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Whelk Stock Assessment in Québec's Inshore Waters – Methodology and Results

Sylvie Brulotte

Fisheries and Oceans Canada
Maurice Lamontagne Institute
850 Route de la Mer
Mont-Joli, Québec G5H 3Z4

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Canada

Foreword

This series documents the scientific basis for the assessment of aquatic resources and ecosystems in Canada. It addresses the issues of the day in the time frames required. The information provided should not be considered as definitive statements on the subjects addressed, but rather as progress reports on ongoing investigations.

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RÉSUMÉ

L’état des stocks de buccin des eaux côtières du Québec est déterminé principalement à partir d’indicateurs de la pêche commerciale. L’évaluation de cette ressource est faite aux trois ans. Ce document présente la méthodologie et les résultats qui ont été utilisés lors de la revue par les pairs tenue le 10 mars 2015.

En 2014, les débarquements québécois de buccins étaient de 951 t et provenaient à 87 % de la Côte-Nord, 12 % de la Gaspésie – Bas-Saint-Laurent et 2 % des Îles-de-la-Madeleine. Les débarquements ont diminué dans la majorité des zones de pêche par rapport à 2011 et les TAC, lorsque présents, n’ont pas été atteints. En 2013 et 2014, les prises par unité d'effort (PUE) étaient au-dessus de leur moyenne de référence (période 2001 à 2013) dans les zones 1, 4 et 13, près de leur moyenne dans les zones 2, 5, 6 et 8 et sous leur moyenne dans les zones 3, 7, 12 et 15. Dans ces quatre dernières zones, les PUE mesurées en 2014 étaient parmi les plus faibles valeurs observées depuis 2001. Les tailles moyennes ont été à peu près stables dans toutes les zones. La proportion des buccins de taille sous-légale (< 70 mm) dans les débarquements de 2014 était inférieure à 4 % partout, sauf dans les zones 1 et 8.

Le relevé de recherche effectué aux deux ans dans les secteurs de Forestville, Pointe-aux-Outardes et Baie-Comeau montre, que les densités moyennes des buccins ≥ 20 mm ainsi que celles des buccins de taille commerciale (≥ 70 mm) obtenues en 2013 étaient plus élevées que les années précédentes à Forestville, mais similaires entre les années aux deux autres secteurs. La structure de taille de 2013 à Forestville affiche une forte proportion de buccins sous la taille légale.

ABSTRACT

The Québec inshore waters whelks stock status is determined primarily based on commercial fishery indicators. The assessment of this resource is done every three years. This document presents the methodologies and data that were presented during the peer review that took place in March 10, 2015.

In 2014, whelk landings totalled 951 t in Québec. A total of 87% of these landings were from the North Shore, 12% from the Gaspé Peninsula–Lower St. Lawrence and 2% from the Îles-de-la-Madeleine. Landings decreased in most fishing areas compared to 2011 and TACs, when present, have not been reached. In 2013 and 2014, catches per unit effort (CPUE) were above their reference average (2001 to 2013) in areas 1, 4 and 13, close to their average in areas 2, 5, 6 and 8 and under their average in areas 3, 7, 12 and 15. In the last four areas, CPUEs measured in 2014 were among the lowest values observed since 2001. Mean sizes have been roughly stable in all areas. In 2014, the proportion of whelk measuring less than the legal limit (< 70 mm) in landings was less than 4% everywhere except in areas 1 and 8.

The research survey conducted every two years in the Forestville, Pointe-aux-Outardes and Baie-Comeau sectors shows that in 2013, the mean densities of whelks ≥ 20 mm and those of commercial size (≥ 70 mm) were higher than in previous years in Forestville but similar between the years in both other sectors. The 2013 size structure in Forestville shows a high proportion of whelks under the legal size.

INTRODUCTION

Fisheries and Oceans Canada (DFO) has reviewed and assessed whelk stocks in Québec's coastal waters for several years, and updates are scheduled to be provided every three years. This report presents the data and analytical methods used for the assessment following the 2014 fishing season.

MATERIAL AND METHODS

COMMERCIAL FISHERY

The commercial whelk fishery data come from three separate sources: purchase receipts, logbooks and commercial catch sampling. The information collected through purchase receipts and logbooks is provided to us in a ZIFF (Zonal Interchange Format File). Purchase receipt are completed by the buyer and provide official whelk landing figures. Landings used in this paper do not include estimates for unreported landings. Whelk logbooks, introduced in 2001, are updated by fishermen on a daily basis. They provide various information including: the fisherman's identification, landing dates, trap haul dates, fishing location (first and last trap haul), fishing area, number of trap hauls, trap soak time and total weight landed.

The DFO commercial whelk sampling program has been in operation in Québec since 1987. Samples are collected dockside or at the plant to describe the size structure of landed individuals.

Commercial fishery indicators used to assess whelk by fishing area are:

- Landings in tonnes (t) of live weight;
- Fishing effort in number of trap hauls;
- Standardized catch per unit effort (CPUE) in kilograms of live weight per trap haul (kg/trap);
- Average (mm) and median size (mm) of landed whelk;
- Percentage (%) of sub-legal size whelk (< 70 mm) in landings.

Data for the current year are generally considered preliminary, because a small percentage of logbook data may not have been entered yet at the time of analysis. Data are validated annually to eliminate outliers (effort, location, etc.). Annual landings are the aggregate of all commercial fishing activities. Fishing effort has been compiled from logbooks since 2002[1]. Because the number of trap hauls per fishing activity is not always known, a correction factor is required to provide an estimate of the total number of trap hauls per area and per year. A rule of three is used to calculate this factor using the sum of landings with their known effort and total landings by area, year and month.

CPUE is calculated for each observation (departure date, location and fisherman). CPUE were standardized to account for the effect of trap soak times on catches (Gavaris 1980). The following variables were standardized (PROC MIXED, SAS version 9.3, values

[1] The 2001 effort data are partial, making it difficult to estimate total effort, but these data were used to calculate CPUE.

previously converted to natural logarithm) by fishing area: soak times (from 24 to 192 hours), month and year, because the effect of these variables is significant in all areas. The number of observations was too small in some years and areas, and these cases were not used to calculate standardized CPUE, for example, the last three years in Area 11. The confidence interval for the average annual CPUE per area is 95%.

Appendix 1 provides the number of samples from the landed commercial catch sampling program by fishing area and year for the commercial whelk fishery. Since 2004, a sample has contained about 150 measured whelks (Appendix 2). In the case of whelk, size is defined as shell height and is measured to the nearest mm (Appendix 3). Whelk size structures are aggregated by year to calculate an annual size structure by fishing area. The figures are aggregated to ensure each sample has the same weighting (does not depend on the number of individuals measured). The structures are then reduced to the number of landed whelk using a linear relationship (one relationship for all areas) between total individual weight (0.01 g) and height (0.1 mm) (values previously converted to natural logarithm). Data used to calculate the relationship were collected in 1998 from formolized individuals harvested in Fishing Areas 1 to 7, 11, 12 and 13. The relationship used is:

$$\text{Total weight} = (2.8148 \times \text{Height}) - 8.3295 (\text{R}^2 = 0.95)$$

These are the most complete data currently available to us, but an effort will be made in the coming years to calculate a relationship on live individuals from the various fishing areas.

Average annual size is calculated by fishing area for all whelk, as well as legal size whelk(≥ 70 mm) with their respective 95% confidence intervals. Size structures are presented in a bubble chart where bubble size is proportional to frequency (%) over which average size is superimposed as a histogram representing the number of whelk landed by 3 mm size class, on which the median value is added.

Baseline landings and CPUE are calculated for each fishing area for the period 2001 to 2013, and fishing effort is calculated for the period 2002 to 2013. Because the Îles-de-la-Madeleine fishery started in 2003, the baseline period for these three indicators is 2003 to 2013 for this area. Baseline sizes are calculated for the period 2004 to 2013. The rate of change between the value of the 2014 indicator and the baseline level is calculated as follows:

$$\text{Rate of change} = \frac{\text{value of 2014 - baseline level}}{\text{baseline level}} \times 100$$

In addition, the position of the annual value can be compared to the baseline level using the 95% confidence intervals. If the baseline level is included in the confidence interval of the value, the value is considered similar to the average, otherwise the value is either above or below average.

Where there are fewer than five active fishermen, landing and fishing effort values are not presented in this paper in order to keep the information confidential.

RESEARCH

A research survey has been conducted every two years in late July since 2005 in the Forestville, Pointe-aux-Outardes and Baie-Comeau areas along the Upper North Shore and in Fishing Areas 1 and 2 (Figure 1). The surveys are conducted with a Digby scallop dredge and its four baskets are lined with 19 mm Vexar™ netting. A fixed-station sampling design was used to cover the three areas, at depths ranging from 8 m to 30 m (Appendix 4

and Table 1). The 11 stations of the 2005 Forestville survey, conducted using only a beam trawl, were not used in the various calculations. In 2007, seven stations were added to the sampling design in Pointe-aux-Outardes to better cover the area. During dredging, start and end positions are noted to calculate the distance travelled for each station. The area covered at each station is the product of basket width (4 x 0.76 m) and distance.

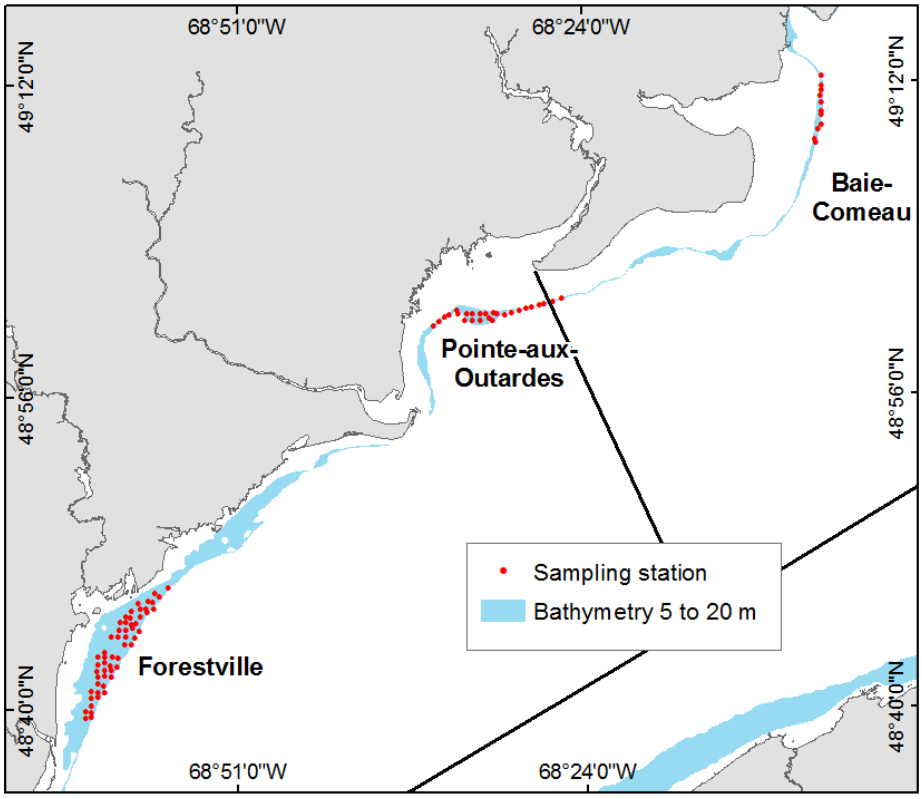

Figure 1. Location of sampling stations for the whelk research survey in Forestville, Pointe-aux-Outardes and Baie-Comeau along the Upper North Shore.

All whelks and whelk eggs masses harvested were retained for further analysis. All whelks were identified by species (except 2007) and counted. Whelk height was measured to the nearest mm using a vernier caliper.

A stratified subsample (2 whelks per mm of height) was stored by area, species and year for morphometric analysis. Individuals were kept frozen until they were tested in the laboratory. A sequential number was assigned to each individual. The height (0.1 mm), width and minimum width (Appendix 3) as well as live weight (0.01 g) and sex of each individual were measured. The operculum was retained for age readings.

Egg masses were collected to estimate a whelk reproduction index in each area. In 2005, egg masses were counted at each station (Table 1). In 2007, data on total weight per station were collected. Finally, since 2009, egg masses have been counted, individual weights measured and the number of capsules estimated on a few egg masses.

Table 1. Characteristics of the stations for each whelk research survey conducted from 2005 to 2013 along the Upper North Shore.

Variable	2005	2007	2009	2011	2013
Period (day/month)	24/07 to 30/07	23/07 to 01/08	17/07 to 28/07	26/07 to 02/08	22/07 to 02/08
Number of stations (dredge)	74 [1]	92 [2]	92 [2]	92 [2]	92 [2]
Duration of the stations (minutes)	6 à 9	8 à 10	5	5	4 à 5
Average station distance (m)	475	650	320	320	311
Egg mass count	X		X	X	X
Egg mass weight		X [3]	X [4]	X [4]	X [4]
Identification of *Buccinum*	X		X	X	X
Identification of associated species [5]	X	X	X	X	X

[1] 44 stations in Forestville, 19 stations in Pointe-aux-Outardes and 11 stations in Baie-Comeau.
[2] 55 stations in Forestville, 26 stations in Pointe-aux-Outardes and 11 stations in Baie-Comeau.
[3] Total weight per station.
[4] Weight per egg mass.
[5] Information collected, but not presented in this paper.

Due to the size of the mesh used to line dredge baskets, whelk less than 20 mm were not included in density and yield calculations. Whelk were divided into two size classes: sub-legal size individuals from 20 mm to 69 mm and legal size individuals ≥ 70 mm. The weight-height relationship, estimated from measurements of individuals in the stored subsample, was used to calculate the weight of each individual harvested (Appendix 5). Density (number/100 m^2) and yield (g/100 m^2) were calculated at each station for each size class by *Buccinum* species and for egg masses. Given that the commercial fishery includes all *Buccinum*, regardless of species, annual density and yield averages (± 95% confidence interval) were calculated for each area for all whelk species. A nonparametric test (Kruskal-Wallis test) was used to compare annual density results by area, with a 0.05 significance level. The Tukey test was used for post hoc comparisons. Size structure histograms are presented in number of individuals per 100 m^2.

Sex-ratio, parasitism and imposex

In 2013, the sex ratio and rate of parasitism and imposex (masculinization of female individuals) in *Buccinum undatum* were estimated. Individuals were collected during the Upper North Shore whelk survey (Forestville, Pointe-aux-Outardes and Baie-Comeau areas) and the Îles-de-la-Madeleine scallop survey from August 24 to 28, 2013 (locations of the Îles-de-la-Madeleine survey stations are provided in Appendix 6).

Only whelk whose size (shell height) was ≥ 35 mm were used for these analyses. The gonads of a total of 7,220 whelk from Forestville, 1,537 from Pointe-aux-Outardes, 3,286 from Baie-Comeau and 245 from the Îles-de-la-Madeleine underwent macroscopic examination to determine the sex ratio and parasitism rate (Tétreault et al. 2000). Only females were used to verify the prevalence of masculinization, characterized by the presence of a rudimentary penis in individuals with a capsule gland (Gibbs 1999).

Sexual maturity

The number of *Buccinum undatum* used to calculate the size at which 50% of individuals were sexually mature (T_{50}) varied by gender and method used (Table 2). Individuals were

collected during the 2013 Upper North Shore whelk and Îles-de-la-Madeleine scallop surveys. Unparasitized individuals and non-masculinized female individuals ≥ 40 mm were used. The male maturity index is the penis length to shell height ratio. Sexual maturity is reached when the index is greater than 0.5 (Gendron 1992).

Table 2. Number of individuals used to determine sexual maturity in Buccinum undatum by sex and area in 2013.

Sex	Method	Forestville	Pointe-aux-Outardes	Baie-Comeau	Îles-de-la-Madeleine
Male	Penis length	130	102	87	29
Female	Conventional	45	47	48	0
	Macroscopic	88	87	94	51

Two methods were used to determine female sexual maturity. The conventional method is based on the relationship between gonad weight and somatic weight (Brulotte 2012). A 6% threshold was used to determine sexual maturity. The macroscopic method consisted of a visual examination of the gonad based on four maturation stages (Elhasni et al. 2010):

Stage 0 = no visible gonad;
Stage 1 = incipient gonadal development characterized by a thin layer around the digestive gland;
Stage 2 = gonads are well developed, but cover less than one third of the digestive gland;
Stage 3 = gonads cover more than one third of the digestive gland.

In this method, females in stage 3 gonadal development were considered mature. The method used to determine the T_{50} is the same as Gendron's (1992). An average T_{50} obtained with both methods was calculated for the Upper North Shore, and the estimated T_{50} provided by the macroscopic method was used for the Îles-de-la-Madeleine (the only method available). Finally, an average T_{50} by sex from Forestville and Pointe-aux-Outardes was calculated determine the T_{50} in Fishing Area 1. Because the Îles-de-la-Madeleine T_{50} that Gendron (1992) estimated in 1989 was derived from whelk harvested in Bay of Plaisance and does not correspond to the current fishing area, only the 2013 T_{50} is presented. However, it should be noted that size at sexual maturity is usually determined using individuals harvested in the spring before spawning. In 2013, all whelk used to determine the T_{50} were harvested in July and August, a few weeks after spawning, which may have affected results.

Determination of age

Age readings were made on *Buccinum undatum* collected during the 2013 Upper North Shore whelk and Îles-de-la-Madeleine scallop surveys. Whelk age can be determined by counting the growth rings on the operculum (Boivin et al. 1985, Gendron 1992). However, care must be taken because whelks can lose their operculum and the operculum can regenerate. First, the operculum must be removed and cleaned. The internal face (attached to the foot) of the operculum is then stained with a 0.2% methylene blue solution. The rings are counted on transparent slides using a binocular microscope.

The von Bertalanffy growth curve (Ricker 1980) is used. It is based on shell height versus age, using the following equation:

$$L_t = L_\infty(1 - e^{-K(t-t_0)})$$

Where: L_t = shell height (mm) at age t
L_∞ = shell height (mm) at infinity (maximum asymptotic size)
K = Brody growth coefficient
t = whelk age (number of growth rings)
t_0 = theoretical age when height equals 0 mm

Two curves were calculated, one for the Upper North Shore (all three areas) and one for the Îles-de-la-Madeleine.

BIOLOGY

The Waved Whelk, *Buccinum undatum*, is a gastropod mollusc found along the western Atlantic coast from New Jersey to Labrador, including the Estuary and Gulf of St. Lawrence (Bousfield 1964). It is very common in cold waters, from the tidal level to depths of 30 m or more (Figure 2). Whelk is an opportunistic carnivorous predator and a carrion feeder (Himmelman and Hamel 1993). It feeds mostly on invertebrates, primarily Polychaeta, Molluscs and Echinodermata (Hamel 1989, Fahy 2001, Morel and Bossy 2004). Whelk detect their prey through waterborne odours, making it vulnerable to baited fishing gear. Whelk's ability to detect prey is therefore highly influenced by current strength and direction. When food or predators are present, whelk can move at a rate of 2 to 15 cm/min over a distance of several tens of metres (Himmelman 1988, Sainte-Marie 1991, Lapointe and Sainte-Marie 1992, Giguère et al. 2007).

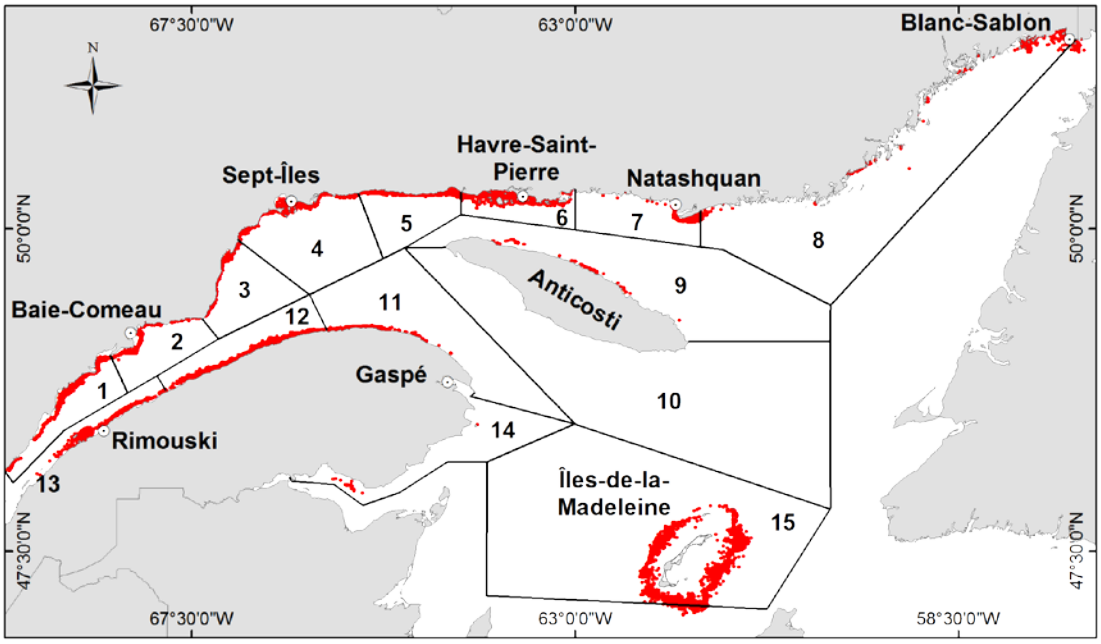

Figure 2. 2014 whelk fishing areas and known <u>Buccinum undatum</u> distribution in the Estuary and Gulf of St. Lawrence (source: logbooks, commercial sampling program, research surveys and exploratory fisheries).

In the St. Lawrence, whelk growth is slow (Jalbert et al. 1989, Gendron 1992). It can reach a 120–130 mm shell height size. According to the literature, its longevity is estimated to be 11–15 years (Jalbert 1986, Gunnarsson and Einarsson 1995, Kenchington and Glass 1998). Based on information collected in tanks, whelk growth varies with the individual's initial size. The annual increase in shell height is higher, nearly 9 mm, in whelk less than

50 mm and gradually declines to about 2 mm in individuals over 70 mm (Brulotte 2012). According to the calculated growth curve for the Upper North Shore, maximum size is 101 mm, and in the Îles-de-la-Madeleine it is 119 mm (Figures 3 and 4). In both cases, minimum legal size should be reached at about 6 years.

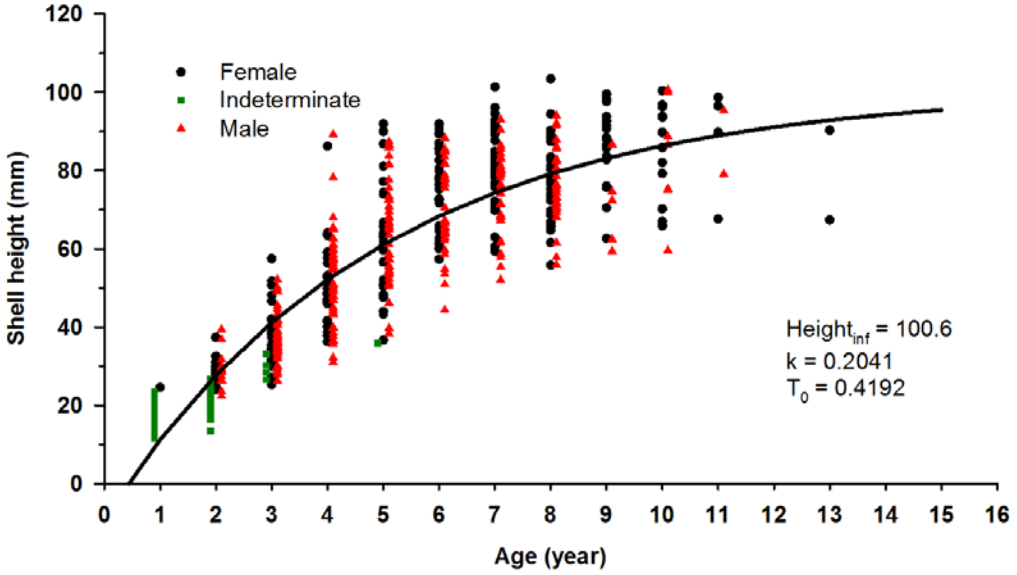

Figure 3. The von Bertalanffy growth curve for Buccinum undatum along the Upper North Shore (all three areas combined) in 2013.

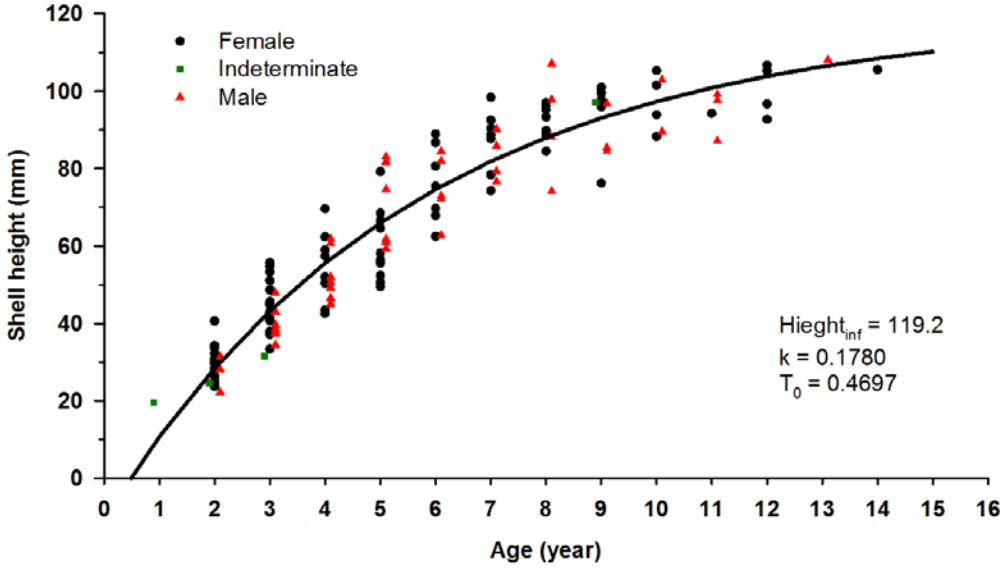

Figure 4. The von Bertalanffy growth curve for Buccinum undatum in the Îles-de-la-Madeleine in 2013.

The sexes are separate in whelk. According to data collected in 2013 at three sites along the Upper North Shore (Areas 1 and 2) and the Îles-de-la-Madeleine, the sex ratio varies with whelk size and site. In Forestville, Pointe-aux-Outardes and the Îles-de-la-Madeleine, the sex ratio is quite balanced in whelk from 35 mm to 89 mm, but is skewed to females in individuals ≥ 90 mm, a group in which 70% and 85% of individuals are female (Table 3). However, in Baie-Comeau, the sex ratio is somewhat skewed to males in individuals less

than 70 mm, with only 39.5% females. The proportion of females increases to 80% in whelk ≥ 85 mm.

Table 3. Sex ratio (% of females) by size class in Buccinum undatum by site in 2013.

Size Class	Forestville	Pointe-aux-Outardes	Baie-Comeau	Îles-de-la-Madeleine
35–69 mm			39.5	
70–84 mm			63.2	
85 mm and +			79.6	
35–89 mm	42.8	49.4	52.1	55.1
90 mm and +	66.2	78.4	84.9	70.5

A parasite, probably cecaria of the trematode *Neophasis* sp., infests the digestive gland and gonads of *Buccinum undatum*. The parasite should be accurately identified using histological sections of tissue taken from parasitized individuals. Severely infected individuals may have decreased reproductive capacity. According to Tétreault et al. (2000) this trematode also stops penis growth or can even cause penis resorption in males. In the four sites surveyed in 2013, the rate of parasitism was relatively high in whelk ≥ 80 mm with values ranging between 34% and 46% except in Baie-Comeau (Area 2) where it was 4% (Table 4).

Table 4. Rate of parasitism (%) by size class in Buccinum undatum by site in 2013.

Size Class	Forestville	Pointe-aux-Outardes	Baie-Comeau	Îles-de-la-Madeleine
35–79 mm	3.8	2.4	0.1	9.9
80–89 mm	12.9	10.2	0	9.1
90 mm and +	46.3	34.0	3.8	45.7

Another problem detected in *Buccinum undatum* females inventoried in 2013 was imposex or masculinization caused by contamination with chemicals such as tributyltin (TBT), a compound formerly used in anti-fouling paints on boats, but banned since 2008 (Viglino et al. 2006). This contamination has various effects including the appearance of male characteristics in females, such as the penis and vas deferens. In severe cases, females can no longer lay eggs. In 2013, there were no cases reported in females less than 70 mm (Table 5). The proportion of females affected increases with size, with 9% to 16% females ≥ 90 mm showing signs of imposex. All females showed only early stages of imposex, i.e. penises less than 5 mm in length and no vas deferens.

Table 5. Imposex in females (%) by size class in Buccinum undatum by site in 2013.

Size Class	Forestville	Pointe-aux-Outardes	Baie-Comeau	Îles-de-la-Madeleine
35–69 mm	0	0	0	0
70–79 mm	5.1	4.7	12.8	0
80–89 mm	9.3	6.4	14.4	0
90 mm and +	16.1	10.9	11.9	8.8
70 mm +	7.0	6.0	13.1	5.7

According to 1989 (Gendron 1992), 1998 (Brulotte 2012) and 2013 data (C. Couillard, Maurice-Lamontagne Institute, Mont-Joli, unpublished data), average size at sexual maturity varies with sex and geographic location. It is generally greater in females than males (Figure 5). It ranges from 58 mm to 80 mm in males and 65 mm to 80 mm in females. The average for all areas studied was 68.8 mm in males and 72.6 mm in females.

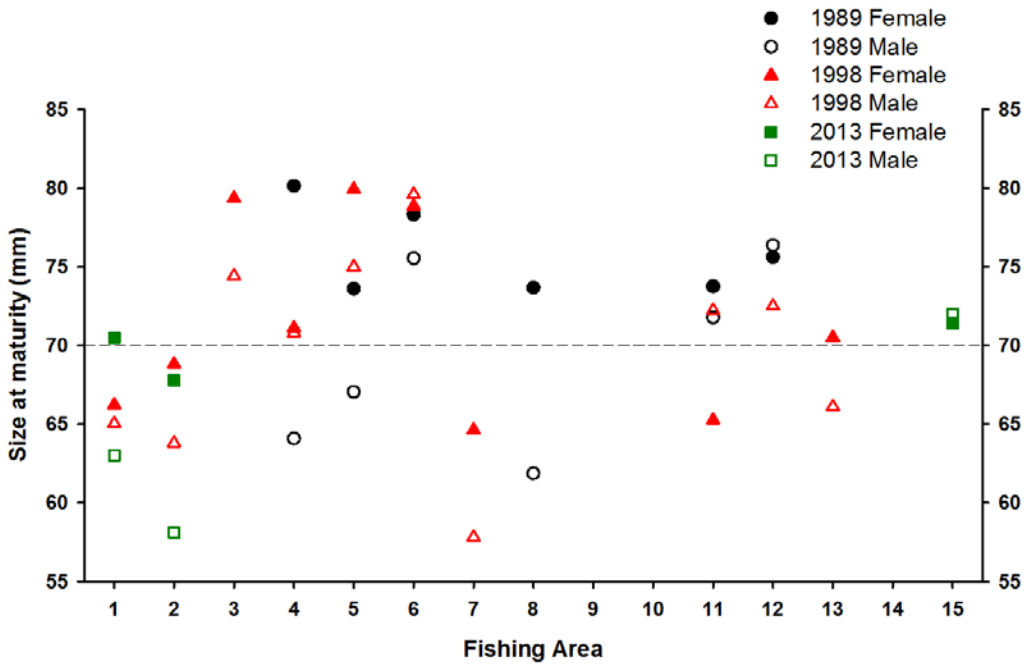

Figure 5. Average size at which 50% of Buccinum undatum were sexually mature by sex and fishing area in 1989 (Gendron 1992), 1998 (Brulotte 2012) and 2013 (C. Couillard, Maurice-Lamontagne Institute, Mont-Joli, unpublished data). The horizontal line represents the 70 mm minimum legal size.

In this gastropod, the ova are fertilized internally. Along the North Shore and the Gaspé, mating occurs in May and June (Boivin et al. 1985, Martel et al. 1986a, Himmelman and Hamel 1993). Eggs are laid two to three weeks after mating, mostly in June and July. They are enclosed in chitin capsules clumped together in a mass several centimetres wide attached to the substrate. Several females can lay their eggs on the same mass, at a rate of about 140 capsules per female (Martel 1985). Each capsule contains an average of 2,700 eggs (Martel et al. 1986b). There is no planktonic larval stage. Young whelk grow directly in the capsules. In the Estuary and northern Gulf of St. Lawrence, juveniles are 2–3 mm long when they emerge from the capsules after five to eight months of development, from November to February. About 30 juveniles can emerge from each capsule (Martel et al. 1986b).

Adults lead a rather sedentary life. They spend most of their time immobile and half buried in sediment (Hamel 1989). Evidence suggests that this behaviour, together with the absence of a larval phase, limits mixing with neighbouring populations and the possibility of rapidly recolonizing overexploited sites (Caddee et al. 1995, Nasution and Roberts 2004).

COMMERCIAL FISHERY

The commercial whelk fishery began in the 1940s in the Estuary and Gulf of St. Lawrence (D'Amours et al. 1983). With the arrival of new processors in the mid-1960s, landings ranged from 100 t to 350 t until 1985. The fishery expanded along the North Shore in the early 1990s and in the Îles-de-la-Madeleine in 2003. It has been more intensive in the Gaspé–Lower St. Lawrence area since 2005. It is a coastal trap fishery. In recent years, fishermen have mainly used conical traps with a 0.8 m to 1.2 m diameter base.

There are 15 whelk fishing areas in Québec waters (Figure 2 and Appendix 7), divided into three regions: the North Shore (Areas 1 to 9), Gaspé–Lower St. Lawrence (Areas 11 to 14) and Îles-de-la-Madeleine (Area 15). Area 10 is open to fishermen in the Gaspé–Lower St. Lawrence area and the Îles-de-la-Madeleine.

In the late 1990s, several stakeholders (industry, fishermen and managers) were concerned about the uncontrolled development of this fishery in Québec, which led to the introduction of various management measures in 1999 (Appendices 8 and 9). Since then, fishing effort has been controlled in all areas by regulating the length of the fishing season, number of licences and number and size of traps and introducing a landings quota in Areas 1, 2, 11, 12, 13 and 15.

Since 2007, the fishing season has been about six months everywhere starting in April–May and ending in October–November (Appendices 8 and 9). The total number of licences issued is controlled, but inactive fishermen sometimes outnumber active fishermen, creating a high potential effort that could become problematic in some areas. Steps have been taken to reduce the number of licences (e.g. licence buy-backs). As a result, the total number of licences has decreased from 281 in 1999 to 249 in 2014. However, there were only 69 active licences in 2014 (Appendix 9). The number of traps allocated to inactive fishermen was also reduced in 1999 and 2006 in order to decrease potential effort (Appendix 8). In 2014, the number of authorized traps varied between 50 and 175 traps per licence (Appendix 9). Some Aboriginal band councils may hold several licences. In 2014, the total number of authorized traps for all licences ranged from 550 to 6,400 traps per fishing area, while the number of traps in use or active was lower, from 50 to 1,300 traps per fishing area. (Appendix 9) In 2014, between 4% and 67% of traps were active depending on the fishing area.

Total allowable catches (TACs) are in effect in Areas 1 and 2 along the North Shore, in Areas 11, 12 and 13 of the Gaspé–Lower St. Lawrence and in Area 15 of the Îles-de-la-Madeleine (Appendices 8 and 9). They were respectively 491, 109, 32, 135, 82 and 376 t in 2014. Finally, the minimum legal size has been 70 mm in all areas since 2005 (Appendix 8).

The commercial whelk fishery focuses on the Waved Whelk. Other species of *Buccinum* (*B. glaciale*, *B. scalariforme*, *B. totteni*) inhabit the Estuary and Gulf of St. Lawrence, but in low densities.

From 1991 to 1998, annual landings ranged from 493 t to 1,032 t and were primarily from the North Shore (Figure 6 and Appendix 10). Landings subsequently peaked at 2,000 t in 2003 with the beginning of the fishery in the Îles-de-la-Madeleine. Subsequently, landings decreased mainly along the North Shore. Since 2006, landings have fluctuated between 951 t and 1,587 t. In 2014, they were 951 t, and 87% were from the North Shore, 12% from the Gaspé–Lower St. Lawrence and 2% from the Îles-de-la-Madeleine. In 2014, landings dropped 24% compared to baseline levels along the North Shore, 25% in the Gaspé–Lower St. Lawrence and 94% in the Îles-de-la-Madeleine. In most fishing areas,

2014 landings were also lower than in 2011. None of the TACs were caught in 2014. Area 10 has not been exploited since 1997, and some fishermen have been fishing in Areas 9, 11 and 14 for a few days in recent years. It is therefore impossible to comment on the status of the resource in these four areas.

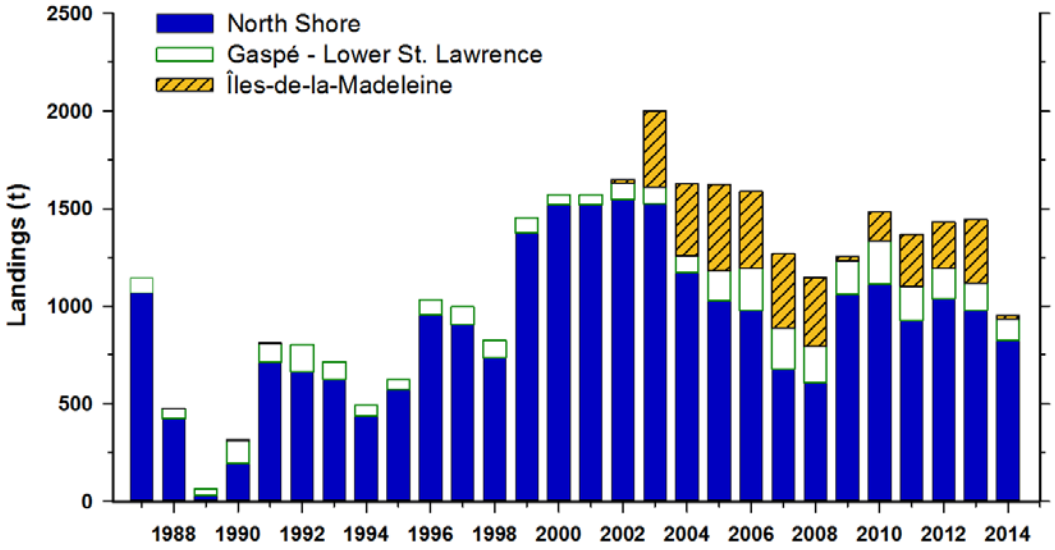

Figure 6. Commercial whelk fishery landings by area from 1987 to 2014.

Fishing effort measured in number of trap hauls for the whole fishing season has only been available since 2002 when logbooks were introduced. Changes in landings since 2002 are largely attributable to changes in fishing effort (Figure 7 and Appendix 11). Overall effort reached a maximum value of nearly 386,000 trap hauls in 2003. Effort subsequently declined to roughly 206,000 trap hauls in 2008. Effort has since ranged from 173,000 to 262,000 trap hauls per year. In 2014, there were 173,100 trap hauls, a 37% decrease in effort compared to baseline levels along the North Shore, 24% in the Gaspé–Lower St. Lawrence and 79% in the Îles-de-la-Madeleine.

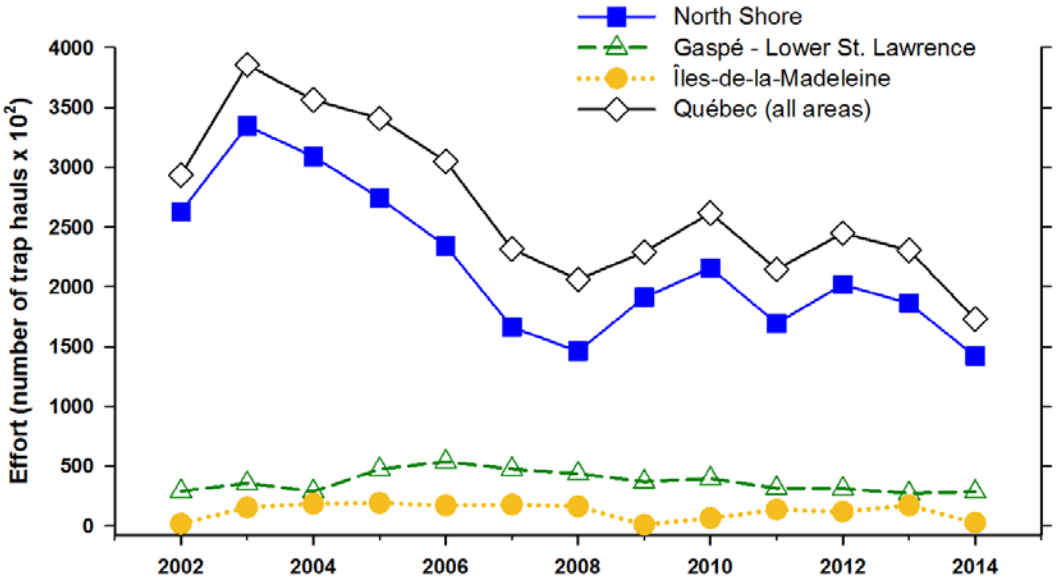

Figure 7. Commercial whelk fishing effort by area and for all of Québec from 2002 to 2014.

NORTH SHORE

Fishing Area 1

Fishing Area 1 extends from Pointe Rouge (Tadoussac) to Pointe du Bout at Pointe-aux-Outardes (Figure 8 and Appendix 7). For several years, commercial fishing has been concentrated mainly in the central-eastern portion of the area. In 2014, there were 6 active licences in this area for 750 traps out of a total of 11 licences issued and 1,300 traps authorized under current management measures (Appendix 9).

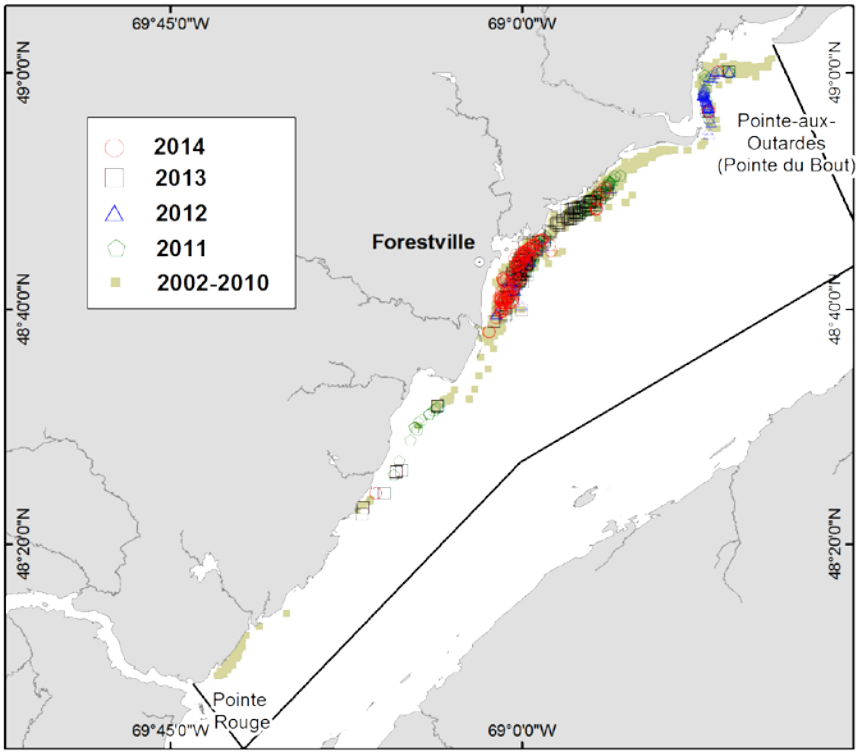

Figure 8. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 1.

Landings greater than 500 t were recorded in 2001 and 2002 (Figure 9 and Appendix 10). A preventive 491 t TAC was introduced in 2003 to limit exploitation in this area. The TAC has never been caught. Since 2004, landings have ranged from 114 t to 300 t. They were 114 t in 2012, 241 t in 2013 and 290 t in 2014. In 2014, Area 1 produced 35% of North Shore landings.

Fishing effort decreased from close to 50,700 trap hauls in 2002 to 19,500 trap hauls in 2011 (Figure 9 and Appendix 11). In the past three years, effort has ranged from 13,600 to 27,700 trap hauls. Changes in landings are largely attributable to changes in fishing effort.

From 2001 to 2004, CPUE declined from 12.7 to 6.4 kg/trap, the lowest value in the series. Subsequently, CPUE were fairly stable and ranged from 6.6 to 8.7 kg/trap until 2012 (Figure 10 and Appendix 12). 2013 and 2014 CPUE (approximately 10 kg/trap) were almost as high as 2001 and 2002 CPUE and were above 2001–2013 baseline levels.

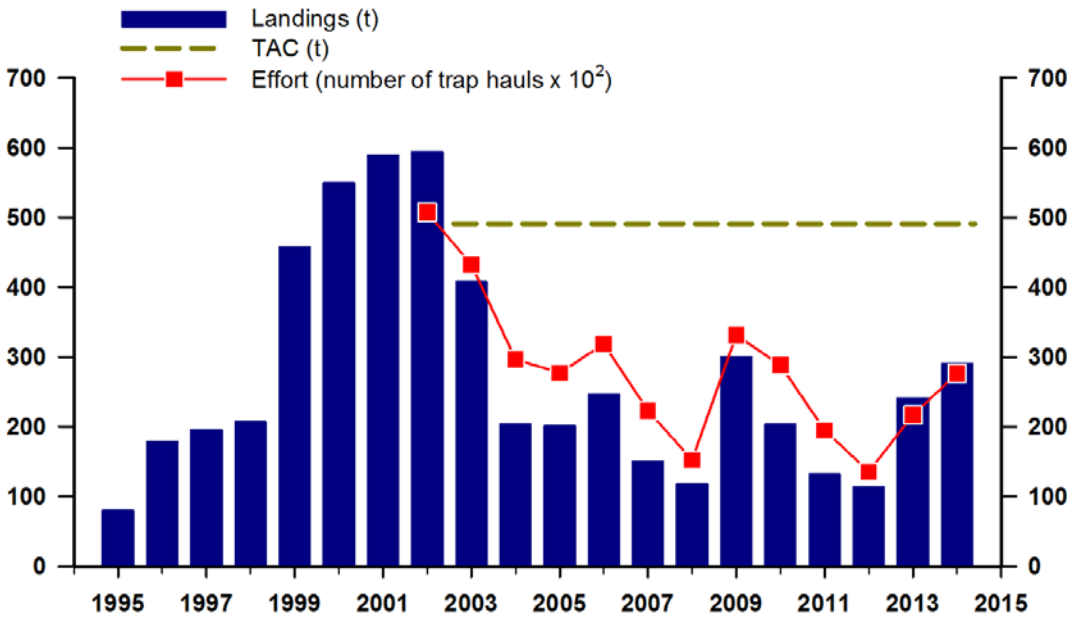

Figure 9. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2014 in Fishing Area 1.

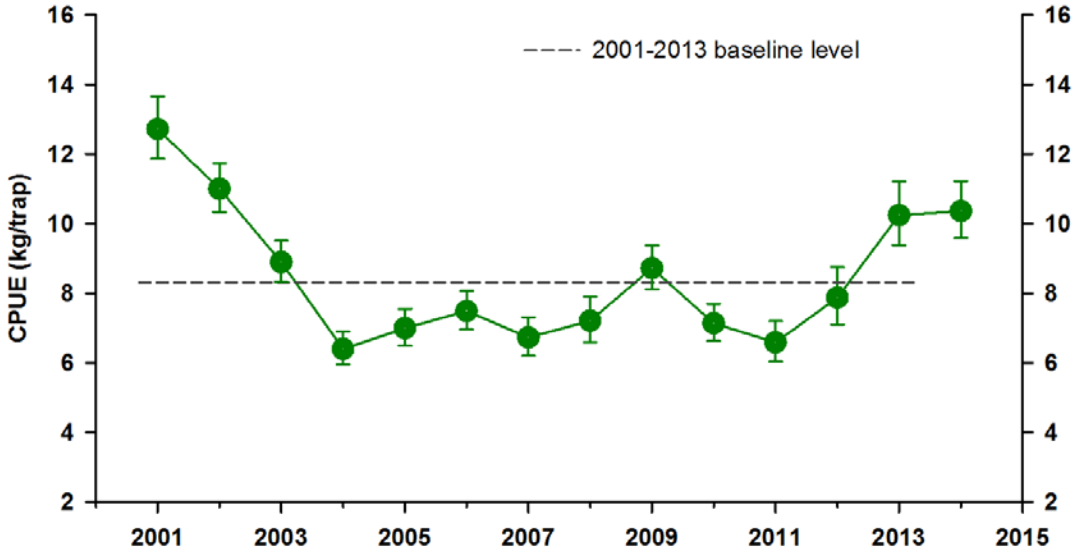

Figure 10. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 1.

Since 2007, the average size of landed whelk has been similar to or higher than 2004–2013 baseline levels (Figure 11 and Appendix 13). In 2014, the average size was 78 mm, similar to the baseline level. However, this baseline level is one of the lowest in Québec. The average size of legal size whelk at landing (≥ 70 mm) varies little from year to year (Figure 11). In the past four years, whelk landings contained between 5% and 10% sub-legal size individuals (Figure 11 and Appendix 14). Since 2006, landed whelk size structures have been very consistent from year to year (Figure 11 and Appendix 15).

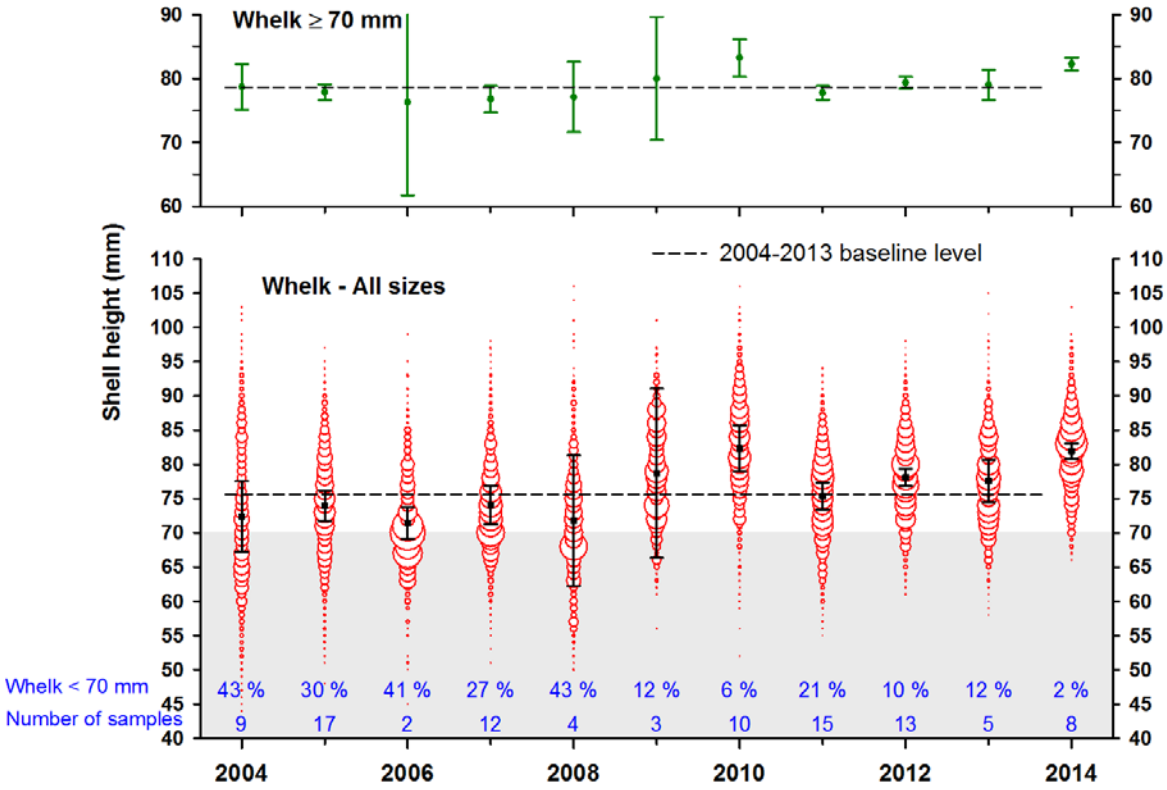

Figure 11. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 1. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

Fishing Area 2

Fishing Area 2 extends from the Pointe du Bout at Pointe-aux-Outardes to Pointe-des-Monts (Figure 12 and Appendix 7). In recent years, fishing has been concentrated in the Baie-Comeau area. Two or three licences have been active since 2007. In 2014, there were three active licences for 300 traps out of a total of 6 licences issued and 550 authorized traps (Appendix 9).

Landings from this area were quite high from 2000 to 2003 with values ranging from 119 t to 207 t (Appendix 10). Subsequently, landings decreased. A preventive 109 t TAC was introduced in 2003 to limit landings. This TAC was caught only once, in 2003. Landings and fishing effort in recent years are confidential, given the low number of active fishermen. The 2001–2013 baseline landings were 70 t, and baseline effort was 6,900 trap hauls (Appendices 10 and 11).

Since 2010, the average annual CPUE has been greater than 10 kg/trap (Figure 13 and Appendix 12). The 2001–2013 baseline level for this area was 10.4 kg/trap. The CPUE for the last three years were similar to baseline levels.

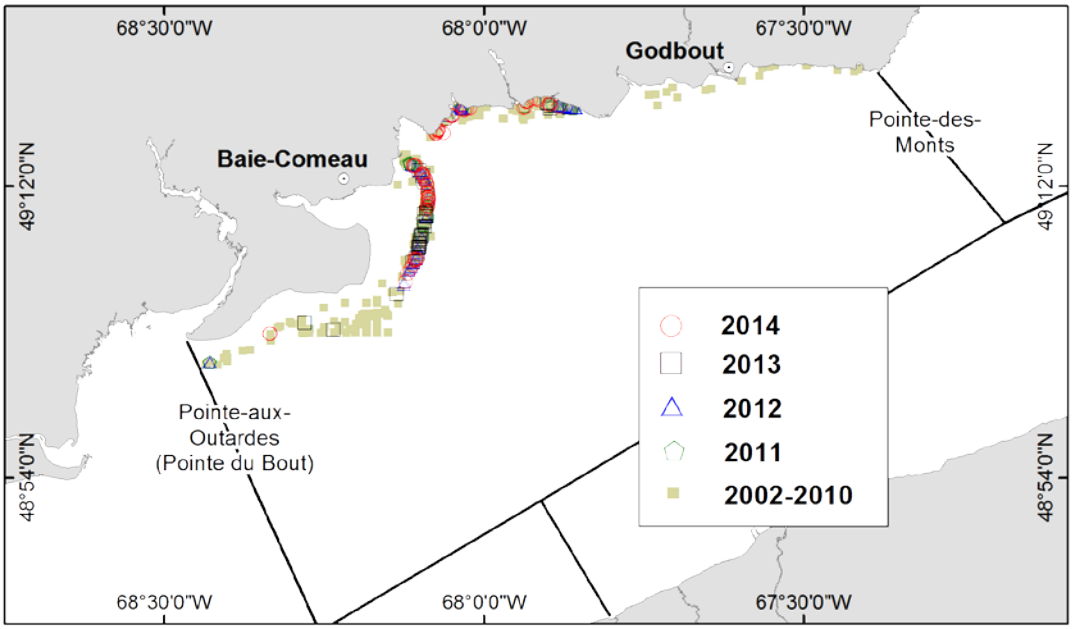

Figure 12. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 2.

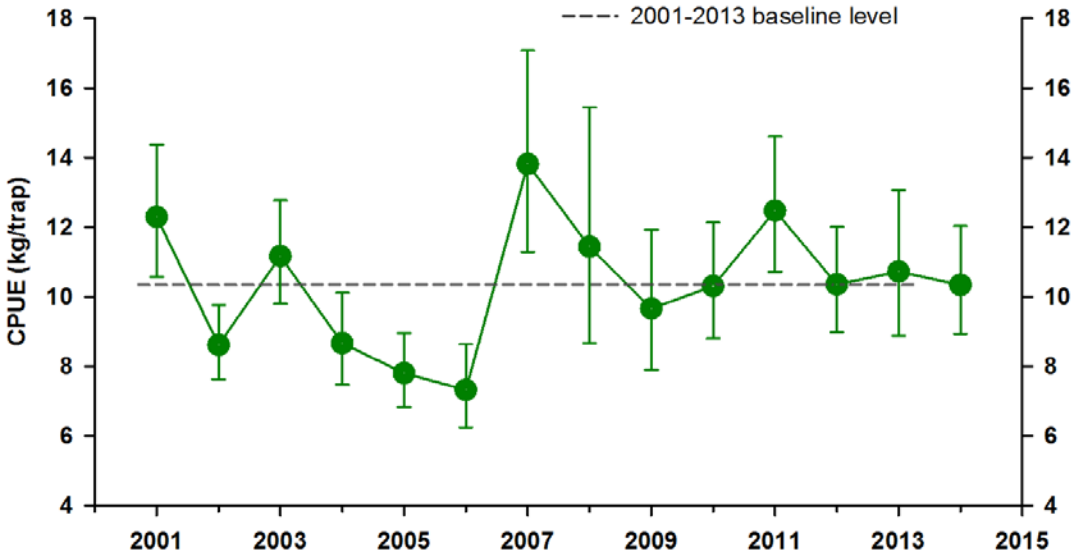

Figure 13. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 2.

Landed whelk size structures vary significantly from year to year (Figure 14 and Appendices 13 and 16). The 2004–2013 baseline size for this area was 76 mm. This was one of the lowest values in Québec. The number of samples taken to measure landed whelk was low in 2006, 2008 and 2009, which accounts for the high variability in average size, mainly in 2008 and 2009. The percentage of sub-legal size whelk in landings is often over 20%, except in the last three years (Figure 14 and Appendix 14). Size structures show variations in average and median sizes caused by the quantity of landed sub-legal size whelk.

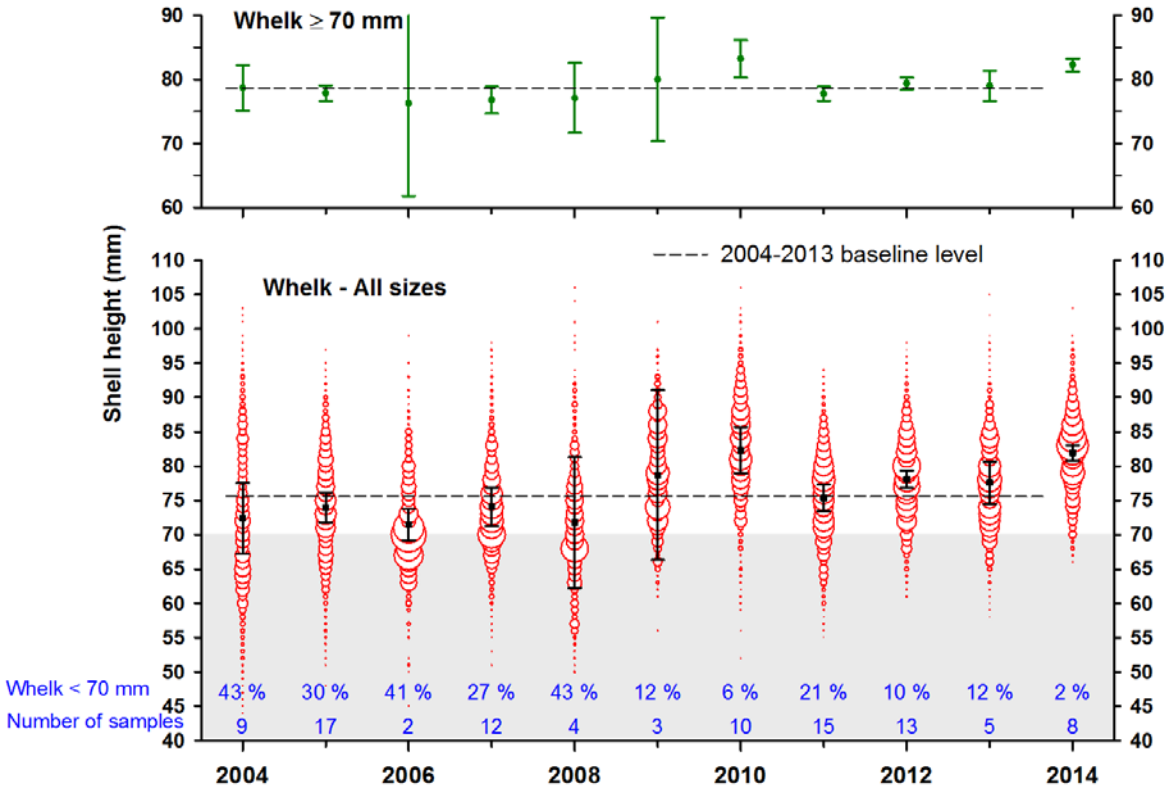

Figure 14. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 2. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

Fishing Area 3

The boundaries of Fishing Area 3 extend from Pointe-des-Monts in the west to Pointe Jambon in the east (Figure 15 and Appendix 7). The areas near Baie-Trinité and east of Rivière-Pentecôte have been the most visited since 2012. The number of active fishermen is usually low. In 2014, there were 3 active licences for 350 traps out of a total of seven licences issued and 850 authorized traps (Appendix 9).

Landings peaked at 52 t in 2001 (Appendix 10). Landings and fishing effort have been confidential since 2008, given the low number of active fishermen. The 2001–2013 baseline landings were 22 t, and the baseline fishing effort was 3,600 trap hauls (Appendices 10 and 11).

Average CPUE have been somewhat variable since 2009, but were below 2001–2013 4.8 kg/trap baseline levels in 2009, 2011, 2013 and 2014 (Figure 16 and Appendix 12). The 2014 value is among the lowest in the series.

In this area, landed whelk sampling is sporadic. The most recent sampling campaign was in 2012 and the average size was 92 mm with less than 1% sub-legal size whelk in landings (Appendices 12, 14 and 17).

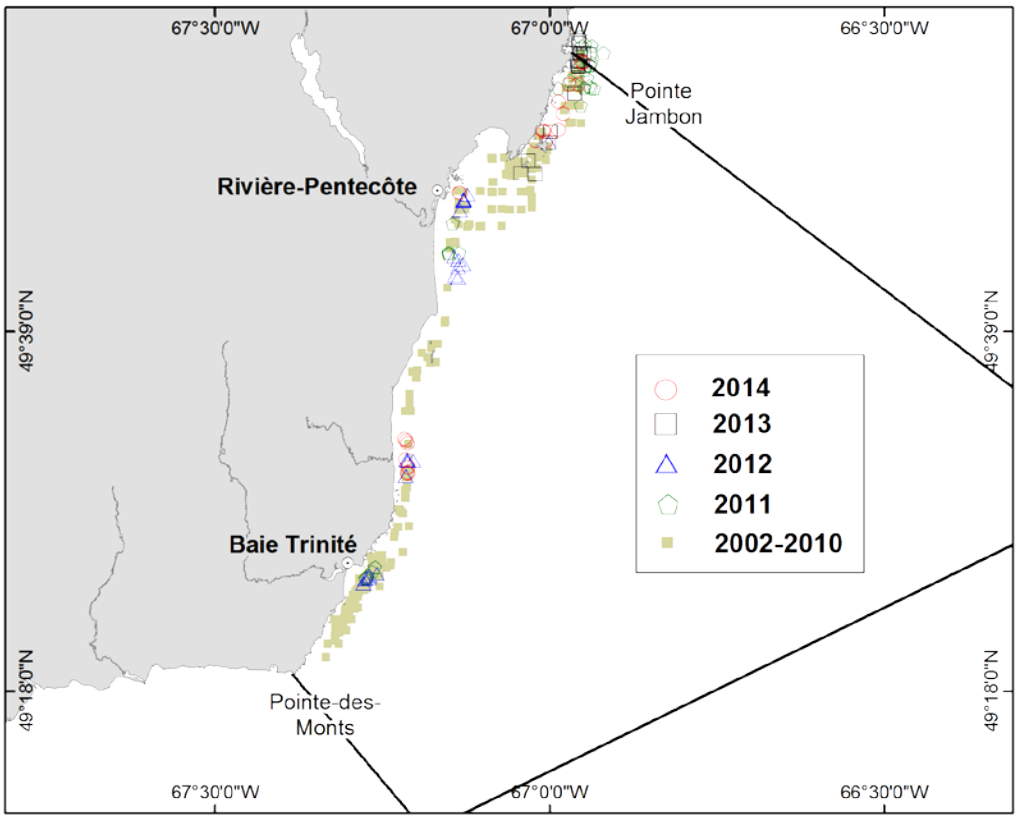

Figure 15. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 3.

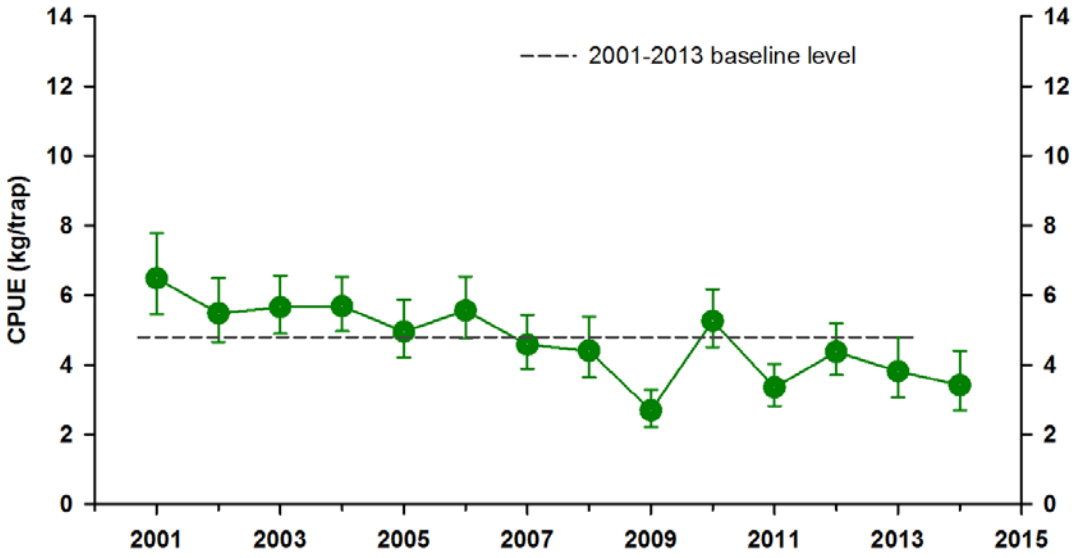

Figure 16. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 3.

Fishing Area 4

Fishing Area 4 extends from Pointe Jambon to Cap du Cormoran (Rivière-au-Tonnerre) (Figure 17 and Appendix 7). In recent years, the commercial fishery has covered the

central portion of the area in the Sept-Îles sector fairly well. In 2014, there were 6 active licences for 700 traps out of a total of 28 licences issued and 2,559 authorized traps (Appendix 9).

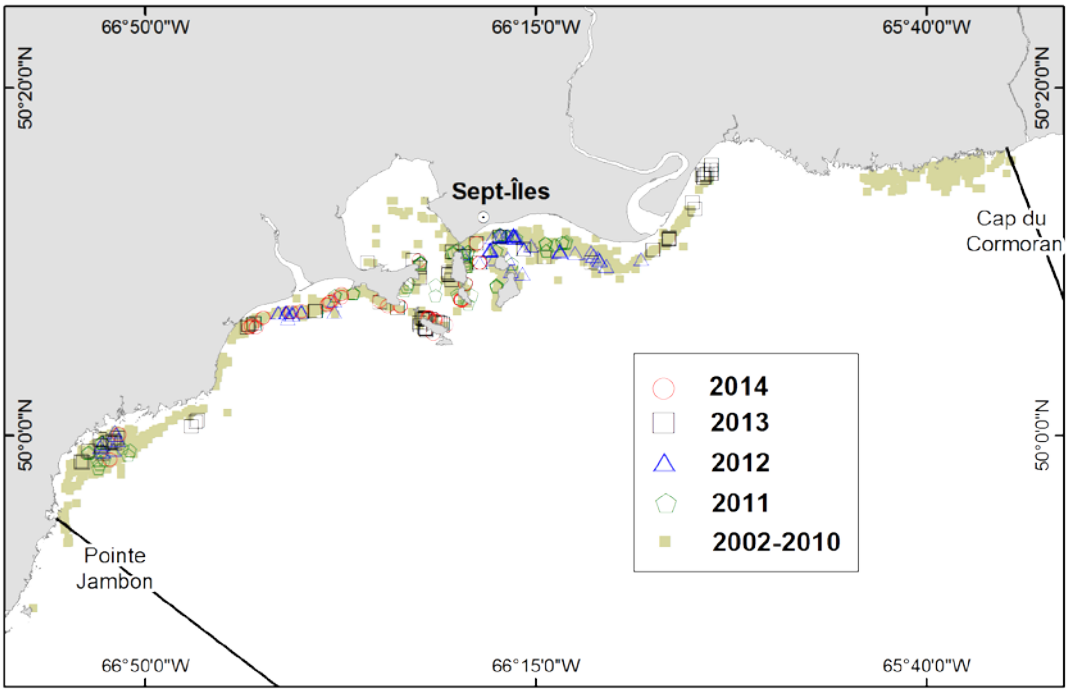

Figure 17. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 4.

From 2001 to 2004, landings exceeded 142 t and declined thereafter (Figure 18 and Appendix 10). Since 2008, annual landings have remained between 40 t and 82 t. In 2014, the 41 t landed from this area accounted for 5% of North Shore landings.

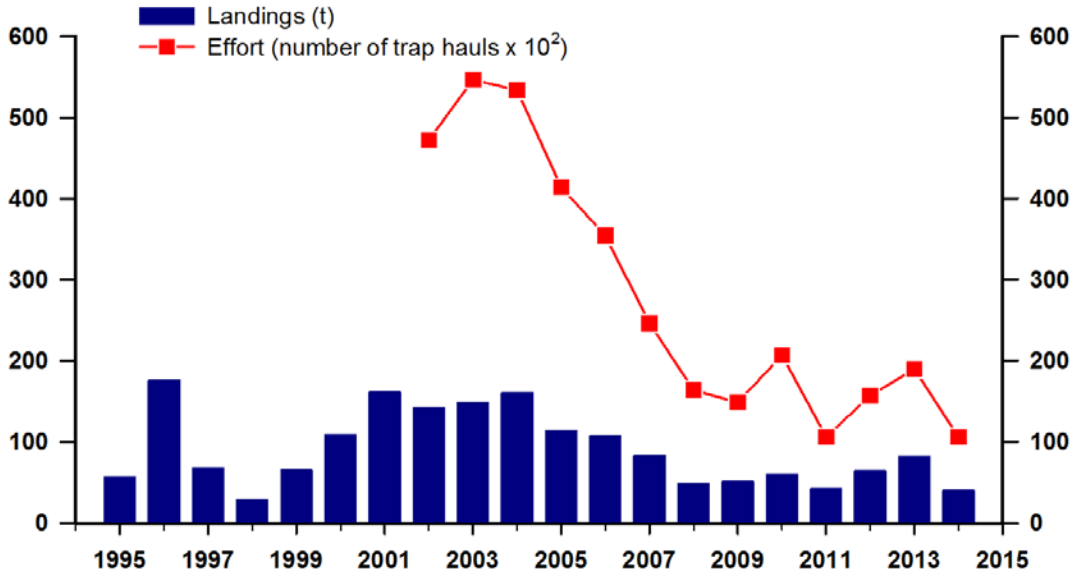

Figure 18. Whelk landings and fishing effort from 1995 to 2014 in Fishing Area 4.

Fishing effort peaked in 2003 and 2004 with over 50,000 trap hauls (Figure 18 and Appendix 11). Subsequently, fishing effort decreased. There were 15,700, 19,000 and 10,600 trap hauls in 2012, 2013 and 2014.

CPUE were fairly stable from 2002 to 2010 at around 3 kg/trap (Figure 19 and Appendix 12). Since 2012, CPUE have been above the 2001–2013 3.5 kg/trap baseline level. In 2014, the CPUE was 4.0 kg/trap.

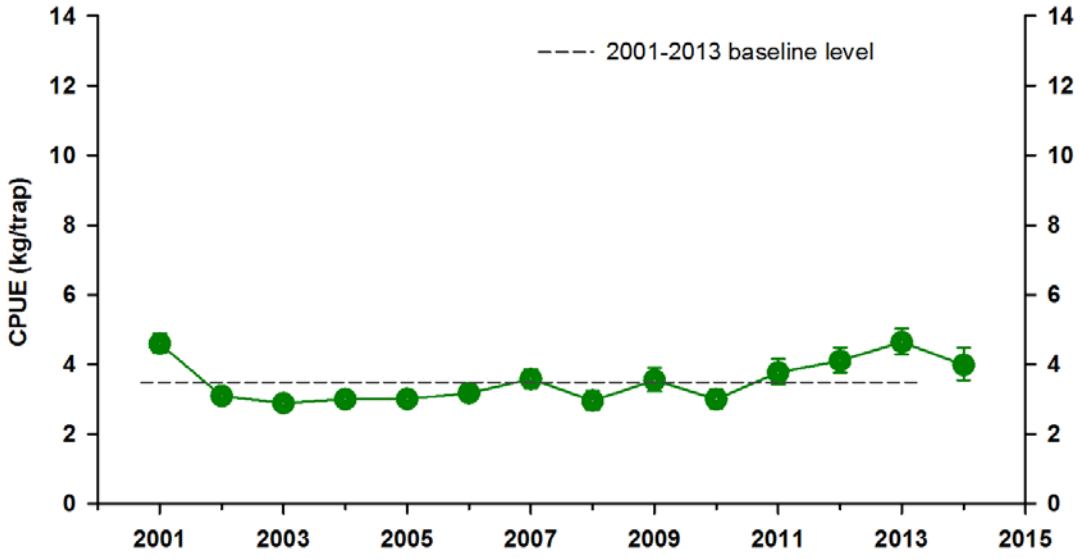

Figure 19. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 4.

The average size of landed whelk increased to 95 mm between 2010 and 2014 (Figure 20 and Appendix 13). From 2012 to 2014, the average size of legal size whelk was above 2004–2013 baseline levels (Figure 20). In the last three years, sub-legal size whelk accounted for less than 1% of landings (Figure 20 and Appendix 14). Size structures are varied with maximum sizes occasionally reaching 120 mm (Figure 20 and Appendix 18).

Fishing Area 5

Fishing Area 5 extends from Cap du Cormoran (Rivière-au-Tonnerre) to Rivière Saint-Jean (Figure 21 and Appendix 7). The fishing effort covers most of the area. In 2014, there were 4 active licences for 550 traps out of a total of 20 licences issued and 1,900 authorized traps (Appendix 9).

Landings peaked at 493 t in 1999 (Figure 22 and Appendix 10). From 2003 to 2008, they increased from 385 t to 146 t. Subsequently, landings ranged from 250 t to 409 t. 2014 landings and fishing effort in this area are confidential given the low number of active fishermen.

Since 2002, changes in landings have been largely attributable to changes in fishing effort (Figure 22). Effort peaked in 2003 and 2004 with over 100,000 trap hauls and remained between 40,900 and 85,400 trap hauls until 2013 (Appendix 11).

From 2004 to 2008, CPUE were low, below 4 kg/trap, and then increased to 6.4 kg/trap in 2011. CPUE for 2013 and 2014 were 4.4 and 4.1 kg/trap, similar to 2001–2013 baseline levels (Figure 23 and Appendix 12).

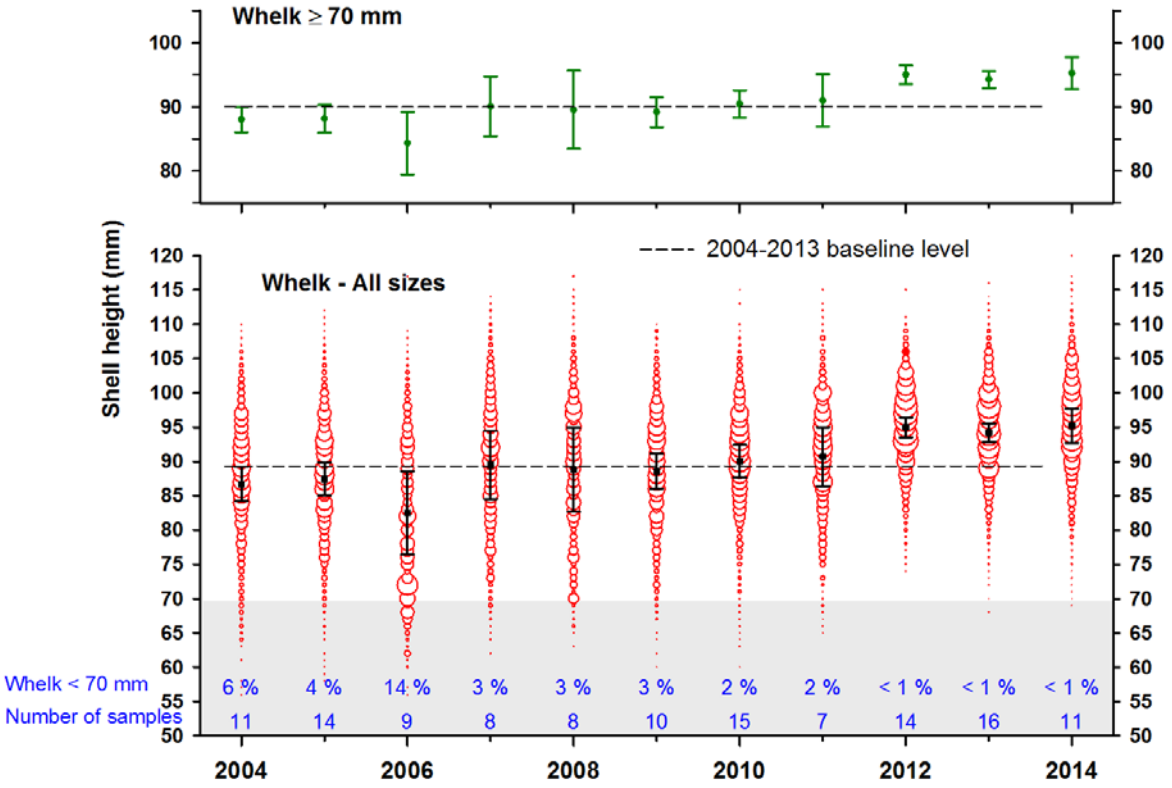

Figure 20. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 4. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

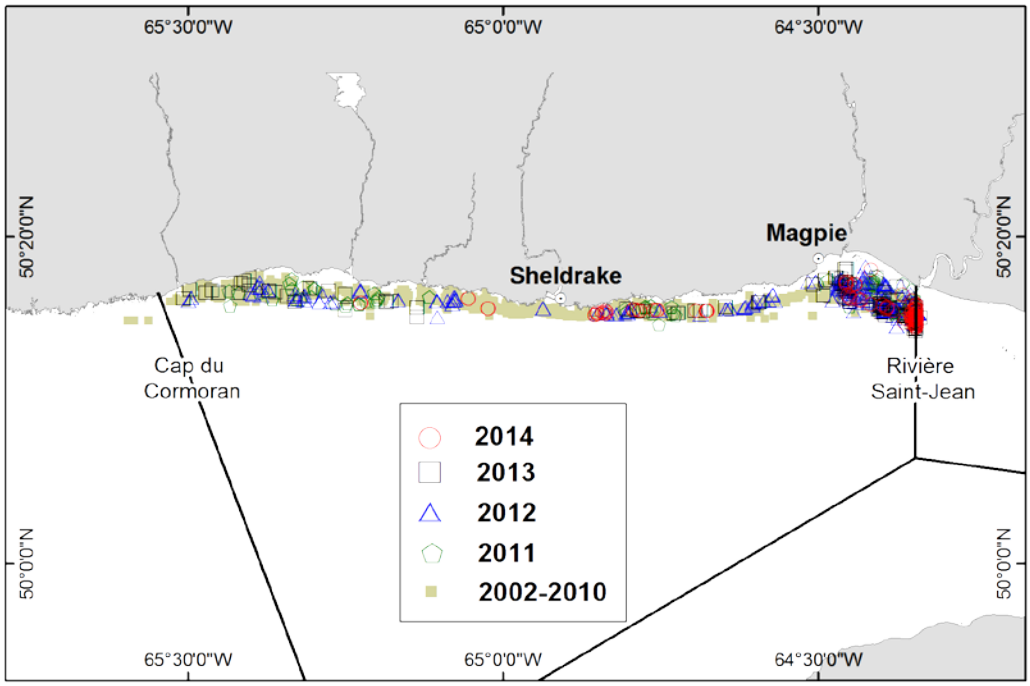

Figure 21. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 5.

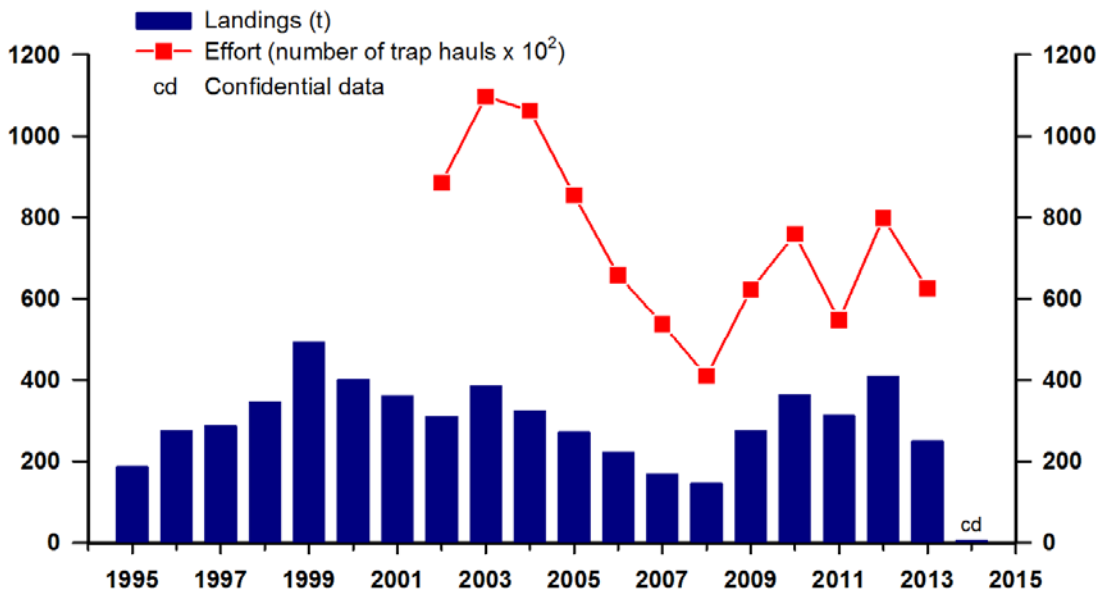

Figure 22. Whelk landings and fishing effort from 1995 to 2014 in Fishing Area 5.

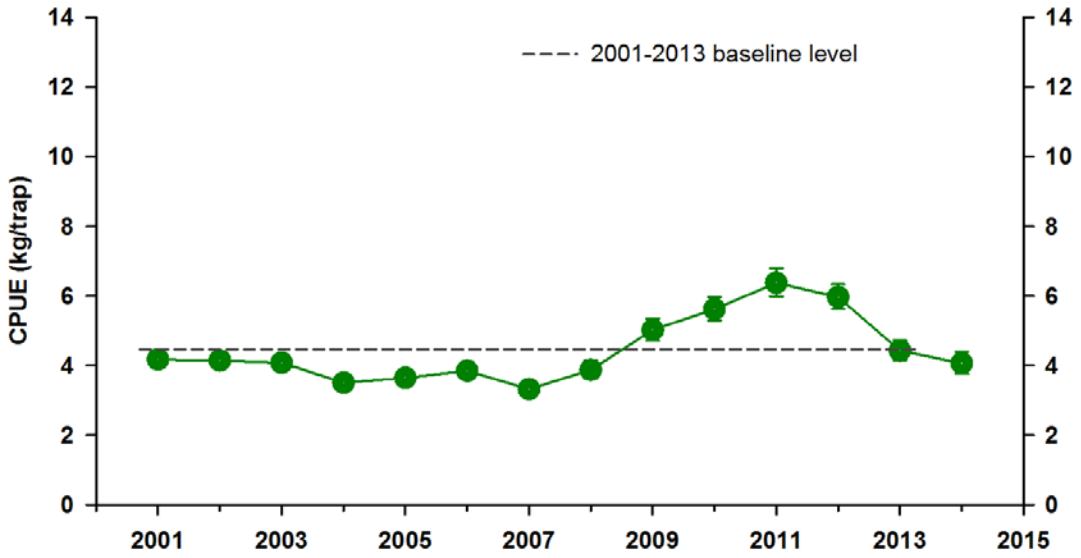

Figure 23. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 5.

The average size of landed whelk has been above 84 mm since 2007 (Figure 24 and Appendix 13). In 2014, it was 88 mm. The percentage of sub-legal size whelk in landings has remained below 5% since 2008, which is reflected in size structures and average and median sizes (Figure 24 and Appendices 14 and 19). There is little difference between the average size of landed whelk and that of legal size whelk, given the small percentage of sub-legal size whelk in landings.

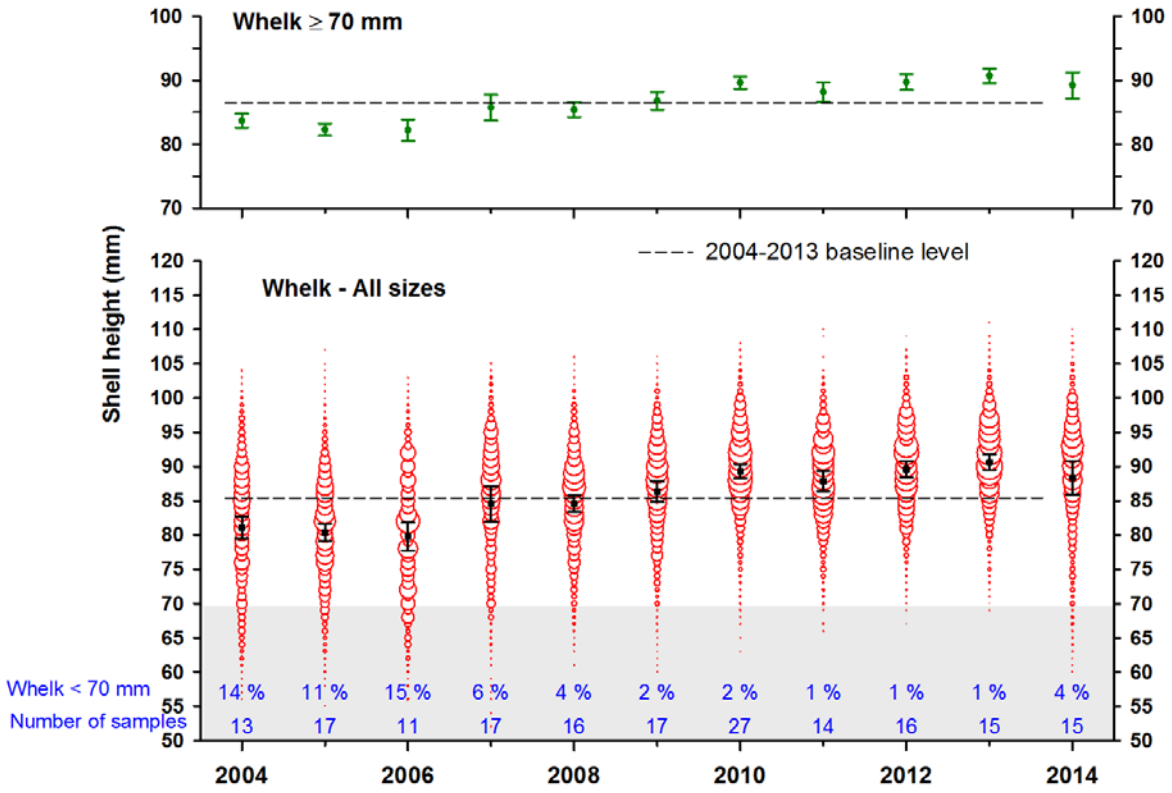

Figure 24. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 5. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

Fishing Area 6

The boundaries of Area 6 extend from Rivière Saint-Jean in the west to baie de la Grande Hermine in the east (Figure 25 and Appendix 7). Commercial fishing covers almost the entire area except the far eastern portion. In 2014, there were 9 active licences for 850 traps out of a total of 15 licences issued and 1,300 authorized traps (Appendix 9).

Between 2001 and 2008, landings ranged from 152 t to 282 t (Figure 26 and Appendix 10). The highest landings were recorded from 2009 to 2011 at over 300 t. From 2012 to 2014, they ranged from 270 t to 296 t. In 2014, Area 6 accounted for 33% of North Shore landings.

The largest fishing effort occurred in 2003, 2004 and 2005, with over 71,000 trap hauls (Figure 26 and Appendix 11). Subsequently, effort remained stable between 47,000 and 67,500 trap hauls annually. In 2014, fishing effort was 55,300 trap hauls.

Between 2004 and 2007, CPUE was below the 2001–2013 baseline level (Figure 27 and Appendix 12). In 2009, CPUE peaked at 5.6 kg/trap and remained above average in 2010 and 2011. From 2012 to 2014, CPUE have been stable near baseline levels. The 2014 figure was 4.7 kg/trap.

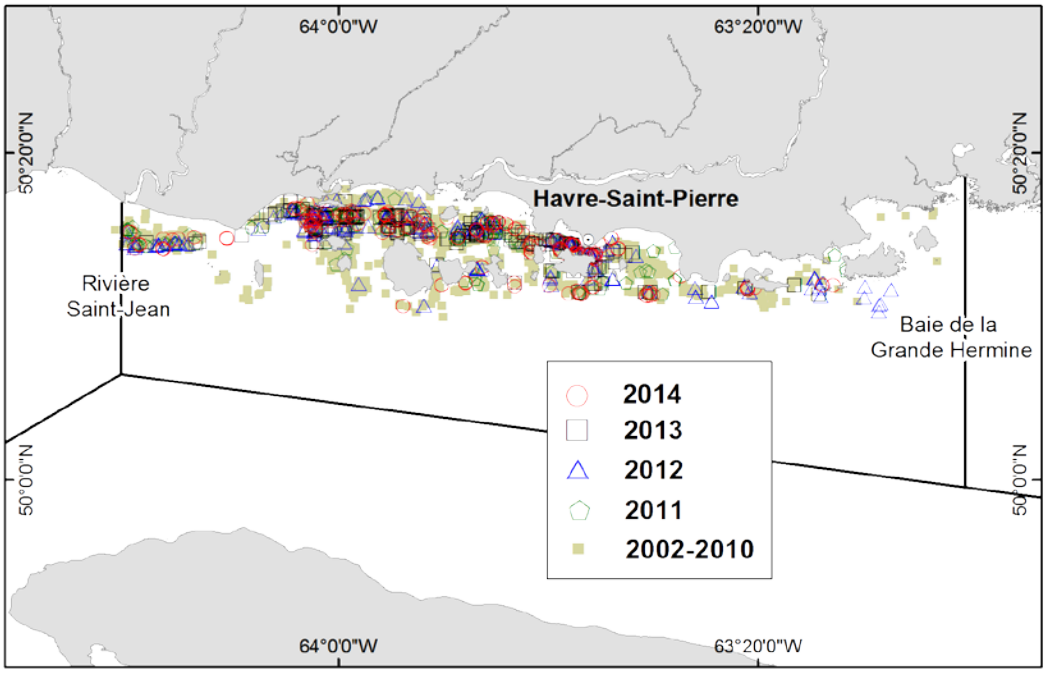

Figure 25. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 6.

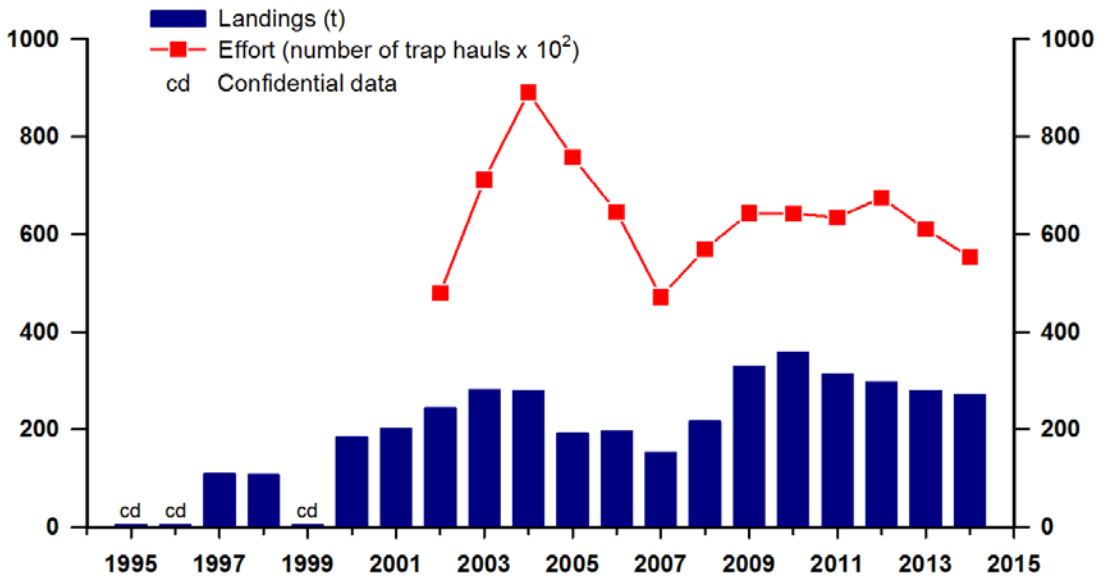

Figure 26. Whelk landings and fishing effort from 1995 to 2014 in Fishing Area 6.

Since 2010, the average annual size of landed whelk has been above the 2004–2013 86 mm baseline level (Figure 28 and Appendix 13). In 2014, the average size was 88 mm. The percentage of sub-legal size whelks in landings has remained below 3% since 2010 (Figure 28 and Appendix 14). Since 2007, the size structures of landed whelk have been quite consistent. Starting in 2010, the fishery seems to have targeted larger individuals, resulting in an increase in average size (Figure 28 and Appendix 20).

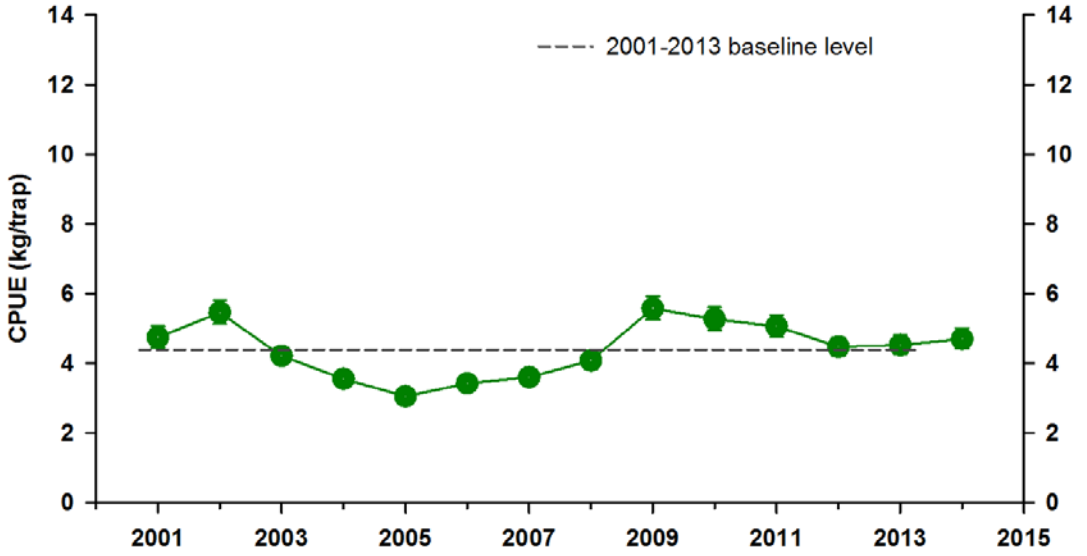

Figure 27. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 6.

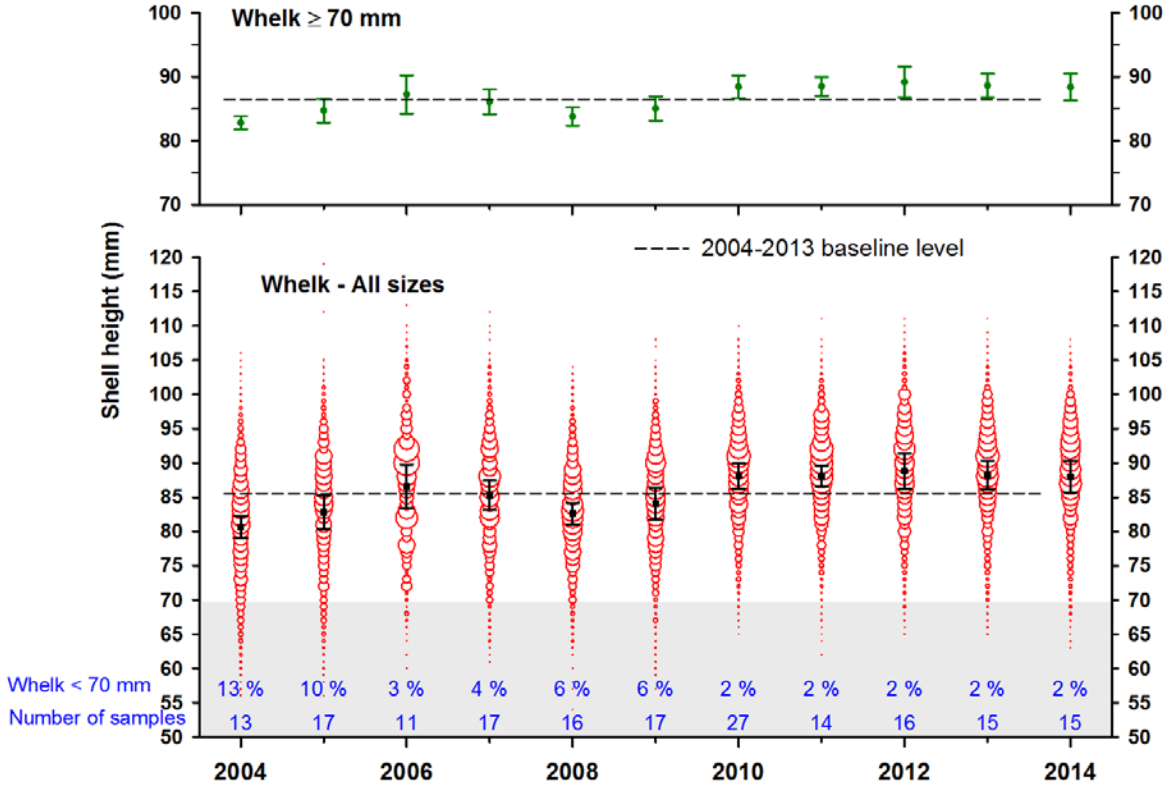

Figure 28. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 6. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

Fishing Area 7

Fishing area 7 extends from baie de la Grande Hermine to Rivière de l'Étang (Figure 29 and Appendix 7). However, the commercial fishery is conducted only near Natashquan. Since 2008, there have been two or three active licences. In 2014, there were 3 active licences for 400 traps (Appendix 9). There are 7 licences issued in this area for a total of 600 traps.

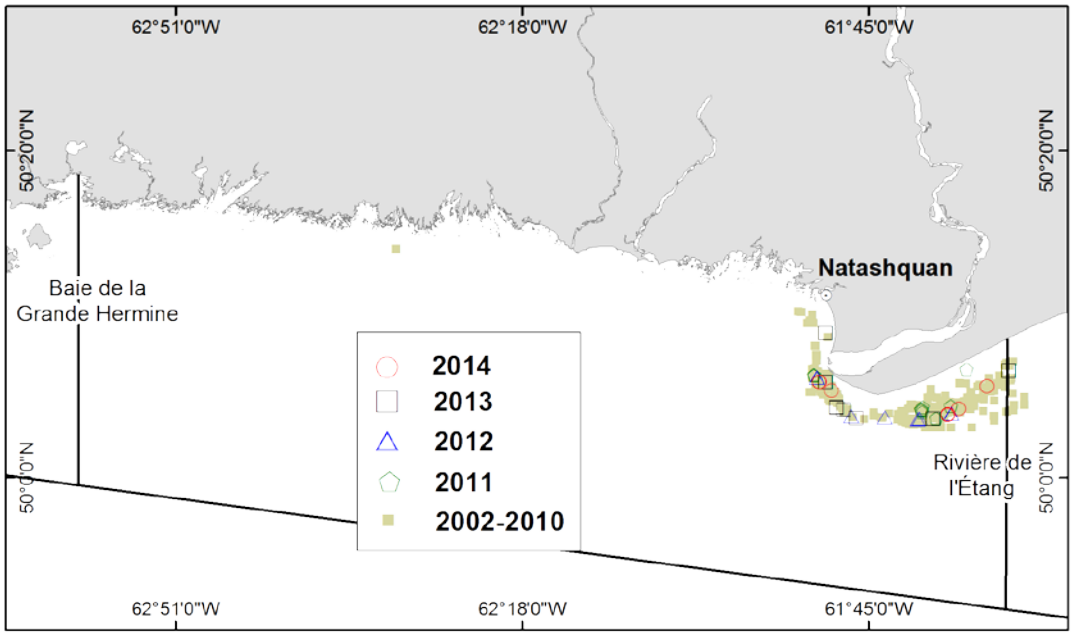

Figure 29. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 7.

Landings and fishing effort in this area are confidential given the low number of active fishermen. Baseline landings (2001–2013) were 52 t for this area, and baseline fishing effort (2002–2013) was 8,400 trap hauls (Appendices 10 and 11).

CPUE vary somewhat from year to year, possibly due to low fishing effort (Figure 30 and Appendix 12). However, over the past seven years, the annual CPUE was below the baseline level in 2008, 2010, 2011 and 2014, with values of 5.5 or 5.6 kg/trap.

From 2011 to 2013, the average size of whelk landed was above the 86 mm baseline level (Figure 31 and Appendix 13). In 2014, the high variance in average size was attributable to the small number of samples. Since 2004, the number of sub-legal size whelks in landings has always been below 10%. It was 3% in 2014 (Figure 31 and Appendix 14). From 2005 to 2011, the size structure shifted upward or to the right (depending on graph) when larger individuals were landed (Figure 31 and Appendix 21). Since then, size structures have been quite consistent.

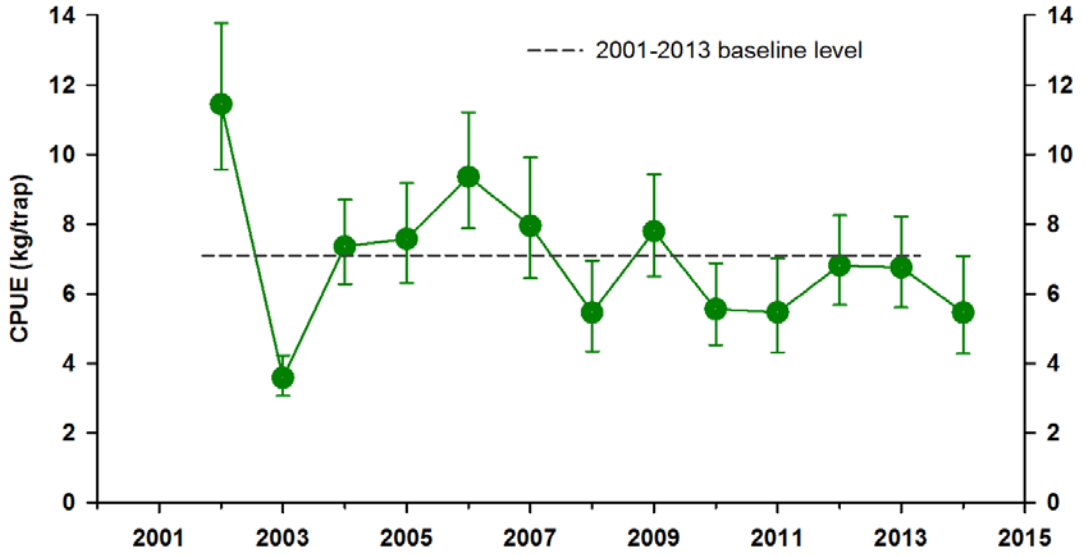

Figure 30. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 7.

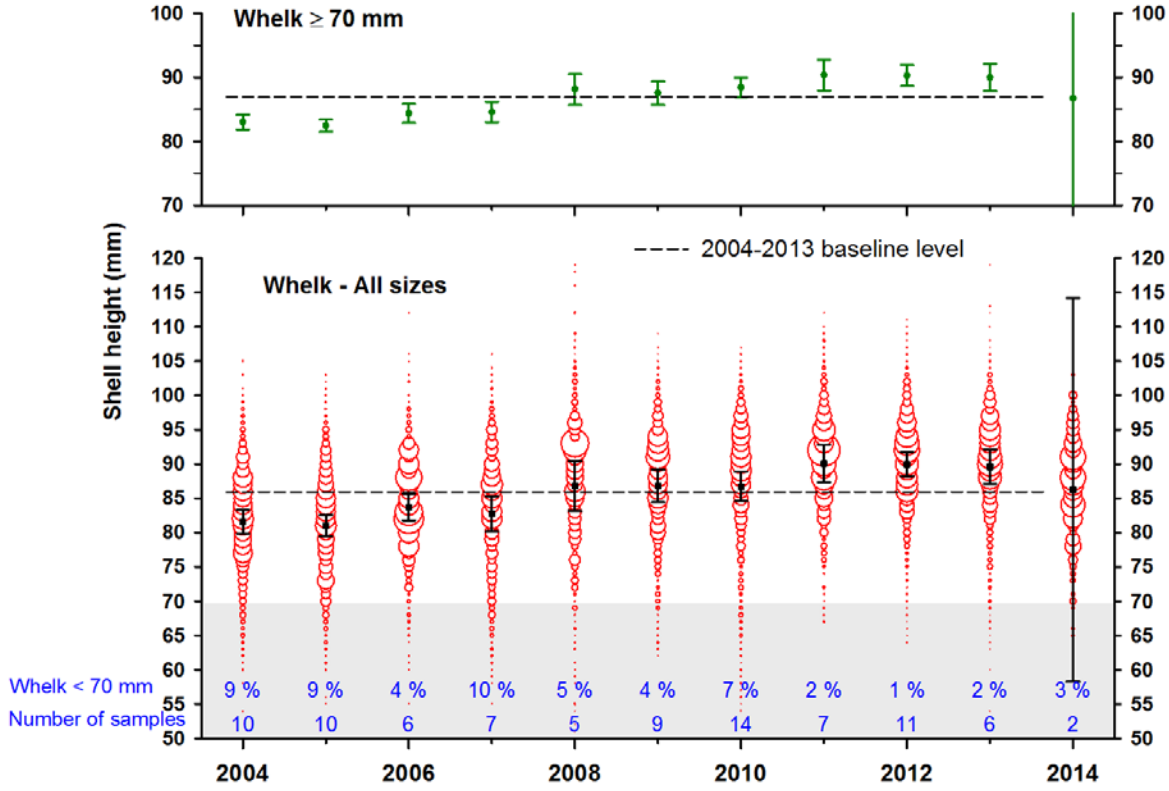

Figure 31. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 7. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

Fishing Area 8

Fishing Area 8 is the largest fishing area in Québec, extending from Rivière de l'Étang to Blanc-Sablon (Figure 32 and Appendix 7). However, the commercial fishery is primarily concentrated in the Blanc-Sablon area. In 2014, there were 13 active licences for 1,300 traps out of a total of 64 licences issued and 6,400 authorized traps (Appendix 9).

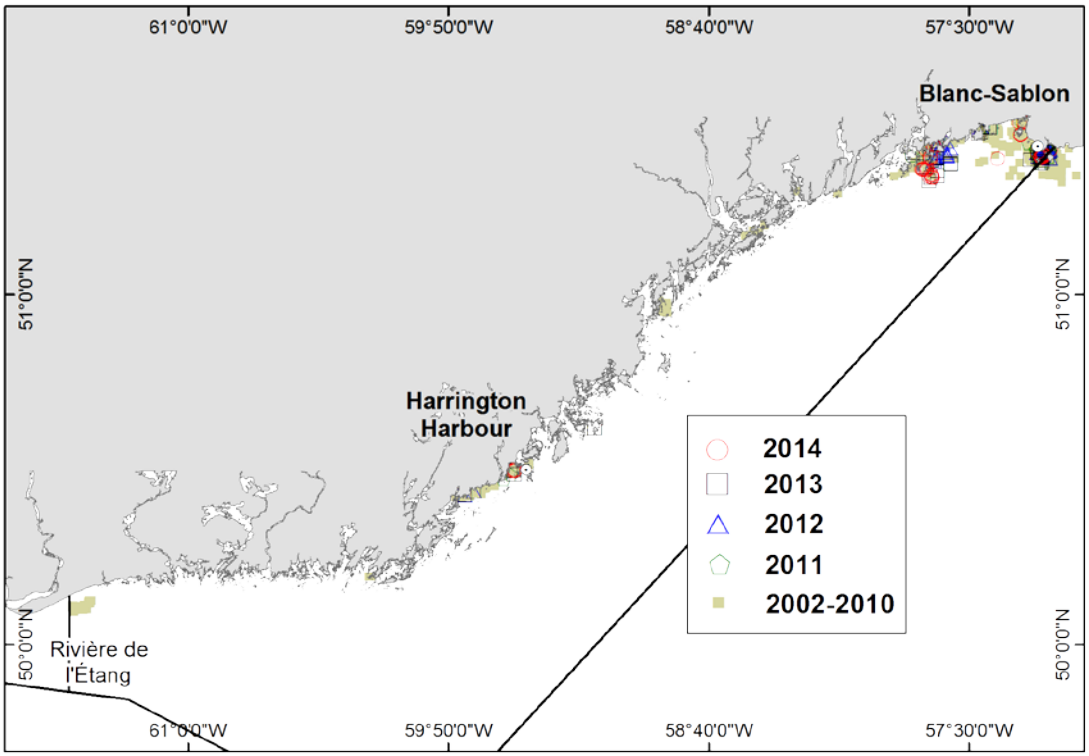

Figure 32. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 8.

Landings from Area 8 are highly variable from year to year and highly dependent on fishing effort (Figure 33 and Appendices 10 and 11). Maximum landings of just over 80 t were recorded in 1995, 1996 and 2003. Landings in recent years were 27, 36 and 23 t in 2012, 2013 and 2014. Fishing effort from 2012 to 2014 ranged from 6,900 to 8,700 trap hauls. In 2014, landings in this area accounted for 3% North Shore landings.

CPUE in this area fluctuate around the 2001–2013 4.3 kg/trap baseline level (Figure 34 and Appendix 12). CPUE in recent years were 4.1 kg/trap in 2012, 5.0 kg/trap in 2013 and 3.9 kg/trap in 2014.

The average size of landed whelk was low in this area due to the high percentage of sub-legal size whelk in landings (Figure 35 and Appendices 13 and 15). The 2004–2013 baseline level was 74 mm, only a few millimetres above the minimum legal size. In 2014, the average size was 75 mm. Since 2005, the percentage of sub-legal size whelk in landings ranged from 19% to 40% (Figure 35 and Appendix 14). This was clearly reflected in size structures where there is a large percentage of 60 mm–69 mm individuals in landings (Figure 35 and Appendix 22).

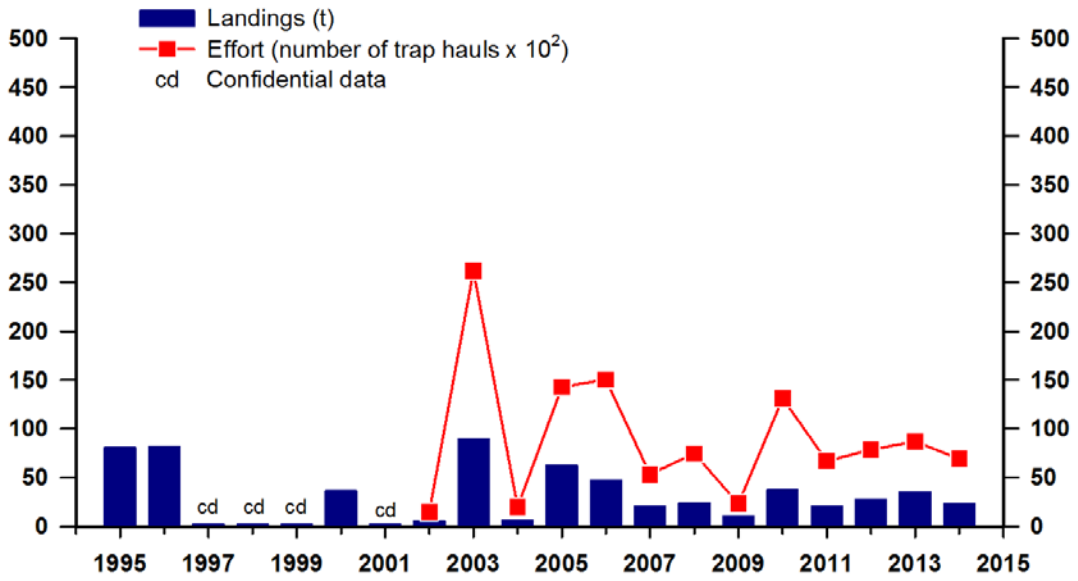

Figure 33. Whelk landings and fishing effort from 1995 to 2014 in Fishing Area 8.

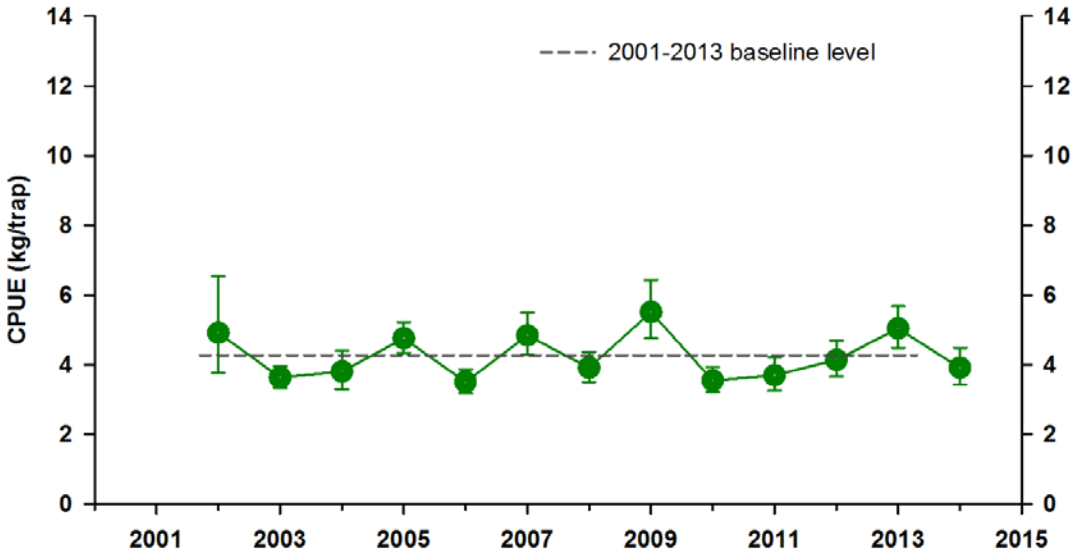

Figure 34. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 8.

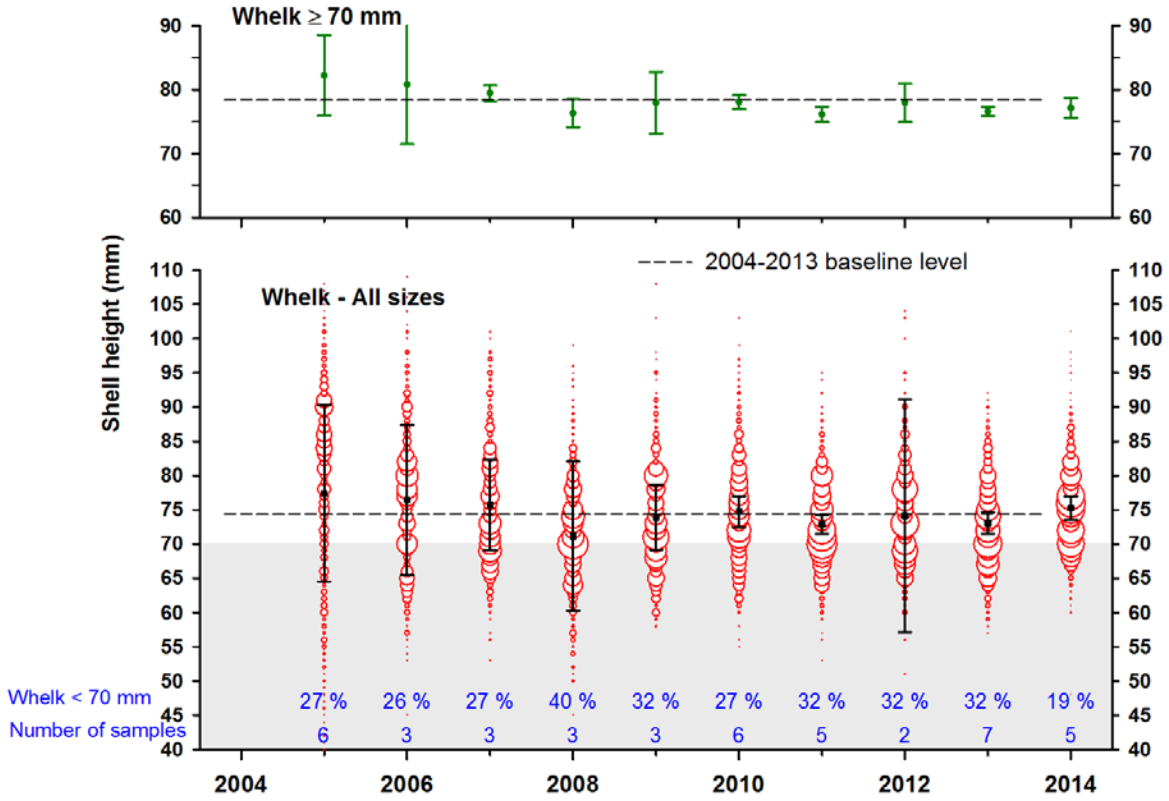

Figure 35. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 8. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

GASPÉ–LOWER ST. LAWRENCE

Fishing Area 12

Fishing Area 12 extends from Rivière Tartigou to Pointe de Chasse (Rivière-à-Claude) (Figure 36 and Appendix 7). The commercial fishery covers most of the area. In 2014, there were 9 active licences for 950 traps out of a total of 37 licences issued and 2,950 authorized traps (Appendix 9).

From 2005 to 2011, landings remained stable between 84 t and 150 t (Figure 37 and Appendix 10). Landings peaked in 2006. A 128 t TAC was introduced in 2010 and slightly exceeded (129 t) the same year, but was not caught in 2011. It was raised to 135 t in 2012 and has not been caught since. In 2014, landings were 45.6 t and accounted for 41% of Gaspé–Lower St. Lawrence landings.

Fishing effort reached the maximum value of 36,900 trap hauls in 2006 (Figure 37 and Appendix 11). Values for the last three years were under 20,000 trap hauls.

The average CPUE for this area was 2.2 kg/trap in 2003, the lowest in the series (Figure 38 and Appendix 12). By 2007, CPUE had increased to 4.2 kg/trap. Subsequently, CPUE remained between 3.5 and 4.1 kg/trap. However, the CPUE for 2014 was the lowest value since 2004, at 2.2 kg/trap, the same level as in 2003.

Since 2004, average sizes of landed whelk have been similar to the 2004–2013 87 mm baseline level (Figure 39 and Appendix 13). The average size was 90 mm in 2014. The

proportion of sub-legal size whelk has been less than 4% in landings since 2007 (Figure 39 and Appendix 14). Size structures have been very similar since 2008 (Figure 39 and Appendix 23).

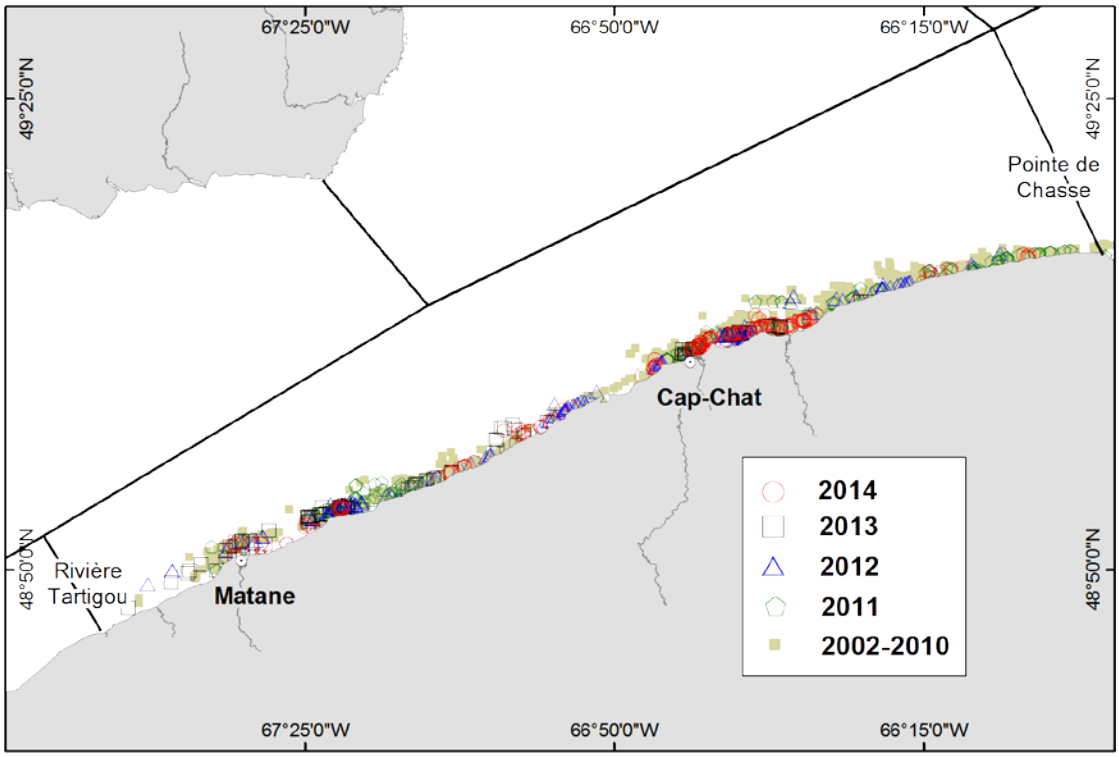

Figure 36. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 12.

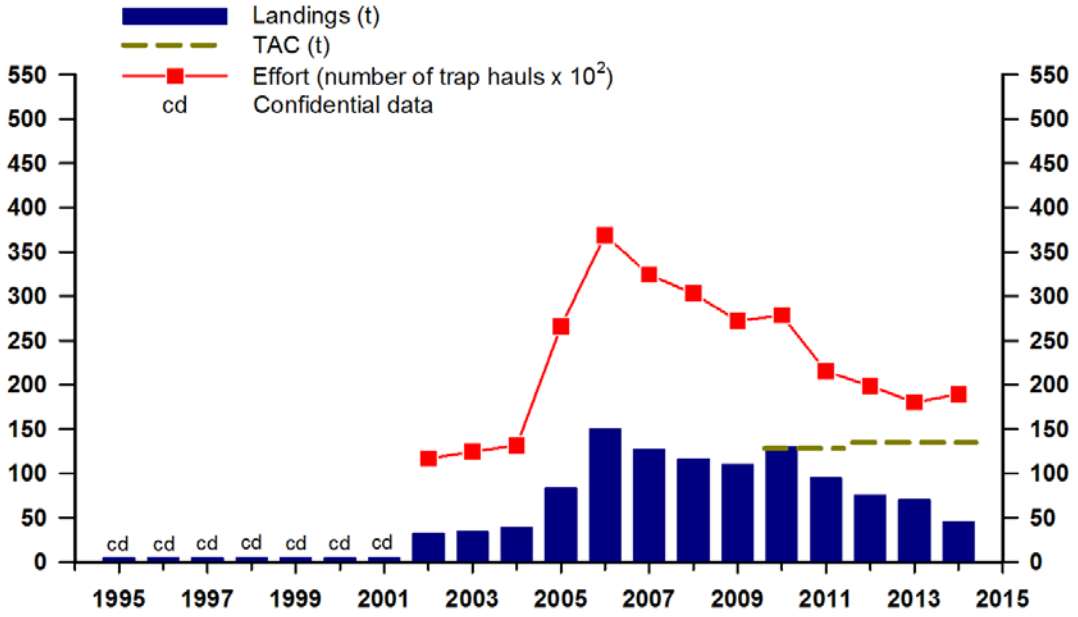

Figure 37. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2014 in Fishing Area 12.

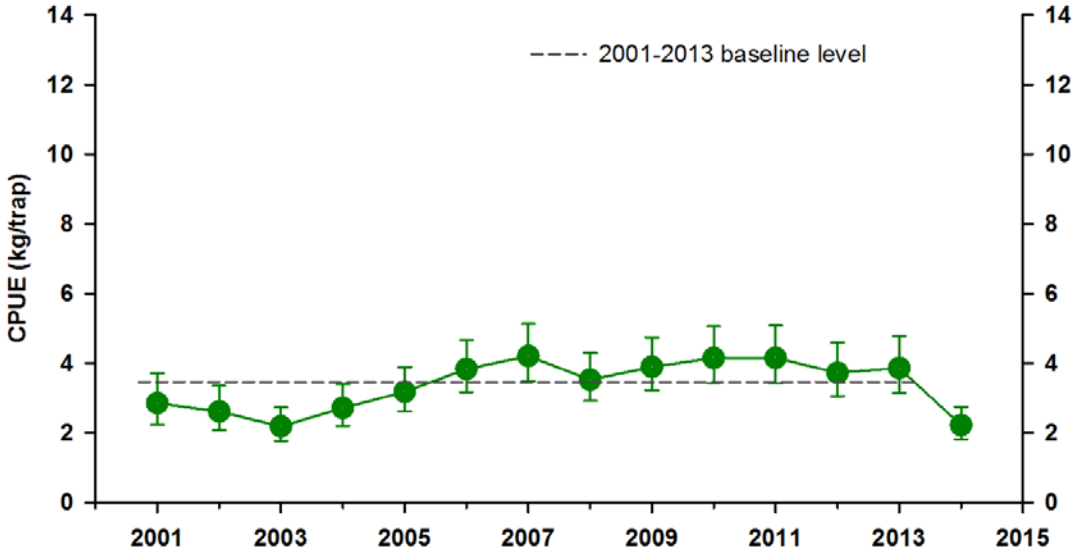

Figure 38. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 12.

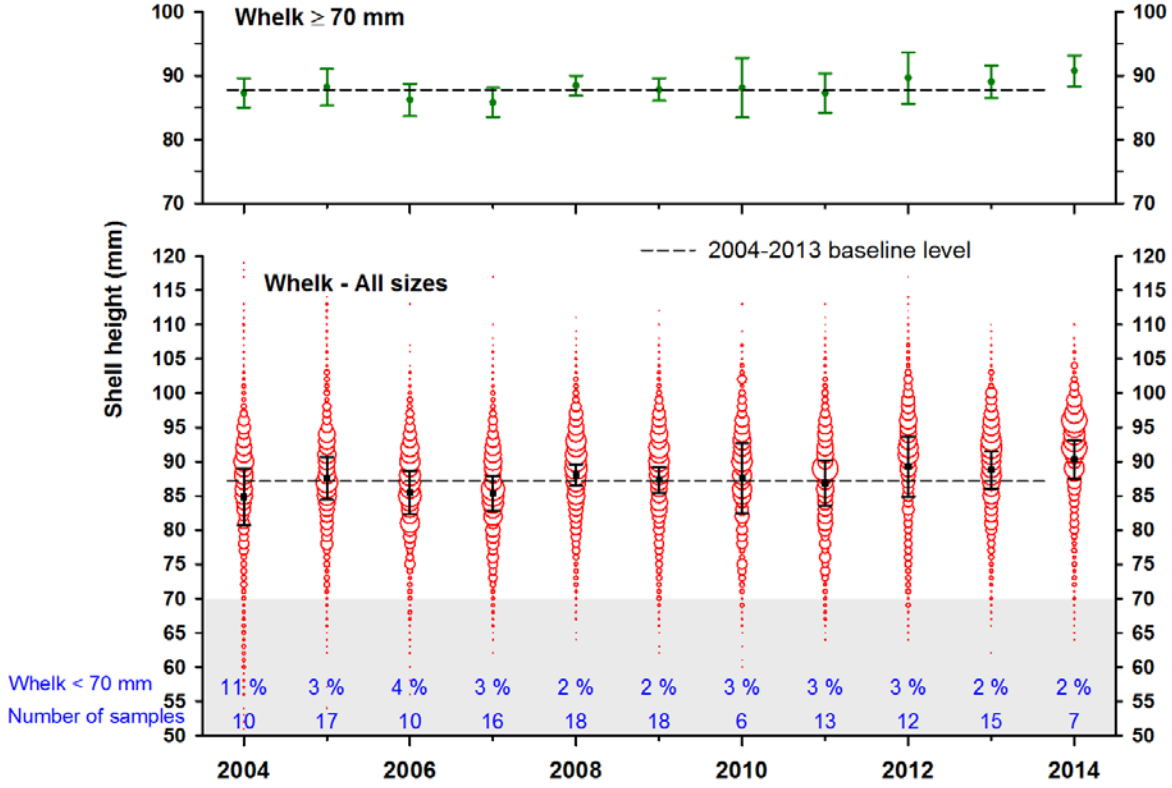

Figure 39. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 12. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

Fishing Area 13

The western boundary of Fishing Area 13 is the eastern point of Île d'Orléans, from this boundary to Pointe Rouge (Tadoussac), the Area covers both shores of the St. Lawrence estuary (Appendix 7). It then extends from the southern side of the estuary to Rivière Tartigou (Figure 40 and Appendix 7). The commercial fishery exclusively covers the eastern portion of the area, starting at the Bic archipelago (near Rimouski). In 2014, there were 4 active licences for 350 traps out of a total of 13 licences issued for 1,075 authorized traps (Appendix 9). 2014 landings and fishing effort are confidential.

From 1995 to 2006, landings were less than 35 t (Figure 41 and Appendix 10). Later, there was an increase in landings with the discovery of new sites by fishermen. In 2010, the area was subdivided into 13a (eastern portion) and 13b (west of the Bic archipelago). An initial TAC was established for each of these subareas, 59 t in 13a and 50 t in 13b, to encourage fishermen to explore the western portion of the area (Appendix 8). In 2010, after the TAC was caught in 13a, some fishermen made trips to subarea 13b, but landings were disappointing, and the whelk were small. At the end of June 2010, an additional 41 t TAC was allocated for subarea 13a. In 2011, the two subareas were consolidated and a 73 t TAC was allocated to the eastern portion, with landings remaining unrestricted in the western portion of the area. In 2012, the TAC was increased to 82 t (Appendix 8). In 2013 and 2014, the TAC was not caught (Figure 41 and Appendix 10).

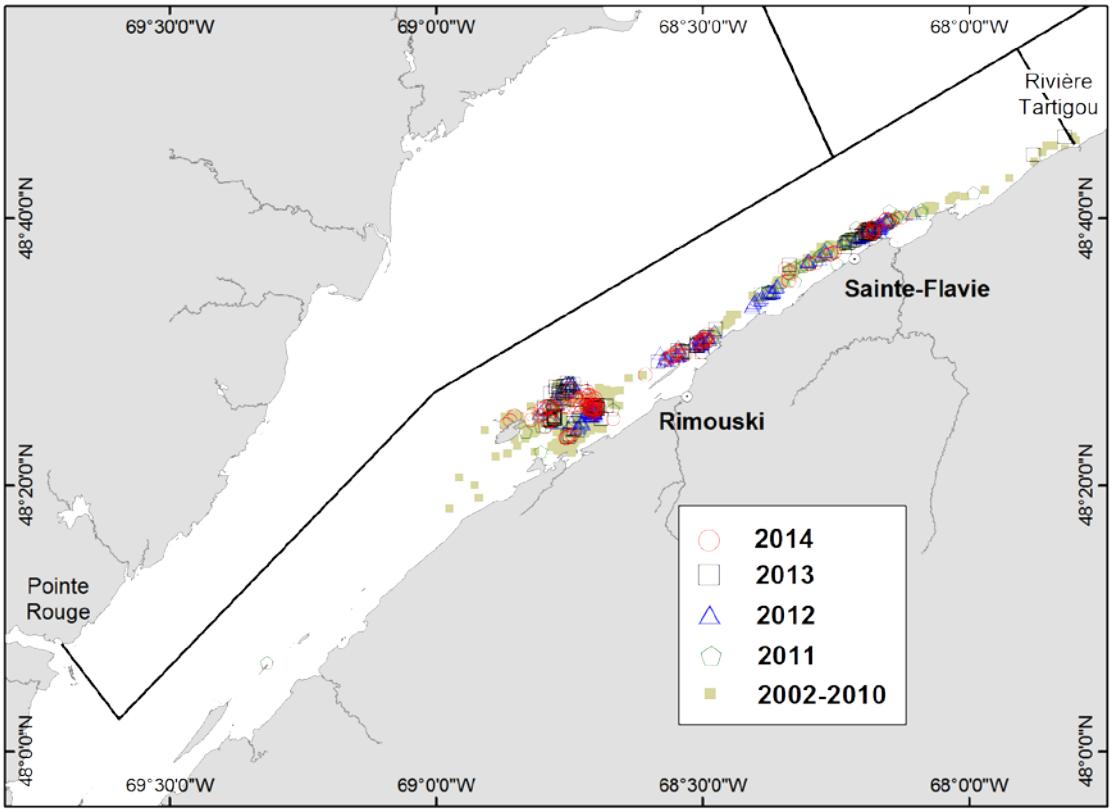

Figure 40. Distribution of commercial whelk fishing effort from 2002 to 2014 in Fishing Area 13.

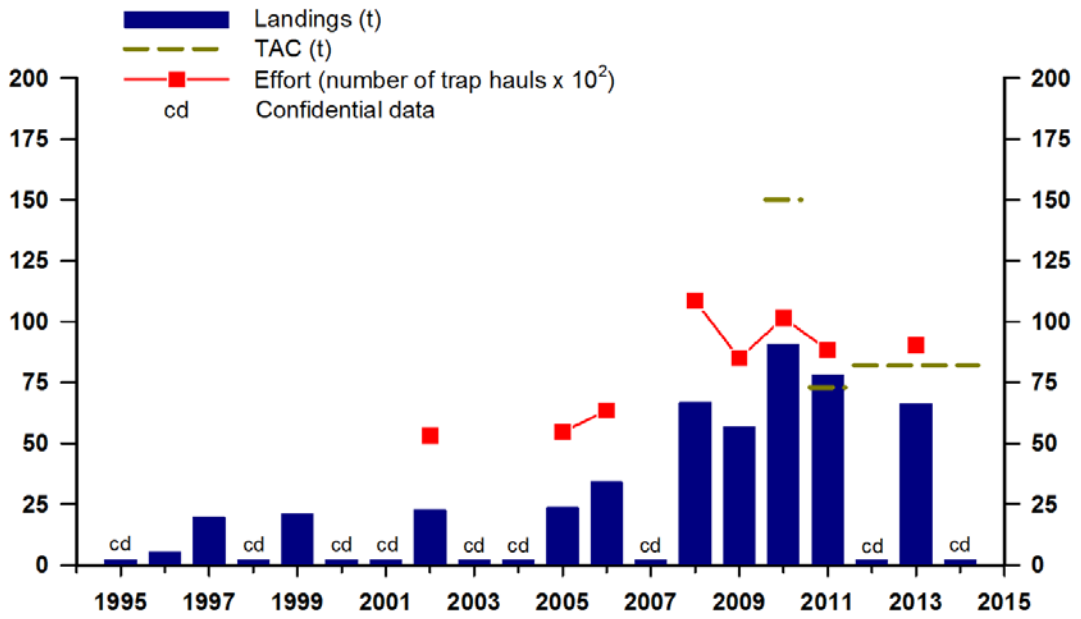

Figure 41. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2014 in Fishing Area 13.

Since 2010, landings in this area have accounted for more than 40% of landings in the Gaspé–Lower St. Lawrence area. Fishing effort has ranged from 8,500 to 12,400 trap hauls since 2007 (Figure 41 and Appendix 11).

In the early 2000s, CPUE values were the lowest in the series, around 4 kg/trap (Figure 42 and Appendix 12). Subsequently, CPUE gradually increased to 8.3 and 8.8 kg/trap in 2010 and 2011, well above the 2001–2013 baseline level. From 2012 to 2014, CPUE remained above average with values ranging from 6.9 to 7.3 kg/trap.

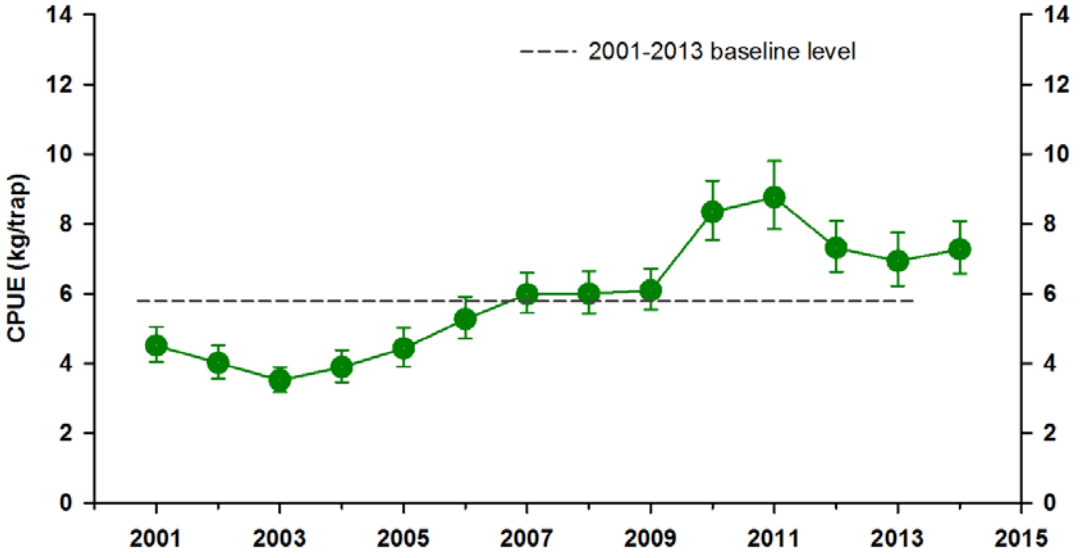

Figure 42. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2001 to 2014 in Fishing Area 13.

The average size of landed whelk increased from 70 mm in 2004 to 87 mm in 2007, possibly as a result of the exploitation of new sites (Figure 43 and Appendix 13). Since then, average size has ranged from 83 mm to 87 mm with values similar to or above the 2004–2013 baseline level. The proportion of sub-legal size whelk in landings has been below 2% since 2010 (Figure 43 and Appendix 14). Size structures have been similar in recent years, with the presence of individuals more than 100 mm long (Figure 43 and Appendix 24).

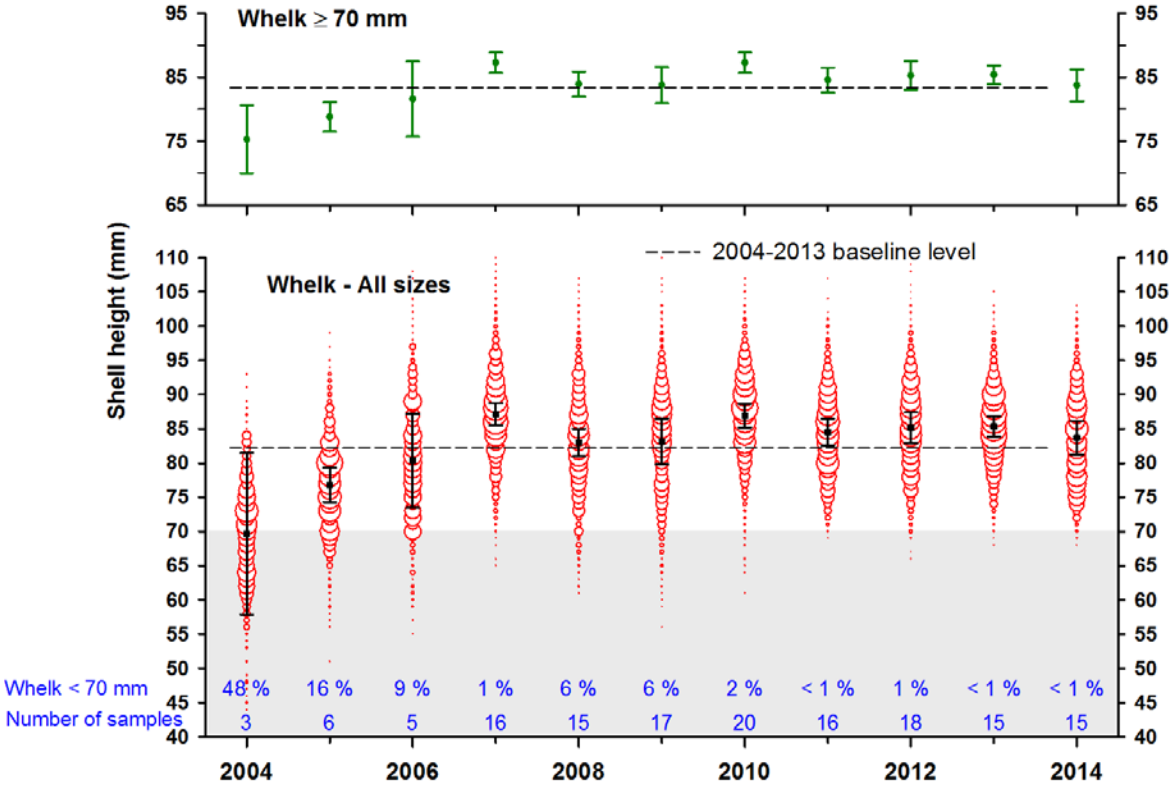

Figure 43. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 13. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

ÎLES-DE-LA-MADELEINE

Fishing Area 15

Fishing Area 15 covers the entire coastal area around the Îles-de-la-Madeleine (Figure 44 and Appendix 7). Commercial fishing gained momentum in 2003. Every year, fishermen travel extensively in search of good fishing areas. In 2008, the area was slightly enlarged to the south, which explains why few trips were made outside Area 15. In 2009, the area boundaries were brought back to their original location. In 2014, there were seven active licences for 700 traps out of a total of 11 licences issued and 1,100 authorized traps (Appendix 9). A management measure was added in 2011, allowing fishermen to use 150 traps each, provided they restrict their fishing season to between August and November, but few fishermen have used this clause to date.

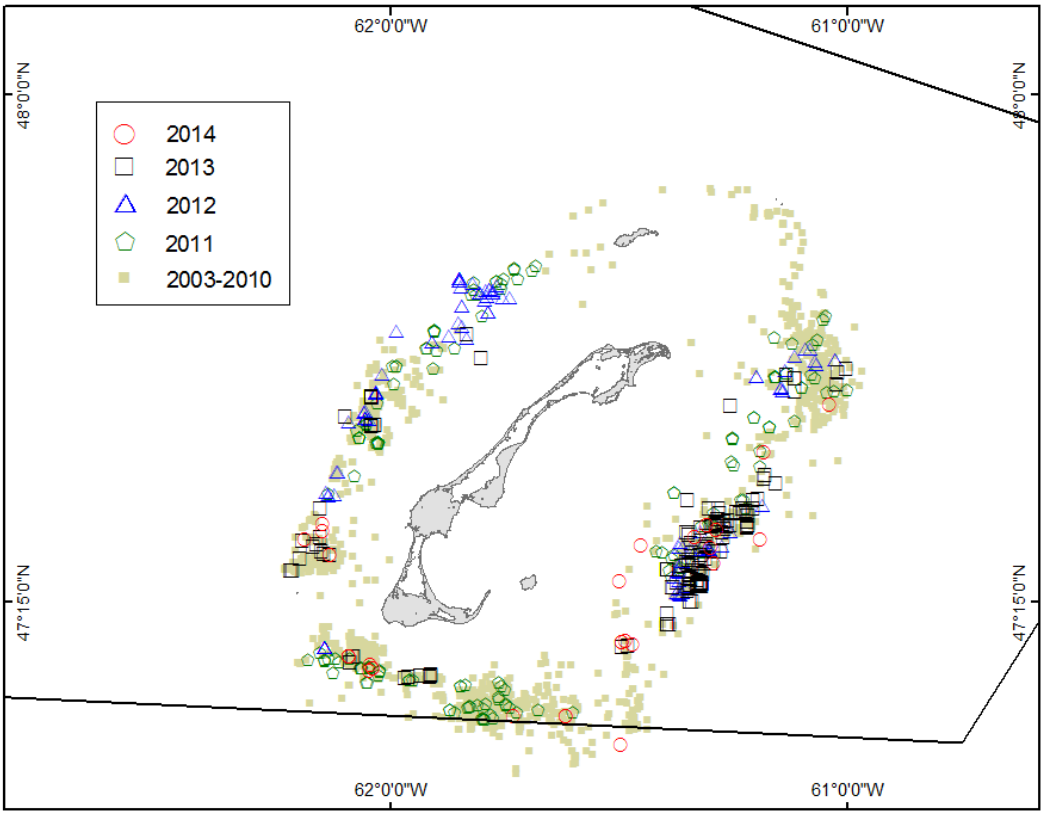

Figure 44. Distribution of commercial whelk fishing effort from 2003 to 2014 in Fishing Area 15.

In 2004, the area was divided into two subareas, with subarea 15a covering the portion that was already being exploited (southern portion), and a 400 t TAC was allocated to this subarea (Appendix 8). The Area was subdivided to better distribute the fishing effort around the Islands. In 2006, because this measure had been successful and at the fishermen's request, the two subareas were regrouped, and a 450 t TAC was allocated to Area 15 as a whole. The TAC was reduced to 376 t in 2012. The TAC has not been caught since 2006. The Area 15 TAC is divided equally among the 11 licence holders.

From 2003 to 2008, landings ranged from 352 t to 442 t (Figure 45 and Appendix 10). In 2009, only two licences were active because of the low price offered by processing plants. From 2010 to 2013, landings increased from 150 t to 327 t. In 2014, landings were only 15 t.

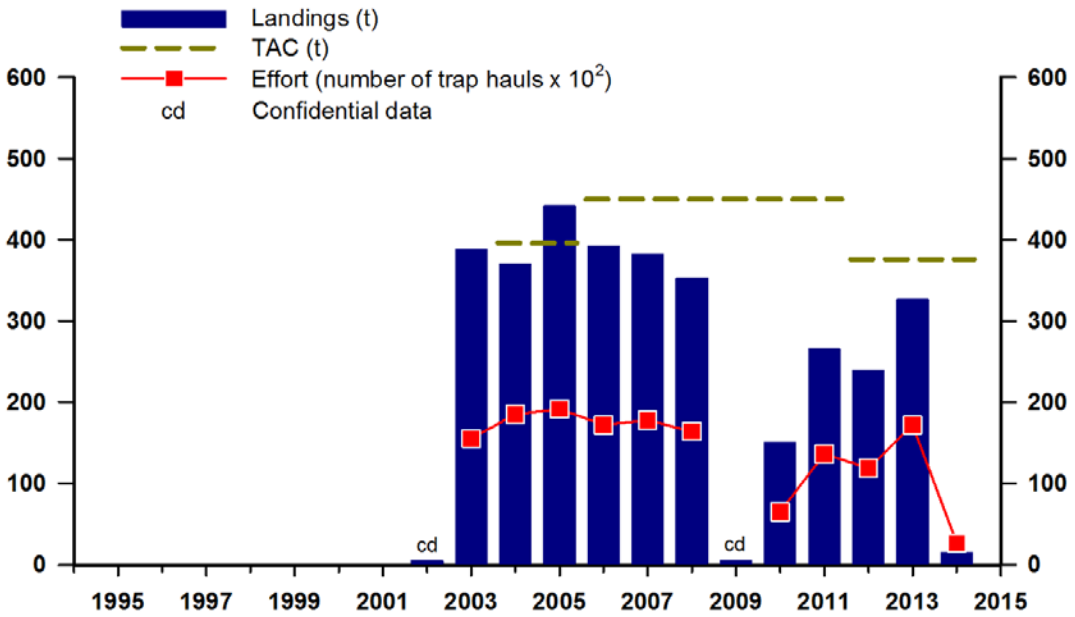

Figure 45. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2014 in Fishing Area 15.

From 2003 to 2008, fishing effort changed little from 15,500 to 19,200 trap hauls (Figure 45 and Appendix 11). Since then, the effort has been more variable and is primarily related to the number of active fishermen. In 2014, fishing effort was 2,700 trap hauls.

From 2003 to 2013, CPUE in this area were the highest in Québec (Appendix 12). They generally ranged around the 2003–2013 20.3 kg/trap baseline level (Figure 46 and Appendix 12). From 2011 to 2013, there was a slight decrease in CPUE with values around 18 kg/trap, below the baseline level. In 2014, the average CPUE was only 3.9 kg/trap, by far the lowest value in the series.

The 2013 CPUE did not foreshadow such a sharp decline in CPUE in 2014 (Figure 47). Environmental conditions in the Îles-de-la-Madeleine during the 2014 season, such as abnormally cold temperatures at fishing sites from April to August (Galbraith et al. 2015), could be responsible for the low yields.

Since 2008, the average size of landed whelk has exceeded 83 mm (Figure 48 and Appendix 13). The percentage of sub-legal whelk in landings has been below 9% since 2004 (Figure 48 and Appendix 14). Size structures have changed little since 2008 (Figure 48 and Appendix 25).

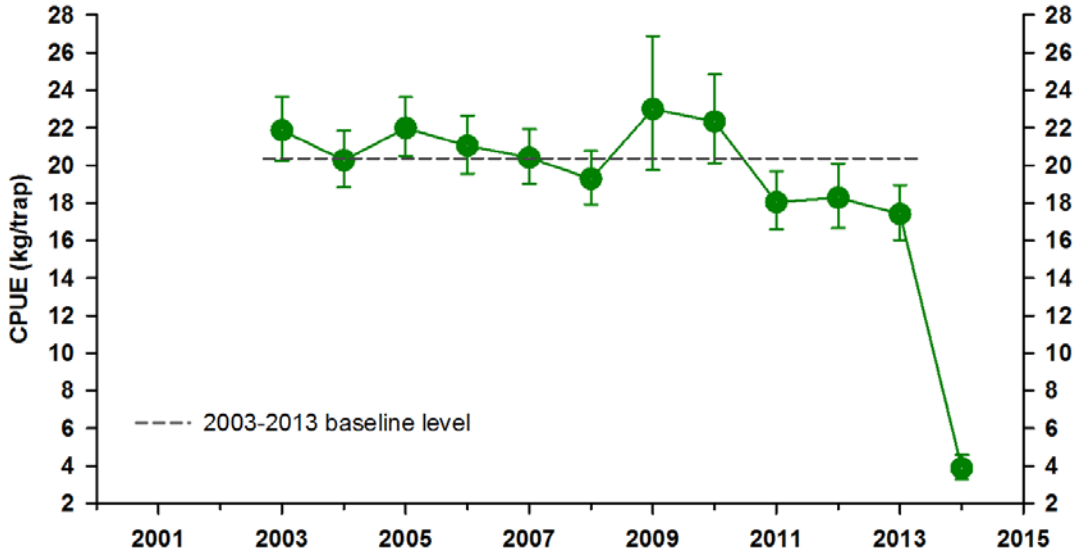

Figure 46. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the commercial whelk fishery from 2003 to 2014 in Fishing Area 15.

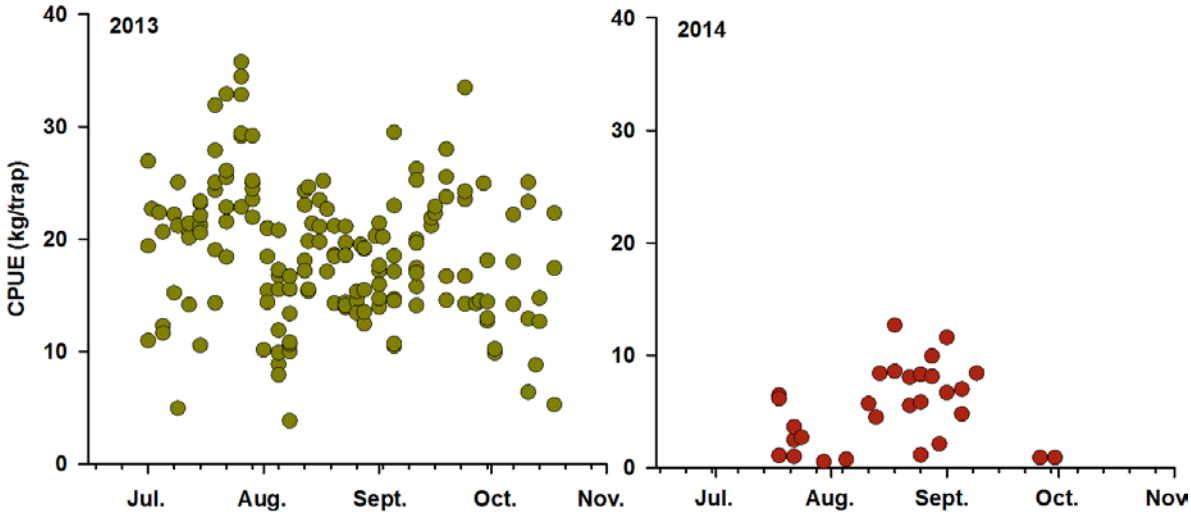

Figure 47. 2013 and 2014 non-standardized daily catch per unit effort (CPUE) in Fishing Area 15.

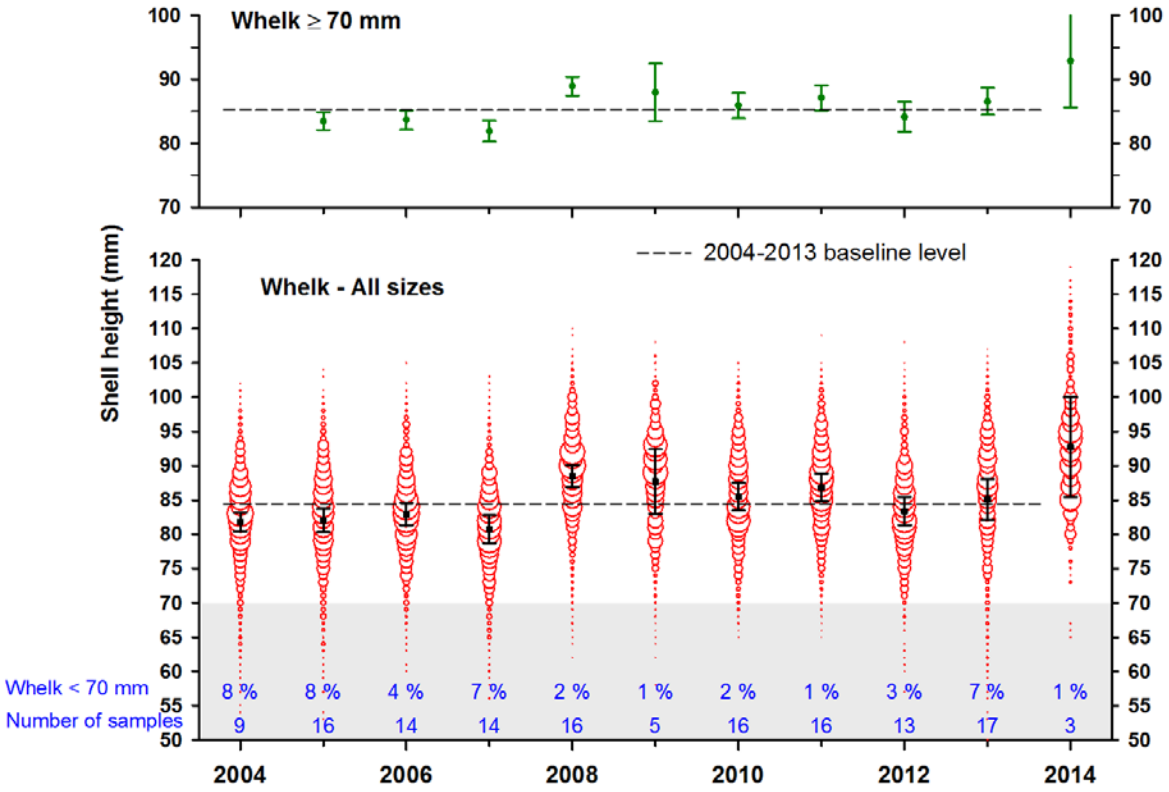

Figure 48. Average size (± 95% confidence interval) of landed whelk ≥ 70 mm (top graph) and size structure (circle proportional to frequency) and average size of all landed whelk (bottom graph) from 2004 to 2014 in Fishing Area 15. The percentage of sub-legal size whelk in landings and the number of samples collected are shown at the bottom of the figure.

RESEARCH

In response to intensive fishing in the early 2000s in Areas 1 and 2, a research survey was conducted in 2005. The three areas covered by the survey were based on distribution of commercial fishing effort from 2001 to 2004 (Figure 49). In recent years, fishing effort has dropped sharply in Pointe-aux-Outardes whereas the Forestville and Baie-Comeau areas continue to be visited by fishermen (Appendix 26).

A few species of *Buccinum* were identified in the Upper North Shore survey, *Buccinum undatum*, *B. glaciale*, *B. scalariforme*, *B. totteni* and *Buccinum* ssp. However, nearly 99% of whelk harvested belonged to the *Buccinum undatum* species (Appendix 27).

The average relative densities of whelk by size class, area and year are presented in Table 6, as well as the post hoc test results. 2013 whelk densities, yields and egg masses per station are provided in Appendices 28 and 29, and 2013 whelk density maps are presented in Appendix 30. In general, densities were similar in Forestville and Pointe-aux-Outardes (0 to 45 whelk/100 m^2 per station) and higher in Baie-Comeau (1 to 136 whelk/100 m^2).

In Forestville, densities of whelk ≥ 20 mm differed significantly between years (Chi^2 = 84.335 and $P < 0.0001$) and were higher in 2013 than in the previous four surveys (Table 6). In Pointe-aux-Outardes (Chi^2 = 8.655 and $P = 0.0703$) and Baie-Comeau (Chi^2 = 3.908 and $P = 0.4186$) there was no difference between years (Table 6).

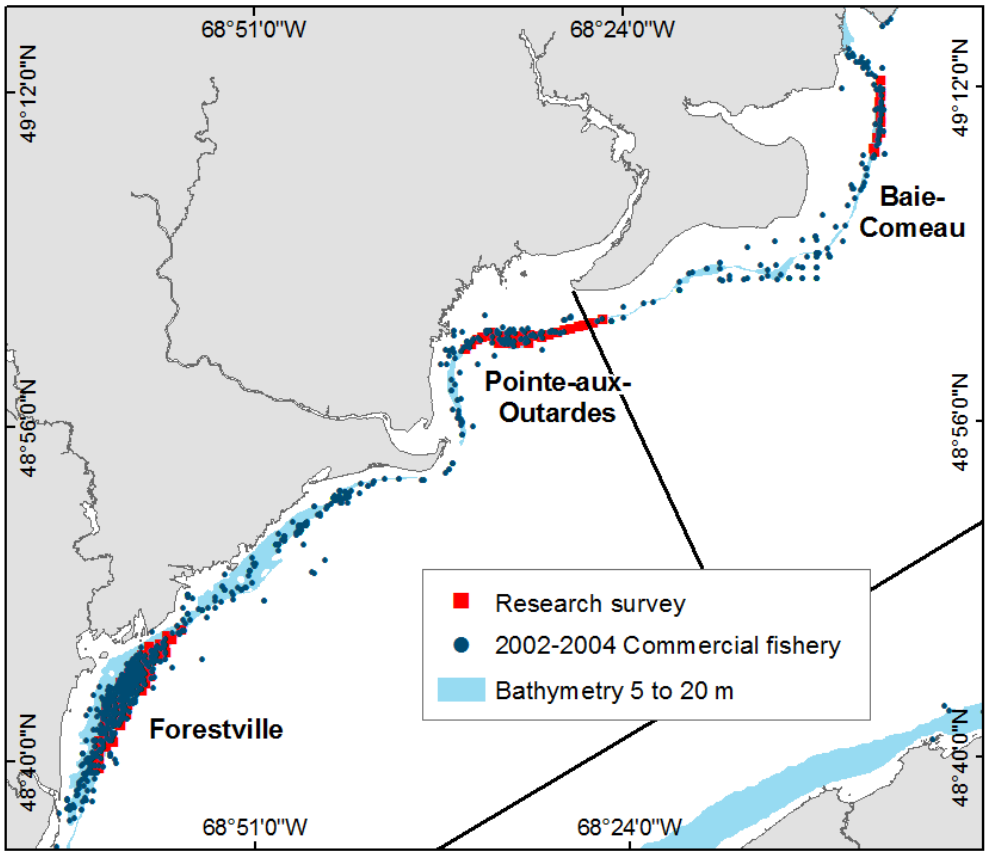

Figure 49. Areas covered by the Forestville, Pointe-aux-Outardes and Baie-Comeau research survey and distribution of commercial fishing effort from 2001 to 2004.

The survey year significantly affected densities of legal size whelk (≥ 70 mm) in Forestville (Chi^2 = 76.850 and P < 0.0001), and 2013 densities were higher than in other years (Table 6). In Pointe-aux-Outardes, these densities were similar across the five years of the survey (Chi^2 = 4.511 and P = 0.3412) (Table 6). In Baie-Comeau, densities differed between years (Chi^2 = 9.749 and P = 0.0449), and although densities were much higher in 2011 and 2013, they were not significantly different from 2005 and 2007 values (Table 6).

Results for sub-legal size whelk (20 mm to 69 mm) indicated that densities differed significantly between years in Forestville (Chi^2 = 84.951 and P < 0.0001) and that 2011 and 2013 densities were higher than in other years. In Pointe-aux-Outardes, densities also differed significantly between years (Chi^2 = 14.406 and P = 0.0061), but only 2011 densities were higher than those in the other surveys (Table 6). In Baie-Comeau, there was no difference between the five years of the survey (Chi^2 = 5.622 and P = 0.2292).

Average whelk yields by size class and egg mass recorded during the various research surveys are presented in Table 7. As with densities, yields in Baie-Comeau were much higher than in the other two areas, and average yields could exceed 1,000 g/100 m^2. In Forestville and Pointe-aux-Outardes, average yields ranged from 200 to 300 g/100 m^2.

The presence of egg masses was much more pronounced in the Pointe-aux-Outardes and Baie-Comeau areas, with average densities ranging from 0.6 to 4.2 masses/100 m^2, compared to Forestville where average densities ranged from 0.01 to 0.02 mass/100 m^2

(Table 6). However, the average weight of the masses was quite similar between areas, with values ranging from 51 to 222 g/mass (Table 7).

Table 6. Average whelk density (± 95% confidence interval) by size class and egg mass by area and year in research surveys.

Area and Year	Whelk Size Class [1]			Egg Masses
	≥ 20 mm	≥ 70 mm	20-69 mm	
Forestville				
2005	6.6 ± 1.0 c	3.3 ± 0.5 b	3.3 ± 0.7 b	0.02 ± 0.04
2007	5.5 ± 0.8 c	2.4 ± 0.3 c	3.1 ± 0.7 b	
2009	6.5 ± 1.1 c	1.9 ± 0.3 c	4.7 ± 0.8 b	0.01 ± 0.01
2011	12.2 ± 2.1 b	2.9 ± 0.4 b	9.3 ± 1.9 a	0.02 ± 0.01
2013	15.9 ± 2.5 a	5.6 ± 0.9 a	10.3 ± 1.9 a	0.01 ± 0.01
Pointe-aux-Outardes				
2005	3.3 ± 1.6 a	1.9 ± 1.4 a	1.4 ± 0.6 b	1.0 ± 0.7
2007	4.2 ± 1.6 a	2.8 ± 1.2 a	1.4 ± 0.6 b	
2009	4.7 ± 1.4 a	2.0 ± 0.7 a	2.7 ± 1.0 b	1.1 ± 0.9
2011	12.0 ± 4.7 a	3.3 ± 1.3 a	8.6 ± 3.9 a	1.4 ± 1.3
2013	6.8 ± 3.3 a	3.9 ± 2.0 a	2.9 ± 1.4 b	1.5 ± 1.0
Baie-Comeau				
2005	42.7 ± 28.3 a	7.7 ± 7.2 ab	35.0 ± 22.8 a	1.5 ± 2.2
2007	21.7 ± 9.2 a	6.4 ± 2.8 ab	15.3 ± 8.1 a	
2009	24.3 ± 12.3 a	6.0 ± 2.8 b	18.3 ± 11.7 a	0.6 ± 0.4
2011	41.7 ± 18.2 a	16.4 ± 8.8 a	25.3 ± 11.1 a	4.2 ± 4.2
2013	36.2 ± 28.7 a	17.9 ± 11.9 abc	18.4 ± 19.1 a	1.6 ± 1.4

[1] Like letters identify similar densities between years by size class and area.

Generally, there was little change in the size structure of legal size whelk between years (Figures 50, 51 and 52). However, the percentage of sub-legal size whelk was much more variable between areas and years. In 2011, the density of young whelk (≤ 50 mm) was greater than 5 individuals/100 m^2 in all areas; whereas in 2013, these density levels occurred only in Forestville.

The size of landed whelk has ranged from 9 mm to 112 mm since the surveys began in 2005. The largest whelk were caught at Pointe-aux-Outardes with maximum sizes ranging from 103 mm to 112 mm depending on the year (Figures 50, 51 and 52).

ACKNOWLEDGEMENTS

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commercial whelk fishery. We would also like to thank Charley Cyr and Steve Trottier for revising the paper.

Table 7. Average whelk yield (g/100 m^2 ± 95% confidence interval) by size class and egg mass, and average individual weight (g ± 95% confidence interval) of egg masses by area and weight in research surveys.

Area and Year	Whelk Size Class			Egg Masses	
	≥ 20 mm	≥ 70 mm	20–69 mm	Yield	Average Weight
Forestville					
2005	255.3 ± 38.2	198.7 ± 30.2	56.5 ± 12.7		
2007	174.1 ± 21.8	127.0 ± 18.4	47.1 ± 8.1	0.7 ± 0.6	
2009	169.2 ± 27.1	107.9 ± 20.1	61.3 ± 9.3	0.4 ± 0.4	51 ± 44
2011	209.5 ± 39.7	166.5 ± 22.9	124.0 ± 22.4	3.9 ± 3.4	222 ± 163
2013	507.7 ± 79.7	318.0 ± 50.2	189.7 ± 39.6	1.6 ± 1.9	133 ± 167
Pointe-aux-Outardes					
2005	159.2 ± 102.6	125.5 ± 99.1	33.7 ± 13.4		
2007	196.9 ± 77.6	160.0 ± 67.3	36.9 ± 16.5	89.6 ± 56.6	
2009	175.3 ± 62.2	126.5 ± 47.7	48.8 ± 20.7	72.7 ± 65.4	69 ± 9
2011	337.3 ± 122.1	192.6 ± 74.0	144.7 ± 61.2	105.6 ± 110.3	77 ± 8
2013	303.6 ± 145.8	232.9 ± 118.1	70.7 ± 32.3	106.7 ± 76.8	55 ± 17
Baie-Comeau					
2005	1,223.1 ± 899.7	396.9 ± 366.2	826.2 ± 577.2		
2007	650.0 ± 244.0	312.2 ± 137.9	337.8 ± 149.1	36.6 ± 40.4	
2009	681.6 ± 263.9	326.6 ± 148.9	354.9 ± 173.0	41.6 ± 37.1	72 ± 25
2011	1,468.6 ± 726.6	863.0 ± 463.3	605.6 ± 308.1	554.1 ± 631.3	130 ± 12
2013	1,525.7 ± 1 093.9	973.2 ± 636.2	552.5 ± 538.0	268.8 ± 266.5	136 ± 80

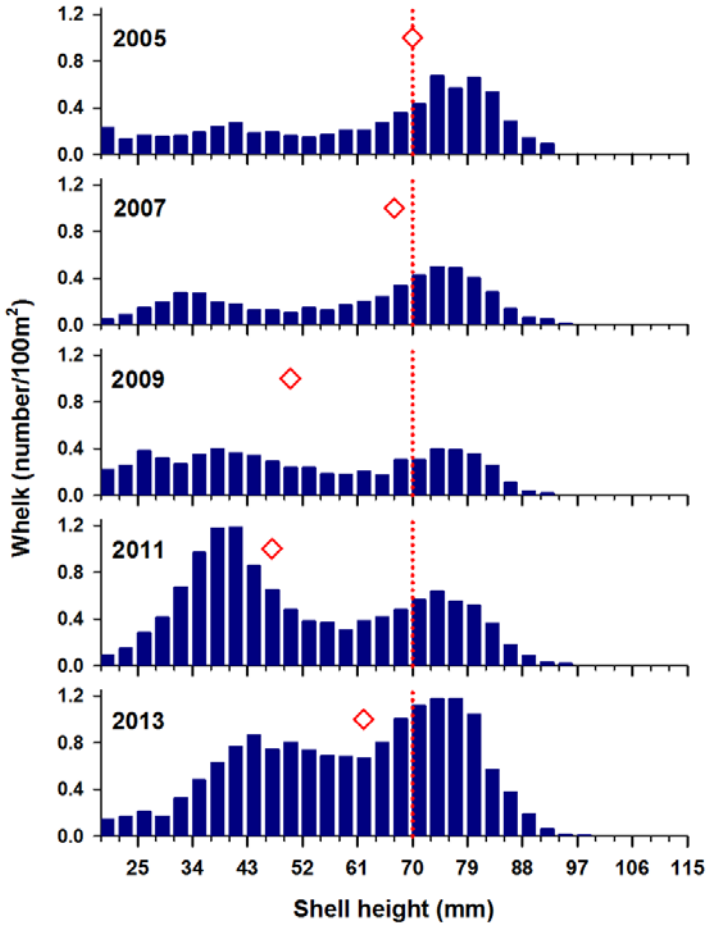

Figure 50. Whelk size structure and median size (red diamond) from the 2005 to 2013 Forestville research surveys. The vertical line represents the 70 mm minimum legal size.

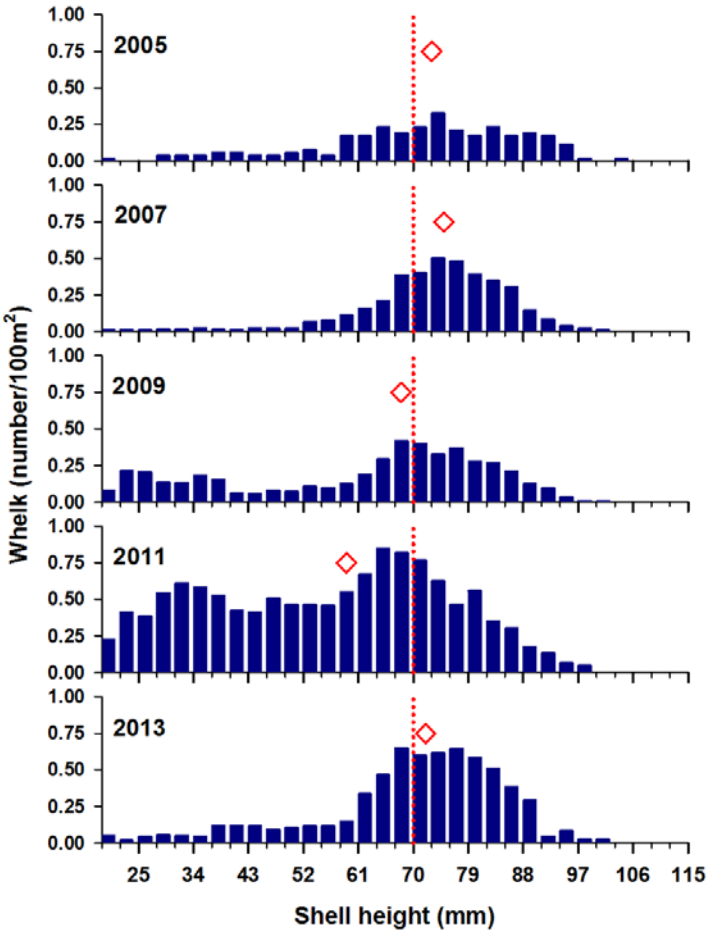

Figure 51. Whelk size structure and median size (red diamond) from the 2005, 2007, 2009, 2011 and 2013 Pointe-aux-Outardes research surveys. The vertical line represents the 70 mm minimum legal size.

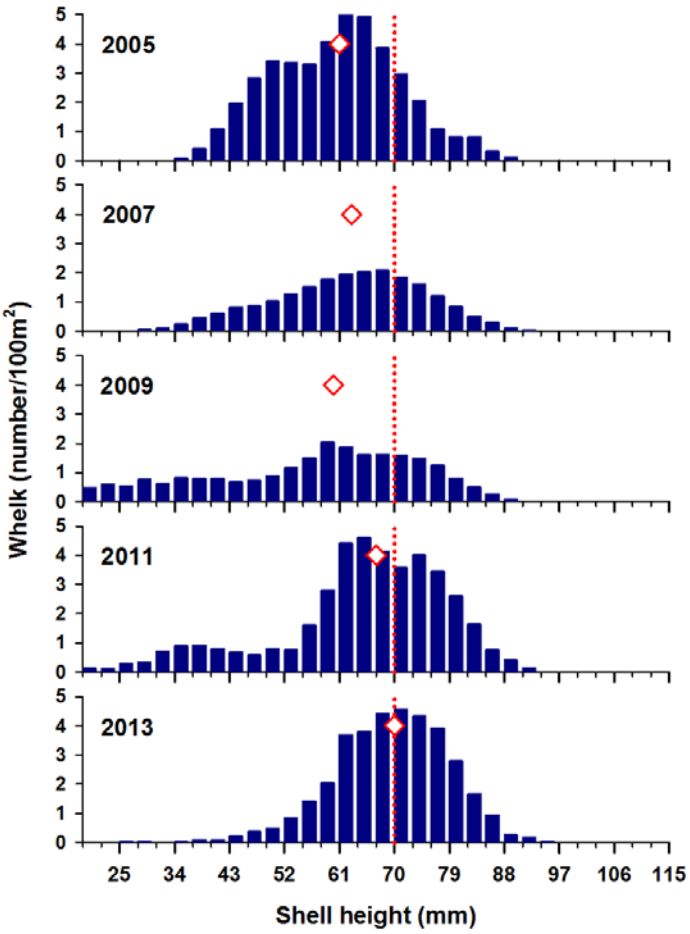

Figure 52. Whelk size structure and median size (red diamond) from the 2005, 2007, 2009, 2011 and 2013 Baie-Comeau research surveys. The vertical line represents the 70 mm minimum legal size.

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APPENDICES

Appendix 1. Number of whelk specimens collected by region, Fishing Area and year as part of DFO's landed commercial catch sampling program.

Year	North Shore								G-LSL [1]		IM [2]
	1	2	3	4	5	6	7	8	12	13	15
1987	0	0	0	12	0	5	0	0	0	3	0
1988	0	0	0	5	5	1	0	3	0	1	4
1989	0	0	0	2	0	0	0	0	0	2	2
1990	0	0	1	7	0	0	0	0	0	0	0
1991	0	0	0	17	8	6	0	0	0	0	0
1992	0	0	0	11	10	0	0	6	0	0	0
1993	0	0	0	4	1	4	0	2	12	0	0
1994	2	0	0	6	1	5	0	3	0	10	0
1995	6	0	0	8	6	6	0	11	0	10	0
1996	0	0	0	5	0	5	0	3	0	16	0
1997	4	4	0	4	3	4	0	1	0	12	0
1998	10	3	2	6	8	8	3	1	1	3	0
1999	3	4	3	6	9	9	7	5	0	5	0
2000	9	5	2	4	5	6	2	2	3	7	0
2001	10	6	5	10	8	8	0	0	4	7	0
2002	4	4	2	11	2	3	2	1	5	7	1
2003	2	5	0	12	10	12	6	5	6	5	8
2004	22	9	5	11	13	13	10	0	10	3	9
2005	28	17	0	14	17	16	10	6	17	6	16
2006	28	2	0	9	11	9	6	3	10	5	14
2007	28	12	0	8	17	19	7	3	16	16	14
2008	35	4	0	8	16	15	5	3	18	15	16
2009	42	2	0	10	17	18	9	3	18	17	5
2010	50	10	0	15	27	21	14	6	6	20	16
2011	23	15	0	7	14	15	7	5	13	16	16
2012	17	13	8	14	16	16	11	2	12	18	13
2013	20	5	0	16	15	15	6	7	15	15	17
2014	17	8	0	11	15	15	2	5	7	15	3

[1] Gaspé–Lower St. Lawrence
[2] Îles-de-la-Madeleine

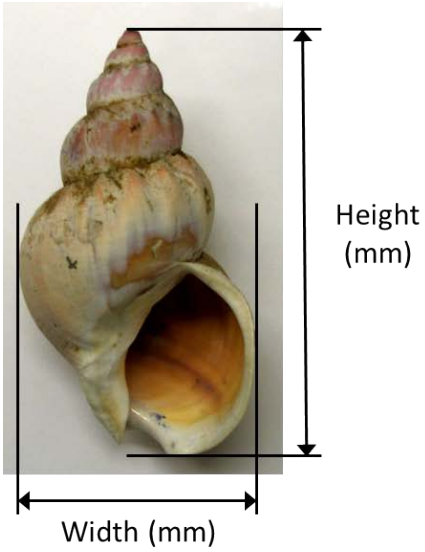
Appendix 2. Number of whelks measured by region, Fishing Area and year through DFO's landed commercial catch sampling program since 1995.

Year	North Shore								G-LSL [1]		IM [2]
	1	2	3	4	5	6	7	8	12	13	15
1995	650			831	628	601		1,213		1,000	
1996				640		507		351		1,646	
1997	448	485		420	301	381		101	1,216		
1998	1,051	373	193	640	828	839	315	101	97	301	
1999	314	409	310	615	928	920	712	545		663	
2000	1,090	644	226	397	516	669	195	203	307	421	
2001	1,079	615	497	1,043	802	819			389	515	
2002	409	4,444	207	1,156	2,284	3,185	203	133	622	906	120
2003	219	4,380		1,256	1,021	1,208	602	536	755	940	
2004	5,178	1,832	1,252	2,771	3,304	3,282	2,514		1,766	725	2,341
2005	4,347	2,879		2,154	2,567	2,473	1,513	876	2,600	984	2,837
2006	4,538	385		1,359	1,645	1,351	919	489	1,724	839	2,323
2007	4,449	2,162		1,213	2,580	2,936	1,055	500	2,753	2,634	2,324
2008	5,754	621		1,209	2,423	2,257	754	519	2,808	2,439	2,699
2009	6,690	344		1,543	2,553	2,698	1,364	484	2,832	2,627	794
2010	7,837	1,537		2,309	4,134	3,232	2,153	1,023	935	3,056	2,559
2011	3,631	2,337		1,040	2,116	2,283	1,123	882	1,950	2,409	2,503
2012	2,571	1,963	1,207	2,130	2,443	2,437	1,658	318	1,802	2,703	1,977
2013	3,008	756		2,431	2,269	2,263	907	1,126	2,251	2,250	2,626
2014	2,555	1,465		1,659	2,246	2,228	300	778	1,050	2,250	462

[1] Gaspé–Lower St. Lawrence

[2] Îles-de-la-Madeleine

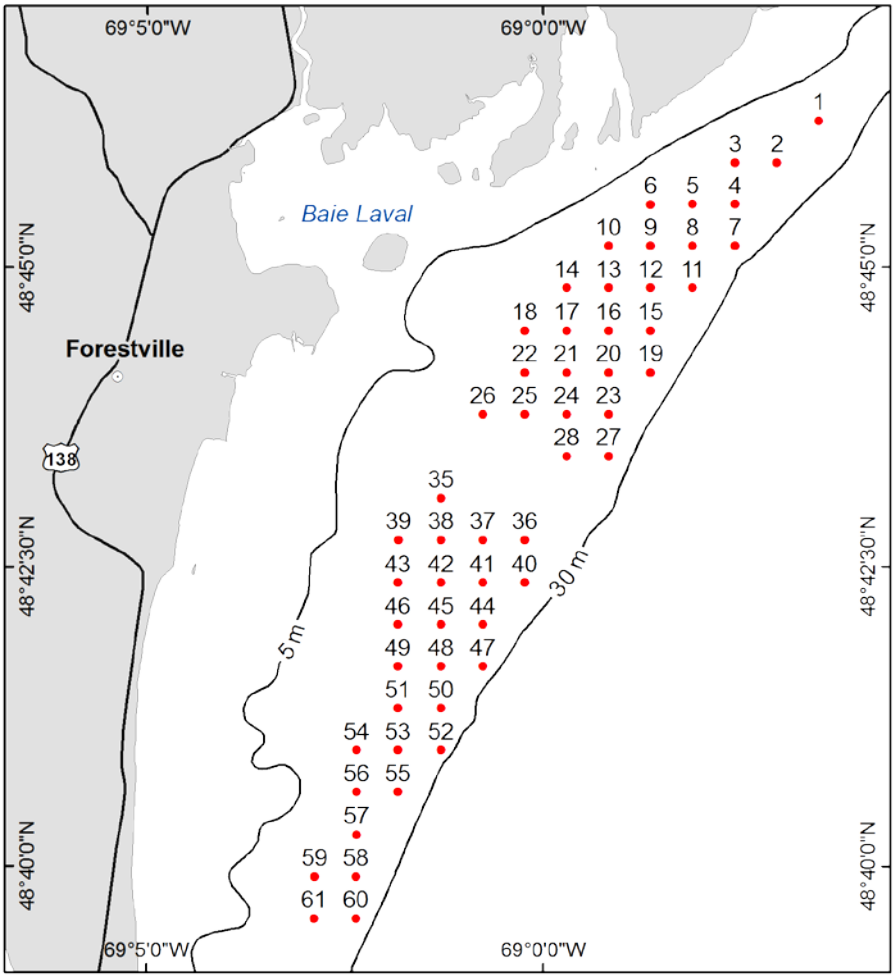
Appendix 3. Identification of the various whelk measurements.



Minimum width (mm)

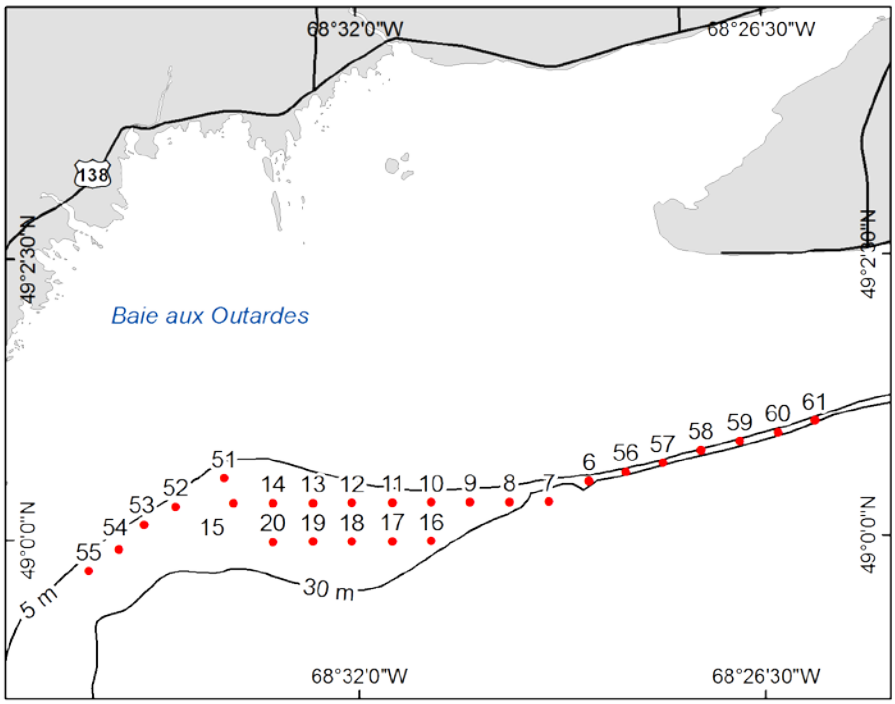
Appendix 4. Location of the whelk research survey sampling stations in A) Forestville, B) Pointe-aux-Outardes and C) Baie-Comeau.

A)

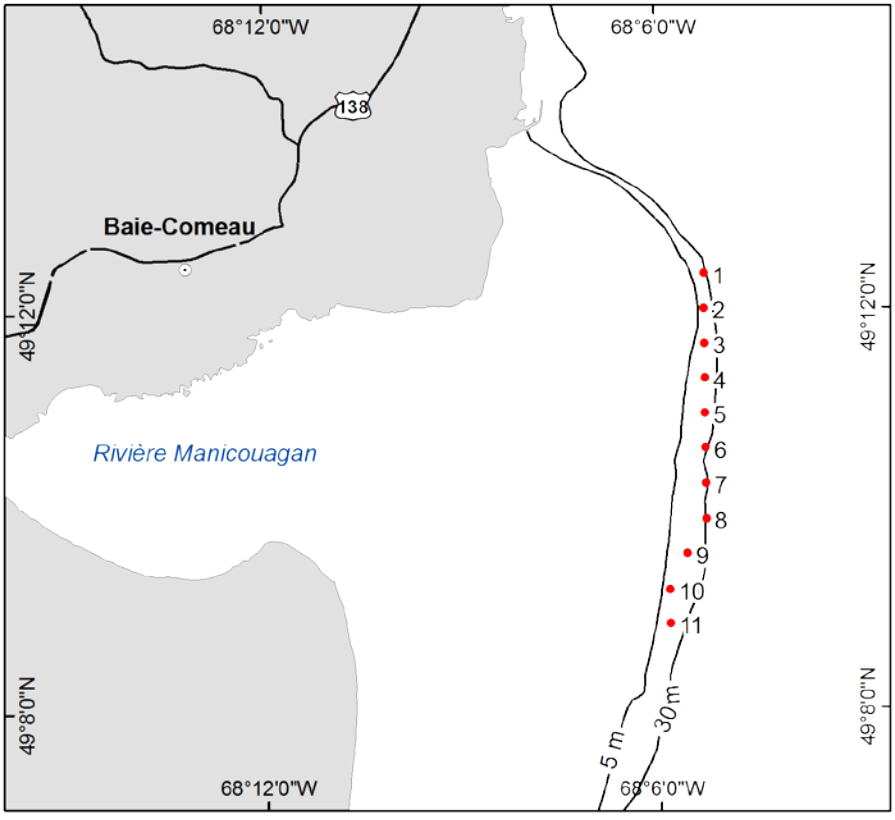


Appendix 4. (continued).

B)



C)



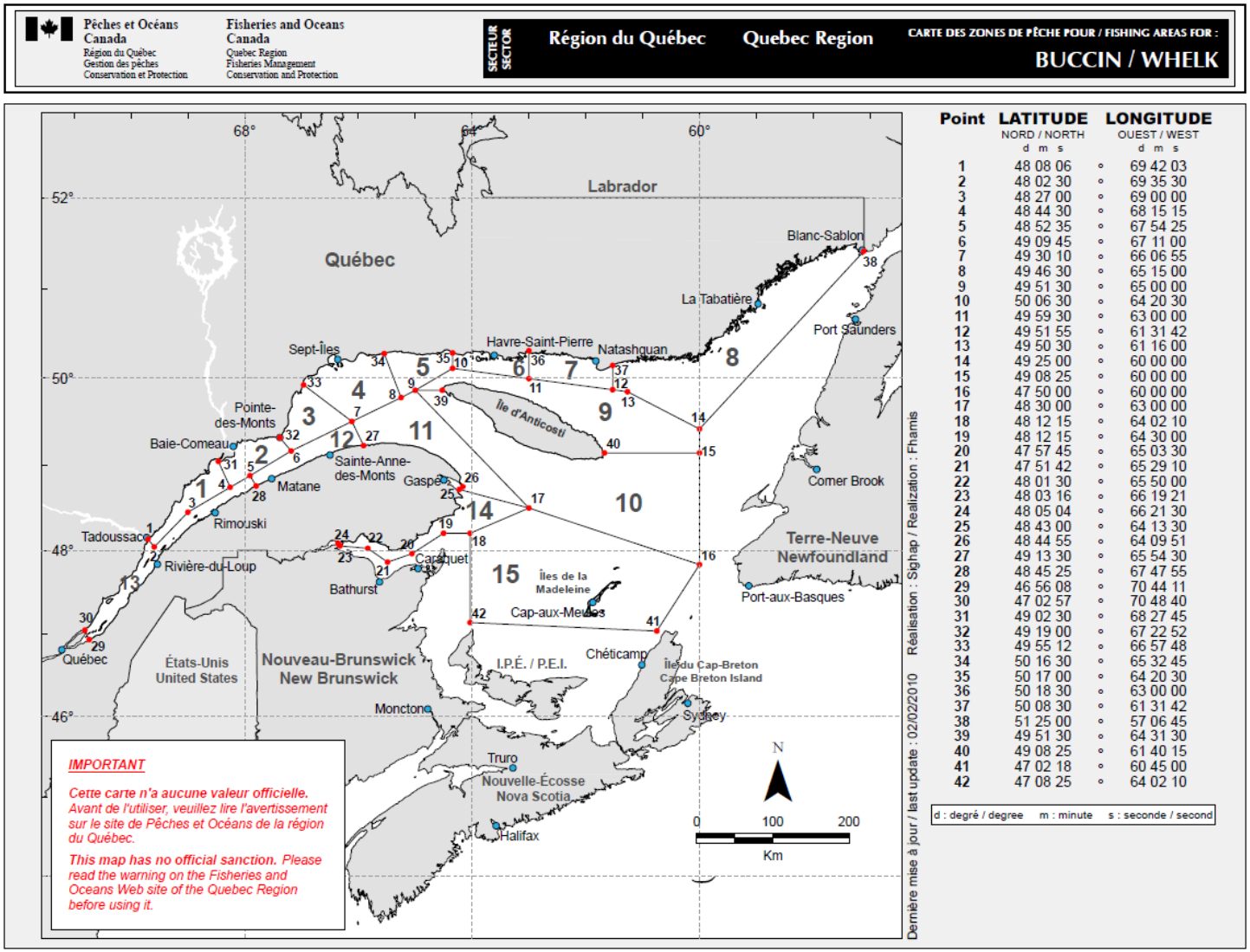
Appendix 5. Parameters of linear relationships between total live weight and height of Buccinum undatum and estimated weight of an 80 mm whelk from research surveys conducted in Forestville, Pointe-aux-Outardes and Baie-Comeau since 2005.

Area	Year	Equation	R^2	*n*	Weight (g) for an 80 mm whelk
Forestville	2005	ln(y) = 2.897 ln(x) – 8.566	0.974	303	62
	2007	ln(y) = 2.875 ln(x) – 8.566	0.992	176	56
	2009	ln(y) = 2.904 ln(x) – 8.594	0.991	324	62
	2011	ln(y) = 2.930 ln(x) – 8.708	0.993	269	62
	2013	ln(y) = 2.914 ln(x) – 8.663	0.992	238	61
Pointe-aux-Outardes	2005	ln(y) = 2.861 ln(x) – 8.447	0.963	133	60
	2007	ln(y) = 2.805 ln(x) – 8.244	0.987	155	57
	2009	ln(y) = 2.927 ln(x) – 8.696	0.992	261	62
	2011	ln(y) = 2.881 ln(x) – 8.556	0.995	196	58
	2013	ln(y) = 2.894 ln(x) – 8.609	0.995	191	59
Baie-Comeau	2005	ln(y) = 2.823 ln(x) – 8.297	0.972	209	59
	2007	ln(y) = 2.797 ln(x) – 8.244	0.984	137	55
	2009	ln(y) = 2.975 ln(x) – 8.909	0.995	250	62
	2011	ln(y) = 2.924 ln(x) – 8.750	0.993	171	58
	2013	ln(y) = 2.820 ln(x) – 8.258	0.988	123	60

Appendix 6. Location (latitude and longitude WGS84) of sampling stations for the whelk harvest conducted during the 2013 Îles-de-la-Madeleine scallop research survey.

Station	Latitude (N)	Longitude (W)
41	47° 09.636'	61° 46.972'
76	47° 08.363'	61° 48.987'
77	47° 08.639'	61° 48.013'
79	47° 08.498'	61° 45.799'
96	47° 07.931'	61° 50.180'
98	47° 08.138'	61° 48.012'
117	47° 07.490'	61° 51.022'
141	47° 07.000'	61° 46.797'
142	47° 07.007'	61° 45.798'
147	47° 07.026'	61° 41.000'
171	47° 06.504'	61° 36.203'
181	47° 06.002'	61° 40.796'
188	47° 06.011'	61° 33.980'
194	47° 05.363'	61° 40.008'
198	47° 05.497'	61° 35.991'
206	47° 05.000'	61° 40.037'
220	47° 04.517'	61° 38.016'
228	47° 03.862'	61° 41.002'
230	47° 04.001'	61° 38.995'
300	47° 08.638'	61° 51.007'
302	47° 05.861'	61° 45.002'
303	47° 05.500'	61° 44.798'
305	47° 05.498'	61° 42.798'
311	47° 04.003'	61° 36.794'
503	47° 17.003'	62° 08.207'
513	47° 15.362'	62° 10.002'
518	47° 14.998'	62° 08.996'
520	47° 14.662'	62° 06.888'
522	47° 14.494'	62° 07.995'
527	47° 14.019'	62° 06.038'
530	47° 13.362'	62° 08.001'
536	47° 13.004'	62° 05.795'
541	47° 12.362'	62° 04.999'
554	47° 11.502'	62° 03.206'
556	47° 11.561'	62° 01.185'
562	47° 11.006'	62° 02.796'
563	47° 10.981'	62° 01.947'
577	47° 10.000'	61° 57.799'

Appendix 7. 2014 whelk Fishing Areas in Québec.



Appendix 8. Implementation year of various management measures and changes for commercial whelk fisheries.

Management measures	Year	Details
Fishing season	2000	Areas 1 to 7 and 9 to 15: 6 months, except in Area 8 (12 months).
	2004	Area 8: Reduced to 8 months
	2005	Area 8: Reduced to 7 months
	2007	Area 8: Reduced to about 6 months
Number of traps	1999	Areas 1 to 7 and 11 to 13: Fishermen who made landings in 1996 and 1997 are entitled to use 150 traps (volume ≤ 0.15 m^3). Other fishermen are entitled to use 100 traps (volume ≤ 0.3 m^3). Areas 8, 9 and 15: 100 traps ≤ 0.3 m^3.
	2007	Areas 1 to 14: The number of traps allocated to fishermen who did not report any landings from 2000 to 2005 was reduced to 50.
	2011	North Shore and Gaspé–Lower St. Lawrence: Licence buy-back (reduces potential effort) with the option of increasing the number of traps. Area 15: Option to use 150 traps if the fisherman chooses to shorten his fishing season from August to October.
Minimum legal size	2000	Areas 1 to 15: 65 mm
	2001	Areas 1 to 15: 66 mm
	2002	Areas 1 to 9 and 15: 67 mm Areas 11 to 14: 70 mm
	2003	Areas 1 to 9: 68 mm Area 15 = 70 mm
	2004	Areas 1 to 9: 69 mm
	2005	All Areas: 70 mm
TAC	2001	Area 1: 491 t Area 2: 109 t
	2003	Area 15A (southern portion of Area 15): 400 t
	2006	Area 15 (grouping of subareas 15 and 15A): 450 t
	2010	Area 11: 32 t Area 12: 128 t Area 13 (east of Bic): 100 t Area 13B (west of Bic): 50 t
	2011	Area 13 (east of Bic): 73 t Area 13 (west of Bic): no TAC
	2012	Area 12: 135 t Area 13: 82 t Area 15: 376 t
Buddying up		Maximum of two captains (licences) per boat with the addition of traps
	2012	Area 8
	2014	Areas 4 and 7

Appendix 9. Management measures for the 2014 commercial whelk fishery.

Area	Number of Active/ Issued Licences	Number of Active/ Authorized Traps	TAC	Season	Number of Authorized Traps per Licence
1	6 / 11	750 / 1,300 (58%) [1]	491	06/04 to 27/09	50, 100 and 150
2	3 / 6	300 / 550 (55%)	109	06/04 to 14/09	50, 100 and 150
3	3 / 7	350 / 850 (41%)		16/04 to 12/11	100 and 150
4	6 / 28	700 / 2,559 (27%)		16/04 to 15/10	50, 59, 100 and 150
5	4 / 20	550 / 1,900 (29%)		09/04 to 08/10	50, 100 and 150
6	9 [2] / 15 [2]	850 / 1,300 (65%)		09/04 to 08/10	50, 100 and 150
7	3 / 7	400 / 600 (67%)		09/04 to 08/10	50, 100 and 150
8	13 / 64	1 300 / 6,400 (20%)		24/05 to 29/11	100
9	1 / 1 [3]			09/04 to 08/10	100
10	0				
11	1 / 16	50 / 1,200 (4%)	32	01/04 to 30/09	50 and 100
12	9 / 37	950 / 2,950 (32%)	135	01/04 to 30/09	50, 100, 125, 150 and 175
13	4 / 13	350 / 1,175 (33%)	82 [4]	01/04 to 30/09	50, 100 and 175
14	1 / 13	100 / 800 (12%)		01/04 to 30/09	50 and 100
15	7 / 11	700 / 1,100 (64%)	376 [5]	28/04 to 28/11	100 or 150 [6]
Total	**69 / 249**				

[1] Percentage of active traps.

[2] Including six licences to an Aboriginal Band Council, agreement with DFO to use 400 traps instead of 600 traps (6 x 100 traps).

[3] Fishermen in Areas 5, 6 and 7 also have access to Area 9.

[4] The TAC is solely for the portion located to the east of the Bic archipelago, the only portion currently exploited.

[5] The TAC is divided equally among the 11 licence holders, who are entitled to 37.54 t each (for a total of 413 t). If the TAC is exceeded, fishermen who landed more than 34.18 t will have their quota reduced the following year by the excess amount caught.

[6] Fishermen who shorten their fishing season from August to November have the option of using 150 traps.

Appendix 10. Commercial whelk fishery landings (t) from 1995 to 2014 by region and Fishing Area and for Québec as a whole.

Year	North Shore									Gaspé–Lower St. Lawrence					Îles-de-la-Madeleine	Québec
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1995	80	cd [1]	cd	56	186	cd	cd	81	0	0	34	cd	cd	0	0	624
1996	179	cd	cd	176	275	cd	cd	82	0	0	51	cd	5	cd	0	1,032
1997	196	cd	cd	68	286	109	cd	cd	0	0	54	cd	20	0	0	995
1998	207	cd	cd	29	346	107	cd	cd	0	0	47	cd	cd	cd	0	825
1999	457	cd	cd	65	493	cd	cd	cd	0	0	cd	cd	21	0	cd	1,453
2000	550	cd	cd	108	401	184	cd	37	0	0	cd	cd	cd	0	0	1,571
2001	589	157	cd	162	359	201	0	cd	0	0	cd	cd	cd	0	0	1,573
2002	594	132	cd	143	310	243	cd	6	0	0	cd	32	23	cd	cd	1,649
2003	408	cd	cd	149	385	282	cd	90	0	0	25	34	cd	cd	388	2,000
2004	204	71	39	161	322	279	cd	7	0	0	cd	39	cd	cd	369	1,628
2005	202	72	cd	114	272	193	cd	63	cd	0	cd	84	24	0	442	1,623
2006	247	cd	28	107	221	196	cd	47	cd	0	34	150	34	0	392	1,587
2007	151	cd	14	83	168	152	cd	21	0	0	cd	127	cd	0	382	1,269
2008	118	cd	cd	48	146	216	cd	24	0	0	cd	117	67	0	352	1,147
2009	300	cd	cd	51	274	330	cd	11	0	0	cd	110	57	0	cd	1,255
2010	204	cd	cd	60	363	358	cd	38	0	0	cd	129	91	0	150	1,484
2011	132	cd	cd	42	312	314	cd	22	0	0	cd	95	78	0	265	1,368
2012	114	cd	cd	64	409	296	cd	27	0	0	cd	75	81	0	239	1,432
2013	241	cd	cd	82	250	280	cd	36	cd	0	cd	70	66	cd	327	1,445
2014	290	cd	cd	41	cd	270	cd	23	cd	0	cd	46	cd	cd	15	951
Average [2]	269	70	22	97	292	257	52	30	cd	0	15	82	51	cd	258	1,497
Variation [3]	8%			- 58%		5%		- 23%				- 45%	27%		- 94%	- 36%

[1] cd = confidential data (four fishermen or fewer).
[2] 2001–2013 baseline level, except for Area 15, where the 2003–2013 average was used.
[3] Variation between the 2014 value and the baseline level.

Appendix 11. 2002 to 2014 commercial whelk fishing effort (number of trap hauls x 10^2) by region and Fishing Area and for Québec as a whole.

Year	North Shore								Gaspé–Lower St. Lawrence		Îles-de-la-Madeleine	Québec
	1	2	3	4	5	6	7	8	12	13	15	
2002	507	147	cd [1]	472	885	479	cd	15	117	53	cd	2,937
2003	433	cd	cd	547	1,097	711	cd	262	124	cd	155	3,858
2004	297	81	68	533	1,062	891	cd	20	131	cd	185	3,563
2005	277	105	cd	414	854	758	cd	143	266	55	192	3,409
2006	319	cd	49	354	658	646	cd	150	369	63	172	3,052
2007	223	cd	30	246	538	472	cd	53	324	cd	178	2,317
2008	153	cd	cd	164	409	569	cd	75	303	109	164	2,062
2009	331	cd	cd	149	622	643	cd	23	272	85	cd	2,291
2010	288	cd	cd	207	758	643	cd	131	278	101	65	2,619
2011	195	cd	cd	106	547	634	cd	67	215	88	136	2,147
2012	136	cd	cd	157	799	675	cd	79	199	cd	119	2,449
2013	217	cd	cd	190	625	610	cd	87	180	90	172	2,306
2014	277	cd	cd	106	cd	610	cd	69	189	cd	26	1,731
Average [2]	281	69	36	295	738	644	84	92	232	85	130	2,751
Variation [3]	- 2%			- 64%	- 60%	- 14%		- 25%	- 18%		- 79%	- 37%

[1] cd = confidential data (four fishermen or fewer).

[2] 2002–2013 baseline level, except for Area 15, where the 2003–2013 average was used.

[3] Variation between the 2014 value and the baseline level.

Appendix 12. Standardized catch per unit effort (kg/trap) in the 2001 to 2014 commercial whelk fishery by region and Fishing Area.

Year	North Shore								Gaspé–Lower St. Lawrence		Îles-de-la-Madeleine
	1	2	3	4	5	6	7	8	12	13	15
2001	12.7	12.3	6.5	4.6	4.2	4.7			2.8	4.5	
2002	11.0	8.6	5.5	3.1	4.1	5.5	11.4	4.9	2.6	4.0	21.9
2003	8.9	11.2	5.6	2.9	4.1	4.2	3.6	3.6	2.2	3.5	23.0
2004	6.4	8.7	5.7	3.0	3.5	3.6	7.4	3.8	2.7	3.9	20.3
2005	7.0	7.8	4.9	3.0	3.6	3.1	7.6	4.8	3.2	4.4	22.0
2006	7.5	7.3	5.6	3.2	3.8	3.4	9.4	3.5	3.8	5.3	21.0
2007	6.7	13.8	4.6	3.6	3.3	3.6	7.9	4.8	4.2	6.0	20.4
2008	7.2	11.4	4.4	3.0	3.9	4.1	5.5	3.9	3.5	6.0	19.3
2009	8.7	9.7	2.7	3.5	5.0	5.6	7.8	5.5	3.9	6.1	23.0
2010	7.1	10.3	5.3	3.0	5.6	5.3	5.6	3.5	4.1	8.3	22.3
2011	6.6	12.5	3.4	3.8	6.4	5.1	5.5	3.7	4.1	8.8	18.0
2012	7.9	10.4	4.4	4.1	6.0	4.5	6.8	4.1	3.7	7.3	18.3
2013	10.2	10.7	3.8	4.6	4.4	4.5	6.8	5.0	3.9	6.9	17.4
2014	10.4	10.3	3.4	4.0	4.1	4.7	5.5	3.9	2.2	7.3	3.9
Average [1]	8.3	10.4	4.8	3.5	4.5	4.4	7.1	4.3	3.4	5.8	20.3
Variation [2]	25%	0%	- 29%	14%	- 9%	7%	- 23%	- 9%	- 36%	26%	- 81%

[1] 2001–2013 baseline level, except for Area 15, where the 2003–2013 average was used.

[2] Variation between the 2014 value and the baseline level.

Appendix 13. Average size (mm) of whelk landed by region and Fishing Area during the commercial whelk fishery from 1995 to 2014.

Year	North Shore								Gaspé–Lower St. Lawrence		Îles-de-la-Madeleine
	1	2	3	4	5	6	7	8	12	13	15
1995	68			73	77	75		74		67	
1996				79		78		66		69	
1997	74	73		84	79	82		65		65	
1998	76	67	89	82	81	79	76	70	76	66	
1999	75	70	82	81	78	86	78	73		62	
2000	76	65	85	84	80	84	79	75	84		
2001	77	74	83	83	82	87			85	57	
2002	76	72	86	84	80	87	80	70	84	61	70
2003	72	74		89	83	85	83	80	87	67	80
2004	73	72	87	87	81	81	82		85	70	82
2005	74	74		87	80	83	81	77	88	77	82
2006	77	71		83	80	87	84	76	85	80	83
2007	79	74		89	85	85	83	76	85	87	81
2008	78	72		89	85	83	87	71	88	83	88
2009	78	79		89	86	84	87	74	87	83	88
2010	79	82		90	89	88	87	75	88	87	85
2011	81	75		91	88	88	90	73	87	85	87
2012	80	78	92	95	90	89	90	74	89	85	83
2013	79	78		94	91	88	90	73	89	85	85
2014	78	82		95	88	88	86	75	90	84	93
Average [1]	78	76	89	89	85	86	86	74	87	82	84
Variation [2]	0%	8%		7%	3%	3%	0%	1%	4%	2%	10%

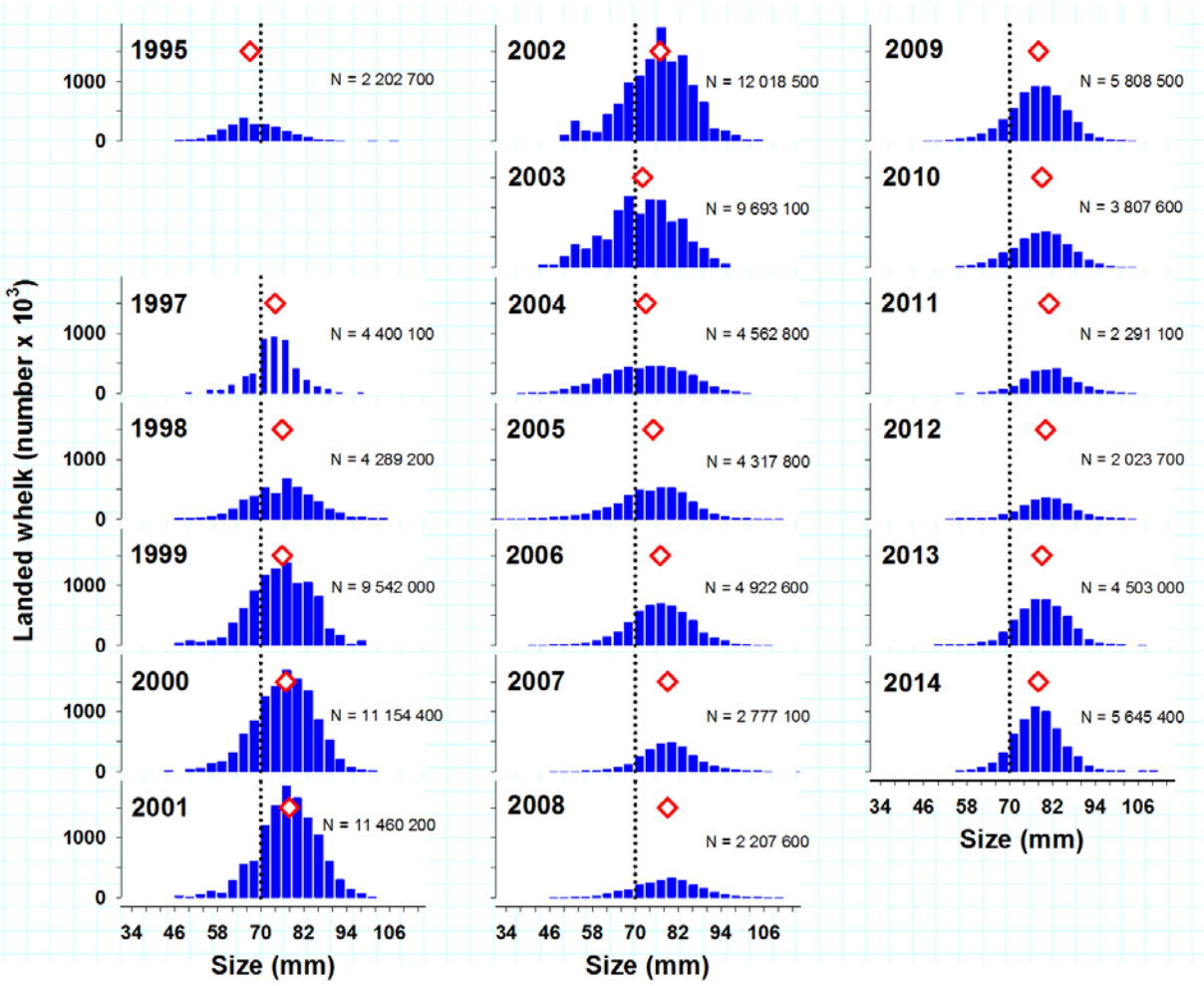
[1] 2004–2013 baseline level.

[2] Variation between the 2014 value and the baseline level.

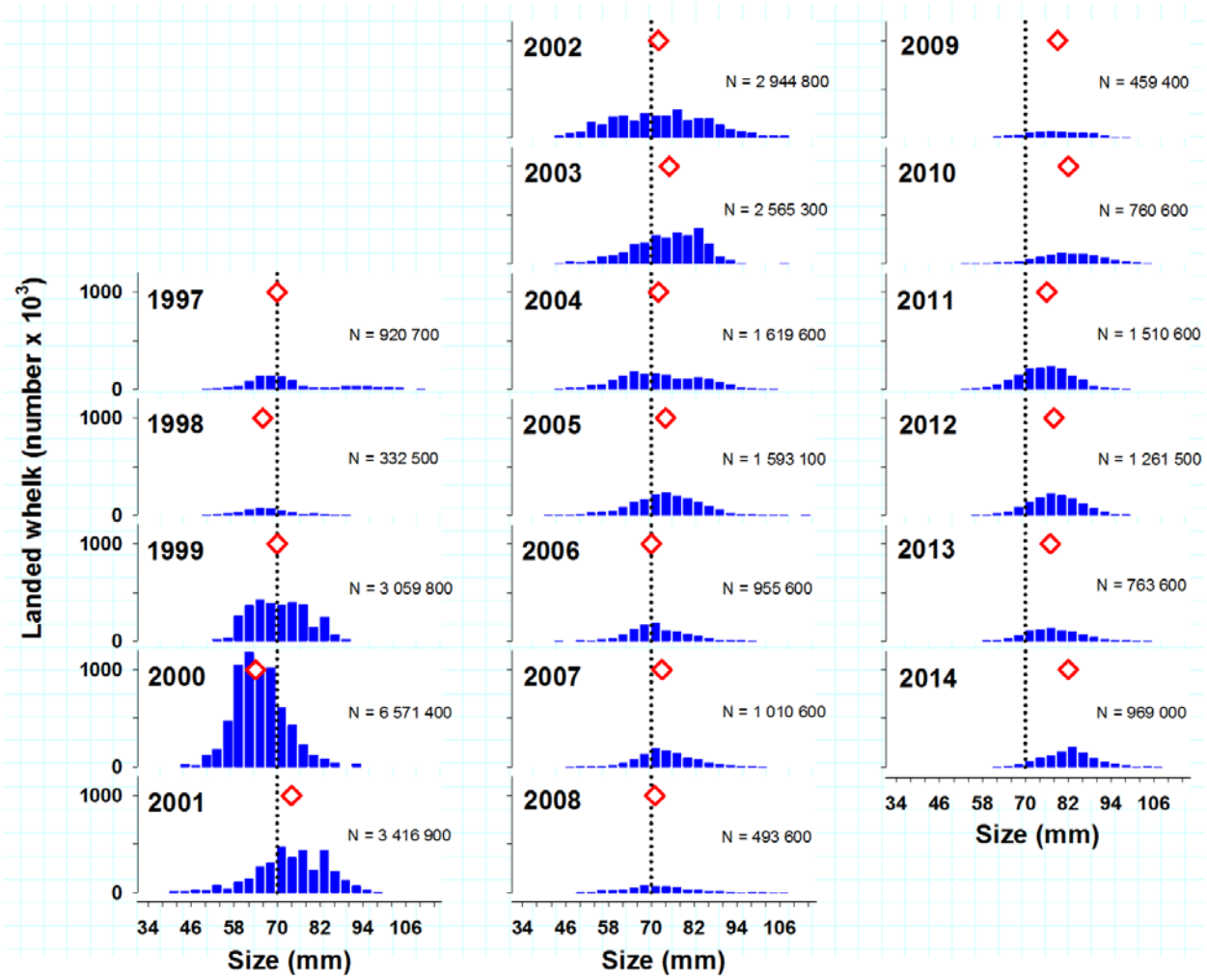
Appendix 14. Percentage (%) of sub-legal size whelk in commercial whelk fishery landings from 2004 to 2014 by region and Fishing Area.

Year	North Shore								Gaspé–Lower St. Lawrence		Îles-de-la-Madeleine
	1	2	3	4	5	6	7	8	12	13	15
2004	38	43	2	6	14	13	9		11	48	8
2005	29	30		4	11	10	9	27	3	16	8
2006	19	41		14	15	3	4	26	4	9	4
2007	8	27		3	6	4	10	27	3	1	7
2008	15	43		3	4	6	5	40	2	6	2
2009	14	12		3	2	6	4	32	2	6	1
2010	12	6		2	2	2	7	27	3	2	2
2011	5	21		2	1	2	2	32	3	<1	1
2012	7	10	<1	<1	1	2	1	32	3	1	3
2013	8	12		<1	1	2	2	32	2	<1	7
2014	10	2		<1	4	2	3	19	2	<1	1
Average 2004-2013	**15**	**25**	**1**	**4**	**6**	**5**	**5**	**31**	**4**	**9**	**4**

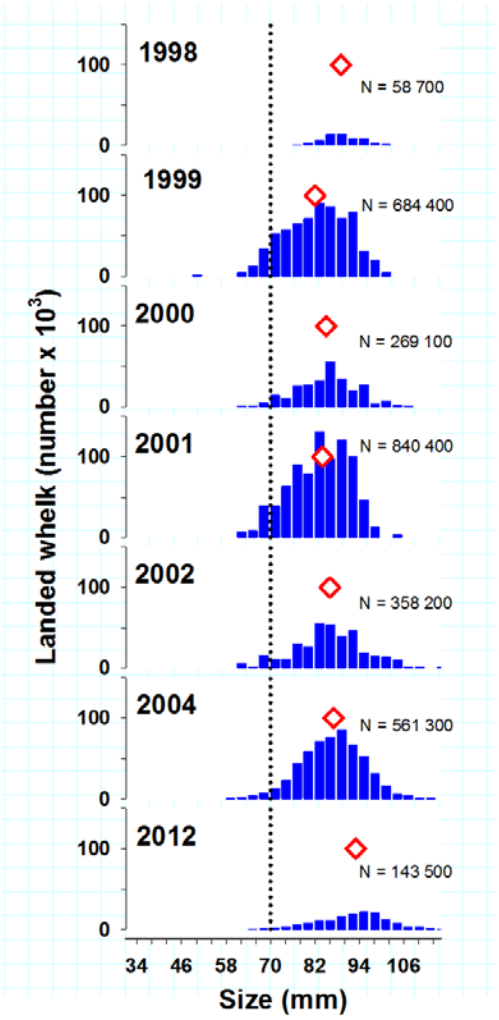
Appendix 15. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1995 to 2014 in Fishing Area 1. The vertical line represents the 70 mm minimum legal size.



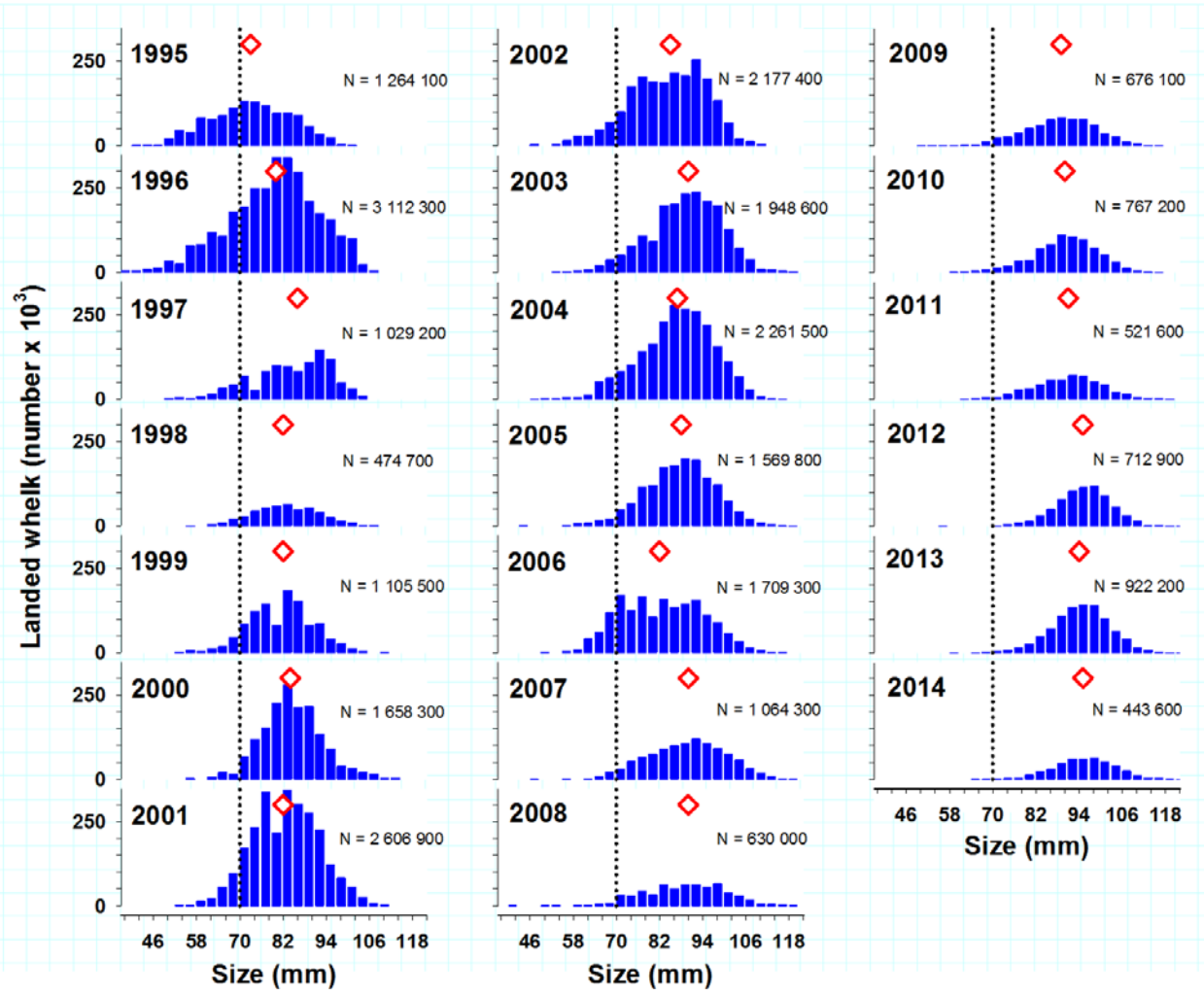
Appendix 16. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1997 to 2014 in Fishing Area 2. The vertical line represents the 70 mm minimum legal size.



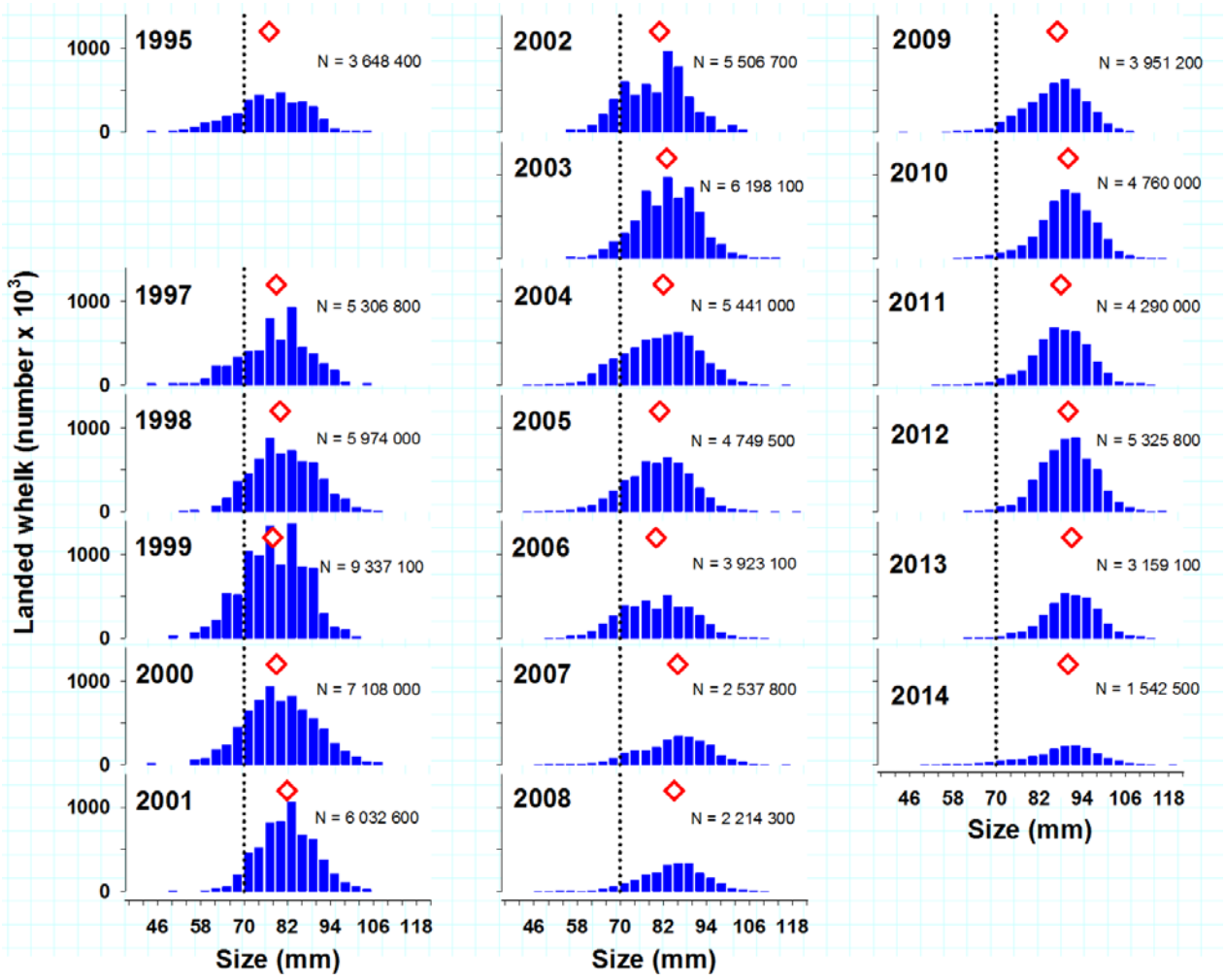
Appendix 17. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1998 to 2012 in Fishing Area 3. The vertical line represents the 70 mm minimum legal size.



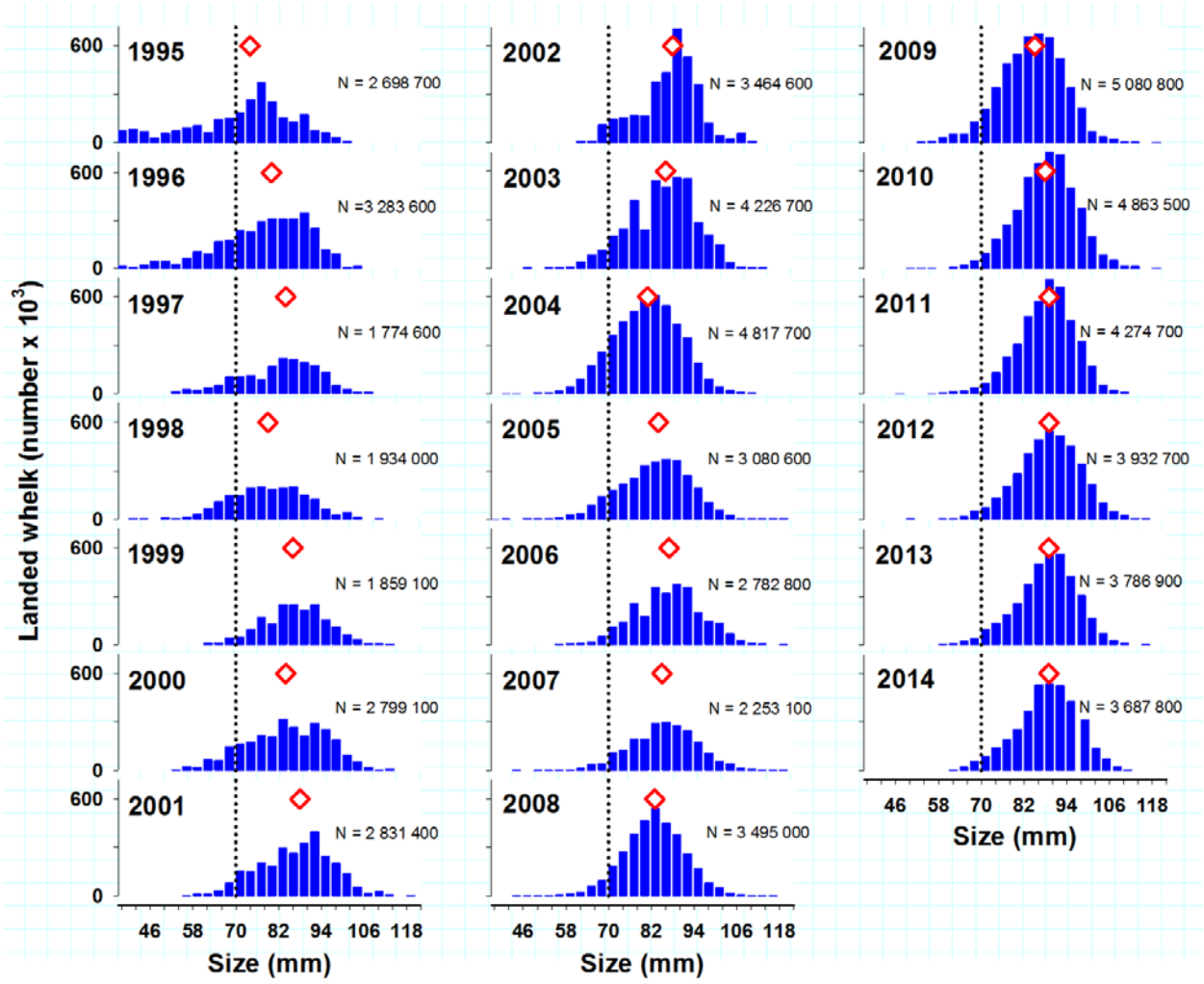
Appendix 18. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1995 to 2014 in Fishing Area 4. The vertical line represents the 70 mm minimum legal size.



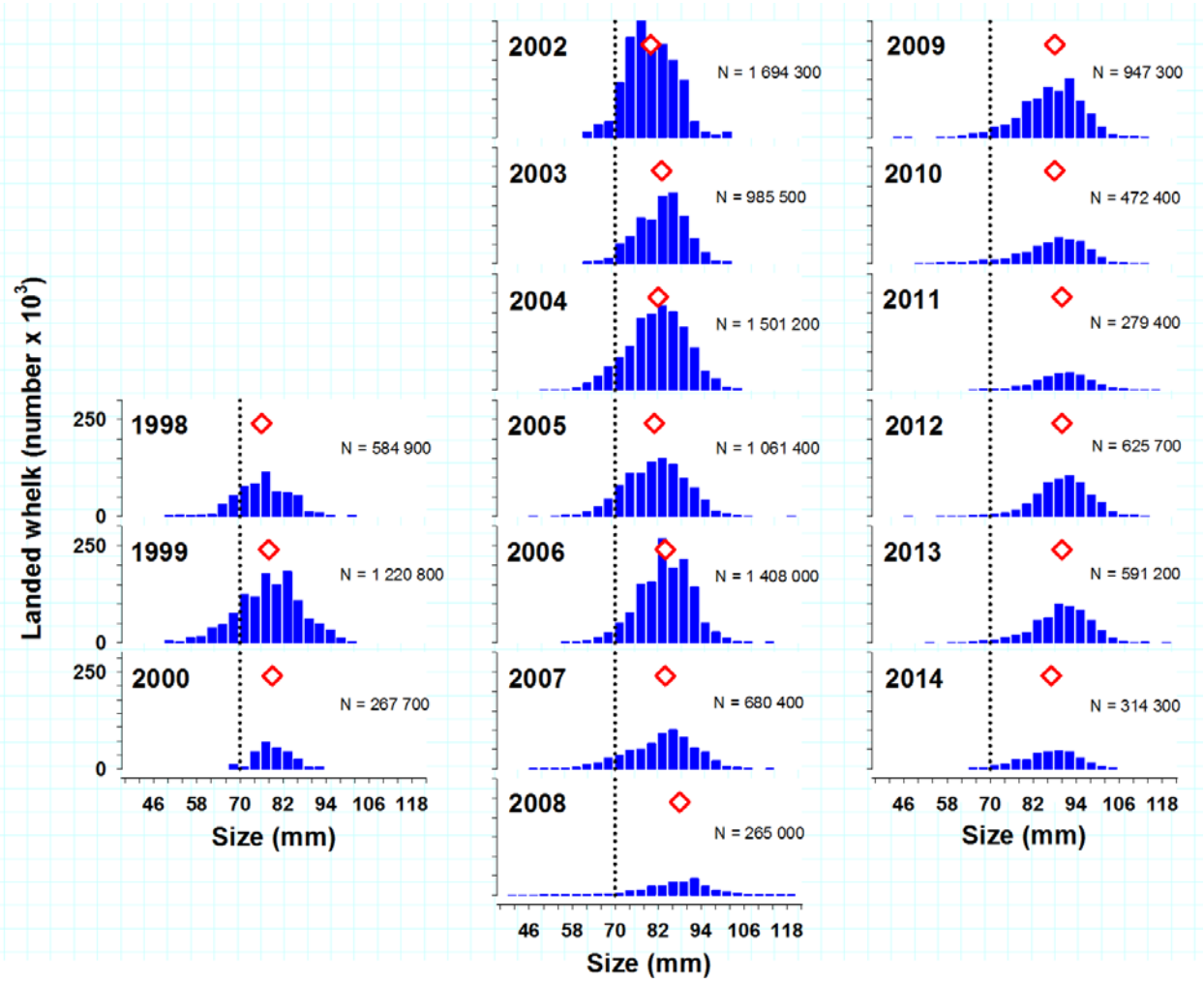
Appendix 19. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1995 to 2014 in Fishing Area 5. The vertical line represents the 70 mm minimum legal size.



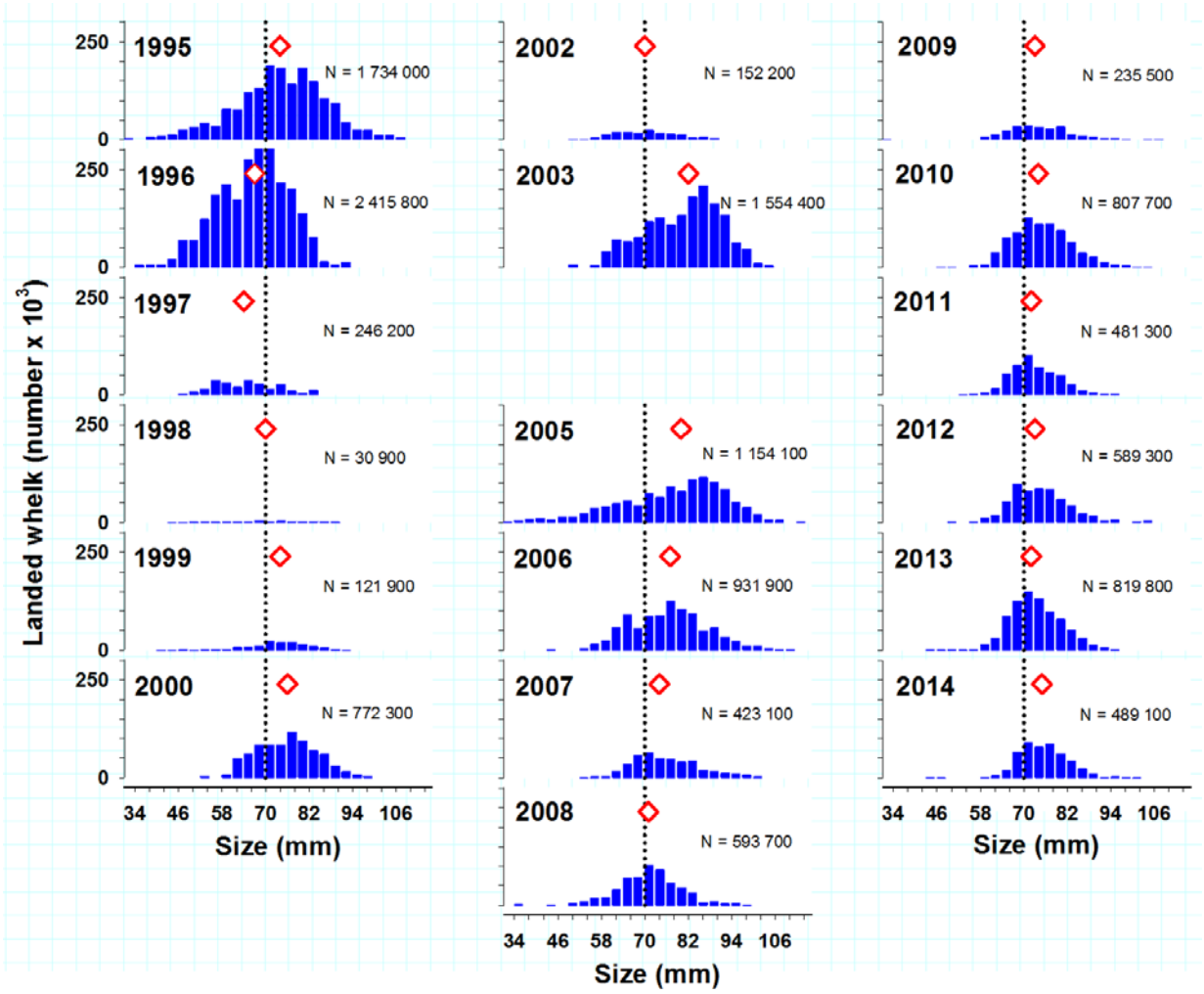
Appendix 20. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1995 to 2014 in Fishing Area 6. The vertical line represents the 70 mm minimum legal size.



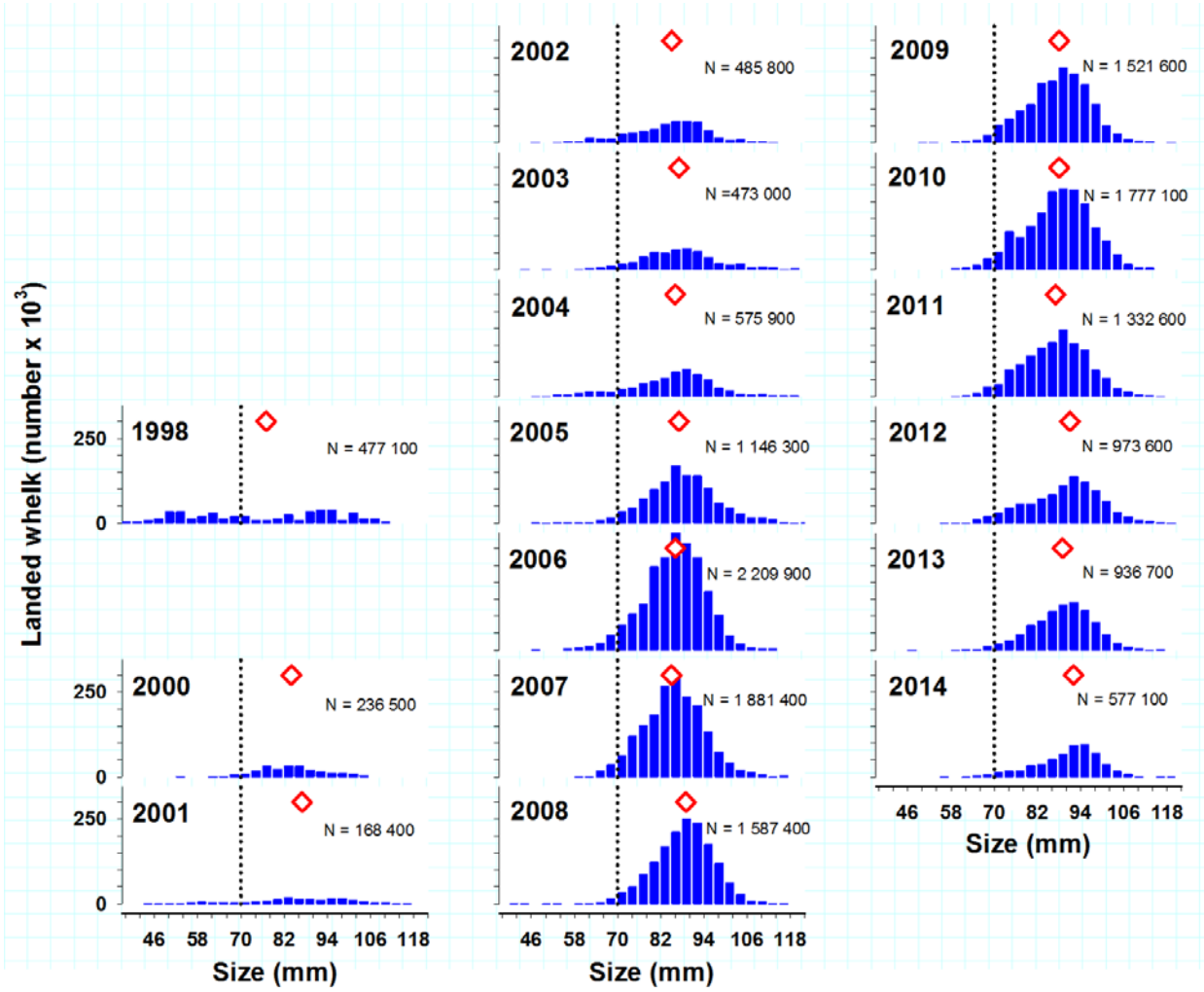
Appendix 21. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1998 to 2014 in Fishing Area 7. The vertical line represents the 70 mm minimum legal size.



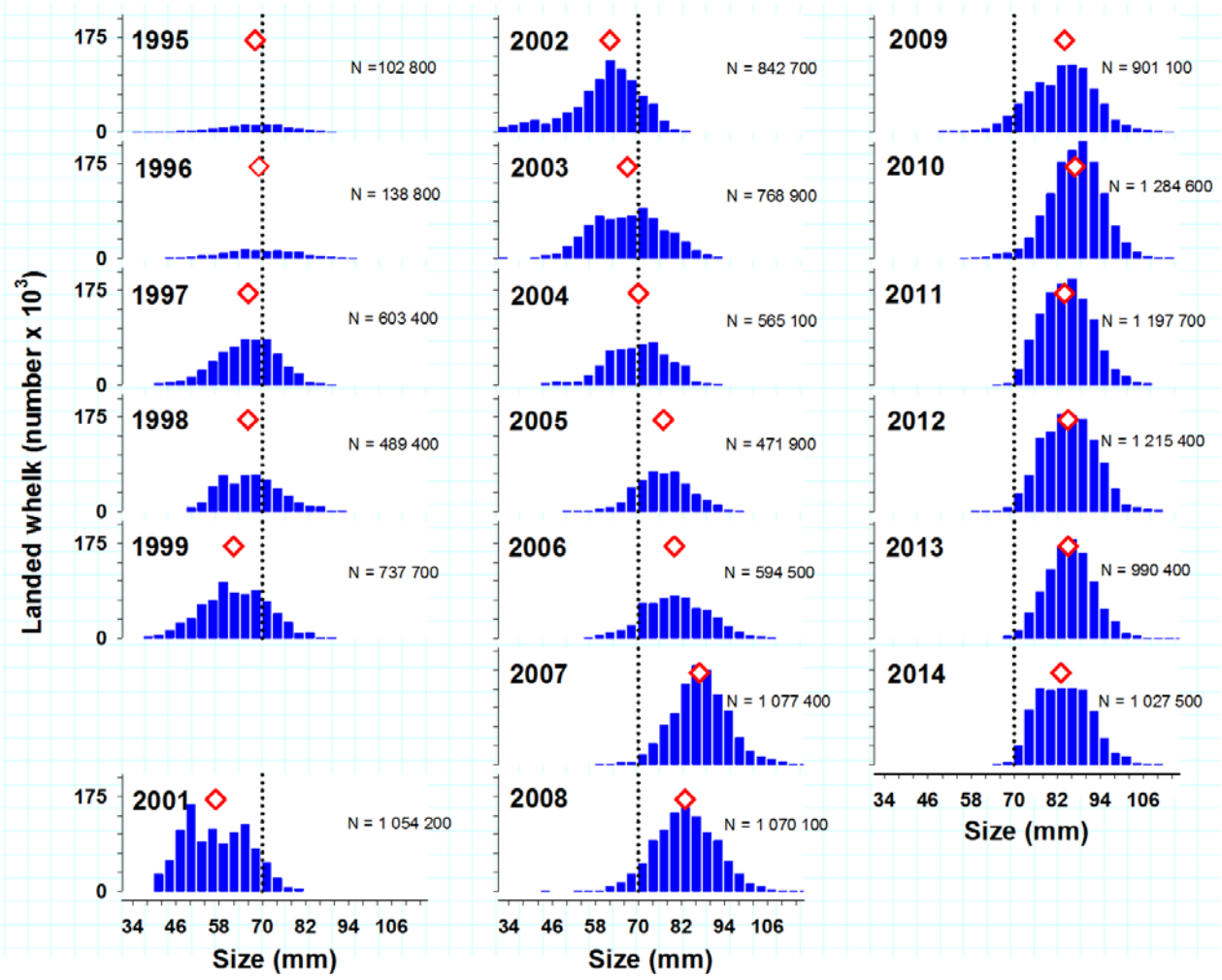
Appendix 22. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1995 to 2014 in Fishing Area 8. The vertical line represents the 70 mm minimum legal size.



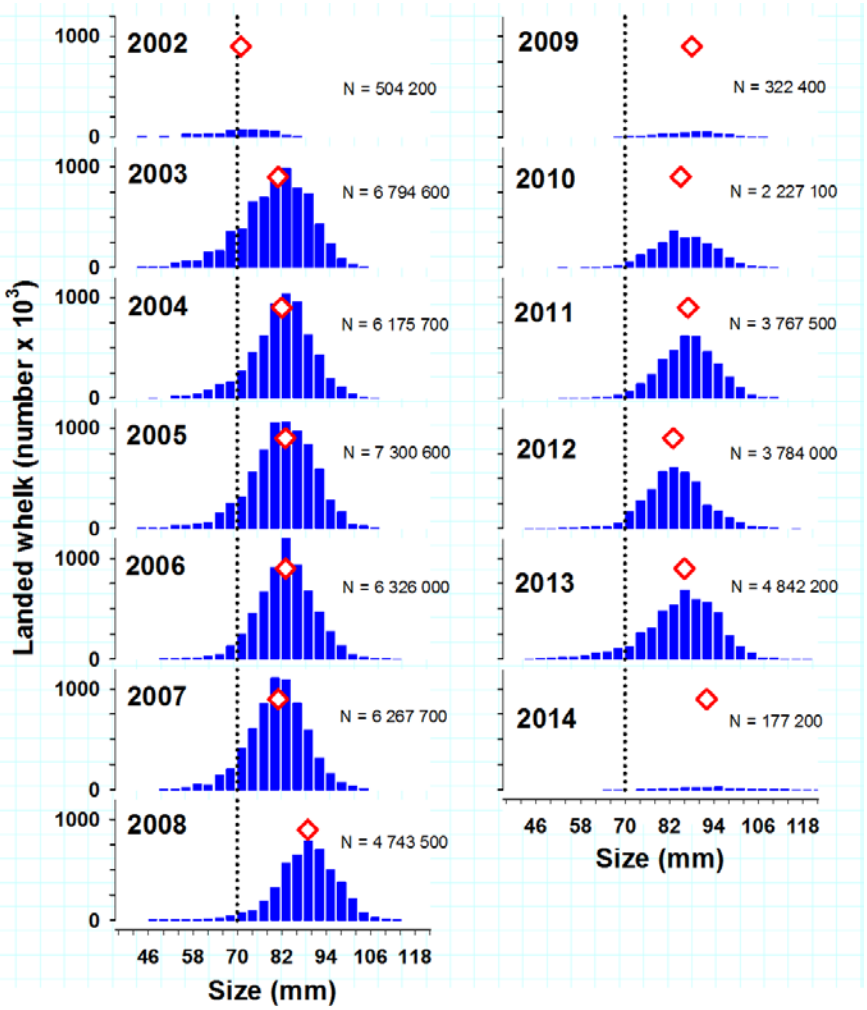
Appendix 23. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1998 to 2014 in Fishing Area 12. The vertical line represents the 70 mm minimum legal size.



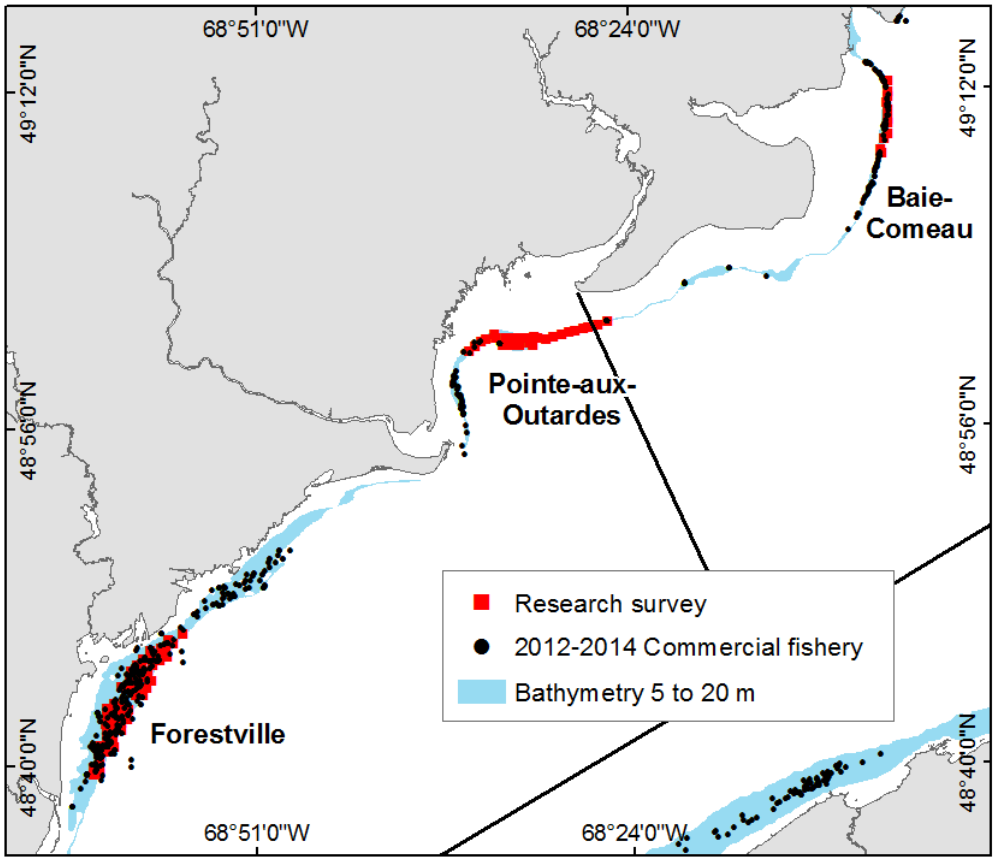
Appendix 24. Landed whelk size structure, median size (red diamond) and number of individuals landed from 1995 to 2014 in Fishing Area 13. The vertical line represents the 70 mm minimum legal size.



Appendix 25. Landed whelk size structure, median size (red diamond) and number of individuals landed from 2002 to 2014 in Fishing Area 15. The vertical line represents the 70 mm minimum legal size.



Appendix 26. Distribution of 2012 to 2014 commercial fishing effort in the Forestville, Pointe-aux-Outardes and Baie-Comeau areas of the research survey.



Appendix 27. Average density and number of individuals harvested (in parentheses) of the various species of Buccinum and percentage (%) of B. undatum (density) of all Buccinum by area and year during the Upper North Shore research surveys.

Area and Year	Density (number/100 m^2) and Number					Percentage (%)
	B. undatum	***B. glaciale***	***B. scalariforme***	***B. totteni***	***Buccinum* ssp.**	
Forestville						
2009	6.421 (3,343)	0.022 (11)	0.002 (1)	0.073 (40)	0.002 (1)	98.5%
2011	11.832 (6,241)	0.059 (30)	0	0.281 (132)	0.002 (1)	97.2%
2013	15.723 (7,754)	0.052 (26)	0.002 (1)	0.162 (81)	0.002 (1)	98.6%
Pointe-aux-Outardes						
2009	4.561 (1,106)	0	0.004 (1)	0.181 (42)	0	96.1%
2011	11.911 (2,912)	0	0.015 (3)	0.029 (7)	0	99.6%
2013	6.833 (1,605)	0	0.004 (1)	0.004 (1)	0	99.9%
Baie-Comeau						
2009	24.264 (2,429)	0	0.010 (1)	0.040 (4)	0.010 (1)	99.8%
2011	41.683 (4,396)	0	0	0.046 (5)	0.010 (1)	99.9%
2013	36.217 (3,297)	0	0	0	0.0011 (1)	100.0%

Appendix 28. Whelk location (latitude and longitude WGS84), density (number/100 m^2) and yield (g/100 m^2) by area and station during the 2013 research survey.

Area and Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
				Subleg [1]	Leg [2]	Subleg [1]	Leg [2]
Forestville							
1	48° 46.232'	68° 56.511'	307	24.34	9.25	821.6	526.2
2	48° 45.821'	68° 57.092'	300	22.77	7.78	625.5	460.7
3	48° 45.841'	68° 57.643'	305	17.17	5.32	434.9	285.5
4	48° 45.509'	68° 57.606'	303	8.92	3.79	298.0	222.3
5	48° 45.552'	68° 58.073'	306	14.48	6.30	479.4	336.9
6	48° 45.511'	68° 58.659'	298	20.40	7.25	660.2	395.6
7	48° 45.115'	68° 57.629'	317	4.37	1.81	160.6	112.4
8	48° 45.162'	68° 58.111'	307	17.15	4.18	448.4	223.4
9	48° 45.178'	68° 58.637'	301	18.88	6.18	554.6	352.6
10	48° 45.187'	68° 59.157'	296	17.21	6.04	546.9	330.7
11	48° 44.778'	68° 58.199'	300	6.64	1.91	195.1	108.0
12	48° 44.829'	68° 58.643'	305	24.69	7.31	683.2	401.4
13	48° 44.803'	68° 59.198'	307	24.12	8.81	762.6	512.5
14	48° 44.800'	68° 59.743'	265	45.01	12.11	1384.1	639.3
15	48° 44.467'	68° 58.699'	311	21.93	10.97	863.9	617.5
16	48° 44.438'	68° 59.163'	309	16.17	8.19	580.3	459.5
17	48° 44.460'	68° 59.768'	312	23.28	5.09	483.9	284.1
18	48° 44.462'	69° 00.233'	304	17.10	4.44	501.8	228.6
19	48° 44.120'	68° 58.637'	306	33.30	19.18	1488.8	1117.5
20	48° 44.071'	68° 59.215'	308	11.94	4.38	377.6	246.5
21	48° 44.097'	68° 59.613'	328	31.60	11.73	1109.3	681.7
22	48° 44.119'	69° 00.225'	331	19.38	5.71	524.0	322.4
23	48° 43.825'	68° 59.324'	297	18.32	8.99	725.6	508.3
24	48° 43.759'	68° 59.687'	323	12.95	6.79	526.3	409.4
25	48° 43.742'	69° 00.239'	326	21.76	6.53	596.1	368.7
26	48° 43.778'	69° 00.754'	326	12.03	5.91	467.2	334.1
27	48° 43.379'	68° 59.236'	296	13.26	9.37	670.1	564.3
28	48° 43.418'	68° 59.698'	325	12.07	3.54	350.2	204.3
35	48° 43.041'	69° 01.334'	305	32.83	4.66	651.9	269.1
36	48° 42.678'	69° 00.236'	320	9.91	5.06	394.6	307.0
37	48° 42.684'	69° 00.764'	328	13.41	4.85	398.3	276.5
38	48° 42.693'	69° 01.300'	324	5.00	2.29	193.5	141.5
39	48° 42.672'	69° 01.830'	315	12.00	3.97	386.2	232.1
40	48° 42.329'	69° 00.236'	338	8.00	4.20	322.6	252.5
41	48° 42.355'	69° 00.763'	331	15.92	6.63	561.1	380.4
42	48° 42.348'	69° 01.293'	328	5.77	3.19	247.1	191.5
43	48° 42.361'	69° 01.830'	327	18.28	6.30	611.0	368.7
44	48° 42.047'	69° 00.754'	334	12.46	5.47	440.9	320.5

Appendix 28. (continued).

Area and Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
				Subleg [1]	Leg [2]	Subleg [1]	Leg [2]
45	48° 42.035'	69° 01.288'	308	13.18	2.74	349.5	158.7
46	48° 42.071'	69° 01.805'	325	6.02	4.47	284.8	250.3
47	48° 41.628'	69° 00.765'	206	1.80	0.16	21.8	8.9
48	48° 41.653'	69° 01.256'	327	10.14	4.34	361.6	248.5
49	48° 41.710'	69° 01.780'	333	12.47	3.85	360.7	227.9
50	48° 41.298'	69° 01.335'	329	15.59	5.33	509.5	299.0
51	48° 41.288'	69° 01.849'	376	12.67	3.95	364.9	222.1
52	48° 40.938'	69° 01.299'	333	3.25	0.91	94.4	49.6
53	48° 40.988'	69° 01.807'	338	14.80	3.90	383.6	214.6
54	48° 40.946'	69° 02.327'	336	6.43	2.61	218.0	137.8
55	48° 40.588'	69° 01.863'	330	14.95	6.86	543.1	373.2
56	48° 40.570'	69° 02.356'	329	14.28	5.75	465.2	292.2
57	48° 40.259'	69° 02.345'	306	8.71	2.54	263.0	135.5
58	48° 39.872'	69° 02.364'	308	17.58	4.28	436.0	216.9
59	48° 39.914'	69° 02.873'	305	11.51	1.33	276.0	65.5
60	48° 39.506'	69° 02.316'	291	3.36	1.97	145.0	104.2
61	48° 39.550'	69° 02.978'	305	45.21	9.97	1317.5	492.0
Pointe-aux-Outardes							
6	49° 00.501'	68° 28.906'	328	5.47	2.78	238.9	149.1
7	49° 00.321'	68° 29.411'	333	0.20	0.10	7.9	5.9
8	49° 00.335'	68° 29.911'	329	0.21	0.21	13.8	13.8
9	49° 00.339'	68° 30.434'	330	14.01	6.75	516.4	376.6
10	49° 00.323'	68° 30.975'	334	22.63	12.73	942.8	672.8
11	49° 00.315'	68° 31.545'	332	10.38	4.48	425.7	224.0
12	49° 00.310'	68° 32.102'	340	4.28	1.29	165.0	68.2
13	49° 00.318'	68° 32.650'	316	2.03	1.07	85.1	57.2
14	49° 00.319'	68° 33.142'	335	4.65	2.12	183.2	118.6
15	49° 00.310'	68° 33.776'	329	1.95	1.13	92.3	75.8
16	48° 59.972'	68° 31.009'	337	4.71	4.31	290.2	276.2
17	48° 59.940'	68° 31.635'	239	17.81	10.88	810.2	651.7
18	48° 59.972'	68° 32.087'	250	0.14	0.00	3.3	0.00
19	48° 59.961'	68° 32.590'	230	27.87	15.26	1104.3	873.2
20	48° 59.989'	68° 33.104'	328	8.74	4.42	333.5	269.8
51	49° 00.516'	68° 33.896'	323	25.13	17.49	1314.6	1110.4
52	49° 00.264'	68° 34.503'	334	6.67	4.75	375.8	320.9
53	49° 00.149'	68° 34.851'	324	3.24	2.09	168.3	147.3
54	48° 59.910'	68° 35.206'	331	7.97	5.41	406.5	358.7
55	48° 59.711'	68° 35.641'	342	3.46	2.27	179.1	153.8
56	49° 00.595'	68° 28.336'	336	0.60	0.10	20.2	4.3

Appendix 28. (continued).

Area and Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
				Subleg [1]	Leg [2]	Subleg [1]	Leg [2]
57	49° 00.649'	68° 27.911'	330	2.86	1.33	112.7	68.7
58	49° 00.749'	68° 27.337'	309	0.88	0.33	36.4	21.9
59	49° 00.853'	68° 26.761'	327	0.52	0.10	15.0	4.1
60	49° 00.918'	68° 26.279'	327	1.14	0.41	43.0	22.1
61	49° 01.014'	68° 25.821'	327	0.21	0.21	10.5	10.5
Baie-Comeau							
1	49° 12.373'	68° 05.271'	266	5.46	3.56	268.3	208.9
2	49° 12.043'	68° 05.258'	284	11.76	7.96	595.0	505.2
3	49° 11.661'	68° 05.263'	273	4.21	2.48	202.2	148.1
4	49° 11.383'	68° 05.249'	279	42.81	25.47	1924.1	1353.5
5	49° 11.027'	68° 05.256'	280	87.91	54.75	4069.0	2968.4
6	49° 10.654'	68° 05.248'	278	16.30	10.22	741.8	541.6
7	49° 10.295'	68° 05.255'	282	2.16	1.44	100.5	83.8
8	49° 09.915'	68° 05.257'	275	4.05	3.44	215.2	194.2
9	49° 09.601'	68° 05.542'	276	56.40	32.86	2560.6	1802.8
10	49° 09.255'	68° 05.790'	282	135.64	38.10	4724.8	2011.7
11	49° 08.895'	68° 05.793'	279	31.68	16.20	1381.1	887.3

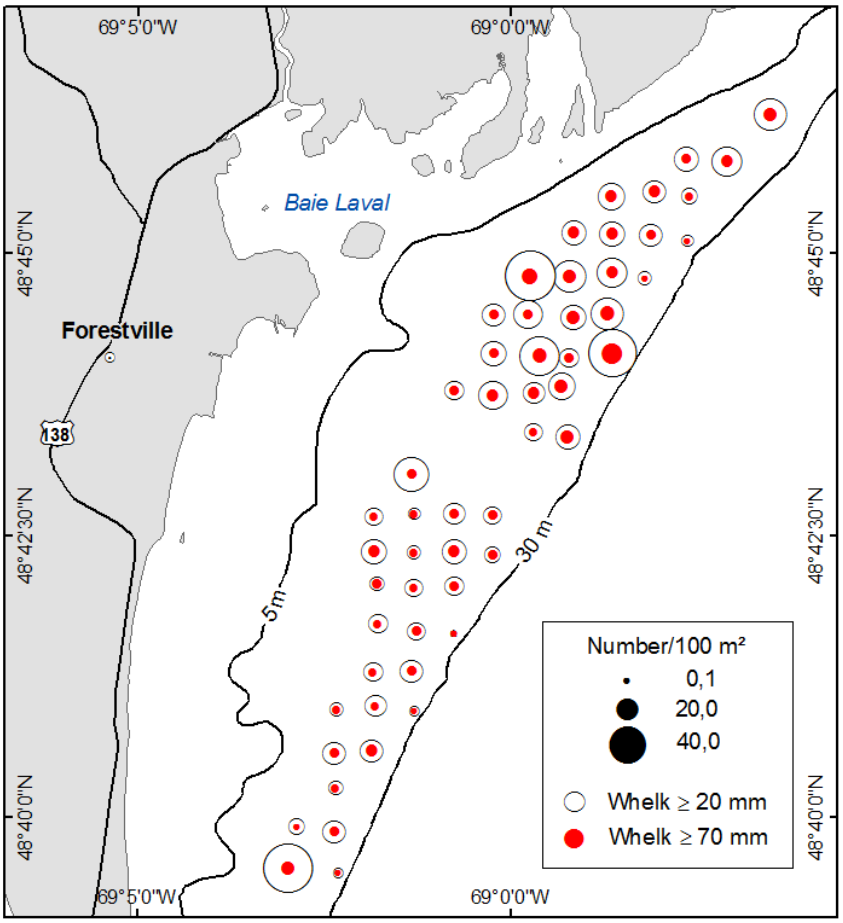
[1] Subleg = sub-legal size whelk (20 mm to 69 mm).
[2] Leg = legal size whelk(≥ 70 mm).

Appendix 29. Density (number/100 m^2) and yield (g/100 m^2) of egg masses (when present) by area and station in the 2013 research survey.

Area	Station	Density	Yield
Forestville	1	0.11	5.29
	9	0.11	14.16
	13	0.11	48.46
	19	0.11	2.38
	36	0.11	14.70
	61	0.22	4.52
Pointe-aux-Outardes	6	0.72	42.60
	9	1.64	160.73
	10	7.48	689.04
	11	0.51	52.52
	12	0.10	1.10
	13	0.11	1.12
	14	0.20	20.81
	15	0.10	5.35
	16	1.20	146.03
	17	6.08	578.23
	18	7.16	344.73
	19	7.04	375.70
	20	0.51	30.50
	51	3.67	277.04
	52	0.10	2.07
	54	0.10	0.97
	56	0.50	17.98
	57	0.51	22.67
	59	0.10	1.34
	60	0.10	0.50
Baie-Comeau	2	0.48	19.99
	3	0.12	1.39
	4	1.94	345.94
	5	6.27	1,280.86
	6	0.12	3.77
	8	0.25	84.96
	9	2.70	392.45
	10	4.31	641.53
	11	1.57	186.29

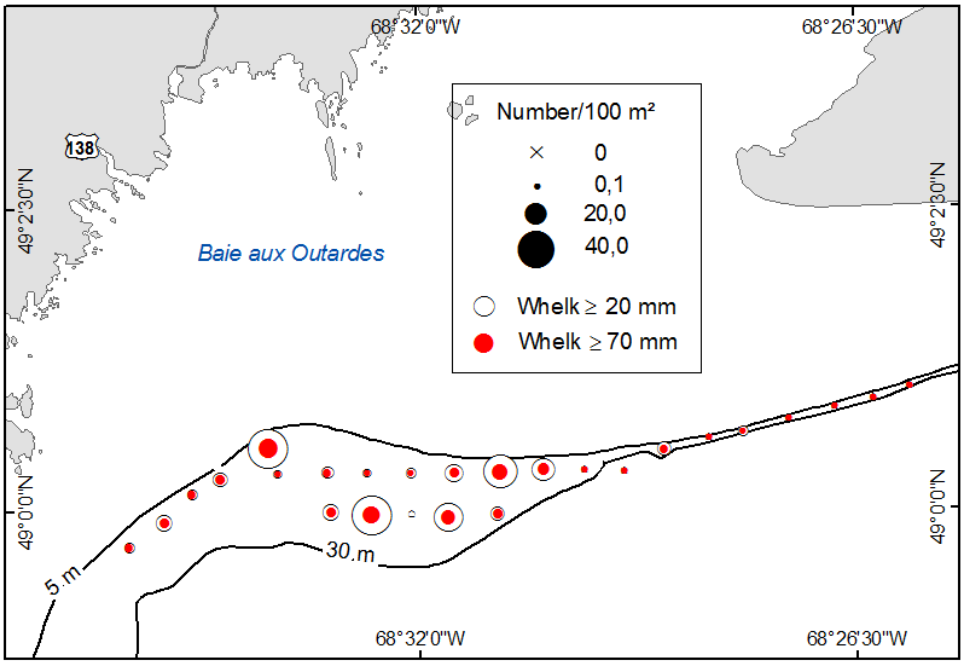
Appendix 30. Density (number/100 m^2) of all whelk (≥ 20 mm) and legal size whelk (≥ 70 mm) per station during the 2013 research survey in A) Forestville, B) Pointe-aux-Outardes and C) Baie-Comeau.

A)



Appendix 30. (continued).

B)



C)