



Bat Ecology

Program Purpose

Through hands on games and activities students will learn how bats live and how they benefit ecosystems.

Length of Program: 1 hour

Age: Grades 3rd-12th

Maximum Number of Participants: 25

Objectives:

After completion of all activities, students will be able to:

- List the different food sources consumed by bats
- Explain several bat adaptations
- Name several reasons why bats are beneficial and important to people
- Define and explain echolocation and how it is used by bats

Preparation:

Before the class arrives:

- Locate the program box in the work room
- Decide which activities to use based on age appropriateness
- Set up and review photo slides or PowerPoint presentation

Materials:

Bat Quiz
Slinky
Mega and Micro Bat Masks
2 Blindfolds
4 Rattles
Cotton balls with 6 scents
Bat skeleton diagram
Bat Skeleton
2 Little Brown Bats
*Optional visual aids:**

- Slide presentation
- PowerPoint presentation (see Appendix A)

*An optional PowerPoint presentation is available on the laptop. Photo slides of North American bats is located in the program box and a slide projector is kept in the Darkroom in the Nature Center.

Outline:

- I. Introduction
- II. Bat quiz
- III. Taxonomy

IV. Bat adaptations/2 games

V. Myths about Bats

VI. Benefits of Bats

VII. Conclusion/quiz answers

Introduction:

Introduce yourself to the class and explain that we will be talking about bats. Ask the students if they are afraid of bats and possibly why. Say that by the end of the class you hope to have relieved some of their fears and helped them better understand bats.

Humans tend to find some animals naturally compelling, while others are not so appealing. For example, many of us would much rather see moose, loons, and rabbits on a jaunt in the woods than snakes, spiders, and bats. Because of the way these animals have been portrayed in myths, folklore, books, and movies, many of us are biased towards cute, furry animals, even though all species play important roles in their ecosystems. Although some of our responses to certain wildlife help protect us from danger, logic does not always guide our beliefs and behaviors. Furthermore, we tend to overlook the benefits some species offer humans and other wildlife. Many of our beliefs about animals are not based on scientific facts.

Bat Quiz:

This is a quiz of ten crazy questions intended to get the kids thinking about bats. It should be read out loud; asking for raised hands if they think the answer is true, and hands down if they think the answer is false.

Taxonomy:

Does anyone know what this is? It is a way for scientists to classify and organize organisms (i.e. you use folders to keep you papers in and separated from class to class). Ask if they know about vertebrates and invertebrates, if yes then they will know mammals, reptiles and such, thus being able to understand the concept of taxonomy.

Use real examples to demonstrate the progression from general to specific.

Kingdom – Amimalia [Earth]

Phyllum – Chordata (nerve chord) [North Amer]

Class – Mammalia [U.S.A]

Order – Chiroptera (hand-wing) [Wisconsin]

Family – Vespertilionidae [their town]

Genus – Myotis (mouse-eared) [WI Dells]

Species – lucifugus (little brown bat) [Upham Woods]

Bat Adaptations:

The ONLY flying mammal

When people think about mammals, bats don't usually come to mind right away. Maybe it's because they don't like bats, maybe in their head they've grouped them with birds because they fly, or perhaps they have forgotten about them altogether since we don't see them often. In fact, bats are very abundant in the class of mammals. Of the 4,000 species of mammals in the world, about ¼ are species of bat.

Echolocation

Carnivorous and insectivorous bats use echolocation to locate food. This process is much like the sonar that is used on submarines to find objects in the water. A bat makes a sound like a beep. That sound is actually a sound wave that travels away from the bat like a wave in the lake when you drop a stone. When these waves move outward they hit objects and bounce back. Bats have very sensitive ears and can hear these sounds bouncing back like an echo in a canyon. Bats are so good at using echoes that they can tell the difference between what is food and what is a predator or an obstruction by the shape the echo returns in.

The bat can make up to 500 beeps in one second. Search mode for a bat is 10 beeps/sec. (Have the students try to clap their hands 10 times in a second, while you count for them "one one-thousand".) When they hear something of interest, bats will speed up the beeps to get a more detailed listen. As they close in they'll speed up to 200 beeps/sec, and they also coming back just as fast. Each time they send out a beep they have to close their ears so as not to deafen themselves. This adaptation helps bats find up to 3000-7000 insects/night.

A good example of how a bat uses echolocation is to get a volunteer from the audience and have them hold onto one end of a slinky. You will be holding the other end and both of you will drop to your knees to bring the slinky to the ground. Move about ten to fifteen feet apart and make a beep noise. When you make the noise send a single wave down the slinky and it will travel to the student and back to you. Every time you beep move closer and closer to the student making the beeps more rapid and more intense until you reach the student and pretend to eat them.

Game: Bat Moth

The bat moth game is intended to show students how echolocation works. Have the students make a circle and space themselves an arm length apart. Pick one student to be the bat. Put them in the center of the circle with a blindfold on. You will then pick one to four students to be the moth. Give each moth a rattle and the game begins. Every time the bat says beep the moths must shake their rattle. The moth may move but if the bat tags them they rejoin the circle and a new moth will enter the

circle. When the group gets the hang of the game you can add another bat to make things more challenging.

Mega vs. Micro

Bats are divided into two main groups: Megachiroptera and Microchiroptera.

- Megachiroptera is one group found all over the world but mostly in Southeast Asia. These bats are identified by their big eyes and small ears and better than average vision. They do not use echolocation because they are fruit eaters so they depend on eyesight and their sense of smell for food.
- Microchiroptera are found all over the world also and are very common in the U.S. These bats have large ears and small eyes with unusual skin folds around their nose to aid with echolocation. They can see but do not depend on vision for food collection.

The smallest and largest

The smallest bat in the world is the Kitti's hognosed bat, also known as the bumblebee bat. Its wingspan is only 6 inches, and it weighs less than a penny. It is the smallest (size not mass) mammal in the world. The largest bat in the United States is the Western Mastiff Bat, with a wingspan of 2 feet. The largest bats in the world are the Flying Foxes. These bats can have a wingspan of 6 feet.

Eating Adaptations

Did you ever stop to think what the world would be like if all animals suddenly tried to eat just one kind of food? What if they all decided to eat just grass? The answer is simple. They soon would run out of grass and starve to death. Because animals eat a wide variety of foods, they compete less, allowing many different species of animals to live in the same habitat and maintain healthy ecosystems.

Most of the world's bats eat insects, and in areas with cold winters, that is all they eat. Many tropical bats eat fruit and nectar, and a few are carnivores that eat other animals, including rats and mice, small birds, frogs, lizards, or even fish. Only three out of more than 1,000 species of bats drink blood.

Each species of bat has special adaptations for the food it eats. Experienced bat scientists can guess what a bat eats by looking closely at its adaptations. Long, narrow wings or large tail membranes are usually adaptations or catching insects, but if the bat also has huge feet and claws, it probably eats fish. Large, but not overly large, feet would indicate a bat that catches insects from pond surfaces. If a bat is large and has strong jaws, long canine teeth and a large tail membrane, it is probably a carnivore, adapted both to eating meat and to turning quickly while chasing prey. If it has strong jaws and long canine teeth, but has only a very small tail membrane, it is a fruit bat that does not need to chase

prey, but is adapted for biting into tough-skinned fruit to squeeze the juice out. All of these special adaptations allow bats to find and eat certain kinds of food with little or no competition from other species.

All bats that live in northern climates—where changes are frequent and unpredictable—are insect-eaters who seldom specialize on any one type of insect. In these places, it is rare to find a bat with highly specialized wings, feet, or ears.

Tail Scoop

A bat's wing membrane spreads all the way to its tail allowing for extra lift and ease of flight. The tail membrane has two other very important functions. First, it enables the bat to fly through the air and catch large amounts of bugs by making a cup with the membrane. It works like a bug net, sweeping an area to catch as many bugs as possible, and then flipping the insects towards the bat's mouth. This very effective method allows bats to catch around 600 gnat-sized insects an hour. The second important function is a baby seat. If a bat mother needs to transport her baby she will put it in the tail scoop and carry it with her.

Hanging upside down

Bats have adapted to hang upside down to avoid predators and to help conserve heat. Bats can do this because they have a tendon in their feet that requires them to have the foot closed. This makes it possible for bats to hang up side down from small cracks in rocks or trees and hibernate for around six months without exerting any energy. A bat foot is more like our hand in how it functions. Our hand requires us to exert energy to close the hand and make a fist. A bat foot does the opposite: it requires energy exertion to open the foot, allowing the bat to hang upside down while fully asleep.

Falling Flight

Bats are like jets, they need a runway to take off. Jets have engines that propel them forward and bats have gravity to propel them down. Bats fall a little ways to pick up speed and then take off before they hit the ground. If they are on the ground most of them can't take off. They will crawl with their legs and the claws on their thumbs to a higher position (on a tree or building) and fall into flight.

Roosts

The place where a bat hangs upside down to sleep, or just to stop and rest, is called a roost. Some bats roost in trees while other bats prefer to roost in caves. Bats might have different roosts for different times of the day (day or night roosts), or for different seasons (summer and winter roosts). Bats will often roost in a group, which is called a colony.

Colonies

When you find a bat in a cave or some other location it is probably not alone. The bats of Bracken Cave in Texas may number up to 25 million. These bats all share this close living space for a very good reason: Heat. All of these bodies create a lot of heat and keep the cave a little warmer. As many as 200 bats can be found clinging to one square foot of rock. The nursery at Bracken Cave may have up to four million babies in it at one time. How does a bat mother find her baby? Bats have an excellent sense of smell and hearing so they can easily identify their babies by their sound and smell in a group of four million.

Hibernation

Ask the students what hibernation is to get an idea of their level of knowledge. Many students will say that the animal is sleeping through the winter, but it is much more than that. When an animal goes into hibernation, it is trying to conserve as much energy as possible. To do this, a bat's body temperature will drop to match its surroundings (sometimes from over 100°F to 40-60°F). In addition the bats breathing rate and heart rate will drop dramatically. A bat whose heart would normally beat 400 times per minute, might only beat 25 times per minute.

Bats that roost in trees are less likely to hibernate during the winter because they do not have as much protection from the cold. Instead these bats will migrate south for the winter, sometimes up to 800 miles into the southern U.S. and Mexico.

Endangered bat species are typically those with the narrowest requirements for hibernation.

Baby Bat Adaptations

To give the babies the best chance at survival, bats need to be very developed when they are born. The average baby bat is about one-fourth to two-thirds the weight of its mother. This means that if your mom weighs 100 pounds, you would have weighed 33 pounds when you were born. Some bats, like the red bat, have twins.

Game: Where's my baby?

Many mother bats and their babies will live in a nursery colony. Born without fur, the babies pack tightly together to share body heat and stay warm. Mothers usually roost together in another part of the cave, each returning to nurse her baby several times a day. Each mother locates her own baby through recognition of its scent and call.

The class participates, but only six mothers and six babies are selected. Each baby is given a cotton ball with a scent. The mother needs to become acquainted with the smell. The baby is then assigned a call, some simple pattern of tongue clicking. Mother and baby

should practice several times to ensure recognitions of scent and sound. Mothers are then blindfolded. The other students in the class are also babies but without a scent or assigned call. All babies are arranged in an open space, and the teacher places the six special babies throughout the group. All babies are stationary. Only mothers move.

Delayed Conception (advanced topic for older groups)
Bats live half to two thirds of their life in hibernation. Bats do not have enough time to mate and carry young to term in the short time they are awake. To overcome this problem, bats delay their conception. Unlike most animals who mate early in the spring bats mate in late fall. The female stores the sperm in her uterus and actually feeds the sperm through her cells. About two months before the end of hibernation, the sperm is released to the egg and conception occurs. This allows the female to be ready for birth at about the same time she is ready to come out of hibernation. This way, the baby is given the maximum amount of time to grow and develop into an adult before it must hibernate.

Activity: Adaptation Artistry

At this point you have covered many of the adaptations that bats have. Have students create their own bat, thinking of which adaptations their bat will have, and drawing it on a piece of paper using pencil, crayons, markers, etc. Encourage students to think about where their bat will live, what it will eat, and how those factors will affect the way the bat looks and behaves.

Myths About Bats:

Vampire Bat Adaptations

There are three species of vampire bats in the world: the common vampire, the hairy-legged vampire, and the white-winged vampire. All of the vampires feed on the blood of mammals but they will also feed on the blood of birds. Vampires have very pronounced upper incisor and canine teeth but the rest of their teeth are much smaller than the average bat. These teeth are razor sharp and are used to make a cut in their prey. They wait for the blood to drip down, forming a puddle, so they can lap up the blood the way that a dog drinks water. Vampires have a strong anticoagulant in their saliva that stops the blood from forming a scab, and keeps the blood flowing freely. The most common place to make a cut is around the eyes, lips, ears, feet, fingers, and base of the tail, of cows, pigs, horses and birds. Although it has occurred, it is very uncommon for vampire bats to bite humans.

(Advanced discussion) After feeding, the bat is too heavy to fly after having consumed two to three ounces of blood. The vampire bat will crawl away from its prey to a safe place to wait for digestion. The vampire bats kidneys are very quick and will process most of the water out of the blood, making the bat urinate. After urinating, the bat can fly away. The prey will bleed for a

long time sometimes days and babies will occasionally bleed to death because the anticoagulant will not allow the wound to heal.

Rabies

A common myth about bats is that they all have rabies. Like all mammals, bats can carry rabies but they are no more likely than dogs, cats, foxes, raccoons, skunks, coyotes, and livestock. The most likely reason a person would get rabies from a bat is because they are curious when they see a bat on the ground, and they pick it up. Healthy bats fly around and usually try to avoid humans, but bats lying on the ground are usually sick. That doesn't always mean they have rabies, but they would not normally let a human get close to them, so you should know that something is wrong. You should assume that any bat or wild animal that lets you get close might be sick. If a bat bites you, you should bring the bat and yourself to a doctor. The doctor will have the bat tested for rabies and if it does have rabies you can be treated with a series of shots.

Flying Mice

Because of their physical appearance, many people have been led to believe bats are related to mice. Just look at the translations of "bat" from other languages; German *fledermus* (flutter-mouse), French *chauve-souris* (bald mouse), Spanish *ratones voladores* (flying rats). However, bats and mice are very different creatures, and no more alike than bats are like humans. The average lifespan of a mouse is between six months to one year, and a bat on average lives for about 30 years. Also, mice can have up to 50 babies in a year, whereas most bats only have one.

Benefits of Bats:

Ecological Benefits

Bats also have a niche in the environment. Bats play an especially important role in the pollination and seed dispersion of many different plant species. Without bats to help these plants reproduce, some plants that humans use and appreciate would no longer exist. Bats can be the sole pollinator to some the many plants that only bloom at night. If the bats were not around to help pollinate these plants, they would soon cease to exist as well because of their dependent relationship with bats.

Bats who eat fruit will consume the entire thing, seeds and all. What happens to the seeds after they are eaten by the bat? The seeds come out of the bat in their own personal pile of fabulous fertilizer—bat guano. In this way, bats are helping to plant more of this type of plant in more places.

Because some species of bats are predatory (they hunt for and consume other animals) without them as a part of the ecosystem, things may look very different. If a single bat can catch hundreds of insects in an hour, just

think about the impact of an entire colony. The 20-million Mexican Free-tailed bats living in bracken cave in Texas can consume more than 200-tons of insects in a single night. What kind of an infestation would we have if bats were not around to control insect populations?

Bats can also be prey for other animals. Bats are eaten by snakes, birds, other mammals, and other bats. Without this important source of food, some of these animals might not be able to survive, which could in turn disrupt the balance of an entire ecosystem.

Human Benefits

Humans all over the world benefit from bats and their nightly habits. In this section you will expose the students to a few of these benefits.

Ask the students, who likes black pepper, chewing gum, Fig Newton's, bananas? Who has a grand parent or parent that has under-gone heart surgery? All of these things could not exist without bats.

- 75% of the black pepper grown in the world uses bat guano as a fertilizer.
- Gum trees, fig trees, peach trees, mango trees, avocado trees, date trees, cashew trees, and banana trees are all pollinated by bats. Without bats we would not have these wonderful foods to eat.
- If they have a parent or grand parent who has had heart problems they were probably given an anticoagulant made from broken down vampire bat saliva. When a vampire bat makes a cut in its prey its saliva keeps the cut from healing by thinning the blood. This technology has been adapted to make anticoagulants for use in humans to thin blood and make it easier for the heart to pump through clogged arteries.
- Bat guano was used as an ingredient in gun powder during the civil war.
- Bat guano is an awesome fertilizer because it contains some very important nutrients. Some people even purchase bat guano fertilizer for their plants.
- Bats control insect populations like mosquitoes that pester us personally, or like the grubs and worms that eat our agricultural crops.

Conclusion:

Ask the students if they think that it is important to have bats in an ecosystem? What can we do to help bats to ensure that they are around for years to come?

Staying out of caves during months when bats might be hibernating is a huge help to the species. If a bat is disturbed just once during hibernation and it moves over one inch, it could use a month worth of energy, forcing it to come out of hibernation sooner.

Another great way to help bats is to conserve and protect their habitat. This could also include building a bat house, where the bat can roost and raise young, or limiting the destruction of their natural habitat through land development.

Other ways to help bats:

- Adopt a bat from Bat Conservation International
- Join Bat Conservation International as a member
- Share all of the awesome information you've just learned about bats so that they will know that bats are not as scary as you might think.

Optional Activities:

Some bats specialize in eating just one or a few kinds of food, but others are generalists that eat a wide variety of foods. Some bats that catch insects have adaptations for hunting certain kinds of prey or for capturing them in certain places.

Food Game

1. Divide class into groups of six or more students.
2. Distribute one complete set of Food Cards, a piece of paper and pencil to each group. Tell the group to divide the fact cards among themselves, so each student can become an expert on one of the bat eating habits.
3. Ask students to number their paper 1 – 12 down the left-hand side. Ask questions by reading the "Bat Food Clues" to the class one at a time.
4. Give each group a minute or two to discuss each given clue, and decide what type of bat it is.
5. After all clues are given and students have written their answers, go back through the clues and lead the class in discussing the answers. Bonus questions after each clue can be used to stimulate additional discussion. Each group's expert on each feeding type can be called upon to help lead discussions.

References:

Tuttle, Merlin D. (1988)

America's Neighborhood Bats. University Of Texas Press, Austin, TX.

Greenaway, Frank. (1991)

Amazing Bats. Alfred A. Knopf, Inc., New York, NY.

Shea, George. (1977)

Bats. EMC Corporation, St. Paul, MN.

Bat Conservation International. (1991)

Educators Activity Book About Bats. Bat Conservation International. Austin, TX.

Hill, John & Smith, James. (1984)

Bats, A Natural History. University Of Texas Press, Austin, TX.

Appendix A

Power Point Presentation

- Slide 1: Title Slide
- Slide 2: Taxonomy
- Slide 3: The only flying mammal
- Slide 4: Bat skeleton picture
- Slide 5: Ecolocation
- Slide 6: Ecolocation Adaptations
- Slide 7: Micro vs. Mega
- Slide 8: The smallest
- Slide 9: The Largest
- Slide 10: Microchiroptera = Insectivores
- Slide 11: Eating Adaptations
- Slide 12: Tail Scoop
- Slide 13: Hanging Upside-down
- Slide 14: Roosts
- Slide 15: Where do bats live?
- Slide 16: Hibernation – Where, what, & why?
- Slide 17: Bat Babies
- Slide 18: Myth #1 All bats are vampires!
- Slide 19: Myth #2 Bats will give you rabies!
- Slide 20: Myth #3 Bats are flying mice!
- Slide 21: Bats of Wisconsin – Hibernators
- Slide 22: Bats of Wisconsin – Migrators
- Slide 23: Bat Benefits – Pollination
- Slide 24: Bat Benefits – Seed Dispersal
- Slide 25: What can you do for bats? (Cave)
- Slide 26: What can you do for bats? (House)
- Slide 27: Thank you to...