Mexican Free-Tailed Bats: Biodiversity & Ecological Relationships Grades 6 – 8

Learning Objectives

1. Students will describe and give examples of predatory, competitive, and symbiotic relationships that Mexican free-tailed bats are a part of.
2. Students will describe how biodiversity contributes to the sustainability of an ecosystem.
3. Students will play a board game to investigate how environmental changes impact ecological relationships and sustainability.

Essential Questions

1. What ecological relationships are Mexican free-tailed bats a part of?
2. How does biodiversity contribute to ecological sustainability?
3. How do environmental changes in Texas impact Mexican free-tailed bats and the ecosystem they are a part of?

Time Needed

• Engage: Bat Facts or Bat Myths?	15-20 minutes
• Explore 1: Mexican Free-Tailed Bats & Bracken Cave	15-20 minutes
• Explore 2: Biodiversity	30 minutes
• Explore 3: Ecological Relationships & Sustainability	45-60 minutes
• Explore 4: Dawn to Dusk: A Bat's Nightly Journey Board Game	45 minutes
• Explain: Dawn to Dusk: Board Game Reflection	10 minutes
• Elaborate: Back to Bat Facts & Bat Myths	15 minutes
• Evaluate: What did you learn?	15 minutes

Texas Essential Knowledge & Skills (TEKS)

2017 Science TEKS	Science TEKS Approved by SBOE 2021
• 7(10)(B) describe how biodiversity contributes to the sustainability of an ecosystem	• 6(12)(B) describe and give examples of predatory, competitive, and symbiotic relationships between organisms, including mutualism, parasitism, and commensalism • 8(12)(C) describe how biodiversity contributes to the stability and sustainability of an ecosystem and the health of the organisms within the ecosystem
Scientific and Engineering Practices Approved by SBOE 2021	
• 6-8(1)(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems • 6-8(3)(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats	
Recurring Themes and Concepts Approved by SBOE 2021	
• 6-8(5)(A) identify and apply patterns to understand and connect scientific phenomena or to design solutions • 6-8(5)(D) examine and model the parts of a system and their interdependence in the function of the system • 6-8(5)(G) analyze and explain how factors or conditions impact stability and change in objects, organisms, and systems	

2018 Social Studies TEKS	Social Studies TEKS Adopted by SBOE 2022
• 6(3)(C) identify and locate major physical and human geographic features such as landforms, water bodies, and urban centers of various places and regions	• 6(3)(C) identify and locate major physical and human geographic features such as landforms, water bodies, and urban centers of various places and regions

• 6(19)(C) organize and interpret information in outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps • 7(8)(A) locate and compare the Mountains and Basins, Great Plains, North Central Plains, and Coastal Plains regions • 7(8)(B) locate & compare places of importance in Texas in terms of physical & human characteristics such as major cities, waterways, natural & historic landmarks, political & cultural regions, & local points of interest • 7(20)(C) organize and interpret information from outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps • 8(29)(C) organize and interpret information from outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps	• 6(19)(C) organize and interpret information from outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps • 7(8)(A) locate and compare the Mountains and Basins, Great Plains, North Central Plains, and Coastal Plains regions • 7(8)(B) locate & compare places of importance in Texas in terms of physical & human characteristics such as major cities, waterways, natural & historic landmarks, political & cultural regions, & local points of interest • 7(20)(C) organize and interpret information from outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps • 8(29)(C) organize and interpret information from outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps

Next Generation Science Standards (NGSS)

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

The performance expectation listed above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science & Engineering Practices Engaging in Argument from Evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.
Disciplinary Core Ideas LS2.A: Ecosystem Dynamics, Functioning, and Resilience

• Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
Crosscutting Concepts Stability and Change • Small changes in one part of a system might cause large changes in another part.

Academic Vocabulary

From: lead4ward Academic Vocab https://lead4ward.com/resources/

Grade 6	Grade 7	Grade 8
• community • equilibrium • fungi • population *Previously Introduced* • ecosystem • nonrenewable resources (coal, oil, natural gas) • organism • renewable resources (wind) • species	• environmental change • parasitism *Previously Introduced* • basic need • biodiversity • compete • competition • ecosystem • environment • habitat • hibernation • migration • offspring • organism • population • predator-prey relationship • species • sustainability	• host • parasitism *Previously Introduced* • biodiversity • compete • competition • ecosystem • environment • environmental change • fungi • habitat • organism • population • predator-prey relationship • offspring • space • species • sustainability

Background Information

Bats are unique and fascinating animals. They are the only mammals capable of true flight. They belong to the order Chiroptera which includes more than 1,400 bat species. They live on every continent, apart from Antarctica, and have survived on Earth for over 50 million years (BCI, 2023).

Mexican Free-Tailed Bats

This lesson focuses on one species of bat that is native to North, Central, and South America, the Mexican free-tailed bat, *Tadarida brasiliensis*. These bats are also called Brazilian free-tailed bats.

- Habitats
  Mexican free-tailed bats live in a variety of habitats, including caves, abandoned mines, culverts, bat houses, and under bridges. The colonies of this species tend to be large, reaching hundreds of thousands, even millions of bats.
- Distribution
  In North America, most Mexican free-tailed bats are migratory. They spend the summer months in the central and southern United States where males and females roost separately. The females form maternity colonies where they each give birth to and raise a new pup. Males form smaller bachelor colonies.

  In the summer, Mexican free-tailed bats are found throughout the state of Texas. Although some appear to stay in Texas year-round, most of the western sub-species of Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) that spend the summer in Texas migrate to Mexico in the autumn. The subspecies, *Tadarida brasiliensis cynocephala* lives in the eastern quarter of Texas year-round. Due to their wide distribution throughout the state, Mexican free-tailed bats are designated as the state's official flying mammal (Texas Tech University, 2023).
- Diet
  Mexican free-tailed bats are insectivores that primarily feed on moths. They also eat other flying insects such as beetles, flies, true bugs, and ants, to name a few. Insectivore bats play an important role in controlling the insect population. It is estimated that one nursing Mexican free-tailed bat eats at least her body mass in insects every night. An adult female Mexican free-tailed bat has a mass of about 12 grams. This means each night a nursing Mexican free-tailed bat eats

roughly 12 grams of insects, which is about the same mass as 2 quarters or 1 AAA battery. This may not seem like a lot, but 20 million bats each consuming 12 grams of insects every night adds up to 220 tons of insects. That's the approximate mass of 55 elephants – consumed each night!

- Role in the Ecosystem
  Mexican free-tailed bats play an important role in the ecosystem. Large populations help control insect populations. When they live near farmland, Mexican free-tailed bats protect agricultural crops from pests. Bats also are a food source for many animals including hawks, owls, raccoons, and snakes.
- Echolocation
  One of the *Deep in the Heart* videos included in this lesson, *Bats of Bracken Cave* mentions echolocation. In addition to sight, a Mexican free-tailed bat relies on echolocation to navigate its environment and hunt prey. A bat emits high-frequency sounds through its mouth or nose that are too high for a human to hear. These sounds bounce off objects and return to the bat as echoes which provide information about the distance and size of objects around it. The echolocation calls of Mexican free-tailed bats range between 20 and 75 KHz, depending on habitat and weather conditions (BCI, 2023).
- Communication
  Mexican free-tailed bats also make a variety of social vocalizations including isolation calls, begging calls, and multi-syllabic songs (BCI, 2023). Each night a mother bat leaves the cave to hunt. She leaves her new pup in the cave, huddled with the other pups in the colony. Upon her return, she uses calls and smells to find and nurse her own pup. An amazing feat in a colony of millions!
- Structures & Functions
  - Mexican free-tailed bats' fur varies in color and may include shades of dark brown, rusty brown, and gray.
  - A bat's body is adapted for flight. Its chest and shoulders are larger with muscles that provide power to the wings. Its hips and legs are slender (Wilson, n.d.).
  - An adult Mexican free-tailed bat has a mass of about 12 grams, about the same as 2 quarters or 1 AAA battery.
  - An adult Mexican free-tailed bat's wingspan ranges from 11-14 inches, and its body length ranges from 3.5-4 inches.

- A bat's wing has a similar bone structure to a human's hand. The bones of a bat's wing are connected by a thin membrane of skin. The thumb, however, is free from the wing membrane, has a claw at the end, and is used for crawling and climbing. (Bonus fact: As mentioned above, bats are mammals that belong to the order Chiroptera. This name comes from the Greek words, "cheir" which means hand, and "pteron" which means wing.)
- The uropatagium is a skin membrane that extends between the legs and tail of a bat. In many bat species, the uropatagium extends from the legs to the entire length of the tail. However, in Mexican free-tailed bats, some of the tail extends beyond the uropatagium. This is why this species has "free-tailed" in its name. Other species of bats also have this feature. All free-tailed bats are classified in the Molossidae family which is the 4th largest family of bats. The Molossidae family includes over 100 bat species that live in North America, South America, Europe, and Africa. Insectivores, like the Mexican free-tailed bat, use the uropatagium to catch insects mid-flight.
- Mexican free-tailed bats have small dark eyes. They see about as well as humans see in the dark. To hunt and navigate their environment at night, Mexican free-tailed bats rely on echolocation.

- Conservation Status
  Mexican free-tailed bats are classified as "Least Concern" on the International Union for Conservation of Nature's (IUCN) Red List. They currently have a broad geographic range and large population sizes. They have adapted to living in urban areas and roost in human-made structures such as houses, tunnels, and under bridges. Potential conservation threats to this species include habitat loss, the impacts of climate change, wind energy development, accumulation of pesticides in their diet, and persecution.

Bracken Cave

Texas is home to the world's largest bat colony and one of the largest concentrations of mammals on Earth. Bracken Cave, located along the southeastern edge of the Hill Country near San Antonio, Texas, is home to approximately 20 million Mexican free-tailed bats. This population is a maternity colony, consisting of females and their pups. The emergence of these millions of bats as they leave the cave at dusk during the

spring, summer, and fall for their nightly insect hunt, is an unforgettable sight. They fly out of the cave in a spiral that looks like a tornado, a tornado of bats, a batnado!

Congress Avenue Bridge in Austin, Texas
The largest urban colony of bats in the world is made up of an estimated 1.5 million Mexican free-tailed bats that live under the Congress Avenue Bridge in Austin during the summer. The emergence of this colony each night has become one of the city's most popular summer tourist attractions.

Threats to Bats Worldwide
Bat populations are declining worldwide. Some of the main reasons for their population declines include:

- Human activity that destroys bat habitats such as cutting down forests, mining guano (bat poop), and thoughtless tourism into caves and abandoned mines.
- The impacts of climate change harm bat populations. Some examples include:
    - Increased extreme weather events increase bat mortality.
    - Increased aridity and drought make it difficult for some bat populations to survive and reproduce.
    - Changes in seasonal timing negatively impact bats that migrate.
- A disease called white-nose syndrome is currently spreading throughout bat populations in the United States and Canada. This disease is caused by a fungus that infects hibernating bats.
- Hunting bats for sport and meat.
- Wind turbines. Dead bats are found under wind turbines worldwide. While wind turbines are a step toward reducing our reliance on fossil fuels, they are negatively affecting bats.
  (BCI, Bats 101, 2024)

Common Misconceptions about Bats

Myth	Facts
Bats are blind.	No. All bats are able to see. There is variation in eyesight from species to species. Some bat species have night vision which allows them to see in dimmer light, similar to the adaptation of a cat's eyes. Some species of bats can see ultraviolet light. Other bat species, like the Mexican free-tailed bat, rely on echolocation to navigate and hunt in the dark. While these species do not see well in the dark, they are still able to see. Their night vision is similar to that of a human's (BCI, FAQ, 2023).
All bats drink blood.	No! Of the 1,400+ species of bats on Earth, only three are vampire bats that feed on blood. These three species all live in the New World tropics (i.e., South America, Central America, and Mexico) (BCI, FAQ, 2023). Vampire bats do not actually suck blood. Instead, they use sharp, pointed front teeth to make small cuts in the skin of another animal and then lap up the blood. The saliva of these bats has proteins that prevent wounds from clotting. This anticoagulant has been developed into a medication that helps prevent strokes in humans (BCI, Common Vampire Bat, 2023).
Bats will fly into your hair.	No! Bats are not attracted to human hair. This is an old misconception. This idea could have evolved from humans seeing bats foraging for insects low, just above people's heads. Bats are able to catch small flying insects mid-flight and can definitely avoid a human head! (Virginia Department of Wildlife Resources, 2023). This myth may have been told as a way to deter young women from going out at night (Neighborhood Bat Watch, n.d.).
All bats have rabies.	Most bats do NOT have rabies. It is estimated that less than 0.005% of bats in wild populations contract the

	rabies virus (Idaho Fish and Game, 2005). Even among bats submitted for rabies testing in the U.S., only about 6 percent had rabies (Florida Fish and Wildlife Conservation Commission, 2024). All mammals can contract rabies. In 2021, 8,686 mammals (multiple species) in Texas were tested for rabies. Of those 8,686 animals, 455 (5%) were positive for rabies. In 2021, skunks were the primary source of positive rabies cases in Texas and bats had the second-highest number of confirmed rabies cases (Texas Department of State Health Services, 2021). It is very important to NEVER touch a wild animal, including a bat. If you find a bat on the ground or out during the daytime, there is a high chance that it is sick or injured. If you encounter a bat in a building or on the ground, contact a local rescue organization to help (BCI, FAQ, 2023).
Bats are not that important. Bats are "vermin" and should be exterminated.	Not true! All around the world, bats provide vital ecosystem services such as insect pest consumption, plant pollination, and seed dispersal. They are essential to the health of global ecosystems (BCI, Bats 101, 2023).
Bats are flying mice.	No! The most recent studies using gene comparisons suggest that bats are in the superorder Laurasiatheria. Bats' exact placement within the Laurasiatheria superorder is still uncertain, but they are thought to share a most recent common ancestor with hooved animals like horses and antelope as well as carnivores (Tsagkogeorga et al., 2013).
All bats are the same.	There are over 1,400 different bat species worldwide that vary in size, appearance, and characteristics. 32 of those species live in Texas.

Tips for Addressing Concerns/Fears About Bats

Many people are afraid of bats. For some people, this may stem from a personal experience. However, most people have never been close to a bat. They may have seen the silhouette of a bat flying at night but have never encountered a bat in close range. This means that a fear of bats often comes from social cues.

Some of the common myths listed above may teach people to fear bats. The way bats are depicted for Halloween could also make people leery of bats. These portrayals may come from the fact that bats are different than us. They are active at night and live in dark spaces like caves. A fear of bats may develop due to unfamiliarity.

Watch carefully for your students' reactions as you introduce bats in the Engage section of this lesson. If you notice any fears or discomfort, gently address these concerns directly. Ask students to share what they know about bats and any previous experiences they've had with bats. Use the information in this background reading to speak to any misconceptions students have about bats. Encourage students to become curious about bats, to learn more about bats through this lesson, and see if any of their ideas about bats change by the end of the lessons.

As students observe Mexican free-tailed bats in pictures, diagrams, and videos throughout this lesson, they may develop the opinion that Mexican free-tailed bats are cute! They are small, furry, and curious about what is going on around them.

There are legitimate reasons to steer clear of bats. Like all wild animals, bats should never be touched. If a bat is found on the ground and/or outside during the day, it may be sick. Give the bat plenty of room and contact a local rescue organization to help. Like all mammals, bats can have rabies. This is one reason why one should never touch a bat or any other wild animal.

The organization Bat Conservation International is leading the charge to ensure the worldwide survival of bats. Part of their conservation work includes teaching people about specific bat species and the ecological and economic value of this extraordinary mammal. Learn more about their conservation work and bats in general here: https://www.batcon.org/our-work/inspire-through-experience/

References & Sources for Additional Information

Amsel, Sheri. (2023). *Bat (Mexican Free-Tailed or Brazilian Free-Tailed)*. Exploring Nature Science Education. https://www.exploringnature.org/db/view/Bat-Mexican-Free-tailed-or-Brazilian-Free-tailed

Bat Conservation International (BCI). (2023). *Bats 101*. https://www.batcon.org/about-bats/bats-101/

Bat Conservation International. (2024). *Bracken Cave Preserve*. https://www.batcon.org/see-bats-live/visit-bracken-cave-preserve/

Bat Conservation International (BCI). (2023). *Common Vampire Bat*. https://www.batcon.org/bat/desmodus-rotundus-2/

Bat Conservation International (BCI). (2023). *Experience Bats*. https://www.batcon.org/experience-bats/

Bat Conservation International (BCI). (2023). *FAQ*. https://www.batcon.org/about-bats/faq/

Bat Conservation International (BCI). (2023). *Mexican Free-Tailed Bat*. https://www.batcon.org/bat/tadarida-brasiliensis/

Florida Fish and Wildlife Conservation Commission. (2024). *Bats and Health, Rabies*. https://myfwc.com/conservation/you-conserve/wildlife/bats/health/rabies/

Idaho Fish and Game. (2005). *Bats and Rabies: Just the Facts*. Idaho Official Government Website. https://idfg.idaho.gov/press/bats-and-rabies-just-facts

IUCN Red List. (2015). *Tadarida brasiliensis*. https://www.iucnredlist.org/species/21314/22121621

Neighborhood Bat Watch. (n.d.). *Bat Myths*. Ministere des Forets, de la Faune et des Parcs, Quebec. https://batwatch.ca/bat-myths

National Parks Service. (2022). *Myth Busters*. https://www.nps.gov/subjects/bats/myth-busters.htm

New Hampshire PBS (NH PBS). (2023). *Molossidae - free-tailed bats*. Wildlife Journal Junior. https://nhpbs.org/wild/molossidae.asp

Texas Department of State Health Services. (2021). *Rabies in Animals, Texas – 2021 Prepared by Zoonosis Contro*. https://www.dshs.texas.gov/sites/default/files/IDCU/disease/rabies/cases/Reports/Epi-Annual-Rabies-2021-compiled.pdf

Texas Tech University. (2023). *Brazilian Free-Tailed Bat Tadarida brasiliensis.* Natural Science Research Laboratory. https://www.depts.ttu.edu/nsrl/mammals-of-texas-online-edition/Accounts_Chiroptera/Tadarida_brasiliensis.php

Tsagkogeorga, G., Parker, J., Stupka, E., Cotton, J. A., & Rossiter, S. J. (2013). Phylogenomic analyses elucidate the evolutionary relationships of bats. *Current Biology*, 23(22), 2262-2267. https://doi.org/10.1016/j.cub.2013.09.014

University Museum of Paleontology. (n.d.). *Chiroptera: More on Morphology*. https://ucmp.berkeley.edu/mammal/eutheria/chiromm.html

University of Illinois Urbana- Champaign. (2020). B*at hands*. From the Field. Prairie Research Institute. Illinois Natural History Survey. https://blogs.illinois.edu/view/7362/1702667390

UC Museum of Paleontology. (n.d.). *Chiroptera: Systematics*. https://ucmp.berkeley.edu/mammal/eutheria/chirosy.html

U.S. Department of the Interior. (2021). *13 Awesome Facts About Bats.* https://www.doi.gov/blog/13-facts-about-bats

Virginia Department of Wildlife Resources. (2023). *Bats: Frequently Asked Questions.* https://dwr.virginia.gov/wildlife/bats/bat-faqs/

Wilson, D.E., (n.d.). *Form and function.* Britannica. https://www.britannica.com/animal/bat-mammal/Form-and-function

University of Michigan Museum of Zoology. (2020). *Chiroptera bats.* Animal Diversity Web (ADW). https://animaldiversity.org/accounts/Chiroptera/classification/#Chiroptera

Materials

Per Class

- *Deep in the Heart: A Texas Wildlife Story* Mexican Free-Tailed Bats: Biodiversity & Ecological Relationships Grades 6 – 8 PowerPoint files
  - English: https://docs.google.com/presentation/d/1qcatYt9nL1vWv7HhVzrzt9qkptwqIb_4/edit?usp=sharing&ouid=103309533954542071568&rtpof=true&sd=true
  - Spanish: https://docs.google.com/presentation/d/1ZFVpMRy4Kmy8HFxNhhowd5Ne_UIKrCTe/edit?usp=sharing&ouid=103309533954542071568&rtpof=true&sd=true
- Videos (these videos are embedded in the PowerPoint files):
  - *Deep in the Heart: A Texas Wildlife Story Bats of Bracken Cave* video https://youtu.be/H-q58Jd50Lk?si=gm5xZp_WkthqGXd0
  - *Deep in the Heart: A Texas Wildlife Story Snakes Hunt Bats* video https://youtu.be/60Zf7-hLS4E?si=RmHjTr73O0oyXQCS
  - *Deep in the Heart: A Texas Wildlife Story Bats' Greatest Strength: Their Numbers* video https://youtu.be/Va7otBnHq_s?si=lZjAKVvxg2ujWA60
- 2 quarters or 1 AAA battery
  to represent the mass of a Mexican free-tailed bat ~12g
- Organisms Cards (pages 41-48 for English, 63-70 for Spanish)
- 'Bat Facts or Bat Myths?' Answer Key (pages 37-38)

Per Group

- 'Relationships in Ecosystems' handout (Page 26 for English, 50 for Spanish)
- 1 die
- 1 deck of playing cards *to represent "insect cards" in the board game*
- 1 stopwatch *any device that can track time*
- 'Dusk to Dawn: A Bat's Nightly Journey Board Game Directions' (pages 27-28 for English, 51-52 for Spanish)
- 'Dusk to Dawn: A Bat's Nightly Journey – Quick Start' Guide (page 29 for English, 53 for Spanish)
- 'Dusk to Dawn: A Bat's Nightly Journey – Board Game Key' (pages 30-32 for English, 54-56 for Spanish)
- 'Dusk to Dawn: A Bat's Nightly Journey – 3 Game Boards' (pages 33-35 for English, 57-59 for Spanish)

Per Student

- 1 "game piece"
  something about the size of a paperclip that can be moved around the game boards. Students will work in groups of 4 and each student in the group will need a unique game piece. Ideas: colored paper clips, small stones, coins, math manipulatives
- 1 pencil or pen
- 'Bat Facts or Bat Myths?' handout (page 25 for English, 49 for Spanish)
- 'Dusk to Dawn: Board Game Reflection' handout (page 36 for English, 60 for Spanish)
- 'Apply What You Learned' handout (pages 39-40 for English, 61-62 for Spanish)

Prep

1. Watch the videos ahead of time to ensure they are appropriate for your students. The 2nd and 3rd videos show predators hunting prey. See the links in the Materials List above or in PowerPoint slides 18-20.
2. Download the PowerPoint files instead of viewing them in Google Drive so you have access to the embedded videos and animations. See the links in the Materials List above.
3. Print and prepare the materials for the 'Dusk to Dawn: A Bat's Nightly Journey' board game. See pages 27-36 for English, 51-60 for Spanish. Try out playing the game yourself ahead of time so you are prepared to support students.
4. Prepare the additional handouts listed in the Materials List above.

Engage – Bat Facts or Bat Myths?

1. Give each student a copy of the 'Bat Facts or Bat Myths?' handout. Review the directions and provide time for students to complete the chart. See page 25 below for English, 49 for Spanish.
2. Once all students have completed the chart individually, record the class's responses on PowerPoint slide 3. One way to do that is to:
   a. Read each statement and ask students to raise their hands if they marked Fact on their handout for that statement. Record the number of students with their hands raised on PowerPoint slide 3.
   b. Then ask students to raise their hands if they marked Myth for that statement and record that number of students on PowerPoint slide 3.
   c. Repeat this process for all 8 statements. Emphasize that you are collecting information on what students think at this point in the lesson.

Tell students the class will return to this chart at the end of the lesson and revise responses if needed.

Optional: Set up a digital poll using a tool such as Mentimeter, Google Forms, Kahoot, Pear Deck, etc. Have students submit their responses digitally and then display the data to show what the class thinks at this point in the lesson. Save the poll results to return to later in this lesson.

Explore 1 – Mexican Free-Tailed Bats & Bracken Cave

3. Show students the images of Mexican free-tailed bats on PowerPoint slides 5-9.
4. At first, provide time for students to make observations of the bats in the pictures quietly to themselves. Then ask a few students to share what they notice about Mexican free-tailed bats.
5. Here are some bat facts you can use to guide the discussion:
    a. The Mexican free-tailed bat is considered a medium-sized bat, although it is pretty small. On average, an adult Mexican free-tailed bat is about 12 grams. That's about the same mass as 2 quarters or 1 AAA battery. Show students 2 quarters or 1 AAA battery or something else that has a mass of about 12 grams. Pass the object you choose around the room so students can hold 12 grams in their hands and imagine what it might feel like to hold a Mexican free-tailed bat.
    b. Mexican free-tailed bats have short, dense fur, large, rounded ears, and wrinkly upper lips.
    c. They live in a variety of habitats including caves, abandoned mines, bridges, culverts, and bat houses. The colonies of Mexican free-tailed bats tend to be large, including hundreds of thousands and sometimes millions of bats.
    d. In North America, most Mexican free-tailed bats are migratory, seasonally moving from the central and southern United States to Mexico.
    e. Mexican free-tailed bats are fast! They can reach average flying speeds of over 60 miles per hour. The fastest Mexican free-tailed bat flight recorded was just under 100 miles per hour.
6. Ask, "Why do you think these bats have 'free-tailed' in their name?" Give students a few moments to think and then have some students share their initial ideas.
7. Show PowerPoint slide 10 and ask, "What do you notice about the bat tails in the illustrations?" Then, pose the question again, "Why do you think Mexican free-tailed bats have 'free-tailed' in their name?" In PowerPoint presentation mode,

activate the animation feature so this question appears on the slide. Guide the discussion so that students identify:

a. The tails of Mexican free-tailed bats extend beyond the tail membrane.
b. The tails of most other bats are completely enclosed within the tail membrane. However, there are other free-tailed bats. Of the 1,400+ bat species worldwide, about 100 of them are classified in the family Molossidae, the 'free-tailed bat' family (NH PBS, 2023).
c. The entire length of the tail of a Mexican free-tailed bat can be almost half its total body length.

8. Show the map on PowerPoint slide 11 that identifies where Mexican free-tailed bats live. Ask students, "Do Mexican free-tailed bats live in your area?" Guide students to use the map to answer this question.
9. Tell students they will learn more about the Mexican free-tailed bats that live in Bracken Cave. Bracken Cave, a cave in Texas, is home to approximately 20 million Mexican free-tailed bats during the summer months. This population is a maternity colony, consisting of females and their pups.
10. Show students the images on PowerPoint slides 12 & 13 to introduce them to Bracken Cave.
11. Show the Texas map on PowerPoint slide 14 that identifies where Bracken Cave is located. Ask the questions posted on the slide to help students make a connection to the location of Bracken Cave:
    a. What large city is closest to Bracken Cave?
    b. How long would it take you to get to Bracken Cave?
    c. Have you heard of Bracken Cave before?
    d. Have you visited the cave yet?
    e. Which physical region of Texas is Bracken Cave located in?
12. PowerPoint slide 15 shows that Bracken Cave Preserve is located in the Great Plains and Coastal Plains physical regions of Texas. (Bracken Cave Preserve spans 1,400+ acres.)

Explore 2 – Biodiversity

13. Show the word biodiversity on PowerPoint slide 17. Tell students they will explore the biodiversity in and around Bracken Cave. Use the following question to gauge students' current understanding of biodiversity:
    a. Ask, "What do you notice about the word biodiversity?"
    Students may notice "bio" and "diversity" in the word. Ask students to

explain if they have heard the word bio used on its own or as a prefix. Responses could include using "bio" to mean biography or a short, written profile of someone. Students may have also heard the term "bio break." Some words with the prefix bio include biology, biography, biosphere, and biotic (just to name a few).
Ask how students have heard the word diversity used before. For example, students may be familiar with the phrase "diversity, equity, and inclusion" (DEI).

b. Ask, "What does bio mean?"
Bio means relating to life.
c. Ask, "What does diversity mean?"
Diversity means being diverse. Diverse means a great deal of variety.
d. Ask, "After looking at those two parts of the word, what do you think biodiversity means?"

14. Direct students' attention to the 'What organisms live in and around Bracken Cave?' section of the student handout they used in the Engage phase of this lesson (under the 'Bat Facts or Bat Myths?' section of the page). Review the directions on the handout which say: *As you watch the Deep in the Heart bat videos, create a list of the organisms you observe.*
15. Show the *Deep in the Heart* bat videos. Note there are three separate short bat videos embedded in slides 18-20. These videos are also available at the following links:
    a. *Bats of Bracken Cave* (4 minutes)
    https://youtu.be/H-q58Jd50Lk?si=1j1TePoUr2TrAiua
    b. *Snakes Hunt Bats* (5 minutes)
    https://youtu.be/60Zf7-hLS4E?si=RmHjTr73O0oyXQCS
    c. *Bats' Greatest Strength: Their Numbers* (4 minutes)
    https://youtu.be/Va7otBnHq_s?si=lZjAKVvxg2ujWA60
16. After watching the films, ask students to share what organisms they observed.
17. As they mention each one, post that organism card in a place where all students can see it. See pages 41-48 below for the organism cards in English and 63-70 in Spanish. The cards include the following organisms. Note: Students will observe cacti, trees, shrubs, and grasses in the video, but may not know the names of specific organisms. Use the organism cards to introduce them to the common organisms (listed below) that live in Texas.

• Mexican free-tailed bat
• coachwhip snake
• agricultural pests
  ○ cotton bollworm moth
  ○ corn earworm moth
  ○ cucumber beetle
  ○ grasshopper
• crops
  ○ cucumber plants
  ○ cotton
  ○ corn
• birds of prey
  ○ great horned owl
  ○ peregrine falcon
  ○ red-tailed hawk
  ○ Swainson's hawk
	• cacti
	  ○ desert Christmas cactus (aka Tasajillo)
	  ○ prickly pear cactus
	• trees
	  ○ ashe juniper
	  ○ hackberry
	  ○ live oak
	• shrubs
	  ○ beautyberry
	  ○ beebush
	  ○ Texas persimmon
	• grass
	  ○ little blue stem
	  ○ sideoats grama

18. Next, ask students what crops the insects eat. Post these 3 organism cards:

• corn	• cotton	• cucumbers

19. Ask students to imagine that they were going to spend the entire day in the environment shown in the *Deep in the Heart* bat videos. Ask, "What other animals do you think you'd see?" As students mention other organisms, post the rest of the organism cards. If students do not know the specific names of animals, introduce the animal names via the cards. For example, if students say "birds" tell them the names of the birds on the cards as you post them.

• raccoon • skunk • rat snake • green anole • fox squirrel • rock squirrel	• white-footed mouse • black-crested titmouse • northern cardinal • painted buntings • white-eyed vireos • white-winged dove

Explore 3 – Ecological Relationships & Sustainability

20. Review the ecological relationships definitions on PowerPoint slides 22-25.
    a. Slide 22: Predatory Relationship - one organism (the predator) hunts and eats another organism (the prey)
    b. Slide 23: Competitive Relationship

i. occurs when two or more organisms need the same limited resources to survive & reproduce within an ecosystem
ii. competition can happen between organisms of the same species & among members of different species

c. Slide 24: Symbiotic Relationship - a close, prolonged (lengthy) association between two or more different species
d. Slide 25: Symbiotic Relationships
    i. Mutualism (+/+) - a symbiotic relationship between two species in which both benefit
    ii. Commensalism (+/0) - a symbiotic relationship between two species in which one benefits, and the other is unaffected
    iii. Parasitism (+/-) - a symbiotic relationship between two species in which one benefits, and the other is harmed

21. Then have students work in small groups to complete the 'Relationships in Ecosystems' handout. See page 26 below for English, 50 for Spanish. Each group will need 1 copy of the handout. Review the directions as a class and then provide time for each group to complete the handout.
22. When all groups have added at least one idea to each open space, discuss students' responses as a class. Ideas to guide the discussion include:
    a. Predatory
        i. Bats hunt insects.
        ii. Snakes hunt bats.
        iii. Birds of prey hunt bats.
    b. Competition
        i. The 20 million Mexican free-tailed bats living in Bracken Cave must compete with each other for space, including space to roost in the cave and space to fly.
        ii. The snakes compete with each other to catch the bats that are stuck in cacti.
    c. Mutualism
        i. Humans & Bats - Humans grow crops and bats eat pests that are attracted to the crops. In this relationship, bats gain a food source and the humans' food source (the crops) is protected from pests.
        ii. Bats & Crops - The crops attract pests that bats eat. The bats help protect the crops from agricultural pests and bats have a food source.

d. Commensalism
    i. Snakes & Cacti - When bats get caught in the cacti, the snakes benefit because their prey is easier to catch and the cacti are generally not impacted.

   Tip: Commensalism can be a challenging symbiotic relationship for students to remember and identify. If students have trouble identifying an example of this relationship, pose questions to guide their thinking. Such as, "In the videos, were there any living thing that helped one of the predators catch their prey without getting any benefit in return?" Or, "How were the snakes in the video able to catch bats, an animal that flies?"

23. Show students the phrase "ecosystem sustainability" on slide 26. Read the phrase out loud to the class and then ask students to think quietly about the meaning of this phrase.
24. After a few moments ask students to turn to a partner and share what they think "ecosystem sustainability" means.
25. Then, show the content on slide 27. This slide is animated so in presentation mode, each section of content will appear when you initiate each animation:
    a. **A sustainable ecosystem** can remain consistent over time despite disturbances and stressors.
        i. Disturbances are natural events like storms and fires.
        ii. Stressors are caused by human activity like building a highway and pollution.
    b. **High biodiversity** supports a sustainable ecosystem because if one species in a biologically diverse ecosystem declines, other organisms can fill the declining organism's roles.

       Sources:
       Tutor Chase. (n.d.) Explain the concept of a stable ecosystem. https://www.tutorchase.com/answers/ib/biology/explain-the-concept-of-a-stable-ecosystem
       U.S. Department of Agriculture. (n.d.). Disturbances and Stressors. Climate Hubs. https://www.climatehubs.usda.gov/disturbances-and-stressors
    c. Read the directions aloud:
        i. Tell your partner what each of the BOLD phrases means in your own words.

ii. As you and your partner work together, write down at least 1 question you have about these ideas. Or write down at least 1 question you think a classmate might have about these ideas.

Provide time for partners to discuss.

26. As partner conversations are wrapping up, bring the class back together as a group and ask partners to share the question(s) they wrote down. After each question is read, ask if anyone in the class would like to try to answer it. Guide the discussion until most students have a general understanding of the concept of a sustainable ecosystem. Tell students they will further investigate this concept throughout the rest of the lesson.
27. Show PowerPoint slide 28 and pose the first question:
    a. "Do you think the ecosystem you observed in the bat videos is sustainable?"

    Use the animation feature on the PowerPoint slide to show the second question:
    b. Do you need more info to answer this question? If so, what info do you need?

    Tell students to discuss these two questions with their partner. If students are familiar with the Claim, Evidence, and Reasoning (CER) framework, direct students to support their answer (their "claim") to the first question with evidence and reasoning. (Evidence is data/facts that support the claim. Reasoning is the explanation that links the evidence to the claim. Reasoning explains why the data/facts support the claim.)
28. As partner discussions are wrapping up, tell students they will explore this question in the next part of the lesson by playing a board game.

Explore 4 – Dawn to Dusk: A Bat's Nightly Journey Board Game

29. In this part of the lesson, students will play the 'Dawn to Dusk: A Bat's Nightly Journey Board Game.' Make sure you gather the needed materials ahead of time and test out playing the game, so you are prepared to guide students.
30. To play this game, students will work in groups of 2-4. Each group will play 3 rounds of the game. Each round typically takes about 7-10 minutes. However, since it relies on chance, the exact length of time needed for each round can vary. If needed, set a time limit for each round, and tell students if their group does not finish by that time, the player with the most insect cards wins. There are some directions about setting a time limit at the bottom of page 29 below. See page 53 for the Spanish version.

31. To begin the game, either read the 'Dusk to Dawn: A Bat's Nightly Journey Board Game Directions' on pages 27-28 for English and 51-52 for Spanish as a class or have each group read the directions on their own.
32. Provide time for all students to complete three rounds of the game. Each round will be played on a different game board. (The game boards are numbered 1-3). Make sure each group records the amount of time it takes to play each round on the 'Dusk to Dawn: A Bat's Nightly Journey Quick Start Guide.' See page 29 below for the English handout and page 53 for the Spanish version.

Explain – Dusk to Dawn: Board Game Reflection

33. Give each student a 'Dusk to Dawn: Board Game Reflection' handout. Review the directions and then provide time for students to respond. See page 36 below for English and 60 for Spanish.
34. When all students have responded, discuss their responses as a class. Some notes to guide the discussion:
    1. Which round took your group the longest to complete?
    2. What events do you think caused this round to take the most time to complete?
       Responses will vary by group. Have each group share their response and reasons why that round took their group the longest. Note differences and similarities between the groups' responses. If groups have different responses, challenge students to explain why different boards took groups different amounts of time to complete.
    3. Which round took your group the least amount of time to complete?
    4. What events do you think caused this round to take the least amount of time to complete?
       Same notes as above for this discussion about which round took the least amount of time.
    5. How did the addition of the housing development and the wind turbines impact biodiversity in this ecosystem?
       Guide students to think about how bats, insects, birds of prey, trees, shrubs, and crops were impacted during the game.
    6. Do you think this ecosystem will be sustained over time, despite the stressors (the housing development and wind turbines)? Why or why not? Refer back to PowerPoint slide 27 if needed:

i. *A sustainable ecosystem can remain consistent over time despite disturbances and stressors.*
ii. *High biodiversity supports a sustainable ecosystem because if one species in a biologically diverse ecosystem declines, other organisms can fill the declining organism's roles.*

Answers to this question may vary by group depending on what happened during each group's game. Guide students to support their responses with evidence they gathered while playing the board game.

Elaborate – Back to Bat Facts & Myths

35. Return to 'Bat Facts or Myths?' handout. Tell students to access the individual responses they made on this handout in the Engage phase of this lesson. Provide time for students to review their original responses quietly and make updates if needed, based on what they have learned during this lesson.
36. Then, discuss students' responses as a class. Refer to the 'Bat Facts or Myths? Answer Key' on pages 37-38.
37. Draw students' attention to the class chart that was created during the Engage phase of this lesson. (You may have used PowerPoint slide 3 for this or a digital tool such as Mentimeter, Google Forms, Kahoot, Pear Deck, etc.)
38. Read each statement on the 'Bat Facts or Myths?' handout. Tell students to react to each statement with a thumbs up (Fact) or a thumbs down (Myth). Discuss any discrepancies until the class comes to an agreement. Update the Fact and Myths columns on the class chart to reflect what the students now know about bats.

Evaluate – What did you learn?

39. Distribute an 'Apply What You Learned' handout and provide time for students to complete it. See pages 39-40 for English and 61-62 for Spanish. You can collect this completed handout as an assessment or use the handout as a starting point for a class discussion.

Name _____

Bat Facts or Bat Myths?

Directions: Mark whether you think each statement is a **bat fact** or a **bat myth**. For now, record what you know so far. After you learn more about bats, you'll return to this sheet to check and update your responses.

	Fact	Myth
1. Bats are blind.		
2. All bats drink blood.		
3. Bats will fly into your hair.		
4. All bats have rabies.		
5. Bats are not that important.		
6. Bats are "vermin" and should be exterminated.		
7. Bats are flying mice.		
8. All bats are the same.		

What organisms live in and around Bracken Cave?

Directions: As you watch the *Deep in the Heart* bat videos, create a list of the organisms you observe.

Name _____

Relationships in Ecosystems

Directions: Think about the interactions between organisms you observed while watching the *Deep in the Heart* bat videos. Identify at least one example of each relationship shown in the videos in the open boxes below.

<table>
<tr><th colspan="2">Predatory</th><th>Competitive</th></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><th colspan="3">Symbiotic</th></tr>
<tr><th>Mutualism</th><th>Parasitism</th><th>Commensalism</th></tr>
<tr><td></td><td>SKIP
This relationship was not shown in the videos.</td><td></td></tr>
</table>

Dusk to Dawn: A Bat's Nightly Journey

Board Game Directions

The goal of this game is to successfully move your "bat" all the way around each game board, collecting enough insects to survive and avoiding the nightly dangers on your path.

Step 1: Gather Materials

- Each student needs:
    - 1 game piece
      something that fits on the game board, can be moved around the board, and is different from the other players' pieces (e.g. a colored paperclip)
- Each group needs:
    - 1 deck of playing cards (which will be used as the "insect cards")
    - 1 die
    - 1 timing device
    - 3 game boards

      Note each of the 3 game boards are slightly different:
        - Board 1 - Original
        - Board 2 - A Housing Development
        - Board 3 - Wind Turbines
    - Board Game Key

Step 2: Setup

Work in small groups, roughly 4 students per group. Gather the materials above and arrange chairs around a table or desk so all group members can see and reach the game board.

Step 3: Read These Directions

Your game piece represents a Mexican free-tailed bat living in Bracken Cave. Each night you must fly a great distance to farm fields. There you must eat enough insects flying above the fields to give you energy for your flight and to produce milk for your pup. You must then safely fly back to your cave to feed your pup and rest. Many dangers are found along your path.

In this game, each player will take turns rolling the die. When it is your turn, roll the die and move that number of spaces on the game board. Read the directions on the Board Game Key for the space you land on, following the directions exactly, and then give the die to the next player for their turn.

The goal of the game is to make it safely back to the cave with 6 insect cards or more (the playing cards will be used as insect cards). Each insect card (1 card from the deck) represents 2 grams of insects. So, the goal is for your bat to eat 12 grams of insects each night. This is enough food for a nursing mother bat to maintain her energy and produce enough milk for her pup.

As you run into dangers on your journey, you may die and be told to return to the cave. If this happens, return all your insect cards to the pile. You will roll the die again on your next turn and begin your journey as a new bat.

The first bat to fly back to the cave, alive with 6 insect cards (or more) wins!

There are 3 different game boards. Each board represents different environmental conditions. You will play 3 rounds of this game, using a different game board for each round. Use the boards in order from Board 1 to Board 3.

Time how long it takes to complete each round. A round starts when the first player rolls the die for a game board. A round ends when the first bat makes it back to the cave with 6 insect cards (or more).

GOOD LUCK ON YOUR NIGHTLY FLIGHT!!

Group Name or Number _____

Dusk to Dawn: A Bat's Nightly Journey – Quick Start Guide

1. Gather the materials.
2. Start with Board 1.
3. Start a timer.
4. Take turns rolling the die and moving your game piece around the board. When you land on a space, read the directions on the Game Board Key for that space and follow the directions.
5. The round ends when the first bat makes it back to the bat cave with 6 insect cards. When the first bat makes it back to the cave, stop the timer. Mark how long the round took to play below. All players should return their insect cards.
6. Repeat with Game Boards 2 and 3. Remember to reset and start the timer at the beginning of each round. The winner from the last round begins the next.

Board 1 – Original Environment

Hazards on this board include dermestid beetles, prickly pear cacti, snakes, and birds of prey.

Time to complete Board 1 round: _____

Board 2 – A Housing Development

The hazards from Board 1 are still in place AND two of the agriculture fields where the bats used to find insects are now a housing development, resulting in fewer insects available for the bats.

Time to complete Board 2 round: _____

Board 3 – Wind Turbines

This board has the same dangers as Board 2 with one addition. Wind turbines have been built on the plains that the bats must fly over to get to the agriculture fields. Flying too close to the spinning blades can cause bats to die. Some turbines emit a sound that causes bats to fly away from the danger of the blades. Other turbines do not have this warning system.

Time to complete Board 3 round: _____

If you are short on time, set a time limit for each round:

For each round, stop at _____ minutes. The bat with the most insect cards at that time wins! If there is a tie, the bat with the most cards AND is further along on the board wins.

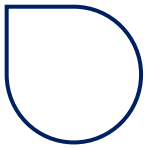
Dusk to Dawn: A Bat's Nightly Journey – Board Game Key

	**Bracken Cave** • This is the "home" location. All game pieces will start & end here. • If a bat dies on its journey, the player must return all their insect cards to the pile & move the bat back to the cave. On the player's next turn, the player will roll the die again & begin the journey around the board as a different bat.
	**Dermestid Beetles on Cave Floor** Oh, no! You collided with another bat while leaving the cave & injured your wing. When you fell to the cave floor, dermestid beetles ate you. Start over.
	**Prickly Pear Cactus** Ouch! You are stuck in a cactus. Skip your next turn.
	**Coachwhip Snake** That was quick. You got snagged on a cactus & were immediately eaten by a coachwhip snake. Return to the cave.
	**Always stop at the blue stop sign.** **IF you are moving toward the tree** continue moving toward the tree. Finish moving the number of spaces your rolled. **IF you are moving toward the prickly pear cactus**, stop here and turn around. Wait here until your next turn. On your next turn start moving toward the tree & continue moving in that direction.
	**Shrub** Just a shrub. No dangers to avoid here.
	**Moth** Yum! Pick up 1 insect card.

	**Tree** Just a tree. No dangers to avoid.
	**Agriculture Field – red** Delicious. You are eating corn earworm moths as fast as you can. Collect 2 insect cards.
	**Agriculture Field – white** These cotton bollworm moths seem to be moving slower than usual tonight & are easy to catch. Collect 2 insect cards.
	**Agriculture Field – blue** Yum! There are a ton of cucumber beetles here. Collect 2 insect cards.
	**Housefly** Delicious! Pick up 1 insect card.
	**Bird of Prey** Caught! A red-tailed hawk grabbed you with its talons. Return your insect cards to the pile & move back to the cave. Start again on your next turn.
	**Plains** Just fields of prairie grasses & plants. No dangers to avoid here.
	**Houses** Your stomach grumbles. You remember the fields filled with moths & beetles that used to be here. Nothing to eat here now. Wait here until your next turn.

	**Windmill** Yikes. You were curious about a windmill & got too close. A blade hit you. Return your insect cards to the pile & move back to the cave. Start again on your next turn.
	**Windmill with Ultrasonic Deterrent** You're lucky. An ultrasonic deterrent has been installed on this windmill. This deterrent makes a sound to alert you to danger & you don't get caught up in the blades. Fly on!
	**Always stop at the red stop sign.** **Do you have 6 insect cards?** **YES** – Congrats! Continue moving ahead. Finish moving the number of spaces your rolled. **NO** – Stop here. On your next roll & every turn that follows, move backward on the board until you have collected 6 insect cards. Once you have 6 insect cards, begin moving forward on the board again. (Note: If you go all the way back to the blue stop sign, you'll be directed to begin moving forward again.)

Tips:

- It is okay if two or more bats (game pieces) land on the same square. Each bat (each player) will share the space until their next turn.
- When you get to the cave at the end of the game, stop – even if you rolled a higher number on the die than you needed to get back into the cave.
-  This shape does not mean anything special on the board. It is just what the corner shapes look like!

Dusk to Dawn

A Bat's Nightly Journey

Board 1

DEEP IN THE HEART

Dusk to Dawn

A Bat's Nightly Journey

Board 2

DEEP IN THE HEART

Dusk to Dawn

A Bat's Nightly Journey

Board 3

Name _____

Dusk to Dawn: Board Game Reflection

Directions: Once you complete playing all 3 rounds (1 round on each of the 3 boards) of the 'Dusk to Dawn: A Bat's Nightly Journey Board Game,' respond to the reflection questions below.

1. Which round took your group the longest to complete?

   a. Board 1 – Original **b.** Board 2 – A Housing Development

   c. Board 3 – Wind Turbines

2. What events do you think caused this round to take the most time to complete?

   _____

   _____

   _____

3. Which round took your group the least amount of time to complete?

   a. Board 1 – Original **b.** Board 2 – A Housing Development

   c. Board 3 – Wind Turbines

4. What events do you think caused this round to take the least amount of time to complete? _____

   _____

   _____

5. How did the addition of the housing development and the wind turbines impact biodiversity in this ecosystem? _____

   _____

   _____

6. Do you think this ecosystem will be sustained over time, despite the stressors (the housing development and wind turbines)? Why or why not?

   _____

   _____

   _____

   _____

   _____

Bat Facts or Bat Myths?

Answer Key

	Fact	Myth
Bats are blind.		At 3:27 in the *Bats of Bracken Cave* video, the narrator says, "They must also rely on sight." Additional Background Information: All bats are able to see. There is variation in eyesight from species to species. Some bat species have night vision which allows them to see in dimmer light, similar to the adaptation of a cat's eyes. Some species of bats can see ultraviolet light. Other bat species, like the Mexican free-tailed bat, rely on echolocation to navigate and hunt in the dark. While these species do not see well in the dark, they are still able to see. Their night vision is similar to that of a human's (BCI, 2023, FAQ).
All bats drink blood.		Students can infer this is a myth based on the fact the *Bats of Bracken Cave* video says Mexican free-tailed bats eat insects. Additional Background Information: Of the 1,400+ species of bats on Earth, only three are vampire bats that feed on blood. These three species all live in the New World tropics (i.e. South America, Central America, and Mexico) (BCI, FAQ, 2023). Vampire bats do not actually suck blood. Instead, they use sharp, pointed front teeth to make small cuts in the skin of another animal and then lap up the blood. The saliva of these bats has proteins that prevent wounds from clotting. This anticoagulant has been developed into a medication that helps prevent strokes in humans (BCI, Common Vampire Bat, 2023).
Bats will fly into your hair		Challenge students to find a reliable source that shows this is a myth. Two Suggested Sources: Virginia Department of Wildlife Resources. (2023). *Bats: Frequently Asked Questions.* https://dwr.virginia.gov/wildlife/bats/bat-faqs/ Neighborhood Bat Watch. (n.d.). *Bat Myths.* Ministere des Forets, de la Faune et des Parcs, Quebec. https://batwatch.ca/bat-myths

All bats have rabies.		Challenge students to find a reliable source that shows this is a myth. Suggested Source: Bat Conservation International. (2023). *FAQ.* https://www.batcon.org/about-bats/faq/
Bats are not that important.		Students can infer both these statements are myths from the *Bats of Bracken Cave* video that says, "Their biggest impact is up to 100 miles away where they will consume over 150 tons of agricultural pest every single night." Additional Background Information: All around the world, bats provide vital ecosystem services such as insect pest consumption, plant pollination, and seed dispersal. They are essential to the health of global ecosystems (BCI, Bats 101, 2023).
Bats are "vermin" and should be exterminated.		
Bats are flying mice.		Students can infer this is a myth because the *Bats of Bracken Cave* video says, "There are 32 different species [of bats] in Texas and hundreds of millions of bats." Additional Background Information: The most recent studies using gene comparisons suggest that bats are in the superorder Laurasiatheria. Bats' exact placement within the Laurasiatheria superorder is still uncertain, but they are thought to share a most recent common ancestor with hooved animals like horses and antelope as well as carnivores (Tsagkogeorga et al., 2013).
All bats are the same.		The *Bats of Bracken Cave* video says, "There are 32 different species in Texas and hundreds of millions of bats."

Name _____

Apply What You Learned

1. What is one thing humans can do to help ensure bats survive and thrive in their environment?_____
   _____
   _____
   _____

In the board game you learned that habitat loss and wind turbines are two environmental stressors that bats face. Another threat to bat populations is white-nose syndrome. Read the passage below to learn more about white-nose syndrome and then respond to the questions that follow.

White-Nose Syndrome (WNS)

White-nose syndrome (WNS) is a fungal disease that impacts bats. It is estimated that the disease has killed millions of bats in North America in almost two decades. The disease is caused by the fungus, *Pseudogymnoascus destructans* (Pd for short). Sometimes the fungus looks like white fuzz growing on bats' faces. This is why the disease is called "white-nose" syndrome. Pd thrives in cold, dark, and humid conditions, such as caves and abandoned mines where bats often live in the winter (WNS Response Team, n.d.).

The fungus grows on the nose, tail membrane, and wings of hibernating bats. The infection causes hibernating bats to use more energy than normal, often leading to starvation before springtime (NPS, 2017).

In North America, the fungus was first identified in New York in 2006. Since then, it has spread rapidly west across the US and Canada. WNS impacts multiple species. Currently, 12 bat species have been confirmed with WNS in North America (WNS Response Team, n.d.). The disease has caused severe and widespread mortality in three of these species. One species is now listed as endangered in the US because of WNS and two other species may also be added to the US endangered list soon.

Pd was first detected in Texas in 2017 and since 2019, WNS has significantly impacted the populations of cave myotis (a bat species) in northern and central Texas. During the winter of 2023-24, tri-colored bats in Texas were identified with

symptoms of WNS. This species has been greatly impacted by WNS in other parts of North America so is a species of concern in Texas.

Two additional bat species in Texas have been detected with Pd: Townsend's big-eared bats and Mexican free-tailed bats. Not all bats that are detected with Pd, develop WNS. Some bats seem to be more resistant to and tolerant of Pd infection. However, these numbers will change as Pd continues to spread. Stay up to date here.*

2. What type of ecological relationship exists between bats and the fungus *Pseudogymnoascus destructans* (Pd)?

a. predatory **b.** competitive **c.** mutualism **d.** parasitism **e.** commensalism

Explain why: _____
_____
_____

3. Do you think white-nose syndrome could impact ecosystem sustainability? If yes, how? If no, why not? _____
_____
_____
_____

4. Do you think it is important for humans to work together to protect bat populations? Why or why not? _____
_____
_____
_____

References & Sources for Additional Information

If you'd like to learn more about white-nose syndrome and how it is impacting bats, visit the sites below.

White-Nose Syndrome (WNS) Response Team. (n.d.). *What Is White-nose Syndrome?* *https://www.whitenosesyndrome.org/static-page/what-is-white-nose-syndrome

Texas Parks & Wildlife Department (TPWD). (2023 January 26). *Briefing White-Nose Syndrome.* https://tpwd.texas.gov/business/feedback/meetings/2023/0126/agenda/item.phtml?item=5

National Park Service (NPS). (2017). *What Is White-nose Syndrome?* https://www.nps.gov/articles/what-is-white-nose-syndrome.htm

ORGANISM CARDS PAGE 1 of 4


Photo from Fin & Fur Films Productions
Mexican free-tailed bats


IMG_3454 by Always a birder! on Flickr CC BY 2.0 DEED
coachwhip snake


Helicoverpa armigera by Ilia Ustyantsev on Flickr CC BY-SA 2.0 DEED
cotton bollworm moth


corn earworm, moth, back_2014-06-06-15.37.55 ZS PMax from USGS Bee Inventory and Monitoring Lab on Flickr PDM 2.0 DEED
corn earworm moth


Western Striped Cucumber Beetle
Acalymma trivittatum by Dion Lowris, Flickr CC BY 2.0 DEED
cucumber beetle


Differential Grasshopper (Melanoplus differentialis) by AgentageWPS on Flickr PDM 1.0 DEED
grasshopper


cucumber..JPG by Joe Quick on Flickr CC BY-SA 2.0 DEED
cucumber plants

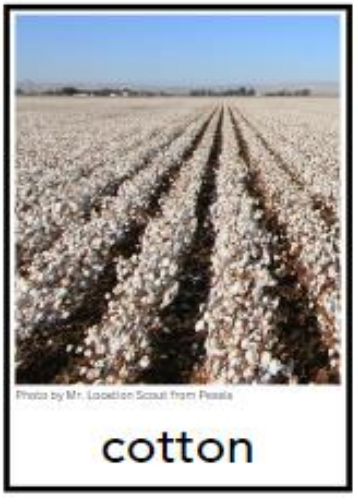


Photo by Mr. Location Scout from Pexels
cotton


Photo by Markus Spiske from Pexels
corn

Blank page for printing two-sided.
This will be the back of ORGANISM CARDS PAGE 1.

ORGANISM CARDS PAGE 2 of 4


great horned owl


peregrine falcon

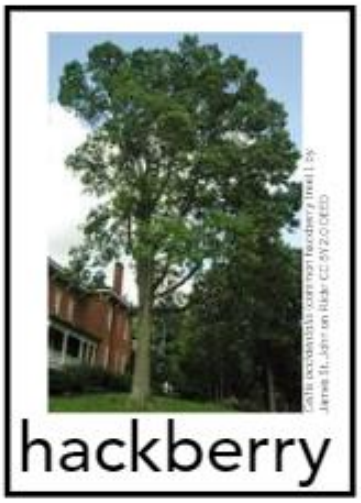

red-shouldered hawk


Swainson's hawk


desert Christmas cactus


prickly pear cactus

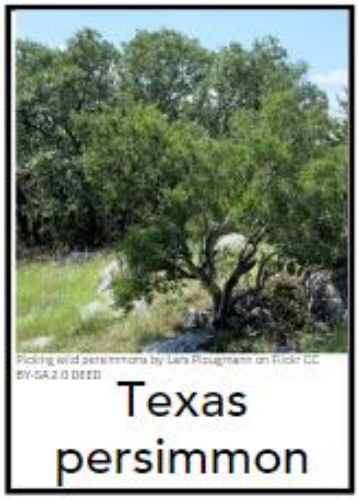

ashe juniper

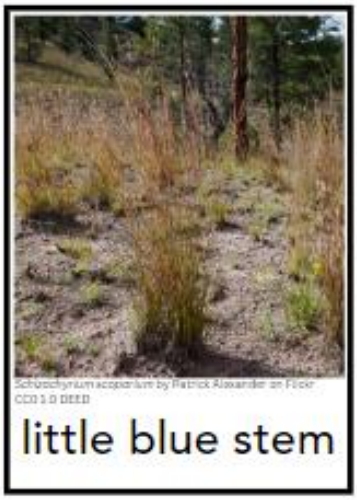

hackberry


live oak

Blank page for printing two-sided.
This will be the back of ORGANISM CARDS PAGE 2.

ORGANISM CARDS PAGE 3 of 4





Blank page for printing two-sided.
This will be the back of ORGANISM CARDS PAGE 3.

ORGANISM CARDS PAGE 4 of 4

Mammals - Eastern Fox Squirrel by Laurie Sheppard U.S. Fish & Wildlife Service on Flickr PDM 1.0 DEED

fox squirrel

2015-10-14_12-33-51_USA_Zion_National_Park_P_JH by Jan Holzbrant on Flickr CC0 1.0 DEED

rock squirrel

P187 Either Peromyscus leucopus (a white footed mouse) or its very similar close cousin, P. maniculatus (deer mouse) by Royce Milamon on Flickr CC BY 2.0 DEED

mouse

682 - BLACK-CRESTED TITMOUSE (10-25-2016) by Alan Schmierer on Flickr CC0 1.0 DEED

black-crested titmouse

Northern Cardinal by Shenandoah National Park on Flickr PDM 1.0 DEED

northern cardinal

Male Painted Bunting by U.S. Fish & Wildlife Service Kenny Seasai on Flickr PDM 1.0 DEED

painted bunting

618 - White-Eyed Vireo (2-21-08) bentsen rio grande state park, mission, tx (3) by Alan Schmierer on Flickr CC0 1.0 DEED

white-eyed vireos

432 - (White-Winged Dove (1-24-2022) americana rv park, palmview, tx -01 by Alan Schmierer on Flickr CC0 1.0 DEED

white-winged dove

Blank page for printing two-sided.
This will be the back of ORGANISM CARDS PAGE 4.

Nombre _____

¿Hechos o mitos sobre los murciélagos?

Instrucciones: Marca para mostrar si crees que cada oración es **un hecho** o **un mito** sobre los murciélagos. Por ahora, registra lo que sabes hasta el momento. Después de haber aprendido más sobre los murciélagos, volverás a esta hoja para revisar y actualizar tus respuestas.

	Hecho	**Mito**
1. Los murciélagos son ciegos.		
2. Todos los murciélagos beben sangre.		
3. Los murciélagos volarán hacia tu pelo.		
4. Todos los murciélagos tienen rabia.		
5. Los murciélagos no son muy importantes.		
6. Los murciélagos son "alimañas" y deberían ser exterminados.		
7. Los murciélagos son ratones voladores.		
8. Todos los murciélagos son iguales.		

¿Cuáles organismos viven en y alrededor de la Cueva Bracken?

Instrucciones: Mientras miras los videos sobre murciélagos de "*Deep in the Heart,*" escribe una lista de los organismos que observas.

Nombre _____

Relaciones en los ecosistemas

Instrucciones: Piensa en las interacciones entre los organismos que observaste cuando miraste los videos sobre murciélagos de "*Deep in the Heart*." Identifica al menos un ejemplo de cada relación mostrada en los videos en los recuadros de abajo.

<table>
<tr><th colspan="2">Predatoria</th><th>Competitiva</th></tr>
<tr><td colspan="3"></td></tr>
<tr><th colspan="3">Simbiótica</th></tr>
<tr><th>Mutualismo</th><th>Parasitismo</th><th>Comensalismo</th></tr>
<tr><td></td><td>SALTA
Esta relación no se presentaba en los videos.</td><td></td></tr>
</table>

Del atardecer al amanecer: El viaje nocturno de un murciélago

Instrucciones para el juego de tablero

El objetivo de este juego es mover tu "murciélago" todo el camino alrededor de cada tablero de juego, recogiendo suficientes insectos para sobrevivir y evitando los peligros nocturnos en tu camino.

Paso 1: Reunir los materiales

- Cada estudiante necesita:
  - 1 ficha de juego
    algo que cabe en el tablero, puede moverse alrededor del tablero, y se ve diferente de las fichas de los otros jugadores (e.g. un clip de color)
- Cada grupo necesita:
  - 1 baraja de cartas (se usarán como las "tarjetas de insectos")
  - 1 dado
  - 1 dispositivo de cronometraje
  - 3 tableros de juego
    Tenga en cuenta que cada uno de los 3 tableros es distinto:
    - Tablero 1 - Original
    - Tablero 2 – Una promoción de viviendas
    - Tablero 3 – Turbinas eólicas
  - Clave para el juego de tablero

Paso 2: La configuración

Trabajarán en grupos pequeños, con aproximadamente 4 estudiantes en cada grupo. Recopilen los materiales alistados arriba y arreglen las sillas alrededor de una mesa o escritorio para que todo miembro del grupo pueda ver y alcanzar el tablero.

Paso 3: Leer las instrucciones

Tu ficha de juego representa un murciélago mexicano de cola libre que vive en la Cueva Bracken. Cada noche debes volar una gran distancia hacia los campos de cultivo. Ahí tienes que comer una cantidad suficiente de los insectos volando sobre los campos para darte energía para tu vuelo y para que produzcas leche para alimentar a tu cría. Luego necesitas regresar volando con seguridad a tu cueva para alimentar a tu cría y descansar. Se encuentran muchos peligros a lo largo de tu camino.

En este juego, cada jugador tirará el dado por turnos. Cuando sea tu turno, tira el dado y mueve ese número de espacios en el tablero de juego. Lee las instrucciones en la Clave del juego de tablero para el espacio en el que aterrizas, siguiendo exactamente las instrucciones, y luego dando el dado al siguiente jugador para su turno.

El objetivo del juego es regresar a la cueva con seguridad y con 6 o más tarjetas de insecto (las cartas de juego se usarán como tarjetas de insecto). Cada tarjeta de insecto (1 carta de la baraja) representa 2 gramos de insectos. Entonces, el objetivo es que tu murciélago coma 12 gramos de insectos cada noche. Esto es suficiente comida para que una madre lactante pueda mantener su energía y producir suficiente leche para su cría.

Cuando te encuentres con peligros en tu viaje, puedes morir y puede que te digan que vuelvas a la cueva. Si eso ocurra, devuelve todas tus tarjetas de insecto a la pila. Volverás a tirar el dado en tu próximo turno y empezarás tu viaje como un nuevo murciélago.

El primer murciélago que regrese volando a la cueva, vivo con 6 tarjetas de insecto (o más) ¡gana!

Hay 3 distintos tableros de juego. Cada tablero representa varias condiciones medioambientales. Jugarás 3 rondas de este juego, usando un tablero diferente para cada ronda. Usa los tableros en orden del Tablero 1 al Tablero 3.

Mide el tiempo que se tarda en completar cada ronda. Una ronda empieza cuando el primer jugador tire el dado para un tablero. Una ronda termina cuando el primer murciélago llegue a la cueva con 6 tarjetas de insecto.

¡¡BUENA SUERTE CON SU VUELO NOCTURNO!!

Nombre o número del grupo _____

Del atardecer al amanecer: El viaje nocturno de un murciélago – Guía de inicio rápido

1. Reunir los materiales.
2. Empezar con el Tablero 1.
3. Iniciar el temporizador.
4. Tomen turnos tirando el dado y moviendo sus fichas de juego alrededor del tablero. Cuando caes en un espacio, lee las instrucciones en la Clave para el juego de tablero para ese espacio y sigue las instrucciones.
5. Una ronda termina cuando el primer murciélago llegue a la cueva con 6 tarjetas de insecto. Cuando el primer murciélago llegue a la cueva, para el temporizador. Registra el tiempo que se tardó en completar la ronda abajo. Todos los jugadores deben devolver sus tarjetas de insecto.
6. Repetir el proceso con los Tableros 2 y 3. Recuerda poner en cero e iniciar el temporizador al principio de cada ronda. El ganador de la ronda anterior empezará la próxima.

Tablero 1 – Medioambiente original

Los peligros en este tablero incluyen escarabajos derméstidos, nopales, serpientes, y aves de presa. **Tiempo para completar la ronda con el Tablero 1: _____**

Tablero 2 – Una promoción de viviendas

Los peligros del tablero 1 siguen presentes Y dos de los campos agrícolas donde los murciélagos anteriormente pudieron encontrar insectos ahora forman una promoción de viviendas, por lo que hay menos insectos disponibles para los murciélagos.

Tiempo para completar la ronda con el Tablero 2: _____

Tablero 3 – Turbinas eólicas

Este tablero contiene los mismos peligros encontrados en el Tablero 2 y uno adicional. Se han construido unas turbinas eólicas en las praderas sobre que los murciélagos tienen que volar para llegar a los campos agrícolas. Volar demasiado cerca de las palas giratorias puede causar que se mueran los murciélagos. Algunas turbinas emiten un sonido que provoca que ellos vuelen lejos del peligro de las palas. Otras turbinas no tienen este sistema de alerta.

Tiempo para completar la ronda con el Tablero 3: _____

Si tienes poco tiempo, establece un límite de tiempo para cada ronda:

Para cada ronda, detenla después de _____ minutos. El murciélago con el mayor número de tarjetas de insecto en ese momento ¡gana! En caso de empate, el murciélago que tenga el mayor número de tarjetas Y que haya avanzado más en el tablero gana.

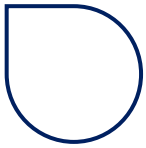
Del atardecer al amanecer: El viaje nocturno de un murciélago – Clave para el juego de tablero

	**La Cueva Bracken** • Este lugar se considera "el hogar." Todas las fichas de juego empezarán y terminarán aquí. • Si un murciélago se muere durante su viaje, el jugador debe devolver todas sus tarjetas de insecto a la pila y mover el murciélago de nuevo a la cueva. Cuando toma su próximo turno, el jugador tirará el dado de nuevo y empezará el viaje alrededor del tablero como un murciélago diferente.
	**Escarabajos derméstidos en el suelo de la cueva** ¡Ay, no! Chocaste con otro murciélago al salir de la cueva y te lastimó el ala. Cuando caíste al suelo de la cueva, los escarabajos derméstidos te comieron. Comienza de nuevo.
	**Nopales** ¡Uy! Estás atrapado en un cacto. Salta tu próximo turno.
	**Serpiente látigo** Eso fue rápido. Te enganchaste en un cacto y inmediatamente un serpiente látigo te comió. Regresa a la cueva.
	**Detente siempre ante una señal de STOP azul.** **SI estás moviendo hacia un árbol,** continúa moviendo hacia el árbol. Completa moviéndose el número de espacios que sacaste con el tiro del dado. **SI estás moviendo hacia un nopal,** detente aquí y date la vuelta. Espera aquí hasta tu próximo turno. En tu próximo turno, empieza moviendo hacia el árbol y continúa moviendo en esa dirección.
	**Arbusto** Sólo un arbusto. No hay peligros que evitar aquí.

	**Polilla** ¡Qué rico! Recoge 1 tarjeta de insecto.
	**Árbol** Sólo un árbol. No hay peligros que evitar aquí.
	**Campo de cultivo– rojo** Delicioso. Estás comiendo gusanos eloteros lo más rápido que puedas. Recoge 2 tarjetas de insecto.
	**Campo de cultivo – blanco** Estos gusanos cogolleros parecen estar moviéndose más despacio que lo usual esta noche y son fáciles de capturar. Recoge 2 tarjetas de insecto.
	**Campo de cultivo – azul** ¡Qué rico! Hay muchos escarabajos de pepino aquí. Recoge 2 tarjetas de insecto.
	**Mosca** ¡Deliciosa! Recoge 1 tarjeta de insecto.
	**Ave de presa** ¡Capturado! Un halcón de cola roja te agarró con sus garras. Devuelve tus tarjetas de insecto a la pila y regresa a la cueva. Empieza de nuevo con tu próximo turno.
	**Llanuras** Sólo campos de pastos de pradera y plantas. No hay peligros que evitar aquí.
	**Casas** Tu estómago gruñe. Te acuerdas de los campos llenos de polillas y escarabajos que antes estaban aquí. No hay nada que comer aquí ahora. Espera aquí hasta tu próximo turno.

	**Turbina eólica** ¡Caramba! La turbina te picó la curiosidad y te acercaste demasiado. Una pala te golpeó. Devuelve tus tarjetas de insecto a la pila y regresa a la cueva. Empieza de nuevo con tu próximo turno.
	**Turbina con equipo ultrasónico disuasorio** Tienes suerte. Un elemento disuasorio ha sido instalado en esta turbina. Este equipo produce un sonido para alertarte del peligro y tú no te quedaste atrapado entre las palas. ¡Sigue volando!
	**Detente siempre ante una señal de STOP roja.** **¿Tienes 6 tarjetas de insecto?** **SÍ**– ¡Felicidades! Continúa avanzando. Completa moviéndose el número de espacios que sacaste con el tiro del dado. **NO** – Detente aquí. En tu próximo turno & cada turno que sigue mueve hacia atrás en el tablero hasta que hayas recogido 6 tarjetas de insecto. Una vez que tengas 6 tarjetas de insecto, empieza de nuevo moviendo hacia adelante en el tablero. (Nota: Si regresas hasta la señal de alto azul, se te indicará que comiences a avanzar nuevamente.)

Consejos:

- No pasa nada si dos o más murciélagos (fichas de juego) caen en el mismo cuadrado. Cada murciélago (cada jugador) puede compartir el espacio hasta su próximo turno.
- Al llegar a la cueva al final del juego, para – aunque haya sacado un número mayor que lo necesario para regresar a la cueva.
-  Esta figura no significa nada especial en el tablero. ¡Sólo representa cómo se ve la esquina del tablero!

Del atardecer al amanecer

El viaje nocturno de un murciélago

Tablero 1

DEEP IN THE HEART

Del atardecer al amanecer

El viaje nocturno de un murciélago

Tablero 2

DEEP IN THE HEART

Del atardecer al amanecer

El viaje nocturno de un murciélago

Tablero 3

DEEP IN THE HEART

Nombre _____

Del atardecer al amanecer: Reflexión sobre el juego de tablero

Instrucciones: Una vez que hayas completado todas las 3 rondas (1 ronda en cada una de los 3 tableros) del juego de tablero 'Del atardecer al amanecer: El vieje nocturno de un murciélago,' responde las preguntas de reflexión abajo.

1. ¿Cuál ronda fue la que más tardó en completarse?

   a. Tablero1 – Original **b.** Tablero 2 – Una promoción de viviendas

   c. Tablero 3 – Turbinas eólicas

2. ¿Cuáles eventos crees que causaron que esta ronda tardara más tiempo en completarse? _____
   _____
   _____

3. ¿Cuál ronda fue la que tardó menos tiempo en completarse?

   a. Tablero1 – Original **b.** Tablero 2 – Una promoción de viviendas

   c. Tablero 3 – Turbinas eólicas

4. ¿Cuáles eventos crees que causaron que esta ronda tardara menos tiempo en completarse? _____
   _____
   _____

5. ¿Cómo la adición de la promoción de viviendas y las turbinas eólicas afectó la biodiversidad de este ecosistema? _____
   _____
   _____

6. ¿Crees que este ecosistema se mantendrá a lo largo del tiempo, a pesar de las tensiones (la promoción de viviendas y las turbinas eólicas)? ¿Por qué o por qué no? _____
   _____
   _____

Nombre _____

Aplica lo que has aprendido

1. ¿Qué es algo que los humanos pueden hacer para asegurar que los murciélagos sobrevivan y prosperen en su medio ambiente?_____

   _____

   _____

   _____

   En el juego de tablero aprendiste que la pérdida de su hábitat y las turbinas eólicas son dos de los retos que se enfrentan los murciélagos. Otra amenaza a las poblaciones de murciélagos es el síndrome de la nariz blanca. Lee el pasaje abajo para aprender más sobre el síndrome de la nariz blanca, y luego responde las preguntas a continuación.

   El síndrome de la nariz blanca (WNS)
   El síndrome de la nariz blanca (WNS) es una enfermedad fúngica que afecta los murciélagos. Se estima que esta enfermedad ha matado a millones de murciélagos en Norteamérica durante dos décadas. Esta enfermedad es causada por el hongo, *Pseudogymnoascus destructans* (Pd para abreviar). A veces el hongo parece una pelusa blanca que crece en la cara del murciélago. Por eso la enfermedad se llama el síndrome de "la nariz blanca". Pd prospera bajo condiciones frías, oscuras y húmedas, incluso las cuevas y las minas abandonadas donde los murciélagos a menudo viven en el invierno (WNS Response Team, n.d.).

   El hongo crece en la nariz, la membrana de la cola, y las alas de los murciélagos en hibernación. La infección causa que los murciélagos en hibernación usen más energía que lo usual, muchas veces causando la inanición antes de que llegue la primavera (NPS, 2017).

   En Norteamérica, el hongo fue identificado por primera vez en New York en 2006. Desde entonces, se ha extendido rápidamente hacia el oeste a través de los Estados Unidos y Canadá. WNS afecta a varias especies. Actualmente, 12 especies de murciélagos se han confirmado con WNS en Norteamérica (WNS Response Team, n.d.). Esta enfermedad ha causado una mortalidad grave y generalizada en tres de estas especies. Una especie está ahora catalogada como en peligro de extinción en los EE.UU. debido a WNS y dos otras especies muy pronto pueden añadirse a la lista de organismos en peligro de extinción en los Estados Unidos.

   Pd se detectó por primera vez en Texas en 2017 y desde 2019, WNS ha afectado significativamente las poblaciones del miotis mexicano (una especie de murciélago) en

el norte y centro de Texas. Durante el invierno de 2023-24, el pipistrelo del este americano en Texas fue identificado con síntomas de WNS. Esta especie se ha afectado mucho por WNS en otras partes de Norteamérica, entonces es una especie que suscita preocupación en Texas.

Dos otras especies de murciélago en Texas han sido detectadas con Pd: el murciélago orejón de Townsend y el murciélago mexicano de cola libre. No todos los murciélagos con Pd, desarrollan WNS. Algunos murciélagos parecen ser más resistentes y tolerantes de la infección Pd. Sin embargo, estos números cambiarán mientras Pd continúe propagándose. Puedes mantenerte informado aquí.*

2. ¿Qué tipo de relación ecológica existe entre los murciélagos y el hongo *Pseudogymnoascus destructans* (Pd)?

a. predatoria **b.** competitiva **c.** mutualismo **d.** parasitismo **e.** comensalismo

Explica por qué: _____
_____
_____

3. ¿Crees que el síndrome de la nariz blanca podría afectar la sostenibilidad del ecosistema? Si crees que no, ¿por qué no? _____
_____
_____
_____

4. ¿Crees que es importante que no humanos trabajen juntos para proteger a las poblaciones de murciélagos? ¿Por qué o por qué no? _____
_____
_____
_____

Referencias & fuentes para información adicional:
Si quisieras aprender más sobre el síndrome de la nariz blanca y como esto afecta a los murciélagos, visita los sitios abajo.

White-Nose Syndrome (WNS) Response Team. (n.d.). *What Is White-nose Syndrome?* *https://www.whitenosesyndrome.org/static-page/what-is-white-nose-syndrome

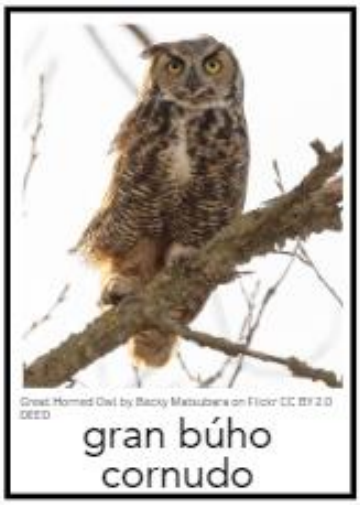
Texas Parks & Wildlife Department (TPWD). (2023 January 26). *Briefing White-Nose Syndrome*. https://tpwd.texas.gov/business/feedback/meetings/2023/0126/agenda/item.phtml?item=5

National Park Service (NPS). (2017). *What Is White-nose Syndrome?* https://www.nps.gov/articles/what-is-white-nose-syndrome.htm

ORGANISM CARDS SPANISH PAGE 1 of 4

Blank page for printing two-sided.
This will be the back of ORGANISM CARDS SPANISH PAGE 1.

ORGANISM CARDS SPANISH PAGE 2 of 4


Great Horned Owl by Becky Matsubara on Flickr CC BY 2.0 DEED

gran búho cornudo


Photo by Frank Cone from Pexels

halcón peregrino


Red-Shouldered Hawk by jeannettejvonne on Flickr PDM 1.0 DEED

halcón de hombro rojo


ZZT - Swainson's Hawk (10-3-2015) san rafael grasslands, santa cruz co, az -01 by Alan Schmierer on Flickr CCO 1.0 DEED

halcón de Swainson


Photo from Fin & Fur Films Productions

tasajillo


Opuntia sp. (prickly pear cactus) (Guadalupe Mountains National Park, Texas, USA) 10 by James St. John on Flickr CC BY 2.0 DEED

nopal


Government Canyon by John Hayes on Flickr CC BY 2.0 DEED

retoño de cedro de montaña


Celtis occidentalis common hackberry (trees) 15 James St. John on Flickr CC BY 2.0 DEED

almez


Wiess Park, Beaumont, Texas 16040261349 by Patrick Feller on Flickr CC BY 2.0 DEED

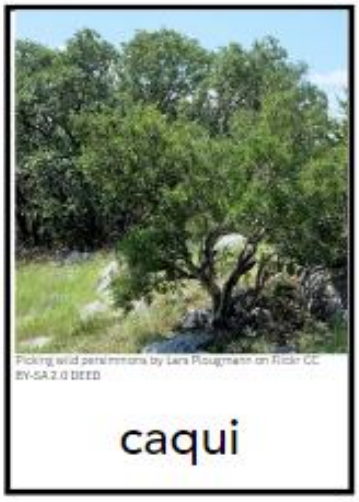
roble vivo

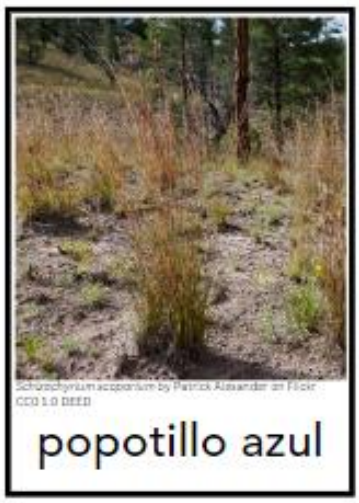
Blank page for printing two-sided.
This will be the back of ORGANISM CARDS SPANISH PAGE 2.

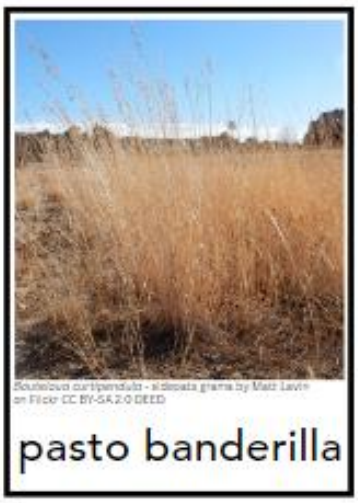
ORGANISM CARDS SPANISH PAGE 3 of 4


callicarpa americana

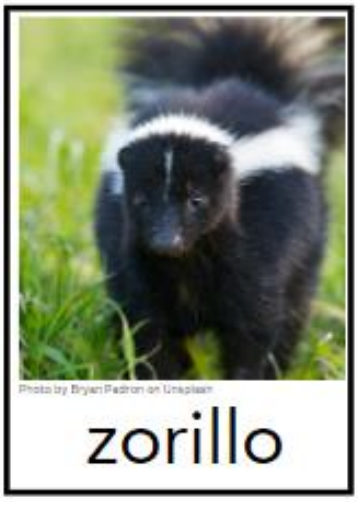

cedrón del río de la Plata


caqui

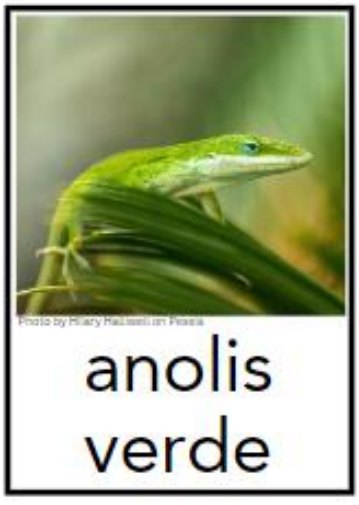

popotillo azul


pasto banderilla


mapache


zorillo


serpiente rata


anolis verde

Blank page for printing two-sided.
This will be the back of ORGANISM CARDS SPANISH PAGE 3.

ORGANISM CARDS SPANISH PAGE 4 of 4

ardilla zorro oriental

ardillón de roca

ratón

herrerillo crestinegro

cardenal norteño

azulillo pintado

vireo ojiblanco

paloma de alas blancas

Blank page for printing two-sided.
This will be the back of ORGANISM CARDS SPANISH PAGE 4.

IMAGE SOURCES

Organism Cards Images

- Mexican free-tailed bat photo from Fin & Fur Films Productions
- Coachwhip snake image IMG_3414 by Always a birder! on Flickr CC BY 2.0 DEED
- Helicoverpa armigera by Ilia Ustyantsev on Flickr CC BY-SA 2.0 DEED
- corn earworm, moth, back_2014-06-06-15.37.55 ZS PMax from USGS Bee Inventory and Monitoring Lab on Flickr PDM 1.0 DEED
- Western Striped Cucumber Beetle *Acalymma trivittatum* by Don Loarie on Flickr CC BY 2.0 DEED
- Differential Grasshopper (*Melanoplus differentialis*) by AssateagueNPS on Flickr PDM 1.0 DEED
- cucumber.JPG by Joe Quick on Flickr CC BY-SA 2.0 DEED
- Cotton filed photo by Mr. Location Scout from Pexels
- Corn field photo by Markus Spiske from Pexels
- Great Horned Owl by Becky Matsubara on Flickr CC BY 2.0 DEED
- Peregrine falcon photo by Frank Cone from Pexels
- Red-Shouldered Hawk by jeannetteyvonne on Flickr PDM 1.0 DEED
- 227 - Swainson's Hawk (10-3-2015) san rafael grasslands, santa cruz co, az -01 by Alan Schmierer on Flickr CC0 1.0 DEED
- Desert Christmas cactus photo from Fin & Fur Films Productions
- Opuntia sp. (prickly pear cactus) (Guadalupe Mountains National Park, Texas, USA) 10 by James St. John on Flickr CC BY 2.0 DEED
- Ashe Juniper Government Canyon by John Hayes on Flickr CC BY 2.0 DEED
- *Celtis occidentalis* (common hackberry tree) 1 by James St. John on Flickr CC BY 2.0 DEED
- Wiess Park, Beaumont, Texas 1604281349 by Patrick Feller on Flickr CC BY 2.0 DEED
- American Beautyberry by Pam Morgan on Flickr CC0 1.0 DEED
- *Aloysia gratissima* - whitebrush by Matt Lavin on Flickr CC BY-SA 2.0 DEED
- Picking wild persimmons by Lars Plougmann on Flickr CC BY-SA 2.0 DEED
- Little blue stem *Schizachyrium scoparium* by Patrick Alexander on Flickr CC0 1.0 DEED
- *Bouteloua curtipendula* - sideoats grama by Matt Lavin on Flickr CC BY-SA 2.0 DEED
- Raccoon photo by Henry Dinardo on Unsplash
- Skunk photo by Bryan Padron on Unsplash
- Great Plains Rat Snake (*Pantherophis emoryi*) by Peter Paplanus on Flickr CC BY 2.0 DEED
- Green anole photo by Hilary Halliwell on Pexels
- Mammals - Eastern Fox Squirrel by Laurie Sheppard U.S. Fish & Wildlife Service on Flickr PDM 1.0 DEED
- Rock squirrel 2015-10-14_12-33-51_USA_Zion_National_Park_P_JH by Jan Helebrant on Flickr CC0 1.0 DEED
- P197 Either Peromyscus leucopus (a white footed mouse) or its very similar close cousin, P. maniculatus (deer mouse) by Royce Milamon on Flickr CC BY 2.0 DEED
- 682 - BLACK-CRESTED TITMOUSE (10-25-2016) by Alan Schmierer on Flickr CC0 1.0 DEED
- Northern Cardinal by Shenandoah National Park on Flickr PDM 1.0 DEED
- Male Painted Bunting by U.S. Fish & Wildlife Service (Kenny Seals) on Flickr PDM 1.0 DEED
- 618 - White-Eyed Vireo (2-21-08) bentsen rio grande state park, mission, tx (1) by Alan Schmierer on Flickr CC0 1.0 DEED

- 431 - (White-Winged Dove (1-24-2022) americana rv park, palmview, tx -01 by Alan Schmierer on Flickr CC0 1.0 DEED

Board Game Icons

- Moth icon made by AmethystDesign from www.flaticon.com
- Shrub icon made by Flat Icons from www.flaticon.com
- Prickly Pear icon made by Freepik from www.flaticon.com
- Tree Icon made by Freepik from www.flaticon.com
- Snake icon made by berkahicon from www.flaticon.com
- Housefly icon made by bsd from www.flaticon.com
- Prairie "Grass icon" made by Freepik from www.flaticon.com
- Stop Sign icon made by Bartama Graphic from www.flaticon.com
- Beetle "Bug icon" made by Freepik from www.flaticon.com
- Cave icon made by kerismaker from www.flaticon.com
- Wind Turbine icon made by Culmbio from www.flaticon.com
- Field icon "Agriculture" created by Made from Noun Project
- Bird of prey icon "Eagle" created by Iconic from Noun Project
- Bats icon created by Vallone Design from Noun Project
- Houses icon created by Made from Noun Project
- Arrow icon "turn around" created by Made from Noun Project