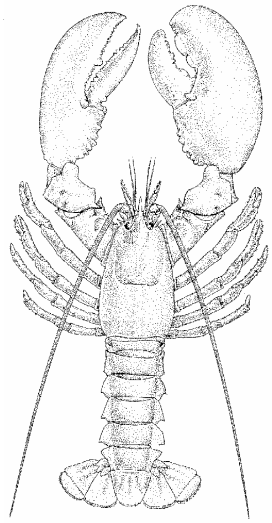
ASSESSMENT OF LOBSTER STOCKS OF THE MAGDALEN ISLANDS (LFA 22) IN 2008



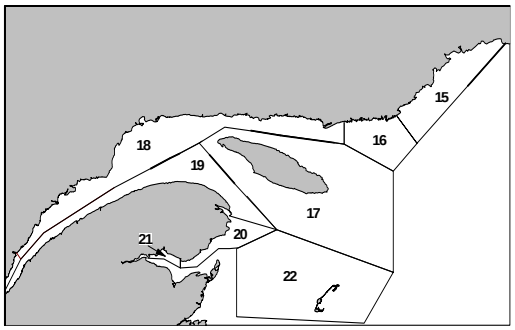


Figure 1. Map showing the lobster fishing areas (LFAs) in Quebec (LFAs 15 to 18: North Shore and Anticosti; LFAs 19 to 21: Gaspé Peninsula; and LFA 22: Magdalen Islands).

Context

Lobster fishing is practiced in the Magdalen Islands (LFA 22, Figure 1) by 325 fishing enterprises. Approximately two thirds of the fleet is active along the southern side of the Islands (Old Harry to Havre-Aubert) and one third along the northern side (Grosse Isle to Millerand) (Figure 2). The lobster fishery is managed by controlling the fishing effort (number of permits, number and size of traps, season and daily fishing schedule, organisation of the fishing lines) and by escapement measures: release of berried females and minimum legal size. The management strategies introduced over the last decade were developed based on the recommendations from the Fisheries Resource Conservation Council (FRCC).

The resource status assessment was done on an annual basis until 2005, which helped to closely monitor the impacts of the increase in minimum legal size on the lobster populations. Assessments are now conducted every three years. This advice describes the situation in 2008 and the changes observed over the 2006-2008 period.

SUMMARY

- The **abundance indicators** remained generally high from 2006 to 2008. Landings have increased from 2,341 t in 2005 to 2,492 t in 2008. In 2008, they were 20% higher than the average over the last 25 years (2,082 t). The mean catch per unit effort (CPUE) for commercial lobsters was relatively stable from 2006 to 2008, at 0.7 lobster/trap and 0.4 kg/trap, but dropped by about 7% compared to 2005. In 2008, even though the CPUE in numbers was 12% lower than the 1985-2007 series average, it was about 4% higher in weight.

- The **demographic indicators** showed that the average size of lobster caught has been stable since 2003 at a level about 6-7 mm larger (carapace length, CL) than the mean size recorded prior to the increase of the minimum legal size, and a mean weight of about 25% higher. From 2005-2008, the sex-ratio remained in favour of males overall and seems appropriate for reproduction. Size structures were truncated and consequently, the proportion of jumbo size lobster (≥ 127 mm CL) remained low (< 1%), but slightly increased nevertheless from 2005-2008.

- The **fishing pressure indicators** revealed that the estimated exploitation rates for 2005 to 2007 varied between 71 and 77% in the south and between 69 and 71% in the north, compared with 74% in 2004. However, fishing mortality for the portion of the population ≥ 76 mm CL dropped as a result of the increase in the minimum legal size.

- The stock **productivity indicators** remained positive from 2006 to 2008. The abundance of berried females has remained higher than prior to the increase of the minimum legal size, despite a drop in their CPUE in 2008. As in 2005, egg production estimates for 2006-2008 were higher by a factor of around two compared to those prior to the increase of the minimum legal size. In 2008, the number of multiparous females was slightly higher than in 2005 and their relative contribution to the total egg production was also higher. Recruitment indices recorded in 2008 suggest that the 2009 landings could remain high. The juvenile abundance indices also suggest there could be a good recruitment to the fishery in the medium term.

- Despite the efforts and positive signs, some improvements to the size structure of the stocks appear necessary. This will help reduce the dependence of the fishery on the annual recruitment and will also help increase the proportion of multiparous females in the population and ensure their reproductive success by maintaining suitable sex-ratios, according to the recommendations by the FRCC (2007). Thus, it is important to continue the program for reducing the fishing effort introduced in 2006. In a long term outlook, it is important to identify some biological reference points in developing a formal precautionary approach for this fishery.

INTRODUCTION

Biology

American lobster (*Homarus americanus*) occurs along the west coast of the Atlantic Ocean, from Labrador to Cape Hatteras. 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. Females reach sexual maturity at around 79 mm (carapace length) on the southern side of the archipelago and 84 mm on the northern 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 (jumbo size) can lay up to 35,000 eggs. In addition to being more fertile, certain large females could spawn two consecutive years 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 was also noticed that larvae at the time of release could be larger for multiparous females than 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 benthic cryptic stages is impacted by predation as well as by hydrodynamic factors that cause advection or retain the larvae near the areas that are favourable for benthic settlement. During the first few years of benthic life or until they reach approximately 40 mm, lobsters lead a cryptic existence, i.e. they live hidden in habitat providing many shelters. Lobsters are estimated to reach the minimum legal size (83 mm) around 8 years of age, after having moulted approximately 16 times since their benthic settlement.

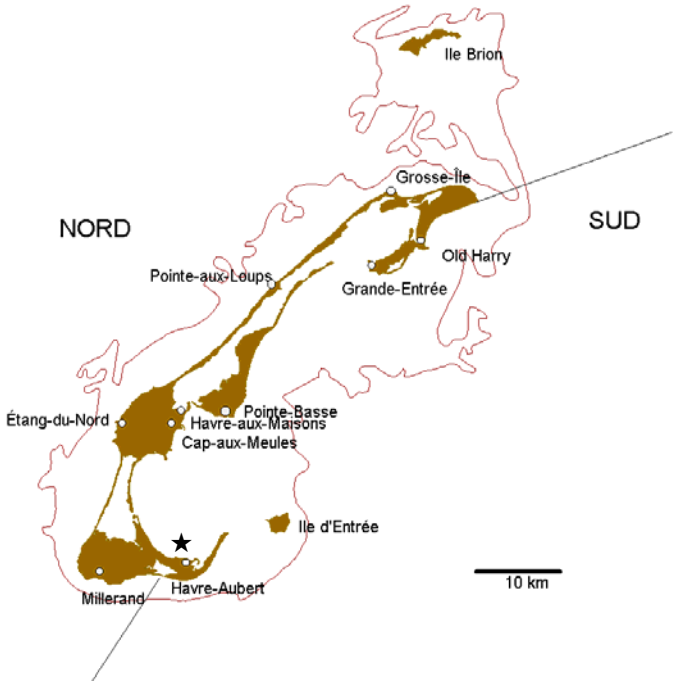


Figure 2. Map of the Magdalen Islands showing the boundaries of the southern (SUD) and northern (NORD) parts and the Les Demoiselles site (star).

Fishery Management

The lobster fishery is managed by controlling fishing effort by restricting the number of licences, the number and size of traps, and the duration of the fishing season. The lobster fishery is a spring activity that lasts 9 weeks in the Magdalen Islands. There is no trap hauling on Sundays. In 2005, 325 commercial licences were issued with a limitation of 300 traps each. In 2006, a program was introduced for reducing the fishing effort by 3 traps per fishermen per year over 10 years. In 2015, the nominal fishing effort will have been reduced by 10%. In addition, the number of traps per fishing line was set at seven and the length of the lines was limited to 56 fathoms. In 2007, fishing schedules were also introduced (05h00 to 21h30) in line with the prohibition of hauling the traps more than once a day. These measures are aimed at reducing the effective fishing effort. In addition to the size of the traps, which is currently limited to 81 cm in length, 61 cm in width and 50 cm in height, the presence of escape vents on traps has been mandatory since 1994, and the size of their vertical opening went from 43 mm to 47 mm in 2003, to comply with the introduction of the new minimum legal size of 83 mm. In the medium

term, the vertical height should be reduced to 42 cm for rectangular traps so that their volume does not exceed that of the traditional hemi-cylindrical traps.

Fishery management also includes escapement measures. Along with a minimum legal size (carapace length), berried females must be released. The minimum legal size was increased starting in 1997 by 1 mm per year, over seven years. It reached 83 mm in 2003 and was 76 mm in 1957 and 1996. The objective of increasing the minimum legal size was to double the 1996 level of egg production per recruit.

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, catch rates of commercial-size lobsters obtained from at-sea samplings and from logbooks kept on a voluntary basis since 1992 by a variable number of index fishermen. In 2008, index-fishermen took part in a pilot-project for implementing an electronic logbook (ELB). The demographic indicators were 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 (modal analysis). A fishing mortality index for the portion of the population ≥ 76 mm is also calculated and is based on the change-in-ratio method (CIR). Productivity indicators are based on abundance of berried females and on egg production (reproduction), and the abundance of pre-recruits, one year before the fishery, and on the strength of the cohort at the time of benthic settlement (recruitment). At-sea sampling has been conducted annually since 1985 on the fishing grounds of the southern and northern parts of the archipelago. A trawl survey has also been carried out on the southern part of the archipelago since 1995. The survey data is used to validate indices obtained from the fishery and make short-term predictions about recruitment to the fishery. Benthic settlement in the Les Demoiselles sector (Plaisance Bay) has been monitored annually since 1995. For each indicator, data from the three previous years are examined and the 2008 data are compared to the averages from the existing data series, prior to 2008.

Abundance Indicators

Landings

Landings recorded in the Magdalen Islands have increased since 2005, reaching 2,487 tons in 2008 (preliminary data), from 2,341 tons in 2005 (Figure 3). They remained stable and high from 2004 to 2007, between 2,340 tons and 2,370 tons. In 2008, they were 20% higher than the average of the last 25 years (2,082 tons). The 2008 landings represented the highest level observed since the 1991-1993 peak (2,600-2,800 tons). Compared with 2005, landings increased in both the southern and northern parts, reaching 1,717 tons and 770 tons in 2008, compared with 1,595 and 741 tons in 2005, respectively. In 2008, 69% of the total landings were made in the southern part and 31% in the northern part of the archipelago. In 2008, lobster landings in the Magdalen Islands accounted for 73% of total landings in Quebec.

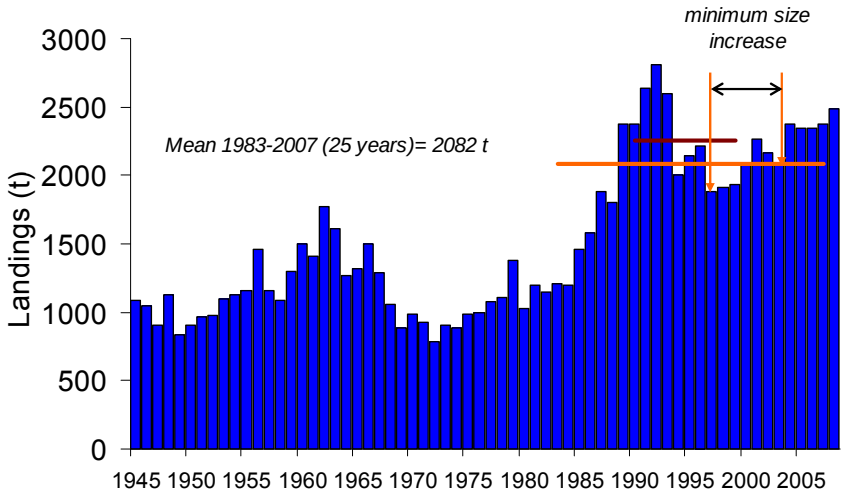


Figure 3. Lobster landings in the Magdalen Islands, 1945-2008.

Prevailing weather conditions in 2008 during the fishing season were favourable and the temperatures recorded on the bottom were average based on the last 14 years (1994-2007), which favoured lobster catchability. The number of recorded trips in 2008 totalled 16,387, which is 2.5% higher than the 1994-2007 average and corresponds to 93.4% of the maximum allowed (325 fishermen x 9 weeks x 6 days = 17,550 trips). Each trip consists of one daily outing per fisherman for which a purchase slip is produced. The number of traps hauled (number of trips x number of authorized traps) reached 4.77 million in 2008, which corresponds to the 1990-2007 average. In 2008, fishermen were only allowed 291 traps, compared to 300 up to 2006.

Catch rates for commercial-size lobsters

Catch rates correspond to the catches per unit of effort (CPUEs) expressed in number or weight of lobster per trap. Since 1985, in LFA 22, average annual CPUEs of commercial-size lobsters derived from at-sea sampling of commercial captures ranged from 0.5 to 1.1 lobster per trap (l/t) (Figure 4A). For the same period, the CPUE in weight ranged between 0.27 and 0.53 kg/trap (kg/t) (Figure 4B). The average CPUE was relatively stable from 2006 to 2008, measuring around 0.68 l/t and 0.42 kg/t, but dropped by about 7% compared to 2005. In 2008, although the CPUE was 12% lower than the 1985-2007 series average, it was almost 4% higher in weight.

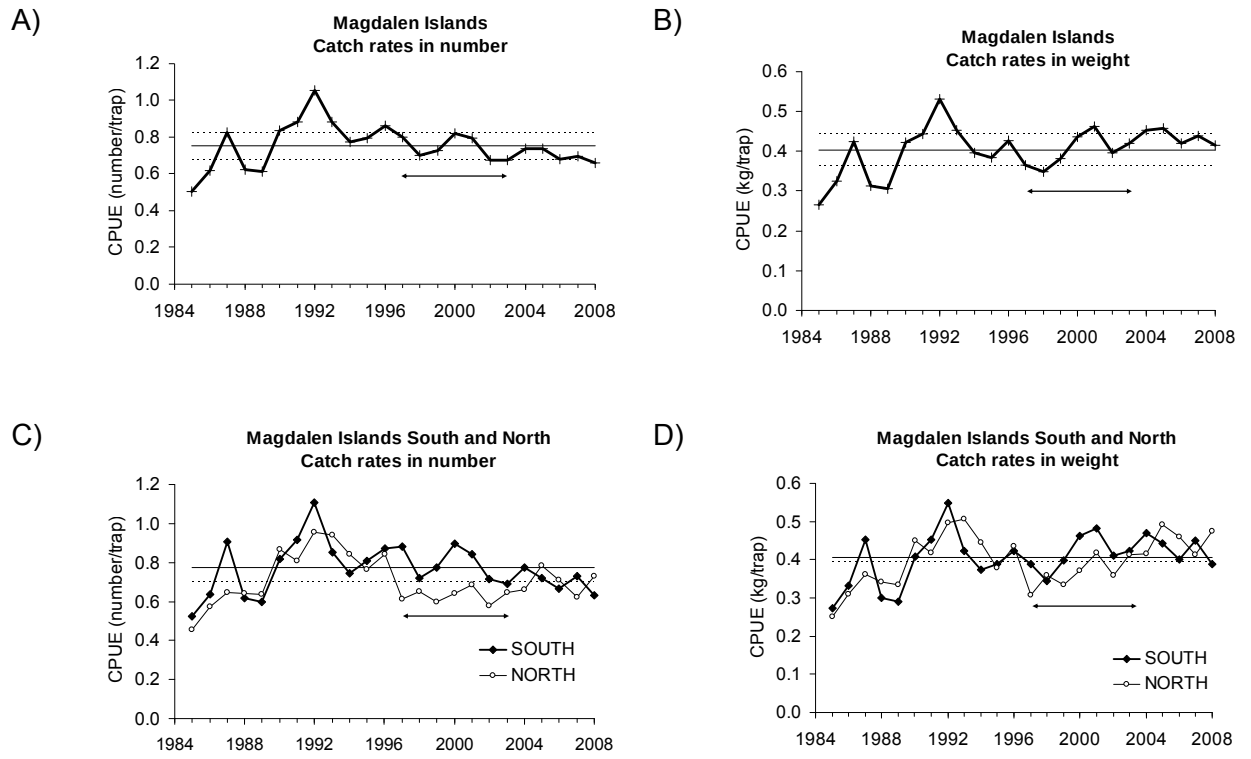


Figure 4. Catch rates (CPUEs) of commercial-size lobsters in the Magdalen Islands from 1985 to 2008 A) in number and B) in weight per trap; 1985-2007 mean (solid line) ± 10% (dotted line). CPUE values for the southern and northern Magdalen Islands C) in number and D) in weight. The solid line represents the 1985-2007 mean for the southern part and the dotted line represents the mean for the northern part for the same period. The horizontal arrow indicates the period (1997-2003) when the minimum legal size was increased by 1 mm per year, from 76 to 83 mm CL.

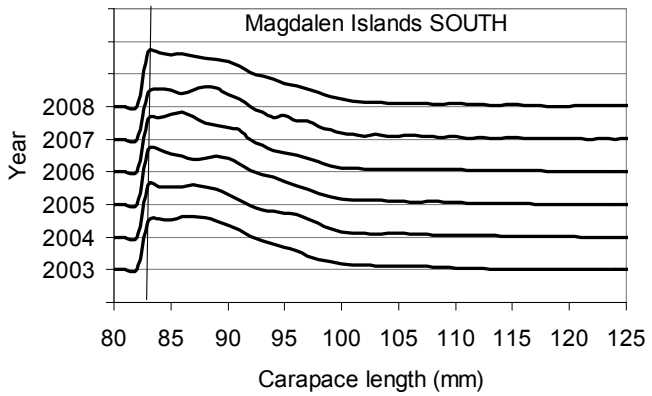
In the southern part, CPUE in number has shown a downward trend since 1997 (Figure 4C). Up to 2003, this drop could be associated to the increase in the minimum catch size as lobsters remain on the bottom an extra year before being harvested, and they are subjected to an estimated natural mortality of approximately 10-15%. The 2008 CPUE mean number was 0.63 l/t, which was lower than 2003 and 18% below the series average (1985-2007) (0.77 l/t). The larger size of lobsters landed somewhat compensates for the drop in numbers. The CPUE in weight in 2008 (0.39 kg/t) was only 5% lower than the series average (0.41 kg/t) (Figure 4D). Higher catch rates (0.74 l/t and 0.47 kg/t) were nevertheless recorded in another project conducted in 2008 in the southern part of the Islands, based on the same regular sampling protocol, which is closer to the time series average.

In the northern part, CPUE in number dropped in 1997 and remained stable until 2004 at levels relatively lower than what had been recorded in the 1990s, ranging between 0.60 and 0.68 l/t (Figure 4C). Since 2005, values have generally been higher. In 2008, it reached 0.73 l/t, which was 4% higher than the 1985-2007 series average. Between 1997 and 2004, CPUE in weight was higher, reflecting the increase in the mean size of lobsters in the catch. It increased from 0.31 to 0.42 kg/t (Figure 4D). In 2008, CPUE in weight reached 0.47 kg/t, which is 21.5% higher than the 1985-2004 series average.

Demographic indicators

There has been no noticeable changes in the size structures of lobster from the commercial portion over the last three years and they have remained similar to those observed since the end of the minimum legal size increase in 2003 (Figures 5AB). Size structures have a truncated appearance. They present a strong mode corresponding to the recruits of the year. A second less significant mode can be noticed at around 96 mm, which would correspond to recruits from the previous year.

A)



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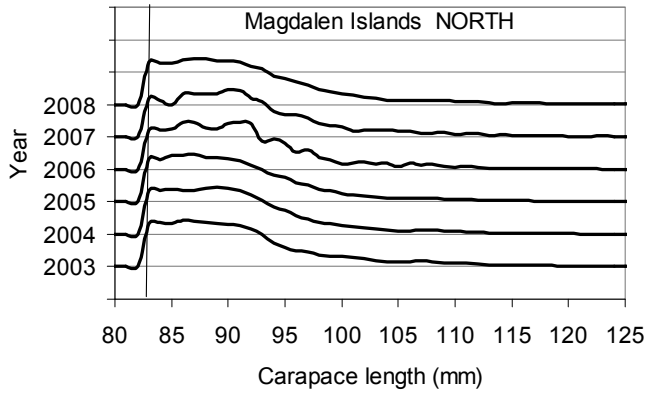

Figure 5. Size frequency distributions of harvested lobsters (commercial portion) from 2003 to 2008 for A) the southern part and B) the northern part of the Magdalen Islands.

In 2008, in the southern part, the average size of harvested lobsters was 90.9 mm and their mean weight was 640 g. In the northern part, the average size was 91.7 mm and their mean weight was 650 g. In the southern part of the Islands, the mean size and weight increased by 8 and 34% respectively compared to 1996, before the minimum legal size increase. In the northern part, the increase was 7% in size and 26% in weight. The data from the trawl survey in the southern part of the Islands revealed the same trends.

Marked differences were also observed between male and female size structures. Female size distributions were more truncated toward smaller sizes than those of males, which reflect a decrease in female growth as they reach sexual maturity.

The proportion of large-size lobsters (jumbo, CL ≥ 127 mm) observed during at-sea samplings remains relatively low. In 2005, it represented about 0.3%. However, it has since increased, in the southern part, to reach 0.7% in 2008. The proportion reached 0.4 and 0.5% in the northern part in 2006 and 2007, and 0.3% in 2008.

Fishing pressure

Truncated size structures are indicative of high exploitation rates. Exploitation rates calculated for the commercial-size males in LFA 22 (modal analysis) remained high from 2005 to 2007, both in the north and south. It ranged between 71 and 77% in the south and between 69 and 71% in the north (Figures 6AB). Rates were higher than the 1985-2006 period average; 67% in the south and 59% in the north. The exploitation rates calculated for the 1996-2007 period derived from the trawl survey were on average around 65%. For 2008, the estimated rate was slightly lower at 60% (Figure 6A). The male ≥ 76 mm CL mortality rate index (CIR) reveals that since 2003, when the minimum legal size of 83 mm was reached, the mortality rate of this portion of the population has been around 50%.

Overall, female mortality is not as high because they are protected when they are berried. Consequently, the sex-ratio of lobsters left on the sea floor could favour females, especially when exploitation rates are high. For the time being, the sex-ratio (number of males/number of non-berried females) seems to be suitable for mating. It is usually around one for all commercial-size lobsters and around two for sizes ≥ 90 mm.

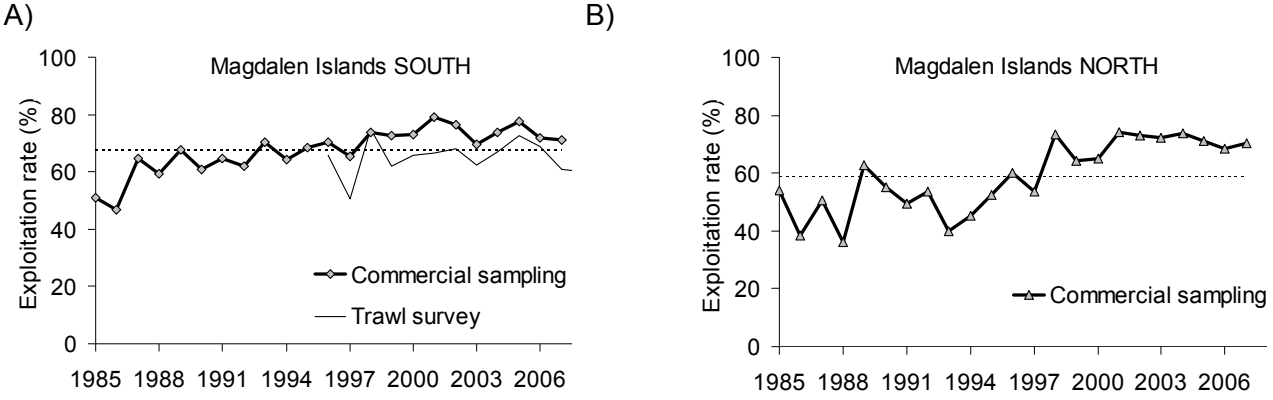

Figure 6. Exploitation rate indices for commercial-size males estimated by modal analysis based on data from commercial sampling and from the trawl survey for A) the southern part and B) the northern part of the Magdalen Islands from 1985 to 2008. Dotted lines represent the mean for the 1985-2006 period.

Productivity indicators

Berried females and egg production

Data from at-sea sampling showed an increase in the abundance of berried females beginning in 1996 in the southern part of the Magdalen Islands, and beginning in 2000 in the northern part. This increase occurred during a period when the abundance of commercial-size lobster varied only slightly (Figures 7AB). The drop in abundance recorded in 2003 was the result of the increase in the size of escape vents from 43 to 47 mm, which allowed a larger proportion of berried females under the legal size to escape. Nonetheless, the number of berried females has remained relatively abundant over recent years despite the drop recorded in 2008 in both parts of the Islands. These low values could be influenced by the sampling area and period. It is also possible that these values reflect changes in the fishing spatial pattern which may be aimed at avoiding as much as possible berried female concentrations.

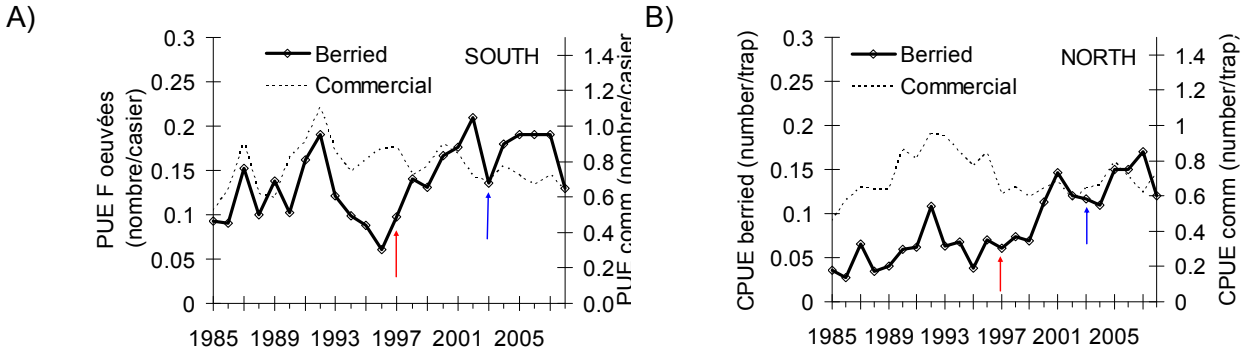

Figure 7. Catch rates (CPUEs) of berried females for A) the southern part and B) the northern part of the Magdalen Islands from 1985 to 2008. The first arrow indicates the start of the increases in minimum legal size and the second arrow indicates the year when the height of the escape vent was increased from 43 mm to 47 mm. The dotted line represents CPUE trends for commercial-size lobster during the same period.

The examination of the size structures and abundance of berried females suggests that egg production doubled since 1996 (Figures 8AB). The egg production index is obtained by multiplying the abundance index of berried females for each 1-mm size class by the size-specific fecundity. The abundance index of berried females is obtained by weighting size frequency distributions by abundance indices (average annual CPUEs). In 2008, the mean size of berried females was 81.5 mm in the south and 85.7 mm in the north. The larger size of berried females in the north is largely the result of a larger size at sexual maturity. In 2008, the proportion of multiparous females (that spawn at least for the second time) was 17% in the south and 23% in the north, contributing for 23% in the south and 32% in the north of the total egg production. It represents a slight increase since 2004.

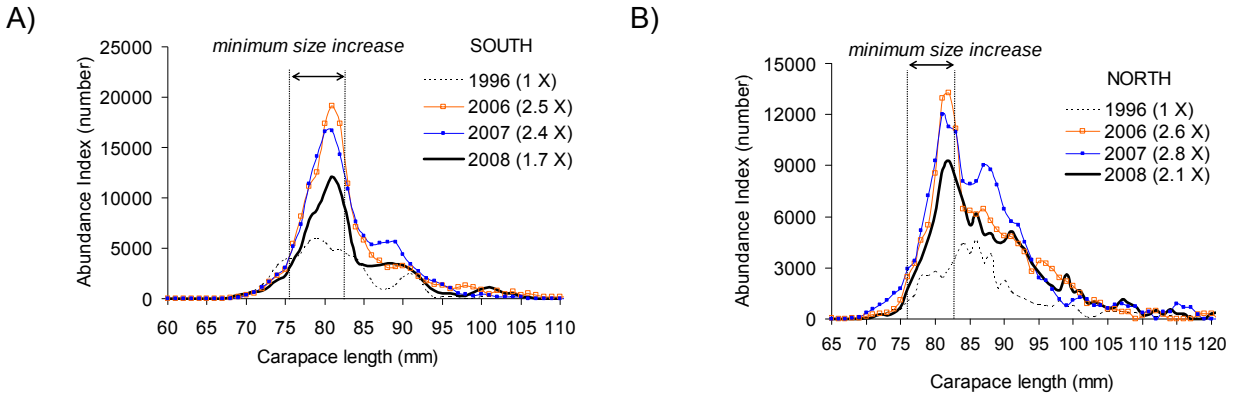

Figure 8. Egg production index calculated for A) the southern part and B) the northern part of the Magdalen Islands in 1996 and from 2006 to 2008. Egg production relative to that in 1996 is indicated in parenthesis.

Mating success

Since 2004, in the trawl survey, postmoult females larger than 80 mm have been examined to see whether they had a sperm plug at the entrance to their seminal receptacle. Presence of a sperm plug indicates that the female has mated and that her seminal receptacle contains sperm. Between 985 and 2,268 females have been examined every year (Figure 9).

The percentage of females larger than 80 mm with a sperm plug varied between 71 and 79%. It varied between 72 and 84% for females larger than 95 mm. Over the five observation years, there has been no trend detected. Annual fluctuations could be the result of variations in the moulting and mating period in relation to when the survey is conducted. This indicator will continue to be monitored in the coming years to detect any problem in mating success that could result from overly intense fishing pressure on males creating an unbalanced sex-ratio in favour of females.

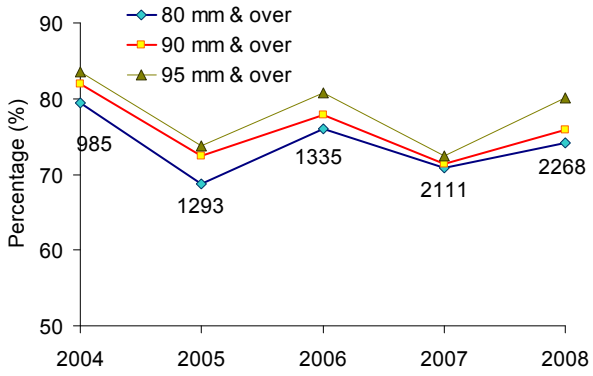

Figure 9. Percentage of postmoult females with a sperm plug. Trawl survey. The numbers represent the number of females examined.

Recruitment

The recruitment index obtained from the trawl survey suggests that landings in 2009 could remain high, similar to what has been observed over the last five years. The correlation between the abundance of commercial-size lobsters in a given year estimated from the trawl survey and landings made the following year is positive and significant (Figure 10). The relationship improved after adding the data from the last three years. Abundance indices for prerecruits and juveniles remain high, suggesting that recruitment could be maintained in the medium term.

Benthic settlement in the Les Demoiselles site (see map, Figure 2) has been higher since 2002 compared to the average observed between 1996 and 2001. High values recorded in recent years coincide with the increase in egg production. Benthic settlement is also influenced by the strength and direction of winds during the larval period. Over the last three years, from 2006 to 2008, benthic settlement has been high, particularly in 2008, which was the highest value in the series (since 1995). In 2005, in the Les Demoiselles site, no benthic settlement (2005 cohort) was recorded. The 2006 observations confirmed the low abundance of this cohort in the Les Demoiselles site. However, scuba-diving surveys conducted a little further offshore found individuals from this cohort, suggesting a settlement or the survival of this cohort in an area a few meters deeper.

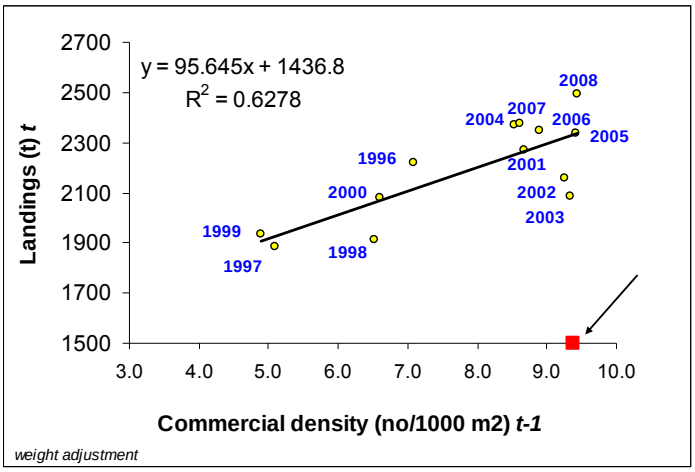

Figure 10. Relationship between the abundance index of commercial-size lobsters obtained from the trawl survey and landings recorded one year later. Abundance indices were adjusted by the mean weight of lobsters. The square on the X-axis (arrow) indicates the density observed during the 2008 survey.

Sources of uncertainty

The landing data presented correspond to the landings recorded on processing plant purchase slips. There are uncertainties as for the non-recorded lobster captures, which correspond among other things to the quantities set aside for personal consumption and to the quantities poached. A bipartite group composed of industry and DFO representatives is currently working on developing and validating a model to assess non-recorded lobster landings.

The lack of logbooks prevents the calculation of precise abundance indices for each fishing sectors of the archipelago. Abundance indices are derived from at-sea sampling of commercial catches that covers 0.14% of all fishing activities and from data gathered by index-fishermen,

which represent between 2-3% of all fishermen. The work carried out by index-fishermen is done strictly on a volunteer basis and in some years, for different reasons, they may not collect the data. The low sampling effort creates uncertainty on the representativeness of the estimates.

Although it is considered that catch rates reflect the abundance of lobster on the seafloor, they can also be affected by both intra and inter-annual variations in lobster catchability. Cold temperatures, winds and currents are factors that have a negative impact on catchability. These effects are difficult to quantify and introduce uncertainty into the interpretation of catch rates. In addition, fishing patterns can also have an impact on the abundance index of berried females if, for instance, fishermen avoid the sectors where they concentrate. Changes in catchability can also create uncertainty in the calculation of exploitation rate indices.

Short-term forecasting appears possible based on the results obtained from the trawl survey since 1995. Longer term forecasting is however more difficult given the difficulty in sampling early benthic stages, the uncertainty and variability of the age at recruitment and the absence of knowledge on the factors influencing lobster survival between settlement and their entry in the fishery (8-10 years later). There is also uncertainty in the representativeness of observations made on a small spatial scale for the population as a whole.

CONCLUSION AND ADVICE

In 2008, in the Magdalen Islands, abundance indicators were high and productivity indices were all positive. Despite the efforts and positive signs, some improvements to the size structure of the stocks appear necessary. This will help reduce the dependence of the fishery on the annual recruitment and will also help increase the proportion of multiparous females in the population and ensure their reproductive success by maintaining suitable sex-ratios, according to the recommendations by the FRCC (2007). Thus, it is important to continue the program for reducing the fishing effort introduced in 2006 and to monitor the changes to the fishing gear or practices that could be used to counterbalance fishing effort reductions. In a long term outlook, it is important to identify some biological reference points in developing a formal precautionary approach for this fishery.

SOURCES OF INFORMATION

FRCC. 1995. A Conservation framework for Atlantic Lobster. Report to the Minister of Fisheries and Oceans. November 1995. 49 p. + appendices.

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