NATIONAL BIGHORN SHEEP CENTER

DUBOIS, WY

LAMBS: Lessons, Activities and Materials about Bighorn Sheep

Our education mission

Using best practices that inspire youth and adults to understand, appreciate and sustain our regional wildlife and wildlands.
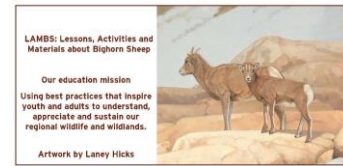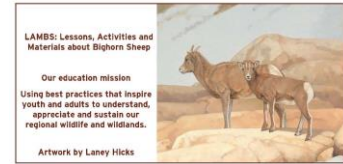
Artwork by Laney Hicks

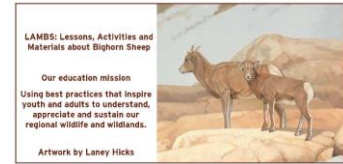| Title	How Many Bighorns Can Live in This Habitat? Adapted by the National Bighorn Sheep Center (www.bighorn.org) from Project Wild
Objectives	Students will be able to describe the food needs of bighorn sheep, identify a limiting factor and define carrying capacity by becoming a "bighorn" and looking for food in this active simulation.
DURATION	60-90 minutes
Materials	1. Large playing field or gymnasium 2. Colored plastic tokens, each labeled with appropriate markings (see step 1 procedure) 3. Envelope for each student 4. Calculator (optional)
ADVANCE PREPARATIONS	1. Mark tokens as shown in Table 1 2. Scatter the tokens in the playing field 3. With rope, mark one side of the area as the starting line
APPENDIX	1. Bighorn Sheep Background Information 2. Sample Concept Map 3. North American Bighorn Sheep Distribution Maps 4. Wyoming Science Curriculum Standards and Connection Ideas
VOCABULARY	1. **CARRYING CAPACITY** The maximum number of individuals of a given species that an area's resources can sustain indefinitely without significantly depleting or degrading those resources. In population biology, carrying capacity is defined as the environment's maximal load. 2. **HABITAT** The place an animal lives, which includes all the resources an animal needs to survive and reproduce.

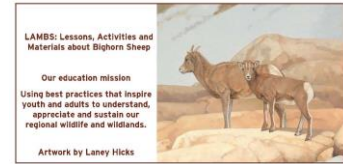# Instructional Sequence

ENGAGE	*What* Is *a Bighorn Sheep?* 1. Ask students how they would describe a bighorn sheep to someone who had never seen one. 2. They will likely list physical traits. You can guide them toward behavioral and physiological traits by encouraging them to consider the kinds of "things they do" and "how their body's work."

EXPLORE	*Concept Map*
	1. Tell students we want to look more closely at things that bighorns need and things that might be harmful to them.
	2. Using the dry erase board, guide students in creating a concept map of bighorn sheep resources and things that are harmful to bighorns. Appendix 2 is an example concept map. Their map does not have to look exactly like the example. It will depend on what types of things they think of with some guidance from you. Start with a circle in the middle labeled "bighorns" and a circle on the left and right of the "bighorns" circle. Ask questions such as:
	  a. What are some things that bighorns need to survive?
	    i. They will likely list food, water, shelter, etc, first. Draw circles for each of these attached to the blank circle to the right of the "bighorns" circle. Other things they may list are space, habitat, escape terrain, cover.
	    ii. Ask what these things are called and they should think of the word "resources". Fill in the blank circle next to the "bighorns" circle with the word "resources".
	    iii. Ask them for examples of bighorn foods. Answers could include grasses, forbs (flowers) and brushes. List these on lines next to the "food" circle.
	    iv. If applicable, ask for examples of other items they thought of that are resources for bighorns.
	  b. What are some things that might be harmful to bighorns?
	    i. They may start by listing mountain lions, wolves, coyotes, bears or golden eagles. Ask what those animals could be called as a group. If they don't think of the word "predator" right away, ask them the term for animals that eat other animals. Draw a circle attached to the blank circle to the left of the

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	"bighorns" circle and write "predator" in that circle then list the examples on lines connect to the "predator" circle. ii. Ask what other things can be harmful to bighorns. They may think of accidents, disease, overhunting/poaching or others. Draw circles for each of the things they list attached to the blank circle to the left of the "bighorn" circle. If applicable, ask for examples of each of the harmful items they listed. An example of a disease that affects bighorns is pneumonia. An example of an accident is a car hitting a bighorn on the road. iii. Ask what term could be used to fill in the circle to the left of the "bighorn" circle that would describe all the things they listed to the left. Possible answers include hazards, harmful, detrimental, bad, etc. Write the word they agree on in the blank circle to the left of the "bighorns" circle.
Explain	*Forage requirements and Population Estimates* 1. Tell students that, now that they know some basic information about bighorns, they will be looking more closely at forage requirements and population estimates for the Whiskey Mountain bighorn sheep herd as well as how and why the population changes over time. 2. Hand out student worksheets. 3. Have the students look at the forage requirements and population estimate numbers for each year and ask what they observe. If you must guide them, ask if the numbers increase every year. Do they decrease some years? 4. Ask them what might cause of the increases and decreases. If necessary, encourage them to recall some of the resources and harmful factors from the concept map.
ELABORATE	*Students Perform Simulation* 1. Tell the students that they will now participate in the activity, pretending they are bighorn sheep and "grazing" by collecting tokens. Do not tell them what the colors, numbers and letters on the tokens represent until the end of the activity. 2. Tell the students to read the introductory information and activity instructions on the student worksheet.

	3. Have the students perform the simulation. 4. Explain what the colors and numbers on the tokens represent. 5. Have students complete the table in the activity section of their worksheet to determine the number of pounds of forage they collected and the percentage that each type of forage made up in their diet.
EVALUATE	*Students Use the Table to Answer Questions* 1. Have the students answer the questions on their student worksheet. They will have to work as a class to answer some of the questions.
ADAPTATIONS AND EXTENSIONS	1. Do the simulation again, using the same amount of food, but fewer students. Were more bighorns able to survive? 2. Repeat the simulation again. Add in a ram that wandered from the herd and acquired *Mycoplasma ovipneumoniae* from domesticated sheep. This ram walks around coughing and as he touches (or sprays with a water bottle since the bacteria is most likely spread through the air) another bighorn, the bacteria are spread. Infected bighorns can then infect other bighorns. The teacher could randomly call out a few student names as they are about to be infected and tell them they are immune, as in some individual bighorn sheep the bacteria doesn't develop into pneumonia. In reality, individual herd losses can range from 5%-95%. 3. Repeat the simulation again, but include a wounded bighorn who lost a leg where the student must hop on one leg, and a blind bighorn (use a blindfold) who was wounded by either a predator or fighting during the rut. 4. Add in a predator, such as a mountain lion, who can prey upon the bighorns. For this, the mountain lion must also walk and once it captures a student, needs to escort him or her off the playing field. Then, count to 20 quickly, representing the week the mountain lion would feed on the dead bighorn, and then return to pursue more bighorns.

		Discuss Questions and Answers as a Class
WRAP-UP		*Discuss Questions and Answers as a Class* 1. Call on students to share answers to the questions on the student worksheet and discuss as a class. 2. Ask a few students to summarize what they learned from this lesson.
ACKNOWLEDGEMENT		All data and results used in this lesson were generously provided by bighorn sheep scientists who work with Wyoming Game and Fish and Montana Fish Wildlife and Parks. Additional information was provided by the Wild Sheep Working Group, which was formed by the Western Association of Fish and Wildlife Agencies and members are wildlife biologists from western states and Canadian Provinces.

Table 1: Mark the tokens as follows (the number after each letter is how many pounds of that kind of food the token represents).

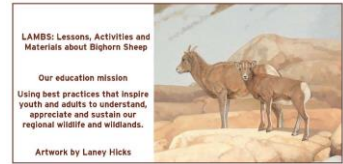| Color	Type of forage	Label	Tokens per approximate number of students			
			10 Students	**20 students**	**30 students**	**40 students**
White	Grasses	G-493	5	10	15	20
White	Grasses	G-247	10	25	40	55
Red	Forbs	F-219	5	10	15	20
Red	Forbs	F-110	10	25	40	55
Yellow	Browse	B-383	5	10	15	20
Yellow	Browse	B-192	10	25	40	55
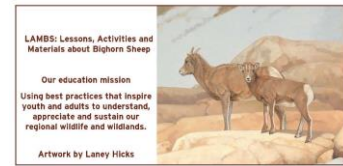
Appendix 1: Bighorn Sheep Background Information

There are four species of wild sheep in North America, broken down into two categories: bighorn and thinhorn. Desert bighorns live in seven of the western states and parts of northern Mexico, with a population of ~39,000. This type of bighorn can live up to six months without drinking water, getting the moisture it needs from plants alone if conditions require. Rocky mountain bighorns live in 14 of the western states and two Canadian provinces with a population of ~48,000. The thinhorns include dall and stone sheep. The dall sheep, with its white fur, is often considered the most beautiful sheep. The ~90,000 dall sheep live in Alaska and northeast Canada. The ~14,500 stone sheep, with their darker fur, live only in two Canadian provinces. This activity will focus on the Rocky Mountain Bighorn.
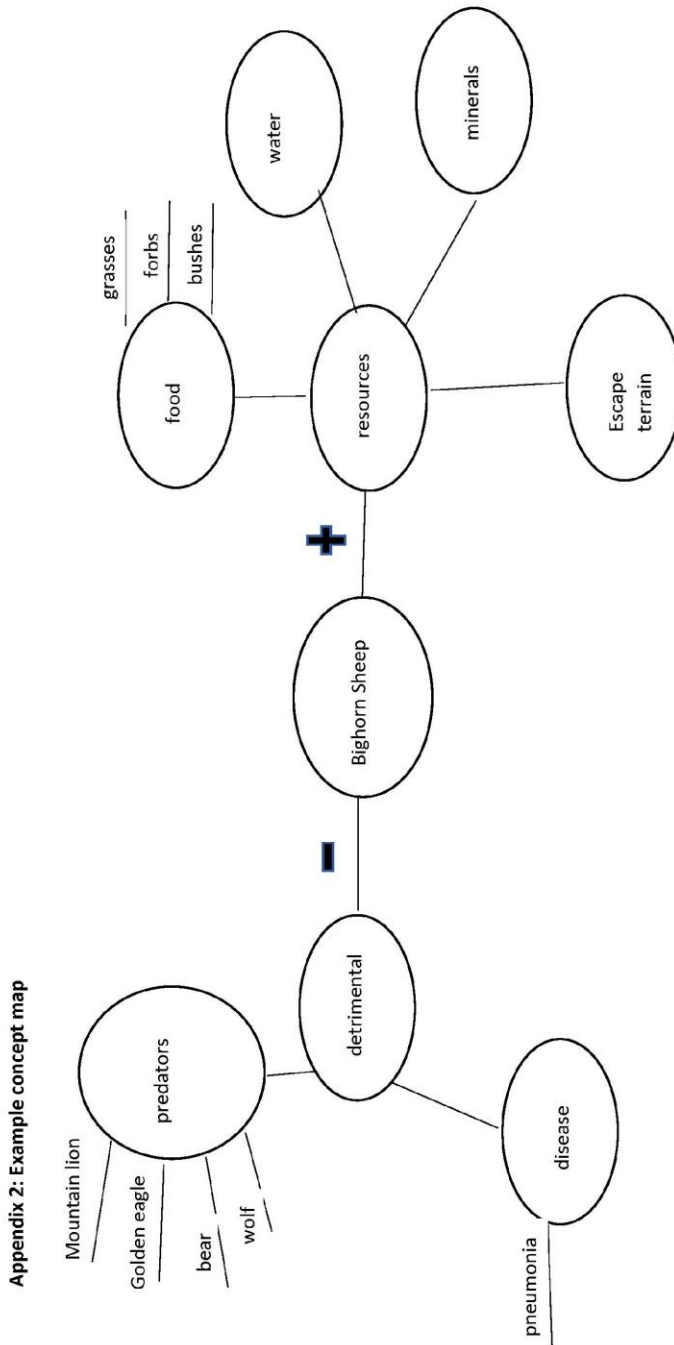
Bighorn sheep have many adaptations that help them survive. Their hairs are hollow, allowing for better insulation, in both cold and hot conditions. The coloration of their fur helps them camouflage into their surrounding habitat. Bighorn sheep have a double-layered skull honeycombed with bone struts to protect their brains during their impressive head-bashing battles. They are ruminants, and like other ungulates (hoofed animals), don't chew their food when first eaten, but instead these "cud chewers" ingest grass, brush or forbs (flowering plants) quickly while in the open, and regurgitate it to chew later while they are relaxed and protected in the safety of cover.
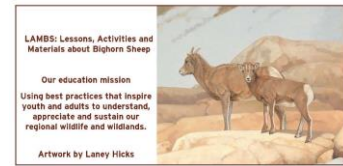
Historically, bighorn lived in every western state. After gold was discovered in California in 1849 and human populations expanded west, bighorns began to be impacted. The 1960s saw the lowest population of bighorns, due to many factors including: habitat loss, diseases from domesticated animals, competition with livestock, and predation.

Efforts to reestablish bighorns into their historic mountain ranges have been occurring for many decades, with the first translocation taking place in 1922. These efforts have really paid off. For example, Nevada had just a remnant of bighorn sheep in 1960, but over 11,000 today. See appendix 3. One of the biggest issues facing bighorns today is the transfer of bacteria, most often *Mycoplasma ovipneumoniae*, from domesticated sheep and goats, which results in pneumonia and often death.
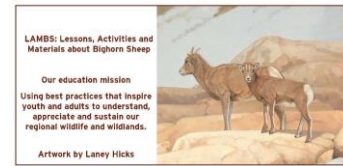
![National Bighorn Sheep Center logo — Dubois, WY]

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Appendix 2: Sample Concept Map

Appendix 2: Example concept map

WILD SHEEP Foundation

Appendix 3: Distribution of Bighorn Sheep in North America

WAFWA

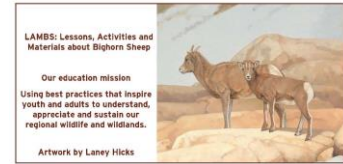**1850**   **1960**   **2012**

Appendix 4: Wyoming Science Curriculum Standards and Connection Ideas

3-LS4-2	Use evidence to construct an explanation for how the variation in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. • Discuss how those more immune to *Mycoplasma ovipneumoniae* bacteria have greater chance of surviving, how those not crippled have greater chance of getting enough food and escaping predators, lighter or darker fur could help camouflage a bighorn better to reduce predation.
3-LS2-1	Construct an argument that some animals form groups that help animals survive. • Discuss how herd watches over each other, looking for predators, as they forage for food, then return to more protected area to "chew their cud".
3-LS4-3	3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. • Discuss how uneven food distribution could lead to some sheep not getting the amount they need for survival, or even just enough to survive but not a healthy sheep.
4-LS1-1	Construct an argument that animals have internal and external structures that function to support survival, growth, behavior, and reproduction. • Discuss their 4-chambered stomach (they are ruminants) that allows them to quickly swallow food while out in the open and then move to more secluded and safe area to regurgitate food, chew their cud, and then swallow it again. Could discuss more compact horns against their head vs. antlers, which allow them to walk along cliffs easier so they don't knock themselves off.
5-LS2-1	Develop a model to describe the matter of movement among plants, animals, decomposers, and the environment. • Could have students draw diagram of sun's energy helping plant grow, this energy being transferred to bighorn when it eats plant, then animal dying and being broken down by decomposers. Could develop food chains involving bighorn.
MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. • Could discuss herding of sheep to protect young, fighting during rut and most dominant males winning chance to mate.

MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. • Discuss how *Mycoplasma ovipneumoniae* bacteria could be passed on to young bighorns with no immunity, discuss availability of food spread unevenly in area could limit some sheep in getting the amount they need as they wander their range. Evidence could be growth of trees and large bushes reducing grass growth.
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. • Combine data from food tokens collected. Determine carrying capacity. Determine amount of food needed to sustain the current "herd" of the class.
MS-LS4-4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. • Could discuss traits leading to larger or smaller horn growth, which could help during rut. Discuss how, genetically, some individuals are faster, which allows some individual sheep to escape predators more easily.

Student Worksheet
How Many Bighorns Can Live in this Habitat?

The activity is based on the following figures that represent the yearly average of a typical Rocky Mountain Bighorn Sheep in the Whiskey Mountain herd. Whiskey Mountain bighorn sheep eat an estimated 3 pounds of weight vegetation a day. The components of an actual bighorn's diet will vary depending on the size of the animal, the area, season, and year. For this simulation, 3 pounds of forage per day for a total of 1,095 pounds of forage per year is needed to "survive". Although a bighorn *may* survive with a little less, the energy obtained from the vegetation would go directly to staying alive instead of horn growth, good health, etc.

Forage requirements for a Rocky Mountain Bighorn Sheep

Type of forage	Pounds of forage	Percentage of diet
Browse (brushes)	383	35%
Forbs (flowering plants)	219	20%
Grasses	493	45%
Total	**1,095**	**100%**

This activity uses data from the Whiskey Mountain herd of Rocky Mountain Bighorn Sheep. Recent herd populations are below.

**Whiskey Mountain Bighorn Sheep Herd Population Estimates**

YEAR	TOTAL BIGHORNS
2012	1010
2013	941
2014	1044
2015	975
2016	841
2017	827
2018	700
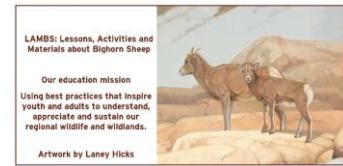
ACTIVITY

1. In this activity, you will pretend that you are a bighorn sheep. Decide whether you will be a ram, ewe or lamb.

2. Line up behind the starting line, with an envelope with your name on it, at your feet on the ground. You will be looking for food (tokens) and your envelope represents your shelter. The tokens represent various kinds of bighorn food and this simulation represents one year's worth of grazing. Since bighorns eat different kinds of food at different times of the year, you should gather different colored tokens to represent a variety of food.

3. You must walk because bighorns do not run down their food; they graze for it, usually out in the open. When you find a token, you should pick it up and return to your shelter (your envelope) so predators have less chance of seeing you, and put it in your envelope. (Bighorns would actually eat the food as they find it, but chew their cud later in the safety of shelter.)

4. When your teacher says you can begin, start "grazing". When all the food tokens have been collected, the year is over.

5. Pick up your envelope containing the food you gathered and listen while your teacher explains what the token colors and numbers represent.

6. Calculate how many pounds of each of the three categories of forage you gathered and convert these numbers into percentages of the total poundage of forage you gathered. Example: pounds of brush ⁄ total pounds of forage x 100= percent of brush in diet.

Type of forage	Pounds of forage	Percentage of diet
Browse (brushes)		
Forbs (flowering plants)		
Grasses		
Total		
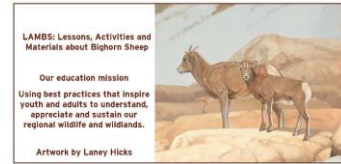
QUESTIONS

1. Each bighorn needs 1,095 pounds of food a year to survive. Did you survive?

2. If you survived the year, think about how healthy you were. Did you have the proper percentage of each type of vegetation?

3. Work with the rest of your class to calculate a total for all the pounds of food the class gathered. Divide the total by 1,095 pounds needed by an individual rocky mountain bighorn to survive in a year, and then answer the following:
   a. How many bighorns could this habitat support? Why?

   b. What percentage of the bighorns survived in this activity?

   c. What percentage would have survived had the food been evenly divided?

4. Define carrying capacity. What is the carrying capacity for this habitat?

5. What would happen the following year, with the same amount of vegetation (sheep graze only so low on a plant so that it grows back the following year) and fewer bighorns living in the area?

6. What would happen the following year, with the same amount of vegetation (sheep graze only so low on a plant so that it grows back the following year) and more bighorns living in the area?