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Évaluation des stocks de buccin des eaux côtières du Québec

Assessment of whelks stocks of Québec's coastal waters

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ABSTRACT

The status of whelk stocks in Québec's inshore waters is primarily determined based on commercial fishery indicators. This paper presents the methodologies and data presented at the February 2012 peer review.

In 2011, whelk landings totalled 1,360 t in Québec. A total of 68% of these landings were from the North Shore, 12% from the Gaspé–Lower St. Lawrence and 20% from the Îles-de-la-Madeleine. Since 2006, catches per unit effort (CPUE) have increased in Areas 5, 6 and 13, been relatively stable in Areas 1, 3, 4, 12 and 15, dropped in Areas 7 and 11, and varied in Areas 2 and 8. However, CPUE in Areas 1, 3, 11 and 15 were below baseline levels in 2011. Average sizes have been fairly stable in all areas since 2006. The proportion of sub-legal size whelk (< 70 mm) in 2011 landings was below 6% in all areas, except Areas 2 and 8.

The research survey conducted every two years in the Forestville, Pointe-aux-Outardes and Baie-Comeau areas indicated that in 2011 average densities for all whelks and the percentage of juveniles (25 mm–50 mm) were higher than in previous years in Forestville and Pointe-aux-Outardes.

RÉSUMÉ

L'état des stocks de buccin des eaux côtières du Québec est déterminé principalement à partir d'indicateurs de la pêche commerciale. Ce document présente les méthodologies et les données qui ont été présentées lors de la revue par les pairs ayant eu lieu en février 2012.

En 2011, les débarquements québécois de buccins étaient de 1 360 t et provenaient à 68 % de la Côte-Nord, 12 % de la Gaspésie–Bas-Saint-Laurent et 20 % des Îles-de-la-Madeleine. Depuis 2006, les prises par unité d'effort (PUE) ont été à la hausse dans les zones 5, 6 et 13, plutôt stables dans les zones 1, 3, 4, 12 et 15, à la baisse dans les zones 7 et 11 et variables dans les zones 2 et 8. Cependant, dans les zones 1, 3, 11 et 15, les PUE se situaient en 2011 sous leur moyenne de référence respective. Les tailles moyennes ont été à peu près stables dans toutes les zones depuis 2006. La proportion des buccins de taille sous-légale (< 70 mm) dans les débarquements de 2011 était inférieure à 6 % partout, sauf dans les zones 2 et 8.

Le relevé de recherche effectué aux deux ans dans les secteurs Forestville, Pointe-aux-Outardes et Baie-Comeau montre, qu'en 2011, les densités moyennes de l'ensemble des buccins et la proportion de juvéniles (25-50 mm) étaient plus élevées que les années précédentes à Forestville et Pointe-aux-Outardes.

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 techniques and analyses used for the assessment following the 2011 fishing season.

MATERIAL AND METHODS

BIOLOGY

Sexual maturity

In 1998, the sexual maturity of whelks was studied to complete Gendron's (1992) information for all fishing areas (Appendix 1). Traps were used to collect between 92 and 173 individuals in each area for a total of 1,316 whelks with sizes ranging from 30 mm to 102 mm. The individuals were conserved in 4% formaldehyde solution until they were analyzed in the laboratory. Sexual maturity was determined using the Martel *et al.* (1986a), Gendron (1992) and Bell and Walkers (1998) methods, which was:

$$\text{Female : gonadosomatic index} = \text{WO} + \frac{\text{WO} + \text{WOv}}{\text{Ew}} \times 100$$

$$\text{Male : Maturity index} = \frac{\text{PL}}{\text{SH}}$$

where:

- WO = weight of the ovary (0.01 g)
- WOv = weight of the oviduct (0.01 g)
- Ew = eviscerated weight (wet meat weight – weight of the digestive gland – weight of the ovary – weight of the oviduct (0.01 g)
- PL = penis length (0.1 mm)
- SH = shell height (0.1 mm)

Sexual maturity is reached when the gonadosomatic index is ≥ 6% in females or the maturity index is ≥ 0.5 in males. The percentage of mature individuals was calculated by 5-mm size class. Logistic curves were used (PROC NLIN, Marquardt method, SAS, version 9.3) to calculate the height (shell height) at which 50% of individuals are sexually mature (T_{50}):

$$Y = \frac{Y_{max}}{1 - e^{b(T_{50} + SH)}}$$

The method used to determine the T_{50} is the same as Gendron's (1992). Only the ascending portion of the curve was used in the calculations to eliminate outliers that can occur in large individuals. Parasitized individuals (gonadal atrophy in both sexes and penile atrophy in males) were not used in the calculations.

Growth

Whelk growth trials were completed in tanks from 2000 to 2003. Traps were used to harvest whelk in Fishing Area 1 from June 18 to July 20, 2000. They were kept in flow-through tanks. They were fed twice a week, mainly with pieces of herring. All whelks were identified with a numbered tag glued to the shell with cyanoacrylate. Shell height and width (to the nearest mm) (Appendix 2) and total weight (to the nearest 0.1 g) measurements

were taken on a regular basis until May 6, 2003. Average annual shell height growth was calculated based on two periods: 22/11/2000 to 28/11/2001 and 28/11/2001 to 19/11/2002. Individuals were grouped by initial 10-mm size class (beginning of period) (< 50 mm, 50 mm–59 mm, 60 mm–69 mm, 70 mm–79 mm and ≥ 80 mm).

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 receipts 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. Whelk are occasionally sampled at sea under the DFO sampling program or DFO Observers Program (coordinated by the Biorex company) to gather data on size structure and the percentage of the population caught with traps.

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 size (mm) of landed whelk and whelk caught (at sea),
- 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 calculate 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.

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 previously converted to natural logarithm) by fishing area: soak times (from 24 to 144 hours) and year, because the effect of these two variables is significant in all areas. Standardized annual CPUE was calculated for Areas 1 to 8, 11 to 13 and 15.

Appendix 3 provides the number of samples from the commercial catch sampling program (dockside and at sea) by fishing area and year for the commercial whelk fishery. Since 2004, a sample has contained about 150 measured whelks (Appendix 4). In the case of whelk, size is defined as shell height and is measured to the nearest mm (Appendix 2). Whelk size structures are aggregated by year to calculate an annual size structure by

[1] The 2001 effort data were partial and not used.

fishing area and component (dockside and at sea). The figures are aggregated to ensure each sample has the same weighting. Size structure histograms and box and whisker plots are used to provide a visual representation of changes in whelk size. The information provided with box and whisker plots includes: 1) average size (central bar in the box), 2) the 25th (Q1) and 75th (Q3) percentiles (top and bottom of the box), 3) the average size represented by a cross generally located near the median, 4) the range of values represented by the whiskers (vertical lines on either side of the box) equal to 1.5 times the interquartile range (distance between Q1 and Q3) and 5) the extreme values represented by a circle if they are between 1.5 and 3 times the interquartile range or by an asterisk, for more than 3 times the interquartile range.

The confidence interval for the average annual CPUE and average size values is 95%. Baseline landings and CPUE are calculated for each fishing area for the period 2001 to 2010, and fishing effort is calculated for the period 2002 to 2010. Because the Îles-de-la-Madeleine fishery started in 2003, the baseline period for these three indicators is 2003 to 2010. Baseline sizes are calculated for the period 2004 to 2010. The rate of change between the value of the 2011 indicator and the baseline level is calculated as follows:

$$\text{Rate of change} = \frac{\text{2011 value} - \text{baseline level}}{\text{baseline level}} \times 100$$

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 four active fishermen, landing and fishing effort values are not presented in this paper in order to keep the information confidential.

RESEARCH SURVEY

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 (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, between 8 m and 30 m of depth (Appendix 5 and Table 1). In 2005, 11 stations in Forestville were surveyed using only a beam trawl. Three of these stations were re-surveyed using a dredge. However, the stations surveyed only by trawl were not used in the various calculations. Seven stations were added to the sampling design in 2007 in Pointe-aux-Outardes to better cover the area. During dredging, start and end positions are noted to calculate the distance travelled for each dredge. The area covered at each station is the product of basket width (4 x 0.76 m) and distance.

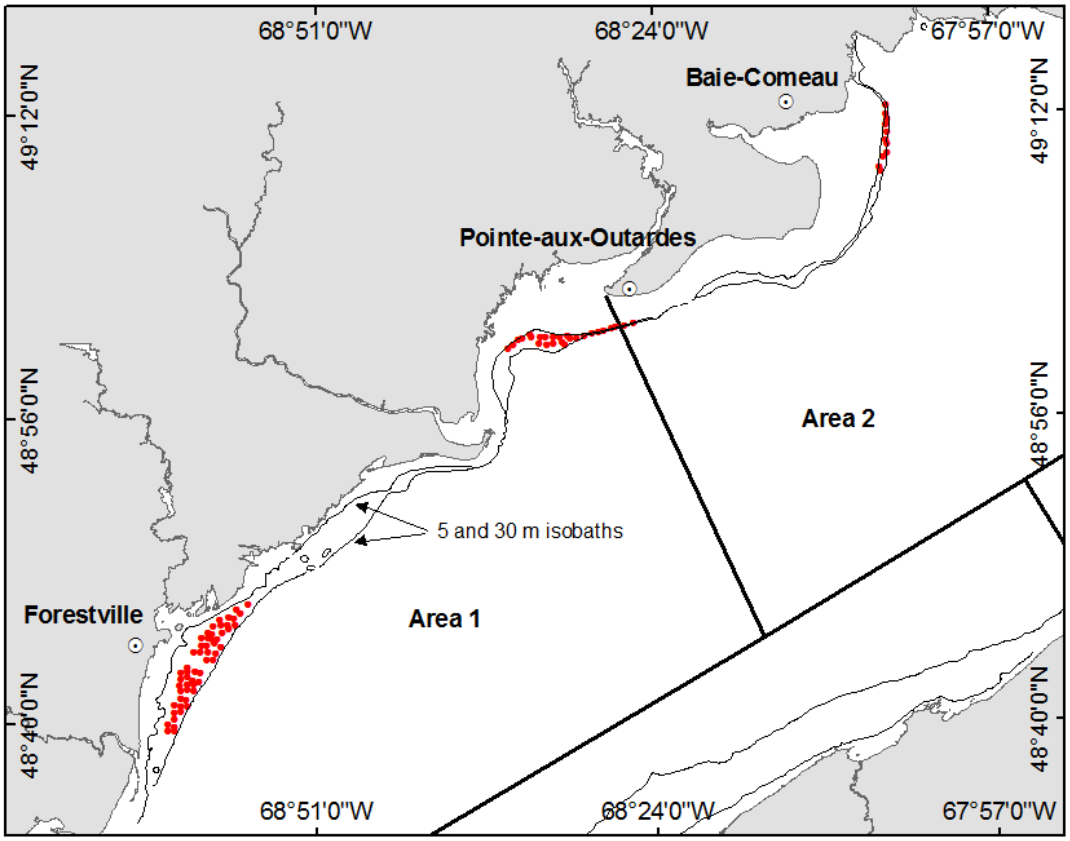

Figure 1. Location of sampling stations (red circle) for the whelk research survey in Forestville, Pointe-aux-Outardes and Baie-Comeau (Fishing Areas 1 and 2).

All whelk and whelk egg masses caught by dredge are retained for further analysis. All whelks were identified by species (except in 2007) and counted. Whelk height is measured to the nearest mm using a vernier caliper.

A stratified subsample (2 whelks per mm of height) is stored by area, species and year for morphometric analysis. A serial number is assigned to each individual. The height, width and minimum width (to the nearest mm) (Appendix 2) as well as the live weight (to the nearest gram) and sex of each individual are measured. The operculum is kept for future 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 and 2011, egg masses were counted, individual weights were also measured and the number of capsules was estimated on a few egg masses.

Due to the size of the mesh used to line dredge baskets, whelks less than 20 mm are not included in density and yield calculations. Whelks are 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 sub-samples, is used to calculate the weight of each individual harvested. Density (number/100 m^2) and yield (g/100 m^2) are calculated at each station for each size class by whelk species and for egg masses. Annual average (± 95% confidence interval) densities and yields are calculated for each area and 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.

Table 1. Dredge characteristics for each whelk research survey conducted between 2005 and 2011.

Variable	2005	2007	2009	2011
Period (day/month)	24/07 to 30/07	23/07 to 01/08	17/07 to 28/07	26/07 to 02/08
Number of stations				
Trawl	11[1]	0	0	0
Dredge	74[2]	92[3]	92[3]	92[3]
Dredge times (minutes)	6 to 9	8 to 10	5	5
Average dredge distance (m)	475	650	320	320
Identification of whelk species	X		X	X
Egg masses				
Count	X		X	X
Weight		X[4]	X[5]	X[5]
Number of capsules [6]			X	X
Identification of associated species [7]	X	X	X	X

[1] All completed in Forestville.
[2] 44 stations in Forestville, 19 stations in Pointe-aux-Outardes and 11 stations in Baie-Comeau.
[3] 55 stations in Forestville, 26 stations in Pointe-aux-Outardes and 11 stations in Baie-Comeau.
[4] Total weight per station.
[5] Weight per egg mass.
[6] Estimated number of capsules per 100 g for a few egg masses.
[7] Information collected, but not presented in this paper.

Two methods were used to assess whelk dredge harvest efficiency in 2009, a depletion study and underwater images and videos to compare densities with dredge densities. The depletion study involves assessing the speed at which whelk yields fell following successive dredges. First, the homogeneity of the study site was verified. In order to delineate the portion of the area to be used, yield variation between two parallel lines must be less than 15%. The vessel's route is monitored in real time. Two dredgers equipped with four doubled baskets make successive dredges in the same location and in the same direction, always against the current. The weight of the whelk catch is record for each dredger and dredge. The analytical software (fine tuned by M. Fréchette and D. Lefaivre, DFO Québec Region and developed by Cogéni Technologie) divides the area covered into 1 m by 10 m cells and calculates the rate of passages in each cell for each dredge and all dredges. Based on initial yields, it estimates an expected decrease in yields and dredging efficiency. This exercise was performed in two areas, in Forestville near station 55 (6 consecutive dredges) and Pointe-aux-Outardes near station 17 (8 consecutive dredges).

The images and videos were taken with two cameras installed on a sled towed along the seabed. The first, a Nikon D80 with a 35-mm f/2.0 lens, was installed to take photographs of the seabed at a rate of 10 images per minute. Each image covered a 0.116-m^2 area (41.6 cm wide by 27.8 cm high). The second camera, a Canon HV20 set to the panorama mode with a Raynox 0.5x lens, was installed on the front of the sled and used to record videos of the seabed directly in front of the sled. The camera was installed at an angle. The width of the image in the foreground was 0.91 m and the width of the background was 2.02 m. The average length of the dredge videos was 15 minutes. The average distance

travelled was 452 m, and there were 86 images per dredge on average. The dredge videos were made prior to dredging at 13 stations in Forestville and 10 stations at Pointe-aux-Outardes. The number of whelks (*Buccinum* sp.) on each image was counted and a size was estimated. However, size measurements were often inaccurate because of the whelks' position. In addition, it was difficult to accurately identify gastropods less than 20-25 mm in height. Whelk density was calculated by dredge, based on the total number of whelks ≥ 25 mm divided by the area covered in the set of images analyzed. The videos were used to estimate egg mass density. The area used in this case was equal to the distance travelled multiplied by the width of the background image. The same stations were dredged again a few days later. Densities of whelks ≥ 25 mm were calculated and compared with those on the images to produce a dredging efficiency rate.

EXPLORATORY FISHERY

An exploratory fishery was conducted from July 4 to 12, 2011 in the northwestern portion of Anticosti Island (Fishing Area 9) by Agence Mamu Innu Kaikusseth (AMIK) and Pêcheries Shipek, in collaboration with DFO (Figure 2). The work was done aboard the vessel La Marée Haute and two samplers were on board to monitor and collect data for the duration of the fishery. The whelks were caught with 98 conical traps with base diameters ranging from 0.76 m to 0.94 m, set on 14 lines. The traps were set about 30 m apart on each line. A total of 36 transects perpendicular to the coast were positioned at approximately every minute of longitude between 62°44' W and 63°55' W. Four lines were to be set at each transect, one line at 18, 27, 37 and 46 m depth (10, 15, 20 and 25 fathoms). Some modifications were made to the initial protocol based on the bathymetry of the area. However, at least one line was set at each transect, at a depth of approximately 27 m. Each line was placed parallel to the isobaths, at least 300 m apart, the topography of the seabed permitting, to avoid having neighbouring traps' areas of attraction interfere with one another. Soak time was 24 hours. A total of 84 lines were surveyed and sampled during the period. For each line, the following data were recorded at soak and haul times: date, time, line number, line start and end position, depth and number of traps. The information also included the total weights of both legal size and sub-legal size (< 70 mm) whelk caught per line. A sorting system (distance between the 28-mm rods) was used aboard the vessel to separate whelk caught, by legal or sub-legal size.

In addition, the 3rd and 5th trap on each line were sampled in greater detail. The following information was collected for each trap sampled: line number, trap serial number, weight of legal size and sub-legal size whelk. In addition, shell height was measured on all whelk caught. The number of unmeasurable broken whelks was also noted.

A stratified whelk sample was retained for additional morphometric measurements. Four whelks were retained by 2-mm size class throughout the study area. These whelks were kept frozen until they were tested in the laboratory. The following measurements were made on these whelks: height, width and minimum width (Appendix 2) to the nearest 0.1 mm and whole wet weight to the nearest 0.01 g. Sex was also noted and the opercula preserved for possible age readings.

Finally, the presence of species other than whelk (crab, starfish, other gastropods, etc.) was noted in all traps on each line.

Data were processed on all whelk (*Buccinum undatum*, *B. scalariforme* and *B. totteni*) caught, except for the weight-height relationship where only the *B. undatum* species was used. CPUE (kg/trap) by size class (legal and sub-legal) were calculated per line.

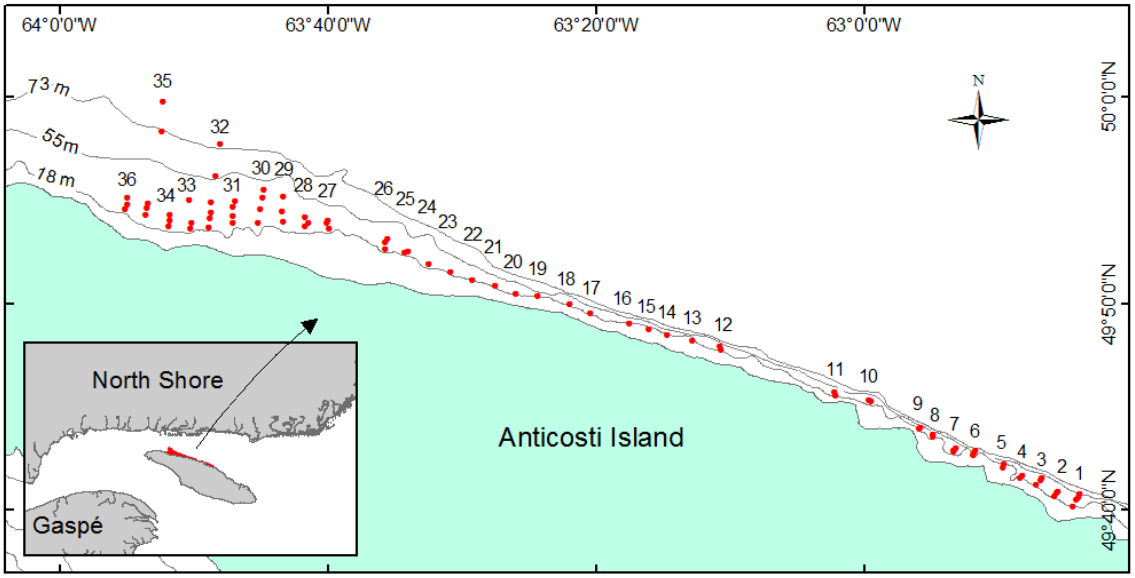

Figure 2. Location of trap lines and identification of transects of the 2011 Anticosti Island exploratory fishery.

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 3). Whelk is an opportunistic carnivorous predator and a scavenger (Himmelman and Hamel 1993). It feeds mostly on invertebrates, primarily Polychaeta, Molluscs and Echinodermata (Hamel 1989, Fahy 2001, Morel and Bossy 2004). Whelk detects 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).

In the St. Lawrence, whelk growth is slow (Jalbert *et al.* 1989, Gendron 1992). It can reach a 120 mm–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, from July 2000 to May 2003, 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 (Table 2 and Appendix 6).

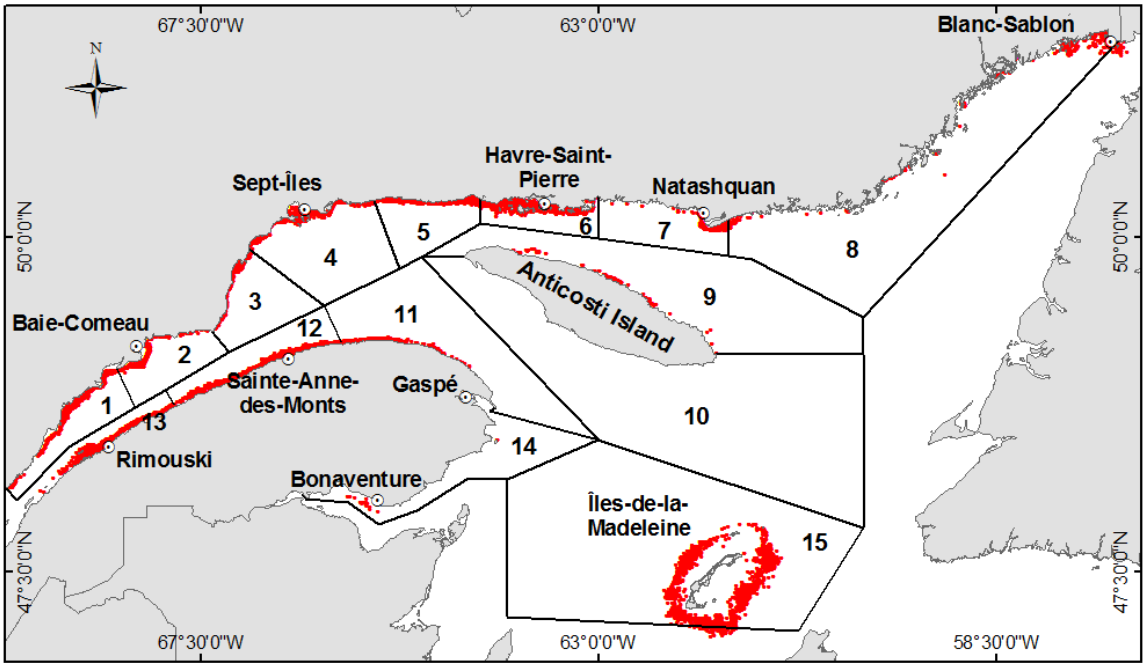

Figure 3. 2011 Waved Whelk Buccinum undatum fishing areas and known distribution in the Estuary and Gulf of St. Lawrence (source: logbooks, commercial sampling program, research surveys and exploratory fisheries).

Table 2. Average annual growth (± standard deviation) in Waved Whelk (Buccinum undatum) shell height by initial size class, measured in tanks from November 2000 to November 2002.

Size Class	Number of Individuals	Average Growth (mm)
< 50 mm	45	8.6 ± 3.3
50–59 mm	71	5.7 ± 3.6
60–69 mm	54	3.1 ± 2.9
70–79 mm	24	1.9 ± 0.8
≥ 80 mm	38	1.6 ± 1.3

The sexes are separate in whelk. The sex ratio is generally balanced (Mensink *et al.* 1996). According to the results of work performed in 1989 (Gendron 1992) and in 1998, the average size at which 50% of whelk are sexually mature (T_{50}) varies with geographic location. The parameters of the logistic curves obtained are presented in Appendix 7. T_{50} is between 49 mm and 76 mm in males and between 60 mm and 81 mm in females (Figure 4). It is generally greater in females than males. The average for all areas studied in 1989 and 1998 was 66.6 mm in males and 71.6 mm in females.

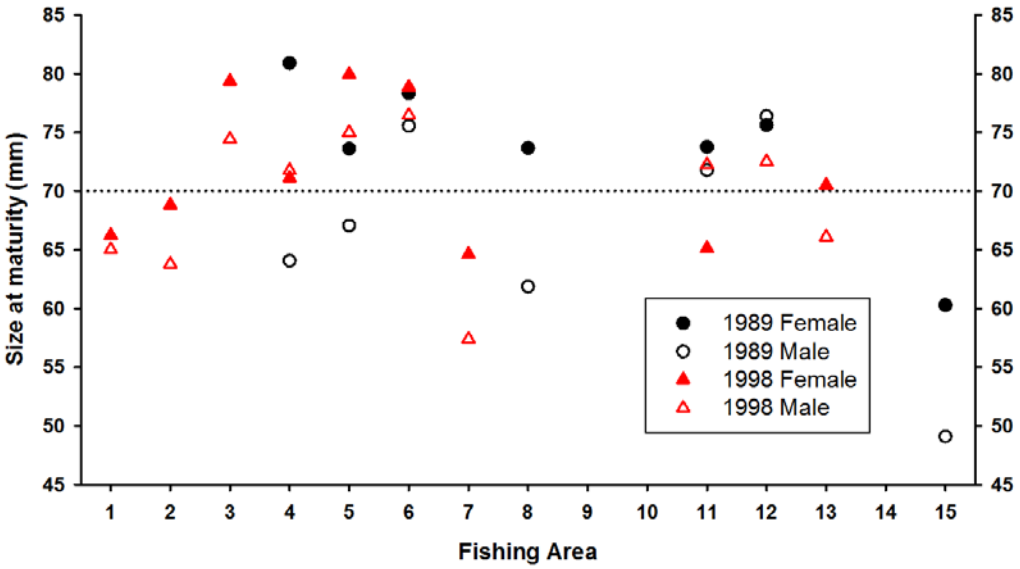

Figure 4. Average size (mm) at which 50% of Waved Whelk (Buccinum undatum) were sexually mature by sex and fishing area in 1989 (Gendron 1992) and 1998. The horizontal line represents the 70-mm minimum legal size.

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, 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 grows 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. The fishery expanded along the North Shore in the early 1990s and started in the Îles-de-la-Madeleine in 2003. It is a coastal trap fishery. In recent years, fishermen have mainly used conical traps with a 0.8 m to 1.2 m-base diameter.

There are 15 whelk fishing areas in Québec waters (Figure 3 and Appendix 8), divided into three regions: the North Shore (Areas 1 to 9), Gaspé–Lower St. Lawrence (Areas 10 to 14) and Îles-de-la-Madeleine (Area 15).

Fishing effort is controlled in all areas by regulating the length of the fishing season, number of licences and number and size of traps and in certain cases by introducing a

landings quota. 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 (Appendix 9).

In 2000, the fishing season was reduced to six months in all fishing areas, except Area 8 where it remained at 12 months. Since 2007, the fishing season has been about six months everywhere starting in April or May and ending in October or November (Appendices 9 and 10). 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 decreased from 281 in 1999 to 253 in 2011. There were only 70 active licences in 2011 (Appendix 10). The number of traps allocated to inactive fishermen was also reduced in 1999 and 2006 in order to decrease this potential effort (Appendix 9). In 2011, the number of traps ranged from 50, 59, 100, 150 and 175 traps. However, some Aboriginal band councils may hold several licences. Total allowable catches (TACs) are in effect in Areas 1 and 2 along the North Shore, Areas 11, 12 and 13 of the Gaspé–Lower St. Lawrence and Area 15 of the Îles-de-la-Madeleine (Appendices 9 and 10). Finally, the minimum legal size has been 70 mm in all areas since 2005 (Appendix 9).

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 varied from 493 t to 1,032 t and came primarily from the North Shore (Figure 5 and Appendix 11). Landings subsequently peaked at 2,000 t in 2003 with the beginning of the fishery in the Îles-de-la-Madeleine. Subsequently, North Shore landings declined, Îles-de-la-Madeleine landings remained fairly stable, while Gaspé–Lower St. Lawrence landings increased slightly. From 2009 to 2011, total landings fluctuated between 1,255 t and 1,484 t. In 2011, landings were 1,360 t, and 68% were from the North Shore, 12% from the Gaspé–Lower St. Lawrence and 20% from the Îles-de-la-Madeleine. In 2011, landings decreased from baseline levels by 18% along the North Shore, increased by 15% in the Gaspé–Lower St. Lawrence area and fell 15% in the Îles-de-la-Madeleine. There is little if any exploitation in a few areas. Area 10 has not been exploited since 1997. A few fishermen visited Areas 9 and 14 between 2002 and 2006, but there has not been any fishing since then.

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 6 and Appendix 12). Overall effort peaked at 384,924 trap hauls in 2003. Effort subsequently declined to 206,807 trap hauls in 2008. Effort measured in trap hauls in 2009, 2010 and 2011 was 228,175, 259,955 and 213,470 respectively. In 2011, effort dropped 28% from baseline levels along the North Shore and 26% in the Gaspé–Lower St. Lawrence but was stable in the Îles-de-la-Madeleine.

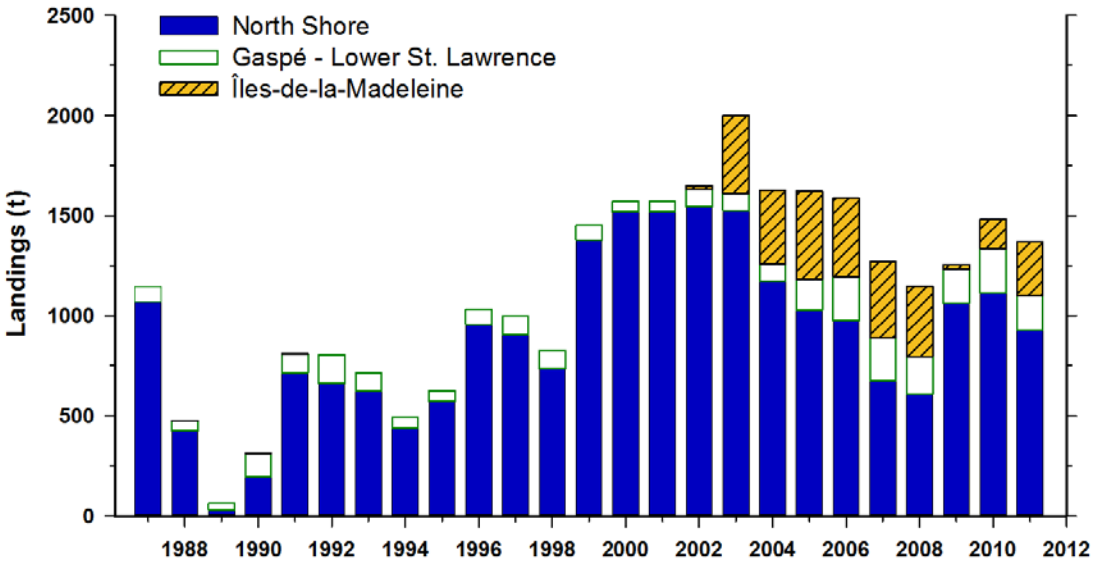

Figure 5. Commercial whelk fishery landings by area from 1984 to 2011.

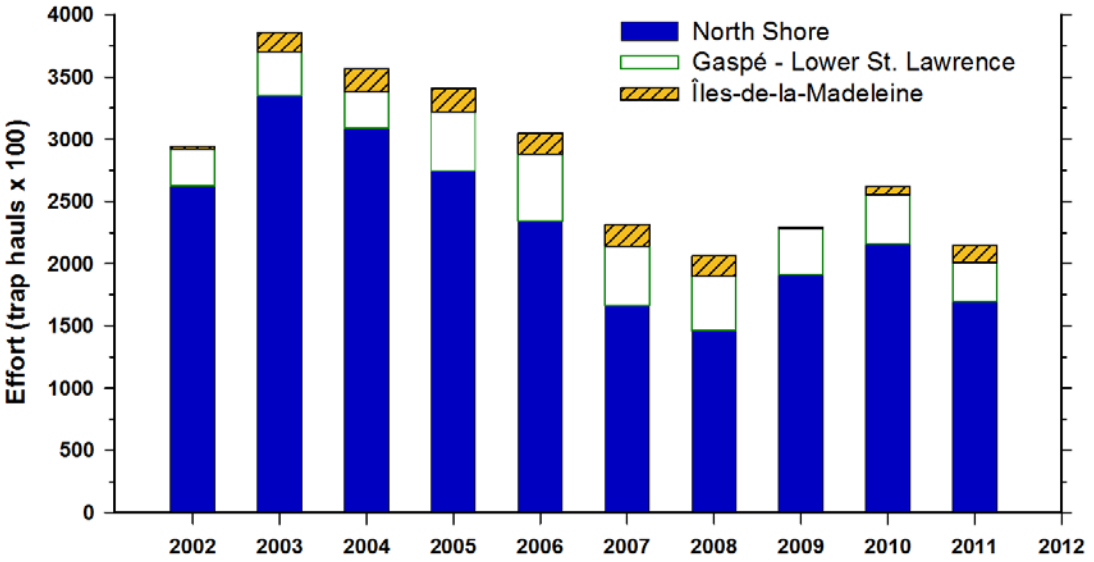

Figure 6. Commercial whelk fishing effort by area from 2002 to 2011.

NORTH SHORE

Fishing Area1

Fishing Area 1 extends from Pointe Rouge (Tadoussac) to point of Bout de Pointe-aux-Outardes (Figure 7 and Appendix 8). In recent years, commercial fishing has been concentrated mainly in the eastern portion of the area. In 2011, there were six active licences in this area for 800 traps out of a total of 11 licences issued and 1,300 traps (Appendix 10).

Landings exceeded 500 t in the early 2000s (Figure 8 and Appendix 11). A preventive 491-t TAC was introduced in 2003 to limit exploitation in this area. The TAC has never

been caught since then. From 2004 to 2008, landings ranged from 117.8 t to 246.9 t. They were 300.1 t in 2009, 203.7 t in 2010 and 132.4 t in 2011. In 2011, Area 1 accounted for 14.3% of North Shore landings.

Fishing effort decreased from 50,580 trap hauls in 2002 to 15,261 trap hauls in 2008 (Figure 8 and Appendix 12). In the past three years, effort has increased somewhat and ranged from 19,623 to 33,022 trap hauls. Variations in effort largely account for variations in landings.

From 2001 to 2004, CPUE decreased from 13.2 to 6.7 kg/trap. Subsequently, CPUE were fairly stable and ranged from 6.8 to 9.1 kg/trap (Figure 9 and Appendix 13). 2004 and 2011 CPUE were the lowest in the series and below the 2001–2010 baseline level.

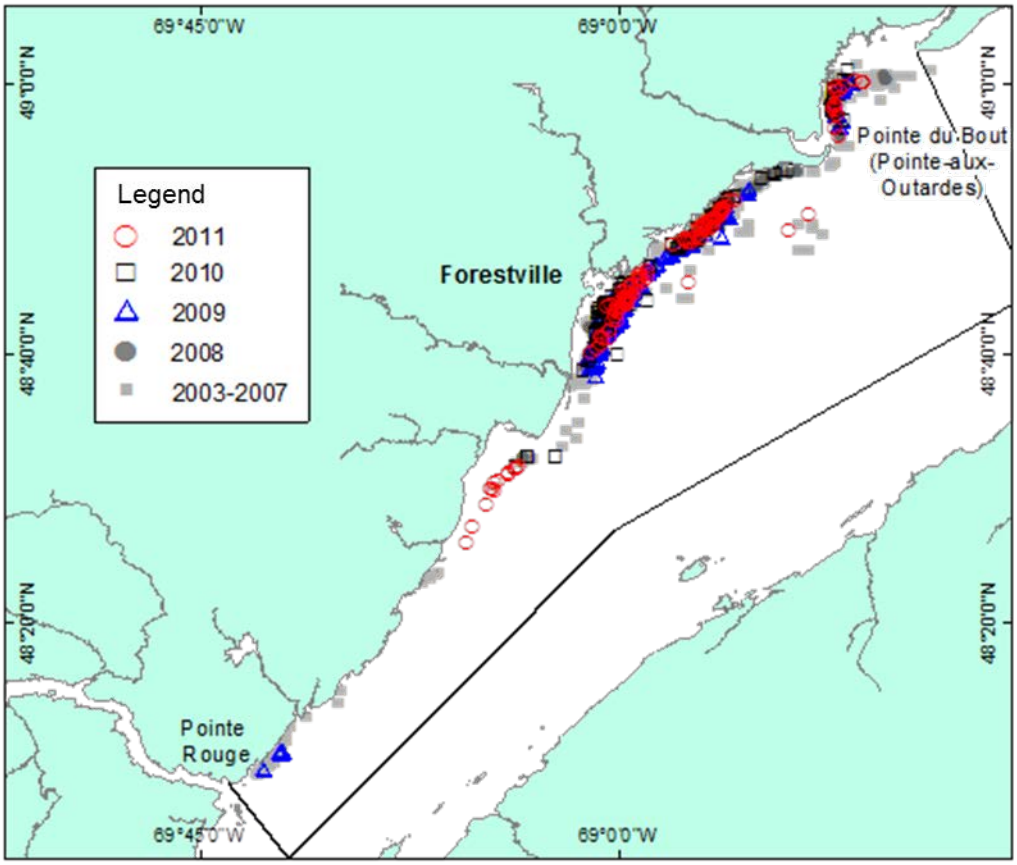

Figure 7. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 1.

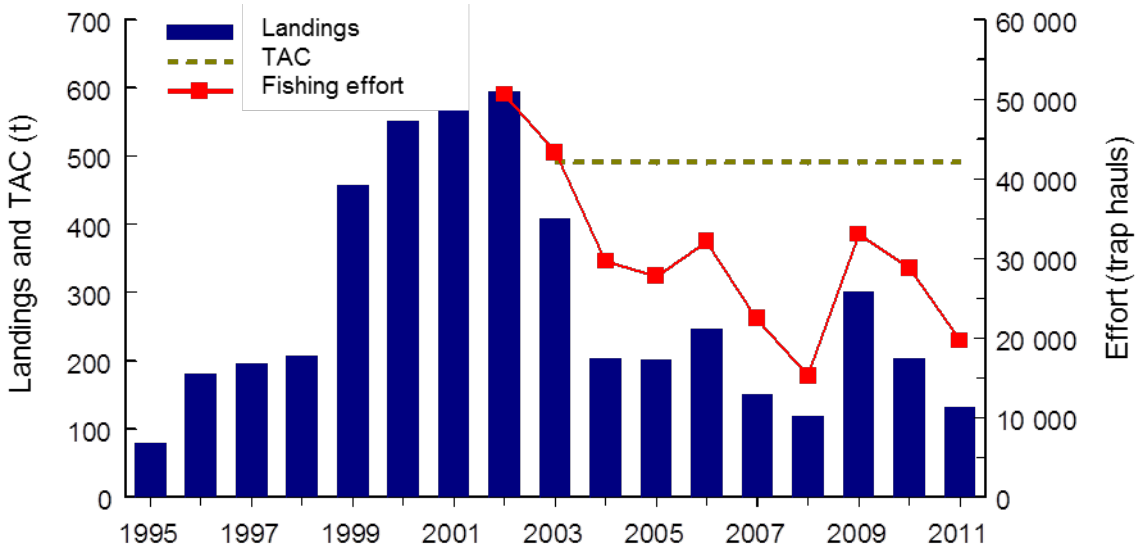

Figure 8. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2011 in Fishing Area 1.

Figure 9. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 1. The horizontal line represents the 2001–2010 baseline level.

Since 2006, average size has been similar to or higher than the baseline level (Figure 10). In 2011, the average size of landed whelk was 81.0 mm, the highest value since 2004. This value was above the 2004–2010 baseline size of landed whelk, which is 76.8 mm in this area (Figure 10 and Appendix 14). However, this baseline level is one of the lowest in Québec. The proportion of sub-legal size whelk in landings is generally over 10%. However, it was 5% in 2011 (Figure 10 and Appendix 15). Since 2006, size structures of landed whelk have been very consistent from year to year (Appendix 16).

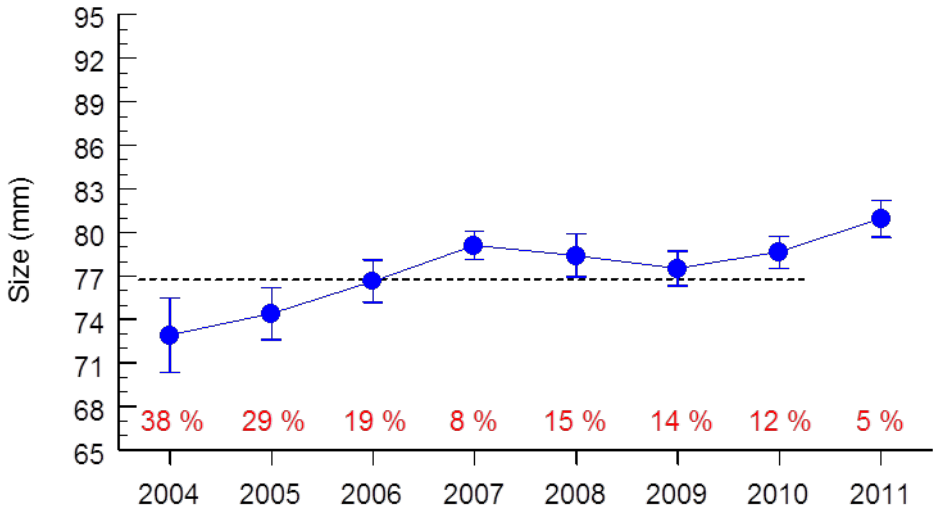

Figure 10. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 1. The horizontal line represents the 2004–2010 baseline level.

Fishing Area 2

Fishing Area 2 extends from the point of Bout de Pointe-aux-Outardes Point to Pointe-des-Monts (Figure 11 and Appendix 8). In recent years, fishing has been primarily concentrated between Baie-Comeau and Franquelin. Two or three licences have been active since 2007. In 2011, there were two active licences for 200 traps out of a total of six licences issued and 550 traps (Appendix 10).

Landings from this area were quite high from 2000 to 2003 with values ranging from 119.0 t to 206.9 t (Figure 12 and Appendix 11). 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 limited number of active fishermen. 2001–2010 baseline landings were 12.1 t and baseline effort was 7,072 trap hauls (Appendices 11 and 12).

CPUE vary somewhat from year to year (Figure 13 and Appendix 13). The 2001–2010 baseline level for this area was 9.7 kg/trap. Values for the last three years were 7.6, 9.5 and 11.4 kg/trap, and the last two values were similar to the baseline level.

The number of samples taken to measure landed whelk was low in 2006, 2008 and 2009, which accounts for the large variability in average size, mainly in 2008 and 2009 (Figure 14 and Appendices 3 and 14). The 2004–2011 baseline level for this area was 75.3 mm. This was the second lowest value in Québec. The proportion of sub-legal size whelk in landings is over 20%, except in 2009 and 2010 (Figure 14 and Appendix 15). Size structures show variations in median and average sizes caused by the quantity of landed sub-legal size whelk (Appendix 17).

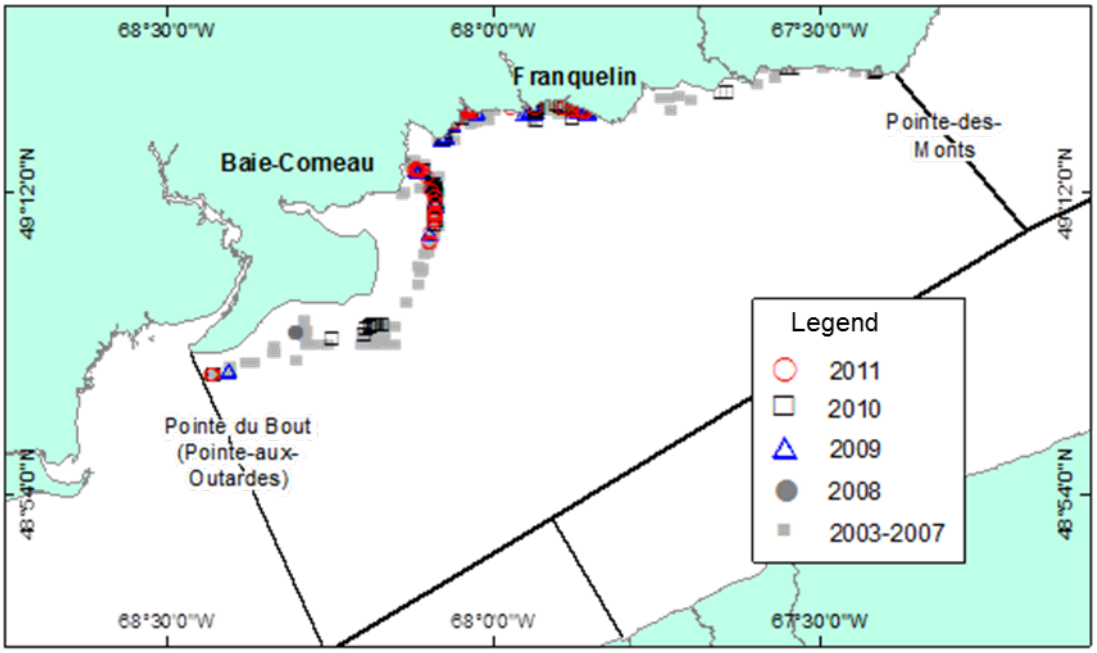

Figure 11. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 2.

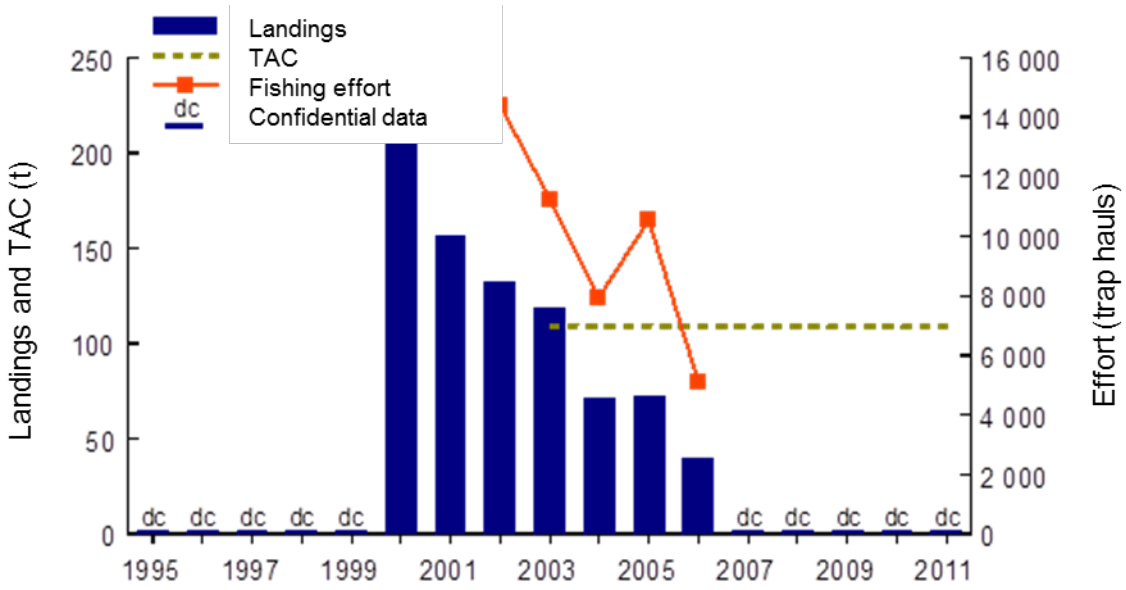

Figure 12. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2011 in Fishing Area 2.

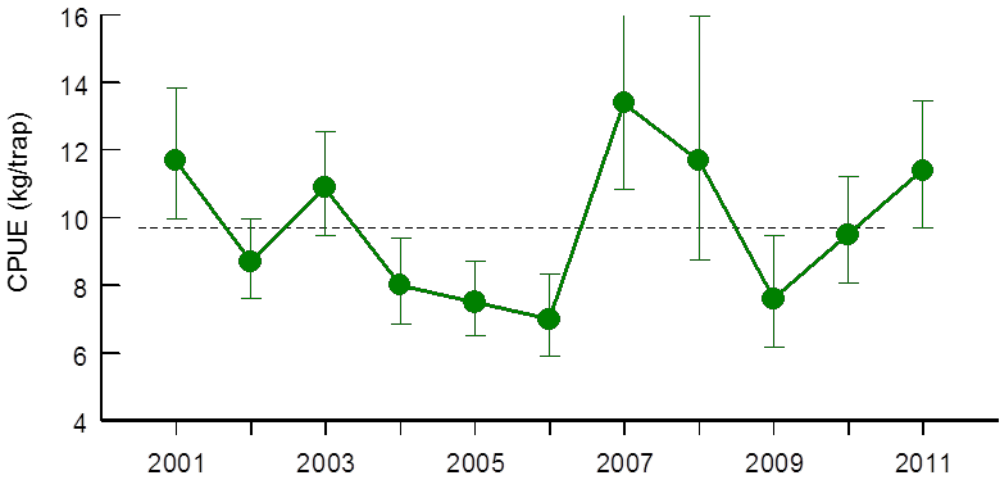

Figure 13. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 2. The horizontal line represents the 2001–2010 baseline level.

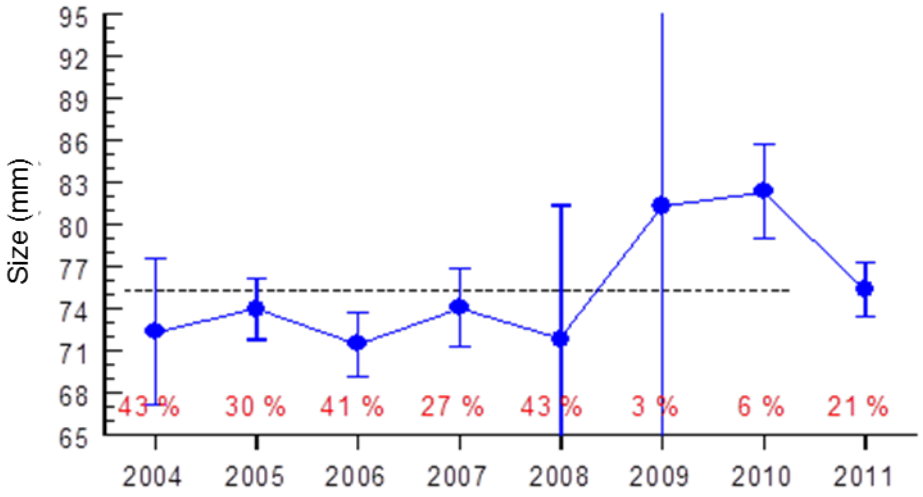

Figure 14. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 2 The horizontal line represents the 2004–2010 baseline level.

Fishing Area 3

The boundaries of Fishing Area 3 are Pointe-des-Monts in the west and Pointe Jambon in the east (Figure 15 and Appendix 8). The Pointe-des-Monts area in Baie-Trinité and the Rivière-Pentecôte and Pointe Jambon areas have been the most visited since 2009. There have been two or three active fishermen since 2008. In 2011, there were three active licences for 400 traps out of a total of seven licences issued and 850 traps (Appendix 10).

Landings peaked at 52.4 t in 2001 (Figure 16 and Appendix 11). From 2003 to 2007, they varied from 13.6 t to 39.2 t. From 2008 to 2011, landings and fishing effort have been confidential given the limited number of active fishermen. Baseline landings (2001–2010) were 25.2 t in this area, and baseline fishing effort (2002–2010) was 4,038 trap hauls (Figure 16 and Appendices 11 and 12).

Since 2002, CPUE have been quite stable near the 2001–2010 4.6-kg/trap baseline level (Figure 17 and Appendix 13). The 2009, 2010 and 2011 CPUE were 2.7, 4.8 and 3.2 kg/trap. 2009 and 2011 values are the lowest in the series and were below the

baseline level.

The last time whelk size samples were taken was in 2004 (Appendices 14, 15 and 18). At the time, the average size was 86.5 mm.

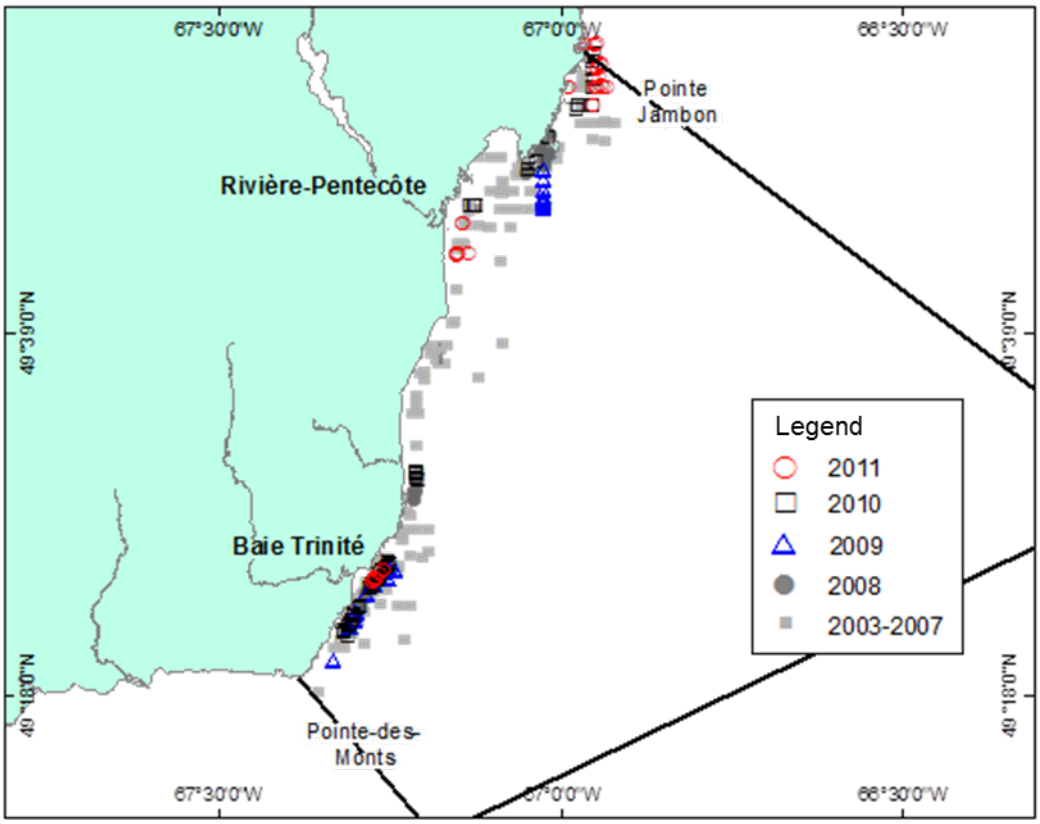

Figure 15. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 3.

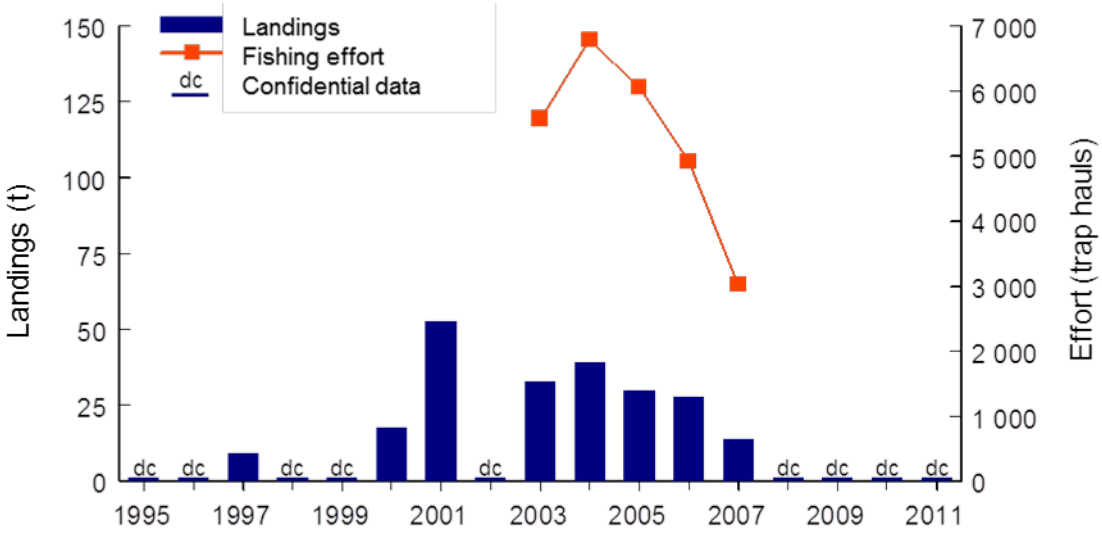

Figure 16. Whelk landings and fishing effort from 1995 to 2011 in Fishing Area 3.

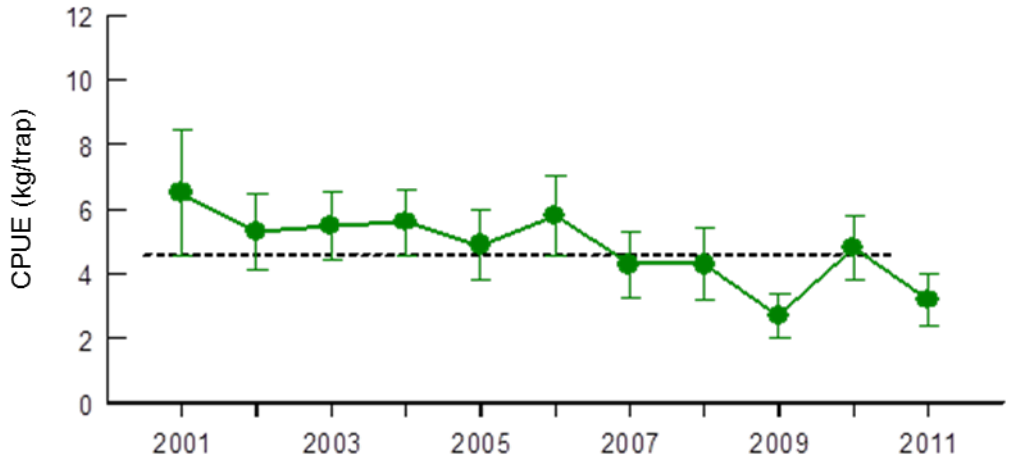

Figure 17. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 3. The horizontal line represents the 2001–2010 baseline level.

Fishing Area 4

Fishing Area 4 extends from Pointe Jambon to Cap du Cormoran (Rivière-au-Tonnerre) (Figure 18 and Appendix 8). The commercial fishery covers the central and western portion of the area fairly well. In 2011, there were six active licences for 750 traps out of a total of 29 licences issued and 2,459 traps (Appendix 10).

From 2001 to 2004, landings exceeded 142 t and declined thereafter (Figure 19 and Appendix 11). Since 2008, annual landings have remained between 41.8 t and 60.1 t. Area 4 accounted for 4.5% of North Shore landings in 2011.

Fishing effort peaked in 2003 and 2004 with over 50,000 trap hauls (Figure 19 and Appendix 12). Subsequently, effort decreased to 14,837, 18,795 and 10,687 trap hauls in 2009, 2010 and 2011.

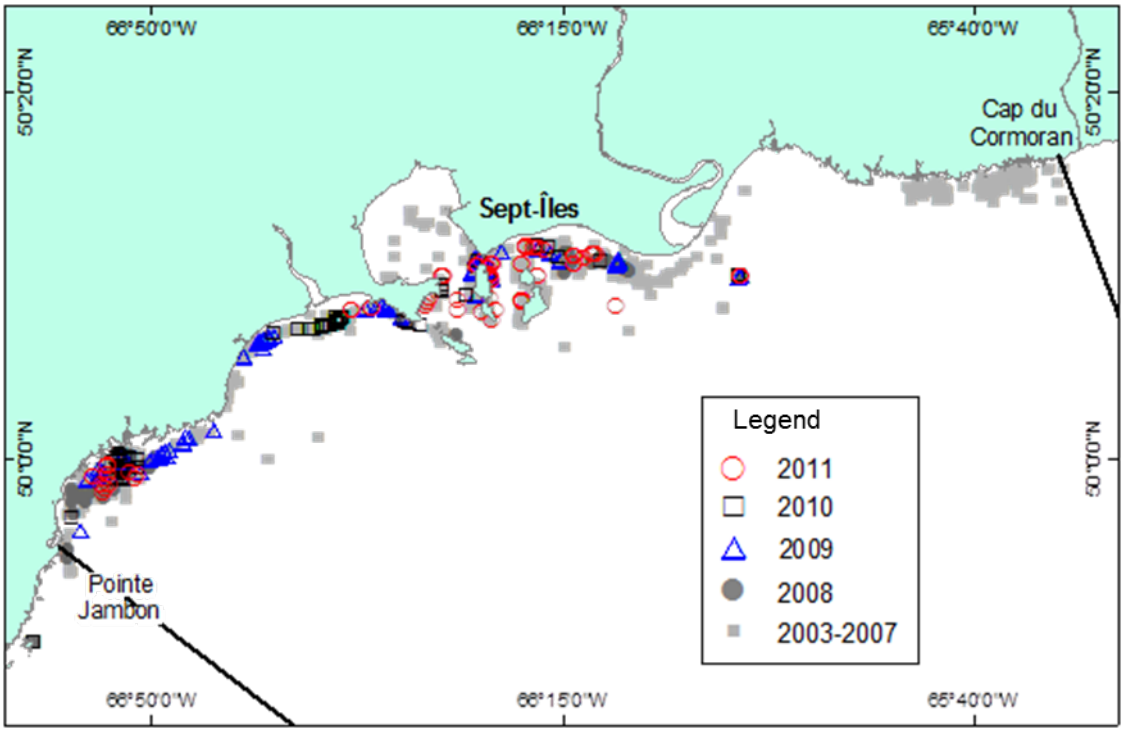

Figure 18. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 4.

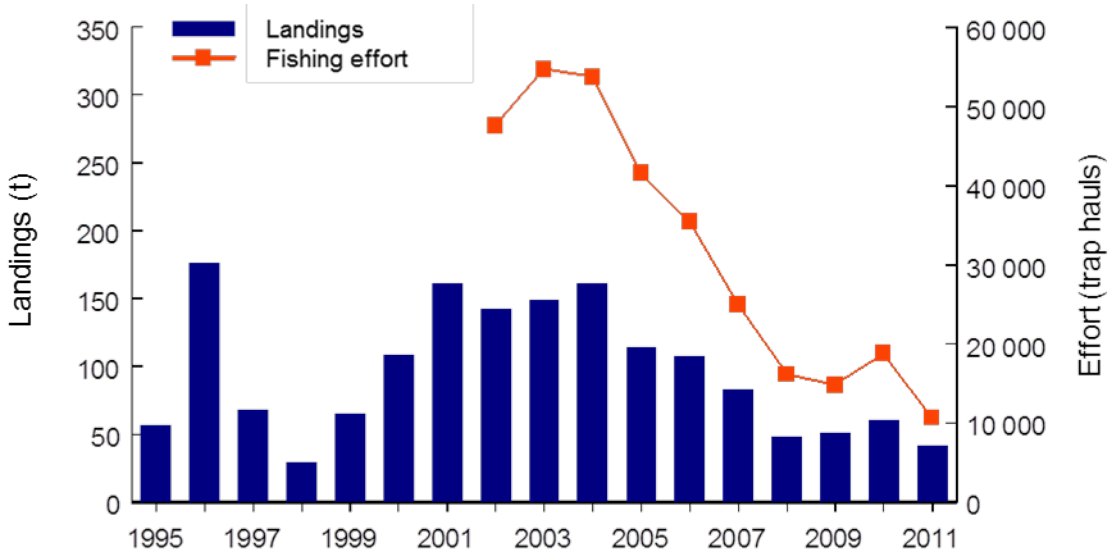

Figure 19. Whelk landings and fishing effort from 1995 to 2011 in Fishing Area 4.

CPUE have been very stable since 2002 and have remained near the 2001–2010 3.2-kg/trap baseline level (Figure 20 and Appendix 13). In 2011, CPUE was above the baseline level at 3.8 kg/trap.

The average size of landed whelk has been quite stable since 2007, between 88.6 mm and 90.7 mm (Figure 21 and Appendix 14). In recent years, whelk landings contained between 2% and 3% sub-legal size individuals (Figure 21 and Appendix 15). Size structures are varied with maximum sizes occasionally reaching 120 mm (Appendix 19).

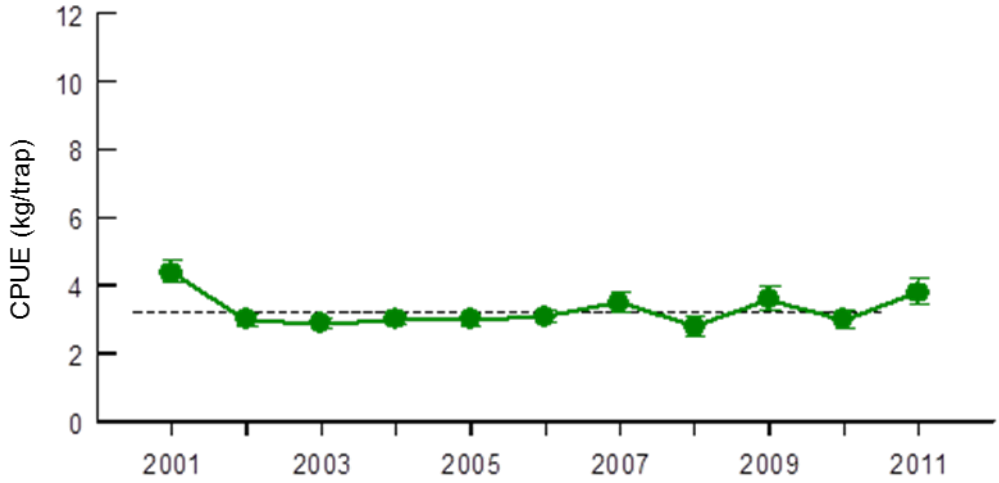

Figure 20. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 4. The horizontal line represents the 2001–2010 baseline level.

Figure 21. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 4. The horizontal line represents the 2004–2010 baseline level.

Fishing Area 5

Fishing Area 5 extends from Cap du Cormoran (Rivière-au-Tonnerre) to Rivière Saint-Jean (Figure 22 and Appendix 8). The commercial fishery covers most of the area. In 2011, there were six active licences for 700 traps out of a total of 21 licences issued and 1,850 traps (Appendix 10).

Landings peaked at 492.6 t in 1999 (Figure 23 and Appendix 11). From 2003 to 2008, they dropped from 385.1 t to 145.5 t. Landings have increased in recent years. They were 274.3 t in 2009, 362.9 t in 2010 and 312.1 t in 2011. In 2011, this Area accounted for 33.7% of North Shore landings.

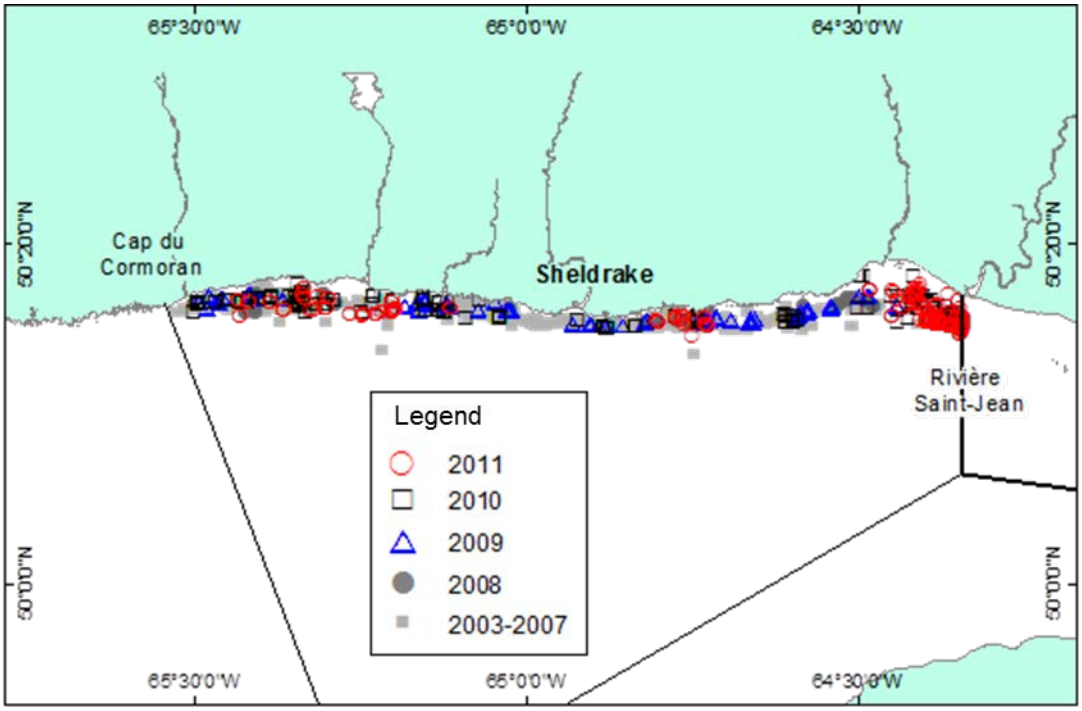

Figure 22. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 5.

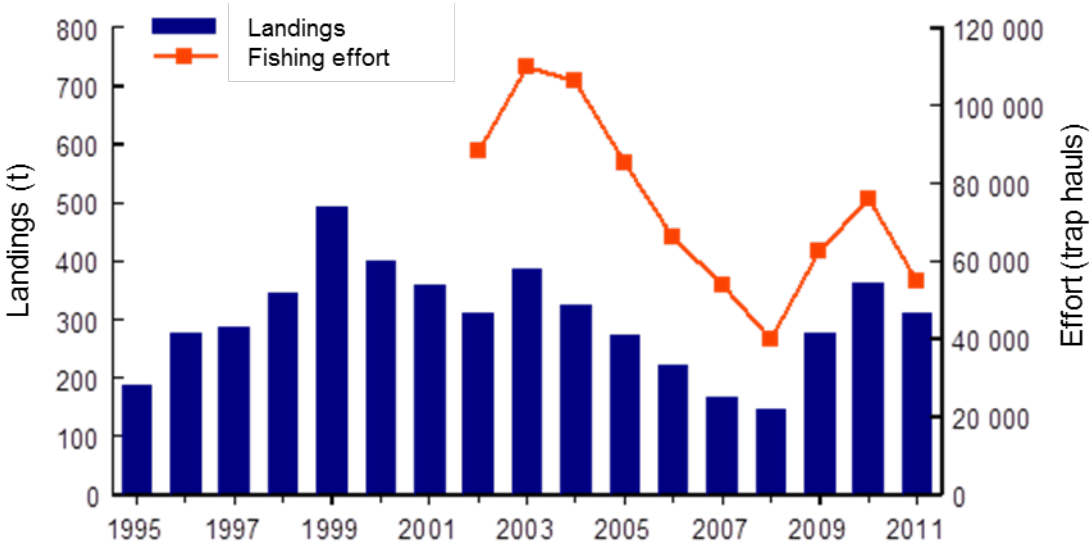

Figure 23. Whelk landings and fishing effort from 1995 to 2011 in Fishing Area 5.

Since 2002, variations in effort have largely accounted for variations in landings (Figure 23). Effort peaked in 2003 with 109,727 trap hauls and subsequently decreased to 40,048 trap hauls in 2008 (Appendix 12). Values in recent years were 62,345, 75,874 and 54,995 trap hauls in 2009, 2010 and 2011.

From 2001 to 2007, CPUE were relatively stable at 3.2 to 4.3 kg/trap (Figure 24 and Appendix 13). Since 2007, CPUE have increased, peaking at 6.3 kg/trap in 2011, the highest value in the series.

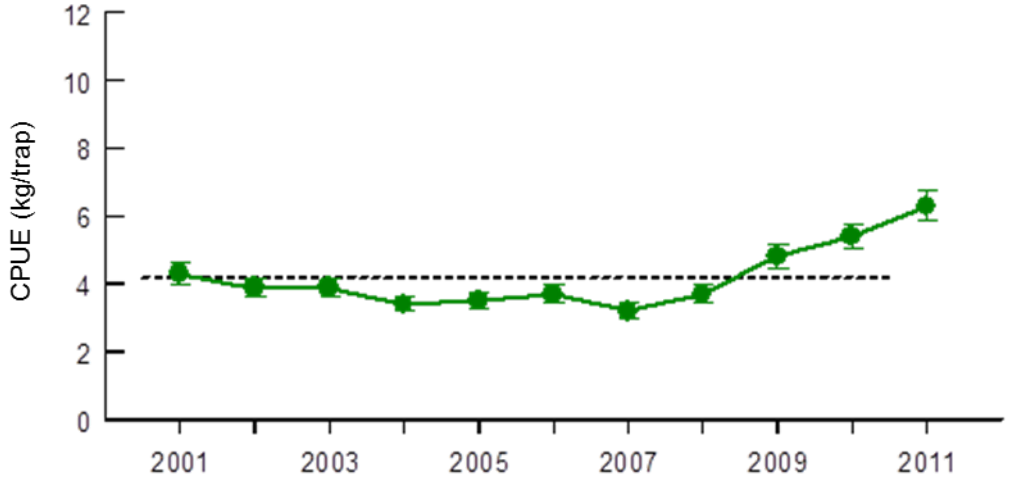

Figure 24. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 5. The horizontal line represents the 2001–2010 baseline level.

The average size of landed whelk has been above 84 mm since 2007 (Figure 25 and Appendix 14). In 2011 it was 87.9 mm. The proportion of sub-legal size whelk in landings has remained below 7% since 2007, which is reflected in size structures and median and average sizes (Figure 25 and Appendices 15 and 20).

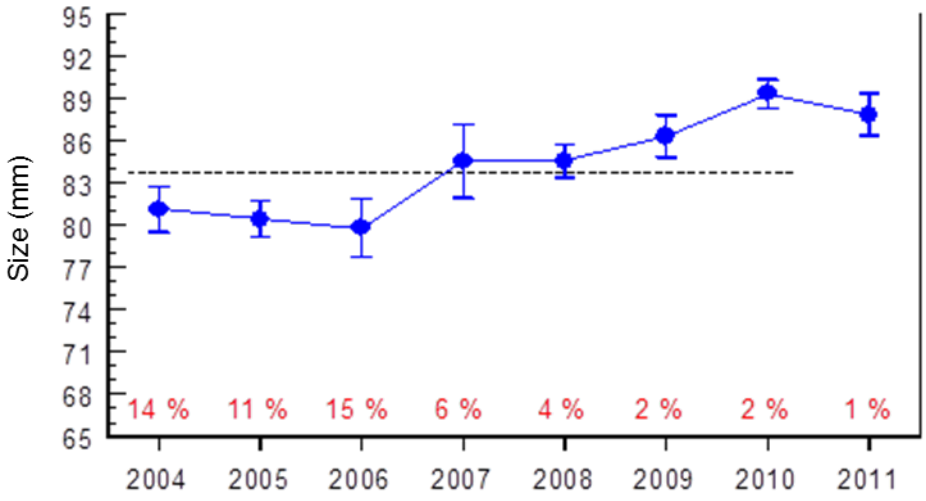

Figure 25. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 5 The horizontal line represents the 2004–2010 baseline level.

Fishing Area 6

The boundaries of Area 6 range from Rivière Saint-Jean in the west to Baie de la Grande

Hermine in the east (Figure 26 and Appendix 8). The commercial fishery mainly covers the central portion of the area. In 2011, there were nine active licences for 850 traps out of a total of 16 licences issued and 1,300 traps (Appendix 10).

Between 2001 and 2008, landings ranged from 152.4 t to 281.6 t (Figure 27 and Appendix 11). The highest landings were recorded in the last 3 years, 329.6 t in 2009, 357.8 t in 2010 and 313.8 t in 2011. Landings from this area and Area 5 were the highest in Québec in 2010 and 2011. In 2011, Area 6 accounted for 33.9% of North Shore landings.

In 2004 and 2005, variations in fishing effort were not reflected in similar variations in landings (Figure 27). However, since 2007, there seems to be a better balance between the two variables. From 2009 to 2011, effort was quite stable with values ranging from 63,625 to 64,017 trap hauls from 2009 to 2011 (Figure 27 and Appendix 12).

Between 2004 and 2007, CPUE were below the 2001–2010 baseline level (Figure 28 and Appendix 13). However, CPUE started trending upward in 2005 to 5.5 kg/trap in 2009. The 2010 and 2011 values, 5.2 and 5.1 kg/trap, were similar to 2009 values and were above the baseline level.

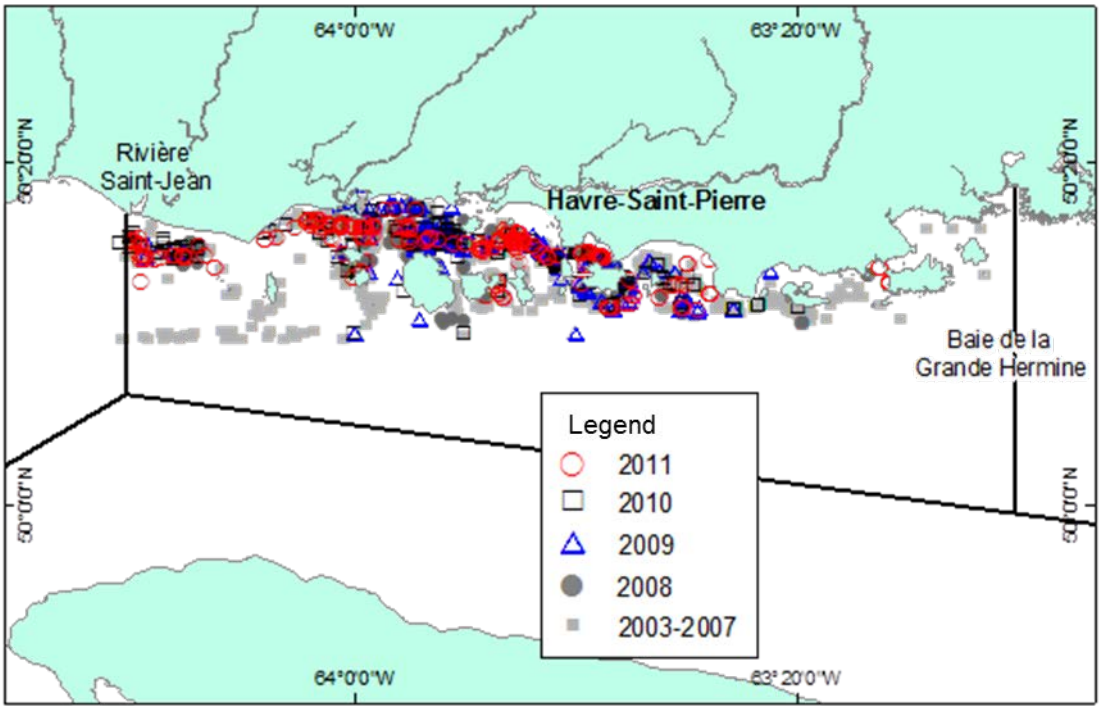

Figure 26. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 6.

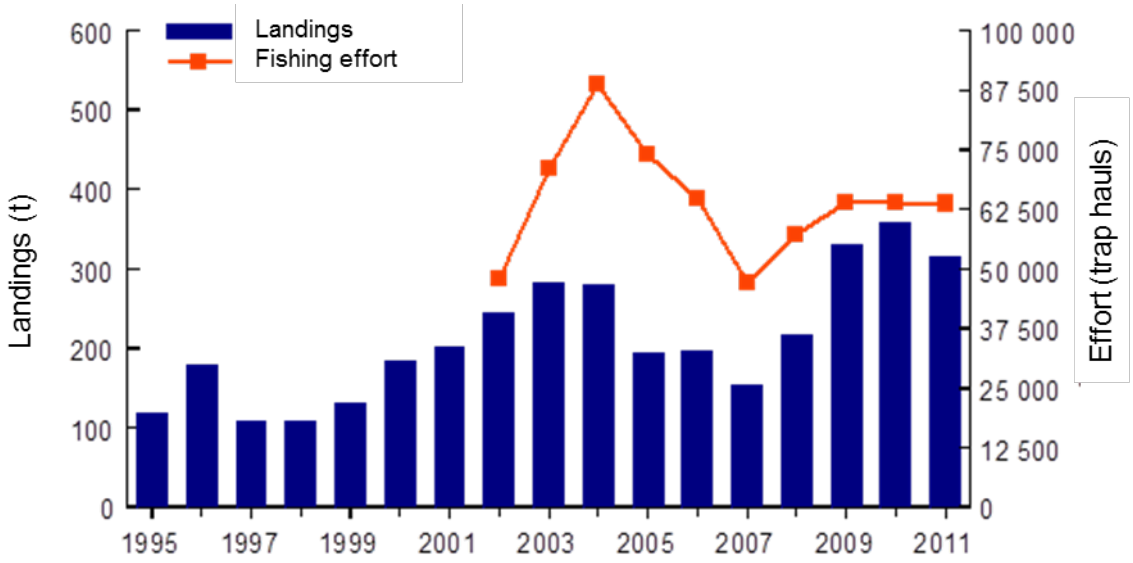

Figure 27. Whelk landings and fishing effort from 1995 to 2011 in Fishing Area 6.

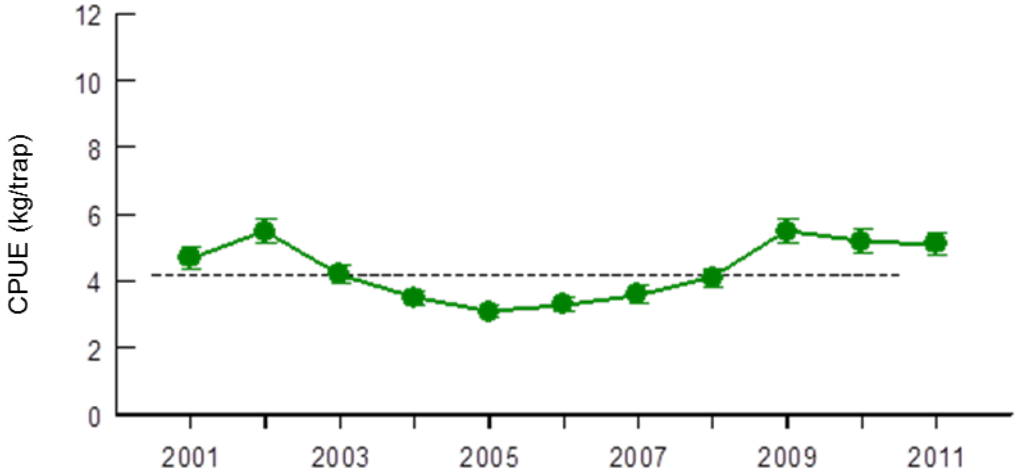

Figure 28. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 6. The horizontal line represents the 2001–2010 baseline level.

Average sizes of landed whelk have been near the 2004–2010 84.3-mm baseline level (Figure 29 and Appendix 14). In 2010 and 2011, average sizes were above the baseline level at 88.1 mm. The proportion of sub-legal size whelk in landings has remained below 7% since 2006 (Figure 29 and Appendix 15). Since 2007, the size structures of landed whelk have been similar with a slight shift to the right in 2010 and 2011 (Appendix 21).

In 2011, a number of fishing trips were conducted in collaboration with the active fishermen in this area. The size structure of all whelk caught was similar to that of landed whelk (Appendix 21). However, the greater presence of whelk < 75 mm in the size structure at sea clearly reflects the effectiveness of sorting aboard ship. During these expeditions, species other than whelk were counted. The species counted were, in order of importance: *Cancer irroratus*, *Strongylocentrotus droebachiensis*, *Asterias rubens*, *Hyas araneus*, *Pagurus* sp. and *Aporrahais occidentalis* (Appendix 22).

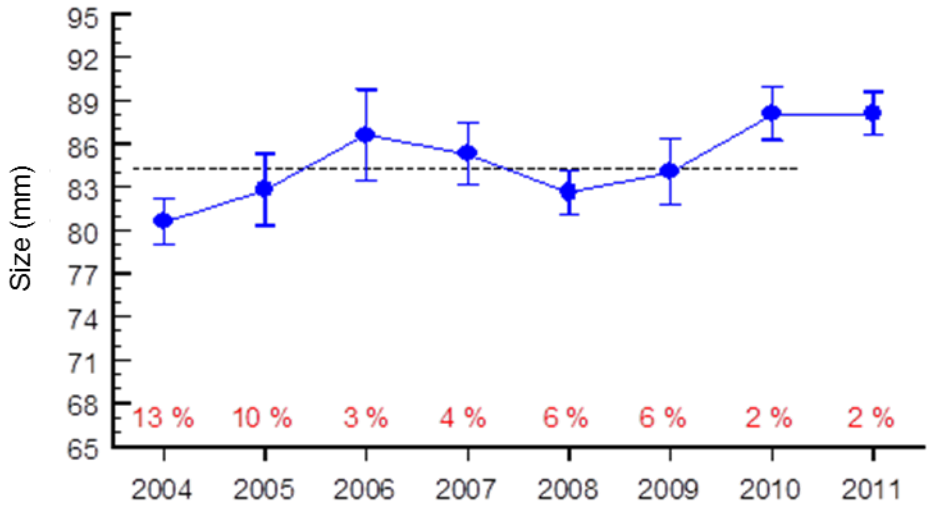

Figure 29. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 6. The horizontal line represents the 2004–2010 baseline level.

Fishing Area 7

Fishing area 7 extends from Baie de la Grande Hermine to Rivière de l'Étang (Figure 30 and Appendix 8). However, the commercial fishery is conducted only near Natashquan. Since 2008, there have been two active licences. In 2011, these two active licences were for 300 traps (Appendix 10). There are seven licences issued in this area for a total of 600 traps.

The number of active licences ranged from zero to four from 2001 to 2011. Landings and fishing effort are therefore generally confidential. Baseline landings (2001–2010) were 55.7 t for this area, and baseline fishing effort (2002–2010) was 9,014 trap hauls (Appendices 11 and 12).

CPUE vary somewhat from year to year, possibly due to low fishing effort (Figure 31 and Appendix 13). CPUE in recent years were 7.9 kg/trap in 2009, 5.6 kg/trap in 2010 and 4.9 kg/trap in 2011.

Since 2005, the average size of landed whelk has increased (Figure 32 and Appendices 14 and 23). The 2009, 2010 and 2011 values were above the 2004–2010 84.2-mm baseline level. The 2011 average size, 90.1 mm, was the highest in the series. Since 2004, the proportion of sub-legal size whelk in landings has always been below 10% (Figure 32 and Appendices 15 and 23).

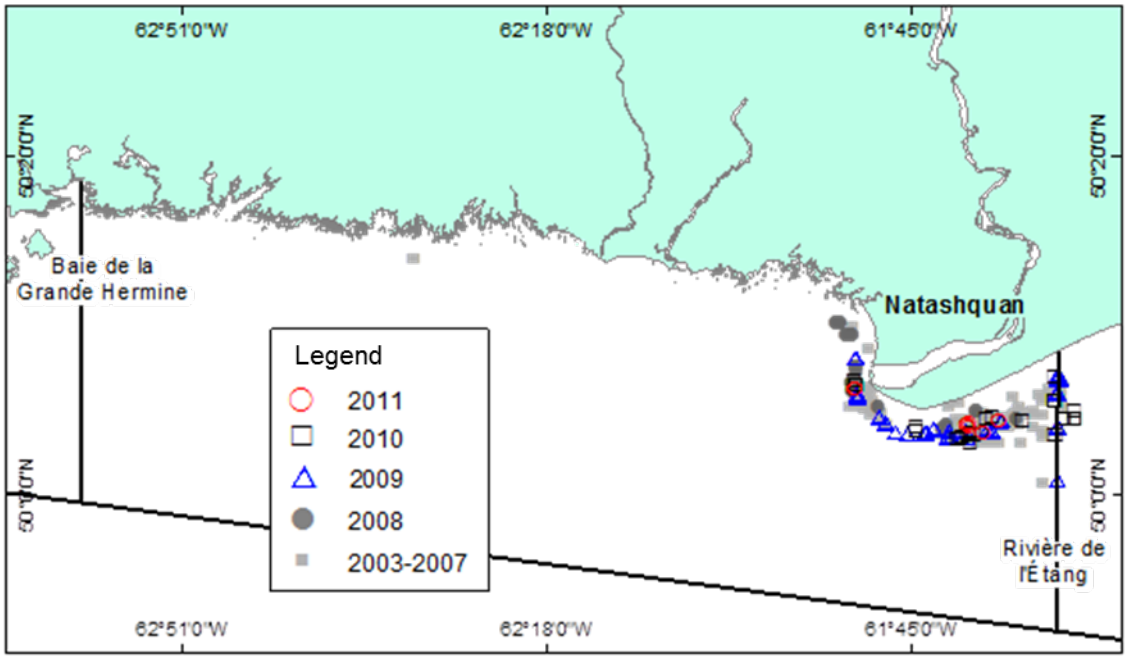

Figure 30. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 7.

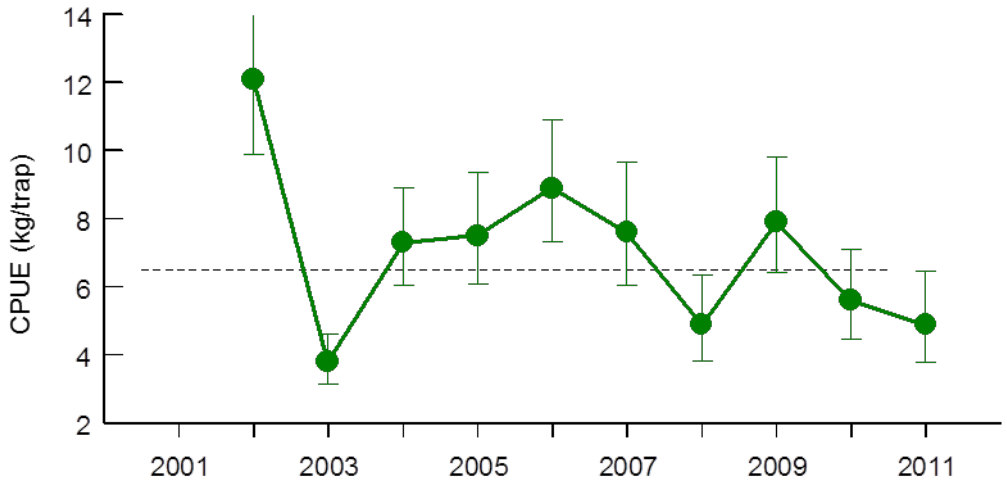

Figure 31. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 7. The horizontal line represents the 2001–2010 baseline level.

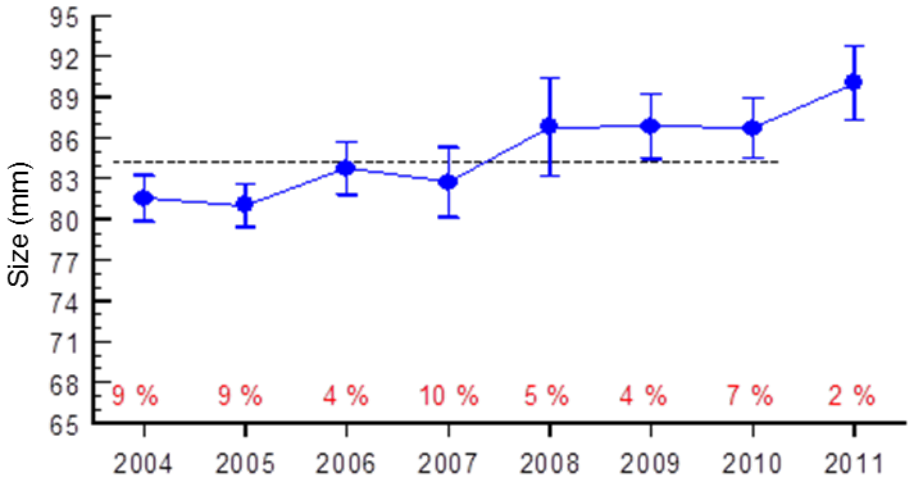

Figure 32. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 7. The horizontal line represents the 2004–2010 baseline level.

Fishing Area 8

Area 8 is the largest fishing area in Québec, extending from Rivière de l'Étang to Blanc-Sablon (Figure 33 and Appendix 8). However, the commercial fishery is concentrated in the Blanc-Sablon area. In 2011, there were eight active licences for 800 traps out of a total of 64 licences issued and 6,400 traps (Appendix 10).

Landings from Area 8 are highly variable from year to year (Figure 34 and Appendix 11). Maximum values of just over 80 t were recorded in 1995, 1996 and 2003. Landings in recent years were 10.7 t in 2009, 37.7 t in 2010 and 20.7 t in 2011. In 2011, this area accounted for 2.2% of North Shore landings.

As with landings, fishing effort varies greatly from year to year (Figure 34 and Appendix 12). The 2009 to 2011 values were 2,331, 13,113 and 6,704 trap hauls, respectively.

CPUE in this area fluctuate around the 2001–2010 4.1-kg/trap baseline level (Figure 35 and Appendix 13). CPUE were 5.5 kg/trap in 2009, 3.6 kg/trap in 2010 and 3.7 kg/trap in 2011.

The average size of landed whelk was low in this area (Figure 36 and Appendix 14). The 2004–2010 baseline level was 74.9 mm, only a few millimetres above the minimum legal size. In 2011, the average size was 72.9 mm. Since 2005, the percentage of sub-legal size whelk in landings was over 25% (Figure 36 and Appendix 15). This was clearly reflected in size structures where there is a large percentage of 60 mm–69 mm individuals in landings (Appendix 24).

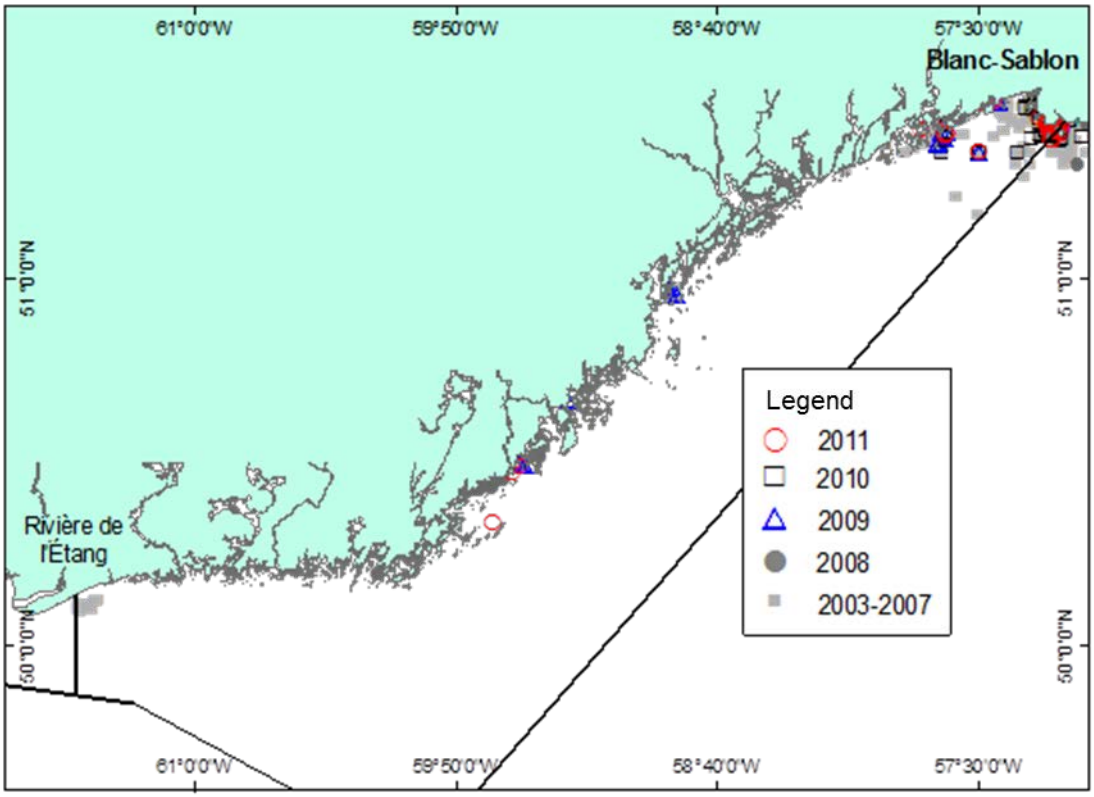

Figure 33. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 8.

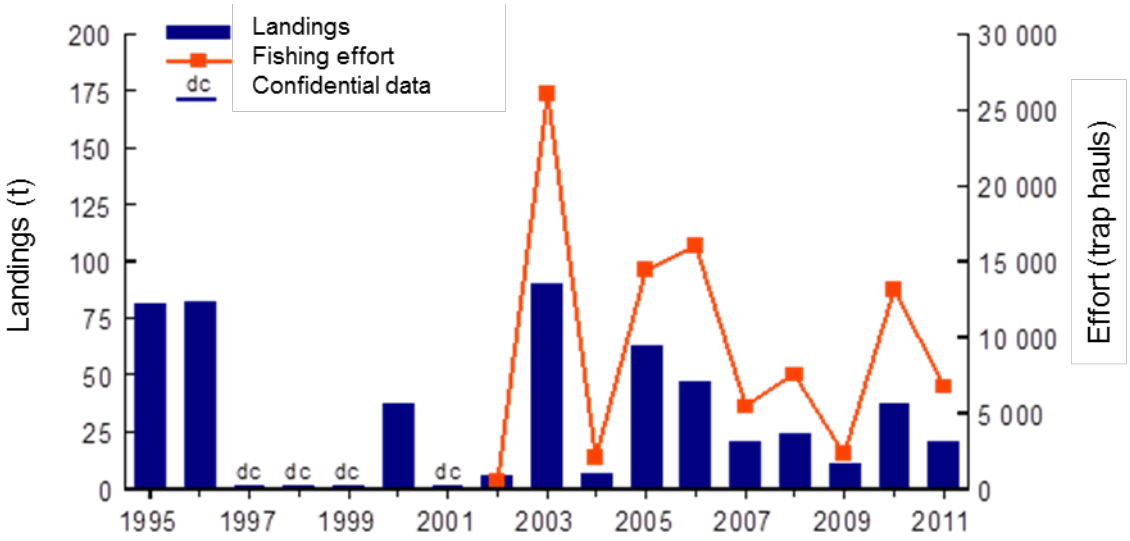

Figure 34. Whelk landings and fishing effort from 1995 to 2011 in Fishing Area 8.

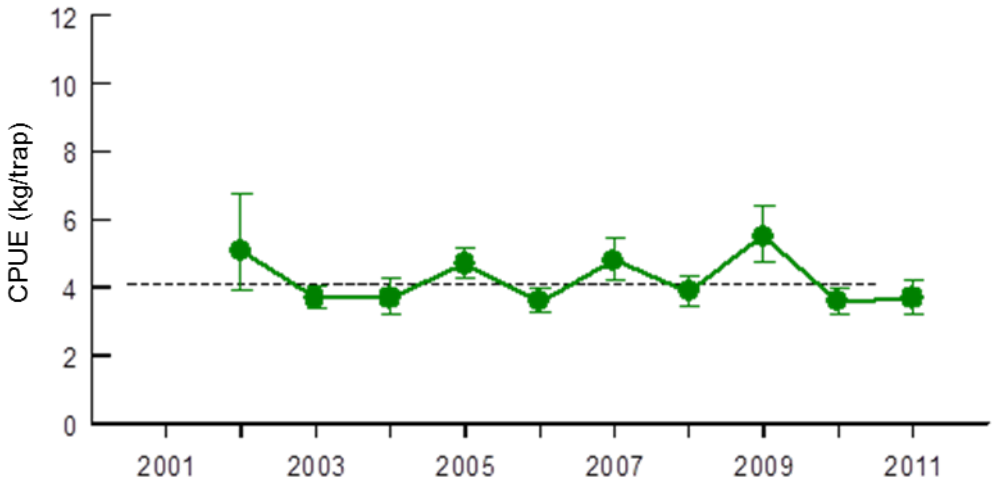

Figure 35. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 8. The horizontal line represents the 2001–2010 baseline level.

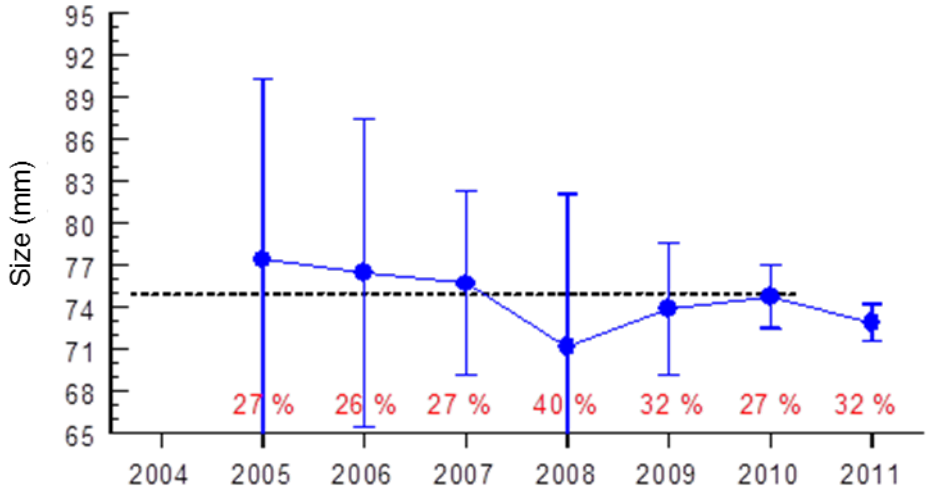

Figure 36. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 8. The horizontal line represents the 2004–2010 baseline level.

Fishing Area 9

Fishing Area 9 covers the northern portion of Anticosti Island (Appendix 8). There has been no commercial fishery in this area since 2007. In 2011, one licence was issued for 100 traps (Appendix 10). Licence holders in Areas 5, 6 and 7 are also allowed to fish in Area 9.

Landings and fishing effort data are confidential since there have always been fewer than four active licences. The only information available is the size of landed whelk. However, fishing in this area is an exploratory fishery and size structures are provided for guidance only. The size structures for the two years for which data are available, 2005 and 2006, are quite different from one another. In 2005, the average size was 79.4 mm and in 2006, it was 90.6 mm, with less than 4% sub-legal size whelk in landings (Appendices 14, 15 and 25).

GASPÉ–LOWER ST. LAWRENCE

Fishing Area 10

Fishing Area 10 covers the southern portion of Anticosti Island (Appendix 8). A few exploratory licences were issued for this area between 2002 and 2008, but there has not been any commercial fishing since 1993.

Fishing Area 11

Fishing Area 11 extends from Ruisseau de la Pointe de Chasse to Cape Gaspé (Figure 37 and Appendix 8). However, the commercial fishery in recent years has been concentrated west of Gros-Morne. In 2011, there was one active licence for 100 traps out of a total of 18 licences issued and 1,300 traps (Appendix 10).

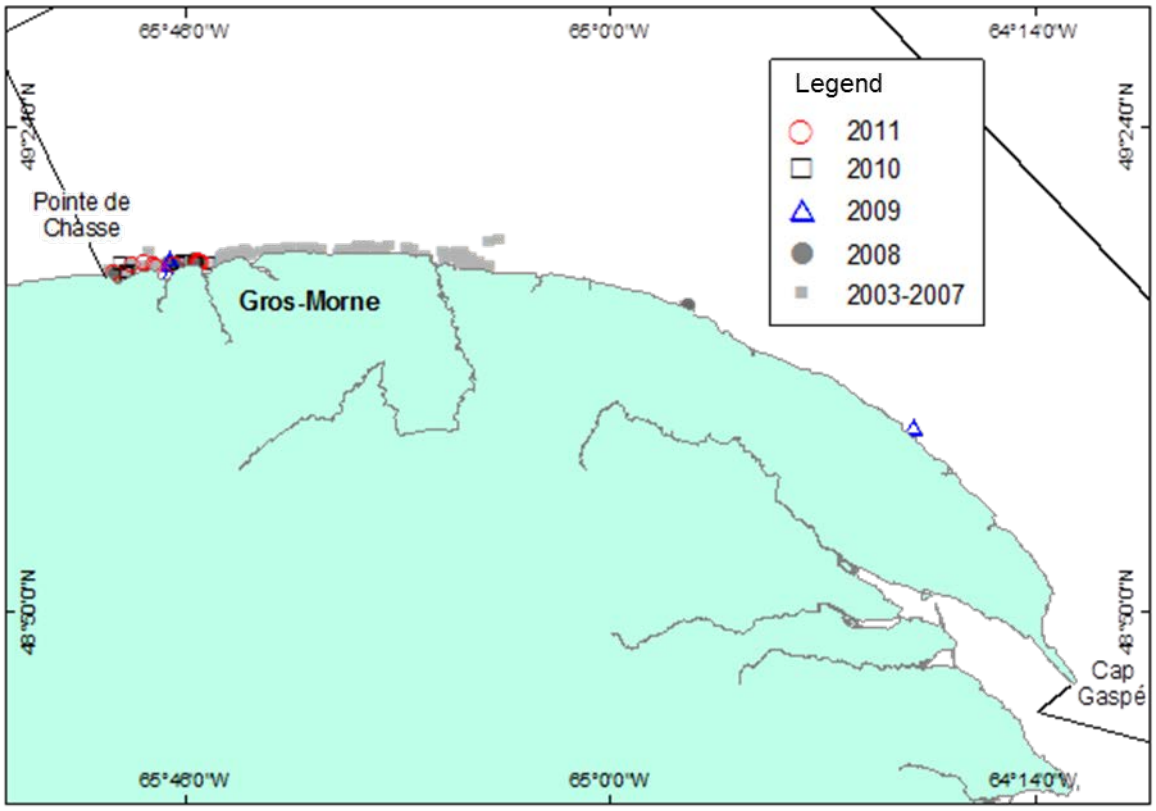

Figure 37. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 11.

Landings in this area were higher in the late 1990s than they are now (Figure 38 and Appendix 11). A 32-t TAC was introduced in 2010. Landings and fishing effort in the last three years are confidential, given the low number of active licences. Baseline landings (2001–2010) were 18.9 t, and baseline fishing effort (2002–2010) was 7,409 trap hauls (Appendices 11 and 12).

CPUE peaked at 4.1 and 4.4 kg/trap in 2005 and 2006 (Figure 39 and Appendix 13). Since then, CPUE decreased to 1.1 kg/trap in 2011, the lowest value in the series. The 2010 and 2011 CPUE were below 2001–2011 2.6-kg/trap baseline level.

Average sizes of whelk landed in Area 11 are the highest in Québec (Figure 40 and Appendices 14 and 26). They have been higher than 90 mm since 2007 and the

proportion of sub-legal size whelk in landings is very low, < 2% (Figure 40 and Appendix 15).

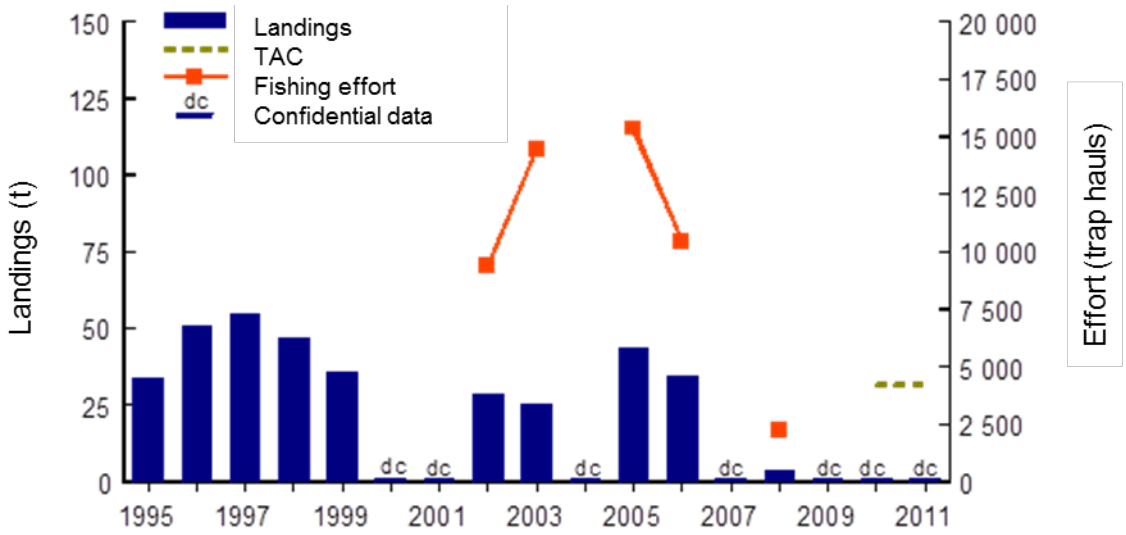

Figure 38. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2011 in Fishing Area 11.

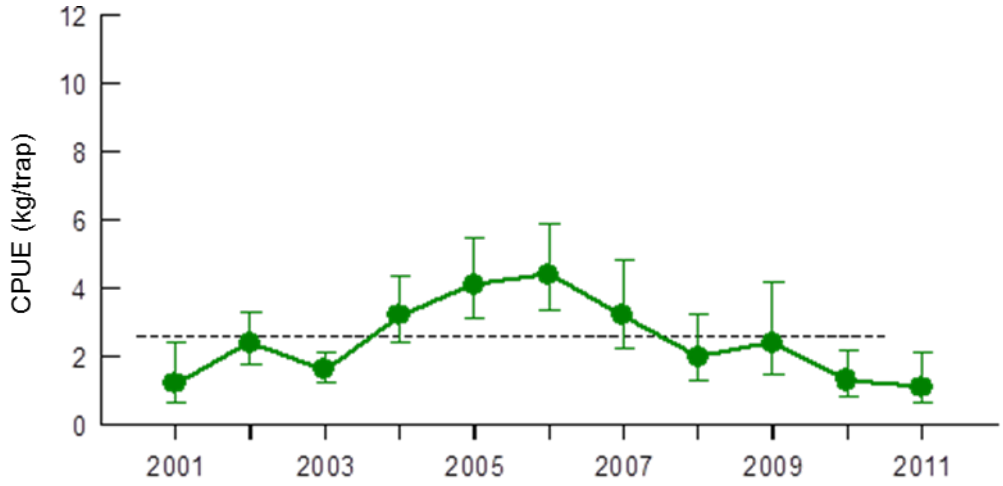

Figure 39. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 11. The horizontal line represents the 2001–2010 baseline level.

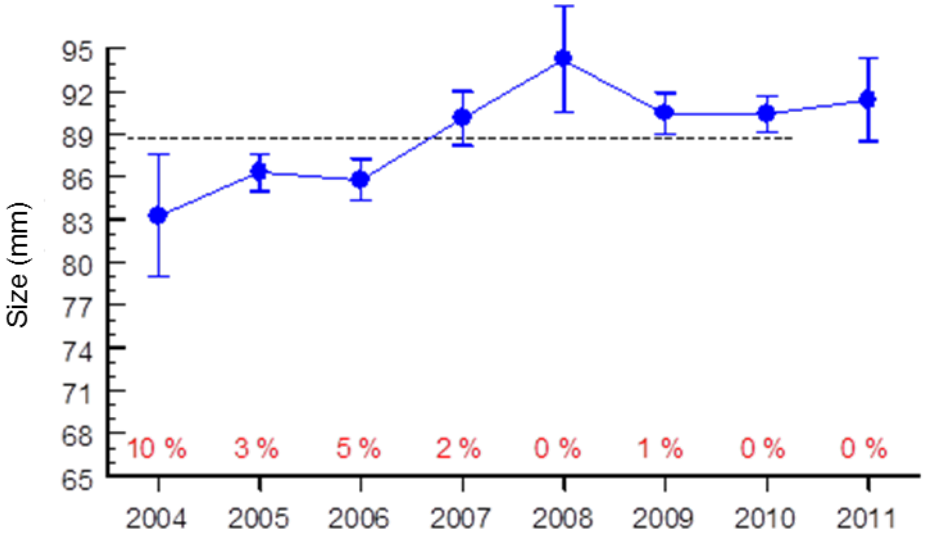

Figure 40. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 11. The horizontal line represents the 2004–2010 baseline level.

Fishing Area 12

Fishing Area 12 extends from Rivière Tartigou to Ruisseau de la Pointe de Chasse (Rivière-à-Claude) (Figure 41 and Appendix 8). The commercial fishery covers most of the area, except the western edge. In 2011, there were 12 active licences for 950 traps out of a total of 36 licences issued and 2,925 traps (Appendix 10).

Since 2005, landings remained stable between 83.7 t and 149.8 t (Figure 42 and Appendix 11). Landings peaked in 2006. A 128-t TAC was introduced in 2010 and was slightly exceeded (129.2 t) the same year, but was not caught in 2011. In 2011, Area 12 accounted for 52.9% of landings in the Gaspé–Lower St. Lawrence.

Fishing effort peaked at 37,353 trap hauls in 2006 (Figure 42 and Appendix 12). Values for the last three years were 26,562, 27,973 and 19,601 trap hauls. Since 2002, variations in effort have largely accounted for variations in landings.

The average CPUE for this area was 2.4 kg/trap in 2003, the lowest in the series (Figure 43 and Appendix 13). By 2007, CPUE had increased to 4.6 kg/trap. Since, CPUE have remained above 3.7 kg/trap. The values in the last three years were 4.2, 4.5 and 4.4 kg/trap.

Since 2004, average sizes of landed whelk have been near the 2004–2010 86.6-mm baseline level (Figure 44 and Appendix 14). The average size was 86.9 mm in 2011. The proportion of sub-legal size whelk has been less than 4% in landings since 2005 (Figure 44 and Appendix 15). Size structures have been very similar since 2008 (Appendix 27).

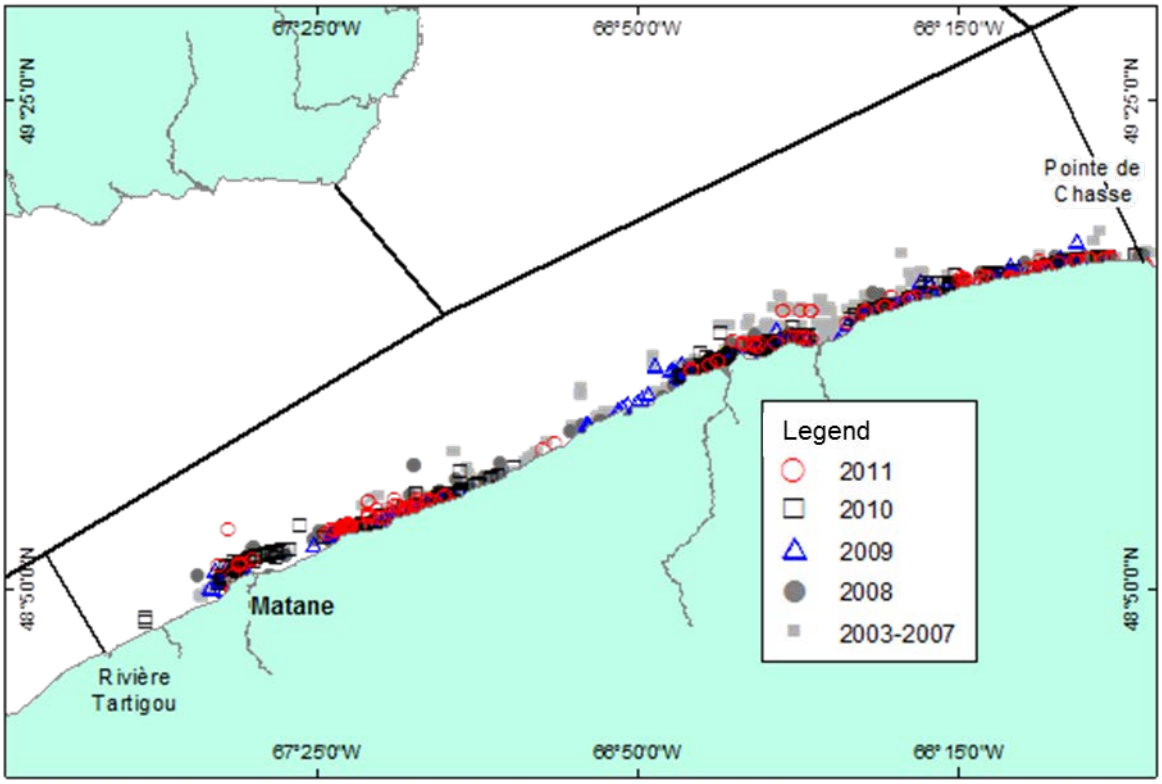

Figure 41. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 12.

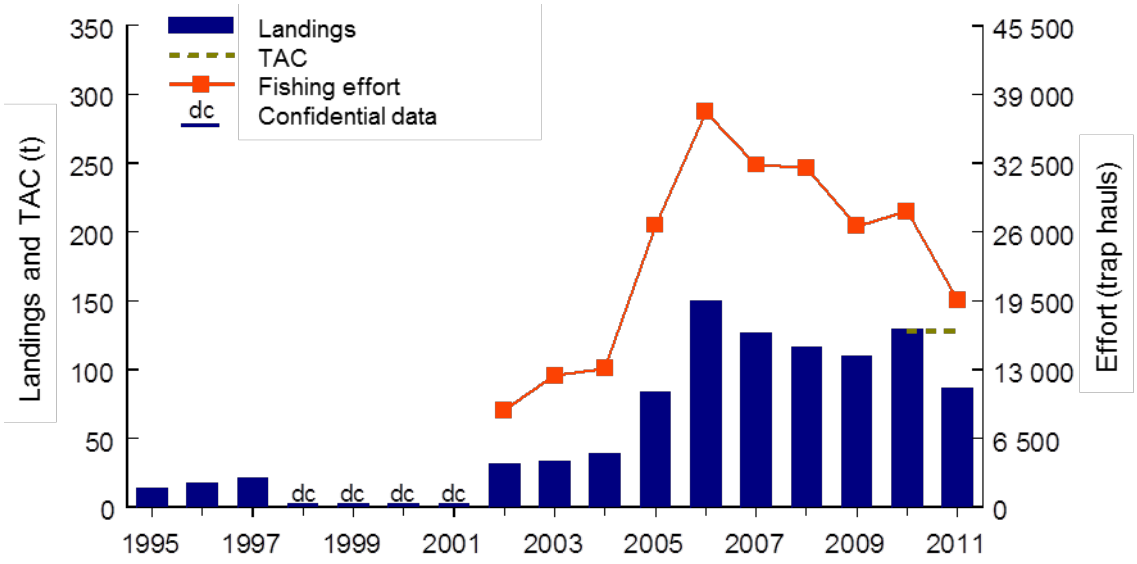

Figure 42. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2011 in Fishing Area 12.

Figure 43. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 12. The horizontal line represents the 2001–2010 baseline level.

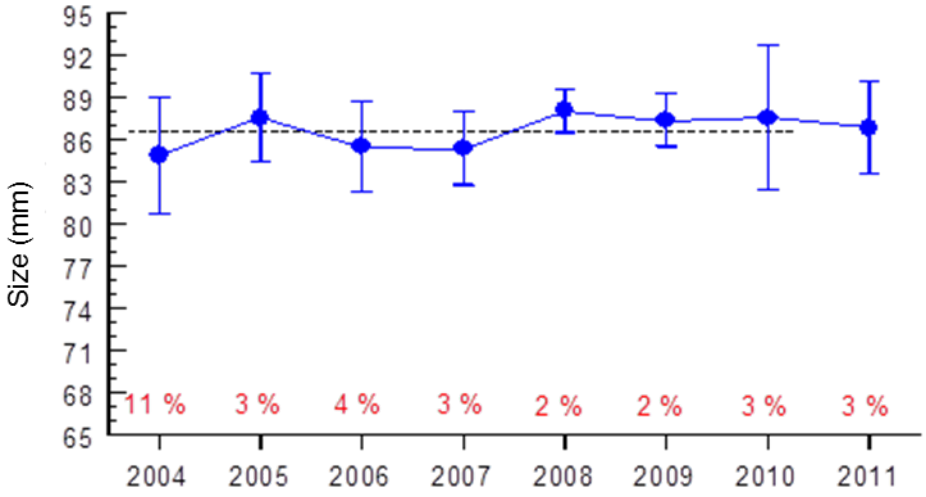

Figure 44. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 12. The horizontal line represents the 2004–2010 baseline level.

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 banks of the St. Lawrence estuary (Appendix 8). It then extends from the southern side of the Estuary to Rivière Tartigou (Figure 45 and Appendix 8). The commercial fishery exclusively covers the eastern portion of the area, starting at the Bic archipelago (near Rimouski). In 2011, there were five active licences for 500 traps out of a total of 14 licences issued and 1,100 traps (Appendix 10).

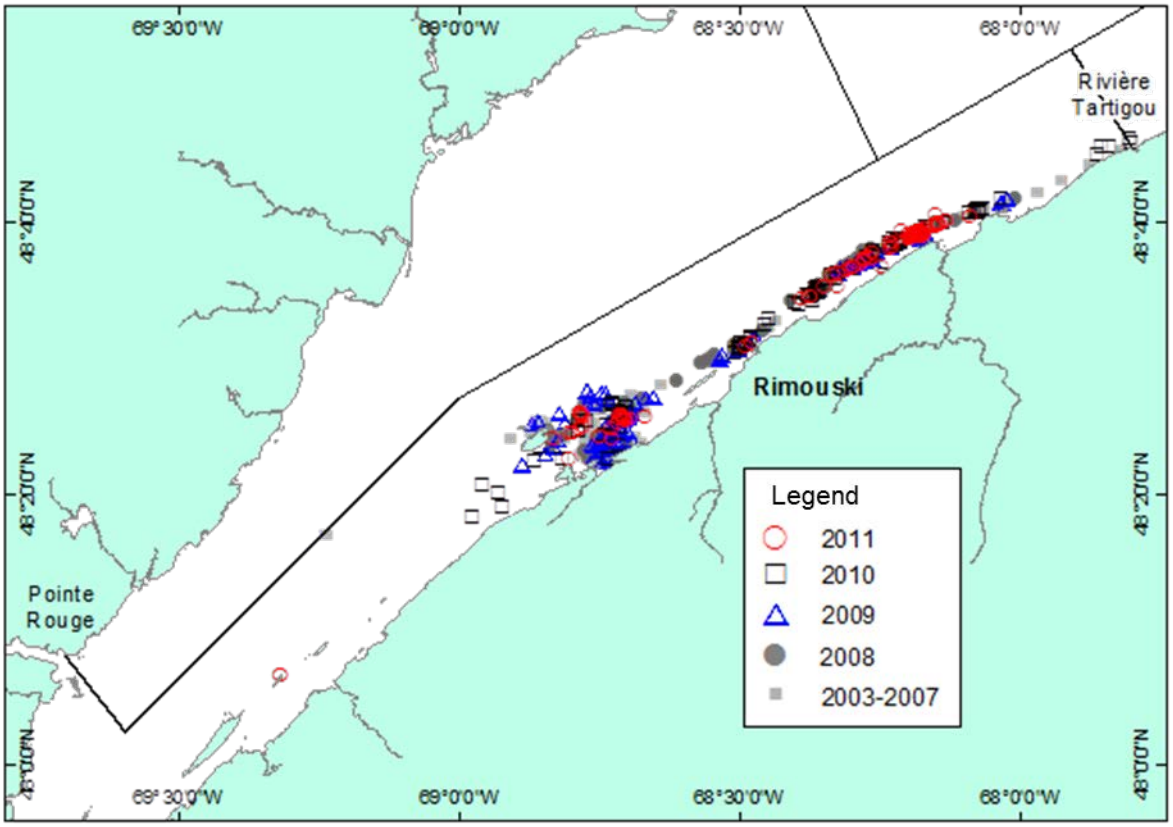

Figure 45. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 13.

Landings were below 35 t from 1995 to 2006 (Figure 46 and Appendix 11). Subsequently, landings increased when fishermen discovered promising new whelk beds. 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 (Appendices 9 and 10). After the TAC was caught in 13a in 2010, some fishermen made trips to subarea 13b, but landings were disappointing. 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. Landings were 56.7 t in 2009, 90.7 t in 2010 and 78.0 t in 2011 for the whole of Area 13 (Figure 46 and Appendix 11). In 2011, this area accounted for 46.3% of landings in the Gaspé–Lower St. Lawrence.

Fishing effort peaked at 12,440 trap hauls in 2007, but this maximum effort did not coincide with peak landings recorded in 2010 (Figure 46 and Appendix 12). This may be attributable to fishermen's experience and better knowledge of the new beds.

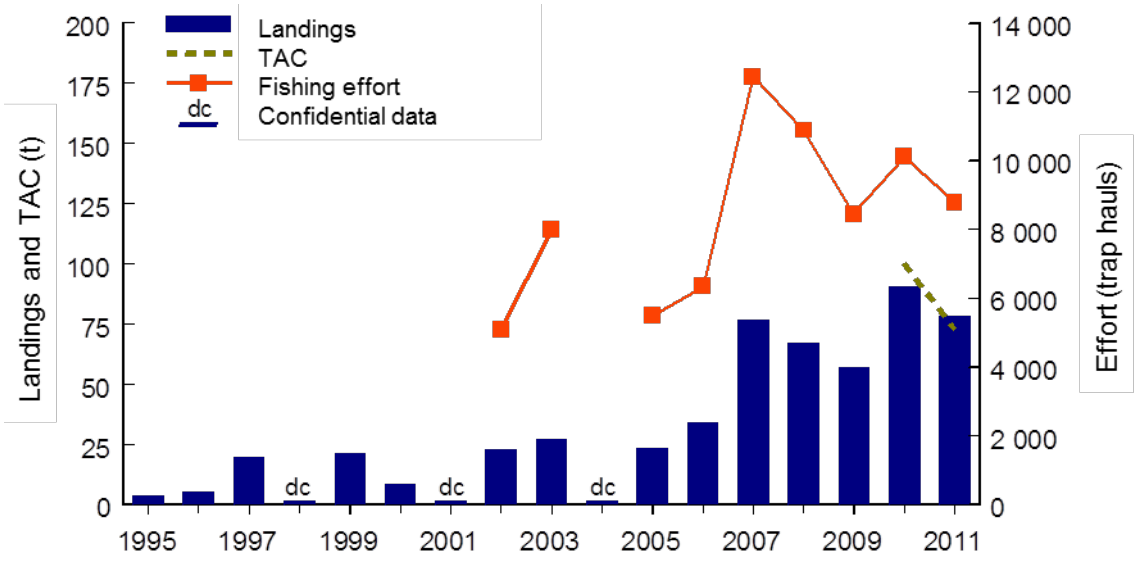

Figure 46. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2011 in Fishing Area 13.

In the early 2000s, CPUE values were the lowest in the series, around 4 kg/trap (Figure 47 and Appendix 13). Subsequently, CPUE gradually increased to 8.3 and 8.8 kg/trap in 2010 and 2011, well above the 2001–2010 baseline level.

Figure 47. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 13. The horizontal line represents the 2001–2010 baseline level.

The average size of landed whelk increased from 69.7 mm in 2004 to 87.1 mm in 2007, possibly as a result of the exploitation of new sites (Figure 48 and Appendix 14). Since then, average size has ranged from 83.0 mm to 86.9 mm with values above the 2010–2011 baseline level. The proportion of sub-legal whelk in landings has been below 7% since 2007 (Figure 48 and Appendix 15). Size structures have been similar in recent years, which have included individuals more than 100 mm long (Appendix 28).

In 2010 and 2011, some fishing trips were conducted in this area, to assess the size structure of whelk caught in the eastern portion of the area (Appendix 28). Size structures of legal size individuals are similar, but include more whelks < 70 mm in samples collected at sea.

Samples were taken at dockside and at sea in June 2010 in the western portion of the area to document the fishery in this new area. The median of landed whelk was only 71 mm and accurately reflects the high proportion of sub-legal size whelk (39%) in this landing (Appendix 28). Moreover, CPUE in this part of the area during the few commercial fishing trips were low, at 1 kg/trap.

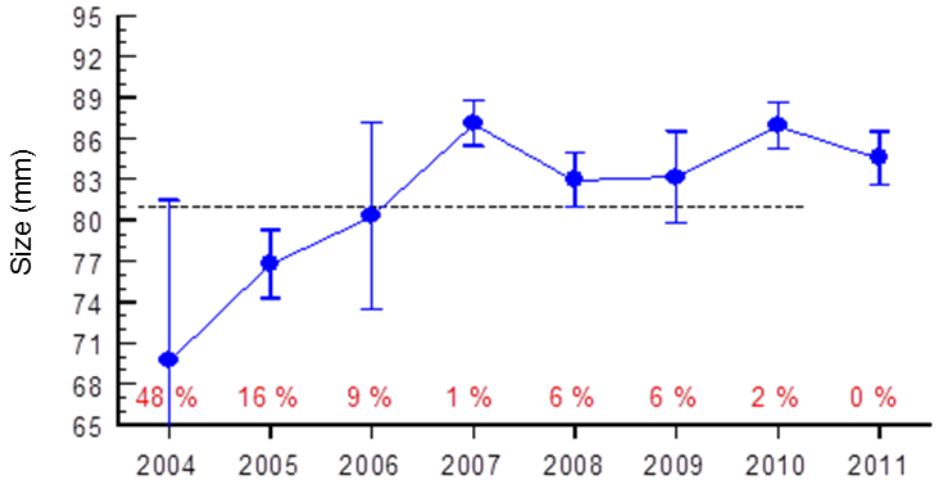

Figure 48. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 13. The horizontal line represents the 2004–2010 baseline level.

Fishing Area 14

Fishing Area 14 covers the South Shore of the Gaspé, from Cape Gaspé to the end of Chaleur Bay (Appendix 8). There has been no commercial fishery in this area since 2005. In 2011, 12 licences were issued for 700 traps (Appendix 10).

Historical landing and fishing effort data are confidential. There has been no fishing effort in this area for several years. The only information available is the size of whelk landed in 2004, which is provided as an indication only (Appendices 14, 15 and 25). At that time, the average size of landed whelk was 72.4 mm, and the proportion of sub-legal size whelk in landings was 34%.

ÎLES-DE-LA-MADELEINE

Fishing Area 15

Fishing Area 15 covers the entire coastal area around the Îles-de-la-Madeleine (Figure 49 and Appendix 8). Commercial fishing gained momentum in 2003 and is still developing. Every year, fishermen travel extensively in search of promising new fishing areas. In 2008, the area was slightly enlarged to the south, which explains the few trips outside Area 15. In 2009, the area boundaries were brought back to their original location. In 2011, there were nine active licences for 900 traps out of a total of 11 licences issued and 1,100 traps (Appendix 10). A measure was added in 2011, allowing fishermen to use 150 traps each provided they restrict their fishing season to between August and November.

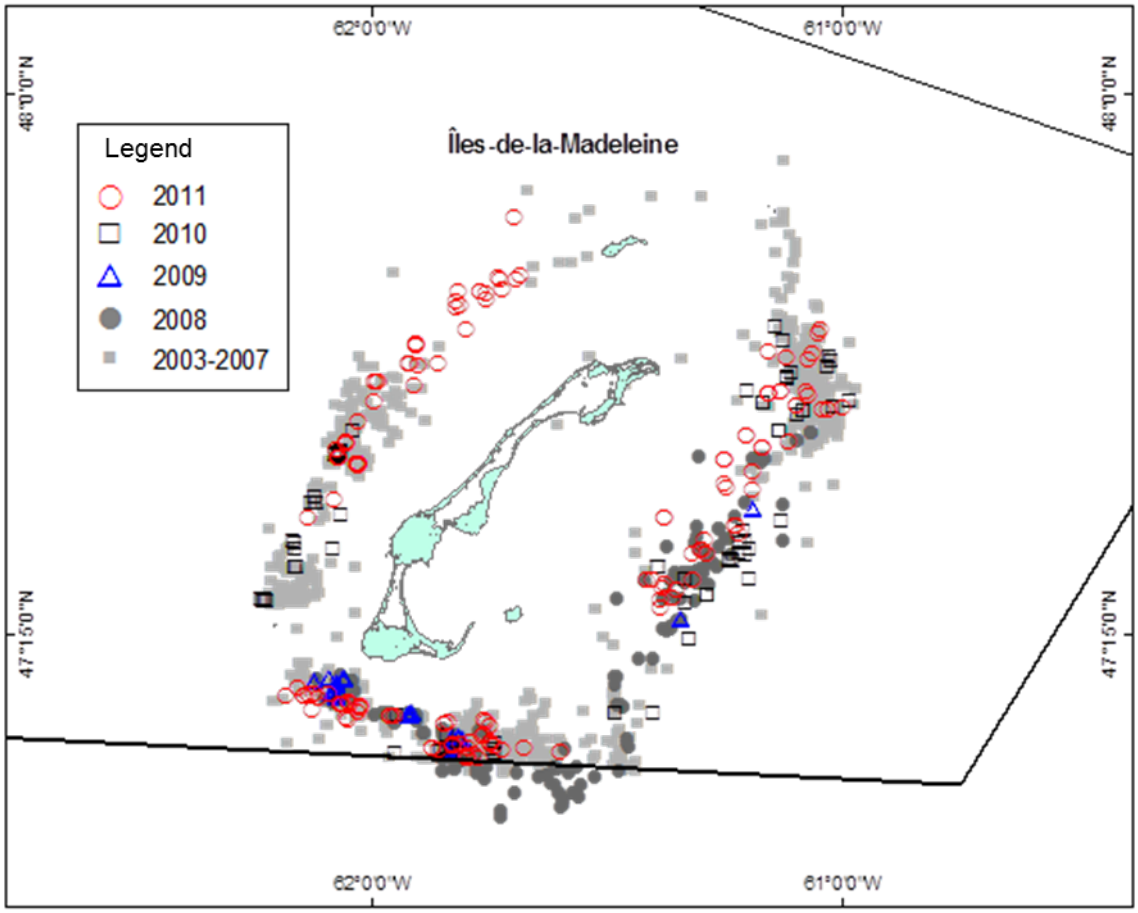

Figure 49. Distribution of commercial whelk fishing effort from 2003 to 2011 in Fishing Area 15.

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 (Appendices 9 and10). The Area was subdivided to better distribute 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. This TAC is divided among the 11 licence holders. From 2003 to 2008, landings ranged from 352.4 t to 441.7 t (Figure 50 and Appendix 11). Although all licence holders were active, the TAC was not caught from 2006 to 2008, because some fishermen were not interested. In 2009, only two licences were active because of the low price offered by processing plants. In 2010 and 2011, there were six and nine active licences, and 150.5 t and 265.4 t were landed.

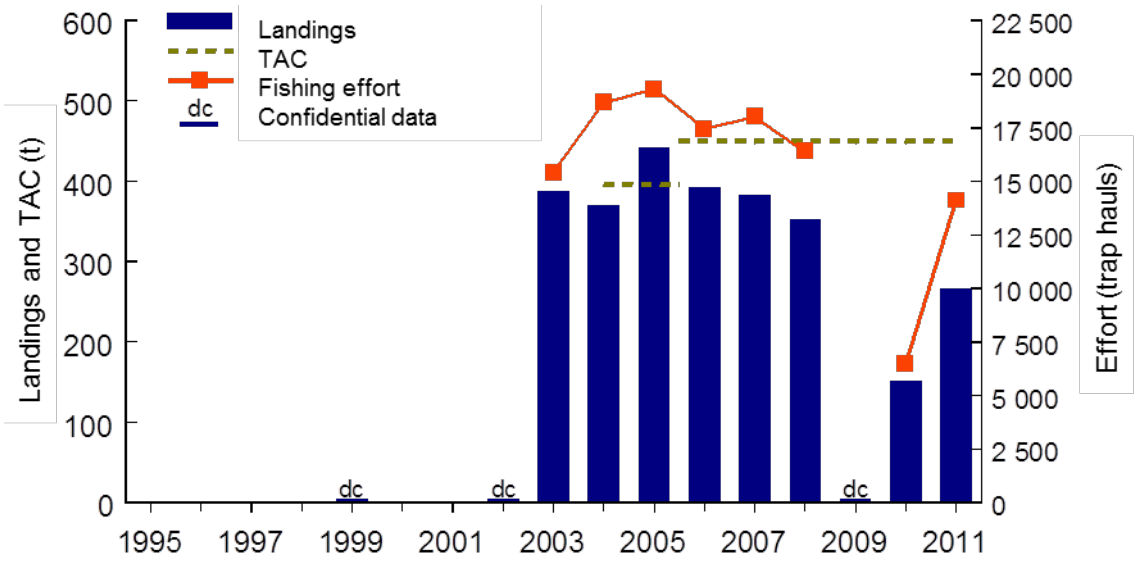

Figure 50. Whelk landings, total allowable catch (TAC) and fishing effort from 1995 to 2011 in Fishing Area 15.

From 2003 to 2008, fishing effort changed little from 15,397 to 19,296 trap hauls (Figure 50 and Appendix 12). Subsequently, the reduced number of active licences therefore affected fishing effort, which stood at 6,499 trap hauls in 2010 and 14,100 in 2011.

CPUE in this area were the highest in Québec (Appendix 13). They ranged around the 2003–2010 21.8-kg/trap baseline level (Figure 51 and Appendix 13). Because CPUE are variable, there are few significant differences between years. However, the 2011 18.9-kg/trap CPUE is the lowest in the series and below the baseline level.

Figure 51. Standardized catch per unit effort (CPUE ± 95% confidence interval) in the whelk fishery from 2001 to 2011 in Fishing Area 15. The horizontal line represents the 2003–2010 baseline level.

Since 2008, the average size of landed whelk has exceeded 85 mm (Figure 52 and Appendix 14). The percentage of sub-legal whelk in landings has been below 9% since 2004 (Figure 52 and Appendix 15). Size structures have changed little since 2008 (Appendix 29).

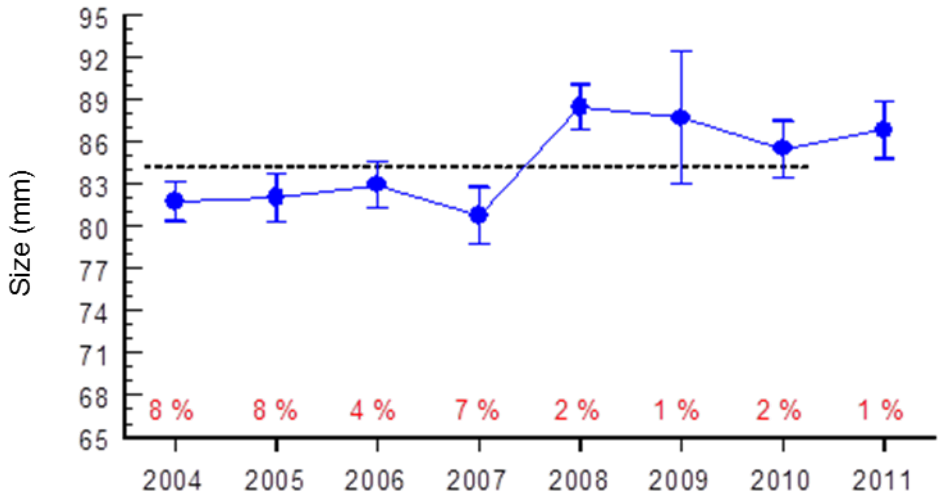

Figure 52. Average size of landed whelk and percentage of sub-legal size whelk in landings from 2004 to 2011 in Fishing Area 15. The horizontal line represents the 2004–2010 baseline level.

RESEARCH SURVEY

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 adjusted based on commercial fishing from 2001 to 2004 (Figure 53). In recent years, fishing effort has dropped sharply in Pointe-aux-Outardes and Baie-Comeau, whereas the Forestville area has continued to be visited by fishermen (Figure 54).

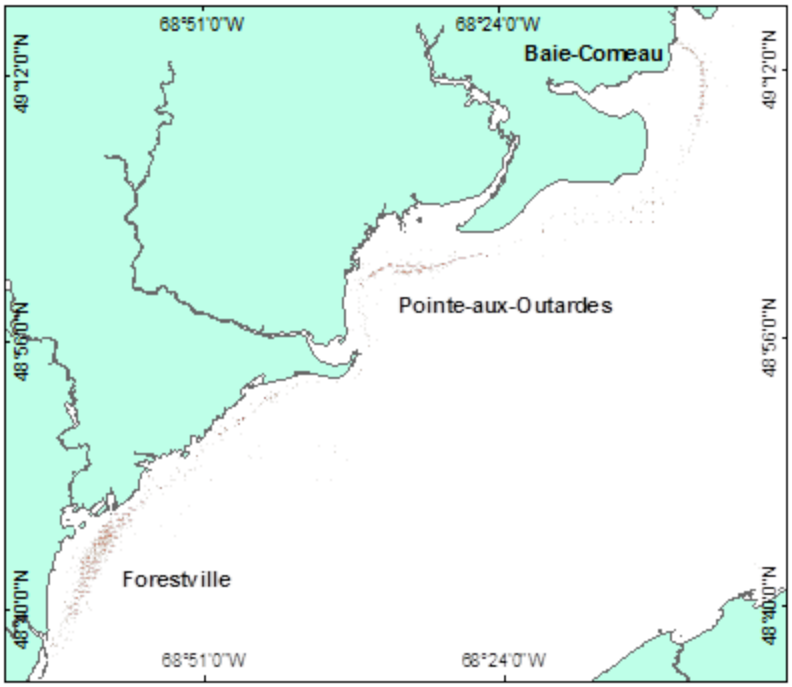

Figure 53. Distribution of commercial fishing effort from 2001 to 2004 (black circle) and research survey sampling stations (red square) from Forestville to Baie-Comeau.

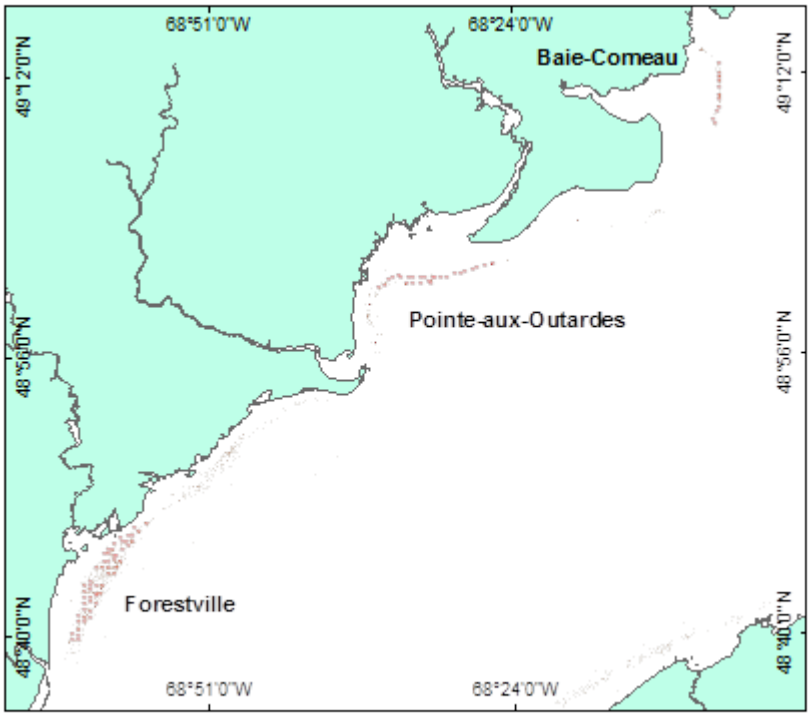

Figure 54. Distribution of commercial fishing effort from 2008 to 2011 (black circle) and research survey sampling stations (red square) from Forestville to Baie-Comeau.

A few species of *Buccinum* were identified in the Upper North Shore survey, *Buccinum undatum*, *B. glaciale*, *B. scalariforme* and *B. totteni*. However, nearly 99% of whelk harvested belonged to the *Buccinum undatum* species (Table 3).

Table 3. Average density (number/100 m^2) of the various species of Buccinum and all Buccinum (total) and percentage (%) of B. undatum by year and area in the 2009 and 2011 research surveys.

Area and Year	Forestville	Pointe-aux-Outardes	Baie-Comeau
2009			
B. undatum	6.423	4.561	24.264
B. glaciale	0.022	0	0
B. scalariforme	0.002	0.004	0.010
B. totteni	0.073	0.181	0.040
Total	**6.519**	**4.746**	**24.314**
Percentage of *B. undatum* (%)	98.5	96.1	99.8
2011			
B. undatum	11.831	11.920	41.690
B. glaciale	0.059	0	0
B. scalariforme	0	0.005	0
B. totteni	0.285	0.029	0.046
Total	**12.176**	**11.954**	**41.736**
Percentage of *B. undatum* (%)	97.2	99.7	99.9

The average relative densities of whelk by size class, area and year are presented in Table 4, as well as the post hoc test results. Whelk densities, yields and egg masses per station are provided in Appendices 30 and 31, and 2011 whelk density maps are presented in Appendix 32. In general, densities were similar in Forestville and Pointe-aux-Outardes (0 to 41 whelk/100 m^2 per station) and higher in Baie-Comeau (1 to 118 whelk/100 m^2). Densities within the same area generally differ between years.

In Forestville, densities of all whelk ≥ 20 mm differed significantly between years (Chi^2 = 38.728 and P < 0.0001) and were higher in 2011 than in the previous three surveys (Table 4). Results were the same in Pointe-aux-Outardes (Chi^2 = 8.941 P = 0.0301). 2011 densities differed from other years (Table 4). Finally, they were similar in the four years of the Baie-Comeau survey (Chi^2 = 4.289 P = 0.2319).

The survey year significantly affected densities of legal size whelk (≥ 70 mm) in Forestville (Chi^2 = 25.495 and P < 0.0001), and 2005 and 2011 densities were higher than in 2007 and 2009 (Table 4). In Pointe-aux-Outardes, these densities were similar across the four years of the survey (Chi^2 = 4.861 and P = 0.1823). In Baie-Comeau, densities differed between years (Chi^2 = 9.087 and P = 0.0282), and 2011 densities were similar to those in 2005 and 2007 and higher than those in 2009 (Table 4).

Table 4. Average whelk density (± 95% confidence interval) by size class and egg mass by area and year in the 2005, 2007, 2009 and 2011 research surveys.

Area and Year	Whelk Size Class [1]			Egg Masses
	≥ 20 mm	≥ 70 mm	20–69 mm	
Forestville				
2005	6.6 ± 1.0 b	3.3 ± 0.5 a	3.3 ± 0.7 b	0.02 ± 0.04
2007	5.5 ± 0.8 b	2.4 ± 0.3 b	3.1 ± 0.7 b	
2009	6.5 ± 1.1 b	1.9 ± 0.3 b	4.7 ± 0.8 b	0.01 ± 0.01
2011	12.2 ± 2.1 a	2.9 ± 0.4 a	9.3 ± 1.9 a	0.02 ± 0.01
Pointe-aux-Outardes				
2005	3.3 ± 1.6 b	1.9 ± 1.4 a	1.4 ± 0.6 b	1.0 ± 0.7
2007	4.2 ± 1.6 b	2.8 ± 1.2 a	1.4 ± 0.6 b	
2009	4.7 ± 1.4 b	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
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

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

Sub-legal size whelk (20 mm–69 mm) density results differed significantly between years in Forestville (Chi^2 = 48.581 and P < 0.0001) and Pointe-aux-Outardes (Chi^2 = 14.183 and P = 0.0027) and 2011 densities were higher than in the other three surveys (Table 4) In Baie-Comeau, there was no difference between the four years of the survey (Chi^2 = 3.298 and P = 0.3480).

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

Forestville (0.01 to 0.02 mass/100 m^2) (Table 4). However, the average weight of the masses was quite similar between areas (Table 5).

Average whelk yields by size class and egg mass recorded during the various research surveys are presented in Table 5. The average weight of the egg masses in an area can vary greatly from one year to the next. In 2009 and 2011, average weights ranged from 51 g to 222 g. The number of capsules with eggs was measured on six masses. The results were 336, 389 and 425 capsules/100 g in 2009 and 425, 565 and 838 capsules/100 g in 2010, with an average 496 capsules/100 g.

Table 5. 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 year in the 2005, 2007, 2009 and 2011 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
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
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

In Forestville, there has been little change in the structure of legal size whelk since 2005 (Figure 55). However, the percentage of sub-legal size individuals varied greatly between surveys and the 2011 size structure showed a significant juvenile mode at around 40 mm. The presence of juveniles with a 32 mm mode was also observed in Pointe-aux-Outardes in 2011(Figure 56). The largest whelks were caught in Pointe-aux-Outardes with maximum sizes ranging from 103 mm to 112 mm depending on the year. In Baie-Comeau, the mode ranged from 59 mm to 68 mm (Figure 57). Whelks less than 50 mm were not very abundant in 2011.

The morphometric relationship between whole live weight and whelk height varied between areas and years (Figure 58). The parameters of the linear relationships (natural logarithm) are provided in Appendix 33. In 2005 and 2007, individuals were generally lighter for the same size than in 2009 and 2011, with the weight of an 80-mm individual ranging from 55 g to 62 g.

The relationship between minimum diameter and height is useful in developing an effective sorting method aboard fishing vessels or a more selective trap. The minimum

diameter of a 70-mm whelk ranges from 31.54 mm to 32.65 mm depending on the area and year (Figure 59 and Appendix 33).

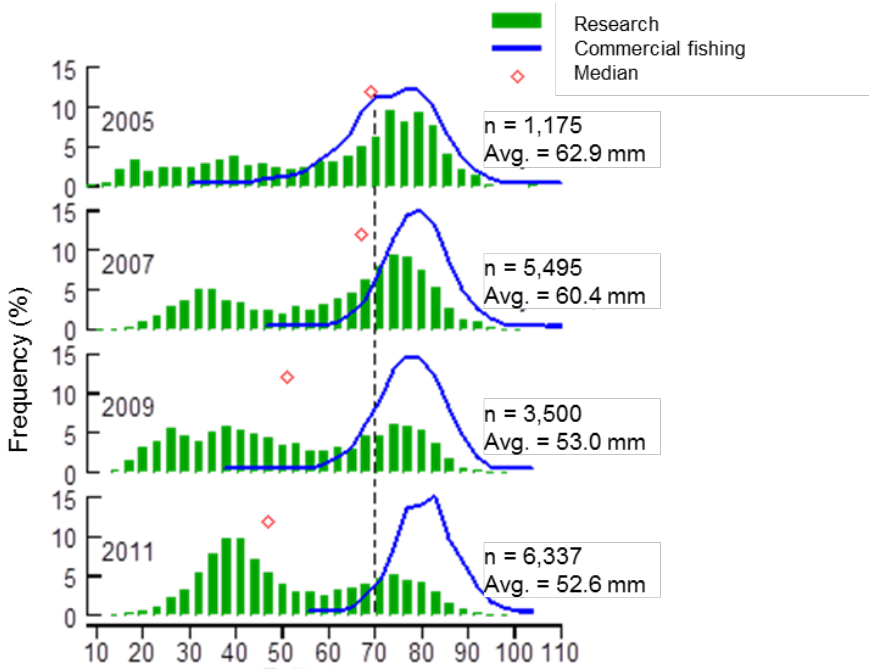

Figure 55. Whelk size structure, median size, number of whelks measured and average size in the Forestville research surveys and size structure in the 2005, 2007, 2009 and 2011 commercial fisheries in Fishing Area 1. The vertical line represents the 70-mm minimum legal size.

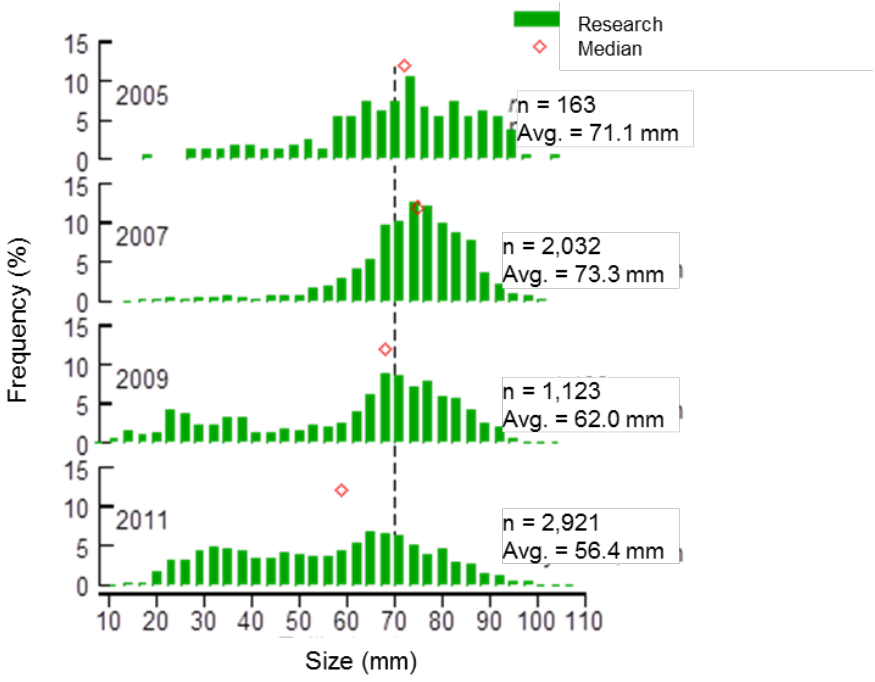

Figure 56. Whelk size structure and median size, number of whelks measured and average size in the 2005, 2007, 2009 and 2011 Pointe-aux-Outardes research surveys. The vertical line represents the 70-mm minimum legal size.

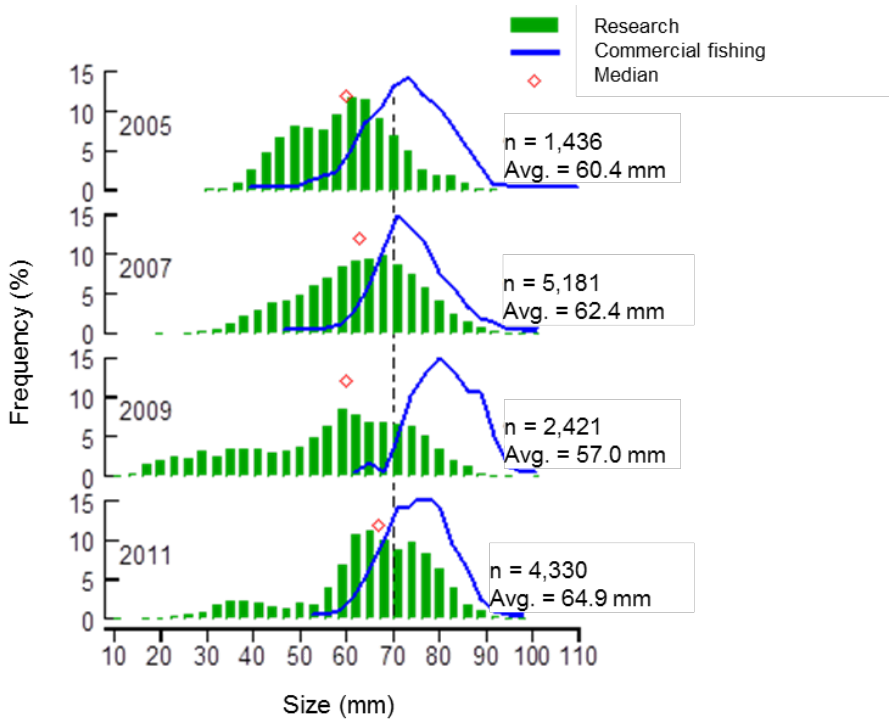

Figure 57. Whelk size structure, median size, number of whelks measured and average size in the Baie-Comeau research surveys and size structure in the 2005, 2007, 2009 and 2011 commercial fisheries in Fishing Area 2. The vertical line represents the 70-mm minimum legal size.

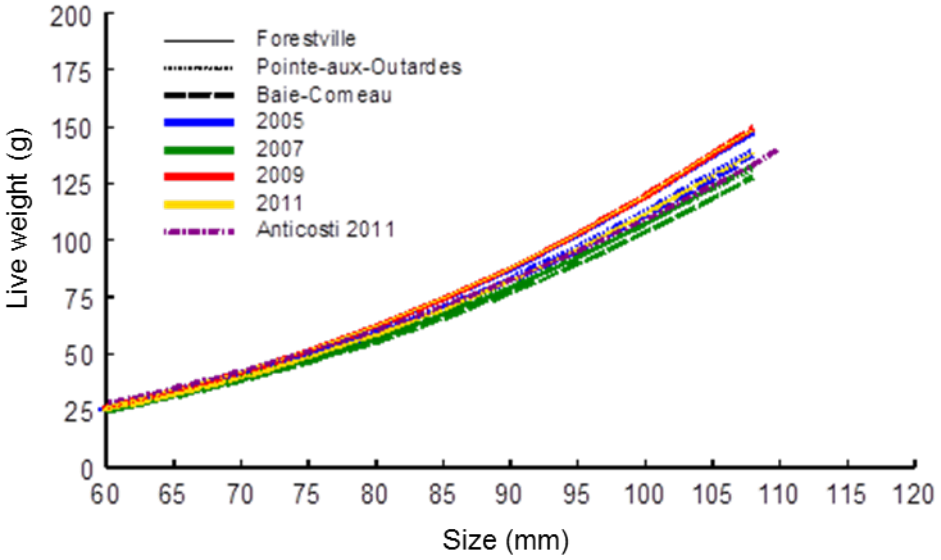

Figure 58. Relationship between the whole live weight and height of Waved Whelk (Buccinum undatum) by area and year in the 2005, 2007, 2009 and 2011 research surveys and the 2011 exploratory fishery off the coast of Anticosti Island.

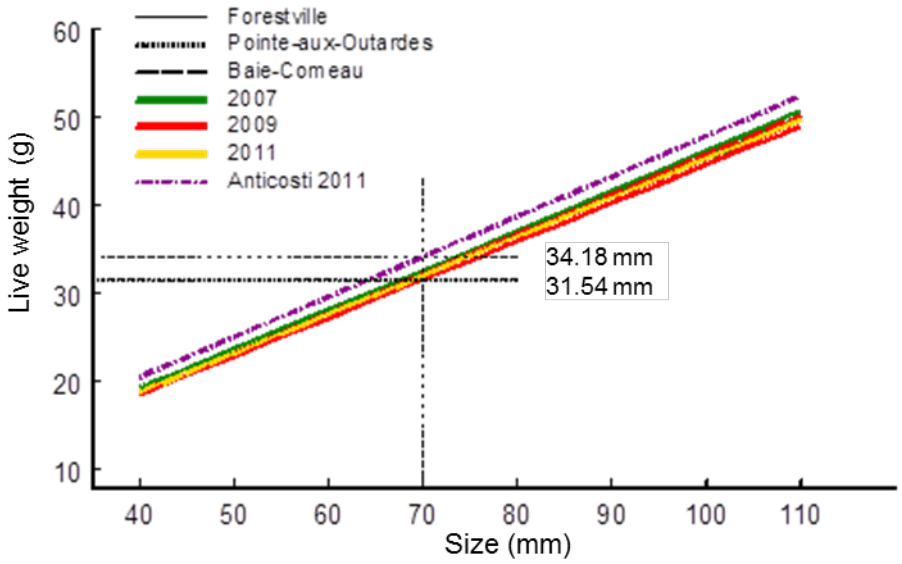

Figure 59. Relationship between the minimum diameter and height of Waved Whelk (Buccinum undatum) by area and year in the 2007, 2009 and 2011 research surveys and the 2011 exploratory fishery off the coast of Anticosti Island.

DREDGE EFFICIENCY

Depletion

Based on two depletion trials in Forestville and Pointe-aux-Outardes, whelk harvest dredge efficiency was estimated to be 40% in both areas (Appendix 34). Two areas were selected to assess efficiency in two different habitats. Although different, both habitats had sandy substrates, one with a significant presence of sand dollars, *Echinarachnius parma*, (Forestville), the other with empty mollusc shells (Pointe-aux-Outardes).

In scallop (*Placopecten magellanicus* and *Chlamys islandica*) research surveys conducted with the same dredge and vessel, dredge efficiency (assessed using the same method) in harvesting scallops can, depending on the type of substrate, currents, depth and climate conditions, vary between 5% and 70% for an average of about 50% (H. Bourdages, DFO Québec Region, personal communication).

Underwater images and videos

A comparison of whelk densities obtained with two sampling methods, dredging and images–videos, shows that dredge efficiency is low, between 9% and 24%, compared to that of photographs (Table 6 and Appendix 35). On the other hand, it is impossible to assess egg mass density on the images, since only two small masses were seen. Their density was estimated based on the videos. However, video use remains limited and image quality depends on various factors such as tow speed and large obstacles, which temporarily blur the image.

Table 6. Average whelk density (number / 100 m^2 ± 95% confidence interval) by size class and egg masses by area for two sampling methods and dredge efficiency in the 2009 research survey.

Area and Gear	Whelk Size Class		Egg Masses
	≥ 25 mm	≥ 70 mm	
Forestville			
Dredge	7.2 ± 2.4	2.1 ± 0.7	0
Image	78.4 ± 41.3	17.1 ± 11.1	0.07 + 0.06 [1]
Efficiency (%)	9%	12%	0%
Pointe-aux-Outardes			
Dredge	4.8 ± 2.2	2.4 ± 1.5	1.3 ± 2.1
Image	19.7 ± 18.7	10.2 ± 11.2	0.4 + 0.4 [1]
Efficiency (%)	24%	24%	325%

[1] Density estimated based on videos.

According to these results, dredging is a moderately efficient way to harvest whelk, which means that this information provides relative density and biomass values. The efficiency of the images is considered absolute, but some buried whelks escaped detailed image analysis. It should also be mentioned that the area covered by images (average of 10 m^2 per station) is very limited compared to the dredged area (average of 944 m^2 per station). The small area covered by the images is not necessarily appropriate for whelk, which may exhibit contagious distribution. It should also be noted that it can sometimes be difficult to identify the gastropods in the images, especially individuals less than 25 mm. Also, depending on the whelk's position in the image, it may be difficult to determine the individual's status (dead, empty shell occupied by a *Pagurus* sp., etc.) and measure its size. Finally, analyzing the images is very time-consuming. However, occasional use of images and videos provides a different perspective on habitat, a three-dimensional view of the seabed and a better understanding of the structural composition of populations and behaviour of organisms.

EXPLORATORY FISHERY

Of the 84 lines set off the coast of Anticosti Island (Fishing Area 9) in July 2011, 51 did not catch any whelk, and four did not catch any legal size whelk (Table 7). The average CPUE on all lines was 0.17 kg/trap for all whelk and 0.06 kg/trap for legal size whelk (Figure 60). However, caution should be exercised because some weights are missing in the legal and sub-legal size classes at transects 7, 8 and 9, where CPUE were high (Appendix 36). Given the near absence of whelk in the western portion of the study area, it is interesting to calculate the average CPUE for transects 1 to 11 only (eastern portion). However, even in this case, the average CPUE of legal size whelk remains low at 0.20 kg/trap (Table 7).

Of the 168 traps sampled, 128 did not catch any whelk, and 132 traps out of 164 did not catch any legal size whelk (Table 7). The highest CPUE, 11.5 kg/ trap, was in transect 9 at a depth of 20 m.

Table 7. Results obtained by size class of whelk on all lines or in traps sampled during the 2011 exploratory fishery off the coast of Anticosti Island.

Variable	Total	Legal (≥ 70 mm)	Sub-legal (< 70 mm)
Per line (84 lines set)			
Number of empty lines	51 [1]	55 [2]	62 [2]
Average CPUE [3]	0.17 ± 0.12	0.06 ± 0.07	0.01 ± 0.01
Average CPUE in east portion [3 4]	0.51 ± 0.36	0.20 ± 0.17	0.02 ± 0.03
Maximum CPUE (kg/trap)	3.7	1.6	0.2
Per trap (168 traps sampled)			
Number of empty traps	128	132 [5]	143 [5]
Maximum CPUE (kg/trap)	11.5	9.7	1.8

[1] Information missing for one line.
[2] Information missing for seven lines.
[3] Kg/trap ± 95% confidence interval.
[4] Transects 1 to 11.
[5] Information missing for four traps.

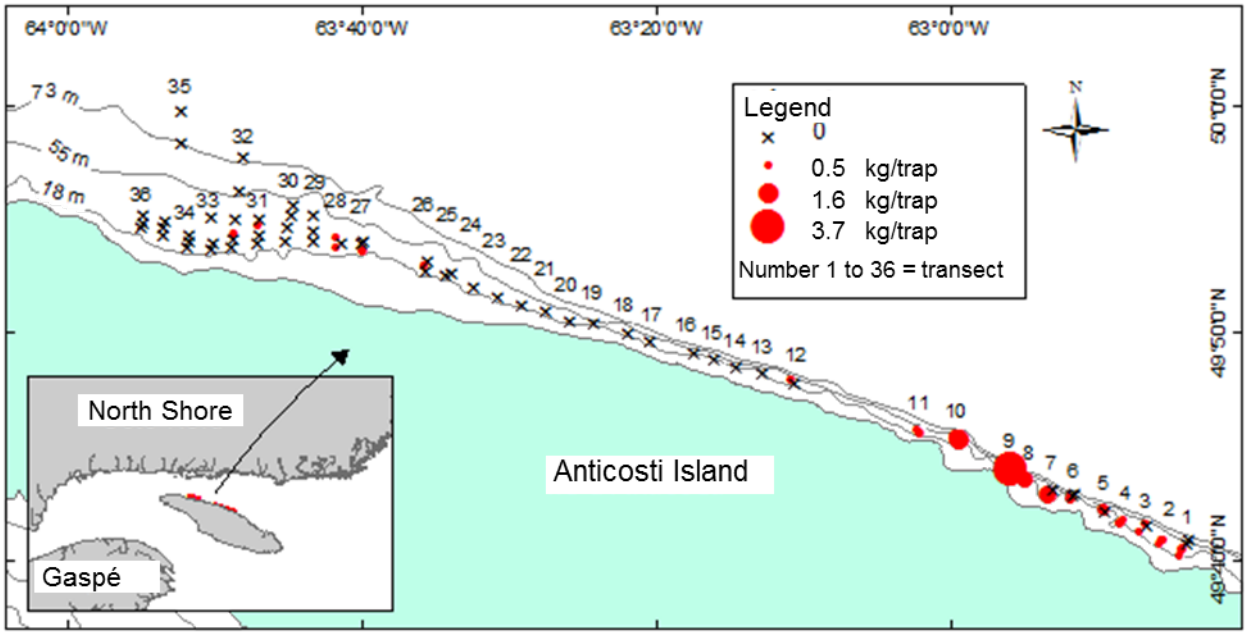

Figure 60. Catch per unit effort (kg/trap) for legal size whelk by line set during the 2011 exploratory fishery off the coast of Anticosti Island.

CPUE for legal size whelk were well below those in the 2011 Middle North Shore commercial fishery (Fishing Areas 4 to 6), with values between 3.8 and 6.3 kg/trap. However, the eastern area (transects 1 to 11) seemed more promising (Figure 60).

A total of 655 whelks were measured, 399 of which were legal size. The size range was 37 mm to 111 mm (Figure 61). The average size of all whelk caught was 73 mm and the median size was 75 mm, while the average and median size of legal size whelk were

83 mm and 82 mm respectively.

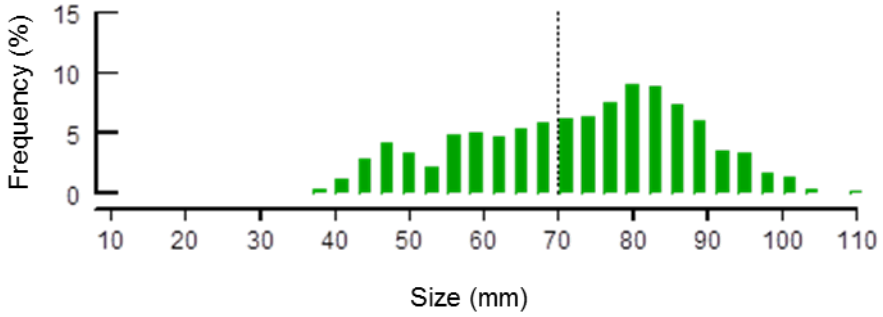

Figure 61. Size structure of whelk caught in the 2011 Anticosti Island exploratory fishery. The vertical line represents the 70-mm minimum legal size.

Of the 170 whelk in the sub-sample, four were *Buccinum totteni* from transect 11 line 1 at 49 m depth, on was a *B. scalariforme* whose exact origin was unknown, and all others were *B. undatum* (97%). The sex ratio of *B. undatum* in the sample was skewed to females, 102 females to 63 males. The weight-height relationship is similar to the ones in the Upper North Shore research surveys (Figure 58 and Appendix 33). A *B. undatum* with an 80-mm shell height weighs 60 g on average, while a 70-mm whelk has a minimum 34.18-mm diameter.

Twenty taxa, other than *Buccinum* sp., were found in traps during the exploratory fishery (Appendix 37). The most frequent taxa were:

- Brittle Star, *Ophiopholis aculeata:* 83% of lines
- Green Sea Urchin, *Strongylocentrotus droebachiensis*: 56% of lines
- Rock Crab, *Cancer irroratus*: 27% of lines
- Arctic Lyre Crab, *Hyas* spp.: 25% of lines
- Starfish, *Asterias rubens* and *Crossaster papposus*: 24% of lines
- Hermit Crab, *Pagurus* sp.: 16% of lines
- Snow Crab, *Chionoecetes opilio*: 6% of lines.

Some species, such as the Iceland Scallop (*Chlamys islandica*) and sea cucumber (*Cucumaria frondosa*), may have entered the traps possibly when the lines were raised and the traps scraped the substrate. The presence of pebbles and rocks in the traps (66% of lines) confirms this fact.

CONCLUSION AND ADVICE

Whelk is a sedentary benthic species that attaches its eggs to the substrate during the egg-laying period. Development continues on the egg-laying site, and there is no pelagic larval stage to help disperse the young. These biological characteristics make whelk vulnerable to local overfishing.

To limit this risk, a minimum 70-mm legal size has been in place since 2005 in all areas. The harvest of sexually immature individuals can have negative impacts on the resource. It is therefore recommended that the minimum legal size be maintained in all areas and that the number of sub-legal-size whelk continues to be reduced or even eliminated in landings.

Since 2006, CPUE have increased in Areas 5, 6 and 13, been relatively stable in Areas 1,

3, 4, 12 and 15, dropped in Areas 7 and 11, and varied in Areas 2 and 8. However, 2011 CPUE were below baseline levels in Areas 1, 3, 11 and 15 (Table 8).

Average sizes have been fairly stable in all areas since 2006. The proportion of sub-legal size whelk in 2011 landings was less than 6% everywhere except in Areas 2 and 8 where values were 21% and 32% (Table 8).

Table 8. Total allowable catch (TAC), landings (Lan.), fishing effort, catch per unit effort (CPUE), average size at which 50% of females are mature (T_{50}), average landing size and percentage of whelk (< 70 mm) in 2011 landings and rates of change (C) of some indicators relative to their baseline levels.

Area	TAC	Lan.	Effort (traps)		CPUE (kg/trap)		T_{50}	Size (mm)		< 70 mm
	(t)	(t)	2011	C[1]	2011	C[1 2]		2011	C[2 3]	(%)
1	491	132	19,623	-38%	6.8	-11% ▼	66	81	5% Δ	5
2	109	cd [4]	cd	2%	11.4	18% =	69	75	0% =	21
3		cd	cd	-40%	3.2	-30% ▼	79			
4		42	10,687	-69%	3.8	19% Δ	71	91	3% =	2
5		312	54,995	-28%	6.3	50% Δ	80	88	5% Δ	1
6		314	63,625	-1%	5.1	22% Δ	79	88	4% Δ	2
7		cd	cd	-49%	4.9	-24%	65	90	7%	2
8		21	6,704	-31%	3.7	-10%	74	73	-3% ▼	32
11	32	cd	cd	-85%	1.1	-58% ▼	65	91	3% =	< 1
12	128	89	19,601	-19%	4.4	18% =	76	87	0% =	3
13	73	78	8,785	9%	8.8	53% Δ	70	85	4% Δ	< 1
15	450	265	14,100	0%	18.9	-13% ▼	61	87	3%	1

[1] Rate of change from the 2001–2010 baseline level, except 2003–2010 in Area 15.
[2] Information on the position of the value compared to the baseline level:
Δ 2011 value is above average
= 2011 is equal to the average, the confidence interval of the value includes the average
▼ 2011 value is below average.
[3] Rate of change from the 2004–2010 baseline level.
[4] cd: confidential data (three fishermen or fewer).

The two main indicators, CPUE and average landed size, have stabilized somewhat since 2006 in most areas where fishing effort has been sustained. This suggests that the stock status has been maintained in recent years and that this level of exploitation is probably sustainable under current environmental conditions. The drop in effort between 2003 and 2006 theoretically favoured this stabilization of indicators.

To conserve this resource in the long term, we recommend directly controlling fishing effort in all fishing areas because available whelk data cannot be used to assess the exploitable biomass of the various stocks. We therefore recommend that effort be limited to the average of the three highest values in the 2006–2011 series (Table 9). In the special case of Areas 7 and 11 where the fishery is focused on only a small area, it would be better to explore and expand the fishing area. The low 2011 fishing effort in Area 15 may be due to fishermen exploiting slightly less productive areas, but the situation is not troubling for the time being.

In the absence of fishing effort controls, the rule outlined above could be applied to

landings. However, this method will not necessarily ensure that fishing effort is maintained (Table 9).

Table 9. Fishing effort (number of trap hauls) or landings (t) proposed for the 2012, 2013 and 2014 commercial whelk fishing seasons by fishing area and years used in the calculation.

Sector and Area	Fishing Effort (years used)	Landings (years used)
North Shore		
1	31,303 (2006-2009-2010)	250 (2006-2009-2010)
2	5,879 (2006-2010-2011)	55 (2007-2010-2011)
3	3,745 (2006-2007-2008)	19 (2006-2007-2008)
4	26,379 (2006-2007-2010)	83 (2006-2007-2010)
5	68,071 (2006-2009-2010)	316 (2009-2010-2011)
6	64,261 (2006-2009-2010)	334 (2009-2010-2011)
7	8,810 (2006-2009-2010)	66 (2006-2007-2009)
8	12,214 (2006-2008-2010)	36 (2006-2008-2010)
Gaspé–Lower St. Lawrence		
11	5,136 (2006-2007-2008)	15 (2006-2007-2008)
12	33,918 (2006-2007-2008)	135 (2006-2007-2010)
13	11,146 (2007-2008-2010)	82 (2007-2010-2011)
Îles-de-la-Madeleine		
15	17,286 (2006-2007-2008)	376 (2006-2007-2008)

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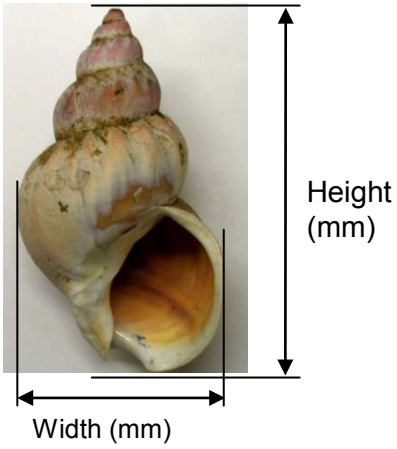
Appendix 1. Fishing area, sampling date, location (latitude and longitude WGS84), depth, number by sex and size range of Waved Whelk (Buccinum undatum) harvested in 1998 to measure sexual maturity.

Area	Date	Latitude (W)	Longitude (N)	Depth (m)	Number		Size (mm)
					Female	Male	
1	05-05-1998	49° 29.12'	068° 29.40'	10	86	87	40-93
2	06-05-1998	49° 01.80'	068° 10.80'	13	71	61	47-91
3	11-05-1998	49° 15.11	067° 10.65'	16	55	58	55-99
4	12-05-1998	50° 06.60'	066° 12.60'	27	76	79	40-92
5	09-05-1998	50° 10.39'	065° 14.54'	20	56	82	40-97
6	09-05-1998	50° 07.20'	063° 25.20'	11	75	81	30-102
7	30-06-1998	50° 03.60'	061° 25.20'	19	65	66	45-94
11	13-05-1998	49° 09.30'	065° 10.50'	14	62	61	41-96
12	24-05-1998	49° 05.40'	066° 18.00'	20	41	51	40-101
13	12-05-1998	47° 14.70'	068° 26.40'	12	54	49	42-89

Appendix 2. Identification of the various whelk measurements.



Minimum width (mm)

Appendix 3. Number of whelk specimens collected by region, fishing area and year as part of DFO's dockside and at sea commercial catch sampling program.

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

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

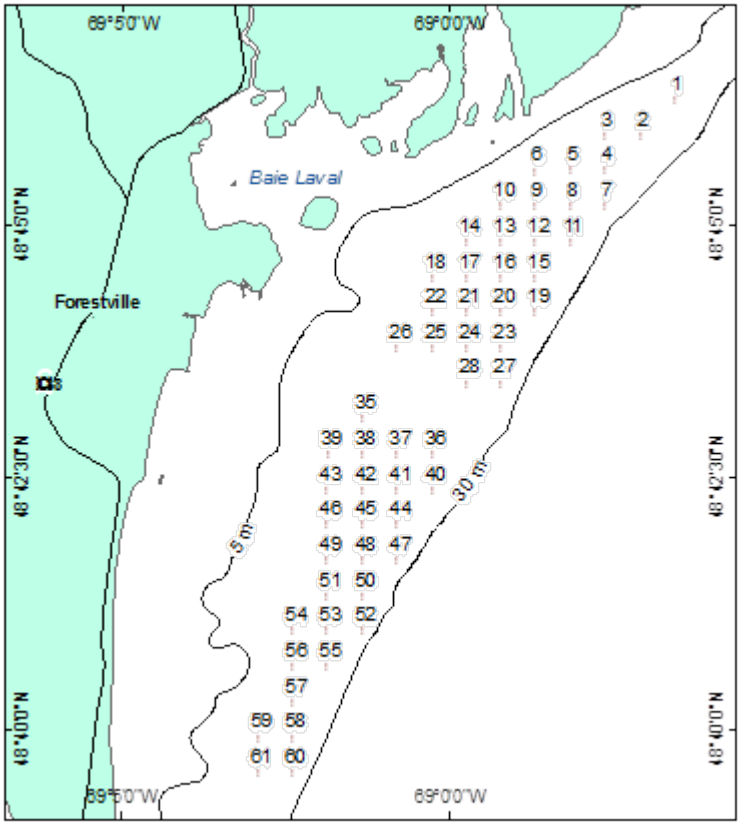
Appendix 4. Number of whelks measured by region, fishing area and year through DFO's landed commercial catch sampling program since 1995.

Year	Type	North Shore									G-LSL[1]					IM[2]
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1995	Dock	650			831	628	601		1,213			867		1,000		
1996	Dock				640		507		351			742		1,646		
1997	Dock	448	485		420	301	381		101			616	1,216			
1998	Dock	1,051	373	193	640	828	839	315	101			1,065	97	301		
1999	Dock	314	409	310	615	928	920	712	545			352		663		
2000	Dock	1,090	644	226	397	516	669	195	203			634	307	421		
2001	Dock	1,079	615	497	1,043	802	819					591	389	515		
2002	Dock	409	4,444	207	1,156	2,284	3,185	203	133			701	622	906		120
2003	Dock	219	4,380		1,256	1,021	1,208	602	536			695	755	940		
2004	Dock	5,178	1,832	1,252	2,771	3,304	3,282	2,514				1,856	1,766	725	1,069	2,341
2005	Dock	4,347	2,879		2,154	2,567	2,473	1,513	876	159		1,983	2,600	984		2,837
2006	Dock	4,538	385		1,359	1,645	1,351	919	489	149		2,288	1,724	839		2,323
2007	Dock	4,449	2,162		1,213	2,580	2,936	1,055	500			1,722	2,753	2,634		2,324
2008	Dock	5,754	621		1,209	2,423	2,257	754	519			1,078	2,808	2,439		2,699
2009	Dock	6,690	344		1,543	2,553	2,698	1,364	484			2,166	2,832	2,627		794
2010	Dock	7,837	1,537		2,309	4,134	3,232	2,153	1,023			1,095	935	3,056		2,559
2011	Dock	3,631	2,337		1,040	2,116	2,283	1,123	882			353	1,950	2,409		2,503

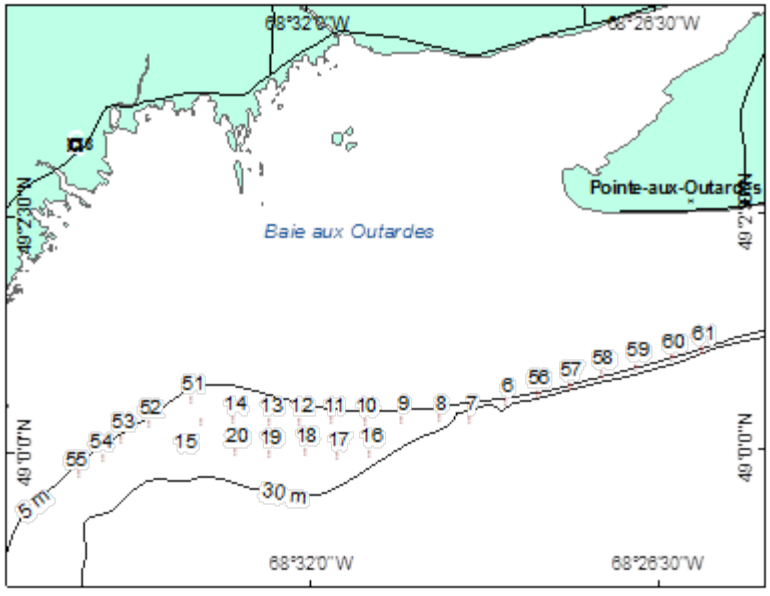
[1] Gaspé–Lower St. Lawrence
[2] Îles-de-la-Madeleine

Appendix 5. Location of the whelk research survey sampling stations in A) Forestville, B) Pointe-aux-Outardes and C) Baie-Comeau.

A)

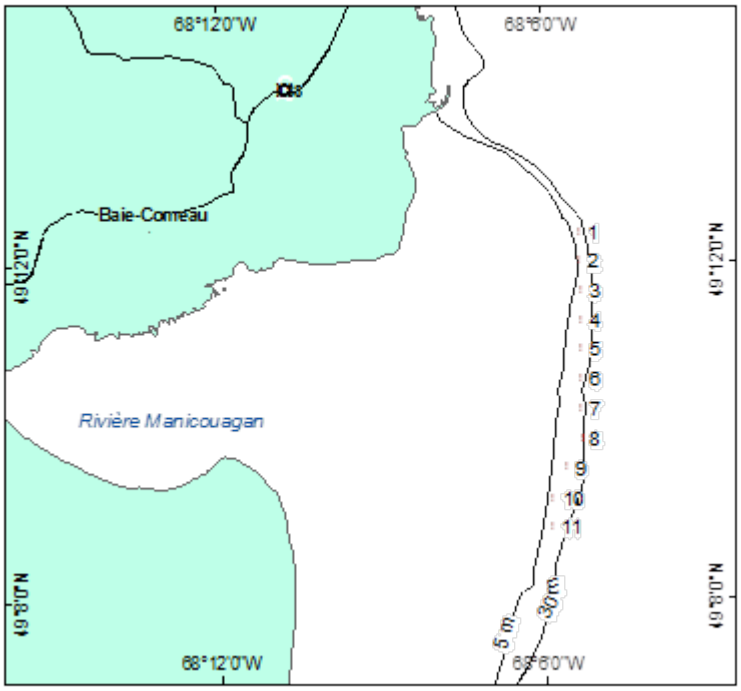


B)

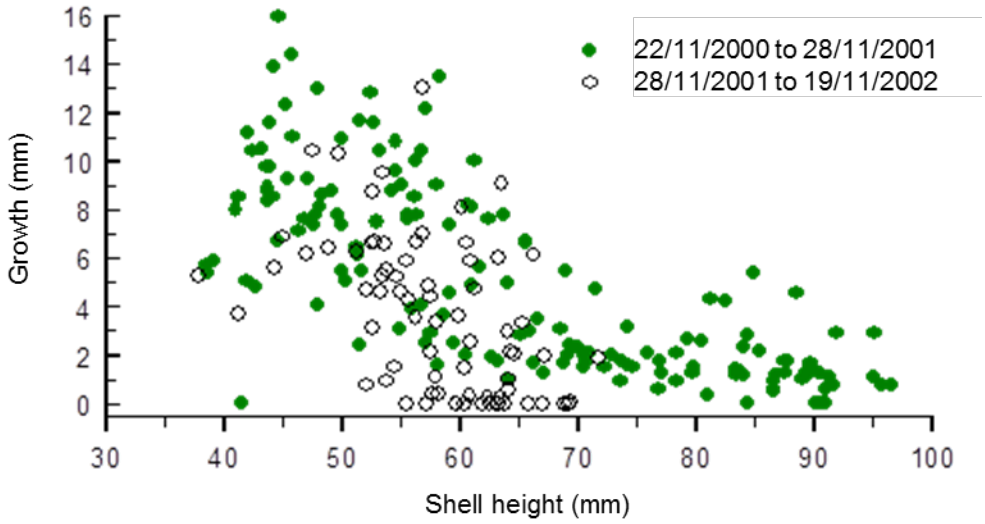


Appendix 5. (continued).

C)



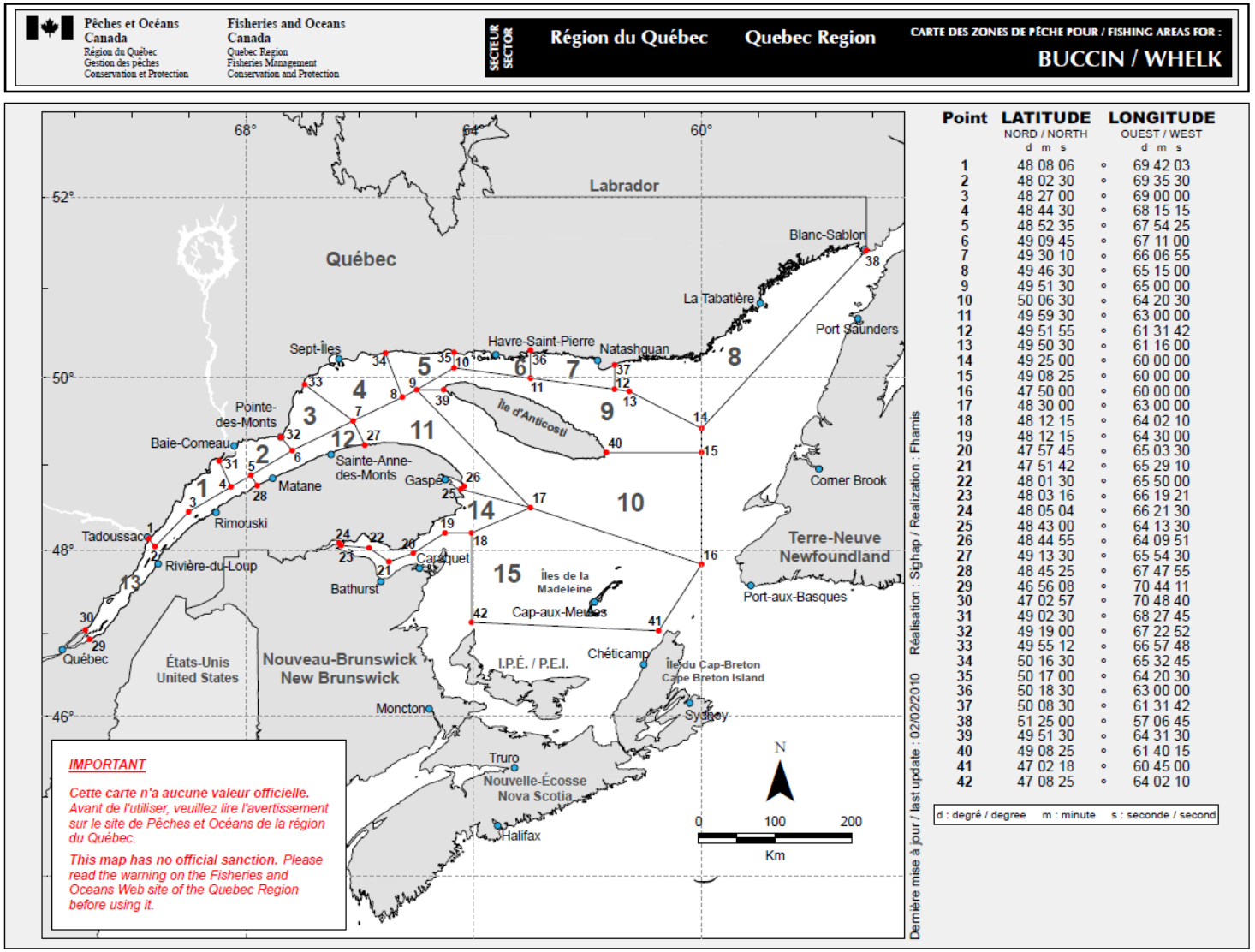
Appendix 6. Annual growth in Waved Whelk (Buccinum undatum) shell height by initial, measured in tanks from November 2000 to November 2002.



Appendix 7. Parameters of the logistic equation used to determine the size at which 50% of Waved Whelk (Buccinum undatum) were sexually mature (T_{50}) by fishing area and sex in 1989 and 1998.

Area	Sex	Y_{max}	T_{50}	Standard Error	*b*
1989 Results (Gendron 1992).					
4	Female	100	80.8	1.05	-0.342
4	Female	100	79.5	2.65	-0.165
5	Female	100	73.6	1.09	-0.236
6	Female	100	78.3	1.87	-0.285
8	Female	100	73.7	1.63	-0.250
11	Female	100	75.6	1.25	-0.153
12	Female	70	75.6	2.06	-0.166
15	Female	70	60.3	0.87	-4.425
4	Male	100	69.2	2.15	-0.124
4	Male	95	58.9	3.91	-0.315
5	Male	85	67.1	0.62	-0.855
6	Male	100	75.6	1.25	-0.259
8	Male	100	61.9	4.29	-0.098
11	Male	100	71.8	1.39	-0.821
12	Male	75	76.4	1.10	-0.268
15	Male	75	49.1	2.26	-0.290
1998 Results					
1	Female	100	66.3	1.93	-0.125
2	Female	100	68.8	1.27	-0.148
3	Female	100	79.3	3.78	-0.319
4	Female	45	71.1	2.08	-0.381
5	Female	60	79.9	0.21	-3.694
6	Female	85	78.9	14.30	-1.764
7	Female	100	64.6	0.30	-0.463
11	Female	75	65.1	0.15	-3.316
13	Female	70	70.5	0.48	-3.001
1	Male	70	65.0	5.31	-0.068
2	Male	85	63.8	5.33	-0.094
3	Male	90	74.4	0.82	-0.459
4	Male	75	71.2	1.69	-0.275
5	Male	60	75.0	0.13	-4.779
6	Male	55	76.5	1.56	-0.643
7	Male	100	57.4	1.83	-0.256
11	Male	60	72.2	2.89	-0.358
12	Male	100	72.5	0.12	-3.066
13	Male	70	66.1	3.24	-0.180

Appendix 8. 2011 whelk fishing areas in Québec.



Point	LATITUDE NORD / NORTH d m s		LONGITUDE OUEST / WEST d m s
1	48 08 06	°	69 42 03
2	48 02 30	°	69 35 30
3	48 27 00	°	69 00 00
4	48 44 30	°	68 15 15
5	48 52 35	°	67 54 25
6	49 09 45	°	67 11 00
7	49 30 10	°	66 06 55
8	49 46 30	°	65 15 00
9	49 51 30	°	65 00 00
10	50 06 30	°	64 20 30
11	49 59 30	°	63 00 00
12	49 51 55	°	61 31 42
13	49 50 30	°	61 16 00
14	49 25 00	°	60 00 00
15	49 08 25	°	60 00 00
16	47 50 00	°	60 00 00
17	48 30 00	°	63 00 00
18	48 12 15	°	64 02 10
19	48 12 15	°	64 30 00
20	47 57 45	°	65 03 30
21	47 51 42	°	65 29 10
22	48 01 30	°	65 50 00
23	48 03 16	°	66 19 21
24	48 05 04	°	66 21 30
25	48 43 00	°	64 13 30
26	48 44 55	°	64 09 51
27	49 13 30	°	65 54 30
28	48 45 25	°	67 47 55
29	46 56 08	°	70 44 11
30	47 02 57	°	70 48 40
31	49 02 30	°	68 27 45
32	49 19 00	°	67 22 52
33	49 55 12	°	66 57 48
34	50 16 30	°	65 32 45
35	50 17 00	°	64 20 30
36	50 18 30	°	63 00 00
37	50 08 30	°	61 31 42
38	51 25 00	°	57 06 45
39	49 51 30	°	64 31 30
40	49 08 25	°	61 40 15
41	47 02 18	°	60 45 00
42	47 08 25	°	64 02 10

d : degré / degree m : minute s : seconde / second

Appendix 9. 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

Appendix 10. Management measures for the 2011 commercial whelk fishery.

Area	Number of Licences		TAC	Season	Number of Traps
	Issued	Active			
1	11	6	491	01/04 to 25/09	50, 100 and 150
2	6	2	109	07/04 to 15/09	50, 100 and 150
3	7	3		19/04 to 13/11	100 and 150
4	29[1]	6		19/04 to 18/10	50, 59, 100 and 150
5	21	6		13/04 to 08/10	50, 100 and 150
6	16[2]	9[2]		13/04 to 18/10	50, 100 and 150
7	7	2		13/04 to 12/10	50, 100 and 150
8	64	9		25/05 to 30/11	100
9	1[3]	0		13/04 to 12/10	100
10	0	0			
11	18	1	32	01/04 to 30/09	50 and 100
12	36	12	128	01/04 to 30/09	50, 100, 150 and 175
13	14	5	73[4]	01/04 to 19/08	50 and 100
14	12	0		01/05 to 31/10	50 and 100
15	11	9	450[5]	02/05 to 25/11	100 or 150[6]
Total	**253**	**70**			

[1] Including 5 licences to an Aboriginal Band Council, agreement with DFO to use 150 traps instead of 450 traps (4 x 100 and 1 x 50 traps).

[2] Including 6 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 with the option to transfer a maximum 30% of their quota.

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

Appendix 11. 1993 to 2011 whelk landings (t) and baseline level by region and fishing area and for Québec as a whole.

Year	North Shore									G-LSL[1]					IM[2]	Québec[3]
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1993	125	0	37	53	182	204	0	cd[4]	0	0	58	28	3	cd	0	715
1994	54	cd	24	60	161	111	cd	14	0	0	24	28	3	cd	0	493
1995	80	cd	cd	56	186	119	cd	81	0	0	34	14	4	0	0	624
1996	179	cd	cd	176	275	178	cd	82	0	0	51	17	5	cd	0	1,032
1997	196	cd	9	68	286	109	cd	cd	0	0	54	21	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	130	cd	cd	0	0	36	cd	21	0	cd	1,453
2000	550	207	18	108	401	184	cd	37	0	0	cd	cd	8	0	0	1,571
2001	589	157	52	162	359	201	0	cd	0	0	18	cd	24	0	0	1,573
2002	594	132	cd	143	310	243	cd	6	0	0	29	32	23	cd	cd	1,649
2003	408	119	33	149	385	282	60	90	0	0	25	34	27	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	30	114	272	193	cd	63	cd	0	44	84	24	0	442	1,623
2006	247	39	28	107	221	196	90	47	cd	0	34	150	34	0	392	1,587
2007	151	46	14	83	168	152	cd	21	0	0	cd	127	77	0	382	1,269
2008	118	cd	cd	48	146	216	cd	24	0	0	4	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	21	0	0	cd	89	78	0	265	1,360
Average[5]	302	73	25	108	282	245	56	31	cd	0	19	83	44	cd	312	1,522

[1] Gaspé–Lower St. Lawrence
[2] Îles-de-la-Madeleine
[3] Total for all fishing areas.
[4] cd: confidential data (three fishermen or fewer).
[5] 2001–2010 baseline level, except 2003–2010 in Area 15.

Appendix 12. 2002 to 2011 commercial whelk fishing effort (number of trap hauls) and baseline level by region and fishing area and for Québec as a whole.

Year	North Shore								G-LSL[1]			IM[2]	Québec[3]
	1	2	3	4	5	6	7	8	11	12	13	15	
2002	50,580	14,406	cd[4]	47,579	88,260	47,881	cd	481	9,412	9,134	5,100	cd	286,625
2003	43,310	11,198	5,578	54,704	109,727	70,830	12,968	26,097	14,440	12,450	8,002	15,397	384,924
2004	29,648	7,935	6,783	53,687	106,330	88,728	cd	1,997	cd	13,132	cd	18,672	356,117
2005	27,755	10,532	6,066	41,556	85,340	73,828	cd	14,431	15,353	26,664	5,490	19,296	339,560
2006	32,085	5,102	4,916	35,427	65,995	64,772	10,995	16,032	10,446	37,353	6,350	17,444	307,531
2007	22,413	3,940	3,031	24,916	54,020	47,180	cd	5,395	cd	32,335	12,440	18,026	232,443
2008	15,261	cd	cd	16,171	40,048	57,114	cd	7,497	2,205	32,067	10,890	16,388	206,807
2009	33,022	cd	cd	14,837	62,345	64,017	cd	2,331	cd	26,562	8,454	cd	228,175
2010	28,801	cd	cd	18,795	75,874	63,995	cd	13,113	cd	27,973	10,107	6,499	259,955
2011	19,623	cd	cd	10,687	54,995	63,625	cd	6,704	cd	19,601	8,785	14,100	213,470
Average[5]	31,430	7,072	4,038	34,186	76,438	64,260	9,708	9,708	7,049	24,186	8,073	14,086	289,126

[1] Gaspé–Lower St. Lawrence
[2] Îles-de-la-Madeleine
[3] Total for all fishing areas.
[4] cd: confidential data (three fishermen or fewer).
[5] 2002–2010 baseline level, except 2003–2010 in Area 15.

Appendix 13. Standardized catch per unit effort (kg of live weight / trap) of whelk from 2001 to 2011 and baseline level by region and fishing area.

Year	North Shore								G-LSL[1]			IM[2]
	1	2	3	4	5	6	7	8	11	12	13	15
2001	13.2	11.7	6.5	4.4	4.3	4.7			1.2	3.6	4.4	
2002	11.4	8.7	5.3	3.0	3.9	5.5	12.1	5.1	2.4	2.9	4.1	
2003	9.2	10.9	5.5	2.9	3.9	4.2	3.8	3.7	1.6	2.4	3.4	23.0
2004	6.7	8.0	5.6	3.0	3.4	3.5	7.3	3.7	3.2	2.9	3.8	21.3
2005	7.2	7.5	4.9	3.0	3.5	3.1	7.5	4.7	4.1	3.3	4.4	22.9
2006	7.8	7.0	5.8	3.1	3.7	3.3	8.9	3.6	4.4	4.1	5.1	21.3
2007	7.0	13.4	4.3	3.5	3.2	3.6	7.6	4.8	3.2	4.6	5.8	20.6
2008	7.5	11.7	4.3	2.8	3.7	4.1	4.9	3.9	2.0	3.7	5.7	19.7
2009	9.1	7.6	2.7	3.6	4.8	5.5	7.9	5.5	2.4	4.2	6.2	24.8
2010	7.4	9.5	4.8	3.0	5.4	5.2	5.6	3.6	1.3	4.5	8.3	23.5
2011	6.8	11.4	3.2	3.8	6.3	5.1	4.9	3.7	1.1	4.4	8.8	18.9
Average[3]	7.6	9.7	4.6	3.2	4.2	4.2	6.5	4.1	2.6	3.8	5.7	21.8

[1] Gaspé–Lower St. Lawrence
[2] Îles-de-la-Madeleine
[3] 2001–2010 baseline level, except 2003–2010 in Area 15.

Appendix 14. Average size (mm) of landed whelk (dockside sampling) from 1995 to 2011 and baseline level by region and fishing area.

Year	North Shore									G-LSL[1]				IM[2]
	1	2	3	4	5	6	7	8	9	11	12	13	14	15
1995	68.1			72.9	76.9	71.5		73.8		74.1		66.9		
1996				79.2		77.9		66.3		77.5		69.1		
1997	73.8	73.3		84.4	78.5	82.1		64.7		77.7		65.5		
1998	75.5	66.7	89.3	82.5	80.8	79.0	76.2	70.4		76.3	75.9	66.4		
1999	73.4	74.3	82.2	81.3	78.0	86.3	78.0	73.3		76.6		62.2		
2000	76.2	64.9	84.8	82.7	79.8	84.0	84.9	75.4		82.5	84.0			
2001	77.4	73.8	83.1	82.6	81.7	86.6				83.9	85.2	57.0		
2002	76.0	72.4	85.7	84.0	79.9	86.5	79.6	69.9		85.4	84.1	60.6		69.9
2003	71.6	74.4		89.0	82.9	84.8	82.7	80.3		86.1	86.7	66.9		80.2
2004	72.9	72.4	86.5	86.7	81.1	80.6	81.6			83.3	84.9	69.7	72.4	81.8
2005	74.4	74.0		87.4	80.4	82.8	81.0	77.4	79.4	86.3	87.6	76.8		82.0
2006	76.6	71.5		82.5	79.8	86.6	83.7	76.4	90.6	85.8	85.5	80.3		82.9
2007	79.1	74.1		89.5	84.5	85.3	82.7	75.7		90.1	85.4	87.1		80.7
2008	78.4	71.8		88.8	84.6	82.6	86.8	71.1		94.3	88.0	83.0		88.4
2009	77.5	81.3		88.6	86.3	84.1	86.8	73.9		90.5	87.4	83.1		87.7
2010	78.6	82.3		90.0	89.3	88.1	86.7	74.7		90.4	87.6	86.9		85.5
2011	81.0	75.4		90.7	87.9	88.1	90.1	72.9		91.4	86.9	84.5		86.8
Average[3]	76.8	75.3	86.5	87.6	83.7	84.3	84.2	74.9	85.0	88.7	86.6	81.0	72.4	84.2

[1] Gaspé–Lower St. Lawrence
[2] Îles-de-la-Madeleine[3] 2004–2010 baseline level.

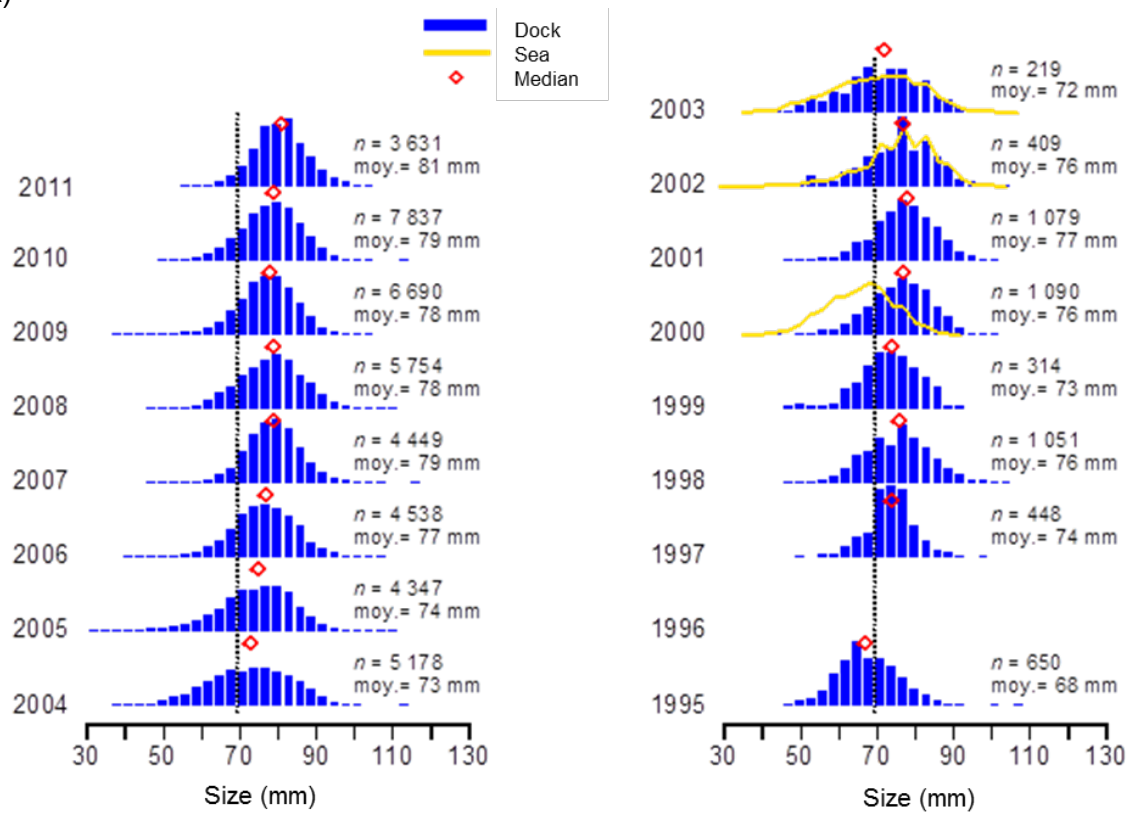
Appendix 15. Percentage (%) of sub-legal size whelk in landings from 2004 to 2011 by region and fishing area.

Year	North Shore									G-LSL[1]				IM[2]
	1	2	3	4	5	6	7	8	9	11	12	13	14	15
2004	38	43	2	6	14	13	9			10	11	48	34	8
2005	29	30		4	11	10	9	27	4	3	3	16		8
2006	19	41		14	15	3	4	26	1	5	4	9		4
2007	8	27		3	6	4	10	27		2	3	1		7
2008	15	43		3	4	6	5	40		0	2	6		2
2009	14	3		3	2	6	4	32		1	2	6		1
2010	12	6		2	2	2	7	27		0	3	2		2
2011	5	21		2	1	2	2	32		0	3	0		1

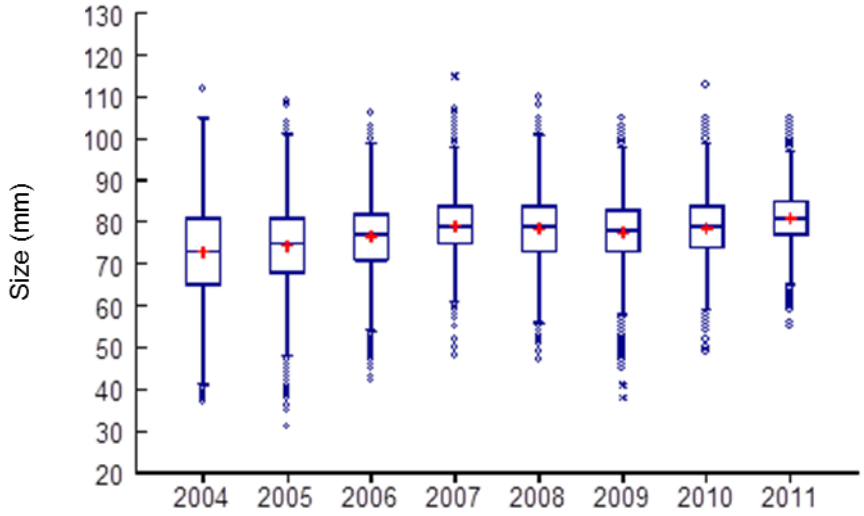
[1] *Gaspé–Lower St. Lawrence*
[2] *Îles-de-la-Madeleine*

Appendix 16. A) Size structure (%) of whelk landed (dockside) and caught (at sea) and median size, number of individuals measured and average size of whelk landed from 1995 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 1. The vertical line (Chart A) represents the 70-mm minimum legal size.

A)

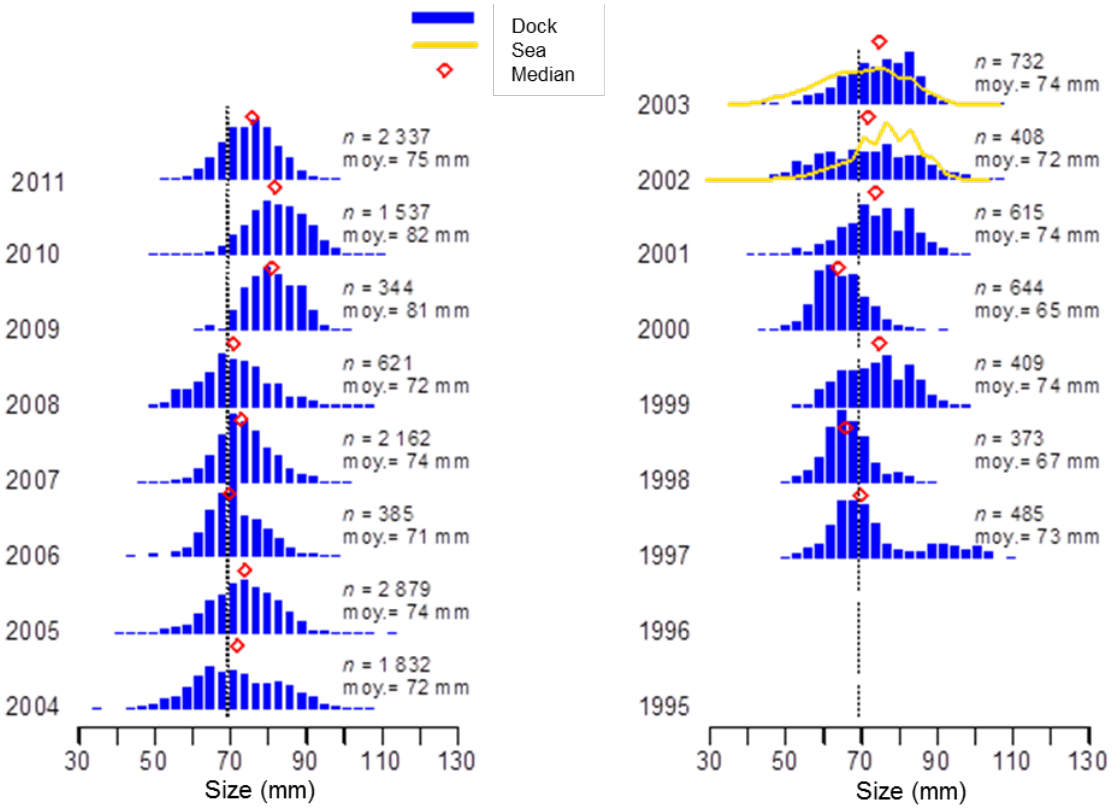


B)

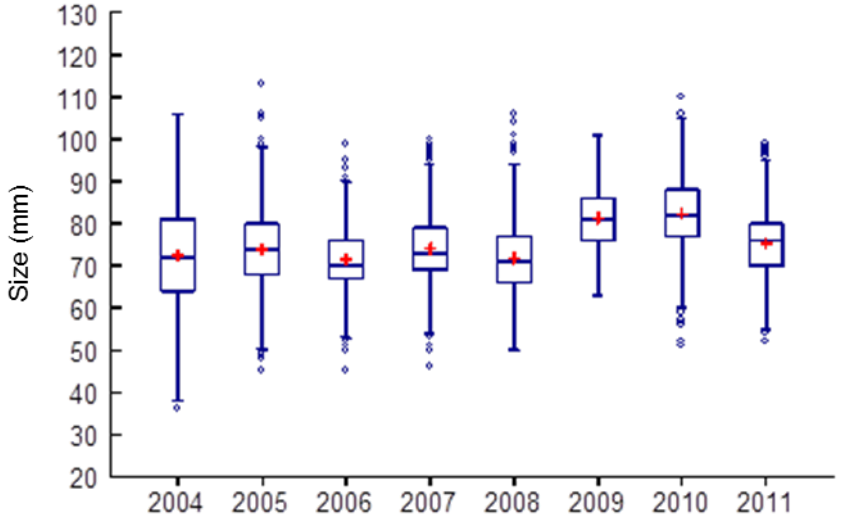


Appendix 17. A) Size structure (%) of whelk landed (dockside) and caught (at sea) and median size, number of individuals measured and average size of whelk landed from 1997 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 2. The vertical line (Chart A) represents the 70-mm minimum legal size.

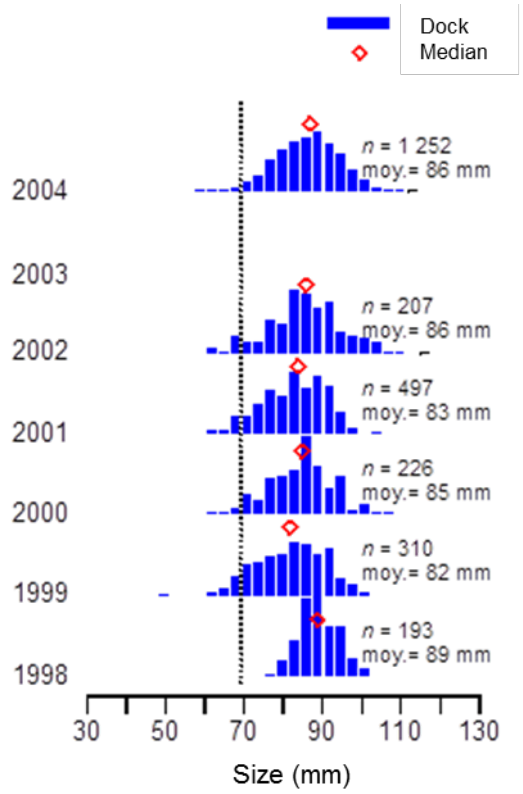
A)



B)

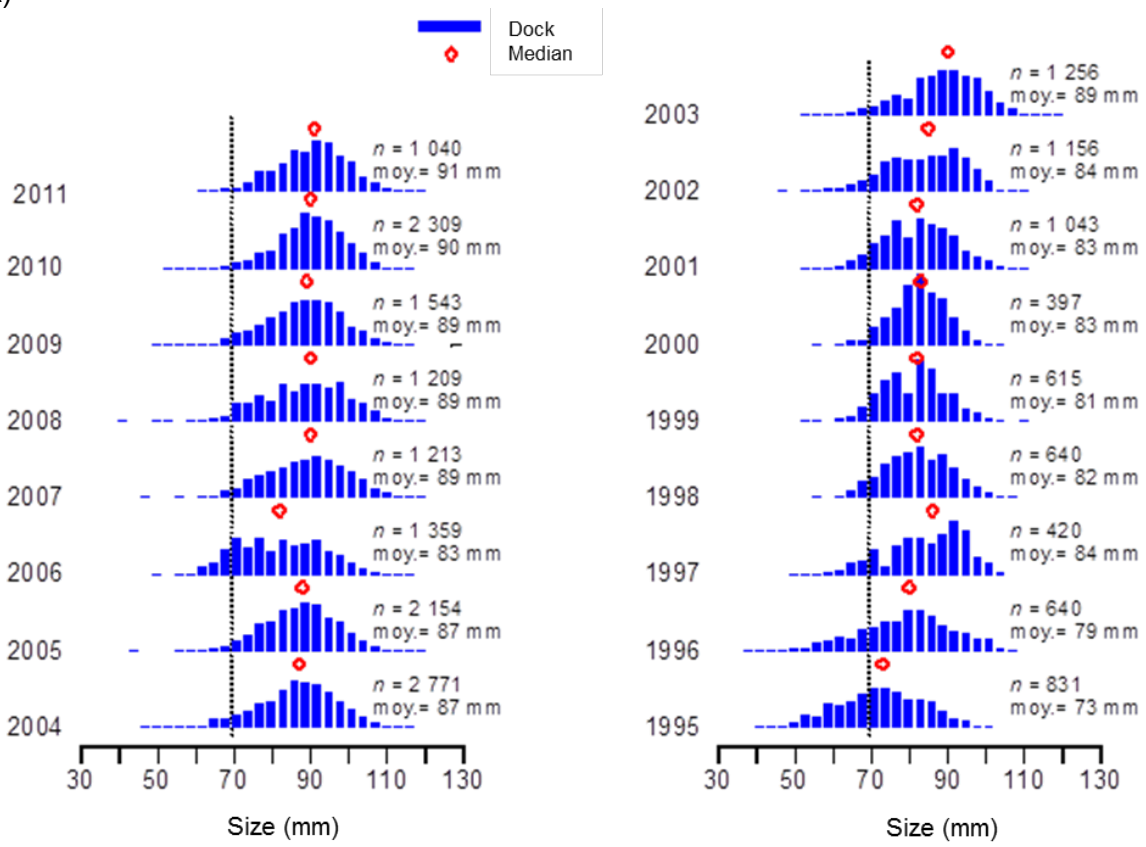


Appendix 18. Size structure (%,) average size, number of individuals measured and average size of whelk landed (dockside) from 1998 to 2004 in Fishing Area 3. The vertical line represents the 70-mm minimum legal size.

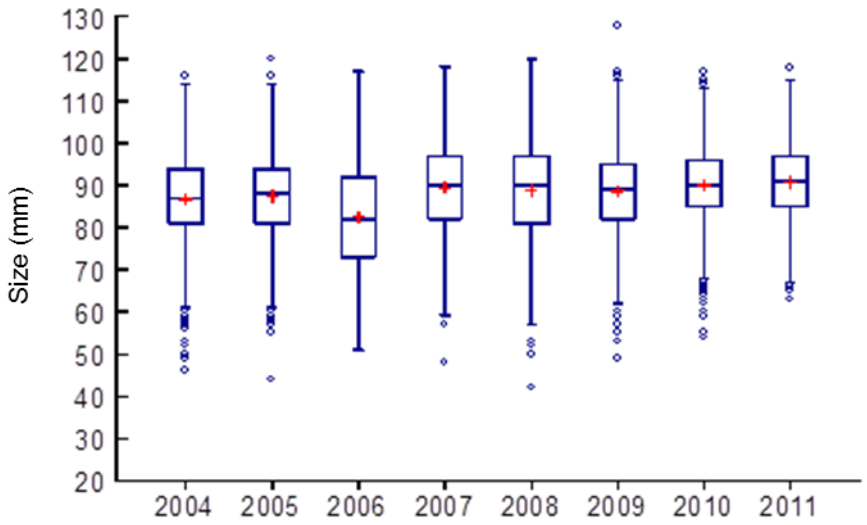


Appendix 19. A) Size structure (%), median size, number of individuals measured and average size of whelk landed (dockside) from 1995 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 4. The vertical line (Chart A) represents the 70-mm minimum legal size.

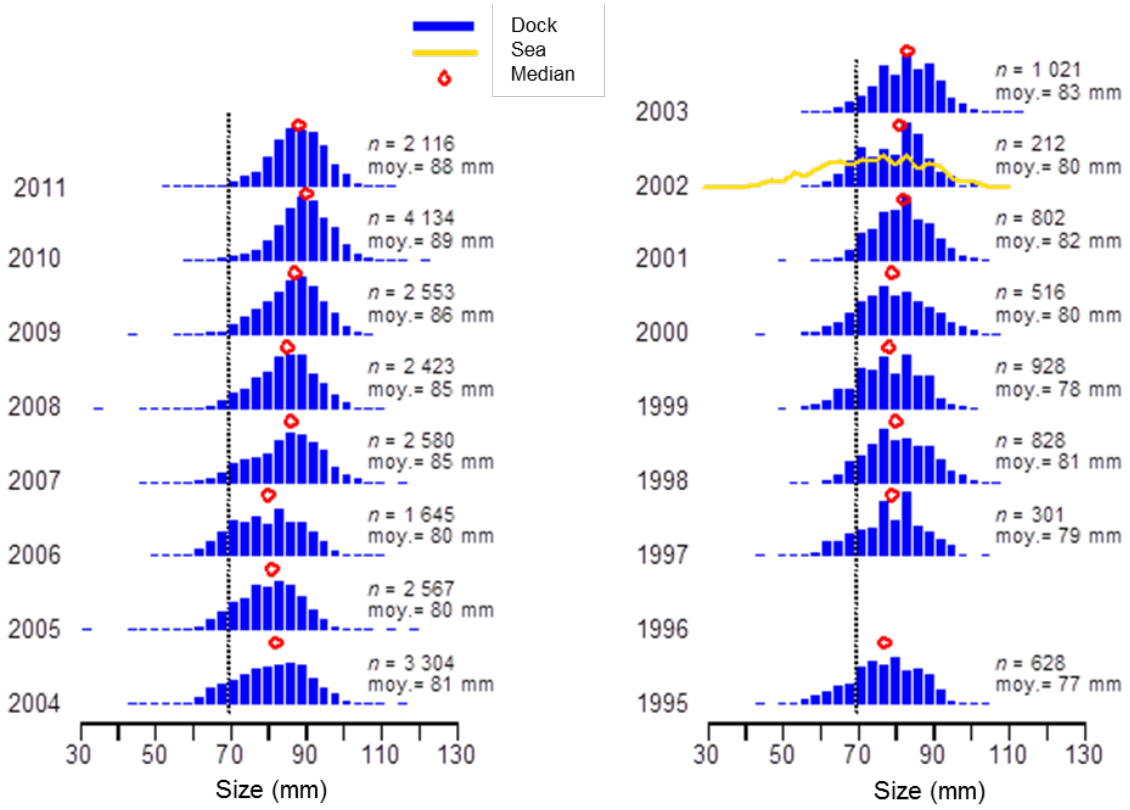
A)



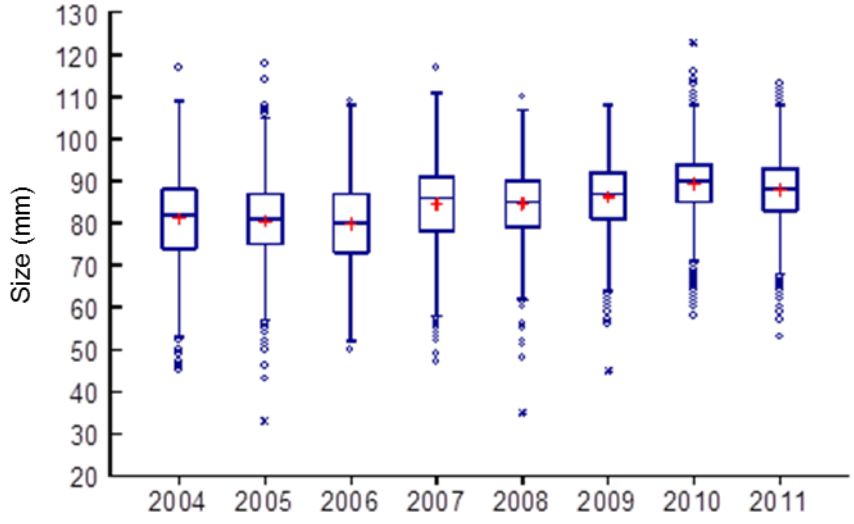
B)



Appendix 20. A) Size structure (%) of whelk landed (dockside) and caught (at sea) and median size, number of individuals measured and average size of whelk landed from 1995 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 5. The vertical line (Chart A) represents the 70-mm minimum legal size.

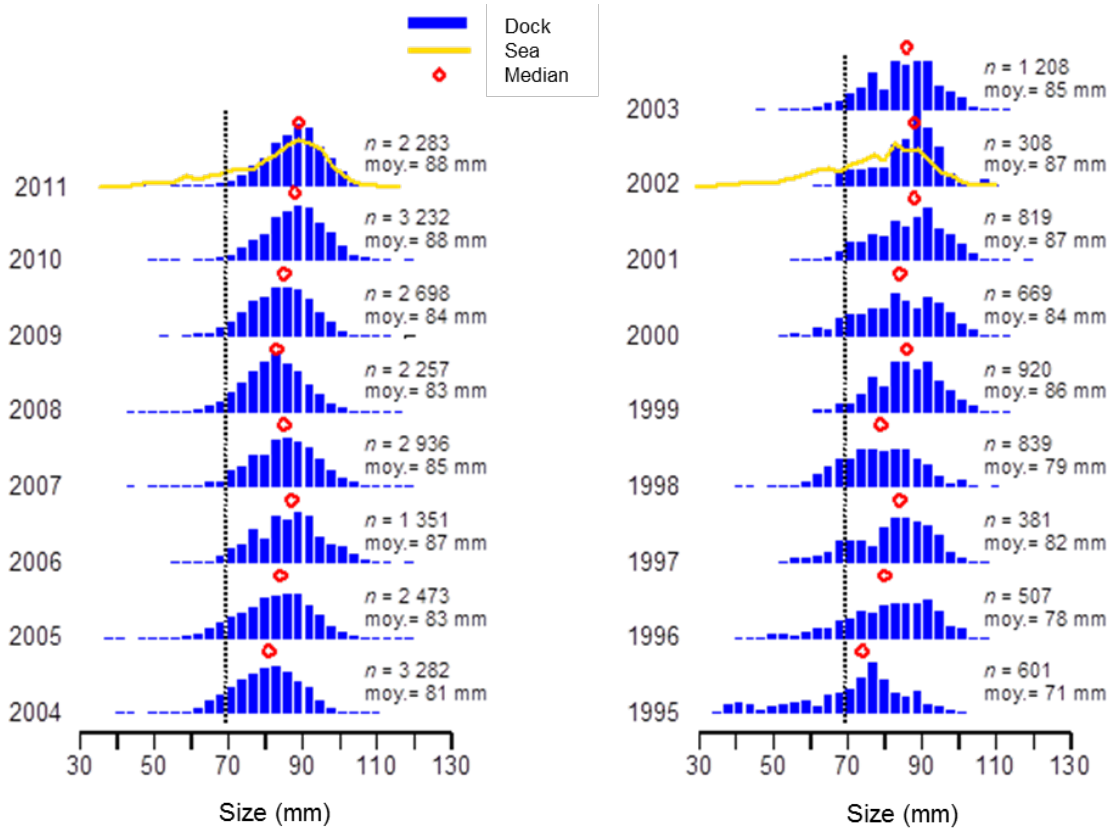


B)

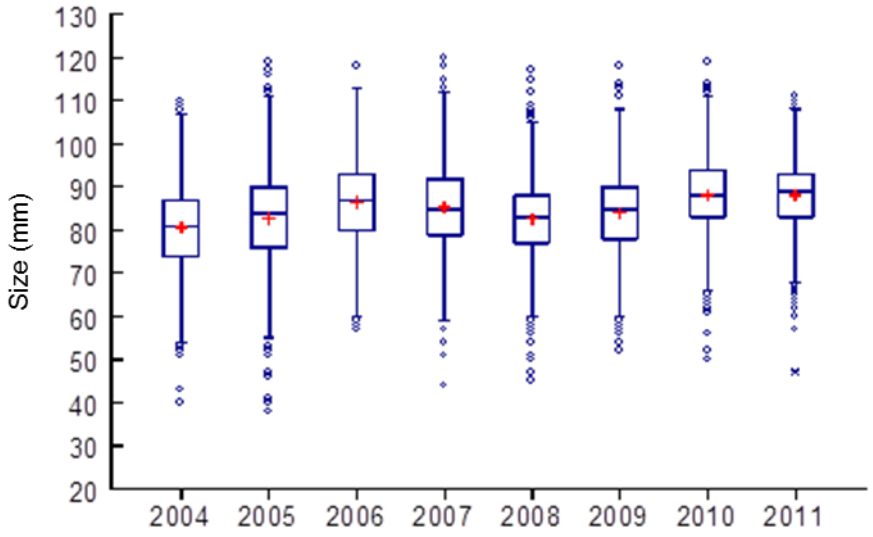


Appendix 21. A) Size structure (%) of whelk landed (dockside) and caught (at sea) and median size, number of individuals measured and average size of whelk landed from 1995 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 6. The vertical line (Chart A) represents the 70-mm minimum legal size.

A)



B)

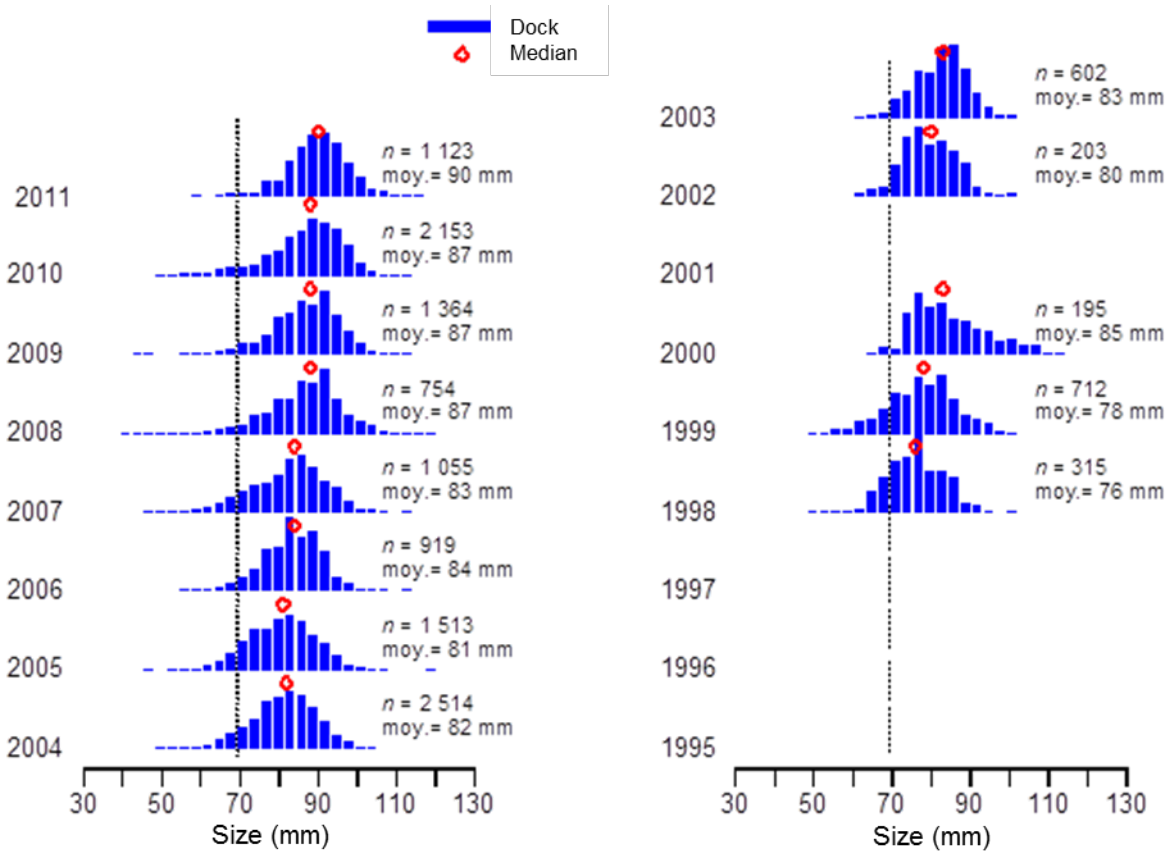


Appendix 22. Trap haul date, depth, soak time, weight and whelk count by size class and count of other species per trap during 2011 fishing trips in Fishing Area 6.

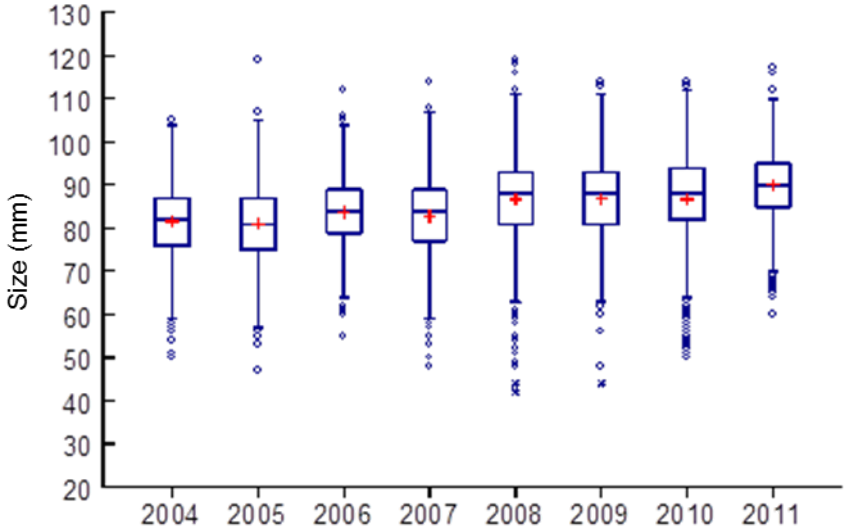
Date			Whelk per Trap			Number per Trap					
	Depth (m)	Duration (hours)	≥ 35 mm (kg)	≥ 35 mm (*n*)	≥ 70 mm (*n*)	*Cancer irroratus*	*Strongylocentrotus droebachiensis*	*Asterias rubens*	*Pagurus* sp.	*Hyas araneus*	*Aporrhais occidentalis*
13-09-2011	11.9	24	5.9	91	73	13	6				
13-09-2011	16.8	24	6.4	109	74	8	4	1			
13-09-2011	14.1	24	3.4	41	40	2	1				
13-09-2011	12.6	24	4.4	59	48	2		6		1	
13-09-2011	10.6	24	4.4	83	49	4	13			1	
13-09-2011	13.0	24	8.8	137	116	4		2	1		
13-09-2011	25.2	24		132	102	2	4		1		
13-09-2011	10.4	24	7.9	98	97	1	2		3	3	
13-09-2011	12.3	24	6.9	97	92		13		2	3	
13-09-2011	17.7	24	2.5	33	30	2	1				
13-09-2011	16.5	24	1	14	12		1				
14-09-2011	11.4	24	4.5	51	48				3		
14-09-2011	12.2	24	6.1	61	61	1					
14-09-2011	13.8	24	7.3	68	68						
14-09-2011	15.1	24	7	68	68				3		
14-09-2011	15.3	24	4.2	43	43	2			2		
14-09-2011	19.8	24	5.6	57	54	10			2		
14-09-2011	21.0	24	5	61	52	5			4	1	
14-09-2011	15.2	48	5.7	80	69	2	1			3	
15-09-2011	18.1	48	7.6	115	83	3		8			
15-09-2011	20.5	48	18	231	108	5		2			
15-09-2011	24.3	48	6.6	115	89	1	22				
15-09-2011	11.8	48	3.8	57	44		2	6	1		
15-09-2011	11.8	48	3.9	72	39	2	1	4			1
15-09-2011	9.8	48	3.4	38	35	7			3		
15-09-2011	12	48	7.5	95	83	3		5	2		
15-09-2011		48	8.5	120	92	3	8	7			
15-09-2011		48	5.5	78	59	1	49	5			
15-09-2011		48	13.4	206	147	8	12	2			
15-09-2011		48	13.7	206	161	7	6	7			
Average (number/trap)					71.2	3.3	4.9	1.8	0.8	0.4	0.03
Presence (%)					100	80	57	40	37	20	3

Appendix 23. A) Size structure (%), median size, number of individuals measured and average size of whelk landed (dockside) from 1998 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 7. The vertical line (Chart A) represents the 70-mm minimum legal size.

A)

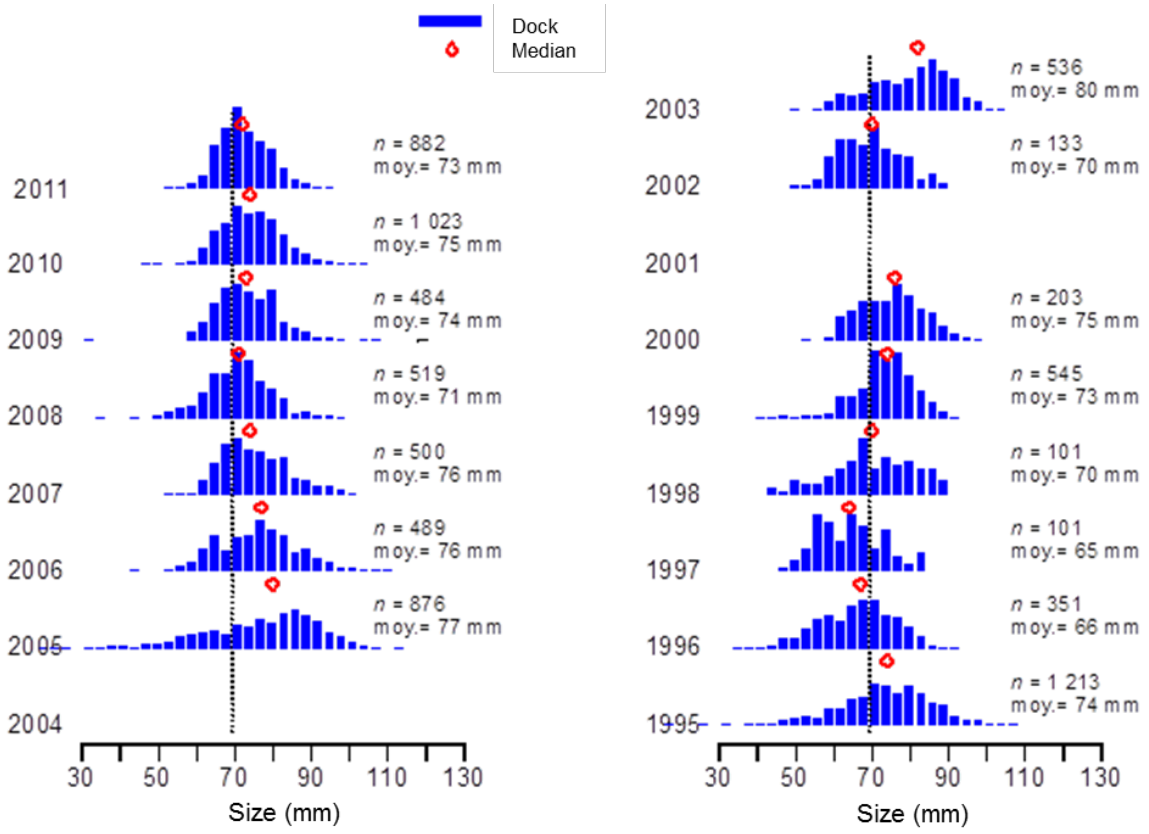


B)

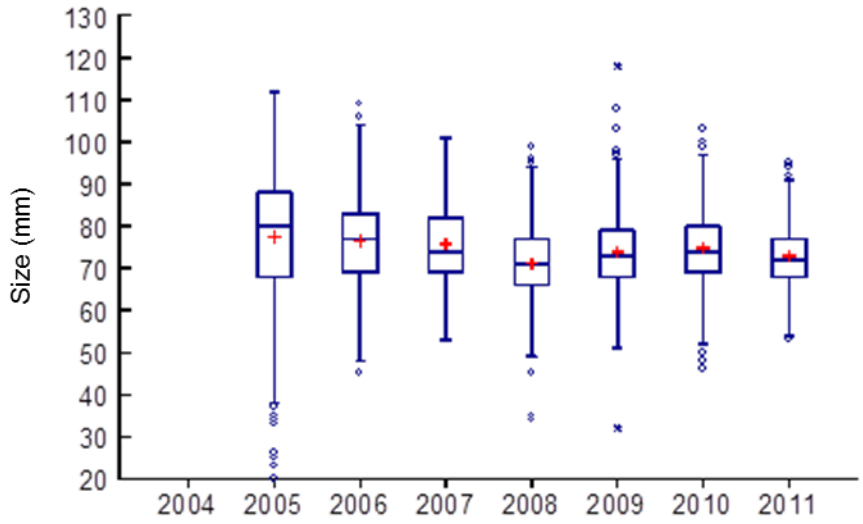


Appendix 24. A) Size structure (%), median size, number of individuals measured and average size of whelk landed (dockside) from 1995 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 8. The vertical line (Chart A) represents the 70-mm minimum legal size.

A)

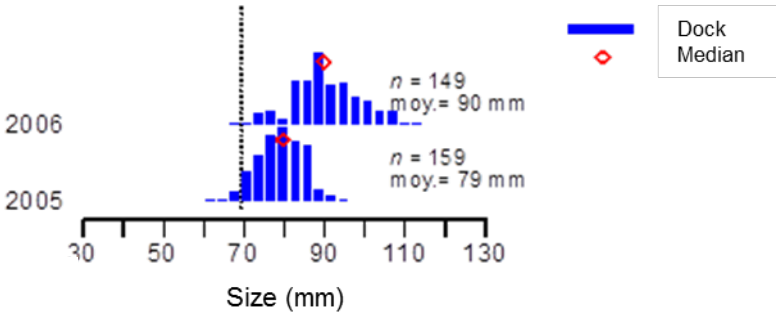


B)

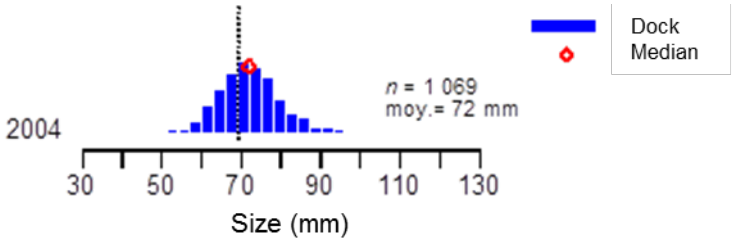


Appendix 25. Size structure (%), average size, number of individuals measured and average size of whelk landed (dockside) from 2004 to 2006 in Fishing Areas A) 9 and B) 14. The vertical line represents the 70-mm minimum legal size.

A)

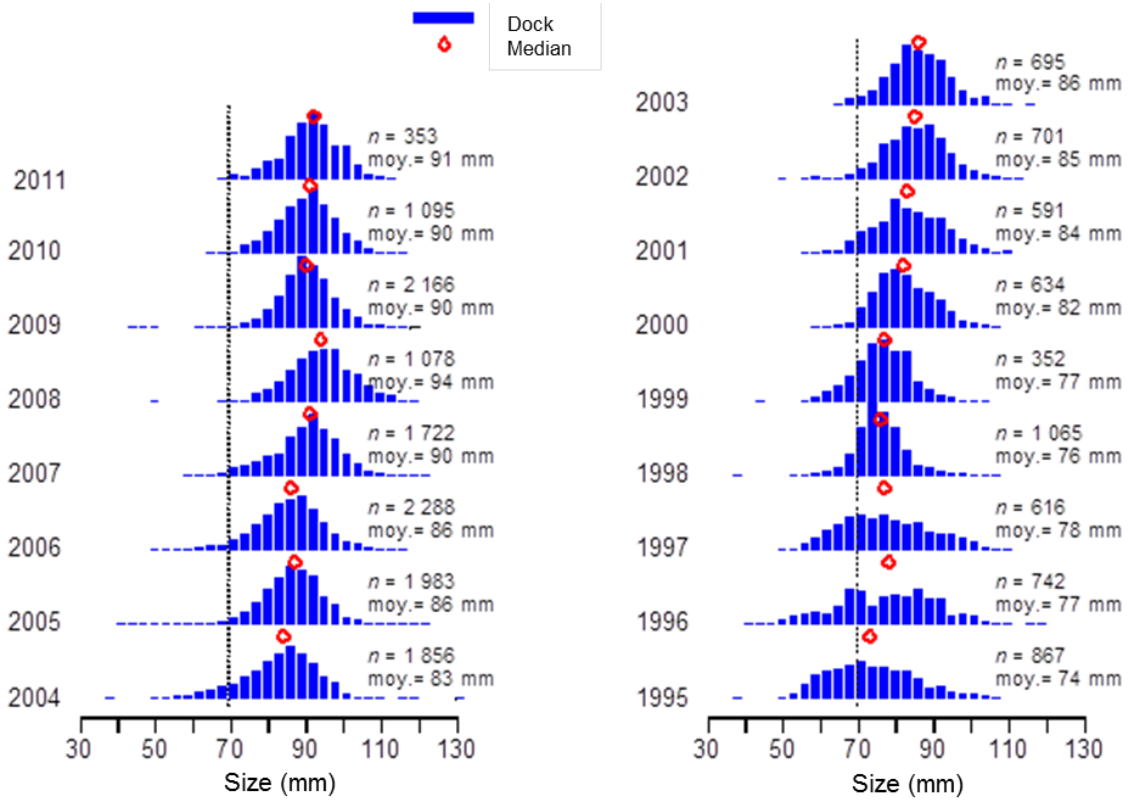


B)

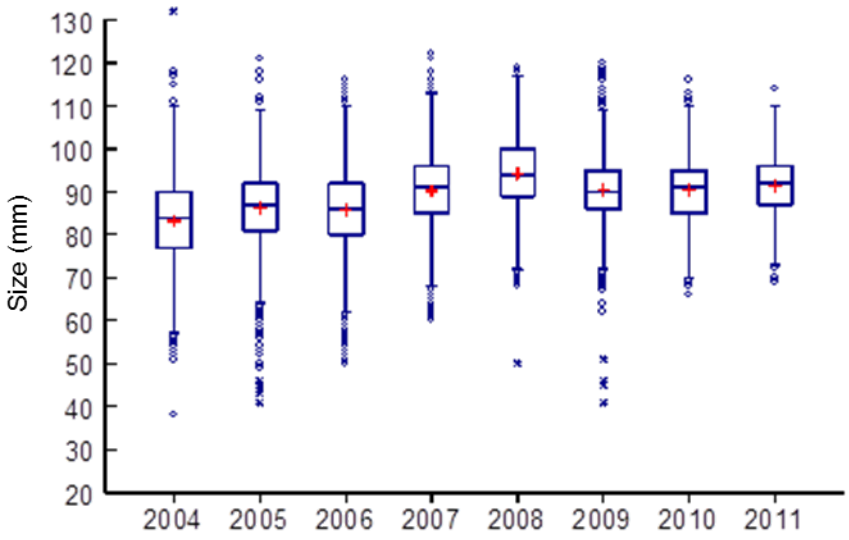


Appendix 26. A) Size structure (%), median size, number of individuals measured and average size of whelk landed (dockside) from 1995 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 11. The vertical line (Chart A) represents the 70-mm minimum legal size.

A)

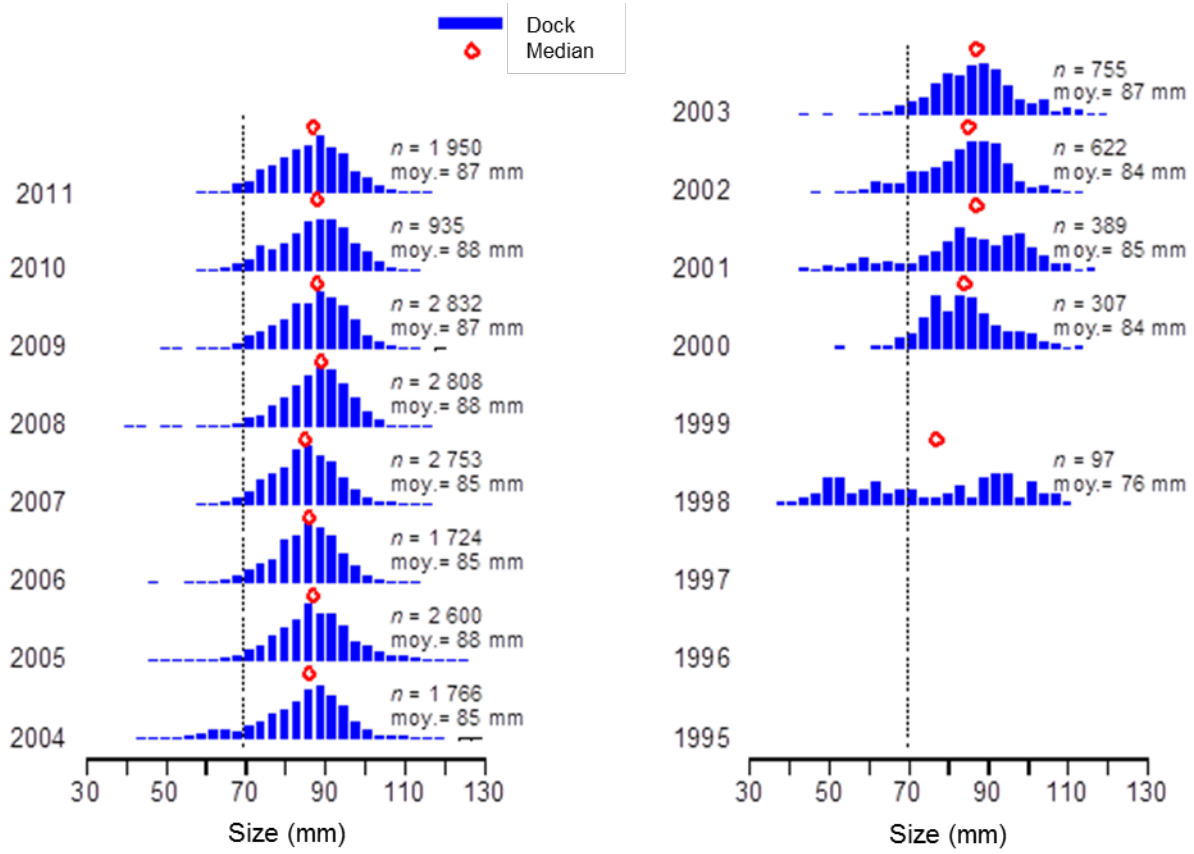


B)

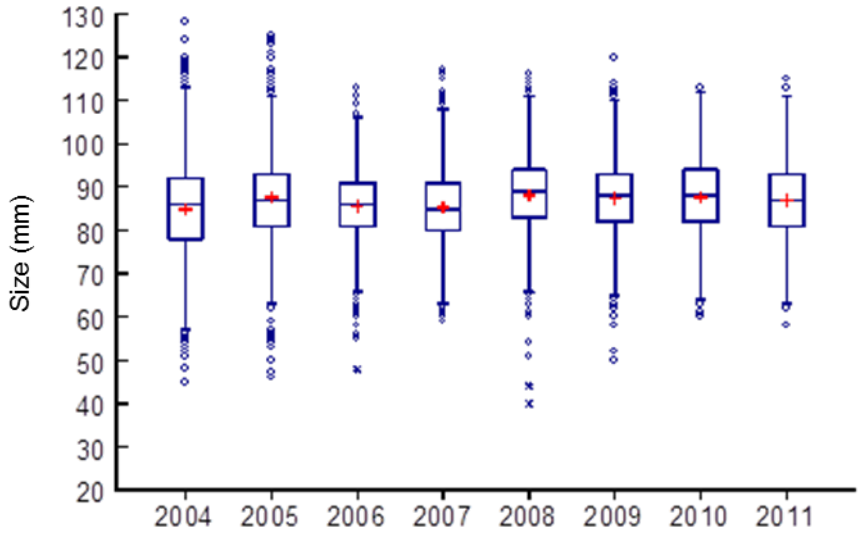


Appendix 27. A) Size structure (%), median size, number of individuals measured and average size of whelk landed (dockside) from 1998 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 12. The vertical line (Chart A) represents the 70-mm minimum legal size.

A)

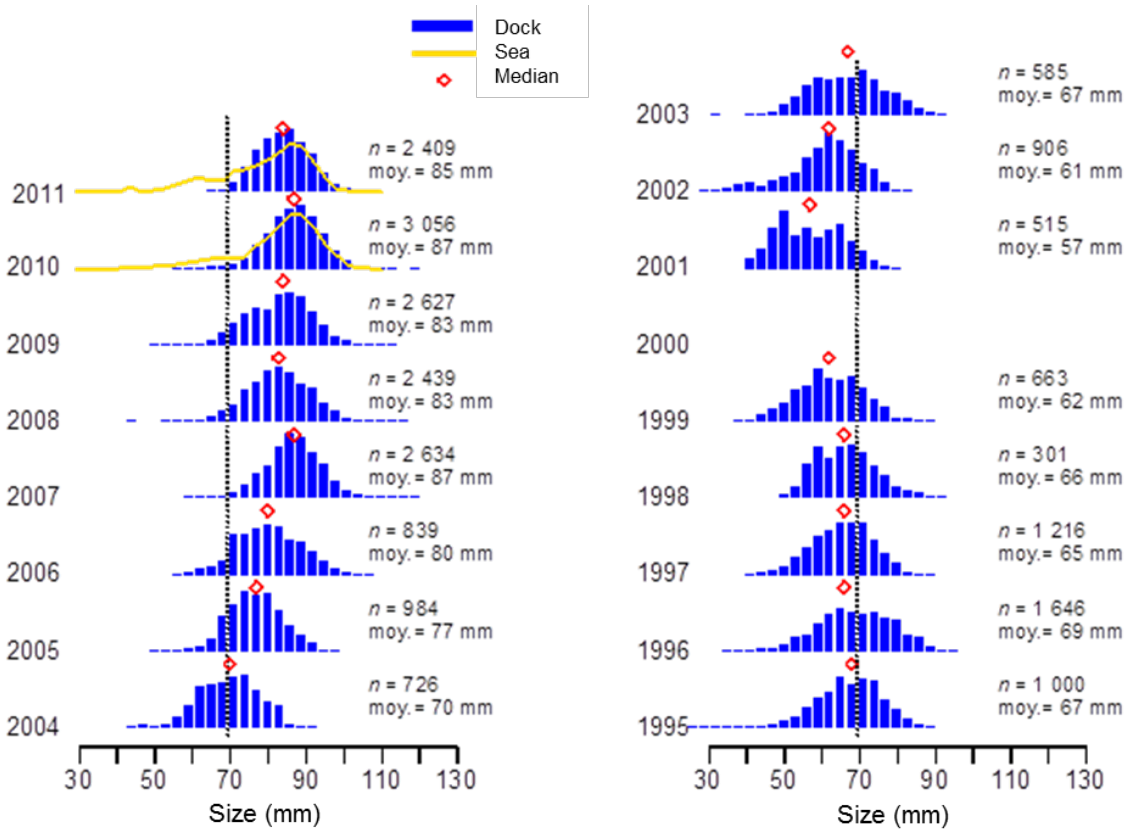


B)

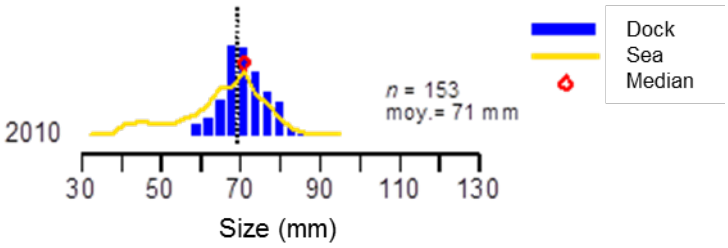


Appendix 28. A) Size structure (%) of whelk landed (dockside) and caught (at sea) and median size, number of individuals measured and average size of whelk landed A) from 1995 to 2011 in the eastern portion of the area (portion usually exploited), B) in 2010 in the western portion of the area (west of Bic) and C) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 13. The vertical line (Charts A and B) represents the 70-mm minimum legal size.

A)

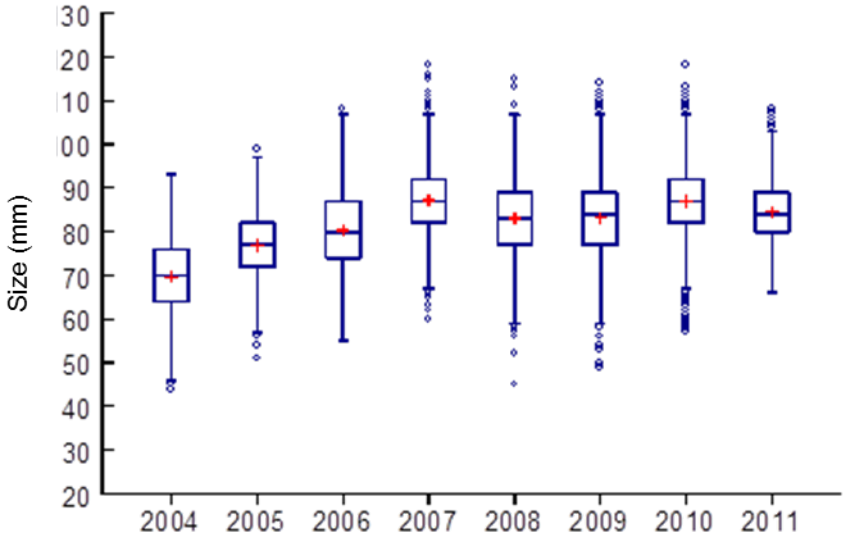


B)



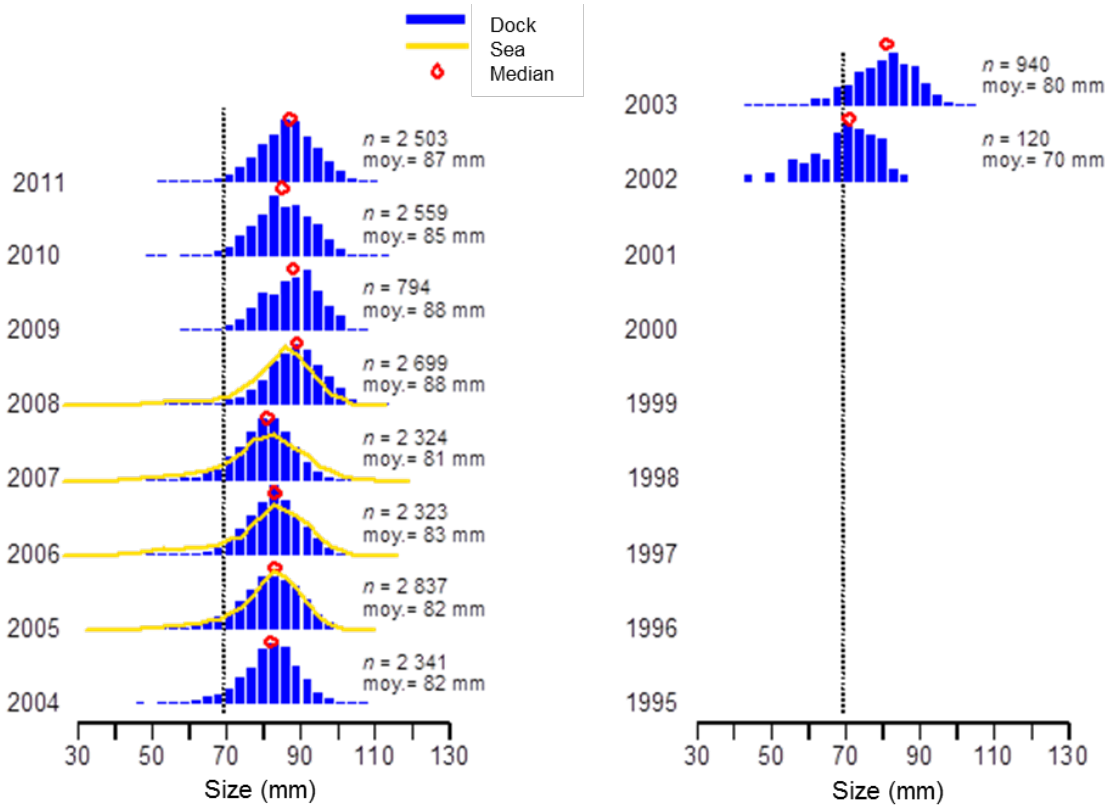
Appendix 28. (continued).

C)

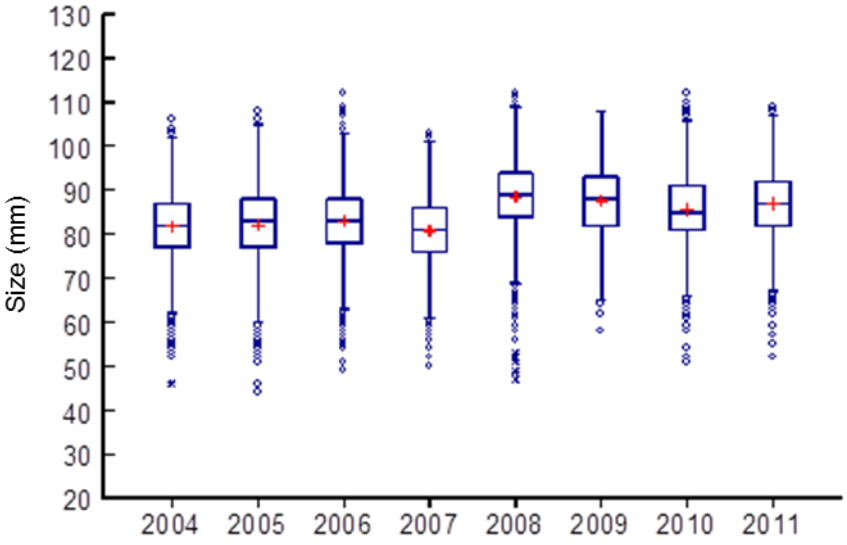


Appendix 29. A) Size structure (%) of whelk landed (dockside) and caught (at sea) and median size, number of individuals measured and average size of whelk landed from 2002 to 2011 and B) size structure of landed whelk (box and whisker plot) from 2004 to 2011 in Fishing Area 15. The vertical line (Chart A) represents the 70-mm minimum legal size.

A)



B)



Appendix 30. Whelk location (latitude and longitude WGS84), density (number/100 m^2) and yield (g/100 m^2) by area and station (Digby dredge) in the 2005, 2007, 2009 and 2011 research surveys.

Year	Station	Latitude	Longitude	Distance	Density		Yield	
		(N)	(W)	(m)	Subleg[1]	Leg[2]	Subleg[1]	Leg[2]
Forestville								
2005	1	48° 46.15'	068° 56.61'	595	6.36	1.36	67.21	87.38
2005	2	48° 45.81'	068° 57.12'	558	3.87	0.97	56.44	63.99
2005	3	48° 45.83'	068° 57.66'	543	2.99	3.24	27.94	201.39
2005	4	48° 45.41'	068° 57.69'	605	2.24	2.91	42.94	186.80
2005	5	48° 45.61'	068° 58.02	513	2.63	0.79	33.22	50.46
2005	6	48° 45.47'	068° 58.74'	545	4.47	1.49	19.34	95.91
2005	7	48° 45.39'	068° 57.51'	621	3.48	1.96	82.26	143.94
2005	8	48° 45.10'	068° 58.11'	628	3.45	3.88	59.94	237.51
2005	9	48° 45.32'	068° 58.44'	572	9.21	2.83	101.88	164.64
2005	10	48° 45.14'	068° 59.34'	545	3.97	5.20	36.12	292.99
2005	11	48° 44.66'	068° 58.38'	591	4.35	1.60	90.42	94.88
2005	12	48° 44.99'	068° 58.65'	589	4.13	4.59	82.58	281.54
2005	13	48° 44.95'	068° 58.95'	613	2.20	3.31	26.04	191.31
2005	14	48° 44.75'	068° 59.76'	610	8.42	4.87	118.14	287.09
2005	16	48° 44.55'	068° 59.07'	672	3.82	4.02	82.63	246.24
2005	17	48° 44.37'	068° 59.79'	682	2.58	3.57	34.09	214.87
2005	18	48° 44.35'	069° 0.39'	593	2.73	2.05	15.83	115.46
2005	19	48° 44.17'	068° 58.59'	570	0.24	1.90	7.6	130.95
2005	20	48° 44.10'	068° 59.16'	607	2.45	4.23	61.94	264.39
2005	21	48° 44.28'	068° 59.73'	477	1.42	4.53	25.07	266.22
2005	22	48° 44.09'	069° 0.06'	582	7.44	4.18	124.71	250.51
2005	23	48° 43.75'	068° 59.16'	548	2.22	7.15	71.05	427.25
2005	24	48° 43.79'	068° 59.67'	607	2.67	4.45	61.14	289.50
2005	25	48° 43.80'	069° 0.21'	528	10.49	6.91	173.77	425.81
2005	26	48° 43.82'	069° 0.69'	616	7.46	5.27	120.96	302.50
2005	27	48° 43.58'	068° 59.04'	475	0.85	3.98	23.61	259.38
2005	28	48° 43.44'	068° 59.70'	432	0.94	2.82	22.77	190.72
2005	36	48° 42.68'	069° 0.24'	523	1.29	3.88	38.22	218.21
2005	37	48° 42.75'	069° 0.75'	527	0.77	1.80	7.8	125.75
2005	38	48° 42.61'	069° 1.32'	573	0.71	3.30	10.63	197.25
2005	40	48° 42.41'	069° 0.18'	474	0.86	2.28	20.45	134.89
2005	42	48° 42.32'	069° 1.26'	510	2.12	2.39	31.38	140.75
2005	43	48° 42.44'	069° 1.83'	578	1.87	5.37	43.13	310.64
2005	44	48° 41.84'	069° 0.93'	597	0.90	2.04	20.45	128.31
2005	45	48° 42.02'	069° 1.23'	534	2.28	0.25	53.53	13.13
2005	46	48° 42.06'	069° 1.77'	220	1.23	1.84	46.51	98.86
2005	47	48° 41.72'	069° 0.87'	352	3.07	2.69	45.14	144.01
2005	48	48° 41.68'	069° 1.26'	449	1.81	4.82	55.96	287.46
2005	49	48° 41.64'	069° 1.83'	571	0.71	2.13	5.85	127.28
2005	50	48° 41.28'	069° 1.32'	613	6.61	6.83	163.33	428.67
2005	51	48° 41.30'	069° 1.83'	278	2.43	3.89	25.64	207.19
2005	53	48° 41.01'	069° 1.83'	614	5.50	2.64	130.34	158.39
2005	54	48° 40.95'	069° 2.37'	312	1.30	0.87	27.15	47.27
2005	56	48° 40.55'	069° 2.37'	376	4.31	3.95	91.67	213.20
2007	1	48° 46.29'	068° 56.37'	764	6.37	1.90	95.42	96.81
2007	2	48° 45.83'	068° 57.06'	698	9.24	1.89	131.13	97.15
2007	3	48° 46.01'	068° 57.39'	687	11.81	3.10	80.61	156.20
2007	4	48° 45.57'	068° 57.54'	713	5.64	2.27	85.6	118.42
2007	5	48° 45.62'	068° 57.93'	647	5.85	1.10	44.4	60.59
2007	6	48° 45.52'	068° 58.65'	686	8.81	1.92	77.44	98.33
2007	7	48° 45.21'	068° 57.48'	803	0.67	0.34	14.04	15.97
2007	8	48° 45.22'	068° 58.05'	812	2.75	1.67	52.23	89.88
2007	9	48° 45.24'	068° 58.53'	679	2.09	2.49	36.7	133.30
2007	10	48° 45.13'	068° 59.22'	698	2.76	2.61	27.14	137.58

Appendix 30. (continued).

Year	Station	Latitude	Longitude	Distance	Density		Yield	
		(N)	(W)	(m)	Subleg[1]	Leg[2]	Subleg[1]	Leg[2]
2007	11	48° 45.03'	068° 57.96'	769	1.27	0.75	18.27	40.38
2007	12	48° 44.83'	068° 58.50'	715	3.07	2.60	54.13	134.48
2007	13	48° 44.78'	068° 59.31'	823	2.46	3.00	32.17	154.60
2007	14	48° 44.84'	068° 59.61'	666	5.23	3.86	63.19	194.29
2007	15	48° 44.48'	068° 58.89'	455	3.64	5.35	69.92	288.87
2007	16	48° 44.42'	068° 59.22'	535	1.96	4.42	39.74	251.53
2007	17	48° 44.51'	068° 59.67'	514	4.60	3.68	52.11	201.16
2007	18	48° 44.54'	069° 0.09'	619	1.36	0.98	23.19	51.78
2007	19	48° 44.09'	068° 58.65'	557	0.97	1.33	25.03	74.81
2007	20	48° 44.27'	068° 59.13'	554	1.77	2.44	44.23	126.68
2007	21	48° 44.16'	068° 59.67'	436	4.42	5.12	66.31	274.09
2007	22	48° 44.16'	069° 0.09'	503	3.76	1.55	63.88	72.45
2007	23	48° 43.71'	068° 58.98'	489	2.01	4.43	49.91	250.71
2007	24	48° 43.81'	068° 59.64'	629	1.13	3.70	24.2	211.27
2007	25	48° 43.78'	069° 0.21'	515	10.56	4.13	118.32	234.19
2007	26	48° 43.78'	069° 0.75'	533	2.79	5.07	32.24	257.45
2007	27	48° 43.36'	068° 59.16'	552	0.92	2.45	26.48	146.42
2007	28	48° 43.40'	068° 59.67'	419	1.37	1.29	24.18	69.55
2007	35	48° 43.00'	069° 1.29'	450	2.55	4.88	25.14	267.79
2007	36	48° 42.72'	069° 0.27'	753	1.30	2.60	29.04	134.65
2007	37	48° 42.77'	069° 0.66'	782	0.60	1.25	9.66	66.94
2007	38	48° 42.76'	069° 1.29'	771	0.96	2.19	16.56	126.01
2007	39	48° 42.74'	069° 1.80'	533	1.01	1.65	15.22	84.73
2007	40	48° 42.27'	069° 0.30'	715	3.21	1.89	47.19	95.68
2007	41	48° 42.33'	069° 0.81'	762	1.77	1.91	21.6	102.95
2007	42	48° 42.50'	069° 1.29'	727	0.79	1.30	8.41	68.04
2007	43	48° 42.38'	069° 1.80'	547	3.09	2.96	40.47	154.68
2007	44	48° 42.09'	069° 0.72'	789	0.09	0.17	1.4	9.25
2007	45	48° 42.07'	069° 1.26'	730	1.07	2.32	23.52	118.24
2007	46	48° 42.04'	069° 1.83'	565	1.43	2.09	27.86	103.86
2007	47	48° 41.72'	069° 0.72'	863	1.14	1.45	25.08	74.10
2007	48	48° 41.81'	069° 1.29'	620	1.42	3.16	39.06	159.95
2007	49	48° 41.73'	069° 1.80'	544	2.98	2.86	51.06	134.85
2007	50	48° 41.28'	069° 1.35'	814	2.65	3.73	50.97	187.72
2007	51	48° 41.37'	069° 1.77'	775	0.96	2.40	20.39	118.46
2007	52	48° 40.95'	069° 1.26'	590	0.63	0.40	7.8	21.43
2007	53	48° 40.93'	069° 1.80'	560	2.23	2.05	42.09	99.34
2007	54	48° 41.00'	069° 2.28'	602	1.96	2.58	36.78	127.30
2007	55	48° 40.68'	069° 1.80'	544	4.22	3.66	100.1	177.85
2007	56	48° 40.63'	069°' 2.34'	557	3.64	2.00	70.84	95.66
2007	57	48° 40.27'	069° 2.31'	565	4.06	2.69	92.47	124.10
2007	58	48° 39.88'	069° 2.34'	589	4.59	1.84	89.92	85.50
2007	59	48° 39.98'	069° 2.76'	556	2.92	1.09	57.84	51.87
2007	60	48° 39.65'	069° 2.28'	627	5.82	1.67	103.49	78.66
2007	61	48° 39.64'	069° 2.79'	569	3.15	1.48	64.46	75.55
2009	1	48° 46.21'	068° 56.58'	367	3.59	0.64	56.23	36.29
2009	2	48° 45.85'	068° 57.09'	373	3.71	0.36	56.7	22.77
2009	3	48° 45.85'	068° 57.66'	371	7.19	2.91	79.36	171.31
2009	4	48° 45.56'	068° 57.57'	339	2.69	1.89	48.91	112.02
2009	5	48° 45.50'	068° 58.17'	349	8.14	3.88	89.71	221.38
2009	6	48° 45.52'	068° 58.68'	355	14.94	2.00	150.5	106.91
2009	7	48° 45.17'	068° 57.60'	363	1.30	1.49	20.8	79.65
2009	8	48° 45.20'	068° 58.11'	356	4.94	2.09	72.74	120.47
2009	9	48° 45.20'	068° 58.65'	291	8.49	3.95	117.3	247.94
2009	10	48° 45.20'	068° 59.19'	306	10.72	3.43	116.21	190.02
2009	11	48° 44.81'	068° 58.14'	314	1.62	0.54	28.34	26.45
2009	12	48° 44.83'	068° 58.65'	345	4.21	1.96	70.36	123.13
2009	13	48° 44.83'	068° 59.19'	365	6.66	2.68	86.88	154.18

Appendix 30. (continued).

Year	Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
					Subleg[1]	Leg[2]	Subleg[1]	Leg[2]
2009	14	48° 44.82'	068° 59.70'	380	9.26	3.65	81.54	212.35
2009	15	48° 44.47'	068° 58.65'	349	3.00	2.32	58.5	137.72
2009	16	48° 44.48'	068° 59.22'	351	5.59	2.41	86.97	147.76
2009	17	48° 44.47'	068° 59.73'	333	5.69	3.45	49.24	205.14
2009	18	48° 44.49'	069° 0.24'	348	3.01	1.26	26.23	70.08
2009	19	48° 44.11'	068° 58.71'	404	3.26	3.43	82.67	195.88
2009	20	48° 44.12'	068° 59.16'	308	3.95	0.88	52.54	52.30
2009	21	48° 44.22'	068° 59.58'	258	3.27	1.18	51.75	68.45
2009	22	48° 44.10'	069° 0.24'	325	5.83	2.08	62.21	118.53
2009	23	48° 43.76'	068° 59.16'	358	1.51	1.61	29.77	93.88
2009	24	48° 43.78'	068° 59.70'	294	2.64	1.03	33.75	71.08
2009	25	48° 43.76'	069° 0.24'	290	7.34	1.75	80.92	103.72
2009	26	48° 43.80'	069° 0.72'	309	10.59	2.29	109.94	129.58
2009	27	48° 43.40'	068° 59.22'	307	1.65	3.08	48.85	182.18
2009	28	48° 43.43'	068° 59.70'	303	4.69	0.78	44.25	50.78
2009	35	48° 43.07'	069° 1.29'	301	4.49	1.46	45.68	83.51
2009	36	48° 42.71'	069° 0.21'	282	8.40	3.48	95.14	215.32
2009	37	48° 42.77'	069° 0.69'	308	2.31	2.53	29.59	151.74
2009	38	48° 42.77'	069° 1.29'	290	5.72	2.22	94.03	131.80
2009	39	48° 42.78'	069° 1.83'	321	1.90	1.90	42.85	104.04
2009	40	48° 42.34'	069° 0.24'	410	6.17	1.40	82.55	80.40
2009	41	48° 42.39'	069° 0.69'	302	3.69	2.02	57.35	125.19
2009	42	48° 42.39'	069° 1.23'	312	1.19	2.17	30.12	125.19
2009	43	48° 42.37'	069° 1.83'	295	10.07	4.69	143.46	268.98
2009	44	48° 42.02'	069° 0.72'	280	4.70	2.29	67.71	136.66
2009	45	48° 42.05'	069° 1.23'	312	3.68	1.08	56.81	62.70
2009	46	48° 42.03'	069° 1.83'	318	1.38	0.42	23.38	29.04
2009	47	48° 41.72'	069° 0.72'	319	0.42	0	7.53	0
2009	48	48° 41.72'	069° 1.26'	280	7.71	1.57	70.74	89.52
2009	49	48° 41.62'	069° 1.83'	284	8.45	1.67	56.45	92.33
2009	50	48° 41.31'	069° 1.29'	285	6.75	6.27	102.97	345.17
2009	51	48° 41.31'	069° 1.83'	258	1.70	0.52	26.05	29.00
2009	52	48° 40.98'	069° 1.29'	275	0	0.25	0	13.67
2009	53	48° 40.97'	069° 1.83'	267	6.20	2.02	67.02	127.50
2009	54	48° 40.95'	069° 2.37'	328	1.44	0.31	25.26	19.45
2009	55	48° 40.58'	069° 1.77'	298	0	0	0	0
2009	56	48° 40.63'	069° 2.37'	286	2.36	0.47	22.78	25.22
2009	57	48° 40.21'	069° 2.34'	223	4.39	1.67	60.1	91.58
2009	58	48° 39.90'	069° 2.37'	324	5.31	1.15	111.9	60.52
2009	59	48° 39.95'	069° 2.82'	319	4.13	0.74	66.31	36.93
2009	60	48° 39.59'	069° 2.31'	320	0	0	0	0
2009	61	48° 39.63'	069° 2.82'	311	4.46	0.76	91.32	38.37
2011	1	48° 46.24'	068° 56.53'	319	12.58	1.84	140.42	108.29
2011	2	48° 45.88'	068° 57.05'	319	11.99	1.70	163.29	101.15
2011	3	48° 45.89'	068° 57.54'	331	19.70	2.35	216.14	140.27
2011	4	48° 45.54'	068° 57.56'	340	8.14	2.18	127.96	121.03
2011	5	48° 45.55'	068° 58.11'	338	13.89	4.30	153.07	236.83
2011	6	48° 45.52'	068° 58.67'	305	9.64	2.11	118.67	115.15
2011	7	48° 45.18'	068° 57.56'	322	1.05	0.84	13.35	35.48
2011	8	48° 45.18'	068° 58.10'	347	12.35	3.31	172.74	193.29
2011	9	48° 45.19'	068° 58.61'	337	17.36	2.31	174.9	135.22
2011	10	48° 45.16'	068° 59.22'	318	15.09	2.44	151.19	137.89
2011	11	48° 44.82'	068° 58.11'	333	4.32	1.89	66.3	96.03
2011	12	48° 44.81'	068° 58.69'	311	11.51	5.10	171.18	312.32
2011	13	48° 44.81'	068° 59.20'	319	18.75	4.45	241.28	265.78
2011	14	48° 44.82'	068° 59.72'	333	36.34	3.55	402.49	204.38
2011	15	48° 44.48'	068° 58.69'	343	5.42	5.13	114.93	290.85
2011	16	48° 44.47'	068° 59.22'	328	15.95	5.35	288.73	333.60

Appendix 30. (continued).

Year	Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
					Subleg[1]	Leg[2]	Subleg[1]	Leg[2]
2011	17	48° 44.46'	068° 59.75'	309	11.81	4.26	145.15	253.05
2011	18	48° 44.45'	069° 0.25'	319	12.62	0.95	167.39	50.75
2011	19	48° 44.13'	068° 58.66'	320	2.64	4.32	71.15	274.80
2011	20	48° 44.12'	068° 59.16'	296	4.68	1.48	56.8	85.53
2011	21	48° 44.08'	068° 59.67'	317	16.08	5.22	192.18	318.79
2011	22	48° 44.11'	069° 0.25'	330	23.55	5.12	297.28	284.38
2011	23	48° 43.78'	068° 59.18'	321	2.53	4.32	68.59	272.14
2011	24	48° 43.78'	068° 59.71'	338	6.00	2.60	110.29	150.82
2011	25	48° 43.78'	069° 0.28'	370	13.25	3.56	193.59	202.13
2011	26	48° 43.77'	069° 0.78'	327	12.41	1.55	122.75	82.75
2011	27	48° 43.42'	068° 59.18'	320	0.32	1.90	11	123.77
2011	28	48° 43.42'	068° 59.71'	296	3.88	3.65	62.72	249.07
2011	35	48° 43.06'	069° 1.30'	296	6.05	2.28	63.68	140.03
2011	36	48° 42.67'	069° 0.37'	338	7.69	3.10	103.55	197.79
2011	37	48° 42.70'	069° 0.76'	321	9.79	2.95	113.49	169.97
2011	38	48° 42.74'	069° 1.30'	334	2.53	1.42	21.16	84.79
2011	39	48° 42.73'	069° 1.85'	316	8.02	3.10	120.17	173.16
2011	40	48° 42.38'	069° 0.22'	325	0.83	1.35	10.27	85.24
2011	41	48° 42.41'	069° 0.76'	321	7.79	3.58	100.24	221.98
2011	42	48° 42.40'	069° 1.32'	317	3.94	2.24	41.62	133.78
2011	43	48° 42.37'	069° 1.88'	348	11.67	1.75	117.58	100.11
2011	44	48° 42.02'	069° 0.76'	311	3.59	3.15	69.73	188.51
2011	45	48° 41.99'	069° 1.32'	348	6.70	3.50	83.97	207.73
2011	46	48° 42.03'	069° 1.80'	327	6.62	2.89	71.53	160.44
2011	47	48° 41.67'	069° 0.74'	305	1.11	0.11	5.76	8.19
2011	48	48° 41.65'	069° 1.31'	313	19.19	7.22	272.83	400.71
2011	49	48° 41.66'	069° 1.84'	371	9.47	1.18	111.93	65.02
2011	50	48° 41.31'	069° 1.31'	327	8.37	3.10	134.31	178.31
2011	51	48° 41.33'	069° 1.85'	321	6.63	2.11	92.02	133.45
2011	52	48° 40.98'	069° 1.29'	321	2.11	1.16	19.52	67.74
2011	53	48° 41.00'	069° 1.83'	325	24.92	4.15	322.23	223.05
2011	54	48° 40.96'	069° 2.38'	319	3.82	1.80	50.24	96.64
2011	55	48° 40.57'	069° 1.87'	309	5.80	2.63	124.15	143.90
2011	56	48° 40.62'	069° 2.34'	298	5.00	3.07	68.1	161.10
2011	57	48° 40.23'	069° 2.32'	309	7.43	1.31	126.34	67.60
2011	58	48° 39.91'	069° 2.35'	312	4.65	2.70	78.6	138.48
2011	59	48° 39.92'	069° 2.82'	333	2.23	1.52	41.42	77.72
2011	60	48° 39.47'	069° 2.43'	304	5.22	4.89	132.94	244.42
2011	61	48° 39.55	069° 2.83	333	6.49	2.13	107.29	111.42
Pointe-aux-Outardes								
2005	7	49° 0.33'	068° 29.22'	692	0.20	0	4.5	0
2005	8	49° 0.31'	068° 29.94'	249	0	0	0	0
2005	9	49° 0.31'	068° 30.54'	402	0.67	1.01	11.6	67.94
2005	10	49° 0.34'	068° 30.96'	303	2.23	4.01	58.65	284.17
2005	11	49° 0.31'	068° 31.47'	402	1.68	2.02	32.33	94.98
2005	12	49° 0.30'	068° 32.16'	610	1.11	1.55	31.53	73.65
2005	13	49° 0.25'	068° 32.46'	352	2.30	0.77	56.56	35.88
2005	14	49° 0.39'	068° 32.91'	375	0.36	0.36	9.53	15.22
2005	15	49° 0.36'	068° 33.75'	365	0.37	0.37	9.27	28.49
2005	16	49° 0.04'	068° 30.93'	304	0	0.45	0	33.08
2005	17	48° 59.95'	068° 31.65'	364	0.74	12.26	24.79	901.43
2005	18	48° 59.94'	068° 32.31'	397	2.04	2.72	53.83	168.27
2005	19	48° 59.96'	068° 32.37'	328	1.65	0.41	60.52	19.65
2005	20	49° 0.09'	068° 33.12'	269	1.00	0.50	30.64	28.13
2005	51	49° 0.49'	068° 33.93'	305	4.43	4.43	103.8	275.48
2005	52	49° 0.25'	068° 34.59'	329	2.06	1.23	69.79	82.79

Appendix 30. (continued).

Year	Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
					Subleg[1]	Leg[2]	Subleg[1]	Leg[2]
2005	53	49° 0.06'	068° 34.95'	294	0.46	2.30	16.77	143.42
2005	54	48° 59.86'	068° 35.37'	375	1.80	0.36	23.92	28.86
2005	55	48° 59.67'	068° 35.73'	297	3.65	1.37	42.82	102.82
2007	6	49° 0.49'	068° 28.98'	804	0.08	0.71	2.61	38.80
2007	7	49° 0.35'	068° 29.55'	952	0.18	0.14	3.51	9.39
2007	8	49° 0.26'	068° 30.15'	896	0.30	0.45	8.63	26.91
2007	9	49° 0.28'	068° 30.69'	835	1.33	5.42	38.68	316.65
2007	10	49° 0.36'	068° 30.93'	653	1.19	2.48	37.74	134.70
2007	11	49° 0.32'	068° 31.53'	444	3.58	1.52	105.51	78.72
2007	12	49° 0.30'	068° 32.04'	465	1.45	1.09	40.08	54.83
2007	13	49° 0.31'	068° 32.61'	376	0.99	0.99	17.89	51.52
2007	14	49° 0.30'	068° 33.06'	752	1.08	0.99	28.02	51.27
2007	15	49° 0.30'	068° 33.78'	498	0.20	0.20	5.92	11.22
2007	16	48° 59.94'	068° 31.08'	900	0.34	4.77	11.78	289.73
2007	17	49° 0.07'	068° 31.29'	840	1.37	6.03	42.29	357.15
2007	18	48° 59.97'	068° 32.01'	412	2.22	7.88	65.3	466.08
2007	19	48° 59.95'	068° 32.58'	446	3.34	12.58	104.92	722.76
2007	20	48° 59.97'	068° 33.21'	553	0.61	1.34	16.31	81.85
2007	51	49° 0.47'	068° 33.87'	320	1.16	2.32	18.81	151.43
2007	52	49° 0.25'	068° 34.47'	723	0.65	0.84	17.04	47.34
2007	53	49° 0.17'	068° 34.80'	782	2.29	3.37	44.78	193.66
2007	54	48° 59.90'	068° 35.22'	741	1.55	2.23	28.49	136.70
2007	55	48° 59.71'	068° 35.64'	808	0.75	0.46	8.12	28.94
2007	56	49° 0.58'	068° 28.44'	717	0.33	1.37	9.42	73.56
2007	57	49° 0.63'	068° 28.05'	652	6.89	5.60	182.94	272.27
2007	58	49° 0.76'	068° 27.42'	698	1.36	4.89	45.59	244.74
2007	59	49° 0.82'	068° 27.06'	647	1.83	2.87	56.18	149.96
2007	60	49° 0.93'	068° 26.34'	628	0	0.38	0	18.84
2007	61	49° 1.07'	068° 25.62'	789	0.64	2.74	19.03	149.85
2009	6	49° 0.49'	068° 28.89'	315	0.21	0.75	5.83	39.70
2009	7	49° 0.32'	068° 29.40'	324	0	0.42	0	24.83
2009	8	49° 0.32'	068° 29.94'	277	0	0.49	0	33.68
2009	9	49° 0.32'	068° 30.48'	324	1.04	1.77	32.97	98.57
2009	10	49° 0.32'	068° 31.02'	301	4.94	4.60	105.39	288.80
2009	11	49° 0.31'	068° 31.56'	306	5.20	2.32	93.55	135.03
2009	12	49° 0.31'	068° 32.10'	281	2.05	0.84	47.59	42.61
2009	13	49° 0.25'	068° 32.49'	297	0.57	0.80	5.18	46.16
2009	14	49° 0.26'	068° 33.27'	292	6.94	0.23	46.57	17.12
2009	15	49° 0.29'	068° 33.63'	350	1.16	0.39	15.16	21.88
2009	16	48° 59.97'	068° 30.99'	303	0.33	4.23	11.93	305.42
2009	17	48° 59.93'	068° 31.50'	354	1.91	6.40	50.43	455.15
2009	18	48° 59.97'	068° 32.10'	321	4.64	4.95	101.39	307.78
2009	19	48° 59.96'	068° 32.61'	336	1.71	1.31	35.65	79.33
2009	20	48° 59.96'	068° 33.12'	345	1.76	2.06	46.57	130.47
2009	51	49° 0.50'	068° 33.90'	312	3.90	1.19	41.12	73.74
2009	52	49° 0.31'	068° 34.41'	319	2.12	0.85	23.61	56.38
2009	53	49° 0.12'	068° 34.89'	312	3.57	1.08	19.42	80.26
2009	54	48° 59.93'	068° 35.13'	283	4.18	1.32	38.45	82.35
2009	55	48° 59.77'	068° 35.55'	292	9.59	1.16	66.31	68.19
2009	56	49° 0.59'	068° 28.32'	383	2.20	2.20	75.44	134.83
2009	57	49° 0.66'	068° 27.90'	299	1.92	3.28	57.13	186.18
2009	58	49° 0.76'	068° 27.39'	320	7.17	6.54	250.34	354.71
2009	59	49° 0.85'	068° 26.82'	319	2.22	2.43	68.55	130.93
2009	60	49° 0.92'	068° 26.34'	320	0.53	0.63	19.64	37.56
2009	61	49° 1.04'	068° 25.74'	310	0.33	0.98	11.54	57.50
2011	6	49° 0.50'	068° 28.85'	259	0.78	0.26	22.77	17.34
2011	7	49° 0.32'	068° 29.42'	276	0	0	0	0
2011	8	49° 0.33'	068° 29.90'	283	0.12	0.12	1.68	10.48

Appendix 30. (continued).

Year	Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
					Subleg[1]	Leg[2]	Subleg[1]	Leg[2]
2011	9	49° 0.33'	068° 30.50'	334	10.52	4.65	199.58	250.80
2011	10	49° 0.30'	068° 31.08'	348	25.66	8.36	398.77	491.56
2011	11	49° 0.32'	068° 31.59'	342	20.85	4.74	361.45	243.50
2011	12	49° 0.31'	068° 32.10'	341	13.16	2.37	169.31	121.21
2011	13	49° 0.31'	068° 32.58'	316	3.10	1.50	46.8	83.49
2011	14	49° 0.32'	068° 33.15'	330	0.31	0.10	0.93	5.07
2011	15	49° 0.31'	068° 33.65'	304	1.78	0.44	16.04	32.77
2011	16	48° 59.98'	068° 31.00'	194	0.17	1.91	5.52	117.83
2011	17	48° 59.94'	068° 31.51'	326	2.90	4.15	47.85	264.52
2011	18	48° 59.99'	068° 32.03'	318	38.08	2.55	373.9	136.16
2011	19	48° 59.98'	068° 32.59'	342	14.72	5.73	244.57	334.83
2011	20	48° 59.99'	068° 33.12'	318	9.99	3.19	110.4	218.49
2011	51	49° 0.55'	068° 33.81'	326	21.06	11.83	281.32	744.92
2011	52	49° 0.29'	068° 34.48'	339	5.88	3.39	71.44	227.78
2011	53	49° 0.14'	068° 34.92'	352	1.63	0.77	18.23	54.95
2011	54	48° 59.93'	068° 35.21'	334	6.67	3.94	87.85	260.34
2011	55	48° 59.77'	068° 35.60'	362	4.39	2.71	66.04	177.70
2011	56	49° 0.59'	068° 28.36'	290	2.91	1.51	95.18	80.78
2011	57	49° 0.67'	068° 27.84'	278	8.86	11.05	278.38	562.15
2011	58	49° 0.79'	068° 27.33'	267	18.25	5.70	506.24	279.91
2011	59	49° 0.87'	068° 26.77'	262	10.96	3.74	317.63	187.94
2011	60	49° 0.95'	068° 26.21'	267	0	0.25	0	13.09
2011	61	49° 1.04'	068° 25.74'	274	1.36	1.73	39.6	89.86
Baie-Comeau								
2005	1	49° 12.19'	068° 5.40'	449	0.90	0	27.58	0
2005	2	49° 12.10'	068° 5.31'	406	8.99	1.00	211.24	56.86
2005	3	49° 11.62'	068° 5.28'	400	5.40	2.70	151.05	143.10
2005	4	49° 11.17'	068° 5.31'	454	81.28	36.92	2362.7	1861.20
2005	5	49° 10.79'	068° 5.40'	396	102.61	15.00	2473.7	772.90
2005	6	49° 10.63'	068° 5.31'	432	7.50	4.06	199.53	220.88
2005	7	49° 10.24'	068° 5.40'	409	7.27	1.32	196.12	78.20
2005	8	49° 9.97'	068° 5.46'	338	28.36	12.78	708.51	675.02
2005	9	49° 9.65'	068° 5.64'	375	50.45	4.68	965.71	232.26
2005	10	49° 9.29'	068° 5.82'	442	51.70	3.67	922.59	187.35
2005	11	49° 8.87'	068° 5.88'	442	40.40	3.06	869.46	138.55
2007	1	49° 12.38'	068° 5.22'	652	2.69	2.80	64.3	143.45
2007	2	49° 11.89'	068° 5.25'	724	18.76	8.82	337.87	440.40
2007	3	49° 11.64'	068° 5.22'	557	8.55	6.55	224.71	305.00
2007	4	49° 11.34'	068° 5.28'	740	18.94	14.29	507.34	688.70
2007	5	49° 10.99'	068° 5.19'	684	17.88	11.26	486.49	559.56
2007	6	49° 10.57'	068° 5.28'	706	18.32	8.56	462.54	400.24
2007	7	49° 10.35'	068° 5.25'	811	6.21	2.63	162.3	125.92
2007	8	49° 9.88'	068° 5.22'	843	2.89	1.44	66.58	78.96
2007	9	49° 9.65'	068° 5.52'	775	20.57	8.72	452.17	422.89
2007	10	49° 9.14'	068° 5.85'	779	45.20	2.39	777.91	108.50
2007	11	49° 8.93'	068° 5.76'	863	7.86	3.36	173.07	160.88
2009	1	49° 12.37'	068° 5.28'	312	1.95	5.52	63.75	329.54
2009	2	49° 12.02'	068° 5.25'	308	24.57	2.52	425.19	141.49
2009	3	49° 11.64'	068° 5.28'	338	11.21	4.00	211.92	215.81
2009	4	49° 11.29'	068° 5.28'	313	18.65	13.58	482.74	700.67
2009	5	49° 10.95'	068° 5.28'	308	17.25	13.84	485.9	767.87
2009	6	49° 10.58'	068° 5.22'	332	10.07	4.17	206.61	227.38
2009	7	49° 10.31'	068° 5.28'	393	4.91	3.27	123.54	179.27
2009	8	49° 9.96'	068° 5.28'	407	2.99	1.33	76.61	73.92
2009	9	49° 9.58'	068° 5.58'	317	23.23	7.67	457.21	417.41
2009	10	49° 9.20'	068° 5.79'	337	64.88	4.71	947.69	261.40
2009	11	49° 8.85'	068° 5.85'	281	22.08	5.04	423.25	277.99

Appendix 30. (continued).

Year	Station	Latitude (N)	Longitude (W)	Distance (m)	Density		Yield	
					Subleg[1]	Leg[2]	Subleg[1]	Leg[2]
2011	1	49° 12.33’	068° 5.21’	330	7.87	7.26	179.4	404.82
2011	2	49° 11.98’	068° 5.25’	335	39.79	16.36	589.8	889.49
2011	3	49° 11.65’	068° 5.26’	315	42.10	13.61	1089.9	652.46
2011	4	49° 11.32’	068° 5.28’	317	13.63	7.88	366.8	407.68
2011	5	49° 10.97’	068° 5.27’	316	58.47	47.89	1721.7	2502.80
2011	6	49° 10.58’	068° 5.28’	353	30.15	24.40	693.1	1244.30
2011	7	49° 10.24’	068° 5.28’	319	9.54	11.23	240.36	614.10
2011	8	49° 9.86’	068° 5.30’	321	5.90	10.00	151.95	538.05
2011	9	49° 9.56’	068° 5.57’	326	20.70	30.43	595.04	1650.40
2011	10	49° 9.22’	068° 5.81’	303	23.10	3.46	414.69	179.60
2011	11	49° 8.90’	068° 5.84’	317	27.48	7.88	618.96	409.75

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

Appendix 31. Egg mass density (number/100 m^2) and yield (g/100 m^2) by station (when present) and area in the 2005, 2007, 2009 and 2011 research surveys.

Area and Year	Station	Density (number/100 m^2)	Yield (g/100 m^2)
Forestville			
2005	10	0.25	
2005	37	0.06	
2005	43	0.23	
2005	56	0.36	
2007	5		5.09
2007	14		1.22
2007	26		9.32
2007	37		0.67
2007	43		12.66
2007	45		5.30
2007	51		4.45
2009	3	0.09	2.18
2009	4	0.10	7.82
2009	25	0.12	8.28
2009	56	0.12	3.49
2011	8	0.10	26.21
2011	13	0.11	36.64
2011	16	0.10	59.10
2011	17	0.11	4.82
2011	28	0.11	55.96
2011	39	0.11	21.25
2011	44	0.11	0.67
2011	45	0.10	2.68
2011	55	0.11	4.99
Pointe-aux-Outardes			
2005	8	0.54	
2005	9	0.34	
2005	10	2.23	
2005	11	0.67	
2005	17	3.72	
2005	18	3.06	
2005	19	3.30	
2005	20	0.50	
2005	51	4.43	
2005	53	0.46	
2007	6		42.79
2007	8		5.15
2007	9		176.67
2007	10		414.11
2007	11		68.86
2007	12		17.78
2007	14		36.47
2007	16		101.44
2007	17		131.71
2007	18		563.41
2007	19		328.69
2007	20		19.52
2007	51		37.27
2007	52		8.25
2007	53		35.15
2007	54		0.21
2007	56		112.24
2007	57		55.24
2007	58		33.76
2007	59		8.96

Appendix 31. (continued).

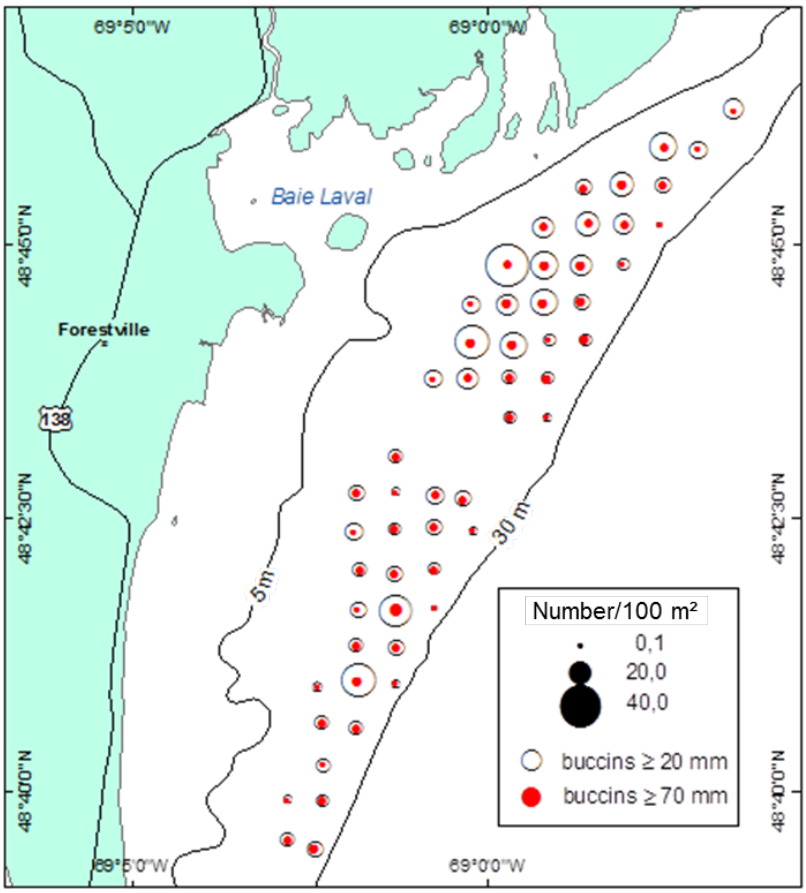
Area and Year	Station	Density (number/100 m^2)	Yield (g/100 m^2)
2007	60		4.12
2007	61		127.27
2009	6	0.21	7.03
2009	9	0.52	19.64
2009	10	6.40	660.45
2009	11	0.44	75.30
2009	13	0.34	9.84
2009	16	0.22	16.93
2009	17	2.48	194.88
2009	18	9.48	529.90
2009	19	1.81	78.56
2009	20	0.10	18.55
2009	51	0.22	9.47
2009	52	0.11	1.48
2009	54	0.12	0.66
2009	56	0.62	47.73
2009	57	0.45	37.76
2009	58	2.64	138.26
2009	59	0.74	26.14
2009	60	0.42	16.50
2011	6	1.05	57.78
2011	7	0.12	5.50
2011	9	1.32	74.16
2011	10	15.26	1,275.77
2011	11	0.69	46.44
2011	15	0.33	30.89
2011	17	1.35	61.83
2011	18	1.06	59.46
2011	19	0.30	9.19
2011	51	8.30	664.44
2011	52	0.60	44.67
2011	56	2.56	202.88
2011	57	0.24	21.49
2011	58	0.25	14.58
2011	59	0.52	18.12
2011	60	0.13	15.46
2011	61	1.85	143.20
Baie-Comeau			
2005	4	10.72	
2005	5	3.41	
2005	9	1.44	
2005	10	0.31	
2005	11	0.31	
2007	2		3.20
2007	3		67.07
2007	4		117.76
2007	5		179.45
2007	6		3.80
2007	9		7.98
2007	10		12.62
2007	11		11.27
2009	1	0.32	26.54
2009	4	0.86	16.66
2009	5	2.20	194.81
2009	6	0.31	22.99
2009	7	0.09	9.17
2009	8	0.33	53.82

Appendix 31. (continued).

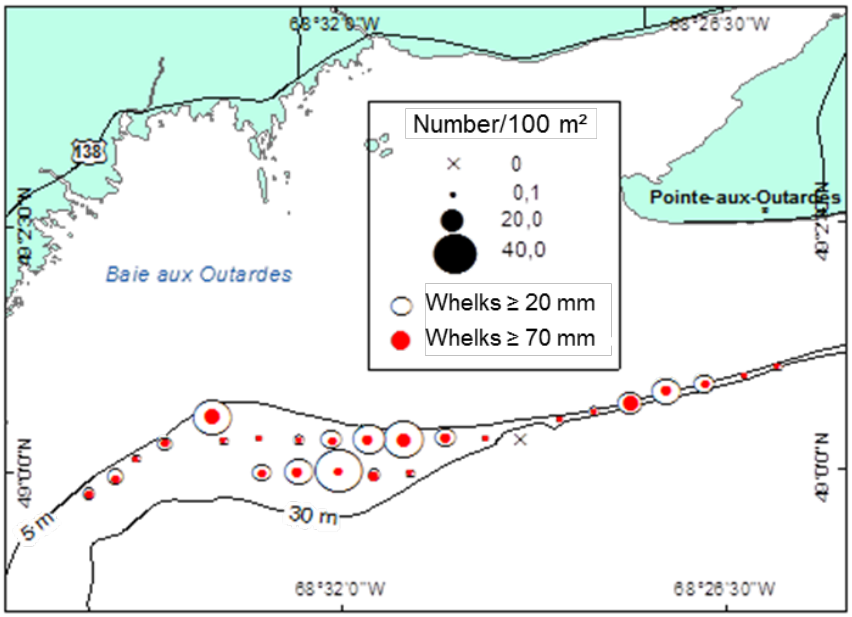
Area and Year	Station	Density (number/100 m^2)	Yield (g/100 m^2)
2009	9	0.96	66.34
2009	10	0.60	46.68
2009	11	0.84	20.46
2011	1	0.92	69.57
2011	2	1.11	147.91
2011	3	0.21	14.30
2011	4	3.73	450.15
2011	5	19.56	2,993.59
2011	6	3.83	286.38
2011	7	0.32	38.73
2011	9	13.04	1,687.27
2011	10	0.78	162.54
2011	11	3.20	244.26

Appendix 32. Density (number/100 m^2) of all whelk (≥ 20 mm) and legal size whelk (≥ 70 mm) by station and area in the 2011 research survey in A) Forestville, B) Pointe-aux-Outardes and C) Baie-Comeau.

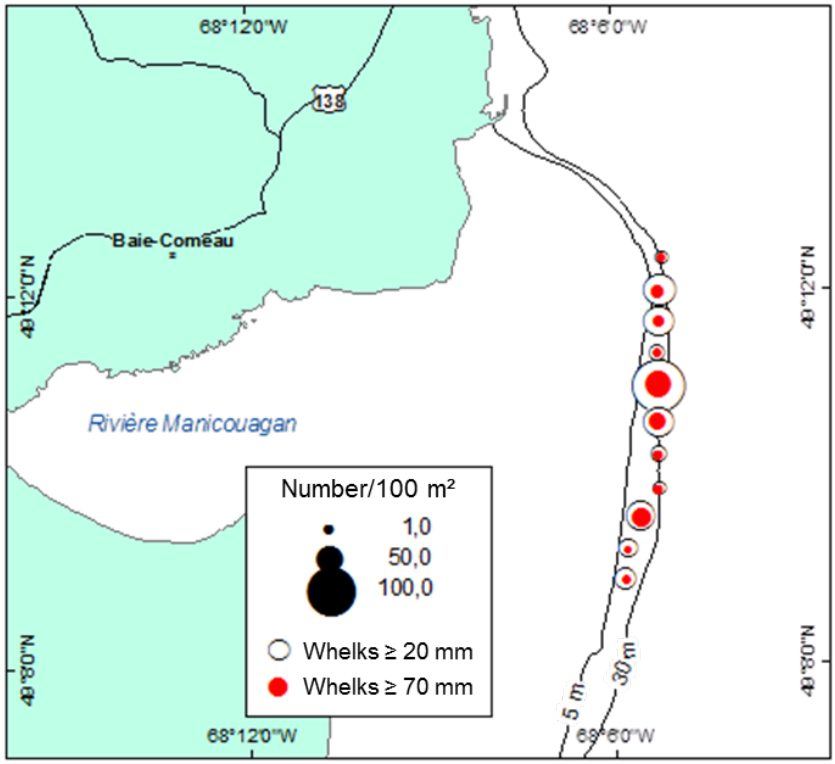
A) Forestville



Appendix 32. (continued).
B) Pointe-aux-Outardes



C) Baie-Comeau

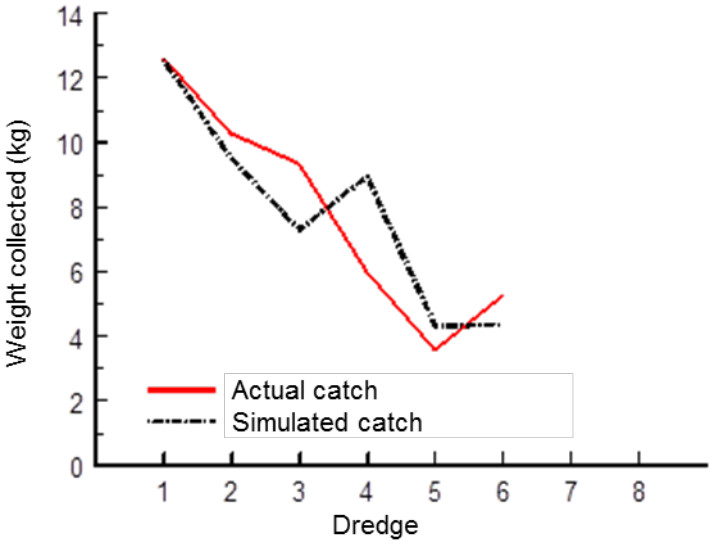


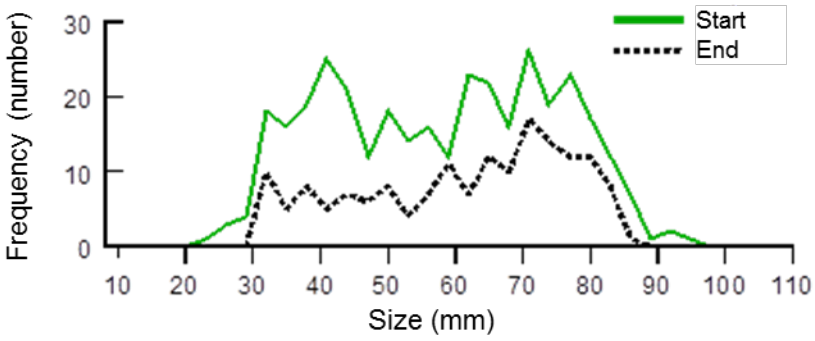
Appendix 33. Parameters of linear relationships between whole live weight or minimum diameter and height of Waved Whelk, Buccinum undatum, estimated weight for an 80-mm whelk and an estimated diameter for a 70-mm whelk from the 2007, 2009 and 2011 Forestville, Pointe-aux-Outardes and Baie-Comeau research surveys and during the 2011 exploratory fishery off the coast of Anticosti Island.

Area and Year	Equation	R^2	*n*	Weight (g) for an 80-mm Whelk	Diameter (m) for a 70-mm Whelk
Relationship between live weight and height					
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	
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	
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	
Anticosti Island					
2011	ln(y) = 2.654 ln(x) – 7.530	0.948	165	60	
Relationship between minimum diameter and height					
Forestville					
2007	y = 0.451 x + 1.079	0.990	176		32.65
2009	(y) = 0.436 (x) +1.053	0.985	324		31.54
2011	y = 0.438 x + 1.436	0.985	269		32.10
Pointe-aux-Outardes					
2007	y = 0.439 x + 1.756	0.986	155		32.51
2009	y = 0.441 x + 0.943	0.988	261		31.81
2011	y = 0.441 x + 1.326	0.991	196		32.17
Baie-Comeau					
2007	y = 0.436 x + 1.803	0.982	137		32.31
2009	y = 0.450 x + 0.654	0.992	250		32.19
2011	y = 0.443 x + 0.999	0.990	171		32.01
Anticosti Island					
2011	y = 0.456 x + 2.287	0.903	165		34.18

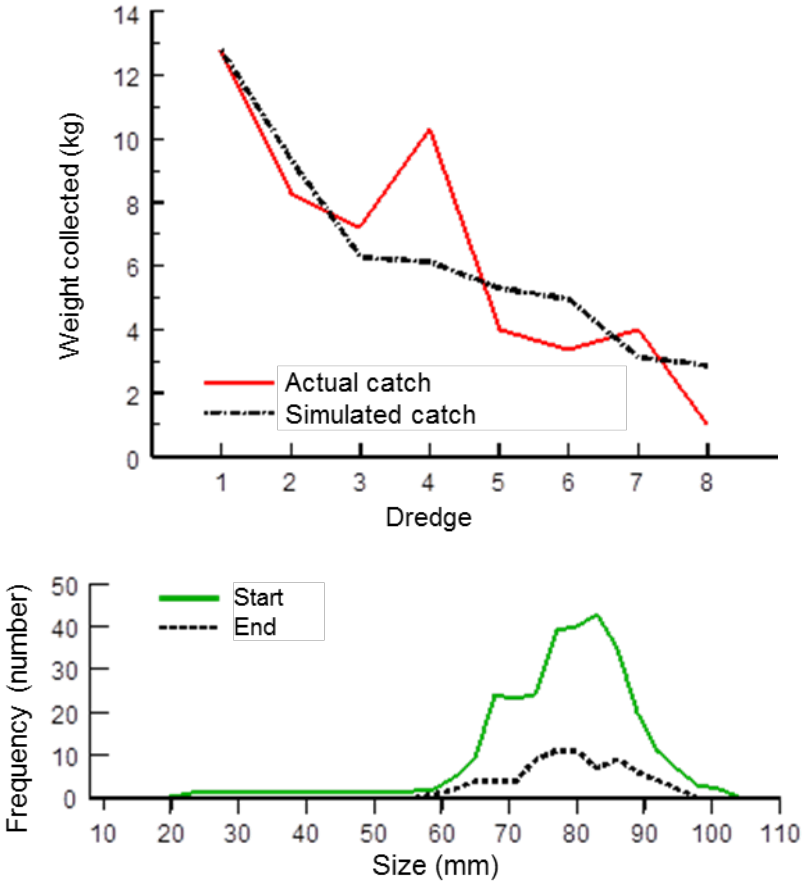
Appendix 34. Changes in actual and simulated whelk catches and size structures when measuring dredge efficiency by depletion in 2011 in A) Forestville and B) Pointe-aux-Outardes.

A) Forestville





Appendix 34. (continued).
B) Pointe-aux-Outardes



Appendix 35. Number of images, area of images and density, (number/100 m^2) of whelk on the images and dredged by area and station in the 2009 research survey.

Area and Station	Image				Dredge	
	Number	Area (m^2)	Density		Density	
			25-69 mm	≥ 70 mm	25-69 mm	≥ 70 mm
Forestville						
1	71	8.21	93.3	24.4	3.6	0.6
2	64	7.40	139.6	72.0	3.7	0.4
6	89	10.29	63.2	17.0	13.2	2.0
9	90	10.41	28.8	12.8	7.9	4.0
10	94	10.87	18.4	18.4	9.3	3.4
12	84	9.71	61.8	0.0	4.1	2.0
14	92	10.64	159.8	18.8	6.4	3.7
15	92	10.64	59.5	16.4	3.0	2.3
16	87	10.06	19.9	9.9	5.6	2.4
18	93	10.76	139.5	18.6	2.4	1.3
21	65	7.52	13.3	0	3.0	1.2
23	94	10.87	0	13.8	1.5	1.6
27	94	10.87	0	0	1.7	3.1
Pointe-aux-Outardes						
8	95	10.99	0	0	0	0.5
9	86	9.95	0	7.5	1.0	1.8
12	93	10.76	9.3	0	1.7	0.8
15	93	10.76	0	0	1.1	0.4
16	93	10.76	39.5	4.6	0.3	4.2
17	92	10.64	28.2	42.3	1.8	6.4
18	92	10.64	17.9	35.2	4.2	5.0
20	93	10.76	0	0	1.8	2.1
54	71	8.21	0	12.2	4.0	1.3
55	72	8.33	0	0	7.7	1.2

Appendix 36. Trap haul date, depth, start and end position (latitude and longitude WGS84) and catch per unit of effort (CPUE) by whelk line, size class during the 2011 exploratory fishery off the coast of Anticosti Island.

Transect	Line	Number	Haul Date[1]	Depth	Start Latitude	Start Longitude	End Latitude	End Longitude	CPUE (kg/trap)	
		Number		(m)	(N)	(W)	(N)	(W)	Total	≥ 70 mm
1	1	1	06-07-2011	49.4	49° 40.80’	062° 43.88’	49° 40.74’	062° 43.73’	0	0
1	2	2	06-07-2011	36.6	49° 40.61’	062° 44.03’	49° 40.60’	062° 43.89’	0	0
1	3	3	06-07-2011	28.3	49° 40.49’	062° 44.21’	49° 40.47’	062° 44.10’	0.258	0.258
1	4	4	06-07-2011	19.9	49° 40.16’	062° 44.39’	49° 40.12’	062° 44.21’	0.019	0.019
2	5	5	06-07-2011	36.6	49° 40.89’	062° 45.52’	49° 40.87’	062° 45.38’	0.063	0.063
2	6	6	06-07-2011	29.3	49° 40.84’	062° 45.61’	49° 40.80’	062° 45.49’	0.143	n/a[2]
2	7	7	06-07-2011	20.1	49° 40.67’	062° 45.79’	49° 40.62’	062° 45.67’	0.007	0.007
3	8	8	06-07-2011	34.8	49° 41.56’	062° 46.71’	49° 41.51’	062° 46.59’	0.007	0.007
3	9	9	06-07-2011	29.3	49° 41.45’	062° 46.81’	49° 41.41’	062° 46.71’	0.004	0
3	10	10	06-07-2011	20.1	49° 41.23’	062° 47.18’	49° 41.18’	062° 47.09’	0.043	0.043
4	11	11	06-07-2011	38.4	49° 41.70’	062° 48.22’	49° 41.65’	062° 48.13’	0.029	0.029
4	12	12	06-07-2011	27.4	49° 41.57’	062° 48.36’	49° 41.54’	062° 48.25’	0.286	0.286
5	13	13	06-07-2011	26.5	49° 42.23’	062° 49.54’	49° 42.16’	062° 49.41’	0.664	0.636
5	14	14	06-07-2011	18.3	49° 42.06’	062° 49.67’	49° 42.03’	062° 49.58’	0.004	0
6	14	15	07-07-2011	42.1	49° 42.88’	062° 51.69’	49° 42.86’	062° 51.55’	0	0
6	13	16	07-07-2011	31.1	49° 42.81’	062° 51.75’	49° 42.80’	062° 51.56’	0	0
6	12	17	07-07-2011	27.4	49° 42.68’	062° 51.83’	49° 42.67’	062° 51.67’	0.443	0.429
7	11	18	07-07-2011	40.2	49° 43.03’	062° 53.18’	49° 42.99’	062° 53.08’	0.286	n/a
7	10	19	07-07-2011	31.1	49° 42.91’	062° 53.28’	49° 42.89’	062° 53.14’	0.464	0.321
7	9	20	07-07-2011	23.8	49° 42.86’	062° 53.33’	49° 42.84’	062° 53.20’	1.257	n/a
8	8	21	07-07-2011	44.8	49° 43.67’	062° 54.90’	49° 43.61’	062° 54.78’	0.107	0.107
8	7	22	07-07-2011	27.4	49° 43.55’	062° 54.88’	49° 43.59’	062° 54.98’	1.100	n/a
9	6	23	07-07-2011	27.4	49° 44.02’	062° 55.83’	49° 43.98’	062° 55.70’	2.643	n/a
9	5	24	07-07-2011	20.1	49° 43.97’	062° 55.89’	49° 43.94’	062° 55.72’	3.725	n/a
10	4	25	07-07-2011	35.7	49° 45.36’	062° 59.61’	49° 45.31’	062° 59.44’	n/a	n/a
10	3	26	07-07-2011	27.4	49° 45.29’	062° 59.45’	49° 45.25’	062° 59.52’	1.883	1.633
11	2	27	07-07-2011	38.4	49° 45.57’	063° 02.11’	49° 45.63’	063° 02.23’	0.250	0.212
11	1	28	07-07-2011	49.4	49° 45.71’	063° 02.18’	49° 45.68’	063° 02.07’	0.175	0.150
12	1	29	08-07-2011	58.5	49° 47.96’	063° 10.78’	49° 47.93’	063° 10.63’	0.008	0.008

Appendix 36. (continued).

Transect	Line	Number	Haul Date[1]	Depth	Start Latitude	Start Longitude	End Latitude	End Longitude	CPUE (kg/trap)	
		Number		(m)	(N)	(W)	(N)	(W)	Total	≥ 70 mm
12	2	30	08-07-2011	27.4	49° 47.76’	063° 10.66’	49° 47.77	063° 10.79’	0	0
13	3	31	08-07-2011	18.3	49° 48.19’	063° 12.83’	49° 48.20’	063° 12.93’	0	0
14	4	32	08-07-2011	27.4	49° 48.47’	063° 14.69’	49° 48.48’	063° 14.82’	0	0
15	5	33	08-07-2011	25.6	49° 48.76’	063° 16.08’	49° 48.78’	063° 16.22’	0	0
16	6	34	08-07-2011	29.3	49° 49.03’	063° 17.53	49° 49.05’	063° 17.64’	0	0
17	7	35	08-07-2011	36.6	49° 49.55’	063° 20.45’	49° 49.56’	063° 20.55’	0	0
18	8	36	08-07-2011	32.9	49° 49.97’	063° 22.00’	49° 50.00’	063° 22.12’	0	0
19	9	37	08-07-2011	38.4	49° 50.38’	063° 24.36’	49° 50.37’	063° 24.50’	0	0
20	10	38	08-07-2011	31.1	49° 50.46’	063° 25.99’	49° 50.47’	063° 26.11’	0	0
21	11	39	08-07-2011	31.1	49° 50.87’	063° 27.54’	49° 50.91’	063° 27.71’	0	0
22	12	40	08-07-2011	27.4	49° 51.14’	063° 29.24’	49° 51.16’	063° 29.37’	0	0
23	13	41	08-07-2011	25.6	49° 51.54’	063° 30.88’	49° 51.57’	063° 31.02’	0	0
24	14	42	08-07-2011	32.9	49° 51.94’	063° 32.48’	49° 51.96’	063° 32.59’	0	0
25	14	43	11-07-2011	34.8	49° 52.55’	063° 34.04’	49° 52.56’	063° 34.15’	0	0
25	13	44	11-07-2011	29.3	49° 52.46’	063° 34.31’	49° 52.44’	063° 34.16’	0	0
26	12	45	11-07-2011	36.6	49° 53.14’	063° 35.58’	49° 53.15’	063° 35.69’	0	0
26	11	46	11-07-2011	31.1	49° 52.99’	063° 35.77’	49° 52.98’	063° 35.63’	0.020	0.019
26	10	47	11-07-2011	25.6	49° 52.65’	063° 35.70’	49° 52.69’	063° 35.83’	0	0
27	9	48	11-07-2011	34.8	49° 54.00’	063° 40.01’	49° 54.01’	063° 40.11’	0	0
27	8	49	11-07-2011	31.1	49° 53.89’	063° 40.10’	49° 53.88’	063° 39.94’	0.006	0
27	7	50	11-07-2011	25.6	49° 53.63’	063° 39.97’	49° 53.65’	063° 40.08’	0.216	0.183
28	6	51	11-07-2011	34.8	49° 54.19’	063° 41.70’	49° 54.18’	063° 41.54’	0.036	0.036
28	5	52	11-07-2011	31.1	49° 53.91’	063° 41.51’	49° 53.94’	063° 41.65’	0	0
28	4	53	11-07-2011	25.6	49° 53.72’	063° 41.69’	49° 53.72’	063° 41.52’	0.038	0.025
29	3	54	11-07-2011	29.3	49° 53.94’	063° 43.31’	49° 53.95’	063° 43.39’	0	0
29	2	55	11-07-2011	38.4	49° 54.44’	063° 43.40’	49° 54.42’	063° 43.25	0	0
29	1	56	11-07-2011	49.4	49° 55.16’	063° 43.32’	49° 55.22’	063° 43.13’	0.008	0
30	1	57	12-07-2011	45.7	49° 55.53’	063° 44.77’	49° 55.58’	063° 44.91’	0	0
30	2	58	12-07-2011	38.4	49° 55.12’	063° 44.91’	49° 55.16’	063° 45.06’	0.003	0
30	3	59	12-07-2011	36.6	49° 54.57’	063° 45.09’	49° 54.58’	063° 45.22’	0	0
30	4	60	12-07-2011	28.3	49° 53.93’	063° 45.25’	49° 53.99’	063° 45.37’	0	0

Appendix 36. (continued).

Transect	Line	Serial Number	Haul Date[1]	Depth (m)	Start Latitude (N)	Start Longitude (W)	End Latitude (N)	End Longitude (W)	CPUE (kg/trap)	
									Total	≥ 70 mm
31	5	61	12-07-2011	39.3	49° 54.98’	063° 46.96’	49° 55.00’	063° 47.13’	0	0
31	6	62	12-07-2011	32.9	49° 54.70’	063° 47.08’	49° 54.72’	063° 47.22’	0.020	0.016
31	7	63	12-07-2011	31.1	49° 54.24’	063° 47.09’	49° 54.25’	063° 47.17’	0	0
31	8	64	12-07-2011	25.6	49° 53.89’	063° 47.14’	49° 53.92’	063° 47.27’	0	0
32	9	65	12-07-2011	38.4	49° 54.92’	063° 48.70’	49° 54.93’	063° 48.82’	0	0
32	10	66	12-07-2011	27.4	49° 54.39’	063° 48.74’	49° 54.41’	063° 48.84’	0.013	0.013
32	11	67	12-07-2011	31.1	49° 54.11’	063° 48.84’	49° 54.13’	063° 48.97’	0	0
32	12	68	12-07-2011	21.9	49° 53.71’	063° 48.92’	49° 53.73’	063° 49.06’	0	0
32	13	69	12-07-2011	56.7	49° 56.17’	063° 48.38’	49° 56.27’	063° 48.35’	0	0
32	14	70	12-07-2011	74.1	49° 57.69’	063° 48.09’	49° 57.78’	063° 48.08’	0	0
33	12	71	13-07-2011	35.7	49° 55.00’	063° 50.33’	49° 54.98’	063° 50.48’	0	0
33	11	72	13-07-2011	30.2	49° 53.91’	063° 50.20’	49° 53.90’	063° 50.36’	0	0
33	10	73	13-07-2011	26.5	49° 53.61’	063° 50.25’	49° 53.62’	063° 50.37’	0	0
34	9	74	13-07-2011	32.9	49° 54.29’	063° 51.80’	49° 54.31’	063° 51.95’	0	0
34	8	75	13-07-2011	29.3	49° 54.00’	063° 51.85’	49° 54.02’	063° 52.00’	0	0
34	7	76	13-07-2011	25.6	49° 53.76’	063° 51.93’	49° 53.76’	063° 52.07’	0	0
35	6	77	13-07-2011	36.6	49° 54.84’	063° 53.45’	49° 54.85’	063° 53.60’	0	0
35	5	78	13-07-2011	32.9	49° 54.63’	063° 53.57’	49° 54.60’	063° 53.72’	0	0
35	4	79	13-07-2011	27.4	49° 54.29’	063° 53.63’	49° 54.28’	063° 53.81’	0	0
36	3	80	13-07-2011	36.6	49° 55.13’	063° 54.97’	49° 55.12’	063° 55.09’	0	0
36	2	81	13-07-2011	29.3	49° 54.79’	063° 54.96’	49° 54.81’	063° 55.11’	0	0
36	1	82	13-07-2011	31.1	49° 54.57’	063° 55.13’	49° 54.55’	063° 55.30’	0	0
35	14	83	13-07-2011	93.3	49° 59.76’	063° 52.36’	49° 59.67’	063° 52.34’	0	0
35	13	84	13-07-2011	73.2	49° 58.32’	063° 52.41’	49° 58.21’	063° 52.41’	0	0

[1] 24-hour soak time except for transects 44 to 56 where soak time was 72 hours.
[2] n/a = data not available.

Appendix 37. Identification of taxa in traps by line set during the 2011 exploratory fishery off the coast of Anticosti Island.

			Crustaceans						Echinoderms					Molluscs				Other				
Transect	Line	Number	*Cancer irroratus*	*Chionoecetes opilio*	*Gammarus* sp.	*Hyas* sp.	*Pagurus* sp.	*Pandalus montagui*	*Asterias rubens*	*Cucumaria frondosa*	*Crossaster papposus*	*Echinarachnius parma*	*Strongylocentrotus droebachiensis*	*Aporrhais occidentalis*	*Chlamys islandica*	*Plicifusus kroeyeri*	*Neptunea* sp	*Ophiopholis aculeata*	*Mallotus villosus*	*Myoxocephalus scorpius*	*Ptilota serrata*	Kelp
1	1	1		x	x	x							x					x				
1	2	2	x	x		x	1		x					1				x				
1	3	3	x						x									x				
2	5	5	x			x			x					1				x				
2	6	6	x			x			x							1		x				
2	7	7	x			x			x									x				
3	8	8					1						x					x				
3	9	9								1		1						x				
4	11	11					1											x				
6	14	15	x	x		x							x					x				
8	8	21		2																		
9	6	23							x				x									
9	5	24										x				1						
10	4	25														2						
11	1	28															2					
12	1	29				x		2	x				x									
12	2	30																				
13	3	31					2														x	
14	4	32																x			x	
16	6	34					2												1		x	
21	11	39								1		x										
24	14	42											x									
25	14	43																x				
25	13	44	x															x				
26	12	45											x		1			x				
26	11	46	x															x				
26	10	47	x															x				
27	9	48											x					x				
27	8	49									1		x					x	1			
27	7	50																x				
28	6	51	x			x							x					x				
28	5	52	x			x			x				x		1			x				
28	4	53	x			x							x					x				
29	3	54											x					x				
29	2	55											x		x			x				
29	1	56											x					x				

Appendix 37. (continued).

Transect	Line	Number	Crustaceans						Echinoderms					Molluscs				Other				
			Cancer irroratus	*Chionoecetes opilio*	*Gammarus sp*	*Hyas sp.*	*Pagurus sp*	*Pandalus montagui*	*Asterias rubens*	*Cucumaria frondosa*	*Crossaster papposus*	*Echinarachnius parma*	*Strongylocentrotus droebachiensis*	*Aporrhais occidentalis*	*Chlamys islandica*	*Plicifucus kroeyeri*	*Neptunea sp*	*Ophiopholis aculeata*	*Mallotus villosus*	*Myoxocephalus scorpius*	*Ptilota serrata*	Kelp
30	1	57	x							1			x					x				
30	2	58	x							2			x					x				
30	3	59	x				3						x					x				x
30	4	60							1				x					x				
31	5	61				1				1			x					x				
31	6	62					1		1				x		1			x				
31	7	63					2			1	1		x					x				
31	8	64											x					x				
32	9	65											x					x		1		
32	10	66							1	1			x					x				
32	11	67											x					x				
32	12	68											x					x				
32	13	69	x			x	1						x		1			x				
32	14	70	x			x	x											x				
33	12	71											x					x				
33	11	72							1				x					x				
33	10	73											x					x	1			
34	9	74											x					x				
34	8	75				2		1					x					x				
34	7	76																x				
35	6	77																x				
35	5	78																x				
35	4	79																x				
36	3	80																x				
36	2	81											x					x				
36	1	82						1		3	1		x					x	2			
35	14	83				1												x				
35	13	84				x							x		x			x				