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# Project Caribou

## An Educator's Guide to Wild Caribou of North America

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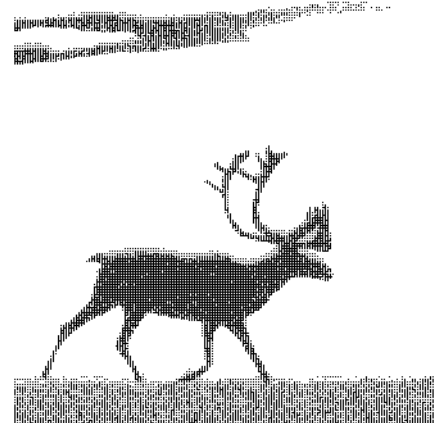
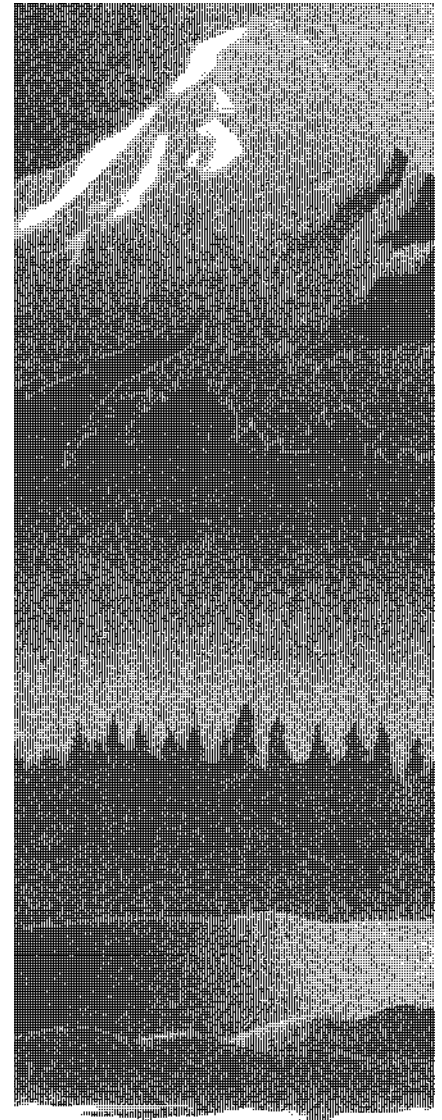
For more info: [www.projectcaribou.org](http://www.projectcaribou.org)

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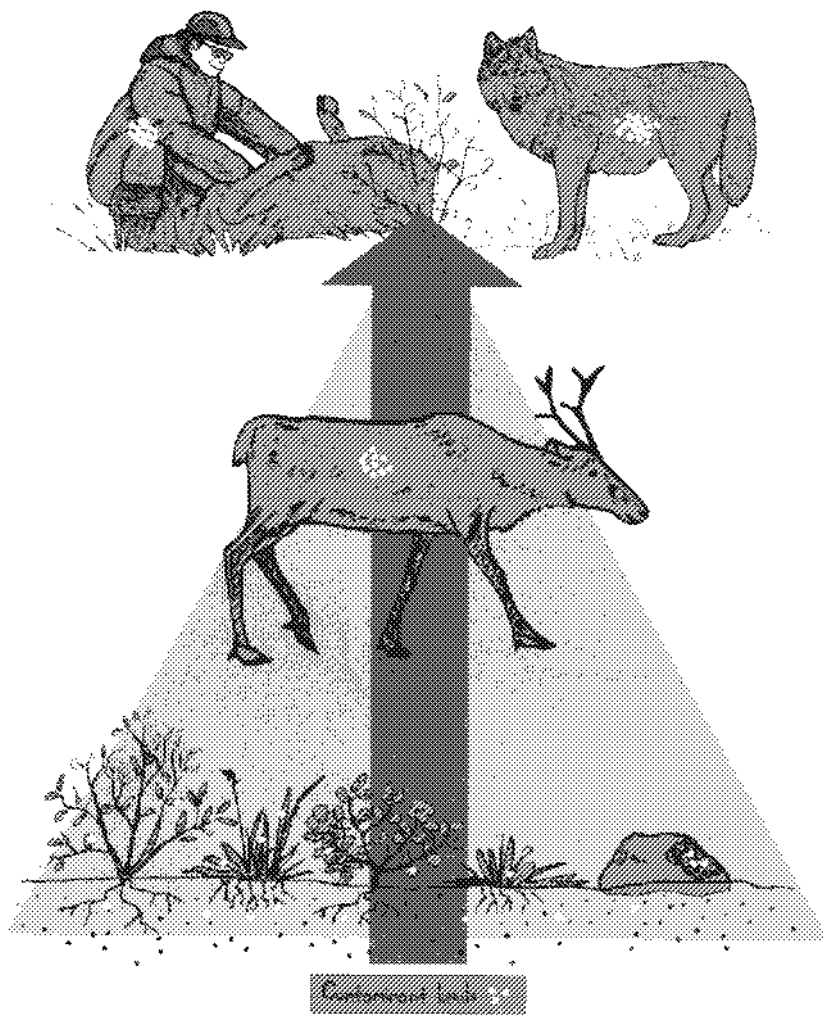


**Environment Canada (Canadian Wildlife Service—Yukon)**

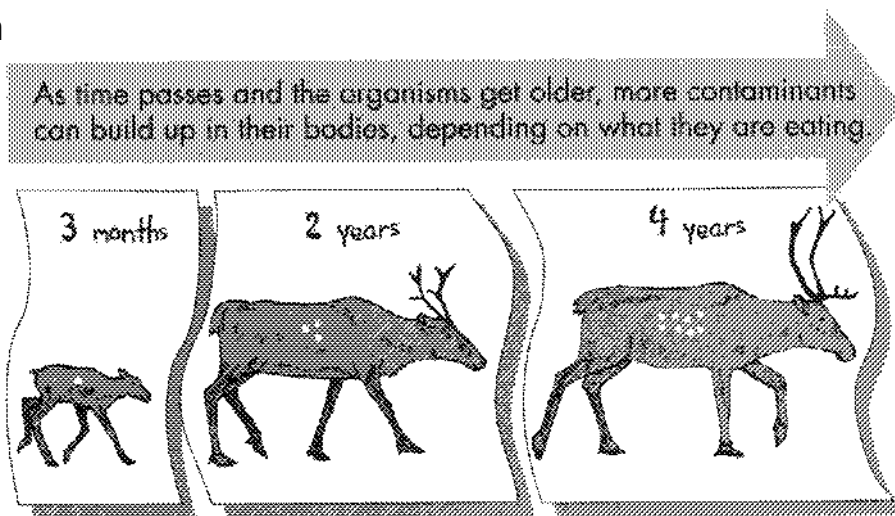
**Beverly and Qamanirjuaq Caribou Management Board**



### Biomagnification



### Bioaccumulation



## Bioaccumulation: the story of time

(Adapted from *Contaminants Found Me* by the Yukon Contaminants Committee)

### Objectives

Students should be able to:

1. Understand that contaminants occur naturally and will accumulate in organisms over time.
2. Play an active game that allows them to understand how contaminants build up in caribou over time.

### Background

Naturally occurring substances are found in the soils of the earth. These substances originate from the rock under the soil. Rock contains a variety of elements. The roots of the willow or any plant might absorb these elements. Some plants absorb some elements more easily than other plants. Willow, for example, absorbs cadmium more readily than does dogwood. Elements absorbed from some soils may be in amounts that can cause environmental or human health concerns.

Caribou eat great quantities of lichens. Lichens do not have a root system that can absorb contaminants from the soil. However, lichens are sensitive to airborne contaminants, either naturally occurring (such as volcanic activity or forest fires) or human made (such as pollution or radio-nuclides).

It is useful for people to know at what amounts essential elements become harmful, and where in an organism these elements will concentrate. Cadmium tends to concentrate in an animal's liver or kidneys. Mercury concentrates in the brain. Aluminum concentrates in bones. These metals are water soluble, but may be difficult to eliminate. "Organochlorines" (PCBs, toxaphene or DDT) concentrate in fatty tissue and are more difficult for an organism to eliminate.

"Biomagnification" is a process whereby an animal eats a plant or another animal, consuming the contaminants stored in that organism. Contaminant values increase, or magnify, with each "trophic level." Trophic levels are successive levels of nourishment in a food chain.

"Bioaccumulation" is a normal and essential process for the growth and nurturing of organisms. All animals bioaccumulate vital nutrients daily. Bioaccumulation also refers to the building up of contaminants in the body over time, as animals eat food or drink water containing the contaminants. Contaminants are either water soluble or fat soluble. Contaminants such as organochlorines are fat soluble. They are not easily eliminated from organisms. Contaminants such as metals are water soluble and are more readily eliminated through normal bodily functions.

### Method

1. Select four students to represent caribou and assign them letters A through D.

#### Age

Grades 6 – 8

#### Subjects

Science, Math, Physical Education

#### Skills

Concept development, application, counting, physical mobility

#### Duration

20 minutes

#### Setting

Outside or gymnasium

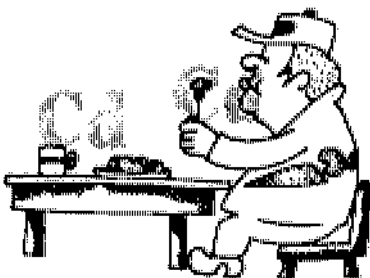
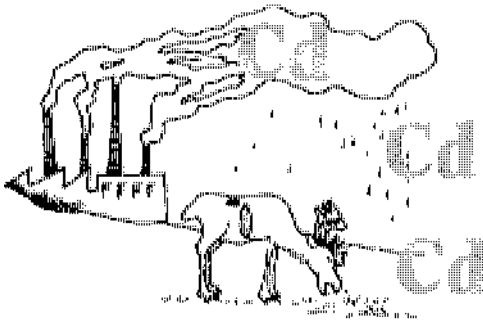
#### Materials

- Stopwatch or clock with a second hand
- Chart paper
- "Bioaccumulation" illustration on page 38
- Tokens with a value of 5. For a class of 20 students, you will need approximately 10 sheets of tokens. (A photocopy master is on page 41.)

**Adaptations for different ages**

**Primary:** Play a simplified version of the game.

**Senior:** Make the game more complicated. Introduce various kinds of shrubs and their different abilities to absorb different elements. Have several caribou play at once. To show the effects of contaminants, place a limit. When caribou have gathered enough tokens to reach the limit, they die and become hunters who are allowed to tag other caribou. Watch and record the results.



2. Ask other students to be willows. Each willow holds a few tokens with a value of 5. Each of these tokens represents contaminants in the environment.
3. Set the playing area boundaries. This activity can be done in a classroom or on an outdoor playing field.
4. Play one caribou at a time. Caribou A goes first and is allowed three minutes to gather willow. Since it is the oldest, it gets the most time. Caribou B is not as old, so it is allowed two minutes to gather willow. Caribou C is younger still, and is allowed one minute. Caribou D is a calf and is allowed only 30 seconds.

The object of the game is for each caribou to tag as many willows as possible. When a willow is tagged, it must give the caribou one token only, then scatter. Encourage willows to keep moving, refraining from standing still and handing tokens to caribou. A willow can be tagged a number of times, handing out as many tokens as required.

5. Count & record tokens on chart paper after each caribou has had its turn.

**Results**

The oldest caribou usually gathers the most tokens, and the youngest caribou gathers the least. An extremely fast caribou will collect more tokens, therefore simulating the accumulation of more toxins. In discussion with the group, point out that individual caribou in nature may indeed gather more food and contaminants due to access to better food sources. Regardless of the actual amounts, bioaccumulation takes place to lesser or greater degree.

**Variations**

1. Mark some of the tokens with a "C" to signify contaminants and others with an "N" to signify nutrients. Discuss 'acceptable' and 'unacceptable' levels of contaminants. When the caribou have gathered an unacceptable number of contaminant tokens, have them become willows.
2. Experiment with times and numbers of contaminant tokens.

**Extensions**

1. Do a classroom case study on contaminants and caribou.
2. Study the effects of an industrial accident such as a nuclear meltdown or an oil spill. Map the way that contaminants move through the environment.

**Evaluation**

1. Discuss what contaminants are.
2. Ask students to define biomagnification and explain how it works.
3. Ask students to define bioaccumulation and explain how it works.

