



ASSESSMENT OF GREEN SEA URCHIN STOCKS IN THE ESTUARY AND NORTHERN GULF OF ST. LAWRENCE IN 2021



Photo : Claude Nozères, DFO

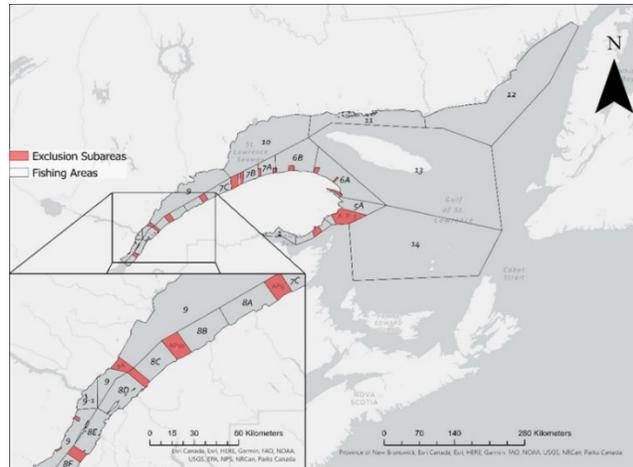


Figure 1. Management areas (framed in black) and fishing exclusion zones (in red) for green sea urchins in the Estuary and Northern Gulf of St. Lawrence.

Context:

The commercial Green Sea Urchin (*Strongylocentrotus droebachiensis*) fishery began in the Estuary and northern Gulf of St. Lawrence in 1991. Fourteen areas were created (Figure 1); however, many are still unfished or underutilized. Although trap fishing is permitted, green sea urchins are mainly collected by diving. Current management measures include a limited number of licences per area, a minimum catch size of 50 mm test diameter, a daily catch limit in some areas, a total allowable catch (TAC) in sub-area 8E since 2017 and dive fishing seasons generally set from the end of March to the end of December. Harvesting takes place once the ice cover opens up and the gonad yield increases from the end of March to May and from September to December.

Fishing effort in Quebec is concentrated mainly in Areas 8 and 9 in the St. Lawrence Estuary. Annual landings of green sea urchin in Quebec were sporadic and generally low (< 200 t) until 2005. Since 2006, they have remained above 415 t with the exception of 2009 (341 t) and reached a peak of 762 t in 2007 and 2016.

The resource is usually assessed every three years, with some exceptions, to determine whether recent changes in the status of the resource provide a rationale for adjusting the conservation approach and management plan. The last assessment of this fishery dates back to 2016 and focused primarily on Areas 9 and 11.

This Science Advisory Report is from the June 15-16, 2022 meeting on the Assessment of the green sea urchin stocks in the Northern Estuary and Gulf of St. Lawrence in 2022. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

SUMMARY

- Annual landings of green sea urchins in Quebec were sporadic and generally low (< 200 t) until 2005. They have remained above 415 t since 2006, except in 2009 (341 t), and peaked at 762 t in 2007 and 2016. Although landings have been reported for Areas 3, 7, 10, 11, 12 and 14 since 1991, they have been intermittent or small. Since 2007, among those areas only area 11 had average landings of 33.4 t from 2016 to 2020. Since 2004, nearly 98% of Quebec's cumulative landings have come from Areas 8 and 9, with the largest proportion from subarea 9-1. Area 9 is the only green sea urchin harvesting area in Quebec that has commercial fishery status.

North Shore

Area 9

- From 2017 to 2021, average annual landings totalled 315.1 t and came almost exclusively from Batture aux Alouettes in subarea 9-1. Since 2018, the daily catch limit has dropped from 6,000 kg to 4,200 kg in subarea 9-1, which partly explains the 26.9% decrease in average landings relative to the 2012-2016 period (431.2 t).
- The total number of authorized fishing days (80 boat-days) for subarea 9-1 has been used every year since this measure first came into effect in 2010, except in 2020 (61 boat-days) due to the pandemic. The average fishing effort in diver-hours (dh) for the 2017-2021 period (967.0 dh) is comparable to what it was in 2012-2016 (977.8 dh).
- The annual CPUE decreased between 2017 and 2019 and has been relatively stable since then. The average CPUE for the 2017-2021 period (324.1 kg/dh) was 15.6% lower than that of the 2004-2016 historical series (384.1 kg/dh).
- The average size of landed sea urchins appears to have been stable since 2010 and ranges from 59 to 62 mm. The proportion of sublegal-sized sea urchins (< 50 mm) in landings is less than 5% on average.
- The results of the surveys conducted by DFO (2008 and 2010) and the Agence Mamu Innu Kaikusseth (AMIK 2016) indicate an increase in the biomass density of legal- and sublegal-sized sea urchins in 2016 relative to 2008 and 2010 in the area fished. A modal value of around 20 to 30 mm in diameter is seen in 2008, 2010 and 2016, indicating that recruitment to the fishery could continue. AMIK's 2019 survey suggests some stability in the density of legal-sized sea urchins relative to 2016 for the entire Batture aux Alouettes.
- For Area 9 (subarea 9-1), keeping removals near the average level for 2017-2021 should not have a major impact on sea urchin abundance over the next three seasons.

Area 11

- Annual landings averaged 40.0 t from 2016 to 2019, for an average effort of 188.5 dh (26 boat-days). These are the highest landings since the start of the fishery. In 2020, only 6.7 t of sea urchins were landed, representing an effort of 5 boat-days over the 60-day fishing period. The 2021 data were not available at time of the assessment.
- The mean CPUE from 2017 to 2020 (211.9 kg/dh) is comparable to that of the 2002-2016 historical series (205.9 kg/dh).
- There has been a lack of size structure data since fishing started in the area.

Quebec Region

- The lack of information prevents us from commenting on the status of the resource in Area 11.

Lower St. Lawrence and Gaspé Peninsula

Area 8

- Fishing has historically been conducted at the eastern tip of Île Verte (subarea 8D) and, since 2008, on the southeast side of the eastern tip of Île aux Lièvres and Batture de l'Île Blanche (subarea 8E). An annual TAC of 110.7 t has been in effect in subarea 8E since 2017.
- In subarea 8D, the fishing and landings data for the period prior to 2018 are unreliable or incomplete. From 2018 to 2021, landings averaged 103.3 t, for an average effort of 36 boat-days and a mean CPUE of 353.8 kg/dh. The average landed size appears to have been stable since 2012 and is between 59 and 62 mm. The proportion of sublegal-sized sea urchins in landings is less than 2% on average.
- In subarea 8E, annual landings averaged 105.7 t for the 2017-2021 period, which equals 95.5% of the TAC. The average effort in dh decreased by 4.1% relative to the 2012-2016 period, whereas the average effort in boat-days was comparable. The mean CPUE from 2017 to 2021 (148.5 kg/dh) remains below the historical average for 2003-2016 (234.7 kg/dh), but has been increasing since the historical low in 2019. The average size of landed sea urchins has varied from year to year, but there is no clear trend. The proportion of sublegal-sized sea urchins in landings is less than 2% on average.
- The survey conducted in 2021 by the Wolastoqiyik Wamspekwuk First Nation in subarea 8E showed an average density of legal-sized sea urchins of 2.5 individuals/m² and 0.25 kg/m². The size distribution ranges from 15 to 94 mm in diameter, with an average of 46.1 mm. Sixty-two percent of individuals were sublegal-sized.
- For Area 8 (subareas 8D and E), keeping removals near the average level for 2017-2021 should not have a major impact on sea urchin abundance over the next three seasons.

BACKGROUND

Species biology

The green sea urchin, *Strongylocentrotus droebachiensis*, is an echinoderm present in all boreal and arctic marine regions. On the east coast of North America, its distribution extends from Cape Cod in the United States to the Canadian Arctic Archipelago (Scheibling and Hatcher 2001). The green sea urchin prefers to live on hard substrates (bedrock, stones, rocks and gravel) in the subtidal zone, generally between 0 and 50 m depth, but is sometimes found on soft bottoms (Scheibling and Hatcher 2001) up to 300 m depth (Jensen 1974). In Quebec, the green sea urchin is found in great abundance in the maritime parts of the territory, including the areas of the St. Lawrence Estuary

Green sea urchins have separate sexes and there is no obvious sexual dimorphism. Both male and female sea urchins are harvested for their gonads. The five gonads undergo significant changes in volume, firmness and colour over an annual reproductive cycle. In the St. Lawrence Estuary, the gonads increase in size and weight during the fall, reaching their maximum at the end of winter (up to 25% of the individual's weight). Spawning takes place in May or June

Quebec Region

depending on the location, and generally the gonad weight remains below 10% of the individual's weight throughout the summer (Himmelman et al. 1979, 1997; Starr et al. 1993). The sea urchin loses its commercial value during this period.

The green sea urchin reaches sexual maturity with a test (shell) diameter ranging from 25 to 30 mm at approximately three to four years of age (Scheibling and Hatcher 2001; DFO 2008; Sainte-Marie and Paille 2020). Fertilization is external and produces pelagic larvae that drift in the surface water from one to four months and then settle on the bottom. In the early benthic phase, juvenile sea urchins barely measure 0.5-1.0 mm in diameter (Scheibling and Robinson 2008). They reach the 50-mm minimum legal size when they are between five to seven years of age and can live several more decades depending on the region (Vadas et al. 2002; Blicher et al. 2007). Sea urchin growth rate may vary considerably and depends primarily on the quality and quantity of available food. Sea urchins grow more rapidly along the edges of kelp beds or in areas where there is a regular supply of drifting algae.

In more favourable areas, green sea urchins form feeding fronts or high-density aggregates and strip the algae from the substrate. When large sea urchins are removed from feeding fronts, they can be replaced by sea urchins already present in the area or sea urchins that have migrated from deeper waters.

The green sea urchin survival rate is usually quite high in the absence of fishing. The main causes of natural mortality among sea urchins are osmotic stress, predation and disease. Larvae and juveniles are especially sensitive to low salinity and it has been suggested that recruitment in the upper St. Lawrence estuary can be episodic due to unfavourable salinity conditions that sometimes impact larval survival. Along the Quebec coastline, the main green sea urchin predators include lobster, crab, large starfish, wolfish, and seabirds.

Description of the fishery

The Quebec coastline is divided into 14 main green sea urchin fishing areas. Areas 9 to 12 of the North Shore area are much larger than areas in the Gaspé region (Figure 1). This advisory report focuses primarily on Areas 8, 9 and 11. Area 8 extends from Île d'Orléans to Les Boules. Area 9 extends from Pointe-au-Pic to Pointe-des-Monts. Since 2010, the subarea 9-1 boundary has been set at the mouth of the Saguenay to better monitor more intensive fishing operations in this area. This subarea includes Batture aux Alouettes, Baie Ste-Catherine and Batture de la Pointe aux Vaches. Area 11 begins east of the Rivière Sheldrake bridge and extends to the tip of Natashquan.

There are two authorized methods for harvesting green sea urchins in the Quebec region: underwater diving and whelk traps. The trap fishery has never been widespread. Traps were primarily used in Area 9 and have not been used since 2007. Towed fishing gear is prohibited in the commercial fishery outside culture sites.

Green sea urchin management measures in effect in the Quebec region are designed to protect reproductive potential by controlling fishing effort. The number of exploratory licences, divers and traps is limited in each fishing area. The minimum legal size is a 50 mm test diameter in all fishing areas. Underwater diving for sea urchins is permitted almost all the time, but the use of traps is usually prohibited from spring to fall. Since 2010, exclusion zones are in effect in areas 8 and 9.

Logbooks are mandatory in the Quebec region. They indicate fishing trip duration and landings, harvesting method, locations where catches were made and, if applicable, the number of divers

Quebec Region

or traps and their immersion time, as well as the duration, depth and composition of the sea floor at each dive. This information is supplemented by purchase receipts and dockside sampling of commercial catches.

Seven licences have been issued for Area 9, five of which have been permanent since 2009. Permanent licence holders have exclusive use of subarea 9-1, but are limited to a total of 80 boat days (bd) since 2010. The daily catch limit, which had been 6,000 kg since 2014, was reduced to 4,200 kg in 2018. They are also entitled to fish for an additional 12 days in the Saguenay–St. Lawrence Marine Park and another 12 days outside the park, but still in Area 9. Two exploratory licences may be issued for trap fishing, but this type of fishing has not been practised since 2007. The maximum number of divers per licence is four; however, only three can dive at once while the other diver waits aboard the vessel. The number of traps (maximum 0.3 m³ volume, minimum 102 mm mesh size with mandatory escape vents) is limited to 100 per boat. In 2020 and 2021, dive fishing was authorized from March 20 to December 31. Trap fishing is prohibited within the boundaries of the Saguenay–St. Lawrence Marine Park and during the whelk fishery. Mandatory dockside monitoring and the Vessel Monitoring System were added in 2015 for all areas.

A total of 10 exploratory licences are authorized in Area 11. Fishing effort, initially limited to 40 bd, has been increased to 60 bd beginning in 2019 for all licence holders. Over the past 10 years, only one to three fishermen have been active each year. The number of divers is limited to four per boat, three of whom can dive at once while the other waits aboard. There has been no trap fishing since 1999. Dive fishing has been authorized from April 1 to December 31.

In Area 8, only two fishermen are active, one in subarea 8D the other in subarea 8E. The number of divers is limited to five per boat, and they can carry out harvesting at the same time. Licences are not issued for trap fishing. An initial TAC of 85 t was introduced in 2013 in one part of subarea 8E (southwest of Batture de l'Île Blanche). In 2017, a TAC of 110.7 t was established for all of subarea 8E. Since 2018, fishing vessels have been required to have an on-board electronic monitoring system (EMS) that continuously records videos or photos of all fishing activities. Dive fishing has been authorized from August 1 of one year to May 31 of the following year.

ASSESSMENT

Various commercial fishery indicators were used to assess the status of the resource in Areas 8, 9 and 11. These indicators provide information on spatial distribution, fishing effort and success, as well as green sea urchin abundance and size. Commercial fishery statistics are used for estimating fishing effort and calculating catches per unit effort (CPUE). Effort and CPUE are expressed in diver-hours (dh) and kilograms per diver-hour (kg/dh). CPUE estimated in kilograms per diver-hour (kg/dh) is a much better indicator of sea urchin abundance than that estimated in kilograms per boat day. This is because the total number of dive hours may vary from day to day for the same boat.

The first green sea urchin landings in Quebec were made in 1991 (7 t), and they increased to 158 t between then and 1997. Annual landings in subsequent years remained below 50 t until 2002 (Figure 2). From 2003 to 2005, there was a gradual increase in landings followed by a sharp increase in 2006 and 2007, with a record landing of 762 t. After that, landings dropped to 341 t in 2009, due in part to greater control of fishing effort, and then fluctuated between 513 t and 762 t between 2010 and 2016 (Figure 2). From 2017 to 2021, landings averaged 551.9 t

Quebec Region

(Figure 2). Since 2004, nearly 98% of green sea urchin landings in Quebec have come from Areas 8 and 9 in the St. Lawrence Estuary.

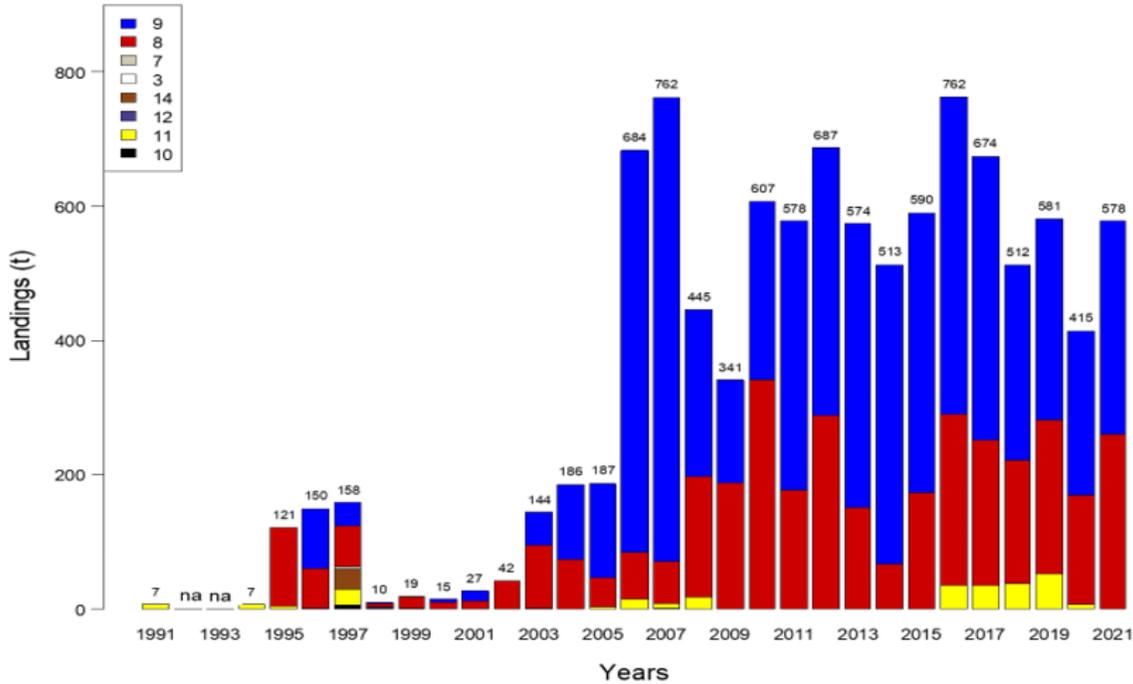


Figure 2. Green sea urchin landings for all Quebec areas from 1991. Numbers indicate total landings in Quebec for each year. na = information not available.

Area 9

The fishery began in 1996 with landings of 89 t. Landings then fell to between 1 and 50 t between 1998 and 2003. They then increased to a peak of 690 t in 2007 (Figure 3) before declining to a low of 154 t in 2009. Since 2005, virtually all fishing has been conducted in subarea 9-1 at the mouth of the Saguenay, specifically at Batture aux Alouettes, where the area of the fishing grounds is only 1.67 km². From 2012 to 2016, average landings were relatively stable at around 431.2 t. Landings began a decline starting in 2017 with average annual landings for the 2017-2021 period of 315.1 t, a 26.9% decrease from the 2012-2016 period (Figure 3). The daily catch limit implemented in 2018 may partially explain the decrease in landings. Since 2004, sub-area 9-1 alone has accounted for between 34 and 91% of landings in Quebec since 2004.

Fishing effort measured in bd stabilized starting in 2010 when an 80 bd limit was introduced (Figure 4). All authorized days are used every year except in 2020 (61 db) due to the Covid-19 pandemic. This fishing effort limit combined with the daily catch limit is a factor that may have contributed to keeping landings at a more reasonable level. Since this management measure was introduced, fishermen have nevertheless been able to increase their fishing effort measured in dh by 65.6% between 2010 and 2016, from 657.2 to 1088 dh (Figure 4). From 2017 to 2021, the average effort deployed was 967.0 dh, and is comparable to the 2012-2016 period (977.8 dh). The majority of effort is deployed in the spring (≥ 62%) in recent years, except in 2020 when only 47% of effort was deployed during this period due to the COVID-19 pandemic (Table 1).

**Assessment of the green sea urchin
stocks in the Estuary and northern Gulf of
St. Lawrence in 2021**

Quebec Region

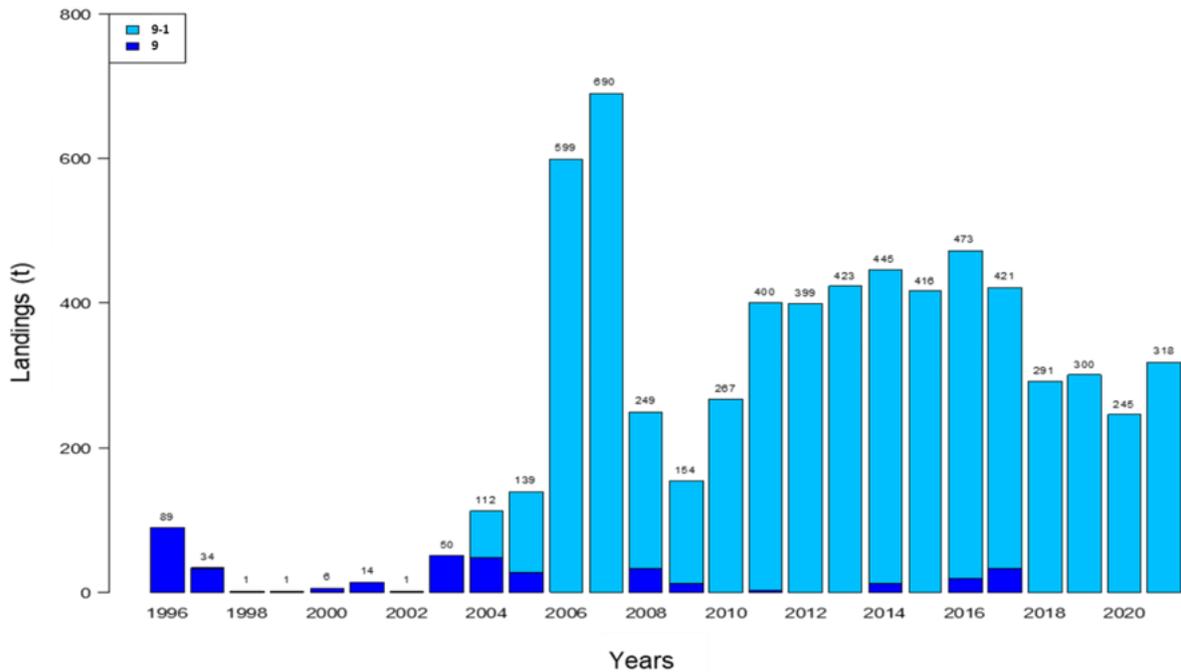


Figure 3. Green sea urchin landings in Area 9 from 1996 to 2021. Subarea 9-1 has existed only since 2010, but landings from this subarea calculated from fishery data with geo-referenced positions, are shown for previous years to show its significance compared to the rest of Area 9. The numbers above the bars indicate total landings in Area 9 for each year.

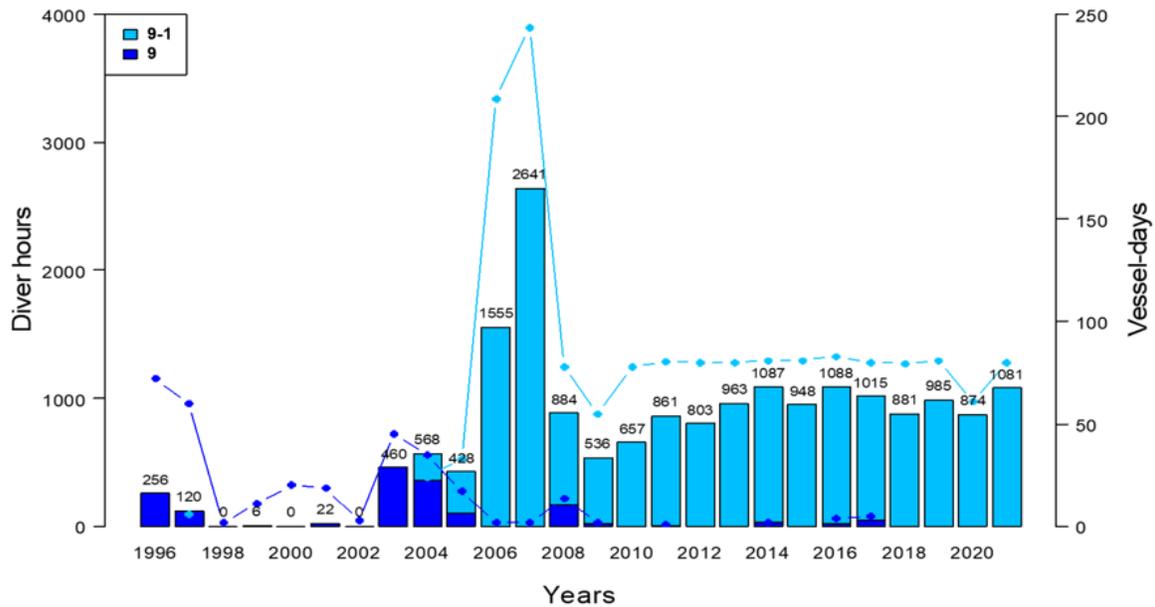


Figure 4. Green sea urchin fishing effort in Area 9 measured in dh (histogram) and bd (dots and lines) at the mouth of the Saguenay (subarea 9-1 in light blue) and in the western and eastern portions of Area 9 (dark blue) from 1996 to 2021. The numbers shown above the bars indicate the total effort in dh in Area 9 for each year.

**Assessment of the green sea urchin
stocks in the Estuary and northern Gulf of
St. Lawrence in 2021**

Quebec Region

Following a decrease in CPUE from 2005 to 2007, the adoption of management measures in subarea 9-1 in the fall of 2009 appears to have promoted an increase in CPUE starting in 2010, peaking at 498.6 kg/dh in 2012 (Figure 5). Despite a decrease that began from 2013 to 2014 followed by a slight increase through 2016, the values during this period remain above the historical average (2004-2016). Annual CPUE decreased again from 2017 to 2019 and has been relatively stable since. The 2017-2021 average CPUE (324.1 kg/dh) was 15.6% lower than the historical average (2004-2016).

The spring and fall CPUE increased in 2011, exceeding the 408.3 kg/dh spring average calculated for 2010 to 2021 and the 382.3 kg/dh fall average (Table 1). The spring and fall CPUE decreased from 2018 to 2021, but there was a slight increase in fall 2021 (310.1 kg/dh). From 2018 to 2021, the CPUE values in the spring and fall remained below the respective averages for the 2010-2021 period.

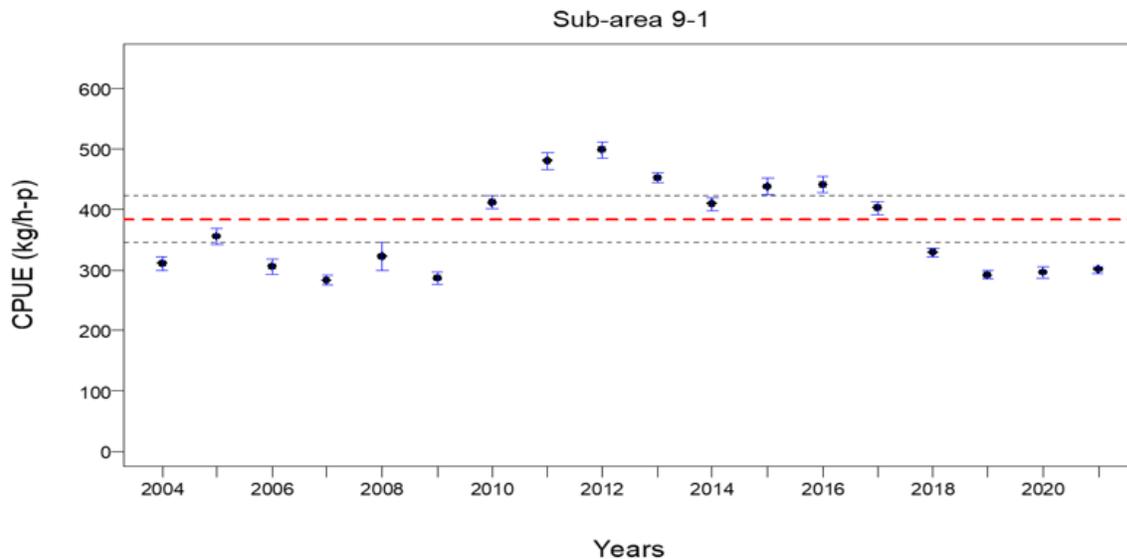


Figure 5. CPUE for green sea urchin in subarea 9-1 measured in kg/dh from 2004 to 2021 and the 2004-2016 historical average ($\pm \frac{1}{2}$ standard deviation). The vertical bars over each point represent standard error. Subarea 9-1 has only existed since 2010, but the data were extracted from georeferenced positions to obtain a longer fishing history.

Table 1. Average (\pm one standard deviation, SD) catch per unit effort measured in kg by diver-hours (kg/dh) in subarea 9-1 in the spring of 2008 and 2009 and the spring and fall of 2010 to 2021. The mean for all years and the percentage of fishing effort in the spring are also listed.

Subarea 9-1		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Mean 2010-2021
Spring	Mean	322.2	286.2	402.9	502.4	513.7	434.7	423.4	467.5	467.5	411.2	337.7	322.0	326.0	290.3	408.3 \pm 13.9
	(SD)	(23.0)	(10.5)	(11.1)	(14.6)	(106.5)	(36.3)	(17.1)	(22.9)	(15.3)	(11.9)	(12.0)	(9.6)	(18.2)	(7.3)	
	% of total effort	100	100	82	73	71	73	70	67	62	71	72	66	47	67	
Fall	Mean	-	-	425.5	433.3	482.4	470.4	393.8	402.3	414.3	393.7	319.9	262.9	269.5	310.1	382.3 \pm 15.1
	(SD)	-	-	(27.0)	(25.8)	(93.0)	(74.8)	(14.8)	(11.1)	(20.6)	(18.6)	(5.7)	(8.1)	(7.9)	(8.6)	

Quebec Region

Since 2005, commercial catch sampling in Area 9 have only collected samples from subarea 9-1. These samples represent sorted and landed sea urchins. The average size of the overall and commercial portion (≥ 50 mm test diameter) of the samples (Figures 6 and 7) has been relatively stable since 2010, ranging from 57.8 to 61.5 mm for the overall samples and from 58.5 to 61.8 mm for the commercial portion. This stability does not foreshadow the arrival and migration of new cohorts of sea urchins. Rather, this suggests that sea urchin catches were offset by local growth or migration of individuals from peripheral sites. Approximately 5% of landings are below legal size (< 50 mm).

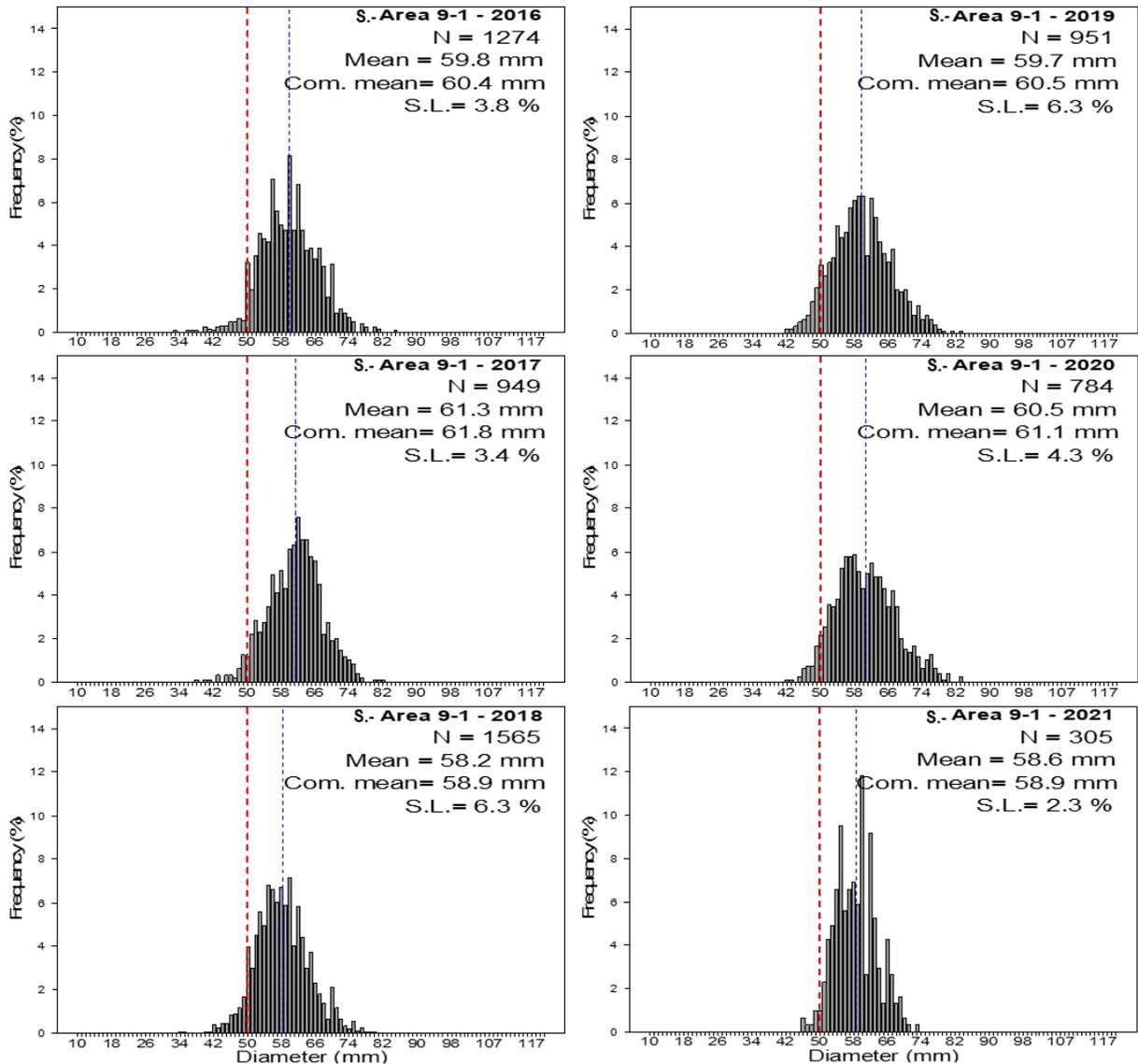


Figure 6. Size structures of green sea urchins from subarea 9-1 based on commercial sampling from 2016 to 2021. The number (N), average size (Mean) and the percentage of sub-legal-sized individuals (SL) are based on all sea urchins landed, whereas the average commercial size (Com. mean) is 50 mm in diameter and over. The dotted line represents the minimum legal size and the sample average size (in blue).

Quebec Region

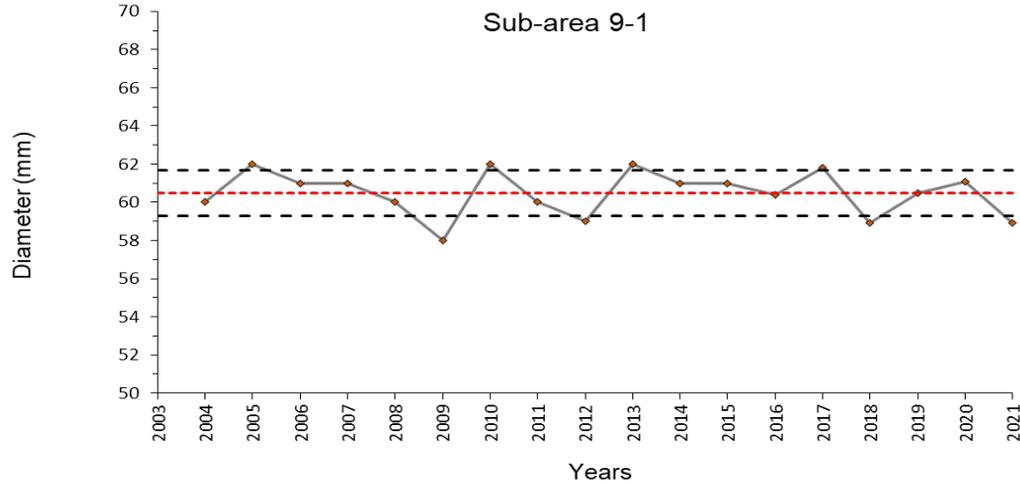


Figure 7. Average commercial size of green sea urchins based on commercial sampling in subarea 9-1 from 2004 to 2021. Only the 2004 dot includes sizes measured outside subarea 9-1, i.e. Area 9 near Saint-Siméon. The average (red dashed line) of the series (\pm standard deviation, black dashed line) is shown. Subarea 9-1 has only existed since 2010, but the data were extracted from georeferenced positions to provide a longer history.

Research dive surveys

In 2016, the Agence Mamu Innu Kaikusseht (AMIK) conducted a demographic monitoring dive survey in subarea 9-1, covering the Batture aux Alouettes and Batture de la Pointe aux Vaches sectors. The survey used the same sampling protocol as DFO used during the 2008 and 2010 scientific surveys.

The results from the DFO (2008 and 2010) and AMIK (2016) surveys consistently showed a higher average density (in number and weight) of legal-sized sea urchins in the fished area than in the unfished area, but only for Batture aux Alouettes (Figure 8). With regard to sublegal-sized sea urchins, the densities in number and weight are usually higher in the unfished area than in the fished area; however, the 2016 survey at Batture de la Pointe aux Vaches was an exception in this regard.

The survey results also showed an increase in density (at least in abundance) of sublegal-sized sea urchins in 2016 relative to 2008 and 2010 in the fished area (Figure 8), which suggests that recruitment to the population targeted by the fishery should continue.

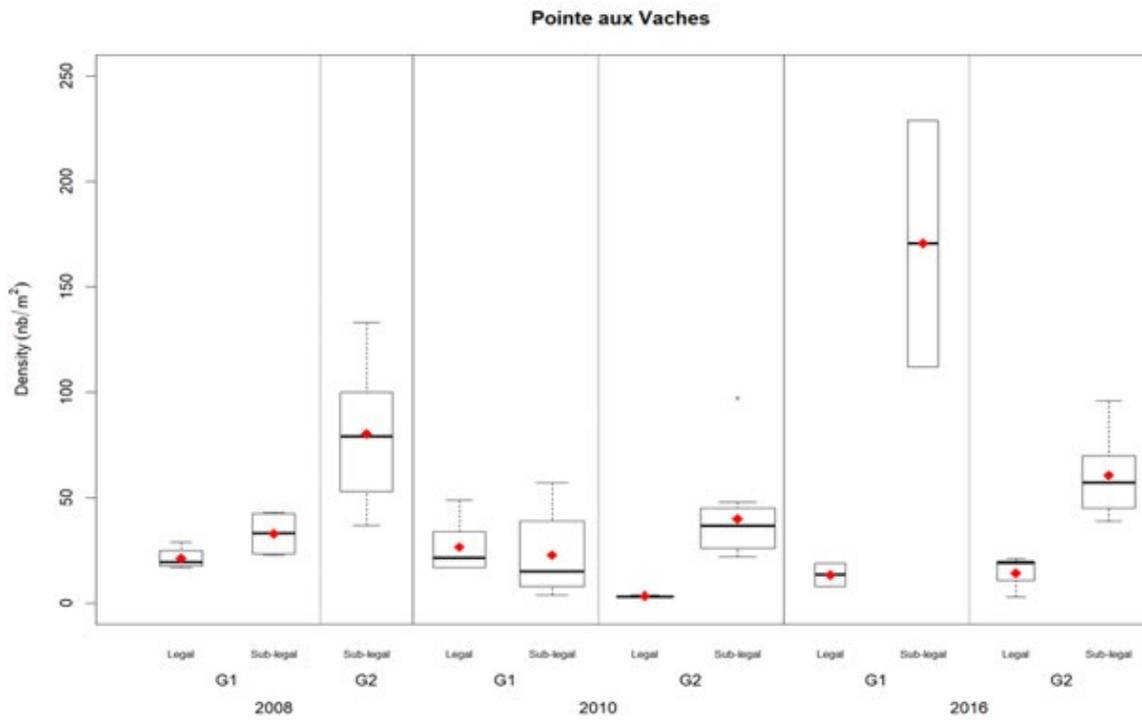
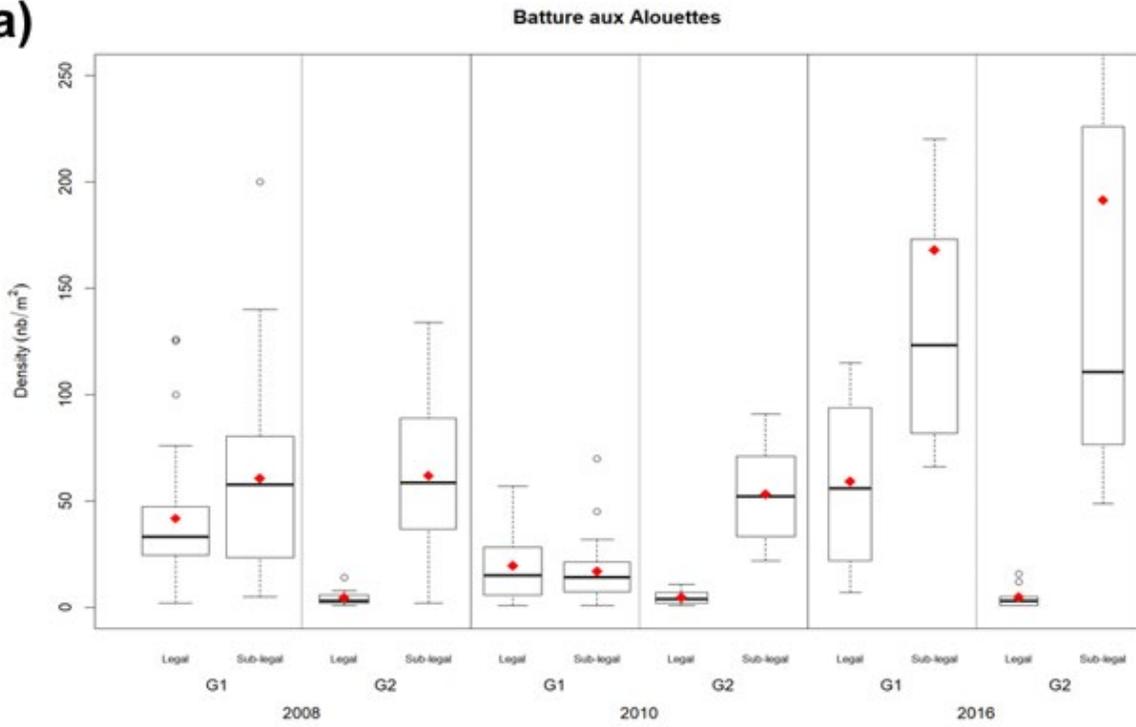
A survey conducted by AMIK in summer 2019 using the same sampling protocol pointed to relative stability in the density of legal-sized sea urchins relative to 2016 for the entire Batture aux Alouettes sector (AMIK 2019, unpublished data). However, this finding must be interpreted with caution because the analysis took into account all fished and unfished grounds.

The size frequency distributions from the 2008, 2010 and 2016 surveys show a wide range of test diameters in the fished and unfished areas, suggesting that many age classes are likely represented. A modal value around 20 to 30 mm in diameter is observed, indicating that recruitment to the fishery should continue.

Assessment of the green sea urchin
stocks in the Estuary and northern Gulf of
St. Lawrence in 2021

Quebec Region

a)



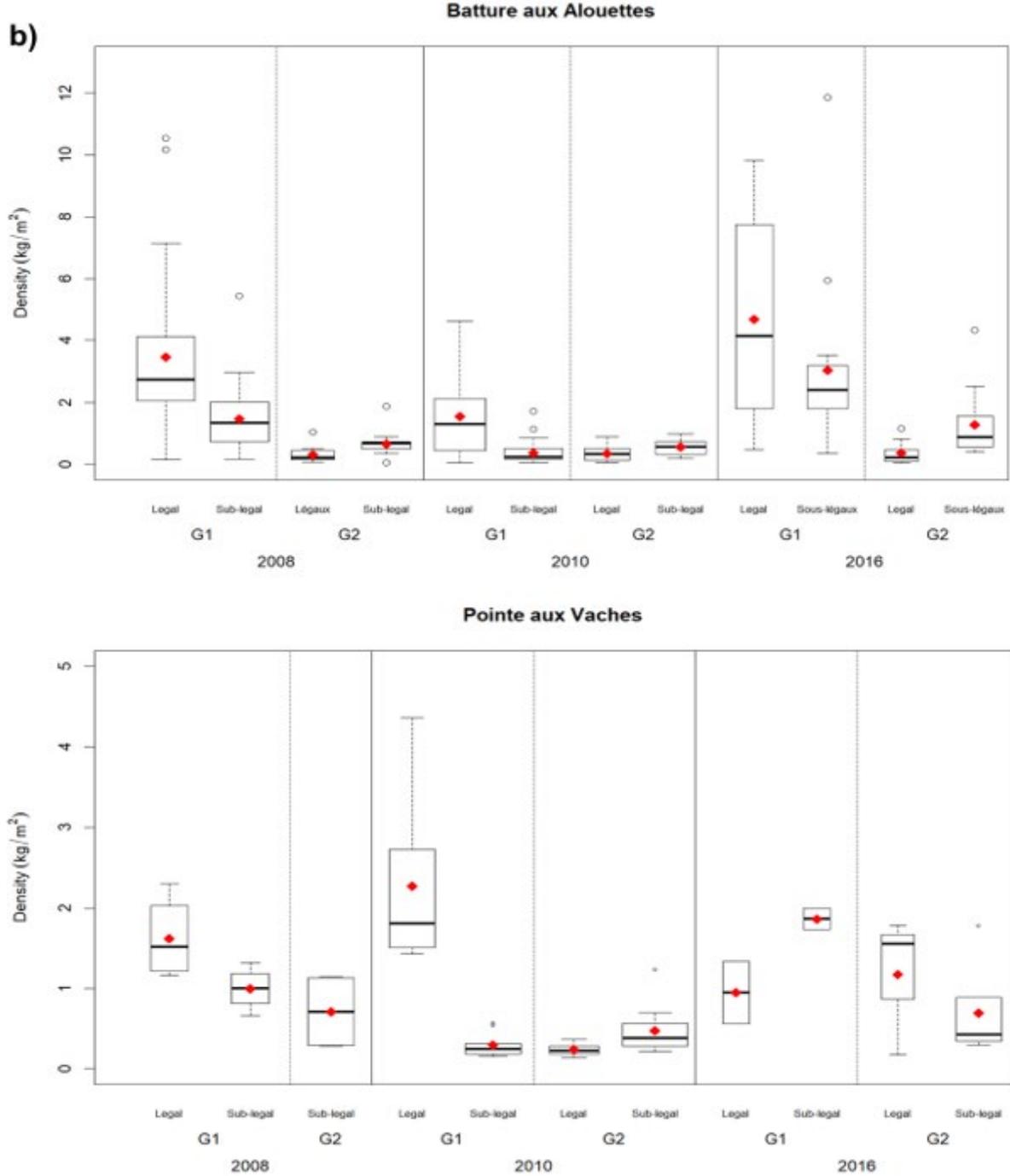
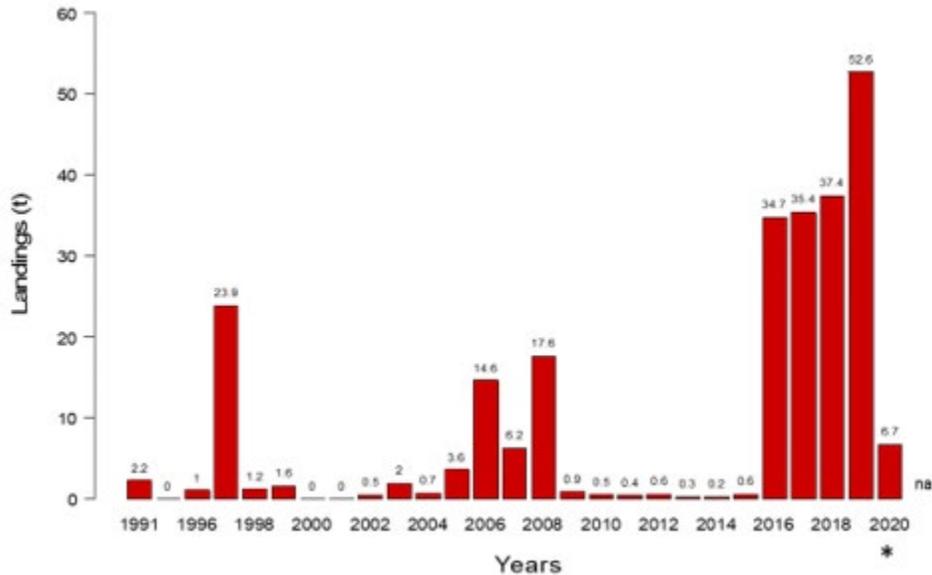


Figure 8. Density expressed a) in abundance per unit area (nb/m^2) and b) biomass (kg/m^2) per unit area of green sea urchins, legal-sized and sublegal-sized, observed in the DFO's 2008 and 2010 surveys and AMIK's 2016 survey, in the fished areas of Batture aux Alouettes and Batture de la Pointe aux Vaches (G1) and the unfished areas (G2). Box-and-whisker plots: the line inside the box represents the median; the box, the 25th to the 75th percentiles; the error bars, the 95% confidence interval; the red diamond, the mean, and the circles, outliers.

Quebec Region

Area 11

Area 11 landings have, to date, been sporadic and weak, with peaks of 23.9 t in 1997 and 17.6 t in 2008 (Figure 9). Landings have been increasing since 2016, and reached a high of 52.6 t in 2019 with average landings of 40.0 t between 2016 and 2019. These are the largest landings recorded since fishing began. In 2020, only 6.7 t of sea urchins were landed owing to the COVID-19 pandemic. The 2021 data were unavailable at time of the assessment. It should be noted that some years prior to 2016 may be slightly underestimated due to incomplete data.



*Figure 9. Green sea urchin landings in Area 11 from 1991 to 2020. The numbers indicate total landings each year. *The 2020 year contains only fall fishing data. Data for 2021 were not available at the time of this assessment.*

Some sectors are visited most years: near Havre-Saint-Pierre in the center of Area 11 and near Natashquan in the far eastern sector. Other sectors still need to be explored. Eleven fishermen have reported landings since 1991, but very few (one to three fishers) have participated in the fishery in recent years. Since 2016, the effort in diver-hours and boat-days has been increasing, but the authorized effort in boat-days has never been reached (Figure 10). In 2020, only five boat-days were used out of a possible 60 days, perhaps due to the COVID-19 pandemic.

Average CPUE varied significantly from year to year (Figure 11), which may reflect low fishing effort. Yields were relatively high in 2008 (312.8 kg/dh) and above the historical series average (2002-2016, 205.9 kg/dh) between 2010 and 2015, except for 2013. From 2017 to 2020, average yields (211.9 kg/dh) are comparable to those of the 2002-2016 series. Average yields of the past two years (2019 and 2020) are slightly above the historical average for 2002-2016. There are no discernible trends for the mean CPUE between spring and fall for the four years from 2016 to 2019, a period when fishing was conducted during both seasons.

**Assessment of the green sea urchin
stocks in the Estuary and northern Gulf of
St. Lawrence in 2021**

Quebec Region

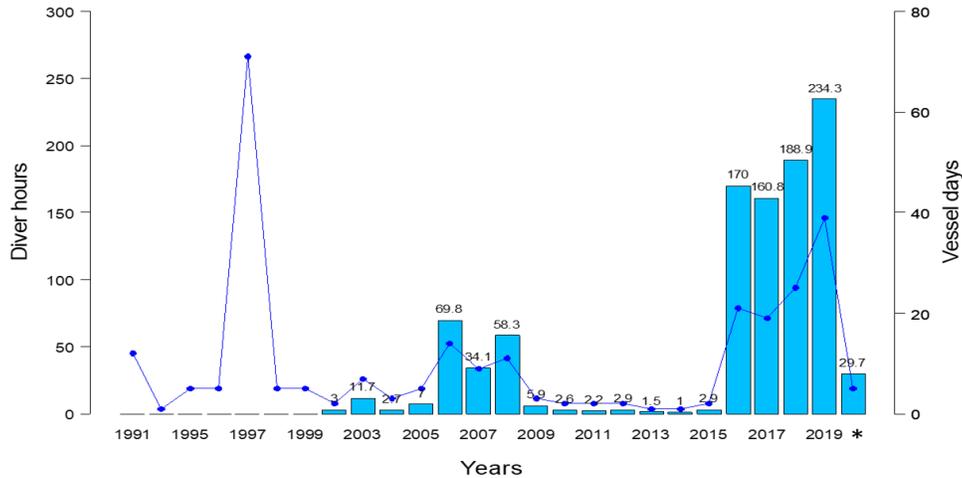


Figure 10. Green sea urchin fishing effort in Area 11 measured in diver hours (dh) (histogram) and boat days (bd) (Line and dots) from 1991 to 2020. The numbers shown above the bars indicate fishing effort measured in dh for each year (this information is not available for the initial years). *In 2020, fishing occurred only in the fall. Data for 2021 were not available at the time of the assessment.

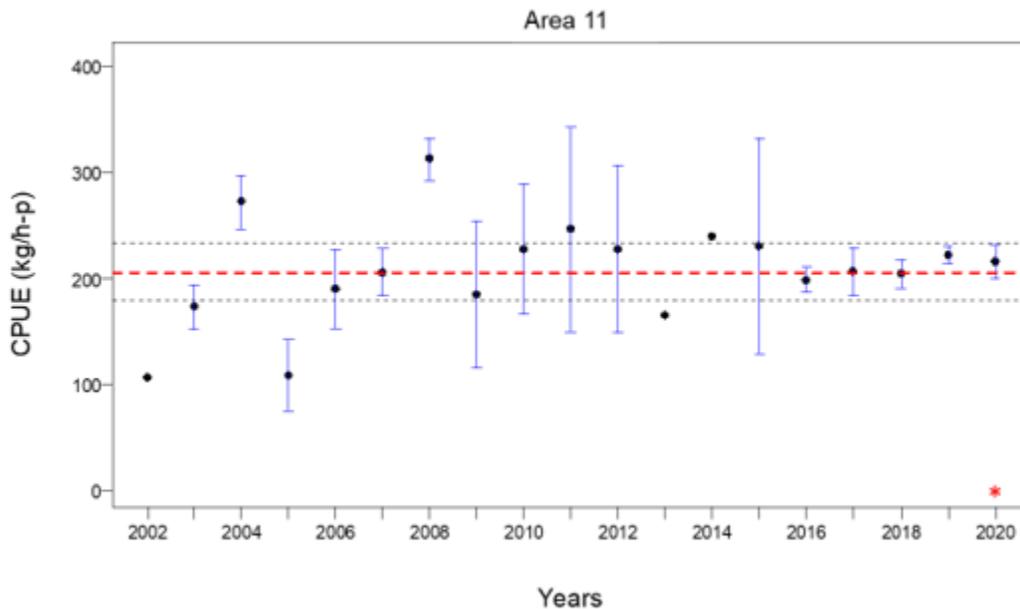


Figure 11. Catches per unit effort of green sea urchin measured in kg/dh from 2002 to 2020 and the historical average 2002-2016 (dotted line in red) ($\pm 1/2$ standard deviation) in Area 11. The vertical bars over each point represent standard error. *The 2020 year contains only fall fishing data.

Size structure data have remained very fragmentary since fishing began in Area 11, making it difficult to comment on the status of the resource.

Quebec Region

Area 8

The most recent assessment of Area 8 dates back to 2011 (DFO 2012). Fishing in this area has traditionally been conducted in two small sectors: at the eastern tip of Île Verte (subarea 8D) and the southeastern tip of Île aux Lièvres and southwest of Batture de l'Île Blanche (subarea 8E).

In subarea 8D, the fishing and landings data for the 2015–2017 period are unreliable or incomplete. From 2018 to 2021, landings averaged 103.3 t, for an average effort of 36 boat-days and a mean CPUE of 353.8 kg/dh (Figures 12 to 14).

In subarea 8E, landings peaked in 2010 and 2012. Following a significant drop in landings over the next two years (Figure 12), a catch limit of 85 t was introduced for only one sector of subarea 8E in 2013, to limit fishing effort. Landings subsequently rebounded, reaching 122.9 t in 2016 (Figure 12). A TAC of 110.7 t has been applied to all of subarea 8E since 2017. Average annual landings for the 2017–2021 period totaled 105.7 t, or 95.5% of the TAC. From 2017 to 2021, average effort was 694.5 dh, a 4.1% decrease relative to the 2012–2016 period (724.0 dh); no change was observed in boat-days (Figure 13).

In subarea 8E, after peaking in 2008 at 418.2 kg/dh, CPUE values began a sharp decline until 2015–2016, falling below the historical average. Since then, CPUE values have been relatively stable, but remain below average. The mean CPUE from 2017 to 2021 (148.5 kg/dh) remains below the historical average for 2003–2016 (234.7 kg/dh), but has been rising since the historical low of 2019 (Figure 14).

The spring and fall CPUEs show a fairly similar trend. The average for the 2003–2021 spring period (208.6 kg/dh) is slightly higher than the fall average (196.7 kg/dh), for a similar average effort.

Commercial catch samples of sea urchins sorted and landed at the dock are available for subareas 8D and 8E. In subarea 8D, the average annual size of landed sea urchins has been fairly stable year over year since 2012, ranging from 59 to 62 mm (Figure 15). However, a slight decrease was observed in 2020 and 2021. In subarea 8E, the average size varied between 2012 and 2021, but with no clear trend. The average size of sea urchins is slightly larger in subarea 8E than in subarea 8D (Figure 15). In both subareas, the proportion of sublegal-sized sea urchins in landings has been less than 2% on average since 2016 (Figure 16).

**Assessment of the green sea urchin
stocks in the Estuary and northern Gulf of
St. Lawrence in 2021**

Quebec Region

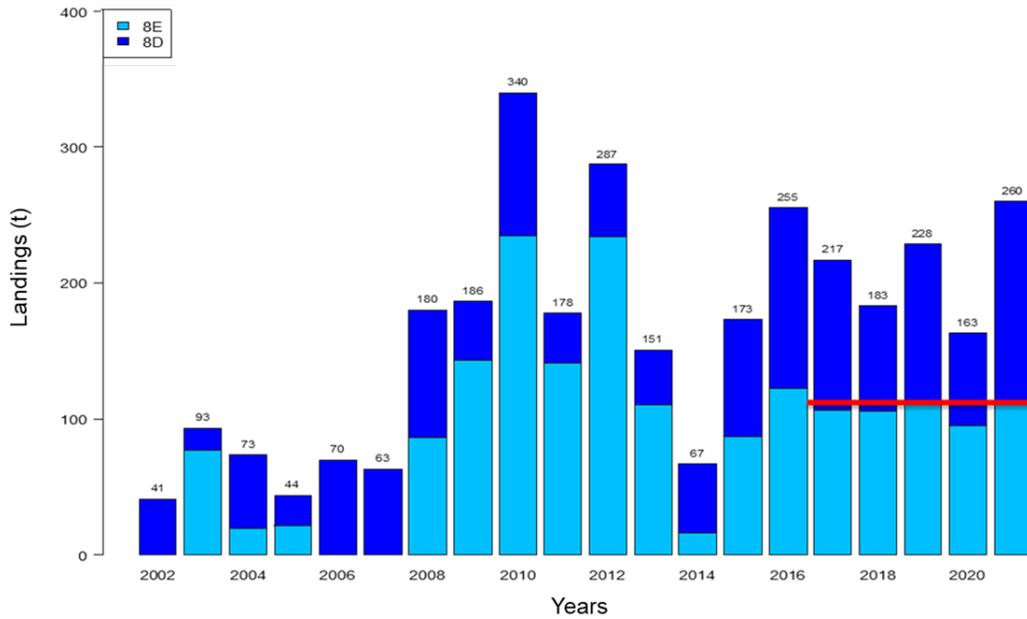


Figure 12. Green sea urchin landings in tons in Area 8 (subarea 8D dark blue and subarea 8E light blue) from 2002 to 2021. The numbers shown above the bars indicate total landings for each year. The red line represents the TAC in effect in subarea 8E from 2017. 2020 contains only fall fishing data.

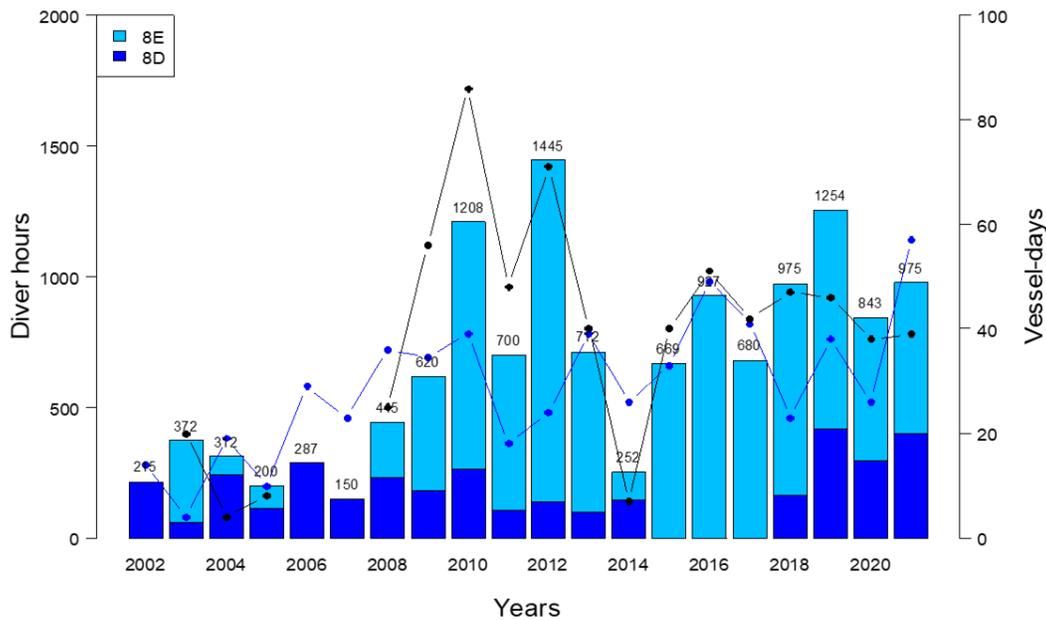


Figure 13. Green sea urchin fishing effort in Area 8 measured in diver hours (dh) (histogram, subarea 8D dark blue and subarea 8E light blue) and boat days (bd) (line and dots, subarea 8D dark blue and subarea 8E light blue) from 2002 to 2021. The numbers shown above the bars indicate fishing effort measured in dh for each year.

Quebec Region

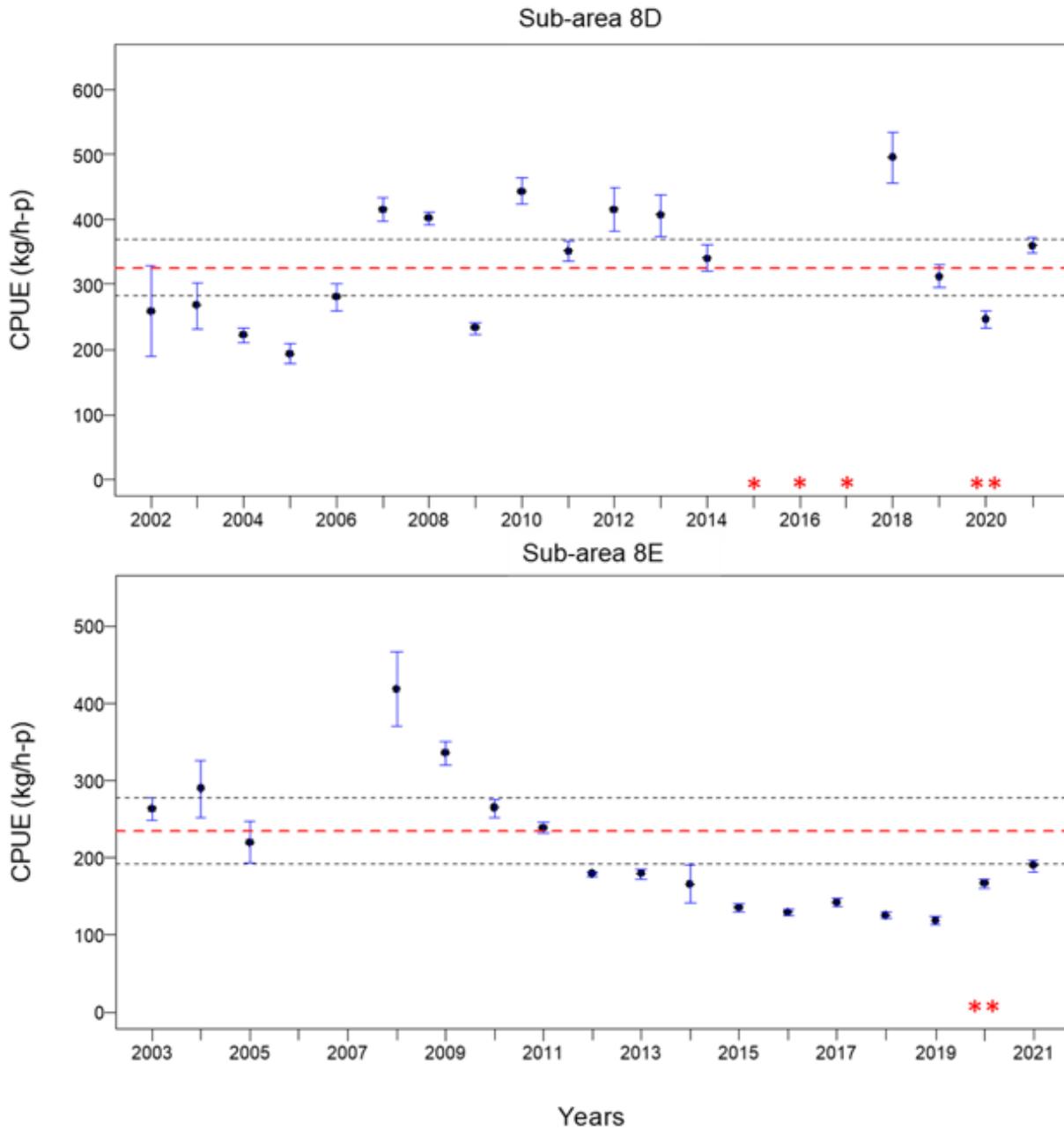


Figure 14. Catches per unit effort of green sea urchin measured in kg/dh from 2002 to 2021 and the historical average 2002-2016 (dotted red line) ($\pm 1/2$ standard deviation (dotted black line) in Area 8. The vertical bars over each point represent standard error. In 2006 and 2007, there was no fishing in Subarea 8E. * Missing data; ** Contains only fall fishing data.

Quebec Region

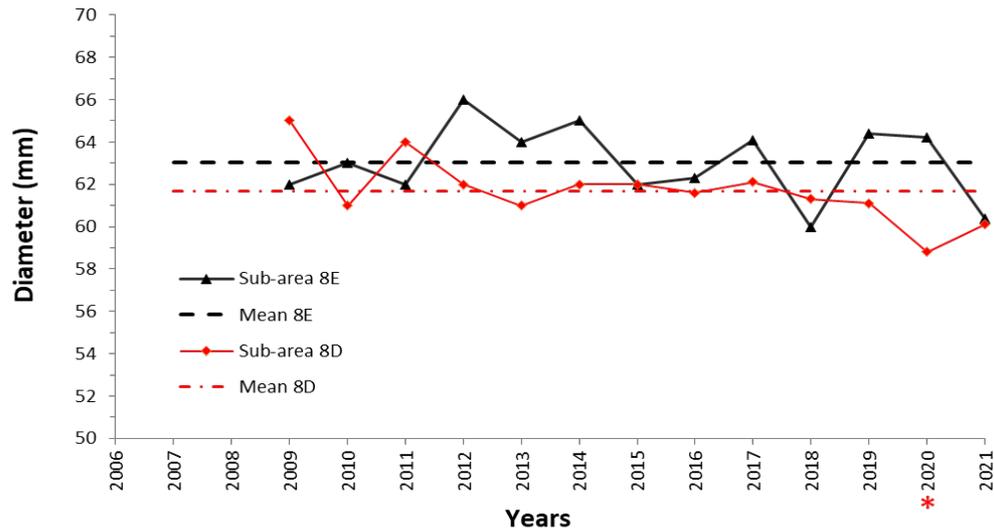


Figure 15. Average commercial size of green sea urchins based on commercial sampling in Area 8 (subarea 8D and 8E) from 2009 to 2021. The average (dashed line) of the series for each subarea is shown. * contains only samples from the fall fishery.

Subarea 8E dive survey

The Wolastoqiyik Wahsipekuk First Nation conducted a dive survey in subarea 8E in summer 2021; it covered the southeast side of Île aux Lièvres and the southwest part of Batture de l'Île Blanche.

In this survey, the maximum density (in abundance and biomass) of legal-sized sea urchins was 19.6 individuals/m² and 2.3 kg/m² respectively. The average density of legal-sized sea urchins was 2.5 individuals/m² and 0.25 kg/m² (WWFN 2021, unpublished data). The size distribution ranges from 15 to 94 mm in diameter, with an average of 46.1 mm. Nearly 62% all the sea urchins measured were below legal size. A modal value around 30 to 40 mm based on test diameter was observed, suggesting that recruitment in the population targeted by the fishery should continue over the coming seasons (WWFN 2021, unpublished data).

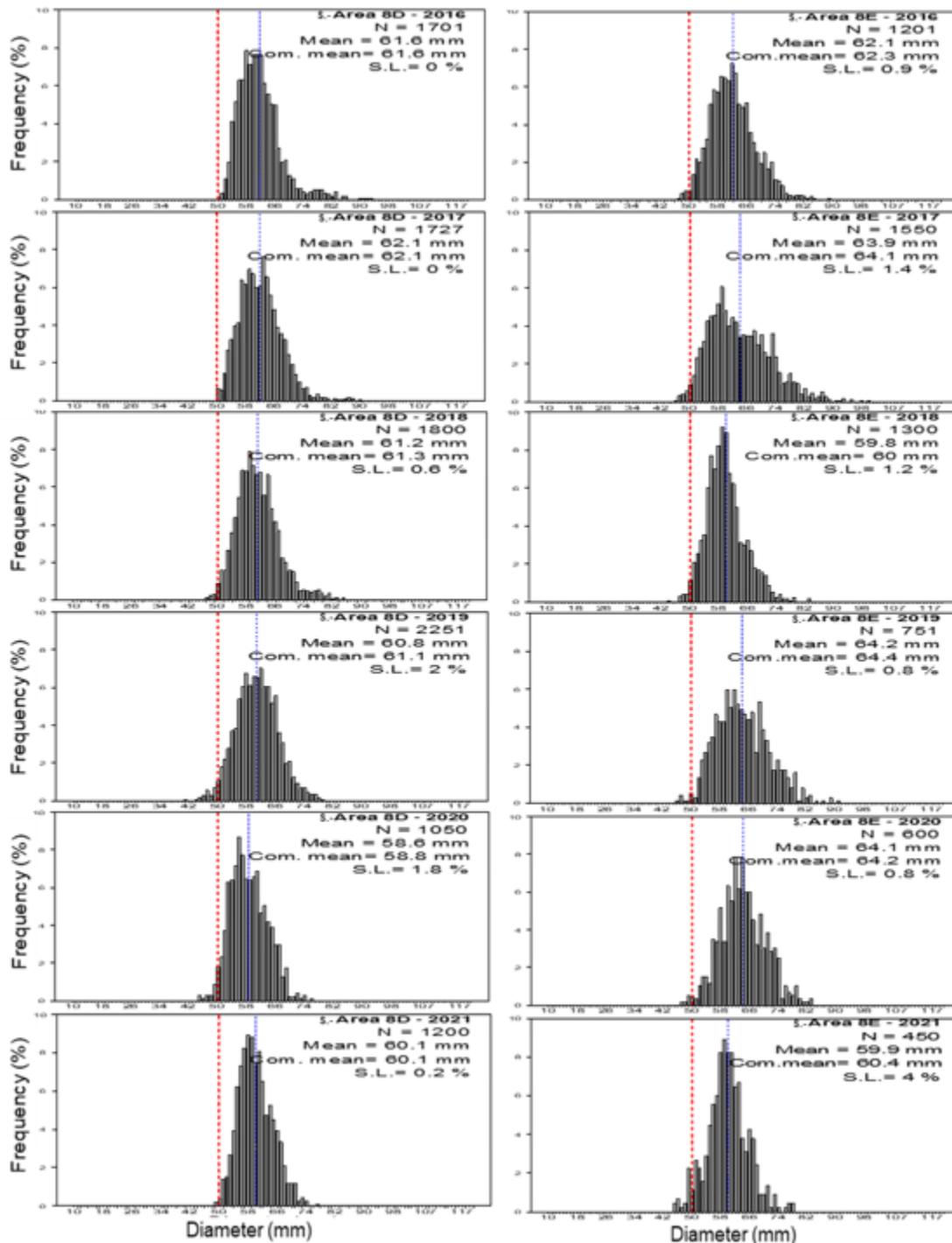


Figure 16. Size structures of green sea urchins from Area 8 (subarea 8D left panel and subarea 8E right panel) based on commercial sampling from 2016 to 2021. The number (N), average size (Mean) and the percentage of sub-legal-sized individuals (SL) are based on all sea urchins landed, whereas the average commercial size (Com. mean) is 50 mm in diameter and over. The dotted line represents the minimum legal size and the sample average size (in blue).

Quebec Region

Sources of Uncertainty

This assessment relies largely on the quality of the indices obtained from logbooks, purchase slips collected at the dock and at-sea commercial catch sampling. The data on effort and number of hours spent underwater by each diver to harvest sea urchins that were subsequently landed may be affected by a high degree of uncertainty, particularly because of the way that the logbooks are filled in by fishers and, in some cases, because of the lack of data on effort in diver-hours for some areas. Also, the time series are either short, or discontinuous depending on the management areas, which limits the type of analysis that can be done to assess the fishery's impact on the resource.

There is no reliable method yet to determine the age of green urchins and thus assess growth rates and determine time and recruitment patterns. Methods for estimating sea urchin age based on the urchin's mouth (Aristotle's lantern), or the calcified plates of the urchin's shell, known as the test, would not be reliable and representative of actual sea urchin aging.

Green sea urchin recruitment is likely dependant on salinity conditions in the estuary and may be increasingly more sporadic moving upstream from Pointe-des-Monts into the St. Lawrence.

The lack of demographic data and data on reproduction results in uncertainty regarding stock productivity and recruitment, whether local or from nearby sources for the coming years.

Natural and indirect mortality of sub-legal or legal size urchins linked to fishing activities remains unknown. Catches are sorted at sea on a grid to eliminate sub-legal size individuals. In addition, legal-size sea urchins are sometimes thrown-back to sea if their gonads are not of sufficient quality. The survival of sea urchins that have been thrown-back might depend on sorting conditions and the location where the sorting occurred and where they were thrown-back.

The divers' experience can affect the CPUE estimates. Therefore, year-to-year variations in CPUE values are possible if the various divers do not visit the same sites from year to year or if their experience differs from that of the other divers. Environmental conditions, such as water temperature at the fishing sites, can also affect the fishery's performance. These various sources of uncertainty constrain the interpretation of the indicators and could therefore mean that the conclusions in this advisory report do not accurately reflect the current status of green sea urchin stocks.

CONCLUSIONS AND ADVICE

Fishing for sea urchins in Quebec in environments as dynamic as those found in the various fishing areas calls for a precautionary approach in order to prevent localized overfishing. Examples from elsewhere in Canada have shown that green sea urchin populations can take a long time to recover from localized depletion.

For Area 8 (subareas 8D and 8E) and 9 (subarea 9-1), keeping catches near the average level for 2017-2021 should not have a major impact on sea urchin abundance over the next three seasons.

In Area 11, owing to the lack of information, it is not possible to comment on the status of the resource.

OTHER CONSIDERATIONS

Dive fishing is not considered harmful to the resource and the benthic habitat. However, the green sea urchin is a key organism in the ecosystem and when it is abundant it can determine the nature and diversity of benthic communities in shallow waters. Severe green sea urchin population depletion, either from disease or harvesting, can therefore lead to significant changes in the coastal ecosystem. In addition, certain ducks may depend on the green sea urchin for part of their diet.

Current knowledge of many aspects, including green sea urchin biology and ecology on the fishing grounds, should be improved, especially in the context of environmental changes. Efforts should therefore be directed in particular at updating the demographic parameters for the fishing grounds, such as the growth rate, in order to refine our data on temporal patterns of recruitment by assessing the age structure of landed sea urchins and the population as a whole on the fishing grounds; the exploitation rate; and spatio-temporal dynamics. It would also be helpful to derive specific weight-diameter relationships for the green sea urchin at the main sites harvested and for the different seasons.

Recruitment to the fishery in very dynamic systems, such as Areas 8 and 9, may depend on the growth rate of sea urchins in fishing grounds, the migration rate of juvenile sea urchins from adjacent areas to fishing grounds that promote high growth, and possibly storms that primarily transport or eliminate the largest urchins. Fishing effort control (bd quota and TAC, daily landing limit, limit on the number of divers per boat, limit on extraction technology) appears well-adapted measures to ensure sustainable harvesting of the resource.

LIST OF MEETING PARTICIPANTS

Name	Affiliation
Belley, Rénaud	DFO – Science
Bernier, Denis	DFO – Science
Busawon, Dheeraj S	DFO – Science
Couillard, Catherine	DFO – Science
Croussette, Yolaine	DFO – Resource management
Cyr, Charley	DFO – Science
Desjardins, Christine	DFO – Science
Dubé, Sonia	DFO – Science
Gendreau, Yanick	DFO – Science
Gianasi, Bruno	DFO – Science
Hardy, Magalie	DFO – Resource management
Juillet, Cédric	DFO – Science
Lacasse, Olivia	DFO – Science
Léonard, Pierre	Essipit First Nation
Loboda, Sarah	DFO – Science
MacGregor, Kathleen	DFO – Science
Morneau, Jacques	Fisher
Ouellette-Plante, Jordan	DFO – Science
Rondeau, Marie-Hélène	AGGHAM
Roy, Marie-Josée	DFO – Resource management
Roy, Virginie	DFO – Science
Sainte-Marie, Bernard	DFO – Science
Tamdrari, Hacène	DFO – Science
Tremblay, Jason	Fisher

Name	Affiliation
Weiner, Guy-Pascal	Wolastoqiyik Wahsipekuk First Nation

SOURCES OF INFORMATION

This Science Advisory Report is from the regional peer review on June 15-16, 2022 on Assessment of the Green Sea Urchin stocks in the Northern Estuary and Gulf of St. Lawrence in 2022. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

- Blicher, M.E., Rysgaard, S. and Sejr, M.K. 2007. Growth and production of sea urchin *Strongylocentrotus droebachiensis* in a high-Arctic fjord, and growth along a climatic gradient (64 to 77°N). *Mar. Ecol. Prog. Ser.* 341: 89-102.
- DFO. 2008. [Assessment of green sea urchin of the North Shore of the St. Lawrence Estuary in 2008](#). DFO Can. Sci. Advis. Sec., Sci. Advis. Rep. 2008/048.
- DFO. 2012. [Assessment of the Green Sea Urchin Fishery in the Estuary and the Gulf of St. Lawrence in 2011](#). Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/055.
- DFO. 2016. [Assessment of the Green Sea Urchin Fishery in the Northern Estuary and Gulf of St. Lawrence in 2015](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/054.
- Himmelman, J., Axelsen, F., and Lavergne, Y. 1979. Étude des populations et du cycle sexuel de l'oursin vert au Québec. Ministère de l'Industrie, du Commerce et du Tourisme, Direction générale des Pêches maritimes, Cahier d'Information 93: 38 p.
- Himmelman, J.H., Lavergne, Y. and Axelsen, F. 1997. Variations saisonnières de la taille et de la composition chimique des gonades chez l'oursin vert (*Strongylocentrotus droebachiensis*) de l'estuaire et du golfe du Saint-Laurent. Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Direction de l'innovation et des technologies, Cahier d'information 131: 34 p.
- Jensen, M. 1974. The Strongylocentrotidae (Echinoidea), a morphologic and systematic study. *Sarsia* 57: 113-148.
- Sainte-Marie, B. and Paille, N. 2020. [Spatial distribution and demography of the green sea urchin, *Strongylocentrotus droebachiensis*, around Île Blanche and the eastern tip of Île aux Lièvres \(Quebec\) in 2011](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2019/007. vii + 35 p.
- Scheibling, R.E. and Hatcher, B.G. 2001. The ecology of *Strongylocentrotus droebachiensis*. Dans Lawrence, J.M. (dir.). *Edible sea urchins: Biology and ecology*. Developments in Aquaculture and Fisheries Science, vol. 32. Elsevier, Amsterdam. pp. 271-306.
- Scheibling, R.E. and Robinson, M.C. 2008. Settlement behaviour and early post-settlement predation of the sea urchin *Strongylocentrotus droebachiensis*. *J. Exp. Mar. Biol. Ecol.* 365: 59-66.
- Starr, M., Himmelman, H. and Therriault, J.-C. 1993. Environmental control of green sea urchin, *Strongylocentrotus droebachiensis*, spawning in the St. Lawrence Estuary. *Can. J. Fish. Aquat. Sci.* 50: 894-901.
- Vadas, R.L., Smith, B.D., Beal, B. and Dowling, T. 2002. Sympatric growth morphs and size bimodality in the green sea urchin (*Strongylocentrotus droebachiensis*). *Ecol. Monogr.* 72: 113-132.

THIS REPORT IS AVAILABLE FROM THE:

Centre for Science Advice (CSA)
Quebec Region
Fisheries and Oceans Canada
Maurice Lamontagne Institute
P.O. Box 1000
Mont-Joli, QC (Canada)
G5H 3Z4

E-Mail: bras@dfo-mpo.gc.ca

Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-5087

ISBN 978-0-660-46471-8 N° cat. Fs70-6/2022-053E-PDF

© His Majesty the King in Right of Canada, as represented by the Minister of the
Department of Fisheries and Oceans, 2022



Correct Citation for this Publication:

DFO. 2022. Assessment of the Green Sea Urchin Stocks in the Estuary and Northern Gulf of
St. Lawrence in 2021. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2022/053.

Aussi disponible en français :

*MPO. 2022. Évaluation des stocks d'oursin vert dans l'estuaire et le nord du golfe du Saint-
Laurent en 2021. Secr. can. des avis sci. du MPO. Avis sci. 2022/053.*