

Bio/Diversity Project
Lesson 1: Introduction to Pollination

Teacher: Ashley Parker, Shea Cutter

Adapted from: <https://www.calacademy.org/educators/lesson-plans/flowers-seeking-pollinators>

Grade Level: *8th*

Time: *60 minutes*

AZ State Science Standard:	8.L3U1.9 <i>Construct an explanation of how genetic variations occur in offspring through the inheritance of traits or through mutations.</i>
Content Objective: Math, Reading, Science, Writing, Other:	<ul style="list-style-type: none"> • <i>Students will be able to define the term cross-pollination.</i> • <i>Students will be able to explain why cross-pollination is important.</i> • <i>Students will be able to explain how cross-pollination leads to genetic variations</i>
Language Objective: (Optional)	“N/A”
Scientist of the Week:	Valerie Madera-Garcia <ul style="list-style-type: none"> • From Peñuelas, Puerto Rico • PhD student at the University of Arizona studying Epidemiology • Working to identify mosquito breeding sites and their exposure to vector-borne diseases

Vocabulary	Materials
<ul style="list-style-type: none"> • Pollination • Pollinator • Stigma • Stamen 	<ul style="list-style-type: none"> • Colored Cotton Balls • Plastic Cups • Plastic Straws

Seasonality: (If more specificity is required, please note date/time range under the season)

Highlight which season(s) your lesson would be most suited to. When working with the natural world, it is important to keep this in mind for your planning! Some activities are possible for a brief window of time while others may be appropriate during any time of year.



<i>Monsoons</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec.- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
Guiding Questions: <ul style="list-style-type: none">• What is cross-pollination?• What how does cross-pollination occur?• What are the different parts of a flower?				

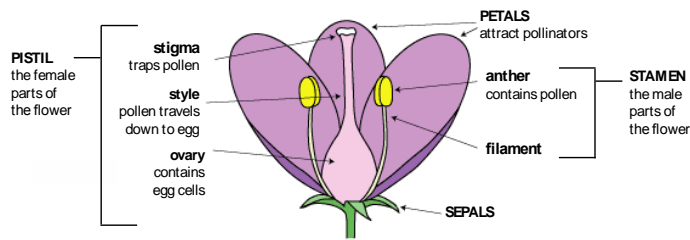
Engagement/Introductory Activity: First we will ask students the guided questions and to gauge what they already know about cross-pollination and how it works. Then we will go over the diagram below to see if they were right/reinforce their understanding of the process.

Flower Diagram

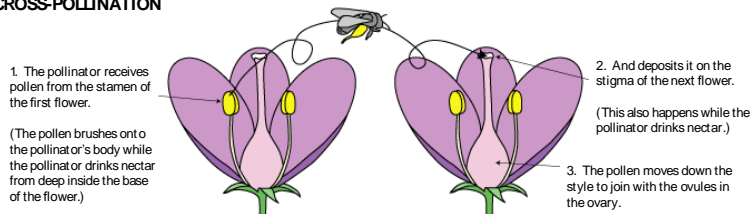


PLANTS

INSIDE A FLOWER



CROSS-POLLINATION



Think About It....

What if cross-pollination happens between *two* flowers of the same kind? What is self-pollination?

Exploratory Activity:

“Pollen Distribution”

1. Divide students into 4 groups
2. Each group will have a flower that must be cross pollinated with other flowers across the room
 - a. The “flower” will be a plastic cup full of colored cotton balls which represent the pollen
3. In a relay-race fashion, one student at a time from each group will transfer a piece of pollen from their flower to a flower on the opposite side of the room and bring a different piece back.
 - a. Students must use straws as chopsticks to pick up the pollen
 - b. Students can only carry one piece of pollen at a time
4. When we call time, each group will show the class how well their flower was cross-pollinated

Explain:

Was it hard to capture/carry the pollen? Think about where pollen is stored in most flowers. (Look over diagram from earlier if necessary) Why do you think that it is stored in the middle of the flower? How might this help them get pollinated?

“The nectaries are usually located deep in the middle of a flower so that pollinators have to first brush against the anthers, and then the stigma to get to the nectar. Some pollinators, like bees, need pollen in addition to nectar. Some pollinating insects (e.g. some flies) are attracted to flowers by scent but gain no reward when they visit. The insects try to leave quickly but the flowers may have traps to slow the insects down.”

Extension Activity/Questions:

Ask the students for ideas on what could affect cross-pollination in the real world and prevent it from happening. What would happen if cross-pollination didn't occur? Why is genetic variation important?

Topics to discuss

- Species survival
- Adaptations
- Biodiversity

Evaluation Activity:

On a piece of paper, the students will write:

- Name
- One thing they still had a question about
- Two new things they learned as well



Sonoran Pollinators Relay Race Instructions

Bats:

Bats will use **Long Sticks** to obtain pollen from **Big Bowls**. As large animals, they require large sturdy flowers that can support their weight.

Bees:

Bees will wear **Glasses** to represent their UV vision, and will use their **Hands** to obtain pollen from **Small Bowls with no pattern**.

Butterflies:

Butterflies will use **Straws** to obtain their pollen from **Paper Bags**, which mimic the proboscis they use to collect nectar from real flowers.

Hummingbirds:

Hummingbirds will use **Tweezers** to obtain their pollen from **Pitchers**. They enjoy similarly tube-shaped flowers to butterflies, but prefer a platform which they can rest on (tweezers representing their little feet).

Flies:

Flies will use **Popsicle Sticks** to represent their small limbs, and will obtain pollen from **Little Bowls with grid patterns** that fit their body size well.

Moths:

Moths will use **Binder Clips** to represent their limbs being used to grab onto a flower, and will get their pollen from **Coffee Filters**, which are representative of their preference for white flowers.

Birds

Pollinator Profile

- Birds visit flowers during the daytime
- Birds use their beaks to reach inside flowers to drink nectar
- Birds do not rest on the flower petals to eat
- Birds have good vision but a poor sense of smell
- Birds are attracted to bright colors, like red or orange



©Dick Daniels

Bees

Pollinator Profile

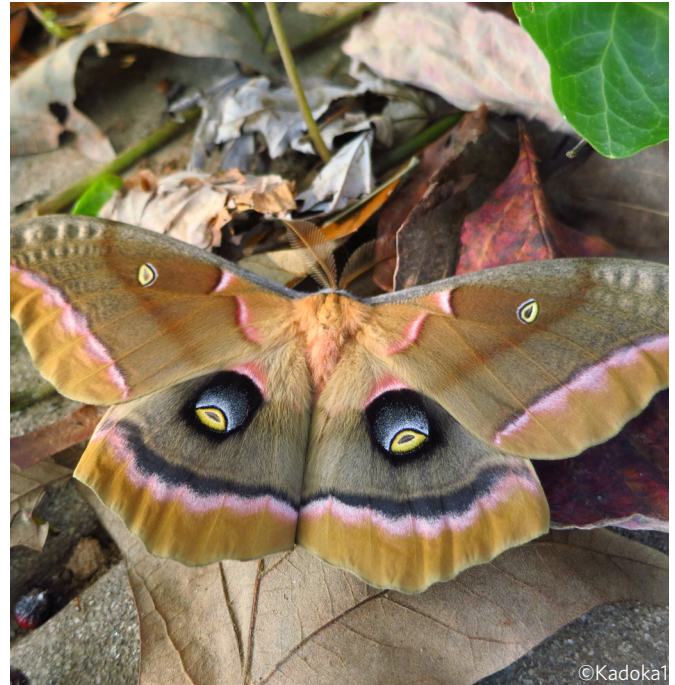
- Bees visit flowers during the daytime
- Bees land on the flower petals to gather pollen
- Bees are attracted to sweet smelling flowers
- Bees seeks bright colors, like yellow, blue, and violet.
- Bees can see colors in the UV spectrum



©John Severns

Moths

- Moths visit flowers during the nighttime
- Moths use their long mouth parts to reach inside flowers to drink nectar
- Moths do not rest on the flower petals to eat
- Moths are attracted to flowers that are pale colors, or white
- Moths are attracted to sweet smelling flowers



©Kadoka1

Pollinator Profile

Flies

- Flies visit flowers during the daytime
- Flies land on the flower petals to gather pollen
- Flies are attracted to flowers that smell like rotting meat because they lay their eggs on rotten meat
- Flies like to visit flowers that are low to the ground
- Flies like to visit flowers that are pale colors with dark brown or purple patches



©USDAgov

Butterflies

- Butterflies visit flowers during the daytime
- Butterflies use their long mouth parts to reach inside flowers to drink nectar
- Butterflies rest on the flower petals when they eat
- Butterflies are attracted to flowers that are bright colors, like violet, red, or orange
- Butterflies have good vision but a weak sense of smell

Pollinator Profile



Bats

- Bats visit flowers during the night-time
- Bats land on the flower petals to feed on the nectar deep inside the flower
- Bats are attracted to large flowers with strong smells
- Bats like to visit flowers that are white because they are visible at night

Pollinator Profile



Bio/Diversity Project
Lesson 2: Pollinators in the Sonoran Desert

Teacher: Shea Cutter
Adapted from: Pollinators on the Tallgrass Prairie
Grade Level: 8th
Time: 60 minutes

AZ State Science Standard:	<p>8.L3U1.9 <i>Construct an explanation of how genetic variations occur in offspring through the inheritance of traits or through mutations.</i></p> <p>8.L4U1.11 <i>Develop and use a model to explain how natural selection may lead to increases and decreases of specific traits in populations over time.</i></p>
Content Objective: Math, Reading, Science, Writing, Other:	<ul style="list-style-type: none"> • Students will be able to identify what qualities make a pollinator-plant pair compatible • Students will be able to identify Sonoran Desert pollinators and plants. • Students will be able to draw conclusions from raw data and justify those conclusions with biological knowledge
Language Objective: (Optional)	N/A
Scientist of the Week:	<p>Gloria D Degrandi-Hoffman</p> <ul style="list-style-type: none"> • Honey Bee Biologist • Works at the University of Arizona • Helping determine what in the environment is making honey bees more vulnerable

Vocabulary		Materials		
<ul style="list-style-type: none"> • Sonoran pollinators: bees, butterflies, flies, moths, bats, hummingbirds, wasps • Pollinator Syndrome • Symbiosis 		<ul style="list-style-type: none"> • Headbands • Cards with Sonoran Desert pollinators and plants • 3x5 Blank Notecards 		
<p>Seasonality: (If more specificity is required, please note date/time range under the season)</p> <p>Highlight which season(s) your lesson would be most suited to. When working with the natural world, it is important to keep this in mind for your planning! Some activities are possible for a brief window of time while others may be appropriate during any time of year.</p>				
<i>Monsoons</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec.- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June

**Guiding Questions:**

- What factors influence a pollinator to choose a flower?
- Describe the relationship between plants and their pollinators.
- What kind of plants and pollinators are found in the Sonoran Desert?

Engagement/Introductory Activity:

- Show students pictures of Sonoran Desert flowers and ask students to write down a 2 sentence explanation for why one of the flowers is their favorite.
- Think/Pair/Share of which flower students' chose and why.
- Explain to the students that just like they prefer some flowers over others, so do pollinators. For example, the butterfly has a long, slender mouth part (proboscis), they prefer flowers that are long and tube like. Some flies on the other hand, have short, round mouth parts much like a sponge. For these pollinators, a wide-open flower is preferred. For moths, a flower that is open at night is preferred because that is when moths are active. The concept of pollinators preferring some plants over others is known as 'Pollinator Syndromes.' Pollinators have certain characteristics that are specific to their preferred plants.

Exploratory Activity:

- We will assign each student a picture of either a Sonoran Desert plant or their pollinator
- Each student with a plant picture will try to pair up with their most effective pollinator
 - The students will not know what is on their picture
 - The picture will be connected to a headband (similar to the game HeadsUp).
- Each student will have a set of factual clues on their headband to help them find a pollinator or plant that fits into a working pair
- The activity will continue until each student is paired up with a pollinator or plant, they believe they could have a symbiotic relationship with

Plant and Pollinator Pairs:**Chuparosa = Hummingbird**

- Daytime blooms, presence of nectar, and tube shape all support that a hummingbird could pollinate this flower effectively

Smooth Desert Dandelion = 1. Bee, 2. Fly

- Daytime blooms, sturdy petal platform, UV light patterns all support bee pollination. Sweet scent, daytime blooms, and sturdy platform support fly pollination.

Desert Lilly = 1. Moth, 2. Bat

- Nighttime blooms, tube shaped flower, white coloration, and strong smell support moth pollination. Nighttime blooms, large flowers, and strong smell support bat pollination.

Starfish Cactus = 1. Fly, 2. Moth

- Daytime blooms, strong smell both support fly pollination. Strong smell supports moth pollination.

Dakota Mock Vervain = 1. Butterfly, 2. Bee

- Bright coloration, small, long-tube shaped flowers support butterfly pollination. Bright colors and many small flowers support bee pollination.

Yellow Palo Verde = Bee

- Daytime blooms, sturdy petals, and UV light pattern all support bee pollination.

Parry's Agave = 1. Bat, 2. Moth

- Nighttime blooms, strong smell, and sturdy petal platform with large flowers all support bat pollination. Smell, nighttime blooms both support moth pollination.

NOTE: there are enough plants that can have multiple effective pollinators that there may be some students who end up in very ineffective pairs. This is okay, as long as they realize they are not very compatible.

Explain:

- Students will look at and compare their headbands and determine if they chose an effective pollinator.
- Think/Pair/Share: what characteristics do the plants have in common with their pollinator?
- In a class discussion, ask for volunteers who think their pair was especially compatible or especially incompatible to tell the class why.
- Class question: Does anyone know what type of relationship is this called?
 - Short explanation on symbiosis definition

Extension Activity:

- Students will analyze a table of information about pollinator visits to the different plants they had and figure out which is the most common pollinator for their plant and why.
 - They should be able to tell this from the data and be able to justify their data with characteristic of the plant and the pollinator.
- Students should be able to identify that many flowers can be visited by multiple pollinators
 - Prompt students to consider why having multiple possible pollinators is advantageous.





Evaluation Activity:




- On a notecard, list one Sonoran Desert plant/pollinator relationship and why that relationship exists.
- What do they both get out of the relationship?
- Is this an example of symbiosis? If yes, what kind?

These cards can be assessed to see how effective the lesson was in increasing understanding of symbiotic pollinator/plant relationships.

Name: _____

Date: _____

Flower Traits		Number of Pollinator Visits					
		Butterfly	Bat	Bird	Bee	Moth	Fly
 <p>Flower 1: Chuparosa</p> <ul style="list-style-type: none"> No scent Sweet nectar at base of large, long tube-shaped flower No place for bird to rest while feeding Flower points down Blooms during day 		5	0	28	0	0	2
 <p>Flower 2: Smooth Desertdandelion</p> <ul style="list-style-type: none"> Sweet, fragrant smell Sturdy petal platform Bulls-eye design in center of flower, visible only under UV light Blooms during the day 		0	0	0	65	0	30
 <p>Flower 3: Desert Lily</p> <ul style="list-style-type: none"> Large white tube-shaped flower Sweet, fragrant smell Blooms at night 		7	11	0	0	25	0
 <p>Flower 4: Starfish Cactus</p> <ul style="list-style-type: none"> Putrid odor, like rotting meat, carrion, dung, sap or blood Flower is low to the ground Flower blooms during the day 		0	5	0	0	18	42

Flower Traits		Number of Pollinator Visits					
		Butterfly	Bat	Bird	Bee	Moth	Fly
	Flower 5: Dakota Mock Vervain <ul style="list-style-type: none"> No smell Many small flowers Brightly colored Small, long tube-shaped flowers 	55	0	0	14	3	0
	Flower 6: Yellow Palo Verde <ul style="list-style-type: none"> Sturdy petal platform Bulls-eye design in center of flower, visible only under UV light Blooms during the day 	0	0	0	44	0	8
 <small>©Wikipedia</small>	Flower 7: Parry's Agave <ul style="list-style-type: none"> Large flower clusters Strong, musky smell Blooms at night Sturdy petal platform 	0	19	6	0	12	0

Part One: Pollinator Observations

1. Who is your pollinator? _____

2. What number flower did your pollinator visit the most? _____

3. What are 3 flower traits that you think attract your pollinator? Use this sentence starter:

“ _____ are attracted to flowers that are...”
(pollinator)

1. _____

2. _____

3. _____

**Bio/Diversity Project
 Lesson 3: Bats Researchers**

Teacher: Shea Cutter, Amerlia Lappenbusch
 Grade Level: *8th*
 Time: *60 minutes*

AZ State Science Standard:	<p><i>8.L3U3.10</i></p> <ul style="list-style-type: none"> <i>Communicate how advancements in technology have furthered the field of genetic research and use evidence to support an argument about the positive and negative effects of genetic research on human lives.</i>
Content Objective: Math, Reading, Science, Writing, Other:	<ul style="list-style-type: none"> <i>Students will be able to identify bats as pollinators</i> <i>Students will be able to explain conservation efforts for bats</i> <i>Students will use teamwork and problem solving to complete activities focused on the importance of research toward the effort of conservation of bats</i>
Language Objective: (Optional)	<i>N/A</i>
Scientist of the Week:	<p>George Washington Carver (1864-1943)</p> <ul style="list-style-type: none"> Botanist and most prominent scientist and inventor of his time Researched plant biology focused on peanuts, sweet potatoes, soybeans and pecans Invented hundreds of products including 300 from peanuts and 118 from sweet potatoes

Vocabulary	Materials
<ul style="list-style-type: none"> Bat box Echolocation Migration Nectivorous Nose leaf Roost 	<ul style="list-style-type: none"> Bat bridge article Bat population worksheet Trivia slideshow

Seasonality:

<i>Monsoons</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec.- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions:

- Why is research important for conservation?
- What makes research difficult?
- Why are bats endangered?

Engagement/Introductory Activity:

- To begin the students will draw from last week's activity of plants and their pollinator relationships to identify characteristics that attracted bats to flowers to show them they have some knowledge to begin the lesson on bats
- Using a worksheet that labels the anatomy of bats the students will use the paragraph above the bat illustration to help them make educated guesses on how to label the bat analogy.
<https://www.fws.gov/midwest/endangered/mammals/inba/curriculum/Chapter12.pdf>
- After this activity I will go into a background of the two nectivorous bats in Arizona Mexican long-tongued bat and the lesser long-nosed bat
- Bats are the only mammals to fly
- Both bats are members of the diverse leaf-nosed bats, the leaf shaped patch at the top of their snouts is used to direct echolocation cries.
- The echolocation cries come from their nostrils and are too high of a frequency for humans to hear
- They roost in caves, abandoned mines, buildings, and bridges
- Females only birth one single young during the months of June and July
- Both bat species were put on the federal endangered species list however recent studies found that there is improvement in populations and as of last year the lesser long-nosed bat is off of the endangered species list

Exploratory Activity:

Using the article *Ina Road Bridge Bats and Bat Boxes* on pages 24-25 of the Quarterly News Magazine of Tucson Audubon Society Volume 63, Number 2. This article goes into detail about how the town of Marana funded a bat habitat replacement by adapting bridges with bat boxes incorporated within the design.

- Using the article, the students will be able to answer 10 trivia questions
- The questions are based around the idea that the students are researchers trying to help with bat conservation
- The answers can be found in the article about bat bridge
- Once the students have analyzed the article and answered the trivia questions correctly, they will receive a set of data that represents the bat population in Tucson over a 10-year lifespan
- Each answer

Explore activity questions:

- Why would it be important for researchers to look into the bat population in Tucson?
 - Over 50% of bat species are in severe decline or already listed as endangered.
- Researchers are experiencing trouble trying to find a community of bats in Tucson, Arizona. Where is a good place to locate a roosting site?
 - In older bridge designs with crevices such as Ina Road bridge
- Why are new bridge designs not fit for bats to roost in?
 - They have flat bottoms with no crevices for bats to roost
- What months would be the best to monitor the bridge before demolition?
 - May through April
- What type of bats will the researchers find during the winter?
 - Approximately 5,000 Mexican free-tailed bats remain in the Ina road bridge during the winter.
- Researchers want to create a bat box to relocate a colony from a bridge being torn down. What are important characteristics to include in designing the bat box?
 - Well-insulated in order to mimic the temperature moderation provided by the thermal mass of the bridge.
- What are bat bridges made of?
 - Light weight concrete material
- What size should the bat box be?
 - Each bat box is 4 ft x 4 ft x 4ft, with a crevice varying from ¾ inch to 1 ½ inches in width.
- During what months would there be the least number of bats in the bridge to start relocation? Why?
 - During mid-October through December because most of the bats have migrated to warmer climates.
- What can be used to help relocate the bats from the bridge?

- Sheet funnels hanging from the old bridge crevices so that bats can exit but not return.

Explain:

<https://www.youtube.com/watch?v=GFQVgNJGwmc>

Showing a video of bats emerging from bat bridge in Tucson at River and Campbell. During this video the students will answer some questions about research;

- What makes research difficult?
- How can we solve those problems?
- Why is research important for conservation?
- What does climate change have to do with the decline of bat population?
- What do bats do to help agriculture?

Extension Activity/Questions:

Using a graph analysis worksheet, the students will plot their data that they received about the bat population from the explore trivia activity.

- After plotting their data on the graph, it will display a trend in bat population and help the students fill out the bottom of the worksheet.
- The questions will help to gauge how well the students understand the trends in data and the effects of research and conservation on the bat population
 - What % has the bat population increased since year 1978?
 - How many times has the population been decreased since they started being measured in 1968 year?
 - The colony was not measured in year 1975. Using the trends on the graph estimate how many bats were in the that colony that year.
 - When do you think this colony started being protected?

Evaluation Activity:

On a notecard have the students answer a few questions to link the message back to the content objectives

- What kind of human interaction can put bat populations in danger?
- What kind of human interaction can help bat populations?

Ina Road Bridge Bats and

Janine Spencer-Glasson, Environmental Project Manager for the Town of Marana

History of Bats in Bridges

According to Bat Conservation International, over 50% of bat species are in severe decline or are already listed as endangered. The older bridge designs provided crevices for bats to roost; however, as these bridges are being replaced with new, flat-bottomed bridges, bat roosting habitat is being lost at an accelerating rate.

Ina Bridge

While the old Ina Road bridge provided an abundance of high quality crevice habitat, it became structurally unsound and was inadequate to handle traffic volumes. The old Ina Road Bridge had expansion joints and crevices that were used by thousands of bats, but the new design is flat-bottomed without the crevices. Many of the Mexican free-tailed bats migrate to this area during the summer. Some of these bats stay to over-winter under the Ina Road Bridge. As part of the environmental scoping process, Arizona Game and Fish (AZGFD) recommended mitigation by providing replacement habitat for the large bat population roosting in the bridge.



Mexican free-tailed bat, Arizona Game and Fish Department

Bats Using Ina Road Bridge

The Ina Road Bridge is one of many bridges in Tucson that provide significant roosts for bats. This bridge is home to about 15,000 thousand bats, mainly Mexican free-tailed bats (*Tadarida brasiliensis*) and some Cave myotis (*Myotis velifer*) during the summer. Approximately 5,000 Mexican free-tailed bats remain in the bridge in the winter. A large culvert adjacent to the Ina Road Bridge also provides roosting habitat for bats.



New bat boxes under the Ina bridge, Arizona Game and Fish Department

Because Tucson can get very hot during the summer and cold during the winter, it was important to design bat roosting habitat that is well-insulated in order to mimic, as closely as possible, the temperature moderation provided by the thermal mass of the bridge.

A thickened bridge deck was designed with cut-outs so that Modern Bat Boxes™ could be incorporated into the bridge deck mass to moderate temperatures for the bats. Modern Bat Boxes are designed and constructed in New Mexico, from a light-weight concrete material. Each bat box is 4 ft x 4 ft x 4ft, with a crevice varying from ¾ inch to 1 ½ inches in width.

AZGFD and Sandy Wolf gathered baseline information prior to demolition of the old bridge. They monitored bats under the Ina Bridge from May 2015 through April 2016.

AZGFD also installed data loggers that record temperature and humidity inside the crevices in the old Ina Road Bridge and in the bat boxes in the new bridge to determine whether the boxes have a microclimate that is similar to the old bridge crevices.

The Town of Marana made a presentation to the Regional Transportation Authority (RTA) Wildlife Linkages Working Group to request funding for the bat habitat replacement, and the RTA approved just over \$80,000 to fund incorporation of bat habitat into the new Ina Road Bridge and into an existing bridge at Cortaro Road just one mile north of the Ina Road Bridge.

Bat Boxes

Exclusion of Bats from Old Ina Road Bridge and Occupation of New Ina Bridge Bat Boxes

AZGFD coordinated with AZ Department of Transportation (ADOT) to exclude bats from the old bridge prior to demolition. The exclusion was timed during mid-October through December, when monitoring determined that bat numbers are low. AZGFD gradually sealed up unoccupied crevices and crevices when bats left for the evening to forage. They had to create plastic sheeting funnels hanging from some crevices so that the bats could exit but couldn't return to the same crevice. Then biologists could seal up the crevices. There were a few bats in torpor that still had not left the bridge after two weeks so AZGFD gently removed these bats physically and placed them in the new bat habitat incorporated into the new bridge section. The bats were sealed into the new bat habitat until the old bridge was demolished, at which time they were released.

As of January 27, 2018, AZGFD reported that two of the bat boxes in the new bridge section were inhabited by approximately 700 bats. AZGFD will be monitoring the bats in the new bridge for two years post-construction. Hopefully we will see more bats using their new bat habitat this summer as they return to Tucson for the summer.



Mexican free-tailed bats in the new boxes, Arizona Game and Fish Department

Acknowledgements:

Joel Diamond, Sr. Project Manager, Arizona Game and Fish Department
 Eduardo Moreno, Biologist, Arizona Game and Fish Department
 Regional Transportation Authority, Pima County, Arizona
 RD Wildlife Management, New Mexico
 Sandy Wolf, Bat Biologist

Bats are not the only urban wildlife you will find around Tucson! Here are some tips from Tucson Wildlife Center on living in harmony with our urban wildlife.

- You should only approach injured wildlife in extreme circumstances and wearing protection clothing. If you find an injured animal in your backyard, first bring all pets inside and then monitor the situation. Feel free to call Tucson Wildlife Center's 24/7 helpline 520-290-9453.
- Tucson Wildlife Center is the only center who will take injured bats. First of all, do not pick up the bat with your bare hands. Instead, carefully, scoop the bat up with a piece of cardboard into a box or use leather gloves to gently pick up the bat. Put it into a box with a lid and keep in a quiet, dark place to take to TWC.
- If you find a baby bird under a tree unharmed, first check to see if the parents are around and monitor the situation. If the baby has most of its feathers and it flutters its little wings in the presence of an adult, then they are fledging and the parents will feed it on the ground. If the baby cannot walk, only has fluff or no feathers, or its eyes aren't open, they should be placed back in the nest. Do not give food or water, as tempting as it may be. If the bird looks healthy and isn't cold, and you can see the nest and can reach it, try to renest it. If the nest is too high, you can try to make a nest as high as you can with an old plastic container. Cut small holes in the bottom of the container so if it rains the nest won't flood with water. Line the nest with grasses or a soft, dry washcloth with no strings coming off of it. Attach the nest to the tree or fence or whatever is near the original nest with wire, string, or bolts/screws. If it has a broken wing, leg, or otherwise looks injured call the Wildlife Help line.
- Wait until fall to trim your palm trees—many birds use them to nest in the spring!
- Cap your chimneys to prevent raccoons, squirrels, and birds from using them to build nests.
- Do not feed wildlife. Planting native plants is an excellent alternative to feeding wildlife.
- Avoid using poisons to eliminate pests. Animals further up the food chain, such as raptors and mammals, will also die if they eat poisoned rodents or other small animals.

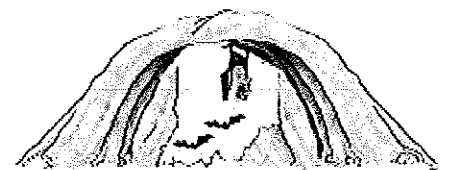
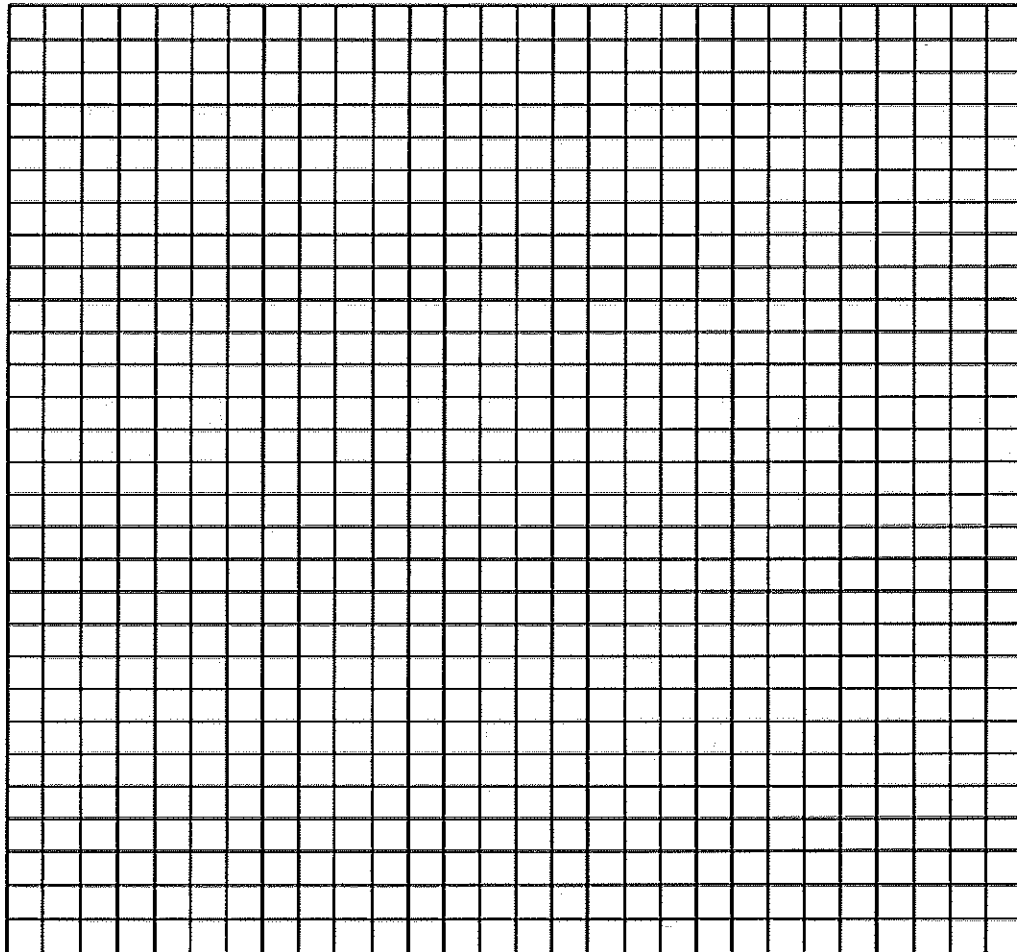


Plotting Populations

Using the data in the table below, make a graph illustrating the changes in a bat population at a single colony in Southern Arizona. Don't forget to label your graph. Use the graph you've create to answer the questions on the next page.

Mexican Free-Tail Bat Populations (Eagle Creek Cave, AZ)

Year	1968	1970	1972	1974	1976	1978	1980	1982	1984	1986
Guano Depth										

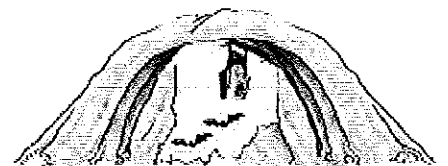


Name _____



Plotting Populations pg. 2

1. This colony has decreased _____% since 1968.
a) 51.1% b) 842% c) 78.2% d) 20.3%
2. How many years has the population decreased since it started being measured in 1968?
3. The colony was not measured in 1988. Using your graph, estimate how many bats were in the colony that year.
4. When do you think this colony started being protected?



INA ROAD BAT BRIDGE TRIVIA

- Why would it be important for researchers to look into the bat population in the Sonoran Desert?
 - Because over 50% of bat species are in severe decline or are already listed as endangered.
 - Great job working through the problem, researchers!
 - The bat population for X year is Y
- Researchers are experiencing trouble trying to find a community of bats. Where is a good place to locate a roosting site?
 - In older bridge designs with crevices such as Ina Road bridge
 - Great job working through the problem, researchers!
 - The bat population for X year is Y

INA ROAD BAT BRIDGE TRIVIA

- Why are new bridge designs not fit for bats to roost in?
 - They have flat bottoms with no crevices for bats to roost
 - Great job working through the problem, researchers!
 - The bat population for X year is Y
- What months would be the best to monitor the bridge before demolition?
 - May through April
 - Great job working through the problem, researchers!
 - The bat population for X year is Y

INA ROAD BAT BRIDGE TRIVIA

- What type of bats will the researchers find during the winter?
 - Approximately 5,000 Mexican free-tailed bats remain in the Ina road bridge during the winter.
 - Great job working through the problem, researchers!
 - The bat population for X year is Y
- Researchers want to create a bat box to relocate a colony from a bridge being torn down. What are important characteristics to include in designing the bat box?
 - Well-insulated in order to mimic the temperature moderation provided by the thermal mass of the bridge.
 - Great job working through the problem, researchers!
 - The bat population for X year is Y

INA ROAD BAT BRIDGE TRIVIA

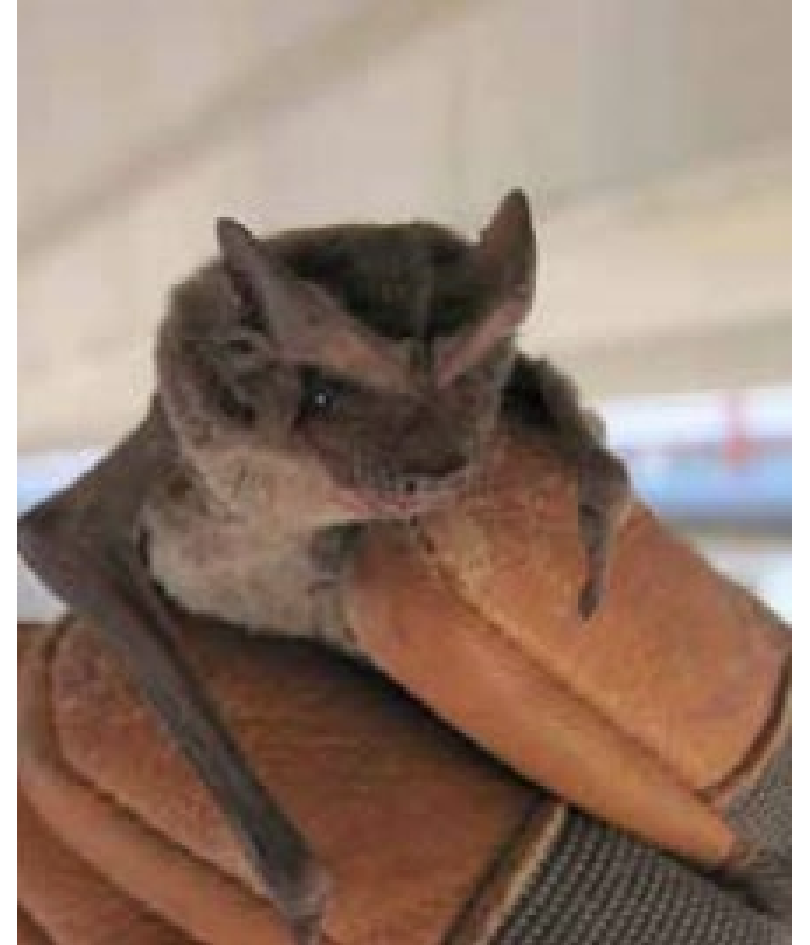
- What are bat bridges made of?
 - Light weight concrete material
 - Great job working through the problem, researchers!
 - The bat population for X year is Y
- What size should the bat box be?
 - Each bat box is 4 ft x 4 ft x 4ft, with a crevice varying from $\frac{3}{4}$ inch to $1 \frac{1}{2}$ inches in width.
 - Great job working through the problem, researchers!
 - The bat population for X year is Y

INA ROAD BAT BRIDGE TRIVIA

- During what months would there be the least number of bats in the bridge to start relocation? Why?
 - During mid-October through December because most of the bats have migrated to warmer climates.
 - Great job working through the problem, researchers!
 - The bat population for X year is Y
- What can be used to help relocate the bats from the bridge?
 - Sheet funnels hanging from the old bridge crevices so that bats can exit but not return.
 - Great job working through the problem, researchers!
 - The bat population for X year is Y

RESEARCH QUESTIONS

- What % has the bat population increased since year XXXX?
- How many times has the population been decreased since they started being measured in XXXX year?
- The colony was not measured in year XXXX. Using the trends on the graph estimate how many bats were in the that colony that year.
- When do you think this colony started being protected?



Bio/Diversity Project
Lesson 4: Life of Bats

Teacher: Shea Cutter

Grade Level: 8th

Time: 60 minutes

Adapted from: https://www.speakcdn.com/assets/2332/activity_-_make_and_play_game1.pdf

AZ State Science Standard:	<i>Learning Standards: 8.EIU3.8</i> <i>Construct and support an argument about how human consumption of limited resources impacts the biosphere.</i>
Content Objective: Math, Reading, Science, Writing, Other:	<ul style="list-style-type: none"> • Students will be able to distinguish the difference between nectivorous and insectivorous bats. • Students will be able to explain how human interaction is threatening the survival of bats. • Students will use teamwork and problem solving to find ways human interaction can positively affect the bat population.
Language Objective: (Optional)	N/A
Scientist of the Week:	Kathrin Barboza Marquez <ul style="list-style-type: none"> • Bolivia • Bat Biologist • Discovered the sword nosed bat thought to be extinct for 72 years • Researching bat bio-acoustics

Vocabulary	Materials
<ul style="list-style-type: none"> • Insectivorous • Megabat • Microbat • Nectivorous 	<ul style="list-style-type: none"> • Bat board game • Dice • 11x17 paper • Color pencils

Seasonality: Summer months when the bats migrate from Mexico after winter

<i>Monsoons</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec.- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions:

- What is the difference between nectivorous and insectivorous bats?
- What human interactions are affecting the survival of bats?
- What are the life threatening obstacles bat face each year?

Engagement/Introductory Activity:

- Introduce the facts about bat species
- Nearly 1,000 species of bats

- Explain the difference between Mega and Micro bats
 - Microbats — *Microchiroptera*
 - Mostly insectivorous
 - Nectivorous bats (pollinators) include – Mexican Long Tongue Bats & Lesser Long Nose bats
 - Small eyes
 - Big ears
 - Echolocation
 - Live everywhere except Antarctica
 - Desert ecosystems rely on nectar-feeding bats to pollinate giant cacti, including the organ pipe and saguaro of Arizona.
 - Megabats — *Megachiroptera*
 - Fruit
 - Big eyes
 - Small ears
 - No echolocation
 - Live in only tropical locations
 - Seeds dropped by bats account for up to 95% of forest regrowth on cleared land

Exploratory Activity:

- The students will participate in groups of 4 to complete a board game based off of bats
- **The goal** of the game is to be the first to make your bat return to the roost
- **The objective** of the game is for each student to take turns rolling the dice and following the situational instructions as you go through a year of a life as a bat
- The board game starts at the beginning of the bat's life cycle in the roost and ends when the bat returns to the roost after a year
- The student who rolls the highest number first moves first on the board
- The play will continue to the right with each player taking a turn
- If a player lands on a board piece with a situational instruction the player will follow those instructions
 - The situational instructions will either help or hurt the player by moving them forward or backward
 - The situational instructions will talk about situations that bats encounter each year that either threaten or help them
- The first player to return back to the roost at the end to give birth will win

Situational Instructions:

- Your mom gave birth to you. She learned your smell and developed a special call you will use to find each other among all the other bats. Move ahead one space.
- Mom left you for the first time successfully found you when she returned. You drank milk and went back to sleep with the other bat pups. Move ahead two spaces.
- You lost your grip on the cave wall and fell to the ground where a raccoon found you. Go back to the beginning
- With all of the other babies jostling for space you were knocked off the cave wall but landed on a ledge. Your breath was knocked from you but you will recover. Miss one turn.
- You are three weeks old you have developed teeth and can fly. Move ahead one space.
- About five 5 weeks after being born you make your first flight out of the cave into the night to hunt with the adults. Move ahead 2 spaces
- A snake hanging at the cave opening almost caught you but you escaped successfully. Move ahead 2 spaces.
- You echolocate to guide yourselves through the night and find a night blooming organ pipe cacti. Move ahead 2 spaces.
- You and your bat colony help to pollinate the Sonoran Desert ecosystem this summer. Move ahead 2 spaces.
- Fall is here. You have found plenty of food during the summer and are ready to follow your colony to Mexico. Move ahead 3 spaces.
- You are chased by an owl and his talons tear your wing. You head to the nearest shelter until you feel well

enough to fly again. Move back 3 spaces

- You make it with your colony to the winter cave for hibernation. Move ahead 2 spaces
- During the winter, hunters who think all bats have rabies enter the cave and kill many of your roost mates. Move back 3 spaces.
- You have a mate. You will be a parent in a few months. Move ahead 1 space.
- You migrate back safe to the United States after a long trip back to your summer roosts. Move ahead 2 spaces.
- It's a stormy night you can't fly or use echolocation to find food. Move back 2 steps
- Its early summer an all the female bats living in the maternity caves are ready to give birth. Move ahead 1 space.
- You have given birth to a healthy pup. Move ahead 2 spaces.
- Climate change has changed the time when cactus bloom flowers this year. Move back 3 spaces
- Schools started teaching students the importance of bats. Move ahead 3 spaces.
- Your roost that was in an old bridge has been destroyed so that another flat bottom bridge could be made. Move back 3 spaces.
- Bat boxes are incorporated in a new bridge design and is your shelter for the next months. Move forward 2 spaces.
- The agave plants are being harvested just before they bloom and removed from your food supply this year. This also affects the following years since agave only flowers once after growing fully for 10-20 years. Move back three spaces.
- The government passes a law that protects your habitat and increases at research. Move ahead 5 spaces.

Explain:

- Discuss in detail the lifestyle of bats from start to finish
 - Females give birth to only one bat during each reproduction cycle during the spring
 - Newborn micro bats nurse up to five weeks and mega bats as long as five months
 - At 3 weeks old the baby has teeth and can fly and find his own food
 - At 4 weeks the babies are ready to leave their mothers
 - During the day bats stay in their roosts until night when they leave to find food
 - The nectivorous bats are the primary pollinators od the saguaro and organ pipe cactus
 - By the end of summer the blooms become fruit and the bats along with other mammals eat the fruit and help to spread the seeds of the cactus
 - By the bats have found enough food during the summer to head back down to Mexico for winter
 - By late fall the bats prepare for hibernation
 - Hibernation happens between September and October
 - The nectar trail leads the bats back north from Mexico to the Sonoran Desert just as the saguaro and organ pipe cactus bloom
 - Microbats live on average 6 to 7 years but have been known to survive past 10
 - The mortality rate for bats is very low due to changing conditions and climates and human interaction

Extension Activity/Questions:

- In the same groups as the explore activity the students will work together to create a public service project that helps the conservation of bats
- The project that they create would have helped them to survive and win the game easier
- The project will include the challenge they want to address that threaten bats, the goal of the project, the materials they will need, how long it will take, a detailed procedure, and how they will measure its effectiveness.
- This activity will be outlined in a worksheet to help the students
- Each group will have one worksheet they will work on

Evaluation Activity:

- Each group will present their project ideas to the rest of the class
- The worksheet will be each student exit ticket

START

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BATS EDITION



5

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	11		10		9		8		7		6
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12



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13		14		15		16		17		18	
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19

FINISH

	24		23		22		21		20	
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**THE GAME OF
LIFE
BATS EDITION**

1

Your mom gave birth to you. She learned your smell and developed a special call you will use to find each other among all the other bats. Move ahead one space.

**THE GAME OF
LIFE
BATS EDITION**

2

Mom left you for the first time successfully found you when she returned. You drank milk and went back to sleep with the other bat pups. Move ahead two spaces.

**THE GAME OF
LIFE
BATS EDITION**

3

You lost your grip on the cave wall and fell to the ground where a raccoon found you. Go back to the beginning

**THE GAME OF
LIFE
BATS EDITION**

4

With all of the other babies jostling for space you were knocked off the cave wall but landed on a ledge. Your breath was knocked from you, but you will recover. Miss one turn.

**THE GAME OF
LIFE
BATS EDITION**

5

You are three weeks old you have developed teeth and can fly. Move ahead one space.

**THE GAME OF
LIFE
BATS EDITION**

6

About five 5 weeks after being born you make your first flight out of the cave into the night to hunt with the adults. Move ahead 2 spaces

**THE GAME OF
LIFE
BATS EDITION**

7

A snake hanging at the cave opening almost caught you, but you escaped successfully. Move ahead 2 spaces.

**THE GAME OF
LIFE
BATS EDITION**

8

You echolocate to guide yourselves through the night and find a night blooming organ pipe cacti. Move ahead 2 spaces.

**THE GAME OF
LIFE
BATS EDITION**

9

You and your bat colony help to pollinate the Sonoran Desert ecosystem this summer. Move ahead 2 spaces.

**THE GAME OF
LIFE
BATS EDITION**

10

Fall is here. You have found plenty of food during the summer and are ready to follow your colony to Mexico. Move ahead 3 spaces.

**THE GAME OF
LIFE
BATS EDITION**

11

You are chased by an owl and his talons tear your wing. You head to the nearest shelter until you feel well enough to fly again. Move back 3 spaces

**THE GAME OF
LIFE
BATS EDITION**

12

You make it with your colony to the winter cave for hibernation. Move ahead 2 spaces

**THE GAME OF
LIFE
BATS EDITION**

13

During the winter, hunters who think all bats have rabies enter the cave and kill many of your roost mates. Move back 3 spaces.

**THE GAME OF
LIFE
BATS EDITION**

14

You have a mate. You will be a parent in a few months. Move ahead 1 space.

**THE GAME OF
LIFE
BATS EDITION**

15

It's a stormy night you can't fly or use echolocation to find food. Move back 2 steps

**THE GAME OF
LIFE
BATS EDITION**

16

Its early summer an all the female bats living in the maternity caves are ready to give birth. Move ahead 1 space.

**THE GAME OF
LIFE
BATS EDITION**

17

You have given birth to a healthy pup. Move ahead 2 spaces.

**THE GAME OF
LIFE
BATS EDITION**

18

Climate change has changed the time when cactus bloom flowers this year. Move back 3 spaces

**THE GAME OF
LIFE
BATS EDITION**

19

Schools started teaching students the importance of bats. Move ahead 3 spaces.

**THE GAME OF
LIFE
BATS EDITION**

20

Your roost that was in an old bridge has been destroyed so that another flat bottom bridge could be made. Move back 3 spaces.

**THE GAME OF
LIFE
BATS EDITION**

21

Bat boxes are incorporated in a new bridge design and is your shelter for the next months. Move forward 2 spaces.

**THE GAME OF
LIFE
BATS EDITION**

22

Bat boxes are incorporated in a new bridge design and is your shelter for the next months. Move forward 2 spaces.

**THE GAME OF
LIFE
BATS EDITION**

23

The agave plants are being harvested just before they bloom and removed from your food supply this year. This also affects the following years since agave only flowers once after growing fully for 10-20 years. Move back three spaces.

**THE GAME OF
LIFE
BATS EDITION**

24

The government passes a law that protects your habitat and increases at research. Move ahead 5 spaces.

Bio/Diversity Project
Lesson 5: Conservation of Monarch Butterflies

Adapted from:

https://www.fs.fed.us/wildflowers/pollinators/Monarch_Butterfly/documents/royal_mail/Making_Decisions.pdf

Teacher: Shea Cutter

Grade Level: *8th*

Time: *60 minutes*

AZ State Science Standard:	8.L3U3.10 <i>Communicate how advancements in technology have furthered the field of genetic research and use evidence to support an argument about the positive and negative effects of genetic research on human lives</i>
Content Objective: Math, Reading, Science, Writing, Other:	<ul style="list-style-type: none"> • <i>Students will be able to justify the cultural importance of butterflies to the Mesoamerican culture</i> • <i>Students will identify how cultural and social perspectives influence the attitudes, beliefs, and biases of people toward the use of resources and environmental protection</i> • <i>Students will use teamwork and analyze the problems that Monarch reserves in Mexico face and propose solutions</i>
Language Objective: (Optional)	N/A
Scientist of the Week:	Catalina Trails <ul style="list-style-type: none"> • Michoacan, Mexico • Discovered the Cero Pelon summit where Monarch overwintering site in 1975 • First Westerner researching Monarch migration to discover this migration pattern and trace it to Mexico • Helped to find other overwintering sites and put them under the Mexican government's protection

Vocabulary	Materials
<ul style="list-style-type: none"> • Ecotourism • Key species • Monarch • Tree harvesting 	<ul style="list-style-type: none"> • Monarch reserve articles • Worksheet • Pencils • Persuasive letter template

Seasonality: N/A

<i>Monsoons</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec.- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions:

- How can ecotourism help Monarchs survive?

- How can the cultural significance of the butterfly to pre-Hispanic cultures help to protect the butterfly population?
- Why are butterflies a key species

Engagement/Introductory Activity:

- Introduce the topic of butterflies with background information and picture slides:
 - There are 250 species of butterflies in the Sonoran Desert
 - The Scientific name is Lepidoptera meaning Scaled and wing
 - Butterflies wings like moths have thousands of tiny overlapping scales, much like tiles on a roof
 - Butterflies are migratory pollinators that we see in the Sonoran Desert in late summer, fall, and early spring
 - Monarchs can travel 50-100 miles a day
 - The Monarch butterfly is unique among the butterflies because of their long distance, round trip migrations.
 - They use a combination of air currents and thermals to travel long distances.
 - Some fly as far as 3,000 miles
 - The eastern population of North America's Monarchs overwinters in the states of Mexico and Michoacan from October to late March
 - Here the temperatures range from 32 to 59 degrees Fahrenheit. If the temperature is lower the monarchs are forced to use their fat reserves. & the humidity assures the monarchs won't dry out allowing them to conserve energy while hibernating
- Talk about the cultural significance of butterflies in pre-Hispanic cultures with picture slides of archeological discoveries:
 - Butterflies represent heroes and important people that died
 - The Teotihuacan culture (200-900 A.D.) used butterflies in their ceremonial pottery
 - Toltec culture (900-1168 A.D.) butterflies were on the breastplates of colossal Tula warrior figures & carved in their temples that were the center of ceremonial Mayan culture
 - The Aztec goddess of happiness, flowers, and housework was represented with a human face and arms and body and wings of a butterfly
 - The name given to Monarch Butterflies was Quetzalpapalotl meaning daughter of the sun
 - Explain to them the myth of how Monarchs came to be/ their migration to the Rocky Mountains in Mexico in the winter

Exploratory Activity:

- Using articles with data tables and information about habitat loss of overwintering sites for Monarchs in Mexico caused by agriculture, cattle raising, the harvesting of trees, fires, pesticides, and plant diseases the students will conduct a debate in 5 groups of 6 students.
- Using a worksheet that states:
 - the stance they are taking regarding the land use of Monarch Reserves in Mexico
 - 3 claims that support their argument

- 3 facts of supporting evidence from the articles
- Each team will play a different role in the debate
 - A conservation group for the Monarch butterfly
 - The lumber dealers in El Rosario for tree harvesting
 - The El Rosario community & neighboring community for lumber job opportunities
 - Sonoran Desert pollinator conservation group
 - Board of directors who are responsible for listening to the groups analyze the proposals and make a decision and communicate their decision with pros and cons
- The debate will go until each group has discussed their positions, claims, and facts
- The Board will take into consideration all of the arguments and basic knowledge they got from their article and state which side had the most persuasive argument

Explain:

- Ask the students after the debate if they wish to change sides because the facts persuaded them?
- Ask the students what side they fall on in this debate?
- Emphasize to the students that each group had valid arguments and reasoning for their position regardless of who won the debate. Finding one solution that satisfies everyone is almost impossible. It is not easy to solve problems related to conservation. It is necessary that each interested party compromise or yield to some of the demands made by opposing groups, even when their interests are affected.

Extension Activity/Questions:

- Talking to the students about the threats to Monarchs
 - Climate change, changing bloom periods and temperature needed to hibernate
 - Pesticides can poison breeding sites for Monarchs
 - Habitat loss/ fragmentation, tree harvesting leaving the forest depleted and changing the climate of the region
- Talking to the students about conservation efforts
 - Plant pollinator gardens and milkweed organically
 - Help by becoming a citizen scientist, monitoring habitats and migration of Monarchs
 - Visit Monarchjointventure.org to find out more ways to help out with the research and dispersal of the monarch population

Evaluation Activity:

- Do you think that there is any action you can take in your community to help out the cutting down of trees in the Monarch Butterfly Special Biosphere Reserve?
- Having students share what are some potential human activities that may harm the monarch population that can be changed
 - What about decreasing the paper consumption? Yes or no?

Monarch Debate Background

OVERVIEW

There are no easy solutions to the problems which emerge in protecting natural areas. Solving them requires that the parties affected participate and compromise in the decisions made. The students will analyze the problems that the MONARCH BUTTERFLY SPECIAL BIOSPHERE RESERVE in Mexico faces, and will propose solutions.

BACKGROUND

Over the years, the final destination of the great majority of migrating Monarch butterfly's was a true mystery, especially for zoologist Fred Urquhart, a professor at the University of Toronto, Canada. Since 1937, he has studied this singular insect. His main objective was to determine the route followed by the butterfly during its migration and the Monarch's overwintering site. To that end, it was necessary to know the distance traveled, the direction and the destination of the flight. It took Dr. Urquhart a long time to figure out a way to obtain this data. He solved the problem by marking the butterflies with a small adhesive tag, which he designed. The tag was affixed by gently applying pressure to the butterfly's wing, and did not affect its flying capability. It is important to note the effort involved in capturing these delicate insects, and subsequently, releasing them without any harm.

In 1952, the first marking of the Monarchs was completed. The tags had an identification number and the inscription "send to Zoology Dept., University of Toronto, Canada". With the collaboration of numerous residents from Canada and United States, it was determined that the butterflies flew on a diagonal route, crossing the US from the northeast to

the southeast. It was observed that large groups of butterflies crossed Texas apparently in route to Mexico.

In 1972 several Mexican newspapers published an announcement, asking for volunteers to locate the hibernation sites. A Mexican-American couple, living in Mexico, solved the enigma. Based on the information from some woodcutters of a small town called Angangueo, they located the first colony in a fir forest (oyamel) in the Michoacán mountains, in 1975.

Dr. Urquhart was notified and visited the site in 1976. He was there for several days, marking butterflies. Some of these marked samples were found north of Texas, in April of the same year. In this way, the migratory route of the Monarch Butterfly was established. But, new questions arose. Why did they choose this area? What characteristics make it special?

Located in the high mountains of the neovolcanic axis of México, this temperate forest is humid with an abundance of pines, firs and cedars. The great number of trees ensures that the temperature and humidity remain steady in the forest, creating the essential conditions for the Monarch's survival.

At the end of autumn, when the Monarch Butterflies arrive at their sanctuaries, they form groups which roam the higher mountain elevations, changing places every night. As winter advances and the temperature goes down, these lepidoptera move to the lower elevations until they find the right altitude, where the temperature and humidity stay at the required level for hibernation. By mid December, they gather, forming large and dense clusters that hang from the trees and, transform the landscape into a handsome tapestry of orange tones. There they remain in hibernation until mid February.

The importance of this forest is that the trees are not only useful to support the butterflies' colonies, but they also provide the ideal micro-climate for hibernation (from 6 to 15° C) as a result of the forest's density. In these forest conditions, the butterflies avoid extreme cold temperatures which would

freeze them to death, and high temperatures which would trigger their activity, forcing them to burn the fat stored for mating and returning north in the spring.

Although variations in temperature could be accounted for by natural causes, they are, as a rule, the result of deforestation. Mortality studies on Monarchs indicate that when tree density is less than 400 trees per hectare, the internal temperature surpasses the critical threshold for the butterflies' survival, freezing hundreds of thousands of butterflies to death.

To avoid this situation and protect the Monarch butterfly's overwintering sites, on October 9, 1986, a Presidential Decree was issued. It declared 16,110 hectares of woodland a Natural Protected Area, classifying it as a Special Biosphere Reserve and turning six nucleus zones into sanctuaries where no exploitation of any kind is allowed. These zones include the following areas: the Cerro Altamirano and the Cerro Pelon in the state of México; and the Sierra El Campanario, the Sierra Chincua, the Cerro Chivati and the Cerro Huacal in the state of Michoacán, each surrounded by a buffer zone or area where harvesting of trees and tourism are permitted but on a limited basis.

A large area of the reserve is occupied by farming communities called "ejidos" where living conditions are poor, particularly in health, education, communication, housing and drinking water. For many years, lumbering has been their principal means of livelihood with agriculture, cattle raising and mining as secondary economic activities.

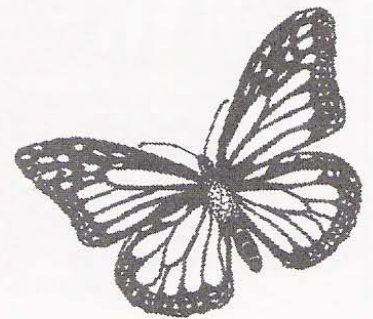
However, economic need has led the inhabitants of this region to overexploit their natural resources. Deforestation caused by excessive felling of trees, whether for the timber industry, for farming, or for cattle raising, has contributed to the destruction of the forest's natural vegetation and, as consequence, to the impoverishment of the inhabitants and the deterioration of the Monarchs' overwintering sites. In the opinion of many researchers, the real danger which threatens the butterflies are these changes in land use.

In an attempt to halt the deforestation caused by the local inhabitants, who are pressed by economic need, various projects have been initiated over the last few years, including an ecotourism project which opened one of the sanctuaries to the public. In theory, the profit made was to be divided among the local residents. The neighboring communities also were to benefit from the tourism, by making food, lodging and transportation available, and by selling their crafts.

However, the local participants in the project complained that their per capita income was still too low and that it did not meet their needs. As a result, the felling of trees continues at an alarming rate.

To further complicate matters, the behavior of tourists exacerbates the problem. Many do not obey the rules established to protect the Monarchs in their sanctuary. They smoke, their noise disrupts the butterflies' peaceful hibernation, they disturb the butterflies by shaking the branches where the butterflies cluster, and even catch the butterflies for their personal collections. They litter a great deal, and start bonfires which in some cases have resulted in larger fires, another factor contributing to the destruction of the Monarch Butterfly's habitat. Many conservation groups have voiced their concern because of the high rate of fires in the reserve. Some have suggested closing the sites to tourists.

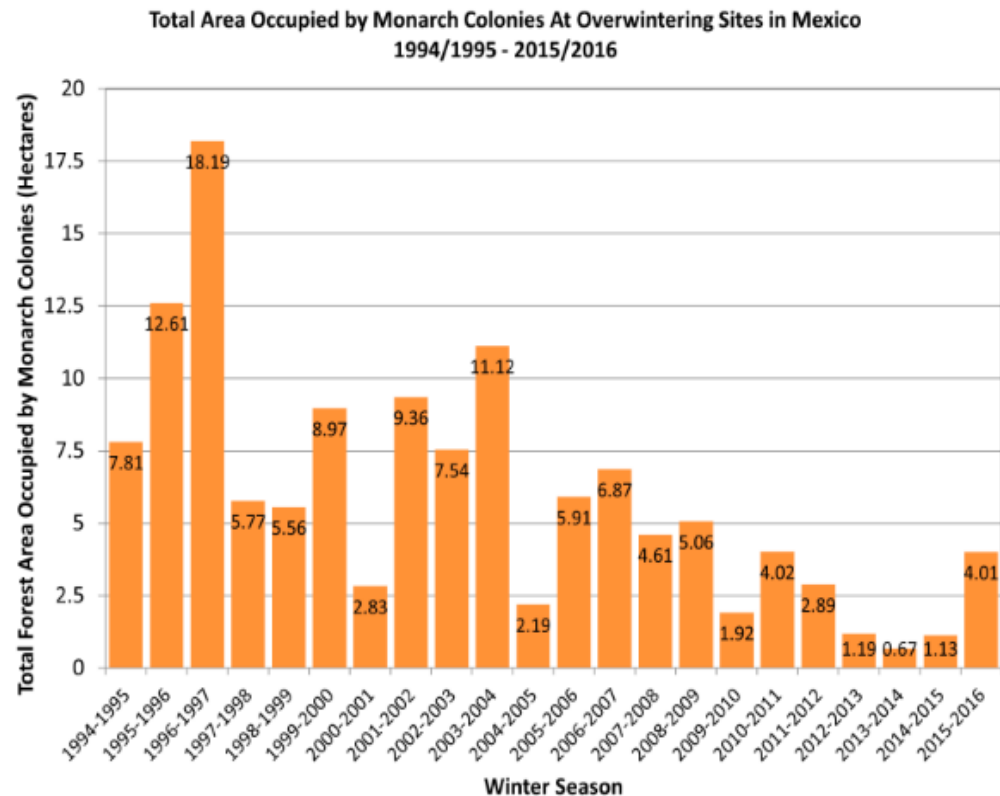
Under these circumstances it is necessary for the people of these communities to find new, alternate ways of sustainable development. The Mexican Government, the U.S. Fish & Wildlife Service and some non-governmental organizations are helping the communities diversify their activities. In addition to tourism, local communities have been encouraged to become involved in soil conservation, horticulture, fruit growing, fish breeding, carpentry, and reforestation to improve the quality of life without affecting the forests they inhabit. As with every official project aiming at helping the communities, this one has faced difficulties; mainly, because it is not simple to change the peasants' customs and practices. It is also not easy to eliminate the corruption that prevails at all levels.



On the other hand, until the peasants benefit economically in a significant way, and become environmentally conscious of their relationship to nature, the pines, firs, and cedars will continue to be harvested indiscriminately. It is also evident that in order to protect the Monarch Butterfly and other species, it is not enough to declare a zone a "protected area." It is essential to consider the needs of the human groups that live in or near the area.

Mexicans face the challenge and the responsibility to ensure that each citizen is able to satisfy his or her most basic needs. Only then will we be able to guarantee not only the protection of the Monarch Butterfly, but also the protection of other species that inhabit our country.

CLASS DEBATE



Teams	Position
Watershed Management Group – Monarch Project	Pro conservation
El Rosario Lumber Dealers	Against conservation, pro tree harvesting
El Rosario Community & Neighboring Communities	Against conservation, pro lumbering jobs, agriculture, and cattle
Southwest Monarch Study	Pro conservation
Board of Directors	Open

DEBATE DISCUSSION CONTINUED

- What side do you choose now that you have heard all everyone's position?
- Did you change sides?
- Are finding conservation solutions easy?



Monarch Debate

The dilemma:

The overwintering sites of the Monarch Butterfly are located in 16,110 hectares of temperate and humid forest with a predominance of pines and Douglas fir. The area includes the municipalities (similar to the US counties, Tucson is a part of Pima County) of Ocampo, Angangueo, Zitacuaro, Hidalgo and Contepec in the state of Michoacan and Donato Guerra, Villa de Allende, and Temascalcingo in the State of Mexico.

Many communities are located in the Reserve. The living conditions are extremely poor in the majority of them. The people mostly practice subsistence agriculture but some raise cattle as well. They only plant corn and beans needed for family use. But, in order to farm they must cut down the trees. And, because the forest soil is quickly depleted of its low-level nutrients (3-4 years), they frequently clear new land for cultivation. In order for the cattle to graze, the people frequently burn the dry and tough grass to allow the growth of green and tender grass. But sometimes the fire gets out of control, causing forest fires. At the same time, the indiscriminate pasturing of the animals destroys the new trees, making it difficult for the forest to recover. The people in the community also supplement their small incomes by commercial harvesting of trees, either on their own or as employees of lumber dealers.

Agriculture, cattle raising, the harvesting of trees, and other factors such as fires, and plant diseases and pests combined contribute to the destruction of the Monarch's winter habitat and could put the species' survival at risk. This situation worries several conservation groups who demand an end to the harvesting of trees, attempt to regulate agricultural and cattle raising practices and try to prohibit tourists from entering the sanctuary, because visitors do not obey the rules.

The communities oppose those measures. Meanwhile, entrepreneurs and lumber dealers put pressure on the government to get permits for tree harvesting, claiming to contribute to the creation of jobs and profits for the region. Governmental organizations in charge of the Reserve, face a big dilemma because they know that if they stop the clearing and harvesting of trees and tourism, the economic problems would get worse, not only in El Rosario, but in the entire region as well.

This situation is critical because all groups wish to impose their view.

The purpose of this debate is to help the Mexican Government decide what is best for the Monarch butterfly, the community members and region.

Who are you?	
What is your point of view on the issue?	
What is your possible solution to this problem?	

Bio/Diversity Project
Lesson 6: Action Project – Bat Conservation

Teacher: Shea Cutter
 Grade Level: 8th
 Time: 60 minutes

AZ State Science Standard:	<i>Learning Standards: 8.EIU3.8</i> <i>Construct and support an argument about how human consumption of limited resources impacts the biosphere.</i>
Content Objective: Math, Reading, Science, Writing, Other:	<ul style="list-style-type: none"> • <i>Students will be able to identify habitat loss as a conservation issue for the bat population</i> • <i>Students will be able to explain how human interaction is threatening the survival of bats.</i> • <i>Students will use teamwork and problem solving to find ways to model a successful bat house</i> • <i>Students will be able to understand the importance of the design process</i>
Language Objective: (Optional)	N/A
Scientist of the Week:	<p>Mario Molina</p> <ul style="list-style-type: none"> • <i>Chemist</i> • <i>Born in Mexico</i> • <i>Won a Nobel Prize in 1995 for research findings on how man-made compounds affect the ozone layer</i> • <i>Interest for science started at a young age when he creates a chemistry laboratory in his bathroom at home.</i> • <i>Studied at the University of California Berkeley</i> • <i>Taught at the Massachusetts Institute of Technology (MIT) and University of California San Diego</i>

Vocabulary	Materials
<ul style="list-style-type: none"> • Bat box • Engineering design process 	<ul style="list-style-type: none"> • Action plan worksheet (<i>Extension</i>) • Design process worksheet (<i>Explore</i>) • Materials list (<i>Extension</i>) • Playdoh • Cardboard • Color construction paper • Duct tape/Regular tape • Flowers • Foam board • Glue • Popsicle sticks • Rubber cement



- Scissors

Seasonality: Summer months when the bats migrate from Mexico after winter

<i>Monsoons</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec.- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions:

- Why is bat conservation an important issue to address?
- How can we address habitat loss and destruction for bats in the Sonoran Desert?
- What characteristics are important to include in a bat box?

Engagement/Introductory Activity:

Introduce our action project for the next two which will be focusing on bat conservation:

- Approximately 70 species of bats live in the Sonoran Desert region. Bats are an important part of our ecosystem, pollinating Saguaro and Yucca flowers and helping to keep populations of night flying insects like mosquitoes in control.
- One of the biggest threats to pollinating bats is habitat loss. Their habitat is made up of their food, water and somewhere to sleep or hide. Development is a major cause of the loss of their habitat.
- Bat houses are excellent management tools that can provide displaced bats with a safe alternate roost away from structures where they are unwelcome. And while it is true that bats in a bat house are not in your house, bats are faithful to their homes, and very rarely voluntarily leave an active roost for a bat house. Even the most well-planned and humanely-intentioned bat exclusion means habitat loss and displacement for bats.
- Our goal is to make a bat box/house that mimics the well-insulated atmosphere and thermal mass of a bridge or cave
 - The bat box will act as a roosting site for bats unable to find a peaceful or thermally comfortable roosting site for the summer
- Explain why bat boxes do not traditionally work in the Sonoran Desert
 - Bat boxes are usually made out of wood and will not work for the climate in Tucson. Bats would prefer the thermal regulation provided by a bridge.
 - <https://batmanagement.com/blogs/bat-roosts/why-do-some-bat-houses-fail> using this article to discuss why some bat boxes fail to become a bat roost
 - Talk about why schools do not want bat houses around their buildings
 - Show what a good location would be for a bat box

Exploratory Activity:

- The explore activity will be the beginning of the modeling and design process of prototyping a bat box that would work in the Sonoran Desert
- This week they will read an article on how to create a bat box that will explain the location and materials needed
 - <http://www.pbs.org/parents/wildkratts/activities/building-homes-for-bats/>
 - <https://www.nwf.org/en/Garden-for-Wildlife/Cover/Build-a-Bat-House>

- The students will work together in groups of 5. Using the articles and knowledge they have learned throughout the course about bats to complete a worksheet outlining their design process
 1. What is the issue? What needs to be improved? What's your goal?
 2. What is the perfect habitat for a bat in the Sonoran Desert?
 3. Draw your design for a bat box. Be creative and add elements that would attract a bat to your bat box. List the materials used to make this box.
 4. Build a miniature prototype with the playdoh provided
 5. What went well with the design? What could work in a real-life bat box? How could you improve your prototype?

Explain:

- After the students have finished creating their playdoh models and creating a design plan for next week share with them the importance of each step in the design process.
- Ask the students if their models came out exactly as they planned?
- Make sure they know it is important to account for time when creating a plan for next week

Extension Activity/Questions:

- Each group will present their bat box design ideas to the class
- They will be given a rubric of what to cover when they present
- The rubric will be used to justify their decisions for their prototype
 - Materials
 - Color
 - Location for the bat box
 - How will the bats feel safe in the box?

Evaluation Activity:

- The evaluation will be looking at the notes they took on grading their peers

Bat Box Design Prototype Worksheet

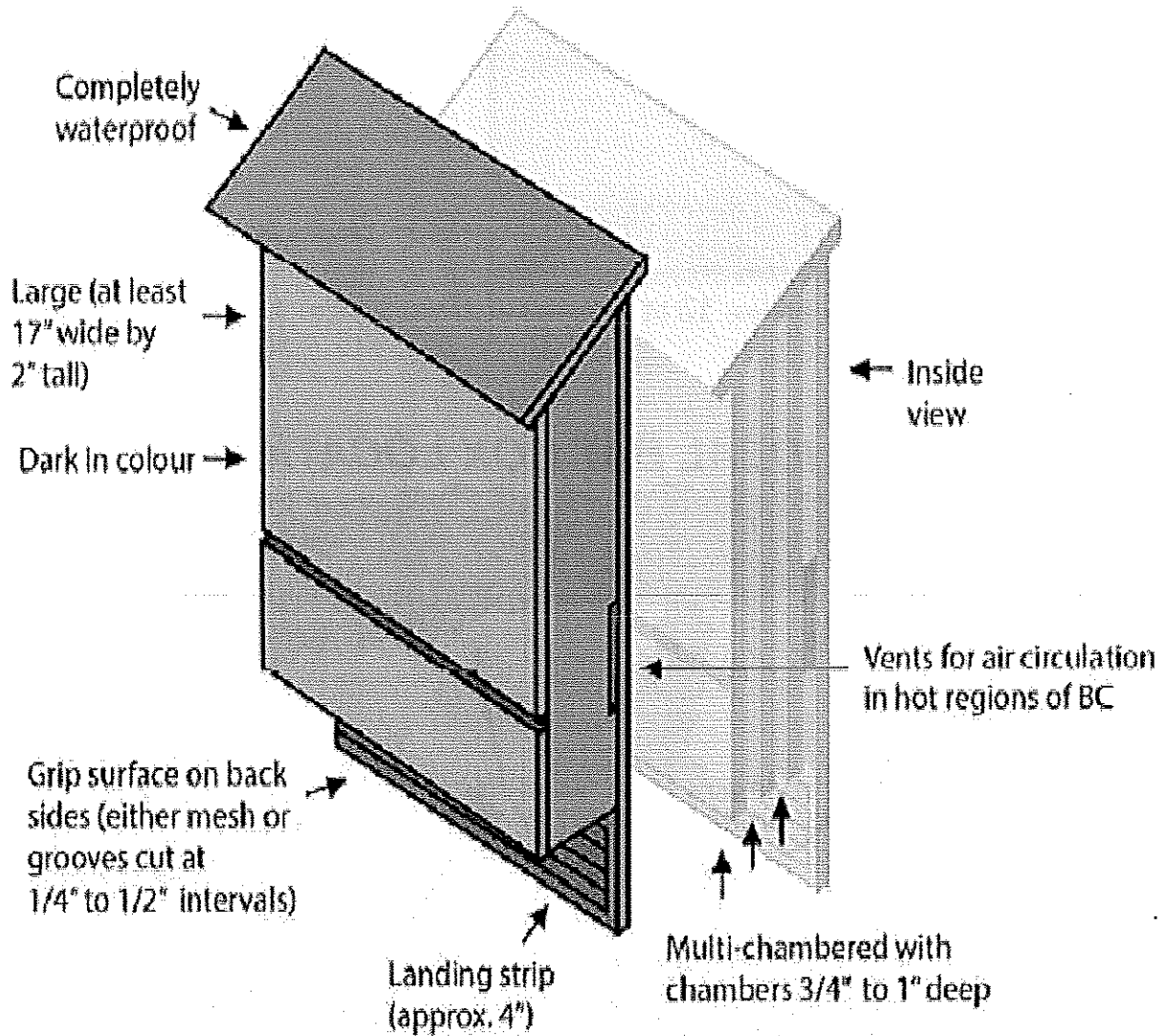
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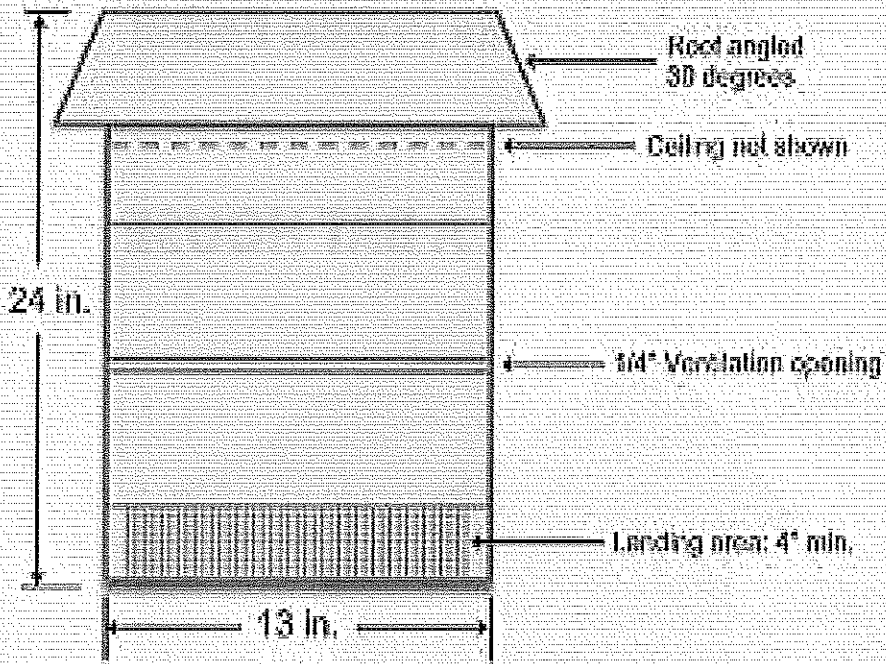


4. Build a miniature prototype with the playdoh provided
5. What went well with the design? What could work in a real-life bat box? How could you improve your prototype?

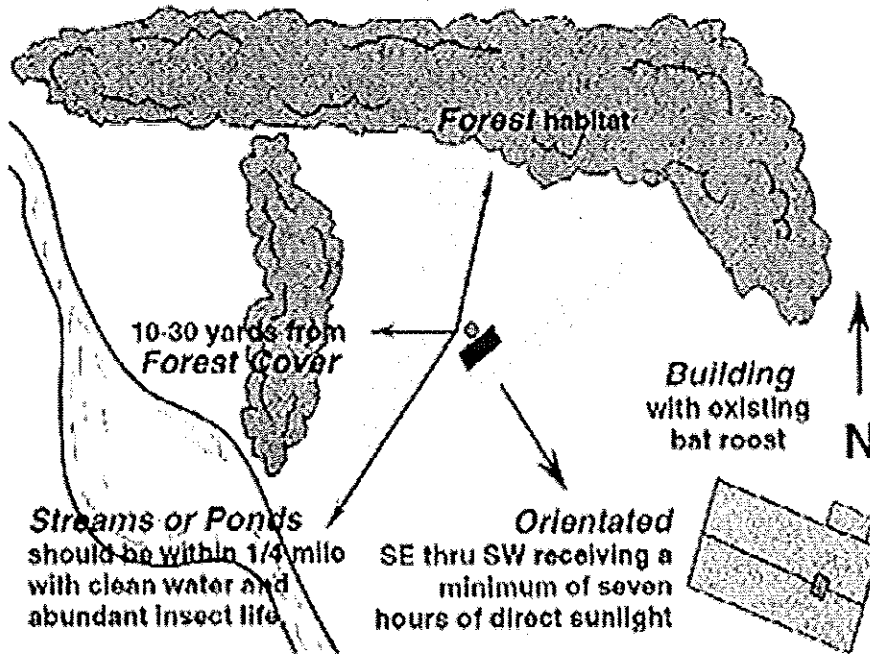
Bat Box Design Process Packet

KEY FEATURES OF A BAT HOUSE





IDEAL BAT BOX LOCATION



Bat Box Design Process

1. What is the issue? What needs to be improved? What is your goal?

2. What is the perfect habitat for a bat in the Sonoran Desert?

5. What worked in your design? What can you improve?

3. Draw your design for a bat box. Be creative and add elements that would attract

4. Model your bat box with the playdoh. See what works.

Bio/Diversity Project
Lesson 7: Action Project – Bat Conservation (Week 2)

Teacher: Shea Cutter
 Grade Level: 8th
 Time: 60 minutes

AZ State Science Standard:	<i>Learning Standards: 8.EIU3.8</i> <i>Construct and support an argument about how human consumption of limited resources impacts the biosphere.</i>
Content Objective: Math, Reading, Science, Writing, Other:	<ul style="list-style-type: none"> • <i>Students will be able to identify habitat loss as a conservation issue for the bat population</i> • <i>Students will be able to explain how human interaction is threatening the survival of bats.</i> • <i>Students will use teamwork and problem solving to find ways to model a successful bat house</i> • <i>Students will be able to understand the importance of the design process</i>
Language Objective: (Optional)	N/A
Scientist of the Week:	<p>Mario Molina</p> <ul style="list-style-type: none"> • <i>Chemist</i> • <i>Born in Mexico</i> • <i>Won a Nobel Prize in 1995 for research findings on how man-made compounds affect the ozone layer</i> • <i>Interest for science started at a young age when he creates a chemistry laboratory in his bathroom at home.</i> • <i>Studied at the University of California Berkeley</i> • <i>Taught at the Massachusetts Institute of Technology (MIT) and University of California San Diego</i>

Vocabulary	Materials
<ul style="list-style-type: none"> • Bat box • Engineering design process 	<ul style="list-style-type: none"> • Action plan worksheet (<i>Extension</i>) • Cardboard • Color construction paper • Design process worksheet (<i>Explore</i>) • Duct tape/Regular tape • Flowers • Foam board • Glue • Popsicle sticks • Rubber cement • Scissors



Seasonality: Summer months when the bats migrate from Mexico after winter

<i>Monsoons</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec.- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions:

- Why is bat conservation an important issue to address?
- How can we address habitat loss and destruction for bats in the Sonoran Desert?
- What characteristics are important to include in a bat box?

Engagement/Introductory Activity:

- Background information about roosting sites in the Sonoran Desert and how to mimic them with a bat box:
 - Pregnant females then move from hibernating sites to warmer roosts, where they form nursery colonies. Birth occurs approximately a month and a half to two months later. Young bats grow rapidly, often learning to fly within three weeks. While they are being reared, males and non-reproductive females often segregate into separate groups called maternity and bachelor colonies.
 - One of the biggest threats to pollinating bats is habitat loss. Their habitat is made up of their food, water and somewhere to sleep or hide. Development is a major cause of the loss of their habitat.
 - Bat houses are excellent management tools that can provide displaced bats with a safe alternate roost away from structures where they are unwelcome. And while it is true that bats in a bat house are not in your house, bats are faithful to their homes, and very rarely voluntarily leave an active roost for a bat house. Even the most well-planned and humanely-intentioned bat exclusion means habitat loss and displacement for bats.

Exploratory Activity:

<https://www.nwf.org/~media/PDFs/Be%20Out%20There/Schoolyard%20Habitats/Night-Friends.ashx>

<http://www.batcon.org/resources/getting-involved/bat-houses/build>

- The students will get back into their groups they created their action plan with
- Using the above article and action plan the students will justify their bat box model designs
- The students will use the materials provided to create a model and present to the team they are paired with to grade
- They will need to justify their design elements to the group they are grading

Explain:

- Why is it important to provide roosting sites for bats?
- America's bats are an invaluable natural resource. Yet, due to decades of unwarranted human fear and habitat loss, bats are in alarming decline. The loss of bats contributes to growing demands for toxic pesticides that increasingly threaten our personal and environmental health.

- Due to killing stemming from carelessness, fear of bats, and continued habitat loss, bat populations have suffered. Bats reproduce slowly, typically rearing only one young per year, making population recovery a slow process.

Extension Activity/Questions:

- Each group will present their bat box prototype to the class
- They will be given a rubric of what to cover when they present
- The rubric will be used to justify their decisions for their prototype
 - Design
 - Safety
 - Location for the bat box
 - Improvements
 - Comments

Evaluation Activity:

- The evaluation activity is using the rubric they are provided to give them a score on their bat box prototype.