Findings
FROM THE FIELD

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Note from the Editors

Findings from the Field is a living, evolving community of student scientists, teachers, and mentors committed to exploring the natural world through careful observation and thoughtful inquiry. This year, as climate change continues to impact our ecosystems in complex and visible ways—from shifts in plankton patterns and warming waters to invasive species like European green crabs and Asian shore crabs—our shared work of noticing has never been more critical. Observation, in its many forms, is a powerful step toward resilience: by paying close attention to the changes around us, we learn how to adapt, care, and act.

This volume marks the introduction of a new submission type: Expressions of **Two-Eyed Seeing**, supported by a collaboration of indigenous and western science educators and inspired by the Mi'kmaq principle of Etuaptmumk, or Two-Eyed Seeing. This approach invites students to observe the world through both Western scientific and Indigenous ways of knowing—valuing stories, relationships, ceremony, and data equally as sources of understanding. It reminds us that no single perspective can hold the whole truth, and that braiding the many ways of seeing deepens our connections and invites us to act with clarity and purpose.

We are deeply grateful to the teachers who guide this work in their classrooms, the students who carry out their investigations with care and curiosity, and the editors who read and respond with thoughtful feedback. A special thank you to NASA for funding and supporting this project, helping bring together a community of young scientists whose work is grounded in wonder, rigor, and relationship.

Together, this journal is more than a collection of student writing—it's a testament to the power of looking closely, asking questions, and learning from each other. Thank you for being part of it!

Grantee

Lead Presence in Kennedy Park & Eben Hill

Nadra H, Casco Bay High School, Grade 11

Purpose

This research showcases how the age of homes in Portland relates to the presence of lead. In Portland, neighborhoods like Eben Hill and Kennedy Park are a crucial comparison due to their differing age. Eben Hill, a newer development, is expected to have little to no lead, while the older Kennedy Park is more likely to contain lead. According to the Maine Tracking Network, there were 21 cases of lead exposure in children under three in Portland in 2022. Given Maine's aging housing stock, lead can be present. Thus, confirming the presence of lead in older Portland homes is essential. This research will provide insight into the potential risks and contribute to better protecting Portland residents, particularly children, from lead exposure.

Introduction

The article "Exposure to Lead and Length of Time Needed to Make Homes Lead-Safe for Young Children" influenced my thinking about my experiment on lead testing in Portland neighborhoods by urging the importance of both immediate action and long-term remediation efforts. The article stressed that lead contamination in homes is often found in paint and dust, and decontaminating a home can be a long process, depending on the extent of the contamination and available resources. Another article, called "Warning Unheeded", the researchers examines how lead exposure disproportionately affects minority children, specifically those living in low-income households. The study states that children from these communities face a higher risk of lead exposure due to factors such as deteriorating housing conditions, which often include lead-based paint and plumbing systems containing lead. The researchers argue that the government's failure to address this issue has led to a rise in lead exposure in these vulnerable populations. In my project, I conducted lead screening in Kennedy Park, a diverse and low-income neighborhood in Maine, which closely aligns with the concerns raised in Warning Unheeded. My experiment tackles this issue by conducting lead testing in two distinct neighborhoods to identify potential hazards and create a safer environment.

Materials

Lead Test Swab & Google Form.

Procedure

| Created a Google form for residential data collection | Showcased a video of lead testing procedure | Watched residence's conduct test | Reviewed results |
| Step 1 | Step 2 | Step 2 | Step 4 |

Hypothesis

The mean presence of lead in Kennedy Park will be substantially higher than in Eben Hill. In 2022, there were twenty-one cases of lead in Portland. The amount of lead in Kennedy Park was higher in 2022 than in 2021. ("Childhood Lead Poisoning | Maine Tracking Network")

Data

= Least amount of lead
= Some amount Lead
= Lead is prevelant
= Highest amount of lead

Dark orange 6.7% Light Orange 6.7%

Median=4
Mean=3.73

Dark Purple 86.7%

Lead presence in Eben Hill

= Least amount of lead
= Some amount Lead
= Lead is prevelant
= Highest amount of lead

Median=4
Mean=3.87

Dark Purple 100%

Lead presence in Kennedy Park

Childern >6 in Kennedy Park and Eben Hill
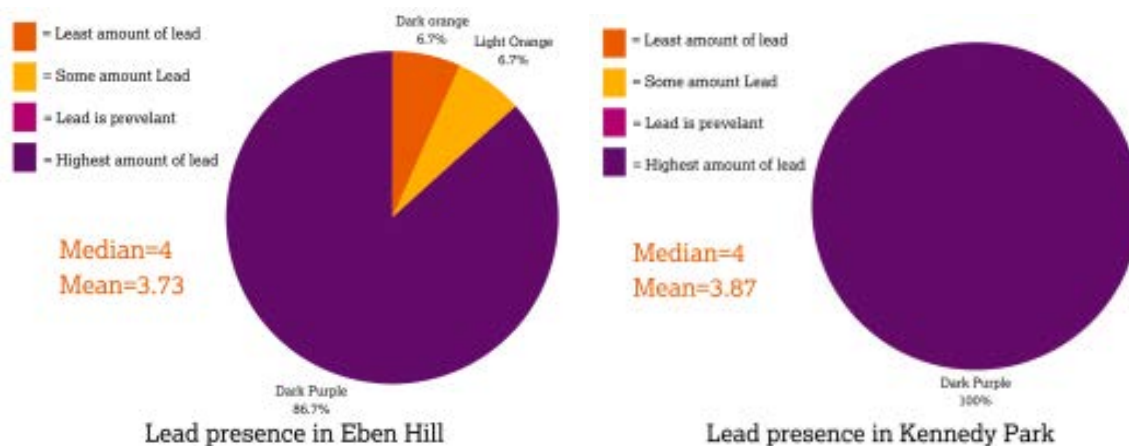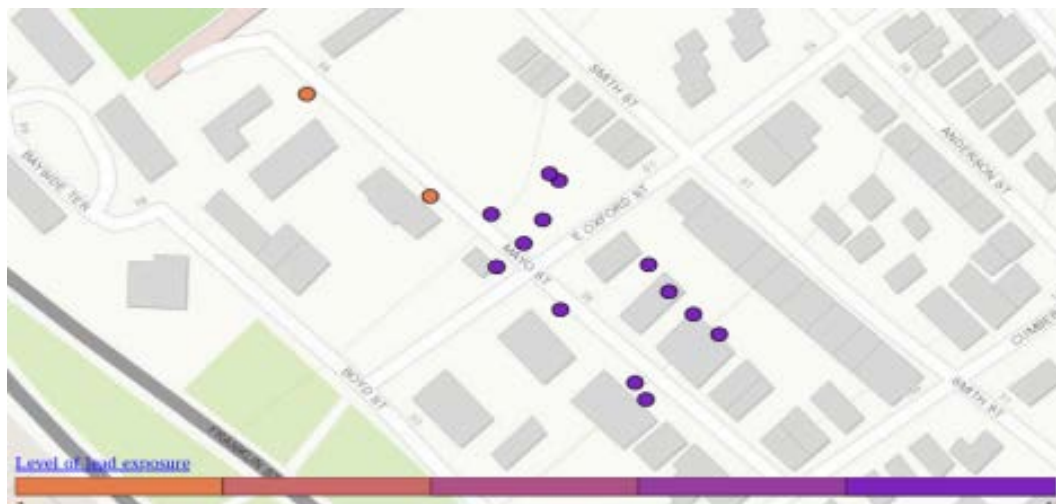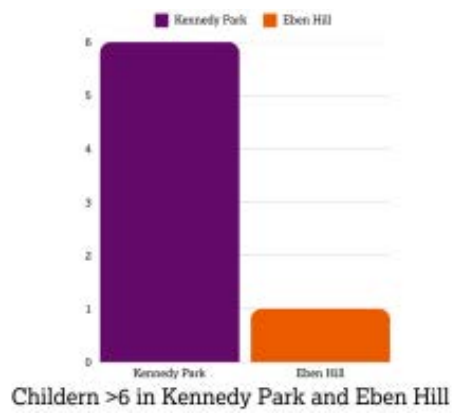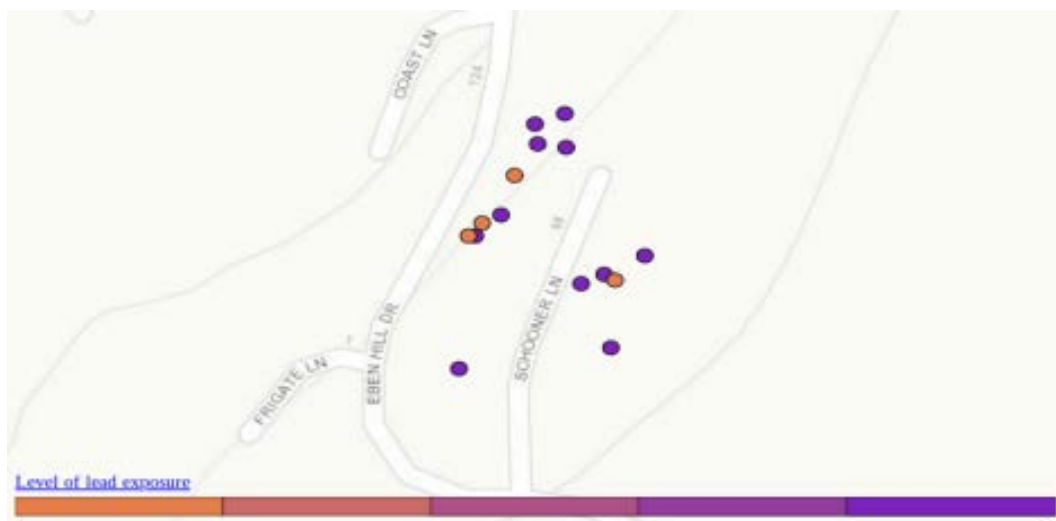
Kennedy Park
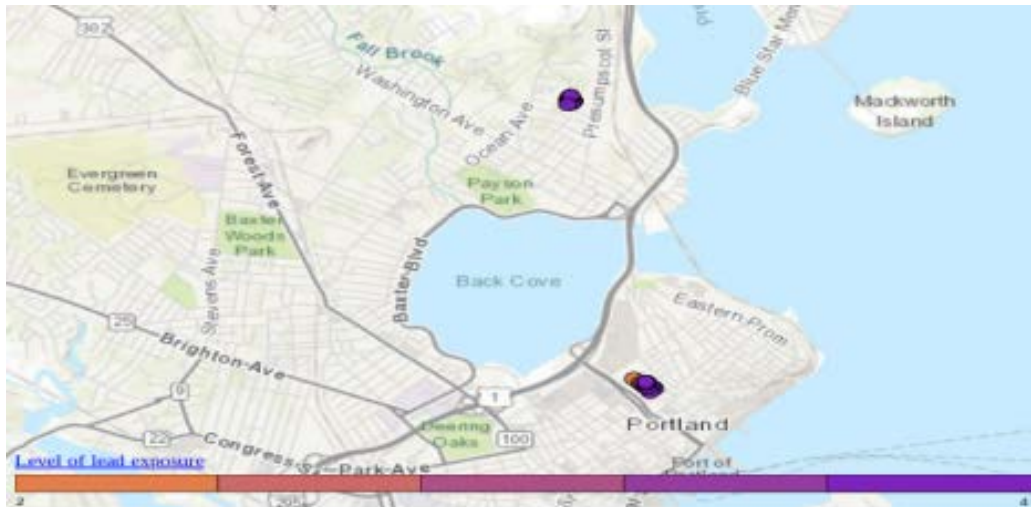
Eben Hill

Portland, Maine

Results

The findings of my research showed that all 15 houses in Kennedy Park tested positive for lead presence, and 13 out of 15 homes in Eben Hill also showed positive results. Both testing sites, Kennedy Park and Eben Hill, have similar means and medians, with both sites having a mean of 4 (the highest percentage of lead presence), and Kennedy Park's median at 3.87 compared to Eben Hill's median of 3.73. The reliability of my data is evident, as all homes in Kennedy Park returned consistent positive results, with no outliers. Similarly, the majority of homes in Eben Hill tested positive, reinforcing the consistency of the findings. With a total of 30 homes tested, 28 came back positive, which suggests a likelihood of lead contamination in Portland. However, it's important to note that the lead screening tool I used only indicated whether there was a significant amount of lead or none at all, without providing a measure of the exact level of contamination. I demonstrated to residents how to perform the lead swabbing using a video, which could have introduced some inaccuracies, as I did not test the sites multiple times. Additionally, this testing method does not account for the validity of the results. While the data strongly indicates the presence of lead in these areas, further, more precise testing is needed for conclusive results. After a positive result from a lead screening test, it is recommended to follow up with a blood lead test for more accurate assessment.

Conclusion

"How does the age of homes in Portland relate to the presence of lead?" This question aimed to determine whether older homes in Portland are more likely to have lead contamination compared to newer homes.

The most important finding of my study is that both neighborhoods, Kennedy Park and Eben Hill, showed high levels of lead presence. This indicates that further, more thorough testing is needed in both areas, as there is daily exposure to lead. This is significant because lead

exposure is harmful to cognitive development, particularly in children. Most of the homes tested had children under the age of 6 or teenagers under the age of 18, making these findings concerning for their long-term health.

My research question was answered, that the age of homes did not appear to affect the presence of lead. Kennedy Park, an older neighborhood built before 1978, showed similar results for lead presence as Eben Hill, which was constructed more recently.

An insight I gained from this research is that the age of a home does not necessarily determine the presence of lead. In a conversation with Michelle Huyette, a scientist with Lead Safe Housing for the City of Portland, she mentioned that lead presence in Kennedy Park is expected, and it would be surprising if it weren't found. Regarding Eben Hill, she suggested that lead could be present in the soil. This research informs Portland residents to conduct research on their homes and consider blood lead testing for themselves. This research contributes to existing studies by providing local data, demonstrating that lead presence can occur in unexpected places, as even my small data set showed high lead results.

Positive aspects of my research include raising awareness among Portland residents about the potential presence of lead in their homes. A negative aspect is that the findings now require further research to ensure the well-being of Portland residents. The limitations of my study included a small data set, with only 15 houses tested in each neighborhood, which may not fully represent the full potential lead presence.

Future Research

What is the specific level of lead contamination in Kennedy Park and Eben Hill?

What are the long-term health effects of lead exposure in Kennedy Park and Eben Hill residents?

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Burmese Pythons vs. Green Crabs

Ford H, Center for Teaching and Learning, Grade 7

Introduction

My research question is how do invasive green crabs in Maine compare to the invasive burmese pythons in florida. Burmese pythons and Maine green crabs are two very different species in terms of biology, habitat, and ecological impact. However, both are invasive species in their respective regions and have become major concerns for local ecosystems.The Burmese python has become a top predator in Florida, drastically altering ecosystems by preying on native species, while the Maine green crab is a small but highly destructive force in coastal ecosystems, particularly in terms of its effect on shellfish populations. Both Animals are originally from the Europe(Green crabs) and Asia(Burmese pythons)

Green crabs were thought to come to Maine by European ships in the 1800s. Pythons were first brought to the United States as exotic pets. When the exotic pet trade boomed in the 1980s, Miami became host to thousands of such snakes. Both are invasive species and are wreaking havoc to the environments they are in and the animals that are in it. Both are posing threats as climate change is making it easier for them to expand and populate as they move to different areas. The most northerly location where a Burmese python has been found in the United States is Lake Okeechobee in Florida. The European green crab has been found as far south as Virginia on the east coast of North America. The crab was first observed in Massachusetts in 1817, and later invaded the Chesapeake Bay in 1879. It has since spread north to Maine and the Canadian coastlines.

In this essay I will be talking about how they impact each of their respective environments and animals that live there. Also, compare and contrast the Maine green crab to the Florida pythons.

I obtained my data from FL Specimen Management Database. I put this data into sheets so I could manipulate it CODAP. When in CODAP I could turn it into tables, charts, and graphs. I downloaded the data into CODAP and I am able to manipulate it so I can get data I need. First, what you do is open up CODAP, then You click 'new' under the three lines in the top left corner. Then when it asks you to create a new document you click 'create new document'. Then you go to the three lines in the top left and click import. Then you drag your file into the designated spot and it will automatically import your data into CODAP. You can then click the 'graph' button and make a graph. You can drop in data into the x and y-axis to create an actual graph. You can do this with most data. When you make the data in CODAP you can then put it into most anything like google docs, or slides. When you master CODAP it is really easy to plug in data and make really simple easy graphs.

The Maine green crab is one of the most successful invasive species in the world. As it is all over the world and is on 6/7 continents. The python have a bit smaller range as they are only in

southern Asia and Florida. Between 1997-2012 the racoon, opossum, and bobcat populations dropped 99.3%, 98.9%, and 87.5% respectively. This is really bad because this can really affect an entire ecosystem and cause a trophic cascade.The economic impact in Florida is mainly indirect. The decline in native wildlife populations, particularly mammals and birds, has affected ecotourism and hunting industries, which rely on healthy ecosystems.
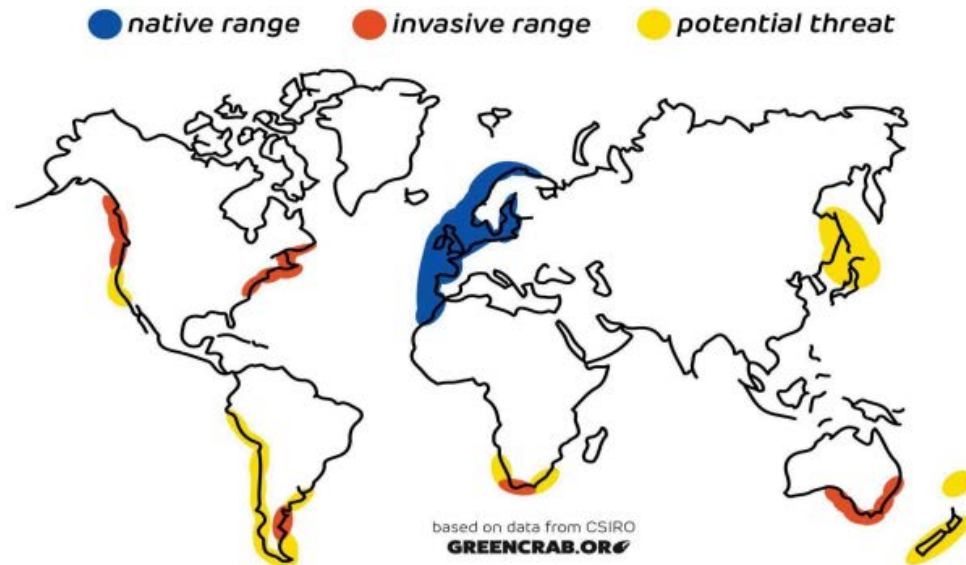
With the Green crabs, they like to eat soft shell clams, and since there are so many green crabs they have been disseminating the populations since they've gotten to Maine. Green crabs cause direct economic damage in Maine, where they negatively affect the shellfish industry. Soft-shell clams and mussels, which are important for local fisheries, have been heavily impacted by green crab predation.
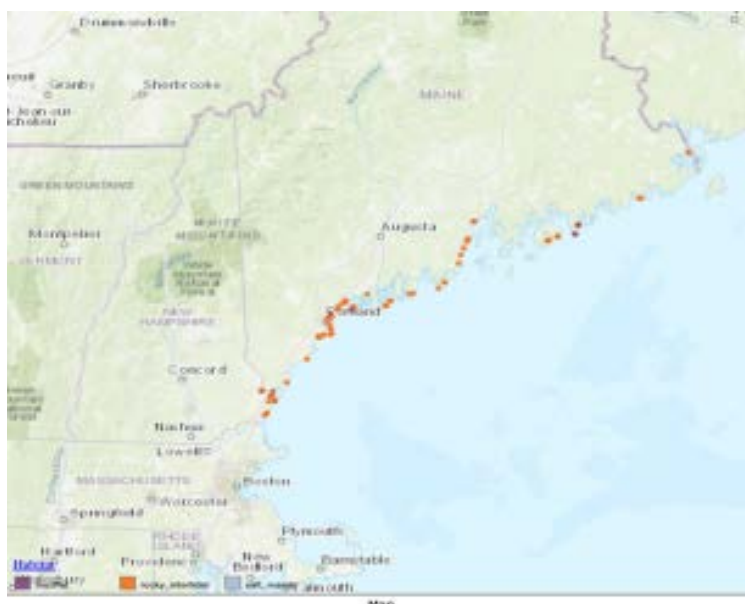
Burmese pythons and Maine green crabs are two very different species in terms of biology, habitat, and ecological impact. Both are expanding and getting to new places with the help from climate change. As the world warms up, the pythons can go farther up north. With warming water the green crabs can go up even farther north.

Suitability classification

■ yes
■ maybe
■ no
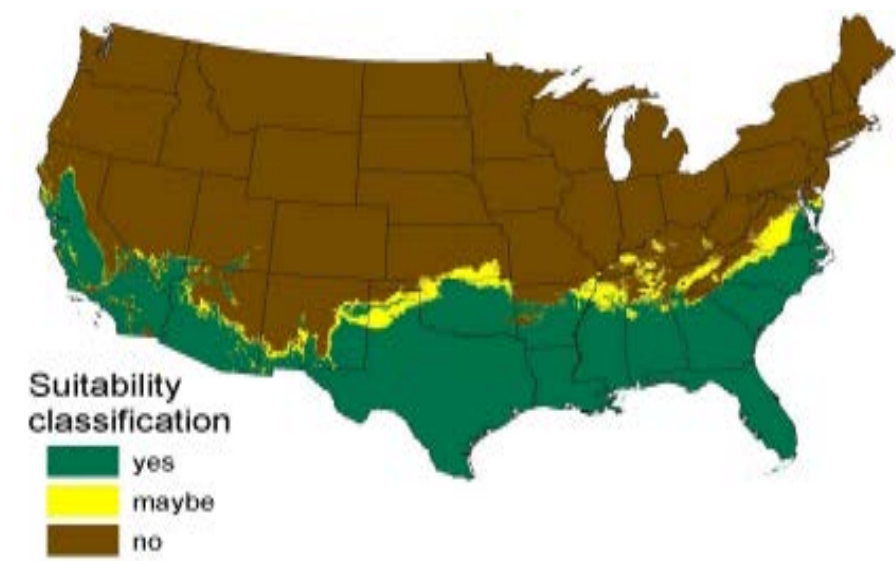
This graph shows the weight of burmese pythons compared to the tail length. This shows how the weight of a burmese python affects the tail length of itself. Burmese pythons are huge, that's why it is so hard to get rid of them. I noticed that the biggest and longest pythons were the females and the males were among the smallest.

Sex
■ Female ■ Male

cases

Throughout my investigation I have found that both species are both extremely disastrous for their respective habitats and with climate change will continue to expand their disastrous domination. I observed that both animals are majorly benefited by

climate change as one of only reasons they can't expand is that the temperatures are too cold, but as the world heats up, they can head farther and farther north. This evidence suggests that we should really start to look at the smaller, but very important effects of climate change because these animals have the power, no matter how big or small they are, to destroy ecosystems.

I unfortunately did not have enough data to complete this research paper because my question is so broad. I don't think anybody has made this comparison, but I think it is a good one. Something I think I can do next time I choose a research question is to do a little background check to make sure it won't be too hard to find data for because no one will ever think to put pythons and green crabs together in a graph. I do think even with not a lot of correlation between the two animals this is a good research question because it was fun researching the individual animals and finding out more about them.

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Effects of Warming Waters and Climate Change on Jellyfish in the gulf of Maine

Serafina R, Center for Teaching and Learning, Grade 8

Introduction

In recent years climate change has had an effect on the whole world, specifically the ocean, with 90% of the warming of the globe taking place in the ocean. When the ocean warms, it and the animals react differently. When the water gets warmer the ocean will expand. This is around one third to one half of the sea level rise lately. In the gulf of Maine one species that can be affected and then lead to affecting other species is jellyfish. My essential question is how does climate change and warming waters affect jellyfish populations?

The gulf of Maine is warming a lot faster than 99% of the ocean so this is an area where the effects of climate change such as the quickly warming waters are magnified and could project possible predictions for the rest of the ocean as it warms at a slower rate. The data for jellyfish here has not really been recorded until recently, so I only have data to work with from 2015 foreward.

Jellyfish are a very interesting species that there is still so much to learn about. They have so many interesting features such as being able to reproduce asexually if they need to and can't find a mate. There are also so many types of jellyfish. One of the most well known species is the man o' war which lives in warmer climates than the waters in Maine. Some species live in jellyfish colonies attached together in a blob and share each other's blood streams. When the colony dies the still living jellies break off to mate and that's how new colonies form. Jelly fish can also survive in very extreme parts of the ocean like low and high temperatures

The gulf of Maine is a shallower area of the ocean; it is a closed off area between nova scotia and massachusetts and cape cod. Like a giant bathtub that is more closed off from the deep ocean more so than coasts of other places. This is probably part of the reason why it is warming so much

faster than other places in the ocean. I think that this is a great opportunity to take data and observe what is happening in these quicker warming waters and use that to project how climate change would affect the rest of the world and jellyfish in other places.

Methods

I used two data sets for this research paper. The first was data collected by GMRI. It is a set of water data over years showing the temperatures. This data has been collected for a long time since the 1800s but I only used the data over the last ten years or so. This data was originally in celsius, I converted it to fahrenheit using google sheets.

The second set of data I used is jellyfish data from Nick Record. This was gathered using reports from people in the gulf of Maine who would email him information about jellyfish sightings that they had. I used the data about species of jellyfish, where they were sighted, the count of jellyfish, and when they were sighted.

I loaded all of this data into graphing websites like codap and tuva to create multiple graphs. I have some on time and count, time and temperature, where there have been sightings over time. I also have the species and where it has been sighted. I screenshotted all the graphs to show in my paper and color coded the maps so that different species are color coded.

Results
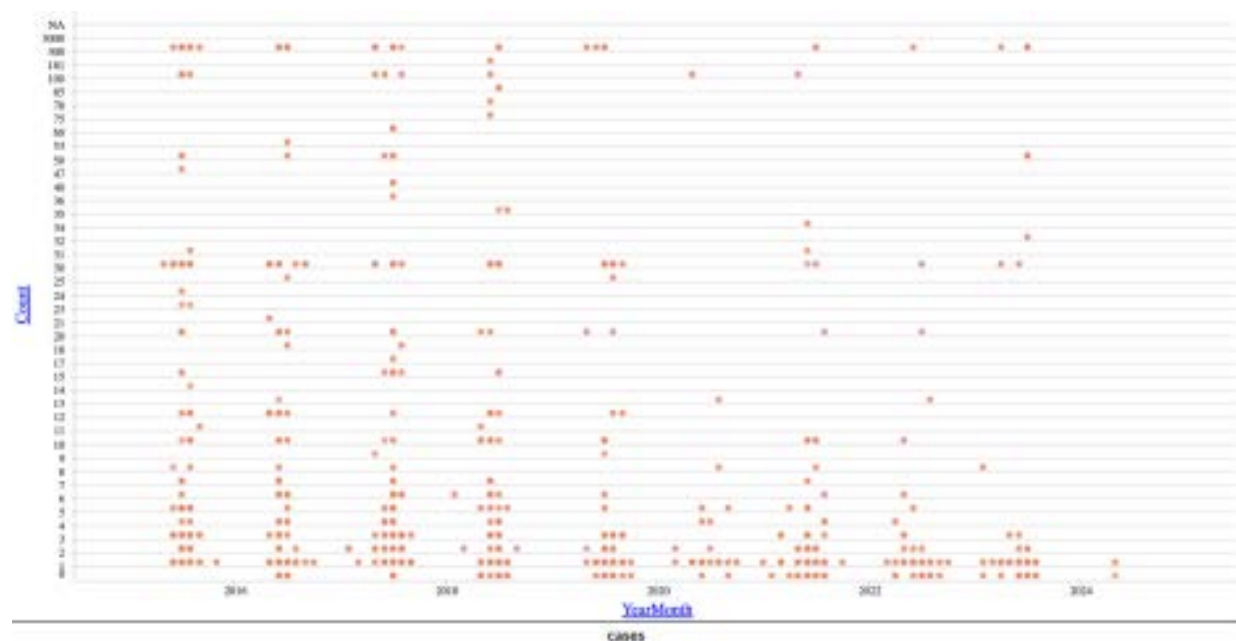
This graph showed the year and that count of jellyfish so like how many jellyfish sightings there were in the gulf of maine over the years up to 2024. You can see in this graph that the sighting numbers go way up in the summer. Jellifish do have a cycle where there are a lot more in the summer.

This graph shows the water temperature over time, the spikes are the increase in temperature in the summer and the dips are the decline in winter. The temperature is measured in fahrenheit, it was converted from celsius to fahrenheit in google sheets.

This next graph shows the latitude of where the different species of jellyfish are reported to be found. The measurement of latitude only goes from the northern part of the gulf of Maine to the southern part. This is because that is where the reported sightings are from. You can also tell from this graph which species are thriving more than others and where, north or more south they are living.

The last graph is more of an experiment, it is an animated graph that shows how the jellyfish migrate. Each image in this animation shows one year and all of the jellyfish sightings in that year and where on the map they are. The color of the points represents species but is cropped out and doesn't matter for this animation.

Conclusion

I am investigating the effect of warming waters on jellyfish in the Gulf of Maine. Through my investigation I found that the sightings of jellyfish have gone down a lot since the waters have been warming recently. This i s important because if jellyfish are decreasing in the gulf of Maine then that means that it's possible that they are going to or already are decreasing in other places or moving to places where that climate suits them better.

My claim is based on the evidence that is shown in the graph of the jellyfish count and year data where you can see the yearly cycle. I observed that the jellies increase during the summer months and decrease during the winter. In the summer the numbers seen at a time can get up to 3000 which is a lot of jellyfish. I also observed that the count and number of sightings is much more depleted in recent years; there are only a couple sightings in 2024. I noticed from the data that most of the sightings reported there to be around 1-5 jellyfish in an area, but there were also a lot of sightings with a count around thirty.

This evidence supports my claim because it shows that the jellyfish have been decreasing in numbers since around 2020. This evidence suggests that the warming waters are causing jellies to migrate further north where the water is colder and more similar than it has been in the past. This evidence connects to what I already know about how many other species have been moving north out of the Gulf of Maine to find more suitable conditions for their species.

Discussion

Some factors might have impacted my data like covid, there are immediately less sightings of jellyfish in 2020 which is when covid hit. This caused there to be less people out at beaches and in the water to report sightings of jellyfish. I do not have enough evidence to make a conclusion because the data I was working with only went back to 2015 which is only ten years of data. This could be common for jellyfish species numbers to go up and down or it could be an even more drastic change than I can see from this data. Some people might interpret my data to show jellyfish decreasing at a very high rate, but I have ruled out this explanation because while working on this paper I found many articles about there being spikes and many more jellyfish seen in Maine. To further this investigation I would continue taking data and find any new patterns in the jellyfish populations. As a result of this study new questions have come up such as, what other species of marine life are the jellyfish population affecting, and are there other factors impacting the jellyfish population?

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How Does the Green Crab Population Affect the Blue Mussel Population?

Alice K, Center for Teaching and Learning, Grade 8

Introduction

This topic is very important and very much needs to be heard, because it shows how much of an impact green crabs have on blue mussels but also many large ecosystems all over the coast of Maine and all over the world. Did you know that the green crab population was up by 176% in some areas of the gulf of maine's intertidal zones this year if you compared it to the amount in 2019. Green crabs are invasive, very aggressive and have a dark green/brown coloring, along with a pentagon shape and five spines on the outer side of their eyes, and they can grow up to four inches wide.

Green crabs are native to the northeast Atlantic, and are commonly found in sheltered, rocky, intertidal, and shallow subtidal habitats. They fancy blue mussels but mostly eat soft shell clams with the occasional eelgrass on the side. They have been very problematic for the shellfish industry, especially for soft shelled clams and mussels because that's what they eat, not to mention their ability to burrow easily and their dense, strong claws which allow them to easily crack open and consume the soft tissues of these organisms, therefore leading to significant damage and downfall for the local shellfish populations.

Green crabs have to compete with the native intertidal creatures, such as native crabs and some other crustaceans, for food and shelter. Also they can adapt to new environments very fast and can very easily outcompete the native species, usually leading to a decline in the local biodiversity. This competition may cause native species to flee and go to environments that may have less of the resources that they need to live, along with the massive decline of them in general. I think that from all of the reseriching I have done, proves that green crabs will have fully taken out the blue mussel population in only a matter of a few years.

One way you can help to eliminate the green crabs is by cleaning off any watercraft you may have before moving to any body of water from another. Or there's lots of volunteering opportunities for people who want to help get rid of this invasive species.

On another note blue mussels are economically and environmentally very important filter feeders, which means they take in large amounts of phytoplankton and other bacteria then consume it and send the clean water back out. Blue mussels usually grow up to 2-4 inches but can reach up to 8 inches. They have a black, blue or brown shell, with a teardrop shape. Blue mussels have very fast growth and reproductive rates. An interesting fact about them is that they mature as males then develop female reproductive capabilities, females can produce between 50-700 million eggs per season.

Methods

The websites that I got my data from were Noaa Fisheries where I got data all about blue mussels and where they preferred to live in certain ecosystems. Next was the Department of Environmental Conservation, which had lots of important information about green crabs and everything you need to know about where and how they live. Then was the Role of Invasive Crabs where I found an article about what would happen if you removed green crabs from certain ecosystems around the coast of Maine. Lastly was the Management Conservation Sciences where I found many facts about the molting process of green crabs, which was very interesting.

I took the tables that I found from those sites and put it into a very helpful website that was called CODAP. All I had to do was save the document as a PDF then download it onto CODAP. Then I was able to turn my table into a graph by putting different information from the table onto the X and Y axis.

Another very convenient thing was that I could easily switch around what information that I wanted to have on both of the axes, such as dates, number of something over a span of however many years, and anything else that would be beneficial for this research. Then I could also choose specific information from the table that I wanted on the graph; like if I only wanted dates from 1926 to 2015 or only wanted data collected from one group of people, then all I had to do was highlight the information on the table and it would show me the highlighted points on the graph. Also I could choose to take away the non highlighted points on the graph or vice versa, and take away the highlighted points.

Results

This is one of the blue mussel graphs that I found while I was researching. On the x-axis it shows that date in years that the data was collected. On the y-axis it shows percent coverage of the total amount of blue mussels that were found in the area. This graph is very effective because it shows data that was collected from 1970 all the way to 2010, so a very wide variety. Also the green line on the graph shows the average of all the data. As you can see the line is going down so it's decreasing. In 1970 the percent cover was 40% but then fast forward to 2010 the percent cover is only 5%.

SAMPLING DATE

cases
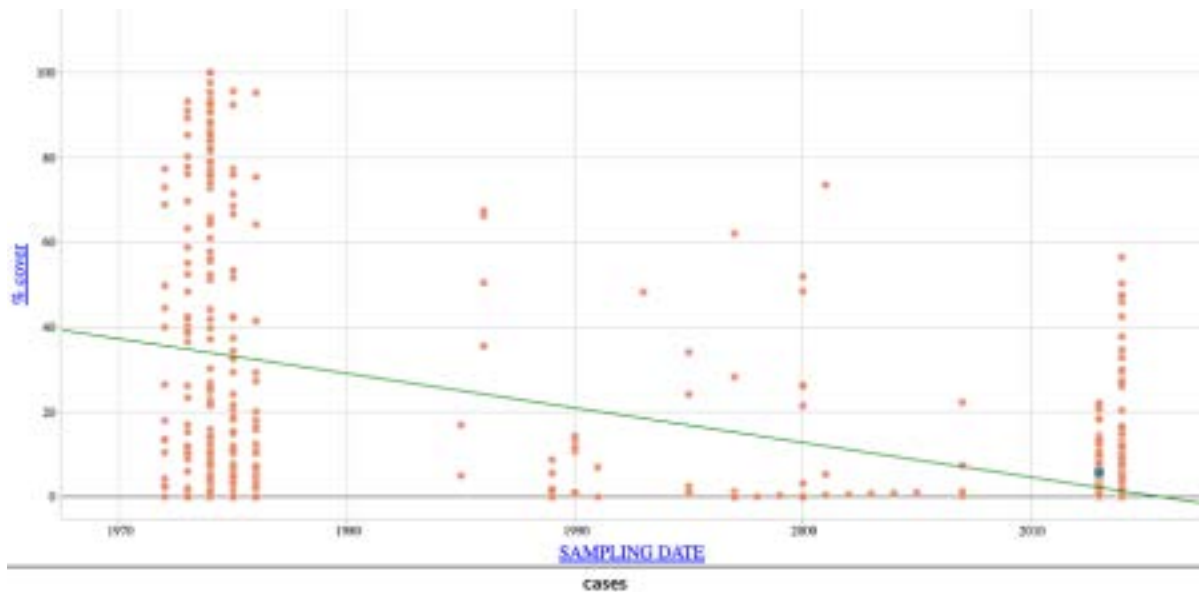
This next graph is a green crab population graph that I found whilst I was doing some research. So on the x-axis I have the date that the data was collected (in years). Then on the y-axis I have the crab density. As you can see it remains pretty steady throughout the years but spikes up a few times between the years of 2022 to 2025. And even though this data set is more recent than the blue mussel graph it still is increasing whereas the blue mussel population is decreasing tremendously.

Quadrat Data

22
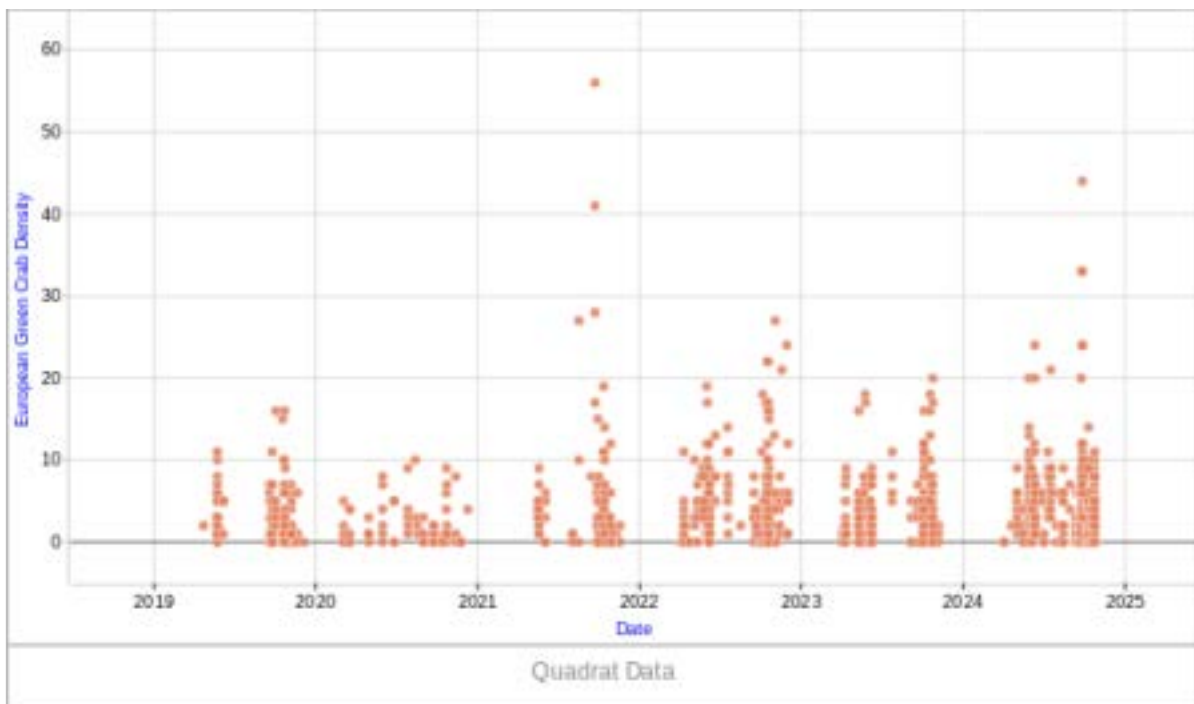
Conclusion

These findings are very important and can be very useful when investigating this problem. It is just going to keep getting bigger and bigger, until something happens and the blue muscle population somehow finds a way to incline rapidly or the green crab population declines. Which would be great!

But, they wouldn't even out completely, and have an average amount of blue muscles left, until most or all of the green crabs are completely gone and still that is going to take a while because there are so, so many green crabs all over the place; hiding in tidepools or scavenging around in the many intertidal zones all over the coast of maine and many other places.

Another thing I noticed from the data I collected was that the blue mussel population has been rapidly declining due to the big increases in the green crab population graph. And that is because the green crabs are taking away all of the "local" sea creatures resources that they need in order to be able to stay in that ecosystem. This evidence definitely connects to what I already know about blue mussels and green crabs, and it is a very important topic that more people should be learning about and helping to solve.

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Hybridization: Evolving With the Climate

Octavia A, Center for Teaching and Learning, Grade 8

Introduction

Today, according to a study done by University College London, about 25% of plant species and more than 10% of animal species are involved with the process of hybridization, or when a plant or animal breeds with another species or variety.

This percentage is increasing, somewhat due to more effective detection of it by scientists but also due to climate change and changing environmental conditions that force different species into new environments and, consequently, into interaction with new species. There is also a steady increase in human-induced hybridization (Consequences of Hybridization in Mammals: A Systematic Review) because of deliberate and accidental introductions of new species to different areas around the globe.

Hybridization, an evolutionary process that much is still unknown about including what, exactly, it has done in evolutionary history, is a still relatively new discovery. Scientists have only recently become aware of its importance in evolution and largely only have conjecture about what the increase of it may do: some argue it will allow species to adapt fast enough to combat climate change and survive in ecosystems they would not be able to otherwise, but at the same time it could lead to hybrid species that struggle more to survive, the loss of specific genetic traits, increased competition in one environment for limited resources, and ecological disruption or negative cascading effects throughout an ecosystem.

Hybridization happens 2-3 times more in disturbed habitats and ecosystems when compared to non-disturbed environments with only native species, according to a study published in Nature Communications (2020). Based on a report done by Intergovernmental Platform on Biodiversity and Ecosystem Services, invasive alien species, or species that have moved into a habitat non-native to it due to human influence and has established a self-sustaining population with negative impacts for its new ecosystem, "has cost the world $423 billion per year – a number that has risen fourfold since the 1970s" (2023).

It goes on to say that "the total number of alien species is projected to increase by more than a third by 2050." This is directly due to human influence and shifting environmental conditions, and, because of the frequency of hybridization among newly introduced species, it's logical to conclude that hybridization will also increase just as rapidly.

Because of the consequential climate change occurring in and around the Maine coastline which is the fastest warming body of water in the world, according to the University of New England, hybridization will also have monumental effects here and is already proving to be able to change ecosystems and species' genetics incredibly quickly. Hybridization may offer a way for organisms to combat climate change and evolve fast enough to survive in our quickly warming world.

One example of this is a study that found two species of sea stars, or starfish, one that "has a limited geographic range with adaptation to local environments, and (the other sea star) has a wider range that extends all the way to western Europe" (Eurekalert.org). Both species of starfish have also been listed as "Species of Greatest Conservation Need" by the state of Maine following population declines due to warmer oceans, decreased oxygen levels, and possibly viruses. Scientists have discovered that hybrids of these two species have thrived from the shores of New England all the way to the Canadian Maritimes.

Both sea stars are considered to be keystone species in their respective environments and though without them their environments might collapse, the new hybrids also have a greater ability to survive in warmer climates near and far from their original habitats. Hybridization is giving these species a viable avenue to survive when faced with environmental changes threatening their population's, they are surviving and adapting in a way that was unprecedented and they are staving off their extinction in a way scientists were not able to accomplish.

My hypothesis that this paper will explore is that hybridization is a path forward that will allow organisms in danger from climate change to survive, and thrive, in changing environments. I will be focusing specifically on the Gulf of Maine and the way hybridized species will change the environment, especially considering the speed at which the water is warming and therefore the increased possibility of hybrid organisms. I intend to research the role hybridization has played in evolutionary history and the role it may play in upcoming years, as our understanding and occurrence of it increases, and as organisms need for it becomes more crucial.

Methods

In order to research hybridization, specifically in the Gulf of Maine, data about a variety of marine animals was used to prove that migration patterns are changing. If organisms are forced to move into or through different environments they will come into contact with new species and, potentially, disturb habitats with their hunting and living patterns. In order to prove changing migration patterns, reported sightings of North Atlantic Right Whales, Blue Whales, and Baird's Beaked Whales along the Gulf of Maine using Seamap: Duke University were used. This data is only on whales though changed migration patterns extend throughout the marine and terrestrial organisms. To measure changing migratory patterns data for latitude and date in the Gulf of Maine was graphed in order to show an increase in sightings farther north or south than usual over time.

The data was downloaded and graphed using Codap.org into scatter plots from which can be seen an increase in both northern and southern sightings over time as well as an increase in range of the travel patterns of each species. To do this I put the data from Seamap: Duke University Codap in comma separated values, used the graph feature to only select data points from and around the Gulf of Maine, and clicked 'Graph' to put this data into a graph with the independent variable date and the dependent variable latitude. From these the trend lines show slight increases in northern sightings, though the sightings in southernmost areas also increase in severity.

Results
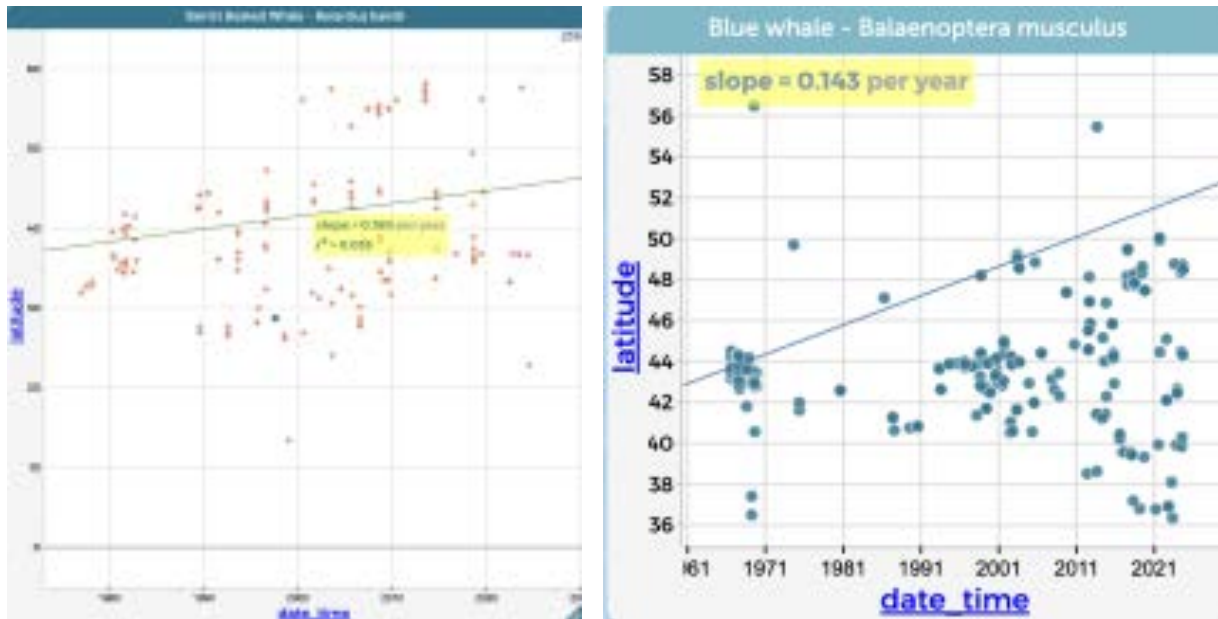
Graph 1 (left) and Graph 2 (right): Data from SeaMap, Duke University

Graph 1 shows the latitude of Baird's Beaked Whales in the Gulf of Maine over time, from 1977 to 2024. In it the trend line's slope is 0.154, and as time increases the range of the points increase from a range from the years 1977-1982 that was 9.9 degrees latitude to the range from years 2018-2024 that has a range of 34.8 degrees latitude. The data points follow a general trend of increasing in both southern and northern latitude over time with ranges that show an obvious increase in variation in migration over the decades.

Graph 2 focuses on the Blue Whale and pinpoints on their latitude in the Gulf of Maine over time, this time from 1966 to 2024. The trend line's slope is 0.0157, again increasing in northern latitudes over time but not a major increase. The range from 2018 to 2023 is 13.7 degrees compared to the range from 1966 to 1969 which is 3.93 degrees latitude as time increases. The data points also show a trend of Blue Whales migrating increasingly northward and southward with much greater extremes in recent years. In 1966 to 1969 there is also a grouping of data points that are in very similar places, which from then on continues with more sparse data points that increase in both southern and northern latitudes.

Graph 3 is on the North Atlantic Right Whale's latitude in the Gulf of Maine from 1983 to 2024. In this graph the trend line's slope is -0.0348, increasing instead in southern latitudes over time. The range from 2020 to 2024 is 22.22 degrees latitude compared to data from 1983 to 1990 which Graph Two, data from SeaMap: Duke University has a range of 7.93. Though more subtle the data still increases in variety between southern and northern sightings, mostly starting to become more northward in 2010 but continuing in southward latitudes throughout the decades.

Conclusion

Overall, I have researched the increasing migration patterns to support my theory that not only are they increasing, but hybridization, a possible way for dying species to evolve fast enough to keep up with the current climate crisis, is likewise increasing. My data of whales in the Gulf of Maine show a clear increase in the range of the latitude of whale sightings. From this data it's logical to extrapolate that because migration patterns are changing, namely increasing in range and more extreme exploration in both southern and northern waters, hybridization is also increasing from the higher amount of disturbed habitats this will cause. These patterns, specifically the increasing ranges of sightings, show both the need, and hopefully some of the solution, for extinction due to climate change.

Each graph showed this increasing range of migration patterns, which will allow for a greater possibility of hybridization, and it supports my hypothesis because of the recent uptick in recorded hybridization. There is conjecture about the possibility that hybridization contributed to the genetic diversity found in birds which does support the idea that this increase in hybridization will not just result in a loss of specific genetic traits, but instead contribute a greater diversity in key species.

At the very least this shows that hybridization is happening at an increasing rate, possibly allowing select species to evolve for warmer climates, changing ecosystems, and unfamiliar competition. I believe that this could be a way for these species to evolve fast enough to, at the very least, keep up with the rapidly changing climate and combat the extinction rates we're seeing today.

Discussion

A few factors that might have influenced my data include an increase in whale sightings over all as well as a more advanced ability to track them over greater distances, the data seems clear but that may be because of the greater amount of data being collected overall. This data also only indirectly confirms my hypothesis as it is about the increase of species migration, which is correlated with an increase in hybridization but does not directly show that increase.

I was not able to support my hypothesis with data about a specific couple species or the active process of hybridization, nor was I able to find data points that show this over a long period of time or at all as most of the processes are done on the genetic level and thus not as accessible as other methods of data collection. There is also little research being done to test the ways hybridization affects environments, again as the specific scientific processes needed have only been recently developed and are difficult to discern exact cause for, and almost none done on a wider scale.

To continue this I would ideally like to track the genetic pool of a specific group of animals, possibly an endangered species, through their migrations and hopefully be able to pinpoint what hybridization looks like and the effects it had on the animals. Possibly this could

also be found by observing the changing looks, patterns, and traits of a specific group of animals over a long period of time as they interact with changed environments and new creatures around them. This way the effect of hybridization is documented and clearly visible, though I'm not surehow clear the change would be unless the study was done over a long period of time as the changes would grow more apparent over time.

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Nudibranch Population and the Plankton Population. Do They Affect Each Other?

Fiona B, Center for Teaching and Learning, Grade 7

Introduction

Many people around the world ask odd questions, like: why is the sky blue? Why do animals act certain ways? Well here's my weird question: Does the nudibranch population affect the plankton population? So you might be wondering what a nudibranch is or maybe you might not know what plankton is so I'm gonna tell you cause if you didn't know this paper would make no sense. Nudibranchs or nudibranchia are sea slugs that live on tropical coasts or just most coasts in general. They range from 0.25 inches to 12 inches and 3.3 pounds at most. They are a variety of colors and take the saying you are what you eat very seriously and by that I mean whatever they eat they turn that color. you may be wondering why this information is important well it is because this can help me find out if different types nudibranchia eat things that would affect plankton or in terms of size it tells me how much space they take up in a ecosystem and that tells me if there is more or less room for plankton. Speaking of plankton, I'm gonna write about that now. Plankton are microscopic plants and animals that are the foundation of our world. They may be small but they are mighty. Plankton have few threats but the threats that do affect them are very problematic. The threats being: ocean acidity and microplastics. but plankton are threats as well. Sometimes there will be plankton blooms called red tides. Red tides are plankton blooms that secrete toxins, block out sunlight for other species, and decrease oxygen. This may all be a bit confusing and seem irrelevant but trust me if you and i didnt know this information the answer to my question wouldn't make sense and I wouldn't even have an answer.

People dont know alot about nudibranchia yet we know a lot about plankton. So I chose this topic because I wanted to find out if a not very well known species is one that is affecting a very important well known species, aka nudibranchia (not known) and plankton (well known). You may think this is not important but if my suspicion is correct then this could uncover another threat to plankton and why it's dying out. and if i'm wrong and they don't affect each other whatsoever then at least then we can rule out nudibranchia on the "might be the cause of plankton dying rapidly" list.

So without further adieu my paper on if the nudibranchia population affects the plankton population.

Methods

To start off let's talk about how I manipulated the data and how you could do it as well. First thing I did was collect my data from inaturalist and my teacher, Glenn. I gathered nudibranchia

population/sighting data. It told me the date and what kind of nudibranch it was. Then I got plankton data from my teacher. It told me the date it was sighted and its pti. To manipulate the data I used a sight called codap. Codap helps you make graphs, tables, maps and more.

If you want to use Codap as well this will be a helpful guide for you. The first thing you do is download the data and transfer it into the empty codap page then you click the graph button in the upper left corner. (I'm going to use my data as an example.) So the first thing I did was make a graph, then I dragged the date attribute to the x axes and then I dragged the scientific name to the y axes. Then I dragged in the plankton data and did the same thing except I used pti instead of scientific name.

Results

These are my graphs/data that show the relationships between the nudibranchia population of specific species and the date they were spotted. The other graph shows how many plankton were spotted on a specific date.
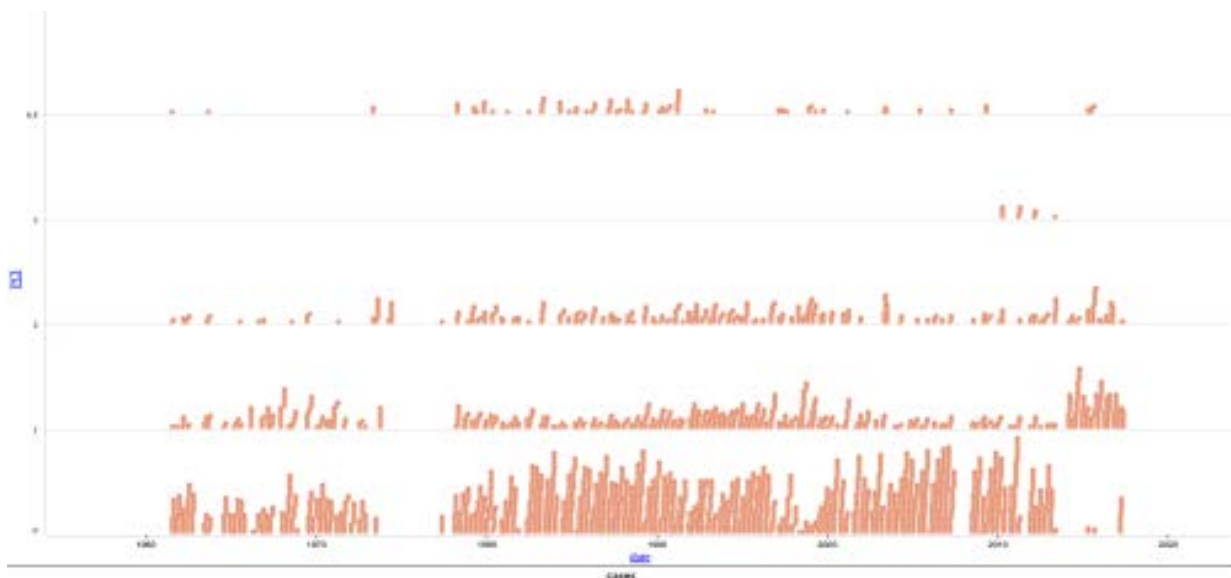
Plankton graph
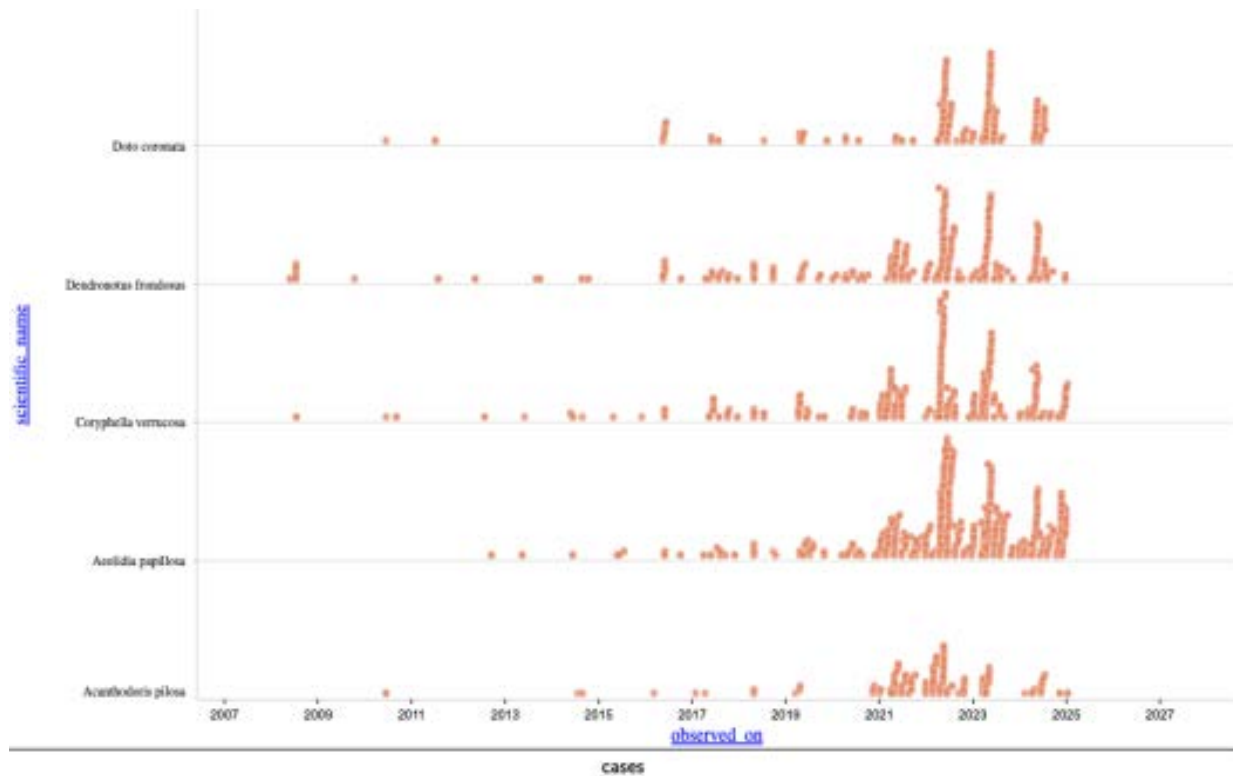
Nudibranchia graph

Conclusion

Throughout my investigation I uncovered many answers to questions I had and I learned about how the population for the five nudibranchia species has increased in the later years. I also learned that the plankton population in the data also had the appearance of growing in the later years but it also told me that in all the sightings that were recorded there were more with just one plankton and few with 2 or more. This means that the nudibranchia population is not affecting the plankton population according to what I learned. So there is the answer to my question: according to this data they do not affect each other whatsoever.

I hope you enjoyed my paper and learned some new facts, and answers to your questions.

How are Native Crabs in Maine Currently Being Affected by Climate Change?

Meghan A, Center for Teaching and Learning, Grade 8

Introduction

My essential question is: How are Native crabs off of the gulf of maine currently being affected by climate change? There are three main types of native crabs off the gulf of Maine: Rock crabs, Jonah crabs, and Peekytoe crabs. During this time of climate change the ocean temps are rising and these native crabs have individual specific temperature preferences of the water. Rock crab temp preference is 16 degrees celsius/60.8 degrees fahrenheit. Jonah crab temp preference is 15.4 degrees celsius/59.7 degrees fahrenheit. But with warming waters, these crabs are having to travel to other parts of the ocean that are closer in temperature to their preference.

Rock crabs have a carapace that is smooth, oval shaped and can range in color from yellowish-brown to reddish-purple. Jonah crabs have a rounded rough edged carapace with small light spots, and robust claws with dark brown-black tips. Peekytoe crabs can reach 5 inches across and have a red or orange shell and a white belly. You can most likely find rock crabs in coastal maine waters. You can most likely find jonah crabs across the North Atlantic Ocean.

Sea level rise, storms, and increased sea and air temps and altered salinity is affecting the native crab population. Some of the native crabs of Maine that live in marshy areas use eelgrass as habitat and protection but since climate change started some of that grass has been disappearing therefore getting rid of that habitat that they used for protection. Some native crabs are vulnerable to any number of aspects of climate change because they rely on salt marsh and beach habitat where the availability of those has decreased.

Some native crabs (ie. fiddler crabs, blue crabs) have traveled to other coastal places like Massachusetts, New Hampshire, and Nova Scotia. Native crabs can't control their body temperature and are dependent on their temperature preference and the temperature of the water to stay alive but with the sea temp rising they are having to travel to other places in order to stay alive.

Methods

The data I am aiming to collect is: is there a main part of climate change that is affecting the native crabs off the coast of main or is it multiple parts. This will give me an idea of the parts I am working with and also give me an idea of an approach for figuring out and answering my essential question. I am aiming to collect some of this data at least once or twice.

I can collect information/data by looking at the data that I collect of native crabs and then

comparing it to some scientists' data and seeing how they are similar or different. This will help me get the data that I need because I will be able to see which places have the most native crabs and which have the least, then I can figure out why they have been sticking to those places.

I can make sure my data is high quality and accurate by making sure that the data was found by an actual scientist from Maine who is collecting the data in Maine.

I made a graph by inputting the data into a website called Codap. This site helps you make graphs and tables if you only have one of those, and you want the table or the graph. In my case I needed a graph but I had a table so I put the table into Codap and they generated a graph for me based on my data.

Results
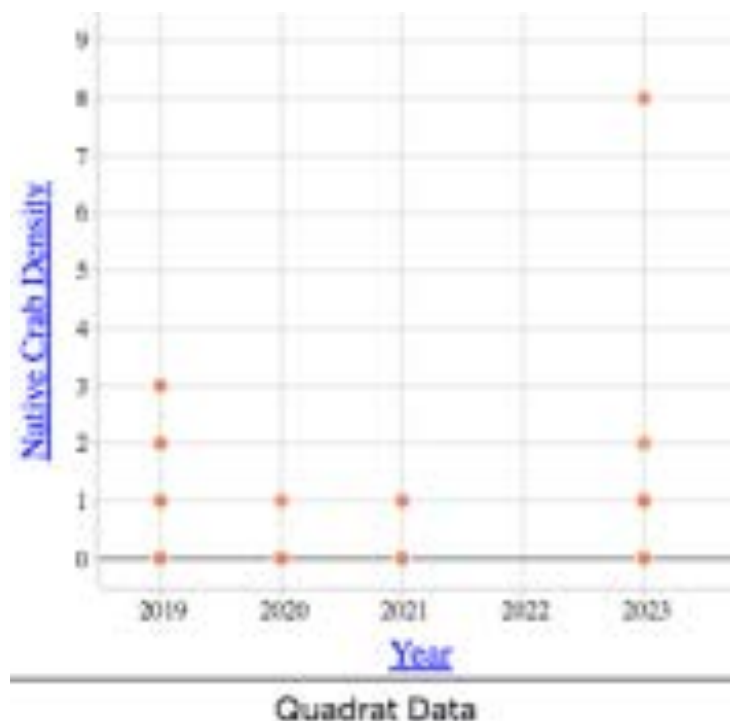
Graph 1

This is a helpful graph because it shows the gap of time where scientists didn't find native crabs. I also like this graph because it shows you the specific amounts of native crabs in each spot the scientists looked.
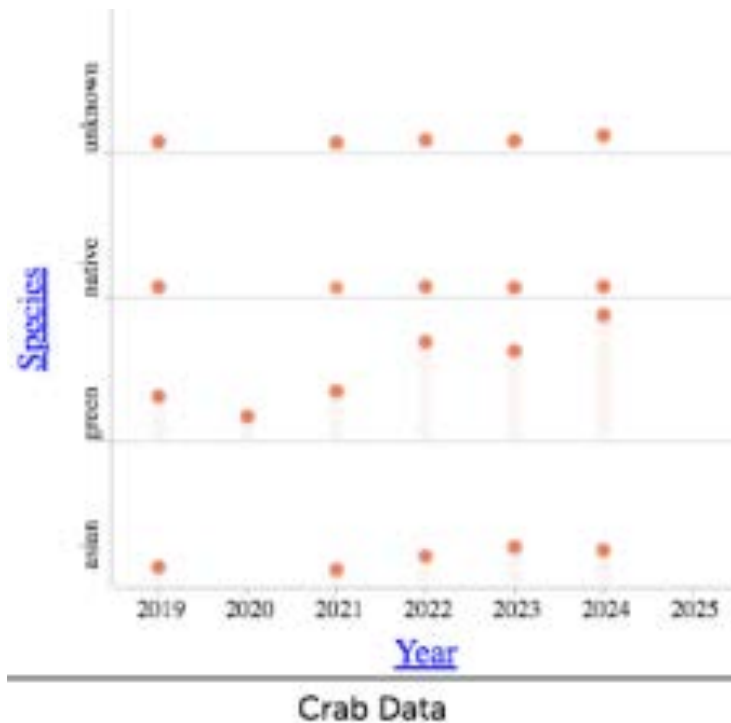
Graph 2

This graph shows how much of each species of crab the scientists in each year caught. This graph is really interesting to me because it shows how much green crabs compared to native crabs they caught which they caught more green crabs than native crabs. I think part of why there were way more green crabs caught is not just because green crabs are invasive but like I said in my introduction, most crabs have a temperature preference and the native crabs current environment is not within there preferences, whereas it is for green crabs so therefore more native crabs are moving to other places that fit them.

Conclusion And Discussion

I am investigating native crabs of Maine through my essential question: how are native crabs currently being affected by climate change. Through my investigation I found out that each crab species in maine whether native or invasive have their own individual water temperature preference. These findings are important because it can explain why so many native crabs are leaving to go to other parts of the ocean that fit their preference, it also explains why so many green crabs are staying in Maine and not going to other places in the ocean because it fits into their temp parameters. During my studies of this topic I made sure to pay close attention to the numbers of each crab type in Maine and if the numbers of each crab type were increasing or decreasing. I noticed from the data that the number of rock crabs was decreasing and the number of green crabs seen were increasing. This evidence suggests that native crabs were moving to other areas because the temperature wasn't in their parameters. It also suggests that green crabs are staying near Maine because it is in their temperature parameters. This

evidence connects to what I already know about green crabs and native crabs because I already knew/noticed that the number of native crabs in Maine has been decreasing and the number of green crabs has been increasing. As a result of this study, new questions to investigate have come up, such as: does a type of native crab and a type of invasive crab have the same temperature preference or does each type of crab have different temperature preference?

Photos

Rock Crab, Jonah Crab.

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The Effect of Recreational and Commercial Fishing on Black Sea Bass

Kelly M, Center for Teaching and Learning, Grade 8

Introduction

In my project I will be studying the effect of how recreational and commercial fisheries have on the black sea bass population and their migration patterns, which has depleted from 11.97 million pounds during 2022 and 2023, to 7.5 million pounds, which is the lowest recreational harvest since 2014.

This would show that the harvest of these marine animals has increased since 2022 which shows the amount of recreational and commercial fishing that had been happening. Another interesting fact to consider when thinking about the decrease of this species is that the government set certain limits to how many Bass you can catch which has helped the population become none overfished and a healthy species. One last fact to take into consideration when talking about the Black sea Bass migration is that they migrate south for the winter to get to warming waters.

There has been lots of migration and population research done on the bass.some interesting facts that scientists discovered was that black sea bass are known as protogynous hermaphrodites. Meaning they have the ability to change their sex/gender as they get to be older.

Some reasons for this to happen was that a relative scarcity of males in a spawning group may be the stimulus for a female to switch sex.

When it comes down to population research there has been lots of research done on the coast of maine's fishery effect on these fish lots of them can be caught in lobster traps as the bigger bass like to try to eat the lobsters in the trap resulting in the entrapment. As of migration data the bass tend to go towards warmer water temperatures between 11-22°C or 50-72°F. So when the seasons start to change they migrate south offshore.

My study about the Black sea bass will combine lots of different information and compile it into one big paper that explains the ups and downs of black sea bass population and migration.

My hypothesis to my question is that as climate change goes on the bass will adapt but also fishermen will suffer as the fish could possibly go farther north. They might even start to stay in the gulf as the waters warm through climate change. Because as the ocean warms the bass will make their way north.

Methods

I am collecting data on Black Sea Bass of ocean warming on these marine animals. Als population and migration data as the ocean warms. I'm really looking to record data on future hypotheses on the effect of data on the already warming waters from 1/1/81 to 2025.This data that I am collecting will help answer my question because it will show and give examples of data of warming water and populations data throughout the time that my data covers. I know this is enough because this data shows all the little details that are in my question like migration, warming water data and recreational and commercial fishing regulations and numbers.

To organize, collect and analyze data I used a data editing tool called CODAP and a program that allows me to organize my data into sets, for example graphs, tables and maps. To use CODAP it was a simple learning process, the hardest part being to download your data into the site. But when using the data it was simple. If you want a graph all you have to do is click the graph and drag the two or more components you want to show up into the X and Y coordinates which then will show the components on the graph. That also goes for when using a map drag all your components in and it will highlight all of them in different shades of color. In case you wanted to stress on one point of your map or graph or table you drag the component you want right into the middle of the data set and it will highlight them in a different color. Another method that I used was sheets specifically for the process of organizing warming water data. When using this it was especially helpful organizing the large set of data into one long list of variables to scroll down.

Results
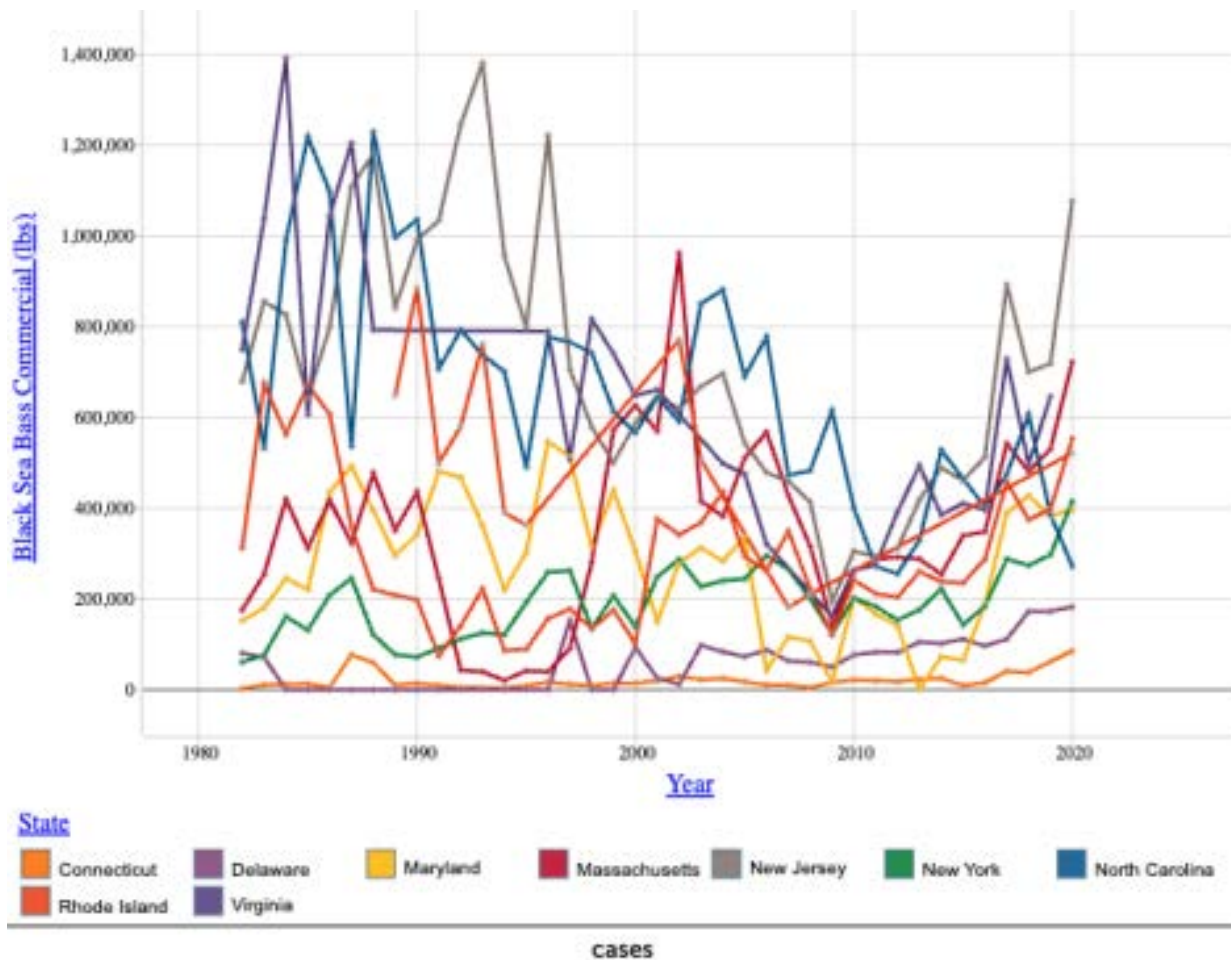
Graph 1 shows the growth of commercials over 40 years. This shows that during the time in the 1980s to 2000s there wasn't a limited amount of fish that you could catch. But since it spiked in around 1984 to 1,400,000 since the limit was set its slowly decreasing to 2010 where its now drastically decreasing down to around 500,000 in 2015. But when looking at the more modern day part of the graph you can see that the overfishing was drastically increasing from 2010 to 2020.

recreational fishing throughout the years
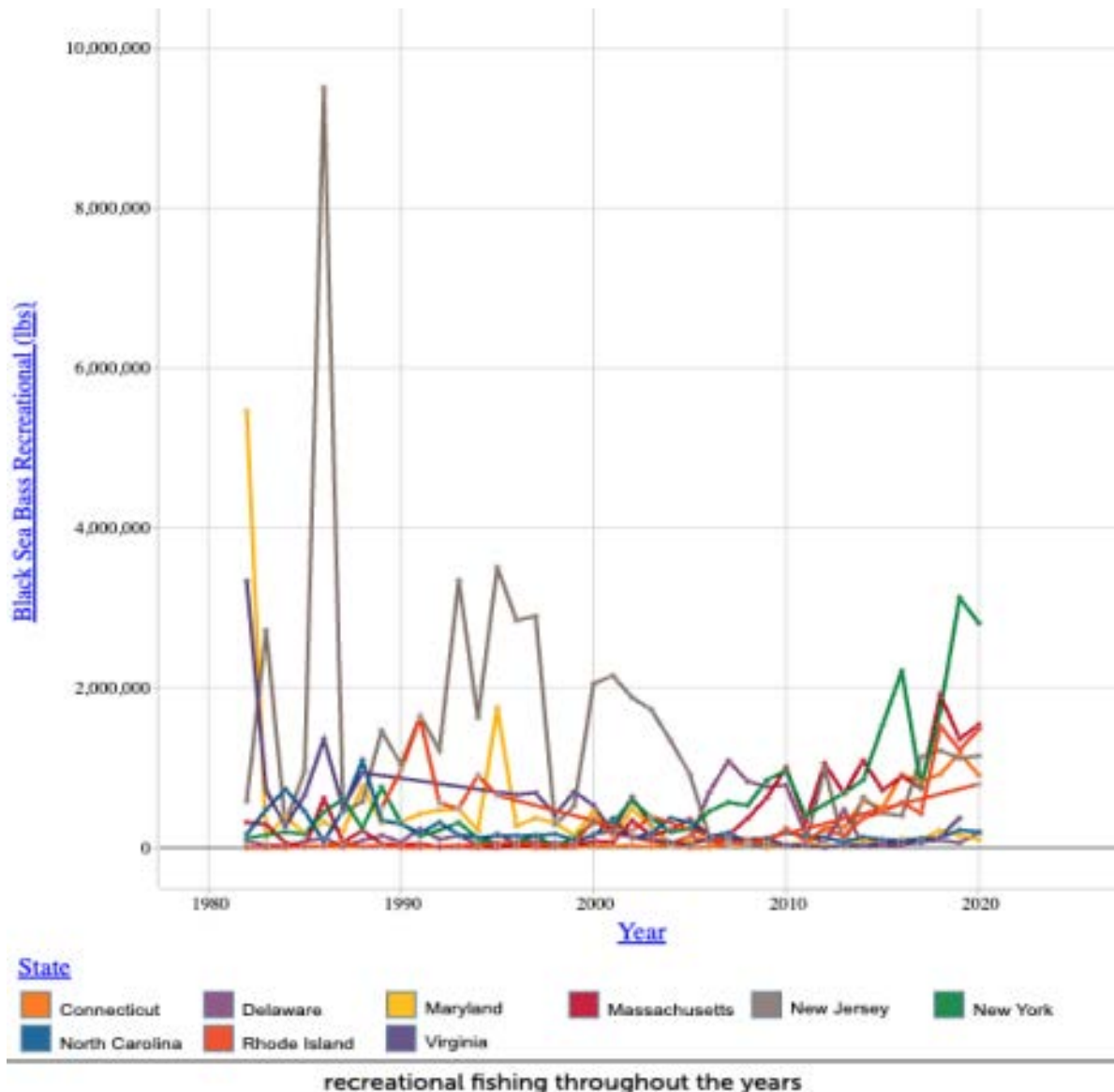
This graph represents the recreational fishing effect on the black sea bass population. This shows that in the 1980s to 2000s the dat has been pretty unsteady until about 2005 as this shows the difference in the commercial and recreational industry. As commercial has been much more proactiv when it comes to amount of fish overtime.

Discussions

I am investigating the effect of how recreational and commercial fisheries have on the black sea bass population and their migration patterns. And through this investigation I found that overfishing in the 1980-2000 lead to a massive drop off in population numbers but when there were rules set to only be able to catch a certain amount of Black Sea Bass that led to restoration of there population today. My claim is based on the following evidence of the drop and increase of the black sea bass species over time. I noticed from the data that both graphs

of recreational and commercial fishing dropped off at the same time that around the same time those rules were put into place. This evidence supports my claim because I talk about when the population increases and decreases. This evidence suggests that during the 1980-2000 the population drops a significant amount just about 1100000. As a result of this study, new questions to investigate have come up, such as the effect of climate change, warming waters or migration patterns with climate change. Some factors might have impacted my data, like unusual spikes in the data after the limitation was set.

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Does the month affect the Green Crab density?

*Austin L, North Hampton School, Grade 7*

Background Information

Although you may think Green Crabs are native to the East Coast, they're actually invasive and causing a lot of damage to the environment around them. First off, the Green Crab came from Europe and North Africa in 1817 in the holds of ships, meaning the Green Crab is invasive. They're causing lots of damage to eelgrass and eelgrass is a necessity for some native species, it provides shelter from predators and safe nesting grounds for native species. Because these Green Crabs cause so much harm to the environment around them, the Department of Marine Resources wants to use Green Crab removal programs to stop the spreading of the crabs. Evidence of this is in the article, "European Green Crabs", written by the Kennebunk Conservation Trust (https://www.kporttrust.org/green-crab), states, "Eelgrass beds are a very valuable and critical habitat for many native-to-Maine and economically important species. Such eelgrass beds provide nesting, refuge, and mating and feeding areas to Maine's vital intertidal native species…They also are responsible for the degradation and loss of criticall nursery-habitat eelgrass beds and salt marsh habitats" (Kennebunk Conservation Trust). This explains how eelgrass is being destroyed and decimated by Green Crabs. As said before, eelgrass is very important to native species by giving them shelter and safe nesting grounds. But because Green Crabs are destroying eelgrass, other native species don't have shelter and safe nesting ground which means the native species will start dying and the whole environment will be disrupted. This creates an imbalance in the food web because of this, some species will thrive and some will die.

Methods

On 10/22/24 my class went to Odiorne State Park at 9:09 AM, it was low tide. It was a clear, very sunny day, it was a bit chilly and there was a nice breeze. The 100 foot transect line was placed along the rocky shore. My teacher, Mrs. Jones, gave me and my group a quadrat along the transect line. We got quadrat number 8 and we noticed the area we were given was rocky. We didn't see any crabs on the surface, so we lifted rocks and other objects in the way, still, we didn't see any crabs. After a while, we started digging in the sand and we found a big crab. We headed up the beach away from the water and we found a comfortable place to sit and measure the crab. We used a caliper to measure the crab's carapace and looking at the color and its number of spines, we figured out that the crab was a Green Crab. We took some pictures of the crab's front side, back side, and spines. After going back to school, we uploaded the pictures we took to the Gulf of Maine Research Institute Data Portal. We also looked at many other schools' information and compared them to our data.

Results
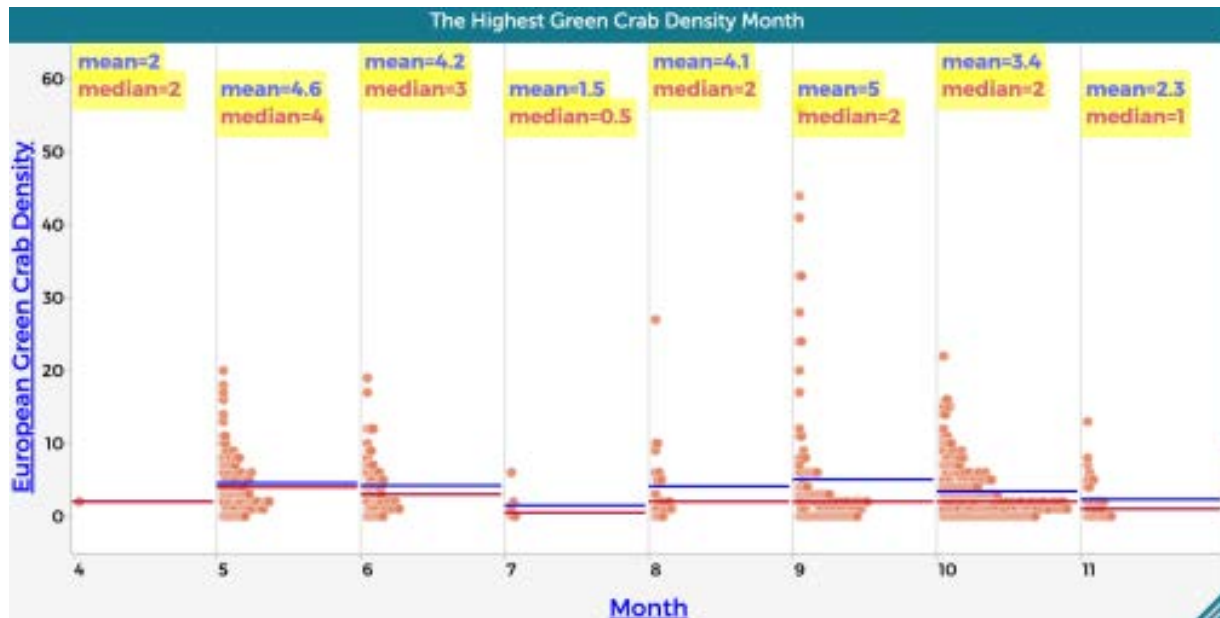
Discussion

Using the data table from above, I noticed that the mean number of Green Crabs per quadrat is highest in September. This means that you'll find the highest average number of green crabs per quadrat in September. Also, the highest median number is in May, meaning that if you order all the numbers of Green Crabs from least to greatest in each month, May would have the highest middle number. So yes, the month does affect the density of Green Crabs. We know this by looking at the graph above. I think this is because most Green Crabs hatch in September meaning the mean Green Crab density per quadrat is higher.

Concluding Statement

Now I'm wondering, why does the mean density of Green Crabs drop so much in October? Is it because the waters are starting to get colder and the crabs start to die? I think Green Crabs hatch in September and start eating all the eelgrass in the area causing a lot of damage. Because the water is getting colder Green Crabs start dying and I think that's when Green Crabs cause the most damage.

On Average, What Habitat Are Green, Asian and Native Crabs Found In?

Tyler E, North Hampton School, Grade 8

Background Information

Although this species is overpopulated on most coasts in the US, the European Green crab is native to the coasts of the Nordic and Baltic seas. You may be wondering how the Green crabs made their way across the oceans. With their habitat mainly being around coastal lines they couldn't have traveled underwater across a whole sea. So what they did was hitchhiking in a way. They were thought to have traveled on oversea shipping in ballast tanks or really any boat they detected shellfish which they eat. The early 1900s were when the Green crabs started arriving in North Eastern states such as Maine in dangerously large amounts. Having Green crabs in the US is very harmful. Just to start, they are not only very disruptive to the ecosystems on the coast, they also make a large dent in the US's economy. This is caused by them feeding on shellfish species such as blue mussels and soft-shelled clams. Having a few of these precious animals being eaten is ok, due to the countless amounts, the little Green crabs can cause a lot of damage to the local environment and the economy. Although Green crabs are smaller than most native crabs, they are physically aggressive enough to take down and eat animals bigger than them, "Lobsters have even been found in the stomachs of Green crabs and studies have shown that Green crabs can outcompete lobsters and native crabs for food," (European Green Crab). With their large population, this continuous occurrence concerns Maine's third largest wild fishery. Some ways people are trying to lower the population of this invasive species is by recycling. In one example, there has been a process made to turn the crab meat into food to provide to livestock.

Methods

On October 25th 2024, my class went to Odiorne State Park in Rye New Hampshire to perform some research and collect some data on crabs in the area. We arrived there at 1:00 pm at low tide. It was 70°F with 100% sunny skies. When setting up for our crab sampling we layed out a transect line (ruler) across 100 feet of coastal line. Everyone in the grade was put into groups of three or four and were stationed at one by one meter square quadrats made of rope which were evenly dispersed along the transect. The first note all group shad to take was what type of habitat was in their quadrant out of a Rocky intertidal, Mudflat or Salt marsh. All groups had approximately 15 minutes to move around rocks and seaweed only in their assigned quadrant to find any type of crab and place it into a bucket to examine later. When time was up all groups had to identify each of the crab's species. We recorded data on how many Green, Asian and Native crabs our group found. If the species was unknown or measured less than 15mm the crabs were not recorded. Other aspects of the crabs we had to take note of were

their sex, number of claws, the size in millimeters, how hard or soft the shell was, and if the crab was egg bearing. When done, the groups had to take one picture of each crab's spine, one picture of the crabs dorsal (top view) and ventral (bottom view). After all the data was collected we uploaded it to the Gulf of Maine Research institute Data Portal.

Results
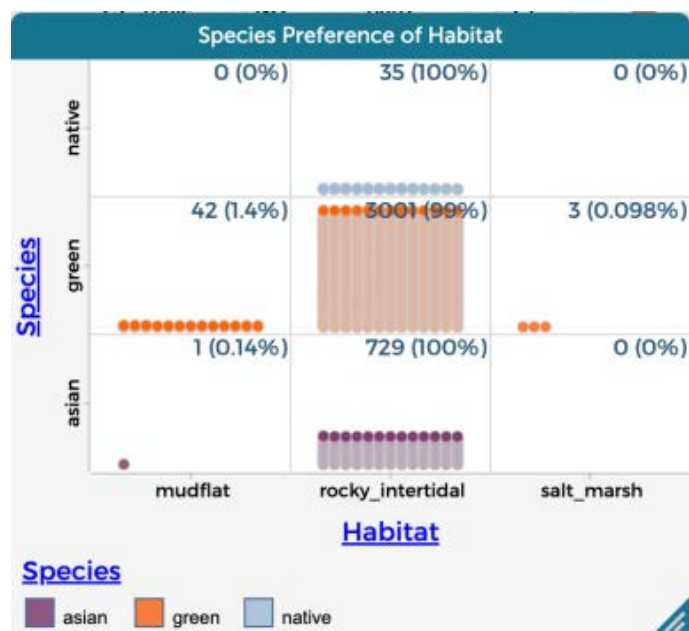
Graph 1
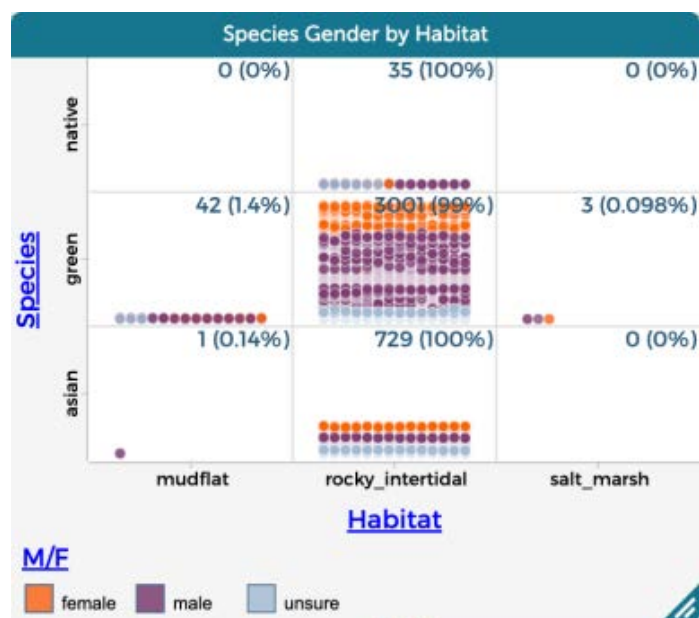
Graph 2

In my first graph I used data of the species and the habitat they were found in. In addition to my first graph I included the gender of the crabs in the center of the graph to include a legend in my second graph. In both of the graphs it is clearly shown that 100% of Native crabs 99% of Green crabs and 100% of Asian crabs were found in rocky intertidals. When I put together which habitat each species was mainly found in, I noticed that most all of speceices, no matter the gender, liked roaming if not living in a rocky intertidal.

Conclusion

The question I was wondering throughout my research was, out of the Green, Asian and Native crabs my grade found, on average for each species, what habitat were they found in? What my grade learned was that no matter the species or gender, most all crabs we found were in rocky intertidals. In the first place, I came up with this question to have an idea of where or what habitat to locate Green, Asian and Native crabs. After my research it turns out that if you are looking for crabs, there is the highest chance that you will find an abundance of crabs and even species in rocky intertidals. The Green crab, a species of crab native to the coasts of the Nordic and Baltic seas which has been hitchhiking on over sea shipping to invade most coasts of the US. With this species of crab having an enormous population on the coasts of the US and that type of crab, having an expensive taste, ended up making a dent in the US's economy. Green crabs need to be stopped. Knowing that Green crabs live in rocky intertidals and there is a way of recycling the crabs by turning them into food, we should come together as a community and build factories. These factories would be set by rocky intertidals along the coasts for the purpose of collecting, processing and decreasing the population of Green crabs while also gaining food to provide for livestock. The only question I would have before collecting the Green crabs, is if there would be a specific size of crab they would have to be processed.

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What Temperatures can Green Crabs and Other Species Survive in?

William M, North Hampton School, Grade 8

Background Information

Green crabs are an invasive species in the US, causing major damage to the East coast's ecosystems. Green crabs are a species of crab native to Europe and Northern Africa. They are thought to have arrived on the East Coast by ships shipping cargo from Europe with ballast water. Green crabs were found on the East coast in 1817. They also harm habitats like salt marshes, "According to Jacob Aman "Green crab burrowing activity damages the roots and rhizomes of grasses that would otherwise hold the salt marsh together" " (Pike). In addition to that, they harm native species like the soft shell clam because green crabs "...can swim (unlike our native crabs) and can therefore make it out to the tidal sand flats to get to the clams between tides" (Pike). Locals have put forward solutions to control the populations of green crabs. For instance, cooking and eating them, getting rid of ballast water outside of bays, and monitoring live food, and aquarium trade (Alaska Dep. of Fish and Game). My research will help further solutions to the green crab infestation along the East coast by finding what temperatures green crabs and other species can survive in.

Methods
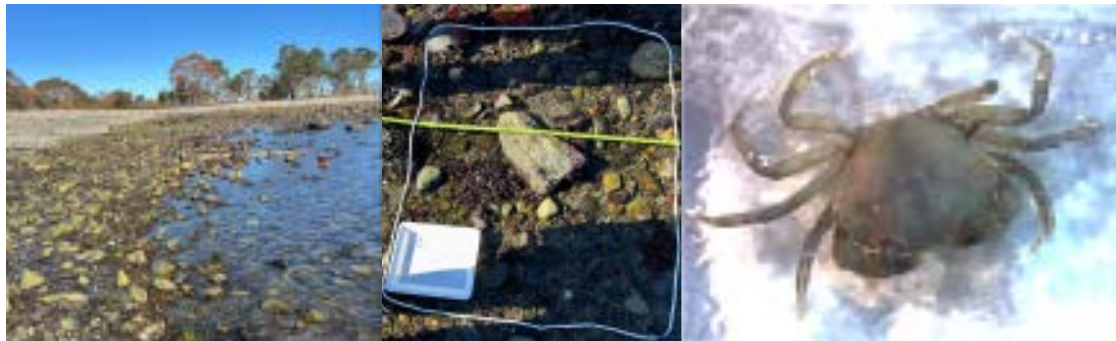
On the 25th of October, 2024, my class went from North Hampton School to Odiorne State Park. When we arrived it was 1:00 pm and low tide well the weather was 100% sunny and 70°F. We then placed a 100 meter transect line and were assigned how many meters out our quadrat should be.

We took a picture of the field set and our quadrat. Next we looked for crabs, moving around rocks, shells, and seaweed to look for them within our quadrat, and kept record of their species, sex, size, shell hardness, egg bearing, number of claws, and then put them into a bucket. Well we recorded information and found crabs. We also took pictures of each crabs spines, and a dorsal view, and a ventral view of them. We didn't take pictures of any unidentified crabs or crabs under 15mm in size. We later uploaded the pictures to the Gulf of Maine Research Institute Data Portal.

Results

Months Species of Crabs are Found in

Monthly Average Temperature by Year
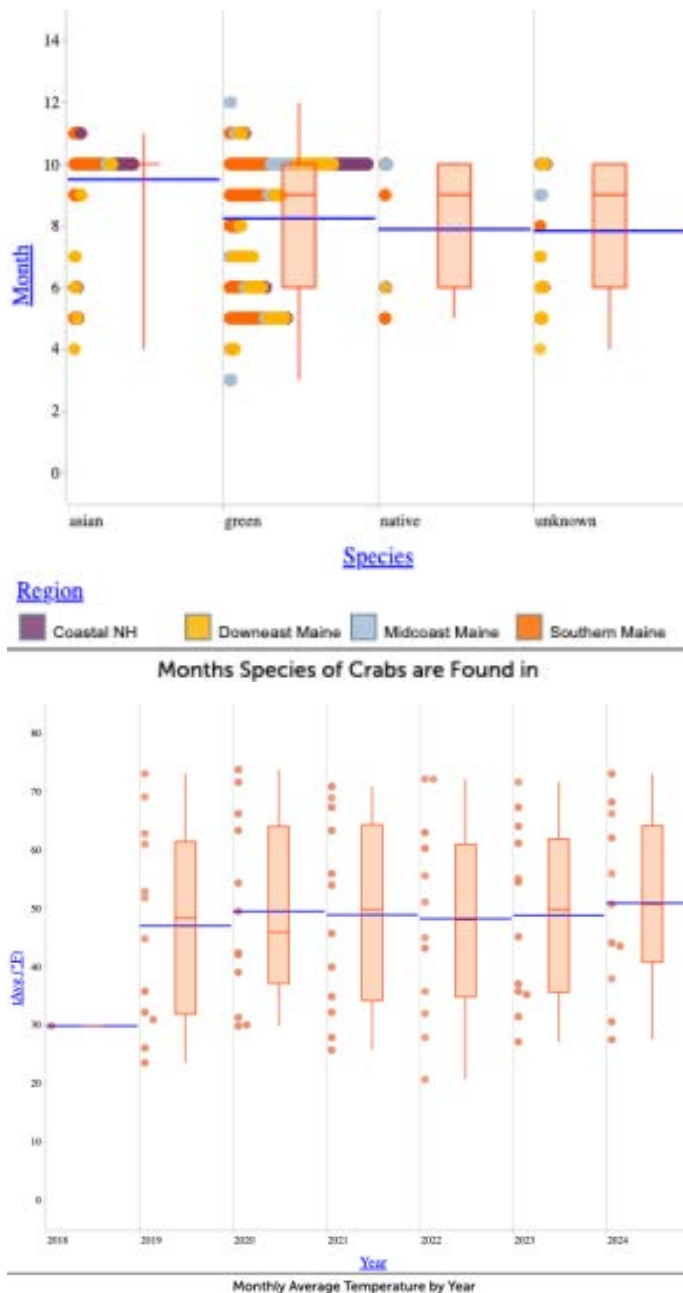
I used the data from the year, tAvg. (°F), Region, Species, and Month attributes in my graphs. I noticed that most crabs were found in October. On average, it was around 50°F in October in the past few years. I also noticed that the least amount of crabs were found in March, April, and May. It was 45°F in March, 55°F in April, and 66°F in May on Average in the past few years. I wonder if the amount of crabs found isn't affected by the temperature, but by the amount of field trips to find crabs. As you can see that the Q3 of several of the box plots within the Months Species of Crabs are Found graph, is October, or 10, which is the beginning of most school years and it isn't too cold or too warm during the month. But, this could be a comfortable temperature for green crabs and other species of crabs.

Conclusion

What temperatures can green crabs and other species survive in? I have this question because I wanted to know the range of temperature green crabs and other species could survive in. This would further help green crab research by finding the reach of green crabs and how far they could spread down towards the equator or up the East coast of Canada. I found that green crabs, along with other species, were most commonly found in October, where is has been around 50°F on average. I also found that green crabs, and other species, were least commonly found in March, April, and May, where it was 45°F, 55°F, and 66°F. Personally, I feel as I didn't find much out and left this project with more questions than answers. But I have left with some ideas to find the answers. How do green crabs and other species of crabs move during the summer? I think to find what temperatures green crabs and other species can survive in, we need to form a few groups of people to go out every month, record the temperature, and find crabs through regular methods.

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Susan Pike
https://www.seacoastonline.com/story/news/2024/05/07/green-crabs-we-cant-beat-them-so-lets-eat-the m-nature-news/73586091007/

# What terrain or habitat has the highest population?

Lilly S, North Hampton School, Grade 8

The following information is needed to understand the green crab problem. The crabs came from Europe in the mid-1800's. They came to America by holding onto boats traveling across the ocean. "travelling in the ballast water of large shipping vessels" (Cassin 1). "The European Green Crab arrived at the eastern seaboard 150 years ago, originally invading New Jersey to Cape Cod, and down in the Chesapeake Bay (1879). In the early 1900s, they started their invasion northwards to Maine" (Holmes1).

The green crabs are harmful for 3 main reasons. The first is bringing down the shellfish and lobster population. The second reason is because it is destroying eelgrass beds. The last main reason is its lowering of the native crab population. "Concerningly, the green crab population in Maine is increasing exponentially. They feed on economically-important shellfish species such as blue mussels and soft-shelled clams. Lobsters have even been found in the stomachs of green crabs and studies have shown that green crabs can outcompete lobsters and native crabs for food. This threatens Maine's third largest wild fishery. They also are responsible for the degradation and loss of critical nursery-habitat eelgrass beds and salt marsh habitats" (Holmes 1).

"While there is no viable commercial market for green crabs (yet)…There is one development being made that converts the protein from green crabs into sustainable aquaculture feed for local and possibly external use. There is also investment in composting such crabs" (Holmes 4). There are several ideas to get rid of or slow down the spread of green crabs but the most environmentally friendly ideas are the following. The first tactic is to take the protein from the crabs to give to the environment including feeding other sea creatures and or using it to help the soil and more.

My class went to Odiorne State Park on October 25th 2024. We did our research at 1 in the afternoon during low tide. The weather during that time was clear sunny skies and was 70 degrees fahrenheit. We started with our teacher placing a 100 foot long transit line. This is so everyone could correctly set up their quadrat (rope box's). These things are to help get an exact amount of how many crabs were in a specific area. As we started looking for crabs there were none visible to begin with. As we started moving rocks we found many more but when moving rocks they were all exceptionally small. As people moved around to bigger rocks instead of being in one space they found bigger and many more crabs. After about 15 minutes of looking we took the crabs in buckets to measure them. What we used to measure the crabs was a digital caliper and observed and recorded green crabs like shallow water with many rocks better than sandy, open, and deep. After collecting all of this information we uploaded data to the Gulf of Maine Research Institute Data Portal.
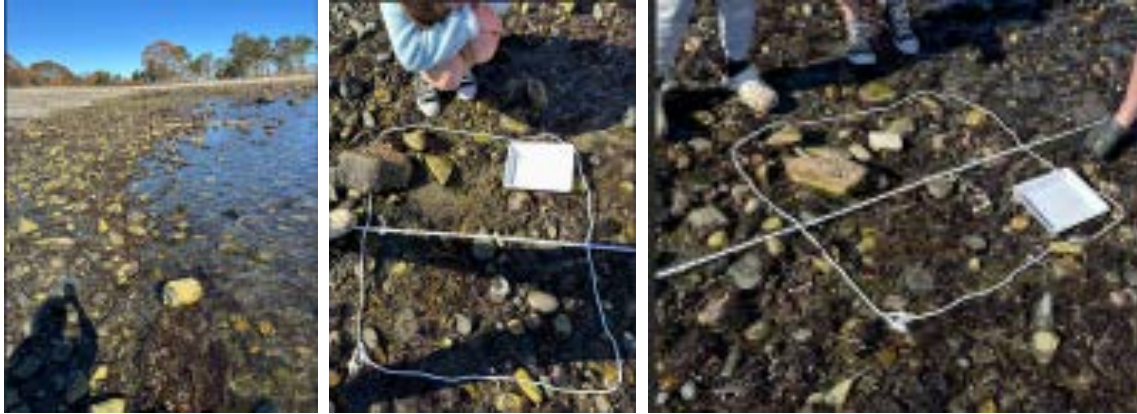
I made a graph based on my question using CODAP. The data I used was with the habitat on the y axis and European Green crab population on the x axis. The results from the graph show how many more crabs live in the rocky intertidals.The difference between mudflat and rocky intertidal is about 2 whole crabs. There have been up to 56 crabs found in one 1 meter by 1 meter square. In the graph the crabs can be in groups up to 60 when in rocky intertidals. Even in general rocky intertidals have the most recordings because people could find them easily. This means That green crabs like to be in rocky areas much more than other places like mudflats and salt marshes.
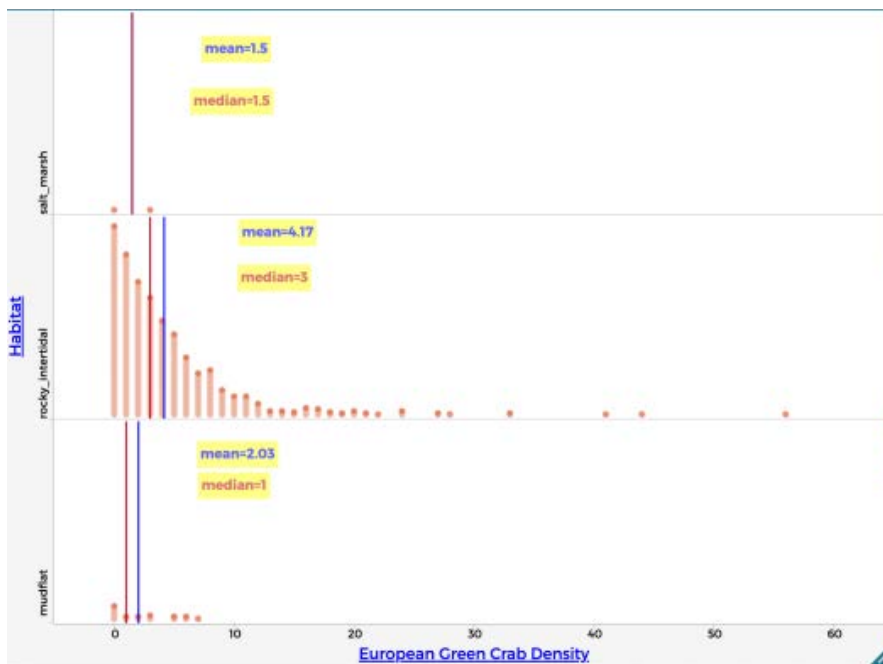
What terrain or habitat has the highest population? Of all the possible questions to ask and be answered I chose this question because when looking for green crabs whether it's for research or to lower the population people can have an easier time finding them. This can help further research because anyone can find crabs and know where the most will be so they can get rid of

or research more. All of the information given was to help people understand that green crabs are taking over new england shores and the information specifically was to find out where the green crabs populate most. This information does not surprise me because crabs enjoy hiding and the rocky area can help them. Another question that could be asked by a researcher is: what is the average size of the crabs in each habitat? This information is to possibly help people catch green crabs to slow down or stop the spread of them.

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Comparison of Abundance of Different Crab Species During High and Low Tide at Odiorne Point State Park

Wyatt M, Lincoln Akerman School, Grade 8

Introduction

Often called the "most extreme habitat on Earth", the rocky intertidal is a "...unique habitat that is used by a variety of endemic plant and animal species, many of them at the edge of their physical and ecological tolerances." (National Park Service, 2023) Thus, it's responsible for fostering species with incredible adaptations not seen anywhere else. Such creatures are crabs. In New Hampshire and Maine, there are many species of crabs, such as the Jonah and rock crabs, which are native to the region. There are also non-native, invasive species, like the Asian shore and green crabs. While searching for organisms at Odiorne Point State Park, I was curious as to which invasive crab is more populous, as well as the native rock and Jonah. According to my research, "Green crab could potentially damage Alaska [and NH's and Maine's] multi-billion dollar fisheries industries, especially for salmon, crab, and mariculture operations. Resource managers in Alaska have been keeping an eye on the invasive crab's northward movement for years." (NOAA) Because of their destructive qualities, green crabs have been heavily researched, while the Asian shore crabs have been overlooked by many. That's what led me to ask a question; Are there more Asian shore crabs than green crabs in the New Hampshire rocky intertidal? Strides have been taken to reduce the number of green crabs present, but the Asian shore crabs remain largely unchecked. "Being opportunistic and omnivorous, [Asian shore crab] feed on a variety of plants and animals including mussels, clams, periwinkles, European green crabs, macroalgae, salt marsh grass, and small invertebrates such as amphipods, gastropods, bivalves, barnacles, and polychaetes (marine worms). Because they are eating so many different things, their impact on ecosystems could be widespread, and is difficult to fully determine." (Meghan Holmes, 2021) To answer my aforementioned question, I (along with the rest of my 8th grade and the 7th grade) went to the rocky intertidal at Odiorne Point State park. We used transects and quadrats to get an estimate as to how many and what types of organisms live in the high, and low tide zones.

Methods

This study was conducted on April 4, 2025 at Odiorne Point State Park, Rye, NH. Both the high and low tide zones where the study was conducted were located at 43.041803, -70.712911. Low tide testing occurred at 10:30AM, and high tide testing at 11:10AM. The study was formatted as such: ten groups with one square meter quadrat each were given a number at random, and positioned next to that number along a transect. Each quadrat was placed on one of the sides of the transect, parallel. First, the photographer of the group would take a photo of the group, the quadrat, and the surrounding environment. Then, the biologists and data

experts would determine percent cover of any seaweeds/rocks/organisms, and then search for and count the organisms underneath. While the count commenced, the photographer would photograph any significant organisms at their discretion. The data expert, while tallying, would identify the different species of organisms in the collecting bucket. When the time was up, the organisms were returned to the quadrat, and we continued to the next site.

Fig. 1: An image of a quadrat at the high tide site.
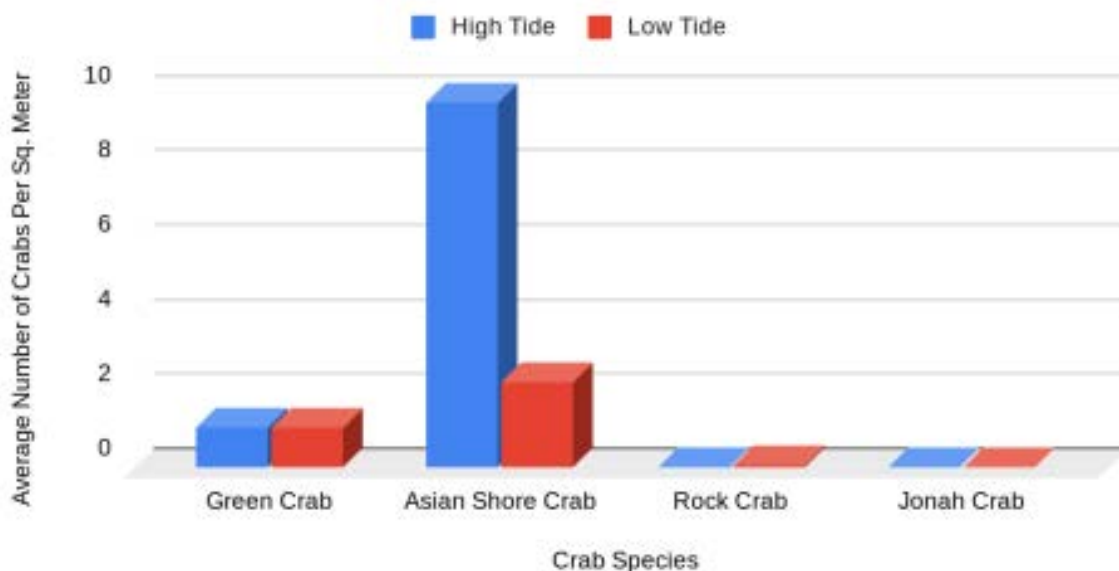
Results

Fig. 2: The graph shows the invasive Asian shore crabs outnumbered the (also invasive) green crabs by 8.7 and 1.2 crabs per quadrat respectively. The native crabs, however (Jonah and rock crabs) were very scarce comparatively (only one rock crab was found in a quadrat). Also, there were many more Asian shore crabs in the high tide site than the low tide site.

Fig. 3 & 4: Images of a female asian shore crab found in a low tide quadrat at Odiorne Point.

Discussion and Conclusion

According to what we saw at Odiorne Point, Asian shore crabs are, in fact, much more abundant than green crabs. Fig. 2 shows the average number of green crabs per quadrat in both high and low tide were 1.1, whereas the number of Asian shore crabs was 9.8 and 2.3 respectively. That means that there was an average of 8.7 and 1.2 more Asian shore crabs per quadrat than green crabs. As earlier mentioned, the likely reason for why these numbers occurred is because Asian shore crab aren't a large danger to commercial fishing, thus aren't as researched. Smithsonian stated, "Although ecological impacts of *H. sanguineus* [Asian shore crabs] on rocky shore communities are quite significant, the economic impacts are unclear, because most of the major fisheries resources in this region are subtidal. This crab preys on young Blue Mussels (*Mytilus edulis*), but since most commercially reared or wild harvested mussels are subtidal, the effect on this resource is likely to be small. Young American Lobsters (*Homarus americanus*), frequently occur in the intertidal zone, especially north of Cape Cod. In laboratory trials, adult *H. sanguineus* preyed on small juvenile American Lobsters (*Homarus americanus*) (Demeo and Riley 2006). However, the effect of this predation on lobster fisheries is unknown." (Smithsonian Institution)

Now, this isn't a complete, perfect sample. Being a middle school class (not scientists), errors are possible. Everyone counted the organisms in their quadrat to the best of their ability, but with the time constraints, and the sheer amount of organisms could have overwhelmed the person tallying. This could be improved for more reliable future results by giving more time to the people who are counting, and having the other group members lend a larger hand in the tallying process.

An interesting note that I wanted to include was the number of native crabs we found. Only one rock crab was found out of all the quadrats, and one Jonah crab was found after, not in a quadrat. The crab population in Odiorne Point State Park only has few native species left, while the vast majority are invasive. This is the reason why it's so important to research and keep an eye on *all* the species of crab (native, non-native, and invasive); the fact that there are barely any native crabs, while there are invasive crabs everywhere you look means something isn't right. According to fig. 2, there are about 8 - 9 times more Asian shore crabs in the high tide zone in Odiorne Point than green crabs, and about 90 times more than native rock crabs. That statistic will grow substantially (since it already has compared to a few years ago) if this growth remains unchecked. That's why it's important to study and pay attention to invasive crab species on the New England rocky intertidal, as well as all other rocky intertidal coasts.

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Study of the Comparison Between the Two Invasive Species, the Green Crab and the Asian Shore Crab Population at Odiorne Point State Park, Rye, New Hampshire

Bennett F, Lincoln Akerman School, Grade 7

Introduction

The rocky intertidal zone is a vast ecosystem with a high biodiversity and a suitable habitat for many organisms, "It's a unique habitat supporting diverse marine life, provides food and resources for coastal species, protects shorelines from erosion, and plays a role in nutrient cycling and biodiversity." (National Park Service, April 18th, 2018) It also acts as a popular spot for many. Hundreds of unique species lie within the rocks of the intertidal and it becomes our duty, as humans, to serve and protect the organisms. "The intertidal zone is an important source of primary production and a conduit for energy, nutrients, and pollutants between terrestrial and marine environments." (National Park Service) Though, some species are invasive to the environment, such as the green crab and Asian shore crab. "Both the green crab (European green crab) and Asian shore crab are invasive species in the US, particularly along the Northeast coast." (Treehugger) This paper addresses the question: How do the invasive European green crab and Asian shore crab compare of the rocky intertidal zone of Odiorne State Park, Rye, NH?

Methods

A study was conducted on April 4th, 2025 to find the comparison between the green crabs and Asian shore crabs population of the rocky Intertidal zone of Odiorne Point State Park, Rye, NH. To find this data, a 30 meter transect had been laid along the shore, each meter, from left to right, marked accordingly. Next, groups would be assigned a random number that would correspond to one of the marked meters on the transect. Groups would then assemble their quadrat (1*m* x 1*m*), find their meter, and place the quadrat on the already given number. Once the quadrat was placed, a search was conducted in the quadrat for different species. This process was repeated two times along the shore in two different locations (*43.041803, -70.712911*, and *43.043920, -70.711907*). Each search would last approximately 15 minutes. Overall, our search led to an identification of many seaweed, crab, and periwinkle species. To support our data, several pictures were taken from the photographers. To find the average percentage of both the Asian shore crab and the green crab, I had collected the total number of each crab species, and divided each sum by the amount of groups there were. All data was collected onto a Google Spreadsheet. Further information that was collected amongst the groups were also included into another Google Spreadsheet.

Fig. 1. This figure shows one of the many quadrats that were placed along the shore, this would then act as a barrier in which to search only in this area. A plastic tray was also provided to the group to collect and take photos of the found organisms.

Results

Comparison of Green and Asian Shore Crabs per square meter of Odiorne Point State Park.
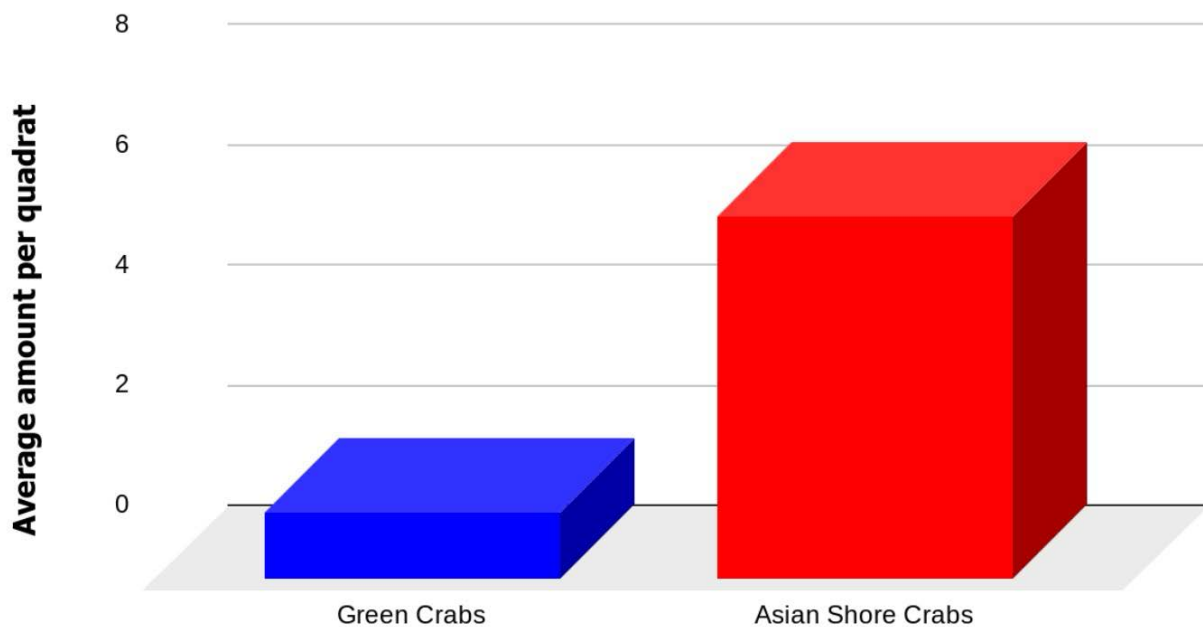
Fig. 2. This graph shows that Asian shore crabs have a higher average percentage (1.10 : 6.05 Difference = 5.05) compared to green crabs of Odiorne Point State Park, Rye, NH.

Discussion and Conclusion

Our results and findings led to the conclusion that the Asian shore crab is a more dominant species compared to the green crab by population in the Intertidal zones of Odiorne Point State Park, Rye, New Hampshire. In figure 2, it displays a graph between the green crab and Asian shore crab species population. It further shows that the Asian shore crab is the more reoccurring species upon the tides (Green crab=1 per quadrat — Asian shore crab=6 per quadrat). I further discovered that our research had related to similar studies, "Asian shore crab is now the dominant crab in rocky intertidal habitat along much of the Northeast coast of the United States, sharing space amidst rocks and boulders with other crab species." (Treehugger)

I believe certainly that this search was a success in which we discovered many unique and abundant species among the tides. However, a miscountage or estimate of a species may affect the data, in which our previously stated conclusion may be of false information. Our day that the experiment was conducted, April 4th, was naturally cold and windy. On a day in summer such as August, the temperature and wind may drastically change, which could change the results. A suggestion to which would result in a more favorable result would probably be to completely count every organism to accurately find a percentage.

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Comparison of Species Biodiversity in the Low Tide Zone vs the High Tide Zone at Odiorne Point State Park in Rye, NH

Mia L, Lincoln Akerman School, Grade 8

Introduction

The rocky shore intertidal ecosystem presents an important connection in the marine food web, and also provides homes for many different organisms. "The intertidal is an extreme ecosystem because it constantly experiences drastic changes…Intertidal zones of rocky shorelines host sea stars, snails, seaweed, algae, and crabs…" (National Geographic) Species biodiversity is an important part of the intertidal zones. "Biodiversity is essential for the processes that support all life on Earth, including humans. Without a wide range of animals, plants, and microorganisms, we cannot have the healthy ecosystems that we rely on to provide us with the air we breathe and the food we eat. And people also value nature itself." (Royal Society) This study will focus on the question; Which tide zone has more species biodiversity? To answer this question, 7th and 8th grade students from Lincoln Akerman School collected data using quadrats at Odiorne State Park in Rye, NH, to identify the species biodiversity in each tide zone.

Methods

This study was conducted on April 4th, 2025 at Odiorne Point State Park Rye, NH. Both high and low tide zones were sampled at 43.043920, -70.711907. The time for the low tide testing was around 9:35 am, and the time for the high tide testing was about 9:10am. We began the testing in 10 different groups using quadrats dispersed throughout a 30 meter transect line. Each group laid their own quadrat along the transect. The spot where we were placing our quadrats was determined by a random number generator on Mrs. Lapointes phone. We then went to our spots and placed our quadrat and began searching for any intertidal organisms. Every time we found an organism, we would identify it then place it into our bucket. We collected photo evidence for most of the organisms, or any organism we thought was cool looking. Then, our data collector would make a tally under which organism. We repeated this once more. In order to calculate the species biodiversity between each tide zone, I counted the number of species per tide zone, and compared them.

Figure 1. This shows the first quadrat we searched at Odiorne Point.

Results

Comparison of Species Biodiversity Between the High Tide Zone & Low Tide Zone at Odiorne Point, New Hampshire.
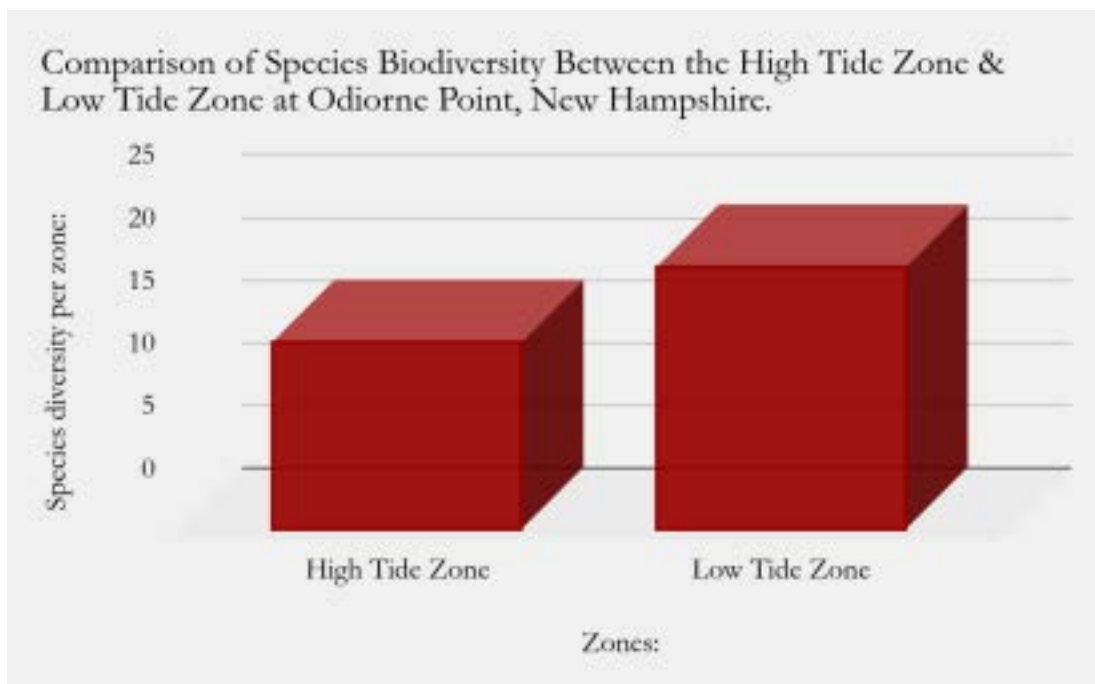
Figure 2. This graph shows that there was more species biodiversity in the low tide zone than the high tide zone at Odiorne Point, in early spring. There were a total of 6 more species found in the low tide zone.

Discussion and Conclusion

The low tide zone at Odiorne Point State Park has more species biodiversity than the high tide zone. Figure 2 shows that there was way more species biodiversity in the low tide zone as opposed to the high tide zone. There were approximately 20 different species found in the low tide zone, and about 15 different species found in the high tide zone. That means that the low tide zone had about 5 more species than the high tide zone - which makes it more species rich. "The low intertidal zone teems with diversity and abundance of animals due to its protection from larger predators because of wave action, tons of food from an endless algae buffet that thrives from ample sunlight, and lack of worry from drying out or desiccation." (CIMI) The reason the low tide zone has more biodiversity is because in the low tide zone, there is less frequent air exposure and desiccation, and the existence of a strong environment in the tide zone. So the low tide zone has a greater species diversity and gives a preferred space for organisms that cannot tolerate long periods of exposure to air.

I think the 7th and 8th grade students did their best to identify and collect data on the species biodiversity, but there most definitely could have been some mistakes while collecting the data - like miscalculating when there were lots of species that were found at once. I can see that there's space for mistakes especially when it gets overstimulating in the quadrat. In the future, my suggestion for groups would be to count each organism very slowly and precisely to get the most accurate data.

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Behavioral Studies of Asian Shore Crabs in the Rocky Intertidal

Riley G, Lincoln Akerman School, Grade 8

Introduction

The rocky intertidal is a vital part of the ecosystem in Maine and New Hampshire. It supports many animals, humans, and the economy, and without it, there would be a bigger impact than you might think. "Rockfish, greenlings, and surfperch often move into these areas during high tide to feed and take refuge from predators. This diversity creates complex food webs that support the broader marine ecosystem." (Pew) This explains how the biodiversity in rocky intertidal shores supports the ecosystem in its entirety, and creates a safe home for the organisms living there. "Humans, historically and currently, harvest animals and plants from the intertidal environment for food, bait, and, more recently, for home aquariums." (Seaworld) The rocky intertidal supports humans for many people's jobs. Here in New Hampshire, people rely on these organisms for fishing, as well as food for us and other animals that support the food webs humans are a part of. As our team of students searched the intertidal, the threat of invasive species crossed my mind. Invasive species affect the rocky intertidal greatly, by posing a threat to native species who have lived there long before these invasive ones. Specifically, we found dozens of Asian shore crabs. When we searched, I found it odd that some groups of people found over 30 crabs in one spot, and many found little to zero. This led me to ask: Do Asian shore crabs prefer to stay in groups? To answer this question, 7th and 8th grade students traveled to the rocky intertidal of Rye, NH. I gathered the data from each quadrat; I tallied the Asian shore crabs and made it into a graph comparing each quadrat, to see if my theory was true.

Methods

Our team of students went to Odiorne Point State Park on April 4th, 2025, at 9:00 AM to 11:00 AM, coordinates 43.o41803, -70.712911, in the high and low tide zones to conduct our research. We started by laying out a transect along the rocky intertidal with a marking for each meter. We were assigned random numbers, and that would tell us the meter to go to. We then built a quadrat (1 meter by 1 meter) and laid it down on either side of the transect. This was repeated for ten groups, each recording their own data and research from their own group's quadrat. Then, we started by writing the percent cover of the different seaweeds on our data sheet. We continued to count the different organisms inside of our quadrat and identify all the different species we found. We took photos of each organism for proof and evidence for our data, as well as photos of our surroundings and quadrat before we went searching.
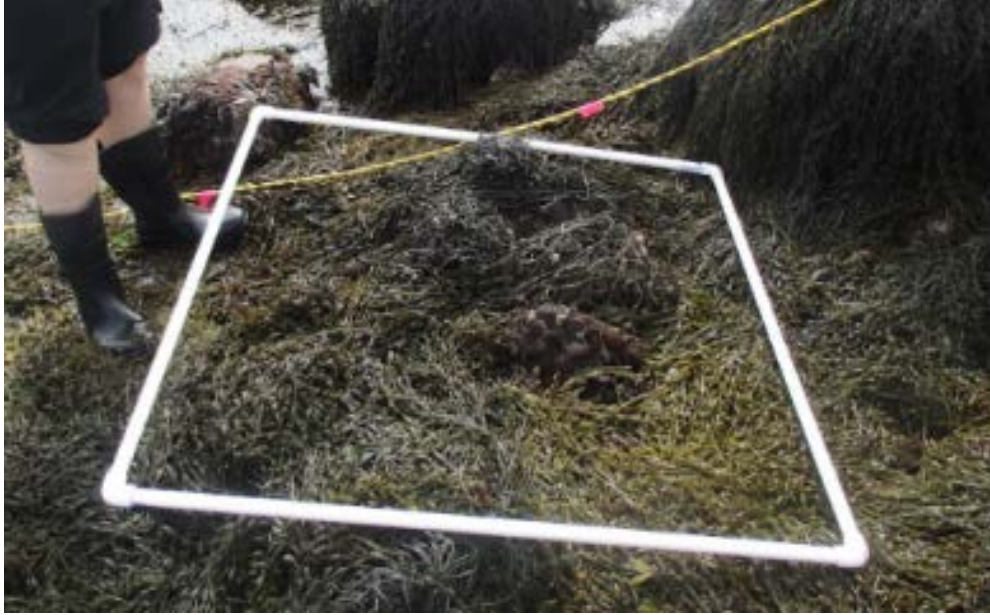
Figure 1: This image shows a quadrat laid on one side of a transect, still untouched by the group, evidence of the quadrat before searching for organisms.
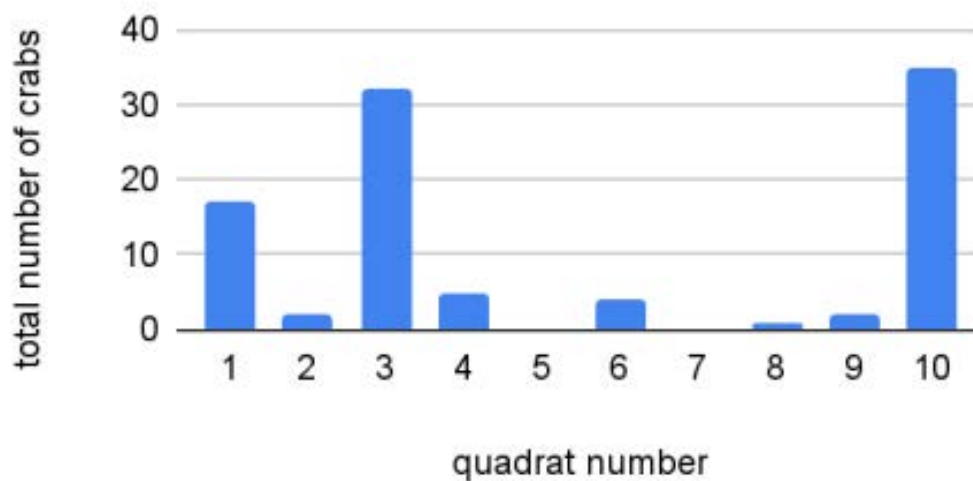
Results

Figure 2: This graph shows how there were large amounts of Asian shore crabs in some quadrats, but none in others. For example, quadrats 1, 3, and 10 had large amounts of Asian shore crabs, while quadrats 2, 4, 5, 6, 7, 8, and 9 all have almost none, proving that they travel in large groups, rather than there being an average amount of them spread among the rocky intertidal.

Discussion and Conclusion

Asian shore crabs prefer to stay in groups. Figure 2 shows that in quadrats 1, 3, and 10, there were around 20-30 crabs, but in the rest of the quadrats, there were little to none. This suggests that Asian shore crabs huddle in groups because we never found an average amount of crabs, only groups of them, or none at all. While there is no specific research that supports my evidence, many other species were studied and proved to have similar behavior, such as the Fiddler crab. "Fiddler crabs travel in groups when it comes to eating and finding prey." (Mitchell Mercer, 2022) (Marshland Crabs) This quote supports my research and evidence because it shows how a crab that lives in similar conditions to the Asian shore crab behaves in similar ways. This also explains why crabs tend to do this, and it is because it helps them survive as they can find food easier and stay together during rough waves for survival. This clumping of Asian shore crabs has also been found in captivity at the Blue Ocean Society in Maine. "They move very quickly and there are often many of them under a rock. The crabs in our touch tank are found in Hampton Harbor and there are often 10-15 of them under one rock! Finding them is very easy." (Blue Ocean Society) Asian shore crabs are seen grouping together both in captivity, and as we have seen it, in the rocky intertidal.

While our groups of students tried to be as accurate as possible, there is only so much precision a human can get. While it is possible that we searched all we can, it is likely that many groups did not search very thoroughly, and there could have been a few crabs we missed. This, although important to exact data, wouldn't matter very much in this study. The point of my data showed loosely how some quadrats had many Asian shore crabs, while some held none. It is unlikely that we missed large sums of crabs in the small quadrat we were given. Another factor that could have affected this data was our time limit on the site, and the weather and season we went, when there could have been less or more crabs. In the future, if someone was specifically interested in finding out for themselves if Asian shore crabs travel in groups, I suggest researching what season Asian shore crabs are most abundant in, and count the Asian shore crabs then, to possibly get a more accurate count because they are thriving and living better.

Scientists can use this behavior of the crabs to easily decrease their population, since they are an invasive crab species. Instead of searching for hours to find them individually, many are hiding in groups. You could research where Asian shore crabs thrive and live, and you will likely find many at once. This helps reduce the amount of invasive crabs for scientists because if you are in an area finding nearly no crabs, this data proves that since they travel in groups, you just need to find big groups of them.

Scientists could also use this data to study other similar animals to see if they also behave the same way, which could lead to questions like do many animals in the rocky intertidal behave this way? Is that why some smaller and fragile animals are able to thrive so well? Scientists can research these questions because of the data and analysis we now have.

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Comparison of the Favorability for Life Between the High and Low Tide Zone Using Abiotic Factors at Odiorne Point State Park

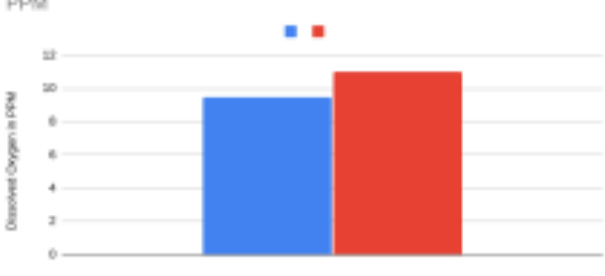*Leon M, Lincoln Akerman School, Grade 8*

Introduction

The rocky intertidal zone is a very important ecosystem. "The intertidal zone is an important source of primary production and a conduit for energy, nutrients, and pollutants between terrestrial and marine environments." (National Geographic). Abiotic factors are a very important factor of any ecosystem, including the rocky intertidal zone. "Abiotic factors are the nonliving parts of the environment that have a major influence on living organisms. They can help determine things like how tall trees grow, where animals and plants are found, and why birds migrate" (Chandler Unified School District) So this leads to my question: What tide zone's abiotic factors at Odiorne Point State Park are the most favorable for life? To answer this question, the seventh and eighth grade students at Lincoln Akerman School went to Odiorne Point State Park. Three students were selected to be chemists to test the water at low and high tide. While the perfect abiotic conditions are important, things can still live in imperfect conditions. What we found was surprising.

Methods

As stated in the introduction, there were three chemists selected from a class of forty-six students, one of them being myself. Two are 8th graders, and one seventh grade student. Two eighth graders tested the abiotic factors in the early morning (8:30 AM to 10:00 AM) and then myself and a seventh grader tested in the late morning (10:30 AM-12:00 AM). The chemists were given a backpack that included: a refractometer, a cup of pH strips and a guide, a dissolved oxygen kit, an electronic thermometer and a bottle of mineral water. The chemists could find whatever spot they would like, but they were not testing right next to each other. We could test them in any order we'd like. We repeated the tests in the high and low tide zone. Data was averaged from all of the chemist's data on a google spreadsheet.

Results:

Comparison of Average Temperature in the Low and High Tide at Odiorne State Park in Celcius	*Fig. 1: This shows that the high tide was significantly warmer than the low tide (8.3°C vs 7.1°C)*
High Tide Averages and Low Tide Dissolved Oxygen Averages in PPM	*Fig. 2: This shows that there was more oxygen in the low tide than in the high tide (9 PPM vs 11 PPM).*
Comparison of Average pH in the Low and High Tide at Odiorne State Park	*Fig. 3: This shows that the pH was very similar in the Low and High tide (6 vs 5.5)*
Comparison of Average Salinity in the Low and High Tide at Odiorne State Park in PPT	*Fig. 4: This shows that the Salinity was way below the healthy ocean number of 34 PPT (29.3PPT and 30 PPT).*

Overall, these graphs show that the abiotic factors are vastly different between the high and low tide. An example is the temperature. The high tide had a temperature of 8℃ and the low tide was 7℃. The only thing that is not shown in the averages was the outliers. The seventh grader and I had a very high dissolved oxygen count of 12+PPT, but the other eighth grader got a much lower number and bumped down the average.

Discussion and Conclusion

The abiotic factors at the low tide zone at Odiorne Point State Park are most favorable for life. 3 of the 4 abiotic factors were better in the low tide. Temperature was lower, the average being 7.1 degrees Celsius and the high tide zone being 8.3 degrees Celsius. The dissolved oxygen was quite a bit better than the high tide, being on average 11 PPM versus 9.5 PPM. The salinity of the low tide zone was also more favorable, being closer to the magic number of 35 PPT, being on average 30 PPT versus 29.3 PPT. The only factor that was more favorable was the pH, where the high tide came on top with a pH of 6, and the low tide had a pH of 5.5. While the pH was not favorable at all, with none of the zones being marginally close to the best number of 8. The temperature could have been higher because the high tide zone only had puddles that were very small and they are not in direct contact with the ocean water most of the day, and this means the sun is beating down on the puddle. Low tide water is directly connected to the ocean, so it heats up slower. Dissolved oxygen is closely tied to temperature, so I'm not surprised with the data there. The pH was very unfavorable, but that is a worldwide issue that affects everybody. The salinity was very close, but for the same reason, when water heats up because of the sun, it evaporates and leaves the salt behind, making the water saltier. The fact that the low tide zone is more favorable for life is not surprising to me, as it is in contact with the ocean water 100% of the day. This means that it is less susceptible to change, as the whole Gulf of Maine would have to change. "The Lower Zone is exposed only during very low tides and abiotic conditions are relatively constant compared to the zones above it." (Seacoast Science Center) The high tide is more susceptible to change as there is water only in small puddles. The factors could swing from day to day.

Some possible sources of error could be that most of the factors were measured by the human eye, with the exception of the temperature. pH was measured using a universal indicator strip and a key. Many of the neutral pHs were a very similar color (i.e 5, 6 and 7). The dissolved oxygen indicator was darker than the key's darkest color, so the dissolved oxygen was over the key's highest number. I am confident that the salinity is correct as we used a clean and calibrated refractometer that was stored and used correctly. For future research, I suggest that the abiotic factors be studied more regularly. I suggest that the factors be tested every day for at least a month, at best all year. The studies could also use more accurate equipment. Future research could also compare Odiorne Point State Park's abiotic factors to other rocky intertidals around the world.

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Why do Green Crabs love to hide?

Oliver B, King Middle School, Grade 7

Observation

I went out to conduct fieldwork at East End beach on October 10th at 1:30 pm. The weather was windy and overcast. I was surrounded by rocks, seaweed, and a pebble beach. I observed it was cold and there weren't a lot of crabs. There were more crabs under rocks and mud than under seaweed. I was surprised to find that there were very many crabs at all, since it was so cold. I thought that they were probably all hiding deep in the mud. When we studied our green crabs in the classroom, I observed that when we studied them, the green crabs in the tanks tended to stay in the corner of the bucket or bin. When we gave them mini shelters in the bins, they went right in, and stayed in. I was surprised by the fact that a lot of them were very lethargic and didn't move around a lot. They also wouldn't eat any of the shrimp we gave them, and instead focused on trying to get out, or hiding in the corners of the bin.

Background information

The focus of this nature note is green crabs, and why they love to hide. I already know that green crabs do not like to be looked upon by bigger beings other than themselves, but maybe hiding like this could also be used as a hunting tactic. According to What Do Green crabs love to eat (see link below), Green Crabs are invasive and opportunistic hunters. They couple this with their great sense of smell to open up numerous hunting opportunities. They also hide under rocks and seaweed to keep cool when the tide shifts and they are stuck on the shore.

Other ideas and questions

This reminds me of crabs I have looked for in dense seaweed, which similarly, would hide under the seaweed and in small spaces. This observation makes me wonder if crabs use their exceptional hiding and sneaking skills for other purposes, like surviving in subzero temperatures. See the link below. If I were to make a test on how many crabs out of 5 like to hide, I would put them all in a bin with little shelters, and see which crabs crawled in.

https://research.library.mun.ca/16579/

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Green crabs and their habitat

Khalid Y, King Middle School, Grade 7

Observation

I conducted fieldwork on September 13th, 2024, at 12 a.m., at East End Beach. It was very windy but nice. Big rocks and the ocean and seaweed surrounded me. I observed the crabs' habitat and what they eat. I noticed most of the crabs were tiny, about 2-6 cm wide when I

found them near shore on East End beach. I was surprised to find 5 crabs in the quadrant. I was excited when I saw a seagull fly over and snatch a big crab from the water. I observed the crabs walk over and climb rocks. Back in the classroom, I also observed them hide in one of the corners of the container. When I grabbed one, its back legs splashed the water in my face, so I dropped it. I noticed how it eats food. They eat food from their gills which is crazy! I was surprised by how they acted in their containers. The asian shore is way more violent than the green crabs.

Background information

The focus of this nature note is about green crabs and their habitat. I know that green crabs live mostly in salt marshes, intertidal zones, beaches, and mudflats. They like living under rocks and seaweed. The further you go into the water, the bigger the crabs. That's all I know so far. My observation is interesting because learning where their habitat is makes it so YOU can find a crab anywhere you go. It's really easy. That's why my observation is important. Green crabs are found in lots of places like beaches and mudflats. Green crabs are mostly found under rocks and seaweed. The further you go, the more crabs you'll find! I learned that green crabs have 9 gills, and I also noticed that they eat nutrients with their gills. Green crabs are awesome in many different ways.

Other ideas and questions

This is unexpected because I didn't know green crabs live in certain places. This reminds me of the crawfish video and how they acted in the tub. In 4th grade we went to the beach and found all sorts of animals. This observation makes me wonder if more animals have the same habitat as green crabs. Based on what I observed and what is already known, green crabs have unique habitats that few animals have. I could investigate this issue further by going to trusted and credible sources to find out more about green crabs and where they live. Maybe an experiment I could do is put green crabs in different habitats and how they would react.

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Green crabs

Adeline T, King Middle School, Age 12

Observation

I went out to conduct fieldwork on September 12th at East
End Beach. I was surrounded by sand, rocks, sea water,
oxygen, and people. I observed the surroundings and looked
to see if there were any creatures. I was surprised to find a
native jonah crab shell helping me add to my observations. I
observed different intertidal zone organisms. I was surprised
by the fact that I searched for around an hour and I didn't find
a single green crab.
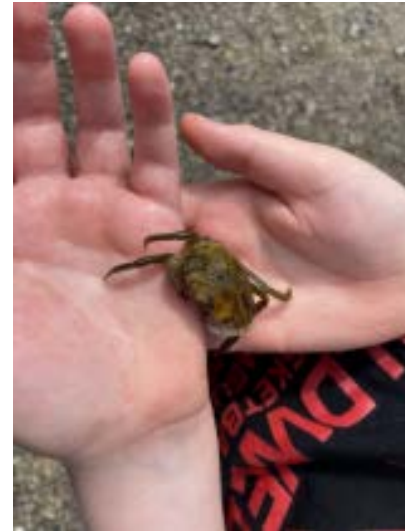
Background information

Green crabs live in areas like salt marshes, mudflats, and
rocky intertidals. In these habitats, they erode the area and
kill off the plants in the area. Green crabs erode the shore lines by burrowing into the soft soil
called peat on the shorelines. I already know that one native crab species that lives in Maine is
the Jonah crab and that green crabs are invasive and erode shorelines. My observation is
interesting because it can help the reader understand why the green crabs are here and why
there is a problem. Green crabs got to Maine by boat from Europe to the East Coast of the
United States. Green crabs build burrows through plants and cause shorelines to collapse,
making people in Maine worry about the erosion as sea level rises.

Other ideas and questions

This reminds me of climate change because most invasive species appear because they have
to move to cooler waters to stay alive but they cause the new places they move to to erode or
they can also cause other species to go extinct. This observation makes me wonder if there are
other types of invasive crab species other than the Asian shore crab and European green crab.

References

Impacts of green crabs on soft-shell clams
Look Out for Invasive Crabs!

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https://downeastinstitute.org/uncategorized/impacts-of-green-crabs-on-soft-shell-clams/.

The European Green Crabs Large Diet

Molly K, King Middle School, Grade 7

I went out to conduct fieldwork on Cow Island in early October, 2024. It was a nice warm day and it was very sunny. We were walking on some tidepools in the intertidal zone and collecting crabs that we were keeping in a small tide pool with no holes. I was surrounded by little tide pools and crabs. My friends were collecting the crabs and my job was to make sure none of the crabs escaped from the small tide pool we were keeping them in. We caught around 15 crabs; they were all either European green crabs, Asian shore crabs, Jonah crabs, or Atlantic rock crabs. Green crabs are very smart, fast animals that originally are from Europe but climbed into big boats and moved to New England's coast. I'm studying what green crabs eat, how often they eat, and how they eat. I already know that green crabs like to eat soft shell mussels, clams, and other crustaceans. I really want to observe crab hunting in real life because I've never seen one killing and eating any other animals. I did observe a green crab eating some small cup up pieces of shrimp in my science class, but it was already dead. Based on what I observed and what is already known about green crabs, I think that we need to put a stop to green crabs. I think that our class should catch more green crabs and do an experiment and put in live animals so we can see how the green crabs hunt.

European Green Crab https://www.invasivespeciescentre.ca/european-green-crab/
Crabby About Invasive Green Crabs https://www.fws.gov/story/2022-10/crabby-about-invasive-green-crabs
The Green Crab Lifecycle https://csimaine.wordpress.com/2018/08/30/the-green-crab-lifecycle/


Intertidal Zone at East End Beach

How is Climate Change Affecting Wild Blueberry Production and Pollination?

Wyatt W, Messalonskee Middle School, Grade 8

How is climate change affecting wild blueberry production and pollination? To answer this question we will look at data recorded over May and June from the year 1989-2020 the data was collected from Blueberry Hill, a wild blueberry research facility. The biggest haul of blueberries was in 2000 weighing 110,600,000 pounds with the average temperature of 55.4°F with 1,426 bees seen. And the lowest haul being 26,800,000 pounds with the average temperature of 58.35°F in 1989 with 3,163 bees seen. The latest recorded information is from 2020 with 77,900,000 pounds with the average temperature of 57.5°F. This data is right to use since it shows if blueberries have decreased or increased in the last 35 years and shows if bees are decreasing or increasing with it.
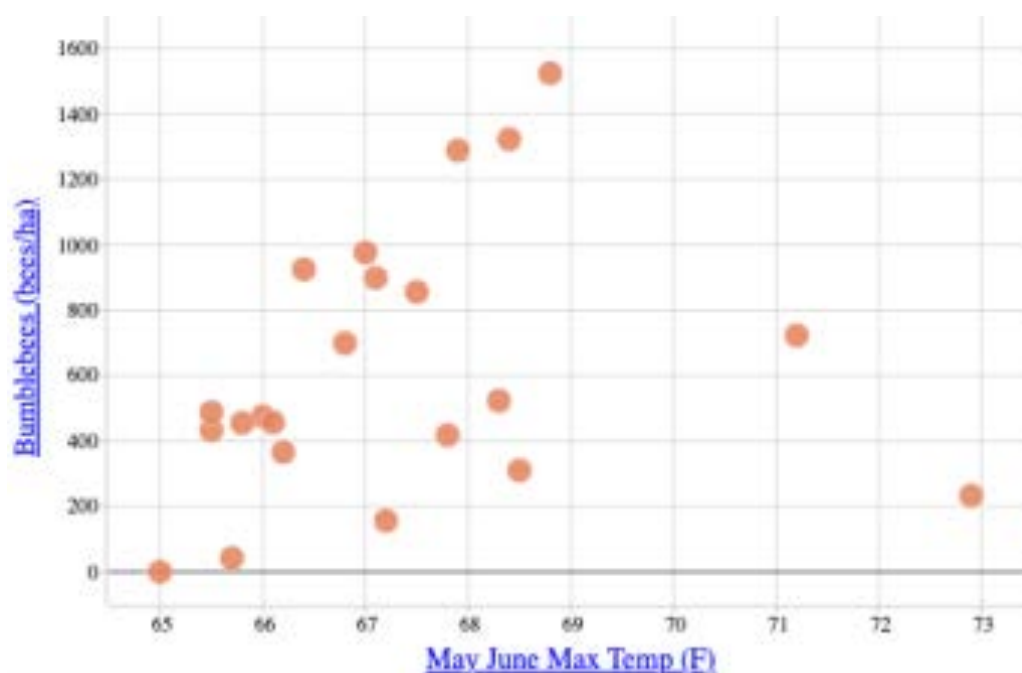
Number of Bumble Bees per hectare versus Temperature in Pollination Season

This graph shows May-June Max Temperature (F) and the number of Bumblebees counted per hectare. The data is showing that around 68 degrees is the greatest number of bumblebees and then after 70 degrees the number starts to drop.

The answer to the question of how climate change is affecting wild blueberry production and pollination, is yes. We know this by looking at the temperatures and blueberry production, which the temperature is increasing with blueberry production decreasing. With facts we already know such as climate change increasing temperatures to the point that bees may stay inside the hive or not go out if it becomes too hot, especially bumblebees. This can result in

bees dying because of starvation or dehydration. This is the main reason for decreasing blueberry production in the U.S., because of constant increasing temperatures making it harder for bees to pollinate different types of vegetation. In conclusion, climate change is affecting the production of blueberries by altering temperatures making it harder for bees to continue to pollinate without it being too hot or cold.

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NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published March 2022, retrieved on March 11, 2022 from https://www.ncdc.noaa.gov/cag/ (NOAA CAG)

Do rain days affect blueberry production?

Caroline C, Messalonskee Middle School, Grade 8

The question

Do rain days affect blueberry production? To answer this question I used data from Blueberry Farm in Winterport, Maine. Bees don't like the rain, they simply can't handle it. A little sprinkle won't bother them but anything more and they will be hiding in the hive or under plant leaves. This made me think, if they can't go out for a string of days or frequently during the months of prime pollination, will that affect the amount of blueberries produced? Let's get into that.

The data
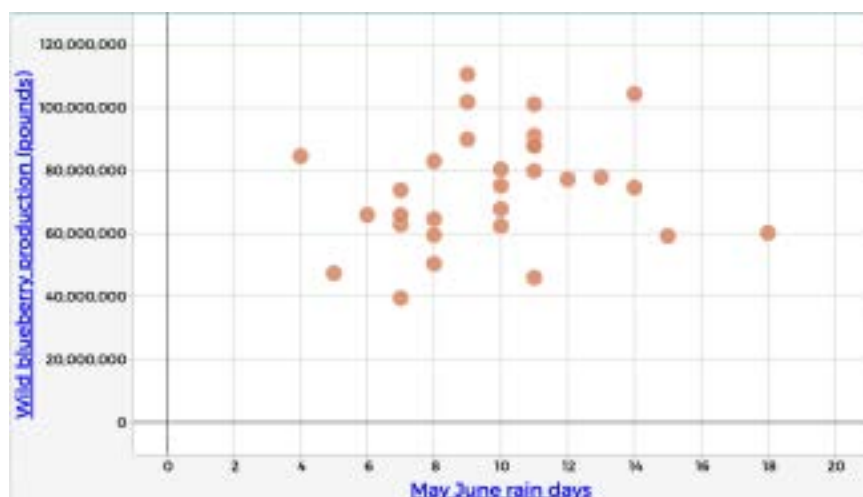
This data shows the amount of Wild Blueberries (in pounds) made in a year and the amount of May - June rain days.

The claim

This data clearly shows that the rain days actually don't really affect the pounds of blueberries. Which is strange as, we have all this evidence showing how bees hate the rain, it hurts their wings, all of that. So why doesn't it affect the product? Turns out on years with many rain days instead of resulting in less blueberries it caused them to be bigger than past years, bigger blueberries and in most cases the blueberries thrived in the rain. The blueberry crop was actually the best when it had many rain days.

Moving away from that question, I have another. What are other types of pollinators and how do they coexist with bees in a peaceful or harmful way? In class we had a presenter come in and show us a deeper explanation into the average bee ecosystem. In her presentation she

explained how there are many other pollinators besides bees, animals and insects like moths, wasps, and even bears are also pollinators. I want to focus on the top pollinator that isn't a bee, an ant. More specifically the relationship they have, how they share the space and help each other. Ants and bees are commonly referred to as "sister groups" meaning they're very closely related to each other. One of their similarities can be traced to both of the species' social

structures, ants and bees both have a queen, workers and similar communication systems. Ants pollinate very closely to the way bumblebees do, attaching pollen to their bodies and carrying that pollen to the next flower. Further dialing into our question we can move on to the specifics of their relationship. Bees and ants share a mutualistic relationship, meaning they both benefit when interacting. Ants sometimes will help out by taking dead bees from a hive to help curb disease spread, while in exchange bees share their food sources. When one pollinates a flower the other normally will eat the nectar from that flower. To wrap up, bees share a very close and important relationship with ants. One that benefits both them and our ecosystems.

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Woods Walk to Ash Trees

Kenny P, Loranger Memorial School, Grade 6

Stop 1. The Bridge. On our way into Jameson Woods we crossed a stream and saw a baby ash growing on the hill near the stream. Some living parts of the ecosystem there were the baby ash, insects, trees, sticks, and leaves. Some nonliving things were rocks, the bridge, and the water from the stream.

Stop 2. On the stream bank to the right of the bridge. There was a mature ash with a yellow string tied around the bottom of the trunk. We can tell it's an ash because of the diamond bark. When we were there in the fall we identified it by the gold leaves and the paired leaflets. It had long paired leaflets with one of them at the end. We knew it was a green ash because the g in green turns into gold in fall. We learned how to identify ash from the ID sheets from GMRI.

Wabanaki people weave baskets from brown ash. We don't have brown ash here in our woods but we've learned a lot about it. We learned the story of Glooscap that shot an arrow into an ash tree and humans came out. I learned it from Mr. Butch Jacobs, Ms. Sapiel, stories that I've read, and a video we watched. Ash trees are important to our environment because they produce us oxygen and take in the carbon dioxide that we breathe out. Ash trees by a stream actually filter the water and hold the soil together so it can't fall into the stream. They provide shade and homes for animals.

Ash trees are in danger because of EAB. EAB (Emerald Ash Borer) is an invasive species that kills ash trees. Signs include bark splitting, crown dieback, peeled bark, and snake shaped galleries. How EAB kills ash trees is that they eat tunnels through the trees. They lay their eggs inside the tree and leave to find another tree. The eggs in that ash tree open and turn into larva. The larvae eat more tunnels in the tree. Once that larva turns into an adult that whole cycle repeats again. There is a species that kills EAB and that's the predator wasp. I went on a field trip in 5th grade to release the predator wasps. The predator wasp is harmless to humans.

Stop 3. On the trail. As we were walking, we saw a bunch of fiddleheads. Fiddleheads are baby cinnamon ferns that are actually edible. You have to eat it cooked. By a log there were beautiful wildflowers. Ash trees have a relationship with these because during the fall and winter, they lose their leaves which gives the sunlight to the fiddleheads and wildflowers to grow.

Stop 4. The roots of a tree. By the roots of a tree, there is a hole that leads to an underground stream. By that hole, there was porcupine poop there. We think the porcupine was trying to get to the water.

Stop 5. The end of the trail. At the end of the trail there were hemlock trees with orange tape and old sponge and straw attached with a clothespin. This means that the hemlock tree had HWA on it previously and predator beetles were released to eat it. HWA (Hemlock Wooly Adelgid), is an invasive species that kills hemlock trees. They are on the underside of the needles and look like little white fuzzy dots. They use their mouths to suck the sap out of the needles, killing the tree.

Walking in Jameson Woods is very peaceful and calm. It made me feel good after seeing that baby ash by the bridge bloom its leaves. It made me more happy when I noticed more baby ashes in the woods. It's also very cool using binoculars looking into the trees. In the future, I think the ash tree population will improve because of the predator wasp and if it does go bad, we have ash seeds in a lab in case that happens.

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I got more information from Mr. Butch Jacobs who is Passamoquoddy. He did a presentation about weaving baskets. We learned more information from Minsoss Sapiel-Bobadilla who is Passamoquoddy and Penobscot and taught us from a weaving workshop. Ms. Minquansis Sapiel has given a lot of information to us who is a Passamoquoddy educator. Stories that I've read and videos that I've watched have given me information.

My Conversation with an Ash Tree

Andy N, Loranger Memorial School, Grade 6

I was walking when I heard a voice call my name. I was confused so I walked in the direction of the voice.

"Hey," said the voice.

"Who and where are you?" I asked the voice.

"I'm an ash tree and I'm literally right behind you," the tree stated. I was really confused because an ash tree was talking to me and was wondering why it was talking to me.

"I need your help, there is a bug called the Emerald Ash Borer or for short, EAB, and they are killing a lot of ash trees and could maybe go extinct, which would be bad since ash trees help the rivers and streams which means the waters would be more unsafe to drink and also affects the fish because the river won't be as healthy for the fish to live in," it said.

"Well how can I help?" I asked.

"First of all, you need to know the signs of EAB. The signs of EAB are crown dieback, D shaped holes, and bark splitting. These signs are important because this shows us where EAB has been and the area that could be infested," the tree said. "Another thing to know is why ash is even important. First of all, ash trees are really important for the Wabanaki people because they have stories about the ash and because they have a tradition where they weave baskets and other things using ash."

"Oh I think I've heard of that before from an article that I read before and also I've seen a bunch of baskets made from ash and heard of multiple stories from Wabanaki people like how Gluscabe shot the arrow through an ash," I said.

"Hey at least you have some prior knowledge on ash trees. However there are more reasons why they're important. Another thing is that ash provides shade for animals, gives us oxygen, and makes our rivers and streams cleaner," it informed me.

"Wow I never knew how important ash was and how much they help us," I said.

"Yes, but now we need to know how to get rid of EAB. First of all, you don't want to spread the EAB so you should try to not spread firewood from place to place because that could spread the EAB to different locations which could be really bad. Another way is expensive but it can kill it directly and it's by releasing parasitic wasps in well populated areas to lay eggs in the larvae to then eat it then it will kill it."

Two Eyed Seeing 4Rs Poster

Reagan P and Lilly G, Loranger Memorial School, Grade 8
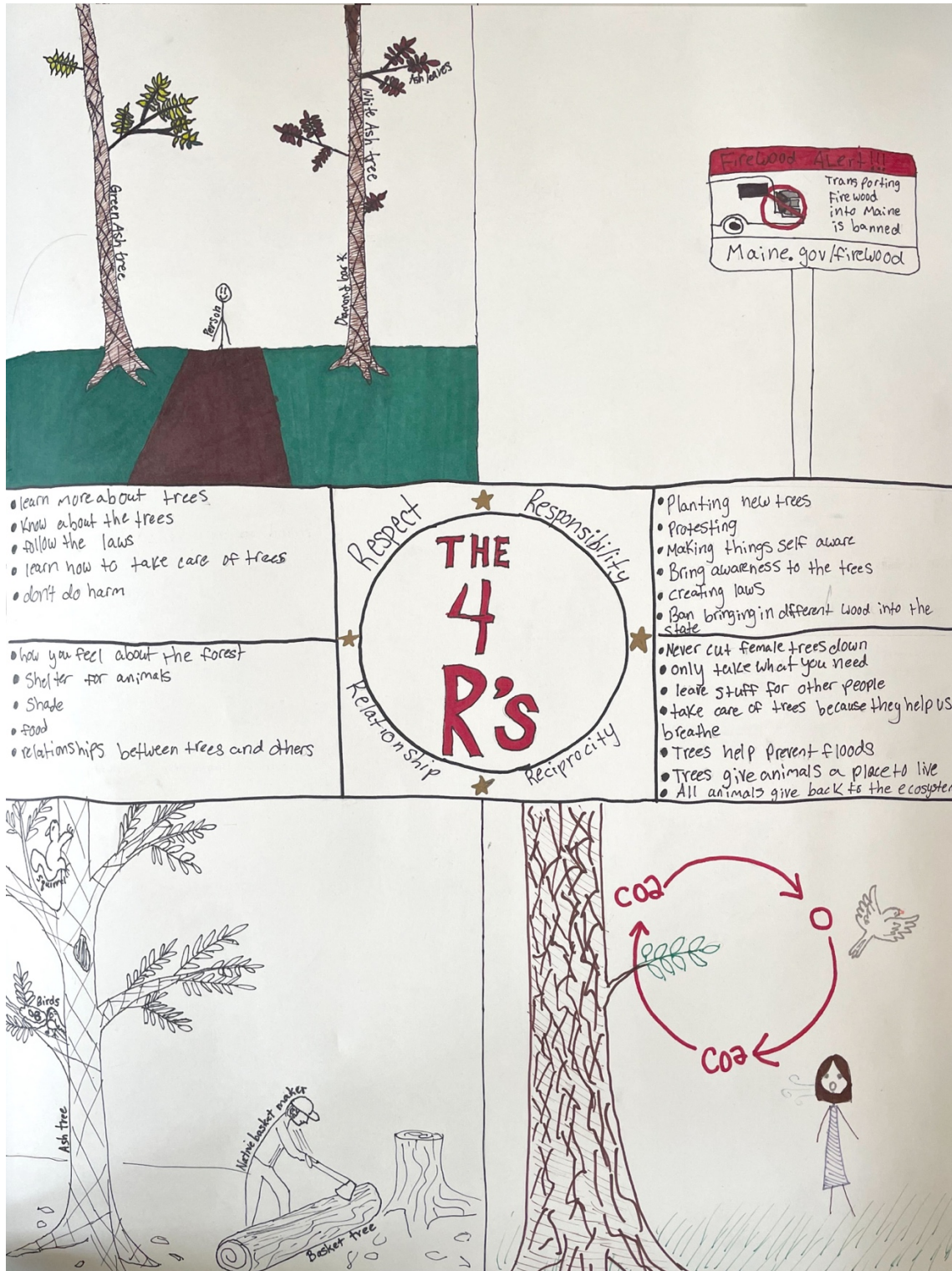
A PSA for Ash

Holden L, Loranger Memorial School, Grade 8

Overview

The world is made up of many ecosystems. I've learned from science class that some parts are biotic some abiotic. Humans need to be able to have positive relationships with both. We can do that in many ways. From the 4 r's to stopping emerald ash borer.

4 r's: Respect

The 4 r's are something anyone can follow. Respect is something that everyone talks about doing but not how to be respectful. It starts with ourselves. We need to have integrity and try to do the right thing. We can't just have respect for ourselves but we also have to respect others and nature. By helping the forest and preserving the woods for future generations.

I've learned from Ms. Sapiel (a Passamaquoddy educator) that we can show respect by learning about the area around us. We can respect ash trees by not cutting them down and keeping the water clean. We can see how the environment respects each other, now it's our turn to respect the environment.

4 r's: Reciprocity

Humans kind has survived because of Reciprocity. But now people are striving away from it. Reciprocity is giving back and helping each other. I've been taught by others that helping peers will help you in the long run. We need to help each other, not just helping ourselves.

Nature shows reciprocity with each other. For example, beans, corn, and squash use reciprocity to grow. When one of the plants grows by themselves or just with their kind, they don't grow as well, but when they three plants grow together their grow faster and stronger.

4 r's: Relationship

Everyone has relationships. What I learned from Miniquansis is that we need to be stewards for the planet and have relationships with biotic and abiotic things. We need to have a relationships with the water and ground by not filling it with toxic chemicals.

4 r's: Responsibility

In western society's everyone is trying to use the resources as just resources. People need to have responsibility and protect some of the forests for future generations. Wabanaki people do that by not cutting down all the ash trees at once and using all of the tree.

Responsibility can be shown in many ways. A possible way is to keep the water clean, you could make sure that all the trees aren't being cut down and the ones cut are used to the fullest. Lastly, protecting ash trees from EAB (emerald ash borer) and other invasive species.

How It All Connects

The 4 r's connect in many ways. To show respect you need to be responsible and take care of the trees. To have reciprocity, relationships are needed. Using the 4 r's with ash trees are possible in many ways: learning about the tree with respect, building relationships with the forest, seeing the reciprocity that is used in nature, seed collecting and protecting the tree using responsibility. If we do all these things, then we can protect ash trees as well as the earth in whole. Wabanaki people taught me to think about the future not just the present.

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