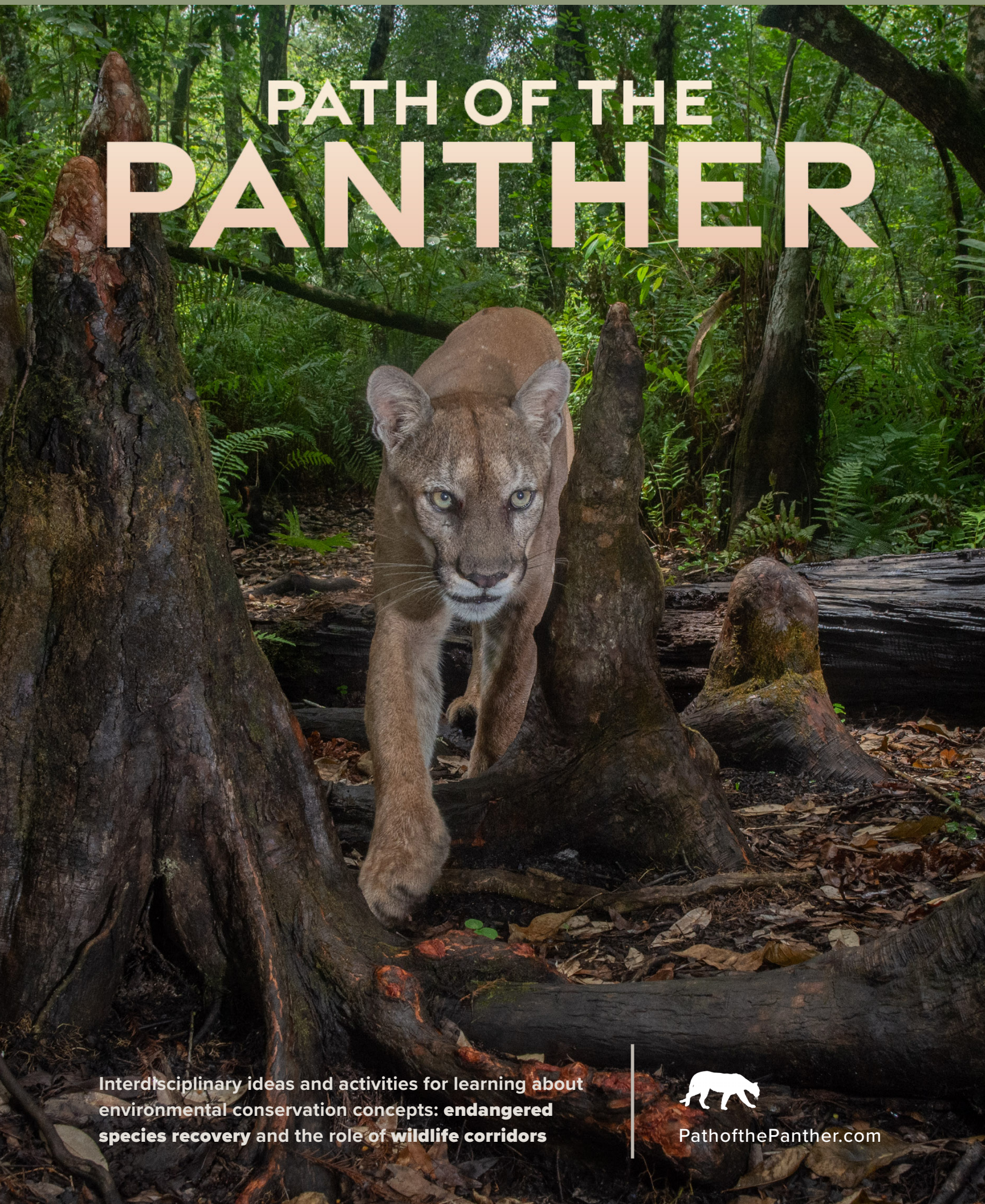
GUIDE FOR MIDDLE SCHOOL EDUCATORS

PATH OF THE PANTHER



Interdisciplinary ideas and activities for learning about environmental conservation concepts: **endangered species recovery** and the role of **wildlife corridors**

PathofthePanther.com

CONTENTS

WELCOME

Thank you for your interest in providing students with learning opportunities connected to *Path of the Panther*, a project that offers unique insight into the lives and struggles of the endangered Florida panther. Through breathtaking visuals and informative narration, the project highlights the importance of conservation and the urgent need to protect the natural habitats of these majestic animals.

This middle school guide has been designed to address essential topics in life science and other subjects through a focus on the **Florida panther**, **wildlife corridors**, and the vast **biodiversity** that connects us to wild places—wherever we are.

Through a series of activities **aligned to national and Florida science standards**, students learn about the benefits and challenges of balancing human needs with the needs of wildlife. They will also understand the value of resilient ecosystems, not just for species such as the Florida panther but for humans as well. The activities are enriched with connections across subjects including social studies, geography, English language arts, math/data literacy, technology, engineering, and art.

Adaptable for both formal and informal settings, educators can **use these activities as a unit or as individual, stand-alone activities**. To provide depth, most of the activities are designed to take 100 minutes, or two class periods, but they can be adapted for your students' learning needs. All together, these activities feature a broad mix of media, including film clips, maps, and photography; interactive resources such as National Geographic's MapMaker tool and ArcGIS StoryMaps; and meaningful citizen science opportunities. Learning about the Florida Wildlife Corridor is a springboard to learning about corridors worldwide, as well as other global conservation efforts.

ESSENTIAL QUESTIONS

- **What is biodiversity?**
- **What is a wildlife corridor?**
- **What is wildlife connectivity?**
- **Why does conservation matter?**
- **Why should I care?**
- **What can I do to help?**

LEARNING ABOUT WILDLIFE CORRIDORS

Why does biodiversity matter? **The Florida panther is a global icon for wildlife and wild places—and also for human connections and interactions with natural environments everywhere. Reaching near extinction in the 1950s, the Florida panther was among the first to be added to the U.S. Endangered Species list in 1973. The population has rebounded from about 30 adults then to nearly 200 today.**

The **Florida Wildlife Corridor** not only provides a natural habitat for countless endangered species including the Florida panther, but also plays a crucial role in maintaining the delicate balance of our planet's ecosystem. By learning about this unique region, students will gain a deeper understanding of the importance of conservation efforts and the impact that humans can have on our environment. Exploring the Florida Wildlife Corridor will help students develop a sense of responsibility toward preserving our natural resources for future generations.

Why should we care? Protecting this umbrella species, with the largest terrestrial home range in the state, also protects dozens of other species in the Florida panther's domain. But this species and other wildlife face a multitude of new challenges, including habitat fragmentation and vehicle collisions, as humans encroach on wild Florida with new housing and roads. Protecting this land also contributes to the health of Florida's water in rivers and streams and underground in aquifers, as well as to the flow of critical waters of the Everglades. The interacting systems of the geosphere, biosphere, hydrosphere, and atmosphere in and around the Florida Wildlife Corridor are a microcosm of our planet's vital balance.

What can we do? These key areas of action hold a world of possibilities for all of us. To help, we can:

- educate ourselves about the science and interdisciplinary nature of biodiversity, wild places, and resilient ecosystems for humans and wildlife;
- foster and connect with wild, biodiverse places and the people and organizations supporting them—wherever we are; and
- take action by observing, analyzing, expressing, and communicating through words and visuals what needs to happen. Visit wildpath.com and follow @PathofthePanther on social media to see how you can help protect our wildlife and lands.

Finally, share this resource widely with educators everywhere! Spreading the word about these invaluable resources can enrich the educational experiences of learners and educators of all ages and backgrounds.

MORE PATH OF THE PANTHER RESOURCES

Watch the film ***Path of the Panther*** on **Disney+** and **Hulu**.

Find more resources at pathofthepanther.com/learn, including a film discussion guide for grades 5-12+, an elementary grades guide, and an activity guide for high school to adult audiences.

THANK YOU for making *Path of the Panther* part of your students' learning. We'd like to learn about what resonated with them. We invite you to post on social media **@PathofthePanther**.

1 JOURNEY OF THE ENDANGERED FLORIDA PANTHER

ESTIMATED TOTAL TIME
50 minutes

- **Grades 5–8 Life Science**
- **Math and Data Literacy Connections**

In this activity, students analyze ***Path of the Panther*** film clips and population data to learn the story of this endangered species. Students will recognize the challenges of tracking and protecting this elusive big cat, as they build understanding of the limiting factors and human threats the Florida panther faces from hunting, habitat destruction, vehicle collisions, and disease. To demonstrate their learning, students create posters with proposals for addressing threats and limiting factors as a way to protect the panther and its habitat.

KEY TERMS

- **endangered species**
- **limiting factor**
- **population**
- **wildlife tracking**

See the glossary on page 44 for definitions.

BACKGROUND

The film *Path of the Panther* provides a window into the ecosystems that support wildlife, the human impacts affecting wildlife **populations**, and the actions of people who are committed to conservation within the Florida Wildlife Corridor. The Florida panther once moved throughout the southeast United States, but it is now found only in the southern region of Florida. The Florida Wildlife Corridor, designed to facilitate movement of wildlife, allows species to roam freely across diverse ecosystems. This network of connected public and private lands provides a natural habitat for countless **endangered species**, including the Florida panther.

Endangered species are organisms threatened by extinction, either due to habitat loss or loss of genetic diversity. Habitat loss can happen naturally or as a result of human-caused threats such as vehicles on roads, land development, industry, or agriculture.

Unlike human-caused threats, a **limiting factor** is a factor in nature that constrains a population's size. Examples of limiting factors include scarce food sources, few mates, and competition for resources. Often, a population is affected by several limiting factors at once. Over time, limiting factors can cause population growth to slow and then stop as a population reaches the carrying capacity of the ecosystem. In addition to habitat loss, vehicle collisions, and hunting, the Florida panther population has been influenced by limiting factors including disease and a decrease in genetic diversity.

JOURNEY OF THE ENDANGERED FLORIDA PANTHER

OBJECTIVES

Students will:

- identify threats and limiting factors affecting the population;
- analyze a graph of population change over time; and
- propose strategies for protecting the Florida panther from extinction.

PREPARATION

Gather and/or print materials:

- Handout: Journey of the Endangered Florida Panther (1 per pair or small group)
- Slide: Florida Panther Population Over Time
- Film Clips: *Path of the Panther*
- Large poster paper
- Markers
- Sticky notes (optional)
- Reference: Endangered Species, Limiting Factors

Set up technology:

Ideally, students will view the film clips (projected) as a whole class, but viewing in pairs or small groups could give students an opportunity for more discussion.

5 MIN INTRODUCE THE ACTIVITY

1. Build interest and access prior knowledge with a short discussion. Ask: *How do you think the population of large wild animals, such as black bears or mountain lions, has changed since 1900?* Generate ideas around changes in habitat for these animals and how they and humans interact. Then ask: *What might have led to those changes?* Explain that while black bears live all over North America, big cats are much less common.
2. Show the slide Florida Panther Population Over Time and discuss the questions provided.
3. Tell students they will examine in clips from a documentary what threats and limiting factors have caused the population of one of North America's big cats, the Florida panther, to decrease so much that it's been listed as an endangered species. Explain to students that limiting factors are factors that affect a population rather than an individual. They will create a proposal to address those factors to better protect the panther.

30 MIN VIEW CLIPS FROM THE FILM

4. Give pairs or small groups the Journey of the Endangered Florida Panther handout to prompt note-taking as they view the film clips—either as a whole class or in small groups. There will likely be moments when there is a need to rewind to clarify what they are learning from the clips.
5. Pause after each clip and discuss as a class the key points, using the following prompt:
   - *What factors have limited the panther population, past and present?*

   Have students circle or highlight notes referring to threats or limiting factors.

15 MIN DEVELOP A PROPOSAL TO PROTECT THE FLORIDA PANTHER

6. Propose to students this key question: *What do panthers need to continue increasing their population?* Have students follow the directions in the wrap-up assignment on the handout to develop their ideas.
7. Have students use large poster paper and markers to create a poster with their proposal ideas. Each group can post their proposal on the walls and present it to the class, or groups can move around the room as a "gallery walk" seeing each group's ideas. Optionally, have students add more ideas to posters using sticky notes.

STANDARDS

This activity addresses the following:

NGSS: MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Florida NGSS: SC.7.L.17.3: Describe and investigate various limiting factors in the local ecosystem and their impact on native populations including food, shelter, water, space, disease, parasitism, predation, and nesting sites.

MORE TO EXPLORE

ENDANGERED SPECIES RESEARCH

Have students find out more about endangered species in their area (by county with this tool) and research the threats to those species. Students can investigate whether wildlife corridors or other conservation strategies have been put in place to address the needs of the endangered species.

NAME: _____ DATE: _____

JOURNEY OF THE ENDANGERED FLORIDA PANTHER

View clips from *Path of the Panther* to gather evidence about impacts on this endangered species and discover how people have been working to help this species survive. Then use this information to propose strategies for protection.

CLIP 1: **A Florida Highway**

1. **What two different settings are presented in this clip? Describe what you see and hear in each.**

2. **What is the primary cause of panther deaths in Florida?**

3. **Where in Florida do these panthers live?**

CLIP 2: **Threats to the Panther**

4. **How does wildlife photographer Carlton Ward Jr. describe the panther?**

5. **What is meant by this quote: "...there are so few panthers that extinction could be just around the corner"?**

6. **According to the film, what are three ways the Florida panther has been negatively impacted, causing a decrease in the population?**

CLIP 3: **Hope for Movement North**

7. **What do Brian Kelly and Carlton Ward Jr. do to try to find panthers?**

8. **Why are they eager to see a female panther in the northern Everglades?**

CLIP 4: **Attempting to Track the Panther**

9. Why is it so difficult to track the Florida panther?

10. How many panthers are believed to be in the northern Everglades, north of the Caloosahatchee River?

CLIP 5: **Panther Danger and Recovery**

11. Why is Carlton Ward Jr. so happy, and then heartbroken, by what he sees?

12. What are two more threats to the panther population?

13. "What the panther needs, what the whole ecosystem needs, is that lifeline to the north." What do you think a "lifeline to the north" could be?

WRAP-UP ASSIGNMENT: **What are the Solutions?**

Consider the threats to the endangered Florida panther (see your answers to questions 2, 6, and 12). What solutions are needed to reduce those threats? Create a proposal to protect the Florida panther from extinction. Present a poster that includes:

- The three solutions
- How each solution will help to reduce a threat
- Details about how to make the solution happen

2 EXPLORING BIODIVERSITY OUTDOORS AND ONLINE

ESTIMATED TOTAL TIME
100 minutes

- **Grades 6–8 Life Science**
- **Technology, Math, and Data Literacy Connections**

In this activity, students develop a sense of the biodiversity in their community through their own outdoor observations and through citizen science observations on iNaturalist.org. After students make observations outdoors, they organize biodiversity data in a pie chart. Then they compare their findings with iNaturalist data in their local ecosystem. Finally, students compare local biodiversity with that of a nearby protected area to explore connections between protected land and biodiversity. Optional learning extensions are provided to further engage students in exploring biodiversity data for the Florida Wildlife Corridor and/or in building food webs using species from the activity.

KEY TERMS

- **biodiversity**
- **citizen science**
- **consumer**
- **decomposer**
- **ecosystem**
- **naturalist**
- **producer**

See the glossary on page 44 for definitions.

BACKGROUND

Biodiversity refers to the variety of life on Earth, encompassing all living organisms. Organisms are often grouped as **producers**, **consumers**, and **decomposers**, and these organisms are interconnected as part of healthy, balanced **ecosystems**.

Land conservation efforts, such as the Florida Wildlife Corridor, help protect biodiversity by providing conditions that species need to survive. Biodiversity data, such as the number and type of species found in a particular place, can help scientists, conservationists, and policymakers determine and monitor areas needing protection.

Several methods are used to measure and record biodiversity. Also called community science or crowd-sourced science, **citizen science** initiatives including iNaturalist, Seek, and eBird engage the public in recording observations of various species. These platforms allow individuals to contribute their sightings and observations, increasing the volume of available data. This information can help researchers better understand the status of different species and ecosystems, track changes over time, and design conservation initiatives—while also engaging the public in observing wild places and species.

EXPLORING BIODIVERSITY OUTDOORS AND ONLINE

OBJECTIVES

Students will:

- define the term biodiversity and its relationship to producers, consumers, and decomposers;
- create a pie graph of biodiversity data;
- compare biodiversity observed near them and in a park or preserve; and
- analyze the impact of protected lands on biodiversity.

PREPARATION

Gather and/or print materials:

- Clipboards or similar, for writing outdoors
- Handout: Adopt a Spot (1 per student)
- Graphing supplies: calculators, colored pencils/markers, rulers
- Website: iNaturalist.org
- Handout: Exploring Local Biodiversity with iNaturalist (1 per student or small group)
- Videos: iNaturalist Video Tutorial (~5 minutes)

Set up technology:

To access iNaturalist.org in Part 2, students can work independently or in small groups, or you can project and view the website as a class.

Additional preparation:

- Identify a green space on your grounds where students will be able to sit and observe, such as a playground with trees or plants, a community garden, a field, or even through a window with a view of green space.
- Review vocabulary. Before this activity, make sure that students are able to define and identify producers, consumers, and decomposers.
  - **Producers:** Organisms that make their own food by absorbing sunlight through a process called photosynthesis. All green plants are producers.
  - **Consumers:** Organisms that eat other organisms, such as cows, rabbits, and grasshoppers.
  - **Decomposers:** Organisms that break down the remains of dead organisms. Although consumers and decomposers are similar, decomposers do not "eat" other organisms. Instead, they break down dead remains and waste to get energy. Examples include mushrooms and earthworms.
- Familiarize yourself with iNaturalist.org using the instructions from the handout to explore observation data. The website is user-friendly, but trying it prior to class will enable you to better help students explore the site and to anticipate their questions.
- Identify one or more nearby parks or nature preserves that students could use in Part 2 to compare with biodiversity observations from Part 1.

PART 1: 50 MIN

10 MIN INTRODUCE KEY TERMS

1. Ask students for examples of **producers**, **consumers**, and **decomposers** that they have observed in their local area, listing them on the board. Then ask: *Which type of organisms do you think are most important for a healthy ecosystem—producers, consumers, or decomposers?* Invite volunteers to state their answer and reasoning, while other students show they agree or disagree with a "thumbs up" or "thumbs down." Call on a student who disagrees to share their reasoning. Repeat several times to determine students' level of understanding of producers, consumers, and decomposers and their roles within an ecosystem, correcting any misconceptions.

STANDARDS

This activity addresses the following:

NGSS: MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Florida NGSS: SC.7.L.17.1: Explain and illustrate the roles of and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.

Florida NGSS: SC.68.CS-CS.2.4: Organize and display information in a variety of ways, such as number formats (e.g., scientific notation, percentages, and exponents), charts, tables and graphs.

2. Check students' understanding of biodiversity by inviting volunteers to share definitions. Point out that ecosystems need a variety of all three types of organisms (producers, consumers, decomposers) to remain healthy. This variety of organisms in an ecosystem represents its **biodiversity**—essential for the processes that support all life on Earth, including humans. Without a wide range of animals, plants, and microorganisms, the **ecosystems** that provide humans with oxygen and food are weakened. Tell students that they will explore the biodiversity in their community in a variety of ways.

30 MIN OBSERVE BIODIVERSITY OUTSIDE

3. Distribute a copy of the Adopt a Spot handout to each student and make sure they have clipboards or similar for leaning. Review the goal of the activity, the chart, and the directions for Step 1.
4. Explain that the class will soon go outside to make observations and record the organisms they see in the table on the handout. For each organism observed, students will do their best to identify the type and record in the appropriate column on the data table. If students are not able to name the organism, have them describe it (e.g. white flower, red beetle).
5. Take students to the "green space." Give students guidance on the spot where they will be to make their observations, staying within one to three paces of the spot, and looking up, down, and all around. Allow students 10 minutes to record their findings.

10 MIN GRAPH THE DATA

6. After they complete the observation portion (Step 1 on the Adopt a Spot handout), provide students with graphing supplies. Have them add up the total number of organisms in each column and then the total number of producers + consumers + decomposers, placing the totals at the bottom of the data table.
7. Have students create a pie chart to represent the biodiversity of the area. Model how to calculate percentages (Step 2 on the Adopt a Spot handout) and how to create the pie chart (Step 3 on the handout), following the instructions in the handout for color-coding.
8. Allow students time to calculate their percentages and complete their pie charts. Rotate around the room, providing support as needed. Then, have students answer the reflection questions on the handout to help them to consider how producers, consumers, and decomposers are interconnected. You can discuss as a whole class to check for understanding.

MORE TO EXPLORE

EXPLORE BIODIVERSITY DATA FOR THE FLORIDA WILDLIFE CORRIDOR

Use iNaturalist.org to explore the biodiversity of the Florida Wildlife Corridor. First, use the following prompt to have students make predictions:

- *How many species do you think citizen scientists have identified in the Florida Wildlife Corridor?*

Write student predictions on the board. To find the answer, under "Community," select "Projects" and then search for "Florida Wildlife Corridor," or see the link above. Ask: *Is the number of species surprising? Why or why not?* Allow students to view the variety of species. Students could choose 5 to 10 that they would like to observe, and then write a news article or adventure story of their discovery of these species while exploring the Florida Wildlife Corridor.

PART 2: 50 MIN

10 MIN INTRODUCE INATURALIST.ORG

1. Remind students that in the Adopt a Spot activity, they recorded their own observations about the biodiversity near them. Ask: *What are some other ways scientists might collect information about the biodiversity of an ecosystem?* Invite volunteers to share their ideas.
2. Explain that another method for monitoring biodiversity involves **citizen science**, in which volunteers contribute to scientific research through data collection, analysis, or other collaboration. For the next task, students will explore the observations of organisms that citizen scientists have contributed to a website, iNaturalist.org. Ask: *What does it mean to be a **naturalist**? Who can be one?* Explain that scientists studying different species and biodiversity can make use of data contributed by citizen scientists to platforms such iNaturalist. With help from millions of wildlife photographers and others uploading photos through the iNaturalist app and website, scientists and others can access data and look for patterns and interconnections.

40 MIN COMPARE STUDENT DATA AND INATURALIST OBSERVATIONS FROM THE SAME AREA

3. Give students copies of the Exploring Local Biodiversity with iNaturalist handout and discuss the introduction and the goal of the activity. Introduce iNaturalist.org by doing Steps 1 and 2 together as a class. Help students to find the numbers of observations and species and discuss the difference(s) between them. Give students an opportunity to answer the questions for Step 3, pausing to discuss as a class.
4. Allow students to complete Steps 4 through 7 independently or in small groups. While students are working, monitor each group and pause for whole-class help as needed. Discuss students' ideas for the question in Step 7.
5. Wrap up with a whole-class reflection. Ask: *What is the importance of biodiversity? Why do you think scientists might find iNaturalist useful for research?* (Crowd-sourced observations from people all over the world allow for large datasets that might otherwise be difficult or time-consuming for scientists to gather without the help.) Collect handouts and reflection questions to determine the mastery level of the content.

MORE TO EXPLORE

BUILD FOOD WEBS
First, review food web concepts with a short video (~6 mins). Provide a selection of photos or illustrations of Florida Wildlife Corridor producers, consumers, and decomposers that students can work with online or in printed form. Have students research the organisms and add captions on index cards to the images. On a large board, ask students to arrange the images to show energy flows among these organisms using string, or by drawing arrows. Discuss the importance of each species in the food web to ensure a balance of the ecosystems within and beyond the Florida Wildlife Corridor.

NAME: _____ DATE: _____

ADOPT A SPOT

Goal: Create a pie chart showing the number of producers, consumers, and decomposers you observe.

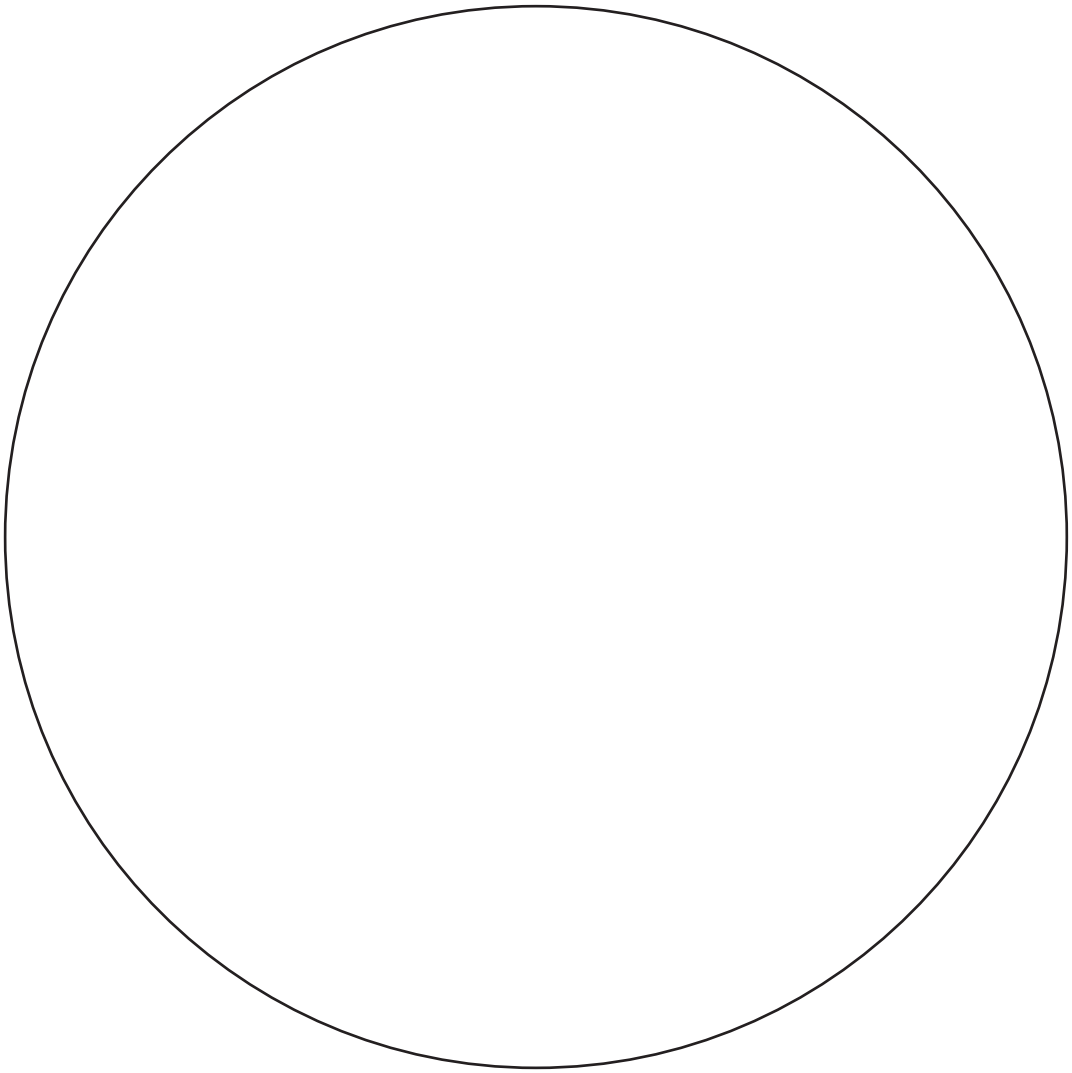
1. **Closely observe the biodiversity in and around your assigned spot. For each different species of organism that you observe, add the name (or a description of the organism) to the column for producers, consumers, or decomposers.**

	producers	consumers	decomposers
Tips: ○ **Record every organism—the plants, animals, fungi—that you observe. If you're not sure of its name, describe it.** ○ **If there are more than one of the same species, record only one time.** ○ **Calculate the total number of different organisms in each column.**			
Number of species for each:			
Total number of species:			

2. Calculate the percentages for each column from the chart in Step 1.

	% of producers = (# of producers/total) x100	% of consumers = (# of consumers/total) x100	% of decomposers = (# of decomposers/total) x100
Percentages			

3. Using the percentages above, create a pie chart to represent the area's biodiversity.
   - Use **green** to represent producers, **red** to represent consumers, and **brown** to represent decomposers.
   - Add labels, percentages, and a title to your pie chart.



4. Which group of organisms did you find the most?

5. Why do you think this group of organisms was the most common?

6. What might happen to the area you observed if...
   - ○ the number of producers increased?

   - ○ the number of consumers decreased?

   - ○ the number of decomposers decreased?

NAME: _____ DATE: _____

EXPLORING LOCAL BIODIVERSITY WITH iNATURALIST

iNaturalist is a free tool that allows people to document and identify the wild animals, plants, fungi, and other organisms they observe worldwide. People contribute data such as photographs, sounds, notes, and identifications that anyone can explore through iNaturalist.org.

Goal: Explore the biodiversity of your local ecosystem through observations made by iNaturalist citizen scientists. Compare these observations to your own.

To explore wildlife observations near you, follow these steps:

1. **Go to iNaturalist.org and choose the "Explore" tab at top left.**

   How many observations have been made worldwide to date? _____

   How many species have people observed globally to date? _____

2. **Type the name of your city or town in the "Location" box and select "Go."**

   Community, city, or town: _____

   How many species have people observed there? _____

   How many observers have contributed to these observations? _____

3. **Select the "Species" tab. Scroll to see photos of the species found in your area. Complete the table below.**

How does this information compare with your own biodiversity observations?	Write one thing that surprised you and one question you have.

4. Go back to the "Observations" tab and select "Places of Interest" and type the name of a wildlife preserve or state park. Parks and preserves are often protected lands, with special attention to healthy ecosystems.

   Name of location: _____

   How many **species** have people observed there? _____

5. Select the "Species" tab. Scroll to see photos of different species found in this place. Complete the table below.

How does the biodiversity in this park or preserve compare with your city or town in Question 2?	Write one thing that surprised you and one question you have.

6. How did the local iNaturalist data compare with your own observations? If they are different, why do you think that is?

7. Thinking about your findings in Steps 4 and 5, do you think protection of land leads to greater biodiversity? Why or why not?

3 ARE WE THERE YET? WILDLIFE CORRIDOR DECISIONS

ESTIMATED TOTAL TIME
75 minutes

- **Grades 6–8 Life Science**
- **Social Studies/Geography Connections**

In this activity, students evaluate local and Florida state maps to predict challenges for the movement of wildlife. Students explore moving across space in a car, on a bike, or by foot using Google Maps. Students read about challenges of protecting the Florida panther and look for evidence of why protection of land will help panthers and other species. They then analyze land cover data using the National Geographic MapMaker tool to determine the need for wildlife corridors. Students outside of Florida can use what they learned about Florida and apply it to their location or other countries, as wildlife habitat fragmentation is a global issue and wildlife corridor efforts are a key strategy used to balance the needs of humans and ecosystems.

KEY TERMS

- **endangered species**
- **fragmented landscapes**
- **geographic information systems (GIS)**
- **population**
- **wildlife corridor**

See the glossary on page 44 for definitions.

BACKGROUND

Wildlife corridors play a vital role in preserving biodiversity and maintaining the health of ecosystems. These pathways of interconnected natural habitats enable wildlife to move, migrate, and disperse across fragmented landscapes—the splitting of large landscapes into smaller areas due to urban development. Wildlife corridors alleviate **limiting factors** by promoting movement, gene flow (the movement of genes into and out of a population), and access to essential resources—ultimately enhancing the resilience and long-term survival of wildlife **populations**.

By facilitating gene flow and species movement, corridors promote genetic diversity and reduce the risk of inbreeding, enhancing species' adaptability to environmental changes. Also supporting the survival of endangered and keystone species—species critical to the ecosystem's health—wildlife corridors provide access to vital resources including food, water, and shelter. Wildlife corridors mitigate the adverse effects of **fragmented landscapes** caused by human activities, fostering ecological resilience and promoting the coexistence of humans and wildlife.

In Florida, new housing developments for the state's growing population are built where wildlife habitat once existed. This results in islands of habitat, with wildlife populations separated by roads and suburbs. For the **endangered** Florida

panther, which needs to move across vast wild spaces, motor vehicle collisions have become the leading cause of death, with nearly 30 individuals killed every year.

The survival of the Florida panther and other wildlife depends on the protection of a network of statewide public and private lands, known as the Florida Wildlife Corridor. In June of 2021, the Florida Wildlife Corridor Act was signed into law with unanimous bipartisan support. The legislation formally defined the Florida Wildlife Corridor and has since inspired more than $2 billion in public investment to help protect the state's vast network of public and private lands supporting both wildlife and people. Investing in rural land conservation will keep the habitats connected, steer new development toward existing urban cores, and secure a future for the Florida panther and other vulnerable species.

OBJECTIVES

Students will:

- use online maps to consider the value of wildlife corridors based on land use where they live;
- explore and analyze a land cover dataset, using geographic information systems (GIS), to determine where wildlife corridors are needed in Florida;
- compare recommendations with actual Florida Wildlife Corridor maps; and
- apply this process in interpreting land cover data and determining wildlife corridor needs for other states or countries (optional).

PREPARATION

Gather and/or print materials:

- Digital Mapping Tool: Google Maps
- Videos: *Path of the Panther* (2:21) or Saving the Florida Wildlife Corridor (10:06)
- Article: The history of the Florida panther, a symbol of reverence and revulsion
- Handout: Corridor Mapping Challenge (1 per small group)
- Online Tool: National Geographic MapMaker
- Map (optional): Florida Corridor Map from this collection, for context

Set up technology:

- Choose a city or location where your students can "travel" via Google Maps in Step 1. The city or location should be far enough away from your city or town so that students would encounter multiple obstacles—such as roads or waterways—if they were to walk there.
- Practice using the MapMaker tool following the instructions on the Are We There Yet? Wildlife Corridor Decisions student handout. If students won't have access to computers, you can project Google Maps and National Geographic MapMaker and work through it as a class. Students will gain more experience, however, evaluating the land cover dataset on a computer in small groups.

20 MIN CONSIDER THE CHALLENGES OF MOVING ACROSS LAND

1. Share this scenario: "Your family is taking a trip from X (city/town where you live) to Y (city selected). Use Google Maps to determine the best driving route to the destination. If multiple routes are suggested by Google Maps, choose one."
2. Have students compare different routes for traveling by car, by bike, and on foot (Tip: Students can take a screenshot of each route map for ease in comparison.):
   - Ask students to share their "driving" route with a partner and explain why they chose that route.
   - Next, ask students to change their route setting to "cycle" and see how it changes.
   - Then ask students to change their route setting to "walk" and see how it changes.

STANDARDS

This activity addresses the following:

NGSS: MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Florida NGSS: SC.6.E.7.6: Identify ways humans protect the environment and/or prevent or reduce harmful effects of human activity on the environment.

Florida Social Studies Standard 1: Understand how to use maps and other geographic representations, tools, and technology to report information.

Florida Social Studies Standard 3: Understand the relationships between the Earth's ecosystems and the populations that dwell within them.

Florida Social Studies Standard 5: Understand how human actions can impact the environment.

ARE WE THERE YET? WILDLIFE CORRIDOR DECISIONS

3. Discuss the walking route(s) as a class. Ask, *What challenges/obstacles might you face when walking across this landscape? How might you overcome them?* Students might describe how difficult crossing a highway or other busy road might be. Explain to students that, like humans, large mammals and other wild animals face challenges moving from place to place. List these challenges on the board.
4. Depending on time available, view the *Path of the Panther* film trailer (2:21) or the short film "Saving the Florida Wildlife Corridor" (optional; 10:06). Ask:
   - *What do you think wildlife corridors are, and why might animals need them?* Encourage students to share their ideas. Then share this definition: Wildlife corridors are networks of protected lands that help wildlife move across large landscapes that have been fragmented by human development. A corridor could be large (across the entire state of Florida) or small (a strip of land connecting two parks or preserves).
   - *Why do people in the film think the Florida Wildlife Corridor is important? What challenges or obstacles do endangered Florida panthers and other wildlife encounter moving across areas of Florida?*

15 MIN EXPLORE WILDLIFE CORRIDORS AND THE NEED FOR PROTECTED SPACES

5. Have students read the online article "The History of the Florida Panther, a Symbol of Reverence and Revulsion." (*Note:* You might assign as homework to provide more time for the group work and discussion in class.) Ask students to think about the following questions while they read:
   - *Before the 1900s, panthers were found across North America, and now they are an* ***endangered species****. What caused their space to be reduced to what it is today?* (hunting, vehicle strikes, habitat loss)
   - *What strategies have helped to restore the population size of the panther?* (introducing cougars to breed with panthers; cultural celebration of panthers)
   - *What do panthers need to successfully increase their population? Why?* (more protected green spaces and prevention of vehicle strikes and habitat loss; they need to expand north of South Florida, where there is not enough room for them to expand to a healthy population size)
6. Have students consider other mammals near them. Ask: *Can you think of any local mammals that have a similar story to the Florida panther?* Guide students to understand that typically any predator (e.g., bears, wolves, mountain lions, coyotes) would have a similar story.

MORE TO EXPLORE

COMPARE AREAS IN DIFFERENT STATES AND COUNTRIES

Have students follow the same steps using the land cover data layer with MapMaker, searching other areas of the world to compare locations and recommend where wildlife corridors could be. Students can find out more about local wildlife that is threatened or endangered, including conservation needs and current efforts. Have students research more about wildlife corridors, wildlife crossings, and the species they support across the U.S., starting with this summary from the National Wildlife Federation.

LEARN MORE ABOUT THE FLORIDA PANTHER

Find a slideshow and more about the plight of the Florida panther in this article: "How America's Most Endangered Cat Could Help Save Florida." Explore more maps for proposed corridor lands in Florida here. Students can research FWC legislation, starting with this article.

RESEARCH MARINE CONSERVATION EFFORTS

Have students compare and contrast wildlife corridors on land with protections in marine environments. They can research Marine Protected Areas (MPAs) and other preserves and find a protected areas data layer in National Geographic MapMaker. Students can focus on marine life that depend on MPAs and other protections, such as the North Atlantic right whale, the Florida manatee, and numerous sea turtle species.

ARE WE THERE YET? WILDLIFE CORRIDOR DECISIONS

25 MIN EXPLORE AND ANALYZE FLORIDA'S LAND COVER DATA

7. Explain to students that next they will work in small groups (2 to 4 students) to explore and compare land types, called "land cover" in the data set, in different areas of Florida. They will identify where protection of land as wildlife corridors seems most urgent. To do this they will interpret an actual land cover data set using National Geographic's MapMaker interactive tool, an online geographic information systems (GIS) tool.

8. Give each group the Are We There Yet? Wildlife Corridor Decisions handout. The first page guides them to find the land cover data set and zoom into Florida. You can project MapMaker on a screen to model for them or challenge students to follow the instructions in their groups.

9. Help students locate the map key, and discuss the different land cover types. On the second page students record what they notice, patterns they see, and questions they have as they explore central Florida and the panhandle. You can evaluate their understanding by monitoring their responses, and pause to have a whole class discussion about ideas in their charts if needed, before they move to the decision-making on the third page of the handout. Students might also want to compare Florida south of Lake Okeechobee, if time allows.

10 MIN DISCUSS STUDENT RECOMMENDATIONS AND COMPARE TO THE FWC PLANS

10. Project MapMaker with the land cover dataset and allow each group to present their recommendations for wildlife corridors in Florida. List each recommendation on the board, or, even better, add to a sketch of a Florida map.

11. After students present their ideas, as a class compare their recommendations with the Florida Wildlife Corridor map of protected (conserved) lands and proposed (opportunity) areas from this collection: floridawildlifecorridor.org/maps.

5 MIN REFLECT

12. Have students complete an exit ticket with one or more of the following questions:

- What else could help you to better understand wildlife and wildlife corridors near you?
- How can we take action to support wildlife corridors?
- In what ways does analyzing land cover data impact your view of land where you live? What questions could we try to answer using land cover data analysis?

GROUP MEMBERS: _____ DATE: _____

ARE WE THERE YET? WILDLIFE CORRIDOR DECISIONS

Task: Decide where protection of land is most important by analyzing land cover data using the MapMaker interactive map. Map designers developed this land cover data using computer programs and satellite images taken of Earth from space.

Follow the steps below to explore different areas of Florida to determine where wildlife corridors are most urgently needed.

Check each box as you move through the instructions.

☐ **1. Go to MapMaker.**

☐ **2. In the bottom menu, select** 

and choose this style of map: 

Imagery (labels) shows satellite imagery for the world and includes labels for places, roads, and more.

☐ **3. Select** 

and then search for "land cover." Click the plus sign on the left to add this layer to your map. Close the box to view the map behind it.

☐ **4. Click on the Search icon at top left to open the search box and type "Florida."**

☐ **5. Select** 

to see the map key. Look for where colors are on the map.

Next you will compare the land cover in two areas of the state: the "panhandle" around the capital city, Tallahassee, and central Florida near Orlando.

☐ 6. Analyze the map data as you think about the questions below. Record your ideas in the chart. Zoom in and out to look carefully at the data.

FLORIDA PANHANDLE	CENTRAL FLORIDA
What do you notice?	What do you notice?
Describe any patterns you see:	Describe any patterns you see:
What do you wonder? What questions do you have?	What do you wonder? What questions do you have?

If time allows, look closely at Florida to the south of large Lake Okeechobee. What do you notice, and what do you wonder?

Use your ideas from the chart on the previous page and the questions below to help you make the case for where wildlife corridors are most urgently needed at this time.

1. Where do you think wildlife corridors are most urgently needed? Where in Florida do you see the greatest challenges for wildlife to move?

2. Where in Florida does it seem like there is plenty of room for wildlife to roam? Will your recommended wildlife corridors connect any of these places?

3. In addition to the red (built) areas on the map, what other obstacles might wildlife encounter to make their movement difficult or dangerous?

4. Will protecting this land help humans? Why or why not?

5. What challenges might there be when trying to protect this land (e.g., it's privately owned, there is already something built there)?

6. Does exploring and analyzing land cover using the MapMaker interactive map give you a different view of land observed from the ground? Explain.

4 ANALYZING A BLACK BEAR'S MOVEMENT

ESTIMATED TOTAL TIME
100 minutes

- **Grades 6–8 Life Science**
- **Geography and Technology Connections**

Through a story, maps, and biologist Joseph Guthrie's explanations in short videos, students track the path of a black bear known as "M34." Students develop an argument explaining the factors affecting M34's movement through different environments and provide supporting evidence for their claim. Students then present, defend, and evaluate one another's arguments. Throughout the activity, students gain insights into technologies and techniques that researchers like Guthrie use to track bears and other wildlife.

KEY TERMS

- **deforestation**
- **ecosystem**
- **limiting factor**
- **migration**
- **urbanization**

See the glossary on page 44 for definitions.

BACKGROUND

The story of black bear M34 became an inspiration for land and habitat conservation in Florida. This bear's story also reveals how biologists answer questions of black bear movement and the factors affecting that movement. **Limiting factors** in ecology are elements that restrain the growth, distribution, or abundance of an organism's population within an **ecosystem**. The availability of food, water, and space can all impact wildlife populations, as can disease, predation, or parasitism. With the story of the tracking of M34, biologists were able to illustrate how human actions including deforestation and urbanization impacted one black bear over several months in Florida. The study of M34 provided insights into wildlife behavior and the need for land conservation.

When shelter, food, or water is scarce, black bears may need to roam far and wide to find these resources. Land development, however, has changed and fragmented the space in which these and other animals can safely roam. **Wildlife corridors**, such as the Florida Wildlife Corridor, can help animals more safely move across large landscapes to access the resources they need. Wildlife corridors directly address and mitigate many of the factors impacting black bear movement. By providing continuous pathways between fragmented habitats, these corridors offer black bears the opportunity to access food, space, mates, suitable habitats, and safe migration routes, supporting their movement and, ultimately, overall population health.

ANALYZING A BLACK BEAR'S MOVEMENT

OBJECTIVES

Students will:

- analyze the movement over time and space of a black bear; and
- develop, find evidence for, and justify a claim about the factors influencing the bear's movement.

PREPARATION

Gather and/or print materials:

- Video: Exploring with GIS: Tracking Black Bears (7:54)
- Handout: A Black Bear's Movement: Develop an Argument (1 per small group)
- Online Resource: Bear Necessities StoryMap, or Handout: Story Line for Path of a Black Bear
- Handout: Evaluation: Black Bear M34 Arguments (1 per student)
- Large chart paper
- Markers

Set up technology:

- Ideally, students in small groups will be able to access the Bear Necessities StoryMap online. If computer access is limited, students can use the Path of a Black Bear handout, reading independently or in small groups. Preview the StoryMap or the reading to determine whether or not students will need vocabulary support.
- Plan whether students will present Part 2 as a slide presentation or as a poster on large chart paper.

PART 1: 50 MIN

15 MIN INTRODUCE THE TASK

1. Give students a few minutes to talk about what they know about black bears, including whether they have ever seen a black bear in a zoo or in the wild. Have them describe behaviors they observed and anything surprising.
2. Tell students that they will be following the path of a Florida black bear to analyze its movement and the **limiting factors** affecting its movement. Discuss with students how limited resources can impact the movement of an animal, while a limiting factor is anything that constrains a **population's size** and slows or stops it from growing.
3. Students will also learn about techniques biologists use to track wildlife. Introduce Dr. Rae Wynn-Grant—one scientist who has made a career studying black bears—through a video about her work. Preview these questions to answer as they watch:
   - *What is a GPS collar? Why does Dr. Wynn-Grant use GPS collars to study black bears?* (She can track a bear's movement every couple of hours for 1–2 years.)
   - *What has her research revealed about bear movement?* (Some bears range widely, while others stay mostly in one small area.)
   - *What is the main reason Dr. Wynn-Grant believes bears are getting closer to cities rather than staying in areas without people?* (They are looking for food.)

   Show the video "Exploring with GIS: Tracking Black Bears" and discuss students' answers to the questions.

STANDARDS

This activity addresses the following:

NGSS: MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

NGSS: MS-LS2-2: Construct an argument supported by evidence for how the number of organisms an ecosystem can support depends on the availability of resources.

Florida NGSS: SC.7.L.17.3: Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.

Florida NGSS: SC.7.E.6.6: Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.

4. Explain that students will explore the path of a 2.5 year old black bear known as "M34" who was tracked for nine months by different scientists as it moved around central Florida. Help students shift their thinking from the human perspective to the bear's perspective by asking for students' ideas:
   - *What do you think a black bear needs to survive?*
   - *What might have prompted M34 to move around?*
   - *Why might movement from place to place in Florida be a challenge for black bear M34?*

   Explain that these questions are similar to the research questions of the team of biologists, including Joe Guthrie, that tracked M34. (Students will see Joe Guthrie in videos.) Guide students to consider the impacts humans have had on wildlife habitats (through, for example, **deforestation** and **urbanization**) that would impact the movement of a bear. Explain to students that they will follow the path of this one bear scientists tracked with a GPS collar, so they may better understand how human activities have impacted bear populations and the availability of resources that bears need to survive and thrive.

35 MIN EXPLORE THE PATH OF A BLACK BEAR AND DEVELOP A CLAIM

5. Divide the class into small groups and distribute one A Black Bear's Movement: Develop an Argument handout per small group. Review the task and guiding question.
6. Show students how to navigate through the Bear Necessities StoryMap—reading the text, looking at the maps, and taking notes as they go in Step 1 of the handout. Consider having students pause as they reach each video; you may want to watch those together as a class before moving on.
7. Before students begin, point out the first example in the data table in Step 1. Note that the first row has been completed based on the first section of the StoryMap.
8. To help students consider the importance of the notes they take, explain that they will use these notes as evidence in Step 3. Also, preview together Step 2, where students will select one factor impacting M34's movement that they are able to support with evidence. Review these definitions if needed:
   - **Claim:** their answer to the guiding question
   - **Evidence:** data (measurements or observations) they collected; an analysis of the data
   - **Justification:** reasoning that involves a rule or scientific principle that describes why the evidence supports the claim
9. Have students begin navigating the StoryMap and completing Step 1 as they go, pausing to watch each video together as a class. Provide ample time for students to complete Steps 2–4 where they develop their claim, use evidence from Step 3 to support their claim, and justify it. Note that as students consider a scientific concept as part of their justification, you can refer them back to what they have learned about limiting factors. (They may come to this conclusion without prompting.)

MORE TO EXPLORE

BEAR SAFETY

Talk about human encounters with American black bears. Ask: *What should you do if you encounter a black bear?* Invite volunteers to share their ideas and record them on the board. These bear safety guidelines from the National Park Service will help with clarifying or expanding responses. Explain that black bears generally prefer to avoid human contact. Understanding their behavior and these guidelines can help to ensure a safe experience for both humans and bears.

GET CREATIVE

Incorporate creative writing to reinforce and deepen students' understanding of what they've learned about bear range and movement. Give students an opportunity to reflect on M34's travels and then write poetry or a short story, such as "If I Were a Black Bear..."

MAKE CONNECTIONS

Exploring animal migrations is an ideal way for students to discover intersections of geography, ecology, and biology, as well as human interactions, impacts, and interventions. Have students research the movement or migration patterns of a variety of terrestrial and marine animals and compare these with what they learned about the path of M34. Find more ideas from National Geographic here.

PART 2: 50 MIN

10 MIN **CREATE A PRESENTATION**

1. Have small groups create a presentation slide(s) or a poster on chart paper of their argument, including the guiding question, claim, evidence, and justification of evidence.
2. Have small groups practice presenting within their group.

25 MIN **PREPARE AND PRESENT**

3. Give small groups 5 minutes to meet with their group and prepare to present. Distribute copies of the Evaluation: Black Bear M34 Arguments handout to each student. Assign each group a number and have them mark it at the top left of their presentation slide or poster, so that students can include it in their group evaluations.
4. Give each small group about 3 minutes to present, followed by brief time for students to independently complete the Evaluation: Black Bear M34 Arguments handout before the next presentation.

15 MIN **HAVE A WHOLE-CLASS DISCUSSION**

5. Have students return to their small group to discuss their insights from the other presentations. Explain to students that scientific knowledge can change when new evidence is introduced. Ask: *Based on the new information, has anyone changed their opinion? Invite volunteers to explain what caused them to change.* Then ask: *Is it possible that there are multiple answers?* If students say yes, have them give evidence that supports this claim. They should realize that there isn't one answer, as multiple factors have influenced the black bears' movements, and new research over time may also change scientists' understanding.
6. Help students synthesize new learning about limiting factors and human actions. Ask: *How might limiting factors impact a population's movement patterns? What can humans do to reduce the effects of some of these limiting factors?*

NAME: _____ DATE: _____

A BLACK BEAR'S MOVEMENT: DEVELOP AN ARGUMENT

Task: Develop an argument, based on evidence, for the factor most affecting the movements of a black bear tracked by researchers in Florida.

Using the Bear Necessities StoryMap and the steps below, analyze the path of Black Bear M34 to determine which factor most impacted its migration.

Guiding Question: Which of the following had the greatest impact on black bear M34's movement: access to food, water, mates, den sites, space, or shelter?

Step 1: Trace the movement of M34. Record details in this table as you move through the Bear Necessities StoryMap**.** Then use these notes as evidence to support your claim in Step 2.

Tracking/Start Date: _____ **Age at start:** _____ **Weight:** _____

Time	Distance/Location	Observations and possible causes or reasons
First 7 months	Stayed along the edge of Lake Wales Ridge	Moving between two conservation areas and near a creek—would have good habitat and water

Step 2: Write a claim to answer the guiding question. Be sure that you can support your claim with evidence.

Our Claim: _____ had the greatest impact on the distance and places where Bear M34 moved.

Step 3: Select evidence from the chart above to support your claim. You may include visuals such as maps or tracking routes.

The Evidence:

Step 4: Justify your claim by explaining how the evidence supports the claim. Your justification should explain your thinking and link to one or more scientific concepts.

Our Justification:

Step 5: Create a poster or a slide presentation for your argument. Include the **guiding question**, the **claim**, the **evidence**, and the **justification**.

NAME: _____ DATE: _____

EVALUATION: BLACK BEAR M34 ARGUMENTS

Group No.	Claim: Factor affecting M34's movement	Key evidence and justification	My thoughts

5 WILDLIFE CROSSING DESIGN CHALLENGE

ESTIMATED TOTAL TIME
100 minutes

- **Grades 6–8 Life Science**
- **Engineering and Geography Connections**

In this activity, students use the engineering design process to develop wildlife crossings that reduce the limitations animals face in fragmented landscapes. First, students analyze the capabilities of selected animal species and predict challenges in moving across fragmented landscapes. Then students design a wildlife crossing, such as a bridge or pathway, to connect habitat areas. Finally, students present their work, provide feedback to others, and revise their designs.

KEY TERMS

- **biodiversity**
- **constraint**
- **criteria**
- **fragmented landscape**
- **wildlife corridor**
- **wildlife crossing**

See the glossary on page 44 for definitions.

BACKGROUND

Across the world, human development has led to the fragmentation of many wilderness areas. Highways, towns, and cities make it difficult for wild animals to safely travel between habitat areas. Networks of protected lands that provide routes from one area of habitat to another—known as **wildlife corridors**—are one solution to this problem. The Florida Wildlife Corridor is an example of a statewide corridor. It is made up of 18 million acres of land that animals can use to travel across the state.

Within wildlife corridors, there are often human-made structures called **wildlife crossings**. They can include highway overpasses or underpasses, tunnels, viaducts, and canopy bridges. These crossings help animals safely travel across a specific barrier, such as a highway, as they move from one habitat area in a corridor to the next.

Wildlife corridors and crossings help to maintain and enhance **biodiversity** by increasing the space animals have to travel and to use as territories. By providing continuous pathways between **fragmented landscapes**, corridors and crossings offer animals the opportunity to access food and water, suitable habitats, and safe migration routes, ultimately supporting the overall population health of many species. Landscape connectivity can also help animals avoid potentially dangerous interactions with humans, as well as decrease genetic isolation by enabling animals to find mates from other areas.

WILDLIFE CROSSING DESIGN CHALLENGE

OBJECTIVES

Students will:

- analyze the capabilities and habits of a wild animal;
- predict challenges the species may face when moving across a human-dominated landscape; and
- design a model of a wildlife crossing or pathway to assist the animal in avoiding a human-made obstruction or threat.

PREPARATION

Gather and/or print materials:

- Video: Tis the season as Christmas Island crabs mass to cross bridge (1:14)
- Handout: Animal Profile Cards (1 per small group)
- Handout: Wildlife Crossing Design Challenge (1 per small group)
- Slide: Engineering Design Process graphic
- Blank paper
- Craft materials for model-building (e.g., popsicle sticks, cardboard, tin foil)
- Sticky notes

Set up technology:

Ideally, the video and graphic will be displayed for the whole class to view.

Additional preparation:

- Read this blog post for more background information about land development and habitat loss.
- Review the engineering design process.
- Print Animal Profile Cards, or use a similar format to create your own cards for local species of interest.
- Preview the Wildlife Crossing Design Challenge handout and make modifications based on time and the needs of your students.

STANDARDS

This activity addresses the following:

NGSS: MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impacts on the environment.

NGSS: MS-ETS1-1: 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.

Florida NGSS: SC8.N.1.6: Understand that scientific investigations involve the collection of relevant empirical evidence, using logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations, and models to make sense of the collected evidence.

PART 1: 50 MIN

10 MIN **INTRODUCE THE TASK**

1. Have students close their eyes and imagine being a pedestrian or bicyclist in a busy city. Then ask: *What would you need to cross a busy intersection? To cross a busy highway?* Discuss students' ideas on how they think roads and highways impact many communities in the United States. Ask: *What structures allow humans to cross a highway safely?* Have volunteers share their ideas. Then explain that highways are human-made pathways that help people travel within a state or even across the United States. Although they are beneficial, they can also divide communities and make it difficult for pedestrians to cross. To help people safely cross highways, communities often build safe ways for people to cross. They often do the same to support wildlife.
2. Introduce the concept with a video of how people designed a safe pathway for the Christmas crab. Preview the following questions to keep in mind as students view the video "Tis the season as Christmas Island crabs mass to cross bridge":
   - What strategies are used to assist the crabs' migration?
   - What are the pros and cons of each strategy?
3. Watch the video (1:14) and discuss as a class what students learned. Explain that their challenge will be to design a crossing or pathway to help a particular species avoid human-made barriers and the dangers they often present.

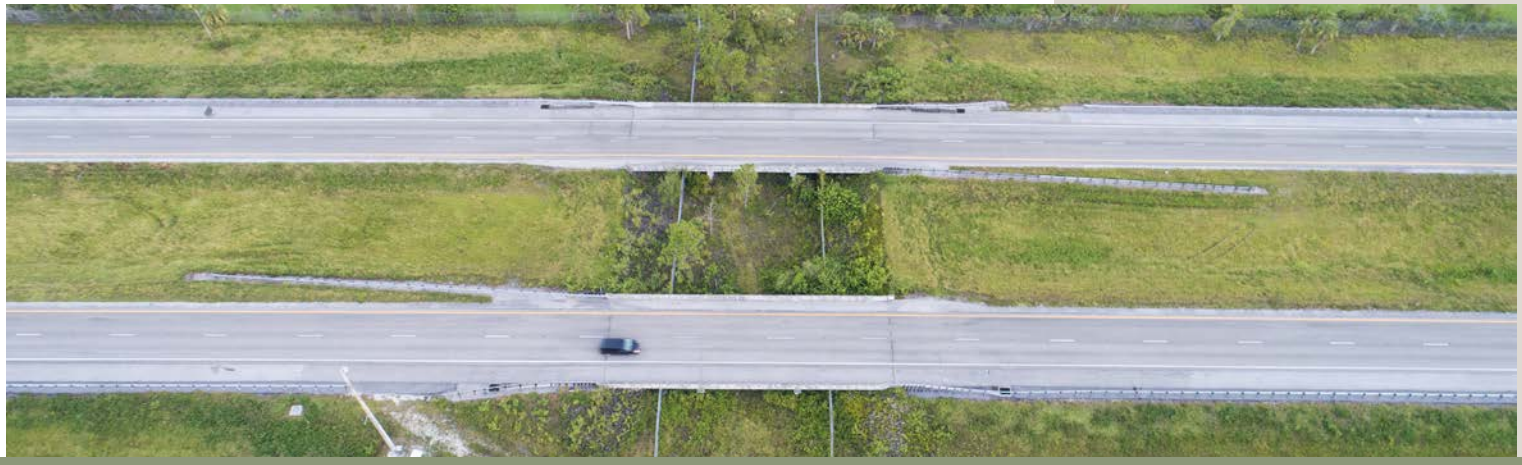
40 MIN **DESIGN CHALLENGE**

4. Divide the class into small groups of 2–4 students and assign an Animal Profile Card to each group.
5. Distribute the Wildlife Crossing Design Challenge handout and read aloud the quote and challenge description in Step 1. As you read, have students circle any keywords or phrases that catch their attention.
6. Next, project for the class the Engineering Design Process graphic and expand on each step.
   - **Ask:** Define the problem. What needs to be solved? Explain to students that they may need to conduct some **Research** to understand the problem fully.
   - **Imagine:** Brainstorm potential solutions.
   - **Plan:** Decide how the solution will work. For example, draw a prototype and label its components.
   - **Create:** Build a model of the solution.
   - **Test:** Explain to students that, typically, the next step would be to test the designs. In this case, because they are models, the next step will be to present them to peers for feedback instead.
   - **Improve:** Revise the design based on peer feedback. Repeat the cycle as needed.
7. Return to the Wildlife Crossing Design Challenge handout and review the "Criteria" and "Constraints" sections. Remind students of the following definitions:
   - **Criteria:** Rules or directions that must be followed; requirements that must be met
   - **Constraints:** Restrictions or limitations
   - **Optional:** If students need more context or find developing ideas challenging, show this video (2:54) about wildlife bridges for inspiration.
8. Provide students with ample time to complete Steps 2–4 in the handout (approximately 40 minutes total). Inform students that they will present the model and the answers to the questions from the Wildlife Crossing Design Challenge handout to their peers.

TIP: Manage the time for each step, and monitor and support each group throughout the process as needed. But do not provide too much guidance. This is a critical thinking activity that requires students to use their imaginations. Allow students to be as creative as they can be within the time. Steer students away from ideas that do not factor in the given constraints.

MORE TO EXPLORE

REVISE THE 3-D MODEL
In class or at home, give students the opportunity to continue the engineering design process by improving their model. Consider contacting an engineering firm or university department that could provide an expert to speak to students about their work and provide feedback on students' designs and/or models.



PART 2: 50 MIN

25 MIN **GROUP PRESENTATIONS**

1. Have students regroup in their small groups, set up their models, and prepare for their presentations. Explain the process:
   - Distribute sticky notes to each student (2 sticky notes x the number of groups presenting).
   - Provide each small group with 3 minutes to present their model and answers from Step 4 in the handout.
   - After each presentation, allow time for the other students to ask questions about the design and the rationale used.
   - Give 1 silent minute for students to provide feedback on a sticky note (2 per presentation):
     - ► one good thing (glow)
     - ► one question or critique (grow)
   - Have one student collect the sticky notes from the class and give them to the group who presented.

15 MIN **DISCUSS AS A GROUP AND REVISE BASED ON FEEDBACK**

2. Have students revisit their Wildlife Crossing Design Challenge handout to complete Step 5. Ask each group to read the feedback on their sticky notes and write a summary of the feedback they received on the handout.
3. Have small groups determine what revisions are needed to their prototype and why. Have them record ideas on the Wildlife Crossing Design Challenge handout and revise their labeled drawing to reflect their agreed-upon ideas.
4. Ask each group to share changes they decided to make and why in a whole class discussion.

10 MIN **REFLECT**

5. Have students reflect verbally or in writing (on blank paper) using the following reflection prompts:
   - Could any design created by the class help more than one species of wild animal? If so, which other animals might also benefit from that design?
   - You may have noticed some designs can be used for multiple species. Which design should local or state governments invest in to get the most impact and why? (e.g., cost-effective; serves the most organisms)
   - How can humans design structures to coexist with wildlife?
   - Why are animal crossings needed?

MORE TO EXPLORE

CONDUCT A DEBATE
Have students debate for and against building wildlife crossings and wildlife corridors. Students can then discuss arguments that could be used to persuade policy makers to support wildlife crossing projects.

ANIMAL PROFILE CARDS

Print, cut, and fold your assigned animal's card to show its photo on one side and description on the other.
All photos by Carlton Ward Jr., unless marked otherwise.

AMERICAN ALLIGATOR
Alligator mississippiensis

OBSTACLE
Interstate highway 75 (also called Alligator Alley)

PHYSICAL CHARACTERISTICS
Five toes on front limbs; webbed toes on the back for swimming

BEHAVIOR
Nocturnal

STRENGTHS
Massive bite pressure; excellent hearing, sight, and sense of smell; able to run up to 35 mph for a short time

CHALLENGE
During the winter months, often moves onto roads where pavement has been warmed by the sun; can then be hit by cars or other vehicles

BOBCAT
Lynx rufus

OBSTACLE
A housing development

PHYSICAL CHARACTERISTICS
Body length between 2 and 4 ft; weighs 15 to 35 lbs

BEHAVIOR
Nocturnal hunters

STRENGTHS
Can climb trees and swim; has keen hearing and sight

CHALLENGE
A far-ranging mammal in need of large areas of interconnected land to hunt and mate

GOPHER TORTOISE

Gopherus polyphemus

OBSTACLE
Golf course cart driveway between a sand dune and low-lying vegetation area

PHYSICAL CHARACTERISTICS
Stumpy, elephant-like hind legs and flattened forelimbs; 10 to 15 inches long

BEHAVIOR
Forages in late afternoon

STRENGTHS
Digging and creating long, deep burrows

CHALLENGE
Males need to move approximately 1 to 114 acres

FLORIDA BLACK BEAR

Ursus americanus floridanus

OBSTACLE
Brightline train from Miami to Orlando

PHYSICAL CHARACTERISTICS
Large body, claws; omnivore

BEHAVIOR
Very curious; can navigate home through unfamiliar territory; excellent swimmer

STRENGTHS
Sees in color, with good eyesight; acute hearing

CHALLENGE
Bears are solitary and need space; their home range is 50 to 120 square miles for males and 10 to 25 square miles for females

WHITE-TAILED DEER
Odocoileus virginianus

OBSTACLE
State Road 54

PHYSICAL CHARACTERISTICS
Great at running and jumping; up to 6 feet

BEHAVIOR
Breed year-round, small home range of 1 to 6 square miles; most active at dawn or dusk

STRENGTHS
Can endure a wide range of climates, smells, and sounds

CHALLENGE
Vehicle collision is a frequent cause of deaths

COYOTE
Canis latrans

OBSTACLE
Housing development

PHYSICAL CHARACTERISTICS
Dog family; can run up to 40 miles per hour

BEHAVIOR
Opportunist feeders; breed once a year; range of 10 miles

STRENGTHS
Smell, vision, and hearing; can run up to 40 miles per hour

CHALLENGE
Vehicle collision is a frequent cause of death

NAME: _____ DATE: _____

WILDLIFE CROSSING DESIGN CHALLENGE

STEP 1: **The Challenge**

With your group, read and think about the quote and the challenge description.

"... The wild borders of the world have hardened into edge cities and millions of miles of highway, making them prime places for animals to be extirpated [rooted out and destroyed]. Car and truck strikes are responsible for the vast majority of known deaths of Florida panthers, as well as black bears and key deer, among other animals. As many as a quarter of those killed in a given year are kittens, cubs, or fawns."

—Cynthia Barrett, in *Path of the Panther: New Hope for Wild Florida*, by Carlton Ward, Jr.

THE CHALLENGE:
Design a structure or pathway to help your assigned animal move safely across the human-built obstacle.

Criteria
Your design must include the following:

- Labeled drawing of a design
- 3-D model
- Explanation of use
- Where would you build it, and why there?
- How would the organism use the path?
- How would you ensure that the organism uses the path?

Constraints

- Time: One class period to design and build
- Materials: Use the materials provided to build your model.

STEP 2: **Identify the Problem**

Review your assigned Animal Profile Card. Answer the following questions:

- Why does this organism need to travel across the obstacle?
- What abilities does this organism have that we should consider when creating a design?
- What limitations does it have?
- What additional information do we need about the organism or obstacle before beginning our design?

Write a problem statement:

Design a _____ for the _____ to move around _____ .

This is important because_____

_____

STEP 3: **Brainstorm and Draw Possible Solutions**

Spend 5 minutes brainstorming possible solutions, writing down all ideas.

Discuss each possible solution. Decide which one would be best for your animal. Consider the following:

- Does the animal have the ability to cross this bridge/pathway?
- Does the bridge/pathway reduce encounters with humans?
- Does this idea meet all the challenge criteria?
- Can this model be built within the time constraints?
- Do we have the materials and ability to build this model?

Determine the best features for your model. Draw the design and label all key components.

STEP 4: **Build a Model** 20 MIN

Using the materials provided, build a model of your design.

Prepare to present your design by answering the following questions:

- ► Where would you put your bridge or pathway? Why?
- ► How would the organism find the path?
- ► How would the organism use the path?

STEP 5: **Present and Record**

Present to your peers and record feedback. After you determine revisions needed below, revise your drawing to reflect these ideas.

- "Glows" (the positive feedback):

- "Grows" (questions and ideas for improvement):

- Revisions needed:

TAKE LEARNING FURTHER

ACTION IDEAS: WHAT CAN STUDENTS DO?

Through the activities in this guide, students develop a deeper understanding of biology, ecology, and connections between humans and their environment. There is so much more they can do to deepen their learning while making an impact—now and in the future.

The Florida Wildlife Corridor is not yet complete. Habitat destruction is still a threat in Florida and in other areas around the world. Help students understand that they can take action and make a difference in these ways and more:

- **EXPERIENCE** the habitats and biodiversity of the Florida Wildlife Corridor. Plan ways to visit and explore through the corridor's parks and preserves. On this site, students can find Florida Wildlife Corridor places and identify those they'd like to visit.
- **FOLLOW PROGRESS** with the corridor on pathofthepanther.com. Talk with friends and family about why it's important. Share the film with them, and discuss opportunities for taking action.
- **WRITE POLICYMAKERS** about the importance of protecting the Florida panther's habitat and the Florida Wildlife Corridor. Go to pathofthepanther.com/takeaction for details on how to write to policymakers.
- **IF OUTSIDE OF FLORIDA,** research nearby wildlife corridors or local keystone species and write to policymakers and government officials about conservation there.

Provide students with opportunities to create art, poetry, essays, or fiction honoring or sharing the story of the Florida panther or the Florida Wildlife Corridor. Seek opportunities to develop research or participate in citizen science by contacting nearby parks, preserves, and universities.

ANSWER KEY

For many of the activities, students' answers will vary. Possible responses for some activities are provided below to help guide instruction.

ACTIVITY 1: JOURNEY OF THE ENDANGERED FLORIDA PANTHER

Handout: *Journey of the Endangered Florida Panther*

Clip 1: A Florida Highway:

1. A wild place: insect noises, owl, large mammal walking in the dark; a highway at night: rescue vehicles and people, a 1-year-old panther hit by a car; 2. Vehicle collisions; 3. A small area along the Gulf of Mexico

Clip 2: Threats to the Panther:

4. Like a ghost; stealth, quiet, lethal; a pioneer that can travel hundreds of miles; 5. Extinction of this rare species could happen soon; 6. Hunting; vehicle collisions; habitat destruction for land development

Clip 3: Hope for Movement North:

7. Find and follow tracks; set up cameras along the trail, attached to trees; 8. A female could reproduce and help to grow the population in the northern Everglades, where none have been seen for a long time.

Clip 4: Attempting to Track the Panther:

9. The terrain is tough to travel; panthers use a huge range/ move long distances; 10. Fewer than a dozen

Clip 5: Panther Danger and Recovery:

11. It's so rare to see a panther, and he finally sees one! But then he realizes the young panther is injured, and the mother is just waiting for it.; 12. Storms, disease; 13. protected land where the panther and other species are protected from human impacts and able to move naturally through their territory—a Florida Wildlife Corridor

Wrap-Up Assignment: What are the Solutions?

Students may propose solutions such as:

- Reduce vehicle collisions:
  - Slow cars with speed limits, signs, and speeding enforcement by police.
  - Avoid the need to cross roads by creating pathways over or under.
- Reduce habitat destruction with less land development:
  - Give financial support to help ranchers and farmers keep their land.
  - Create more nature preserves and parks.
  - Encourage more dense housing development, to protect more land.
- Reduce threats from disease:
  - Use tax funds to continue monitoring, rehabilitating, and finding cures for diseased panthers.

ACTIVITY 2: EXPLORING BIODIVERSITY OUTDOORS AND ONLINE

Handout: *Exploring Local Biodiversity with iNaturalist*

Student responses will vary based on when they access iNaturalist, as observation data is regularly updated. Students' comparisons to their own biodiversity observations and their reflections (what they are surprised by, questions) will also vary but should build toward a clearly stated and supported opinion in Step 7.

ACTIVITY 3: ARE WE THERE YET? WILDLIFE CORRIDOR DECISIONS

As students in this activity analyze complex map data for locations near where they live, their analyses will differ. In step 3 of the activity, students should cite actual data from the map as they identify challenges or obstacles.

The complexity of the land cover data will likely be new to them, so the chart on the handout is designed for open-ended exploration, pattern identification, and questioning. For activity steps 7-10, make sure that students use the map legend (key) as they interpret land cover types. When presenting in step 10, they should back up their wildlife corridor decisions with evidence cited from the map data.

ANSWER KEY

ACTIVITY 4: ANALYZING A BLACK BEAR'S MOVEMENT

Handout: *A Black Bear's Movement: Develop an Argument*

As students develop arguments, their claims and justifications may vary. Evidence from M34's movement will likely include details such as the following from the notes in step 1:

Time	Distance/Location	Observation/potential cause
First 7 months	Stayed along the edge of Lake Wales Ridge	Moving between two conservation areas and near a creek—would have good habitat and water
April 2010	Avon Park Air Force range	
1 week	Lake Kissimmee/town of Frostproof	Swimming shores of Reedy Lake
8 days		In forest during day; crossed roads and open areas at night. Able to safely travel at night
June 1st	Made it to Celebration FL	Encountered highway and development; used crossing under highway; hid in woods
1 week	South toward Lakeland	Approached I-4 but did not try to cross
June 7th	Gave up trying to cross I-4; went south back near Sebring	Traveled in darkness; during day hid in woodlots or swamps
	Kissimmee River	Stayed in narrow strand of trees
	Lake Okeechobee	Short swim – gave up and came to shore
June 24	Reached Fisheating Creek	
July 8th	30 miles south of starting point at Fisheating Creek	Collar fell off (as programmed to do); traveled more than 500 miles in 2 months; ends up in good bear habitat with other bears

ACTIVITY 5: WILDLIFE CROSSING DESIGN CHALLENGE

As this activity is designed for critical thinking and creativity while following the engineering design process—and because students will create for different wildlife needs—student groups' designs will differ. Designs should address the needs of the assigned animal as stated on the profile card, and also meet criteria and constraints included on the handout.

GLOSSARY

biodiversity *n.* the variety of life on Earth, encompassing all living organisms; biodiversity is crucial for maintaining the health and balance of ecosystems

citizen science *n.* the practice of public participation and collaboration in research to increase scientific knowledge; citizen science projects typically incorporate data collection and/or data analysis

competition *n.* the struggle for organisms to survive as they try to use the same resources

constraints *n.* restrictions or limitations in the engineering design process

consumers *n.* organisms that eat other organisms; cows, rabbits, and grasshoppers are examples of consumers

criteria *n.* rules or directions that must be followed; requirements that must be met in the engineering design process

decomposers *n.* organisms that break down the remains of dead organisms; mushrooms and earthworms are examples of decomposers

ecosystem *n.* the community of organisms that live in a particular area, including both living organisms and nonliving things

endangered species *n.* organisms threatened by extinction, often due to habitat loss or loss of genetic diversity

food chain *n.* a linear sequence of organisms through which nutrients and energy pass as one organism consumes another

food web *n.* a group of interacting food chains showing relationships in an ecosystem, including how energy is transferred up food chains that are linked with other food chains

fragmented landscapes *n.* unconnected natural habitats between which wildlife may move or migrate; fragmented habitats present challenges such as access to food, space, mates, suitable habitats, and safe migration routes

geographic information systems (GIS) *n.* a computer system for storing and displaying data related to location. GIS can show many different kinds of data on one map, such as roads, land types, and satellite images.

limiting factor *n.* a factor in nature that causes a population to decrease in size, such as scarce food sources, few mates, or competition for resources

migration *n.* movement of a group of people or animals from one place to another

naturalist *n.* an expert in or student of natural history; someone who studies the natural world

population *n.* a group of organisms of the same species living within a geographic area

producers *n.* organisms that make their own food by absorbing sunlight through a process called photosynthesis; all green plants are producers

trophic level *n.* categories for organisms in food chains; trophic levels are divided into producers (first level), consumers (second level), and decomposers (final level)

wildlife corridors *n.* networks of protected lands that provide pathways from one area of habitat to another

wildlife crossings *n.* human-made structures that help animals safely travel across a specific barrier, such as a highway

CREDITS AND RESOURCES

CREDITS

Middle School Educator Guide Development
Anne Haywood, *project lead*, Mountain to Sea Education; Christina Riska Simmons, *editor*; Jen Agresta, *copy editor*; Tori Linder, Dr. Gabby Salazar, and Amanda Thompson, *advisors*

Design
Project Design Company

Writers
Jaraux Washington, Courtney Vandebunte, Anne Haywood

Reviewers
Dr. Kerryane Monahan, Indian River State College; Alicia Pressel, Career Academy of Engineering and Environmental Sciences, Saint Johns County Schools

Science and Environmental Educator Consultants
Dustin Angell, Archbold Biological Station; Jahna Brooks, Frost Museum of Science, Miami; Kristen Cytacki, Palm Beach Zoo & Conservation Society; Jason Danahy-Sheldon, Khadijah Jones, and Cassandra Lee, Hillsborough County Public Schools; Joseph Montes de Oca, Miami-Dade County Public Schools; Sara Naval and Erin Nocera, Forest Hill Community High School, Palm Beach County; Jennifer Soterakis, Ahfachkee Day School, Big Cypress Seminole Reservation; Amanda Thompson, The Nature Conservancy; Alexa Tillett, UF/IFAS Broward County 4-H; Fred Wiechmann, Polk County (ret.)

Story Maps
Angeline Meeks, Archbold Biological Station, Katie Bryden, Wildpath

Path of the Panther Team
Carlton Ward Jr., Tori Linder, Lisa Baylor, Malia Byrtus, Lauren Yoho, Katie Bryden, George McKenzie Jr., Eric Bendick, Tom Winston, Wildpath, Grizzly Creek Films, Common Pictures, Appian Way, Common Pictures, National Geographic

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