

Findings from the Field

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PRESENTED BY:



Note from the editors

Dear *Findings from the Field* Scientist Community,

As we continue to find our way back to normal from the challenges of the pandemic, the drive to better understand the world around us has not wavered. Students and their teachers continue to muddy their shoes in the intertidal and our impermanent vernal pools to seek out new questions and ideas about our changing ecosystems. The work done by this extraordinary group of young scientists is inspiring. Their curiosity and earnestness demonstrate the skills needed to thrive in today's world, and tomorrow's.

As we wrap up another volume of *Findings from the Field*, we are grateful for the community of scientists that make this journal possible and awed by their commitment to our ecosystems, to science, and the beauty of the natural world.

With gratitude,

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Predator Beetles Will Be Released in Milliken Woods South

By Miriam B., Jacob T., Marcus C., Lily S.

Loranger Memorial School (Mrs. Nye), May 2023

Abstract

Our purpose was to find out how Hemlock Woolly Adelgid (HWA) is affecting Milliken Mills Woods (MMW) in Old Orchard Beach, and where would be the most effective place to release the predator beetles, *Sasajiscymnus Tsugae*. This is important because there is an infestation of HWA in Milliken Mills Woods that could possibly kill the hemlock trees. We used the Gulf of Maine Research Institute's protocol to collect data on the hemlock trees. On March 9th, 2023, we found one infested branch on the north side of MMW. On the south side, we found a heavy infestation. Based on that data, we decided to release the predator beetles on the south side trees.

Introduction

We are investigating Hemlock Woolly Adelgid (HWA) in Milliken Mills Woods to decide whether or not to release predator beetles there. The beetles are expensive, \$3 per beetle from Tree Savers (Tree Savers, n.d.). The Conservation Commission has ordered 1,000 beetles and wants us to release them where they will be most effective. Our investigation will answer the following questions: How is HWA affecting Milliken Mills Woods, and where is the best spot to release the beetles?

We already know that the south side of Milliken Woods has HWA because we found it in two areas in 2018 and 2022. HWA is an invasive adelgid that sucks the nutrients out of hemlock trees causing them to die. It came from Asia overseas. When the adelgid is ready to give birth they cocoon themselves in a white fuzzy ball while they suck out the tree's nutrients. A really cold winter can cause HWA mortality. We learned this from Colleen Teerling, a Maine forest entomologist. While winters have been getting milder, this winter we had a couple really cold days, so we wanted to find out if the adelgids were able to survive.

The predator beetle also known as *Sasajiscymnus Tsugae* is a beetle that only eats HWA which will protect the remaining hemlock trees. Colleen Teerling also taught us about the predator beetles and showed us how to release them. The beetles are very small and they come in a container with a bed of fiber that we clip to the infested trees. We need to find out how the Milliken trees we previously found HWA on are doing. Are they still healthy enough to release beetles on?

This investigation is important because it will allow us to figure out how many adelgids survived through the winter, and where would be the best spot to release the beetles. This is important because the beetles only eat HWA and need a lot of the adelgids to feed on.

The Conservation Commission will be interested in our findings because they want us to release the beetles where they'll be effective. Colleen Teerling will be interested as well. She told us about the beetles and is in charge of HWA management in Maine. Other schools will be interested if they are thinking of starting to release predator beetles.

On March 9, 2023, we went to a new part of Milliken Woods that we hadn't previously been to to find out if HWA had spread to that side of the road. On April 10, 2023, we went back to the south side to check on the trees we collected data on in 2018 and find out whether or not it would be a good place to release the predator beetles. We thought we would find a lot of HWA because it spreads and some of the trees we checked previously had a lot of HWA on them, but we also wondered how much HWA survived the winter.



Methods

On March 9th we went to the north side of Milliken Woods, which we had not checked before. When we got there we first recorded the date, time, team members, and the coordinates of the tree on our data sheet. Second we decided if the hemlock tree is in a forest or in a developed area. Next we collaborated with each other to decide whether or not the tree was actually a hemlock. Then we took four pictures to prove it was: one of the trunk, one of the whole tree, one of the underside of the needles, and one of the needle attachment to the branch. We then flagged the tree with orange flagging tape. After that we checked ten

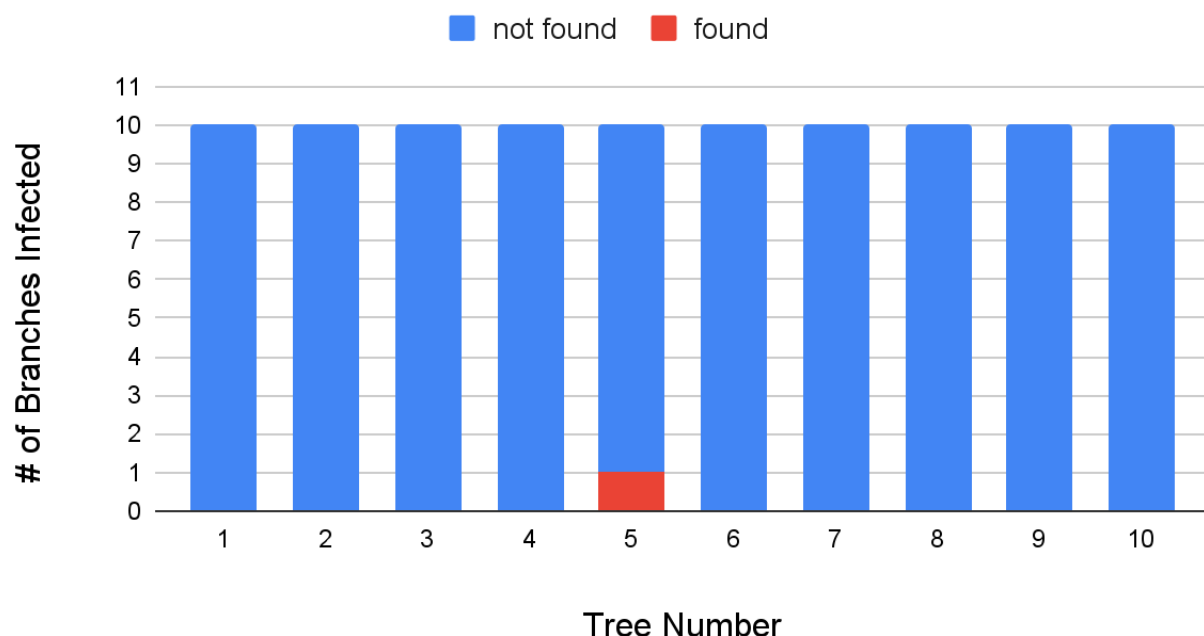
branches. One branch starts at the trunk, and is also at least a meter long. For each branch, we had to mark on our data sheet if we found HWA or not, and if we did we took a photo of it. We collaborated with each other to provide evidence that the data we collected was reliable. We followed the same protocol for all ten trees we checked.

On April 10th we went back to Milliken Mills woods, but we did the south side this time. When we got there we started to do the same procedure as we did on the north side, plus we also added the “smear test”. The smear test is a simple test we do to find out if the HWA is alive or not. What we do is wipe the egg sacs in between our thumb and pointer finger. If the sacs give off a powdery substance then the HWA is dead, but if the sacs give off a slimy brown substance that means that the HWA is alive. We made this change to the protocol because we need to know if there is enough HWA that is alive so we can know if it is a good place to put the predator beetles. HWA is the only thing that the predator beetles eat. Another difference in the protocol is that we made notes whether or not the hemlock tree was healthy, and whether or not the hemlock trees were close to other hemlock trees. To know if a hemlock tree is healthy we looked at the top of the tree and if the needles were green and thick then the tree was healthy enough to house HWA and the predator beetles. While we were in the woods we noticed that the healthy hemlock trees seemed to be near white pine trees, so we began to include that information in our field notes.

Results

This graph shows the data we collected on March 9, 2023.

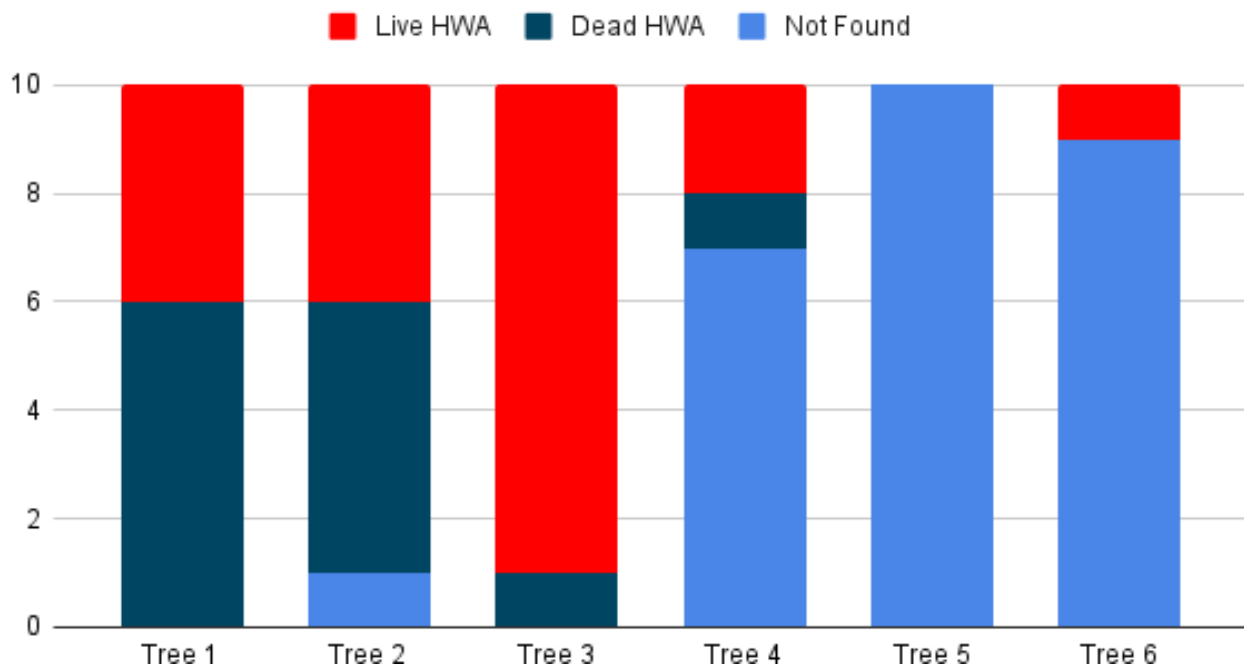
Milliken Mills Woods North HWA Data 3/9/2023



During our trip to Milliken Mills on March, 9 2023 we collected data on 10 trees on the North side. Our data provides a range of one, an outlier of only one tree infested with HWA, and the pattern of nine trees with no HWA. We found no need for a mean, mode, or median due to the fact that there was only 1 tree that wasn't like the others. It's important to note that on the tree with HWA the one branch that had adelgids was heavily infested and close to the ground and the tree was also close to the trail.

The chart below shows the data we collected on our second trip, when we rechecked trees that had been checked in 2018. Trees are numbered in the order we found them along the trail.

Milliken Mills South April 10, 2023



When we went to Milliken Mills on April 10, 2023 we went to check two things. First, were there enough live adelgids for the beetles to feed on? Second, how were the trees we checked on in 2018 doing? We checked on six trees. Overall, 5 out of 6 trees were infested with HWA. The data we found consisted of a range of 10 and a mode of 10. While we had found trees that were on both sides of the range, none were towards the mean of 5.5. All 5 of those trees had HWA on them, but only 3 of them had more than a couple of branches with live HWA. In the data we found of branches with live HWA, the range was 9 and the mode was 4, though we also had an outlier, which was the one tree that was heavily infested with 9 branches with live adelgids.

Conclusion and Discussion

Our investigation helped us answer our questions about how HWA is affecting Milliken Mills Woods and where to release the predator beetles. The data from our first trip shows that the north side of Milliken Mills is not heavily infested, because only one branch out of ten trees has HWA. It would not be a good place to release beetles because there isn't much HWA for them to eat, so we cut the branch off to keep the HWA from spreading to other branches and trees.

The data from our second trip suggests that HWA has increased on trees in the south side that were checked in 2018. According to the data from 2018, seven out of ten trees were infested, which is 70%. In 2023, we checked 6 of the same trees and found five out of six infested, which is 83%. One tree had five infested branches in 2018. That same tree, in 2023, has HWA on all ten branches. However, that tree only has four branches with live HWA. The other branches that were previously infested with live HWA most likely died from the colder days of our most recent winter. Tree three is the priority for beetle release because 9 out of 10 branches that we checked had live adelgid. Tree number one and two also have enough live adelgid for the beetles to eat, because 40% of the branches had live adelgid. All three of those trees were near other hemlock trees, which is important because the beetles will be able to spread to other hemlocks to mate and to continue to eat adelgids on other trees. We couldn't check all ten trees because we ran out of time, but we still got the data we needed for our decision about where to release the beetles.

In late May or early June, when the weather will stay over 62 degrees so the beetles can adjust, we can release the beetles on the three trees we identified. Next year's students can check back on the trees to see the progress of the HWA and do the smear test. Hopefully, the beetles will have eaten some of the HWA.

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Comparison of the Species Richness in High and Low Tide at Odiorne State Park

By Georgia O

Introduction

The rocky intertidal is an important part of our ecosystem because, “as well as providing homes for many animals, rocky shores are a productive food source and an important nursery area for many fish and crustacean species” (Queensland Government, 2018). Studies have shown the low tide zone has a larger abundance of species because it provides more favorable conditions for the organisms that can’t tolerate air as long (National Geographic, 2022). This paper will be answering the question: Which tide zone has a higher species richness? The 8th and 7th grade class of Lincoln Akerman school went to Odiorne Point to identify and tally the different organisms in high and low tide. This question will be answered by looking back on the data that Mrs. Lapointe’s class collected while they went to Odiorne Point State Park on May 11, 2023.

Methods

This study was conducted on May 11, 2023 at Odiorne Point State Park in Rye NH. Both the high and low tide zones were sampled at a location of 43.0440° N, 70.7162° W. The time for the low tide testing was around 10:00 and 10:30 am and the time around the high tide testing was around 8:30 and 11:15 am.

The protocol for this study was 10 one meter quadrats scattered throughout the transect line using a random number generator. The transect line was parallel to the water line. Mrs. Lapointe’s science class studied the high and low tide zone using the same method for both zones. They took photos and took notes on their findings. In order to get the species richness, students recorded every species found/caught. These species were tallied/totalled in order to determine the species richness in the low and high tide zones.

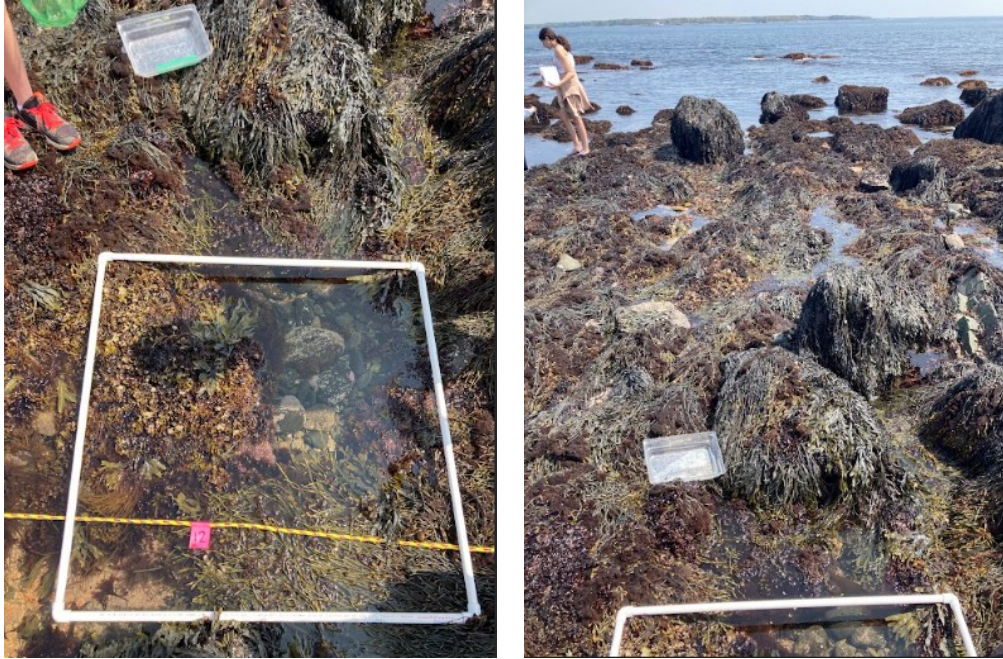


Figure 1 (left). This shows how Mrs. Lapointes class set up the quadrat along the transect line. Figure 2 (right). This shows where Mrs. Lapointe’s class placed the quadrat.

Results

Comparison of the species richness in the high and low tide zone at Odiorne Point State Park on May 11, 2023

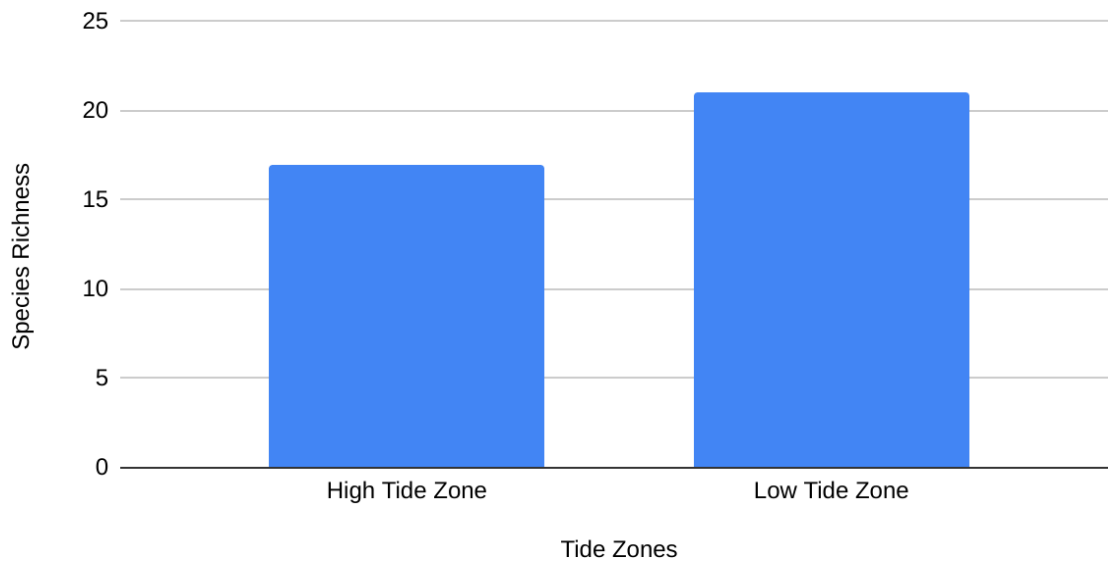


Figure 3. This graph shows that there is a higher species richness in the high tide zone which is 21 species rather than the low tide zone which is 17 species.

Discussion and Conclusion

The low tide zone has a higher species richness than the high tide zone. Figure 3 shows that the low tide, which has 21 species, has more species than the high tide, which has 17 species. It makes sense that the low tide has more species richness because past research suggests that low tide has a higher species richness. This is mostly likely because, “the low tide zone is only exposed [to air] during low tide and has the greatest biodiversity of the three zones because it provides more favorable conditions for those organisms that cannot tolerate air exposure for long” (National Geographic, 2022). Similarly, “at low tide they are exposed to air, sunlight, rainfall, and terrestrial or avian predators and thus have to be adapted to desiccation, heating, freshwater input and predation” (Hodder, 2023). This shows that our conclusions of higher species richness in the low tide zone is consistent with literature.

There are some possible errors towards this experiment, for example there could have been miscommunication between the biologist and the data expert and the groups may have ran out of time. However, the observations of the groups at the intertidal seemed to be focused and seemed to have good time management. Scientists should continue exploring the intertidal areas because next year the biodiversity could be more or different. If we look at the intertidal in two years then it could have more species or maybe there will be more species in the high tide zone. If this study does continue, scientists can come back to this paper to compare their research they find compared to what Mrs. Lapointe’s class found. Scientists need to study this because the intertidal could change and the intertidal is very important to our 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 Park Service, 2023).

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Comparison of Abiotic Factors in High vs. Low Tide Zones of the Rocky Intertidal at Odiorne Point State Park

By Braydon F



Introduction

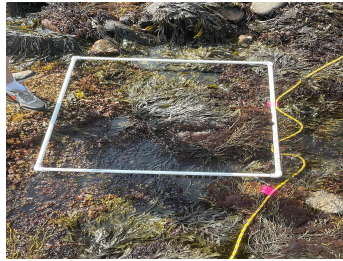
Why are rocky shores important? The rocky intertidal zone is a unique place for animals to live along the rocks, platforms, depressions, cobbles, pebbles and boulders. As well as being a productive food source and an important nursery area for many fish and crustacean species, “Both the physical structure provided by rock itself and the biogenic structure created by seaweeds, mussels, and other attached species offer important habitat for many organisms” (Tyrrell, M.C. 2005). For these organisms to be able to live in these unique habitats, they need specific abiotic factors to survive, which is different for each tide zone. The question this paper will attempt to answer is: “Which tide zone has more compatible abiotic factors for the marine organisms living in the rocky intertidal zone?” Abiotic factors are really important for organisms living in the rocky shore intertidal because of the “...tidally-driven fluctuations which makes it a physiologically challenging habitat for resident organisms to live in. The ideal factors we look for are salinity, pH, dissolved oxygen and temperature” (Horn et al, 2021). In order to answer this question, chemists from the 8th grade science class of Lincoln Akerman School collected data on abiotic factors, including pH, temperature, dissolved oxygen, and salinity, in the low and high tide during our field trip to New Hampshire’s rocky intertidal shore at Odiorne Point State Park in Rye, NH, on May 11, 2023.

Methods

This study was conducted on May 11, 2023 at Odiorne Point State Park in Rye, NH. Both the high and low tide zones were sampled at a location of 43.0438435, -70.7117407. Once at the location, Mrs Lapointe then laid out a transect across the rocky intertidal. Mrs. Lapointe then used a random number generator to randomly assign a group a spot on the transect. The eight groups then gathered their equipment and started walking to their assigned locations.

This paper's question was answered by gathering abiotic data in the high and low tide zone by class chemists. Abiotic data collected was pH, DO, Salinity and Temperature. The pH was collected using litmus paper. The dissolved oxygen was collected using the DO test kit. The salinity was collected using a refractometer. The temperature was collected by a thermometer in celsius.

Figure 1: This shows the instruments to
Left: Quadrat. Right: Includes
salinity 'ppt', Dissolved Oxygen Test
oxygen 'ppm'), Thermometer (measures
Litmus Paper (measures acidity levels).



measure abiotic factors.
Refractometer (measures
Kit (measures dissolved
degrees °C), pH Scale +

Results

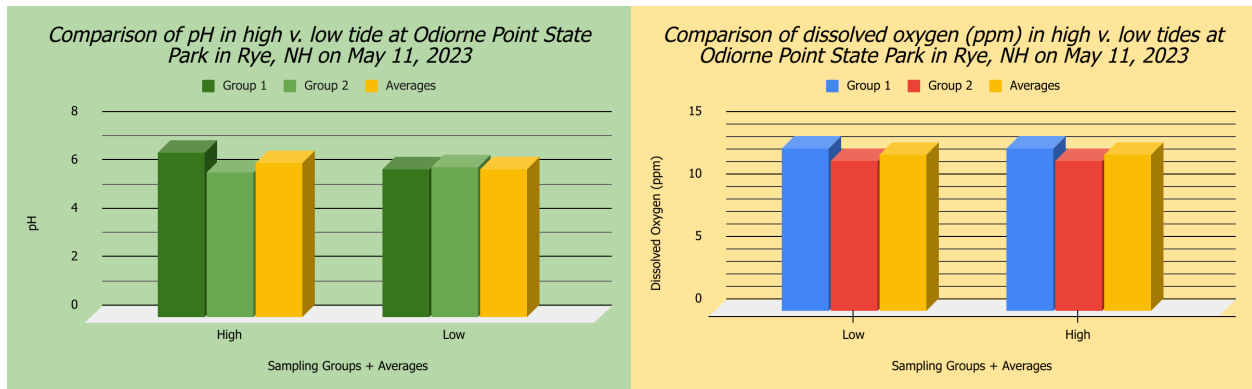


Figure 2 (left): This comparison shows that the pH between the two tide zones has an average difference of 0.3.

Figure 3 (right): This comparison shows that the DO (ppt) has an average difference of zero ppt between the two tide zones.

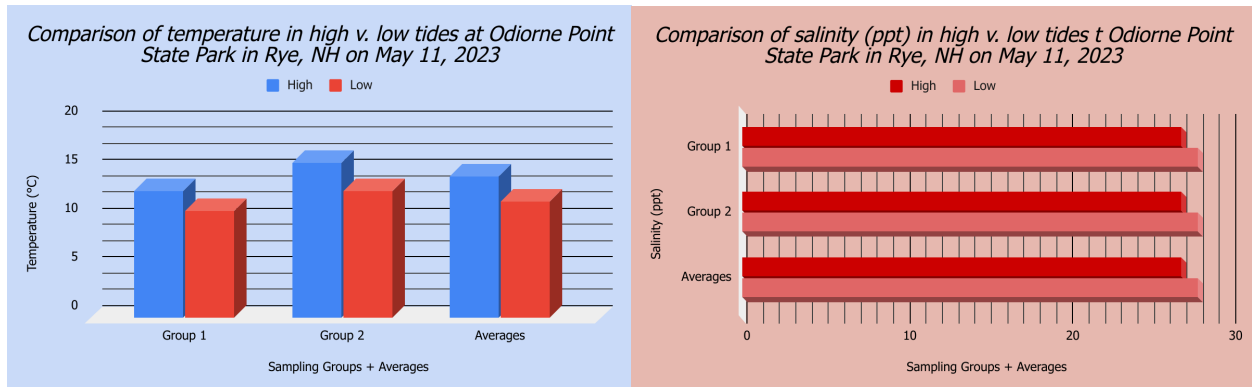


Figure 4 (left): This comparison shows that the temperature (°C) between the two tide zones has a difference of 2.5 °C.

Figure 5 (right): This comparison shows that the salinity (ppt) between the two tide zones has an average difference of 1.

Discussion + Conclusion

Both tide zones have very similar abiotic factors however the low tide has more suitable abiotic factors for the species that are living in the rocky intertidal. Figure 3 shows that it was colder by 2.5 Celsius in the low tide zone which is more optimal for species to live in. Figure 4 shows that the low tide zone has higher salinity (1 ppt) which is closer to open ocean salinity, therefore it is the most preferential for marine organisms. As for the other two graphs, the DO is the same between the two tide zones (12.5 mg/L average) and the high tide has the best pH (High Average: 6.4 Low Average: 6.1). As it was stated, the data between the two tide zones is almost equal however the low tide zone has slightly better abiotic factors. The low tide is likely better because the rocky intertidal is an extreme ecosystem that, "...Constantly experiences drastic changes..." (National Geographic, 2022). The low tide is almost always completely submerged the entire day which means it has the least amount of changes to the ecosystem; therefore, "...Life is more abundant there because of the protection provided by the water." (National Park Service, 2016). The high tide constantly experiences these extreme changes because it is flooded during the peaks of the once or twice daily high tides, and out of the water for long stretches of time in between.

With this study, one of the challenges is having data that can be extrapolated to the entire tide zone of the constantly changing tides which can make it difficult for chemists to study the abiotic factor of the tide zones; however, this is not likely because the chemists took data in a 1 meter by 1 meter quadrat in a single spot in each tide zone. Scientists need to understand the influence of abiotic factors in the rocky intertidal because it allows them to predict the changes in biodiversity of marine organisms. They could most certainly examine the rocky intertidal for the abiotic factors because it is the abiotic factors that make up the environment for the living organisms and allow them to thrive. Without the correct amount of abiotic factors, the abundance and diversity of marine organisms living in the rocky intertidal could diminish rapidly.

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Comparison of Seaweed Biodiversity At Odiorne Point State Park in the High and Low Tides

By Megan K

Introduction

The rocky shore intertidal ecosystem provides homes for many organisms. Rocky shores “are a productive food source and an important nursery area for fish and many other species” (Queensland, 2018). This habitat “also provides lots of food for fish and birds” (Queensland, 2018). Seaweeds are an important part of the intertidal. “Seaweeds, found mostly in the intertidal region, in shallow and deep waters of the sea and also in estuaries and backwaters, absorb the excess nutrients and balance out the ecosystem” (Sundararaju 2021). This study will focus on the question; Which tide zone at Odiorne Point State Park has the most seaweed biodiversity? To answer this question, the 7th and 8th grade students at Lincoln Akerman School gathered data using quadrats at Odiorne Point State Park in Rye, NH to identify the different species of seaweed. This study builds on ongoing research about invasive species. Invasive species threaten other seaweeds and could decrease seaweed biodiversity. “In the 1970s, Kelp and Irish moss accounted for nearly 80 percent of the seaweed cover on the seafloor off southern Maine, an area now dominated by low, scrubby, invasive seaweeds that account for more than 80 percent of the coverage, researchers at the University of New Hampshire have found” (Woodard, 2019).

Methods

The study was conducted on May 11, 2023 at Odiorne Point State Park Rye, NH. Both the high and low tide zones were sampled at 43.0440°N, 70.7162°W. The time for the low tide testing was around 9:00am and 10:45am and the time of the high tide testing was around 9:30am and 11:15am.

The protocol for the study was 10 groups using quadrats scattered throughout a transect line. The groups laid a quadrat, parallel to the water line, along a transect. Mrs. Lapointe used a random number generator for us to find a random location along the transect to place the quadrats. We searched our quadrats for any intertidal organisms. We identified each seaweed species and percent cover of seaweed in the quadrat. We IDed every organism found and recorded our findings on our datasheet. We collected photo evidence to support our findings. These species were tallied/totalled. No changes were made to the protocol in the field. In order to calculate the seaweed biodiversity we totalled the number species of seaweed in both tide zones.



Figure 1. This shows the quadrat and transect method used to gather data.

Results

Comparison of Seaweed Biodiversity In the High and Low Tide Zones At Odiorne Point State Park Rye, NH on May 11 2023

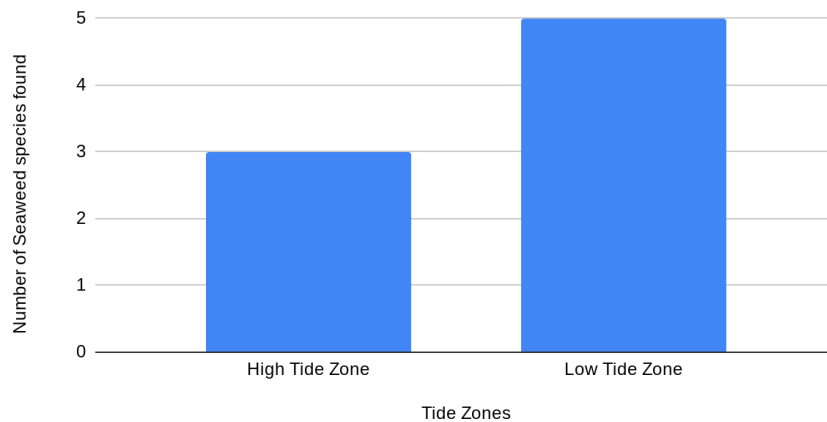


Figure 2. The graph above shows that there are 2 more species of seaweed in the Low Tide Zone than the High Tide Zone.

Discussion and Conclusion

The low tide zone at Odiorne Point State Park has more seaweed biodiversity. Figure 2 shows that there were 3 species found in the high tide zone and 5 species found in the low tide zone. That means that the low tide zone had 2 more species making it more diverse than the high tide zone. The low tide zone is only exposed to air during low tide and “has the greatest biodiversity of the three zones because it provides more favorable conditions for those

organisms that cannot tolerate air exposure for long.”(National Geographic Society). When seaweed is exposed to air for too long it dries up, so they are less likely to thrive in the High tide zone due to the lack of water.

The 7th and 8th graders tried their best to identify the different species of seaweed, however, it is possible that they did not identify every species and didn't look thoroughly enough. This could be improved for future attempts by giving the students more time to identify the seaweeds and to look more thoroughly within the quadrat. From my experience, I looked very thoroughly to make sure that we identified every seaweed in the quadrat. I observed that others did the same. It's important to monitor seaweed in the intertidal because we need to know if invasive species are invading that ecosystem. For example, Dead Man's Fingers, also known as *Codium fragile*, is an invasive species that is “likely to displace native seagrasses and seaweeds”(Danoff-Burg) and, “*Codium* has annihilated the kelp beds of the North Atlantic.” (Danoff-Burg) If this species shows up in the intertidal then it can be a threat to the native seaweeds, and therefore important to monitor the seaweeds of the intertidal.

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Study of Connection Between Crab Species and Seaweed Species in New Hampshire Intertidal

By Lydia L

Introduction

The rocky intertidal shore is an important ecosystem because “rocky habitats provide food for many predatory animals. For example, gulls, diving ducks, and other birds feed on the abundant mollusks, fish, and crabs” (Tyrell, 2005). The crevices in the rocks help to protect algae and small animals such as crabs, snails, amphipods, and isopods from predators. “Boulder reefs and cobble bottom provide nursery habitat for valuable species such as lobster, cod, and many other animals that hide from predators among the cobbles” (Tyrell, 2005). However, the ecosystem is being threatened by the increase of invasive species, mainly invasive crabs. This paper is addressing the question of, “Do green crabs and Asian shore crabs prefer tide zones with more knotted wrack or bladder wrack at Odiorne Point State Park?” This question is important, because we will be able to tell if the invasive green crabs prefer knotted wrack or bladder wrack, and possibly information that could help reduce the amount of invasive crabs in the rocky intertidal shore. In order to answer this question, the 7th and 8th grade students from Lincoln Akerman School went to Odiorne Point State Park on May 11, 2023. Data was gathered and graphed from different sections of the tide zones.

Methods

The 7th and 8th graders of Lincoln Akerman School visited Odiorne Point State Park in Rye, New Hampshire on May 11, 2023. The coordinates were 43°02'40"N 70°42'44"W, the temperature was 78°F, and the wind was 12 mph.

We used a protocol to find information about the intertidal zone. First, Mrs. Lapointe laid down a transect very close to the water, some parts in the water. Then, Mrs. Lapointe gave each group a random number, and each group found their number on the transect. Some groups had mainly dry areas, and some groups were submerged in the water. We all laid down our quadrats on either side of the transect, and before students started searching, they had to calculate the percent cover of the seaweed/anything on top of the rocks. Once the groups were done calculating the percent cover, each group started to thoroughly search their quadrats. When someone found an organism, it was put into a small bucket to be searched and recorded by the data expert. Each group had two sections of the transect to search, and the process repeated for each section. We looked both in the high and low tide. One group went from 8:30 am -10:00 am, and the other group went from 10:00 am -12:30 pm.



Figure 1 (left). This photo shows a quadrat slightly submerged in water, before any of the seaweed was taken out. Some groups had more seaweed than others, and some groups had very little, or even none.

Figure 2 (right). This photo shows a starfish that one of the members of a group found. There weren't a lot of starfish found, but there were quite a few found throughout our visit.

Results

Comparison of Asian Shore Crabs and Green Crabs in high and low tide zones at Odiorne Point State Park on May 11, 2023

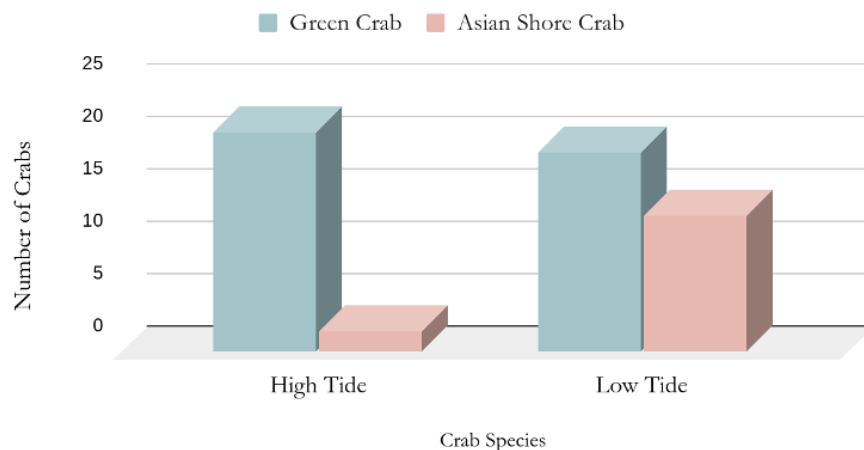


Figure 3. This graph shows that there is a higher abundance of Green Crabs in both tides zones. Green Crabs range in between 15-25 in high and low tide, and Asian Shore Crabs range in between 0-15 in high and low tide.

Comparison of Average Percent Cover of Knotted Wrack and Bladder Wrack in the high and low tide zones at Odiorne Point State Park on May 11, 2023

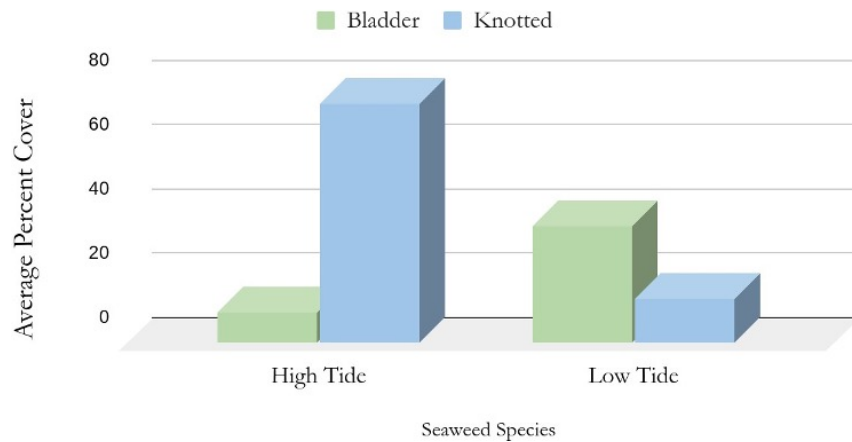


Figure 4. This graph shows that there is a higher abundance of Knotted Wrack in high tide, ranging in between 65%-75%, but a lower abundance of Knotted Wrack in low tide. However, there was more Bladder Wrack found in low tide, ranging in between 30%-40%.

Discussion and Conclusion

Our data shows that there is a correlation between the species of crabs and the seaweed species in the high and low tide zones at Odiorne Point State Park. Figure 3 shows that there was an average of 20-25 green crabs in the high tide zone, and in Figure 4, there was an average of 65-75% of knotted wrack is also found in the high tide zone. However, there is still an average of 15-20 green crabs in low tide, and 30-40% bladder wrack. From our data, we don't know if this is because the green crabs prefer a certain type of seaweed or vice versa, but we can make educated guesses based off of the graphs. Knotted wrack and bladder wrack provide great habitat for many species, because it is moist, provides shelter for crabs, and protects the crabs from predators. Crabs need habitats with moisture, and temperature control, so the seaweeds help provide that for the crabs. In fact, "seaweeds sustain animals in other habitats, as fragments break off, drift away, and enter the food web" (Tyrell, 2005). However, it is possible that there are other factors, such as proximity to food, less competition, etc. Therefore, it is likely that knotted wrack and bladder wrack are preferable habitats.

When collecting the data and making the graph, I had to keep in mind that the data may not be 100% accurate. For example, the groups may have had trouble while counting the species and miscalculated, some groups left sections of their paper blank, etc. If there was more time provided, students could have taken a deeper dive, and made sure the data was accurate. If scientists continue this study, they should provide as much time as needed to make sure everything is accurate. If that succeeds, scientists will have accurate data to be used throughout many years.

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Japanese Knotweed: Findings from the Field

By: Hannah A.

Introduction

Do you know what invasive species do to an ecosystem of native species? Can an invasive species have a large impact on other species? Well, there are many types of invasive species, such as the *Japanese Knotweed*, originating from East Asia. According to the “Invasive Plants: A Field Guide to Individual Species”, this knotweed was first introduced in Japan, and was popular in The United States of America and The United Kingdom as an erosion pre-control method in the late 1880s. The hope was that the Japanese knotweed would stop erosion from advancing along riverbeds. But in 1900, the knotweed was spreading around the US and the UK, to Philadelphia, Pennsylvania, Schenectady, New York, and New Jersey. The Knotweed by the riverbed method was no longer working; and in fact, it was making the problem worse. At MMS, we noticed that we had knotweed growing around the school. Our research question was, what species of knotweed is growing at our school, and is it spreading? So, this project can help us learn more about Japanese knotweed, an invasive species, and how it affects our ecosystems. First, I am going to finish researching the knotweed at my school to help find trends and patterns in what we are seeing.

There are other concerns with the Japanese Knotweed other than its spreading. There is actually a large problem with finding both Japanese *and* Giant Knotweed around our many ecosystems, making up our world as we know it; knotweed is spreading quickly, and it is killing our *native* plants, in turn decreasing biodiversity. Biodiversity is the variety of different types of life that make up our world systems. But sometimes, our ecosystems have certain species that come and take over the space of what we call native species. Native species are a specific organism type that has inhabited, been born into, or lived in a certain habitat that they originate from. These other species that come into the ecosystems are called invasive species. According to our “Invasive Plants: A Field Guide to Individual Species” novel, some of the impacts of invasive species are taking the resources of native species, like space, water, food/nutrients, and sunlight, which cause the native plants to die. Another impact of invasive plant species is that when the invasive species comes, it grows out of control and takes over the natives. One way, or another, both can result in native species going extinct and unstabilizing the balance of species in an ecosystem. Each of the many species in an ecosystem depends on each other to live. The invasive species will spread quickly and become a threat to more of the environment.

We are looking at the Japanese Knotweed because it is an invasive species, and it has a large impact on our own biodiversity and native species around our community. With our research, we can use our information to help stop the knotweed, and make the spreading decrease. This is why the students of MMS decided to help collect data for a scientific purpose, to help

educate our community and hopefully eradicate Japanese Knotweed. It is important to my community to help take a stance on the perspective of invasive species, to help reduce their impact on our environment.

Methods

The property we were looking at included several spots in different locations around our school in Oakland, Maine. We collected data from the corner of the football field, the side of a gravel bus road, and the right and left sides of the trail in our school forest. These sites were chosen at random, but we made sure to note that there *was* knotweed in those places.

Speaking of which, the bus road site is a large patch of land on either side where the knotweed patches are growing. The thick grasses hid the Knotweed on a slanted hill that ends at a stream flowing down to a pond. Here, we had many steps to uncover our knotweed.

Firstly, we set up our sites. We assembled the quadrats and shimmied them down to the roots of the knotweed. Our quadrats measured 1 meter by 1 meter long. We then gathered materials being used, such as our datasheets, and rulers/meter sticks to measure different parts of the plant. Secondly, we counted the number of Japanese Knotweed stems in each of our patches, as one of each of the group members wrote down stem thickness, leaf size, and other leaf attributes. Thirdly, we collected any additional information that needed to be logged on our sheets.

At MMS, we were trying to identify the species of knotweed that was growing in our assigned quadrat around our school property. We looked specifically at the height of the plants, and the leaf size and shape. We also were sure to look at the stems, how long they are, and if they were hollow or not. Japanese Knotweed plants tend to have *spade-shaped* leaves, whereas Giant Knotweed has heart-shaped leaves.

To study the knotweed, we used a 1 meter by 1-meter square, which is called a quadrat. The quadrat was set up through the middle of the patch or along the edge for the full length of the patch. We put the squares over the top of the knotweed, counted the number of stems (stem density), wrote the results on paper, and logged them on the Gulf of Maine Research Institute website. While exploring the knotweed, we didn't just have one patch of knotweed we looked at. We had several places we got data from, which were the forest patches, the bus road, and our football field. These locations were chosen because we had noticed them while exploring our school grounds. The bus road and football field patches are smaller than both the forest patches. Below, Figure 1 is the bus road patch, where my classmates and I assessed the knotweed. Figure 2 is the football field patch and Figures 3 and 4 are of trail right and trail left. These are the two forest patches where we found the most Japanese knotweed; these patches were bigger than the other two were.

We found our information and gathered data, but we had to be sure to collect accurate information. In order to do so, we regularly checked in with other small groups that were also

gathering information from the bus road sites. We made sure we were getting primarily the same data that made sense when put together. For example, when we counted our stems, each person in a small group would count the knotweed stems, just to be sure we all agreed on the research. Another example would be how we measured the entire length of our site, especially because of areas that may be thicker than others. Another important issue in our research was the factors we needed to avoid and be aware of. Some issues experienced were tough terrain, which was the sloped site, burdocks, and very tall knotweed! Burdocks were an issue because they got all over people's clothes when we were trying to sample. Students would avoid the burdocks, and if not, had to then later pick them off. The knotweed being tall also factors into our equation because it made some areas further and down lower on the hill harder to see. We also had to check more than once to be sure the knotweed was a certain height.



Figure 1 (left). Bus road knotweed patch. Figure 2 (right). Football field knotweed patch.



Figure 3 (left). The left side of the trail. Figure 4 (right). The right side of the trail.



japanese

Results

Based on our observations, we found only Japanese Knotweed (see Figures 5, 6, and 7) – We even uncovered a possible *hybrid* species, between Japanese *and* Giant knotweed. We discovered this at the trail right field site. Though we found a possible hybrid, we did not find any trace of giant knotweed. Figure 5. is a picture of our knotweed stems, which can be thick, and are hollow all the way through. We found approximately 12 stems in our quadrant at the bus road. Figure 6 is a picture of the seeds and flowers on the knotweed plant. If you look closely, the white flowers are stiffer, and that is one of the many characteristics we found to decide our knotweed type was Japanese (giant knotweed flowers are droopier.) We also did not see any ants on the knotweed/leaves.



Figure 5: Knotweed stems. Figure 6: Knotweed flowers. Figure 7: Size of leaf.

Other characteristics we used to decide what species we found was the leaf. Figure 7. shows the size of a leaf. When we measured this particular leaf, it was approximately 5 ½ inches long. The middle photo is of the same leaf, but the leaf itself. There were no hairs on the underside of the leaf, and that is another factor of why the leaves can tell us it is NOT Giant knotweed! This last picture on the far right is the actual underside of the leaf. This is where

the tiny little hairs *would* be if it were Giant knotweed. Also, you may notice the leaves are spade-shaped, which tells us this is Japanese knotweed. Giant knotweed has heart-shaped leaves instead.

Figure 8. Specis found; all Japanese knotweed.

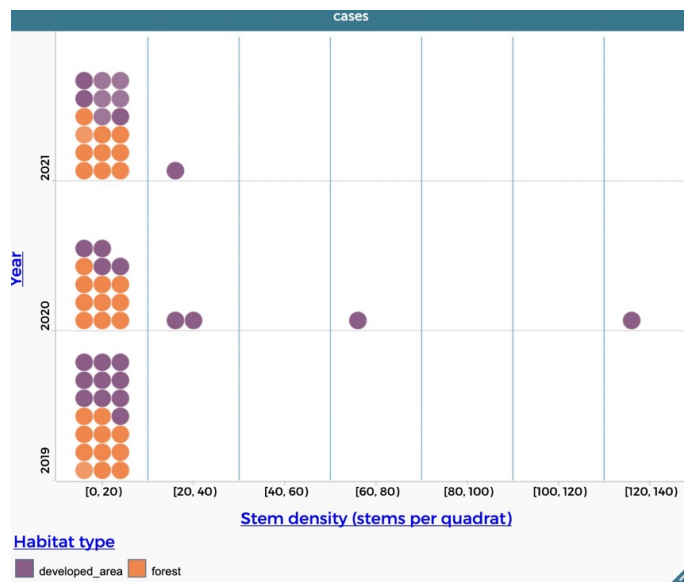


Figure 9. Stem density by year.

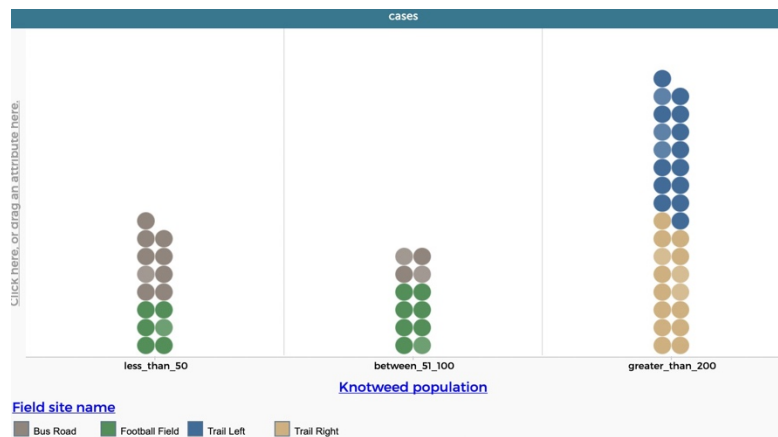


Figure 10. Knotweed population.

Along with the knotweed height, population size (Figure 10), and leaf patterns, we calculated the number of stems in each field site we took samples at (Figure 9). When we were counting the number of stems in a quadrant, most groups counted 0-20 stems in their quadrat each year. The only exception is the football field in 2020, It had many sprouts because the grounds crew had mowed over the patch, which led to the spreading of the invasive plant. Most of the data is in the 0-20 range, and there are a few outliers in the data because of this. In 2019, there were 21 data points and all of the stems were in the 0-20 stems category. A maximum of 120+ stems were counted at the football field in 2020. There was one outlier in the information in the 2021 table. After the mowing incident the stem density appeared to return to normal numbers.

Figure 10 shows the area of knotweed by square feet. Our largest patches were along the trail so those data points show greater than 200 square feet of knotweed. The football field and bus road were smaller patches, so they were 100 square feet or less.

Conclusion

This is the data and information about the Japanese knotweed study we have collected over three years from 2019-to 2021 at Messalonskee Middle School. This is significant and deserves attention because this is information about an invasive species to Maine that spreads and impacts our native plants. My research question was to determine what species of knotweed is growing at my school and to find out if it is spreading? One conclusion I can draw from our data is that there is invasive Japanese knotweed at MMS. Figure 8 shows we only found Japanese knotweed species, not Giant knotweed. In addition, Figure 9 shows that in general the knotweed patches are staying about the same density (less than 20 stems) unless they were disturbed (as seen after the knotweed was mowed). In the future, the knotweed will continue to grow and will probably lean toward being a threat to other species in our ecosystems, as well as decreasing the biodiversity outside our school. I am confident that Japanese knotweed can be frustrating to deal with, but is still a living thing, locating itself in *other* living things' habitats, so we should do something about it!

Another topic to quickly address would be factors that could possibly get in the way of the data I collected. I am very confident in the data we collected however, some factors that could have impacted our data been, unfortunate weather conditions, other species/plants getting in the way, making it harder for us to access the knotweed, and lastly, terrain, like a sloped hill on one of our other sites, which made it harder to measure as accurately as we could. We made sure to peer review in the field so that we all agreed upon the species identification and also we double-checked our counting in each quadrat.

In conclusion, I think we should do something about the Japanese knotweed at our school.

We can keep studying it, but maybe we can help get rid of where the patches are really big, so we can decrease the knotweed population and the little stems. Based on what I have read, knotweed is tough, both to handle, eradicate, and dispose of; more information will be needed to fully eradicate it. In the future, If I am going to help find a way to dispose of knotweed, I will need to know some of the following and continue to research my questions: “*What type of terrain does knotweed like?*”, “*Are there certain types of soil, depths of root areas, or specific needs of the plant in order to live?*” This knotweed study and our findings are relatable to the biodiversity in our world because the knotweed is a limiting factor to the biodiversity where the invasive plant is spreading. The Japanese knotweed decreases the number of diverse species we have in our ecosystem. All in all, I was able to answer my research question with this project and help the Gulf of Maine Research Institute with collecting information to see the varied amount of knotweed in Maine. I hope that our data can help scientists keep our state healthy with *native* species.

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A thank you - A big thanks to my science teacher, Mrs. Ripa, for always supporting me in ways I couldn't think of, and supplying me with whatever I'd need to help me be successful. Thanks!

Fuller Forest Preserve Vernal Pool

By Sofie R

A vernal pool is a habitat for many creatures that may live within the small body of standing water. Since the defining trait of a vernal pool is that it occurs seasonally, the organisms inside have to adapt. The Jefferson Salamander, which is native to the East Coast lays its eggs in early spring so they can mature before the vernal pool dries up for the season. The egg masses are usually laid by the females near branches or bushes/grass in the vernal pools. The eggs are usually smaller in size and amount than other amphibian egg masses, like the spotted salamander.

Those two facts could have supported why it was harder to find the egg masses. I went out to conduct fieldwork on April 25 from 9:00 AM-10:30 AM at Fuller Forest Preserve in York, ME. Our surroundings were open around the vernal pool with trees encircling it. The water was murky with

leaves and branches floating around the edges of the pool. After an hour of searching through the vernal pool, we found nothing except a few unidentified insects. I didn't find any egg masses in person and was surprised by that. I was not expecting the lack of egg masses in the pool because from my research prior to the field day, I had learned that the egg masses were very common.

Students assumed they were larger and easier to see since this is the only time of year they can survive. Because of my lack of finding Jefferson Salamander egg masses, I wonder if I had gone to a different pool and found one or multiple amphibian egg masses, which types would they be. I have especially researched Jefferson and Spotted Salamanders, so I would be curious to know their relationship. Including are there more Spotted Salamander egg masses or Jefferson Salamander egg masses? For example, is one better adapted or survives better? Do their different traits make one have a better chance of survival, and do differences in size of eggs, and places they are placed in affect that? I could investigate this issue further by collecting data on how many egg masses of each kind I could find at the start of the vernal pool season and then at the end to see which one survived better.



Fig. 1.
Grimes, E. (2022, September 1). Jefferson Salamander [Photograph]. Wikimedia.
https://commons.wikimedia.org/wiki/File:Ambystoma_jeffersonianum_184652332.jpg

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Wood Frog Tadpole Behaviour

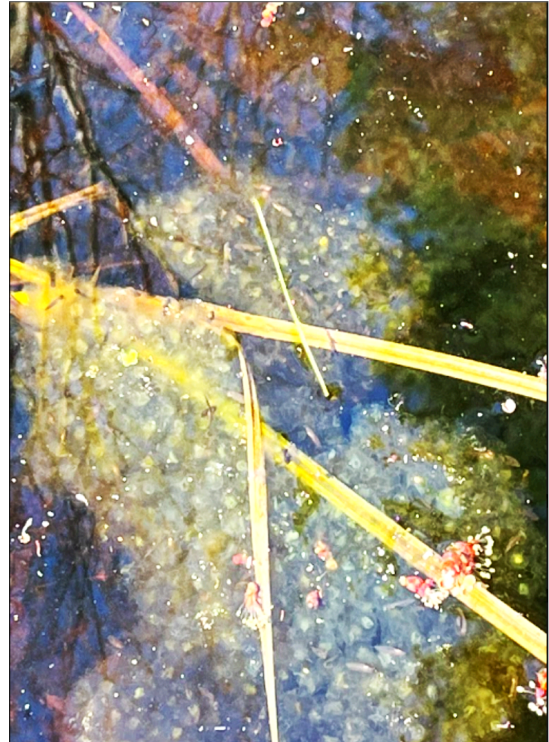
By Sutton H.

Date: 4/20/23

Time: 10:15 am EST

Location: North Hampton School Forest,
North Hampton, New Hampshire

In late April, our science class went out into the marshy forest to search for interesting natural occurrences and creatures to observe. The atmosphere was humid, around 50 degrees fahrenheit and sunny. After about a five minute walk, we approached a small narrow pond with a green bridge stretching over it. The group split up, with some staying and some walking off. I was searching the edge of the pond to look for anything to write about when I stumbled upon a group of Wood Frog (*Lithobates sylvaticus*) eggs, or sometimes called frog spawn. My teacher snapped a few pictures, and then there were only a few people left observing with me.



As I continued to observe the frogs, I noticed that all of the tadpoles would sit stone still on top of the spawn, almost like they were sleeping. Any small disturbance, even water bugs zooming over; the tadpoles would jolt and lay down once more. I got closer and slowly sunk my cupped hand in the water. To my surprise, the tadpoles willingly swam into my hand and rested in the creases of my palm. Why would the tadpoles swim directly into a possible threat, and then touch it? What behavior is connected to this? Was it the color of my hand, or maybe the warmth?

Through further research, I only then found out the tadpoles were Wood Frogs. So, I went to find why the tadpoles went to my hand. I stumbled upon an article that stated “The vernal ponds that the wood frog uses for breeding also warm faster and stay warmer than larger water bodies allowing for rapid growth of tadpoles in an environment largely free from aquatic predators” (‘Biology of the Wood Frog’). This shows that the tadpoles may be attracted to warmth, as well as grow better in warm environments. The water they were in was around 45 degrees fahrenheit, or 7.2 degrees celsius. My hand was roughly 96 degrees fahrenheit. That is 51 degrees warmer than the water! The Wood Frogs live in North America, specifically the North Eastern region. The tadpoles are preyed upon by creatures like water bugs, salamander larvae, and diving beetles. Both males and females live for 3-5

years. The eggs hatch after roughly a month, and they have a high survival rate due to the fact that 1,000 to 3,000 eggs are produced at once. Wood frogs are very active during the night, mostly in warm weather. I hope to see our tadpoles grow to become great members in our ecosystem.

Citations:

G., Parker (2022) "Wood-Are-Frogs," Findings from the Field: Vol. 5, Article 42.

Available at: <https://findings.gmri.org/journal/vol5/iss1/42>

"Biology of the Wood Frog" <http://www.naturenorth.com/spring/creature/woodfrog/wf2.html>

Photo: Our Teacher

Vernal Pool Discovery, Redback Salamanders

By Makayla Z.

On Tuesday, April 25, at 9:45 AM, my class and I went on a walk for science class at the Fuller Forest preserve. I was surrounded by thick dense forests and larger vernal pools. I could hear birds and peepers throughout the woods. The water was very murky, although beautiful water lilies were scattered about the surface. When we started looking in one of the two pools, we found just a few caddisflies but no redback salamanders in sight. *Why were there no salamanders?* We started to look around one of the other vernal pools, and we found out that a lot of people had discovered many different animals. I noticed that one of the two vernal pools had a much greater amount of animal life. This pool had a snake, a redback salamander (see Fig. 1), peepers, frogs, and multiple egg masses. There were almost no animals found in the first pool. This observation stood out to me because I had learned that the organisms in the vernal pools were going to be common and easy to find. I was not expecting there to be almost no organisms visible in the first vernal pool. I knew we were going during a time when we should see some creatures. *Were there too many predators in the first vernal pool? Was there not enough food for the salamanders in my pool?* These are a few questions I wondered about.



Fig. 1: photo of redback salamander, Pierson, Todd. Southern Redback Salamander. "Amphibians and Reptiles of North America," NCPARC.

After some research, I figured out that there could have been more predators of the redback salamander in the first vernal pool, which includes: birds, snakes, and large mammals. Another piece of information I found was that salamanders eat mostly small organisms. Their diet consists of worms, snails, ants, larvae, and insects. The first vernal pool could have had a more reliable and larger source of food containing the small insect they consume.

In conclusion, the second vernal pool had more prey and fewer predators of the redback salamander. I could investigate this issue further by studying the environment closely and finding the differences between other vernal pools and different environments. I could also compare the most beneficial and detrimental factors in both vernal pools.

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A Vernal Pool Discovery: A Redback Salamander

By Grace W

The redback salamander is a type of species that lives in Maine. This salamander was located at Fuller Forest Preserve from 9:00 - 10:30 AM on the 25th of April in 2023.

The redback salamanders have been known to eat arachnids, worms, snails, larvae, and insects. They live in water containing air and prefer to live on forest-filled rocky hillsides. The most common places to find redback salamanders are on the East Coast of the US as well as in Canada. This is important to note because if you live in some of these places, you might be able to find one yourself!



Fig. 1: Barteaux, K 2023 April 25 this is a photo of a Redback Salamander, Barteaux, Kate. Photo of Redback Salamander.

I observed that the redback salamander had really big eyes that bulged out of its head. I also thought it was surprising how short and skinny the legs were. When the Salamander was on a clear surface, it could clearly be identified as a salamander, however when it was absurd on the ground it looked worm-like.

Based on my observations, I wonder: why does it have a red spotted strip along its back, and what are the differences between all of the salamanders in Maine (see fig 1)? Because of my curiosity, I did some research to find the different kinds of salamanders and how their color affects their habitat. In Maine, there are many different kinds of salamanders that all have unique patterns or colors. There are eight native salamander species: The Blue-spotted Salamander, The Eastern Newt, The Eastern Red-backed Salamander, The Four-toed Salamander, Mudpuppy, The Northern Dusky Salamander, The Northern Two-lined Salamander, and The Spotted Salamander. The reason they all have different patterns on their skin is because of the different places they live. If a salamander lives on the forest grounds that are covered in leaves the salamander will most likely be a light brown to match the leaves. This will help them camouflage from predators. Sometimes the salamanders can have a mutation that changes their coloration; this can help or harm the animal. If it helps the animal, they will live longer. This can make the whole species change over time.

This observation was worth noting because I have never noticed how many different kinds of salamanders there were, and the differences between them. This observation makes me wonder if I would be able to spot a salamander with a mutation? I could investigate this issue further figuring out in the woods near vernal pools to try to find a vernal pool.

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Pillbugs (*Armadillidium vulgare*)

By Molly S. and Emma S.



On April 20, 2023 at 10:15 am, my friend and I went walking in the North Hampton, New Hampshire school woods. The weather was sunny, but cold and around 50 degrees fahrenheit. We quickly came across a fallen down log that seemed to be wet and rotting. From previous experience, we knew that sometimes there are small bugs or worms that make places like these their homes.

So, we suggested we lift the log. Underneath we found two roly pollies, what seemed to be a mother and a baby. Another thing we noticed while watching them was that one looked to be about half an inch while the other looked to be about a centimeter long which led us to believe that one was the mom and the other was the child.

This all made us wonder, how long does the baby stay with mom? What is the shell protecting the bug from? Can the bugs live in light?

Doing some research from the University of New Hampshire website, we found that the overlapping plates on the pillbug are used as protective armor from spiders, centipedes, ground beetles, and small mammals. Pillbugs are commonly found under mulch, leaves, and rocks (or in our case, a rotting log). They are nocturnal animals, which is why we found them sleeping. They also require dark and damp conditions and enjoy burrowing under the soil. This made me wonder if they burrow



Zoom

Joseph Berger, Bugwood.org

for warmth in the winter? Is it a form of hibernation? They are detritivores, which means that they eat debris, breaking down organic matter. We found out that the mother was still with the baby because on average, the baby will stay by its mother's side for around a year, until it is fully grown. Pill Bugs are self-fertile animals, meaning they can lay eggs without mating. In the beginning, the eggs stay in a pouch between the mother's legs, but after a few months they hatch and come out as miniature copies of their mom.

This makes us wonder what is happening inside the mother's pouch to help these baby pill bugs grow? Is it similar to the process of how kangaroos keep their children safe? Do the babies get their nutrients from their mom's pouch? These are the questions that this research has left us with.

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Why Do Trees Release Sap

By Madison W

For years upon millions of years we have had trees, trees that provide oxygen, allowing humans to live. In all of the trees there is sap. Think of the tree as a human being. Humans have bodies and inside those bodies there is blood. Trees are very similar to humans, whereas they have a body (the tree's trunk and branches) and blood, also known as sap.

When I started this project I was looking to answer one question: *Why do trees release sap?* Wanting to collect some answers and evidence, I took a walk in the woods behind my school (North Hampton School) on Thursday, April 20th at around 9:15 in the morning. On the way I saw many trees, but not all of them were leaking with sap. Noticing this I started to wonder if all trees produced sap or if it was generally just maple trees or in the maple tree family. Further research concluded that all trees produce sap and it is used as the “blood” of the tree, providing vitamins and nutrients throughout the tree's structure, allowing it to remain strong and healthy.



I had already found out so much about the sap and how the tree uses it to live, but I still hadn't found the answer to why our trees are releasing it. Wanting to know more I went outside and took yet another walk in the woods behind my school on Friday, April 21st at around the same time as my last walk (9:15 am). On that walk I found out more about the sap, such as how it turns purple when it dries in the sun, but that's not what I wanted to know, so I started to investigate the areas where the trees were letting go of the sap. Wherever the sap was dripping there was always a whole or a gash. This leads to two potential reasons, either the tree opens up that gap to release the sap the same way humans release food, or this was the cause of some injury or damage to the tree.





I was glad to have found two potential reasons, so I grabbed my computer and started to research both things. Multiple websites stated that the trees are actually not supposed to be releasing the sap, and that it is usually a cause of injury or that something is wrong with the tree. “Often the reason we encounter sap on the outside of a tree is because something is wrong. Leaking sap on the bark can be a sign of disease, pests or damage” (The Tree Center).

Although this is not quite what I was expecting, I was glad to have finally found the answer to my question. Trees release sap from wounds in the trunk, the same way humans bleed when they have a cut or other wound that has torn their skin, the same way things can tear the bark of a tree. Even after all of this I have other unanswered questions such as: Does the climate affect the amount of sap that is produced inside the tree?

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Gardening Know How. What is Tree Sap?

Red-Breasted Nuthatch Seed Bank

By Lillian.T, St. George School

Observation:

One day while sitting in my living room on the couch, I saw a bird fly by the window and land and hold onto the side of our fence. That bird was a red-breasted nuthatch or *Sitta canadensis*. There were a few flying over, all landing on our fence, and it didn't take me long to see that they were carrying seeds in their beaks. After noticing that, I realized that they were stuffing the seeds in holes in our fence! I probably wouldn't have noticed that if it wasn't for the fact that just a few days before that my family and I had watched a nature documentary about woodpeckers and other birds storing nuts and food and about the life of woodpeckers. When watching the show I learned that some birds hide nuts and seeds in the holes of trees. So there were red-breasted nuthatches hiding seeds in the holes in our fence. There was one nuthatch that hid one seed in the tire on our truck which was fascinating and really funny that a bird would hide a seed in a truck tire. This behavior might be important because it can help show us which birds might be more intelligent and which ones have better memory, or which might be more adaptable to living alongside people.



From left to right: Red-breasted Nuthatch, Seed In Tire, Seed In Fence.

Question:

I wonder, if after time, they would prefer the fence over the tire because they can go back to the fence and get the seed at any time but not the tire because the car has been moved and the seed lost. Can the red-breasted nuthatch adapt to use man-made things and can the bird determine that maybe man made is better than natural crevasses or maybe that natural spaces are better than man made spaces for hiding seeds in?

If we wanted to figure more out about this we could do an experiment like this: What we could do is to have tire tread laid out and next to that a wood board with holes in it and observe which one gets used more often. Maybe even occasionally move the tire tread to symbolize the car or truck moving and see if the bird might start using the wood more or if it would be the same as before. If we did this it could show that maybe the bird

would decide to use the wood more because the tire has moved and the seed was lost. I think doing this experiment could lead to better understanding of the red-breasted nuthatch's intelligence and habits.

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Nature Note: Snow Fleas

By Nola M, Greenville Consolidated School

Snow fleas (Also more commonly known as springtail) are small insects that live in the snow. When my class and I adventured outside to the school trail surrounded by trees and streams at 1:10pm on March 15 2023 in the cold 41°F weather, we were on the hunt to find things we would like to focus on to make a nature note. Our class found many snow fleas in the open sunny areas and by trees. They jump around in the snow and love to move. That is usually how you can tell if it is a snow flea. They have 6 legs and are a greenish brown color, as shown in the picture (To the left). As you can see from the picture (To the right) a snow flea is very small compared to one of my classmate's fingers. They have tails that act like springs called furcula, when the furcula is released the small snow flea shoots forward.

One day after a snowstorm we went out to the trails at the same time to take a second look and we discovered that after new fresh snowfall the snow fleas were very hard to find. There was also a lack of direct sunlight which also could have affected the amount that was visible. They eat microscopic fungi and algae.

While observing the snow fleas we noticed that many of them are no longer living so my question is, “How long does a snow flea live, and at the end of the winter months do the snow fleas just die or burrow in some way until next winter?” I think it would be

interesting to try and tag a snow flea with a microchip and check up on it to see when they die or where they go?

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Salamander or Frog Eggs?

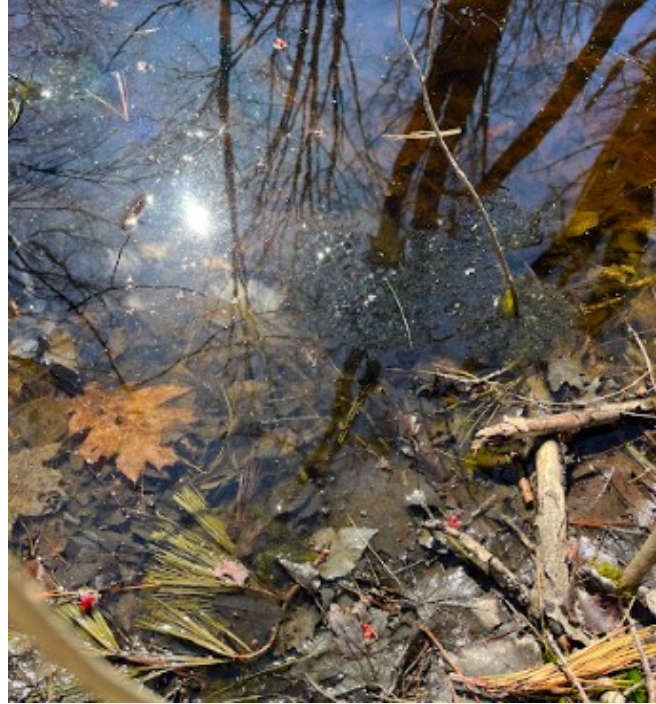
By Ellia J

On April 20th 2023, at 10 a.m. my science teacher took us outside into the trails of the back of our school in North Hampton, New Hampshire. It was a sunny day and about 50°F, but everything was very damp out in the woods. There were some trees and shrubs near the vernal pool. In the vernal pool, there were some leaves and sticks that were completely underwater and some were on the surface. There were multiple egg masses located on sticks and shrubs under the water. There were about 5 to 6 egg masses. They had an outer jelly layer that looked clear enough to see the embryos. The embryos looked very small so we assumed that they were born a couple days ago. As I looked more closely into the pond, I started to notice that some of the egg's mass jelly outer layer was cloudy and foggy looking, while others were clear. This started to make me wonder, are these salamander eggs or frog eggs? I also started to wonder what's the difference between the two?

In my research, I found that in New Hampshire, there are Wood Frogs and Spotted Salamanders. By looking at comparisons of the different types of egg masses, the wood frog and the spotted salamander eggs were both very similar to the pictures and views of the egg masses back in the woods. I found that Wood Frogs start breeding at the end of February or start by early March. Female Wood Frogs lay up to 1,000- 3,000 eggs per clump. The eggs usually end up hatching in 9 to 10 days later. Salamanders usually start laying their eggs between mid-March and mid-April. Salamander egg masses often contain 100 or more eggs in a cluster. I found that salamander eggs are surrounded by an outer layer, while frog eggs lack the outer layer that's protective. Although the two are different types of eggs, they are commonly given birth in the water with strubs, sticks, and logs that are underneath the water fully. The egg masses have to be farther into the vernal pool because if the eggs are not covered with water, they can dry out and die. This then leads to my second question, do the eggs float or do they just stay on the sticks? Also, which spots of the mass do the eggs hatch out of first?



In an article, I found that the eggs use the sticks and shrubs as support from falling into leaves of grasses such as sedges. The eggs stay onto the sticks and shrubs by hanging either vertically or horizontally. Salamander eggs only hatch one or a few times each. The outer eggs tend to grow faster because they are receiving more sunlight. In wood frog egg masses, the center of the sack are the ones that hatch first. Since frog eggs are darker than salamander eggs, the mass absorbs heat better in the middle and that's why the middle eggs hatch first. Once the salamander or wood frog eggs are born, the mother (or the animal) has to watch over her babies because predators such as the eastern newt, the crayfish, and other insects will try to snatch and eat the eggs.



Although I learned about the difference between the wood frog eggs and the salamander eggs, the egg masses, the predators, and the hatching, I would still like to look into this topic more and next time try to figure out if the eggs will die if they float instead of stick on to something and be completely underwater?

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Climate Changing Skunk Cabbage

By Isabella S.

On April 20 at about 9:25 in the morning I was walking around on the North Hampton, New Hampshire trail, when I noticed all the new spring growth around me. There were green leaves on the trees and some plants were sprouting out of the ground! My greatest observation was the Skunk Cabbage that I found all over the swampy areas around the trail. As I took a closer look at this strange plant I noticed a purplish color on the tips of the green leaves. Which got me wondering, if this plant had a purpose, and if so what does it do?



I then did some further research to figure out what this strange purple leaf could be, and found that in February through May (the time the plant blooms) “the skunk cabbage send up a fleshy, highly-modified leaf forming that distinctive purplish hood (Pike 1)”. Inside of that hood is a “collection of tightly-packed flowers, called the spadix”. And when this plant grows every spring, “the spadix starts to respire, breaking down starches stored in the root at an alarming rate. This rapid respiration produces heat (Pike 1)”!

This new information had surprised me, I had never heard of a plant that could heat up to 70 degrees (Fahrenheit), melt all of the snow above and then bloom while some of the ground is still frozen! I thought that this was absolutely fascinating, but it got me to wonder how this heat producing plant could be affecting global warming? Could it make things worse? And if not, could its heat affect the homes of certain animals or insects?

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What Are Burls and How Do They Affect Trees?

By Diya S

On Thursday, April 20, 2023 - a cool, dry, sunny, and windy day - at 10:26 A.M., I was out in the North Hampton School Woods, North Hampton, New Hampshire when I saw a tree with several random bumps along the trunk. The bumps were round and appeared rather smooth. Some of them had openings and they seemed hollow at first glance. There were other trees with similar bumps, but many did not have these. Most of the bumps I saw were of similar sizes, which is something my research did not address.

Upon further research, I learned that these bumps were called burls, but go by many different names, including callus tissue (Grundmann). However, the term burl may be too broad as it means any “anomalous or unusual woody structure with a swirled grain,” and lignotuber is a bit more specific, only applying to “ontogenetically produced structures” (James). Burls appear on the trunk of trees, rather than on branches (“Harmful growth?”). According to Stephens, they are a “large, knobby growth on a tree trunk... and [are] covered in bark.” Nonetheless, while they may have an odd appearance, they don’t have a large effect on the tree’s overall health and if one were to cut off a burl, they might harm the tree greatly, as burls are a tree’s response to injury and cutting it off would be “like making a wound that the tree can’t seal off... [and] you’ll be left with a burl-sized wound with wood tissue that’s wide open to pests and pathogens for many seasons” (Grundmann). Burls are typically caused by abnormalities in cell growth, which in turn, may be caused by stress or injury to a tree, but experts are not sure exactly what causes these. (“Harmful growth?”). Investigations into burls that have been conducted concluded “that the wood contains dormant buds, carbohydrates, and nutrients necessary for bud development” (James).



Despite the answers to my original queries, new questions have come up. What makes a tree likely to produce burls? Could it be the environment, the kind of tree, or just a coincidence? I was also wondering about how long it might take for a burl to grow and the weight of burls? Following that, is there a limit on the amount of burls that can be on a tree before no more can grow or the tree can no longer hold the weight of the burls? I can probably answer most of these questions with further research into the background of trees with burls by finding patterns in the data that may prove or disprove initial wonderings.

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Lupinus perennis

On a Wednesday afternoon around 4:00 p.m on May 25, 2023 the temperature was about 68° and sunny. While exploring my backyard in North Hampton NH, I came upon a small body of water. When looking closer I found a small but relatively tall plant, this discovery intrigued me.



The first thing I noticed other than its height was the purple petals blooming towards the base of the plant head. This observation of the purple petals was interesting because I have never seen that type of plant before growing in the ground. So when I saw this plant growing in the ground being hidden by the green pods it made me curious as to what type of plant this was and why the appearance was purple.

The name of this plant is *Lupinus perennis*. *Lupinus perennis* bloom in the spring, anytime from April to July. Their native habitat is in sand hills and open woods. *Lupinus perennis* is known for “enhancing soil fertility by fixing atmospheric nitrogen into a useful form” (Lady Bird Johnson). Along with enhancing soil fertility they also attract Butterflies and Hummingbirds but the seeds are toxic when eaten in large amounts by humans and animals.

Since learning that *Lupinus perennis* are said to be toxic when ingested in large amounts, this made me wonder what is in the seeds that cause them to be toxic?

According to the United States Department of Agriculture or the USDA, “Toxicity in lupine is believed to result primarily from the alkaloid D-lupaine... If large quantities were consumed, convulsions, coma, and death by respiratory paralysis may occur.” Alkaloid is a naturally occurring organic nitrogen-containing base, commonly found in forms of beverages, drugs and agents. (Drugbank).

Although this plant is toxic, the beauty of *Lupinus perennis* makes up for it. The purple color found on the petals is from anthocyanins which are pigments formed by a chemical called flavonoids. (Cleveland Clinic). Anthocyanins can be found in many plants, such as fruits, flowers and roots. Anthocyanins have low to no toxicity.

With all of this information I have gathered I still have one question left. How do *Lupinus perennis* multiply? To find out this information I could do some additional research to answer this question. I could also plant my own *Lupinus perennis* and see if at any point it multiplies.

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How is climate change affecting wild Maine blueberry production?

By Jack H and Liam A

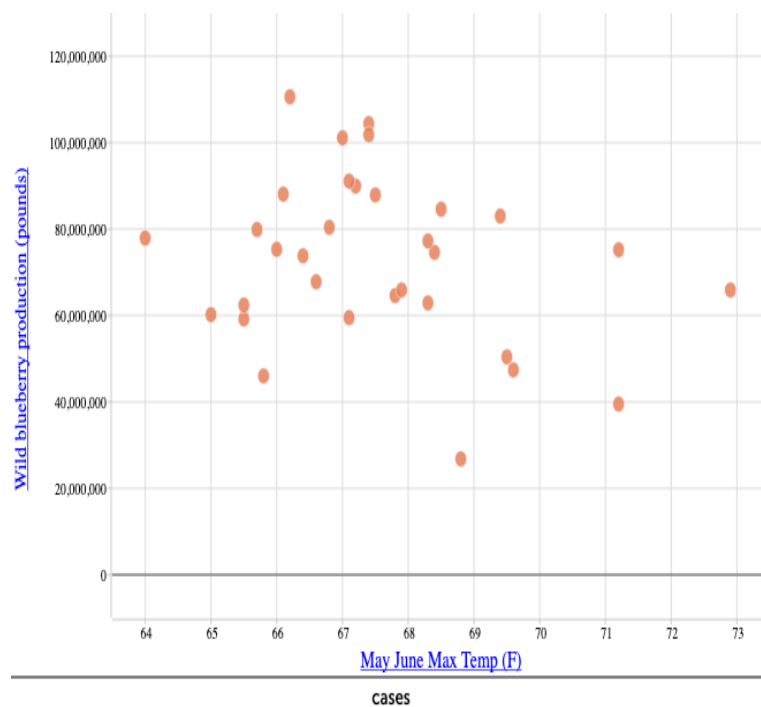
The Question

How is climate change affecting wild Maine blueberry production? This question was answered with information from Blueberry Hill, Winterport, collected by Francis Drummond.

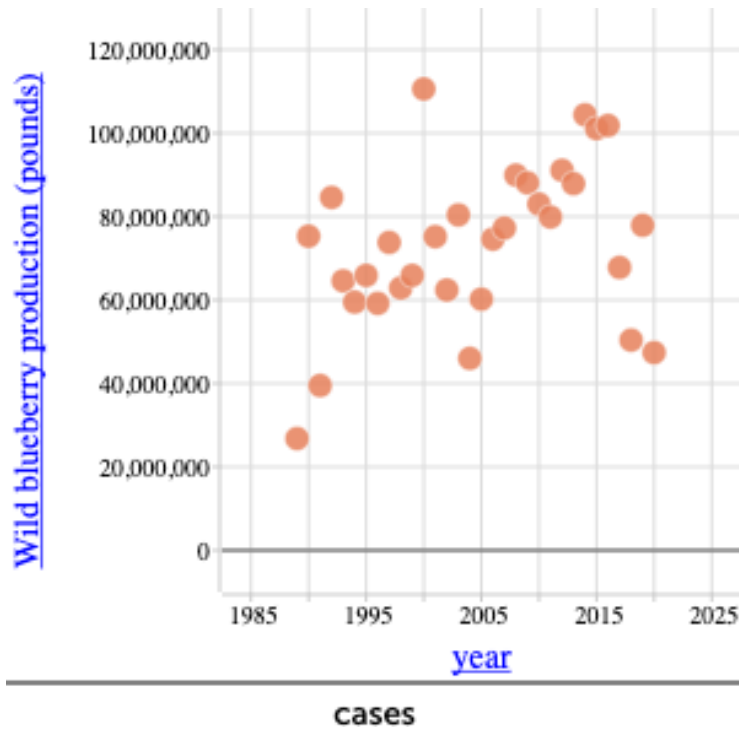
One thing that we gathered from the graph is that blueberry production peaked at around 66 degrees, but as the temperature got higher blueberry production started steadily going down.

Thus our big question has already been answered; the data from the graphs show that as the temperature goes up, the production of blueberries goes down. This data is appropriate to answer my question because it's on Maine blueberries and Maine climate.

The Data



This data shows how the temperature affects blueberry production. You can see that when the temperature is hotter than 70 degrees blueberry production slows down, but the temperature is around 65 degrees blueberry production is much higher.



This graph shows blueberry production in pounds over the years. Blueberry production hit an all-time high in the year 2000, and as of recently, blueberry production has started going down on a steady decline.

Everyone knows that climate change has been affecting the temperature of this planet for many years, and every year the temperature continues rising. This graph shows the correlation of blueberry production over the years, starting around 1989. According to this graph, blueberry production was on an incline starting in 1991. It peaked in the

year 2000 at 110,000,000 pounds of blueberries. Since then blueberry production has been on a steady decline, hitting a low point in 2020, at 50,000,000 pounds harvested that year. Which is 4th to that of 1989 (the lowest). When the temperature was most likely too cold for blueberries to mass produce like they have been. Based on our analysis of the data, we think that blueberry production is decreasing due to the warming climate on Earth. These two graphs connect to what we learned about bees, when the weather gets hotter bumble bees cannot go out and pollinate so therefore blueberry production would decrease.

Blueberries are a very yummy snack that just about everyone loves. Climate change has been warming the Earth significantly for many years. In the warmth, blueberry production starts to go down. If this trend of climate change continues, in the future blueberry population could be at risk. Our data shows how fast blueberry production has been going down, how long will it be until we lose them forever? We need to do more to stop the effects of climate change.

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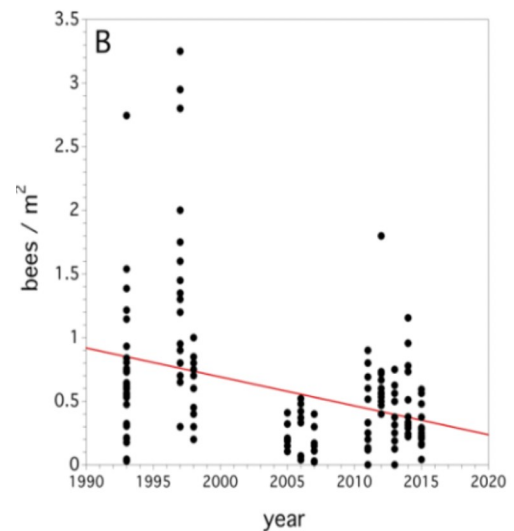
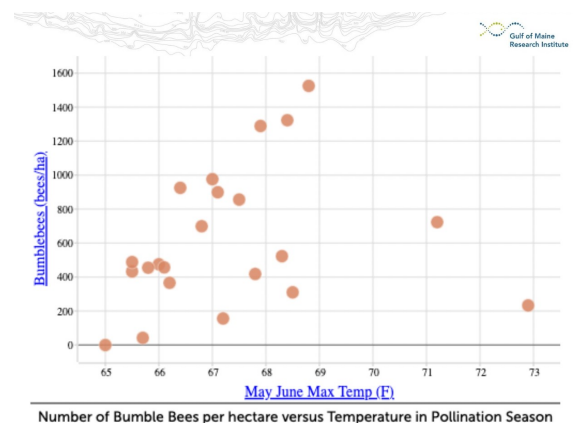
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Is Climate change dramatically affecting the bumblebees' ability to pollinate?

By Elsie B

Is Climate change dramatically affecting the bumblebees' ability to pollinate? Depending on the type of bee they each prefer different kinds that prefer different kinds of weather. Bumblebees prefer colder weather, so this leads us to think that pollination rates could drop dramatically. We found a graph from the Gulf of Maine research Institute Data from Drummond, Francis "Lowbush Blueberry Data," Final Report on Arthropod Decline, Submitted January 7, 2022. It compares the Number of Bumblebees per hectare to the temperature in pollination season. The graph's max temperature was 73°F and there were only about 200 bumblebees per hectare that pollination season. This data is appropriate because we think it shows how much climate change could be affecting bumblebees each pollination season. In 2002 there were 0 hot days. The temperatures were between 43.5°F - 65.5°F. This year there were 488 bumblebees which is the second highest number of bees. Bumblebees go out to pollinate in cold weather, unlike Honeybees who pollinate in hot weather. Since Honey bees are hot weather bees it was a little harder for them in 1962 with 6 days that were too cold for them, and in 2021 there were 4 cold days. Bumblebees were the opposite with only 2 days that were too hot, and a drastic 5 days in 2021. But, the reason why Bumblebees are so crucial is because they pollinate more flowers at a time than Honey bees. If you look back at the graph when the temperatures are lower than there are more bumblebees per hectare.



temperature influences flight activity”. While looking at a graph on “Evidence on Arthropodic decline in Maine” I noticed that at the start of the 1900’s the amount of bees was high but entering the 2000’s it decreased. In the last 20 years the temperature has been average, and above showing that May/June temperatures are increasing. Climate change is only getting worse meaning that it could be the reason why there aren’t as many bees now. Research shows that Honeybees will be benefiting from hot temperatures, and our native bees like bumblebees will not. Which could lead to a big decrease in fruits/seeds.

From the data I think that Climate change is affecting the bumblebees' ability to pollinate. At first I thought that different bees just preferred a certain temperature. But, then from research I discovered from ScienceDaily.com it says that it affects their ability to fly. This gives proof that bumblebees wouldn’t be able to pollinate. If temperatures continue to rise it will “push them past their limits” leaving them unable to fly and pollinate as many flowers as they could in colder temperatures. The Maine’s Climate Future 2020 report is looking at what climate change will look like in Maine. One example is Heat Index which means that the weather feels hotter than it really is. Events like these could result in days where some bumblebee did not pollinate at all.

Also, we know that honey bees are getting a big benefit with temperatures rising. But, they are not native, and don’t carry as much pollen. So, does that mean that eventually our native bees will not be able to fly to pollinate, and we will have to rely on only honey bees to pollinate our food? I think the next step is to work on solutions for our native bees, so they can work through climate change.

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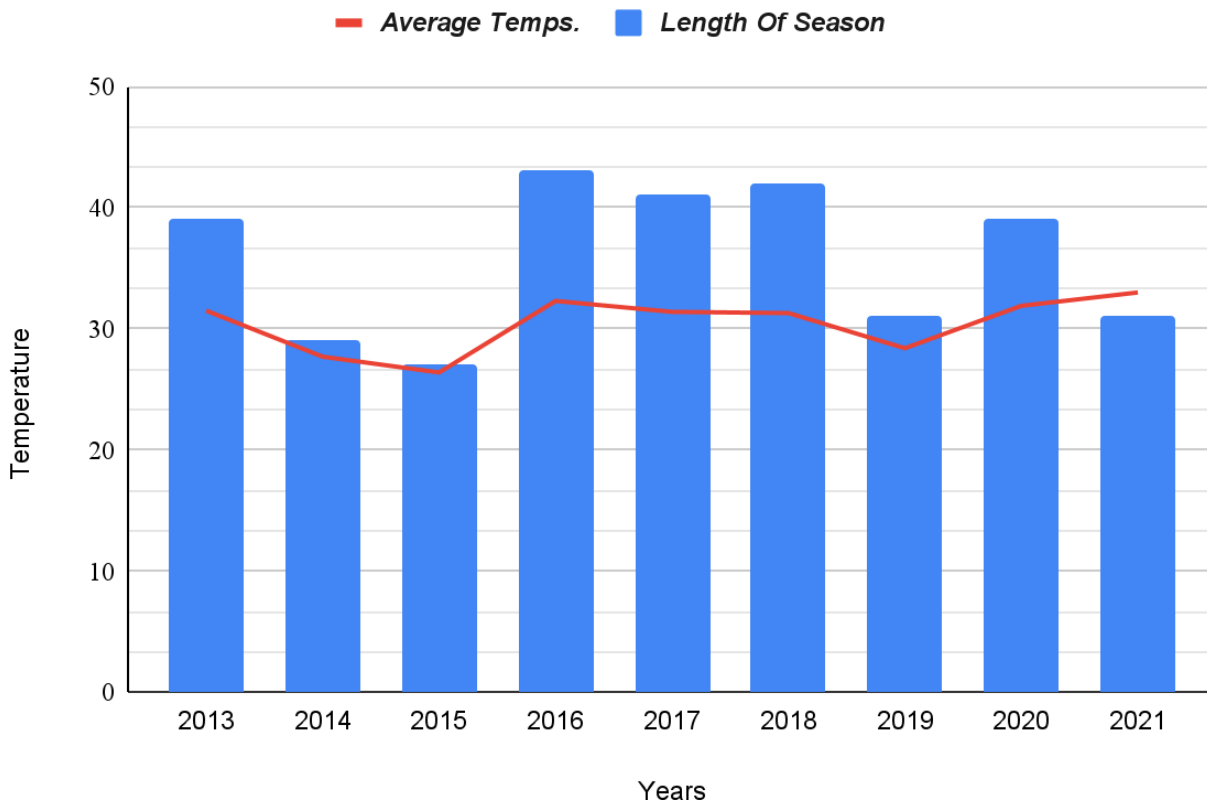
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Maple Sugaring Research Project

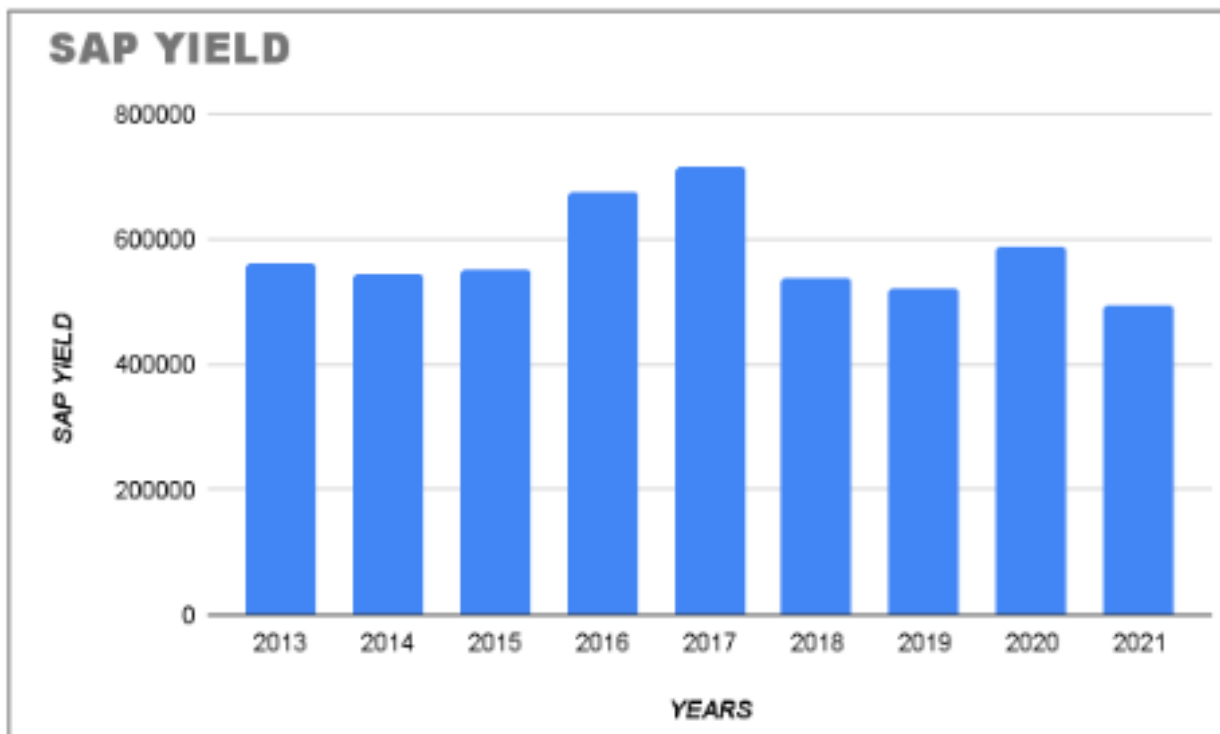
By Jax C.

Don't you just love the fresh maple syrup that you have on your pancakes and your waffles. You just love how the more syrup there is the better. But you soon realize your mother gets fake syrup that doesn't taste as fresh as the glorious fresh maple syrup flavor. Maple syrup is made from sap, the sap is collected from something called a tap, there can be one to four taps in one tree. This tap is connected to a tube which the tube can be connected to an entire line or to one to two buckets (mostly just one just depends on the amount of taps). The most common type of tree that is to be tapped is a maple tree, pretty simple right? Well actually the process isn't simple. First things first you have to boil the sap to separate the water and the sugar into syrup then it will go through a series of filters until you have syrup. And we need sap that is sweet and flows. If we don't have temperatures that are twenty five degrees Fahrenheit at night and thirty five degrees Fahrenheit at day the sap won't flow. And when you add climate change to this system it adds a big problem. It's the forties in the middle of winter, the temperatures are off the charts. This affects the length of the seasons and affects the production of maple syrup.

LENGTHS OF SEASONS AND AVERAGE TEMPS



The big problem is climate change. This makes us start the sugaring season way earlier. The average length of a season in 2013 was thirty eight days. In 2021 it was twenty six days! The average temperature for 2021 was thirty four degrees Fahrenheit! This will affect the flow of sap because like I said earlier it's supposed to be twenty five at night and thirty five in day time to have a strong flow of sap, since the average temperature is thirty four this means that it will probably be thirty at night. You need forty gallons of sap to just make one gallon of syrup. I have a prediction that some winters will be really cold but also really warm, this will cause the flow of sap to stop and go constantly which could cut the production we have today in half or slightly increase but decrease over time. I think this because I observed and studied some charts and graphs(some I made) that show that in 2000, 270,000 gallons of 80,000 gallons. 2020 produced 154,000 thousand gallons of maple syrup which is quite a big difference from 1992 which produced 94,000 gallons. This is the starting point of my prediction I made which soon later on the production could just stop flat, this is because of the high temperatures.



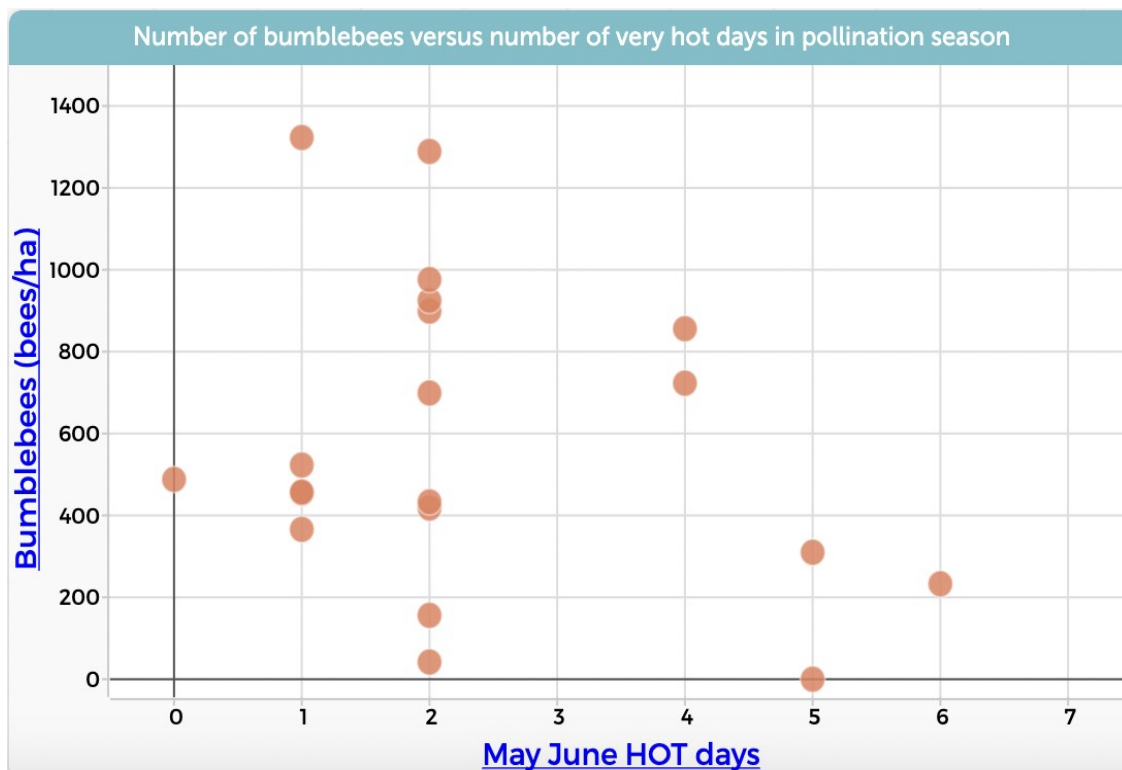
I'm really curious about my prediction if it's right or wrong because it does depend on how we treat climate in the future. If we treat it well it could work but it also couldn't work. A question that I've got to ask is how will the temperature change affect the flow of sap. I mean people keep on starting the season earlier and earlier to avoid the warmer temperatures and to let the sap flow. I'm curious about what you think.

How are temperatures changing how bees pollinate wild blueberries?

By Kaylee F and Brooke S, 9/18/22

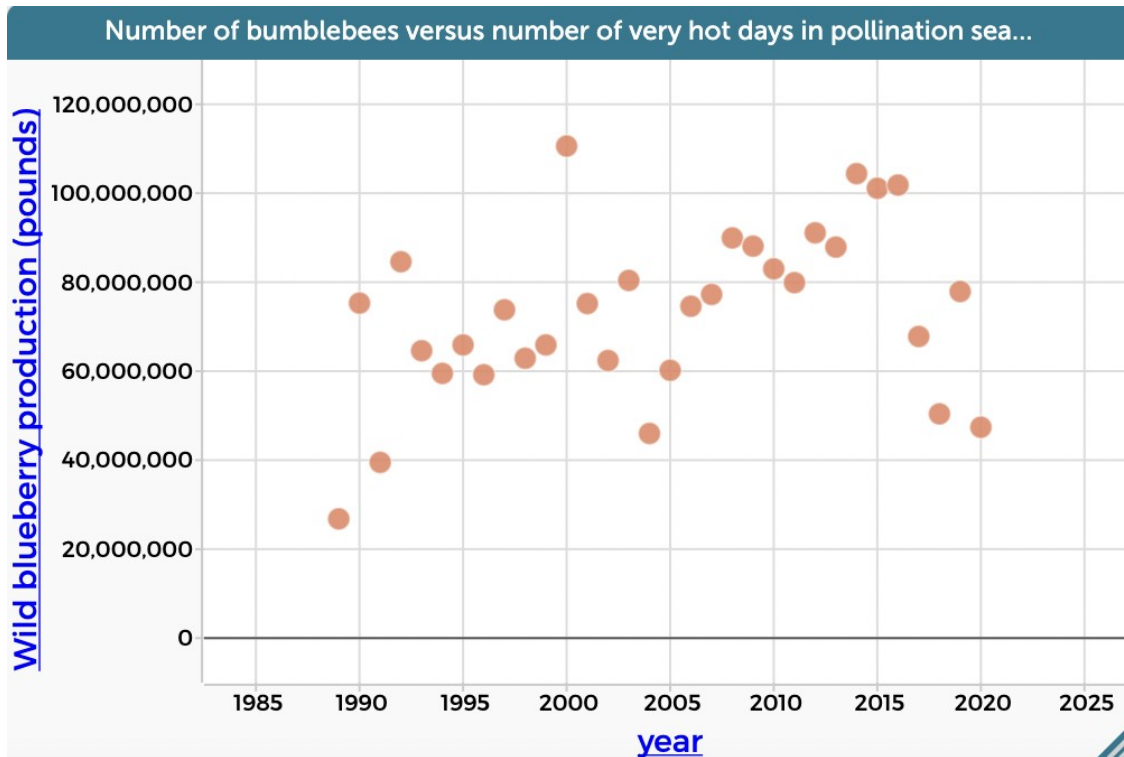
How are temperatures changing how bees pollinate wild blueberries? To answer this question I used bee data from Blueberry Hill, a town owned blueberry field in Winterport, Maine. This data was collected by Francis Drummond. I also used climate data from NOAA

National Centers for Environmental Information, Climate at a Glance. I used blueberry data by commercial growers and compiled by New England Agricultural Statistics. This data is reliable for the question because it's about Maine native bees, blueberries, and climate in Maine.



This graph shows how many bumblebees came out in June on hot days. It also shows how many bumblebees came out in may.

How are temperatures changing how bees pollinate wild blueberries? Temperatures are affecting bees because of the heat. When it gets too hot the bumble bees don't go outside so they stay in the hive instead of pollinating. It's good for the honey bees because they like the heat but they can only pollinate around 1,000 flowers in one day. A bumble can pollinate



This graph shows how many wild blueberries were produced in the past 35 years.

around 5,000 flowers in a day. We need to have bees so they can pollinate the wild blueberries. This makes me wonder what would happen if the bees don't pollinate the blueberries. For blueberries to grow we need to have bees to pollinate them. Bees need to deposit enough pollen on stigmas during bloom, this can be done by honey bees, managed bees, and wild bees. Even though there are other types of blueberries, wild blueberries are healthier than the others. This is why bees need a certain temperature for them to go out and pollinate the wild blueberries. If the temperatures are not the temperature bees like then we won't be able to have wild blueberries because the bees are not pollinating them.

Citations

Bee data: Drummond, Francis. Lowbush Blueberry Data. Final Report on Arthropod Decline, Submitted January 7, 2022.

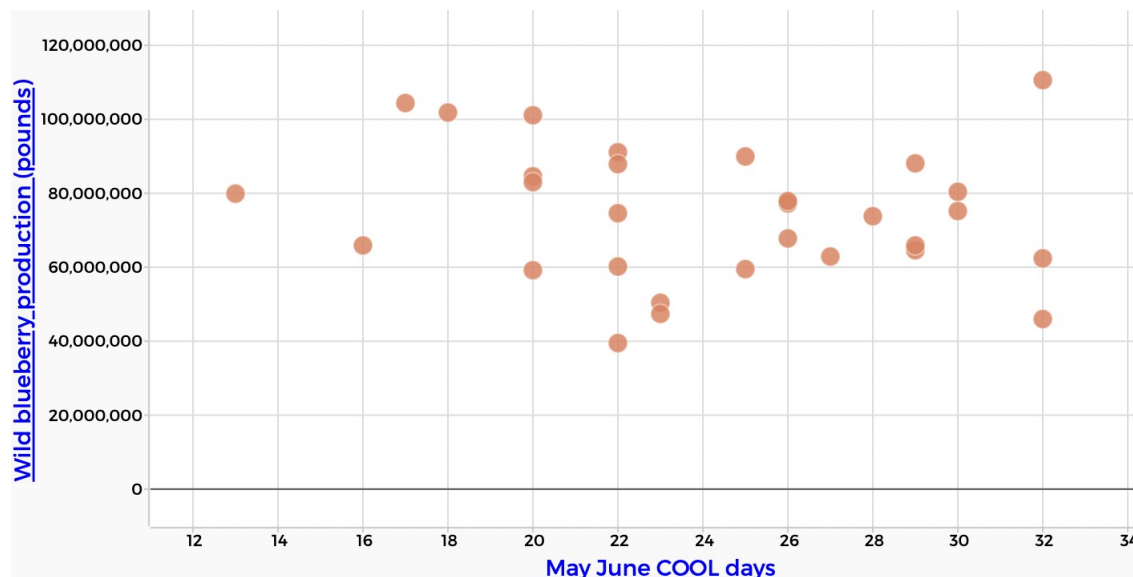
Blueberry Data: New England Agricultural Statistics (NASS). <https://quickstats.nass.usda.gov/>.

Climate Data: Climate at a Glance: County Time Series, published March 2022, retrieved on March 11, 2022 from <https://www.ncdc.noaa.gov/cag/>.

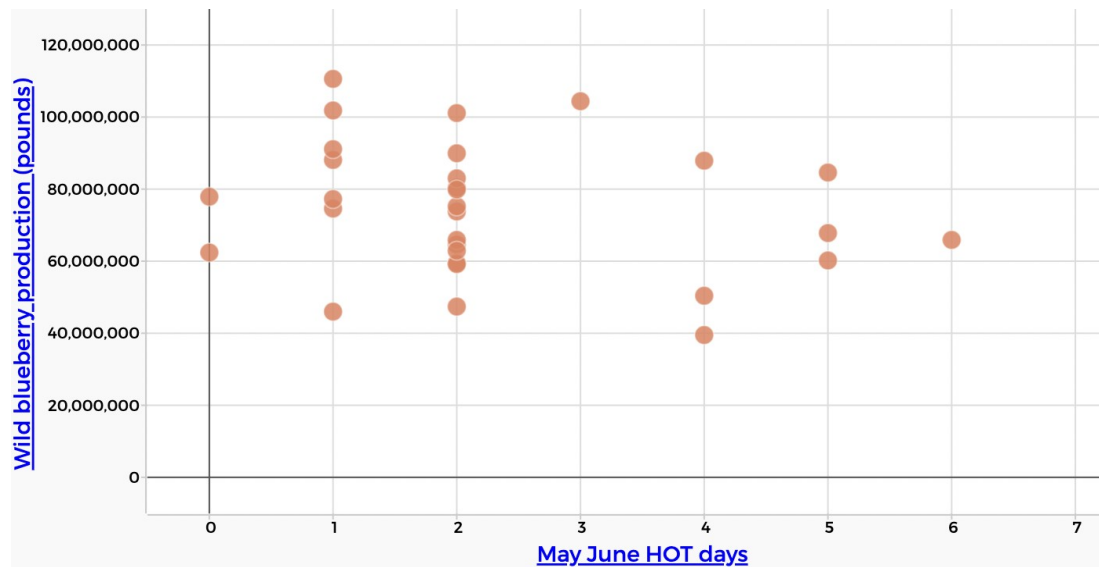
What different kinds of weather are best for Maine blueberry production?

By Lydia P and Grace M

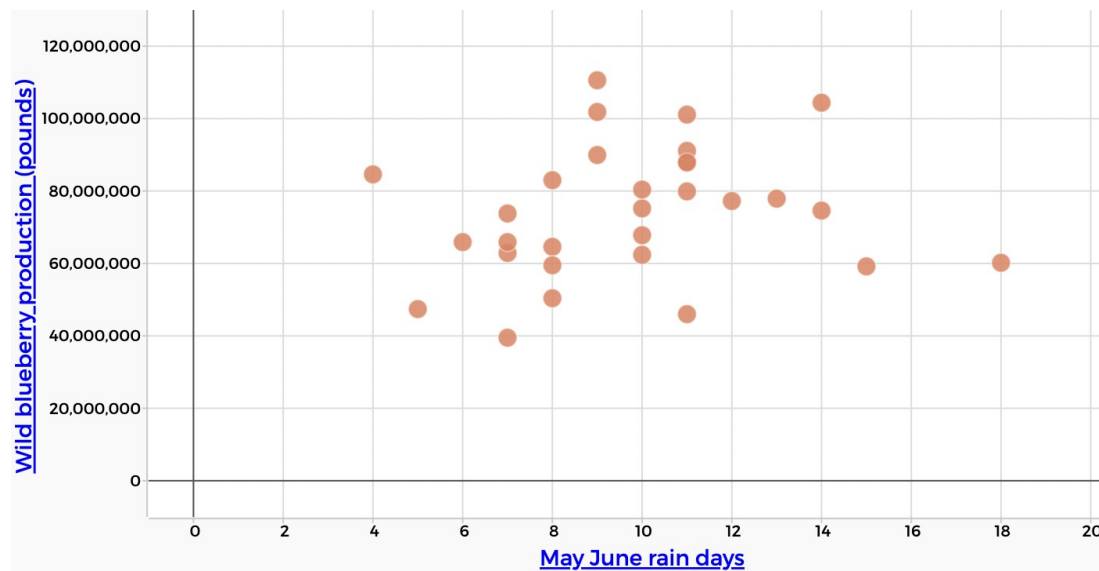
What different kinds of weather are best for Maine blueberry production? Blueberry production has always been an important facton in Maine's economy. I wonder if blueberry numbers are affected by the fluctuating temperatures and weather patterns we have been experiencing in recent years. The information in our graphs covers the days between May 15 and June 15 from 1991-2021, with precipitation in Grand Lake Stream, Washington County, Maine collected by Maine Climate Office, Climate Change Institute, University of Maine; the days between May 15 and June 15 with temperatures higher than 80 degrees F in Grand Lake Stream, Washington County, Maine. The days between May 15 and June 15 with temperatures below 50 degrees F in Grand Lake Stream, Washington County, Maine. As well as pounds of Wild Blueberries harvested in the State of Maine from 1989-2020, reported by commercial growers and compiled by New England Agricultural Statistics (NASS). This data is appropriate for answering our question because it is about how blueberry production is affected by different weather conditions, which is the basis of our question. While we can't reliably predict or influence the weather, it could be beneficial to know what kinds of conditions blueberries thrive in to have a better understanding of them, and possibly recreate those conditions.



This graph shows the number of cool days compared to the number of pounds of wild blueberries produced.



This graph shows the number of hot days compared to the number of pounds of wild blueberries produced.



This graph shows the number of rainy days compared to the number of pounds of wild blueberries produced.

The data may be a bit hard to read, as there are many varied points, but I believe that cooler climates that have around 12 rainy days a season are best for Maine blueberry production. The graphs we have put above show that there are higher numbers of blueberry production when there are higher numbers of cool days and lower numbers of hot days. This correlates with what we know about bumblebees; they come out more when there are fewer hot days, giving them more time to pollinate the blueberry flowers. Science Daily states that in temperatures below

77-80 degrees Fahrenheit bumblebees fly better, making it easier for them to spread pollen. But the number of blueberries harvested has been decreasing, having the lowest year ever in 2020. Global warming has created drastically higher temperatures, for both hot and cold days, making it harder for the blueberries to grow and be pollinated. The blueberries may be able to adapt, increasing production, and if not they will continue to decrease.

Citations

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