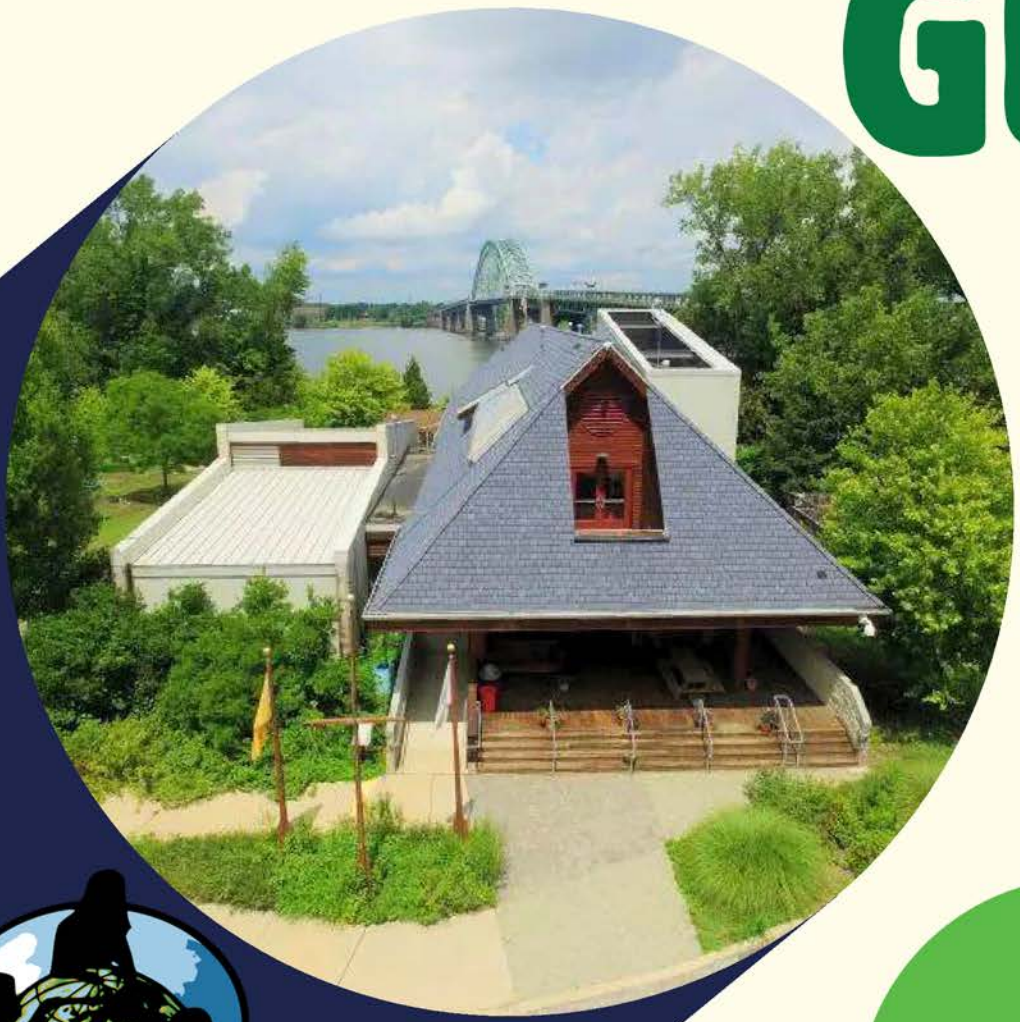
Palmyra Cove NATURE PARK

INSTITUTE FOR EARTH OBSERVATIONS

EDUCATOR'S GUIDE

'25-'26 EDITION



THE GLOBE PROGRAM

Palmyra Cove Nature Park (PCNP)

PCNP is a 250-acre urban oasis along a highly developed area on the Delaware River. Habitats include wetlands, woodlands, meadows, wild creek and river shoreline, and a freshwater Tidal Cove after which the park is named.

- The outdoors setting promotes a unique form of education that can be more engaging and inspiring compared to a traditional classroom environment. It encourages physical activity, exploration, and a personal connection with nature, which can foster a long-term commitment to environmental stewardship.

- Biodiversity: With its wetlands, woods, and river shoreline, the conservation area is home to a variety of plant and animal species unique to the area, offering an opportunity to study biodiversity, ecosystems, and the interactions between different organisms in a natural setting. Many rare, threatened, and even endangered species call the cove home, including Peregrine Falcons and Freshwater Mussels. In Addition, Palmyra Cove has been given the distinction of being designated an Important Bird and Birding Area (IBBA), with 215 bird species being observed in the park so far.

- Ecological Restoration and Sustainability: The transformation of the area from a dumping ground to a conservation site showcases the possibilities of ecological restoration and sustainability. It can serve as a case study for restoration ecology, demonstrating to learners and the community the value of conservation and sustainable practices.

Environmental STEM Center

The Environmental STEM Center at Palmyra Cove is an interactive 2,000-square-foot space that offers exclusive exhibits for the public to learn about science and technology, from climate change to space exploration. It provides opportunities for exploring the park and Planet Earth!

IEO

Institute for Earth Observations (IEO)

A STEM educational initiative for students and teachers that study Planet Earth. This is a unique and engaging facility where experiences can be shared...and innovative collaboration begins!

- Living Laboratory: The conservation area provides a real-world, hands-on learning environment where learners can observe, interact with, and study natural systems and phenomena firsthand. This experiential learning can significantly enhance understanding and retention of ecological and environmental concepts.

- Research Opportunities: The diverse ecosystems within the conservation area provide a broad range of research opportunities. Students and researchers can undertake projects investigating ecological processes, wildlife behavior, water quality, soil science, and many other environmental topics.

- Community Engagement: The conservation area can also serve as a hub for community engagement, where local residents and visitors can participate in educational programs, volunteer for conservation projects, and learn about the importance of protecting natural resources.
- Environmental Monitoring: With its distinct ecosystems, the conservation area can be utilized for environmental monitoring and data collection, aiding in local and potentially broader environmental assessments and policy-making.

GLOBE New Jersey Partnership

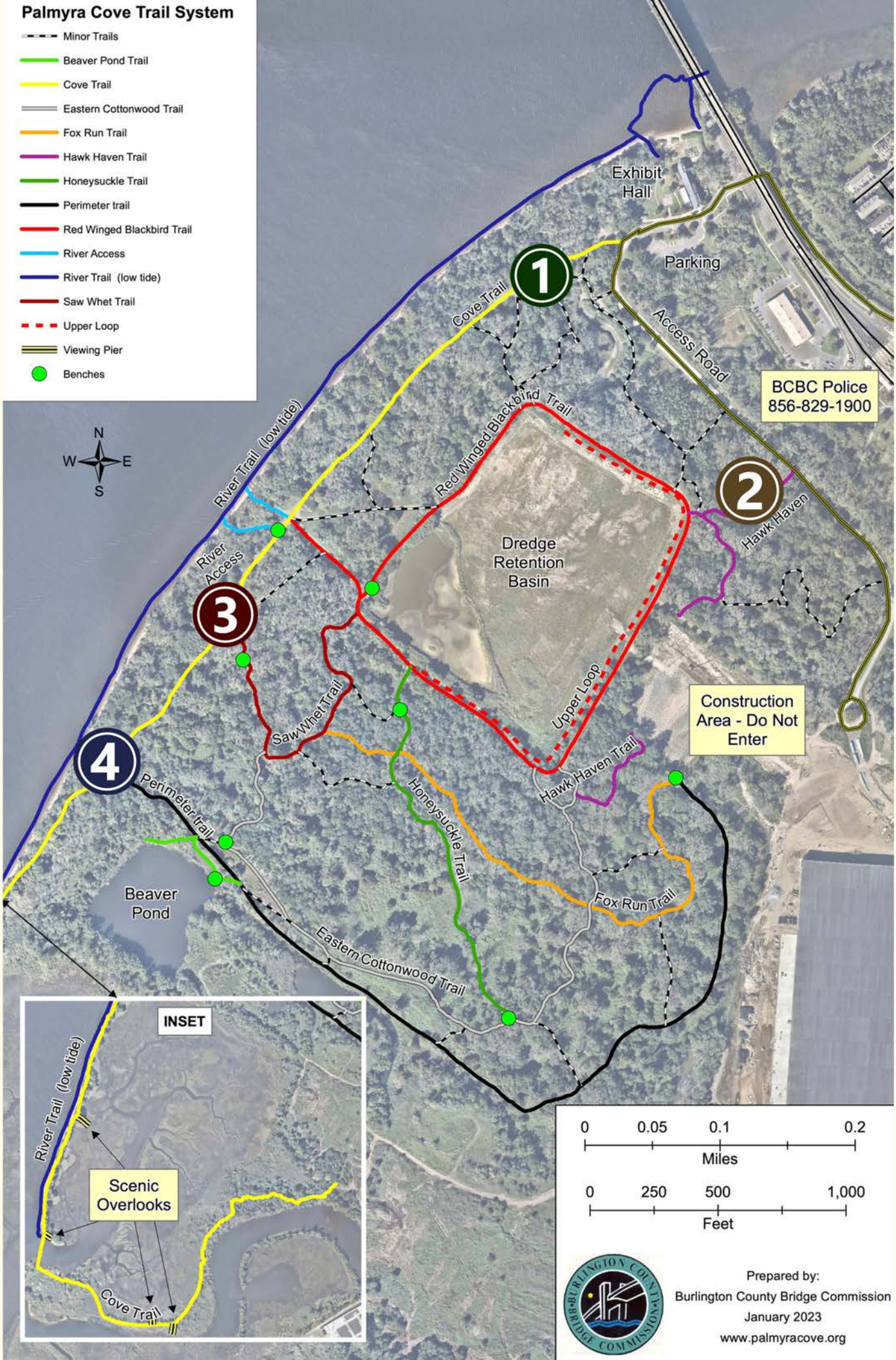
The GLOBE Program's Mission is to promote the teaching and learning of science, enhance environmental literacy and stewardship, and promote scientific discovery.

- ***Specific goals for the GLOBE NJ Partnership include***: Improving student achievement across the curriculum with a focus on student research in environmental and Earth system science, enhancing awareness and support activities of individuals throughout the world to benefit the environment, contributing to scientific understanding of Earth as a system, connecting and inspiring the next generation of global scientists, and getting young minds outside to explore new things!

GLOBE Mission Earth

Our mission is to improve education and involvement in science, technology, engineering and mathematics (STEM) by increasing participation of students and citizens in the GLOBE Program (www.globe.gov).

- ***Specific goals for GLOBE Mission EARTH include:*** Developing vertically-integrated activities and materials to support GLOBE implementation, provide K-12 professional development (PD) and year-long as well as multi-year support for teachers with scaling through Train-the-Trainer models, enhance STEM Experience for Undergraduate Students, and engage the public by supporting and enhancing GLOBE, MY NASA DATA and citizen science initiatives


Palmyra Cove Trail System
Minor Trails
Beaver Pond Trail
Cove Trail
Eastern Cottonwood Trail
Fox Run Trail
Hawk Haven Trail
Honeysuckle Trail
Perimeter trail
Red Winged Blackbird Trail
River Access
River Trail (low tide)
Saw Whet Trail
Upper Loop
Viewing Pier
Benches
N
W
E
S
Exhibit Hall
Parking
Access Road
Cove Trail
Red Winged Blackbird Trail
River Trail (low tide)
River Access
Dredge Retention Basin
Hawk Haven
Upper Loop
Saw Whet Trail
Perimeter trail
Honeysuckle Trail
Hawk Haven Trail
Fox Run Trail
Eastern Cottonwood Trail
Beaver Pond
BCBC Police
856-829-1900
Construction Area - Do Not Enter
INSET
River Trail (low tide)
Scenic Overlooks
Cove Trail
0 0.05 0.1 0.2
Miles
0 250 500 1,000
Feet
Prepared by:
Burlington County Bridge Commission
January 2023
www.palmyracove.org

OBSERVATION STATIONS:

Station 1:

Located between Bullfrog Pond and the Dredge Cell, Observation Station One is just a short walk from the Environmental STEM Center. The presence of different soil profiles nearby, and access to different bodies of water make this a great location to conduct soil and hydrosphere investigations!

Station 2:

Found amongst the cherry trees of Hawk Haven trail, Observation Station Two is easily accessible to busses and other vehicles. The dense canopy and numerous fallen logs make this a perfect location to investigate the flora and fauna of a deciduous forest

Station 3:

Roughly 0.25 miles from the Environmental STEM Center, Observation Station Three sits at the intersection between Cove Trail and the Red Wing Black Bird trail. The lack of tree cover and open sight lines make this a great location for observing clouds, while access to the river and dredge cell offers numerous educational opportunities

Station 4:

Located at the intersection of the Cove and Perimeter trail, Observation Station Four is our farthest from the Environmental STEM Center. Situated between three different bodies of water, Beaver Pond, the Tidal Cove, and the Delaware River, Station Four is ideal for Hydrosphere investigations. The three bodies of water also provide opportunities for students to observe and investigate rare and unique organisms of all kinds, from raptors to endangered freshwater mussels!

THROUGHOUT THE PARK

SECTION I: LESSONS FOR ALL CLASSROOMS:

- **GLOBE Introducing Study Site** - Students select and visit a study site, where they observe and recall their existing knowledge of air, water, soil, and living things to make a list of interconnections among the four Earth system components. They make predictions about the effects of a change in a system, inferring ways these changes affect the characteristics of other related components.

  NGSS Standards:

  - **HS-ETS1-2**: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
  - **HS-LS2-1**: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
  - **HS-LS2-2:** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

- **GLOBE Inputs and Outputs on a region:** Students select and visit a study site, where they observe and recall their existing knowledge of air, water, soil, and living things to make a list of interconnections among the four Earth system components. They make predictions about the effects of a change in a system, inferring ways these changes affect the characteristics of other related components.

  NGSS Standards:

  - **HS-ESS3-5:** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
  - **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.
  - **HS-LS2-1**: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
  - **HS-LS2-6:** 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.
  - **HS-LS2-2**: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
  - **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

SECTION I: LESSONS FOR ALL CLASSROOMS:

- **Connecting The Parts of a Study Site**: Students visit a study site, where they observe and recall their existing knowledge of air, water, soil, and living things to make a list of interconnections among the four Earth system components. They make predictions about the effects of a change in a system, inferring ways these changes affect the characteristics of other related components.

  NGSS Standards:

  - **5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
  - **MS-ESS2-1**: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
  - **HS-LS2-1**: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
  - **HS-LS2-2**: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

- **GLOBE Surface Temperature Protocol**: Students will learn to use an infrared thermometer, and understand how different surfaces radiate energy.

  NGSS Standards:

  - **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
  - **HS-ESS3-6:** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity
  - **HS-ESS3-5**: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global of regional climate change and associated future impacts to Earth systems.
  - **HS-ESS3-4**: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
  - **HS-ESS2-4**: Use a model to describe how variations in the flow of energy into and out of Earth systems result in changes in climate.
  - **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
  - **MS-ESS2-5**: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
  - **K-PS3-1:** Make observations to determine the effect of sunlight on Earth's surface.

- ***BONUS***: **Mosquito Larvae Hunters**: Using the GLOBE Observer App, students will identify potential mosquito breeding habitats (standing water or somewhere water could collect) and report if there are any mosquitos present. Optionally, students can sample, count, and even identify the mosquito larvae found using simple identification materials

OBSERVATION STATION ONE

SECTION II: OBSERVATION STATION ONE

- **GLOBE Clouds Protocol**: Using the GLOBE Observer mobile app, Students observe which types of clouds are visible, how much of the sky is covered by clouds, and the opacity of clouds. Students learn how to make estimates from observations and how to categorize and classify clouds' properties following general descriptions and instructions. Students learn the meteorological concepts of cloud height, cloud cover, and visual opacity, and learn basic cloud types. Students gain confidence in interpretation and analysis of satellite data.

NGSS Standards:

- **K-ESS2-1**: Use and share observations of local weather conditions to describe patterns over time.
- **3-ESS2-1**: Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures
- **MS PS1-4**: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed
- **MS-ESS2-5**: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- **HS-ESS2-3**: Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

- **Water Chemistry (Hydrosphere Protocols)**: Using a variety of sampling and testing methods, students will take measurements of the following parameters and investigate how changing conditions might affect biotic and abiotic conditions in a constantly changing system.

NGSS Standards:

- HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy
- HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- 5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy

SECTION II: OBSERVATION STATION ONE

- **GLOBE Particle Size and Distribution**: Students will be able to relate soil particle size to suspensions, specific gravity, and settling rates. Using dry, sieved soil, Students measure the distribution of different sizes of soil particles in each horizon of a soil profile

NGSS Standards:

- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Bulk Density:** Students will collect and measure the density of soil from each horizon in a soil profile. Then, in the classroom, students determine the mass of the samples, dry them, and determine the mass of them again to determine their dry mass and water content. Students use the Bulk Density Data Sheet to calculate the soil bulk density for each sample.

NGSS Standards:

- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Types of Soil (Characterization):** Students will identify horizons in a soil profile, observe the structure, color, consistence, texture, and the presence of rocks, roots, and carbonates of each horizon, and take samples for use in laboratory characterization protocols.

NGSS Standards:

- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems
- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-PS1-2**: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

SECTION II: OBSERVATION STATION ONE

- **GLOBE Soil Fertility:** Students will use a GLOBE Soil Fertility Kit to prepare samples and determine whether nitrate, phosphate, and potassium are absent from a soil sample or present in low, medium or high concentrations.

NGSS Standards:

- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Soil Moisture - Infiltration:** Students place two cans into the soil and add water to them to a depth of at least 5 cm. Students measure and record the time it takes the water level to drop a fixed 2 - 4 cm distance. Students repeat the measurement to determine how easily water moves vertically through the soil.

NGSS Standards:

- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Soil Moisture:** Students collect soil samples with a trowel or auger and weigh them, dry them, and then weigh them again. The soil water content is determined by calculating the difference between the wet sample mass and the dry sample mass.

NGSS Standards:

- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

SECTION II: OBSERVATION STATION ONE

- **Elementary GLOBE: DIY Aerosol Sampling**: Students will work in groups to make an aerosol sampler, a simple adhesive tool that allows students to collect data and estimate the extent of aerosols present at their school. By participating in this activity, students will obtain a quantitative measurement of the aerosols present at the school and, as an optional activity, can compare results geographically, across their community, or by time, collecting measurements day to day.

NGSS Standards:

- **DCI ESS2.D:** Weather and Climate

- **Elementary GLOBE: "Soil Treasure Hunt"**: Students will make predictions about what they think they will find in a sample of soil. They will investigate the sample and sort out the various items they find. Next they will spend time outside observing one or more sites to see what they find in the soil. After recording and sharing their observations they will create their own stories about the things they found in the soil.

NGSS Standards:

- **ESS2.A:** Earth's Materials and Systems
- **K-LS1-1:** Use observations to describe patterns of what plants and animals (including humans) need to survive.
- **K-ESS2-2:** Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

- **Elementary GLOBE: "We All Need Soil"** Each student will explore three activities that promote understanding of and respect for soil. They will generate responses to the questions: "What makes up soil?" and "What lives in the soil?" and create their own soil connection sentences.

NGSS Standards:

- **DCI ESS2.A:** How do Earth's major systems interact?
- **DCI LS1.C:** Organization for Matter and Energy Flow in Organisms
- **2-LS4-1:** Make observations of plants and animals to compare the diversity of life in different habitats.

SECTION II: OBSERVATION STATION ONE

- **Pond Macroinvertebrates** ***(GLOBE Water Wonders Activity, GLOBE Macroinvertebrate Protocol)***: Millions of small creatures inhabit fresh waters of lakes, streams, and wetlands. Macroinvertebrates, consisting of a variety of insects and insect larvae, crustaceans, mollusks, worms, and other small animals, live in the mud, sand, or gravel of the substrate or on submersed plants and logs. Students will collect, sort, identify, and count these macroinvertebrates from habitats at their study site. Students will also discuss how changes in water quality effect biological life.

NGSS Standards:

- **2-LS4-1**: Make observations of plants and animals to compare the diversity of life in different habitats.
- **4-LS1-1**: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- **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.
- **HS-LS2-1**: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
- **HS-LS2-2**: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

- ***BONUS***: **Mosquito Larvae Hunters**: Using the GLOBE Observer App, students will identify potential mosquito breeding habitats (standing water or somewhere water could collect) and report if there are any mosquitos present. Optionally, students can sample, count, and even identify the mosquito larvae found using simple identification materials

OBSERVATION STATION TWO

SECTION III: OBSERVATION STATION TWO

- **Tree Rings: Living Records of Climate**: Students will analyze tree rings to draw conclusions about precipitation patterns in the past. They also compare their own analysis with actual precipitation data (from NASA) to determine similarities and differences in precipitation.

Class Set of Tree Cookies Available Upon Request

NGSS Standards:

- **HS-LS2-6:** 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.
- **K-ESS2-1**: Use and share observations of local weather conditions to describe patterns over time.
- **5-ESS-2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact

- **Elementary GLOBE Hummingbird Study**: In this activity, students will record a list of things they already know about hummingbirds and a list of things they would like to learn about hummingbirds. Then they will conduct research to find out some of the information they want to know. Using their new knowledge, each student will make a hummingbird out of art supplies. Finally, using their hummingbirds as props, the students will play a game to test each other in their knowledge of the ruby-throated hummingbirds.

NGSS Standards:

- **DCI LS-1A**: Structure and Function
- **Science Practice 2:** Developing and Using Models
- **Science Practice 8:** Obtaining, Evaluating, and Communicating Information

- **Fallen Log Investigation**: It's amazing how many things live in and on rotting logs. In this activity, your students will become familiar with some of those organisms. They will gain an understanding of how decomposition takes place. They will also gain an appreciation for microhabitats and communities

NGSS Standards:

- **2-LS4-1:** Make observations of plants and animals to compare the diversity of life in different habitats.
- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

SECTION III: OBSERVATION STATION TWO

- **GLOBE Particle Size and Distribution**: Students will be able to relate soil particle size to suspensions, specific gravity, and settling rates. Using dry, sieved soil, Students measure the distribution of different sizes of soil particles in each horizon of a soil profile

NGSS Standards:

- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Bulk Density:** Students will collect and measure the density of soil from each horizon in a soil profile. Then, in the classroom, students determine the mass of the samples, dry them, and determine the mass of them again to determine their dry mass and water content. Students use the *Bulk Density Data Sheet* to calculate the soil bulk density for each sample.

NGSS Standards:

- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Types of Soil (Characterization):** Students will identify horizons in a soil profile, observe the structure, color, consistence, texture, and the presence of rocks, roots, and carbonates of each horizon, and take samples for use in laboratory characterization protocols.

NGSS Standards:

- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems
- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-PS1-2**: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

SECTION III: OBSERVATION STATION TWO

- **GLOBE Soil Fertility**: Students will use a GLOBE Soil Fertility Kit to prepare samples and determine whether nitrate, phosphate, and potassium are absent from a soil sample or present in low, medium or high concentrations.

NGSS Standards:

- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Soil Moisture - Infiltration:** Students place two cans into the soil and add water to them to a depth of at least 5 cm. Students measure and record the time it takes the water level to drop a fixed 2 - 4 cm distance. Students repeat the measurement to determine how easily water moves vertically through the soil.

NGSS Standards:

- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Soil Moisture:** Students collect soil samples with a trowel or auger and weigh them, dry them, and then weigh them again. The soil water content is determined by calculating the difference between the wet sample mass and the dry sample mass.

NGSS Standards:

- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

SECTION III: OBSERVATION STATION TWO

- **Elementary GLOBE: DIY Aerosol Sampling**: Students will work in groups to make an aerosol sampler, a simple adhesive tool that allows students to collect data and estimate the extent of aerosols present at their school. By participating in this activity, students will obtain a quantitative measurement of the aerosols present at the school and, as an optional activity, can compare results geographically, across their community, or by time, collecting measurements day to day.

NGSS Standards:

- **ESS2.D:** Weather and Climate

- **Elementary GLOBE: "Soil Treasure Hunt"**: Students will make predictions about what they think they will find in a sample of soil. They will investigate the sample and sort out the various items they find. Next they will spend time outside observing one or more sites to see what they find in the soil. After recording and sharing their observations they will create their own stories about the things they found in the soil.

NGSS Standards:

- **ESS2.A:** Earth Materials and Systems

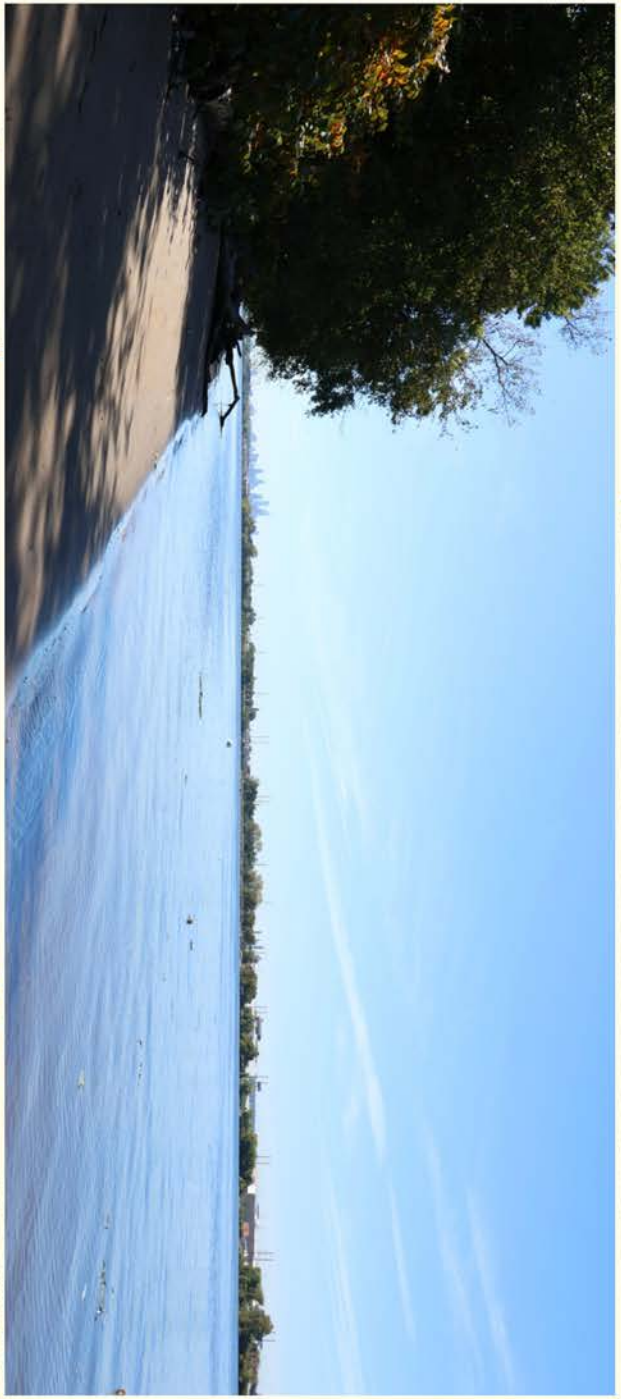
- **Elementary GLOBE: "We All Need Soil"** Each student will explore three activities that promote understanding of and respect for soil. They will generate responses to the questions: “What makes up soil?” and “What lives in the soil?” and create their own soil connection sentences.

NGSS Standards:

- **ESS2.A**
- **LS1.C**
- **2-LS4-1:** Make observations of plants and animals to compare the diversity of life in different habitats.

- **GLOBE Observer Tree Height Protocol**: Using the GLOBE observer app, students will become citizen scientists and estimate the height of different trees around them. Using either a free smartphone app (GLOBE OBSERVER) or a clinometer, measurements can be recorded and contributed towards NASA’s global tree height study. These observations allow NASA scientists to understand the gain or loss of biomass which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere. For more information on the GLOBE Observer Tree Program and how NASA studies trees, click *here*

OBSERVATION STATION THREE



SECTION IV: OBSERVATION STATION THREE

- **GLOBE Clouds Protocol**: Using the GLOBE Observer mobile app, Students observe which types of clouds are visible, how much of the sky is covered by clouds, and the opacity of clouds. Students learn how to make estimates from observations and how to categorize and classify clouds' properties following general descriptions and instructions. Students learn the meteorological concepts of cloud height, cloud cover, and visual opacity, and learn basic cloud types. Students gain confidence in interpretation and analysis of satellite data.

NGSS Standards:

- **K-ESS2-1**: Use and share observations of local weather conditions to describe patterns over time.
- **3-ESS2-1**: Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures
- **MS PS1-4**: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed
- **MS-ESS2-5**: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- **HS-ESS2-3**: Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

- **GLOBE Particle Size and Distribution**: Students will be able to relate soil particle size to suspensions, specific gravity, and settling rates. Using dry, sieved soil, Students measure the distribution of different sizes of soil particles in each horizon of a soil profile

NGSS Standards:

- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

SECTION IV: OBSERVATION STATION THREE

- **GLOBE Bulk Density:** Students will collect and measure the density of soil from each horizon in a soil profile. Then, in the classroom, students determine the mass of the samples, dry them, and determine the mass of them again to determine their dry mass and water content. Students use the Bulk Density Data Sheet to calculate the soil bulk density for each sample.

NGSS Standards:

- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Types of Soil (Characterization):** Students will identify horizons in a soil profile, observe the structure, color, consistence, texture, and the presence of rocks, roots, and carbonates of each horizon, and take samples for use in laboratory characterization protocols.

NGSS Standards:

- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems
- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-PS1-2**: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

- **GLOBE Soil Fertility**: Students will use a GLOBE Soil Fertility Kit to prepare samples and determine whether nitrate, phosphate, and potassium are absent from a soil sample or present in low, medium or high concentrations.

NGSS Standards:

- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

SECTION IV: OBSERVATION STATION THREE

- **GLOBE Soil Moisture - Infiltration:** Students place two cans into the soil and add water to them to a depth of at least 5 cm. Students measure and record the time it takes the water level to drop a fixed 2 - 4 cm distance. Students repeat the measurement to determine how easily water moves vertically through the soil.

  NGSS Standards:

  - **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
  - **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
  - **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Soil Moisture:** Students collect soil samples with a trowel or auger and weigh them, dry them, and then weigh them again. The soil water content is determined by calculating the difference between the wet sample mass and the dry sample mass.

  NGSS Standards:

  - **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **Elementary GLOBE: "We All Need Soil"** Each student will explore three activities that promote understanding of and respect for soil. They will generate responses to the questions: "What makes up soil?" and "What lives in the soil?" and create their own soil connection sentences.

  NGSS Standards:

  - **ESS2.A:** Earth Materials and Systems
  - **LS1.C:** LS1C: Organization for Matter and Energy Flow in Organisms
  - **2-LS4-1:** Make observations of plants and animals to compare the diversity of life in different habitats.

- **Elementary GLOBE: "Soil Treasure Hunt"**: Students will make predictions about what they think they will find in a sample of soil. They will investigate the sample and sort out the various items they find. Next they will spend time outside observing one or more sites to see what they find in the soil. After recording and sharing their observations they will create their own stories about the things they found in the soil.

  NGSS Standards:

  - **ESS2.A:** Earth Materials and Systems

SECTION IV: OBSERVATION STATION THREE

- **Elementary GLOBE: DIY Aerosol Sampling**: Students will work in groups to make an aerosol sampler, a simple adhesive tool that allows students to collect data and estimate the extent of aerosols present at their school. By participating in this activity, students will obtain a quantitative measurement of the aerosols present at the school and, as an optional activity, can compare results geographically, across their community, or by time, collecting measurements day to day.

NGSS Standards:

- **ESS2.D:** Weather and Climate

- **GLOBE Observer Tree Height Protocol**: Using the GLOBE observer app, students will become citizen scientists and estimate the height of different trees around them. Using either a free smartphone app (GLOBE OBSERVER) or a clinometer, measurements can be recorded and contributed towards NASA's global tree height study. These observations allow NASA scientists to understand the gain or loss of biomass which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere. For more information on the GLOBE Observer Tree Program and how NASA studies trees, click *here*

- **Water Chemistry (Hydrosphere Protocols)**: Using a variety of sampling and testing methods, students will take measurements of the following parameters and investigate how changing conditions might affect biotic and abiotic conditions in a constantly changing system.

NGSS Standards:

- HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy
- HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- 5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy

- **Freshwater Mussel Volunteer Survey Protocol**: There are at least 7 species of freshwater mussels found along the shores of the Delaware River here at Palmyra Cove, one of the last sanctuaries for these incredibly important invertebrates. Freshwater Mussels are filter feeding bivalves that trap pieces of sediment in mucous as they pump water through their gills. These mussels can filter over 16 gallons of water every 24 hours and are one of the biggest reasons for the ongoing improvement in water quality in this section of the Delaware River. Students will contribute to the Partnership for the Delaware Estuary's community mussel survey program as they identify survey locations, sort, and identify these little known but incredibly rare and important creatures to the Delaware River Ecosystem.

NGSS Standards:

- **2-LS4-1**: Make observations of plants and animals to compare the diversity of life in different habitats.
- **4-LS1-1**: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- **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.

- **Microplastic Sampling Protocol:** Plastic has become a global problem. About 9% of plastic is recycled and 12% is incinerated. The remaining 79% of plastic is left to accumulate in community landfills and the environment, where it will never biodegrade. Instead, it breaks down into smaller and smaller pieces, becoming tiny plastic particles called microplastics. To determine what impact plastic refuse is having on local beaches along the Jersey Shore, members of Save Coastal Wildlife Nonprofit along with The Plastic Wave Project, started a volunteer microplastic beach monitoring program in 2019. Palmyra Cove has adopted the same monitoring protocol to help better understand how microplastics are moving up our rivers and streams. Students will use to the protocol to investigate the presence of microplastics in our tidal waterways that connect with the areas investigated by save coastal wildlife

NGSS Standards:

- **HS-LS2-2:** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- **HS-LS2-6**: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **HS-LS4-5**: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- **HS-LS4-6: Cre**ate or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

OBSERVATION STATION FOUR

SECTION V: OBSERVATION STATION FOUR

- **GLOBE Clouds Protocol**: Using the GLOBE Observer mobile app, Students observe which types of clouds are visible, how much of the sky is covered by clouds, and the opacity of clouds. Students learn how to make estimates from observations and how to categorize and classify clouds' properties following general descriptions and instructions. Students learn the meteorological concepts of cloud height, cloud cover, and visual opacity, and learn basic cloud types. Students gain confidence in interpretation and analysis of satellite data.

  NGSS Standards:

  - **K-ESS2-1**: Use and share observations of local weather conditions to describe patterns over time.
  - **3-ESS2-1**: Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
  - **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
  - **MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures
  - **MS PS1-4**: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed
  - **MS-ESS2-5**: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
  - **HS-ESS2-3**: Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

- **GLOBE Particle Size and Distribution**: Students will be able to relate soil particle size to suspensions, specific gravity, and settling rates. Using dry, sieved soil, Students measure the distribution of different sizes of soil particles in each horizon of a soil profile

  NGSS Standards:

  - **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
  - **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

SECTION V: OBSERVATION STATION FOUR

- **GLOBE Bulk Density:** Students will collect and measure the density of soil from each horizon in a soil profile. Then, in the classroom, students determine the mass of the samples, dry them, and determine the mass of them again to determine their dry mass and water content. Students use the *Bulk Density Data Sheet* to calculate the soil bulk density for each sample.

NGSS Standards:

- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Types of Soil (Characterization):** Students will identify horizons in a soil profile, observe the structure, color, consistence, texture, and the presence of rocks, roots, and carbonates of each horizon, and take samples for use in laboratory characterization protocols.

NGSS Standards:

- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems
- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-PS1-2**: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- **MS-PS1-3**: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

- **GLOBE Soil Fertility**: Students will use a GLOBE Soil Fertility Kit to prepare samples and determine whether nitrate, phosphate, and potassium are absent from a soil sample or present in low, medium or high concentrations.

NGSS Standards:

- **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
- **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

SECTION V: OBSERVATION STATION FOUR

- **GLOBE Soil Moisture - Infiltration:** Students place two cans into the soil and add water to them to a depth of at least 5 cm. Students measure and record the time it takes the water level to drop a fixed 2 - 4 cm distance. Students repeat the measurement to determine how easily water moves vertically through the soil.

  NGSS Standards:

  - **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
  - **MS-ESS3-3**: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
  - **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **GLOBE Soil Moisture:** Students collect soil samples with a trowel or auger and weigh them, dry them, and then weigh them again. The soil water content is determined by calculating the difference between the wet sample mass and the dry sample mass.

  NGSS Standards:

  - **HS-ESS2-2**: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

- **Elementary GLOBE: "We All Need Soil"** Each student will explore three activities that promote understanding of and respect for soil. They will generate responses to the questions: "What makes up soil?" and "What lives in the soil?" and create their own soil connection sentences.

  NGSS Standards:

  - **ESS2.A:** Earth Materials and Systems
  - **LS1.C**
  - **2-LS4-1:** Make observations of plants and animals to compare the diversity of life in different habitats.

SECTION V: OBSERVATION STATION FOUR

- **Elementary GLOBE: DIY Aerosol Sampling**: Students will work in groups to make an aerosol sampler, a simple adhesive tool that allows students to collect data and estimate the extent of aerosols present at their school. By participating in this activity, students will obtain a quantitative measurement of the aerosols present at the school and, as an optional activity, can compare results geographically, across their community, or by time, collecting measurements day to day.

NGSS Standards:

- **ESS2.D:** Weather and Climate

- **Elementary GLOBE: "Soil Treasure Hunt"**: Students will make predictions about what they think they will find in a sample of soil. They will investigate the sample and sort out the various items they find. Next they will spend time outside observing one or more sites to see what they find in the soil. After recording and sharing their observations they will create their own stories about the things they found in the soil.

NGSS Standards:

- **ESS2.A:** Earth Materials and Systems

- **GLOBE Observer Tree Height Protocol**: Using the GLOBE observer app, students will become citizen scientists and estimate the height of different trees around them. Using either a free smartphone app (GLOBE OBSERVER) or a clinometer, measurements can be recorded and contributed towards NASA's global tree height study. These observations allow NASA scientists to understand the gain or loss of biomass which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere. For more information on the GLOBE Observer Tree Program and how NASA studies trees, click *here*

SECTION V: OBSERVATION STATION FOUR

- **Water Chemistry (Hydrosphere Protocols)**: Using a variety of sampling and testing methods, students will take measurements of the following parameters and investigate how changing conditions might affect biotic and abiotic conditions in a constantly changing system.

NGSS Standards:

- HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy
- HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- 5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy

- **Pond Macroinvertebrates (*GLOBE Water Wonders Activity*, *GLOBE Macroinvertebrate Protocol*)**: Millions of small creatures inhabit fresh waters of lakes, streams, and wetlands. Macroinvertebrates, consisting of a variety of insects and insect larvae, crustaceans, mollusks, worms, and other small animals, live in the mud, sand, or gravel of the substrate or on submersed plants and logs. Students will collect, sort, identify, and count these macroinvertebrates from habitats at their study site. Students will also discuss how changes in water quality effect biological life.

NGSS Standards:

- **2-LS4-1**: Make observations of plants and animals to compare the diversity of life in different habitats.
- **4-LS1-1**: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- **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.
- **HS-LS2-1**: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
- **HS-LS2-2**: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

- **Freshwater Mussel Volunteer Survey Protocol**: There are at least 7 species of freshwater mussels found along the shores of the Delaware River here at Palmyra Cove, one of the last sanctuaries for these incredibly important invertebrates. Freshwater Mussels are filter feeding bivalves that trap pieces of sediment in mucous as they pump water through their gills. These mussels can filter over 16 gallons of water every 24 hours and are one of the biggest reasons for the ongoing improvement in water quality in this section of the Delaware River. Students will contribute to the Partnership for the Delaware Estuary's community mussel survey program as they identify survey locations, sort, and identify these little known but incredibly rare and important creatures to the Delaware River Ecosystem.

NGSS Standards:

- **2-LS4-1**: Make observations of plants and animals to compare the diversity of life in different habitats.
- **4-LS1-1**: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- **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.

- **Microplastic Sampling Protocol:** Plastic has become a global problem. About 9% of plastic is recycled and 12% is incinerated. The remaining 79% of plastic is left to accumulate in community landfills and the environment, where it will never biodegrade. Instead, it breaks down into smaller and smaller pieces, becoming tiny plastic particles called microplastics. To determine what impact plastic refuse is having on local beaches along the Jersey Shore, members of Save Coastal Wildlife Nonprofit along with The Plastic Wave Project, started a volunteer microplastic beach monitoring program in 2019. Palmyra Cove has adopted the same monitoring protocol to help better understand how microplastics are moving up our rivers and streams. Students will use to the protocol to investigate the presence of microplastics in our tidal waterways that connect with the areas investigated by save coastal wildlife

NGSS Standards:

- **HS-LS2-2:** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- **HS-LS2-6**: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **HS-LS4-5**: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- **HS-LS4-6: Cre**ate or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

GLOBE Observer

THE GLOBE PROGRAM

GLOBE MISSION EARTH

This guide is a result of a partnership between the Palmyra Cove Institute for Earth Observations, NASA GLOBE Mission Earth, and the New Jersey GLOBE Partnership. Special thanks to the New Jersey Tidelands Council and the Army Corps of Engineers

Questions/Comments? Contact us at palmyracove.org