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Gulf Region

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Science Advisory Report 2023/029

AMERICAN LOBSTER, *HOMARUS AMERICANUS*, FRAMEWORK AND STOCK STATUS IN THE SOUTHERN GULF OF ST. LAWRENCE: LFAS 23, 24, 25, 26A AND 26B

*American Lobster (*Homarus americanus*)*
Credit: Fisheries and Oceans Canada

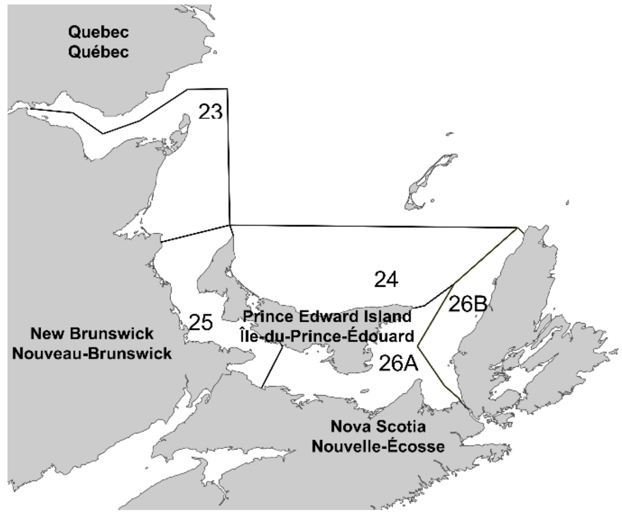

Figure 1. Lobster Fishing Areas in the southern Gulf of St. Lawrence.

Context:

The previous assessment for the southern Gulf of St. Lawrence Lobster stock was completed in 2013 (DFO 2013). The Lobster fishery in this area is an input control fishery, managed entirely using measures that control effort and exploitation and without individual or total allowable catches. A number of management measures have been put in place over the last three decades, including increases to the minimum legal size, the mandatory release of window or maximum size females and reductions in fishing effort, largely with the objective of increasing egg production.

This Science Advisory Report provides an updated framework for the assessment of the American Lobster stock of the southern Gulf of St. Lawrence to 2021-2022 and assesses the stock status based on the reference points (from DFO 2014). This Science Advisory Report is from the March 22-23, 2023, regional peer review on Southern Gulf of St. Lawrence Lobster (LFAs 23, 24,25, 26A,26B). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Preliminary Lobster landings of 39,313 t in 2021 in the southern Gulf of St. Lawrence (sGSL) are well above the Limit Reference Point (LRP, 6,899 t), and approximately 3 times the Upper Stock Reference (USR, 13,798 t) placing the stock within the defined healthy zone of the precautionary approach.
- Since the last assessment (2013), recent estimates of landings, catch per unit effort, and biomass and abundance indicators of commercial-sized Lobster have increased to time series high values.
- Based on a fishery-independent trawl survey conducted in the Northumberland Strait since 2001, Lobster abundance, biomass, and density have increased and their distribution has expanded into a wider range of depths.
- Productivity indicators - pre-recruit abundance, juvenile density, young-of-year density, and egg production - continue to increase or have stabilized at high levels.
- Continued increases in landings and high (> 50%) but largely stable exploitation rates suggest that the stock can likely sustain current levels of exploitation.
- Large decreases in the predator index, mainly due to decreases in groundfish abundance, since the early 2000’s, are indicative of a shift in the ecosystem. Trophic interactions involving Lobster may be changing, and attention should be focused on prey availability to Lobsters (particularly Rock Crab).
- The habitat index analysis showed increases in Lobster habitat in the sGSL, as a result of increases in bottom temperature. While temperature is an important factor in the distribution of Lobsters, additional factors could be considered in the future, including substrate and prey availability.

INTRODUCTION

Background

The last assessment of the American Lobster (*Homarus americanus*) stock for the southern Gulf of St. Lawrence (sGSL) (Lobster Fishing Areas (LFA) 23, 24, 25, 26A, and 26B) was completed in 2013 (DFO 2013; Rondeau et al. 2015). This current assessment relies on fishery-dependent (i.e. landing statistics and at-sea sampling programs) and fishery-independent (i.e. bottom trawl and SCUBA surveys, bio-collector and temperature) data. Indicators of abundance, productivity, fishing pressure and the ecosystem are derived from these data. Current landings are compared to the reference points (DFO 2014) to determine the status of the sGSL Lobster stock.

Species biology

The American Lobster is a large-bodied decapod crustacean found in predominantly coastal habitats in the Northwestern Atlantic Ocean. Lobsters grow indeterminately by moulting their carapace. The moulting period for Lobsters [86-154 mm carapace length (CL)] in the sGSL occurs mostly from early July to early September (Comeau and Savoie 2001). Females generally have a two-year reproductive cycle, whereas mating begins during the summer after the female’s moult while the shell is still soft (Atema et al. 1979; Comeau and Savoie 2002). The eggs are extruded and attached to the underside of the tail the following summer (~ 12 months post-mating) and the clutch is carried for another 10-12 months until the following spring or summer when hatching occurs (Aiken and Waddy 1980; Comeau and Savoie 2002). The hatched larvae enter the water column and are pelagic for three to 10 weeks after which they metamorphose to a stage IV larva and settle to the seafloor. Early benthic and juvenile Lobsters are cryptic and closely associated with burrows or other shelter until they reach 35–40 mm CL (Wahle and Steneck 1991; Lawton and Lavalli 1995).

The sGSL has smaller sizes at maturity than regions with cooler summer temperatures, with a CL of 50% female maturity at 72 mm (Comeau and Savoie 2002, DFO 2016) for most LFAs in the sGSL and 75 mm in LFA 26B (Comeau 2003, DFO 2016). Egg production increases rapidly with female size (Campbell and Robinson 1983; Estrella and Cadrin 1995).

There are few predators of adult Lobster, but larval and juvenile benthic Lobsters are prey for elasmobranchs, groundfish, pelagic fish and other invertebrates (mainly conspecifics and crabs) (Hanson et al. 2014, Boudreau et al. 2015). Lobster actively prey at different trophic levels and are considered omnivorous (Hanson 2009; Boudreau and Worm 2012). Rock Crab (*Cancer irroratus*) are a key diet item for Lobster (Gendron et al. 2001), and were the most commonly identified species in the stomachs of Lobsters > 40 mm CL in Northumberland Strait (Hanson et al. 2014).

Fishery

The Lobster fishery in the sGSL is managed entirely by effort controls including a limited number of fishing licences, individual trap allocations, restrictions on gear characteristics, and a fixed fishing season. Increases in minimum legal size (MLS) have been implemented since 1987, with the main objective of increasing egg production, as recommended in two reports by the Fisheries Resource Conservation Council (1995, 2007). Additional measures to increase egg production include the release of females within a defined size range (i.e. window-size) or above a defined size (i.e. maximum-size) in some LFAs.

There are two Lobster fishing seasons in the sGSL; the spring fishery [LFA 23, 24, 26A and 26B] that takes place mostly during the months of May and June, and the summer/fall fishery (LFA 25) generally operating from August 9 or 10th to October 9-10th. A portion of LFA 26B (referred to as LFA 26B North) has a slightly later spring season (e.g. May 7 to July 7 in 2022, DFO 2022).

ASSESSMENT

For this assessment, two regions were used in LFA 23, 23bc (i.e. 23 “Baie des Chaleurs”) and 23g (i.e. 23 “Gulf”), for areas within Baie des Chaleurs and outside the bay, respectively, to capture the geographical differences between these two portions of LFA 23 (Figure 2). In other LFAs (i.e. 24, 25, 26A and 26B), the entire fishing area is used as the assessment region. An indicator-based approach is used, with indicators of abundance, productivity, fishing pressure and the ecosystem. Indicators were estimated by assessment region and, where appropriate, for the sGSL as a whole.

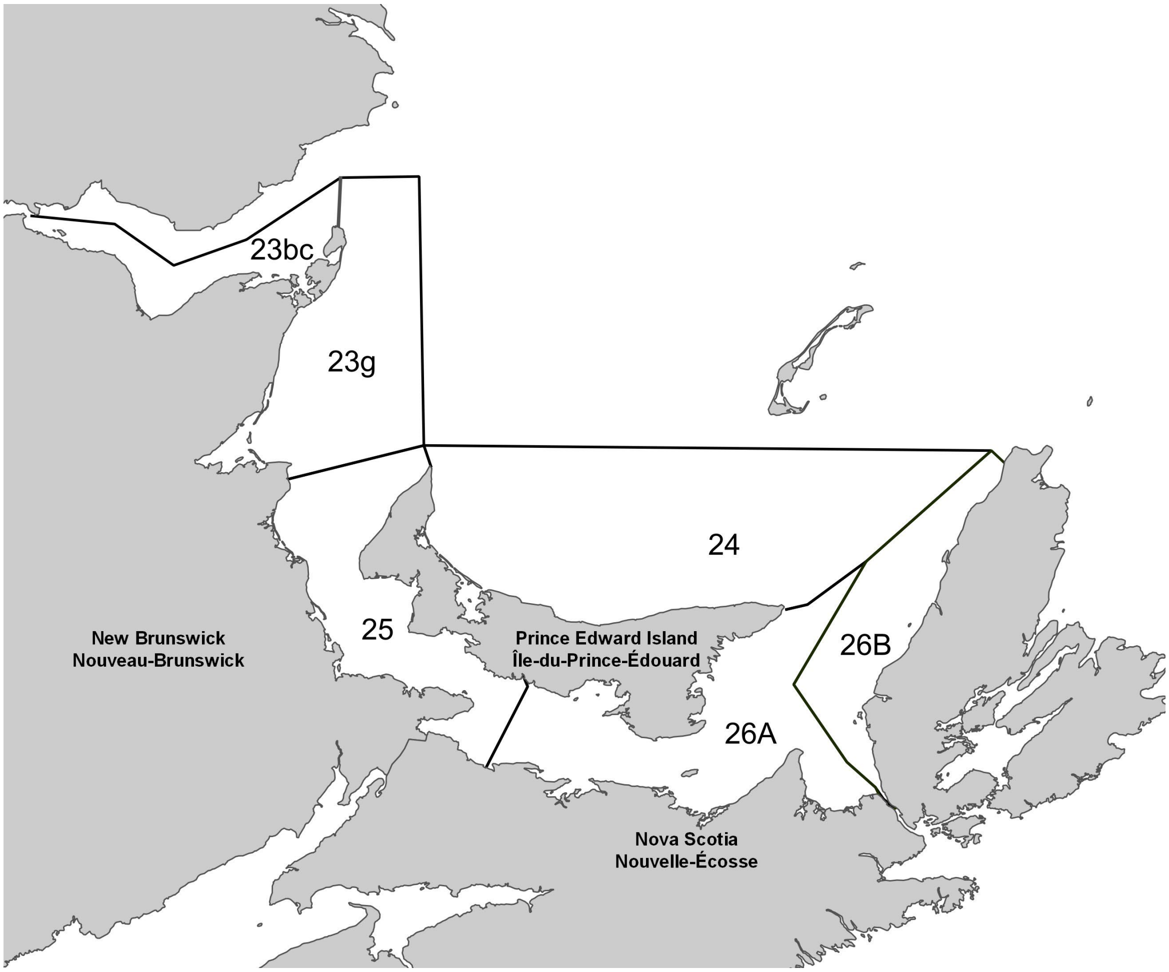

Figure 2. Map of regions used in southern Gulf of St-Lawrence American Lobster stock assessment.

Abundance indicators

Two fishery-dependent [i.e. landings and catch per unit effort (CPUE)] and one fishery-independent (trawl survey biomass) abundance indicators were estimated.

Landings were totaled by assessment region (1968-2021), by LFA (1947-2021) and for the sGSL as a whole (1892-2021) using data on sales transactions. Total preliminary landings of 39,313 t in 2021 in the sGSL are well above the Limit Reference Point (LRP, 6,899 t), the Upper Stock Reference (USR, 13,798 t) and the proxy for Biomass at Maximum Sustainable Yield (BMSY, 17,247 t) (Figure 3, as defined in DFO 2014), placing the stock within the defined healthy zone. Landings in each LFA have increased and were above the long-term (1947-2021), mid-term (1968-2021) and short-term (2012-2021) median landings in 2021 (Figure 4). Landings in 23bc were below the short-term median landings from 2019 to 2021 (Figure 5).

Lower landings in 2020 in LFAs 23, 24, 26A and 26B are considered to be the result of a 2- week delay in the season start (season opening on May 15), and a coincidental 2- week reduction in season length (DFO 2020), due to the COVID-19 pandemic.

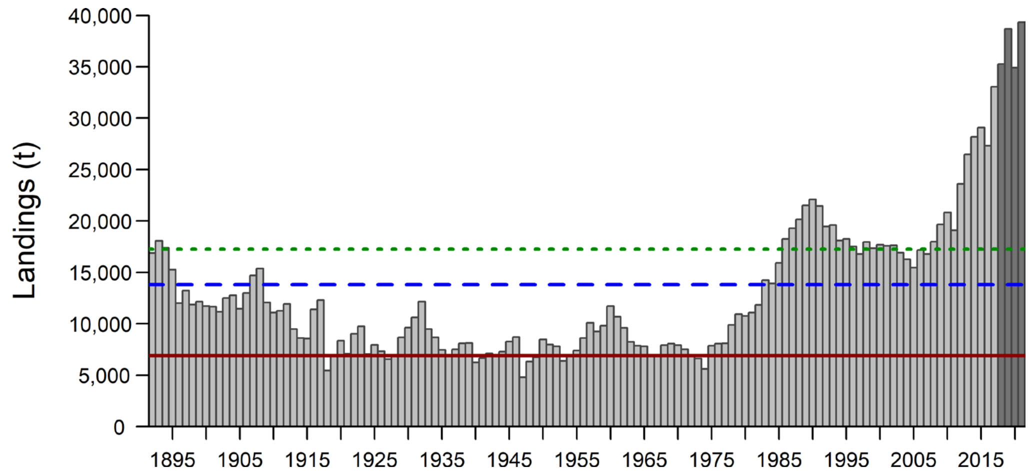

Figure 3. Reported Lobster landings (t) in the southern Gulf of St. Lawrence (DFO Gulf Region) from 1892 to 2021. The red solid line, the blue dashed line and the green dotted line represent the limit reference point (6,899 t), the upper stock reference (13,798 t) and the proxy for biomass at maximum sustainable yield (17,247 t), respectively, for the sGSL Lobster fishery (DFO 2014). Data added since the last update (2018 to 2021) are in a darker grey shading. Data for 2021 are preliminary.

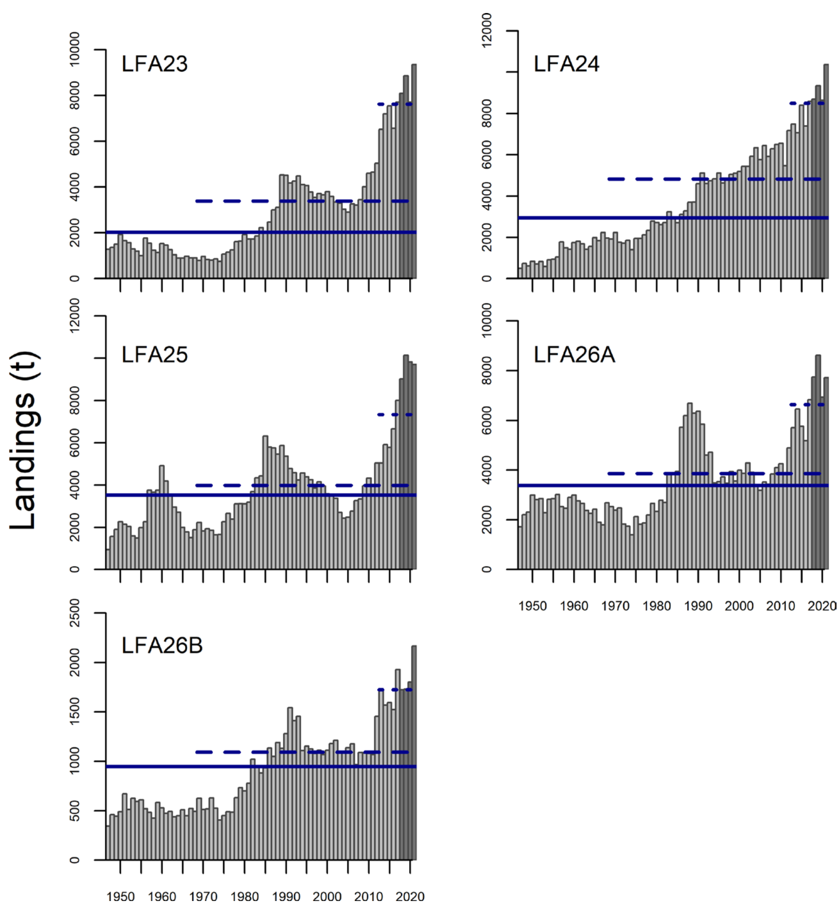

Figure 4. Reported Lobster landings (t) by Lobster Fishing Area (23, 24, 25, 26A, 26B) in the southern Gulf of St. Lawrence, 1947 to 2021. The solid line, the dashed line and the dotted line represent the median long-term (1947-2021), mid-term (1968-2021) and short-term (2012-2021) landings, respectively. Data added since the last assessment update (2018-2021) are in a darker grey shading. Data for 2021 are preliminary.

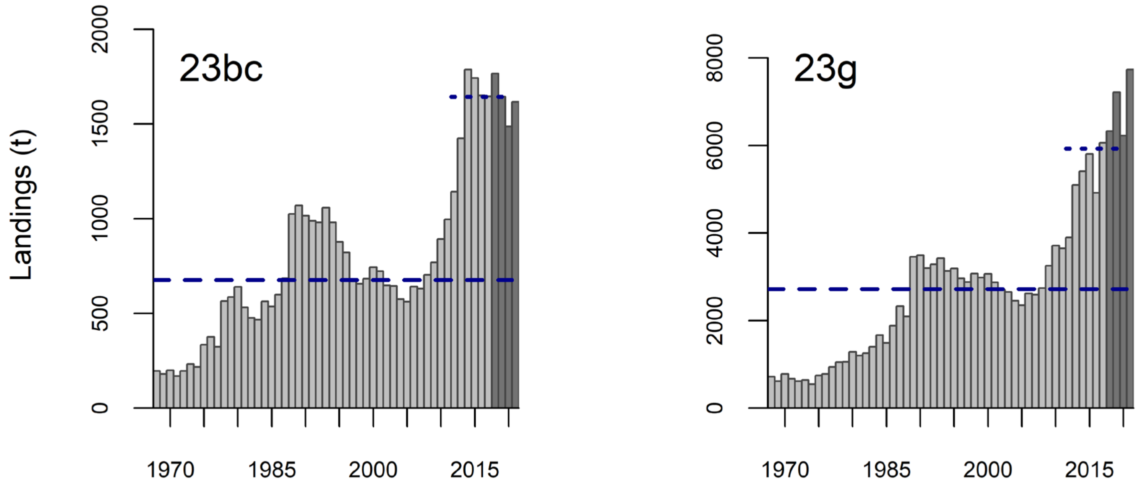

Figure 5. Reported Lobster landings (t) in assessment regions 23bc and 23b in the southern Gulf of St. Lawrence, 1968 to 2021. The dashed line and the dotted line represent the median mid-term (1968-2021) and short-term (2012-2021) landings, respectively. Data added since the last assessment update (2018-2021) are in a darker grey shading. Data for 2021 are preliminary.

CPUE (kg/trap) of commercial Lobsters was estimated using four different methods: one using data from an at-sea sampling program, one using data from a recruitment-index program and two using data from logbooks and sales slips (available for 2014 to 2020 only). For the at-sea sampling program data and recruitment-index program data, average seasonal CPUEs were calculated for each assessment region. CPUEs were calculated by converting length measurements to weights. For recruitment-index program data, where sizes are grouped by 5 to 10 mm bins, the mid-size of the bin was used. Two CPUEs were estimated from logbook data: unstandardized annual weekly maximums and standardized annual daily maximums. All methods show increases in CPUEs over the time series (2001 to 2022, Figure 6) and, where multiple sources of data are available, temporal trends are generally consistent between methods. In all assessment regions, the highest standardized CPUE estimates were in 2020 at 1.4, 1.4, 1.6, 2.7, 2.5 and 2.3 kg/trap in 23bc, 23g, 24, 25, 26A and 26B, respectively. While CPUEs in 2020 may have been impacted by the later start to the fishing season in LFAs 23, 24, 26A and 26B related to the COVID-19 pandemic (DFO 2020), in all assessment regions, 2019 had the second highest standardized CPUE estimates. Since 2020, CPUE estimates from at-sea sampling program data have decreased in 23bc, 23g and 25, to 0.9, 0.8 and 1.5 kg/trap in 2022, respectively. Similarly, in 26A, CPUE estimates from recruitment-index program data are showing a decrease to 1.5 kg/trap in 2022. As logbook data were unavailable for 2021 to 2022, it is not possible to compare these values to those that would have been obtained from logbook data.

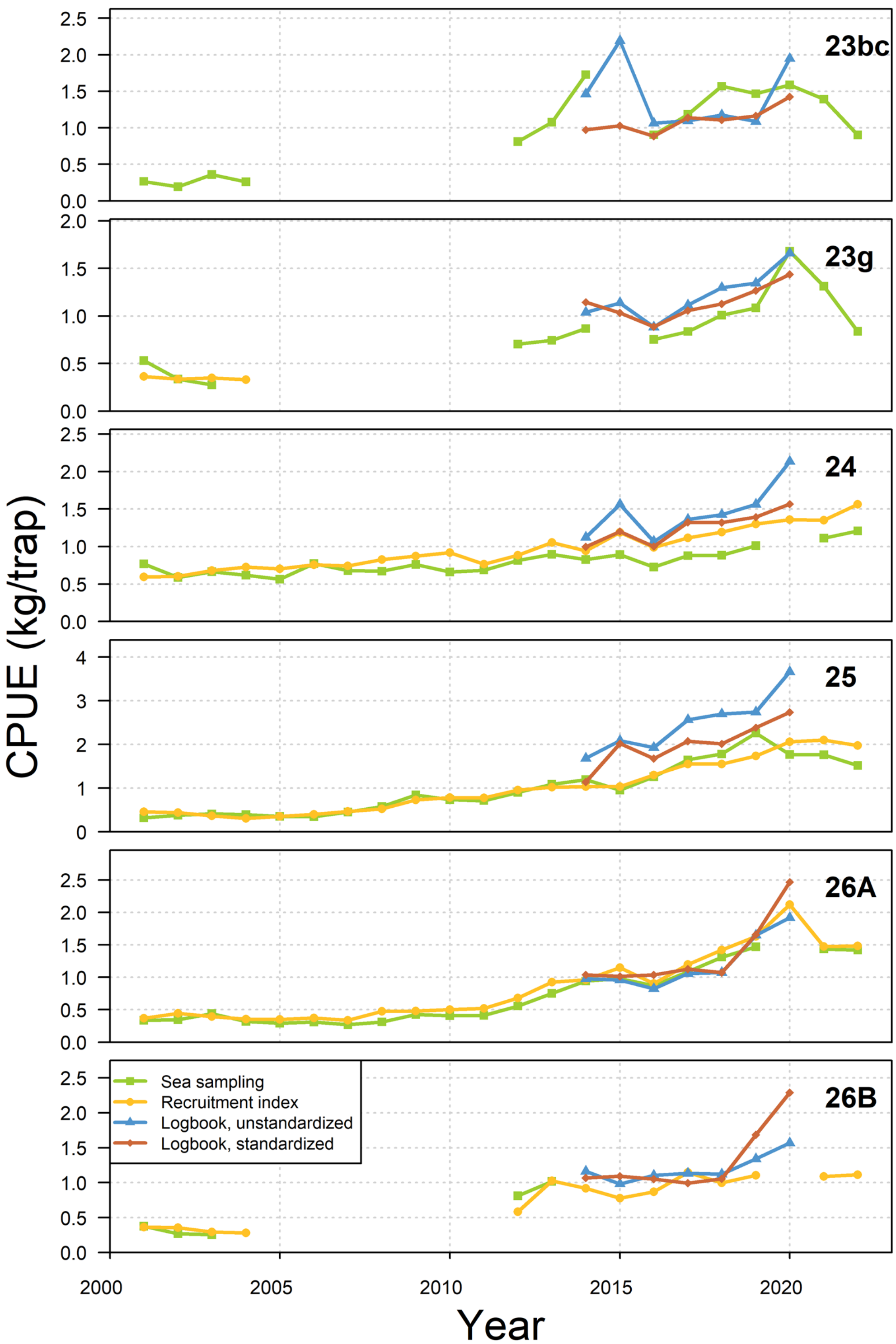

Figure 6. Catch per unit effort (CPUE, kg/trap) of commercial Lobsters estimated from at-sea sampling data, recruitment-index program data and logbook data, 2001 to 2022. CPUE estimates from at-sea sampling data and recruitment-index program data are seasonal averages, unstandardized logbook CPUEs are maximum weekly averages and standardized logbook CPUEs are modelled maximum daily averages.

Data from a fishery-independent multi-species bottom trawl survey in Northumberland Strait (Asselin et al. 2021) were used to estimate pre-fishery and post-fishery biomass in 25 and 26A, respectively. Lobster biomass indices were estimated using a spatio-temporal model. The biomass of commercial Lobsters (Figure 7) has increased over the time series (2001 to 2022) reaching maximum values in 2022. In 25, the biomass of commercial Lobster was 15,700 t (95% CI 9,400-26,300 t) in 2022. In 26A, the biomass of commercial Lobster was 15,600 t (95% CI 9,400-25,900 t) in 2022. The increases in biomass are the result of a combination of increases in both density and distribution within 25 and 26A (Figure 8).

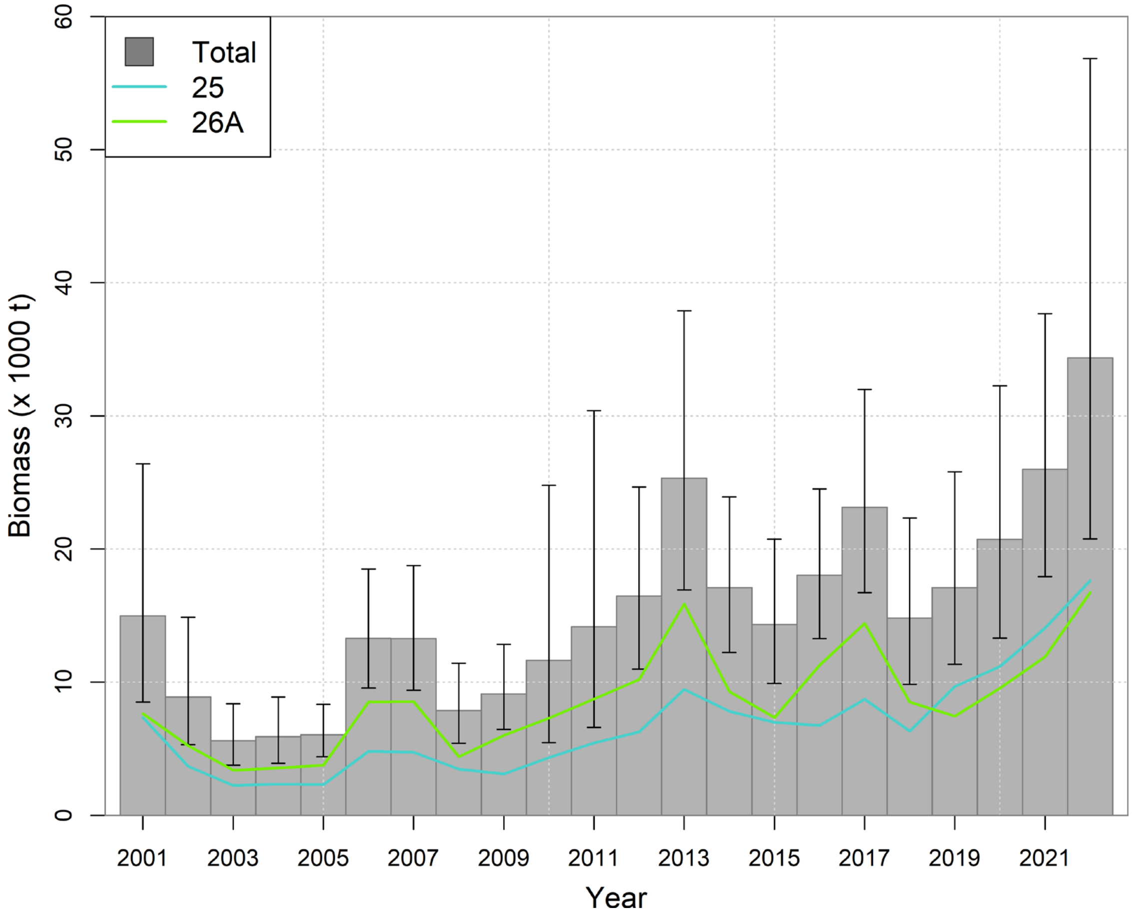

Figure 7. Estimated biomass of commercial Lobsters in LFAs 25 and 26A, 2001 to 2022. Confidence intervals for total commercial biomass are indicated by black lines on each bar.

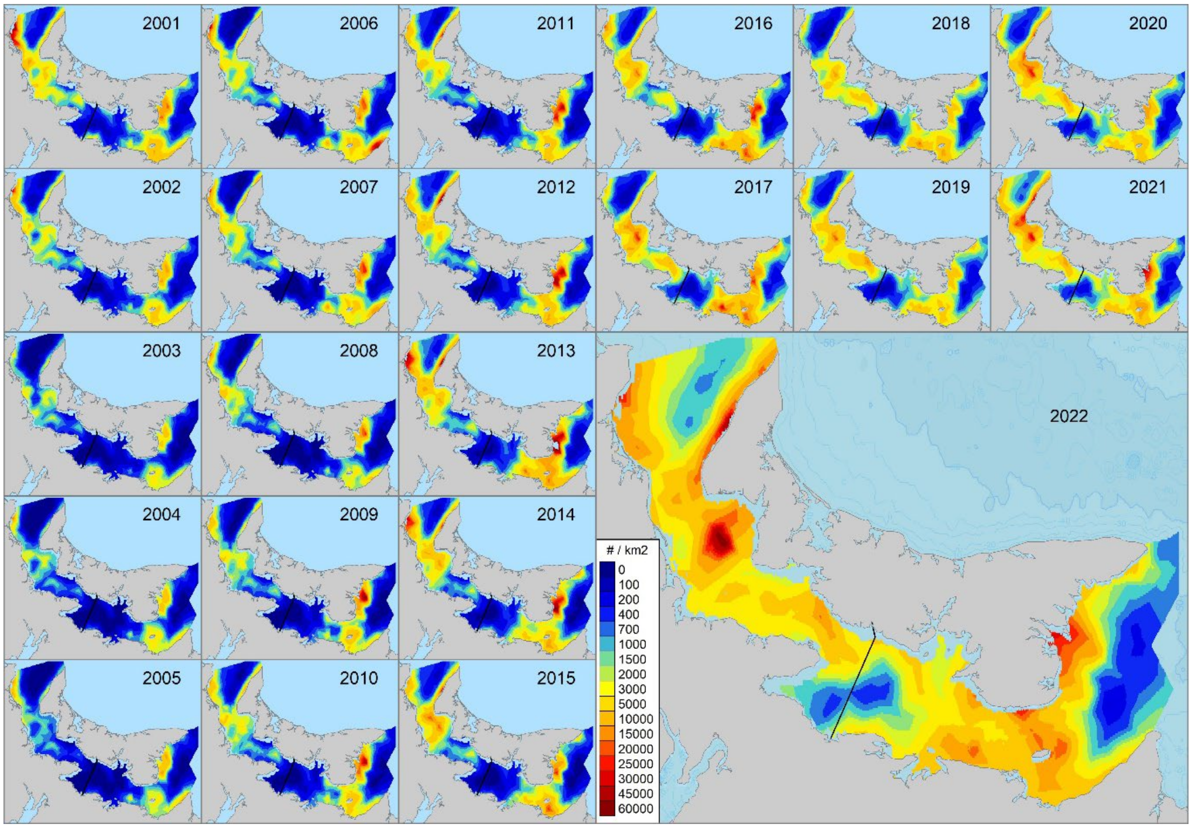

Figure 8. Estimated density of commercial Lobsters (number per km^2) in LFAs 25 and 26A, 2001 to 2022.

Productivity indicators

Five productivity indicators were estimated: CPUE of one-year pre-recruits in the recruitment-index program (traps with blocked escape vents), one-year pre-recruit abundance in the Northumberland Strait multi-species bottom-trawl survey, juvenile Lobsters in SCUBA surveys, young-of-year (YOY) Lobsters in bio-collectors and egg production.

Both pre-recruit indicators show a period of lower abundance from 2001 to 2012, followed by increases (Figure 9). In 25 and 26A, the increases in abundance are the result of a combination of increases in density and increases in distribution (Figure 10).

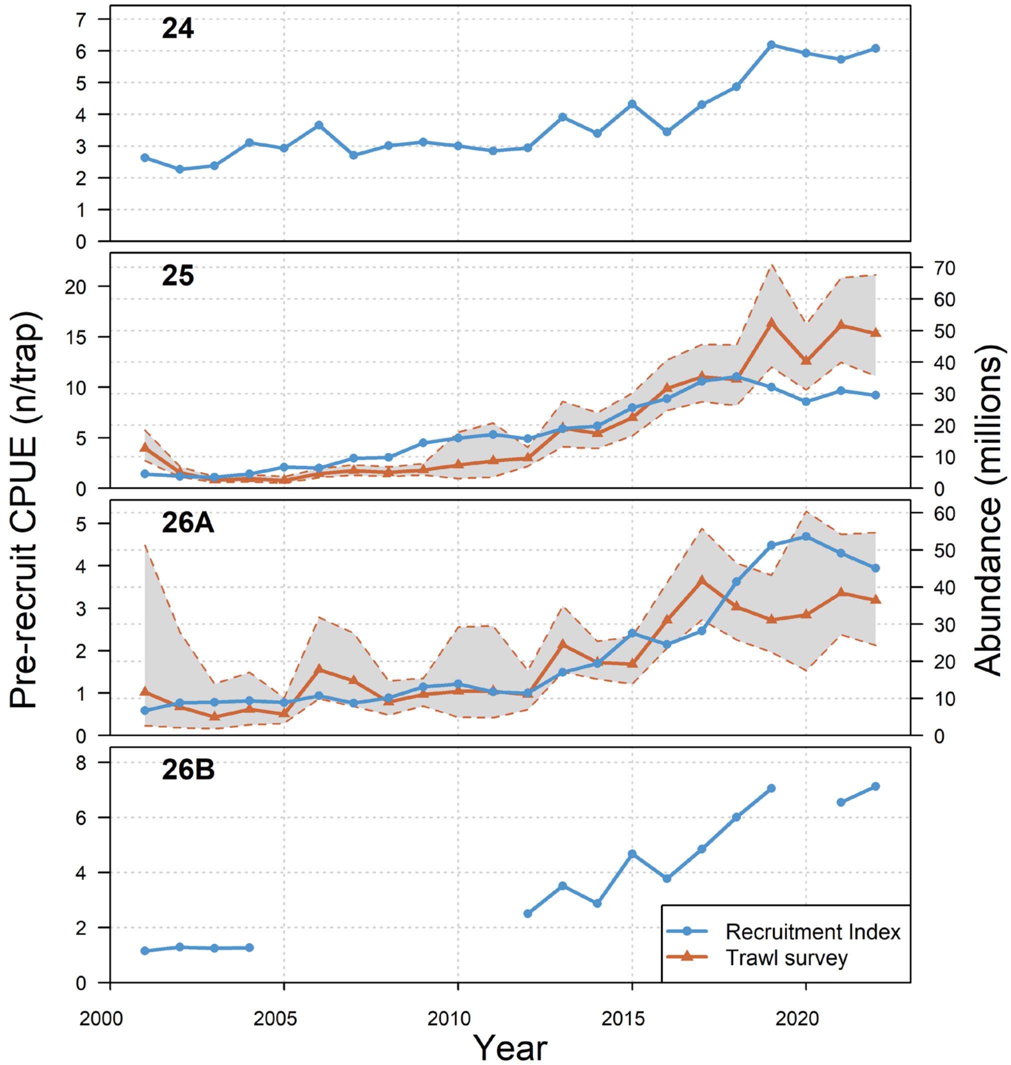

Figure 9. Catch per unit effort (n/trap) of one-year pre-recruit Lobsters in the recruitment-index program (left axis) and estimated abundance (millions) of one-year pre-recruit Lobsters in LFAs 25 and 26A (right axis) from the Northumberland Strait multi-species bottom trawl survey, 2002 to 2022. Confidence intervals for the survey estimate are indicated by the grey area above and below the red line.

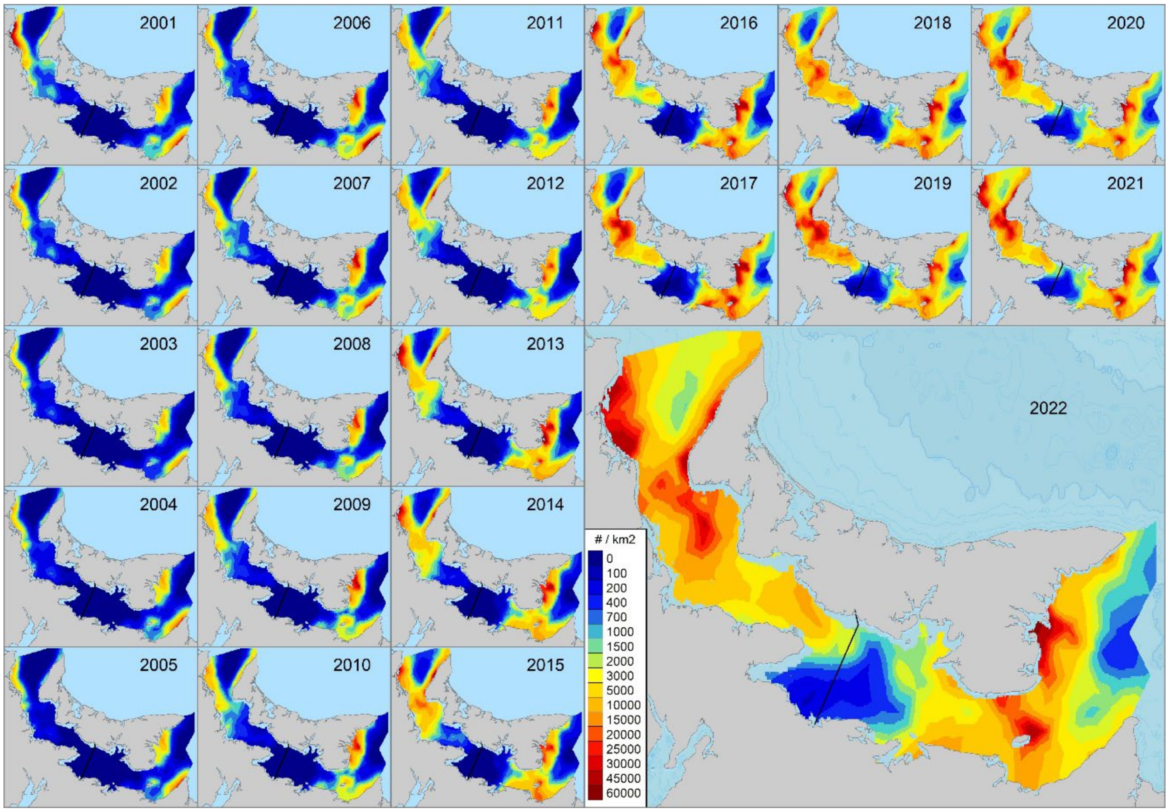

Figure 10. Estimated density of one-year pre-recruit sized Lobsters (number per km^2) in LFAs 25 and 26A, 2001 to 2022.

Juvenile Lobster (21-40 mm CL) densities in the SCUBA survey (2003-2022) showed steady or exponential increases at each of the nine sampling sites over the first half of the time series followed by steadying or decreasing densities in recent years (Figure 11). Densities are highest at the Pointe-Verte (23bc), Caraquet (23bc), Richibucto (25) and Cocagne (25) sites, but are generally much lower in the southernmost sites, with the lowest being Fox Harbour (26A). Murray Corner (25), Fox Harbour (26A) and Toney River (26A) show some signs of having reached peak densities in 2015 and 2014, respectively, but subsequently declining in recent years. Cocagne (25) and Shediac (25) both show marked increases in densities around 2014, which have remained high since. Only Richibucto (25) shows a seeming sustained gradual increase over the study period.

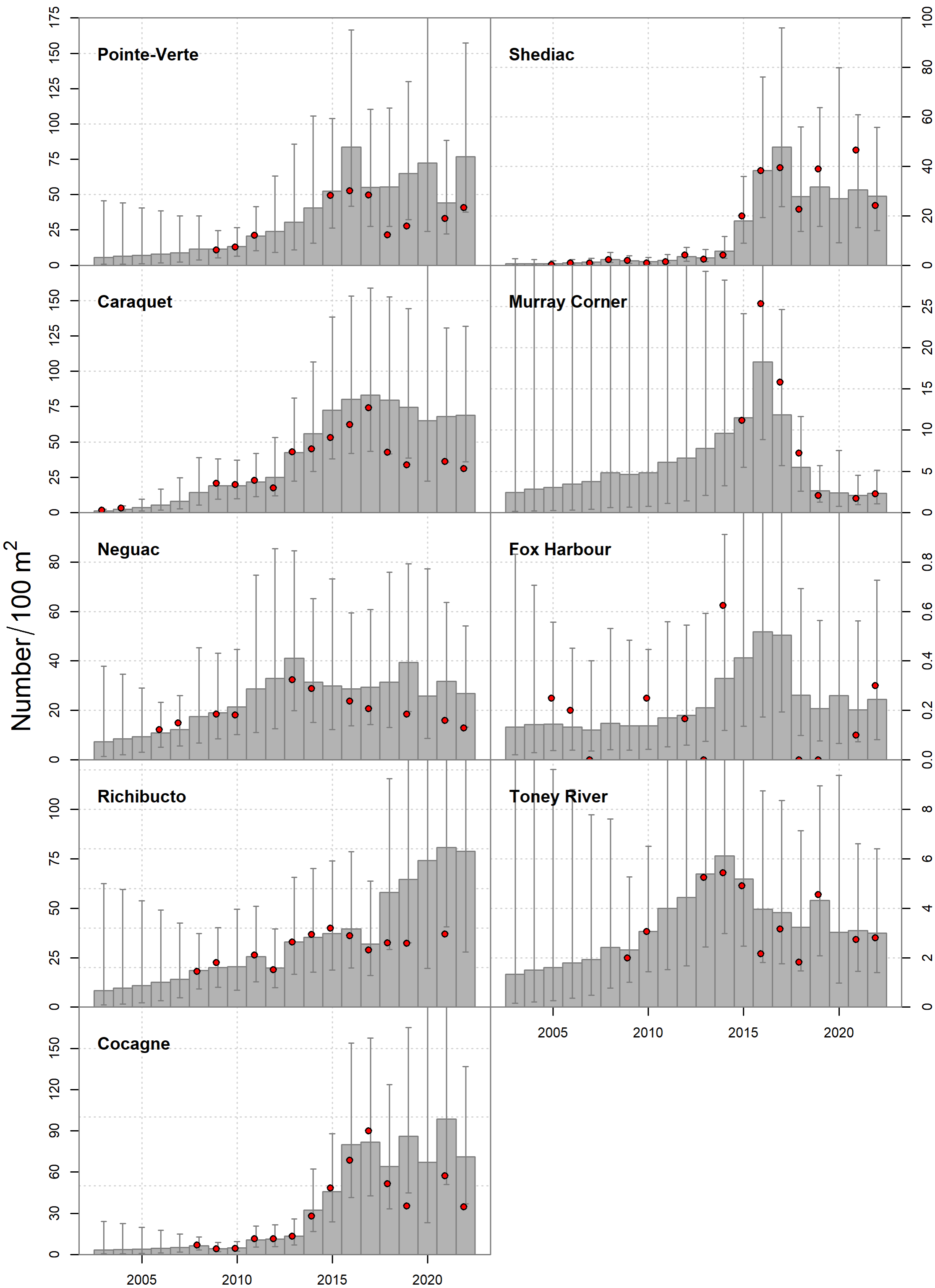

Figure 11. Time series of Lobster recruitment indices by study site from the SCUBA transect analysis, 2003 to 2022. Confidence intervals (95%) are shown as vertical black bars. Red circles show observed means. Grey bars without a red circle are interpolated by the model. Note: the range of values for the y-axis is defined for each study site.

YOY Lobsters were observed consistently at six of the eight bio-collector sites (Figure 12). Higher densities, and increases in densities, were observed at sites along the northern and northwestern coasts of PEI [i.e. Alberton (24), Covehead (24) and Skinner's Pond (25)] and lower densities are observed at sites within western [i.e. Cape Egmont (25)] and eastern [i.e. Fortune (26A) and Murray Harbour (26A)] portions of Northumberland Strait. In central Northumberland Strait, a single YOY was detected twice over the time series in Nine Mile Creek (26A), in 2009 and 2014, and none have been observed in the four years of sampling in Wallace (26A).

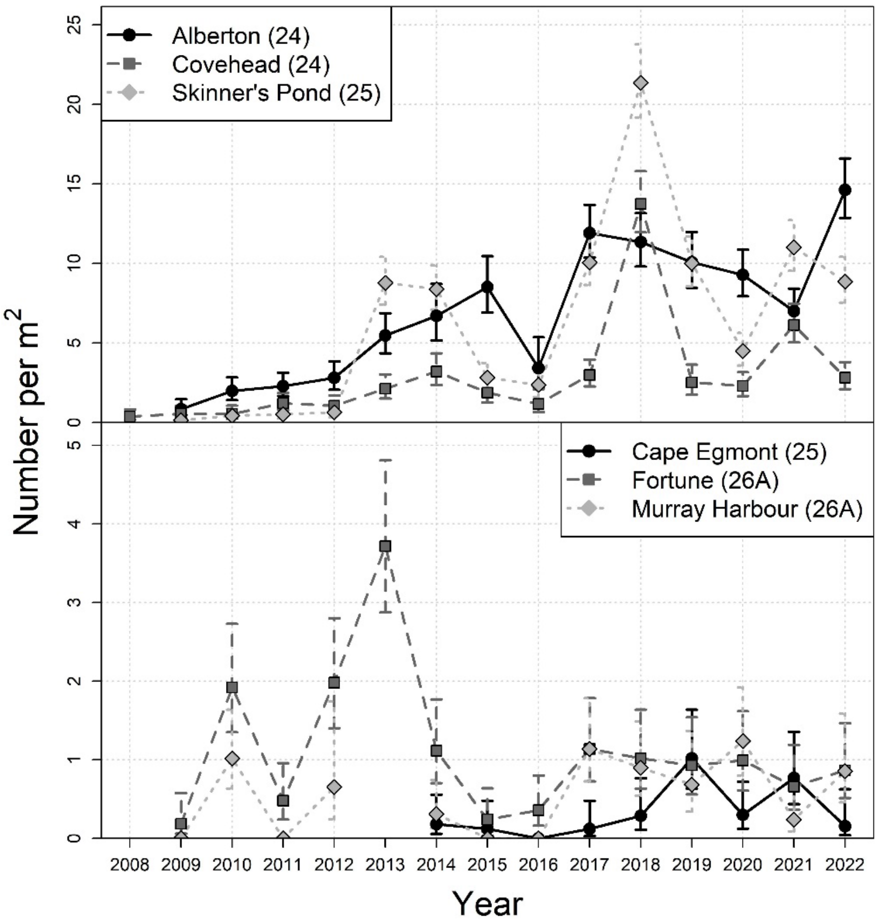

Figure 12. Density of young of the year (YOY) Lobsters in bio-collectors at eight locations in the LFAs 24, 25 and 26A in the southern Gulf of St. Lawrence, 2008 to 2022.

Despite large inter-annual variability, three independent datasets (i.e. at-sea sampling program, recruitment-index program and Northumberland Strait survey), and two analytical approaches (i.e. one based on berried females and one based on all females) yielded similar trends for egg production, as an estimate of the billions of eggs produced annually. While increases were observed in all assessment regions over the time series (Figure 13), there is large inter-annual variability in the results from at-sea sampling program data in 23bc and 23g and from the recruitment-index program data in 26B. In 24, 25 and 26A, where multiple data sets were available, the increasing trend is prevalent.

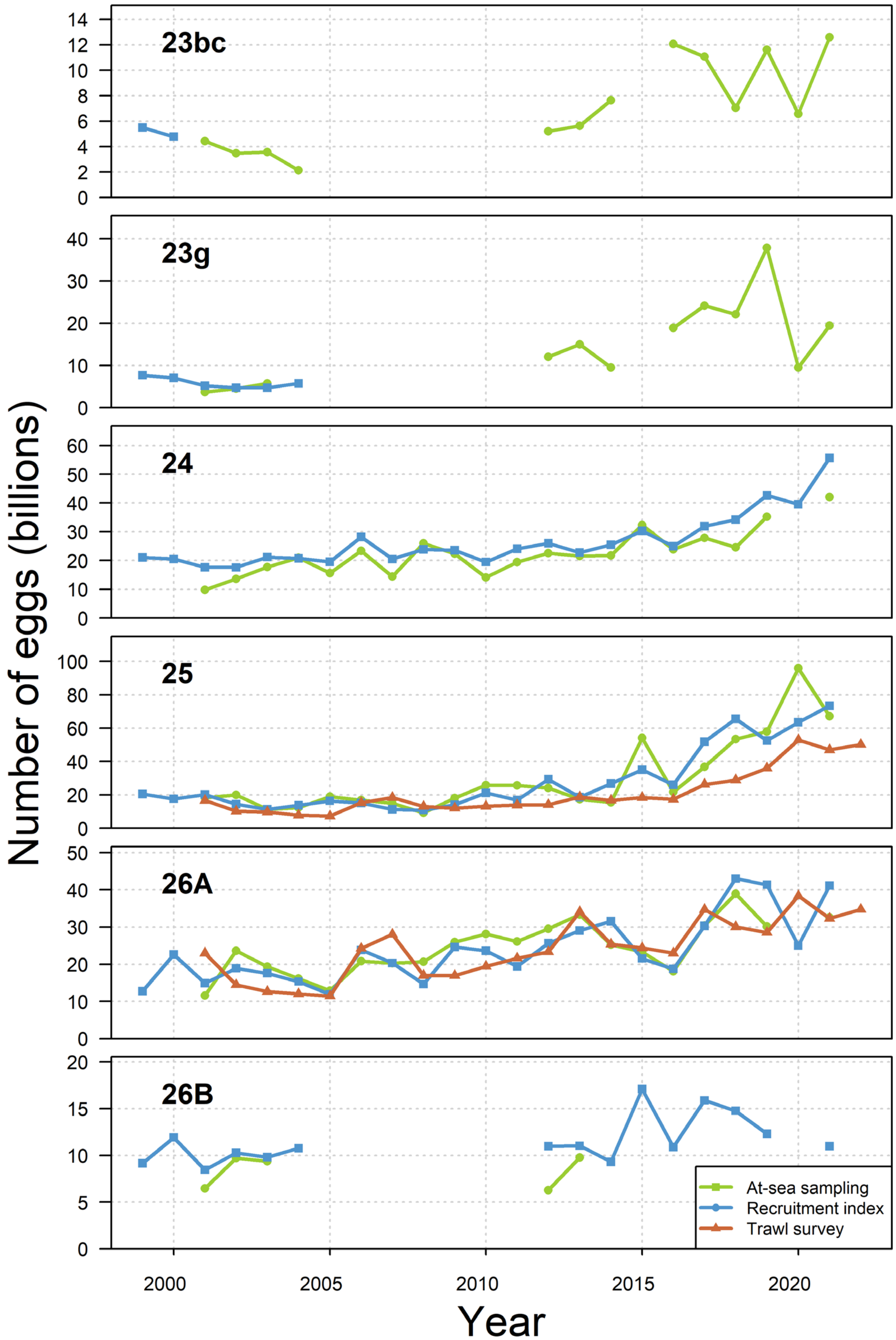

Figure 13. Egg production based on at-sea sampling data, recruitment-index program data and Northumberland Strait multi-species bottom trawl survey data per assessment regions 23bc and 23g and LFA 24, 25, 26A and 26B, 1999 to 2022.

Fishing pressure indicator

Exploitation rates were estimated using data from the recruitment-index program. The change in the ratios of legal sized and sub-legal sized Lobsters over the course of the fishing season was modelled to produce the estimate. A three-year rolling average was applied to the annual results.

Data were not available to calculate exploitation rates in 23bc and 23g after 1999 and 2004, respectively. In all other areas, average exploitation rates are high (> 50%) in all years and annual results are variable (Figure 14). Over the time series (1999 to 2022), 24 had the highest exploitation rates, decreasing slightly over the time series while 25 generally had the most variable and lowest exploitation rates. An increase in exploitation rates in 26A is seen over the time series, from 65 – 70% in the early 2000s to above 80% in recent years. Fewer years of data were available in 26B making it difficult to interpret trends. Three-year average exploitation rates (2020-2022) for 24, 25 and 26A were 80%, 51% and 83%, respectively. In 26B, sampling was not completed in 2020 and a three-year average exploitation rate could not be calculated for 2020-2022. Annual estimates in 26B are 81% in 2021, and 75% in 2022.

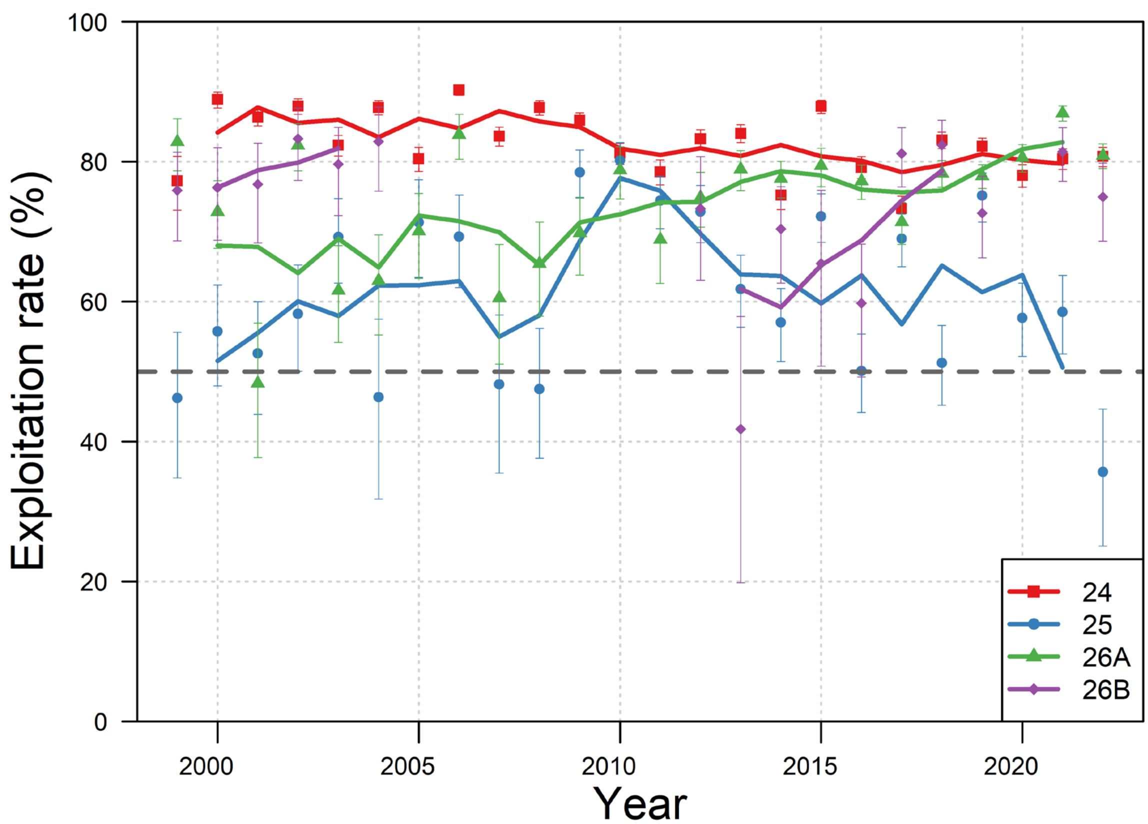

Figure 14. Exploitation rates in LFAs 24, 25, 26A and 26B, 1999 to 2022. The vertical lines represent the 95% credibility intervals. The solid lines represent the three-year rolling averages of the annual results.

Ecosystem indicators

Prey availability, predator pressure and habitat suitability were evaluated.

For prey availability, densities of small (i.e. ≤ 45 mm carapace width or length) Rock Crab and Lobster, and Cunner (*Tautogolabrus adspersus)*, were estimated using bio-collector data. Prey availability varied between sites and inter-annually within each site (Figure 15). Prey densities were highest in Alberton and Covehead (both in 24) but have decreased since 2016-2017, largely as a result of decreases in Rock Crab density. Prey densities were lowest in Wallace (26A).

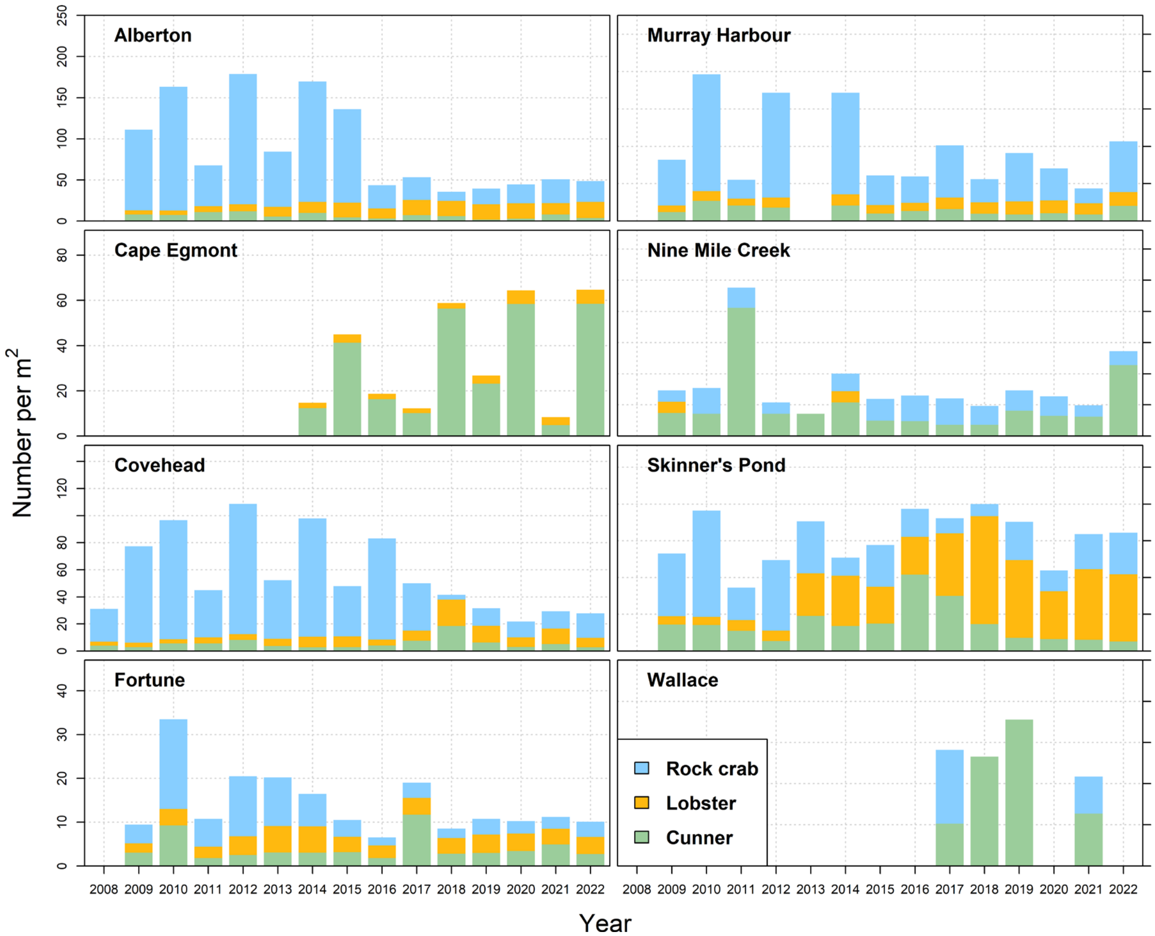

Figure 15. Density of Cunner, small Rock Crab and Lobster in bio-collectors at eight locations, 2008 to 2022. Note: the range of values for the y-axis is defined for each study site.

A predator index was estimated using data from a multi-species bottom trawl survey held annually in September in the sGSL (Ricard et al. In press). An array of possible predators of larval and benthic Lobster found in the dataset were included. From the start of the survey time series in 1971, large decreases in the predator index were seen up until the early 2000s, driven by decreases in groundfish densities over that period (Figure 16). Decreases in the densities of Spiny Dogfish (*Squalus acanthias*) since 2003 are also evident, and modest increases in densities of pelagic fish [i.e. Rainbow Smelt (*Osmerus mordax*), Atlantic Mackerel (*Scomber scombrus*)].

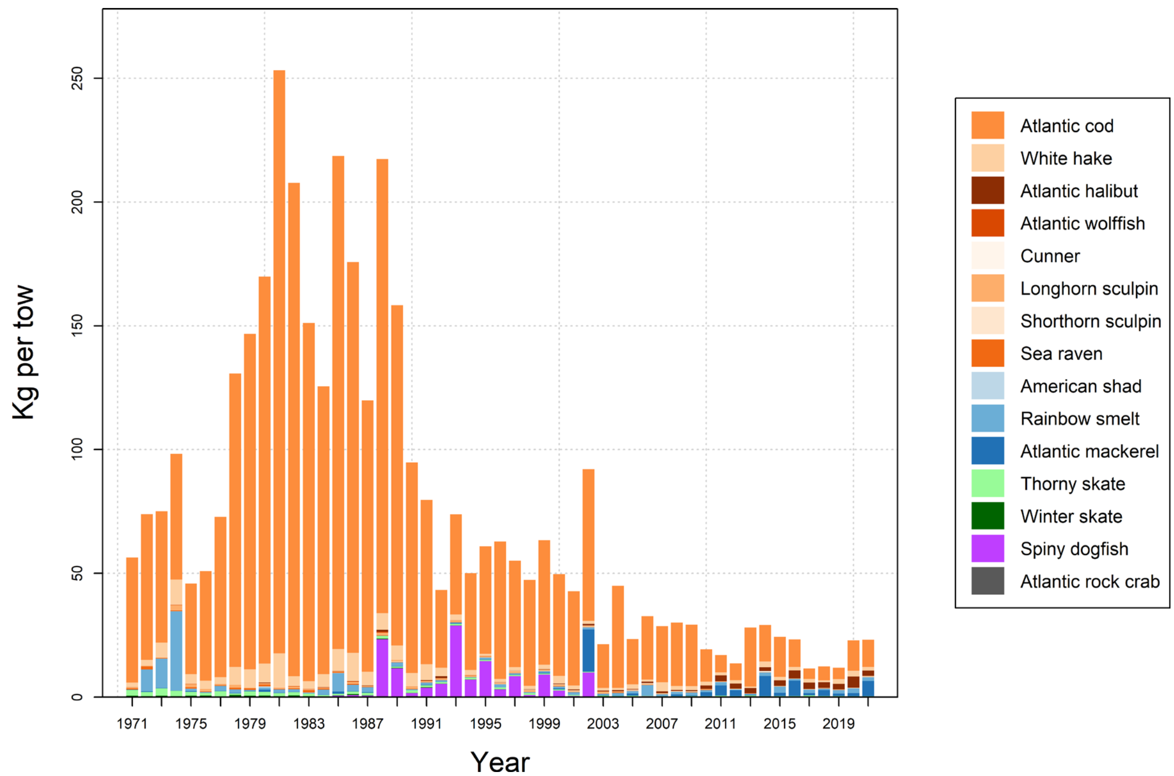

Figure 16. Total average annual catch (kg/tow) of Lobster predators in the September ecosystem survey, 1971 to 2021

Following Chassé et al. (2014), the time series of average bottom temperature within the statistical district boundaries in each assessment region, as well as over the full assessment regions, were derived from June and September scientific survey temperature data. Using landings by statistical district, 95% of the Lobsters were caught in areas with bottom water temperatures between 0.4 and 14.0 °C in June and between 3.3 and 18.0 °C in September. Applying these temperature ranges, the temperature habitat potentially suitable for Lobster has been expanding in June (1985-2020) by an average of 585 km^2/yr, with expansion mostly occurring in the deeper portions of the sGSL that are connected to the Laurentian Channel (Figure 17). Deep waters in this region have shown consistent warming since 2009 (Galbraith et al. 2022). In September, temperature habitat potentially suitable for Lobster has not increased significantly over the time series (1985-2020) but coastal areas and Northumberland Strait have warmed (Figure 18).

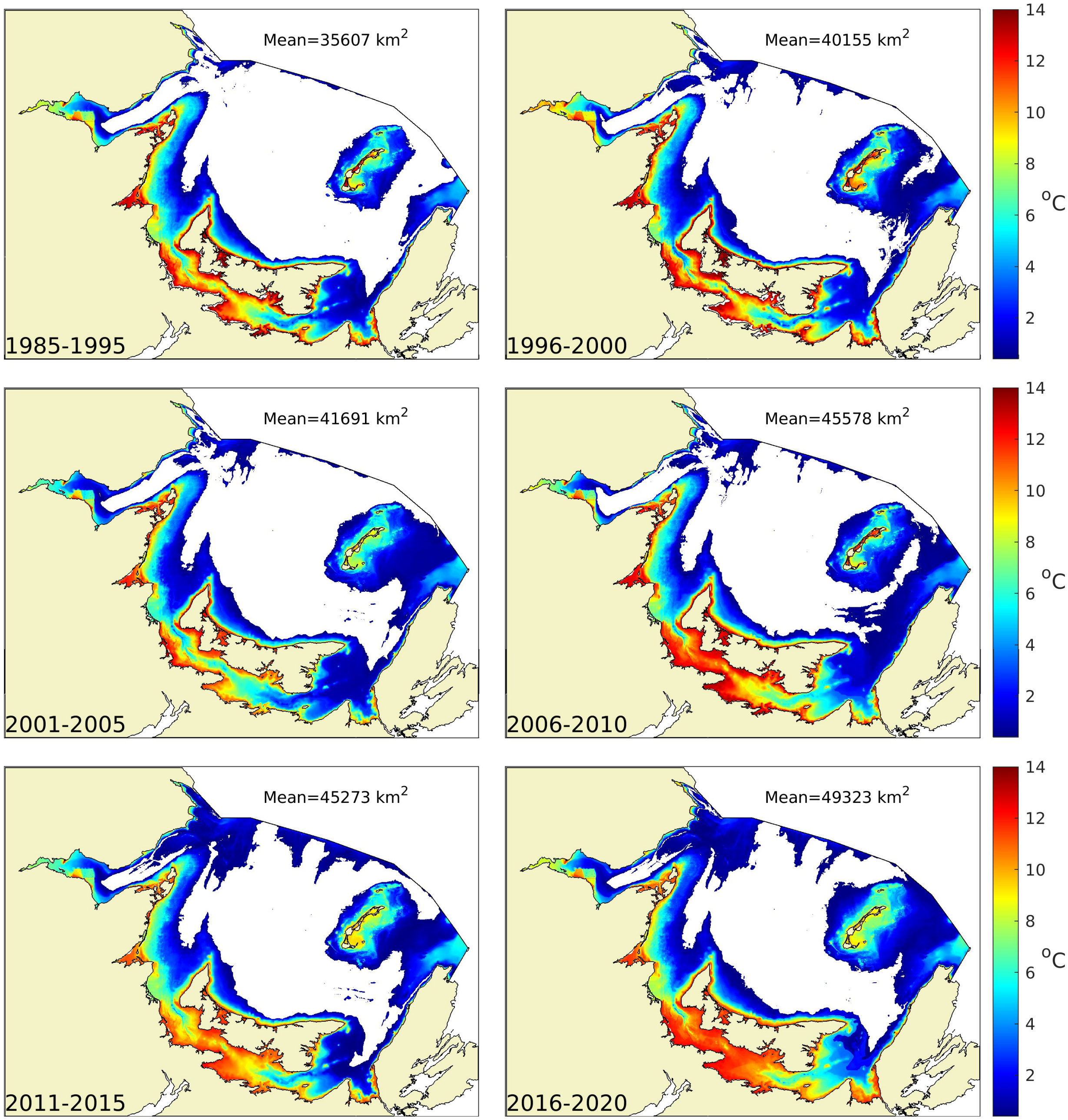

Figure 17. Spatial extent of available Lobster habitat surface area (km^2) in June in the southern Gulf of St. Lawrence for six time periods. The temperature range is 0.4 °C - 14.0 °C.

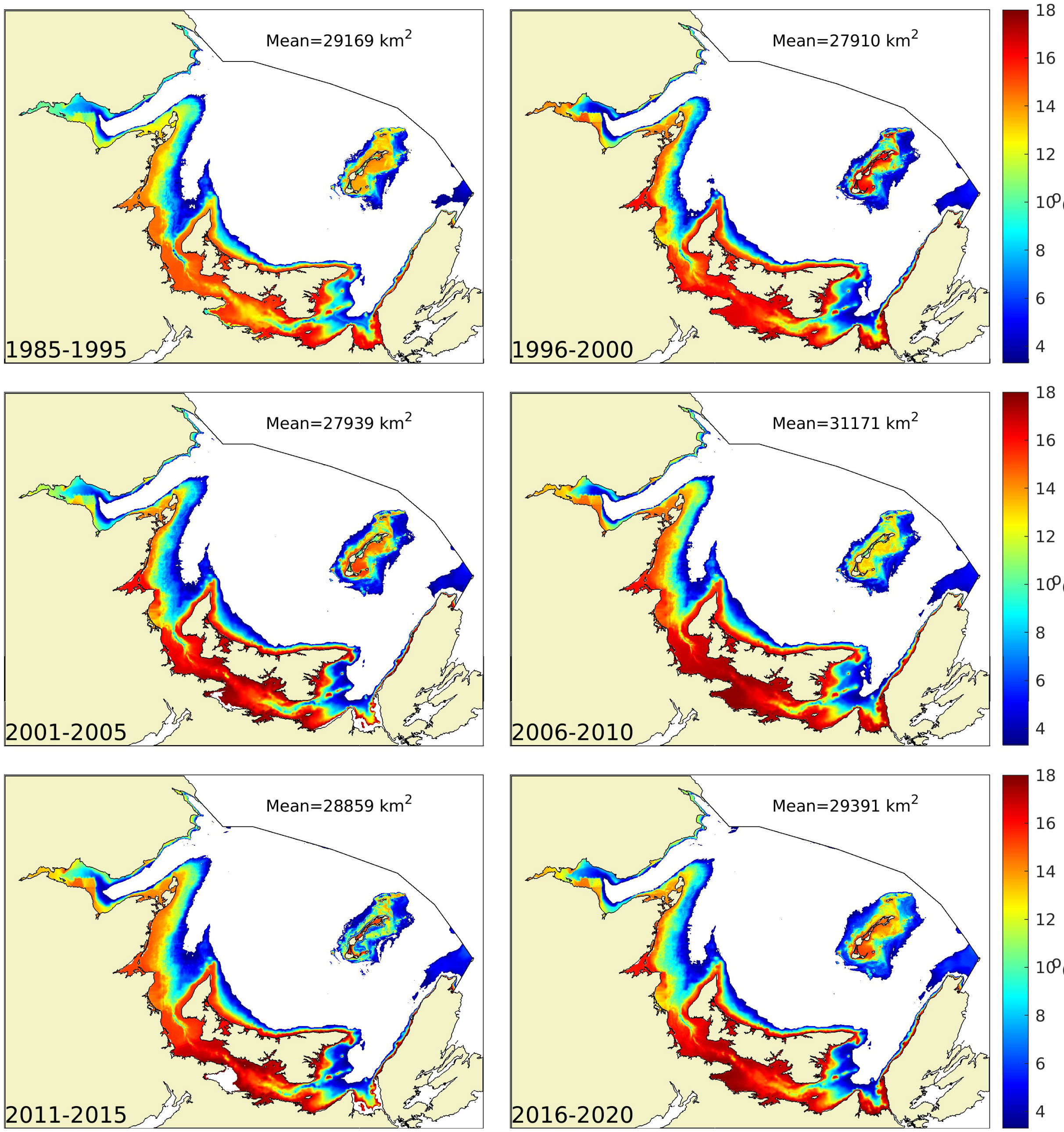

Figure 18. Spatial extent of available Lobster habitat surface area (km²) in September in the southern Gulf of St. Lawrence for six time periods. The temperature range is 3.3 °C – 18.0 °C.

Sources of Uncertainty

The indicators presented are from multiple sources of data, each with their own caveats. Fishery-dependent data and monitoring activities (e.g. landings, at-sea sampling program, recruitment-index program) are impacted by changes in the fishery including those resulting from changes in regulations or socio-economic factors. For example, a delayed start to the fishing season in 2020 in LFAs 23, 24, 26A and 26B due to the COVID-19 pandemic (DFO 2020) may partially explain the higher CPUE estimates in those regions, as Lobster catchability generally increases as water temperature increases in the spring. For the fishery-independent data sources, sampling can be restricted to small areas (e.g. SCUBA and bio-collectors) and/or only be completed in a portion of the sGSL (e.g. Northumberland Strait survey).

For the predator indicator, an array of potential predators of larval and benthic Lobster found in the September trawl survey dataset were included, but the effects of changes in predator abundance on the Lobster stock were not evaluated. Any interpretation of trends in the predator index would need to include careful consideration of biases this approach entails, particularly for species found in habitats with low Lobster densities.

For the Lobster habitat analysis, only temperature was considered while other ecosystem variables (e.g. substrate, depth) also contribute to habitat suitability. In addition, year-to-year differences in the timing of the oceanographic surveys can introduce variability in the temperature time series used for the Lobster habitat index. The technique used for the interpolation of the temperature fields can under/overestimate values especially near the coast when data need to be extrapolated.

CONCLUSION

Based on the reference points (DFO 2014), the sGSL American Lobster stock is within the healthy zone, with landings in 2021 almost three times the level of the Upper Stock Reference (USR; Figure 3).

Since the previous assessment in 2013 (DFO 2013, Rondeau et al. 2015), landings in each assessment region have increased and other abundance indicators also show an increasing trend in the abundance of Lobster in the sGSL (Table 1). Productivity indicators have generally increased since the previous assessment but do show some signs of stabilizing or of reductions in growth. Continued increases in landings and high (> 50%) but largely stable exploitation rates suggest that the stock can likely sustain current levels of exploitation. Collectively, the ecosystem indicators provide contextual information on habitat suitability for Lobster, in terms of predator-prey relationships and water temperature.

Table 1. Summary of trends since 2013 (i.e. previous stock assessment) for the stock status indicators for the southern Gulf of St. Lawrence (sGSL) Lobster stock in assessment regions 23bc, 23g, 24, 25, 26A and 26B. The letters U, S and D, represent upward (U), stable (S) and downward (D) trends, respectively. "NA" indicates data were "not available" for a specific indicator, or the analysis was not completed at the spatial scale of the region indicated.

Category	Indicator	sGSL	23bc	23g	24	25	26A	26B
Abundance	*Landings*	U	S	U	U	U	U	U
	CPUE	U	U	U	U	U	U	U
	Commercial biomass	NA	NA	NA	NA	U	U	NA
Productivity	*Pre-recruit CPUE*	NA	NA	NA	U	U	U	U
	Pre-recruit abundance	NA	NA	NA	NA	U	U	NA
	Juvenile Lobsters	NA	U	S	NA	U	D	NA
	YOY Lobsters	NA	NA	NA	U	U	S	NA
	Egg production	U	U	U	U	U	U	U
Fishing pressure	*Exploitation rate*	NA	NA	NA	S	S	S	U
Ecosystem	*Prey availability*	NA	NA	NA	D	S	D	NA
	Predator index	S	NA	NA	NA	NA	NA	NA
	Habitat index (June)	U	NA	NA	NA	NA	NA	NA
	Habitat index (September)	S	NA	NA	NA	NA	NA	NA

OTHER CONSIDERATIONS

The LRP and the USR were identified using median landings from 1974 to 2009 as a proxy for the Biomass at Maximum Sustainable Yield (BMSY) (DFO 2014). Since 1975, landings steadily increased until approximately 1990, after which they decreased until approximately 2005, before beginning a steady increase from 2005 to 2021. While the current LRP is for sGSL landings as a whole, the pattern has largely been similar in the assessment regions, with the exception of 24 where landings have steadily increased since 1975. These changes in Lobster abundance, and observed concurrent changes in the populations of other commercially fished species in the sGSL, may indicate a regime shift. Re-evaluation of the LRP could be considered to ensure it reflects the current ecosystem. The use of fishery-independent data to establish the LRP would be preferable, to remove uncertainty related to changes in the fishery.

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