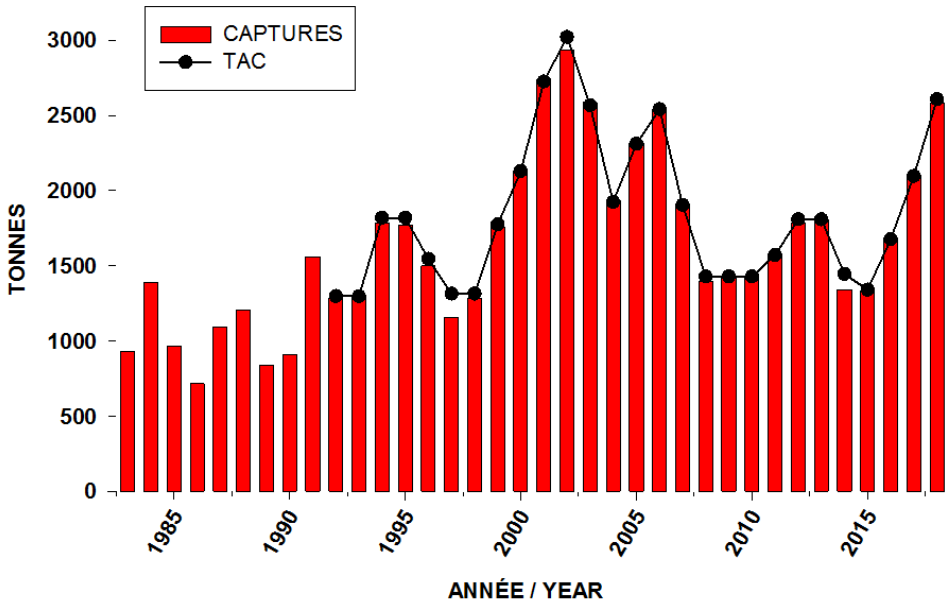


Figure 3. Annual landings and TACs in Area 17.

Resource status in 2018

Commercial fishery. The standardized CPUE decreased in 2018 but remained above the historical average (Figure 4). Landings were mainly made up of recruits (carapace conditions 1 and 2), which have been increasing since 2014. The average size of legal-size crab caught at sea, remained stable between 2017 and 2018, and is below the historical average (Figure 5).

Fishery-independent surveys. The trap-based research survey, a data series that began in 1996 on the North Shore and in 1999 on the South Shore, shows that the NPUE of adults ≥ 95 mm decreased sharply after four years of increase, and is below the historical average (Figure 6). It should be noted that the decline is much more pronounced on the North Shore than on the South Shore. The NPUE of adolescents ≥ 78 mm and recruits decreased in 2018 and is below the historical average (Figure 7) reaching the lowest value of the historical series for recruits.

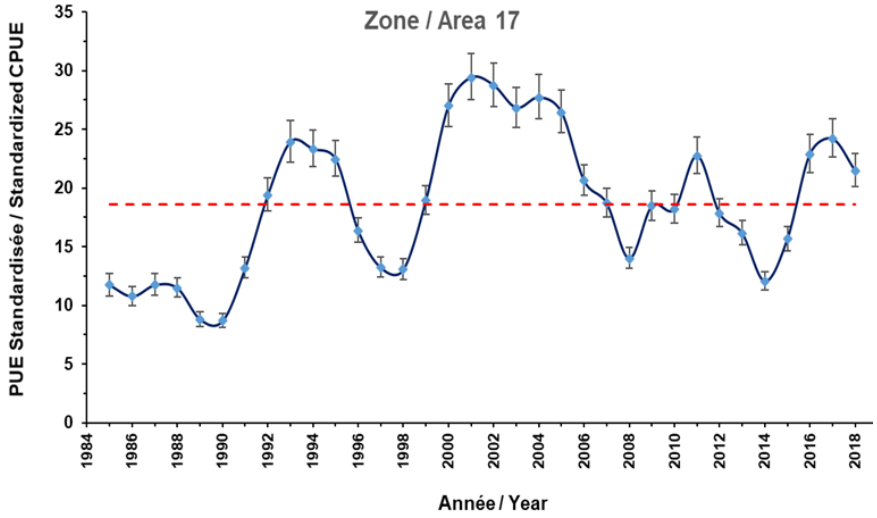


Figure 4. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 17. The dashed line shows the data series average (excluding 2018).

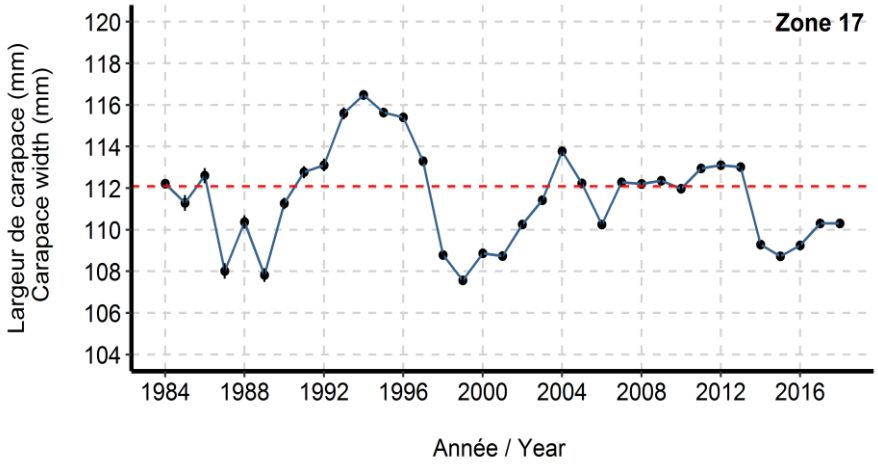


Figure 5. Carapace width (± 95% confidence interval) in the commercial fishery in Area 17. The dashed line shows the data series average (excluding 2018).

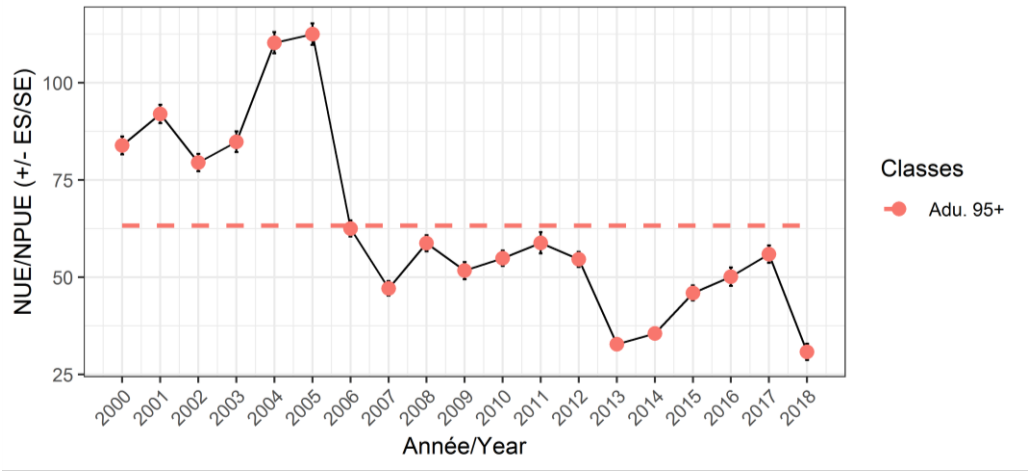


Figure 6. Annual catch rates (NPUE) (± standard error) of adult crab ≥ 95 mm from the post-season survey in Area 17. The dashed line shows the data series average.

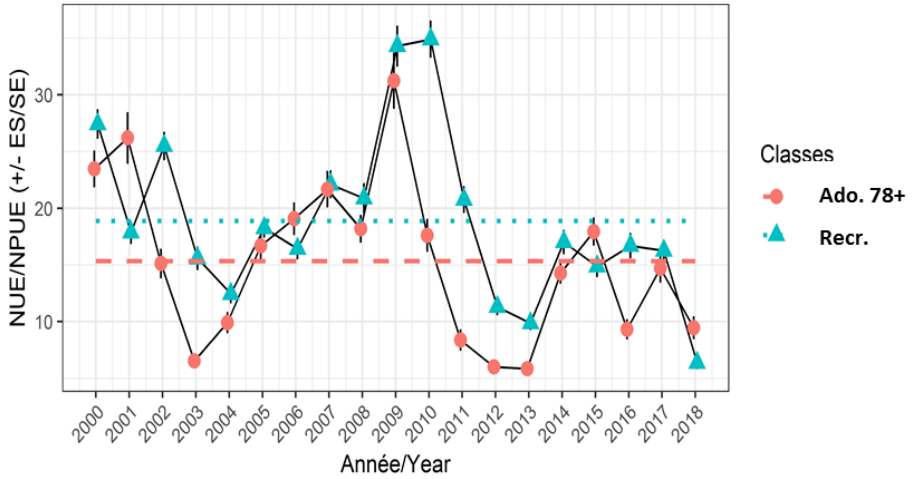


Figure 7. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in Area 17. The dashed and dotted lines show the respective data series averages.

The marked and unexpected decrease in the NPUE values for all crab size classes in the trap survey on the north shore is a significant source of uncertainty with regard to the accuracy of the yield decreases observed on the north shore in this survey between 2017 and 2018. The quality of NPUE observations depends on the survey's capacity to reflect actual changes in abundance at the sampled stations. Our interpretations of variations in NPUE values are based on the premise that crab catchability remains similar from station to station and from year to year. This assumption is no longer valid if the bait is less attractive to snow crab owing to the abundance of other food sources. The low NPUE values recorded in 2018 for the north shore could reflect low detection capacity in view of the greater abundance of capelin, a potential food source for crabs, as reported by participants in the peer review on the assessment of crab stocks in the Estuary and northern Gulf of St. Lawrence conducted in February 2019. Only when the data from the coming fishing season are available will we be able to confirm whether this result is attributable solely to a detection problem or whether the biomass has actually decreased.

The combined index (CI) of commercial CPUE and of NPUE of adult ≥ 95 mm in the post-season survey decreased by 25% between 2017 and 2018. This suggests that there will be less biomass available in the 2019 fishing season than there was in 2018.

A downward trend in snow crab favourable thermal habitat in Area 17 has been observed in recent years, which could have a negative impact on the future stock productivity.

Outlook and conclusions

The sharp decline in the combined index (CI) suggests that harvest should be reduced in 2019. However, given the uncertainty in the results of the post-season survey on the north shore and that stock status is likely to be better than the CI indicates, the decrease in the CI between 2017 and 2018 is used as a lower scenario.

Higher scenario: A 5% decrease in the TAC compared with 2018.

Intermediate scenario: A 15% decrease in the TAC compared with 2018.

Lower scenario: A more than 25% decrease in the TAC compared with 2018.

Area 16

Description of the fishery

In Area 16, 38 fishers hold regular snow crab licences in Group A (92.7% of the TAC) and 16 fishers hold special licences in groups B and C (7.3% of the TAC). The TAC was the same as in 2017, at 3,648 t and was reached (Figure 8). The 2018 fishery opened on April 6 and closed on July 10.

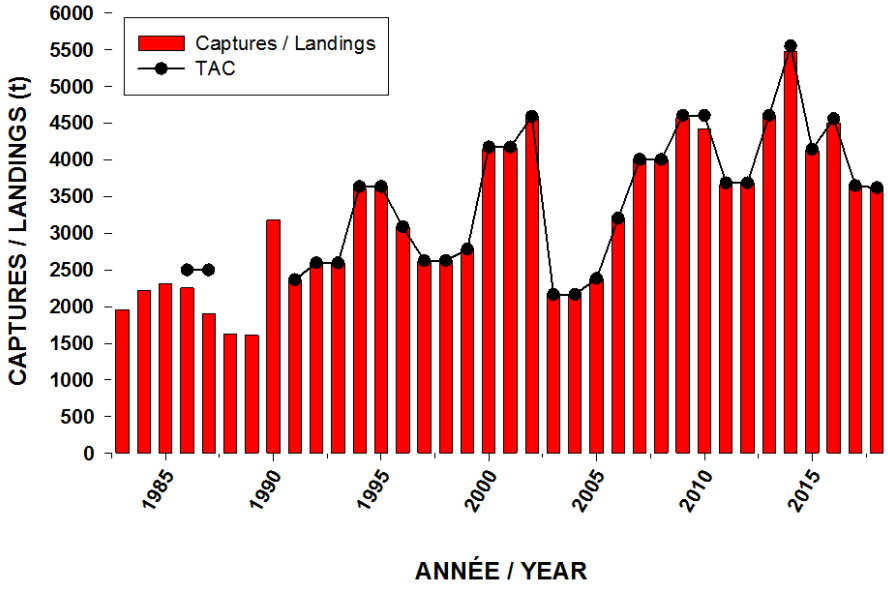


Figure 8. Annual landings and TACs in Area 16.

Resource status in 2018

Commercial fishery. After peaking from 2013 to 2015, the standardized CPUE decreased and was below the historical average in 2018 (Figure 9). Landings consisted of a significant

proportion of recruits (carapace condition 1 and 2) followed by intermediate shell crab (carapace condition 3). The average size of legal-size crabs caught at sea decreased between 2017 and 2018 and is at the historical average level (Figure 10).

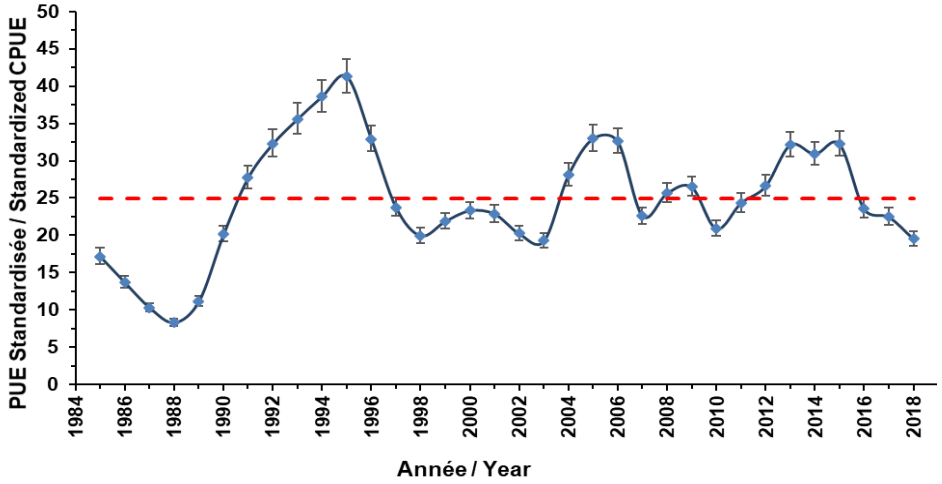


Figure 9. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 16. The dashed line shows the data series average (excluding 2018).

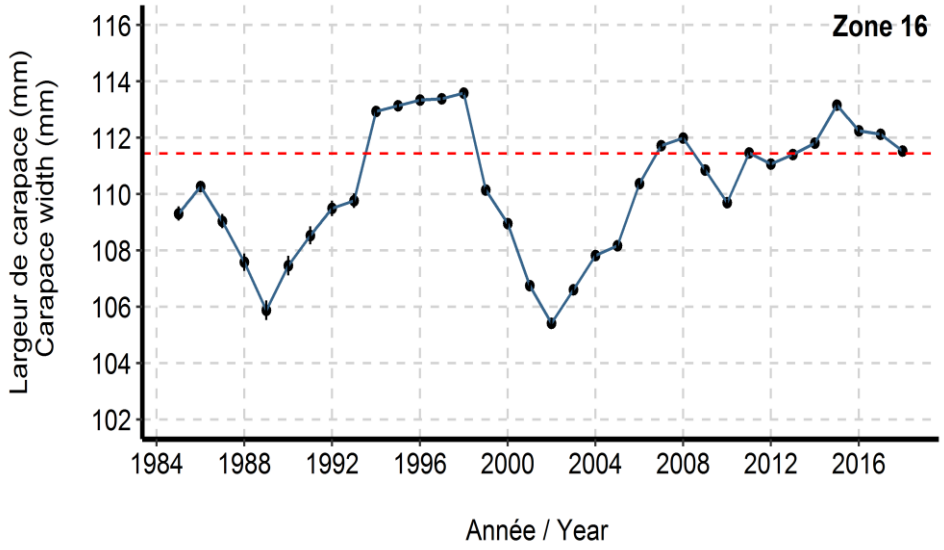


Figure 10. Carapace width (± 95% confidence interval) in the commercial fishery in Area 16. The dashed line shows the data series average (excluding 2018).

Fishery-independent surveys. The trap-based research survey, conducted every fall since 1994, shows that the NPUE of adults ≥ 95 mm decreased between 2017 and 2018, and is still below average, at a lower value than those observed over the past 15 years (Figure 11). The NPUE of adolescents ≥ 78 mm increased slightly in 2018 and reached the historical average (Figure 12). The NPUE of recruits decreased between 2017 and 2018 but is still above the historical average (Figure 12). The trawl survey results suggest lower recruitment in the short to medium term, but an increase in the longer term (3 to 4 years).

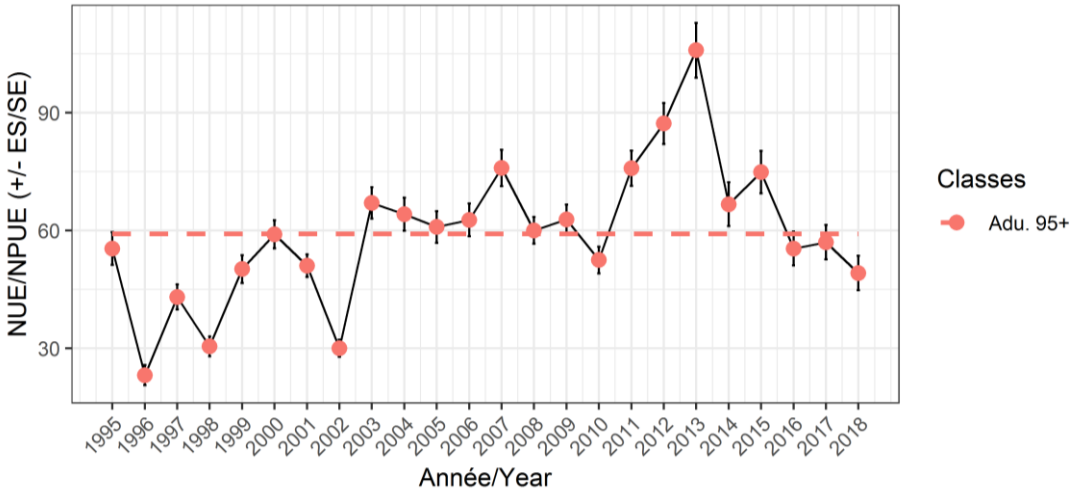


Figure 11. Annual catch rates (NPUE) (± standard error) of adult crab ≥ 95 mm from the post-season survey in Area 16. The dashed line shows the data series average.

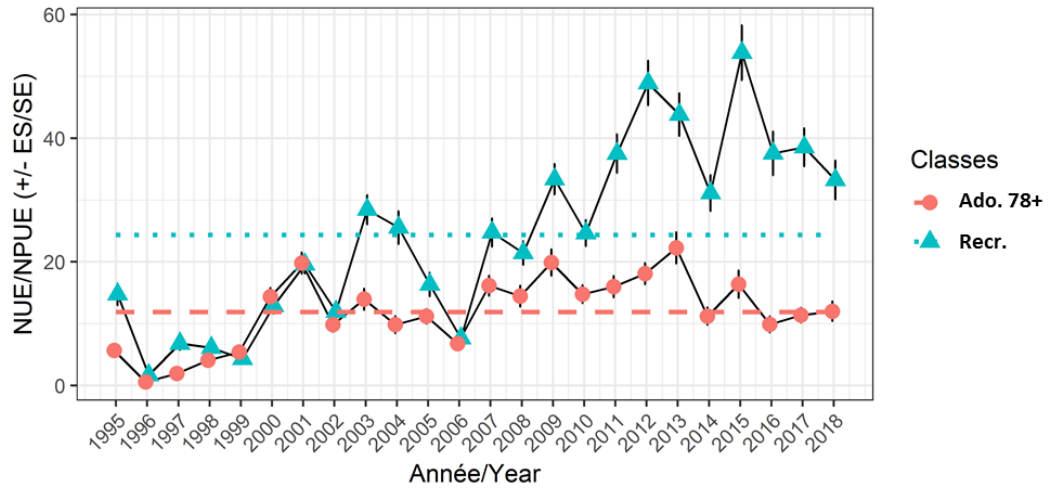


Figure 12. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in Area 16. The dashed and dotted lines show the respective data series averages.

The combined index of commercial CPUE and NPUE of adult ≥ 95 mm from the post-season survey decreased by 13% compared with 2017, which suggests that less biomass will be available to the fishery in 2019 than in 2018.

In 2018, the abundance of primiparous females was increasing, their average size was very large and their mating success, as measured by spermatheca fullness levels, was excellent. The spermathecae of primiparous females from Sainte-Marguerite Bay showed higher fullness values from 2015 to 2018 than in the previous six years. This increased mating success is associated with the higher proportion of large males relative to mature females recorded over the past four years.

A downward trend in the area of favourable thermal habitat for snow crab in Area 16 has been observed since 1990. The marked decrease in the availability of favourable thermal habitat,

during the period from 2011 to 2016, could have a negative impact on the future productivity of the stock.

Outlook and conclusions

The 13% decrease in the combined index, in a context where fishing recruitment is expected to decline until 2021, suggests that the TAC should be reduced in 2019.

Higher scenario: A 10% decrease in the TAC compared with 2018.

Intermediate scenario: A 20% decrease in the TAC compared with 2018.

Lower scenario: A more than 20% decrease in the TAC compared with 2018.

Area 15

Description of the fishery

In Area 15, 8 fishers hold regular licences in Group A (90.7% of the TAC) and 24 fishers hold special licences in Group B (9.3% of the TAC). The TAC remained unchanged between 2017 and 2018 at 632 t, and was reached (Figure 13). In 2018, the fishery was allowed within two optional periods: either from April 11 to July 18 or from April 18 to July 24.

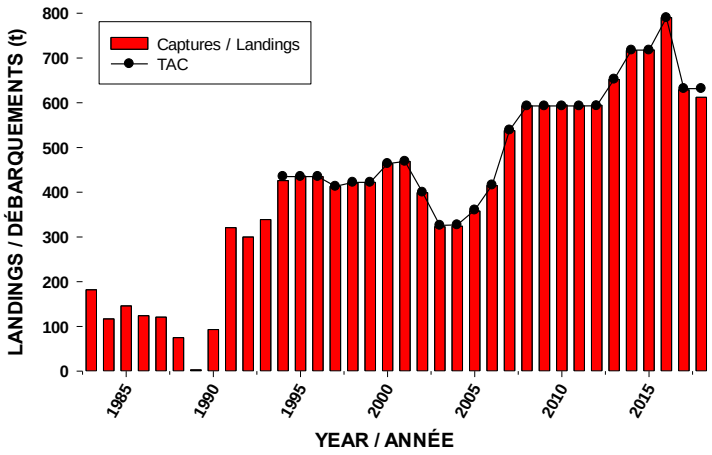


Figure 13. Annual landings and TACs in Area 15.

Resource status in 2018

Commercial fishery. The standardized CPUE decreased between 2017 and 2018 and is now below the historical average (Figure 14). After a decrease from 2013 to 2016, landings in 2018 consisted primarily of recruits (carapace conditions 1 and 2), followed in importance by intermediate-shell crabs (carapace condition 3). The average size of crabs caught in the commercial fishery increased slightly between 2017 and 2018 and has remained fairly stable over the past 12 years at the historical average level (Figure 15).

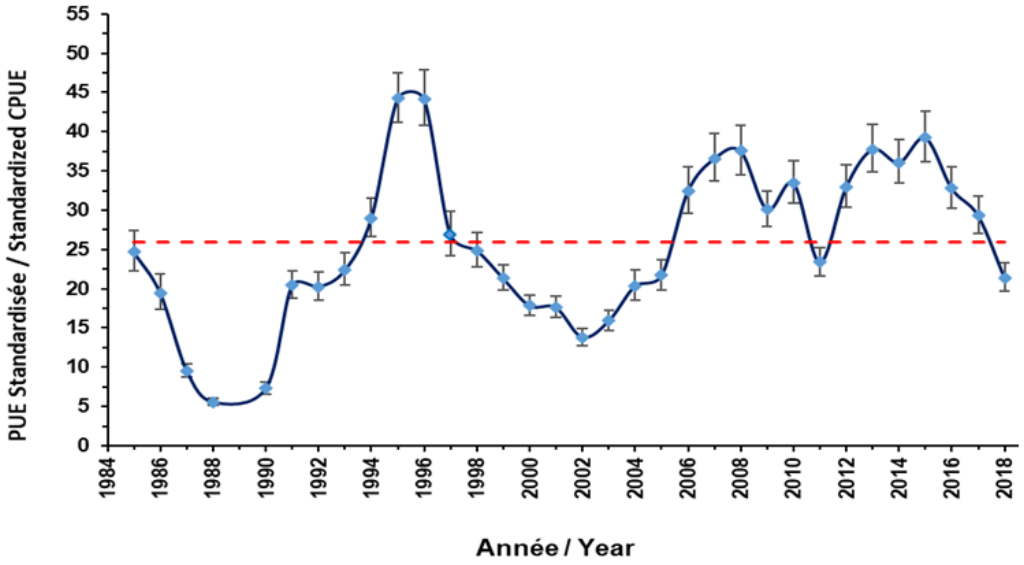


Figure 14. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 15. The dashed line shows the data series average (excluding 2018).

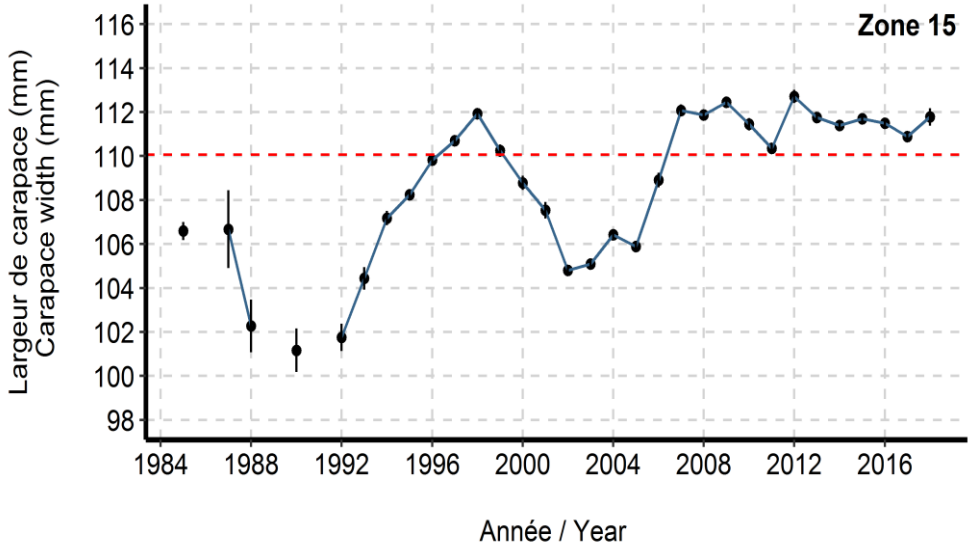


Figure 15. Carapace width (± 95% confidence interval) in the commercial fishery in Area 15. The dashed line shows the data series average (excluding 2018).

Fishery-independent survey. The protocol for trap-based research survey was changed in 2014 to allow the use of a new larger, standard conical trap of 6.5 ft diameter. Both types of traps, former and new, were being used from 2014 to 2016. Since 2017, only the larger trap is used. Since catchability with this new trap needs to be further assessed in comparison with the former traps, only the data including this new trap are presented. The trap-based research survey shows a well below-average decrease in the NPUE of adults ≥ 95 mm in 2018 (Figure 16). The NPUE of adolescent ≥ 78 mm increased in 2018 and is slightly below average. The NPUE of recruits in 2018 is relatively stable compared to 2017 and has reached the lowest value since 2014 when the new trap was introduced (Figure 17).

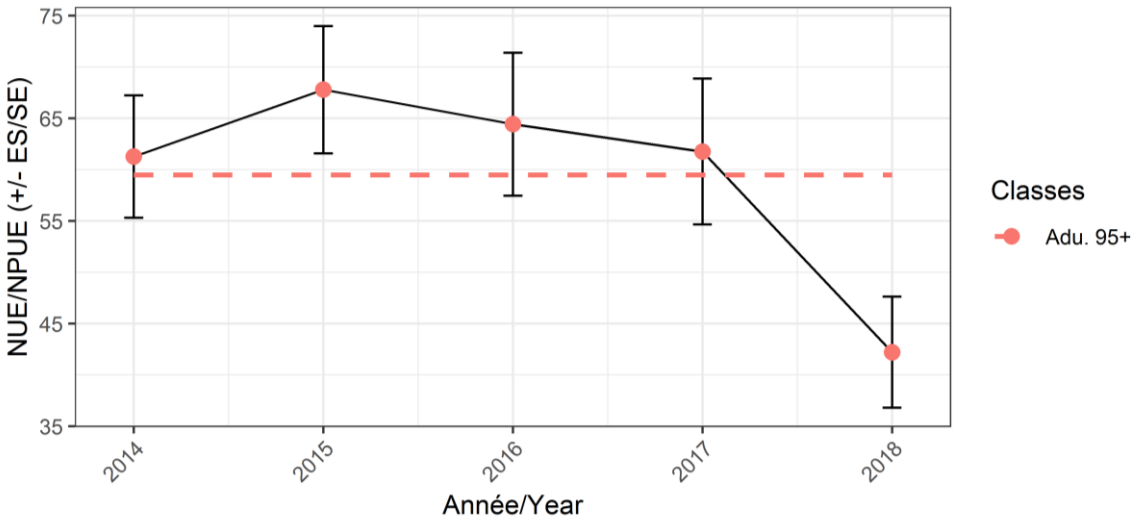


Figure 16. Annual catch rates (NPUE) (± standard error) of adult crab ≥ 95 mm from the post-season survey in Area 15. The dashed line shows the data series average.

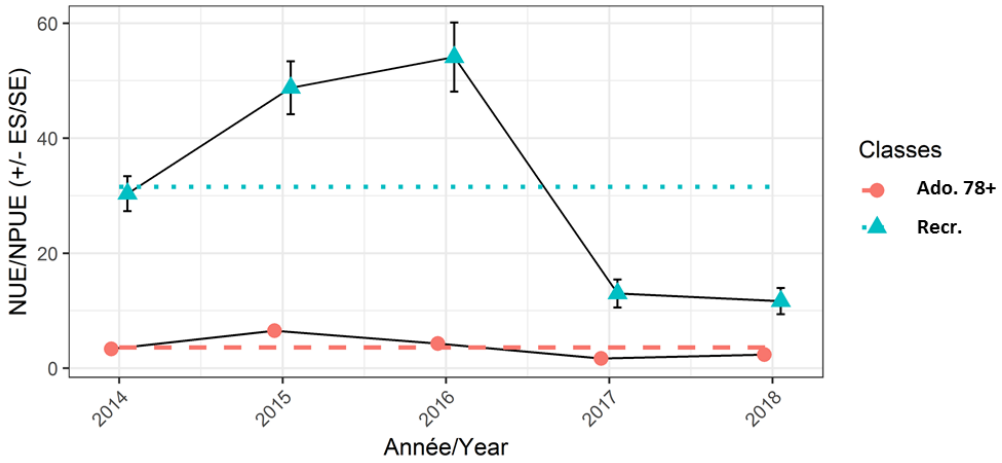


Figure 17. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in Area 15. The dashed and dotted lines show the respective data series averages.

The combined index of the commercial CPUE and NPUE of adult ≥ 95 mm from the post-season survey decreased by 29%. This is the third consecutive decrease. This decline in the indicator suggests that the biomass available to the fishery will be lower in 2019 than in 2018.

Outlook and conclusions

A third decline in the combined index, in a context where recruitment to the fishery is expected to remain low in the short term, suggests that the TAC should be reduced in 2019.

Higher scenario: A 25% decrease in the TAC compared with 2018.

Intermediate scenario: A 30% decrease in the TAC compared with 2018.

Lower scenario: A more than 30% decrease in the TAC compared with 2018.

Area 14

Description of the fishery

Area 14 has 21 regular licences. The TAC decreased by 10% from 2017 to 2018 to 617 t (Figure 18). In 2018, the fishery was allowed from May 1st to August 6 and the TAC was almost reached with 602 t landed.

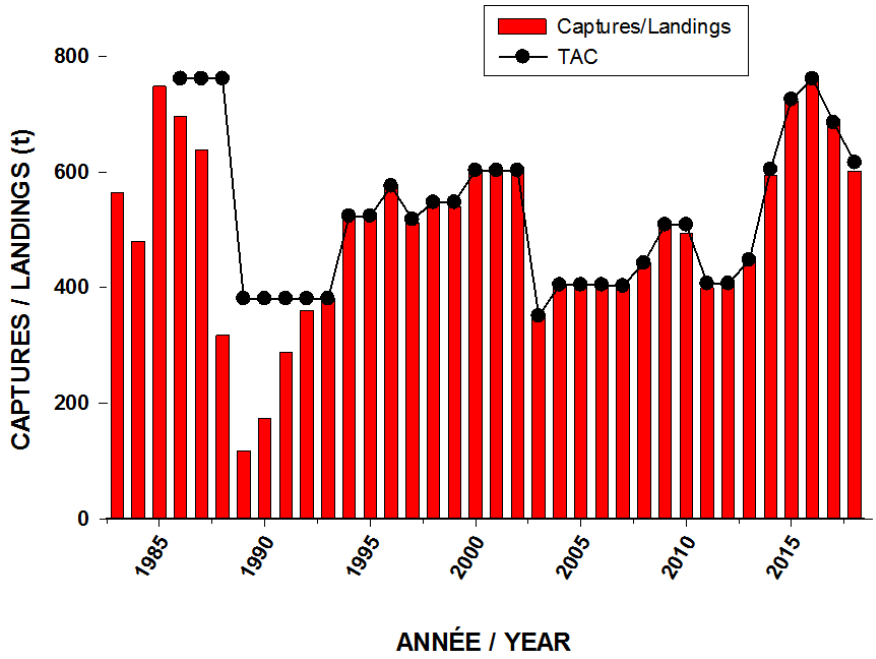


Figure 18. Annual landings and TACs in Area 14.

Resource status in 2018

Commercial fishery. After reaching its highest value in 2016 over the 1985-2018 period, the standardized CPUE decreased sharply in 2017 and 2018 to approach the lowest values observed over the last 10 years (Figure 19). Recruits (carapace conditions 1 and 2), whose proportion increased slightly in landings from 2008 to 2013, remain a minority in landings. This contrasts with the proportion of old-shell crab (carapace conditions 4 and 5), which is increasing sharply to reach its highest proportion in landings since 1994. This results in a decrease in the proportion of intermediate-shell crab (carapace condition 3) between 2017 and 2018. The average size of legal-size crab caught at sea has increased since 2013 and is well above the historical average (Figure 20).

Fishery-independent survey. The trap-based research survey, conducted since 1996, shows that the NPUE of adults ≥ 95 mm (Figure 21) and of recruits (Figure 22) decreased sharply from 2014 to 2018 and were below their historical average in 2018. The NPUE of adolescents ≥ 78 mm has been decreasing since 2013 and was low (Figure 22), suggesting a decrease in recruitment in the short to medium term.

The combined index of commercial CPUE and NPUE of adult ≥ 95 mm from the post-season survey decreased by 38% from 2017 to 2018. This is the 4th consecutive decline, suggesting that the biomass available to the fishery will be lower in 2019 than in 2018.

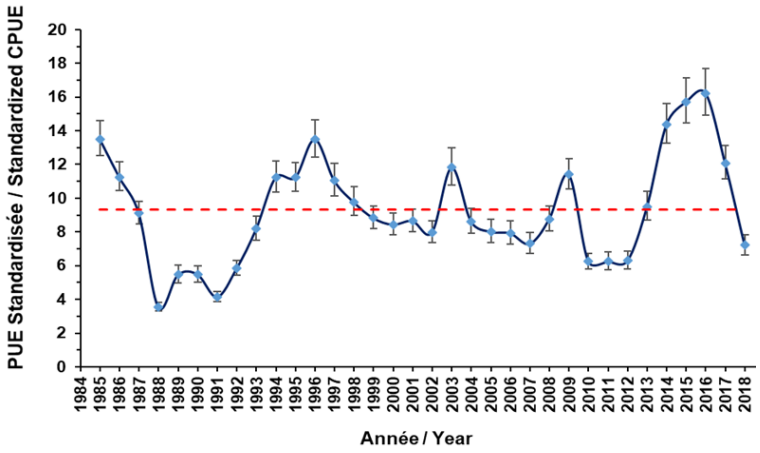


Figure 19. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 14. The dashed line shows the data series average (excluding 2018).

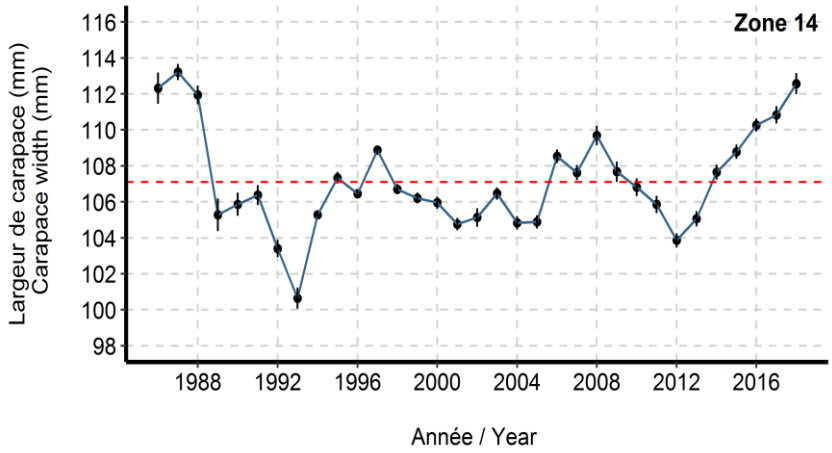


Figure 20. Carapace width (± 95% confidence interval) in the commercial fishery in Area 14. The dashed line shows the data series average (excluding 2018).

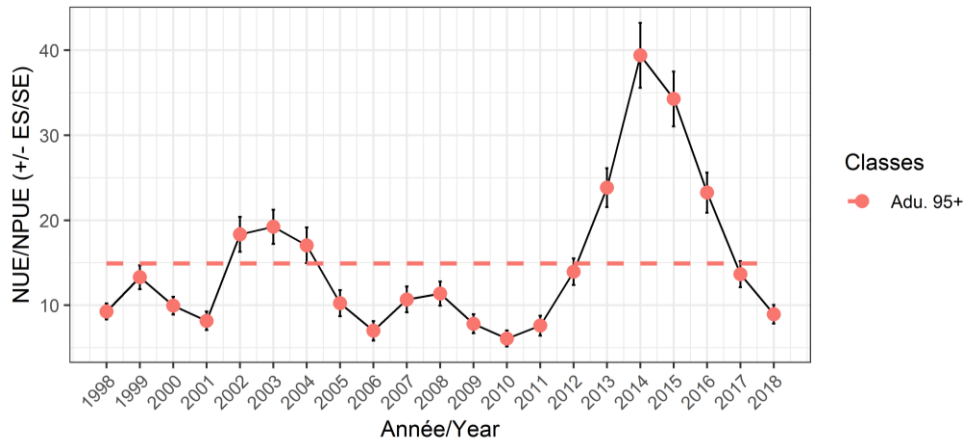


Figure 21. Annual catch rates (NPUE) (± standard error) of adult crab ≥ 95 mm from the post-season survey in Area 14. The dashed line shows the data series average.

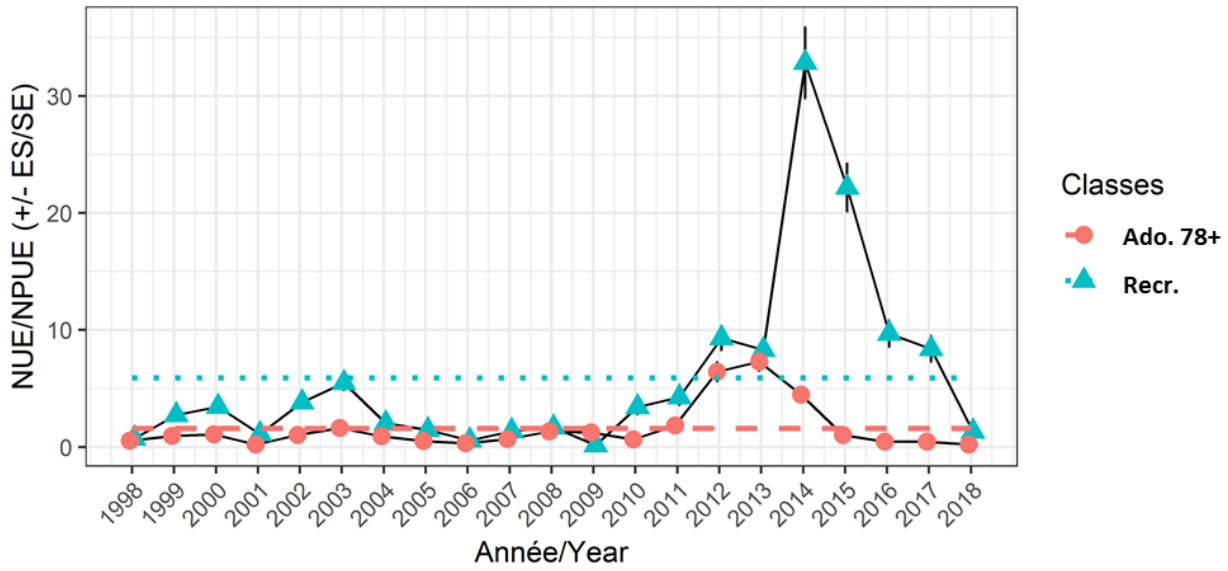


Figure 22. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in Area 14. The dashed and dotted lines show the respective data series averages.

Outlook and conclusions

A significant decrease (38%) in the combined index with no indication of improved recruitment suggests that the TAC should be reduced in 2019.

Higher scenario: A 25% decrease in the TAC compared with 2018.

Intermediate scenario: A 35% decrease in the TAC compared with 2018.

Lower scenario: A more than 35% decrease in the TAC compared with 2018.

Area 13

Description of the fishery

Area 13 has 43 regular fishers from Quebec and 6 from Newfoundland. The area was placed under a moratorium from 2003 to 2007 as a result of a marked decline in the biomass of legal-size crab. However, an index fishery with an annual TAC of 50 t was approved in 2003, 2004 and 2006. When the area was reopened in 2008, it was decided that precautionary, meaning low, TACs would be in effect at first and would gradually increase only if the stock indices remained positive despite harvesting. In 2018, the fishery was allowed from May 2 to August 7 and the TAC remained unchanged at 406 t, but was not reached (landings of 329 t) (Figure 23).

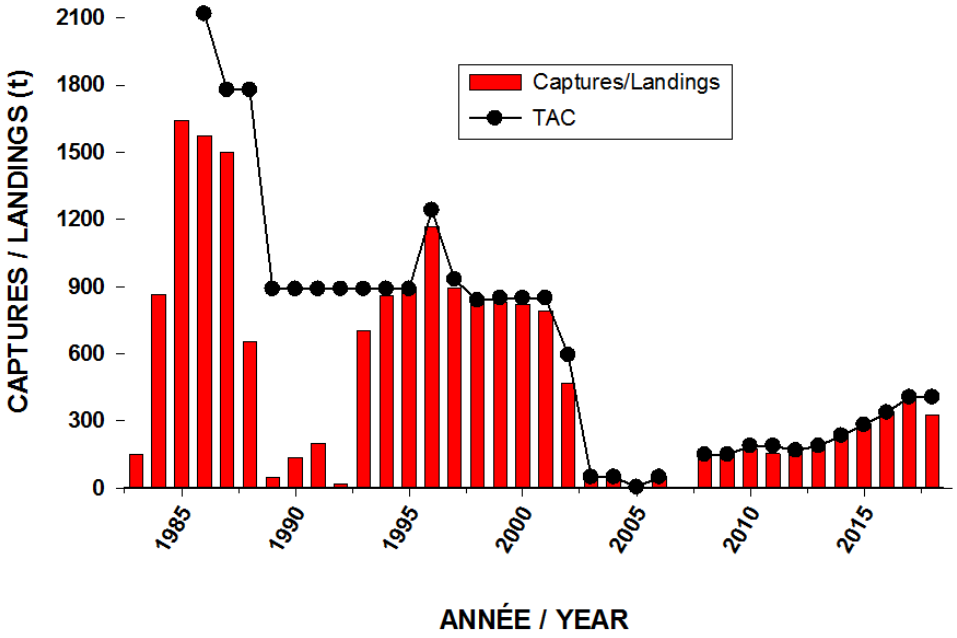


Figure 23. Annual landings and TACs in Area 13.

Resource status in 2018

Commercial fishery. The standardized CPUE decreased sharply from 2017 to 2018 and was below the historical average in 2018 (Figure 24). The proportion of recruits (carapace conditions 1 and 2), increased in 2018, while landings consisted primarily of intermediate-shell crab (carapace condition 3). From 2009 to 2014, the fishing effort was significantly higher in the southern part than the northern part. In 2015 and 2016, the fishing effort was divided almost equally between both parts. In 2017 and 2018, however, it was higher in the northern part. The average size of legal-size crab caught at sea decreased from 2016 to 2018 with a value that is now below average (Figure 25). This average size is low compared with other areas in the Gulf of St. Lawrence.

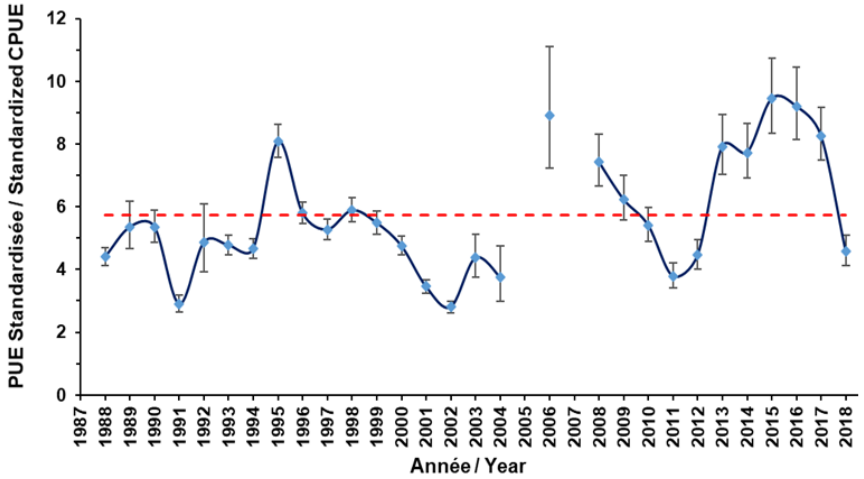


Figure 24. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 13. The dashed line shows the data series average (excluding 2018).

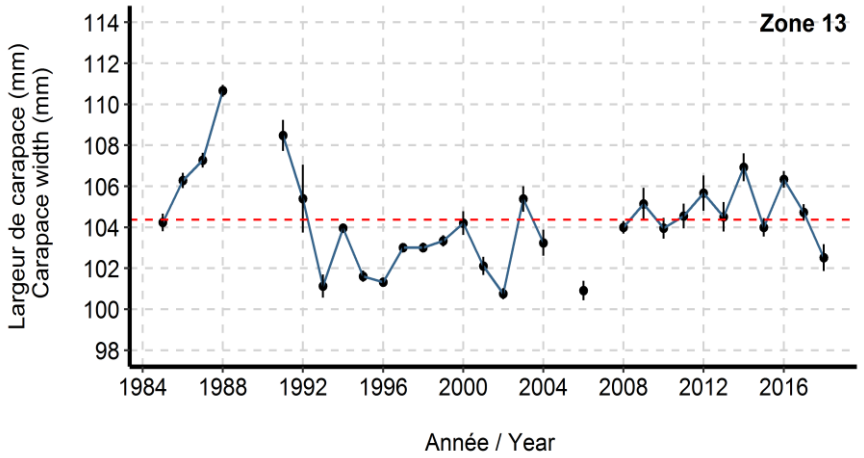


Figure 25. Carapace width (± 95% confidence interval) in the commercial fishery in Area 13. The dashed line shows the data series average (excluding 2018).

Fishery-independent surveys. The trap-based research surveys show a decrease of the NPUE of adults ≥ 95 mm in the northern part between 2016 and 2018 to a value at the historical average level (Figure 26) and an increase in the southern part to a value that remains well below the historical average (Figure 27). In 2018, the NPUE of recruits and adolescents ≥ 78 mm decreased to their respective average level in the northern part (Figure 28), while these two indices increased on the southern part, but still remaining below the average (Figure 29).

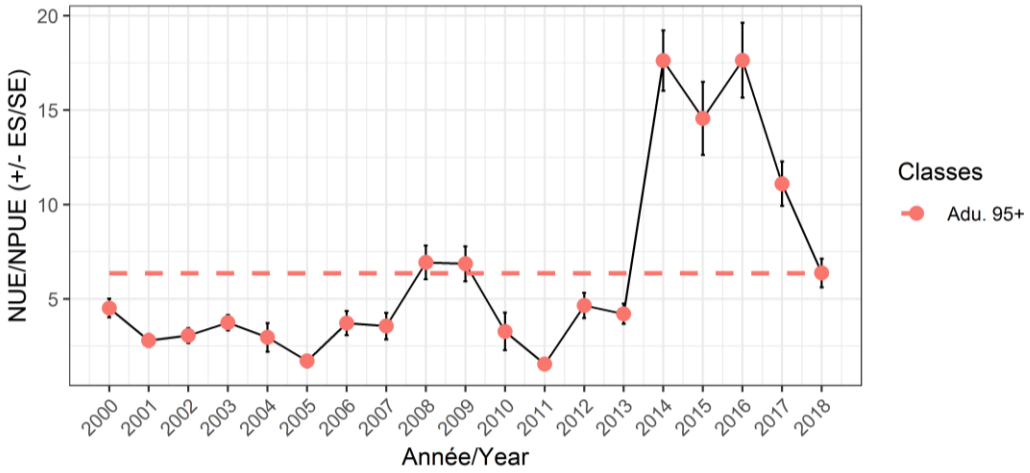


Figure 26. Annual catch rates (NPUE) (± standard error) of adult crab ≥ 95 mm from the post-season survey in northern Area 13. The dashed line shows the data series average.

The combined index of commercial CPUE and NPUE of adult ≥ 95 mm from the post-season surveys decreased by 42% from 2017 to 2018. This result suggests a decrease in the available biomass in 2019 compared with 2018.

The results of the 2016 trawl scientific survey conducted in Area 13 indicated a decrease in recruitment for a few years. This survey also shows, for 2016, a very high abundance of crab less than 35 mm that should start recruiting to the fishery as of the early 2020s.

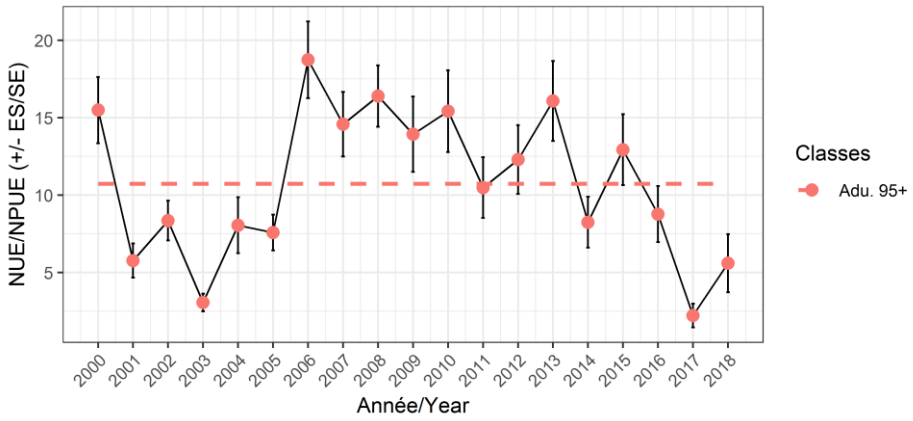


Figure 27. Annual catch rates (NPUE) (± standard error) of adult crab ≥ 95 mm from the post-season survey in southern Area 13. The dashed line shows the data series average.

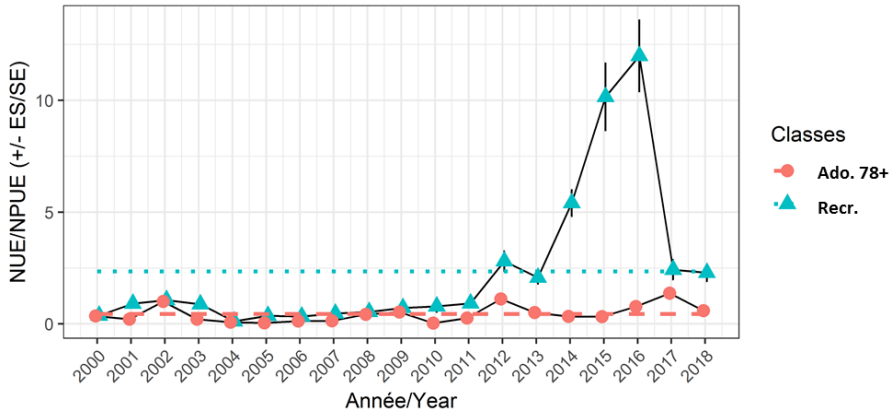


Figure 28. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in northern Area 13. The dashed and dotted lines show the respective data series averages.

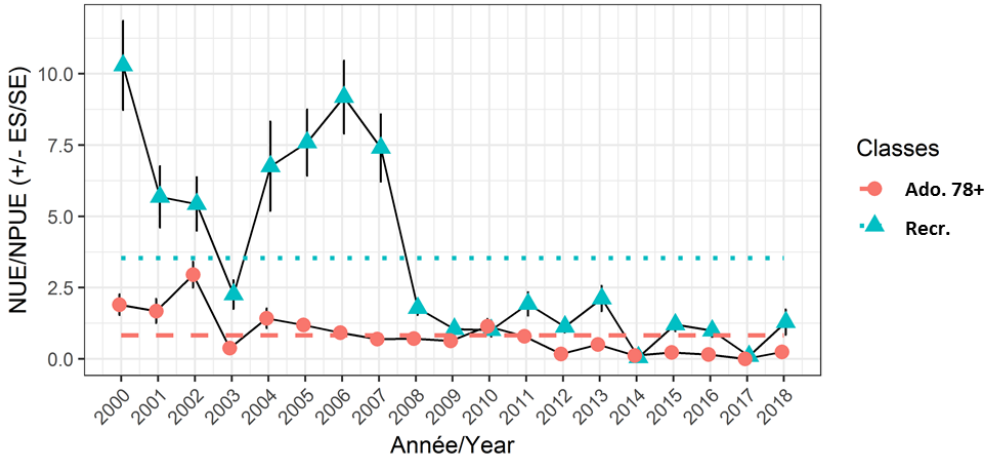


Figure 29. Annual catch rates (NPUE) (± standard error) of recruits (Recruits) and adolescents (Subadults) ≥ 78 mm from the post-season survey in southern Area 13. The dashed and dotted lines show the respective data series averages.

Outlook and conclusions

The significant decrease (42%) in the combined index (CI), while recruitment is expected to remain low, suggests decreasing the TAC in 2019. In the presence of a stock harvested at a lower intensity than neighbouring fishing areas since its reopening, the area's CI value was used as a reference for the lower scenario, which reflects this specific aspect.

Higher scenario: A 25% decrease in the TAC compared with 2018.

Intermediate scenario: A 35% decrease in the TAC compared with 2018.

Lower scenario: A more than 45% decrease in the TAC compared with 2018.

Area 16A

Description of the fishery

Area 16A includes two parts (north and south) separated by the Anticosti Channel. Since 2002, it has been accessible to the 43 Quebec fishers holding a snow crab fishing licence in Area 13. The TAC peaked at 566 t in 2015, then it decreased by 10% per year thereafter to reach 412.9 t in 2018 and was not reached (Figure 30). In 2018, the fishery was allowed from April 11 to July 14.

Resource status in 2018

Commercial fishery. The standardized CPUE increased from 2011 to 2014 and then decreased since 2015 to reach, for the second consecutive year, the lowest value since the beginning of this series (Figure 31). In 2018, recruits (carapace conditions 1 and 2) increased sharply in landings. Landings are now dominated by recruits who now outnumber intermediate-shell crab (carapace condition 3) while the proportion of old-shelled crab (carapace conditions 4 and 5) has declined. The average size of legal-size crab caught at sea has been decreasing since 2016 and was at the historical average in 2018 (Figure 32).

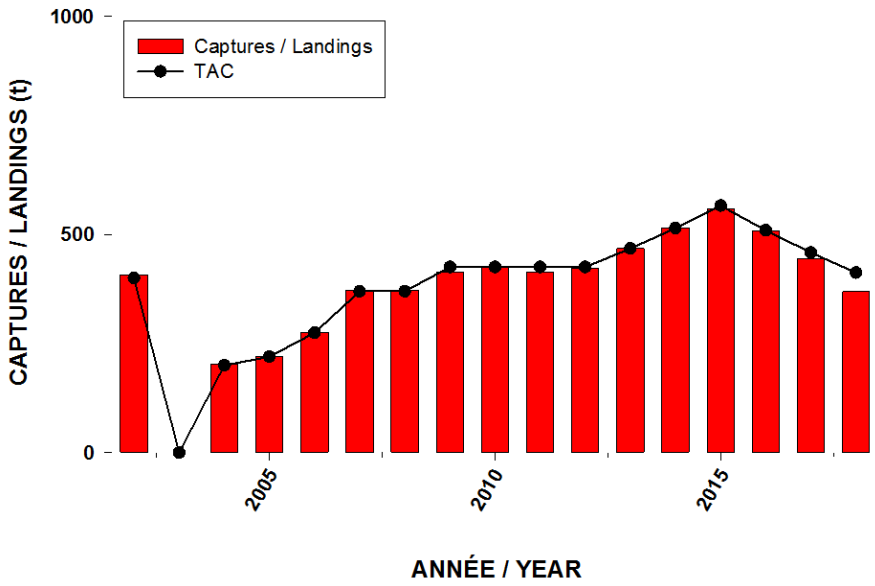


Figure 30. Annual landings and TACs in Area 16A.

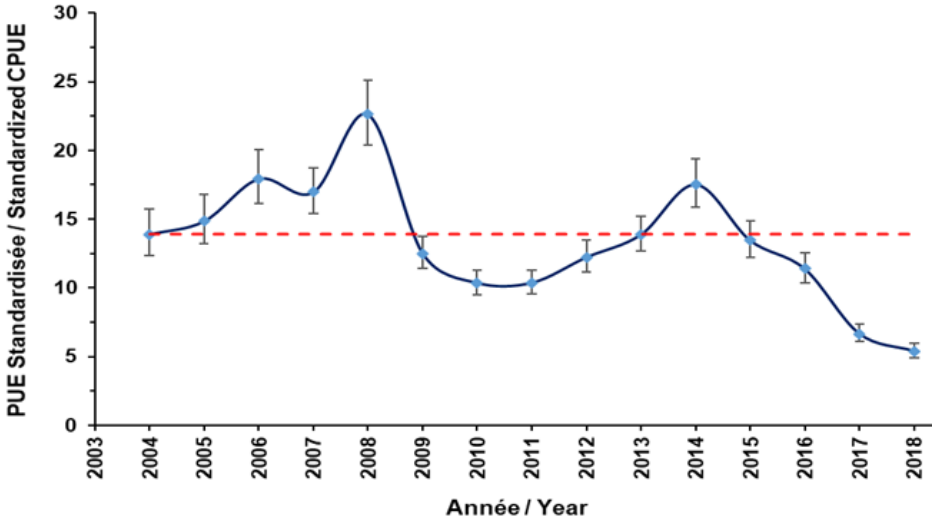


Figure 31. Standardized annual CPUE ± confidence interval in the commercial fishery in Area 16A. The dashed line shows the data series average (excluding 2018).

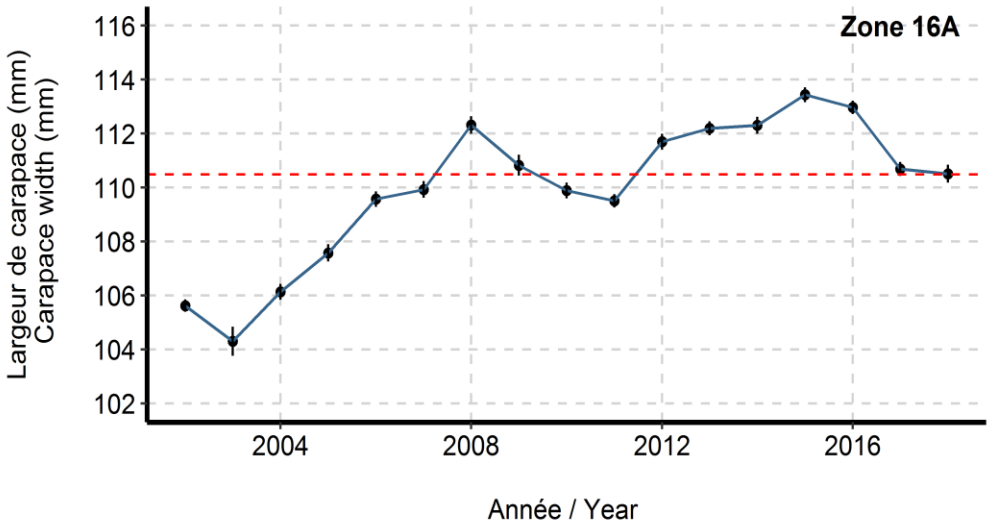


Figure 32. Carapace width ± confidence interval in the commercial fishery in Area 16A. The dashed line shows the data series average (excluding 2018).

Fishery-independent survey. The protocol for trap-based research survey was changed in 2014 to allow the use of a new larger, standard conical trap of 6.5 ft diameter. Both types of traps, former and new, were being used from 2014 to 2016. Since 2017, only the larger trap is used. Since catchability with this new trap needs to be further assessed in comparison with the former traps, only the data including this new trap are presented. The trap-based research survey shows that the NPUE of adults ≥ 95 mm has decreased since the introduction of the new protocol with a yield that has decreased by more than half since 2014 (Figure 33)). The NPUE of adolescents ≥ 78 mm has been gradually increasing since 2014, whereas that of the recruits is stable compared to 2017 and below the 2014-2018 average (Figure 34)).

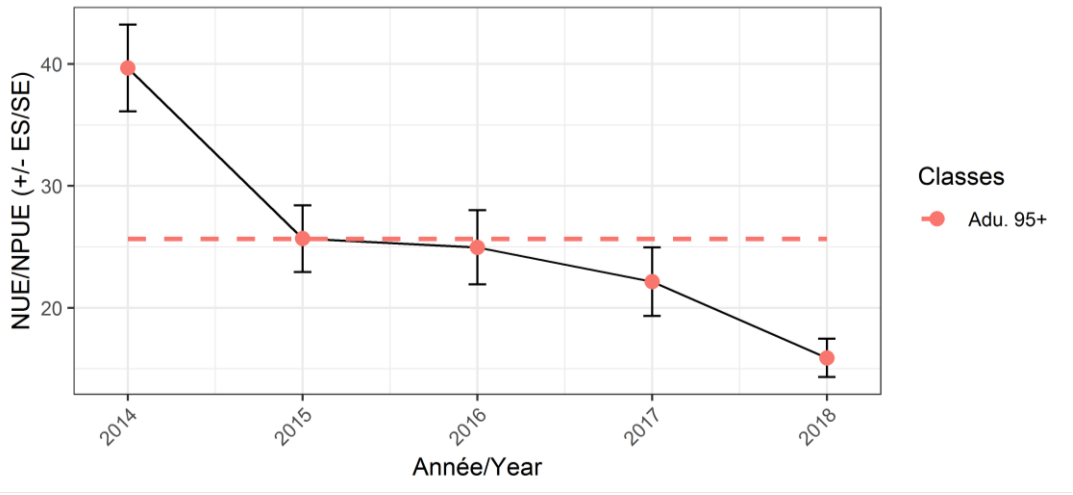


Figure 33. Annual catch rates (NPUE) (± standard error) of adult crab ≥ 95 mm from the post-season survey in Area 16A. The dashed line shows the data series average.

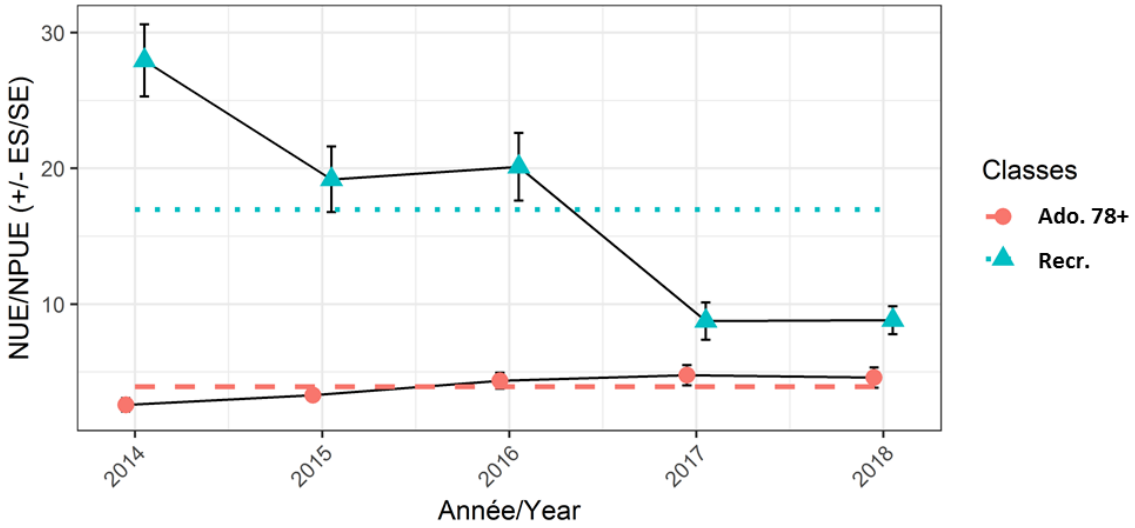


Figure 34. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in Area 16A. The dashed and dotted lines show the respective data series averages.

The combined index of commercial CPUE and NPUE of adult ≥ 95 mm from the post-season survey has been decreasing for a 4th consecutive year (-24% from 2017 to 2018). This decline suggests that the commercial biomass available to the fishery will be lower in 2019 than in 2018.

Preferred snow crab thermal habitat estimated since 1990 in Area 16A was the lowest in 2015, which could have a negative impact on future stock productivity.

Outlook and conclusions

The 24% decrease in the combined index, which was the fourth consecutive one, suggests that the TAC should be reduced in 2019, in a context where recruitment is expected to remain stable and/or low.

Higher scenario: A 25% decrease in the TAC compared with the 2018.

Intermediate scenario: A 30% decrease in the TAC compared with the 2018.

Lower scenario: A more than 30% decrease in the TAC compared with the 2018.

Area 12C

Description of the fishery

Area 12C includes two parts (north and south) separated by the deep Anticosti Channel. Area 12C has 5 regular licences in Group A (68.7% of the TAC) and 38 special licences in Group B (31.3% of the TAC). The TAC peaked at 352 t in 2013 and 2014, and decreased in subsequent years. The TAC was further reduced by 10% in 2018 to 256.4 t and was not reached (landings of 235 t) (Figure 35). In 2018, for Group A fishers, the opening and closing dates were April 11 to July 17 and for Group B from April 18 to July 24.

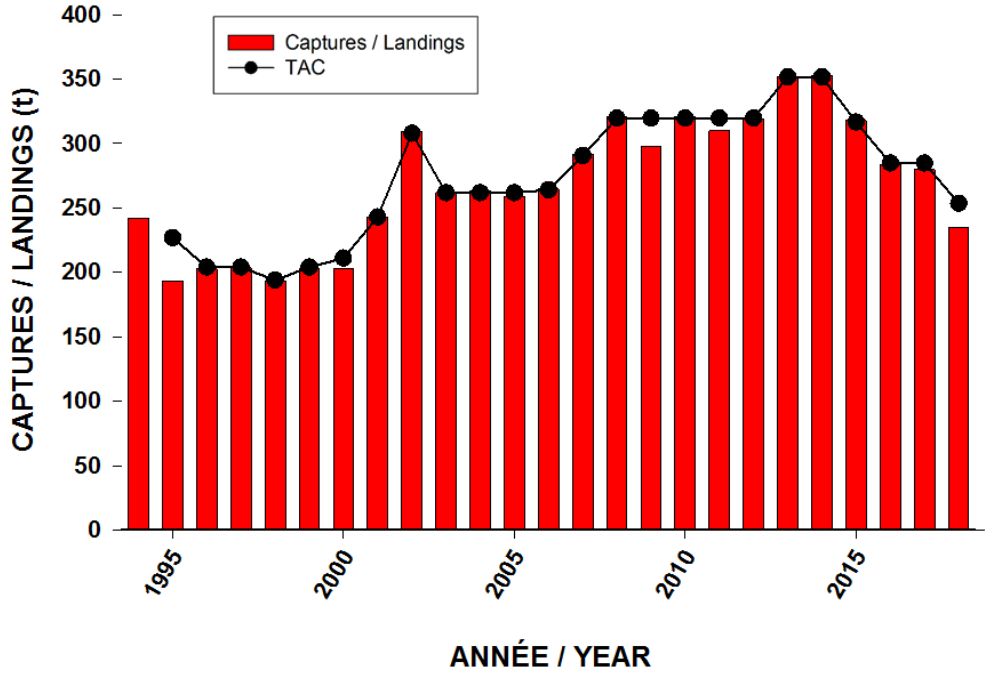


Figure 35. Annual landings and TACs in Area 12C.

Resource status in 2018

Commercial fishery. In 2018, the standardized CPUE decreased, reaching one of the lowest values and well below the historical average (Figure 36). The fishing effort was concentrated mainly in the northern part of the area. The proportion of recruits (carapace conditions 1 and 2) has decreased in landings over the last four years, but increased in 2018 to a level similar to 2014 and 2015. On the other hand, the proportion of intermediate-shell crab (carapace

condition 3) has always predominated in landings over the past five years. The proportion of old-shelled crab (carapace conditions 4 and 5) decreased from 2017 to 2018. The average size of legal-size crab caught at sea increased in 2018 and is slightly above the historical average (Figure 37).

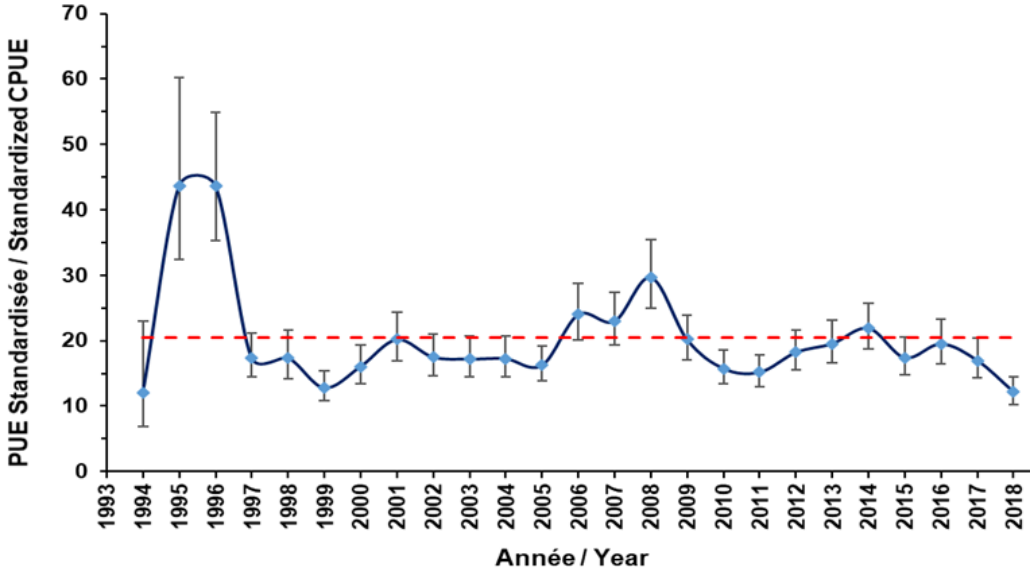


Figure 36. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 12C. The dashed line shows the data series average (excluding 2018).

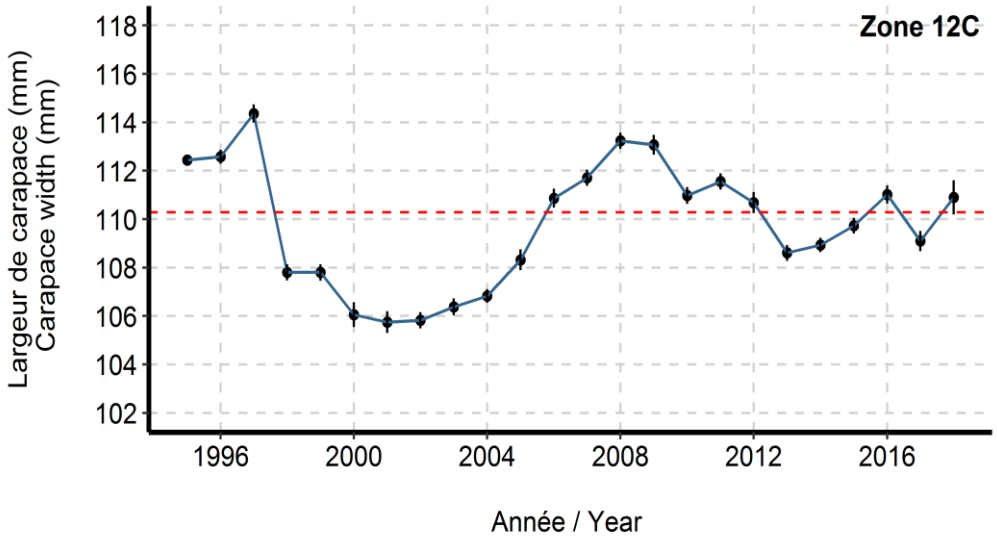


Figure 37: Carapace width (± 95% confidence interval) in the commercial fishery in Area 12C. The dashed line shows the data series average (excluding 2018).

Fishery-independent survey. The protocol for trap-based research survey was changed in 2014 to allow the use of a new larger, standard conical trap of 6.5 ft diameter. Both types of traps, former and new, were being used from 2014 to 2016. Since 2017, only the larger trap is used. Since catchability with this new trap needs to be further assessed in comparison with the

former traps, only the data including this new trap are presented. The trap-based research survey shows that the NPUE of adults ≥ 95 mm significantly decreased since 2014 (Figure 38). The NPUE of adolescents ≥ 78 mm and recruits increased from 2017 to 2018, and are below their respective averages under the new protocol (Figure 39).

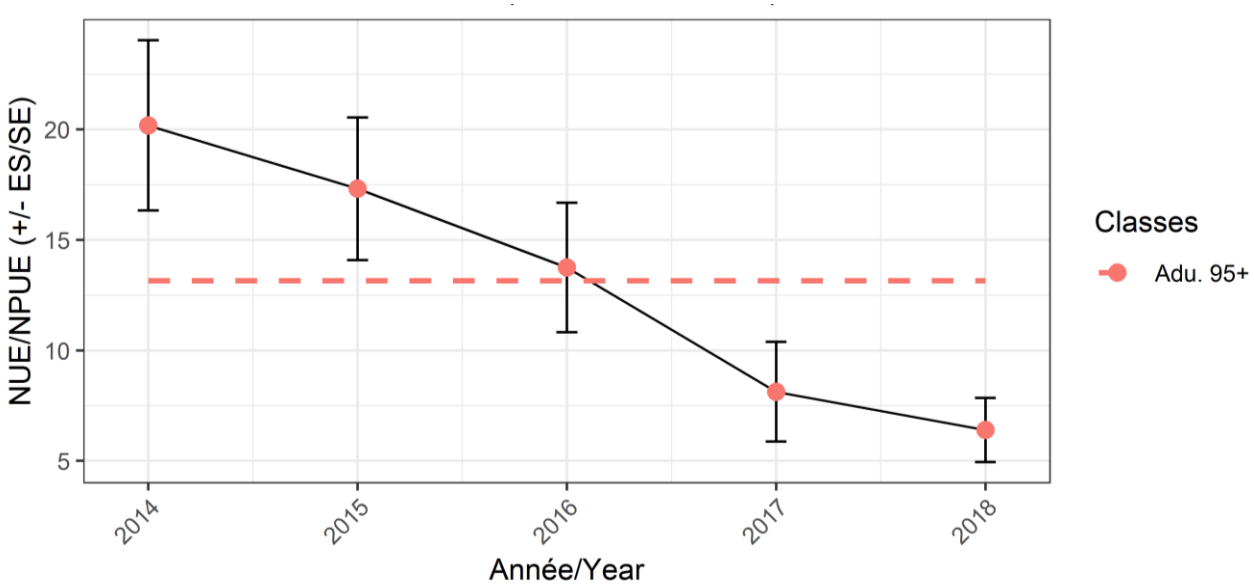


Figure 38. Annual catch rates (NPUE) (± standard error) of adult crabs ≥ 95 mm from the post-season survey in Area 12C. The dashed line shows the data series average.

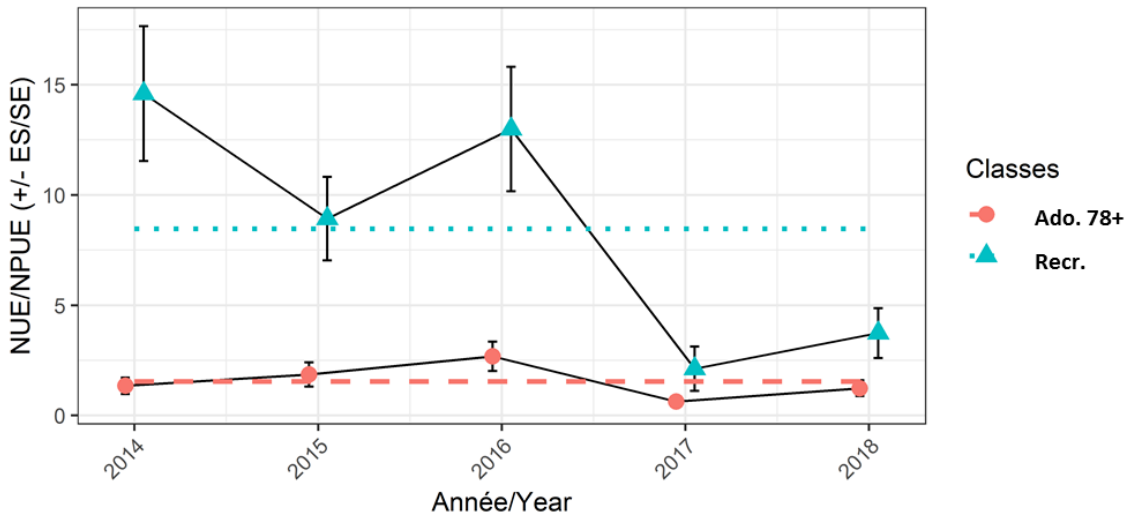


Figure 39. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in Area 12C. The dashed and dotted lines show the respective data series averages.

The combined index of commercial CPUE and NPUE of adult ≥ 95 mm from the post-season survey has been decreasing for a fourth consecutive year with a 26% decrease from 2017 to 2018. This decrease suggests that the biomass available to the fishery will be lower in 2019 than 2018.

A downward trend in the area of favourable thermal habitat for snow crab in Area 12C has been observed since 1990. The marked decrease in the availability of this favourable thermal habitat during the period from 2012 to 2016 could have a negative impact on the future productivity of the stock.

Outlook and conclusions

The 26% drop in the combined index, during a period of stable and low recruitment, suggests that the TAC should be reduced in 2019.

Higher scenario: A 25% decrease in the TAC compared with the 2018.

Intermediate scenario: A 30% decrease in the TAC compared with the 2018.

Lower scenario: A more than 30% decrease compared with the 2018.

Area 12B

Description of the fishery

Area 12B has eight regular licences. The TAC gradually increased from 246 t in 2010 to 468 t in 2014. The 2018 TAC was intended to enable monitoring of snow crab yields for this stock, which was considered to be in poor condition, but whose exact status is uncertain due to the absence of trap surveys in 2017 and 2018. The TAC decreased by 28.6% between 2017 and 2018 to 125 t. Landings totalled only 40 t and the TAC was not reached (Figure 40). In 2018, the fishing season opened on March 26 and closed on June 18. The area was abandoned by several fishers, for various reasons, and fishing effort was low, which could partly explain why the TAC was not reached.

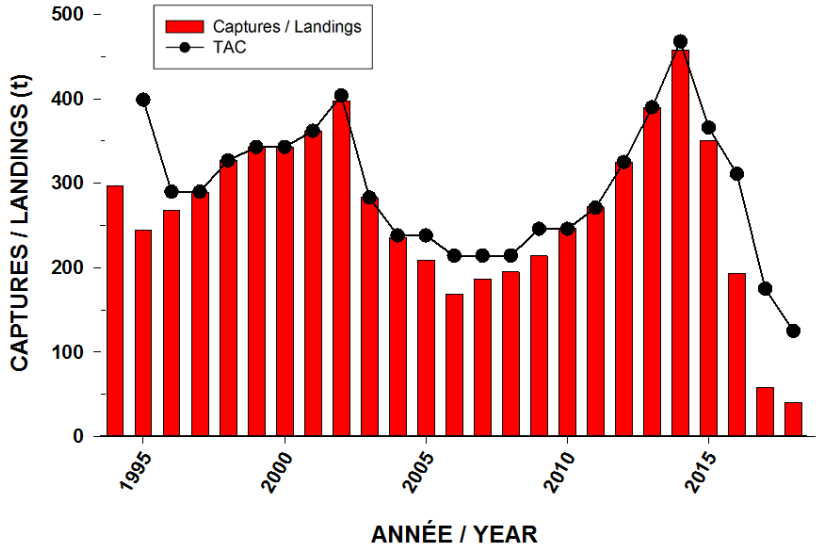


Figure 40. Annual landings and TACs in Area 12B.

Resource status in 2018

Commercial fishery. The standardized CPUE decreased sharply between 2013 and 2017, and despite a slight increase between 2017 and 2018, the value observed in 2018 is the second lowest value in the 1995–2018 series (Figure 41). Landings consisted primarily of intermediate-

shell crabs (carapace condition 3) as in recent years, recruits (carapace conditions 1 and 2) increased slightly while old-shelled crab (carapace conditions 4 and 5) remained relatively stable between 2017 and 2018. The average size of crabs caught in the commercial fishery has been decreasing for the last six years and is well below average (Figure 42).

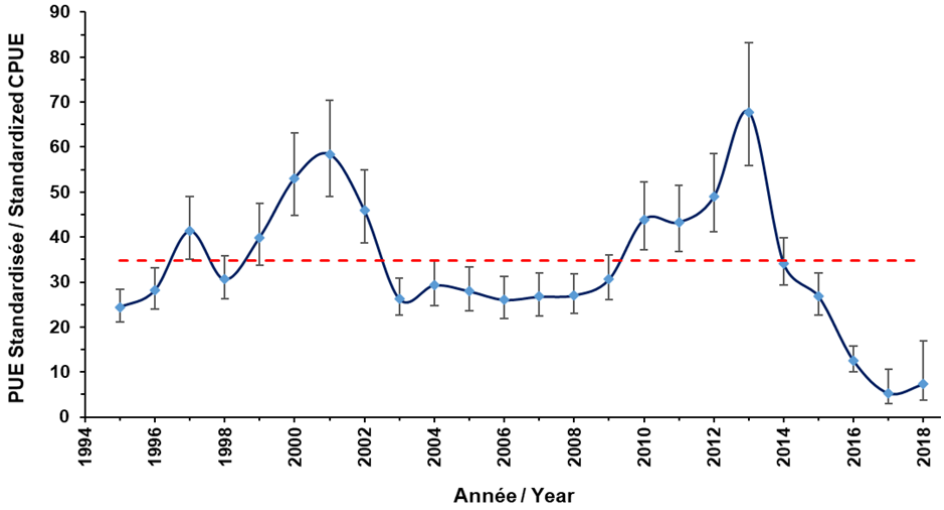


Figure 41. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 12B. The dashed line shows the data series average.

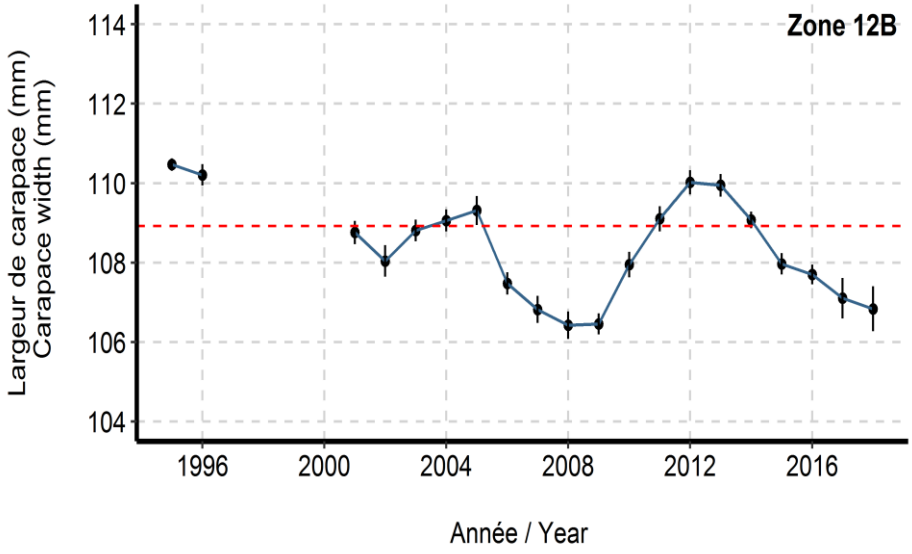


Figure 42. Carapace width (± 95% confidence interval) in the commercial fishery. The dashed line shows the data series average (excluding 2018).

Fishery-independent survey. The trap-based research survey conducted since 2001, the most recent dating back to 2016, shows that the NPUE of adults ≥ 95 mm, recruits and adolescents ≥ 78 mm has decreased sharply since 2013 and reached very low values in 2016. These results suggested a low biomass available to the fishery in the short and medium term. This post-season survey was not conducted in 2017. The absence of a post-season survey in 2017 and 2018 creates uncertainty with regard to future stock prospects.

A marked decrease in the preferred thermal habitat of snow crab in Area 12B has been observed in recent years, which could have negatively affected snow crab productivity and abundance. It should be noted that the corresponding index is up in 2018, for the second consecutive year.

Outlook and conclusions

The non-attainment of the TAC, low catch rates, small size and low recruitment of snow crab suggest that stock status did not improve in 2018. Given the uncertainty about the exact status of the biomass in this area, it is impossible to make specific recommendations.

It is recommended that harvest be set at the lowest level possible for monitoring of the area, further to a consultation between the fishing industry and Fisheries and Oceans Canada (Ecosystem and Fisheries Management sector).

Area 12A

Description of the fishery

Area 12A has 10 regular licences. The TAC was 105.5 t in 2018, an increase of 7% from 2017 (Figure 43) and has been reached. In 2018, the fishery opened on March 26 and closed on June 4.

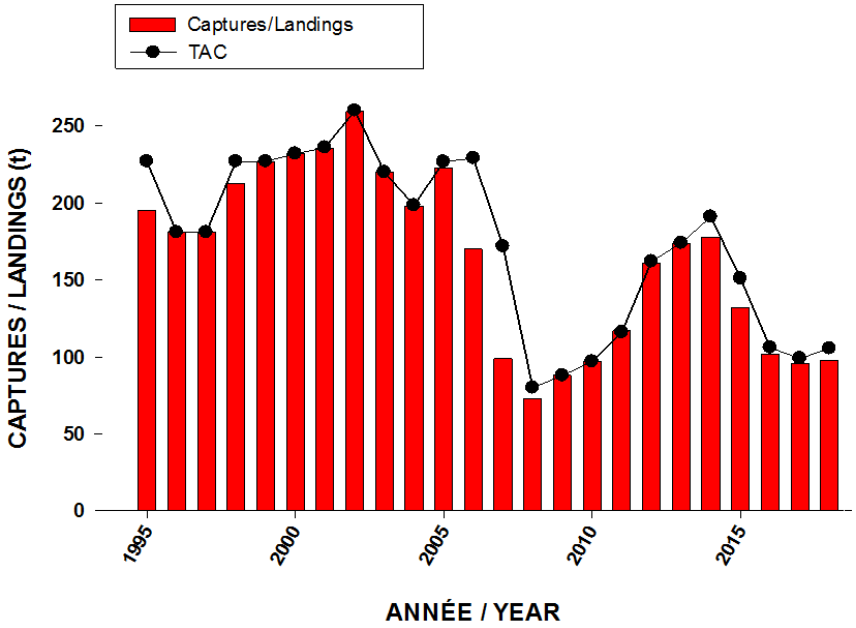


Figure 43. Annual landings and TACs in Area 12A.

Resource status in 2017

Commercial fishery. The standardized CPUE went from the highest value of the series in 2013 to one of the lowest observed in 2017, and remained similar in 2018 (Figure 44). An increase in the proportion of recruits (carapace conditions 1 and 2) in the landings was observed in 2018, which remains clearly dominated by of intermediate-shell crabs (carapace condition 3). The average size of crabs caught in the commercial fishery, which decreased from 2013 to 2016, increased in 2018 and is now above the historical average (Figure 45).

Fishery-independent survey. The trap-based research survey, which started in 2000, was not conducted in 2013 or 2016. The NPUE of adults ≥ 95 mm decreased between 2011 and 2018 from the highest value over the period to the lowest value of the series (Figure 46). The NPUE of recruits and adolescents ≥ 78 mm decreased between 2017 and 2018, reaching the respective lowest values for these two time series (Figure 47).

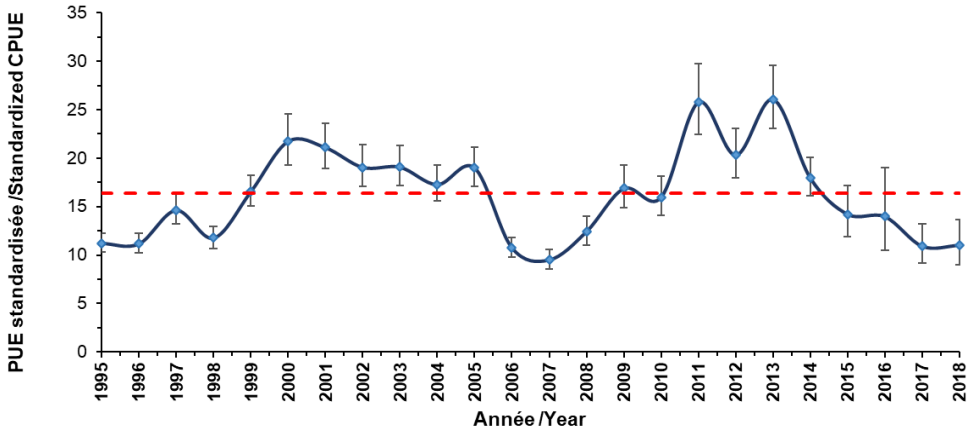


Figure 44. Standardized annual CPUE (± 95% confidence interval) in the commercial fishery in Area 12A. The dashed line shows the data series average (excluding 2018).

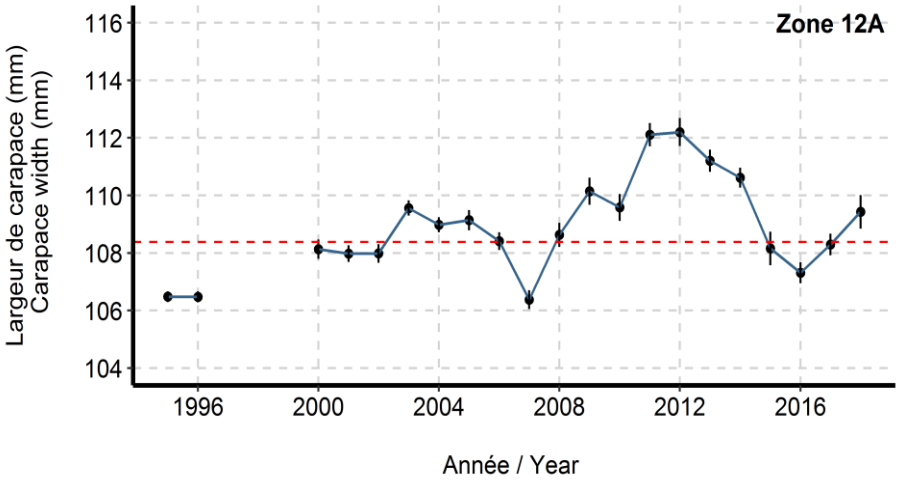


Figure 45. Carapace width (± 95% confidence interval) in the commercial fishery. The dashed line shows the data series average (excluding 2018).

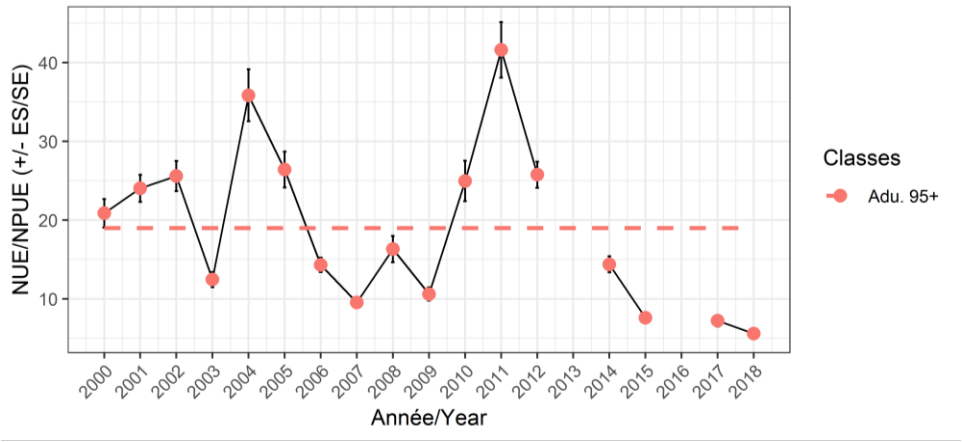


Figure 46. Annual catch rates (NPUE) (± standard error) of adult crabs ≥ 95 mm from the post-season survey in Area 12A. The dashed line shows the data series average.

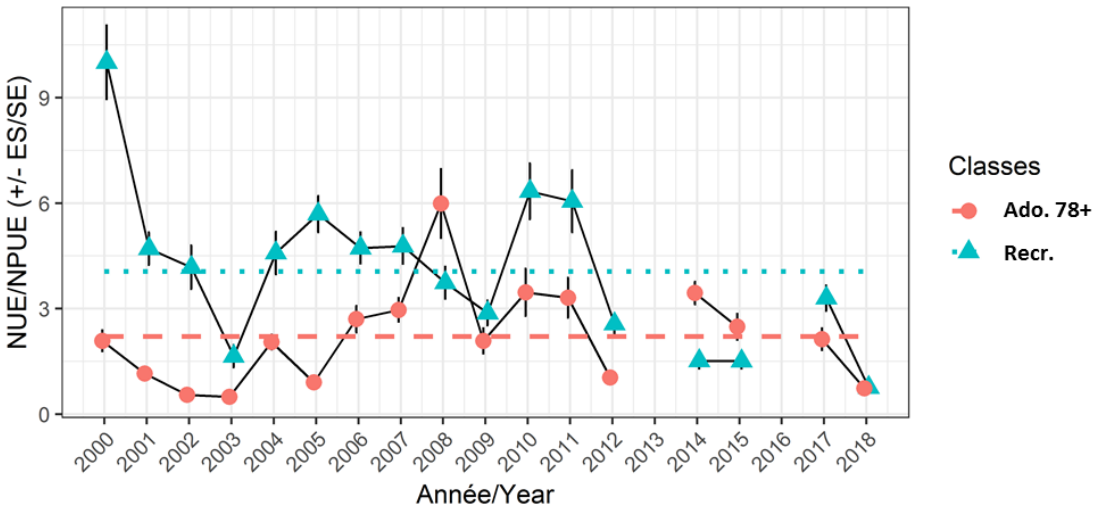


Figure 47. Annual catch rates (NPUE) (± standard error) of recruits (Recr.) and adolescents ≥ 78 mm (Ado. 78+) from the post-season survey in Area 12A. The dashed and dotted lines show the respective data series averages.

The combined index of commercial CPUE and NPUE of adult ≥ 95 mm from the post-season survey decreased by 7% from 2017 to 2018. The biomass available to the fishery in 2019 could be lower than in 2018.

A significant decrease in preferred snow crab thermal habitat in Area 12A was observed in 2015, which could have a negative impact on future stock productivity. Despite rising values of this index in 2017 and 2018, the time series for this index is declining over the 1990-2018 period.

Outlook and conclusions

The slight decline in the combined index suggests that the TAC should be reduced in 2019 compared with 2018:

Higher scenario: Statu quo of the TAC compared with 2018.

Intermediate scenario: A 7% decrease in the TAC compared with 2018.

Lower scenario: A more than 10% decrease in the TAC compared with 2018.

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, an increase in the temperature of the deep water layer and the surface layer has been observed in the Gulf of St. Lawrence. 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. A thermal habitat index (Tamdrari et al. 2012) was calculated for each fishing area based on the surface area where the bottom temperature is favourable to snow crab (-1°C to 3°C). 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.

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SOURCES OF INFORMATION

This Science Advisory Report is from the February 12 and 14, 2019, meeting on the 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.

DFO. 2018. Assessment of the Estuary and Northern Gulf of St. Lawrence (Areas 13 to 17, 12A, 12B, 12C and 16A) Snow Crab Stocks in 2017. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/047.

Dufour, R. and J.-P. Dallaire. 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.

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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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