



# **Findings from the Field**

**A Middle School Journal of Scientific Research**

**Volume 1**

**June 2018**

*Findings from the Field* is a Gulf of Maine Research Institute (GMRI) project. It was made possible by the generosity of the Leon Lowenstein Foundation, the Noyce Foundation Fund of the Cornell University Foundation, and the Davis Family Foundation.

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## **Note from the Editors:**

We are excited to present Volume 1 of *Findings from the Field*, Maine's first journal of scientific research produced by middle school students! This volume is the end result of a process of scientific research, writing, and peer review. Over the course of the 2017-2018 school year, we received sixty-seven submissions from students in six different schools. Each submission was reviewed by at least one peer from a different community, with a total of nine schools engaging in peer review. Students shared their peer reviews through over one hundred comments - comments that included thoughtful critique and encouragement. Based on student recommendations, the editorial board conducted an additional round of review. Through that complete process and this incredible community's effort, the six articles in this volume emerged as the most impressive models of student work. You can find all submitted articles and reviews in the Vital Signs Project Bank at <http://vitalsignsme.org/project-bank>.

Through the collaborative efforts of all these participating classrooms, a community of student scientists has emerged. This community is investigating pressing, ecological questions and conducting data analysis, in their communities and beyond. They are engaging in thoughtful review of their peers' contributions, encouraging and inspiring one another to continue to explore and ask questions in the ecosystems around them. Teachers have been critical partners to their students and this editorial board, learning alongside us how to best support students in this work. We are so impressed with this community of young researchers and their teachers, and we can't wait to see what students contribute to Volume 2!

The Editorial Board  
Bill, Cynthia, Glenn, Meggie, Christine, Molly, and Leigh

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# Homemade Squirrel Repellent Effectively Alters Natural Foraging Behaviors

By Katie Sanborn

Center For Teaching and Learning  
Glenn Powers  
March 30, 2018

**Abstract:**

From doing this experiment I wanted to discover if a homemade squirrel repellent does alter squirrels natural foraging behaviors, causing them to avoid the pallet, as shown in previous experiments. To conduct the experiment I had two pallets with 150 grams of black oil sunflower seeds on each, and put homemade squirrel repellent on one, then placed them 15 feet away from each other and took data points from both every 2-3 days. After collecting 9 data points I found that the plate with squirrel repellent on it had less seeds eaten 100% of the time, and the average of the seeds left on the plate after doing the experiment was higher for the plate with homemade repellent on it. These findings confirmed that using a homemade repellent does effectively alter squirrels natural foraging behaviors, making them avoid the seed surrounded by repellent.

**Introduction:**

Squirrel repellents are common household items, that many people use to keep squirrels away from their birdseed, but do they really work, are they worth the money? Or can you make a more effective, less expensive homemade repellent? This problem affects many people, because they struggle with keeping squirrels away from things like, they're crops, birdseed, etc.

Many People rely on commercial repellents to keep their crops and birdseed safe, but what if you could make a homemade repellent with common household items, that is effective at keeping squirrels away from crops.

Previous studies have shown that using repellents does decrease squirrels natural foraging behaviors:

<https://patents.google.com/patent/US20050274314A1/en> In this article they say that using the repellent will change the squirrels natural foraging behavior, and keep them away from the area where the repellent is applied. But I want to find out if I will find the same results using a repellent that I made, by gathering data against a platform with nothing on it.

So from researching the issues, I decided that my essential question for this experiments will be: Is a homemade squirrel repellent effective then at keeping squirrels away from seeds? Using my previous research of this topic I decided that my hypothesis would be that, yes, a homemade squirrel repellent will work, because when you make it you can include effective ingredients, that have been proven to work in the past, whereas when you have a store-bought repellent you can't modify it, so your stuck with just the included ingredients, which might not be as effective.

To study my essential question and gather accurate data, I will set out two squirrel bate plates, ten feet away from each other, in covered places, with a dried corn cob in the center of the plate, then surround one plate with the homemade repellent, and one plate without repellent, then I will leave each plate for 24 to 72hours and go out and collect them the next day. To collect them I will gather the cob and weigh it, to see how much is left for each plate and record the data in a table. After 10 days of recording data, I will put my data in a bar graph to

compare the data. Then I will find the average amount of corn eaten each day and see which plate had a higher average. The one with the higher average was the least effective.

**Methods:**

During the weeks of *insert date here*, I set out two bait plates every Tuesday and Friday from 8-9 am to 12:30 to 1:30, gathering data every time I collect it.

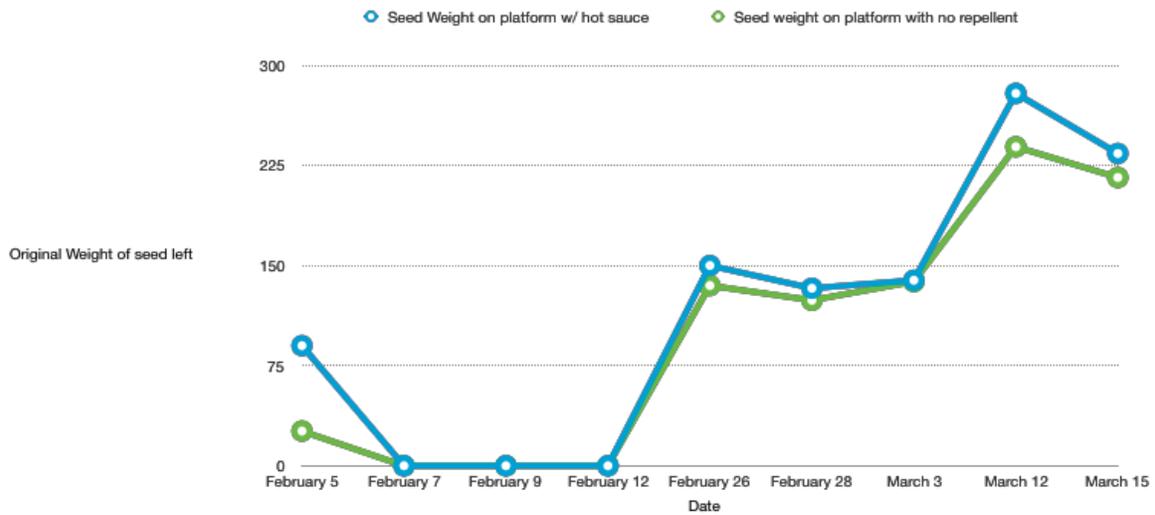
To set up the experiment, you will need to have: Hot sauce, water, Aspirin, apple cider vinegar, dried corncobs, black oil and commercial squirrel repellent, and a two foot by two foot piece of wood with borders. To make the squirrel repellent you combine a half a cup of water, with two cups of apple cider vinegar, and one and a half cups of hot sauce, I used the Hannaford brand. Blend well and pour into an empty plastic container.

To set up the bait plate screw in an I-hook and attach a screw to it with a piece of metal wire, then I screw the corn-cobs base into the screw and then I bring both plates into the woods. Find a covered “safe” place and set the platforms 10 feet apart from each other. Pour a decent amount of repellent all the way around the corn and leave.

After running the experiment three times, and only managing to collect one set of data, I knew something needed change, so I changed to using black oil sunflower seeds instead of corn, so I tested seeds, and when I went out the next day they were also all gone, so I decided to change my location. I took my platforms out of the woods, and placed them in an open field approximately fifteen feet apart from each, and the next day I was able to collect data.

**Results:**

Day	Original weight of seed	Seed Weight on platform w/ hot sauce	Seed weight on platform with no repellent	Percent of seed left on repellent platform	percent left on no repellent platform
February 5	150	90	26	60	17
February 7	145	0	0	0	0
February 9	175	0	0	0	0
February 12	150	0	0	0	0
February 26	150	150	135	100	90
February 28	155	133	124	86	80
March 3	150	139	138	93	92
March 12	300	279	239	93	80
March 15	300	234	216	78	72



From February 7 to February 9 when there was no corn left, I was having issues with a raccoon coming and taking all the corn before I was able to take my measurements, so I had three days where I wasn't able to collect any data. To solve my raccoon problem I decided to switch to black oil sunflower seeds, but then I was having issues with all the seed being eaten so I moved my experiment out of the woods on February 12 and was able to gather data on February 26. For March 12 and March 15 I had decided to put on more sunflower seeds because I wouldn't be able to collect data as often, so when I went to compare my data I switched it into percent's, because all the original weights were different.

The mean percent of seed left on the platform with repellent on it was 56.67%. The mean percent of the seed left on the platform without repellent was 47.8%. This shows that the homemade squirrel did work because the mean for seed left was higher for the platform with repellent on it. If I find the mean percent of seed left, removing the outliers then I get 85% left on the platform with repellent and 71.83% on the platform with no repellent so this shows that my previous claim of the repellent working is still true, even when I remove the data outliers. I decided to drop the outliers because I had issues with both my platforms during the weeks when I was getting no data, so I figured the average would be more accurate.

### Conclusion:

During the experiment I had trouble with gathering data in the beginning, so the next time I conducted this experiment I would start of using black oil sunflower seeds, instead of corn, and I would also recommend conducting the experiment in an open field, instead on in the dense woods. I found that when my experiment was in the woods, I was struggling with all my seed disappearing, and once I moved it out of the woods and to an open field, I gathered more accurate, better data.

After conducting my experiment I found that homemade squirrel repellent does work, and consistently keeps squirrels from eating the seed. This is shown in my results section, because the mean of seed left on the platform with repellent on it, even after removing outliers, was higher than the platform without repellent on it. Also looking at the table, I never collected data where the platform with repellent on it had more eaten than the platform with no repellent. These finding shows that this claim is true because if the mean is higher that tells me that more seed left on the platform, which means that less corn was eaten.

This data agrees with the background research that I gathered in my introduction because the article I gathered research from: <https://patents.google.com/patent/US20050274314A1/en> stated “When placed in an area, it convinces animals of a perceived threatening presence or a danger that self-motivates the animals to avoid the area and prevents thus the contamination, defacing, and/or damage to the area.” Both my experiment and this statement agrees with my findings, proving that homemade repellent effectively repels squirrels.

These findings are important because people can use this research to repel squirrels from their crops, and birdseed, while spending less money than if they bought commercial.

**Maine Birds Choose Camouflage Feeder  
Over Fluorescent Orange Feeder**

***By Forest Holbrook***

**Center for Teaching and Learning  
Teacher: Glenn Powers  
March 30, 2018**

## Abstract

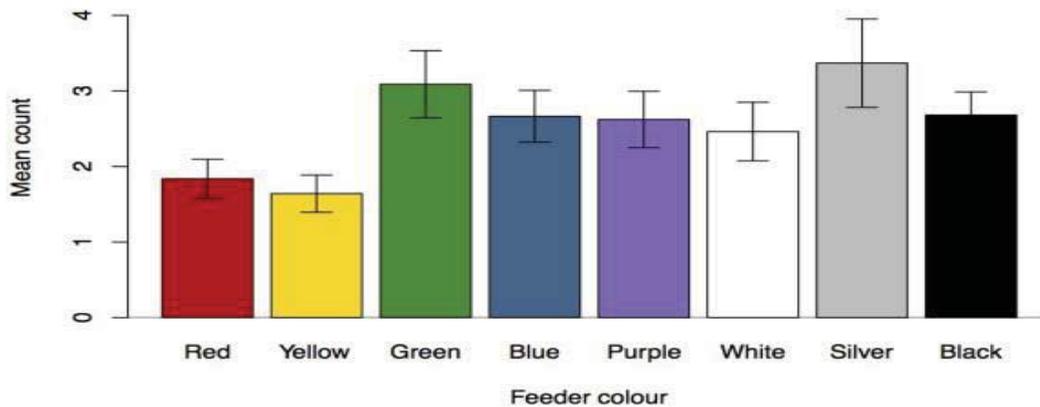
In this science paper, I wanted to figure out if birds preferred bright orange coloring or muted tones. My experiment gives an insight to which colors attract birds and which they see as danger. To create my experiment, I took two identical feeders and filled them with the same seed. Then I covered one feeder in bright orange duct tape and the other in camouflage. I hung the two feeders on the same tree, took them down each science class, and weighed them to find out how much seed had been eaten. I discovered that the camouflage feeder was eaten from more, while the orange feeder was emptied at a slower pace. Like the experiment conducted by *Morrell Labs*, I found that my color popularity matched their results.

## Introduction

A bird feeder can be more attractive to birds depending on its color. Brighter colors catch bird's attention, but their instinct may make them think it's a threat. With a darker, camouflage color, birds might overlook it, but on the other hand, birds won't see it as a threat.

*Morrell Labs* conducted an experiment in which scientists took eight identical feeders and painted the metal lids and bases each a different color per feeder— red, yellow, green, blue, purple, black, silver, and white. The feeders were hung in a row with three scientists recording their sightings for 185 hours during winter and they spotted 7,535 birds in all. The scientists created a bar graph using the means of each number of visits to each color feeder. Red got a mean of about 1.8 visits, yellow got a mean of about 1.6 visits, green got about 3.2, blue, black, and purple got about 2.7, white got about 2.5, and silver got about 3.4 visits. You can see that the shiny silver got birds attention, and so did green. Red and yellow, however weren't as attractive.





By conducting an experiment, I was able to answer my essential research question; do bright colors attract birds or do birds see it as danger? My hypothesis is bright colors will attract birds because they aren't that smart, and I conducted my experiment in a location that isn't hazardous to birds.

I conducted a similar experiment to *Morrell Lab's*, where I took two identical feeders and put strips of blaze orange duct tape on one and camouflage tape on the other. I put the feeders at the same height and only a few feet apart. As often as possible, I weighed how much seed was left in each feeder and recorded the data. This allowed me to answer my hypothesis. The orange feeder stood out from a distance compared to the camouflage feeder. The brightness could have been seen as danger to some birds or attractive and welcoming to others.

## Methods

To find out whether bright colors attract or scare birds, I wanted to use identical feeders, but differently colored to find which the birds prefer.

Materials List:

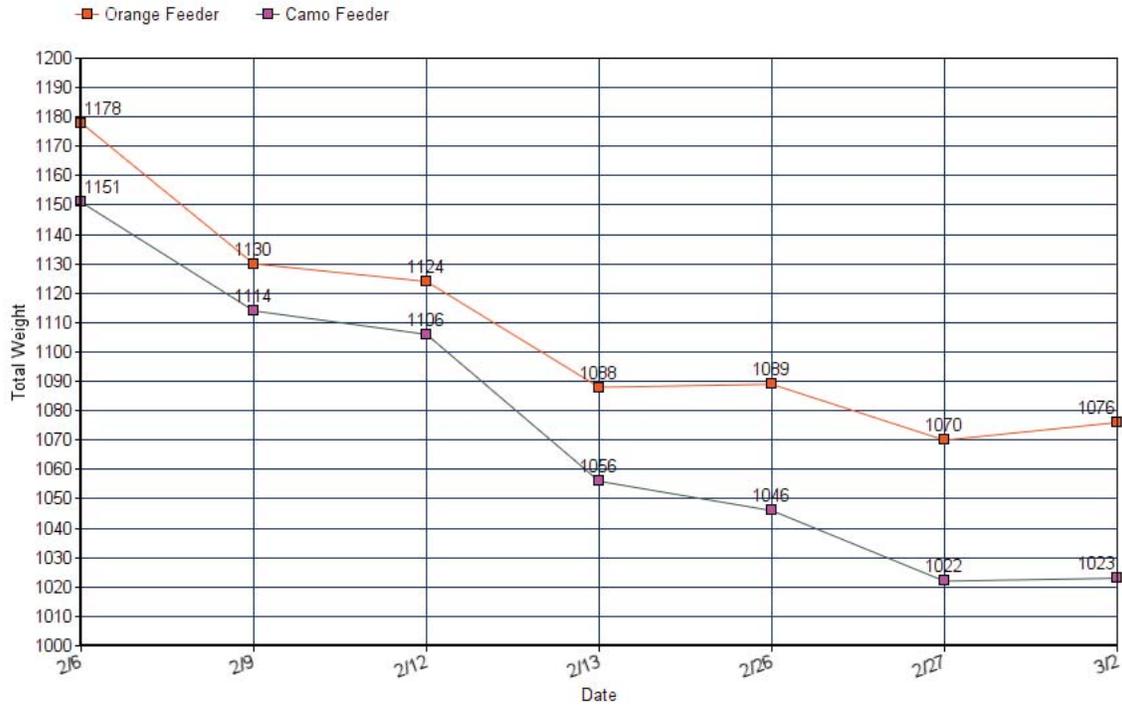
- Two identical bird feeders
- Bright orange duct tape
- Camouflage duct tape
- Electric scale
- Enough seed of the same variety to fill both feeders

I took two feeders that were the same model and color, and covered one in bright orange duct tape. The brightness of this feeder will either attract bird's attention or scare them away. I took the other feeder and covered it in a camouflage-patterned duct tape. The muted tones of this feeder will either make birds feel safer or make them ignore the feeder entirely. Then I filled both feeders to the brim with seed. I hung the two feeders on branches of a small tree in front of my school.

Each science class, I took the feeders down and weighed them with, one feeder at a time. After weighing and recording the weight of one feeder's remaining contents, I would repeat the process for the other feeder

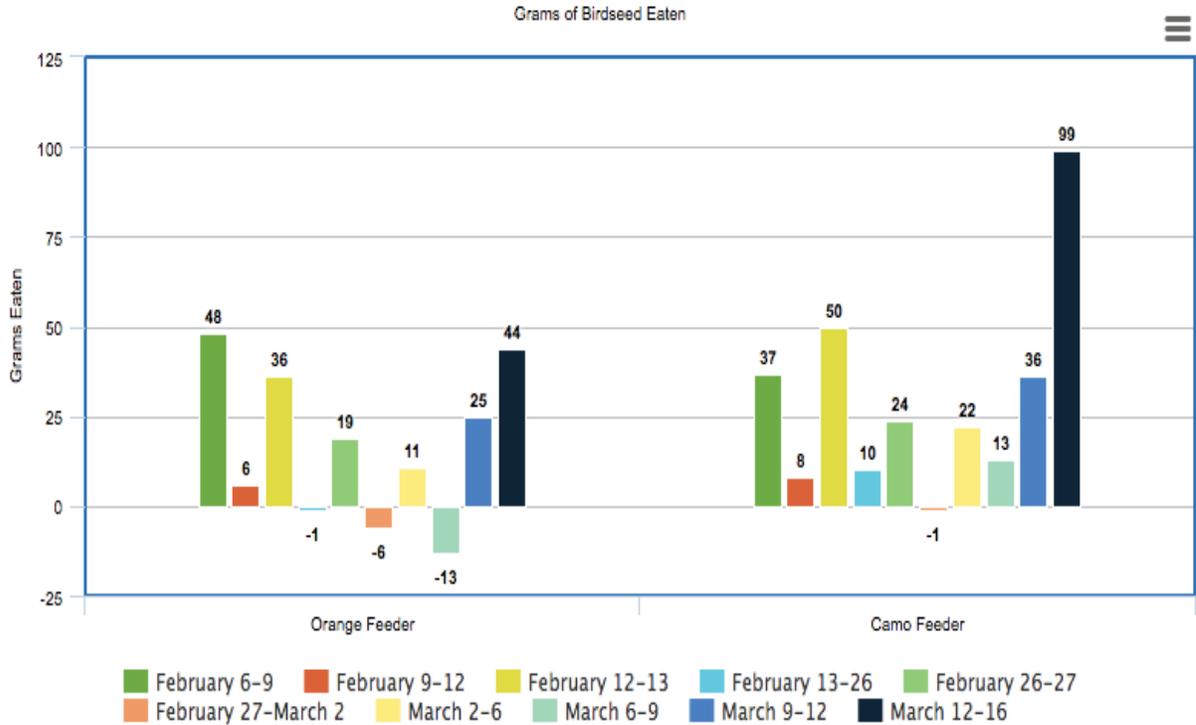
## Results

In my science journal, I would write the date and the total weight of each feeder each time I weighed the remaining seed. This graph shows the data I collected.



In my graph, you can see that both feeders had a started with a steep drop in weight, with the orange feeder dropping at a faster rate than the camouflage feeder at first. From February 12 to 13, the difference between the weights of the two feeders shone through. Over February break (from the 13<sup>th</sup> to the 26<sup>th</sup>), the weather affected the orange feeder, making it heavier, while the camouflage feeder still lost weight despite the weather. More snow affected the weight of both feeders from February 27<sup>th</sup> to March 2<sup>nd</sup>. The range of the orange feeder weights is 102 grams and the camouflage feeder range is 128.

Time Span	Orange Weight Difference	Camouflage Weight Difference
February 6-9	48 grams	37 grams
February 9-12	6 grams	8 grams
February 12-13	36 grams	50 grams
February 13-26	+1 grams	10 grams
February 26-27	19 grams	24 grams
February 27-March 2	+6 grams	+1 grams
March 2-6	11 grams	22 grams
March 6-9	+13 grams	13 grams
March 9-12	25 grams	36 grams
March 12-16	44 grams	99 grams



This table and graph show the same data. The orange feeder had three different outliers in which the snow *added* weight to the feeders. With the camouflage feeder, the weather affected it just once. It also had a major outlier with a difference of 99 grams. The average difference from the orange feeder's differences is 21.3 grams. The average of the camouflage feeder's differences is 29.8. Therefore, the camouflage feeder is more popular than the orange feeder.

## Conclusion

By conducting my experiment, I was able to answer my essential question; do bright colors attract birds, or do they see it as danger? My hypothesis was that birds would see the bright orange and go to the feeder because bird's brains do not have nearly the power as humans, so I figured they'd get excited seeing the bright colors.

However, as you can see in my first graph, more seed was eaten from the camouflage feeder than the orange feeder in total. Despite a few outliers when snow affected my data, and the surprisingly large drop in the camouflage feeder's weight—a drop of 99 grams, my data was the best in my class. I could tell that the camouflage feeder was more popular because its average weight difference is higher than the orange feeder's.

Going back to the *Morrell Labs* experiment, silver and green were the most visited feeders, and the red and yellow feeders were least. My data I collected makes sense because mixing red and yellow makes orange, and camouflage has bits of green and grey in it.

Even though my experiment was taken using bird feeders, my finding can be used to lure and scare birds away in the wilderness. If a scientist wanted to keep birds away from their garden, they could put red, yellow, and orange colors around it. On the other hand, if a scientist wanted to attract lots of birds to study and make drawings of, they could add some green and camouflage material around their property.

**Crab Per Trap to Year and Location  
2013-2017**

Adriana Gonzalez

Bath Middle School  
Bath, ME  
Mrs. Wright  
12.19.2017

## Abstract:

Many workers who harvest these marine mammals are being put at risk because of the invaders who are destroying eelgrass, home to many small fish and even juvenile lobsters, who are putting these creatures out of homes into open and unsafe waters. The catch and release method was used to calculate how big the population of green crabs are in the coastal region of Phippsburg and Georgetown. There was only one re-catch caught at Reid State Park marked with yellow nail polish; making the population of green crabs in the Georgetown area one of the biggest. At Fort Popham there were over 270 crabs caught and no recaptures making the Phippsburg coastal region even bigger than the Georgetown green crab population. My overall results were based on the number of crabs caught per trap to the year they were caught and in multiple locations in which we went. I found that in 2015 crab population started rising in 2 locations and started to decrease in the other. In conclusion, green crabs are one of the biggest and baddest invasive crab species of them all. From towering and dominating population and overall aggressiveness, strength and speed, green crabs aren't going anywhere soon.

## Introduction:

Did you know that because of global warming, Maine has the 2nd fastest warming water in the world? (Greenhalgh 2016) Did you also know that because of this we are suffering major damage to our oceans, also including threats to Maine's economy by even possibly threatening juvenile lobsters? This damage can all be brought back to the invaders the green crabs. In 2013, the population of green crabs exploded, many researchers believed that green crabs were here since the early 1900's because of the warm water that was still quickly increasing. Sadly, they will not die like they are supposed to because we've been experiencing unusually warm winters the past few years. (Byrne 2013) The gap in our knowledge is how many are there?

Green crabs are a threat to Maine's ocean sustainability, the article, [Invasive Species Exploit a Warming Gulf of Maine, Sometimes with Destructive Results](#) by Colin Woodard states that, "Eelgrass coverage in Maquoit Bay fell by 83%," in October of 2015. Maquoit Bay is in Brunswick, Maine, very close to our study site, but imagine that if only one bay near the ocean has fallen more than 50% how the population of eelgrass has decreased in the entire ocean over the past 2 years. The essential question is: How are the invasive crabs species impacting the marine ecosystem?

One of the ways invasive species are impacting the marine ecosystem is by tearing out eelgrass, a crucial need for young fish. Eelgrass is an extremely important survival skill for all ocean species it is a nursery for all baby fish and species such as the juvenile lobster, because these species are fighting for eelgrass and being endangered out in open waters and the species may not survive. Although, lobsters aren't the only thing being harmed by green crabs. Clams are also being endangered because they are one of the most favored foods by green crabs. They are being found less and less throughout Maine's mudflats.

These invasive species have major effects on not only the ecosystem they surround, but the economy as well. If a species like soft-shelled clams aren't surviving it can damage the economy of Maine. If these crucial species aren't surviving it puts many people with jobs harvesting marine animals at risk by lowering their chances to make money and pay for their meals.

It's important to understand that our essential question is important to Maine and its ecosystems. Without it we wouldn't understand the harm green crabs bring and the effect it has on our oceans. We have

an amazing economy today, and delicious food, but with green crabs still thriving in our oceans we may not have it anymore. Green crabs may also make the economy worse by getting rid of the great stock markets of commercial fish and also rid thousands of people of their jobs. In conclusion, green crabs are a very harmful, invasive species destroying our oceans without a good cause.

## Methods:

The method we used was catch and release to see how big the population of green crabs were.

We set 3 traps that were legal green crab traps baited with sardines. The traps were put into the water approximately 24 hours before it was pulled the next day. The day the traps were pulled they were separated into buckets for each body of water they were pulled from in which they were measured, identified by sex, crab color, aggressiveness and if any markings or paint was present. We measured each crab by using the centimeter side of a ruler to measure from final spine to final spine over the carapace of the crab. The sex was determined by the shape of the apron on the abdomen of each crab. The crab color was determined by the color on the abdomen between each claw. Each crab was quickly assessed before being cleaned with acetone (nail polish remover). After each crab was cleaned we applied a thin coat of yellow, quick drying nail polish for our marking color. We released our catch to the body of water in which they were found, one at Todd's Landing and two at Reid State Park, we reset our traps before returning home.

Our next trip, the traps were actually set for 48 hours instead of 24 due to the heavy rains occurring on Wednesday, 10/25, and Thursday, 10/26, an accidental error. Even though there was heavy rains on Thursday we still pulled traps, assessed and marked. We made another small error on Thursday and used the same color nail polish on Tuesday, something to come back at us in the future. On Friday, we assessed each crab and marked just like the days before but this time each crab was marked with a pink, quick drying nail polish instead of yellow so we would know the re-catch.

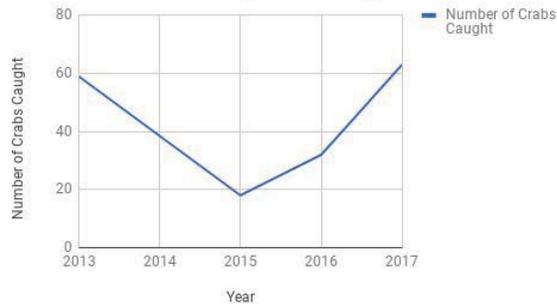
Everything was made fair by using the same amount of bait and the same kind. Each trap was put into the same body of water and each trap was of the same kind.



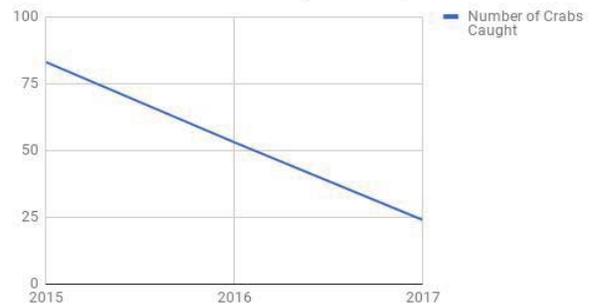
This is the color chart we used to find the color of each crab.

## Results

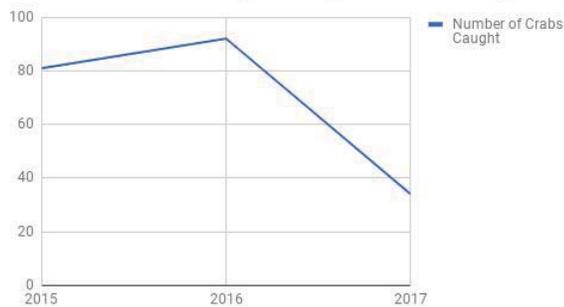
Number of Crabs Caught vs. Year // Reid State Park



Number of Crabs vs. Year // Fort Popham



Number of Crabs Caught Year // Todd's Landing



The line charts above show the number of crabs caught per trap since 2013 at each location we've been to. The reason it is per trap rather than all the traps put together was so it was made fair because at different locations in different years there were more traps set than others which led to more crabs than others. Therefore everything is made fair by using per trap instead of per year.

The number of crabs caught each year is divided by 2 to show what has approximately come out of each individual trap and not all of the traps combined. As you can see in 2016, Todd's Landing had an increase as Reid State Park started to gradually increase as Fort Popham was decreasing. In 2017, Todd's Landing and Fort Popham were both decreasing although Reid was just starting to increase.

See next page for table. ->

Year // Reid State Park	Numbers of Crabs Caught (Per Trap)
2017	63
2016	32
2015	18
2013	59
Year // Todd's Landing	Numbers of Crabs Caught (Per Trap)
2017	34
2016	92
2015	81
Year // Fort Popham	Numbers of Crabs Caught (Per Trap)
2017	24
2016	53
2015	83

## Conclusion

Green crabs are impacting the marine ecosystems of Maine in a very harmful way. For instance, green crabs do the most damage by being the most aggressive and having the largest population. Many may argue that green crabs aren't doing the majority of the damage but if they are right then who's doing this damage?

I argue that green crabs are doing the damage because they have out ranked the population of any other crab in the state of Maine. Green crabs have pushed native crabs out and into deeper waters as they don't thrive in the way that they would if they got equal food. Also, nothing eats green crabs and winters aren't freezing them anymore due to global warming in the state of Maine. With this, green crabs are indestructible.

Green crabs have an appearance like no other. All green crabs have a 5 spined carapace and are usually colored green but can also be dark brown, orange, or red. Did you the species can also survive with missing limbs? The percentage of green crabs that were damaged during our expedition was 2% of survival without every limb from crabs at both Reid and Todd's Landing.

The catch and release method was extremely important to our experiment. Colored nail polish was applied to each crab to know if one was re-caught or not (see page 3 for more info). The reason we did this was to show how big the population of green crabs in the area was. We only had one re-catch and it was on Friday, October 27. Sadly, we made an error. On Thursday, due to the limited supply of nail polish we again

painted the crabs yellow because the re-catch color was yellow, so we can not tell which day it came from, Monday or Thursday.

In conclusion, green crabs are an important topic to learn about. If green crabs aren't more widely known then they may cause even more destruction to not just Maine oceans but oceans all around the world. If the green crab population continues to grow than they may also wipe out a majority of crab populations world wide. If green crabs are still eating away the marine ecosystems many workers whose jobs are harvesting and maintaining the marine life may be out of jobs which of course affects the economy. If people are out of jobs they do not have enough money to support themselves or their families.

Green crabs are bad to marine ecosystems and need to be stopped. If not many things may and probably will become scarce for not only Maine's but the world's environment.

## References

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<<https://www.climate.gov/news-features/climate-and/climate-lobsters>>

Bryne, Matt (2013): In Maine, Green Crabs Threatening Clamming

<[http://www.pressherald.com/2013/05/27/green-crabs-threaten-clamming\\_2013-05-28/](http://www.pressherald.com/2013/05/27/green-crabs-threaten-clamming_2013-05-28/)>

# **Effects of Climate Change on Green Crab Population in Maine Coast**

By Riley Dunn

Bath Middle School  
Bath, ME  
Mrs. Wright  
12/19/17

## **Abstract**

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

## **Introduction**

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

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

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

## **Methods**

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

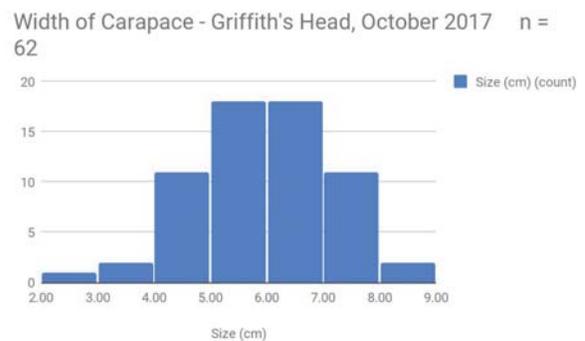
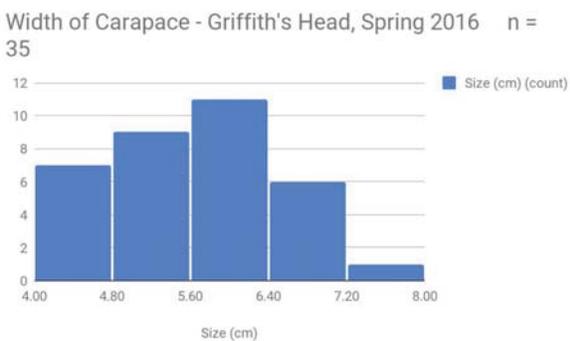


*This is the color chart used to check the color under the crabs' claws.*

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

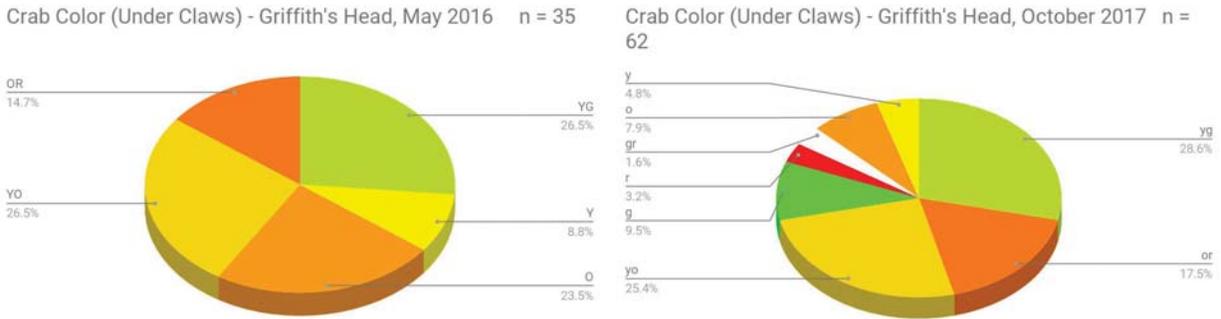
Controls worked into the study were the fact that the bait was the same each time the trap was set, and it was fresh each time, the location was the same, and the trap was set and pulled up during the same tide cycle each time. The trap would have been allowed to sit for the same amount of time each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

## Results



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

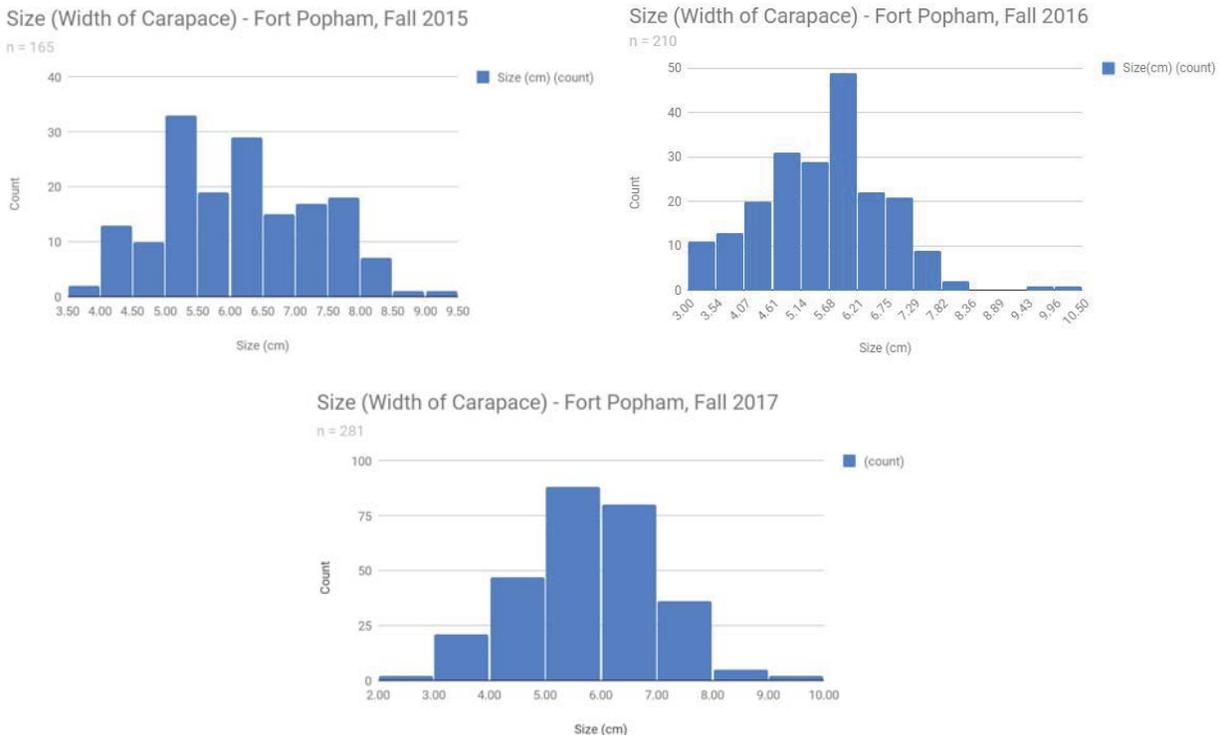
Next are two pie charts showing the proportions of color under the claws. It is over the same time span as the last two, one in the autumn and one in the spring of the previous year. This can show the crabs' wellbeing over the different seasons.



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

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

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



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

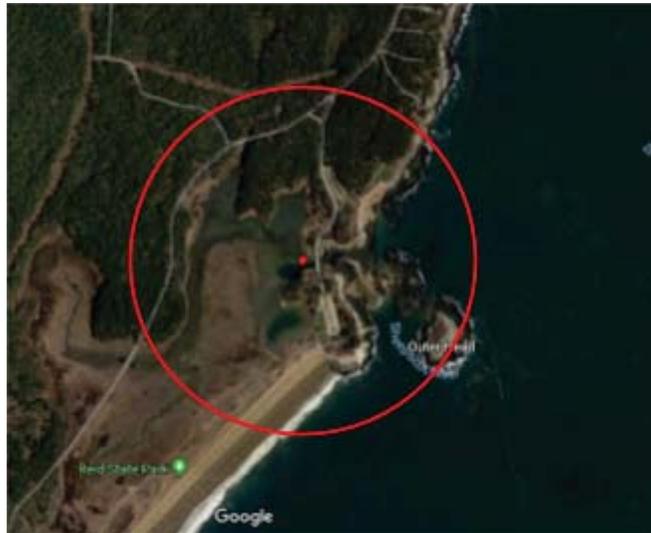
Finally is a formula which can estimate the population of crabs. Using the data from two consecutive visits, the Lincoln-Petersen index,

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

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

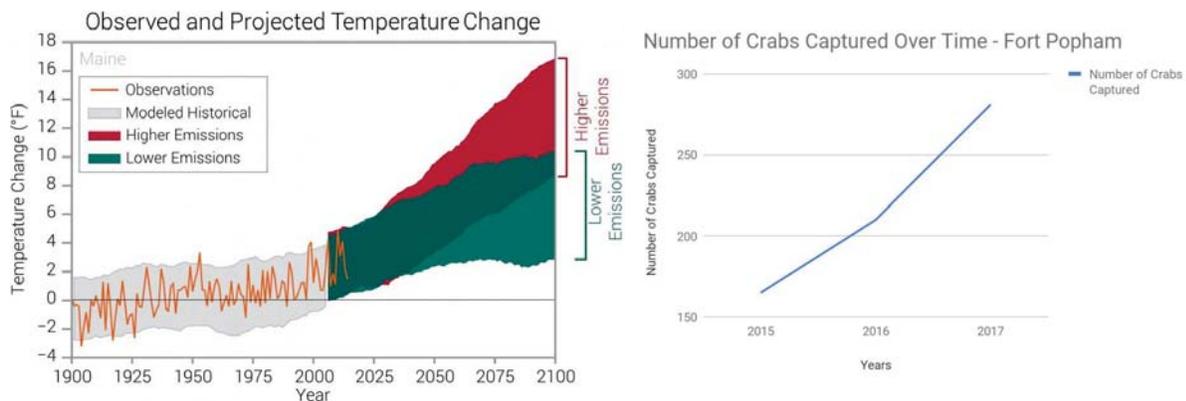
$$N = \frac{20 \times 25}{1}$$

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



## Conclusions

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



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

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

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# **Goosefare Brook is Cleaner than it was in 2013**

**Kailee Morin**

**Loranger Memorial School**

**Ms. Seaver and Mrs. Nye**

**March 2018**

# Goosefare Brook is Cleaner than it was in 2013

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March 2018

## **Abstract**

We wanted to make sure that the Goosefare Brook was healthy because the brook leads into the ocean which is a big tourist attraction and if the water is dirty, people going in the water could get sick. We went to three different places and tested the water, looked for macroinvertebrates, and counted biodiversity. All the water tested “good”. We found lots of macroinvertebrates in one place, not as many in another, and no macroinvertebrates in the last place. In one place we found a patch of phragmites with a biodiversity count of 4, in another place they found a small patch of phragmites with a biodiversity of 7, and in the last place they didn't find any phragmites they had a biodiversity count of 7+.

## **Introduction**

Our investigation started with a Question: Is Goosefare Brook a Healthy Ecosystem? This question is important because the Goosefare Brook is a important watershed in Saco and Old Orchard Beach. The Goosefare Brook leads into our ocean and could cause people to get sick and not come to the beach and that can damage our economy.

We read an article from 2013 that states Goosefare Brook has been known to have dangerous levels of fecal matter bacteria in it. We know that it starts in Saco Heath, which is a pretty healthy ecosystem, and has endangered butterflies that live there. We know it empties into the ocean near Ocean Park. There used to be a huge salt water pool at Ocean Park, and today there are some phragmites there.

We know phragmites are a super invasive plant which takes over. We know phragmites makes a wall, its stem is hollow and round, and it has long sword like alternately placed leaves. We know Megan from the DEP continues to test the water because it has been “listed” as an “impaired” stream, and they are trying to figure out where the pollution comes from.

The purpose of our investigation is to see if the Goosefare Brook is healthier now than it was in 2013. We want to look at three different factors that will tell us if the Goosefare Brook is healthy or not. We will be testing the water, searching for macroinvertebrates, and looking to see if there is any phragmites. Testing the water will tell us if there is still fecal matter in it, the macroinvertebrates will tell us how healthy the water is, and if there are phragmites there is less biodiversity and places without phragmites have more biodiversity.

I think we will discover that Goosefare Brook is a healthy-ish ecosystem, because once people found out the problems in 2013 they would find a way to fix it. If there's still fecal matter in the water it's probably not a very healthy ecosystem.

## Methods

The group that tested the water used a LaMotte Water Monitoring kit, test tubes, testing tablets, and a thermometer. They used a digital meter from the Department of Environmental Protection that measured conductivity and a refractometer for testing salinity. They collected data on a sheet called Water Testing: Goosefare Brook.

The group that investigated phragmites and biodiversity used a GPS, quadrats, and a science notebook with species identification pages. They had an iPad to take photos. They wore waders and boots so they could go in the water. They collected data on a sheet called Species & Habitat Survey: Freshwater Habitats.

The group that looked for macroinvertebrates used a Macroinvertebrate Identification sheet from Vital Signs, a Macroinvertebrate Data sheet from Vital Signs, a Macroinvertebrate Stream Health Index from Vital Signs, an iPad for taking photos, a pencil for recording data with, and a clipboard for recording data.

The group that tested the water used the LaMotte Water Monitoring kit tablets for testing the dissolved oxygen, nitrates, phosphates, pH levels, and coliform bacteria. We also tested the water for salinity using a refractometer from the DEP, and we used a digital meter from the DEP to test for conductivity.

The group that looked for macroinvertebrates scooped up muck from the bottom of the water body in a pie pan and watched until they saw something moving. Then they would scoop the moving thing into a different or smaller dish with a spoon and observe it with a magnifying glass and identify it using a Guide to Macroinvertebrate Pollution Tolerance Chart, and they used the Macroinvertebrate Stream Health Index

The group that searched for phragmites looked near small water bodies. Once they found a place to put their quadrat and counted the biodiversity in a square meter they were looking how many different species there were and then if there was phragmites they also estimated the percentage of the area covered.



The photo on the left shows students identifying phragmites near Trout Brook. The photo on the right shows a quadrat with phragmites at Old Salt Tributary.

**Results**

## Trout Brook

Macroinvertebrates	Water Testers	Plants
The macroinvertebrate team found a cadice fly case, caddis fly larva, riffle beetles, gilled snails, dragonfly nymph, water bugs and yellow spotted salamander.	The water testing team found out that the water was pretty healthy the ph level was 7 = good, the dissolved oxygen was 11 = good, and the nitrates and phosphates were low.	The plant team found phragmites, butterflies, mosquitoes, songbird, oil in the water, and cattails.

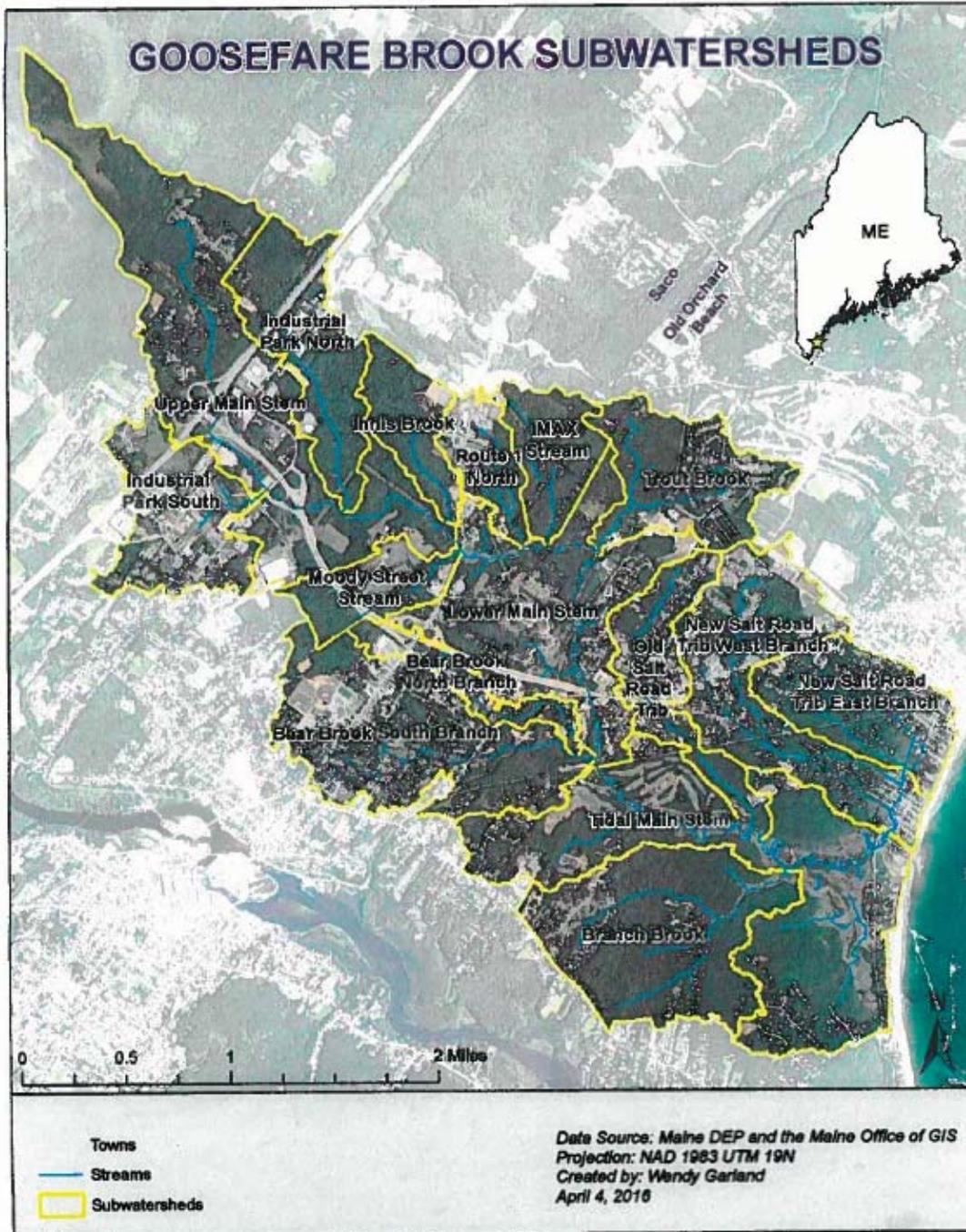
## Goosefare Pond

Macroinvertebrates	Water Testing	Plants
The macroinvertebrate team only a few level 2 macroinvertebrates it could be good or somewhat polluted.	Ph level 7 = good Dissolved oxygen 7 = decent Nitrates= less than 5 ppm/low Phosphate= less than 2 ppm/low	No phragmites

## Old Salt Tributary

Macroinvertebrates	Water Testing	Plants
Not many not sure if dirty water or just hard to find	Ph levels 7= good Dissolved oxygen 9= good Nitrates = less than 5 ppm/low	Phragmites found only small patch Lots of other plants and animals = pretty good biodiversity

All the information in the table above tells about our results from the three different places.

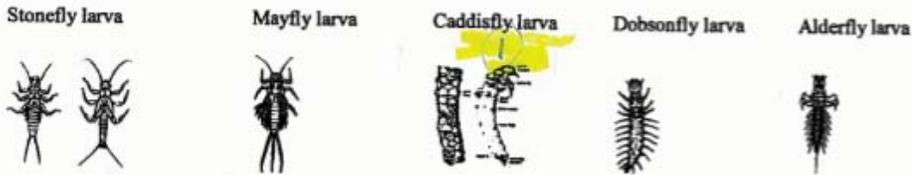


This map shows the source of Goosefare Brook and the sub watersheds. We investigated three of the sub watersheds: Innisbrook in Saco, Trout Brook and Old Salt Tributary both on the Old Orchard Beach side.

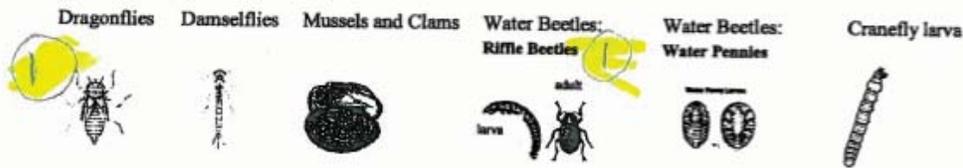
# Trout Brook

## Guide to Macroinvertebrate Pollution Tolerance Groups

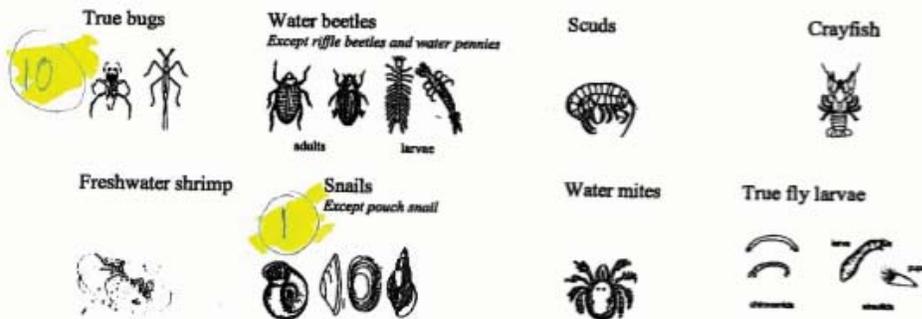
**Group 1: Sensitive.** Most animals in Group 1 are quite sensitive to pollution. They live in clean water with plenty of oxygen, and indicate healthy stream conditions when common or abundant. In very polluted waters, few (if any) animals in this group will be able to survive.



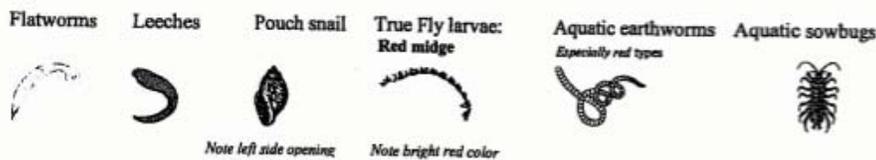
**Group 2: Somewhat Sensitive.** Most Group 2 animals are relatively sensitive, but can tolerate some pollution and slightly reduced levels of oxygen in the water.



**Group 3: Facultative (wide range of tolerance to pollution):** Facultative animals typically can live in a wide range of different habitats, and are found in both healthy water bodies and somewhat polluted sites. Within this group, certain species are more sensitive while others are more tolerant.



**Group 4: Tolerant.** In general, animals in Group 4 are tolerant to pollution, although some types are more sensitive than others. They are often found in healthy water bodies in low numbers, however the presence of large numbers of Group 4 animals typically indicates poor water quality. This is especially true if animals from Groups 1 and 2 are absent.



This chart shows the macroinvertebrates that we found at Trout Brook and their pollution tolerance.

9/27/17 Trout Brook

Maddy + Kailee

### Macroinvertebrate Stream Health Index<sup>1</sup>

Aquatic macroinvertebrates are animals without backbones (insects, worms, snails, etc.) living in the water that are big enough to see without using a microscope. We can determine the health of a stream or other water body by looking at the number and types of macroinvertebrates living there, along with information about how sensitive or tolerant each animal is to pollution. Use the *Guide to Macroinvertebrate Tolerance Groups* to calculate the Stream Health Index score based on your macroinvertebrate community sample.

**Step 1.** For each pollution tolerance group, record the total number of animals in the spaces below.

**Step 2.** Multiply the number of animals in each group by the factor shown and record the results.

**Step 3.** Add the number of animals for all groups and record the total where indicated.

**Step 4.** Add the values from Step 2 for all groups and record the total where indicated.

**Step 5.** Divide the total value from Step 4 by the total number of animals from Step 3 to obtain the Stream Health Index score. Use the chart at the bottom of the page to determine the Stream Health Category.

Number of Group 1 animals	<u>1</u>	x	4	=	<u>4</u>
Number of Group 2 animals	<u>2</u>	x	3	=	<u>6</u>
Number of Group 3 animals	<u>11</u>	x	2	=	<u>22</u>
Number of Group 4 animals	<u>0</u>	x	1	=	<u>0</u>
Total animals (all groups)	<u>14</u>				
			Total value (all groups)		<u>32</u>

Total value 32 ÷ Total animals 14 = Index Score 2.28

Stream Health Category (Excellent, good, fair or poor): Fair

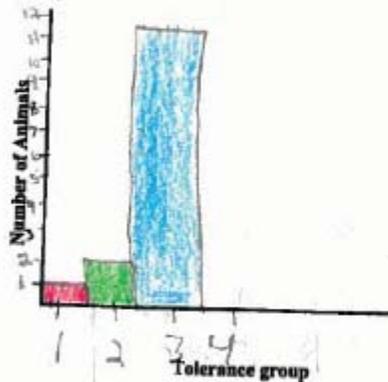
#### Stream Health Index

Excellent.....3.6 and higher

Good.....2.6 - 3.5

Fair.....2.1 - 2.5

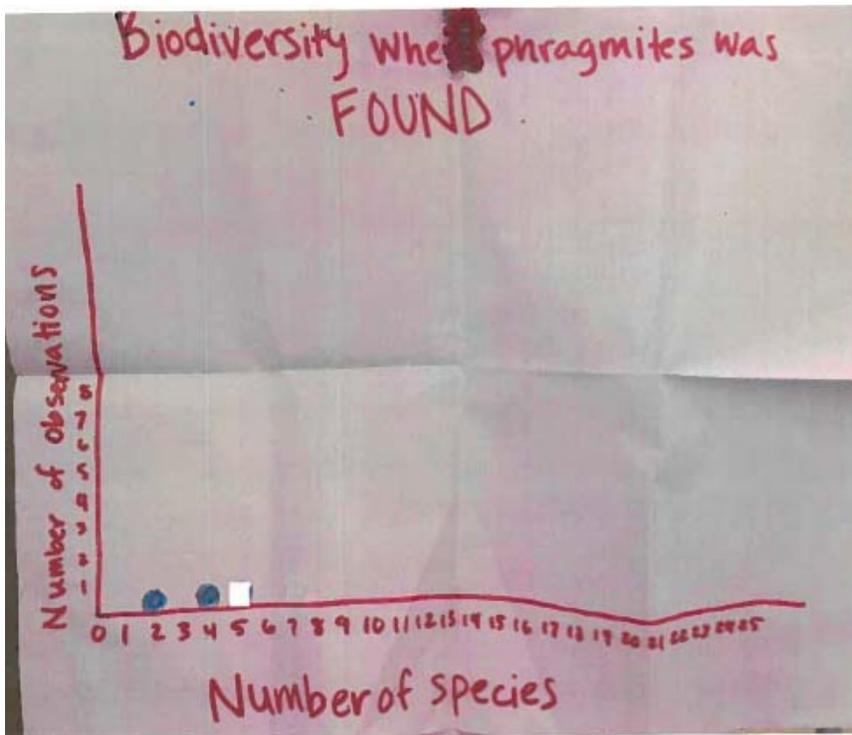
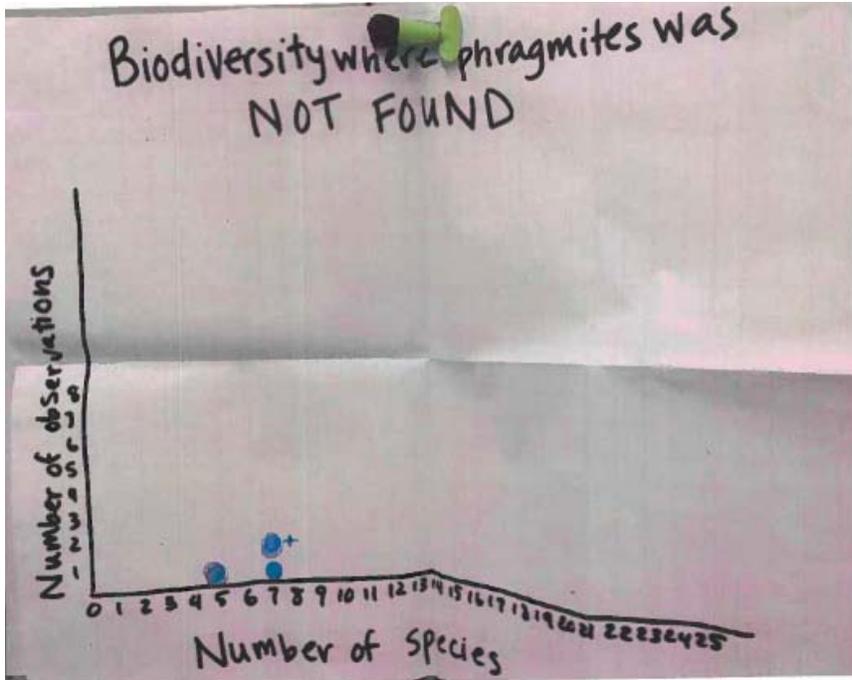
Poor.....1.0 - 2.0



**Challenge:** Create a graph of the number of animals in each tolerance group in the space provided above.

<sup>1</sup> Adapted from Citizen Monitoring Biotic Index, University of Wisconsin 2014, Water Action Volunteers - Volunteer Monitoring Factsheet Series, [watermonitoring.uwex.edu/web/monitoring/sheets.html](http://watermonitoring.uwex.edu/web/monitoring/sheets.html)

This is the Macroinvertebrate Stream Health Index we completed for Trout Brook. It shows the number of animals in different groups and says that Trout Brook stream health is fair.



The chart with two dots shows the biodiversity where phragmites were found at Trout Brook and Old Salt Tributary. The chart with three dots shows the biodiversity where there was no phragmites at Trout Brook, Old Salt Tributary, and Goosefare Pond. There are more species where phragmites was not found.

## Conclusions

Is Goosefare Brook a healthy ecosystem? I believe, from all the data we collected, Goosefare Brook is a pretty healthy ecosystem. I believe that the water quality is the most important part because that's the water going into the ocean, and people and animals in or near the water could get sick if the water is dirty. In all three places that we tested, the water quality was "good". When we went to Trout Brook, Old Salt Tributary, and Goosefare Pond, we did some water tests and we found that the water was pretty healthy. When we went to Trout Brook, Old Salt Tributary, and Goosefare Pond we did a biodiversity count in a square meter. It's important to do a biodiversity count where there is phragmites to see how many species are living near phragmites. When we went to Trout Brook we found lots of macroinvertebrates that are sensitive to pollution. When we went to Old Salt Tributary we didn't find many. When we went to Goosefare Pond we found some level two macroinvertebrates which means it could be clean or could be somewhat polluted. That's why I still believe that Goosefare Brook is a healthy ecosystem. Other people could think that it's still dirty because we didn't find any macroinvertebrates when we went to Old Salt Tributary. We could go search again and might and find some. Two of the sites we visited had phragmites and we can help get rid of them by cutting off the plume, which contains the seeds. The DEP will keep testing the water to see if it gets any better or worse, especially if it gets high levels of dangerous bacteria so the beach gets shut down. Hopefully the water will stay as clean as it has been in 2016.

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[https://docs.google.com/presentation/d/1YdiZ9BayIE\\_GtpzJwhzdus7Jey69p8KzLvmtycJZM1Q/edit#slide=id.p3](https://docs.google.com/presentation/d/1YdiZ9BayIE_GtpzJwhzdus7Jey69p8KzLvmtycJZM1Q/edit#slide=id.p3)

# **Goosefare Brook Watershed has Good Biodiversity but Phragmites is Invading**

**Madison Shaw**

**Loranger Memorial School**

**Mrs. Nye and Mrs. Seaver**

**January 30, 2018**

## **Abstract**

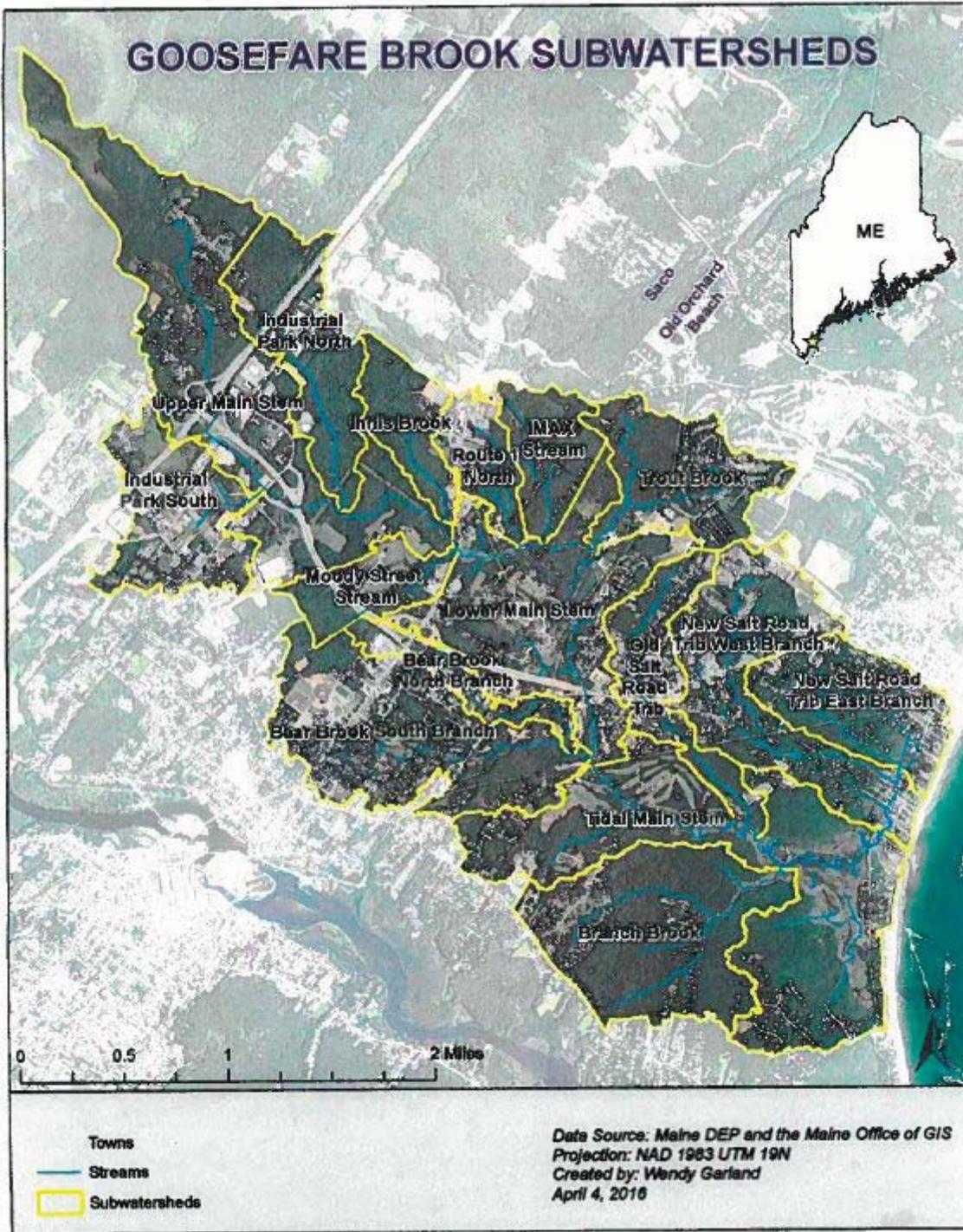
Our purpose was to find out if the Goosefare Brook ecosystem is healthy. My group focused on biodiversity. Our method was to go to sites along the Goosefare Brook watershed and count the number of different plant and animal species we found. We used a quadrat to count the number of species in a square meter. We were looking for an invasive species, phragmites. We found that phragmites is not all over the watershed, but it is in three places. Where we found it, biodiversity was lower. We concluded that the ecosystem is fairly healthy but we need to control the phragmites population so it doesn't spread.

## **Introduction**

We are investigating phragmites and biodiversity in the Goosefare Brook watershed. Phragmites is an invasive species, not native to Maine. It is a tall plant with long leaves and it grows like a wall. It has large purplish seedheads. Because it's so tall, it sways in the wind and the seeds blow around and spread so more plants grow. It fills in marshes, ponds, and streams and kills off other plants. Goosefare Brook is an important watershed in Saco and Old Orchard Beach. The Goosefare Brook is eight miles long. It starts in the Saco Heath and goes to the Ocean Park beach where it flows into the ocean. There are many unique species that live along the Goosefare watershed, including rare and endangered animals and insects. Some of them are rare Pitcher Plants, Atlantic White Cedar, and the endangered Hessel's Hairstreak Butterfly. All of these organisms live in the source of the Goosefare, the Saco Heath. We started our investigation at the heath. We observed a lot of biodiversity in the heath. We didn't see any phragmites there. Then we went to the mouth of the Goosefare Brook, where it flows into the Goosefare marsh and the ocean. We saw phragmites in the marsh and in the woods near the marsh.

Mr. Kimbark Smith from the Conservation Commission met us at the tide gate where the marsh connects to the Goosefare Brook and the ocean. He told us why the marsh is so important. "All of Ocean Park is below sea level, so the marshes are our protection from storms and rising tides," he said. Marshes also have high biodiversity levels. Many types of plants, fish, shellfish, mammals, insects, and birds depend on the marsh for food, shelter, and space to live. Phragmites could take over the marsh and hurt other species, so the Conservation Commission wants to get rid of it.

We wanted to find out if phragmites is all over the Goosefare watershed or just in one place. If it's just in one place, we could try to get rid of it before the seeds spread. Our plan was to go to Trout Brook near the Blueberry Plains, Goosefare Pond, and Old Salt Tributary. In each place groups would look for phragmites and biodiversity, look for macroinvertebrates, and test the water. We thought we would find phragmites in all those places because they are connected and all go into the marsh and we saw a lot of phragmites at the marsh.



This map shows where we went. Goosefare Pond is in the Innis Brook subwatershed on the Saco side of the town line. Trout Brook is in the northeast on the Old Orchard Beach side. Old Salt Tributary is closer to the ocean towards the middle of the highlighted area.

## Methods

I was on the team that looked for phragmites and biodiversity at Trout Brook. When we got to Blueberry Plains, we walked to Trout Brook and looked for phragmites. We found a big patch of phragmites in a little stream that is a tributary to Trout Brook. We used species identification cards to make sure it was phragmites. Then we went into the phragmites to set our quadrat. We opened a side of the quadrat and pushed the ends into the patch because we could not get the quadrat over the tall phragmites. Then we counted the biodiversity in the quadrat. Then we estimated how much of the area was covered by phragmites. Some other people in our group set a quadrat where there wasn't phragmites and counted the species in that quadrat. We wanted to compare the biodiversity count in areas with phragmites and without phragmites to find out if the biodiversity count was higher or lower.

The next day another class went to Goosefare Pond and followed the same procedure. The last day the third class went to Old Salt Tributary and the marsh and followed the same procedure. At each site, groups also looked for macroinvertebrates and tested the water quality.

Back at school, we put all our data together in a chart. We made dot graphs for phragmites and biodiversity. We looked at the TUVA website to see data for phragmites in Maine. We posted entries on Vital Signs and wrote Goosefare Brook lab reports.

## Results

DATA	Macroinvertebrates	Phragmites and Biodiversity	Water Testing
Trout Brook Tributary	<p style="text-align: center;"><u>Found</u></p> 1 caddisfly case 1 caddisfly larva 1 riffle beetle 1 filled snail 1 dragonfly nymph 10 water bugs/true bugs 1 yellow-spotted salamander  found caddisflies = Group 1, sensitive to pollution so water must be pretty good  Stream Health Index Score = 2.2 = fair	We found phragmites in a tributary to Trout Brook.  Where we found phragmites biodiversity = 4: phragmites, two short plant species and a mosquito  Where we did not find phragmites biodiversity = 7: cattails, 3 short plant species, butterflies and mosquitoes	pH was 7 = good  dissolved oxygen was 11 ppm = good  nitrates less than 5 ppm phosphates less than 2 ppm low = good

Goosefare Pond	found a few Group 2 animals, somewhat sensitive to pollution = could be good, could be somewhat polluted	No phragmites. They identified cattails, sedges, plus ten other species= high biodiversity Biodiversity 7+	pH was 7 = good  dissolved oxygen was 7 ppm = decent
Old Salt Tributary	Not many animals- not sure if dirty or just hard to find	Yes a small patch but it covered 100% of the area - biodiversity = 2: phragmites and short grass = low biodiversity Where there was no phragmites - biodiversity = 5	pH was 7 = good  dissolved oxygen was 9 ppm = good  nitrates were low = good

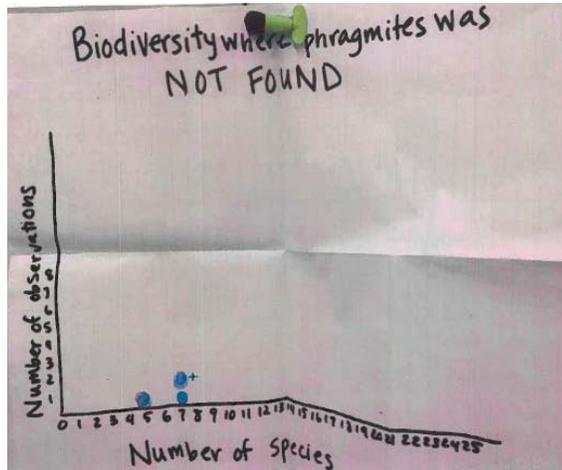
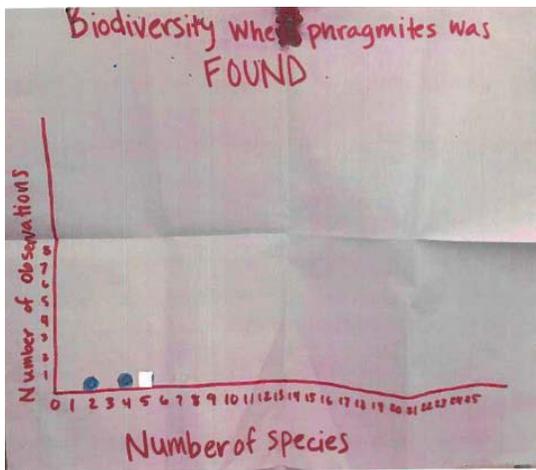
This table shows all the data we collected. At Trout Brook, my group found a big patch of phragmites in a tributary that flows into Trout Brook. The patch of phragmites was so thick that we had to make a path into it. It was hard to walk through because the phragmites would drag at our ankles and the seeds would start spreading. The phragmites formed a canopy that blocked light from getting to shorter plants that could have been growing there but weren't.



We found phragmites near Trout Brook.

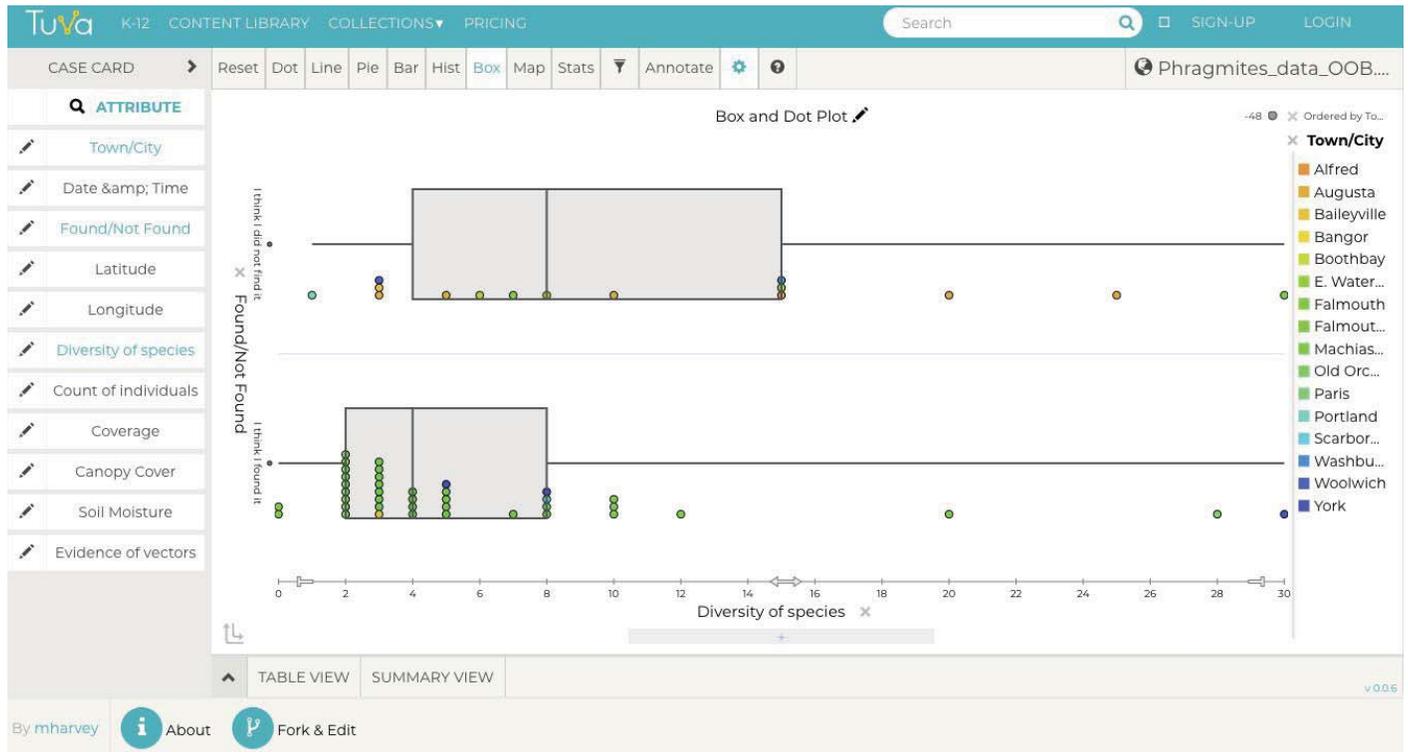


We found a small patch of phragmites in Old Salt Tributary. The biodiversity was higher in the square meter with no phragmites.



These dot plots show that biodiversity was higher in the places where we did not find phragmites. The dots where we found phragmites are Trout Brook and Old Salt Tributary. The white out covers a mistake.

## Diversity of Species in Towns in Maine Where Phragmites was Found and Not Found



I made this graph using the [TUVa phragmites database](#). It shows data from 16 towns. There is more biodiversity where people think they did not find phragmites, and the data is more spread out. Where they think they found it, the data is more towards the low end meaning they found fewer species. The tuva data helped us be more confident in our our results because the data other people collected around the state of Maine is similar to ours. Their data and our data both show that where phragmites is found, the biodiversity is lower than where it is not found.

### Discussion and Conclusion

We wanted to find out if phragmites is all over the Goosefare watershed or just in one place. We found that phragmites is not all over the watershed, but it is in three places. There is a large patch near Trout Brook Tributary, a small patch in the Old Salt Tributary, and the marsh has lots of it. We found that places with phragmites had less biodiversity and places without phragmites had more biodiversity. The TUVa data for Maine also shows that where other people found phragmites the biodiversity count was lower. We learned it is better to have more biodiversity because that means the ecosystem is healthier. We could help the ecosystem by getting rid of the phragmites. We Loranger School students want to help get rid of it. One method is to poison it. The Conservation Commission is going to get a company to do that but we might be able to help by cutting down some plants first. Mr. Smith told us it would be risky trying to take it away in the fall because the seeds spread so easily. We could take trash bags, lean the seed heads over the trash

bags and cut the plants off into the trash bags so they don't spread. We could do that next fall in September when the seed heads are still small and won't spread. We could also cut them off in the spring or even in the summer before the seedheads start to spread.

We are confident that we found phragmites and that it can cause problems. It is already filling in the marshes, which can stop the marshes from preventing flooding. Our data shows that phragmites is reducing the biodiversity in at least three places. We could look for it in more places, and we would find it because we have seen it already in the Goosefare Brook Watershed and along the road in other areas. Some people think that phragmites is beautiful, and that's why it was brought here for decoration and even planted near people's houses on the beach. We can help people understand that it is really a problem.

## **Sources**

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## **Acknowledgements**

Thank you to Mrs. Nye for typing for me when my hand was broken!