

PAW

PROJECT ARIZONA WILDLIFE



Recommended Grades: 6th – 12th

Type of Lesson: Self-paced curriculum with videos, discussions, activities, and final project.

Recommended Timeframe: 9-week research-based project. Approximately 90-minute sessions per week with opportunities for extended learning and independent research.

Overview: This program will guide participants through research experiences involving the Phoenix Zoo's conservation efforts. Participants will learn about the complex process of saving endangered species, then be inspired to create their own "Save a Species" plan. This project is aligned to state and national science standards.

Key Concepts:

- Identify everyday actions that people can take to conserve and protect wildlife
- Discuss how human actions positively and negatively affect animal habitats and populations
- Respectfully engage in argument about the controversial aspects of human intervention on wildlife populations
- Conduct research about the ecosystem and needs of endangered and threatened species
- Understand the importance of genetic diversity in endangered and threatened populations
- Define and create a solution for a real-world problem
- Collaborate with peers to complete a project
- Evaluate own work and the solutions of others
- Present work to an audience using public speaking skills
- Develop empathy for animals by considering multiple perspectives
- Identify the conservation efforts of the Phoenix Zoo
- Identify how multiple careers engage in conservation efforts

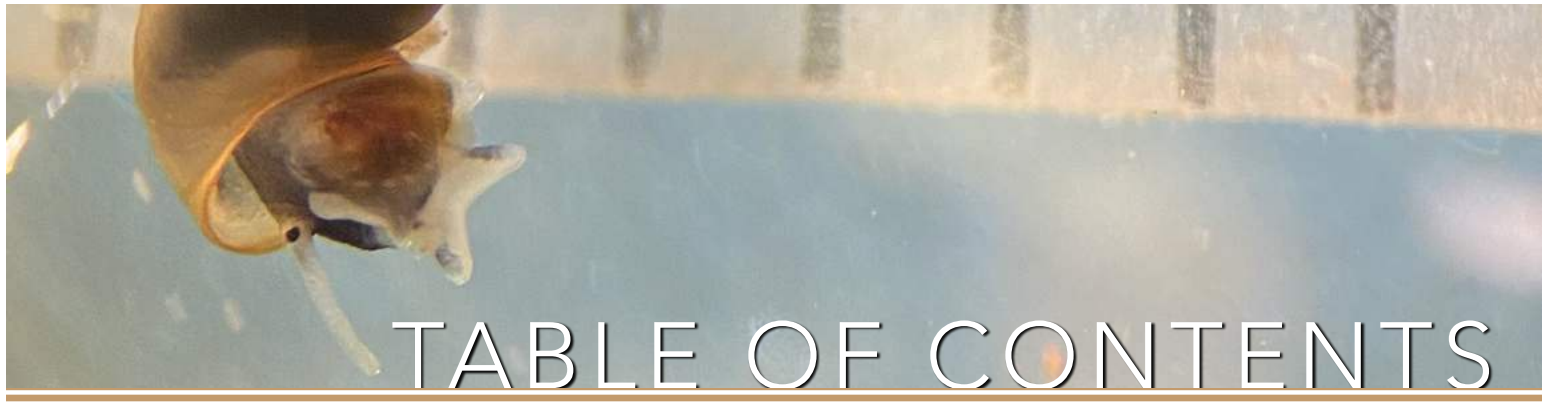


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Provided by the Zoo (digitally)	Provided by the School	Optional Digital Tools
<p>Teacher guide (with lesson plans and rubrics for assessment)</p> <p>Student research notebook</p> <p>Pre/post assessment</p> <p>Live, virtual Q&A with Zoo Educator</p> <p>Case study videos</p> <ul style="list-style-type: none"> • Week 1: Intro & Chiricahua Leopard Frog • Week 2: Jaguar • Week 4: Narrow-headed gartersnake • Week 5: Springsnails • Week 9: Conservation Careers <p>Printable student worksheets</p> <ul style="list-style-type: none"> • Pronghorn Corridor Map • Pronghorn Species Info • Types of Corridors cards • Ferret Survival • Bottleneck Scenarios • Articles from AZ Game & Fish “Perspectives in Wolf Conservation” • Debate roles worksheet • Telemetry Matching • Article: Awareness and Action Campaigns 	<p>Access to internet connection</p> <p>Ability to print out digital resources provided by the Zoo</p> <p>Ability to play videos for the class</p> <p>Rope or chalk</p> <p>Empty plastic water bottle</p> <p>Minimum 100 Assorted colored beads (10 different colors)</p> <p>Scrap Paper</p> <p>Optional:</p> <ul style="list-style-type: none"> • Chart paper • Post-it notes 	<p>Access to individual computers for individual research (sources can be printed if this is not possible)</p> <p>Access to reliable databases for additional research</p> <p>Access to a digital presentation tool</p> <p>Access to iPads (or similar technology) to have students create a video for their presentation and use an editing app such as iMovie.</p>

NGSS Standards Alignment

MS-ETS1-1 Engineering Design

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ESS3-3 Earth and Human Activity

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

HS-ETS1-3 Engineering Design

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

ENGLISH LANGUAGE ARTS
READING & WRITING

<p>6th Grade</p>	<p>6.RI.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.</p> <p>6.W.1 Write arguments to support claims with clear reasons and relevant evidence.</p> <p>6.W.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.</p> <p>6.W.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.</p>
<p>7th Grade</p>	<p>7.W.1 Write arguments to support claims with clear reasons and relevant evidence.</p> <p>7.W.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.</p> <p>7.W.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.</p>
<p>8th Grade</p>	<p>8.RI.7 Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.</p> <p>8.W.1 Write arguments to support claims with clear reasons and relevant evidence.</p> <p>8.W.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.</p> <p>8.W.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.</p>
<p>9th and 10th Grade</p>	<p>9-10.W.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.</p> <p>9-10.W.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.</p> <p>9-10.W.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.</p>
<p>11th and 12th Grade</p>	<p>11-12.RI.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in print in order to address a question or solve a problem.</p> <p>11-12.W.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.</p>

ENGLISH LANGUAGE ARTS
SPEAKING & LISTENING

6th Grade	<p>6.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.</p>
7th Grade	<p>7.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.</p> <p>7.SL.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, appropriate vocabulary, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.</p>
8th Grade	<p>8.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.</p> <p>8.SL.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.</p> <p>8.SL.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.</p>
9th and 10th Grade	<p>9-10.SL.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.</p> <p>9-10.SL.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task; use appropriate eye contact, adequate volume, and clear pronunciation.</p> <p>9-10.SL.5 Make strategic use of digital media in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.</p>
11th and 12th Grade	<p>11-12.SL.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.</p> <p>11-12.SL.4 Present information, findings, and supporting evidence in an organized, developed style appropriate to purpose, audience, and task, allowing listeners to follow the speaker's line of reasoning, message, and any alternative perspectives.</p> <p>11-12.SL.5 Make strategic use of digital media in presentations to enhance understanding of findings, reasoning, and evidence to keep the audience engaged.</p>

S C I E N C E

<p>6th Grade</p>	<p>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.</p> <p>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</p>
<p>7th Grade</p>	<p>Core Ideas for using Science - U3 Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</p>
<p>8th Grade</p>	<p>8.L3U3.10 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.</p>
<p>High School</p>	<p>Essential HS.L2U3.18 Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.</p> <p>Essential HS.L3U1.24 Construct an explanation of how the process of sexual reproduction contributes to genetic variation.</p> <p>Essential HS.L3U3.26 Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.</p> <p>Essential HS.L4U1.27 Obtain, evaluate, and communicate evidence that describes how changes in frequency of inherited traits in a population can lead to biological diversity.</p>
<p>High School Plus</p>	<p>Plus HS+B.L4U1.2 Engage in argument from evidence that changes in environmental conditions or human interventions may change species diversity in an ecosystem.</p>

Final Project

By the end of this project, the students will create and present a Save a Species plan (as a poster, PowerPoint, video, etc.) based on the recovery of the endangered species of their choice.

The project will include the importance of that animal, common challenges the animal faces in the wild, and a proposed solution which identifies the interested parties and potential partners involved. It will also include how they are planning to monitor the animal's progress and an awareness campaign or action-based element to involve the public in saving the species.

WEEK 1

- **Biodiversity:** The full range of life in all its forms. This includes the habitats in which life occurs, the ways that species and habitats interact with each other, and the physical environment and the processes necessary for those interactions.
- **Connectivity:** The ability of organisms to move among separated patches of suitable habitat.
- **Endangered:** “Endangered” is an official status according to the IUCN to indicate that a species is facing a very high risk of extinction in the wild. Endangered can also be used to mean that a species is in peril or threatened.
- **Habitat degradation:** When the condition of a habitat declines due to factors such as pollution, invasive species, and over-utilization of natural resources.
- **Habitat destruction:** The elimination or alteration of the conditions necessary for animals and plants to survive; The complete destruction of an area used by wildlife. Often causes the most immediate danger to wildlife.
- **Habitat fragmentation:** When habitat is separated into smaller patches; correlates with lower overall species richness as well as lower biodiversity of native species.
- **Habitat loss:** The process by which a natural habitat becomes incapable of supporting its native species. The organisms that previously inhabited the site are displaced or dead, thereby reducing biodiversity and species abundance. Habitat destruction is the leading cause of biodiversity loss.
- **Habitat patch:** A fragment of habitat with a unique size, shape, perimeter and core area used by one or more species for resources.
- **Human-wildlife conflict:** The negative interactions between humans and wild animals, with undesirable consequences both for people and their resources on the one hand, and wildlife and their habitats on the other.
- **Matrix:** The uninhabitable landscape or “non-habitat”; the portion of the landscape in which habitat patches and corridors are embedded.

WEEK 2

- **Continuous corridor:** Large, unbroken strips of suitable corridor habitat that lead to another habitat.
- **Corridor:** Any space that facilitates connectivity over time among habitat patches.
- **Dispersal:** The process of individuals leaving their home territory to look for a new place to live. This behavior can occur within and between habitat patches.
- **Metapopulation:** A group of spatially separated populations of a single species which interact through dispersal or migration.
- **Migration:** Seasonal movements between breeding and nonbreeding animal ranges.
- **Stepping-stone corridor:** Small patches of habitat that are not physically connected but can facilitate dispersal or migration movements.

WEEK 3

- **Adaptation:** The ways in which living things have adjusted to their environment through biology or behavior, thereby improving their chances of survival.
- **Bottleneck effect:** When a population experiences a severe change that kills off many individuals, the survivors retain only a portion of the original genetic diversity. The consequent diversity of genes and associated genetic characteristics or traits of the new population are thus limited by the effect of this “genetic bottleneck” event.
- **Dominant gene:** A gene that always shows its effect, or expression, in an organism, even if a corresponding recessive gene is also present.
- **Gene:** A piece of DNA that codes for a particular trait; the basic unit of heredity.
- **Genotype:** The set of genes that an organism carries; specifically, the two alleles an organism has inherited for a particular gene.

- **Genetic diversity:** Variation in the genes found in individuals within a population of a single species, and the pattern of genetic variation found within different populations of the same species.
- **Gene pool:** All the genes present in a given population at a particular time.
- **Keystone species:** A species on which other species in an ecosystem largely depend, such that if it were removed the ecosystem would change drastically.
- **Phenotype:** The detectable expression of an organism’s genotype; an organism’s observable characteristics.
- **Recessive gene:** A gene whose expression is repressed when the dominant gene is present.

WEEK 4

- **Habitat degradation:** When the condition of a habitat declines due to factors such as pollution, invasive species, and over-utilization of natural resources.
- **Habitat fragmentation:** When habitat is separated into smaller patches; correlates with lower overall species richness as well as lower biodiversity of native species.
- **Receiver:** This is the unit that translates the message from the transmitter into a signal to receive data.
- **Telemetry:** A method in wildlife biology that uses radio or satellite signals from a transmitter in one location to transfer data to a receiver in another location. Depending on the equipment, signals can be received over very long distances, allowing scientists to study an animal without disturbing it once a transmitter has been affixed
- **Transmitter:** This is the unit that is attached to the collar or other attachment system on the animal.

CASE STUDY**Step 1: Introduce the topic and define the problem**

The animal that is the topic of that week's case study will be introduced through a video or article. It will guide them through basic facts about the animal and introduce the real-world problem that needs to be solved by conservation scientists, as well as the current solutions in which the Phoenix Zoo is involved.

Step 2: Discuss observations and brainstorm possible solutions

In small groups or as a whole group, ask open-ended questions to help students think about their observations of the problem and brainstorm possible solutions. Have students record their thoughts in their notebook. Some example questions include:

- What do you observe about the animal and its environment?
- What is the cause of the problem?
- Who are the key players in the situation?
- What relevant data do you have?
- What other information do you need or would be helpful?
- What are possible solutions – both short-term and long-term?

Step 3: Analyze the presented solution

Discuss the solution the conservation scientist came up with. Afterward, make sure to emphasize that even though students may have come up with a different answer or solution, their idea is still worth researching. Ask reflective questions such as:

- What can we learn from this situation?
- What are the pros and cons of the current solution?
- What are the pros and cons of your proposed solution?
- What do you think are the next steps for the conservation community?

SOCRATIC SEMINARS

The students discuss by responding to a question developed in advance. Usually, the discussion focuses on a moral dilemma or ethical question that inspires multiple viewpoints. The teacher acts as facilitator by asking follow-up questions and making sure that the students are speaking and behaving respectfully. **However, it is important that the teacher does not state whether an answer is correct or not and does not dictate who gets to speak (i.e., no raising hands and calling on students).** This structured form of conversation balances freedom of expression, critical thinking, listening skills, and accountability for students.

Typically, the students sit in a circle, so they can see everyone. If you have a larger group, you can do two separate circles to give students more opportunity to speak. If your class is unfamiliar with this type of discussion, begin with expectations for respectful conversation (no interrupting one another on purpose, no insults or accusing others because of their viewpoint, etc.) Since they will not be raising hands to discuss, have them think about how to read body language to predict who wants to speak and what to do if you accidentally interrupt someone. Then, pose the question and see how the students respond. You may need to rephrase the question or break it down in order to get the conversation rolling. If you have time, you can provide the question to the students beforehand, so they can do independent research or prepare their thoughts. A basic rubric for grading the seminars can be found in the Assessments portion of this teacher guide.

5 Expectations for the Seminar:

1. Always speak respectfully. There will be no insults.
2. Don't raise your hand. Just wait patiently for a moment when you can speak.
3. Apologize if you interrupt someone.
4. It's ok to say if you are confused or need to ask someone to repeat something.
5. Listen carefully.

STRUCTURED DEBATE

Have students choose a side that they want to argue. You can assign a side, but it is often less effective for the overall debate. Feel free to use your own structure for the debate – a simple and quick version is suggested below. A resource for even more structured roles (including charts for organizing information and sentence stems to prompt their thinking) is provided with the worksheets online. A basic rubric for grading the debates can be found in the Assessments portion of this teacher guide.

Debate Expectations

- Speak respectfully, even when you disagree.
- You must raise your hand if it's not your time to speak.
- Teams lose 1 point for each interruption.
- Teams lose 1 point for whispering while another speaker is talking.

Basic sections and timings

1. Opening statements for both sides. Groups put their best foot forward and present the basics of their argument/perspective. 3 minutes for each team. Up to 5 points.
2. Arguments for both sides. Groups present 2-3 reasons with evidence in support of their perspective. 5-6 minutes each. Up to 6 points.
3. Rebuttal conference. Each group huddles together to come up with a defense to address the arguments that the other side just presented. 5 minutes.
4. Rebuttals for both sides. Groups present their defense that addresses the arguments from the other side. 5-6 minutes each. Up to 6 points.
5. Closing statements for both sides. Final chance to make a case for their perspective. 3 minutes each. Up to 5 points.

INTRODUCTION & COMMON CHALLENGES
TO ENDANGERED SPECIES

Lesson Title (Timeframe)	Description / Directions	Objective	Materials	Extensions / Research
<p>Pre-Assessment (10 mins)</p>	<p>Students will complete a short pre-assessment. Remind students that a pre-assessment should include their best guess – it’s ok if they don’t know the right answers.</p>	<p>Assess student background knowledge and initial feelings about the program.</p>	<ul style="list-style-type: none"> • Pre/post Assessment (answer key in Teacher Guide) 	<p>Please share pre/post assessment data with the Zoo to help us evaluate and improve our program!</p>
<p><u>CASE STUDY</u></p> <p>Chiricahua Leopard Frog (15 - 20 mins)</p>	<p>Play video which will review project expectations, then talk about the Chiricahua leopard frog. The video will introduce students to the Phoenix Zoo Johnson Conservation Center, some of the staff who work there, and their efforts to combat the common challenges the frogs face by creating a “head start” program.</p> <p><i>See page 7 of this teacher guide for additional facilitation instructions for Case Studies.</i></p>	<p>Students will be able to understand the purpose and expectations of this project.</p> <p>Students will be able to identify common challenges for endangered and threatened aquatic life in Arizona.</p>	<ul style="list-style-type: none"> • Video: Week 1 Intro & Chiricahua Leopard Frog • Research notebook 	<p>Give students some time to look through their research notebook.</p> <p>As a class, create a chart or contract that states expectations for engaged discussion or “accountable talk”.</p> <p>Accountable Discussions - The Teacher Toolkit</p>
<p><u>LEARNING ACTIVITY</u></p> <p>Shrinking and Fragmenting Habitats (30 mins)</p>	<p>As a class, students will participate in a group simulation to discover how human activities cause habitat fragmentation. By acting out scenarios, students will explore how landscape patch size is correlated to lower species biodiversity, richness, and abundance.</p>	<p>Students will be able to explain human-wildlife conflict and the cause and effect of habitat fragmentation on wildlife.</p>	<ul style="list-style-type: none"> • Rope (or chalk substitute) • Scrap paper to label each student’s assigned “species” (minimum 10) 	<p>For an optional example of preventing fragmented landscapes, see ranching strategies outlined by the Oregon Department of Fish and Wildlife for non-lethal measures to minimize wolf/ livestock conflict:</p> <p>dfw.state.or.us/Wolves/non-lethal_methods.asp</p>
<p><u>DISCUSSION</u></p> <p>Brainstorm Areas for Research (10 - 20 mins)</p>	<p>In small groups, students generate questions and topics they want to research related to the project, endangered species, and/or the Phoenix Zoo.</p> <p>Use post-it notes or chart paper to record these ideas to add and refer back to them each week as the project continues.</p>	<p>Students will be able to connect what they currently know to what needs to be learned in order to solve an identified problem.</p>	<ul style="list-style-type: none"> • Research notebook • Optional: chart paper, post-it notes 	<p>Have students create a mind map for brainstorming.</p>

OVERVIEW

Students will represent Sonoran Desert species living in a healthy habitat patch represented by a large circle of rope or chalk. Outside of the habitat patch is an uninhabitable landscape (matrix). Point to specific areas of the healthy habitat patch within the rope and mark them as made uninhabitable by human activity. Species that can survive in smaller patches may move on, but species that cannot survive must sit down. The habitat patch can be shrunken, split in half, or divided into several sections to represent fragmentation. At the end, students may calculate species loss to judge the effect human development has on biodiversity.

BACKGROUND

Humans have altered Earth's land for thousands of years, but the rapid population growth along with the industrialization of the last 300 years- and even more so over the last 70 years- has led to a great expansion of human land use, and therefore disturbance and loss of habitats all over the world.

Habitat patches are areas large enough to sustain healthy wildlife populations and support essential biological processes into the future.

DIRECTIONS (With Example Script):

Part 1: Set the Stage

Place a large piece of rope or string on the floor in the shape of a circle (or draw a large circle with chalk on the floor to represent the habitat patch boundary).

SAY: The area inside the rope represents a healthy and large habitat patch in the Sonoran Desert." (You can also name the patch after a local park, wilderness or protected area). "Each of you will represent a different species and stand in this habitat patch. Write the name of your species on your nametag, or piece of paper. **Note:** If students do not know the local animal species, ask students to create a list of species in the Sonoran Desert region. It is fine if students choose the same species but ensure you have at least 10 different species to represent biodiversity. (Examples of Arizona species: Javelina, Coyote, Chiricahua Leopard Frog, Cottontail, Gopher Snake, Roadrunner, Quail, Cactus Ferruginous Pygmy Owl, Mexican wolf, Bobcat, Bighorn sheep, Kit fox, Jack rabbit, Coatimundi, Black bear, Elk).

SAY: This habitat is healthy and diverse and contains (# of students) species.

Record the number of species in a place visible to all students.

Part 2: Human Activity

SAY: Surrounding the habitat patch is the matrix or uninhabitable landscape. The matrix is a combination of human development including homes, roads, industrial sites (manufacturing plants), oil and gas activity, ranching, and mining.

Note: You can name the primary human activities that occur around your school or region.

SAY: One day, a real estate developer decided that your habitat patch was in the prime location for new homes they wanted to develop. They decided to cut down the forest and build their new subdivision.

Part 3: Facing Consequences

Point to a specific part inside the rope.

SAY: As a result, this part of your habitat can no longer support any species. I need the students standing in this section to step into the matrix. **Note:** When you are fragmenting your large habitat patch make sure to target specific species that cannot live on small patches (example: Bighorn sheep, Mexican wolves, or Black bears).

Close the rope into a smaller circle around the remaining students to show how the habitat is getting smaller (draw a smaller circle or new boundary with the chalk).

VOCABULARY

- **Biodiversity:** The full range of life in all its forms. This includes the habitats in which life occurs, the ways that species and habitats interact with each other, and the physical environment and the processes necessary for those interactions.
- **Connectivity:** The ability of organisms to move among separated patches of suitable habitat.
- **Endangered:** "Endangered" is an official status according to the IUCN to indicate that a species is facing a very high risk of extinction in the wild. Endangered can also be used to mean that a species is in peril or threatened.
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- **Habitat patch:** A fragment of habitat with a unique size, shape, perimeter and core area used by one or more species for resources.
- **Human-wildlife conflict:** The negative interactions between humans and wild animals, with undesirable consequences both for people and their resources on the one hand, and wildlife and their habitats on the other.
- **Matrix:** The uninhabitable landscape or "non-habitat"; the portion of the landscape in which habitat patches and corridors are embedded.

SAY: Several months have passed, and now this habitat has turned into new homes and these species (point to the students which moved) can no longer survive because this area is lacking the resources they need to live. These students must take a seat.

Part 4: Wildfire

SAY: Now, one year has passed and summer is here. It is a very hot and dry summer. Someone camping in your habitat patch failed to put out their campfire fully and a wildfire started. I need the species standing in this section to crowd into the rest of the habitat if you can fit, but anyone who touches the matrix will unfortunately be destroyed in the lethal fire and will need to take a seat.

Note: Prescribed fires can be good, but this was a lethal fire, and it will take many years before the habitat is restored.

Close the habitat into a smaller circle to represent the wildfire.

Part 5: Build a Road

SAY: Now, a new road is being built through your habitat to access mountain biking and hiking trails.

Split the rope or chalk circle in half to make room for a ‘road’, fragmenting the habitat patch into 2 smaller patches.

SAY: Unfortunately, any species who were on the new road can no longer survive because they were hit by cars. Those students may take a seat. **Note:** If you still have plenty of students, continue to invent more human activities that shrink and fragment your habitat patch. You should play the game until you have half or less of the students left on the fragmented landscape. (Ex: water resource diversion, development of residential areas, agriculture, etc.).

SAY: Now our large, connected landscape looks quite small and fragmented. Do we have the same biodiversity we did in the beginning? (Students should say no. There is less biodiversity).

Part 6: Calculating Species Loss

As a group, count and record the number of species left in your habitat fragments.

Calculate the percentage of species lost:

$$\frac{\text{original \# of species} - \text{\# of species remaining}}{\text{original \# of species}}$$

ex: (10 - 5) / 10 = 50% loss in biodiversity

SAY: This smaller fragmented habitat has led to (your calculation %) extinction of species in our landscape. This is an example of what is currently devastating our world globally. Extinction rates are 1,000 times higher than historic rates documented in the fossil record. This loss in biodiversity is threatening the survival of humans and wildlife. Healthy and intact ecosystems provide us with clean air, water, food, and other natural resources.

Part 7: Reconnecting

SAY: However, just as humans played a role in causing this loss, humans can also play a role in rebuilding it. Looking to the future, what could we do to bring back our large habitat or connect our fragmented landscape? (Students could say wildlife corridors, underpasses, overpasses, limits on development in a community, community planning to reduce urban sprawl, seasonal temporal closures on landscapes, reclamation and restoration of agricultural land to support wildlife while maintaining productivity for agriculturalists, or human-wildlife cohabitation measures.)

Now, you will rebuild the population using a few of the strategies discussed.

SAY: Let’s try some of these solutions and see how much of the habitat we can reconnect and renew. A team of conservation scientists have worked with the local community, builders, and other interested parties to create an overpass for the animals. Those of you who were hit by cars can return to the habitat.

Remove the split in the rope or have animals stand on the chalk circle half.

SAY: Governments, communities, and real estate developers have worked with conservation scientists to create a community plan that reduces urban sprawl. As a result, this portion of the habitat has become inhabitable to some animal species again. Which species do you think will return first?

Expand the habitat space some by moving the rope or re-drawing the chalk line. Allow some students to return to the newly expanded habitat.

Re-calculate the species loss. Discuss how effective these solutions were for the habitat?

S U C C E S S F U L S O L U T I O N S

Lesson Title <i>(Timeframe)</i>	Description / Directions	Objective	Materials	Extensions / Research
<p>CASE STUDY</p> <p>Jaguars <i>(15 - 20 mins)</i></p>	<p>Show Jaguar video that will introduce students to the Phoenix Zoo’s field research work and their efforts to help the jaguar species in the wild</p>	<p>Students will be able to identify at least one successful solution conservationists use.</p>	<ul style="list-style-type: none"> • Video: Week 2 Jaguar • Research notebook 	
<p>LEARNING ACTIVITY</p> <p>Design a Wildlife Corridor for Arizona Pronghorn <i>(30 - 60mins)</i></p>	<p>Using the map provided and recommended research websites, students will design and place a wildlife corridor connecting two or more real pronghorn populations that are currently separated by Arizona highways.</p>	<p>Students will be able to explain dispersal of animal species.</p> <p>Students will be able to identify the different types of wildlife corridors.</p>	<ul style="list-style-type: none"> • Printable worksheets: Pronghorn Corridor Map, Pronghorn Species Info, Types of Corridors cards • Research notebook 	<p>Recommended articles for students to independently research corridors:</p> <p>fws.gov/story/wildlife-corridors</p> <p>mossy.earth/rewilding-knowledge/wildlife-corridors</p>
<p>DISCUSSION</p> <p>What is the value of human intervention on wild populations? <i>(20 - 30 mins)</i></p>	<p>Facilitate a Socratic seminar where students discuss the question and are free to take different viewpoints on the subject. However, they should have some form of evidence or reasoning to back up their viewpoint. They can use their research notebook to record notes and ideas from the discussion.</p> <p><i>See page 7 of this teacher guide for additional facilitation instructions for Socratic seminars.</i></p>	<p>Students will be able to discuss how human actions positively and negatively affect animal habitats and populations.</p>	<ul style="list-style-type: none"> • Research notebook 	<p>Before beginning this discussion, give students time to do independent research to prepare evidence for their viewpoint in the discussion</p>

OVERVIEW

Students will observe a map depicting pronghorn populations and major Arizona highways, as recorded by the Arizona Game and Fish department (AZGF). Students should use basic, independently researched information on pronghorns and wildlife corridors (websites provided) to determine what kind of corridor to design and where to put it to connect any two patches (pronghorn populations) on the map.

BACKGROUND

The process through which previously intact areas of habitat are divided into smaller disconnected areas by roads, urbanization, and other barriers is known as habitat fragmentation, which decreases the degree of habitat connectivity of the landscape for wildlife. The disruption of animal movement by habitat fragmentation presents problems for Arizona’s wildlife, ranging from direct mortality on roadways to the genetic isolation of separated populations. This disruption of animal movement patterns also negatively affects human welfare by increasing the risk of wildlife-vehicle collisions and the frequency of unwanted “close encounters” with wildlife. However, the effects of habitat fragmentation can often be mitigated by identifying and protecting areas that wildlife use for movement, known as wildlife corridors. Ridgelines, canyons, riparian areas, cliffs, swaths of forest or grassland, and other landscape or vegetation features can serve as wildlife corridors. Wildlife corridors are most effective when they connect (or are located within) relatively large and unfragmented areas referred to as habitat patches (sometimes called islands or blocks). Habitat patches are areas large enough to sustain healthy wildlife populations and support essential biological processes into the future.

DIRECTIONS

Discuss with participants what wildlife corridors are: What does it take to create a wildlife corridor? What is a continuous vs. stepping-stone corridor? What are the different design choices?

Use the “Types of Corridors” cards to identify and review.

Independent research can be done on corridors. Recommended articles for students to independently research corridors can be found at the following:

fws.gov/story/wildlife-corridors

mossy.earth/rewilding-knowledge/wildlife-corridors

Supply participants with the included materials: Pronghorn Corridor Map and Pronghorn Species Information. See the Printable Student Worksheets section on the website for easy printing of this activity.

EXAMPLE SCRIPT: Habitat patches are areas that contain all the necessities for wildlife

to survive and thrive. Often these patches are not large enough to provide long-term support for the animals who live within. Areas surrounding these patches are not hospitable to wildlife, and wildlife that naturally venture beyond the confines of their habitat patches are often at risk of conflict with humans and human development. The concept of wildlife corridors has become a way to direct animal movement away from, or safely through, areas of human-wildlife conflict. As humans continue to dominate the landscape, habitat patches and wildlife corridors will become increasingly necessary for the survival of our many wild species.

This map shows the effect of roadways on the movement of pronghorn. Radio and satellite telemetry studies by the Arizona Game and Fish Department reveal that major roadways (dark red lines) can act as barriers to pronghorn movement. This barrier effect can effectively isolate populations, potentially reducing genetic diversity and reproductive success over time. Colors indicate groups of animals studied in separate projects. Each color will represent a habitat patch that is home to populations of pronghorn. You will use

VOCABULARY

- **Continuous corridor:** Large, unbroken strips of suitable corridor habitat that lead to another habitat.
- **Corridor:** Any space that facilitates connectivity over time among habitat patches.
- **Dispersal:** The process of individuals leaving their home territory to look for a new place to live. This behavior can occur within and between habitat patches.
- **Metapopulation:** A group of spatially separated populations of a single species which interact through dispersal or migration.
- **Migration:** Seasonal movements between breeding and nonbreeding animal ranges.
- **Stepping-stone corridor:** Small patches of habitat that are not physically connected but can facilitate dispersal or migration movements.

the information provided about the behavioral and physical characteristics of the pronghorn and decide where you would like to place a wildlife corridor to connect any two or more patches.

Directions for students:

1. You can work with a partner or individually.
 2. Pick a location on the map where you would like to put a corridor. You must connect at least 2 different patches.
 3. Select a type of corridor: continuous or stepping stone
 4. Plan a design and draw it in your research notebook.
- Consider doing an example as a group to model expectations.
 - While working, students should consider: What kinds of human developments (neighborhoods, roads, etc.) might be on the area of the map you picked that might affect what corridor you can have?
 - Time permitting, students should discuss their finished corridor designs as a class, discussing how their corridor connects the landscape, as well as how it directs pronghorn movement away from, or safely through, dangers caused by humans.

RELEASE METHODS AND CONSIDERATIONS

Lesson Title (Timeframe)	Description / Directions	Objective	Materials	Extensions / Research
<p>INDEPENDENT RESEARCH</p> <p>Black-Footed Ferret (15 - 20 mins)</p>	<p>Use the websites listed to introduce students to the Phoenix Zoo’s efforts to help the black-footed ferret population and the “boot camp” that ferrets must go through to be deemed ready for release into the wild.</p>	<p>Students will be able to identify 2-3 factors that conservationists must consider before releasing endangered species into the wild.</p>	<ul style="list-style-type: none"> • Access to computer research • Research notebook 	<p>phoenixzoo.org/local-conservation/black-footed-ferret/</p> <p>snexplores.org/article/boot-camp-teaches-rare-animals-how-go-wild</p> <p>theguardian.com/environment/2020/sep/07/an-invisible-enemy-the-battle-to-save-black-footed-ferrets-from-the-plague-aoe</p> <p>defenders.org/blog/2023/04/precious-cargo-my-experience-black-footed-ferret-reintroduction</p>
<p>LEARNING ACTIVITY</p> <p>The Bottleneck Effect & Black Footed Ferrets (30 mins)</p>	<p>Students will participate in a visual representation of a genetic bottleneck effect. Using colored beads and the provided chart, participants will select their ferret’s “genome” from the beads and translate it into the corresponding phenotype. Participants will then be presented with a number of scenarios. Their gene pool will determine the survival of their ferrets, demonstrating the effects of genetic bottlenecks in endangered populations.</p>	<p>Students will be able to identify the significance of diverse genetics in a population, including the effects that the bottleneck effect have had on the endangered Black Footed Ferret.</p>	<ul style="list-style-type: none"> • Empty plastic water bottle • Minimum 100 colored beads (10 different colors. Listed here are: orange, red, blue, pink, purple, green, yellow, black, white, and ivory.) • Printable worksheets: Ferret Survival, Bottleneck Scenarios 	<p>Genetic Bottleneck Effect extension activity:</p> <p>biologysimulations.com/genetic-drift-bottleneck-event</p>
<p>DEBATE</p> <p>Multiple Perspectives of Interested Parties and Potential Partners (60+ mins)</p>	<p>Have students read the articles from AZ Game & Fish “Perspectives in Wolf Conservation”. Break students into debate teams and review debate expectations, rules, and roles. Allow time for them to prepare their argument as a team. Then, conduct the debate.</p> <p><i>See page 7 of this teacher guide for additional facilitation instructions for Debates</i></p>	<p>The students will be able to respectfully engage in arguments about the controversial aspects of human intervention on wildlife populations and relate to multiple viewpoints. The students will be able to provide evidence and reasoning for their viewpoint.</p>	<ul style="list-style-type: none"> • Printable worksheets: Articles from AZ Game & Fish “Perspectives in Wolf Conservation” • Debate rubric • Optional for additional notes and structure: Debate roles worksheet 	<p>Students can write their own article expressing their viewpoint.</p>

OVERVIEW

Students will participate in a visual representation of a genetic bottleneck. Using colored beads and the provided chart, participants will select their ferret's "genome" from the beads and translate it into the corresponding phenotype. Participants will then be presented with a number of scenarios. Their gene pool will determine the survival of their ferrets, demonstrating the effects of genetic bottlenecks in endangered populations.

BACKGROUND

The endangered black-footed ferret is a member of the weasel family. It is the only ferret native to North America—the domestic ferret is a different species of European origin. Its large skull and strong jaw are adapted for eating meat. Prairie dogs make up 90% of a black-footed ferret's diet. A ferret may eat over 100 prairie dogs in one year. Black-footed ferrets once numbered in the tens of thousands, but widespread destruction of their habitat and exotic diseases (like canine distemper and Sylvatic plague) in the 1900s brought them to the brink of extinction. Because black-footed ferrets eat prairie dogs and live in their burrows, they are completely dependent upon large prairie dog colonies for survival. But prairie dog colonies have been reduced to less than 5% of the area they originally occupied due to habitat destruction, poisoning, shooting, and exotic disease. The remaining colonies are relatively small and fragmented, and often separated by great distances. With the dramatic loss of prairie dogs came the loss of almost all black-footed ferrets as well. Only 18 remained in 1986. Due to the low number of ferrets, the population underwent a genetic bottleneck. Today, due to conservation efforts, black-footed ferrets are making a comeback, with approximately 200-300 black-footed ferrets in the wild, and another 280 living in managed breeding facilities (2020).

Today, you will be simulating why genetic diversity is important for the survival of species like black-footed ferrets. A lack of genetic diversity means that a population can easily be wiped out. For example; If all the ferrets left alive have short fur, and a particularly cold winter occurs that only long-furred ferrets could survive, then the remaining short-furred ferrets will die. In a healthy, genetically diverse population, there would have been long-furred ferrets left after the cold winter to breed.

DIRECTIONS

Briefly revisit some of the backstory and causes for Black-footed ferret population decline, detailed in the Background Information section of this activity. Review what they learned through their Independent Research.

EXAMPLE SCRIPT: The bottom of the bottle represents the larger population from the past. The narrow neck of the bottle represents a severe decrease in population size (in this case caused by disease, loss of food source, and loss of habitat). The beads that we will pour into your hand represent the new population of ferrets. Some traits may be lost, which could have disastrous effects on the survival of the population. The Environmental

Scenario chart will tell you whether or not your new ferret population will survive.

Tip the bottle over and give it one shake to release no more than 10 beads into the participants hands.

Have students match up their beads to the corresponding traits on the colored chart (thus translating colored bead "genotype" into observable "phenotype"). Have students write down the traits their ferret population now possesses.

After determining the traits of their population, assign students about 5-6 scenarios from the

VOCABULARY

- **Adaptation:** The ways in which living things have adjusted to their environment through biology or behavior, thereby improving their chances of survival.
- **Bottleneck effect:** When a population experiences a severe change that kills off many individuals, the survivors retain only a portion of the original genetic diversity. The consequent diversity of genes and associated genetic characteristics or traits of the new population are thus limited by the effect of this "genetic bottleneck" event.
- **Dominant gene:** A gene that always shows its effect, or expression, in an organism, even if a corresponding recessive gene is also present.
- **Gene:** A piece of DNA that codes for a particular trait; the basic unit of heredity.
- **Genotype:** The set of genes that an organism carries; specifically, the two alleles an organism has inherited for a particular gene.
- **Genetic diversity:** Variation in the genes found in individuals within a population of a single species, and the pattern of genetic variation found within different populations of the same species.
- **Gene pool:** All the genes present in a given population at a particular time.
- **Keystone species:** A species on which other species in an ecosystem largely depend, such that if it were removed the ecosystem would change drastically.
- **Phenotype:** The detectable expression of an organism's genotype; an organism's observable characteristics.
- **Recessive gene:** A gene whose expression is repressed when the dominant gene is present.

Environmental Scenario chart. This chart can be printed and the tiles cut out to easily distribute scenarios at random. Have students fill out the Survival Prediction chart.

Finally, have all students answer the final questions related to genetic diversity, bottleneck events, and characteristics.

MONITORING METHODS

Lesson Title <i>(Timeframe)</i>	Description / Directions	Objective	Materials	Extensions / Research
<p><u>CASE STUDY</u></p> <p>Narrow-headed Gartersnake <i>(15 - 20 mins)</i></p>	<p>Show pre-recorded narrow-headed gartersnake video that will introduce students to the Phoenix Zoo's work with this animal and the challenges of monitoring them.</p>	<p>The students will be able to identify the factors to consider when working with narrow-headed gartersnakes</p>	<ul style="list-style-type: none"> • Video: Week 4 Narrow-headed gartersnake • Research notebook 	
<p><u>LEARNING ACTIVITY</u></p> <p>Telemetry Engineering Challenge <i>(30 - 60 mins)</i></p>	<p>Students will explore the use of telemetry in conservation biology with a matching warm-up activity, and independently design a telemetry transmitter for the Narrow-headed gartersnake.</p>	<p>The students will be able to understand telemetry as a tool for wildlife conservation and design their own telemetry transmitter.</p>	<ul style="list-style-type: none"> • Research Notebook • Printable Worksheets: Telemetry Matching 	<p>For more information and examples of radio telemetry in wildlife biology, see the recommended article:</p> <p>files.dnr.state.mn.us/mcvmagazine/young-naturalists/young-naturalists-article/telemetry/wiredlife.pdf</p>
<p><u>DISCUSSION</u></p> <p>When is monitoring as an intervention necessary for a species? In your opinion, what is the most effective form of monitoring? <i>(20 - 30 mins)</i></p>	<p>Facilitate a Socratic seminar or structured debate where students discuss the questions and are free to take different viewpoints on the subject. However, they should have some form of evidence or reasoning to back up their viewpoint. They can use their research notebook to record notes and ideas from the discussion.</p>	<p>The students will be able to discuss how human actions positively and negatively affect animal habitats and populations.</p>	<ul style="list-style-type: none"> • Research notebook • Socratic seminar or debate rubric 	<p>Students can use a graphic organizer to compare and contrast the different forms of monitoring:</p> <p>Tracking devices, telemetry, camera traps, acoustic monitoring, catch & release</p>

OVERVIEW

Students will explore the use of telemetry in conservation biology and independently design a telemetry transmitter for a species of conservation need, the Narrow-headed gartersnake.

BACKGROUND

Telemetry is a tool scientists can use to track the movements of an animal. Use of telemetry requires that a transmitter be attached to the animal that sends a signal to a receiver. Telemetry allows scientists to locate their subjects and potentially record additional information about the individual such as activity level and habitat usage. The various shapes and lifestyles of animals means there are many different styles of transmitters and attachment methods. In most cases, transmitters must be less than 10% of the body weight of an animal. Collars (terrestrial mammals), epoxy (marine mammals), leg transmitters or backpacks (birds), internal transmitters (fish), belts (amphibians), and glue (some reptiles) are all methods of attaching transmitters. The Narrow-headed gartersnake is both terrestrial and aquatic, so they pose a particular challenge when it comes to telemetry.

The narrow-headed gartersnake (*Thamnophis rufipunctatus*) is a non-venomous, semi-aquatic snake that gets its name from its distinctly elongated, narrow head. Narrow-headed gartersnakes spend much of their time in or around water and primarily eat fusiform (torpedo-shaped) fish such as trout and dace, salamanders and tadpoles. Narrow-headed gartersnakes are found in central Arizona into western New Mexico, along rocky creeks and streams. The species is listed as Threatened under the US Endangered Species Act, as population numbers have declined significantly across the snake's range. Invasive non-native species such as bullfrogs, crayfish, and sportfish have contributed greatly to the disappearance of Narrow-headed gartersnakes and continue to be a major threat. In some places, the snakes' habitat has also been lost or fragmented because of human activities and development. People have also needlessly killed or collected Narrow-headed gartersnakes.

At the Arthur L. and Elaine V. Johnson Conservation Center, conservation scientists are working to breed Narrow-headed gartersnakes for release to the wild, in partnership with wildlife agencies. The goal of these efforts is to strengthen existing populations and develop new populations within the snakes' historic range. Currently, this work focuses on understanding how to reliably breed the snakes and produce offspring, as well as working to test new methods for tracking gartersnakes in the field. More than 40 narrow-headed gartersnakes raised at the Phoenix Zoo have been released to the wild in Arizona. This includes the largest-ever release to the wild for this species in 2022, with 25 individuals released.

DIRECTIONS

Discuss telemetry as a tool and why scientists may use it.

EXAMPLE SCRIPT: Telemetry is a tool scientists can use to track the movements of an animal. The use of telemetry requires that a transmitter be attached to the animal, which then sends a signal to a receiver. The various shapes and lifestyles of animals means there are many different styles of transmitters and

attachment methods. In most cases, transmitters must be less than 10% of the body weight of an animal. In wildlife biology, transmitters can be attached using collars, epoxy, leg bands, backpacks, internal transmitters (implanted surgically), belts, and glue.

Telemetry allows scientists to locate their subjects and is especially useful when studying habitat usage and determining the effects of habitat fragmentation and degradation. When

VOCABULARY

- **Habitat Degradation:** When the condition of a habitat declines due to factors such as pollution, invasive species, and over-utilization of natural resources.
- **Habitat Fragmentation:** When habitat is separated into smaller patches; correlates with lower overall species richness as well as lower biodiversity of native species.
- **Receiver:** This is the unit that translates the message from the transmitter into a signal to receive data.
- **Telemetry:** A method in wildlife biology that uses radio or satellite signals from a transmitter in one location to transfer data to a receiver in another location. Depending on the equipment, signals can be received over very long distances, allowing scientists to study an animal without disturbing it once it has been collared with a transmitter.
- **Transmitter:** This is the unit that is attached to the collar or other attachment system on the animal.

we learn about habitat usage and the impacts of change, we can better determine how to protect a species.

Students should fill out the picture matching activity. In this activity, students can match the transmitter/method of attachment to its corresponding animal. See the Printable Student Worksheets document for easy printing of this activity. The answer key for this activity can be found on the next page.

Small mammal – Small collar



Amphibian – Small belt



Students should draw out a design for a transmitter on a Narrow-headed gartersnake, taking into consideration size, weight, behavior, and habitat. Adults weigh on average 130 grams and can grow up to approximately 44 inches in length. Students should calculate 10% of 130 grams and approximate the size and weight of their design based on this calculation, but there is no 'right' or 'wrong' design.

Fish – Internal



Large bird – Leg band



At the End of this Activity

At the end of this activity, students can look at the pictures showing how scientists currently attach transmitters to Narrow-headed gartersnakes, shown below. Transmitters are attached with duct tape, which eventually falls off when the snake sheds.

Small bird - Backpack



Review the answers with your students. These are just a few of the ways scientists attach transmitters to wild animals. Transmitters and attachment methods can look completely different for different species.

Discuss the pros and cons of using the duct tape method. Is it more or less effective than the design the students made?

Finally, ask students what their favorite animal is. How would they track that kind of animal? Calculate weight (10% of body weight or less) and determine the animal's lifestyle to choose a method of attaching a transmitter.

Turtle/Tortoise - Glue



Review the Narrow-headed gartersnake and how its lifestyle makes attaching a transmitter a challenge. Additional independent research can be done on the Narrow-headed gartersnake, or more background information can be shared from the teacher guide background section of this activity.



Marine mammal - Epoxy



EXAMPLE SCRIPT: The Narrow-headed gartersnake is both terrestrial and aquatic, so they pose a particular challenge when it comes to telemetry.

Large mammal – Large collar



Ask students how they might attach a transmitter to the snakes. Let them talk and reason it out, prompting with open-ended questions such as:

- o What things do we need to consider for an aquatic animal?
- o What things do we need to consider for an animal that burrows or climbs?
- o What things do we need to take into account for reptiles?



AWARENESS AND ACTION CAMPAIGNS

Lesson Title <i>(Timeframe)</i>	Description / Directions	Objective	Materials	Extensions / Research
<p>CASE STUDY</p> <p>Springsnails <i>(5 - 10 mins)</i></p>	<p>Show video about springsnails that will review the challenges of caring for this species. It will introduce them to a species that is not commonly known or appreciated.</p>	<p>The students will be able to identify the importance and difficulties of working with miniscule animals.</p>	<ul style="list-style-type: none"> • Video: Week 5 - Spring snails • Research notebook 	<p>For discussion, use information from the article “Wildlife conservation tends to save charismatic species. That may be about to change.” from NPR</p> <p>npr.org/2022/09/12/1110852137/wildlife-conservation-charismatic-species-change</p>
<p>DISCUSSION</p> <p>How can you help people care about animals that are not conventionally “cute”? <i>(20 - 30 mins)</i></p>	<p>Read the article about Awareness and Action Campaigns. Facilitate a Socratic seminar where students discuss the question and put forth different solutions. Use the article as a starting point – is it a compelling way to make people care? What would you add or change? Students should also use this information to help them craft that part of their Save a Species Plan.</p>	<p>The students will be able to identify the important factors to encourage behavioral change.</p>	<ul style="list-style-type: none"> • Article: Awareness and Action Campaign 	
<p>LEARNING ACTIVITY</p> <p>Introduction to Project and Independent Research <i>(60+ mins)</i></p>	<p>Discuss the Save a Species project expectations and the many potential ways to present the information (poster, video, PowerPoint, etc.)</p> <p>Review the rubric together and all the information they will need to include.</p> <p>Especially if you have younger grades, consider doing an animal as a model together before releasing students to research independently.</p> <p>Once students have a clear understanding of the expectations, allow them to independently research their animal and begin to develop their project.</p>	<p>The students will be able to apply what they have learned to the final project.</p> <p>The students will be able to conduct independent research using reputable sources.</p> <p>The students will be able to collaborate with a group to create a final product.</p>	<ul style="list-style-type: none"> • Research notebook • Research material (computers, printed articles, books, etc.) • Rubric for final project (in teacher guide and student research notebook) • Materials needed for project completion (posters, iPads, craft supplies, etc.) 	<p>Consider using these resources/lessons to review the criteria for a reliable source of information:</p> <p>edutopia.org/blog/evaluating-quality-of-online-info-julie-coiro</p>

PROJECT WORK

Lesson Title <i>(Timeframe)</i>	Description / Directions	Objective	Materials	Extensions / Research
<p>DISCUSSION</p> <p>What additional information do you need to complete your project? <i>(15 - 20 mins)</i></p>	<p>In their small groups, students brainstorm any additional research or information they will need to complete their project. They should make a plan for when and how they will obtain the information. If the information truly doesn't exist yet, they can incorporate into their project how they would theoretically study it.</p>	<p>The students will be able to generate questions and complete research needed for their project.</p>	<ul style="list-style-type: none"> • Research notebook 	<p>Use the questions generated from this activity for your virtual check-in next week!</p>
<p>LEARNING ACTIVITY</p> <p>Independent Project Work <i>(60+ mins)</i></p>	<p>The students will continue to work on their Save a Species plan.</p>	<p>The students will be able to conduct independent research using reputable sources.</p>	<ul style="list-style-type: none"> • Research notebook • Project supplies from previous week 	
<p>LEARNING ACTIVITY</p> <p>Receive peer feedback on the Project <i>(15 - 20 mins)</i></p>	<p>Have students share their project idea with at least one other group to receive feedback. You can use sentence stems to structure the feedback if desired:</p> <ul style="list-style-type: none"> • One suggestion I have is... • One question I have is... • One thing I like is... 	<p>The students will be able to evaluate the solutions of others and provide constructive feedback to strengthen ideas.</p>	<ul style="list-style-type: none"> • Research notebook • Sentence stems (optional) • Post-it notes (optional) 	<p>Consider making this a “gallery walk” where students walk silently around the room and leave feedback on post-its for each of the groups.</p>

FINISH PROJECT & PLAN PRESENTATION

Lesson Title <i>(Timeframe)</i>	Description / Directions	Objective	Materials	Extensions / Research
<p style="text-align: center;"><u>DISCUSSION</u></p> <p style="text-align: center;">Virtual Check-in with Zoo Staff <i>(30 mins)</i></p>	<p style="text-align: center;">** Live, virtual conversation with Zoo staff **</p> <p>How would your class like to spend this time?</p> <p>Option #1: Q&A session with whole class</p> <p style="text-align: center;">OR</p> <p>Option #2: approximately 5 minutes per group with Zoo staff to receive specific feedback</p>	<p>The students will be able to generate questions and complete research needed for their project.</p> <p style="text-align: center;">OR</p> <p>The students will be able to receive feedback from Zoo staff on their project idea.</p>	<ul style="list-style-type: none"> • Research notebook • Access to Zoom or other virtual platform • Individual computers for students to log in or projector & screen for classroom 	
<p style="text-align: center;"><u>LEARNING ACTIVITY</u></p> <p style="text-align: center;">Finish Project & Presentation <i>(60+ mins)</i></p>	<p>The students will finish their Save a Species plan. They should also practice how they will present their idea to the class. Consider giving a timeframe for their presentation as a guideline.</p>		<ul style="list-style-type: none"> • Research notebook • Project supplies from previous week 	<p>Have students create a visual for their presentation using:</p> <ul style="list-style-type: none"> • Poster board or butcher paper • PowerPoint • Prezi • PowToon <p>If you have access to iPads (or similar technology) have students create a video for their presentation and use an editing app such as iMovie.</p>

PRESENTATIONS AND POST-ASSESSMENT

Lesson Title <i>(Timeframe)</i>	Description / Directions	Objective	Materials	Extensions / Research
Presentations <i>(Time as needed, depending on classroom size)</i>	The students will present their final projects to the class.	The students will be able to demonstrate public speaking and active listening skills.	<ul style="list-style-type: none"> • Research notebook • Project supplies from previous week 	Consider inviting parents, other grade levels, or admin staff to be additional audience members.
Post-Assessment <i>(about 30 mins)</i>	Students will complete the post-assessment to show the change in what they have learned from Week 1 to now.	Assess student knowledge and feelings about the program.	<ul style="list-style-type: none"> • Pre/post Assessment (with answer key) 	Please share pre/post assessment data with the Zoo to help us evaluate and improve our program!

CONSERVATION CAREERS
AND REFLECTION

Lesson Title <i>(Timeframe)</i>	Description / Directions	Objective	Materials	Extensions / Research
<p><u>CASE STUDY</u></p> <p>Phoenix Zoo Conservationists <i>(15 - 20 mins)</i></p>	<p>Show pre-recorded video interviewing current conservation workers in multiple fields and roles.</p>		<ul style="list-style-type: none"> • Video: Week 9 - Conservation Careers • Research notebook 	
<p><u>LEARNING ACTIVITY</u></p> <p>Reflection and Feedback <i>(15 - 20 mins)</i></p>	<p>As time allows, complete the Reflection questions in their research notebook.</p>	<p>The students will be able to reflect on their learning experience.</p>	<ul style="list-style-type: none"> • Research notebook 	<p>Discuss how students can share what they've learned with others.</p>
<p><u>DISCUSSION</u></p> <p>Personal reflection - How has this project impacted you? Has this project impacted what you want to do as a future career? <i>(15 - 20 mins)</i></p>	<p>Conduct a Socratic seminar for students to discuss the question and how they felt about this project. No matter what field of study you're interested in, you can be involved in conservation!</p>	<p>The students will be able to discuss potential future career interests.</p>		



PRE/POST ASSESSMENT ANSWER KEY

1. How excited are you to learn about the conservation of animals and nature?

- a. Very excited
- b. Kind of excited
- c. Neutral
- d. Kind of bored
- e. Very bored

Please mark this answer as correct, regardless of which answer they circle. For the pre-assessment, you can use this information to gauge student motivation and to assign groups and partners. For the post-assessment, we hope to see an increase in excitement from students.

2. Explain one of the common challenges that endangered aquatic life in Arizona face.

Water withdrawal, invasive species, disease, habitat fragmentation

3. Why do conservationists need to identify and communicate with all the interested parties in any conservation effort?

Interested parties (like those in the community) and potential partners can help or hinder any effort depending on how well you communicate and collaborate. Identifying them also ensures that humans will not be negatively impacted by the project. Partnering with others increases resources and the chance of success.

4. Why is genetic diversity so important in managed endangered animal populations?

The healthiest species have genetic diversity. This allows them to adapt to future challenges in their environment and avoid the effects of inbreeding.

5. What monitoring practice would you use to monitor a narrow-headed gartersnake that was released into the wild?

- a. Telemetry
- b. Camera traps
- c. GPS tracking
- d. Catch and release
- e. Acoustic monitoring

would you use that monitoring practice for the snake?

This question could have multiple correct answers, but their response should include a consideration of the snake's size, mobility, and environment.

6. What makes an animal awareness and action campaign successful?

This question could have multiple answers. Here are some things their response should address:

Helping others feel a connection with the animal and understand why they should care

Having a clear, simple action that they can incorporate into their daily life

Addressing how to overcome barriers to be able to help

7. How can you be involved in conservation efforts now and in the future?

This response will be personal for each student based on their daily habits and future career goals.

8. What is the value of human intervention with wild animal populations?

This question could have multiple answers. Here are some things their response could include:

Undoing the actions of humans where changing an environment has caused the problem for the endangered species.

Many species' populations cannot recover on their own without human intervention, so they would face extinction. Human intervention preserves the species for future generations.

Humans gain a better understanding of the animal and its environment, which could inspire inventions and solutions for future problems.

Each species plays an important role in their environment, and often, saving the species means preserving the environment as well.

9. What are some of the negative impacts to consider for human intervention with wild animal populations?

This question could have multiple answers. Here are some things their response could include:

Too much intervention can lead to unnatural behaviors and adaptations.

If wildlife get too used to humans that can be detrimental. If they come to rely on humans for food and other necessities too much, then they cannot survive on their own in the wild.

Human-wildlife conflict.

Marginalizing the humans who call that environment home.

Re-introducing a species can alter the current environment.

10. What do you think about the Phoenix Zoo's conservation programs?

This response will be personal for each student based on their experience and opinion.

Answer these questions only after you've finished the project:

11. How do you feel about the animal you chose for your project? Why?

This response will be personal for each student based on their experience and opinion.

12. How likely are you to do the conservation action that you created as part of your Save a Species plan?

- a. Very likely
- b. Likely
- c. Neutral
- d. Unlikely
- e. Very unlikely

Why?

Please mark this answer as correct, regardless of which number they circle, as long as they have explained their reasoning why.

SOCRATIC SEMINAR RUBRIC

5 Expectations for the Seminar:

1. Always speak respectfully. There will be no insults.
2. Don't raise your hand. Just wait patiently for a moment when you can speak.
3. Apologize if you interrupt someone.
4. It's ok to say if you are confused or need to ask someone to repeat something.
5. Listen carefully.

4 Exceeds	3 Proficient/Meets	2 Approaching	1 Falls Far Below
<ul style="list-style-type: none"> • All criteria in the Proficient category has been met • More advanced work was included (more detail, a different example than what was in the article or video, etc.) 	<ul style="list-style-type: none"> • Paraphrases/connects to another student's comment • Response has a main idea • Response contains logical reasoning • Uses vocabulary words correctly • Student speaks loudly and clearly • Student's behavior demonstrates respect for others 	<ul style="list-style-type: none"> • Response is missing 1-2 elements from proficient criteria 	<ul style="list-style-type: none"> • Response is missing more than 2 elements from proficient criteria

DEBATE SCORECARD

	1 point	2 points	3 points	4 points	5 points	6 points
Opening Statement (up to 5 pts)	No preparation demonstrated Main idea is unclear Audience struggles to hear or understand	Main idea is unclear Audience struggles to hear or understand	Main idea needs some clarification Demonstrates good speaking skills with some prompting	Clear main idea Demonstrates good speaking skills	Demonstrates good speaking skills Clear main idea Compelling “hook” to engage audience	
Arguments (up to 6 pts)	No preparation demonstrated Arguments are unclear and do not include evidence Audience struggles to hear or understand	Arguments are clear but no evidence is used Audience struggles to hear or understand	Arguments need some clarification but most have evidence or reasoning Demonstrates good speaking skills with some prompting	2 clear arguments with evidence and reasoning Demonstrates good speaking skills	3 clear arguments with evidence and reasoning Demonstrates good speaking skills	3 clear arguments with multiple evidence and reasoning provided Demonstrates good speaking skills
Rebuttals (up to 6 pts)	No preparation demonstrated Arguments are unclear and do not include evidence Audience struggles to hear or understand	Arguments are clear but no evidence is used Audience struggles to hear or understand	Arguments need some clarification but most have evidence or reasoning Demonstrates good speaking skills with some prompting	2 clear arguments with evidence and reasoning Demonstrates good speaking skills	3 clear arguments with evidence and reasoning Demonstrates good speaking skills	3 clear arguments with multiple evidence and reasoning provided Demonstrates good speaking skills
Closing Statement (up to 5 pts)	No preparation demonstrated Arguments are unclear and do not include evidence Audience struggles to hear or understand	Main idea is unclear Audience struggles to hear or understand	Arguments need some clarification but most have evidence or reasoning Demonstrates good speaking skills with some prompting	Clear main idea Demonstrates good speaking skills	Demonstrates good speaking skills Clear main idea Compelling ending to resolve	
Deductions						
Total Score & Feedback						

FINAL SAVE A SPECIES RUBRIC

	4 Exceeds	3 Proficient/Meets	2 Approaching	1 Falls Far Below
TEAMWORK	The team worked together well and was able to resolve any conflicts that arose successfully on their own.	The team worked together well to complete their project: <ul style="list-style-type: none"> • Everyone contributed equally • Everyone stayed on task • Everyone spoke to one another with respect 	The team worked together well for most of the project or with only a few problems that needed teacher intervention.	The team could not work together and had to be separated.
PROJECT MASTERY OF CONTENT	The final project includes all 5 elements and demonstrates a creative approach to saving an endangered species	The final project includes all 5 elements: <ul style="list-style-type: none"> • endangered animal and its importance • challenges & solutions • release considerations • monitoring methods • awareness campaign 	The final project is missing one element or has some inaccuracies that interfere with understanding the overall project.	The final project is missing multiple elements or has many inaccuracies that interfere with understanding the overall project.
PRESENTATION & VISUAL	The presentation clearly communicated mastery of content in all 5 elements. The visual was creative, detailed, organized and easy to understand.	The presentation clearly communicated mastery of content in all 5 elements. The visual was organized and easy to understand.	The presentation clearly communicated mastery of content in 4 elements. The visual was mostly organized and easy to understand with some clarification from the group.	The presentation did not clearly communicate mastery of content and was missing multiple elements. The visual was not organized and was difficult to understand.
SPEECH & LANGUAGE	The presenters spoke loudly and clearly enough for everyone to understand with an engaging tone of voice and body language. The presenters used vocabulary correctly.	The presenters spoke loudly and clearly enough for everyone to understand. The presenters used vocabulary correctly.	The presenters mostly spoke loudly and clearly enough for everyone to understand. May have needed a reminder or prompt. The presenters used most vocabulary correctly.	The presenters did not speak loudly and clearly enough for everyone to understand despite a reminder or prompt. The presenters used vocabulary incorrectly to the point where it interfered with understanding the topic.
RESPECT	The student showed active listening skills and had feedback for other groups.	The student showed active listening skills during the presentations and throughout the project.	The student interrupted, wasn't paying attention or spoke disrespectfully, but corrected the behavior after a reminder.	The student did not listen to other groups or spoke disrespectfully throughout the project despite a reminder of expectations.