GENETIC DIVERSITY AND FRAGMENTATION (Part II)

GRADE Grade 9

PART 2 of 3

TOPICS Biodiversity, conservation, habitat, fragmentation, connectivity

CURRICULAR CONNECTIONS

Grade 9 Science

Unit A – Biological Diversity

2. Investigate the nature of reproductive processes and their role in transmitting species characteristics
   - Identify examples of dominant and recessive characteristics and recognize that dominance and recessiveness provide only a partial explanation for the variation of characteristics in offspring
4. Identify impacts of human action on species survival and variation within species, and analyze related issues for personal and public decision making.
   - Describe ongoing changes in biological diversity through extinction and extirpation of native species, and investigate the role of environmental factors in causing these changes
   - Evaluate the success and limitations of various local and global strategies for minimizing loss of species diversity

OVERVIEW

Following an investigation of biodiversity and more specifically genetic diversity in Part I, students will begin to look at some of the mechanisms that may threaten biodiversity within the Bow Valley. The focus of this lesson will be on the grizzly bear, a keystone species which has been at the forefront of research efforts and conservation interventions for many decades. Finally students will get to imagine what it takes for a grizzly bear to navigate this complex landscape through an interactive game.

OBJECTIVES

- Students will understand how habitat fragmentation impacts grizzly bears and other wildlife species
- Students will be able to explain the importance of wildlife corridors
- Students will explore considerations for designating effective wildlife corridors

KEY TERMS

- **Fragmentation** – the process during which a large expanse of habitat is transformed into a number of smaller habitat patches that are isolated from one another
- **Habitat connectivity** – the degree to which separate habitat patches are connected
- **Habitat patch** – a discrete area with a definite shape that is used by a species for breeding or obtaining other resources
- **Keystone species** – a species on which other species in an ecosystem largely depend, such that if it were removed the ecosystem would change drastically
- **Wildlife corridor** – physical links that connect two or more large areas of a similar habitat

GUIDING QUESTIONS

- What are some of the major barriers to wildlife movement in the Bow Valley?
- How are animals able to overcome the barriers that you identified?

BACKGROUND ESSAY

Imagine that you are a grizzly bear living in the Canadian Rocky Mountain Parks, a massive 23 600 km^2 network of protected areas. Your territory spans two provinces, seven national and provincial parks, and three numbered Treaties (Treaty 6, 7 and 8). The rugged mountain peaks, vibrant green forests, alpine meadows, glaciers and turquoise lakes supply all the food, water, shelter and space necessary for you to survive and thrive. This space is crucial, because the home range of a grizzly bear in the Central Rockies can be up to 200-500 km^2 for females and an enormous 1000-2000 km^2 for males.

However instead of the huge expanse of comparatively undeveloped wilderness that your relatives once knew, your home now looks more like a collection of much smaller islands of habitat. These habitat "islands" are also called **habitat patches**. Your ability to travel between them has been compromised by a virtually impassible network of roads, fences, settlements, trails and railway tracks, making it very challenging for you to acquire the resources that you need to survive. The process during which a large expanse of habitat is broken up into smaller, isolated habitat patches is called **fragmentation**. As the remaining habitat patches become smaller, they are likely to support smaller populations. As we learned in Part I, the likelihood of inbreeding depression is higher among smaller, more isolated populations.

Highways act as barriers to wildlife movement directly through vehicle-wildlife collisions or indirectly by wildlife avoiding these areas, thus preventing interaction between different populations. In addition to the added difficulty of acquiring seasonal food resources, roads, railways and towns restrict the ability of bears to find mates and access breeding opportunities. This in turn can lead to decreased genetic diversity, which can have massive repercussions for the population as a whole.

DURATION 10-15 minutes

MATERIALS

- Whiteboard & projector
- Scrap paper
- Writing utensils
- Post-It® Notes

ACTIVITY – QUESTION FORMULATION

This activity is designed to get students to start thinking critically about the topic. Asking good questions is a key part of scientific inquiry, participation in democracy, advocating for oneself and community and holding elected officers accountable.

1. Divide the students into groups of 3 or 4. Explain to students that you will be showing them an image or phrase related to the topic (e.g. an image of a bear trying to cross a road).

2. Explain the rules of the activity:
    a. Ask as many questions as you can
    b. Do not stop to discuss, judge, or answer the questions
    c. Write down every question exactly as it is stated
    d. Change any statement into a question

3. Once the students have had ample time to ask questions, tell them to stop. Tell the group to select the question(s) that they consider the most important, that they would most like to learn about, or would be the most helpful for finding a solution to a problem. Students can circle, underline, or write their chosen questions on a Post It note.

4. Ask the groups to share these questions with the group. As an extension, task the groups with organizing their questions together based on similarities. You may choose to revisit these

questions later on and ask students how they could turn their questions into scientific research questions.

Source: The Right Question Institute (RQI). The Question Formulation Technique (QFT) was created by RQI. Visit www.rightquestion.org for more information and free resources.

KEEP WATCHING

"Living with Wildlife" (Run Time – 23:18) is the story of how communities in the Bow Valley have come together over the past 20 years to live with grizzly bears and other wildlife. vimeo.com/214597705.

BACKGROUND ESSAY

Bears have been extensively studied as they are considered to be a **keystone species**. The loss of carnivores from the landscape can result in far reaching impacts across the food chain, and these megafauna are susceptible around the world to population declines owing to human causes. Bears have low population densities and low reproductive rates to begin with, as well as large territorial requirements. In the Bow Valley, research has found little evidence of female movement across human settlement and transportation corridors. Female movement is most restricted by these corridors, while male movement appears to be reduced in some areas.

Not only do wildlife need to move from habitat patch to habitat patch in order to find mates and exchange genetic information, but they also need to access land for food and other needs. Wildlife tend to move along similar pathways. These pathways are called **wildlife corridors**. In towns like Canmore, the best corridors for wildlife are already often taken up by development which competes for the flat areas in the valley bottoms which are preferred by wildlife. Developing communities, especially those which are constrained by topography as is the case in the Bow Valley, must take wildlife corridors into effect in their design if they are to maintain ecosystem function and minimize human-wildlife conflict. They must take into account not just how much land will be set aside for wildlife corridors, but also where and what type of land is being set aside.

The pressing need for wildlife corridors is only expected to increase over time as climate change forces species to move from their present-day ranges to new, more favourable habitats. A key consideration in our efforts to maintain habitat connectivity must be to build more climate resilient landscapes. In Part III, we will look at some strategies for protecting biodiversity and maintaining habitat connectivity in landscapes that have already been fragmented.

DURATION 20-25 minutes

MATERIALS

- Pylons (optional)
- Coloured cards, x4 different colours
- Sheet
- Rope x2 or 3
- Plank of wood

ACTIVITY – BEARS OF BANFF SIMULATION

In this simulation of the flow of genetic material between grizzly bears, students – the grizzly bears – will have to survive increasing development pressures in order to pass their genes on to successive generations.

1. Create a playing area for the students that has defined boundaries. Achieve this by moving the desks aside and placing

the chairs in a circle, by using rope or pylons, etc. The area should be large enough that students can freely move around.

2. Tell the students that they are grizzly bears and the area that you have created represents a protected area. They are not allowed to leave the boundaries of the protected area.

3. Recap the basic needs that all animals have to meet in order to survive (food, water, space and shelter). Tell the students that for this activity, these needs are all met. Their only responsibility will be to find mates and pass their genes on to future generations of grizzly bears.

4. Each student will receive four cars, each one a different colour. Explain to the students that the cards represent genes. At your signal, the students must trade cards with each other until they have four of the same colour card.

5. Ask who was able to collect four cards of the same colour. Were there any barriers to them passing their genes on?

6. Next ask students if there was anybody who was unable to collect four cards of the same colour. Explain that these students were victims of inbreeding. Any bear that interbreeds for three rounds in a row will be eliminated from the game. *Note: Students may point out that having four of the same colour card is akin to having the same genes. You may need to provide additional clarification that in this activity, the cards simply illustrate the passing of genes through generations. The colours do not represent different genes.*

7. Continue with successive rounds, each time changing the game slightly. In the second round, the goal will be to obtain four different coloured cards. Have students alternate between rounds from collecting four different coloured cards to four identical coloured cards.

8. At the end of each round, ask for a show of hands to see who has been a victim of inbreeding. Create a story of gradual development and fragmentation of the protected area in which the grizzly bear population has a harder and harder time finding mates. Remind students how much time actually occurs between successive generations of cubs that are born by the same mother, about 5 years. What challenges could this present?

This activity has been adapted from the “Bears of Banff Simulation” activity from *Teaching Green: The Middle Years*. For additional background information and the complete activity description, including a description of the different round variations, view the

original lesson plan at http://www.earthrangers.org/wp-content/uploads/2016/08/habitat_fragmentation1.pdf.

REFERENCES

Grant, T., & Littlejohn, G. (2004). *Teaching green: The middle years: Hands-on learning in Grades 6-8*. Gabriola Island, B.C: New Society Publishers.