# The Earth Scientist

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**FREE INSIDE**
**Earth Science Week Poster**
**"Earth Materials in Our Lives"**
*compliments of the American Geoscience Institute (AGI)*

Ahinahina (silverswords) blooming along Sliding Sands Trail, Haleakala National Park.
Photo Credit: A. Rulison, National Park Service

## INSIDE THIS ISSUE



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# Letter from the Guest Editor

*By Alexandria Gillen, Education Specialist, NOAA National Ocean Service Education*

These days, it may feel difficult to find good environmental news. We are hovering at a crossroads of crisis with news and social media making it easier than ever to feel inundated by environmental tragedy. While these tragedies deserve our attention, stories of hope and resilience are essential for refilling our hearts and minds with the determination to continue. NOAA Planet Stewards is a place where we can find those stories of hope and resilience. For 15 years, Planet Stewards has been supporting educators around the country to implement hands-on action-based projects that conserve, restore, and protect human communities and natural resources from environmental challenges. The program has been a catalyst for incredible projects, an inspiration for educators and students alike, and an agent for change in communities across the nation.

In the following pages you'll read the stories of amazing educators and students supported by NOAA Planet Stewards. They have been hard at work restoring and expanding native habitats, reducing marine debris, and addressing a myriad of environmental impacts affecting their local communities and the world. They are making a difference. During just the past year, these projects collectively made impressive progress. More than 30,317 students, educators, partners, and families engaged in 35,454 hours learning the science related to their stewardship projects and carrying out stewardship activities. They removed more than 2,000 pounds of marine debris from beaches and wetlands, as well as 231 invasive plants. They planted 1,126 native plants and 42 pounds of native seed, and restored nearly 8 acres of land. Their work will lead to a calculated reduction of more than 250 tons of atmospheric carbon dioxide over the expected life of all of these plants. I hope that as you read this issue, you will be inspired by these stories of hope and resilience to make a difference in your own communities today.

Be sure to subscribe to the NOAA Planet Stewards Newsletter: *The Watch* and discover new and exciting opportunities for you and your students through NOAA and our partners.

Alexandria
Guest Editor

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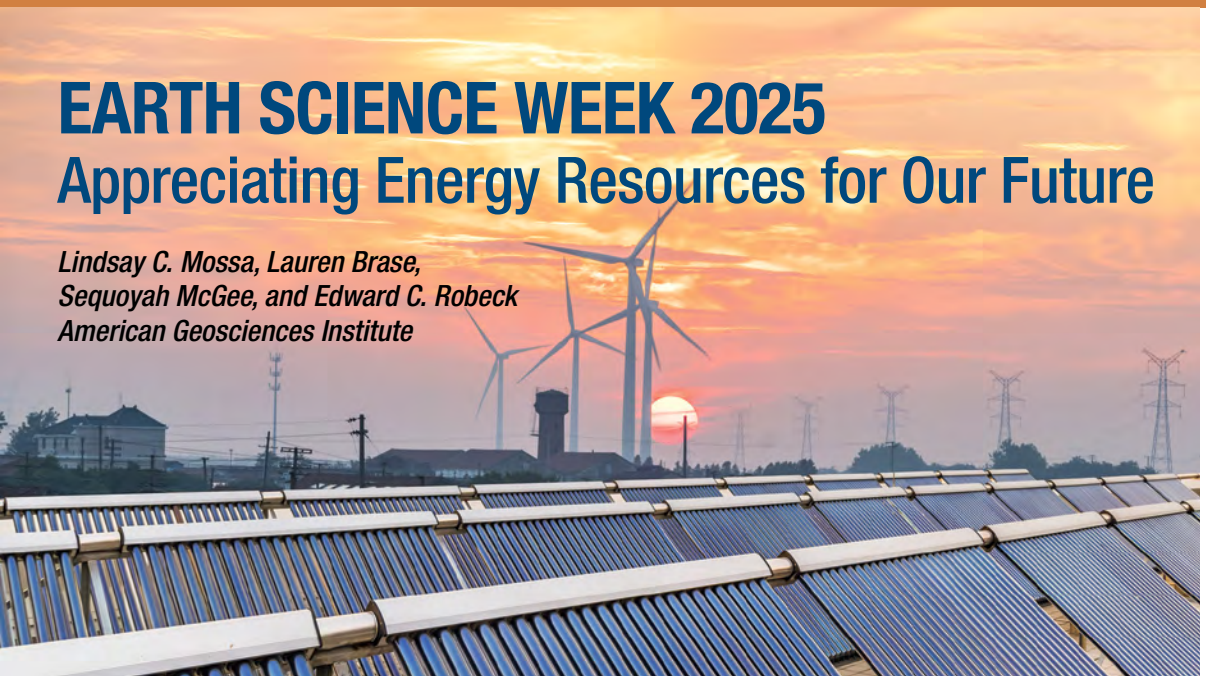
# EARTH SCIENCE WEEK 2025

## Appreciating Energy Resources for Our Future

*Lindsay C. Mossa, Lauren Brase, Sequoyah McGee, and Edward C. Robeck*
*American Geosciences Institute*



Educators around the world are invited to celebrate Earth Science Week 2025 as we focus on the theme "Energy Resources for Our Future." Through this theme, the American Geosciences Institute (AGI) and our 50+ partners – including NESTA, NOAA, the U.S. Geological Survey (USGS), National Park Service (NPS), and many others – aim to increase knowledge about Earth's energy resources and how they are being used.

Earth Science Week (ESW) 2025 will take place on October 12-18. As part of the celebration, AGI and our partners have created a toolkit with posters, activities, and other educational materials that can be used in K-12 classrooms or at outreach events with participants of all ages. All educational materials are linked with science standards, and many also connect to the United Nations' Sustainable Development Goals (SDGs) (https://sdgs.un.org/goals), which supports NOAA's Planet Stewards initiative. Adopted in 2015, the SDGs aim to improve living conditions and protect the environment globally. By exploring how geoscience helps achieve these goals, Planet Stewards educators and others can inspire a greater appreciation for earth science and its role in shaping a sustainable future, especially when it comes to using energy resources in a way that is sustainable.

The ESW toolkit includes a calendar in which we highlight geoscience-related dates, Earth observation data, and learning activities designed by our partners. Calendar dates such as Earth Day, Zero Emissions Day (sponsored by the UN), and World Oceans Month (sponsored by NOAA) can inspire conversations about how Earth science relates to energy use and environmental health. Each month's educational activity relates to the Next Generation Science Standards (NGSS) and the SDGs. As an academic year calendar, it begins in August with an activity written by the American Association of Petroleum Geologists (AAPG). The activity has students explore a variety of renewable and nonrenewable energy sources. This is the first activity in the calendar so students could begin by understanding where energy comes from before completing other activities on applications of energy technologies, and finally considering how the use of energy resources affects the environment. Each month also has a callout box describing an organization that collects Earth observation data. These callout boxes include links to datasets and images that can be used to help students (see Figure 1) see how Earth's systems are monitored. For example, the December callout box features stories on a range of topics from air quality to energy sources.

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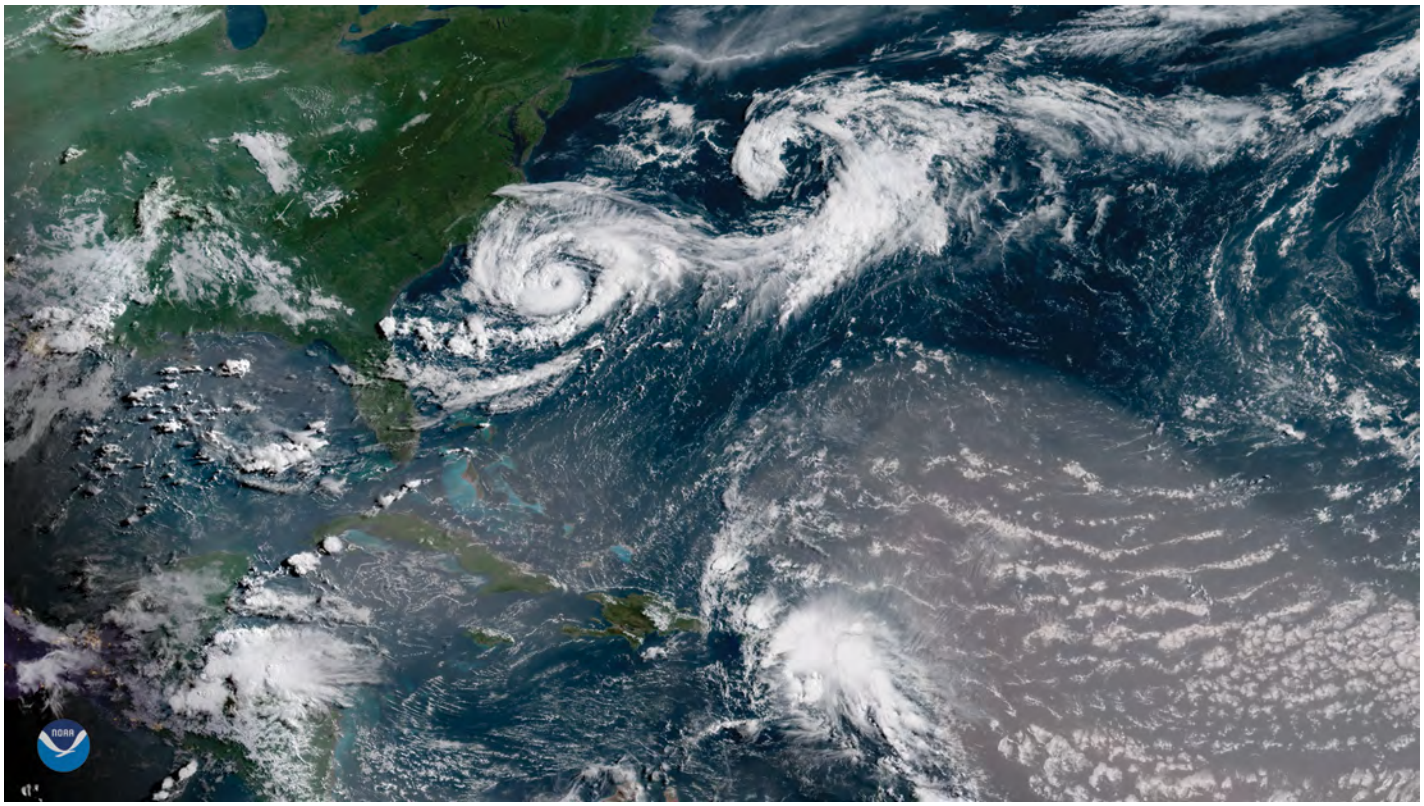

**Figure 1.** Earth observation data can be used to monitor nearly every system of Earth, as well as interactions between them. From the swirling winds of the atmosphere to the ocean currents that help drive those winds, to the sand and dust that those winds carry, NOAA, NASA, and other organizations work to monitor conditions that affect the health of our planet as well as human populations. Photo credit: NOAA

The 2025 Earth Science Week Toolkit is available for the cost of shipping and handling. This year, AGI will send the ESW Toolkits to all NESTA members for free. AGI also hosts the Earth Science Week website (https://www.earthsciweek.org/) where resources from AGI and our partners can be accessed for free. In addition to the toolkit, AGI hosts a free webinar series in which geoscientists and educators present topics related to the theme as well as strategies to bring these topics into the classroom. Airing at 1 PM Eastern Time each day of Earth Science Week, the 2025 webinar topics include: geothermal energy, energy careers, educational resources from the National Energy Education Development Project, and geologic mapping.

**Figure 2.** As a finalist for the 2024 Earth Science Week Visual Arts Contest, Adeline Kong portrayed changes on Earth across different timescales and magnitudes.

AGI also hosts four annual Earth Science Week contests (https://www.earthsciweek.org/contests/). The visual arts contest (see Figure 2) is for U.S. students in grades K-5. Submissions for the 2025 visual arts theme, "A World of Energy Possibilities," should illustrate Earth's natural sources of energy. The essay contest asks U.S. students in grades 6-9 to write about "The Power of Tomorrow," with a focus on a specific renewable energy source of their choice and how it contributes to a more sustainable future. The photography and video contests are open to people of all ages in any part of the world. Photo submissions should show "Capturing Energy in Motion." Video submissions can be created by teams or individuals and should address "Energy Efficiency in Action: Small

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Changes, Big Impact" and how energy choices we make relate to SDG 7: Affordable and clean energy.

To celebrate Earth Science Week, we encourage you to host online or in-person events, or attend the presentations, exhibits, and interactive activities that many individuals and organizations host to engage students and the public with the Earth Science Week theme. Many of these events center on the week's Focus Days, especially National Fossil Day (sponsored by the NPS on the Wednesday of Earth Science Week), and highlight a specific aspect of the geosciences, while other events look at how different geoscience fields work together. Our Earth Science Week website has guidance on hosting events, as well as a map showing past events, from which you can draw inspiration or discover who in your area is getting involved in Earth Science Week.

Whatever your role—educator, student, or community member—there are endless opportunities to engage and explore the vital role of earth sciences in our everyday lives. Visit the Earth Science Week website for more information and email us at info@earthsciweek.org to let us know how you are celebrating "Energy Resources for Our Future."

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This journal is an example of what membership includes!

- quarterly peer-reviewed journal
- monthly newsletter
- current event alerts
- website for Earth Science teachers

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# Helping Pollinators Help Us: Creating Habitat for Climate Change Resilience

*Michelle Rebilas, American Littoral Society*

Monarch butterflies need milkweed to survive.
Photo credit: Shutterstock

## Abstract

This NOAA Planet Stewards Project addressed the decline of pollinators due to habitat loss and climate change. Students at Cumberland Regional High School (CRHS) in Bridgeton, New Jersey designed and planted a 1-acre pollinator habitat at their school, raised 450 native plants in their school greenhouse, enhanced half an acre of a restored agricultural site with native plants, and created informational signage on the importance of pollinators in our ecosystem. This was a collaborative project between Michelle Rebilas, Director of Education at the American Littoral Society and Nicole Smith, the dedicated Agriculture, Food, and Natural Resources teacher at CRHS. Over the 2-year project, 212 9-12th grade students planted close to 2000 native plants to increase pollinator habitat at their school and in their community. They explored the role of pollinators in the ecosystem as well as their connection to the food we eat and the crops that are grown locally. Students involved in the project showed an increase from pretest to posttest about their knowledge of pollinators and the threats they face, and agreed that they can help protect pollinators through environmental stewardship and outreach in their community. Students also gained direct experiences in the outdoors and increased confidence in their individual and collective ability to make a difference in the community and for their future.

## Introduction

The American Littoral Society has partnered with Cumberland Regional High School (CRHS) for many years to implement various “green space” projects on their school campus. NOAA Planet Stewards gave us the opportunity to build upon this partnership and embark on the 2-year journey to engage students in an environmental stewardship project that would increase pollinator habitat at their school and in the community. We had the unique opportunity to work with students that were studying Agriculture, Food, and Natural Resources. It enabled us to discuss the importance of pollinators from both the ecological perspective as well as the relationship between pollinators and the crops we grow, and the food we eat. We were able to study how the agricultural industry would be impacted if pollinators continue to decline with increased environmental challenges.

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Cumberland Regional High School is a Title I school, located in Cumberland County, New Jersey. Cumberland County makes up 500 square miles, in rural southern New Jersey, and has over 40 miles of Delaware Bay coastline and nearly 70,000 acres of farmland. This area offers great ecological diversity. However, it is threatened by pressures from coastal development, urban sprawl, and climate change. Cumberland County is also positioned directly in the flight path of the monarch butterfly's 2500-mile migration along the Atlantic Coast to Mexico. A recent study found that between 2000 and 2020, the total abundance of butterflies in the contiguous United States fell by 22% across 554 recorded species at a rate of 1.3% annually, largely due to habitat loss, pesticide use, and climate change. (Edwards et. al. 2025).

This project, to increase pollinator habitat at Cumberland Regional High School and in the local community, was needed because access to high quality, pesticide free habitat can help butterflies and other pollinators be more resilient to climate change (Edwards et. al. 2025). Managing areas to increase habitat can help declining butterfly populations, ensuring that host plants and nectar sources are available throughout the entire growing season (Edwards et. al. 2024). Outreach around this environmental issue is locally significant due to the role farmers, landowners, and schools can play in the protection of habitat and reduction of pesticide and herbicide use. Youth engagement is also important because we are preparing the next generation of environmental stewards and decision makers for a more resilient future in the face of climate change.

## Project Objective

Engage students in an environmental stewardship project to increase pollinator habitat at their school and in the community.

## Project Goals

- Engage 120 students, grades 9-12 in an environmental stewardship project to increase pollinator habitat at 2 locations in Cumberland County, NJ.
- Convert 1 acre of turfed grass area on school grounds to a pollinator habitat designed by the students.
- Plant 150 native plants on .5 acres of restored farmland at Barretts Run Nature Preserve in Hopewell Twp, NJ.
- Students will create informational signage to inform their community about the environmental issue and how they can be a part of the solution.

## Project Overview

Through this project, students at Cumberland Regional High School explored the role of pollinators in ecosystems and agriculture. They investigated how climate change is impacting local pollinators, including monarch butterflies and wild bees. They delved into the life cycle and migration patterns of the monarch butterfly, raised monarchs in their classroom and ventured to Cape May Point State Park to participate in professional monarch tagging efforts with the Monarch Monitoring Project (https://njaudubon.org/monarch-monitoring).

**Figure 1.** Michelle Rebilas assisting a student with releasing a monarch butterfly. Photo Credit: Nicole Smith

**Figure 2.** Students releasing a monarch butterfly. Photo Credit: Nicole Smith

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**Figure 3.** Habitat Design Posters designed by students. Photo Credit: Michelle Rebilas

**Figure 4.** Students measure plant growth rate in the greenhouse. Photo Credit: Michelle Rebilas

**Figure 5.** Student conducting a Bio Blitz. Photo Credit: Michelle Rebilas

Next students researched more threatened pollinator species and developed an action plan. They created habitat designs based on the needs and habitat requirements of their chosen pollinator and created posters to share with their peers and school community.

Their hands-on learning extended to the school greenhouse, where they nurtured over 450 native plants that would later be planted on school grounds. Throughout the project, students collected data and practiced scientific skills such as observation and analysis. Data collection included bio blitz of species abundance and diversity, plant growth, and soil sampling. Students used iNaturalist (https://www.inaturalist.org) to identify and sort the species observed during the bio blitz.

**Figure 6.** Planting on the field trip to Barrett's Run.
Photo Credit: Michelle Rebilas

**Figure 7.** Planting in the pollinator habitat at Cumberland Regional HS.
Photo Credit: Michelle Rebilas

Over the 2-year project, 212 9-12th grade students planted close to 2000 native plants to increase pollinator habitat at their school and in their community. Students installed one acre of pollinator habitat on school grounds, and attended a field trip to Barrett's Run Nature Preserve, where they enhanced .5 acres of pollinator habitat.

Students researched and designed pollinator habitat signage on posters and using online graphic design software. Student designs will be installed as permanent signage at the new CRHS Pollinator Habitat.


**Figure 8.** Students present their Pollinator Sign design.
Photo Credit: Michelle Rebilas

**Figure 9.** Students present their Pollinator Sign design.
Photo Credit: Michelle Rebilas

When asked about their favorite part of the program, students highlighted the joy of being outdoors, the satisfaction of planting, the connection with nature and animals, the newfound knowledge about pollinators, the tangible results of their efforts, and

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**Figure 10.** Releasing a tagged monarch butterfly at Cape May Point State Park with the Monarch Monitoring Project.
Photo Credit: Michelle Rebilas

**Figure 11.** Planting native plants at Cumberland Regional High School's pollinator habitat. Photo Credit: Michelle Rebilas

**Figure 12.** Planting on the field trip to Barrett's Run.
Photo Credit: Michelle Rebilas

**Figure 13.** Watering milkweed in the CRHS Greenhouse.
Photo Credit: Michelle Rebilas

the excitement of discovering new aspects of the natural world.

## Student Quotes

**Student, Arianna:** "Taking care of them was such a fantastic experience...It was so awesome being able to see its beautiful bright orange wings flapping ready to go live its new life, as I took it outside to release it sat on my finger for a second to probably let me know 'Thank you'".

**CRHS Student, Grade 12:** "What I liked most about working with the Littoral Society and Michelle was being able to make something that will be preserved here such as the (pollinator) signs and habitat. Not to be dramatic or anything, but as a senior, leaving any sort of legacy behind means a lot."

**Sample Lesson Plan:** Pollinators and their Habitats - Bio Blitz Lesson Plan (https://docs.google.com/document/d/1go5vz0KBWVIyr7eVjDaO9JbCbBbxlWWz)

**Figure 14.** Releasing a monarch butterfly. Photo Credit: Nicole Smith

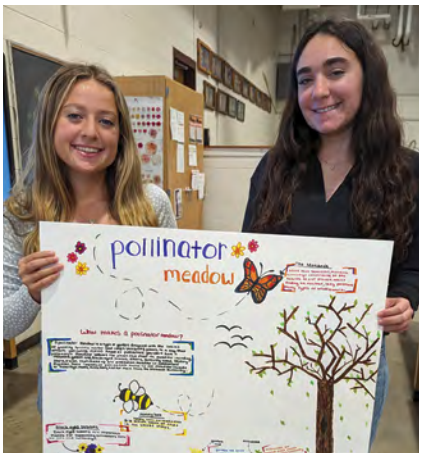


**Figure 15.** Students presenting their Pollinator Sign design. Photo Credit: Michelle Rebilas

**Table 1. Project Timeline**

| Year 1 Semester 1: September 2022 – January 2023 | Year 1 Semester 2: February 2023 – June 2023 |
|---|---|
| • Monarch Conservation Project<br>• Climate Change Impacts on Pollinators Lesson<br>• Raising Monarch Butterflies in the Classroom<br>• Habitat Planning & Design Project<br>• Growing Plants in the Greenhouse<br>• STEM Careers Presentation | • STEM Careers Presentation<br>• Climate Change Impacts on Pollinators Lesson<br>• Greenhouse Growing & Data Collection<br>• Carbon Cycle/Soil Sampling and Analysis<br>• Habitat Planting and Field Trip<br>• Pre/Post Planting Bio Blitz |
| **Year 2 Semester 1: September 2023 – January 2024** | **Year 2 Semester 2: February 2024 – June 2024** |
| • Pollinators Lesson & Habitat Fall BioBlitz<br>• Climate Change Impacts on Pollinators Lesson<br>• Growing Milkweed in the Greenhouse<br>• Field Trip to Cape May Point State Park to tag and release Monarch Butterflies<br>• Pollinator Habitat Signage Design Project<br>• STEM Careers Presentation | • STEM Careers Presentation<br>• Climate Change Impacts on Pollinators Lesson<br>• Growing Plants in the Greenhouse<br>• Carbon Cycle/Climate Change Lesson<br>• Field Trip to Barrett's Run Nature Preserve<br>• Habitat Planting<br>• Pre/Post Planting Bio Blitz |

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**Table 2. Connections to Next Generation Science Standards (NGSS, 2013)**

| Performance Expectations | Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|---|
| **HS-LS2-6**<br>Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. | Practice science skills including observation, data collection, prediction, research and communication.<br><br>Investigate how climate change is impacting pollinators locally and globally. | **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** | **Stability and Change**<br>Much of science deals with constructing explanations of how things change and how they remain stable. |
| **HS-LS2-7**<br>Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. | Evaluate strategies to address environmental problems. | **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**<br>**LS4.D: Biodiversity and Humans**<br>**ETS1.B: Developing Possible Solutions**<br>When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. ) | **Stability and Change**<br>Much of science deals with constructing explanations of how things change and how they remain stable. |
| **HS-LS4-6**<br>Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity | Develop a plan to address the decline of pollinators due to climate change and habitat loss. | **LS4.C: Adaptation**<br>**LS4.D: Biodiversity and Humans**<br>**ETS1.B: Developing Possible Solutions** | **Cause and Effect**<br>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. |

## Data Collection

Student Pre and Post tests: Students were given a 5-question knowledge and attitude pre and post test while participating in the program. Students were asked multiple choice and open-ended questions about their knowledge of pollinators and their importance, as well as to what extent they agreed they could help protect pollinators and share what they learned with the community.

**Table 3. Year 1 Pre Post Test Data**

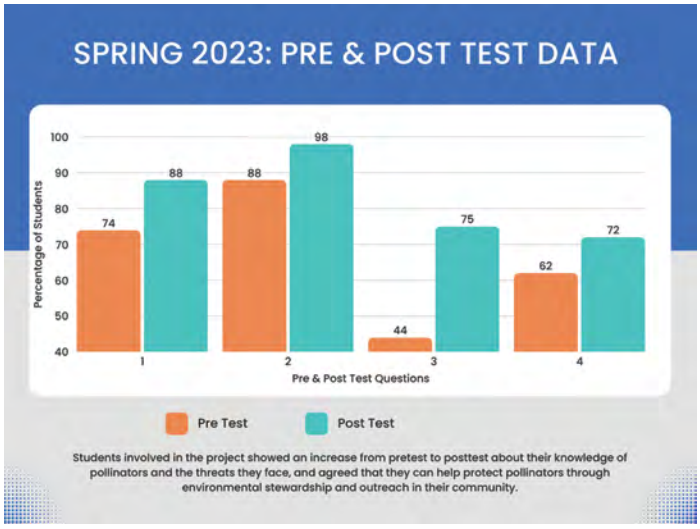
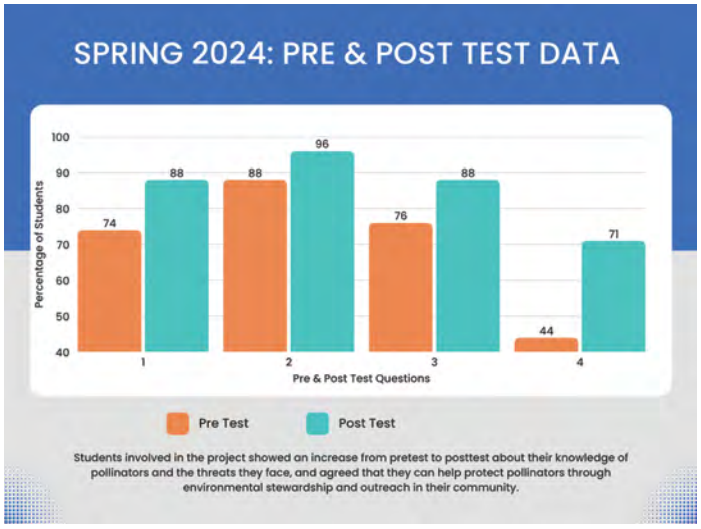



**Table 4. Spring 2024 Student Pre and Post Tests**

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After participation in the program, students demonstrated an increase in their knowledge about pollinators and the threats they face, and an increase in their self-efficacy, believing they could help pollinators because they were able to experience problem-solving firsthand and the step-by-step process of developing a solution to an environmental problem.

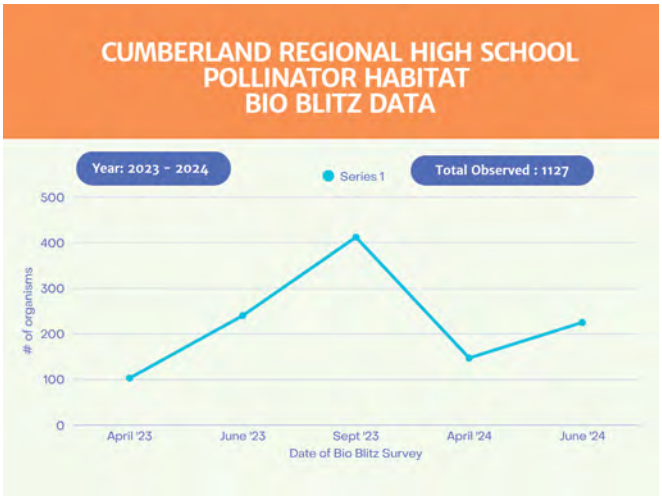
When asked the open-ended question about their favorite part of the program, student responses included: *Going outside, planting the plants, being around nature and animals, learning more about pollinators, seeing results, finding new things they'd never seen before, and going on the field trip.*

## Bio Blitz Habitat Surveys

Students conducted bio blitz surveys to collect data on species abundance and diversity at the planting site before and after the pollinator habitat installation over the 2-year project period. Surveys were conducted in April 2023, June 2023, Sept 2023, April 2024 and June 2024.

In September of 2023, 4 months after initial planting of the pollinator habitat, students found 412 organisms representing 27 species/categories. The data collected suggests that the installation of the pollinator habitat on school grounds has increased the availability and suitability of pollinator habitat in the area surrounding Cumberland Regional High School. Seasonality was also considered a contributing factor in the students' observations.

**Table 5. Pollinator Habitat Bio Blitz Data**




## Results

- **Student Engagement in Environmental stewardship**: 212 students, grades 9-12, engaged in the step-by-step process of investigating an environmental problem, development of a strategy to address the problem, and implementing a solution. Students practiced science skills including making observations, data collection, asking questions, making predictions, research and sharing information, planning and design. Students also gained direct experiences in the outdoors and increased confidence in their individual and collective ability to make a difference in the community and for their future.
- **New Pollinator Habitat Installation**: Over the 2 Year project, students planted 1650 native plants on school grounds to convert 1 acre of turfed grass area to a pollinator habitat. Students planted 340 native plants on .5 acres of restored farmland at Barretts Run Nature Preserve.
- **Greenhouse:** 450 native plants were cared for by the students in the greenhouse.
- **Monarch Rearing and Release**: 12 monarch butterflies were successfully released in Fall 2022. Students in Fall 2023 tagged and released 8 monarch butterflies with the Monarch Monitoring Project of Cape May, NJ.
- **Habitat Design Project**: 9 students completed a habitat planning and design project.
- **Habitat Signage:** 3 student designs were created on graphic design software to be printed and permanently displayed at the new Pollinator Meadow.
- **Bio Blitz Habitat Pre & Post Surveys:** Students collected data on species abundance and diversity before and after the pollinator habitat installation over the 2-year project period. A total of 1127 organisms were observed.

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## Conclusion

The goal of this NOAA Planet Stewards project: *Helping Pollinators Help Us: Creating Habitat for Climate Change Resilience* was to engage students in an environmental stewardship project to increase pollinator habitat at their school and in the community. Through this program, students gained hands-on conservation and stewardship experiences that built skills and confidence in their individual and collective ability to make a difference in the community and for their future. From the classroom to the field, students didn't just learn about the vital role of habitat in a changing world – they became active agents of change.

Students achieved the outcome of creating one acre of pollinator habitat on their school grounds and increasing the availability and suitability of pollinator habitat in the area surrounding Cumberland Regional High School. In addition, the pollinator habitat will provide a stopover site for monarch butterflies during migration. The project will continue to benefit the teachers and students at CRHS by providing an outdoor learning space, living laboratory to study climate change, and an opportunity to practice skills. Additionally, student designed signage will be permanently installed to share what they have learned with their school and local community.

## References

Edwards CB, Schultz CB, Campbell SP, et al. (2024). Phenological constancy and management interventions predict population trends in at-risk butterflies in the United States. *Journal of Applied Ecology*. 2024;61(10):2455-2469. doi:https://doi.org/10.1111/1365-2664.14735

Edwards CB, Zipkin EF, Henry EH, et al. (2025). Rapid butterfly declines across the United States during the 21st century. *Science*. 2025;387(6738):1090-1094. doi:https://doi.org/10.1126/science.adp4671

NGSS. (2013), *Next Generation Science Standards: For States, By States*. National Research Council. Washington, DC: The National Academies Press. https://doi.org/10.17226/18290

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# Sparking Change: Student Restoration of a Longleaf Ecosystem

*Karen Metcalf, Cornerstone Learning Community, Tallahassee, FL*

Mature Longleaf-wiregrass system.

Photo credit: Jason Flom

## Abstract

A two-year habitat restoration effort was led by middle school students at Cornerstone Learning Community, Tallahassee, Florida focused on the longleaf pine ecosystem of Northwest Florida. Supported by NOAA Planet Stewards and local conservation partners, students collected, propagated, and planted over 4,500 wiregrass plugs and 100 native wildflowers. They evaluated restoration progress using bioblitzes, comparing a newly restored site with a reference ecosystem. The project engaged students in authentic science practices, supported cross-grade environmental education, and helped them apply life and Earth science concepts in real-world settings. Using the framework of "handprints" not "footprints," students focused on their potential to create positive ecological change. Pre- and post-modeling assessments revealed growth in systems thinking and understanding of keystone species, fire ecology, and biodiversity.

## Introduction

A handful of seeds can tell a powerful story. One student put it best, "In November 2022, Cornerstone Learning Community's middle school went to the Apalachicola Bluffs and Ravines Preserve, and came back with one million, eight hundred sixty-five thousand, five hundred and four seeds, hoping to *spark* a change." This reflection captures the spirit of a two-year habitat restoration project in the longleaf pine ecosystem of Northwest Florida. The project, supported by NOAA Planet Stewards, engaged students in authentic field science. Fostering a *spark* for environmental stewardship empowers students to apply science skills, deepen their understanding of ecosystems, and see their efforts make a difference.

## The Issue

Longleaf pine ecosystems once covered 60-90 million acres of the Southern United States. Currently, longleaf forests cover less than 5 million acres (Oswalt et al, 2012). Longleaf pine (*Pinus palustris)* and wiregrass (*Aristida stricta)* are keystone species in these highly biodiverse ecosystems, which are home to many endangered and threatened animals such as the gopher tortoise, flatwoods salamander, indigo snake, and red-cockaded woodpecker. Fully restoring the diversity and ecosystem services of the longleaf pine forests requires not

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only planting trees, but also reestablishing the smaller woody and herbaceous plants that once thrived there.

To sustain a thriving longleaf pine ecosystem, fire must be a regular part of the landscape. Periodic, low-intensity burns help maintain the open canopy and support a diverse ground layer of plants that quickly recover after fire (Winger, 2022). Since European settlement, natural fire cycles have been interrupted by land use changes (i.e., agriculture, timber production, development). In the absence of fire, fast-growing deciduous trees begin to dominate, shading out native grasses and wildflowers and reducing biodiversity. Wiregrass plays a critical role by providing the fuels that carry fire across the forest floor, making restoration efforts that include wiregrass essential for long-term ecosystem health (Seamon, et al, 1989).

Our school has a long history of service and learning in longleaf pine habitats. Engaging with this ecosystem offers opportunities to explore our region's cultural and ecological history, examine human impacts on the environment, and apply scientific concepts in real-world contexts. The goal of this project was to develop a process that can persist as a new, long-term tradition of meaningful habitat restoration; raising and planting both wiregrass and wildflowers for local environments.

## Goals and Strategy

Our goals were to conduct habitat restoration in two ways. First, we planned to have middle school students raise 4,500 wiregrass plants over two years and outplant them in a restoration area at the Apalachicola Bluffs and Ravines Preserve (ABRP). Second, we planned to have all the students at our PreK-8th grade school raise 100 *Coreopsis* (tickseed) plants over two years and distribute them in our school pollinator gardens and a local park. In a time of increasing eco-anxiety about our impacts on the environment, students need to feel like they can make a difference in the world. This project helps us teach a "handprints" not "footprints" mindset with students (Norris, 2018). They practice making things better through their handprints rather than only considering their negative impacts through unavoidable ecological footprints. These terms are explicitly taught through a lesson so that they can be referred to on a regular basis.

**LESSON PLAN:** Handprint Thinking: Your Impact on the World (https://docs.google.com/document/d/1cs9TRz4KYc8zFkSsOLUaZrwZbzxteemNvTmo4fqCtaw/edit?usp=sharing)

**Figure 1.** Restoration site prior to beginning the project at the ABRP. Photo credit: Karen Metcalf

Making connections to community partners, such as NOAA's Planet Stewards Program, The Nature Conservancy's Apalachicola Bluffs and Ravines Preserve (ABRP) and Leon County Parks Department in this case, are critical to the success of projects that tackle real-world problems. It's not easy to find opportunities for middle school aged students. Eleven-to-fourteen--year olds are capable of much and eager to give when special projects like this one are facilitated.

Once these partnerships were established and with their expert advice about propagation and siting, we set up an on-campus nursery for growing the

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**Figure 2.** Celebrating seed collection from the donor site at the ABRP.
Photo credit: Rob Diaz de Villegas

**Figure 3.** Removing wiregrass seeds from spikes.
Photo credit: Karen Metcalf

grass and wildflowers. A site had been identified at the preserve that was recently cleared of hardwood to make way for longleaf ecosystem restoration. The restoration site is located adjacent to the ABRP administrative buildings and nursery. The plot was cleared of hardwoods just before our project began.

## Wiregrass Seed Collection and Growth

In the fall of 2022, middle school students traveled to the ABRP. To preserve genetic diversity, students collected wiregrass culms from a donor site adjacent to the restoration area. These were brought back to campus and the seeds stripped from the culms, resulting in what we estimated to be 1.8 million seeds. These seeds were kept refrigerated to maintain viability and successfully germinated for the 2022, 2023, and 2024 plantings. Students used a subsampling lesson to make the estimate.

**LESSON PLAN:** Subsampling to Estimate Wiregrass Seed Abundance (https://docs.google.com/document/d/1KPYD0Tbsp9BuqvqEtM5oGmVOyZnvUsiyDwtWJrNAyfs/edit?usp=sharing).

**Table 1. NGSS Connections: Performance Expectations: Wiregrass Ecosystem Restoration Projects (NGSS, 2013)**

| MS-LS2-1 | MS-LS2-2 | MS-LS2-3 | MS-LS2-4 | MS-LS2-5 | MS-ESS3-3 |
|---|---|---|---|---|---|
| Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. | Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. | Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. | Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. | Evaluate competing design solutions for maintaining biodiversity and ecosystem services. | Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. |

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**Table 2. Three Dimensions of the Standards (NGSS, 2013)**

| Science & Engineering Practices (SEP) | Disciplinary Core Ideas (DCI) | Crosscutting Concepts (CCC) |
|---|---|---|
| • Planning and carrying out investigations<br>• Analyzing and interpreting data<br>• Constructing explanations and designing solutions<br>• Engaging in argument from evidence<br>• Communicating information | • **LS2.A:** Interdependent Relationships in Ecosystems<br>• **LS2.B:** Cycle of Matter and Energy Transfer in Ecosystems<br>• **LS2.C:** Ecosystem Dynamics, Functioning, and Resilience<br>• **LS4.D:** Biodiversity and Humans<br>• **ESS3.C:** Human Impacts on Earth Systems | • Cause and Effect<br>• Systems and System Models<br>• Stability and Change<br>• Energy and Matter<br>• Scale, Proportion, and Quantity<br>• Interdependence of Science, Engineering, and Technology |

**Figure 4.** Wiregrass plugs in our school planting tables.
Photo credit: Karen Metcalf

**Figure 5.** Tray of wiregrass ready to plant.
Photo credit: Jason Flom

Each spring, students prepare deep-cell trays with a 50:50 mix of sand and potting soil, planting 20–30 seeds per cell to ensure robust plug development. These are monitored through the school year and again in the fall.

The plugs were planted at the restoration site in the late summer/fall of 2023 and 2024. At the restoration site, shovels were much more effective than dibbles in preparing a hole for wiregrass. Students worked with a partner, taking a plug tray to any spot they thought looked good for planting.

**Figure 6.** Preparing a hole for a new wiregrass plug. Photo credit: Karen Metcalf

One partner prepared the hole and the other placed the plug and pushed the sandy soil back in place. Wiregrass plugs are documented to have a 99% survival rate (Seamon and Meyers, 1992). Students evaluated the success of their first planting six months later. While they were conducting a bioblitz, they took note of every plug they sighted and kept a tally of whether it survived or not. Since plugs were planted haphazardly, there was no way to confirm the status of every original plug, but our measured survival of the plugs that we counted was over 95%.

## Biodiversity Evaluation and Planting Success

As a way to evaluate the success of our wiregrass planting, middle school students conduct bioblitzes to quantify the diversity of species. A bioblitz is a short-term, intense outing that attempts to document all the living things in an area. In this case, student groups select a taxonomic group for their focus and spend an hour documenting all they can in an iNaturalist project. After returning, classes proof the information and tally the observations.

In order to make comparisons, a reference longleaf pine ecosystem site was identified and sampled in March 2023. The restoration site was sampled in March of 2024.

**LESSON PLAN:** Bioblitz (https://docs.google.com/document/d/1mewB_mCkvdspCvYe7IXkggz5T2bm0b8_kV99mG-9Ts0/edit?usp=drive_link).

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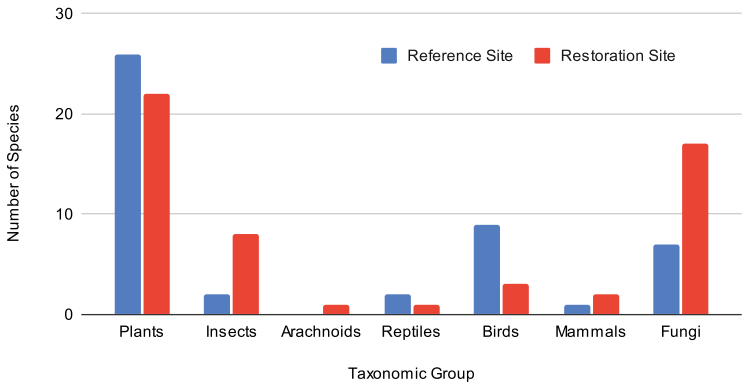
The restoration site was completely cleared to remove undesirable vegetation the year prior to our first planting. By March 2024, both sites supported similar species counts. However, the restored site was dominated by early successional annuals—plants germinated from the seedbank following clearing. Over time, we expect a shift toward greater resemblance to the reference ecosystem.

**Table 3. Bioblitz results from reference site (existing longleaf pine ecosystem) and habitat restoration site 4 months after planting**




## Wildflower Restoration

In addition to the ABRP work, a wildflower restoration effort closer to home was designed to engage our youngest learners. The wildflower component was a more local restoration project that included all PreK-8th grade students at the school. In order to restore wildflowers, the older students planted native *Coreopsis* seeds in pots each fall, monitoring the germination and growth over time. In April, several gallon pots were distributed to each of the younger grade classes and older students taught how to care for them, as well as leading a discussion about the importance of the plants in the ecosystem. In April/May of each year, every student, under the leadership of middle schoolers, was involved in planting the flowers either at Jackson View Park near our campus or in our campus pollinator gardens.

Older students also partnered with teachers of younger grades for "reading buddy" sessions. They shared passages from the book *Kingdom of Longleaf* (Kwiatkowski, 2015), a non-fiction children's book about this unique ecosystem, to teach about some of the species and processes that occur there.

## Student Learning

This long-term project enabled students to apply many scientific concepts to the longleaf pine ecosystem. These are most relevant to life and Earth sciences. Shown in Tables 1 and 2 are corresponding performance expectations integrated into this project.

In order to measure learning outcomes for the older students, they were asked to create models of the ecosystem, before and after being involved in the habitat restoration. This method is fully described by Dentzau (2021) for students at an informal environmental education center. A prompt asks students to create a model of the longleaf pine ecosystem; showing the organisms, processes, and components they understand to be part of it. The sixth-grade students have little experience with scientific modeling, so the task is preceded by an explanation of scientific conceptual models.

Student models in the post-test showed more complexity and sophistication in their understanding of the system. Most pre-test models were limited to organisms in the system. In comparing the pre- and post-test models, students demonstrated increased understanding of ecological relationships, the importance of fire and other abiotic factors, and the role of keystone species. All but one student showed growth in their models after being involved in the restoration project.

**LESSON PLAN:** Pre- and Post-Test: Longleaf Pine Ecosystem Modeling (https://docs.google.com/document/d/1vpPEQLL7sN2q5TffutXHZng2niFTPW5U9_-OPxTFwjw/edit?usp=sharing)

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## About the Author

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## Conclusion

This project showed students how small actions can drive ecological change. By focusing on handprints—their positive impact—they made meaningful contributions through care, effort, and collaboration. Habitat restoration helped them apply science in a real-world context. We hope this tradition continues to grow.

## References

Dentzau, Michael. (2021). "Student Mental Models of the Longleaf Pine Ecosystem". Interdisciplinary Journal of Environmental and Science Education, vol. 17, no. 4, 2021, e2254. https://doi.org/10.21601/ijese/10972.

Kwiatkowski, Frances. (2015). "*Kingdom of Longleaf*", Coneflower Design.

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states.* Washington, DC: The National Academies Press. https://www.nextgenscience.org/standards

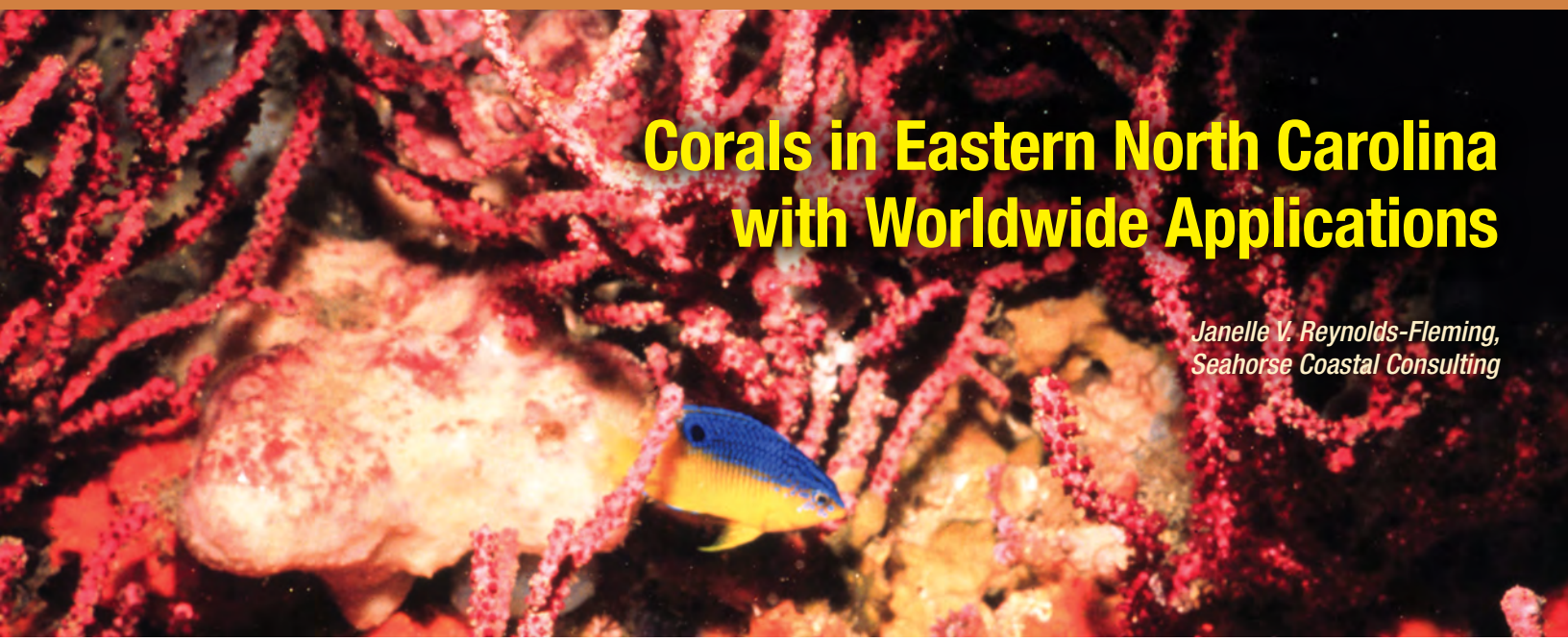
Norris, G. (2018). Living Future, Footprints and Handprints: The Ripple Effects of our Presence. https://trimtab.living-future.org/trim-tab/issue-35/footprints-and-handprints-the-ripple-effects-of-our-presence.

Oswalt, Christopher M.; Cooper, Jason A.; Brockway, Dale G.; Brooks, Horace W.; Walker, Joan L.; Connor, Kristina F.; Oswalt, Sonja N.; Conner, Roger C. (2012). History and current condition of longleaf pine in the Southern United States. Gen. Tech. Rep. SRS–166. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 51 p.

Seamon, Paula A., et al. (1989). Wiregrass Reproduction and Community Restoration. Natural Areas Journal, vol. 9, no. 4, 1989, pp. 264–65. JSTOR, http://www.jstor.org/stable/43911091.

Seamon, P. and R. Myers. (1992). Propagating Wiregrass from Seed. The Palmetto, Vol 12, No 4, Winter.

Winger, Jennifer. (2022). "Pine Country." The Nature Conservancy, 26 Aug. 2022, www.nature.org/en-us/magazine/magazine-articles/longleaf-pine.



# Corals in Eastern North Carolina with Worldwide Applications

*Janelle V. Reynolds-Fleming, Seahorse Coastal Consulting*

Sponges, soft corals and other invertebrates similar to those found in the Caribbean can be found on the reefs offshore of North Carolina. Read more at Coastal Review, coastalreview.org. Photo credit: NOAA

## Abstract

While reef building corals typically found in tropical waters are not generally noted in North Carolina, there are a few scleractinian corals that exist and provide habitat on rocky and artificial reefs. In particular, the coral, *Oculina arbuscula* is a branching coral that is cold, low-light and sediment tolerant, but often competes for space with algae. Many organisms, such as juvenile slippery dicks (*Halichoeres bivittatus*), white belted sandfish (*Serranus subligarius*), the commercially regulated black sea bass (*Centropristis striata*) and crabs (*Mithrax Sculptus*) use the coral for habitat, defense and protection. Working in partnerships with the Duke Marine Lab RESTORE Coral Team, the National Park Service, the Nature Conservancy, and Reef Renewal USA and with funding provided by the NOAA Planet Stewards program, an *O. arbuscula* coral nursery was established, monitored, and used for genetic testing and outplanting by the **M**arine **E**ducation, **R**esearch, and **R**esilience for **O**ceans **W**orldwide (MERROW) AQUAneers, a group of AAUS (American Academy of Underwater Sciences) teen science divers. The students' efforts in coral restoration helped restore a local jetty and instilled a greater sense of conservation awareness in the next generation of decision makers.

## Introduction

Over recent decades to centuries, continued declines of coastal ecosystems have occurred globally, such that the global coverage of saltmarshes, mangroves, seagrasses, oyster reefs, kelp beds and coral reefs has been reduced by 35–85% (Lotze, et al. 2006, Waycott, et al. 2009, Hughes, et al. 2018, Wernber, et al. 2016, Valiela, et al. 2001, Beck, et al, 2011, Silliman, et al, 2009). At least 775 million people globally have high dependence on coastal marine ecosystems (Selig, et al. 2019). These systems provide services such as sequestering carbon at twice the rate of terrestrial forests, supporting habitats for half of assessed commercial fish stocks, underpinning food supplies for 500 million people, reducing concentrations of human- derived pathogens, supporting eco-tourism that can fuel local economies and small countries, and reducing wave energy on shorelines by up to 95%. As such, intact coastal

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ecosystems improve human health, physically as well as psychologically. Reestablishing coastal marine ecosystems at large scales will play a key role in supporting human health and wellbeing, achieving the UN Sustainable Development Goals, and adapting to and mitigating global climate change.

Human communities of coastal North Carolina (NC) rely heavily on key marine ecosystems – marshes, oyster reefs, dune and seagrasses – to provide essential services including food provisioning, flood protection, tourism, and carbon storage. While much research and funding has been directed to conserving and restoring these systems, comparatively little has been focused on another NC ecosystem – temperate coral reefs. While this imbalance has been justified given these reefs are not nearly as common, coral reefs are likely to increase in the future in NC with increasing sea temperatures. In addition, given coral sensitivity to even low nutrient loading, it's very plausible that coral reefs were more common in NC shallow waters than current thought.

The dominant reef building coral in NC is *Oculina arbuscula*. It is a branching coral that is cold, low-light and sediment tolerant, but often competes for space with algae (Miller and Hay, 1996). It is unique in that it can exist and prosper with or without its symbiotic zooxanthellae (Miller, 1995). Those coral individuals that have the zooxanthellae (symbiotic) are reddish/brown in color and those that don't have them or are lower in abundance (aposymbiotic) are generally white. This coral species primarily generates reefs in offshore deeper areas, but reefs do occur inland in some locations; for instance, on the Shackleford and Radio Island Jetties in Carteret County, NC. When these reefs do occur, they facilitate native diversity and increase local abundance of non-commercial and commercially important invertebrates and fish such as juvenile slippery dicks (*Halichoeres bivittatus*), white belted sandfish (*Serranus subligarius*), the commercially regulated black sea bass (*Centropristis striata*) and crabs (*Mithrax Sculptus*). While NC supports restoration of marshes, oyster reefs and seagrasses through funded plantings and nurseries, no work currently exists to augment these coral populations. The potential to facilitate regrowth of these temperate reefs is likely high however, given rapid evolution of technology in rearing and out-planting tropical corals.

Key to rapidly elevating the field of temperate coral reef restoration in NC is to:

1. gain a better understanding of the distribution and facilitative effects of our current reefs and how that varies between shallow and deep hard bottom sites,
2. begin to evaluate the physical and biological factors that could be driving their populations which could help identify areas for restoration,
3. begin to understand if corals in deep and shallow sites are genetically different,
4. begin rearing baby corals in coral nurseries to be able to supply future coral restoration efforts.

## Project

The **M**arine **E**ducation, **R**esearch, and **R**esilience for **O**ceans **W**orldwide (MERROW) Foundation began in 2016 and initially started working with teens in 2019. The teen science diving group is called the MERROW AQUAneers and they range in age from 10 up to 20 years old. Many are already open water SCUBA certified, although that is not a pre-requisite and they can earn that qualification through participation in the program. There are

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22 AQUAneers and they join this group with their parents and learn about the marine environment with a focus on North Carolina. During the school year, the AQUAneers met monthly and learned the basics of marine science. These sessions included introductory concepts of physical, chemical, biological, and geological oceanography in general and then applied to North Carolina, in particular. Learning sessions included lectures based on the freely available *Introduction to Oceanography* book by Paul Webb (https://rwu.pressbooks.pub/webboceanography/). As students were also working towards their American Academy of Underwater Sciences (AAUS) authorization, some weekend training including first aid, CPR, swim tests, and SCUBA training occurred. This project formally began at the end of 2023 with a final push towards data collection in 2024. Informational presentations on the anatomy and physiology of corals, the ecology of coral reefs, and science diving training techniques began in earnest during 2023.

The goals of this project were fourfold:

1. Increase AQUAneer understanding of the temperate coral reef systems in North Carolina
2. Increase knowledge of organisms sustained by temperate coral reef systems
3. Improve science diving skills
4. Contribute to the rehabilitation of a temperate coral reef using techniques employed worldwide

Following techniques provided by Johnson, et al (2011), a coral nursery of *O. arbuscula* was established at Radio Island Rock Jetty, an inshore, easily accessible and anthropogenically influenced location. MERROW AQUAneers collected fragments of corals from the jetty and placed them on the established nursery sites. Prior to collection, fish and invertebrate surveys were conducted to quantify organisms that the local coral population support and to compare to the habitat diversity at other locations. In the summer of 2024, with financial support from the NOAA Planet Stewards Program, the AQUAneers surveyed sites that were deeper offshore wrecks that were less accessible and not as easily disturbed anthropogenically. The five offshore sites varied between the depths of 35 and 90 feet and included:

1. The 435-foot-long tanker *W.E. Hutton*, a casualty of the World War II battle in the Atlantic, sank in March, 1942, and sits in about 70 feet of water.
2. The landing craft repair ship, *Indra* that was purposely sunk in 1992 as part of the artificial reef program and sits in about 70 feet of water.
3. The *J. J. Francesconi* tug that was sunk in 2016 as part of the artificial reef program and sits in about 60 feet of water.
4. The tug Boat *Fort Fisher* that was sunk in 2018 as part of the artificial reef program.
5. The *Caribsea*, a casualty of a World War II battle in the Atlantic, that sank in March, 1942, and sits in about 90 feet of water.

For each site, the AQUAneers collected samples for their growing coral nursery and for genetic identification and classification. In addition, transect and quadrat surveys were conducted to provide baseline information about habitat complexity at each location. Belt transects of 30 meters in length were used to identify the fish populations along the transect. The AQUAneers identified, quantified and size-classed the organisms. At 5-meter intervals,

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0.5m quadrats were placed along the transect to identify the invertebrates and quantify the percent cover of invertebrates along the wreck. They also noted the presence or absence of corals (with or without symbionts) and their configuration. Examples of configurations are patchy (small sections of partial coral cover with low (<3cm) vertical extent), clumped

**Figure 1.** The coral *O. arbuscula* with (reddish/brown color) and without its symbionts in a communal clump at Radio Island Rock Jetty.

Photo credit: Janelle Fleming

**Figure 2.** AQUAneers Lauren and Jyvanna practice their fish transect techniques above ground prior to practicing at Radio Island Rock Jetty.

Photo credit: Janelle Fleming

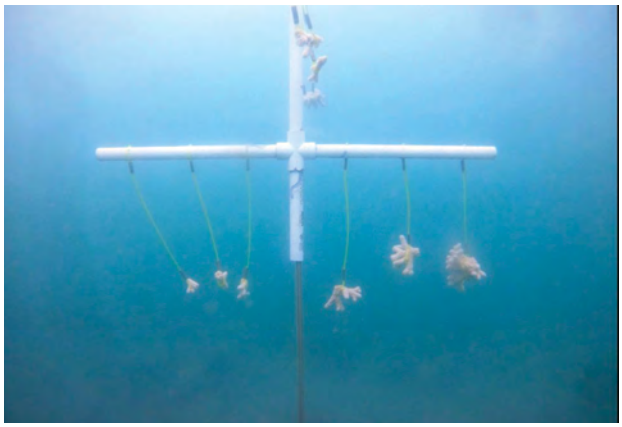

**Figure 3.** An example of the *O. arbscula* nursery tree created, deployed, and populated by the MERROW AQUAneers.

Photo credit: Janelle Fleming

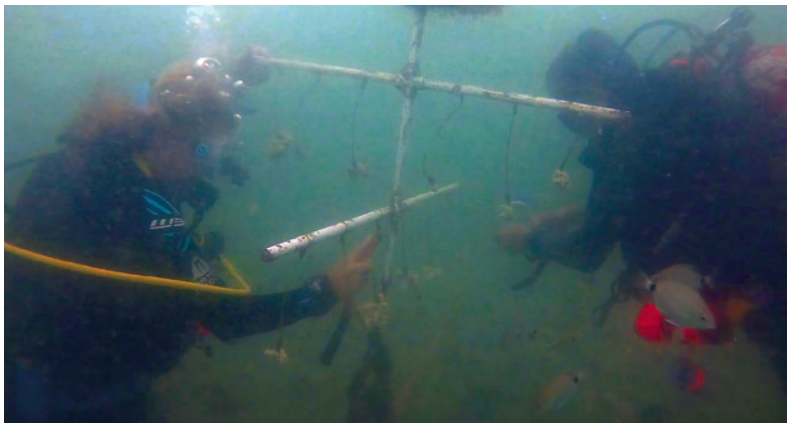

**Figure 4.** AQUAneers Bryn and Alex maintain the coral nursery tree with regular cleaning. Photo credit: Janelle Fleming

**Figure 5.** AQUANeers Lauren, Alistair, Adler, Sammy, and Morgan conduct fish transects on the Hutton during the 2024 collection period.

Photo credit: Janelle Fleming

**Figure 6.** AQUAneers Lauren conducts a quadrat survey on the Atlas wreck during the 2024 collection period.

Photo credit: Janelle Fleming

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(larger patches with medium (>3cm – 6cm) vertical extent), and branching colonies (colonies of corals that had high >6cm vertical extent and branching). Temperature readings from dive computers were collected as a basic physical parameter for comparison.

## Data Collection

Prior to the start of the project, the AQUAneers were quizzed on their current level of invertebrate and vertebrate identification. We used the REEF (Reef Environmental Education Foundation) Tropical Western Atlantic (TWA) and Southern Atlantic States (SAS) identification guides for fish and invertebrates quiz prior to a seminar to assess their initial knowledge. Students were presented images of an organism and asked to identify the scientific names. The vertebrate and invertebrate quizzes consisted of 25 questions and students needed above an 80% to count towards REEF Experience Level 2.

Students were then presented with study material, including an inhouse-developed Kahoot quiz game as well as REEF-developed identification quizzes (https://www.reef.org/quizzes). Example surveys were conducted at Radio Island Rock Jetty to practice techniques. At the end of the project, quizzes were re-administered and the grades recorded. Table 1 indicates a marked increase in the identification of both fish and invertebrate species. More than half of the AQUAneers scored above 70% and were able to reach their REEF Experience Level 2 qualifications.

**Table 1. Testing results of the REEF Fish and Invertebrate quiz**

| Quiz Score | Pre-assessment FISH (# students) | Post-assessment FISH (# students) | Pre-assessment INVERTS (# students) | Post-assessment INVERTS (# students) |
|---|---|---|---|---|
| 0-10% | 0 | 0 | 2 | 0 |
| 10-20% | 5 | 0 | 3 | 0 |
| 20-30% | 4 | 0 | 5 | 0 |
| 30-40% | 5 | 0 | 2 | 1 |
| 40-50% | 2 | 1 | 4 | 0 |
| 50-60% | 3 | 0 | 3 | 0 |
| 60-70% | 2 | 4 | 2 | 5 |
| 70-80% | 0 | 3 | 0 | 6 |
| 80-90% | 0 | 7 | 0 | 6 |
| 90-100% | 0 | 6 | 0 | 3 |

**Table 2. Summary of the differences in coral communities among the different sampling locations**

The primary fish species were Black Sea Bass (*Centropristis Striata*), White belted Sandfish (*Serranus Subligarus*), Slippery Dick (*Halichoeres Bivitatus*), Spottail Pinfish (*Diplodus Holbrookii*), Sheepshead (*Archosargus probatocephalus*), Angelfish (*Chaetodipterus faber*), Tautog (*Tautoga onitis*), Seaweed blennies (*Parablennius marmoreus*), Grouper (*Mycteroperca microlepis*), trunkfish (*Lactophrys trigones*), beaugregory (*Stegastes leucostictus*), greater amberjack (*Seriola dumerili*), Whitebone porgy (*Calamus leucosteus*), and goatfish (*Mullus auratus*).

| Location | # of Different Fish Species | # of Different Invert Species | Avg # of corals (formation and +/- with or without symbionts) |
|---|---|---|---|
| Radio Island Rock Jetty (10-35 ft) | 8 | 16 | 15 branching colonies – 10 with symbionts and 5 without |
| *Hutton* | 8 | 17 | 10 clumped with symbionts |
| *Indra* | 9 | 17 | 10 clumped with symbionts<br>*inside structure, corals are without symbionts |
| *Franscesconi* | 9 | 17 | 8 patchy with symbionts<br>*inside structure, corals are without symbionts |
| *Ft. Fisher* | 12 | 17 | 5 patchy + |
| *Caribsea* | 13 | 18 | 5 clumps + |

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**Figure 7.** AQUAneers Bryn and Alex maintain an *A. cervicornis* nursery for Reef Renewal Bonaire in March 2025. Photo credit: Janelle Fleming

**Figure 8.** AQUAneers Alistair and Morgan maintain an *A. cervicornis* nursery for the Nature Conservancy in St. Croix, USVI. Photo credit: Janelle Fleming

## Results

Although not represented in the table, there was a significant difference in the size class of certain species like Black Sea Bass (*Centropristis Striata*). In general, there are larger organisms at the offshore sites versus the inshore Radio Island Rock Jetty site. There were also larger schools of fish like tomtates (*Haemulon aerolineatum*) offshore and had a variety of size classes within the schools

Regional differences were seen in the number of different fish species between sites. Typical invertebrate species noted were Seapork (*Aplidium stellatum*), Yellow sponge, Regal Sea Fan (*Leptogorgia hebes*), Sea Whip (*Leptigorgia virgulata*), True Tulip Snail (*Fasciolaria tulipa*), Florida horse Conch (*Pleuroplaca gigantea*), Common Octopus (*Octopus vulgaris*), Black Sea Spider (*Anoplodactylus lentus*), Christmas Tree worms (*Spirobranchus giganteus*), Variegated Feather Duster (*Bispira variegata*), Purple Sea Urchin (*Arvacia punctulata*), Variegated Sea Urchin (*Lytechinus variegatus*), Common Sea Star (*Asterias forbesi*), Sargassum (*Sargassum spp*), Padina Pavonica, Dictyota menstrualis, Sea Nettle (*Chrysaora quinquecirrha*), White Eye Sea Spray (*Thesia Nivea*), and murex snails. Again, regional differences were noted.

In 2023, four of the AQUAneers graduated from high school and began college. Those AQUAneers returned to participate in the summer sampling and data analysis. Two of those graduates completed a high school senior thesis that focused on coral conservation and climate change. Of the college attendants, two are biology majors, one is a chemistry and chemical oceanography major, and one is a mechanical engineering major. All have stated that this research project influenced their choice of majors.

As a bonus, because the AQUAneers had trained in what could be considered difficult conditions in Eastern North Carolina (strong current, low visibility, etc), they were able to complete work in other areas of the world easily. Examples include working on the Nature Conservancy's Cane Bay Nursery in St. Croix and the Reef Renewal Bonaire's Nursery on Klein Bonaire.

## Conclusion

Overall, this project restored a section of the Radio Island Rock Jetty, established a coral nursery, trained at least 20 science divers in the process of coral nursery maintenance,

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and characterized the habitat of 6 diving locations in Bogue Sound. In addition, several of the participants took their knowledge to college and are inspired to major in several STEM areas including biology, chemistry, and mechanical engineering. Students worked on their diving skills, earned advanced training, and learned how to categorize the organisms in the temperate reef habitats inshore and offshore communicated their results.

## References

Beck, Michael W., et al. (2011). "Oyster reefs at risk and recommendations for conservation, restoration, and management." *Bioscience* 61.2: 107-116.

Hughes, Terry P., et al. (2018). "Spatial and temporal patterns of mass bleaching of corals in the Anthropocene." *Science* 359.6371: 80-83.

Johnson, M. E., C. Lustic, E. Bartels, I. B. Baums, D. S. Gilliam, L. Larson, D. Lirman, M. W. Miller, K. Nedimyer, S. Schopmeyer. (2011). *Caribbean Acropora Restoration Guide: Best Practices for Propagation and Population Enhancement*. The Nature Conservancy, Arlington, VA.

Lotze, Heike K., et al. (2006) "Depletion, degradation, and recovery potential of estuaries and coastal seas." *Science* 312.5781: 1806-1809.

Miller, MW. (1995). Growth of a temperate coral: effects of temperature, light, depth, and heterotrophy. *Marine Ecology Progress Series*, 121: 217-225.

Miller MW, Hay ME (1996). Coral-seaweed–grazer–nutrient interactions on temperate reefs. *Ecological Monographs*, 66, 323– 344.

Selig, Elizabeth R., et al. (2019). "Mapping global human dependence on marine ecosystems." *Conservation Letters* 12.2: e12617.

Silliman, Brian R., Edwin D. Grosholz, and Mark D. Bertness, (2009). *Human impacts on salt marshes: a global perspective*. University of California Press.

Waycott, Michelle, et al. (2009). "Accelerating loss of seagrasses across the globe threatens coastal ecosystems." *Proceedings of the national academy of sciences* 106.30: 12377-12381.

Wernberg, Thomas, et al. (2016). "Climate-driven regime shift of a temperate marine ecosystem." *Science* 353.6295: 169-172.

Valiela, Ivan, Jennifer L. Bowen, and Joanna K. York. (2001). "Mangrove Forests: One of the World's Threatened Major Tropical Environments." *Bioscience* 51.10: 807-815.

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# Project EEASY: Education and Engagement to Active Stewardship with the Youth Environmental Alliance

*Kristen Hoss, Youth Environmental Alliance*

A great white heron sits among the mangroves in the Florida Keys. Photo Credit: Shutterstock

## Abstract

Working in partnership with three Title 1 schools (5 different grade levels), local cities and a State Park and with funding provided by the NOAA Planet Stewards program, Youth Environmental Alliance (YEA) created Project EEASY-Education and Engagement to Active Stewardship with YEA- where 286 students and 25 teachers found it EEASY to be Eco-friendly and enact change for the environment and themselves. The goal of this project was to empower students from underserved communities with the knowledge, skills and abilities to restore vital habitats that they rely on for food, clean air and water and direct protection from climate-based issues and to succeed in STEM careers. The students' efforts of removing 57 lbs. of marine debris and 2300 square feet of invasive plants, followed by the planting of 1484 native plants and 9 trees and mangroves in a dune, wetland or mangrove system, helped restore 17,828 square feet of shoreline, while instilling a greater sense of environmental stewardship and understanding (38%-180% knowledge gains achieved) that each one of them can make a difference. We know they felt empowered based on their testimonials and the changes in behaviors reported on our post-event surveys, where between 48%-100% of students reported either following up with eco-actions at home or changing behaviors based on what they experienced as NOAA Planet Stewards.

## Introduction

Broward County, FL is uniquely situated between the Ocean and the Everglades with Eastern 1/3 of the county being developed and drained by 266 linear miles of canals which flow through Broward's 24 miles of coastline as the water reaches the Atlantic Ocean. The region faces a variety of environmental threats, including biodiversity and habitat loss due to urbanization, marine debris, reef degradation, deterioration of water resources, ocean acidification and climate change. Other threats include decreased coastal resilience and associated impacts to the local economy. These environmental impacts also threaten a large, underserved community that lives in Broward, in part due to lack of knowledge and empowerment to enact change in their circles of influence. In order to mitigate these environmental and societal impacts, Project EEASY-Education and Engagement to Active

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Stewardship with YEA, was developed to empower people of all ages and abilities, especially those in underserved communities to enact change within their circles of influence such as at home, school or community. In order to enact change, a variety of environmental issues must be understood and addressed, primarily habitat loss; secondarily, marine debris and carbon sequestration. Research shows that "...if current rates of coastal development continue, more than one-quarter of the nation's coastal lands will be altered by 2025" (NOAA, 2022). In South Florida, we are suffering the consequences of this habitat loss and globally only "3% of the earth's terrestrial surface is ecologically intact" (Plumptre et al., 2021). In Broward County, loss of biodiversity due to lack of habitat and reef degradation from polluted runoff and sedimentation leads to loss of ecotourism dollars and loss of the organisms which provide ecosystem services. Habitat loss impacts coastal resilience, thus promoting flooding, erosion, and runoff. In Broward, there is: increased saltwater intrusion into the aquifer, causing municipalities to close or move their freshwater wells; increased flooding; impacts to the Everglades, and increased beach erosion. As of 2019, 21.3 miles of the Broward coastline was critically eroded (Florida, 2019). These compounding issues have led to a now >98% loss of hard corals on our reef (NOAA Coral, 2022), many of which are listed on the NOAA T&E list (NOAA Fisheries, 2025). This reef provides habitats for commercially important fisheries and is the first line of defense against storms.

The primary focus of EEASY is habitat restoration, however, throughout our lessons, we weave in the other issues such as marine debris, carbon footprints and resulting changes in climate, ocean acidification, and carbon sequestration/storage. Marine debris, land-based sources of pollution (LBSP) and CO2 pollution cause habitat degradation and loss of biodiversity. Trash that eventually becomes marine debris and other sources of LBSP, running off into our waterways and seeping into our aquifer have polluted our drinking water, made waterways un-swimmable, increased toxins in food fish, increased the ocean's load of plastics and is killing native plants and animals. In southeast FL, our marine debris contributes to the North Atlantic Garbage patch which contains an estimated 200,000 pieces of debris/square kilometer (mdpi.com).

In 2022, the global mean abundance of CO2 was 417 parts per million (ppm), indicating a 49% increase in the warming influence of greenhouse gases compared to 1990. (NOAA Research, 2022). Atmospheric CO2 is a leading cause of ocean acidification (NOAA State of the Coast, 2022) and climate change. Ocean acidification results in organisms at the base of the food chain unable to build shells or to dissolve (Feely, 2004 and Orr et al., 2005), thus increasing mortality and impacting food webs. Increased levels of CO2 also lead to changes in climate which negatively impacts weather patterns, organism populations and society in a variety of ways. Much of that CO2 is removed and stored by plants, especially systems which capture then store carbon underground in sediment held by root masses, such as is the case for vegetated

**Figure 1.** White mangrove planted during Planet Stewards restoration is thriving, providing habitat and sequestering carbon 4.5 months later. Photo credit: Youth Environmental Alliance

**Figure 2.** South Plantation HS student taking personal action and planting native blue porterweed to support pollinators in this forested upland habitat bordering the mangrove swamp. Photo credit: Youth Environmental Alliance

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dunes and in mangrove forests, many of which have been removed or degraded due to coastal development and use (NOAA Blue Carbon, 2022).

For Project EEASY to succeed against some of these impacts, we worked with five grade levels at three schools in SE Florida and Hugh Taylor Birch State Park. The schools include South Plantation High School and Somerset Academies – Title 1 schools which serve disadvantaged communities that experience environmental injustices such as polluted waterways, air pollution, food deserts, etc. Their situations are perpetuated by lack of knowledge of the environmental issues plaguing them and lack of empowerment to correct the situations through personal action. Aforementioned partners also provided restoration locations.

## Project

The goal of this project was to utilize industry professionals in teaching hands-on STEM programming (Table 1.) during our "Creating Environmental Stewards" class to 250+ children in 3rd, 4th, 5th, 10th and 12th grades. We also wanted to engage the 4 teachers from the 3 different schools. The education component was to be followed by engaging them in meaningful, correlated eco-actions to increase their understanding and to empower them to enact change in a way that is pertinent to their lives. To do this, our goals were to teach lessons that used curriculum standards as invited speakers in a classroom setting, engage the students and teachers in planting 3000 native plants during 3 restoration events in 3 different habitats, remove marine debris, restore native habitat including removal of exotic plants, obtain knowledge increase of at least 10% between pre- and posttests, determine survival of plants and estimate potential carbon sequestered due to restorations, assess environmental impact of restored areas by quantifying sand accretion at dune sites and changes in biodiversity across all 3 sites, create NOAA Planet Stewards that enact change in their circles of influence.

**Table 1. Project EEASY's primary STEM lesson topics and the corresponding presenter's profession and affiliation from where they received their expertise.**

The STEM fields were highlighted to the students as a means of career exposure and development.

| Learning Topic | Presenter's Profession | Professional Affiliation |
|---|---|---|
| Water Quality | Fisheries Biologist | Fish Florida |
| Photosynthesis | Biologist | Shippensburg University |
| Ocean Acidification and Climate Change | Marine Ecologist | Vone Research |
| Restoration | Wildlife/ Restoration Ecologist | USDA-Wildlife Services |
| Impacts on Wildlife | Marine Biologist | Nova Southeastern University |

The timeline of the project started after grant approval. The first 3 months involved scheduling with the schools and coordinating transportation and identifying restoration sites. During months 3-6, we administered pre-tests followed by restorations. Following class work, post-tests were administered, data was compiled, analyzed, and reported midterm. From months 6-12 we surveyed students to determine what behaviors students changed based on the lessons. In month 12, the final report was submitted.

One of the learning activities utilized to teach 10 and 12 grade during this Project EEASY, was the Synthesis of Photosynthesis, which was woven into the "Creating Environmental Stewards" class. Earth Scientist Submission (https://drive.google.com/drive/folders/11DX_50K2FIKrN89H3QI3guGzg1KBmSLU).

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## Data Collection

Information was collected to determine the project's success. This included:

- quantifying the numbers of students and teachers participating in classes and events
- quantifying the number of plants planted
- monitoring the survival of plants
- measuring growth of plant height, stem increase and root length
- weighing the amount of marine debris removed
- measuring the square footage of restored areas
- determining student knowledge gain between pre- and post-tests
- determining gains in environmental stewardship by surveying students 3-6 months post lesson
- assessing environmental impact by measuring sand accretion on dunes
- evaluating changes in biodiversity utilizing iNaturalist (https://www.inaturalist.org/), a global citizen science database

## Results

We engaged 286 students and 25 teachers and chaperones and planted 1,484 large 1-gallon and 3-gallon size plants and 9 trees including 6 mangroves which provided more plant mass than the 3,000 plugs we originally planned on planting. During restorations, we also removed 57 lbs. of trash and 2,300 square feet of invasive plants, thus reviving 17,828 square feet of habitat inclusive of 15,407 sqft dunes, 1,221 sq ft wetland, 1,200 sqft mangrove habitat.

**Figure 3.** South Plantation High School students engaged in tug-o-war with invasive plants that are crowding out beneficial mangroves. Photo credit: Youth Environmental Alliance

**Figure 4.** Third graders restore Somerset Academy's wetland habitat. They learned about the value of and planted numerous plants including the spatterdock in Daphine's hand. Photo credit: Youth Environmental Alliance

To quantitatively determine the percent of knowledge gained before and after the Project EEASY lessons and activities, students were administered a pretest and a posttest that referred to the lessons and standards being taught. Calculations of test results were compared for each class of students to determine knowledge gain. To calculate this knowledge gain, the following formula was used: [(correct # pretest – correct # posttest)/ correct # pretest] x 100. For 3rd grade wetland restoration knowledge gain was 38%, mangrove restoration gain was 180% for 4th and 5th grade and 40% for 10th grade, dune restoration gain was 91% for 12th graders.

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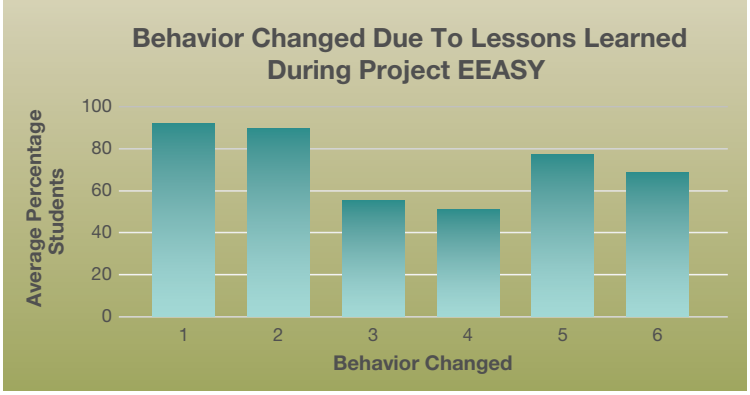
**Table 2. Behavior change due to lessons learned**

Lessons include 1) Changed some behavior, 2) Picked up more trash from outside, 3) Planted trees beyond those planted during class, 4) Participated in additional plantings, 5) Shared what the learned with others, 6) Walked, rode bike or carpooled.




Based on a 16-question survey given 4 to 7 months post Project EEASY activities, an average 72% of students modified behaviors based on what they learned (Figure 1). Behaviors included actions such as water conservation measures (taking shorter showers, turning off water when brushing teeth, planting native plants in right place to avoid needing to water them once established), Reducing their role in creating trash (recycling more, growing their own food so they do not have to buy packaged food, picking up trash off of the ground), reducing their carbon footprint (planting trees, carpooling, walking, ride bikes) and sharing what they learned with others to spread the lesson.

Specific questions asked were followed up with more open-ended questions to gather specific behavior changes, numbers of trees planted and examples of change outcomes. Questions included: based on what you have learned about your role in the state of the environment, have you changed any of your behaviors to help improve it; have you planted any trees and why; have you decreased your water use and how; have you reduced your carbon footprint by planting plants and how many; have you decreased electric use, bought less new stuff, ate less dairy and beef, mowed lawns less, reduced car transportation; have you started picking up trash and provide examples, have you done any of the following to stop polluted runoff: plant trees and plants to filter runoff, pick up pet waste, compost, pick-up trash, clean-up oil leaks; and have you taught others what you know and provide examples of how.

**Figure 5.** Planting day where we are "Dune it Right" to restore the dunes for habitat and community protection. Photo credit: Youth Environmental Alliance

**Figure 6.** Plants installed in December showing significant growth just over 5 months after installation. Photo credit: Youth Environmental Alliance

Finally, the 15,407 ft2 (1431.4m2) of dune area we restored has the potential to sequester and store Total Organic Carbon of 4.67 kg·m- 2·year- 1 (Yang et al. 2014). The wetland restoration of 1,221 $ft^2$ of shoreline has the potential to remove 0.11 tons of CO2 per year which is equivalent to the burning of 12.55 gallons of gas/year (Blue Carbon Calculator, https://www.mass.gov/info-details/use-the-blue-carbon-calculator); students determined that their mangrove restoration efforts resulted in 119 lbs. of carbon being stored in the mangroves alone in the first year (Chowdhury et al, 2023).

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## Conclusion

This project helped restore valuable sections of wetland, dune and mangrove ecosystems and empowered students and teachers from underserved communities to be stewards of their environment beyond the scope and duration of this project. It also provided the knowledge, skills and abilities (KSA's) needed to make pertinent environmental improvements that impact local and global systems. To do this, a three-part approach was used that included a hands-on, practical education coupled with meaningful restorations in the student's own "backyards". The third part provided an understanding how these KSAs can lead to STEM careers. This approach provided a unique experience and opportunity for participants. So much so, that some students volunteered to participate in other restorations offered, showing commitment to their new planet stewardship.

Overall, students restored approximately 1/2 acre of valuable shoreline habitat by removing invasives and planting native vegetation, returning ecosystem services and sequestering carbon to mitigate climate change and ocean acidification. We feel this project was very successful and serves as a model for continuing hands-on, engaging projects to empower people of all ages and abilities, to enact change in their communities.

These experiences connected the students with their environment and the resources they rely on much more than traditional education does, and it helps them feel empowered and gives them a sense of control over some environmental issues they face. These experiences show students how lessons in school can be applied to real life and how their choices matter for themselves and their communities, locally and globally from now and into the future.

**Figure 7.** Somerset Elementary School student removing invasive plants to make room for native mangroves while his classmate takes a breather.
Photo credit: Youth Environmental Alliance


**Figure 8.** Native, native, native! After removing dozens of invasive Scaevola from our newly restored dune, a South Plantation student is planting a few pollinator plants to help increase the butterfly, moth, and other flying insect populations. Photo credit: Youth Environmental Alliance

**Figure 9.** Success! South Plantation Magnet students are happy to have made a difference in restoring Florida's coastline by restoring yet another dune.
Photo credit:Youth Environmental Alliance

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## References

Chowdhury, A., Naz, A., & Maiti, S. K. (2023). Variations in Soil Blue Carbon Sequestration between Natural Mangrove Metapopulations and a Mixed Mangrove Plantation: A Case Study from the World's Largest Contiguous Mangrove Forest. *Life*, *13*(2), 271. https://doi.org/10.3390/life13020271

Feely, R. A., Sabine, C. L., Lee, K., Berelson, W., Kleypas, J., Fabry, V. J., & Millero, F. J. (2004). Impact of anthropogenic CO2 on the CaCO3 system in the oceans. *Science (New York, N.Y.)*, *305*(5682), 362–366. https://doi.org/10.1126/science.1097329

Florida Department of Environmental Protection. (2019). floridadep.gov/sites/default/files/FDEP-Critically-Eroded-Beaches-2019.pdf

NOAA Blue Carbon Webpages, (2022). *Coastal Blue Carbon.* https://oceanservice.noaa.gov/ecosystems/coastal-blue-carbon/

NOAA Coral Reef Conservation Program. (2022). *Coral Reef Conservation Program***.** https://www.coris.noaa.gov/monitoring/status_report/

NOAA Fisheries. (2022). *Threats to Habitat | NOAA Fisheries.* https://www.fisheries.noaa.gov/insight/threats-habitat

NOAA Fisheries. (2025). *Species Directory - ESA Threatened & Endangered | NOAA Fisheries.* https://www.fisheries.noaa.gov/species-directory/threatened-endangered

NOAA Research. (2022). NOAA index tracks how greenhouse gas pollution amplified global warming in 2022

2023. https://research.noaa.gov/noaa-index-tracks-how-greenhouse-gas-pollution-amplified-global-warming-in-2022/

NOAA State of the Coast. (2022). *Ocean Acidification Today and Future.* https://www.climate.gov/news-features/featured-images/ocean-acidification-today-and-future

Orr, J. C., Fabry, V. J., Aumont, O., Bopp, L., Doney, S. C., Feely, R. A., Gnanadesikan, A., Gruber, N., Ishida, A., Joos, F., Key, R. M., Lindsay, K., Maier-Reimer, E., Matear, R., Monfray, P., Mouchet, A., Najjar, R. G., Plattner, G. K., Rodgers, K. B., Sabine, C. L., Yool, A. (2005). Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature*, *437*(7059), 681–686. https://doi.org/10.1038/nature04095

Plumptre AJ, Baisero D, Belote RT, Vázquez-Domínguez E, Faurby S, Jędrzejewski W, Kiara H, Kühl H, Benítez-López A, Luna-Aranguré C, Voigt M, Wich S, Wint W, Gallego-Zamorano J and Boyd C. (2021). Where Might We Find Ecologically Intact Communities? *Frontiers in Forests and Global Change. Change* 4:626635. doi: 10.3389/ffgc.2021.626635. https://www.frontiersin.org/journals/forests-and-global-change/articles/10.3389/ffgc.2021.626635/full

Yang, H., Li, X., Wang, Z., Jia, R., Liu, L., Chen, Y., Wei, Y., Gao, Y., & Li, G. (2014). Carbon sequestration capacity of shifting sand dune after establishing new vegetation in the Tengger Desert, northern China. *The Science of the total environment*, *478*, 1–11. https://doi.org/10.1016/j.scitotenv.2014.01.063

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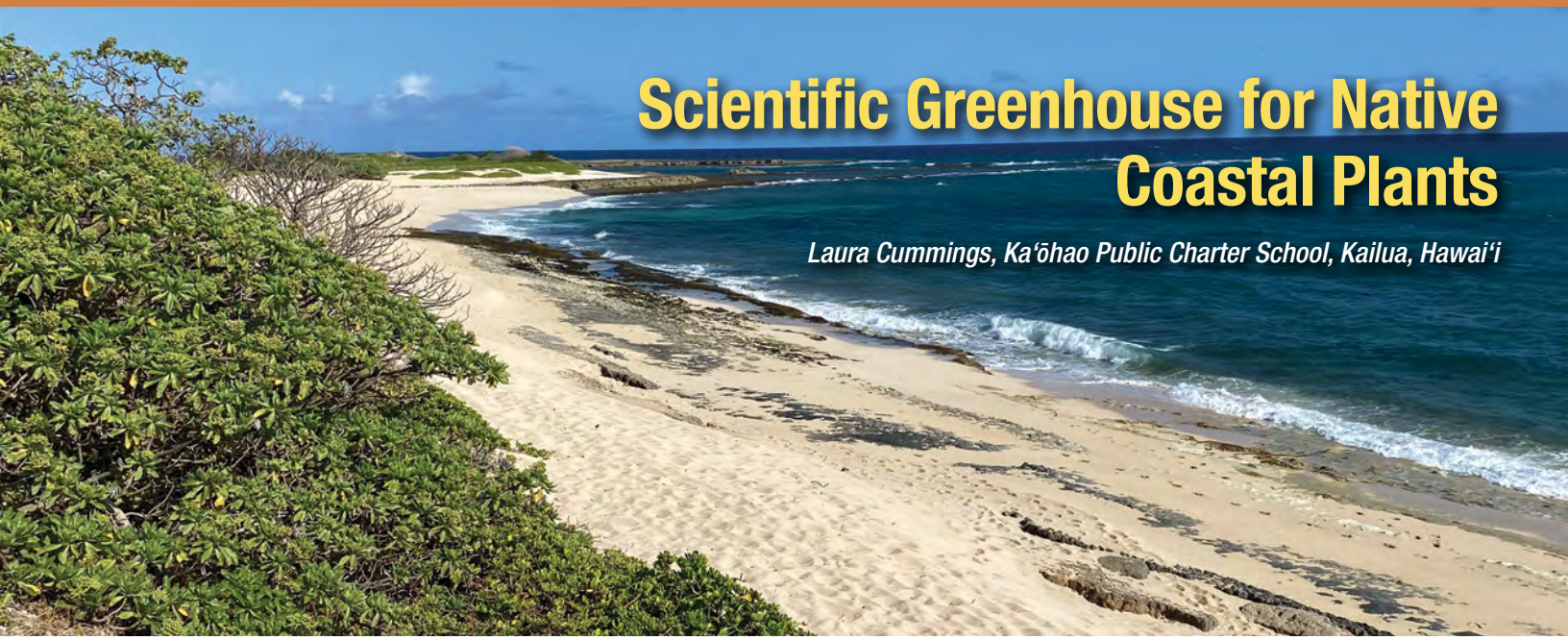

# Scientific Greenhouse for Native Coastal Plants

*Laura Cummings, Ka'ōhao Public Charter School, Kailua, Hawai'i*

**Kalaeokauna'oa, or** Kahuku Point, the northernmost point of O'ahu's North Shore. Restoring this coastal region is vital because of its high biodiversity and location to allow residents and visitors to the island to responsibly enjoy recreational activities and learn about the value of natural resources in Hawai'i. Photo credit: Laura Cummings

## Abstract

This NOAA Planet Stewards and National STEM Scholars project was a student-centered, interdisciplinary coastal restoration initiative at Kalaeokauna'oa, the northernmost point of O'ahu in Hawai'i. Fifth and sixth grade students at Sunset Beach Elementary School partnered with conservation professionals to integrate traditional ecological knowledge (TEK) with scientific experimentation. Students conducted greenhouse-based trials testing environmental variables on native coastal plants, out-planted six native plant species at a designated restoration site, and contributed to habitat recovery for culturally and ecologically important species. The project not only yielded positive ecological indicators—such as 90% ground cover in one of the restored zones—but also fostered deep student learning about biodiversity, stewardship, and the scientific process. This model of place-based science education demonstrates how students can take active roles in meaningful, community-driven environmental work.

## Introduction

Hawai'i's native ecosystems are among the most biologically and culturally unique in the world. Coastal areas, particularly dune systems, are increasingly threatened by urban development, invasive species, sea level rise, and erosion. Kalaeokauna'oa, a remote and ecologically important dune ecosystem on O'ahu's north shore, has seen degradation over time according to the director of conservation at the North Shore Community Land Trust (NSCLT), Tim Tybuszewski. Once rich in endemic plant species and native wildlife, the location was turned into a cattle ranch and ironwood trees were planted there to block the wind. Once the cattle industry was no longer financially viable, the area was neglected. The ironwood trees took over and many of the native coastal plant species died off, in turn causing species such as the mōlī (Laysan albatross), nalo meli maoli (yellow faced bee), honu (Hawaiian green sea turtle), and 'īlio holo i ka uaua (Hawaiian monk seal) to dwindle. Now, Kalaeokauna'oa is a focus of community-based restoration efforts, supported by the North Shore Community Land Trust (NSCLT).

In response to the need for habitat restoration and the opportunity for place-based learning, the advanced science program at Sunset Beach Elementary School launched a student-led

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environmental project that integrates science, cultural heritage, and conservation action. In partnership with the NSCLT's Tim Tybuszewski, and under the guidance and facilitation of National Board Certified Teacher, Laura Cummings, fifth and sixth grade students engaged in a full cycle of restoration, from propagating plants in a school greenhouse to collecting data in the greenhouse and in the field, and analyzing their findings. The goal was not just to restore native vegetation but also to cultivate students' roles as knowledgeable, empowered stewards of their home environment.

**Figure 1.** Sixth grade students took cuttings of six different native coastal plants, used various growing mediums for cycle one of testing in the Scientific Greenhouse, watered the plants twice a day, and recorded height and plant observations weekly. Photo credit: Laura Cummings

**Figure 2.** For the first cycle of out-planting, under the guidance of the director of conservation for the North Shore Community Land Trust, Tim Tybuszewski, sixth grade students transported 51 plants from their Scientific Greenhouse on our school campus to Kalaeokauna'oa where they planted them close together for biodiversity and to be able to find them easily for monitoring over the next several months. Students used clean tools and gloves and made sure to water the plants as soon as they went into the ground at their new home. Photo credit: Laura Cummings

## Project Goals

The Kalaeokauna'oa restoration project was guided by three overarching goals:

1. Ecological Restoration: Reintroduce and reestablish native coastal plant species to improve ecosystem resilience, control erosion, and support native fauna.
2. Scientific Inquiry and Data Collection: Engage students in designing and conducting experiments to test environmental variables such as drought tolerance, growing medium composition, salt water tolerance, and erosion prevention using native coastal plants.
3. Cultural Integration and Stewardship: Combine traditional ecological knowledge (TEK) in Hawai'i, mo'olelo (stories), and scientific methods to deepen student understanding of ecological practices and responsibilities to the land.

To achieve these goals, students collaborated with scientists, conservationists, and cultural practitioners. The project was supported by NOAA Planet Stewards, the National STEM Scholars program, and grant from the National Geographic Society. Additional resources and funding were generated through local recycling initiatives and school-community exchanges with Ka'ōhao Public Charter School.

## Project Implementation

Students constructed a school greenhouse with family and community support, took plant cuttings at Kalaeokauna'oa while learning about the area, propagated these native coastal plants, and established multiple cycles of experimentation and restoration.

Field-based restoration events were held in January and May 2024, with follow-up monitoring and additional experimentation through 2025.

Students successfully propagated six native species: 'Ahinahina, 'Ākulikuli, 'Ilima, 'Āweoweo Papa, Pā'ūohi'iaka, and Pōhuehue. A total of 86 plants were outplanted at Kalaeokauna'oa between January and May 2024, and 20 additional plants were provided to Ka'ōhao Public Charter School for a NOAA Ocean Guardian Schools erosion control project under the guidance of Cummings' long time colleague, Parker Sawyer, who teaches sixth grade at Ka'ōhao Public Charter School.

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**Figure 3.** ʻAhinahina, ʻĀkulikuli, ʻĀweoweo Papa, ʻIlima, Pāʻūohiʻiaka, and Pōhuehue were the native coastal plant species grown in cycle one of testing in the Scientific Greenhouse. Surviving plants after testing were out-planted at Kalaeokauna'oa. Photo credit: Laura Cummings

**Figure 4.** Tim Tybuszewski, Director of Conservation, shows sixth grade students how their plants have spread out and covered much of the area of our restoration location in 4 months. Photo credit: Laura Cummings

By January 2025, 90% of the ground in the January 2024 out-planting zone was covered by thriving native plants, with 70% coverage in the area that students restored in May 2024. While not directly due to the students' restoration efforts, it is notable that the number of Laysan albatross nests at Kalaeokauna'oa increased from 17 in 2024 to 33 in 2025, a promising ecological indicator that certainly demonstrates that the collaborative restoration work in these many acres is effective.

## Scientific Experiments

Students conducted four major experimental cycles on native coastal plants: ʻAhinahina, ʻĀkulikuli, ʻĀweoweo Papa, ʻIlima, Pāʻūohiʻiaka, and Pōhuehue.

- Cycle One (Fall 2023): Growing medium composition and rooting hormones were tested. Results showed that ʻIlima responded best to rooting hormone, and a soil-sand-perlite mix supported the highest survival rate across species (as opposed to only soil, soil and sand, or soil and perlite).
- Cycle Two (Winter-Spring 2024): Drought tolerance was examined. ʻĀkulikuli proved the most drought-resistant of the six plant varieties, surviving with minimal watering. Pāʻūohiʻiaka and Pōhuehue were least resilient under very dry conditions.
- Cycle Three (Fall 2024): Focused on erosion control. ʻĀweoweo and ʻIlima held the most soil/sand in place, but their survival post-experiment was poor. ʻĀkulikuli, while slightly less effective at holding sediment, survived at a much higher rate—highlighting a trade-off between function and durability.
- Cycle Four (Winter-Spring 2025): Salt water spray and salt water inundation tolerance was tested to understand possible impacts of sea level rise on native coastal plants. All of the plants tolerated some salt water spray (or misty seawater breezes), but tended to develop yellow leaves with high levels of salt water spray. Once again, ʻĀkulikuli proved to be the heartiest surviving the longest with salt water inundation.

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***(clockwise from top left)***
**Figure 5.** Ms. Cummings and sixth grade students document the location and out-plant greenhouse grown native coastal plants for restoration.

Photo credit: Spencer Klein

**Figure 6.** Sixth grade students learn how to take cuttings of native coastal plants to bring back to the school's scientific greenhouse to start the next cycle of testing the impact of environmental factors on plant growth.

Photo credit: Laura Cummings

**Figure 7.** Ms. Cummings' sixth grade students meet Tim Tybuszewski at the trailhead out to Kalaeokauna'oa to deliver a second round of native coastal plants and record data from the previous out-planting excursion.

Photo credit: Emily Klein

## Educational and Cultural Outcomes

Students gained fluency in writing scientific procedures, developing hypotheses, and analyzing quantitative and qualitative data. (NGSS, 2013)

### NGSS Standards Addressed

- MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

The integration of mo'olelo (stories) and 'ike (knowledge) from community partners deepened their understanding of how traditional knowledge and Western science can complement one another. Students took ownership of the project by mentoring incoming classes and developing stewardship plans for continuity.

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Quotes from students underscore their engagement and learning:

> "It's really cool that we have a greenhouse and we can help restore an area by growing plants and testing them here at school, then plant them out in nature."
>
> – Deia Klein, Grade 6

> "This project has been fun. The restoration at Kahuku Point is helping to save the endangered plant and animal species. It's giving the birds a place to nest."
>
> – Piper Taylor, Grade 5

> "I love learning about plants. It's cool that ʻĀweoweo smells like fish and was used by Native Hawaiian people for fish hooks and bait."
>
> – Julian Cole, Grade 6.

> "The greenhouse is really fun because we get to grow native plants and learn about them. It's not just paper and pencil work. We get to get out and do hands-on science."
>
> – Coco Mellum, Grade 5

> "Seeing the students take ownership of this project and mentor the next class makes me excited about the work that will continue for years to come. We've built a special relationship with the North Shore Community Land Trust and watched students act locally while considering global connections."
>
> – Educator, Laura Cummings

## Conclusion

The Kalaeokaunaʻoa restoration project illustrates how environmental education can transcend classroom boundaries. Through a combination of traditional ecological knowledge, rigorous experimentation, and hands-on restoration, students engaged deeply with both science and place. They emerged not only as informed learners but as empowered caretakers of Hawaiʻi's fragile coastal ecosystems.

This model of student-led stewardship, rooted in science, culture, and community, can serve as a replicable approach for other schools seeking to integrate NGSS-aligned learning with authentic, place-based restoration work. View a possible NGSS lesson written for this project here: https://docs.google.com/document/d/1k0uN8DEFRmGivjRRU4BRYpUFuySJB4ne/edit?usp=sharing&ouid=105231989385816396450&rtpof=true&sd=true.

With continued community partnerships, this project is positioned to grow in scope and legacy, nurturing both ecological health and the next generation of stewards.

## Reference

NGSS Lead States, 2013. *Next Generation Science Standards: For states, by states.* Washington, DC: The National Academies Press. https://www.nextgenscience.org/standards

## About the Author

**Laura Cummings** is a National Board Certified Teacher currently transitioning from teaching 4th-6th grade science and math at Sunset Beach Elementary School in Haleʻiwa, Hawaiʻi to the K-6 STEM specialist at Kaʻōhao Public Charter School in Kailua, Hawaiʻi. She holds a Bachelor of Arts in education from Madonna University and a Master of Education in Curriculum and Instruction from American College of Education. Her distinguished work includes NOAA Climate Educator Fellowship, Grosvenor Teacher Fellowship with National Geographic and Lindblad Expeditions, Fulbright Teachers for Global Classrooms Fellowship, NEA Foundations Global Learner Fellowship, and National STEM Scholar. She can be reached at LCummings@kaohaoschool.org.

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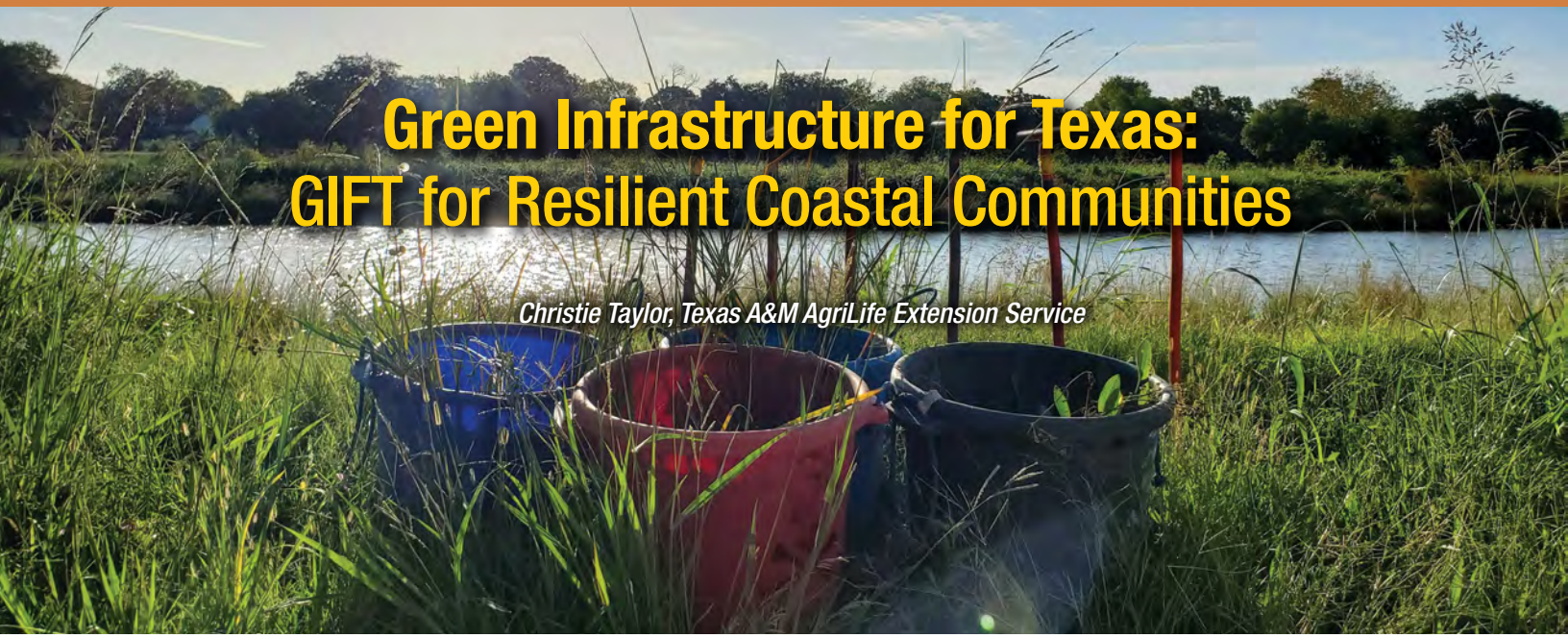

# Green Infrastructure for Texas: GIFT for Resilient Coastal Communities

*Christie Taylor, Texas A&M AgriLife Extension Service*

Planting buckets and tools ready for October, 2023, Stewardship Saturday, Planting in Exploration Green Phase 4. Photo credit: AgriLife Extension staff


## Abstract

Funding from NOAA Planet Stewards supported the mission of Exploration Green and expanded our AgriLife Extension Service Green Infrastructure for Texas (GIFT) program. These projects support high school students in green infrastructure or environmental science internship opportunities. The funding supported additional project materials and the creation of new lessons in stormwater wetland installation and maintenance such as how to install and maintain stormwater practices like stormwater wetlands, rain gardens, rain barrels, and the use of permeable concrete.

This program met or exceeded the majority of the goals outlined in the project's development, and with the materials purchased, allowed us to continue hosting monthly stewardship events with our project partners. These goals included wetland plantings for habitat creation, seed distribution lessons for habitat restoration and diversity enhancement, removal of non-native vegetative species to improve the quality of the created habitat, and general litter removal to protect infrastructure and promote the proper functioning of the green infrastructure practice. We also reduced runoff pollution by capturing rainwater to reduce the amount of runoff.


## Program Background

This program idea originated from the work of the Texas A&M AgriLife Extension Service Disaster Assessment and Recovery unit (www.agrilife.org/gift), which collaborates with communities to mitigate flood risk and address water quality issues through the Texas Community Watershed Partners office in Houston, Texas. One of the core teams in this office is the Green Infrastructure for Texas (GIFT) Program team, which provides technical support to Texas communities to help educate and implement green infrastructure practices across the state, with a strong focus on coastal communities in the Houston area. Through communications with these communities and others across the state, it was expressed that there was a lack of practitioners and expertise to install and maintain such projects. The

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**Figure 1.** Student giving her end-of-program presentation in May 2024. At the end of the 12-week internship, each participant gave a presentation about what they learned in the internship program.

Photo credit: AgriLife Extension staff

**Figure 2.** Scouts and program staff Christie Taylor and Gabrielle Scott cleaned litter and debris off the trash grate at the Exploration Green Bluebird Pond outfall.

Photo credit: AgriLife Extension staff

field of green infrastructure (GI), also known as nature-based solutions, is ripe for educational and career development training programs and we have had several requests from city leaders and others in the industry to find and promote qualified installers and technicians, such as the GIFT Green Infrastructure High School Student Internship Program. This program was originally funded for a three-year pilot program by an Environmental Protection Agency (EPA) environmental education in green infrastructure career development funding opportunity. Through the program, students in grades 9 to 12 work with GIFT team members on various projects, including rain gardens, rainwater harvesting, stormwater wetland planting, wetland plant nursery operations, and community outreach and engagement. During their 60-hour training, students complete a site-scale project of their own design and give a presentation on their work.

**Figure 3.** Cleaning seeds collected after planting on September 2023. Photo credit: AgriLife Extension staff

To take the NGICP certification test, students need to have graduated high school or have some years of experience in the field to determine how many hours of training are needed to qualify for certification. We worked with students from eleven area high schools in the 9th-12th grades. Only about a quarter of the thirty students were seniors at the time of their internship. To keep students involved in community stewardship and interested in environmental science issues, we partnered with the Exploration Green Conservancy (https://www.explorationgreen.org/) at the Exploration Green Stormwater Wetland in Houston, Texas. Exploration Green Stormwater is a stormwater wetland park system owned by the Clear Lake City Water Authority and managed by the nonprofit Exploration Green Conservancy Board. It is designed as stormwater detention for Clear Lake portion of Houston and at capacity holds half a billion gallons of stormwater. The wetlands provide shoreline stabilization, habitat for waterfowl and other aquatic life, and reduce the pollution from stormwater runoff by trapping debris and absorbing nutrients and other pollutants.

The park provides 6 miles of hiking and biking trails to promote recreation and healthy living. Exploration Green protects over 3000 homes and businesses from flooding caused

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**Figure 4.** Students plant wetland plants in Exploration Green's Bumblebee Pond in April, 2024.
Photo credit: AgriLife Extension staff

**Figure 5.** Student painting and marking her rain barrel during a GIFT HS Internship Program workday.
Photo credit: AgriLife Extension staff

by storm events. The Exploration Green Conservancy and Texas A&M AgriLife Extension Service use this site to promote these practices around the area by holding educational and experiential learning opportunities at the site. Through this partnership we could not only work with high school students but we worked with local elementary to college aged students and adults through our Stewardship Saturday events. Our student intern alumni helped lead teams of community volunteers and some of their peers in stewarding and maintaining the stormwater wetland system.

## Planet Stewards Project Development

The goal of our project is to enhance the habitat creation and restoration of the stormwater wetland by collaborating with our local partner organization, Exploration Green. We began by propagating wetland plants in Exploration Green's wetland plant nursery and

**Figure 6.** Students prepared the irises to plant at the planting event in April for Exploration Green as part of their high school internship program. Photo credit: AgriLife Extension staff

**Figure 7.** October, 2023, scouts from Troop 487 collected 6.8 pounds of litter from a 3-mile stretch of trail at Exploration Green.
Photo credit: AgriLife Extension staff

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providing some basic botany lessons. Then, high school aged students in our afterschool program, received a lesson on plant selection, diversity, and designing a planting plan, and were asked to create a planting plan for the group planting project. Once the design was selected by combining the student plans into a single group project, the plants were prepared for planting. Then, the students held planting events to plant the selected plants into the larger Exploration Green Project. As part of the stormwater wetland maintenance lesson, we discussed the removal of non-native and aggressive vegetative species, introduced native seeds, documented water quality improvements, and removed and cataloged debris. Many of these activities are the focus of our continuing Stewardship Saturday program. We rotate activities throughout the year. These activities involved local students participating in the high school internship program, as well as local Boy Scouts and Girl Scouts, and residents.

The other GI practices we completed in the program included rainwater harvesting, which utilized recycled plastic drums to create rain barrels for residential use. Students prepared and painted the drum, and then some chose to install rain barrels of their design (either recycled or purchased) at their homes as part of their projects. The rain barrels designed in the program were purchased from the Galveston Bay Foundation, a local nonprofit, and they provided a rainwater harvesting workshop for the student groups.

We also hosted a week-long educational workshop on green infrastructure and water quality for a small rural high school in Matagorda County.

**Figure 8.** Scout with Troop 487 planting pickerelweed (*Pontederia cordata*).

Photo credit: AgriLife Extension staff

## Project Goals and Outcomes

Our desired outcomes for this project included planting 2000 wetland plants, propagating an additional 1000 wetland plants, removing 200 pounds of invasive or aggressive plant material, creating 500 seed balls for wetland and prairie restoration efforts, and removing 300 pounds of litter through a series of stewardship events called Stewardship Saturdays at Exploration Green. Students also learned how to conserve water while reducing runoff through rainwater harvesting. The final outcome of the project was to create and install at least four rain barrels during this workshop, thereby reducing annual runoff by 4,000 gallons.

## Project Implementation

We began implementing the stewardship plan in September of 2023 with our first Stewardship Saturday event. We chose to hold these events on the third Saturday of every month. However, in the fall and spring semesters, we had extra wetland planting events, usually on the first Saturday of the month, to take advantage of the nice weather and plant more plants in our wetland restoration project. In the first five months of the program, we held seven volunteer events. We continued hosting the Stewardship Saturday events once a month in the winter and then twice a month in the spring to get more planting events completed. We can typically plant 1000 – 2000 plants per event, depending on how many volunteers we have that day.

We held our fourth cohort of High School student interns, featuring new lessons on wetland delineation and water quality testing, during the fall semester from September to November 2023. Our fifth cohort of high school student interns was from late February to early May 2024. We were then able to purchase supplies for a rural school program in Matagorda

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**Table 1. Project Outcomes**

| Objective | Goal | Actual |
|---|---|---|
| Wetland plants installed | 2000 | 2380 |
| Wetland plants propagated | 1000 | 934 |
| Seed distribution mechanisms created | 500 | 720 |
| Nonnative plant species removed | 200 pounds | 70 |
| Litter removed | 300 pounds | 380 |
| Rain barrels created & installed | 4 | 1 |
| Stewardship Saturday Events held | 9 | 24 |
| Students involved | 16 | 30 |

**Table 2. High School Interns Student Assessments**

| Aspect | N | % Agree | % Strongly Agree |
|---|---|---|---|
| Participation in this program was a good use of my time. | 37 | 27.03 | 27.03 |
| Overall, I would recommend this program to my peers. | 37 | 27.03 | 45.95 |
| Overall, the presenters were knowledgeable about the topics. | 37 | 16.22 | 75.68 |
| Overall, the presenters delivered their material well. | 37 | 21.62 | 67.57 |

**Table 3. High School Internship Program Understanding of Green Infrastructure**

Cohorts 1-7 November 2022 – December 2024 (Including Matagorda ISD Program)

Participation 41 students, Completed Pre-survey = 38, Post-surveys = 38, Response Rate = 92.68%.
Understanding Scale: Poor, Fair, Good, Excellent

| Understanding of | Pre % Good or Excellent | Post % Good or Excellent | Change | % Increase in Understanding |
|---|---|---|---|---|
| Green infrastructure practices | 18.42 | 60.53 | 42.11 | 71.05 |
| How to identify plant species | 15.79 | 34.21 | 18.42 | 47.36 |
| How stormwater flows through your neighborhood | 28.95 | 67.57 | 38.62 | 60.53 |
| Where GI practices can reduce runoff volumes | 15.79 | 68.42 | 52.63 | 81.58 |
| Employment options in green infrastructure or related fields | 7.89 | 28.95 | 21.06 | 57.89 |

County. We held an on-campus, week-long program for Matagorda ISD 8th-12th graders from May 13 to 21, 2024.

The program's total participation of 85 people included K-12 students, post-secondary students, adult community volunteers, K-12 educators, post-secondary educators, and representatives from six partner organizations, who attended regular monthly events for 9 months or one of three student intern cohorts. Some of our presenters came on multiple occasions.

## Quantitative Results

Our outcomes for this project include planting 2380 wetland plants, propagating an additional 934 wetland plants, additionally planting 600 prairie plants, removing 70 pounds of invasive or aggressive plant material, creating 720 seed balls created by Boy Scout service projects for wetland and prairie restoration efforts, and removing 380 pounds of litter through a series of stewardship events called Stewardship Saturdays at Exploration Green.

One high school intern from cohort 5 created a rain barrel as their home project, potentially reducing the stormwater runoff by 1000 gallons per year in the Clear Creek Watershed.

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## Student Quote

"Here is what we can do to prevent NPS runoff pollution...

Don't put anything down the storm drain and pick up trash even if it's not yours because it will help the environment."

– Josephine Carrillo, HS Internship Program student, 10th grade

## Conclusion

This program surpassed our initial expectations. We learned a great deal about the willingness of partners and community members to contribute to the ongoing environmental education aspects of the program. We have an ongoing and evolving stewardship program in partnership with the Clear Lake City Water Authority's (CLCWA) Land Steward Program. With the assistance of the CLCWA land stewards, we have six trained adults to rotate the lead on our monthly Stewardship Saturday program. We usually have 2 adult leaders and at least one trained youth leader for each of the monthly events.

We received positive feedback from most of the students involved, and they demonstrated an increase in understanding of the environmental issues associated with green infrastructure practices through the program.

**Figure 9.** Student cleans up litter around the "hugging tree" in Turtle Pond of Exploration Green.

Photo credit: AgriLife Extension staff

## Lasting Impacts

The lessons created during this project were incorporated into plans developed for Texas teachers. GIFT Lesson Plans (https://drive.google.com/file/d/10OMIm8c4PPWSIEyfJobzBfy-jJ-2yF-J/view?usp=drive_link)

These lesson plans were shared at the November 2024 Science Teachers Association of Texas Conference for the Advancement of Science Teaching (STAT CAST) conference in San Antonio. We are continually exploring new funding sources to expand our high school internship training program, enabling students to make a lasting impact in their community for years to come. The habitat created at Exploration Green by the students and other volunteers continues to filter the water and reduce the flood risk for the community. The plant and animal makeup of the area is also continuing to grow and evolve.

## About the Author

**Christie Taylor** is an AgriLife Extension Program Specialist at Texas Community Watershed Partners (TCWP), where she manages the Stormwater Wetland Program and the Green Infrastructure for Texas High School Internship Program. Christie holds a B.S. in Marine Biology from Texas A&M University-Galveston and an M.S. in Rangeland Ecology and Management from Texas A&M University. Christie has worked in the wetland field for 20 years. Christie was awarded the Disaster Assessment and Recovery Unit's Excellence Award in March 2025. She has been with TCWP since December 2018 as part of the Green Infrastructure for Texas (GIFT) team. As part of the GIFT team, Christie presents the benefits of wetlands at multiple community workshops, Master Naturalist training classes, and school groups. She created and implemented the GIFT High School Internship Program, a training program designed for future professionals in the field of green infrastructure. Before joining the team, she worked as a wetland consultant and independent wetland delineator for 14 years. She can be reached at christina.taylor@ag.tamu.edu.

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