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Summary of the 2019 snow crab bottom trawl survey activities in the southern Gulf of St. Lawrence

R. Allain, T. Surette, J.-F. Landry, S. Boudreau, M. Hébert, and M. Moriyasu

Fisheries and Oceans Canada
Science Branch
Gulf Region
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

The present document summarizes the details of the 2019 snow crab bottom trawl survey conducted in the southern Gulf of St. Lawrence. Details of survey protocols and activities, tow characteristics and information on snow crab catches and by-catch species are included. The primary objective of these surveys is to provide data on abundance and distribution of snow crab and other by-catch species. This report accompanies the in-depth analysis of the survey data presented in the stock assessment document. The 2019 survey was conducted from July to September using a chartered commercial fishing vessel, the FV Avalon Voyager II. A total of 355 grids were visited and 352 grids were successfully sampled in 2019. Additionally, in 2019, a side-by-side comparative survey was performed at the final 40 stations using the current FV Avalon Voyager II and previous FV Jean Mathieu survey vessels. The total duration of the 2019 survey was 76 days with 46 days at sea. Total number of adult male crab catches increased from 5,439 in 2018 to 6,416 in 2019 whereas catches of commercial-male crabs slightly decreased from 2,441 to 2,419. For adult females, the total number of crabs increased from 8,802 in 2018 to 12,305 in 2019. Recorded by-catch during the 2019 survey consisted of 84 species/groups that comprised of 53 fish and 31 invertebrates. Observed increases in overall catches may be due in part to an unaccounted prolongation of the tow distance that was more pronounced in 2019 compared to previous years.

INTRODUCTION

The southern Gulf of St. Lawrence (sGSL) snow crab fishery, made up of fishermen from the Maritime Provinces and Quebec, began in the mid-1960s and entered a development phase in the 1970s. From initially modest landings, record catches were landed in the early 1980s (Hébert et al. 2016a). During this period, the status of this snow crab stock was poorly understood and the analysis was mostly based on fishery data. In 1989, the Area 12 fishery was closed prematurely due to a rapid decline in catch rates associated with a high incidence of soft-shelled crabs. Subsequently, new management measures were introduced in 1990.

One such measure was to set the total allowable catch (TAC) based on a trawl survey estimate of commercial biomass. This fishery independent survey uses a modified Nephrops-type trawl, used to fish Norway lobster in Europe, which has a footrope that digs into soft sediment and has a high catchability for snow crab. A 40 mm liner in the cod-end ensures that the wide range of snow crab sizes is caught. This survey is conducted annually and is the main assessment tool for determining the population status and dynamics in the sGSL. It provides indices of future recruitment to the fishery, spawning stock size, natural mortality, and relative exploitation rates.

From its inception in 1988, the survey area has been modified and expanded to include most of the sGSL snow crab habitat. In 1988, the survey area only covered the boundaries of the commercial fishery in snow crab fishing area 12. The survey was expanded to include Area 19 in 1990 and Areas 12E and 12F in 1997 (Hébert et al. 1998). In Areas 12, 12E and 12F, the survey was conducted after the fishing season, which usually opened in late April and finished by mid-July. The trawl survey normally starts in early to mid-July and ends in September or October. In Area 19, the survey was conducted between the spring and summer fishing seasons between 1990 and 1992. Since 1993, the snow crab fishery in Area 19 only occurs in the summer and the survey is conducted after the fishery. Further details of these survey design changes are provided by Moriyasu et al. (2008).

Since 2013, the survey has been financed through a collaborative agreement with the snow crab industry of the sGSL under Section 10 of the Fisheries Act.

The present document summarizes the 2019 survey activities of the snow crab bottom trawl survey in the sGSL. The information includes survey protocols, characteristics of each tow, and catches of snow crab and by-catch species.

SURVEY DESIGN AND PROTOCOL

STATISTICAL DESIGN

The survey follows a grid sampling design with random assignment of sampling stations within each grid (Moriyasu et al. 1998). The spatial sampling design from 1988 to 2011 used 10 *x* 10 minute (latitude-longitude) grids overlaying the survey area, with one or more random sampling locations in each grid. Locations which were deemed too difficult to trawl were reassigned to new random sampling locations within the same grid. Further stations were added in an *ad hoc* manner to increase the precision of biomass estimates in smaller fishing areas (Areas 19, 12E, 12F and Chaleur Bay) or as the survey expanded.

In 2006, the sampling design was modified in accordance with recommendations from the 2005 Assessment Framework Workshop on the sGSL snow crab (DFO, 2006; Moriyasu et al. 2008). The new design was introduced to increase spatial sampling homogeneity while keeping within the 10 x 10 minute spatial grid scheme. The updated survey design was spatially unbiased in the sense that the expected number of stations per 10 x 10 minute grid was proportional to its

surface area. This implies that in practice the actual number of stations per grid was either one or two stations, and partial grids along the survey area margins often had zero stations. Past survey stations were retained as much as possible, but others were redistributed to other grids as prescribed by the sampling method (Moriyasu et al. 2008).

In 2012, the sampling design was again modified following recommendations from the 2011 Snow Crab Assessment Methods Framework Science Review (DFO 2012). The boundaries of the survey area were extended to the 20 and 200 fathom isobaths, which encompass the vast majority of favorable snow crab habitat (i.e. bottom temperatures between -1°C and 3°C) and better represented the sGSL snow crab biological unit. To further improve spatial homogeneity, grids were set to be square rather than rectangular with dimensions defined as a function of the number of total samples, so that each grid included only a single sampling station (DFO 2012). This protocol resulted in an entirely new set of sampling stations. The revised survey sampling design in 2012 is presented in Wade et al. (2014).

Following the 2012 protocol, the survey area was partitioned into a new set of square grids and sampling stations. In 2013, the number of stations increased from 325 to 355 following recommendations from the snow crab advisory committee to increase the precision of the biomass estimates in smaller fishing zones. Since 2013, the number of sampling stations has remained at 355 and the sampling locations within each grid have been fixed from year to year, with exception to adjustments for untrawlable areas.

SURVEY PROTOCOL

The 2019 survey protocol (sampling grid setting, target number of stations, and their locations) was similar to the years 2013 to 2018 (DFO 2012; Hébert et al. 2020). The survey spatial sampling design is based on a survey area partitioned into 355 square grids of 12.7 km x 12.7 km (Figure 1). In each grid identified for sampling, a primary station (P) and three alternate stations (A1 to A3) are defined; the alternate stations are defined in case the primary station cannot be trawled and are randomly chosen prior to the survey. If the trawl net becomes damaged while fishing and the station is considered unsuccessful by the onboard chief scientist, a tow at the first alternate sampling station (A1) within the same grid is conducted. If the tow is considered unsuccessful at the first alternate station (A1), another tow is conducted at the second alternate station (A2), and up to the third alternate station (A3). If the primary (P) and the three alternate stations (A1 to A3) within a given grid are considered unsuccessful, the grid is abandoned, and no further tows are undertaken in this grid. Unsuccessful tows are defined as nets with significant tears and damage.

In 2018, 31 grids were successfully sampled at alternate stations. These stations were used as primary stations for the 2019 survey (Allain et al. 2020). For the abandoned grid GP150 in 2018, one primary and three alternate stations were randomly generated.

Trawling was completed during civil twilight time (civil twilight begins prior to sunrise when the geometric center of the sun reaches 6° below the horizon and ends when the geometric center of the sun reaches 6° below the horizon after sunset, Figure 2). There is enough light from the sun during this period that artificial sources of light are not needed to complete outdoor activities such as snow crab measurements. This usually occurs approximately 30 minutes earlier and later than sunrise and sunset, respectively. Standard tows were made using a *Nephrops* trawl at a speed of two knots with a target duration of five minutes.

In the event of adverse weather conditions (winds above 20 to 25 knots) or unsafe working conditions, the sampling protocol calls for the survey to be postponed.

COMPARATIVE SURVEY

Since 2013, the trawl survey contract has been issued to the FV Jean Mathieu and the 2018 season was the last year of the contract (Table 1). In 2019, following a tender process, a three-year contract was issued to a new vessel, the FV Avalon Voyager II.

From September 19th to September 25th, 2019, a side-by-side comparative fishing experiment was performed at the final 40 stations of the 2019 snow crab survey, off the coast of western Cape-Breton (Figure 3). Both vessels used the standard fishing gear and applied the regular survey protocol. Comparative trawl stations were selected owing to survey timing, budget considerations, spatial contiguity and suitability of the sea bottom to trawling.

TRAWL MONITORING DATA

After the survey, snow crab catches are standardized by the swept area of the trawl, i.e. the area covered by the trawl between the time it first touches the bottom (touchdown time) and the time when active trawling stops, i.e. the engine throttle is cut and hauling of the net begins. The width of the trawl, as well as the height of the headline opening and trawl depth, is measured by a set of hydro acoustic sensors (eSonar®) at a rate of once per ~7s (for layout, see Figure 4). Floats are attached to counteract the negative buoyancy of the sensors and to avoid distortion of the headline. The swept area estimation method is described in Moriyasu et al. (2008).

In 2019, an additional backward facing acoustic receiver was attached to the underside of the vessel to boost signal strength. The addition of this acoustic receiver reduced the number of tows for which an average swept area had to be calculated (determined by the mean swept area of the ten nearest tows with valid swept area estimates) from 53 in 2018 to 32 in 2019. By their nature, acoustic data are noisy and the rate and quality of valid observations vary by bottom type, depth and terrain.

Star-Oddi© probes

Environmental variables during trawling have been obtained using two Star-Oddi © probes since 2014. Vemco ® Minilogs, used since the mid-1990s, failed after the first 42 survey tows and were therefore not used in the 2019 analysis and have been discontinued. The Star-Oddi © TD (temperature/depth) probe was attached to the headline while the TDT (temperature/depth/tilt) was placed within a steel pivoting casing and attached directly onto the footrope of the trawl (Figure 4). The TDT determines the tilt angle of the probe which provides a good estimate of trawl touchdown times. The sampling rate of these probes was set to one per second and data recorded was only recovered after the trawl is hauled on deck.

OTHER ENVIRONMENTAL DATA COLLECTED

A vertical profile of the water column was made using a CTD (SeaBird 19 plus®) to obtain information regarding water temperature, conductivity (salinity), pressure (depth) and pH. In 2019, vertical water profiles were not obtained at the last 15 stations as the CTD cable broke while conducting a profile and the CTD was not able to be recovered, even after numerous grappling trials.

BIOLOGICAL DATA COLLECTED

Catches for each successful tow are photographed for reference purposes and to produce an image map of the sGSL. Species identifications (Landry et al. 2014; Moriyasu et al. 2015) were established for the snow crab survey in the sGSL based on Scott and Scott (1988), Pohle (1990), Squires (1990), Brunel et al. (1998), Nozères et al. (2010) and using an unpublished species identification guide developed for the Scotian Shelf snow crab survey. Although species

identification other than snow crab were recorded since the first year of the survey, the protocol and effort put on other species have not been consistent over the years. In 2006, a more thorough collection of information on the count per species began and since 2010, size measurements of sub-sampled (maximum of 100 individuals per station) fish species from 100 randomly selected stations was conducted. All other catches were sorted by species or group of higher taxa, counted, weighed and returned to the sea.

For every snow crab captured, detailed measurements included carapace width (CW), carapace conditions (categories 1-5: see Hébert et al. 2016a), missing legs, and presence of diseases (i.e. chitinoclastic disease “cigarette burn”, bitter crab disease (BCD)) and morphological abnormalities (such as malformation of carapace and appendages). For males larger than 40 mm CW, chela (claw) height was also recorded.

Gonad color was recorded for immature females with carapace width larger than ~15mm. All females smaller than 15mm were considered to have non-developing gonads (white in color). For females bearing eggs, egg color was visually assessed (Moriyasu and Lanteigne, 1998).A colorimeter (Konica-Minolta CR-400 Chroma Meter) was used to validate the visual assessments of carapace condition and egg colour. For the carapace condition assessments, a sub-sample of 1,415 male snow crabs larger than 90 mm CW was measured. Similarly, the colorimeter was used to characterize egg color determination of a random sub-sample (356) of ovigerous females. The egg masses from these females were collected and preserved in formalin for fecundity and embryonic analysis in the laboratory.

SURVEY RESULTS

SURVEY ACTIVITIES

Historical information of the survey timing and duration is summarized in Figure 5. The comparison of monthly patterns of the progress of the surveys from the last four years (2016 to 2019) is presented in Figure 6. Similar to previous years and to benefit from better weather conditions, trawling began in the most northern parts of the survey (Areas 12E and 12F). Furthermore, as in previous years, trawling in Area 19 was completed in September, during the last trip of the survey. As much as similar survey schedules are planned every year, the actual itineraries are often modified due to weather conditions, vessel maintenance or equipment damage such as ripped trawl nets needing to be repaired.

Personnel and Duties

Captain Ghislain Bourgeois took command on FV Avalon Voyager II for the 2019 survey and was in charge of net repairs. Five other crew members during the 2019 survey included Tommy Turbide (net repairs master, left door setting), Denis Bédard (winch operator, cook, net repairs), Denis Poirier (engineer, CTD casting, net repairs, right door setting), Denis Cormier (net repairs, helper in by-catch species measurements) and Paul-André Arseneau (net repairs, helper in by-catch species measurements).

Four employees from DFO Science (Marcel Hébert and Jean-Francois Landry (by-catch species identification and measurement, tow monitoring and recording), Murray McWilliams (snow crab measurements and data recording) and Yves Larocque (snow crab measurements and data recording) participated in the 2019 survey; as such, there were always at least three DFO Science employees on board at any given time throughout the survey period.

For the comparative survey, crew members on the FV Jean Mathieu included Denis Éloquin (captain), Tommy Turbide, Paul-André Arseneau, Lucien Doyle (engineer/cook) and Jean-Marc

Arseneau (net repair) while DFO employees included Marcel Hébert, Mikio Moriyasu (snow crab measurements and data recording, Tobie Surette (snow crab measurements and data recording) and Yves Larocque. Crew members on the FV Avalon Voyager II included Ghislain Bourgeois (captain), Denis Bédard, Denis Cormier, Denis Poirier and Jacky Arseneau (helper in by-catch species measurements) while DFO employees included Jean-Francois Landry, Murray McWilliam et Renée Allain (snow crab measurements and data recording). Since the vessels' manoeuvrability and gear operations may be dependent on the captain's handling and preferences, the captains switched vessels after 25 stations to compare catch results. Other crew members and DFO employees remained on their original vessel.

Survey Itinerary

The 2019 survey began on July 12th and ended on September 25th, over a total of 76 days (46 days at sea). The starting date was seven days earlier and two days later than 2018 and 2017, respectively and the survey was completed nine and three days later than the 2018 and 2017 surveys, respectively (Allain et al. 2020). It took six trips in 2019, compared to five trips in 2018 and seven trips in 2017, to complete the survey with each total trip duration varying from six to ten days with the number of successful stations sampled varying from 38 (trip 5) to 75 (trip 2) (Table 2). The start of the first and last tows of any given day began after morning civil twilight and before evening twilight time, respectively (Figure 2). Additional trip details are presented in Appendix 1.

In 2019, serious net damage which required repairs at the wharf occurred 13 times, compared to 11 and 13 times in 2018 and 2017, respectively. Four of the seven nets were deemed to be unrepairable during the season, compared to one in 2018 and three in 2017. Historical information of the surveys timing and duration is summarized in Figure 5.

CHARACTERISTICS OF TOWS IN 2019

Descriptive information of tows for various periods are presented in Tables 3 and 4, and Figure 7. Details of each 2019 tow (date, fishing area, tow number, position, swept area estimation, depth, temperature, and station type (whether the station is primary or alternate) with snow crab catches are summarized in Appendix 2.

In 2019, a total of 419 tows were attempted from which 352 were considered successful and 67 were considered unsuccessful (Table 2). The breakdown of tows by station type was: 319 tows were completed at the primary station, 15 tows were completed at the first alternate station, 15 tows were completed at the second alternate station, 3 tows were completed at the third and fourth alternate stations and three grids were abandoned (Tables 2 and 4). Grids GP43, GP47 and GP225 were abandoned after four trawling attempts: one at the primary station and the others at the three alternate stations. Unsuccessful tows consisted of 37 tows at the primary station, 21 tows at the first alternate station, six tows at the second alternate station and three tows at the third alternate station. The percentage of unsuccessful tows for 2019 (16 %) is slightly higher than previous years. The unsuccessful tows for 2019 were mostly located between the Magdalen Islands and Prince Edward Island, around and south of Miscou bank, the American bank and south of the Laurentian Channel (Figure 7).

The distribution of 2019 stations among Areas 12, 12E, 12F and 19 was 299, 12, 17 and 24, respectively (Figure 7). The chosen orientation of a given tow depends on the current and/or wind direction. There were two cases in 2019 where the trawl track fell into neighboring grids (Figure 7). Such stations are reassigned to their proper grids the following year.

The mean swept area over all successful tows in 2019 was 2,738 m^2, corresponding to an average tow length of 331.2 m and an average wing spread of 8.27 m. These values were very

similar to those of past years (Table 3). It should be noted that in 2019, the distance covered by the trawl after the standard 5-minute trawling period was greater than previous years; however, this distance is currently unaccounted for when calculating swept areas (Surette unpublished results).

The depth of the trawl stations in 2019 (measured with the vessel's depth sounder) varied from 32.9 m to 384.0 m which is consistent with recent years of the survey (Appendix 2). The 2019 bottom temperatures at each station varied from -0.2 to 7.0ºC with an average of 1.51ºC.

The spatial and depth distributions of bottom temperatures for 2018 and 2019, as measured by the Star-Oddi© headline probe are shown in Figure 8. These show the typical stratification pattern of the southern Gulf during the summer and fall season, with high coastal temperatures in shallower waters less than 40-meter depth, the cold intermediary layer from 40 to 150-meters and the relatively warmer waters in deeper waters along the edge of the Laurentian Channel. Significantly warmer temperatures were observed in the most eastern part of the 2019 survey (especially between PEI and Cape Breton). These warmer temperatures were likely a result of the significant mixing of the water column due to hurricane Dorian.

CATCHES

It should be noted that the following information on catches (snow crab and by-catch species) are unstandardized and not directly comparable between years. In addition, catches were inflated in 2019 due to a slower winch operation onboard the FV Avalon Voyager II. This caused the trawl net to continue fishing on the sea bottom after active trawling was expected to have ended (Surette unpublished results).

SNOW CRAB

The details of catches commercial sized (>= 95 mm CW) male snow crab of all carapace conditions, and the residual component of the commercial sized male crab (carapace conditions 3 to 5) in numbers and weight by tow in 2019 are summarized in Appendix 2.

Snow crabs were captured at 328 of 352 stations sampled in 2019 (Figure 9) and the total catch was 46,328 individuals, sex and sizes combined (Table 5). No snow crab were captured at 24 grids in 2019. The geographic distribution of grids with no snow crab were similar to those of 2016 to 2018, occurring mainly along the Laurentian Channel, south of the Magdalen Islands and around the northeastern tip of Prince Edward Island (Figure 9).

The historical data in the mean number per tow of all male snow crab caught (sizes and maturity confounded) during the surveys are shown in Table 5 and Figure 10. The mean number per tow of male snow crab has fluctuated throughout the time series with peak and low values in 1999 and in 2009 at 70.2 and 33.7 male snow crabs per tow, respectively. Of all the male snow crabs caught in 2019, 74.4% were immature or adolescent (Hébert et al. 2018 for terminology), compared with 70.4% in 2018 and 70.7% in 2017 (Figure 10).

The total number of commercial-sized male snow crab captured was highest in 2004 at 3,321 individuals and was at its lowest level of 900 individuals in 2009 (Table 6). The number of individuals slightly decreased in 2019 compared to the previous year from 2,441 to 2,419 (Table 6). Since 1997, the peak catch of commercial-sized adult male snow crab per tow was in 2004, at approximately ten crabs per tow. The mean individual size and weight of commercial-sized adult males was 109.2 mm and 556 g in 2018 and 105.9 mm and 547 g in 2019, respectively (Table 6). The estimated densities (number per km²) for 2019 were 2,538 crabs per km².

The mean number of females per tow has also fluctuated since 1997 (Table 7; Figure 11) with a peak in 1999 of 62.4 females per tow, and a low of 25.5 females per tow in 2006. The mean number of females per tow was 60.2 in 2019 and 42.8 in 2018.

BY-CATCH SPECIES

A total of 53 fish species/groups and 31 invertebrate species/groups were recorded during 2019, similar to previous years (Appendix 3a and 3b, Hébert et al. 2016b). The majority of the invertebrates were not identified to the species level but rather gathered into common name groups. The spatial distribution of the most common fish, invertebrate and crab species/groups by weight are shown in Figures 12 and 13 for the 2019 survey. The catches for these species are not corrected for their catchability with respect to the *Nephrops* trawl. Therefore, the information on other by-catch species should be interpreted with caution.

Fish (Figure 12**)**

- **American Plaice** (*Hippoglossoides platessoides*) has the same wide distribution throughout the sGSL as snow crab, with densities tapering off in shallower coastal areas and in deeper waters along the Laurentian Channel. Catch numbers increased from 34,905 and 32,883 in 2017 and 2018, respectively, to 42,678 in 2019 while catch weights remained similar at around 2,500 kg.
- **Redfish** caught in the survey is composed of two closely related species which cannot be easily identified, the Deepwater Redfish (*Sebastes mentella*) and the Acadian Redfish (*S. fasciatus*). The spatial distribution of combined species shows that they are concentrated along the Laurentian Channel as well as deep water channels off the eastern Gaspé Peninsula. Total catch has drastically increased from around 7,000 in 2017 to 19,904 in 2018 but decreased in 2019 to around 11,000. Catch weights mirror this trend. Due to the schooling behaviour of these fish, large individual catches are not uncommon leading to variability when comparing catches.
- **Atlantic Cod** (*Gadus morhua*) has a wide but sparse distribution throughout the sGSL during the snow crab survey with the majority of catches to be found in and around the American and Orphan Banks off the Gaspé Peninsula. Total catch numbers more than doubled in 2019 compared to 2017 and 2018; however, total catch weights decreased in the last three years from 838 kg and 577 kg in 2017 and 2018, respectively, to 521 kg in 2019.
- **Witch Flounder** (*Glyptocephalus cynoglossus*) are found in deeper waters in the Troughs off western Cape Breton, all along the Laurentian Channel, and the highest concentrations were in and around the American and Orphan Banks. Catch totals were 730, 872 and 987 in 2017 to 2019 and catch weights were between 208 kg and 268 kg for the last three years.
- **Thorny Skate (***Amblyraja radiata*) had a very similar distribution to Witch Flounder except it was found in slightly deeper waters. Total catches increased from around 550 in 2017 and 2018 to 713 in 2019 but total weights were comparable in the past three years at about 200 kg per year.
- **Yellowtail Flounder** (*Limanda ferruginea*) are mainly distributed in the southernmost part of the Gulf around Prince Edward Island and southeast of the Magdalen Islands. Catches in the past three years are increasing and have gone from 1,477 to 2,308 to 2,840 fish. Catch weights mirror this trend (96 kg, 124 kg and 159 kg for 2017, 2018 and 2019, respectively).
- **White Hake** (*Urophycis tenuis*) total catches decreased from 333 in 2017 and 2018 to 273 fish in 2019. Total weights also showed a decrease from around 140 kg in 2017 and 2018

to 111 kg in 2019. These fish are mainly distributed along the length of the Laurentian Channel and the Cape Breton Troughs.

- **Atlantic Halibut** (*Hippoglossus hippoglossus*) are only caught sporadically by the snow crab survey and total catches have fluctuated in the past three years with 19, 6 and 13 fish caught from 2017 to 2019. Total catch weights for the same period have fluctuated from 55 kg (2017) to 20 kg (2018) and to 229 kg (2019) . In 2019, they were mainly caught along the northern part of the Laurentian Channel, west of Bradelle Bank and in the Cape Breton Strait.

Invertebrates (Figure 13)

- **Basket stars** (*Gorgonocephalus eucnemis*) are found throughout the gulf with main concentrations along the shallower edge of the Laurentian Channel. Total catches were similar in 2017 and 2018 at around 3,000 but increased in 2019 at close to 4,000. Totals weights mirror this trend at around 660 kg in 2017 and 2018 and up to 991 kg in 2019.
- **Green sea urchins** (*Strongylocentrotus droebachiensis*) are widely distributed in the sGSL with main concentrations over hard sea bottoms in the Bradelle Bank and around the Magdalen Islands. Total catches significantly increased from 19,877 kg and 14,366 kg in 2017 and 2018, respectively to 23,852 in 2019. Total catch weights also mirror this trend at 754 kg and 565 kg in 2017 and 2018, respectively, and up at 913 kg in 2019.
- **Brittle stars** (Ophiuroidea) were mostly caught around St. George's Bay and in Bay des Chaleurs. Individual counts are challenging as they tend to break in pieces in the trawl, however, total weights have fluctuated in the past three years from 122 kg to 708 kg to 362 kg in 2017, 2018 and 2019, respectively.
- **Starfish** refer to many species in Class Asteroidea, including the polar seastar (*Leptasterias polaris*), horse stars (*Hippasteria phrygiana*), mudstars (*Ctenodiscus crispatus*), spiny sunstars (*Crossaster papposus*), purple sunstars (*Solaster endeca*), blood sea star (*Henricia sanguinolenta*) and in rarer proportions the winged seastar (*Pteraster militaris*), the cookie star (*Ceramaster granularis*) and *Pseudoarchaster parelii*. Grouped together as they are, these species space the whole range of habitats and depths in the sGSL. Total catches have decreased in the last three years from 11,782 in 2017 to 7,408 in 2018 to 6,808 in 2019.
- **Sea cucumbers** contain at least three species, dominated by the orange-footed sea cucumber (*Cucumaria frondosa*) which comprise of vast majority of catches, the Scarlet psolus (*Psolus fabricii*) and the Brown psolus (*Psolus phantapus*). The distribution of *Cucumaria frondosa* is mainly to the south of the Magdalen Islands and annual catches in the last three years were around 585. Total catch weights ranged between 239 kg to 293 kg for 2017-2019.
- **Sea squirts** are primarily comprised of sea potatoes (*Boltenia ovifera*) and a few scattered individual sea peaches (*Halocynthia pyriformis*) and a few *Ascidia* sp. These are found to the north and especially the south of Magdalen Islands, as well as the eastern Gaspé Peninsula and the Bradelle Bank. Total counts were around 2,600 and total catch weights were 285 kg, 247 kg and 274 kg in the past three years.
- **Lesser toad crab** (*Hyas coarctatus*) are generally found in shallower depths than snow crab, all around the Magdalen Islands and northern PEI. They are generally not found in the Cape Breton Trough. They are often found along with their sister species the Greater toad crab (*H. araneus*) as their habitat ranges overlap considerably, though *H. coarctatus* is generally smaller sized. Catch numbers slightly increased from 1,649 and 1,498 in 2017 and

2018, respectively to 2,207 in 2019. Total catch weights also show a similar trend with 120 kg, 98 kg and 147 kg in 2017, 2018 and 2019, respectively.

- **Greater toad crab** (*H. araneus*) favour shallower depths than *H. coarctatus* and are concentrated around the Magdalen Islands and the northern edge of PEI. They are generally not found in the Cape Breton Trough. Catch numbers were fairly stable with 726, 732 and 842 crabs and weights were 95, 95 and 113 kg in 2017-2019 respectively.

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TABLES

Table 1. Annual summary of vessel and equipment characteristics during the snow crab survey. Columns are the survey year, survey start month and day, survey end month and day, vessel name, length, horsepower, hull material, trawling method, acoustic sensor type and use of Minilog and Star-Oddi © sensors. Note: Catchability comparisons were not performed during transition years (when a change in vessel occurred).

Year	Start month	Start day	End month	End day	Vessel	Length (feet)	Horsepower	Hull Material	Trawl Method	Acoustic Sensor	Minilog	Star-Oddi
1997	7	9	9	11	Emy Serge D.	64	375	wood	side	Scanmar	yes	no
1998	7	7	9	14	Emy Serge D.	64	375	wood	side	Scanmar	yes	no
1999	7	9	9	10	Den C. Martin	64	402	steel	stern	Netmind	yes	no
2000	8	1	9	21	Den C. Martin	64	402	steel	stern	Netmind	yes	no
2001	8	9	10	2	Den C. Martin	64	402	steel	stern	Netmind	yes	no
2002	7	8	9	19	Den C. Martin	64	402	steel	stern	Netmind	yes	no
2003	7	15	10	7	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2004	7	14	10	1	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2005	7	13	9	20	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2006	8	2	10	18	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2007	7	10	9	22	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2008	7	16	9	25	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2009	7	16	9	27	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2010	7	8	9	14	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2011	7	13	10	4	Marco-Michel	65	660	fiberglass	stern	Netmind	yes	no
2012	7	10	9	23	Marco-Michel	65	660	fiberglass	stern	Netmind/eSonar	yes	no
2013	7	9	10	14	Jean Mathieu	65	720	steel	stern	eSonar	yes	no
2014	7	9	10	12	Jean Mathieu	65	720	steel	stern	eSonar	yes	yes
2015	7	9	10	15	Jean Mathieu	65	720	steel	stern	eSonar	yes	yes
2016	7	10	10	4	Jean Mathieu	65	720	steel	stern	eSonar	yes	yes
2017	7	10	9	22	Jean Mathieu	65	720	steel	stern	eSonar	yes	yes
2018	7	19	9	16	Jean Mathieu	65	720	steel	stern	eSonar	yes	yes
2019	7	12	9	25	Avalon Voyager II	64	850	fiberglass	stern	eSonar	no	yes

Table 2. The 2019 survey performance statistics (duration of each trip, number of days at sea, number of attempted tows, number of successful tows at the primary station and alternate stations, number of unsuccessful tows, number of untrawlable grids and frequency of serious net damage).

	Trip number						
Statistics	1	2	3	4	5	6	Total
Duration (day) of each trip	8	10	10	8	6	9	48
Number of days at sea	7	9	10	8	6	7	41
Number of attempted tows	73	100	87	73	45	41	419
Tows completed at primary station	63	63	62	56	36	39	319
Tows completed at 1st alternate station	1	4	4	4	1	1	15
Tows completed at 2nd alternate station	1	7	3	3	1	0	15
Tows completed at 3rd alternate station	1	1	1	0	0	0	3
Number of unsuccessful tows	7	25	17	10	7	1	67
Number of untrawlable grids	0	1	1	0	1	0	3
Number of tows with serious net damage	1	3	4	2	2	1	13

Table 3. Swept area statistics by survey year from 2010 to 2019. Columns are survey year, the number of tows (n) with sufficient wing spread data used to calculate the statistics, the mean tow distance, the mean and standard deviation of the trawl wing spread, the mean trawl swept area, the acoustic sonar system used and the survey vessel.

Year	n	Tow distance (m)	Mean wing spread (m)	Standard error wing spread (m)	Mean swept area (m²)	Sonar system	Survey vessel
2010	315	-	8.40	1.78	2,736	NetMind	Marco-Michel
2011	289	-	8.45	2.44	2,711	NetMind	Marco-Michel
2012	281	-	8.71	1.61	2,675	NetMind	Marco-Michel
2013	286	352.0	7.93	1.86	2,591	eSonar	Jean Mathieu
2014	335	336.1	7.91	1.47	2,665	eSonar	Jean Mathieu
2015	319	342.6	7.91	1.65	2,712	eSonar	Jean Mathieu
2016	327	355.7	7.77	1.58	2,763	eSonar	Jean Mathieu
2017	301	345.4	8.18	1.57	2,824	eSonar	Jean Mathieu
2018	301	339.0	8.16	1.65	2,766	eSonar	Jean Mathieu
2019	320	331.2	8.27	1.71	2,738	eSonar	Avalon Voyager II

Table 4. Annual summary of tow characteristics during the snow crab survey. Columns are the survey year, the total number of successful tows, the station type (primary stations, alternate stations 1, 2 or 3 (first, second and third alternate stations, respectively)) or abandoned stations, separated by the type of swept area estimation method, which was either calculated or averaged from neighbouring tows.

Year of survey	Total successful tows	Primary		Alternate station 1		Alternate station 2		Alternate station 3		Abandoned	Total tows attempted
		Calculated	Averaged	Calculated	Averaged	Calculated	Averaged	Calculated	Averaged		
1997	259	190	51	15	3	0	0	0	0	0	277
1998	261	152	95	9	3	1	1	0	0	0	277
1999	277	127	127	14	6	1	2	0	0	0	303
2000	280	232	30	10	1	6	0	0	0	0	302
2001	292	253	15	13	7	1	2	1	0	0	321
2002	319	285	13	15	4	1	1	0	0	0	342
2003	317	283	10	13	1	6	1	3	0	0	354
2004	333	271	46	4	5	6	0	1	0	0	357
2005	344	290	11	32	3	8	0	0	0	0	395
2006	354	294	34	17	1	8	0	0	0	1	395
2007	355	294	31	13	3	12	1	1	0	0	400
2008	355	284	37	23	0	8	1	2	0	0	402
2009	355	293	39	10	0	11	1	0	0	0	388
2010	354	285	32	23	7	7	0	0	0	1	401
2011	353	274	46	24	3	3	2	1	0	2	401
2012	321	220	50	36	5	7	1	2	0	4	400
2013	352	230	52	45	13	10	1	1	0	3	447
2014	353	295	17	36	0	2	1	2	0	2	409
2015	353	275	28	36	3	9	1	1	0	2	423
2016	354	292	27	27	0	6	0	2	0	1	409
2017	353	275	49	18	3	6	0	2	0	2	402
2018	354	272	50	24	2	5	1	0	0	1	395
2019	352	288	31	15	0	14	1	3	0	3	419

Table 5. Snow crab survey annual summary statistics for adolescent (including immature), adult and total male snow crab. Columns are the survey year, the total number of observed adolescent and adult male snow crab, the number of adolescent, adult and total males caught per tow, and the overall density (number standardized by trawl swept area) of males in survey catches.

	Total number			Crabs per tow			Mean density
Year	Adolescent	Adult	Total	Adolescent	Adult	Total	(number per km²)
1997	10,998	3,127	14,191	42.5	12.1	54.6	24,369
1998	12,299	3,848	16,242	47.1	14.7	61.8	26,629
1999	13,962	5,487	19,548	50.4	19.8	70.2	28,103
2000	13,027	5,248	18,377	46.5	18.7	65.2	23,820
2001	13,050	5,460	18,648	44.7	18.7	63.4	23,532
2002	10,578	5,503	16,210	33.2	17.3	50.5	20,477
2003	11,459	6,297	17,907	36.1	19.9	56.0	19,663
2004	10,420	6,645	17,238	30.0	19.1	49.1	15,474
2005	8,588	4,908	13,614	24.2	13.8	38.0	13,876
2006	7,923	4,362	12,370	22.4	12.3	34.7	12,282
2007	8,277	3,963	12,365	23.3	11.2	34.5	12,624
2008	8,705	3,498	12,299	24.5	9.9	34.4	13,020
2009	9,029	2,950	12,055	25.4	8.3	33.7	11,977
2010	12,512	3,799	16,398	35.3	10.7	46.0	16,843
2011	11,313	5,073	16,470	32.0	14.4	46.4	16,986
2012	10,020	4,775	14,917	31.2	14.9	46.1	17,081
2013	8,274	3,961	12,335	23.5	11.3	34.8	13,383
2014	9,739	4,129	14,002	27.6	11.7	39.3	15,228
2015	11,499	3,755	15,402	32.6	10.6	43.2	16,317
2016	11,431	5,453	16,991	32.3	15.4	47.7	18,167
2017	12,060	4,995	17,186	34.2	14.2	48.4	17,655
2018	12,960	5,439	18,512	36.6	15.4	52.0	19,091
2019	18,529	6,416	25,138	52.6	18.2	70.8	25,981

Table 6. Snow crab survey annual summary statistics for commercial crab (adult males with >= 95 mm carapace width). Columns are the survey year, the number of crab observed, the mean number per tow, the mean crab weight and the mean density.

Year	Number of crabs captured	Mean number per tow	Mean weight (g)	Mean density (number per km^2)
1997	1,335	5.2	600.4	2,258
1998	1,420	5.4	597.3	2,198
1999	1,472	5.3	563.9	2,106
2000	1,346	4.8	587.5	1,756
2001	1,744	6.0	540.0	2,232
2002	1,915	6.0	547.3	2,417
2003	2,682	8.5	561.1	2,957
2004	3,321	9.6	581.2	2,974
2005	2,427	6.8	592.1	2,469
2006	2,302	6.5	617.6	2,192
2007	1,911	5.4	610.6	1,958
2008	1,431	4.0	611.9	1,546
2009	900	2.5	610.5	899
2010	1,057	3.0	606.5	1,093
2011	1,970	5.6	583.5	2,035
2012	2,093	6.5	566.3	2,358
2013	1,886	5.4	596.8	1,994
2014	1,885	5.3	581.0	2,011
2015	1,741	4.9	584.0	1,784
2016	2,896	8.2	573.9	2,998
2017	2,001	5.7	555.7	2,061
2018	2,441	6.9	556.6	2,513
2019	2,419	6.9	547.8	2,538

Table 7. Snow crab survey annual summary statistics for immature, adolescent and adult female snow crab. Columns are the survey year, the total number of observed immature, adolescent, adult and total female snow crab counts, the number of immature, adolescent, adult and total females caught per tow, and the overall density (number per km²) of females in survey catches.

	Total catch (number)				Crabs per tow (number)				Mean density
Year	Immature	Adolescent	Adult	Total	Immature	Adolescent	Adult	Total	(number per km²)
1997	4,317	3,166	6,661	14,240	16.7	12.2	25.7	54.6	23,976
1998	4,886	2,290	7,755	14,933	18.7	8.8	29.7	57.2	24,486
1999	2,896	3,268	11,110	17,277	10.5	11.8	40.1	62.4	24,792
2000	1,295	2,668	11,171	15,134	4.6	9.5	39.9	54.1	19,931
2001	823	611	12,537	13,974	2.8	2.1	42.9	47.8	17,823
2002	935	542	10,905	12,387	2.9	1.7	34.2	38.8	15,246
2003	1,907	758	10,709	13,376	6.0	2.4	33.8	42.2	14,534
2004	2,294	1,088	9,583	12,966	6.6	3.1	27.6	37.3	12,129
2005	2,617	1,089	6,645	10,351	7.4	3.1	18.7	29.1	10,611
2006	3,213	1,316	4,491	9,020	9.1	3.7	12.7	25.5	9,062
2007	3,551	1,941	5,066	10,558	10.0	5.5	14.3	29.8	10,716
2008	3,174	1,883	4,975	10,032	8.9	5.3	14.0	28.2	10,649
2009	2,256	2,330	5,118	9,707	6.4	6.6	14.4	27.3	9,680
2010	4,344	1,629	7,845	13,826	12.3	4.6	22.2	39.1	14,081
2011	3,769	1,691	7,866	13,333	10.7	4.8	22.3	37.8	13,796
2012	2,865	2,388	7,486	12,740	8.9	7.4	23.3	39.7	14,688
2013	1,712	1,350	6,221	9,286	4.9	3.8	17.7	26.4	10,062
2014	2,958	998	6,682	10,639	8.4	2.8	18.9	30.1	11,404
2015	3,341	1,482	7,448	12,302	9.5	4.2	21.1	34.8	12,822
2016	3,252	2,241	7,891	13,401	9.2	6.3	22.3	37.8	14,116
2017	3,500	2,391	8,819	14,744	9.9	6.8	25.0	41.7	14,800
2018	4,418	1,921	8,802	15,172	12.5	5.4	24.9	42.8	15,133
2019	5,778	3,106	12,305	21,190	16.4	8.8	35.0	60.2	21,483

FIGURES

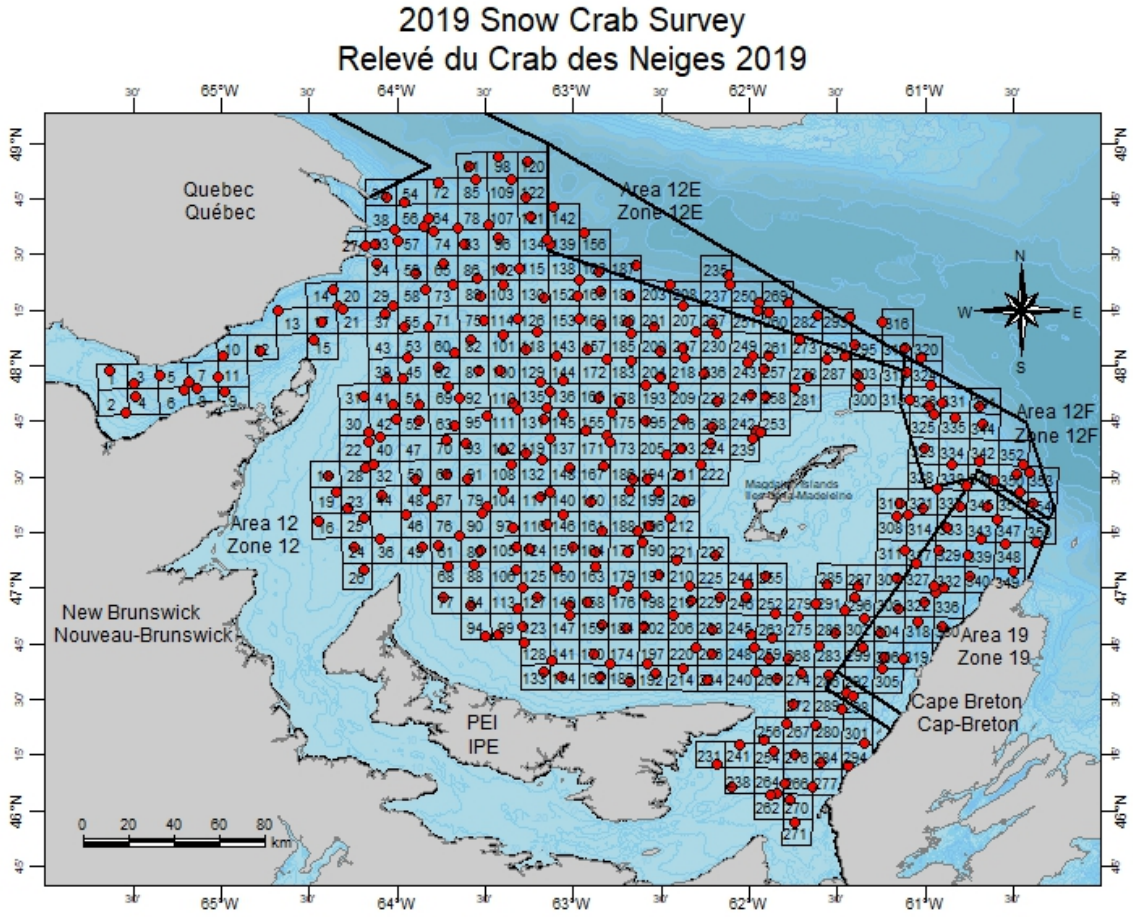

Figure 1. Snow crab trawl survey grid sampling design for the southern Gulf of St. Lawrence used since 2013. There are a total of 355 sampling grids defined by squares measuring 12.7 by 12.7 kilometers. Red dots indicate 2019 survey stations and numbers are station identifications (ID numbers).

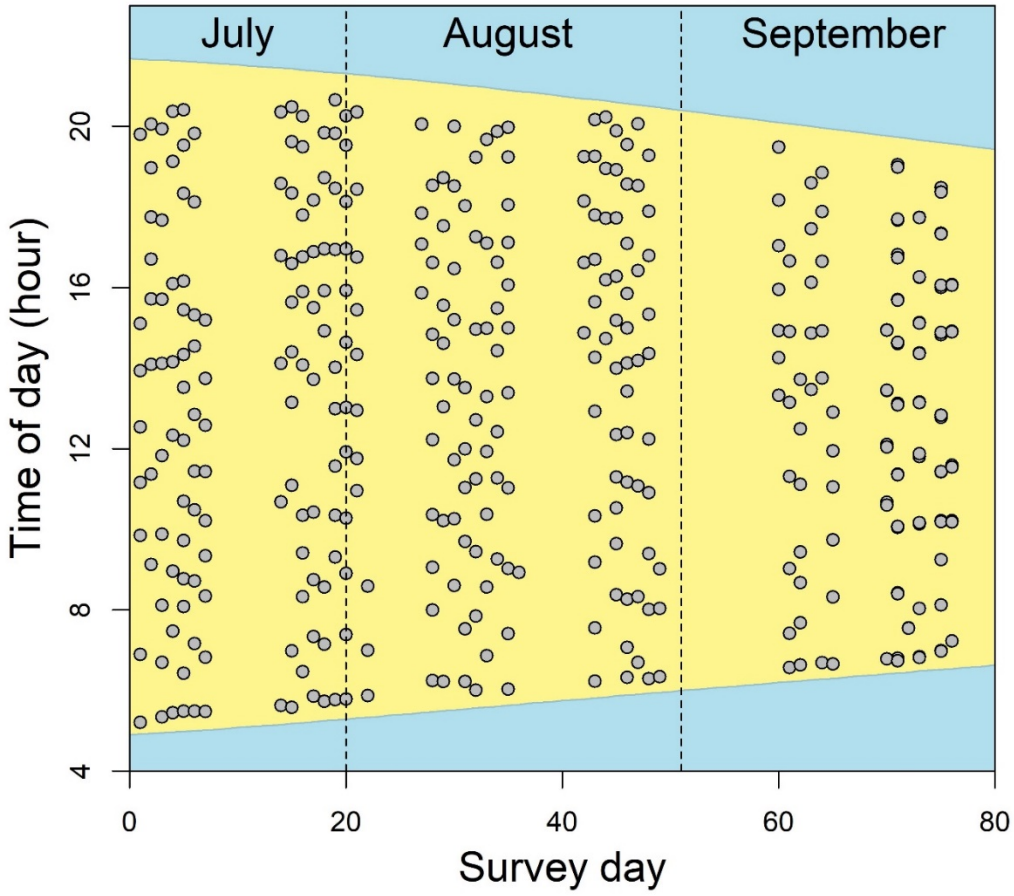

Figure 2. Daily fishing operations (grey circles) within corresponding morning and evening civil twilight (yellow area) during the 2019 trawl survey. Civil twilight times were for Charlottetown, PE (46° 39' N, 63° 13' W) based on Sunrise/sunset calculator - National Research Council Canada.

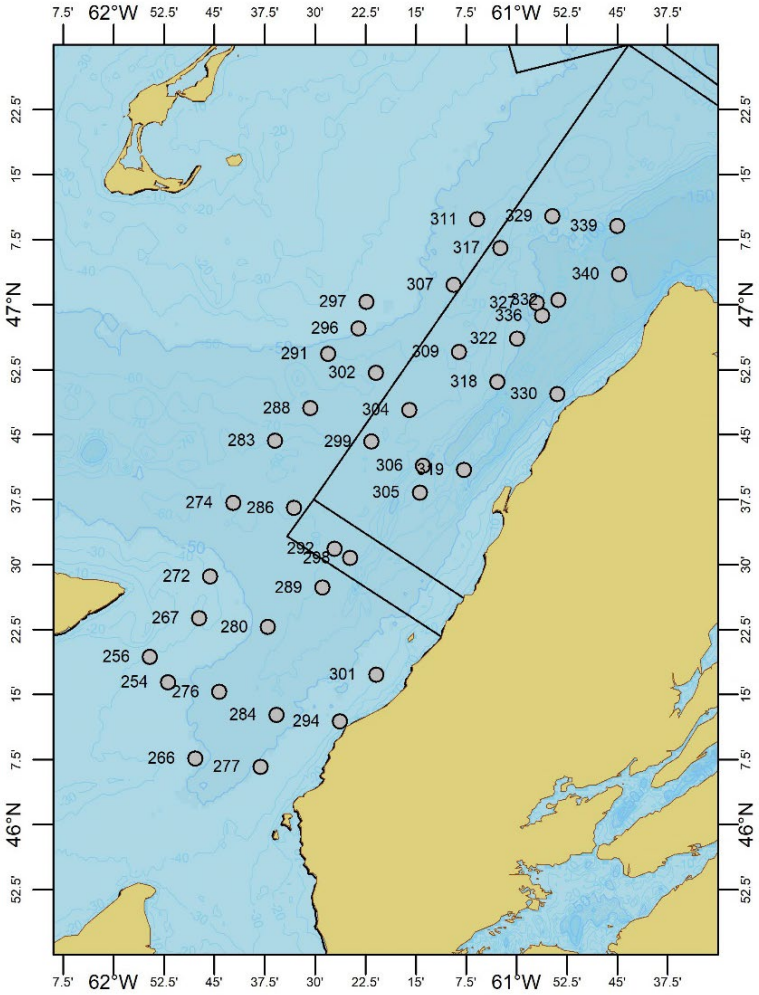

Figure 3. Comparative survey stations (n = 40) off the western coast of Cape Breton completed between September 19th and September 25th, 2019. The current FV Avalon Voyager II and previous FV Jean Mathieu survey vessels were used for this side-by-side comparative fishing survey.

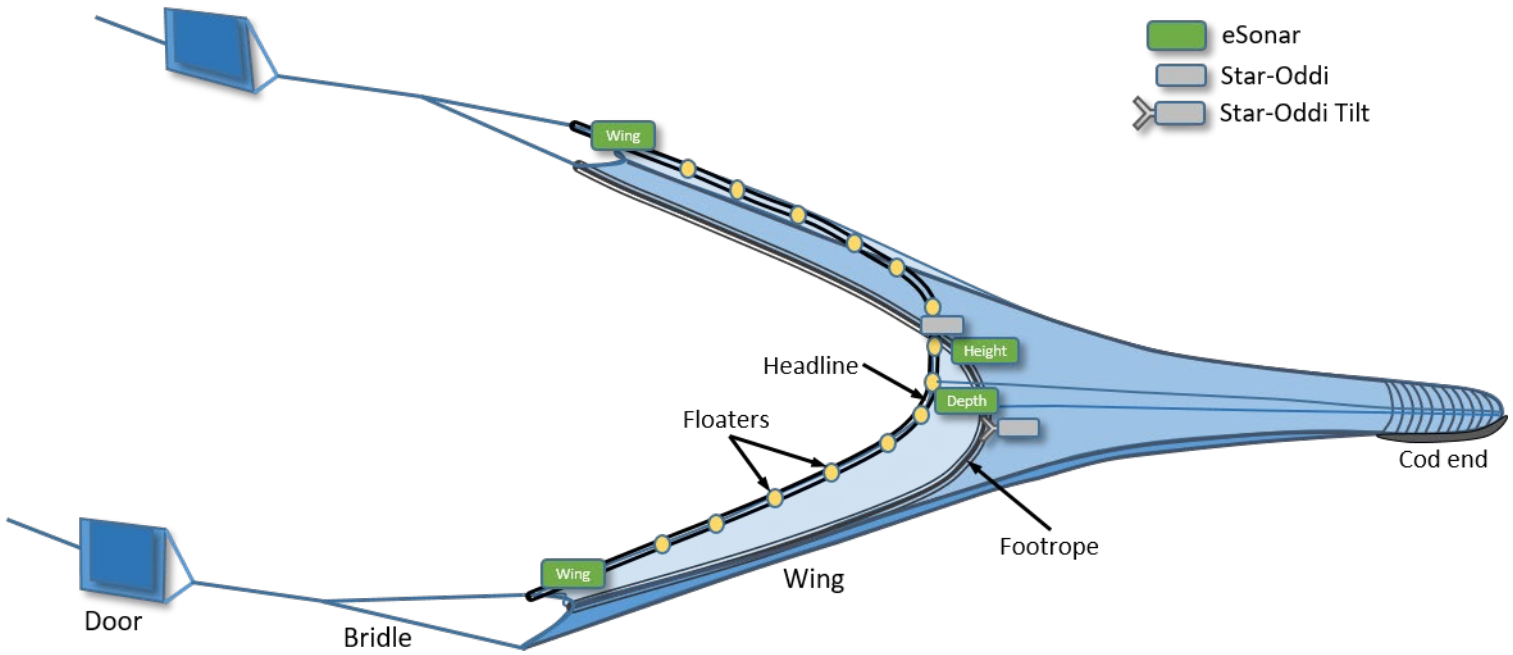

Figure 4. Schematic view of the various sensors deployed on the 2019 snow crab bottom trawl survey. eSonar net sensors (a pair of distance/wing sensors and height sensor), Star-Oddi © temperature/depth (TD) and temperature/depth/tilt (TDT) sensors.

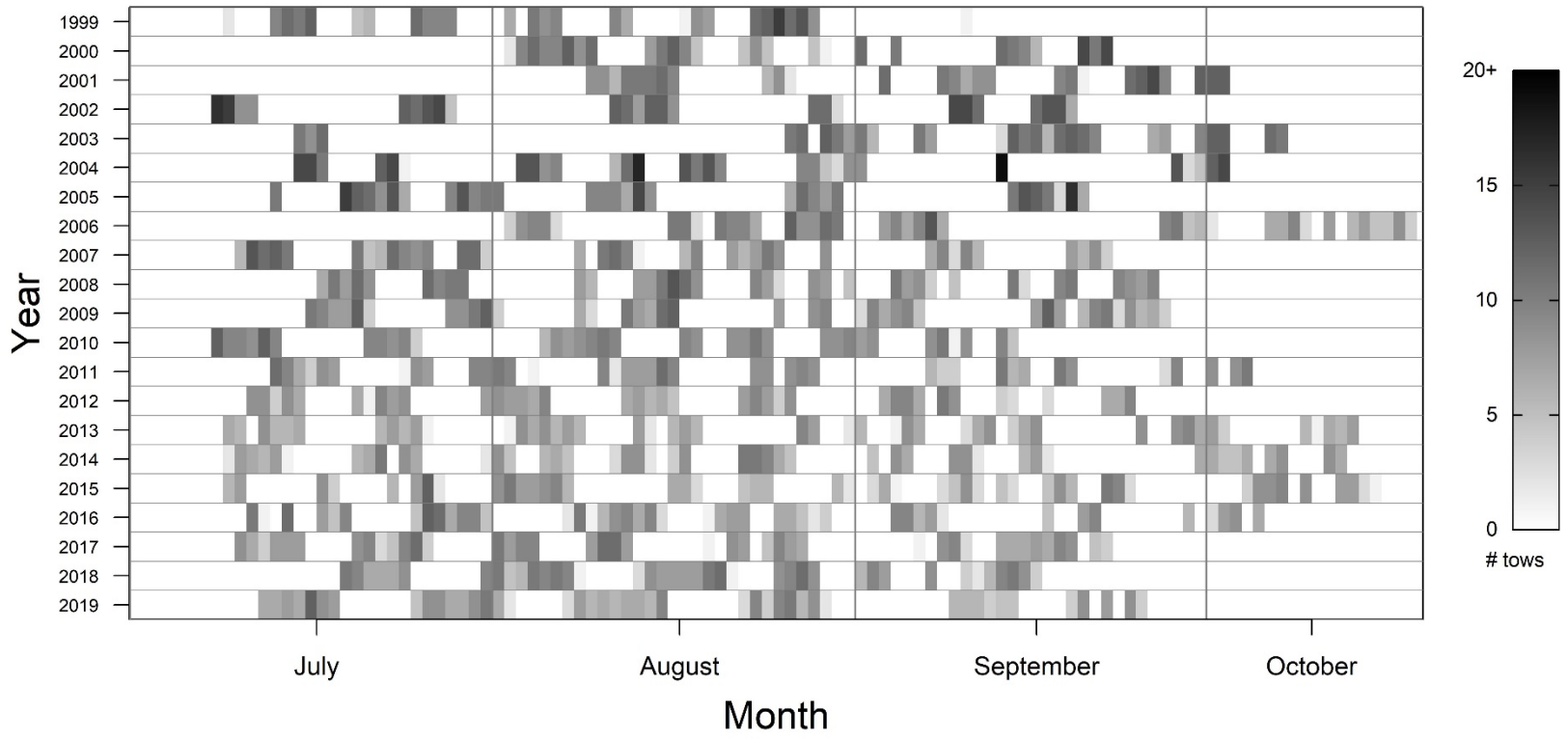

Figure 5. Timeline of daily snow crab survey activity from 1999 to 2019. Shading showing tow numbers per day varying from white (no tows) to black (21 tows per day).

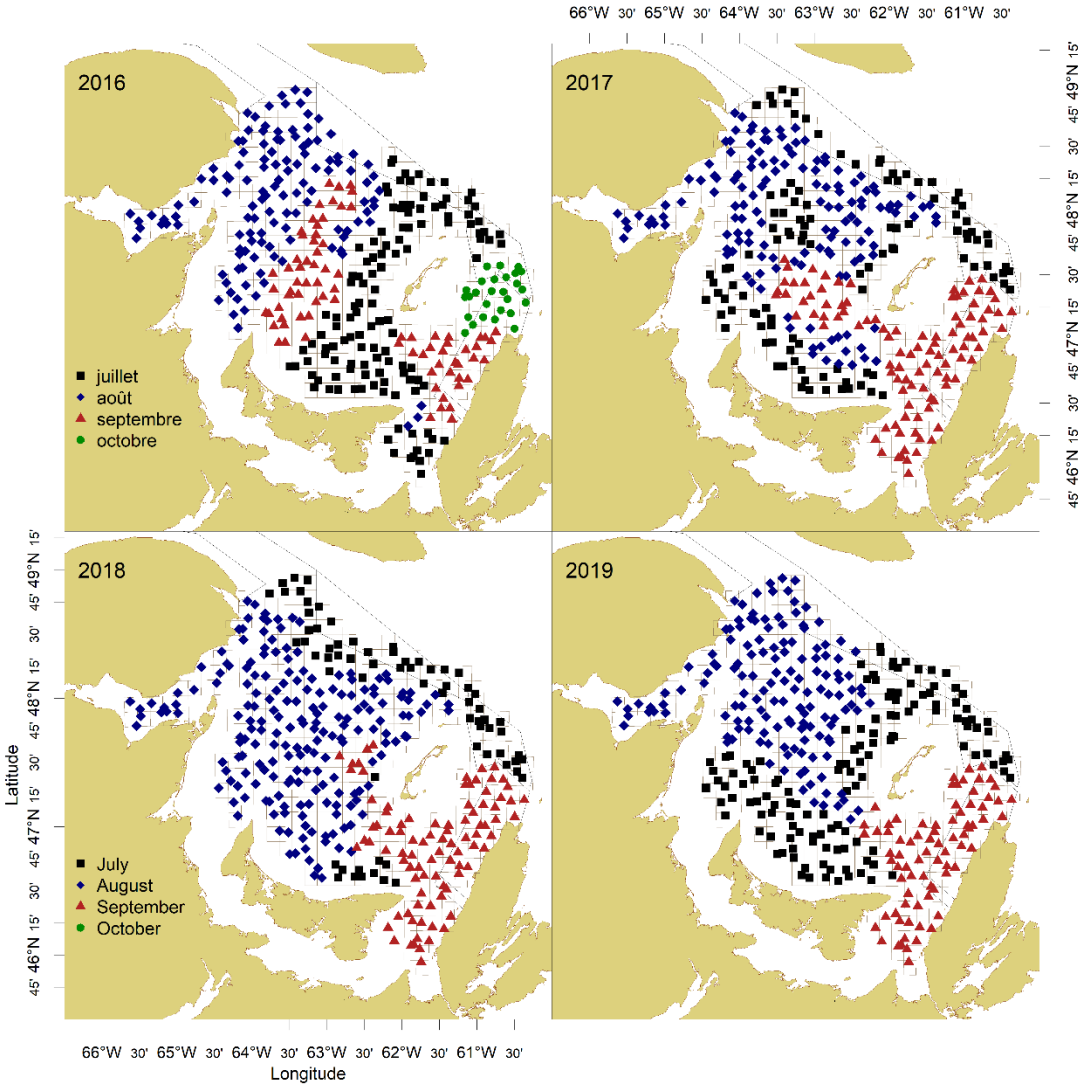

Figure 6. Monthly geographic distributions of the stations sampled by the snow crab survey (2016-2019). The survey typically takes place in the months of July (black squares), August (blue diamonds), September (red triangles), and October (green circles). Snow crab fishing areas and survey grid in grey.

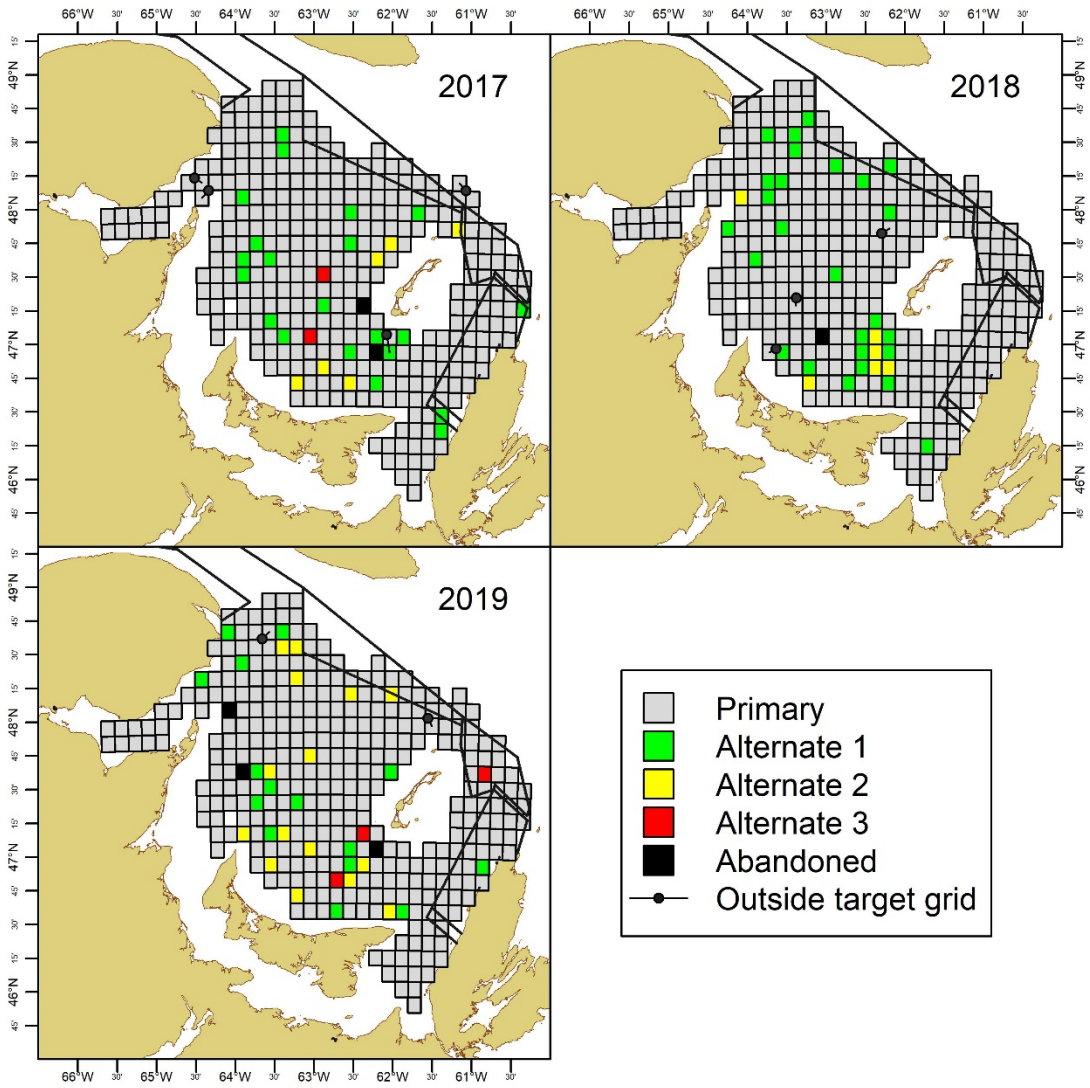

Figure 7. The type of station sampled within each grid during the 2017 to 2019 surveys. Snow crab fishing areas are outlined in black.

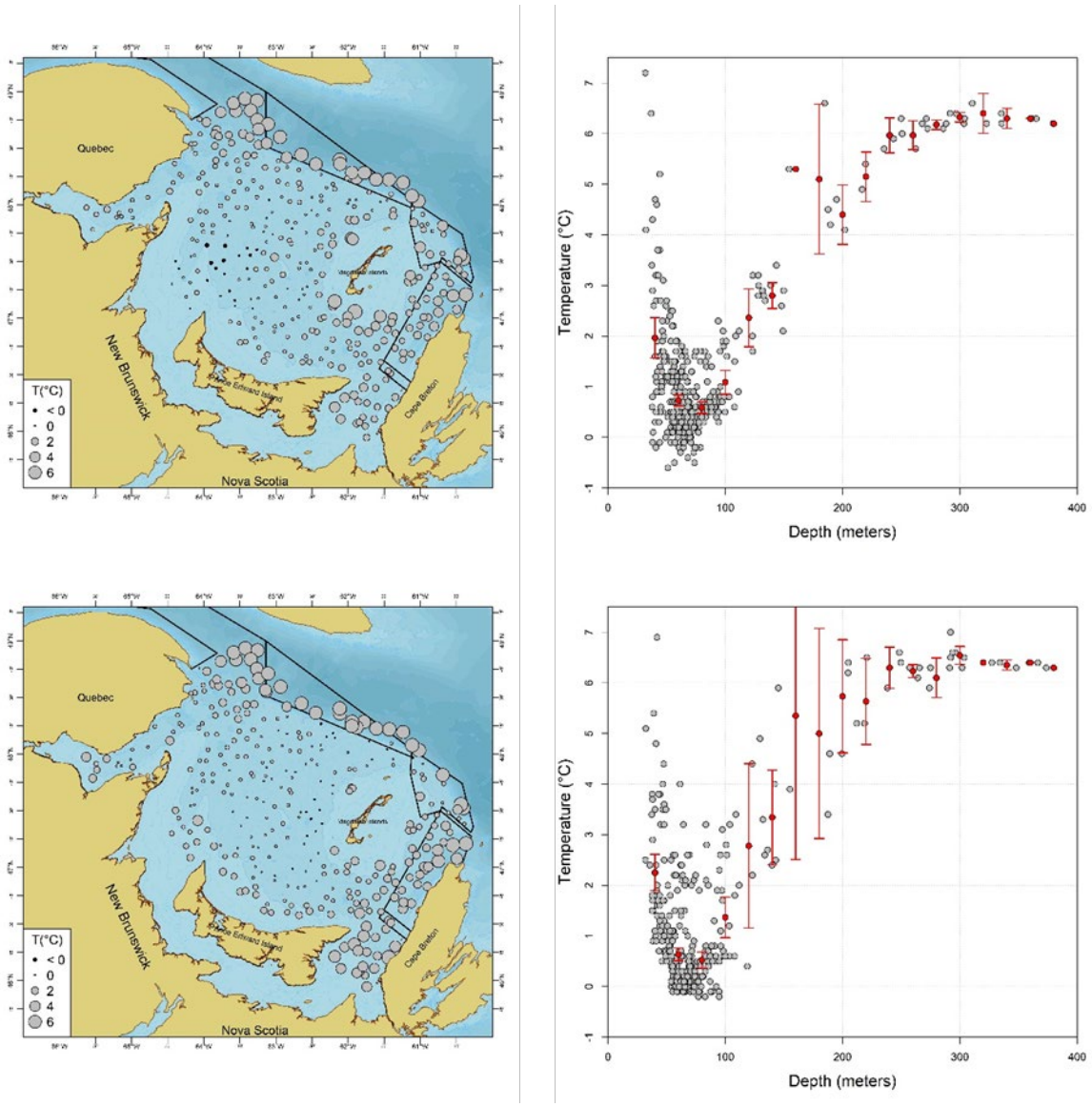

Figure 8. Geographic location of bottom temperatures as measured by Star-Oddi © temperature probes attached to the headline of the trawl (left) and scatter plot of bottom temperatures versus water depths (right) during the 2018 (top panel) and 2019 (bottom panel) bottom trawl surveys. Circle sizes in the maps are proportional to the observed temperatures. Shown in red are the mean temperatures and 95% confidence intervals by 20-meter depth bins.

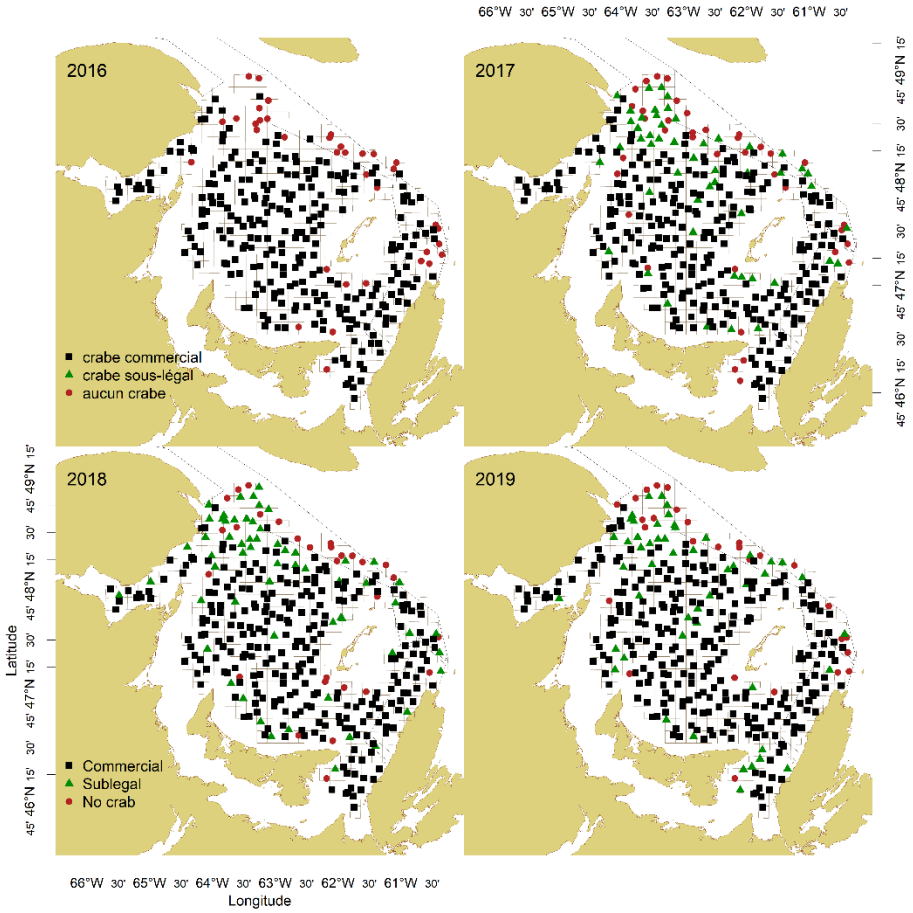

Figure 9. Snow crab survey stations, sampled in 2016-2019, where commercial-sized snow crab (black squares), sublegal snow crab only (green triangles), or no male snow crab (red circles) were captured. Snow crab fishing areas and the survey grid in grey.

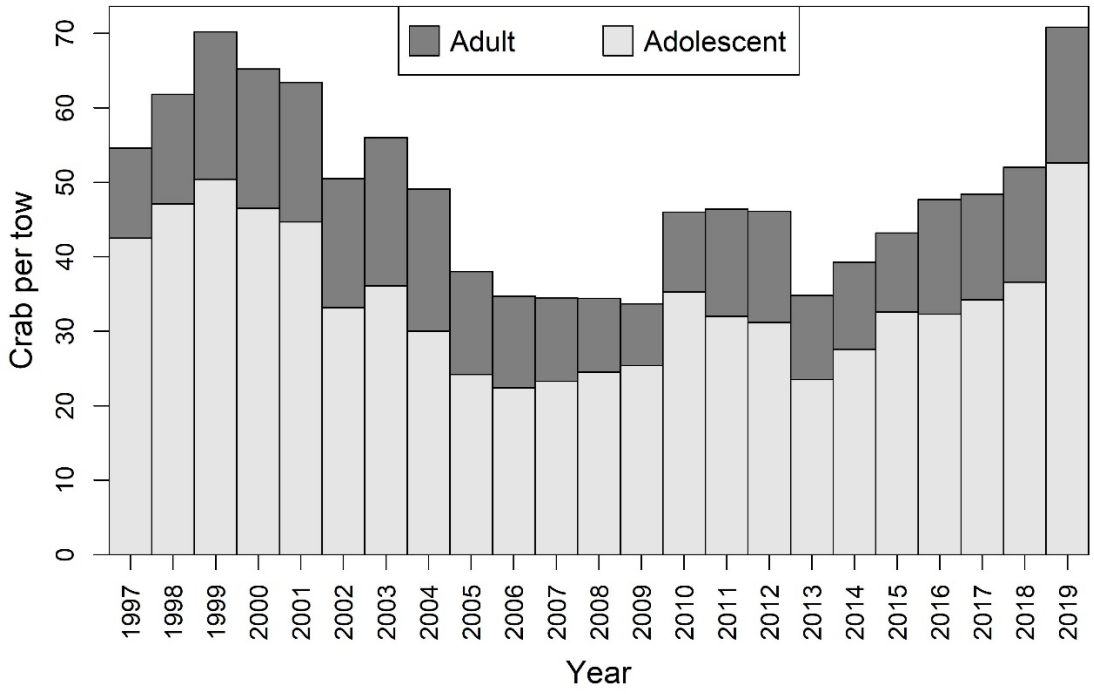

Figure 10. Mean number of male snow crab per tow (unstandardized) by maturity stage from snow crab survey data from 1997 to 2019.

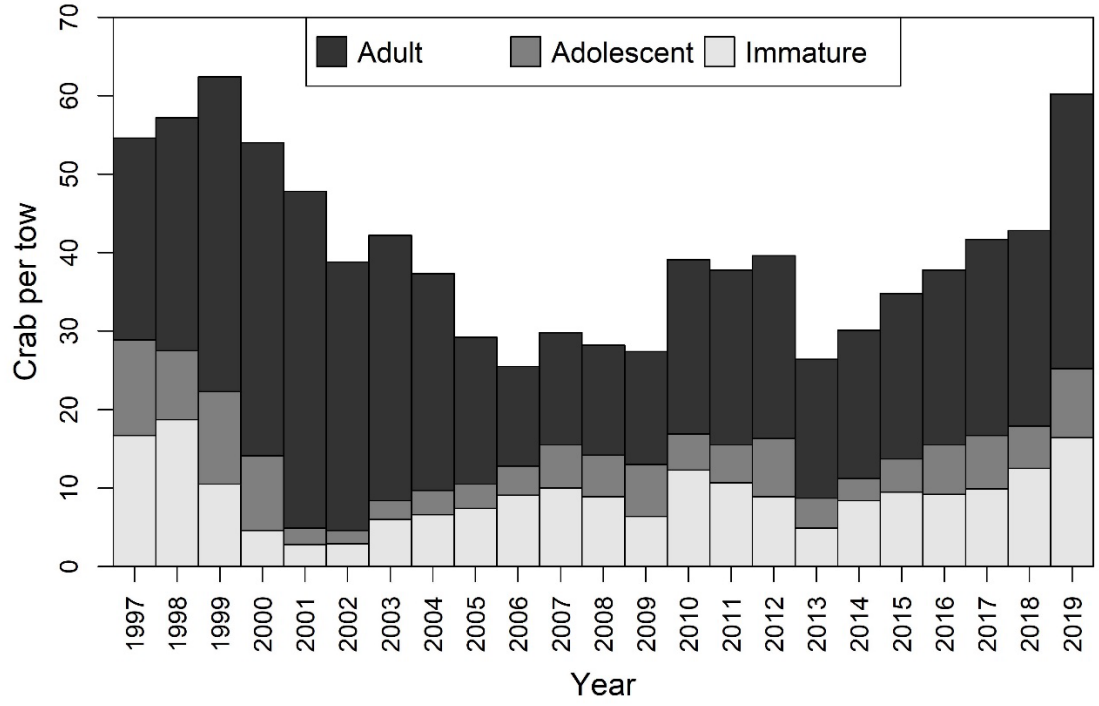

Figure 11. Mean number of female snow crab per tow (unstandardized) by maturity stage from snow crab survey data from 1997 to 2019.

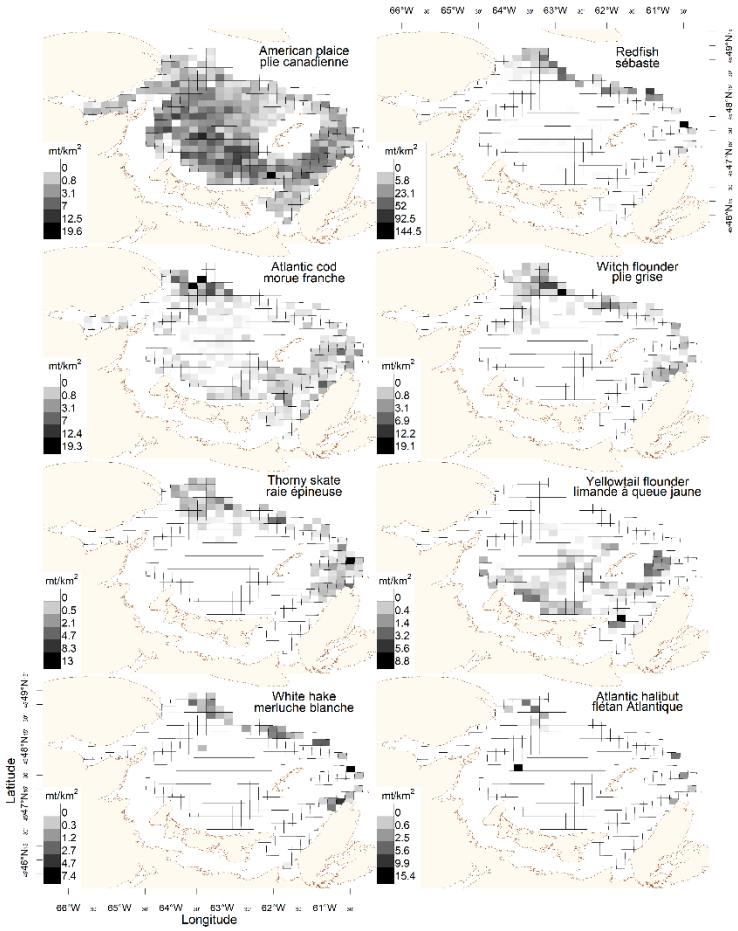

Figure 12. Distribution of the eight most common recorded fish species bycatch, by weight, standardized to the area swept (t per km^2), in the 2019 snow crab survey. Snow crab survey grid is displayed in grey and the colour bars have been scaled to the maximum standardized weight (t per km^2) by species over all grids.

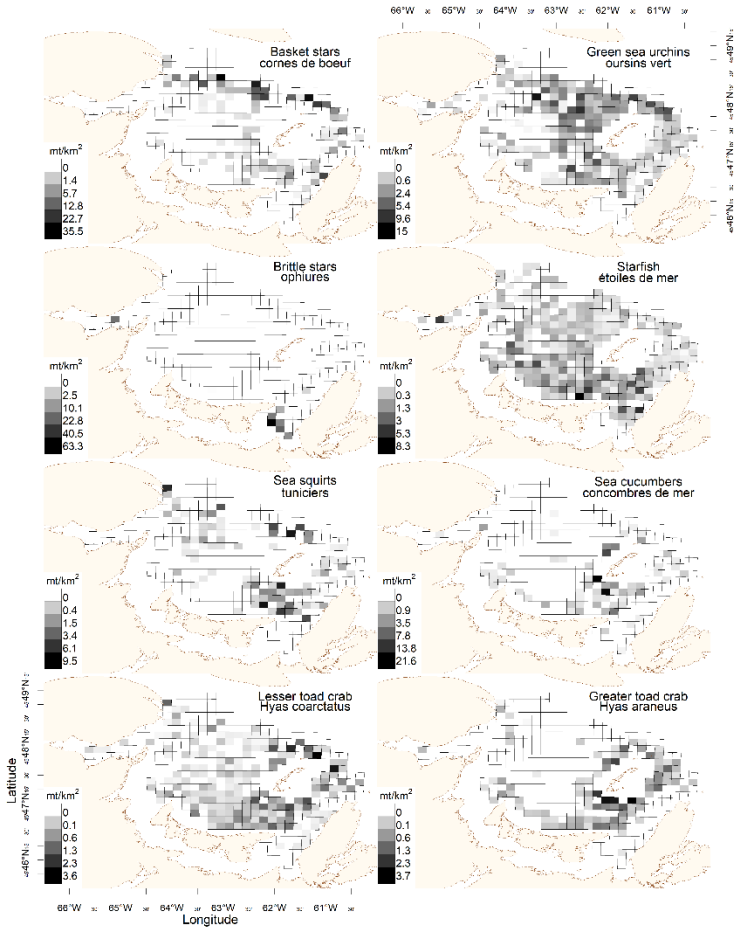

Figure 13. Distribution of the eight most commonly recorded invertebrate species / group bycatch, after snow crab, by weight standardized to the area swept (t per km^2), in the 2019 snow crab survey. Species of commercial interest (greater and lesser toad crabs) are also presented. The snow crab survey grid is displayed in grey and the colour bars have been scaled to the maximum standardized weight (t per km^2) by species/group over all grids.

APPENDICES

APPENDIX 1

SUMMARY OF PROGRESSION OF SURVEY

Summary of progression of survey by trip, number of grids sampled, number of tows undertaken, number of successful tows and number of grids abandoned during the 2019 snow crab survey in the southern Gulf of St. Lawrence.

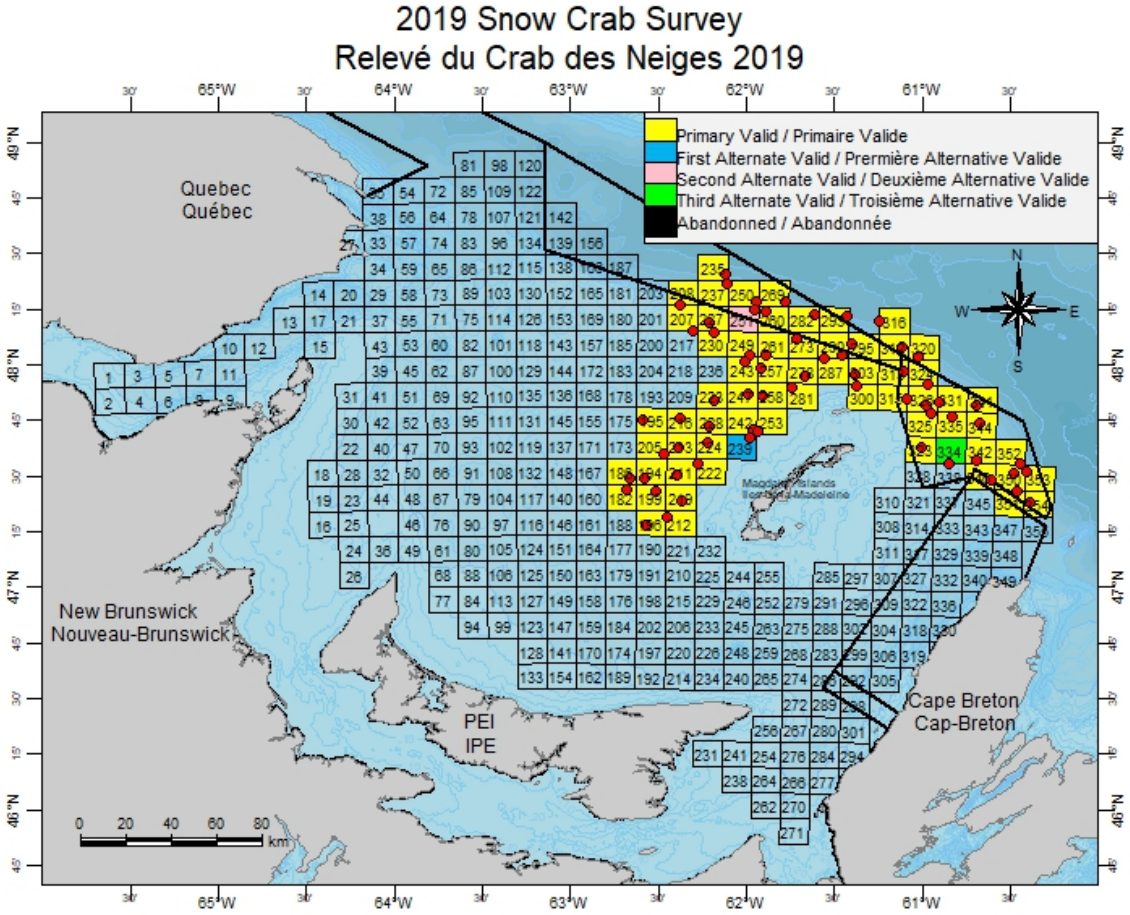

Figure A1-a. Stations visited during trip 1.

Table A1-a. Trip 1 travel details.

Date	Departure	Arrival	Station category					Total	Total successful tows	Number of damaged nets
			Primary	Alternate 1	Alternate 2	Alternate 3	Abandoned			
12-Jul	Souris	At sea	8	0	0	0	0	8	8	0
13-Jul	At sea	At sea	7	0	0	1	0	8	8	0
14-Jul	At sea	At sea	9	0	0	0	0	9	9	0
15-Jul	At sea	At sea	7	0	1	0	0	8	8	0
16-Jul	At sea	At sea	14	0	0	0	0	14	14	0
17-Jul	At sea	At sea	9	1	0	0	0	10	10	1
18-Jul	At sea	Magdalen Islands	9	0	0	0	0	9	9	0
Total (Trip 1)			**63**	**1**	**1**	**1**	**0**	**66**	**66**	**1**

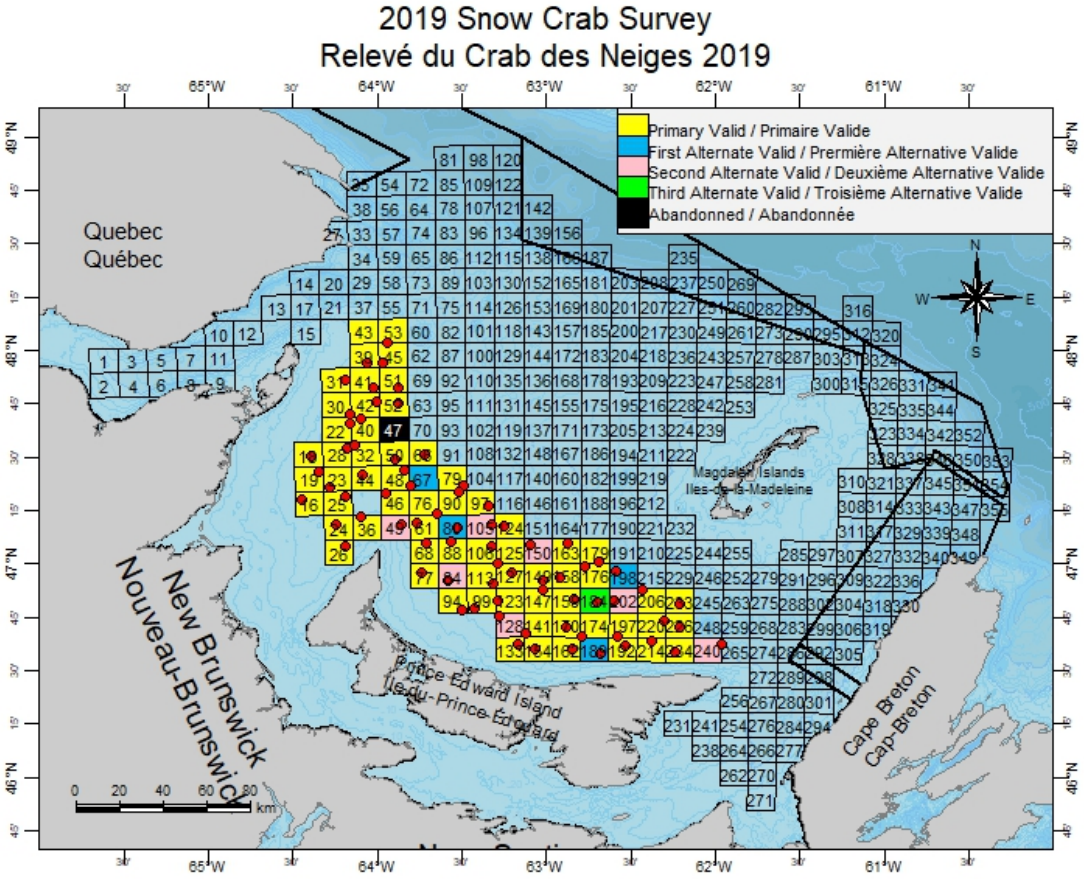

Figure A1-b. Stations visited during trip 2.

Table A1-b. Trip 2 travel details.

Date	Departure	Arrival	Station category					Total	Total successful tows	Number of damaged nets
			Primary	Alternate 1	Alternate 2	Alternate 3	Abandoned			
25-Jul	Magdalen Islands	At sea	3	1	1	1	0	6	6	0
26-Jul	At sea	At sea	8	1	1	0	0	10	10	0
27-Jul	At sea	At sea	9	0	1	0	0	10	10	0
28-Jul	At sea	At sea	7	0	1	0	0	8	8	1
29-Jul	At sea	At sea	5	1	2	0	0	8	8	1
30-Jul	At sea	At sea	8	1	1	0	0	10	10	0
31-Jul	At sea	At sea	12	0	0	0	0	12	12	0
01-Aug	At sea	At sea	8	0	0	0	1	9	8	1
02-Aug	At sea	Caraquet	3	0	0	0	0	3	3	0
Total (Trip 2)			**63**	**4**	**7**	**1**	**1**	**76**	**75**	**3**

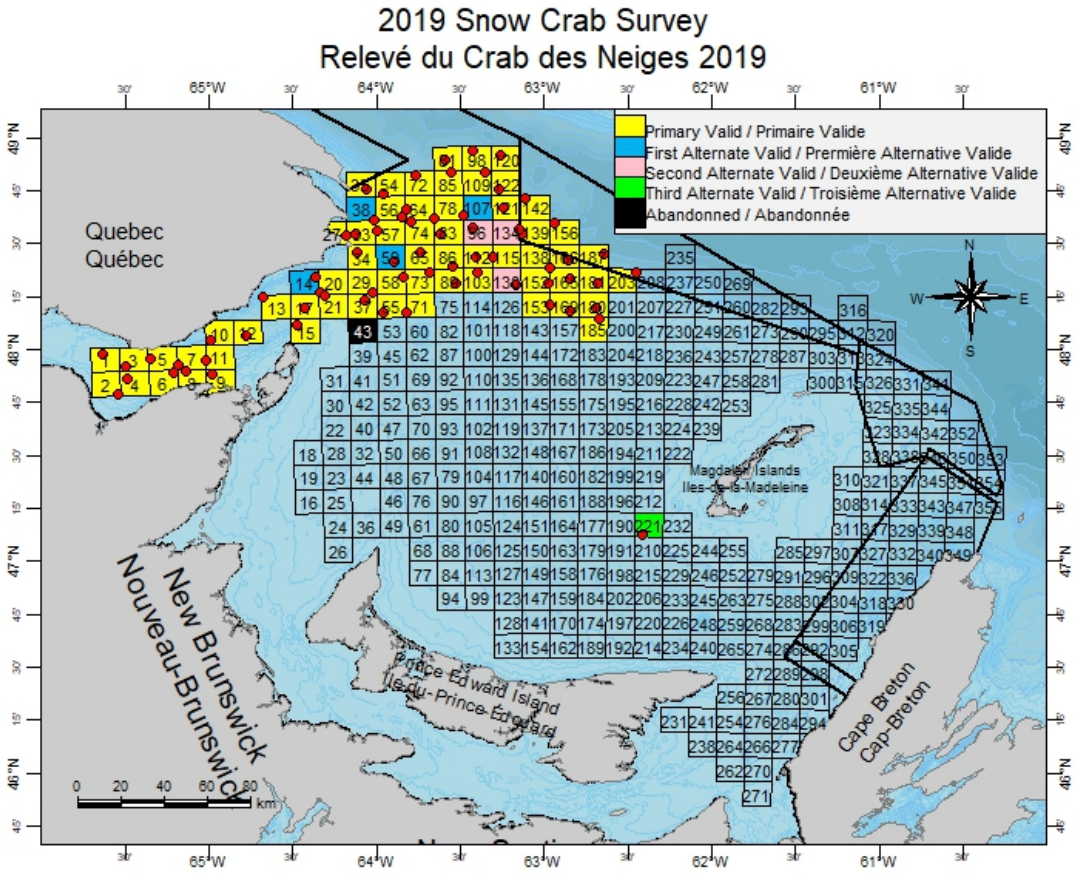

Figure A1-c. Stations visited during trip 3.

Table A1-c. Trip 3 travel details.

Date	Departure	Arrival	Station category					Total	Total successful tows	Number of damaged nets
			Primary	Alternate 1	Alternate 2	Alternate 3	Abandoned			
7-Aug	Caraquet	At sea	4	0	0	0	0	4	4	0
8-Aug	At sea	At sea	9	0	0	0	0	9	9	0
9-Aug	At sea	At sea	6	1	0	0	0	7	7	0
10-Aug	At sea	At sea	7	1	0	0	1	9	8	1
11-Aug	At sea	At sea	5	1	1	0	0	7	7	0
12-Aug	At sea	At sea	7	1	0	0	0	8	8	0
13-Aug	At sea	At sea	8	0	0	0	0	8	8	0
14-Aug	At sea	At sea	5	0	2	0	0	7	7	2
15-Aug	At sea	At sea	11	0	0	0	0	11	11	0
16-Aug	At sea	Magdalen Islands	0	0	0	1	0	1	1	1
Total (Trip 3)			**62**	**4**	**3**	**1**	**1**	**71**	**70**	**4**

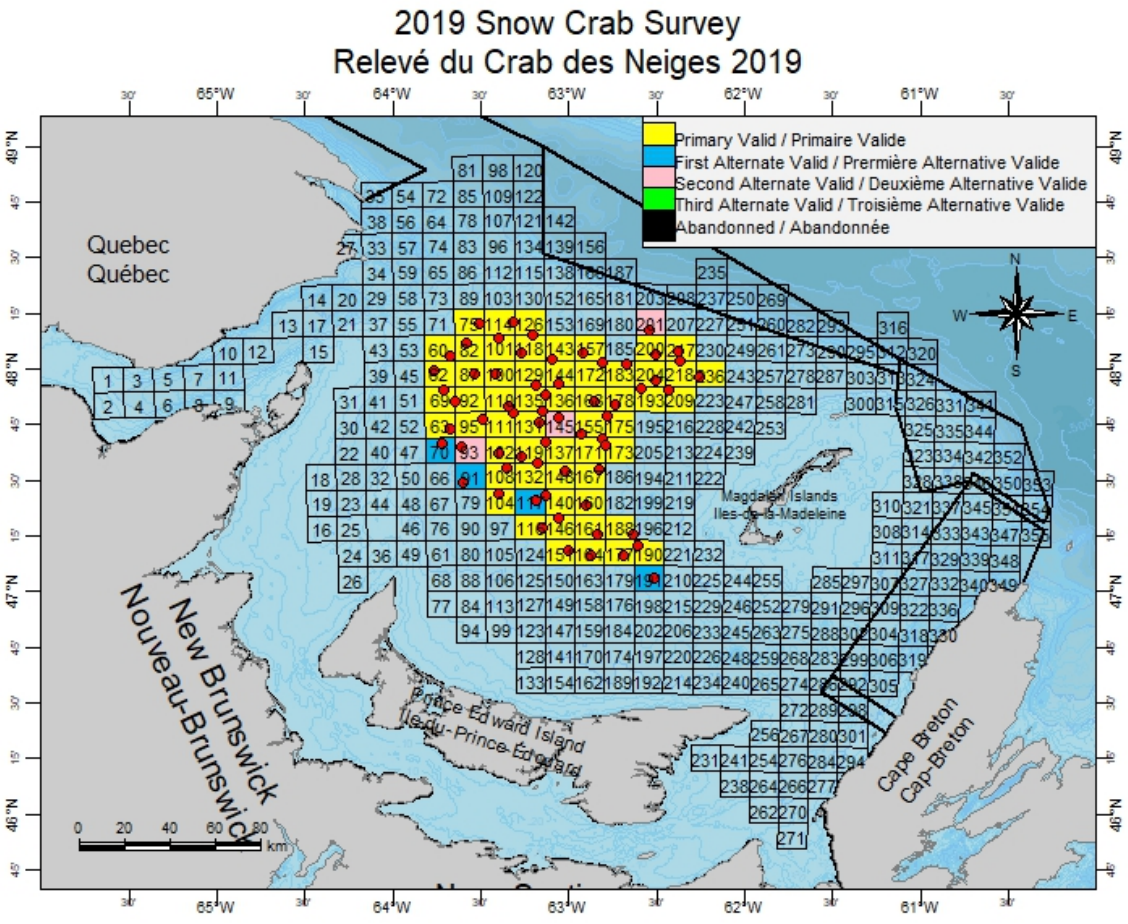

Figure A1-d. Stations visited during trip 4.

Table A1-d. Trip 4 travel details.

Date	Departure	Arrival	Station category					Total	Total successful tows	Number of damaged nets
			Primary	Alternate 1	Alternate 2	Alternate 3	Abandoned			
22-Aug	Magdalen Islands	At sea	3	1	0	0	0	4	4	0
23-Aug	At sea	At sea	11	0	0	0	0	11	11	0
24-Aug	At sea	At sea	5	0	0	0	0	5	5	0
25-Aug	At sea	At sea	10	0	1	0	0	11	11	0
26-Aug	At sea	At sea	11	0	1	0	0	12	12	1
27-Aug	At sea	At sea	4	2	1	0	0	7	7	1
28-Aug	At sea	At sea	9	1	0	0	0	10	10	0
29-Aug	At sea	Magdalen Islands	3	0	0	0	0	3	3	0
Total (Trip 4)			**56**	**4**	**3**	**0**	**0**	**63**	**63**	**2**

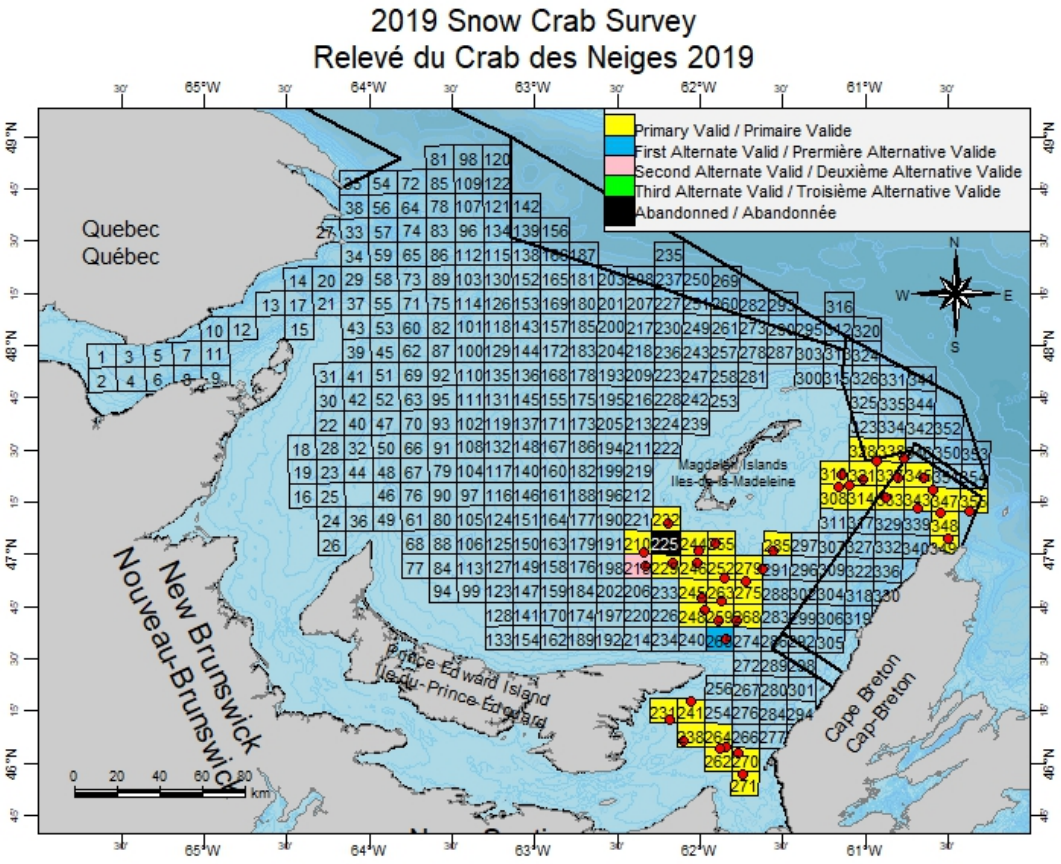

Figure A1-e. Stations visited during trip 5.

Table A1-e. Trip 5 travel details.

Date	Departure	Arrival	Station category					Total	Total successful tows	Number of damaged nets
			Primary	Alternate 1	Alternate 2	Alternate 3	Abandoned			
9-Sep	Magdalen Islands	At sea	7	0	0	0	0	7	7	0
10-Sep	At sea	At sea	7	0	0	0	0	7	7	0
11-Sep	At sea	At sea	7	0	0	0	0	7	7	0
12-Sep	At sea	At sea	4	1	0	0	0	5	5	0
13-Sep	At sea	At sea	5	0	1	0	1	7	6	2
14-Sep	At sea	Magdalen Islands	6	0	0	0	0	6	6	0
Total (Trip 5)			**36**	**1**	**1**	**0**	**1**	**39**	**38**	**2**

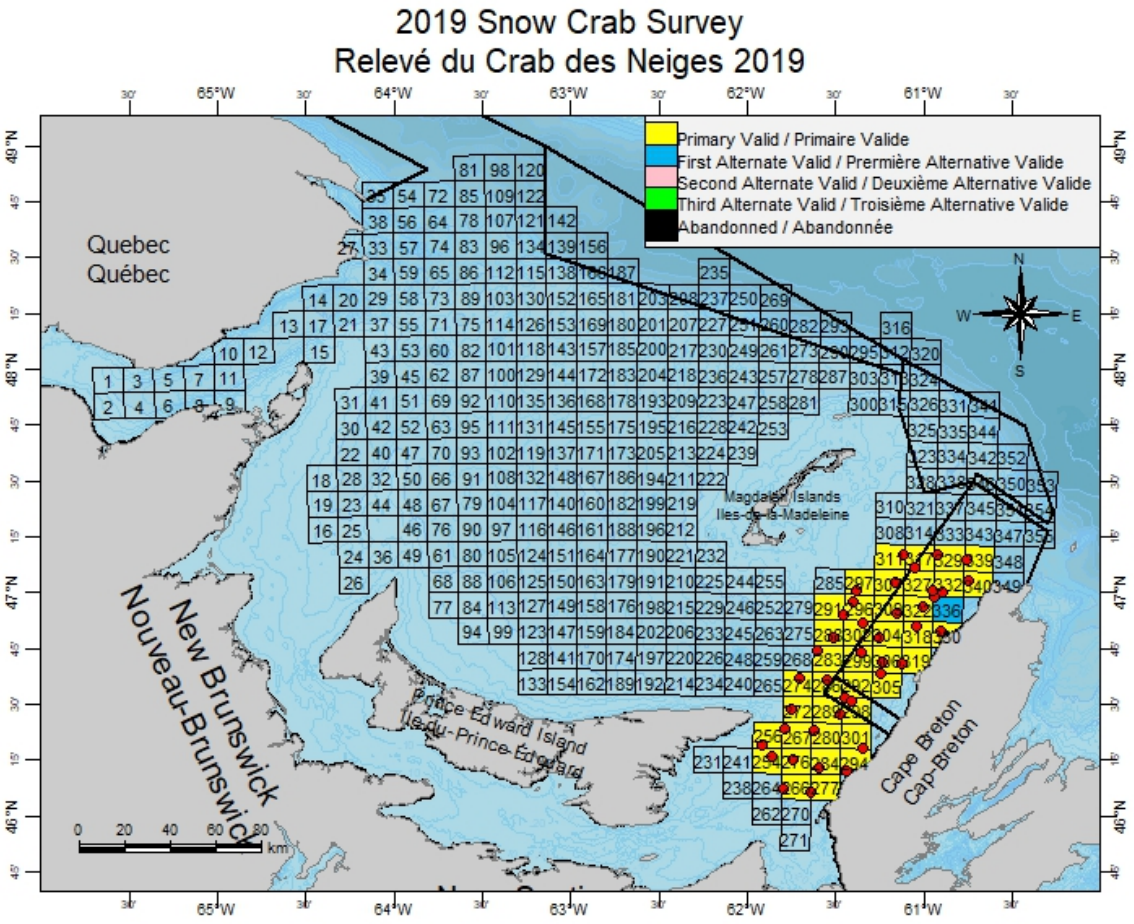

Figure A1-f. Stations visited during trip 6.

Table A1-f. Trip 6 travel details.

Date	Departure	Arrival	Station category					Total	Total successful tows	Number of damaged nets
			Primary	Alternate 1	Alternate 2	Alternate 3	Abandoned			
19-Sep	Cheticamp	At sea	4	1	0	0	0	5	5	1
20-Sep	At sea	At sea	10	0	0	0	0	10	10	0
21-Sep	At sea	At sea	1	0	0	0	0	1	1	0
22-Sep	At sea	At sea	9	0	0	0	0	9	9	0
23-Sep	Cheticamp	Cheticamp	0	0	0	0	0	0	0	0
24-Sep	At sea	At sea	10	0	0	0	0	10	10	0
25-Sep	At sea	Magdalen Islands	5	0	0	0	0	5	5	0
Total (Trip 6)			**39**	**1**	**0**	**0**	**0**	**40**	**40**	**1**

APPENDIX 2

Summary details for each successful tow from the 2019 snow crab survey. Columns are: Date, Area (crab fishing area), Tow # (sequential daily tow number), Latitude (tow mid-point in decimal degrees), Longitude (tow mid-point in decimal degrees), Swept area (area covered by the trawl in square meters), Depth (water depth in meters), T (bottom temperature in ˚C, provided by the Star-Oddi © TD probe attached to the head rope), Commercial count (number of male commercial crab, >= 95 mm carapace width, all carapace conditions), commercial weight (weight of male commercial crab in kg), residual count (number of male commercial crab with carapace conditions 3, 4 and 5), residual weight (weight of male commercial crab with carapace conditions 3, 4 and 5 in kg), and station type (whether the station is primary (P) or an alternate station (A1, A2 or A3 (first, second and third alternate stations, respectively)).

Table A2. Summary details for each successful tow from the 2019 snow crab survey.

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (ºC)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
7/12	12F	1	47.38342	-60.38937	2,288	80.5	0.5	0	0	0	0	P
7/12	12	2	47.43065	-60.46547	2,750	95.1	0.6	8	3.648	5	2.199	P
7/12	12F	5	47.55585	-60.43940	1,886	241.4	7.0	0	0	0	0	P
7/12	12F	6	47.51007	-60.48347	2,117	140.8	3.3	0	0	0	0	P
7/12	12F	7	47.48110	-60.60980	2,634	73.2	0.6	9	4.559	7	3.812	P
7/12	12F	8	47.56932	-60.69317	2,603	56.7	0.3	72	40.283	4	1.974	P
7/12	12F	11	47.62625	-61.00437	2,487	40.2	2.9	3	1.327	0	0	P
7/12	12F	4	47.52278	-60.40383	2,456	314.6	6.5	0	0	0	0	R
7/13	12F	2	47.55893	-60.84390	2,454	51.2	0.7	2	0.887	1	0.419	A3
7/13	12F	3	47.74118	-60.67617	1,977	84.1	0.7	6	2.401	5	1.93	P
7/13	12F	4	47.81593	-60.69043	2,309	201.2	6.2	0	0	0	0	P
7/13	12F	5	47.76965	-60.83257	2,419	69.5	0.0	4	2.416	3	1.734	P
7/13	12F	6	47.83212	-60.90010	2,063	73.2	0.0	3	1.423	3	1.423	P
7/13	12F	7	47.78293	-60.95262	3,030	53.0	1.0	51	29.506	15	8.007	P
7/13	12F	8	47.82098	-60.97748	2,597	56.7	0.5	25	13.173	9	4.436	P
7/13	12F	9	47.84345	-61.08987	2,875	51.2	0.7	2	0.955	0	0	P
7/14	12F	1	47.91402	-60.96530	3,774	84.1	0.1	5	2.835	4	2.339	P
7/14	12F	2	47.96787	-61.10522	2,656	82.3	-0.2	1	0.538	0	0	P
7/14	12	3	48.03373	-61.01915	2,720	281.6	6.6	1	0.392	0	0	P
7/14	12	4	48.07890	-61.11337	2,762	294.4	6.6	0	0	0	0	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (°C)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
7/14	12	5	48.19428	-61.23990	2,813	380.4	6.3	0	0	0	0	P
7/14	12E	6	48.09492	-61.40238	2,698	96.9	0.4	10	4.733	0	0	P
7/16	12	12	47.89502	-61.74120	2,605	60.4	0.2	5	2.48	3	1.662	P
7/16	12	13	47.86477	-61.90830	2,926	54.9	0.5	10	4.474	4	1.549	P
7/16	12	14	47.86747	-61.98495	2,615	53.0	0.5	10	4.119	0	0	P
7/17	12	10	47.67472	-61.98440	2,476	36.6	1.5	3	1.282	0	0	A1
7/17	12	1	47.83913	-62.18577	2,952	60.4	0.4	10	5.13	1	0.524	P
7/17	12	2	47.75983	-62.37962	2,811	62.2	-0.1	6	2.49	6	2.49	P
7/17	12	3	47.75465	-62.58415	2,685	65.8	0.0	6	2.867	1	0.518	P
7/17	12	4	47.60015	-62.46558	2,834	75.0	-0.1	2	0.948	1	0.45	P
7/17	12	5	47.63162	-62.38723	3,162	54.9	0.0	13	5.838	1	0.385	P
7/17	12	6	47.72592	-62.21005	3,198	56.7	0.1	4	1.572	2	0.792	P
7/17	12	7	47.70723	-61.96027	2,520	40.2	1.4	2	0.847	0	0	P
7/17	12	8	47.69868	-61.93715	2,581	40.2	1.7	1	0.405	0	0	P
7/17	12	11	47.65243	-62.21740	2,708	53.0	0.1	5	2.008	2	0.839	P
7/18	12	1	47.55845	-62.27935	2,799	56.7	0.0	8	3.585	8	3.585	P
7/18	12	2	47.50720	-62.39400	2,813	58.5	-0.1	4	1.648	3	1.28	P
7/18	12	3	47.48887	-62.58000	3,067	67.7	-0.1	9	4.553	5	2.447	P
7/18	12	4	47.48672	-62.65825	2,734	60.4	0.1	4	2.428	2	0.962	P
7/18	12	5	47.44190	-62.68122	2,784	62.2	0.2	6	2.662	4	1.854	P
7/18	12	6	47.42887	-62.51577	2,360	67.7	-0.2	7	3.767	1	0.754	P
7/18	12	7	47.38517	-62.36238	2,477	53.0	-0.1	1	0.414	1	0.414	P
7/18	12	8	47.31883	-62.44937	3,004	60.4	-0.1	5	2.612	2	0.852	P
7/18	12	9	47.27843	-62.56953	2,881	64.0	-0.1	6	2.777	2	0.903	P
7/25	12	10	46.96513	-62.58657	2,151	62.2	0.1	3	1.515	1	0.388	A1
7/25	12	8	46.83078	-62.59992	2,672	60.4	0.2	5	2.384	0	0	A2
7/25	12	5	46.82067	-62.69407	2,436	56.7	0.2	13	6.18	0	0	A3
7/25	12	1	46.83522	-62.83792	2,803	60.4	0.2	51	27.762	2	0.752	P
7/25	12	11	46.87938	-62.43463	2,872	64.0	0.1	34	18.79	1	0.465	P
7/25	12	12	46.81253	-62.21387	2,543	67.7	0.2	19	9.557	2	0.892	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (ºC)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
7/26	12	11	46.57755	-62.68067	2,884	45.7	1.7	1	0.377	0	0	A1
7/26	12	5	46.62268	-61.96350	2,634	60.4	1.1	5	2.835	0	0	A2
7/26	12	1	46.73435	-62.30065	2,528	64.0	0.7	24	13.926	0	0	P
7/26	12	2	46.70518	-62.21057	2,266	71.3	0.5	2	1.34	0	0	P
7/26	12	6	46.58527	-62.24122	2,456	47.5	1.7	1	0.413	0	0	P
7/26	12	7	46.63925	-62.37512	2,793	58.5	1.1	7	3.834	1	0.358	P
7/26	12	8	46.61393	-62.53670	2,444	47.5	1.8	2	1.428	0	0	P
7/26	12	9	46.66208	-62.57613	2,423	53.0	1.1	1	0.671	0	0	P
7/26	12	12	46.60387	-62.84493	2,653	49.4	1.1	0	0	0	0	P
7/26	12	13	46.66300	-62.78825	2,618	49.4	0.8	1	0.72	0	0	P
7/27	12	7	46.75768	-63.27818	2,772	43.9	1.6	0	0	0	0	A2
7/27	12	1	46.70525	-62.87855	2,973	54.9	0.4	6	3.36	1	0.385	P
7/27	12	2	46.60100	-63.06800	2,371	45.7	1.2	1	0.441	0	0	P
7/27	12	3	46.62083	-63.16817	2,405	42.1	1.6	5	2.339	0	0	P
7/27	12	4	46.67452	-63.12020	2,472	45.7	0.5	7	3.288	0	0	P
7/27	12	8	46.78522	-63.49667	2,756	40.2	1.8	6	2.644	0	0	P
7/27	12	9	46.79178	-63.42218	2,448	43.9	1.8	5	2.846	0	0	P
7/27	12	10	46.82678	-63.28555	2,441	49.4	1.0	15	8.015	0	0	P
7/27	12	11	46.88257	-63.02023	3,301	60.4	0.2	5	2.72	0	0	P
7/27	12	12	46.92563	-63.01720	3,132	60.4	0.1	16	7.416	11	4.673	P
7/28	12	7	47.09138	-63.09563	2,964	60.4	0.3	2	0.97	0	0	A2
7/28	12	1	46.94027	-62.91525	2,876	60.4	0.0	22	11.634	7	2.912	P
7/28	12	2	46.98735	-62.77058	2,853	64.0	-0.1	34	18.319	7	3.06	P
7/28	12	3	47.01270	-62.68797	3,041	65.8	0.0	10	4.73	4	1.487	P
7/28	12	4	47.09655	-62.87700	2,852	58.5	0.0	30	17.567	0	0	P
7/28	12	8	46.95872	-63.20015	2,573	58.5	0.1	36	21.195	0	0	P
7/28	12	9	47.00568	-63.28720	2,915	58.5	0.2	5	2.98	0	0	P
7/28	12	10	46.90912	-63.31688	2,752	54.9	0.3	9	5.202	0	0	P
7/29	12	10	47.16918	-63.52915	2,992	54.9	0.1	5	2.363	0	0	A1
7/29	12	1	46.92123	-63.58267	2,547	45.7	1.4	3	1.759	0	0	A2

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (ºC)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
7/29	12	6	47.18720	-63.85763	1,606	36.6	1.8	0	0	0	0	A2
7/29	12	2	46.96150	-63.73370	2,909	42.1	1.9	3	1.239	0	0	P
7/29	12	3	47.09550	-63.70625	3,555	54.9	0.8	3	1.342	0	0	P
7/29	12	7	47.19507	-63.76830	3,076	54.9	0.2	14	7.873	2	0.985	P
7/29	12	8	47.23807	-63.64185	3,996	64.0	0.0	13	6.984	1	0.413	P
7/29	12	11	47.10662	-63.56287	3,421	54.9	0.9	8	4.166	1	0.37	P
7/30	12	10	47.36655	-63.80240	3,212	64.0	0.0	6	2.911	2	0.754	A1
7/30	12	4	47.18580	-63.32102	2,900	58.5	0.2	59	33.505	2	0.771	A2
7/30	12	1	47.08187	-63.32538	2,589	56.7	0.6	12	7.261	2	0.863	P
7/30	12	5	47.17532	-63.24603	3,284	65.8	0.1	20	11.015	4	2.163	P
7/30	12	6	47.26828	-63.34492	3,479	60.4	0.2	2	1.19	0	0	P
7/30	12	7	47.36670	-63.48707	2,402	73.2	0.1	5	2.917	0	0	P
7/30	12	8	47.33998	-63.51618	3,614	69.5	0.0	14	8.149	5	2.432	P
7/30	12	11	47.50935	-63.72267	2,666	71.3	0.0	18	10.448	2	1.019	P
7/30	12	12	47.48815	-63.89842	2,932	60.4	0.0	22	13.222	1	0.441	P
7/30	12	13	47.44273	-63.83660	3,468	60.4	0.0	6	3.259	0	0	P
7/31	12	1	47.33097	-63.94962	2,405	42.1	1.0	0	0	0	0	P
7/31	12	2	47.41507	-64.08438	1,866	36.6	3.8	0	0	0	0	P
7/31	12	3	47.31430	-64.19212	3,238	43.9	0.7	2	1.006	1	0.384	P
7/31	12	4	47.22355	-64.09588	2,655	36.6	1.5	0	0	0	0	P
7/31	12	5	47.08562	-64.18830	3,449	38.4	1.7	5	2.528	1	0.44	P
7/31	12	6	47.18798	-64.24598	2,811	42.1	1.1	2	0.772	1	0.373	P
7/31	12	7	47.30035	-64.44442	2,731	42.1	0.9	6	3.236	0	0	P
7/31	12	8	47.35808	-64.28447	2,155	53.0	0.5	5	2.161	2	0.853	P
7/31	12	9	47.43465	-64.34735	1,770	54.9	0.6	8	3.902	5	2.505	P
7/31	12	10	47.50363	-64.39323	2,483	43.9	1.6	20	12.625	7	3.74	P
7/31	12	11	47.54373	-64.18068	1,563	64.0	0.2	12	6.871	12	6.871	P
7/31	12	12	47.55252	-64.13063	2,087	65.8	0.2	21	11.491	19	10.174	P
8/1	12	5	47.68125	-64.09480	1,508	75.0	0.2	7	4.71	5	3.262	P
8/1	12	6	47.65882	-64.16010	1,906	71.3	0.2	9	5.521	9	5.521	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (°C)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
8/1	12	7	47.69782	-64.15823	1,781	71.3	0.2	21	12.837	20	12.138	P
8/1	12	8	47.76305	-64.00813	1,854	82.3	0.5	12	8.128	6	3.758	P
8/1	12	9	47.75367	-63.87788	2,451	73.2	0.2	21	12.814	5	2.601	P
8/1	12	10	47.82192	-63.87473	2,197	82.3	0.5	7	4.046	2	0.891	P
8/1	12	11	47.82353	-64.02083	1,910	87.8	0.4	10	6.367	5	3.108	P
8/1	12	12	47.86332	-64.18733	2,111	42.1	0.9	0	0	0	0	P
8/2	12	1	47.94468	-64.05638	3,551	64.0	0.5	7	4.358	3	1.689	P
8/2	12	2	47.94013	-63.96682	2,335	91.4	0.5	7	3.974	5	2.885	P
8/2	12	3	48.03893	-63.94158	1,874	80.5	0.6	5	3.347	2	1.085	P
8/7	12	1	47.88685	-64.98445	2,887	47.5	1.4	0	0	0	0	P
8/7	12	2	47.89695	-65.13868	1,823	76.8	0.2	8	5.494	0	0	P
8/7	12	3	47.89385	-65.20720	2,157	71.3	0.2	8	4.825	3	1.42	P
8/7	12	4	47.78715	-65.53967	2,804	42.1	2.4	4	2.083	0	0	P
8/8	12	1	47.97503	-65.62978	2,578	47.5	3.2	3	1.73	1	0.383	P
8/8	12	2	47.91627	-65.49243	2,921	45.7	0.9	1	0.787	0	0	P
8/8	12	3	47.86187	-65.48298	1,778	60.4	1.5	4	3.26	0	0	P
8/8	12	4	47.95953	-65.34525	2,512	47.5	2.0	5	2.812	0	0	P
8/8	12	5	47.92843	-65.18610	1,957	75.0	0.2	4	2.533	3	1.777	P
8/8	12	6	47.95157	-65.01510	1,990	78.6	0.2	2	1.043	1	0.487	P
8/8	12	7	48.04180	-64.99082	3,003	78.6	0.4	5	2.812	4	2.008	P
8/8	12	8	48.06460	-64.77558	2,157	84.1	0.3	7	4.589	1	1.035	P
8/8	12	9	48.24392	-64.67697	1,943	93.3	0.6	1	0.553	0	0	P
8/9	12	4	48.34420	-64.36172	2,303	113.4	0.6	1	0.621	1	0.621	A1
8/9	12	1	48.11902	-64.47045	2,667	45.7	2.5	2	0.883	2	0.883	P
8/9	12	2	48.19697	-64.42410	1,957	95.1	0.5	1	0.723	0	0	P
8/9	12	5	48.26972	-64.33370	1,678	109.7	0.6	6	4.574	1	1.131	P
8/9	12	6	48.25342	-64.30618	2,742	106.1	0.6	6	4.547	0	0	P
8/9	12	7	48.23377	-64.06850	1,951	71.3	0.7	12	6.413	6	2.567	P
8/9	12	8	48.17682	-63.96293	2,302	54.9	0.7	0	0	0	0	P
8/10	12	7	48.41325	-63.89138	3,644	96.9	0.8	0	0	0	0	A1

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (°C)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
8/10	12	3	48.17442	-63.82140	2,473	89.6	0.6	8	4.663	2	0.93	P
8/10	12	4	48.27072	-64.02153	3,507	65.8	0.6	1	0.51	0	0	P
8/10	12	5	48.34170	-63.84002	2,496	107.9	1.2	4	2.43	2	1.319	P
8/10	12	8	48.35992	-63.68275	4,100	89.6	0.8	0	0	0	0	P
8/10	12	9	48.45645	-63.73543	3,108	151.8	2.2	0	0	0	0	P
8/10	12	10	48.55792	-63.99340	3,242	93.3	0.8	1	0.688	0	0	P
8/10	12	11	48.45682	-64.11623	4,111	65.8	0.6	0	0	0	0	P
8/11	12	4	48.61035	-64.01005	3,737	87.8	0.7	5	3.717	0	0	A1
8/11	12	10	48.57542	-63.42108	3,069	133.5	2.7	0	0	0	0	A2
8/11	12	1	48.54260	-64.12545	1,971	102.4	1.1	18	9.393	2	0.869	P
8/11	12	2	48.53820	-64.17713	1,983	82.3	0.7	2	0.84	1	0.364	P
8/11	12	5	48.62198	-63.84707	3,784	166.4	3.9	0	0	0	0	P
8/11	12	6	48.60440	-63.79620	3,379	140.8	2.5	0	0	0	0	P
8/11	12	7	48.54817	-63.61577	3,513	118.9	1.8	0	0	0	0	P
8/12	12	1	48.63252	-63.47762	3,041	157.3	4.0	0	0	0	0	A1
8/12	12	2	48.61705	-63.65698	3,578	120.7	1.9	0	0	0	0	P
8/12	12	3	48.65977	-63.82143	2,969	142.6	2.6	0	0	0	0	P
8/12	12	4	48.73192	-63.96047	3,173	144.5	2.4	14	8.168	6	3.099	P
8/12	12	5	48.75877	-64.06193	2,442	78.6	0.1	0	0	0	0	P
8/12	12	6	48.81965	-63.76522	3,219	182.9	4.6	0	0	0	0	P
8/12	12	7	48.83428	-63.55513	3,238	243.2	5.9	0	0	0	0	P
8/12	12	8	48.89708	-63.58868	3,131	307.2	6.3	0	0	0	0	P
8/13	12	1	48.93528	-63.42600	3,126	347.5	6.4	0	0	0	0	P
8/13	12	2	48.91725	-63.25555	3,513	384.0	6.3	0	0	0	0	P
8/13	12	3	48.83702	-63.34895	3,187	307.2	6.3	0	0	0	0	P
8/13	12	4	48.75353	-63.26665	3,136	270.7	5.9	0	0	0	0	P
8/13	12	5	48.66848	-63.24352	2,522	228.6	5.2	0	0	0	0	P
8/13	12E	6	48.71155	-63.10903	2,916	343.8	6.3	0	0	0	0	P
8/13	12E	7	48.59532	-62.93613	2,897	365.8	6.3	0	0	0	0	P
8/13	12E	8	48.54785	-63.13403	2,897	223.1	4.6	0	0	0	0	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (°C)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
8/14	12	3	48.56677	-63.14747	2,657	214.0	5.2	0	0	0	0	A2
8/14	12	11	48.30692	-63.16848	2,387	54.9	0.5	0	0	0	0	A2
8/14	12	4	48.43975	-63.30143	2,555	98.8	2.0	0	0	0	0	P
8/14	12	5	48.43615	-63.40987	3,695	117.0	2.0	0	0	0	0	P
8/14	12	6	48.39408	-63.54173	3,844	109.7	1.7	0	0	0	0	P
8/14	12	7	48.31067	-63.52358	3,798	95.1	1.9	3	2.202	3	2.202	P
8/14	12	8	48.36133	-63.40018	3,436	87.8	1.3	1	0.434	1	0.434	P
8/15	12	1	48.38835	-62.96478	1,985	75.0	0.0	2	0.727	2	0.727	P
8/15	12	2	48.41890	-62.85177	2,609	171.9	3.4	0	0	0	0	P
8/15	12E	3	48.44735	-62.64663	3,019	340.2	6.3	0	0	0	0	P
8/15	12	4	48.36377	-62.44995	3,128	254.2	6.1	0	0	0	0	P
8/15	12	5	48.30972	-62.67923	3,196	93.3	0.0	2	0.921	0	0	P
8/15	12	6	48.33212	-62.84800	3,397	82.3	0.2	0	0	0	0	P
8/15	12	7	48.31298	-62.97840	3,048	78.6	0.4	4	1.733	1	0.383	P
8/15	12	8	48.21038	-62.96820	2,550	71.3	0.1	3	1.827	2	1.16	P
8/15	12	9	48.18075	-62.84773	3,172	73.2	0.1	2	0.906	1	0.442	P
8/15	12	10	48.19255	-62.68687	3,612	91.4	0.5	13	6.840	10	5.214	P
8/15	12	11	48.14632	-62.66647	4,122	98.8	0.8	15	8.287	14	7.86	P
8/16	12	4	47.12492	-62.41410	3,052	60.4	0.1	27	14.083	0	0	A3
8/22	12	2	47.05797	-62.51635	3,195	69.5	0.1	26	12.991	8	3.598	A1
8/22	12	3	47.16247	-62.68493	2,859	65.8	0.0	15	7.058	4	1.589	P
8/22	12	4	47.16622	-62.87718	2,899	58.5	0.0	16	8.215	0	0	P
8/22	12	5	47.18773	-63.00108	2,822	58.5	0.3	21	12.100	0	0	P
8/23	12	1	48.15293	-63.20655	2,776	71.3	0.2	11	5.589	3	1.607	P
8/23	12	2	48.21292	-63.31403	4,383	93.3	0.6	12	6.695	2	1.022	P
8/23	12	3	48.20157	-63.50797	2,727	96.9	0.8	0	0	0	0	P
8/23	12	4	48.13622	-63.40173	3,807	91.4	0.7	9	4.869	1	0.45	P
8/23	12	5	48.11870	-63.58168	3,887	89.6	0.8	3	1.918	0	0	P
8/23	12	6	48.05937	-63.67665	1,742	96.9	0.7	10	6.228	1	0.526	P
8/23	12	7	47.99277	-63.76942	2,453	96.9	0.5	7	4.827	3	2.235	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (°C)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
8/23	12	8	47.90815	-63.71133	1,564	67.7	0.4	0	0	0	0	P
8/23	12	9	47.85713	-63.64475	2,607	60.4	0.1	1	0.432	1	0.432	P
8/23	12	10	47.97885	-63.53333	3,113	75.0	0.5	1	0.626	0	0	P
8/23	12	11	47.97632	-63.41693	3,087	76.8	0.6	1	0.424	0	0	P
8/24	12	1	48.07083	-63.26428	3,738	76.8	0.5	10	4.729	2	0.944	P
8/24	12	2	48.04578	-63.09572	2,377	56.7	0.4	1	0.398	0	0	P
8/24	12	3	48.07255	-62.91693	3,254	65.8	0.2	3	1.454	1	0.554	P
8/24	12	4	48.03115	-62.80770	3,565	82.3	0.4	8	3.981	4	1.973	P
8/24	12	5	48.02487	-62.67172	4,001	86.0	0.6	13	7.042	7	3.618	P
8/25	12	3	48.17743	-62.54025	2,646	71.3	0.7	2	1.060	0	0	A2
8/25	12	4	48.06705	-62.50032	2,808	58.5	0.1	10	5.068	3	1.323	P
8/25	12	5	48.07933	-62.37712	2,761	73.2	0.1	6	3.666	5	3.196	P
8/25	12	6	48.03443	-62.36847	2,421	78.6	0.2	3	1.425	2	0.719	P
8/25	12	7	47.96195	-62.25868	3,213	75.0	0.0	2	1.185	0	0	P
8/25	12	8	47.90690	-62.42903	2,645	75.0	0.2	9	4.687	9	4.687	P
8/25	12	9	47.95102	-62.50580	2,891	64.0	0.2	1	0.365	0	0	P
8/25	12	10	47.91130	-62.58672	2,502	62.2	0.1	0	0	0	0	P
8/25	12	11	47.84260	-62.73173	3,064	69.5	0.1	9	4.554	2	0.849	P
8/25	12	12	47.85282	-62.85808	3,399	76.8	0.1	15	7.466	10	5.063	P
8/25	12	13	47.79172	-62.77943	2,389	64.0	0.2	0	0	0	0	P
8/26	12	6	47.78065	-63.05760	3,507	73.2	0.1	15	8.655	3	1.435	A2
8/26	12	1	47.68467	-62.81275	2,700	56.7	0.5	4	1.671	2	0.830	P
8/26	12	2	47.65917	-62.79187	2,663	56.7	0.5	0	0	0	0	P
8/26	12	3	47.70802	-62.93015	2,339	58.5	0.2	0	0	0	0	P
8/26	12	7	47.67528	-63.13113	3,001	65.8	0.0	12	6.545	5	2.166	P
8/26	12	8	47.76305	-63.16968	3,451	75.0	0.1	17	9.443	3	2.001	P
8/26	12	9	47.80837	-63.14503	3,690	75.0	0.3	24	12.983	12	6.563	P
8/26	12	10	47.88180	-63.13177	3,528	69.5	0.1	10	4.980	2	0.899	P
8/26	12	11	47.93325	-63.05672	2,964	62.2	0.4	11	6.603	0	0	P
8/26	12	12	47.92608	-63.18567	2,469	64.0	0.3	7	4.065	1	0.374	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (°C)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
8/26	12	13	47.80573	-63.31597	3,524	80.5	0.5	13	6.840	2	0.739	P
8/26	12	14	47.83210	-63.34140	3,907	76.8	0.5	6	3.421	2	1.166	P
8/27	12	4	47.66170	-63.72138	2,671	69.5	0.5	7	4.373	1	0.793	A1
8/27	12	9	47.49138	-63.59623	2,791	65.8	0.1	3	1.461	2	0.728	A1
8/27	12	7	47.64678	-63.61383	3,688	71.3	0.3	5	2.540	2	0.739	A2
8/27	12	1	47.77377	-63.49300	3,628	76.8	0.4	2	1.271	1	0.815	P
8/27	12	2	47.72970	-63.67050	2,627	71.3	0.4	4	2.645	1	0.492	P
8/27	12	10	47.61822	-63.40017	2,941	80.5	0.1	8	5.449	2	1.375	P
8/27	12	11	47.60638	-63.26563	2,452	86.0	0.2	10	5.751	1	0.436	P
8/28	12	7	47.40993	-63.18512	2,077	78.6	0.0	12	6.575	5	2.149	A1
8/28	12	1	47.54880	-62.83102	1,927	53.0	0.4	1	0.413	0	0	P
8/28	12	2	47.53902	-63.02078	2,812	51.2	0.5	0	0	0	0	P
8/28	12	3	47.57630	-63.17240	3,003	65.8	0.1	42	23.030	5	2.642	P
8/28	12	4	47.55832	-63.35518	2,736	76.8	0.0	4	2.719	1	0.681	P
8/28	12	5	47.43798	-63.40098	2,375	80.5	0.1	19	10.612	7	3.476	P
8/28	12	8	47.43528	-63.13033	3,669	69.5	0.2	53	28.564	13	5.582	P
8/28	12	9	47.28588	-63.14812	2,785	67.7	0.2	24	12.942	4	2.147	P
8/28	12	10	47.32832	-63.05430	2,663	58.5	0.3	52	29.146	9	4.608	P
8/28	12	11	47.38603	-62.90288	2,670	49.4	0.6	1	0.417	0	0	P
8/29	12	1	47.26068	-62.83995	2,717	58.5	0.4	2	1.196	0	0	P
8/29	12	2	47.25558	-62.63195	3,106	64.0	0.0	10	5.068	6	2.773	P
8/29	12	3	47.20775	-62.60807	3,113	65.8	0.1	22	9.240	7	2.889	P
9/9	12	1	47.37872	-61.14118	2,393	42.1	2.0	3	1.420	0	0	P
9/9	12	2	47.32515	-61.15820	2,430	45.7	1.7	6	3.108	3	1.330	P
9/9	12	3	47.32798	-61.09953	2,626	49.4	1.3	10	4.417	3	1.565	P
9/9	12	4	47.35805	-61.01638	2,426	53.0	1.2	6	2.634	2	0.744	P
9/9	12	5	47.44578	-60.93468	2,196	49.4	1.2	3	1.992	1	0.748	P
9/9	12	6	47.46215	-60.76895	2,398	56.7	1.1	8	4.548	4	2.385	P
9/9	19	7	47.36970	-60.80438	2,456	62.2	1.5	1	0.494	1	0.494	P
9/10	19	1	47.36703	-60.64975	2,961	64.0	3.2	3	1.868	2	1.255	P

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9/10	19	2	47.30948	-60.59002	2,945	67.7	1.5	2	1.073	0	0	P
9/10	19	3	47.20887	-60.36968	4,554	186.5	7.0	0	0	0	0	P
9/10	19	4	47.07675	-60.49465	2,671	129.8	4.9	19	12.980	13	8.099	P
9/10	19	5	47.19663	-60.54900	2,536	164.6	6.8	0	0	0	0	P
9/10	19	6	47.22123	-60.67863	2,457	95.1	2.1	0	0	0	0	P
9/10	19	7	47.27263	-60.87668	3,636	80.5	1.9	7	2.941	7	2.941	P
9/11	12	1	45.94607	-61.74285	2,164	40.2	3.5	1	0.387	1	0.387	P
9/11	12	2	46.04568	-61.76522	2,241	51.2	2.0	4	2.455	0	0	P
9/11	12	3	46.08003	-61.84620	1,891	49.4	3.2	3	1.986	2	1.231	P
9/11	12	4	46.06885	-61.88087	1,881	47.5	3.5	11	8.196	0	0	P
9/11	12	5	46.10702	-62.10242	2,255	38.4	3.7	0	0	0	0	P
9/11	12	6	46.21247	-62.18600	2,266	32.9	5.1	0	0	0	0	P
9/11	12	7	46.29678	-62.05028	3,171	38.4	3.4	0	0	0	0	P
9/12	12	1	46.59485	-61.83995	2,779	54.9	4.0	1	0.600	0	0	A1
9/12	12	2	46.68185	-61.77380	2,298	65.8	2.6	13	7.866	0	0	P
9/12	12	3	46.68448	-61.88727	3,380	56.7	1.4	3	1.251	1	0.462	P
9/12	12	4	46.73360	-61.97483	2,029	78.6	1.1	8	3.923	3	1.597	P
9/12	12	5	46.79025	-61.99098	2,390	67.7	0.9	5	2.137	2	0.865	P
9/13	12	8	46.94135	-62.33378	3,356	62.2	0.6	15	7.016	1	0.380	A2
9/13	12	1	47.14885	-62.18940	2,263	36.6	2.4	0	0	0	0	P
9/13	12	9	47.00942	-62.33698	2,817	58.5	0.5	14	7.313	2	0.804	P
9/13	12	10	46.96213	-62.16220	2,165	54.9	0.7	2	0.987	0	0	P
9/13	12	11	46.95820	-62.01915	2,577	51.2	1.2	2	1.195	0	0	P
9/13	12	12	47.01433	-62.00845	3,034	49.4	1.3	2	1.030	0	0	P
9/14	12	1	47.05697	-61.90700	2,322	36.6	2.5	0	0	0	0	P
9/14	12	2	46.88955	-61.85552	2,951	56.7	1.1	22	12.546	3	1.293	P
9/14	12	3	46.77428	-61.86670	3,218	67.7	1.0	20	9.508	7	3.040	P
9/14	12	4	46.87490	-61.71835	2,636	54.9	0.9	11	5.928	1	0.694	P
9/14	12	5	46.92862	-61.62232	2,588	49.4	1.0	7	3.357	0	0	P
9/14	12	6	47.01685	-61.55787	1,839	32.9	3.8	0	0	0	0	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (°C)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
9/19	19	3	46.98280	-60.93708	2,519	106.1	3.2	3	2.207	0	0	A1
9/19	19	1	46.83058	-60.90368	3,010	91.4	2.6	3	2.015	1	0.441	P
9/19	19	4	47.00717	-60.95343	3,017	100.6	2.8	9	4.691	2	1.402	P
9/19	19	5	47.00550	-60.89043	3,540	113.4	3.4	9	4.947	0	0	P
9/19	19	6	46.93522	-61.00667	2,982	96.9	2.6	11	6.653	1	0.881	P
9/20	19	1	46.68198	-61.12425	2,409	84.1	2.8	1	0.384	1	0.384	P
9/20	19	2	46.79860	-61.25505	2,838	67.7	2.0	11	6.601	5	2.970	P
9/20	19	3	46.84977	-61.04000	2,428	102.4	2.3	7	4.460	3	2.021	P
9/20	19	4	46.90937	-61.14843	2,650	62.2	1.9	7	4.005	0	0	P
9/20	12	5	46.86515	-61.34433	2,777	60.4	2.1	6	2.980	2	0.820	P
9/20	12	6	46.79908	-61.50635	2,728	62.2	2.1	17	8.538	4	1.907	P
9/20	12	7	46.90140	-61.45547	3,587	58.5	2.2	2	1.236	1	0.429	P
9/20	12	8	46.96182	-61.39970	2,526	47.5	1.7	2	1.11	0	0	P
9/20	12	9	47.00652	-61.38068	2,336	45.7	1.1	2	0.886	0	0	P
9/20	12	10	47.04532	-61.15705	2,902	56.7	2.2	2	0.754	0	0	P
9/21	19	1	46.63523	-61.24177	2,796	80.5	3.2	11	6.209	7	3.811	P
9/22	19	1	46.69187	-61.23473	1,910	100.6	3.1	6	3.670	3	2.162	P
9/22	19	2	46.73598	-61.35537	2,263	67.7	2.6	11	6.164	3	1.510	P
9/22	12	3	46.73807	-61.60648	3,463	73.2	2.0	7	2.839	3	1.128	P
9/22	12	4	46.61497	-61.70820	2,066	60.4	1.2	2	0.917	1	0.526	P
9/22	12	5	46.60933	-61.54550	2,825	60.4	1.5	21	11.950	2	1.208	P
9/22	12	6	46.53260	-61.44615	2,822	62.2	2.2	11	6.404	5	3.236	P
9/22	12	7	46.51155	-61.40895	3,099	58.5	2.4	6	4.080	4	2.656	P
9/22	12	8	46.45567	-61.47820	2,066	62.2	2.4	7	4.641	0	0	P
9/22	12	9	46.38135	-61.62068	2,606	54.9	2.5	11	7.131	1	0.687	P
9/24	12	1	46.47802	-61.74863	2,468	42.1	3.8	0	0	0	0	P
9/24	12	2	46.39273	-61.78577	2,054	40.2	4.8	0	0	0	0	P
9/24	12	3	46.32177	-61.91685	3,328	40.2	5.4	0	0	0	0	P
9/24	12	4	46.26535	-61.86113	2,133	49.4	4.0	3	2.151	0	0	P
9/24	12	5	46.25272	-61.74168	1,418	53.0	2.6	2	0.976	0	0	P

Date (mm/dd)	Area	Tow #	Latitude	Longitude	Swept area (m^2)	Depth (m)	T (ºC)	Commercial count	Commercial weight (kg)	Residual count	Residual weight (kg)	Station type
9/24	12	6	46.12465	-61.79613	2,267	49.4	3.6	3	1.663	2	0.979	P
9/24	12	7	46.10865	-61.63878	2,034	49.4	3.5	1	0.408	1	0.408	P
9/24	12	8	46.21822	-61.59580	2,063	54.9	2.6	2	1.091	2	1.091	P
9/24	12	9	46.20392	-61.43978	3,234	40.2	6.9	1	0.892	0	0	P
9/24	12	10	46.30178	-61.34837	2,322	47.5	4.4	0	0	0	0	P
9/25	19	1	47.05418	-60.74767	1,330	146.3	5.9	7	4.184	1	0.358	P
9/25	19	2	47.10832	-61.05223	2,915	76.8	2.1	11	5.773	5	2.606	P
9/25	12	3	47.16655	-61.11220	3,226	58.5	2.2	4	1.657	2	0.739	P
9/25	19	4	47.15142	-60.75815	2,166	150.0	4.4	2	1.367	0	0	P
9/25	19	5	47.17207	-60.91758	1,491	82.3	2.2	6	3.302	4	2.334	P

APPENDIX 3A

Summary of total by-catches (by number and total weight in kg) by species (excluding snow crab), genus or group of invertebrates and number of grids sampled where the species were present in the catches of the survey in 2017 to 2019. A dash indicates no record (Hébert et al. 2016b).

Table A3-a. Summary of total by-catches of invertebrates.

		2019			2018			2017		
Common name	Scientific name	Count	Grids	Weight (kg)	Count	Grids	Weight (kg)	Count	Grids	Weight (kg)
Anemone	Anthozoa	839	102	119	662	83	83	2,411	86	166
Basket star	*Gorgonocephalus* eucnemis	3,978	93	991	2,944	110	660	3,198	136	667
Brittle star	Ophiuroidea	9	9	362	0	11	708	3	12	122
Clam	Mactridea	48	26	4	46	28	3	-	-	-
Cockle, Iceland	*Clinocardium ciliatum*	227	48	10	247	36	10	633	70	30
Crab, hermit	*Pagurus* ssp.	442	99	13	468	103	16	509	108	16
Crab, northern stone	*Lithodes maja*	82	25	25	101	25	30	115	30	36
Crab, rock	*Cancer irroratus*	9	5	1	12	4	2	20	5	1
Crab, toad greater	*Hyas araneus*	842	99	113	732	104	95	726	98	95
Crab, toad lesser	*Hyas coarctatus*	2,207	195	147	1,498	175	98	1,649	164	120
Jellyfish	Scyphozoa sp.	55	41	60	396	180	381	18	13	8
Lobster	*Homarus americanus*	711	19	163	84	4	22	154	6	39
Mussel	Mytilidae	1	1	0	1	1	0	26	15	3
Octopus	Incirrina	18	13	1	10	10	0	15	9	1
Quahog	*Arctica islandica*	90	18	9	92	13	8	3	3	0
Sand dollar	Clypeasteroidea	9,659	79	235	9,350	80	183	7,659	98	152
Scallop	Pectinidae	167	49	16	119	37	14	74	31	8
Sea cucumber	Holothuroidea	593	62	270	579	56	239	594	67	293
Sea mouse	*Aphrodita hastata*	16	6	2	6	4	0	10	8	0
Sea pen	Pennatulacea	8	8	77	276	11	46	137	9	124
Sea squirt	*Ascidiacea*	2,530	100	274	2,631	84	247	2,783	95	285
Sea worm	Polychaeta	8	7	0	6	5	0	-	-	-
Shrimp	Decapoda	9,592	114	91	8,162	93	66	3,437	70	34
Sponge	Porifera	30	30	33	44	31	43	31	64	89
Squid	Cephalopoda	49	27	6	35	25	3	12	11	2
Starfish, unspecified	Asteroidea	6,808	228	604	7,408	292	536	11,782	290	611
Urchin, green sea	*Strongylocentrotus droebachiensis*	23,852	211	913	14,366	209	565	19,877	214	754
Urchin, heart	Spatangoida	160	7	3	24	3	5	50,494	3	52
Whelk	Buccinidae	1,091	174	32	725	162	22	628	153	24
Whelk eggs	Buccinidae	135	55	9	103	49	6	10	43	8

APPENDIX 3B

Summary of total by-catches (by number and total weight in kg) by species, genus or group of fish, and number of grids sampled where the species were present in the catches of the survey in 2017 to 2019. A dash indicates no record (Hébert et al. 2016b).

Table A3-b. Summary of total by-catches of fish.

		2019			2018			2017		
Common name	Latin name	Count	Grids	Weight (kg)	Count	Grids	Weight (kg)	Count	Grids	Weight (kg)
Alewife	*Alosa pseudoharengus*	16	4	2	-	-	-	-	-	-
Aligatorfish	*Aspidophoroides monopterygius*	366	97	2	328	106	2	292	78	2
Aligatorfish, Arctic	*Aspidophoroides olrikii*	10	8	2	4	4	0	1	1	1
American plaice	*Hippoglossoides platessoides*	42,678	330	2,485	32,883	332	2,252	34,905	330	2,545
Atlantic hagfish	*Myxine glutinosa*	4	4	0	1	1	0	1	1	0
Atlantic sea poacher	*Leptagonus decagonus*	213	84	6	145	67	4	214	69	6
Blenny, fourline snake	*Eumesogrammus praecisus*	212	41	6	149	46	5	87	35	3
Blenny, snake	*Lumpenus lumpretaeformis*	108	26	2	82	32	2	121	47	2
Blenny, stout eel	*Anisarchus medius*	4	3	0	-	-	-	-	-	-
Capelin	*Mallotus villosus*	324	36	2	246	33	3	389	49	2
Cod, Atlantic	*Gadus morhua*	4,254	198	521	1,555	168	577	1,954	183	838
Cod, rock	*Gadus ogac*	7	6	4	4	3	1	9	8	2
Common wolf eel	*Lycenchelys paxillus*	-	-	-	-	-	-	3	3	0
Dogfish	*Centroscyllium fabricii*	1	1	0	15	1	4	-	-	-
Daubed shanny	*Leptoclinus maculatus*	68	48	0	33	23	0	-	-	-
Eelblenny, slender	*Lumpenus fabricii*	3	2	0	-	-	-	-	-	-
Eelpout, Atlantic	*Lycodes terraenovae*	-	-	-	-	-	-	-	-	-
Eelpout, laval's	*Lycodes lavalaei*	246	94	51	138	75	32	158	83	54
Eelpout, Vahl's	*Lycodes vahlii*	1	1	0	-	-	-	-	-	-
Eelpout, wolf	*Lycenchelys verrillii*	-	-	-	-	-	-	3	3	0
Fish doctor	*Gymnelis viridis*	2	2	0	-	-	-	-	-	-
Flounder, winter	*Pseudopleuronectes americanus*	401	10	46	191	7	19	345	9	41
Flounder, witch	*Glyptocephalus cynoglossus*	987	75	268	872	79	229	730	92	208
Flounder, yellowtail	*Limanda ferruginea*	2,840	101	159	2,308	88	124	1,477	92	96
Fourbeard rockling	*Enchelyopus cimbrius*	30	14	1	68	23	4	87	32	3
Grenadier, marlin-spike	*Nezumian bairdii*	514	26	25	669	24	28	644	27	25
Haddock	*Melanogrammus aeglefinus*	5	2	3	4	2	3	5	3	4
Hake, longfin	*Phycis chesteri*	15	7	2	34	10	3	36	11	8
Hake, silver	*Merluccius bilinearis*	31	12	8	50	18	13	36	19	16
Hake, white	*Urophycis tenuis*	273	35	111	333	42	146	333	45	137
Halibut	*Hippoglossus hippoglossus*	13	11	102	6	3	20	19	16	229
Herring	*Clupea harengus*	179	9	28	19	4	3	210	11	32
Lumpfish	*Cyclopterus lumpus*	13	11	1	19	14	2	4	4	3
Mackerel	*Scomber scombrus*	11	1	2	-	-	-	-	-	-
Monkfish	*Lophius americanus*	3	3	21	2	2	10	7	5	38

		2019			2018			2017		
Common name	Latin name	Count	Grids	Weight (kg)	Count	Grids	Weight (kg)	Count	Grids	Weight (kg)
Northern sand lance	*Ammodytes dubius*	19	6	0	16	10	0	24	5	0
Ocean pout	*Zoarces americanus*	18	11	3	12	9	2	18	13	5
Redfish	*Sebastes* sp.	11,013	71	1,820	19,904	57	2775	6,344	94	721
Sculpin, Atlantic hookear	*Artediellus atlanticus*	34	21	0	26	17	0	1	1	0
Sculpin, Arctic hookear	*Artediellus uncinatus*	-	-	-	-	-	-	-	-	-
Sculpin, Arctic staghorn	*Gymnocanthus tricuspis*	871	138	65	583	121	44	984	138	64
Sculpin, grubby	*Myoxocephalus aenaeus*	-	-	-	4	2	0	15	5	5
Sculpin, longhorn	*Myoxocephalus octodecemspinosus*	102	22	15	50	20	9	57	20	10
Sculpin, moustache	*Triglops murrayi*	516	155	9	456	148	9	401	135	7
Sculpin, shorthorn	*Myoxocephalus scorpius*	240	78	44	176	68	34	230	83	43
Sculpin, spatulate	*Icelus spatula*	-	-	-	176	41	2	9	7	0
Sculpin, two horn	*Icelus bicornis*	334	56	3	64	11	1	166	40	2
Sea raven	*Hemitripterus americanus*	16	11	2	10	8	3	10	7	5
Sea tadpole	*Careproctus reinhardti*	5	5	0	10	7	1	3	2	0
Shanny, Arctic	*Stichaeus punctatus*	4	3	0	-	-	-	-	-	-
Skate, eggs	Rajidae	12	3	0	51	4	1	238	6	4
Skate, smooth	*Malacoraja senta*	166	27	37	145	26	42	86	31	41
Skate, spiny	*Bathyraja spinicauda*	1	1	12	-	-	-	-	-	-
Skate, thorny	*Amblyraja radiata*	713	89	213	561	75	200	556	87	199
Skate, winter	*Leucoraja ocellata*	-	-	-	2	2	2	7	5	7
Smelt	*Osmerus mordax*	-	-	-	-	-	-	5	2	0
Snailfish	Liparidae	726	146	46	165	74	21	218	58	13
Spiny lump sucker	*Eumicrotremus spinosus*	68	43	1	33	26	1	71	47	2
Tomcod, Atlantic	*Microgadus tomcod*	10	1	4	-	-	-	-	-	-
Turbot	*Reinhardtius hippoglossoides*	52	28	26	78	28	41	58	26	24
Wolfish, Atlantic	*Anarhichas lupus*	2	2	0	12	8	3	5	3	1
Wolfish, spotted	*Anarhichas minor*	-	-	-	-	-	-	2	2	5
Wrymouth	*Cryptacanthodes maculatus*	-	-	-	3	2	0	-	-	-