LEVEL: Grades 8-12

SUBJECTS: *Science, Biology, Ecology, Environmental Education, Communication, Social Studies.*

PROCESS: *Through group communication, students solve an ecological mystery.*

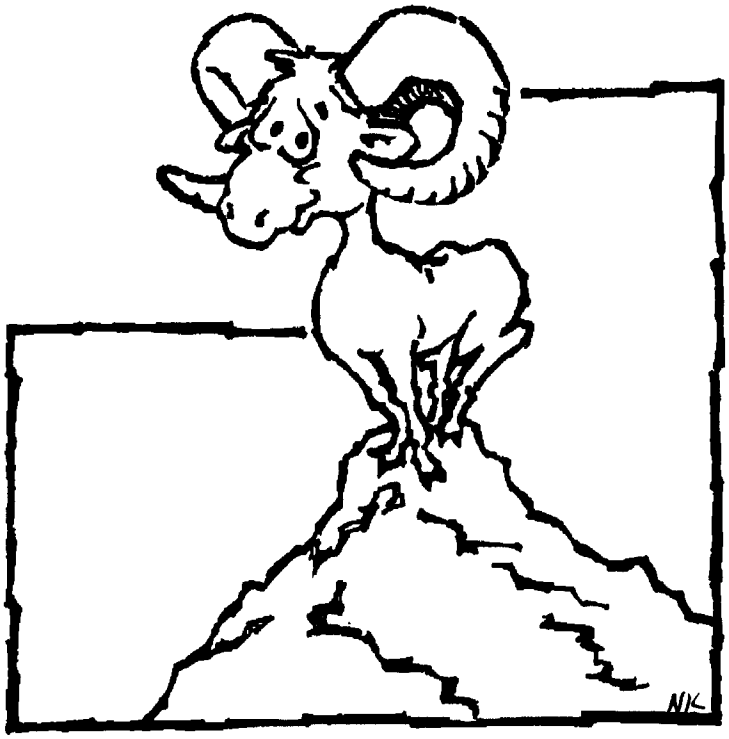
OBJECTIVES: *The student will:*
1. *Analyze information and solve a mystery.*
2. *Diagram the solution.*
3. *Create alternative plans to prevent the combined conditions from reoccurring.*

TIMEFRAME: *45 minutes to 1 hour.*

SKILLS: *Analyzing, debating, discussing, evaluating, listening, problem solving, public speaking, reading, synthesizing, working in small groups.*

MATERIALS: *Writing materials, dictionaries, encyclopedias, resource books with information about bighorn sheep, "Mystery Story," "Mystery Questions," and "Mystery Fact Cards" sheets (attached).*

VOCABULARY: *Alpine, ewe, fetus, kid, larval stage (larvae), lifecycle, parasites, placenta, pneumonia, public land, ram.*



MURDER EWE WROTE

OVERVIEW: Bighorn sheep, *Ovis canadensis*, live in the rugged terrain of the Rocky Mountains. They are tan-to-brown color, weigh about 75-200 pounds and stand about two-and-a-half to three-and-a-half feet tall. Adult males are called rams, adult females are called ewes (pronounced like "you"), and young are called lambs. They eat grasses and similar plants in high mountain meadows and rocky cliff areas. They are usually found in herds numbering 10 to 100. Rams are very muscular and known for their large curling horns which they use in dramatic collisions with other rams during breeding season. Ewes have small horns that don't curl very much. Bighorn sheep should not be confused with the Rocky Mountain goat, its shaggy, white, small-horned cousin.

The overall population of bighorn sheep has rebounded somewhat from destruction by market hunters in the late 1800s. Limited hunting is now allowed under strict regulations. Throughout recorded history, bighorn sheep herds were known for precipitous die-offs. The reasons for these population crashes have remained a mystery and only recently have they been thoroughly investigated. Die-offs still occur today, but with proper wildlife and ecosystem management techniques, they are less severe.

The bighorn sheep die-off example used in this activity is fictional, but it is based on several case studies of bighorn population crashes in the west.

Students will solve an ecological mystery using the information provided, thinking and problem solving skills, and perhaps some resource books.

PROCEDURE:

PRE-ACTIVITY:

Photocopy one copy of "Mystery Fact Cards" to be cut apart, and a photocopy of the "Mystery Story" and "Mystery Questions" for each group of four to five students.

ACTIVITY:

1. Ask students to share what they know about bighorn sheep. Discuss any additional background information about bighorn sheep with students (see Overview). Tell students they will be solving a mystery about bighorn sheep as a class using fact cards. They will also have a copy of a story and questions in their small group for reference.

2. Divide into groups of four to five students. Distribute the "Mystery Story" to each group. Have them read the story as a class or in their small groups.

3. Share the following guidelines with students: Using the story and 24 fact cards, we will solve this ecosystem mystery. Once you are given a fact card, you may not pass or trade it with others. Only as a group, using good communication skills, can we solve the mystery. The fact cards will be read to the rest of the class one at a time and in order.

As the facts are read aloud, we will begin to piece together the solution to the mystery. It will be helpful to focus on the "cause," "weapon," and "motive," as well as previewing the questions.

4. Distribute a set of "Mystery Questions" to each group, so students can preview them.

5. Distribute one fact card to each student. Remind students they may not trade fact cards or give them to someone else!

Have students read their fact cards one at a time in order. As fact cards are read, let students decide how best to organize the information and begin to solve the mystery. Students may struggle at first with the wealth of information, but that is part of the process. A possible strategy is to designate students as recorders of specific information for the class.

Good group communication and participation are critical. Beware of letting a few students dominate the activity. It may be helpful for you to preview the questions and answers.

6. Discuss the questions as a class or have students address them in their small groups. Leave ample time for thorough discussion of mystery questions nine and ten.

Mystery Questions and Answers:

The overall message in this activity is that numerous factors, not one or two, lead to the population crash.

1. How many bighorn sheep died between the summer and February 5? *(Approximately 202 sheep died.)*

2. What unusual wildlife behavior could have been an early clue that something was wrong with the herd? *(On January 18, tourists were getting very close to the bighorns. Wild animals very rarely let humans approach them.)*

3. Why did so many of the herd die in such a short period of time (January through February 5)? *(Once the disease established itself in the unhealthy herd, deaths occurred quickly.)*

4. Why did the rams die earlier than the ewes? *(Rams were tired and worn out as a result of fighting during the breeding season.)*

5. Why were there only a few kids in December, though there were many in the summer? *(The lungworm is passed from the ewe's body through the placenta and into the fetus' body. Kids are more likely to eventually succumb to an infection of lungworm.)*

6. How do bighorn sheep get lungworms? What is the lifecycle of the lungworm? *(Bighorn sheep accidentally eat small snails while they graze. These snails are a host for lungworm larvae. The larvae penetrate the intestinal wall and travel to the lungs where they become adults. Lungworms lay eggs in the lungs. The eggs hatch and the young larvae enter the air passages where they are coughed up and swallowed by the bighorns. The lungworm larvae are excreted in fecal pellets and seek the host snail.)*

7. Why don't all bighorn sheep die of pneumonia/lungworm? *(Many bighorn herds are infected with both lungworm and bacteria. Healthy herds are usually able to cope with these disease-causers. Unhealthy herds cannot.)*

8. What is the relationship between the pneumonia bacteria and the lungworm? *(In weakened, stressed, or young bighorn, the lungworm lesions provide suitable sites for the pneumonia-causing bacteria to grow.)*

9. Who or what caused the die-off of the bighorns? *(No one intended to harm the bighorn sheep. Numerous factors working together caused the population crash. These factors include:*

A. Presence of lungworm and pneumonia-causing bacteria.

B. Extreme weather caused bighorns to expend more energy than usual and this weakened them. Crowding caused by deep snows allowed the diseases to transmit from one animal to another easily.

C. Heavy grazing by cattle in the valley bottoms during the summer left little for wintering bighorns.

D. Stresses caused by the breeding season.

E. Stress caused by elk hunters riding snowmobiles nearby.

F. Habitat loss of critical winter grazing areas by real estate development.)

10. As a class or in small groups, assume the role of an ecosystem manager. Discuss and/or write a management plan about how you will prevent such a die-off in the future. What will be the best management practice(s)? What will be the least expensive management practice(s)? How will privately-owned land affect your plan? How will you include others in your planning efforts? If you don't have suggestions for the preceding questions, how can you learn more so you can form an opinion? *(Numerous possibilities. Be sure to include the issue of private and public lands in the management proposal.)*

7. To summarize the activity, ask:

-What was the hardest part of this activity? The easiest?

-What information was the most helpful? Why? Least helpful? Why?

-What was the best way for you to organize all the information? Why?

-How did you find your mind working when you knew you were trying to solve a mystery?

-What is something you learned that you will share with others?

-How can what you learned doing this activity help you in the future?

ASSESSMENT:

1. Have students list the various factors that lead to the bighorn sheep population crash.

2. Using the factors on their lists, they create diagrams to show how the factors are connected.

3. Have students create a diagram showing the lifecycle of the lungworm from the information given.

EXTENSIONS:

1. Have students research other parasitic lifecycles. Other animal species, including humans, have had dramatic population crashes as the result of parasites. What were the parasites, why, and how were they eventually controlled?

2. Working in small groups, ask students to research and report about the techniques used by wildlife agencies to trap and medically treat bighorn sheep for diseases. Ask each group to also report how they decided where to go for the information they were seeking.

RESOURCES:

Bighorn Sheep Mortality in the Taylor River-Almont Area, Feverstein, Schmidt, Hibler, and Rutherford, 1978-1979: A case study. 1980.

MYSTERY STORY

The Taylor Canyon bighorn sheep herd lives in a typical Rocky Mountain ecosystem characterized by rugged mountains, canyons, and small grassy valleys. Valley bottoms are privately owned; most of the other higher terrain is public land.

During the summer months, wildlife biologists estimated the bighorn sheep herd to number 250. This was the largest herd size in many years. Numerous ewes with kids were sighted in alpine meadows and scattered bands of rams were noted at higher elevations.

Late-season (December) elk hunters in the area reported lots of bighorns. All appeared healthy, although there seemed to be few kids. Many male rams were observed fighting other male rams for females with whom to mate.

January brought heavy snows and cold weather. Snow depths were up to five feet and mid-day temperatures were as low as -20 degrees (F).

On January 18, wildlife biologists noted ski tourists pulled off the highway taking pictures of the bighorn sheep. One tourist came within ten feet of a ram. Bitter cold and deep snows persisted.

Ranchers noted that many of the bighorns appeared to be tired, ragged, and weak. The bighorns staggered and mucous discharge was observed coming from their mouths and noses. Many bighorns were coughing. On January 21, one rancher notified wildlife officials.

Two days later, wildlife officers found eight dead rams and two extremely sick ewes. Two dead bighorns were sent to a university lab where autopsies were performed to determine the cause of death.

On February 5, ground surveys and aerial fly overs found only 48 bighorn sheep alive. Some of the remaining bighorn sheep were netted and medically treated. Food was brought in. No more deaths occurred.

What caused this dramatic population crash?

MYSTERY QUESTIONS

1. How many bighorn sheep died between the summer and February 5?

2. What unusual wildlife behavior could have been an early clue that something was wrong with the herd?

3. Why did so many of the herd die in such a short period of time (January through February 5)?

4. Why did the rams die earlier than the ewes?

5. Why were there only a few kids in December, though there were many in the summer?

6. How do bighorn sheep get lungworms? What is the lifecycle of the lungworm?

7. Why don't all bighorn sheep die of pneumonia/lungworm?

8. What is the relationship between the pneumonia bacteria and the lungworm?

9. Who or what caused the die-off of the bighorns?

10. From the role of an ecosystem manager, discuss and/or write a management plan about how you will prevent such a die-off in the future. What will be the best management practice(s)? What will be the least expensive management practice(s)? How will privately-owned land affect your plan? How will you include others in your planning efforts? If you don't have suggestions for the preceding questions, how can you learn more so you can form an opinion?

Mystery Fact Cards:

(Cut the facts apart on dotted lines and give one to each student.)

Fact #1
The autopsies revealed that the dead bighorns had pneumonia-causing bacteria.

Fact #2
Autopsies revealed dead bighorn were found to have parasites called lungworms.

Fact #3
The elk hunters were riding snowmobiles. Bighorn are easily spooked by the presence of these noisy machines. They get nervous.

Fact #4
Heavy snows make travel difficult for bighorn. Herds begin to congregate on the few pieces of bare ground (or shallow snow accumulation areas) available.

Fact #5
When grazing, bighorn sometimes eat small land snails by accident.

Fact #6
The lungworm larvae can move across the placenta from the pregnant ewe into its fetus.

Fact #7
Lungworms form open sores in the lungs.

Fact #8
During cold weather, bighorn sheep spend lots of energy trying to stay warm. Their caloric needs increase.

Fact #9
Young lungworm larvae are excreted in bighorn sheep fecal pellets.

Fact #10
During the summer, bighorn sheep stay at high elevations on public lands eating nutritious alpine plants. When winter snows arrive, they typically move down onto private lands in the valleys and canyons.

Fact #11
Pneumonia causes bighorn sheeps' lungs to fill up with mucous. They try to cough it out.

Fact #12
During winter bighorn paw through the snow to eat grass. This is tiring.

Fact #13
Even healthy bighorn sheep have the bacteria that causes pneumonia.

Fact #14
The larval stage of the lungworm is found in small land snails.

Fact #15
The breeding season for bighorn sheep is November and December. Rams actively fight for the right to breed ewes.

Fact #16
The larval stage of the lungworm travels from the bighorn's stomach to its lungs.

Fact #17
Diseases spread easily among herds in crowded conditions.

Fact #18
Generally speaking, only unhealthy wild animals allow humans to get close.

Fact #19
Bacteria that cause pneumonia can only cause this disease if it finds open sores in the lungs.

Fact #20
Healthy bighorn sheep rarely get diseases. Young or physically stressed animals are more likely to succumb to diseases.

Fact #21
Ranchers grazed large numbers of cattle on their private lands in canyon/valley bottoms during the summer.

Fact #22
Once in the lungs, the lungworms mate and lay eggs. When the eggs hatch, the young larvae are coughed up and swallowed.

Fact #23
High activity levels tire and stress bighorns.

Fact #24
During the summer, one rancher sold some of her valley land to a real estate developer. A few homes were built that summer. A few more are planned.