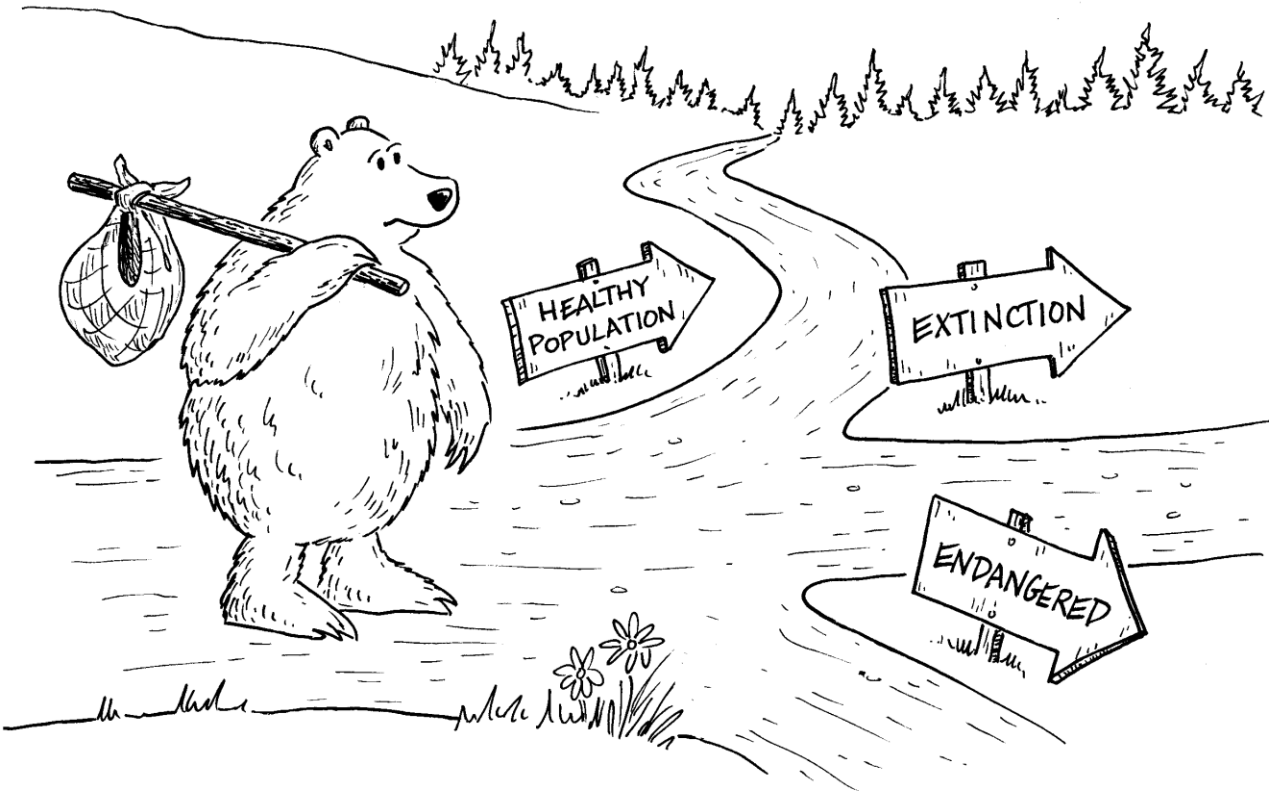
Grizzly Bears Forever!



a teacher activity guide for Senior High Science

CPAWS
CANADIAN PARKS AND WILDERNESS SOCIETY

Welcome!

This guidebook is a living document and is one of the vital components of the Canadian Parks and Wilderness Society's education program, *Grizzly Bears Forever!* We welcome all feedback and will incorporate suggested changes. Please email us at education@cpaws.org using the form on the following page. For comments, questions and inquiries, please contact us at 403-232-6686 or education@cpaws.org.

With *Grizzly Bears Forever!*, we have tried to create a relevant, exciting, and informative resource that carefully examines the present day challenges we face in the field of large mammal conservation. We collaborated with the *Eastern Slopes Grizzly Bear Project* (ESGBP) to provide factual, science-based activities that meet current curriculum needs. CPAWS wishes to thank the ESGBP, without which many aspects of *Grizzly Bears Forever!* could not have been created. The mandate of the ESGBP is restricted to research and education, and suggestions within *Grizzly Bears Forever!* on how to help grizzly bears are offered by CPAWS alone.

Written and Researched by Gareth Thomson, Jennifer Grant and Kim Kiel. Illustrations by Ed Carswell. Thanks to Colleen Campbell, Elizabeth Surridge, Derek Ebner and Rob Osiowy for providing their comments, feedback and thought on this guide.

About the Canadian Parks and Wilderness Society (CPAWS)

CPAWS
CANADIAN PARKS AND WILDERNESS SOCIETY

The Canadian Parks and Wilderness Society was founded in 1963 and is Canada's true grassroots voice for wilderness. Our mission is to establish new parks and make sure nature comes first in their management. CPAWS has played a key role in saving almost 500,000 km^2 of Canada's spectacular wildlands. Built from the ground up, we have thirteen chapters across the country, where people passionate about nature can get actively involved.

The Southern Alberta Chapter is the only CPAWS chapter to have a full-time education office. Our education program delivers in-class programs and interpretive hikes about species at risk, watersheds, biodiversity, ecosystem management, parks and protected areas and other concepts relevant to the CPAWS mission. For more information about CPAWS visit our website, www.cpaws-southernalberta.org

For more information about our teacher resources, in-class programs and hikes, visit:

www.cpaws-southernalberta.org/campaigns/education

EVALUATION FORM
TO: CPAWS EDUCATION
Email: education@cpaws.org

Your feedback is important to us! The Canadian Parks and Wilderness Society has tried to create a relevant, bias-balanced and curriculum-tied resource. This guidebook is a living document and we welcome all comments and suggestions for change.

The goals of this guidebook are to inform students about conservation biology and the issues surrounding grizzly bears living in the central Rockies of Alberta. By presenting the facts through current and authentic scientific data, and providing ideas for action, we hope that we've empowered students to make changes.

Do you feel that this guidebook has attained its goals? Please state why.

_____
_____
_____

Which section of *Grizzly Bears Forever!* did you find most useful?

_____
_____

Least useful?

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Is there anything you would add or change?

_____
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_____

Additional comments:

_____
_____

Name (optional): _____School: _____

Thank you! Please return this form to the below address, either via fax, mail or email. We look forward to hearing from you.

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Grizzly Bears Forever!

Annotated Table of Contents

Please note that activities in this guide are placed in an order that allows for concept building; working through the guide from beginning to end is recommended.

Table of Contents continued

Be sure to check out additional activities available free from:

cpaws-southernalberta.org/campaigns/resources-for-environmental-education

The Canadian Parks and Wilderness Society would like to thank the following organizations for their support during the initial development of this program guide.

The J.W. McConnell Family Foundation

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Why Study the Grizzly Bear?

People are interested in grizzly bears. The grizzly bear (*Ursus arctos*) is one of the most loved, feared, and misunderstood of Canada's wild animals. As a result, the grizzly bear serves as an excellent entry point into learning about larger issues such as ecosystems, interactions and biological diversity.

As well, the long-term persistence of the grizzly bear in our province is uncertain. Ever-expanding development, recreational, and resource extraction pressures continue to increase while wildlife populations dwindle and habitat quality decreases. Since European settlement, Alberta's grizzly bear population has fallen from 6000 bears to an estimation of less than 700 (2015). If this trend continues, a local or even a global extinction of the grizzly bear may occur.

Should we care? Will the loss of the grizzly bear affect us? Biologists and wildlife managers consider the grizzly bear to be:

- an indicator species used to assess ecosystem health
- a surrogate for land-use planning
- a habitat effectiveness indicator

We need the grizzly bear not only for ecological reasons but also for ethical reasons; all living things have intrinsic value and the right to exist.

CPAWS Educational Principles

Science-Based
Our education is based on sciences such as conservation biology; it is grounded in fact.

Student-Centered
All activities are learner-centered and experiential in nature.

Bias-Balanced
Our education programs are bias-balanced. Although the CPAWS point of view is clearly expressed, other points of view are discussed and respectfully considered.

Curriculum-Tied
Programs for students are closely tied to Alberta curriculum content areas such as science and social studies.

Empowering
Educational programs lead participants through the process of awareness and understanding, and allow them to take action through personal lifestyle changes or through democratic, citizenship-building processes such as letter-writing.

Based on our five educational principles, *Grizzly Bears Forever!* has:

- Well defined learning outcomes that are linked to current curriculum
- Variety of learning approaches; lessons for teacher-led material and ideas for independent study
- Activities that appear in a sequence that reflects students' learning styles
- Interesting, interactive activities
- Local (Alberta) content
- Evocative yet simple lessons

Curriculum Connections

The activities in the guide were designed to meet the Alberta Learning Curriculum Knowledge Outcomes and Concepts. Please refer to the Table of Contents to see which activities meet specific curriculum.

Science 14, Unit D: ***Investigating Matter and Energy in the Environment*** – Outcome 1: Flow of matter in biosphere can be disrupted by human activity. Outcome 2: Analyze a local ecosystem in terms of biotic and abiotic components, and describe factors of the equilibrium.

Science 20, Unit D: ***Changes in Living* Sys*tems*** – Outcome 1: analyze ecosystems and ecological succession in the local area and describe the relationships and interactions among subsystems and components. Outcome 2: analyze and investigate the cycling of matter and the flow of energy through the biosphere and ecosystems as well as the interrelationship of society and the environment. Outcome 3: analyze and describe the adaptation of organisms to their environments, factors limiting natural populations, and evolutionary change in an ecological context.

Biology 20, Unit A: ***Energy and Matter Exchange in the Biosphere*** – Outcome 1: explain the constant flow of energy through the biosphere and ecosystems (food webs). Outcome 3: explain the balance of energy and matter exchange in the biosphere, as an open system, and how this maintains equilibrium. **Unit B:** ***Ecosystems and Population Change*** **–** Outcome 1: explain that the biosphere is composed of ecosystems, each with distinctive biotic and abiotic characteristics. Outcome 2: explain the mechanisms involved in the change of populations over time.

Biology 30, Unit D: ***Population and Community Dynamics*** – Outcome 1: describe a community as a composite of populations in which individuals contribute to a gene pool that can change over time. Outcome 2: explain the interaction of individuals in populations with each other and with members of other populations. Outcome 3: explain, in quantitative terms, the changes in populations over time.

This guide also encourages the development of **Attitudes** cited in the Alberta Learning curricula, including:

- Appreciating the role of, and developing an interest in science
- Valuing curiosity, openness to new ideas
- Appreciating role of science in advancing our understanding of the natural world, being open-minded and respectful of other viewpoints, and appreciating that science and technology can have beneficial and harmful effects
- Appreciating the complexity of our planet and its diversity of ecosystems, taking responsibility toward environmental use within the limits of sustainable development
- Stewardship, collaboration, scientific inquiry, mutual respect

and the following **Skills**:

- Performing investigations, ask questions
- Collecting and organizing data into tables, graphs and diagrams
- Analyzing data
- Using mathematical language

The Grizzly Bear and You

This introductory activity prompts students to brainstorm their unbiased feelings and knowledge of grizzly bears and allows you to establish students' background knowledge. This activity will allow you to answer three basic questions: What do my students know? What are my students able to do? What else do I want them to know and be able to do?

Materials

- Grizzly bear picture

Time Required

- 30 minutes

Did you Know???

The Latin name for grizzly bear is *Ursus arctos horribilis* meaning bear of the north.

Instructions for the Teacher

1. Show students the following picture of the grizzly bear. Alternatively use a photo of a grizzly bear. Ask the students to think of the first word that pops into their heads when they see the picture. Ask the students to write a "one-minute paper" that states: what their word is, why they thought it, and what, if any, experience they've had with grizzly bears. Students may write about a personal encounter in the backcountry, a movie about grizzly bears, or even a bear joke. The sky is the limit! Have some students read their papers aloud.

2. **Computer Activity:** Before any discussion of bears can occur, students should have an understanding of basic bear biology, ecology and behaviour. During a computer class with Internet access, have students review the following website in an effort to answer these questions that you can write on the board, or provide in your own activity sheet. Have your students take the grizzly bear safety quiz that appears on this website to see how bear aware they truly are.

1. What is the average weight of a grizzly bear?
150-385 kg / 380 – 880 lbs

2. Name two plants and two animals that grizzly bears might consume
Plants: Hedysarum, cow parsnip, bearberry, buffaloberry; Animals: ground squirrels, marmots, rodents, goats, sheep, deer, fish, ants

3. Describe two key characteristic differences between black bears and grizzly bears
Grizzlies: hump of muscle on back, long claws for digging, silver-tipped fur, round face, small round ears. Black bears: no hump, short claws, uniform colour (though not always black), narrow face with "Roman" nose, large pointed ears. Note: colour and size are NOT acceptable answers as black bears can be blond and size is relative

4. Describe two signs of bear activity
Footprints, scat, diggings, claw marks, carrion

5. When do females give birth to cubs?
Winter

6. Name three precautions to take when travelling in bear country
Travel in groups, make noise, watch for bear signs and food, check bear reports

7. Name one thing you just learned about grizzly bears

http://www.mountainnature.com/Wildlife/Bears/

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Keys and Webs

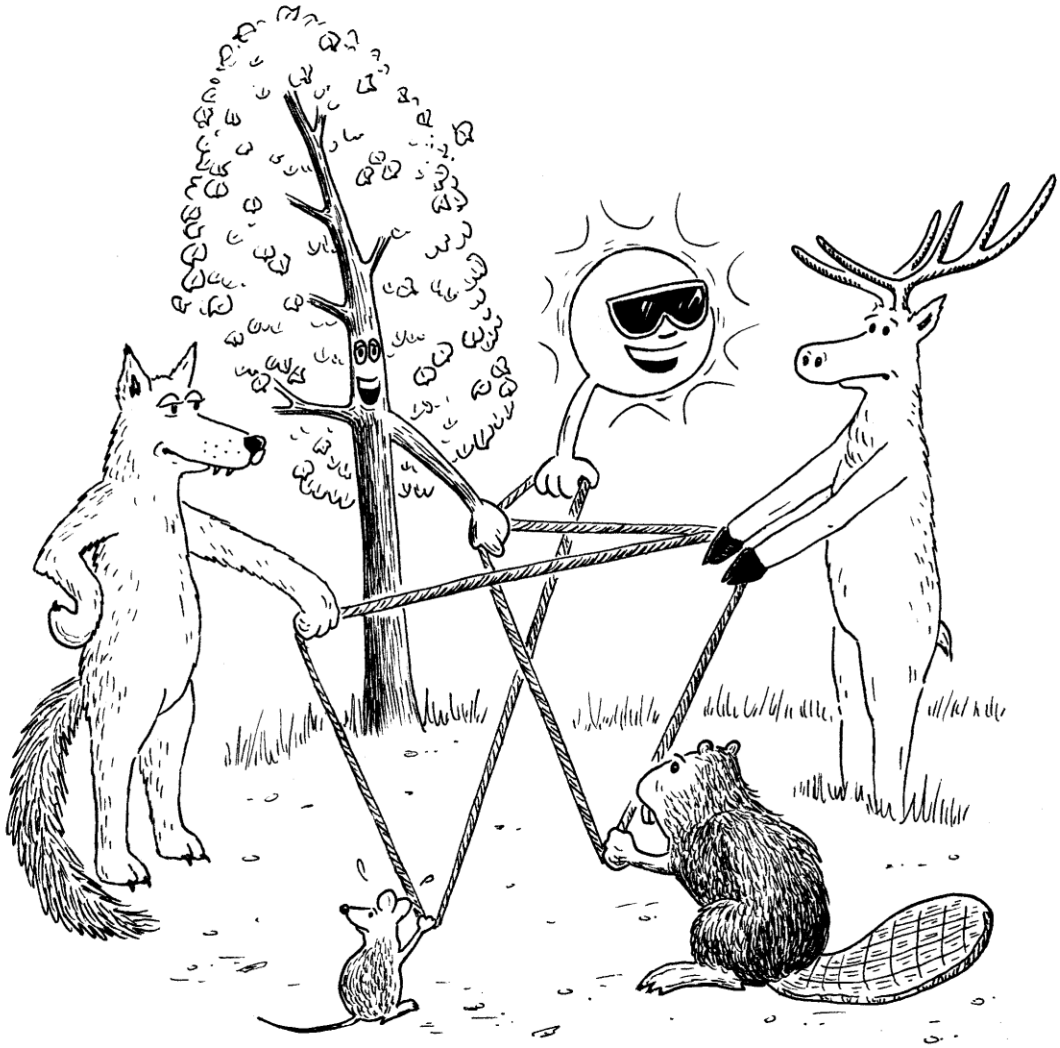
This activity has students use a dichotomous key to classify different organisms found in a Rocky Mountain Ecosystem. After identifying the different components, students build a food web to illustrate the linkages within ecosystems. *This activity was adapted with permission from Ducks Unlimited Canada's Wetland Ecosystems III (www.ducks.ca/edu).*

Materials

- Copies of the Rocky Mountain Species Diversity Table
- Copies of the Dichotomous Key

Time Required

- 45 minutes



Instructions for the Teacher

1. Review the following definitions and keywords with students.

Key Words

- ***carnivore:*** an animal that eats meat (e.g. a cougar)
- ***herbivore:*** an animal that eats plants (e.g. deer)
- ***omnivore:*** an animal that eats both animal and vegetable matter (e.g. grizzly bear)
- ***decomposer:*** an organism that breaks down organic matter (e.g. worm)
- ***predator:*** an animal that hunts, captures and kills another animal (the prey) for food
- ***prey:*** an animal that is a source of food for a predator
- ***producer/autotroph:*** an organism that makes its own food (e.g. green plant)
- ***heterotroph:*** a consumer organisms that cannot produce its own food and must rely on eating other organisms to meet its energy requirements
- ***consumer:*** an organism that feeds upon those below it in a food chain (e.g. herbivores that eat grass are consumers)
- ***primary consumer:*** herbivores that feed upon green plants or producers
- ***secondary consumer:*** carnivores or omnivores that feed upon herbivores
- ***tertiary consumer:*** carnivore that feeds on other carnivores
- ***food web:*** a complex system of interdependent food chains in a given ecosystem
- ***Law of Conservation of Energy:*** during a physical or chemical change energy is neither created nor destroyed, but may be changed in form and moved from place to place

2. Hand out the Rocky Mountain Species Diversity Table and Dichotomous Key. Review with your students how to use a dichotomous key. Keys have been developed by biologists to help others identify unknown organisms. As new species are discovered, their taxonomy must be developed using existing keys modified to include them. A ***dichotomous key*** is a simple chart that enables observers to identify and isolate the name of a specific item from a larger group of items, based on a series of either/or choices.

3. Review with students what a food web is. Ecosystems are characterized by their energy and matter exchange, which can be explained or illustrated using food chains, webs, or energy pyramids. In this exercize, students will create a food web from the species descriptions in the Diversity Table.

4. **Discussion:**

After the students have identified the scientific names and drawn their food webs, examine the interrelatedness of ecosystems. Ask students to consider what might happen if a component of the ecosystem was removed. For example, if a large development is created in a wildlife corridor, there may be too many humans and infrastructure to allow large carnivores to remain. If the large carnivores (wolf, bear, cougar) are removed from the web of life, many other species will be affected: buffaloberries and other plants would not get distributed or fertilized; rodent and ungulate populations may not be kept in check and they could destroy their food sources and habitat, which in turn would affect numerous other species.

Emphasize two points:

- Recent studies show that carnivores are far more important than previously thought. Their presence or absence will actually dictate how healthy the entire ecosystem is. This is known as the 'top down' or regulatory effect.
- Humans usually understand only a small amount of what actually goes on in an ecosystem: the relationships and interdependencies are too complex. This often makes our attempts to manage ecosystems unsuccessful or cause more damage than intended. Biologists and members of the environmental community have often asked decision-makers to use the ***precautionary principle***. In the face of uncertainties, it is better to be conservative in decision-making and take precautions to avoid unnecessary environmental damage.

5. For further extension, give your students a species and ask them to identify it as a primary, secondary or tertiary consumer (e.g. long-tailed salamander = secondary consumer).

Biology 30 Extensions:

Review with your students the following terms:

- ***Intraspecific competition:*** competition between members of the same species for limited resources, such as food, water or space
- ***Interspecific competition:*** competition between members of different species
- ***Commensalism:*** an interaction between two species that benefits one species, while the other is not affected
- ***Mutualism:*** a mutually beneficial relationship between two species
- ***Parasitism:*** a relationship that benefits one species, but harms the other

After developing the food web with students, ask them to describe the relationships between any linkages. Some examples:

- Canada buffaloberry – grizzly bear: *mutualism* (berries get distributed and fertilized)
- Grizzly bear – grizzly bear: *intraspecific competition* (for food in the harsh rockies)
- Hoary marmot – water vole: *interspecific competition* (for willow shrubs)
- Willow shrubs – lichens that grow on them: *commensalism* (no harm to willows)
- Wood ticks – moose: *parasitism* (tick outbreaks can harm moose populations)

Student Activity
Rocky Mountain Organisms

The following is a list of a few organisms found in the Rocky Mountain Ecosystem. Using the dichotomous key on the next page, identify the animals using correct species and genus names. Note that in this key, genus and species names are in italics. The genus name is capitalized and the species name is not. When you have identified the scientific name of each organism, use an underline to indicate italics (i.e. *Ursus arctos* may be written Ursus arctos).

COMMON NAME	SCIENTIFIC NAME
Mountain bluebird – These relatives of the robin are bright blue and can be found nesting in woodpecker cavities or nest boxes throughout the mountains. They may swoop to eat flying insects, or forage on the ground for beetles, ants and other terrestrial invertebrates.	
Hoary marmot – This marmot relies on sleeping to survive the harsh alpine environment – it hibernates for up to 9 months. This "whistler" feeds on grasses, sedges and herbs like yellow glacier-lily. These large, furry rodents run into their burrows to escape their predators, which include grizzly bears and golden eagles.	
Long-tailed salamander – These secretive amphibians feed on invertebrates under logs and rocks. As tadpoles, they are preyed upon by waterfowl; as adults, they are preyed upon by weasels and red-tailed hawks.	
Red-tailed hawk – The distinct "kieeeeaaarrr" call of this raptor can be heard throughout Alberta and on many movie soundtracks. Identified by their rusty-red tails, they dive to capture mice, voles, birds and amphibians.	
Yellow glacier-lily – One of the first flowers to bloom in early spring, the glacier lily's bright yellow flowers have 6 petals and grow from a bulb in the ground. Bears and rodents eat the nutritious roots, while deer and sheep graze on the seed pods.	
Moose – The largest member of the deer family in North America, the moose is well-adapted to its environment: long legs allow it walk over forest debris and through deep snows, and its big bulbous nose and lips hold willow twigs in place so the lower incisors can rip them off. Grizzly bears, cougar and wolverine prey upon moose calves. Only the bulls (males) grow antlers.	
Wolverine – Wolverines are extremely sensitive to human disturbance and their populations have declined across North America. These elusive weasels are highly predatory and hunt for birds, rodents and even large mammals like moose. These 5-toed carnivores look like a small bear with a long bushy tail.	
Mallard duck – Found across Alberta, these dabbling ducks feed on seeds, aquatic invertebrates and larval amphibians at the surface of the water, tipping only their head in, rather than diving to deeper depths. Mallards are frequently hunted by humans and other predators like coyotes.	
Willow shrubs – There are many types of willows that dot the Alberta landscape. Their woody vegetation is an important food source for ungulates (hoofed mammals) and rodents alike. Willows are also important for humans: willow bark contains a compound that is used in Aspirin. Seeds are hairy capsules (i.e. not fleshy).	

COMMON NAME	SCIENTIFIC NAME
Lynx – One of three wild cats found in our mountains, the lynx is identified by the long black tufts of fur protruding from its ears. Its primary prey is the snowshoe hare. Wild cats have four toes with retractable claws.	
Snowshoe hare – These animals are found almost anywhere there is dense shrub in the Rockies. They feed primarily on grasses and brush, including the buds, twigs and bark of willows. These hares are often mistakenly called rabbits.	
Grizzly bear – an emblem of the wilderness, grizzlies require large home ranges for finding food and surviving. 80% of this bear's diet comes from vegetation, including Canada buffaloberry or northern sweet-vetch. With their long 5-toed claws they will dig up ground squirrel burrows or pull apart decaying logs to eat ants. They will follow the smell of and eat rotting carrion up to 16 km away and occasionally hunt and kill young hoofed animals like moose or bighorn sheep. Their predators include other grizzlies, wolves, cougars and humans.	
Gray wolf – resembling a long-legged German shepherd with long large paws, the gray wolf can actually vary in colour (coal black to creamy white). Wolves are designed to eat large herbivores like bighorn sheep. Due to human hunting and habitat changes, wolf populations have declined across North America.	
Bighorn sheep – While both the females and males have horns throughout their lives, it is the ram's curl that is most recognized. Bighorns feed on non-woody plants (glacier lily) and grasses on alpine meadows and rocky slopes. Newborn lambs become prey for grizzlies, cougar and eagles.	
Northern sweet-vetch – Found on moist open slopes, these pink-flowered plants are members of the pea family (5 unequal petals). Sweet-vetch roots were widely used by native people for food. Grizzly bears will dig up the roots of sweet-vetch for food.	
Canada buffaloberry – Also called soapberry, the fleshy berries from this woody shrub are an important food source for grizzly bears in the Rockies. Grizzlies will eat up to 200,000 red buffaloberries per day!	
Wood Ant – There are at least 21 species of wood ants in Alberta that live in ant hills. Wood ants can bite when provoked leaving a stinging sensation from the formic acid stored in their abdomens. These invertebrates play an important role in pollinating flowers, distributing seeds and assisting in decomposing plant matter.	
Water Vole – Hikers may spot the small water vole hanging out by streams and creeks. The mouse-like vole's tail can be almost 10 cm long. These rodents feast on various plants and roots, including willows and glacier lilies.	

Student Activity
Rocky Mountain Organisms – Dichotomous Key

1. a) autotroph (go to 2)
   b) heterotroph (go to 5)

2. a) mainly woody stem or shrub-like (go to 3)
   b) not woody, herbaceous stem (go to 4)

3. a) fruits are fleshy……*Shepherdia canadensis*
   b) fruits not fleshy……*Salix spp.*

4. a) member of the pea family, 5 unequal petals ……*Hedysarum boreale*
   b) member of the lily family, petals in 3's or 6's……*Erythoronium grandiflorum*

5. a) invertebrate (no backbone)……*Formica spp.*
   b) vertebrate (backbone) (go to 6)

6. a) flying (go to 7)
   b) not flying (go to 9)

7. a) web footed, water living……*Anas platyrhynchos*
   b) not web footed, not water living (go to 8)

8. a) carnivorous……*Buteo jamaicensis*
   b) insectivorous……*Sialia currucoides*

9. a) hairy or furred (go to 10)
   b) not hairy or furred……*Ambystoma macrodactylum*

10. a) rodent (yellow upper and lower incisors) (go to 11)
    b) not rodent (go to 12)

11. a) mouse-sized……*Microtis richardsoni*
    b) larger than mouse-sized……*Marmota caligata*

12. a) hopping or jumping locomotion……*Lepus americanus*
    b) not hopping or jumping locomotion (go to 13)

13. a) carnivore (go to 14)
    b) herbivore (go to 17)

14. a) four-toed mammal (go to 15)
    b) five-toed mammal (go to 16)

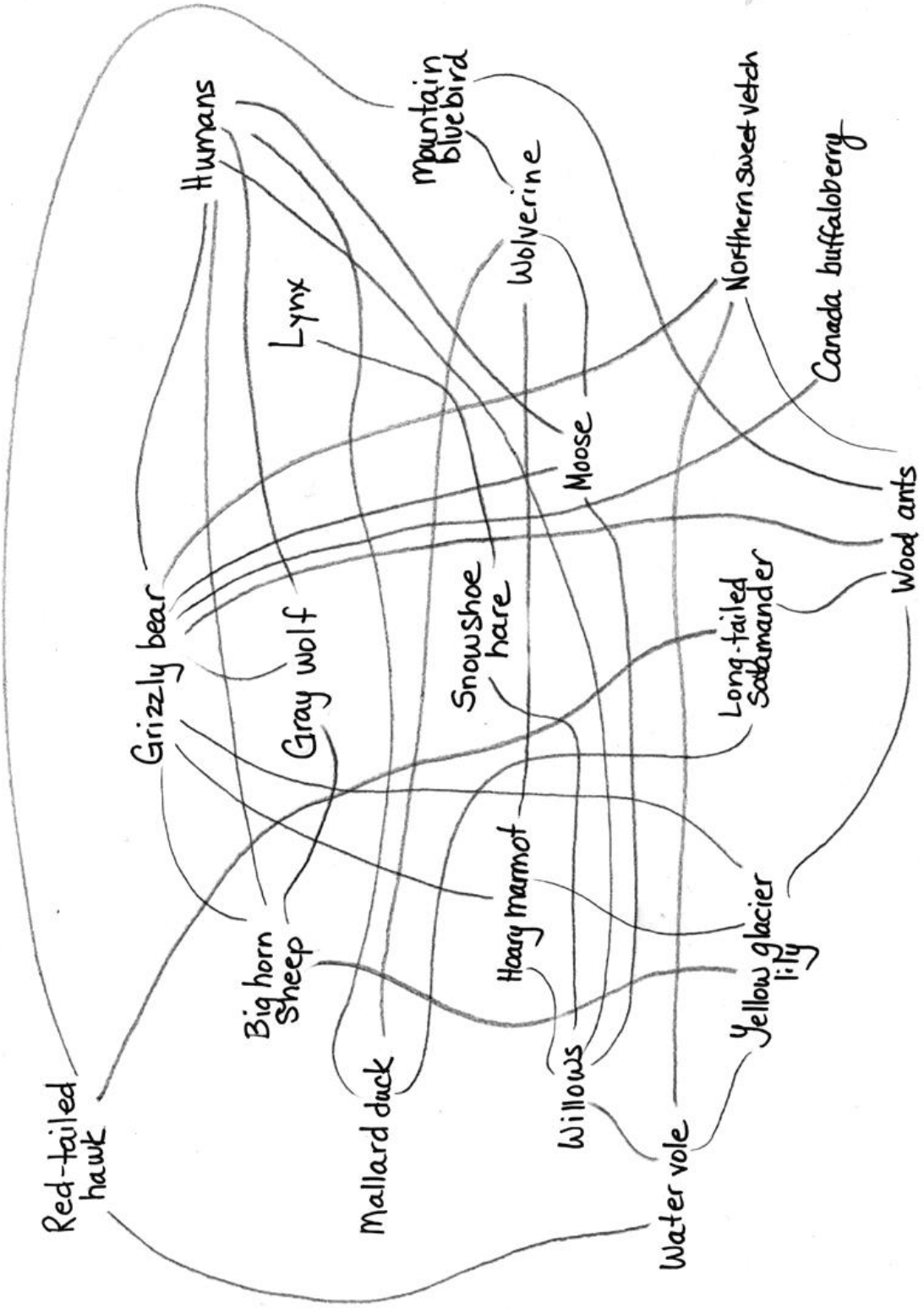
15. a) retractable claws……*Lynx canadensis*
    b) non-retractable claws……*Canis lupus*

16. a) tail small and inconspicuous…*Ursus arctos*
    b) long, bushy tail……*Gulo gulo*

17. a) both males and females have horns……*Ovis canadensis*
    b) only males have antlers……*Alces alces*

On the other side of this page, draw a food web to illustrate the linkages between the various species mentioned in this exercise.

Sample Food Web



Teacher Solution – Keys and Webs

COMMON NAME	SCIENTIFIC NAME
Mountain bluebird	Sialia currucoides
Hoary marmot	Marmota caligata
Long-tailed salamander	Ambystoma macrodactylum
Red-tailed hawk	Buteo jamaicensis
Yellow glacier-lily	Erythoronium grandiflorum
Moose	Alces alces
Wolverine	Gulo gulo
Mallard Duck	Anas platyrhynchos
Willow shrubs	Salix spp.
Lynx	Lynx canadensis
Snowshoe hare	Lepus americanus
Grizzly bear	Ursus arctos
Gray wolf	Canis lupus
Bighorn sheep	Ovis canadensis
Northern sweet-vetch	Hedysarum boreale
Canada buffaloberry	Shepherdia canadensis
Wood Ant	Formica spp.
Water Vole	Microtis richardsoni

Ecosystem Enigmas

In this activity, students learn about the enigmas that occur when we try to manage something as complex as an ecosystem. In small groups, students learn about ecosystem enigmas that arise from human interventions. Students subsequently design an experiment that they would do if they were biologists seeking to disprove or confirm their results. This activity describes the relationships between predator and prey species and their influence on population changes. It concludes with a real-life enigma: *Why Trees Need Salmon and Bears*.

Materials

- copies of the overheads
- student copies of "Why Trees Need Salmon and Bears"

Time Required

- 20 minutes

Instructions for the Teacher

1. Ask students:

Why do aspen trees need wolves?

It turns out that aspens need wolves to help keep populations of ungulates like elk in check - an elk's favourite food is the young shoots that aspen send up as they try to reproduce. Some areas around Banff townsite, for example, are so overrun by elk (because wolves rarely come close to the townsite) that there are no young aspen trees, and the ecosystem is changing as a result.

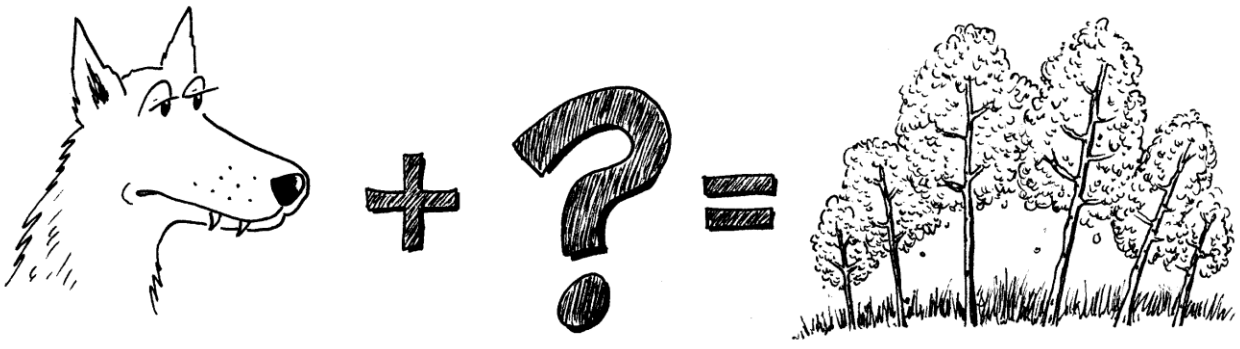
2. Tell students that this is an example of an ecosystem enigma. An enigma is a strange or odd observation, one that seems different from expected. Challenge students to "put on their ecologist hats" as they try to answer the following ecosystem enigmas...

Why do beavers need to be in the area in order for Yellowthroat warblers to flourish?

Beavers create swamps and ponds surrounded by low-lying shrubs - the favourite habitat of the Yellowthroat warbler.

Why are pollutants found in high alpine lakes that have never even been visited by humans?

The answer has to do with the "leapfrog effect." Scientists are finding that chemicals (such as



toxaphene, spread to control cotton pests in the U.S.) used in lower latitudes move northwards in air currents and only come to earth again where they are trapped by precipitation, such as the copious snow that falls in the Canadian Rockies.

Why do fences built to keep elk off the Trans-Canada Highway in side Banff National Park attract coyotes onto the road, where they are sometimes killed?
The fences work. Elk stay out of the highway area, allowing the grass inside the fence and beside the highway to grow tall. These grasses provide excellent cover for mice - and mice attract coyotes, who can squeeze through holes in the fence to get to the food. Unfortunately, they may stray too close to the highway and are killed by vehicles.

Why do these same fences sometimes mean death for Bighorn Sheep?
A coyote herd in the area of Lake Minnewanka learned how to use the fence to trap Bighorn Sheep against it, eventually causing the extinction of a whole herd of sheep.

Why does the presence of numerous elk in the Bow Valley threaten the very existence of the moose population - even though there's enough food for both species?

For decades, elk have been carriers of a nasty parasite called a liver fluke, a large slug-like parasite that tunnels into the liver of ungulates. Elk have grown used to this parasite, and it doesn't seem to affect them. But if a moose is infested with more than a couple of liver flukes, it may die. Increasing numbers of elk in the Bow Valley increases the chance that moose populations are infested with liver flukes.

Why does a beautiful ornamental plant, purple loosestrife, decrease duck populations in an area?
Purple loosestrife is a popular plant used in gardening. Unfortunately, this **non-native/introduced species** is very productive: each plant can disperse 2 million seeds per year. Once these seeds enter a waterway, the plant continues to grow and overtake wetlands, choking out native vegetation. Native herbivores eat around the plants, essentially eating themselves out of food. When purple loosestrife, a plant introduced to North America in the late 1800s, overtakes an area, wildlife populations, including ducks, suffer.

3. Ask the students:

Why do the numbers of songbirds decrease when an ecosystem loses its large, tertiary consumers/predators?
The overheads on the next pages can be used to answer this interesting question. The lesson for each overhead is described below

Overhead #1
Start by asking students:

If the population of wolves goes down in an ecosystem, how would it affect the population of song sparrows?

Accept all answers - but tell students that in this activity the habitat itself is assumed not to change, and that there is no direct predator/prey relationship – wolves don't eat sparrows.

Overhead #2

It turns out that when wolf numbers decrease, so do sparrow populations. Can you think of some kind of interaction or interrelationship that can be used to explain this?

Accept some guesses and theories from students, asking them to back up their answers and suggest how they would prove or disprove their theories if they were biologists.

Overhead #3 and #4

Tell students that animals such as raccoons are called ***mesopredators*** - they do not sit at the top of the food chain, but they definitely prey on the eggs and young found in any sparrow nest they might find on the ground (i.e. they are ***secondary consumers***). Wolves in an area might keep raccoon populations in check.

Overhead #5

This overhead shows the whole picture. Ask students:

Can you think of any other mesopredators that make life difficult for primary consumers?

Several exist around our urban centres. Skunks, raccoons, and coyotes are all examples of mesopredators that can become a problem in urban and rural areas where the tertiary predators (wolves, grizzlies, cougars) that once preyed on them are no longer part of the ecosystem.

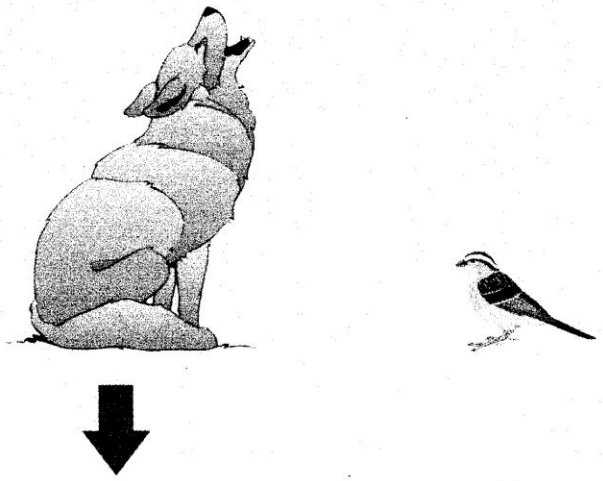
OVERHEAD #1

In an ecosystem, what will happen to the sparrow population if the number of wolves go down . . .

increase?

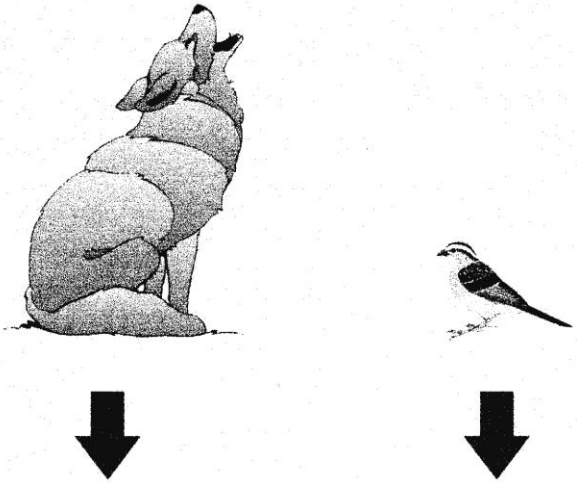
decrease?

stay the same?

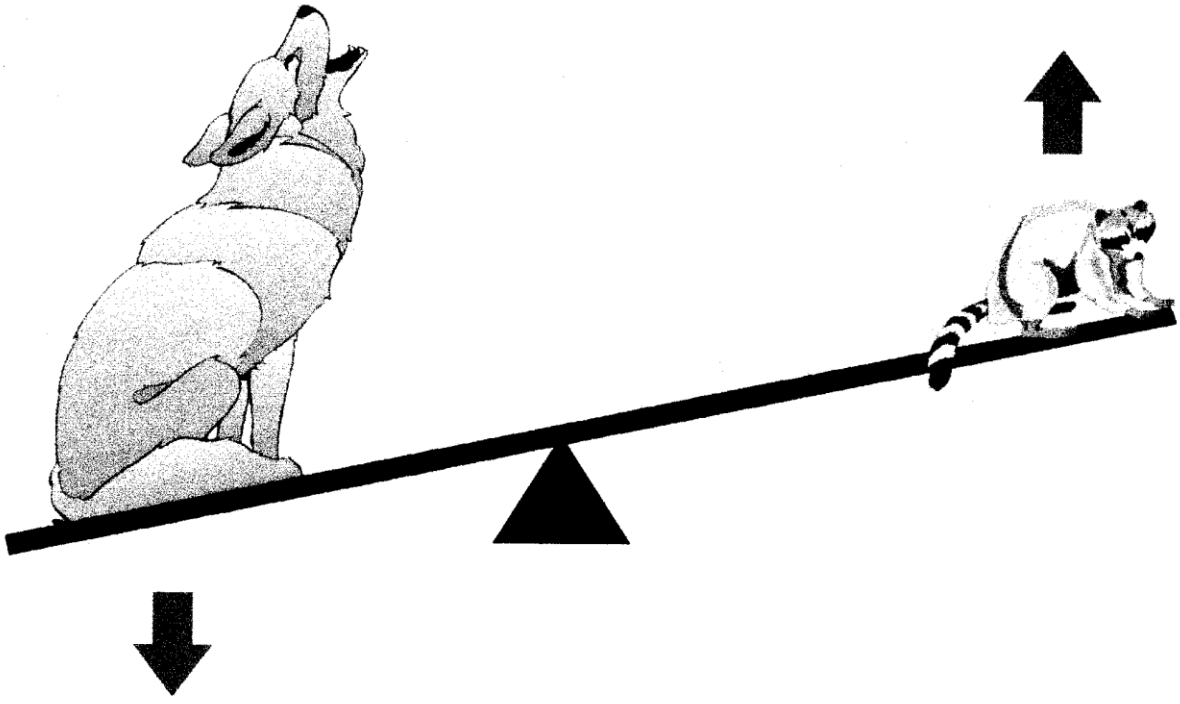


OVERHEAD #2

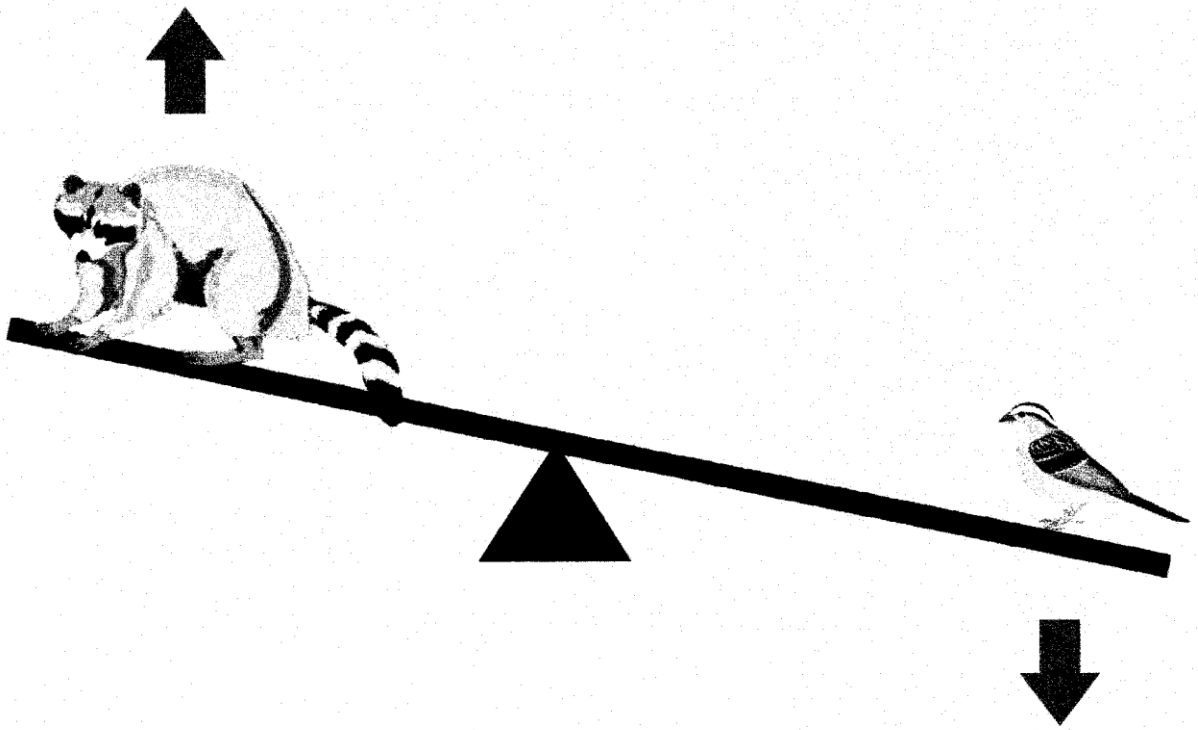
When wolf numbers decline, so do sparrow numbers even though wolves don't eat sparrows. What's going on?



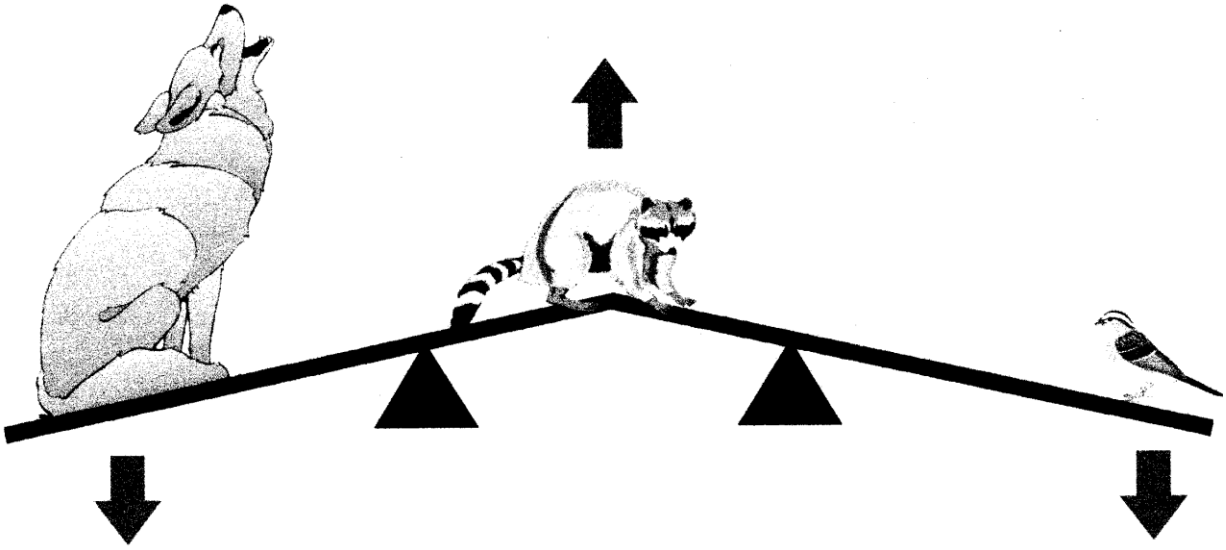
OVERHEAD #3



OVERHEAD #4



OVERHEAD #5



Large carnivores (e.g. wolves) keep meso-predator populations (e.g. raccoons) in check.

Further Extension

For a more scientific example of how ecosystem enigmas work, have your students read and answer the three discussion questions from the following article, ***Why Trees Need Salmon and Bears***.

Discussion

How would salmon populations be affected if grizzly bears were extirpated from this ecosystem?

Initially, salmon populations may increase if they lost a main predator. Over the long-run, though, salmon populations might be in jeopardy if grizzly bears become extirpated: there will be fewer nutrients entering the forest, which may cause the health of the forest to decline. The riverbank may become less stable and erode, contributing to a loss in water quality and oxygen content in the stream ultimately reducing salmon survival.

What would happen to riparian (riverside) forests if salmon populations plummeted?

The state of British Columbia's salmon stocks often make the news. Native marine salmon may be adversely affected by salmon-farming (aquaculture). Overharvesting also threatens populations. If salmon populations dropped, grizzly bears would not be able to transfer important nutrients into the riparian forests. Forest and overall ecosystem health might deteriorate.

How could information about these types of ecosystem interactions affect land management?

Knowing that ecosystem components are intrinsically linked should affect the way we manage ecosystems. Traditionally, land management has focused on a single species rather than viewing an ecosystem as a function of several interrelated factors. Decisions concerning land management should be ecosystem-based, or should focus on several species as opposed to a single species. More funds might be needed for managing lands in this manner.

Dr. Reimchen's discoveries, though thorough, may lead us to ask: "What else don't we know or understand?" It is part of the nature of science that there will always be outstanding questions. Yet development continues in spite of biologists' unanswered questions. The reaction of biologists and of many in the environmental community has been to call for decision-makers to use the ***"precautionary principle".*** Concerned citizens and professionals say: "In the face of so many uncertainties please be conservative in your decision-making and take precautions to avoid unnecessary environmental damage."

Why Trees Need Salmon and Bears

Grizzly bears have a huge appetite. In the fall, they must consume 20,000 calories of food energy per day – equivalent to eating 40 hamburgers and 40 sundaes! The grizzlies in Alberta's Rockies receive the majority of their food energy from vegetation, like Canada buffaloberries. They aren't as lucky as the bears in British Columbia's temperate coastal forests, who can feast on a high protein and energy diet of spawning salmon. Here, grizzly bears will smash salmon against the riverbed or scoop them up the swipe of one claw and feast on the choicest parts of the salmon carcass. The coastal grizzly bears' annual salmon feed is critical to their health as they receive between 33-94% of their yearly protein from salmon (Klinka 2002). This in turn positively effects their body size, reproductive success, litter size and population density. It's easy to understand that bears benefit from these fish; however, researchers wondered if grizzly bears were the only species that benefited from spawning salmon.

University of Victoria professor, Dr. Tom Reimchen, investigated this over a decade ago and since then has learned that there are many linkages between marine and terrestrial ecosystems. Eagles, ravens, gulls and crows transfer salmon nutrients from water to land. However, Dr. Reimchen and his research team learned that both black and grizzly bears are the primary vectors for recycling salmon. In 40 days, (the average length of time for the salmon run), one bear can carry up to 700 salmon into the forest! (Baron 2000). Decaying salmon helps feed maggots and insects in the spring, which in turn feed warblers and flycatchers. The decaying salmon matter also serves as an important forest fertilizer by releasing nutrients such as nitrogen into the soil.

To prove that plants and trees were using the decaying salmon as a fertilizer, Dr. Reimchen traced a nitrogen isotope, N_{15}, that is found only in the deep waters of the Pacific Ocean (by comparison, our atmosphere consists of 78% N_{14}). He found that N_{15} appears in the growth rings of trees in the coastal rainforest. How did it get there? Dr. Reimchen concluded that when spawning salmon return to BC coastal rivers, their bodies carry large amounts of N_{15}, gathered during their years in the Pacific Ocean. Bears catch and devour the salmon, bringing the nitrogen-rich fertilizer into the forest (Coastal 2003).

By finding and measuring the concentration of N_{15} in various plants and trees, Dr. Reimchen confirmed that salmon are present in the forest. In fact, some studies show that N_{15} accounts for between 22 and 50% of the total nitrogen within the trees, demonstrating that salmon are directly contributing to the nutrient needs of coastal and terrestrial plants (Baron 2000, Helmfield 2001).

But the cycle doesn't stop there. It seems that by fertilizing forests, salmon are actually protecting their own habitat. Trees on the banks of salmon-filled rivers grow faster than those along salmon-free rivers. These larger trees clean and shade the water, enhancing salmon egg survival. Strong river currents cannot shift large fallen trees, leaving small fish somewhere to hide (Helmfield 2001). As these trees decompose, nitrogen is released back into the rivers and streams, feeding tiny insects and plants that new salmon depend on for survival (Baron 2000).

Discussion Questions

1. How would salmon populations be affected if grizzly bears were extirpated from this ecosystem?
2. What would happen to riparian (riverside) forests if salmon populations plummeted?
3. How could information about these types of ecosystem interactions affect land management?

References

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Disperse or Decease

In this activity, students learn about how dispersal helps young animals find a home and spread the family genes into another area. In the role of their favourite animal, students try to help their offspring disperse into new habitat areas - or deal with the horrible consequences! Students practice their basketball skills as they learn what kinds of parks are easily colonized and how this affects communities and populations. An examination of island biogeography and how grizzly bear habitat has been fragmented over time follows. Follow up the discussion with the next activity, *Uncertain Future*, to have a look at how bears have been affected by habitat fragmentation. Note*: this activity is adapted from one developed by the Province of British Columbia, found in an activity guide entitled "Protected Areas: Preserving our Future."*

Materials Needed

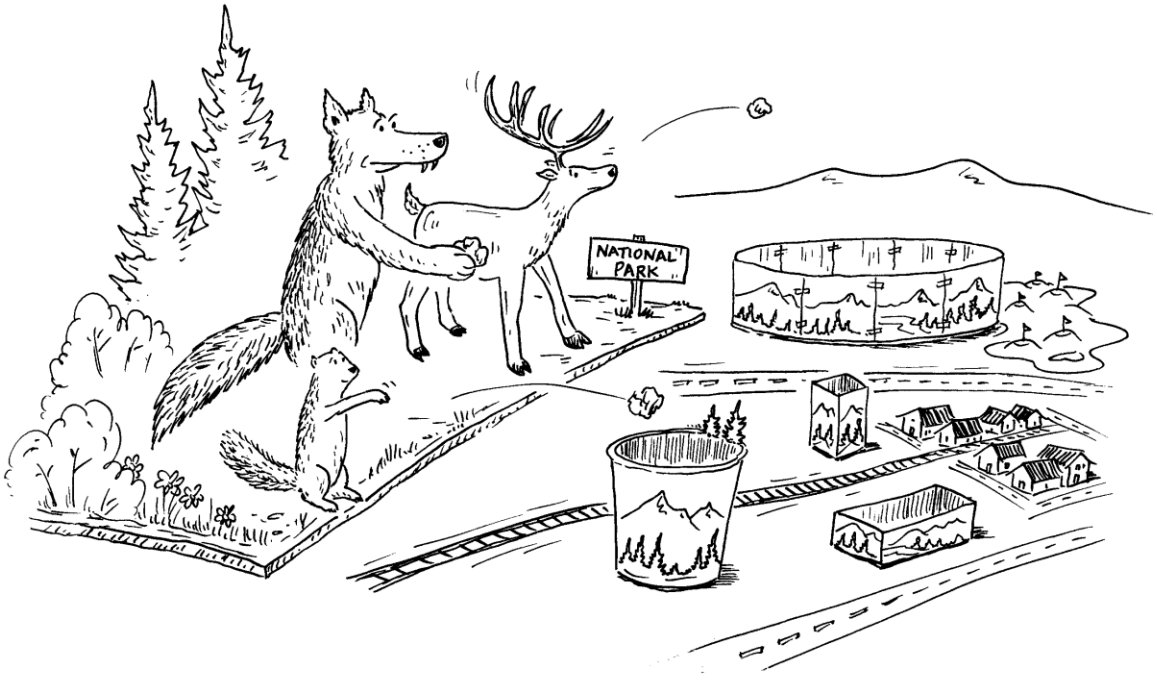
- at least a dozen clean scraps of paper from the paper recycling bin per student
- half a dozen containers of similar sizes (these can be gallon ice cream containers or similarly-sized receptacles)
- six containers of dramatically different sizes (e.g. a large box, the classroom garbage can, a large mug, etc. All containers should be as deep as possible.)

Time Required

- 20 – 30 minutes

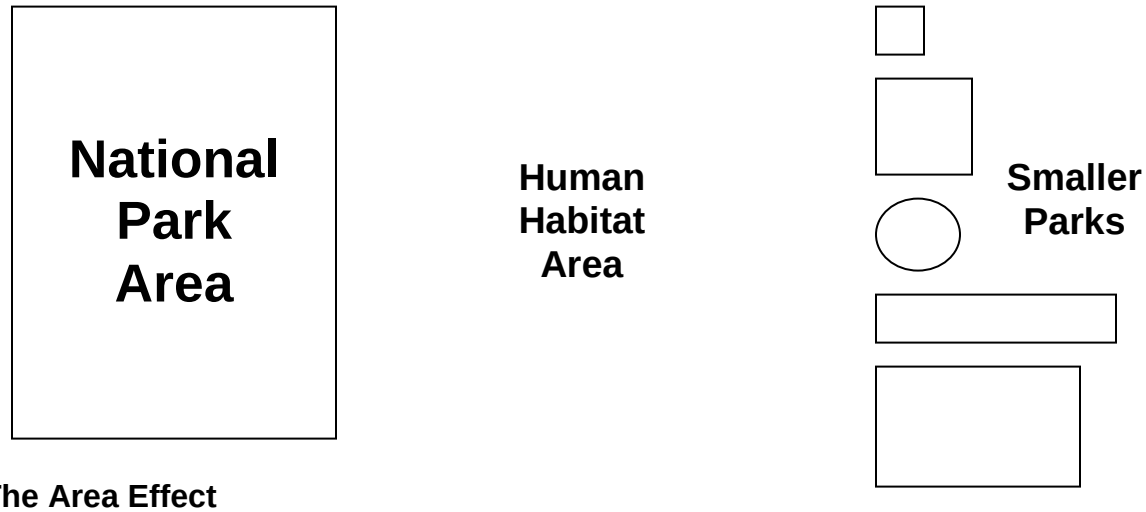
Instructions for the Teacher

1. Ask students if they plan to always live at home. They'll probably say "No!" Tell them that the same is true for ALL young animals, and that they'll learn more about how this works in this activity.



Ask students to define the following terms.

- ***Immigration*** – the movement of animals into an area
- ***Emigration*** – the movement of animals out of an area
- ***Dispersal*** – this is a process in which animals move from place to place within their habitat. It is commonly used to mean the movement of adolescents away from their family group to an area where they begin life as an adult. (Note: this term is also used to describe the movement of animals AND plants; however, this activity focuses on animal movement).
- ***Colonize*** **–** this is derived from the word 'colony,' which is a portion of land that is an outpost of a larger 'mother' country. Colonization in the animal world refers to a process in which animals disperse into an area previously uninhabited by their immediate family.
- ***Island Biogeography*** **–** the study of the distribution and dynamics of species in island environments.



The Area Effect

2. Spread the containers out in the pattern shown above. All containers must be the same distance from the largest rectangle, which you should refer to as the "national park area."

3. Distribute the paper to the students, and ask them to wad up the paper to create a dozen projectiles that they think they could throw with a fair degree of accuracy. (As an option, have them mark their paper with their initials on the outside, or use some other distinguishing feature so that each student can identify them later).

4. Invite the students to enter the national park area (it should be large enough and long enough to comfortably hold all of them). Tell them:

In this game, all of you will take on the role of a wild animal that might live in a national park. What kind of animal would you like to be?

Have students decide which animal they want to be (it doesn't change their performance in the activity, but it does turn out to be important during the discussion at the end).

Tell students:

In this activity, you are all parent animals. You have a large, healthy family, and all your offspring are old enough to leave home. These juvenile animals will be represented by paper balls you have made.

But this national park is overflowing with these juveniles! The only place that the juveniles can find good habitat and reproduce is in one of the adjacent parks, which all offer suitable habitat for your animal, even though they are different sizes. Each of the parks is surrounded by settled human farmlands, towns and cities, and your animal cannot live there. But you can travel across these areas if you are lucky.

There are two important reasons it would be good if your juvenile paper ball could 'colonize' these parks. One is that a large forest fire had eradicated all species from two adjacent parks (indicate two adjacent parks of different size). The other reason is that ALL of the other parks are isolated, and even the wildlife populations in the larger parks are beginning to suffer from inbreeding. New genetic stock from the national park is desperately needed to help those populations survive in the long term.

So... when I say "Disperse!" you will have exactly one minute to help all of your offspring disperse into the nearby parks. To represent the long and dangerous voyage through settled land, you will throw your juveniles. You can choose any park as a target. Any jostling or elbowing at the edge of your national park will not be permitted.

5. Say "go!" and let the students start throwing. Distances should be such that there are lots of paper balls that miss their target. After one minute is up, count the number of balls inside each container. Then have students collect and count their paper balls.

6. Ask the students:

What happened to those juveniles that fell onto the floor?

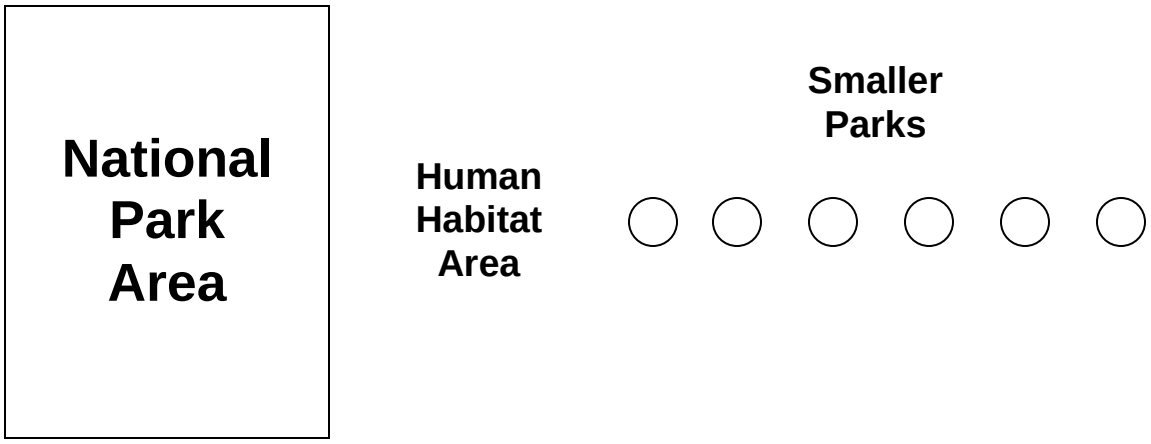
Without the food, water, and shelter afforded by the habitat found in parks, juveniles will eventually die. Travelling through inhospitable land is a hazardous activity; this is the reason the juveniles of most species have high death rates in their first year.

How many of your offspring made it into a park?

Have students indicate with a show of fingers, and highlight the most successful families (i.e. those with a certain number of juveniles that made it). Remind students that the most successful parent "throwers" are the most likely to have their family genes occur in subsequent generations.

7. Summarize your data in a table, and plot your results on a rough graph. You may wish to have students do this more exactly, calculating the area of each island.

Tell students that they have just discovered the ***Area Effect:*** parks of larger area are more likely to be colonized by juveniles than smaller parks. For this reason, smaller islands have fewer species than large islands.



The Distance Effect

8. Spread the six identical containers out in the pattern shown above. All containers must be the same size - the only difference is their distance from the national park. Again, invite the students to disperse into as many of the 'islands' of habitat as possible. Because students may try to get as close to the parks as possible, you may wish to avoid jostling for position by dividing students into four or five groups and give them each a minute to disperse their balls.

Again, count the number of balls inside each container, then have students collect and count their paper balls. Summarize your date in a table, and plot your results on a rough graph. You may wish to have students do this more exactly, measuring the distance from the national park to each island.

9. Tell students that they have discovered the ***Distance Effect:*** the further an island of habitat is from the national park, the less likely it is to be colonized.

10. Ask students if their species would benefit if you were to place a thin strip of land between the national park area and the closest small park! (You could even lay down several sheets of paper to illustrate what this might look like). Most of them would benefit! This illustrates the usefulness of ***wildlife corridors***, strips of land that dispersing species can use to get from one refugia to another.

Wildlife Corridors

Segments or pathways of land that connect critical wildlife habitat; used by animals to migrate and disperse. In the Rockies, valley bottoms are important corridors for large carnivores.

11. Review with the students the basic principals of Island Biogeography, including a discussion of the genetic implications of isolation.

Some general principals of colonizing islands (land surrounded by water or disconnected, fragmented habitat)

1) The closer the island to another land mass, the higher the probability of colonization.
2) The older the island, the more likely it will be colonized.
3) The larger the island, the more species are likely to be established.
4) Geographic isolation reduces gene flow between populations.
5) Over time, colonial populations become genetically divergent from their parent population due to natural selection, mutation, and/or genetic drift.

Discussion

12. Ask the students:

In many ways, this activity is not realistic. Why?

Students should realize that some animals that are more sensitive to human presence would not be able to disperse through the settled landscape of farmland and human habitation - particularly if there were a lot of towns and cities in that landscape.

Also, when it comes to dispersal, 'not all animals are created equal.' The students that chose to be fast-flying birds would be able to disperse much easier than slow-moving ground mammals such as bears.

How can land managers and conservationists use this type of information when considering new parks?

- focusing on conserving large reserves over smaller ones
- minimize the distance between parks
- ensure the presence of effective wildlife corridors to facilitate travel between refuges

How could human use of the landscape make it easier for animals to disperse?

Suggestions might include:

- preserve or create wildlife travel corridors between all parks
- build overpasses or underpasses to help animals cross train tracks and roads
- in farming areas, leave hedgerows and hedges to provide animals some cover as they travel
- have slower speed limits and warning signs in areas used extensively by dispersing animals

For a "real-life" example of these issues, present the following activity, *Uncertain Future*.

Uncertain Future

As a follow-up activity to *Disperse or Decease*, students compare the historical and present distribution of grizzly bears in North America and try to deduce from this information what changes have occurred within the ecosystems.

Materials

- tcopies of all illustrations

Time Required

- 60 minutes

1. Illustrate for students how grizzly bear habitat has become fragmented or island-like and discuss how that has affected the population over time. With your students review the map, Historical Distribution of Grizzly Bears. Ask them:

Was the grizzly once found in Mexico, throughout the mid-west states, or Saskatchewan?

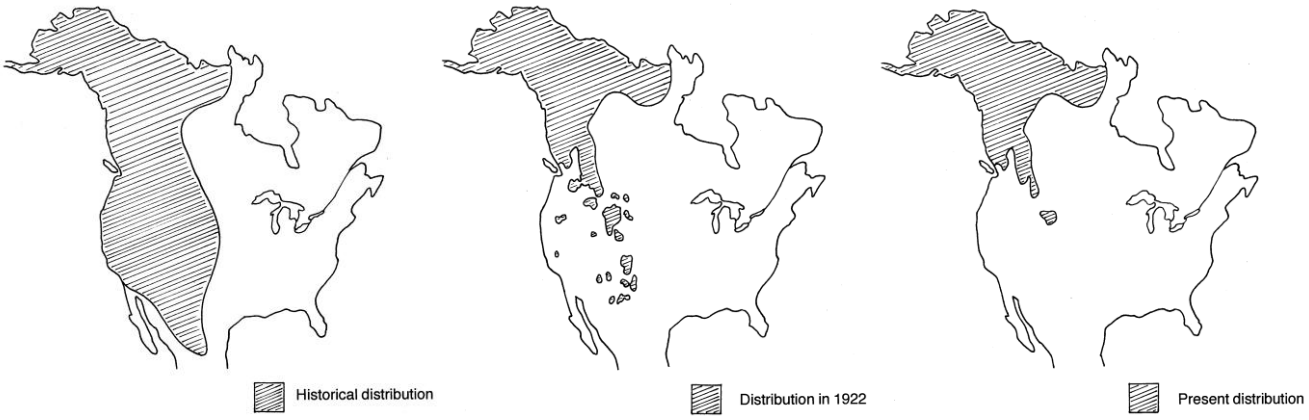
The answer is to all three questions is yes! In fact, the grizzly is believed to have evolved in the grasslands, developing its long claws and hump of muscle on its back to help dig up plants and ground squirrels.

2. Show the 1922 Distribution of Grizzly Bears. This map shows where the grizzly could be found over 75 years ago. Ask students:

Why do you think the range of the bear has shrunk?

The West experienced massive immigration of pioneering families over the last century. As the land was ploughed up and cities, railways, roads and industrial plants were built, the natural habitat that bears need to survive was fragmented or destroyed. This habitat loss, along with intense hunting pressure, eventually caused grizzly bears to disappear from settled areas.

In 1922, the scattered remaining 'grizzly bear areas' in the U.S. became surrounded by human development, and might as well be considered as islands of habitat floating in a sea of developed land.



Ask the students:

What if you were a bear in one of these smaller "islands" of habitat (point to one of the smaller enclaves in California). Would you predict that grizzly bears still live there today? Why or why not?

Grizzly bears no longer live here. The "islandization" of bear populations means they are isolated from other populations. They cannot connect with each other for breeding purposes. As a result, inbreeding and weakening of the population occurs, usually resulting in ***extirpation*** (local extinction) of bears from the area. Once a population dies out, whether from disease or over-hunting, no new bears can colonize the area because the islands of habitat are no longer connected to each other. This is what happened to the habitat islands of 1922.

Extirpation

When a species goes extinct in one area, but still exists elsewhere; also known as local extinction

3. Show students the Present Distribution of Grizzly Bears map. Ask them:

What is the name of the remaining U.S. "island?"

This is Yellowstone National Park. It supports a population of approximately 300 grizzly bears, which are believed to be isolated from grizzly bears to the north by ranches, highways, and other development.

Do you think the bear will become extinct in Yellowstone?

Nobody knows. Much uncertainty still exists about "how low you can go" in population numbers and still be sustainable. The U.S. government spends millions of dollars annually to keep the Yellowstone population alive.

Brainstorm with the class possible answers to the following question:

If you were the park superintendent in the year 2020, and your bear population was becoming inbred, what could you do to save this population?

Scientific evidence suggests that the best solution to this problem is to create sufficient **wildlife corridors** and **core refugia** to allow the bears to reconnect with populations to the north.

Other, less effective measures could include the capture and release of grizzlies from Canada into Yellowstone. The probability of survival for relocated bears is low because some grizzly bears try to return to their home, and encounter roads, hunters or other threats on their way. Other grizzly bears are released into areas that are already occupied by a more powerful, dominant grizzly. This approach also requires a healthy Canadian bear population, political will on both sides of the border, and must be continued forever.

Core Refugia

Protected areas that provide critical habitat and areas to rest.

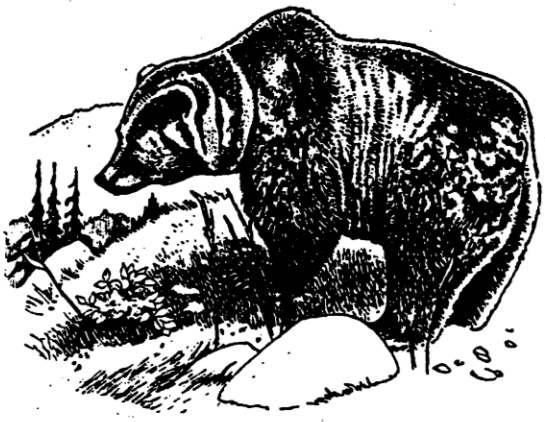
On the Present Distribution of Grizzly Bears map, locate the "pinch point," the slimmest point at the base of the long peninsula that reaches down into the northern U.S. Tell students that the Banff Bow Valley is located here, and ask them:

What human activities would cause this point to pinch off completely, forming a second island of habitat?

Increased development in the Bow Valley would cause this, particularly if it cuts off the wildlife corridors that connect the peninsula with habitat north of the valley. Development includes railways, highways, urban expansion, resort development, and increased human use.

4. Introduce to students the concept of the Yellowstone to Yukon Conservation Initiative (poster provided). Additional information about the Y2Y can be found at their website: *http://www.y2y.net*.

Historical Distribution of Grizzly Bears (1800s)



Historical distribution

1922 Distribution of Grizzly Bears

Present Distribution of Grizzly Bears

Bears of Banff

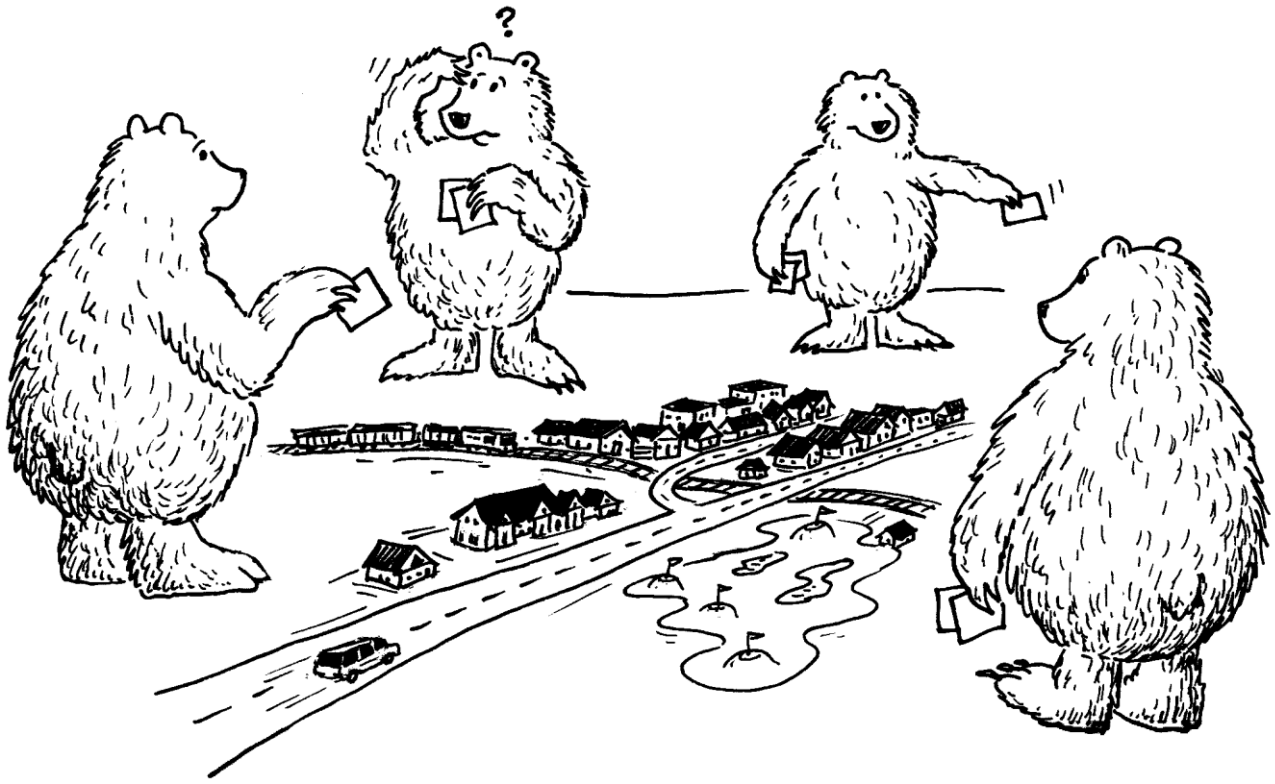
In this simulation activity, students assume the role of grizzly bears as they try to survive and pass on their genes in Banff, Canada's 'flagship' national park. Students will discover how human activities can sometimes "get in the way" of a bear's procreation opportunities...This activity compliments Births and Deaths.

Materials

- Two or three large sheets of fabric or paper
- two 5 metre lengths of coloured twine or rope
- two short (30 cm) boards or two pieces of construction paper
- enough coloured cards so that each student has a set of five cards (i.e. in a class of 30 students you'll need 30 blue, 30 green, 30 red, 30 yellow, and 30 black cards)
- an open space of at least 3 x 5 metres

Time

- 30-40 minutes



Instructions for the Teacher

1. This activity is all about breeding! If needed, review the key words below and then begin this activity by inviting students into a large area that can comfortably hold the entire group. This could be as simple as the classroom with desks moved aside.

Key Words

- ***Population genetics:*** the study of how the principles of genetics function in populations
- ***Genes:*** a unit of heredity composed of deoxyribonucleic acid (DNA)
- ***DNA:*** deoxyribonucleic acid, the genetic material of living organisms
- ***Genetic diversity****:* differences in the genetic make up of an animal population; these differences are passed from the parents to the young. Genetic diversity improves the ability of a species to survive in a changing environment
- ***Gene pool:*** the sum of all the genes present in a population of organisms
- ***Inbreeding:*** mating between closely related individuals
- ***Inbreeding depression*****:** when continued inbreeding results in harmful characteristics in a population because of poor genetic diversity
- ***Dispersing:*** when an animal travels long distances from their birthplace to mate with individuals from other families

2. Tell students that they have just entered a national park, and show them the boundaries of the park. Tell them that the park borders are all impassable mountains, that all activities must occur within the park area you have defined and that, in this activity, they will play the role of grizzly bears!

3. Ask the students to name three very basic things that every animal needs to survive. They should answer 'food, water, and shelter.' Tell students that in this game, it is assumed that they can meet these basic needs - what they will be tested on is their ability to *mate*!

4. Distribute the cards so that every student has five differently coloured cards. Tell the students that the long-term *sustainability* of animal populations requires the mixing of *genes* to keep the population healthy, and that normally individuals ensure proper genetic mixing by *dispersing*.

Teaching Tip

Handing out all those cards can really take up time…

Save time by asking 5 students to stand in a circle while each holds a stack of cards (one student has all blue, one has all red, etc.)

Get the remaining students to walk around these students in a circle and take one card from each.

5. Tell students that the cards they are holding represent their genes, and that when you give the word to "Disperse" their task is to trade cards with other bears from across the room until they have five identical cards.

6. Say "Disperse!" It should only take a minute until all trading ceases. Ask students to put up their hands if they were able to achieve the task; you should see all or the vast majority of students put up their hands. Congratulate them on their ability to disperse and their good genetic prospects.

7. Next, find out how many students were unable to fill their hand with five identical cards. Tell these unfortunate individuals that they are the victims of ***inbreeding***, a genetic phenomenon in which mating with related animals results in not enough genetic mixing. Inbreeding may result in the appearance of harmful recessive traits or body asymmetry. Tell students that any bears who suffer from inbreeding in three successive rounds will be diagnosed as suffering from so much ***inbreeding depression*** that they can no longer reproduce, or even survive long enough to reproduce. These bears will be forced to leave the game.

Remind students that inbreeding depression is one of the more obvious reasons our human society has *taboos* against incest and inbreeding.

Inbreeding Depression

Occurs when individuals in a population are harmed by generations of inbreeding (not enough genetic mixing).

These individuals may not be able to reproduce as well as healthy individuals, may suffer from mutations and may have a lowered resistance to disease.

The Florida Panther (pop = 30-50 cats) show signs of inbreeding: 80% of males show reduced sperm count and there is a failure of reproductive organs to develop properly.

8. Tell students:
"Great news! Humans have finally come to live in the valley, and will be located in a modest townsite in the centre of the park, with a simple road crossing through the park to supply essential services to the town." (place a large sheet of paper or fabric in the centre of the space, and a rope through the sheet that bisects the park area). "Sorry, bears, but as you know towns and roads are dangerous for bears; bears are asked not to step onto the sheet, and any bear seen stepping across the road will be killed by myself, who today will also playing the role of a truck."

9. Tell students that when you say "Disperse" this time, their task is to fill their hand with five differently coloured cards (i.e. it will look like the hand they started off with). Say "Disperse" and let the next round proceed.

10. Play several more rounds with the students: after each "Disperse!" their task is to fill their cards either with five identical cards or five differently coloured cards. Have students give a show of hands so that you can all monitor the onset of inbreeding depression!

Add any of the following changes to the park after each round:

Round 3: Add a railway track at right angles to the road (divides the game area into quarters).

Round 4: Double the size of the town by adding commercial shopping area "to give people something to do when they come to the national park."

Round 5: Build a large oil refinery just outside the park boundary - the "halo" around this development creates a large area inside the park where bears will not go (put a sheet here).

Round 6: Build an affordable housing unit and an airfield in two different places, reaching from the townsite to the boundary, causing yet more habitat fragmentation.

Round 7: Pause here and tell the bears that there has been a proposal by an environmental group to build a wildlife overpass that would allow animals to cross the highway (place the board over the highway to show them what it would look like). Ask the 'bears' if they are in favour of this proposal - but then tell them, "Who ever asks bears for their opinion?!" Tell the bears that the proposal has been turned down, and say "Disperse!"

Round 8: Pause again and tell students that the government has twinned the highway, but to make up for it has built two wildlife overpasses over the highway (put these two boards in place). Also, the Banff-Bow Valley Study spent two years (and two million dollars) and to come up with a set of recommendations that included closing the airfield. Ask the bears again if they are in favour of these changes; there may be some dangerously inbred populations that are very happy about this restoration! Take out the airfield, put overpasses on the highway in two places, and find out if these changes help cure any bad cases of inbreeding depression.

Discussion

11. The main intent of this game is to demonstrate how incremental development in this park makes genetic mixing more difficult. Scientists have noticed the first signs of inbreeding depression in the park's grizzly populations, which might eventually lead to the extirpation of the species within and south of Banff. Please see the next activity ("Bear Genetics") for specifics.

Ask students:

In future rounds of this game, do you think it would get easier or more difficult for the bears?

Things could go either way, but one thing is for sure: even in a national park, humans have a hard time saying, "That's enough." Incremental development, in which human structures advance in tiny increments year after year, is a major threat to our remaining natural areas.

12. Banff National Park is the site of discussion between those who believe that "Parks are for

People," and those who believe that the first job of a national park is to protect the animals that live in it. Ask your students to discuss what they believe parks are for. As a follow-up, remind students that our National Parks Act holds protection of plants and animals to be of primary importance.

13. **Bio 30 Extensions**

Use this activity to engage students in discussion of the Hardy-Weinberg Equilibrium.

- ***Hardy-Weinberg Equilibrium:*** a situation where allele frequencies and genotype frequencies remain constant from one generation to the next under certain assumptions (no mutation, no migration, random mating, no selection, infinitely large population)

Ask your students

In this activity, which of the assumptions in Hardy-Weinberg is/are violated?

Large population. The population in this activity is very small, which can cause inbreeding. Inbreeding causes a loss in heterozygosity, leading to inbreeding depression, the appearance of harmful recessive traits, or body asymmetry.

Does the Alberta Rocky Mountain population of grizzly bears meet the Hardy-Weinberg Equilibrium?

No. Bears migrate over great distances; this violates one of the assumptions of Hardy-Weinberg.

Bear Genetics

Ok, everyone out of the (gene) pool! This activity explores the genetic diversity of grizzly bear populations in the central Rockies ecosystem. Students use data collected by the *Eastern Slopes Grizzly Bear Project* to examine what is happening to the bears' gene pool, and to find out if the Trans-Canada highway is causing genetic isolation of bear populations.

Materials

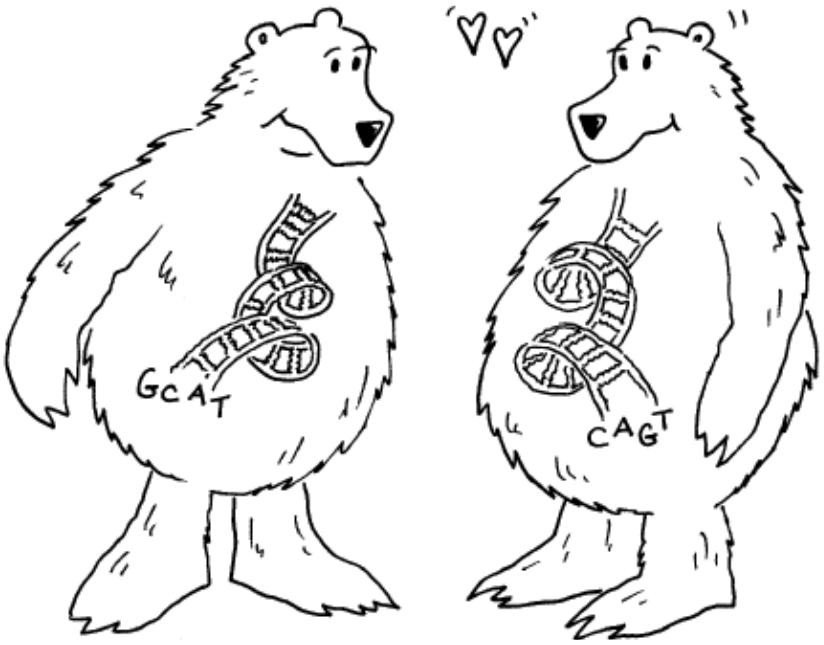
- Pencil and paper for each student
- Calculator for each group
- Photocopies of *worksheet* and *Table 2* for each pair of students

Time required

- 60 minutes

Background

Blood samples taken from grizzly bears during the 1994 and 1995 field seasons were analyzed by researchers in the Eastern Slopes Grizzly Bear Project to provide two different measures of genetic diversity: **microsatellite** DNA and **mitochondrial** DNA. These measures were used to assess genetic diversity between individuals in a population. Mitochondrial DNA (mtDNA) is inherited from the mother and for simplicity's sake, will be referred as *Maternal DNA*, while Microsatellite DNA will be referred to as *Regular DNA.* If one particular line of DNA is found throughout most of a population, there is a high degree of interrelatedness and low degree of genetic diversity. For a human example, if three-quarters of the people in one village could trace their family trees back to the same female ancestor, then the genetic diversity of the village would be relatively low.



Instructions for the Teacher

1. If necessary, review the following key words with the class.

Key Words

- ***Genes*:** a unit of heredity composed of DNA
- ***DNA (deoxyribonucleic acid)***: the genetic material found within living organisms responsible for transmitting hereditary characteristics from parent to offspring
- ***Genetic diversity***: differences in the genetic make up of an animal population that are inherited by an organism's parents. High genetic diversity improves the ability of a population to survive in a changing environment.

2. Discuss why genetic diversity is important and explain the consequences of low genetic diversity. Low genetic diversity can mean that inbreeding is occurring, and the bear populations are less able to adapt to changes in their environment.

Share the following scenario with your students. One summer in the Bow Valley is extremely dry, and there isn't enough moisture in the soil to yield a substantial berry crop. Grizzly bears depend on berries as one of their main food sources and can eat up to 200,000 berries a day in the late summer. If the grizzly bear population has:

- ***High/good genetic diversity****:* Some bears will have the necessary genes to help them endure the poor food conditions and subsequently survive the long winter in hibernation. Other bears may die of malnutrition or starvation. The bears that can endure the dry conditions will survive and pass on their genes to their cubs.
- ***Low/poor genetic diversity****:* Since all bears possess similar genetic makeup, all bears may die or all may survive.

3. Photocopy Maternal DNA table and 'The Grizzly Facts' worksheet (one for each group). Divide students into groups of 3 or 4, depending on class size. Distribute the worksheets and, working together, have students consider the implications of Regular DNA data for question 1 of the worksheet. The Kluane population has the highest genetic diversity. Possible reasons why this is the case include the size of the Kluane region. A larger habitat area = more dispersion, and subsequently more diversity.

4. Have the students use the Maternal DNA table to calculate genetic diversity for question number 2 of the worksheet. Explain what each parameter represents and how it is calculated.

5. For question number 3 of the worksheet, students are asked to consider why *Regular* and *Maternal DNA* yield such different results.

6. Discuss question number 4 with the class. The Trans Canada Highway bisects the Eastern Slopes grizzly bears' habitat. Female grizzly bears are especially reluctant to cross the Trans-Canada Highway. This means that the already fragmented grizzly bear population of the Eastern Slopes is cut in half, isolating the females even further. Yellowstone National Park bears are an isolated population of an estimated 350-400 bears. There may be factors within Yellowstone National Park that affect the female population, as in Alberta's Eastern Slopes.

STUDENT WORKSHEET:
'THE GRIZZLY FACTS'

1. Look at the genetic data in the following table. Genetic diversity is a measure of the diversity of genetic material that exists in a population. Which grizzly bear population has the highest genetic diversity? Think about some possible reasons why and discuss them with your group. Some other populations have less genetic diversity. Why do you think that is?

Table 1. Genetic Variability in North American Grizzly Populations.
(0.1= very low diversity and 0.99 = very high diversity)

Population Name	**Genetic Diversity-Regular DNA**	**Genetic Diversity-Maternal DNA**
East Slope (Alberta)	.646	
West Slope (BC)	.661	
Kluane (Yukon)	.738	
Yellowstone (Wyoming)	.617	

(Eastern Slopes Grizzly Bear Project, Progress Report, 1994)

2. Next, calculate the genetic diversity (h) for the grizzly bear populations on the table entitled: *Genetic Diversity of NA Grizzly Bear Populations: based on Maternal DNA analysis.* The data on the grizzly bear table sampled a special type of DNA that comes from only the female (mother) side of the family. Once (h) has been calculated, fill in the above table so that you can compare the two types of genetic diversity.

3. Are there differences between the Regular and Maternal DNA analysis of genetic diversity? Discuss with your group possible reasons why this is so.

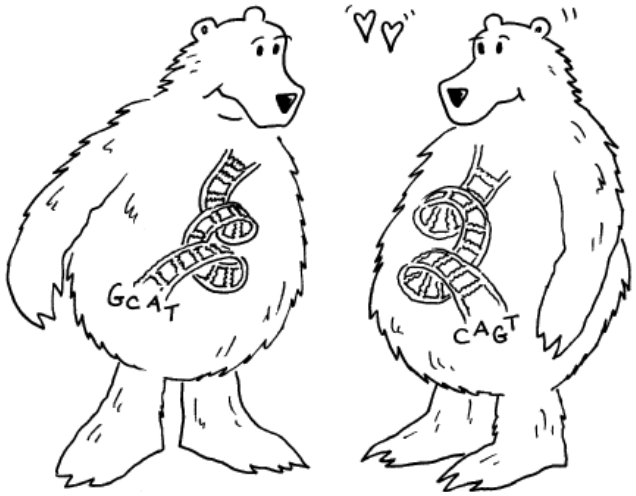
4. What might have happened or be happening to create this situation? What is happening to the land in the area of the Eastern Slopes that might affect grizzly bears this way?

Table 2. Maternal DNA Analysis Showing Genetic Diversity of North American Grizzly Bear Populations.

Population	N	Line n_1	Frequency (x_1)	$(x_1)^2$	Line n_2	Frequency (x_2)	$(x_2)^2$	Line n_3	Frequency (x_3)	$(x_3)^2$	Line n_4	Frequency (x_4)	$(x_4)^2$	Sum $\Sigma (x_l)^2$	Diversity (h)
East Slope	63	1	.016	.003	62	.98		-	-	-	-	-	-	.963	.04
West Slope	24	1			12			1			1	.042			
Kluane	24	2			3	.125	.02	12			6		.063		
Yellow-stone	46	40			4			2			-	-	-		

N= total number of bears in a population
N_i= number of bears related to a single mother bear
Frequency= n_l / N
$\Sigma (x_l)^2 = (x_1)^2 + (x_2)^2 + (x_3)^2 + \ldots$

Genetic Diversity: $h= [N X (1- \Sigma(x_l)^2] / (N-1)$
Example East Slope: .04 = [63 X (1-.963)] / (63-1)



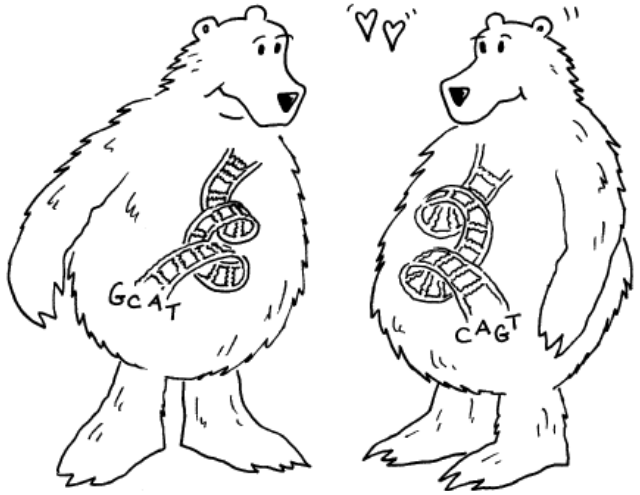
Teacher Solution

Table 2. Maternal DNA Analysis Showing Genetic Diversity of North American Grizzly Bear Populations.

Population	N	Line n_1	Frequency (x_1)	$(x_1)^2$	Line n_2	Frequency (x_2)	$(x_2)^2$	Line n_3	Frequency (x_3)	$(x_3)^2$	Line n_4	Frequency (x_4)	$(x_4)^2$	Sum $\Sigma (x_l)^2$	Diversity (h)
East Slope	63	1	.016	.003	62	.98	.96	-	-	-	-	-	-	.963	.04
West Slope	24	1	.042	.002	12	.5	.25	1	.04	.002	1	.042	.002	.256	.78
Kluane	24	2	.08	.007	3	.125	.02	12	.5	.25	6	.25	.063	.34	.68
Yellow-stone	46	40	.86	.74	4	.09	.008	2	.04	.002	-	-	-	.75	.25

N= total number of bears in a population
N_i= number of bears related to a single mother bear
Frequency= n_l / N
$\Sigma (x_l)^2 = (x_1)^2 + (x_2)^2 + (x_3)^2 + \ldots$

Genetic Diversity: $h = [N \times (1 - \Sigma(x_l)^2] / (N-1)$
Example East Slope: .04 = [63 X (1-.963)] / (63-1)



Births and Deaths: Natality and Mortality of Grizzly Bears

If the number of bear deaths exceeds the bear births in a bear population, then that population will decline. In this activity, students will be able to use real data from the *Eastern Slopes Grizzly Bear Project* to discover the ups and downs of the grizzly bear population in Banff. Natality and mortality rates and K-and R-selected species are discussed. This activity complements Bears of Banff.

Materials

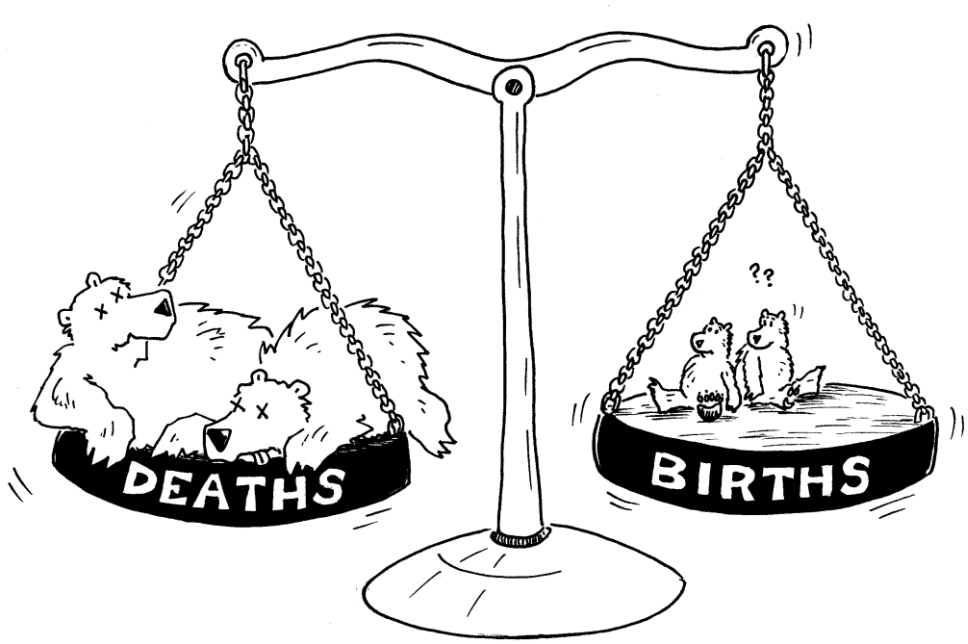
- Copies of worksheets for each student
- Coloured pencil crayons for each student
- Calculators for each student

Time Required

- 60-90 minutes

Background

Introduce the concept of population dynamics. Over a long period of time, the number of bears in a population is affected not only by the number of births during that period, but also by the number of deaths. To maintain a stable population of bears over time in an ecosystem, wildlife managers must ensure that the birth rate equals or exceeds the death rate!



Tell the students that they will be using real data from the Eastern Slopes Grizzly Bear Project:

Gibeau, M., S. Herrero, J. L. Kansas, B. Benn. 1996. Grizzly bear population and habitat status in Banff National Park: A report to the Banff Bow Valley Task Force. University of Calgary, AB. 62pp.

Copies of this report and updates may be downloaded from: *http://www.canadianrockies.net/Grizzly/rspub.html.*

Instructions for the Teacher

1. Define the words **mortality** (death rate) and **natality** (birth rate) for the class. Grizzly bears have a very low birth rate and are among the least reproductive large mammals in North America. The mortality rate is a very important factor for determining bear populations! Review the terms **r-selected and k-selected** species.

K-selected species usually live near the carrying capacity of their environment. Their numbers depend on the availability of resources. In other words, they are a density dependent species. Food availability, habitat quality/security are resources that control population size. K-selected species have long maturation time, breeding relatively late in life, a long lifespan, producing relatively few offspring, large newborn offspring, low mortality rates of young, and extensive parental care.

R-selected species are the opposite. They are very opportunistic. R-selected species have short maturation times, breed at a young age, have a short lifespan, produce many, small offspring quickly, high mortality rates of young, and nonexistent parental care.

2. Ask the students to brainstorm possible causes for grizzly bear mortalities in Banff National Park. Have them rank these in order of most significant to the least significant. Compare the students' list with the statistics on the following page. In Banff National Park, **habituated bears** die more then any other cause. Habituated bears are bears who have lost their natural fear of humans. These bears may have been fed by humans, or have encountered garbage or food left behind by careless campers. Habituated bears often are shot by conservation officers or wardens if they pose a threat to human safety.

Habituation

When a bear becomes used to and loses its natural wariness of humans and human things (highways, cars, photographers)

Positive reinforcement and rewards play a role (feeding bears, careless storage of food/garbage).

3. Distribute worksheets to the class and have students fill in the table titled, *Grizzly Bear Mortalities in Banff National Park.* A teacher solution is also provided. Have students fill in the blanks by calculating:

- the totals for each type of mortality
- the average number of mortalities per 5 year period for each type
- the combined total average number of mortalities

4. Have the students complete a histogram (plotting the number of deaths per year versus the five year periods) to represent the mortalities for each five-year period. Have them divide each bar into portions to represent the causes of mortality.

Worksheet Discussion

Which part of the histogram surprises your class the most? Why?

The following might be useful in answering students' questions:

- **Railroad:** Bears are often attracted to the railroad due to spilled grain along the tracks and are hit by trains.
- **Highway:** Vegetation is often cleared along roadsides, creating false bear habitat: fresh shoots and buffaloberries grow in these cleared areas. As well, bears come into contact with roads that pass through their habitat (Trans-Canada Highway).
- **Habituation**: Many bears are attracted to areas near development because of the great smelling garbage that humans create. As a result, these bears become less wary of humans. Unfortunately, a close encounter with humans usually means death or imprisonment in zoos.

Problem Bears or Problem Humans?

Not long ago, bears who had become habituated by garbage, careless storage of camping food, etc., were called, "problem bears."

Today, we realize that humans are the problem when it comes to unwary bears threatening human safety. Problem bears are now called 'victimized' or habituated bears.

Are the mortality numbers completely accurate? What are the 'sources of error' that are possible?

Fifty percent of all grizzly bear deaths are unknown! This is because:

- Bears who die of natural causes may never be found; bears included in the population may die outside of the park, or move out of the park to live elsewhere
- Hunting occurs outside of BNP, legally and illegally
- Wildlife managers are realizing that poaching may be a more serious threat than previously thought (the many roads into the backcountry allow greater human access)

The researchers for the Eastern Slopes Grizzly Bear Project found that the majority of the bears dying in Banff National Park are females. Ask students why this might be a problem for grizzly bear populations.

Biologists believe that females are far more important than males. Females are the reproductive "engines" of the bear populations and are key to maintaining stable populations - so long as there are some males around to help out!

Some environmentalists and Parks managers claim that, "What we have here is not a bear problem - it is a human problem." Ask students if they agree. Ask students what they think a "problem bear" is.

This question is one that challenges our assumptions and perceptions regarding bears. A problem bear is one that, through its aggressive or non-conforming behaviour, breaks some of the rules we've set out for how 'good bears' ought to behave. Today, we refer to problem bears as habituated bears. Most conflicts between humans and bears can be ascribed to some error made by people in the Park.

Biologists feel that large, well-protected areas should serve as a source of grizzly bears by creating an excess of bears every year. These excess bears would disperse to less protected areas. Is Banff National Park a 'source' or a 'sink' for grizzlies?

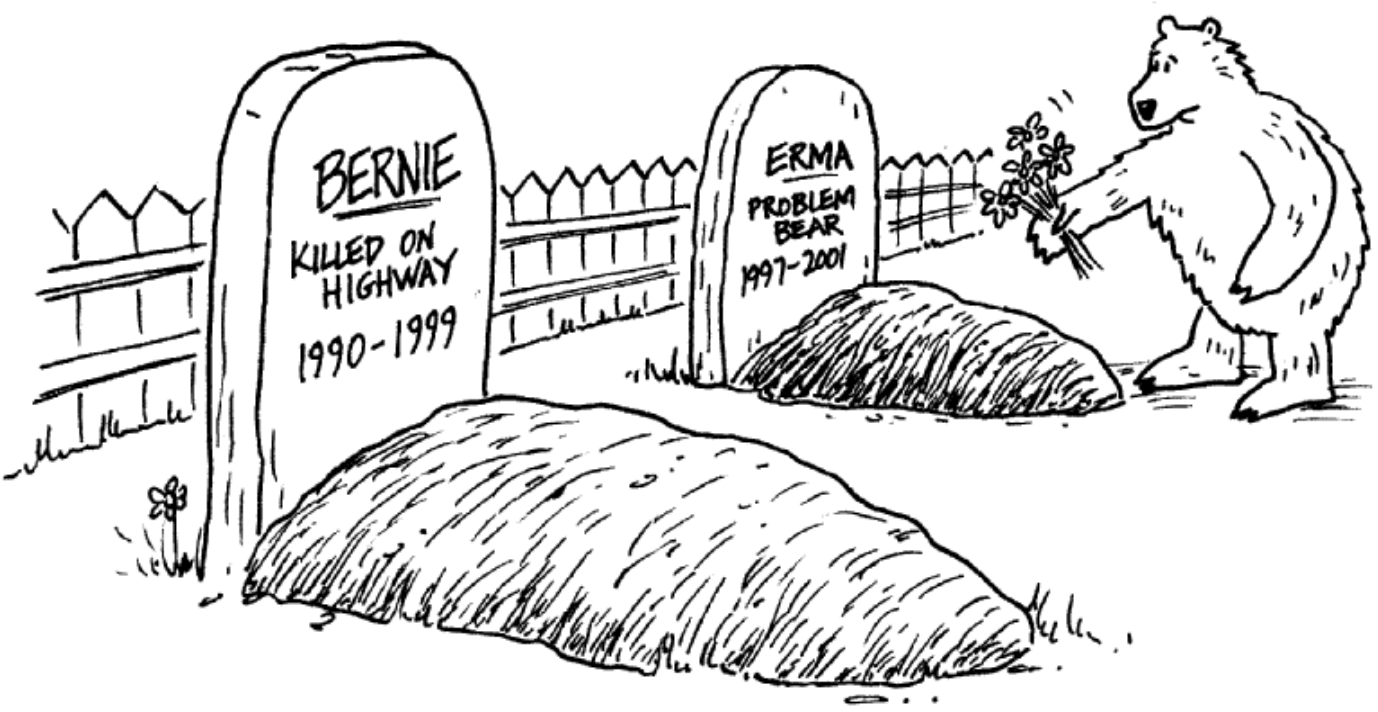
Given the known natality and mortality rates for Banff, it should be a source of grizzly bears.

However, if the *actual* mortality rate is higher than the natality rate, then Banff would be a sink.

What are suggestions for reaching a stable, or better yet, a growing number of grizzlies?
Slower speed limits on the highways, restrictions on human access to some areas, travelling responsibly in bear country, importing bears from other areas (costly and long-term).

5 Main Causes of Grizzly Bear Mortality in Banff

1. Habituation
2. Highway Kills
3. Unknown
4. Railroad Kills
5. Natural Causes



Student Worksheet: Grizzly Bear Births and Deaths
Natality (birth rate) and Mortality (death rate)

Name:_____

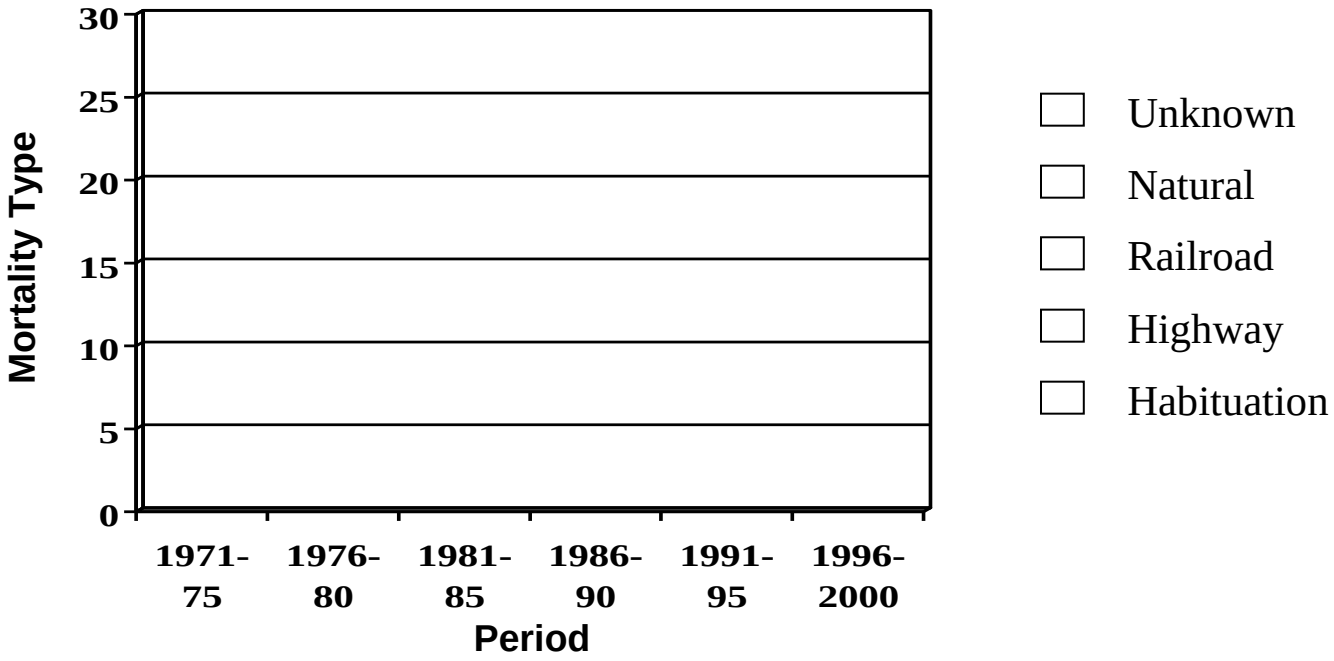
1) Fill in the blanks on the following table:

Type of Grizzly Bear Mortalities in Banff National Park, in 5-year periods 1971-2000

Period	Mortality Type					Totals	Average # of Mortalities/ year
	Habituation	Highway	Railroad	Natural	Unknown		
1971-75	6	0	1	0	1		
1976-80	17	8	2	2	0		
1981-85	14	0	0	0	4		
1986-90	10	1	0	0	1		
1991-95	5	1	0	0	0		
1996-00	0	0	1	3	0		
Totals							

2) Using the numbers from the table above, create a histogram with coloured pencils in the provided space below plotting the number of deaths per year versus each five-year period.

Type of Grizzly Bear Mortalities in Banff National Park (BNP)



3) Based on the data, what is the greatest cause of grizzly bear mortalities?

4) What reasons might have contributed to the peak in mortalities in the late 1970's?

5) What factors may have caused the decrease in mortalities in the late 1980's and early 1990's?

6) Within Banff National Park the grizzly bear death rate for the most recent period we have data for (1996-2000) is 0.8 deaths/year. In your opinion, is this mortality rate too high for a bear population to remain in Banff Park for the years to come? What else do you have to know in order to answer such a question?

Use the following data to answer questions # 7, 8 and 9.
Between 1994 and 1999, 17 female bears in Banff National Park had the following cubs:

Bear #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
# of cubs	3	4	2	1	3	4	5	5	1	2	1	0	2	0	0	0	0

7) What is the average number of cubs born per year during this period?

8) What is the average number of cubs born per bear per year?

9) Many cubs will not survive to adolescence. Only about 70% will survive to adulthood. Take the total number of cubs per year from question 7 and multiply it by .70 to get the number of cubs who survive to become adults. This is the *natality rate*.

Comparing Mortality (death) and Natality (birth) Rates
10) Based on the mortality and natality rates in BNP, should the bear population increase or decrease over time? **(m>n = ⬇pop; m<n = ⬆ pop)**

11) Biologists feel that the grizzly population in BNP is decreasing, not increasing. This is because the mortality rate (2.56 bears/year) does not represent the *actual* number of mortalities. Many deaths are undocumented or occur outside the park boundaries. Based on an increased mortality rate of 5.0 bears/year and a natality rate of 4.6 bears/year, what will happen to the grizzly bear population over time?

12) Biologists estimate that within Banff National Park, the current population of grizzly bears is 70. Use the numbers in the question above to find out how many bears there will be 25 years from now.

13) You have just done an extrapolation, where you take a certain rate and project it forward in time in order to make a prediction. Can you think of any problems in making such a prediction?

Population Dynamics

14) Compare the following two species. Identify which is an r-selected species and which is a k-selected species.

Grizzly Bears:
Age of sexual maturity – 5
litters – 1 every 3 years
young per litter – 2
population density – 1 bear/ 60 km^2

Snowshoe Hares:
Age of sexual maturity – 1
litters – 2 to 3 per year
young per litter – 1 to 7
population density – 14 hares/ km^2

15) How do you think human alterations/interventions affect the populations of r- and k-selected species?

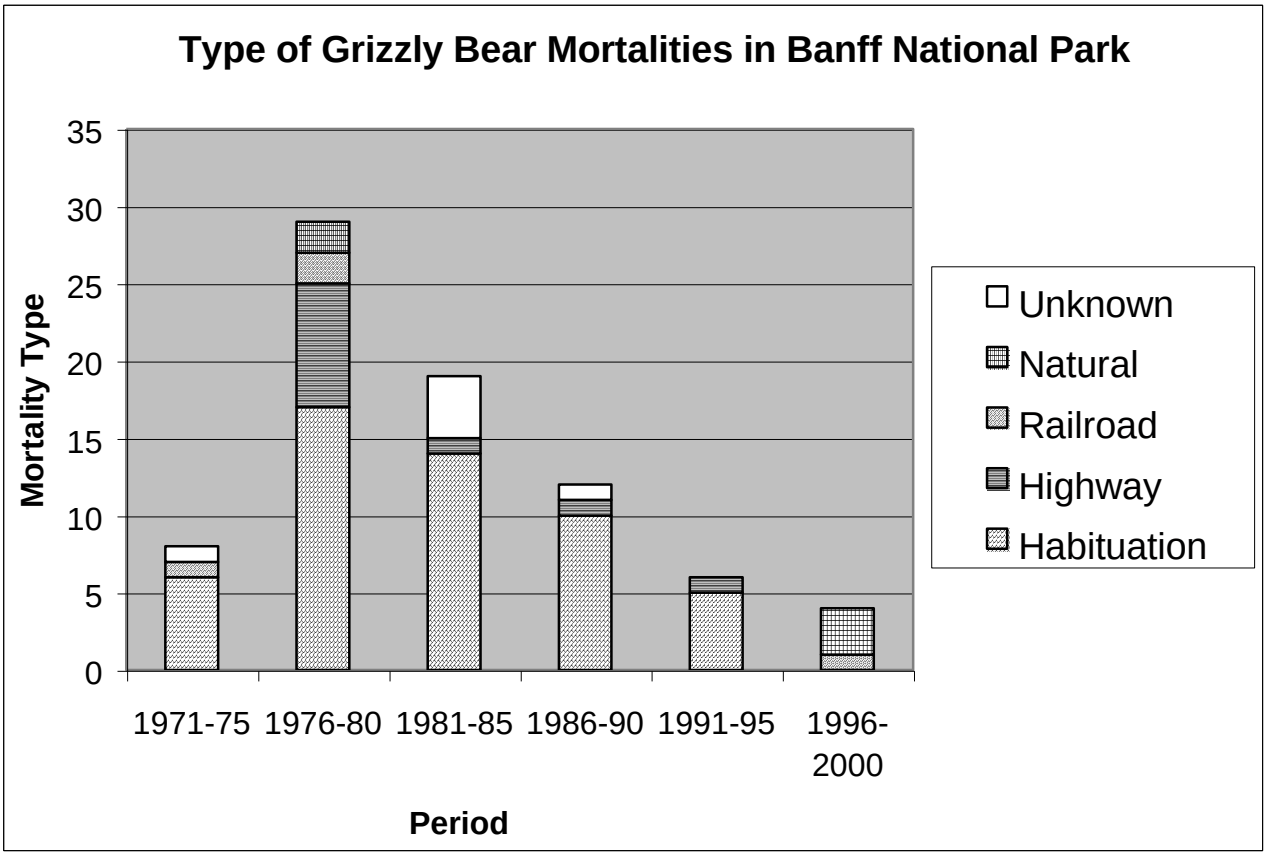
16) Do you think that r-selected or k-selected species are more likely to be endangered? Discuss your reasons.

TEACHER'S SOLUTION
Type of Grizzly Bear Mortalities in Banff National Park

1)

Period	Mortality Type					Totals	Average # of Mortalities / year
	Habituation	Highway	Railroad	Natural	Unknown		
1971-75	6	0	1	0	1	8	1.6
1976-80	17	8	2	2	0	29	5.8
1981-85	14	0	0	0	4	18	3.6
1986-90	10	1	0	0	1	12	2.4
1991-95	5	1	0	0	0	6	1.2
1996-00	0	0	1	3	0	4	0.8
Totals	52	10	4	5	6	77	2.56

2)



Teacher Key to Written Questions:

3) Based on the data, what is the greatest cause of grizzly bear mortalities?

Habituation: when a bear becomes conditioned by humans through positive reinforcement (feeding bears, stopping to take photographs of bears, attracting bears by being careless with garbage or food etc. are all examples of positive reinforcement)

4) What reasons might have contributed to the peak in mortalities in the late 1970's?

Banff National Park was managed differently in the late 1970s than it is today. People used to allow bears to approach cars for photos. There were no fences on the highway. Garbage wasn't properly stored in bear-proof garbage bins; in fact, bears used to feed at the Banff Dump. When the dump closed in the late 70s, the habituated bears may have had more human encounters while searching for food. Park managers also killed several bears after a mauling that involved only one bear (they couldn't find the "culprit").

5) What factors may have caused the decrease in mortalities in the late 1980's and early 1990's?

Factors such as the fencing along the side of the Trans-Canada Highway, better education of park visitors and campers, and the use of bear-proof garbage bins.

6) Within Banff National Park the grizzly bear death rate for the most recent period we have data for (1996-2000) is 0.8 deaths/year. In your opinion, is this mortality rate too high for a bear population to remain in Banff Park for the years to come? What else do you have to know in order to answer such a question?

To answer this question, we need to know the birth rate (see the next section).

Use the following data to answer questions # 7, 8 and 9.
Between 1994 and 1999, 17 female bears in Banff National Park had the following cubs:

Bear #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
# of cubs	3	4	2	1	3	4	5	5	1	2	1	0	2	0	0	0	0

7) What is the average number of cubs born per year during this period?

There were 33 known grizzly bear cubs in the park: 33/5 = 6.6cubs/year.

8) What is the average number of cubs born per bear per year?

6.6 cubs/year divided by 17 females = .039 cubs/bear

9) Many cubs will not survive to adolescence. Only about 70% will survive to adulthood. Take the total number of cubs per year from question 7 and multiply it by .70 to get the

number of cubs who survive to become adults. This is the *natality rate*.

6.6 cubs/year x 0.70 = 4.60 cubs/year will survive to adulthood

Comparing Mortality (death) and Natality (birth) Rates
10) Based on the mortality and natality rates in BNP, should the bear population increase or decrease over time?

(m>n = ⬇ pop; m<n = ⬆ pop)

m (2.56) < n (4.56) = population should increase over time.

11) Biologists feel that the grizzly population in BNP is decreasing, not increasing. This is because the mortality rate (2.56 bears/year) does not represent the *actual* number of mortalities. Many deaths are undocumented or occur outside the park boundaries. Based on an increased mortality rate of 5.0 bears/year and a natality rate of 4.6 bears/year, what will happen to the grizzly bear population over time?

The bear population will decrease. If this trend continues, bears will become extirpated (locally extinct) in Banff National Park.

12) Biologists estimate that the current population of grizzly bears in Banff National Park is 70. Use the numbers in the question above to find out how many bears there will be 25 years from now.

Growth rate*(# of years) + current population = future population (*Growth rate = BR – MR)

{(4.6 – 5) X 25} + 70 = 60 bears

13) You have just done an extrapolation, where you take a certain rate and project it forward in time in order to make a prediction. Can you think of any problems in making such a prediction?

Yes. Problems exist when making extrapolations because they presume that factors such as habitat effectiveness remain constant. In the unlikely event that developed land becomes restored, the population may actually increase despite the prediction made. On the other hand, if wild areas become developed and visitor use increases, the population prediction of the Banff Park grizzlies could be much smaller than 60. Also, a smaller population of bears in 25 years might have trouble finding each other! Similarly, the population might start to suffer from inbreeding as it grows smaller. Both of these would hasten the decrease in population over time. This positive feedback loop is known as the "Extinction Vortex."

14) Compare the following two species. Identify which is an r-selected species and which is a k-selected species.

Grizzly Bears are k-selected; snowshoe hares are r-selected

Grizzly Bears:
Age of sexual maturity – 5
litters – 1 every 3 years
young per litter – 2
population density – 1 bear/ 60 km^2

Snowshoe Hares:
Age of sexual maturity – 1
litters – 2 to 3 per year
young per litter – 1 to 7
population density – 14 hares/ km^2

15) How do you think human alterations/interventions affect the populations of r- and k-selected species?

R-Selected: Sometimes the changes can help a species, sometimes they are destructive. Destroying or poisoning the habitat has a wide-ranging effect (ex. Frogs). In some cases, however, the environment is altered in ways that enlarge the region a species inhabits (ex. Mice or cockroaches). When conditions are changing, r-selected organisms tend to respond favourably. R-selected species also have the ability to increase their populations rapidly.

K-Selected: K-selected organisms have evolved to live within the carrying capacity of their environments, and when that environment changes, they and the environment suffer (ex. grizzly bears). The ecosystem is out of balance, and the number of the animals who live in it needs to be readjusted. K-selected individuals, because they are born only periodically, also affect the environment if they die prematurely. As numbers of animals drop, the loss of individuals becomes more and more significant. K-selected organisms have no mechanism by which they can suddenly increase their numbers. This is why small, rapidly maturing animals (r-selected) tend to be the survivors after global catastrophes.

16) Do you think that r-selected or k-selected species are more likely to be endangered? Discuss your reasons.

With a few exceptions (amphibians, Banff Springs Snail), k-selected species are more likely to be endangered because they are greatly affected by changes in their environment. They are less able to adapt to changes and a low birth rate means that it is difficult to "rebuild" the population if it has been compromised.

Where is Sophie?

Using real GPS (Global Positioning Systems) data points, this activity asks students to determine whether or not the behaviour of a local Kananaskis bear is healthy and normal. Building on their knowledge of grizzly habitat, students will examine the location points of Sophie in an attempt to deduce her history through her actions today.

Materials

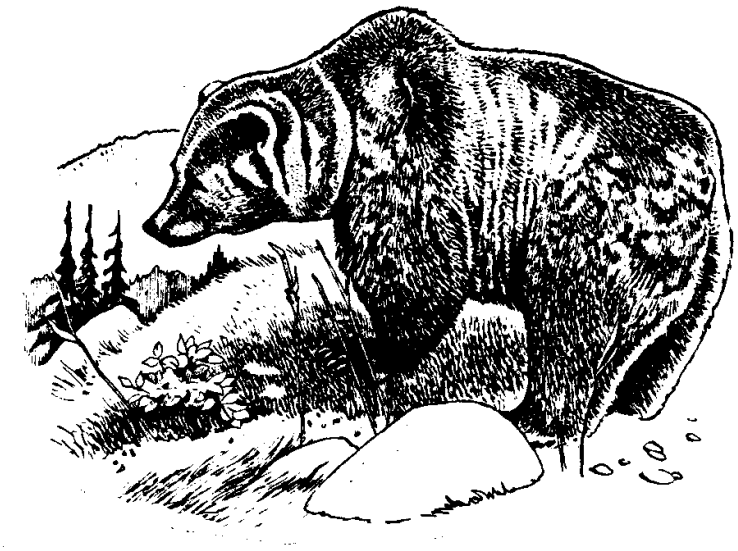
- Copies of "Where is Sophie?" for students

Time Required

- 30-40 minutes

Instructions for the Teacher

1. Discuss the characteristics of habituated bears with the class. Habituated bears seem to be fearless of humans and show a tendency to wander into campgrounds, travel on roads and act oblivious to human activity. It is important to note that bears become habituated through what they consider to be positive experiences with humans. For example, if people leave food on their picnic table unattended, a hungry bear may be drawn to the food to feast. Bears exposed to human food or garbage will learn to associate food with humans. As a result, they may even seek humans out in order to get their "reward." Most habituated bears are relocated or killed. The expression, *"A fed bear is a dead bear"* holds true.



2. Distribute the map titled, *Where is Sophie?* to students and ask them to scrutinize her movements. The location points were collected using GPS (Global Positioning Systems) technology. In the early fall of 2000, Sophie was captured by the Eastern Slopes Grizzly Bear Project researchers and fitted with a GPS collar, providing researchers information about where Sophie lives. The location points illustrate her movements over a period of 44 days.

3. Ask the students:

Where does Sophie like to forage?
In the fall of 2000, Sophie frequented the Mt. Kidd alpine meadow, the Kananaskis River, Kananaskis Village, Kananaskis golf course, Mt. Kidd R.V. Park and the Ribbon Creek Day Use area. She also spent some time on the Nakiska ski hill.

Does Sophie spend time in the 'zone of influence,' - the 500 m area that surrounds human features like roads, trails and buildings? What implications does this have for Sophie and people who enjoy Kananaskis Country?
Yes, Sophie spends a lot of time in the zone of influence, which indicates an unwariness of people. Sophie appears to be habituated and could potentially be a threat to humans, in which case she would probably be relocated or destroyed.

What are some possible reasons why Sophie spends so much time near human populated areas?
Some possible reasons include:
- Sophie may have been fed by humans and has learned that careless campers leave food rewards.
- Sophie may have had an inadequate and disruptive upbringing as a cub, and may have learned some bad habits from her mother.

4. Read aloud or independently *The Story of Sophie, a collared bear in Kananaskis Country.*

After reading the story, ask the students:

How did the story make you feel? Did you feel sorry for the mountain biker, Sophie, the hikers, or for all subjects in the story?

Do you feel that the mother should have been captured?
Students should realize that before capturing a bear and relocating it in the wild or to a zoo, alternative measures can be taken to 'teach' a bear proper behaviour. These measures, referred to as ***aversive conditioning***, can re-train bears to fear and avoid people. Aversive conditioning can involve firing rubber bullets and using bear bangers. A highly effective and somewhat new way to deal with problem behaviour in bears is the use of Karelian Bear Dogs. These dogs have been bred and used by grizzly bear hunters and farmers in Finland and western Russia for centuries. Today they are used as bear shepherds, to help prevent bears from being habituated to human areas.

Aversive Conditioning

A method of teaching habituated bears to avoid human features.

Techniques:
-bear dog shepherding
-bear bangers
-yelling
-"spanking" with rubber bullets.

Do you think Sophie should have been relocated?
Often, relocated bears are killed – either by other bears, or by legal and illegal hunting outside park boundaries. CPAWS believes that the federal and provincial agencies should provide more resources to its staff, enabling them to practice aversive conditioning with habituated bears, rather than just removing them to other areas, where they will likely get into more trouble or be killed by other bears.

What do you think happened to Sophie's sister, Bear #70?
It is likely that she was killed or severely injured to allow a person to cut the collar off her neck. Her body may have been taken by poachers or illegal hunters or scavenged by predators.

5. **What you can do to help bears like Sophie**
Brainstorm with your class different ways they can help bears like Sophie. For ideas, review *Helping the Great Bear*.

The Story of Sophie, a collared bear in Kananaskis Country

Sophie and her sister were born in a den in the winter of 1996 under a heavy, deep blanket of snow. Their mother, Nakiska, was a large grizzly with a thick, cozy chestnut-brown coat. Emerging from their den in the last week of April and seeing the lit world for the first time must have alarmed the cubs. The den was the only life they had ever experienced, and their mother was now leading them into a world full of wind, puddles of melting snow, and a great diversity of flora and fauna. Cubs are especially vulnerable to predation in their first year of life, so Sophie and her sister didn't stray far from their mother.

Being a mischievous cub, Sophie would often wrestle and play with her sister. When they weren't playing, they were busy learning about what types of plants were safe to eat and where they could find them.

Sophie and her family were careful to avoid noisy, invasive humans. Their sensitive noses could smell things over a kilometre away. From time to time, groups of hikers would unknowingly pass by the family, sending Sophie and her sibling scampering to find their mother. Towards the end of the summer, the grizzly family began looking for a den, one that was located up in the subalpine where the snow fell steadily to keep the family insulated and warm.

The next spring, the family poked their heads out of their den and upon smelling the wet spring air, groggily emerged to begin their search for food. Finding food in the Rockies can be especially difficult for large mammals because so little of the land is comprised of montane and subalpine - areas where grizzly bears' favourite foods grow. To find enough food, Sophie and her family would have to pass by the edge of the sprawling town of Canmore. On one occasion, the family of grizzly bears passed through the Canmore Nordic Centre and encountered a couple of fast approaching mountain bikers. The cubs rushed for cover, and Nakiska, in defense of her cubs, knocked one biker down and bit him. The biker suffered from minor injuries, and Nakiska became even more wary of humans in her home range.

A few weeks later, Sophie and her family encountered humans again while traveling near Skogan Pass. This time, Sophie's mother bluff charged two hikers, successfully frightening them away. The grizzly family stumbled upon more and more people each year as they were forced to share their home range with 1.4 million people who came to the Evan Thomas Valley to golf, ski, hike, bike and climb.

Soon after these two events, the family came across a strange looking culvert with an irresistible odor. Nakiska entered the strange cylindrical object to investigate, and *SLAM!, a* door locked shut, and she was trapped inside. Abandoned and left to fend for

themselves, Sophie and her sister spent the night near the metal trap. The next day the cubs were tranquillized and collared by researchers. When they awoke, Sophie and her sister could not find their mother anywhere. The cubs separated, going their own ways and trying hard to remember all that their mother taught them.

On her own, Sophie tried to avoid people but often found herself pushed into poor habitat by bigger, wiser grizzly bears. This poor habitat included the Kananaskis Country golf course and the Mt. Kidd R.V. Park. She also frequented the power line near a popular swimming spot called Quarry Lake located on the edge of Canmore. The power line runs adjacent to a hotel, a subdivision, and a recreational area where people regularly walk their dogs. Needless to say, Canmore residents were repeatedly bumping into Sophie.

One August afternoon in 2001, Sophie made an appearance in a busy subdivision, where she crossed three streets sending surprised locals running for their homes and vehicles. To prevent future human encounters and further habituation, Sophie was tranquillized, captured and relocated to a region hundreds of kilometers south of the Evan Thomas Valley in Kananaskis Country. When captured, she weighed 250lbs and was estimated to be 5 years of age.

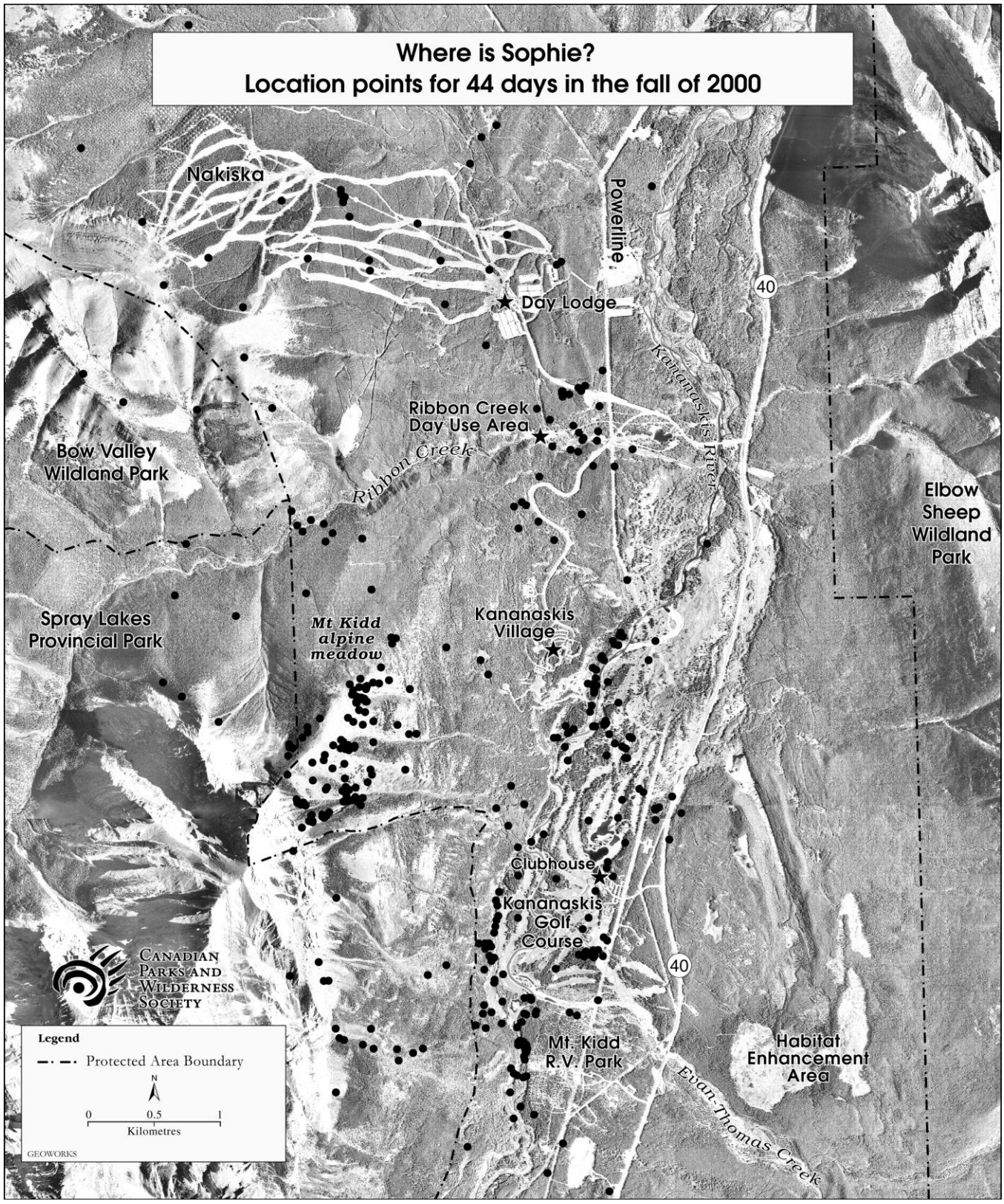
Epilogue

- After the two encounters with humans, Sophie's mother, Nakiska, was moved to the Calgary Zoo. She was initially considered to be a very 'wild' bear and showed little signs of being habituated. Nakiska was a living reminder that we must practice better bear management and try harder to prevent bears from becoming habituated.

- On September 25, 2001, Nakiska died of infected wounds after fighting with another grizzly bear in the zoo. Clio Smeeton, president of the Cochrane Ecological Institute, stated that integrating animals in a foreign enclosure isn't without its dangers. "I wouldn't say it was bound to happen . . . but you're keeping some very large animals in a very small space."

- During the summer of 2002, Conservation Officers received a report that Sophie had been legally shot on the Eden Valley Indian Reserve, south of Kananaskis Country. She is the seventh grizzly bear known to have been killed on an Indian Reservation in the Central Rockies Ecosystem since 1993.

- Sophie's sister, bear #70 underwent several summers of aversive conditioning around Canmore, AB. In 2004, she was relocated to northern Alberta. Scientists later found her collar, which appeared to have been cut off by humans. Bear #70 has never been found.


Where is Sophie?
Location points for 44 days in the fall of 2000
Nakiska
Powerline
Day Lodge
40
Kananaskis River
Ribbon Creek
Day Use Area
Ribbon Creek
Bow Valley
Wildland Park
Elbow
Sheep
Wildland
Park
Spray Lakes
Provincial Park
Mt Kidd
alpine
meadow
Kananaskis
Village
Clubhouse
Kananaskis
Golf
Course
40
Canadian
Parks and
Wilderness
Society
Legend
Protected Area Boundary
N
0
0.5
1
Kilometres
GEOWORKS
Mt. Kidd
R.V. Park
Habitat
Enhancement
Area
Evan-Thomas Creek

Fire and Succession

In this activity, students critically examine the role of fire in our Montane, or valley bottom ecosystems. After reading a summary of the Mount Shanks fire of 2001 and a fire information sheet, students will assume various roles in our society to debate this controversial topic. This activity culminates in a discussion and take home worksheet.

Materials Needed

- Copies of worksheet and fire information handout
- Long length of rope or string (10 ft)

Time Required

- 60 minutes

Background Information

Natural communities are in a constant state of flux: as organisms die, others are born, and energy and nutrients are continually circulated. Disturbance to a community, whether it is by an overturned boulder, an avalanche, logging or fire, can alter the ecosystem. Disturbances or alterations set the stage for the succession of plant and animal species. Pioneering species such as fireweed or members of the pea family are first to establish themselves and, in turn, are successively replaced by others until the disturbed area once again attains its former structure and composition also known as the climax community. Successive stages or seres are constantly influenced by abiotic factors such as sun, precipitation or wind.

Two types of succession exist. **Primary succession** is the development of a new ecosystem in an area devoid of organisms (i.e. after glaciers recede, on barren rock). **Secondary succession** is the change that occurs after an ecosystem has been disturbed (i.e. flooding or forest fires). Secondary succession is generally more rapid than primary succession because the soil is usually already in place.

An intense forest fire triggers secondary succession and is a natural and often controversial component of ecosystems. For most of the past century, nearly all fires in North America's national parks were suppressed. In 1945, the USA Forestry Service created Smokey the Bear to symbolize fire prevention and forest protection. Today some feel that perhaps Smokey's message was taken too literally and that we have eliminated fire to the point that it is hurting not only forest management, but also building fuel for future fire disaster. The science of ecology tells us something about fire that is completely different from Smokey's message: that it is a part of nature, and that eliminating fire from ecosystems is like denying vegetation from wind or the rain.

Key Words

- ***Primary succession*:** sequence of communities developing in a newly exposed habitat devoid of life
- ***Secondary succession:*** progression of communities in habitats where the climax community has been disturbed or removed
- ***Climax Community:* t**he end point of a successional sequence or sere; a community that has reached a steady state under a particular set of environmental conditions
- ***Sere:*** A series of stages of community change in a particular area leading toward a stable state
- ***Abiotic:*** non-living components of the biosphere including chemical and physical factors
- ***Biotic:*** biological or living components of the biosphere
- ***Biodiversity:*** a measure of the variety of life in a specific habitat—is also an indicator of the environment health

Instructions for the teacher

1. Review background information and key words with students.

2. Read the story, "The Mt Shanks Fire of 2001."

3. Place a long piece of rope or string on your classroom floor and establish one end as agree and one end as disagree.

Make the following statement,

"***The Mt. Shanks fire was disruptive and posed health risks to Bow Valley and Calgary residents. Tourists were forced to alter their travel plans or cancel them altogether. The Mt. Shanks fire should never have been allowed to burn as much as it did."***

Ask students to physically take a stand on the rope or string you laid out in response to the statement. Ask individual students to explain why they are standing at that particular point on the spectrum.

4. Hand out copies of the Fire Information Sheet and allow students a few moments to read it. Ask the above question again and have students take another stand along the spectrum between agree and disagree.

Did anyone's position change after reading more information? How so? Ask individual students along the spectrum to explain their positions. Try to spark debate among the students.

As students stand there, assign one of the following characters to the students:

- Parks Canada Ecologist
- Canadian Parks and Wilderness Society staff person
- Tour Operator in Banff National Park
- Calgary parent with asthmatic children
- Grizzly bear who lives in Kootenay and Banff National Parks
- Alberta Forestry Planner

Encourage students to put themselves in the shoes of their character, and ask them where they stand on the issue.

5. Ask students to return to their seats. Engage them in a discussion on the role of fire in ecosystems by asking them the following questions:

What is prescribed fire and why do we need it?
For both the environment and public safety, prescribed fires are becoming common practice in our National Parks. Ecologically, fire helps an ecosystem maintain its landscape and species diversity. Without fire, forest debris can accumulate and result in more intense, unmanageable fires that are difficult to control and threaten human property and safety.

How do you think Parks Canada ensures that homes are not destroyed when they prescribe an area to be burned?
The area where a town or development meets combustible vegetation is called the wildland-urban interface. To prevent any damage to homes and communities, prescribed burn fire managers establish a '**defensible space**' or fire guard. A defensible space is an area that is managed by logging, thinning, pruning or clearing and hence made a fuel-free area. Often fire fighters are positioned in a defensible space to stage their attack against a spreading fire.

In the spring of 2002, a forested area of 180 hectares in Banff National Park was thinned by logging and burning to serve as a fireguard between the community of Harvie Heights and the proposed prescribed burn in the Fairholme Bench. The Fairholme Bench land is protected as the largest intact block of secure wildlife habitat in the park's Montane (valley bottom) ecoregion. By burning the Fairholme Bench, Parks Canada hopes to restore the montane habitat, reduce the potential for wildfire to affect downwind assets such as Harvie Heights, and reduce the effects of the mountain pine beetle. Although grizzly bears currently use the Fairholme region, it is thought that their use of the region will increase after the burning because open spaces will encourage the growth of Canada buffaloberry bushes.

What is the relationship between fire and grizzly bears?
Grizzly bears benefit from wild or prescribed fire because it creates cleared areas where grizzly and black bears' preferred food sources live. For example, post-fire flora and fauna may include an abundance of greenery that no longer needs to compete for light with large stands of trees, as well as a variety of ants and other insects which are drawn to the decaying, blackened wood. Floods and avalanches can also produce the same high quality habitat grizzly bears depend on.

Do you think any animal populations decrease after an area has been burned?

Yes. The patchiness that results in an ecosystem following a fire is not uniformly good for every species. For example, the Townsend's warbler spends it day high in tall coniferous trees, and a forest fire would result in less habitat for this species. On the whole, however, biological diversity of an area increases following a forest fire.

Do slash and burn or clear cutting practices have the same positive effects on an ecosystem as fire?

The type of burns used by logging industries does not have the same effects as a wild or prescribed fire. Fire research literature suggests that logging (and subsequent burning) can increase fire hazards by opening up forests to more rapid drying, and greater wind circulation, accelerating fire spread by exaggerating the effects of drought and wind. Unless trees are removed over millions of acres, logging will only worsen fire conditions, not help. Logging removes trees and nutrients whereas fire recycles them. Logging is also coupled with the construction of roads and landings leading to unnatural habitat fragmentation.

What effect do the emissions from prescribed fires have on global warming?

On a national scale, global warming, or the excess of carbon dioxide and other harmful gases in our atmosphere, is primarily caused by burning fossil fuels and tropical deforestation. When a forest burns, carbon dioxide is also released into our atmosphere. The prescribed burning in Canada accounts for approximately 3% of the amount of carbon dioxide produced by automobiles and industry. Pioneer species often absorb this 3% of CO_2 during photosynthesis. Studies have indicated that the net amount of CO_2 released from a fire is negligible.

Is the Mountain Pine Beetle really a 'pest' to our boreal forests?

The Mountain Pine Beetle is as natural a part of the ecosystem as fire is. The trees they "destroy" become habitat for woodpeckers and other animals and insects. Large infestations of Mountain Pine Beetle may predispose a forest to burning (because of the dead, dry trees they leave behind) and therefore they may play an important part in the cycle of "renewal".

Is lighting a fire as in a prescribed burn interfering with nature?

In a way, it is. Unfortunately, our provincial and national parks are too small to be self-regulated by fire. Because so little land is untouched by people, it is best to prescribe fire to avoid risks to public safety.

After the discussion distribute the worksheet about fire ecology, included at the end of this lesson.

Mt. Shanks Fire – July and August 2001

On July 12 of 2001, lightning struck the west slopes of Mount Shanks, an area 57 km north of Radium Hot Springs in Kootenay National Park, British Columbia. In 1993 Parks Canada identified Mount Shanks as one of the many target regions to restore with prescribed fire. When natural fire suddenly presented itself, Parks Canada had to quickly evaluate whether or not the fire should be suppressed. The appointed fire team's recommendations were made to the Superintendent to manage the lightening fires as a random ignition prescribed fire. This bold decision led to "the biggest inferno in 75 years in Kootenay National Park." (Calgary Sun, 08-30-02)

Allowing the fire to burn required thoughtful consideration by Parks Canada on a variety of issues. Summer is the Parks' busiest season, making public safety a primary concern especially for backcountry users, curiosity seekers and the media. Smoke and ash management was also a major concern as well as evacuation plans, highway closures and communication to the general public and media. The nearby Kootenay Lodge and associated facilities also needed protection from the fire.

The fire burned predictably and safely for the first month. By mid August, a dry and gusty wind quickly fanned the Mount Shanks fire to a much larger size. In just eight days the fire grew expanded by 3,194 hectares! The total area burned was slightly over 3,800 hectares (38 km^2). This is similar to the size of over 6,388 football fields!!

To control and physically manage the burn, Parks Canada employed 150 incident personnel, 6 helicopters, 3 cats, a contract compressed air foam truck, a 75-man equipment trailer, a helicopter fuel truck, a command trailer, and 3 successive Parks Canada overhead teams. No injuries ensued from the fire.

The prolonged hot, dry weather of the summer of 2001 was enough for the Alberta Government to issue fire bans in many regions in southern Alberta. Certain parts of Kananaskis Country were closed off to public use completely. Vacationers were forced to cancel and postpone their holidays. Many Canmore and Calgary residents were inconvenienced for several weeks by the smoky air the Mount Shanks fire produced. Local environmental interest groups praised the fire for its long-term ecological benefits to the mountain parks.

What do you think? Should this fire have been suppressed, or was Parks Canada right to let it burn?

Fire Information Sheet

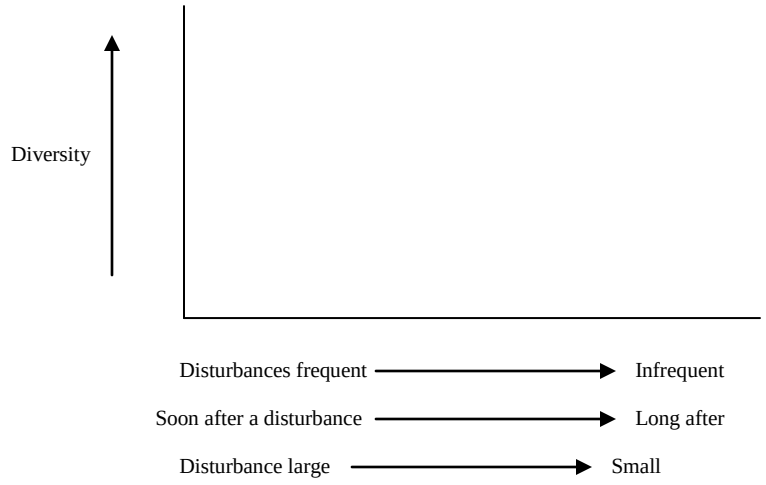
- A 1996 grizzly bear study recommended that fire should be restored to its historic, natural regime in all possible areas of Banff National Park because grizzly bears in the Central Rockies Ecosystem find some of their best food sources in post-fire environments.
- Although an essential part of nature, fire can threaten property, adjacent lands, and public safety.
- If the right conditions (wind, humidity and topography) present themselves, fires can blow out of control, threatening forest designated for harvesting by the Alberta government.
- Fire triggers the release of seeds in serotinous cones such as lodgepole and jack pines.
- The carbon dioxide released from Canada's prescribed burns amounts to only 3% of that produced by automobiles and industry in Canada.
- Fire stimulates vegetative reproduction of many woody and herbaceous species.
- Fire helps recycle nutrients and creates habitat diversity.
- Dense smoke can irritate peoples' respiratory tracts and exaggerate the symptoms of asthma.
- The Mountain Pine Beetle thrives in older pine trees, and has had a very negative impact on the forest industry of British Columbia. Alberta foresters are very apprehensive that these beetles could destroy the Alberta forestry industry.
- Fire can help control outbreaks of the Mountain Pine Beetle, which destroyed over 500 trees in the Bow valley in Banff National Park in 2000. Creating younger stands of pine can help reduce the impact of this insect.
- In the summer of 1994, the town of Pentiction, B.C., lost 18 homes to wildfire. The wildfire also forced 3,000 people to evacuate their homes and final damage cost five million dollars.
- Frequent fires make a forest less susceptible to blow downs.
- Fire suppression can lead to late succession species domination (e.g. White Spruce, Douglas Fir) and is accompanied by loss of understory plants preferred by ungulates and some omnivorous species such as the grizzly bear.
- Certain species of wildlife thrive in the mature stages of succession represented by the White Spruce and Douglas Fir stands.
- Immediate post-fire ecosystems are charred, appear devoid of life and are not aesthetically appealing to some.

Fire and Succession Worksheet

1. Give two reasons why secondary succession is a necessary component of a healthy, functioning ecosystem.

2. Based on the species descriptions, number the plants and trees below as they would emerge in a successional series. (e.g. 1 = pioneer species) .
___ Douglas Fir – long living- oldest Douglas Fir in Banff National Park is 690 years old
___ Fireweed – helps control erosion in open areas
___Grouseberry – grows in open to wooded sites
___ Cow parsnip – thrives in moist, open or shadey sites; a favourite food of grizzly bears

3. There is a growing acceptance that disturbances such as fire are processes that change the structure, pattern and composition of a landscape. Some scientists believe that when disturbance is small or infrequent, strong resident species (Douglas Fir tree) eliminate weaker competitors (Lodgepole Pine) thereby reducing biological diversity. Similarly, when disturbance is frequent and/or intense, strong competitors are eliminated and although colonizers may increase, total biodiversity is reduced. When disturbances are intermediate in frequency and intensity, the resulting landscape diversity increases, as the disturbance provides good homes for both resident(old) and colonizing(new) species to persist and thrive. Draw a line that explains this phenomenon on the blank graph below.



Reference: Introduction to Wildfire by Stephen J. Pyne et al. Second edition, 1996.

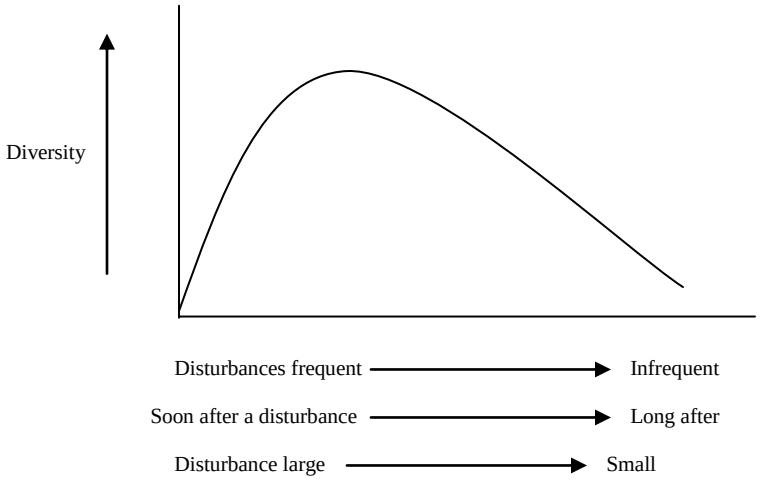
4. List three advantages and three disadvantages of fire.
5. In your opinion should fire be allowed to burn in our parks? Use the backside of this worksheet if more space is needed.

Fire and Succession - Teacher key

1. Give two reasons why succession is a necessary component of a healthy, functioning ecosystem.
-creates habitat diversity
-creates species diversity

2. Based on the species descriptions, number the plants and trees below as they would emerge in a successional series. (e.g. 1= pioneer species) .
__**4**_ Douglas Fir – long living- oldest Douglas Fir in Banff National Park is 690 years old
__**1**_ Fire weed – helps control erosion in open areas
_ **3**_Grouseberry – grows in open to wooded sites
__**2**_ Cow parsnip – thrives in moist, open or shades sites; a favourite food of grizzly bears

3.



Reference: Introduction to Wildfire by Stephen J. Pyne et al. Second edition, 1996.

4. List three advantages and three disadvantages of fire. In your opinion should fire be allowed to burn in our parks? **Responses may include, but are not limited to, the following:**

Three advantages
- **Fire stimulates vegetative reproduction of many woody and herbaceous species**
- **Fire helps recycle nutrients and creates habitat diversity**
- **Fire can help control outbreaks of the Mountain Pine Beetle**

Three disadvantages
- **Prescribed fire is costly**
- **The smoke from fire can negatively impact human health**
- **Fire is difficult to control in favourable weather and can destroy human property**

CSI: CPAWS Science Investigation

In this short exercise sheet, students apply their knowledge of genetics and the Hardy-Weinberg Equilibrium (HWE) to the rare, white Kermode bear in British Columbia. This activity is intended for advanced science classes and assumes that you have already covered the science of genetics and HWE.

Materials Needed

- Copies of the student worksheet
- Calculators

Time Required

- 20 minutes

Background Information

Review with your students the components of Population Genetics and the Hardy-Weinberg Principal.

The **Hardy-Weinberg Equilibrium** describes the relationship between allele frequencies and genotype frequencies under the assumption of random mating. To maintain this equilibrium, a number of assumptions must be met:

1) There must be no mutation
2) There must be no migration
3) Individuals must mate at random with respect to genotype
4) There must be no selection
5) The population must be infinitely large

The Hardy-Weinberg equation can be expressed as:

$$p + q = 1 \quad \text{or} \quad p^2 + 2pq + q^2 = 1$$

The following references were used in the creation of this activity:

Fairbanks, DJ and W.R. Andersen. 1999. Genetics: the continuity of life. Brooks/Cole Publishing Company. Pp. 581-587.

Kermode Bear Genes Revealed. 2001. Research Highlight, Forest Sciences Department, University British Columbia. http://www.forestry.ubc.ca/brchline/01September/FSC_Sept01.pdf.

Population Genetics/Hardy-Wienberg Equilibrium Practice Questions. 2003, Jan 17. www.csuchico.edu/~dmwood/Biol6B/Sample%20Exam%20questions/PopGenPracticeProblems.rtf.

Rood, Stewart. Professor, University of Lethbridge. Personal communication.

Snustad, D.P., et al. 1997. Principles of Genetics. John Wiley and Sons Inc. pp. 722 – 729.

CSI: CPAWS Science Investigation

Black bears can be...white??

ALONG the Pacific coast in British Columbia's temperate rainforests wander three populations of rare white-coloured bears. Some people believe they are albino black bears, while others believe they are polar bears. In actuality, they are a sub-species of black bear called the Kermode bear, *Ursus americanus kermodei*. Named after a Canadian scientist who studied them, the Kermode bear (also known as the Spirit Bear) has been protected from sport-hunting since 1925.

Researchers at the University of British Columbia decided to study the populations to find out why some bears in the region were coloured white, while the majority were coloured black. Researchers used hair-snares to help them with their analysis: they put bait (animal carcasses) in trees surrounded with barbed wire. The bears attracted to the odour would catch their fur on the wire, which researchers collected and analyzed for DNA. They sampled 220 bears across the region where white bears occur.

After studying the samples, they concluded that white bears were the result of a recessive gene, W (the dominant gene for the black colour is B). Further genetic analysis demonstrated that of the 220 bears, the following genotypes were found: 22 white bears (WW), 34 black bears (BW), and 164 black bears (BB). These results confirmed a genetic control and recessive inheritance of the white coat.

This kind of information can be useful in predicting and monitoring the numbers of Kermode bears in coastal British Columbia, and may have implications for forest management and sport-hunting. There are estimated to be less than 400 Kermode bears in the world.

What are the observed frequencies in this population?

BB: **BW:** **WW:**

What percentage of bears is likely to be coloured white?

Assuming a total coastal black bear population of 4352, how many will likely be coloured white?

What are the five assumptions of the Hardy-Weinberg Equilibrium?

What is the allele frequency (p) of B? **p =**
What is the allele frequency (q) of W? **q =**

Assuming HWE, what are the genotypic frequencies?
p^2 = 2pq = q^2 =

Given a population of 220 bears, fill in the following table:

Genotypes	BB	BW	WW	total
Observed #s	164	34	22	220
HW genotype frequencies	p^2 =	2pq =	q^2 =	1
HW predicted numbers (freq x population)				220

Is this population in Hardy-Weinberg Equilibrium? Explain.

If white bears prefer to mate with white bears, which HW assumption is violated?

You are the senior wildlife biologist for Spirit Bear Park, which provides critical habitat for both black and white bears. While hunting for white black bears is prohibited, hunting for black bears in this area is still permitted. The Park Manager is reviewing the hunting policy. What do you tell her? Given your knowledge of genetics, how might this affect the white bear gene pool over time?

A forestry company is proposing to clear-cut an area adjacent to Spirit Bear Park. As a wildlife biologist, you have been called upon to comment on the proposal. You know that black bears prefer forested landscapes and are likely to migrate into neighbouring habitat if they become displaced. How do you think this immigration of black bears into Spirit Bear Park would affect the Kermode bear gene pool?

Spirit Bear Youth Coalition

In grade nine, Simon Jackson wanted to help protect B.C.'s spirit bears (the rare white Kermode bear). He launched a letter writing campaign to protect the bears' habitat.

Today, Simon is the founder of one of the largest youth environmental networks in the world, and is supported by Jane Goodall, Charlotte Church and the Backstreet Boys. Time Magazine honoured him as one of 60 Heroes for the Planet in 2000. To find out more about Kermode bears or to find out how you can get involved, check out:

http://dsimonjackson.com/

CSI Teacher Solution

What are the observed frequencies in this population?

BB: 164/220 = 0.75 **BW:** 0.15 **WW:** 0.1

What percentage of bears is likely to be coloured white?
10%

Assuming a total coastal black bear population of 4352, how many will likely be coloured white?
435

What are the five assumptions of the Hardy-Weinberg Equilibrium?
Large population, random mating, no migration, no mutation, no selection

What is the allele frequency (p) of B? **p =** (2 X 164 + 34)/440 = **0.823**
What is the allele frequency (q) of W? **q =** (2 X 22 + 34)/440 = **0.177**

Assuming HWE, what are the genotypic frequencies?
p^2 = 0.677 **2pq =** 0.291 **q^2 =** 0.177

Given a population of 220 bears, fill in the following table:

Genotypes	**BB**	**BW**	**WW**	**total**
Observed #s	164	34	22	220
HW genotype frequencies	**p^2 =** 0.677	**2pq =** 0.291	**q^2 =** 0.177	1
HW predicted numbers (freq x population)	148.94	64.02	6.82	220

Is this population in Hardy-Weinberg Equilibrium? Explain.
No…the observed and predicted numbers are too different. The observed numbers are obviously not in HW frequencies.

If white bears prefer to mate with white bears, which HW assumption is violated?
Random mating – if bears choose their mates by colour, we will not achieve HW equilibrium expectations.

You are the senior wildlife biologist for Spirit Bear Park, which provides critical habitat for both black and white bears. While hunting for white bears is

prohibited, hunting for black bears in this area is still permitted. The Park Manager is reviewing the hunting policy. What do you tell her? Given your knowledge of genetics, how might this affect the white bear gene pool over time?
The white bear gene pool might be compromised, given that 15% of the black bears in this region could be carrying the recessive white gene. Eliminating these bears would reduce the likelihood that future white bears would be born.

A forestry company is proposing to clear-cut an area adjacent to Spirit Bear Park. As a wildlife biologist, you have been called upon to comment on the proposal. You know that black bears prefer forested landscapes and are likely to migrate into neighbouring habitat if they become displaced. How do you think this migration of black (coloured) bears into Spirit Bear Park would affect the Kermode bear gene pool?
This could affect the gene pool in a couple of ways. On one hand, more black bears carrying the recessive gene may enter the park, allowing the white bear genes to continue. On the other, more likely hand, the majority of bears do NOT carry the recessive white gene and more of these bears breeding with Kermode bears could potentially eliminate the white gene all together.

For more information on the Kermode Bear, check out:
http://www.spiritbear.com/site/wildlife/spirit-bears.html

The Grizzly Game of Life

In this grizzly bear game of life, the class plays the role of two grizzly bear populations: Banff National Park bears and Kananaskis Country bears. The populations must roll the dice and answer questions to make their way along a turbulent and thought provoking path towards a safe and suitable den for the winter. This culminating activity focuses on communities and population dynamics.

Materials

- Transparency of game and overhead projector
- A pair of dice
- Two game pieces (e.g. small eraser, button, paperclip)
- One calculator per team
- Teacher's copy of game questions
- Option: break the class into groups to play the game. For this, you will need as many game boards and copies of the questions/answers as there are groups

Time Required

- 90 minutes

Background Information

The status of grizzly bear populations in Banff National Park and Kananaskis Country is not scientifically known although it is speculated that anywhere from 50 to 100 grizzly bears live in the combined areas. Scientists may not be certain of exactly how many grizzlies exist in two of Alberta's most prized wilderness areas, but they are certain of the important role the grizzly bear plays in the management of these regions. The grizzly bear serves as an excellent indicator for the ecological integrity of our wild spaces because of certain biological traits: low birth rate (0.5 cub/year), large habitat requirements, and low population density. Natural selection, genetic isolation, human impact, interspecific and intraspecific competition, space restrictions, and birth and death rates are just a few of the factors that may influence population size and composition of grizzly bear populations and affiliated communities. Human impact through development and activities has been and continues to be one of the more severe factors hindering grizzly bear survival and population stability. Grizzly bear populations that are stable or increasing are an important indicator that the ecosystem in which grizzly bears and many other species live is properly functioning and healthy.

Instructions for the Teacher

1. Review the following key words and background information with the class. Most key words will also be addressed throughout the game.

Key Words

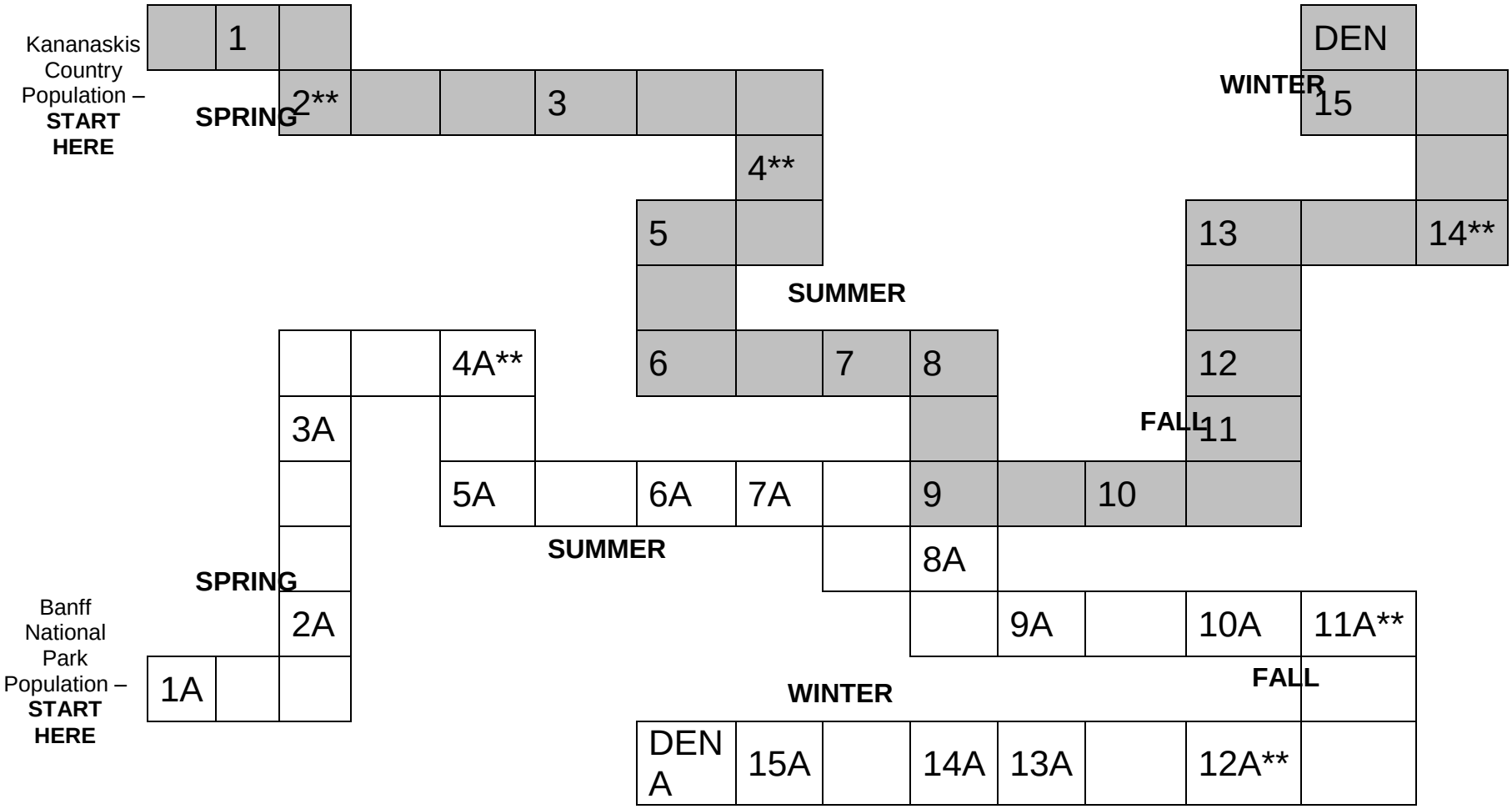
Population – a group of individuals of the same species within a community; characterized by geographic range, habitat, and size.
Community – an association of interacting populations, usually defined by the nature of their interaction of the place in which they live.
Natural selection – change in the frequency of genetic traits in a population through differential survival and reproductions of individuals bearing those traits.
Adaptation – a genetically determined characteristic that enhances the ability of an individual to cope with its environment; an evolutionary process by which organisms become better suited to their environments.
Competition – Use or defence of a resource (buffalo berry patch) by one individual (grizzly bear) that reduces the availability of that resource to other individuals.

Bio 30 vocabulary
Commensalism – an association between two species in which one benefits and the other is unaffected.
Mutualism – relationship between two species that benefits both.
Interspecific competition – competition for a resource between individuals of different species (e.g. wolf and grizzly bear competing for an elk carcass).
Intraspecific competition – competition for a resource between individuals of the same species (e.g. two male grizzly bears competing for same female to mate with).
Immigration –movement of individuals into a population.
Emigration – movement of individuals out of a population.

2. Divide the class into two teams. These two teams will represent two adjacent grizzly bear populations from Kananaskis Country and Banff National Park. Flip a coin to determine which team gets to choose where they will live (after the game, remember to ask this team if they are glad they made the choice they did).
3. Tell the class their goal is to maintain a stable population and reach their respective denning areas in preparation for the winter.
4. Designate a leader from each population to roll their dice.
5. Begin the game with the team of your choice. On the game overhead, move their game piece the number of spaces they roll. Read the corresponding text that is linked with each number. Depending on what the text reads, the game piece may have to be moved again either forward or backward. Some of the corresponding text may ask a skill-testing question from either one or both teams. If there is a double asterisk beside the number, the question will be asked of both teams. The first team to successfully answer the question will move ahead the designated number of spaces.

   A population must roll the exact number of spaces to make into the den. I.e. if there are three spaces left between game piece and den, the group MUST stay stationary until three is rolled.

The Grizzly Game of Life



** = Question for both teams to answer (team who successfully answers first may move ahead)

Game Clues and Questions

** =For both populations to respond. First team with the correct response moves ahead the designated number of spaces
note: we have also provided advanced questions for Biology 30 or really smart kids

Banff National Park Grizzly Bear Population (1 to 5)

Spring (1-5)

1. Food is scarce in early spring and grizzly bears have to rely on overwintered bearberries, small patches of grass, or sweet vetch roots to fill their starving stomachs. Stay put to save energy and lose a turn.

2.**Your population emerged from hibernation with a total of 12 new cubs. Congratulations! If there are 24 female grizzly bears in Banff National Park, what is the annual birth rate? The population who can correctly answer this question may move ahead one space. The losing population stays stationary.

Answer: 0.5 cub per year – the number of female grizzlies indicated here is hypothetical, although there is evidence to support the birth rate of 0.5 cub/year.

3. The fat content in human milk is less than 4%. What percent fat does a nursing grizzly bear's milk contain? **1**. 2% **2.** 6% **3.** 30% **4**. skim

Answer: Grizzly bear's milk is ~ 30% milk fat. The richness of bear's milk fat is only exceeded by that of cold water marine mammals such as whales or seals. **Move ahead one space if the question was answered correctly. Move back one space if the question was answered incorrectly.**

4.**Move ahead two spaces if group can define natural selection and give an example.

*****Advanced Level**:* Move ahead two spaces if you can define and give three distinct characteristics of a population.

Answer: see keyword list. **First group to respond correctly moves ahead two, other group stays stationary.**

5. Habitat fragmentation (when a human feature such as a highway, community or railroad dissects habitat rendering it unusable by large mammals) is the second most significant threat to the long-term survival of grizzly bears in North America. **Move ahead one space if you can identify the primary threat**.

Answer: habitat loss

Summer (6-10)

6. A careless hotel worker left a stinky bag of garbage outside overnight. A grizzly in your population rips it open and gorges on old porkchop bones and tin cans. Move back 4 spaces for becoming habituated. (For discussion: is this really the grizzly bear's fault? NO!!! It is peoples' responsibility to maintain clean and odour-free hotels, restaurants, yards and campgrounds.)

7. Name the species of bears we have in Alberta.

Answer: black bear and grizzly bear. **If correct, move ahead one space; if incorrect, move back one space.**

8. As summer progresses, grizzly bears switch to eating ants in dry open south and west facing forests. Ants and other insects account for a portion of grizzlies' carnivorous diet. If the population can name two other specific plant or animal species that grizzly bears eat during the summer months, they may **move ahead one space**.

Answers: buffaloberry, huckleberry, blueberry, cow parsnip, glacier lily, ground squirrel, marmot

9. A Banff grizzly bear has chased away the Bow Valley wolf pack that was eating a freshly killed elk.

Move ahead one space if you can name 3 other scavenging species that would benefit from such a kill.

Advanced Level: **Move ahead one space** if you can define and explain this type of competition.

Answers: coyote, raven, crow, chickadee, magpie, marten, wolverine, weasel, this is an example of interspecific competition.

10. Grizzly bears are believed to have evolved over 2.5 million years ago in Asia. **Move ahead one space** if your population can identify three ways in which grizzly bears' behavioral or physiological adaptations help it survive?

Answers may include but not be limited to the following:

- *A bear's instinct to den is an adaptation to life in places where winter conditions would otherwise threaten survival. The problems of reduced food availability, deep snow, and increased energy needs in winter are solved by denning. In the central Rockies, grizzly bears den between mid October and early November for about five months.*
- *The grizzly bear's distinct shoulder hump and long claws are physical adaptations to their feeding behavior. The longer claws are used for digging roots and excavating the burrows of small animals. The bone and muscle structure of the hump is an adaptation for power in digging and for attaining bursts of speed, up to 35 mph, necessary in capturing moose, caribou and deer for food.*
- *Grizzly bears are a unique species of the Order Carnivora as the bulk of their diet is plant matter, not meat. As opportunistic omnivores, they have adapted an elongated gut to better*

absorb the nutrients in plant matter. They have also adapted front molars to help them grind roots and bulbs.

- *A grizzly bear's thick fur traps heat insulating a grizzly from the cold and affords it some protection from insects in the summer.*

Early Fall (11-15)

11. A member of the Banff grizzly population, tempted by the decadent chocolate shops and restaurants that exist in Banff town site, walked down busy Banff Avenue and sent tourists running. Banffite Grant Capel, first saw the grizzly at about 9:30 p.m. as he was driving away from his parents' house on Otter Street. "I backed my car into the street and was suddenly parallel with it," he said. **Move back two spaces** as this bold bear is showing definite signs of habituation. (This is a true story taken from the Banff Crag and Canyon, June 23, 2002.)

12. The Lake Louise ski hill produces an abundance of natural grizzly bear foods, especially during summer and fall. However, the high numbers of human visitors in the area makes Lake Louise a dangerous place for grizzly bears to live. Between 1971-1996, a minimum of 107 grizzlies were killed or removed from Banff Park by wardens. Only 2 adult grizzlies were known to have died naturally. More bear deaths occurred at Lake Louise than anywhere else in the Park. All of the grizzly bear deaths or removals were within 500m of a road or developed area, or 200m of a high use trail. Name three ways grizzly bears die as a result of human use and presence in bear habitat.

Answers may include but are not limited to: habituation, vehicle collisions, railway collisions, poaching, hunting. **If population can name three ways, move ahead one space**.

13, 14 & 15. Read the following to the students and then have them answer the skill-testing questions at the end.

> Whitebark pines play an important role in the harsh subalpine ecosystems where they coexist with grizzly bears and many other species. Whitebark pines can tolerate colder, drier, windier sites than their competitors, and commonly dominate treeline communities in the Rockies ecosystem.
>
> The abundance and regeneration of Whitepark pine is closely linked to the Clark's nutcracker. Whitebark pine coevolved with the Clark's nutcracker, and depends upon the nutcracker's seed selection and caching habits for seed dispersal and reproduction. In the late summer, when the cones are mature, dry and open, Clark's nutcrackers extract the seeds and disperse them up to 22 kilometers away. They cache the seeds in small middens of 7-10 seeds placed 2-4 cm beneath the soil surface, hidden from most other seed predators. It is estimated that a single nutcracker can disperse up to 98,000 whitebark pine seeds per year!
>
> Red squirrels also harvest whitebark pine seeds as a fall and winter food source, burying large quantities of seeds in middens up to 40cm deep. These middens are the predominant source of whitebark pine seeds consumed by grizzly bears. Such seed caches often persist

throughout the winter, giving grizzly bears a food source upon emergence from hibernation, before other plant foods become available. Grizzly bears have been observed finding and unearthing squirrel caches under 6 feet of snow! Grizzly bears in Yellowstone National Park derive 23% of their energy needs from whitebark pine seeds and there is evidence to suggest that whitebark pine seeds can lead to higher reproductive rates of female grizzly bears.

13. **Move ahead one space** if you can correctly name two competing species from this example of ecosystem interactions.

Answer: Clark's nutcracker and red squirrel.

14** FOR both populations to answer: Commensalism is the association between two species in which one benefits and the other is unaffected. Identify two species in the example above that maintain this sort of relationship.

Answer: grizzly bear and red squirrel (squirrels will not suffer from the lost seeds). **If correct, move ahead one space; if incorrect, move back two spaces.**

15. Mutualism is the relationship between two species that benefits both. Name two species that benefit from each other.

Answer: Clark's nutcracker and the Whitebark pine (Clark's nutcracker receives seeds as food and the Whitebark pine receives seed dispersal and planting). **If correct, move ahead one space.**

Kananaskis Country Grizzly Bear Population (1A to 15A)

Spring (1A – 5A)

1A. Spring's warm rays finally melt the last few patches of snow revealing a variety of food sources such as herbs (flowers), grasses and sedges. Grizzly bears are finally feeling energized again by the abundance of fresh green shoots. **Move ahead one space**.

2A. Avalanche-killed elk or sheep carcasses are exactly what a hungry grizzly bear craves after hibernation. The Rockies' cold temperatures preserve the carcasses well into the springtime. With its powerful nose, a Kananaskis Country grizzly has discovered such a carcass. **Move forward one space**.

3A. A variety of complex relationships exist within a grizzly bear's community. Epiphytes are plants that live on other plants (example: lichen or moss growing on a Douglas fir tree). There is no evidence that epiphytes harm their supporting trees and shrubs. Epiphytes derive no nutrients or water directly from the host plant.

This is a form of:
i. Commensalism – an association between two species in which one benefits and the other is unaffected
ii. Mutualism – relationship between two species that benefits both
iii. Parasitism- an organism that lives in or on another organism, from which it obtains food.

Advanced Level: Name and define this sort of relationship.

Answer: Commensalism. **Move ahead two spaces.**

4A** The home range of grizzly bears in the Central Rockies Ecosystem are quite large: 200 to 500 sq. km. for females, and 1000 to 2000 sq. km. for males. Population density describes the number of organisms in a defined area. The density (D) of a grizzly bear population is calculated by dividing the total numbers counted (N) by the total area or space (S) occupied by the population.
D= N/S

What is the population density in Banff National Park if the Park is 6,640 square kilometers and there are an estimated 80 grizzly bears in the Park? **First team to answer correctly moves ahead two spaces.**

Answer: ***80 bears /6640 km^2 = 0.012 bear/km OR one bear/100km^2***

5A. Two quick and silent mountain bikers have startled you and your two cubs. **Move back two spaces** in order to relocate cubs to an area farther away from busy trails and human features.

Summer (6A to 10A)

6A.Grizzly bears can be legally hunted in certain areas outside our national and provincial parks. A member of the Kananaskis grizzly population has wandered outside of the provincial park

boundary (because bears can't read signs!) to an area north of the Bow River where hunting grizzlies is legal. **Lose a turn**.

7A. Sweet clover is a tempting treat for grizzly bears. Unfortunately, this sweet clover has proliferated along the unfenced Highway 40. Bears who feed along Highway 40 not only run the risk of being injured or killed by a vehicle but also becoming habituated. Name three ways to prevent bear habituation.

Answer: don't stop car along highway, aversive conditioning (using bear dogs, rubber bullets, bear bangers to scare bears out of an area) **If correct, move ahead 1 space; if incorrect, move back 2 spaces** into the safe solitude of the forest.

8A. A curious subadult grizzly bear from your population has wandered off to find its own unique home range. **Move back a space** as you lost a bear.

Advanced Level: Define this incident. *Emigration- movement of individuals out of a population*

9A. Through research, humans can better understand grizzly bear habitat needs and make appropriate management decisions. One technique researchers use to analyze grizzly bear genetic composition is by setting up a hair snare (hanging a smelly carcass in a tree surrounded by barbed wire – bears attracted to the smell will snag their hair on the barbed wire). The fur is analyzed in a laboratory for DNA. **Move ahead one space** if you can name two other ways humans research grizzly bears.

Answers: collaring and radio or GPS telemetry, tracking or scatology (studying fecal matter).

10A. A cub in your population was abandoned by her mother and is now trying hard to survive in a human-dominated environment. Because of her small size and incomplete knowledge of her home range, she is forced to forage in the marginal habitat that exists along the town of Canmore's Nordic Centre and Three Sisters Developments. After frightening many joggers, mountain bikers and children, this bear is finally captured by conservation officers and translocated to another area. Translocation is the movement of an animal to another area within its home range. **Move ahead one space** if you can name two problems associated with translocation.

Answers may include:

- *High cost - a bear moved by helicopter may cost up to $1800*
- *Rates of return of translocated bears may be as high as 60-70% (Malaspina University-college)*
- *Grizzly bear may be released into a more dominant bear's home range – conflict may ensue and translocated bear may become injured or die*

This happened to a bear during the summer of 2001. After translocation, the female grizzly wandered onto an Indian Reservation, where she was legally shot and killed.

Fall (11A –15A)

11A and 12A.** Grizzly bears, especially males, need to travel long distances to meet their biological needs. To do this, grizzly bears routinely have to go outside of protected areas such as Peter Lougheed Provincial Park into low-quality, fragmented habitat. Some ecologists compare some of our national and provincial parks to islands because they are areas of good habitat surrounded by 'seas' of civilization. These islands isolate grizzly bear, coyote, wolf etc. populations from other populations and communities.

11A. **Isolated populations experience little to no *immigration* (define if need be). How does this "islandization" negatively affect a population in the long term**? First population to answer this question correctly may move ahead one space**.

Answer: Relatively small, isolated populations eventually show reduced genetic diverisity, which may cause problems associated with inbreeding (less adaptable to change, less resistant to disease, underdeveloped reproductive organs in offspring).

12A.** Isolated populations of bears also experience little to no emigration (define if need be). **First team to suggest one way in which this could be a problem for grizzly bears can move ahead one space**.

Answer : This results in a decreased ability to respond to short- and long-term changes in their habitat (e.g. changes resulting from a forest fire, or from climate change).

13A. Ground squirrels are sought out in September when they are fat and slow. The diggings for ground squirrels are large and often trench-like. They reveal the large amount of effort that grizzly bears are willing to expend for this source of protein and minerals. Your population has discovered a ground squirrel meadow Mecca**! Move ahead two spaces.**

14A. Unfortunately, Kananaskis Country grizzly bears must coexist with non-native species of plant or animal within their community. Most non-native species are introduced to an area by people and many are valued for their recreational and/or aesthetic properties. In Kananaskis Country, rainbow trout were introduced in the 1940's and still persist today in the Elbow, Sheep and Highwood river drainages (Freshwater Research Ltd., 1995). **Move ahead one space** if your population can name two environmental consequences of introduced species.
Possible answers:

- *Predation on native wildlife, in some cases wiping out native populations (e.g. It has been suggested that the introduction of rainbow trout may have impacted the reproductive capacity of amphibians, including spotted frogs, in at least one wetland complex in Peter Lougheed Provincial Park.)*
- *Introduced species can propagate diseases that harm native species.*
- *Introduced species can dominate an ecosystem by outcompeting native species for food, space, and other natural resources.*
- *Introduced plants can also harm native ones by producing and releasing chemicals.*

- *Mating between some introduced and native species can lead to an extinction of the native species by replacing some of its genes.*

15A. A bear in your population has gotten too close to a hotel development in the Evan Thomas Valley. Luckily, a Karelian bear dog and its owner have discovered your somewhat unwary behaviour. Karelian Bear Dogs are used by aversive conditioning specialists to teach bears to recognize and avoid human territory. This in turn, helps prevent bears from becoming habituated. The yappy Karelian bear dog has sent you running! **Jump ahead to your safe and quiet winter den**.

Where would you rather live: Kananaskis or Banff?

As a National Park, Banff enjoys one of the highest levels of legal protection that Canadians give to land; however, its commercial development and extensive use by humans have reduced its ecological integrity, and many bears have died through habituation or on the highway or railway.

Kananaskis Country is not an easy place to live either – but for significantly different reasons. Although visitation to this area is lower than Banff, it is not as well protected. Only 60% of this area enjoys protected area status, and part of this is the Evan Thomas Recreation Area, a zone of excellent bear habitat that is managed with recreation – not protection – as the priority.

The Great Bear Debate

This culminating activity will have students represent various stakeholders in the issue of conserving habitat for bears, and illustrate the complexities of the situation. Through role-playing, questions about development, conservation, and land use will be addressed.

Materials

- Role cards
- Any literature from previous activities that might help students make their point

Time required

- 60 minutes

Instructions for the Teacher

1. Tell the students that in this simulation activity they will play the parts of various sectors of society.

Ask students to predict what the position of the following groups is with respect to conserving habitat for grizzly bears: conservation biologists, outdoor enthusiasts, grassroots environmentalists, hunters and anglers, business leaders, government land managers.

2. Divide the students up into six groups and distribute the role cards to each group. Tell them:

In 10 minutes, I will be convening the first-ever multi-stakeholder meeting regarding grizzly bears in Banff and I need you to be ready. Each of you has been handpicked to represent all members of your sector of society. The main goal of this meeting is to consider a proposal by Parks Canada to close a popular trail and snack shop in prime bear habitat in Banff National Park in order to conserve grizzly bear habitat and stabilize the mortality rate.

3. Advise the groups that they will have 10 minutes to discuss their position and their strategy for the meeting. Tell each group they should begin by having one person in their group read the role card out loud, and that each group must choose a speaker to address the class. Ask the groups to prepare a one-minute statement that summarizes their position on the issue.

4. Gather into a circle with group members sitting together. Ask each group for a one-minute opening statement. Then allow a few minutes of questions so the groups can sort out the various positions being taken.

5. Allow the students to discuss and debate the various facets of their arguments. The teacher should act as a facilitator, keeping the discussion on track, and mediating when required.

6. Tell the group they have been involved in a style of decision-making known as a consensus process. The group as a whole must now strive to agree on the recommendations to be made to Parks Canada.

Ask the group:

- ***Are there some things that the whole group can agree on? What is our common ground?***
- ***Is anyone here willing to make a compromise in order to help the discussion progress?***
- ***Are there any sectors of the public who are missing from the table?***

Discussion

7. Tell the students that the simulation is now over – they can go back to being students! Have each group review their role card. Ask them:

- ***Do you think these cards create an over-generalized image, or 'stereotype' of the different groups? (You may need to give an example of a stereotype: e.g. "All long-haired young people smoke drugs.")***
- ***Were you surprised by the amount of common ground that was identified?***
- ***Are the personalities and abilities of the individuals involved important to this process?***
- ***Do you think your initial feelings about this process (on the role card) might change with time?***

Remind students that there exists a grizzly bear crisis in our Central Canadian Rockies. The Eastern Slopes Grizzly Bear Project has shown that habitat fragmentation and lacking security may threaten the future population of bears in Banff National Park and Kananaskis Country. Trail closures are only one small way to improve bear habitat. Although it seems simple, the general public often doesn't respect these closures and tries to have closures lifted. In the past, a

popular hiking trail, Mt. Indefatigable in Kananaskis Country, has been closed for a grizzly bear and her cub. This is usually only a short closure, but is often met with public outcry. How do you think that park managers should handle these situations?

Conservation biologists

What you believe in:
Your job strives to maintain the preservation of natural areas and the animals that inhabit them. You base your work on scientific research and fact. In your opinion, genetic and species biodiversity are crucial components of a healthy ecosystem.

Your position regarding conservation of grizzly bear habitat:
As a conservation biologist, you know that grizzly bears are indicators for ecological integrity. This means that the presence or absence of a healthy grizzly bear population is an excellent indicator of how well human impact upon a region is managed. You are also aware that the grizzly bear is an umbrella species, meaning that if grizzly bears can successfully thrive in an area, then all the species protected by the 'umbrella' of grizzly bear conservation can also successfully live there. Your work has revealed that bears in Banff National Park are suffering from low genetic biodiversity and would benefit greatly from an enlarged protected area to roam, as well as stricter controls of human use within the Park.

Your initial feelings about this meeting:
You're a bit uncomfortable with politics and hope there won't be any arguments or unpleasantness.

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Outdoor Enthusiasts

What you believe in:
You value natural areas not only for their beauty but also for what they offer and enable you to do: hike, bike, rock climb and ski. You would like to manage the Park so that you and your family can enjoy its benefits for years to come.

Your position regarding conservation of grizzly bear habitat:
You are keen to help protect grizzly bears in Banff National Park. You are "bear aware" and take all the necessary precautions in the backcountry. You feel that since you act responsibly there is no reason to close trails and/or limit access to them.

Your initial feelings about this meeting: You are excited to have the opportunity to speak your mind. You want to ensure your way of life remains unchanged by the outcome of the meeting.

Grassroots environmentalists

What you believe in:
You believe in the preservation of all living things and the ecosystem that houses them. You put the environment first on your list of priorities and feel that living sustainably is the only option.

Your position regarding conservation of grizzly bear habitat:
It's totally necessary and should happen as soon as possible. This initiative gives a greater meaning to all the local campaigns you're involved in. You believe what scientists have told you about needing more secure areas within the park to preserve biodiversity. You want there to be a park left with grizzlies in it for your grandchildren to see, and for you and your "tree-hugger" friends to enjoy. You feel that Banff is over-developed and that restoration (including the removal of some development) is necessary. In fact, last year you started a letter writing campaign urging Parks Canada to develop a grizzly bear management plan.

Your initial feelings about the meeting:
You are suspicious of the business leaders and don't like the style of the facilitator. You feel it is your duty to save the grizzly bears, and any compromises you make will come back to haunt you. You disagree with hunting because you believe all animals should live – plus, you're a vegetarian.

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Hunters and Anglers

What you believe in:
The rights of the individual, the right to own guns, fiscal conservatism, access to natural areas, predator control and the conservation of prey species like elk, deer, and sheep.

Your position regarding conservation of grizzly bear habitat:
It seems like an OK idea, but you're uneasy because you've never really got along with environmentalists. You love fishing, hunting, driving and camping in the great outdoors. You support this conservation initiative as it will help ensure that the Park will be able to supply grizzly bears to adjacent, unprotected areas where grizzly bear populations are limited.

Your initial feelings about this process:
You're a little impatient with long-winded meetings, and are liable to jump up and start shouting if things don't go your way.

Business leaders

What you believe in:
You are aware that development means trouble for bears, but you're confident that these can be solved by better management and technology. You believe in the capitalist system and think things are being run just fine.

Your position regarding conservation of grizzly bear habitat:
Yikes! This looks like trouble for all those new condos and shops you had planned and you don't like it one bit. This conservation initiative represents a threat to the bottom line of your company and you owe it to your shareholders to maximize profits in your area.

Your initial feelings about this process:
You feel that you can tolerate this process so long as it doesn't create any major changes. You yearn to explain to everyone the importance of allowing your business to continue to grow in Banff National Park, as it represents your livelihood.

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Government land managers

What you believe in:
Conservation, protected areas, keeping a level head, the ability of a democratic state to reflect the will of the people, and the government's ability to enforce things.

Your position regarding conservation of grizzly bear habitat:
You feel that it is a good idea (but your boss doesn't). You also feel a little insulted by the premise that the status-quo in Banff National Park is inadequate to conserve habitat. You work really hard at protecting the park's environment while keeping businesses and townspeople happy. You suspect that one of the environmentalists across the table is the person who started last summer's letter-writing campaign that gave you so much trouble.

Your initial feelings about this process:
Given political realities and the power of business and industry, you're pretty sure this idea is going nowhere, and that this process will end up being a waste of time. You're also afraid to speak out in favour of conservation in case your political bosses make life difficult for you.

Helping the Great Bear

Learn how personal actions can make a difference and how to answer the question, "WHAT CAN I DO?!" In this activity, students are empowered to take responsibility into their own hands by example of a past success story.

"If you think that the action of one individual can't make a difference, just try spending the night with a mosquito in your tent!"

-Unknown-

Materials

- None

Time Required

- 45 minutes of class time to discuss action options

Instructions for the Teacher

1. Read the following success story to your class or ask a student to read it.

2. Ask your class if the story is inspiring and if they wish to help the grizzly bear. If yes, brainstorm with the class some ideas to help grizzly bears (or your own bear, if you adopt one) and write all ideas on the board.

3. Together with the class review the list of actions and evaluate which actions are realistic and feasible. It is important that you pick actions that have a good chance of success as well as feel comfortable for you, the teacher.

Minister of Canadian Heritage Sheila Copps recognizes student action on the environment

Students in the Bow Valley, just outside Alberta's Banff National Park, care a lot about wildlife. In September 2000 students from Canmore's Lawrence Grassi Middle School received a program about wolves. Following the presentation the students focussed on a goal: persuading all stakeholders to build an engineered wildlife crossing structure over the Rundle Forbay, a man-made lake that interrupts a major wildlife corridor. With the help of teachers Brenda Davidson and Wendy Allsopp, the students used local media to raise this issue within their community, and made presentations to hundreds of elementary students, who sent posters, postcards and letters to local decision makers...

What happened? In June of 2002, the Honorable Sheila Copps, Minister of Canadian Heritage, announced that the federal government and its partners would build a wildlife crossing structure, as part of the federal government's 'G8 Legacy,' a commitment designed to help improve the quality of the local environment. The longest and loudest applause was reserved for the students, who were told in no uncertain terms by the Minister: "Today, it is clear to everyone in this room that your actions have made a difference."

How to Make a Difference

Be informed about development issues in Alberta. What implications do they have for bear habitat?

Educate yourself about the challenges faced by grizzly bears. Start by investigating the web resources at the end of this guide. Invite students to visit the websites and consider some of the actions suggested there. Check out CPAWS' Take Action site (http://cpaws-southernalberta.org/actions), to find out more about things you can do.

Share your knowledge and concern with parents, friends and various teachers. Develop a presentation about bears that you teach to other classes.

Join or make a donation to an environmental conservation organization. Perform a web search to find out about organizations in your area that support the same things you do. Check out our suggested links in the next section.

Practice careful management of your food and garbage when you are in bear country. If you see carelessness, help others understand the importance of being bear aware. Encourage friends and family to follow the speed limits (slow down) in the parks.

Practice more environmentally friendly lifestyles. Grizzly bears and their habitat are threatened by development that is a direct result of consumer habits and lifestyle choices. Industrial activities such as forestry, and oil and gas exploration are reduced in their scale and rate if we all conserve energy, recycle materials, and make lifestyle decisions that have lower environmental impacts.

Practice your writing skills. Write letters to your local paper or decision-makers to ensure your concern for the future of grizzly bears and their habitat is heard by decision-makers and the media. Letter writing is an effective way to have a say: a letter from ONE person represents ONE THOUSAND people who share that view but didn't get around to writing, and letters from youth have extra impact. Be sure to send copies of your letters to CPAWS!!

Take the Action Challenge!

Your class can be part of a special group of students who are taking CPAWS' Action Challenge for Nature. After learning about grizzly bears and conservation biology, you and your students may want to do something to help. Positive stewardship actions, from picking litter or being bear-aware while camping, will help grizzlies.

CPAWS Southern Alberta has created some terrific resources to help students brainstorm action ideas and make them happen. We've designed a special website, www.actionchallenge.ca for classes who want to take positive action to help the environment. This website features special tools for teachers and students to help them with their projects from start to finish.

Need ideas? We've created an Action Menu that can be downloaded from our website (or call our office for a copy). Be sure to check out the **Action Challenge** section of the website, where we've collected actions other classes have achieved – look here for ideas and inspiration! And when you've accomplished your goals, be sure to let us know so we can feature **your** work on our Action Challenge webpage. We have included our Action Reporting Form – please fill it out and send it to us so we can add your actions to our webpage.

Not sure of where to start? Consider these ideas:

- Have students develop and deliver a public (school) education campaign to teach people how to travel safely in bear country
- School-yard cleanup or school-wide recycling programs
- Write letters to protect wildlife habitat
- Find creative ways to raise money to adopt-a-species or donate to an environmental organization

In the following pages, we've provided you with contacts of other organizations that provide environmental education and action opportunities. Action projects can be as simple or complex as you choose to make them. But they all have a measurable effect on students and on the environment.

Never doubt that a group of thoughtful, committed citizens can change the world. Indeed, it's the only thing that ever has.
– Margaret Mead

www.actionchallenge.ca

CPAWS' Action Challenge Reporting Form

We are so happy you've decided to do something to help the environment – every action, large or small, counts! We'd like to find out what you've done so we can profile your work on our webpage and send you a certificate for participating in our program!!!

Please fill out this form and send to the address below. Please print clearly.

School Name: _____
Teacher name:_____
Number of students:_____
School Address:_____
_____
_____
Tel/Fax:_____
Email:_____
School Website URL: _____

Please describe the action your class will take to help grizzly bears or endangered species. Feel free to use extra pages. If you need help with your action plans, contact us – we have lots of great ideas!

_____
_____
_____
_____

How much time did it take to work towards your project goals? _____
What resources will/did you need?_____
_____
_____

* Please send/email us pictures of your class, posters or events, and copies of any letters, reports or posters you create so we can post them on:

www.actionchallenge.ca

SEND TO: Canadian Parks and Wilderness Society (CPAWS)
Southern Alberta Chapter
88 Canada Olympic Road SW
Calgary, AB T3B 5R5
Email: education@cpaws.org
Fax: 403-232-6988

Related Resources and Web Sites

Find out more about grizzly bears, safety in bear country, and other educational resources.

Canadian Parks and Wilderness Society Education
http://cpaws-southernalberta.org/campaigns/education

- Learn more about CPAWS field trips, in-school presentations, teacher P.D., student action awards, and activity guides.

Canadian Parks and Wilderness Society
http://cpaws-southernalberta.org/

- Information about membership, volunteering, current campaigns and special events

Eastern Slopes Grizzly Bear Project
http://www.canadianrockies.net/grizzly

- ESGBP created to address the need for scientific information about the cumulative effect of human development and activities on grizzlies in the Central Rockies Ecosystem
- Grizzly bear facts, reports, publications and feature articles
- Video/film productions and other resources

Foothills Model Forest Grizzly Bear Research Program
http://www.fmf.ca/pa_GB.html

- Aims to advance the long-term survival of bears worldwide by replacing misconceptions with scientific facts about bears, their role in ecosystems, and their relations with humans.
- Works to conserve bear habitat, stop poaching, rehabilitate injured and orphaned bears back to the wild, and implement methods to reduce conflict between humans and bears.

Alberta Parks - Kananaskis Country Environmental Education Programs
http://www.albertaparks.ca/kananaskis-country/education/environmental-education-programs-resources/
- Download free teaching resources for all grade levels

Craighead Environmental Research Institute
http://craigheadresearch.org/
- Aims to increase understanding, appreciation and protection of the natural environment
- Information on the status, distribution and trends for North American grizzly populations
- Map of Canadian grizzly bear population sizes

Environment Canada - Canadian Wildlife Service - Hinterland Who's Who
http://www.hww.ca/
- Excellent information about many species, including grizzlies

Friends of Banff National park - Bear Edukit
http://www.friendsofbanff.com/learn-more/edu-kit-rentals/
- Book the Friends of Banff Edukit for pelts, books, movies, tracks and classroom activities

Interagency Grizzly Bear Committee
http://www.igbconline.org/
- Working for recovery of the grizzly bear in the lower 48 states
- Many useful pages on this site, including a report on the monitoring of grizzly bear populations using DNA

International Association for Bear Research & Management
http://www.bearbiology.com/
- Dedicated to conservation of all species of bear
- Find out about bears and what is being done to protect them

National Wildlife Federation spotlight on Grizzly Bears
http://www.nwf.org/Wildlife/Wildlife-Library/Mammals/Grizzly-Bear.aspx
- Offers a glance into the life and activities of the grizzly bear, as well as current reintroduction efforts
- Science facts, creatures in conflict, life cycle, audio/video clips, Q&A

North American Bear Center
http://www.bear.org/website/
- Promotes understanding & appreciation of bears
- Amazing photos of grizzly bears in Katmai National Park (Alaska) - suitable for presentations/reports

Wind River Bear Institute
http://www.beardogs.org/
- Innovative bear conservation program aimed at preventing the destruction of 'problem' bears
- Karelian bear dogs used in 'aversive conditioning' to teach bears to recognize and avoid human territory

Why Bears? Video
https://www.youtube.com/watch?v=yGC6Ja1ZZkQ
- This film is for teachers, scientists, non-profits and people interested in bears and preserving wild spaces.

WWF Canada Grizzly Bear Species Profile
http://wwf.panda.org/about_our_earth/species/profiles/mammals/brown_bear2/
Learn more about the Grizzly Bear and what is being done to protect them.