European Green crab (*Carcinus maenas*) monitoring in the Maritimes Region 2008-2015

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Table of Contents

ABSTRACT

Vercaemer B. and Sephton D., 2016. European Green crab (*Carcinus maenas*) monitoring in the Maritimes Region 2008-2014. Can. Tech. Rep. Fish. Aquat. Sci. 3147: v + 56p.

The European green crab, *Carcinus maenus*, one of the ten most unwanted aquatic invasive species worldwide, is now present throughout Atlantic Canadian waters. This species impacts native species and communities through competition with other crustaceans and direct predation on clams, bay scallops and juvenile lobsters, as well as impacting eel fisheries and shellfish aquaculture. Green crabs also alter ecosystems and are defined as "ecosystem engineers". Fisheries and Oceans Canada (DFO) monitored populations by standardized Fukui trapping at 134 locations between 2008-2015, initially in the Bras d'Or Lakes, and followed by the Atlantic shore of Nova Scotia and the Bay of Fundy. Green crabs are indeed well established in the Region with CPUEs, a coarse indicator of abundance, above 30 crabs/trap/day at many locations. Lowest catches (from <5 crabs/trap/day) were recorded in the Bay of Fundy, along the shore of southwest NB, the northwest shore of NS and in the Bras d'Or Lakes, while highest catches were noted along the eastern shore of Nova Scotia (up to 340 crabs/trap/day) . Overall, CPUEs were highest in all regions in 2011.

Seasonal variability in green crab abundance in 2011-2013 was noted at North Sydney and the Dobson Yacht Club, and at Cole Harbour on the eastern shore, where CPUE was higher in July versus June. Overall female carapace width averaged 42.77 mm, compared with 53.41 mm for males. Carapace widths were significantly smaller for crabs sampled in northern regions of NS. Overall, females made up 32.25% of the trapped populations. Ovigerous females were found in early summer, and represented 0.4% of the trapped populations.

Trap comparison studies were conducted in 2012 and 2014, to compare the efficiency of the Fukui traps with other trap types used in earlier studies and in other Regions. Preliminary work in 2012 found no difference, based on CPUE, between Fukui and eel traps at 11 locations. Multi-Regional trapping, conducted for 3-4 consecutive days in August 2014, determined that Fukui traps had significantly higher CPUEs than both eel and shrimp traps, with similar CPUEs. Fukui traps also caught a wider size range of crabs compared to eel and shrimp traps.

RÉSUMÉ

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Le crabe vert, *Carcinus maenus*, l'une des dix espèces aquatiques envahissantes les plus indésirables au monde, est maintenant présent dans la majorité des eaux canadiennes de l'Atlantique. Cette espèce impacte les espèces et les communautés, par compétition avec les autres crustacés et par prédation directe sur les palourdes, les pétoncles de baie et les juvéniles de homards, ainsi que la pêche de l'anguille et la conchyliculture. Les crabes verts modifient également les écosystèmes et sont définis comme des «ingénieurs de l'écosystème». Pêches et Océans Canada (MPO) a réalisé un suivi des populations normalisé avec des trappes Fukui à 134 stations entre 2008-2015, d'abord dans le lac Bras d'Or, et ensuite sur la côte atlantique de la Nouvelle-Ecosse (NE) et de la baie de Fundy. Les crabes verts sont en effet bien établis dans la Région avec un PUE, un indicateur grossier de l'abondance, supérieur à 30 crabes / piège / jour à de nombreux endroits. Les taux de captures les plus faibles (à partir de <5 crabes/trappe/jour) ont été enregistrés dans la baie de Fundy, le long de la rive du sud-ouest du Nouveau-Brunswick et de la rive nord-ouest de NE, et dans le lac Bras d'Or, tandis que les plus fortes captures ont été observées le long de la côte est de la Nouvelle-Écosse (jusqu'à 340 crabes/trappe/jour). Dans l'ensemble, les PUE étaient les plus élevés dans toutes les zones en 2011.

La variabilité saisonnière de l'abondance de crabe vert en 2011-2013 a été notée à North Sydney et au Dobson Yacht Club, et à Cole Harbour, sur la côte est de NE, où les PUE étaient plus élevés en juillet qu'en juin. La largeur de la carapace femelle globale moyenne est 42,77 mm, comparativement à 53,41 mm pour les mâles. Les largeurs de carapace diminuent de façon significative pour les populations échantillonnées dans les régions nord de la Nouvelle-Écosse. Globalement, les femelles représentaient 32,25% des populations piégées. Les femelles ovigères ont été trouvées au début de l'été, et ont représenté 0,4% des populations piégées.

Des études comparatives des pièges ont été menées en 2012 et 2014, pour comparer l'efficacité des trappes Fukui avec d'autres types de pièges utilisés dans des études antérieures et dans d'autres régions. Les travaux préliminaires en 2012 n'ont trouvé aucune différence, sur la base de PUE, entre les trappes Fukui et les trappes à anguille à 11 sites. Par contre, un piégeage multi-régional, mené pendant 3-4 jours consécutifs en août 2014, a déterminé que les trappes Fukui avaient une PUE significativement plus élevée que les trappes à anguilles et ou à crevettes, dont le PUE était similaire. Les trappes Fukui piègent également une taille plus large de crabes par rapport aux trappes à anguilles ou à crevettes.

Introduction

The European green crab *Carcinus maenas* (hereafter referred as green crab), native to Europe and North Africa, is considered one of the ten most unwanted aquatic invasive species worldwide (IMO 2006). Green crabs are now found throughout Atlantic Canada and the spread of this species is the result of at least two introductions. The first wave from Southern Europe (warm water tolerant) invaded the Eastern US seaboard where it first arrived in the New York area in the early 1800's, probably with dry ballast/fouling-boring wooden ships. It slowly spread south and north to the Bay of Fundy (early 1950's) and southern Nova Scotia to Halifax where it stalled (Roman 2006). The second wave came from Northern Europe (cold water tolerant, more effective foragers) through water ballasts in the late 1980's-early 1990's. This second invasion moved rapidly around Cape Breton, into the Bras d'Or Lakes and into the Gulf of St. Lawrence where it now reaches the Magdalen Islands, Quebec, and southwest Newfoundland and Labrador where the species was first detected in 2004 and 2007, respectively (Audet et al. 2003, Roman 2006, Blackelsee et al. 2010, DFO 2011, Simard et al. 2013).

Several studies of relative frequency of the mitochondrial Cytochrome Oxidase I (COI) gene from many locations sampled in North America (Roman 2006, Roman and Darling 2007, Pringle et al. 2011) documented these invasions and found that the first wave of invasions introduced 3 of 61 haplotypes found in Europe and that the most recent wave added 7 haplotypes to the pool. Blakeslee et al. (2010) and Darling et al. (2014) found that there is some mixing between the populations in Nova Scotia (NS) and that green crabs detected in Newfoundland (4 haplotypes) in 2007 probably came from southwest Nova Scotia around 2002. The broad Halifax zone (Central NS) is part of a dynamic mixing area and is referred to as the admixing zone. The genotypes from the original introduction have been moving in a north-east direction and those from the second wave are progressing rapidly (currents) to the south-west (Blakeslee et al. 2010). While the genetic study of these invasions and spread is on-going in Atlantic Canada and risk assessments have been conducted for both coasts of Canada (Therriault et al. 2008), there are few studies on green crab abundance or on potential biological characteristics/behaviour differences across the Maritimes and very little monitoring of the populations (Tremblay et al. 2006, Vercaemer et al. 2011, Rossong et al. 2012, MacDonald 2014).

Green crabs are found in broad environmental conditions (temperature, salinity and oxygen) and bottom types, but prefer shallow, sheltered areas. In invaded areas, green crabs are known as "ecosystem engineers" (Audet et al. 2003, Klassen and Locke 2007). Aggressive and resistant, they can become a dominant species, competing with native crustaceans and destroying eelgrass beds (Davis et al. 1988, Malyshev and Quijon 2011, Garbary et al. 2014). They are

generalist predators, although significant predators of bivalves such as clams and bay scallops and can outcompete and prey on juvenile lobsters (Floyd and Williams 2004, Rossong et al. 2006, Klassen and Locke 2007 and references within). Green crabs are a potential threat to the eel fishery and are problematic for shellfish aquaculture (Miron et al. 2005, McKindsey et al. 2007). On the east coast of the United States, the cost of green crab damages to the shellfish fishery was estimated at $22.6 million per year (Lovell et al. 2007).

Management strategies proposed for green crabs include mitigation (e.g. intense trapping) (Grosholz and Ruiz 2002). In Southwest Nova Scotia, an experimental green crab fishery was initiated in 2011 for 3 years followed by a commercial licensed fishery from 2014 on. Five to 19 active licence holders (75 traps/licence) removed 157 tons of crabs (~3 million crabs) from 2011 to 2015 (DFO Policy & Economics, pers. comm.) and temporarily resulted in localized reduced catch rates. However, a number of questions remain as to how to effectively remove green crabs (e.g. location of harvestable populations, type of trap and bait, long-term strategies).

Fisheries and Oceans Canada (DFO) has been monitoring green crab abundance at selected locations in the Atlantic zone since the establishment of the Aquatic Invasive Species program in 2006. The DFO Maritimes AIS group has first focused on the Bras d'Or Lakes (Vercaemer et al. 2011), and then along the Atlantic shore of NS and in the Bay of Fundy (Nova Scotia and New Brunswick shores). Here we report on the monitoring conducted in the Maritimes from 2008 to 2015. While the Fukui trap is the standard monitoring trap used on both coasts of Canada by DFO staff and academia, this type is not used by fishermen as the trap is relatively small and quite fragile. However, Fukui traps are used for monitoring the efficiency of the intense trapping (conducted with modified shrimp traps) in Nova Scotia at Kejimkujik National Park Seaside Adjunct and in Newfoundland (Placentia Bay). In 2014, several DFO Regions compared the different traps used (or recommended) for intense green crab trapping. We also report here on the results of the comparison of the standard Fukui trap with modified eel trap and modified shrimp trap, two types of traps used in the Maritimes.

1. Materials and Methods

Monitoring for green crab abundance in the Maritimes was performed through trap surveys. As per DFO protocol (established nationally in 2006), baited Fukui traps soaked for 24 hours were used to determine catch per unit effort (CPUE), size distributions and crab characteristics (e.g. morphometrics) along with spatial and temporal variability. Eel traps were used in early surveys in 1999 and 2005 (Tremblay et al. 2006), but mainly in Cape Breton, and soak time was only 3 hours. Trap surveys began in July 2008 in both Nova Scotia and southern New Brunswick and monitoring is currently on-going, conducted either directly by DFO staff or by monitoring partners. Here we report on all monitoring results up to November 2015.

Survey locations were selected to represent a wide range along the coast of Nova Scotia and southern New Brunswick (Figure 1 and Appendix A for details). These were determined using a combination of factors, including locations of the AIS biofouling monitoring program, local knowledge, known preferred green crab habitats and safe access. A portion of the Eastern shore and the upper Bay of Fundy were not surveyed.

Not every location was sampled annually but rather efforts were made to determine seasonal and inter-annual variability of the catch rate at a number of locations. Spatial variability was also considered during the AIS Rapid Assessments conducted in Gillis Cove and at the Lunenburg Yacht Club in 2009, in Aspy Bay and Ben Eoin in 2010, and in Cole Harbour in 2011 (Appendix A). In addition, four locations in the Bras d'Or Lakes (Eskasoni, Potlotek, We'koqma'q and Wagmatcook) were used to study the relationship between eel grass coverage and green crab abundance in 2008-2010 (Vercaemer et al. 2011). Finally, to compare catch rate data from different types of traps, additional surveys were conducted during the summer of 2012 at 11 locations using Fukui and eel traps and a multi-day multi-trap study was performed in August 2014 in Cole Harbour.

Beach surveys were also performed sporadically in the Passamaquoddy Bay area but are not reported here.

1.1. Green crab surveys

A minimum of three rectangular (61 x 46 x 20 cm) Fukui traps (Figure 2) were used for regular sampling. They are constructed of 1.6 cm mesh size with wide slit openings at both ends of the trap. While this type of trap is ideal for large scale monitoring (i.e. light, foldable), they are fragile and require regular inspection and maintenance to insure integrity.

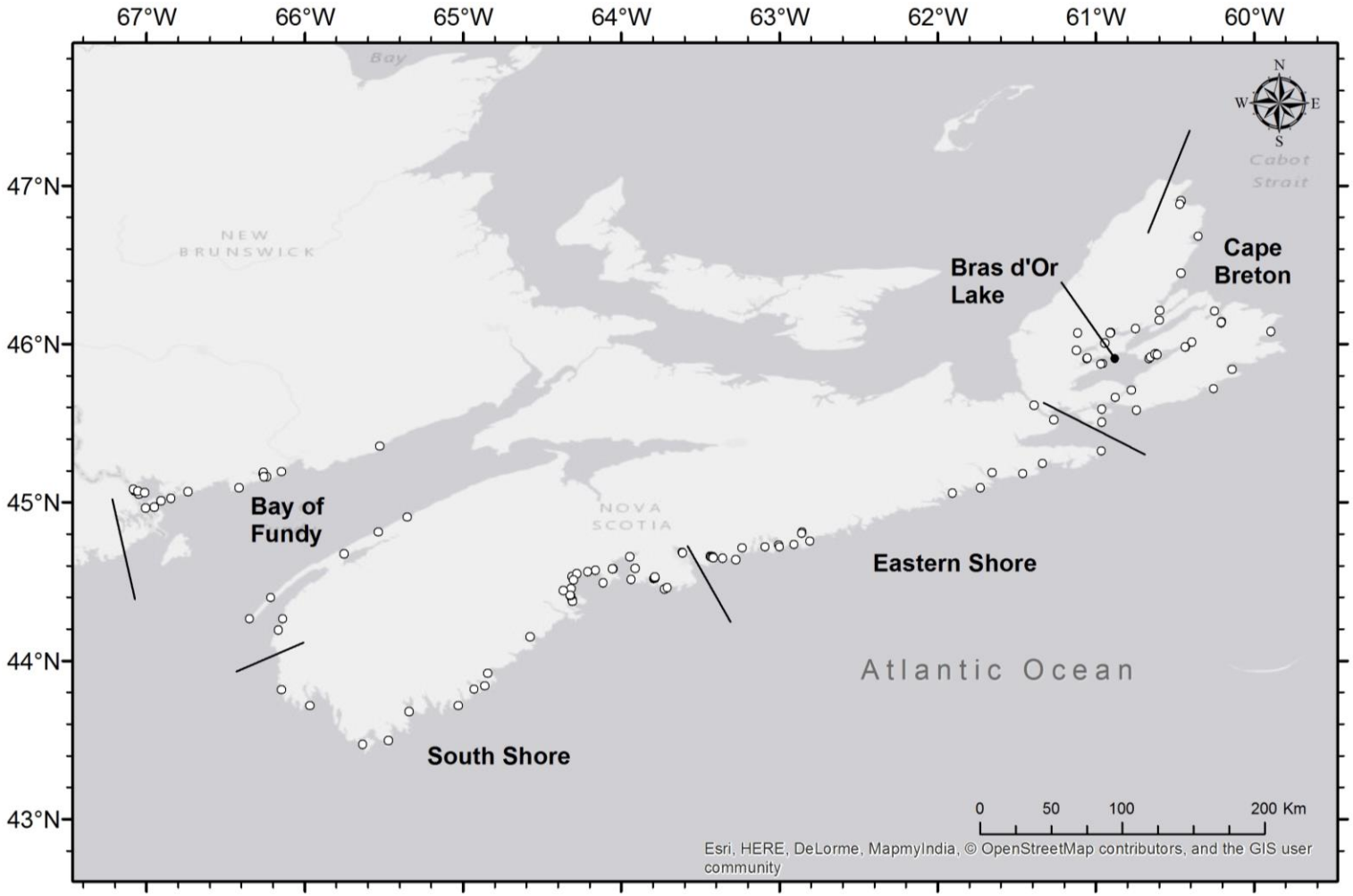


Figure 1. Location of stations established throughout the Maritimes green crab monitoring program (2008-2015) and broad divisions into five areas. See Appendix A for details.

Figure 2. Standard Fukui trap used in the National DFO green crab monitoring program. Photo. B. Vercaemer, DFO.

Freshly thawed mackerel (or occasionally herring) were placed in a standard perforated plastic bait box. Traps were deployed from shore, at a low tide (minimum depth of 0.5 m) to ensure that they would be submerged at all times. They were spaced 5-10 m apart, secured with a weight and marked by a float.

Each monitoring location was photographed and georeferenced using a Garmin eTrex unit. Temperature (°C), salinity (psu) and dissolved O_2 (mg L^{-1}) content were measured off bottom at deployment time using a YSI 85, Pro+ or 6600 sonde. Bottom type and vegetation (type and % cover) was also recorded at each deployment location.

After 24 hrs, traps were removed at low tide and the catch was sorted. Only data from fully functioning traps (e.g. not open, even partially) were recorded. Green crabs were either processed on site or they were bagged per trap and frozen until further analyses. Total weight of all green crab trapped was recorded per trap and crabs were individually sexed and carapace width (CW) was measured point-to-point[1] to the nearest mm using a digital caliper. Shell and abdomen colors were also recorded individually (see Appendix B) as well as shell condition (e.g. softness, wear or fouling) and injuries (missing limbs and other injuries). CPUE (Catch Per Unit Effort) was defined as the average number of green crabs caught in a Fukui trap in 24 hr (or number of green crabs/trap/day thereafter).

[1]Point-to point corresponds to the longest measurement across the carapace as opposed to notch-to-notch measurements made with caliper tips placed in the notches between the 4th and 5th anterolateral spines.

By-catch was recorded, by number of individuals for each species, and released live on site.

All data were entered into an ACCESS database and are available upon request.

1.2. Experimental trapping

Earlier trap surveys conducted in the Maritimes (Tremblay et al. 2006) used modified eel traps (hereafter eel trap) and made comparison with Fukui traps difficult (Vercaemer et al. 2011). In addition, fishermen have used other types of traps and these varied from region to region. To assess the differences in the catchability of different trap designs, small experimental field studies were conducted using two different traps: Fukui and eel traps or three different traps: Fukui traps, eel and shrimp traps (a.k.a. modified shrimp trap) simultaneously. The latter was designed by a Port Mouton fisherman, M. Russell Nickerson and the trap is also known as the Russell's trap. In the second experiment conducted over one week, variation in CPUEs over consecutive days was also assessed. Statistical analyses were performed using the R packages. Two way ANOVAs were conducted on the square root transformed counts of total (male + female) green crabs/trap/day (sqGC).

1.2.1. Fukui trap - Eel trap comparison

Preliminary trap comparisons were performed from June to September 2012, in parallel to the monitoring surveys, using three Fukui traps and three eel traps (Figure 3) at 11 locations on the South Shore, Eastern Shore and Cape Breton (CB), representing a variety of habitats: Big Harbour, Shad Bay Cannon Rock, East Jeddore (2), Indian Point, Lawrencetown River, Little Harbour CB, Mill Cove (1), Mill Cove (2), Sonora, Cole Harbour (6), Cole Harbour (9) and South Haven (see Appendix A for details). The last three stations were sampled twice. Eel traps were cylindrical (61 cm length x 37 cm in diameter), constructed of 1.3 cm Vexar mesh, with an entrance shaped like a funnel of 9 cm (Figure 3). Fukui and eel traps were randomly interspaced by 5-10 m. Traps were baited with mackerel and allowed to soak for 24 hr (as per standard protocol). Catch processing was identical to the surveys: green crabs were retrieved, counted, sexed and measured (CW) and by-catch identified, counted and released.

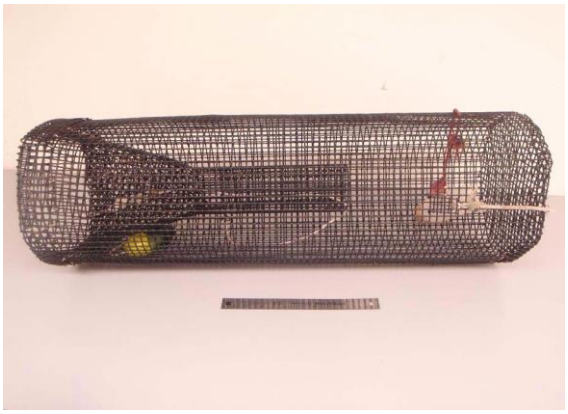


Figure 3. Eel trap used in experimental trapping (2012). Photo: D. Pouliot, Parks Canada.

1.2.2. Fukui trap - Eel trap - Shrimp trap comparison

The experiment took place from August 18 to 22, 2014 when water temperature averaged 18°C and when crabs are foraging and mobile. Shrimp traps are constructed of coated wire mesh, with dimensions of 61.5 cm x 61.5 cm x 36 cm with a 39 cm x 7 cm slit top opening (Figure 4). Eighteen traps (6 x 3 types) were deployed at a single site, Cole Harbour (Station 6), in a ~100 m x 20 m area of mixed bottom type (sand-mud-pebbles) at 0.5-1m depth. The area where the traps were deployed was relatively uniform with 5% eelgrass coverage. The traps were baited with mackerel and randomly deployed at low tide ~5-10 m apart, to minimize interference, in a zig-zag fashion, and allowed to soak for 24 hr (as per standard protocol). Crabs were retrieved, counted, sexed and measured (CW) and traps were re-baited and re-deployed for three additional consecutive days.

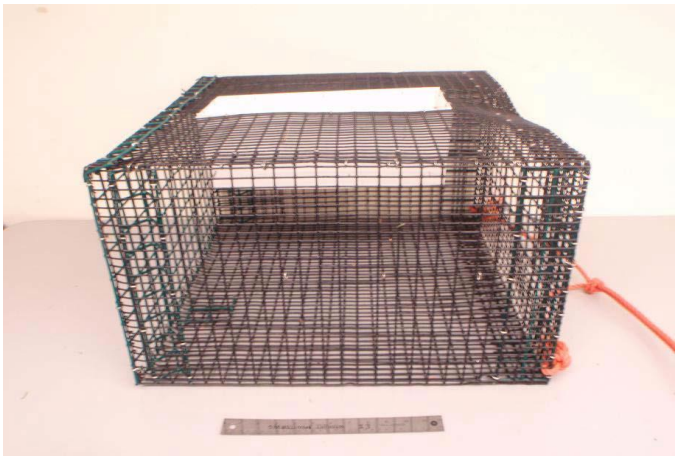


Figure 4. Shrimp trap (a.k.a. Russell's trap) used in experimental trapping (2014). Photo. D. Pouliot, Parks Canada.

2. Results and Discussion

2.1. Green crab abundance in the Maritimes 2008-2015

Catch rates obtained in this study are a function of both the abundance and the catchability of green crabs. Temperature, salinity, bottom type and tidal cycle are important factors influencing catch and it is important to record these when possible as well as biological factors such as molting and reproductive status and the presence of prey and predator species in the trap. As trap design, depth and soak time are standardized and soak time includes the higher foraging night period, the catch rates or CPUEs recorded in this study may be used as a coarse indicator or index of abundance. However, sampling with Fukui traps excluded a portion of the green crab population (i.e., juvenile and ovigerous crabs).

2.1.1. Distribution and overall catch rates

The trapping surveys conducted in the Maritimes between 2008 and 2015 included 134 locations, 1,348 recovered functional traps and 16,376 crabs sampled over 8 years. Green crabs were caught between June and October each year (with the exception of a few May and November samplings), within a 6.5-22.8°C range in temperature and 20.62-30.24 psu in salinity. The survey confirmed the overwhelming establishment of *C. maenas* across the Maritimes, with large populations present in several areas along the Atlantic shore of Nova Scotia where CPUEs > 30 green crabs/trap/day in any given year of the monitoring program are not uncommon (Figure 5). Lower catches were often observed in the Bay of Fundy along both the southwestern shore of New Brunswick and northwestern shore of Nova Scotia and in the Bras d'Or Lakes of Cape Breton. Only two survey locations, Baddeck and Ingonish, Cape Breton, NS which were surveyed only once, did not return any crab.

The current range of *C. maenas* on the East coast of Canada includes not only southwest New Brunswick and Nova Scotia, but the Northumberland Strait where the species has been present since the late 1990s and further north into the Gulf of St. Lawrence where it was detected in the Iles de la Madeleine and in southwest Newfoundland in 2004 and 2007, respectively. However, the population range margins are shifting with increase (Fortune Bay, Newfoundland, C McKenzie, pers. comm.) and decrease (Iles de la Madeleine, Québec, N. Simard, pers. comm.) in catch rates recorded in the past two years.

Over all years and locations, the average catch rate was 12.54 crab/ trap/day but varied from 0 (Ingonish or Baddeck) to 340.33 crab/trap/day (n=3) in Clam Bay on the Eastern Shore of NS on

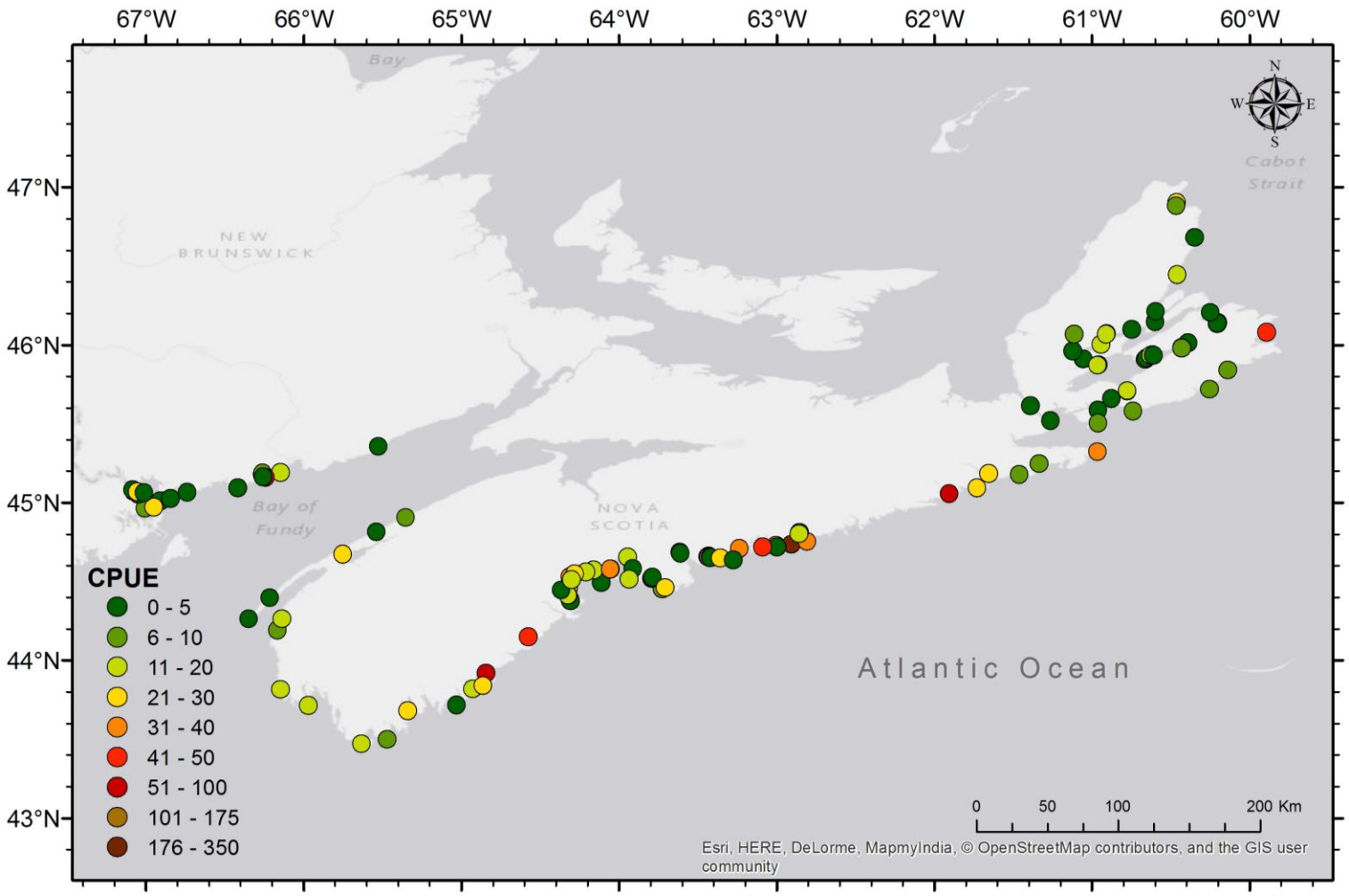


Figure 5. Average CPUE (number of green crabs/trap/day) recorded during the Maritimes green crab monitoring 2008-2015.

Sept. 22, 2011 (see Appendix A). On the west coast of Canada, Gillespie et al (2015) recorded an average of 5.13 green crabs/Fukui trap/day between 2006 and 2013 with a maximum of 122.67 green crabs/trap/day in Barkley Sound on the west coast of Vancouver Island where the species was first detected in 1999. No green crabs were captured on the North Coast, Haida Gwaii or on the east coast of Vancouver Island despite extensive sampling efforts (Gillespie et al. 2015).

2.1.2. Regional variations in catch rate

Overall, the surveys conducted on the Eastern Shore and in Cape Breton seemed to return the highest yearly regional average CPUEs of the Maritimes; 52.0 and 43.0 green crabs/trap/day, respectively (Figure 6). Average CPUEs in 2011 were the highest (from 16.4 to 50.9 green crabs/trap/day) across all regions of Nova Scotia while they were the lowest the previous year. However, these results are limited to 8 years of surveys and the number of locations surveyed varied from year to year.

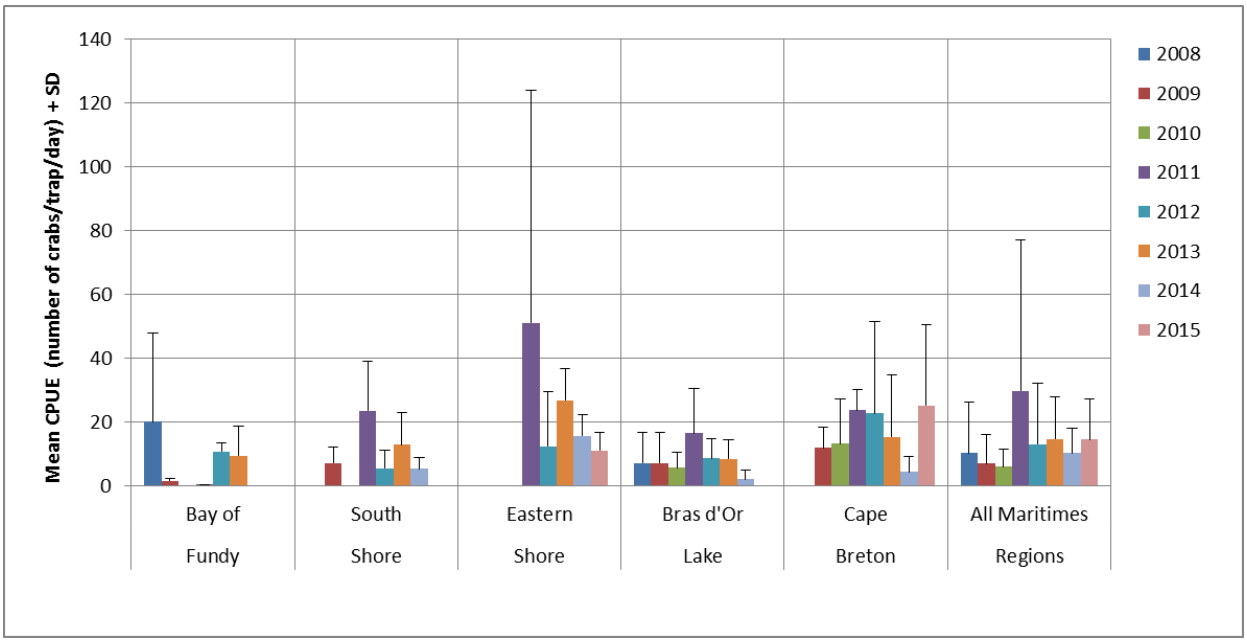


Figure 6. Mean CPUE (number of green crabs/trap/day) + SD per region and per year.

On a regional basis, in the Bay of Fundy, CPUEs varied on a yearly average from 0.1 to 20.1 green crabs/trap/day and the highest values (>40 green crabs/trap/day) were obtained only in the Musquash Estuary Marine Protected Area (MPA) (Figure 7). In September 2015, an independent survey of the estuary using Fukui traps yielded similar results with low CPUEs (0-20 green crab/trap/day) at Five Fathom Hole and on the West side but high CPUEs (up to 85 green crab/trap/day) on the Eastern side portion of the estuary where there is more freshwater

input (J. Fitzgerald, pers. comm.) . CPUE values <40 but >20 green crabs/trap/day were found at the entrance of the Bay of Fundy, in the Passamaquoddy Bay (St. Andrews and Leonardville on Deer Island) and at Battery Point, near Digby (Figure 7).

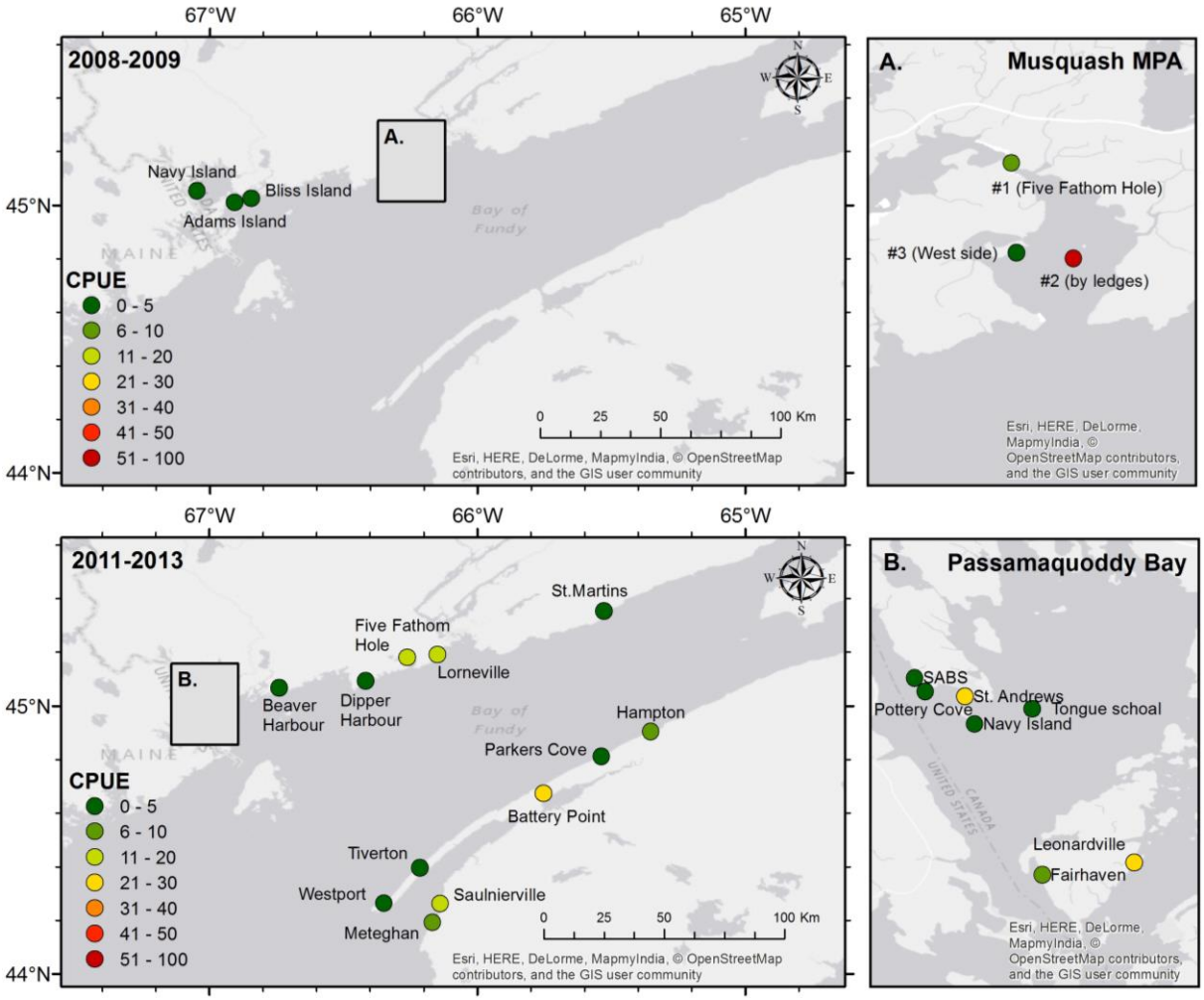


Figure 7. CPUE (number of green crabs/trap/day) recorded in the Bay of Fundy, NB and NS (2008-2013).

It is interesting to note that green crabs appear to be less abundant in the Bay of Fundy, where they were first detected in 1951 (in the Passamaquoddy Bay in rocky intertidal habitats), than in other areas of NS invaded later (Figure 5). However, even if their abundance is low, in particular inside the bay (CPUE < 10 green crabs/trap/day in St. Martins, Hampton and Parker's Cove), their range has expanded well into the upper Bay of Fundy, both in Chignecto Bay and the Minas Basin (D. Drolet, pers. comm, A. MacDonald, pers. comm.). Using Fukui traps and a similar protocol, Mac Donald (2014) recorded an average CPUE of 1 to 8 and 1 to 12 crabs/trap/day at a rocky intertidal site and a mud flat site, respectively, 80 km northeast of St.

Martins. On the Nova Scotia shore of the upper Bay of Fundy, green crab molts have been observed on mud flats south of the Minas Basin, but no live or dead individuals were detected (MacDonald, 2014). This contrasts with recent beach surveys conducted in the Passamaquody Bay area where hundreds of small live crabs are found regularly (T. Dean, pers. comm.).

On the South Shore, CPUEs varied on a yearly average from 5.2 to 23.5 green crabs/trap/day and the highest values (>40 green crabs/trap/day) were obtained at Central Port Mouton and East Port Medway (Figure 8). On the Eastern Shore, CPUEs varied on a yearly average from 11 to 50.9 (Figure 6) and numerous locations showed CPUEs well above 40 green crabs/trap/day at Cole Harbour, Lawrencetown River, East Jeddore, Ostrea Lake and Sonora with a maximum of 340.3 green crabs/trap/day at Clam Bay causeway in 2011 (Figure 9). On both the South Shore and Eastern shore, the estuaries sampled were more complex in terms of habitat characteristics (mix of salt marsh, mud flat, eelgrass bed, deep channel, rocky bottom) and may support a larger species diversity (hence predators and competitors) than relatively simpler estuaries with mud flats, shallow sandy bottom and salt marches.

In Cape Breton, yearly average CPUEs in the BDOL, where salinity averages 20 psu (Petrie and Bugden 2002), were systematically low (7.0 - 8.5 green crabs/trap/day) throughout the extensive sampling of 2008-2013 with the exception of 2011 when average CPUE =16.4 green crabs/trap/day (Figures 10). Only three sampling events at Morrisons Cove, Eskasoni and Potlotek showed CPUEs > 40 green crabs/trap/day but on average CPUEs were 25.9, 9.9 and 10.2 respectively (Figure 10). In Wagmatcook, where salinity is even lower (average of 16 psu), green crab CPUE varied from 0 to 13 in October 2009 and October 2010 in areas where the bottom was covered with patchy eelgrass (Vercaemer et al. 2011). Between October 7-31, 2014, an independent study indicated a daily average CPUE of 1.24 (min 0.8 – max 2.5) (Wagmatcook Fisheries, pers. comm). Crabs were caught at the same location in 2009-10 on similar bottom type but in deeper waters (2.7 m). The Atlantic shore of Cape Breton exhibited a wider range of yearly average CPUEs (4.3 to 25.2 green crabs/trap/day) for 2010-2015 (Figure 6). The two locations with the highest average CPUEs in the region and where CPUEs >40 green crabs/trap/day were False Bay (CPUE=43 green crabs/trap/day) and Dobson Yacht Club in Sydney Harbour where 5 out of 13 samplings returned CPUEs>40 green crabs/trap/day with a maximum of 91 green crabs/trap/day (Figure 10 and Appendix A).

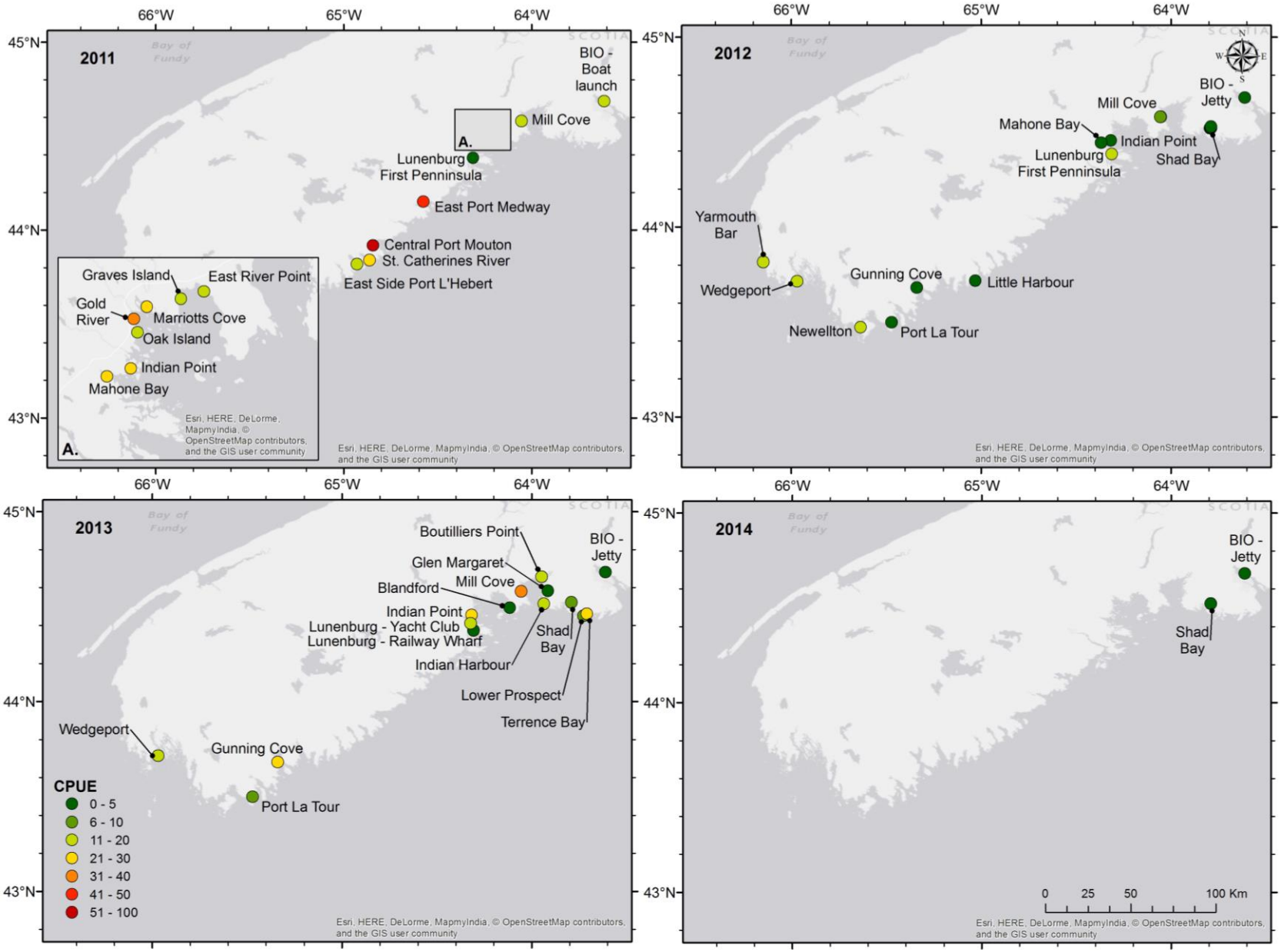


Figure 8. CPUE (number of green crabs/trap/day) recorded on the Shore Shore, NS (2011-2014).

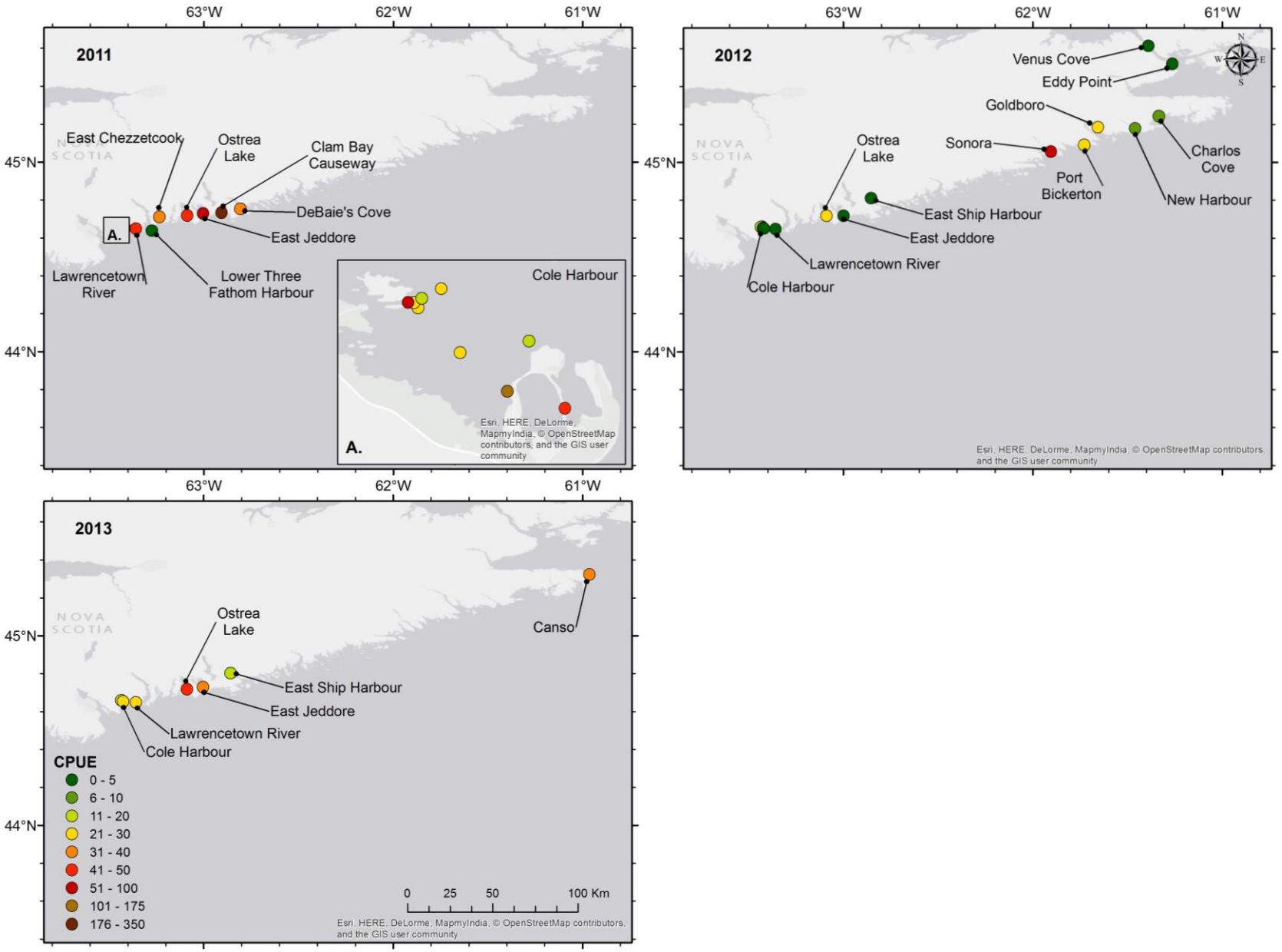


Figure 9. CPUE (number of green crabs/trap/day) recorded on the Eastern Shore, NS (2011-2013).

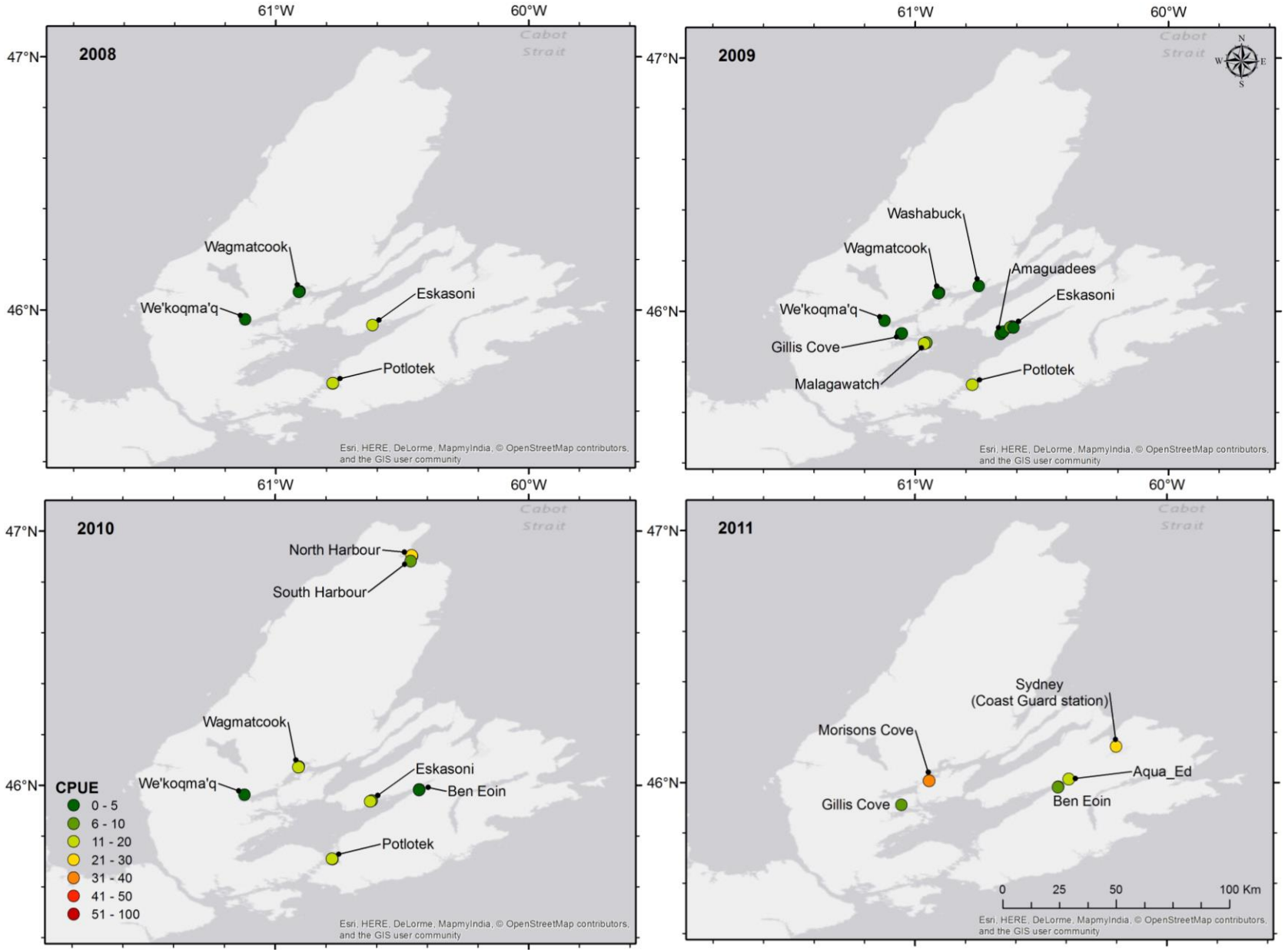


Figure 10. CPUE (number of green crabs/trap/day) recorded in the Bras d'Or Lakes (BDOL) and along the Atlantic shore of Cape Breton, NS (2008-2015).

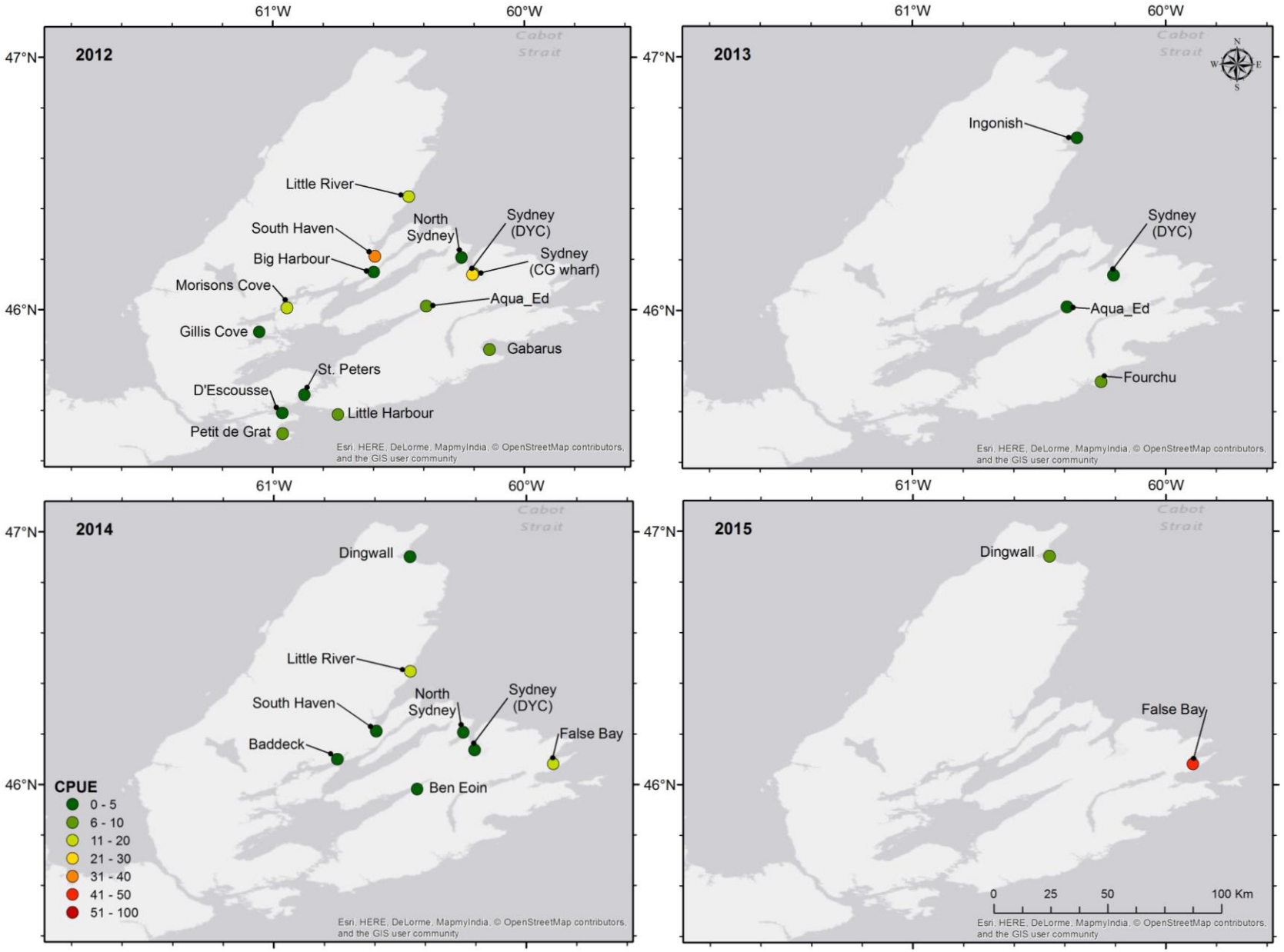


Figure 10. Continued.

2.1.3. Spatial-temporal variations in catch rate

Large variations in catch rates were often observed at a small spatial (~1 km) and temporal scale (~1 week):

Spatial variations:

CPUEs were determined during AIS Rapid Assessments (RA) conducted in Lunenburg and Gillis Cove in 2009 (Figure 11) and in Aspy Bay and Ben Eoin in 2010 (Figure 12). They were low (<10 green crabs/trap/day) and varied little at a scale of less than a few hundred meters. The habitat was relatively uniform within the different sites surveyed at those locations. However when distances between sites increased such as during the RA in Cole Harbour in 2011 (Figure 13), more differences could be observed between sites. The average CPUE for stations 1 to 5, distant from a few hundred meters, varied from 18 to 24 crabs/trap/day whereas CPUE reached 173 green crabs/trap/day at station 6, situated 1 km south. The bottom type there consists predominantly of a sandy/muddy bottom, close to eel grass beds, between a small fresh water input and a deep channel. The area is also a well know soft-shell clam harvesting zone. This habitat is in fact conducive to the establishment of a healthy breeding green crab population. Several stations were considered in Cole Harbour as sentinels and were surveyed each year following the 2011 RA (Figure 14). However, sites were not sampled at the same time of the year so the overall lower CPUEs reported reflect both spatial and temporal variations.

Temporal variations:

Temporal variations, both inter-annually and intra-annually, were assessed in Cape Breton from 2011 to 2013 in the Bras d'Or Lakes (Aqua_Ed and Morrisons Cove) (Figure 15) and in Sydney Harbour where two stations on opposite sides of the harbour were surveyed regularly: North Sydney and Dobson Yacht Club (Figure 16), as well as on the Eastern shore at two sentinel stations in Cole Harbour (stations designated as Cole Harbour 5 and Cole Harbour 6) (Figure 17). In all cases, the highest CPUEs were recorded when temperature was high. For example in East Bay, CPUEs are higher in July (17.5 – 32.5 crabs/trap/day, n=4) than in June 2011 (1.7 – 7.0 crabs/trap/day, n=6) or June 2012 (6.7 – 9.7 crabs/trap/day, n=6). It is not uncommon to observe a doubling of CPUE between consecutive days or up to a seven time increase within a week. At Cole Harbour 5 and 6, even though CPUEs were high in 2011 (i.e. 57 and 173 crabs/trap/day, respectively), they were lower in the following years and varied between 3 to 30 and 2 to 23 green crabs/trap/day, respectively (Figure 14 and Appendix A). Similarly, CPUEs in North Sydney decreased from 15.5 – 31.5 crabs/trap/day (n=6) in June 2011 to 5.3-9.3 crabs/trap/day (n=4) in June 2012 (Figure 16. A).

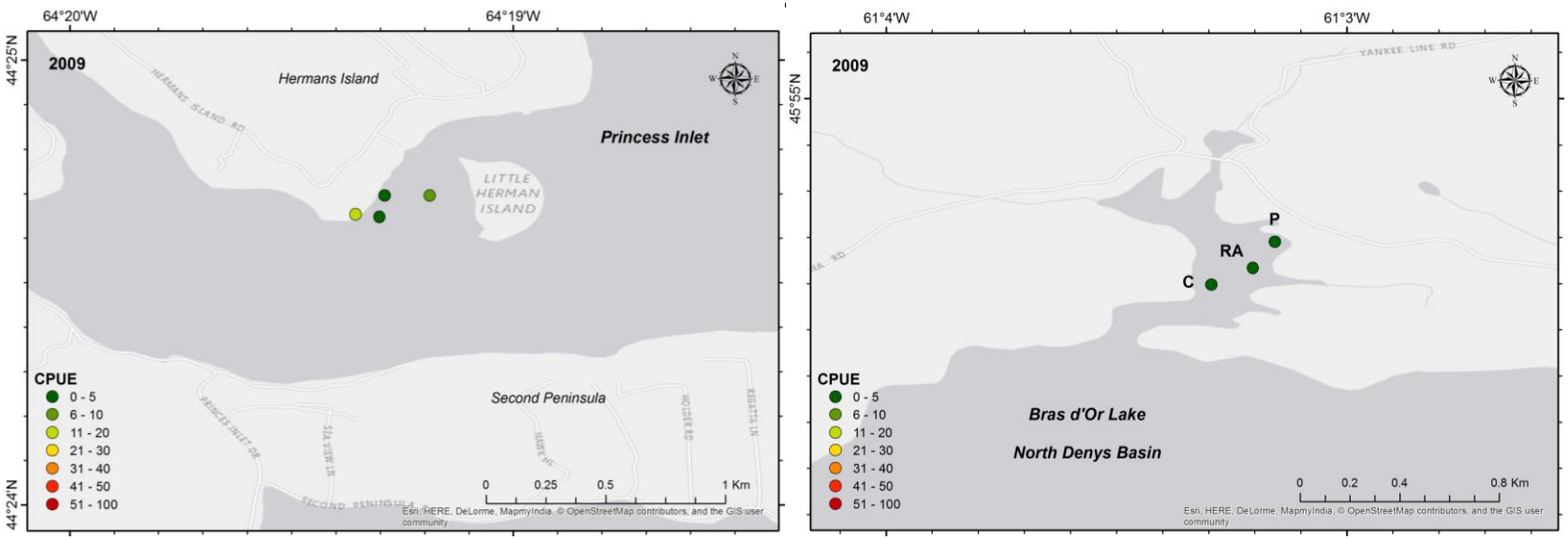


Figure 11. CPUE (number of green crabs/trap/day) recorded during AIS Rapid Assessment surveys A. Lunenburg (Sept. 30, 2009) and B. Gillis Cove (Oct. 7, 2009). RA: Rapid Asessment C: Continuous eelgrass coverage. P: Patchy eelgrass coverage

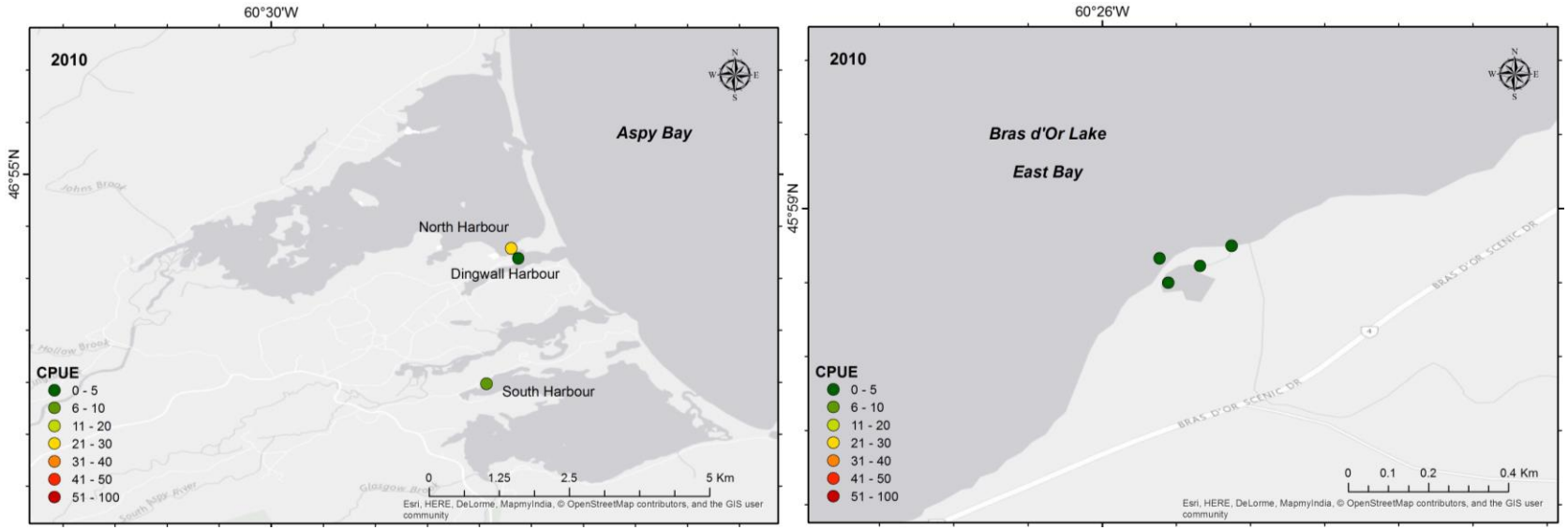


Figure 12. CPUE (number of green crabs/trap/day) recorded during AIS Rapid Assessment surveys A. Aspy Bay (Sept 7-8, 2010) and B. Ben Eoin (Sept 20-21, 2010).

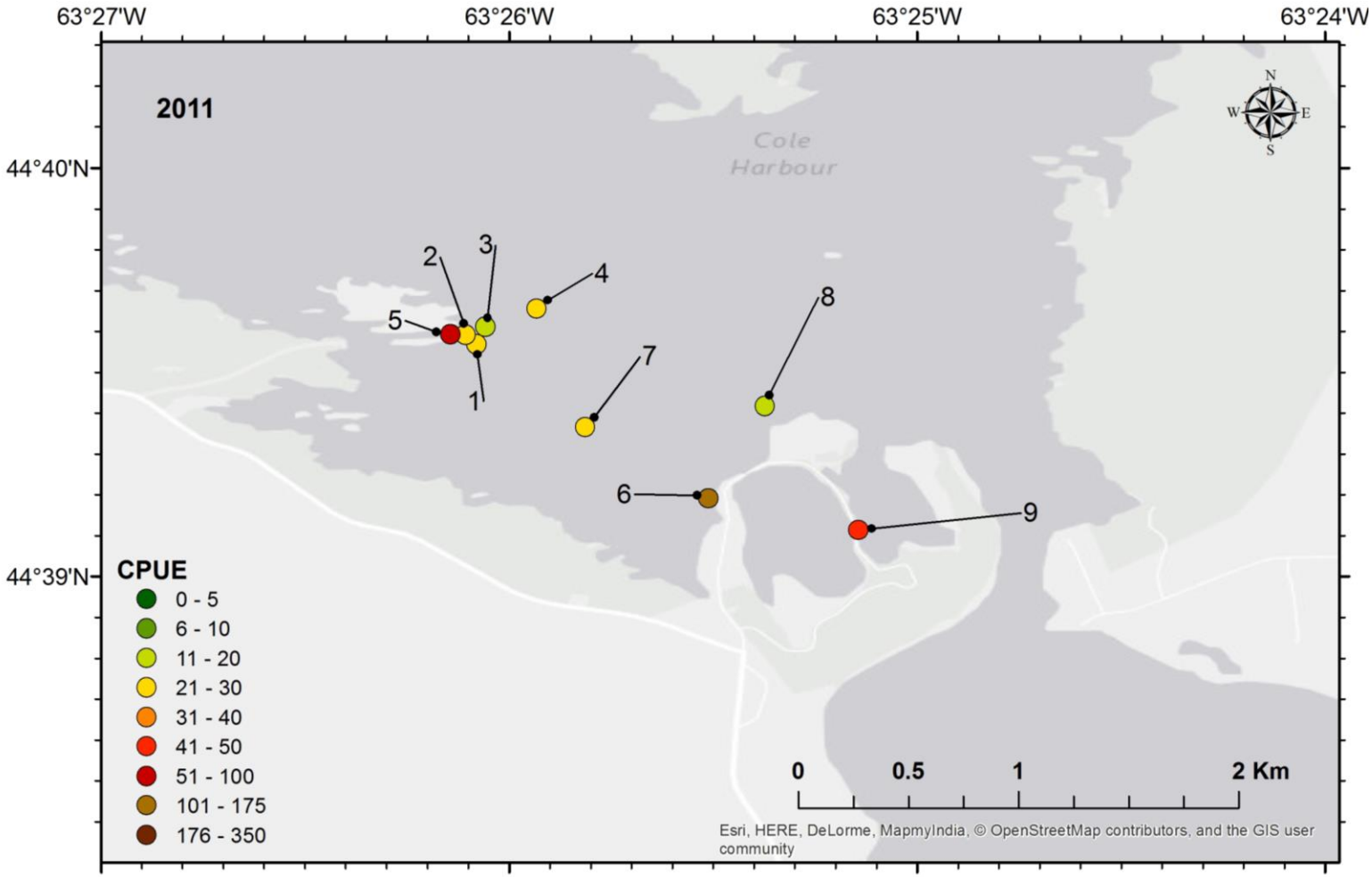


Figure 13. CPUE (number of green crabs/trap/day) recorded during AIS Rapid Assessment surveys in Cole Harbour. Stations (1) to (5) were surveyed on May 25-26, 2011; stations (6) and (9) on July 28, 2011 and stations (7) and (8) on Sept.13, 2011.

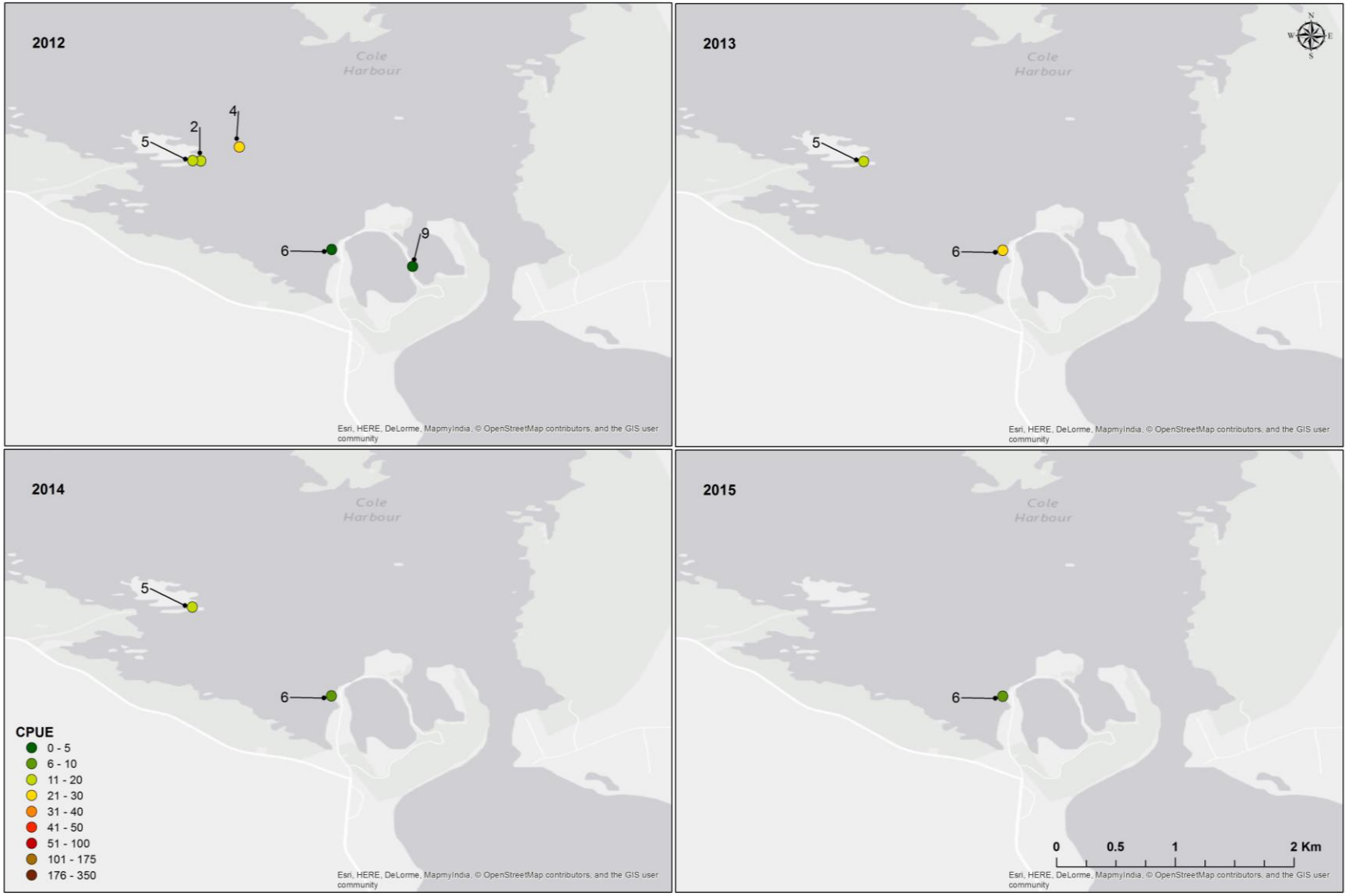


Figure 14. Yearly average CPUE (number of green crabs/trap/day) recorded during regular monitoring in Cole Harbour 2012-2015.

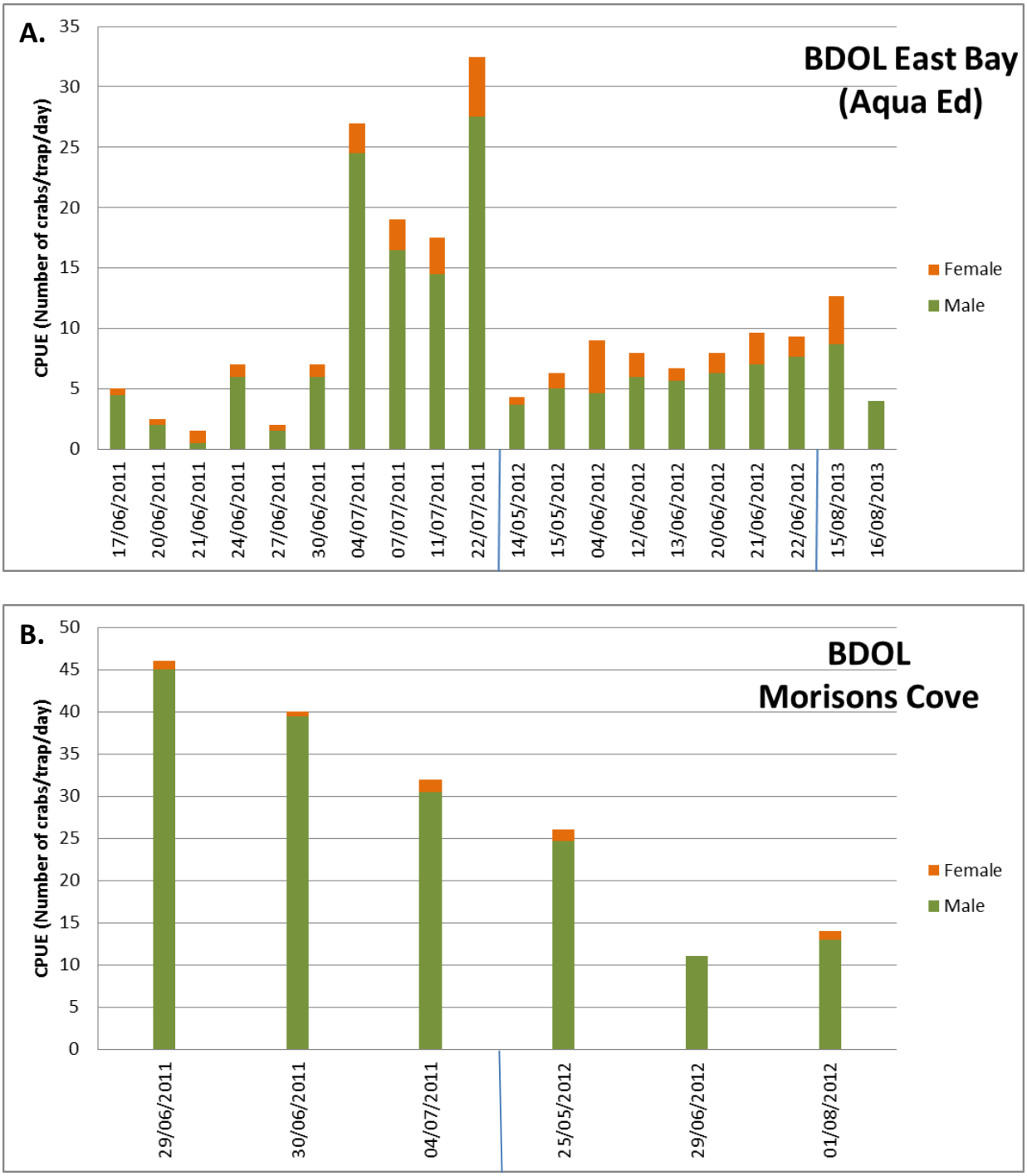
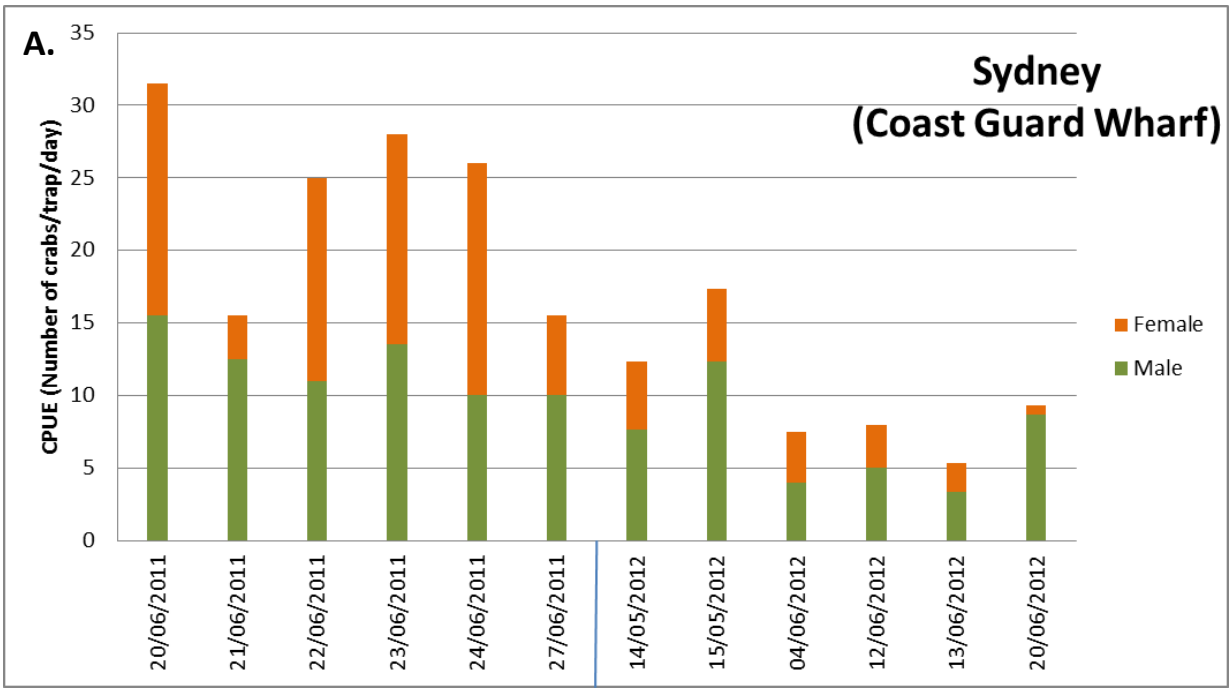


Figure 15. CPUE (number of green crabs/trap/day) recorded in the Bras d'Or Lakes (BDOL) at, A. East Bayat Aqua Ed and, B. Morisons Cove in 2011-2013.



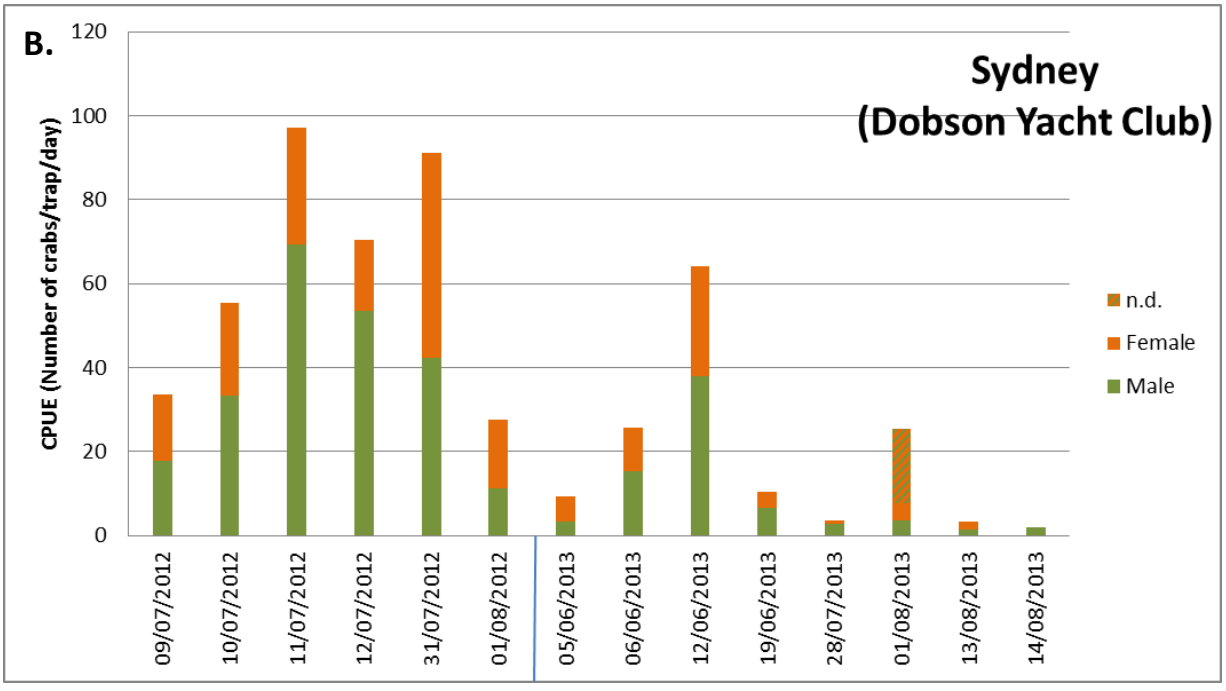


Figure 16. CPUE (number of green crabs/trap/day) recorded in Sydney Harbour, A. Coast Guard wharf and, B. Dobson Yacht Club, 2011-2013 (n.d. non determined).

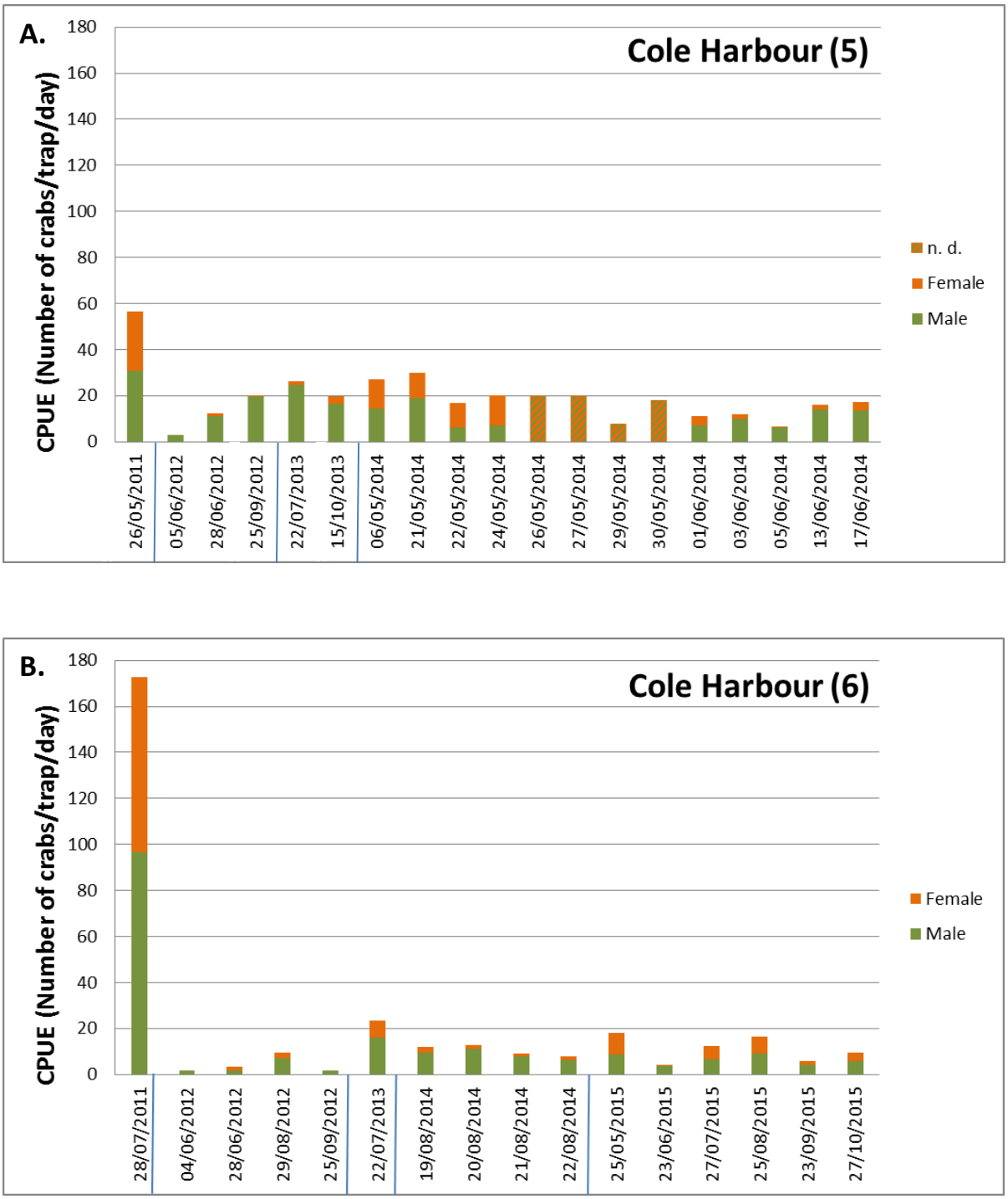


Figure 17. CPUE (number of green crabs/trap/day) recorded at, A. Cole Habour (5) and, B. Cole Harbour (6), 2011-2015 (n.d. non determined).

There was no winter sampling conducted for the green crab monitoring program in the Maritimes. However, it is likely that *C. maenas* individuals would have been caught especially

on the Eastern shore and in Cape Breton where populations are genetically different and more cold tolerant (Roman et al. 2006, Blakeslee et al. 2010). Male green crabs in Newfoundland still captured and consumed blue mussels (up to 13 in a 4 hr period, at 4°C) (Matheson and Gagnon 2012). Gillespie et al. (2015) noticed that green crab continued to forage at a depth temperature as low at 4-5°C on the Canadian west coast. In contrast, in a New Hampshire estuary, Fulton et al. (2013) found that green crab catches were maximized when bottom temperature reached ~12°C (April and November) and not during the summer months when temperature was warmer. With a more cold tolerant population spreading throughout the region, it would be interesting to extend the Maritimes green crab monitoring program year-round to determine differences in activity between green crab populations established at selected locations during the winter months.

2.1.4. Crab sizes and sex ratio

Overall, the surveys show that the average female and male *C. maenas* had an average carapace width of 42.77 and 53.41 mm respectively (Table 1, Figure 18). Female CW and male CW were significantly different (Table 2). On the west coast of Canada, female and male CWs averaged 57 and 60 mm (and were significantly different) during an eight year monitoring survey using Fukui traps (Gillespie et al. 2015). It appears that both female and male green crabs are larger and that the difference in CW between male and female green crab is much smaller on the west coast of Canada than on the East coast.

Based on the trapping surveys over locations and years, female and male crabs comprised 32.25% and 67.75% of sexed crabs, respectively. Twenty-two or 0.4% of the 5104 female crabs sampled were ovigerous. However, the sex ratio varied depending on sampling date, with more females (especially ovigerous) caught early in the summer, or if females enter the traps first. Cameron (2003) and Audet et al. (2008) found similar results in Nova Scotia and Prince Edward Island, respectively. In Eskasoni, in the Bras d'Or Lakes, females outnumbered males during the monthly samplings in 2008 especially in July (Vercaemer et al. 2011). It is interesting to note, however, that in that case and others such as in Clam Bay and Cole Harbour, where CPUEs peaked at 340.3 and 172.7 respectively in 2011, sex ratio (F:M) was above the average at 0.74 and 0.44 respectively. Fulton et al. (2013) found that peaks of CPUEs at salinity 30-31 psu were at times the result of a large turnout of females.

Table 1. Summary statistics of female and male *C. maenas* CW (mm) caught during the Maritimes Region monitoring surveys (2008-2015).

	Bay of Fundy	South Shore	Eastern Shore	Cape Breton	Bras d'Or Lakes	Maritimes Total
Counts						
Female	136	593	2177	1013	1185	**5104**
Male	544	1827	3698	1690	2964	**10723**
Mean CW						
Female	48.06	47.41	43.25	37.14	43.75	**42.77**
Male	59.93	59.35	53.98	45.61	52.30	**53.41**
Standard Deviation						
Female	9.53	10.00	9.17	8.37	8.18	**9.44**
Male	12.03	12.62	14.57	11.60	9.82	**13.18**
Minimum						
Female	29.90	20.64	17.57	20.00	17.10	**17.10**
Male	18.98	13.40	19.02	20.00	18.90	**13.40**
Maximum						
Female	75.98	86.20	77.57	69.00	88.00	**88.00**
Male	111.90	85.64	92.19	83.71	85.00	**111.90**

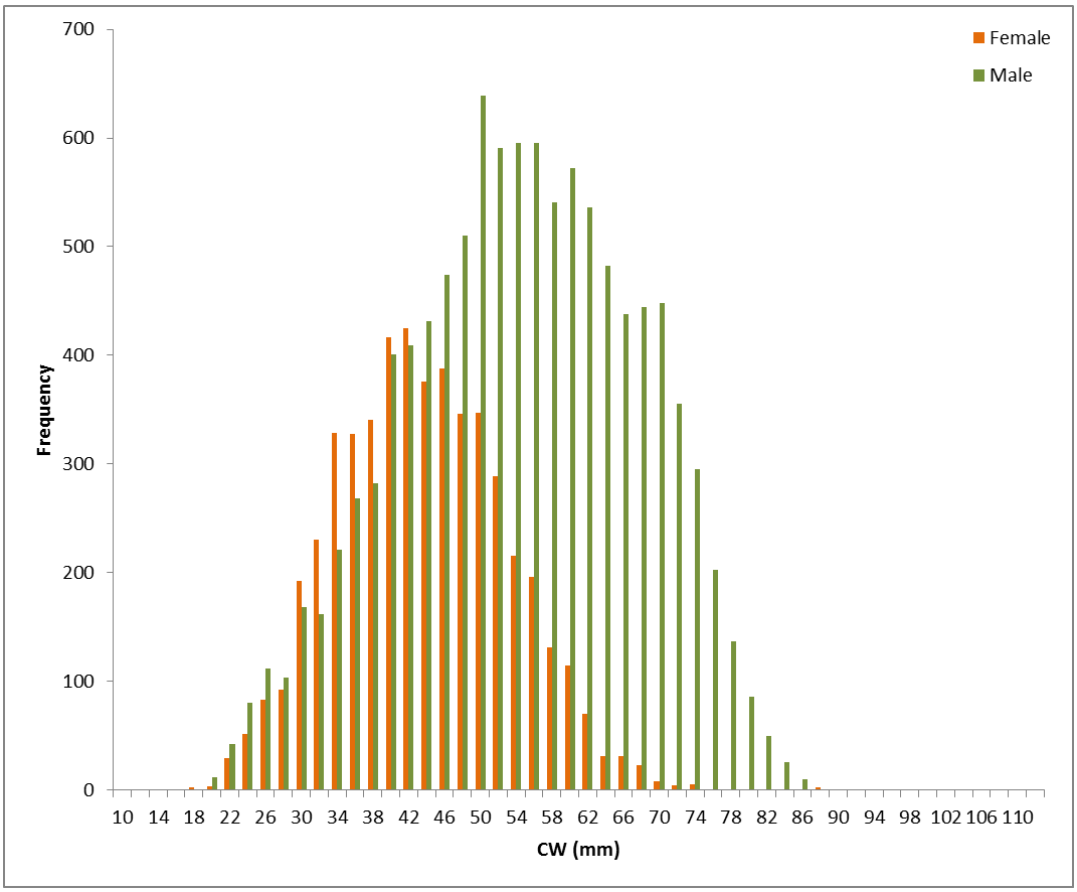


Figure 18. Size frequency (CW, mm) of female and male *C. maenas* caught during the Maritimes monitoring surveys (2008-2015).

Table 2. Anova table; effect of Sex and Region on CW.

Response: CW

	SS	Df	F value	Pr(>F)
Region	239579	4	457.167	< 0.0001 ***
Sex	338236	1	2581.703	< 0.0001 ***
Region:Sex	6050	4	11.544	<0.0001 ***
Residuals	2072229	15817		

The comparison of carapace width CW between sex and different regions is represented with a plot of means (Figure 19). Interestingly, there is a significant effect of Region on CW (Table 2), with lower mean CW for the northern regions. The significant interaction is probably due to the smaller difference between male and female CW for the Cape Breton and Bras d'Or Lakes regions. Tukey post hoc multiple comparisons tests showed that only Bay of Fundy-South Shore and Eastern Shore-Bras d'Or Lakes are not significantly different from each other. Further north, in North Harbour, Placentia Bay, Newfoundland, CW of female and male green crabs caught in Fukui traps (2008 through 2011) averaged 46.73 mm (n = 4497) and 51.99 mm (n = 7043), respectively (K. Matheson, pers. comm.). In the Magdalen Islands, QC, the average CW of female and male green crabs caught in Fukui traps between the same period 2008-2011 was 48.27 mm (n=3165) and 54.24 (n=8384) mm, respectively (N. Simard, pers. comm.).

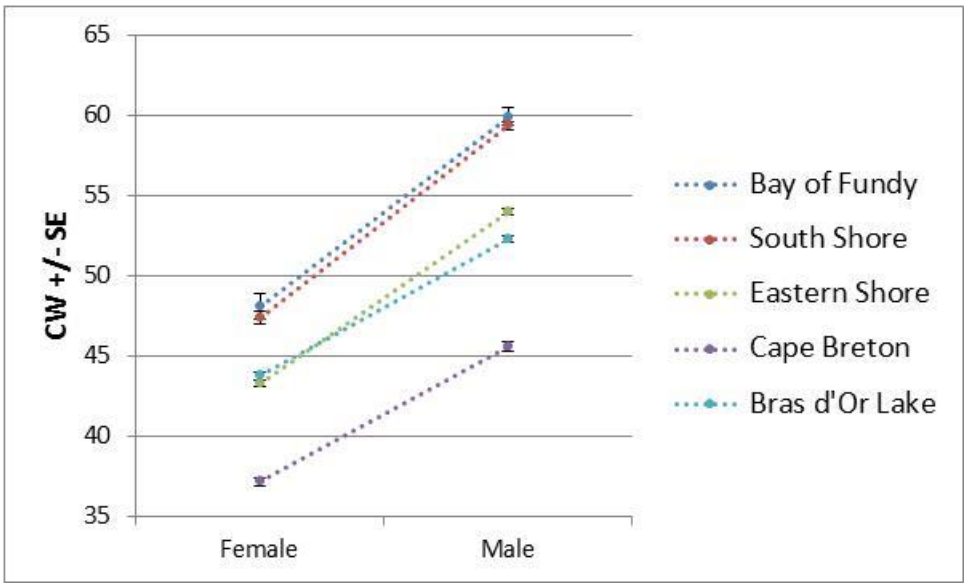


Figure 19. Mean CW (mm) +/-SE for female and male *C. maenas* caught during the Maritimes monitoring surveys (2008-2015) per region.

2.1.5. By-catch

During the eight years of monitoring, 256 out of 1262 traps (or 20.3%) contained 15 different species of by-catch upon retrieval with an average, median and mode of 4.27, 2 and 1 individuals/trap. Crustaceans made up 80.3% of the by-catch and fish 18.8% (Table 3).The most common by-catch species was the rock crab *Cancer irroratus* and, in one instance, 108 individuals were caught in a trap in Cole Harbour (2) in 2011. By-catch consisting of prey and/or predator alters the behaviour and interactions of green crab and thus can modify CPUEs. However, by-catch was low in terms of numbers per trap (with the exception mentioned above) and individuals were small (with the exception of one big eel and one mammal), therefore, CPUEs were considered valid for monitoring purposes.

Table 3. Number of crustaceans, fish, echinoderms, molluscs and mammals caught as by-catch during the 2008-2015 green crab monitoring.

	Crustaceans	**Fish**	**Echinoderms**	**Molluscs[a]**	**Mammals[b]**	**Total**
Number of traps with:	218	44	5	1	1	256[c]
Total number of:	878	206	8	1	1	1094
%	80.3	18.8	0.7	0.1	0.1	100

[a]Periwinkles were the only molluscs caught in traps but many fell off and out upon retrieval, thus underestimating their prevalence.
[b]One mink was caught as by-catch.
[c]By-catch could consist of different taxa simultaneously.

During eight years of green crab monitoring using Fukui traps in British Columbia, Gillespie et al. (2015) found, on average, 4.25 individuals/trap and 77.99% and 18.51% of the by-catch consisted of crustaceans and fish, similar to the present monitoring.

2.2. Trap comparisons

2.2.1 Fukui trap - Eel trap comparison

In 2012, there was no difference in CPUE between Fukui and eel traps (Paired t-test: t = -0.9026, df = 14, p-value = 0.382) at the 11 locations selected (Figure 20).

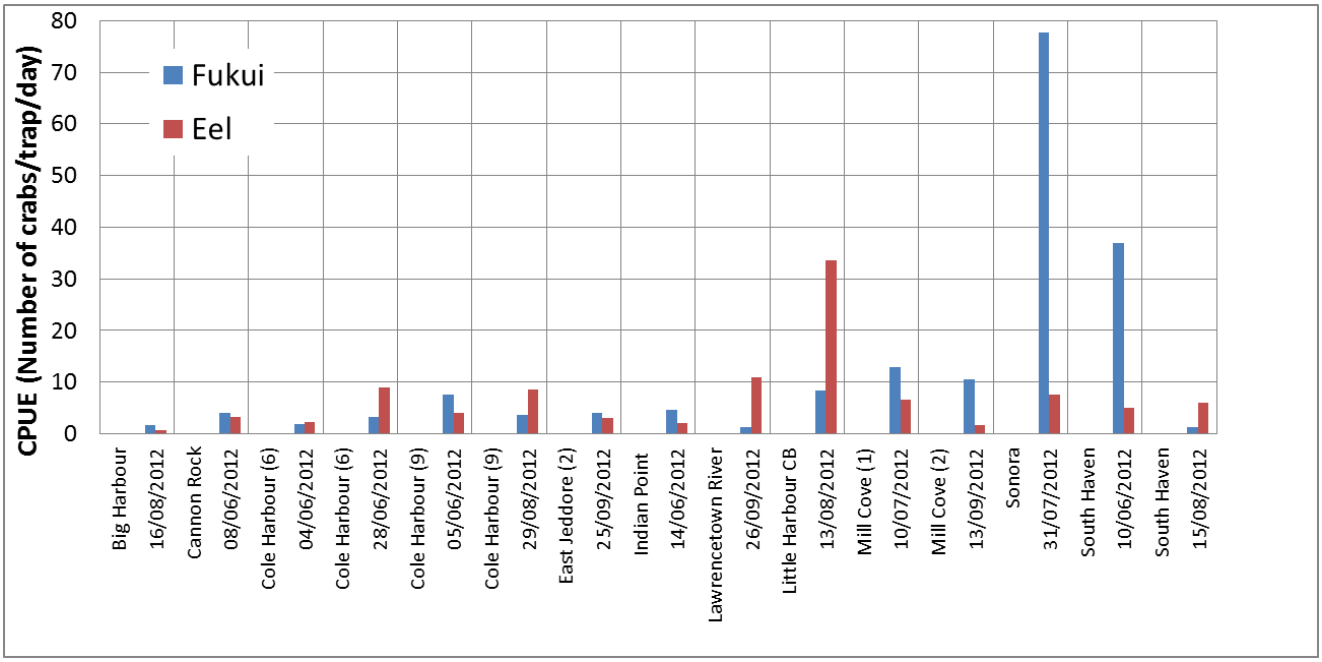


Figure 20. CPUE (number of green crabs/trap/day) at 11 selected locations in Nova Scotia (2012).

Other monitoring studies have used eel traps. For example, on the South shore of NS, CPUE in July 2009 averaged 15.36 and 21.84 green crabs/trap/day in the Little Port Joli lagoon and St. Catherine lagoon, respectively (Pouliot, 2009).

2.2.2. Fukui trap - Eel trap - Shrimp trap comparison

Unfortunately a few traps were lost during the experiment in August 2014, thus a total of 64 traps were analysed (Table 4). A total of 475 crabs were caught, sexed and measured (CW) and CPUEs calculated for each trap on each day were higher for the Fukui traps (Figure 21).

Table 4: Frequency table of different types of traps recovered per day.

Type	Fukui	Eel	Shrimp
Date			
Aug. 19	6	5	6
Aug. 20	6	5	6
Aug. 21	6	4	5
Aug. 22	5	4	6

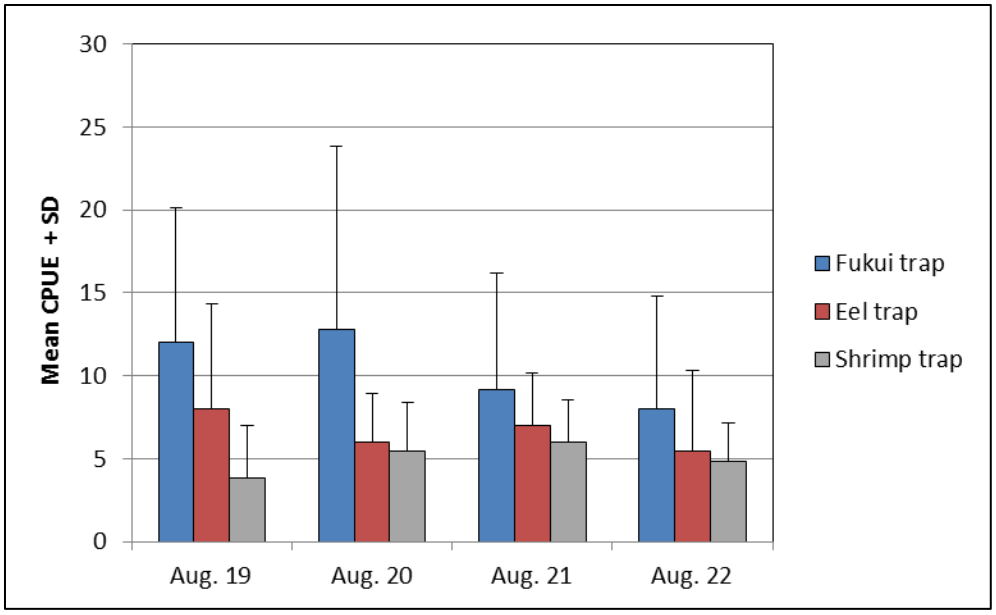


Figure 21. Mean CPUEs (number of green crabs/trap/day) for each trap type on each date.

There was no significant effect of date but a significant effect of trap type on CPUE (Table 5). Summary statistics (results pooled across days) are presented in box plots (Figure 22).

Table 5. Anova table; effect of Date and Trap Type on CPUE

Response: sqTotGC

	SS	Df	F value	P
Date	1.128	3	0.3683	0.77618
Type	8.428	2	4.1291	0.02166 *
Date:Type	2.711	6	0.4427	0.84682
Residuals	53.071	52		

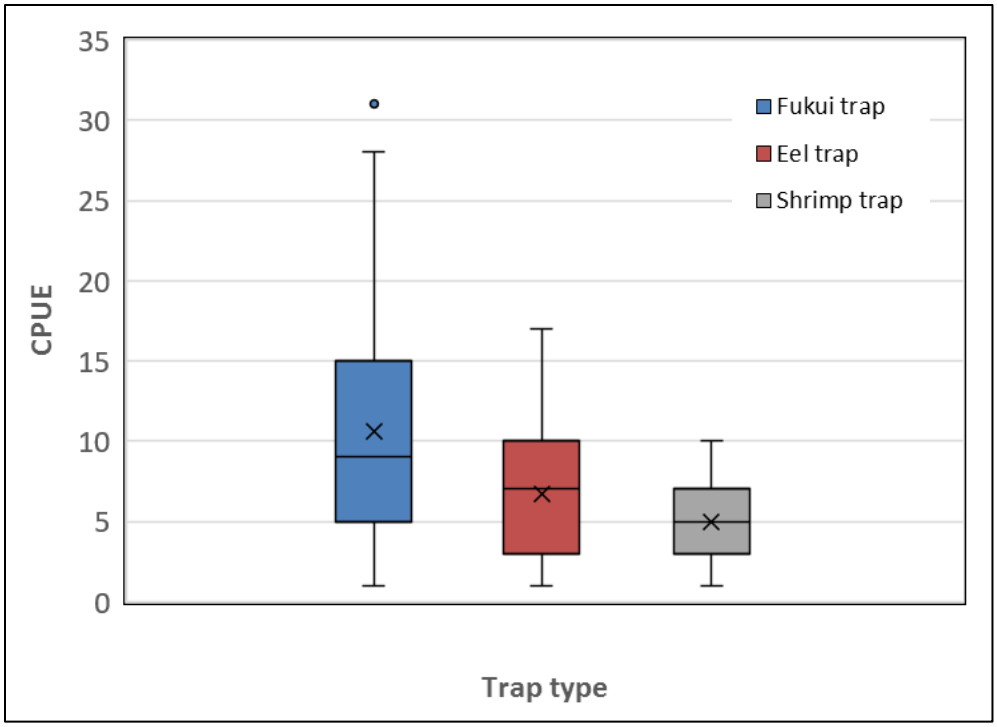


Figure 22. Boxplots of CPUE (number of green crabs/trap/day) for Fukui, eel and shrimp traps.

Post-hoc comparisons showed that Fukui traps are significantly different from the other two types and CPUE is higher, although with high variability; however CPUEs recorded with eel and shrimp traps are not statistically different from each other. In all types of traps, there were more males caught than females.

Carapace Width (CW) differed significantly between male and female green crab and there was a very marginal effect of trap type on CW (Table 6). Not only are Fukui traps catching more crabs, they also tend to catch a wider size range of crabs, especially males (Figure 23).

Table 6. Anova table; effect of Sex and Trap Type on CW

Response: CW

	SS	Df	F value	P
Sex	17683	1	207.4932	< 0.000 ***
Type	543	2	3.1836	0.04233 *
Sex:Type	173	2	1.0157	0.36293
Residuals	39970	469		

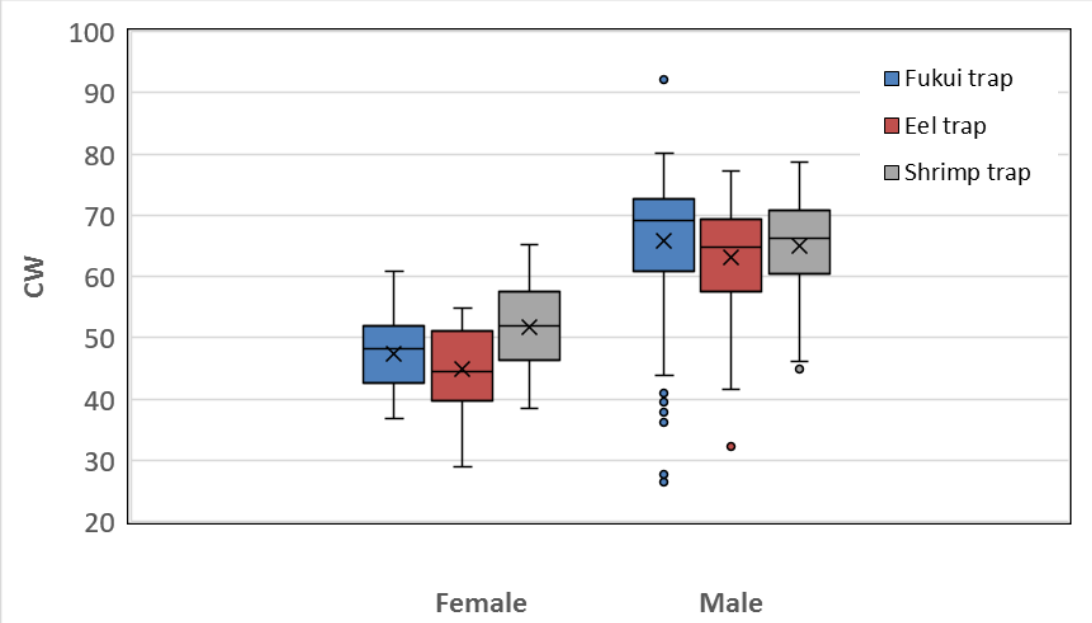


Figure 23. Boxplots of CW (mm) per sex for Fukui, Eel and shrimp different traps.

Similar to the monitoring surveys, female green crabs tend to be less “catchable”. They hesitate before entering a trap with males already present and are certainly less mobile when bearing eggs. They could also be easier to trap earlier in the summer (Cameron 2003). Shrimp type traps caught very few, but larger females compared to the other traps.

The green crab population in Cole Harbour, station 6, is well established although CPUEs seem to vary over the years even when monitoring took place at roughly the same time. Mean CPUE varied there from 172.7 crabs/Fukui trap/day in late July 2011, to 9.33 in late August 2012, and to 23.33 in late July 2013 (Appendix A). The effectiveness of a trap depends not only on the design but also on biological factors such as molting and reproductive status and the presence of prey and predators. Very little by-catch (4 rock crabs, 2 eels, 2 small fish and 2 shrimps) was recorded, on either a particular Date or in a particular Trap type. Environmental parameters such as temperature, salinity, tidal cycle and bottom type, which may account for internal variation, were somewhat controlled in this five day experiment. However, the mean CPUE recorded in mid-August 2014 of 10.61 + 8.13 SD green crabs/Fukui trap/day during this field experiment reflected a “low” abundance year. The trap effects could have been different if sampling had been conducted during a high abundance year such as in 2011. Trap effectiveness is a complex issue, not easily understood (Miller 1990). It is interesting to note that a similar experiment conducted at the same time in St. Mary’s Bay, PEI, showed very similar results, with significantly higher CPUEs recorded for Fukui trap than for eel trap and higher CPUEs recorded for eel traps compared to shrimp (a.k.a. Russell’s) traps (R. Bernier, pers. comm.).

Concluding remarks

Because of the variations in CPUEs even at a small spatial-temporal scale, it is rather difficult to compare stations and sampling years and assess trends. Spatial variation likely reflects differences in habitat (bottom type, salinity, vegetation) and temporal variations reflect differences in temperature which drives survival at different stages. There was no indication of change in abundance at the sites surveyed intensively in the BDOL between 2008 and 2010 yet CPUEs varied significantly with site, salinity and depth (Vercaemer et al. 2011). CPUEs were higher in all regions in 2011, during the 2008-2015 monitoring period, which could mean that the environmental conditions during the few years prior were conducive to a high overall recruitment and survival. Also, CPUEs were particularly high at some locations on the Eastern shore and on the Atlantic Coast of Cape Breton.

CPUEs were used in this study as a coarse indicator or index of abundance. They are a function of trap efficiency and abundance and catchability of the target species. Trap efficiency differs significantly between trap design and the Fukui trap was found to be more efficient at catching green crabs than the eel or shrimp traps. There is no indication that CPUEs varied significantly for each trap type over four consecutive days. As monitoring for green crab abundance continues on both coasts of Canada, it is important to keep a standardized protocol by controlling trap type, bait, depth and soak time as well as recording important environmental factors such as temperature, salinity, bottom type and biological factors such as molting, reproductive status for female crabs and abundance and diversity of by-catch species.

Even though the Fukui trap seems to be very efficient at catching green crabs, it is small and fragile and unsuitable for intense trapping either for removal or for a lobster bait fishery. On the south shore, intense trapping at the Kejimkujik National Park Seaside Adjunct (Little Port Joli estuary) removed 1.5 million crabs from 2010 to 2014 (C. McCarthy, pers. comm.) using modified eel and shrimp (Russell's) traps with average CPUE> 70 from 2011 to <15 in 2014. The new commercial licensed fishery on the south shore of NS removed twice as many crabs between 2011 and 2015 (DFO Policy & Economics, pers. comm.) using different types of commercial traps with an average CPUE of ~50 crabs/trap/day. However, fishing was done in the colder months during lobster fishing season to use green crabs as bait and could have been more efficient in the summer/fall. DFO management is currently hesitant to extend the lobster bait fishery to the Eastern Shore and Cape Breton, where there is a summer lobster season, and where monitoring indicates potentially more abundant populations of green crabs, due to

potential transmission of parasites to lobsters (Fishermen and Scientists Research Society, pers. comm.). Other potential uses of green crabs (e.g. compost/fertilizer, food products such as soft shell, crab meat/paste, pet/aquaculture food, chitin/poly N-acetylglucosamine) are still under investigation.

The monitoring stations that have been established could be incorporated in future monitoring of Coastal Ecologically and Biologically significant areas in DFO Maritimes Region or in present or potential Marine Protected Areas (MPA). Similarly, population studies (genetic and behavioural) could be linked with DFO green crab monitoring at locations with historical data, such as the Musquash estuary MPA, Cole Harbour and Sydney Harbour, which represent different regions of the *C. maenas* admixture zone in Atlantic Canada. As conservation of biodiversity is a major goal in MPAs or reserves, and as the invasive green crabs constitute a major threat to biodiversity, MPAs management plans should include this invasive non-indigenous species (NIS). Recent studies suggest that, without control or management of NIS, commonly exercised for their terrestrial counterpart, MPAs can have positive effects on NIS (Burfeind et al. 2013).

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Appendix A. 1. Location of stations (Latitude and Longitude) and number of traps, number of female, male green crabs caught and CPUE per location and sampling date (2008-2015).

Location	*Latitude*	*Longitude*	*Nb of traps*	*Female*	*Male*	*nd*	*Total GC*	*CPUE*
Adams Island	**45.0110**	**-66.9084**	**4**	**0**	**6**	**0**	**6**	**1.50**
25/08/2008			1	0	4	0	4	4.00
17/08/2009			3	0	2	0	2	0.67
Amaguadees C	**45.9088**	**-60.6621**	**6**	**1**	**0**	**0**	**1**	**0.17**
13/05/2009			3	0	0	0	0	0.00
08/09/2009			3	1	0	0	1	0.33
Amaguadees P	**45.9182**	**-60.6523**	**6**	**0**	**1**	**0**	**1**	**0.17**
13/05/2009			3	0	0	0	0	0.00
08/09/2009			3	0	1	0	1	0.33
Aqua_Ed	**46.0132**	**-60.3900**	**50**	**93**	**383**	**0**	**476**	**9.52**
17/06/2011			2	1	9	0	10	5.00
20/06/2011			2	1	4	0	5	2.50
21/06/2011			2	2	1	0	3	1.50
24/06/2011			2	2	12	0	14	7.00
27/06/2011			2	1	3	0	4	2.00
30/06/2011			2	2	12	0	14	7.00
04/07/2011			2	5	49	0	54	27.00
07/07/2011			2	5	33	0	38	19.00
11/07/2011			2	6	29	0	35	17.50
22/07/2011			2	10	55	0	65	32.50
14/05/2012			3	2	11	0	13	4.33
15/05/2012			3	4	15	0	19	6.33
04/06/2012			3	13	14	0	27	9.00
12/06/2012			3	6	18	0	24	8.00
13/06/2012			3	3	17	0	20	6.67
20/06/2012			3	5	19	0	24	8.00
21/06/2012			3	8	21	0	29	9.67
22/06/2012			3	5	23	0	28	9.33
15/08/2013			3	12	26	0	38	12.67
16/08/2013			3	0	12	0	12	4.00
Baddeck	**46.0994**	**-60.7484**	**3**	**0**	**0**	**0**	**0**	**0.00**
23/10/2014			3	0	0	0	0	0.00
Battery Point	**44.6747**	**-65.7528**	**3**	**11**	**51**	**0**	**62**	**20.67**
10/07/2013			3	11	51	0	62	20.67
Beaver Harbour	**45.0685**	**-66.7400**	**3**	**3**	**4**	**0**	**7**	**2.33**
08/07/2013			3	3	4	0	7	2.33
Ben Eoin	**45.9818**	**-60.4314**	**3**	**0**	**12**	**0**	**12**	**4.00**
26/08/2014			3	0	12	0	12	4.00

Ben Eoin_1	**45.9825**	**-60.4304**	**9**	**9**	**10**	**69**	**88**	**9.78**
20/09/2010			3	8	9	0	17	5.67
24/11/2010			3	1	1	0	2	0.67
26/07/2011			3	0	0	69	69	23.00
Ben Eoin_2	**45.9822**	**-60.4320**	**3**	**0**	**9**	**0**	**9**	**3.00**
21/09/2010			3	0	9	0	9	3.00
Ben Eoin_3	**45.9820**	**-60.4311**	**9**	**1**	**6**	**47**	**54**	**6.00**
21/09/2010			3	1	5	0	6	2.00
24/11/2010			3	0	1	0	1	0.33
26/07/2011			3	0	0	47	47	15.67
Ben Eoin_4	**45.9817**	**-60.4319**	**9**	**1**	**11**	**21**	**33**	**3.67**
21/09/2010			3	0	10	0	10	3.33
24/11/2010			3	1	1	0	2	0.67
26/07/2011			3	0	0	21	21	7.00
Big Harbour	**46.1485**	**-60.5982**	**3**	**1**	**4**	**0**	**5**	**1.67**
16/08/2012			3	1	4	0	5	1.67
BIO boat launch	**44.6853**	**-63.6139**	**2**	**5**	**18**	**0**	**23**	**11.50**
12/07/2011			2	5	18	0	23	11.50
BIO Jetty	**44.6812**	**-63.6109**	**46**	**127**	**108**	**0**	**235**	**5.11**
17/05/2012			3	3	3	0	6	2.00
18/05/2012			3	4	3	0	7	2.33
22/05/2012			3	0	2	0	2	0.67
22/07/2013			3	1	7	0	8	2.67
27/08/2014			2	2	12	0	14	7.00
23/09/2014			10	75	45	0	120	12.00
25/09/2014			8	30	15	0	45	5.63
26/09/2014			8	6	6	0	12	1.50
28/09/2014			6	6	15	0	21	3.50
Blandford	**44.4938**	**-64.1139**	**3**	**5**	**6**	**0**	**11**	**3.67**
30/07/2013			3	5	6	0	11	3.67
Bliss Island	**45.0263**	**-66.8453**	**4**	**2**	**12**	**0**	**11**	**2.75**
25/08/2008			1	1	4	0	5	5.00
17/08/2009			3	1	8	0	6	2.00
Boutiliers Point	**44.6570**	**-63.9466**	**3**	**13**	**27**	**0**	**40**	**13.33**
26/07/2013			3	13	27	0	40	13.33
Shad Bay - Cannon Rock	**44.5210**	**-63.7931**	**9**	**14**	**65**	**0**	**79**	**8.78**
20/05/2012			3	14	44	0	58	19.33
22/05/2012			3	0	9	0	9	3.00
08/06/2012			3	0	12	0	12	4.00
Canso	**45.3232**	**-60.9636**	**3**	**2**	**108**	**0**	**110**	**36.67**
16/09/2013			3	2	108	0	110	36.67
Central Port Mouton	**43.9187**	**-64.8447**	**3**	**43**	**118**	**0**	**161**	**53.67**
24/08/2011			3	43	118	0	161	53.67

Chapel Island C	**45.7081**	**-60.7749**	**45**	**140**	**318**	**0**	**458**	**10.18**
04/09/2008			3	3	4	0	7	2.33
16/09/2008			3	5	11	0	16	5.33
14/10/2008			3	7	15	0	22	7.33
28/05/2009			3	62	94	0	156	52.00
13/08/2009			3	8	55	0	63	21.00
26/08/2009			3	9	13	0	22	7.33
08/10/2009			3	17	21	0	38	12.67
14/06/2010			3	0	13	0	13	4.33
28/06/2010			3	1	12	0	13	4.33
13/07/2010			3	8	24	0	32	10.67
11/08/2010			3	0	15	0	15	5.00
31/08/2010			3	2	9	0	11	3.67
28/09/2010			3	5	5	0	10	3.33
12/10/2010			3	4	1	0	5	1.67
02/11/2010			3	9	26	0	35	11.67
Chapel Island P	**45.7095**	**-60.7755**	**45**	**124**	**334**	**0**	**458**	**10.18**
04/09/2008			3	0	6	0	6	2.00
16/09/2008			3	13	34	0	47	15.67
14/10/2008			3	17	23	0	40	13.33
28/05/2009			3	37	54	0	91	30.33
13/08/2009			3	2	17	0	19	6.33
26/08/2009			3	3	3	0	6	2.00
08/10/2009			3	8	20	0	28	9.33
14/06/2010			3	0	9	0	9	3.00
28/06/2010			3	0	11	0	11	3.67
13/07/2010			3	3	24	0	27	9.00
11/08/2010			3	0	24	0	24	8.00
31/08/2010			3	2	28	0	30	10.00
28/09/2010			3	20	40	0	60	20.00
12/10/2010			3	7	13	0	20	6.67
02/11/2010			3	12	28	0	40	13.33
Charlos Cove	**45.2454**	**-61.3349**	**3**	**1**	**17**	**0**	**18**	**6.00**
31/07/2012			3	1	17	0	18	6.00
Clam Bay Causeway	**44.7338**	**-62.9068**	**3**	**751**	**270**	**0**	**1021**	**340.33**
22/09/2011			3	751	270	0	1021	340.33
Coast Guard wharf	**46.1423**	**-60.2006**	**28**	**175**	**254**	**0**	**429**	**15.32**
20/06/2011			2	32	31	0	63	31.50
21/06/2011			2	6	25	0	31	15.50
22/06/2011			2	28	22	0	50	25.00
23/06/2011			2	29	27	0	56	28.00
24/06/2011			1	16	10	0	26	26.00
27/06/2011			2	11	20	0	31	15.50

14/05/2012			3	14	23	0	37	12.33
15/05/2012			3	15	37	0	52	17.33
04/06/2012			2	7	8	0	15	7.50
12/06/2012			3	9	15	0	24	8.00
13/06/2012			3	6	10	0	16	5.33
20/06/2012			3	2	26	0	28	9.33
Cole Harbour (1)	**44.6595**	**-63.4347**	**3**	**20**	**53**	**0**	**73**	**24.33**
25/05/2011			3	20	53	0	73	24.33
Cole Harbour (2)	**44.6599**	**-63.4351**	**9**	**55**	**117**	**0**	**172**	**19.11**
25/05/2011			3	28	42	0	70	23.33
26/05/2011			3	17	45	0	62	20.67
25/09/2012			3	10	30	0	40	13.33
Cole Harbour (3)	**44.6602**	**-63.4343**	**6**	**63**	**43**	**0**	**106**	**17.67**
25/05/2011			3	35	24	0	59	19.67
26/05/2011			3	28	19	0	47	15.67
Cole Harbour (4)	**44.6609**	**-63.4322**	**10**	**122**	**67**	**0**	**189**	**18.90**
25/05/2011			3	60	28	0	88	29.33
26/05/2011			3	53	20	0	73	24.33
05/06/2012			3	0	7	0	7	2.33
28/06/2012			1	9	12	0	21	21.00
Cole Harbour (5)	**44.6599**	**-63.4357**	**42**	**194**	**548**	**66**	**808**	**19.24**
26/05/2011			3	78	92	0	170	56.67
05/06/2012			3	0	9	0	9	3.00
28/06/2012			3	4	33	0	37	12.33
25/09/2012			3	1	59	0	60	20.00
22/07/2013			3	5	74	0	79	26.33
15/10/2013			5	18	81	0	99	19.80
06/05/2014			2	25	29	0	54	27.00
21/05/2014			1	11	19	0	30	30.00
22/05/2014			1	11	6	0	17	17.00
24/05/2014			1	13	7	0	20	20.00
26/05/2014			1	0	0	20	20	20.00
27/05/2014			1	0	0	20	20	20.00
29/05/2014			1	0	0	8	8	8.00
30/05/2014			1	0	0	18	18	18.00
01/06/2014			1	4	7	0	11	11.00
03/06/2014			3	6	30	0	36	12.00
05/06/2014			3	1	19	0	20	6.67
13/06/2014			3	6	42	0	48	16.00
17/06/2014			3	11	41	0	52	17.33
Cole Harbour (6)	**44.6532**	**-63.4252**	**80**	**467**	**815**	**0**	**1282**	**16.03**
28/07/2011			3	228	290	0	518	172.67
04/06/2012			6	0	11	0	11	1.83

28/06/2012			3	5	5	0	10	3.33
29/08/2012			3	7	21	0	28	9.33
25/09/2012			3	0	5	0	5	1.67
22/07/2013			3	22	48	0	70	23.33
19/08/2014			6	14	58	0	72	12.00
20/08/2014			6	11	66	0	77	12.83
21/08/2014			6	8	47	0	55	9.17
22/08/2014			5	8	32	0	40	8.00
25/05/2015			6	55	53	0	108	18.00
23/06/2015			6	2	23	0	25	4.17
27/07/2015			6	34	39	0	73	12.17
25/08/2015			6	44	55	0	99	16.50
23/09/2015			6	9	26	0	35	5.83
27/10/2015			6	20	36	0	56	9.33
Cole Harbour (7)	**44.6561**	**-63.4302**	**8**	**51**	**170**	**0**	**221**	**27.63**
13/09/2011			8	51	170	0	221	27.63
Cole Harbour (8)	**44.6570**	**-63.4229**	**9**	**70**	**107**	**0**	**177**	**19.67**
13/09/2011			9	70	107	0	177	19.67
Cole Harbour (9)	**44.6519**	**-63.4191**	**12**	**70**	**105**	**0**	**175**	**14.58**
28/07/2011			3	66	73	0	139	46.33
05/06/2012			3	1	22	0	23	7.67
29/08/2012			3	3	8	0	11	3.67
25/09/2012			3	0	2	0	2	0.67
DeBaie's Cove	**44.7545**	**-62.8077**	**3**	**16**	**103**	**0**	**119**	**39.67**
22/09/2011			3	16	103	0	119	39.67
D'Escousse	**45.5887**	**-60.9618**	**3**	**0**	**9**	**0**	**9**	**3.00**
13/08/2012			3	0	9	0	9	3.00
Dingwall	**46.9017**	**-60.4606**	**8**	**5**	**26**	**0**	**31**	**3.88**
16/09/2014			3	0	4	0	4	1.33
25/09/2014			2	2	3	0	5	2.50
02/08/2015			3	3	19	0	22	7.33
Dingwall Public Wharf	**46.9032**	**-60.4604**	**3**	**1**	**7**	**0**	**8**	**2.67**
08/09/2010			3	1	7	0	8	2.67
Dipper Harbour	**45.0941**	**-66.4176**	**3**	**0**	**1**	**0**	**1**	**0.33**
08/07/2013			3	0	1	0	1	0.33
Dobson Yacht Club	**46.1355**	**-60.2043**	**3**	**0**	**3**	**0**	**3**	**1.00**
26/08/2014			3	0	3	0	3	1.00
Dobson Yacht Club beach	**46.1378**	**-60.2054**	**42**	**602**	**901**	**53**	**1556**	**37.05**
09/07/2012			3	48	53	0	101	33.67
10/07/2012			3	66	100	0	166	55.33
11/07/2012			3	83	208	0	291	97.00
12/07/2012			3	51	160	0	211	70.33
31/07/2012			3	146	127	0	273	91.00

01/08/2012			3	49	34	0	83	27.67
05/06/2013			3	18	10	0	28	9.33
06/06/2013			3	31	46	0	77	25.67
12/06/2013			3	78	114	0	192	64.00
19/06/2013			3	11	20	0	31	10.33
28/07/2013			3	3	8	0	11	3.67
01/08/2013			3	12	11	53	76	25.33
13/08/2013			3	6	4	0	10	3.33
14/08/2013			3	0	6	0	6	2.00
East Chezzetcook	**44.7110**	**-63.2363**	**3**	**52**	**57**	**0**	**109**	**36.33**
28/07/2011			3	52	57	0	109	36.33
East Jeddore 1	**44.7290**	**-63.0045**	**6**	**42**	**235**	**0**	**277**	**46.17**
22/09/2011			3	33	151	0	184	61.33
19/08/2013			3	9	84	0	93	31.00
East Jeddore 2	**44.7184**	**-62.9993**	**3**	**1**	**11**	**0**	**12**	**4.00**
25/09/2012			3	1	11	0	12	4.00
East Port Medway	**44.1512**	**-64.5765**	3	30	112	0	142	47.33
24/08/2011			3	30	112	0	142	47.33
East River Point	**44.5732**	**-64.1605**	**3**	**4**	**44**	**0**	**48**	**16.00**
29/06/2011			3	4	44	0	48	16.00
East Ship Harbour	**44.8115**	**-62.8544**	**3**	**10**	**5**	**0**	**15**	**5.00**
26/09/2012			3	10	5	0	15	5.00
East Side Port L'Hebert	**43.8197**	**-64.9289**	**3**	**16**	**25**	**0**	**41**	**13.67**
24/08/2011			3	16	25	0	41	13.67
Eddy Point	**45.5210**	**-61.2637**	**3**	**2**	**10**	**0**	**12**	**4.00**
13/08/2012			3	2	10	0	12	4.00
Eskasoni C	**45.9391**	**-60.6178**	**84**	**256**	**582**	**0**	**838**	**9.98**
21/07/2008			3	48	28	0	76	25.33
18/08/2008			3	18	21	0	39	13.00
17/09/2008			3	18	15	0	33	11.00
15/10/2008			3	5	16	0	21	7.00
12/05/2009			6	2	0	0	2	0.33
02/06/2009			6	22	49	0	71	11.83
24/06/2009			3	5	90	0	95	31.67
09/07/2009			3	8	40	0	48	16.00
28/07/2009			9	62	90	0	152	16.89
18/08/2009			6	7	26	0	33	5.50
08/09/2009			3	2	25	0	27	9.00
29/09/2009			3	3	6	0	9	3.00
21/10/2009			3	1	8	0	9	3.00
17/05/2010			3	7	24	0	31	10.33
02/06/2010			3	0	4	0	4	1.33
16/06/2010			3	0	14	0	14	4.67

28/06/2010			3	0	17	0	17	5.67
13/07/2010			3	5	18	0	23	7.67
26/07/2010			3	11	37	0	48	16.00
11/08/2010			3	0	4	0	4	1.33
31/08/2010			3	4	14	0	18	6.00
28/09/2010			3	19	18	0	37	12.33
12/10/2010			3	9	18	0	27	9.00
Eskasoni P	**45.9356**	**-60.6246**	**75**	**331**	**446**	**0**	**777**	**10.36**
21/07/2008			3	109	18	0	127	42.33
18/08/2008			3	21	33	0	54	18.00
17/09/2008			3	54	9	0	63	21.00
15/10/2008			3	4	11	0	15	5.00
12/05/2009			6	2	2	0	4	0.67
03/06/2009			6	8	23	0	31	5.17
24/06/2009			3	1	16	0	17	5.67
09/07/2009			3	3	44	0	47	15.67
28/07/2009			3	22	50	0	72	24.00
18/08/2009			3	10	23	0	33	11.00
08/09/2009			3	4	6	0	10	3.33
29/09/2009			3	10	20	0	30	10.00
21/10/2009			3	12	12	0	24	8.00
17/05/2010			3	6	21	0	27	9.00
02/06/2010			3	1	24	0	25	8.33
16/06/2010			3	0	11	0	11	3.67
28/06/2010			3	1	15	0	16	5.33
13/07/2010			3	21	28	0	49	16.33
26/07/2010			3	7	16	0	23	7.67
11/08/2010			3	0	16	0	16	5.33
31/08/2010			3	5	11	0	16	5.33
28/09/2010			3	7	6	0	13	4.33
12/10/2010			3	23	31	0	54	18.00
Eskasoni SR	**45.9342**	**-60.6114**	**24**	**13**	**95**	**0**	**108**	**4.50**
02/06/2009			6	8	39	0	47	7.83
03/06/2009			6	2	9	0	11	1.83
24/06/2009			6	0	26	0	26	4.33
09/07/2009			6	3	21	0	24	4.00
Fairhaven	**44.9641**	**-67.0079**	**3**	**5**	**15**	**0**	**20**	**6.67**
08/07/2013			3	5	15	0	20	6.67
False Bay	**46.0809**	**-59.8926**	**6**	**93**	**67**	**1**	**161**	**26.83**
04/09/2014			3	22	9	1	32	10.67
11/11/2015			3	71	58	0	129	43.00
Five Fathom Hole	**45.1811**	**-66.2624**	**3**	**15**	**46**	**0**	**61**	**20.33**
08/07/2013			3	15	46	0	61	20.33

Fourchu	**45.7173**	**-60.2545**	2	2	15	0	17	8.50
16/07/2013			2	2	15	0	17	8.50
Gabarus	**45.8404**	**-60.1382**	3	6	16	0	22	7.33
14/08/2012			3	6	16	0	22	7.33
Gillis Cove C	**45.9100**	**-61.0549**	9	4	12	0	16	1.78
21/07/2009			3	2	0	0	2	0.67
25/08/2009			3	1	8	0	9	3.00
07/10/2009			3	1	4	0	5	1.67
Gillis Cove P	**45.9106**	**-61.0534**	21	12	29	0	41	1.95
27/05/2009			6	7	7	0	14	2.33
21/07/2009			3	0	3	0	3	1.00
25/08/2009			3	2	1	0	3	1.00
07/10/2009			3	3	3	0	6	2.00
29/06/2011			2	0	8	0	8	4.00
30/06/2011			1	0	7	0	7	7.00
22/06/2012			3	0	0	0		0.00
Gillis Cove RA	**45.9115**	**-61.0526**	9	4	1	0	5	0.56
19/10/2009			9	4	1	0	5	0.56
Glen Margaret	**44.5833**	**-63.9132**	3	1	5	0	6	2.00
26/07/2013			3	1	5	0	6	2.00
Gold River	**44.5313**	**-64.3099**	3	11	89	0	100	33.33
28/06/2011			3	11	89	0	100	33.33
Goldboro	**45.1869**	**-61.6560**	3	7	80	0	87	29.00
31/07/2012			3	7	80	0	87	29.00
Graves Island	**44.5624**	**-64.2093**	3	4	31	0	35	11.67
29/06/2011			3	4	31	0	35	11.67
Gunning Cove	**43.6807**	**-65.3397**	6	18	52	0	70	11.67
11/07/2012			3	0	0	0		0.00
04/07/2013			3	18	52	0	70	23.33
Hampton	**44.9065**	**-65.3517**	3	3	24	0	27	9.00
10/07/2013			3	3	24	0	27	9.00
Indian Harbour	**44.5150**	**-63.9351**	3	0	39	0	39	13.00
16/08/2013			3	0	39	0	39	13.00
Indian Point	**44.4566**	**-64.3158**	9	50	118	0	168	18.67
28/06/2011			3	20	62	0	82	27.33
14/06/2012			3	0	14	0	14	4.67
30/07/2013			3	30	42	0	72	24.00
Lawrencetown River	**44.6486**	**-63.3587**	9	75	123	0	198	22.00
28/07/2011			3	48	75	0	123	41.00
26/09/2012			3	1	3	0	4	1.33
19/08/2013			3	26	45	0	71	23.67
Leonardville	**44.9716**	**-66.9526**	3	12	76	0	88	29.33
08/07/2013			3	12	76	0	88	29.33

Little Harbour	**43.7173**	**-65.0302**	3	0	9	0	9	3.00
11/07/2012			3	0	9	0	9	3.00
Little Harbour CB	**45.5828**	**-60.7398**	3	10	15	0	25	8.33
13/08/2012			3	10	15	0	25	8.33
Little River	**46.4471**	**-60.4594**	6	36	39	0	75	12.50
15/08/2012			3	9	32	0	41	13.67
26/08/2014			3	27	7	0	34	11.33
Lorneville	**45.1923**	**-66.1487**	3	12	35	0	47	15.67
08/07/2013			3	12	35	0	47	15.67
Lower Prospect	**44.4518**	**-63.7269**	3	0	17	0	17	5.67
26/07/2013			3	0	17	0	17	5.67
Lower Ship Harbour	**44.8029**	**-62.8595**	3	2	37	0	39	13.00
19/08/2013			3	2	37	0	39	13.00
Lower Three Fathom Harbour	**44.6378**	**-63.2759**	3	5	11	0	16	5.33
28/07/2011			3	5	11	0	16	5.33
Lunenburg First Peninsula	**44.3846**	**-64.3113**	6	20	32	0	52	8.67
11/07/2011			3	6	10	0	16	5.33
10/07/2012			3	14	22	0	36	12.00
Lunenburg Railway Wharf	**44.3753**	**-64.3069**	3	1	1	0	2	0.67
30/07/2013			3	1	1	0	2	0.67
Lunenburg Yacht Club_1	**44.4116**	**-64.3215**	3	3	10	0	13	4.33
30/09/2009			3	3	10	0	13	4.33
Lunenburg Yacht Club_2	**44.4116**	**-64.3198**	9	31	57	0	88	9.78
30/09/2009			9	31	57	0	88	9.78
Lunenburg Yacht Club_3	**44.4109**	**-64.3226**	9	12	101	0	113	12.56
30/09/2009			9	12	101	0	113	12.56
Lunenburg Yacht Club_4	**44.4108**	**-64.3217**	3	0	6	0	6	2.00
30/09/2009			3	0	6	0	6	2.00
Lunenburg Yacht Club_5	**44.4121**	**-64.3219**	3	6	35	0	41	13.67
30/07/2013			3	6	35	0	41	13.67
Maclords Point Wharf Ingonish	**46.6800**	**-60.3500**	2	0	0	0		0.00
27/07/2013			2	0	0	0		0.00
Mahone Bay	**44.4442**	**-64.3671**	6	24	68	0	92	15.33
11/07/2011			3	24	66	0	90	30.00
10/07/2012			3	0	2	0	2	0.67
Malagawatch C	**45.8746**	**-60.9572**	3	9	13	0	22	7.33
27/05/2009			3	9	13	0	22	7.33
Malagawatch P	**45.8718**	**-60.9653**	3	11	38	0	49	16.33
27/05/2009			3	11	38	0	49	16.33
Marriotts Cove	**44.5500**	**-64.2818**	3	13	62	0	75	25.00
29/06/2011			3	13	62	0	75	25.00
Meteghan	**44.1938**	**-66.1675**	3	0	17	0	17	5.67

04/07/2013			3	0	17	0	17	5.67
Mill Cove (1)	**44.5803**	**-64.0537**	6	16	77	0	93	15.50
13/07/2011			3	12	42	0	54	18.00
10/07/2012			3	4	35	0	39	13.00
Mill Cove (2)	**44.5803**	**-64.0552**	4	18	68	0	86	21.50
13/09/2012			2	3	18	0	21	10.50
30/07/2013			2	15	50	0	65	32.50
Morisons Cove	**46.0061**	**-60.9435**	15	13	376	0	389	25.93
29/06/2011			2	2	90	0	92	46.00
30/06/2011			2	1	79	0	80	40.00
04/07/2011			2	3	61	0	64	32.00
25/05/2012			3	4	74	0	78	26.00
29/06/2012			3	0	33	0	33	11.00
01/08/2012			3	3	39	0	42	14.00
Musquash 1 (by Five Fathom Hole)	**45.1889**	**-66.2596**	2	2	9	0	11	5.50
15/08/2008			1	1	4	0	5	5.00
18/08/2008			1	1	5	0	6	6.00
Musquash 2 (by ledges)	**45.1621**	**-66.2422**	2	14	71	0	85	42.50
15/08/2008			1	3	23	0	26	26.00
18/08/2008			1	11	48	0	59	59.00
Musquash 3 (west side)	**45.1637**	**-66.2582**	2	13	62	0	75	37.50
15/08/2008			1	13	61	0	74	74.00
18/08/2008			1	0	1	0	1	1.00
Navy Island	**45.0547**	**-67.0485**	7	5	2	0	7	1.00
25/08/2008			1	0	1	0	1	1.00
17/08/2009			3	5	1	0	6	2.00
26/07/2011			3	0	0	0	0	0.00
New Harbour	**45.1800**	**-61.4601**	3	3	19	0	22	7.33
31/07/2012			3	3	19	0	22	7.33
Newellton	**43.4718**	**-65.6344**	3	20	16	0	36	12.00
12/07/2012			3	20	16	0	36	12.00
North Harbour	**46.9048**	**-60.4615**	3	28	59	0	87	29.00
07/09/2010			3	28	59	0	87	29.00
North Sydney	**46.2068**	**-60.2490**	12	11	18	0	29	2.42
16/07/2012			3	2	10	0	12	4.00
17/07/2012			3	0	2	0	2	0.67
14/08/2012			3	9	6	0	15	5.00
25/08/2014			3	0	0	0	0	0.00
Oak Island	**44.5112**	**-64.3019**	3	12	26	0	38	12.67
28/06/2011			3	12	26	0	38	12.67
Ostrea Lake	**44.7185**	**-63.0887**	9	52	290	0	342	38.00
22/09/2011			3	18	117	0	135	45.00

26/09/2012			3	23	46	0	69	23.00
19/08/2013			3	11	127	0	138	46.00
Parker's Cove	**44.8134**	**-65.5371**	3	2	11	0	13	4.33
10/07/2013			3	2	11	0	13	4.33
Petit de Grat	**45.5071**	**-60.9605**	3	9	9	0	18	6.00
13/08/2012			3	9	9	0	18	6.00
Port Bickerton	**45.0943**	**-61.7290**	3	12	67	0	79	26.33
31/07/2012			3	12	67	0	79	26.33
Port La Tour	**43.4977**	**-65.4718**	6	3	24	0	27	4.50
11/07/2012			3	0	1	0	1	0.33
04/07/2013			3	3	23	0	26	8.67
Pottery Cove	**45.0741**	**-67.0781**	3	0	1	0	1	0.33
19/07/2011			3	0	1	0	1	0.33
SABS	**45.0823**	**-67.0846**	3	1	6	0	7	2.33
08/07/2013			3	1	6	0	7	2.33
Saulnierville	**44.2629**	**-66.1383**	3	16	36	0	52	17.33
04/07/2013			3	16	36	0	52	17.33
Shad Bay private pontoon	**44.5231**	**-63.7884**	3	3	10	0	13	4.33
29/08/2012			3	3	10	0	13	4.33
Shad Bay Public Beach	**44.5233**	**-63.7898**	9	8	38	0	46	5.11
29/08/2012			3	2	13	0	15	5.00
26/07/2013			3	2	19	0	21	7.00
29/08/2014			2	2	4	0	6	3.00
08/09/2014			1	2	2	0	4	4.00
Shad Bay Public Wharf	**44.5290**	**-63.7879**	3	1	2	0	3	1.00
29/08/2012			3	1	2	0	3	1.00
Sonora	**45.0580**	**-61.9046**	3	82	151	0	233	77.67
31/07/2012			3	82	151	0	233	77.67
South Harbour	**46.8831**	**-60.4655**	3	4	20	0	24	8.00
07/09/2010			3	4	20	0	24	8.00
South Haven	**46.2112**	**-60.5940**	8	16	106	0	122	15.25
10/06/2012			3	14	97	0	111	37.00
15/08/2012			3	1	3	0	4	1.33
23/10/2014			2	1	6	0	7	3.50
St. Peters	**45.6612**	**-60.8744**	3	0	3	0	3	1.00
13/08/2012			3	0	3	0	3	1.00
St. Andrews	**45.0712**	**-67.0544**	3	18	45	0	63	21.00
08/07/2013			3	18	45	0	63	21.00
St. Catherines River	**43.8408**	**-64.8622**	3	18	54	0	72	24.00
24/08/2011			3	18	54	0	72	24.00
St. Martins	**45.3557**	**-65.5273**	3	0	15	0	15	5.00
08/07/2013			3	0	15	0	15	5.00
Terrence Bay	**44.4619**	**-63.7078**	3	4	72	0	76	25.33

16/08/2013			3	4	72	0	76	25.33
Tiverton	**44.3970**	**-66.2142**	3	0	1	0	1	0.33
10/07/2013			3	0	1	0	1	0.33
Tongue schoal	**45.0637**	**-67.0140**	6	0	0	0	0	0.00
18/07/2011			3	0	0	0	0	0.00
02/08/2011			3	0	0	0	0	0.00
Venus Cove	**45.6153**	**-61.3901**	3	2	2	0	4	1.33
13/08/2012			3	2	2	0	4	1.33
Wagmatcook C	**46.0726**	**-60.9065**	39	64	48	0	112	2.87
29/07/2008			3	4	5	0	9	3.00
27/08/2008			3	0	0	0	0	0.00
22/09/2008			3	4	1	0	5	1.67
20/10/2008			3	13	3	0	16	5.33
11/06/2009			3	3	3	0	6	2.00
20/07/2009			3	12	7	0	19	6.33
01/09/2009			3	0	0	0	0	0.00
14/10/2009			3	4	3	0	7	2.33
22/06/2010			3	0	1	0	1	0.33
19/07/2010			3	3	9	0	12	4.00
17/08/2010			3	0	0	0	0	0.00
16/09/2010			3	0	0	0	0	0.00
28/10/2010			3	21	16	0	37	12.33
Wagmatcook P	**46.0700**	**-60.9085**	39	34	135	0	169	4.33
29/07/2008			3	0	3	0	3	1.00
27/08/2008			3	4	0	0	4	1.33
22/09/2008			3	0	1	0	1	0.33
20/10/2008			3	2	0	0	2	0.67
11/06/2009			3	0	2	0	2	0.67
20/07/2009			3	15	37	0	52	17.33
01/09/2009			3	0	10	0	10	3.33
14/10/2009			3	0	0	0	0	0.00
22/06/2010			3	0	2	0	2	0.67
19/07/2010			3	6	23	0	29	9.67
17/08/2010			3	0	5	0	5	1.67
16/09/2010			3	1	19	0	20	6.67
28/10/2010			3	6	33	0	39	13.00
Washabuck C	**46.0994**	**-60.7484**	3	0	1	0	1	0.33
15/06/2009			3	0	1	0	1	0.33
Washabuck P	**46.0994**	**-60.7484**	3	0	0	0	0	0.00
15/06/2009			3	0	0	0	0	0.00
Wedgeport	**43.7147**	**-65.9696**	6	15	75	0	90	15.00
12/07/2012			3	11	25	0	36	12.00
04/07/2013			3	4	50	0	54	18.00

We'koqma'q C	**45.9620**	**-61.1210**	36	34	49	0	83	2.31
30/07/2008			3	1	3	0	4	1.33
28/08/2008			3	0	1	0	1	0.33
23/09/2008			3	8	0	0	8	2.67
21/10/2008			3	6	5	0	11	3.67
20/07/2009			3	5	19	0	24	8.00
01/09/2009			3	0	2	0	2	0.67
14/10/2009			3	6	2	0	8	2.67
22/06/2010			3	0	1	0	1	0.33
19/07/2010			3	0	4	0	4	1.33
17/08/2010			3	1	3	0	4	1.33
16/09/2010			3	1	3	0	4	1.33
28/10/2010			3	6	6	0	12	4.00
We'koqma'q P	**46.0700**	**-61.1126**	36	31	52	0	83	2.31
30/07/2008			3	2	8	0	10	3.33
28/08/2008			3	3	0	0	3	1.00
23/09/2008			3	0	0	0	0	0.00
21/10/2008			3	0	1	0	1	0.33
20/07/2009			3	11	15	0	26	8.67
01/09/2009			3	1	1	0	2	0.67
14/10/2009			3	2	8	0	10	3.33
22/06/2010			3	0	0	0	0	0.00
19/07/2010			3	1	0	0	1	0.33
17/08/2010			3	0	8	0	8	2.67
16/09/2010			3	0	1	0	1	0.33
28/10/2010			3	11	10	0	21	7.00
Westport	**44.2642**	**-66.3483**	3	2	1	0	3	1.00
10/07/2013			3	2	1	0	3	1.00
Yarmouth Bar	**43.8165**	**-66.1479**	3	12	26	0	38	12.67
12/07/2012			3	12	26	0	38	12.67
Grand Total			**1262**	**5130**	**10443**	**257**	**15827**	**12.54**

Appendix A. 2. Location of stations within each Region and total number of traps, total number of female and male green crabs caught and average CPUE per location (2008-2015). BoF: Bay of Fundy, SS: South Shore, ES: Eastern Shore, CB: Cape Breton, BDOL: Bras d'Or Lakes, DYC: Dobson Yacht Club, C: Continuous eelgrass bottom, P: Patchy eelgrass bottom, SR: Sandy/Rocky bottom, RA: Rapid Assessment.

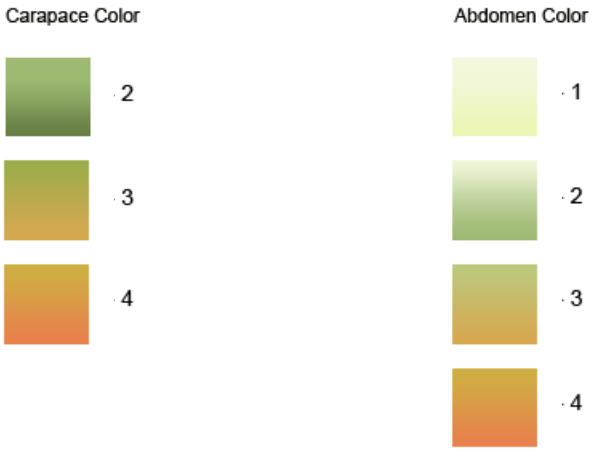
Location	*Region*	*Latitude*	*Longitude*	*Nb of traps*	*Female*	*Male*	*nd*	*Total GC*	*CPUE*
Adams Island	BoF	45.0110	-66.9084	4	0	6	0	6	1.50
Amaguadees C	BDOL	45.9088	-60.6621	6	1	0	0	1	0.17
Amaguadees P	BDOL	45.9182	-60.6523	6	0	1	0	1	0.17
Aqua_Ed	BDOL	46.0132	-60.3900	50	93	383	0	476	9.52
Baddeck	BDOL	46.0994	-60.7484	3	0	0	0	0	0.00
Battery Point	BoF	44.6747	-65.7528	3	11	51	0	62	20.67
Beaver Harbour	BoF	45.0685	-66.7400	3	3	4	0	7	2.33
Ben Eoin - marina	BDOL	45.9818	-60.4314	3	0	12	0	12	4.00
Ben Eoin_1	BDOL	45.9825	-60.4304	9	9	10	69	88	9.78
Ben Eoin_2	BDOL	45.9822	-60.4320	3	0	9	0	9	3.00
Ben Eoin_3	BDOL	45.9820	-60.4311	9	1	6	47	54	6.00
Ben Eoin_4	BDOL	45.9817	-60.4319	9	1	11	21	33	3.67
Big Harbour	CB	46.1485	-60.5982	6	2	5	0	7	1.17
BIO boat launch	SS	44.6853	-63.6139	2	5	18	0	23	11.50
BIO Jetty	SS	44.6812	-63.6109	46	127	108	0	235	5.11
Blandford	SS	44.4938	-64.1139	3	5	6	0	11	3.67
Bliss Island	BoF	45.0263	-66.8453	4	2	12	0	11	2.75
Boutiliers Point	SS	44.6570	-63.9466	3	13	27	0	40	13.33
Shad Bay - Cannon Rock	SS	44.5210	-63.7931	12	17	72	0	89	7.42
Canso	ES	45.3232	-60.9636	3	2	108	0	110	36.67
Central Port Mouton	SS	43.9187	-64.8447	3	43	118	0	161	53.67
Chapel Island C	BDOL	45.7081	-60.7749	45	140	318	0	458	10.18
Chapel Island P	BDOL	45.7095	-60.7755	45	124	334	0	458	10.18
Charlos Cove	ES	45.2454	-61.3349	3	1	17	0	18	6.00
Clam Bay Causeway	ES	44.7338	-62.9068	3	751	270	0	1021	340.33
Coast Guard wharf	CB	46.1423	-60.2006	28	175	254	0	429	15.32
Cole Harbour (1)	ES	44.6595	-63.4347	3	20	53	0	73	24.33
Cole Harbour (2)	ES	44.6599	-63.4351	9	55	117	0	172	19.11
Cole Harbour (3)	ES	44.6602	-63.4343	6	63	43	0	106	17.67
Cole Harbour (4)	ES	44.6609	-63.4322	10	122	67	0	189	18.90
Cole Harbour (5)	ES	44.6599	-63.4357	42	194	548	66	808	19.24
Cole Harbour (6)	ES	44.6532	-63.4252	127	503	1045	3	1551	12.21

Cole Harbour (7)	ES	44.6561	-63.4302	8	51	170	0	221	27.63
Cole Harbour (8)	ES	44.6570	-63.4229	9	70	107	0	177	19.67
Cole Harbour (9)	ES	44.6519	-63.4191	18	71	142	0	213	11.83
DeBaie's Cove	EC	44.7545	-62.8077	3	16	103	0	119	39.67
D'Escousse	CB	45.5887	-60.9618	3	0	9	0	9	3.00
Dingwall	CB	46.9017	-60.4606	8	5	26	0	31	3.88
Dingwall Public Wharf	CB	46.9032	-60.4604	3	1	7	0	8	2.67
Dipper Harbour	BoF	45.0941	-66.4176	3	0	1	0	1	0.33
Dobson Yacht Club	CB	46.1355	-60.2043	3	0	3	0	3	1.00
DYC beach	CB	46.1378	-60.2054	42	602	901	53	1556	37.05
East Chezzetcook	ES	44.7110	-63.2363	3	52	57	0	109	36.33
East Jeddore (1)	ES	44.7290	-63.0045	6	42	235	0	277	46.17
East Jeddore (2)	ES	44.7184	-62.9993	6	2	19	0	21	3.50
East Port Medway	SS	44.1512	-64.5765	3	30	112	0	142	47.33
East River Point	SS	44.5732	-64.1605	3	4	44	0	48	16.00
East Ship Harbour	ES	44.8115	-62.8544	3	10	5	0	15	5.00
East Side Port L'Hebert	SS	43.8197	-64.9289	3	16	25	0	41	13.67
Eddy Point	ES	45.5210	-61.2637	3	2	10	0	12	4.00
Eskasoni C	BDOL	45.9391	-60.6178	84	256	582	0	838	9.98
Eskasoni P	BDOL	45.9356	-60.6246	75	331	446	0	777	10.36
Eskasoni SR	BDOL	45.9342	-60.6114	24	13	95	0	108	4.50
Fairhaven	BoF	44.9641	-67.0079	3	5	15	0	20	6.67
False Bay	CB	46.0809	-59.8926	6	93	67	1	161	26.83
Five Fathom Hole	BoF	45.1811	-66.2624	3	15	46	0	61	20.33
Fourchu	CB	45.7173	-60.2545	2	2	15	0	17	8.50
Gabarus	CB	45.8404	-60.1382	3	6	16	0	22	7.33
Gillis Cove C	BDOL	45.9100	-61.0549	9	4	12	0	16	1.78
Gillis Cove P	BDOL	45.9106	-61.0534	21	12	29	0	41	1.95
Gillis Cove RA	BDOL	45.9115	-61.0526	9	4	1	0	5	0.56
Glen Margaret	SS	44.5833	-63.9132	3	1	5	0	6	2.00
Gold River	SS	44.5313	-64.3099	3	11	89	0	100	33.33
Goldboro	ES	45.1869	-61.6560	3	7	80	0	87	29.00
Graves Island	SS	44.5624	-64.2093	3	4	31	0	35	11.67
Gunning Cove	SS	43.6807	-65.3397	6	18	52	0	70	11.67
Hampton	BoF	44.9065	-65.3517	3	3	24	0	27	9.00
Indian Harbour	SS	44.5150	-63.9351	3	0	39	0	39	13.00
Indian Point	SS	44.4566	-64.3158	12	51	123	0	174	14.50
Lawrencetown River	ES	44.6486	-63.3587	12	77	154	0	231	19.25
Leonardville	BoF	44.9716	-66.9526	3	12	76	0	88	29.33
Little Harbour	SS	43.7173	-65.0302	3	0	9	0	9	3.00

Little Harbour CB	CB	45.5828	-60.7398	6	28	98	0	126	21.00
Little River	CB	46.4471	-60.4594	6	36	39	0	75	12.50
Lorneville	BoF	45.1923	-66.1487	3	12	35	0	47	15.67
Lower Prospect	SS	44.4518	-63.7269	3	0	17	0	17	5.67
Lower Ship Harbour	SS	44.8029	-62.8595	3	2	37	0	39	13.00
Lower Three Fathom Harbour	SS	44.6378	-63.2759	3	5	11	0	16	5.33
Lunenburg First Peninsula	SS	44.3846	-64.3113	6	20	32	0	52	8.67
Lunenburg Railway Wharf	SS	44.3753	-64.3069	3	1	1	0	2	0.67
Lunenburg Yacht Club_1	SS	44.4116	-64.3215	3	3	10	0	13	4.33
Lunenburg Yacht Club_2	SS	44.4116	-64.3198	9	31	57	0	88	9.78
Lunenburg Yacht Club_3	SS	44.4109	-64.3226	9	12	101	0	113	12.56
Lunenburg Yacht Club_4	SS	44.4108	-64.3217	3	0	6	0	6	2.00
Lunenburg Yacht Club_5	SS	44.4121	-64.3219	3	6	35	0	41	13.67
Ingonish - Maclords Point Wharf	CB	46.6800	-60.3500	2	0	0	0		0.00
Mahone Bay	SS	44.4442	-64.3671	6	24	68	0	92	15.33
Malagawatch C	BDOL	45.8746	-60.9572	3	9	13	0	22	7.33
Malagawatch P	BDOL	45.8718	-60.9653	3	11	38	0	49	16.33
Marriotts Cove	SS	44.5500	-64.2818	3	13	62	0	75	25.00
Meteghan	BoF	44.1938	-66.1675	3	0	17	0	17	5.67
Mill Cove (1)	SS	44.5803	-64.0537	9	17	96	0	113	12.56
Mill Cove (2)	SS	44.5803	-64.0552	7	18	73	0	91	13.00
Morisons Cove	BDOL	46.0061	-60.9435	15	13	376	0	389	25.93
Musquash 1 (by Five Fathom Hole)	BoF	45.1889	-66.2596	2	2	9	0	11	5.50
Musquash 2 (by ledges)	BoF	45.1621	-66.2422	2	14	71	0	85	42.50
Musquash 3 (west side)	BoF	45.1637	-66.2582	2	13	62	0	75	37.50
Navy Island	BoF	45.0547	-67.0485	7	5	2	0	7	1.00
New Harbour	ES	45.1800	-61.4601	3	3	19	0	22	7.33
Newellton	SS	43.4718	-65.6344	3	20	16	0	36	12.00
North Harbour	CB	46.9048	-60.4615	3	28	59	0	87	29.00
North Sydney	CB	46.2068	-60.2490	12	11	18	0	29	2.42
Oak Island	SS	44.5112	-64.3019	3	12	26	0	38	12.67
Ostrea Lake	ES	44.7185	-63.0887	9	52	290	0	342	38.00
Parker's Cove	BoF	44.8134	-65.5371	3	2	11	0	13	4.33

Petit de Grat	CB	45.5071	-60.9605	3	9	9	0	18	6.00
Port Bickerton	ES	45.0943	-61.7290	3	12	67	0	79	26.33
Port La Tour	SS	43.4977	-65.4718	6	3	24	0	27	4.50
Pottery Cove	BoF	45.0741	-67.0781	3	0	1	0	1	0.33
SABS	BoF	45.0823	-67.0846	3	1	6	0	7	2.33
Saulnierville	BoF	44.2629	-66.1383	3	16	36	0	52	17.33
Shad Bay - private pontoon	SS	44.5231	-63.7884	3	3	10	0	13	4.33
Shad Bay - public Beach	SS	44.5233	-63.7898	9	8	38	0	46	5.11
Shad Bay - public Wharf	SS	44.5290	-63.7879	3	1	2	0	3	1.00
Sonora	ES	45.0580	-61.9046	6	86	170	0	256	42.67
South Harbour	CB	46.8831	-60.4655	3	4	20	0	24	8.00
South Haven	CB	46.2112	-60.5940	14	22	133	0	155	11.07
St Peters	BDOL	45.6612	-60.8744	3	0	3	0	3	1.00
St. Andrews	BoF	45.0712	-67.0544	3	18	45	0	63	21.00
St. Catherines River	SS	43.8408	-64.8622	3	18	54	0	72	24.00
St. Martins	BoF	45.3557	-65.5273	3	0	15	0	15	5.00
Terrence Bay	SS	44.4619	-63.7078	3	4	72	0	76	25.33
Tiverton	BoF	44.3970	-66.2142	3	0	1	0	1	0.33
Tongue schoal	BoF	45.0637	-67.0140	6	0	0	0	0	0.00
Venus Cove	ES	45.6153	-61.3901	3	2	2	0	4	1.33
Wagmatcook C	BDOL	46.0726	-60.9065	39	64	48	0	112	2.87
Wagmatcook P	BDOL	46.0700	-60.9085	39	34	135	0	169	4.33
Washabuck C	BDOL	46.0994	-60.7484	3	0	1	0	1	0.33
Washabuck P	BDOL	46.0994	-60.7484	3	0	0	0	0	0.00
Wedgeport	SS	43.7147	-65.9696	6	15	75	0	90	15.00
We'koqma'q C	BDOL	45.9620	-61.1210	36	34	49	0	83	2.31
We'koqma'q P	BDOL	46.0700	-61.1126	36	31	52	0	83	2.31
Westport	BoF	44.2642	-66.3483	3	2	1	0	3	1.00
Yarmouth Bar	SS	43.8165	-66.1479	3	12	26	0	38	12.67
Grand Total				**1348**	**5204**	**10915**	**260**	**16376**	**12.15**

Appendix B. Carapace and abdomen color determination key.

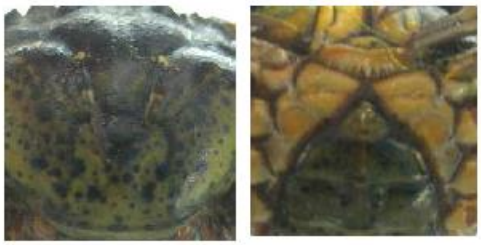


Carapace (2)
Abdomen (1)

Carapace bright emerald green, no fouling, no wear. Abdomen yellow-light green, no discoloration of abdomen.

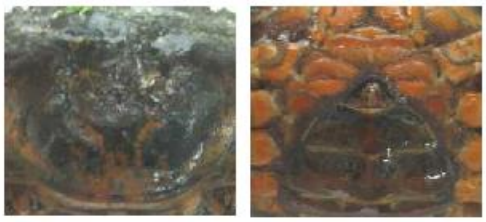
Carapace (2)
Abdomen (2)

Carapace bright emerald green, no fouling, no wear. Abdomen yellow-green, slight discoloration or signs of wear.



Carapace (3)
Abdomen (3)

Carapace green-brown. If green, brown discoloration may be present. Abdomen green with orange/brown discoloration or orange/brown.



Carapace (4)
Abdomen (4)

Carapace deep orange/red with, or without, fouling. Abdomen deep orange/red.