COMPANION LEARNING RESOURCE GUIDE

6th-8th Grade Formal Education Curriculum:

You Are the Conservation Engineer

Teacher Guide





Companion Learning Resource Guide for Teachers

America the Beautiful: Our Natual Wonders

Narrated by Kelsey Grammer

Teacher Guide

6th-8th Grade Formal Education Curriculum:
You Are the Conservation Engineer

Next Generation Science Standards

MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

"Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations."

MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

"Evaluate competing design solutions for maintaining biodiversity and ecosystem services."

MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

"Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions."

Objective

A wildlife population is declining, but 6-8th graders know the perfect solution! Students work in groups to identify the problem facing the nocturnal animal communities of a national park, research solutions, establish criteria and constraints, and design a solution that allows people and wildlife to safely share the landscape.

Key Concepts

▶ Ecosystems are highly interconnected. Making even a few small changes to physical or biological components of an ecosystem affect the dynamics of the entire community.

▶ High biodiversity describes a habitat with many different kinds of plants and animals. High biodiversity is important because it makes habitats strong, healthy, and balanced.

▶ Human activity can be harmful to the environment. However, humans can also find real, creative ways to live well while also supporting thriving, diverse ecosystems.

▶ When building a model and determining the effectiveness of a new design, a multitude of variables should be considered, tested, and analyzed.

Materials

▶ "Park Ranger Report" packet (enough for 1 packet per group)

▶ Flashlights (enough for 1 flashlight per group)

▶ Brown or orange tissue paper

▶ Paper coffee filters

▶ Plastic cups

▶ Aluminum foil

▶ Plastic wrap

▶ Cardstock paper

▶ Pipe cleaners

▶ Washable markers

▶ Scissors

▶ Tape

▶ Rubber bands

Setup

▶ Pre-assign groups of 3-4 students.

▶ Identify activity locations for the building phase and the testing phase. The building phase location should offer students room to experiment with a variety of materials. The testing phase location should offer students the chance to turn off the lights, and experience as much darkness as possible.

▶ Place materials in neat piles or bins.

▶ Test that all flashlights are in working order.

▶ If possible, allot 5-15 minutes during which students can spend time outside to notice and enjoy nature

▶ Print "Park Ranger Report" packets (enough for 1 per group).

Vocabulary

Biodiversity: the variety of life in a habitat or ecosystem.

Ecosystem: a community of organisms and the places they live.

Nocturnal: most active during the night.

Variable: a characteristic, factor, or condition that can be changed or controlled in an experiment.

Procedure *You Are the Conservation Engineer*

1 Read or share the following text with students:

America's national parks are precious, protected places of historical significance, wild beauty, and ecological importance. The actions that we take to learn about, support, and protect our national parks today will have a great effect on the generations of plants, animals, and people to come.

2 Tell students that they will be conducting an investigation to understand and assist with a fictional problem happening at one of America's national parks..

3 Read or share the following text with students:
Fictional Story About Grand Canyon National Park:

"Millions of people visit Grand Canyon National Park each year. With its thriving desert ecosystems, interesting rock formations, and beautiful sunsets, it is an incredible place to explore. In fact, Grand Canyon National Park has so much to offer that it is even an exciting place to visit at night! Adults, families, and even school groups visit the park at night to marvel at its clear, starry desert skies.

Recently, due an increase in the number of school groups visiting Grand Canyon National Park, a brand new education center has just been built within park boundaries.

The education center has allowed hundreds of thousands of students to learn about the importance of Grand Canyon National Park and its plant and animal communities. For example, many students are learning about the park's biodiversity, which is the variety of life in a habitat or ecosystem. The education center has been a great tool for connecting children to nature, which will help to protect the park in years to come!

Sometimes, school groups are hosted at the education center at night to learn about the park's nocturnal species. Many of the park's animals are nocturnal, which means that they are most active at night. Owls, bats, moths, and many other creatures are adapted to darkness and require a dark habitat in order to thrive and survive. However, since the education center was built, there has been a steady decline in many nocturnal species populations. School group students and park rangers search the skies for nocturnal creatures on their tours, but sightings are becoming more and more rare!

The park rangers at Grand Canyon National Park need your help to identify the reason for the decline in nocturnal species, and to design a solution to the problem so that the park's ecosystems and young visitors can continue to thrive."

4 Provide students with one "Park Ranger Report" packet per group.

5 Instruct students to discuss and review the park ranger's notes, searching for the problem causing the decline in Grand Canyon National Park's nocturnal animal species. Once students believe they have their answer, instruct them to complete Question 1 in their report packets:

- **Question 1:** "Identify the problem that you believe is causing the decline of nocturnal species in Grand Canyon National Park. Explain your answer."

6 Inform the students that while there could be a combination of issues facing the nocturnal animals in the park, the one that they will focus on today is the issue of light pollution. Light pollution can disrupt a nocturnal animal's navigation, natural cycles of activity, and predator-prey interactions.

7 Tell the students that the next step of their investigation will be to identify some of the constraints, or limits on what can be done, around solving the problem. Instruct students to work together to complete Questions 2-5 in their report packets:

- **Question 2:** "What are the needs of the nocturnal species in the park?"
- **Question 3:** "What are the needs of the school group students who tour near the education center at night?"
- **Question 4:** "What are the needs of both the nocturnal species and the school group students that cannot be compromised?"
- **Question 5:** "What are the needs of both the nocturnal species and the school group students that can be compromised, or met in a creative new way?"

8 It is time for creative problem-solving! Instruct students to work together to verbally develop 2-3 possible solutions to the problem they have identified. Encourage students to consider many different angles and approaches, thinking

big and boldly! Then, instruct students to answer Question 6 in their report packets:

• **Question 6:** "Formulate 2-3 solutions for the problem you have identified. Explain how each solution balances the needs of both the park's nocturnal animals, and its visiting school groups."

9 Tell the students that they will now be building a model to test their solutions. Each group will be offered one flashlight and a variety of materials to approach solving the problem of population decline in the park's nocturnal animal populations, while also balancing the needs of the student groups visiting the education center.

10 Provide students with the following instructions and parameters for the building phase of their investigation:

• **Goal**

To build a model for a new nighttime light system that will better balance the needs of both the nocturnal animal populations at Grand Canyon National Park, and the visiting school groups. The new lighting system must be dimmer than the original, basic flashlight design, but still bright enough to make walking safe for visiting humans.

• **Considerations**

> A scientific variable is a characteristic, factor, or condition that can be changed or controlled in an experiment. While developing your model, test multiple variables to determine which changes are most and least effective. For example, your group may test the following variables:

(a) Color

(b) Direction

(c) Level of focus

> If flashlights have different settings, any setting may be used for this experiment.

> In the final testing phase, the following variables will also be considered as part of the design:

(a) Position of flashlight being held

(b) Height at which flashlight is being held

For this portion of the investigation, students should be provided with ample room and supplies to test their solutions with a variety of materials. Lights should be dimmed if possible, or turned off periodically for testing purposes.

11 Once students have finished building their models, instruct them to complete Questions 7-9 in their report packets:

• **Question 7:** "Describe all modifications made to your lighting system model, and explain the reason behind your choice for each modification."

• **Question 8:** "Describe the position that you plan to hold your light, and explain the reason behind your choice."

• **Question 9:** "Describe the height at which you plan to hold your light, and explain the reason behind your choice."

12 It's time to test out some innovative solutions! Tell students that you will now be helping them to test their solutions using the models they have constructed. Every student group should take a turn describing and explaining their modifications to the class, as well as their choice of position and height. Then, turn off the lights and invite them to demonstrate their solution for a new lighting system for the education center!

For this portion of the investigation, students should be able to experience as much darkness as possible.

As students explain and perform their demonstrations of the lighting system models, praise students for choices that balance dimness for the nocturnal animal populations, as well as choices that maintain an appropriate amount of visibility for safe walking. Key variables include:

• Dimmer light

• Warm colored light, as opposed to harsh white or blue light

• Downward-facing light

• Light positioned lower to the ground, but not too low for safe walking

• Shielded light (such as with a cardstock or coffee filter funnel)

13 Instruct students to discuss their final test results with their small groups, and complete Questions 10-11 in their report packets:

• **Question 10:** "Did the modifications to your lighting system work as expected? Explain."

• **Question 11:** "Which design aspects of your model worked well? Explain."

• **Question 12:** "Which design aspects of your model could use improvement? Explain."

14 Ask students what they found to be the most successful modifications, including positioning and height, out of all the models demonstrated. As a class, discuss what the best set of modifications might be overall, and what solution they would ultimately recommend for the lighting at Grand Canyon National Park's new education center. Instruct students to complete Question 13 in their report packets:

• **Question 13:** "What is the best possible design that you would recommend for a new lighting system at the education center? Explain."

15 Ask students to have one final discussion as a group to answer and complete Questions 14-16 in their report packets. After a few minutes, ask students to share their answers with the class.

• **Question 14:** "Think creatively! What are some other ways that a lighting system could be modified to reduce light pollution for nocturnal animal species in Grand Canyon National Park? Explain."

Once students have shared their ideas, offer the following additional practices that can help solve this problem:

- Turning off unneeded lights
- Using lights only at specific times, with lights on an automatic timer or using a motion sensor
- Closing blinds to shield interior lights
- Using shielded exterior lights, such as with a funnel
- Direct light downwards
- Use warm or amber-colored light
- Use the smallest quantity of lights needed

• **Question 15:** "What are the benefits of supporting Grand Canyon National Park's nocturnal animal species? Explain your answer in terms of the importance of biodiversity."

• **Question 16:** "What are the benefits of supporting Grand Canyon National Park's visiting school groups? Explain your answer in terms of interactions between people and the natural environment."

16 Remind students that while the problem they investigated in their activity today was fictional, Grand Canyon National Park is a real and wonderful place to visit. In fact, Grand Canyon National Park is an International Dark Sky Place!

17 Read or share the following text with students, sourced from the National Park Service website:

Parks are home to some of the last remaining harbors of starlit skies—some practically untouched by light pollution! Over forty parks within the National Park System are International Dark Sky Places, certified by Dark Sky International. These places provide amazing opportunities to experience night and gaze up at the celestial wonders of the night sky.

Protecting the night sky has many benefits!

> ***Adequate night lighting provides for human safety, health, and home security.***

> ***Dark nights (and bright days) are key in keeping our circadian rhythm in sync.***

> ***Enhances neighborhood aesthetics.***

> ***Light pollution can affect wildlife interactions and other vital ecological processes including predator/prey relationships, reproduction, habitat selection, navigation and migration. Nearly half the species on Earth are nocturnal, including migratory birds.***

> ***Preserving starry night skies can provide opportunities for local economic growth through astro-tourism.***

Stay up late and discover the night on any visit to a national park!

https://www.nps.gov/articles/000/dark-sky-parks-tour.htm

https://www.nps.gov/subjects/nightskies/athome.htm

18 (Optional) As a class or with individual devices, encourage students to explore the light pollution map on **www.lightpollutionmap.info.**



Analysis *"My Home, the Beautiful" Time*

19 Move students to an outdoor area for just 5-15 minutes, as far away from human-induced noise as possible. Invite them to quietly sit, stand, or lay down in the grass, and notice beauty worth protecting around them—however small or familiar! Encourage them to touch the dirt, grass, twigs, and leaves; feel the warm/cool air on their skin; listen for birds, bugs, and the wind; smell the plants around them; and search for insects.



- **Review & Discussion**
  - **>** How can making a small change to an ecosystem, such as adding new lighting to a building, have huge effects on the dynamics of the community?
  - **>** What is biodiversity, and why is it important?
  - **>** What is a scientific variable? What were some of the variables that your group tested while building your lighting system model?
  - **>** What were some of the constraints, or limitations, that you had to consider while building your model? Answer in terms of the ways that your designs might affect both the natural world (nocturnal animals) and people (visiting school groups).
  - **>** Human activity can be harmful to the environment. Give two examples of how humans can also find ways to live in harmony with other life on earth.
  - **>** What is one thing you saw in the *America the Beautiful: Our Natural Wonders* film that surprised or amazed you?







COMPANION LEARNING RESOURCE GUIDE

6th-8th Grade Formal Education Curriculum:

You Are the Conservation Engineer

Student Packet



Name: _____



Companion Learning Resource Guide for Students

America the Beautiful: Our Natual Wonders

Narrated by Kelsey Grammer

America's National Parks

America's national parks are precious, protected places of historical significance, wild beauty, and ecological importance. The actions that we take to learn about, support, and protect our national parks today will have a great effect on the generations of plants, animals, and people to come.

The Investigation Begins

Imagine that America's newest national park is your very own school or neighborhood. To protect the new park, it is your job to investigate and solve the problems that are threatening the ecosystem. Ready to learn more?

Fictional Story About America's Newest National Park:

"Millions of people visit Grand Canyon National Park each year. With its thriving ecosystems, interesting rock formations, and beautiful sunsets, it is an incredible place to explore. In fact, Grand Canyon National Park has so much to offer that it is even an exciting place to visit at night! Adults, families, and even school groups visit the park at night to marvel at its clear, starry skies.

Recently, due an increase in the number of school groups visiting Grand Canyon National Park, a brand new education center has just been built within park boundaries.

The education center has allowed hundreds of thousands of students to learn about the importance of Grand Canyon National Park and its plant and animal communities. For example, many students are learning about the park's biodiversity, which is the variety of life in a habitat or ecosystem. The education center has been a great tool for connecting children to nature, which will help to protect the park in years to come!

Sometimes, school groups are hosted at the education center at night to learn about the park's nocturnal species. Many of the park's animals are nocturnal, which means that they are most active at night. Owls, bats, moths, and many other creatures are adapted to darkness and require a dark habitat in order to thrive and survive. However, since the education center was built, there has been a steady decline in many nocturnal species populations. School group students and park rangers search the skies for nocturnal creatures on their tours, but sightings are becoming more and more rare!

The park rangers at Grand Canyon National Park need your help to identify the reason for the decline in nocturnal species, and to design a solution to the problem so that the park's ecosystems and young visitors can continue to thrive."

Park Ranger Notes

Vocabulary

Biodiversity: the variety of life in a habitat or ecosystem.

Ecosystem: a community of organisms and the places they live.

Nocturnal: most active during the night.

Variable: a characteristic, factor, or condition that can be changed or controlled in an experiment.

Notes & Observations

- Grand Canyon National Park gained its status as a national park in 1919, and is located within the state of Arizona.
- Grand Canyon National Park is home to many different ecosystems. Ecosystems are highly interconnected. Making even a few small changes to physical or biological components of an ecosystem affect the dynamics of the entire community.
- High biodiversity describes a habitat with many different kinds of plants and animals. High biodiversity is important because it makes habitats strong, healthy, and balanced.
- Grand Canyon National Park has always been a place of high biodiversity, with high populations of many nocturnal species such as owls, bats, and moths. However, shortly after the new education center was built, nocturnal species began to decline.





Notes & Observations continued

- Grand Canyon National Park is home to many owl species, such as flammulated owls and Mexican spotted owls. Most owl species eat primarily small mammals such as mice and shrews, have extraordinary hearing, and prefer hunting in dim or dark conditions. Light pollution may be harmful to owls by damaging their eyes and disrupting their hunting rhythms and sleep cycles.
- Grand Canyon National Park is home to many bat species, such as canyon bats and pallid bats. Many bat species can live for more than 30 years, help with plant pollination, and rely on darkness for protection from predators. Light pollution may be harmful to bats by disrupting their hunting routes and fragmenting their habitats.
- Grand Canyon National Park is home to many moth species, such as the black witch moth which migrates north from the tropical Americas each year. Many moth species have feathery or thread-like antennae, drink flower nectar, and are disoriented by artificial lights. Light pollution may be harmful to moths by disrupting their flight patterns, hunting rhythms, and ability to rely on darkness for protection from predators.

Nocturnal Animal Population Table

TIME OF YEAR	POPULATION PERCENTAGE
January 2014	97%
February 2014	101%
March 2014	98%
April 2014	96%
May 2014	88%
June 2014	82%
July 2014	79%
August 2014	73%
September 2014	71%
October 2014	68%
November 2014	64%
December 2014	60%

Nocturnal Animal Population Table

TIME OF YEAR	INSTALLATION TIMELINE UPDATES
January 2014	Planning for the education center is still in progress.
February 2014	Planning for the education center is still in progress.
March 2014	Education center is under construction.
April 2014	Education center is under construction.
May 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.
June 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.
July 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.
August 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.
September 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.
October 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.
November 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.
December 2014	School groups tours begin, including daytime hikes and excursions, and evening tours to learn about nocturnal animals.

Notes & Observations

- Education center features:
  - > Large sign on the front of the building.
  - > Pamphlet kiosk outside with translations in multiple languages.
  - > Nature-themed mosaic walkway with images of plants, animals, and landscapes.
  - > Water fountain and bathrooms.
  - > Medium-sized parking lot with ample room for school bus parking.
  - > Designated lunch area, which is cleaned every morning and every evening.
  - > Full staff on duty from 9:00 a.m. - 5:00 p.m. for daytime tours. Half staff on duty from 6:00 p.m. - 11:00 p.m. for nighttime tours.
  - > Bright, unshielded external lights for student safety when walking during nighttime tours. Lights are blue-white, and stay illuminated all night.
  - > Indoor lights are left on at all times, with blinds left open to display student art on the walls.
  - > Bug zappers and fly traps are not used on the premises.



Student Investigation

Identify the Problems

Question 1: Identify the problem that you believe is causing the decline of nocturnal species in Grand Canyon National Park. Explain your answer, with clear evidence for how changing the ecosystem by building the education center has affected the animal populations.

Establish Contraints

Question 2: What are the needs of the nocturnal species in the park?

Question 3: What are the needs of the school group students who tour near the education center at night?

Question 4: What are the needs of both the nocturnal species and the school group students that cannot be compromised?

Question 5: What are the needs of both the nocturnal species and the school group students that can be compromised, or met in a creative new way?

Formulate Solutions

Question 6: Formulate 2-3 solutions for the problem you have identified. Explain how each solution balances the needs of both the park's nocturnal animals, and its visiting school groups.

Soultion 1:

Explanation of Balanced Needs:

Soultion 2:

Explanation of Balanced Needs:

Soultion 3: _____

Explanation of Balanced Needs: _____

Build a Model

You will now be building a model to test your solutions! Your group will be offered one flashlight and a variety of materials to approach solving the problem of population decline in the park's nocturnal animal populations, while also balancing the needs of the student groups visiting the education center.

Before you begin building, review the following instructions and parameters closely:

- **Goal**

To build a model for a new nighttime lighting system that will better balance the needs of both the nocturnal animal populations at Grand Canyon National Park, and the visiting school groups. The new lighting system must be dimmer than the original basic flashlight, but still bright enough to make walking safe for visiting humans.

- **Considerations**

A scientific variable is a characteristic, factor, or condition that can be changed or controlled in an experiment. While developing your model, test multiple variables to determine which changes are most and least effective. For example, your group may test the following variables:

> Color
> Direction
> Level of focus
> If flashlights have different settings, any setting may be used for this experiment.

In the final testing phase, the following variables will also be considered as part of the design:

> Position of flashlight being held
> Height at which flashlight is being held

Question 7: Describe all modifications made to your lighting system model, and explain the reason behind your choice for each modification.

Example:

Modification: Adding two layers of wax paper over the flashlight lens.

Explanation: The wax paper has softened and diffused some of the light's harshness.

Modification: _____

Explanation: _____

Modification: _____

Explanation: _____

_____

Modification: _____

Explanation: _____

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Modification: _____

Explanation: _____

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Modification: _____

Explanation: _____

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Modification: _____

Explanation: _____

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Modification: _____

Explanation: _____

_____

Modification: _____

Explanation: _____

_____

Modification: _____

Explanation: _____

_____

Question 8: Describe the position that you plan to hold your light, and explain the reason behind your choice.

Example:
Position Description: Straight ahead, at eye-level.

Position Description: _____

Explanation: _____

_____

Question 9: Describe the height at which you plan to hold your light, and explain the reason behind your choice.

Example:
Height Description: Approximately 6-feet off the ground

Height Description: _____

Explanation: _____

_____

Analyze the Results

Question 10: Did the modifications to your lighting system work in the way you expected? Explain.

_____

_____

_____

_____

_____

Question 11: Which design aspects of your model worked well? Explain.

_____

_____

_____

_____

_____

Question 12: Which design aspects of your model could use improvement? Explain.

Solving the Problem

Question 13: What is the best possible design that you would recommend for a new lighting system at the education center? Explain.

Group Reflection

Question 14: Think creatively! What are some other ways that a lighting system could be modified to reduce light pollution for nocturnal animal species in Grand Canyon National Park? Explain.

Question 15: "What are the benefits of supporting Grand Canyon National Park's nocturnal animal species? Explain your answer in terms of the importance of biodiversity."

Question 16: "What are the benefits of supporting Grand Canyon National Park's visiting school groups? Explain your answer in terms of interactions between people and the natural environment."

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Protecting the night sky has many benefits!

> Adequate night lighting provides for human safety, health, and home security.

> Dark nights (and bright days) are key in keeping our circadian rhythm in sync.

> Enhances neighborhood aesthetics.

> Light pollution can affect wildlife interactions and other vital ecological processes including predator/prey relationships, reproduction, habitat selection, navigation and migration. Nearly half the species on Earth are nocturnal, including migratory birds.

> Preserving starry night skies can provide opportunities for local economic growth through astro-tourism.

Stay up late and discover the night on any visit to a national park!

https://www.nps.gov/articles/000/dark-sky-parks-tour.htm

https://www.nps.gov/subjects/nightskies/athome.htm



Review & Discussion

How can making a small change to an ecosystem, such as adding new lighting to a building, have huge effects on the dynamics of the community?

What is biodiversity, and why is it important?

What is a scientific variable? What were some of the variables that your group tested while building your lighting system model?

What were some of the constraints, or limitations, that you had to consider while building your model? Answer in terms of the ways that your designs might affect both the natural world (nocturnal animals) and people (visiting school groups)

Human activity can be harmful to the environment. Give two examples of how humans can also find ways to live in harmony with other life on earth.

What is one thing you saw in the *America the Beautiful: Our Natural Wonders* film that surprised or amazed you?