Developing the invasive European Green crab (*Carcinus maenas*) as a new fishery in Casco Bay

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Nonindigenous species are increasing the instability of marine ecosystems on a global scale (Grosholz 2000). One major representation of this issue is the invasion of the European Green crab (*Carcinus maenas*). Originating from locations ranging from Norway to Mauritania, they now have a presence in ecosystems located in Australia to both the East and West coasts of the United States. The green crabs have started negatively impacting the areas' ecosystems, which can be observed on trophic levels due to their ability to adapt to different food varieties (Cohen et al. 1995). The green crab's predatory diet has altered the structure of soft bottom ecosystems and has decreased the prey population significantly—clam fisheries are being eliminated swiftly with the increased population of green crabs (Tan et al. 2015). Tackling the reduction of ecological impacts of green crabs has been tried in numerous ways, but a new study in Canada has revealed a new economic opportunity for fisherman in the Gulf of Maine as a possible answer (Poirier et al. 2016). Exploiting patterns in the green crab's moulting synchrony showed a promising step towards developing a soft-shell, green crab industry.

The goal of this project was to use the annual green crab monitoring program run by the Carlon laboratory at Bowdoin to provide new information on the moulting dynamics during the warm summer months in Casco Bay. Certain aspects of the project were targeted on whether the molting dynamics of *C. maenas* changed between different habitats, how the molting dynamics changed throughout the summer season, and the length of an average "pre-molt" stage in a green crab's molting cycle. Over the course of ten weeks, field collected crabs from different habitats were used to answer these questions. Twice a week, a twenty-four-hour set was completed at four different sites: Ash Point Cove, Widgeon Cove, Strawberry Creek, and Brewer's Cove. Crab traps were placed into the areas during hide tide then left until the next day, where the crabs were then collected and counted. Out of the collections, green crabs were chosen to be observed in the Schiller Coastal Studies Marine Lab for the course of the project based on their pre-molt signs. To recognize the four stages of the green crab's 'molting window,' Seagrant College of Maine and the Manomet Foundation's guide was used for this experiment (throughout the experiment, the Carlon Lab partnered with the Manomet Foundation to compare findings throughout the summer and help convey new information to the foundation's fisherman). The four stages of a green crab's molting cycle include: Intermolt, Pre-molt, Imminent, and Soft-shell. Intermolt crabs are hard-shelled and unusable for the soft-shell fishery. After Intermolt, the green crabs enter the 'pre-molt' stage, which can be determined by a thin, white line and dark shadow on their abdominal platelets. There are still signs that have yet to proven and explored, which was a goal of this experiment. Some new discoveries include bright-blue shading on their abdominal platelets or a difference in durability of a pre-molt crab's leg to an intermolt crab's—a pre-molt's crab leg will have a more flexible structure when compressed, while an intermolt's will be more stable. Right before a crab molts and becomes a 'soft-shell' crab, it will enter the 'imminent' stage, where all signs of molting wash away and it becomes cloudy.

The differences in a green crab's 'pre-molt' stage was a main focus of the experiment. When a crab enters this stage, it will later molt and become a soft-shell crab, which can then be used to sell to restaurants or local stores. Being able to determine the signs of a pre-molt crab is very important and the data collected will be used for the future fishermen in this industry. To observe the progression of a green crab's molting cycle, pictures of each chosen crab were taken once a week. This allowed for the length of the pre-molt stage to be estimated and when pre-molt crabs started to appear at each site, based on their size or sex. Looking at each site, both size and sex were a major factor for the timing of the pre-molt stage. Ash Point, which contained a majority of males and large crabs, had longer pre-molt stages. By Week 7, 18.95% (18/95) of the crabs collected at this site were pre-molt and 7.37% had molted. In comparison, Widgeon had 12.50% (15/120) pre-molt crabs and 7.50% had molted. This showed that although Ash Point has a higher percentage of pre-molt crabs, their larger size caused them to be in this stage longer. Because Widgeon has a more even ratio of sex and a smaller average size, their pre-molt stage is shorter, but the percentage of molted crabs is very similar. Females molt much later in the season, so Widgeon will continue to have molts throughout the summer because of their 43% female population compared to Ash Point's 9.28%. Another factor observed was difference in habitat. Both Ash Point and Widgeon had eelgrass (*Zostera marina*), while Brewer's and Strawberry had soft sediment. The locations with soft sediment did not start to have molts until much later in the season; by Week 7, no molts had even occurred at Strawberry Creek. The data collected in this experiment will continue to be analyzed for more interpretation regarding the molting cycle of the green crab. There is also more to explore on this issue. In the future, the Carlon Lab would like to look more into the effect of the increasing water temperature on the green crab's molting cycle and finding more signs that indicate a 'pre-molt' crab.

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