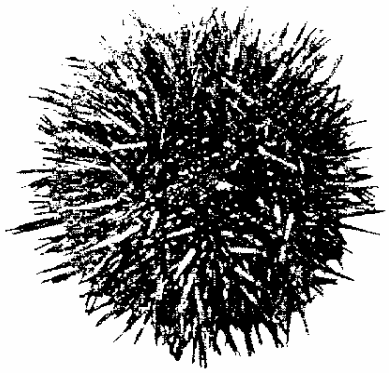
# ASSESSMENT OF GREEN SEA URCHIN OF THE NORTH SHORE OF THE ST. LAWRENCE ESTUARY IN 2008



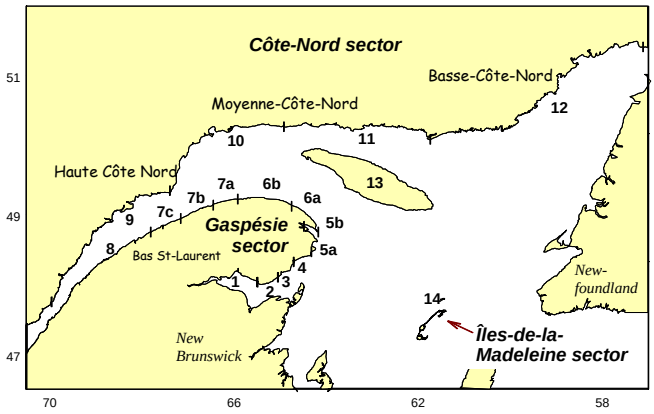



*Figure 1. Green sea urchin management areas in the Estuary and Gulf of St. Lawrence.*

## Context

*The green sea urchin (*Strongylocentrotus droebachiensis*) fishery began in the Quebec region in 1991. The Quebec region coastline is divided into 14 fishing areas (Figure 1) which are exploited by divers or with traps. The main management measures are limits on the number of permits per area, prohibition of towed gear, limits on the number of traps and divers, and a minimum legal size of 50 mm test diameter. The fishery is mostly conducted from March to May and from September to December, when gonad yield and quality are highest.*

*Green sea urchin landings in Quebec totalled less than 100 t annually, except in 1995 (122 t), 1997 (159 t) and after 2002. Landings soared from 146-188 t annually in 2003-2005 to 757 t in 2007, mostly because of the exploitation of a substantial bed at the mouth of the Saguenay River in Area 9. Many stakeholders were concerned about the volume of sea urchin landings from the river mouth. In February 2008, at the Area 9 sea urchin advisory committee meeting, it was recommended that harvesting be limited to a one-month period in spring at the river mouth, until a resource status update in Area 9 along with a specific assessment of the resource at the river mouth was done. This advice accounts for the work accomplished on this issue.*

## SUMMARY


- Green sea urchin landings in Area 9 (Upper North Shore) varied between 0 and 86 t annually from 1994 to 2002. Beginning in 2003, they rose sharply and reached 689 t in 2007. In 2008, preliminary recorded landings as of August totalled 232 t.

- Fishing effort, measured in boat-days, was not evenly distributed in Area 9 over the years. From 2005 to 2008, 98% of landings in Area 9 came from the mouth of the Saguenay. The fishery at the river mouth was concentrated over an area of less than 2 km² on the south-

east side of Batture-aux-Alouettes. Around 25% of the landings occurred between early April and mid-May (spring) and 60% from early September to the end of November (fall).

- On Batture-aux-Alouettes, the mean catch per unit effort (CPUE) recorded in diver-hours decreased between 2005 and 2007, whereas the size of landed sea urchins remained the same in 2006, but dropped between spring and fall in 2007. Data from the spring fishery showed a steady increase in CPUE variability between 2006 and 2008, and the size of landed sea urchins in the spring of 2008 continued to drop compared to the fall of 2007. These changes can be interpreted as signs of overfishing.

- An underwater diving survey conducted at the mouth of the Saguenay in June 2008 confirmed the occurrence of a substantial sea urchin population around the Batture-aux-Alouettes and helped characterize the spatial distribution, density and size structure of sea urchins. An abundance of sea urchins of 15-25 mm in diameter suggests that recruitment was good in 2005 and 2006.

- Fishing effort and catches at the mouth of the Saguenay were five times higher in 2006 and 2007 compared to 2005. The 2008 fishing plan was aimed at considerably decreasing exploitation at the river mouth by reducing the fishing season to a month in the spring. Fishing effort and catches did in fact drop, but fishery statistics suggest that the two high-exploitation years have impacted the abundance and size of sea urchins. It is therefore recommended that the river mouth remained closed in the fall of 2008 and that the 2009 fishing effort be limited to a similar level as in the spring of 2008.

# INTRODUCTION

## Species Biology

The sexes are separate in green sea urchins and cannot be distinguished on the basis of external characteristics. It is the gonads that are sought and male and female sea urchins are caught indiscriminately in this fishery. The five gonads, which are located on the upper part of the internal cavity of the test, undergo significant changes in volume, firmness and colour over an annual reproductive cycle. In winter, gonad weight may account for as much as 25% of the sea urchin's total weight. During spawning, in May or June in the St. Lawrence Estuary, gonad weight drops below 10% of total weight and remains low throughout the summer. The commercial value of sea urchins decreases during this time period. However, with the arrival of fall, gonad weight increases once again, restoring the species' appeal for commercial harvesting.

The green sea urchin reaches sexual maturity at a test diameter of around 25-30mm and around 3-4 years old. Fertilization is external and produces pelagic larvae that drift for about 1-4 months in the surface water and then settle on the bottom. At the time of settlement, the juvenile sea urchin measures barely 0.5 mm in diameter. The green sea urchin reaches a minimum legal size of 50 mm at around 5-7 years of age and could still live several more decades. The sea urchin growth rate may vary considerably and depend more on the quality and quantity of available food than on temperature or season. The sea urchin grows more rapidly along kelp beds, or in areas where currents bring a regular supply of algae, than on barren substrates.

In more favourable areas, the green sea urchin forms feeding fronts or high density aggregates and strips the algae from the substrate. The depths where these feeding fronts are found were

used as intensity indicators of commercial exploitation. When the larger sea urchins are removed from feeding fronts, they may be replaced by growth of sublegal-size sea urchins in the area and by migration of legal-size sea urchins located in deeper waters.

The green sea urchin survival rate, excluding harvesting, is usually quite high. The main causes of natural mortality for the sea urchin are osmotic stress, predation and disease. Larvae and juveniles are especially sensitive to low salinity and it has been suggested that recruitment in the Quebec region could be episodic because of occasional unfavourable salinity conditions for larval survival, particularly in the middle Estuary (Île d'Orléans to the mouth of the Saguenay) and to a lesser extent further downstream. Along the Quebec coastline, the main green sea urchin predators include lobster, crab, large starfish, wolfish, and seabirds. In Nova Scotia, mass mortalities of green sea urchins have occurred on several occasions over the last 30 years, over several kilometres of coastline. These mortalities are believed to have been caused by a pathogenic amoeba (*Paramoeba invadens*), which spreads in warmer water masses. Mass mortalities of this sort have never been reported in the cold waters of the Estuary and Gulf of St. Lawrence. More recently, the bryozoan *Membranipora membranacea*, an invasive species, could be threatening the kelp beds along the south coast of the Gaspé Peninsula and around the Magdalen Islands.

## Description of the Fishery

The Quebec coastline is divided into 14 green sea urchin main fishing areas. Areas from 9-12 of the North Shore sector are much larger than the Gaspé sector areas (Figure 1). Area 9, which is targeted by this advice, extends from Pointe-au-Pic to Pointe-des-Monts.

There are two authorized methods for harvesting green sea urchins in the Quebec region; underwater diving and whelk traps. The trap fishery is not very popular and is mostly done in Area 9. Towed harvesting gear is prohibited except in sea urchin rearing sites along the Lower St. Lawrence coastline between Trois-Pistoles and Rimouski (Area 8) where the *Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec* has approved the use of a small dredge for harvesting sea urchins.

The management measures in effect for green sea urchins in the Quebec region are aimed at controlling fishing effort and protecting the reproductive potential. The number of exploratory permits, divers and traps is limited in each fishing area. A minimum legal size of 50 mm test diameter is mandatory everywhere. Underwater diving for sea urchins is permitted almost all the time but traps are usually prohibited from spring to fall.

In Area 9, there are 7 exploratory permits for harvesting green sea urchins; 4-6 of them have been active in recent years. Divers are limited to 5 per boat, and traps (maximum volume of 0.5 $m^3$, minimum mesh size of 102 mm with mandatory escape vents) are limited to 100 per boat. In 2008, underwater diving was authorized from March 17$^{th}$ to December 31$^{st}$, except at the mouth of the Saguenay, which could only be accessed from March 30$^{th}$ to May 9$^{th}$. Traps were prohibited from March 31$^{st}$ to October 5$^{th}$.

Logbooks are mandatory in the Quebec region. These logbooks indicate the duration of the fishing trips and the landings, the harvesting method, the locations where catches were made and the number of divers or the number of traps and their immersion time, as well as the duration, depth and composition of the sea floor at each dive.

The first green sea urchin landings in Quebec occurred in 1991. Landings increased from 7 t in 1991 to 159 t in 1997, dropped to less than 25 t annually between 1998 and 2001, and then increased and peaked at 757 t in 2007. Only in Area 9, the first landings occurred in 1995 (less than one ton) and reached 86 t in 1996, dropped to less than 12 t annually between 1998 and 2002, and then sharply increased beginning in 2003 and reached 689 t in 2007 (Figure 2). Landings in Area 9 totalled 232 t during the 2008 spring fishery. Ninety eight percent of sea urchins landed in Area 9 between 2005 and 2008 (a total of 1,658 t) were from the mouth of the Saguenay (river mouth), including Batture-aux-Alouettes, Baie-Sainte-Catherine and Batture-de-la-Pointe-aux-Vaches. In 2006 and 2007, the bulk of the landings were made between early April and mid-May (spring season: average of 25% of the annual landings) and between September and November included (fall season: 61%). The remaining landings were made in February, March, August and especially December.

## ASSESSMENT OF THE RESOURCE IN AREA 9

The status of the resource in Area 9 was established by examining various commercial fishery indicators. These indicators provide information on spatial distribution, fishing effort and success, as well as green sea urchin abundance and size. An underwater research survey conducted in June 2008 provided information on spatial distribution, density and green sea urchin size structure at the river mouth.

Commercial fishery statistics are used for estimating fishing effort and for calculating catches per unit effort (CPUE). Effort and CPUE are first given in boat-days (bd) and in kilograms per boat-day (kg/bd) because the information regarding the harvesting method is not always indicated in the logbooks. Even when the harvesting method is indicated, the effort (number of traps lifted or number and duration of dives) is not always recorded. The CPUE given in kg per diver-hours (kg/dh) is also presented because it has been the principal harvesting method in recent years (> 85% of the landings) and because it is a better indicator of sea urchin abundance. The geo-referenced CPUEs were used to map fishing effort distribution.

### Status of the Resource from 1996 to 2007

#### Fishing Effort

The fishing effort measured in boat-days has not been evenly distributed in Area 9 over the years (Figure 3). The area west of the mouth of the Saguenay, which includes the coastal area around Saint-Siméon and Île-aux-Lièvres, was targeted (i.e. an annual effort of at least 20 bd) in 1996 and 1997 (only Saint-Siméon) and again in 2003 and 2004 (Saint-Siméon and Île-aux-Lièvres). The effort in the western portion of Area 9 was nil in 1994 and only 3 bd (less than one ton landed) in 1995. The area east of the river mouth, which includes coastal areas extending from Pointe-à-Boisvert to Pointe-aux-Outardes and around Pointe-des-Monts was targeted in 2000 and harvested with an effort of 10 bd in 2003 and 2004. The river mouth was targeted beginning in 2004 and the effort then increased to 251 bd in 2007. Even within the three parts of Area 9, spatial distribution of the fishing effort was not consistent from one year to the next. At the river mouth in particular, the fishing effort became increasingly concentrated from 2004 to 2008.

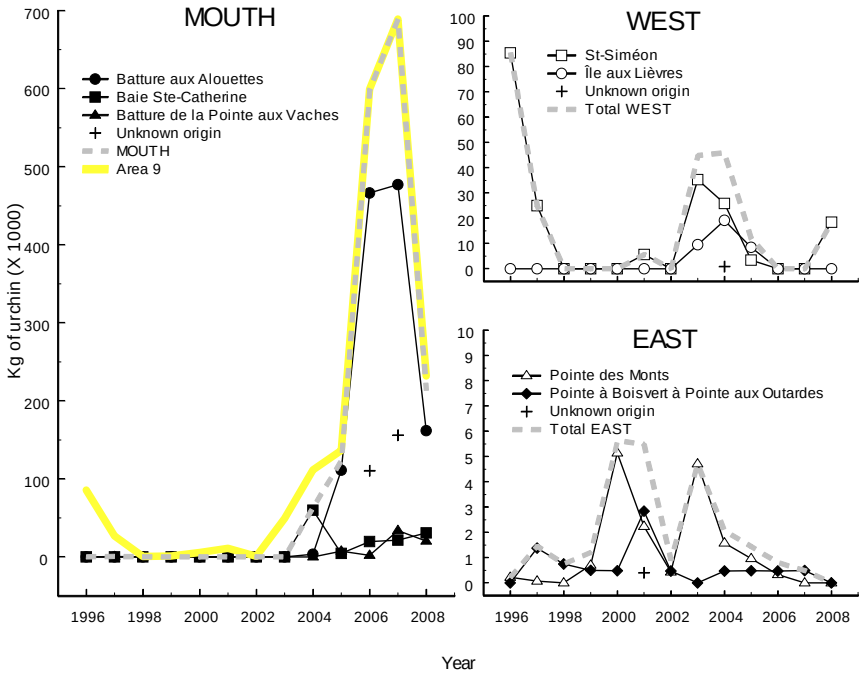



*Figure 2. Green sea urchin landings at the mouth of the Saguenay and in the western and eastern portions of Area 9 from 1996 to 2008. The total for Area 9 is indicated on the left. The designation "unknown origin" refers to landings that cannot be linked to a specific location.*

## Catch Per Unit Effort (CPUE)

The CPUEs were also inconsistent from one year to the next (Figure 4). In the western part of Area 9, harvesting was stopped in 1998 following a sharp drop in CPUEs measured in bd or dh between 1996 and 1997. From 2003 to 2005, the CPUE in bd returned to a level equal (> 1,000 kg/bd) to that of 1996, but the CPUE in dh (< 150 kg/dh) remained considerably lower than the 1996 value.

The CPUE in bd in the eastern part was lower and more consistent than elsewhere in Area 9 (Figure 4). It varied around 250 kg/bd, reaching a maximum in 2003 and a minimum in 2004. CPUEs in dh were sporadic because traps were used more than divers. The values were below 100 kg/dh in 1996 and 1997 and above 150 kg/dh in 2001 and 2003.

At the mouth of the Saguenay, the CPUE recorded in bd or in dh first increased from 2004 to peak in 2005, and then dropped by 17-18% up to 2007 (Figure 4). Geo-referenced CPUEs from 2006 to 2007 served to identify the two best harvesting areas at the river mouth (Figure 5). These areas correspond to the concentrations of harvesting positions where yield was usually within the top 75% of the distribution of CPUE values in diver-hours. The largest of these areas (A) extends over around 1.7 $km^2$ south-east of Batture-aux-Alouettes, the second (B) over 0.2 $km^2$ of the north-east portion of Batture-de-la-Pointe-aux-Vaches. The first of these areas contributed to landings from Batture-aux-Alouettes in a proportion of at least 19% in 2005, 66% in 2006 and 85% in 2007. The relative contribution of area A to landings from the river mouth was at least 17% in 2005, 63% in 2006 and 77% in 2007. Between these two areas, there is a

harvesting area (C) of about 8.1 km$^2$ where the fishing effort was scattered and yield was generally weak.

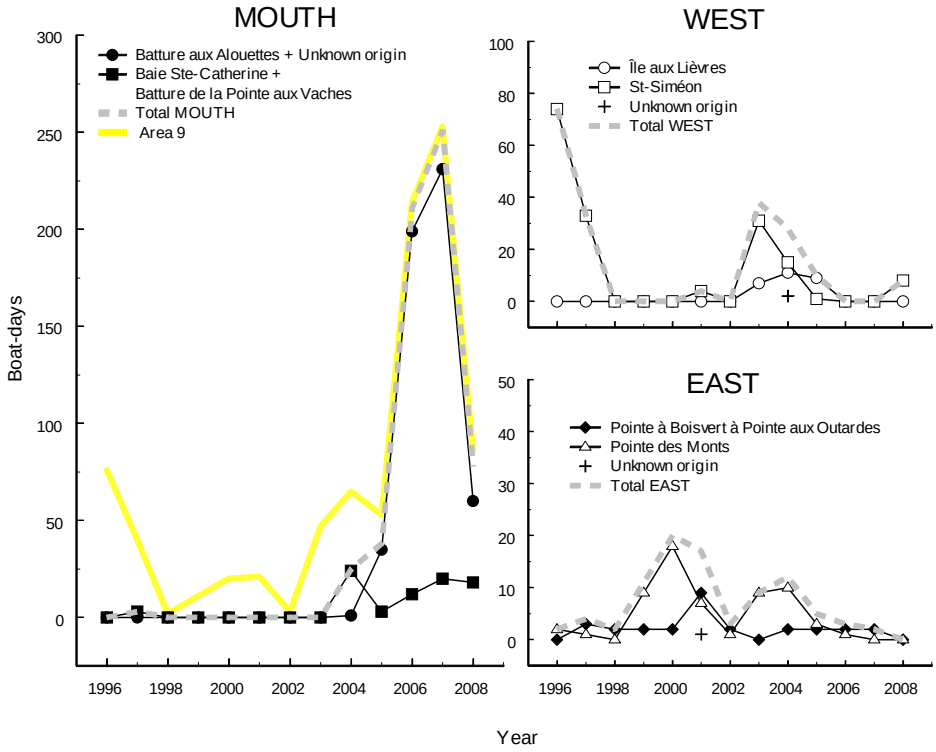



*Figure 3. Green sea urchin fishing effort measured in boat-days at the mouth of the Saguenay and in the western and eastern portions of Area 9 from 1996 to 2008. The total for Area 9 is indicated on the left. The designation "unknown origin" refers to landings that cannot be linked to a specific location.*

## Size Structures

Samples from commercial catches are usually scarce and their origin is not always certain prior to 2004. In addition, before 2005, samples represented what the traps or divers brought back on board, before sorting them. Beginning in 2005, samples represent sorted and landed sea urchins. Samples from Saint-Siméon (west of Area 9) show a median size and sub-legal proportion that were respectively weak and high (1996), or high and weak (2003). Sea urchins from the eastern part of Area 9, in 2000 and 2001, were characterized by a very small median size and a very large proportion of sub-legal size individuals. In 2004, more than half the landed sea urchins from Area 9 were from Baie-Sainte-Catherine and the rest from the western portion (Saint-Siméon and Île-aux-Lièvres, more or less in equal proportions) and the median size of sea urchins caught was small and the proportion of sub-legal size individuals was relatively high. Overall, theses observations could suggest that sea urchins are smaller in the eastern part of Area 9 than in the western part.

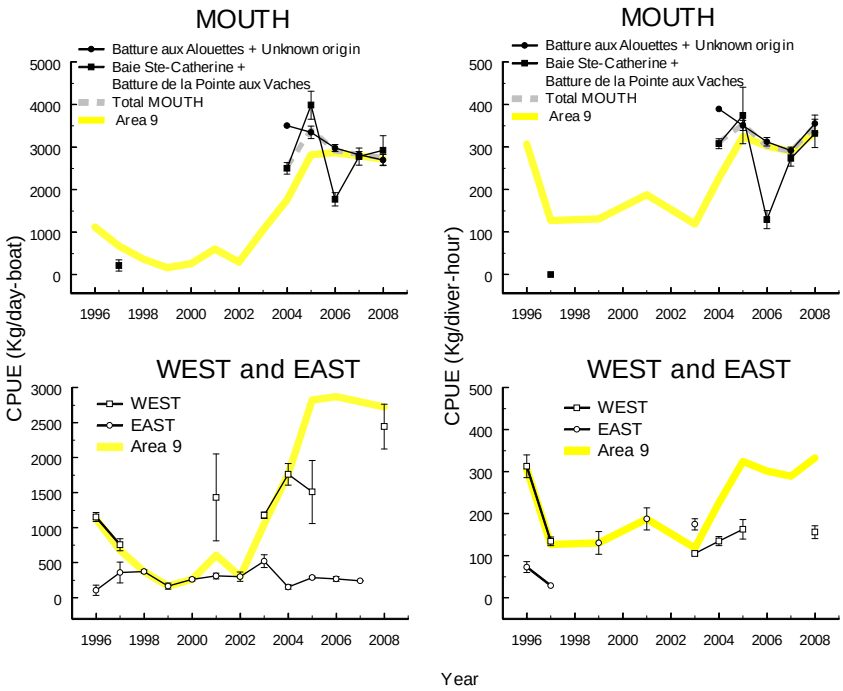



*Figure 4. Average ± one standard error of green sea urchin catches per unit effort (CPUE) recorded in boat-days or in diver-hours at the mouth of the Saguenay and in the western and eastern parts of Area 9 between 1996 and 2008.*

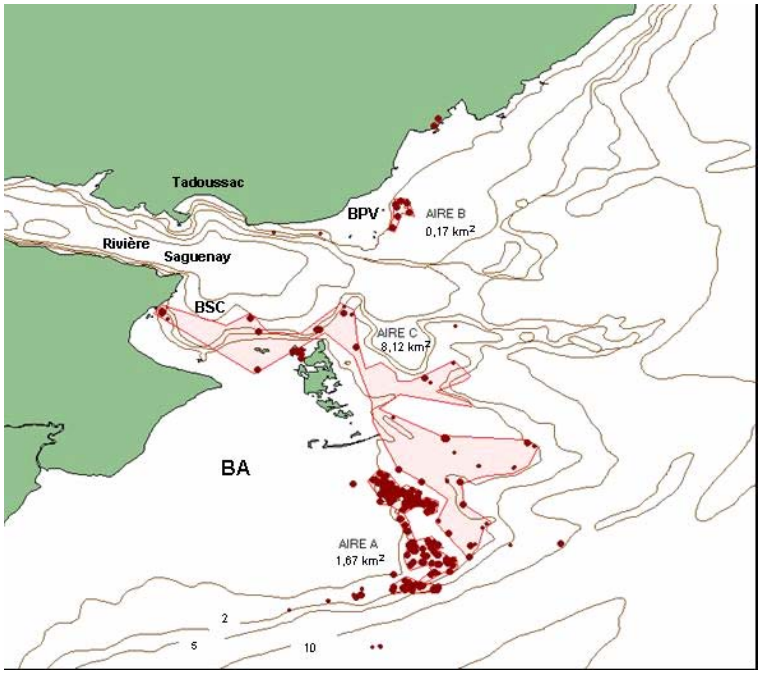



*Figure 5. Main harvesting areas (= aire) at the mouth of the Saguenay in 2006 and 2007 determined by the level and spatial concentration of catches per unit effort (CPUEs) recorded in diver-hours. Dots that correspond to harvesting positions with low CPUEs (small dots, lower 25% of values) or to higher CPUEs (large dots, upper 75% of values). The identified isobaths are in meters. BA, Batture-aux-Alouettes; BPV, Batture-de-la-Pointe-aux-Vaches; BSC, Baie-Ste-Catherine.*

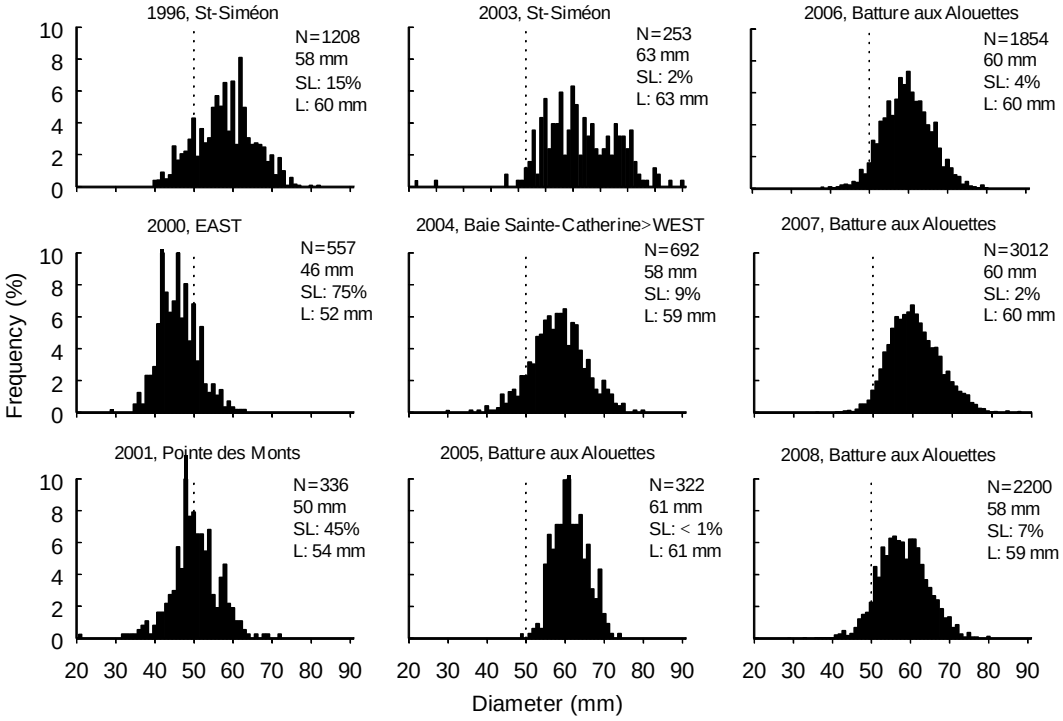



*Figure 6. Green sea urchin size structures from different parts of Area 9 from 1996 to 2008 based on commercial sampling. The number (N), the median diameter of all the sea urchins, the percentage of sub-legal size individuals (SL) and the median diameter of legal size sea urchins (L) are indicated. The dotted line represents the minimum legal size. The known or presumed origin of the samples is indicated at the top of each figure: EAST, eastern part of Area 9; WEST, western part of Area 9.*

Beginning in 2005, green sea urchin landings in Area 9 were mostly from Batture-aux-Alouettes. From 2005 to 2006, the median size of all the landed sea urchins dropped slightly from 61 to 60 mm and the proportion of sub-legal sea urchins increased from less than 1% to 4% (Figure 6). In 2007, size appeared to be more stable, but in depth analysis revealed that median size decreased and the proportion of sub-legal sea urchins increased between spring (62 mm, 1%) and fall (59 mm, 3%). In 2006, sea urchin size did not decrease from spring to fall.

## Resource Status in 2008

The spring fishery in Area 9 was from March 30$^{th}$ to May 9$^{th}$ 2008 at the mouth of the Saguenay. Fishing effort reached 86 bd and was concentrated at 91% at the river mouth, mostly at Batture-aux-Alouettes, and for the rest around Saint-Siméon (Figure 3). The effort deployed in the spring of 2008 was higher in area A, both absolutely and relatively compared with the rest of the river mouth (52 bd, 67%), than in the spring of 2007 (21 bd, 36%) or 2006 (24 bd, 51%).

At the mouth of the Saguenay, the CPUE in bd revealed a slight drop in 2008 compared to 2007, mostly showing a decrease in yield at Batture-aux-Alouettes (Figure 4). However, the CPUE in dh increased considerably and returned to the 2005 level both at the Batture and the river mouth overall (Figure 4). The CPUE drop in bd and the CPUE increase in dh occurred as the fishing effort in 2008 was mostly concentrated in area A, which alone represented 87% of

the landings from the Batture and 66% of those from the river mouth. The contradicting CPUE drop in bd and the CPUE increase in dh can be explained by a considerable drop in terms of fishing effort upon each outing. The average number of divers per boat was consistent from 2006 to 2008 (3.0 - 3.1 divers), but the mean number of diving hours per bd dropped by more than 30% in 2008 (8.4 h) compared to 2007 (13.6 h) and 2006 (12.0 h). This decrease is likely caused by the increase in fishing effort in bd in area A in the spring of 2008 compared to the spring of 2006 and 2007, tide conditions in area A being more often limiting for the number of daily dives than elsewhere at the river mouth.

A more in depth analysis of the fishery in area A was done on account of the concentration of effort in this location in 2008. During the spring, the CPUE recorded in dh in area A is high and did not change from 2006 to 2008 (Table 1). Furthermore, there was a drop in harvesting yield between spring and fall for each complete harvesting year. The mean CPUE recorded in dh was between 6 or 11% lower in the fall compared to spring in 2006 and between 15 or 18% lower in 2007, depending on whether the mean or the median was used respectively (Table 1). The analysis of the cumulated landing progress in relation to the cumulated effort in area A in 2007 showed that the CPUE decrease was mostly felt beginning on October 22$^{nd}$, 2007, at which point there was a cumulated effort of 800 dh for a cumulated landing of 248 t. The total effort in area A in 2007 reached around 1,460 dh for a total landing of 408 t. These numbers are likely a little conservative because 21% of the landings at the river mouth cannot be attributed to a specific location. Importantly, it should also be noted that variability in terms of the mean or median CPUE has increased over the years (Table 1).

In 2008, the median size of landed sea urchins in spring dropped and the proportion of sub-legal size sea urchins increased considerably compared to the 2007 values (Figure 6). A more in depth analysis revealed a drop in size between the fall of 2007 and the spring of 2008.

*Table 1. Mean (± standard deviation, SD) and median (Med, with quartiles) of catch per unit effort recorded in diver-hours (kg/dh) in area A at the Batture-aux-Alouettes in the spring and fall from 2006 to 2007 and in the spring of 2008.*

| | Spring | | Fall | |
|---|---|---|---|---|
| Year | Mean ± SD | 25% – Med – 75% | Mean ± SD | 25% – Med – 75% |
| **2006** | 336.0 ± 59.7 | 302.4 – 320.7 – 378.0 | 299.5 ± 65.6 | 264.6 – 302.4 – 340.2 |
| **2007** | 341.2 ± 118.9 | 283.5 – 343.9 – 414.1 | 290.9 ± 108.4 | 197.9 – 283.5 – 354.0 |
| **2008** | 358.8 ± 149.4 | 225.3 – 347.4 – 494.4 | — | — |

The research survey conducted underwater at the mouth of the Saguenay in June 2008 revealed the existence of a significant green sea urchin population. The large sea urchins were more abundant in shallow than in deep waters, both at Batture-aux-Alouettes and on the south side of Batture-de-la-pointe-aux-Vaches. In deeper waters, sea urchins of 15-25 mm in diameter, likely 2-3 years-old, were abundant, which suggests that recruitment to the population was good in 2005 and 2006.

## Outlook

Between 1996 and 2005, green sea urchin harvesting in Area 9 has been inconsistent in terms of intensity and spatial coverage. According to some stakeholders, Area 9 has been extensively

explored and seafloor areas that are interesting in terms of commercial harvesting have now been identified. Some beds, such as Îles-aux-Lièvres, are significant but currents or depths limit access for divers. The Batture-aux-Alouettes bed was discovered in 2004 and the subsequent exploration in 2005 of this abundant green sea urchin bed led to a spatial concentration and increase in harvesting effort in Area 9 in 2006 and 2007.

Although green sea urchin harvesting in Area 9 has been exploratory in nature and its intensity has been very inconsistent until recently, some signs of resource fragility are noticeable. This first became obvious as the CPUE decreased in dh in the western part of the area (Saint-Siméon) in only three consecutive harvesting years (1995-1997) and this portion of the area was subsequently abandoned except for a brief incursion in 2003 and 2004. The CPUE recorded in dh in the western part of Area 9 remains below the 1996 values.

Batture-aux-Alouettes is home to a very substantial green sea urchin population and supported intense harvesting in 2006 and especially in 2007. Within the main harvesting area (A) around the Batture, the consistency of the CPUE in dh in the spring of 2007 and 2008 compared with the spring of 2006, even though there was a certain drop in the number of sea urchins over the fall of 2006 and 2007, would seem at first glance to indicate a good resilience to exploitation. Within the context of such a young fishery, the spring recovery of the CPUE in dh following a fall depletion and a winter resting period of about four months could reflect (i) replacement of the commercial green sea urchin population by migration of individuals of legal size and by the growth of sub-legal size individuals on site, (ii) spatial concentration of surviving sea urchins towards the more productive sites (kelp beds and trenches where currents concentrate a regular supply of drifting algae) that are now better known and targeted by harvesters, (iii) or a combination of both. However, the increasing variability of the CPUE from 2006 to 2008 (both in spring and in fall), the decrease in size of landed sea urchins from 2005 to 2008, along with verbal reports from some harvesters and divers who claim the resource has been decreasing, strongly suggest that sea urchins are not replaced at the same pace they are removed. Although the green sea urchin population at the mouth of the Saguenay is still substantial, as the underwater diving survey suggests, it may be made up of accumulated individuals from a wide range of year-classes because of the species' potentially long lifespan and the mortality rate of adults which is presumed to be quite low – especially in the absence/scarcity of significant natural predators such as lobster or rock crab around the Batture.

Signs of depletion of green sea urchins in Area 9 occurred even though harvesting has never been fully exercised because of inactive permits and a fishing effort below the authorized limit. For example, if the 7 exploratory permits had been active for 6 weeks in the spring and 12 weeks in the fall for 5 harvesting days per week with 5 divers per boat, the nominal effort in Area 9 would have reached 3,150 diver-days (dd), yet, to this day it has never exceeded 750 dd. In addition, existing but undeveloped technology, such as turbine assisted pumping, could greatly improve diver success. The potential green sea urchin harvesting capacity in Area 9 appears to far exceed the resource's productivity.

## Sources of Uncertainty

The spatial volatility of the green sea urchin fishing effort in Area 9 up until 2005, combined with regional populations with apparently different demographic characteristics, limits the type of analysis that can be done regarding the impact of harvesting on the resource. In fact, time series are either short or discontinuous. Elsewhere, where the green sea urchin fishing effort

has been more consistent in space and over time, production surplus models have been developed that have helped measure appropriate catch levels for this species.

In the short term, the most significant information in order to better understand green sea urchin dynamics at the mouth of the Saguenay and in Area 9 as a whole, would be an age structure assessment of landed sea urchins and of the population as a whole. There are methods for evaluating the age of sea urchins from the calcareous plates of the test or Aristotle's lantern. This information would provide a way to measure the growth rate and determine time and recruitment patterns. Green sea urchin recruitment is likely dependant on salinity conditions in the Estuary and that it may be increasingly more sporadic moving upstream from Pointe-des-Monts into the St. Lawrence.

Studying the movements of sea urchins around the Batture-aux-Alouettes is of great interest for better understanding the significance of migration versus growth for replacing sea urchins on the harvested seafloor. It would be especially interesting to verify whether area A is a sink (sea urchins enter but do not exit) and in what ways its replenishment alters the density and distribution of neighbouring sea urchins.

The spatial variability of sea urchin gonad quality is still unknown within the main harvesting areas. Even though the diving survey suggests an abundant sea urchin population at the mouth of the Saguenay, perhaps only a portion is of good enough quality for harvesting. It is known that sea urchins that do not have access to kelp in their diet have gonads of lesser quality. However, the time required in nature to condition gonads following the migration of a sea urchin on an area of the seafloor rich in nutrients is still unknown. There may also be a variation in terms of sea urchin quality based on their position in the feeding front.

It would also be important to examine the indirect mortality of sub-legal or legal size sea urchins linked to harvesting activities. 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.

Finally, it would be important to develop specific weight-diameter relationships for the green sea urchin at the mouth of the Saguenay, for the different seasons of the year.

## CONCLUSIONS AND ADVICE

Harvesting in Area 9 has increased sharply since 2004 and contributed to 91% of the total green sea urchin landings in Quebec in 2007. More than 98% of the 1,657 t of green sea urchin landings in Area 9 between 2005 and 2008 were from a harvesting area less than 10 $km^2$ at the mouth of the Saguenay. Even within this area, 66% of landings in 2007 and 2008 came from a harvesting area less than 2 $km^2$ located south-east of the Batture-aux-Alouettes. This extreme concentration of the fishing effort goes against the recommendations made in the previous Quebec sea urchin stock status report (DFO, 2000), which recommended that the fishing effort be spread out spatially.

The intensity of harvesting at the mouth of the Saguenay requires great caution. In fact, the growing variability of the CPUE in dh, the increased fall depletion of the resource in 2007

compared to 2006 and the drop in landed sea urchin median size appear to be signs of overfishing. Caution is also required because green sea urchin populations may take a long time to recover from localized overfishing, considering the events at Saint-Siméon (western part of Area 9) and elsewhere in Canada.

Consequently, it is recommended not to open the green sea urchin fishery at the mouth of the Saguenay in the fall of 2008 and to implement measures to limit the effort (and landings) in 2009. In the event this decision is made, a complete shift of the fishing effort level that existed in 2007 towards other parts of Area 9 in the fall of 2009 could be detrimental. A preventive fishing effort for Batture-aux-Alouettes could be established using the relationship between cumulated landings and cumulated effort for area A. This level corresponds roughly to the level that existed in the spring of 2008. In addition, harvesting could be limited to the spring when sea urchin gonad quality is highest.

Harvesting capacity in Area 9 has never been at its maximum potential and it would be important to monitor it properly to also prevent overfishing elsewhere than at Batture-aux-Alouettes. Various measures can be considered for reducing fishing capacity.

## OTHER CONSIDERATIONS

Underwater diving is not considered harmful for the environment. However, the green sea urchin is a structuring 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 seabirds could depend in part on the green sea urchin for their diet.

## SOURCES OF INFORMATION

DFO. 2000. Green sea urchin of the inshore waters of Quebec. DFO – Sciences, Stock Status Report C4-13 (2000).

Sainte-Marie, B., S. Brillon and N. Paille. In prep. Historique de la pêche et état actuel des populations d'oursin vert de la côte nord de l'estuaire du Saint-Laurent, avec une emphase sur l'embouchure du Saguenay. DFO Can. Sci. Advis. Sec., Res. Doc. In prep.

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