Fisheries and Oceans Canada | Pêches et Océans Canada
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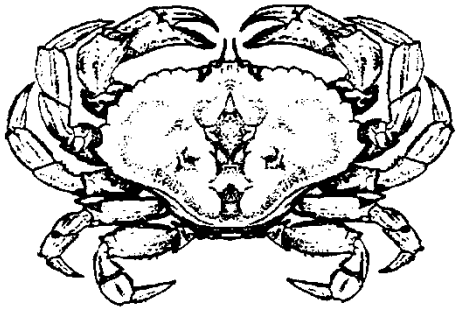
Canadian Science Advisory Secretariat
Quebec Region | Science Advisory Report 2018/044

ASSESSMENT OF ROCK CRAB STOCK STATUS IN QUEBEC IN 2016



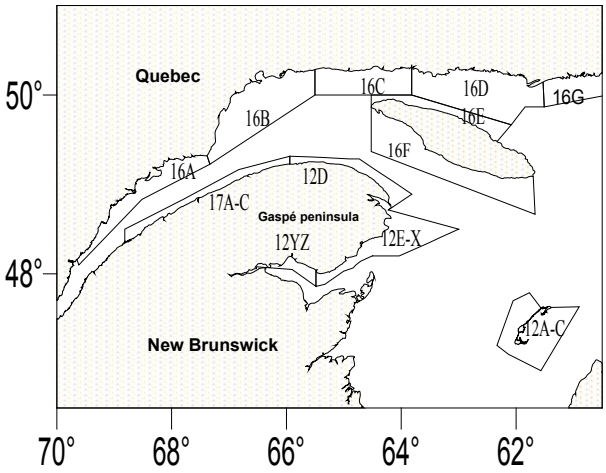


Figure 1. Rock crab fishing areas in Quebec

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 harvest in the Magdalen Islands and the Gaspé Peninsula. Harvesting is also limited spatially through fishery closures. 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 2013 to 2016 fishing seasons, with recommendations provided for the 2017 to 2020 fishing seasons.

This science advisory report is from the meeting held from February 28 to March 1, 2017, on the Stock Assessment of Rock Crab in Quebec Inshore Waters. Additional publications from this meeting will be posted on the *Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available*

SUMMARY

- In Quebec, landings of rock crab from the directed fishery totalled 923 t in 2016. Fifty-two percent of these landings came from the Magdalen Islands (477 t), 21% from the northern part of the Gaspé Peninsula (192 t), 20% from the southern part of the Gaspé Peninsula (186 t), and 7% from the North Shore (68 t). Landings have been declining since 2009 (1,777 t) and have dropped by 42% since the last assessment in 2012 (1,587 t). The relative decline in landings was much more pronounced in the Gaspé Peninsula and on the North Shore (53-59%) than in the Magdalen Islands (15%).
- The sharp decrease in landings since 2012 is mainly explained by a reduction in quotas in the Magdalen Islands and a decrease in fishing effort and, sometimes, catch rate in other areas. From 2013 to 2016, quotas, if applicable, were not approached or reached, except in the Magdalen Islands.
- Since 2012, catch rates have decreased or have apparently stabilized at very low levels in most areas. In particular, in the Magdalen Islands, the 2016 CPUE was 36%–43% below the 1995–2015 average. However, in certain areas of the Gaspé Peninsula and the North Shore where fishing effort and landings have dropped sharply, the CPUE was rather stable or even increased in one case.
- Size structures and average sizes have remained generally stable or have even improved compared to 2012 in the Gaspé Peninsula and the North Shore where fishing effort and landings saw a sharp decline. However, they are still deteriorated in the Magdalen Islands and, in 2016, the average size was less than or equal to historical lows.
- The decrease in fishing effort and deterioration of the rock crab population indicators seem inversely correlated to the increase in landings of its main predator, the American lobster. Natural mortality resulting from predation by lobster has certainly increased sharply, adding to mortality caused by fishing.
- For all of Quebec, it is recommended not to increase the intensity of the directed fishery and to better document rock crab by-catches. Quotas should be reduced in the Magdalen Islands, given the decrease in the catch rate and the average size. Quotas in the Gaspé Peninsula should be reduced, given the decline in CPUE in the northern region and in a sub-area of the southern region, or because they are set so high that they have no preventive value.
- 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 in 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), settle and begin their benthic life. 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 colder, northern regions.

The rock crab is omnivorous and displays a certain amount of opportunism in its diet. Lobster is a rare (larval phase) or uncommon (benthic phase) prey of rock crab, 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, work conducted in the southern Gulf of St. Lawrence suggests that the rock crab is an important prey for many species of demersal fish, making it a key species of the coastal marine ecosystem.

The fishery

Rock crab is managed by a directed fishery for which a licence is required. It is also caught by a varying number of lobster fishers who, in accordance with the *Atlantic Fishery Regulations*, 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 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 zones were established in the northern Gaspé Peninsula in 2009 (Figure 2) 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 fishers are concerned that the rock crab fishery may harm lobster. There is also an exclusion zone in the Magdalen Islands (12C1), which was closed to the rock crab directed fishery in 2000 (Figure 3).

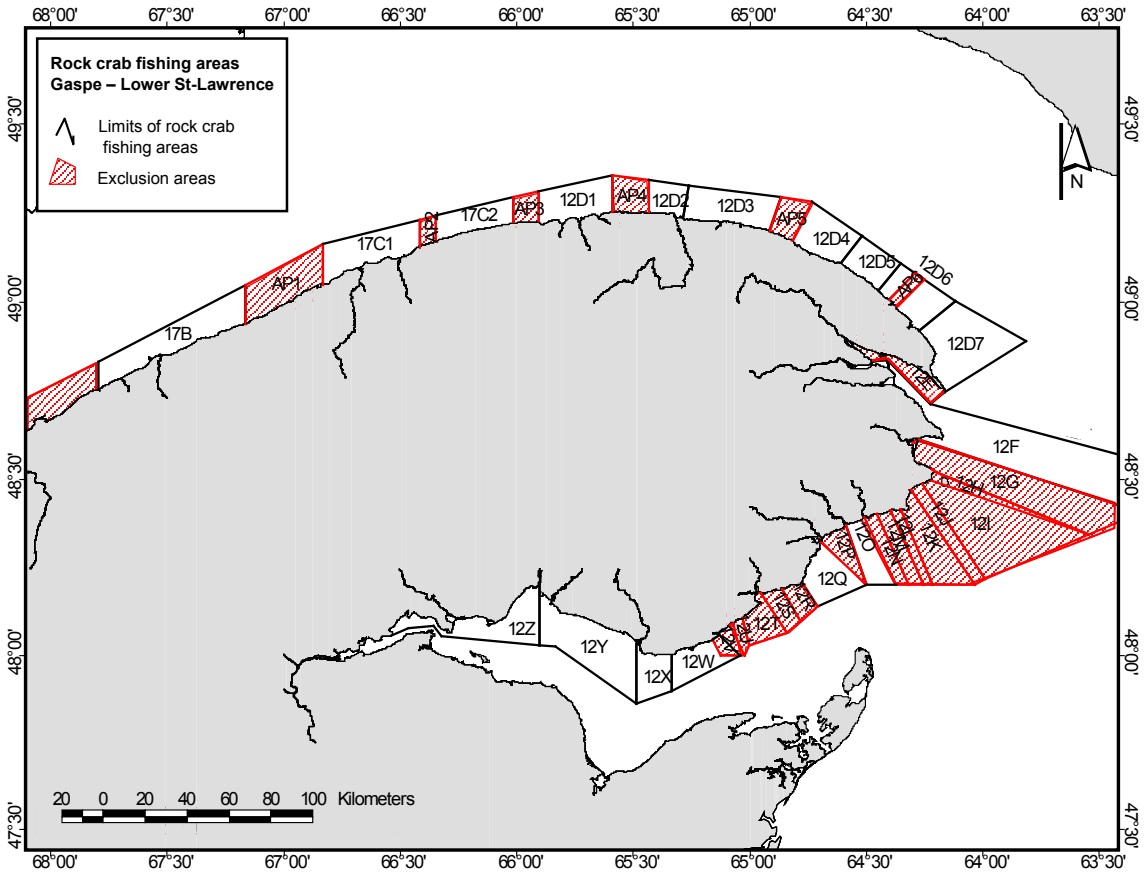


Figure 2. Rock crab fishery sub-areas in the Gaspé Peninsula with protected areas indicated in red hatching (sub-areas in the southern Gaspé Peninsula and AP1-AP6 in the northern Gaspé Peninsula).

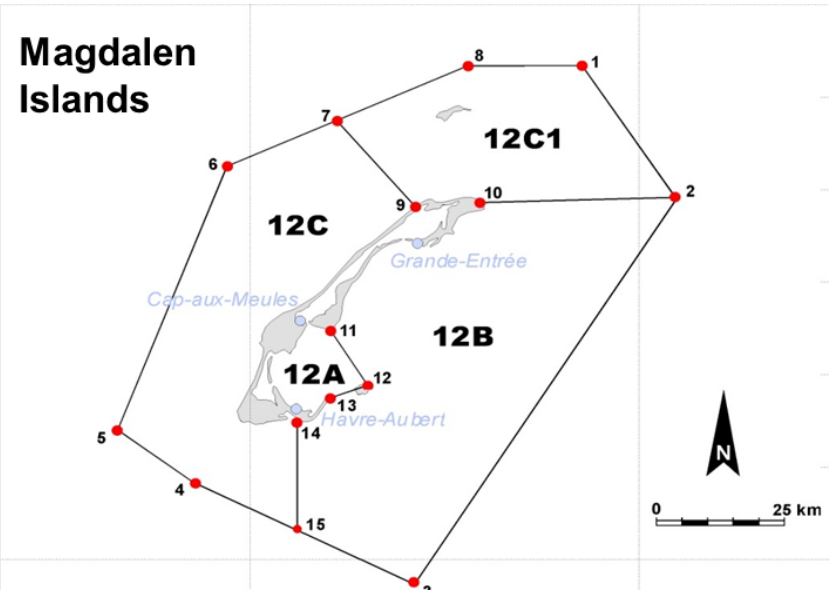


Figure 3. Rock crab fishery sub-areas in the Magdalen Islands (12A, 12B and 12C) and the exclusion zone (12C1).

The directed fishery in the Gaspé Peninsula and Magdalen Islands occurs after lobster season. In 2016, the season in the Gaspé Peninsula began on July 30 and ended when quotas were filled or on October 7, at the latest. In the Magdalen Islands, the fishery is authorized every year from August 1 to December 31. On the North Shore, depending on the area, the season began between June 20 and 30 and ended between October 20 and 28. On Anticosti Island, the season ran from July 20 to October 31.

In the Magdalen Islands, in 2016, each of the14 fishers (directed fishery) was entitled to a quota of 34.727 t out of an overall quota of 486.17 t. There are two types of traps in the Magdalen Islands. A fisher can use 85 traps that are 1.219 m (4 feet) in diameter, or 140 traps that are 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. Fishers have access to one or, in some cases, two of the three fishing areas.

In the southern Gaspé Peninsula in 2016, there was a total of 4, 7, 7 and 5 licences in areas 12EP, 12QX, 12Y and 12Z, which shared quotas of 163, 155, 123 and 183 t, respectively. However, only 3, 2, 0 and 5 fishers were active in these respective areas in 2016. In the northern Gaspé Peninsula in 2016, out of 5 licences in area 17-12D3, 3 were active. They shared a total quota of 150 t. In area 12D4-D7, the 4 authorized fishers shared a quota of 225 t. In 2016, there were 150 traps per fisher in the northern Gaspé Peninsula and 75 to 150 depending on the areas in the southern Gaspé Peninsula.

On the North Shore, in 2016, there was a total of 15 exploratory licences in addition to the 5 regular licences in area 16B. However, only 3 exploratory licences and 3 regular licences were active. The number of traps on the North Shore was 150, except for fishers in area 16B (excluding area 16B1), who were entitled to 200 traps. Fishers from the North Shore (16B, 16B1, 16C and 16D) were authorized to fish in area 16E (Anticosti) on the request of a condition and were entitled to 200 traps. There were no requests from these fishers in 2016.

ASSESSMENT

Data source

The resource assessment is based primarily on the review of abundance indicators and the size of crabs landed. The abundance indicators are 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 on the Magdalen Islands, 2001 in the Gaspé Peninsula and 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. Size structures are weighted by landings. 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 to obtain abundance and demographic indicators for lobster. Rock crab catches in this survey are also analyzed to obtain abundance and recruitment indicators.

Landings

In 2016, total rock crab landings for all of Quebec totalled 923 t (Figure 4, Table 1). Landings have been decreasing since 2009, when they reached 1,777 t. Before then, Rock crab landings in Quebec had increased steadily from 1996 to 2002, from 687 t to 1,761 t. From 2002 to 2012, they were above 1,500 t, peaking at 2,025 t in 2005 (Table 1). The sharp decline of 42% in landings since 2012 (Figure 4, Table 1) is mainly explained by a reduction in quotas in the Magdalen Islands and a decrease in fishing effort and catch rates in other areas. The relative

reduction in landings was much more pronounced in the Gaspé Peninsula and on the North Shore (53-59%) than in the Magdalen Islands (15%). Quotas from 2013 to 2016, if applicable, were not met or nearly met except in the Magdalen Islands. Fifty-two percent of landings came from the Magdalen Islands (477 t), 21% from the northern Gaspé Peninsula (192 t), 20% from the southern Gaspé Peninsula (186 t), and 7% from the North Shore (68 t). Since 2011, no rock crab landings were reported from bycatches in the lobster fishery (Table 1). However, rock crab bycatches kept and/or used by lobster fishers are not documented.

In the Magdalen Islands, the overall quota was reduced by 12.5% in 2013 and another 12.5% in 2014, to 486 t, and then remained at this level. The quota was met or nearly met from 2013 to 2016, with a fishing effort equal to or greater than the average for 1998–2015. In 2016, rock crab landings from the directed fishery reached 477 t, a 15% decrease, down from 565 t in 2012. Landings of rock crab bycatch during the lobster fishery can be quantified at the next assessment, from logbooks implemented in 2015.

In the Gaspé Peninsula, quotas, which were in place since 2010, were rarely reached. In 2016, landings by area represented only between 8 and 20% of the quota, except in 12Z, where they were minimally at 63%. Landings in the southern Gaspé Peninsula decreased over the past four years, from 474 t in 2012 to 186 t in 2016, a decline of 59%. Decreases in the southern Gaspé Peninsula were due to a reduction in fishing effort. In the northern Gaspé Peninsula, quotas have not been reached since 2012. In 2016, landings represented between 33 and 52% of the quota. Landings decreased from 404 t in 2012 to 192 t in 2016, a decrease of 52%. The drop in landings in 12D4-D7 is explained mainly by a decrease in CPUE of approximately 40% between 2012 and 2016, to a value well below the historical average.

In 2016, on the North Shore, rock crab landings were 68 t, down 55% from 2012. There has not been any fishery in 16A, 16C and Anticosti (16E and 16F) since 2009. In 2016, landings came solely from 16B and 16D, at 56 and 44%, respectively. The quota of 110 t in effect in 16B was not reached. Fishing effort in 16B decreased by 60% between 2012 and 2016. In 16D, effort was fairly stable in 2013, 2015 and 2016, at an average of 44% lower than that of 2012, but it was almost non-existent in 2014.

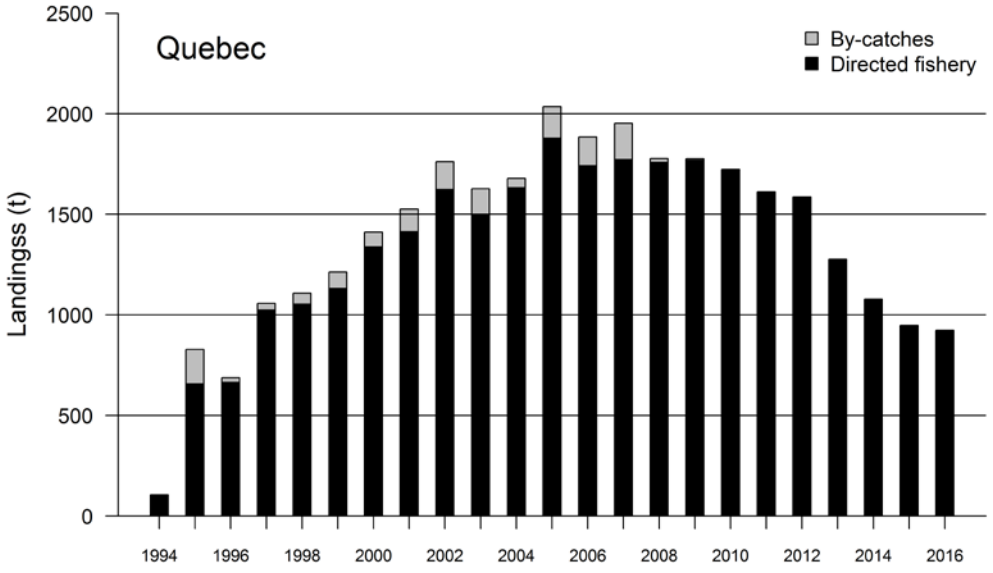


Figure 4. Rock crab landings (t) in Quebec from 1994 to 2012 from the directed fishery and bycatches by lobster vessels.

Table 1. Rock crab landings (t) in Quebec from 2005 to 2016 by area and sub-area (directed fishery). Values for 2015 and 2016 are preliminary. Total by-catches are indicated. Some data are confidential (CD).

Region and Areas	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Magdalen Islands (MI)												
12A	113	124	114	130	128	130	97	94	81	84	75	81
12B	301	284	299	279	278	274	307	284	259	226	218	228
12C	223	226	220	227	215	207	214	188	190	171	191	168
MI directed	**637**	**635**	**634**	**636**	**621**	**611**	**619**	**565**	**530**	**481**	**483**	**477**
MI bycatch	**145**	**131**	**169**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
MI Total	**782**	**766**	**803**	**645**	**621**	**611**	**619**	**565**	**530**	**481**	**483**	**477**
North Gaspé (NG)												
17	13	10	5	10	8	14	0	1	0	1	0	0
12D	396	365	404	423	360	407	350	403	275	328	207	192
NG directed	**408**	**374**	**399**	**432**	**362**	**420**	**349**	**404**	**276**	**329**	**207**	**192**
NG bycatch	**0**	**0**	**10**	**0**	**6**	**1**	**2**	**0**	**0**	**0**	**0**	**0**
NG Total	408	374	409	432	368	421	350	404	276	329	207	192
South Gaspé (SG)												
12EP	178	149	123	141	143	179	115	119	100	45	39	33
12QX	150	158	155	136	136	140	87	124	65	63	44	DC
12Y	112	112	139	115	132	118	107	70	43	7	14	0
12Z	163	135	151	151	212	152	166	161	196	119	89	114
SG directed	**602**	**554**	**566**	**543**	**621**	**580**	**475**	**474**	**403**	**234**	**186**	**186**
SG bycatch	**0**	**0**	**2**	**0**	**2**	**9**	**0**	**0**	**0**	**0**	**0**	**0**
SG Total	**602**	**554**	**568**	**543**	**623**	**589**	**475**	**474**	**403**	**234**	**186**	**186**
NG + SG directed	**1011**	**928**	**965**	**975**	**983**	**999**	**823**	**878**	**679**	**563**	**393**	**377**
NG + SG bycatch	**0**	**0**	**12**	**0**	**8**	**10**	**2**	**0**	**0**	**0**	**0**	**0**
NG + SG Total	**1011**	**928**	**977**	**975**	**991**	**1009**	**825**	**878**	**679**	**563**	**393**	**377**
North Shore (NS)												
16A	0	0	0	0	0	0	0	0	0	0	0	0
16B	125	79	88	75	116	78	123	113	61	40	48	39
16C	6	4	1	0	5	0	0	0	0	0	0	0
16D	31	40	41	39	44	32	46	40	16	1	25	29
16E	70	57	43	35	0	0	0	0	0	0	0	0
16G	0	0	0	0	0	0	0	0	0	0	0	0
NS directed	**231**	**180**	**174**	**148**	**165**	**110**	**169**	**153**	**76**	**42**	**73**	**68**
NS bycatch	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
NS Total	**231**	**180**	**174**	**148**	**165**	**110**	**169**	**153**	**76**	**42**	**73**	**68**
QUEBEC directed	**1879**	**1742**	**1772**	**1759**	**1769**	**1721**	**1611**	**1596**	**1285**	**1085**	**949**	**923**
QUEBEC bycatch	**145**	**131**	**181**	**9**	**8**	**10**	**2**	**0**	**0**	**0**	**0**	**0**
QUEBEC TOTAL	**2025**	**1874**	**1953**	**1768**	**1777**	**1731**	**1612**	**1596**	**1285**	**1085**	**949**	**923**

Catch rates

In the Magdalen Islands, catch rates, which had been down since 2004, stabilized between 2011 and 2015 (Figure 5), depending on the area, to the lowest levels in the 1999–2016 series. 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 2016, CPUEs in 12A, 12B and 12C were 43, 37 and 36% below their 1998–2015 average, respectively (Figure 5). In 12A, the 2016 CPUE (12.4 ± 1.0 kg/trap) was not only below the 1998–2015 historical average (21.9 kg/trap), but was also the lowest value in the series (1998: 16.1 ± 1.6

kg/trap). The trend has been downward since 2004, reaching a certain stability in more recent years. The CPUE pattern in 12B is similar to that in 12A and the 2016 value (12.4 ± 0.7 kg/trap) was the lowest recorded since 1998 (17.4 ± 1.2 kg/trap). In 12C, after a steady drop from 2003 to 2011, there was a period of stability between 2011 and 2015, followed by another drop in 2016. The CPUE then reached 11.8 ± 0.8 kg/trap, the lowest value since 1999 (14.6 ± 1.0 kg/trap). The CPUE average for 1998–2015 was 18.6 kg/trap. The commercial-sized male abundance index from the trawl survey reached minimum values in 2013 and then began to increase moderately (Figure 5). Abundance indices for non-commercial-sized females and males in the trawl survey reached a minimum in 2012 and in 2012–2013, respectively, and have since increased sharply.

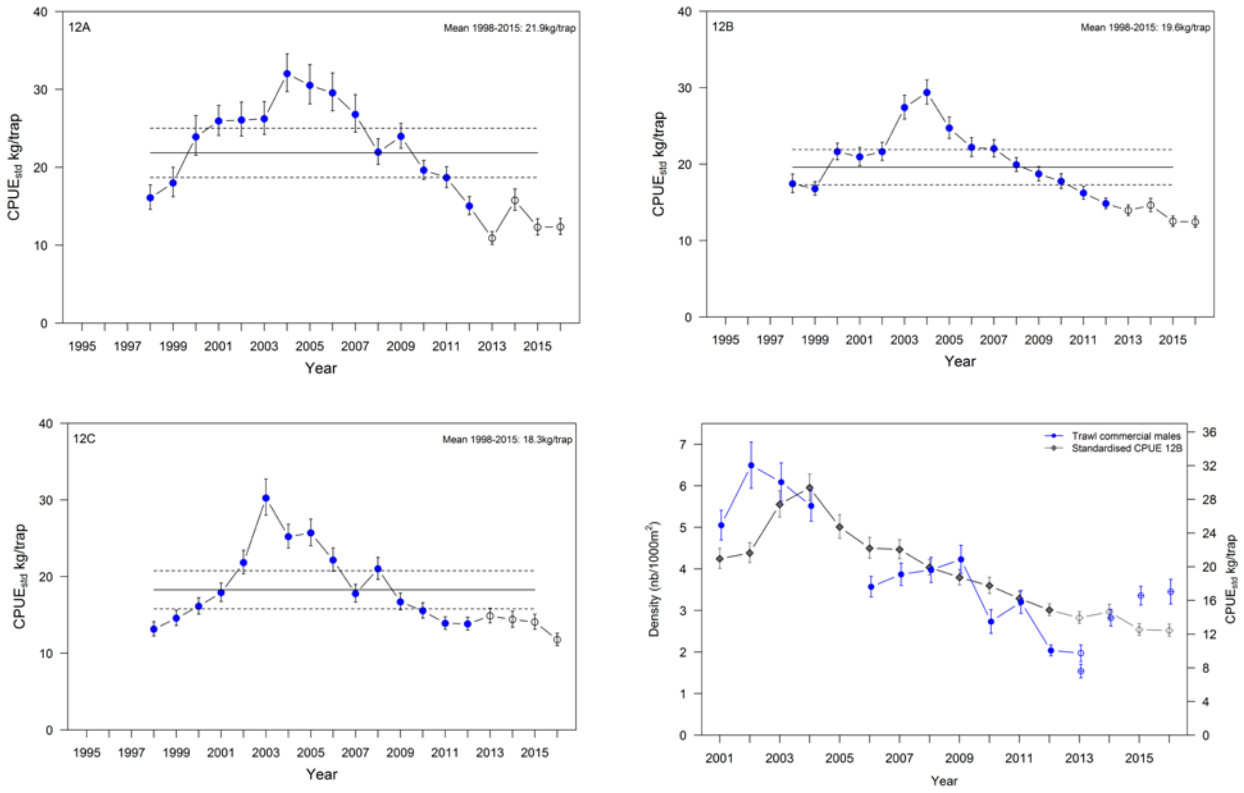


Figure 5. Estimated rock crab catch rates (CPUEs) (kg/trap) in the Magdalen Islands based on logbook data. Catch rates from 12A–C were standardized (CPUE$_{std}$) to account for both types of traps. The straight solid line indicates the average for the 1998–2015 period, and the dotted lines represent a 0.5 standard deviation from the average. 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, 2001 to 2016.

In the southern Gaspé Peninsula, CPUEs increased to 9.1 ± 1.2 kg/trap and were well above the historical average in 12QX (Figure 6). They remained rather stable and close to or slightly above the average in 12Y and 12Z (Figure 6). However, in 12EP, CPUEs dropped between 2012 and 2016, from 8.3 to 6.0 kg/trap (–28%) and are now just below the average (Figure 6). In the northern Gaspé Peninsula in 2016, CPUEs were 39.6% lower than in 2012 in 12D4-D7 (Figure 6). In 17-12D1-D3, CPUEs were quite variable between 2012 and 2016. Although the 2016 value is 21% lower than the 2012 value (6.1 vs. 7.8 kg/trap), it remains near the average and the decrease in effort has largely contributed to the decrease in landings.

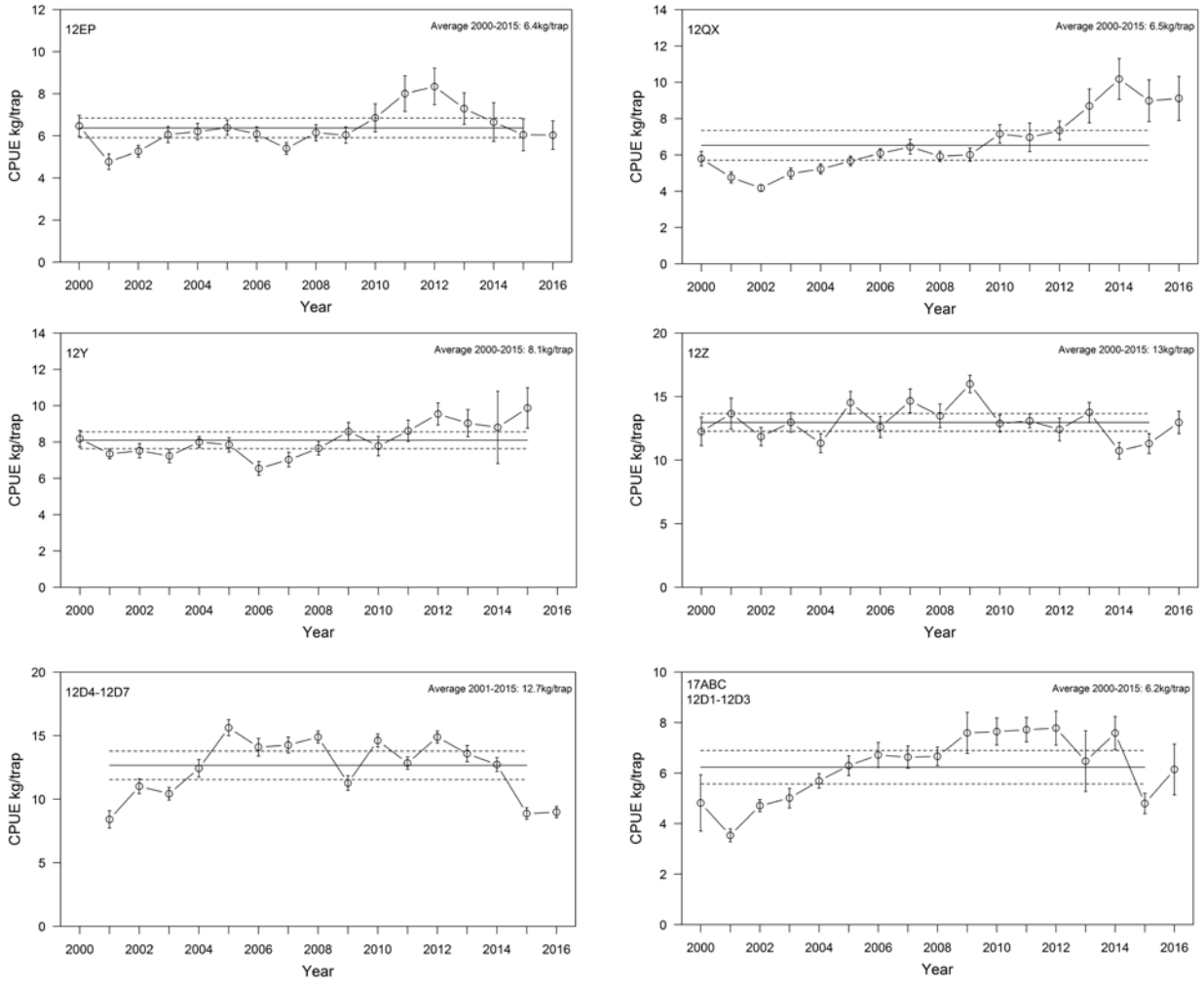


Figure 6. Estimated rock crab catch rates (CPUEs) (kg/trap) based on logbook data in the southern Gaspé Peninsula (12EP, 12QX, 12Y and 12Z) and northern Gaspé Peninsula (12D4-D7 and 17-12D3) from 2000 or 2001 to 2016. The straight solid line indicates the reference average, and the dotted lines represent a 0.5 standard deviation from the average.

In 2016, in 16B, CPUEs remained stable between 2013 and 2016 at about 7.6 to 8.0 kg/trap, values on average 14% lower than that of 2012 but slightly above the 2004–2015 average (Figure 7). CPUEs in 16D reached maximums in 2015 and 2016 of about 8.5 kg/trap, a value 31% above the historical average, after having been at historical lows of about 5.3 kg/trap in 2013–2014.

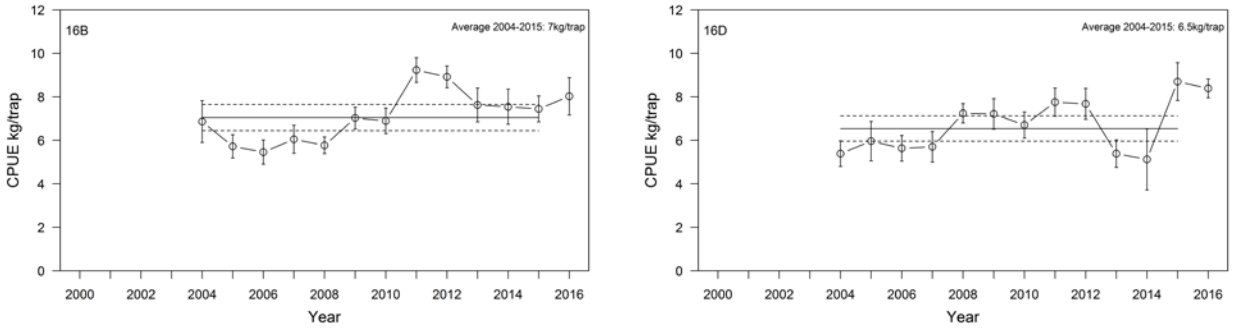


Figure 7. Estimated rock crab catch rates (CPUEs) (kg/trap) based on logbook data on the North Shore (16B and 16D) from 2004 to 2016. The straight solid line indicates the average for 2004–2015, and the dotted lines represent a 0.5 standard deviation from the average.

Size structures

The average size of landed rock crab in the Magdalen Islands (Figure 8) decreased noticeably in all sub-areas in 2012 and 2014 and has since remained fairly stable (12B and 12C) or decreased further (12A). The average size observed in 2016 ranged from 118 to 122 mm, depending on the area, and showed the smallest (12A and 12C) or close to the smallest (12B) sizes recorded during the reference period. The proportion of large crab remained stable in 12B and 12C and decreased in 12A. The size at the 90th percentile was around 135 mm in 12A until 2012, then around 131 mm for 2013 to 2015 before falling sharply to about 127 mm in 2016. In 12B and 12C, the size at the 90th percentile has remained around 134 mm and 132 mm since 2015 and 2013, respectively (Figure 8).

In the southern Gaspé Peninsula, the average size and the size at the 90th percentile have remained stable in 12QX and 12Y, have increased in 12EP, but have decreased in 12Z since 2012 (Figure 9). In 2016, the average size was around 114 or 115 mm and above the average in 12EP and 12Y, whereas it was around 112 mm and below or equal to the average in 12QX and 12Z, respectively (Figure 9). In the northern Gaspé Peninsula, the average size and the size at the 90th percentile have been relatively stable since 2012 in 12D4-D7 and in 2016, the average size was 114 mm, slightly below the historical average (Figure 10). The information fails to address the trend in the average size in 17-12D1-D3, but in 2014 it was 116 mm, well below the historical average (Figure 10).

On the North Shore, in 16B, the average size and the size at the 90th percentile (Figure 11) varied between 2013 and 2016, but there were no trends and values were around those of 2012 (112 mm and 121 mm, respectively). In 2016, the average size was 114 mm, above the 2005–2015 average of 113 mm. In 16D, the average size and the size at the 90th percentile (Figure 11) decreased between 2009 and 2013 but have stabilized since. In 2016, the average size was 112 mm, below the historical average of 114 mm.

Recruitment

The recruitment index, corresponding to the abundance of crabs one moult before reaching commercial size, obtained in the Magdalen Islands from the trawl survey, decreased in 2001 to 0.7 individuals/1000 m^2 in 2013, but has since increased to 3.0 individuals/1000 m^2 in 2015. There are no recruitment indices for the Gaspé Peninsula or the North Shore.

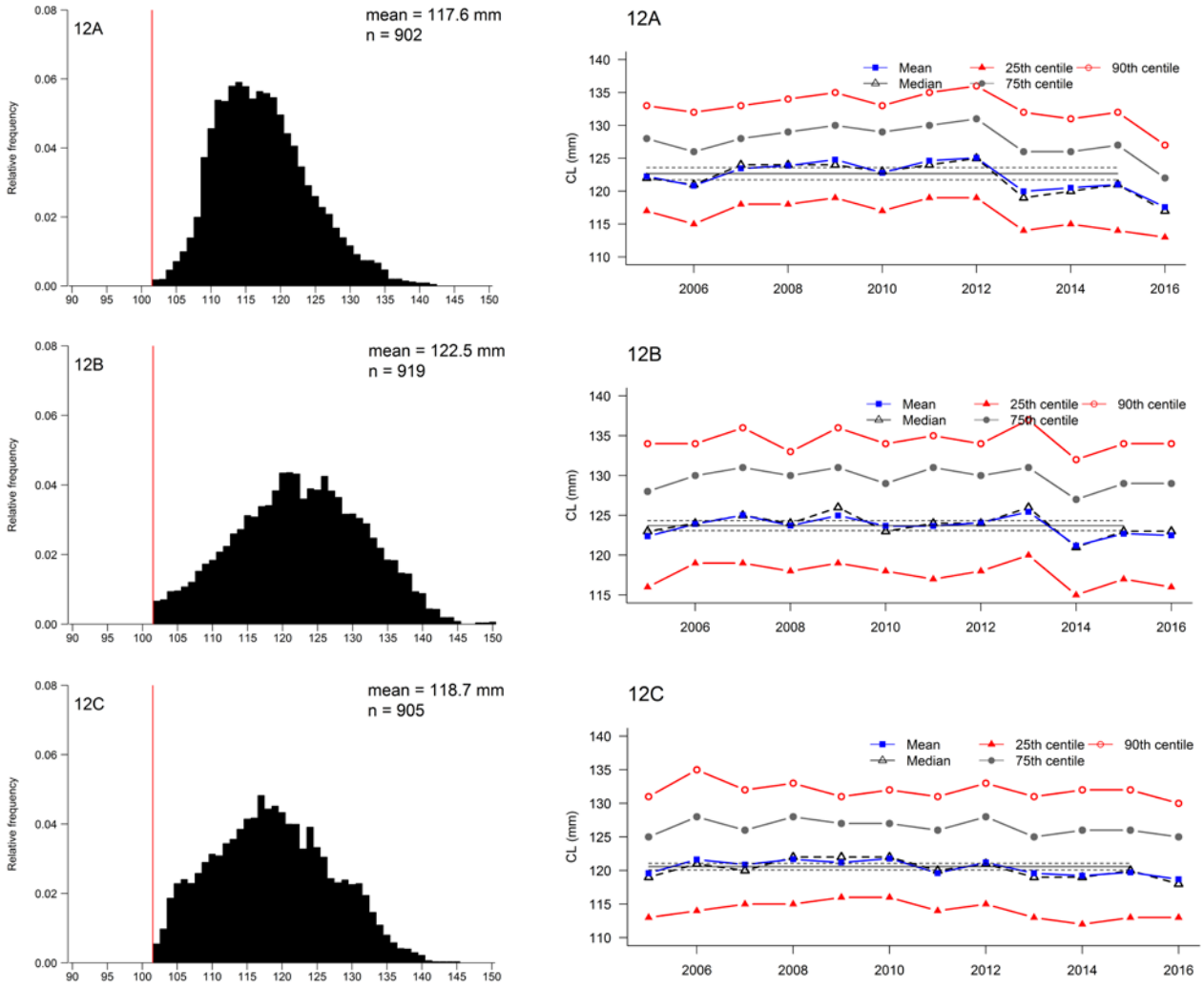


Figure 8. Size structures of rock crab landed in the Magdalen Islands in 2016 in 12A, 12B and 12C. The number of crabs measured is indicated. The dotted vertical line represents the minimum catch size. Average sizes, median and 25th, 75th and 90th percentiles from 2005 to 2016. The straight solid grey line indicates the average for the 2005–2015 period, and the grey dotted lines represent a 0.5 standard deviation from the average.

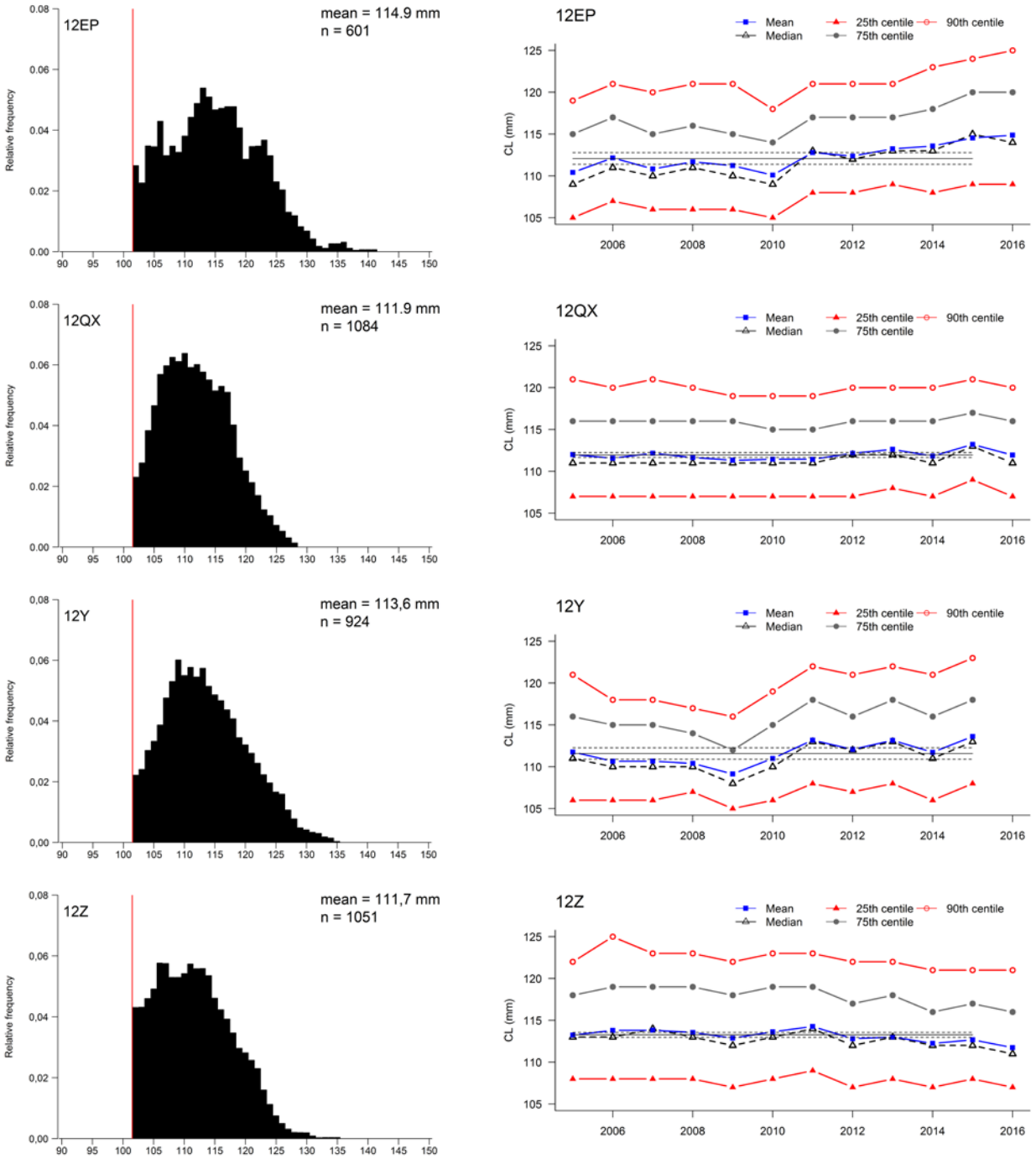


Figure 9. Size structures of rock crab landed in the southern Gaspé Peninsula in 2016 in 12EP, 12QX and 12Z; whereas 2015 data are presented for 12Y. The number of crabs measured is indicated. The dotted vertical line represents the minimum catch size. Average sizes, median and 25th, 75th and 90th percentiles from 2005 to 2016. The straight solid grey line indicates the average for the 2005–2015 period, and the grey dotted lines represent a 0.5 standard deviation from the average.

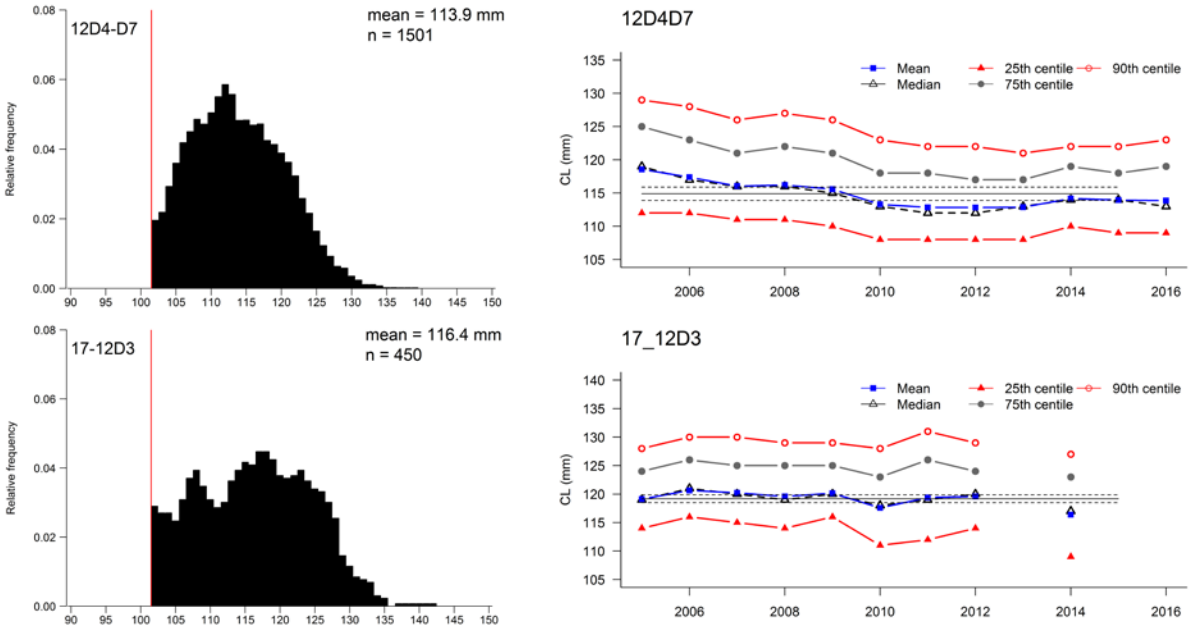


Figure 10. Size structures of rock crab landed in the southern Gaspé Peninsula in 2016 in 17-12D3 and in 2014 in 12D4-D7. The number of crabs measured is indicated. The dotted vertical line represents the minimum legal size. Average sizes, median, and 25th, 75th, and 90th percentiles from 2005 to 2016. The straight solid grey line indicates the average for 2005–2015 and the dotted grey lines represent a 0.5 standard deviation from the average.

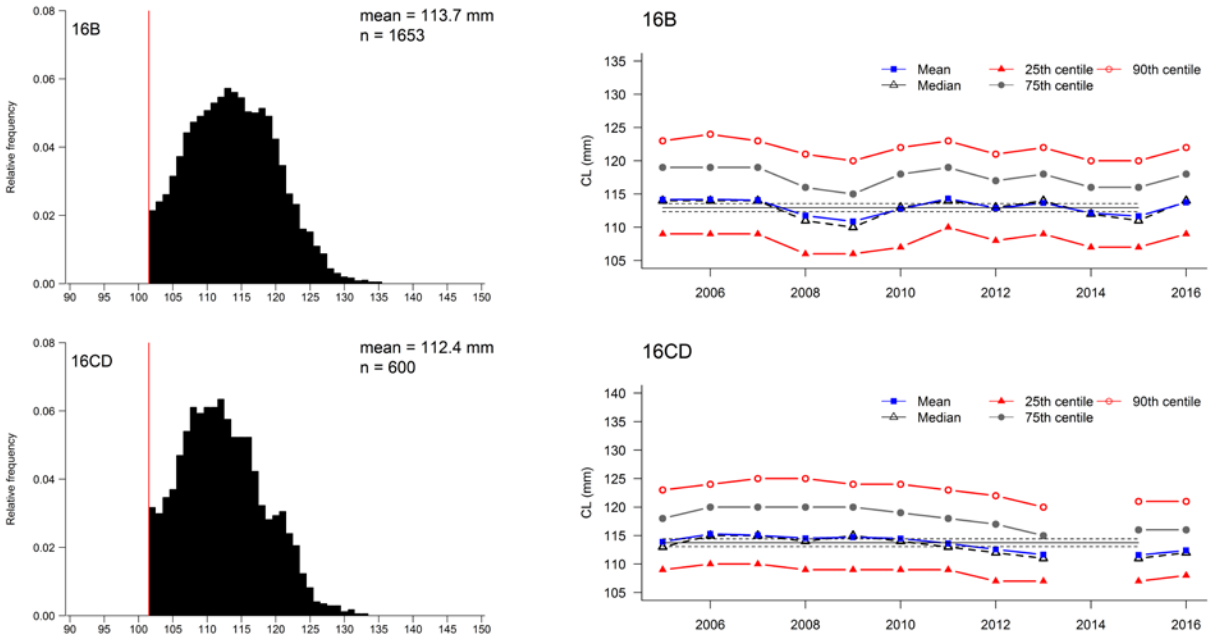


Figure 11. Size structures of rock crab landed in the Magdalen Islands in 2016 in 16B and 16D. The number of crabs measured is indicated. The dotted vertical line represents the minimum legal size. Average sizes, median, and 25th, 75th, and 90th percentiles from 2005 to 2016. The straight solid grey line indicates the average for 2005–2015 and the dotted grey 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 kept by lobster fishers for use as bait. In certain areas, this practice is quite common, and catches used for this purpose could be significant. This practice could escalate in the future should the cost of traditional bait increase.

We do not really know the fishers' harvesting strategies. In some cases, they might move around in their area 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 limits sometimes imposed by plants on daily landings. In such cases, catch rates could voluntarily be decreased. Over the past three years, fishers 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 describe 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, is not well known and it is difficult to gauge the impact the recent increase in lobster abundance has on the abundance of rock crab. That said, the decrease in fishing effort and deterioration of the rock crab population indicators seem inversely correlated to the increase in landings of its main predator, the American lobster. Since rock crab is the principal and preferred prey of lobster, natural mortality resulting from predation by lobster must have increased proportionally to the sharp augmentation of lobster populations, thus adding to mortality caused by fishing. We still do not know enough about the growth and natural mortality of rock crab, which limits our interpretation of size structures of populations in terms of the combined effects of recruitment, natural mortality and fishing.

CONCLUSIONS AND ADVICE

Throughout Quebec, the rock crab directed fishery has always been managed cautiously. In 2016, stock status indicators suggest that harvesting levels combined with the significant increase in lobster abundance – an important predator of rock crab – have weaken rock crab populations in many areas. In order to maintain harvesting levels moderate for this species, it is recommended to limit the intensity of the directed fishery and that rock crab by-catches by lobster fishers be better documented and controlled. The lack of control of lobster vessel by-catches could compromise the attainment of this objective.

In the Magdalen Islands, lower yields in the three fishing areas since the mid-2000s suggest a decline in the abundance of rock crab. The size structures have deteriorated, which suggests that the fishery intensity remains too high despite recent quota reductions. 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. It is also recommended that these values be lowered by an additional 10% to restore size structures. This results in decreases of 38% for 12A, 28% for 12B, and 15% for 12C.

For the Gaspé Peninsula, fishery indicators have decreased in the north and in sub-areas 12EP, suggesting that fishing is impacting populations, whereas they are stable or increasing in sub-areas 12Q to 12Z. 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 ensures a moderate harvesting level, since the fishing effort has slowed and the quotas have

not been reached since 2012. They were therefore of no preventive value. It is therefore recommended, for all sub-areas of the Gaspé Peninsula, that the quota be decreased by 50% or to the level of average landings over the past two years.

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 at a harvest level not exceeding that observed in the past. It is recommended that a catch limit be introduced equal to the average landings for the past seven years, in other words, 72 t in 16B, split equally between 16B1 and the rest of 16B, and 31 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.

OTHER CONSIDERATIONS

Rock crab is a major foraging species for lobster and for many demersal species. It is therefore important that the harvesting of rock crab not disrupt trophic linkages, especially those with lobster. Management of the rock crab fishery has been conducted accordingly. 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 28 – March 1, 2017, on the Stock Assessment of Rock Crab in Quebec Inshore Waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2013. Assessment of Rock Crab Stock Status in Quebec in 2012. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/007.

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Center for Science Advice (CSA)
Quebec Region
Fisheries and Oceans Canad
Maurice Lamontagne Institute
850 route de la Mer
P.O. Box 1000
Mont-Joli (Quebec)
Canada G5H 3Z4

Telephone: (418) 775-0825
E-Mail: bras@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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