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Status of Snow Crab (*Chionoecetes opilio*) Stocks in the Estuary and Northern Gulf of St. Lawrence (Areas 13–17, 12A, 12B, 12C and 16A) in 2024

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

We describe the status of the nine snow crab stocks in the Estuary and northern Gulf of St. Lawrence (nGSL), using a range of indicators derived from the commercial fisheries (logbooks, at-sea observations and dockside monitoring) as well as fishery-independent data (DFO trawl surveys and post-season scientific trap surveys). The analysis also considers temporal trends in indices that characterize suitable thermal habitat for snow crab.

In 2024, total landings reached 6,294 tonnes (t), suggesting that stocks have recovered after a period (2019–2020) of low recruitment and biomass decline that was observed in all fishing areas. This critical period coincided with the suspension of two trawl surveys and a significant reduction in at-sea observer coverage due to the pandemic, which increased the uncertainty in stock assessments.

Fishery-independent surveys recorded an exceptional abundance of berried (spawning) females between 2018 and 2022 in the eastern portion of the nGSL (from Havre-Saint-Pierre to Blanc-Sablon), as well as two years later in the western portion (west of Havre-Saint-Pierre, including the Estuary). The resulting cohorts began to show up in the most recent surveys in the Sept-Îles area (crabs < 10 mm), but were not detected along the Lower North Shore in 2024.

In recent years, a significant proportion of males have undergone their terminal moult before reaching legal size, limiting harvesting opportunities and potential catches in the Estuary and parts of the nGSL. In 2024, this situation was showing signs of improvement along the Lower North Shore, but persisted in the Estuary. High concentrations of adolescents measuring 62–78 mm observed along the Lower North Shore in 2024 suggest potential recruitment to the fishery in the years ahead, while short-term recruitment prospects in the Estuary remain uncertain.

INTRODUCTION

Since the early 2000s, Canada has accounted for most of the world's snow crab landings (Hvingel et al. 2021). In Canada, snow crab (*Chionoecetes opilio* Fabricius 1788) is 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. This research document presents the status of snow crab stocks in the nine management areas of the Estuary and northern Gulf of St. Lawrence (nGSL), based on indicators from the commercial fisheries, Fisheries and Oceans Canada (DFO) trawl surveys, and post-season trap surveys (Figure 1). The findings were examined during the February 2025 peer review to determine the status of the stocks and provide science advice (DFO 2025). The previous research document on the status of snow crab stocks in the Estuary and nGSL was published in 2016 (Lambert and Dallaire 2016). The current document primarily highlights key trends and changes in stock dynamics in the last ten years.

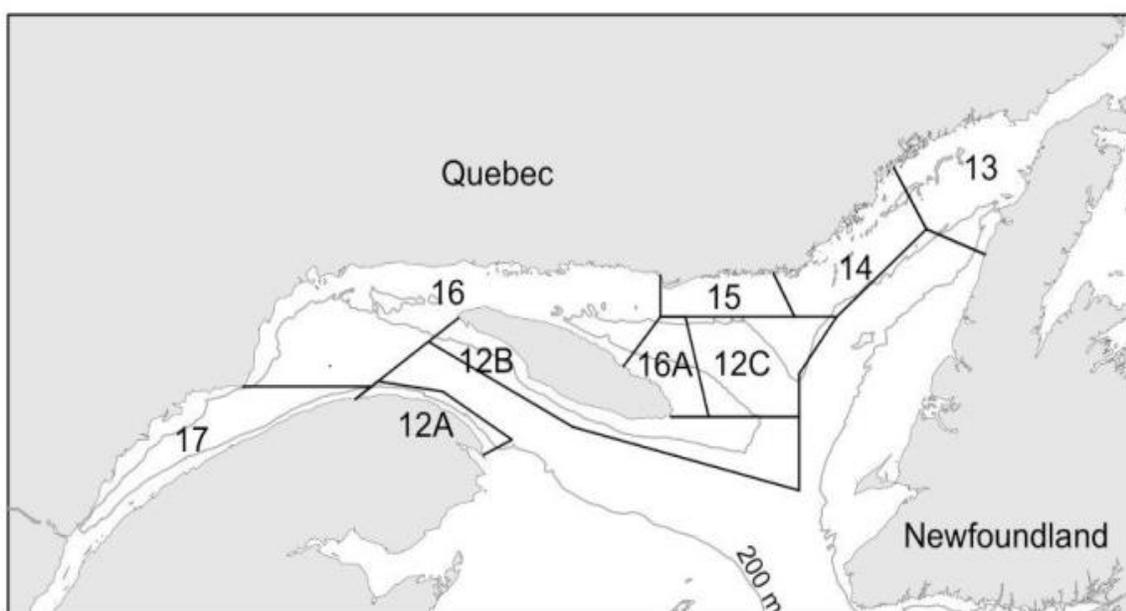


Figure 1. Snow crab management areas in the Estuary and the northern Gulf of St. Lawrence

BIOLOGY AND ECOLOGY

Snow crab is a stenothermic crustacean of subarctic waters. It belongs to the family Oregoniidae, which also contains two *Hyas* species found in the St. Lawrence. Similar to other arthropods, snow crabs grow by undergoing successive moults—typically twice a year during the first two years of benthic life and then annually between April and June (Conan and Comeau 1986; Sainte-Marie et al. 1995). Growth ceases after the terminal moult, when crabs reach full maturity and their final size. At this point, males have a carapace width (CW) ranging from 40 to 165 mm, while females, which are smaller, have a carapace width ranging from 30 to 95 mm (Watson 1970; Conan and Comeau 1986). This sexual dimorphism reflects the different number of instars in males and females. Males reach adult size between 9 and 12 years at instars XII to XIII (Sainte-Marie et al. 1995), while females mature earlier—at an age between 5.5 and 6.5 years, at instars IX to X (primarily instar X)—and reproduce for the first time shortly after their terminal moult (Alunno-Bruscia and Sainte-Marie 1998; Comeau et al. 1998; Sainte-Marie et al. 1999). Growth patterns may vary with temperature and density; for example, skip moulting occurs more frequently in colder waters (Sainte-Marie et al. 2021; Mullaney and

Baker 2021; Mallowney et al. 2023). After moulting occurs, it takes approximately five to six months for the carapace to harden and flesh content to increase (Sainte-Marie 1997). Soft-shelled adult males, referred to as “white crabs,” cannot reproduce during the year after their terminal moult (Conan and Comeau 1986). Male snow crabs can live up to seven years after this moult, although the appearance and integrity of their shells deteriorate (Fonseca et al. 2008). Males of high commercial value—those with clean shells and relatively intact bodies (few or no missing legs)—can typically be harvested for up to three years after undergoing the terminal moult (Sainte-Marie and Dufour 1994). The estimated maximum lifespan of males and females is 19 years and 13 years, respectively (Comeau et al. 1998).

Each mature female can mate with multiple males, storing the excess sperm for later fertilization in organs called spermathecae (Sainte-Marie et al. 1999). Copulation occurs in winter after the female undergoes her terminal moult, with males often “guarding” females during this period to ensure copulation. The females carry the eggs under their abdomens for one to two years, depending on water temperatures (Sainte-Marie and Gilbert 1998), until hatching occurs, sometime between April and June.

According to Sainte-Marie (1993), females reproduce only two to three times during their lifetime, producing a total of 82,000 eggs on average. The pelagic larvae (the first two instars after hatching, also known as the zoea I and II instars) feed on plankton and occupy the upper mixed layer of the water column, which is relatively warmer (between 2°C and 8°C in summer; Ouellet and Sainte-Marie 2018). Upon reaching the final pelagic instar, also referred to as the megalopa instar, the larvae drift downward through the water column, undergo a metamorphic moult, and settle on the seabed as juvenile crabs. In the nGSL, the summer larval drift lasts from two to four months (Ouellet and Sainte-Marie 2018). Although the survival rates of the larval (pelagic) and immature (benthic) instars remain unknown, natural mortality owing to predation is expected to decline as individuals grow (Otto 1998).

Snow crabs inhabit sandy or muddy bottoms at temperatures from -1°C to 4.5°C (Dionne et al. 2003; Ouellet and Sainte-Marie 2018). In the Gulf of St. Lawrence, large males (≥ 95 mm CW) are typically found at depths of 50–200 m, except during moulting or winter spawning, when they migrate toward shallower coastal areas (Sainte-Marie and Hazel 1992). Newly mature primiparous females migrate to the cold intermediate layer at depths of 40–110 m (Sainte-Marie et al. 2005), while multiparous females—those that have produced at least one brood—congregate at greater depths (> 80 m), similar to their large adult male counterparts (Sainte-Marie and Hazel 1992). During their benthic phase, male snow crabs travel an average distance of approximately 20 km per year, with a maximum recorded distance of 160 km based on tagging studies in the Gaspé Peninsula (Dufour and Bernier 1994) and the southern Gulf of St. Lawrence (Biron et al. 2008). The movements of immature individuals and females are currently unknown.

From a genetic perspective, snow crab in Atlantic Canadian waters form a single biological unit (Puebla et al. 2008). However, environmental factors such as temperature, topography and substrate can lead to localized differences in populations in various management areas (Lambert and Dallaire 2016). For example, the cold waters of the Mecatina Trough in Area 13 seem to be associated with smaller average crab sizes in that part of the Gulf.

RESOURCE MANAGEMENT

Snow crab fishing in the Estuary and nGSL began in the late 1960s and grew substantially between 1979 and 1985. Total allowable catch (TAC) management was introduced gradually from 1985 to 1995. In the Estuary and nGSL, snow crab is managed in nine fishing areas (13 to 17, 16A, 12A, 12B and 12C).

Annual landings in each area have fluctuated along with the TAC, which is adjusted based on recruitment pulses and troughs, which affect the number of crabs available to the fishery.

The fishery exclusively targets legal-size males (CW \geq 95 mm). This management measure aims to preserve stocks' reproductive potential by protecting females and a portion of male spawners, specifically those that have undergone their terminal moult but have not reached 95 mm CW. In addition, the fishery must retain all legal-size crabs, except for recently moulted crabs (white crabs) and adolescent crabs (small-clawed crabs), which are excluded to allow these two groups to increase meat yield and participate in spawning. Since 1985, a closure protocol by management area or sub-area has been implemented when the proportion of white crabs in catches exceeds a defined threshold. This measure is intended to reduce potential mortality from handling these more fragile individuals. Although fall fishing took place in some management areas during the 1990s, the fishing season for snow crab currently begins as early as possible in spring and lasts for 10 to 14 weeks, depending on the area. Fishing is conducted using baited traps soaked for a maximum of three days. In Quebec, two types of traps are used: Japanese traps (conical with a 120 cm base) and conical traps (with a base exceeding 180 cm).

METHODOLOGY

DATA SOURCES AND SAMPLING

Commercial fishery

Commercial fishery data comes from three separate sources: Zonal Interchange File Format (ZIFF) data, DFO's dockside sampling program and the at-sea observer program.

ZIFF data originates from fishers' logbooks and the purchase slips issued by processors. The logbooks record details of each fishing trip, including the vessel number, trip start and end times, type and quantity of traps used, location (fishing quadrant and, since 2015, latitude and longitude of the start and end points), and catch weight.

As part of the dockside sampling program, DFO employees conduct subsampling of landed catches in each management area. The detailed protocol for snow crab measurements, updated annually, is available online (see [Commercial sampling protocols](#)). Although the sampling plan (i.e., the seasonal schedule and number of samples per area) is reviewed annually, it remains much the same from year to year.

The at-sea observer program is intended to ensure timely verification of fishing activities at sea by an independent third party. Certified private-sector observers are placed aboard fishing vessels to monitor fisheries-related activities, collect scientific data and ensure industry compliance with fisheries regulations and licence conditions. Observer coverage varies by snow crab fishing area (Table 1).

Table 1. Percentage of fishing trips covered by at-sea observers in the commercial snow crab fishery in the nine management areas of the Estuary and northern Gulf of St. Lawrence

Fishing Areas	Percentage of Coverage
12A, 12C, 15, 16, 16A and 17	10%
14	5%
13	5% of fishers from Quebec and 2.5% of fishers from Newfoundland and Labrador

This document presents only the scientific data collected by at-sea observers.

Fishery-independent surveys

DFO trawl surveys

DFO conducts two annual trawl surveys: a summer survey, carried along the Lower North Shore in one year and in the St. Lawrence Estuary in the next, and a spring survey southwest of Sept-Îles, in Sainte-Marguerite Bay (Figure 2).

Sampling is performed using a beam trawl measuring 2.8 m in width and approximately 0.76 m in height. The codend is lined with a net with a stretched mesh size of 16–17 mm. Three heavy chains attached to the trawl shoes drag along the seabed to dislodge partially buried individuals. In the northeastern Gulf, a row of rubber rollers (roughly a third of a metre in diameter) may be added, and two of the chains replaced with rubber tubes to prevent the trawl from snagging on uneven and partially rocky bottoms. Trawl tows generally last 10 minutes at a speed of approximately 2 knots (tow distance of roughly 600 m). The vessels used for these surveys have included the CCGS *Calanus II* (until 2012) and the CCGS *Leim* (since 2013). A comparative survey took place with the two vessels in 2013, but no conversion factor was required because of the rigid-frame fishing gear used (i.e., beam trawl).

On the Lower North Shore, a systematic sampling plan is used to conduct the survey, which covers the area between La Tabatière and Blanc-Sablon. A total of 47 fixed stations (referred to as “conventional” stations) are sampled in Areas 13 and 14, along with as many as 60 exploratory stations, mainly between Baie-Johan-Beetz and Kegaska (Areas 15, 16 and 13). These stations were selected after a successful trial (i.e., no significant net damage occurred). Sampling depths range from 96 to 228 m.

The St. Lawrence Estuary survey also employs a systematic sampling plan, consisting of 92 fixed stations, all within Management Area 17. The 68 stations on the North Shore have been sampled since 1993, while South Shore sampling began in 2009. Both surveys are generally conducted between mid-June and early August. The Lower North Shore survey did not take place in 2020 owing to the COVID-19 pandemic and the Estuary survey was cancelled in 2021, because the CCGS *Leim* was unavailable.

The Sainte-Marguerite Bay spring survey is carried out annually, with stations selected based on a stratified random sampling plan. A maximum of six trawl tows are conducted per depth stratum (4–20 m, 20–50 m, 50–80 m, 80–110 m, 110–140 m and 140–200 m). Tow duration ranges from 5 to 10 minutes, depending on the nature of the seabed and the anticipated amount of bycatch. Trawling speed is approximately 2 knots. This survey generally takes place in late April or early May, several weeks after the start of the commercial fishing season in Area 16. In

2020 and 2022, owing to the research vessel's unavailability in spring, surveys were conducted in July after the fishing season ended.

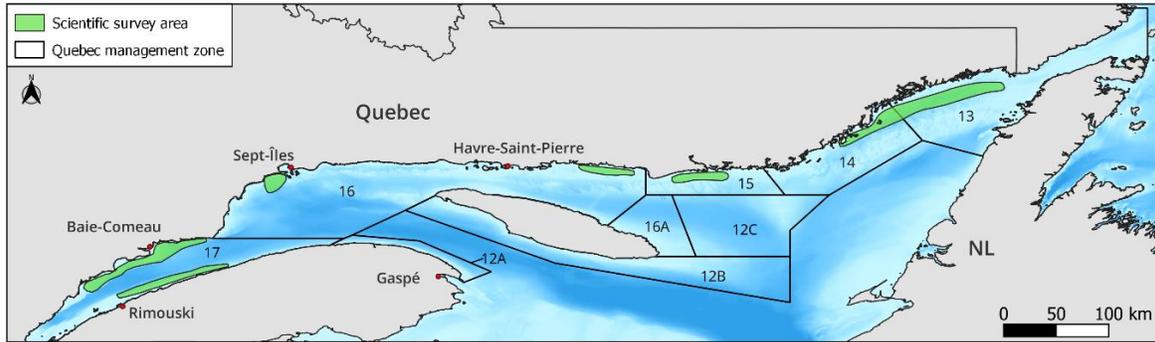


Figure 2. Areas targeted (in green) by DFO snow crab trawl surveys in Quebec.

Post-season surveys

Post-season trap surveys are carried out annually following a protocol involving fixed-station transects. These surveys are funded and conducted by the industry after the end of the fishing season (Figure 3). One survey is carried out in each management area, except in Area 13, where two separate surveys take place: one in the northern part (13Q) and one in the southern one (13TN).



Figure 3. Geographic locations of traps used in post-season snow crab surveys in the nine management areas of the Estuary and northern Gulf of St. Lawrence. Maps of the trap locations for each post-season survey are provided in Appendix 1.

The soak time for traps, which are baited, is approximately 24 hours. All captured crabs are measured and categorized, except when catches are too large (see subsampling section of the protocol in Appendix 1), to maximize the survival of crabs returned to the water. Detailed protocols for the 10 post-season surveys are presented in Appendix 1, and a summary of their characteristics is provided in Table 2.

Table 2. Characteristics of the 10 post-season snow crab surveys conducted by the industry in the nine management areas of the Estuary and northern Gulf of St. Lawrence. The start and end dates represent the median values for previous surveys, and the number of days reflects the median duration based on historical data.

Area	No. of Transects	No. of Traps	No. of Days	Beginning Date	End Date	Year of First Survey
17	23	299	35	July 21	August 13	1996
16	25	175	15	Sept. 08	Sept. 19	1994
15	10	60	20	August 24	Sept. 02	1998
14	12	84	20	Sept. 10	Sept. 20	1996
13Q	10	70	30	Sept. 16	Sept. 26	1999
13TN	12	138	15	Sept. 18	Sept. 20	1999
16A	14	59	20	August 30	Sept. 09	2002
12C	19	54	20	August 24	Sept. 01	2000
12B	16	160	20	August 27	Sept. 03	2001
12A	10	130	20	Sept. 02	Sept. 14	2000

Water temperature

The thermal habitat index for adult and juvenile (< 12 mm) snow crab is calculated using water temperature data obtained in the Atlantic Zone Monitoring Program (AZMP). Temperatures are interpolated from samples taken in August and September during the 1990–2024 period (Galbraith et al. 2024). These data are used to understand seasonal and interannual variations in the ocean and to help estimate the proportion of habitat that falls within the preferred temperature ranges of adult (-1°C to 3°C) and juvenile (0°C to 2°C) crabs (Dionne et al. 2003; Sainte-Marie et al. 2005; Ouellet and Sainte-Marie 2018).

BIOLOGICAL MEASUREMENTS

Sex (M/F)

In snow crabs, sex is determined by the relative size and shape of the abdomen: males have a narrow, rectangular abdomen, while females have a wider, oval-shaped abdomen. Sexing very small individuals (< 8.13 mm) is challenging and they are assigned a sex in order to maintain a 1:1 sex ratio for the figures illustrating size and density distribution.

Size (in mm)

Snow crab carapace width (CW) is measured to the nearest millimetre using a vernier caliper. In males, the claw (or chela) height is also measured to the nearest tenth of a millimetre (see the section on morphometric maturity below).

Morphometric and sexual maturity

Male (adult/adolescent)

Following their terminal moult, males develop enlarged claws. These crabs, which no longer increase in size, are classified as adults. Those that have not yet undergone their terminal moult are classified as adolescents. Therefore, morphometric maturity in males is determined by the relationship between carapace width (CW) and chela height (CH) using the following equation:

$$Y = 2.6077 - (1.2209 \cdot \ln CW) + \ln CH \text{ (Sainte-Marie and Hazel 1992)}$$

Crabs are classified as adolescent if $Y \leq 0$ and adult if $Y > 0$.

Female (immature/primiparous/multiparous)

Females reach sexual maturity upon undergoing their terminal moult. Immature females are identified by their smaller abdomen, which does not extend over the entire leg area. Primiparous females have a smooth, clean carapace with no signs of wear or grasping marks (mating scars), while multiparous females have a worn carapace with grasping marks. Egg colour (an indicator of the eggs' developmental stage) and clutch size are also monitored, but results are not included in the present stock assessment (see Appendix 1 for the post-season survey protocol and a description of egg characteristics).

Carapace condition (1 to 5)

Male carapace condition is assessed using multiple criteria to describe the aging and appearance of the carapace following moulting. This metric is recorded for males with a CW greater than 40 mm. For analysis purposes, legal-size individuals with carapace conditions 1 and 2 are categorized as recruits, while those with carapace conditions 3, 4 and 5 are categorized as "crabs left by the fishery" (i.e., residual abundance).

A summary table of the visual characteristics used to determine carapace condition is provided in Appendix 1.

Shell hardness is measured exclusively in the at-sea observer program, in male crabs with a carapace condition of 2, to identify crabs more vulnerable to handling. A durometer is used to take this measurement, using the right claw. In addition, individuals with a carapace condition of 1 or 2 and a hardness value below 68 are considered "white crabs" and the percentage of crabs in this category is tracked during the fishing season. Since shell hardness measurements are used for management purposes rather than for determining population status, the results of this biological measurement are not presented here.

Spermathecal load

During certain fishery-independent surveys (the three trawl surveys and the post-season surveys in Areas 17, 15, 14 and 13), approximately 40 primiparous females are dissected annually to collect the right spermatheca, which is preserved in 4% formalin. In the laboratory, the spermathecal contents are isolated by removing the surrounding maternal tissue and the thin outer membrane. The weight of the spermathecal contents is measured to the nearest ten thousandths of a gram (0.0001 g).

DATA ANALYSES

Landings, catch per unit effort and fishing effort

The spatial distribution of commercial catch per unit effort (CPUE), fishing effort, and landings, derived from data in the ZIFF files, is shown for the nine fishing areas, as well as annual changes in these metrics in each area. The distribution of fishing effort was obtained from the number of trap hauls per fishing position during each commercial fishing trip recorded in the ZIFF files. Given that crabbers generally use 150 Japanese traps or 75 conical traps per licence, effort values were corrected so that effort could be compared spatially without giving twice as much weight to Japanese traps.

Raw (unstandardized) catch per unit effort (CPUE in kg/trap) was calculated based on the weight of commercial catches and the number of traps used for each fishing trip. However, raw CPUE values may vary depending on factors such as soak time and trap type. To compare mean annual CPUE values, standardization is required to account for the effects of some of these factors on catchability and to isolate variations due solely to year effects. Ideally, interannual variations in standardized CPUE would be proportional to variations in biomass.

In 2003, an initial method using a multiplicative model was proposed in order to standardize CPUE in the five largest fishing areas in the Estuary and nGSL (Areas 13–17) (Gavaris 1980; Bourdages and Dufour 2003). In 2006, the model was expanded to include the random effect of vessel number, the fixed effect of fishing quadrant, and the interactions between month, trap type and soak time (DFO 2007). The following model was used to standardize the CPUE for fishing trip i and vessel number j (1) in each management area (Areas 13–17, 12C and 16A), as follows:

$$\ln CPUE_i = \mu + b_1 A + b_2 E + b_3 M + b_4 Q + B + \varepsilon_{ij} \quad (1)$$

$$B_j \sim N(0, \sigma_B^2)$$

$$\varepsilon_{ij} \sim N(0, \sigma^2)$$

where

CPUE: Raw (unstandardized) catch per unit effort (kg/trap) for each fishing trip

μ : Intercept

A: Year

E: Fishing gear (68 = conical traps; 66 = Japanese traps)

M: Month

Q: Fishing quadrant (a square with 10 nautical-mile-long sides, defined by a geographic grid)

B_j: Random effect of the fishing vessel number, capturing vessel-specific variability

ε_{ij} : Error with a normal distribution around a mean of zero.

The method used to standardize the CPUE for Areas 13–17, 12C and 16A uses the MIXED procedure and LSMEAN option in the SAS software (for details on code, see Appendix 2 of Lambert and Dallaire 2016). The CPUE standardization program was adapted and applied separately to each fishing area. Before standardization, certain CPUE data were excluded from the calculation of the mean to retain only those that are the most representative (data selection details in Lambert and Dallaire 2016).

The standardization of commercial CPUE for Areas 12A and 12B was reviewed and approved during peer reviews in 2023 and 2024. The standardization method used for these areas employs a combined state space model (SSM) and multi-model inference approach. Several models were developed by adding different variables and factors affecting catchability, and were then compared to select the most parsimonious model that explains the greatest variability. In the SSM, the mean annual CPUE at time t ($CPUE_t$) is based on the previous year's mean (ecological process), while the variability and imprecision of each observation (raw CPUE) are accounted for in the observation model:

$$\begin{aligned} \ln(CPUE_{t+1}) &= \ln(CPUE_t) + \lambda_t + \varepsilon_{proc} \\ y_i &\sim dlnorm(\bar{y}_i, \tau_{obs_i}) \\ \tau_{obs_i} &= \tau_{obs_t} * weight_{traps_i} \\ \bar{y}_i &= CPUE_t + b_1 Soak_i + b_2 WeekF_i + b_3 1stDay_i \end{aligned} \quad (2)$$

where

λ_t : Annual intrinsic growth rate of the population (log scale);

$CPUE_t$: Mean CPUE in year t ;

ε_{proc} : Ecological process error, normally with a normal distribution around a mean of 0 and a variance of σ^2_{ε} ;

y_i : Raw (unstandardized) CPUE for a fishing trip;

τ_{obs_i} : Precision (inverse of variance; used here for consistency with the NIMBLE language; see Valpine *et al.* 2021a, 2021b) associated with the observation process for year t ;

\bar{y}_i : Expected raw (unstandardized) CPUE considering the year t , soak time ($Soak_i$), fishing week ($WeekF_i$) and first day of fishing ($1^{st}Day_i$);

$weight_{traps_i}$: Annual proportion of traps used on trip i , reduced and centred, used for weighting raw (unstandardized) CPUE values.

Abundance and densities in trawl surveys

Trawl surveys of the Lower North Shore and Estuary

Only data from the conventional (fixed) stations were used to calculate snow crab densities along the Lower North Shore, to enable comparison across the entire time series. Given the standardized sampling protocol employed in the trawl surveys along the Lower North Shore and in the Estuary, which is based on the use of fixed stations, annual abundance values were converted to density values for comparison purposes. This was done by calculating the swept area covered by each trawl haul, based on the trawl width and the distance travelled (derived from the start and end positions). Density was then estimated, using the formula *number of crabs* ÷ *swept area* (per km^2), for the following categories:

Immature males < 40 mm;

Adolescent and adult males 40–62 mm;

Adolescent and adult males 62–78 mm;

Adolescent and adult males 78–95 mm;

Legal-size adolescent and adult males (≥ 95 mm);

Immature females;

Multiparous females;

Primiparous females.

The average density by sex and maturity category was also calculated by using size classes (0.02 \log_{10} units). To monitor the proportion of males undergoing an early terminal moult, the densities of recently moulted (i.e., carapace conditions 1 and 2) adolescents and adults are calculated annually for each instar from IX (44–57 mm) to XII (87–105.5 mm). Temporal trends

in the proportions of adults undergoing an early terminal moult in each instar are presented separately for the Lower North Shore, the north shore of the Estuary and the south shore of the Estuary.

Sainte-Marguerite Bay survey

For the Sainte-Marguerite Bay survey, the average density of individuals by depth stratum (4–20 m, 20–80 m and 80–140 m) was calculated by size class (0.02 log₁₀CW units) for the different categories of crabs. The densities were then extrapolated based on the surface area of each depth stratum in the bay. By summing the estimated abundances for the three strata, an abundance index was obtained for the entire bay for each size class and crab category. The average annual abundance values (centred moving average ± 1 year) therefore represent extrapolated abundance values, expressed in millions of individuals, for the following categories:

Immature individuals < 6 mm (benthic instars I and II);

Adolescent males 26–40 mm;

Adolescent and adult males 40–62 mm;

Adolescent and adult males 62–78 mm;

Adolescent and adult males 78–95 mm;

Legal-size adolescent and adult males (≥ 95 mm);

Primiparous females.

As is done for the Lower North Shore and the Estuary, the prevalence of early terminal moult is monitored annually by comparing the proportion of recently moulted adult males (carapace conditions 1 and 2) in each instar between VIII (33–44 mm) and XIII (105.5–125 mm) using the following formula:

$$\text{Prop.adults}_i = \frac{\sum \text{AduCC12}_i}{(\sum \text{AduCC12}_i + \text{AdoCC12}_i)}$$

where

i: Instar (VIII–XIII)

AduCC12_{*i*}: Average density (centred moving average ± 1 year) of adults with carapace conditions 1 and 2 at instar *i*;

AdoCC12_{*i*}: Average density (centred moving average ± 1 year) of adolescents with carapace conditions 1 and 2 at instar *i*.

Average annual sizes of primiparous and multiparous females, legal-size adolescent and adult males, and sub-legal size adult males are presented.

Post-season surveys

Densities by number per unit effort (NPUE)

Since the post-season surveys use traps, abundance indicators are expressed as numbers per unit effort (NPUE), and calculated for the following crab categories:

Legal-size adults (≥ 95 mm);

Legal-size adolescents (≥ 95 mm);

Recruits (adults ≥ 95 mm with a CC of 1 or 2);

Left by the fishery (adults ≥ 95 mm with a CC of 3, 4 or 5);

Sub-legal size adults (78–95 mm);

Sub-legal size adolescents (78–95 mm).

These annual NPUE values are calculated using data from conventional traps exclusively—i.e., traps employed in the commercial fishery with a mesh size of 5–5.5 inches (type C traps; see protocol in Appendix 1). The NPUE represents the ratio of the total number of crabs caught in each category to the number of successful traps. Traps that perform poorly (e.g., broken, overturned) are excluded from the calculations.

When measuring all the crabs caught in a trap is not feasible owing to excessive numbers, a subsampling strategy is adopted (see protocol in Appendix 1). At a minimum, crabs are sexed and each sex is counted. In cases of partial counts or measurements, crab characteristics are extrapolated from the values obtained from all the crabs measured. Some of the SAS software codes for these calculations are provided in the appendix of Lambert and Dallaire (2016). As was done for the commercial CPUE, the NPUE calculations for Areas 12A and 12B were reviewed and calculated using an SSM.

Mean carapace width

Time series of the mean annual sizes of legal-size male crabs and mature females (primiparous and multiparous) are presented for each area. For males, these values are based on crabs caught and measured in commercial traps and, for females, on crabs caught and measured in experimental traps.

Stock status indicators

Since 2013, a combined indicator has been used to obtain more accurate estimates of short-term trends in commercial biomass, providing the basis for more consistent recommendations for a given stock over the years. This indicator is derived from two indices of biomass and abundance: the standardized CPUE from the commercial fishery and the NPUE of adult males measuring 95 mm or more from the post-season survey. Each index is standardized using its mean and standard deviation for the 2000–2012 reference period, and the combined indicator is calculated as the average of these standardized values for the current year. This approach is used in Areas 13–17, 16A and 12C.

As part of the process of developing precautionary approaches for Areas 12A and 12B, a multi-indicator method has been proposed. In Area 12A, a limit threshold of 10.02 kg/trap for the standardized CPUE for the commercial fishery and a limit threshold of 6.63 kg/trap for the CPUE95 from the post-season survey would be used to determine the status of the main commercial biomass indicators. In Area 12B, these thresholds are 24.5 kg/trap for the standardized commercial CPUE and 6.29 kg/trap for the CPUE95 from the post-season survey. Subsequently, a scoring grid would be applied individually to each area each year to assess resource status, based on the CPUE and CPUE95 values. If both indicators fall below their respective thresholds, the combined score is 0 according to the grid. A final score below 1.5 would place the stock in the critical zone (see Table 3).

Table 3. Proposed weighting system for biomass indicators as part of a precautionary approach for snow crab stocks in Areas 12A and 12B. The final score is the sum of points assigned based on the status of each indicator.

Criteria	CPUE	CPUE95	Precautionary Approach Zone	Final Score
Above the upper threshold	2	4	Healthy zone	≥ 5
Between the limit threshold and the upper threshold	1	2	Cautious zone	2 to 4
Below the limit threshold	0	0	Critical zone	0 and 1

Thermal habitat indices

Two indicators of suitable thermal habitat for snow crab have been developed: one for adult crabs and another for juvenile crabs (< 12 mm). These indicators represent the surface area of the seabed where the water temperature is between -1°C and 3°C for adults and 0°C and 2°C for juveniles, based on spatial temperature interpolations from the Atlantic Zone Monitoring Program (AZMP) for August (Galbraith et al. 2024).

RESULTS

COMMERCIAL FISHERY

Landings

From 2006 to 2018, total landings in the nine fishing areas remained at around 8,000 t (Figure 4). However, 2019 was a turning point, with a sharp overall decline recorded. In 2021, landings reached a historic low of approximately 4,000 t, a level not seen since 1990 (Figures 4 and 5). Landings in 2019–2020 were below their historical averages but, since then, most areas have shown an upward trend (Figure 5).

The situation is unique in Area 12B, where annual quotas (TACs) were not met between 2015 and 2020 (Figure 5), reflecting a decline in the status of the resource (DFO 2021) that culminated in the implementation of a moratorium in 2022.

Area 17 has been characterized by a predominance of landings in its southern portion since 1997 (Figure 6). However, declining yields have led to shifts in fishing strategies: during periods of marked declines in yields in the southern portion (2014 and 2024), the proportion of landings in the northern portion increased in response to this.

Area 13 also shows an alternating pattern of fishing activity: although landings were concentrated in the southern part (Newfoundland coast) between 2009 and 2016, activity has primarily shifted to the northern part (Quebec coast) since 2017 (Figure 7).

In Area 16, the north shore of Anticosti Island has been lightly fished historically (Figure 8). Elsewhere in the area, landings are evenly distributed among three main sectors: Sept-Îles, Rivière-au-Tonnerre and Natashquan (Figure 8).

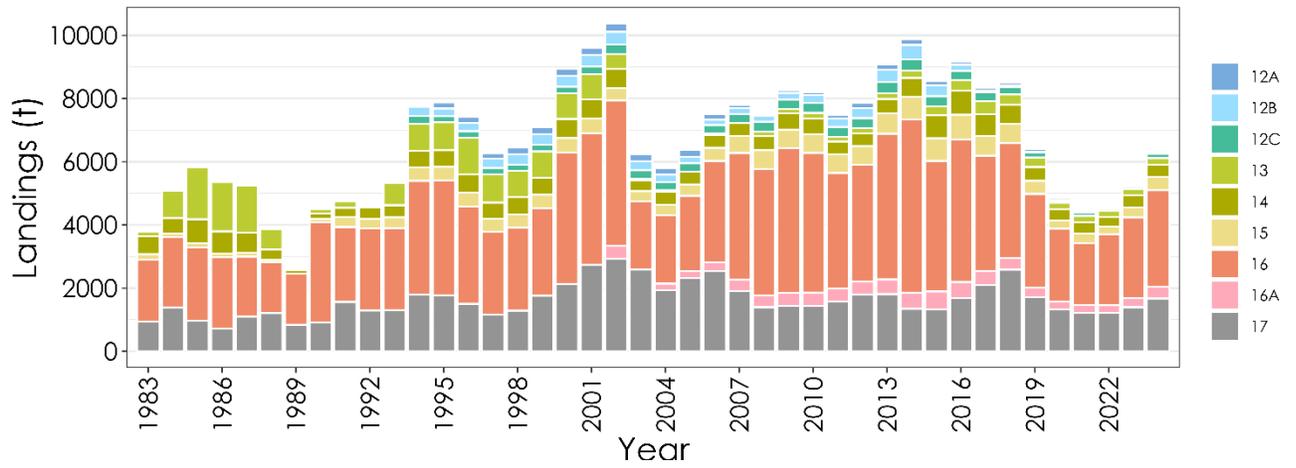


Figure 4. Snow crab landings (t) in the Estuary and northern Gulf of St. Lawrence by management area.

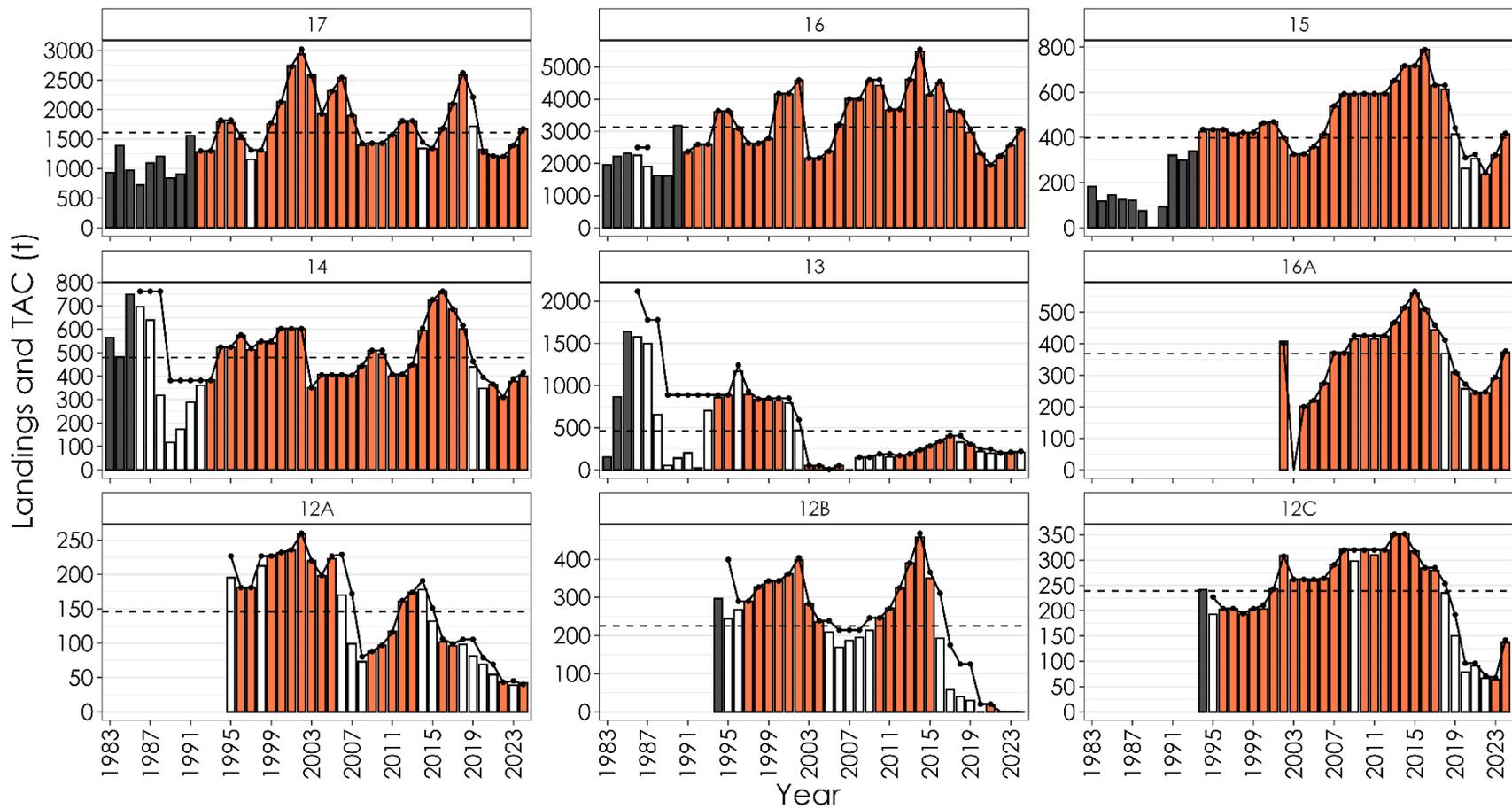


Figure 5. Landings (red bars) and TAC (black line) (t) from 1983 to 2024 in the nine fishing areas of the Estuary and northern Gulf of St. Lawrence. White bars representing landings signify that the TAC was not reached that year (a difference of 5% or more relative to landings). Grey bars indicate snow crab landings prior to the introduction of TACs. The black dotted line shows the historical average for landings in each area (time series of landings, excluding the most recent year).

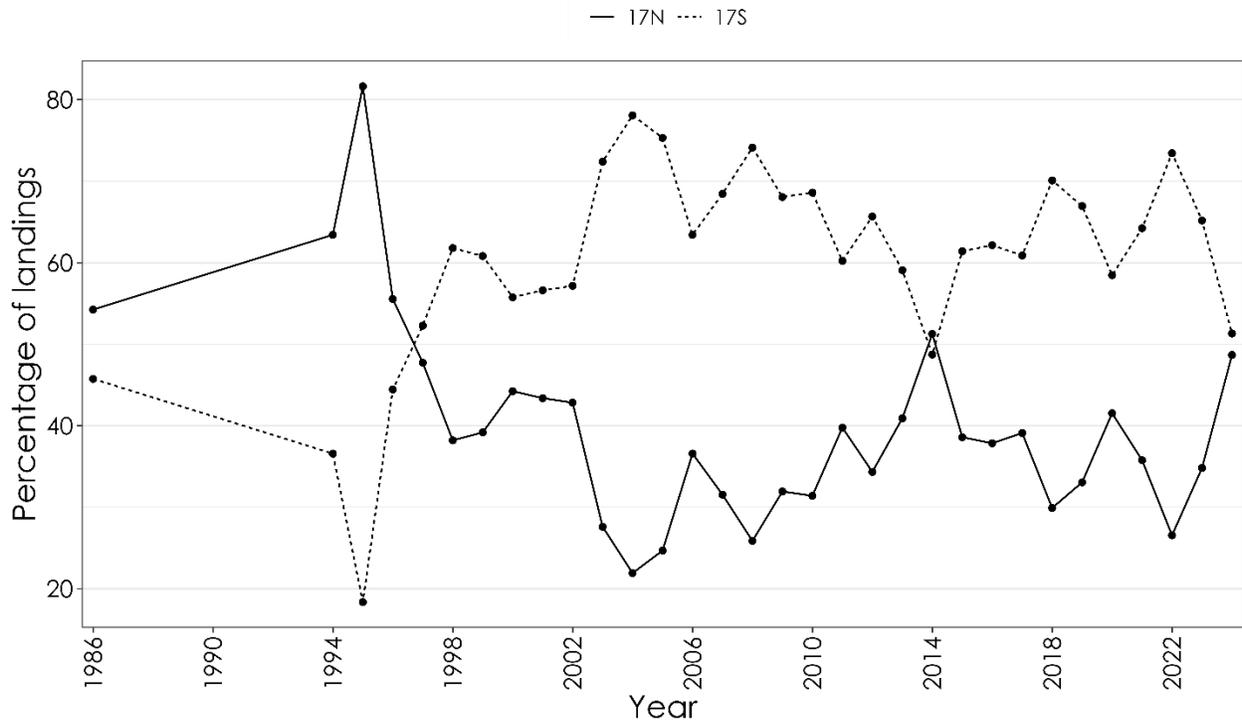


Figure 6. Percentage of landings in the northern (solid line) and southern (dotted line) portions of Area 17 from 1986 to 2024.

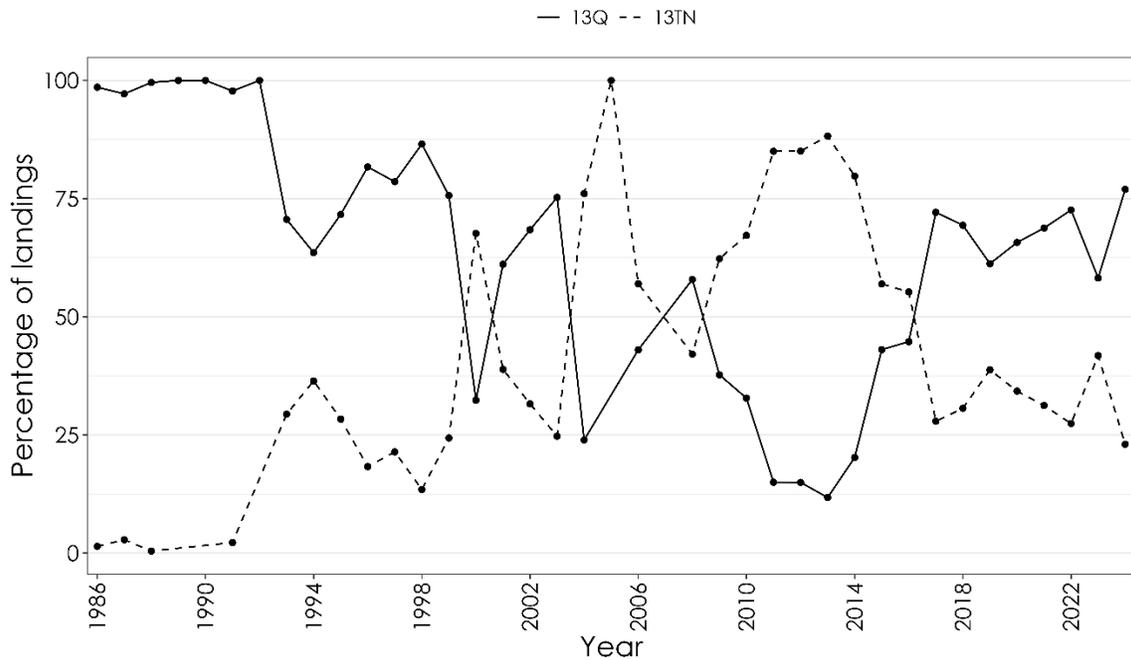


Figure 7. Percentage of landings in the northern portion (13Q – solid line) and southern portion (13TN – dashed line) of Area 13 from 1986 to 2024.

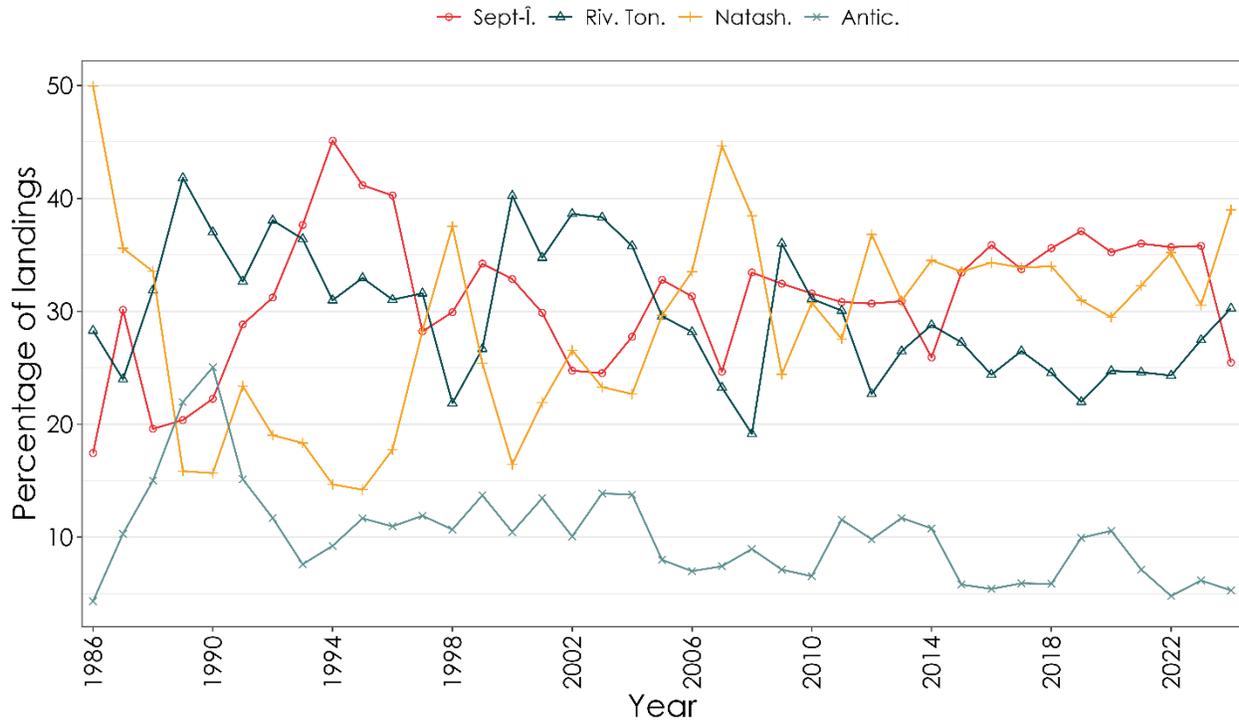


Figure 8. Percentage of landings in the Sept-Îles (red circles), Rivière-au-Tonnerre (green triangle), Natashquan (yellow cross) and Anticosti (blue diagonal cross) sectors of Area 16 between 1986 and 2024 (for a map of the four sectors, see Appendix 2).

Spatial distribution of fishing effort

Fishing effort is relatively well distributed across all the inshore waters of the Estuary and nGSL, except for a few areas less suitable for snow crab, such as the eastern part of Area 15 (Figure 9). In Area 17, fishing effort is concentrated near the major ports, including Rimouski and Matane (Figure 9).

Commercial CPUE values

Over the past 20 years, the highest raw (unstandardized) CPUE values have been recorded in Area 16 east of Havre-Saint-Pierre (Figure 10). The values observed in Areas 13, 14 and 12A are generally lower than those in Area 16.

The standardized CPUE values observed in 2019 and 2020—corresponding to the most recent low point in the abundance cycle for snow crab—are among the lowest in their respective time series (Figure 11). Standardized CPUE values tend to be lower in Areas 13 and 14 and higher in Area 16, setting aside certain years in Area 12B with very high values (Figure 11). Within this large area, standardized CPUE values also show contrasting patterns in the east and west, with these differences intensifying in 2024: CPUE values in the west (Sept-Îles) were low and declining, but were high and increasing in the east (Appendix 2). In Area 12B, standardized CPUE values peaked between 2010 and 2014, reaching values nearly three times the average in other areas in some years. However, following this peak, standardized CPUE values dropped sharply to near-zero levels (Figure 11).

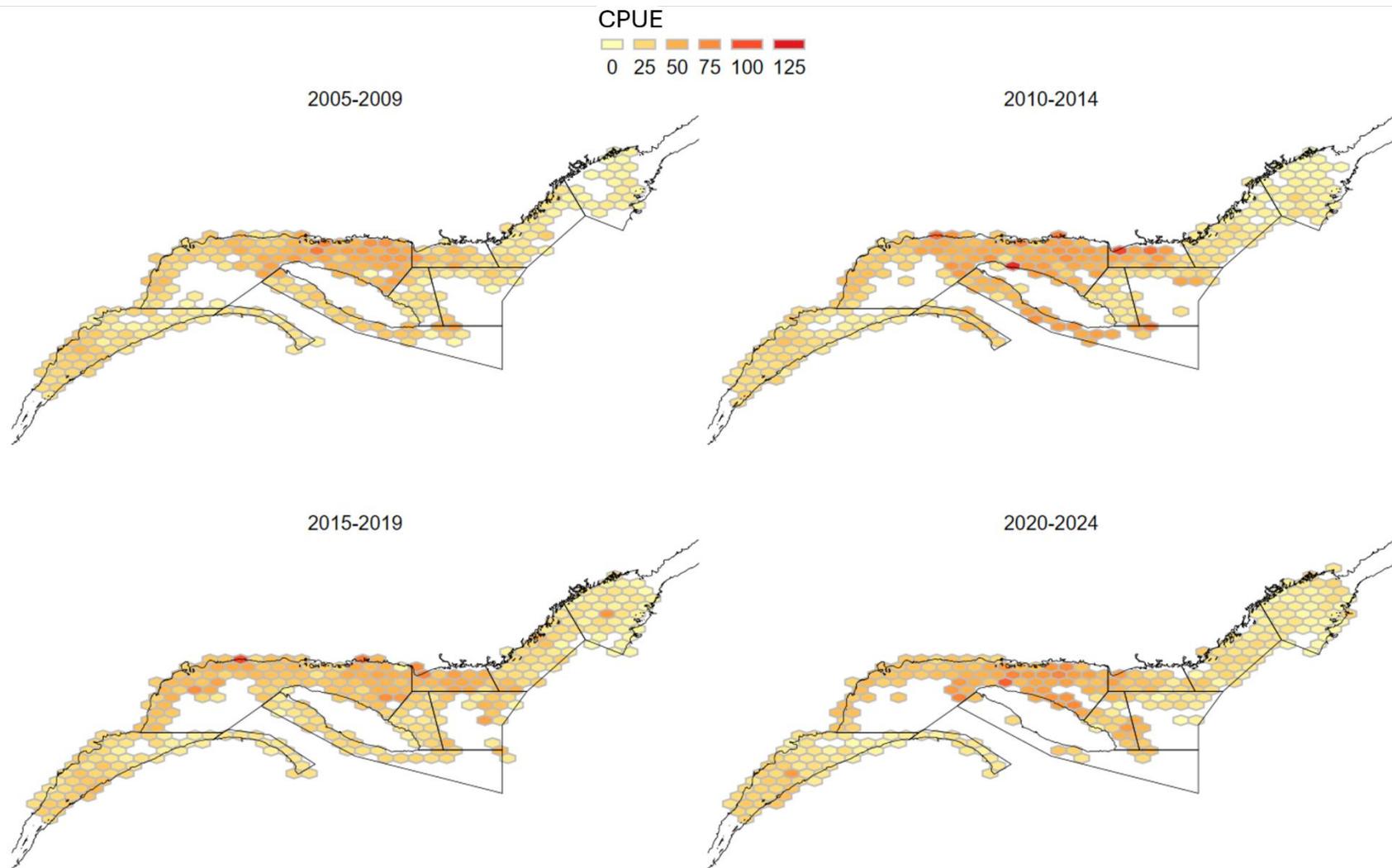


Figure 10. Spatial distribution of average raw (unstandardized) CPUE values (kg/trap-day) per hexagon, shown in five-year intervals, from 2005 to 2024, in the commercial snow crab fishery in the Estuary and northern Gulf of St. Lawrence.

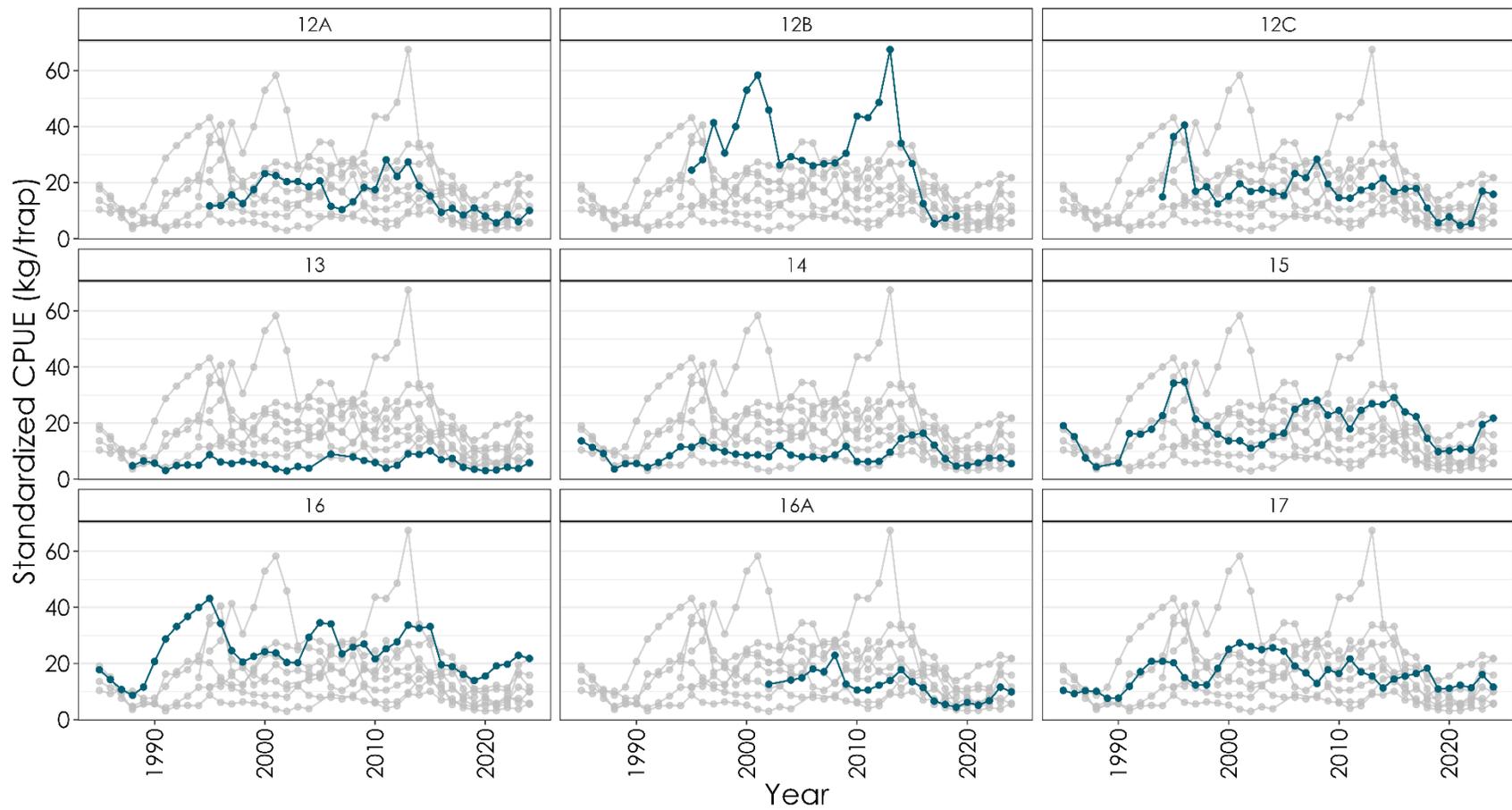


Figure 11. Standardized CPUE values (kg/trap-day) in the commercial snow crab fishery in the nine management areas of the Estuary and northern Gulf of St. Lawrence from 1986 to 2024. For each area, the blue curve represents annual standardized CPUE values, while the grey curves show the values for the other management areas for comparison purposes.

Carapace condition at dockside and at sea

Since the late 2000s, all areas have shown an overall increase in the percentage of recruits observed in at-sea sampling (Figure 12). This increase has been particularly significant in Areas 16 and 17, where recruits have represented roughly two thirds of catches since 2016 (Figure 12).

Landings consistently show lower percentages of recruits than those observed in at-sea sampling (Figure 13). This discrepancy is attributable to release practices: crabbers are permitted to release legal-size white crabs (carapace condition 1) and legal-size adolescents (small claws) without this being considered illegal high-grading.

Despite these quantitative differences, the same temporal trend is seen in dockside samples and in at-sea observations in most areas: a low percentage of recruits prior to 2005, followed by a period of higher percentages (Figure 13).

Significant variability in sample sizes at sea in recent years complicates the interpretation of these data. Details on the number of crabs measured by area and year are provided in Appendix 3.

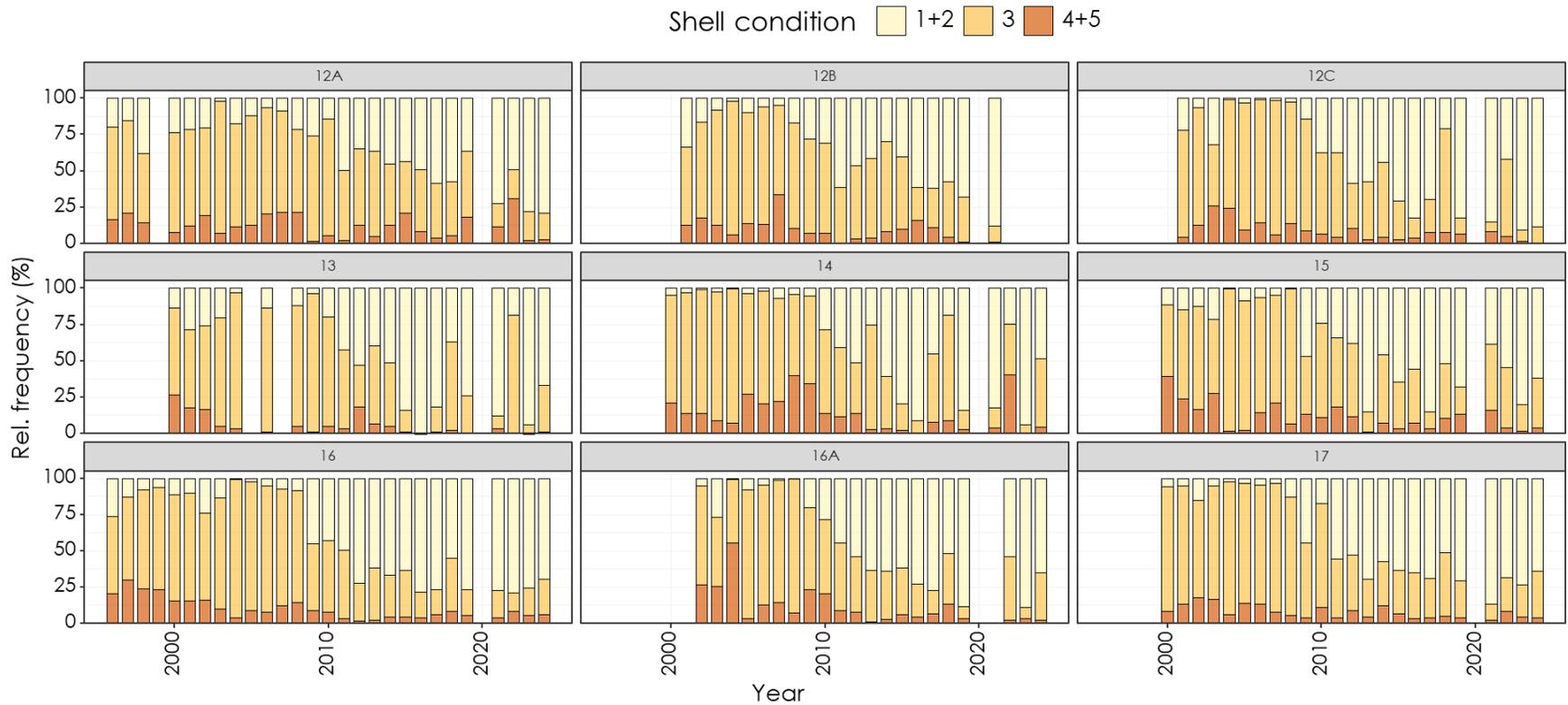


Figure 12. Percentages of recruits (crabs with carapace conditions 1 and 2), intermediate-shell crabs (condition 3) and old-shell crabs (conditions 4 and 5) among legal-size snow crabs sampled at sea in the commercial fishery in the at-sea observer program in the nine fishing areas of the Estuary and northern Gulf.

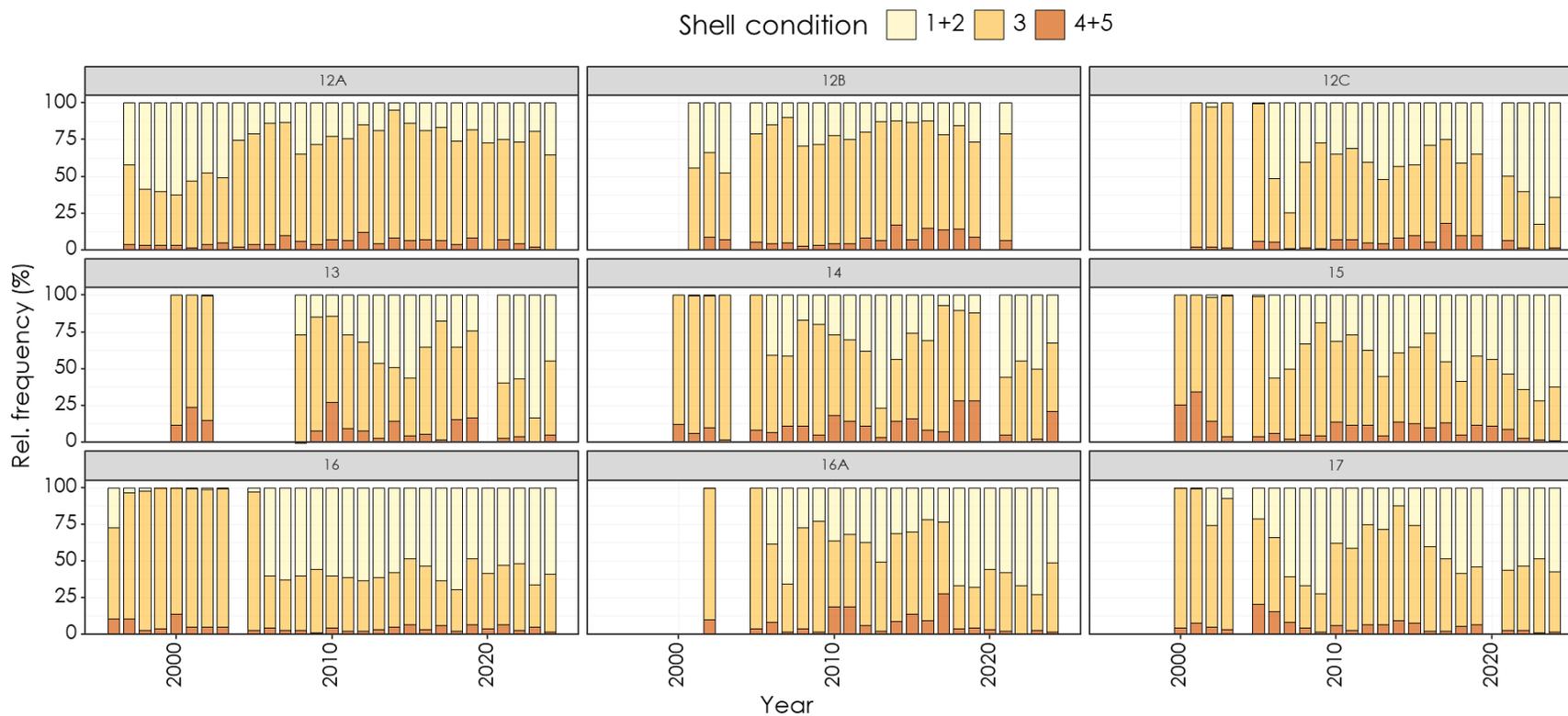


Figure 13. Percentages of recruits (crabs with carapace conditions 1 and 2), intermediate-shell crabs (condition 3) and old-shell crabs (conditions 4 and 5) among snow crabs sampled at dockside in DFO's commercial dockside sampling program for the nine fishing areas in the Estuary and northern Gulf.

Average size at dockside and at sea

An east-west gradient in the average size of legal-size male crabs is observed, with crabs generally smaller in Area 13 compared with Areas 16 and 17 (Figure 14). A decline in the average size of legal-size crabs has been noted in several areas since the most recent low point in the abundance cycle was reached in 2019–2020, suggesting that residual biomass is declining (Figure 14).

The average sizes of commercial crabs sampled at sea and dockside were fairly similar in Areas 13, 14 and 16A. However, dockside measurements tended to be higher than those taken at sea in Areas 17, 16, 15, 12A and 12B, although the temporal trends remain similar (Figure 14). This discrepancy may reflect systematic high-grading by crabbers, a practice that began around 2005, a period that also coincides with a marked shift in carapace condition percentages in several areas (Figure 12 and 13).

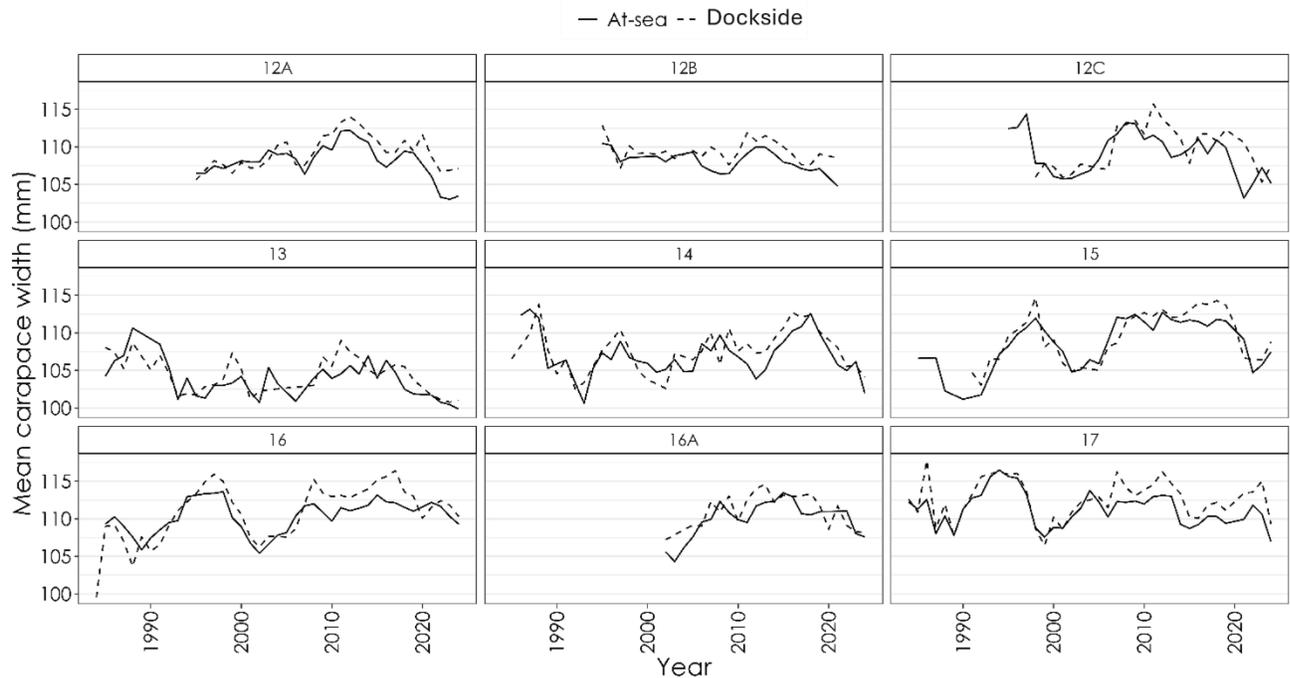


Figure 14. Average carapace width (mm) of commercial-size crabs based on at-sea sampling (solid line) and dockside sampling (dashed line) in the nine fishing areas of the Estuary and northern Gulf of St. Lawrence.

FISHERY-INDEPENDENT SURVEYS

DFO trawl surveys

Sainte-Marguerite Bay

Trawl surveys in Sainte-Marguerite Bay have documented a cyclical pattern of recruitment over a roughly 10-year period, involving the early benthic instars (i.e., living on the seabed) (Sainte-Marie et al. 1996; Émond et al. 2015; Lambert and Dallaire 2016). This pattern has also been observed in the last decade, with two major cohorts, 2015–2016 and 2023–2024, identified (Figures 15 and 16).

The abundant 2015–2016 cohort, with a CW of less than 6 mm (instars I and II), reached the final instar in 2022–2024 (Figure 15). However, in 2022 and 2024, the abundance of legal-size males remained moderate, while that of sub-legal size adults in the 62–78 mm and 78–95 mm size classes was high (Figures 16 and 17). Since 2020, the proportion of adults in each instar from IX to XIII has exceeded the historical average (Figure 18). These data show that most males are undergoing the terminal moult before attaining legal size, thereby reducing their potential of being recruited to the fishery. In 2024, the mean CW of legal-size adults fell considerably, while that of sub-legal size adults rose sharply (Figure 19). In addition, the abundance of 62–78 mm and 78–95 mm adolescent crabs in recent years suggests that potential recruitment to the fishery will remain moderate (Figure 17).

A peak in abundance in primiparous females was observed between 2020 and 2022 (Figure 16). This peak is typically seen around five years after the recruitment of instar I and II juveniles. Declining densities in 2024 and a gradual decrease in CW starting in 2019 (Figure 19) indicate that this pulse of mature females has ended.

Lastly, the 2023–2024 surveys show abundant populations of instar III–VI crabs (Figures 15 and 16). These cohorts will likely help to increase the size of the commercial male stock starting in 2029, if the proportion of male crabs undergoing an early terminal moult is low or moderate.

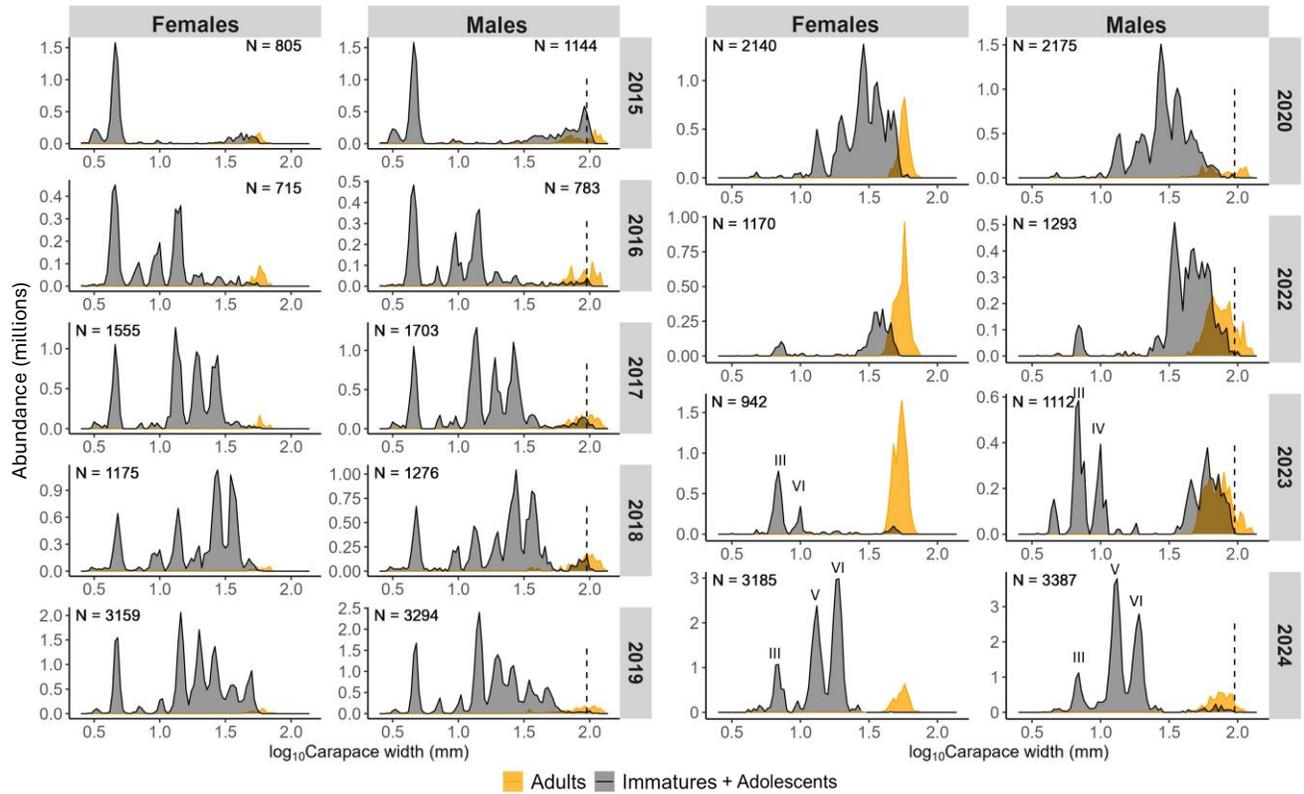


Figure 15. Abundance distribution (in millions of individuals) by mean \log_{10} carapace width (in mm) of immature and adolescent (black) and adult (yellow) male and female snow crabs caught in trawl surveys in Sainte-Marguerite Bay from 2015 to 2024. The commercial size for males (95 mm) is indicated by the dashed vertical black line. Abundance distributions for the entire time series starting in 1989 are available in Appendix 5.6.

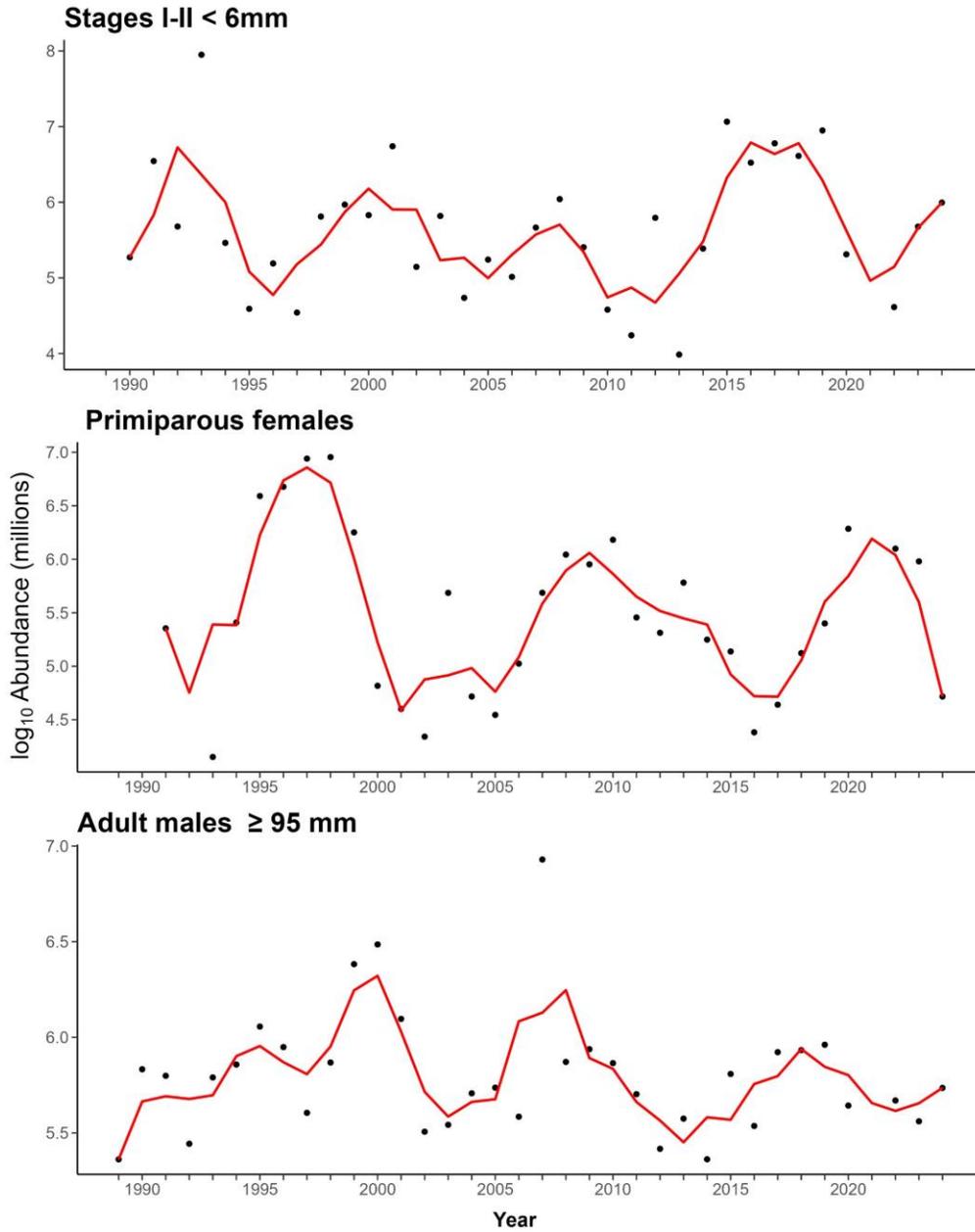


Figure 16. Mean abundance (\log_{10}) (± 1 year centred moving average) of crabs with a carapace width of less than 6 mm (instars I and II), primiparous females and legal-size (≥ 95 mm) adult males caught during trawl surveys in Sainte-Marguerite Bay from 1989 to 2024. The lines indicate the variation in the moving average (± 1 year).

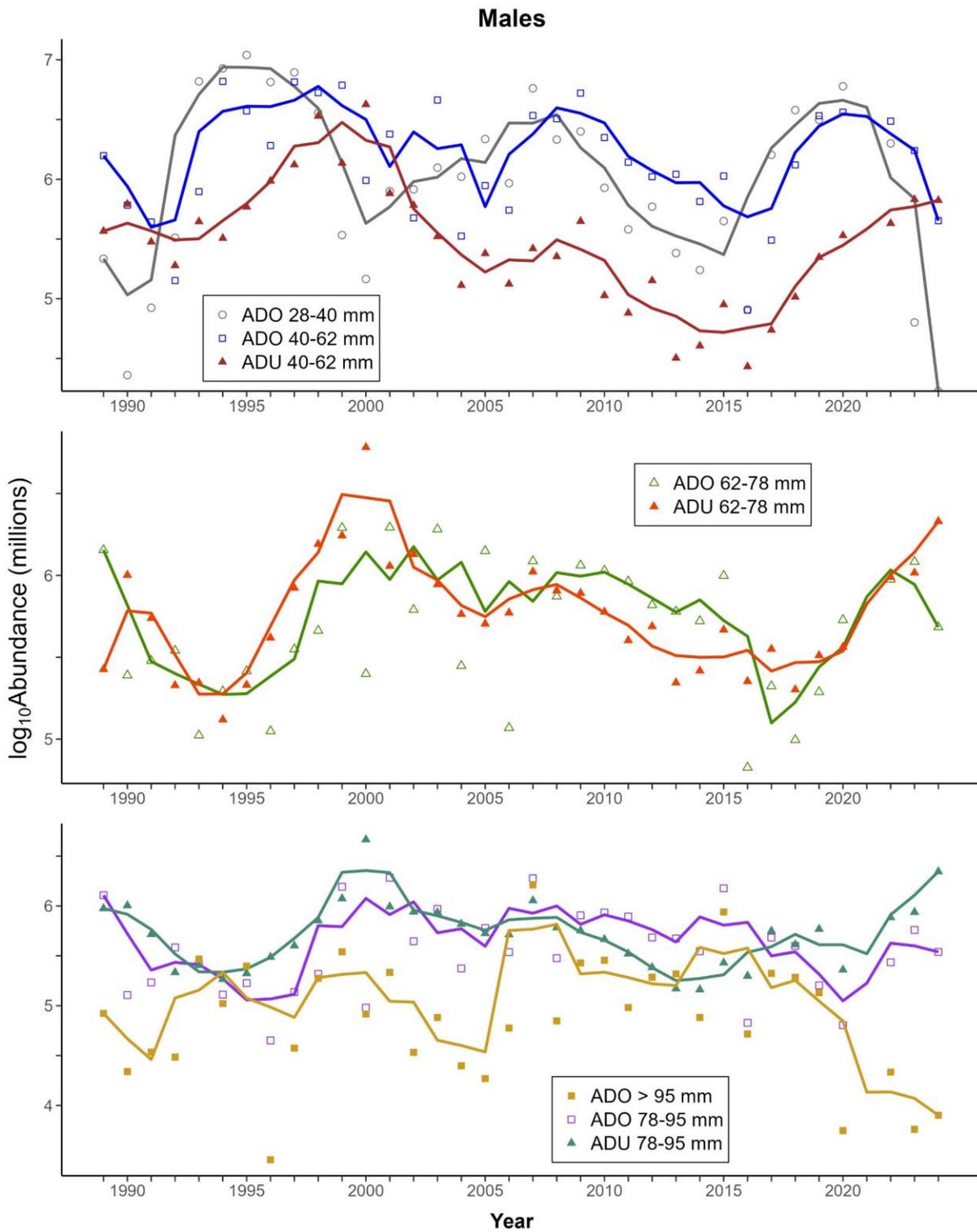


Figure 17. Mean abundance (\log_{10}) (± 1 year centred moving average) of male snow crabs with a carapace width of 28–40 mm, 40–62 mm, 62–78 mm, 78–95 mm and ≥ 95 mm (ADO = adolescents, ADU = adults) caught during trawl surveys in Sainte-Marguerite Bay from 1989 to 2024. The lines indicate the variation in the moving average (± 1 year) for each time series.

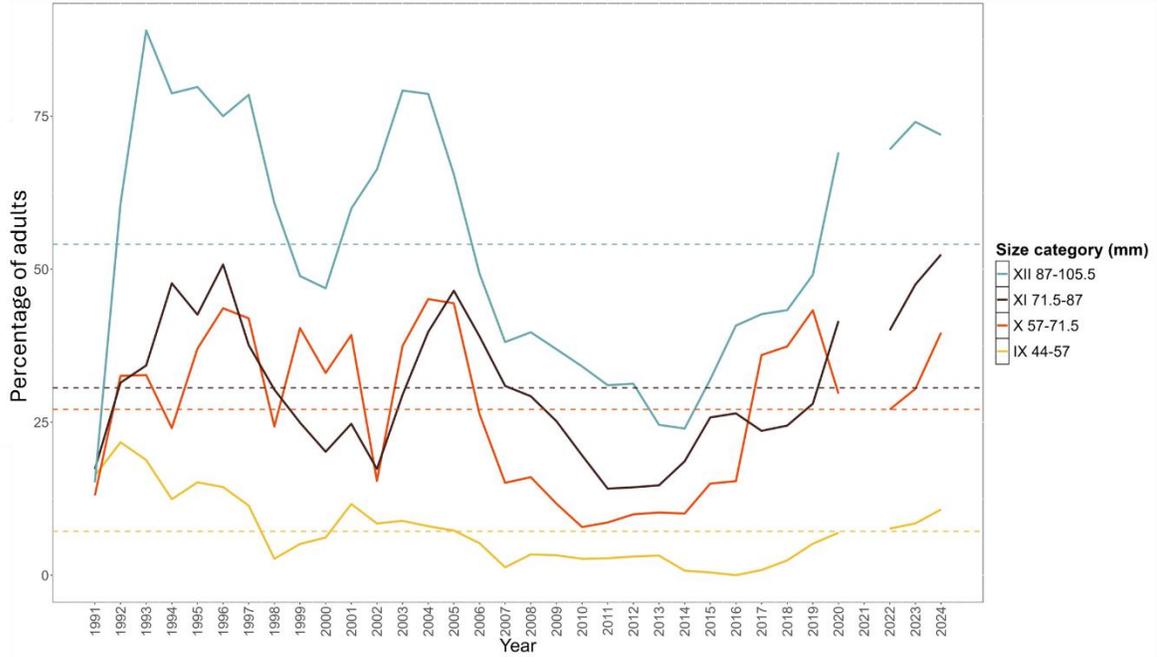


Figure 18. Proportion of adults among new-shelled males (± 1 year centred moving average) in size classes IX (44–57 mm), X (57–71.5 mm), XI (71.5–87 mm) and XII (87–105.5 mm) caught during trawl surveys in Sainte-Marguerite Bay from 1990 to 2024.

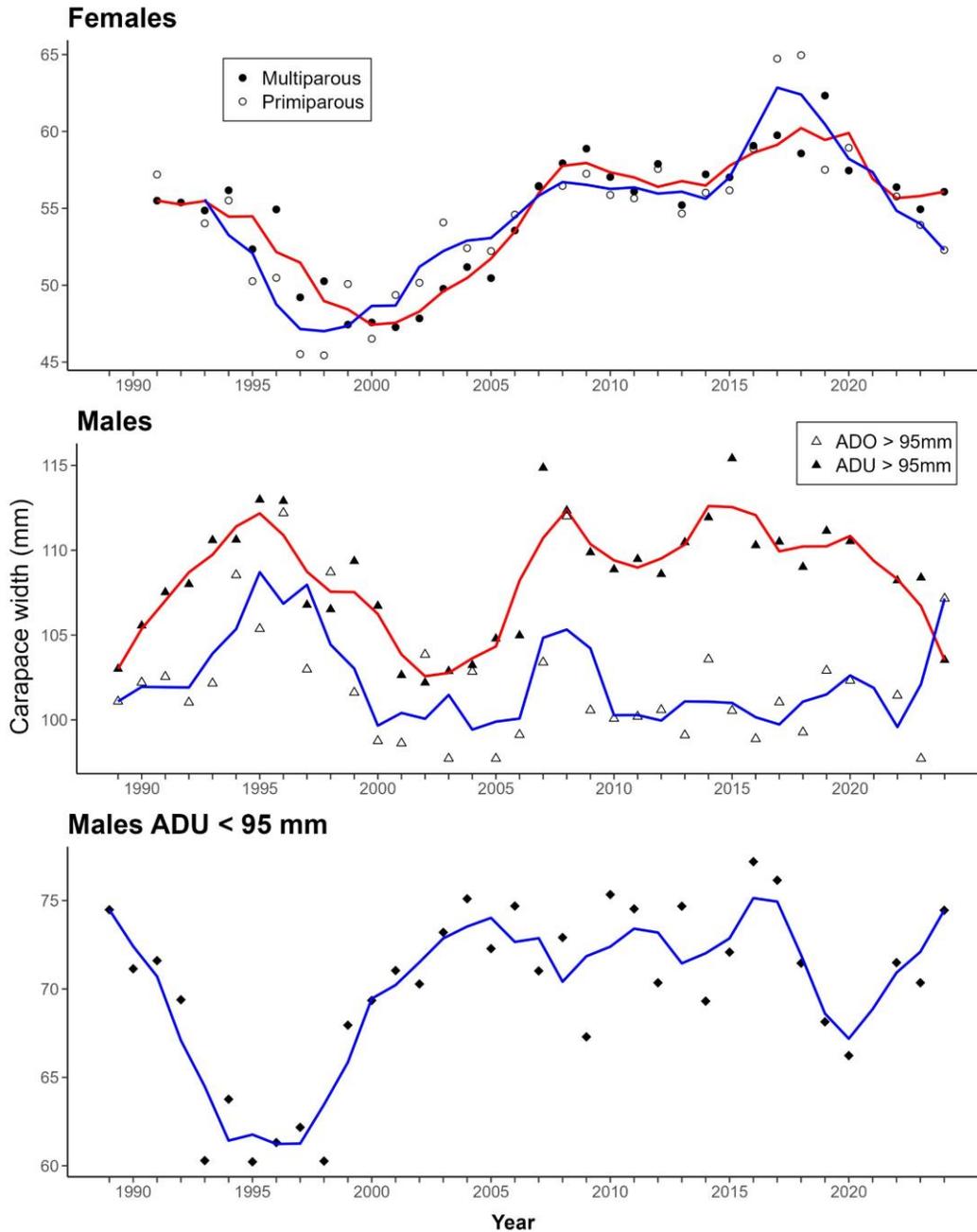


Figure 19. Mean carapace width (mm) (± 1 year centred moving average) of mature female (multiparous and primiparous) crabs, legal-size (≥ 95 mm) male crabs (ADO = adolescent, ADU = adult), and adult sub-legal size (< 95 mm) male snow crabs caught during trawl surveys in Sainte-Marguerite Bay from 1989 to 2024.

Lower North Shore

The abundance cycles in snow crab populations can be observed in the progression of cohorts through the size classes over the years along the Lower North Shore (Figures 20 to 22). High densities of immature crabs (< 40 mm) in 2006 progressed to high densities of larger size classes in the years that followed, culminating in high densities of commercial-size crabs in 2014 (Figure 21). A new cycle began with a pulse of immature (< 40 mm) crabs in 2016. This

large cohort was behind the increased densities of 40–62 mm adolescents in 2018–2022 and 62–78 mm adolescents in 2020–2024. However, a break in the progression then occurred: this pulse of abundance was not replicated in adolescents in the 78–95 mm size class, which have been found in low abundance since 2016 (Figure 21). In contrast, the abundance of sub-legal size (62–95 mm) adult males has been increasing since 2018 and the density of legal-size adults has been very low since 2018. The increase that should have resulted from the high densities observed in 2014 has not materialized (Figure 21).

According to size distribution data, most males are undergoing their terminal moult before they reach legal size (Figure 20). This adversely affects prospects for recruitment to the fishery, since crabs cannot grow any larger after they undergo the terminal moult. This trend is confirmed by the percentage of adult crabs by size class; from 2014 to 2022, the proportion of sub-legal size adults exceeded the historical average (Figure 23). However, the trend towards early terminal moult appears to have subsided in 2024 (Figure 23). This recent development could enable a larger proportion of 62–78 mm adolescents, which were still abundant in 2024 (Figure 21), to reach the legal size before their terminal moult and to be recruited to the fishery over the medium term.

This progression of cohorts can also be seen in females. For example, the pulse of immature females seen in 2006 was reflected in a high abundance of mature primiparous females in 2008 and multiparous females in 2012 (Figure 22). A second cycle began in 2014, with high densities of immature females in the years until 2016. From 2018 to 2022, high densities of primiparous females were recorded in the eastern portion of the Lower North Shore, with the peak appearing to end in 2024 (Figure 22). The density of multiparous females has risen sharply in the last two surveys, reaching an all-time high in 2024. However, the new cohorts of immature crabs that would result from this high abundance of mature females have not yet appeared in the data as of the 2024 survey (Figure 21).

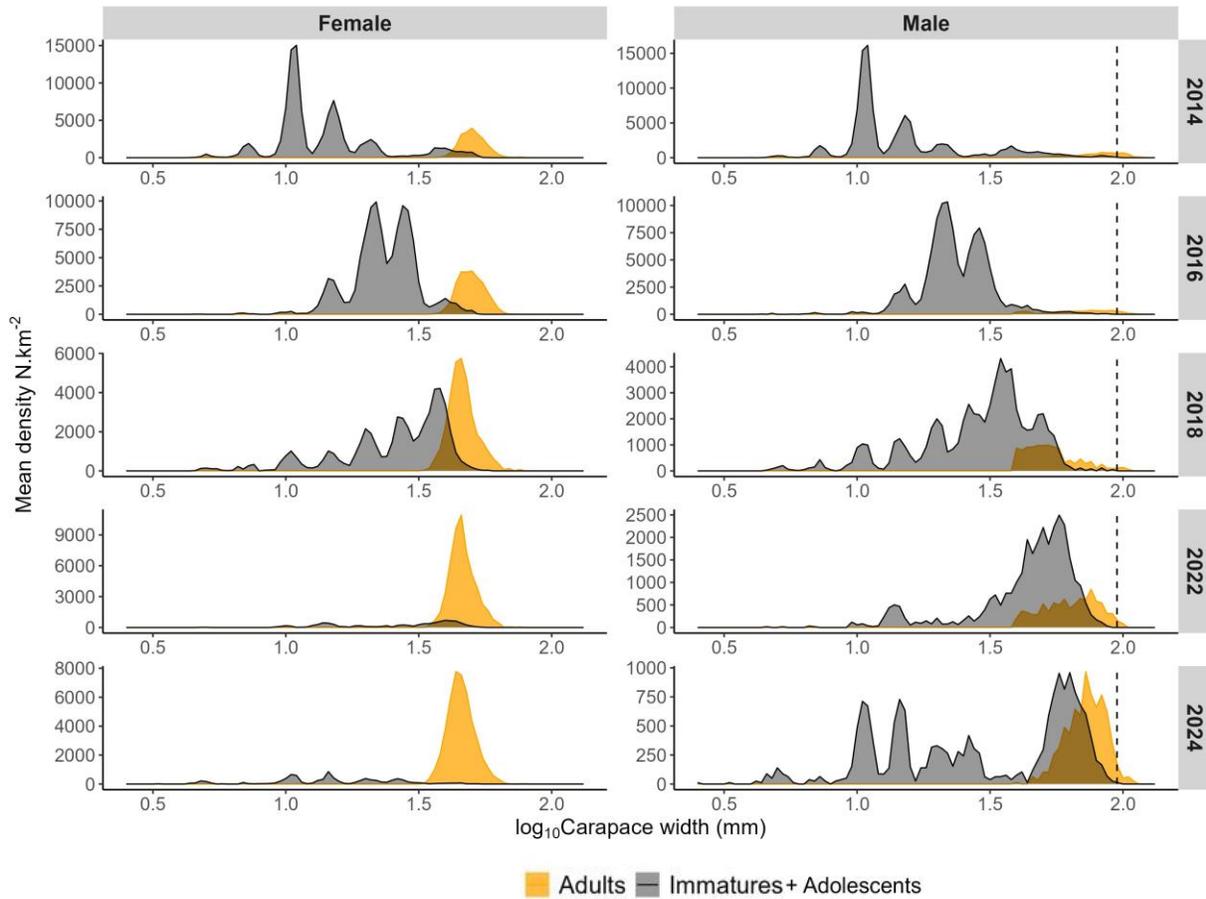


Figure 20. Distribution of mean density (N/km^2) by mean \log_{10} carapace width (in mm) of immature and adolescent (black) and adult (yellow) male (right) and female (left) snow crabs caught during trawl surveys along the Lower North Shore from 2014 to 2024. The commercial size for males (95 mm) is indicated by the dashed vertical black line. Distributions for the entire time series starting in 1994 are available in Appendix 5.5.

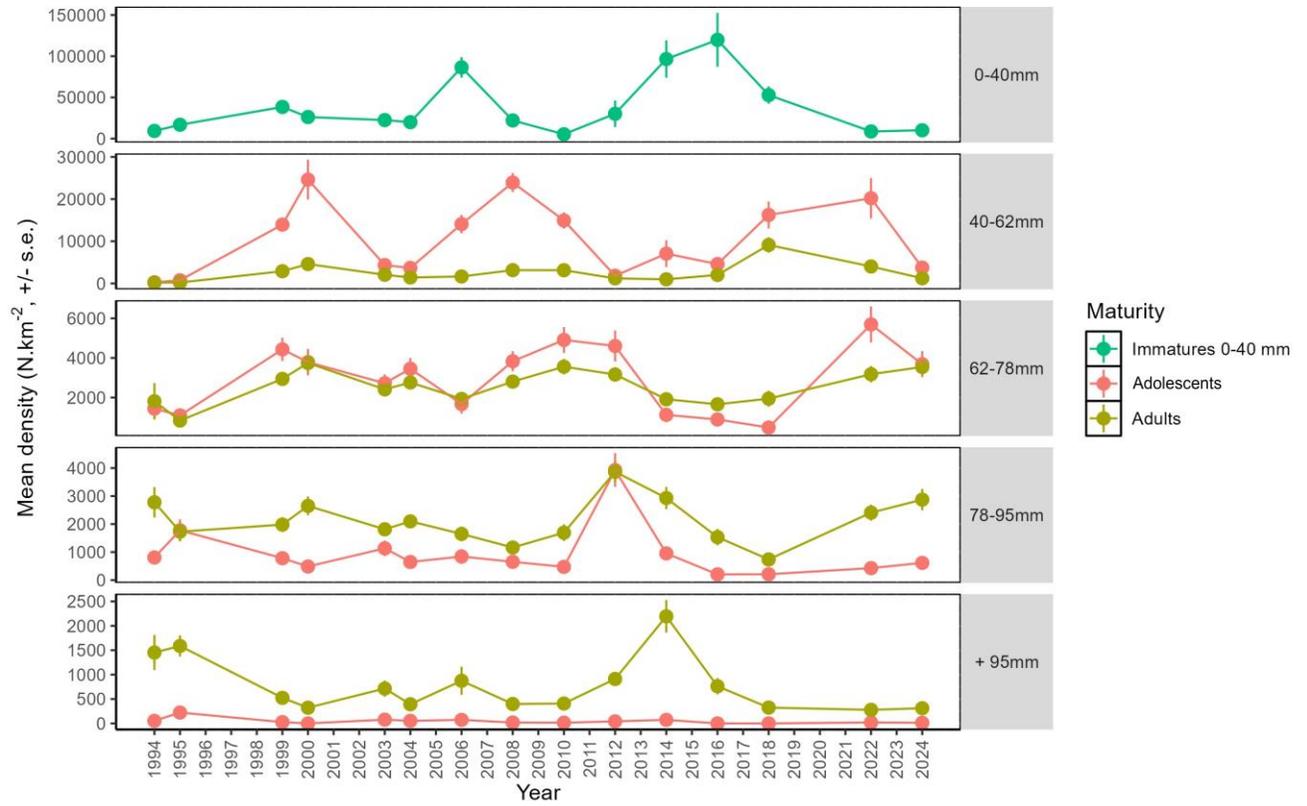


Figure 21. Mean density (N/km² ± standard deviation) of immature (0–40 mm) and adolescent and adult (40–62 mm, 62–78 mm, 78–95 mm and ≥ 95 mm) male crabs in DFO trawl surveys along the Lower North Shore from 1994 to 2024.

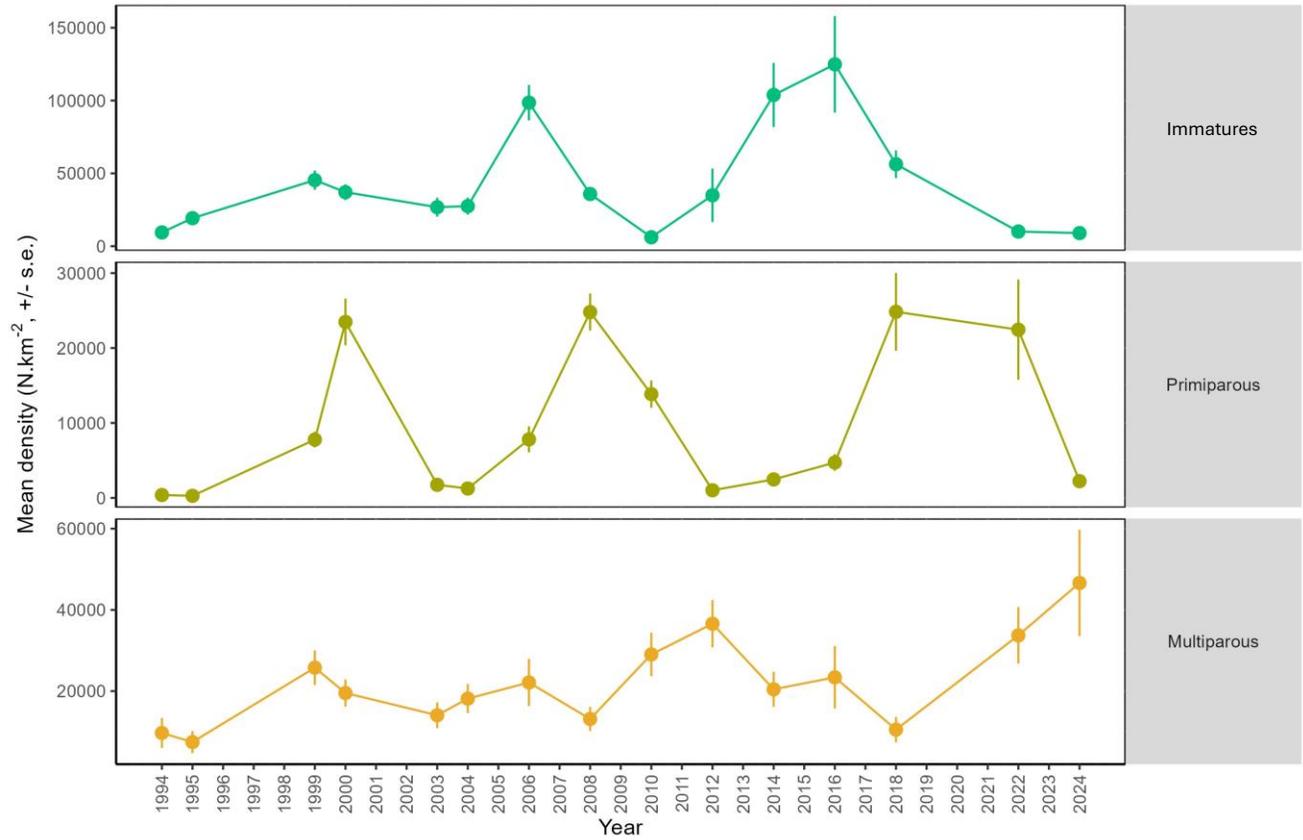


Figure 22. Mean density (N/km² ± standard deviation) of immature, primiparous and multiparous female snow crabs caught during trawl surveys along the Lower North Shore from 1994 to 2024.

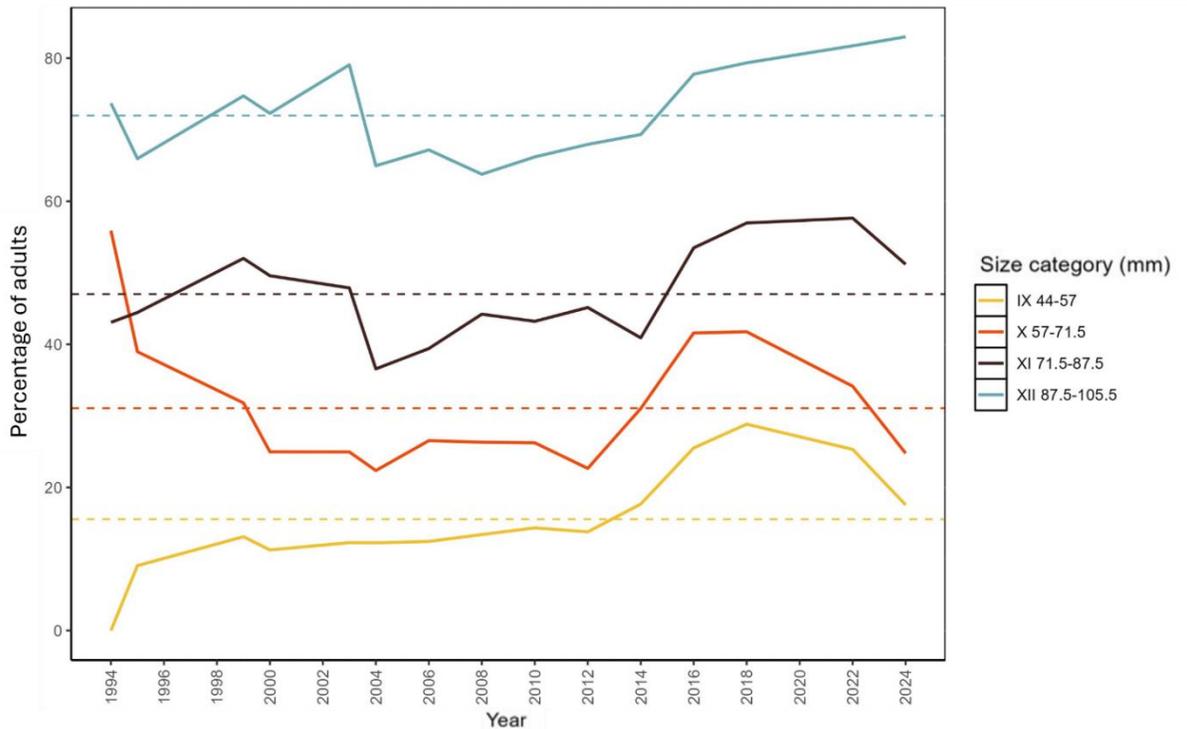


Figure 23. Proportion of adults among new-shelled males (± 1 year centred moving average) in size classes IX (44–57 mm), X (57–71.5 mm), XI (71.5–87.5 mm) and XII (87–105.5 mm) caught during trawl surveys along the Lower North Shore from 1994 to 2024. The dashed line shows the time series mean.

Estuary

In the Estuary, densities of immature (0–40 mm) crabs were high between 2009 and 2011 but fell sharply in 2013 (Figure 26). Between 2015 and 2017, they remained low to moderate along both shores of the Estuary. A marked influx of new cohorts was observed throughout this region starting in 2019 (Figures 24 and 26). That year, densities of instar III (5.5–7.9 mm) juveniles along the south shore were twice as high as those along the north shore (Figure 25).

The 2023 survey shows significant differences between the two sides of the Estuary in Area 17. The density of 40–62 mm adolescent crabs along the south shore was twice that along the north shore (Figure 26). A similar increase in density was seen in 62–78 mm adolescents along both shores, while the increase in the density of 78–95 mm males (adolescents and adults) was limited to the north shore.

Since 2015, the trajectories of the density of legal-size males along the two sides of the Estuary have been diverging. Along the north shore, densities increased steadily and peaked in 2023. In contrast, along the south shore, densities peaked in 2017 and then plummeted in 2023 to the lowest levels since 2009 (Figure 26).

The percentage of adult males among all new-shelled males (CC 1 and 2) has increased in all instars since 2017. In 2023, the values for this metric in instar XI (71.5–87.5 mm) and instar XII (87–105.5 mm) crabs were well above the historical average for both shores (Figure 28), suggesting that a significant number of males had undergone their terminal moult before reaching commercial size. The increase in early terminal moulting in the Estuary does not appear to be diminishing, unlike what has occurred along the Lower North Shore. Therefore,

although densities of adolescent (62–95 mm) crabs were still high in 2023 (Figure 26), the prospects for recruitment to the fishery remain uncertain over the short and medium term.

Lastly, densities of primiparous females increased sharply in 2023 on both sides of the Estuary, surpassing the record levels set in 1998 (Figure 27). Densities of multiparous females also increased, and densities of females overall were higher along the south shore than the north shore.

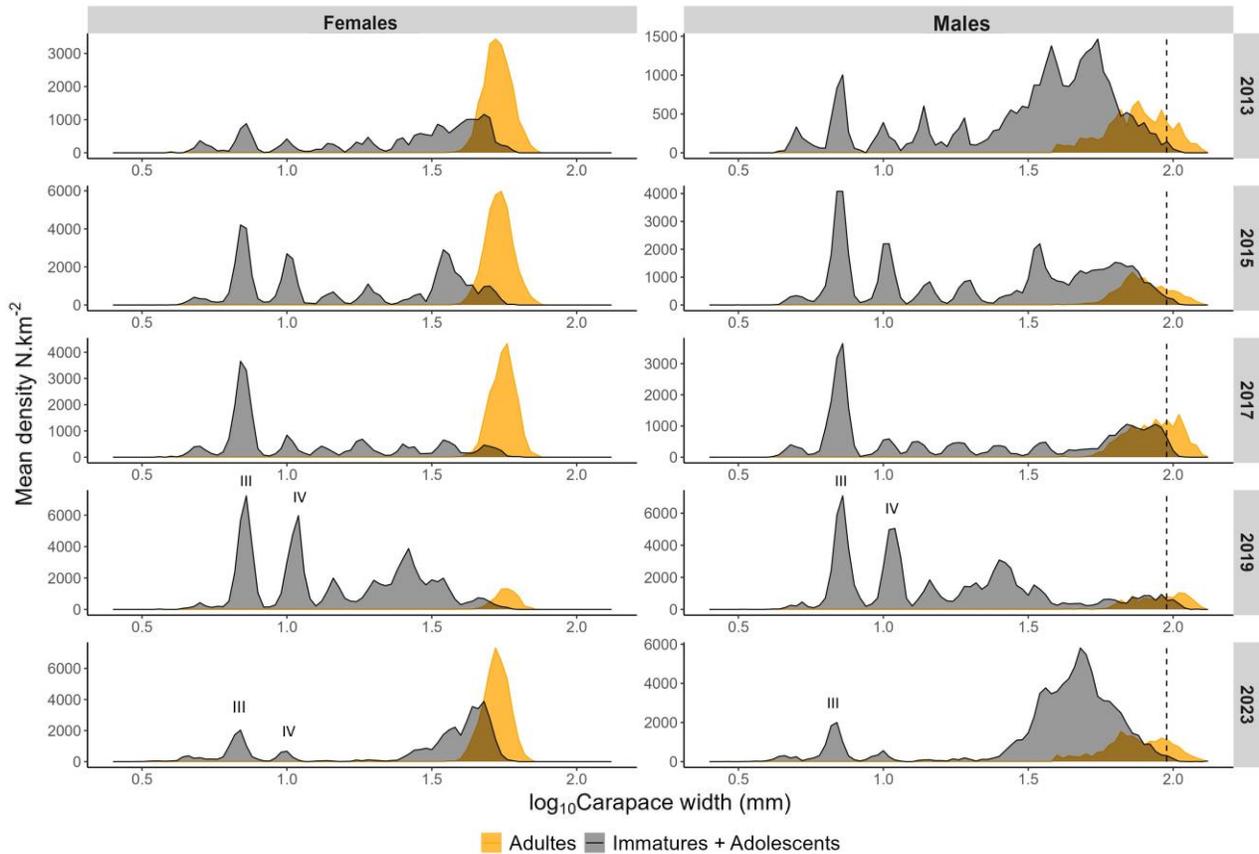


Figure 24. Distribution of mean density (N/km^2) by mean \log_{10} carapace width (mm) of immature and adolescent (black) and adult (yellow) male and female crabs caught during trawl surveys along both shores of the Estuary. The commercial size for males (95 mm) is indicated by the dashed vertical black line. Distributions for the entire time series starting in 1992 are available in Appendix 5.4.

ESTUARY

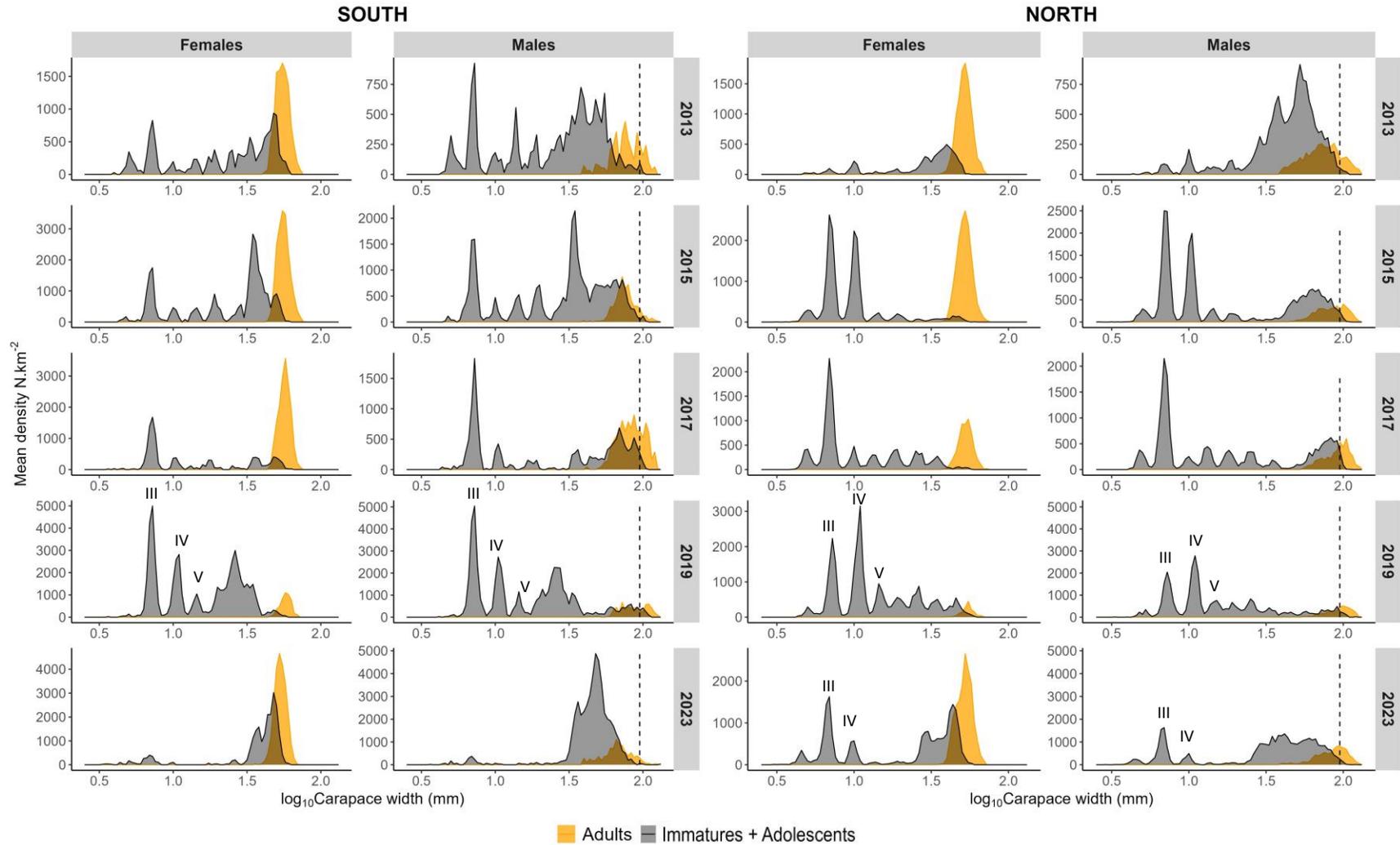


Figure 25. Distribution of mean density (N/km²) by mean log₁₀ carapace width (mm) of immature and adolescent (black) and adult (yellow) male and female crabs caught during trawl surveys along the north and south shores of the Estuary from 2013 to 2023. The commercial size for males (95 mm) is indicated by the dashed vertical black line.

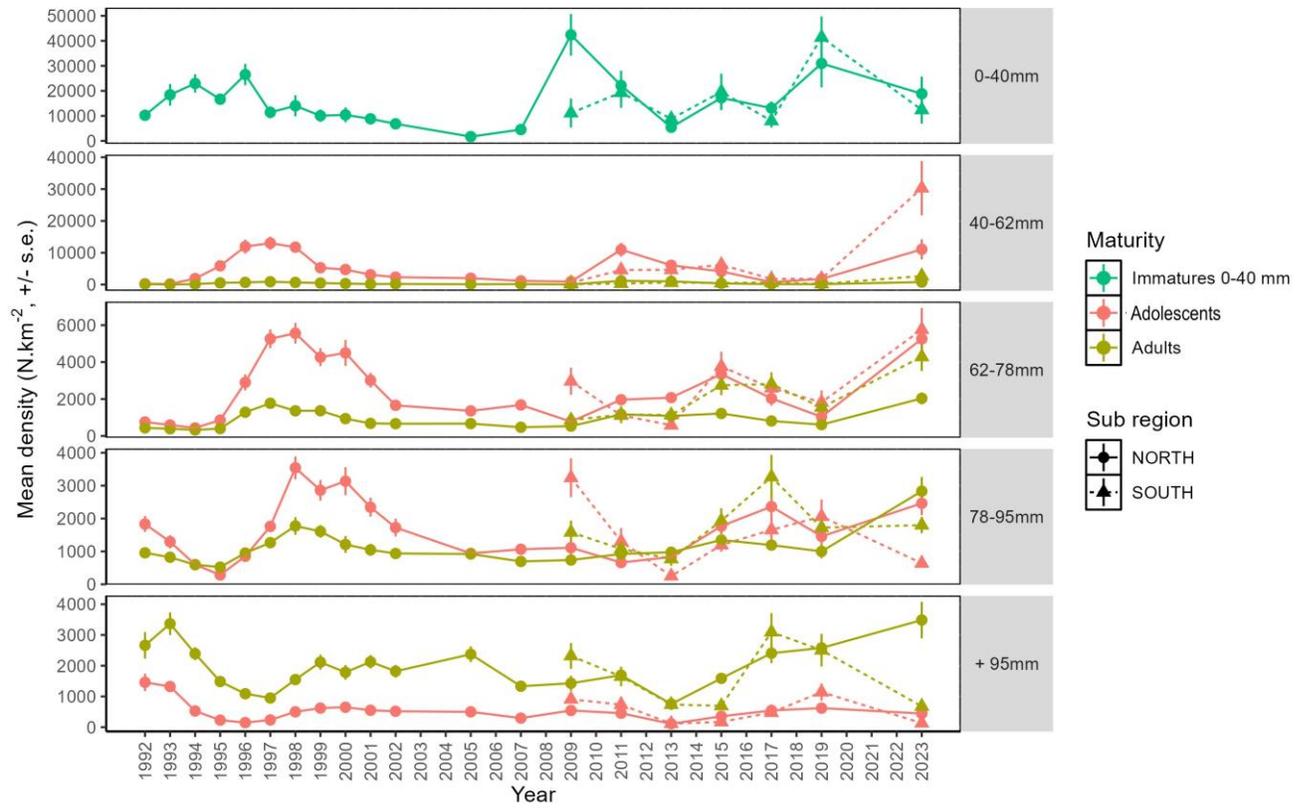


Figure 26. Mean density (N/km² ± standard deviation) of immature (0–40 mm) and adolescent and adult (40–62 mm, 62–78 mm, 78–95 mm and ≥ 95 mm) male crabs caught during trawl surveys along the north shore of the Estuary from 1992 to 2023 and along the south shore from 2009 to 2023.

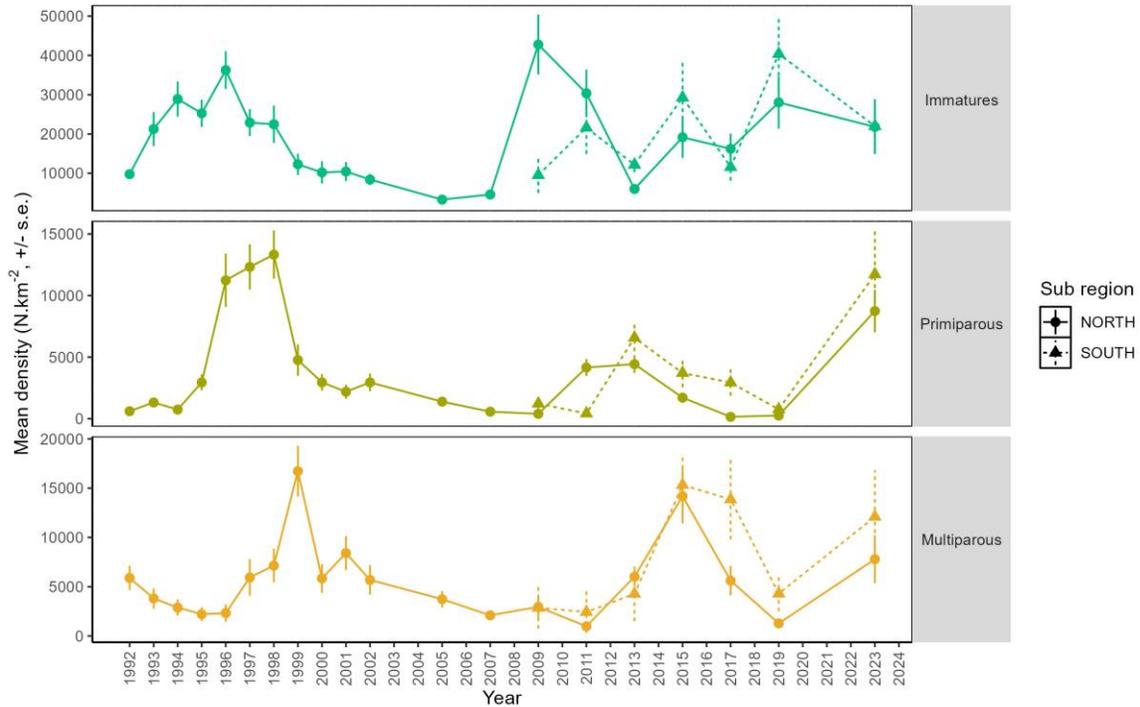


Figure 27. Mean density ($N/km^2 \pm$ standard deviation) of immature, primiparous and multiparous female snow crabs caught during biannual trawl surveys along the north shore of the Estuary (solid line) from 1992 to 2023 and along the south shore (dotted line) from 2009 to 2023.

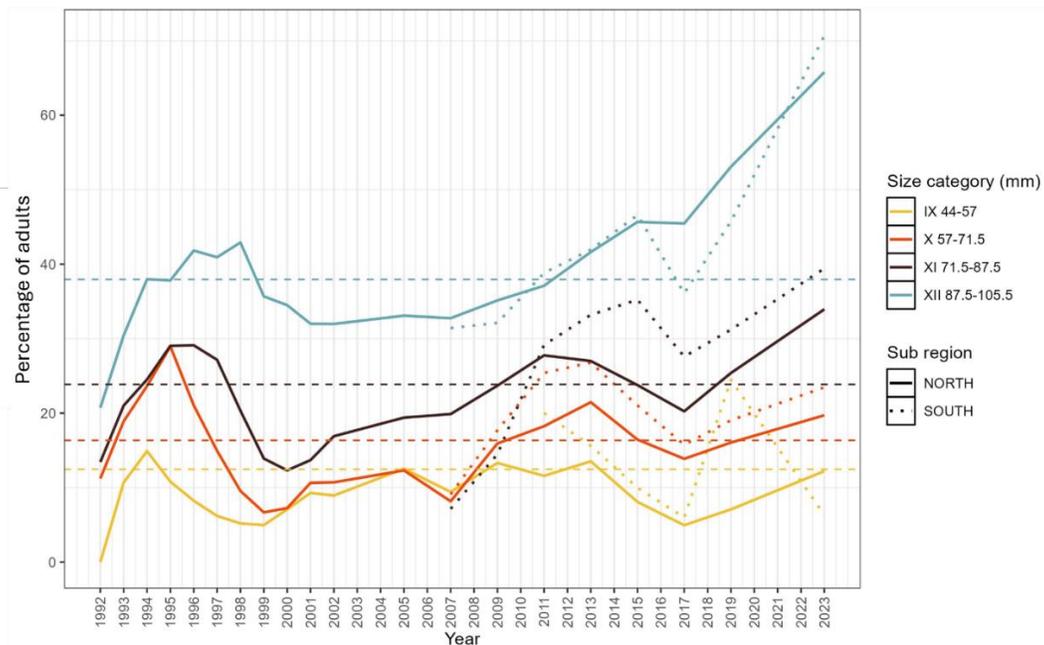


Figure 28. Proportion of adults among new-shelled males (CC 1 and 2) (± 1 year centred moving average) in size classes IX (44–57 mm), X (57–71.5 mm), XI (71.5–87.5 mm), XII (87–105.5 mm) and XIII (105.5–125 mm) caught during trawl surveys along the north shore of the Estuary (solid line) from 1992 to 2023 and the south shore (dotted line) from 2007 to 2023. The horizontal line shows the time series mean.

Post-season surveys

Number per unit effort (NPUE)

In Area 17, the abundance of the various categories of adults, which had been rising since 2021, declined in 2024 (Figure 29). However, in the southern portion of this fishing area (17S), the abundance of recruits rose slightly in 2024. Despite a small increase in the abundance of 78–95 mm adolescents, the overall abundance of adolescent crabs remains low and below the historical average. Since 2016, crab densities appear to have been higher along the south shore than the north shore (Figure 29).

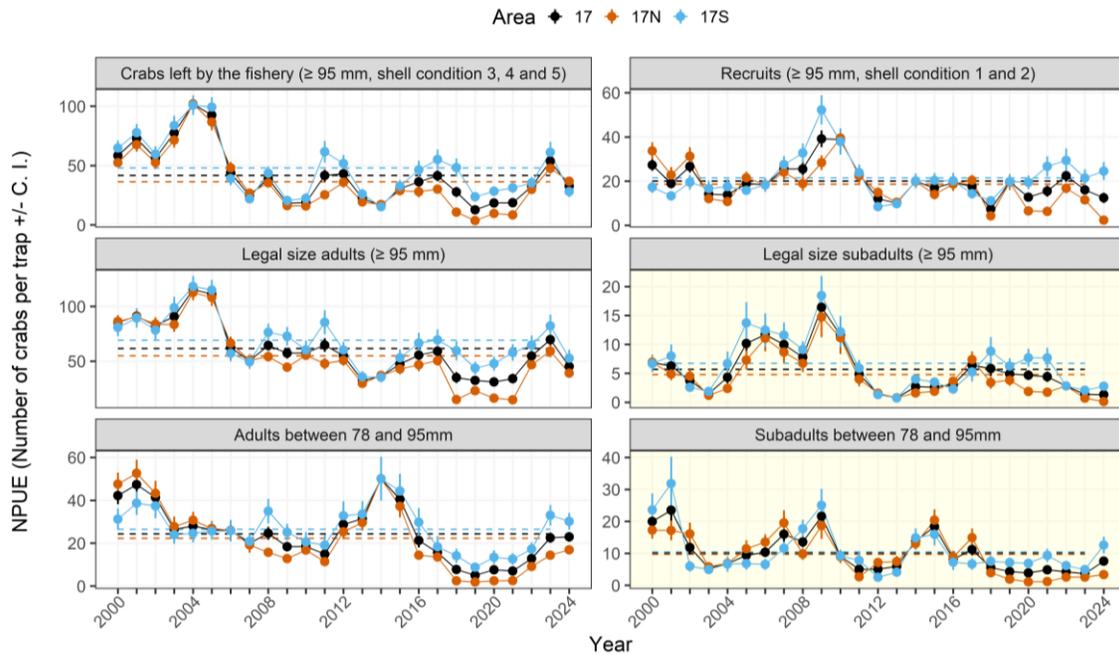


Figure 29. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs in the trap survey in Area 17 (black) overall and in the northern and southern portions (17N, orange, and 17S, blue, respectively). The dashed line shows the historical average for the time series (excluding the last year).

In Area 16, after one of the lowest NPUE values for legal-size adults was recorded in the time series in 2020, this abundance index, which is derived from the results of the post-season survey, rose for two years before declining again (Figure 30). Since 2014, the abundance of crabs left by the fishery has remained below the historical average, while that of recruits has been near or above the historical average (Figure 30). Starting in 2020, a marked increase was seen in the number of sub-legal size adults, indicating that a significant proportion of males had undergone an early terminal moult, a phenomenon that also occurred between 1999 and 2004. The abundance index for sub-legal size adolescents rose sharply in 2024, while that for legal-size adolescents has remained below the historical average since 2020 (Figure 30).

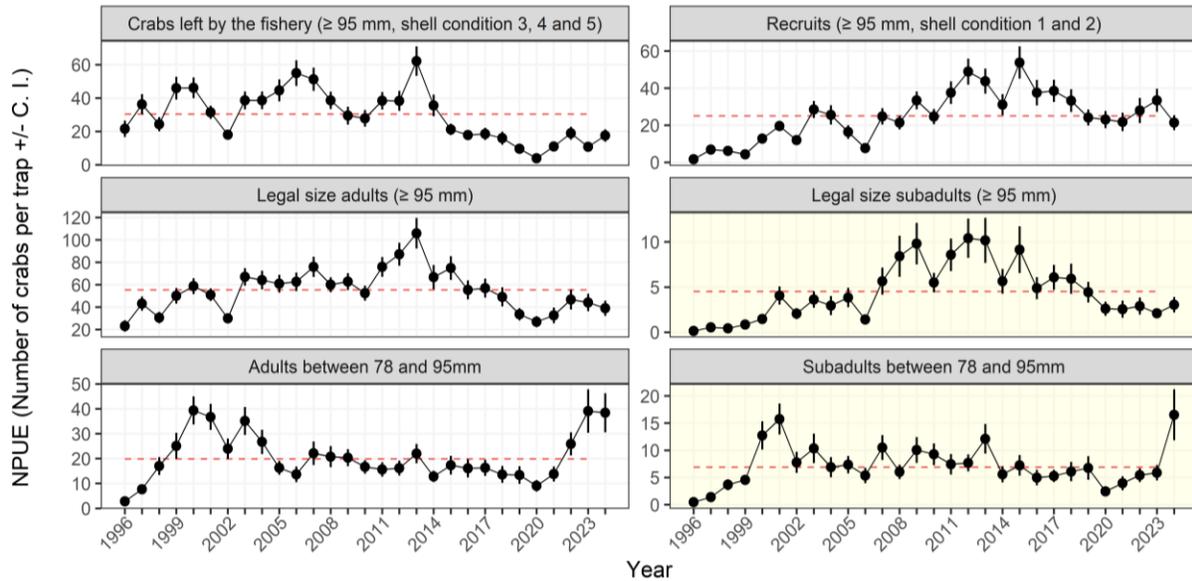


Figure 30. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs from the trap survey in Area 16. The dashed line shows the historical average for each time series (excluding the last year).

In Area 15, the value of the abundance index for commercial-size adults has remained stable, exceeding the historical average for the past three years (Figure 31). The abundance index values for legal-size and sub-legal size (78–95 mm) adolescents increased from 2021 to 2023 to high levels and then declined significantly in 2024 to the historical average, suggesting that recruitment to the commercial fishery will slow down in the coming years (Figure 31).

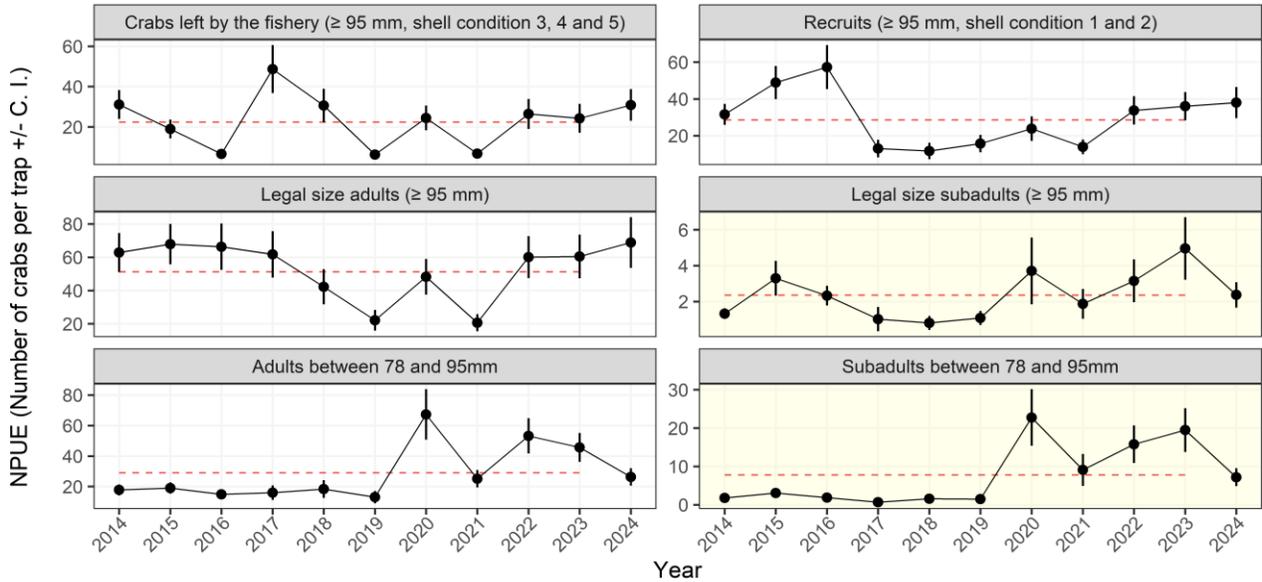


Figure 31. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs in the trap survey in Area 15. The dashed line shows the historical average for each time series (excluding the last year).

In Area 14, the abundance index for legal-size adults, mainly consisting of crabs left by the fishery, has declined in the last two years (Figure 32). The abundance index for recruits, after falling since 2020, increased slightly in 2024 (Figure 32). As in other areas along the Lower North Shore, the abundance index for sub-legal size (78–95 mm) adults has been higher in recent years, indicating that a greater proportion of male crabs have undergone an early terminal moult. The number of legal-size adolescents per trap has been low for the last four years, although the number of 78–95 mm adolescents has been relatively stable, remaining above the historical average (Figure 32).

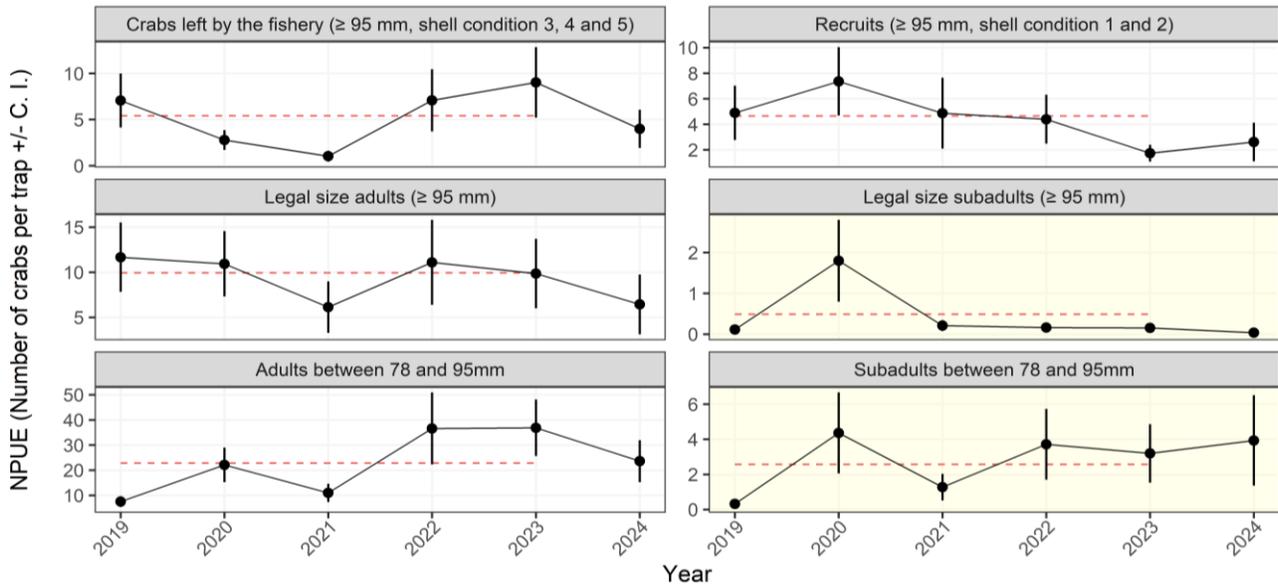


Figure 32. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs from the trap survey in Area 14. The dashed line shows the historical average for each time series (excluding the last year).

In Area 13, the abundance index for commercial-size crabs has been rising since 2019, with higher values in the northern portion than the southern one (Figure 33). After several years at near-zero levels, the number of crabs left by the fishery increased sharply in 2024, especially in the northern portion (Figure 33). The abundance of sub-legal size (78–95 mm) adult males, which increased between 2019 and 2022, is now declining. The abundance index for legal-size adolescents, however, has remained low.

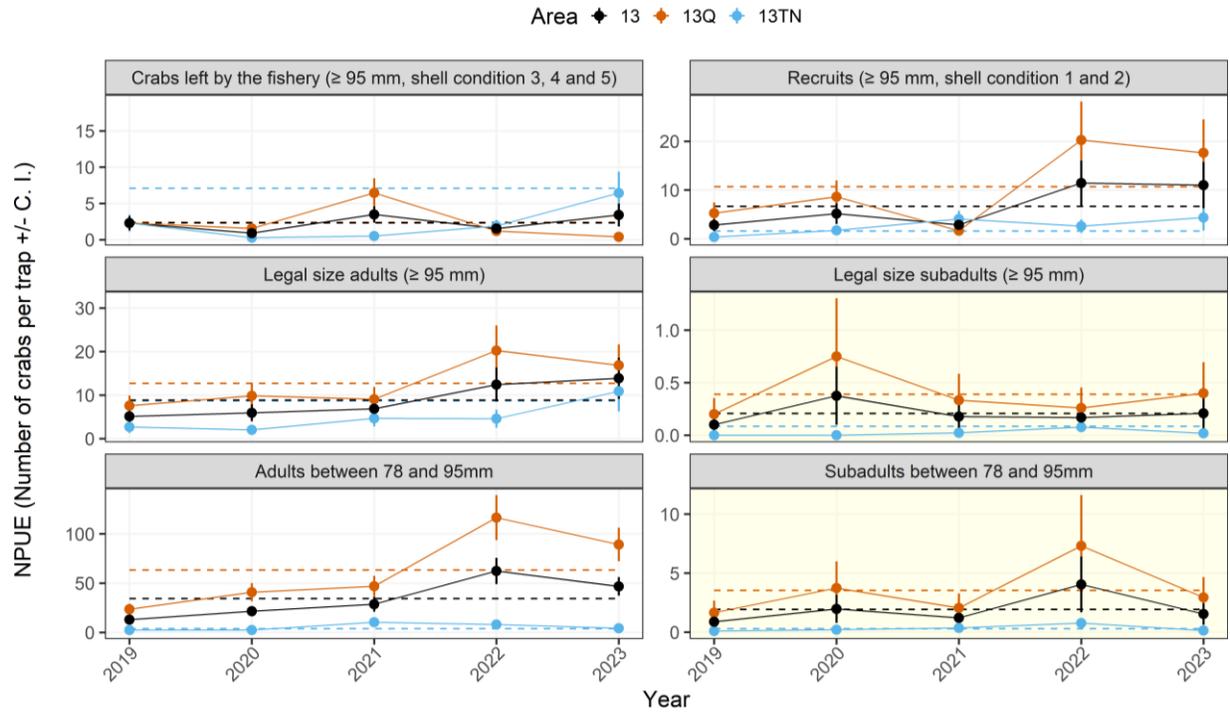


Figure 33. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs in the trap survey in Area 13 (black line) and specifically in the northern portion of Area 13 (13Q, orange line) and the northern portion of Area 13 (13TN, blue line). The dashed line shows the historical average for each time series (excluding the last year).

Area 16A is split into northern and southern portions, with the Anticosti Channel serving as the dividing line. In the 2021 post-season survey, traps were deployed only on the southern side of the Anticosti Channel, creating uncertainty over the indicators for 2021. The abundance of legal-size adult crabs, composed mainly of recruits, decreased from 2014 to 2021 and then increased from 2021 to 2023 (Figure 34). The reason for the sharp drop in the indicator in 2024 is unclear, given that the number of legal-size adolescents rose sharply in 2023 and the abundance of sub-legal size adolescents has been high in recent years (Figure 34). The sharp decline in sub-legal size adults suggests that the catchability of crabs may be lower in the 2024 post-season survey. However, it will not be possible to verify this hypothesis or consider other reasons until the data from the 2025 commercial fishery and post-season survey become available.

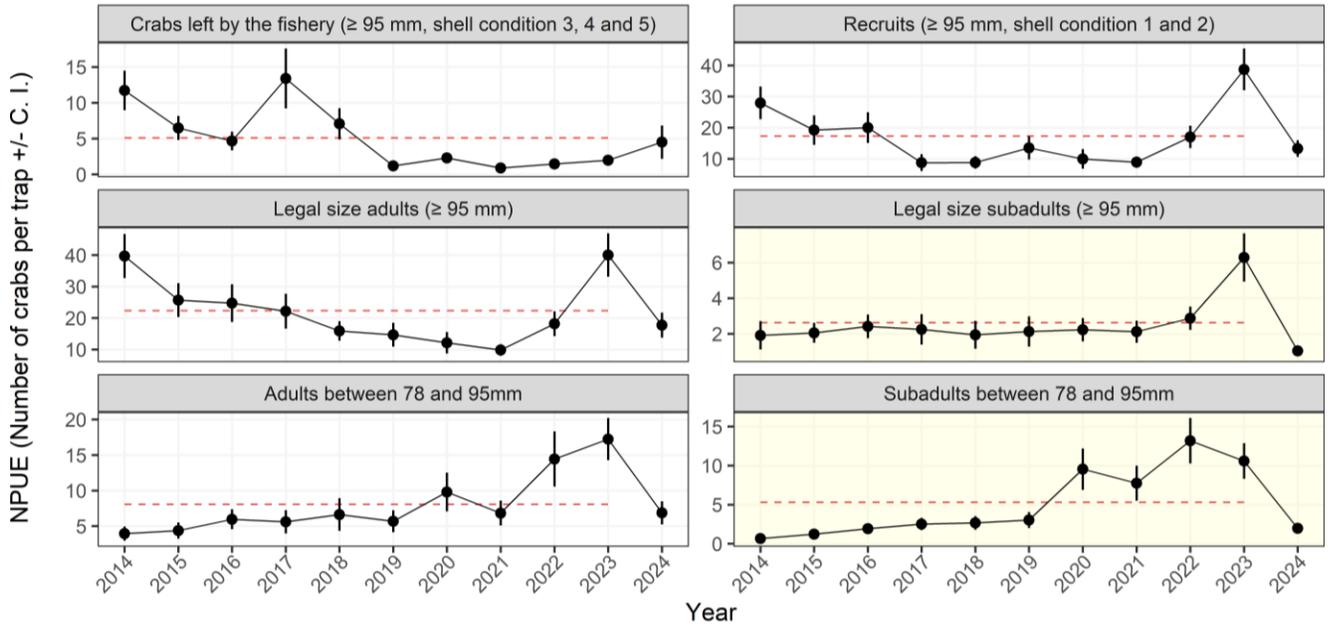


Figure 34. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs in the trap survey in Area 16A (black line). The dashed line shows the historical average for each time series (excluding the last year).

In the 2021 post-season survey in Area 12C, traps were deployed only on the northern side of the Anticosti Channel, resulting in significant uncertainty over the state of the resource and the trends in indicators for 2021 and 2022. However, starting in 2022, traps were deployed in both the northern and southern parts of the fishing area. The abundance of legal-size crabs has been increasing since 2021, but that of crabs left by the fishery has been low for a number of years, suggesting that the fishery in this area is a recruitment fishery (Figure 35). The number of legal-size adolescents is very low, with a historical average of close to 0.7 crabs/trap, while the number of 78–95 mm adolescents has been on an upward trend since 2017, despite a decrease in 2024 (Figure 35). The value of the abundance index for sub-legal size adults has been high in recent years, indicating that a significant proportion of crabs underwent an early terminal moult in this area as well.

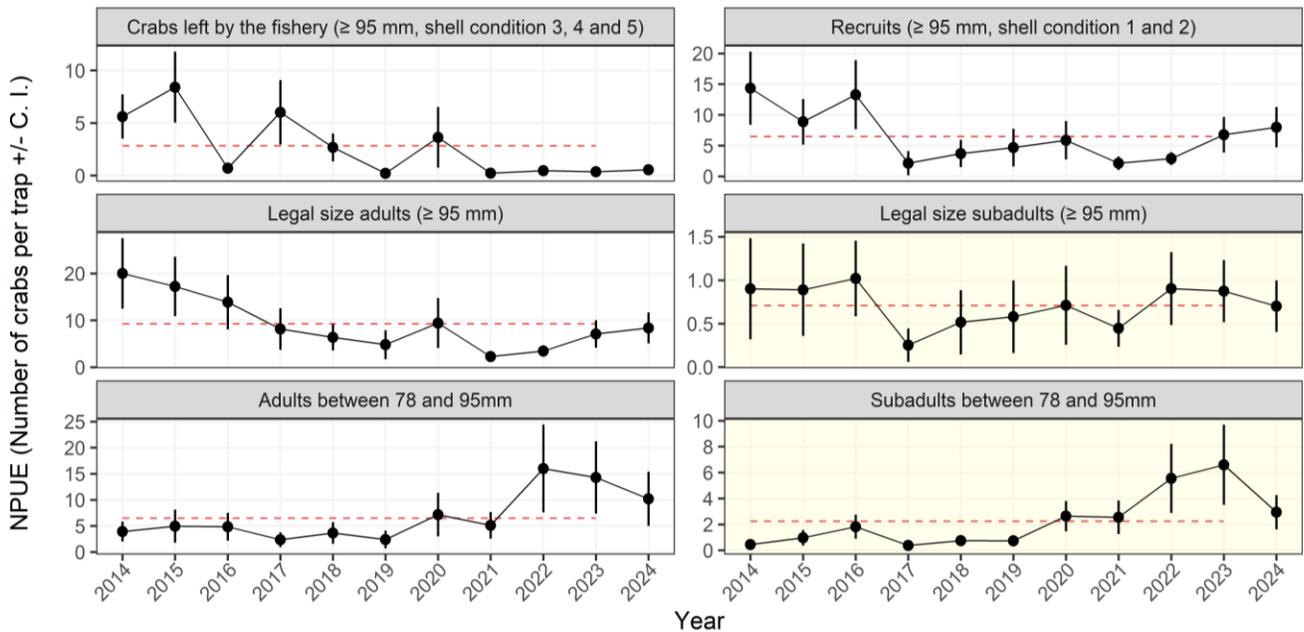


Figure 35. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs in the trap survey in Area 12C (black line). The dashed line shows the historical average for each time series (excluding the last year).

In Area 12A, the value of the abundance index for legal-size adults has remained below the historical average since 2015 (Figure 36), dipping almost to zero in 2021. However, since then, it has increased gradually, reaching a value slightly above the historical average in 2024. These legal-size adults primarily consist of crabs left by the fishery (Figure 36). As in many other areas of the Gulf, the abundance of sub-legal size adults dropped below the historical average in Area 12A in 2015, but has not rebounded as it has in the other areas (Figure 36). Abundance index values for adolescents were close to the historical average in 2023 and 2024 (Figure 36).

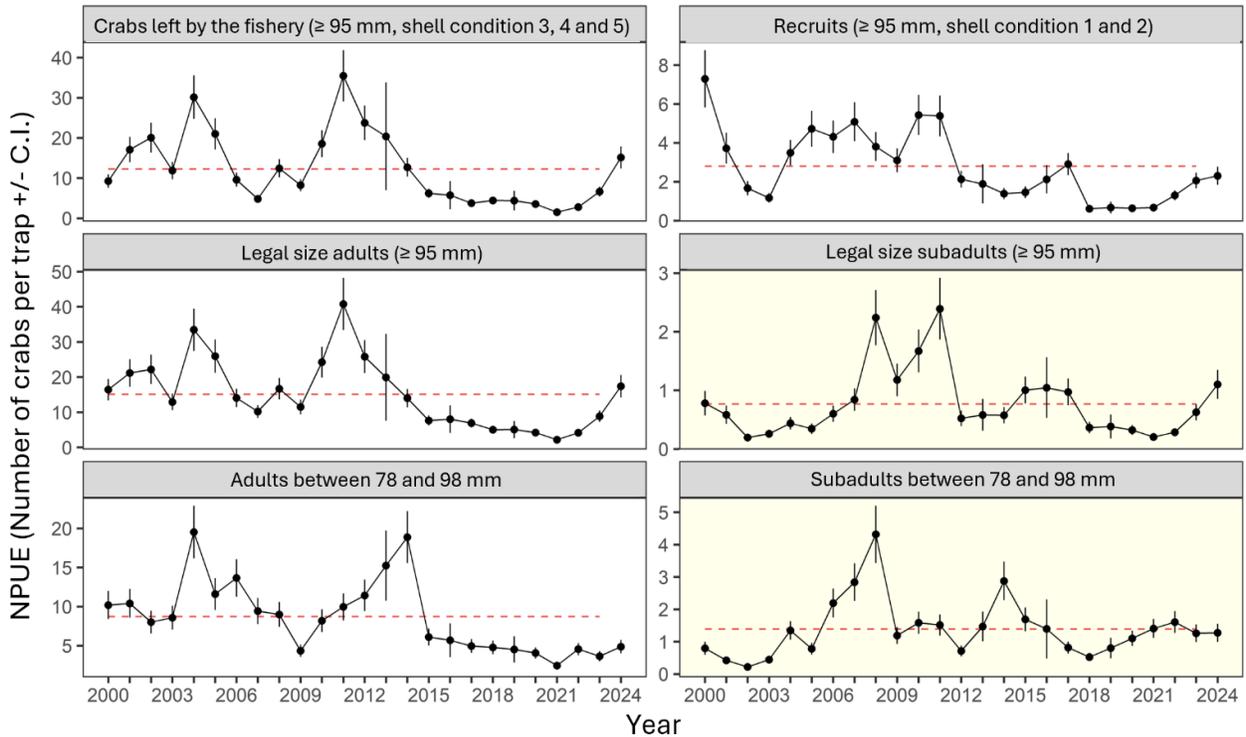


Figure 36. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs in the trap survey in Area 12A. The dashed line shows the historical average for each data series (excluding the last year).

In Area 12B, a post-season survey was not conducted in 2023 or 2024. The value of the abundance index for legal-size adults in Area 12B has been declining since 2013, as it has in Area 12A; in 2015, it reached a value below the historical average (Figure 37). Between 2015 and 2022, the lowest abundance index values for legal-size adults in the time series were recorded. The value of the abundance index for recruits was above the historical average between 2007 and 2013, but then dropped below the historical average from 2014 onwards. In general, abundance index values for sublegal-size adolescents and adults also fell in 2014 and have remained at very low values since then (Figure 37).

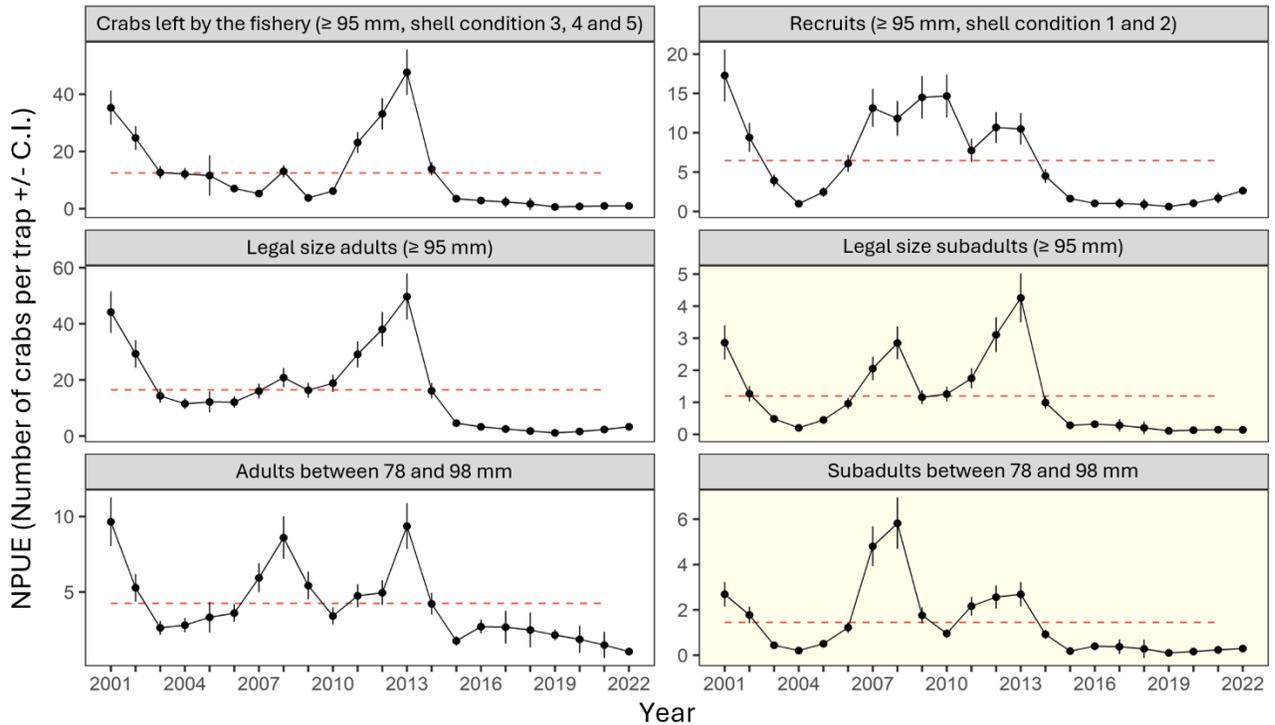


Figure 37. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs in the trap survey in Area 12B. The dashed line shows the historical average for each data series (excluding the last year).

The bathymetric distribution of densities of male crabs differs depending on the area. In Areas 17 and 16, the number of males per trap is high but varies with depth, while densities are lower and more uniform in Areas 13 and 14. In the Estuary (Area 17), the number of males per trap gradually decreases with depth, while the highest densities of males in Areas 13 and 14 are found in deep waters (Figure 38).

In Area 17, densities have been converging in all bathymetric strata along the north shore of the Estuary since 2016, but not along the south shore. Conversely, densities in Area 16A had a homogeneous bathymetric distribution until 2013, but now show a high degree of variability.

In Areas 16 and 16A, the highest densities are found at depths of 80–120 m. In 2024, Area 16 recorded a dramatic increase in the density of males per trap in this bathymetric stratum, while densities at depths greater than 200 m were at historically low levels.

In Areas 15 and 12C, densities of male crabs in shallow waters (0–80 m) have risen sharply over the past two years. Furthermore, in Area 15, these densities have also increased significantly in the 80–120 m and 120–160 m strata over the past five years.

Finally, along the north shore of Area 13 (13Q), a generalized increase in the densities of male crabs has occurred in all bathymetric strata, reaching the highest values observed since the start of the time series in 2000 (Figure 38).

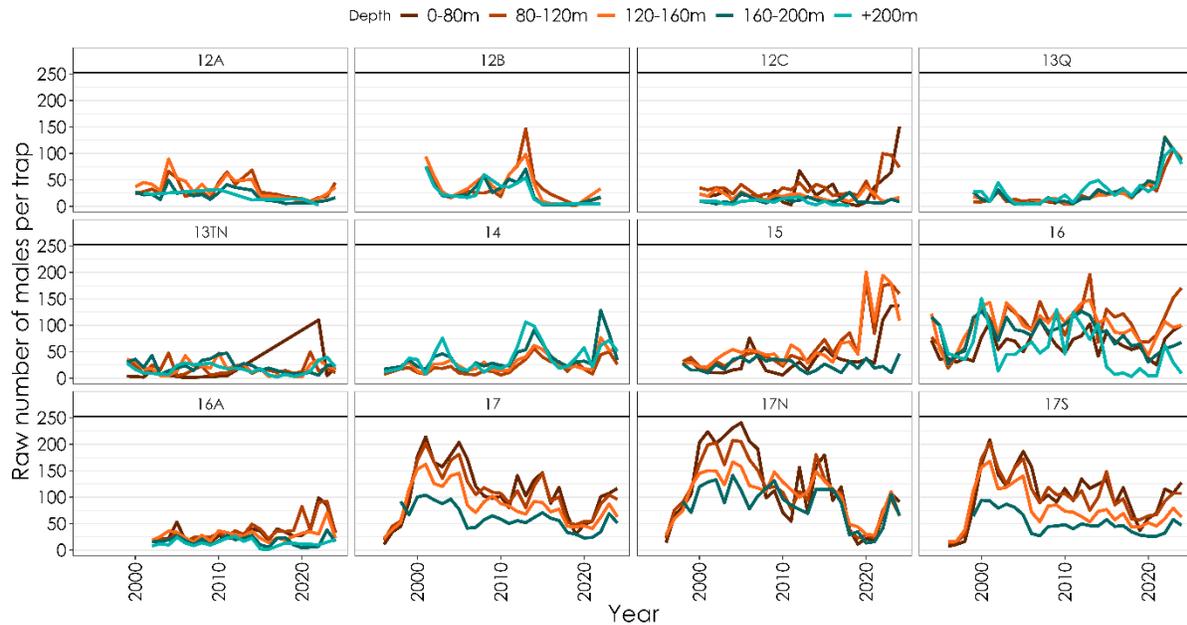


Figure 38. Number of male crabs (adults and adolescents of all sizes) per trap during post-season surveys between 1996 and 2024 in the nine management areas of the Estuary and northern Gulf of St. Lawrence, by depth stratum.

Size distributions

Males in commercial traps

In Areas 16 and 17, the pulse of adolescents that had been observed between 2013 and 2015 (Figures 39 to 41). Since 2020, residual biomass has been declining, characterized by a decreased proportion of crabs exceeding legal size among both adults and adolescents. Conversely, in Areas 15, 12C, 16A, 13Q and 12A, the proportion of legal-size crabs has been increasing since 2020, suggesting an increase in the recruitment of males to the fishery (Figures 42, 44 and 46–48). In Area 14, the proportion of legal-size crabs has also been growing since 2020 but at a slower rate than in adjacent areas (Figure 43). Meanwhile, in Area 12B, the number of legal-size crabs plummeted between 2012 and 2016, and adolescents were absent in post-season surveys (Figure 49).

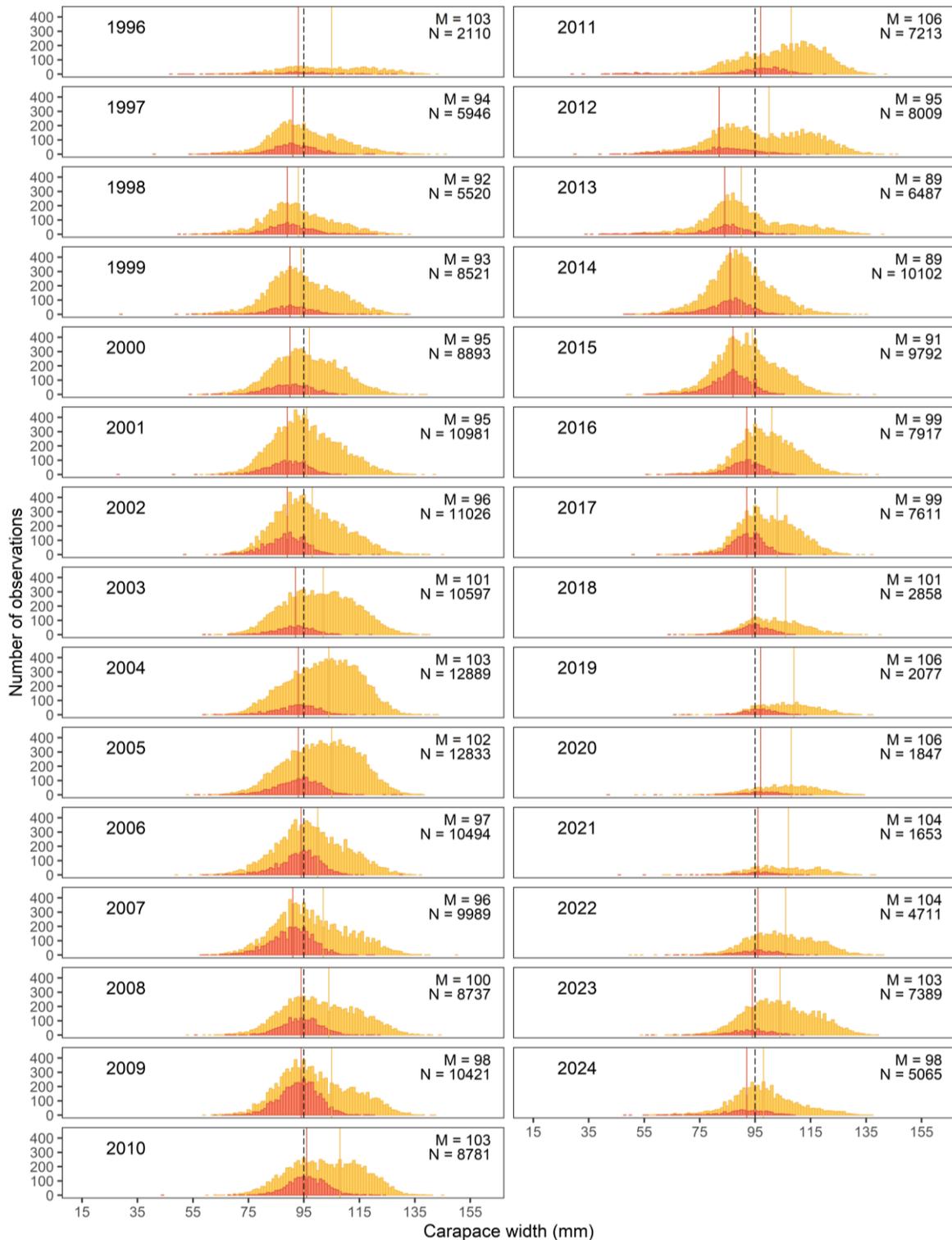


Figure 39. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in the northern portion of Area 17 (17N). The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

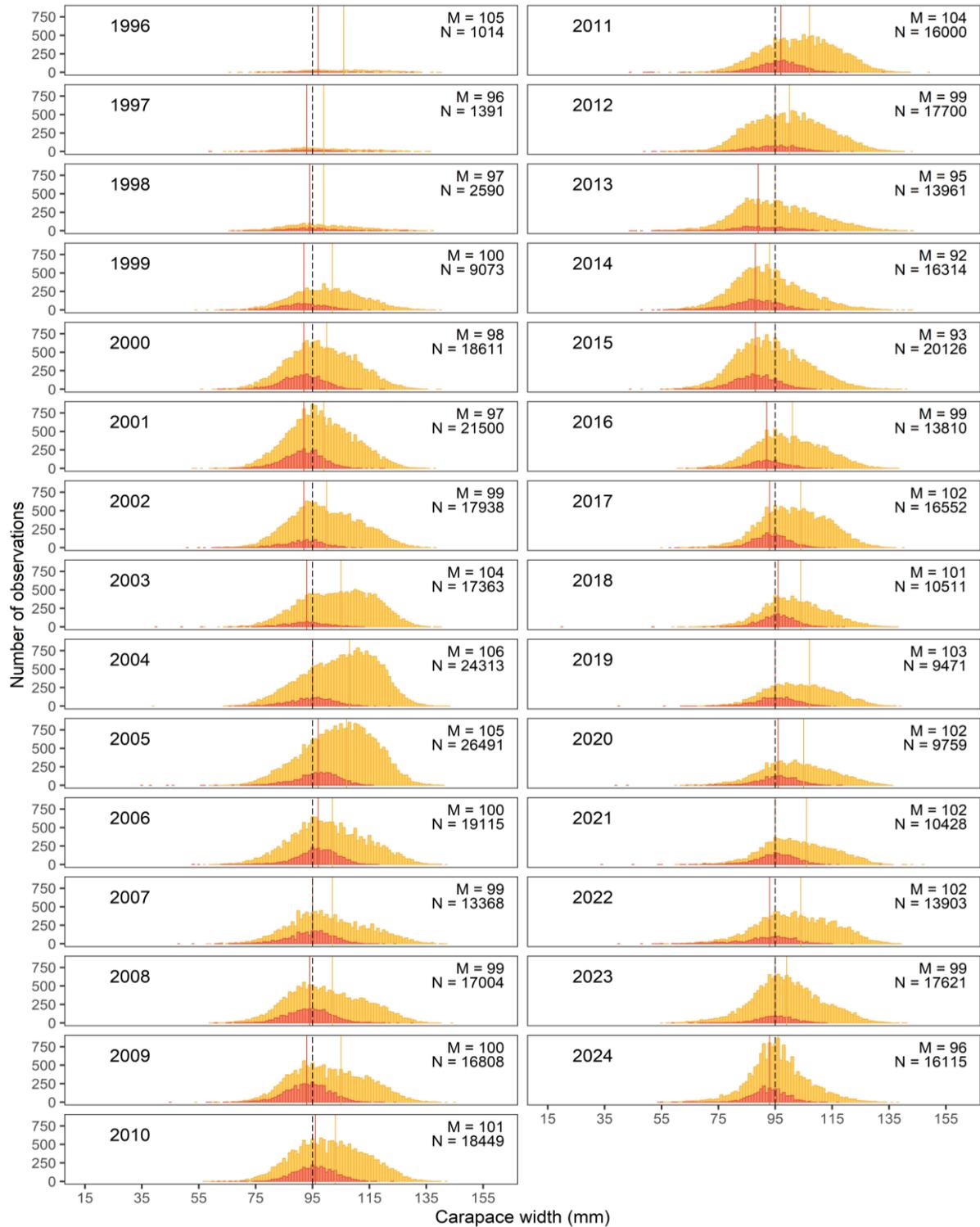


Figure 40. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in the southern portion of Area 17 (17S). The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

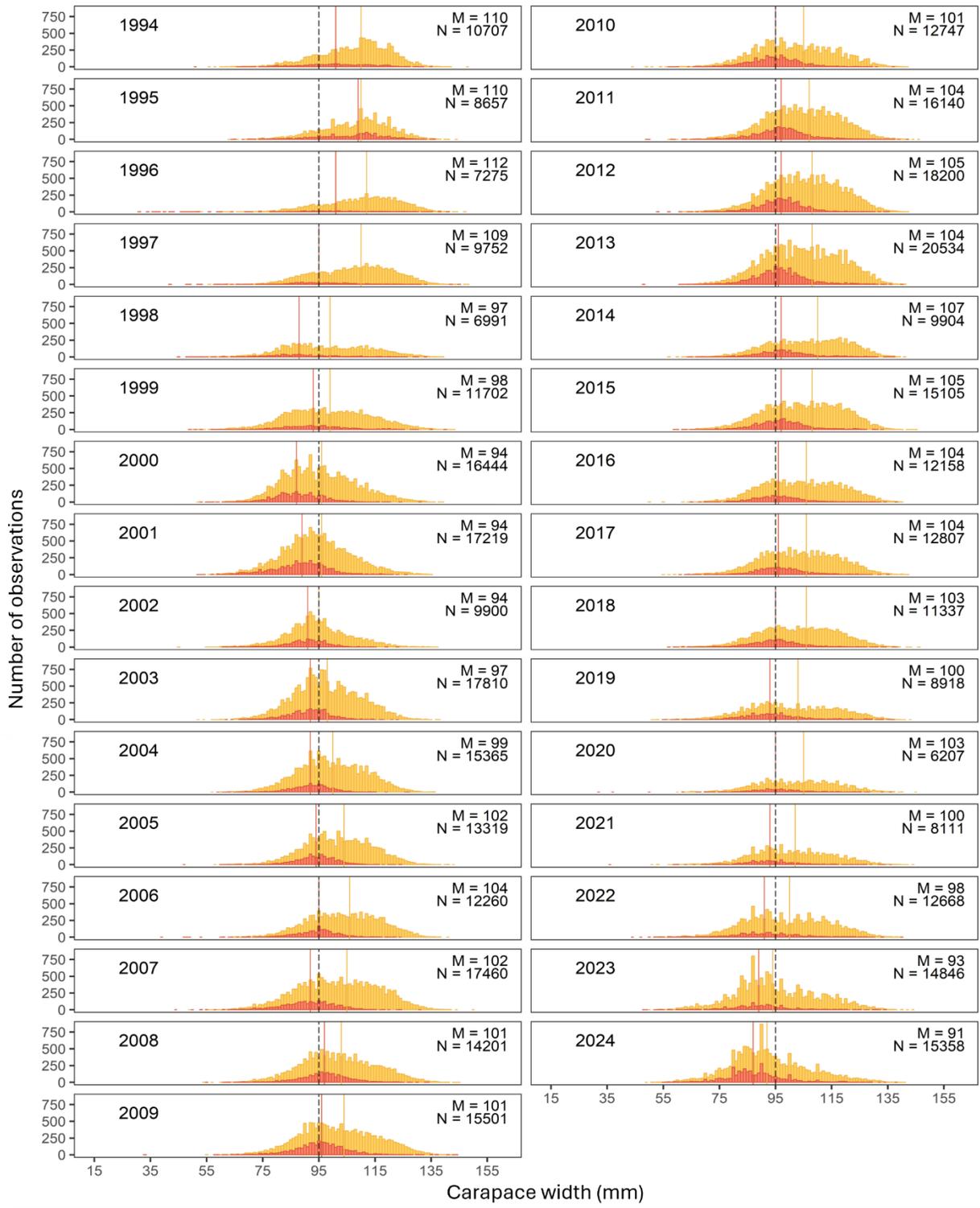


Figure 41. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in Area 16. The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

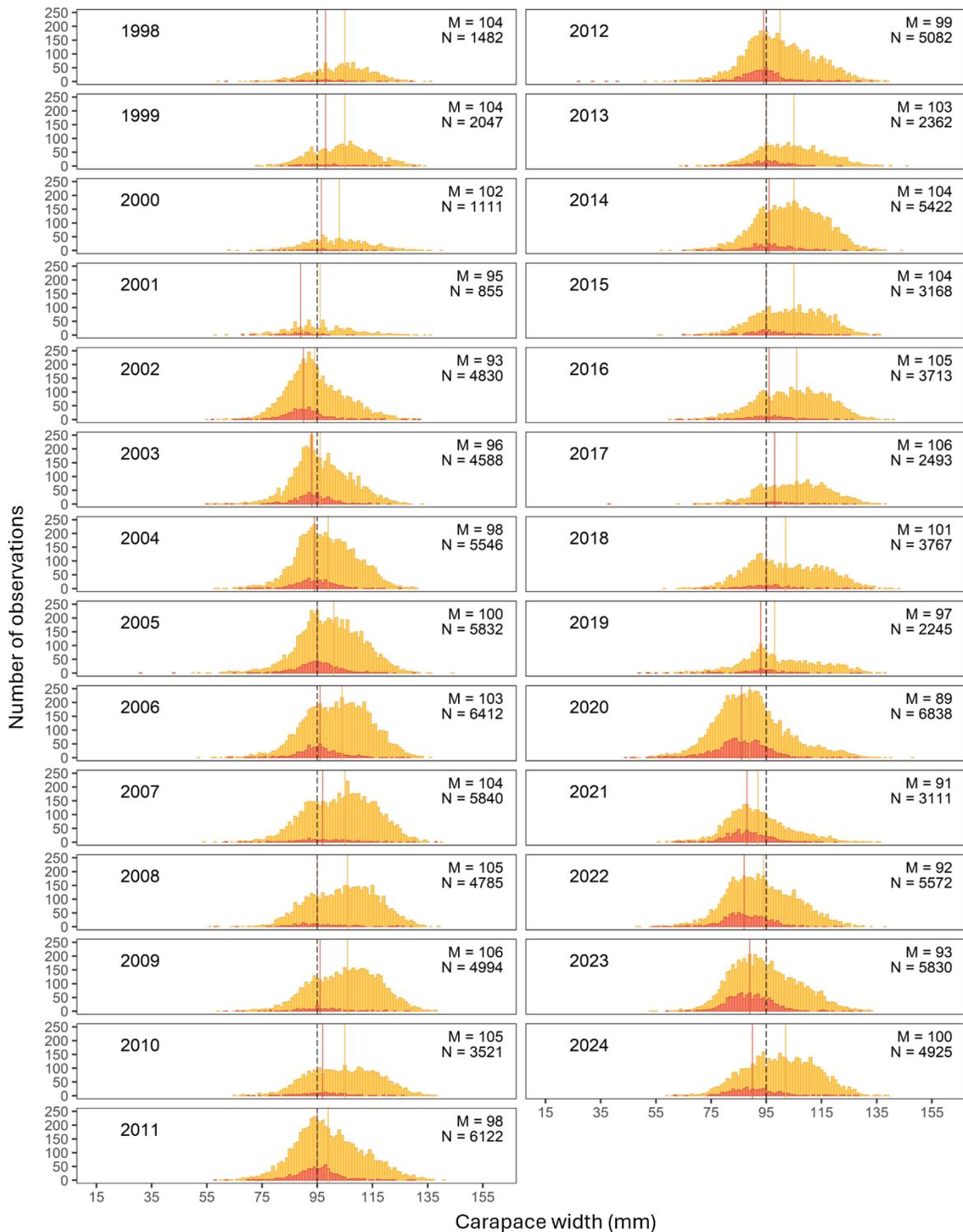


Figure 42. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in Area 15. The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

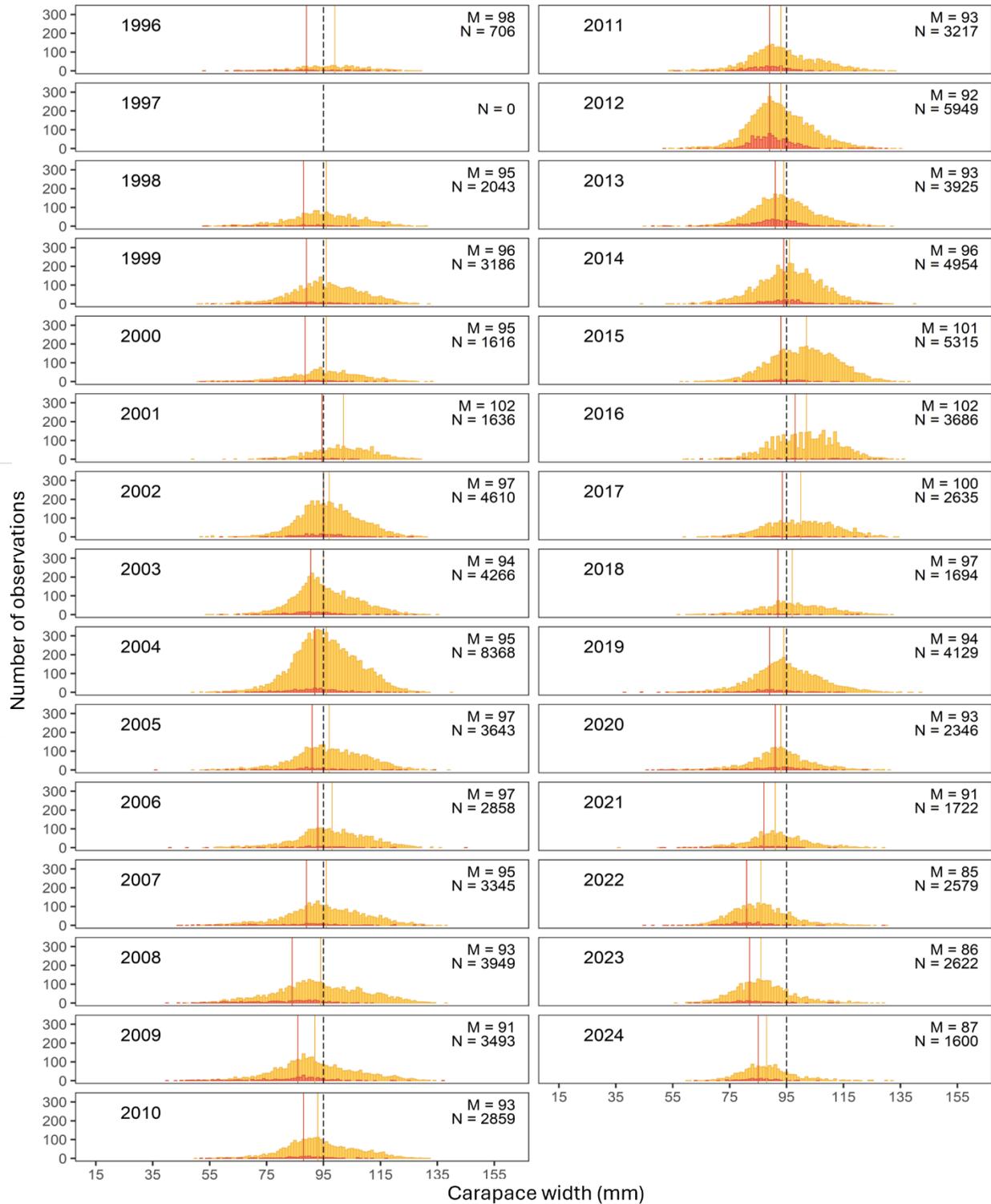


Figure 43. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in Area 14. The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

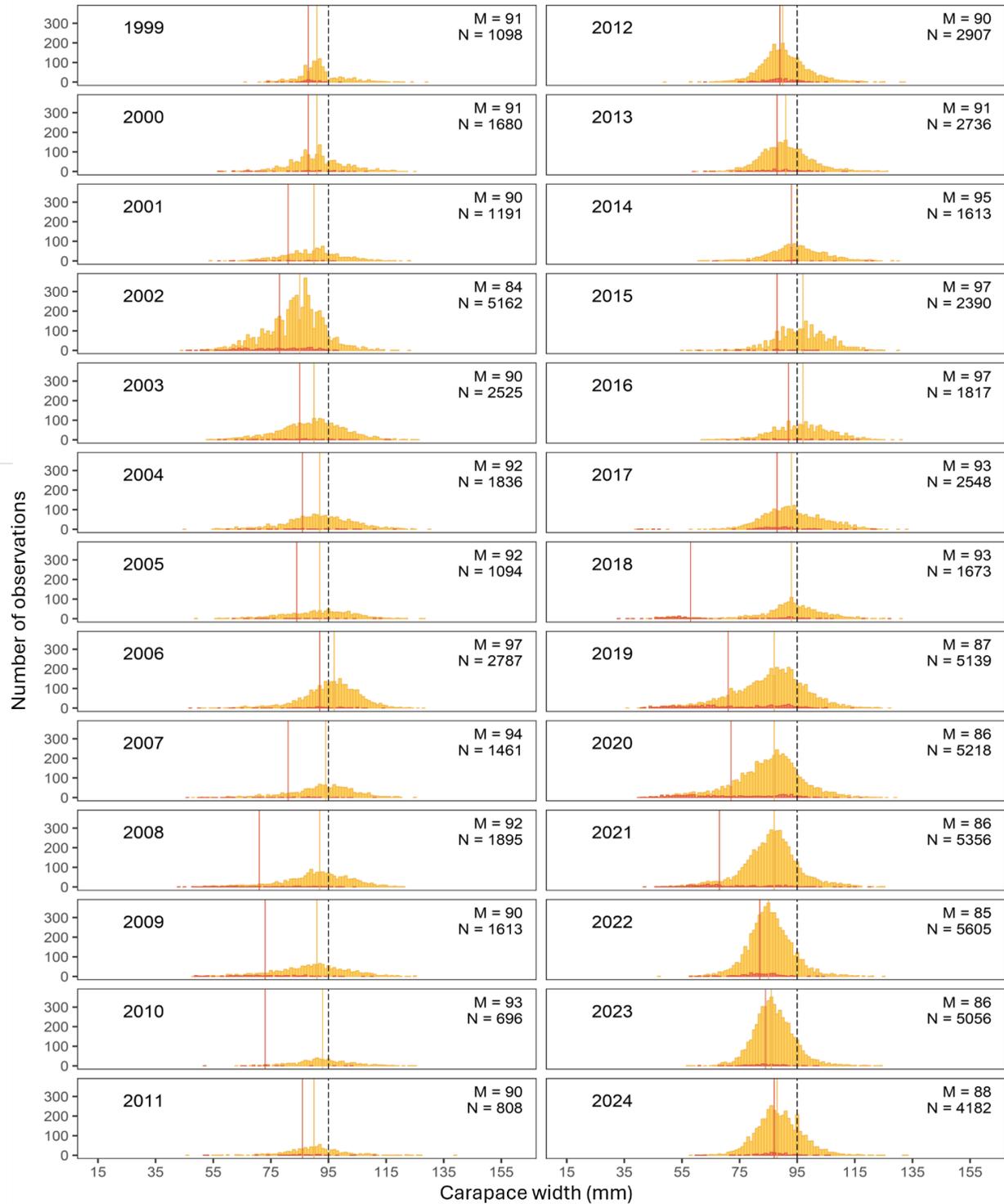


Figure 44. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in the northern portion of Area 13 (13Q). The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

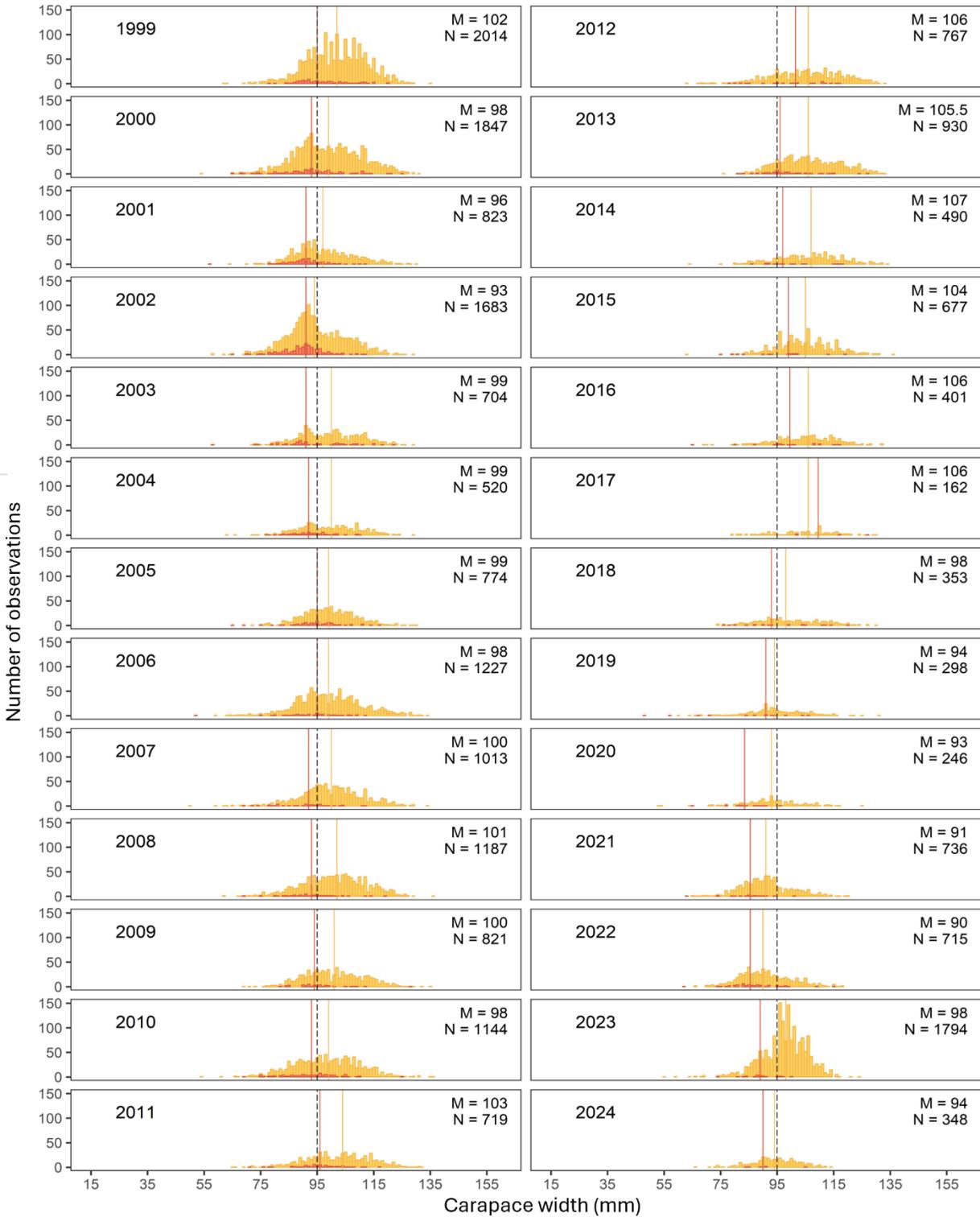


Figure 45. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in the southern portion of Area 13 (13TN). The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

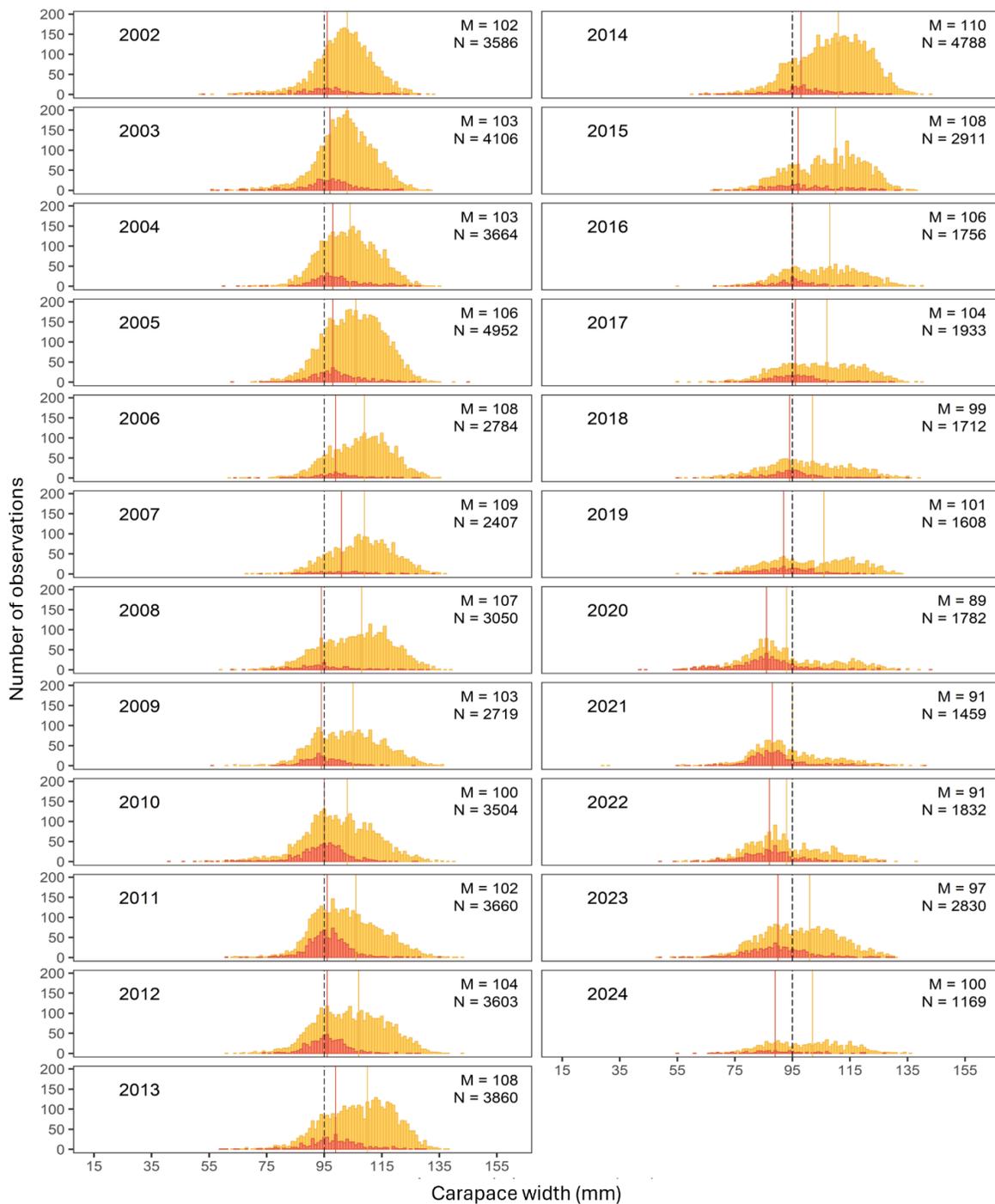


Figure 46. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in Area 16A. The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

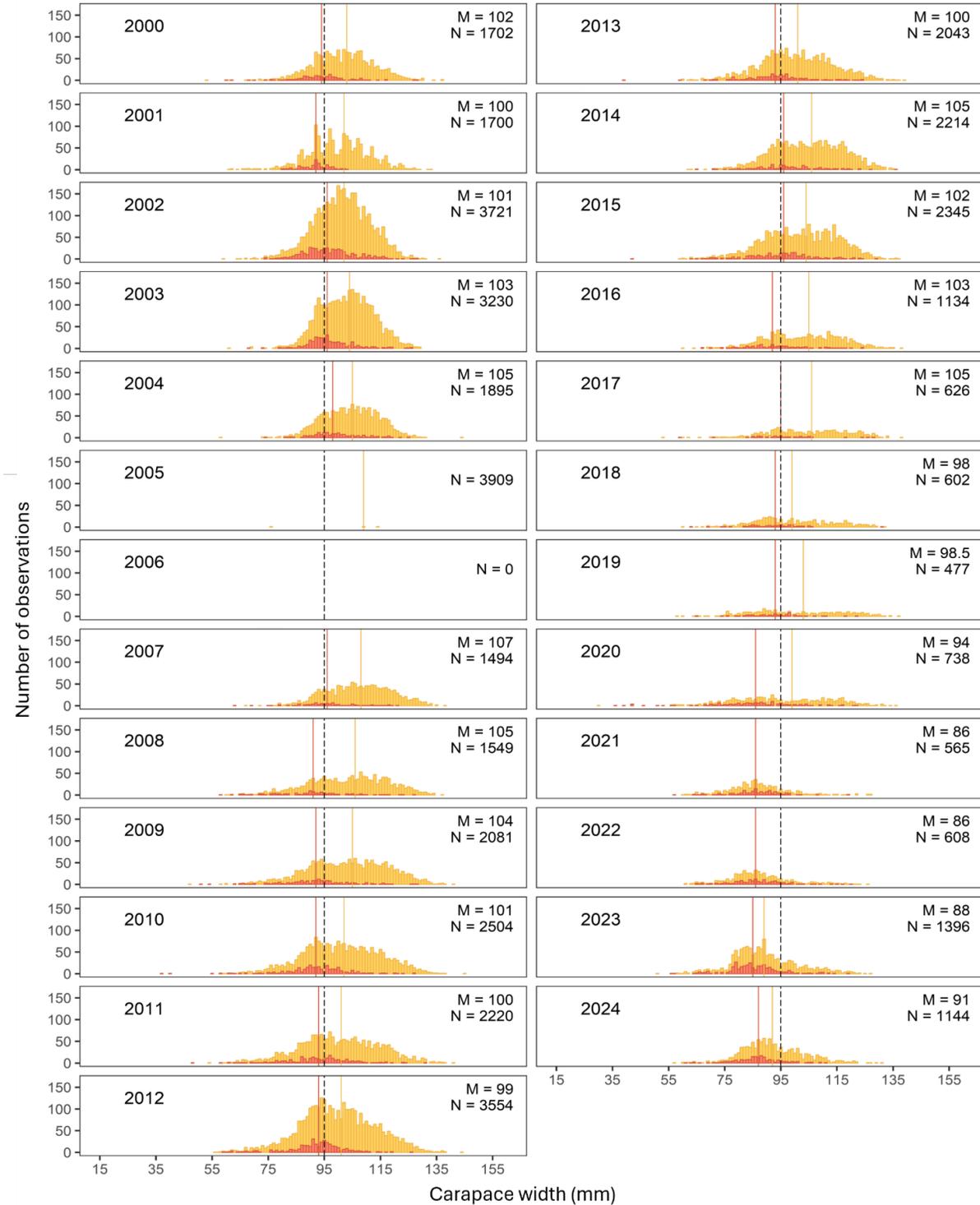


Figure 47. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in Area 12C. The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

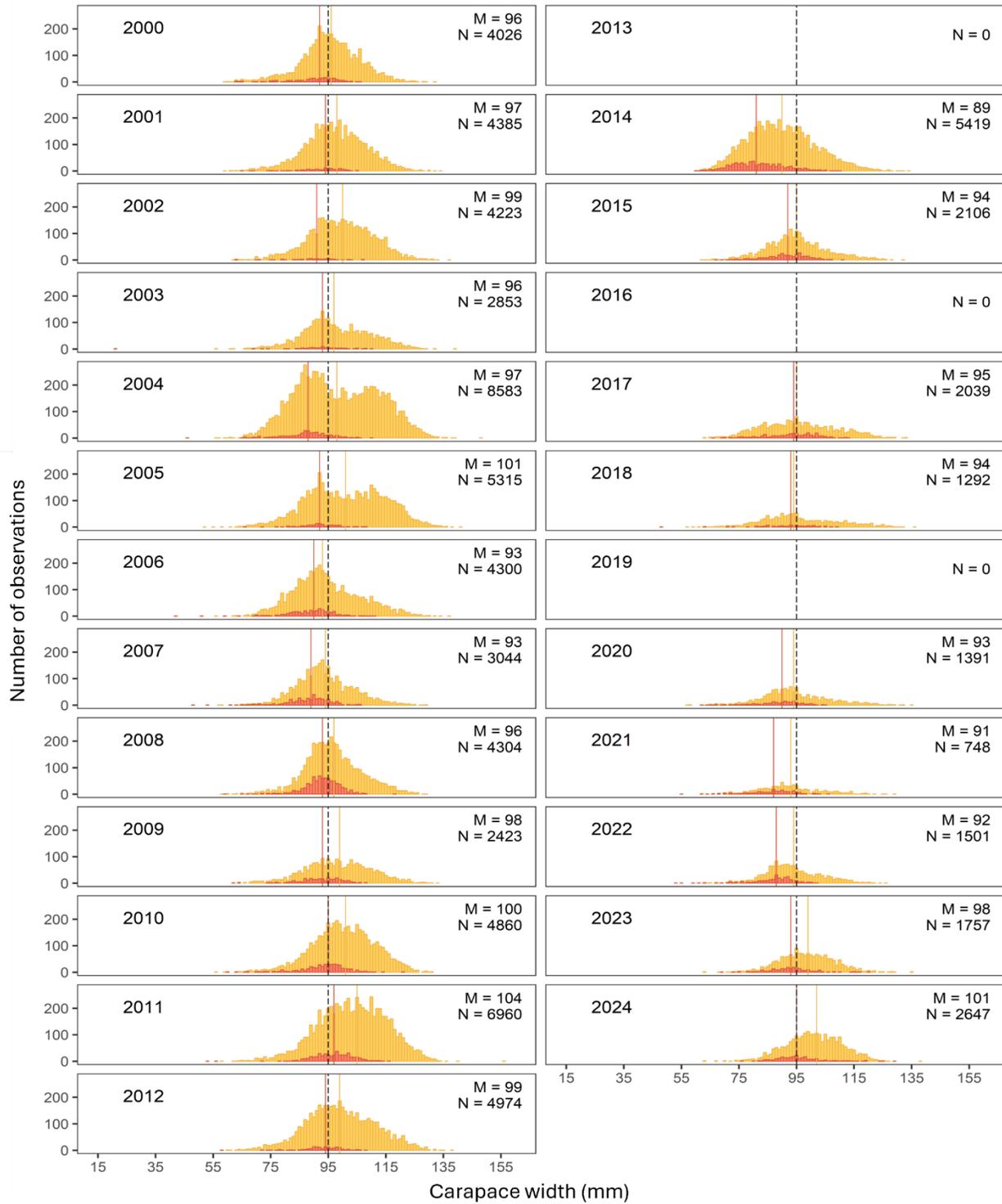


Figure 48. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in Area 12A. The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

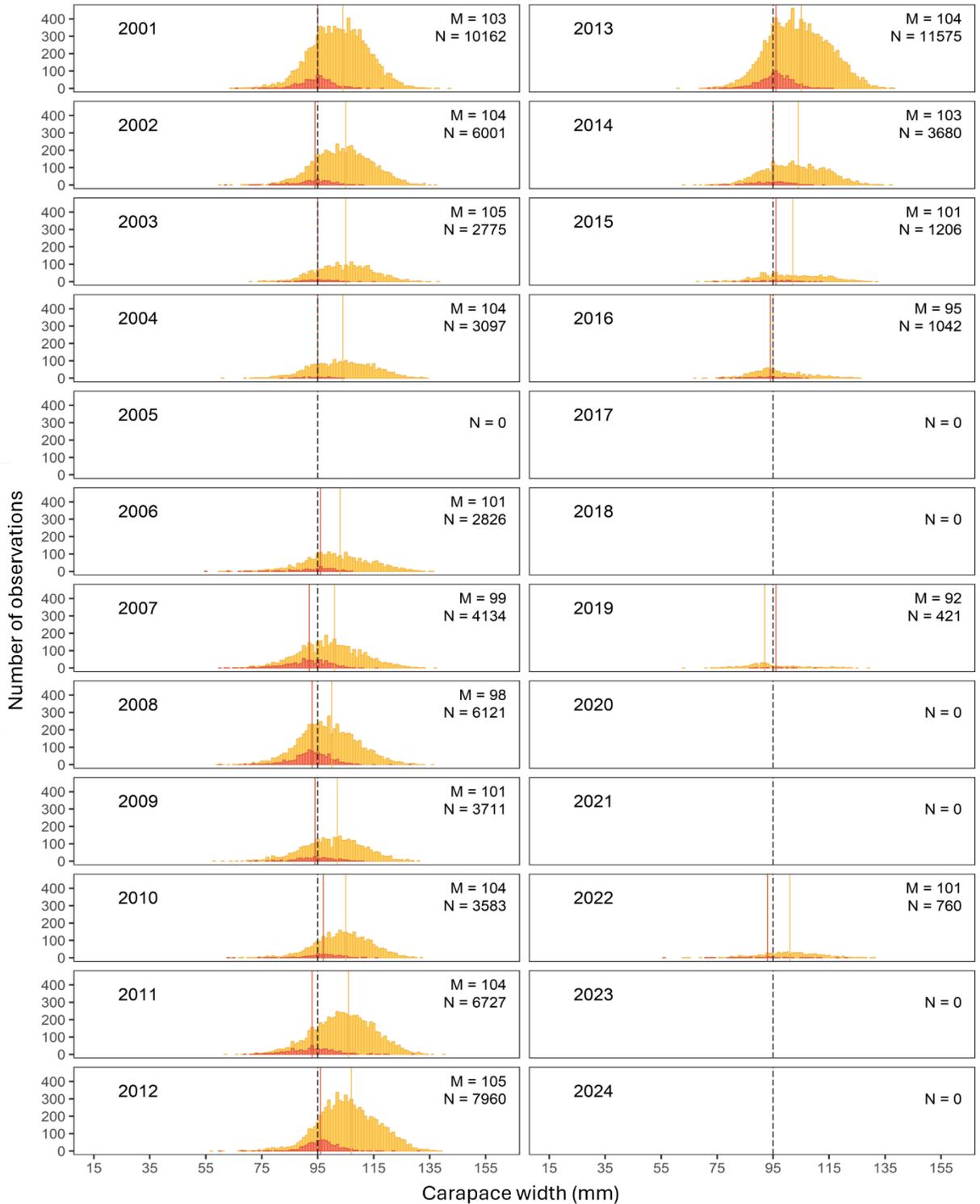


Figure 49. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs in post-season surveys in Area 12B. The median value is indicated by a solid vertical line (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by a dashed vertical black line. The median size of all male crabs (adults and adolescents combined) (M) and the number of male crabs measured (N) are also provided for each year.

Females in experimental traps

In Areas 17 and 12A, the proportion of mature females in the catches in 2021–2023 was high, as it was in 2011–2013 (Figures 50, 51 and 58). In the Estuary (Area 17), female abundance appears to be higher along the south shore than the north shore, especially in recent years (Figures 50 and 51). In Areas 16, 15, 14, 13Q, 12C and 16A, the pulse of primiparous females occurred slightly earlier than in Area 17 and appears to have ended by 2024 (Figures 52 to 57).

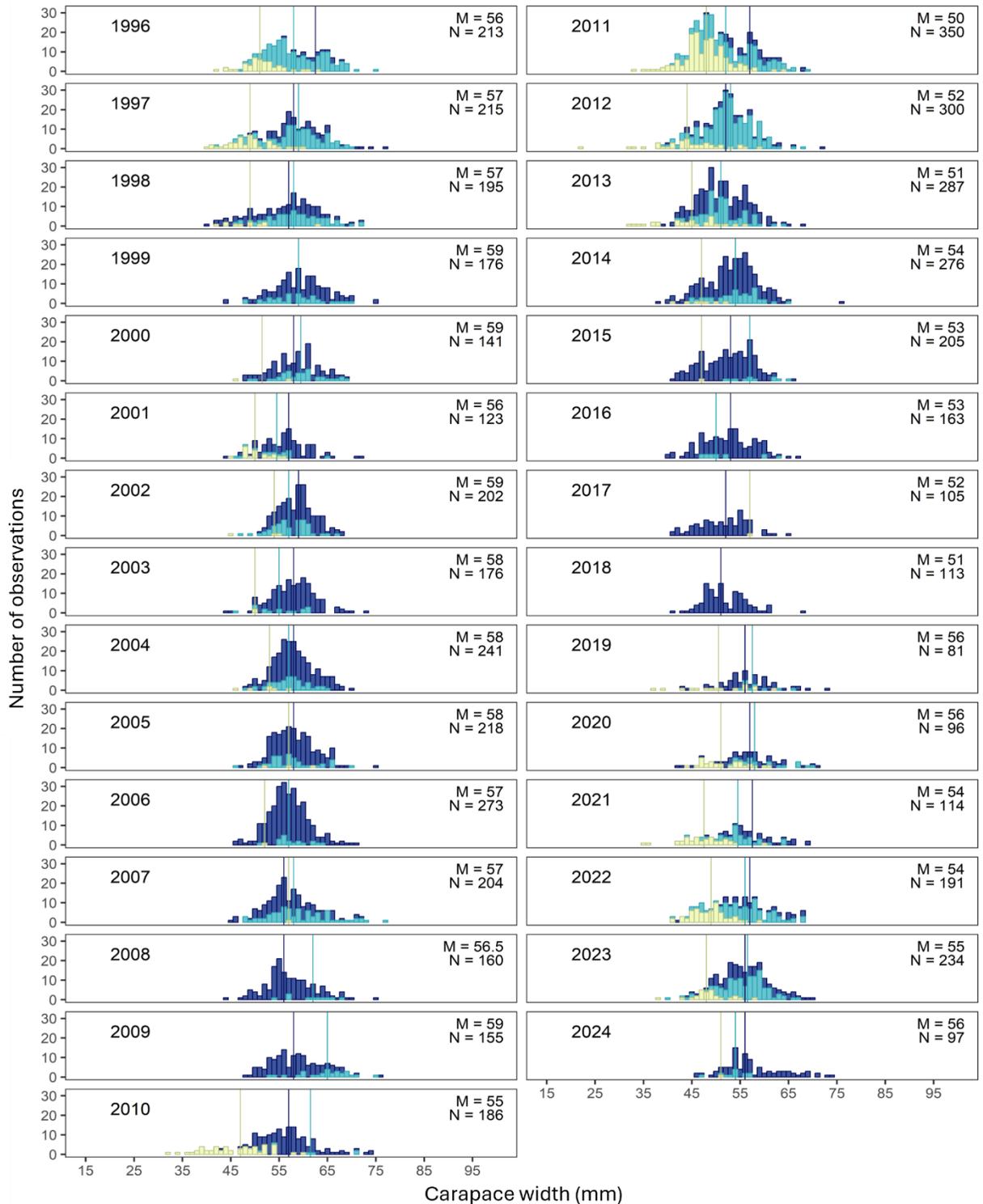


Figure 50. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in the northern portion of Area 17 (17N). The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

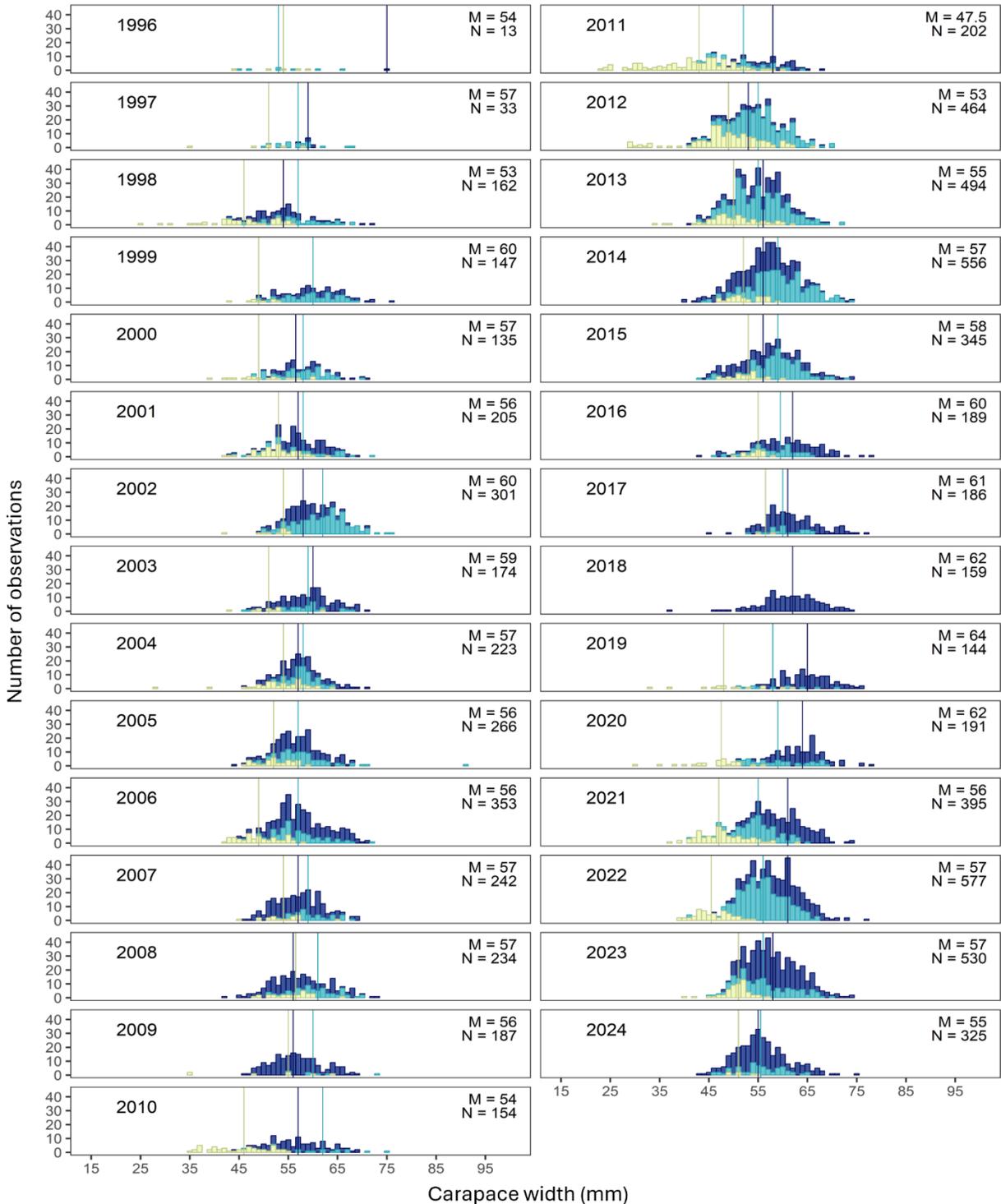


Figure 51. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in the southern part of Area 17 (17S). The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

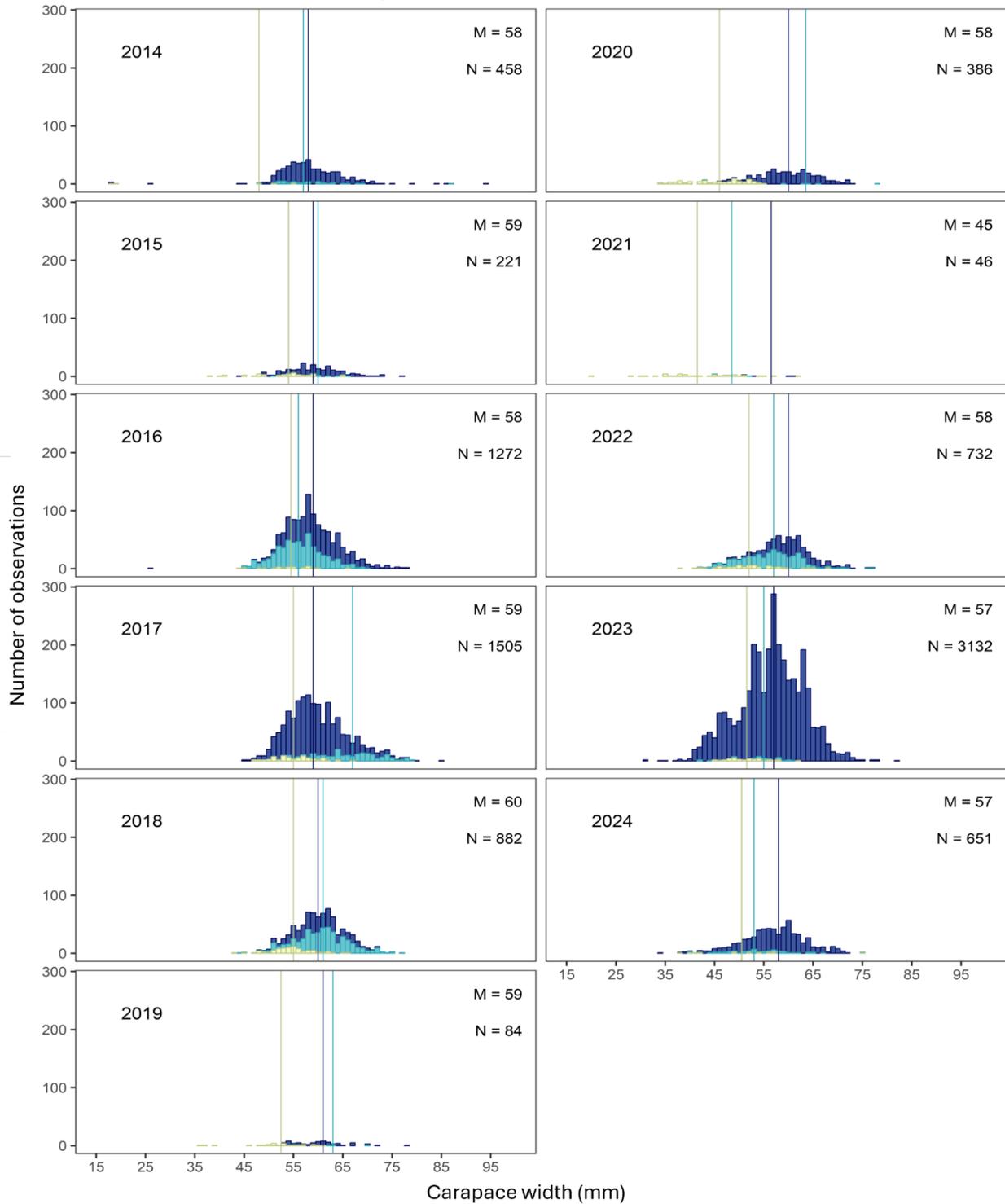


Figure 52. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in Area 16. The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

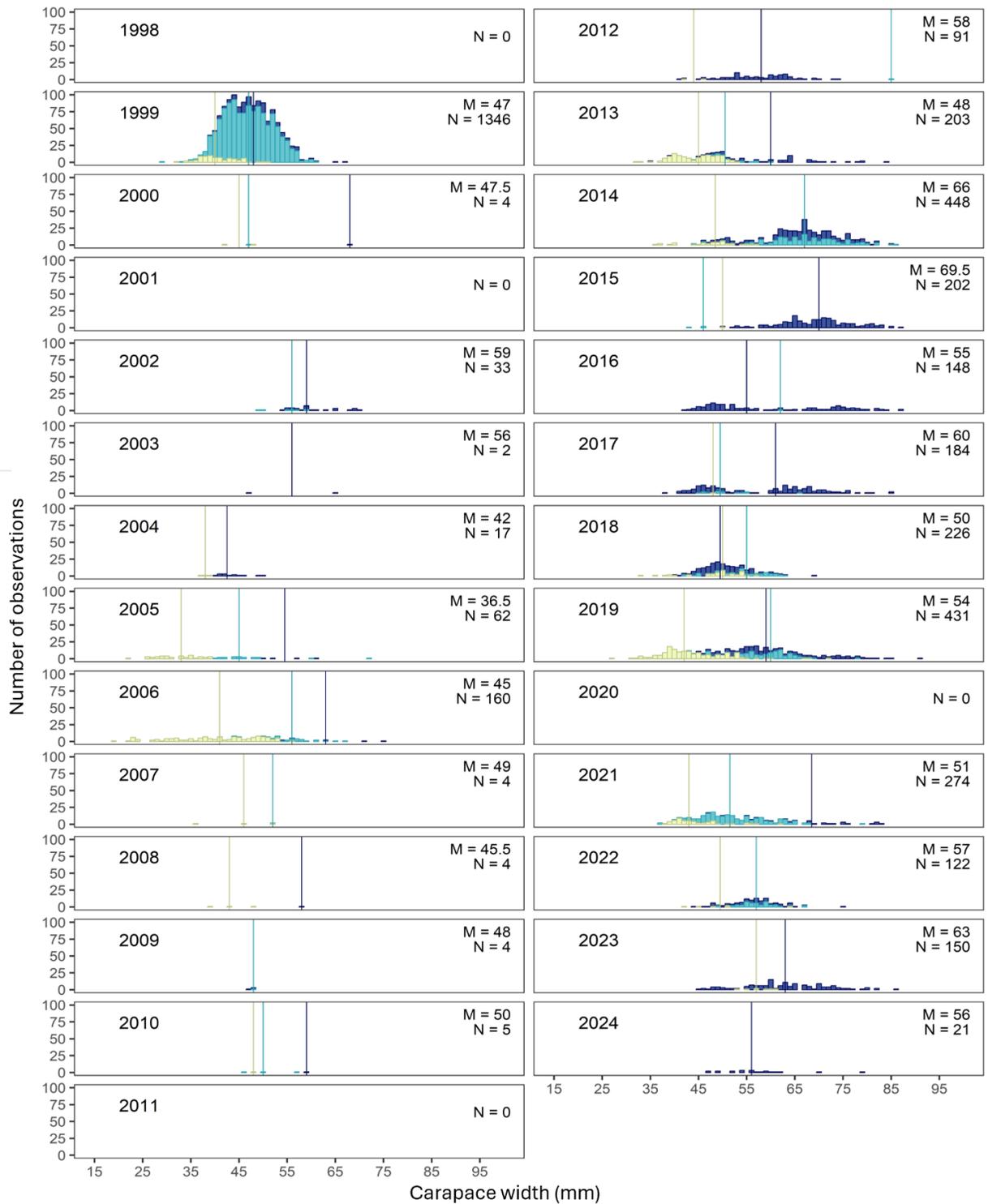


Figure 53. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in Area 15. The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

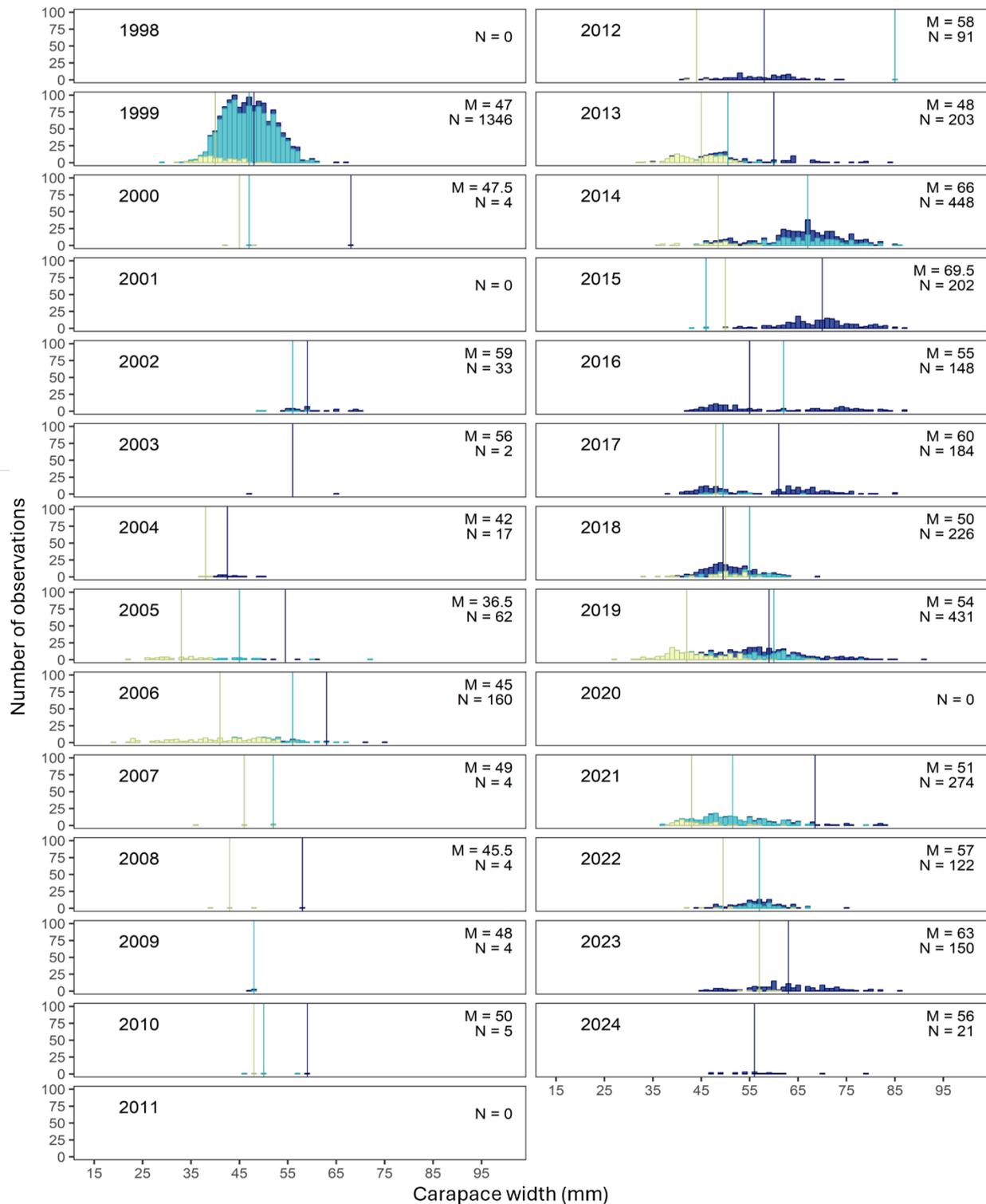


Figure 54. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in Area 14. The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

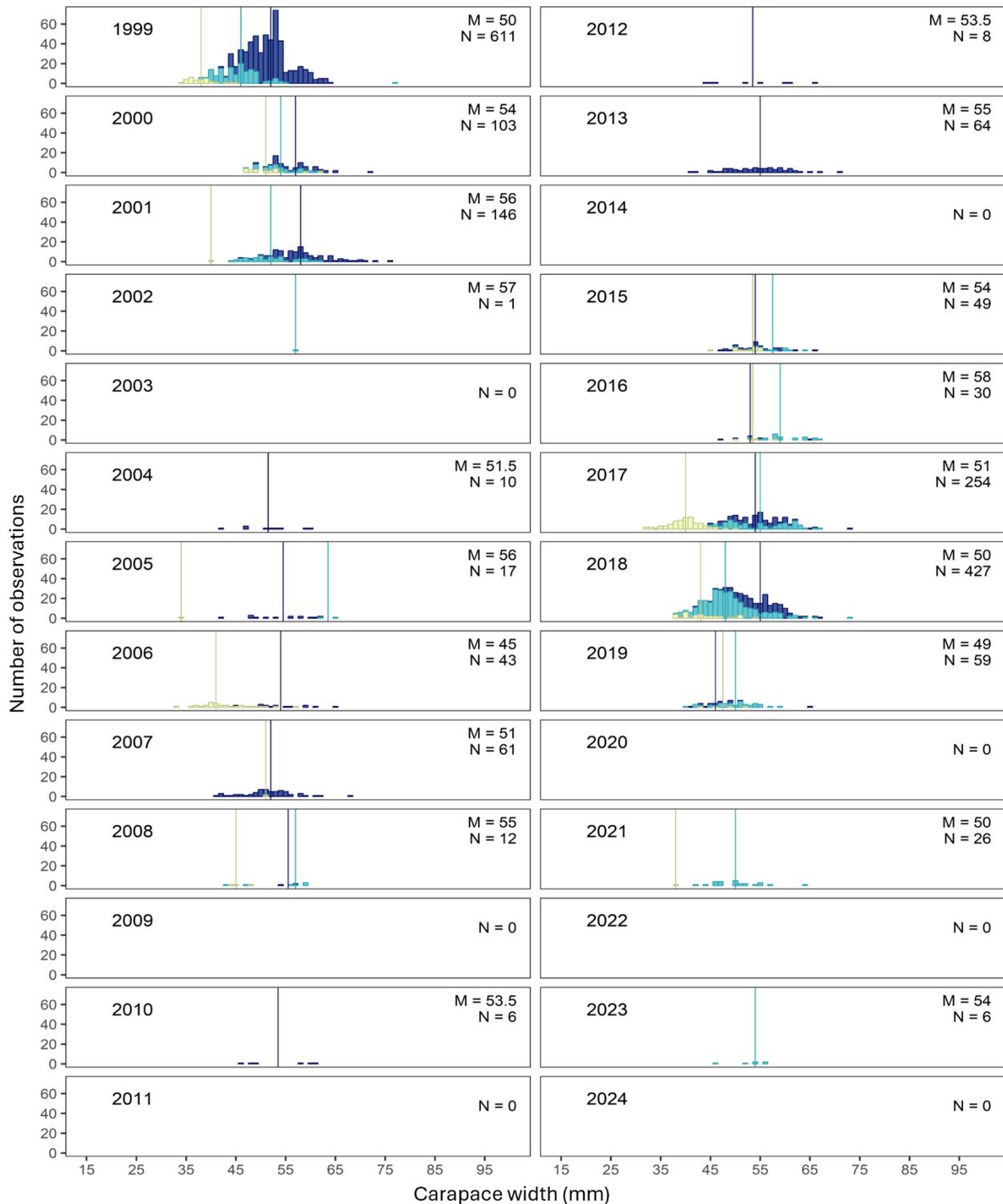


Figure 55. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in the northern portion of Area 13 (13Q). The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

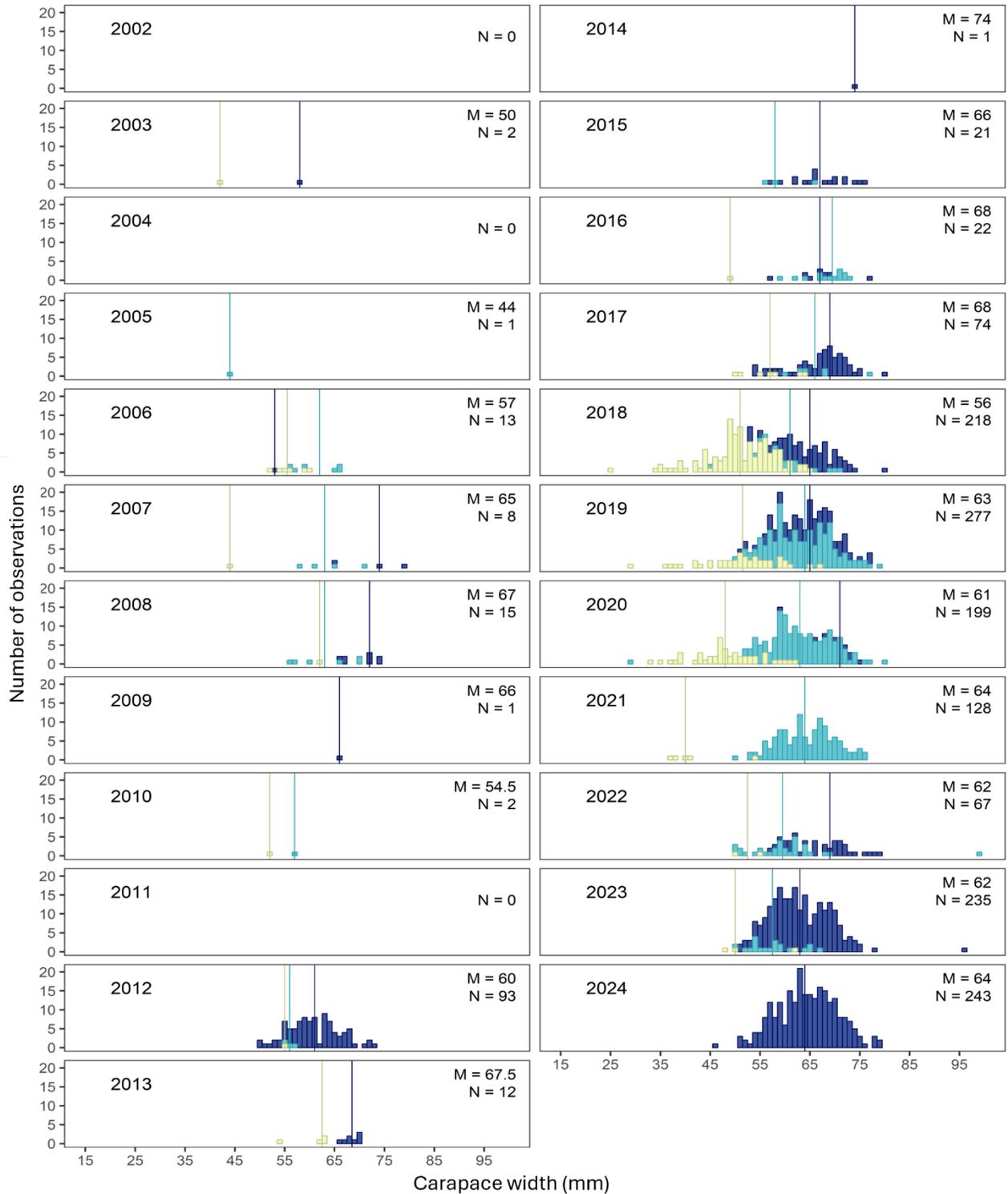


Figure 56. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in Area 16A. The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

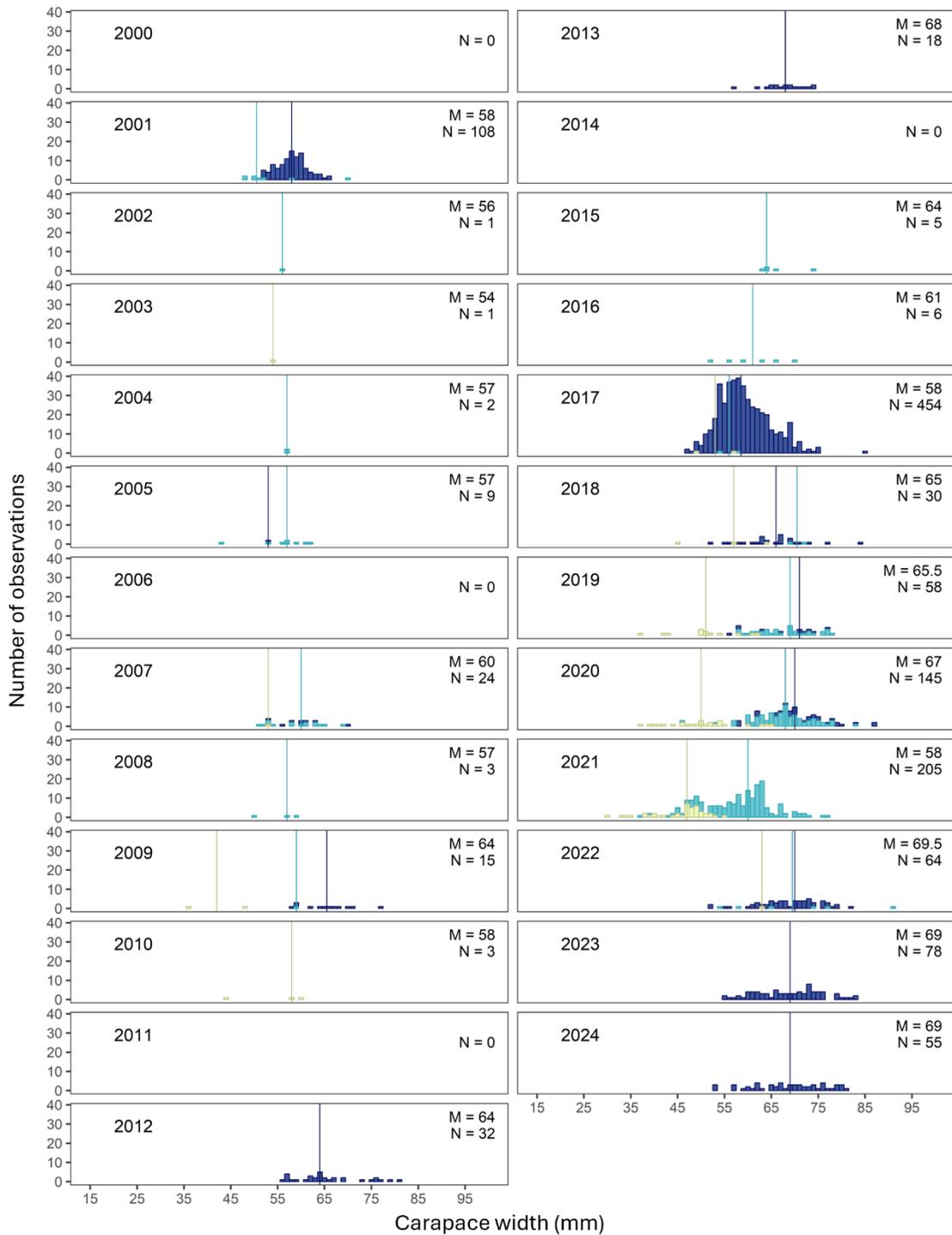


Figure 57. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in Area 12C. The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

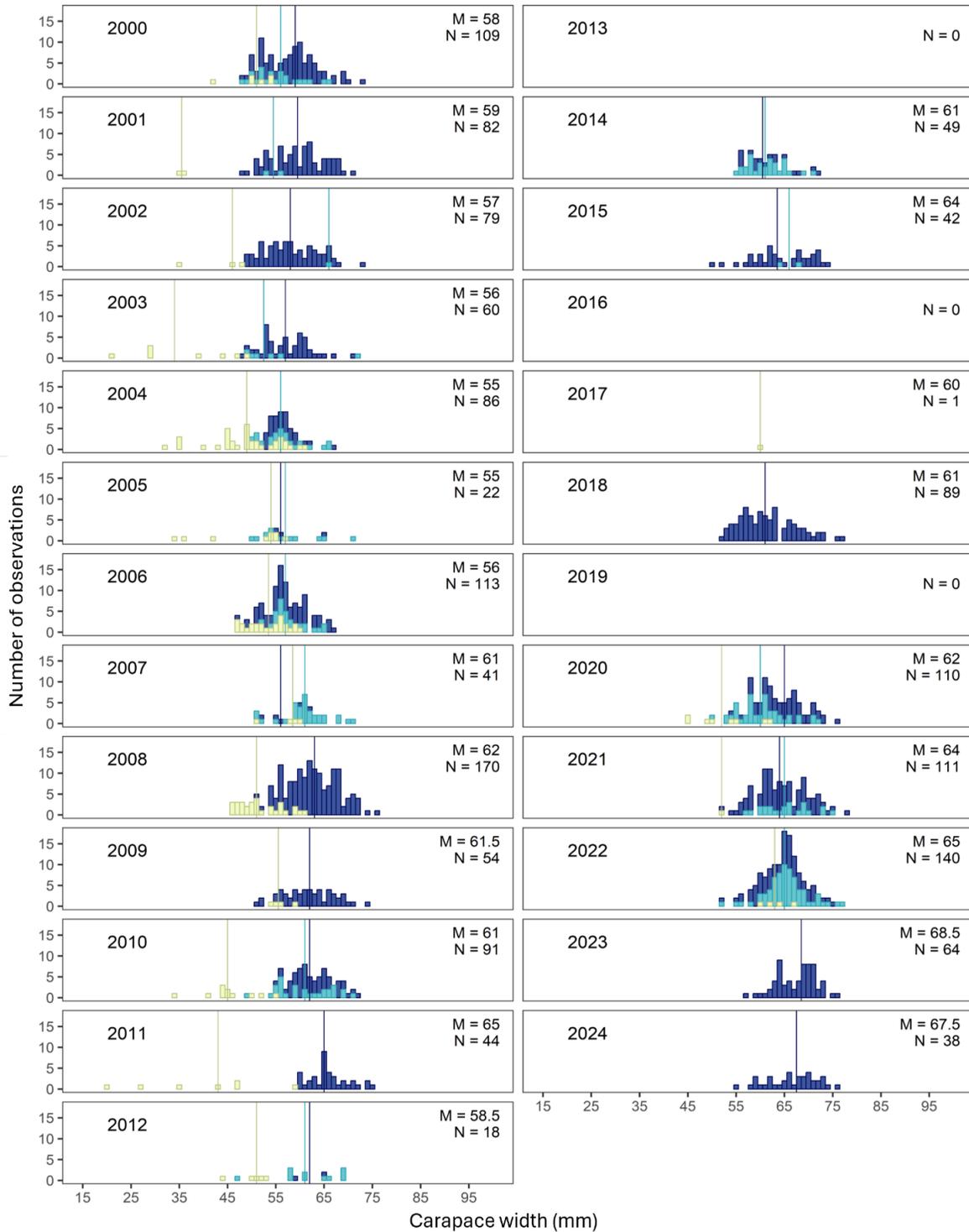


Figure 58. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in Area 12A. The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

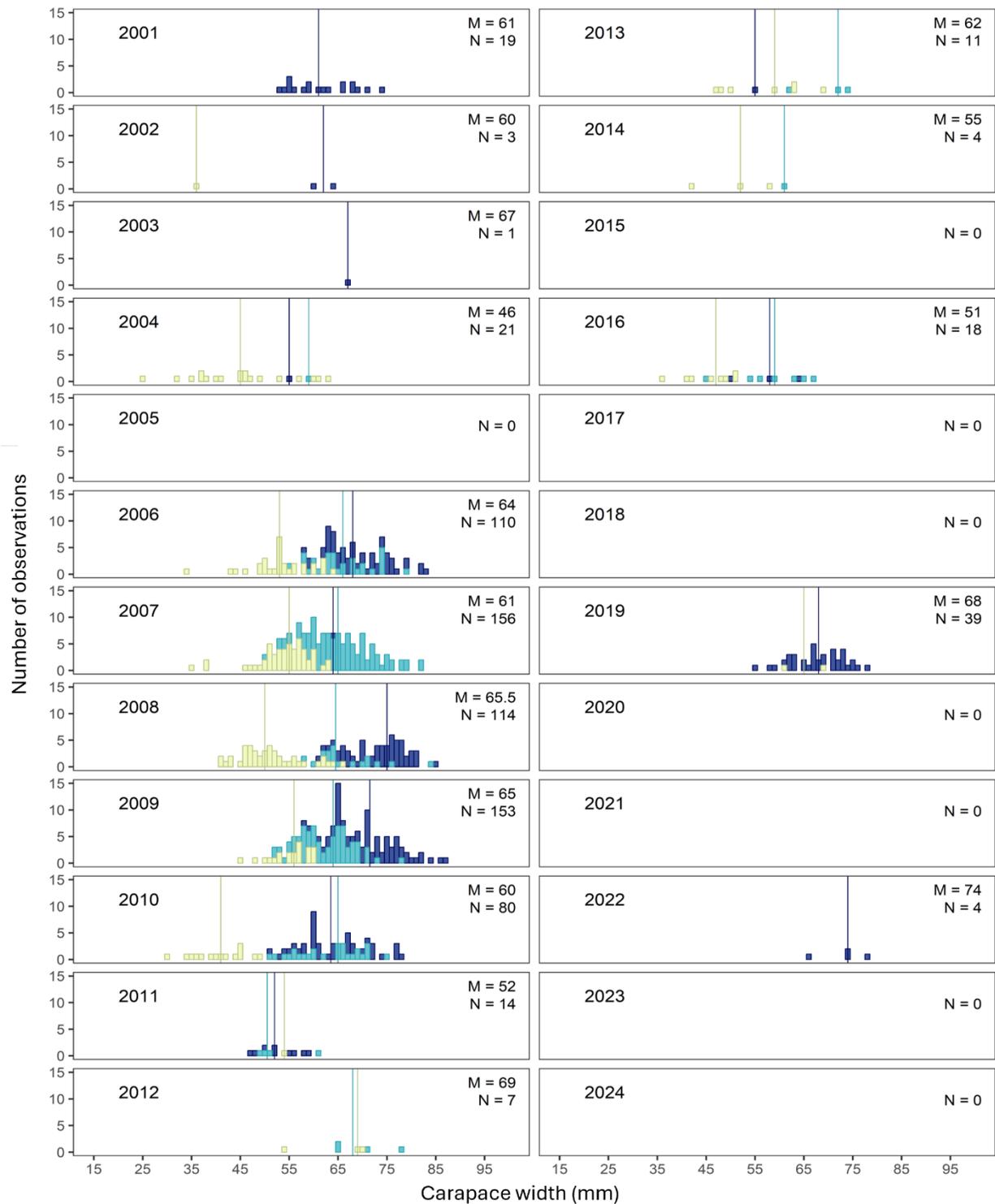


Figure 59. Size frequencies of multiparous (dark blue bars), primiparous (light blue bars) and immature (light green bars) female crabs caught with experimental traps during post-season surveys in Area 12B. The median value for each category is indicated by a vertical line of the same colour. The median size of all female crabs (adults and immatures combined) (M) and the number of crabs measured (N) are provided for each year.

Carapace width

The mean size of male crabs varies considerably from one management area to the next. Individuals in the northern portion of Area 13 (13Q) are generally smaller than those in other areas, while Areas 12C, 16A and 16 have the largest mean sizes (Figure 60). In recent years, the mean size has decreased significantly in a number of areas (12C, 13Q, 13TN, 14, 16, 17N and 17S), in some cases dropping to the lowest value in the time series (Figure 60). Area 12A has a different pattern, with a gradual cyclical reduction in the average maximum size of commercial crabs after a peak in 2004 (Figure 60).

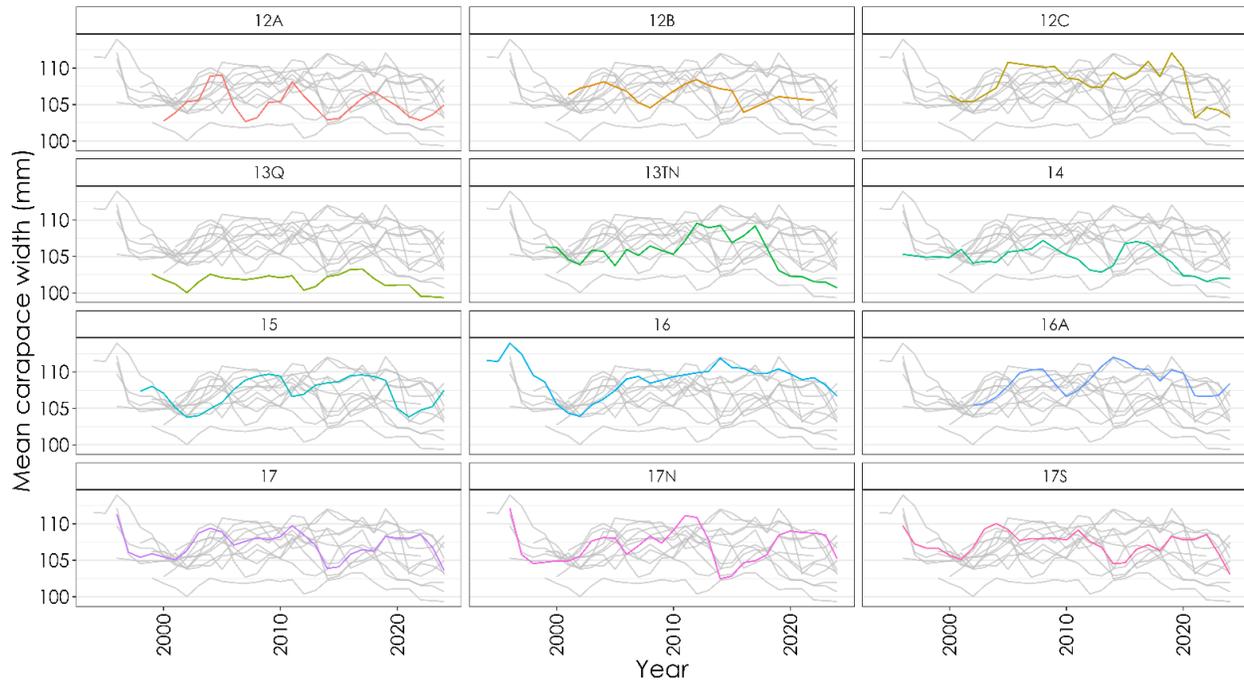


Figure 60. Yearly values for mean carapace width (in mm) of legal-size male crabs caught during post-season surveys in the Estuary and northern Gulf of St. Lawrence management areas from 1995 to 2024. The coloured curves represent the annual mean values for carapace width for the given area, while the grey curves show the values for the other management areas for comparison purposes.

In 2024, the average size of mature females (multiparous and primiparous) ranged from 50 to 70 mm. Females were generally larger in Areas 12A, 12C and 16A, and smaller in Areas 13Q, 17 and 16 (Figure 61). In Area 17, the average sizes of mature females on the north and south shores of the Estuary were similar from 2000 to 2010 but then began to diverge significantly (Figure 62). The average size of mature females on the north shore decreased until 2017 and then increased until 2020, while that of south shore females increased from 2012 to 2019. In 2017, females along the south shore were 9 mm larger on average than those along the north shore. However, the average size along the south shore began to decrease in 2019 and, by 2024, was smaller than the average size along the north shore (Figure 62). Since the commercial fishery does not target females, environmental factors—notably the different temperature regimes in these areas—are likely the main cause of these size differences at maturity between the two shores.

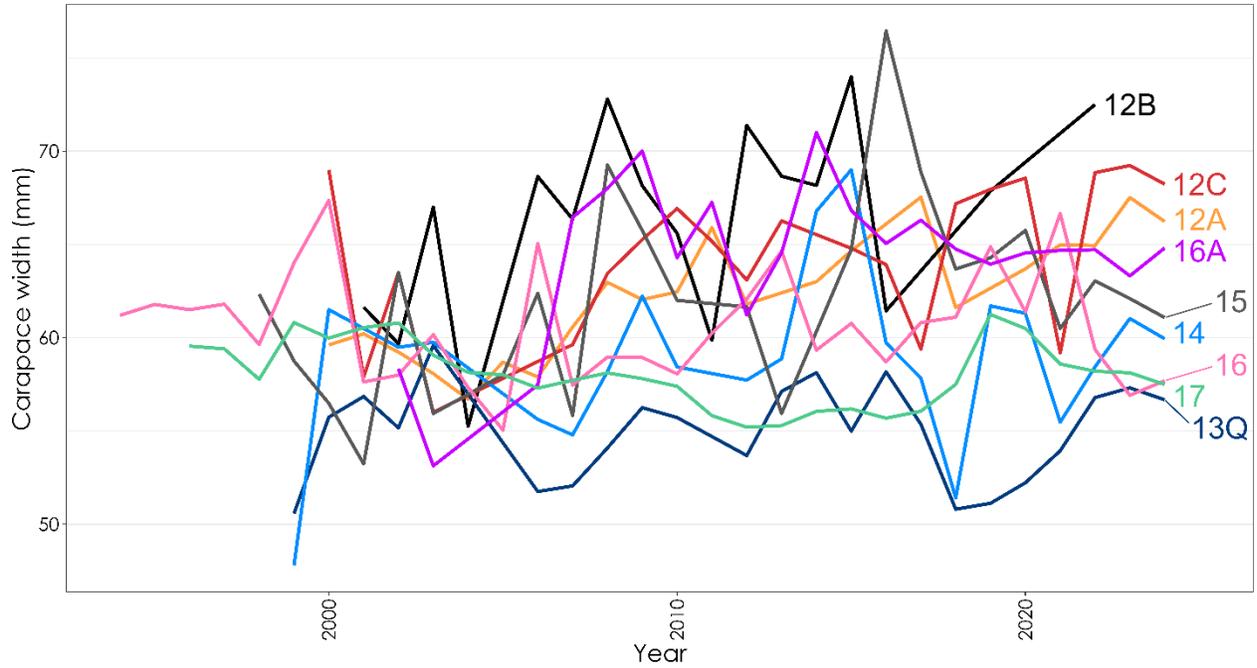


Figure 61. Yearly values for mean carapace width (in mm) of mature female crabs caught during post-season surveys in the Estuary and northern Gulf of St. Lawrence management areas from 1995 to 2024.

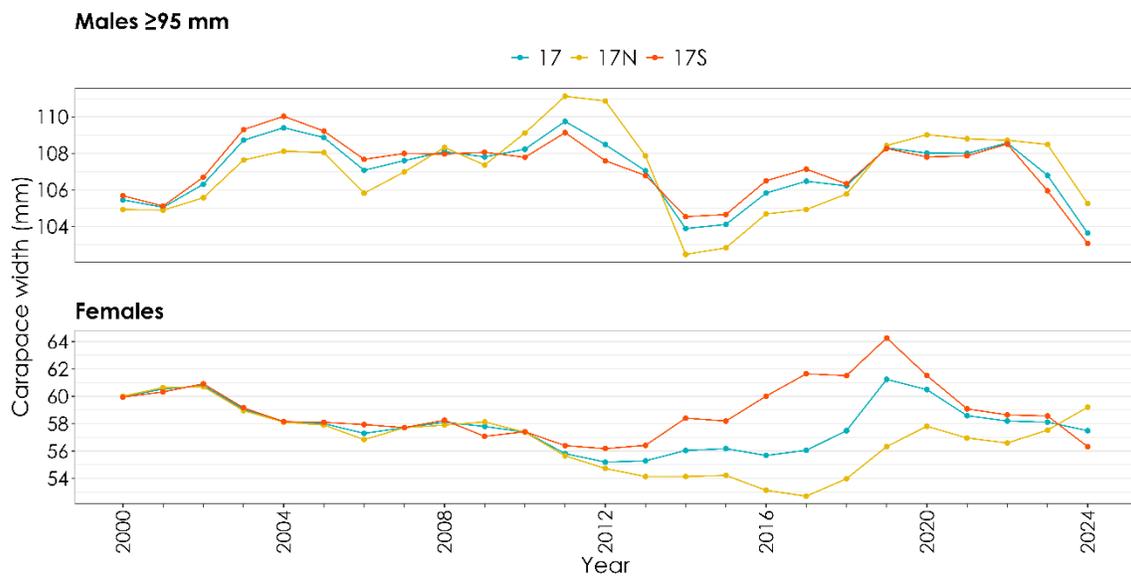


Figure 62. Yearly values for mean carapace width (in mm) of legal-size (≥ 95 mm) male crabs and mature female crabs caught during post-season surveys in Area 17, by shore (north shore, 17N, and south shore, 17S) and overall, from 2000 to 2024.

Spatial distribution in 2024

In 2024, the highest densities of legal-size male crabs were near Natashquan, where Areas 16 and 15 meet (Figure 63), while the highest densities of adolescent crabs (all size classes combined) were around Sept-Îles, in Area 16 (Figure 64).

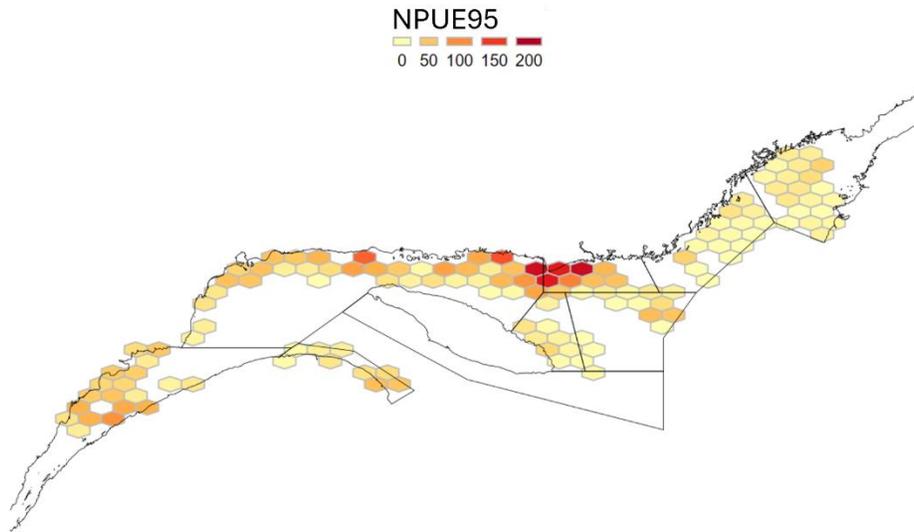


Figure 63. Spatial distribution of average NPUE95 (raw number of legal-size male crabs per unit effort) based on the 2024 post-season survey data.

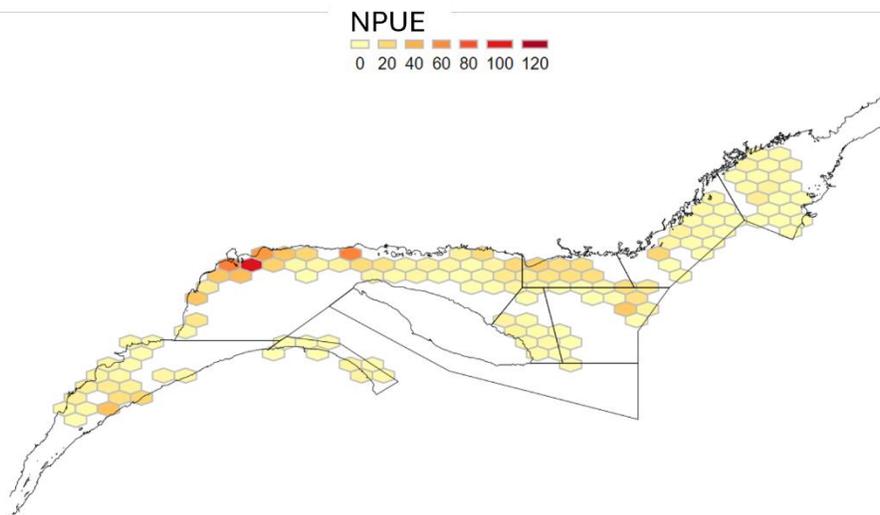


Figure 64. Spatial distribution of average NPUE (raw number of adolescent crabs per unit effort) based on the 2024 post-season survey data.

Reproductive success indicator

In Area 17, the mean weight of the spermathecal load of primiparous females, which had declined between 2019 and 2023, increased in 2024 (Figure 65). In the more easterly areas, particularly Areas 16, 15, 14 and 13Q, an increase has been apparent since 2020–2021 (Figure 65). This suggests an asynchrony between the abundance cycle in areas in the Estuary and those farther east, which is also seen in the size distribution of females described earlier.

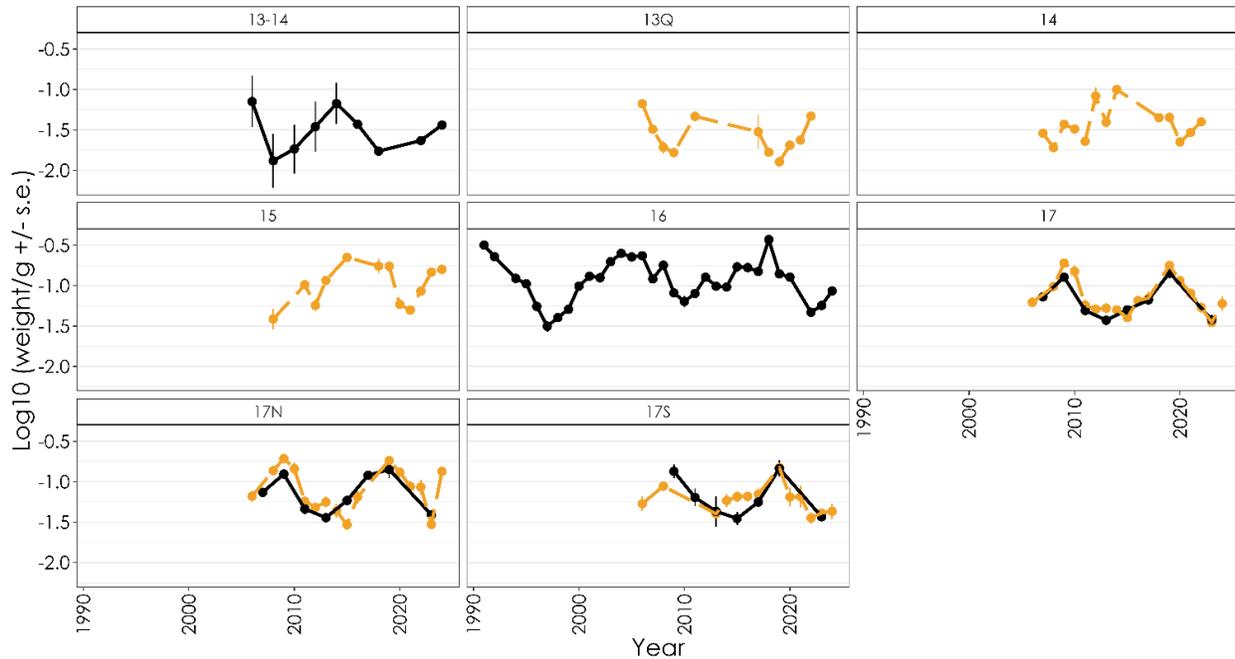


Figure 65. Mean spermathecal load weight (\log_{10} in g \pm standard error) in primiparous females in different areas of the Estuary and northern Gulf of St. Lawrence. The yellow dotted lines represent the values obtained from the post-season surveys, while the solid black lines represent the values from the DFO trawl surveys.

STOCK STATUS: COMBINED INDEX

The combined index is derived from the standardized CPUE values obtained in the commercial fishery and NPUE values for legal-size crabs obtained from the post-season surveys. Time series of varying length are available for this index, depending on the area and corresponding to the length of the time series for post-season NPUE values (Figure 66). In all areas except Area 14, the combined index began to fall in 2014–2015 and reached its lowest value in 2019–2021 (Figure 66). In 2024, only Area 15 and the northern part of Area 13 (13Q) saw an increase; in all other areas, the value of the index levelled off or declined after a brief increase. A persistent downward trend can be observed in Areas 17, 16 and the southern portion of Area 13 (13TN), despite cyclical fluctuations (Figure 66).

In Area 12A, there was a lag between the two index indicators: the post-season NPUE95 began to fall in 2012, but the commercial CPUE did not start to decline until 2014 (Figure 67). The CPUE95 continued to fall until 2021 and then began to recover gradually, while the commercial CPUE remained above the limit threshold until 2020 before falling again in 2021 (Figure 67). This divergence may be the result of CPUE hyperstability, a phenomenon in which high commercial yields temporarily mask a decline in biomass.

In Area 12B, both indicators (the commercial CPUE and the post-season CPUE95) began to fall simultaneously in 2014. Since 2015, they have remained below the limit thresholds (Figure 68). The isolated increase in the commercial CPUE in 2021 is the result of limited exploratory fishing (20 t in six trips) concentrated in the centre of the fishing area, and does not indicate an overall increase in the resource. No commercial fishing has taken place since then, and no post-season surveys have been conducted since 2022.

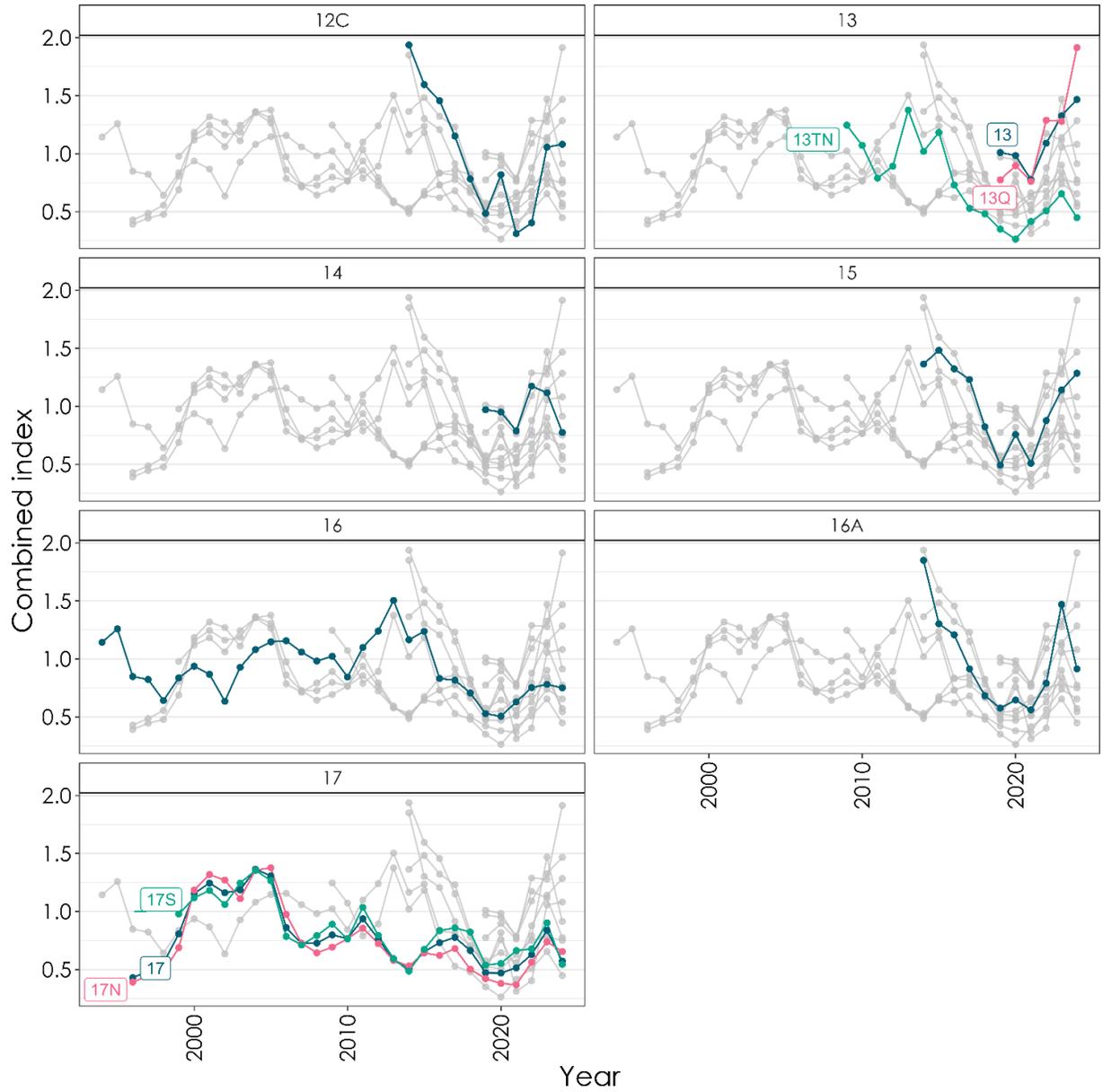


Figure 66. Combined index derived from the standardized annual commercial CPUE and the annual NPUE for legal-size males in the post-season survey in snow crab management Areas 13 to 17, 12C and 16A. The coloured curves show the values of the combined index for the given area, and the grey curves show the values for the other areas for comparison purposes. In Areas 13 and 17, the combined index is calculated separately for the northern and southern portions.

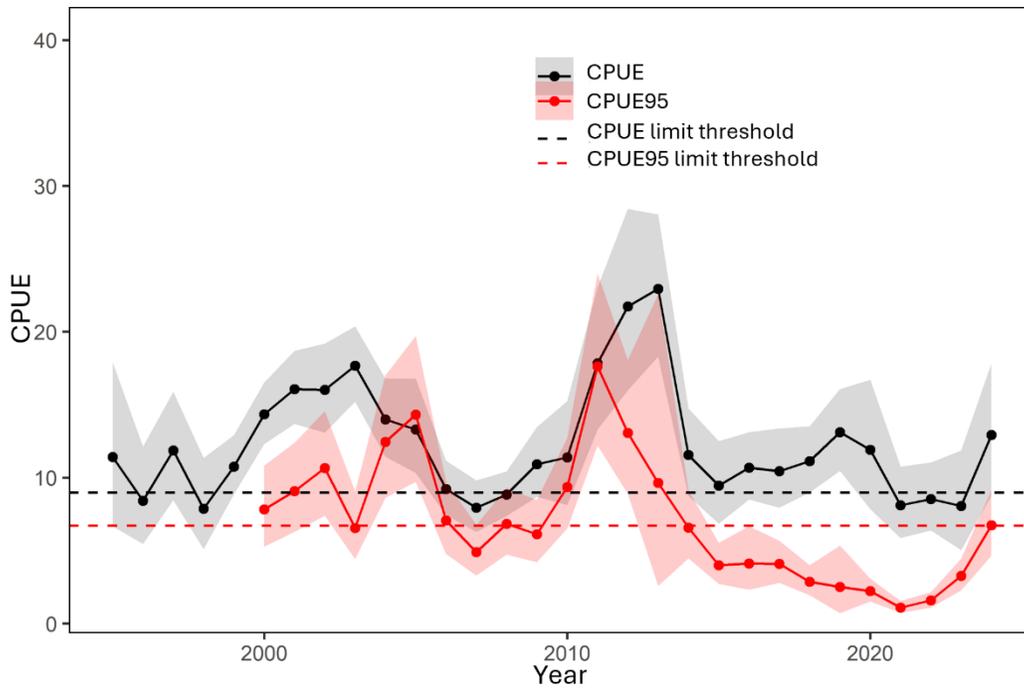


Figure 67. CPUE from the commercial fishery and CPUE95 from the post-season survey (\pm 95% credible interval) and their respective limit thresholds in Area 12A.

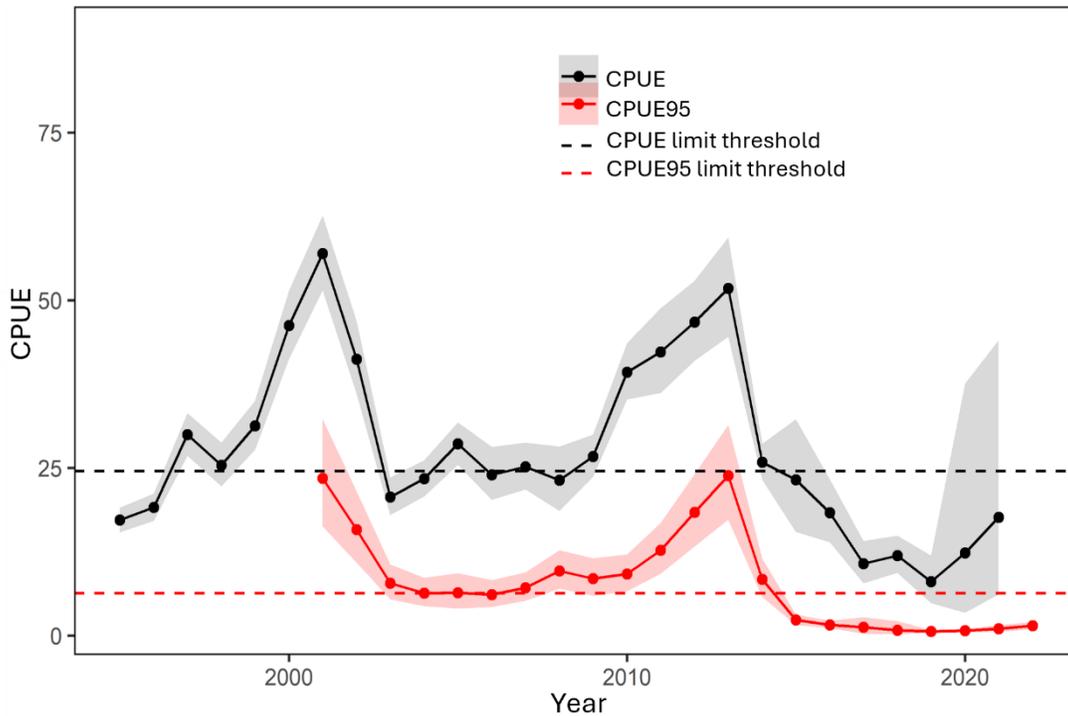


Figure 68. CPUE from the commercial fishery and CPUE from the post-season survey (\pm 95% credible interval) and their respective limit thresholds in Area 12B.

FAVOURABLE THERMAL HABITAT INDICES

In general, favourable thermal habitat for adult crabs declined in most areas from 1990 to 2024. This particularly affected Areas 12A, 12B, 12C, 15, 16A, 16 and 17, while the northern portion of Area 13 saw a slight improvement (Figures 69 to 79).

Areas 16, 17S, 12C, 12A and 12B have lost roughly 10% of their favourable thermal habitat since 1990 (Figures 70, 71 and 77–79). The loss is particularly critical in Area 17, where only 10–20% of the area has remained suitable for snow crabs in recent years (Figures 69 and 70). In comparison, despite a significant loss, Area 15 still has over 70% of its favourable habitat (Figure 72). The decline has left Area 17 (including both its northern and southern portions) with approximately 1,800 km² of favourable thermal habitat in total, similar to that in Areas 12C and 16A.

Changes in favourable habitat for juvenile crabs have followed a heterogeneous pattern: declines in Areas 16 and 17, but expansion in Areas 13, 15 and 16A (Figures 69 to 76). The increase in suitable habitat for juveniles is particularly striking in Areas 15, 16A and 13, with the area of favourable habitat doubling over the past 30 years (Figures 72 and 74–76).

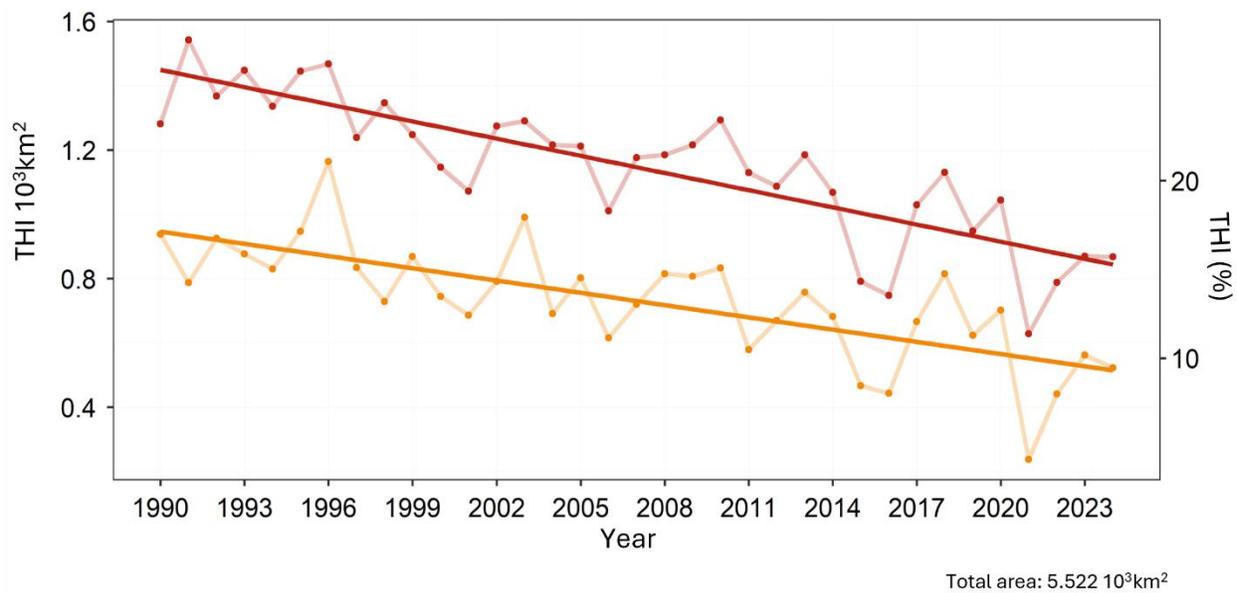


Figure 69. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in the northern portion of Area 17 (17N) from 1990 to 2024. The straight line indicates the significant temporal trend for each indicator. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

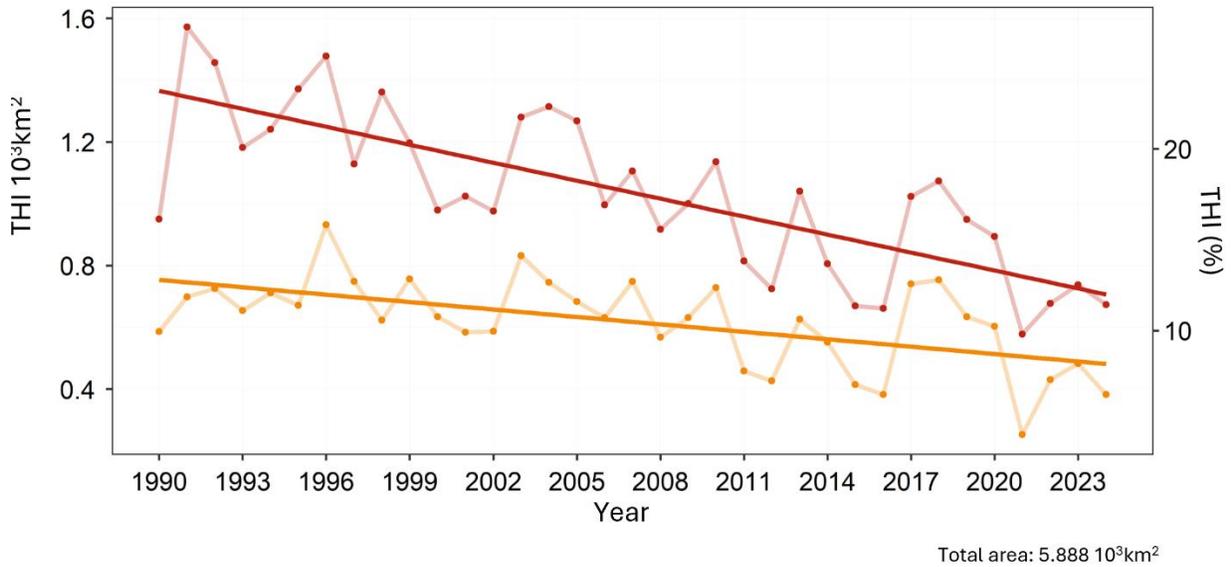


Figure 70. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in the southern part of Area 17 (17S) from 1990 to 2024. The straight line indicates the significant temporal trend for each indicator. On the left axis, the favourable THI is expressed in thousands of square kilometres (10³km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

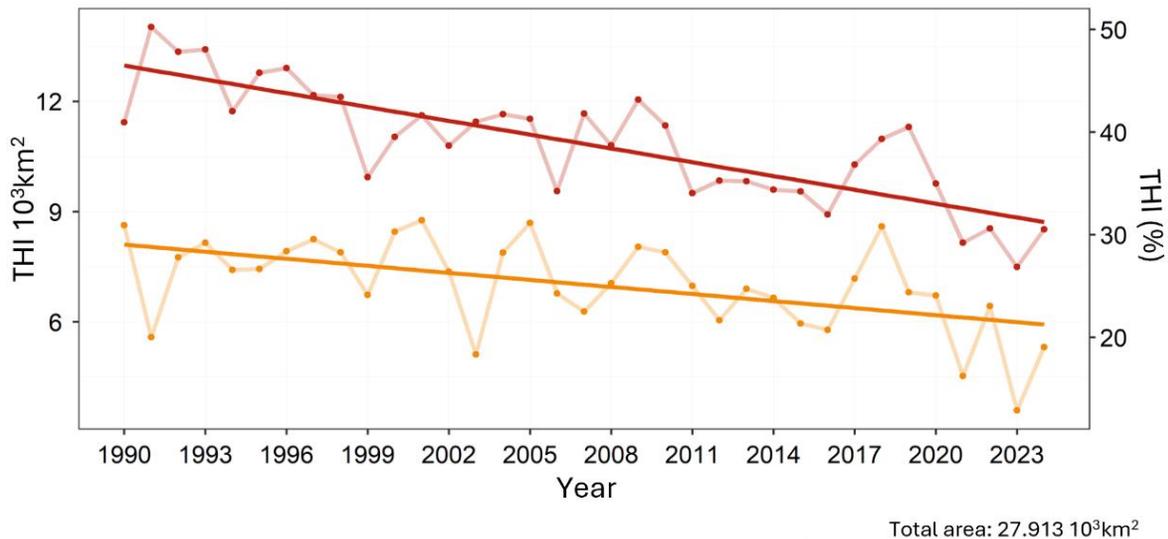


Figure 71. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in Area 16 from 1990 to 2024. The straight line indicates the significant temporal trend for each indicator. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

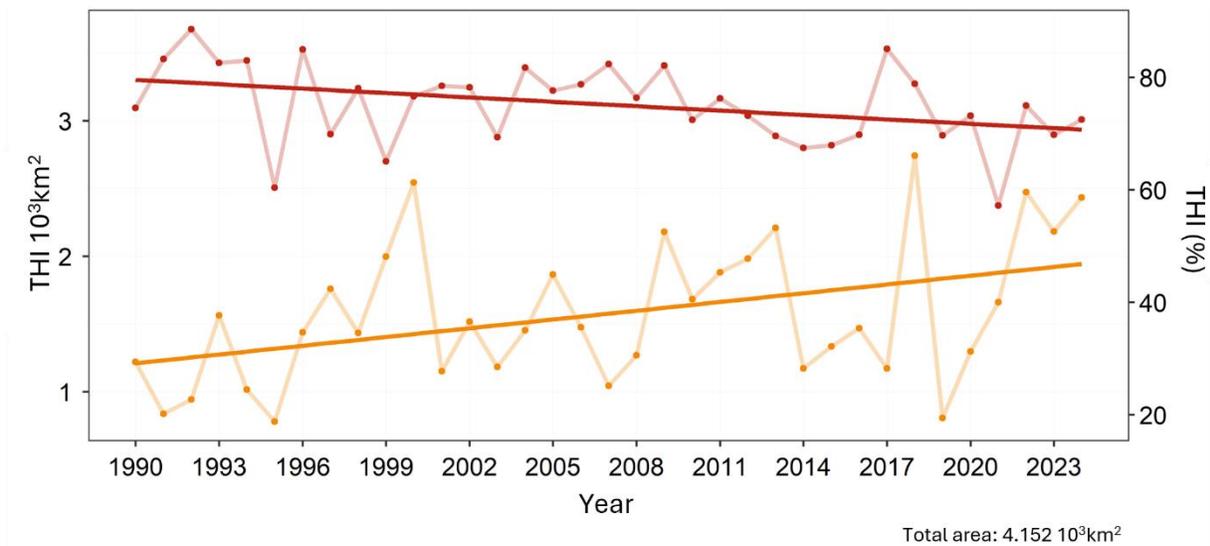


Figure 72. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in Area 15 from 1990 to 2024. A straight line indicates a significant temporal trend for each index. The straight line indicates the significant temporal trend for each indicator. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

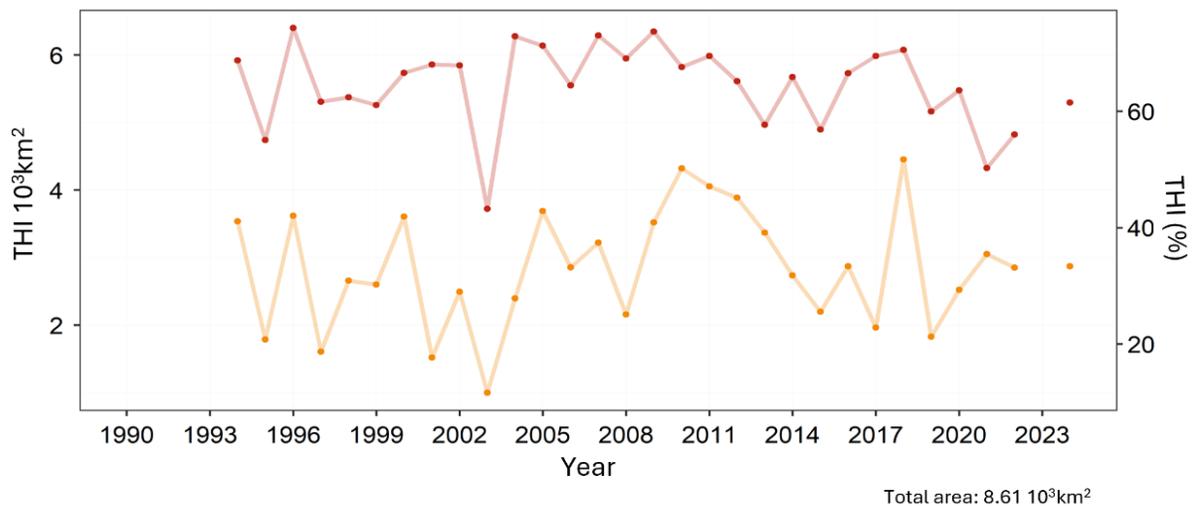


Figure 73. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in Area 14 from 1994 to 2024. The temporal trend in terms of habitat loss or gain is not significant. The favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

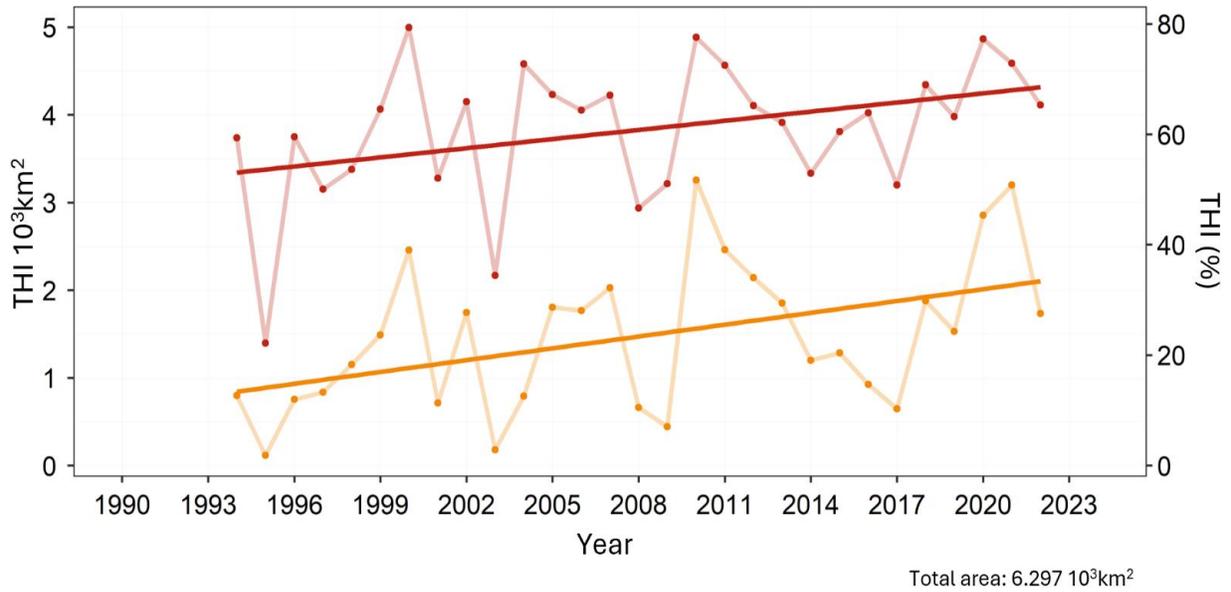


Figure 74. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in the northern portion of Area 13 (13Q) from 1994 to 2022. The straight line indicates the significant temporal trend for each indicator. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

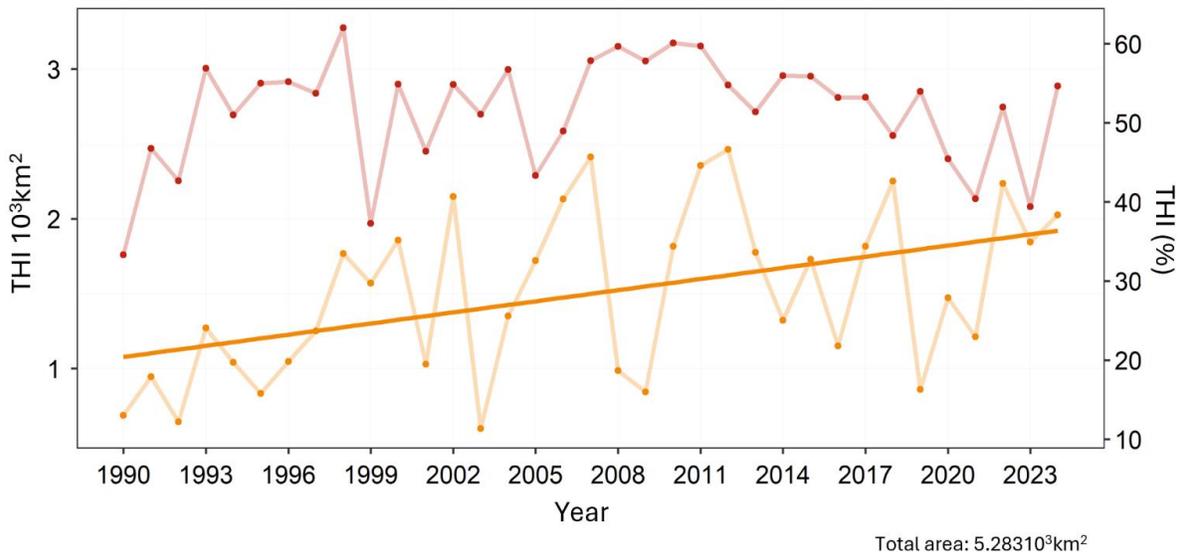


Figure 75. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in the southern portion of Area 13 (13TN) from 1990 to 2024. The straight line (orange) indicates the significant temporal trend. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

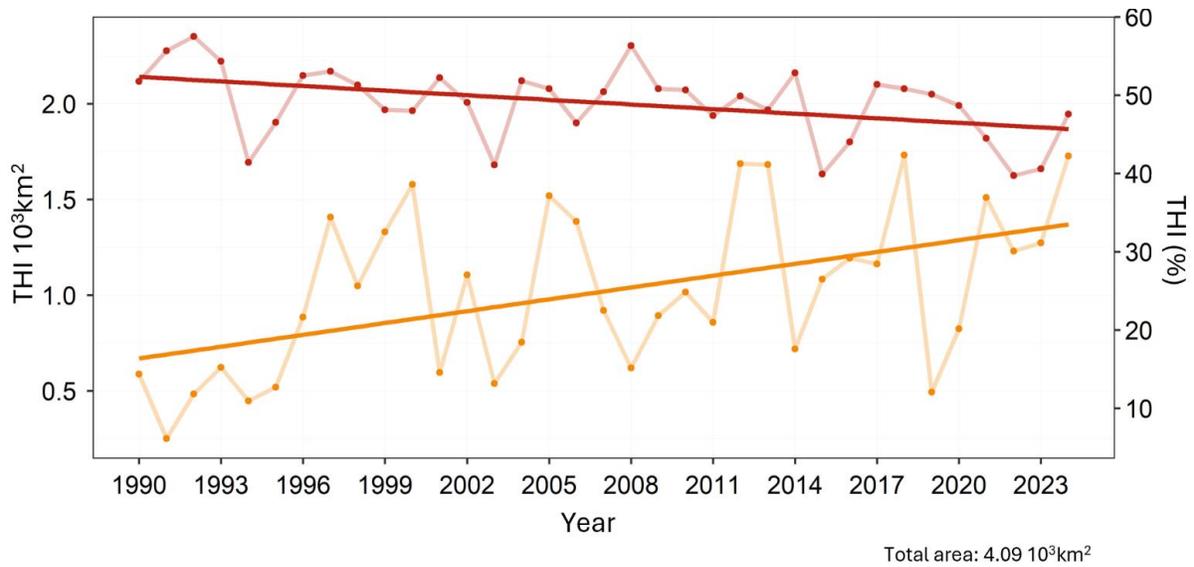


Figure 76. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in Area 16A from 1990 to 2024. The straight line indicates the significant temporal trend for each indicator. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

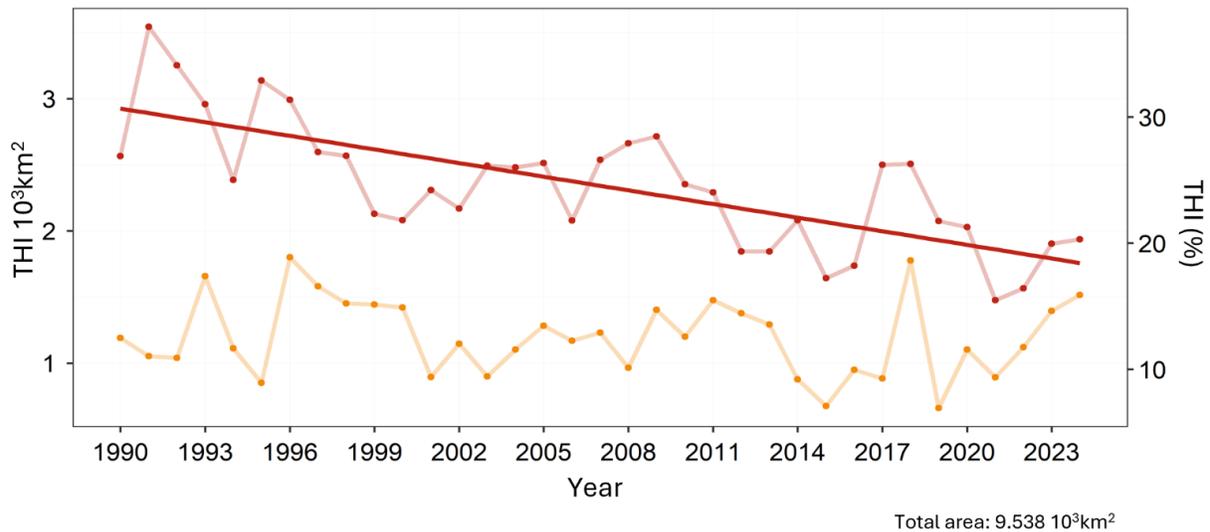


Figure 77. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in Area 12C from 1990 to 2024. The straight line (red) indicates the significant temporal trend. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

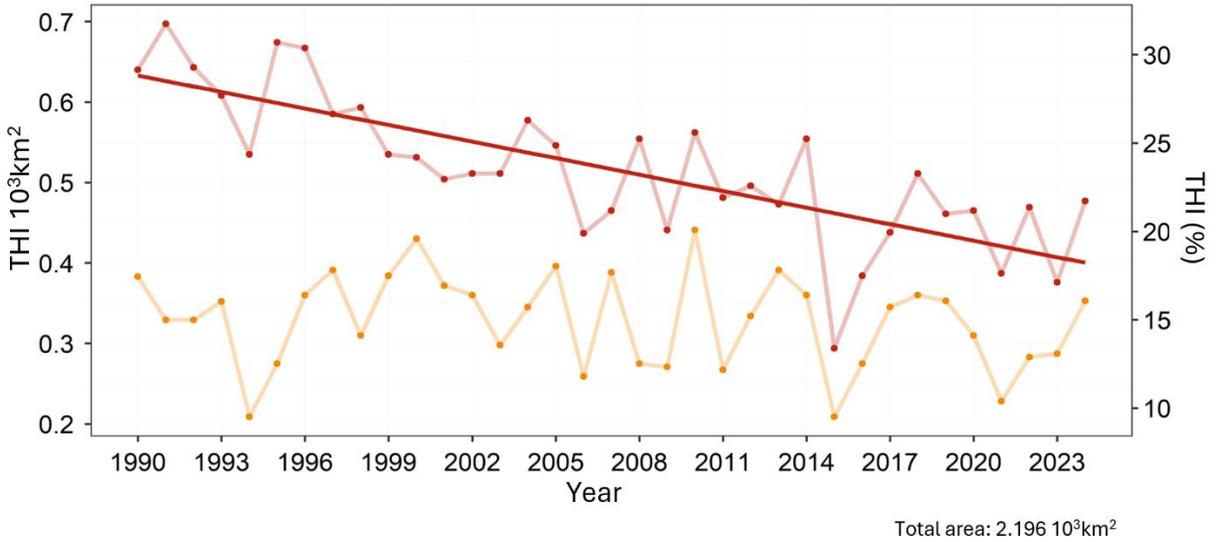


Figure 78. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in Area 12A from 1990 to 2024. The straight line (red) indicates the significant temporal trend. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

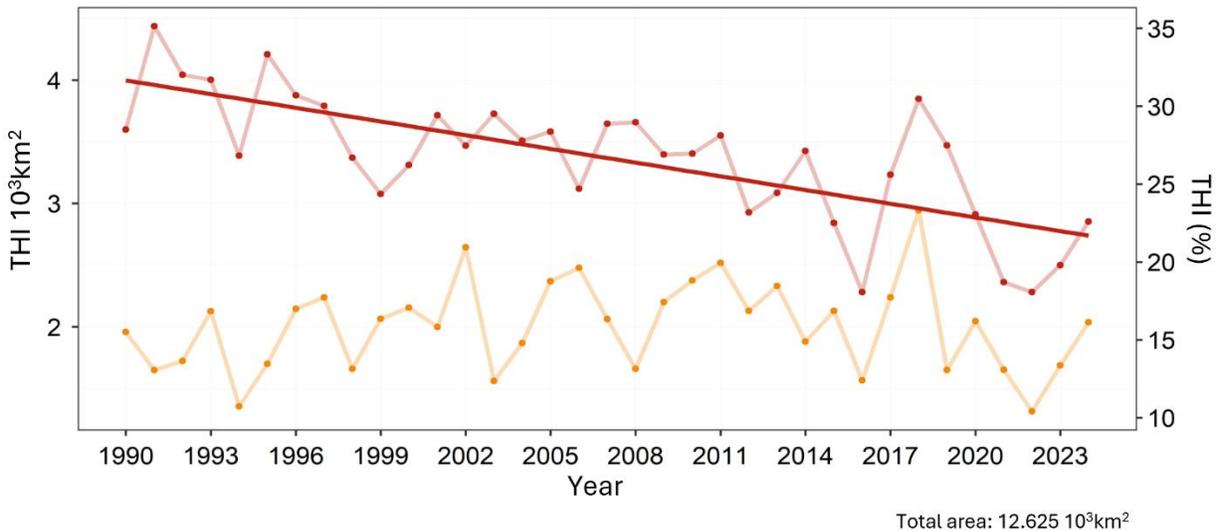


Figure 79. Temporal trends in the favourable thermal habitat indices (THI) for juvenile (< 12 mm) (orange) and adult (red) snow crabs in Area 12B from 1990 to 2024. The straight line (red) indicates the significant temporal trend. On the left axis, the favourable THI is expressed in thousands of square kilometres (km²) of surface area. On the right axis, this value is converted to a percentage of the total area of the fishing area (or sub-area).

DISCUSSION

Although the most recent low point in the snow crab abundance cycle occurred in 2019–2020 across all areas, the upswing in the cycle appears to be delayed by approximately two years in some areas, taking place later in the western areas than in the eastern areas. This discrepancy may be due to the smaller number of moults that crabs generally undergo in the colder waters of

the Lower North Shore before they reach maturity. A higher temperature is associated with a greater number of moults before maturity, resulting in a larger final size (Sainte-Marie et al. 2021). This relationship has been confirmed in the trawl surveys, which show that adults in the colder waters to the east are typically smaller than those in the Estuary. Moreover, the proportion of sub-legal size crabs undergoing the terminal moult is generally higher in the east than in the west.

Although the abundance of male crabs increased during the upswing in the cycle, the frequency of early terminal moult has also increased in recent years, reducing the potential for recruitment to the fishery in many areas. In the western part of Area 16 and along the south shore of the Estuary in Area 17, densities of legal-size adults and adolescents continue to vary cyclically but no longer reach the high levels previously observed.

Although a precise estimate of the removal rate is not available, several indicators suggest that fishing pressure may be higher in the west. For example, the spermathecal load weight is lower along the south shore than the north shore in Area 17, but mature females are larger. In addition, the average size of legal-size males fell sharply in 2024, and the frequency of early terminal moult is higher. A smaller size at maturity has previously been associated with high removal rates in lobster and snow crab (Haarr et al. 2018; Mullaney and Baker 2021). Despite very high densities of immature crabs in 2009 and 2019, subsequent recruitment pulses have not matched those observed between 2000 and 2004. On average, Area 17 accounts for 23% of total landings in the region (i.e., all nine areas), but contains only 6% of the favourable thermal habitat in the region. In contrast, Area 15 accounts for only 6% of landings but represents 8.5% of the favourable thermal habitat. Given that the proportion of early terminal moult is increasing and the amount of favourable habitat is decreasing in the western areas, there is an urgent need to assess the impact of these factors on distribution, survival and recruitment to the fishery. In addition, temporal variations in average size differed in the Estuary depending on the shore and sex. Comparing females (which are not targeted by the fishery) with males (which are commercially harvested) may make it possible to dissociate the effects of fishing pressure from those caused by environmental factors and provide a better understanding of their respective influence on the biology of the species.

Spermathecal load weight is an indirect indicator of the local sex ratio and can be monitored (Sainte-Marie et al. 2002). Specifically, low spermathecal load weight is associated with a high proportion of primiparous females in relation to that of male spawners, since males reduce the amount of sperm allocated to each female when the availability of females is high (Sainte-Marie et al. 2002). Although the role played by the spermathecae and the absence of fishing pressure on females may suggest that the reproductive success of snow crabs may be resilient to some extent, it is vital to remain cautious in managing stocks, since too high a male removal rate may affect the number of offspring per female by restricting sperm availability (Taylor 1988; Pardo et al. 2017; Baker et al. 2022).

A number of analytical improvements are planned for the near future. The spermathecal load data presented in this study were not corrected for female size, a factor that significantly influences this metric (Baker et al. 2022). The sampling protocol for the Sainte-Marguerite Bay trawl survey already incorporates stratification by female size, ensuring that the results for this area are reliable. However, such standardization is required for all areas, given the significant differences in the average size of primiparous females in the various management areas and even within the same area (for example, between the north shore and south shore in Area 17). Standardizing the protocols for the post-season surveys in the Lower North Shore fishing areas, where the types of traps used have changed in recent years, would enable the existing time series to be extended, thereby making long-term analyses more robust.

The health of snow crab populations in the Estuary and northern Gulf of St. Lawrence is cause for concern. Rising temperatures in combination with the summertime reduction in favourable thermal habitat result in an accumulation of stress factors that may increase disease rates and worsen the overall health of individuals. For example, a major concern is bitter crab disease, which is caused by a dinoflagellate infection. This disease has caused epidemics in Newfoundland (Mullowney et al. 2014) and Alaska, notably before the 2021 collapse of snow crab populations in the Bering Sea (Balstad et al. 2024), raising questions about links between global warming and the prevalence of the pathogen. The population collapse in the Bering Sea may have also resulted from an increase in crabs' energy requirements as a result of global warming, leading to widespread, large-scale starvation (Szuwalski et al. 2023). It is therefore crucial that DFO continue its research, in particular through surveys using trawls, a non-selective type of fishing gear that can capture all individuals, including the least competitive. This approach is essential to carefully monitor the body condition of populations, including detecting diseases and estimating disease prevalence in snow crab populations.

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APPENDIX 1. PROTOCOLS FOR SNOW CRAB POST-SEASON TRAP SURVEYS

CONTEXT, DESCRIPTION AND GENERAL OBJECTIVES

For the northern Gulf and St. Lawrence Estuary regions, information on long-term population trends is acquired using research surveys carried out with a beam trawl in Sainte-Marguerite Bay since 1988 as well as in the estuary and in the northeastern part of the gulf since 1992. These surveys are carried out by the DFO Sciences, Quebec region. These surveys make it possible to predict the relative abundance of crab recruitment to commercial size sometimes up to eight years in advance, but, given the small surface area covered, they do not provide sufficient information on the exploitable biomass or on the quantity of crabs that will be recruited to the fishery in the short term, i.e. in the next two years. Post-season surveys have been developed to better determine the abundance of commercial-sized crabs that will be in the fishery in the short term. These are complementary to the existing scientific surveys.

SAMPLING PROTOCOLS OF POST-SEASON SURVEYS ACROSS FISHING AREAS

Trap type

- Conical with base of 6 feet or more (standard);
- 5.25 in. or 5.5 in. mesh for standard traps (C type);
- Less than 3 in. mesh for experimental traps (E type);

It is important to use the same type of trap at each station and each sampling year to allow an unbiased comparison of catches.

Bait

The bait (type and quantity) must always be the same in each trap and each year. This is essential so that all traps have the same fishing efficiency.

Immersion time

The immersion time of the traps must be 24 hours.

It is essential to respect this 24-hour period to ensure that all lockers have the same effectiveness. Obviously, this will not always be possible due to bad weather and uncontrolled problems; however, when operations take place normally, the traps must be reassembled approximately 24 hours after their immersion (Immersion between 20 and 28 hours is acceptable). For example, if 12 traps are placed along a transect in the morning, they will need to be hauled out the following day, preferably in the morning and in the same order as they were put into the water.

Distance between traps

The minimum distance between lockers must be 60 fathoms. Each bin should represent an independent sampling unit and interference between bins should be avoided.

Sampling the catch

Information on the capture of each trap must be noted by a trained technician. For each crab, the following information must be indicated on the specially designed form:

- Sex (Section A)
- Carapace condition (Section B)

- Carapace width (in mm; See Figure A1.1)
- For males: Clamp height (to the tenth of a mm)

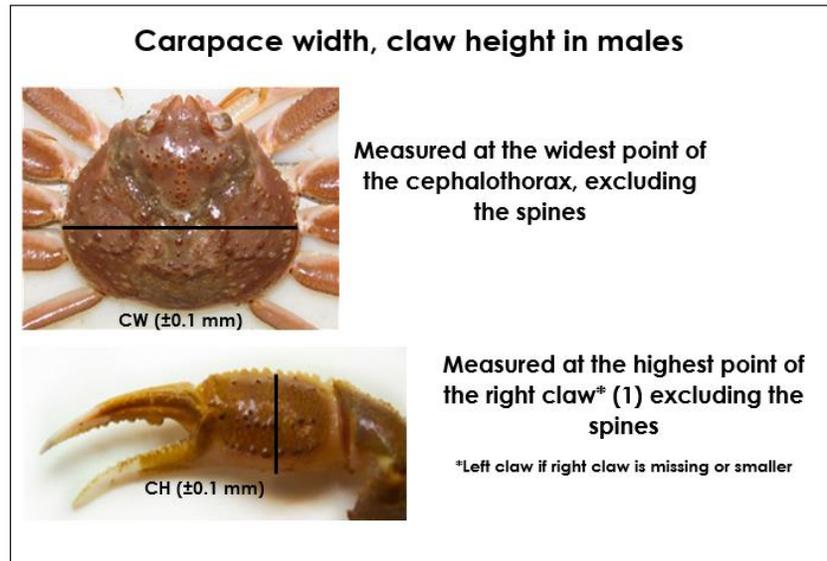


Figure A1.1. Measurement of carapace width and claw height in male crabs.

For females:

- Sexual maturity (MAT_F; Section C)
- Level of egg development (Section C)
- Collect and store spermathecae from 40 primiparous females following the attached protocol (Section D).

Sub-sampling large catches

Crabs that are captured must be returned to the water as quickly as possible in order to ensure the highest possible survival rate. When catches are very high, it may be very difficult to take all measurements on all crabs within a reasonable period of time. Because it is difficult to separate the catch from a given trap in a uniform manner, subsampling cannot be carried out and measurements are therefore required for all crabs in the trap. Nevertheless, the measurement process may be limited to males only.

The procedure would be as follows: all traps are processed and the catch from each trap is placed into properly labelled containers. After assessing the amount of time available to complete the work, measurements will be taken in the following order:

1. All males in the trap
2. All females in the trap

The number of crabs captured in each trap, by sex, must be recorded. Information on subsampling must be indicated during data entry in the “sample type” field:

C = complete, meaning all crabs were measured;

P = partial, meaning some crabs were measured but not all; and

D = counted only, meaning traps for which crabs were counted but not measured.

Section A: Determining sex in snow crabs

It is determined by the shape and relative size of the abdomen: males have a narrow, rectangular abdomen, and females' abdomens are wider and oval in shape.

Section B: Shell condition

1. Clean, iridescent carapace, without epibiont. Tips of spines and pincers without signs of wear. The pliers are fragile and break or become deformed under moderate to heavy thumb pressure. "White" or "Soft" crab.
2. Clean carapace, usually iridescent without or with only a few epibionts and the occasional presence of brown or black scars. Tips of spines and pincers showing no or minor wear. The pliers are hard and will not break or become distorted under moderate to heavy thumb pressure.
3. Fairly clean carapace, slightly iridescent or not at all, with a few large epibionts and/or a few brown or black scars. Tips of thorns and pincers quite sharp with little wear. The pliers are hard and will not break or warp under moderate to heavy thumb pressure.
4. Dirty (yellowish or brownish) carapace with many large epibionts and/or many brown or black scars. Tips of thorns and pincers worn. The pliers are hard and will not break or warp under moderate to heavy thumb pressure.
5. Dirty carapace (yellowish, brownish or blackish) with many large epibionts and/or many brown or black scars. Tips of thorns and claws worn or very worn. The pliers are generally soft and deform under moderate to heavy thumb pressure. The carapace around the posterior part of the cephalothorax is soft. Amorphous crab.

State	1 "white"	2	3	4	5 "dirty"
Carapace	clean and iridescent	clean, usually iridescent, with rare brown or black markings	Rather clean, slightly or not iridescent, some brown or black marks	dirty (yellow or brown), several brown or black marks	dirty (yellow, brown or black), several brown or black marks, softened posterior part
Claws	fragile break/deform under thumb pressure	hard	hard	hard and worn	<u>soften</u> <u>deform</u>
Epizoites	none	with or a few and small	<u>numerous</u> and large	<u>numerous</u> and large	<u>numerous</u> and large
Dactyls	not <u>worn</u>	<u>little</u> or no wear	<u>lightly worn</u>	<u>worn</u>	<u>very worn</u>

Figure A1.2. Visual criteria used to assign carapace condition scores from 1 to 5 according to the degree of aging.

Section C: Female maturity and egg development

Maturity stages of female snow crab (column MAT_F during data entry) :

I for Immature: Very small female without eggs. Abdomen not covering the entire leg area.

P for Primiparous: Female in her first clutch (with eggs). The shell is smooth, without organisms. Without signs of wear or stress on the shell (Figure A1.3.)

M for Multiparous: Female having laid more than one egg. Female of all sizes usually carrying eggs and having a worn shell and marks caused by claw handling.



Figure A1.3. Ventral view of primiparous females

For egg development (Egg Devel.):

1. bright light orange eggs (Figure A1.4)
2. opaque dark orange eggs (Figure A1.4)
3. black eggs (Figure A1.5)
4. empty case (or gray mass) – or whitish decomposing eggs (Figure A1.6)

For the volume of the clutch of eggs (Brood Vol.):

I: incomplete; when the case is not filled

C: complete



Figure A1.4. Example of egg colors: opaque orange (2- right); bright orange eggs (1- left). Both egg clutches are complete (C).



Figure A1.5. Example of black eggs (3).



Figure A1.6. Example of empty case after eggs releasing (4).

Section D: Sampling spermathecae

Forty primiparous females may be sampled during the survey, coming from almost everywhere in the sampling area. Ideally, selected primiparous females will not have missing legs (in cases where primiparous females are rarer, all females collected can be selected for spermathecae). For each female you must record:

- The identification number (a sequential number from 1 to 40)
- The origin of the female (station number, transect and trap number and date of capture)
- The shell condition of the female (1, 2)
- The female's carapace width (measured to the nearest 0.01 mm)
- The width of the female's abdomen (measured across the 5th segment, to the nearest 0.01 mm)
- The size and color of the ovaries (small = occupy less than a quarter of the internal surface, medium = occupy a quarter to half of the internal surface, large = occupy more than half of the internal surface; color = creamy white, salmon, or orange)
- Any other comments deemed relevant

Each female must be dissected alive:

- Extract the right spermatheca, being careful not to damage it (in dorsal view and the rostrum of the female pointing in the opposite direction to the sampler) and place it in a vial bearing the identification number of the female and code "spd" and containing 4% formalin.

Protocol specific to each fishing area**Trap positions in Area 17**

- 299 traps in total
- 276 standard traps and 23 experimental traps
- 23 transects.

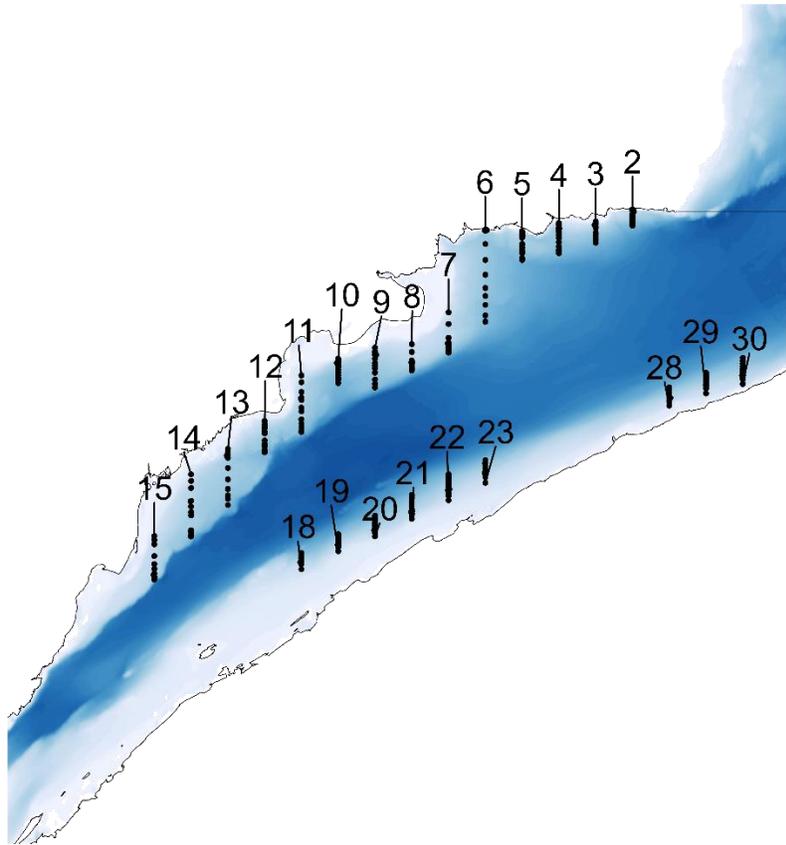


Figure A1.7. Trap positions during the post-season survey in Area 17. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 16

- 175 traps in total
- 150 standard traps and 25 experimental traps
- 25 transects

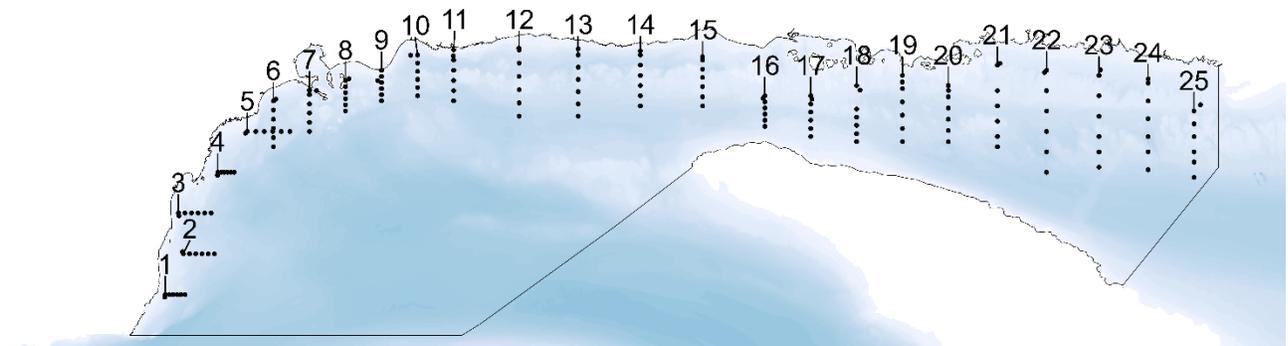


Figure A1.8. Trap positions during the post-season survey in Area 16. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 15

- 70 traps in total
- 60 standard traps and 10 experimental traps
- 10 transects

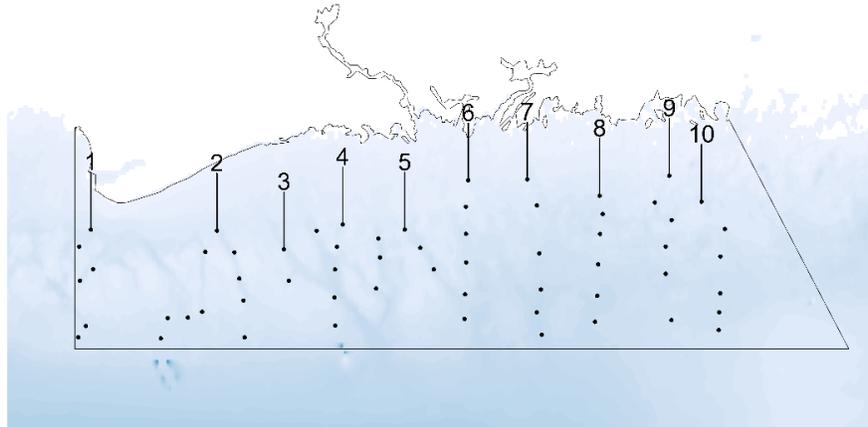


Figure A1.9. Trap positions during the post-season survey in Area 15. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 14

- 84 traps in total
- 72 standard traps and 12 experimental traps
- 12 transects

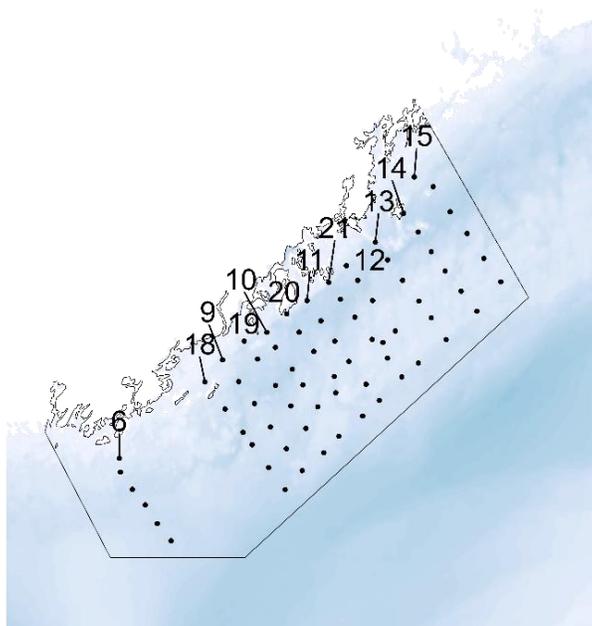


Figure A1.10. Trap positions during the post-season survey in Area 14. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 16A

- 71 traps in total
- 59 standard traps and 12 experimental traps
- 14 transects

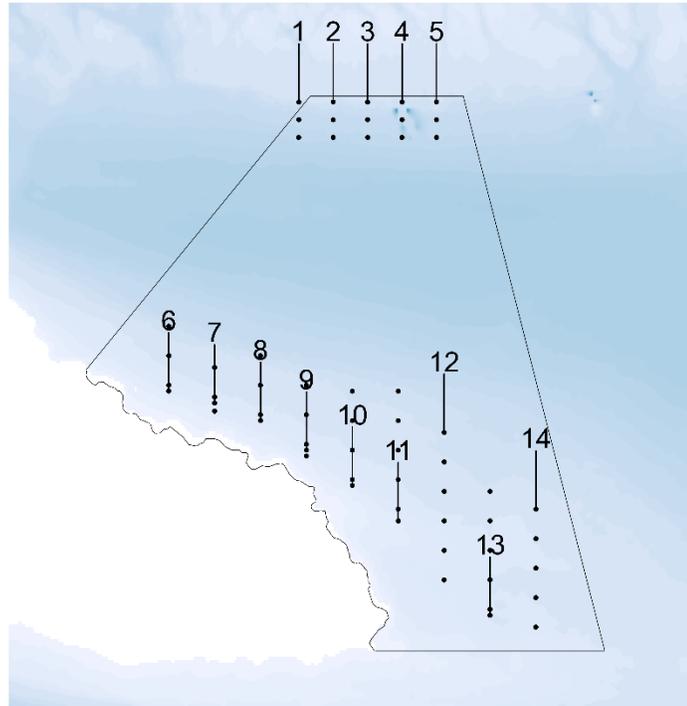


Figure A1.11. Trap positions during the post-season survey in Area 16A. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 13TN

- 138 standard traps in total
- 12 transects

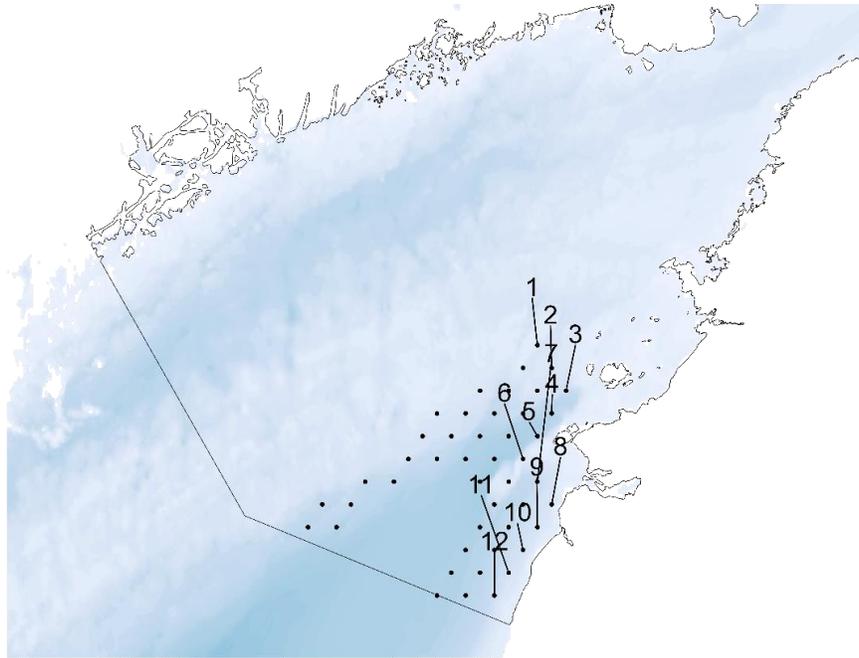


Figure A1.12. Trap positions during the post-season survey in Area 13TN. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 13Q

- 70 traps in total
- 60 standard traps and 10 experimental traps
- 10 transects

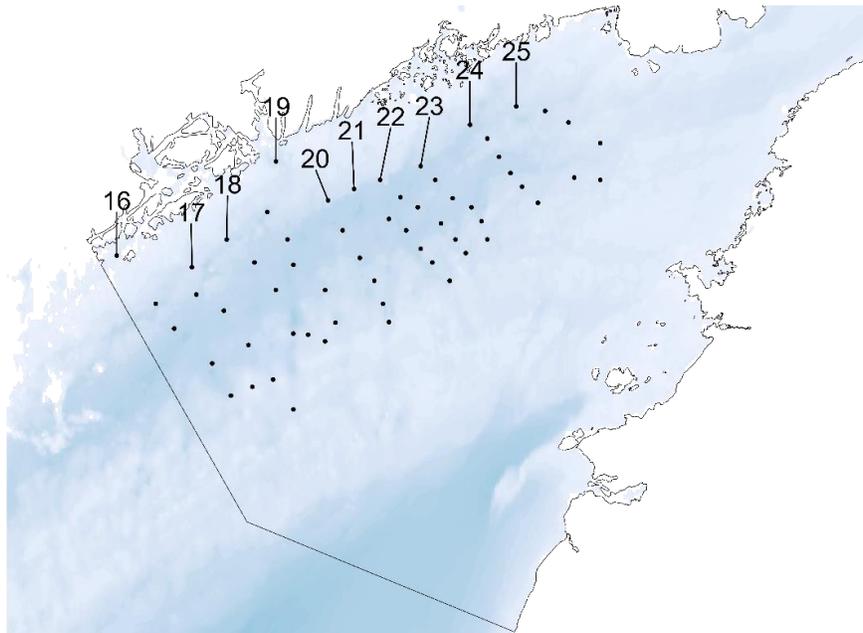


Figure A1.13. Trap positions during the post-season survey in Area 13Q. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in area 12C

- 65 traps in total
- 54 standard traps and 11 experimental traps
- 19 transects

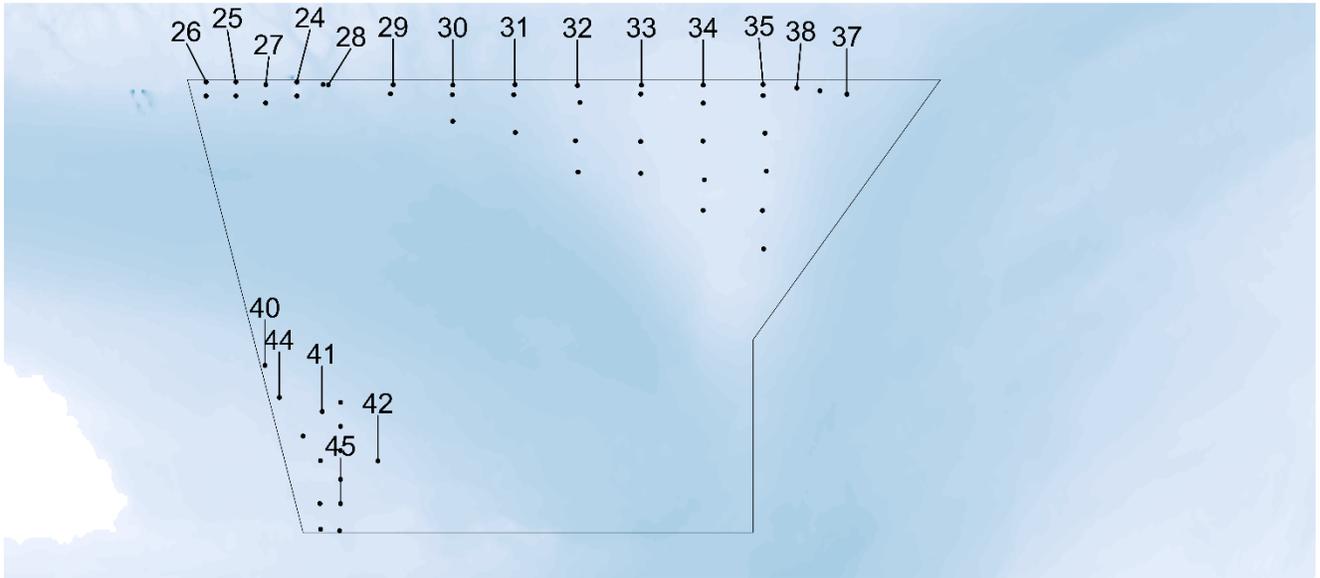


Figure A1.14. Trap positions during the post-season survey in Area 12C. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 12A

- 130 traps in total
- 120 standard traps and 10 experimental traps
- 10 transects

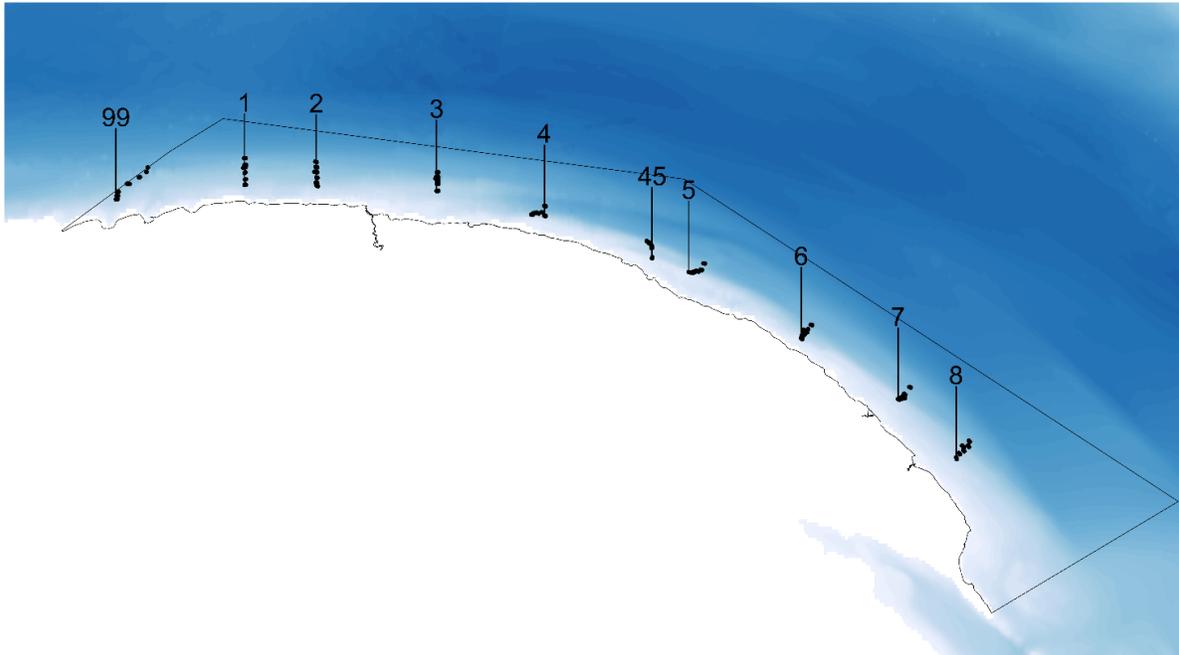


Figure A1.15. Trap positions during the post-season survey in Area 12A. Black dots indicate trap locations, and numbers indicate transect numbers.

Trap positions in Area 12B

- 160 traps in total
- 144 standard traps and 16 experimental traps
- 16 transects

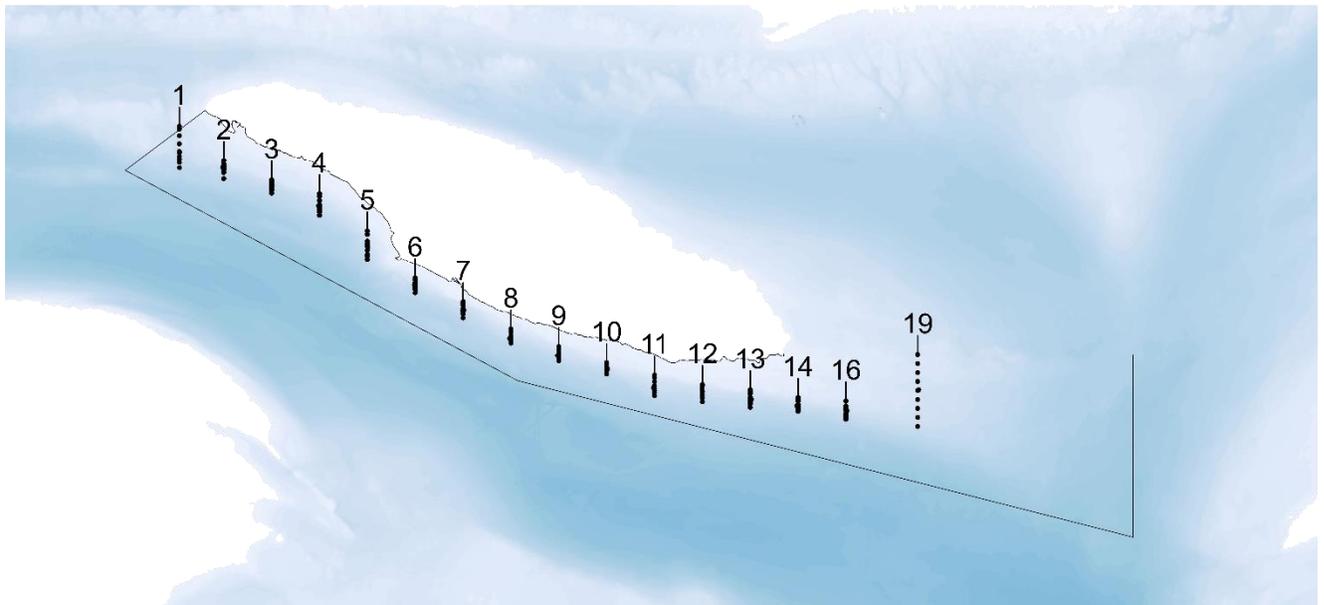


Figure A1.16. Trap positions during the post-season survey in Area 12B. Black dots indicate trap locations, and numbers indicate transect numbers.

APPENDIX 2. MAP OF SUB-AREAS OF AREA 16 AND CPUE VALUES BY SUB-AREA

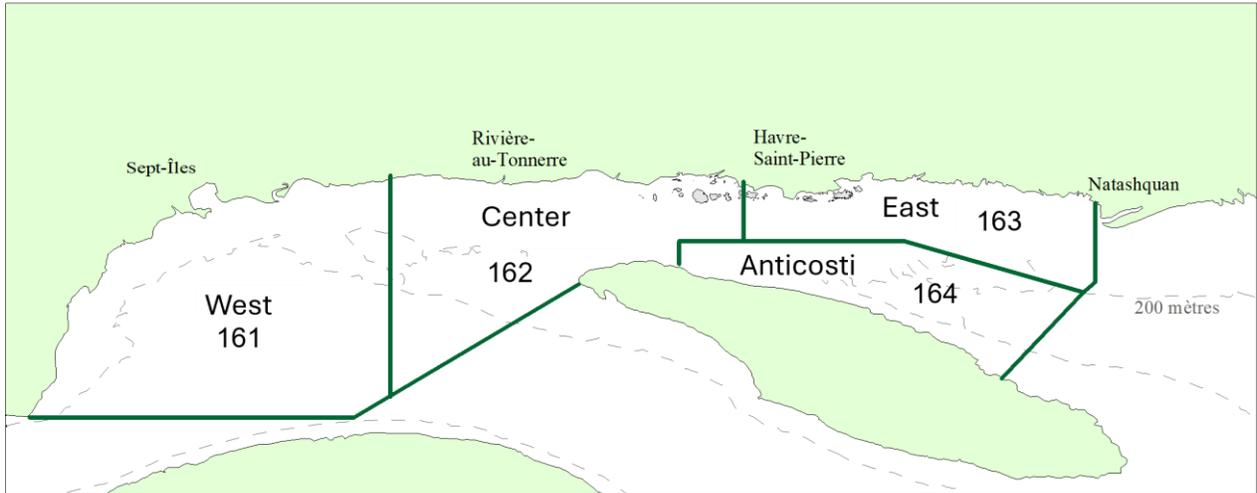


Figure A2.1. Map of the sub-areas of Snow Crab Management Area 16: 161 = Sept-Îles; 162 = Rivière-au-Tonnerre; 163 = Natashquan and 164 = Anticosti.

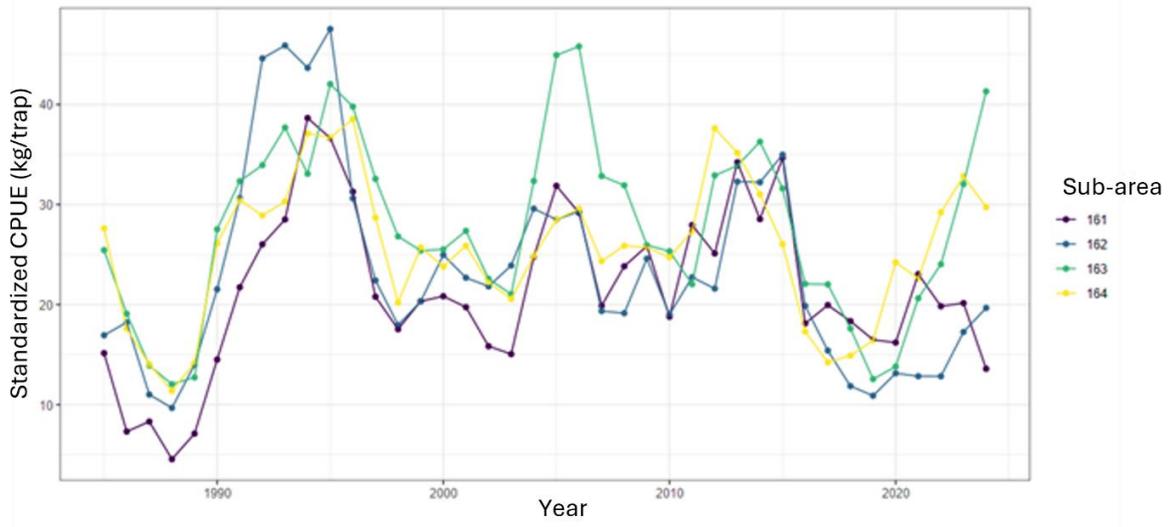


Figure A2.2. Standardized CPUE (kg/trap) for the commercial snow crab fishery in each of the four sub-areas of Area 16 between 1985 and 2024.

APPENDIX 3. AT-SEA AND DOCKSIDE SAMPLING DATA

Table A3.1. Number of snow crabs measured per year in the nine fishing areas in Quebec in the at-sea observer program (the “Sea” column) and during dockside sampling (the “Dock” column). The number and percentage of legal-size crabs ($CW \geq 95$ mm) in the samples of crabs measured at sea are shown in the “Sea95” and “%Sea95” columns, respectively.

NUMBER OF CRABS MEASURED					
AREA	YEAR	DOCK	SEA	SEA95	%SEA95
12A	1996	0	10872	6442	59
	1997	1755	6052	3797	63
	1998	2567	3485	2525	72
	1999	2700	0	0	0
	2000	1750	2539	2084	82
	2001	2000	3341	2805	84
	2002	1968	3059	2486	81
	2003	2232	4360	3815	88
	2004	178	4522	3678	81
	2005	1799	3089	2243	73
	2006	1800	3897	2847	73
	2007	1800	2695	2184	81
	2008	1337	1485	1324	89
	2009	1137	1578	1348	85
	2010	1627	1313	1176	90
	2011	1325	1842	1700	92
	2012	1342	1315	1245	95
	2013	1138	2090	1945	93
	2014	1116	2871	2481	86
	2015	1292	1126	897	80
	2016	1290	2708	1991	74
	2017	1326	2481	1916	77
	2018	1399	1063	851	80
	2019	1132	822	703	86
2020	192	0	0	0	
2021	1315	658	450	68	
2022	1469	333	189	57	
2023	1015	339	243	72	
2024	1195	480	358	75	
12B	2001	996	2616	2459	94
	2002	1735	1572	1405	89
	2003	2458	3396	3141	92
	2004	0	3245	3017	93
	2005	1800	1786	1639	92
	2006	1645	3415	2917	85

NUMBER OF CRABS MEASURED

AREA	YEAR	DOCK	SEA	SEA95	%SEA95
	2007	1495	2547	2061	81
	2008	1650	2601	2055	79
	2009	1648	3617	2935	81
	2010	1332	2433	2179	90
	2011	1353	2480	2332	94
	2012	928	3041	2906	96
	2013	1264	4004	3701	92
	2014	1653	7519	6597	88
	2015	1698	4132	3459	84
	2016	1608	5151	4005	78
	2017	1298	1426	999	70
	2018	1054	1013	708	70
	2019	1124	330	241	73
	2020	0	0	0	0
	2021	484	490	426	87
12C	2001	500	973	778	80
	2002	750	2538	1782	70
	2003	750	2041	1655	81
	2004	0	2661	2326	87
	2005	290	1487	1295	87
	2006	600	1833	1640	89
	2007	600	3132	2867	92
	2008	900	2616	2488	95
	2009	751	1908	1788	94
	2010	900	2882	2537	88
	2011	1350	3988	3431	86
	2012	1351	2280	1983	87
	2013	1500	3740	3037	81
	2014	1200	3986	3472	87
	2015	1211	3318	2865	86
	2016	1236	2458	2175	88
	2017	1199	2058	1682	82
	2018	1200	717	634	88
	2019	1050	1137	969	85
	2020	0	0	0	0
	2021	1050	1337	626	47
	2022	1199	1487	737	50
	2023	150	1226	947	77
	2024	750	906	498	55
13	2000	500	1139	539	47
	2001	750	2121	752	35

NUMBER OF CRABS MEASURED

AREA	YEAR	DOCK	SEA	SEA95	%SEA95
	2002	750	6336	1645	26
	2003	0	873	498	57
	2004	0	810	484	60
	2006	0	529	394	74
	2008	900	2419	1823	75
	2009	1508	488	334	68
	2010	1206	901	647	72
	2011	1661	920	547	59
	2012	1050	417	288	69
	2013	1059	841	503	60
	2014	1050	964	721	75
	2015	1051	1109	816	74
	2016	1150	1142	1026	90
	2017	1400	1443	1099	76
	2018	1505	665	348	52
	2019	1350	790	392	50
	2020	0	0	0	0
	2021	905	2014	816	41
	2022	1200	396	76	19
	2023	1351	2378	739	31
	2024	1648	2118	824	39
14	2000	500	2898	1974	68
	2001	750	2779	1813	65
	2002	750	1290	828	64
	2003	500	2874	1970	69
	2004	0	2148	1443	67
	2005	580	1808	1322	73
	2006	600	1836	1616	88
	2007	750	1645	1385	84
	2008	744	1112	930	84
	2009	1199	1157	817	71
	2010	1652	1959	1235	63
	2011	1959	2022	1227	61
	2012	2098	2313	1253	54
	2013	1649	1464	1063	73
	2014	1502	1447	1282	89
	2015	1502	1799	1611	90
	2016	1500	2305	2089	91
	2017	1508	1417	1273	90
	2018	1509	1088	987	91
	2019	1506	985	811	82

NUMBER OF CRABS MEASURED

AREA	YEAR	DOCK	SEA	SEA95	%SEA95
	2020	0	0	0	0
	2021	1499	391	256	65
	2022	1499	1065	806	76
	2023	1500	909	607	67
	2024	1350	1657	786	47
15	2000	500	3249	2703	83
	2001	1250	2555	1874	73
	2002	1250	5999	3638	61
	2003	1250	8720	4872	56
	2004	0	3903	3069	79
	2005	580	4001	3140	78
	2006	750	2870	2403	84
	2007	600	3831	3523	92
	2008	1473	6399	5749	90
	2009	1649	4741	4361	92
	2010	1953	4122	3687	89
	2011	1802	7844	6525	83
	2012	1638	4823	4207	87
	2013	1651	7060	6107	87
	2014	1646	7217	6242	86
	2015	1192	4991	4525	91
	2016	1847	6719	5844	87
	2017	1652	6368	5638	89
	2018	1651	2330	2049	88
	2019	1653	3549	2776	78
	2020	601	0	0	0
	2021	1654	673	541	80
	2022	1650	2894	2088	72
	2023	1203	1215	979	81
	2024	1650	2351	1919	82
16	1996	2729	57996	52329	90
	1997	2783	79595	67385	85
	1998	2495	106047	89970	85
	1999	1749	38588	28585	74
	2000	1754	23826	17506	73
	2001	2000	27741	19373	70
	2002	1500	32678	21473	66
	2003	1751	17886	12934	72
	2004	0	14124	11702	83
	2005	585	11248	9683	86
	2006	1049	12999	11301	87

NUMBER OF CRABS MEASURED

AREA	YEAR	DOCK	SEA	SEA95	%SEA95
	2007	1350	34319	29302	85
	2008	1800	36565	30883	84
	2009	2843	49940	40460	81
	2010	3151	46429	35178	76
	2011	2401	49393	41929	85
	2012	2105	35007	30898	88
	2013	2247	36119	31785	88
	2014	2100	50842	43162	85
	2015	2260	36576	32222	88
	2016	2316	36501	31240	86
	2017	2111	44556	38031	85
	2018	2110	23878	19412	81
	2019	1961	27554	21727	79
	2020	601	0	0	0
	2021	2101	12790	11350	89
	2022	2102	8824	7216	82
	2023	2102	21052	16039	76
	2024	2100	35571	25113	71
16A	2002	496	5585	3976	71
	2003	0	873	582	67
	2004	0	2715	2277	84
	2005	580	2172	1963	90
	2006	603	3466	3045	88
	2007	750	3351	2833	85
	2008	1050	3191	2868	90
	2009	1198	2675	2167	81
	2010	2100	3762	3378	90
	2011	1051	6005	5026	84
	2012	1201	4804	4189	87
	2013	1366	5650	5122	91
	2014	1203	3313	2957	89
	2015	1482	4245	3962	93
	2016	1387	5150	4757	92
	2017	1204	5414	4711	87
	2018	1208	3860	3139	81
	2019	1222	4352	3527	81
	2020	150	0	0	0
	2021	1208	0	0	0
	2022	901	1443	1280	89
	2023	901	3332	2667	80
	2024	750	4535	3679	81

NUMBER OF CRABS MEASURED

AREA	YEAR	DOCK	SEA	SEA95	%SEA95
17	2000	2472	10113	8851	88
	2001	2493	10975	9379	85
	2002	2748	12327	10649	86
	2003	2960	14830	13199	89
	2004	0	11285	10567	94
	2005	2040	13506	12400	92
	2006	2657	15456	12631	82
	2007	2924	12748	10883	85
	2008	2511	13541	11594	86
	2009	3160	13741	12177	89
	2010	4269	15100	13362	88
	2011	2509	12825	11505	90
	2012	3142	19271	16602	86
	2013	2645	20948	16671	80
	2014	1858	18903	12741	67
	2015	2535	11140	8792	79
	2016	2477	7573	6425	85
	2017	2504	13393	11304	84
	2018	2907	14465	12496	86
	2019	1834	10851	9210	85
	2020	0	0	0	0
	2021	1335	4531	3726	82
	2022	1663	11794	9940	84
	2023	1378	7844	6399	82
	2024	1854	19133	13906	73

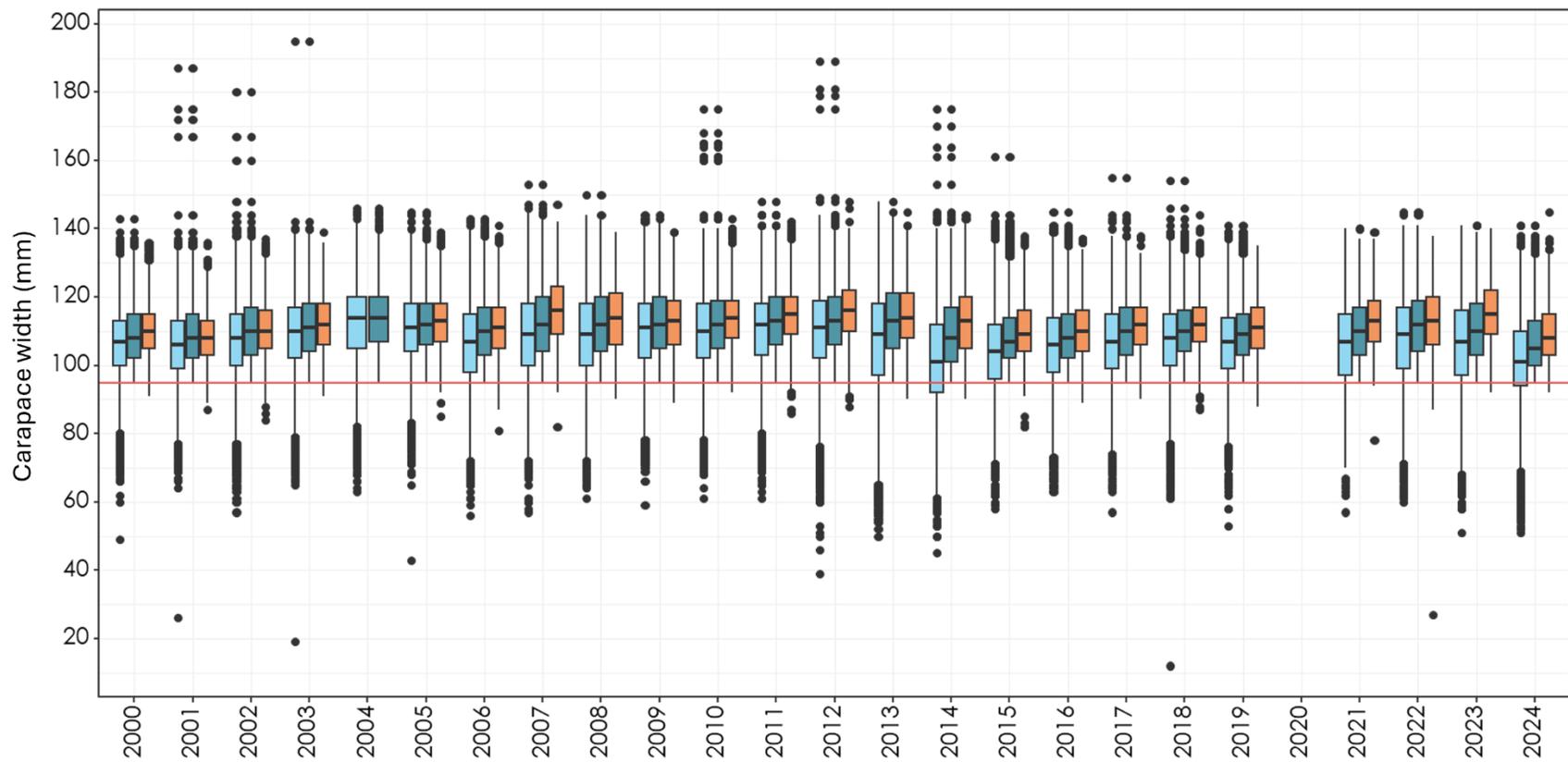


Figure A3.1. Distribution of carapace widths (CW) of snow crabs measured between 2000 and 2024 in Area 17 during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs (CW \geq 95 mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

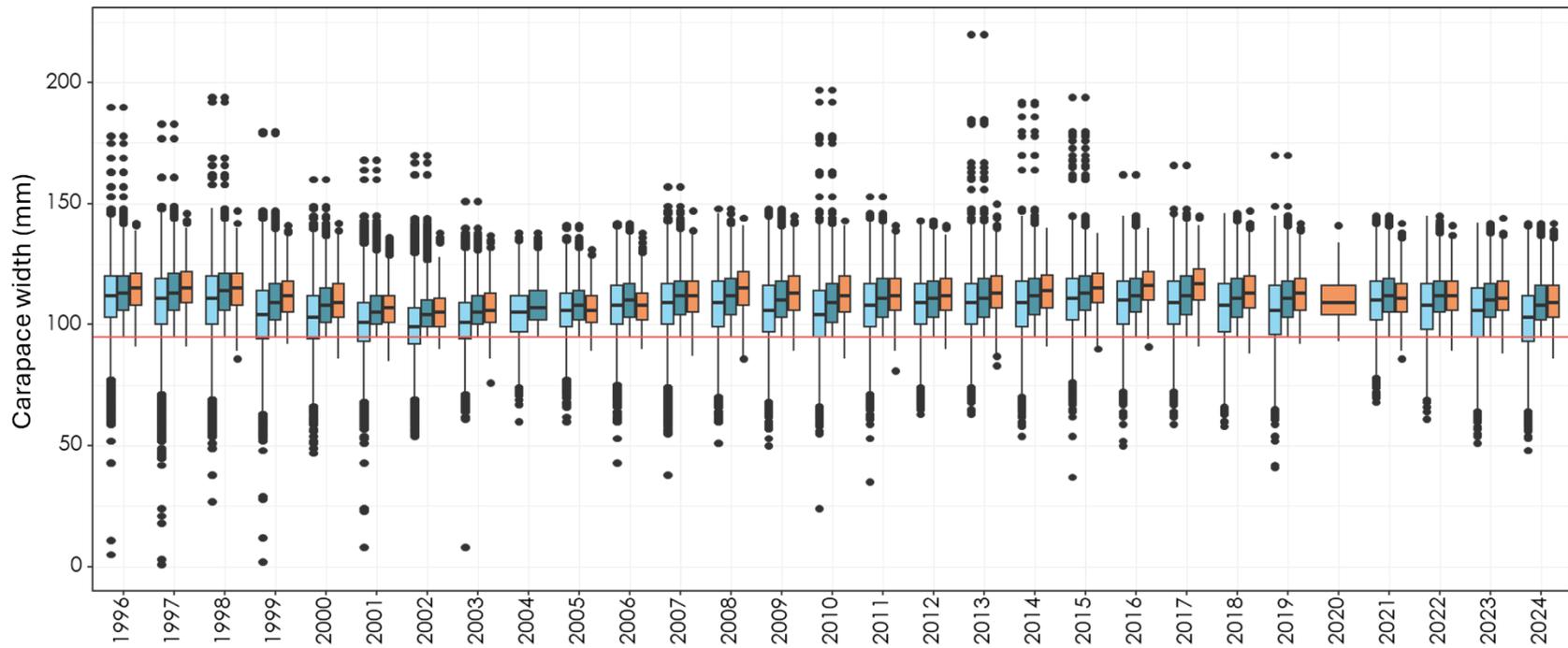


Figure A3.2. Distribution of carapace widths (CW) of snow crabs measured between 1996 and 2024 in Area 16 during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs (CW \geq 95 mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

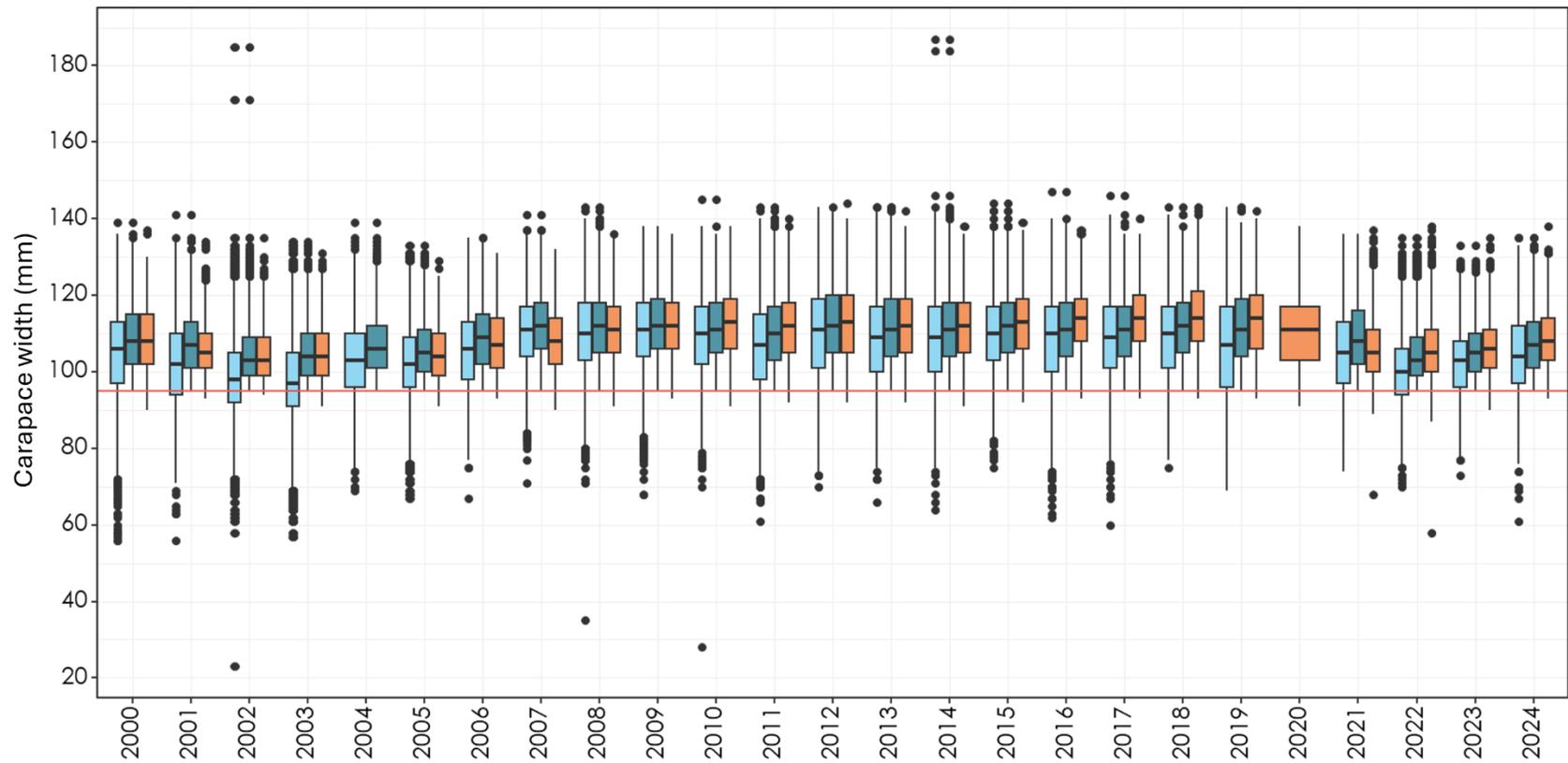


Figure A3.3. Distribution of carapace widths (CW) of snow crabs measured between 2000 and 2024 in Area 15 during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs (CW \geq 95 mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

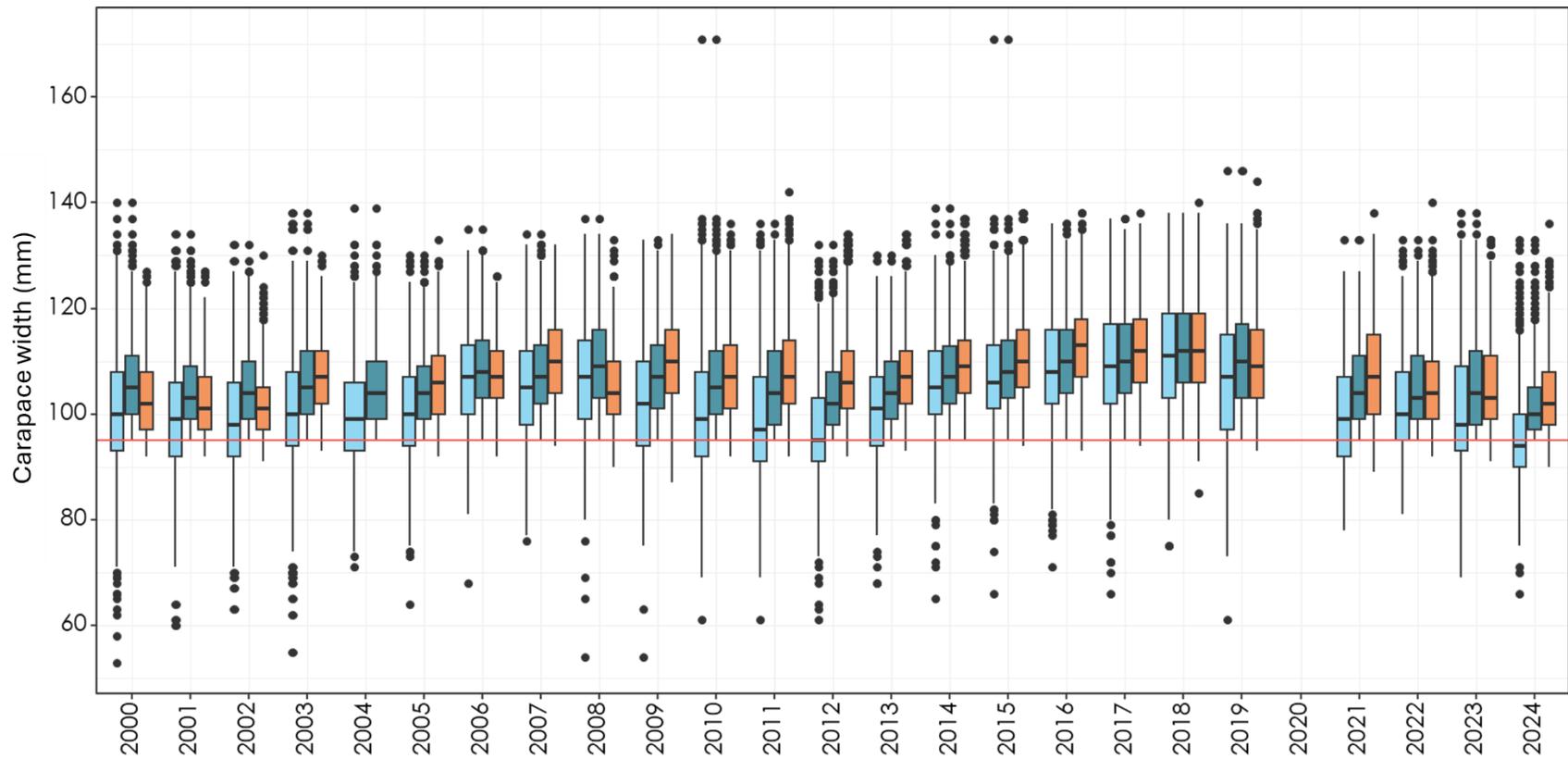


Figure A3.4. Distribution of carapace widths (CW) of snow crabs measured between 2000 and 2024 in Area 14 during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs ($CW \geq 95$ mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

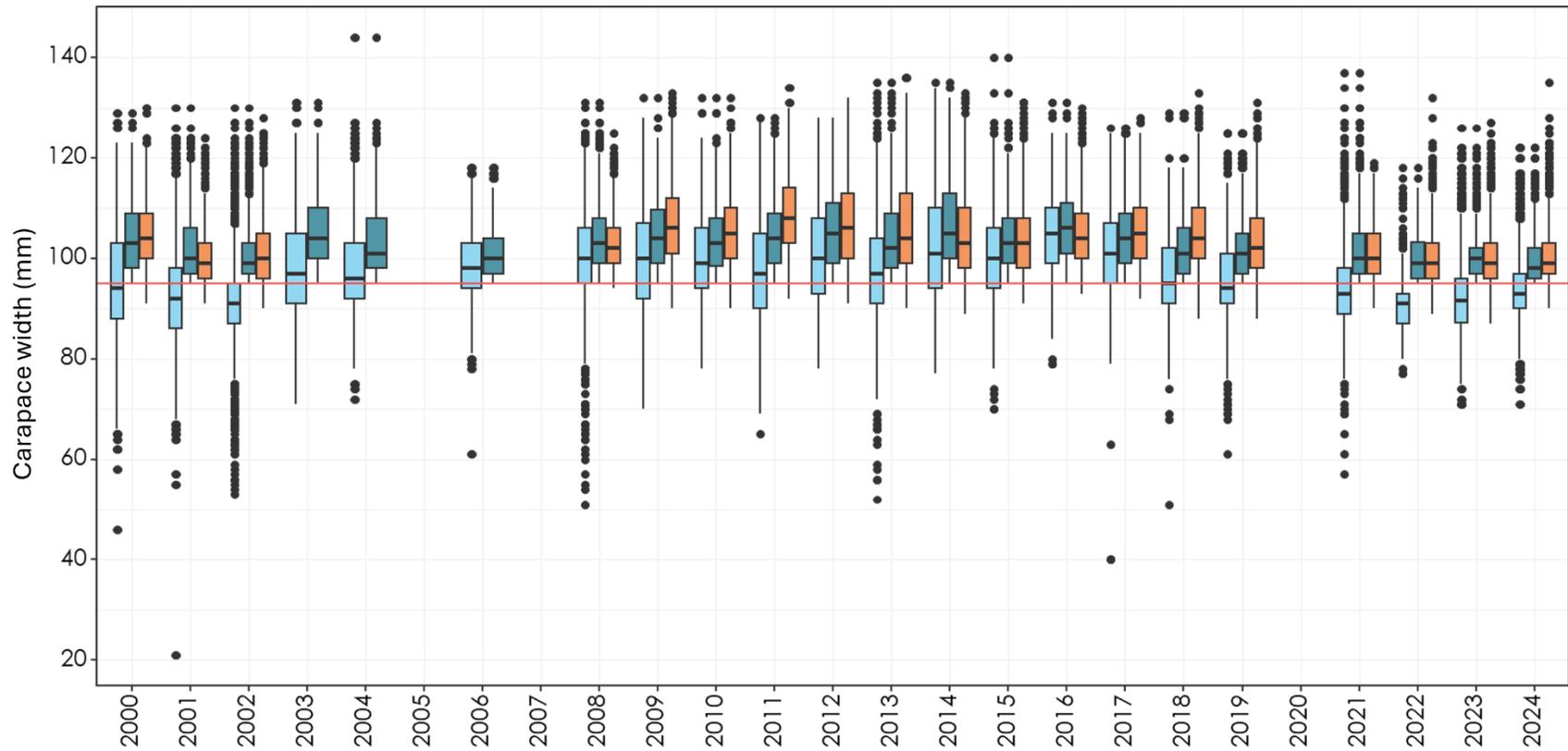


Figure A3.5. Distribution of carapace widths (CW) of snow crabs measured between 2000 and 2024 in Area 13 during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs (CW \geq 95 mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm). There were no dockside samples between 2003 and 2007 due to the moratorium during this period.

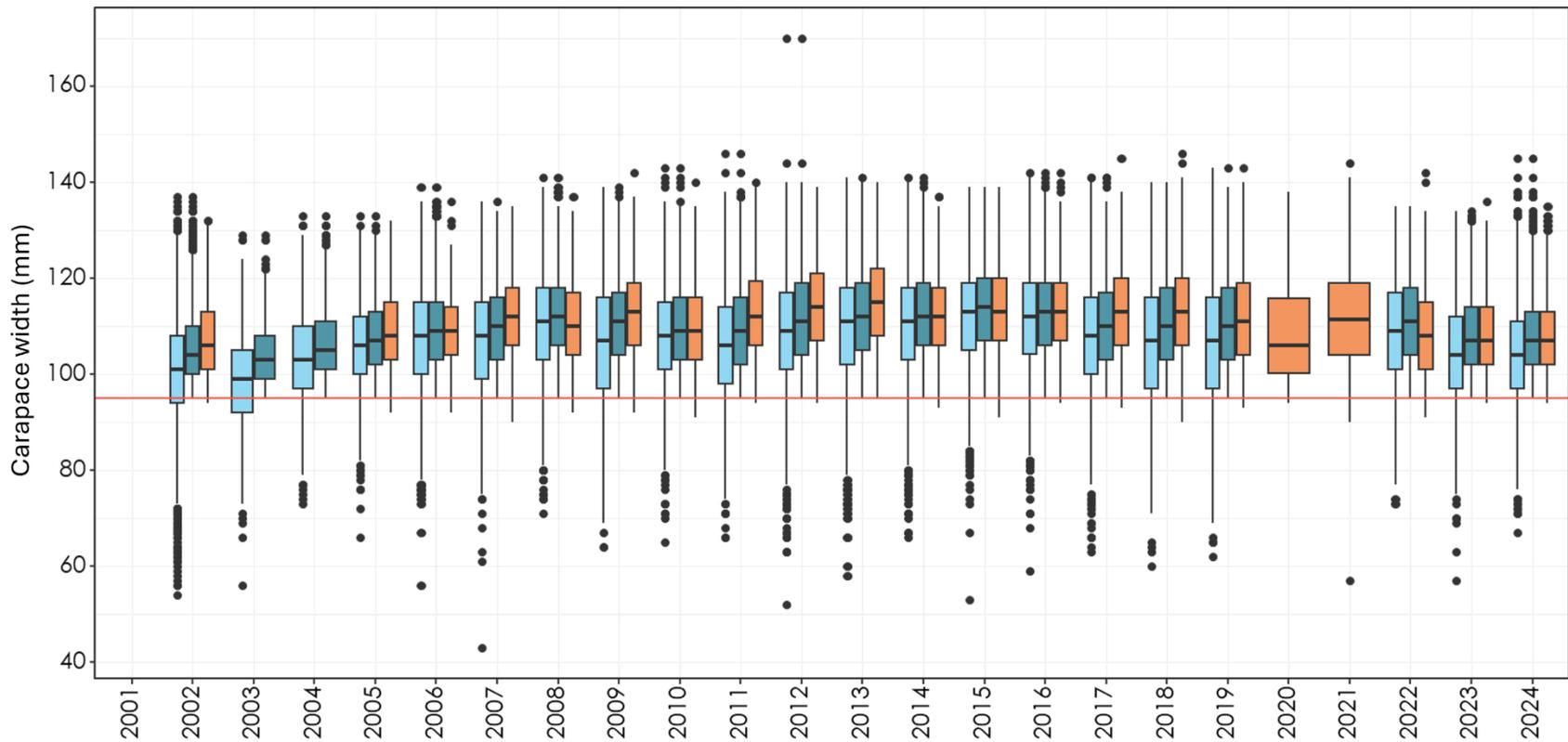


Figure A3.6. Distribution of carapace widths (CW) of snow crabs measured between 2001 and 2024 in Area 16A during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs ($CW \geq 95$ mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

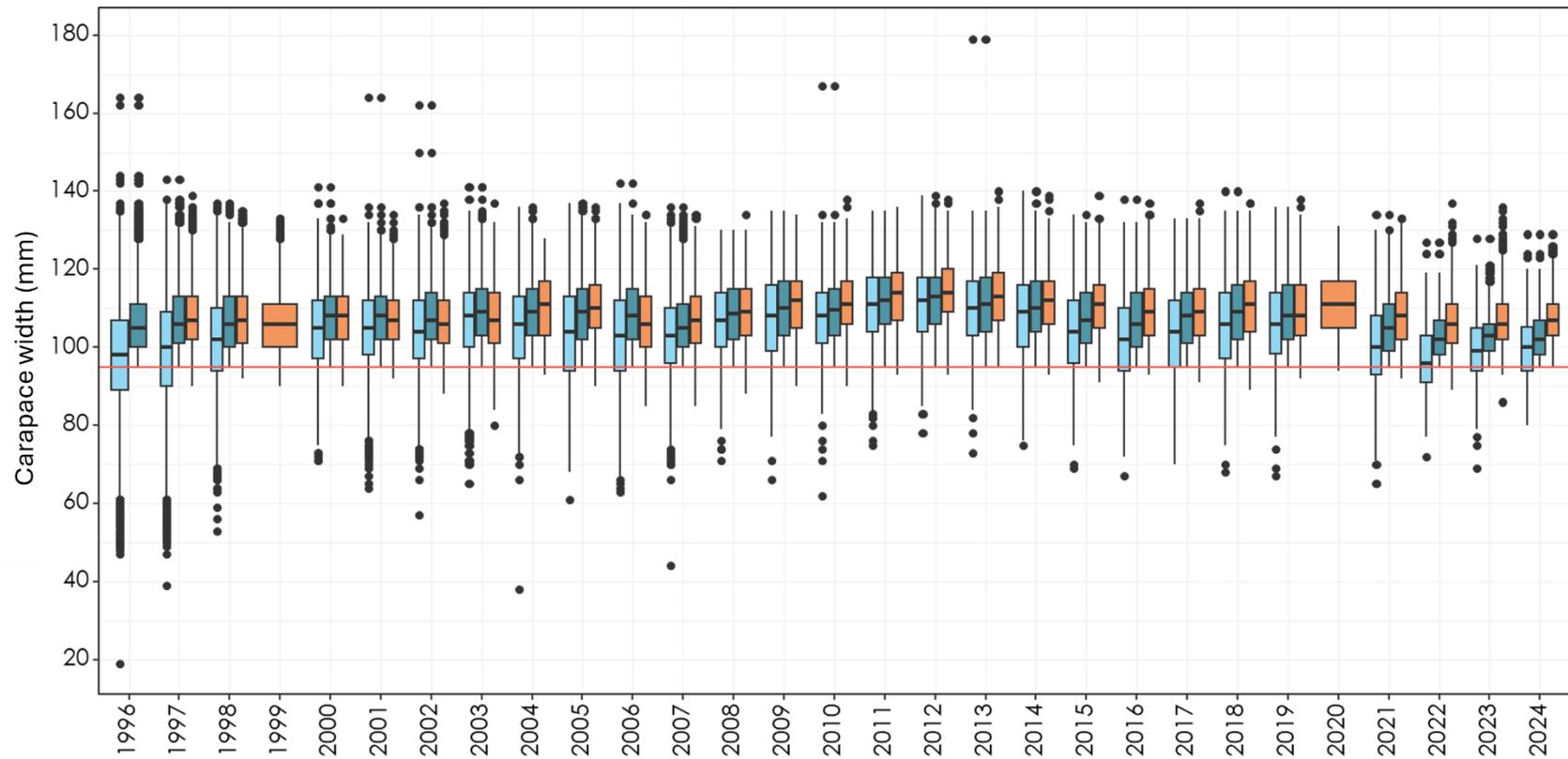


Figure A3.7. Distribution of carapace widths (CW) of snow crabs measured between 1996 and 2024 in Area 12A during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs (CW \geq 95 mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

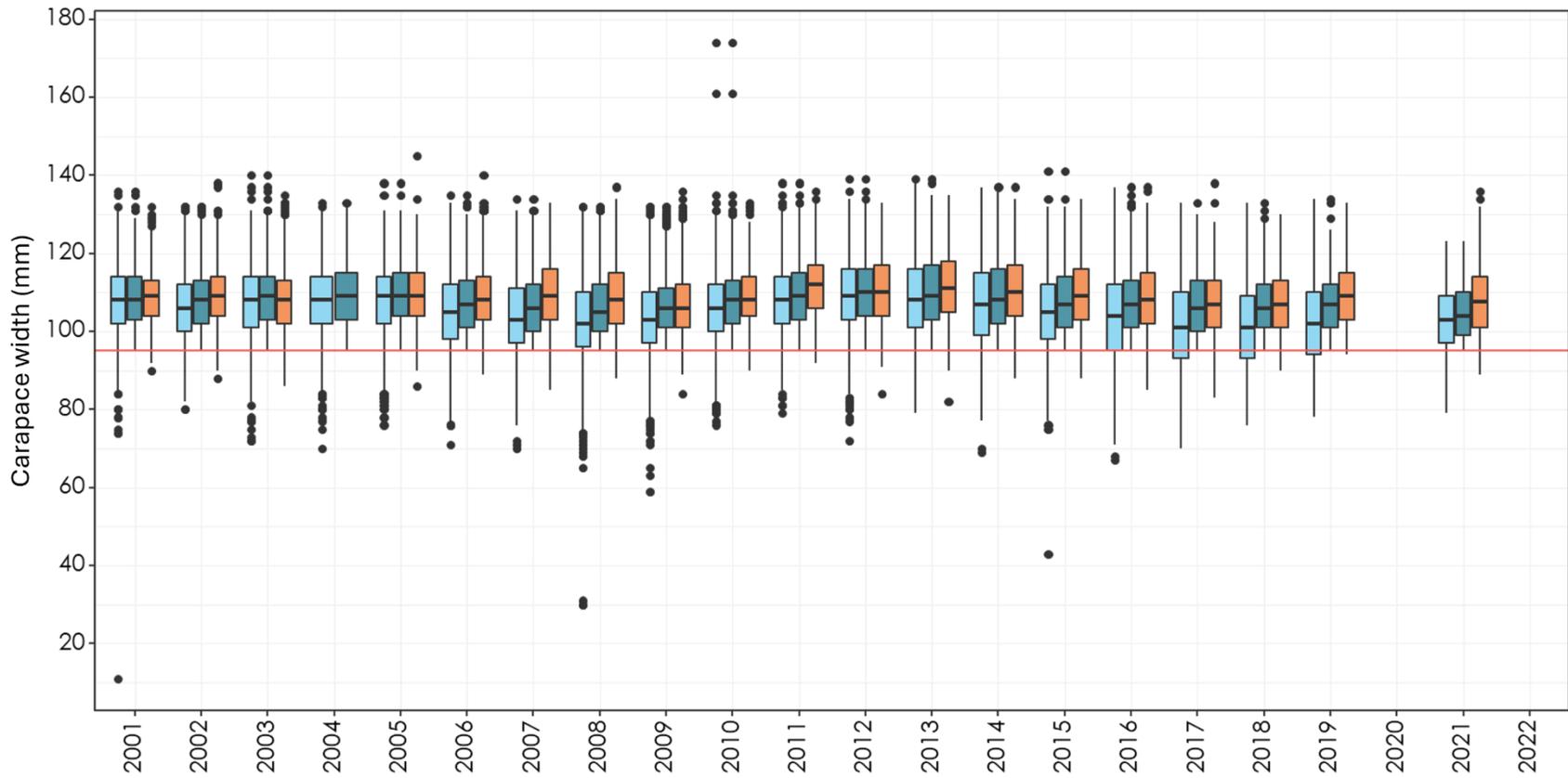


Figure A3.8. Distribution of carapace widths (CW) of snow crabs measured between 2001 and 2021 in Area 12B during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs (CW \geq 95 mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

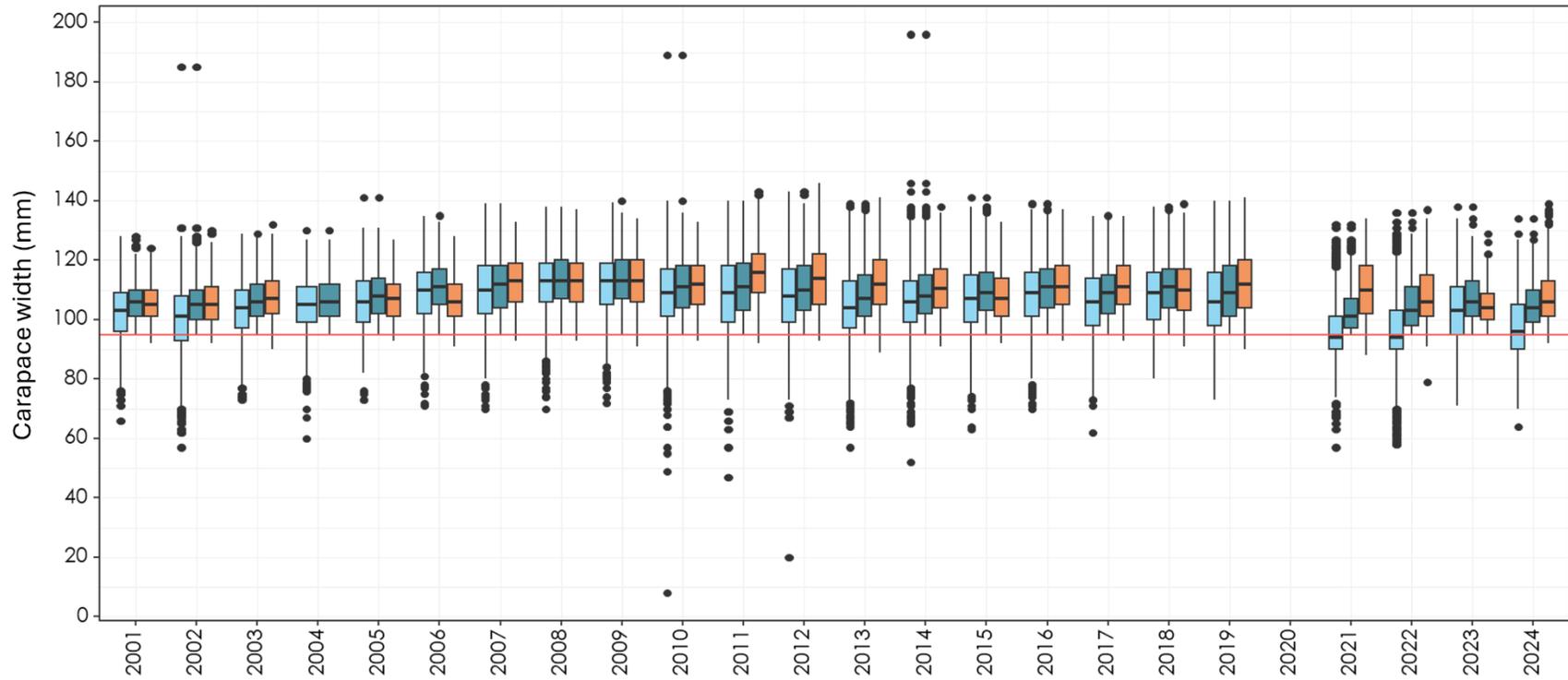


Figure A3.9. Distribution of carapace widths (CW) of snow crabs measured between 2001 and 2024 in Area 12C during at-sea sampling (light blue boxplot) and dockside sampling (orange boxplot). The distribution of legal-size crabs (CW ≥ 95 mm) is shown in dark blue. The horizontal red line indicates the legal size (95 mm).

APPENDIX 4. LANDINGS AND NUMBER OF LICENCES

Table A4.1. Landings (Lndgs), total allowable catch (TAC) and number of fishing licences (No. of lic.) issued by management area over the last 10 years. Landings and TACs are expressed in tonnes.

Year	Area 17			Area 16			Area 15		
	Lndgs	TAC	No. of lic.	Lndgs	TAC	No. of lic.	Lndgs	TAC	No. of lic.
2014	1,343	1,447	45	5,481	5,552	54	717	717	8
2015	1,334	1,342	41	4,132	4,145	54	718	717	46
2016	1,683	1,678	41	4,506	4,560	54	790	789	32
2017	2,103	2,098	41	3,644	3,648	54	628	631	32
2018	2,584	2,623	41	3,633	3,620	54	612	630	32
2019	1,714	2,210	39	2,959	3,073	51	413	442	30
2020	1,324	1,277	39	2,300	2,326	51	263	310	30
2021	1,217	1,213	36	1,963	1,951	51	306	325	30
2022	1,211	1,203	33	2,251	2,236	51	237	243	30
2023	1,396	1,394	33	2,552	2,585	51	323	322	30
2024	1,671	1,674	33	3,051	3,067	51	416	418	30

Year	Area 14			Area 13			Area 12C		
	Lndgs.	TAC	No. of lic.	Lndgs.	TAC	No. of lic.	Lndgs.	TAC	No. of lic.
2014	595	605	21	234	235	49	353	352	5
2015	724	726	21	286	282	49	318	317	29
2016	762	762	21	338	338	49	284	285	43
2017	686	686	21	406	406	49	280	285	43
2018	602	617	21	329	406	49	235	254	43
2019	439	463	19	302	304	43	150	192	37
2020	348	395	19	214	244	43	79	96	37
2021	363	365	19	199	244	41	91	96	37
2022	311	310	19	188	199	41	66	72	37
2023	377	388	19	200	207	40	64	67	36
2024	399	415	19	204	220	40	137	142	37

Year	Area 16A			Area 12A			Area 12B		
	Lndgs.	TAC	No. of lic.	Lndgs.	TAC	No. of lic.	Lndgs.	TAC	No. of lic.
2014	516	515	43	178	191	10	458	468	8
2015	560	566	43	132	151	10	350	366	8
2016	510	510	43	102	106	10	193	311	8
2017	444	459	43	96	99	10	58	175	8
2018	369	412	43	98	106	10	40	125	8
2019	309	309	36	81	106	9	30	125	6

Year	Area 16A			Area 12A			Area 12B		
	Lndgs.	TAC	No. of lic.	Lndgs.	TAC	No. of lic.	Lndgs.	TAC	No. of lic.
2020	257	272	36	69	79	9	0	20	2
2021	244	245	35	54	69	10	19	20	6
2022	244	247	35	43	43	9	0	0	-
2023	290	294	34	39	45	9	0	0	-
2024	373	376	35	42	40	9	0	0	-

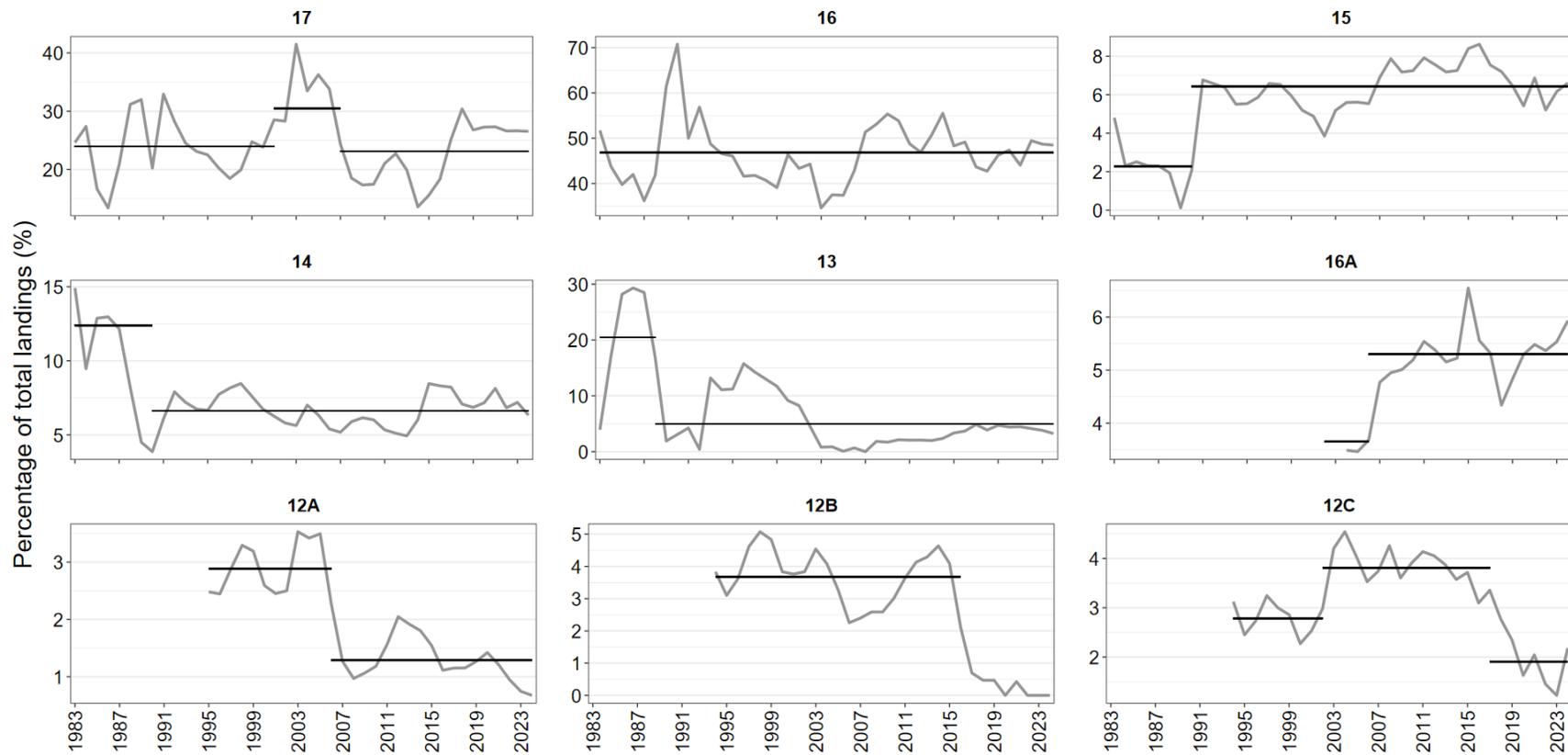


Figure A4.1. Percentage of total landings in the Estuary and northern Gulf of St. Lawrence (1983–2024) by management area (grey line). The horizontal black lines indicate the average percentage for a particular period, delimited by change points. The change points were identified using the Bayesian multiple change point method in the “mcp” package. These points indicate significant changes in the average percentage.

APPENDIX 5. ADDITIONAL RESULTS FROM DFO TRAWL SURVEYS



Figure A5.1. Beam trawl installed on the aft winch of the CCGS Leim.

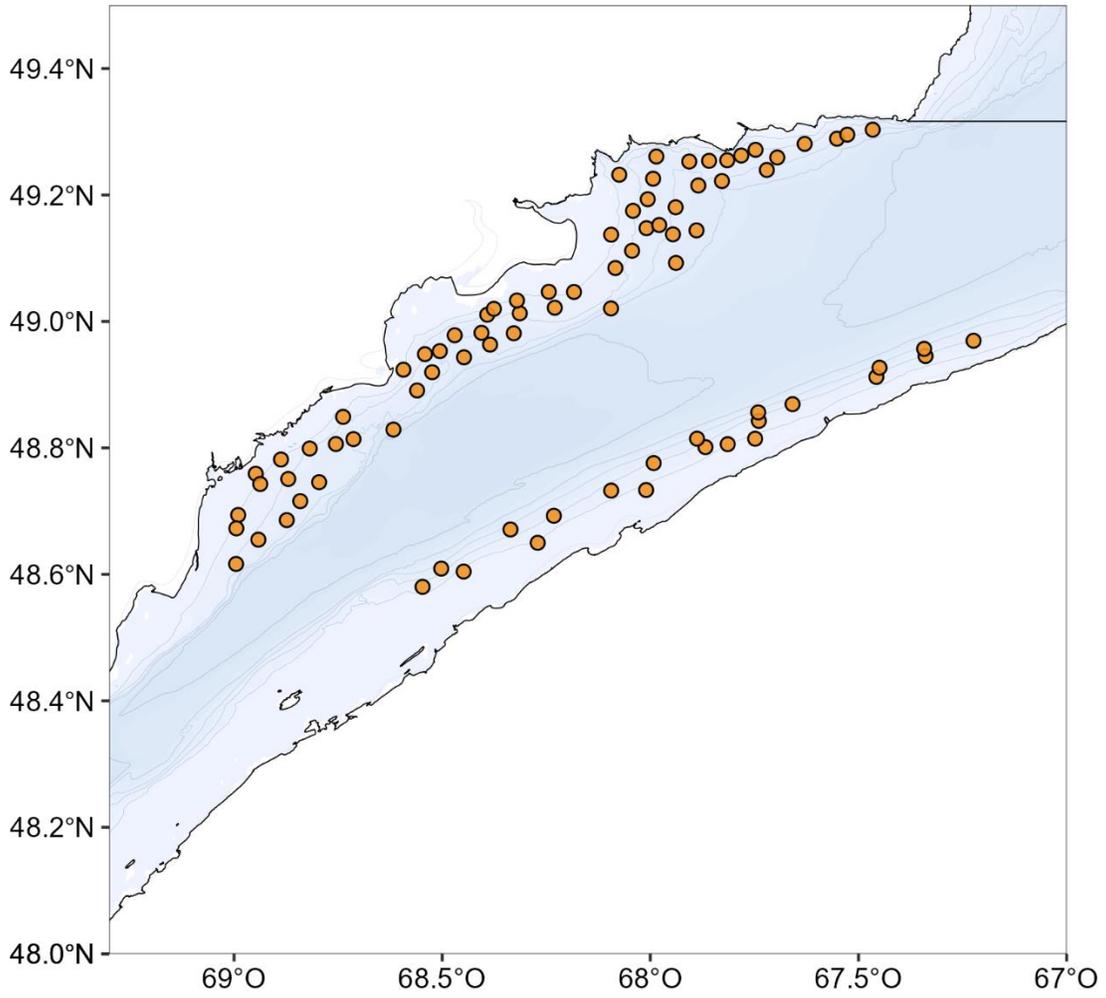


Figure A5.2. Geographical location of stations in the DFO trawl survey in the Estuary.

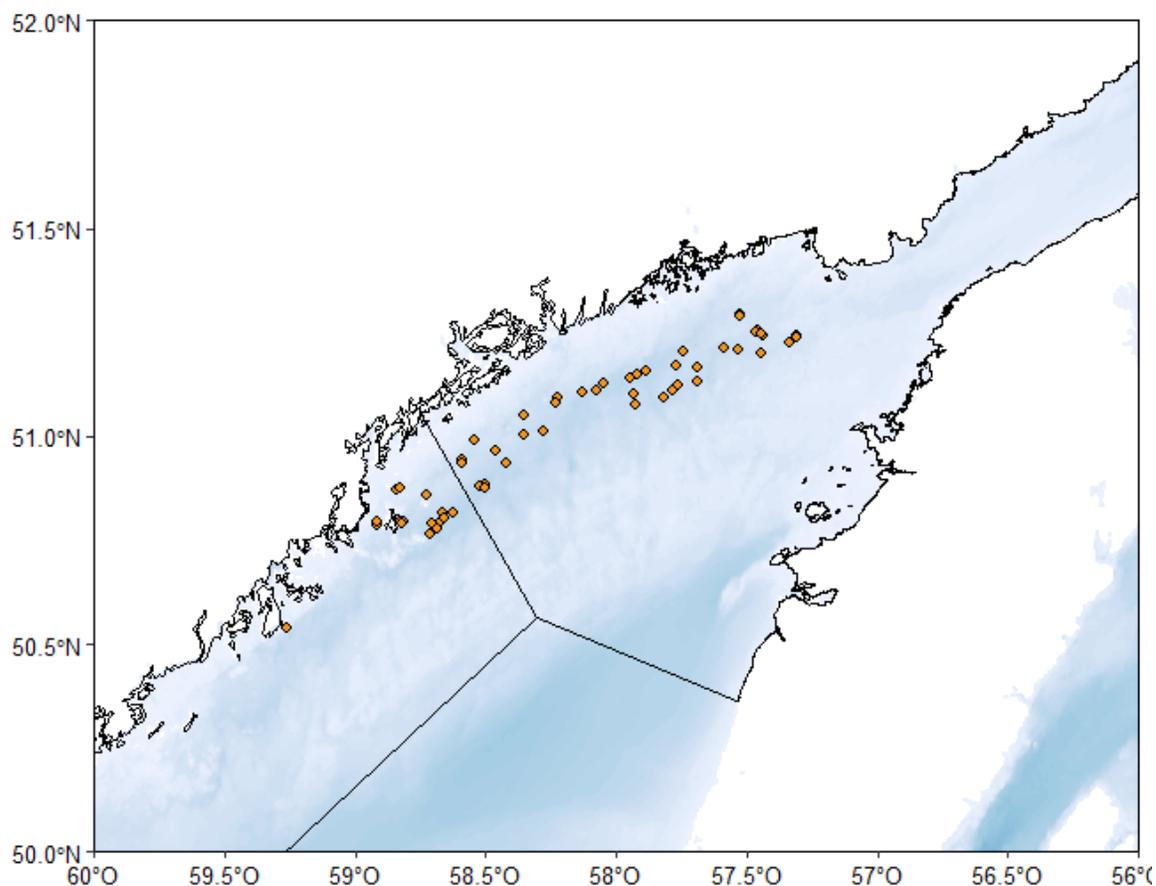


Figure A5.3. Geographical location of conventional (fixed) stations in the DFO trawl survey on the Lower North Shore.

Table A5.1. Summary of scientific trawl surveys of snow crabs in the St. Lawrence Estuary between 1992 and 2023.

Year	No. of <i>C. opilio</i>	No. of stations	Start date	End date	No. of days
1992	7,102	63	1992-07-25	1992-08-07	13
1993	15,894	73	1993-07-28	1993-08-09	12
1994	24,076	86	1994-07-28	1994-08-12	15
1995	20,500	85	1995-07-23	1995-08-04	12
1996	25,593	66	1996-07-29	1996-08-09	11
1997	20,515	74	1997-07-28	1997-08-10	13
1998	21,083	76	1998-07-26	1998-08-09	14
1999	11,909	69	1999-07-11	1999-07-20	9
2000	8,703	63	2000-08-06	2000-08-14	8
2001	8,884	76	2001-07-21	2001-08-04	14
2002	7,823	77	2002-07-26	2002-08-05	10

Year	No. of <i>C. opilio</i>	No. of stations	Start date	End date	No. of days
2005	4,309	70	2005-07-03	2005-07-10	7
2007	4,317	77	2007-07-08	2007-07-19	11
2009	20,959	85	2009-07-02	2009-07-15	13
2011	16,946	90	2011-07-09	2011-07-22	13
2013	8,612	87	2013-07-04	2013-07-13	9
2015	15,888	87	2015-07-02	2015-07-12	10
2017	9,797	86	2017-07-05	2017-07-17	12
2019	10,379	67	2019-07-07	2019-07-26	19
2023	12,950	82	2023-07-02	2023-07-14	12

Table A5.2. Summary of scientific trawl surveys of snow crabs at the conventional (fixed) stations (eastern part of Area 14 and northern part of Area 13) in the St. Lawrence between 1992 and 2024.

Year	No. of <i>C. opilio</i>	No. of stations	Start date	End date	No. of days
1994	25,813	25	1994-09-29	1994-10-05	7
1995	24,340	30	1995-07-13	1995-07-18	6
1999	30,420	65	1999-07-26	1999-08-06	12
2000	20,751	42	2000-07-22	2000-07-30	9
2003	8,573	44	2003-07-18	2003-07-24	7
2004	9,761	64	2004-07-17	2004-07-30	14
2006	15,244	33	2006-07-23	2006-08-01	10
2008	13,895	62	2008-07-13	2008-07-26	14
2010	6,693	47	2010-07-09	2010-07-22	14
2012	8,922	44	2012-07-07	2012-07-15	9
2014	13,983	48	2014-06-23	2014-07-09	17
2016	17,967	52	2016-06-25	2016-07-09	15
2018	8,953	37	2018-07-02	2018-07-14	13
2022	6,905	35	2022-07-15	2022-07-27	13
2024	6,150	46	2024-07-06	2024-07-13	8

Estuary 2 shores

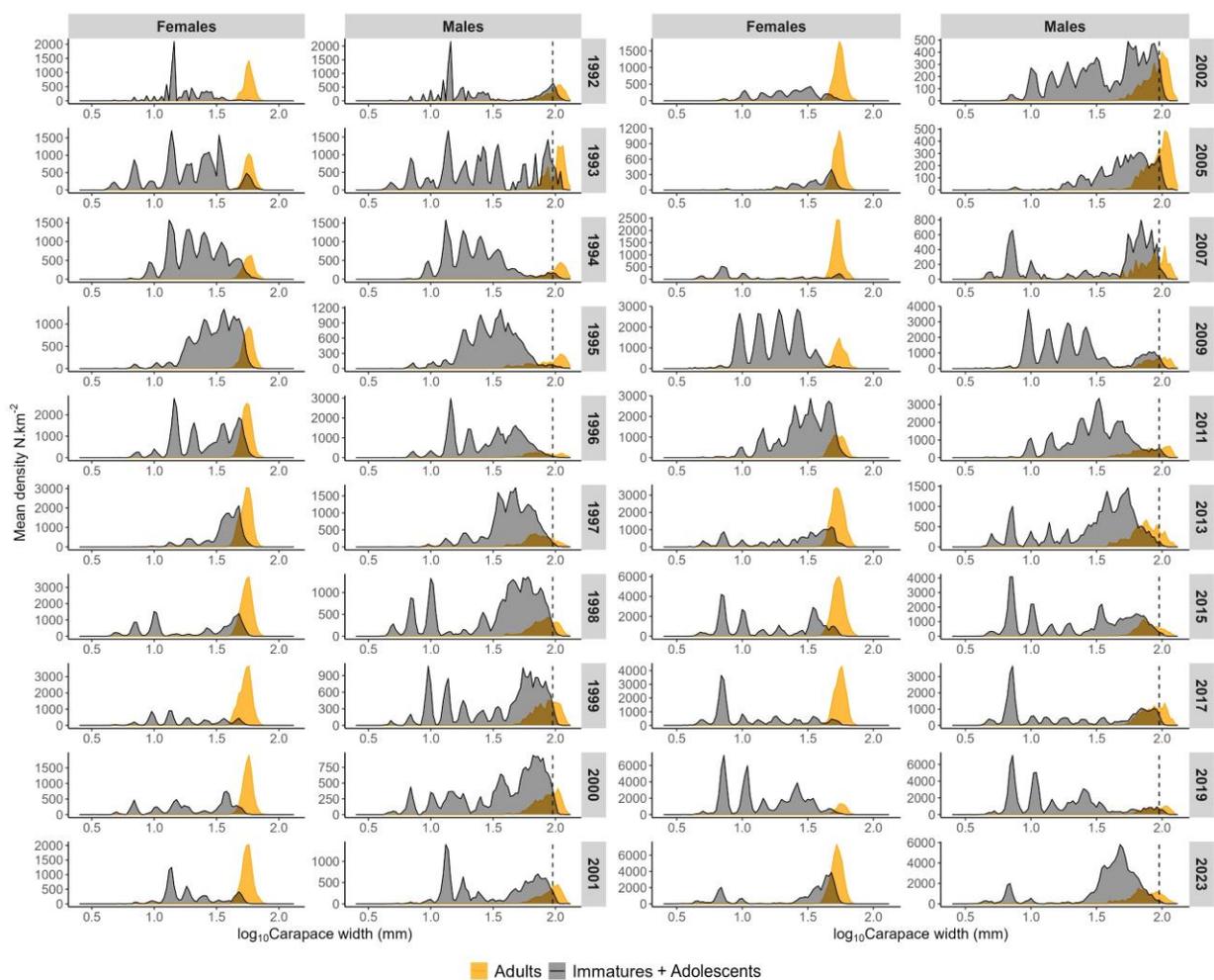


Figure A5.4. Distribution of mean density (N/km^2) by mean \log_{10} carapace width (mm) of immature and adolescent (black) and adult (yellow) male and female crabs caught during trawl surveys in the Estuary from 1992 to 2023. The commercial size for males (95 mm) is indicated by the dashed vertical black line.

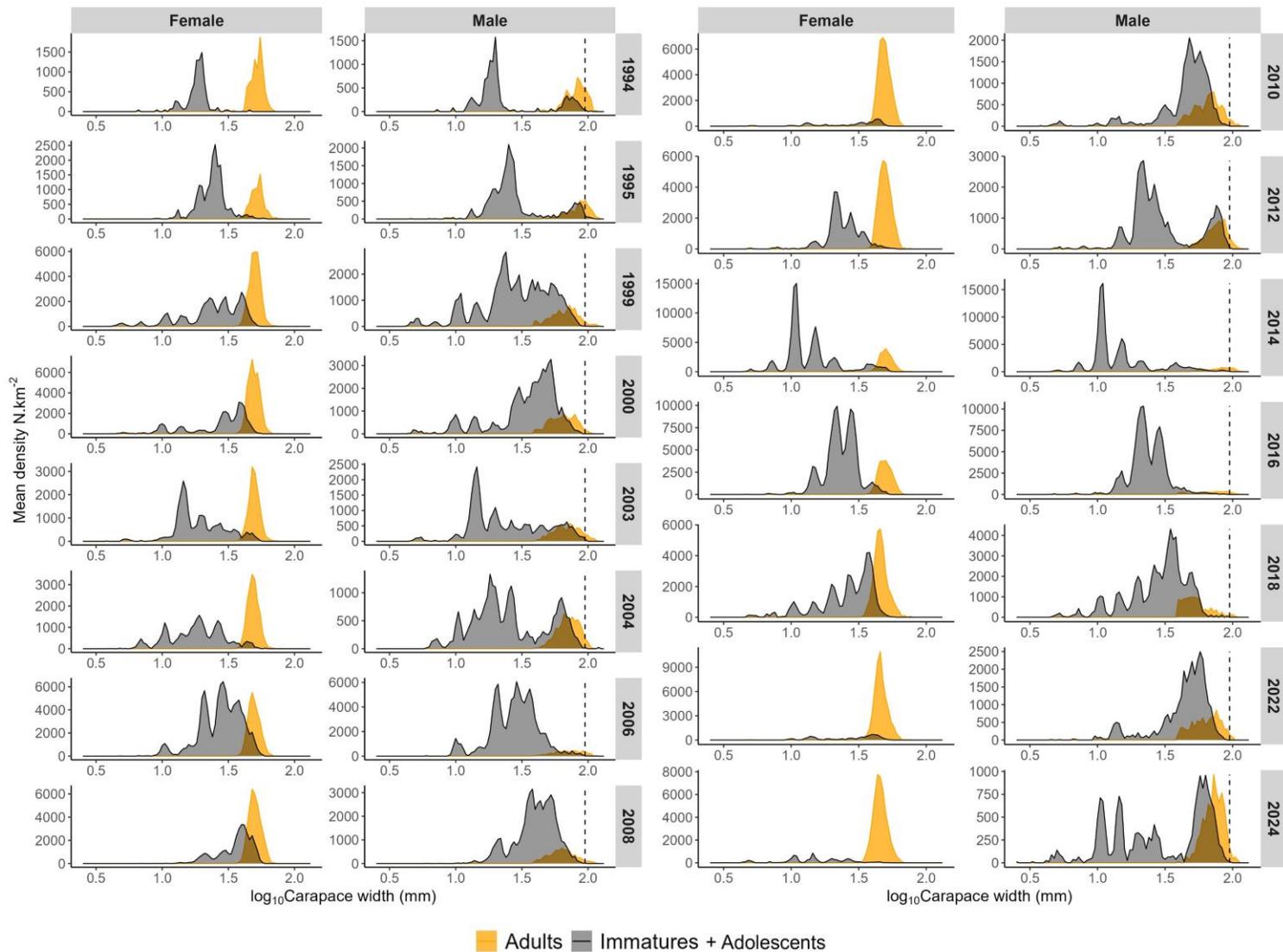


Figure A5.5. Distribution of mean density (N/km^2) by mean \log_{10} carapace width (mm) of immature and adolescent (black) and adult (yellow) male and female snow crabs caught during trawl surveys along the Lower North Shore (eastern part of Area 14 and northern part of Area 13) from 1994 to 2024. The commercial size for males (95 mm) is indicated by the dashed vertical black line.

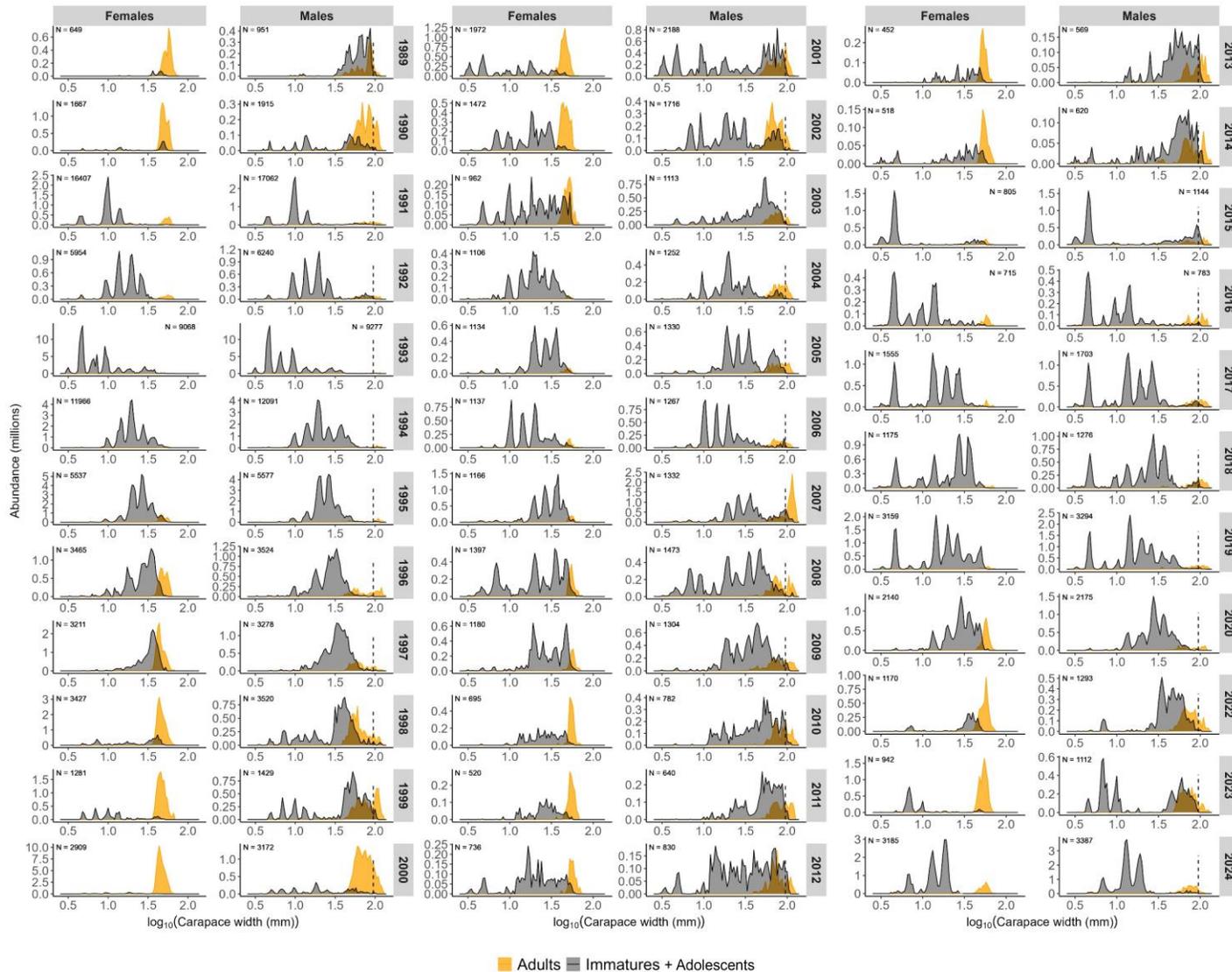


Figure A5.6. Abundance distribution (in millions of individuals) by mean \log_{10} carapace width (mm) of immature and adolescent (black) and adult (yellow) male and female snow crabs caught during trawl surveys in Sainte-Marguerite Bay from 1989 to 2024. The commercial size for males (95 mm) is indicated by the dashed vertical black line.

APPENDIX 6. ADDITIONAL RESULTS FROM POST-SEASON SURVEYS

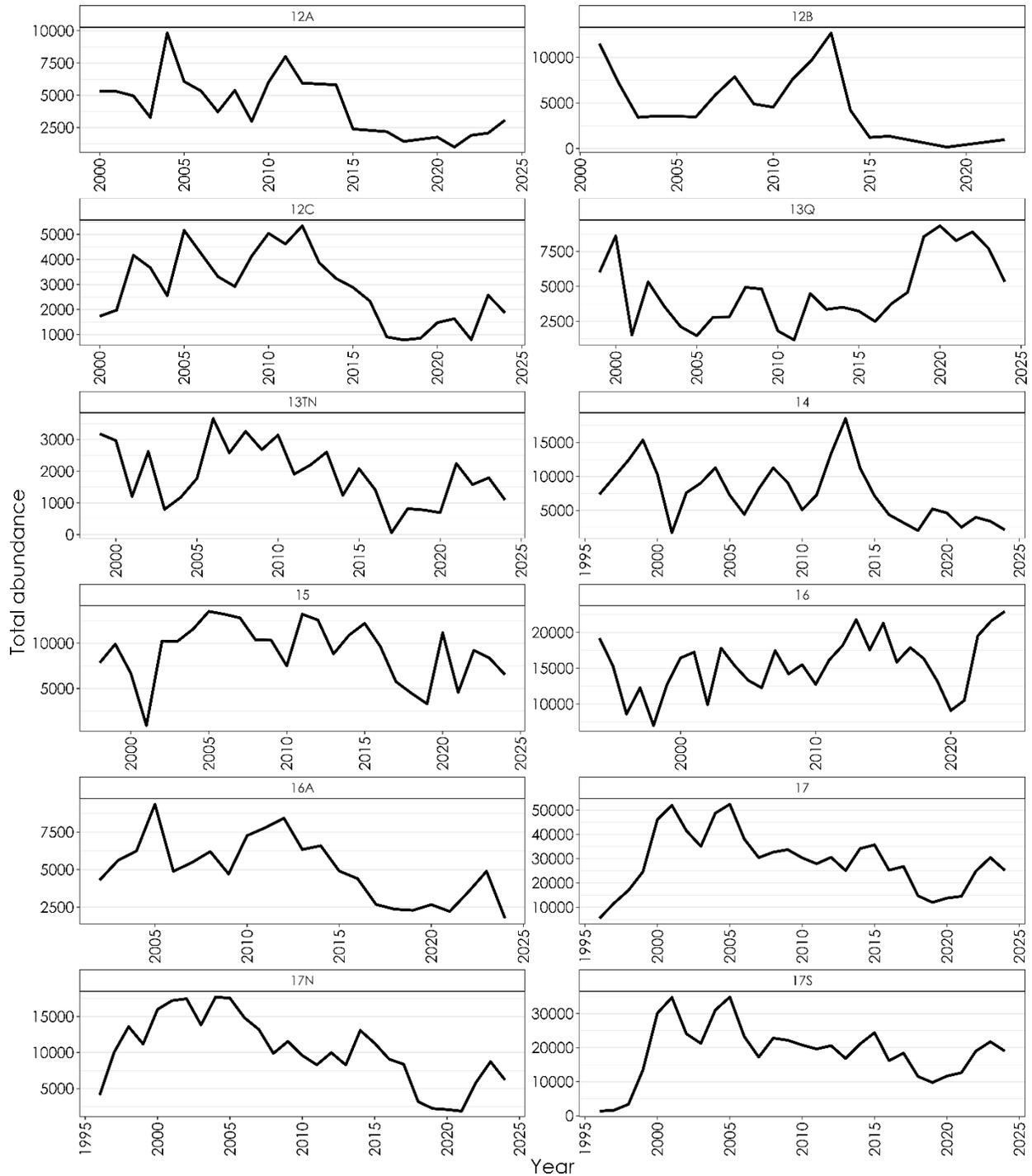


Figure A6.1. Total number of male crabs caught by fishing area and by year during post-season surveys of snow crabs in Quebec.

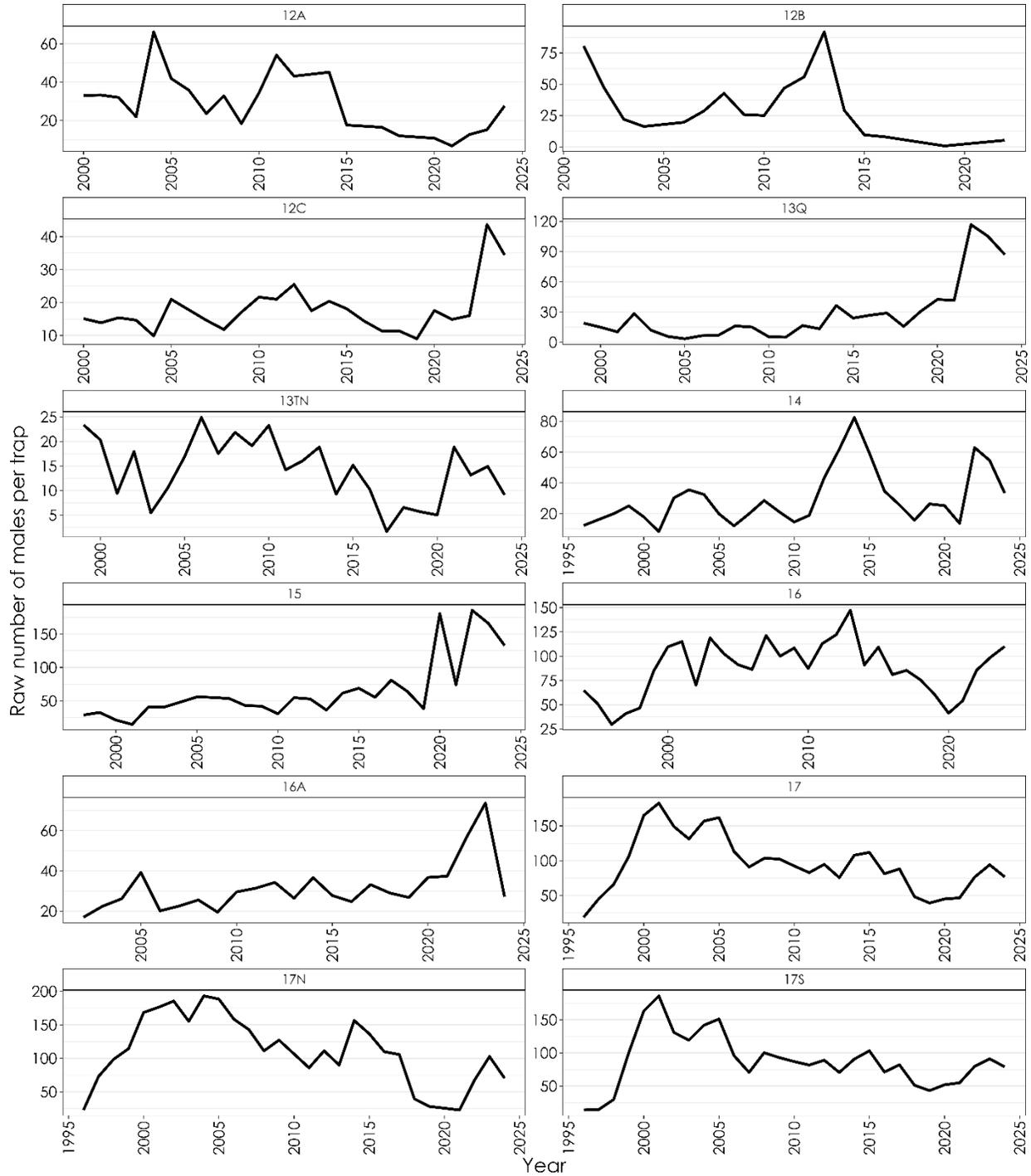


Figure A6.2. Raw (unstandardized) number of male crabs per trap, by year and by fishing area, during post-season surveys of snow crabs in Quebec.

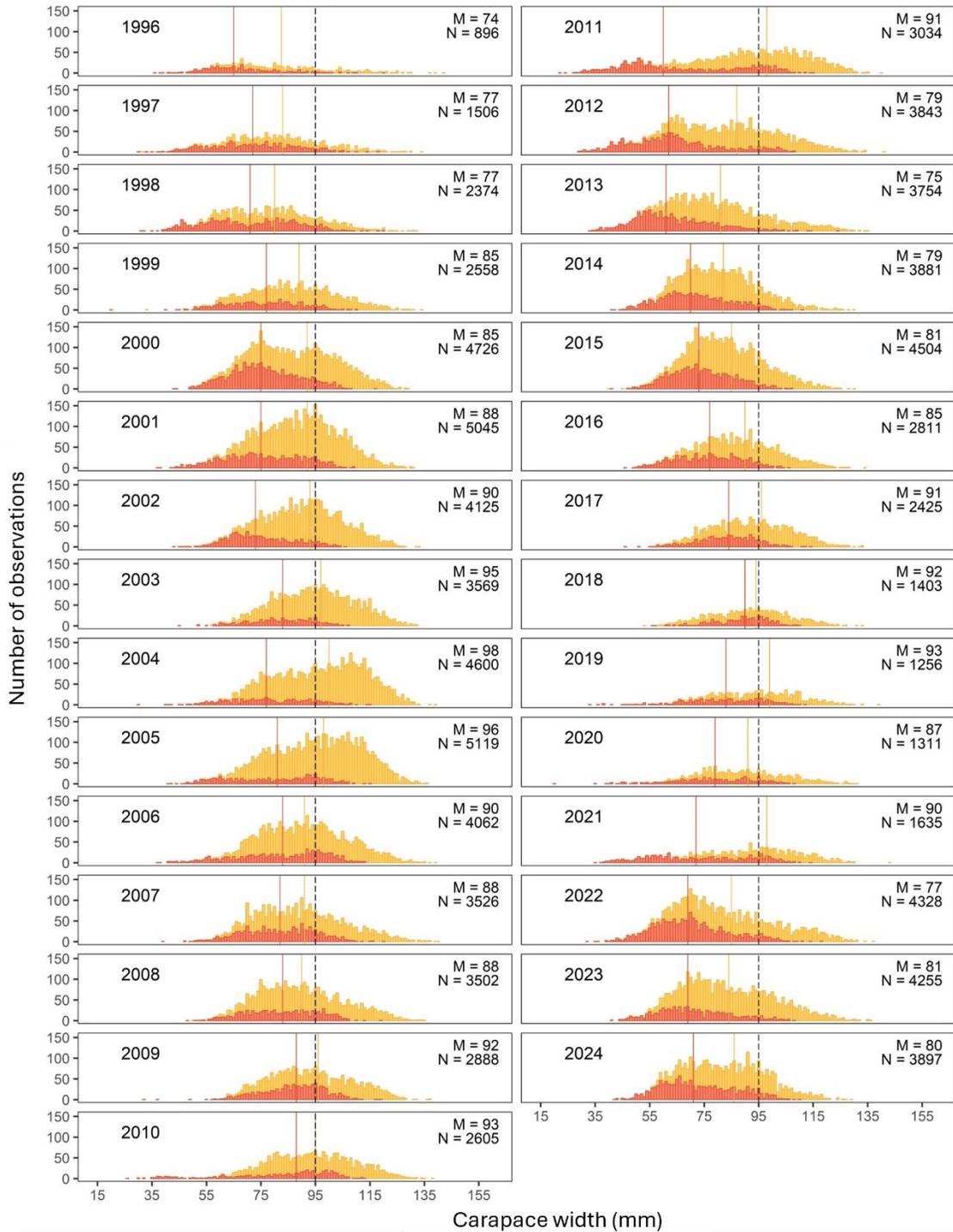


Figure A6.3. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs caught with experimental traps (E traps) during post-season surveys in Area 17. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

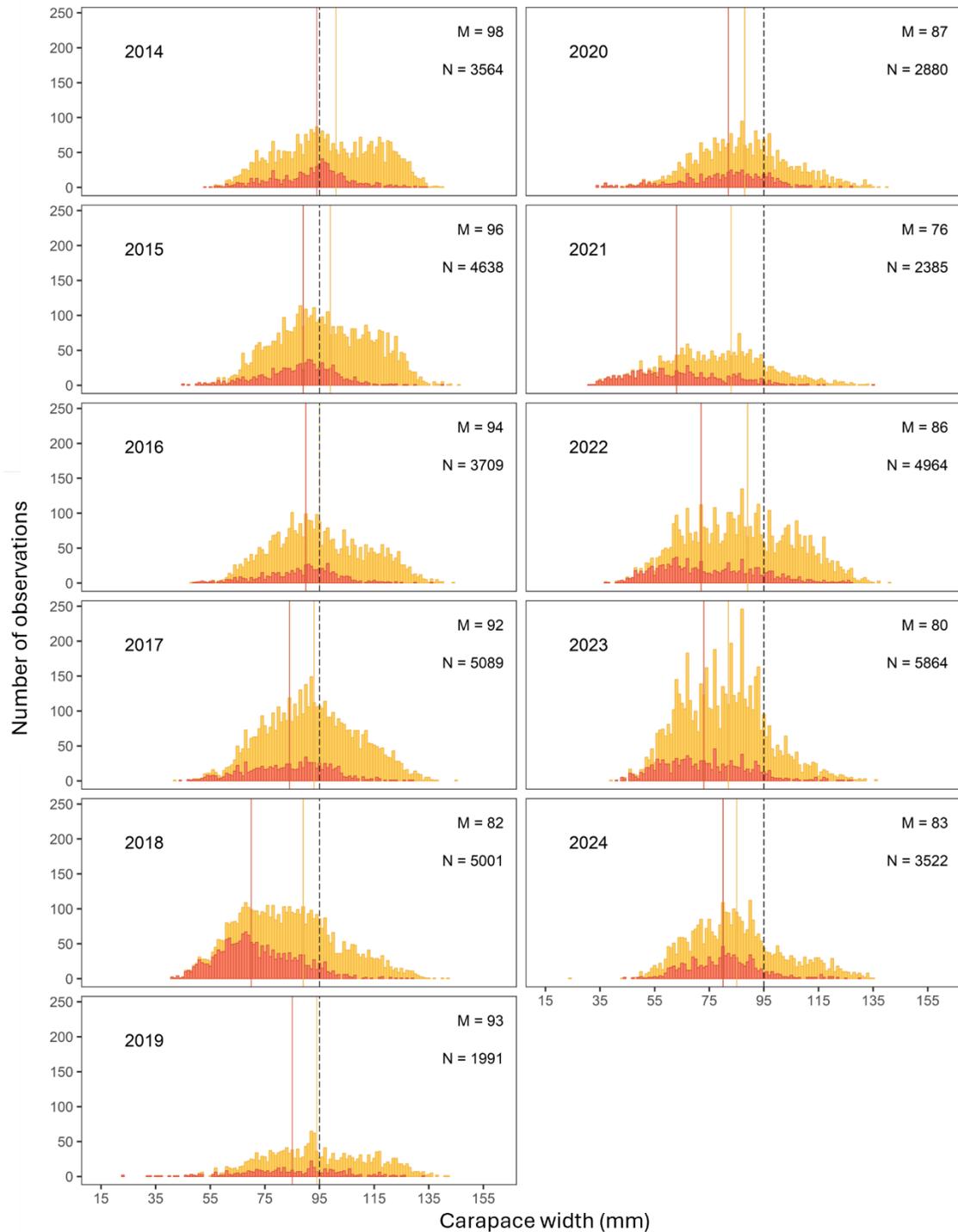


Figure A6.4. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs caught with experimental traps (E traps) during post-season surveys in Area 16. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

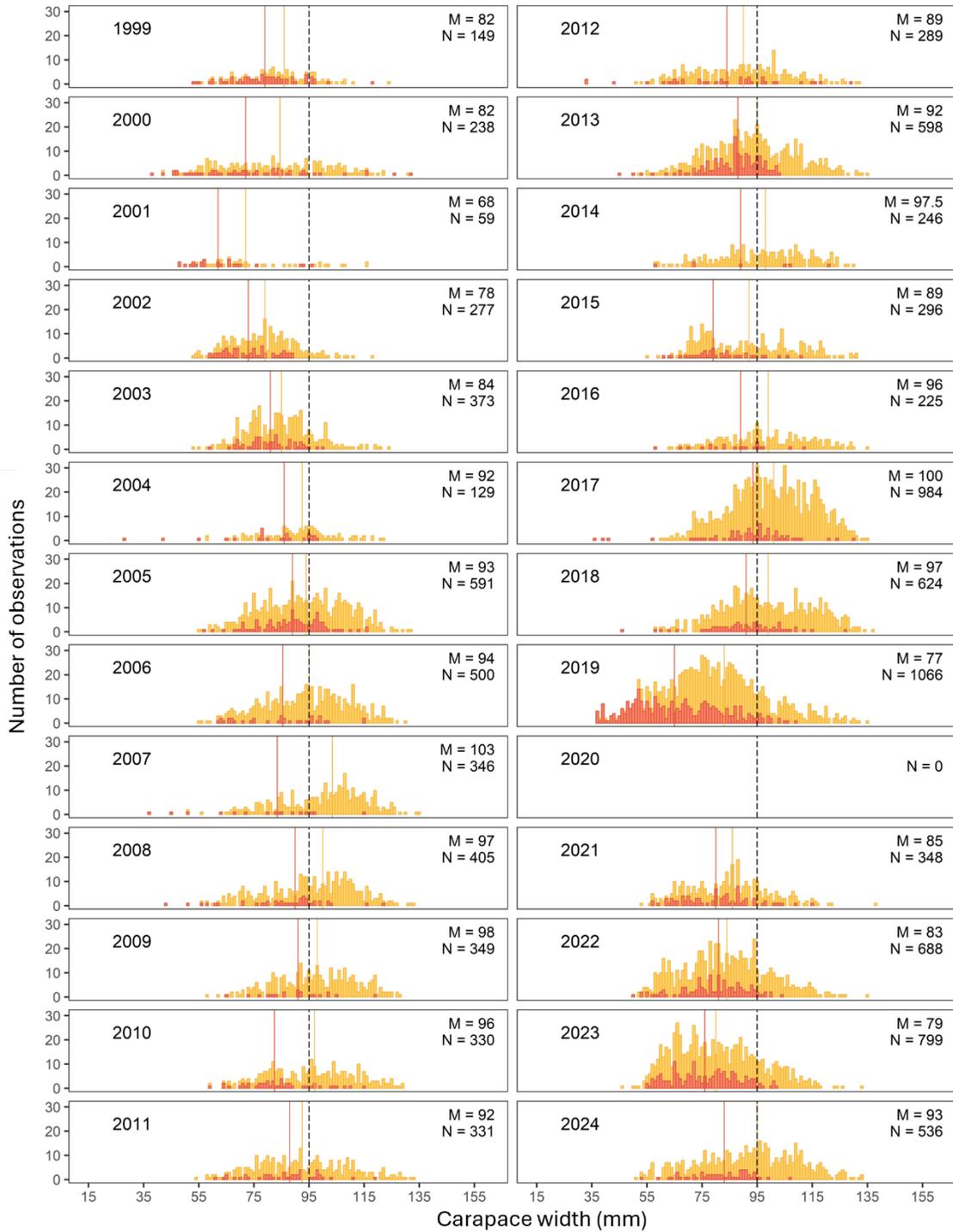


Figure A6.5. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs caught with experimental traps (E traps) during post-season surveys in Area 15. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

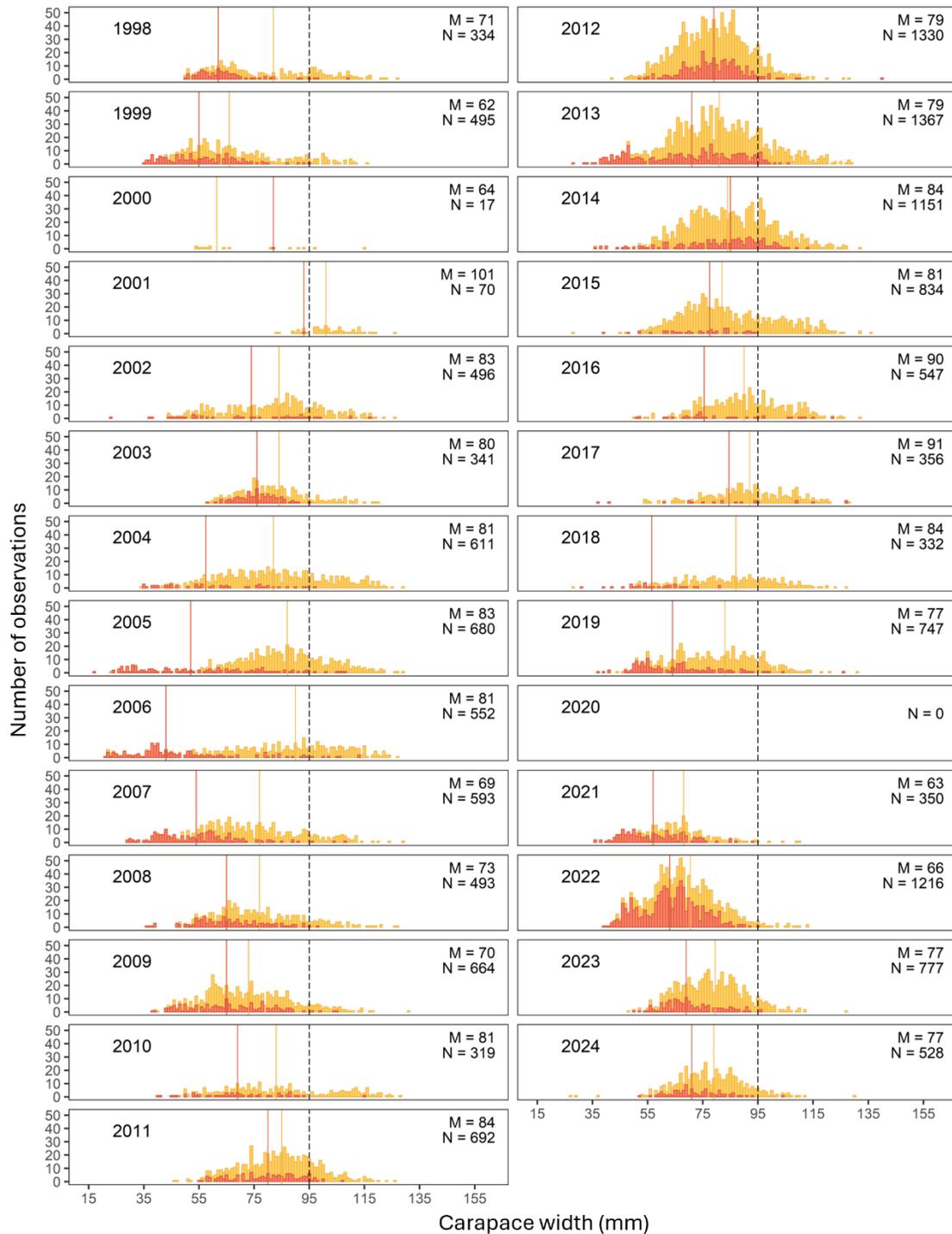


Figure A6.6. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs caught with experimental traps (E traps) during post-season surveys in Area 14. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

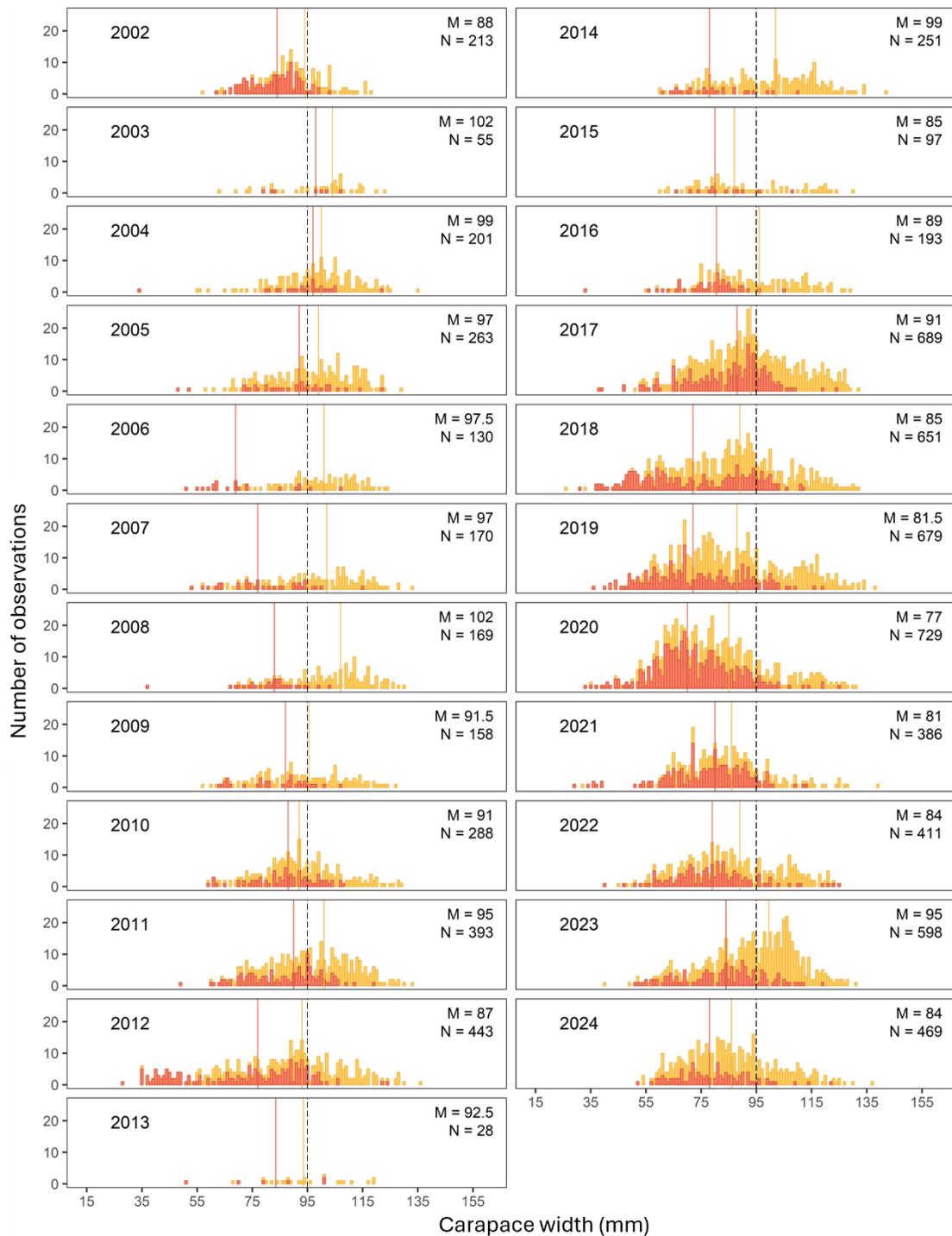


Figure A6.7. Size frequencies of adolescent (red bars) and adult (yellow bars) males caught with experimental traps (E traps) during post-season surveys in Area 13Q. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

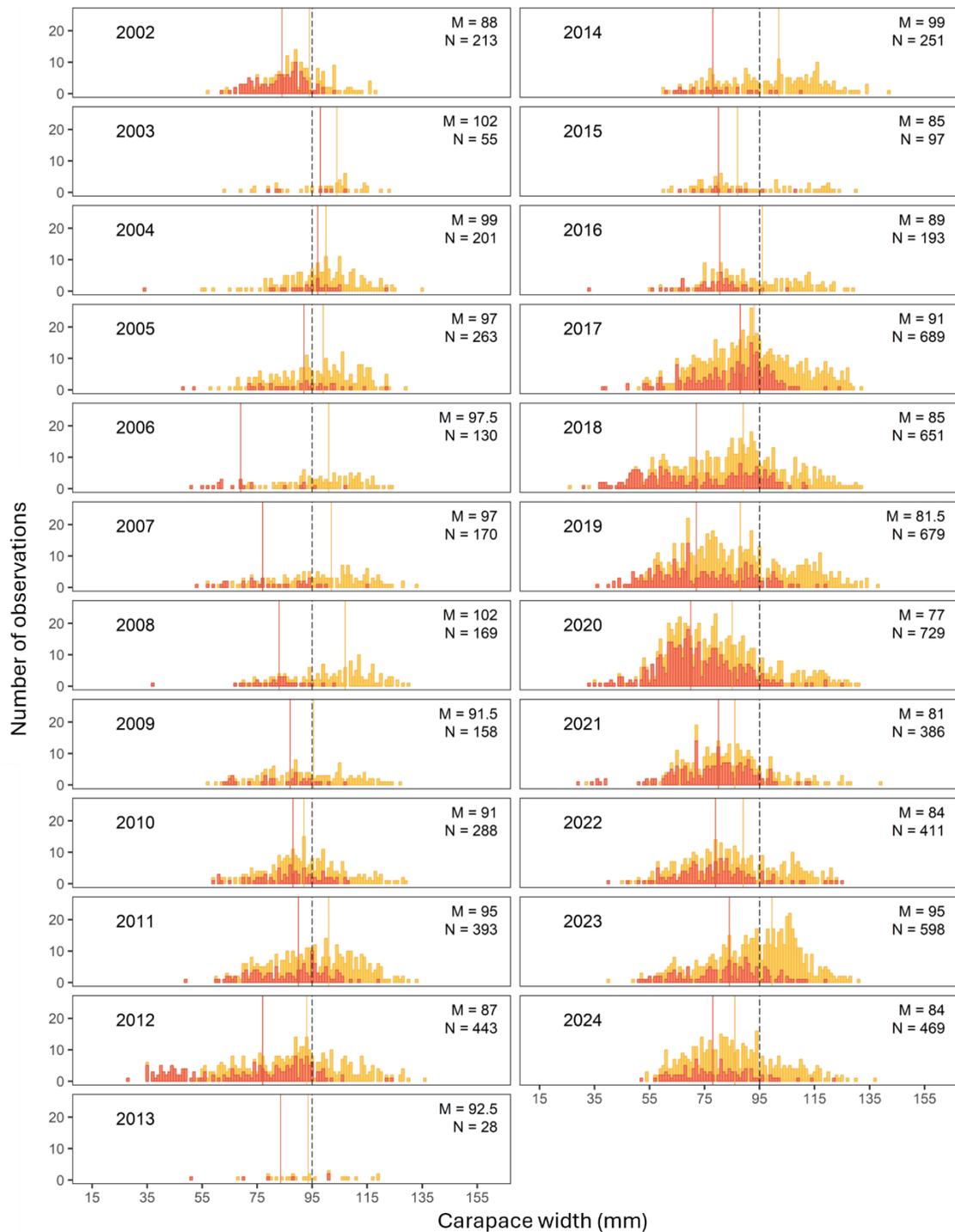


Figure A6.8. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs caught with experimental traps (E traps) during post-season surveys in Area 16A. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

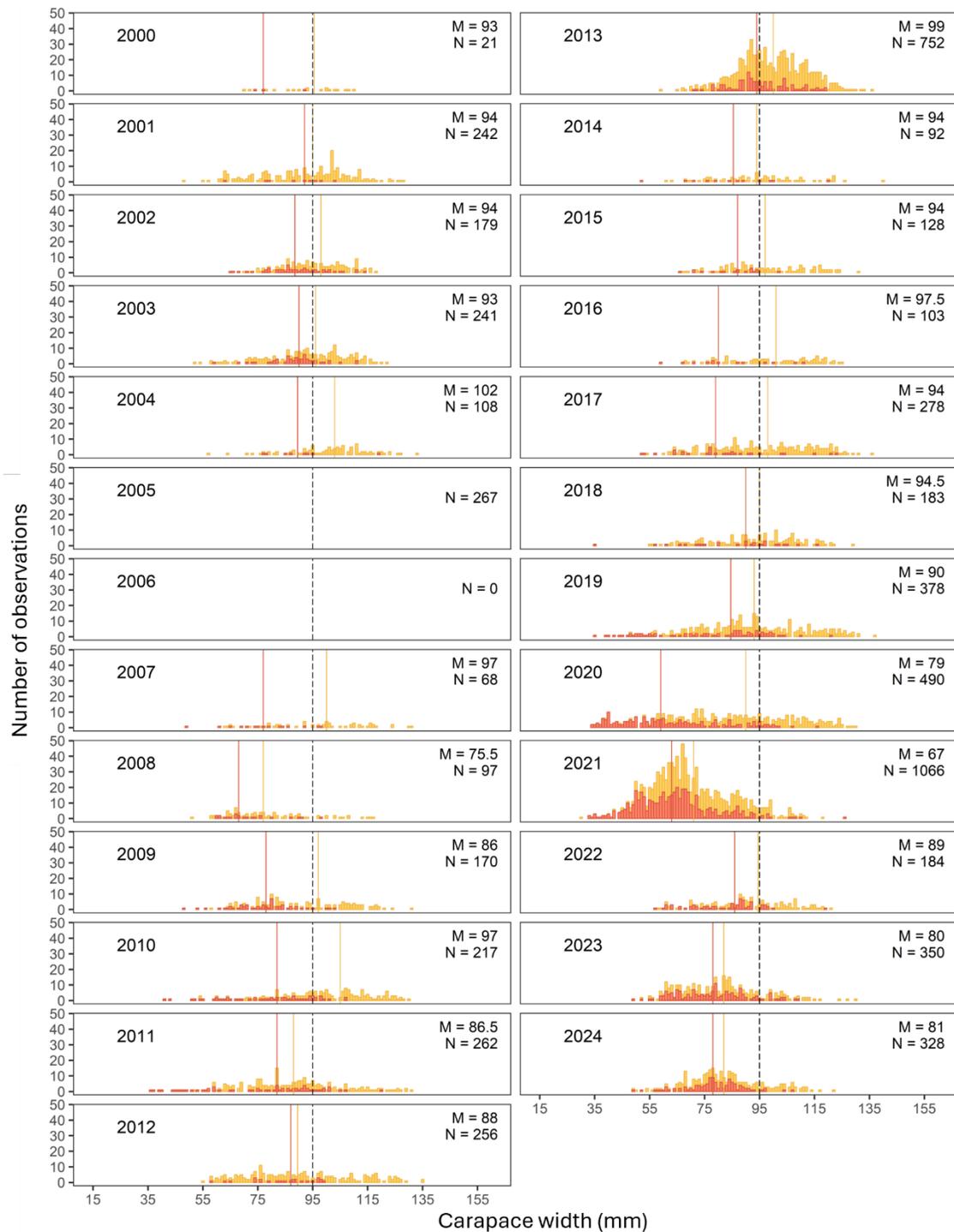


Figure A6.9. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs caught with experimental traps (E traps) during post-season surveys in Area 12C. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

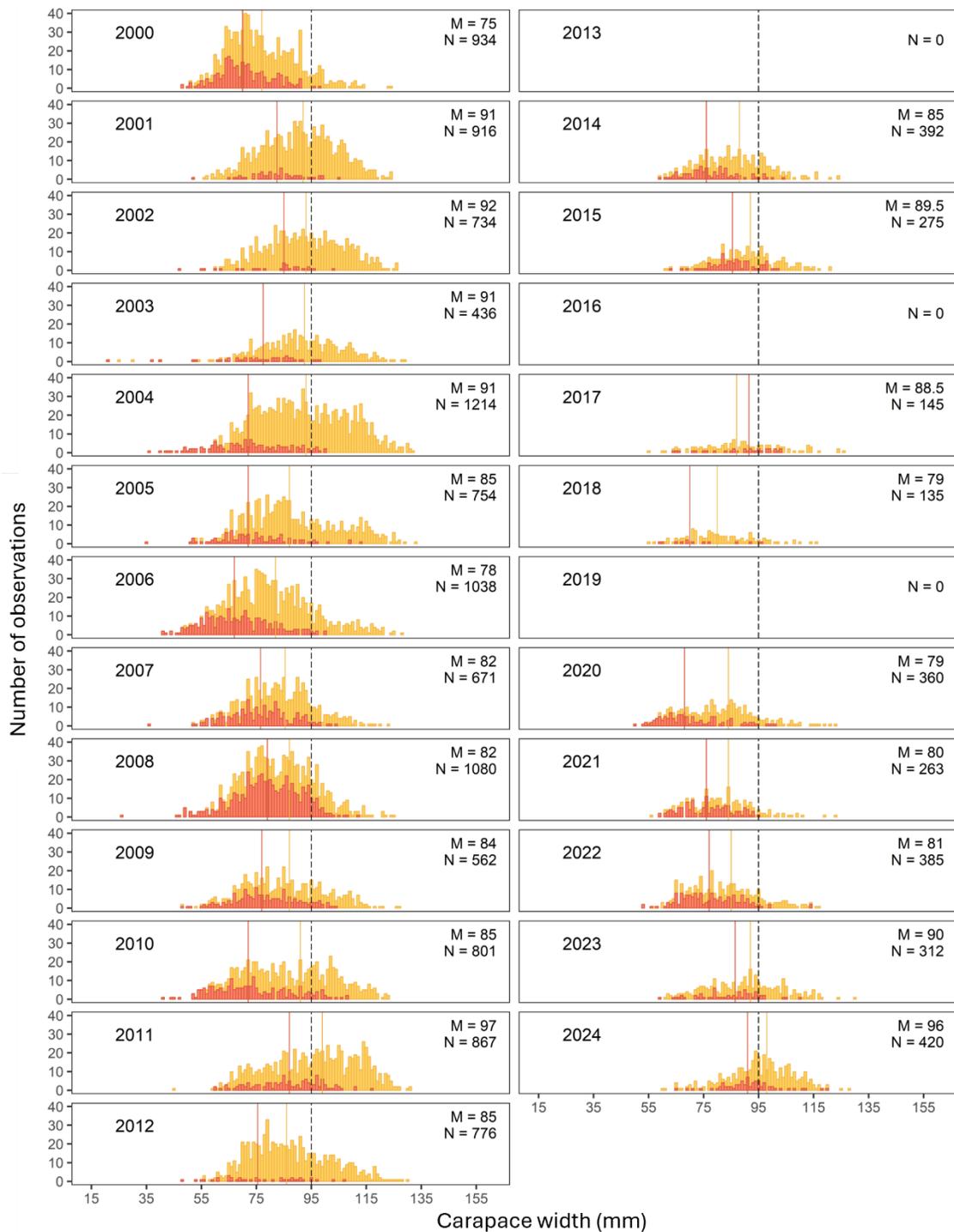


Figure A6.10. Size frequencies of adolescent (red bars) and adult (yellow bars) male crabs caught with experimental traps (E traps) during post-season surveys in Area 12A. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

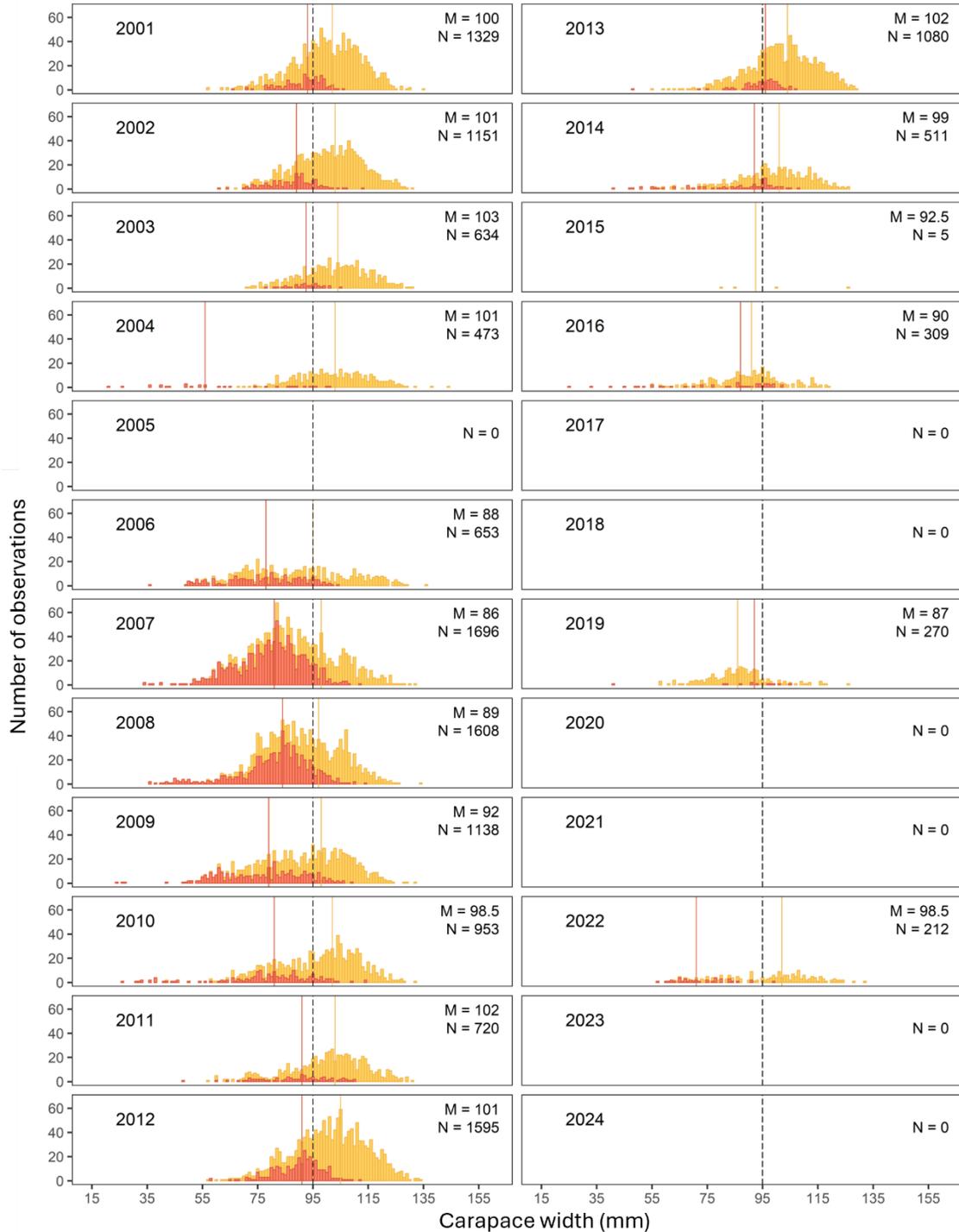


Figure A6.11. Size frequencies of adolescent (red bars) and adult (yellow bars) males caught with experimental traps (E traps) during post-season surveys in Area 12B. The median is indicated by a vertical bar (yellow for adults and red for adolescents) and the minimum legal size (95 mm), by the dashed vertical black line. The median size of all male crabs (adult and adolescent combined) (M) and the number of crabs measured (N) are provided for each year.

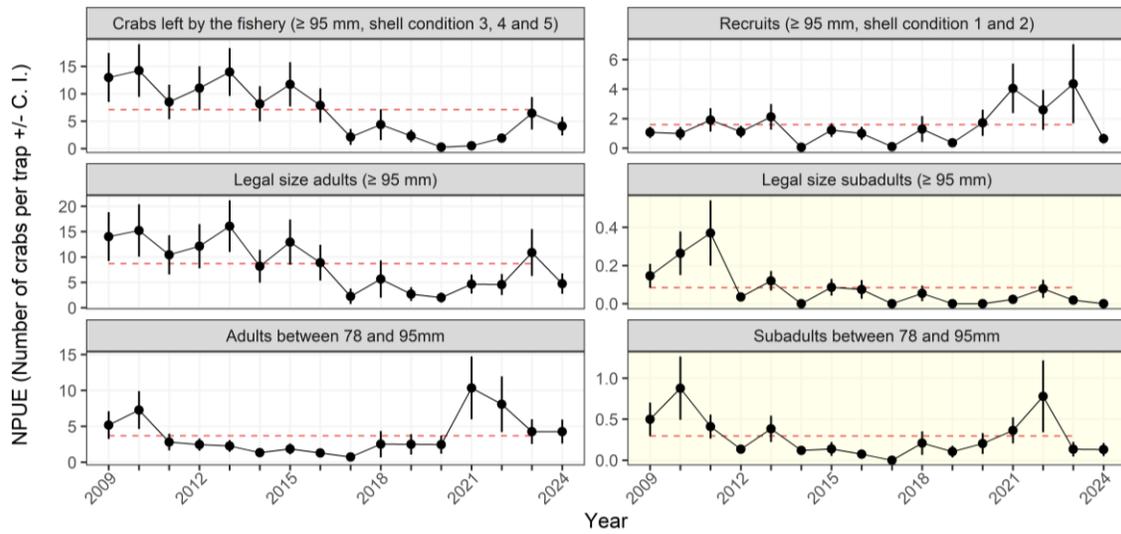


Figure A6.12. Annual catch rates (NPUE) (\pm 95% confidence interval) for various categories of adult (white background) and adolescent (yellow background) crabs from the trap survey in Area 13TN. The dashed line shows the historical average for the time series (excluding the last year).