ASSESSMENT OF SOFTSHELL CLAM STOCKS IN QUEBEC'S COASTAL WATERS IN 2010

Source: DFO 2003

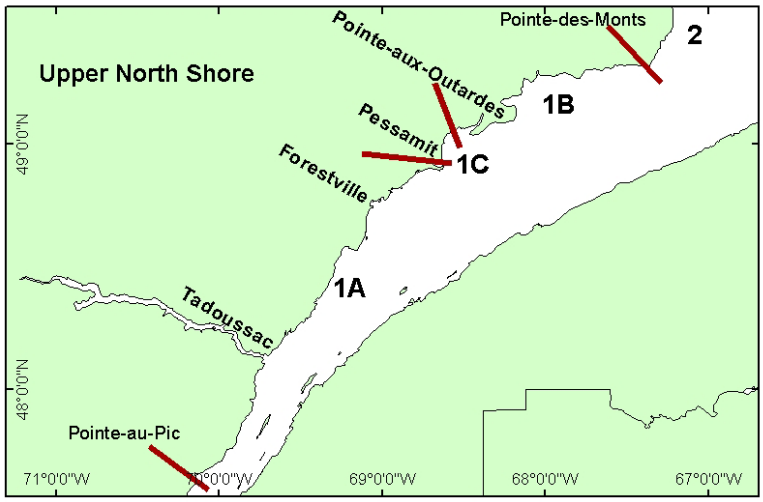

Figure 1. Softshell clam management areas of the Upper North Shore in 2010.

Context:

Softshell clams are present along most of Quebec's shoreline. Recreational harvesting of softshell clams has been practised for a long time in Quebec without being well documented. However, commercial landing data has been available since 1917.

Commercial harvesting expanded on the North Shore during the 1970s and peaked in 2000. There are three management sub-areas, 1A, 1B and 1C, on the Upper North Shore (Figure 1). Commercial activities are regulated by the number of licenses issued, a minimum legal harvest size (51 mm), a season and a participation clause. Hand tools are the only permitted tools. The management measures that are used for recreational harvesting are the season, minimum legal size and the daily number of clams harvested. The main indicators used for monitoring stocks are landings, harvesting effort, catches per unit effort, and the demographic structure.

The assessment of softshell clam stocks is carried out every three years and the last assessment was conducted in 2007. The Fisheries and Aquaculture Management Branch requested that science advice be provided on these stocks for the 2011-2013 harvesting seasons. This document should meet their request, at least in part, since it updates the status of this resource based on the information currently available.

SUMMARY

- Softshell clams are present along most of Quebec's shoreline. They are exploited by commercial and recreational harvesters. In recent decades, commercial harvesting has

been practised essentially on the Upper North Shore. Commercial harvests have been documented for all shellfish beds since 2002. The quantities that are harvested recreationally, a prized activity by coastal communities, remain unknown.

- Since 2007, landings have primarily been from approved or conditionally approved shellfish beds: Baie des Chevaux, Banc Marie-Marthe, Anse du Colombier and Îlets Jérémie in sub-area 1A, Pointe-aux-Outardes in sub-area 1B and Réserve Pessamit Sud in sub-area 1C, as well as three harvesting areas for depuration (limited status): Baie des Grandes Bergeronnes, Baie des Escoumins and Rivière Blanche.
- On the Upper North Shore, clam landings totalled 1,173 t in 2000 and have declined since. They totalled 176 t in 2008, 190 t in 2009 and 56 t in 2010. The harvesting effort dropped from 11,585 vendor-days in 2002 to 1,942 vendor-days in 2009, an 83% drop. The effort was even lower in 2010 due to the closure of two clam processing plants on the Upper North Shore.
- Approved shellfish beds on the Upper North Shore generally showed low catches per unit effort (CPUEs) between 2006 and 2008 compared to 2002-2005. Since 2009, CPUEs have increased somewhat, except for Réserve Pessamit Sud where the 2010 CPUE was the lowest of the series. However, there is some uncertainty on the interpretation of the CPUE in recent years due in part to the inaccurate assessment of the number of harvesters involved in the unit effort (vendor-day).
- The size structures of landed clams vary from area to another. From 2008 to 2010, the median size varied between 52 and 78 mm on the main exploited beds. However, the proportion of clams of sub-legal size (<51 mm) often exceeds 15%.
- The survey conducted in 2010 on the Reserve Pessamit Sud bed indicates a decrease in legal-size clam density and biomass of about 35% and sub-legal size clam density of 57% compared with the 2005 survey. The decline in commercial CPUE observed at this clam bed likely reflects a population decrease. It is recommended, annually, to harvest less than 10% of the commercial biomass to ensure the sustainability of these beds.
- Since the last assessment in 2007, landings and harvesting effort have decreased. The drop in effort could be due to a resource decline or to socio-economic factors. The CPUEs from 2006 to 2008 were among the weakest. The proportion of sub-legal size clams in the landings is sometimes high suggesting a low abundance of legal size clams on certain beds. Despite the low harvesting effort in recent years, there has been no noticeable improvement in the status of the resource
- To protect the reproductive potential of each clam bed, it is recommended to enforce the minimum legal size and limit harvesting effort on the Upper North Shore at a level not exceeding the 2007-2009 average. To mitigate incidental mortality caused by harvesting, it is recommended to close the fishery when the air temperature is at or below 0° C. In addition, better knowledge of recreational harvesting is needed to better assess its impact on the resource.

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 occurs in the intertidal zone in the Estuary and Gulf of St. Lawrence and in Chaleur Bay. It is an endobenthic organism that lives buried in loose sediment. Clams feed on plankton and suspended particles in the water. They grow according to the amount of time they are immersed, as they live in intertidal zones, and

according to the quality of the site where they occur. In Quebec, they grow fast during spring and summer, but slowly in the fall and nil in winter. Clams need 5-8 years to reach its minimum legal harvesting size of 51 mm and they can measure 110+ mm. They have a sedentary lifestyle which is sometimes disrupted by wave action and storms that displace them. They must therefore re-burry themselves. The time required to burry themselves is mostly based on the clam's size and water temperature.

Clam sexes are separate and the sex-ratio is usually even. The mean size at which 50% of individuals are sexually mature is 38 mm in Quebec. The lowest recorded value was in the Havre aux Maisons lagoon (28-29 mm) in the Îles-de-la-Madeleine, and the highest at Pointe-aux-Outardes (45-46 mm) on the Upper North Shore. Gametes are released in the water and fertilization occurs outside the shell. 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.

Description of the Fishery

In several Quebec communities, clam harvesting is a very popular activity because of the resource's availability, its wide accessibility and the simple harvesting techniques. The Quebec coastal area is divided into several shellfish harvesting areas. In Quebec and throughout Canada, the management of harvesting sites is ensured by three united bodies forming the Canadian Shellfish Sanitation Program. Environment Canada monitors water quality in these areas and recommends their closure to harvesting molluscs (softshell clams, surfclams, razor clams, mussels, etc) when bacteriological analysis exceeds a certain contamination level. The Canadian Food Inspection Agency monitors, among other things, the consumption quality of molluscs, the toxin level they contain, the effectiveness of the molluscs depuration process and recommends the closure of areas where molluscs are considered unsafe for human consumption. DFO establishes the regulations for managing the commercial species' stocks, monitors mollusc harvesting and orders the closure of harvesting sites.

In 2010, there were 347 harvesting sites and 62 aquacultural sites listed in Quebec. Some areas had limited clam resources while others had more than one clam bed. These areas include the Îles-de-la-Madeleine (47), Gaspé's south shore (77), Lower St. Lawrence and Gaspé's north shore (71), the North Shore (132) and a few other regions (20). Many of these areas have been closed to harvesting due to bacterial contamination. In 2010, there were 67 harvesting sites on the Upper North Shore, including 22 with approved status, 7 conditionally approved (closed from June 1st to September 30st), 16 with limited status and 22 were closed (Figure 2). The areas with limited status were available for harvesting combined with plant 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. The depuration facility at Les Escoumins was in operation from 1999-2004 and from 2006-2009.

Both commercial and recreational harvesting occupies the same coastal territory. Both these activities are carried out at low tide primarily during spring tides. In Quebec, the minimum legal size is 51 mm for softshell clams regardless the type of harvesting. Quebec's maritime regions are divided into three large management units: the North Shore, Gaspé - Lower St. Lawrence and Îles-de-la-Madeleine. The North Shore is divided into three harvesting areas, area 1 (sub-areas 1A, 1B and 1C) corresponds to the Upper North Shore (UNS), area 2 to the Middle North Shore and area 3 to the Lower North Shore (Figure 1). Sub-area 1C is managed by the Innu aboriginal community of Pessamit. Commercial exploitation of clams is done exclusively with hand tools (clam digging fork and shovel), except on the Middle North Shore, where there are two hydraulic dredge harvesting licenses.

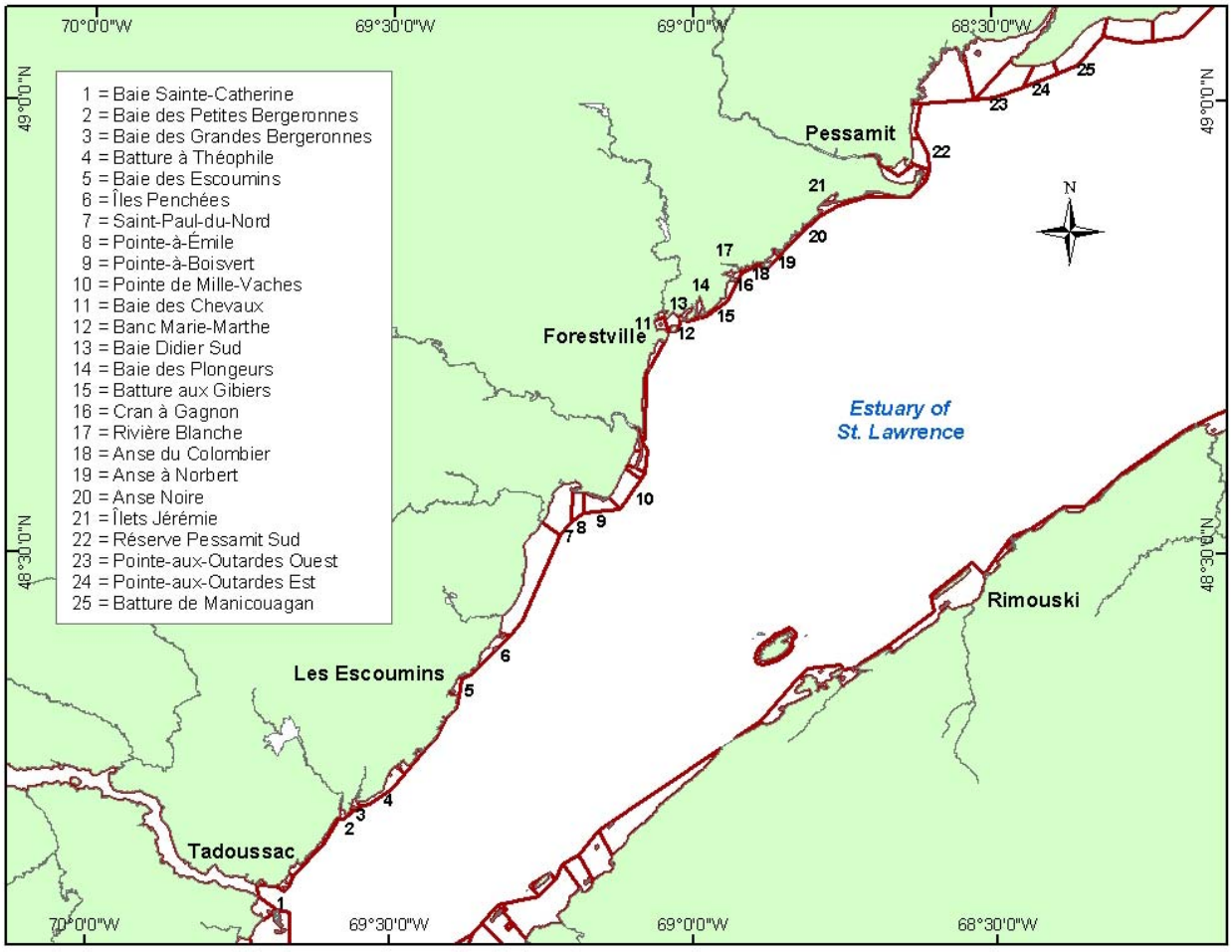

Figure 2. Location of commercially exploited harvesting sites since 2002, in the western part of the Upper North Shore.

Since 2008, commercial manual harvesting on the UNS has been regulated by the number of licenses, type of harvesting gear, a minimum legal size of harvested clams, a harvesting season, a participation clause and the obligation to keep a logbook. Since 2009, the areas Baie des Chevaux, Banc Marie-Marthe, Baie Didier Sud, Baie des Plongeurs and Cran à Gagnon have been reserved exclusively for commercial harvesting. Three areas are closed for conserving the reproductive potential: Baie des Petites Bergeronnes, Baie Didier Sud and Baie des Plongeurs. In the Îles-de-la-Madeleine, there is a harvesting season and the obligation to keep a logbook. In Quebec, recreational harvesting is permitted only with hand tools and is limited to 300 clams per day. The commercial fishery statistics are fairly well documented and known for all shellfish harvesting areas since 2002, while the quantities harvested recreationally remain unknown.

ASSESSMENT

Since 1970, commercial harvests have come mainly from the North Shore (Figure 3). In the Îles-de-la-Madeleine, landings have been below 1 t since 2005. There has been virtually no

commercial harvesting on the Middle North Shore, in the Lower St. Lawrence and Gaspé since 2004 (Table 1). Thus, the information in this document refers only to the UNS.

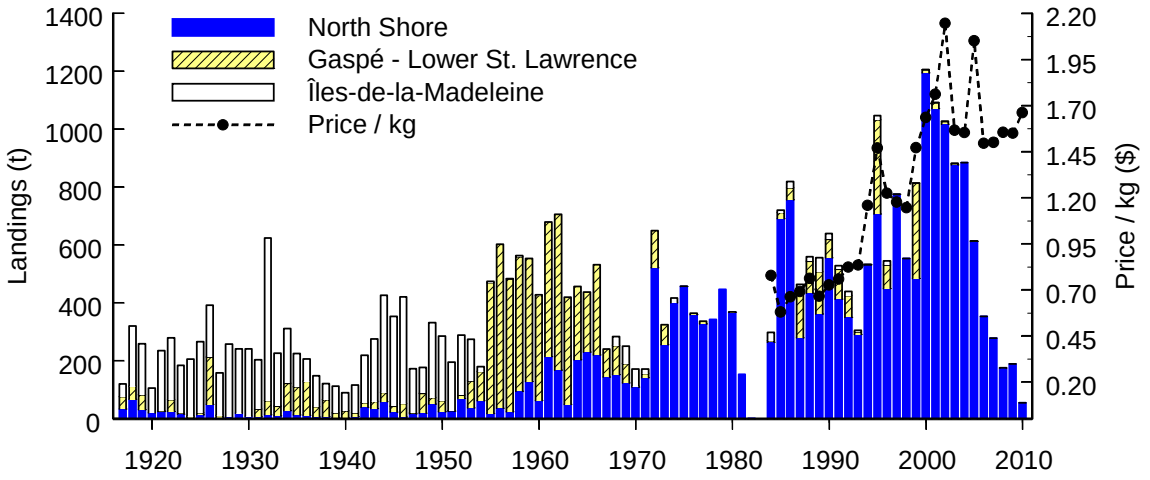

Figure 3. Commercial clam landings (t) per region and average price paid in Quebec.

From 1993 to 1999, clam landings fluctuated between 289 and 745 t on the UNS. Landings totalled 1,173 t in 2000 and have been declining since. They totalled 176 t in 2008, 190 t in 2009 and 56 t in 2010 (Table 1). Commercial landings have been recorded throughout the harvest area only since 2002 which limits the series' length. The distribution of landings between sub-areas 1A, 1B and 1C and depuration varied during the 2002-2010 period (Table 1). From 2002 to 2005, landings came mainly from sub-area 1A. Subsequently, this sub-area's contribution declined gradually until the end of the decade. Landings in sub-area 1B, though smaller, followed the same trend. In sub-area 1C, besides the high values of 2004 and 2005, landings remained relatively stable until 2009. The quantities of clams that have gone through the depuration plant have fluctuated over time and reached maximum values of 115 and 103 t in 2004 and 2007 respectively. It should be noted that in 2006, landings were divided almost equally among the three sub-areas and depuration. In 2010, landings were low everywhere due to the closing of the processing plants.

On the UNS, harvesting effort decreased from 11,585 vendor-days in 2002 to 1,942 vendor-days in 2009, a decrease of 83% (Figure 4). The 2010 harvesting effort was even lower with 1,061 vendor-days. From 2002 to 2005, sub-area 1A was the most exploited, but since 2007 there has been a shift towards sub-area 1C. The shellfish harvesting areas most exploited since 2006 have been, in descending order: Réserve Pessamit Sud (1C), Pointe-aux-Outardes (1B), Baie des Grandes Bergeronnes (depuration), Baie des Escoumins (depuration), Banc Marie-Marthe (1A) and Îlets Jérémie (1A). The decline in effort is largely due to the decrease in the number of commercial harvesters for the entire UNS (Figure 4).

Table 1. Commercial clam landings (t) from 2002 to 2010 per shellfish area and region (Upper North Shore).

Area	Shellfish area or region	2002	2003	2004	2005	2006	2007	2008	2009	2010
1A	Baie Sainte-Catherine [1]	0	4.7	10.0	0	0	0.6	0	0	0
1A	Baie des Petites Bergeronnes	15.5	31,.7	26.4	115.5	0 [2]	0 [2]	0.9 [3]	0 [3]	0 [3]
1A	Baie des Grandes Bergeronnes [1]	0	22.2	100.1	0	75.0	27.8	14.4	18.2	0
1A	Batture à Théophile	0.03	0	0	0	0.9	0	0	0	0
1A	Baie des Escoumins [1]	0	0	0	0	0	61.6	10.7	21.8	0
1A	Iles Penchées	5.4	4.5	6.6	1.9	5.9	0	0	0	0
1A	Saint-Paul-du-Nord	0	2.1	0	0	0	0	0	0	0
1A	Pointe-à-Émile	0	2.3	0.3	0	0	0	0	0	0
1A	Pointe-à-Boisvert	125.1	48.5	23.5	20.6	12.3	4.2	1.5	0.5	0
1A	Pointe de Mille-Vaches	31.9	137.4	62.4	19.6	7.6	2.2	0.1	0	0
1A	Baie des Chevaux	81.6	58.6	44.7	26.7	10.3	3.6	4.7	2.7	0.3
1A	Banc Marie-Marthe	232.8	117.5	48.8	11.5	13.1	11.1	13.1	12.1	0.3
1A	Baie Didier	3.5	19.1	11.8	7.8	4.6	2.4	0.2	0.7	0 [2]
1A	Baie des Plongeurs	30.2	17.4	27.4	31.6	18.4	3.6	0.5	0	0 [2]
1A	Battures aux Gibiers	1.7	2.5	0.5	0	0	0	0.4	0	0
1A	Cran à Gagnon	27.0	14.2	7.3	3.3	1.6	1.9	1.3	0.1	0
1A	Rivière Blanche [1]	0	24.0	5.3	0	0	13.0	10.7	10.6	0
1A	Anse du Colombier	10.0	17.0	22.7	21.6	5.3	3.7	3.0	2.1	0.1
1A	Anse à Norbert	13.3	0.4	1.3	0.2	1.7	0.6	0.2		0
1A	Anse Noire	3.8	2.2	4.4	3.8	1.6	1.0	0.0	0.2	0
1A	Îlets Jérémie	30.8	23.0	29.9	34.9	8.9	11.8	8.3	10.8	8.5
1C	Réserve Pessamit Sud	153.5	129.2	304.3	214.5	99.7	98.4	80.2	82.5	37.7
1B	Pointe-aux-Outardes	149.6	154.2	136.3	79.4	70.5	31.0	25.9	27.4	8.5
1B	Baie Saint-Ludger	0	0	0	0	1.4	0	0	0	0
1B	Rivière Mistassini	3.8	3.2	1.6	4.7	5.4	0	0	0.1	0
1B	Anse à Frigault [1]	0	8.5	0	0	0	0	0	0	0
1B	Baie Saint-Nicolas	10.0	14.6	10.5	16.9	9.4	0	0	0	0
Upper North Shore		929.6	859.1	886.2	614.4	353.7	278.6	176.2	189.6	55.5
	1A	612.7	498.5	318.2	298.9	92.2	46.2	34.3	29.1	9.3
	1B	163.4	172.0	148.3	101.0	86.8	31.0	25.9	27.5	8.5
	1C	153.5	129.2	304.3	214.5	99.7	98.4	80.2	82.5	37.7
	Depuration	0	59.4	115.4	0	75.0	103.0	35.8	50.5	0
Middle North Shore		87.9	18.1	0	0	0	0.5	0	0	0
Lower St. Lawrence		0	0.1	0	0.4	0	0	0	0	0
Gaspé		10.3	6.1	0	0	0	0	0	0	0
Îles-de-la-Madeleine					0.1	0.4	0.5	1.0	0.5	0.9
Quebec (total)		**1027.8**	**883.4**	**886.2**	**614.9**	**354.1**	**279.7**	**177.2**	**190.1**	**56.4**

[1] : limited status site (depuration).
[2] : site closed for resource conservation.
[3] : limited status with a TAC of 10 t.

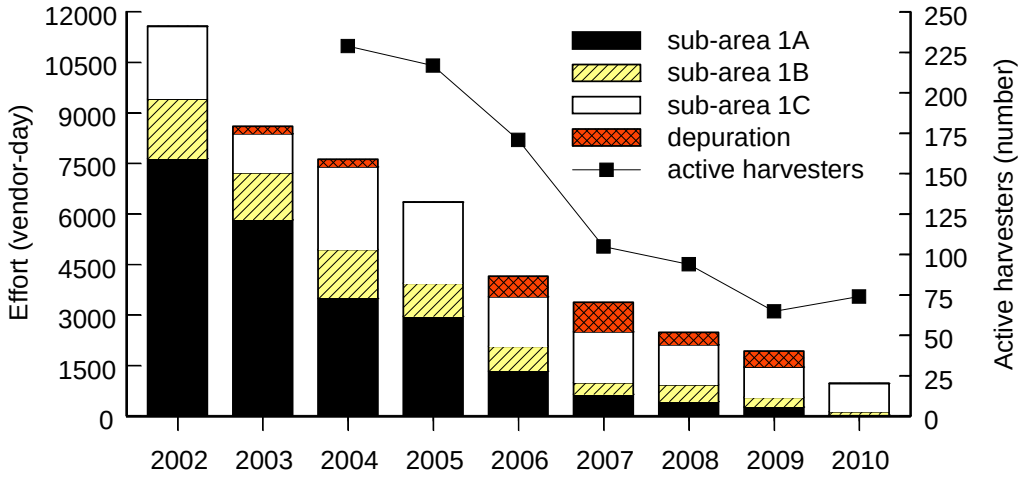

Figure 4. Commercial manual clam harvesting effort per Upper North Shore sub-area from 2002 to 2010 and number of active harvesters for the entire Upper North Shore.

Sub-area 1A

From 2002 to 2007, the main shellfish areas exploited in the sub-area 1A were: Baie des Petites Bergeronnes (closed in 2006), Pointe-à-Boisvert, Pointe de Mille-Vaches, Banc Marie-Marthe and Baie des Plongeurs (closed in 2010) (Table 1). In 2008 and 2009, the main areas exploited were: Baie des Chevaux, Banc Marie-Marthe, Anse du Colombier and Îlets Jérémie. Due to the market uncertainty of 2010, commercial harvesting occurred almost exclusively at Îlets Jérémie in 1A.

Landings in sub-area 1A decreased from 613 t in 2002 to 29 t in 2009 (Table 1). In 2010, landings totalled only 9 t. There was a significant drop in effort during this same period, from 7,651 vendor-days in 2002 to 273 vendor-days in 2009 (Figure 4). Five shellfish beds were chosen to illustrate trends in sub-area 1A, three sectors with approved status, Pointe de Mille-Vaches, Banc Marie-Marthe and Baie des Plongeurs, and two with conditionally approved status, Baie des Chevaux and Îlets Jérémie. Pointe de Mille-Vaches and Pointe-à-Boisvert were two significant sectors of sub-area 1A before 2002. But according to harvesters, Baie des Chevaux, Banc Marie-Marthe and Baie des Plongeurs were the most interesting areas for harvesting clams in the early 2000s. The Baie des Chevaux and Banc Marie-Marthe areas represent the same clam bed located on both sides of the Laval River channel.

For the 2002-2010 period, landings from Pointe de Mille-Vaches reached a maximum of 137 t in 2003 (Table 1). Since, there has been a steady decline in landings associated with a decrease in harvesting effort. The 2008 landings were only 0.1 t and nil in 2009 and 2010. The CPUEs peaked at 82 kg/vendor-day in 2002 and 2003 and declined thereafter (Figure 5). The 2002-2009 CPUE average was 65.6 kg/vendor-day. Size structures differed substantially between years (Figure 6). The median average (2004-2009) was 62 mm.

Baie des Chevaux landings totalled 82 t in 2002, and then decreased gradually to about 3 t in 2009 (Table 1). The decline in landings is a result of decreased effort, from 744 vendor-days in 2002 to 25 vendor-days in 2009. The 2002-2005 CPUEs were above the reference average (99.7 kg/vendor-day), and the 2005 CPUE was the highest of the series (Figure 5). Since 2006, the CPUE fell sharply below the average to reach 72.8 kg/vendor-day in 2008. The 2009 CPUE was high, 112.9 kg/vendor-day, but affected by significant variability due to low harvesting effort. The average median size of clams landed at this bed is 57 mm. Median sizes were lower in

2004, 2006 and 2009, associated with high proportions of landed clams of sub-legal size between 17 and 24% (Figure 6).

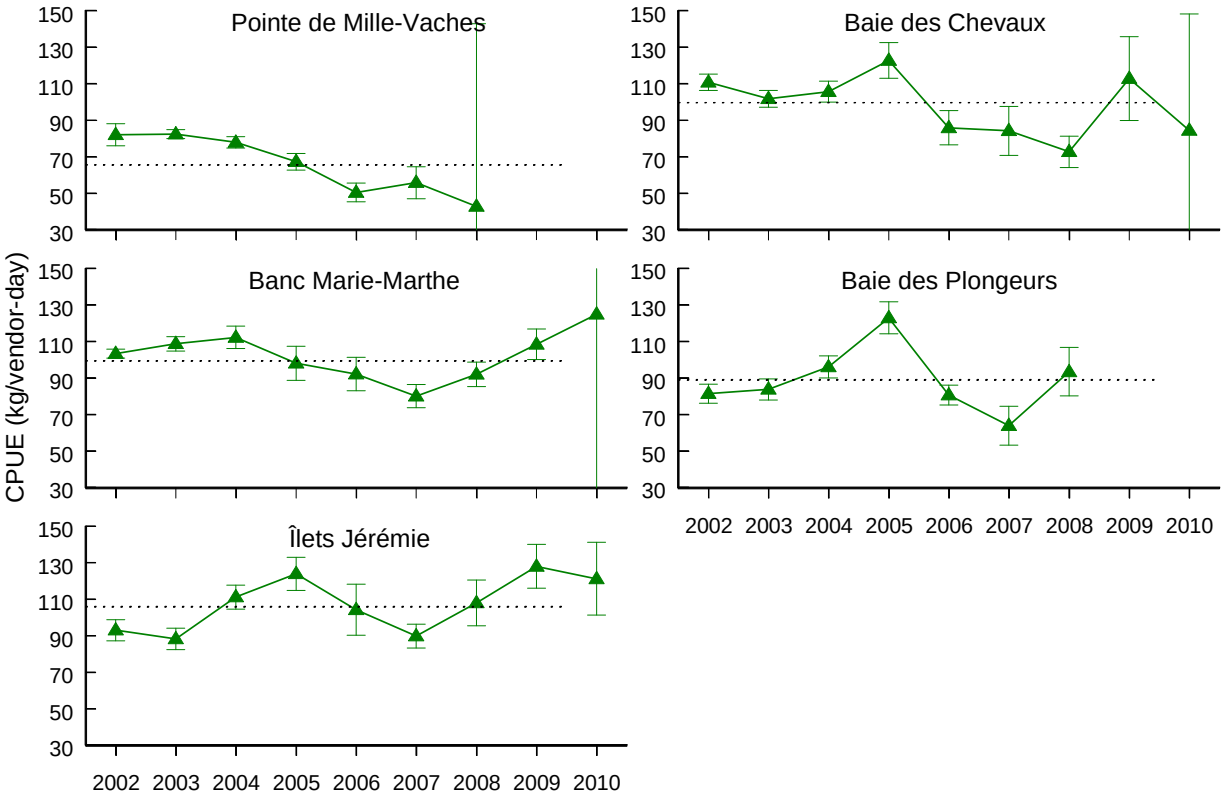

Figure 5. Catches per unit effort (CPUE ± 95% confidence interval) from 2002 to 2010 for five harvesting sites in sub-area 1A. The horizontal dotted line indicates the 2002-2009 reference mean CPUE.

Since 2002, the Banc Marie-Marthe harvesting area has provided a significant proportion of annual landings in sub-area 1A (Table 1). Landings reached 233 t in 2002 and totalled only 11-13 t from 2005 to 2009. During the same period, the effort grew from 2,293 vendor-days in 2002 to 111 vendor-days in 2009. After reaching a peak of 112.4 kg/vendor-days in 2004, the CPUE decreased to 80.2 kg/vendor-day in 2007 (Figure 5). In 2008 and 2009, this indicator was adjusted. The average CPUE (2002-2009) was 99.5 kg/vendor-day for this area. The average median (2004-2009) of the size of clams landed at Banc Marie-Marthe was 60 mm. Since 2007, the size structures have been similar and the proportion of clams under 51 mm in the landings remains below 10% (Figure 6).

Landings from Baie des Plongeurs totalled between 17 and 32 t from 2002 to 2006 (Table 1). The effort was 405 vendor-days in 2002, reached a plateau at about 275 vendor-days between 2004 and 2006, and was only 62 vendor-days in 2007 and 5 vendor-days in 2008. There was no commercial harvest from this sector in 2009 and 2010. The mean CPUE is 89.0 kg/vendor-day (Figure 5). A maximum CPUE of 123.1 kg/vendor-day was attained in 2005 and the lowest, 64.0 kg/vendor-day, was reached in 2007. The median size is small (Figure 6), with an average size of only 52 mm, only slightly higher than the minimum legal size. In fact, the proportion of sub-legal size clams exceeded 50% in 2006 and 2008. This harvesting area was closed to commercial and recreational harvesting in March 2010 to protect the reproductive potential of this bed. This decision was taken in response to the small size of landed clams, which suggested overexploitation, and based on requests from several commercial harvesters.

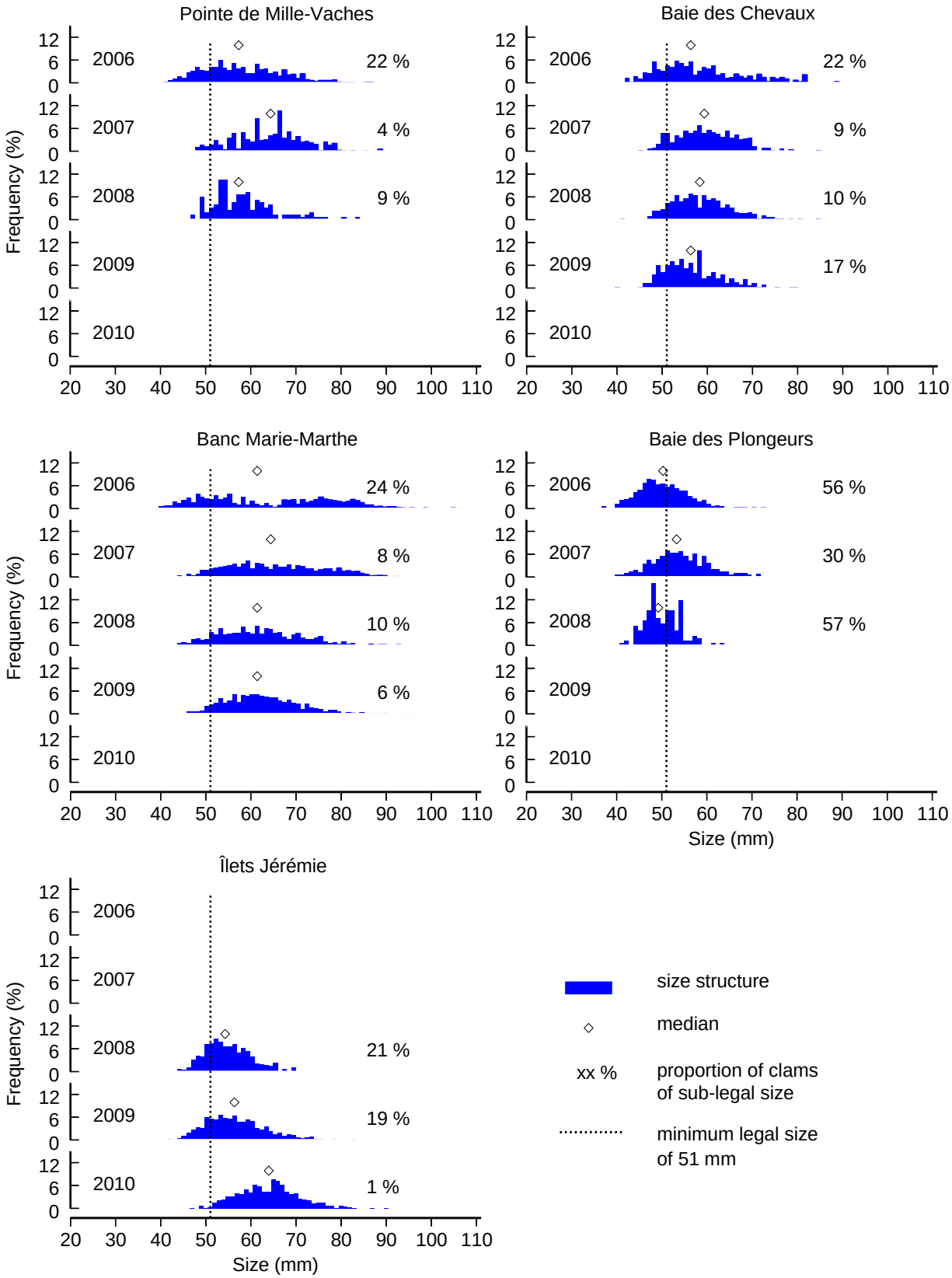

Figure 6. Size structures, median size and proportion of clams of sub-legal size from 2006-2010 for five harvesting sites in sub-area 1A.

Landings from the Îlets Jérémie area, which varied between 23 and 35 t from 2002 to 2005, declined and have then stabilized around 8-12 t since 2007 (Table 1). This sector and the Banc Marie-Marthe have shared more than 50% of the landings in sub-area 1A since 2007. The effort at Îlets Jérémie was 264-335 vendor-days from 2002 to 2005, and has dropped by over 50% since 2006. In 2008, 2009 and 2010, the effort was respectively 77, 84 and 51 vendor-days. The reference mean CPUE was 106.0 kg/vendor-day (Figure 5). The CPUEs were near average in 2008 and exceeded it in 2009 and 2010. The average median size of clams landed is 60 mm. In 2008 and 2009, the median was below this value and the proportion of sub-legal size clams reached 19-21% (Figure 6).

Sub-area 1B

Landings from sub-area 1B are almost exclusively from Pointe-aux-Outardes and occasionally Rivière Mistassini and Baie Saint-Nicolas (Table 1). Landings at Pointe-aux-Outardes decreased from 154 t in 2003 to 27 t in 2009 and finally to 9 t in 2010. Landings from this area, depending on the year, total between 10 and 20% of landings on the UNS. The decline in fishing effort, from 1,654 to 79 vendor-days, is the reason for almost all of the decrease in landings (Figure 4). The reference mean CPUE was 98.5 kg/vendor-day (Figure 7). The CPUE varies from year to year and showed high values in 2003 and 2006. The minimum value of 2008 was partly due to bad weather conditions. The Pointe-aux-Outardes harvesting site has some of the largest clams on the UNS. The average median size is 73 mm (Figure 8). The proportion of clams under 51 mm in the landings has been below 5% since 2004.

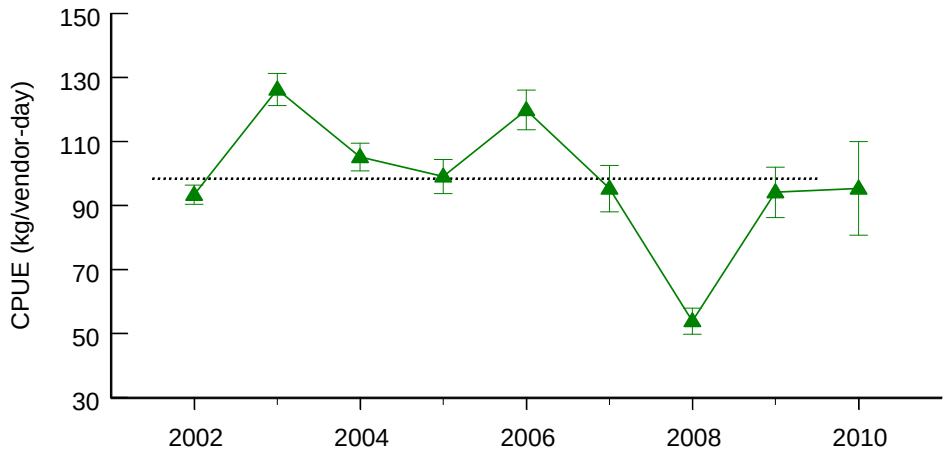

Figure 7. Catches per unit effort (CPUE ± 95% confidence interval) from 2002 to 2010 for Pointe-aux-Outardes in sub-area 1B. The horizontal dotted line indicates the 2002-2009 reference mean CPUE.

Sub-area 1C

The only area opened (approved status) to harvesting in sub-area 1C is Réserve Pessamit Sud (formerly named Réserve Betsiamites Sud). The exploitation of this bed is more recent than the other two sub-areas on the UNS. Peak landings of 304 t were made in 2004 (Table 1). Landings declined rapidly to about 100 t in 2006 and 2007, and to about 80 t in 2008 and 2009. The Réserve Pessamit Sud area was the primary source of landings in 2010 with 38 t. The effort dropped from 2,448 vendor-days in 2004 to 894 vendor-days in 2009 and 923 vendor-days in 2010 (Figure 4). The CPUE reached a maximum value of 128.4 kg/vendor-day in 2004, a value well above the reference average of 88.4 kg/vendor-day (Figure 9). However, from 2006 to 2008, the CPUE remained at 67-69 kg/vendor-day or below the reference average. In 2010, the CPUE reached a minimum value of 43.9 kg/vendor-day. The reference median size at this bed

is 60 mm. Since 2007, the median size has remained near the average or slightly below (Figure 8). The proportion of clams under 51 mm in the landings has varied from one year to the other with high values in 2008 and 2009.

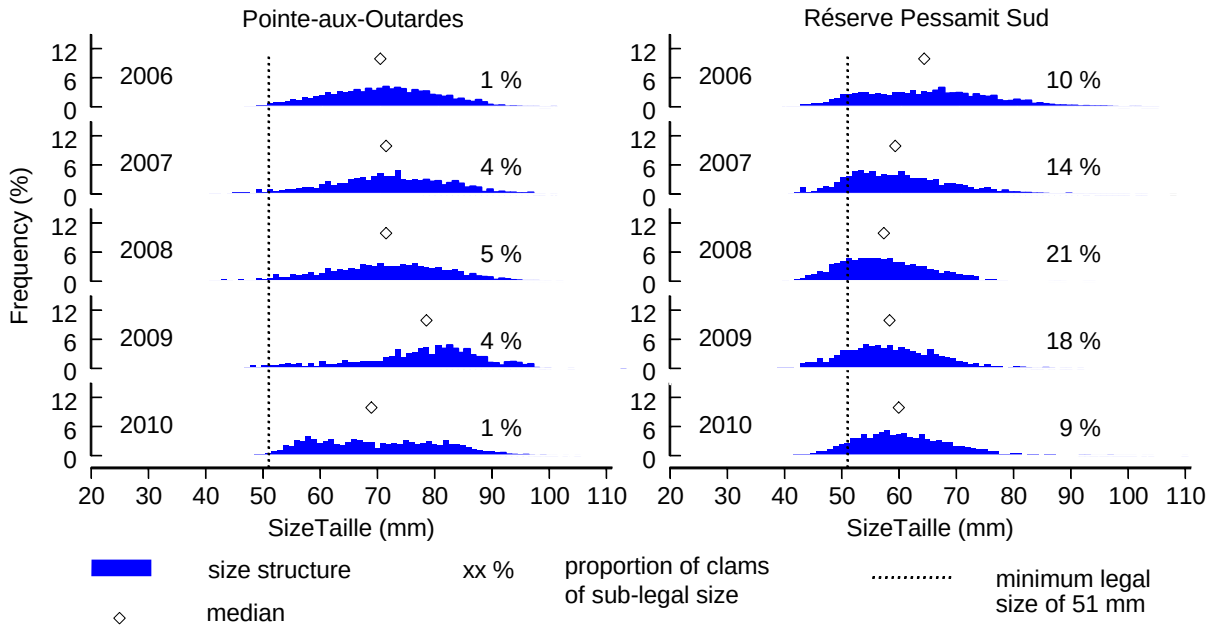

Figure 8. Size structures, median size and proportion of clams of sub-legal size from 2006-2010 for two harvesting sites in sub-area 1B (Pointe-aux-Outardes) and 1C (Réserve Pessamit Sud).

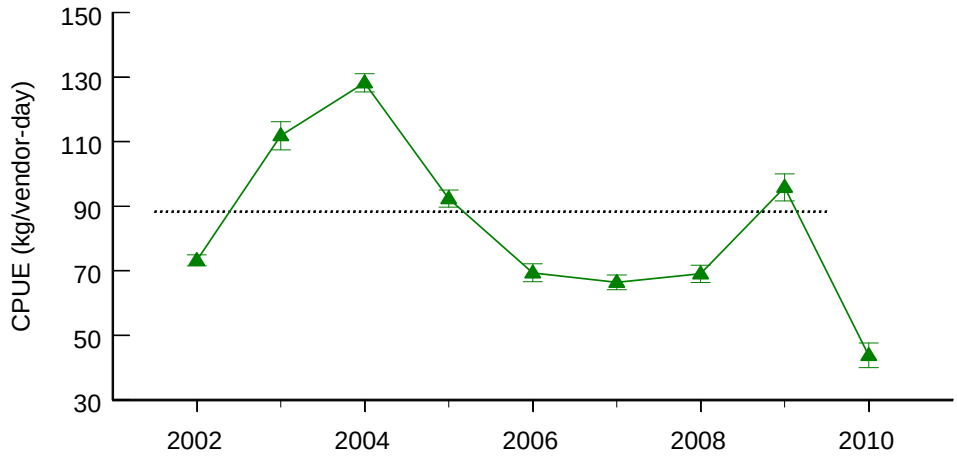

Figure 9. Catches per unit effort (CPUE ± 95% confidence interval) from 2002 to 2010 for Réserve Pessamit Sud in sub-area 1C. The horizontal dotted line indicates the 2002-2009 reference mean CPUE.

Depuration

The depuration areas are used to supply clam depuration processing plants when approved and conditionally approved areas are closed because of clam bacterial contamination or toxicity. The plant had a mollusc depuration license and was closed in 2005 and 2010 and consequently, there were no landings from these depuration areas in these two years. Since 2006, stricter monitoring of landings in depuration areas has been introduced. These measures have provided detailed information per harvester rather than by vendor. Due to the improved accuracy of the data, the reference period used for the CPUE begins in 2006.

Since 2003, areas used for depuration have been Baie Sainte-Catherine, Baie des Grandes Bergeronnes, Rivière Blanche, Baie des Escoumins and Anses à Frigault (Table 1). Landings were high at Baie des Grandes Bergeronnes in 2004 (100 t) and 2006 (75 t) and at Baie des Escoumins (62 t) in 2007. Otherwise, annual landings totalled between 5 and 28 t per area. From 2006 to 2009, landings were relatively consistent with fluctuations in harvesting effort. The reference mean CPUE was 107.1 kg/harvester-day at Baie des Grandes Bergeronnes, 110.4 kg/harvester-day at Baie des Escoumins and 101.3 kg/harvester-day at Rivière Blanche (Figure 10). The average median sizes differ slightly between the three areas, 59 mm at Baie des Grandes Bergeronnes, 63 mm at Baie des Escoumins and 57 mm at Rivière Blanche. Despite tighter monitoring of harvesting in these areas, the proportion of sub-legal size clams is often above 10% (Figure 11). It even reached 20% at Rivière Blanche in 2007.

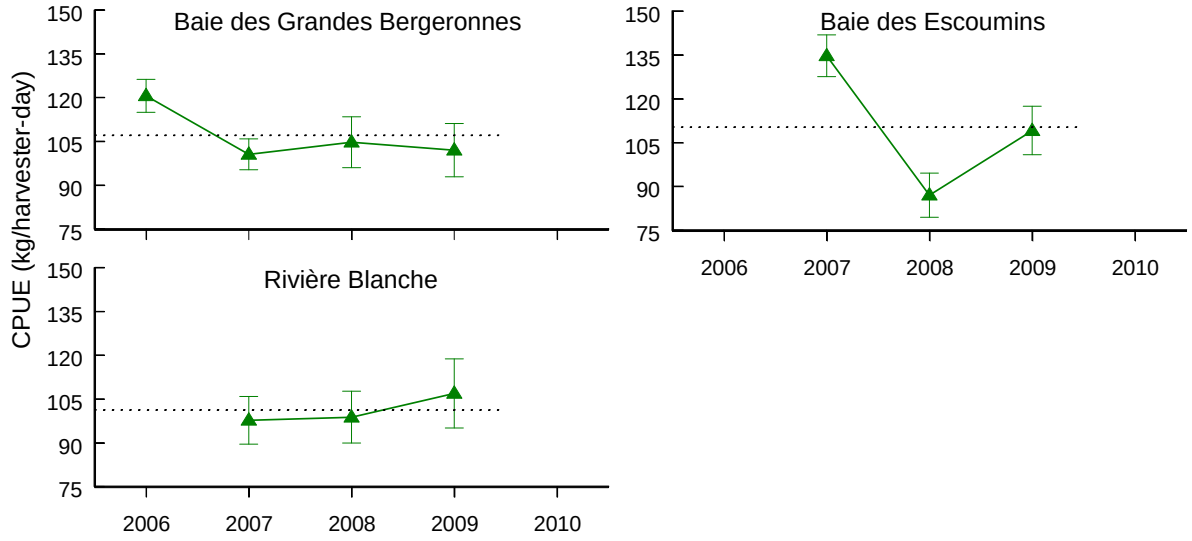

Figure 10. Catches per unit effort (CPUE ± 95% confidence interval) from 2006 to 2009 for three limited status areas (depuration). The horizontal dotted line indicates the 2006-2009 reference mean CPUE.

Daily monitoring of the CPUEs in depuration areas suggests that harvesters move across the clam bed to try to maintain their yield level above a certain level, for example at Baie des Escoumins in 2007 (Figure 12). This type of behaviour and the quest for better yields could explain why some areas are abandoned after intensive harvesting, as was the case for Baie des Plongeurs and possibly Pointe de Mille-Vaches and Pointe-à-Boisvert.

Research Indices

Several Quebec clam bed surveys have been conducted by DFO since 2001. The 2005 and 2010 results of surveys conducted on the Réserve Pessamit Sud harvesting site are presented in this document. The clam bed area was estimated at 1.4 km^2. Clams of 51+ mm were present throughout the bed, and their average density was 19.2 and 12.2 clams/m^2 in 2005 and 2010 respectively. Survey results showed that clam densities and yields declined between 2005 and 2010, with the exception of sub-legal size clams where the decline was not significant (Tables 2 and 3). The drop in density was 57% for sub-legal size clams and 36% for clams of legal size, and the latter corresponds to a 33% decline in yields.

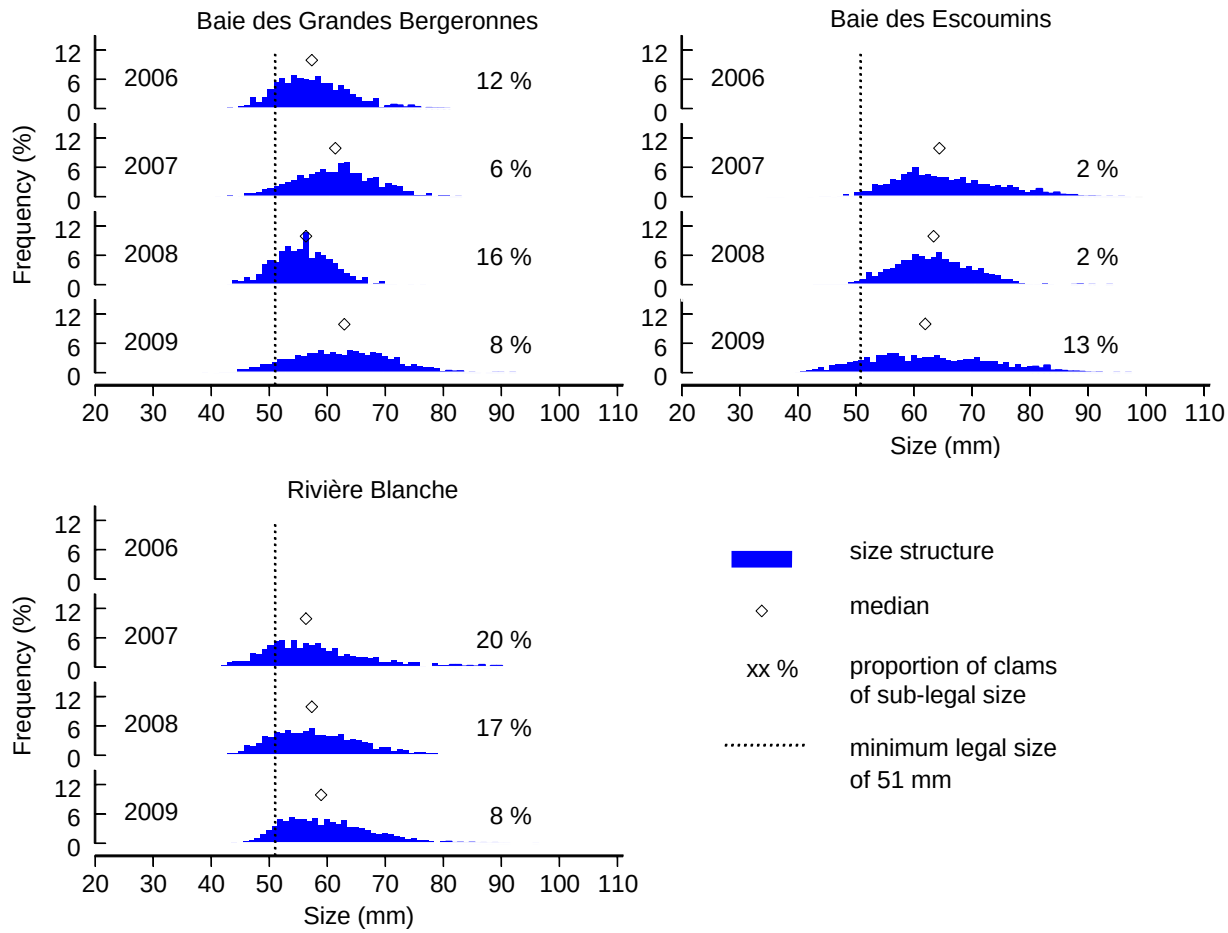

Figure 11. Size structures, median size and proportion of clams of sub-legal size from 2006-2009 for three harvesting sites with limited status (depuration).

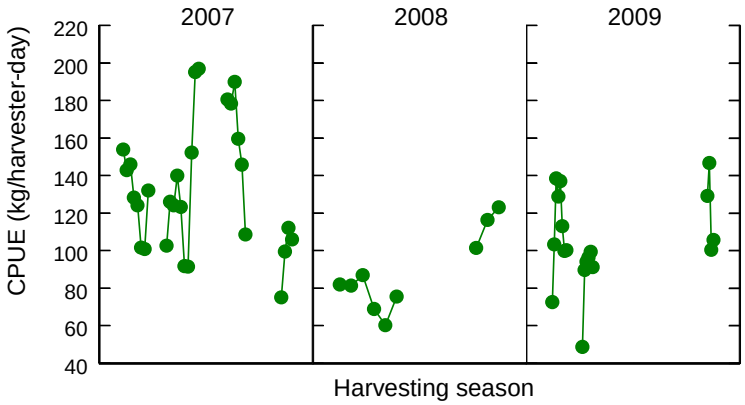

Figure 12. Catches per unit effort (CPUE) daily averages for Baie des Escoumins from 2007 to 2009.

Because the 2010 survey was conducted before the start of commercial harvesting, it is possible to estimate an exploitation index by relating landings to estimated biomass of legal size clams. This index would be about 8% for 2010. However, it is important to note that with the closure of processing plants in 2010, the Réserve Pessamit Sud landings were lower than previous years. With a harvesting season similar to that of 2006-2009, landings would have been about 90 t and the exploitation index 18-19%. The drop in commercial CPUEs observed at this bed would reflect a decrease in population abundance. An annual harvest of less than 10%

of the commercial biomass could be acceptable for clam populations to ensure the sustainability of the clam beds.

Table 2. Mean density (± standard deviation) and abundance of clams per size class estimated in 2005 and 2010 on the Réserve Pessamit Sud bed.

Year	Mean density (number/m^2)			Abundance (million individuals)	
	≥ 11 mm	11-50 mm	≥ 51 mm	≥ 11 mm	≥ 51 mm
2005	89.9 ± 24.3	70.8 ± 21.4	19.2 ± 3.7	125.9	26.9
2010	42.9 ± 8.0	30.7 ± 6.9	12.2 ± 1.9	60.1	17.1

Table 3. Mean yield (± standard deviation) and biomass of clams per size class estimated in 2005 and 2010 on the Réserve Pessamit Sud bed.

Year	Mean yield (g/m^2)			Biomass (t)	
	≥ 11 mm	11-50 mm	≥ 51 mm	≥ 11 mm	≥ 51 mm
2005	757.5 ± 141.6	228.5 ± 62.3	529.0 ± 86.6	1,060.5	740.6
2010	515.8 ± 78.9	159.7 ± 43.0	356.1 ± 51.2	722.1	498.5

Sources of Uncertainty

Sharing the territory between commercial and recreational harvesters combined with the lack of information from the recreational component makes it difficult to clearly identify landings and total effort on the different clam beds. The recreational component could explain the lack of recovery in the exploited areas (no significant increase in CPUE) despite the low level of harvesting effort observed in recent years. Partial data or data not reflecting reality can change commercial indicator trends. There is uncertainty in terms of CPUE interpretation in recent years. The effort unit used is expressed in vendor-days, but the actual number of harvesters is unknown. The vendor/harvester ratio may have changed over the years. In this case, the CPUE level may reflect the performance or the number of harvesters rather than the status of the resource. The lack of independent indicators for the commercial component, such as those from research surveys, does not provide clam advisory reports that are not uniquely commercial-fishery-dependant. Environmental conditions, such as weather conditions or the increase of abnormal tides, can also affect certain fishery 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

On the UNS, clam landings peaked in 2000 and have declined since. Since 2008, landings have been among the lowest values observed since 1970. The harvesting effort has also declined. The closure of clam processing plants on the UNS in 2010 has impacted this fishery considerably.

Most shellfish harvesting sites with approved and conditionally approved status on the UNS showed low CPUEs between 2006 and 2008 compared to 2002-2005, despite a significant decrease in effort in all areas. Since 2009, there have been some increases in CPUE, with the exception of Réserve Pessamit Sud where the 2010 CPUE was the lowest in the series. The interest of harvesters for certain areas (e.g. Pointe de Mille-Vaches, Pointe-à-Boisvert and Baie

des Plongeurs) has declined significantly since 2005-2006. This lack of interest from harvesters could be explained by low yields which suggest a decrease of the resource on these beds.

The survey conducted in 2010 on the Réserve Pessamit Sud bed indicates a decrease in density and yield of legal size clams of about 35% and density of sub-legal size clams of 57%, compared to the 2005 survey. The decline in commercial CPUE observed at this clam bed would thereby be a reflection of a declining population. To ensure the sustainability of clam beds, it is recommended to annually harvest less than 10% of the commercial biomass. In the case of Réserve Pessamit Sud, this harvesting level would represent 50 t annually given the current stock size.

Since the last assessment in 2007, landings and harvesting effort have decreased. The decline of the effort could be due to a decrease in the resource or to socio-economic factors (e.g. lower prices, little relief, plant closures). The CPUEs from 2006 to 2008 were among the weakest. The proportion of sub-legal size clams in the landings is sometimes high, suggesting a low abundance of legal size clams on certain beds. Despite the low harvesting effort in recent years, there has been no noticeable improvement in the status of the resource.

In order to protect the reproductive potential of each harvesting site, the legal harvesting size should be respected and harvesting effort limited on the UNS at a level not exceeding the 2007-2009 average. To mitigate incidental mortality caused by harvesting, it is recommended to close the fishery when the air temperature is at or below 0°C.

It would be appropriate to continue the surveys of commercially exploited beds to determine their exploitation index. In addition, better knowledge of recreational harvesting is needed to better assess its impact on the resource.

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 stunting 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 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.

Such management is only possible if all stakeholders get involved. To ensure the sustainability of this fishery, it would be beneficial to develop a small-scale exploitation strategy, such as subdividing clam beds into usable parcels, by a limited number of harvesters-aquaculturists who are responsible for their parcel like farmers. In the present state, more specifically the use of areas with a restricted status (depuration harvesting) could be considered as individual harvest areas. But in such a case, operations would have to resume at the depuration facility or an

alternate depuration method would have to be introduced, such as live-storage in a natural uncontaminated environment.

Finally, the occasional environmental events (e.g. breaking waves, storms) and the continuing erosion of the banks that has been ongoing for several years can have a major impact on clam beds and completely remodel their habitat. Moreover, these effects can differ from one clam bed to another. The assessment of clam stocks in these conditions could be difficult, especially if these events become increasingly frequent.

SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, regional advisory meeting of January 25, 2011 on the Assessment of Quebec Inshore Waters Softshell Clam Stocks. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm

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