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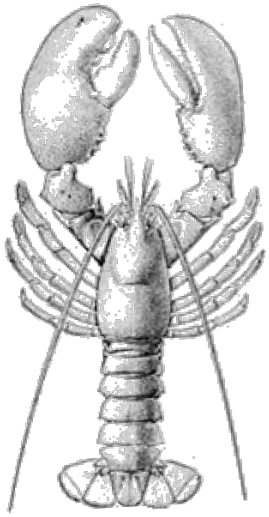
Canadian Science Advisory Secretariat
Quebec Region **Science Advisory Report 2016/045**

2015 LOBSTER STOCK ASSESSMENT IN THE MAGDALEN ISLANDS (LFA 22), QUEBEC AREA



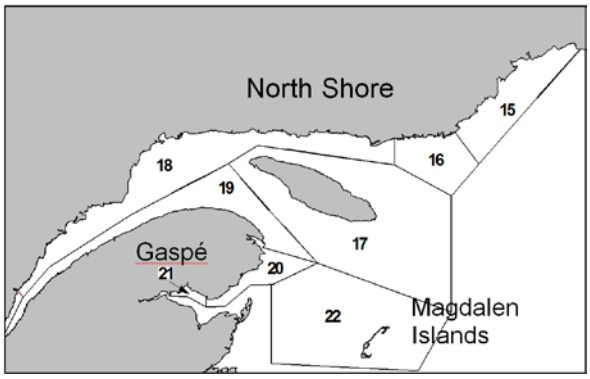


Figure 1. Map showing lobster fishing areas (LFAs) in Quebec (LFAs 15 to 18: North Shore and Anticosti, LFAs 19 to 21: Gaspé and LFA 22: Magdalen Islands).

Context:

Lobster fishing in the Magdalen Islands (LFA 22, Figure 1) is practiced by 325 enterprises (a skipper-owner and one or more fishers' helpers). About two-thirds of the fleet is on the south side (Old Harry to Havre-Aubert) and one-third is on the north side (Grosse-Île to Millerand) (Figure 2). The fishery is managed by controlling the fishing effort (number of licences, number and size of traps, fishing season and daily fishing schedule, organization of trap lines) and by escapement measures (release of berried females and minimum legal size [MLS]). Management and conservation measures introduced over the past 19 years follow the recommendations of the Fisheries Resource Conservation Council (FRCC). In 2011, a precautionary approach was suggested for LFA 22. It will guide future management decisions. The status of the resource is assessed every three years. This report describes the situation in 2015 and changes observed since the last stock status assessment in 2012.

SUMMARY

- **Landings**, the main indicator of abundance, reached a historic peak of 3 486 t in 2015, which was 52 % higher than the 25-year average for a similar or lesser fishing effort. The increase in landings between 2011 and 2015 was greater in the north (51%) than in the south (23%).
- In 2015, for the Islands as a whole, the **capture per unit effort** (CPUE) in weight for commercial sampling was slightly higher (2%) than in 2011 and 30% (18% in the south and 55% in the north) higher than the average of the historical series (1985–2014).

- The **demographic indicators** show that the average size of commercial lobsters sampled during the fishery has increased slightly, but in a sustained manner since the end of the legal size increase in 2003. In the trawl survey, the average size of commercial lobster was also found to have risen for females since 2003, but had decreased for males since 2013.
- The **fishing pressure indicators** show a slight decrease in exploitation rates since 2011.
- The **productivity indicators** remained high. For the Islands as a whole, the egg production increase factor for the period from 1994–1996 preceding the increase in the legal size was 2.9x in 2012–2015, compared to 3.3x in 2009–2011. For these same periods, the contribution of multiparous females to egg production increased, which fosters stock productivity. Indicators of fishery pre-recruitment and recruitment suggest that landings will remain high in the coming years.
- High abundance, productivity and landings indicate that the Magdalen Islands lobster stock is in good condition and in the healthy zone according to the **precautionary approach**. In the current environmental conditions, the current exploitation levels have allowed these indicators to remain stable or to improve.

INTRODUCTION

Biology

American Lobster (*Homarus americanus*) occurs along the Atlantic coast, from Labrador to Cape Hatteras, North Carolina. Adult lobsters prefer rocky substrates where they can find shelter, but can also live on sandy and even muddy bottoms. Commercial concentrations are generally found at depths of less than 35 m. In the Magdalen Islands, females reach sexual maturity at around 79 mm (carapace length, CL) on the south side and around 84 mm CL on the north side. Males reach sexual maturity at a smaller size. Females generally have a two-year reproductive cycle, spawning one year and moulting the next. Females spawning for the first time can produce nearly 8 000 eggs while large females measuring 127 mm CL (jumbo size) can lay up to 35 000 eggs. In addition to being more fertile, some large females could spawn two years in a row before moulting. Once released, the eggs remain attached to the females' swimmerets for 9 to 12 months, until the planktonic larvae hatch the following summer. Spawning and hatching can occur earlier in the season for multiparous females (females spawning for the second time at least) than for primiparous females. It has also been observed that larvae can be larger upon emergence for multiparous females than for primiparous females. The larvae's planktonic phase lasts from 3 to 10 weeks, depending on the temperature of the water. Following metamorphosis, postlarval lobsters (stage IV), which now resemble adult lobsters, drift down from the surface layer to settle on the sea floor. The survival of lobster from their larval stage to their initial benthic stages is impacted by predation as well as hydrodynamic factors that cause advection or retain the larvae near areas that are favourable for benthic settlement. During the first few years of benthic life, until they reach approximately 40 mm, lobsters lead a cryptic existence; i.e., they live hidden in habitats that provide many hiding places. Lobsters are estimated to reach the minimum legal size (MLS) (83 mm CL) at around eight or nine years of age after having moulted approximately 16 times since their benthic settlement.

Figure 2. Map of the Magdalen Islands showing the boundaries of the southern and northern areas and the Les Demoiselles site (indicated by a star).

Description of the fishery

The lobster fishery is managed by controlling fishing effort that restricts the number of licences, the number and size of traps, and the duration of the fishing season. In the Magdalen Islands, the lobster fishery is a spring activity that lasts nine weeks. Traps are not hauled on Sundays. In 2005, 325 commercial licences were issued with an allocation of 300 traps each. In 2006, a fishing effort reduction program (three traps per licence per year) was implemented. This program ended in 2014. In 2015, the authorized trap haul was 273. The minimum number of traps per line was set at seven, with a maximum distance of eight fathoms between traps. The length of the trap lines was limited to 56 fathoms. In addition, fishing hours (5:00 a.m. to 9:30 p.m.) were implemented in 2007, in keeping with the ban on making more than one trap haul per day. These measures will allow the effective effort to be controlled or even reduced. Trap size is limited to 81 cm in length, 61 cm in width and 50 cm in height, and the presence of escape vents for juvenile lobsters has been mandatory since 1994. From 2011 to 2015, the number of fishers in the southern area of the Magdalen Islands has decreased (respectively 222 to 207 fishers) in favor of the northern area (respectively 103 to 118 fishers)

In addition to the MLS, berried females must be released. Starting in 1997, the MLS was increased by one millimetre every year for seven years. It reached 83 mm in 2003 whereas it had been 76 mm between 1957 and 1996. The increase in the MLS allowed the level of egg production per recruit to double in 2003-2004 compared to 1996. In 2012-2015, egg production per recruit was in average 2.9 times those of 1996. At the same time as the MLS was increased, the size of the vertical opening in trap escape vents was increased from 43 mm in 1996 to 47 mm in 2003.

STOCK STATUS ASSESSMENT

Source of data

The stock status assessment is based on indicators of abundance, demographics, fishing pressure and stock productivity. Abundance indicators include landings recorded on processing plant purchase slips and catch rates of commercial-size lobsters obtained from samplings. The demographic indicators are taken from the lobster size structures and include mean size and weight, jumbo (≥ 127 mm) abundance, and sex ratios. The fishing pressure index (exploitation

rate) is derived from a measurement of the ratio between the number of individuals (males) from the first moult class recruited to the fishery in a given year and that of the second moult class recruited to the fishery one year later (tracking cohort strength). Productivity indicators are based on abundance of berried females and on egg production (reproduction), abundance of pre-recruits (one year before entering the fishery), and cohort strength at the time of benthic settlement (recruitment). The indicators are compiled mainly from two sources of data: at-sea sampling (0.14% of fishing activities), which has been conducted on board fishing vessels since 1985 and covers the south and north sides of the Islands; and a trawl survey, which has been conducted on the south side of the Islands since 1995. The latter is a source of fishery-independent data. The impact of changing research vessels in 2013 (from the *CCGS Calanus II* to the *CCGS Leim*) on the survey results remains to be determined, but the preliminary results seem to indicate an under-estimation of abundances by the Leim.

In addition, divers have studied the benthic settlement of lobster in the Les Demoiselles area (Baie de Plaisance) since 1995. For each indicator, data from the three previous years are examined and the 2015 data are compared to the averages from the existing data series (from before 2015).

Abundance indicators

Landings

Lobster landings recorded for the Magdalen Islands reached a historic record of 3 486 t in 2015 (preliminary data) (Figure 3). They had increased by 31.7% compared to 2011 (2 487 t). In 2015, they were 51.6% higher than the 25-year average (2 300 t). In 2015, landings were higher than in 2011 both in the south and north. The south side accounted for 64.5% (2 250 t) of the total landings on the Islands in 2015, and the north side accounted for the other 35.5% (1 236 t). In 2015, lobster landings from the Magdalen Islands accounted for 59% of the total landings in Quebec (5 880 t).

Commercial lobster catch rate (≥ 83 mm CL)

Catch rates correspond to catches per unit effort (CPUE) expressed in number or weight of commercial lobster per trap. In 2015, for the Islands as a whole, the CPUE for commercial-size lobsters was 0.83 lobster per trap (no./trap), which corresponds to 0.57 kg of lobster per trap (kg/trap) (Figures 4A and 4B). The CPUE in number for 2015 was 1.1% lower than in 2011 and 7.8% higher than the series average (1985 to 2010), which stood at 0.77 no./trap. The CPUE in weight was 1.8% higher than in 2011 and 29.6% higher than the historical serie's average, which was 0.44 kg/trap. These values are lower than those calculated based on landings. It would seem that fishing activities were less successful among fishers sampled for the 2015 season.

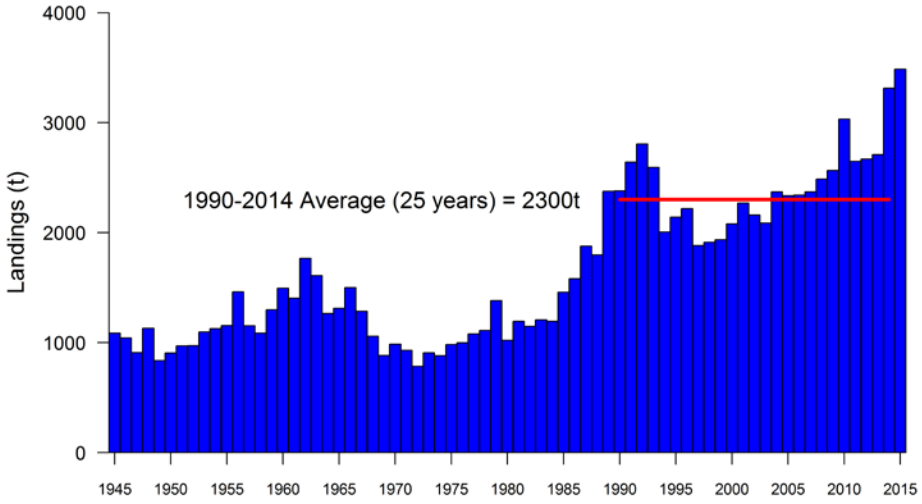


Figure 3. Lobster landings in the Magdalen Islands from 1945 to 2015.

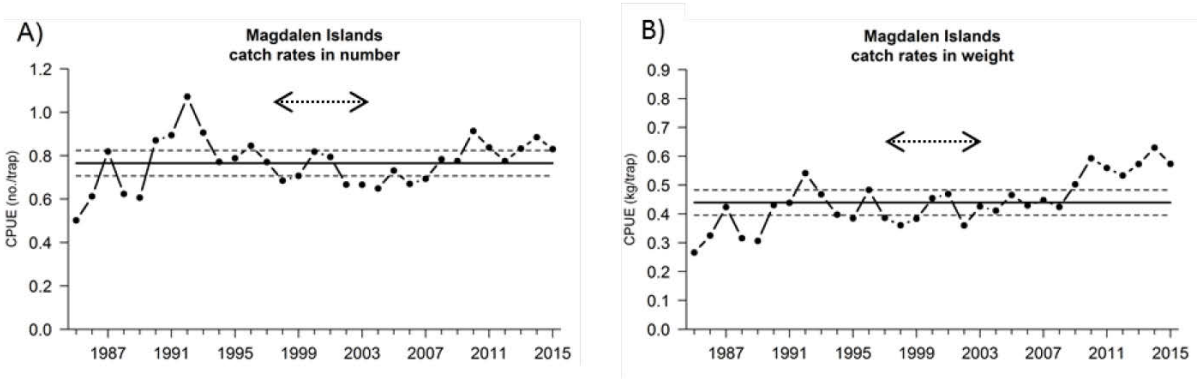


Figure 4. Catch rates (CPUE) of commercial-size lobsters for the Magdalen Islands from 1985 to 2015 in A) number and B) in weight per trap. 1985–2014 mean (solid line) ± 0.5 standard deviation (dotted lines). The horizontal arrow indicates the period (1997 to 2003) when the MLS was increased by 1 mm per year, from 76 to 83 mm.

Number and biomass of commercial lobsters (trawl)

The lobster population sampled in the fall of one year during the trawl survey represents the population to be available to the fishery in the spring of the following year. The commercial lobster density observed in the 2014 trawl survey was 5.88 lobsters per 1000 m^2 (no./1 000 m^2) (Figure 5A). The corresponding biomass was 4.12 kg of lobster per 1000 m^2 (kg/1 000 m^2) (Figure 5B). The values observed in 2014 were 26.5% and 25.5% respectively—lower than those observed in the 2010 survey. The 2014 values were lower than or equal to the series average for 1995 to 2013. Preliminary analyses from the comparative survey between the *CCGS Calanus II* (1995–2013) and the *CCGS Leim* (2013 onward) indicate an underestimation of densities for recent years by the *CCGS Leim*.

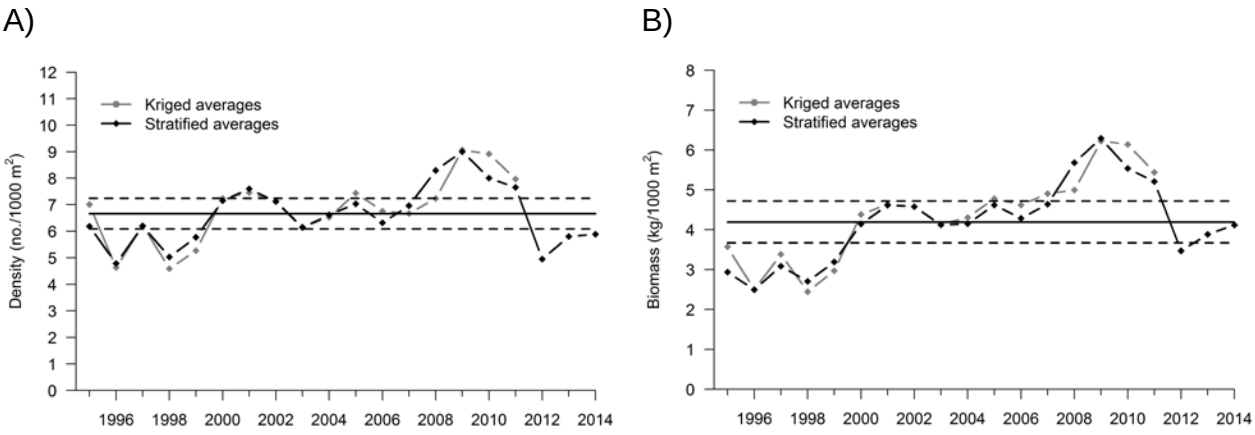


Figure 5. Commercial-size lobster A) number and B) biomass in kg per 1000 m^2 of commercial sized lobster observed during the September trawl survey conducted on the south side of the Magdalen Islands between 1995 and 2014. 1995–2013 mean (solid line) ± 0.5 standard deviation (dotted lines).

Demographic indicators and fishing pressure

There has been no notable change in commercial-size lobster size structures (≥ 83 mm) since 2011 (Figures 6A and 6B) or since the end of the MLS increase in 2003. Size structures appear truncated and are dominated by a moult class (83–94 mm for males and 83–90 mm for females) reflecting the year's recruits. Female size distributions are more truncated toward small sizes than male size distributions, reflecting slowed growth among females upon sexual maturity.

The average size and weight of landed lobsters have slightly increased since 2011, from 91.1 mm to 92.0 mm and from 619 g to 640 g in the south, and from 92.2 mm to 93.1 mm and from 640 g to 662 g in the north. Stability in the average size and weight of commercial-size lobsters was observed in the trawl survey. The proportion of jumbo lobsters (≥ 127 mm) observed during at-sea sampling is generally less than 1%. Within the fishery, it was 0.56% in 2015 for the south side of the islands, compared to 0.37% in 2011, and for the north side of the islands, it was 0.86% in 2015, compared to 0.65% in 2011. In the trawl survey conducted on the south side, the proportion of jumbos was 0.6% in the fall of 2014, compared to 1.2% in the fall of 2010.

Truncated size structures are indicative of high exploitation rates. The exploitation rate calculated for commercial-size males has been declining since 2010 and was 65.4% in the south and 63.8% in the north in 2015. These values are respectively lower or higher than the series average (1985–2009), which is 67.6% in the south and 60.3% in the north.

Overall, female mortality due to fishing is not as high because they are protected when berried. As a result, the sex ratio for lobsters left on the sea floor could shift towards females, which is more likely when exploitation rates are high. For now, the sex ratio (number of males/number of non-berried females) seems appropriate for ensuring mating (≥ 1).

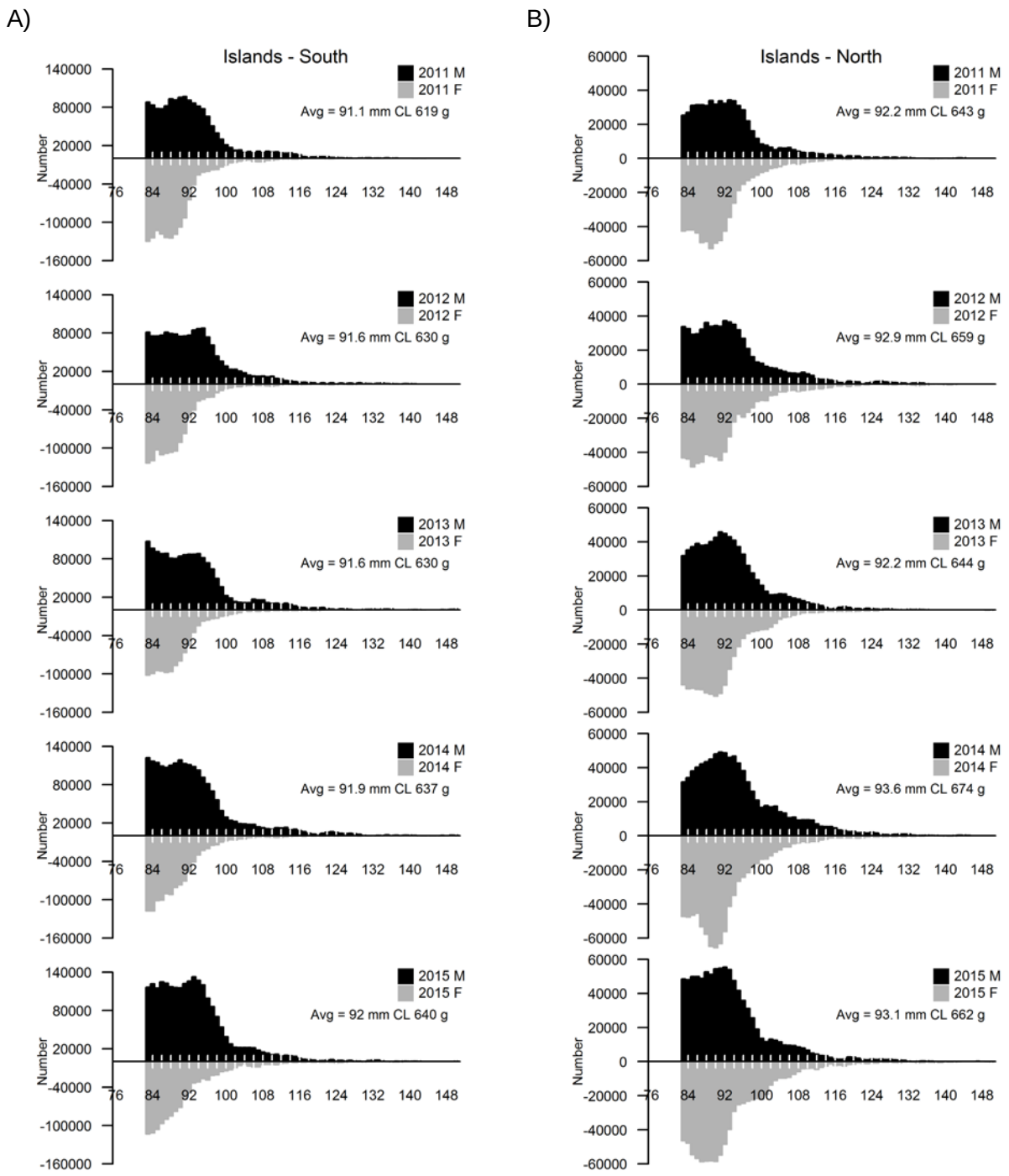


Figure 6. Size frequency distribution of commercial male (black) and female lobsters (grey) within the fishery from 2011 to 2015 for A) the south side and B) the north side of the Magdalen Islands. Frequencies are in numbers weighted by landings.

Productivity indicators

Berried females and egg production

In 2015, for the Islands as a whole, the CPUE for berried females was 0.16 no./trap. The average CPUE since the end of the increase period (2003–2010) of the MLS to 83 mm, was 0.18 no./trap compared to 0.09 no./trap for 1985 to 1996 when the MLS was 76 mm (Figure 7). The 2015 CPUE was lower than its 2011 counterpart (0.23 no./trap). An abundance index for mature females (≥ 79 mm CL) calculated from data in the trawl survey also shows an increase from 1995 to 2011, and a decrease from 2012 to 2014. The density of mature females was less than 3.0 no./1 000 m^2 before 1997 and had reached an average of 3.6 no./1 000 m^2 in the fall from 2012 to 2014.

The examination of the size structure of berried females shows a strong mode under the MLS on the south and north sides (Figures 8A and 8B). On the south side, 56% of berried females are under the MLS whereas on the north side, 35% are below it. Before the MLS was increased, most of these females between 76 and 83 mm CL did not contribute to egg production. In 2015, the average size of berried females was 83.4 mm in the south and 87.2 mm in the north. The largest size of berried females on the north side is mainly explained by a larger size at sexual maturity. Berried female size structures from the trawl survey are similar to those from at-sea sampling on the south side of the Islands. In 2015, multiparous females (those that are spawning for the second time at least) represented 22% and 20% of berried females in the south and the north, respectively, compared to 21% and 20% in 2011. An egg production index was calculated by multiplying the abundance index of berried females for each 1-mm size class by the size-specific fecundity. In 2015, the egg production index for the Magdalen Islands was 2.6 times higher than that calculated for 1994 to 1996, before the MLS began to be increased. In 2015, multiparous females contributed to 32% of total egg production.

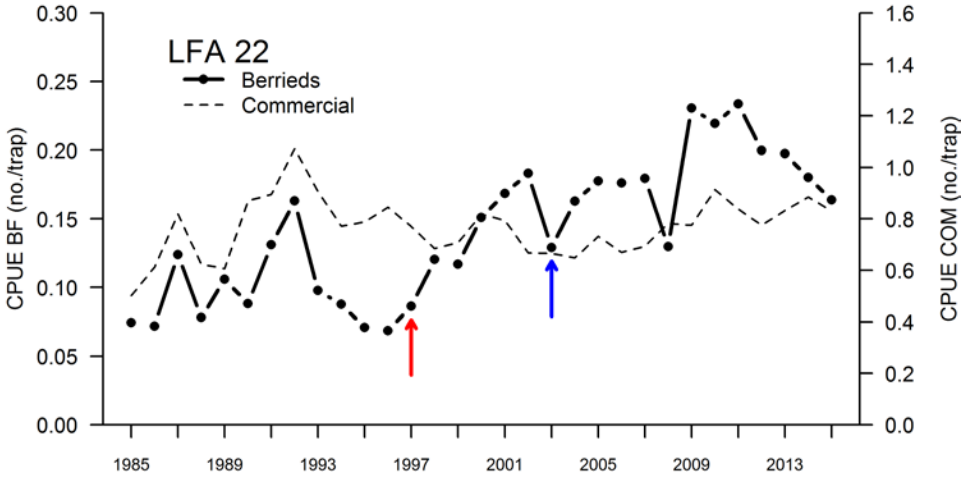


Figure 7. Catch rates (CPUE) of berried females (BF) for the Magdalen Islands from 1985 to 2015. The first arrow indicates the start of the increases in MLS and the second arrow indicates the year when the height of the escape vents was increased from 43 mm to 47 mm. The dotted line indicates CPUEs of commercial-size lobsters (COM) during the same period.

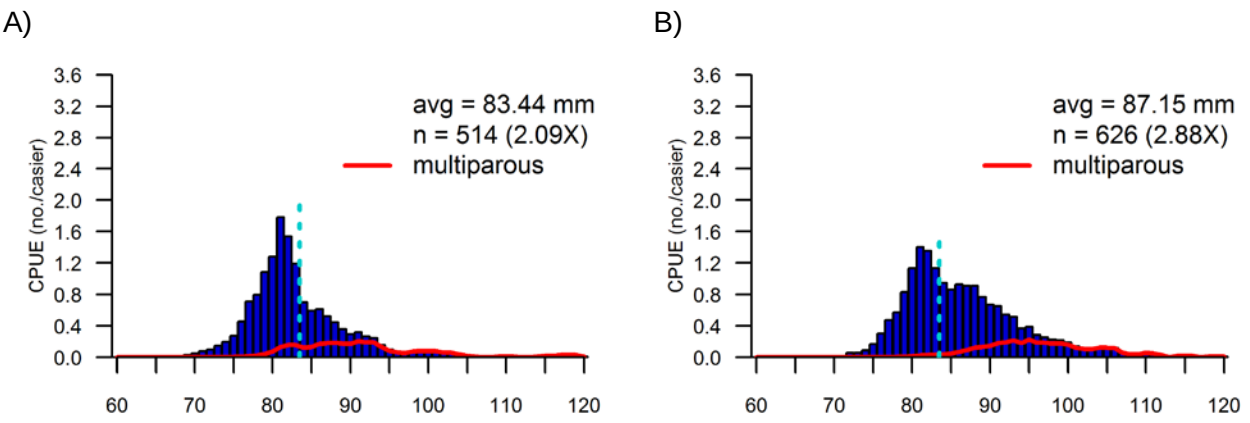


Figure 8. Size distribution frequencies of berried females on A) the south side and B) the north side of the Magdalen Islands in 2015. The red line represents multiparous females. Distributions are weighted by abundance indices (annual CPUE). The average size and total number of berried females and the rate of increase in egg production compared to the 1994–1996 average (in parentheses) are indicated.

Since 2004, at the time of the trawl survey, females ≥ 80 mm in recent postmoult have been examined to see if they have a sperm plug in the entrance of the seminal receptacle. The presence of a sperm plug indicates that the female has mated and that there is sperm in the seminal receptacle. The purpose of this type of observation is to detect any anomalies in mating success that could be consistent with excessive fishing pressure on males and a sex ratio imbalance. The average of the percentages from 2012 to 2014 (70%) was identical to 2011 but smaller than the historic high of 82% reached in 2015.

Recruitment

Commercial-size lobster biomass estimated during the trawl survey in a given year gives a fairly good prediction of total landings in the Islands for the following year (Figure 9). It must be noted that for the 2013–2015 years, the abundance of commercial lobster appears to have been underestimated (see section: Sources of data). The biomass index of commercial lobsters from the 2015 trawl survey (8.94 kg/1 000 m^2) was higher than that of the previous years (maximum of 6.3 in 2009). This suggests, for the 2016 season, landings greater than the historic series (1995–2014) if catchability remains similar. The abundance indices observed in the trawl survey for pre-recruits and juveniles follow the same pattern, which suggests that good recruitment to the fishery will be maintained in the medium term.

The benthic settlement at the Les Demoiselles site (Figure 2) has been higher on average since 2002 compared to what was observed between 1996 and 2001. In recent years (2014–2015), a discrepancy between the settlement periods and the underwater diving mission did not allow for the young-of-the-year (age 0+) to be used as an indicator. The density of lobsters age 1+ was used instead in order to represent the settlement of the year to t-1. Since 2010, the density of young aged 1+ has decreased from 2.62 to 0.77 no./m^2. These numbers are still higher than the 2002–2009 average (0.61 no./m^2) which was considered excellent. The survival of these young lobsters until they reach commercial size is still uncertain. The 2010 cohort was the strongest observed between 1995 and 2015. The high values since 2001 coincide with the increase in egg production. Benthic settlement may also be influenced by wind strength and direction and by the growth and survival rate during the larval period.

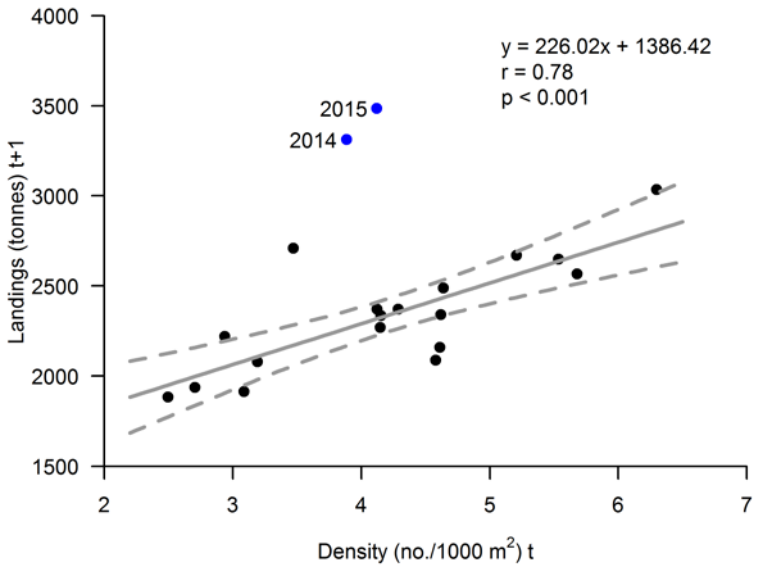


Figure 9. Relationship between the commercial-size lobster biomass index from the trawl survey in a given year (t) and the total lobster landings in the Magdalen Islands one year later (t+1). The dotted lines show a confidence interval of 95% around the regression line. The blue points (excluded from the relationship) show the biomass values observed in the 2013 and 2014 survey (at time t) and the landings for 2014 and 2015 (at time t+1).

Precautionary approach

A precautionary approach (PA) based on an empirical method was suggested for the lobster fishery in the Magdalen Islands. The Limit Reference Point (LRP) and the Upper Reference Point (URP), as well as the stock status zones (healthy, cautious and critical) were defined using a stock biomass indicator, in accordance with the DFO operational policy framework. According to the definition in the framework, a stock is considered to be in the critical zone if its biomass is equal or less than 40% of the biomass at maximum sustainable yield (B_{MSY}). The LRP is 40% of B_{MSY}. The stock is in the healthy zone if its biomass is higher than 80% of B_{MSY} (the URP level). The stock is in the cautious zone if its biomass is between the LRP and the URP. In the absence of estimates of a stock's biomass from an explicit model, the framework states that provisional estimates of B_{MSY} can be used. Since there are no biomass estimates for lobster stocks in the Magdalen Islands, a provisional estimate of B_{MSY} was calculated using landings from a productive period. In the case of the Islands, landings are considered as an indicator that is reasonably representative of the biomass. The mean value of landings from 1985 to 2009 was used as an approximation of B_{MSY}. These 25 years correspond to a productive period for lobsters and during which at least two large cohorts of lobster were produced. Average landings from 1985 to 2009 were 2188 t. The LRP (40% x average) was 875 t and the URP (80% x average) was 1750 t. (Figure 10). Based on 3,486 t of landings in 2015, the stock was considered in the healthy zone (Figure 10).

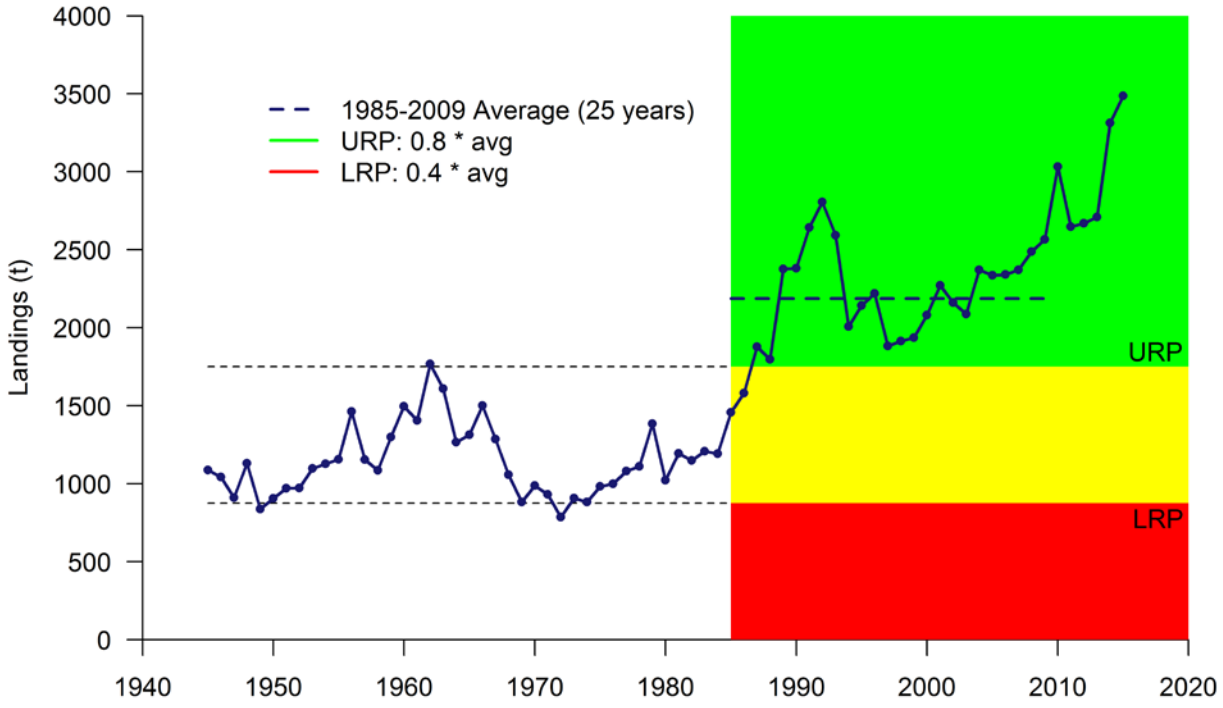


Figure 10. Lobster landings in the Magdalen Islands from 1945 to 2015. Healthy zone is green. Cautious zone is yellow, and the Critical zone is red.

Sources of uncertainty

The climate (long term) and weather conditions (short term) have significant impacts on all stages of lobster development. The climate determines periods of migration, moulting, reproduction, larval release and benthic settlement. It also conditions feeding and growth rates and periods. Weather conditions (temperature and wind) can affect lobster catchability. For example, when the water temperature is slow to increase in the spring or if it falls rapidly due to cold water upwelling, lobster catchability will be lower. Interannual or seasonal variability in climate and weather conditions can therefore have impacts on several demographic assessment indicators, including trawl and commercial fishery catch rates, which are considered to be abundance indicators and which are used in calculating indexes of exploitation rates.

At-sea sampling coverage is low (0.14% of fishing trips), which may brings about uncertainties in the representativeness of the CPUE estimates. Spatial fishing patterns can affect the abundance index of berried females if, for example, fishers avoid areas where these females can gather. Predictions for recruitment to the fishery from data on benthic settlement are not very accurate because of the age variability at the time of recruitment and uncertainty as to the survival of lobsters between the time of their benthic settlement and their entry into the fishery (8 to 10 years later). There is also uncertainty as to the representativeness of small-scale observations for the entire population.

CONCLUSION

High abundance, productivity and landings indicate that the Magdalen Islands lobster stock is in good condition and in the healthy zone according to the precautionary approach. In the current environmental conditions, the recent exploitation levels have allowed these indicators to remain stable or to improve lobster stock as assessed by the different measured indicators.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 25 and 26, 2016 meeting on the Assessment of Lobster in Quebec Inshore Waters. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

Gendron, L. and Savard, G. 2012. Lobster stock status in the coastal waters of Quebec (LFAs 15 to 22) in 2011 and determination of reference points for the implementation of a precautionary approach in the Magdalen Islands (LFA 22). DFO Can. Sci. Advis. Sec. Res. Doc. 2012/010. xvii+ 143 p.

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