

Learn About Ecology?: Elk and Chronic Wasting Disease in the Rocky Mountains

Abstract

This activity shows students how competition, predation, and disease affect populations of elk, cattle, wolves, and hunters in a Rocky Mountain community. The game is interactive and perfect for 8th-12th grade students studying ecology.

Key Words: Ecology, population, community, food web, competition predation, disease

Standards:

The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.

Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.

Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.

Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.

Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

Introduction

Have you ever wanted a fun and interactive lesson to tie together the various concepts you teach about ecology (food webs, trophic levels, predation, competition, disease, carrying capacity, human impacts, and demography)? Look no further. A great activity that we have used successfully with 8-12th graders is an interactive game in which students play a “role” in a

1 food web that is being impacted by disease and human intervention. Because we live in the
2 Rocky Mountain region, we chose to create a game about elk. In this 1-hour game, each student
3 becomes an elk, cow, hunter, or wolf. As animals in a pretend ecosystem, they must search for
4 food, avoid predation, reproduce, and deal with the adverse affects of disease. This game
5 reinforces classroom and textbook instruction about the factors that influence the birth and death
6 of individuals in a population, helps students see how food webs work, and asks students to think
7 about how humans impact natural ecosystems. This game is basically an abstract model of
8 populations in a community, similar to an abstract computer model that a professional ecologist
9 would use. After playing the game students can use their quantitative skills to graph the size
10 changes in each population and hypothesize about what caused the changes. Students can also
11 benefit from a brainstorming session about how this abstract game or model is similar or
12 different to a real life situation.

13

14 **Background**

15 **Basic Population and Community Ecology**

16 Before playing the game, make sure students are familiar with the different *trophic levels*
17 in a *food web* and how energy moves from one level to the next. In other words, plants are
18 *primary producers* that are eaten by primary consumers (*herbivores*), which are in turn eaten by
19 secondary consumers (*carnivores*). Explain that the energy that an organism consumes
20 determines how much energy it will have to do things like reproduce and escape from predators.
21 Students should also know that a *population* is a group of individuals of the same species who
22 live and interbreed in the same geographic area, and that a *community* is a group of populations
23 of different species living and interacting in the same geographic area. They should understand
24 that organisms can compete with member of the same species or members of a different species
25 and that *competition* is usually for resources such as food, water, space, or mates. In addition to
26 competition for limiting resources, predation and disease also influence population sizes. There
27 are two types of predation in this game. One type of predation is herbivory in which elk and
28 cattle consume plants. Another type of predation is carnivory in which one animal kills another
29 and eats it. Furthermore, diseases like Chronic Wasting Disease (CWD) can influence
30 populations by causing death of individuals directly or by weakening individuals and making
31 them less able to obtain food, reproduce, or avoid predation.

1 **Elk and Chronic Wasting Disease**

2 Chronic Wasting Disease is a transmissible spongiform encephalopathy (TSE) that
3 affects deer and elk. It is found mostly in populations in Colorado, Wyoming, and Nebraska,
4 although it has also been seen in other states. The disease is similar to Mad Cow disease that
5 affects bovines and scrapie that affects sheep. Exactly what causes the disease is unknown.
6 Some hypotheses are that CWD is caused by an unconventional virus or a prion (an abnormal
7 form of a normal protein) that attacks the nervous system. The disease is progressive and always
8 fatal. Symptoms include chronic weight loss, decreased interactions with other animals,
9 repetitive walking in set patterns, listlessness, and sometimes apparent nervousness. The origin
10 and mode of transmission of the disease are unknown, but it is thought that the disease transfers
11 laterally from animal to animal. Epidemiologists from the Federal Center for Disease Control
12 have studied the disease and found no links between CWD and human neurological diseases.
13 CWD is a serious disease that has greatly affected deer and elk populations and has caused
14 expensive regulatory precautions in the hunting and wildlife industries (source).

15

16 **Materials**

17 5 buckets or coffee cans (1 gallon)

18

19 1000 Bites of Plants - We used pieces of green foam cut into 2 in X 4 in pieces. You could also
20 use play money or poker chips.

21

22 30 Bites of Plants infected with Chronic Wasting Disease. We used a marker to write “CDW”
23 on the regular bites of plants.

24

25 Elk Costumes – brown bandanas and/or “antlers” made with plastic head bands and pipe
26 cleaners. We used blue pipe cleaners to make antlers for male elk and pink pipe cleaners to
27 make antlers for female elk.

28

29 Cow Costumes – cow print bandanas and/or small cow bells from a craft store

30

31 Hunter Costumes – camouflage bandanas and/or blaze orange hats or vests

32

33 Wolf Costumes – head bands with grey “wolf ears” made of pipe cleaners and/or gray bandanas

34

35 Hunter’s bullets – small foam balls such as Nerf balls that can be aimed and thrown at a student
36 without injuring them

37

1 Chalkboard or poster board for tallying up the amount of energy in each population after each
2 round of play
3

4 **Procedure**

- 5 1) Find an appropriate area for playing the game such as a gym, cafeteria, or playground.
6 Designate a small part of the area as a holding pen which is where animals will go if they die
7 of starvation, disease, or predation. This is also where animals will come if they want to
8 reproduce. At the holding pen, they will exchange money for an individual and that
9 individual will enter the playing field as a “baby”.
- 10 2) Place buckets containing plant energy units around the playing area. How you distribute the
11 buckets will affect the foraging behavior of the animals. You can distribute the buckets far
12 from each other or clumped near each other. You can divide the plant units evenly among
13 each bucket or you can put more plant units in some buckets than in others. Do not put the
14 CWD infected plant units in the buckets yet.
- 15 3) Assign each student to a role and give them their costumes. The number of players in each
16 role will depend on the size of your class. Assign approximately 50% of the class as elk,
17 20% as cows, 5% as hunters, and 10% as wolves. The remaining 15% will be in the in the
18 holding area. To assist, it is a good idea to assign 1-2 students to manage the holding area.
19 They will gather the costumes from students who enter the holding pen as “dead” animals.
20 They will also exchange a person from the holding pen for energy units from players that
21 want to reproduce. They will give the “offspring” the appropriate costume and release them
22 from the holding pen out onto the playing field. Note that an individual student may die and
23 be reborn as another type of animal, thus playing more than one role in the game.
- 24 4) Explain the rules to the students. It is also helpful to put the rules up on the board as a
25 reference or give students a sheet of paper with the rules on them.

26 27 **Rules for Elk**

28 **Eating** - Elk must visit each food patch only once per round and take 200 plant units (1
29 bite) from each patch.

30 **Reproduction** - If a male elk has at least 200 units of plant energy and wants to
31 reproduce, he must find a receptive female elk (to be receptive she must have at
32 least 600 units of plant energy). Together they must go to the holding pen and

1 pay 800 units of energy for a baby elk (600 units from the mom and 200 from the
2 dad). In real life, as in this game, the mother contributes more energy to obtaining
3 the baby because she is the one that must expend the most energy by carrying and
4 nurturing the baby. The baby elk must stay at its mother's side for the rest of the
5 round because babies have to learn from their mothers how to forage for food and
6 avoid predators.

7 **Predation** – A hunter can kill an elk by hitting it with a bullet (Nerf ball) on the shin. A
8 pack of wolves can kill an elk if all members of the pack touch the elk on the
9 shoulder. If an elk dies, it must give half of its energy to the hunter or wolf pack
10 and return half of its energy to the buckets of food. This is because predators
11 rarely eat all of an animal. Bones and other indigestible parts are decomposed
12 and contribute nutrients to plant production. After giving up its energy, the elk
13 must go to the holding pen as a “dead” animal waiting to be reborn. A male elk
14 can have as many babies as he can afford per round. A female elk can have only
15 one baby per round.

16 **Disease** – If an elk eats a plant unit that has “CWD” written on it, it must move around by
17 hopping on one leg until it is killed by a predator or until it dies of the disease
18 after 2 complete rounds, whichever comes first. This signifies that the animal is
19 not healthy. Individuals with CWD cannot reproduce.

20 *Rules for Cows*

21 **Eating** – Cows must visit each food patch only once and take 200 units (1 bite) from
22 each patch.

23 **Reproduction** – Cows cannot reproduce in this population because they are all female.

24 **Predation** – A wolf pack can kill a cow if all members of the pack touch the cow on the
25 shoulder.

26 **Disease** – CWD does not affect cows and cannot make them unhealthy.

27 *Rules for Hunters*

28 **Eating** – Hunters can kill 2 elk per round by hitting them in the shin with their Nerf ball
29 “bullets”. When the hunter kills an elk, the elk must give the hunter half of its
30 energy units and put half of its energy units back in the grass buckets. This is

1 because the hunters won't take all of the elk parts, some of them (such as bones)
2 will decompose and the nutrients will contribute to plant production.

3 **Reproduction** – Hunters do not reproduce in this system.

4 **Predation** – Hunters are defended by their bullets and cannot be killed.

5 **Disease** – Although humans may become sick from eating CWD infected elk, the
6 symptoms are unclear and may not appear for decades. Therefore, in this game,
7 hunters are not affected by disease.

8 *Rules for Wolves*

9 **Eating** – Wolves must hunt in a pack. A pack of wolves can kill up to 2 elk or cows
10 during each round. In order to kill an animal, all members of the pack must touch
11 it gently on the shoulder. If a wolf kills an elk, the elk must give it half of its
12 energy units and put half of its energy units back in the grass buckets. This is
13 because the wolves won't eat all of the elk parts, some of them (such as bones)
14 will decompose and the nutrients will contribute to plant production.

15 **Reproduction** – Wolves can reproduce. In order to obtain an offspring, a pack of wolves
16 must exchange 800 units of energy for a baby in the holding pen. Wolf packs can
17 only have up to 3 babies per round.

- 18 5) Have the students interact and accomplish their eating and reproduction goals while trying to
19 avoid predation. Each round should last about 3-5 minutes. At the end of each round, have
20 all of the elk, cows, hunter, and wolves, tally up the amount of energy units they have in their
21 respective populations. Record the amounts of energy. You will refer to these numbers later
22 during discussion and use them in a graphing exercise.
- 23 6) You can play as many rounds as you want in the time you have allotted. We suggest that the
24 teacher alters the game every once in a while by doing things like adding chronic wasting
25 disease to the buckets of food, reducing the amount of food in the buckets, changing the way
26 of food buckets are distributed around the room, removing some or all of the wolves from the
27 community, or by revoking hunting licenses. After manipulating the game, play a few more
28 rounds and watch how the energy in the populations changes as a result of the manipulation.
29 Keep track of when and how you manipulated the game for later discussion.
- 30 7) Have the students graph the change in energy in each of the populations over each of the
31 rounds. Put Round Number on the X-axis and Energy on the Y-axis. Have the students

1 discuss why some of the changes occurred and why some trophic levels had more total
2 energy than others.

3 8) Discuss how this abstract game is similar or dissimilar to what would really happen in nature
4

5 Conclusions

6 After playing the game, the students should understand how complex interactions between
7 populations and the environment are. They should see that food webs have top down and bottom
8 up controls, i.e. removing a predator can affect the lower trophic levels and a reduction in
9 primary producers can affect the higher trophic levels. By looking at the elk population, the
10 students should understand that the carrying capacity for a population is controlled by the supply
11 of limiting resources such as food, the abundance of predators, intra- and interspecific
12 competition and disease. The results of the interactions may not have been what you predicted
13 and may not have matched what would occur in natural systems. If so, the students should learn
14 from that too. This game is an abstraction or model of a natural system. When constructing a
15 model, ecologists often have to make choices between perfectly representing the complexity of
16 interactions between all biotic and abiotic components and making the model simple enough to
17 understand and manipulate. Have the students talk about how this model game is different than
18 the real environment. This will stimulate them to think about the actual processes that influence
19 populations and communities. Have them also talk about how their behaviors may have
20 influenced the outcomes. For example, if your pack of wolves is played by 7th grade boys the
21 outcome will probably be different than if your pack of wolves is played by 11th grade girls.
22 Overall, we hope the students have a great time playing the game, gain a deeper understanding of
23 ecological principles, and develop and appreciation for the sensitivity of the environment to
24 human influence.

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26

27 Extenstions

28 1) Have the students think of another ecosystem with herbivores, carnivores, and disease.
29 Have them draw the food web for that ecosystem and make-up a set of rules for a game
30 involving those animals. For example, you might want to divide the students into small

- 1 groups and have each group think of an example for a particular biome type (arctic,
- 2 desert, aquatic etc.).
- 3 2) Have students research and report about other diseases that affect plant or animal
- 4 populations. Some interesting association are between Wildebeest and Rinderpest, ...
- 5

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| ROUND | ENERGY | | | |
|-------|--------|------|--------|---------|
| | Elk | Cows | Wolves | Hunters |
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