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How are Crab Sizes Changing Over Time Along the Coasts of Maine and New Hampshire?

By Adam T

Introduction

As the climate starts to get warmer and warmer, it is disturbing all kinds of plants and animals. The purpose of this study is to examine the size of crabs along the coasts of Maine and New Hampshire. Are the warming temperatures making them smaller and weaker, or are they adapting well and getting bigger and stronger? For this project, data from GMRI (Gulf of Maine Research Institute) will be used, the data will be from 2018 to 2020. It will include the average winter temperatures from each year, this will allow us to determine whether the crabs are getting larger over time or smaller over time and if that is related to the temperature, and therefore, to climate change.

An invasive species is a species of animal that comes from somewhere it is native to, to somewhere where it is not native to. Invasive species usually have negative effects on the ecosystem when they arrive, because they don't have natural predators, and other animals are not prepared to protect themselves from this new threat. Invasive species usually get to a new place by tagging along on a boat, or in shipping containers by accident. Then that animal starts to take over while harming the ecosystem.

This project is important to the scientists at GMRI because they can use this to help them save the native crabs from becoming extinct due to excess amounts of invasive crabs controlling food sources. This data is meaningful to my community because they can use it to see how fast they need to act to save certain species of crabs, or if they need to prepare for bigger crabs than before, crabs that have even

more potential to wreak havoc on the native crabs natural food sources. But the green crabs don't only prey on other crabs' food sources, they also prey on Maine's economy. Green crabs are eating shellfish as a food source, they destroy the shellfish populations to the point where shellfish revenue will soon be almost impossible, and shellfish is one of Maine's biggest sources of income. The green crabs are also cutting down Eelgrass looking for food, and baby lobsters hide in Eelgrass. Lobsters are another massive source of income for Maine, so if these two species take a plunge in abundance, the consequences will be massive for Maine.

My question is: "How are Crab Sizes Changing Over Time Along the Coasts of Maine and New Hampshire?" It is known that climate change is affecting invasive crabs, such as green crabs and Asian Shore crabs, in positive ways. It is allowing them to spread their "*homes*" to further reaching areas due to the fact that the waters are much warmer than they were before. Whereas the warming temperatures due to climate change might be helping invasive crabs, native crabs may be being pushed out.

According to <https://www.thoughtco.com/european-green-crab-facts-2291840>, climate change is making winters warmer, which allows green crabs, females in particular, to have a longer growth period each year. Since the females are growing faster, they are able to reproduce quicker, which is causing the green crab population to escalate at an even greater rate than before. The native crabs are used to colder waters, so when the temperature starts to change, they are becoming weaker and more vulnerable.

 This research is helping scientists to see how large green crabs are growing in certain areas, and how other species of crabs are changing in size.

Methods

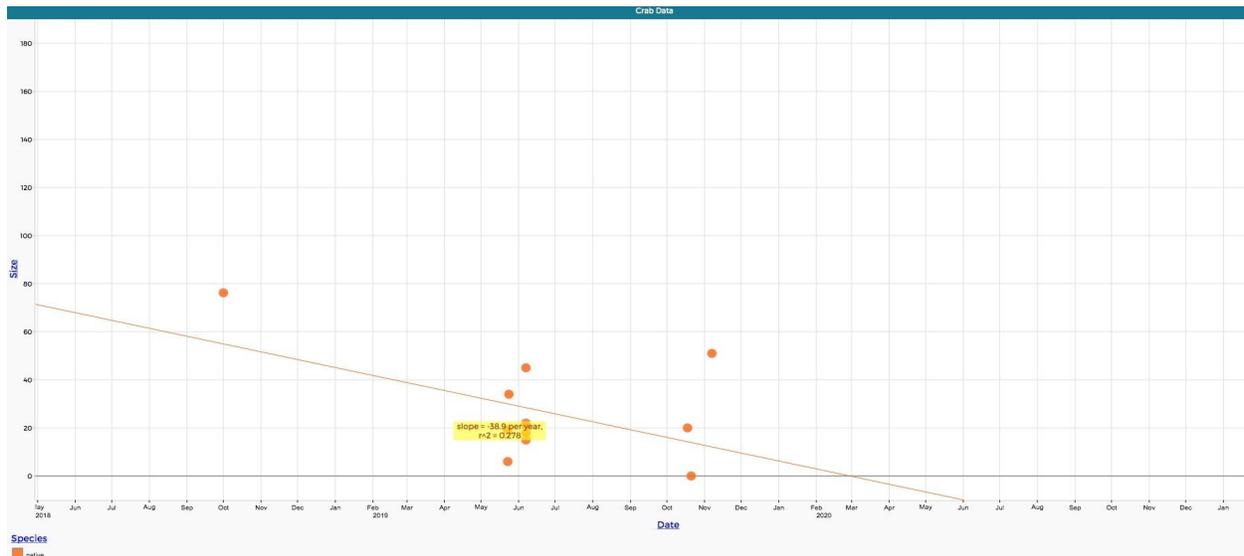
During 2020 and 2021, our class took a field trip at least once a month to Moose Point state park in order to collect crab data. As of May 4th, 2021, we have searched 61 quadrats at Moose Point state park, accounting for 33% of the total data collected.

When we got to Moose Point (always at low tide), we found our landmark boulder, then set up a transect running in a line approximately one meter from the water's edge. We had randomly generated numbers to tell us where to set up each quadrat. The quadrat can be anywhere from 0 to 100 meters away from the starting spot. A quadrat is a one meter by one meter square of PVC piping that we placed on the ground, this is to make sure that we only search in specific areas and can keep track of where we searched.

Then we split the class into two groups of three or four, depending on how many people were there that day. Then everyone searched their specific quadrat location for crabs, each group did a minimum of three quadrats. When we found a crab that was over 1.5cm wide from side to side along its carapace, we measured its carapace, number of claws, if it had eggs, its sex, and if its shell was hard or soft. Two people checked the crabs, and everyone had to agree as a group on whether they were correct or not. Then we recorded the information on GMRI's site when we got back. All the steps listed above are to help make sure that the data is accurate and helps GMRI with its research and allows us to compare our data with the data that other schools collected. We made sure to always search within the quadrants and in line with the transect. Unfortunately, since we were not the only ones who collected the data, other groups may have searched less thoroughly, which could have allowed some crabs to remain unfound.

The fact that the quadrats were randomly generated could have made it so that certain

substrates were searched less than others, so if crabs were larger in certain substrates, then we might not have collected that data. We did not find it necessary to change the procedure in the field in any way.



Results

Figure 1: Graph of Native Crab Sizes Over Time.

This graph shows that the size of native crabs has been decreasing since 2019, as the slope is negative. Although, the data is very minimal because not that many native crabs have been found, which is severely limiting how accurate this data is. As is shown in the graph, no native crabs have been found since November of 2019, and that would force the slope down, along with the fact that the very first native crab found was a large one, which sets the start of the slope high, and since there haven't been enough native crabs found to offset that, the graph may not be exact for another few years, at least until more data is collected.

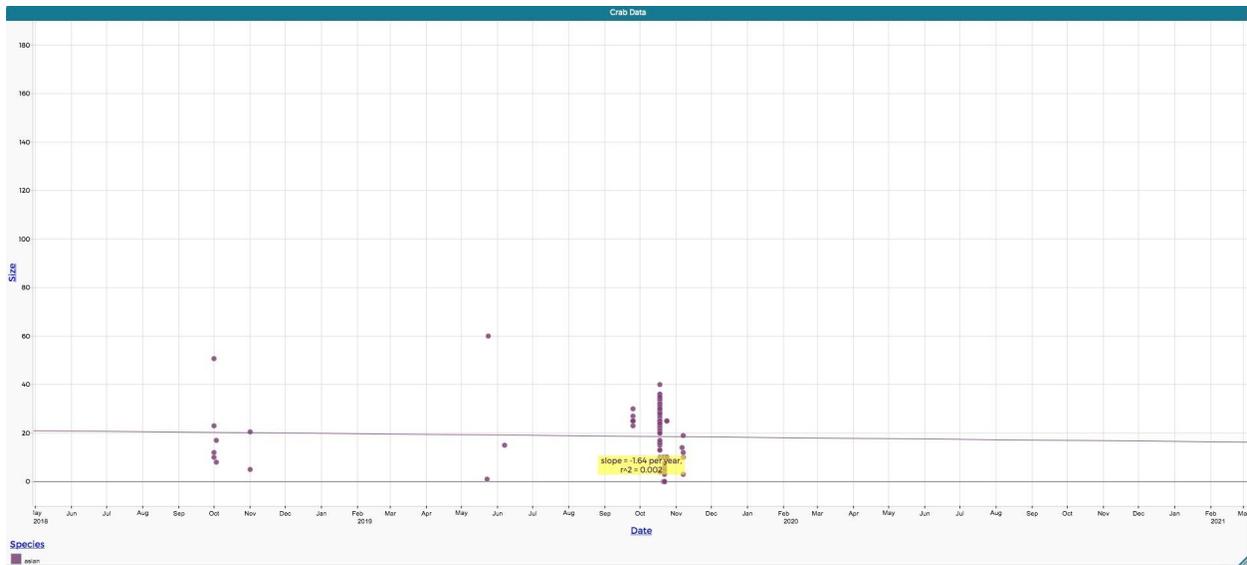


Figure 2: Graph of Asian Shore crab sizes over time.

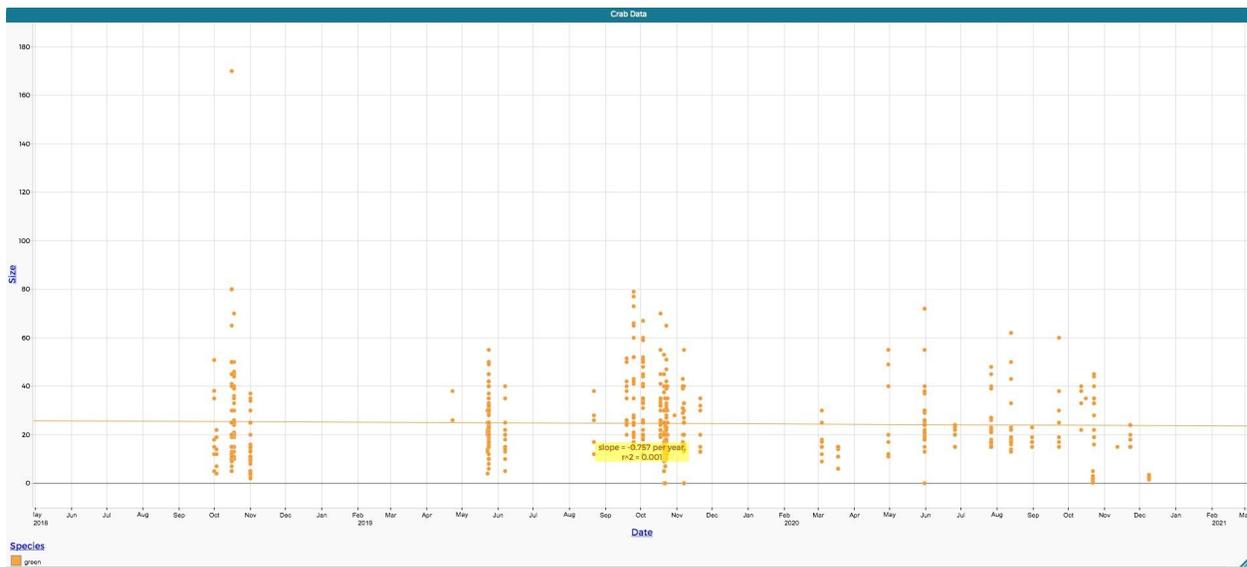


Figure 3: Graph showing green crab sizes over time.

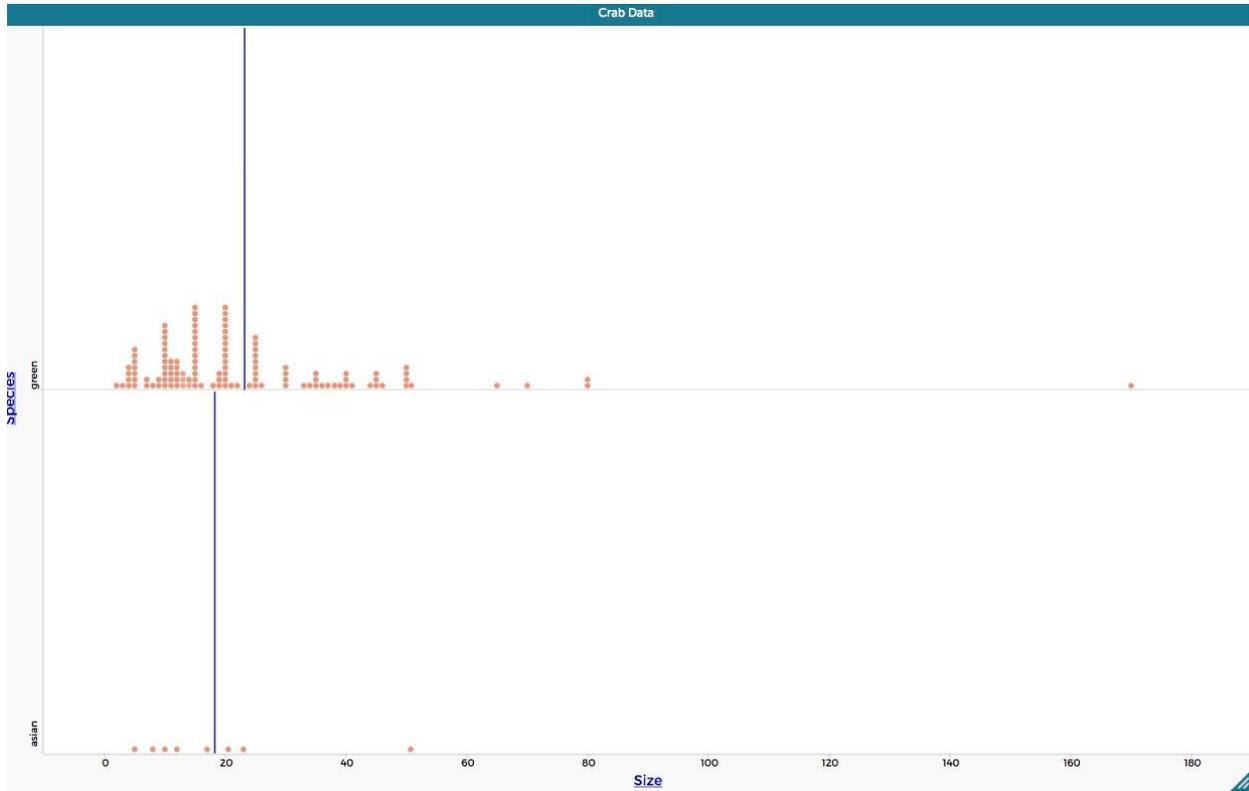


Figure 4: 2018 average crab sizes

This graph shows the sizes of green crab and Asian Shore crab in 2018. The mean of green crab sizes was 23.2 mm, and the mean of Asian Shore crab sizes was 18.3 mm.

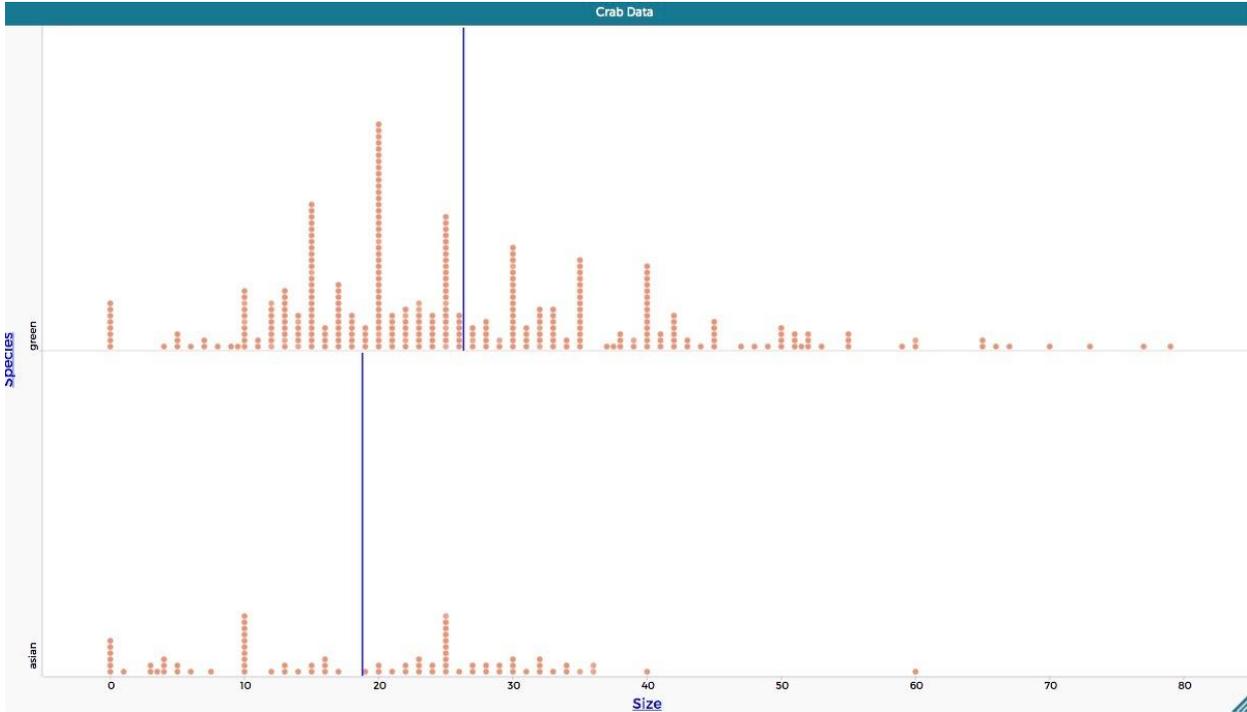


Figure 5: 2019 average crab sizes

This graph shows the sizes of green and Asian Shore crabs in 2019. The mean for Green crabs was 26.32 mm, and the mean for Asian Shore crabs was 18.79 mm.

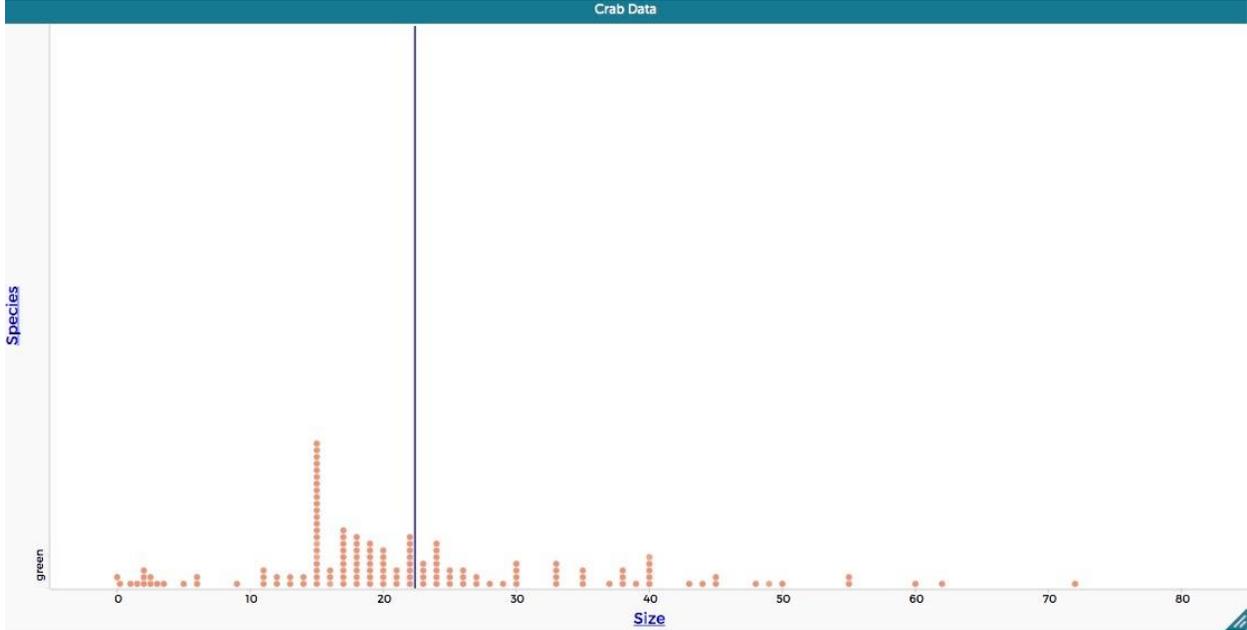


Figure 6: 2020 average crab sizes

This graph shows the sizes of green and Asian Shore crabs in 2020. The mean of green crab sizes was 22.32 mm, and no Asian Shore crabs were found that year.

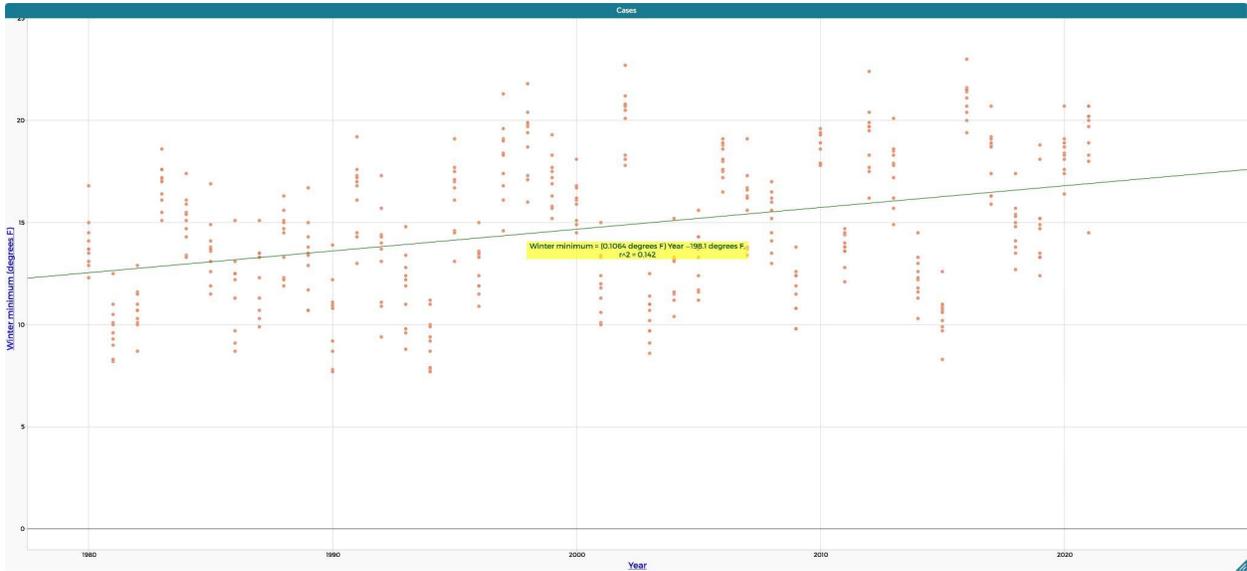


Figure 7: Winter Minimum Temperature

This graph shows the winter minimum temperature is steadily increasing each year.

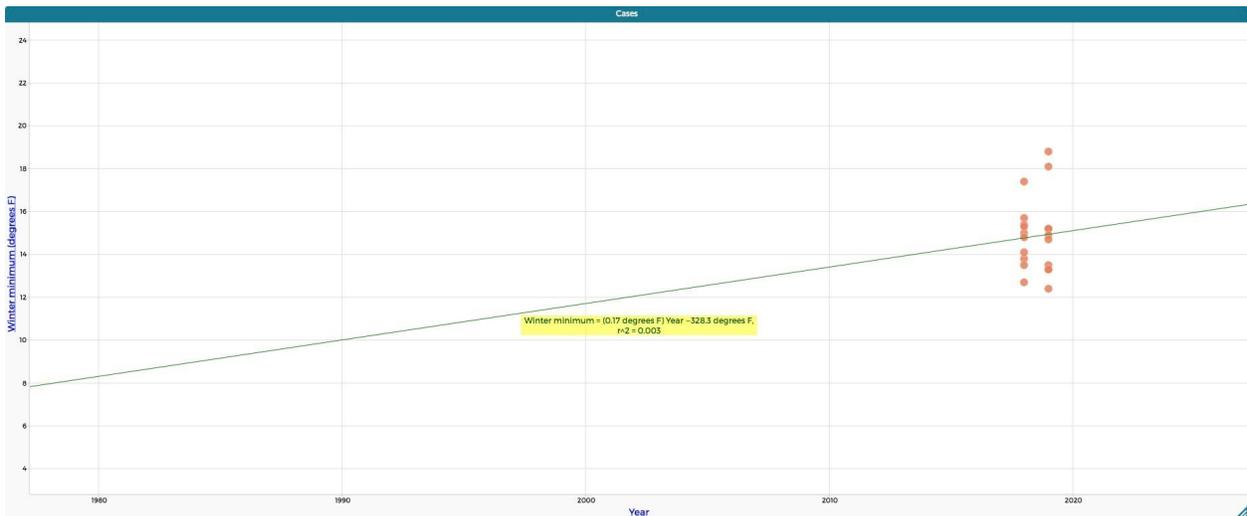


Figure 8: this graph shows rising winter minimum temperatures from 2018 to 2019

Conclusion and Discussion

Through this investigation, it was found that green crab sizes had some variation between 2018 and 2020 (Figures 3, 4, 5, and 6), but that asian shore crabs are getting bigger overall (Figure 2). Unfortunately native crabs are decreasing in size at a much faster rate (Figure 1), which is not good for native crab populations if they are going to survive climate change. These findings are important because it shows that the invasive species are taking over, and that the native species will soon be pushed out if we don't do something to help them. I observed that the graphs show the Asian shore crabs are getting bigger (Figure 2). In 2018 they had an average size of 18.3 mm (Figure 4), then in 2019 the average size was 18.79 mm (Figure 5), which was an increase of 0.49 mm. However, none were found in 2020 (Figure 6). Although, this is probably because not many people went out and collected data in 2020 due to the Covid-19 pandemic. The green crabs are steadily changing and adapting to our environment here in Maine. With climate change, winters are getting warmer. In 2018 to 2019 the minimum temperature in the coastal counties rose by 0.003°F (Figure 8), which allowed the crabs to mature faster because they have a longer growth season. Their average size varies each year, but the data showed that they got bigger from 2018 to 2019, by a solid 3.12 mm increase in average size (Figures 4 and 5). But then in 2020 they got smaller on average, with only a 22.38 mm average (Figure 6), which I suspect is due to the fact that not many people were actually searching for crabs in general so they didn't have the ability to find enough crabs to even out the data. This evidence supports my claim because both asian shore crabs and green crabs average sizes increased, exactly as claimed . This evidence connects to what I already know about invasive species and

native species and how they react when coming into contact with one another. Some factors may have impacted my data, like the small amount of data we have on native crabs and Asian Shore crabs, which could cause the graphs to be inaccurate. Another factor that affected the data was the Covid-19 pandemic, which caused many groups to not search for crabs, which resulted in a large decrease in data for 2020. This could have caused the mean to be different and the data to be inaccurate and tell another story. Winter temperature changes due to climate change also affected the data, but not inaccurately, it just affected crab sizes, because green crab females could mature faster, and have babies faster, becoming more abundant faster. I also cannot say whether other groups followed protocol as they were supposed to, so they might have made some mistakes that affected the data in some way. I do not have enough evidence to make this conclusion for more than a few years, because I would need more data for it to be accurate, and we simply haven't had the time to collect enough yet. However, as a result of this study, new questions that could be investigated to further this research have come up, such as how climate change is affecting the size of crabs along the coasts of Maine and New Hampshire, and how much of a difference these continuously changing temperatures will make on crab populations and their size.

Sources

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