COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
Women in Science & Engineering

Bio/Diversity Project
Lesson Title: Introduction to Sonoran Desert Pollinators

Teacher: Megan Bootz and Lucy Drey
Grade Level: *7th*
Time: *60 minutes*

AZ State Science Standard:	*6.L2U3.12* • ***Engage in argument from evidence*** *to support a claim about the factors that cause species to change and how humans can impact those factors.* *6.L2U1.13* • ***Develop and use models*** *to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors.*
Content Objective:	• *Students will be able to name 2-3 common pollinators in the Sonoran Desert.* • *Students will be able to describe pollination.* • *Students will be able to explain why pollination is important.*
Scientist of the Week:	• *Kathleen "Katy" Prudic* • *Entomologist and University of Arizona Professor* • *University of Arizona, Tucson, Arizona, USA* • *Codirects "Citizen Science" platform eButterfly (like iNaturalist) and uses data to help protect butterflies globally and understand behavioral patterns and changes when threatened or when surroundings change. Also a published author in many recognizable places, like BBC and National Geographic.*

Vocabulary	**Materials**
• Adaptation • Biodiversity • Species • Pollination • Pollinators	• 18 sheets of blank paper • 74 popsicle sticks • 74 Seek iNaturalist handouts • 6 simple paper dinner menus • Colored pom-poms • Chopsticks • *Crop Plants Pollinated by Bees*,

Seasonality:

Monsoons July-Sept.	*Autumn* Oct.-Nov.	*Winter* Dec.- Feb.	*Spring* Mar.-Apr.	*Dry Summer* May-June

Guiding Questions:
Write down bulleted, guiding questions that you will ask students in order to promote a deeper understanding of the subject matter. These are questions you will ask many students, and maybe even more than once per student.

1. Why do plants need insects and mammals (etc.) to pollinate them? Are there other kinds of pollinators?
2. Is cross-pollination beneficial or harmful to plants? Or, is there no major effect?

Engagement/Introductory Activity: First 10 minutes of class: Introducing ourselves, Scientist of the Week, and a Game!

1. Introduce ourselves and tell them some fun facts about us. (2-3 minutes).
2. Talk about the scientist of the week for 5 minutes.
3. Introduction Game:
    a. Students will get into groups of 4 people. There should be no more than 6 groups per our class sizes of 24 & 26.
    b. The students will have 2 minutes to name as many pollinators as they can, writing the names down on a blank sheet of paper.
    c. Once the timer ends, we will call on a group. One student from that group will read out their list. Ask if any other group has this pollinator, having them raise their hands.
    d. If more than one group has the same pollinator on their list, EVERY group with the same pollinator on their list crosses it off. Once that student is finished, we will move to another group and have a student from that group read off their list.
    e. Make sure that every pollinator has been called before counting up group totals. For clarity, have each group read out their final list to the class again, ensuring there are no duplicates. The group with the most pollinators remaining wins.
4. Briefly introduce the Seek app and what it does.

Transition: As everyone moves back to their regular seats, we will pass out a Seek (iNaturalist) handout. The handout will include directions about how to download the free app. Students will go home and ask their parents for permission to download the Seek app and create an iNaturalist account. This will be necessary for when we do our bioblitz for the 2nd lesson and gives the students time to explore and get familiar with the app on their own.

Exploratory Activity:
"Pollen Distribution" (10 minutes)

1. Divide students into 4 groups.
2. Each group will have a flower that must be cross pollinated with other flowers across the room. The "flower" will be a plastic cup full of colored pom-poms which represent the pollen.
3. In a relay fashion, WITHOUT RUNNING, one student at a time from each group will transfer a piece of pollen from their flower to another flower on the opposite side of the room using chopsticks, and bring a different piece back.
    a. Students can only carry one piece of pollen at a time.
    b. If student is running, they must return to the start and begin again.
    c. If pollen is dropped, student must return to the start and begin again.
4. When we (the interns) call time, each group will show the class how well their flower was pollinated, hopefully demonstrating a cup full of multiple colors.

Explain:

1. Pull up the PowerPoint while students complete their next activity.
2. Students will complete a Think, Pair, Share (TPS) discussion for 5 minutes.
    a. Questions include:
        i. Was it hard to capture/carry the pollen?

ii. Think about where pollen is stored in most flowers. Why do you think that it is stored in the middle of the flower? How might this help them get pollinated?
    1. "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."
iii. What types of pollinators were you?
iv. Why are pollinators important?
    1. "Pollinators are important because they move the pollen from the male part of a plant to the female part of another plant. This causes fertilization resulting in seeds or fruits in some plants. Pollination is crucial to the production of several crop plants which will be explored later."

3. After ~3 minutes, turn to a 5 minute class discussion asking for volunteers, or using popsicle sticks if necessary.
4. After the TPS discussion, continue the presentation and walk the students through 4 typical pollinators to see in the Sonoran Desert. (~10 minutes?)
5. At the end of the presentation, ask if there are any questions. If none, ask if anyone has seen any of these pollinators.

Extension Activity/Questions:

Adapted from: https://microscopy4kids.org/Life_Without_Pollinators

1. Group students into teams of 4.
2. Give each student a dinner menu (e.g., hamburger, fries, coke)
3. For each menu, have them identify ingredients or foods required to complete that menu (e.g., Hamburgers require beef for the burger; tomatoes for the catsup and to slice over the burger; cucumbers for the pickles; mustard plants for the mustards; lettuce; potatoes for the fries; wheat for the buns).
4. Have students research which of the ingredients require pollinators. Print out lists from these websites and make them available for students to use in class. *Crop Plants Pollinated by Bees, website*
5. Have students work in teams to help determine which foods will no longer be available if pollinators became extinct (e.g., Hamburgers and buns are still available; but catsup, pickles, tomatoes, chocolate and vanilla shakes and cola are no longer available because they require pollinators).
6. Have them record how their favorite menus will look in a Pollinator-Free world
7. Debrief: Have each team report 1-2 of their findings.
8. Introduce the topic of pollinator decline, its scope, and some of the reasons why it is happening.

Evaluation Activity:

Students, when randomly called on by using popsicle sticks if no student volunteers, will be able to recall facts or "tidbits" about each pollinator. Before students leave, challenge them to find 1-2 friends or family members to talk about pollinators with. We will call for about 3 volunteers next session, either right before or after beginning class with "Scientist of the Week". Challenge students to come back next session with 1-2 consequences they think would occur if pollination were to cease.

COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
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Bio/Diversity Project
Lesson Title: Plant Adaptations and Pollinators

Teacher: Lucy Drey & Megan Bootz
Grade Level: *7th*
Time: *30-60 minutes*
Adapted from: Garfield Park Conservatory Alliance: Pollination Lesson Plan
Adapted from: file:///C:/Users/missl/Downloads/Hollinger%20Lesson%20Plan%202.pdf (Basic Plant Anatomy/Morphology and Classification from BDP)

AZ State Science Standard:	**6.L2U3.12** • *Engage in argument from evidence to support a claim about the factors that cause species to change and how humans can impact those factors.*
Content Objective:	• *Students will be able to distinguish different plant parts related to pollination.* • *Students will be able to explain the difference between sexual and asexual reproduction.* • *Students will be able to explain and demonstrate how plants are pollinated.* • *Students will be able to apply their knowledge to explain the benefits of pollination and pollinators.*
Language Objective:	"N/A"
Scientist of the Week:	• *Dr. Eijiro Miyako* • *Associate professor in School of Materials Science at Japan Advanced Institute of Science and Technology (JAIST)* • *Ishikawa, Japan* • *Helping to create tiny drones that can help pollinate flowers that bees typically pollinate*

Vocabulary	**Materials**

• Reproduction
  ○ Sexual
  ○ Asexual
• Gametes
• Fertilization
• Anatomy
	• Plant Pollinator Stories Handout
	• **Plant Pollinator Stories Adapted Handout for 3rd period**
	• Sonoran Desert Flower Cards
	• Chester's Butter Flavored Puffcorn Snacks
	• Cotton Squares
	• Paper Plates

Seasonality:

Monsoons	*Autumn*	*Winter*	*Spring*	*Dry Summer*
July-Sept.	Oct.-Nov.	Dec.- Feb.	Mar.-Apr.	May-June

Guiding Questions:
- How do plants and pollinators benefit each other?
- How do plants reproduce and what role does pollination play?

- Do plants adapt to pollinators, do pollinators adapt to plants, or is there a mutual "contribution"?

Engagement/Introductory Activity: (~5 minutes)

- Show video of a bacteria reproducing. Have students describe what they notice and jot down differences between how the bacteria reproduce and how people reproduce. https://www.youtube.com/watch?v=DY9DNWcqxI4 (start playing at 40s).
    - The bacteria in the video are reproducing asexually (1 parent, offspring are identical to parent), while people reproduce sexually (2 parents, offspring are genetically different from parent). **Are plants more similar to bacteria or people in how they reproduce?**
        - GUIDE with "How many parents/"parties" rather than asking how they're "doing it" as the lesson is for 7th graders.

Exploratory Activity: (~20 minutes)

- What do you already know about how plants reproduce?
- "Puffcorn Pollination" Activity

Explain: (~15 minutes)

- After bees and insects inadvertently pick up pollen, when they fly to a different flower, what happens?
    - Show students a diagram of plant reproductive anatomy.
        - Which parts do you think are male? Which parts do you think are female? *Have students label their own diagrams.*
- Show pollination between 2 flowers: take the pollen from the anther of one flower and put it on the stigma of the other flower.
    - How do you think the sperm in the pollen can fertilize the egg, which is contained in the ovule?
        - When the pollen, which contains the male gametes (sperm) lands on the stigma, it travels down the pollen tube down to the ovule, where it fertilizes the female gametes (eggs). The fertilized egg(s) now becomes the seed(s) and the ovaries become the fruit—the fleshy meat protects the developing seeds! *Dissect the flower and show students the path the pollen takes. Have students trace the path of the pollen and label where fertilization happens on their diagrams.*

Extension Activity/Questions: (~ 12 minutes)

- How do pollinators know which flowers to go to? What strategies do flowers have to attract the most pollinators?
    - Flowers can be particular colors or give off particular scents to attract pollinators, or grow in a shape that fits with the pollinator (i.e. hibiscus and hummingbird)
    - Students will participate in the Plant-Pollinator Stories gallery walk, filling out the template as they go.
        - 3 minutes per flower
            - Senna Covesii
            - Velvetpod Mimosa
            - Passionflower Vine
            - Rosary Babybonnets

Handout for shortened 3rd period instead of going around room to write down flower facts.

Evaluation Activity: (~5 minutes)

Exit Ticket (answer on a Notecard, then turn into the basket)

- How does pollination work? What happens after pollination?
- How does the pollinator benefit by pollination? How does the plant benefit?

COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
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Bio/Diversity Project
Lesson Title: Pollinators in Urban Areas

Teacher: Lucy Drey & Megan Bootz
Grade Level: *7th*
Time: *60 minutes*
Adapted from: Habitat and Pollinators
Adapted: Plot survey Sheet and Invasive Species Activity

AZ State Science Standard:	*6.L2U3.11* • ***Use evidence*** *to* ***construct an argument*** *regarding the impact of human activities on the environment and how they positively and negatively affect the competition for energy and resources in ecosystems.*
Content Objective: Math, Reading, Science, Writing, Other:	• Students will be able to describe and record observations about their natural surroundings. • Students will be able to try to connect their current knowledge about pollinators to the significance of certain plants in their pollinator garden. • Students will be able to describe (albeit simply) what citizen science projects are and why they are important for scientists.
Language Objective:	"N/A"
Scientist of the Week:	• *Wangari Maathai* • *The first woman in East and Central Africa to earn a doctorate degree. First female chair of the Department of Veterinary Anatomy and associate professor in her region of the world.* • *Kenya; She passed away in 2011* • *Founded the Green Belt Movement; won the Nobel Peace Prize Laureate in 2004; wrote several books, and was the subject of several books and films* • *https://www.greenbeltmovement.org/wangari-maathai*

Vocabulary	**Materials**
• Biotic/Abiotic • Invasive Species • Plot Census • "Citizen Scientist"	• National Geographic Plot Study Chart • 1st page of Habitat Data Analysis • Modified Habitat Evaluation Sheet • 3 sets of 6 different articles on non-native species • Clipboards or hard notebook to write on

Seasonality:

Monsoons July-Sept.	*Autumn* Oct.-Nov.	*Winter* Dec.- Feb.	*Spring* Mar.-Apr.	*Dry Summer* May-June

Guiding Questions:
- Why is biodiversity in urban areas important?
- How can you promote biodiversity in Tucson?

- How does your desert garden promote biodiversity?

Engagement/Introductory Activity: (~10 minutes)

- Show the 4.5 minute video Urban Habitat: Biodiversity in Our Cities.
- Put the following questions on a slide:
  - How can you promote biodiversity in Tucson?
  - How does your desert garden promote biodiversity?
  - What sort of pollinators and plants have you seen around campus?
- In pairs, have the students think and discuss the questions for 1 minutes and then take 2 minutes to share their thoughts with the class.
- *** Before diving into explain activity, connect students' plot census to the saguaro census the BDP does on Feb. 15th ***
  - **General Facts & ask about how we can do a plot survey in our school**

Exploratory Activity: (~25 minutes) [5 minutes directions, 20 activity]**Recommend Sunscreen and Water Bottles**

1. Have students get into groups of 4 people they don't usually work with; if not cooperating, divide into groups using popsicle sticks.
2. Explain to students that they will be gathering data on animals in the garden by conducting a species census. This means they will be looking very closely and carefully at every part of the garden, taking notes on the different animals they see, and counting how many they see of each different kind.
3. Tell students that by conducting a species census they will be practicing important skills that scientists use to study biodiversity. By identifying and counting the animals in a specific habitat, scientists monitor species populations to determine if stressors – such as drought, competition from other species, or pollution - are threatening a species. In this way, students may eventually contribute to the work of what are called "citizen scientists" — ordinary people who collect data to help scientists with research.
   a. **Say: It's this kind of scientific field work that enables scientists to identify endangered species, like the Mexican Long-Nosed Bat and the Jaguar and take steps to protect them. Scientists often get data from volunteers when they conduct a species census, and it could be that someday a scientist will take data from the students' species census to study the effect of school gardens on biodiversity.**
4. Review how students will use the National Geographic plot study chart to record data on organisms in the garden.
5. (2 min.) Brainstorm the characteristics students think are important to observe and record for each organism observed; for example, size, color, and markings.
   a. **Repeat Directions Multiple Times: label each box in the first column ONLY of the datasheet with the characteristics they have determined to be important. (ex. one row for abiotic characteristics, one for possible invasive species [like weeds], one for flowering plants [angiosperm], one for non-flowering plants [gymnosperm], one for pollinators, and non-pollinating animals/insects/etc.**
6. Go Outside! (20 minutes)
   a. **Repeat Directions Multiple Times: Draw a sketch of each species/characteristic observed in the garden on the plot census.**

Explain: (~13 minutes)
https://www.nationalgeographic.org/idea/citizen-science-projects/

1. Explore "Citizen Scientists" **Think-Pair-Share** Complete on a blank sheet of paper PER STUDENT:
2. (1 min.) Turn to the person on your right. Answer question #1: Did you observe any DIFFERENT species from each other? Write your partner's name, draw the animal/plant/insect, write one characteristic of it.
3. (1 min.) Turn to the person on your left. Answer Question #2: Did you observe more diversity in one part of the garden or another? Can you think of any reasons why? Write responses down.
4. (1 min.) Sit next to the 3rd person in the group you haven't spoken to yet. Answer Question #3: How many pollinators did you observe? How many different plants had flowers in this observation? Do you think these two things are related? Write responses down.

Use the first page ONLY of the "Habitat Data Analysis" Handout to describe the characteristics of the Alice Vail pollinator garden with a brief "presentation" of class-contributed data, to fill out the worksheet together as a class. (Habitat Data Analysis)

- Ask one group for their answer to one question on the sheet, write the response and have students copy it on their own sheet, THEN ask for raised hands if there are any more examples. Some groups/volunteers may speak more than once.

Extension Activity/Questions: (~15 minutes)
"Invasive Species Activity"

Present brief background knowledge:

- An **invasive species** is defined as a species that is **1)** non-native (or alien) to the ecosystem under consideration and **2)** causes harm to the economy, the environment or human health. Invasive species may compete with native species for food and living space. A successful invader will take over space in which a native species normally lives. Eventually, invaders can reduce the variety of species in an area, which is called a loss of biodiversity.
    - An invasive species usually thrives in an environment for two main reasons. First, it reproduces rapidly. It either has many offspring that survive and flourish and/or the individuals grow quickly and produce offspring of their own relatively soon. Secondly, the invader can often survive in a wider range of conditions than the native species surrounding it. Changes in temperature or amounts of food, water, or nutrients may not adversely affect the invasive species as much as the native species. In their introduced range, invasive species may also escape from predators, diseases or other natural controls.
    - Sonoran Desert examples:
        - Buffelgrass
            - Threaten the plants that many pollinators, including monarchs and the lesser-long nosed bat, rely on while migrating.
        - Fountain grass
        - Starlings
            - Throw out other nesting birds in Saguaro cacti and trees.
- A **non-native species** is a species introduced to a region intentionally or accidentally and does not have the negative effects of an invasive species.

Activity Procedures:

1. Divide the class into groups of four. Distribute an article of either an invasive or non-native species to each group.
    a. Buffelgrass (Invasive species) [Pg. 3-8]
    b. Sahara Mustard (Invasive species) [Pg. 17-21]
    c. Red Imported Fire Ant (RIFA) (Invasive species) [Pg. 28-33]
    d. Honey Bees (Invasive, Non-native species)
    e. Dark Rover Ant (Non-native species)
    f. European Earwig (Invasive species)
2. Have the students research their species using the article. Students will answer the following questions in their groups:

   a. What species did they have?
   b. Where did their species originate from?
   c. What effects did their species have on the environment?
   d. What Sonoran Desert Pollinators did their species affect and how did their species affect those Pollinators?
3. Have a designated speaker from each group briefly present their species.

Evaluation Activity: (~5 minutes)
Exit ticket: The modified Habitat evaluation worksheet with four questions. Have students answer two of the four questions.

1. Explain how biodiversity benefits an ecosystem.
   a. *Biodiversity increases the resilience and adaptability of an ecosystem by multiplying the interactions between organisms and their interactions with the environment upon which the ecological health of the ecosystem depends.*
2. Describe three animal species that you observed in your school garden habitat.
   a. *Answers will vary.*
3. Describe the role of pollinators in a garden habitat.
   a. *Pollinators play a crucial role in plant reproduction by transferring pollen from the male to the female organs of flowers, which leads to the production of fruits and vegetables.*
4. Describe one way to increase biodiversity in a garden habitat.
   a. *Increasing the variety of different plant species in a garden habitat is one way to increase biodiversity among animal species.*

COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
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Bio/Diversity Project
Lesson Title: Specific Lesson Bats (Ina Bridge)

Teacher:Megan Bootz & Lucy Drey
Grade Level: *7th*
Time: *60 minutes*
Adapted from: Smithsonian in Your Classroom, Culturally Relevant Adaptation.docx, Bats of the Americas, file:///C:/Users/missl/Downloads/Eighth%20Grade_Sonoran%20Desert%20Butterflies%20and%20Bats%20Curriculum.pdf (Bats Researchers BDP Lesson Plan in Eighth Grade_Sonoran Desert Butterflies and Bats Curriculum.pdf)

AZ State Science Standard:	***6.L2U1.13*** ● *Develop and use models to demonstrate the interdependence of organisms and their environment including biotic and abiotic factors.* ***8.L4U1.11*** ● *Develop and use a model to explain how natural selection may lead to increases and decreases of specific traits in populations over time.*
Content Objective: Math, Reading, Science, Writing, Other:	● *Students will be able to compare and contrast the different bat adaptations.* ● *Students will be able to determine what flower characteristics attract bats.* ● *Students will be able to apply their knowledge to create a flower adapted to one of their classmates.* ● *Students will be able to define the terms nectarivore and nocturnal.*
Language Objective:	"N/A"
Scientist of the Week:	● *Gillian Bowser* ● *Research Scientist, was previously a Wildlife Biologist and Ecologist* ● *Colorado State University* ● *Promoting diversity and inclusion of underrepresented students in the fields of ecology, science and sustainability.* ● *Promoting citizen science through the use of smartphone apps.*

Vocabulary	**Materials**
● Conservation ● Nocturnal ● Echolocation ● Nectarivore	● 74 notecards ● Activity 3B worksheet from Smithsonian Lesson Plan ● Color Boxes ● 74 Ina road bridge articles

Seasonality:

Monsoons July-Sept.	*Autumn* Oct.-Nov.	*Winter* Dec.- Feb.	*Spring* Mar.-Apr.	*Dry Summer* May-June

Guiding Questions:

- Why is conservation and research important?
- What adaptations have Sonoran Desert bats developed?
- What are the benefits of these adaptations?
- Why are bats important to the Sonoran Desert ecosystem?

Engagement/Introductory Activity: (~15 minutes) [7 to design, 3 for volunteer sharing]

Designing Mr. Drudge's "Scientist Sanctuary"

- Use the Activity 3B worksheet from the Smithsonian lesson plan for "designing your own flower."
- Pair students up using popsicle sticks to randomize and ensure everyone has a partner they may not usually work with. If uneven, a group of 3 will work.
- Have students state their preferences to each other. *What colors, flavors and scents do they prefer?* Then have each of them draw simultaneously their partner's "designer flower." **Remind students that the goal is to get the pollinator (the student) to pick up pollen from this flower and carry it to another flower of the same species.**
- Have them list the attributes of the plant that attract the pollinator (the student's partner) and the mechanism or mechanisms by which the pollinator carries the pollen to the next plant (ex. by mouth, or by residue picked up when eating a part of the flower life pizza petals). For fun, have them make it as unreal as possible.
    - For example, one might design a flower that is black, triangular in shape, smells like fresh-baked brownies, and provides pizza as a reward. Have each pair present their "designer flowers" to the class.
- Explain Pollinator Syndrome at the end
- Transition with a question from what SPECIFICALLY attracts a classmate to the "designer flower" to what SPECIFICALLY attracts bats to flowers.
    - "What kinds of specific traits do you think bats are looking for in the flowers that they pollinate?"

Exploratory Activity: (~15 minutes)

- Have students read 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
- Once the students have read the article, have them play the kahoot game with trivia questions related to the article

Explain: (~10 minutes)

- Show a video of bats emerging from the bat bridge in Tucson at River and Campbell
- After the video, introduce the students to some facts about the types of flowers bats visit and a brief overview of the two nectarivore (nectar-eating) bats that live in Arizona (Lesser-long nosed bat and Mexican long-tongued bat) in a presentation.
    - The flowers that are visited by bats are typically:
        i. Open at night
        ii. Large in size (1 to 3.5 inches) and bowl shaped
        iii. Pale/dull white, green, or purple in color
        iv. Very fragrant, a fermenting or fruit-like odor; and/or
        v. Copious dilute nectar.

- Bats feed on the insects in the flowers as well as on the nectar and flower parts, such as calabash, sausage tree, areca palm, kapok tree, banana.
- Over 300 species of fruit depend on bats for pollination. These fruits include:
    i. mangoes,
    ii. bananas, and
    iii. guavas.
- The Agave plant and the Saguaro, state cactus of Arizona, also depend upon bats for pollination. The agave is an important plant because it is used to make Agave syrup which is a sugar substitute.

- Since we covered the lesser-long nosed bat in a previous lesson I will brush over this species with a quick reminder and focus more on an overview of the Mexican long-tongued bat.

Extension Activity/Questions: (~20 minutes)

- pages 103-121 to read up on the mexican long tongued bat and lesser long nosed bat: https://www.fwspubs.org/doi/suppl/10.3996/052013-JFWM-039/suppl_file/052013-jfwm-039r1-s04.pdf
- Assign groups of 4; within lab table groups, have students pair up. One pair will read about the Mexican Long Tongued Bat, the other will read about the Lesser Long Nosed Bat. (~10 minutes)
- Read January 2020 was Earth's hottest January on record (~2 minutes)
- Read Bats as barometer of climate change: Shifting behavioral patterns due to environmental change could have far-reaching implications for agriculture globally individually (~2 minutes)

As a group, make inferences about how the changing climate affects Sonoran Desert Bats based on the following scenario: (~8 minutes)

This past January was the warmest ever on record. Knowing that bats migrate for survival, are entirely dependent weather patterns for signaling migration times, and are responsible for pollinating many fruits that we are dependent on, what might happen when the weather patterns continue to change over time? What would bat extinction mean for biodiversity of the Sonoran Desert? What kind of responsibility should humans take in conserving bats? Please describe your answer in 3-4 sentences.

Evaluation Activity:

- Collect responses to Extension Activity

COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
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Bio/Diversity Project
Lesson Title: Nectivorous Bats

Teacher: Megan Bootz & Lucy Drey
Grade Level: *7th*
Time: *60 minutes*
Adapted from: SNP Travel Trunk_Bats and Bat Curriculum Bats, Need Nectar, Will Travel.P65

AZ State Science Standard:	*6.L2U3.11* • ***Use evidence to construct an argument*** *regarding the impact of human activities on the environment and how they positively and negatively affect the competition for energy and resources in ecosystems.* *6.L2U3.12* • ***Engage in argument from evidence*** *to support a claim about the factors that cause species to change and how humans can impact those factors.*
Content Objective: Math, Reading, Science, Writing, Other:	• *Students will be able to participate in games describing adaptations and survival skills in bats, and observe different methods of hunting and pollinating.* • *Students will be able to participate in active demonstrations for the class.* • *Students will be able to use the given information to construct a model or drawing (in the "Build a Bat" activity).*
Scientist of the Week:	• *Rachel Louise Carson* • *Nature writer, environmentalist, and marine biologist* • *Exploration of the oceans in a trilogy.* ***Exploration of the dangers of synthetic pesticides in "Silent Spring"***

Vocabulary	**Materials**
• Echolocation • Ultrasonic • Simulate • Bat boxes	• Bat Traveling trunk from Tucson Audubon Society • Bat board game w/ situational cards • Dice • 74 Public Service Project worksheets

Seasonality:

Monsoons July-Sept.	*Autumn* Oct.-Nov.	*Winter* Dec.- Feb.	*Spring* Mar.-Apr.	*Dry Summer* May-June

Guiding Questions:
- How can the skeletons and models help inform our designs for bat boxes?
- How can we use the demonstrations of echolocation and bat "design" to better understand nocturnal

pollinators?

Engagement/Introductory Activity: (~7 minutes)

- Show the NatGeo Wild video Bats' Desert Fruit Feast
- Explain the difference between Mega and Microbats
    - Microbats (*Microchiroptera*)
        - Mostly insectivorous
        - Nectivorous bats (pollinators) include – Mexican Long Tongue Bats & Lesser Long Nose bats
        - Small eyes
        - Big ears
        - Echolocation
        - Live everywhere except Antartica
        - 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:

1. The students will participate in groups of 4 to complete a board game based off of bats.
2. The goal of the game is to be the first to make your bat return to the roost.
3. The 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.
4. The student who rolls the highest number first moves first on the board.
5. The play will continue to the right with each player taking a turn.
6. If a player lands on a board piece with a situational instruction the player will follow those instructions.
    a. The situational instructions will either help or hurt the player by moving them forward or backward.
    b. The situational instructions will talk about situations that bats encounter each year that either threaten or help them.
7. The first player to return back to the roost at the end to give birth will win.

Explain: (~ 5 minutes)

explain that this information will be useful in our future engineering project, the bat house models, in 2 weeks
https://www.youtube.com/watch?v=GFQVgNJGwmc
Showing a video of bats emerging from the bat bridge in Tucson at River and Campbell. During this video the students will answer some questions about research;
PICK 2 (Questions will be written on the board next to the video)

- 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?

Collect notecard as measurement of what students gathered from the video.

Extension Activity/Questions: (~10 minutes)

- 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.

Evaluation Activity: (~10 minutes)

The students will take out their mobile devices and play a kahoot game about bats.

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Bio/Diversity Project
Lesson Title: Protecting Pollinators

Teacher: Megan Bootz & Lucy Drey
Grade Level: *7th*
Time: *60 minutes*
Adapted from: Endangered Species Curriculum, build a bat house!, and Flower Dissection Mandalas

AZ State Science Standard:	***8.L3U1.9*** • *Construct an explanation of how genetic variations occur in offspring through the inheritance of traits or through mutations.*
Content Objective: Math, Reading, Science, Writing, Other:	• *Students will be able to identify threats to the Sonoran Desert.* • *Students will be able to explain what the purpose of the Endangered Species Act is.* • *Students will be able to develop ways to protect an endangered species.*
Language Objective:	"N/A"
Scientist of the Week:	• *Ynés Enriquetta Julietta Mexía* • *Botanist* • *Berkely, California* • *Traveled to remote locations in South America, Central America, and Alaska and discovered a new genus of Compositae (Mexianthus mexicanus) and more than 500 new species of plants.* • *She is unique as she started her career in her mid fifties, having previously been a social worker, and was a hispanic woman in a largely white male dominated field.*

Vocabulary	**Materials**

• Population
• Endangered Species Act (ESA)
  ○ Endangered species
  ○ Threatened Species
	• 18 Missing Species Reports
	• 6 copies of each article
	• 74 notecards

Seasonality: Dependent on Migration Patterns

Monsoons	*Autumn*	*Winter*	*Spring*	*Dry Summer*
July-Sept.	Oct.-Nov.	Dec.- Feb.	Mar.-Apr.	May-June

Guiding Questions:
- What is the importance of protecting pollinators?
- How can conservation and restoration be used to help protect pollinators?
- How do current laws help protect pollinators?
- How do pollinators impact students personally?

Engagement/Introductory Activity: (~20 minutes)
In the following 3 weeks, we will be constructing models of Bat Boxes. Let's read a short article together, about Joel Diamond, our local Arizona Game and Fish bat expert. (Popcorn reading)
https://www.azgfd.com/gates-to-abandoned-mines-protect-bat-colonies-public-safety/
6 different readers (~1 paragraph per student) ***(~6 min?)***

Why Build a Bat House

Why Build a Bat House? 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. The most important goal is to preserve America's most abundant bats in sufficient numbers to maintain nature's balance. If you live in areas of bat habitats, putting up a bat house near your home or school can help provide a critical safe haven for bats. Bats make good neighbors; as primary predators of night-flying insects, they play a vital role in maintaining the balance of nature. People with occupied bat houses on their properties benefit from having fewer lawn and garden pests, and they enjoy learning about bats and sharing their knowledge with friends and neighbors. Few efforts on behalf of wildlife are more fun or rewarding than helping bats. Note: Some teachers opt to buy ready-to-hang bat houses and concentrate the lesson instead on selecting a good site for mounting it. Superior quality bat houses are available through the Bat Conservation International catalogue at 1-800-538-BATS in the U.S. and Canada. Looking for additional or other ways to provide better bat habitat? You can try these other simple actions to attract bats to your Backyard Wildlife Habitat or Schoolyard Habitats site, by providing the insects to eat, water to drink, and places to hide that bats need for their habitat.
✓ Got an anti-bug zapper in your yard? You might want to think about getting rid of it! Zappers are useless on most biting insects and only kill light-attracted moths, which are good food for bats.
✓ Trees and shrubs, even dead ones left standing, are excellent hideouts for bats—and birds.
✓ Bats need water to drink. If you build a mini-pond, you'll also attract frogs and many other water creatures. Find out how to do this on NWF's website: www.nwf.org/backyardwildlifehabitat/ or at a garden center or library.
✓ Close any holes in the attic to ensure your neighborhood bats use your outdoor wildlife habitat, not your house.

Exploratory Activity: (~15 minutes)

- Give a brief summary about the Endangered Species Act (ESA) and its purpose.
    - The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. It is administered by the U.S. Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration (NOAA). Under the ESA, species may be listed as either endangered or threatened. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. ESA also provides for the designation of critical habitat and prohibits the destruction of that habitat.
- In groups of four, have students fill out a missing species report using information in an assigned article.
    - Lesser long-nosed Bats
    - Monarch Butterflies
    - Africanized Honey Bees

Explain: (~10 minutes)

- Have each group present their missing species report to the group next to them for 3-4 minutes.
- After students finish presenting their species, have a representative from each group answer why their species should be protected.
- As a class, come up with some of the threats to each species and ways to protect the three species: Lesser long-nosed bats, Monarch butterflies, and Africanized Honey Bees.
    - List these on the board for the students to write down on the back of their notecard.

Extension Activity/Questions: (~10 minutes)
Group Posters for Adam's wall

- 4 parts
    - Drawn and colored picture of one of the local endangered pollinators
    - What impact this pollinator has on each group member
    - Why it is important to protect this pollinator
    - How we can protect this pollinator on a small scale

Evaluation Activity: (~5 minutes)

- Exit ticket: On a notecard students will answer the following questions:
    - What did you learn about your endangered pollinator species?
    - What can **you** do to help protect and save your endangered species?

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Bio/Diversity Project
Lesson Title: Bats #3

Teacher: Megan Bootz & Lucy Drey
Grade Level: *7th*
Time: *60 minutes*
Adapted from: Biodiversity Project Bats Curriculum

AZ State Science Standard:	*6.L2U3.12* • ***Engage in argument from evidence*** *to support a claim about the factors that cause species to change and how humans can impact those factors.* *8.L4U1.11* • ***Develop and use a model*** *to explain how natural selection may lead to increases and decreases of specific traits in populations over time.*
Content Objective: Math, Reading, Science, Writing, Other:	• *Demonstrate an understanding of pollinator and plant attractions.* • *Utilize online technologies to work with classmates and practice both memory and critical thinking.* • *Demonstrate a previous knowledge of pollination from previous lessons.*
Language Objective:	"N/A"
Scientist of the Week:	*Kathrin Barboza Marquez* • *Bolivia* • *Bat Biologist* • *Discovered the sword nosed bat thought to be extinct for 72 years* • *Researching bat bio-acoustics*

Vocabulary	**Materials**
• Ecology • Symbiosis • Pollinator Syndrome	• Devices with internet connection • Google classroom • Access to the google surveys

Seasonality:

Monsoons July-Sept.	*Autumn* Oct.-Nov.	*Winter* Dec.- Feb.	*Spring* Mar.-Apr.	*Dry Summer* May-June

Guiding Questions:
- Are pollinators attracted to specific plants, or will they pollinate any plant in their path?
- What adaptations of bats help them pollinate the flowers they are attracted to?

Engagement/Introductory Activity: (~10 minutes)
Students will take a survey to gauge the students knowledge about pollinators, pollination, and bats.

The survey questions are as follows:

1. Without looking it up, what is the definition of pollination?
2. What are pollinators and can you list a local example?
3. What two bat species pollinate some of the Sonoran Desert plants?

Exploratory Activity: (~15 min)
In order to use online, the headbands game will be modified into a Quizlet Matching Game
(First link on the left) Spend 5 minutes studying as a flashcard set (pictures and descriptions with names)
(6th link down, under the "Play" heading) Play the matching game as many times as possible in 3 minutes (matching names and pictures with features of the flower or what pollinators are attracted to)
Google Doc
In a 7 minute "quiz", use the information from the Quizlet in a Google Doc to match a pollinator with the correct plant. There are some plants that can have multiple pollinators, so if the features of a plant seem like they could attract multiple pollinators, list all that apply!

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 Lily = 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.

https://quizlet.com/_88p2mk?x=1qqt&i=2r73us
https://docs.google.com/document/d/1ero2qoFwtD6VLnfZVGUWWG-_mmSr0HgskHdXy49VAb8/edit?usp=sharing

Explain: (~5 minutes)
Google Reading (posted as a discussion post from the teacher): "in interactions like these, there are three different types of relationships between organisms: symbiotic, parasitic, and mutualistic. In the Quizlet activity that we did today, we saw that certain pollinators are attracted to specific types of flowers for their shape, color, size, and smell. Why is that? What is this relationship called? Hint: reference the three types of relationships above."

- Short explanation on symbiosis, parasitism, and mutualism definitions
  - symbiosis: interaction between two different organisms living in close physical association, typically to the advantage of both.
  - parasitism: symbiotic relationship between species, where one organism, the parasite, lives on or in another organism, the host, causing it some harm, and is adapted structurally to this way of life
  - mutualism: symbiosis that is beneficial to both organisms involved
- Short reminder of the definition of pollinator syndrome
  - suites of flower traits that have evolved in response to natural selection imposed by different pollen vectors, that can be abiotic (wind and water) or biotic, such as birds, bees, flies, and so forth
- Students can put a thumbs up, or comment what they think is interesting, or just comment a "done" when they've read, and proceed to the extension.

Extension Activity/Questions: (~25 minutes)
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.
- 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

This week they will read two articles on how to create a bat box that will explain the location and materials needed

- Build Homes for Bats | Crafts for Kids
- Build a Bat House

Students will use the articles and knowledge they have learned throughout the course about bats to complete a worksheet outlining their design process. The worksheet will be a google doc that each student must contribute to. The following questions will be asked:

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. Come up with a design for a bat box on a sheet of paper. Be creative and add elements that would attract a bat to your bat box. List the materials used to make this box in the space below.

Evaluation Activity: (~5 minutes)
Students will complete an exit ticket with the following questions at the end of their worksheet:

1. True or False: Pollinator syndrome describes flower characteristics, or traits, that may appeal to a particular type of pollinator.
2. How do bat boxes contribute to bat conservation?

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Bio/Diversity Project
Lesson Title: Action Project Week 3

Teacher: Megan Bootz & Lucy Drey
Grade Level: *7th*
Time: *60 minutes*
Adapted from: Action Project Proposal

AZ State Science Standard:	***8.L4U1.11*** • ***Develop and use a model*** *to explain how natural selection may lead to increases and decreases of specific traits in populations over time.*
Content Objective: Math, Reading, Science, Writing, Other:	• *Students will be able to design a blueprint for a bat box model.* • *Students will be able to construct a bat box model based upon their blueprint.* • *Students will be able to develop a pitch about their specific bat box design.* • *Students will be able to present their pitch to a group of their peers.*
Language Objective:	"N/A"
Scientist of the Week:	*These last few weeks we really want to reinforce that the students can be scientists if they want to be. Therefore we will first go over each intern and the last week we will reveal that each and every student is our scientist of the week. This will showcase the diversity of science and that anyone can be a scientist.* • *Week 1: Miss Lucy* • *Week 2 Miss Megan* • *Week 3: Inform the students that they are all the scientist of the week!*

Vocabulary	**Materials**
• Predators • Models • Bat Boxes • Migration Patterns	• 3 bags of Pom-Poms • Thick and Thin Cardboard (shoeboxes, flattened boxes, cereal boxes, etc.) • 1 sheaf of Construction Paper • 2 Bags of Cotton Balls • Scissors • 2 Bags of Pipe Cleaners • Duct Tape or Packing Tape • Spare materials from WISE office • 18 Handouts of What to Remember • 76 Bat Box Prototype Worksheets • 18 Presentation Preparation Worksheets • 76 Presentation Notes Worksheets

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

Monsoons July-Sept.	*Autumn* Oct.-Nov.	*Winter* Dec.- Feb.	*Spring* Mar.-Apr.	*Dry Summer* May-June

Guiding Questions:
- How can you make a bat house that the public will be willing to put up to protect bats?
- How can you model the bat boxes in order that they might represent how effective real bat boxes are?

Engagement/Introductory Activity: (~15 minutes)
Week 1: Introduction to Building Bat Boxes

- (3 min) refresher of Why Build a Bat House: ask for 2 volunteers who remember an important reason to help protect and conserve bats with bat houses: ex)
    - The loss of bats contributes to growing demands for toxic pesticides that increasingly threaten our personal and environmental health
    - maintain nature's balance
    - provide a critical safe haven for bats
    - primary predators of night-flying insects
        - People with occupied bat houses on their properties benefit from having fewer lawn and garden pests, and they enjoy learning about bats and sharing their knowledge with friends and neighbors.

- (12 min) Important excerpts from the 2 articles Build and Build a Bat House about how to build a successful bat box. One handout of the same specifications will be given to each group.
    - "Multi chamber bat houses are more successful because they can accommodate larger populations making them more thermally stable."
    - "All houses should have 3- to 6-inch landing areas extending below the entrances or recessed partitions with landing space inside."
    - "1⁄2-inch (or thicker) exterior plywood is ideal for fronts, backs and roofs"
    - "1- or 2-inch-thick boards are best for the sides"
    - "Cover roofs with shingles or metal for extra protection"
    - "Alternative materials, such as plastic or fiber-cement board, may last longer than wood and require less maintenance"
    - "White or light shade of paint"
    - "roughen it up to provide places for the bat to crawl up into the house
        - cutting grooves into the wood or find sturdy plastic mesh and staple it along backboard
        - grooves need to be about a half inch apart"
    - "Bats like it dark inside their houses
        - Stain inside"
    - "Seal the bat house to help keep the heat inside"
    - "ventilation slot"

Week 2: 5 min recap presentation about what bat boxes need to be successful.

Week 3: For the next 15 minutes, students will finish up some final touches and minor adjustments on their bat boxes. If the students finish this before the time is up, they will start developing their shark-tank style pitch. The following questions should be answered:

- Why did they design the bat box that way?
- Why we should implement their design
    - The benefits of their design
    - Is it cost effective?

(5 min) Powerpoint about presentation skills!
Reminder: These presentations should address 4 things (it may help to have each team member present one of these things.)

1. What about your model will attract the Mexican Long-Tongued Bats and Lesser Long-Nosed Bats?
2. What did you add to your model to make it more appealing to put up in the public?
3. Why is it important for bat boxes like yours to be put up in the Sonoran Desert?
4. Did your group have any ideas about where to mount a bat box to protect the bats from predators and humans?

Students will receive a handout for presentation preparation. This will be useful in the Explain Section, where 20

minutes will be allotted for preparing for the presentation. Notes can be used in presentation, however students will peer-grade each other's presentations, so practice enough to be able to know the main speaking points and be able to make eye contact.

Exploratory Activity:
Week 1: Taking 5 minutes, discuss with the class why protecting bats is important. After the discussion, students will brainstorm and work on the Bat Box Prototype worksheets for 10 minutes. For the next 10 minutes, students will get into groups and come up with a single, cohesive idea for a prototype. They will discuss the following two questions with their group members as they brainstorm:

- What do the two species require in their roosts?
- How can you fulfill those requirements?

Week 2: Students will get into their groups of 4 from Lesson 8. They will then retrieve their handouts on the specifications for building a bat box, the group's bat box prototype worksheet, and their materials and bat boxes.

Week 3: For the next 20 minutes, students will develop a 5 minute Shark-Tank style pitch and practice it. They will describe the following in their pitch:

- Why did they design the bat box that way?
- Why we should implement their design
    - The benefits of their design
    - Is it cost effective?

Explain:
Week 1: After blueprinting [explore], and refreshing on why it is important to us that we protect pollinators [explain], begin construction, gathering and labeling group materials. The blueprint is subject to change, it is not a perfect system! Make sure to reference the sheet of important things to remember about building bat boxes, and keep a log of notes so you don't forget how or why you built something a certain way (this will be important for the presentations later).

Week 2: Students will continue the construction of their bat box models for the rest of the period. They should have the majority of their bat boxes done by the end of this period. The students should have modified their bat box model when needed, so they may not match the blueprint at all. There should only need to be finishing touches and minor adjustments made, within 10-15 minutes next session. While students are constructing their models, we will take 5-10 minutes to answer the following questions as a class:

- What do Lesser Long-Nosed Bats and Mexican Long-Tongued Bats require in their roosts so that they will actually use a bat box?
- How can you model those requirements?
- Where would a good place be to mount a bat box so the bats are more protected from predators?
- What can you do with your design to encourage people to mount bat boxes on their property?

Week 3: Gather attention back at the front of the room, divide class into the groups presenting to each other, and explain the rubric (how to take Presentation Notes, and the presenting skills) one more time.

Extension Activity/Questions:
Week 1: Students will begin constructing their bat box models for the next 20 minutes. The two questions they should keep in mind when building their model will be written on the board.

Week 2: Ask students to take 10 minutes with their family over the weekend to write down one or two places they find that might be a good place to mount a bat box, and why they think so.

Week 3: Deliver a 5 minute Shark Tank Presentation to another group, answering the questions noted in the Engagement Activity. The listening group will write notes from the presentation and ask questions. The handout filled out with presentation notes will be submitted by each student at the end of class. After the first group presents, the second group will present. It is okay to use the notes to present, but use presentation skills like making eye contact and speaking loudly and clearly.

Evaluation Activity:
Week 1: Initial "bones" of the bat boxes will be a measure of how students are constructing their models. Additionally, take pictures of students and construction. They may not yet be taking shape, but blueprints or written plans will reveal the initial idea or focus of the group.

Week 2: Construction of models is near completion, and appear to resemble bat boxes fairly closely. Boxes do not have to match original blueprints/plans, as adaptation is the key to success. Additionally, collect the Think-Pair-Share notecard from the beginning of class.

Week 3: Submission of Shark Tank Presentation notes taken for the group who presented to the other group.

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Bat Box Design Prototype Worksheet

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. Come up with a design for a bat box and draw it in the box below. Remember to be creative and add elements that would attract a bat to your bat box! List the materials used to make this box below the picture of the drawing.

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Presentation Preparation:

1. **Team Member:** _____
   What about your model will attract the Mexican Long-Tongued Bats and Lesser Long-Nosed Bats?

2. **Team Member:** _____
   What did you add to your model to make it more appealing to put up in the public?

3. **Team Member:** _____
   Why is it important for bat boxes like yours to be put up in the Sonoran Desert?

4. **Team Member:** _____
   Did your group have any ideas about where to mount a bat box to protect the bats from predators and humans?

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Presentation Notes:

1. How did the group model their bat box? (What attracts the two Sonoran Desert Bats?)

2. How does the group plan to get the public to help with mounting more bat boxes?

3. How does the group make **their** bat box survive bad weather or a hot summer?

4. At least 1 question for the group:

5. Letter grade you'd give the presentation:___
   Why? What did the group do well? What did the group need to work on?

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Remember for Construction:

*****These are some of the things that create successful Bat Boxes!*****

- "Multi chamber bat houses are more successful because they can accommodate larger populations making them more thermally stable."
- "All houses should have 3- to 6-inch landing areas extending below the entrances or recessed partitions with landing space inside."
- "1⁄2-inch (or thicker) exterior plywood is ideal for fronts, backs and roofs"
- "1- or 2-inch-thick boards are best for the sides"
- "Cover roofs with shingles or metal for extra protection"
- "Alternative materials, such as plastic or fiber-cement board, may last longer than wood and require less maintenance"
- "White or light shade of paint"
- "roughen it up to provide places for the bat to crawl up into the house
  - cutting grooves into the wood or find sturdy plastic mesh and staple it along backboard
  - grooves need to be about a half inch apart"
- "Bats like it dark inside their houses
  - Stain inside"
- "Seal the bat house to help keep the heat inside"
- "ventilation slot"