



Abundance, distribution, and mitigation of green crab (*Carcinus maenas*) in western Newfoundland, Canada

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Summary

The European green crab (*Carcinus maenas*) has successfully invaded estuaries and protected harbours from Port aux Basques to Port au Choix, along the west coast of Newfoundland (NL). Qalipu Mi'kmaq First Nations (Qalipu) and Mi'kmaq Alsumk Mowimsikik Koqoey Association (MAMKA) have been studying and mitigating green crab in Bay St. George and Bay of Islands since 2009. We conducted rapid assessments and focused removal along a ~270 km latitudinal range from late July to early October to determine the abundance and distribution of green crab in western NL. We successfully removed 8050 green crab from all sites, with 3867 crab removed from Penguin Arm, Bay of Islands, over three nights. This year was the first step towards meaningful reductions of green crab in western NL and has set the framework for upcoming studies investigating the effects of green crab on eelgrass communities. The protection of this significant habitat is essential for maintaining healthy coastal ecosystems and conserving commercially, culturally, and recreationally important species.

Introduction

The introduction of non-native species is quickly becoming one of the biggest challenges facing the conservation of coastal ecosystems and management of natural resources. Recent introductions in marine ecosystems have resulted in large scale decreases in commercially harvested species, such as anchovy and soft shell clams (Ropes 1968, Kideys 1994). Global trade has increased the rate of marine introductions, which is threatening biodiversity and is leading to the global homogenization of species (Molnar et al 2008). The European green crab (*Carcinus maenas*) was first reported in eastern Newfoundland (NL) in 2007 (DFO 2011). By 2008/2009, it had extended its range to include parts of southern and western NL (MAMKA 2009, DFO 2011). Historically, the introduction of green crab to the NW Atlantic has resulted in decreases in populations of invertebrates and drastic declines in ecologically significant eelgrass habitat (Ropes 1968, Garbary et al 2002, 2014).

Qalipu Mi'kmaq First Nations (Qalipu) and Mi'kmaq Alsumk Mowimsikik Koqoey Association (MAMKA) have been researching and mitigating green crab in western NL since 2009. We have been actively studying the distribution and monitoring the abundance of green crab in Bay St. George and along the Port au Port peninsula. In 2011, we were first informed of green crab in Bay of Islands, which was confirmed during our 2012 surveys. The goal of this study is to determine the abundance and distribution of green crab along a ~270 km latitudinal range while increasing our mitigation efforts in sensitive habitats of Bay St. George and Bay of Islands.

Materials and methods

Green crab were trapped with Fukui folding traps between July and October 2015. We conducted rapid assessments using a 1 to 3 hour short term soak at eight sites along a ~270 km latitudinal range in late August and early September to determine the abundance (catch per unit effort [CPUE], see Equation 1) and distribution (Figures 1 and 2) of green crab. Focused removal was carried out using 1 to 6 hour short term soaks and 15 to 26 hour long term soaks at numerous sites in Bay St. George and Bay of Islands (Figures 1, 2, and 3).

$$\text{Equation 1: CPUE for a single trap} = \frac{\text{Total number of crab caught}}{\text{Soak time (hrs)}}$$



Figure 1: Green crab trapping locations along the west coast of Newfoundland, Canada

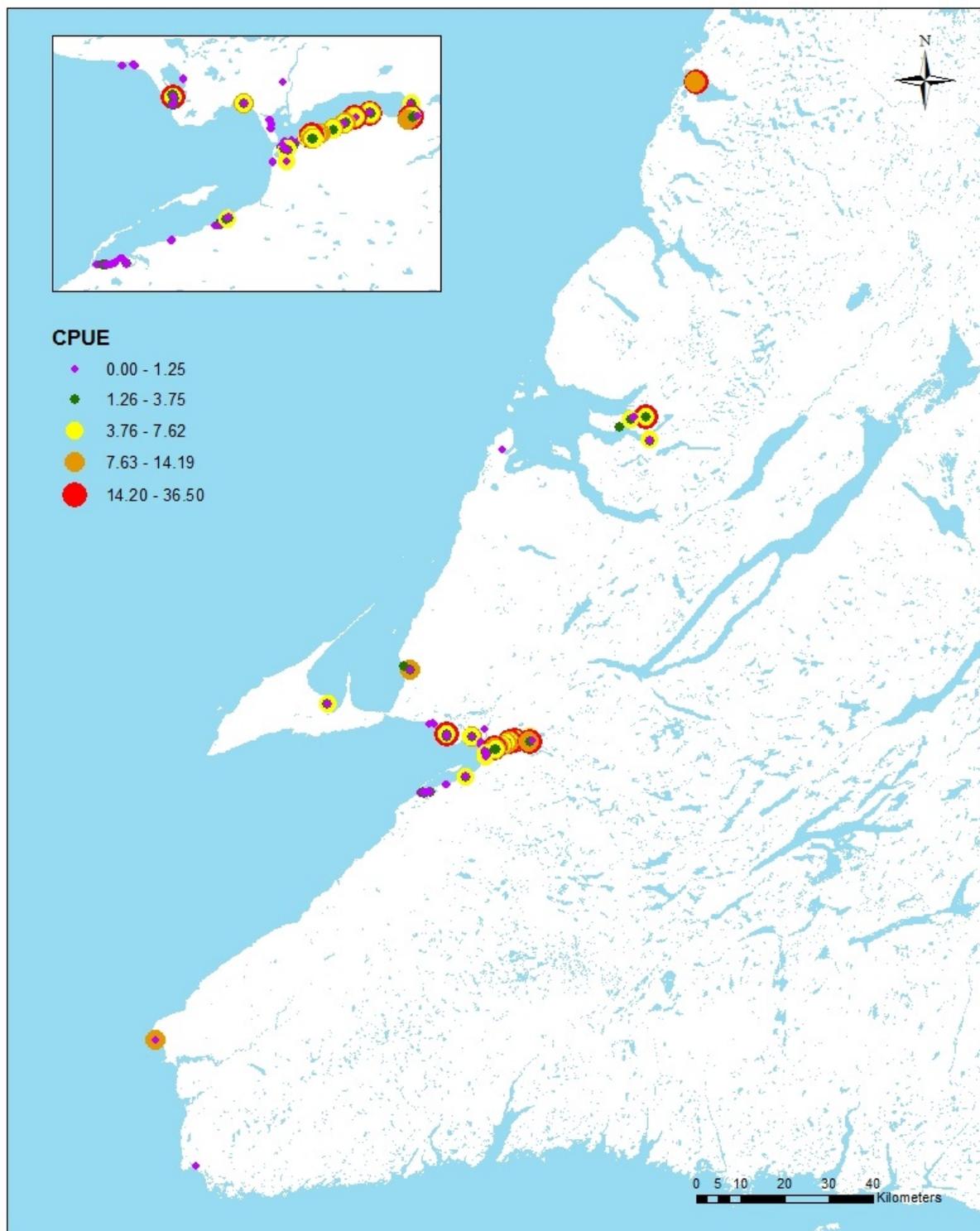


Figure 2: Green crab catch per unit effort (CPUE) for 1 to 6 hour short term soaks along western Newfoundland, Canada

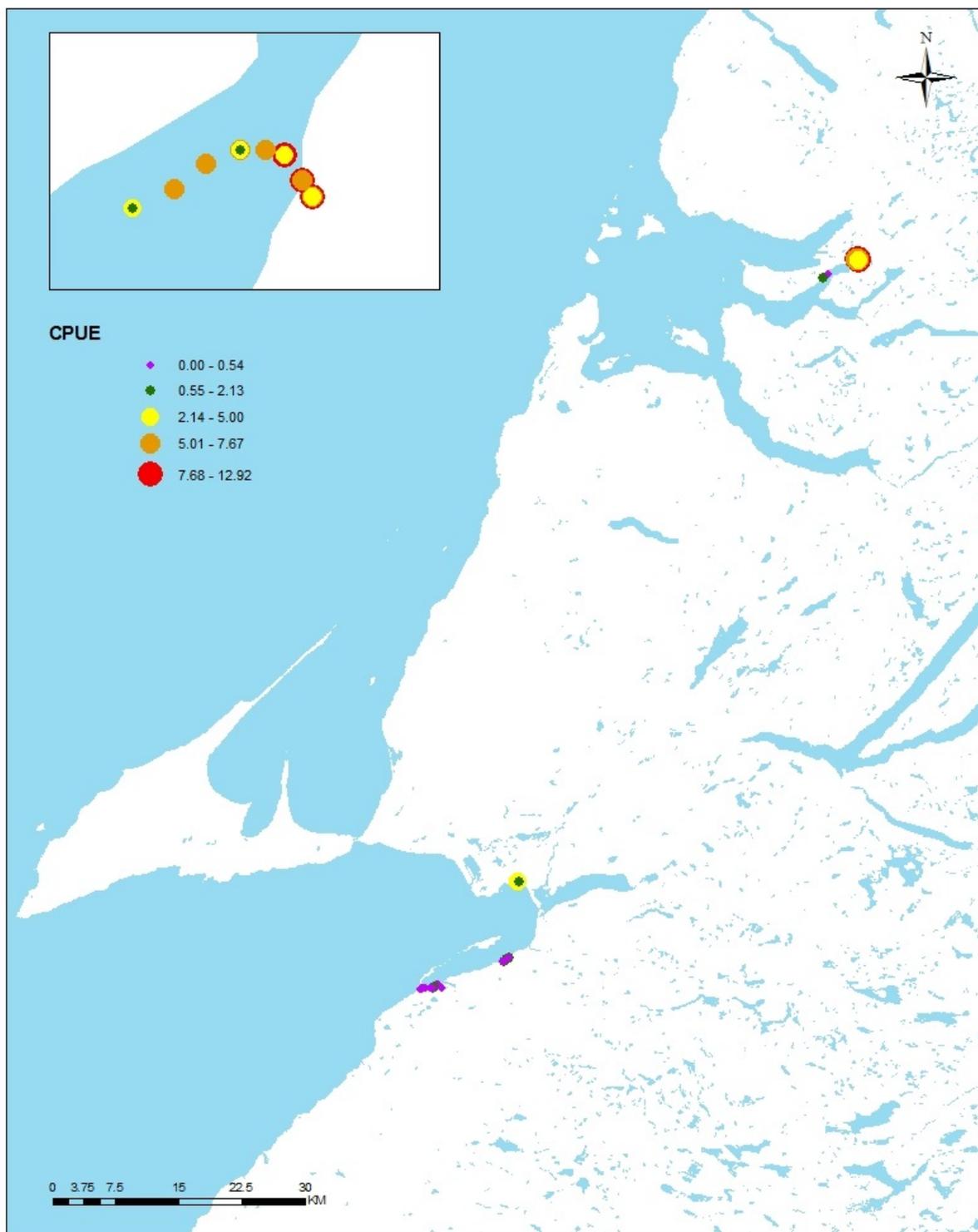


Figure 3: Green crab catch per unit effort (CPUE) for 15 to 26 hour long term soaks along western Newfoundland, Canada

Results

A total of 8050 crabs were removed from western Newfoundland, with 3867 removed from Penguin Arm, Bay of Islands, and 4183 removed during rapid assessments and focused removal at all other sites. Overall, 29.7 % of green crab removed from Penguin Arm in late July were female while 47.3 % of the crab removed from all other sites between early August and early October were female. Mean carapace width of all crab caught was 38.1 mm, with the majority of crabs falling between 30 and 40 mm (Figure 4). Interestingly, the mean carapace width was 36.7 mm for Penguin Arm and the majority of crabs were between 30 and 37 mm. The mean carapace width of crab at other sites was 39.4 mm and the size of the crabs was more evenly distributed (Figure 5). The mean carapace width of male crabs in Penguin Arm peaked at 43.9 mm during the initial short term soak on the 23 July before decreasing to 36.3 mm on the 24 July (Figure 6). Interestingly, the mean carapace width of both female and male green crab increased between the 25 and 26 July despite a decrease in the total number of crab caught (Figures 6 and 7).

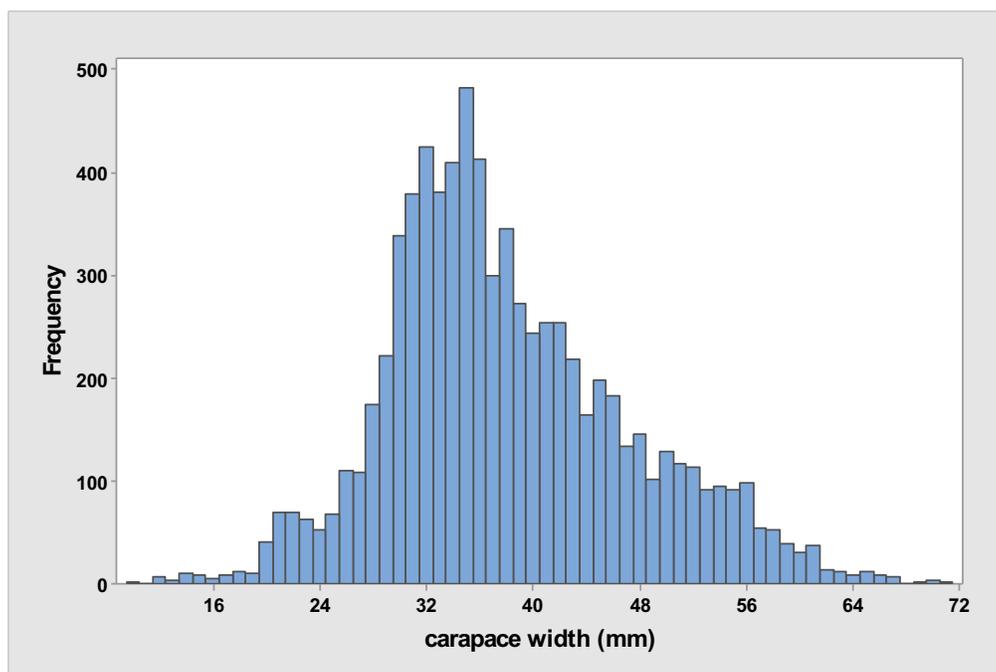


Figure 4: Histogram showing the distribution of carapace widths for green crab caught at all sites in western Newfoundland, Canada.

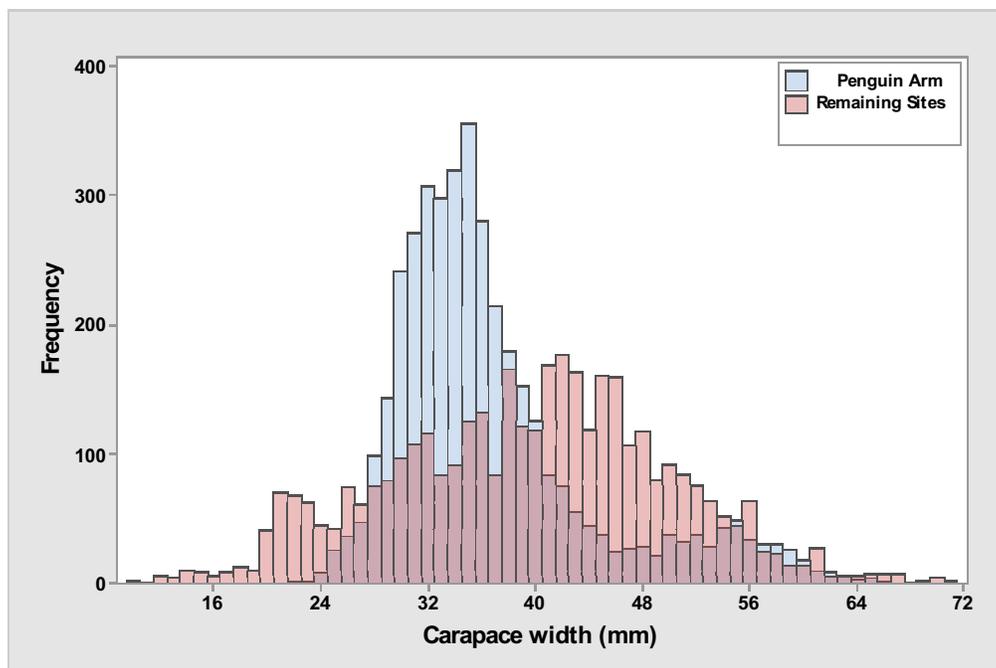


Figure 5: Histogram showing the distribution of carapace widths for green crab caught at Penguin Arm and remaining sites in western Newfoundland, Canada.

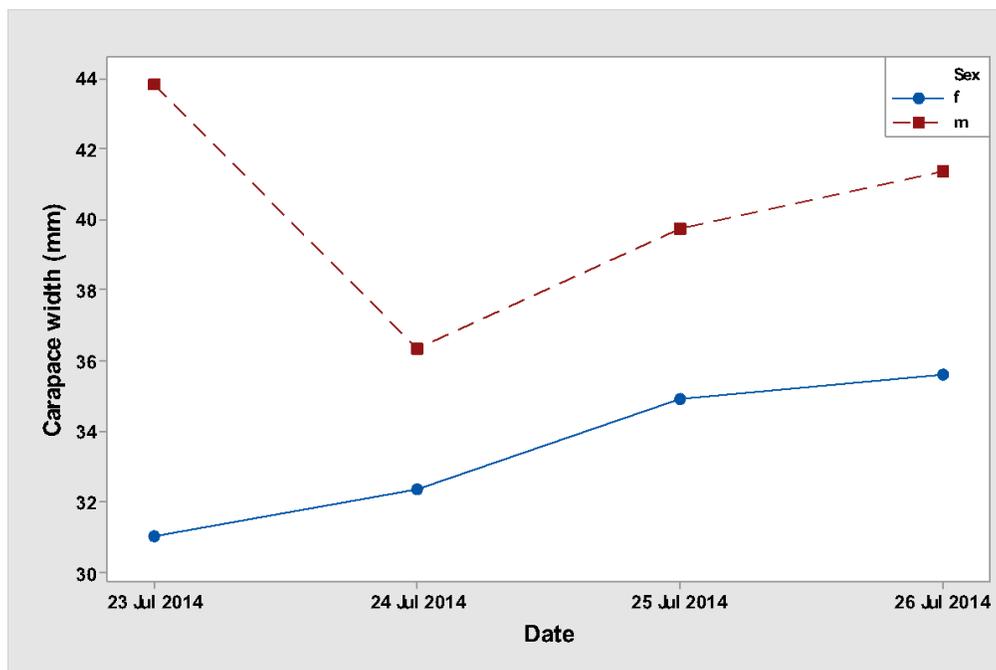


Figure 6: Line graph showing the change in female and male green crab carapace width over four sampling periods at Penguin Arm

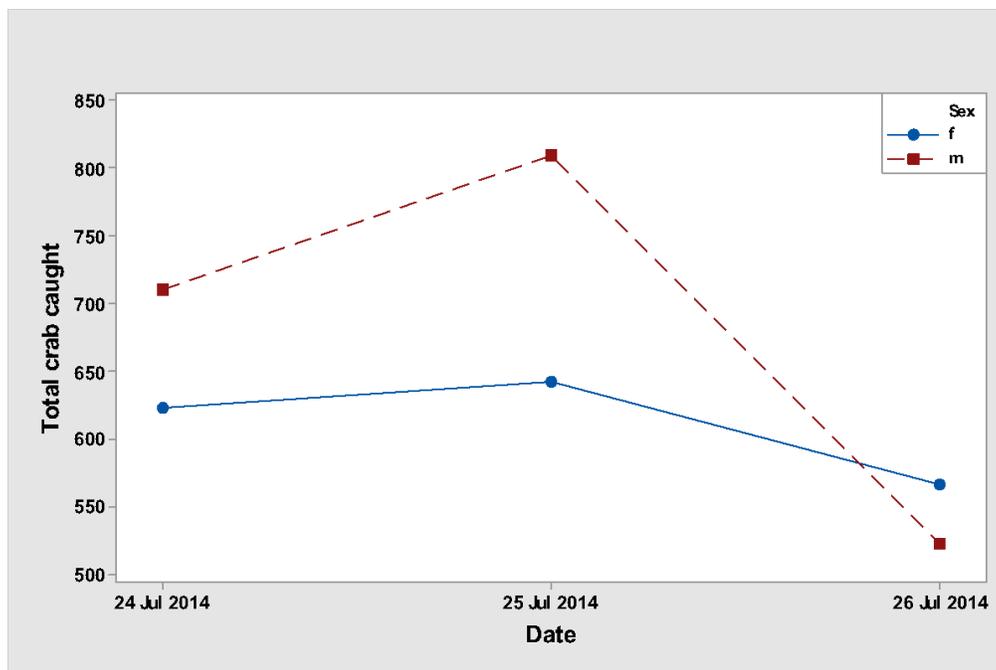


Figure 7: Line graph showing the change in the total number of female and male green crab caught over three sampling periods at Penguin Arm

Discussion

The European green crab has successfully invaded and established large populations in estuaries and protected harbours from Codroy to St. Paul's, NL. Reports indicate that this invader has made it as far north as Port au Choix, but there is no evidence that it has invaded Pistolet or Hare Bay on the Northern Peninsula (DFO 2014). Experimental evidence indicates that green crab can successfully compete with rock crab and American lobsters for resources while field studies indicate that this species is impacting eelgrass habitat and invertebrate communities (Ropes 1968, Garbary et al 2004, 2014, Rossong et al 2006, Matheson and Gagnon 2012a, b). Competition with commercial species, destruction of ecologically significant coastal habitats, and displacement and reduction of native species by green crab are issues that western NL now faces.

Qalipu and MAMKA successfully removed 8050 crab from western NL with almost half of these crab being removed over three nights in Penguin Arm, Bay of Islands. Interestingly, there was a slight reduction in the number of crab caught over time at Penguin Arm. This decrease may be in response to sampling effort, but may also be in response to small scale

changes in trap placement and temporal changes in weather and tides (Caines personal observations, Matheson pers. com.). Similar to Penguin Arm, the CPUE was up to 8.7 and 15.7 crab/hr at Codroy and St. Paul's, respectively. Both St. Paul's and Codroy have extensive eelgrass beds and are known to be important foraging grounds for waterfowl and migratory shore birds (MAMKA 2015a, NCC). Globally, sea grasses are declining in response to multiple stressors, including eutrophication, shoreline development, climate change, and aquatic invasive species (Hauxwell et al. 2001, Orth et al. 2006, Waycott et al 2009). In addition to green crab, recent studies indicate that invasive tunicates have invaded eelgrass habitat in western NL (MAMKA 2015b)

Eelgrass is an important ecosystem engineer and provides essential ecosystem services to coastal NL (Orth et al. 2006, Barbier et al. 2011). Eelgrass provides a highly productive, three dimensional habitat, for fish and invertebrates to forage and take refuge in (Heck and Thoman 1984, Hovel and Lipcius 2001). Furthermore, eelgrass meadows stabilize sandy shores and play an important role in atmospheric carbon cycling through the sequestering and storage of CO₂ (Orth et al. 2006, Barbier et al. 2011). Qalipu and MAMKA are working towards identifying ecologically significant eelgrass habitat and mitigating the effects of green crab in western NL (MAMKA 2015a). This year was the first step towards meaningful reductions of green crab in western NL and has set the framework for upcoming studies investigating the effects that green crab are having on eelgrass communities. The protection of this significant habitat is essential for maintaining healthy coastal ecosystems and conserving commercially, culturally, and recreationally important species. (Hovel and Lipcius 2001, Hughes et al. 2002).

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