Anecdotes: Straight from the Classroom

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Different audiences require different tactics:

Biology 116 – Natural History

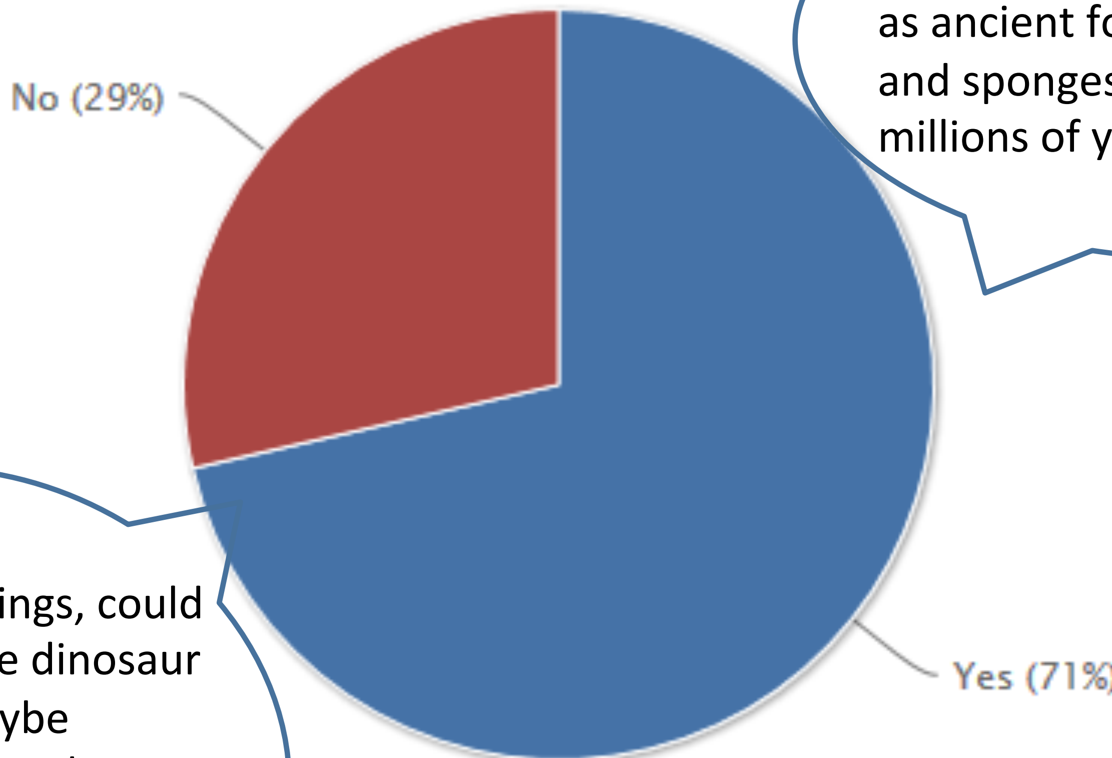
Non-majors class; functions as option for science 'credit'

Surveys at the beginning and end of the semester

Biology 197 – Principles of Modern Biology II

Biology majors class; mostly pre-meds

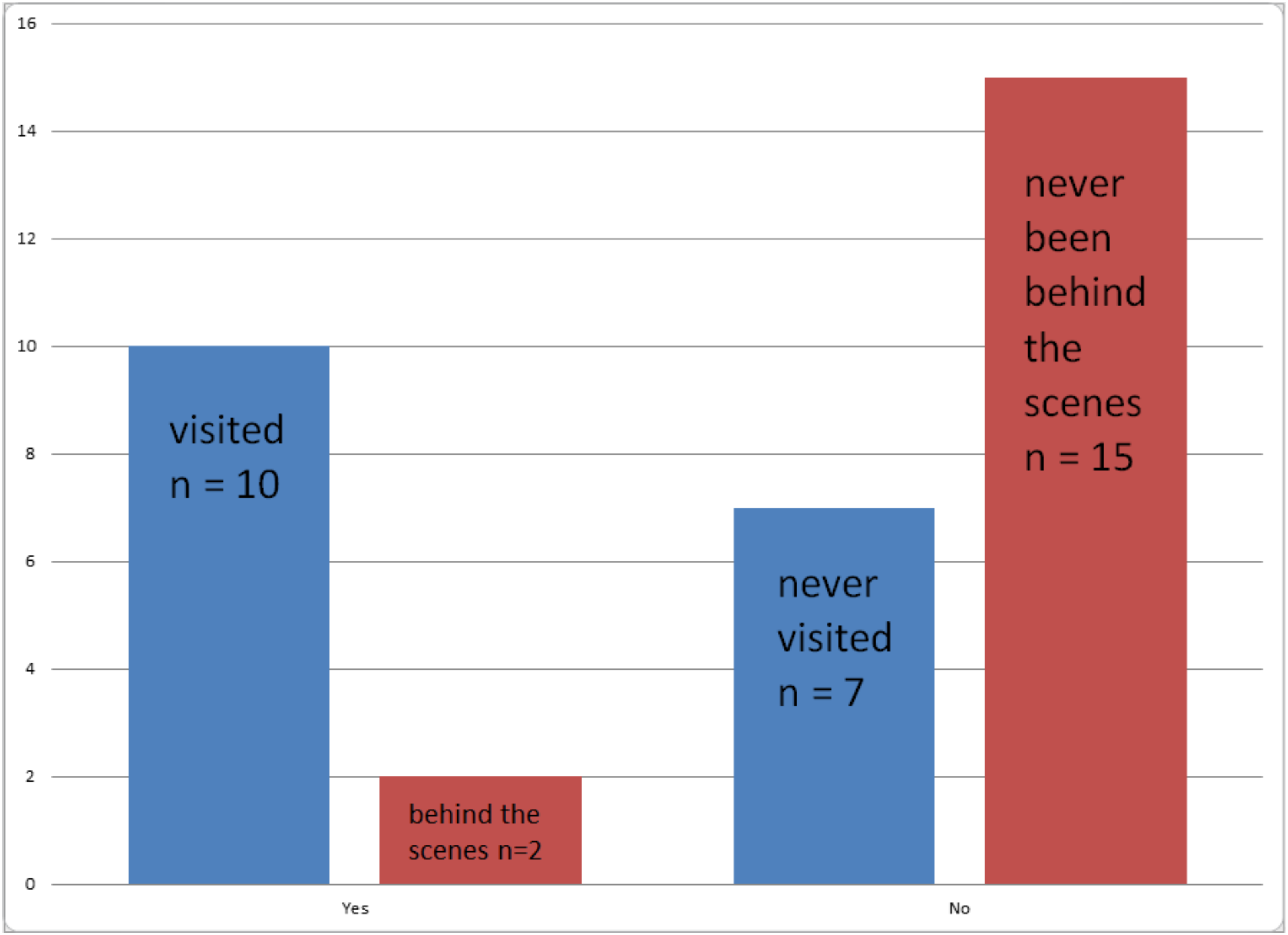
Do you know what is in a natural history collection or museum?



"Many different things such as ancient fossils, animals and sponges and from millions of years ago."

"Important things, could be for example dinosaur fossils. Or maybe collections from the titanic, etc."

Museum visitation by 17 Natural History students (non-science majors)



In what ways do you think natural history collections are (or could be) important to undergraduate education?

"The importance of the world around us is essential for our survival on Earth. I do not know what else could be more important."

"I personally think they're important for every level of education, because they raise awareness and concern (as well as general knowledge) about the planet we live on and just how amazing it is. Natural History is vastly unappreciated by the majority of people."

AIM-UP
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CO-EVOLUTION: Art + Biology Modules

The Spring 2012 AIM-UP! Seminar course was an exciting collaboration with the Art and Ecology program at the University of New Mexico. This seminar course resulted in several Dispersion Modules created by biology and art students. The Dispersion Modules are available as ebooks on the CO-EVOLUTION site. Below are hyper links to the pages for each of the 5 modules.

As with the other modules available from AIM-UP!, we ask that if you use these ebooks you provide us with feedback, the form is attached on this page.

CO-EVOLUTION site

CO-EVOLUTION Dispersion Modules

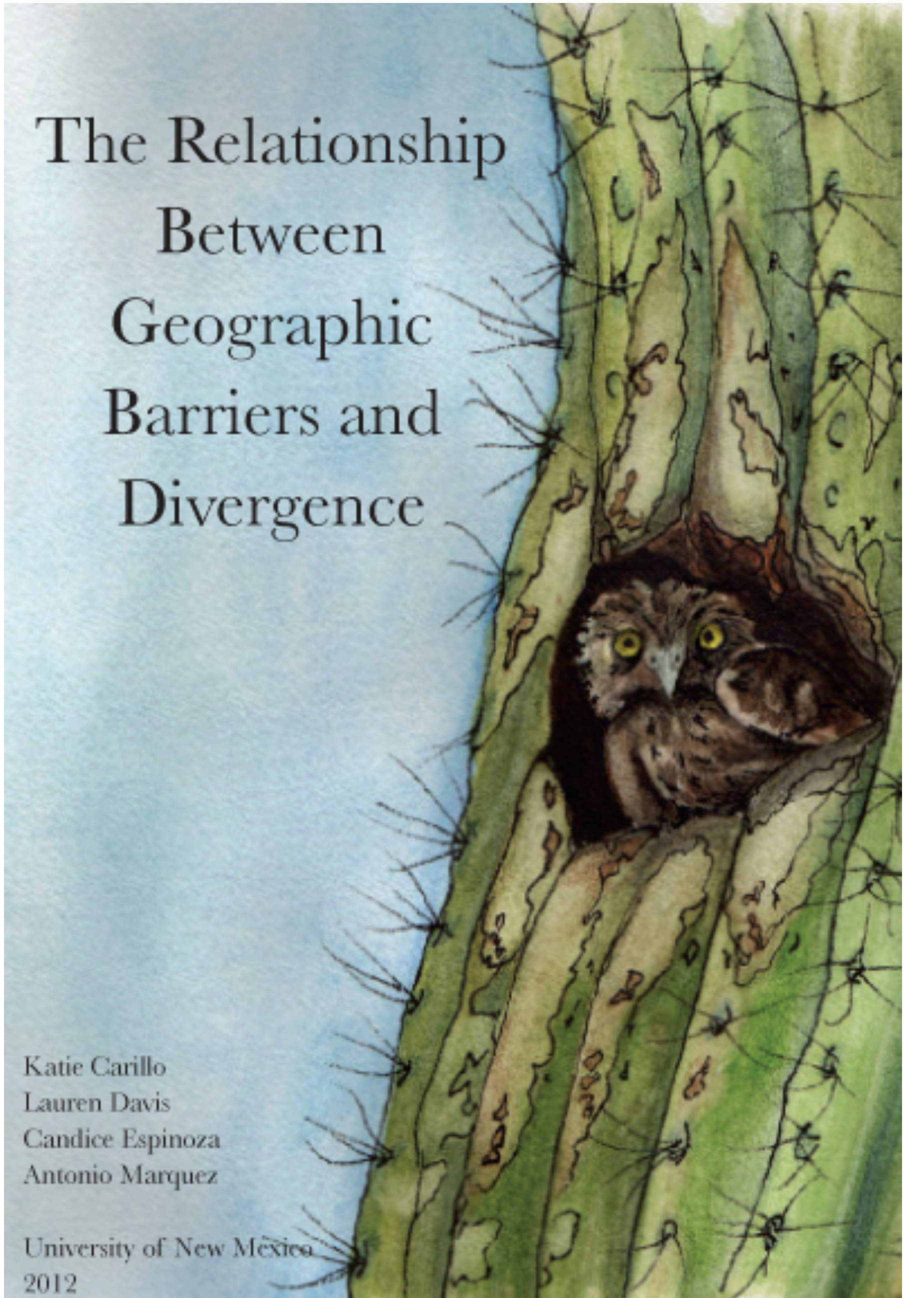
The Relationship between Geographic Barriers and Divergence

The Rock Pocket Mouse, Adaptation by Natural Selection

Specialized Plant Pollination Systems

Using Natural History Collections and Art to Communicate about Climate Change

Ornithological Geographic Variation



Module completed by 2 different classes:

Non-science majors (Natural History)

Biology majors (Principles Modern Biol. II)

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Introduction to Barrier Driven Divergence

There are two populations of Abert's squirrels (*Sciurus aberti*) that currently live in the area surrounding the Grand Canyon in Arizona. The squirrel populations share common ancestors but have long been separated by the Grand Canyon, and divergence has begun to occur producing two different subspecies, *Sciurus aberti kaibabensis* and *Sciurus aberti aberti.*

Activity 1: Related Squirrel Subspecies in the Grand Canyon Area

1. Go to the Arctos database (http://arctos.database.museum/home.cfm) and click on the Museum of Southwestern Biology link.

2. Type in *Sciurus aberti kaibabensis* in the Identification and Taxonomy box.

3. Type Arizona in the Locality box.

4. When the specimen list pops up, click on the button at the top that says Berkeley Mapper & Rangemap. It will open a new page and show a map of this subspecies range. What is the range of this species?

5. Go back to Arctos and choose specimen 191256 from the Grand Canyon National Park.

6. When was the specimen collected?

7. What body parts were retained?

8. What sex was the specimen?

9. Copy the coordinates at which the specimen was collected and paste them in Google Earth http://www.google.com/earth/index.html

10. Go to GenBank http://www.ncbi.nlm.nih.gov/genbank/. Select Taxonomy from the drop box and type *Sciurus aberti kaibabensis*. In the right hand corner there is a box which has nucleotide and protein sequences. Click on the number two in the box next to nucleotide. Choose Mitochondrial cytochrome b. Go to the bottom and look at the nucleotide sequence. Leave this page open.

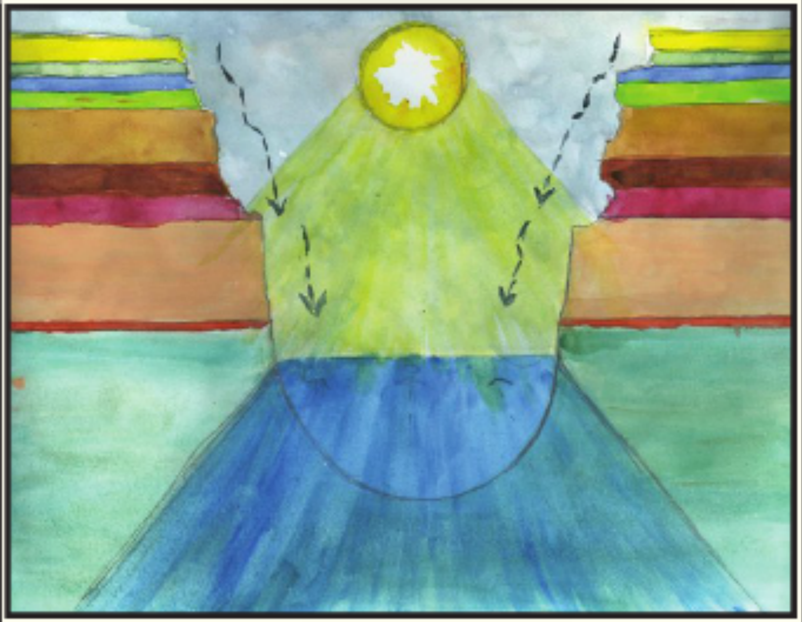
11. Go back to Arctos and type in *Sciurus aberti aberti.*

12. Choose specimen 191249.

13. Answer questions 4, and 6-10.

14. Compare the DNA sequences for Mitochondrial cytochrome b for the two subspecies. Are there differences? Hint: Look very carefully at segment starting with nucleotide 101, and 171. (note: nucleotide 104 and 176 are not the same in the two subspecies). Are there other nucleotide differences?

The Grand Canyon as a Geographic Barrier



The Grand Canyon is 227 miles long, 18 miles wide, and 6000 feet deep. It was carved out by the Colorado River over 17 million years ago and *Sciurus aberti aberti* has long been a resident of the Grand Canyon area.

Sciurus aberti kaibabensis lived in Ponderosa forests on the Kaibab plateau when the climate was warmer and the Ponderosa's were limited in range. The squirrels were isolated from other populations of Abert's squirrels due to discontinuation of Ponderosa pine habitat, and divergence began.

When the climate started to cool again the range of *Sciurus aberti kaibabensis* expanded back down to the edge of the Grand Canyon with the Ponderosa forests.

...Have the squirrels been separated for 17 million years?

Types of Barriers

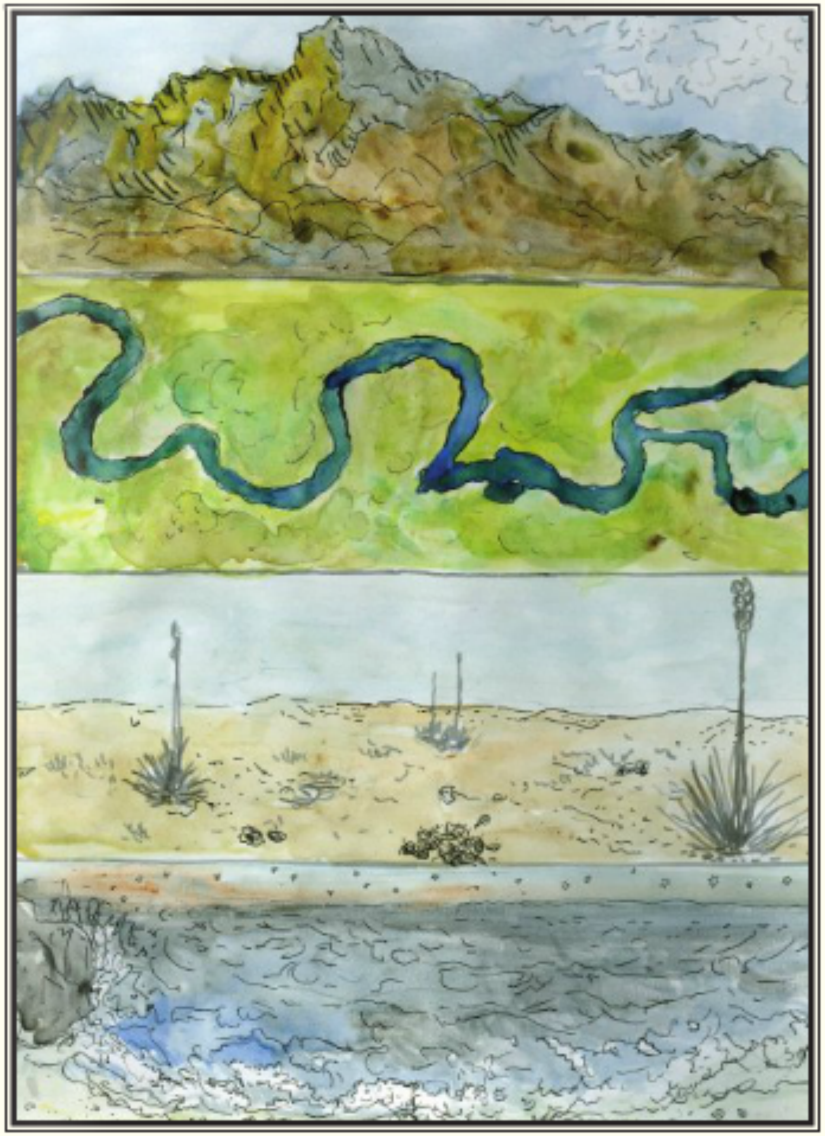
The Grand Canyon is an example of a geographic barrier that caused the divergence of Abert's squirrels into two subspecies. However, canyons are not the only forms of geographic barriers. Other naturally formed barriers include:

Mountains
Rivers
Oceans
Deserts

Human made structures can also act as barriers, such as:

Walls
Highways
Dams

.... Can you think of others?



Crossing Barriers

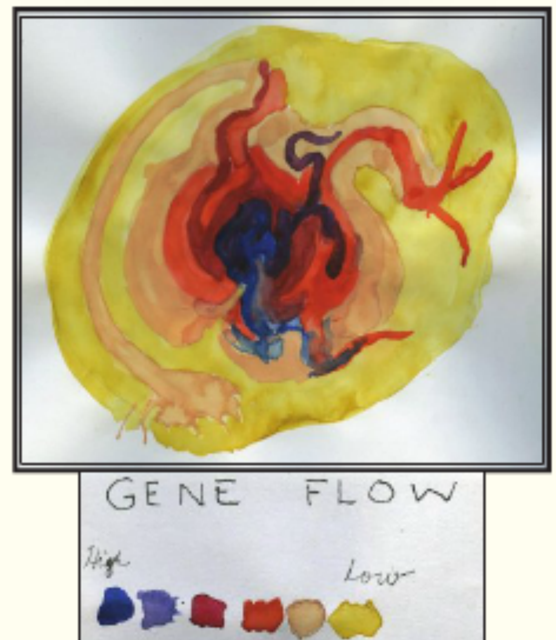
A species' habitat and level of mobility determines what barriers that species can cross. A mountain range may create a barrier for a mouse, but there are geese that can fly over the Himalayas. A camel can cross a desert, a fish cannot. The oceans create a barrier for most terrestrial birds and mammals, but a whale can swim from one ocean to another. Other factors that may contribute to mobility include: ability/inability to fly high off the ground or long distances, and resource availability. Biologists need to know the natural history of a species to understand the impact of barriers on divergence.

Gene Flow

Gene flow is the transfer of genes from one population to another population. An important factor that affects the rate of gene flow between two populations is mobility.

Greater mobility gives rise to increased migratory potential, and migration into or out of a population may be responsible for changes in allele frequency and/or the addition of new genetic variants.

Maintained gene flow between two populations reduces divergence between the groups by admixing the two gene pools. On the other hand, absence of gene flow between two populations can increase genetic divergence by allowing them to change independently. Ultimately divergence can lead to speciation.

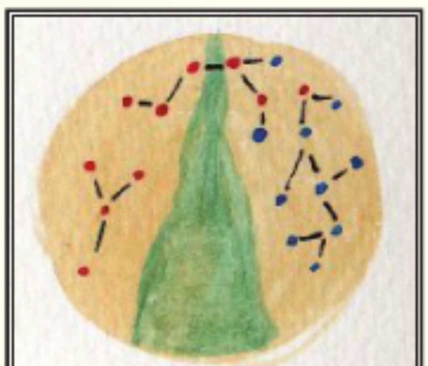


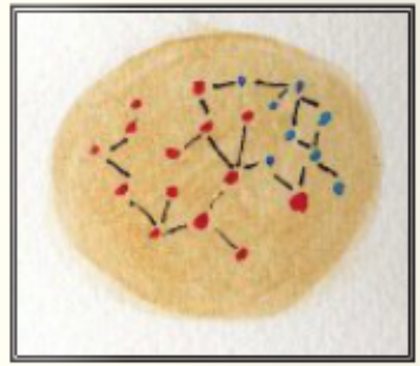
Modes of Speciation

There are four primary modes of speciation: allopatric speciation, parapatric speciation, peripatric speciation, and sympatric speciation.

Allopatric speciation occurs when biological populations of the same species are physically isolated by a geographic barrier.

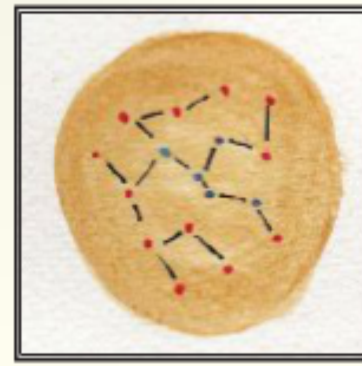
Parapatric speciation takes place when the ranges of two same species populations are immediately adjacent to each other often forming a contact zone.





Peripatric speciation occurs when a small population is isolated at the edge of a larger population of the same species.

Sympatric speciation is the process through which new species evolve from a single ancestral population while occupying the same geographic area.



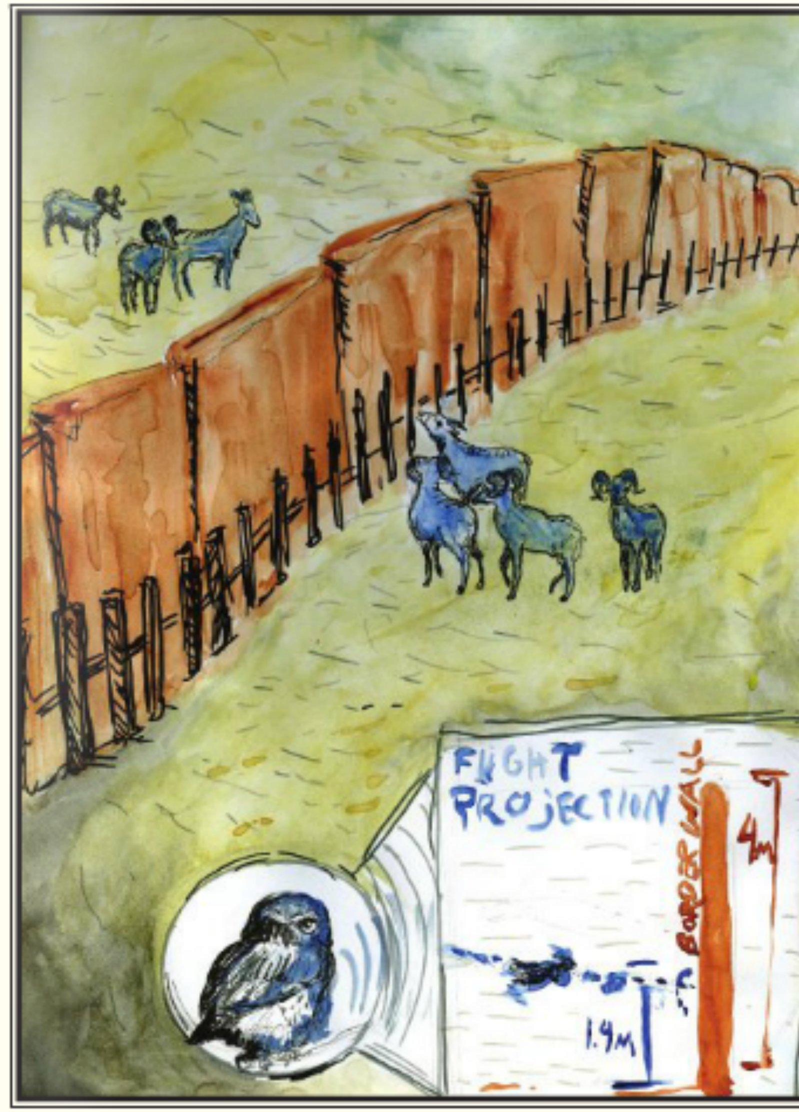
...Divergence could possibly lead to what mode of speciation between *Sciurus aberti kaibabensis* and *Sciurus aberti aberti* squirrels?

Potential Effects of a Man-made Barrier on Wildlife

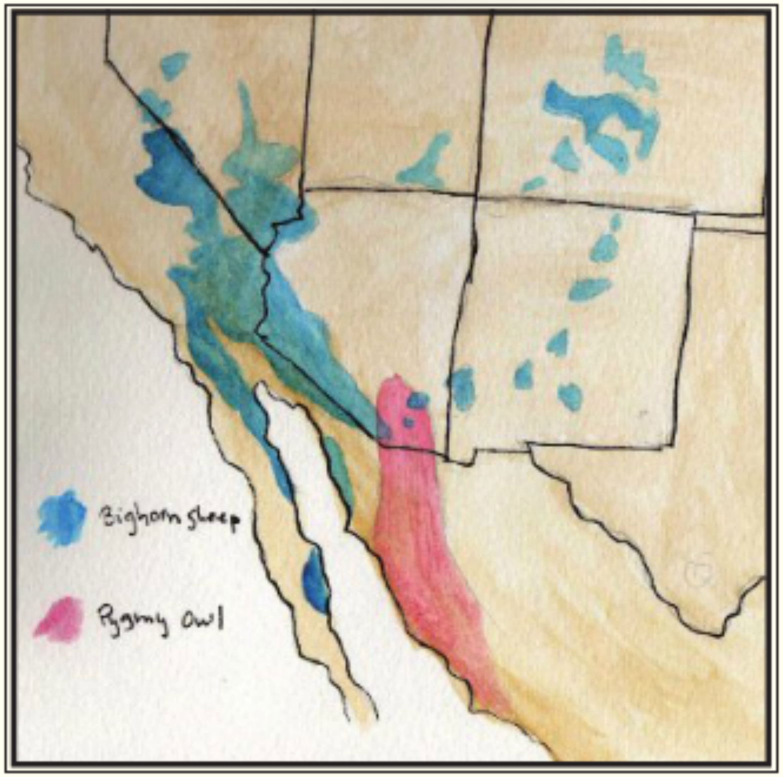
There is currently a 1125-km security fence under construction in United States spanning more than one-third of the U.S.–Mexico border. The fence reaches heights greater than 4 meters and is the cause of large vegetation clearings. The combination of the height of the wall and the large spans of cleared land could greatly impact the movement of wildlife species living in these habitats. Animal movements determine distribution, abundance, and gene flow. Many animal populations will be affected by the construction of U.S. border wall; two of the animals that may be affected are the pygmy-owls and bighorn sheep.

Pygmy-Owls are small nocturnal owls that have an average flight height of only 1.4 meters above ground, therefore they will not be able to fly over the wall nor cross large vegetation gaps.

Bighorn Sheep often form small and fragmented populations making connectivity between the population important. There are currently nine populations of bighorn sheep in northwestern Sonora that are linked by dispersal with those in bordering Arizona. Populations on either side of the wall may become isolated if corridors are disrupted by impermeable fencing.



Activity 2:
Big Horned Sheep and Pygmy Owls



1. Using Arctos, Berkeley mapper, Google Earth, and GenBank examine Ferruginous Pygmy Owl species *Glaucidium brasilianum*, specimens MVZ Birds 166038 and MVZ Egg/Nest 8735.

2. And Big Horned sheep species *Ovis canadensis nelsoni*, Specimens MVZ Mammals 188068, 33619, and 4751.

3. Answer the following questions:

   a. What will limit these two species if the border wall is built across their range?

   b. What will be the result of isolation of different populations? Is it likely that divergence and ultimately speciation will occur?

   c. What type of speciation would it be if it occurred? Would it be the same type of speciation for both species?

Survey Says…

Q18 SINGLE-SELECT MATRIX

As a result of your work on the Relationship between Geographic Barriers and Divergence educational module, what gains did you make in your understanding of each of the following?

	No gains	A little gain	Moderate gain	Good gain	Great gain	Not applicable	Total
The scientific process	0 0%	0 0%	0 0%	4 80%	1 20%	0 0%	5
Geographic barriers	0 0%	0 0%	1 20%	3 60%	1 20%	0 0%	5
Modes of speciation	0 0%	0 0%	0 0%	3 60%	2 40%	0 0%	5
Total	**0**	**0**	**1**	**10**	**4**	**0**	**15**

Survey Says…

Q19 SINGLE-SELECT MATRIX

As a result of your work on the Relationship between Geographic Barriers and Divergence educational module, what gains did you make in each of the following skills?

	No gains	A little gain	Moderate gain	Good gain	Great gain	Not applicable	Total
Accessing on-line databases	0 0%	1 20%	1 20%	2 40%	1 20%	0 0%	5
Using on-line databases	0 0%	0 0%	2 40%	2 40%	1 20%	0 0%	5
Identifying patterns in data	0 0%	0 0%	2 40%	2 40%	1 20%	0 0%	5
Assessing value of on-line data	0 0%	0 0%	3 60%	1 20%	1 20%	0 0%	5
Analyzing data	0 0%	0 0%	2 40%	2 40%	1 20%	0 0%	5
Total	**0**	**1**	**10**	**9**	**5**	**0**	**25**

Survey Says…

Q20 SINGLE-SELECT MATRIX

As a result of working on the Relationship between Geographic Barriers and Divergence educational module, what gains did you make in the following?

	No gain	A little gain	Moderate gain	Good gain	Great gain	Not applicable	Total
Enthusiasm for natural history	0 0%	0 0%	1 20%	3 60%	1 20%	0 0%	5
Interest in taking or planning to take additional classes in this subject	0 0%	1 20%	2 40%	2 40%	0 0%	0 0%	5
Confidence that you understand the material	0 0%	0 0%	1 20%	2 40%	2 40%	0 0%	5
Your comfort level in working with complex ideas	0 0%	0 0%	2 40%	2 40%	1 20%	0 0%	5
Your willingness to seek help from others (teacher, peers) when working on academic problems	0 0%	0 0%	1 20%	2 40%	2 40%	0 0%	5
Total	**0**	**1**	**7**	**11**	**6**	**0**	**25**

University of Alaska **Fairbanks**

LESSON PLAN: **Range and Distribution**

Laura Conner (Research Assistant Prof., ESTES, ldconner@alaska.edu)
Steffi Ickert-Bond (Associate Prof., Dept. Biology & Wildlife, smickertbond@alaska.edu)

Overview
In this activity, students will explore the effects of geography and other abiotic factors on plant range and distribution.

Objectives
The student will:

- Compare ranges of three different plant species;
- Examine temperature, precipitation, and elevation maps of Alaska; and
- Explain what abiotic factors are responsible for plant ranges.

Materials
Access to ARCTOS herbarium database (http://arctos.database.museum/SpecimenSearch.cfm)
Student Worksheet: "Range and Distribution"
Handouts: Elevation map (http://www2.gi.alaska.edu/river_ice/geog_general1.html or similar map), Temperature map (http://www.nps.gov/dena/naturescience/climate-change.htm mean January temperatures), Precipitation map (http://www.climatesource.com/map_gallery.html#ak)

Directions

1. Navigate to this site: http://arctos.database.museum/SpecimenSearch.cfm

2. In the "Identification and Taxonomy" Field, enter the name of the first species, "*Smelowskia media*," then hit "Search."

3. Click on one of the entries in the "Cat Num" column. Look in the lower right hand corner for an image of this plant. Click on the picture (image/jpg) to enlarge it.

4. Describe the plant. Is it short? tall? A tree? An herb? What do the leaves look like? Are they smooth? Hairy? Light? Dark? Enter your answers in the data table below.

5. Click the "back" button on your browser to go back to the original list of specimens. Click the "Berkeley mapper" button.

6. Switch to "Terrain" view on the computer map. Print out the map. Describe the plant RANGE. Does this species appear all over Alaska, or just in a particular area or areas? If so, which areas? Does the plant range align with any geographic features (mountains, rivers, etc.)? Enter your answers in the data table below.

7. Repeat this procedure for the two other species, "*Malus fusca*" and "*Cryptogramma stelleri*."

8. Examine the 3 maps given to you by your teacher. They represent elevation, temperature, and precipitation across Alaska. Compare your printed plant range maps with these maps. Describe the temperature, precipitation, and elevation of each species' RANGE on your data table.

9. Which factors best explain the distribution of each of these three plant species?

10. How might the morphology (physical characteristics) of these plants be related to the characteristics of their range (e.g., temperature, precipitation, and/or elevation)?

Species	**Description**	**Range**	**Temp/precip/elev**
Smelowskia media			
Malus fusca			
Cryptogramma stelleri			

Do you have any additional comments on using on-line natural history databases?

- "The databases were incredibly glitchy and got confusing very quickly to many if they didn't know how to clear their browser cache after each individual search"

- "Very inconvenient unless using Firefox, and that kind of specific browser exclusion proved frustrating"

- "The data itself (once accessible through much struggle) was interesting and informative"

Undergraduate students without access to natural history collections need a ‘helping hand’ to get started.

If they are provided sufficient assistance, they benefit greatly from the exposure to these resources.

Optional does not occur – make them DO something!