



ASSESSMENT OF SOFTSHELL CLAM STOCKS IN QUEBEC'S COASTAL WATERS IN 2007

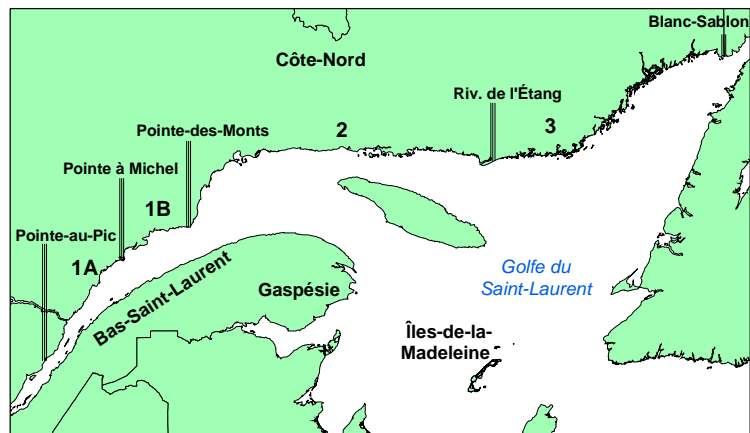


Figure 1: Softshell clam management areas in Quebec.

Context

Recreational harvesting of softshell clams has been practised for a long time along most of Quebec's shoreline without being documented. The commercial harvesting began in 1917 in the Estuary and Gulf of St. Lawrence. It expanded on the North Shore during the 1970s, reaching a peak in 2000. Commercial activities are regulated in this area by the number of permits issued, a minimum size (51 mm) of harvested clams, a season and a participation clause. Hand tools are the only permitted tools (clam digging fork and shovel) for harvesting clams in Quebec. The management measures that are used for recreational harvesting are the season, minimum size and the daily number of clams harvested. Although it is recent, monitoring commercial harvesting will continue on an annual basis in order to detect noticeable changes in the resource. The principal indicators used for monitoring stocks will be harvesting, harvesting effort, harvesting rates and demographic structure. This assessment is a first for clam stocks in Quebec coastal waters.

SUMMARY

- Softshell clams are present along the Quebec shoreline. They are exploited by commercial and recreational harvesters. For a few decades, commercial harvesting has been practised essentially on the Upper North Shore (90% of catches since 2000 have been made in sub-areas 1A and 1B). In addition, recreational harvesting is conducted along most of the St. Lawrence shoreline. Commercial harvests are fairly well documented whereas the quantities that are harvested recreationally remain unknown.

- Commercial clam harvesting on the Upper North Shore peaked at 1,200 t in 2000, then dropped to 354 t in 2006. This represents a 70% drop compared to 2000 and 57% compared to the 2002-2005 reference series' average.
- This drop is mostly due to a 51% decrease in harvesting effort and a 21% drop in harvesting rates compared to the reference average.
- The decrease in effort has mostly been the result of fewer harvesters (30%), in reaction to lower prices and unfavourable weather conditions.
- The decrease in harvesting rates would have been caused by fewer resources since the early 2000s. First, there were fewer effective harvesters and then a decrease in the access to the best harvesting sites.
- The high number of pre-recruits (shell length under 51 mm) in the harvests, between 9% and 19% of clams according to the harvesting site, reduces the yield per recruit.
- The current threshold of the indicators analyzed, i.e. tonnage harvested, harvesting effort, harvest size structures, exploitation index and size at sexual maturity, does not appear to show any immediate danger for the conservation of the resource. However, the high exploitation indices of some of the harvesting sites such as Baie des Petites Bergeronnes and Baie des Escoumins, could eventually have negative impacts on the local resources. The noticeable drops in harvesting rates at Betsiamites as well as the small size of the clams harvested from, among other sites, Baie Didier and Baie des Plongeurs, could be the result of overly intense exploitation.

BACKGROUND

Species Biology

Softshell clams, *Mya arenaria*, are a bivalve mollusc found in North American and European coastal waters. In our area, their distribution extends from the coasts of Labrador to Cape Hatteras in North Carolina. This familiar sea shell in the Estuary and Gulf of St. Lawrence is usually present in the intertidal zone on the North Shore, in the Lower St. Lawrence, Gaspé and Îles-de-la-Madeleine (Figure 1). Clam sexes are separate and the sex-ratio is usually even. The mean size at sexual maturity is 38.4 mm. The lowest recorded value was in the Havre aux Maisons lagoon (29 mm) in the Îles-de-la-Madeleine, and the highest at Pointe-aux-Outardes (45 mm) in the Upper North Shore. Gamete reproduction and fertilization are done outside the shell at sea. Following a short larval stage (3-5 weeks), clams develop into adult form and set on the seabed where they spend the remainder of their life buried in loose sediments.

Clams feed on plankton and suspended particles in the water. They grow according to the amount of time they are immersed, since they live in intertidal zones, and according to the quality of the site where they are. They grow fast during the spring and summer, but slowly in the fall and winter. Clams need 5+ years to reach its legal harvesting size of 51 mm and in certain cases they can measure more than 100 mm. They have a sedentary lifestyle which is sometimes disrupted by wave action and storms that displace them. Therefore, they must burry themselves to avoid predation. The time required to burry themselves is mostly based on

the clam's size and water temperature. Mortality, when there's no predation (in tanks), is low, i.e. about 2% per year.

Description of Harvesting

In several Quebec communities, clam harvesting is a very popular activity chiefly because of the resource's availability, its accessibility and the simple harvesting techniques. Because of their omnipresence on the foreshore and the important role they play within this ecosystem, clams and their related benthic community is at the heart of many problems in terms of the coastal area's management and use.

In Quebec and throughout Canada, the management of harvesting sites is ensured by three organizations that work together under the Canadian Shellfish Sanitation Program (CSSP): Environment Canada (EC), the Canadian Food Inspection Agency (CFIA), and the Department of Fisheries and Oceans (DFO). EC monitors water quality in mollusc harvesting areas by analyzing the bacteriological quality of the water in the harvesting sites, and recommends their closure to harvesting when water has been determined to be polluted. The CFIA monitors, among other things, the consumption quality of molluscs, the level of marine biotoxins they contain, the effectiveness of molluscs depuration processes, and recommends when necessary the closure of the contaminated areas. The DFO establishes the regulations for managing the commercial species' stocks, monitors mollusc harvesting and orders the closure of harvesting sites.

In 2006, there were 395 harvesting and aquaculture sites listed in Quebec. On occasion, some areas had more than one clam bed. These areas range between the Îles-de-la-Madeleine (65), Gaspé's south shore (97), the Lower St. Lawrence and Gaspé's north shore (76), the North Shore (137) and other regions (20) such as Charlevoix and the Saguenay River. Many of these areas have been closed (permanently or occasionally) due to bacterial contamination or the occurrence of marine biotoxin. In 2006, there were 50 harvesting sites on the Upper North Shore, 31 of them in sub-area 1A and 19 in sub-area 1B (Figure 2). Of these 50 areas, 22 were closed, 8 were said to be conditional (closed from June 1st to October 1st), 19 were approved and 1 was closed for resource conservation (Baie des Petites Bergeronnes). Among the 22 closed areas, some were available for harvesting combined with factory depuration. This operation consists in keeping the contaminated clams in closed circuit tanks, in ultraviolet sterilized seawater until the bacteria has been completely eliminated from the organisms.

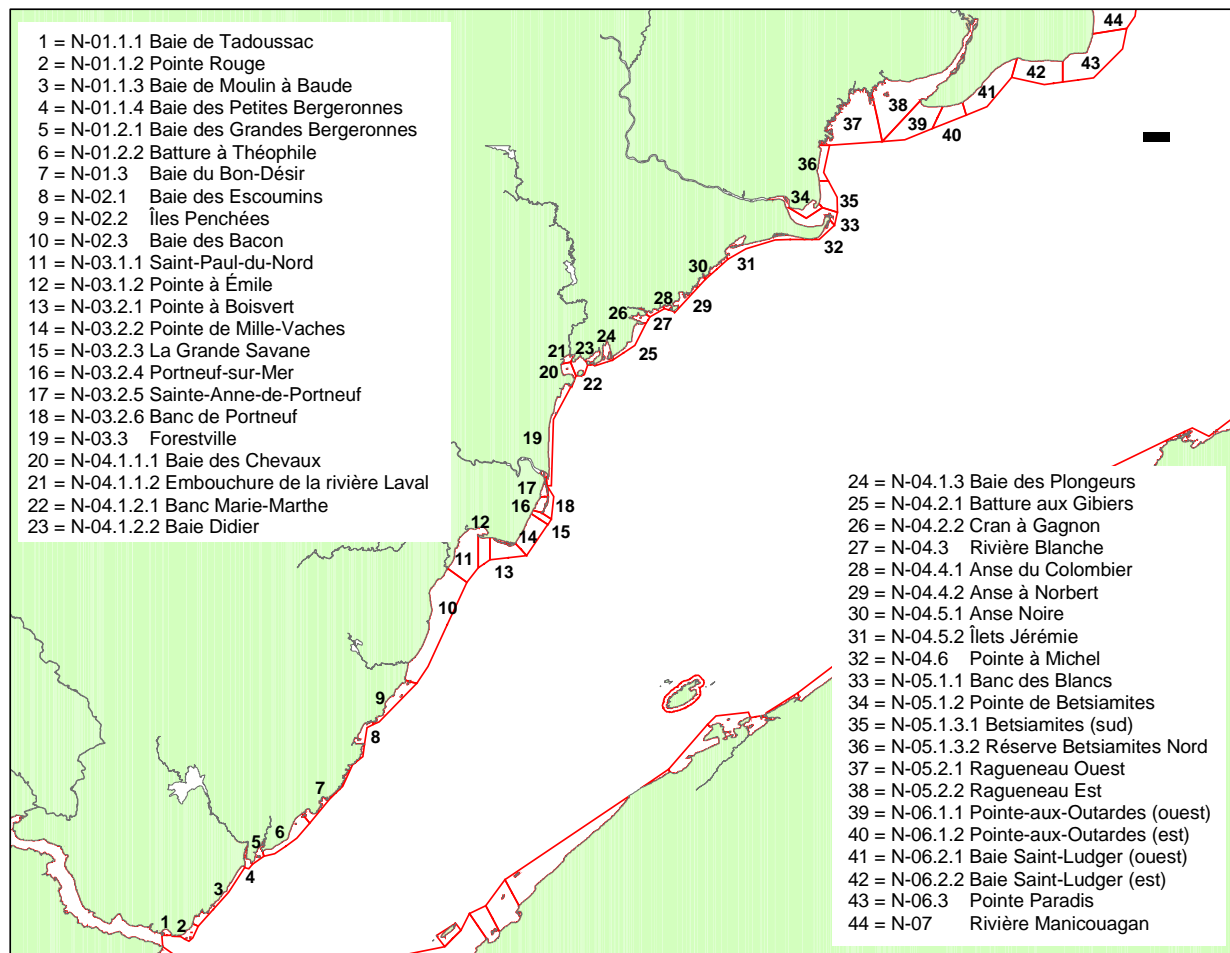


Figure 2. Location of some of the harvesting sites in sub-areas 1A and 1B.

Both commercial and recreational harvesting occupies the same coastal territory. Harvesting is done with hand tools (clam digging fork and shovel) at low tide mostly during spring tides. The recreational harvesting of clams has been conducted for a long time throughout Quebec waters. Commercial harvesting statistics are well documented, whereas the quantities landed by recreational harvesters are still unknown. The commercial harvesting is concentrated on the north shore of the St. Lawrence Estuary (sub-areas 1A and 1B) (Figure 1). It is regulated by the number of permits issued, the type of harvesting gear, a minimum size (51 mm shell length) for harvested clams, a harvesting season and a participation clause. The management measures that are used for recreational harvesting in Quebec are the type of harvesting gear, the season, a minimum size and the daily number of clams harvested.

ASSESSMENT

For the last few decades, harvests have come almost exclusively (90+ %) from sub-areas 1A and 1B on the north shore of the St. Lawrence Estuary, whereas recreational harvesting has been carried out in all regions of Quebec. Commercial harvesting of clams on the Upper North Shore fluctuated from 400 to 700 t between 1975 and 1999, peaked at 1,200 t in 2000, and

dropped to 354 t in 2006 (Figure 3). The latter value represents a 70% decline from 2000 and 57% compared with the 2002-2005 reference series' average. The absence of log books or detailed purchase receipts prior to 2002 limits the length of this series. The drop in the number of captures is particularly significant in sub-area 1A (79%) and especially on the banc Marie-Marthe (87%) (Figure 4 and Table 1).

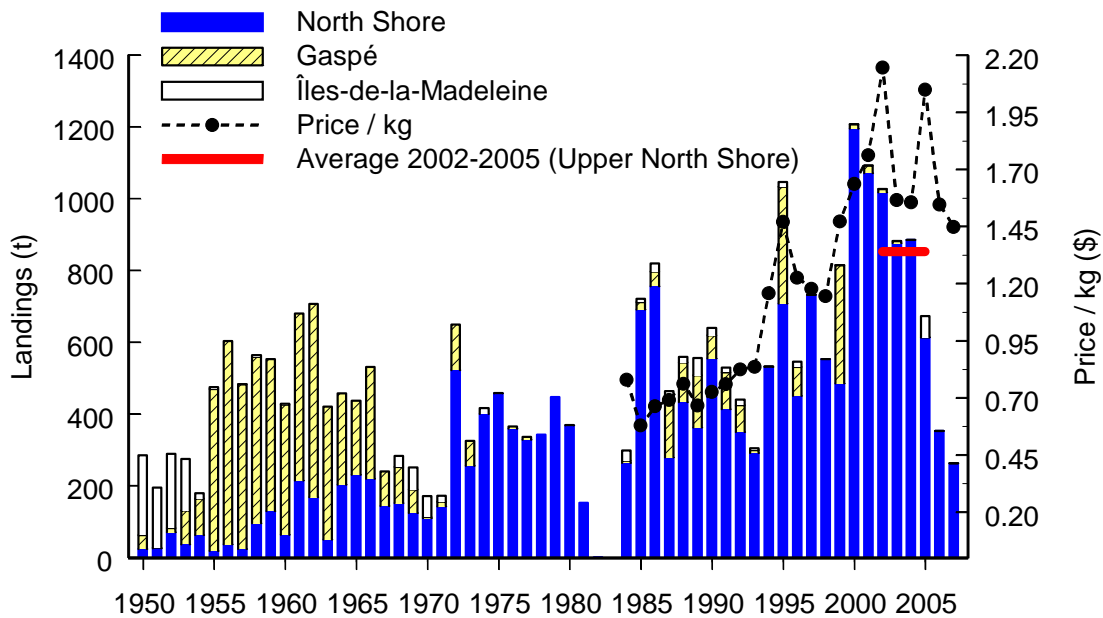


Figure 3. Commercial clam harvests (t) per region and average price paid (per kg) in Quebec (preliminary data for 2007).

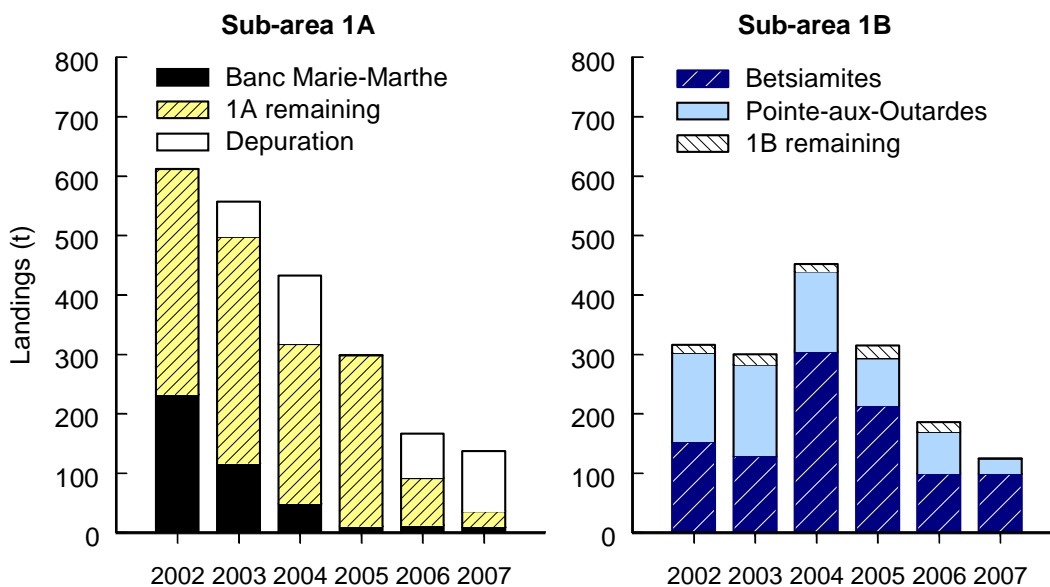


Figure 4. Commercial clam harvests (t) per sub-area from 2002 to 2007 (preliminary data for 2007).

Table 1. Commercial clam harvests (t) per region or harvesting site (Upper North Shore) from 2002 to 2007.

Region and harvesting site	2002	2003	2004	2005	2006	2007*
Upper North Shore	930	859	886	614	354	263
Baie de Tadoussac		5	10			0.3
Baie des Petites Bergeronnes	16	32	26	115		
Baie des Grandes Bergeronnes		22	100		75	28
Batture à Théophile	0.03				1	
Baie des Escoumins						63
Iles Penchées	5	5	7	2	6	0.1
Saint-Paul-du-Nord		2				
Pointe à Émile		2	0.3			
Pointe à Boisvert	125	49	24	21	12	3
Pointe de Mille-Vaches	32	137	62	20	8	1
Baie des Chevaux	82	59	45	27	10	4
Banc Marie-Marthe	233	118	49	11	13	10
Baie Didier	3	19	12	8	5	2
Baie des Plongeurs	30	17	27	32	18	4
Battures aux Gibiers	2	3	1			
Cran à Gagnon	27	14	7	3	2	1
Blanche River		24	5			11
Anse du Colombier	10	17	23	22	5	3
Anse à Norbert	13	0.4	1	0.2	2	0.6
Anse Noire	4	2	4	4	2	1
Îlets Jérémie	31	23	30	35	9	8
Betsiamites	154	129	304	214	100	99
Pointe-aux-Outardes (east and west)	150	154	136	79	71	26
Baie Saint-Ludger (east and west)					1	
Mistassini River	4	3	2	5	5	
Anse à Frigault		8				
Baie Saint-Nicolas	10	15	10	17	9	
Middle North Shore	88	18				
Lower St. Lawrence		0.1		0.4		
Gaspé	10	6				
Îles-de-la-Madeleine				0.1	0.2	0.03
Quebec (total)	1,028	884	886	615	354	263

* preliminary data

The decrease in harvesting is mostly due to a 51% decrease in harvesting effort (Figure 5) and a 21% drop in harvesting rates compared to the reference average. The decrease in effort has mostly been the result of fewer harvesters (30%), in reaction to lower prices and partly because of lower performance rates in the more exploited areas, and due to unfavourable tides. In 2005 and 2006, significant low-pressure systems and strong offshore winds caused water masses to be pushed towards the coasts, reducing tidal fall and restricting access to the harvesting sites. The decrease in harvesting effort compared to the reference average was particularly noticeable for all of the harvesting sites in sub-area 1A (73%), at Pointe-aux-Outardes (52%) and Betsiamites (28%) (Figure 6).

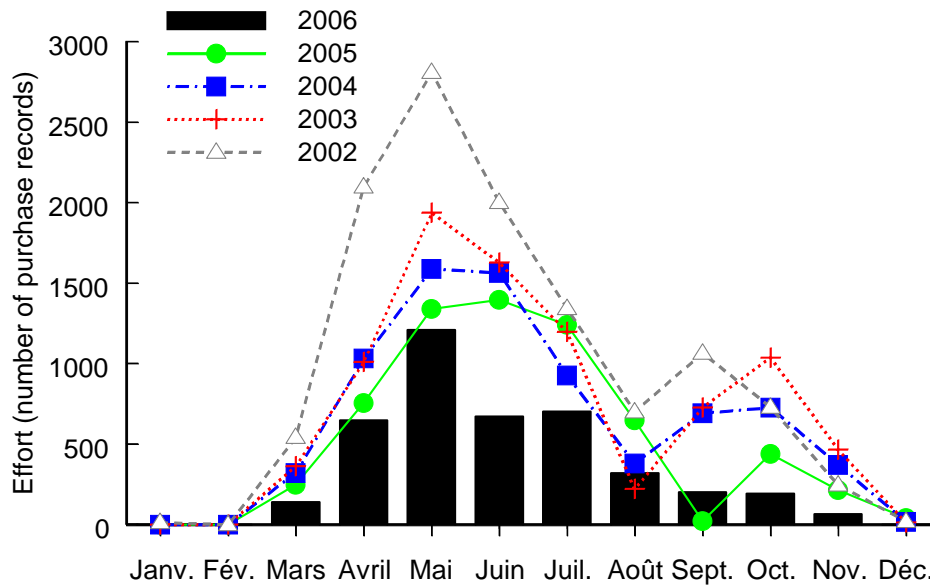


Figure 5. Monthly harvesting effort for the Upper North Shore from 2002 to 2006.

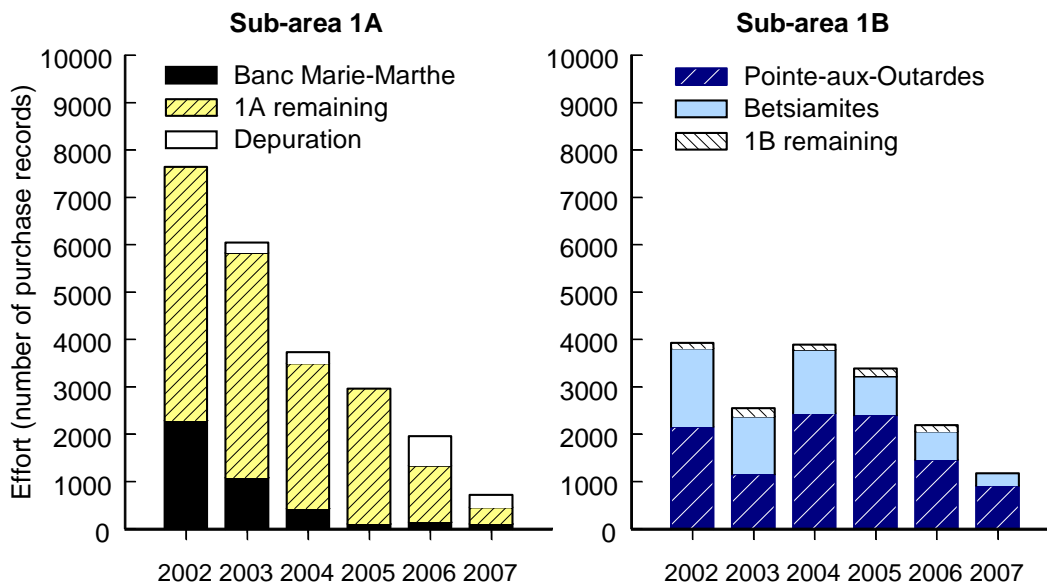


Figure 6. Harvesting effort per sub-area from 2002 to 2007 (preliminary data for 2007).

Harvesting rates at most of the harvesting sites on the Upper North Shore declined significantly in 2006 compared with the reference series (Figure 7). This drop occurred on all the Upper North Shore clam beds, particularly at Betsiamites (26 %). The drop in harvesting rates has likely been the result of a decrease in terms of resources since the early 2000s, the departure of effective harvesters and unfavourable tides.

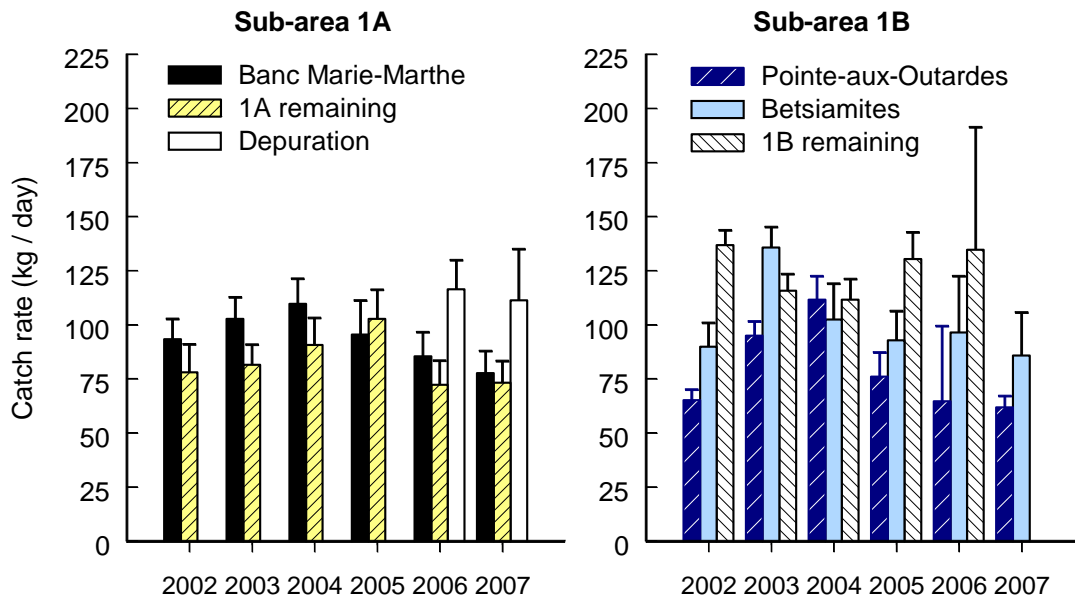


Figure 7. Harvesting rates (\pm 95% confidence interval) per sub-area from 2002 to 2007 (preliminary data for 2007).

Mean size of harvested clams varies according to harvesting site and in time. It is always higher at Pointe-aux-Outardes than at Betsiamites and on the banc Marie-Marthe (Figure 8). Mean size in 2006 was somewhat higher than the 2004-2005 average for these two latter areas, but decreased (9%) at Pointe-aux-Outardes. Preliminary values suggest a decrease at Betsiamites in 2007. The high number of pre-recruits in the harvests, between 9% and 19% of clams less than 51 mm depending on the harvesting site, will decrease performance per recruit.

Exploitation indices have been calculated, such as exploited area compared with total available area, for several harvesting sites on the Upper North Shore (Figure 9). The mean of these indices was 6.6%. Estimated values are sometimes very high, such as the 48.5% index measured for Baie des Petites Bergeronnes in 2005. Exploitation rates have also been calculated for a few areas by dividing harvest totals by available biomass. For the same area, the rate was similar or higher than the calculated index based on the previous method.

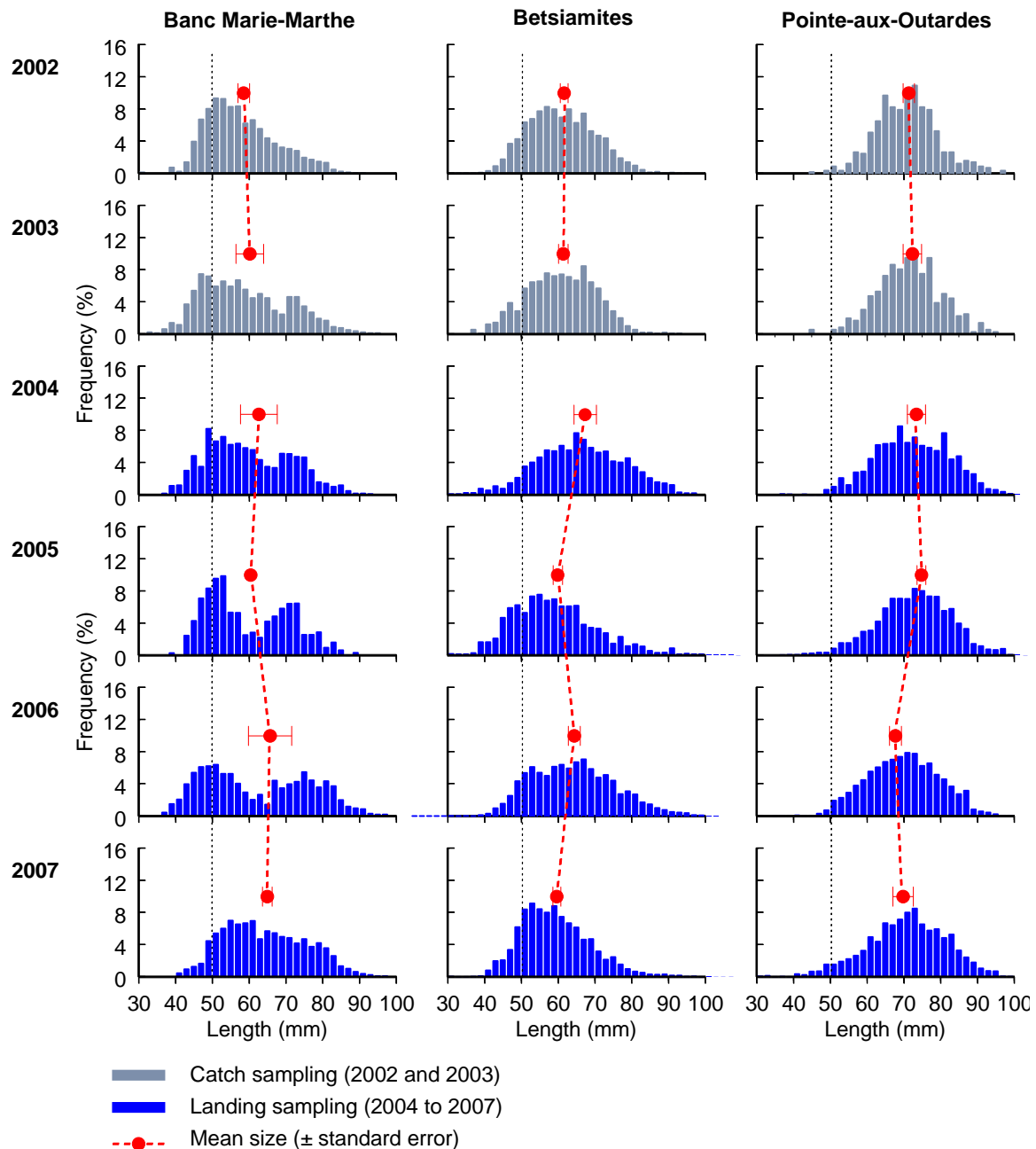


Figure 8. Size structures and mean size (\pm root-mean-square-error) for three harvesting sites from 2002 to 2007. The dotted vertical line shows the legal size of 51 mm.

The current levels of the indicators analyzed, such as catches, harvesting effort, size structure of harvested clams, the exploitation index and the size at sexual maturity, do not appear to show any immediate danger for the conservation of the resource. The high exploitation indices at certain harvesting sites, such as Baie des Petites Bergeronnes and Baie des Escoumins, could lead to negative impacts on a local scale (Figure 9). The evident drops in harvesting rates at Betsiamites as well as the small size of harvested clams at Baie Didier and Baie des Plongeurs for example, could be the result of overly intense exploitation.

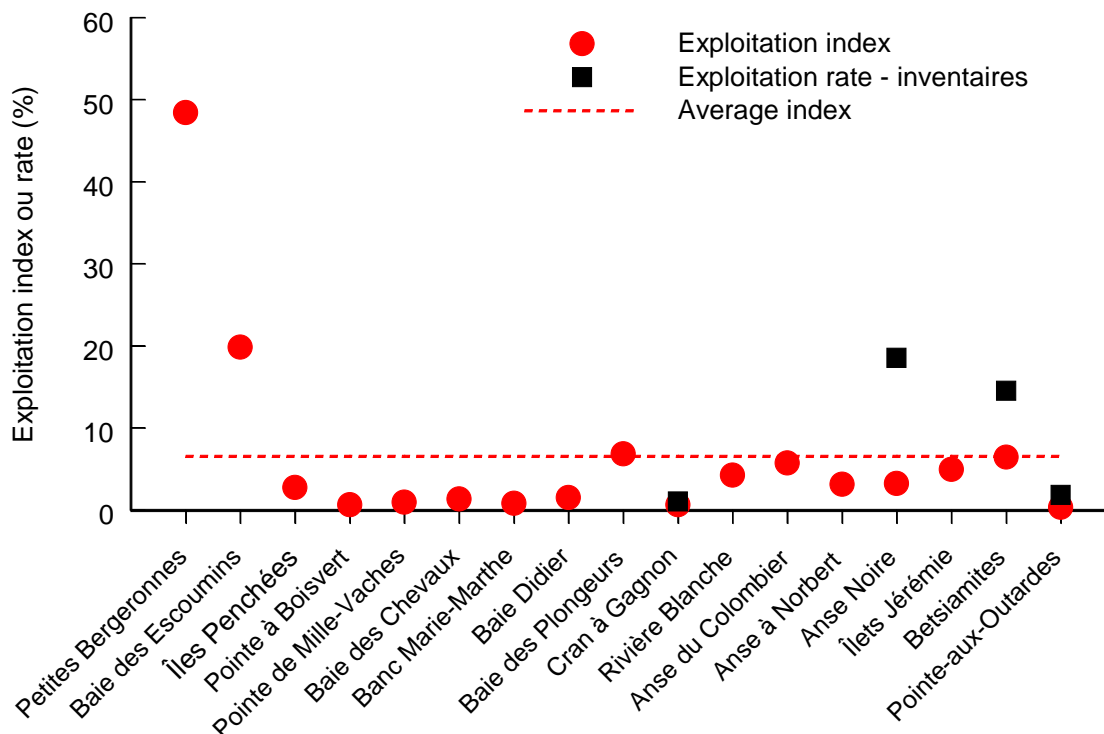


Figure 9. Exploitation index and rate for different harvesting sites on the Upper North Shore in 2006 (except for Baie des Petites Bergeronnes in 2005 and Baie des Escoumins in 2007).

Sources of uncertainty

Sharing the territory between commercial and recreational harvesters combined with lack of information from the recreational component makes it difficult to clearly identify stock status trends and interpret them. Due to the lack of independent indicators for the commercial component, such as those from research surveys, advisory reports on clam are uniquely commercial-harvesting-dependant. Partial data, or data that does not reflect reality, such as a harvesting effort different from what was recorded in the log book, can in certain cases change the trends for some of the commercial indicators. The arrival or departure of experienced harvesters or less experienced harvesters can affect harvesting rates. Environmental conditions, such as abnormal weather conditions or tide ranges, can also affect certain harvesting indicators. The accumulated effect of these sources of uncertainty can lead to advisory reports that do not completely reflect the status of the resource.

CONCLUSIONS AND ADVICE

- Current knowledge on the status of the resource and on the clam's biology is insufficient to determine the harvesting levels that would not jeopardize the conservation of the resource. The high number of harvesting sites and the spatial and time fragmentation of this harvest, caused, among other things, by the occasional closings caused by the presence of bacteria or biotoxins requires adapted conservation and management approaches. The adaptive management approach is particularly recommended for this type of exploitation. Such an approach promotes close interactions between industry, the local population and experts in order to identify problems; propose harvesting, conservation and enhancement strategies adapted to each harvesting site; and choose the indicators to be followed and the monitoring methods for assessing the performance of the selected strategies and adjust them when needed.
- While waiting for this approach to be adopted, the usual conservation principal is recommended for the other exploited molluscs by conserving the integrity of each bed. This can be achieved by protecting the reproductive potential and the larval production capacity, by controlling harvesting mortality and by mitigating fishery by-catches.
- In order to protect the reproductive potential, the legal harvesting size of 51 mm should be respected at all harvesting sites and clams located in the sublittoral zone should be protected.
- In order to control harvesting mortality at each harvesting site, the effective harvesting effort should be limited to a level not exceeding the 2005-2006 average. In addition, no more than 10% of the commercial biomass should be harvested annually. Both these targets will be reached by better monitoring commercial and recreational harvesting and by limiting the number of permits issued, the harvesting season, the daily duration and the number of harvesting days.
- In order to mitigate fishery by-catches, only hand tools should be permitted and the harvesting should be closed when the air temperature nears 0°C.

OTHER CONSIDERATIONS

The recommended conservation measures for clams are aimed at preserving the productive capacity of each clam bed in order to ensure their sustainability. Any approach aimed at maintaining or increasing the reproductive potential of each harvesting site, by leaving more adults on the seabed or by creating refuge areas, will have a positive impact on the conservation of the resource. In addition, because a clam's egg production is proportional to its cubic length, a net gain in productivity will occur if the population ages. Any measure aimed at limiting disturbance of coastal habitats, particularly the sediment, will have positive impacts on resident clams by reducing incidental mortalities and growth stoppages due to stress. Consequently, a rotating harvesting strategy, inter and intra clam bed, will reduce these negative impacts.

The development of a harvesting plan and the introduction of enhancement activities (e.g. spat collection, density readjustments and seeding) for exploited populations would increase this

resource's productivity. Increased knowledge of the species and its exploitation, and improved monitoring of harvest indicators (harvesting rates, size structure, pre-recruit abundance in the harvests and exploitation index) would improve the reaction time when changes to the population occur and also would help focus the actions to be taken in order to readjust the exploitation levels or avoid the collapse of the resource.

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