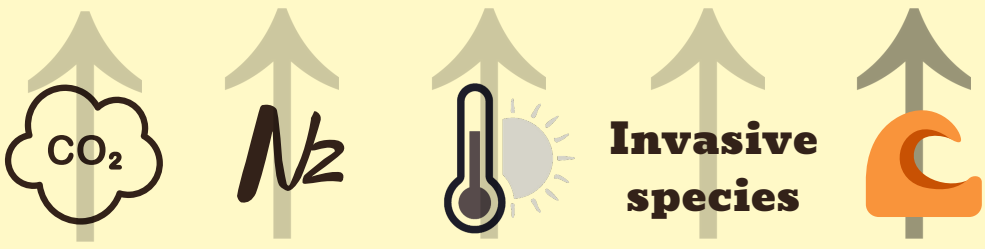
Biogeochemistry

Background

Global Change Research Wetland (GCReW)

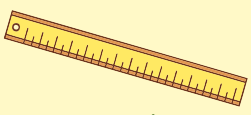
A more than **30** year experiment focusing on how **WETLANDS** respond to environmental changes like:



This past year, the Biogeochemistry Lab added **sea level rise** to their list of explored environmental changes. As part of this experiment, researchers looked at how genotypes (the genetic identity of an organism) and sea level rise impact flowering in marsh sedges, grass-like plants that live in wetlands. Understanding different genotypes of the same plant is important because an organism's genotype plays a big role in how it will respond to environmental stress.

Citizen Science Contributions

Citizen scientists and Teacher Extern, Keith Cook:



- measured growth

- harvested biomass

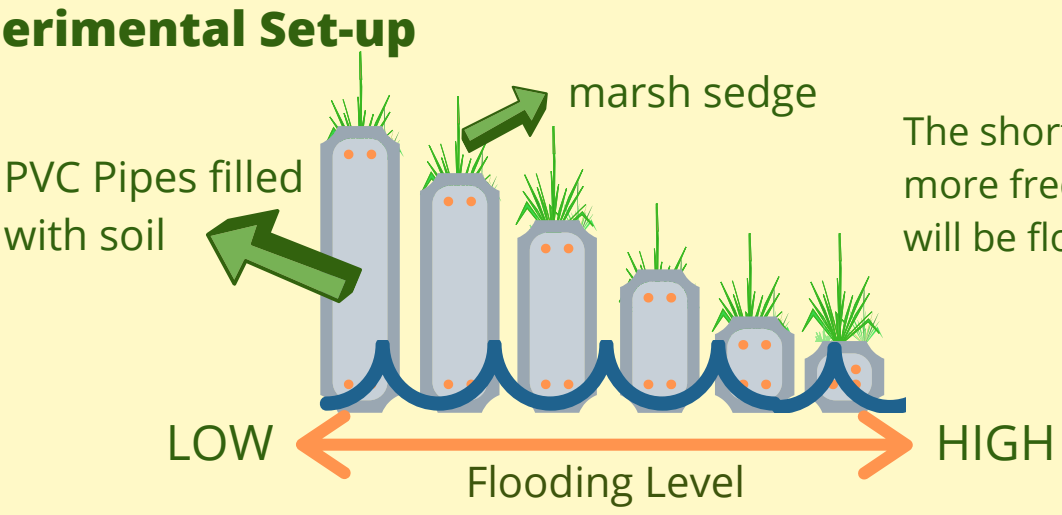
- entered data

- identified marsh species

Thank You!

Results

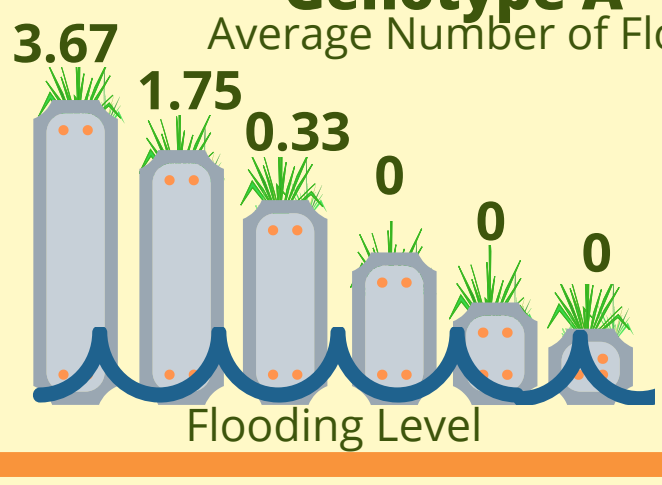
Experimental Set-up



The shorter the PVC pipe, the more frequently the plants will be flooded.

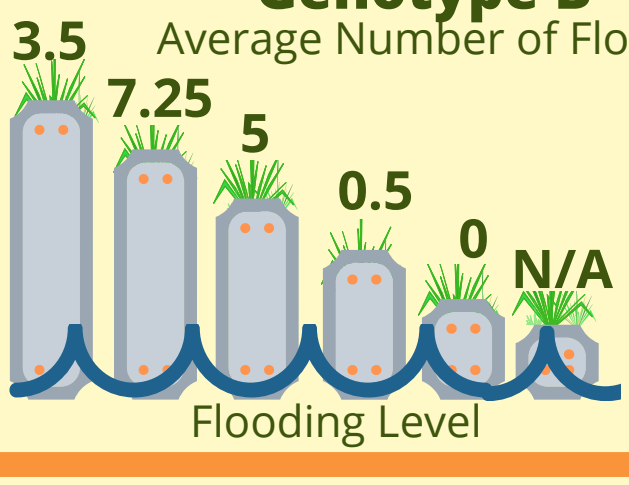
Genotype A

Average Number of Flowers



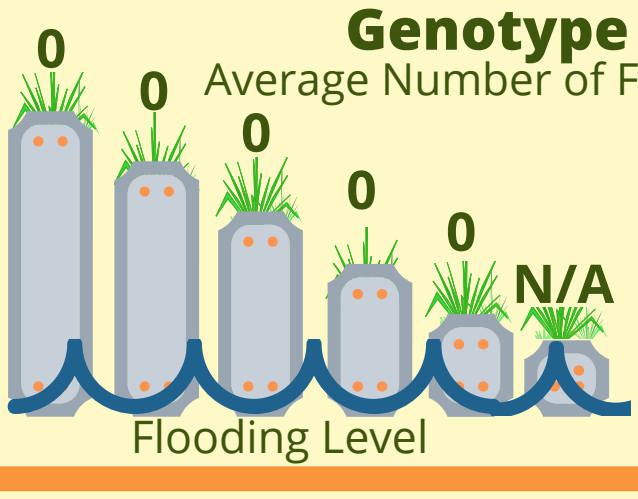
Genotype B

Average Number of Flowers



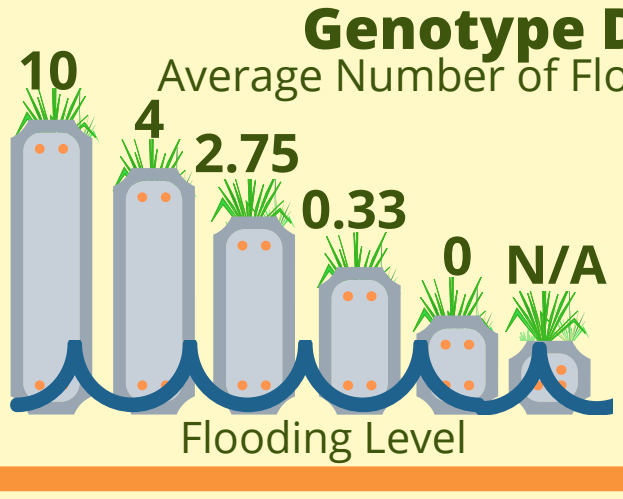
Genotype C

Average Number of Flowers



Genotype D

Average Number of Flowers

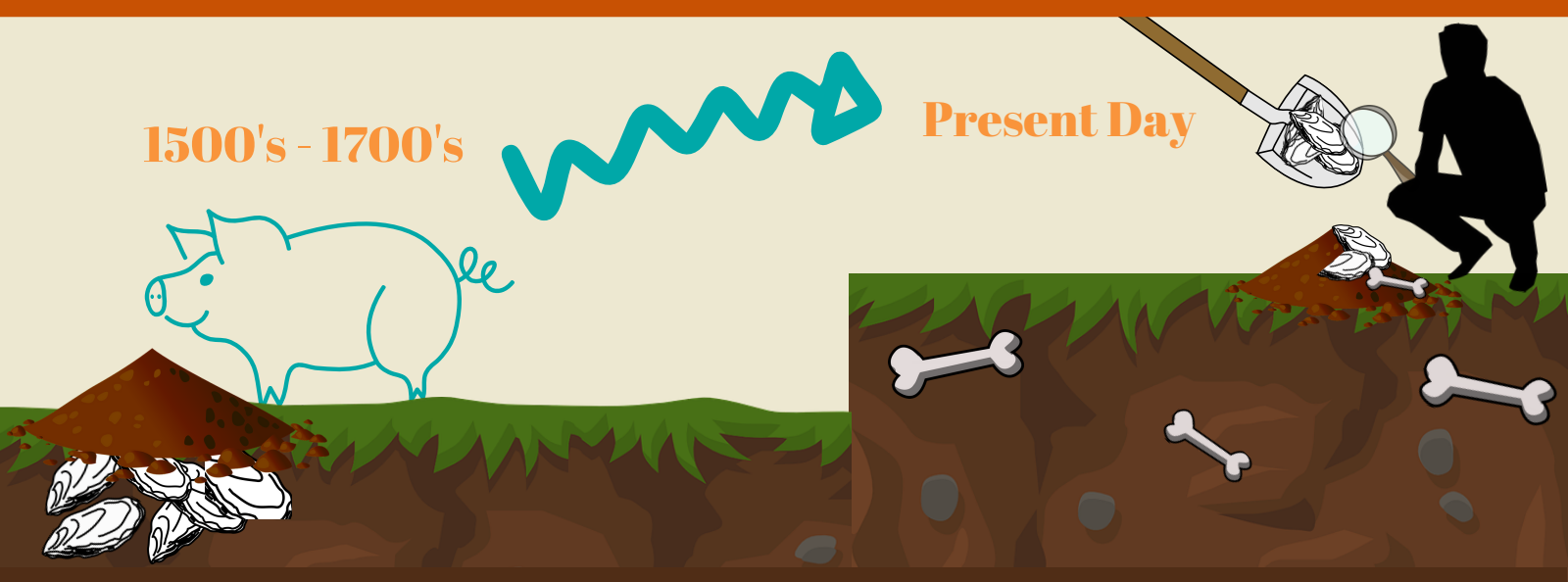


Conclusion: When looking at flower production, the unique sedge genotypes responded to varying flood levels in different ways. The researchers involved in this project had never considered the possibility of various responses before, leading to many more questions about marsh sedge genotypes and the environmental factors that influence them.

Significance: These findings are just the beginning of a series of experiments meant to test whether marsh sedges are able to adapt quickly enough to keep up with climate change. Researchers will use this and other experiments to understand how different genotypes respond to environmental stressors such as flooding, and make predictions about how wetlands will respond to climate change based on these genoytpic responses.

Archaeology

Background



Our Environmental Archaeology Lab digs up, cleans, and catalogs artifacts that people left behind. These objects help us understand how people used and changed the land through time. Combining animal and plant data, citizen scientists work towards understanding how different households impacted land and water ecosystems differently.

Citizen Science Contributions

Multiple projects including:

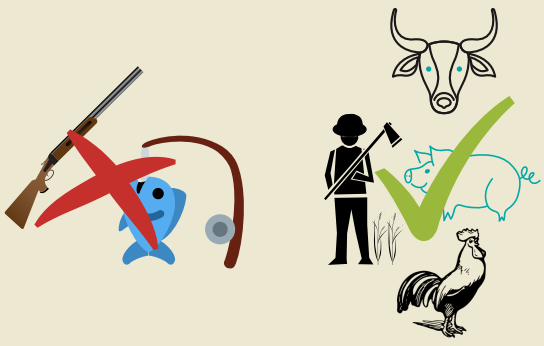
- **dietary patterns and differences in homestead vs. enslaved people's quarters**
- **constructing a pollen record for dig sites at SERC**
- **experimenting with sonic cleaning methods for artifacts**
- **aiding in exhibit design for future visitor center**

Thank You!

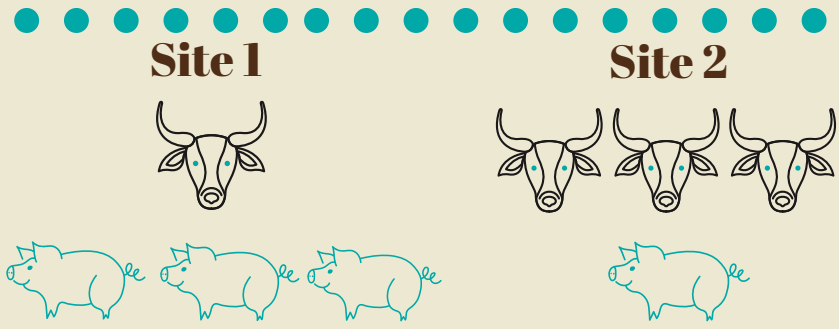
Results

Findings:

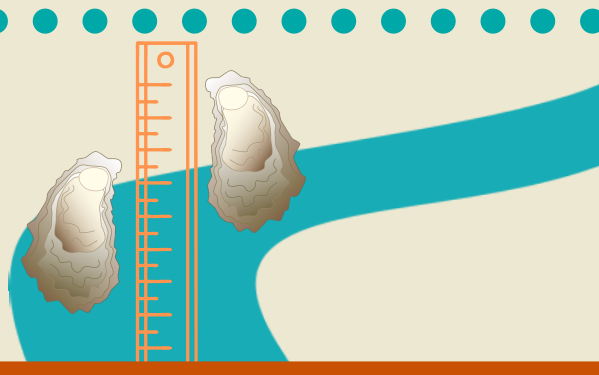
Two of SERC's dig sites show that during the 1650s through 1680s, the families that lived there devoted little of their time to hunting and fishing. Instead, they raised animals.



Bones suggest different animal husbandry strategies



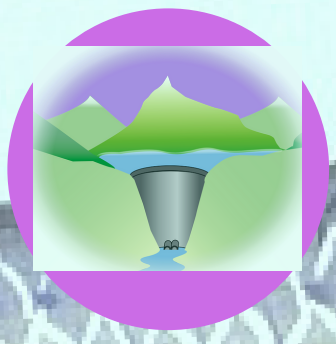
Oysters harvested at two different dig sites were similar in size, since they were harvested from the same source, the Rhode River.

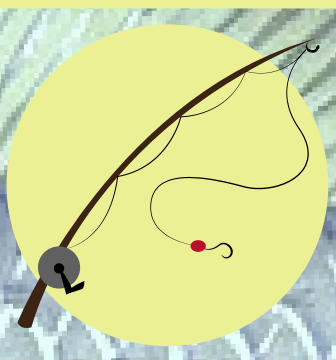


Significance: Though these two families lived in the same place, at the same time, their dietary preferences and food-related practices were likely different. Differences such as the destructive power of pig farming (smaller area but more intense destruction) versus that of cow farming (larger area but less intense destruction) mean that these two families may have affected the land they lived on in different ways. The amount and speed of erosion caused by large mammal farming strategies are of primary interest to the Archaeology Lab.

Fisheries Conservation

Background





Historically, river herring have been one of the most abundant fish in the Chesapeake Bay, and many birds and large fish rely on herring as a food source. However, their population is in trouble. Dam construction, over-fishing, and destruction of spawning habitats have made it difficult for these fish to reach safe areas to reproduce. Researchers are studying the habitat use of river herring and how that changes with the removal of a dam.

Citizen Science Contributions

Volunteer Tasks:

trawling

processing egg samples

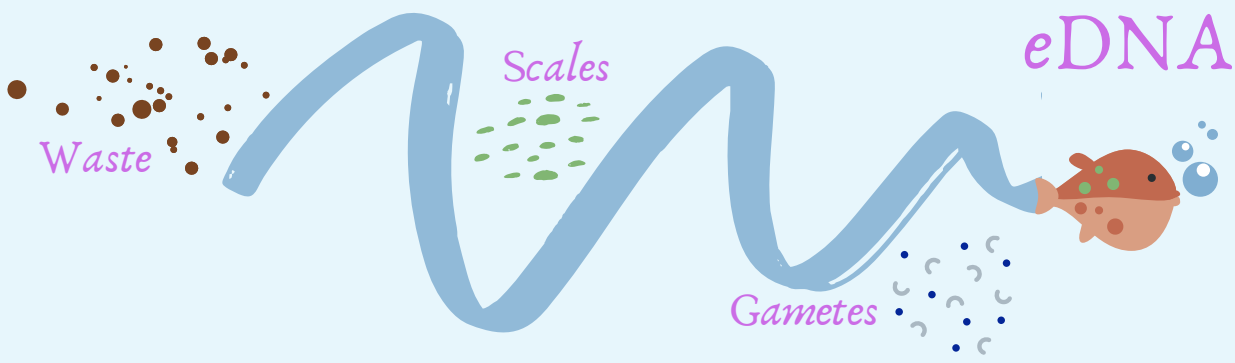
seining

Citizen scientists are processing samples which could be the first data to confirm fish are actually spawning in the new habitat.

Teacher extern Mike Toepper participated in volunteer activities to inspire a new lesson plan.

Thank You!

Results



eDNA: DNA that an organism releases into the environment as it moves

The 2019 dam removal freed 65 river miles for not only migratory fish like river herring, but many other species as well.

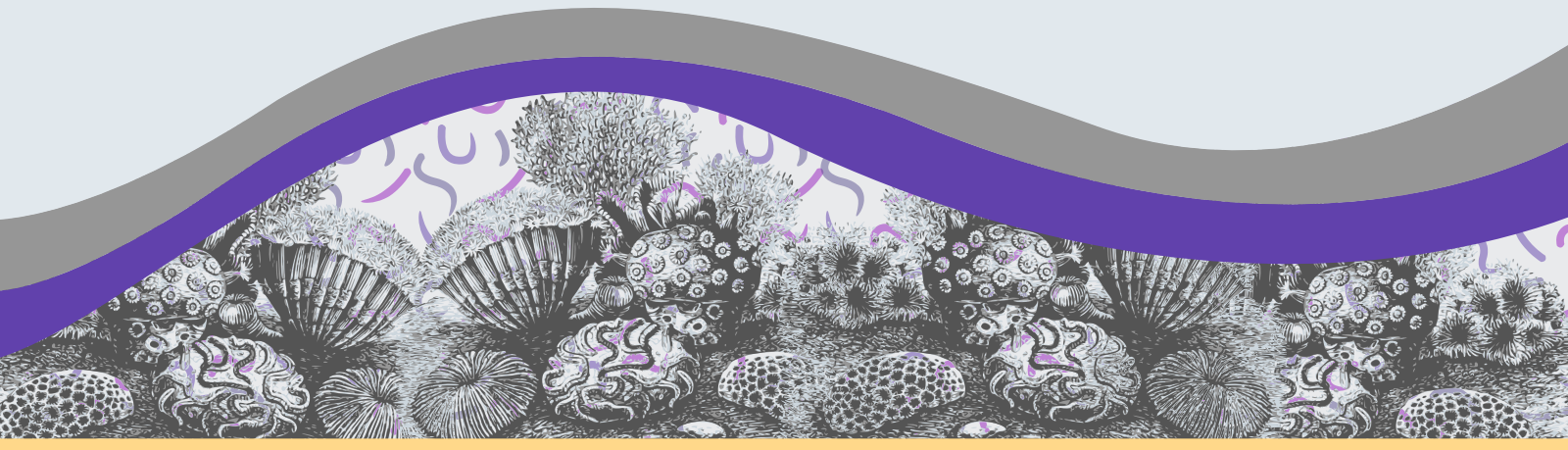
Though they've been sampling both above and below the previous dam site since 2016, the Fisheries Conservation Lab collected the first evidence of river herring in this newly accessible habitat **this year** by sampling eDNA left in the water.

Significance: Finding evidence of river herring presence upriver from where the dam was built means that the fish are now able to access more potential spawning habitat. Hopefully, the additional room to spawn will help this keystone species' population numbers rebound.

Marine Disease

Background

Dermo disease in oysters is caused by the parasitic organism, *Perkinsus marinus*. Once inside an oyster, *Perkinsus* steals nutrients from its host. The parasites grow and multiply, displacing healthy host tissue causing stress, reducing growth, reducing reproductive output, and resulting in oyster death. The Marine Disease Ecology Lab is investigating long term trends of *Perkinsus* presence and infection of oysters in the Rhode River.

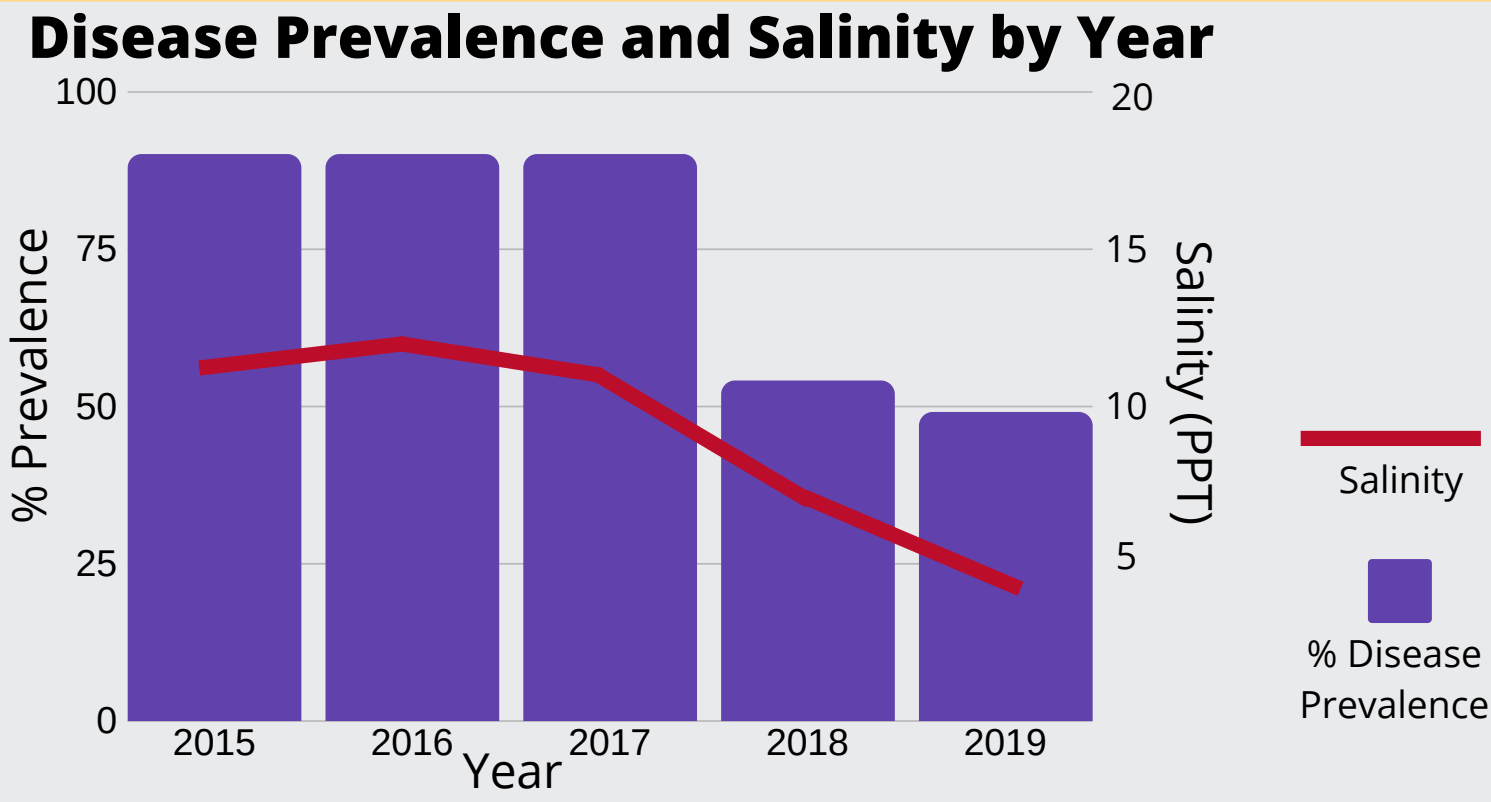


Citizen Science Contributions

After parasite samples are collected from oysters in the Rhode River, volunteers prep and measure them for dissection, incubate possibly infected tissues, and stain samples so that they can be easily seen. Researchers then count the number of parasitic cells to determine infection intensity.

THANK YOU!

Results



Conclusion: Disease prevalence has decreased in SERC reef oysters since 2017. There are three likely explanations for this downward trend.

1. Increased rainfall lowered the salinity in the Rhode River, making it difficult for the salt-loving parasite to survive.
2. Increased death from low salinity stress in oysters has decreased the parasite's chances of finding a healthy host.
3. Both 1 and 2

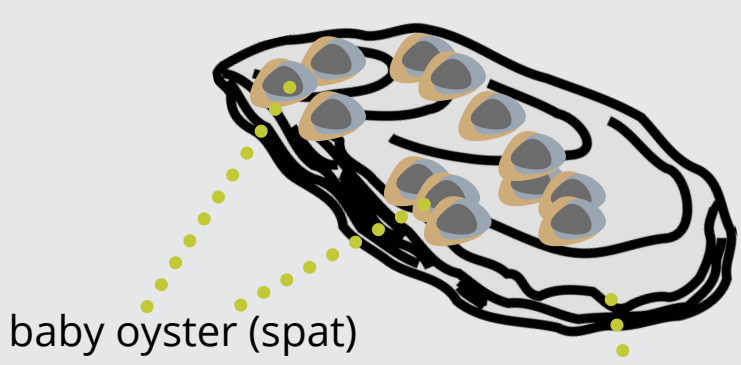
Significance: Understanding how the environment will affect oyster disease and survival can help determine the best locations for oyster aquaculture. Additionally, watermen can use knowledge of the relationship between salinity and disease presence to modify their harvest practices and understand how their income may be affected by future conditions in the Bay.

Oyster Growth in the Rhode River

Background

Oyster reefs contribute to the Bay's health by filtering water and providing safe habitat for other aquatic species. The West and Rhode Riverkeeper works with volunteers to restore Maryland's oyster reefs by growing baby oysters (spat) to put into protected areas. The goals are to supplement oyster reproduction in the Bay and grow spat in conditions similar to what they will experience when they become part of an oyster reef. This year, SERC researchers partnered with the Riverkeeper to study ways to increase to amount of spat that survive, focusing on whether filling oyster baskets to different levels would affect the growth or survival of the spat.

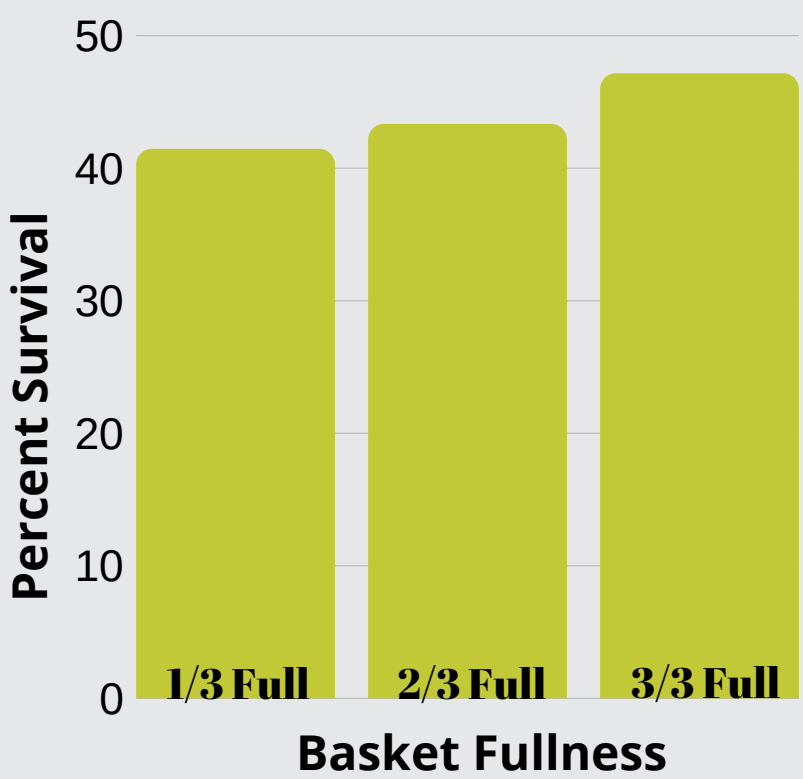
Citizen Science Contributions



Local students and volunteers counted and measured spat from oyster baskets. The cages are filled with spat growing on empty adult oyster shells, and provide a safe habitat for spat to grow before they are released into protected areas.

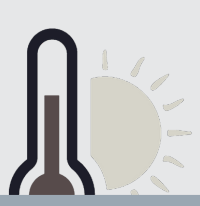
Results

Median Percent of Spat Survival



Conclusion: The concentration of oyster shells in a basket does not affect the growth or survival rate of spat.

Significance: Moving forward, those involved in this project can eliminate basket fullness as a factor affecting spat survival, making it easier for people at different sites to adjust the methods of the experiment to better suit their needs.



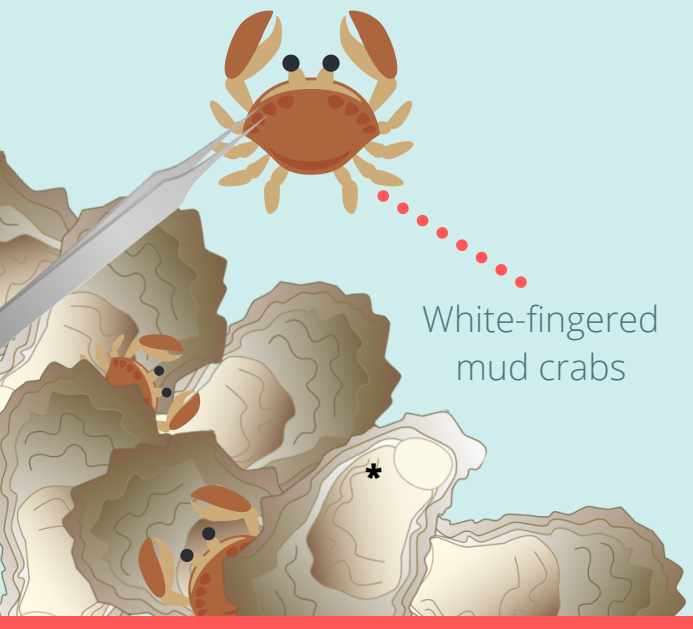
Up Next: So far, researchers have worked on this project with schools very close to SERC. They would like to involve more schools in the project, but are concerned about the spat's ability to withstand the journey to schools that are further away. Testing the effects of temperature, dissolved oxygen, pH, and depth on spat survival will make it possible to estimate how long the spat can survive in transport conditions.

Chesapeake Bay Parasite Project

Background

White fingered mud crabs play an important role in the Chesapeake Bay food web and are prey for many animals. Unfortunately, a non-native, parasitic barnacle called *Loxothylacus panopaei* (Loxo, for short) is infecting mud crabs and making them behave like zombies! Loxo makes the infected crabs change their behaviors and takes away their ability to reproduce. Scientists want to find out how Loxo affects the mud crab population and how the number of infected crabs changes each year.

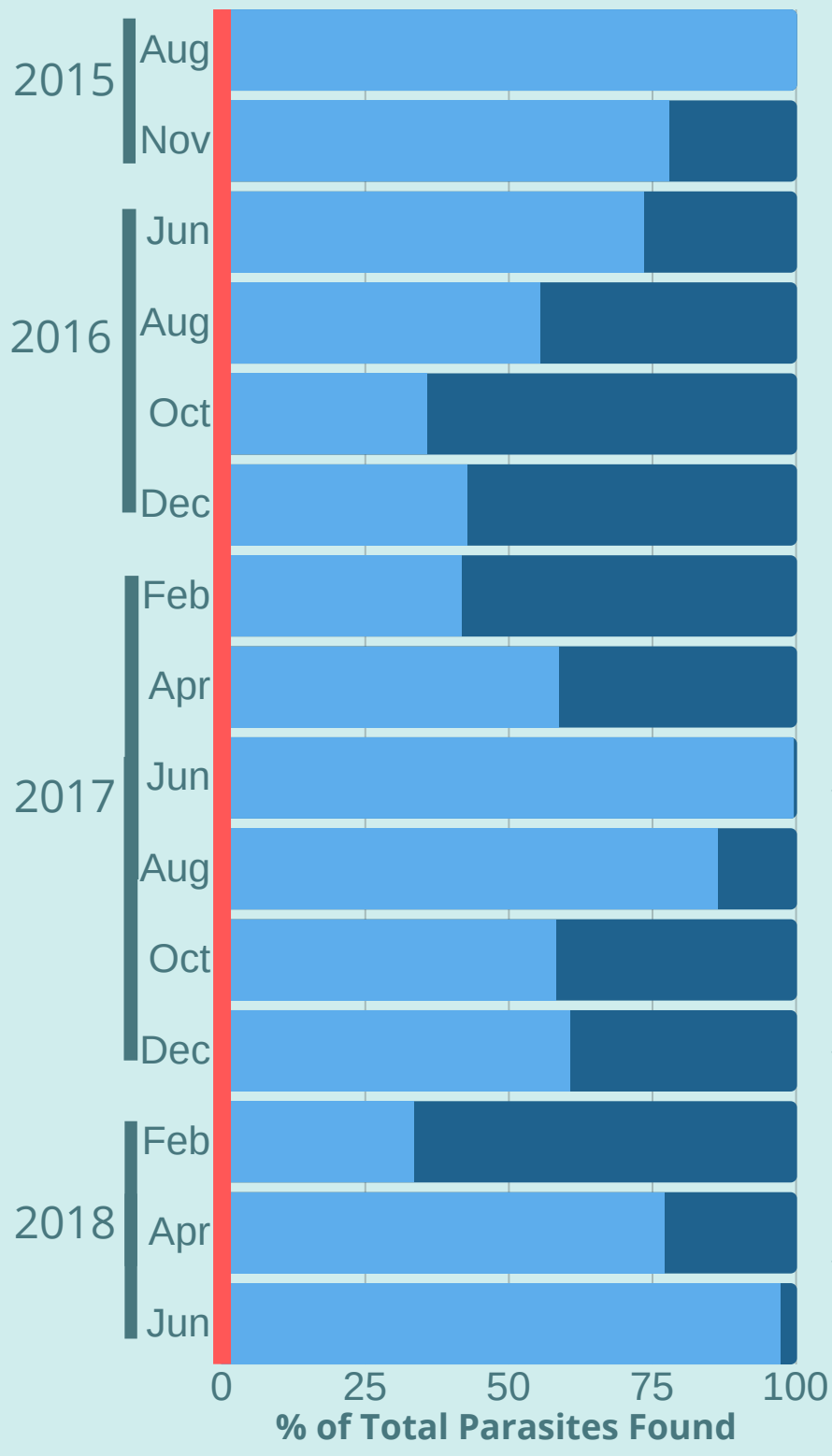
Citizen Science Contributions

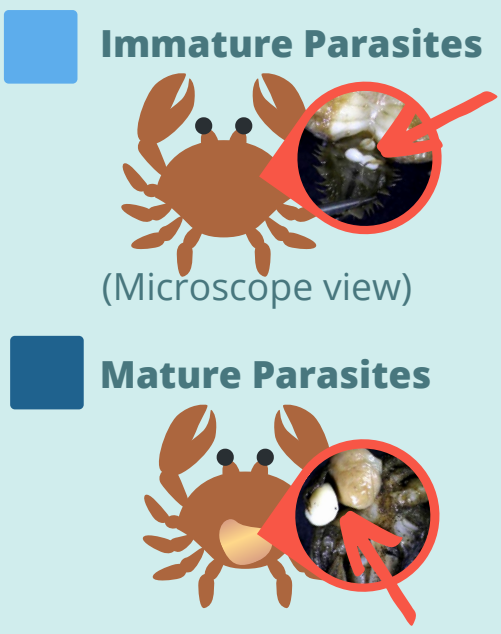


Volunteers in the field sort through oyster shells (and mud) from different parts of the Bay to look through and collect hidden crabs for analysis. Lab volunteers then measure, sex, and check the crabs for zombifying parasites.

THANK YOU!

Results





Conclusion: The ratio of mature to immature parasites varies widely from month to month. Mature parasites are visible on the outside of the crab, while immature parasites are hard to see without a microscope. Both the difference in the ratio of mature to immature parasites, and the high numbers of immature parasites make it necessary to collect the crabs from traps and inspect them in the lab.

Significance: If we did not do collect all crabs, our estimates of overall infection rates would be far less accurate. Researchers are trying to use these data to represent the frequency of the parasite within the entire Chesapeake Bay mud crab population. To scale up to the population level properly, the original data needs to be as precise as possible.

* Oyster and barnacle images by: Tracey Saxby. Retrieved from: IAN Image Library

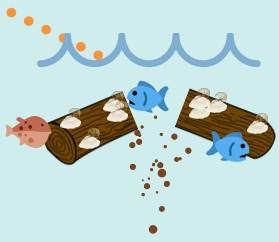
Floating Ocean Ecosystem

Background

Plastic vs. Natural Rafts
What's the difference?

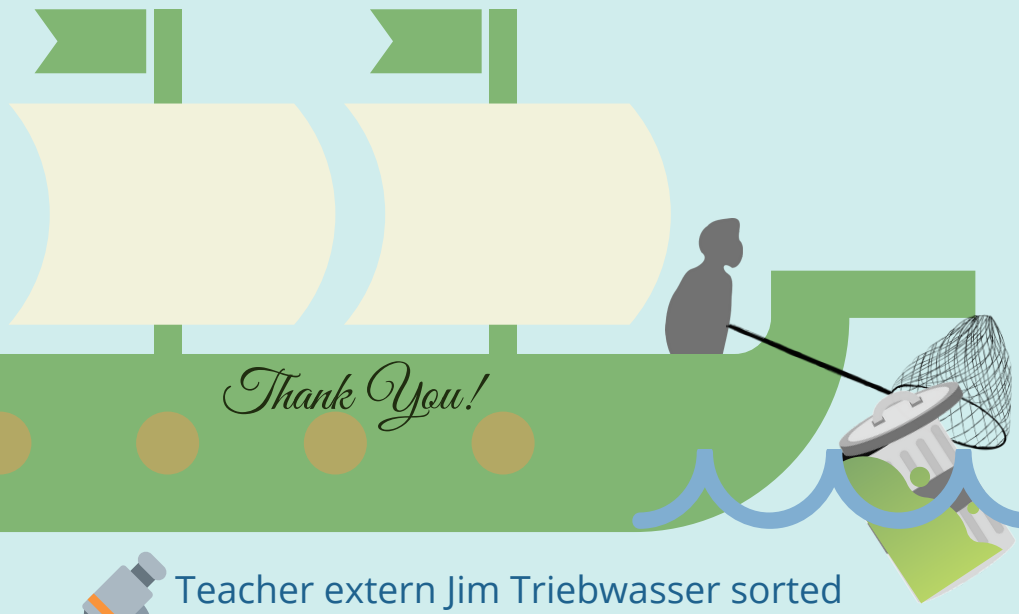
The Marine Invasions Lab explores the diversity and abundance of potentially invasive species. This year they focused on coastal animals' ability to use man-made debris "rafts" in the open ocean.

Hitchhiking species introduced to new areas can cause local ecosystems to become unbalanced by taking over the resources that local species need to survive. Therefore, our researchers are trying to figure out if floating plastics can provide long-term open ocean habitat for species normally restricted to coastal areas.



Decomposition!

Citizen Science Contributions



Volunteers collect floating objects while crossing between California and Hawaii, freeze them, and send them to SERC's lab where the hitchhiking species can be identified.

Teacher extern Jim Triebwasser sorted and cataloged samples in the lab.

Results

105
items analyzed

99%
of items retrieved had living species attached

~50%
of taxa found were non-native coastal species

Conclusion: Not only are coastal organisms frequently found on marine debris in the open ocean, but we found a greater diversity of organisms on the debris than we'd initially expected.

Significance: Our discovery that coastal species are frequently found on plastics picked up in the North Pacific Gyre suggests that coastal species can and do survive in the open ocean. If they can survive for long periods of time, reproduce, and colonize new debris in the open ocean, this could point to an extension of suitable habitat for some coastal species into an open ocean ecosystem.

Invader ID

Background

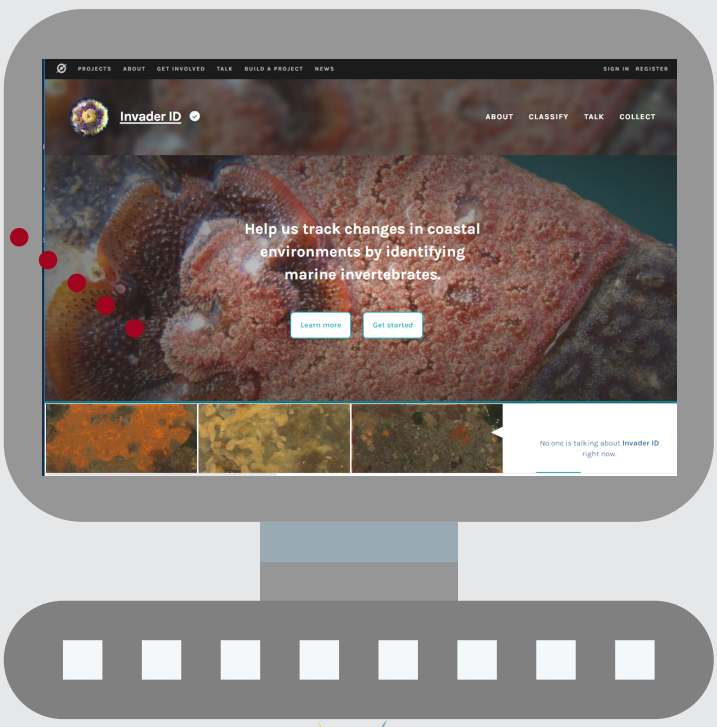
Invasive species are organisms that are not native to an area and harm native populations in an area once they arrive there. The Invader ID project helps researchers understand how populations of organisms are changing due to these invasions and identify invasive species affects on native environments through time.

Scientists deploy tiles in various areas throughout the San Francisco Bay, take photos of the tiles once they are colonized, and identify organisms.

The small Invader ID staff needs massive amounts of time to identify all the species found on their own, limiting the number of sites they can monitor! Last year's summer intern worked on finding more ways to involve citizen scientists in species identification *as well as* data collection.

Citizen Science Contributions

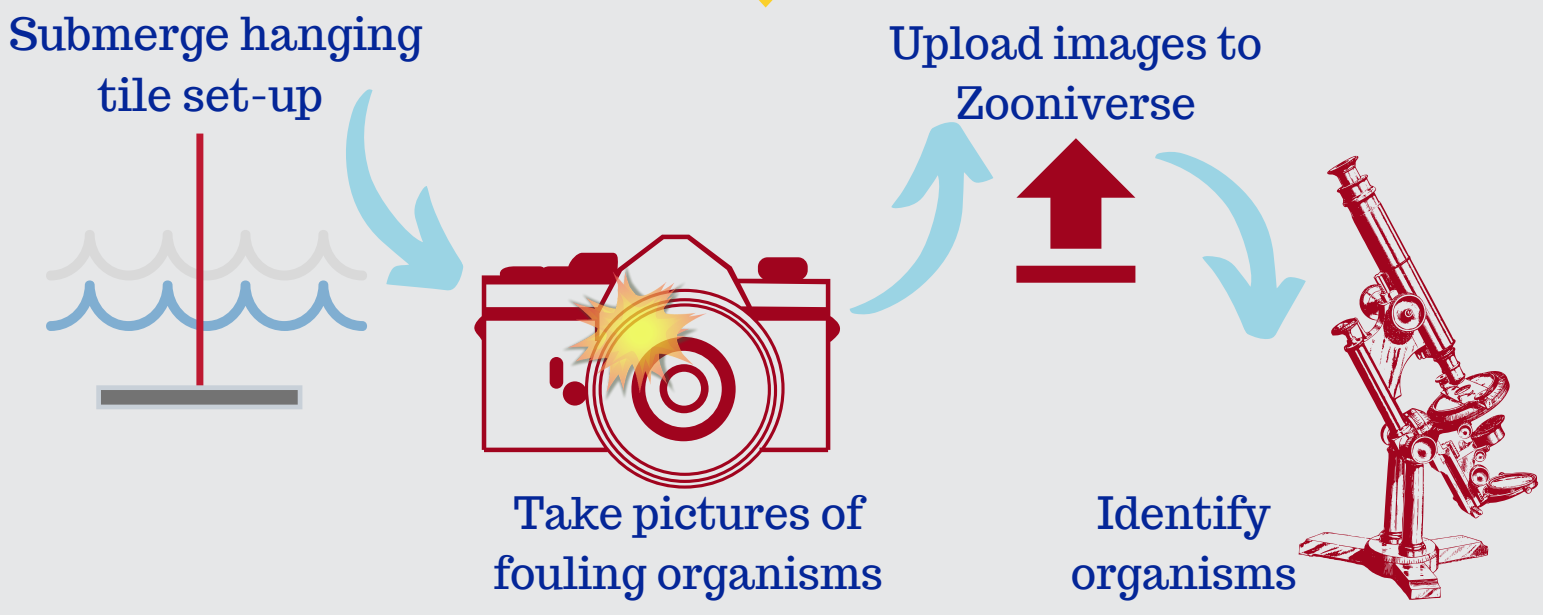
So far, volunteers have been identifying organisms found on tiles using a website called Zooniverse. Soon they will be able to contribute in other ways as well!



Thank You!

Results

The Marine Invasions Lab is in the process of creating a protocol that will allow citizen scientists to deploy their own experimental set-ups. Researchers tested out the protocol with volunteers this year.



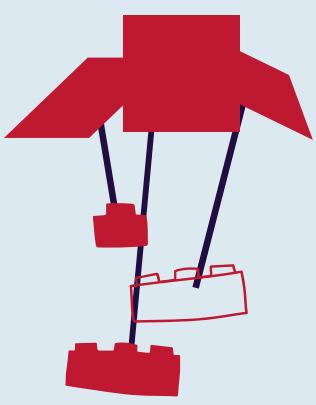
Significance: By engaging volunteers in more part of the project, we can expand Invader ID to more places, increasing the area that SERC scientists can monitor. With more sites, researchers can learn more about invaders nationally, allow for comparisons between sites, and help people respond more effectively to invasive species by creating more effective management strategies.

Plate Watch

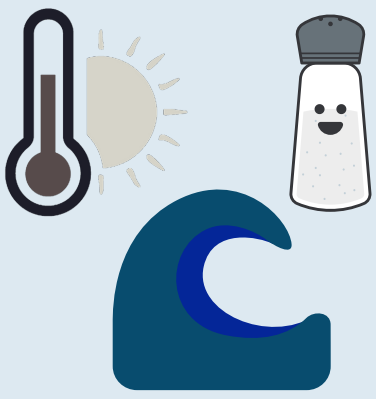
Background

The Marine Invasions Lab has been working with citizen scientists along the Alaska and California coasts to track the movements of invasive fouling species. **Fouling organisms** attach to hard surfaces, including to man-made surfaces, like docks and ship hulls. Because fouling communities are usually found in shallow, coastal areas, they are heavily impacted by human activities. Animals attached to ships can move from one place to another, and sometimes, become problematic in new locations.

Citizen Science Contributions



Clean PVC tiles are deployed from piers and floating docks where they remain for several months to accumulate living organisms.



Participants measure water temperature, salinity and turbidity and take notes on nearby land and water activities.

Specimens of interest are photographed, and suspected non-natives may be collected, and preserved for confirmation by expert taxonomists.

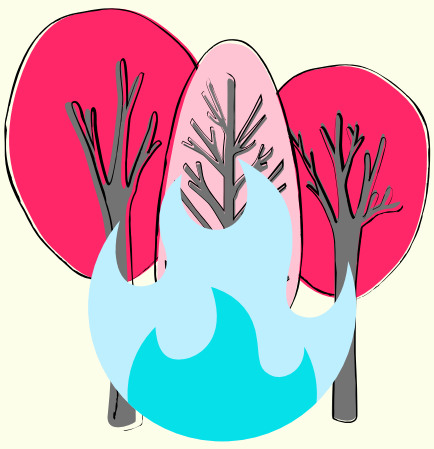
THANK YOU!

Results

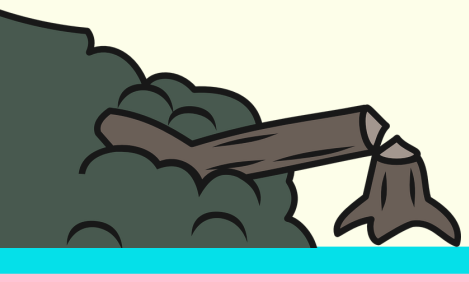
No new invasives were found at our 17 sites this year. For the third year, Plate Watch monitoring occurred in the "gateway" to the arctic: Island of St. Paul Pribilofs. We hope to have a few new sites participate next year including a school in Hoonah, Alaska.

Bluebirds

Background



Habitat destruction



Bluebirds contribute heavily to insect population management, but these pest-controlling birds are facing several threats to their population. To restore bluebird populations, conservationists developed bluebird trails, which provide bluebird nesting habitat in the form of nesting boxes and make it easier to monitor their populations.

Pesticides

Invasive species

Citizen Science Contributions

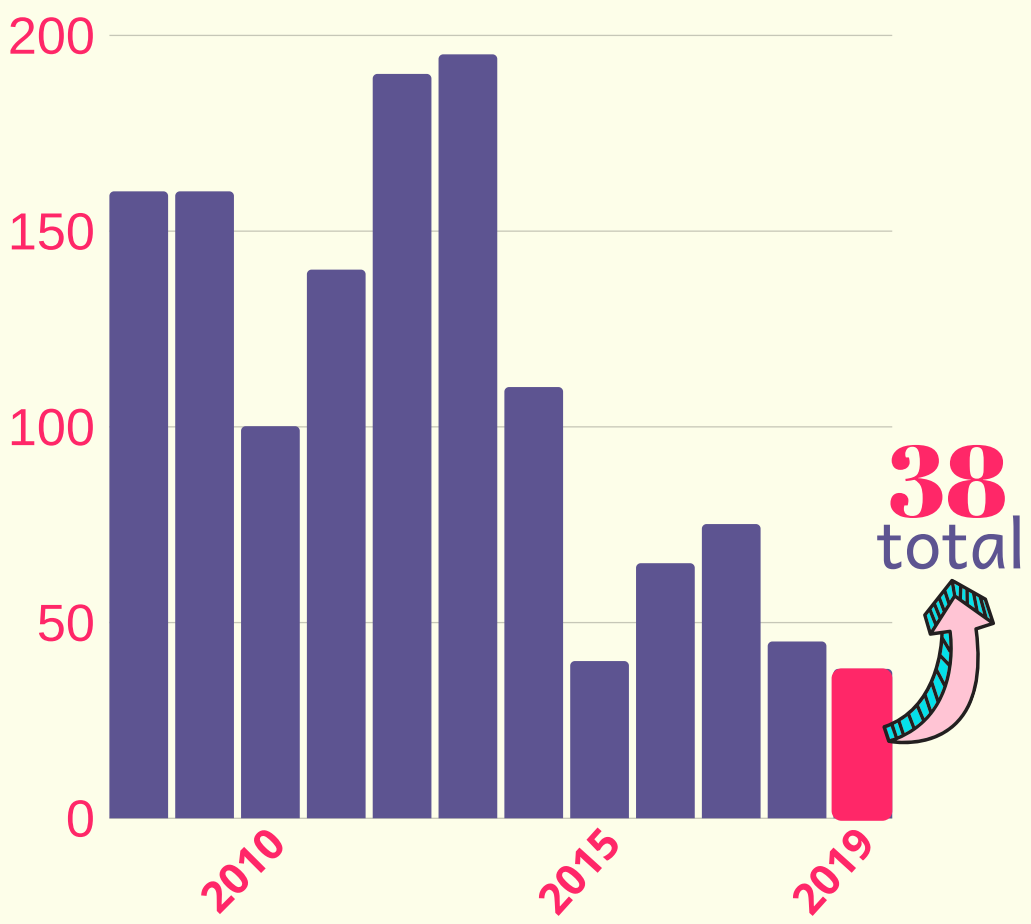
Citizen scientists check on the SERC's bluebird boxes and take note of what they find, including nests, eggs, and baby birds.

Different species can be identified by the **materials** that the nests are made of and the **color** of the eggs.

Thank You!

Results

Number of Fledglings Each Year



Previously

2018

2019

Significance: Overall, the number of bluebird fledglings was lower than usual this year. Volunteers recorded that in the 48 bluebird boxes, many nests were built but birds never laid eggs in them. Though we are not sure why we saw so few bluebirds in 2019, previous year's low numbers have been attributable to weather conditions such as freezing temperatures or heavy rainfall.

Ecosystem Conservation

Background

Legumes, particularly soybeans, are among the most important agricultural food crops.

Researchers want to know if bacterial diversity within soybean plants has an effect on the plants' ability to survive in drought conditions and resist pests.

Citizen Science Contributions

Harvesting

Shelling

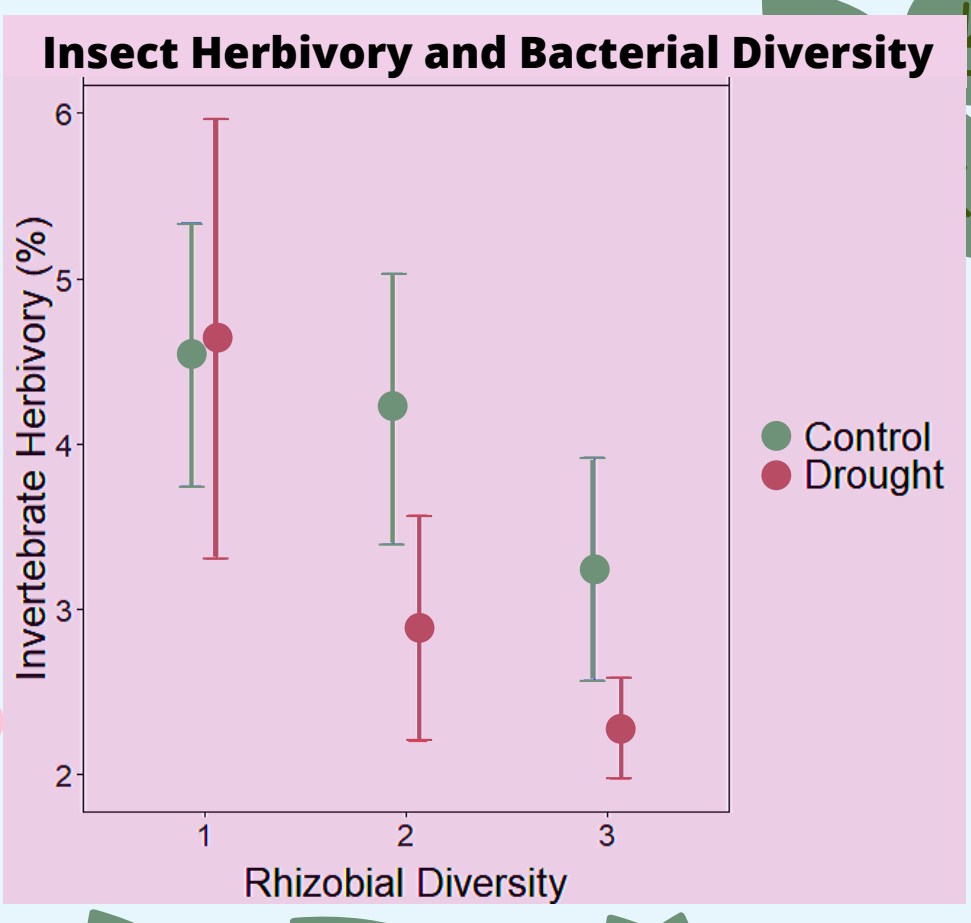
Weighing

Volunteers helped collect data for a pilot study. This study led to an opportunity to scale the experiment up to farms across the state of Maryland.

Results

Herbivory: The process of feeding on plants

Conclusion: We found that soybeans provided with a more diverse soil bacteria community are better able to resist insect pests, particularly under drought conditions.



Significance: Including more bacterial strains in soil can help improve soybean crop health and decrease stress from insect feeding, possibly reducing the need for pesticide use. This effect is particularly apparent during drought conditions, an important consideration given the threat of climate change.

Entomology

Background

Citizen scientists conduct field surveys at SERC to take inventory of all beetle species and track changes in populations over time.

35% of the world's crops pollinated by beetles

40% of all insects are beetles

Many beetle populations are declining (in some cases by upwards of **80%** since the late 1980's)

Beetles are often decomposers and an important part of many animal diets

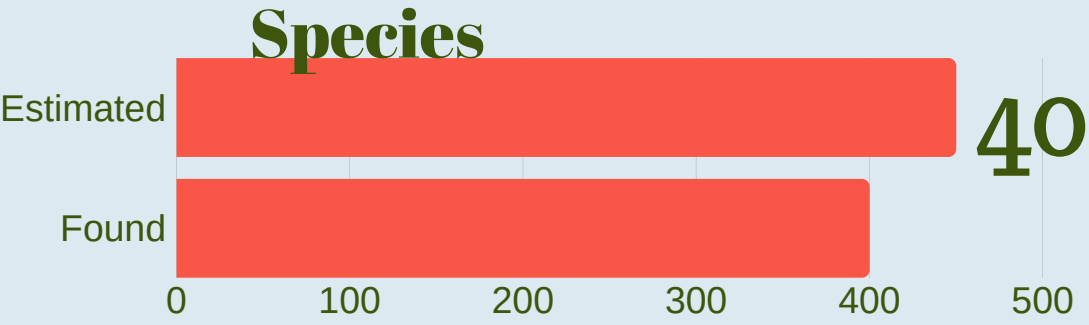
Citizen Science Contributions

Thank You!

Volunteers capture, identify, and catalogue beetle species found on SERC property.

Results

Species



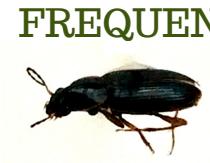
400 Species found

MOST UNEXPECTED

Hairy Ground Beetle

Rare in this area

MOST FREQUENT



Black Ground Beetle

100's captured

LARGEST

Eastern Hercules Beetle

~2 inches

Families

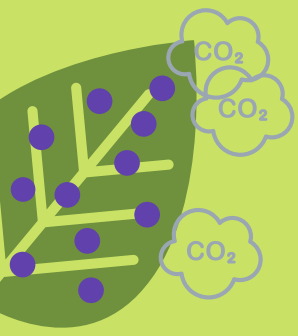
57 Families found

Significance: Insect censuses in other parts of the world have shown declines in several beetle populations. However, in order to determine whether populations in a certain area are growing or shrinking, several measurements from the same area are required. This new SERC project is the first beetle census in this area. Building up an inventory of species and species abundances will help researchers track future changes in beetle populations at SERC.

Fossil Atmospheres

Background

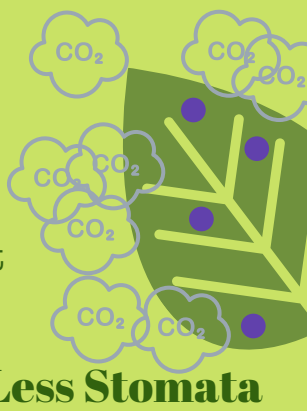
Less CO2



More Stomata

Using fossilized ginkgo leaves, researchers count the number of pores, or stomatal cells, on each leaf. Plants adapt to the amount of available CO_2 by changing the ratio of stomatal cells to other cells in their leaves. The more CO_2 is in the atmosphere, the fewer stomatal cells are needed to take in enough carbon for the plant to grow. Researchers believe that understanding this adaptive behavior can help reconstruct the history of CO_2 levels in the atmosphere.

More CO2



Less Stomata

THEN — NOW

Citizen Science Contributions

Citizen Scientists...

Document rainfall

Photograph ginkgos

Adjust CO_2 levels

Measure leaf temperature

Thank You!

Count Stomata

Measure soil moisture

Results

Experimental Setup

412 ppm- Atmospheric CO2

600 ppm

800 ppm

1000 ppm

CO2 is pumped into small tents surrounding each tree to artificially increase the CO2 ppm (parts per million) in the air around the treated trees. Control trees are planted without the tents and receive only naturally occurring CO2.

This year, researchers found that ginkgos have two "modes of operation." Though unexpected, some of the experimental trees appear to have entered "survival mode."

Healthy Mode

Tolerant of excessive rainfall

Tolerant of summer heat

Tolerant of dry conditions

Survival Mode

Stressed by excessive rainfall

Stressed by heat: **photosynthetic activity** peaks for *only* a few hours each day

Stressed by lack of water: the plant closes the stomatal pores, cutting off **gas exchange**

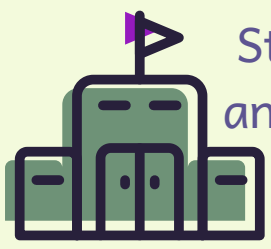
Significance: If we find that entering "survival mode" affects the relationship between CO_2 and a plant's number of stomatal cells, it could indicate that previous estimates of CO_2 based on leaves that were fossilized in this state may be inaccurate. However, because the experimental treatments require forcing the trees to adapt to different CO_2 levels 10 times faster than they would in nature, it may be the experimental methods that are forcing the trees into this newly found "survival mode".

Orchids in the Classroom

Background

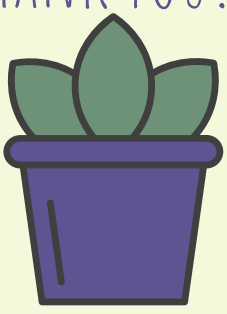
More than half of North American orchid species are endangered or threatened. Researchers need help from citizen scientists to learn how to grow and conserve species that are disappearing due to loss of suitable habitat. Orchids are very sensitive to environmental change and rely heavily on the relationships within their ecological community to survive. Orchids need healthy habitats, specific pollinators, and fungi to give them nutrients.

Citizen Science Contributions



Students from schools and science centers in Maryland, DC, and Florida grew orchids and collected data in their classes.

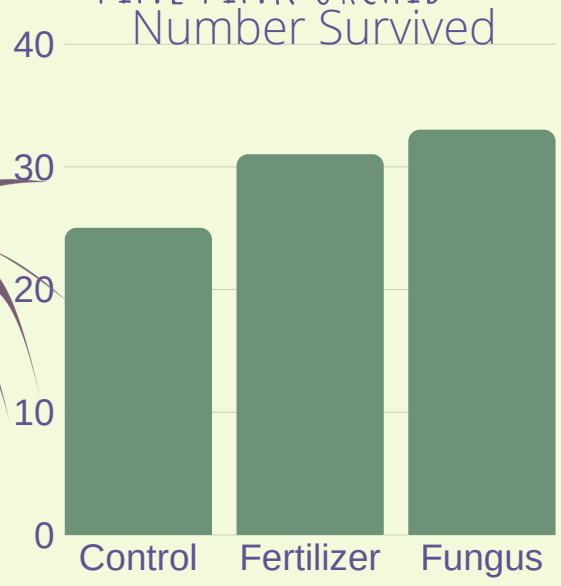
THANK YOU!



Students plant, measure, and water orchids with **3** different treatments (control, fungus, and fertilizer) to see which treatment(s) can grow orchids the best.

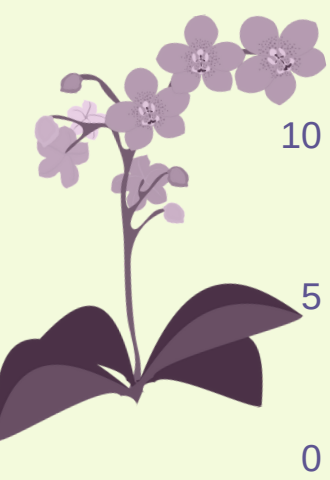
Results

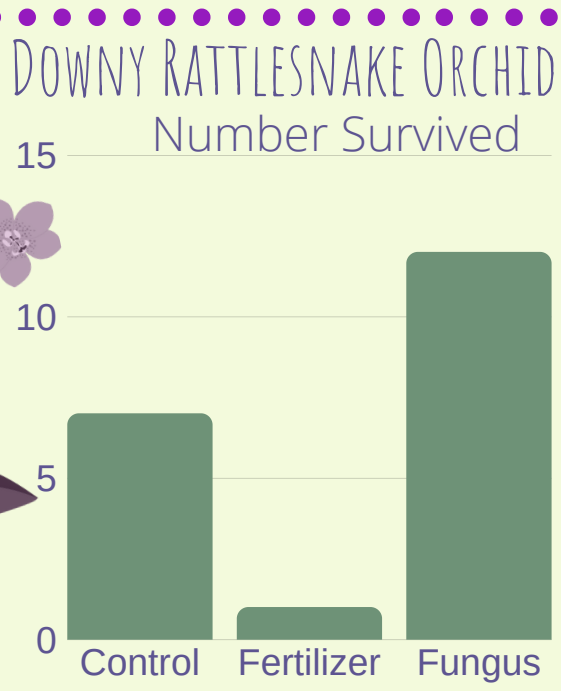
Fall 2018 Experiment



Tropical

Conclusion: No significant difference was found between treatments, though there is a slight trend in favor of the fungus treatment for this species. This means that instead of putting effort into growing the fungal partner for these orchids, conservationists may be able to substitute fertilizer, saving both time and resources.





Temperate

Conclusion: This orchid species appears to be more sensitive to the fertilizer treatment, with a clear preference for its natural fungal partner. Though few individuals survived the experiment this year, we hope to be able to plant surviving native orchid seedlings in school gardens in the future.

Significance: If the orchid species used in these experiments can survive with fertilizer, or even sunlight and water alone, researchers can modify their conservation strategy to be more efficient. It takes extra time and funding to grow and maintain the fungal partners of the orchids. If the orchids can survive just as well without the fungus, this resource-consuming step of the conservation process can be eliminated.

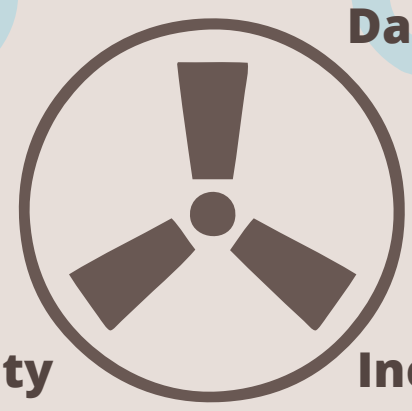
Photobiology

Background

Why is UV radiation ecologically important?

Photosynthesis Rate Reduction

Genetic and Cellular Damage



Primary Productivity Reduction
(sensitivity varies by species)

Increased Cancer and Mortality
(sensitivity varies by species)

Biodiversity Impacts

These potential effects of high UV radiation are why the Photobiology Lab participates in UV monitoring efforts.

Citizen Science Contributions

Lab volunteer Keith Kalinowski completed a very detailed analysis of solar radiation trends which the Photobiology Lab is currently in the process of publishing.

Results

HaZiness: measure of particulate concentration in the air which increases light scattering and UV blockage

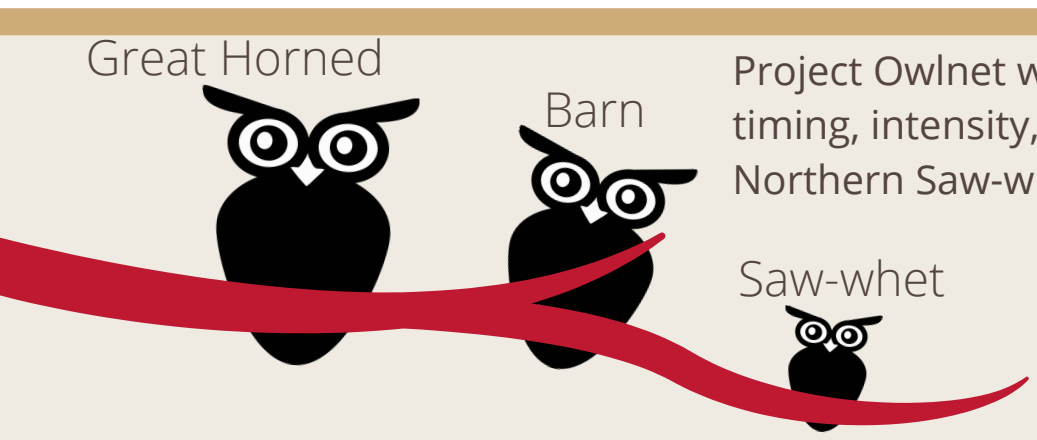
5-10%
reduction in haziness during the past
20
years

Conclusion: There has been a significant decrease in summer haziness over the last 20 years, chiefly due to the restrictions placed on power plant emissions. This means that less of the UV light that enters Earth's atmosphere is reflected before reaching the surface.

Significance: The decrease in UV-scattering particles in the air means that there is more UV radiation reaching Earth's surface and more risk of sunburn in the summer than 20 years ago. However, normal measures of protection against the sun, such as sunscreen and protective clothing, should be enough to address this. The trade-off is that we now have much cleaner air!

Project Owlnet

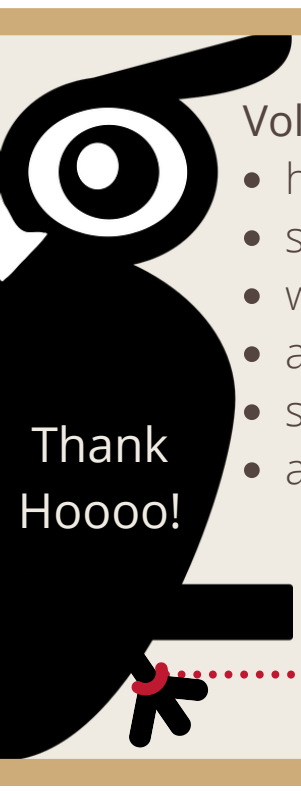
Background



Project Owlnet was created to determine the timing, intensity, and pace of migration of the Northern Saw-whet Owl.

The Northern Saw-whet is one of the smallest owls in North America. This means they are easy prey for larger birds, so they prefer to travel when it is **Dark.** In addition, they are almost **Silent** when migrating, making it difficult to track their movements. The migration of these owls was not well known before this project began in the 1990s.

Citizen Science Contributions



Volunteers Record:

- health
- size
- weight
- appearance
- sex
- age

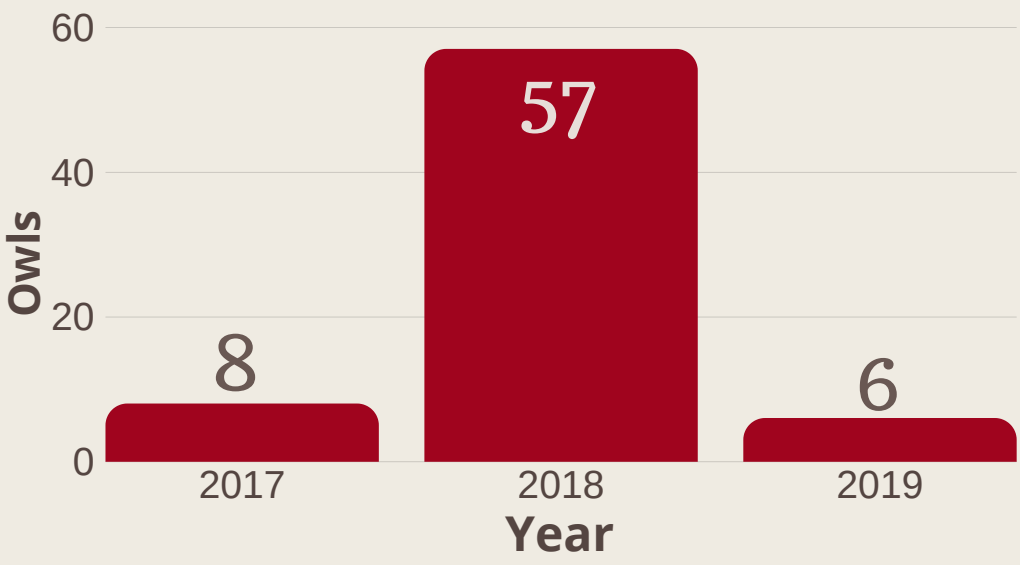
each owl caught receives an identifying band

Ageing Owls:

Owl feathers have a fluorescent pigment that makes newly grown feathers glow bright pink under a blacklight. Since the pigment is lost over time, older feathers will show up as purple due to the color of the blacklight itself.

Results

Northern Saw-whet Owls Caught at SERC per Year

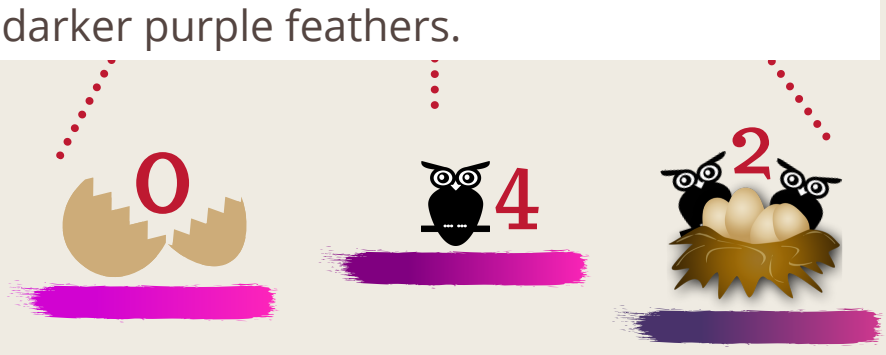


2019 Season Breakdown

6 Northern Saw-whet Owls

Eastern Screech Owl

Under the blacklight, recently hatched owls have all pink feathers, molting owls will have some pink and some purple, and older owls will have a mixture of pink, purple, and darker purple feathers.



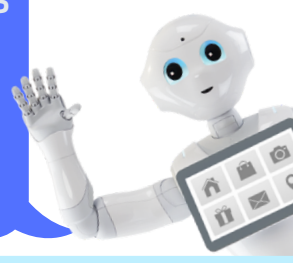
Significance: Capture numbers fluctuate from year to year due to natural variation in the Northern Saw-whet population cycle. Several Project Owlnet sites caught owls later in the season, which may indicate a shift in migration timing. Such a shift could be a fluke, or a trend related to climate change. Though no one can make any claims yet, the sizable scale of the project over both time and space should eventually yield a large enough data-set to see patterns emerge. Understanding Northern Saw-whet's migration patterns can help resource managers create better land management and species protection strategies.

Pepper, the Humanoid Robot

Background

Pepper is a humanoid robot that can provide information, show photos, dance, and tell you all about SERC science.

SERC has two Pepper robots, one that acts as a pre-programmed interactive info station, and another that requires coding skills and has been used to engage STEM students.



Citizen Science Contributions

Students from South River High School investigated ways that Pepper could be used to teach science. They created a lesson plan and programmed Pepper so that she could interact with the students.

Lesson Planning

THANK YOU!

Coding

Additional volunteers facilitated public interactions with Pepper at various SERC events.

Results

Work Products:

- A lesson plan to teach middle school students about native and non native species
- An activity where students fold paper models of orchids and then use Pepper to figure out which orchid species they have just created
- Various games to be used at SERC Science Saturdays
- A more user friendly home page

The Pepper Project will be discontinued at all Smithsonian locations this winter.

Significance: The Pepper Project at SERC has used technology to engage students with strong computer science or robotics backgrounds in environmental science, allowing them to apply their skills in a new way and broadening their perspectives about what it means to be a STEM student.