Findings from the Field

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Effects of Climate Change on Green Crab Population in Maine Coast

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Abstract

The purpose of this study was to find out whether climate change has had an impact on the rapid growth of the green crab population in the Maine coastal region. This one way that we are directly affecting this subject and possibly a way to stop or slow the growth. We went to and placed a crab trap at three different locations, Todd's Landing, Reid State Park, and Fort Popham, over a few days, in several years. The catch and release method was used, and data was collected on population, under-claw color, and whether the crab had been caught and marked before. We found that the population has grown by a lot over the past few years, which confirms the trend. We also found that the crabs partially die out in the winter and thrive in the summer. With data from other sources, I can confirm that the average temperature has been going up everywhere, and one of the fastest places is in the Maine coastal region. Combining this data can prove that climate change has been having an impact on the growing crab population.

Introduction

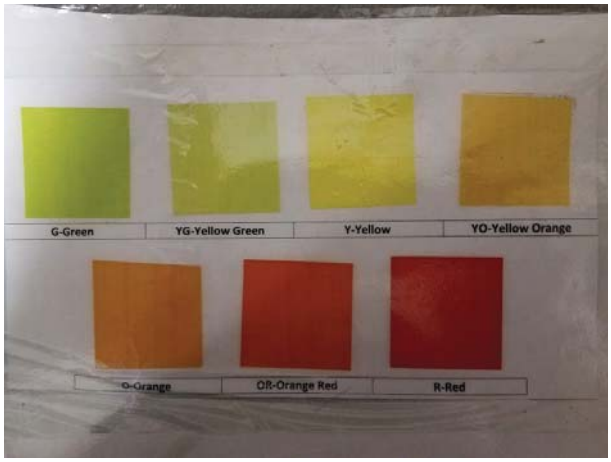
In this research study, we investigated the invasive crab issue. It is an important subject because we have found that invasive crab species, and, more specifically, green crabs, are destroying key elements of the coastal ecosystem such as eelgrass, which normally filters out impurities in the water. We began with learning how other studies have shown that green crabs are harming the environment. This gave us a background for the following investigation, in which we went to Reid State Park, Todd's Landing, and Fort Popham.

The main question we were researching is: How are invasive crab species impacting the Maine coastal ecosystem? I specifically used the data to determine if climate change may have had an effect on the green crab (*Carcinus maenas*) population in the Maine coast region. We had a lot of background research to work with,Control Methods in New England by the Maine Department of Marine Resources, and the story "Scientists Battle to Save Maine's Eelgrass From Destructive Invasive Crab" from NPR. The Seguin and Acadia Houses then conducted the studies to collect data on this question. This topic is important because it could mean the future of Maine's coastal ecosystem, and even more.

Our study can help answer our question about the invasive crabs by finding out more about these species, and collecting data on the surrounding conditions. We can also collect data on native species, if they still exist. By studying these things, we can make graphs of the rise of the invasive species, and armed with this research, could find ways to fix the problem.

Methods

To collect the data, the catch-and-release method was used. First, the legal crab trap was set with a bait, which was, in our case, sardines in oil. Three traps were placed, at Todd's Landing and at Reid State Park in Georgetown, and at Popham Beach in Phippsburg, and allowed to sit for 24 hours, two full tide cycles. After being pulled up, each trap was emptied, with the green crabs being put in buckets, while other creatures were released. The crabs were then cleaned using nail polish remover, and the required data was recorded. Each crab was marked with a small dot of instant-dry nail polish, either yellow or pink, and then released. Finally, each trap was set again, with the same type of bait, and the same amount of time to sit. The study lasted Monday to Friday, with a trap being pulled on Tuesday, Thursday, and Friday. One error that was made was this: On Wednesday, the weather was bad, and the schedule did not allow the data collection. Therefore, the trap sat for 48 hours, or four tide cycles. This produced an error in the data.

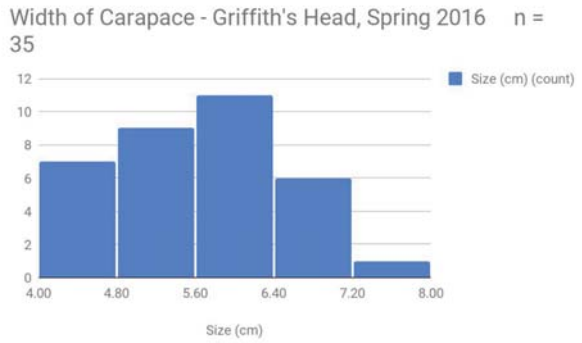


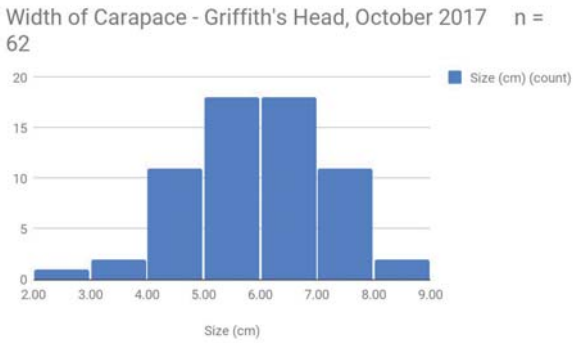
This is the color chart used to check the color under the crabs' claws.

The data collected was mainly data about population, populations of different types of crabs, native and invasive. Population data was also collected relating to male and female population, size data (width of carapace), other notes, a "yes or no" of if it had been previously marked, and color of the underside (under the claws), which gives data on the temperament and lifestyle of the crabs. The color of the underbelly was recorded using the color chart above. The data will be graphed, put on charts, and analysed. The analysis will mainly be comparing the data from this year to data from past years, or day to day, or comparing the data gathered by us (Seguin House) to that gathered by Acadia House.

Controls worked into the study were the fact that the bait was the same each time the trap was set, and it was fresh each time, the location was the same, and the trap was set and pulled up during the same tide cycle each time. The trap would have been allowed to sit for the same amount of time each day, were it not for the error of Wednesday. However, we can use this to compare data for different lengths of time.

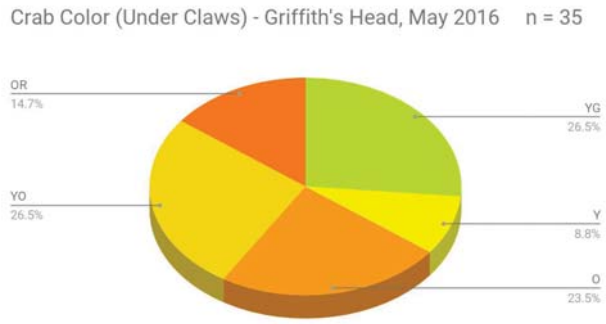
Results

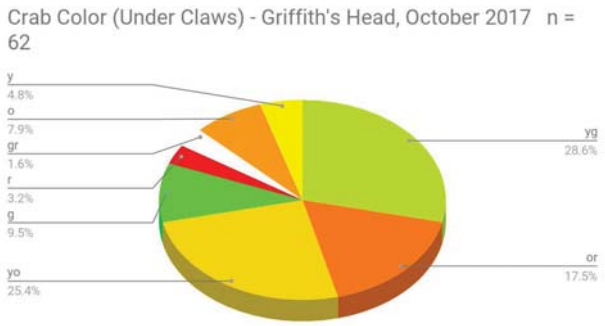




The graphs above show the size of the crab, measured by the width of the carapace in centimeters, between the spring of one year and autumn of the next year. The graphs show that the crabs were generally smaller after winter, with no crabs over 8 cm and mostly between 5.6 and 6.4 cm, and then grew more in the summer, reaching 9 cm, and usually between 6 and 7 cm. This would be expected, as green crabs are known to not be very resistant to the cold, and with little food and energy, the larger ones would die off.

Next are two pie charts showing the proportions of color under the claws. It is over the same time span as the last two, one in the autumn and one in the spring of the previous year. This can show the crabs' wellbeing over the different seasons.

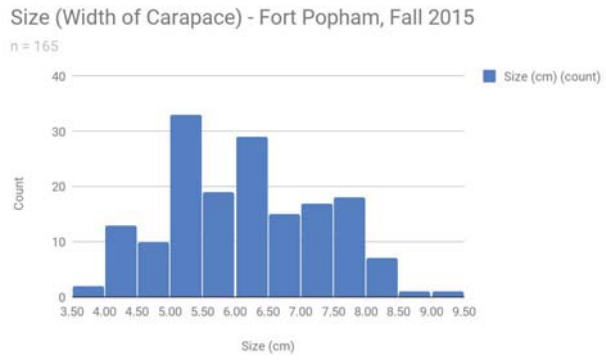


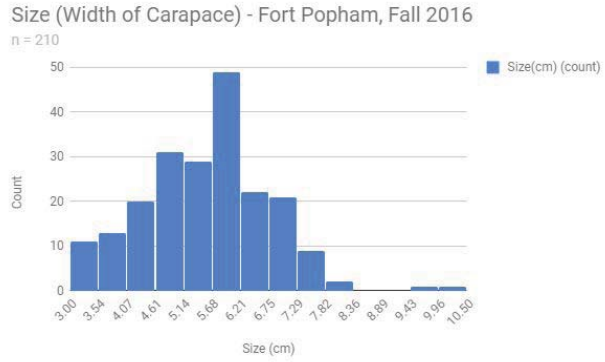


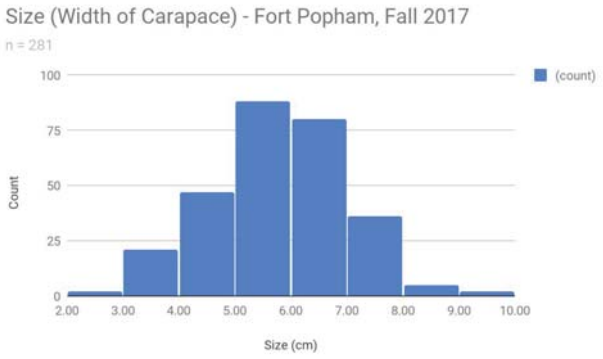
(The white sections on the 2017 chart are typographical errors, there are no colors "green-red" or "yellow-red")

Notice also in the two previous graph pairs that the total number of crabs caught and studied is fewer in the spring (35) than in the fall (62). This provides more proof that the crabs do not do well in the cold.

Next are three charts comparing the number and size of crabs. This is probably the most important chart to our research question because it shows it over time how the crab population has grown.







The number of crabs in the first graph is 165, then, in 2016, the number is 210 crabs, while in 2017, the number is 281 crabs. This shows a large difference in the number of crabs captured.

Finally is a formula which can estimate the population of crabs. Using the data from two consecutive visits, the Lincoln-Petersen index,

$$N = \frac{MC}{R}$$

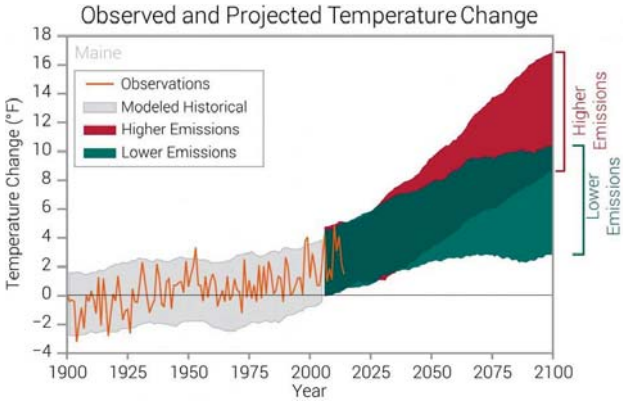
can be used, where N is the population estimate, M is the number caught and marked on the first visit, C is the number caught on the second visit, and R is the number of crabs that were recaptured on the second visit after being marked on the first. One crab was recaptured at Griffith's Head. The number captured one the first visit was 20, and on the second visit the number was 25. Now the equation reads:

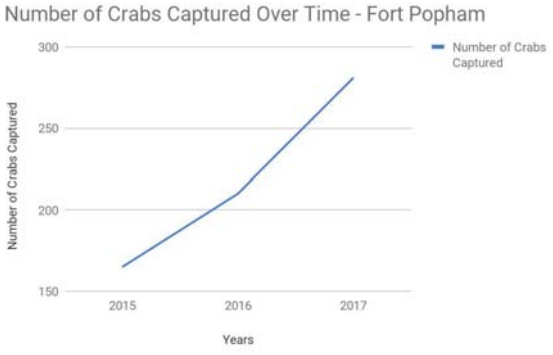
$$N = \frac{20 \times 25}{1}$$

yielding an N of 500 crabs at Griffith's Head alone. This is only an estimate, and since there was only one recapture, a limited amount of data can be used. I estimate that the 500 crabs are in the area shown below, inside the red circle, centered at the red dot, representing the trap spot. This is only an estimate, based on how far a crab could reasonably smell the bait.

Conclusions

Using the data collected from our research, along with a graph from the NOAA National Centers for Environmental Information showing past recorded temperatures and future predicted air temperatures for Maine, I claim that climate change, with average temperatures warming, has had an effect on the growing population of green crabs.





On the left is the graph mentioned above. It shows a trend of rising temperatures, and predictions as to how the temperatures will continue to rise in the future, given possible changes in the amount of carbon emissions. This is combined with the crab population growth at Fort Popham, which can be summed up in the line graph on the right. The time period for the temperature rise graph is a small portion of the whole graph, but the trend is clear, and it points in the direction that climate change has had an effect on the population rise. As shown in the results section, green crabs tend to have a low tolerance to cold temperatures, since the population went down over the winter. They came back in the summer, showing that green crabs thrive in warmer temperatures.

More data could be collected for this claim, mainly continuing the study further into the future to see how the crab population continues to rise. This can be accompanied with more data on how the temperature has also risen, to give a better and more accurate representation of how climate change is affecting the rise in green crab population. In theory, the same kind of trap with the same kind of bait and the same location would give the same result, and any difference would be a real population difference. But there is an enormous number of tiny variables that goes into this, so that with only three data points, a better analysis could be done if the study continued. Even so, I am confident in this claim, as the data that I have clearly show a correlation between climate change and green crab population.

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