BAT CONSERVATION INTERNATIONAL

EDUCATOR'S ACTIVITY BOOK
ABOUT BATS

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BAT CONSERVATION
INTERNATIONAL
Post office Box 162603 Austin, Texas 78716 - 512-327-9721

Dear Educator:

Bats are essential to the balance of nature, playing key roles in maintaining the diversity and quality of life on earth. Nearly a thousand kinds comprise almost a quarter of all mammals. They keep vast numbers of our most serious insect pests in check, and, in tropical areas, their pollination and seed dispersal activities are of enormous ecological and economic value.

Nevertheless, bats also rank among the world's most endangered animals. Almost 40% of our North American species are endangered or are candidates for such status. Like most wildlife, they suffer from habitat loss. However, the single most important cause of bat decline is often deliberate destruction by people who needlessly fear them.

As an educator, you are in a unique position to help. Children are naturally curious about bats, and, with a proper introduction, quickly learn to appreciate them. The craft projects, games, and other activities provided in this handbook are designed to make education fun and can be integrated easily into other classroom studies.

Because bats are misunderstood and intensely feared, they are ideal for teaching basic principles about prejudice and fear of the unknown. As children come to understand how wrong they can be about bats, they may be encouraged to question basic assumptions often made about other unpopular animals and even people. Finally, they must learn to appreciate that wild animals are fascinating but potentially dangerous if handled.

We deeply appreciate your help in enlightening a new generation about the importance of bats and our environment. We also thank the many educators who have played an important role in making this publication possible. Ideas for future materials are always welcome.

Sincerely,

Merlin D. Tuttle
Founder and Executive Director

Table of Contents

Introduction

Objectives, activity types, and targeted grade levels are explained for each activity, and a list of materials is included. Grade level guidelines are suggested, though educators should make their own judgments about which are most appropriate for their classes. The activities can be used individually or as part of a study unit on bats. Before planning to use an activity it will be useful to page through the entire book and familiarize yourself with the background information provided in all of the activities. For example, Activity 1 includes substantial introduction to bats, Activity 2 addresses myths, Activity 12 covers some of the economic benefits of bats, and bat endangerment is discussed in Activity 6. Information from several activities can be combined and educators can build presentations or programs appropriate to their specific needs.

Every effort was taken to provide accurate information for this general-focus bat publication. With nearly a thousand bat species known to science, it is extremely difficult to generalize for all bats.

1. Test Your Bat Q

Objective: To test basic knowledge about bats

Grades: 3-5

Type of Activity: Questionnaire

Materials
- **Copies of page 9**
- **Pencils**

Background Information

What most people believe about bats isn't even true. Because bats fly at night and are shy, they are difficult to understand. People fear most what they understand least. Lack of understanding and deliberate destruction are the most common causes of bat decline worldwide. The following text provides an introduction to bats.

Copy the one-page questionnaire (pre-test) and give to students prior to a study unit on bats or before a program. The text included here will assist in presenting key points on the importance of bats. Following a study unit or program, the questionnaires can be returned to the students who should then be able to correct any errors (post-test).

Answer Key

A. True, 2, 6, 7, 10

B. Circle all

C. Nearly 6 feet, a flying fox bat from Java

D. Bumblebee, the bumblebee bat from Thailand

E. 1,000

F. 40

G. Mammals

H. 1

I. Circle all

J. Everywhere except polar regions

K. Circle all

Bats: Our Allies

Bats are animals of extraordinary importance. Many are so essential that, without them, thousands of other plant and animal species could die out, threatening entire ecosystems from rain forests to deserts.

Yet despite their importance, bats are among the world's least appreciated and most endangered animals. For centuries, people have feared and persecuted bats, exterminating whole species and threatening the survival of many more.

Bats have been neglected even by scientists and conservationists. Although nearly 1,000 kinds comprise almost a quarter of all mammal species, bats are by far the least studied. They are found everywhere except for very dry deserts and polar regions, but bats are often ignored in conservation planning, seriously jeopardizing efforts to save rain forests and other important habitats.

Like most animals, bats suffer from habitat loss and environmental pollution, but the primary cause of their decline is wanton destruction by humans acting out of fear and ignorance. Bats filled the night skies long before we walked the earth, but their survival today requires that we learn to value them as essential allies, deserving of our respect and appreciation.

Many people still believe that bats are blind flying mice that carry diseases and become entangled in hair. But bats are more closely related to people than to mice, none are blind, and they are far too clever to entangle themselves in anyone's hair. Bats seldom transmit disease to people or pets, and our concerns should be no different from those we apply to other wild animals. Simply do not attempt to handle them, and there is little to fear.

Bats are among the most gentle, beneficial, and even necessary animals on earth. They occupy almost every habitat worldwide, eating insects, pollinating flowers, and dispersing the seeds that make rain forests grow. Forty-three species live in the United States and Canada, but the majority live in the tropics. Wherever bats are found, they are essential elements in nature's delicate web of life.

Controlling Insects: Master of the Night Skies

Bats are by far the most important natural predators of night-flying insects, consuming great quantities of mosquitoes, moths, beetles, crickets, leafhoppers, chinch bugs, and a variety of aquatic insects. Many of these are serious crop pests, and others spread disease to humans or livestock.

A single little brown bat, one of North America's most abundant species, is capable of capturing 600 mosquitoes in an hour. One colony of 20 million Mexican free-tailed bats in Central Texas eats up to half million pounds of insects in a single night.

How do they do this? Bats use their sophisticated sonar, called echolocation, to detect prey. Like dolphins, most bats communicate and navigate with these high-frequency sounds. Using echolocation alone, bats can "see" everything but color, and in total darkness can detect objects as fine as a human hair.

By consuming vast numbers of night-flying insects, bats form an integral link in ensuring environmental health. When bat populations are destroyed, insect pests can multiply, unchecked by their natural predators. The repercussions can be extremely harmful to humans.

For example, in Israel a campaign to eradicate fruit bats by poisoning their caves, instead killed almost 90% of the country's insectivorous bats. Noctuid moths, formally controlled by the bats, proliferated and their caterpillars became major agricultural pests. To save crops, extensive chemical control is now required, polluting the environment.

The loss of insectivorous bat populations leaves us increasingly dependent on pesticides, which already threaten our environmental and personal health. With over 850 million pounds of pesticides applied to America's crops each year, our groundwater is increasingly contaminated and runoff is further damaging wildlife habitat in a chain of environment degradation that must be reversed. Protecting bats is part of the solution.

Renewers of Rain Forest, Lifegivers to Deserts

Throughout tropical regions, fruit and nectar-eating bats are vital to the survival of rain forests, which in turn play an essential role in the stability of world climates. These forests, where more than 90% of all terrestrial plant and animal species live, contain our planet's richest biological diversity. But without bats to pollinate flowers or dispersed seeds, the diversity of other rain forest animals and plants would be greatly reduced, threatening delicate balances with unknown consequences.

In West Africa, bats carry 90 to 98% of the seeds of "pioneer plants" that initiate forest regrowth on cleared land. These hardy trees and shrubs grow rapidly, soon attracting other mammals and birds that in turn bring seeds of different plants. Without bats, the cycle of rain forest regeneration might never begin.

Bats also play key roles in other tropical forests from Latin America to Asia and Australia. In the Pacific Islands, as many as 40% of tree species depend on bats for seed dispersal or pollination, and further studies likely will reveal even more.

On the savannas of East Africa, the giant baobab is known as the "Tree of Life" because so many other plants and animals depend on it for their survival. But the tree itself depends on bats. Its showy white flowers open only at night and are specially adapted to be pollinated by bats. Without bats, the baobab could die out, triggering a chain of linked extinctions and threatening plant and animal life throughout the region.

In the Sonoran Desert of the southwestern United States and Mexico, long-nosed bats play a similarly critical role in the lives of several species of agaves (century plants) and giant cacti. As with Africa's baobab tree, the giant cacti provide food and shelter for countless other animals. The bats that pollinate their flowers and disperse their seeds were recently declared endangered; if they disappear, these majestic plants and the wildlife that rely on them, could be seriously threatened.

The relationships between plants and their animal pollinators and seed dispersers are the result of millions of years of evolutionary interplay. Ecologists now know that even small disturbances can destroy entire systems of plant and animal life, and that it takes millions of additional years for species diversity to even begin recovery. Loss of plant and animal diversity is perhaps the most serious of long-term global problems we face.

Bats and Economics

Many of the world's most economically important plants rely on bats. Some crops from these plants are valued in the hundreds of millions of dollars each year and are crucial to the economies of cash-poor developing countries.

In Africa, rapidly declining flying foxes are the only known seed dispersers for the iroko tree, whose timber is worth millions of dollars annually. A recent study documented nearly 300 plant species in the Old World tropics alone that rely on bats. Some 450 commercial products come from these plants. Just one, the durian fruit of Southeast Asia adds $120 million to local economies. Other products include medicines, food and beverages, timber, ornamentals, fiber and cordage, and dyes and tannins.

Many of our cultivated crop plants still rely on bats for their survival in the wild. These include fruits such as bananas, plantain, breadfruit, avocados, dates, figs, peaches, and mangoes. Other bat-dependent products are cloves, cashews, carob, balsa wood, kapok filler for life preservers, and tequila, which come from agaves.

Although most of these plants are now commercially cultivated, wild ancestral stocks remain essential. They are the only source of genetic material for development of disease-resistant strains and for producing new, more productive plants in the future.

With many flying fox populations in jeopardy, the need to understand their vital ecological and economic roles is crucial.

People Need Bats

Bats affect our lives in more ways than we realize. Without bats, our grocery stores might not look the same, and mosquitoes would find the world a much safer place to live. Imagine an Arizona sunset without giant cacti or the savannas of East Africa without baobab trees.

Even in places so hidden from humans that we are rarely aware of them, organisms that depend on bats for their survival are yielding treasures of great benefit to us. New species of bacteria discovered in American bat caves are now being studied by major corporations for use in chemical waste detoxification, gasohol production, and improved detergents. Still others may soon be used in the production of new antibiotics.

When a colony of cave-dwelling bats is lost, the potential benefits of countless microorganisms and other animals perish with them. Some of these live in only one bat cave in all the world.

Loss of bats may seriously damage entire ecosystems upon which we ourselves depend. These losses are not reversible; the consequences are unpredictable and potentially disastrous.

The Need For Bat Conservation

The contributions bats make to the quality of life on earth and to the welfare of humans are many. Yet humans are needlessly destroying bats nearly everywhere.

Bats are virtually defenseless, and large colonies make easy targets. A single act of vandalism can kill millions at a time, having a significant impact on the survival of an entire species. Many bats require large numbers for successful rearing of young, and most produce only one pup per year. These factors combine to make bats exceptionally vulnerable to extinction.

The Decline of Bats in Europe and North America

In Europe, bats that were common only 30 years ago are now endangered. In the United States, nearly 40% of our 43 bat species are on the endangered list or are official candidates for it. Vandalism and repeated disturbance in roosting caves is a primary cause.

Gray bats are among our most abundant animals at the turn of the century; now they are endangered. Indiana bats, also endangered, declined by 55% in less than 10 years.

In the early 1960s, Eagle Creek Cave in Arizona housed the world's largest known bat colony, approximately 30 million Mexican free-tailed bats. Yet they declined 99.9% in only six years. Imagine the local impact of more than a half million pounds of additional insects left uneaten each summer night.

The Plight of Flying Foxes and Other Tropical Bats

Some governments list bats as pests, targeting them for eradication. In Queensland, Australia, mass hunts have killed thousands of flying foxes at a time, even though many of Australia's most economically important timber trees rely on bats for pollination or seed dispersal. Flying fox numbers have declined drastically.

In Latin America, the common vampire bat, who feeds on blood, has proliferated with the arrival of humans who introduced livestock. In many places vampires now require control, but poorly trained government agents and local farmers often indiscriminately kill all bats, unaware that the majority of Latin America's 270 other bat species are highly beneficial.

Dawn bats, the primary pollinators of Southeast Asia's $120 million durian crop, are declining rapidly from loss of cave roosts and uncontrolled harvest for human food.

Throughout Southeast Asia and the Pacific and Indian Ocean islands, flying fox populations are in jeopardy. On Guam, where bats are considered a delicacy, one of the island's flying fox species recently became extinct without even being listed as endangered, and the second is now in serious trouble. Commercial export of flying foxes to Guam has decimated additional populations. Several species are now extinct from this and other unregulated hunting.

The Need is Urgent

The status of bats is so poorly known in most parts of the world that species are becoming extinct before they can be recognized as endangered. Even in the United States, we do not know the true status of some of our most widespread species.

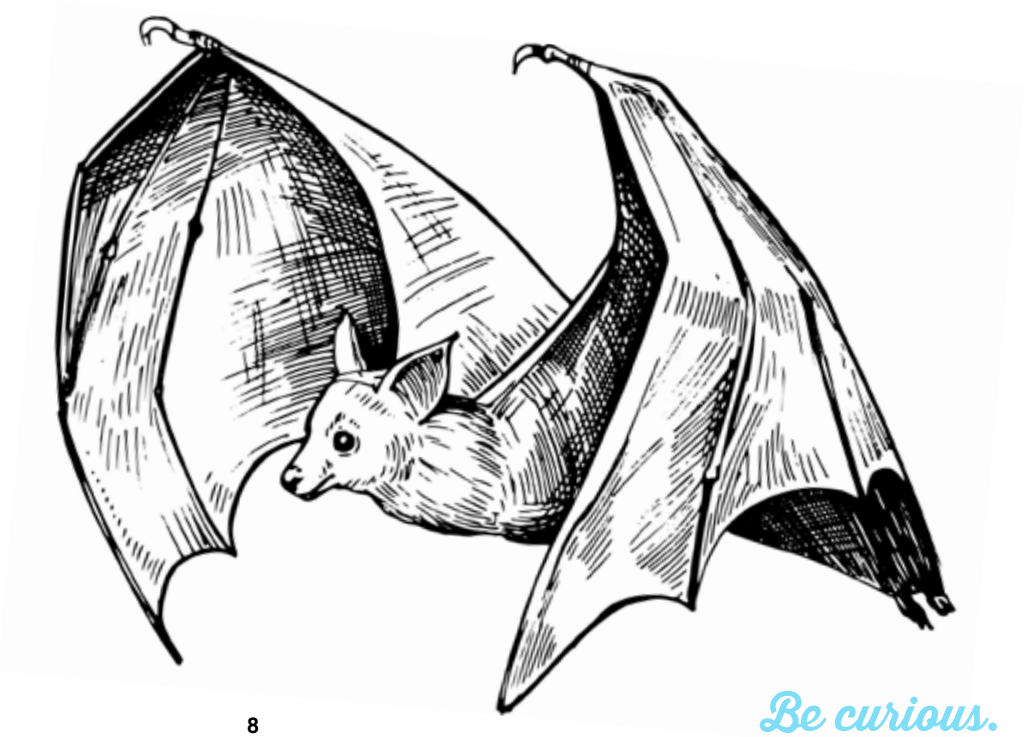
Major ecosystem studies in tropical forests, where bats comprise almost half of all mammals species, have ignored bats as though they did not exist. Conservation planners, therefore, often fail to consider bats in projects to save tropical forests, even when the results of such neglect seriously threaten their success.

In many places, once vast populations of bats now survive only as mere remnants. Many of the species needed in large numbers to maintain the balance of nature are, instead, at such low population levels that they are almost ecologically irrelevant.

For some it is too late, but for many others protective action now can save them

Education is Essential

Bats are among the most intensely feared and relentlessly persecuted animals on earth. Through ignorance, many populations have been needlessly destroyed. Most people know little about bats, often believing popular myths. Changing these false perceptions is essential for lasting conservation progress.



Test Your Bat Q

A. True or False

Bats swoop down and get caught in people's hair. _____
Bats are the only kind of mammal that can fly. _____
Bats are flying mice. _____
Bats are blind. _____
Most bats are dirty and carry rabies. _____
If you see a bat on the ground during the day it might be sick. _____
There really are bats that feed on blood. _____
Bats produce several litters a year, just like mice. _____
Bats are ugly animals. _____
A single bat can catch 600 mosquitoes in just one hour. _____

B. Bats around the world can eat the following things (circle all correct answers):

Fruit Nectar Insects Fish Blood

C. The biggest bat in the world has a wingspan of what size:

1 foot 3 feet 6 feet 50 feet

D. The smallest bat in the world is the size of what animal?

Ant Mouse Guinea pig Bumblebee

E. Worldwide there are about _____ different species (kinds) of bats.

10 100 500 1000

F. In the United States there are about _____ kinds of bats.

5 10 40 100

G. Bats are what kind of animal?

Birds Reptiles Amphibians Mammals

H: Most bats produce _____ baby(ies) a year.

10 5 1 25

I. Bats are found in which of the following places (circle all correct answers):

Tree holes Caves Attics Plant leaves
Bridges Mines Tree bark Rock crevices

J. Bats live in which of the following kinds of areas (circle all correct answers):

Mountains Deserts Rain forests Cities
Prairies Wetlands Farmland Polar regions

K. Bats are important to the environment because they (circle all correct answers):

Pollinate flowers Distribute plant seeds Eat insects

2. Bat Attitudes

Objective: To correct common myths about bats

Grades: K-2

Type of Activity: Simple quiz and coloring

Materials:

- **Copies of pages 11 and 12**
- **Crayons or markers**
- **Scissors**
- **Lamination material (optional)**

Background Information

Throughout history, bats have shrouded in myth and superstition. Bats are shy, fly at night, and are difficult to observe. Hollywood has played a major role in perpetuating misinformation about these fascinating and highly beneficial animals.

On page 11 are six cartoons illustrating something that is true or false about bats. Make double-sided copies of pages 11 and 12 for each student (note that text on page 12 should line up with the appropriate cartoon). Before looking at the answers on the reverse side, ask students to respond, true or false, to the statement on each cartoon the individual cartoons can be colored and cut apart. Cartoons could later be laminated and used as a game for review. Children can also use the cards to quiz other students. The following provides additional information on each statement for educators to use when presenting the activity.

1. Bats are blind.

False

All bats have vision and see well. Insectivorous bats often have small eyes and depend primarily on their echolocation (sonar) to navigate and find food. Fruit bats, especially flying foxes, have excellent vision and a good sense of smell, which they used to find ripe fruit. Flying fox bats, who have large eyes, are not able to echolocate. Sonar is not needed to find stationary food.

2. Bats get caught in your hair.

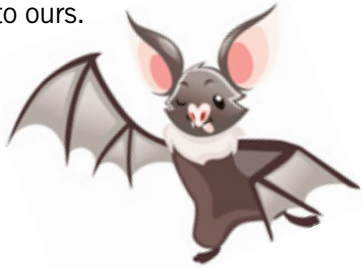
False

Insects often hover around people, and a hungry bat may seem to swoop down in hot pursuit of a pesky mosquito. Their sonar ability is sophisticated enough to find such an insect in complete darkness. They certainly are not going to blunder into a person's hair.

3. Bats are flying mice.

False

While bats may resemble mice with wings, they are not closely related to rodents. Both bats and mice are mammals, but studies indicate bats to be more closely related to primates (and humans) than to rodents. Flying foxes have a brain organization very similar to ours.



4. Bats are dirty and many carry rabies.

False.

Bats are very clean and groom themselves several times a day just like cats. The issue of bats and rabies is greatly exaggerated. Bats can contract rabies just like all mammals, but they are not asymptomatic carriers of rabies, and they quickly die from the disease. The incidence of rabies in bats is less than half of 1% in more than 40 years of record-keeping in the U.S., only 20 people are believed to

have died from contact with bats. As many or more people die annually from being attacked by their own pet dogs. People have little to fear from bats if they never try to handle them. An important message for children, especially when they come to like bats, is that bats are wild animals that should never be touched. Any bat or wild animal that can be approached is more likely than others to be sick.

5. Bats are the only mammals that can truly fly.

True

Mammals such as flying squirrels are actually gliders. Bats are the only mammals capable of sustained flight. There is a great diversity of flight patterns among the nearly 1,000 kinds of bats. Some can hover like hummingbirds while feeding on nectar, and a few diurnal flying foxes are able to soar on thermals just like eagles.

6. Some bats can catch up to 600 mosquitoes in just one hour.

True

The little brown bat, one of America's most common species, is capable of such a feat. On average, insectivorous bats eat about half their weight in insects each night. Nursing mothers sometimes eat more than their body weight. A Texas nursery colony of 20 million Mexican free-tailed bats can consume up to 500,000 pounds of insects in a single night.

True or False?
Bats are blind.

True or False?
Bats get caught in your hair.

True or False?
Bats are flying mice.

True or False?
Bats are dirty and carry rabies.

True or False?
Bats are the only mammals that truly fly.

True or False?
Some bats can catch up to 600 mosquitoes in one hour.

False

Bats can find tiny insects in total darkness. They are much too smart to fly into people.

False

No bats are blind and many can see very well. Insect-eating bats depend on sound and very good hearing to find food and get around in the dark.

False

Bats are clean and groom themselves just like cats.

Bats can get rabies, like all mammals, but few do. Remember, bats are wild animals. You have nothing to fear if you never touch a bat.

False

While both bats and mice are mammals, bats are not rodents and are more closely related to primates and people.

True

Insect-eating bats can eat up to half their body weight in insects in one night. The record for mosquito catching is 600 in an hour!

True

Some mammals, like flying squirrels, can glide. Bats are the only mammals that can really fly.

3. Bat Crossword Puzzles

Objective: To introduce new words associated with bats

Grades: Puzzle A - 2-3 ; Puzzle B - 3-5

Type of Activity: Word game

Materials:
- **Copies of pages 14 or 15**
- **Pencils**

Background Information
To learn about bats, children need to become familiar with the terms used to describe their life style and habits. The following two crossword puzzles will familiarize children with basic bat terminology. The puzzles differ in degree of difficulty. The answers are included in a box on each page. The teacher may choose to cover these when copying the puzzles.

Answer Key

Puzzle A

ACROSS

Bats are the only kind of mammal that can **fly**.

An animal that is disappearing is said to be **endangered**.

Most mother bats produce only **one** (home many) baby each year.

A bat is a **mammal**.

Most bats are active only at **night**.

Many bats use **sound** to navigate and find food.

DOWN

1. Most bats in the world eat **insects**.
2. **Bats** are the only mammals that truly fly.
3. A baby bat is called a **pup**.
4. A bat's wing is very similar to our own **hand**.
5. All bats can see, no bats are **blind**.
6. Many bats spend at least part of the year living in **caves**.

Puzzle B

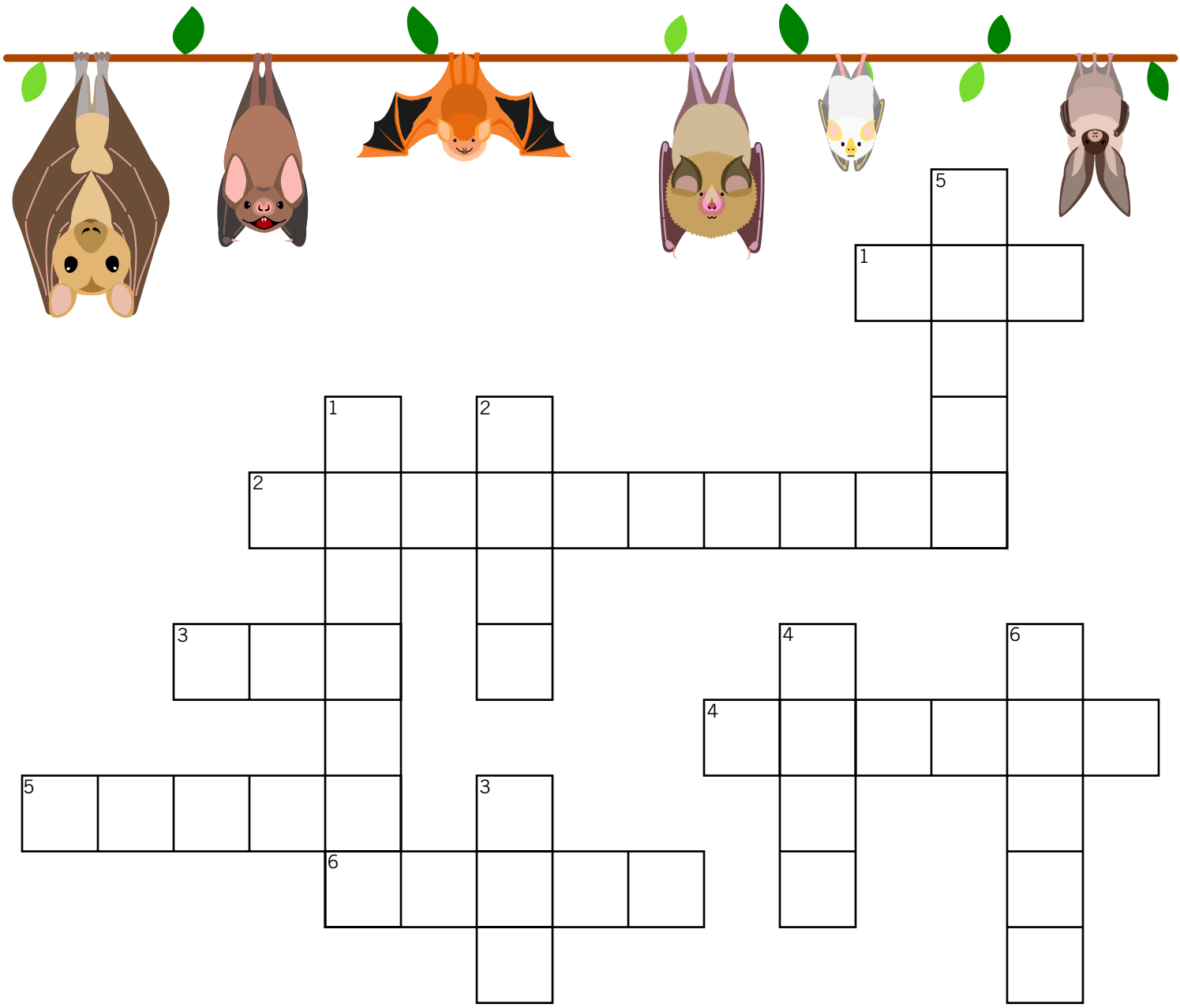
ACROSS

1. An animal that is active at night is called **nocturnal**.
2. All bats can see; no bats are **blind**.
3. The scientific name for bats, which means hand-wing, is **chiroptera**.
4. A kind of bat whose face looks like a dog is a flying **fox**.
5. A bat that feeds on insects is called **insectivorous**.
6. Most mother bats produce only **one** (home many) baby each year.
7. Many bats spend part of the year living in **caves**.
8. Echolocation used by bats is a kind of **sonar**.

DOWN

1. The process of navigating and locating food using sound is called **echolocation**.
2. A bat is a **mammal**.
3. Nectar bats **pollinate** flowers, just like hummingbirds.
4. An animal that is disappearing is said to be **endangered**.
5. There are nearly a **thousand** (how many) kinds of bats.
6. A baby bat is called a **pup**.
7. About 70% of all bats eat **insects**.
8. A group of bats living together is called a **colony**.

Bat Crossword Puzzle A



ACROSS

1. Bats are the only kind of mammal that can _____.
2. An animal that is disappearing is said to be _____.
3. Most mother bats produce only _____ (home many) baby each year.
4. A bat is a _____.
5. Most bats are active only at _____.
6. Many bats use _____ to navigate and find food.

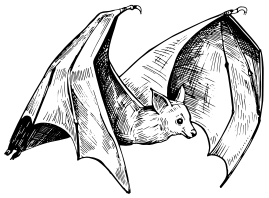
DOWN

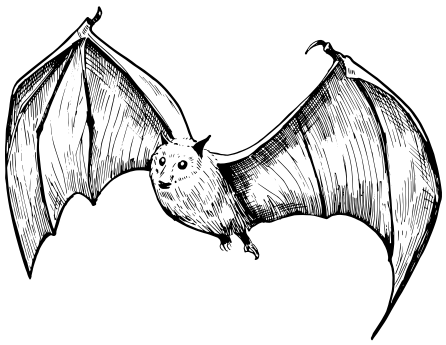
1. Most bats in the world eat _____.
2. _____ are the only mammals that truly fly.
3. A baby bat is called a _____.
4. A bat's wing is very similar to our own _____.
5. All bats can see, no bats are _____.
6. Many bats spend at least part of the year living in _____.

ANSWERS

Caves
Sound
Blind
Night
Hand
Mammal
One
Pup
Endangered
Bats
Fly
Insects

Bat Crossword Puzzle B





ACROSS

1. An animal that is active at night is called _____.
2. All bats can see; no bats are _____.
3. The scientific name for bats, which means hand-wing, is _____.
4. A kind of bat whose face looks like a dog is a flying _____.
5. A bat that feeds on insects is called _____. .
6. Most mother bats produce only _____ (home many) baby each year.
7. Many bats spend part of the year living in _____.
8. Echolocation used by bats is a kind of _____.

DOWN

1. The process of navigating and locating food using sound is called _____.
2. A bat is a _____.
3. Nectar bats _____ flowers, just like hummingbirds.
4. An animal that is disappearing is said to be _____.
5. There are nearly a _____ (how many) kinds of bats.
6. A baby bat is called a _____.
7. About 70% of all bats eat _____.
8. A group of bats living together is called a _____.

ANSWERS

Colony
Caves
One
Thousand
Fox
Endangered
Chiroptera
Pollinate
Pup
Insectivorous
Mammal
Insects
Blind
Nocturnal
Echolocation
Sonar

4. Seeing with your Ears

Objective: To understand how bats use sound to navigate and find food in the dark.

Grades: 3-5

Type of Activity: Demonstration and discussion

Materials:

- **Basketballs or similar sized bouncing balls**
- **Blindfolds**
- **Ear plugs or cotton balls**

Background Information

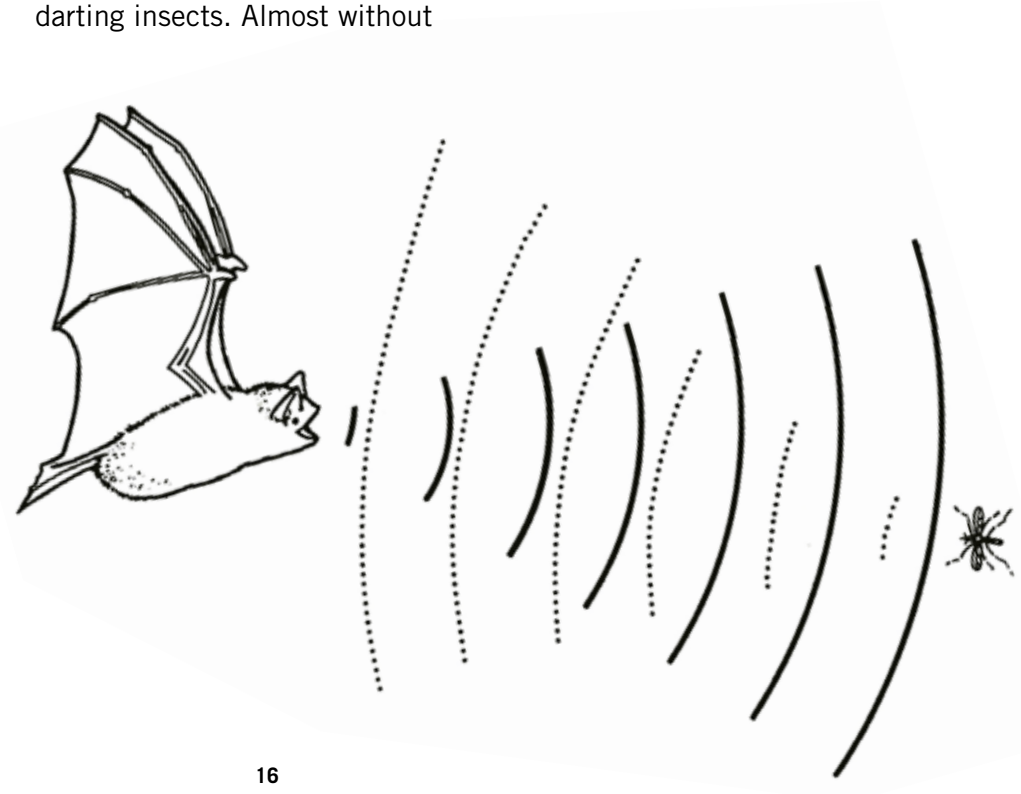
Even though no bats are blind, some 70% use a sonar system, called echolocation, to navigate in the dark and find food. They can detect the size, texture, even the direction of a moving insect, using sound alone. Bats emit sound pulses, produced in the larynx, through the mouth or nose. As these sounds come in contact with objects - trees, buildings, or potential food - they are reflected back as echoes and collected by bat's ears. Information contained in the echoes is processed in the bat's brain instantaneously, enabling the bat to fly rapidly through a cluttered environment without a collision. Most of these sound pulses are produced at a frequency too high for humans to hear without the aid of special equipment. Instruments, called bat detectors, render the calls audible to the human hearing range enabling people to listen in on the hunt. Using special equipment, scientists can now identify many species of bats who use certain frequencies and characteristic patterns, in the same manner that we can identify bird songs.

For many years, scientists were puzzled about how bats were able to navigate in the dark. In the late 1700s, an Italian naturalist and priest, Lazzaro Spallanzani, made the first attempt to understand the mystery about navigation. He put an owl and a bat in a semi-dark room and found both could fly quite well in low light. In complete darkness, the owl was helpless and bumped into everything, but the bat did not. He then put a small hood over the bat's head. With its head covered, the bat too became helpless. Later, Spallanzani reviewed additional experiments by Swiss surgeon Louis Jurine. With renewed interest, he took his research a step further. When placing brass tubes in a bat's ears, he found that its sense of direction totally failed if the tubes were plugged. But it wasn't until about 1938 that Harvard scientist Donald Griffin, with the aid of special recording equipment, learned that bats navigate by transmitting high frequency sound pulses through their mouths and then collect the echoes with their ears.

Not all bats use echolocation. Flying fox bats, from the suborder Megachiroptera (see Activity 8), have very good eyesight and an excellent sense of smell to find food in the dark. They feed on fruit, pollen, and nectar and don't need a sophisticated sonar system to chase darting insects. Almost without exception, they usually roost out in the open and not deep in the dark places like caves. Hence, flying foxes typically have very large eyes and small ears.

Many children are familiar with some aspects of echolocation. Most have had some experience generating echoes in canyons or among tall buildings. In this exercise a ball will be used to simulate a sound wave.

Divide the class into pairs in a gymnasium or other large empty room. Each pair gets a large bouncing ball. They need to use two walls and should stand closer to one wall than the other. Each taking a turn, they will throw the ball (sound wave) towards the wall. As a sound wave (ball) hits the wall, it (the echo) will bounce back. As the thrower sees the ball returning they point and follow it with a finger as it returns. The partner retrieves the ball. Each partner takes a turn at both the close and far walls. Point out to the students that the ball (echo) returns more quickly from the closer wall.



The second part of the exercise enables each pair to do the exercise like bats. One partner is blindfolded. The other partner orients the blindfolded partner toward the wall and hands them the ball to throw. Both partners get a chance to throw against the close wall and far wall, again pointing to the ball (echo) and following it with a finger as it returns. Each student should be able to determine, from hearing alone, which is the close wall and which one is far and indicate the direction in which the ball is moving.

For the third part of the exercise, in addition to the blindfold, the partners will also use a pair of earplugs, or alternative means of blocking hearing, and repeat the same exercise on the near and far walls. Could the student identify the near and far walls, and could they follow the track of the echo (bouncing ball) with a finger? The students should now have a better appreciation of how important echolocation is to navigate in darkness.

Following this indoor exercise, take the class outside for a short hike and discussion. Outside, several questions can be asked. What kinds of obstacles must a bat avoid while it hunts for insects at night (buildings, trees, rocks, power lines, moving cars)? Using examples the children can see, ask how the bat knows what is closer, the tree 10 feet away, or the building 100 feet away (sound waves return faster if the obstacle is closer). How does a bat remember where all the obstacles are while it chases a darting insect (the brain processes and remembers all the information while the bat flies)? What happens if it rains or gets very windy (bats may have to stop hunting until the weather improves)? What happens if two bats are chasing the same insect (first come first served)? What other kinds of animals hunt for flying insects at night (not many. That's why bats hunt at night; they don't have to compete for food with animals like birds.)?

5. Close Encounter with a Bat

Objective: To teach children what to do when encountering a ground bat

Grades: 1-5

Type of Activity: A one-act play

Materials:

- **Copies of script, pages 19 and 20**
- **Jackets**
- **Book bags**
- **Glove**
- **Rubber bat**
- **Pile of leaves**

Background Information

While bats are fascinating, gentle, and frequently very attractive animals, one drawback to their increase in popularity is that children may want to keep them as a pet or pick up a bat they find on the ground. Bats are wild animals and one important role played by educators is to teach kids that no wild animal, including bats, should ever be touched. Bats that can be easily approached are more likely than others to be sick. People need not be afraid if they never try to handle bats. Should a child encounter a bat on the ground, they should never touch it, but rather call an adult to come and remove it so it will not be found by others.

Bat Conservation International does not recommend keeping bats as pets. Insectivorous bats have very specific dietary requirements including large quantities of a variety of insects. Few do well in captivity. Only experienced animal handlers who have pre-exposure rabies vaccinations should handle bats or other wild mammals. While the incidence of rabies in bats is very low (less than half of 1% in the U.S.) It is not worth taking a chance.

The following play will teach children how to behave when finding a sick or injured bat on the ground. Following the production, engage the class in a discussion emphasizing the main points:

1. Never touch a wild bat
2. Call an adult to remove a grounded bat to a safe place

The play can be performed by five children and one adult (or one older student).

Close Encounter with a Bat

Characters: **Meagan, Sarah, Mrs. Johnson, Jeffrey, Carlos and Ryan**

(A group of children are walking home from school carrying jackets and bookbags, singing the school song. Suddenly, a boy bringing up the rear - Carlos - stops and bends down to look at something on the ground. The others stop, turn around, and make a circle around the object on the ground.)

MEAGAN	What is it?
JEFFREY	It's a dead bird.
SARAH	No it isn't! It doesn't have any feathers.
CARLOS	It's a bat!
RYAN	Ick...Be careful, it will suck your blood.
SARAH	You're crazy, Ryan, bats around here don't eat blood. We studied bats in school. This one looks like a little brown bat.
JEFFREY	Is it alive?
MEAGAN	I think so, but it's not moving much.
CARLOS	I'm gonna pick it up and take it home.
SARAH	No! Don't touch it. It might be sick. Our teacher told us never to touch bats, especially those who are on the ground and can't fly.
RYAN	Well, what are we going to do?
MEAGAN	I'm gonna get my mom. She likes bats. She'll know what to do. *(Meagan runs off stage.)*
RYAN	Gee, it's really small. I thought bats were big and had huge fangs dripping with blood.
SARAH	Ryan, you've been watching too many horror movies.
JEFFREY	Well, I think it's cute. I'm sorry that it's sick.
	(Enter Meagan and her mother, Mrs. Johnson. Mrs. Johnson bends down and takes a careful look. She pulls a leather glove out of her pocket, slips it on and gently picks up the bat.)
MRS. JOHNSON	Yes, it's a little brown bat, probably not quite full grown.
MEAGAN	Is it alive?
MRS. JOHNSON	No hone, I'm afraid it's dead.
EVERYONE	Aw.
JEFFREY	Poor little bat.
RYAN	Can I touch it?
EVERYONE	Yeah, can we touch it?
MRS. JOHNSON	No, we don't know whether the bat was sick or died from an injury. Remember, this is a wild animal. Are we supposed to touch wild animals?
EVERYONE	Noooo.
MRS. JOHNSON	But let's look at him a minute. See his soft brown fur. Can anyone tell me what kind of animal he is?
RYAN	He's a flying mouse!
EVERYONE	*(laughs)*
MRS. JOHNSON	Well, that's not exactly right. He's a mammal, just like a dog or cat, but he's not a mouse. In fact, bats are more closely related to people than mice.
MRS. JOHNSON	Look at his wing *(holding up her hand.)* Did you know that the bones in his wing are actually fingers? A bat flies with its hands. *(Motioning her hand like a wing.)*

SARAH	Bats are pretty neat.
RYAN	Does he suck blood?
EVERYONE	(shouts) NO!!
MRS. JOHNSON	No, he eats insects. Would you believe that just one little bat like this can catch up to 600 mosquitoes in just one hour.
CARLOS	Wow, I wish we had more bats at my house. The mosquitoes are terrible.
MRS. JOHNSON	Yes, unfortunately bats are declining all over the world. Most people don't know how important they are and kill them. When I was a little girl, there were many more bats than there are today.
SARAH	What are you going to do with the bat, Mrs. Johnson?
MRS. JOHNSON	We need to take him away so somebody doesn't come along and pick him up. What did we say about wild animals?
EVERYONE	Don't touch them.
MRS. JOHNSON	I think we should bury him. Let's go over to those trees. *(Mrs. Johnson digs a small hole, lays the bat inside and then covers up the hole with leaves.)*
MEAGAN	Poor little bat.
SARAH	I wish we could have saved him.
MRS. JOHNSON	I know, it is sad isn't it? But you can help other bats by just appreciating them and telling your friends what you've learned today. Bats need lots of friends.
MRS. JOHNSON	Well, children, you'd better all go home now. It's late and your parents will worry. *(walks off stage with Meagan.)*
EVERYONE	Goodbye Mrs. Johnson; goodbye Meagan. (Starts walking offstage).
CARLOS	Gee, I don't feel like singing anymore.
SARAH	Me neither.
RYAN	Hey! Maybe we could start a bat club.
JEFFREY	That's a great idea. Then we could learn a lot more about bats. We can ask the science teacher in the morning. *(Chatter continues as kids move off stage.)*

6. Going, Going, Gone

Objective: To understand the reasons for bat decline, endangerment and extinction

Grades: 2-5

Type of Activity: Lecture and discussion followed by coloring

Materials:

- **Copies of pages 23 and 24**
- **Crayons or markers**

Background Information

Bats are in decline nearly everywhere they are found. In the U.S., almost 40% of bat species are endangered or are candidates for such status. In some parts of the world bats have gone extinct before they could even be declared endangered. This activity deals with the causes of that decline. After presenting the background material to the students, lead a discussion about what kinds and combinations of threats there are to bats in the immediate area. Ask the children to think about what they can do to help protect local bats. Following the discussion, give each child a double-sided copy of page 23 and 24 which feature four threatened or endangered bats in the U.S. Be sure the text on the back side lines up with the appropriate bat. The page can be colored and displayed.

Ignorance, Myth and Superstition

Bats have suffered from centuries of myth and superstition. What are some of the myths (see activity two)? This misinformation has been exaggerated by Hollywood films. The shy nature of bats has also helped perpetuate misunderstanding. Bats fly at night and are difficult to become acquainted with - the main reason that education is key to their conservation. When people destroy bats they usually act out of ignorance. Unfortunately, ignorance leads to the destruction of millions of harmless and highly beneficial bats each year. Many people believe that they are doing the world a favor when they kill bats. They couldn't be more wrong. Fortunately, once people learn the facts about bats, most are quite willing to accept them as a beneficial part of nature. Many "converts" become active friends of bats and help others to learn about how important bats are to the environment.

Habitat Loss

Habitat loss is another major reason for bat decline. Habitat is that area an animal needs to "make a living." It's the space where an animal sleeps and finds food. For some bats, that can be a very large area. As more and more wild land is developed for human living space, plants and animals must try to live with less. With the loss of forests, bats have lost food and roosting spaces in trees. For example, a mixed hardwood forest is home to a great variety of insects on which bats will feed. If the forest is replaced with 100 acres of corn, the diversity of insects is dramatically reduced. There will not be a continual variety of hatching insects, so the bats must leave or starve. Most bats are adapted to specific habitats in which to live and find food. They simply cannot move to a different kind of place and learn to eat new food. Many kinds of bats live at least part of the year in caves where they have very specific temperature and humidity requirements. Throughout the world their cave roosts are being destroyed or altered. If they lose their traditional roosting space, it may be impossible to find a new place to live. With disappearing rain forests and other habitats, many animals cannot adapt and are headed toward extinction.

Roosting Habits

Many kinds of bats roost together in large numbers. Baby bats of some species roost in densities of up to 500 per square foot. Packing tightly together helps the small mammals stay warm. Some colonies in the US contain millions of individuals. Unfortunately, when bats are together in large numbers they are extremely vulnerable to disturbance. A single vandalous act can kill millions in a matter of minutes.

Human Disturbance

A major cause of bad decline is intentional human disturbance. Many bat caves have been vandalized by people seeking to kill bats. Many such people are simply uninformed about the value of bats. But the reverse is also true. Some people unknowingly disturbed bats when they only want to see and appreciate them. They enter caves when the bats are hibernating in the winter or raising young in early summer. If bats are disturbed during hibernation they may wake up, fly around, and waste precious body fat needed to keep them alive until spring. Too much disturbance will cause the bats to starve. Most U.S. bats give birth in early June. Disturbance of maternity colonies may cause the mothers to drop or abandon their young, or move to cooler roosts where fewer survive. Many conservation groups are now posting signs at important bat caves to keep people out during critical times of the year. Some very special caves are fitted with gates to keep people out, guaranteeing bats the peace and quiet they need.

Slow Rate of Reproduction

For their size, bats are some of the slowest reproducing animals. While mice and rats produce several large litters of young each year, most bats produce only one baby per year. If a colony suffers some kind of disaster, natural or otherwise, recovery is very slow. Repeated catastrophes or a combination of threats can, over a short time, push a species to extinction.

Pesticide Poisoning

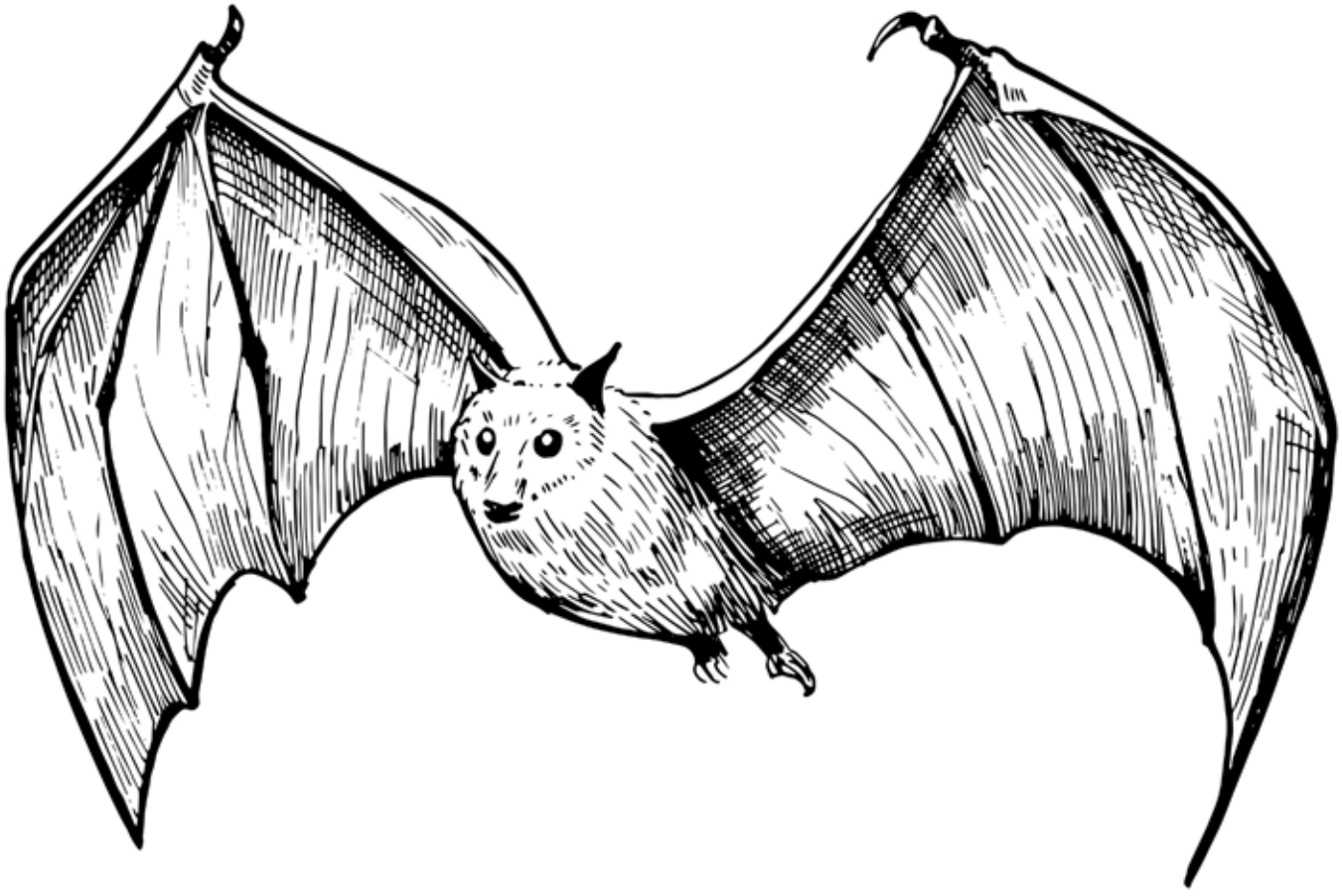
Pesticide poisoning causes problems for many kinds of animals. As agriculture has grown, so has the use of pesticides. In the course of treating crops with poisons, insects eat or become covered with chemicals. Animals, such as bats, later feed on these insects and ingest the toxins. The chemicals are stored in a bat's body fat. When the bat burns up this fat during migration or hibernation, the chemicals are released and the bat dies. Studies at national animal health laboratories have shown that this is a serious problem for bats in parts of the U.S. as well as in many foreign countries where pesticides are less regulated.

Human Consumption

In many parts of the world, such as the Pacific Islands and Southeast Asia, flying fox bats are eaten as food. With the arrival of firearms, freezers, and flight service between islands, bats have been hunted, stored, and shipped to other countries. Because most of these bats produce only a single baby per year, populations cannot sustain unregulated harvest and many species have declined, with few left. On some islands, bats pollinate or disperse the seeds for up to 40% of the forest trees, making them extremely valuable to the people who live there. Several species have already gone extinct. New legislation now prohibits the international sale of many kinds of flying fox fruit bats.

Migratory Species

Many animals migrate to different places when food and water become scarce. Bats that migrate can suffer from all the above threats in at least two different places. For example, several species of southern U.S. bats migrate to Mexico where there is abundant food in the winter. They are vulnerable to disturbance and pesticide poisoning at both the summer and winter roosts as well as in the places they stop to rest while traveling. Migratory birds face many of the same kind of threats.



***Eumops perotis*, Western Mastiff Bat**

Leptonycteris curasoae
Lesser Long-nosed Bat

***Myotis grisescens*, Gray Bat**

Plecotus townsendii
Townsend's Big-eared Bat

Leptonycteris curasoae
Lesser Long-nosed Bat

Many desert plants, including saguaro and organ pipe cacti, and 60 or more kinds of agave plants, rely on this reddish-brown nectar bat for pollination. It is endangered because many of its cave roosts have been disturbed or destroyed. Decline of long- nosed bats threaten the survival not only of plants they pollinate, but also the animals that require these plants for food and shelter.

Eumops perotis
Western Mastiff Bat

Almost nothing is known about mastiff bats. They are no longer found in many previously occupied roosts and are now candidates for endangered status. This is the largest bat found in the US, with a wingspan of nearly 2 feet. These dark gray bats roost in cliff faces in the southwest and feed high above the ground.

Plecotus townsendii
Townsend's Big-eared Bat

Huge ears assist this tan colored endangered bat in finding moths to eat. When sleeping, the bats ears are coiled and look like ram's horns. The base of the ear is crinkled similar to an accordion. Because the bat lives in the entrances of caves, it has suffered greatly from human disturbance.

Myotis grisescens
Gray Bat

The endangered spends most of its life in caves. Human disturbance in its cave roosts led to a severe decline, and the species was declared endangered. With protection, it is now increasing in numbers. This southeastern bat can eat as many as 3000 insects in one night.

7. How A Bat Compares to Me

Objective: To compare anatomy and physiology of bats and humans

Grades: 3-5

Type of Activity: Taking measurements

Materials:

- **Copies of page 25**
- **Pencils**
- **Clock with seconds**
- **Gram scale**
- **Tape measures**

Background Information

Children can learn a great deal about bats and themselves by comparing various aspects to their anatomy, physiology, and behavior. In this activity, children take their own measurements and compare them to those of bats.

Mammals

Even though bats fly and people walk on the ground, bats and people are similar in many ways. That's because both people and bats are mammals. With few exceptions, all mammals give birth to live young, nurse babies with milk, and have hair. Other mammals include dogs, cats, chipmunks, raccoons, elephants, monkeys, and whales.

Wingspan

Bat wingspans vary from about 7 inches to nearly 6 feet. Most bats are small mammals, although the flying fox bats achieve a large size. The world's largest bat is a flying fox from Southeast Asia. Its face is very similar to a fox or dog. It feeds entirely on fruit. Have children outstretch their arms and measure the distance between fingertips.

Numbers of Fingers

A bat's wing is actually a modified hand. The wing bones are actually greatly elongated fingers. The thumb has a small claw which aids the bat and crawling around on rough services.

Resting Heart Rate

Using a clock with a seconds indicator, demonstrate to students how to find their pulse (by putting your fingers against the carotid artery in the neck). Sitting down, students should take a resting pulse by counting the number of heart beats in a 15 second period and multiplying this by four to determine the total for one minute.

Active Heart Rate

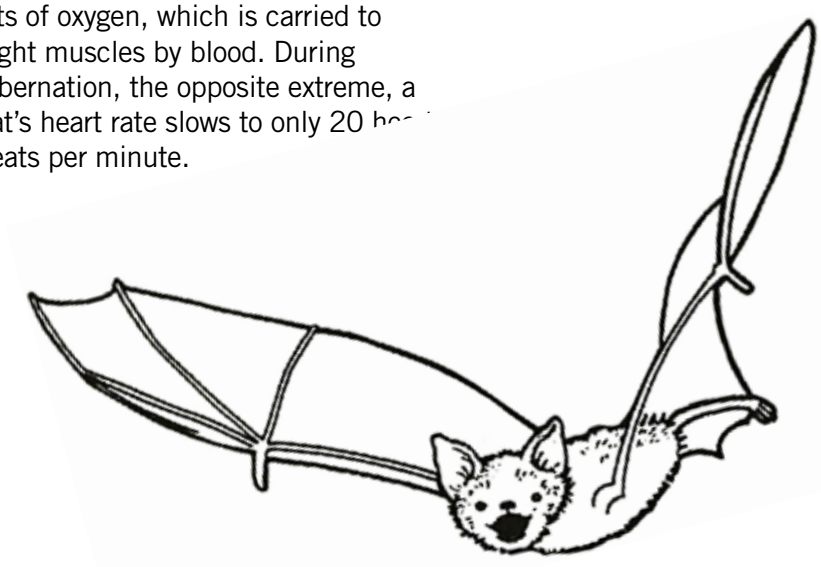
Before taking this rate, have children simulate flight by doing one minute of jumping jacks. Immediately following this, they take their path again using the method described above. The bat's heart rate is high because flight is hard work. Its heart must pump rapidly to provide lots of oxygen, which is carried to flight muscles by blood. During hibernation, the opposite extreme, a bat's heart rate slows to only 20 beats per minute.

Wing Beats

To determine wing beats per second, have the children flap their arms like wings and count the number they can do in five seconds. The teacher then divides that number by five to find a rate per second. To support a body in the air and overcome the force of gravity, a flying animal must beat its wings very quickly (perhaps 12 times a second) to maintain altitude. How does the children's rate compare to the bat's? Some very large bats are capable of soaring on the wind, just like hawks and eagles.

Lifespan

The average lifespan for a human is 74 years. Banding records have shown that some insectivorous bats live up to 32 years or more. For their size, bats are among the longest lived animals. For comparison, most mice have a lifespan of only about two years.



How a Bat Compares to Me

	Student	Bats
Kind of Animal	_____	mammal
Wingspan (arm span)	_____	6 1/2 inches, bumblebee bat from Thailand; almost six feet for the great flying fox from Java
Number of Fingers	_____	four fingers, and one thumb
Heart Beats/Minute Resting	_____	less than 100
Heart Beats/Minute Active	_____	as many as 900
Wing Beats/Second	_____	12 for a little brown bat
Lifespan	_____	some bats live 30 years or more

What other comparisons between humans and bats can you think of?

_____

_____

_____

_____

_____

_____

8. Bat Fruit Salad

Objective: To understand how bats are important to products we use every day

Grades: K-5

Type of Activity: Food preparation

Materials:

- **Mixing Bowl**
- **Spoons for mixing, serving and eating**
- **Knives**
- **Napkins**
- **Selection of food items from the list**

Background Information

Few people realize how many products they use every day depend in some way on bats. These include hardwoods, balsa wood, spices, dues, fibers, and many food items. Some plants depend directly on bats for pollination or seed dispersal. Others, like banana plants and peach trees, no longer need bats in a direct sense since the commercial varieties do not require pollination (bananas) or seed dispersal (bananas and peaches). But the genetic ancestors of these varieties still depend directly on bats. Should there be a need to improve disease resistance, agriculturalists must obtain new genes from ancestry of all types. So bats are still very important to the crop (see activity 1 for a discussion about economics).

This activity is designed to focus on the many benefits bats provide to people. The fruit salad is made up of food items that are in some way bat-dependent. Wild bananas are both pollinated and dispersed by flying foxes, while figs, carob, peaches, dates, and mangos rely on them only for seed dispersal. The seeds of guavas and cashews are disbursed by leaf-nosed bats.

Quantities of the items used will depend on the size of the group so no amounts are listed. During food preparation, encourage the children to talk about the many benefits bats provide both to the environment and to humanity.

Products from Bat-dependent Plans

Bananas
Mangos
Dates
Carob
Peaches
Figs
Cashews
Canned guavas

Steps

1. Purchase a selection of food items from the list.
2. Cut the fruit into bite-sized pieces and place in a large mixing bowl.
3. Mix in peach or banana yogurt.
4. Sprinkle with chopped cashews and carob chips
5. Serve in paper cups.

9. Where's My Baby?

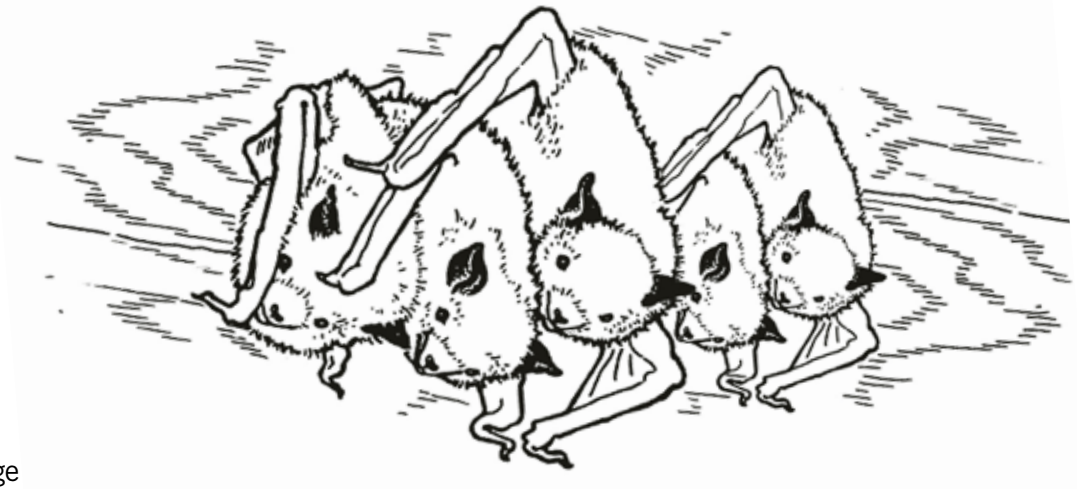
Objective: To learn how mother free-tailed bats find their babies

Grades: 2-4

Type of Activity: Game

Materials:

- **Cotton balls**
- **Variety of scents from the list**
- **Blindfolds**



Background Information

In the southwestern U.S., Mexican free-tailed bats roost together in large numbers. A cave in Central Texas is home to 20 million free-tails. Most of these are females and in early June each produces a single young, approximately doubling the size of the colony. Hundreds of square feet of cave wall space are carpeted with bat pups. Born without fur, the babies pack tightly together in densities of up to 500 per square foot 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.

For many years scientists believed that mothers probably fed any youngster they found. Recently, a study demonstrated each mother actually locates her own baby through recognition of its scent and call. This is amazing considering the fact that they must find their own amidst millions of other active mothers and babies.

This game enables children to play the roles of mothers and babies trying to find each other in a dark, noisy situation. The whole class participates, but only six mothers and six babies are selected.

List of Suggested Scents

Vinegar	Vanilla
Cinnamon	Perfume
Garlic	Banana

Rules

1. Select six mothers and six babies.
2. Each baby is given a cotton ball with a scent (see scent list for suggestions). The mother needs to become acquainted with the smell.
3. The baby is then assigned a call, some simple pattern of a tongue-clicking. Mother and baby should practice several times to ensure recognition of scent and sound.
4. Mothers are then blindfolded.
5. 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 and must not move. Only the mothers will move.
6. The blindfolded mothers are assisted to the edge of the group. Now they must find their own baby. All babies call, clicking at random without a pattern, except for the six babies who must use the pattern they practiced with the six mothers. Babies are hungry so they should click loudly.
7. If a mother bumps into a designated "baby," the baby is required to place the cotton ball near the nose of the mother, otherwise no contact is made.
8. The winner is the mother and baby who find each other first. When pairs find each other they should leave the circle. The game is over when all mothers and babies are reunited.

10. Bat Math

Objective: To use math skills to solve problems dealing with the ecology of bats

Grades: 4-5

Type of Activity: Mathematics

Materials:

- **Paper**
- **Pencil**

Background Information

Many interesting aspects about biology can be taught through solving math problems. The following exercises can also be used as models on which to create additional mathematical problems for any age group. Teachers can select problems appropriate for the class's ability.

1. A little brown back can flap its wings 12 times a second. How many times can it flap in one minute? In 15 minutes? (720, 10,800)

2. A human's active heart beat is 150 times a minute. For a bat it is 900 per minute. How much faster does the bat's heart beat? How many times does a bat's heart beat a second? (750, 15)

3. A little brown bat can catch 600 mosquitoes in one hour. How many can it catch in 2 1/2 hours? (1,500)

4. Twenty little brown bats live in a bat house. If one can catch 600 mosquitoes in an hour, and providing there was an abundant supply of mosquitoes, how many could all the bats catch in three hours? (36,000)

5. A bat's heart rate when active is 900 beats a minute. When it hibernates the rate drops to about 20 per minute. How much does it slow down? How many times will a hibernating bat's heart beat in one day (24 hours)? (880, 28,800)

6. Insectivorous bats can eat half their weight in insects each night, including many agricultural and yard pests - moths for example. If the bat weighs 16 grams and a moth weighs 0.4 grams, how many moths will the bat eat before it's full? If the bat ate only moths, how many moths could it eat from May to September, about 150 days? (20, 3000)

7. A Sonoran Desert bat pollinates the flowers on 12 different saguaro cacti in one night. How many cacti will it pollinate in 30 nights? (360)

8. Fruit bats live in the tropics and discard the seeds after eating a meal. A rain forest bat can disperse 60,000 seeds in just one night. If it has dispersed 480,000 seeds, how many nights must it have been feeding? (8)

9. Mexican free-tailed bats in Texas produce just one baby each year. How many babies with a colony of 5 million females produce in one summer? If half the babies are eaten by predators and or die during the long fall migration back to Mexico, how many are left? If one quarter of the remaining young die in their winter roost or during the spring migration back to Texas, how many young will return? (5 million, 2.5 million, 1,875,000)

10. A colony of 10,000 endangered gray bats can eat 30 million insects in a night. These bats hibernate in caves in the southern U.S. If, during the winter, repeated disturbance by people caused the bats to burn body fat needed to keep them alive until spring, and 3,000 bats starved to death, how many would be left and how many insects would they eat in a night? How many insects would remain uneaten? (7,000, 21 million, 7 million)

11. A Year in the Life of Little Brown Bats

Objective: To become familiar with the lifestyle of one bat species over the course of a year

Grades: 4-5

Type of Activity: Lecture and Discussion

Materials:

- **Calendar**
- **Paper**
- **Pencils**
- **Notebook (optional)**

Background Information

This activity can be utilized as a study unit or can be spread out over the course of a year. The teacher presents the material to students in four distinct segments and leads a discussion using suggested topics. The educator can plan a presentation around each season, bringing the students up to date about activities in the lives of little Browns at that particular time of year. Students may wish to keep a notebook and record what is happening to the bats during different seasons. Additional information, such as seasonal weather conditions and what other animals are doing this time of year can also be included.

A Year in the Life of Little Brown Bats, *Myotis lucifugus*

Introduction

The little brown bat is one of the most abundant species in the U.S. and Canada, found coast to coast in the northern two-thirds of the U.S. A small bat, weighing less than half an ounce, it is one kind of bat frequently found roosting in human dwellings. While not everyone wants bats in their attic, little browns do make good neighbors. When mosquitoes are abundant, a single bat can catch up to 600 in just one hour.

The study of bats reveals creatures far more amazing in fact then their portrayal by myth and legend might suggest. The little brown is one of almost 1,000 species that make up the second largest order of mammals, Chiroptera Bat species represent about one quarter of the world's mammals.

Like most mammals including people, little brown bats have hair, give birth to live young, and feed their babies with milk. Baby bats nurse from two nipples located on their mother's breasts.

Bats are unique among mammals because they are the only ones that can fly. Their forearm and hand evolved into a "hand wing," which is the meaning of the order's name. The wing is formed by membranous skin stretched between elongated finger bones. The clawed thumb is separate from the wing and is used for clinging. Little browns, along with many other bat species, also have a membrane between their hind legs called an interfemoral membrane. It helps a bat to maneuver in flight and to scoop up insects. A bat's legs are adapted for hanging, and they use little muscular effort to hang upside down. Their toes have sharp, curved-under claws that hook onto rough surfaces.

Sonar, or echolocation, (see activity 4) enables little browns and other bats to use dark caves for roosts, to fly at night without collisions, and to locate prey. Night flight allows bats to avoid daytime predators and to take advantage of a variety of food sources without competition from diurnal feeding birds.

Little brown bats, along with snakes, spiders, and other misunderstood and feared animals, have suffered from centuries of myth and superstition. Their ability to fly and maneuver in complete darkness has often been portrayed as unnatural or evil. Bats also have been associated with the spookiness of Halloween, adding to the misconception that all bats are vampires and that they all suck the blood of their prey. In reality little brown bats, like other bat species, are gentle, clean, and fascinating animals as well as being very important to the environment.

Part I, FALL

During the summer months, bats have been consuming great numbers of insects about half their weight and insects each night and putting on body fat that will be utilized during a long hibernation. By August, adults and juveniles depart summer roost and begin migration to winter hibernation sites. The sexes have been apart for the summer, females rearing young in maternity colonies, males roosting nearby as solitary individuals or in bachelor colonies. Banding studies have shown that some little browns migrate more than 200 miles between summer and winter roofs. They can cover more than 20 miles in a single night. Distance traveled probably depends on availability of wintering sites. Their homing ability enables them to return to the same hibernation location year after year.

In late August, male and female little brown bats of all ages begin to "swarm" near hibernation caves. The congregation of bat's in flight may represent some form of orientation behavior, helping to advertise to others suitable hibernation sites, especially inexperienced juveniles. Bats seek out the few caves that provide proper temperature and humidity conditions needed for hibernation. The cave's winter temperature is critical. A cave that is too warm would not enable a bat to enter a deep hibernation, and in very cold temperatures the bats could freeze to death.

Before hibernation, when little browns are in peak physical condition, they mate, setting the stage for the next generation. The female retains live sperm in her reproductive tract while she hibernates; ovulation and fertilization are delayed until she becomes active in the spring. Growing a fetus would be extremely difficult without food to eat and while spending most of the winter in a deep hibernation (low metabolic) state.

Student Activities for Part I, FALL

Discussion:

1. **What is migration?** (A seasonal round-trip journey by an animal.)

2. **What is homing?** (Ability to return directly to the home location when displaced.)

3. **What are some advantages of migration?** (Changing location seasonally helps to find more abundant food and water resources, locate mates, and find appropriate roosting conditions.)

4. **What animals other than bats migrate?** (Birds, whales, turtles, fish, monarch butterflies.)

5. **What is a swarm? Give some examples.** (A group of animals gathering in large numbers, for example, many kinds of insects.)

Writing:

1. You are about flying 100 miles to your winter roost. What are the advantages of going there? What kinds of problems might you encounter getting there?

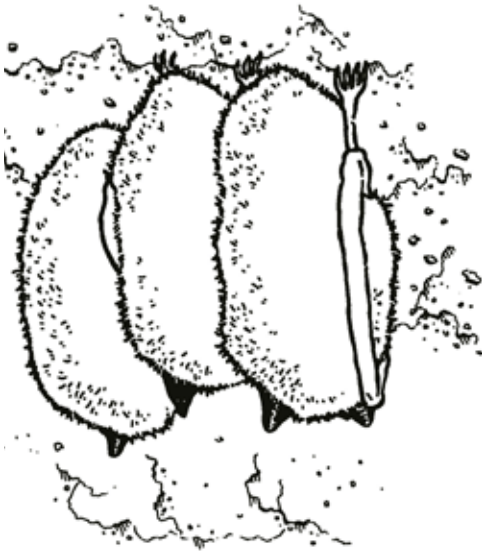
2. What are some possible differences between what bats and people do in the fall to get ready for winter?

Part II, WINTER

As weather grows colder and days become shorter, insects become harder to find, and little brown bats enter hibernation in September or October. They locate a place in a cave where the temperature remains between 40 to 50°F (5 to 10°C) and humidity is 78% or more. High humidity helps prevent evaporated water loss from their body surface (dehydration). They hook their claws into the cave ceiling or walls, hang upside down, and go into a deep hibernation sleep.

All bodily functions slow down. Their heart rate slows to as low as 20 beats per minute, respiration decreases, and body temperature drops to that of the cave wall. By roosting in constantly cool places and allowing body temperature to fall to that of the cave, little brown bats can dramatically lower their metabolism. This enables them to survive for from 6 to 8 months on very little energy. While winter wears on, they live on energy stored in body fat reserves.

Like other mammalian hibernators, bats do not remain asleep for the whole winter but wake up from time to time to urinate and drink. Moisture from cave walls and condensation droplets on their fur are the usual sources of water. Uninterrupted sleep for a little browns averages between 12 and 19 days but my last as long as 83 days. Drafts and changes in temperature will arouse bats, and they may respond by moving to a new location. Increased energy demands created by too frequent arousal may deplete that stored to the point where they die from starvation. For this reason it is important to never disturb bats that are hibernating. Any human activity in their winter caves reduces their chance of surviving until spring. Cues to end hibernation probably include depletion of fat reserves and rising cave temperatures.



Student Activities for Part II, WINTER

Discussion:

1. **What is hibernation?** (The dormant or torpid state in which there is a dramatically slowed body metabolism, such as a reduced heart and respiration rate.)

2. **What are the advantages of hibernation?** (Preserving energy resources to stay alive until food supply and weather are favorable.)

3. **Name some animals that hibernate.** (Some bats, woodchucks, frogs, some insects, etc.)

4. **How do human beings respond to winter?** (Add clothing, move about and exercise to keep warm, consume more calories, stay inside warm shelter, migrate to warmer states like Florida.)

Writing:

1. What are some things that you do in wintertime? Are they at all similar to what bats do?

2. How long can you stay asleep at one time? What would wake you up? Is it different for a bat?

Part III, SPRING

As spring approaches, little brown bats gradually arouse from their deep sleep and make short flights within the cave. As females emerge and begin to feed, ovulation takes place and fertilization is accomplished by sperm that have been stored since mating took place in the fall. Females are now pregnant and usually give birth within two months after fertilization. The gestation period is not fixed, as in most mammals, but varies depending on favorable climate and availability of sufficient quantities of food.

In early April, the pregnant females begin their spring migration to summer roosting sites, often in attics, barns, or other buildings where they establish maternity colonies with often between 300 to 600 other females. Banding studies show that they returned to the same sites each year. The males either roost alone or form small separate colonies by themselves. Little brown bats can survive in attics that are as hot as 103°F (42°C). In extreme heat situations, bats utilize several techniques to cool off, including moving to cooler places within the attic during the heat of the day. Warm sites with relatively stable temperatures are preferred for raising young, which is why buildings are frequently used.

When it is time to give birth in June and July, the females hang onto the roost with their thumbs and feet and help catch their newborns in their interfemoral (tail) membranes. The baby, whose eyes do not open for two days, immediately uses its large thumbs and hind feet to climb up and firmly attach its mouth to a nipple.

Little brown bats produce only one baby per year. This is true for most species, making bats the slowest reproducing mammals for their size. But, relative to other mammals, bats are enormous at birth. Baby little browns may weigh as much as 30% of the mother's weight. A similar ratio of newborn to mother's weight and humans would mean a 120 pound woman would bear a 36 pound infant!

At dusk, mothers leave young behind in the roost and return between foraging flights to nurse their own offspring, apparently recognizing that infants' particular smell and individual chirping call. The baby bats grow rapidly, gaining approximately 18% of their birth weight each day. During lactation, mothers eat increasing amounts of food, up to their body weight in insects each night. Young little browns are able to fly in about three weeks but continue to nurse for a week or more after they begin learning to forage on their own. This delay in weaning probably provides important nutritional support for the juveniles while they improve their hunting skills.

Females usually reach sexual maturity by the end of the first summer and males mature in about 16 months. Banding has shown that it is not unusual for both sexes to live 10 years or more. Some have lived for more than 32 years, making them the longest lived mammals on earth for their size.

Student Activities for Part III, SPRING

Discussion:

1. **What are some comparisons between human and bat pregnancies?** (Gestation length is nine months in human beings and about two months in little brown bats; both are mammals, and in both the fetus is nourished by a placenta while growing in the uterus.)

2. Sometimes fetal growth rate is slowed down for bats due to poor weather and availability of food. **Is it possible for pregnant women to affect the development of the fetus?** (Somewhat; positive effects may be gained by receiving good prenatal care, not smoking or drinking alcohol or using harmful drugs, but they can't appreciably alter the length of pregnancy.)

3. **How do you differ from bats in keeping cool when the temperature is hot?** (You perspire, put on lighter clothing, use electric fans or air conditioners, drink liquids; little brown bats do not sweat or pant, but they can move vertically to lower and cooler places within the roost.)

Writing

1. Imagine that you are a bat living in an attic. What do you think might be some of your adventures? What would you do if you saw a human coming?

2. What kinds of things must a young bat learn on its very first flight?

Part IV, SUMMER

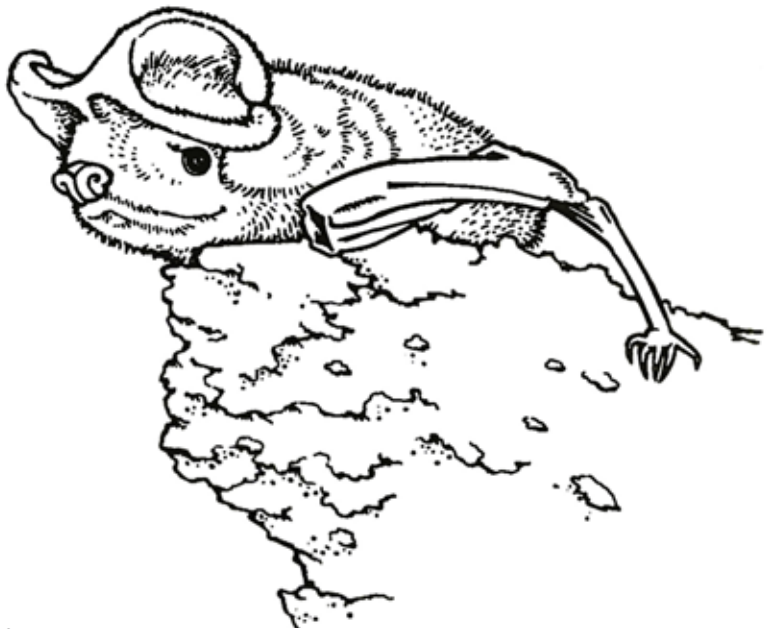
Summer is a crucial period in the life of little brown bats. Finding enough food to eat will, in large part, determine their survival for the next year. Without a significant amount of additional body fat from feeding on the summer's supply of insects, the bats will not have the reserves they need to survive the winter. This is especially true for youngsters.

Little brown bats forage about two hours after sunset and two more hours just before sunrise. They usually make several passes each night through a particular "beat" near ponds and streams. They listen to the cries of other bats to help locate new sources of food, preferring moths, beetles, mosquitoes, and flies. The average insect eaten weighs about 2 milligrams. Insects are caught, on average, at the rate of about one every eight seconds. Between hunts, the bats rest in night roosts, often crevices where they form tight clusters. During heavy rainstorms or high winds, bats save energy by making shorter hunting flights, delaying takeoff, or not flying at all. They also save energy by going into torpor, a physiological state similar to hibernation when metabolic body functions slow down.

Finding enough to eat isn't always easy. Because bats fly at night, they must use echolocation to navigate in the dark and find food. (See activity 4 for a more complete discussion of echolocation.) Echolocation, also called sonar, utilizes a system of sending out sound pulses through the mouth which, as they bounce off objects, are reflected back to the bat's ears as echoes. Little browns can process information about their immediate vicinity instantaneously, enabling them to zig zag through the trees and chase an insect at the same time.

Some insects have developed methods for avoiding bats. Certain insects, like noctuid moths, have a type of ear that can detect a bat's echolocation calls. Upon hearing a nearby bat, they often take an evasive action like making a nose dive towards the ground.

In addition to chasing darting insects through the night, bats must also avoid predators, like hawks and owls, and pay attention to changing weather.



Student Activities for Part IV, SUMMER

Discussion:

1. **What is echolocation or sonar?** (SONAR is an acronym from "sound navigation ranging," a system developed by scientists to locate objects under water by sending out signals and listening to the echo. Although sonar was described by humans, bats and other animals have been using the system for a very long time.) **How long have bats used this technique?** (Fossils of relatively modern bats have been found that date back to the Eocene period, about 54 million years ago; the ability to echolocate probably developed gradually over millions of years.)

2. **Name some animals that use a form of sonar to find their way.** (Whales, dolphins, bats.)

3. **Do people use echolocation?** (Blind and low vision individuals may tap with a cane. Submarines use sonar to navigate the oceans.)

4. Insects and other animals have learned to detect bat sonar to reduce the odds of being caught. **What are some other ways by which prey evade predators?** (By camouflage, possessing great speed for escape, distraction such as the squid's ink, and by performing some defensive behavior like the spraying of a skunk.)

Writing:

1. Pretend you are writing a newspaper article about why little brown bats are very beneficial. Include some interesting facts about their lives

2. Conduct an interview with your family or neighbors to determine what people know about one of the most common bats in the U.S. Make a list of things you can do to help educate people about bats.

Follow Up Activities

1. Visit a nearby nature center, zoo, or museum to find information on bats.

2. Look for bats flying over your yard at twilight. Keep a daily record of what you see, including observations on temperature, wind force and direction, and time of day. When did you see the last bat in the fall and first one in the spring?

3. Have a Bat Party (not just for Halloween), make bat cookies and party decorations with a bat motif.

4. Visit your local library to look up articles about bats; check out books on bats. Use an atlas or globe to find places that were mentioned in connection with bats. For example, Carlsbad Caverns in New Mexico is home to several hundred thousand bats.

12. Refrigerator Bats

Grades: 2-5

Type of Activity: Craft Project

Stove or hot plate

Mixing bowl

- **Large spoon**
- **Plastic bag**
- **Wax paper**
- **Dinner knives**
- **Cornstarch**
- **Baking soda**
- **Water**
- **Acrylic sealer or clear nail polish**
- **Acrylic paints or markers**
- **Glue**
- **Small magnets (available at craft shop)**
- **Copies of bat shapes below, printed on card stock**

Background Information

Bats come in a variety of sizes, shapes, and colors. Children can cut around a copy of the diagrams below as models, or create a bat of their own imagination. The following names might also spark creativity:
Spear-nosed bat
Tube-nosed bat
Yellow-winged bat
Red bat
Spotted bat
Flying fox bat

Recipes for Approximately 10 4" Bats

(Prepare dough ahead of time)

2 cups cornstarch
4 cups baking soda
2 1/2 cups cold water

Mix ingredients in a medium sized saucepan and cook over medium heat, stirring constantly. Cook about 10 minutes or until the mixture is the consistency of mashed potatoes. Remove from heat, turn out onto a plate, and then cover with a damp cloth. After the dough cools, knead it gently into a smooth ball. Then store it in a tightly sealed plastic bag and refrigerate until you're ready to use it.

Steps to Making Bat Magnets

1. Use the palm of your hand, flatten a golf ball-sized lump of dough onto a piece of wax paper. The pressed dough should be at least 1/4" thick. Don't press it too thin or the dough make break as it dries.

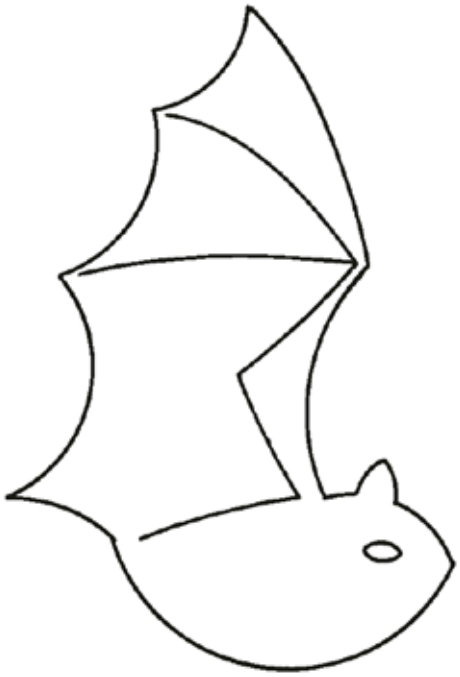
2. Mold the dough into the shape of a bat, using the diagrams included below for reference.

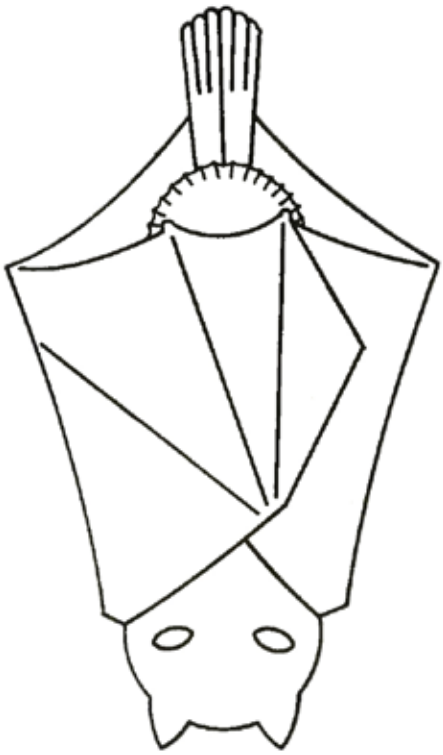
3. Make eyes, nose, ears or other features by adding tiny bits of dough or by carving them into the dough with a pencil point. Be care ful not to push the pencil point too deeply or the dough may break after it dries.

4. Let dry overnight.

5. Carefully remove the bat shape from the wax paper and paint it with acrylic paints or color it with markers. Let dry. Once the bat is dry, paint with clear nail polish or acrylic sealer. This will help pro tect it and make it shine.

6. Glue one or two small magnets to the back of the bat.





Glossary

Asymptomatic carrier — An animal that can contact a disease and transmit it to other animals without showing symptoms itself.

Bachelor colony — A colony of bats composed mostly of males and nonbreeding females.

Carotid artery — Arteries located on either side of the throat, which are the principal suppliers of blood to the head and neck. By placing fingers firmly over an artery, a pulse can be detected.

Chiroptera — The order of mammals that includes all bats. The word literally means "hand-wing." These are the only true flying mammals.

Diurnal — Active during the day.

Echolocation — The use of reflected sound from an emitter (such as a bat or dolphin) to locate objects.

Ecosystems — A major interacting system that involves both living organisms and their physical environment.

Flying foxes — Bats of the suborder Megachiroptera. They all have large eyes, eat primarily fruit or nectar, and generally lack echolocation ability. There are nearly 200 species, and they live only in tropical and subtropical climates in the Old World.

Frugivory — The habit of eating fruit.

Gestation — The period from conception to birth; that is, when the mother is pregnant.

Habitat — The locality in which a plant or animal lives.

Hibernation — A state of greatly reduced activity and metabolism produced by lowering of body temperature. It occurs in winter, enabling an animal to survive on stored fat reserves until spring.

Interfemoral membrane — The membrane that spans the area between bat's legs, feet, and tail. Also called a tail membrane.

Insectivory — The habit of eating insects.

Maternity colony — A group of pregnant or nursing bats that gather into a single large colony, sometimes hundreds or even millions, for the purpose of rearing young. The shared body heat is essential to growth of the young.

Megachiroptera — One of the two suborders of Chiroptera, including a single family the Pteropodiadae. Known as flying foxes.

Microchiroptera — One of the two suborders of Chiroptera. It includes nearly 800 species and 17 families of mostly small insect-eating bats. All bats living in the United States and Canada (and all of the Western Hemisphere) belong to this group. A few eat fruit, nectar, or other animals. This suborder also includes vampire bats.

Nectarivory — The habit of eating nectar.

Nocturnal — Active at night.

Nose leaf — The fleshy flap of skin around the nostrils of some bats. It is usually triangular in shape and rises vertically from the tip of the nose.

Organ pipe — A large desert cactus shaped like organ pipes and pollinated primarily by bats, and also by birds and bees.

Pollination	The transfer of pollen from the anther of a flowering plant to the stigma prior to fertilization.
Rabies	An infectious viral disease of mammals usually transmitted through a bite.
Saguaro	Large columnar species of cactus found in the Sonoran Desert and pollinated by bats, birds, and bees.
Seed dispersal	The act of transporting seeds from the parent plant to new locations where seeds are more likely to survive. When forests are cleared they cannot regenerate without seed dispersal.
Sonar	SONAR is an acronym for "sound navigation ranging," a system developed by scientists to locate objects under water by sending out signals and listening to the echo. Also known as echolocation.
Tail membrane	The membrane that spans the areas between a bat's legs, feet, and tail, often referred to as the interfemoral membrane.
Thermals	A rising body of warm air resulting from the sun heating up the earth.
Torpor	A state of reduced activity and metabolism similar to hibernation but not necessarily associated with a particular season. Many bats, unlike most other mammals, can enter torpor to save energy at almost any time.
Ultrasonic	Having a frequency above the human ear's audibility limit of about 20,000 cycles