LESSON

How Do You Investigate and Represent Data?

Students analyze the data that Dr. Epps collected from the bighorn sheep droppings.

What We Are Hoping For: Learning Goals

- Nature of Science
  - A-E
- Data Representation
  - A-D

Learning Goals

- How do you?
  - Investigate
  - Use DNA data
  - Represent DNA data

DNA from Droppings discussion

This discussion explores why Dr. Epps collected droppings from all over the bighorn sheep range.

Discussion

Key Idea: Dr. Epps collected DNA from bighorn sheep droppings to compare gene similarity amongst different populations.

Question: Why did Clinton Epps collect droppings from all over the bighorn sheep range? How did these droppings help Dr. Epps test his hypothesis that highways block mating between sheep populations from different mountaintops?

Answer: These droppings allowed Dr. Epps to see if the highways isolated bighorn sheep populations. He was able to compare DNA from populations that were not separated by highways with populations that were separated by highways.

Note: Emphasize that sheep droppings are a good source of DNA for testing. You can discuss with your students sources of DNA for forensic testing in people.

Introducing DNA Datasets discussion

Use the DNA datasets to discuss the necessity of data manipulation and visualization.

a. The students will now analyze the data that Dr. Epps collected from the animal droppings.

b. Distribute the datasets to students that are in groups of three or six and use the datasets to begin the discussion on the representation of DNA data.

c. Allow students time to examine their datasets and maps.

d. Discuss with students different ways scientists visualize data based on the type of data and needs for analysis. They will be using a range of arrows to represent the level of breeding between sheep populations (refer to the datasets for more information) as shown in the DNA study of bighorn sheep. The students will transcribe the arrows onto maps to understand the role of habitat fragmentation by highways in changing mating patterns.

Discussion

Key Idea: Scientists represent data in different ways depending upon the needs fo analysis.

Question: How is the DNA data represented in your datasets?
Answer: Arrows.

Question: What are some other types of data and ways of representing data that scient use?
Answer: Graphs, Drawings, Trees

Analyzing the DNA Datasets discussion

In the slideshow, analyze DNA datasets and overview maps to predict breeding levels between bighorn sheep populations with and without highways.

a. Use the prepared slideshow and datasets to help students learn how to analyze the datasets – particularly the meaning of the arrows and the mountaintop names.

b. The slideshow begins by reminding students of Dr. Epps' test question about how highways might affect bighorn sheep.

c. Using the overview slide, ask students to consider how a highway that runs between two sheep populations might affect their mating habits.

Discussion
Key Idea: Highways cause habitat fragmentation, which may lead to inbreeding.

Question: How would a highway running through two sheep populations affect their mating habits? Look at this overview map. What predictions can you make about the mating habits of bighorn sheep populations?
Answer: Populations that are cut off from each other by roads will not show large levels of interbreeding and vice-versa.

Question: How would a highway that runs through two sheep populations affect their mating habits?
Answer: It would cut the male sheep off from the different populations, which would decrease the level of breeding.

d. On the next slides ask the class to make predictions about the bighorn sheep populations interbreeding, first based on proximity, then accounting for barriers presented by highways.

Discussion
Key Idea: Geographic distance and highways affect breeding between populations..

Question: This is a close up of Cady Mountain. Based only upon geographic distance, with which population would you expect Cady Mountain sheep to show more signs of mating, Granite, Old Dad, or Newberry? Why?
Answer: Newberry, because it is closest to Cady Mountain.

Question: If highways block bighorn sheep breeding, which population would you expect Cady Mountain sheep to show the LEAST signs of mating, Granite, Old Dad, or Newberry? Why?
Answer: Newberry Mountain, because it is separated from Cady Mountain by a highway, which isolates the populations from each other.

Instructions on How to Analyze the DNA Datasets

Use the slide show to work through how to use the genetic breeding data to understand the role of highways in bighorn sheep mating.

Tell the students to refer back to their datasets and use the data and the maps to analyze how highways impact bighorn sheep. Each group should receive 6 maps with data and instructions:

1. Cady Mountain
2. Eagle Buzzard Spring Mountain
3. Hackberry Mountain
4. Indian Spring Mountain
5. Marble Mountain
6. San Gorgonio Mountain

Use the first slide to introduce the instructions.

Instructions

1. Use a metric ruler to measure the minimum distance in millimeters between mountaintops.
   Purpose: To give students a baseline for which populations SHOULD have the highest levels of breeding without the impact of the highway.

2. Draw double-headed arrows between populations to signify the level of breeding between populations. More arrows show more connection, i.e. more breeding; fewer arrows show less connection, i.e. less breeding.
   Purpose: To see the genetic data in a visual manner. Populations that share (i.e. mate frequently) a lot of genetic information will have more arrows connecting them than populations that do not mate frequently.

3. Compare your results from step 1 and step 2 and use them to predict where the highways are located. Draw the highways onto the map.
   Purpose: Students will predict that the closest populations share the most genetic information (step 1). However, the genetic data (step 2) tell a different story. They show that nearby populations with a highway between them share less genetic information (i.e. mate less frequently) than nearby populations without highways between them.

The next three slides show the three step instructions overlaid onto the Cady Mountain example.

The final slide is an overview map of the area without highways. When student groups complete their work, they should transfer their data and highways onto the overview map.