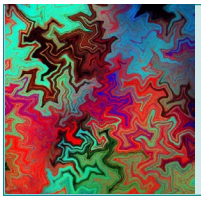

HOW TO USE THIS RESOURCE

The image for this resource shows a wildlife overpass crossing a major highway, which can serve as a phenomenon to explore the key concepts described below.

The pedagogical practice of using phenomena to provide a context for understanding science concepts and topics is an implementation practice supported by the Next Generation Science Standards (NGSS). Phenomena are observable occurrences that students can use to generate science questions for further investigation or to design solutions to problems that drive learning. In this way, phenomena connect learning with what is happening in the world while providing students with the opportunity to apply knowledge while they are building it.

The "Implementation Suggestions" and "Teaching Tips" sections provide options for incorporating the image into a curriculum or unit of study and can be modified to use as a standalone activity or to supplement an existing lesson. The "Student Handout" includes reproductions of the image and the "Background Information" and "Extension Information" sections.

Additional information related to pedagogy and implementation can be found on this resource's webpage, including suggested audience, estimated time, and curriculum connections.

KEY CONCEPTS

- Many human activities decrease the size and connectedness of natural habitats.
- Connecting habitats — for example, by using wildlife overpasses — can increase the overall area available to wildlife, which increases the number of species that these habitats can support.
- Graphs can be used to represent and visualize patterns in nature.

BACKGROUND INFORMATION

The image shows a **wildlife overpass**, a bridge that allows wildlife to move safely over a road, in the Rocky Mountains near Calgary, Alberta. The road in the image is part of the Trans-Canada Highway, one of the longest highways in the world.

Many animals cannot easily cross roads or are hit by cars while crossing. By limiting how far wildlife can move, roads and other humanmade structures may **fragment**, or break, larger habitats into smaller ones. Wildlife in smaller habitats may have a harder time finding food, mates, living space, and other important resources.

A wildlife overpass is one way to reconnect fragmented habitats. By providing a safe path above a road, it allows animals to move freely between habitats on both sides, thereby expanding the overall area in which wildlife can live.

IMPLEMENTATION SUGGESTIONS

The following suggestions outline several options for incorporating the image into a unit of study as a phenomenon:

Engagement, establishing prior knowledge, and providing context:

- Begin the lesson by telling students that they will be examining a photograph taken on the Trans-Canada Highway (one of the longest highways in the world) in the Rocky Mountains near Calgary, Alberta. (It may be helpful to show them where the Trans-Canada Highway and Calgary are on a map.)
- Show students the image and ask them to make observations using the sentence stems "I notice…", "It reminds me of…", and "I wonder…".
- Use a think-pair-share protocol to have students share their observations and questions about the image. Record class observations, noting when students make similar observations and drawing attention to the range of student-generated questions.
    - Students may observe that:
        - There is a wide, multiple-lane road with mountains in the background.
        - There is a bridge (overpass) over the road, which connects the sides of the road.
        - Plants are growing on the overpass and on the sides of the road.
        - The overpass is not flat like a road for cars would usually be.
        - Some of the plants (like grass) are brown, whereas the trees are green. The trees look like evergreen trees, or "Christmas trees," and appear similar to one another.
        - The mountains in the background are fairly tall. Some parts are covered in trees and other plants, and other parts have either exposed rock or possibly snow.
    - Students may wonder:
        - When was this photograph taken?
        - Why was the bridge built over the road?
        - Why does the bridge have plants growing on it?
        - What crosses over the bridge: humans, animals, or both?
        - Are there other similar bridges over other parts of the road? If so, how many bridges, why were they built, and who paid for them?
        - What kinds of animals live in this area?
        - Do animals ever run across the road? If so, do cars hit them?
        - Are there any animals that can't cross the road?
- Have students read the "Background Information" for the image. As they are reading, they should note which of their questions have been answered and which remain.
- Transition to the "Exploration/Investigation" section by telling students that they'll be investigating some of their initial wonderings by exploring resources related to wildlife overpasses and habitat fragmentation.

Exploration/Investigation:

- Have students watch the short film *From Ants to Grizzlies: A General Rule for Saving Biodiversity* and use the accompanying activity to help them engage with the film. The activity includes questions that students answer before viewing the film to prime their thinking, as well as post viewing questions focused on analyzing graphs and articulating understanding of the film's concepts.
    - Questions 3–6 ask students to interpret a scatterplot with logarithmic scales on both axes. Depending on students' familiarity with logarithmic scales, it may make sense to either focus on the remaining, more qualitative questions, or to provide whole-class instruction about how to interpret logarithmic scales.
    - It may also make sense to substitute other figures or to have different groups of students analyze different graphs. The following Data Point activities use published scientific figures to provide more examples of habitat characteristics that influence the number of species in an area:

  - "Habitat Size Impacts Arthropod Species": This figure is a scatterplot that uses a logarithmic scale on just the *x*-axis. It shows the number of arthropod species in habitats (shrubs) of different sizes, before and after fumigation. It can be compared to the Florida Keys fumigation experiment shown in the film (6:36–7:46).
  - "Habitat Isolation Impacts Arthropod Species": This figure is a scatterplot that also uses a logarithmic scale on just the *x*-axis. It shows how distance from a large "mainland" habitat affects the number of species present in smaller "island" habitats.
  - "Habitat Fragmentation Impacts Arthropod Species": This figure is a bar graph that shows how the number of species in a habitat fragment is affected by the size and degree of isolation of that fragment.
- Question 11 asks students to apply what they've learned from the cases presented in the film to a situation or context familiar to them. It may be helpful to use that question as a summative assessment for this lesson sequence. (Refer to the "Assessment" section below.)

- Continue exploring the factors that determine the number of species in an isolated habitat with the "Exploring Island Biogeography through Data" activity.
  - This activity has two handouts, described below and in the "Educator Materials" for the activity. Both handouts use a jigsaw approach to have students analyze graphs from real studies, three of which are the same as in the Data Points linked above.
  - Select whichever handout is more appropriate for your class. You do *not* need to use both handouts, as they cover the same studies and data.
  - The **"Analyzing Graphical Data"** handout engages students in graph interpretation and sensemaking from data. It may be more appropriate for general biology or introductory courses.
    - Extension Question 4 is very similar to Question 11 from the *From Ants to Grizzlies* film activity mentioned above. Again, it may be helpful to use this question as a summative assessment later.
  - The "**Building the Equilibrium Model"** handout guides students through constructing graphical representations of the dynamic equilibrium model of island biogeography, using immigration and extinction curves to show the effects of island area and isolation. It may be more appropriate for advanced high school or undergraduate courses.
    - Figure 1 in this activity is the same as Figure 1 from the *From Ants to Grizzlies* film activity. You may want to remind students of the connections to the film.
- Have students return to their original set of questions, noting which questions have been answered and which remain. Allow time for students to generate new questions about potential ways to reconnect fragmented habitats or other questions that have arisen during the lesson sequence above.
- Transition to the "Assessment" section by telling students that they will be exploring an example of a habitat local to their own contexts.

Assessment:

- As a culminating assessment, have students answer Question 11 from the *From Ants to Grizzlies* film activity. For this question, they must propose a way to help conserve species in a fragmented habitat they are familiar with (e.g., a local habitat).
  - You may want to present students with a local or relevant example of habitat fragmentation. Or you could have students research examples on their own.
  - If local examples are unavailable, other examples can be used as well. For instance, students could read the Science News article "Big cats in urban jungle: LA mountain lions, Mumbai leopards" and watch the embedded video, which discuss the presence of big cats in urbanized areas.

- Ask students to generate questions that need to be answered to inform their proposals. Student questions may include:
  - How effective are wildlife crossings, such as overpasses, in reconnecting fragmented habitats? What kind of data would you collect to answer this question?
  - What other solutions exist to reconnect fragmented habitats?
  - Who (scientists, community members, etc.) should be consulted in determining the best solutions for how to reconnect fragmented habitats?
- Give students time to select and research a few of their questions — it may be helpful to determine one or two priority questions as a class — and incorporate their answers into their proposed solutions.
- It may be helpful to adapt/use portions of the NGSS "Evidence Statements" for HS-LS2-7 to assess student responses.

Extension:

- Habitat fragmentation can also have indirect effects on nonmobile species, such as plants. Extend students' exploration of this topic with the *Seed Dispersal and Habitat Fragmentation* Scientists at Work video and accompanying "Seed Dispersal in Tropical Forests" activity. Both discuss how reconnecting brown spider monkey habitats in Colombia can increase tropical seed dispersal, which aids in forest regeneration.
- Isolating wildlife populations from one another through habitat fragmentation can lead to increased competition for limited resources, as well as a decrease in genetic diversity (since fewer individuals are able to breed with each other). Students can explore the effects of small, isolated populations on inbreeding through additional resources, such as the Science News article "Big cats in urban jungle: LA mountain lions, Mumbai leopards."

TEACHING TIPS

- Present students with the image first, before they read the background information.
- Encourage students to draw upon their prior experiences and knowledge to interpret the image and generate questions.
- Provide opportunities for students to explore outside sources to promote their independent explorations and discussions.
- Background information may be edited to support student proficiency, course sequence, etc.
- The image may be projected in lieu of handouts.
- Printed images can be laminated for use in multiple classes.
- Pair or group students to work through one or more of the implementation suggestions.

CREDITS

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Image from "Trans Canada Highway wildlife crossing" by Road Travel America, used under public domain