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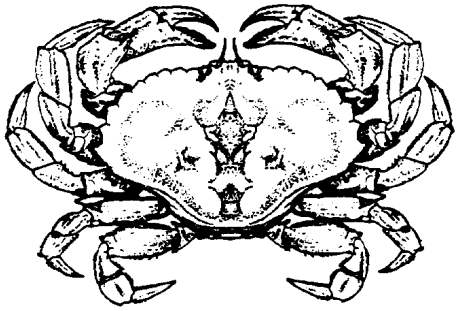
**Canadian Science Advisory Secretariat**
**Quebec Region** | **Science Advisory Report 2013/007**

# ASSESSMENT OF ROCK CRAB STOCK STATUS IN QUEBEC IN 2012



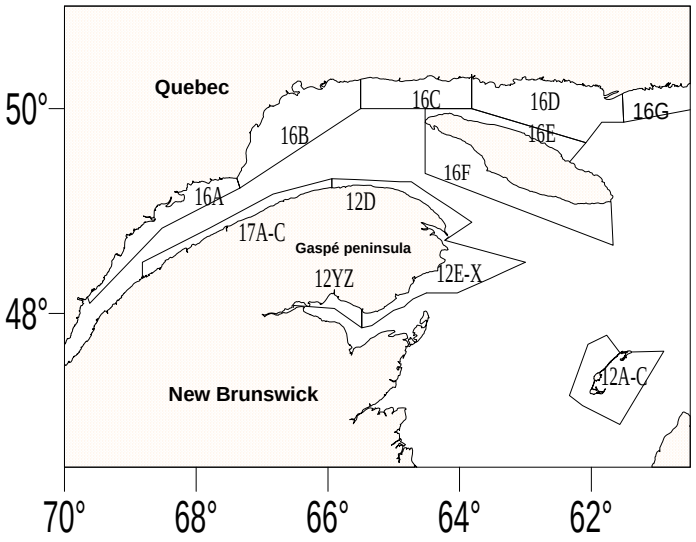



*Figure 1. Rock crab fishing areas in Quebec.*

## Context

*In Quebec, commercial fishing of rock crab began in 1988, but the fishery did not really begin to take off until 1995, first in the southern part of the Gaspé Peninsula (12E-Z) and the Magdalen Islands (12A-C), then along the north shore of the Gaspé Peninsula (12D and 17) and, since 2004, on the North Shore, particularly in 16B and 16D.*

*Rock crab is a keystone species in the ecosystem and is an important prey for lobster and several species of fish. The fishery is managed by a conservation plan intended to protect the trophic relationships, particularly with lobster. The management measures currently in place are intended to protect the reproductive potential by keeping harvesting rates low or moderate.*

*The fishery is managed by controlling fishing effort, and by controlling catches as well in the Magdalen Islands and the Gaspé Peninsula. Harvesting is also limited spatially through fishery closures in certain areas. The minimum catch size is 102 mm (carapace width), creating an exclusively male-directed fishery.*

*Rock crab stocks are assessed every three years. This assessment covers the 2010–2012 fishing seasons, with recommendations provided for the 2013–2015 fishing seasons.*

# SUMMARY


- Landings of rock crab in Quebec totalled 1581 t in 2012 and were exclusively from the directed fishery. In 2012, 35% of landings came from the Magdalen Islands (565 t), 29% from the southern part of the Gaspé Peninsula (457 t), 26% from the northern part of the Gaspé Peninsula (407 t) and 10% from the North Shore (153 t). Landings were down from 2009, when they totalled 1777 t. Quotas were not reached in several sectors due to a decrease in the fishing effort (southern part of the Gaspé Peninsula), or a reduction of rock crab abundance (Magdalen Islands).

- Catch rates have remained above or close to historical averages in the Gaspé Peninsula and North Shore since 2009. However, they have been declining in the Magdalen Islands since 2004 and in 2012, they were 33% below the 1998–2011 average. It is therefore recommended to lower quotas in the Magdalen Islands.

- In most regions, the size structures and average sizes have remained stable for several years. However, that is not the case in the northern part of the Gaspé Peninsula, where a decrease in average size and abundance of large crabs has been observed since 2006. It is recommended to lower quotas in this area.

- The fishery on the North Shore in 16B and 16D is developing well and indicators have remained stable for a number of years. The fishery could become permanent. It is recommended to set a cap on catches at a level equivalent to that in effect for the years when productivity was sustained.

- For all of Quebec, it is recommended not to increase the intensity of the directed fishery given the uncertainty associated with lobster fishermen being able to keep rock crab by-catches without them being fully controlled.

- Lastly, to assess the impact of the rock crab fishery on the ecosystem, in accordance with the DFO *Sustainable Fisheries Framework*, it is recommended that by-catches of the rock crab directed fishery be recorded.


# BACKGROUND

## Species biology

The rock crab (*Cancer irroratus*) is found along the east coast of North America, from Labrador to South Carolina. This species is associated with various types of substrate, ranging from bedrock to soft bottoms. Legal-size crabs > 102 mm (size corresponds to carapace width), and more generally those larger than 50 mm, live on sandy or muddy bottoms, while a smaller portion of the adult population share rocky bottoms where lobster also occur, with individuals smaller than 50 mm. Berried female rock crabs show a marked preference for soft bottoms, where they can bury themselves and where they form aggregations.

Males and females grow to different sizes. Males can reach 140 mm, while females rarely exceed 100 mm. Reproduction occurs in the fall after the females have moulted and while their carapace is still soft. Males moult in winter so their carapace is fully hardened by spawning season. It can take two to three months for carapaces to harden completely. Females reach

sexual maturity at about 60 mm, while males do so at a slightly larger size (≈70 mm). Females lay their eggs and then keep them under their abdomen for nearly 10 months. A 60-mm female can lay 125,000 eggs, while a 90-mm female can lay up to 500,000. The eggs hatch the summer after they are laid, and the larvae remain in the water column from mid-June to mid-September. In the fall, the larvae—which go through five pelagic stages—metamorphose into postlarvae (megalops) and begin their benthic life shortly thereafter. Juveniles (15 mm) are found mainly at shallow depths on bottoms that offer shelter from predators and water turbulence. Growth data for rock crab in the Gulf of St. Lawrence are rather sparse. Data from regions further south suggest that rock crab may attain commercial size at about five or six years of age and live to about seven years. The age at which they attain commercial size and their longevity could be higher in areas located further north.

The rock crab is omnivorous and displays a certain amount of opportunism in its diet. Lobster has never been shown to constitute a significant portion of the rock crab's diet, but analyses of lobster stomach contents indicate that rock crab is a major prey for lobster throughout the lobster's life cycle, even from the earliest larval stage. In addition, recent work conducted in the southern Gulf of St. Lawrence suggests that the rock crab is an important prey for many species of groundfish, making it a key species of the coastal marine ecosystem.

## The fishery

Rock crab is the object of a directed fishery for which a licence is required. It is also caught by a varying number of lobster fishermen who, in accordance with the *Atlantic Fisheries Regulation*, are entitled to keep male rock crab by-catches. Catches that are sold are recorded, but there is no data on the quantity of rock crab that is kept or used as bait in the lobster fishery. Data collected recently in the Gaspé Peninsula and Magdalen Islands on by-catches in the lobster fishery indicate that rock crab is the most abundant by-catch species by weight.

The rock crab fishery is managed first of all by controlling fishing effort. The number of licences and traps is limited, as are the size of the traps and the fishing season. Catches are also controlled in the Magdalen Islands and in the Gaspé Peninsula. Only males with a carapace width of > 102 mm can be legally landed.

The fishery is also managed by fishing areas (Figures 1, 2 and 3), so that fishing effort can be distributed more evenly. Exclusion areas were established for the directed fishery in the northern Gaspé Peninsula in 2009 (Figure 3) to protect a portion of the rock crab population and monitor its natural evolution. In the southern Gaspé Peninsula, there are several sub-areas that are purposely not open to a directed fishery because fishermen are concerned that the rock crab fishery may harm lobster. There is also an exclusion area in the Magdalen Islands (12C1), which was closed to the rock crab directed fishery in 2000 (Figure 2).

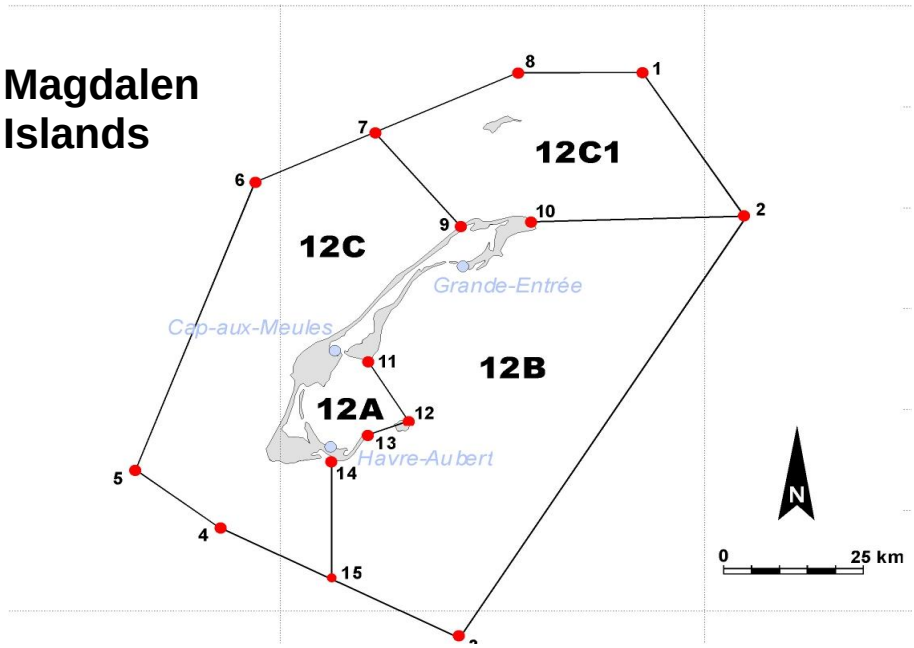



*Figure 2. Rock crab fishery sub-areas in the Magdalen Islands (12A, 12B and 12C) and the exclusion area (12C1).*

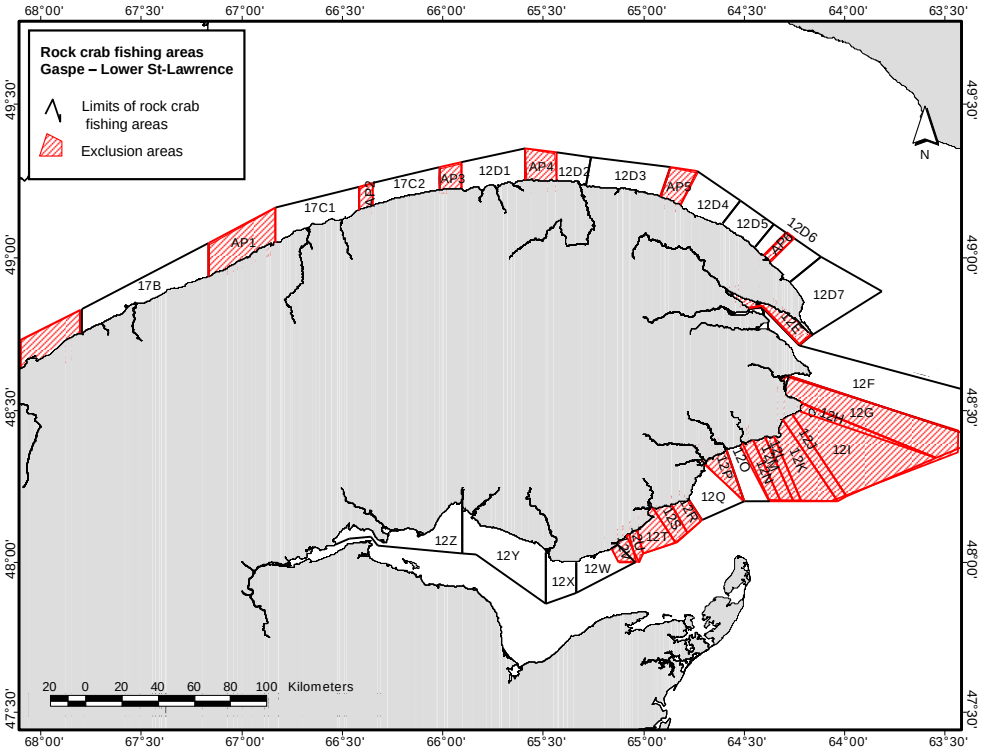



*Figure 3. Rock crab fishery sub-areas in the Gaspé Peninsula showing in red the exclusion areas (sub-areas in the southern Gaspé Peninsula and AP1-6 in the northern Gaspé Peninsula).*

The directed fishery in the Gaspé Peninsula and Magdalen Islands occurs after lobster season. The rock crab fishing season opens between the end of July and the beginning of August, and ends once quotas have been reached or no later than between the end of September and end of November, depending on the area. In 2012, the season was open from June 25 to October 25 on the North Shore, and from July 25 to October 18 on Anticosti Island.

In 2012, in the Magdalen Islands, 14 fishermen had a directed fishing licence with an individual quota of 45 t. An overall quota of 675 t was established for the Magdalen Islands, which includes a quota of 45 t to account for rock crab by-catches by lobster vessels. There are two types of traps in the Magdalen Islands and every fisherman can use 85 traps of 1.219 m (4 feet) in diameter or 140 traps of 0.914 m (3 feet) in diameter, or any combination of these two types of traps calculated according to an equivalency factor of 1 large trap for 1.66 small traps, based on their relative effectiveness. Fishermen have access to one, or in some cases, two of the three fishing areas. In the southern Gaspé Peninsula in 2012, there were 4, 7, 7 and 5 fishermen in areas 12EP, 12QX, 12Y and 12Z who shared quotas of 163, 155, 123 and 183 t, respectively. In the northern Gaspé Peninsula in 2012, 3 fishermen in area 17-12D3 and 4 fishermen in area 12D4-D7 shared quotas of 150 and 250 t, respectively. In 2012, the number of traps per fisherman was 150 in the northern Gaspé Peninsula and between 75 and 150 in the southern Gaspé Peninsula, depending on the area. On the North Shore, a total of 31 exploratory licences were issued in 2012. The number of traps was 150, except for fishermen in area 16B fishing outside the Baie de Sept-Îles (16B1), who were entitled to 200 traps. Moreover, two fishermen from 16B were allowed to fish in 12E with 200 traps.

# ASSESSMENT

## Source of data

The resource assessment is based primarily on the review of abundance indicators and the size of crabs landed. The abundance indicators are the landings and catch rates or catch per unit effort (CPUE) during the directed fishery. Landings and CPUE are compiled from logbooks that became mandatory in 1995 in the Magdalen Islands, in 2001 in the Gaspé Peninsula and in 2004 on the North Shore. The landing data recorded in logbooks are validated by purchase slips and dockside weighing. The data on average sizes and size structures stem from dockside sampling. Over 10,000 crabs are measured annually in a dozen sub-areas. A trawl survey has been conducted in the southern part of the Magdalen Islands since 1995 in order to obtain abundance and demographic indicators for lobster. Catches of rock crab in the surveys are also analyzed to obtain abundance and recruitment indicators.

## Landings

Rock crab landings for all of Quebec totalled 1581 t in 2012 (Figure 4, Table 1). Landings were down from 1777 t in 2009. Rock crab landings in Quebec increased steadily from 687 t in 1996 to 1761 t in 2002. Since 2002, they have been above 1500 t, peaking in 2005 at 2004 t (Table 1).

In 2012, 35% of landings came from the Magdalen Islands (565 t), 29% from the southern part of the Gaspé Peninsula (457 t), 26% from the northern part of the Gaspé Peninsula (407 t) and 10% from the North Shore (153 t). Since 2009, no rock crab landings have been reported from by-catches in the lobster fishery (Table 1). However, rock crab by-catches kept by fishermen are not documented. The quota of 630 t for the directed fishery in the Magdalen Islands was

reached every year between 2002 and 2009 (to within 15 t). However, in the past three years (2010, 2011 and 2012), the quota has not been reached and landings were 19, 21 and 65 t under quota, respectively.

In the Gaspé Peninsula, rock crab landings from the directed fishery have been limited by quotas since 2010. In the southern Gaspé Peninsula, quotas were only just reached in 2010 and in 12EP only. Between 48% and 90% of quotas were reached in 2012, depending on the area. In 2012, landings in the southern Gaspé Peninsula were 26% below the established quota. They declined by 26% in the past three years, from 621 t in 2009 to 457 t in 2012. The decreases are due to a reduced fishing effort. In the northern Gaspé Peninsula, the quota of 250 t was reached between 2010 and 2012, and even exceeded in 12D4-D7. The quota of 150 t in 17-12D3 was reached in 2010 and 2012, but only 105 t were landed in 2011 due to fewer active fishermen.

Rock crab landings in the North Shore reached 153 t in 2012, 7% less than in 2009 and less than the 2004–2011 average of 165 t. There were nine active fishermen on the North Shore in 2012. There has been no fishery in 16C or 16E (Anticosti) since 2008. In 2012, landings came solely from 16B and 16D at 74% and 26%, respectively. Aside from a decrease in 2010, the fishing effort has been fairly stable since 2005 in 16B and 16D.

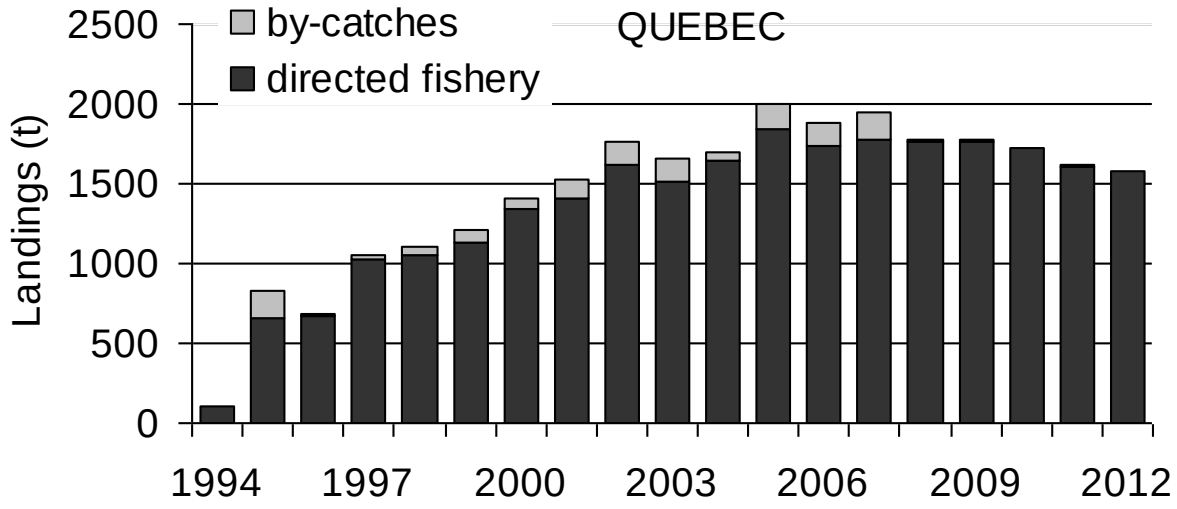



*Figure 4. Rock crab landings (t) in Quebec from 1994 to 2012 from the directed fishery and by-catches by lobster vessels.*

*Table 1. Rock crab landings (t) in Quebec from 2000 to 2012 by area and sub-area (directed fishery). Values for 2012 are preliminary. Total by-catches are indicated.*

| Région & Area | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Magdalen Islands (MI)** | | | | | | | | | | | | | |
| **12A** | *57* | *133* | 117 | *112* | 115 | 113 | 124 | 114 | 130 | 128 | 130 | 97 | 94 |
| **12B** | *340* | *257* | 291 | *296* | 292 | 301 | 284 | 299 | 279 | 278 | 274 | 307 | 284 |
| **12C** | *181* | *224* | 213 | *266* | 228 | 223 | 226 | 220 | 227 | 215 | 207 | 214 | 188 |
| **12 undetermined** | *10* | *9* | | *32* | | | | | | | | | |
| **MI directed** | **562** | **586** | **621** | **634** | **634** | **637** | **635** | **634** | **636** | **621** | **611** | **619** | **565** |
| **MI bycatch** | **26** | **37** | **96** | **72** | **20** | **145** | **131** | **169** | **9** | **0** | **0** | **0** | **0** |
| **MI Total** | **588** | **623** | **717** | **706** | **654** | **782** | **766** | **803** | **645** | **621** | **611** | **619** | **565** |
| **North Gaspé (NG)** | | | | | | | | | | | | | |
| **17** | *15* | *19* | *40* | *29* | *17* | 11 | 10 | 5 | 10 | 8 | 13 | 0 | 0 |
| **12D** | *167* | *218* | *327* | *263* | *268* | 394 | 365 | 395 | 423 | 362 | 407 | 349 | 407 |
| **NG directed** | **162** | **212** | **353** | **281** | **271** | **405** | **374** | **399** | **432** | **362** | **420** | **349** | **407** |
| **NG bycatch** | **20** | **25** | **13** | **10** | **14** | **8** | **8** | **10** | **7** | **6** | **0.25** | **0** | **0** |
| **NG Total** | **182** | **237** | **366** | **291** | **285** | **413** | **382** | **409** | **439** | **368** | **420** | **349** | **407** |
| **South Gaspé (SG)** | | | | | | | | | | | | | |
| **12EP** | *172* | *161* | *161* | *172* | *154* | 164 | 149 | 121 | 141 | 140 | 170 | 115 | 113 |
| **12QX** | *170* | *189* | *192* | *145* | *152* | 150 | 158 | 155 | 136 | 136 | 140 | 87 | 123 |
| **12Y** | *145* | *130* | *149* | *112* | *119* | 110 | 112 | 139 | 116 | 132 | 118 | 107 | 59 |
| **12Z** | *152* | *166* | *175* | *211* | *186* | 149 | 135 | 151 | 151 | 212 | 152 | 166 | 161 |
| **SG directed** | **612** | **595** | **648** | **585** | **599** | **573** | **554** | **566** | **543** | **621** | **580** | **475** | **457** |
| **SG bycatch** | **26** | **51** | **28** | **55** | **11** | **5** | **3** | **2** | **2** | **2** | **2** | **0** | **0** |
| **SG Total** | **638** | **646** | **676** | **640** | **610** | **578** | **557** | **568** | **545** | **623** | **582** | **475** | **457** |
| **NG+SG directed** | **774** | **806** | **1002** | **866** | **870** | **978** | **928** | **965** | **976** | **983** | **999** | **823** | **864** |
| **NG+SG bycatch** | **46** | **76** | **41** | **65** | **25** | **13** | **11** | **12** | **9** | **8** | **3** | **0** | **0** |
| **NG+SG Total** | **820** | **882** | **1043** | **931** | **895** | **991** | **939** | **977** | **985** | **991** | **1002** | **823** | **864** |
| **North Shore (NS)** | | | | | | | | | | | | | |
| **16A** | 0 | 0 | 0 | *0* | *0* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16B** | 3 | 15 | 1 | *1* | *83* | 125 | 79 | 88 | 75 | 116 | 78 | 123 | 112 |
| **16C** | 0 | 0 | 0 | *0* | *3* | 6 | 4 | 1 | 0 | 5 | 0 | 0 | 0 |
| **16D** | 0 | 0 | 0 | *14* | *53* | 46 | 40 | 41 | 39 | 44 | 32 | 46 | 40 |
| **16E** | 0 | 2 | 0 | *0* | *0* | 54 | 57 | 43 | 35 | 0 | 0 | 0 | 0 |
| **16G** | 0 | 3 | 0 | *1* | *2* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **NS directed** | **3** | **21** | **1** | **14** | **139** | **231** | **180** | **173** | **148** | **165** | **110** | **169** | **153** |
| **NS bycatch** | **0** | **0** | **0** | **2** | **3** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **NS Total** | **3** | **21** | **1** | **16** | **142** | **231** | **180** | **173** | **148** | **165** | **110** | **169** | **153** |
| **QUÉBEC directed** | **1339** | **1413** | **1624** | **1514** | **1643** | **1846** | **1742** | **1772** | **1760** | **1769** | **1721** | **1611** | **1581** |
| **QUÉBEC bycatch** | **72** | **113** | **137** | **139** | **48** | **158** | **143** | **181** | **18** | **8** | **3** | **0** | **0** |
| **QUÉBEC TOTAL** | **1412** | **1526** | **1761** | **1653** | **1691** | **2004** | **1886** | **1952** | **1778** | **1777** | **1723** | **1611** | **1581** |

## Catch rates

Catch rates (CPUEs) continued to decline in the Magdalen Islands after 2009 (Figure 5). They have been down since 2004. The decline has been sharper and more rapid for 4' traps than for 3' traps and in recent years, the difference between yields from large and small traps has decreased. In 2012, catch rates (CPUEs standardized to reflect the two types of traps) in 12A, 12B and 12C were 38%, 31% and 29% below the 1998–2011 average, respectively. In 12A, the 2012 CPUE (15.0 ± 1.2 kg/trap) was the lowest value in the series. The average for the 1998–2011 period is 24.3 kg/trap.

The CPUE pattern in 12B is the same and the 2012 value (14.9 ± 0.9 kg/trap) was the lowest recorded value since 1998. The series average is 21.4 kg/trap. In 12C, after a steady drop between 2003 and 2007, the CPUE rebounded slightly in 2008, but has been down since. In 2012, the CPUE was 13.7 ± 0.9 kg/trap, the lowest value since 1999. The CPUE average for 1998–2011 was 19.4 kg/trap. A decline in the abundance of rock crab was also observed in the trawl survey. The correlation between the CPUE and the trawl abundance indicator for 2001–2012 is high (0.78) and significant.

In the southern Gaspé Peninsula, CPUEs have been up since 2009 in 12EP, 12QX and 12Y, and the values recorded in 2012 were the highest since 2001 (Figure 6) at 8.3, 7.4 and 10.2 kg/trap, respectively. Although CPUEs were down in 12Z between 2010 and 2012 compared to 2009, they nonetheless remained equal to the 2001–2011 average of 13.4 kg/trap. In the northern Gaspé Peninsula, CPUEs in 2012 were 32% and 5% higher than in 2009 in 12D4-D7 and 17-12D3, respectively (Figure 6). For these two sectors, the CPUE was 14.9 and 7.9 kg/trap in 2012, values above the 2004–2011 averages.

In 2012, the CPUE (8.9 kg/trap) in 16B was 37% higher than the 2004–2011 average (6.5 kg/trap) (Figure 7). In 16B1, created in 2010, the CPUE was 8.8 and 7.8 kg/trap, respectively for 2011 and 2012. In 2012, the CPUE in 16D was 7.5 kg/trap, which is 10% higher than the 2004–2011 average.

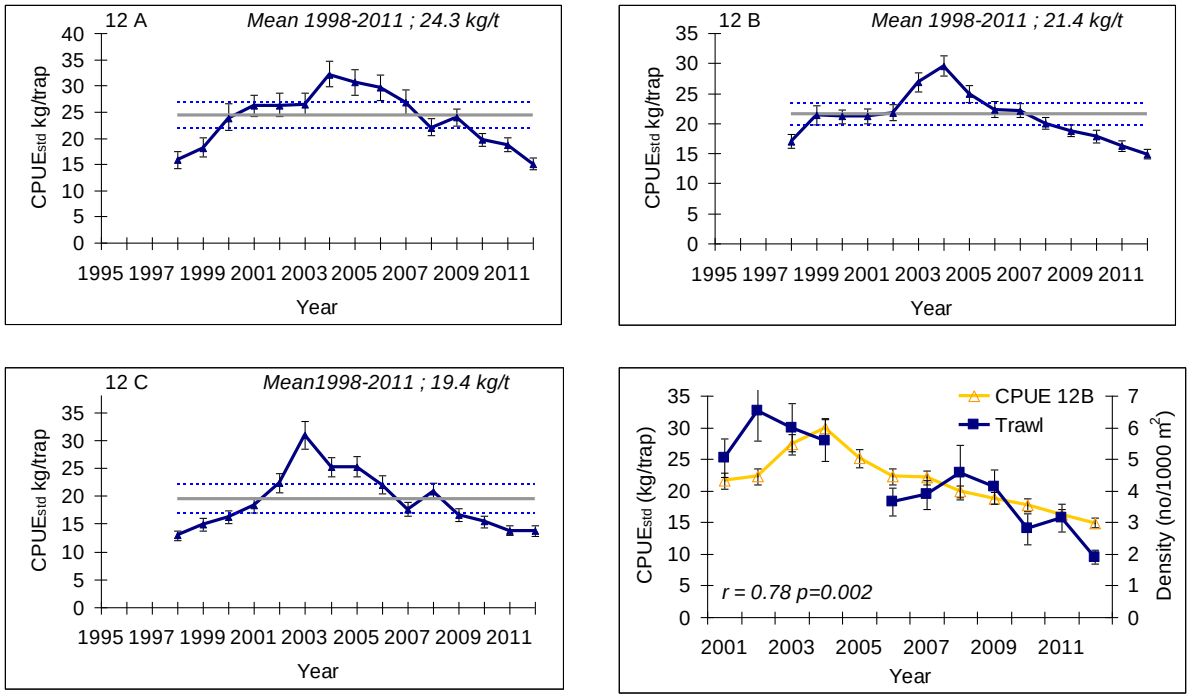



*Figure 5. Estimated rock crab catch rates (CPUEs) (kg/trap) based on logbook data. Catch rates from 12A-C were standardized ($CPUE_{std}$) to account for both types of traps. The figure on the lower right shows ($CPUE_{std}$) for 12B and rock crab density in numbers per 1000 $m^2$ from the trawl survey, from 2001 to 2012.*

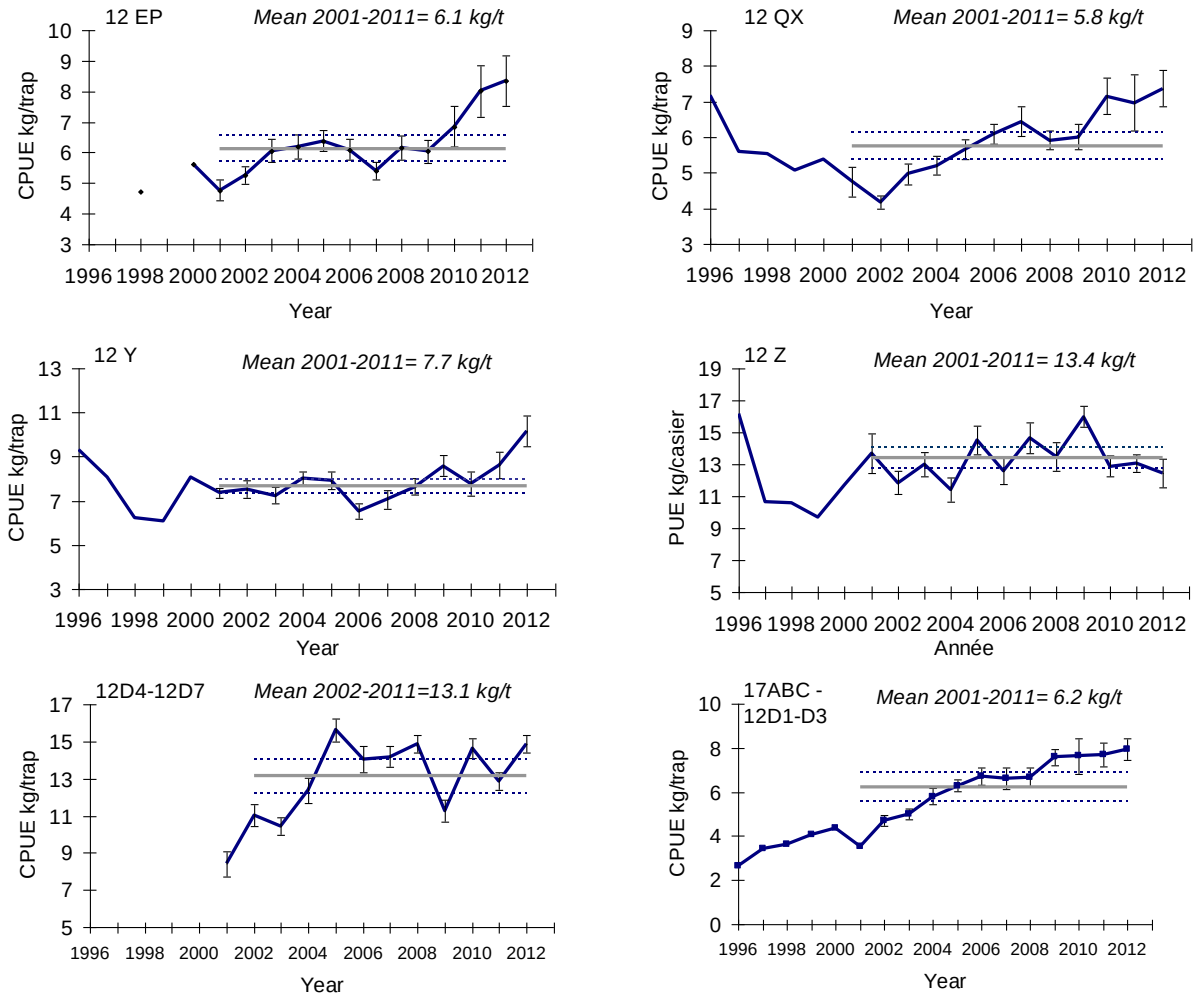



*Figure 6. Estimated rock crab catch rates (CPUEs) (kg/trap) based on logbook data in the southern Gaspé Peninsula (12EP, 12QX, 12Y and 12Z) and northern Gaspé Peninsula (12D4-D7 and 17-12D3) from 1996 to 2012.*

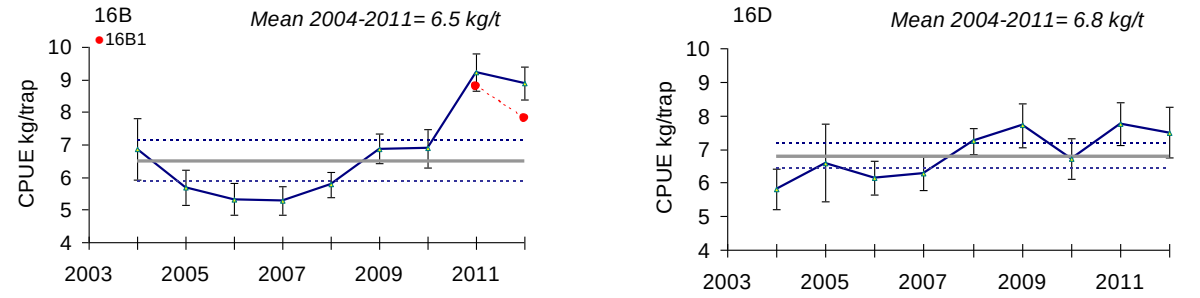



*Figure 7. Estimated rock crab catch rates (CPUEs) (kg/trap) based on logbook data on the North Shore (16B and 16D) from 2004 to 2011 and in 16B1 (Bay of Sept-Îles) in 2011 and 2012*

## Size structures

The overall size frequency distribution pattern observed in 2012 in the Magdalen Islands (Figure 8) changed little compared to observations made in the late 1990s. The average sizes of landed rock crab have remained fairly stable since 1997 in the three areas: around 123 mm in 12A, 124 mm in 12B and 120 mm in 12C (Figure 8). The proportion of large crab has remained high in the three areas and the size at the 90$^{th}$ percentile has been around 135 mm in 12A and 12B since 2001. In 12C, it was slightly lower from 2009 to 2011 compared to 2006–2008, but rebounded to 133 mm in 2012. Stability in the size structures has also been observed in the trawl survey since 2001 in 12A and 12B.

The size structures observed in the southern Gaspé Peninsula in 2012 (Figure 9) have been very stable for all areas since the early 2000s. As of 2009, the average size and the size at the 90$^{th}$ percentile have remained relatively unchanged in 12EP, 12QX and 12Z, although a slight decline (1.5 mm) in the average size was observed in 12Z in 2012 compared to 2011 (Figure 9). Since 2009, the average size and size at the 90$^{th}$ percentile increased by about 3 mm in 12Y, after a 2 mm decline in the average size between 2003 and 2009. In 2012, the average sizes and sizes at the 90$^{th}$ percentile were 111–112 mm and 120–121 mm in 12EP, 12QX and 12Y, and 113 mm and 122 mm in 12Z. They remained similar overall to the 1995–2011 averages.

In the northern Gaspé Peninsula, the size structure appeared truncated in 12D4-D7 (Figure 10) compared to what had been observed previously. The average size and size at the 90$^{th}$ percentile have fallen sharply since 2009 (Figure 10). In 2012, the average size was 112.8 mm, which is 3 mm below the 2009 value and the 2005–2011 average. The size at the 90$^{th}$ percentile was 121 mm in 2012, or 5–7 mm lower than what was observed in the mid-2000s (Figure 10). These recent declines are a continuation of a trend that began in 2006. The situation is stable, however, in 17-12D3 and the average size in 2012 was 119.6 mm, which is similar to the 2009 value and the 2005–2011 average. The size at the 90$^{th}$ percentile was higher in 2011 and 2012 (130–131 mm) than between 2005 and 2010 (128–129 mm).

The average size and abundance of large crab has been up in 16B since 2009, after a major decline between 2006 and 2009 (Figure 11). The average size in 2012 was 113 mm, which corresponds to the 2004–2011 average. In 16D, after a relatively stable period from 2004 to 2010, the average size dropped slightly in 2011 and 2012. There was also a slight drop in the number of large crabs. These two indicators will need to be closely monitored in the future.

## Recruitment

The recruitment indices, corresponding to the abundance of crabs one moult before reaching commercial size, obtained in the Magdalen Islands from the trawl survey are among the lowest in the series, suggesting low recruitment on the short-term. There are no recruitment indices for the Gaspé Peninsula or the North Shore.

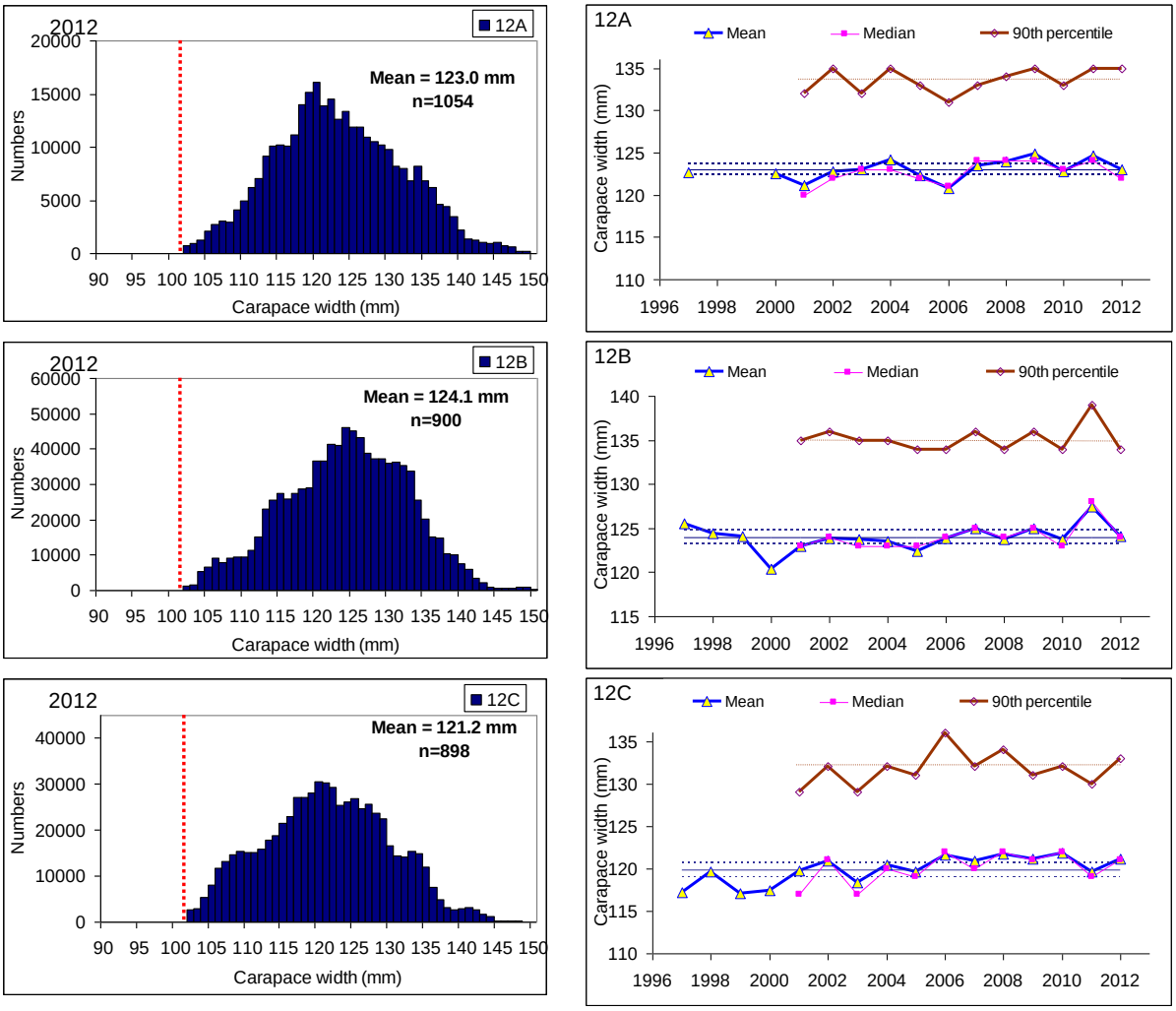



*Figure 8. Size structures of rock crab landed in the Magdalen Islands in 2012 in 12A, 12B and 12C. The number of crabs measured is indicated. The dotted vertical line represents the minimum legal size. Average sizes, median and 90$^{th}$ percentile from 1997 to 2012. The straight solid line indicates the average for 1997–2011, while the dotted lines represent a 0.5 standard deviation from the average.*

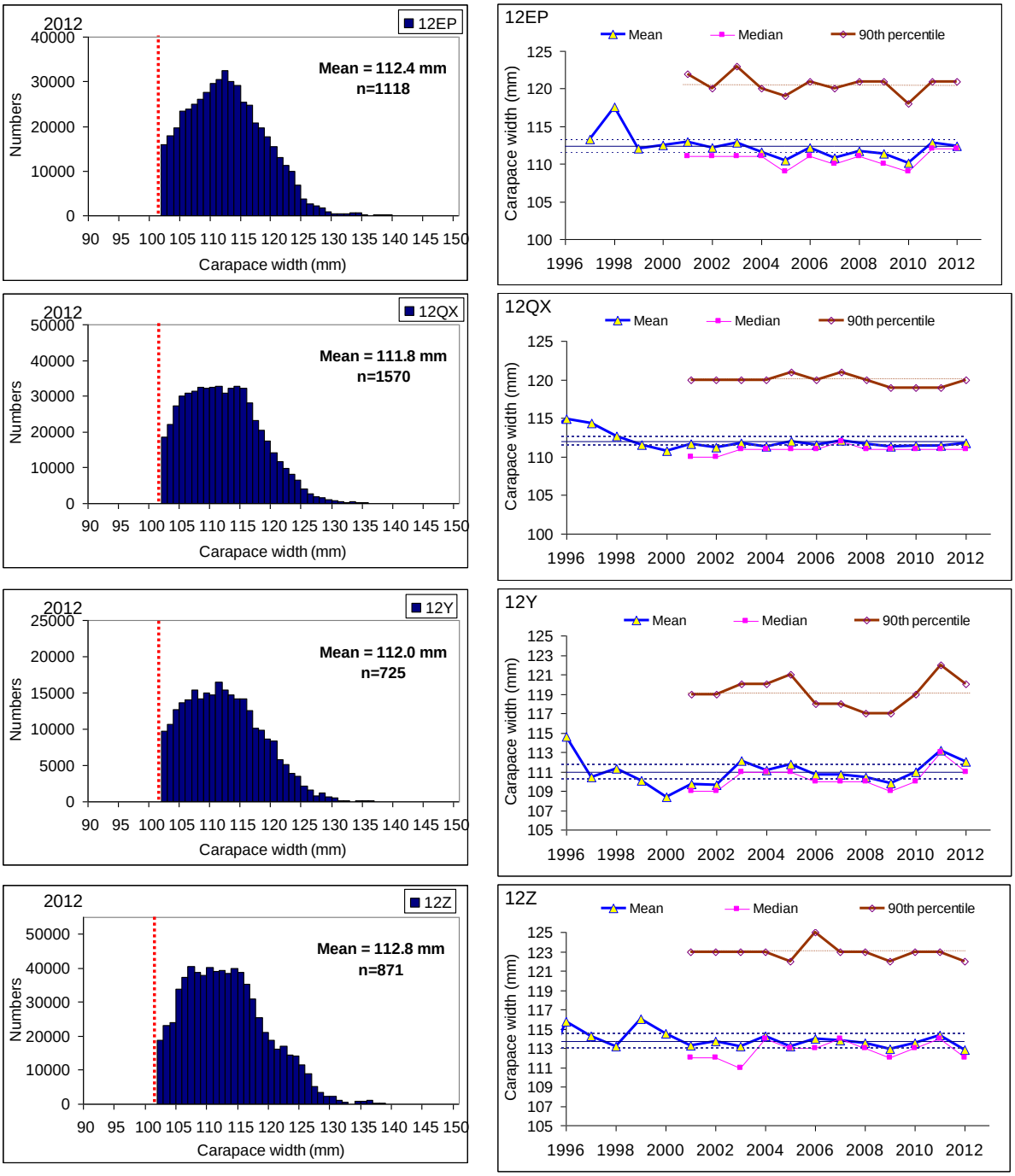



*Figure 9. Size structures of rock crab landed in the southern Gaspé Peninsula in 12EP, 12QX, 12Y and 12Z. The number of crabs measured is indicated. The dotted vertical line represents the minimum legal size. Average sizes, median and 90$^{th}$ percentile from 1996 to 2012. The straight solid line indicates the average for 2001–2011, while the dotted lines represent a 0.5 standard deviation from the average.*

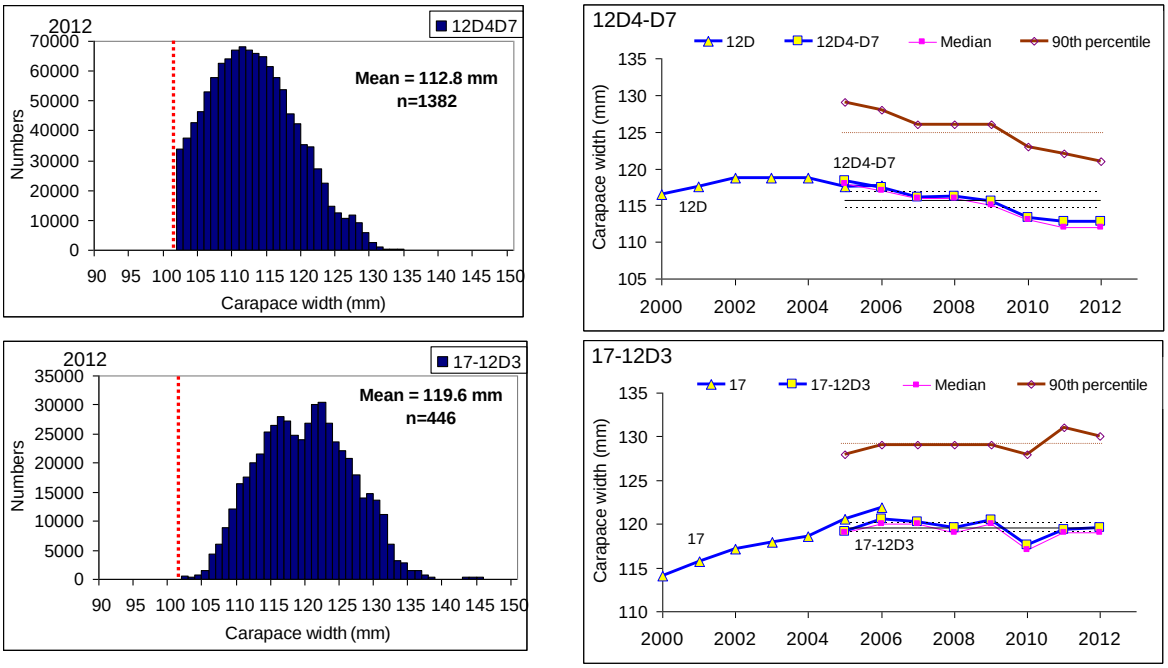



*Figure 10. Size structures of rock crab landed in the northern Gaspé Peninsula in 12D4-D7 and 17-12D3 in 2012. The number of crabs measured is indicated. The dotted vertical line represents the minimum legal size. Average sizes, median and 90$^{th}$ percentile from 2005 to 2012. The straight solid line indicates the average for 2005–2011, while the dotted lines represent a 0.5 standard deviation from the average. The average sizes for 12D and 17 from 2000 to 2006 are also shown.*

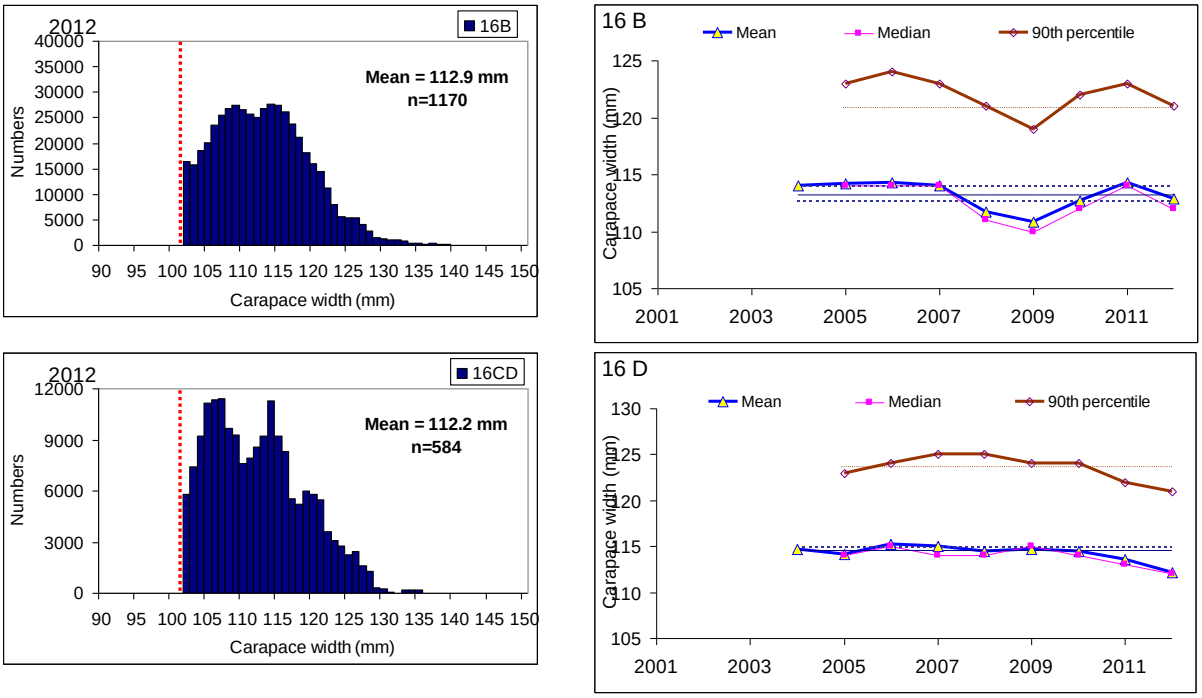



*Figure 11. Size structures of rock crab landed on the North Shore in 16B and 16D in 2012. The number of crabs measured is indicated. The dotted vertical line represents the minimum legal size. Average sizes, median and 90$^{th}$ percentile from 2004 to 2012. The straight solid line indicates the average for 2004–2011, while the dotted lines represent a 0.5 standard deviation from the average.*

## Sources of uncertainty

Rock crab landings presented here do not take into account the by-catches made by lobster fishermen who use them as bait. In certain areas, this practice is quite common and could represent significant quantities. This practice could escalate in the future should the cost of traditional bait increase. We do not really know the harvesting strategies used by the fishermen. In some cases, they might move around in their area in order to maintain good catch rates (hyperstability), which could conceal a drop in stock abundance, if any should occur. We do not know the impact on catch rates of the limitation sometimes imposed by plants on daily landings. In such cases, catch rates could voluntarily be maintained at a lower level. Over the past three years, fishermen have improved the quality of data recorded in their logbooks, especially with regards to fishing positions. This data should help in the future to better identify the spatial harvesting pattern and better interpret catch rate trends.

Our knowledge about the dynamics of rock crab stocks is poor. We do not know whether recruitment dynamics are cyclical, as is the case with other crab species, and whether they are bottom-up (e.g., hydrodynamics) or top-down (e.g., predation) regulated. Quantitative aspects of the prey relationship (consumption rates, target size, etc.) with numerous species, including lobster, are not well known and it is difficult to gauge the impact the recent increase in lobster abundance in the Magdalen Islands has on the abundance of rock crab. Our knowledge about the growth and natural mortality of rock crab is rather sparse, which limits our interpretation of size structures in terms of the combined effects of recruitment, natural mortality and fishing on populations.

# CONCLUSIONS AND ADVICE

The rock crab directed fishery has always been managed cautiously. In 2012, stock status indicators suggest that, to date, harvesting levels are not causing any major disruptions for populations in most areas. The management objective of keeping harvesting levels moderate for this species appears to have been achieved in most cases. However, a lack of control of lobster vessel by-catches threatens the attainment of this objective. Based on such uncertainty, it is impossible to consider recommending an increase in the intensity of the directed fishery.

In the Magdalen Islands, lower yields observed in the three fishing areas since the mid-2000s suggest a decline in the abundance of rock crab. This decline has been confirmed by the trawl survey in 12A and 12B. Although the causes are unknown, it is suspected that the higher abundance of lobster, a major predator of rock crab, may be an explanation. The size structures have remained stable, which suggests that the fishery has not had major effects on stock thus far, even though harvesting rates have increased. However, stock is declining and there is no indication that recruitment is on the rise. Consequently, to minimize the risks of a greater increase in harvesting rates that could truncate size structures, it is recommended that quotas be lowered in the three areas proportionally to the difference between the CPUE average over the past three years and the average CPUE for the series. This translates to a 25% decrease.

For the Gaspé Peninsula, fishery indicators have remained fairly stable since the early 2000s, suggesting that the fishery has had only a minor impact on populations, which is in keeping with the conservation objectives. The introduction of quotas in 2010 in the Gaspé Peninsula has helped eliminate the issue of latent effort. However, it is impossible to tell whether the set quotas will maintain stock at a moderate harvesting level, since the fishing effort has slowed since 2009 and the quotas have not always been reached. In this case, it is recommended that

current harvest levels be maintained. However, the abundance of large crabs (> 130 mm) in 12D4-D7 has fallen in recent years, which translates into a significant decrease in average size. This situation is worrisome and might be a sign of excessive fishing pressure. Therefore, it is recommended that harvesting levels in this area be decreased by 10%.

The rock crab fishery on the North Shore really took off in 2004, but only maintained a steady momentum in 16B and 16D. Indicators suggest that a sustained fishery in both these areas is possible with a level of removal not exceeding that observed in the past. Therefore, to ensure the sustainability of an activity that could become permanent, it is recommended that a catch limit be introduced equal to the average of the last five years, in other words, 100 t in 16B, split equally between 16B1 and the rest of 16B, and 40 t in 16D. Moreover, as in other rock crab fisheries in Quebec, it is recommended that protected areas corresponding to about 15% of the fished area be created.

Lastly, to assess the impact of rock crab fishery on the ecosystem, in accordance with the DFO *Sustainable Fisheries Framework*, it is recommended that by-catches of the rock crab directed fishery be recorded for all rock crab stocks.

## OTHER CONSIDERATIONS

Rock crab is a major foraging species for lobster as well as many groundfish species. It is therefore important that the harvesting of rock crab does not disrupt trophic linkages, especially those with lobster. So far, management of the rock crab fishery has been conducted accordingly and the effect of the fishery on stocks has been negligible. The measures in place aim to protect the reproductive potential by maintaining the minimum catch size above the size at sexual maturity, as well as maintaining moderate harvesting rates so as not to alter the size structures and ensure the occurrence of large males, which could play a significant role in reproduction. The high minimum size also mitigates the impacts of fishing on the lobster diet since the latter does not prey on legal size crabs (> 102 mm). Although management of the rock crab fishery is advised and prudent, it cannot guarantee stability in landings due to multiple upstream factors, such as predation.

## SOURCES OF INFORMATION

This science advisory report is from the meeting of February 5, 2013, on the Assessment of Rock Crab in Quebec Inshore Waters. Additional publications arising from this meeting will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule.

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