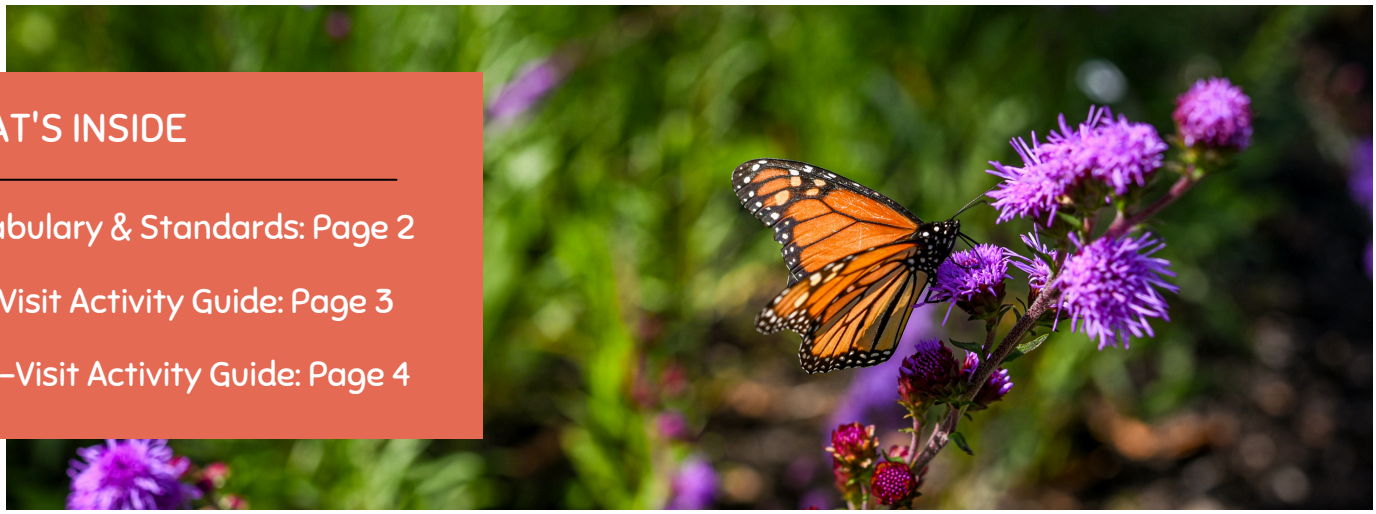
ADAPTIVE ECOSYSTEMS
EDUCATOR GUIDE

Thank you for registering for the Adaptive Ecosystems field trip at New England Botanic Garden at Tower Hill. This guide provides an overview and introduction to the program. The optional pre- and post-visit activities on the following pages will support your students' learning during the program and help extend their knowledge beyond your trip. Prior to your visit you are not mandated to complete any specific lessons or units of study.



WHAT'S INSIDE

OVERVIEW

During this guided program, your students will conduct an exploration into the garden's ecosystem by observing native and invasive species and their relationships. They will follow the transfer of energy through the trophic levels, learn how biotic and abiotic factors influence an ecosystem's biodiversity, and investigate real environmental events and discuss human impact on the environment. We recommend you complete the optional pre- and post-visit activities on the following pages to enhance your visit and support the integration of the concepts addressed during this program.

Throughout the 90-minute field trip, Teacher Naturalists will guide small working groups of no more than 15 students to various habitats in search of various plant and animal species. Students will be encouraged to make observations, explore, and ask questions throughout. Each student will be provided with a hand lens, clipboard, and field notebook to use during their visit. Teacher Naturalists will engage students using a combination of stories, investigations, games, and writing activities.

LEARNING OBJECTIVES

Students will...

- Identify species and categorize their relationships to other living organisms.
- Learn about the transfer of energy across trophic levels.
- Understand that environmental factors and human behavior have impacts on an ecosystems carrying capacity and biodiversity.

BACKGROUND

Ecosystems are formed through a complex network of species relationships and environmental factors. These relationships help native species in an ecosystem create natural balance. When an invasive species is introduced that does not coincide with this balance of species, disruption and damage to the health of the ecosystem can occur. For this reason, it is important that we are considerate towards our direct impact on the environment.

VOCABULARY

Biotic Factor: an impact to an ecosystem created by living organisms.
Abiotic Factor: an impact to an ecosystem created by non-living sources.
Producer: an organism that creates its own food using energy from the sun.
Consumer: an organism that cannot produce its own food and eats other organisms to get energy.
Decomposer: an organism that gets its energy from eating dead organisms and organic matter.
Symbiosis: interaction between two or more different living organisms habituating in close physical proximity to each other.
Parasitism: a relationship between two living species in which one organism is benefitted at the expense of the other.
Mutualism: a relationship between two living species in which both organisms benefit.
Commensalism: a relationship between two living species in which one organism benefits and the other neither benefits nor is harmed.
Competition: a relationship between any number of living organisms in which they vie for access to limited resources in an ecosystem.
Predation: the act of one organism consuming another as a food source.
Native Species: an organism that is indigenous to the ecosystem it inhabits.
Invasive Species: a foreign organism that is introduced to an ecosystem usually through direct or indirect human activity.

STANDARDS

IN ALIGNMENT WITH THE 2016 MASSACHUSETTS SCIENCE AND TECHNOLOGY/ENGINEERING CURRICULUM FRAMEWORKS

Biology

- HS-LS2-1: Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity.
- HS-LS2-4: Use a mathematical model to describe the transfer of energy from one trophic level to another. Explain how the inefficiency of energy transfer between trophic levels affects the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment.
- HS-LS2-7: Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.

Science & Technology

- HS-ESS3-3: Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.

PRE-VISIT ACTIVITY GUIDE

The following optional pre-visit activities and resources are designed to support the understanding of concepts that will be addressed during the Adaptive Ecosystems program.

MICROCLIMATE EXPLORATION

Students will compare the land cover and temperatures in different microclimates to begin to explain why organisms live where they do.

MATERIALS

Pencils & Paper
Clipboard
Thermometer

The contour of the land, the presence or absence of plants, moisture, and time of day may result in many microclimates within one ecosystem. Today we will explore and document the microclimates in our schoolyard.

- Define the boundaries of your study and ask students to each select a defined area of land and look for trends. The plots should all be the same size roughly a few square meters.
- Students should record the plants and animals living there. Encourage students to be as detailed as possible and rely on their observation skills.
- Record temperatures at each plot at various times of the day and the year and look for changes in species biodiversity.
- Have students group back up and share their findings. Discuss these questions:
    - What is the hottest and coolest spot? What is making this the hottest or coolest spot?
    - What plants and animals do you notice living here? Did you notice any differences between the species that live in the other locations?
    - How might the highs and lows change during the day? The year? How might these changes affect the plants and animals?

TERRARIUM IN A JAR

Students will construct a miniature terrarium and make observations as to the growth and health of the ecosystem contained within.

MATERIALS

Recycled jar
Soil
Moss/ferns
Bark
Rocks
Water
Hot glue
Tape

Break students into partners or small groups and provide each with a recycled jar or plastic bottle along with the other listed materials. Note: large-mouth jars will work best as they provide easier access when adding materials to the terrarium. Plastic bottles can also be used by cutting in half and resealing with glue or tape afterwards. Explain that they will be creating a self-sustaining terrarium.

1. Add rocks to the bottom of the jar. This will help with drainage and mitigate root rot.
2. Add a layer of soil. Make sure that it is not compacted and provides space for plants to develop their roots.
3. Add plants (moss or ferns work best) and gently position them within the jar.
4. Add bark and any other natural materials as desired.
5. Water plants around the inside edge of the jar to ensure that the soil gets evenly moist. Then seal the container.
6. Make observations as to the health and growth of the plants inside. Additional water is not needed as the water inside will be recycled as long as the jar remains sealed.

EXTENSION

Increase the bioactivity of your terrarium by introducing decomposer invertebrates like isopods. Use this as an opportunity to observe interspecies relationships between producers and decomposers.

POST-VISIT ACTIVITY GUIDE

The following optional post-visit activities and resources are designed to reinforce concepts that were addressed during the Adaptive Ecosystems program. We would love to see your students' work! Please share with us by mail or email us at youtheducation@nebg.org

INVASIVE SPECIES STUDY

Students will research and then present on an invasive species and its impact to the local ecosystems.

MATERIALS

Computer
Poster Board
Pencils
Scissors
Glue
Paper

Have students conduct a research project on one of the following invasive species: Asian Long-Horned Beetle, Spotted Lanternfly, Emerald Ash Borer, Japanese Knotweed, Bittersweet, Water Chestnut, Crypt Gall Wasp, or Spongy Moth.

Students should answer these questions:

1. Where did the invasive species originate?
2. When and how was it introduced to the local ecosystem?
3. What native species were or currently are being impacted by it?
4. How is the ecosystem being impacted and what are the potential risks to the ecosystem?
5. What methods, if any, are being conducted to combat their spread?

Once research is complete, students should share their work as a presentation or informational poster and present to the class. You can have students work individually or in small groups for this project.

ECO IMPACT

Students will learn about their own personal impact on the environment by calculating their carbon footprint and then create a plan to limit the extent of that impact.

MATERIALS

Computer

Have students reflect back on the case studies portion of the Adaptive Ecosystems program. Remind them that human activity is a major contributor to climate change which has led to an increase in weather disasters and ecosystem destruction.

A key component of climate change is carbon emissions. Explain what a carbon footprint is and how it illustrates our own personal environmental impact. Have students use this Footprint Calculator to find their own carbon footprint. Discuss results as a class. Were the results surprising? What stood out in terms of greatest impacts?

Have students explore the Solutions pages and learn about methods currently being implemented to reduce carbon emissions and limit the impact of global warming. Ask each student to generate achievable solutions towards limiting their own carbon footprint. This could come in the form of starting a recycling program at your school, making a community garden, or small dietary changes.

After brainstorming individual and class wide ideas, have students update their data in the footprint calculator using their new goals to see how this would change their carbon footprint. Encourage students to try to stick to these goals for at least a month.

EDUCATOR RESOURCES

- YouTube video: Ecosystem Dynamics, Functioning and Resilience
- Article: CO2 Emissions by Country