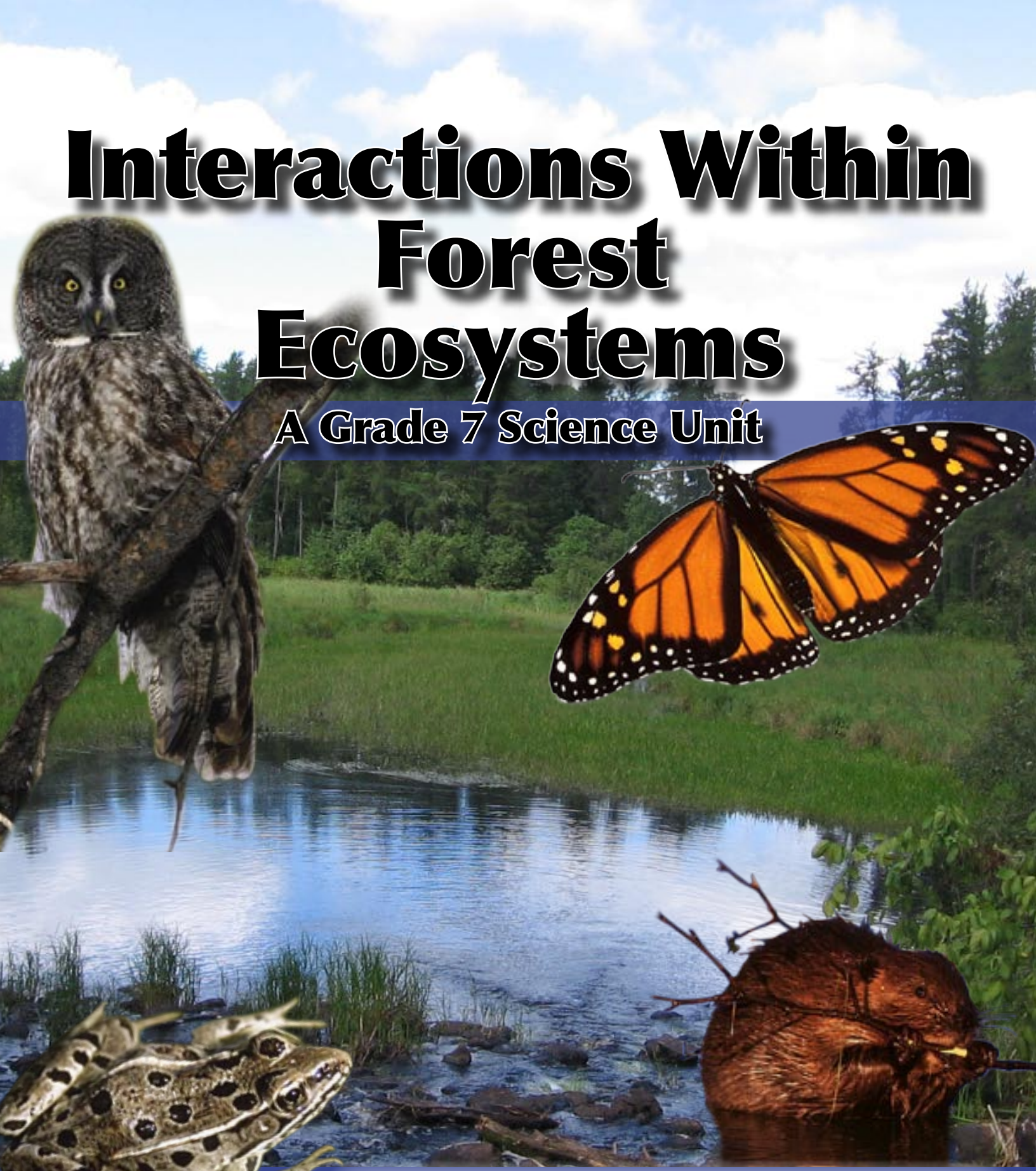
Interactions Within Forest Ecosystems

A Grade 7 Science Unit



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This booklet is dedicated to the memory of Mike Waldram, General Manager of the Manitoba Model Forest (1992-2006). His hard work and complete devotion to forestry brought many diverse groups together to work for the cause of forest sustainability.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the support, advice, and technical information that went into the creation of this project. Thanks Bev Dube, Acting General Manager for your ability to keep projects moving forward, and providing encouragement to keep working with our youth and their teachers. Thank you to the Manitoba Model Forest Board of Directors for your input and support, and seeing the need to promote forest education. Thank you to Rod Bollman, Chair of the Education Committee who, with more than 30 years as a Biology Professor, encouraged me to think holistically about the forest. Thank you to Professor Peter Miller, who taught everyone to be mindful that every person values the forest in a different way. Thank you to Manitoba Conservation Staff in the Eastern Region, including Stan Kascznowski, Kelly Leavesly, Trevor Barker and Graham Sayer, who have spent their lives working for the sustainability of our forest resources as well as the wildlife that depends on it. Thank you to the Manitoba Forestry Association for their support and use of their library resources, as well as Ken Fosty, Forestry Technician, for teaching myself and other landowners about Forest Management. Thank you to the First Nations Communites within the Model Forest – Brokenhead, Sagkeeng, Black River, and Hollow Water, especially the Elders who provided me with a sense of their deep understanding of and connection to the forest. Thank you to Tembec Industries, for their dedication to forest sustainability and commitment to the Forest Stewardship Council's high standards of forest management, and their willingness to provide technical support in the field, especially Vince Keenan, Divisional Forester, Jennifer Lidgett (also thanks to Jennifer for her dedication for Forest Education), Bob Yatkowsky for his knowledge not only of Forest Management but also of people who live and work "in the bush", and to Dan Phillipot for his dedication to silviculture and his hard work carried out in helping the forest regenerate. Thank you to Natural Resources Canada and the Canadian Forest Service for the financial support, and to all Science teachers willing to use this booklet to help our students understand the forest ecosystem and its importance to life on our planet.

CORRELATION TO GRADE 7 CURRICULUM OUTCOMES
CLUSTER 1

Students will...

7-1-01: Use appropriate vocabulary related to their investigations of interactions within ecosystems, such as *ecosystem, biosphere, abiotic, biotic,organisms, ecological succession, photosynthesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, and micro-organisms.*

7-1-02: Define ecosystem, and describe various examples that range from the microscopic to the entire biosphere.

7-1-03: Identify abiotic and biotic components of ecosystems that allow particular organisms to survive.

7-1-04: Describe ecological succession and identify signs of succession in a variety of ecosystems.

7-1-05: Identify and describe positive and negative examples of human interventions that have an impact on ecological succession or the makeup of ecosystems.

7-1-06: Identify environmental, social, or economic factors that should be considered in the management and preservation of ecosystems.

7-1-07: Propose a course of action to protect the habitat of a particular organism within an ecosystem.

7-1-08: Compare photosynthesis to cellular respiration, and explain how both are part of the cycling of matter and the transfer of energy in ecosystems.

7-1-09: Analyze food webs, using ecological pyramids, to show energy gained or lost at various levels.

7-1-10: Analyze, using ecological pyramids, the implications of the loss of producers and consumers to the transfer of energy within an ecosystem.

7-1-11: Explain, using ecological pyramids, the potential for bioaccumulation within an ecosystem

7-1-12: Provide examples of scavengers and decomposers, and describe their role in cycling of matter in an ecosystem.

7-1-13: Demonstrate proper use and care of the microscope to observe micro-organisms.

7-1-14: Identify beneficial and harmful roles played by micro-organisms.

7-1-15: Research and describe human food production or preservation techniques that apply a knowledge of micro-organisms.

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CHAPTER ONE

Teacher's Lesson Planning Notes

1.1 What is an Ecosystem?

All life on earth is found in a thin layer known as the **BIOSPHERE**. (Greek, BIOS = life, SPHERE = globe). The biosphere, in turn, is made of many smaller parts called **ECOSYSTEMS**, or **BIOMES**. Organisms inhabit these ecosystems - on land, in the soil, in the oceans, and even within the atmosphere, where tiny spores and bacteria can be found. These are large areas of the earth with similar climate, vegetation, soils, and life forms. Several examples are the **TUNDRA, BOREAL FOREST, DECIDUOUS FOREST, OR GRASSLAND ECOSYSTEMS**. Ecosystems appear the way they do because of temperature, precipitation, and distance from the equator.

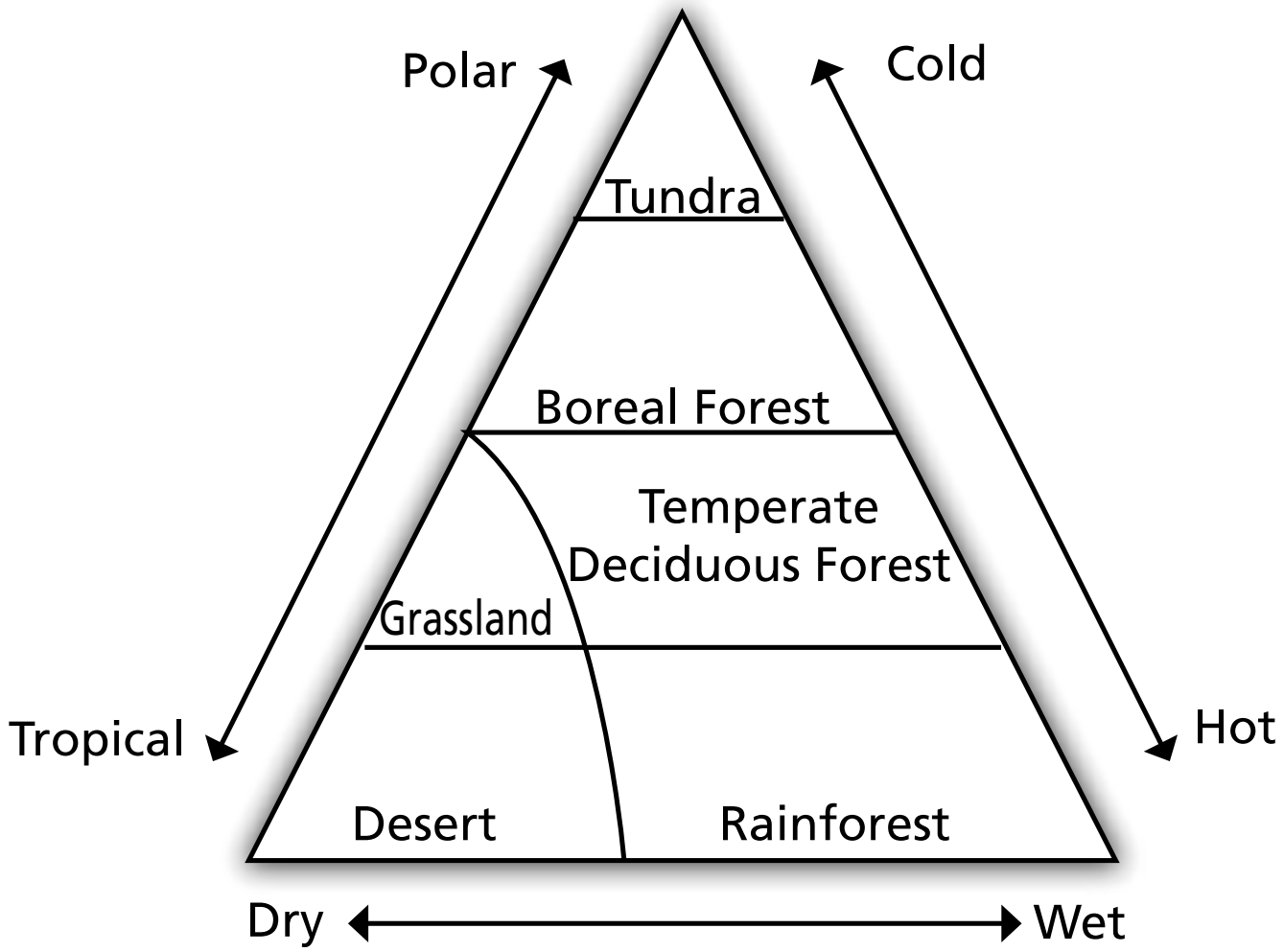
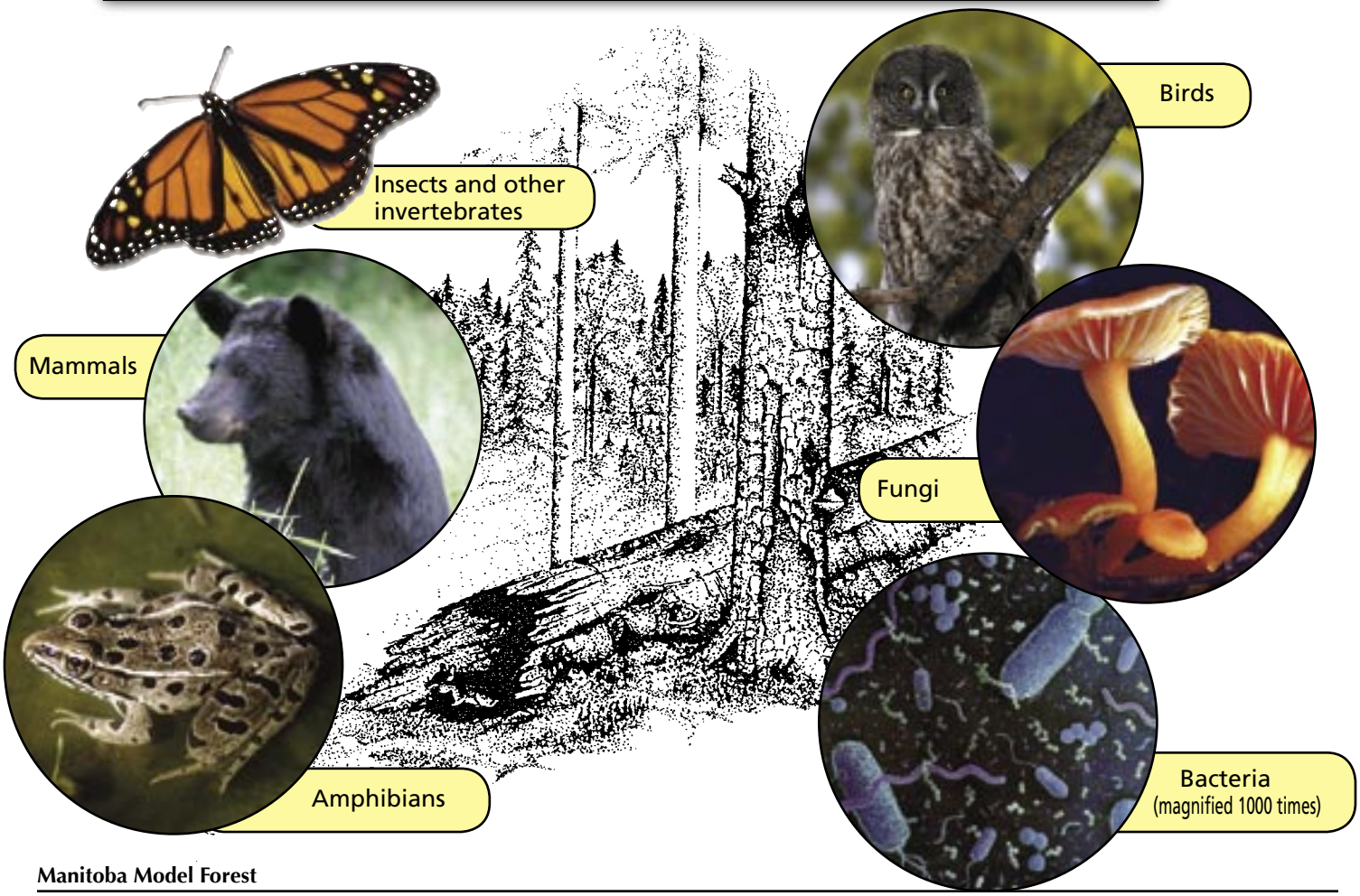


Figure 1a: Major Ecosystems of the Earth.

Ecosystems are made of non-living or **ABIOTIC** things (figure 1b), and living or **BIOTIC** things. (figure 1c) **ECOLOGY** is the branch of science that studies how the biotic and abiotic factors interact with each other.

Figure 1b: Abiotic parts of an ecosytem.

Figure 1c: Biotic parts of the ecosytem.



1.2 The Boreal Forest Ecosystem

Why study the Boreal Forest? Canada owns 10% of the world's forest. Much of it is Boreal Forest. About half of the entire Province of Manitoba is covered by Boreal Forest. It is our largest ecosystem, capable of producing oxygen, protecting soil and water, and supplying humans with lumber, paper, and other products. It provides recreational opportunities, and it provides **HABITAT**, or a home for many species of plants and animals. In Manitoba, over 10,000 people work directly or indirectly in the forest industry. Many communities in Canada rely on the forest industry for their economic survival. There are also over 600 First Nation communities within Canada's Boreal Forest region.

Examine the map below, which shows the area of land covered by the Boreal Forest in Canada (figure 1d).

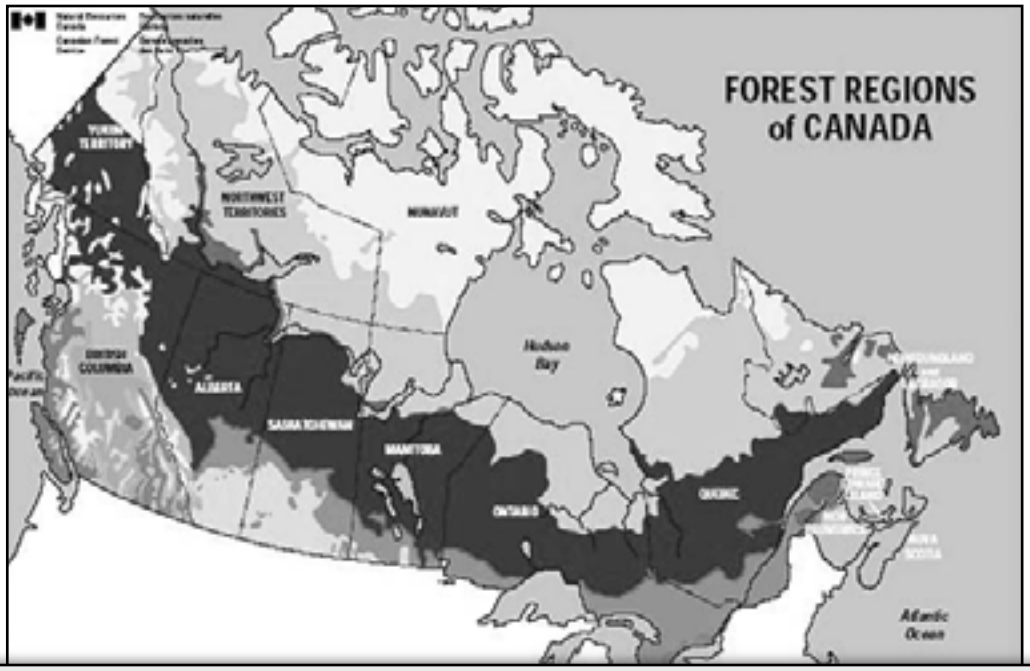


Figure 1d: Map of Canada's Boreal Forest. (marked in dark grey)

Let's take a look at a few facts about this vast ecosystem:

- Covers nearly half of Canada's land mass, and is our largest ecosystem
- It's named after "Boreus" which is Latin for North
- Also known as the Northern Coniferous Forest, or Taiga
- Insects, disease, and fire destroy more forest than we harvest
- Dominated by spruce, pine, tamarack & aspen.
- Requires a disturbance such as fire to create regeneration
- Less than 1% of the forest is harvested annually to ensure that it is sustainable

The Boreal by Numbers

Quick Facts of Canada's Boreal Forest

30%, - Percentage of North American Songbirds dependent on the Boreal Forest for breeding habitat.

600, - Number of First Nation Communities located in the Boreal Forest.

53%, - Area of land covered by the Boreal Forest in Canada.

400 000, - Number of jobs dependent on the Boreal Forest.

30%, - Area of the Boreal Forest covered by water.

Millions, - Number of litres of fresh water filtered daily by the Boreal Forest.

Hundreds, - Number of species at home in the Boreal Forest including Woodland Caribou, Black Bear, Wolves, and Moose.

18,600,000, - Number of hectares destroyed by insects based on a 10 year average.

2,800,000, - Number of hectares destroyed by fire based on a 10 year average.

1,030,000, - Number of hectares harvested per year based on a 10 year average.

Less than 1%, - Area harvested by humans each year.

650,000,000, - Number of seedlings planted annually by forest companies.

1.5 - Number of cubic metres of new wood growing on each hectare of Boreal Forest since each tree produces one new growth ring. It's like interest earned on a bank account.

Examine the map below which shows the Boreal Forest in Manitoba (figure 1e). Our Boreal Forests are adapted for surviving in harsh conditions. The summers are short and cool, with long cold winters. Temperatures can reach – 40 degrees Celsius. The needles of coniferous trees are designed to conserve water, which is not available to the trees for 6 months of the year. They are coated with a waxy substance to prevent evaporation of water. The boughs of the trees are shaped to shed snow to prevent breakage of their limbs.

Some soils in the Boreal Forest are thin, sandy, and nutrient poor, and tend to be quite dry. Trees such as jack pine tend to grow on those sites. Other soils tend to be very wet and cool, and slightly acidic, such as in swamps and bogs. Trees such as black spruce tend to grow on those sites.

Even though conditions are harsh, the Boreal Forest is a rich ecosystem with many forms of plant life, such as mosses, ferns, shrubs, and trees. Trees, like those pictured in figure 1f, are called **CONIFEROUS**. All coniferous trees reproduce from seeds contained in **CONES**. They have needle-like leaves which stay green year round, except for tamarack (larch). They are known as **SOFTWOODS**, and they produce most of the paper and lumber which Canada exports around the world.

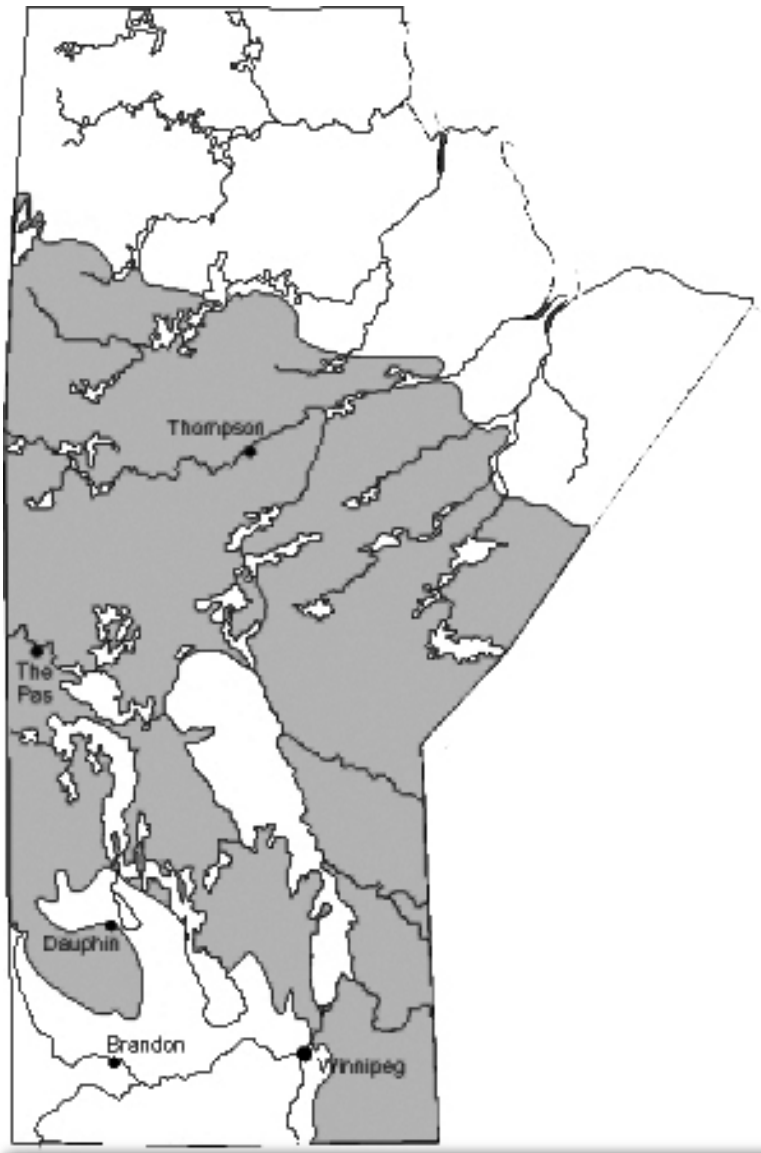


Figure 1e: Map of Manitoba's Boreal Forest

The Boreal Forest also contains trees like those pictured below in Figure 1g, called **DECIDUOUS**. These trees have broad, flat leaves, which are shed every year. These trees are also known as **HARDWOODS**, and examples are poplar, birch, and ash.

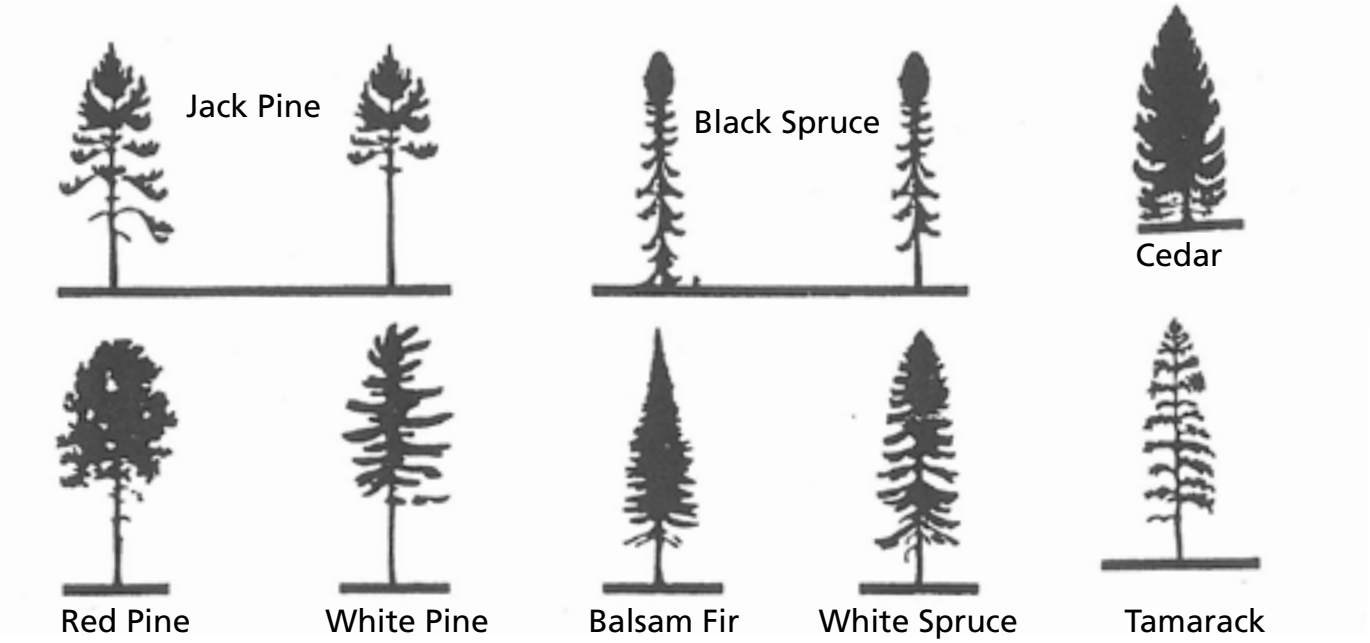


Figure 1f: Coniferous trees found in Manitoba's Boreal Forest

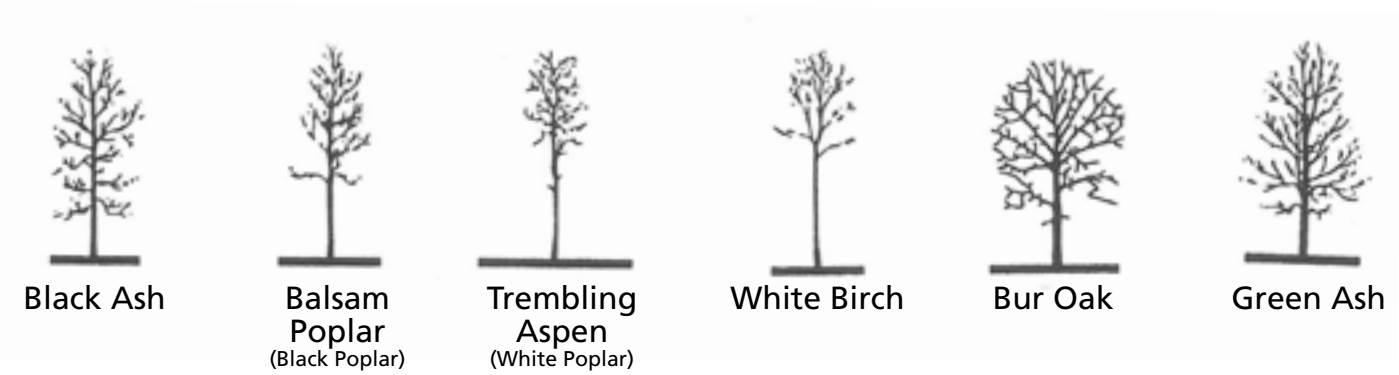


Figure 1g: Deciduous trees in Manitoba's Boreal Forest

1.3 Animal Life in the Boreal Forest

Many kinds of animals, or **ORGANISMS**, live in the Boreal Forest. Each individual organism, for example, moose, belongs to a larger group of moose called the moose **POPULATION**. The moose population, along with the population of other organisms, such as wolves, makes up a **COMMUNITY** of living things.

The specific place that a living organism prefers is known as its **HABITAT**. For example, moose prefer swampy areas rather than dry areas.

Within the community, the population of organisms interact with each other, taking the role of either a **PREDATOR** (wolf) or **PREY** (moose) in a complex food web. The specific role that an organism plays is its **NICHE**. In the food web, energy flows from plants, which are **PRODUCERS**, to animals which consume them, known as **CONSUMERS**. The sun transfers energy to plants in the form of sunlight. The energy is transferred by plants and converted to sugars and other plant products in a process called **PHOTOSYNTHESIS** (photo=light, synthesis = to make). Carbon dioxide gas is taken in during the process, and oxygen is released.

The energy found in plants is then transferred to plant-eating animals called **HERBIVORES** or **PRIMARY CONSUMERS**, such as mice and rabbits. **CARNIVORES**, or **SECONDARY CONSUMERS**, such as foxes and coyotes, feed on the herbivores. Some animals, such as the black bear, are called **OMNIVORES**. They feed on both plant and animal material. Ultimately, when these organisms die, they will be consumed by **SCAVENGERS**, such as ravens, and the remaining animal tissue will be completely broken down by **BACTERIA** in the soil. Nutrients stored in the decaying plants and animals are returned to the ecosystem and recycled. Figure 1h shows a typical forest food web.

Food webs can be affected by human activity. For example, farmers use insecticides to control insects such as beetles or grasshoppers. When predators consume prey which have been sprayed with insecticide, the toxins may not be enough to affect them, but will eventually build up in their bodies. This is known as **BIOACCUMULATION**. Animals at the top of the food chain are most vulnerable to this effect. The buildup of toxins may affect their movement,

Figure 1i: Bioaccumulation. Each step in the food chain has a progressively higher concentration of toxins.

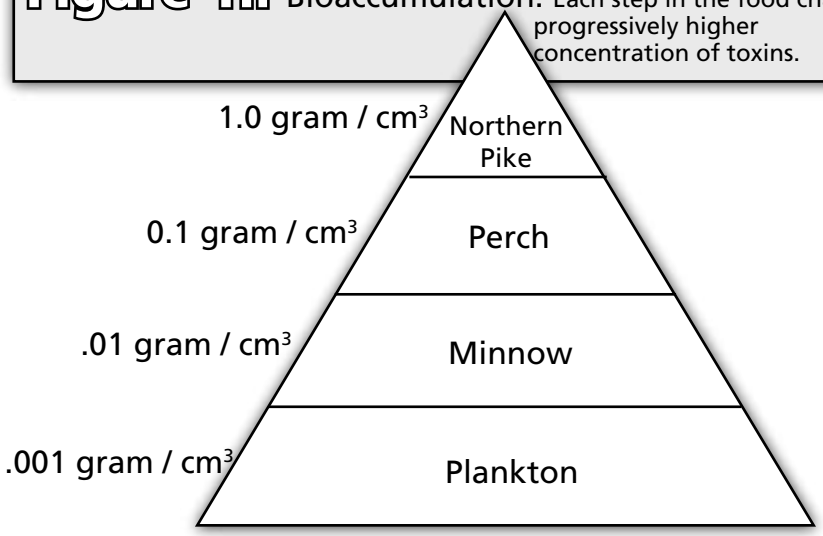
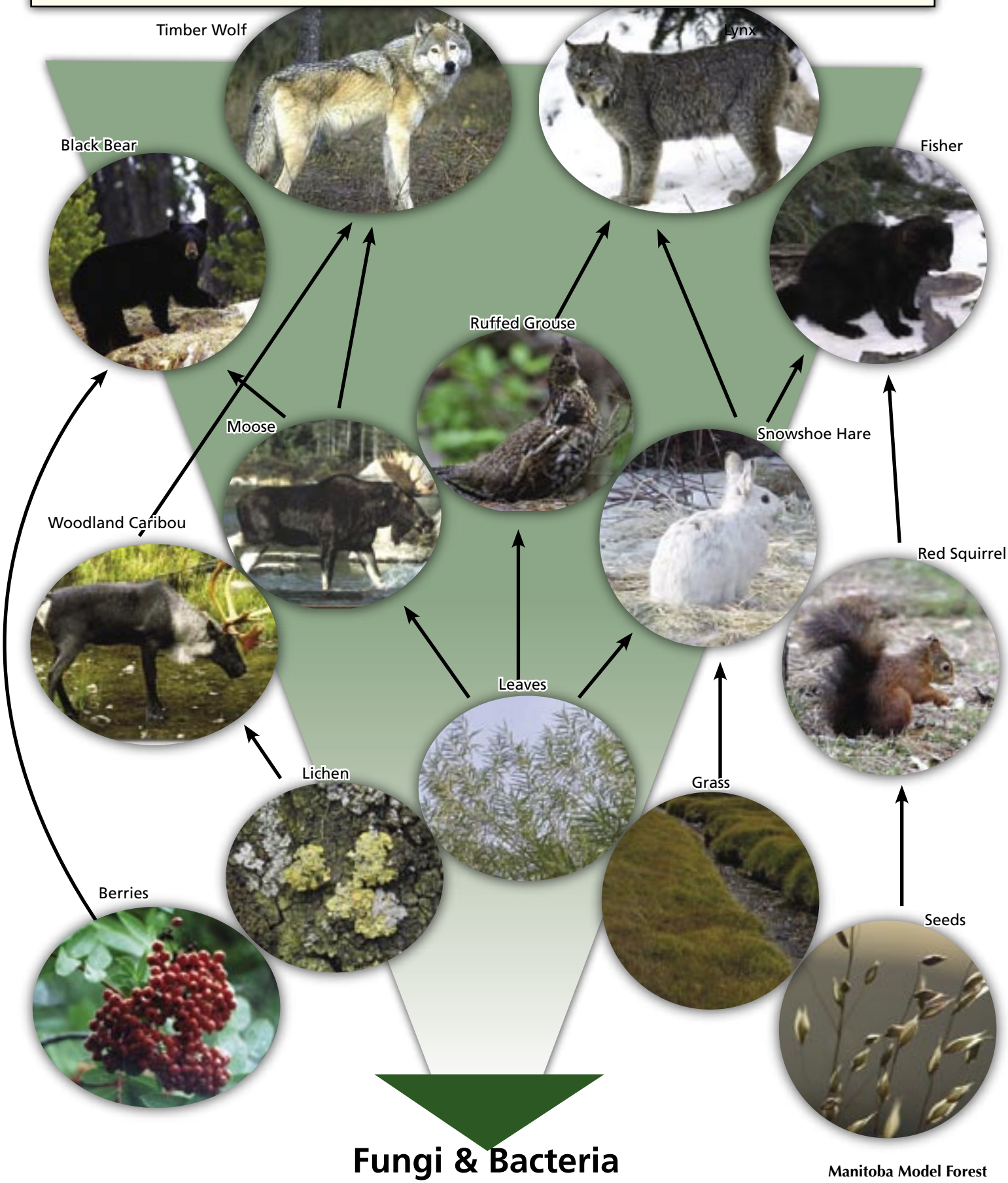


Figure 1h: Food web of the Boreal Forest (Hint: the arows point to the animal doing the eating)



feeding, or reproductive system. For example, mercury, a natural element in the ecosystem, is found in many predatory fish in Lake Winnipeg including Pickerel and Northern Pike. Small amounts are barely measurable in minnows, but Pickerel and Northern Pike have higher levels because they consume so many minnows in their life span. (see Figure 1i) Health Canada has stated that humans should limit their consumption of these fish so that mercury does not bioaccumulate in them. Long term effects of mercury poisoning are well known, and include such symptoms as mental impairment and nerve malfunction.

For the animals in the Boreal Forest, as in all ecosystems, there is an ongoing struggle for survival. Each day brings another challenge – either eat or be eaten. Most animals have some kind of special **ADAPTATION** to help them survive. Some animals are well **CAMOUFLAGED** to escape detection by predators, such as grouse and rabbits. Some hibernate to avoid the harsh conditions and food shortages, such as the raccoon. Some migrate out of the Boreal Forest, heading south for the winter, such as waterfowl and songbirds. Some animals, such as the whitetailed deer can actually lower their metabolism in cold weather, so that they need less food. Some animals will produce fewer young when food is scarce, such as the lynx. Other animals, like the owl, have become **NOCTURNAL**, coming out only at night when their prey (mice) are active.

Animal populations fluctuate from year to year. Each spring new animals are born, and some move in from surrounding areas. Some animals die, and others migrate out. The population is always changing, and is said to be **DYNAMIC**. Population dynamics are an important part of the study of any ecosystem (see figure 1j).

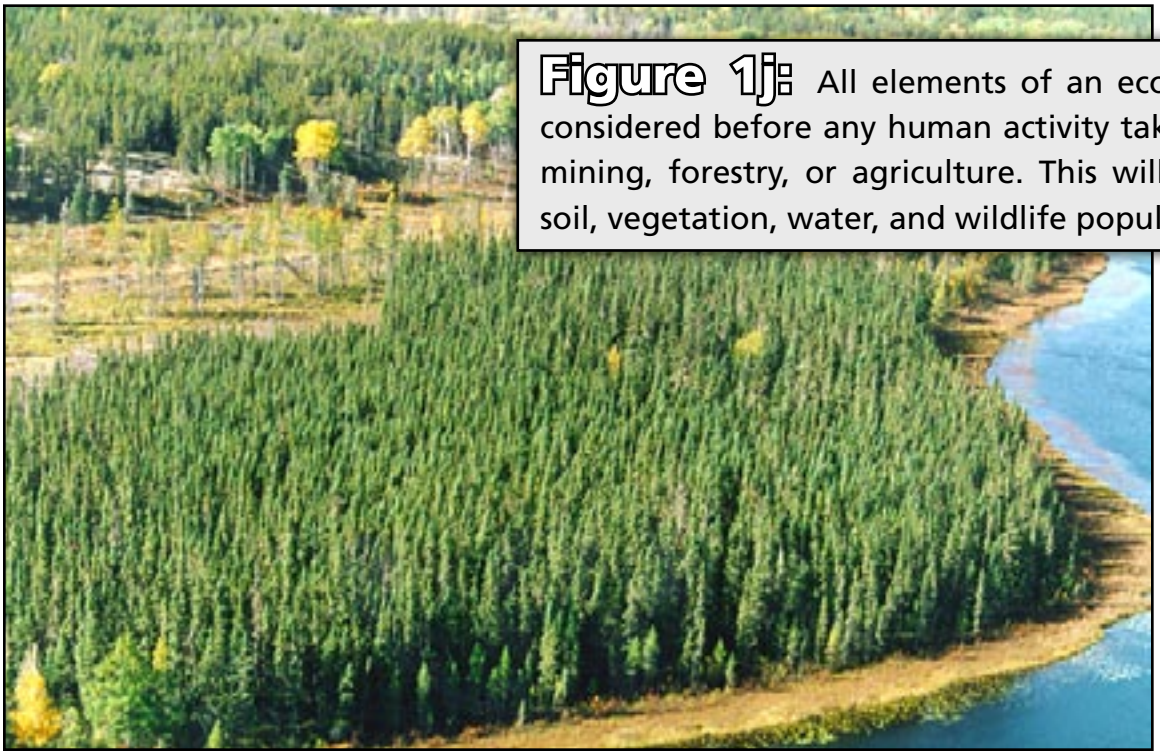


Figure 1j: All elements of an ecosystem must be considered before any human activity takes place such as mining, forestry, or agriculture. This will ensure healthy soil, vegetation, water, and wildlife populations.

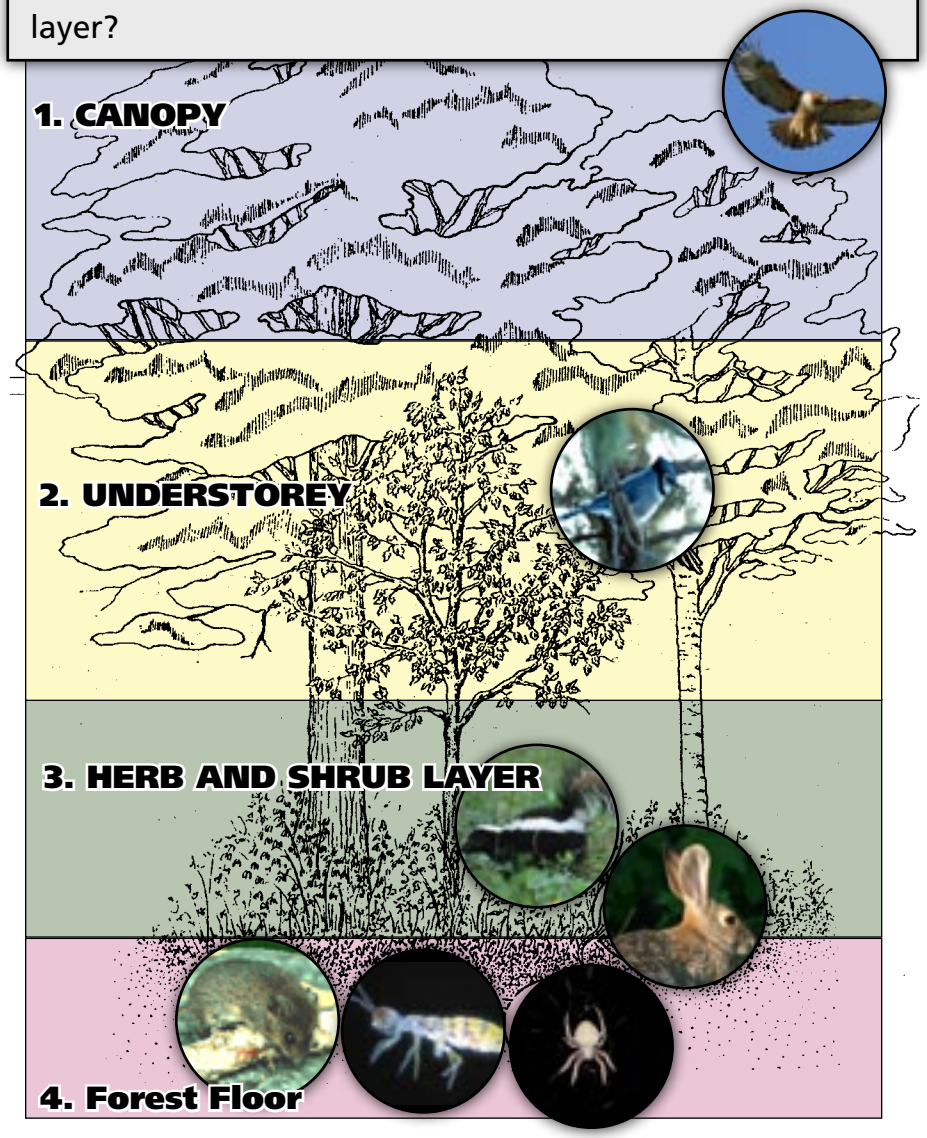
1.4 Plant Life in the Boreal Forest

No ecosystem can exist without plants. It is the plants that have the ability to convert solar energy into food for all other life forms. The plants are the **PRODUCERS**. All life depends on their ability to produce food products such as **GLUCOSE** and **FRUCTOSE**, or plant sugars. Plants also produce oxygen, which makes up 21% of our atmosphere. The process can be summarized in the following word equation:

$$\text{SUNLIGHT} + C02 + H20 \longrightarrow \text{OXYGEN} + \text{GLUCOSE}$$

The trees and plants in the forest form many layers of life. At the highest level, the **CANOPY**, photosynthesis occurs with the greatest intensity (figure 1k). Less light is available in the **UNDERSTOREY**, so the trees that grow there are said to be **SHADE TOLERANT**. Since even less light energy is available on the forest floor, the plants are even smaller. There is only so much solar energy to go around, yet each layer captures enough to support photosynthesis.

Figure 1k: There are several "layers" of plants in the forest ecosystem. Why do species usually use a certain layer?



The forest floor is alive with insects, bacteria, and fungi. They live in the **LITTER LAYER**, made of leaves, twigs, branches, and bark which is shed from the trees and shrubs. Nutrients are constantly cycled in an ecosystem. They are released into the soil when organisms decay, and are picked up by the roots of other plants. Collectively, all forms of life in the ecosystem are known as **BIOMASS**. The more nutrients there are in an ecosystem, the more biomass can be supported. For example, the forest can support more biomass than a nutrient poor desert.

CHAPTER ONE ACTIVITIES

ACTIVITY 1.1: WHO EATS WHAT IN THE FOREST?

(Outcome 7-1-09 Analyze food webs, using ecological pyramids to show energy gained or lost at various levels)

PART A: Using the following Boreal Forest animals and plants, construct a food web which reflects real life. Use the library or internet to find out about the diet of the following organisms.

BEAVER

BLACK BEAR

PORCUPINE

MOUSE

OWL

FOX

WILLOW

MOOSE

WOLF

POPLAR

WOODLAND CARIBOU

PINE MARTEN

LICHEN

SKUNK

SEEDS AND CONES

FISHER

WEASEL

EAGLE

SQUIRREL

BACTERIA

PART B: RESEARCH THE FOLLOWING TOPICS TO FIND OUT MORE ABOUT FOOD WEBS IN THE BOREAL FOREST (see figure 1l):

A. HOW DO SOME SPECIES SUCH AS THE SNOWSHOE HARE OR MEADOW MOUSE SURVIVE IN LARGE NUMBERS EVEN WHEN SUBJECTED TO HEAVY PREDATION?
B. HOW HAVE SPECIES SUCH AS THE SKUNK AND PORCUPINE EVOLVED TO PROTECT THEMSELVES FROM PREDATORS? WHAT PROTECTIVE DEVICES DO OTHER SPECIES USE?
C. HOW DO CREATURES AT THE TOP OF THE FOOD CHAIN BECOME ENDANGERED?
D. DESIGN A SUPER-PREDATOR THAT COULD SURVIVE THE COLD, HARSH CONDITIONS OF THE BOREAL FOREST. WHAT WOULD IT LOOK LIKE?

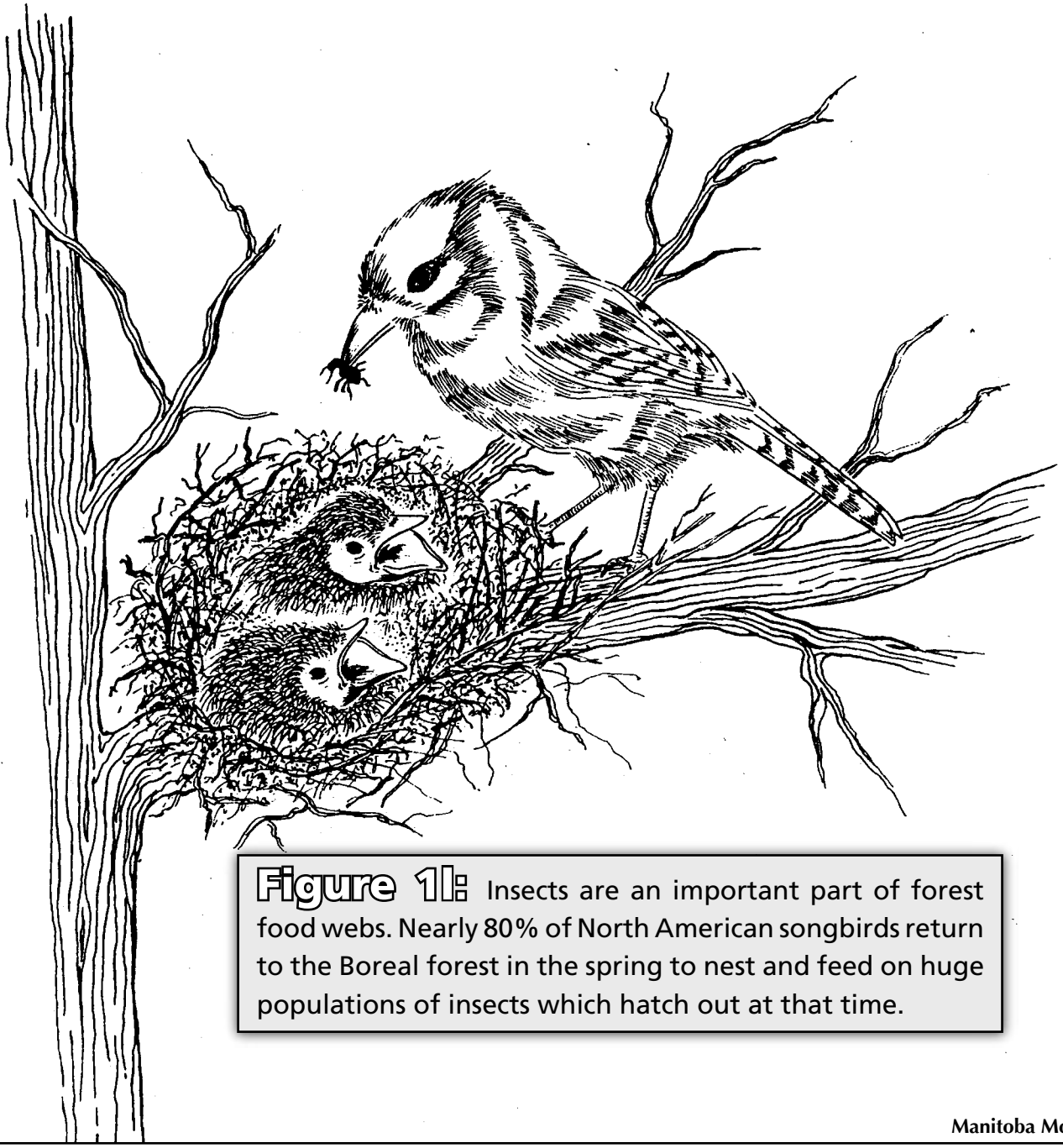


Figure 1l: Insects are an important part of forest food webs. Nearly 80% of North American songbirds return to the Boreal forest in the spring to nest and feed on huge populations of insects which hatch out at that time.

ACTIVITY 1.2: CONSTRUCTING A FOREST FOOD WEB (see figure 1m)

(Outcome 7-1-09 Analyze food webs, using ecological pyramids to show energy lost at various levels)

MATERIALS NEEDED: food web cards
Ball of string
Scissors

PROCEDURE:

a. Brainstorm at least 12 plants and animals that make up a forest food web
b. Make one card for each element of the forest food web, i.e buds, roots, leaves, seeds, berries, and mushrooms. For the animals you might choose fox, squirrels, bears, rabbits, birds, and moose.
c. Seat each student in a circle. Give each student a food web card with one item printed on it. Place the cards on the floor in front of them for all to see.
d. Ask each student which card or cards they need to survive. Connect these students with a length of string.
e. To demonstrate the importance of each item in the food web, have students gently pull on their strings. Discuss what would happen if one or several of the "elements" were destroyed or became unavailable (cut the string with scissors to emphasize the point of a "lifeline" being cut.)
f. Discuss the role of trees, shrubs, and other plants in maintaining a healthy food web within the ecosystem ie. seeds, cones, leaves, bark, sap, etc.
g. Make a poster to visualize what you have learned

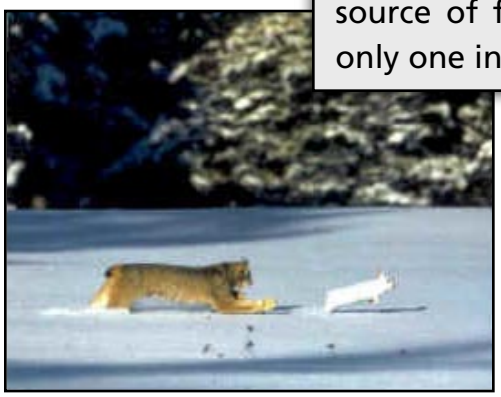


Figure 1m: The Snowshoe Hare is an important source of food for the Lynx. Some studies indicate that only one in ten persuits result in a meal for the Lynx.

ACTIVITY 1.3: COUNT THE CARIBOU – SAMPLING ANIMAL POPULATIONS

(Outcome 7-1-07 Propose a course of action to protect the habitat of a particular organism within an ecosystem)

BACKGROUND: The Boreal Forest of Manitoba is home to the Woodland Caribou, a threatened species of wildlife. As a result, research is being conducted to determine the best way to protect the caribou and its habitat. Your task in this activity is to calculate how many caribou live in the region. (see figure 1o)

PROCEDURE:

A. In your notebook, create a table similar to the one shown below. You have only enough time and money to fly 4 flight paths. To pick a flight path at random, place 10 small pieces of paper labelled A to J in a hat, and draw 4 of them out. These will be the flight paths you will use.

Sample	Flight Path	Number of Caribou
1	C	3
2	G	8
3	F	4
4	B	2

B. Count and record the number of caribou in each of the 4 flight paths you picked at random
C. Find the total number of caribou per sample. Add them up and divide by 4 to get the average number of caribou counted per flight.
D. To calculate the average number of caribou in the 100 square km. plot, multiply by 10.

APPLY YOUR KNOWLEDGE:

A. How many caribou did you calculate in your 100 square km. area?
B. Suppose that a corridor will be cleared in the forest to build a hydro-electric transmission tower in the middle of the caribou's range. Do you think this may affect the population of caribou in the area? Why?
C. Find out how forest harvesting operations are being done to benefit the Woodland Caribou population in Manitoba
D. Research the habitat needs of the Woodland Caribou ie. what it eats, where and when the young are born, range, and habitat needs.

Figure 1n: Grid used to survey Woodland Caribou population.

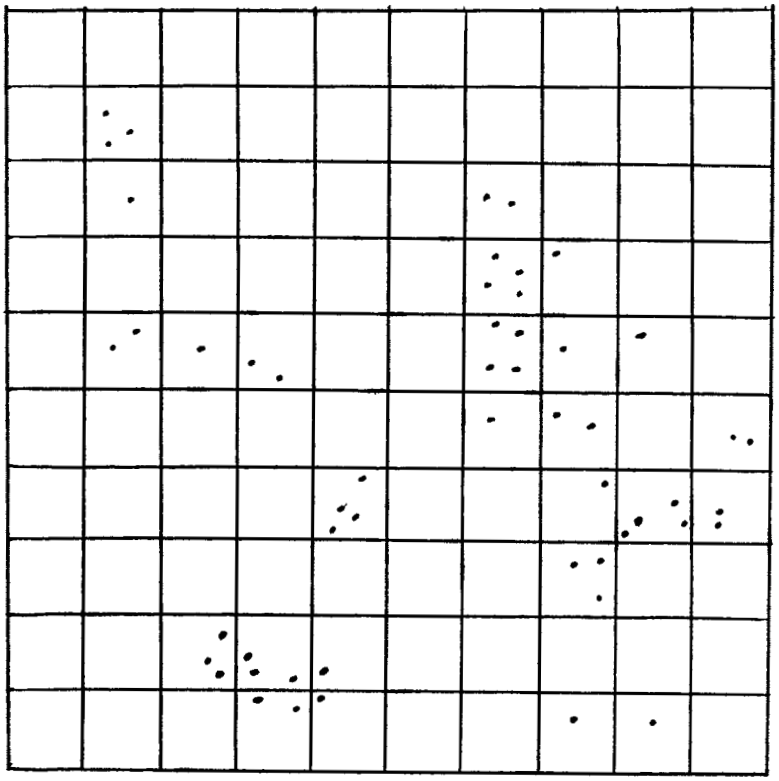


Figure 1o: Strategies are in place to ensure that the habitat needs of the caribou are met. The Manitoba Model Forest is working with government and the Forest Industry to ensure that the strategies are successful.

ACTIVITY 1.4: "ROTTEN LUCK" (figure 1p)

(Outcome 7-1-12 Provide examples of scavengers and decomposers, and describe their role in recycling of matter in an ecosystem)

BACKGROUND: Downed trees and branches, as well as rotting tree stumps, are very important to the forest ecosystem. Known as COARSE WOODY DEBRIS, it provides food, moisture, and shelter for a wide variety of living things, from bacteria and fungi, to insects, birds, and small mammals such as mice. These organisms are necessary for a food web to exist in a healthy ecosystem. Coarse woody debris will eventually decay and put nutrients back into the soil.

MATERIAL NEEDED: clipboard
paper and pencil
magnifying glasses
collecting jars or zip-lock bags

PROCEDURE:

A. Plan a trip to a wooded area. Search the area for downed trees, branches, and stumps, etc.
B. Gather around the coarse woody debris or rotten stump
C. Examine decaying wood tissue and describe its appearance, texture, and odor. Grind some in the palm of your hands to make humus, which is an ingredient of forest soils.
D. Use a magnifying glass to search for insects and other forms of life such as moss, or algae, or fungus. Are there signs of life such as tunnels, bore holes, or larvae present? Sketch them.
E. Compare plants on the forest floor to the ones growing on the stump. Describe the differences, if any.
F. Why are downed logs more moist on the bottom than on the top? Where do you think most animals would be prepared to live? Why?
G. Sketch your tree stump or downed log. Identify all life forms that live there.
H. Predict what the stump or downed log will look like in a year from now. 5 years? 10 years?

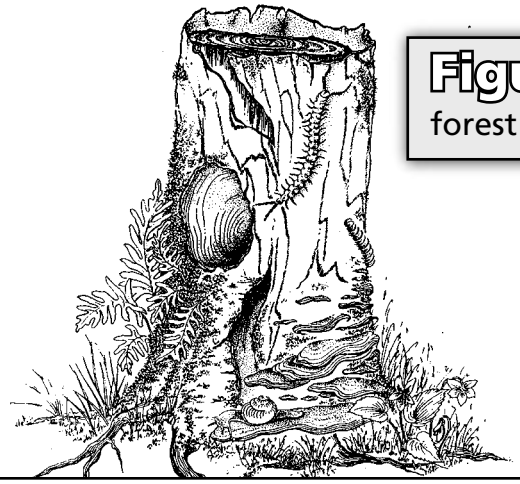


Figure 1p: Rotting logs are an important part of a forest ecosystem.

ACTIVITY 1.5: "CALLING ALL CRITTERS"

(Outcome 7-1-03 Identify abiotic and biotic components of ecosystems that allow particular organisms to survive)

MATERIALS NEEDED: Poster paper
Paints
Markers
Scissors
Glue
Old magazines
Optional: digital camera

BACKGROUND: In this lesson, students will create an advertisement to attract a species of plant or animal to the forest. Using their knowledge of a particular species, and its habitat needs, students will "market" the forest environment to the species of their choice.

PROCEDURE:

A. Brainstorm with students on the topic of "What makes an interesting ad?" A cool song? A slogan? Use of a logo? Humor? A movie star? Which ads are their favorite? What kinds of advertising catches their attention?
B. Now discuss the concept of habitat needs for plants and animals. List all of the things a forest can offer them such as food (insects, leaves, etc.), shelter, nesting sites, shade, etc.
C. Divide the class into groups of 3 or 4. Explain to the students that they will play the role of an advertising firm hired by the forest. The forest wants to attract more plants and animals to live there, and needs the services of the advertising firm.
D. Each group will sign up to attract a specific "target" species, the one they want to attract to the forest. For example, if they choose a bear, the ad campaign would promote the abundance of food such as ants and berries, as well as shade to avoid the summer heat. Each group will need to research the precise habitat needs of their chosen species.
E. After researching the species' habitat needs, students will design a print ad (newspaper or magazine), radio jingle, or TV commercial to attract their particular species to the forest. Students can use drama, music, or other visual effects.
F. Each group will present their ad to the class. The class can evaluate the effectiveness of each ad presented, or vote for the one they found most alluring.

FOLLOW UP DISCUSSION: Discuss how habitat loss can affect the survival of certain species.

ACTIVITY 1.6 "A FOREST SCAVENGER HUNT"

(Outcome 7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems, such as: *ecosystem, biosphere, abiotic, biotic, organisms, ecological succession, photosythesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, and micro-organisms*)

NOTE: This activity is recommended to accompany ACTIVITY FIVE (ROTTEN LUCK).

Tell your students that the items below are just to touch and see – but NOT to collect. Check off the following things that you have found. Later, be able to explain why it is important that they remain a part of the forest ecosystem.

Basic Checklist

Find:

__ A rock
__ Soil
__ Something prickly
__ Something furry
__ Something scratchy
__ A berry
__ Compound leaf (leaf made of smaller leaves)
__ A brown leaf
__ Moss
__ A pine cone
__ Something sticky
__ Something made by a human (this Is litter – pick it up)

Advanced Checklist

__ Something growing on a non-living thing
__ A plant shaded by another plant
__ A plant that is shaded by a plant that is shaded by a plant
__ Something that is changing back into soil
__ An example of erosion
__ Food that would be good for a sparrow
__ A tree with flat needles
__ A leaf that has been chewed by an insect
__ An insect gall
__ A dead branch on a living tree
__ A hole in a tree
__ A bird nest
__ Sap dripping out of a tree
__ A tree snapped off near the top
__ An animal track
__ An animal dropping
__ Something gnawed by an animal

Figure 1q: CAUTION!!! poison ivy. The oily residue on the leaves can cause severe skin irritation.

ACTIVITY 1.7 "CREATE A FOREST COMMUNITY" (figure 1q)

(Outcome 7-1-02 Define ecosystem, and describe various examples that range from the microscopic to the entire biosphere)

PURPOSE: Students will have an opportunity to build a simplified model of a forest ecosystem in the classroom

MATERIALS NEEDED: see individual projects

PROCEDURE: Choose one of the following:

A. SAND TABLE MODEL: Using a sand table as the forest floor, have students create a forest ecosystem model. For example, "trees" can be made out of popsicle sticks and construction paper. Use twigs, moss, stones and other items from the outdoors to complete the scene.

B. FLANNEL BOARD MODEL: Using felt cut-outs of forest plants and animals, design a day in the life of a forest community. Be sure to show animals in the food web, as well as abiotic features such as rock and water.

C. MODELING CLAY FOREST: Have your students create a forest community out of modeling clay. Place them on a large sheet of cardboard. Use water colors to shade in wetlands, rivers, etc.

D. FOREST COMMUNITY MURAL: Have students fill in a large mural on the wall of the classroom, or in the hallway. Select one group to produce the background. Have other students cut and paste items to place on the mural, or draw them in. Be sure to show as many uses of the forest as you can, such as ecotourism, birdwatching, hiking, berry picking, etc.

E. FOREST DIORAMA: Have each student bring a shoebox. Cut out one end of the box so it is completely open. Remove the lid and line the box with colored paper. Use construction paper and markers to create trees and other parts of the forest ecosystem. Place large parts at the back, and smaller ones near the front. Cover the top with blue tissue paper to represent the sky. Display the dioramas so that other students in the school can view them.

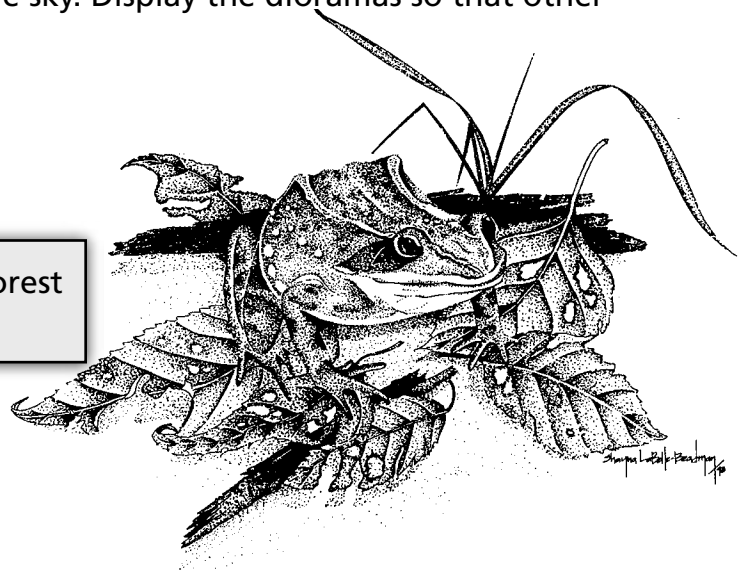


Figure 1q: Be sure to include small forest animals in your diorama.

CHAPTER ONE ASSIGNMENT

1. LIST 4 TYPES OF ECOSYSTEMS OR BIOMES. DESCRIBE THE PLANTS AND ANIMALS YOU MIGHT ENCOUNTER WHEN YOU VISIT THEM.

2. LIST SEVERAL BIOTIC AND ABIOTIC PARTS OF AN ECOSYSTEM.

3. HOW MUCH OF MANITOBA IS COVERED BY THE BOREAL FOREST? WHY IS IT SO IMPORTANT TO HUMANS?

4. HOW DO TREES SURVIVE THE HARSH CONDITIONS IN THE BOREAL FOREST? (figure 1r)

5. EXPLAIN HOW BIOACCUMULATION TAKES PLACE IN A FOOD WEB.

6. GIVE SEVERAL EXAMPLES OF ADAPTATIONS IN ANIMALS THAT HELP THEM SURVIVE THE HARSH CONDITIONS OF THE BOREAL FOREST.

7. WHY ARE PLANTS ON THE FOREST FLOOR IN A MATURE FOREST SO SMALL?

Figure 1r: Young jack pine stand in Manitoba's Boreal Forest. This stand is approximately 20 years old, and developed after a fire swept through the site, creating an opening in which young seedlings could germinate.

CONCEPT FRAME

Concept

Animal Adaptations

Examples

Characteristics

What is it like?

Can you illustrate it?

What is it unlike?

Definition

CONCEPT OVERVIEW

Concept

Bioaccumulation

Draw a figurative representation.

Write down two questions about the concept.

Write an explantion or defintion in your own words. You will be paraphrasing.

List facts (at least five).

Create an analogy.

Concept Overview: Used by permission of Lynda Matchullis and Bette Mueller, Nellie McClung Collegiate, Pembina Valley S.D. No. 27.

CONCEPT RELATIONSHIP FRAME

Problem/Solution Either/Or Compare/Contrast Cause/Effect

Make the distinction between:
Coniferous and Deciduous trees

Coniferous	Deciduous

Write a summary statement:

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CONCEPT OVERVIEW

Concept

Boreal Forest

Draw a figurative representation.

Write down two questions about the concept.

Write an explanation or definition in your own words. You will be paraphrasing.

List facts (at least five).

Create an analogy.

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CONCEPT OVERVIEW

Concept

Ecosystem

Write an explanation or definition in your own words. You will be paraphrasing.

Draw a figurative representation.

List facts (at least five).

Write down two questions about the concept.

Creat an analogy.

Concept Overview: Used by permission of Lynda Matchullis and Bette Mueller, Nellie McClung Collegiate, Pembina Valley S.D. No. 27.

Definition	Word or Concept	Diagram
	Population	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Habitat	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Predator	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Photosynthesis	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Primary Consumers	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Secondary Consumers	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Canopy	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Litter Layer	
	Synonym/Example	

CHAPTER ONE ANSWER KEY

1. FOUR TYPES OF ECOSYSTEMS OR BIOMES AND SOME PLANTS AND ANIMALS YOU MAY ENCOUNTER ARE:

Tundra

Plants: moss, lichen, small shrubs ie willow
Animals: Barren Ground Caribou, Arctic Fox, Ptarmigan, Polar Bear

Boreal Forest

Plants: spruce, pine, fir, birch, poplar trees, ferns, alder and willow shrubs, ferns, moss, lichen
Animals: black bear, timber wolf, moose, fisher, marten, otter, fox, porcupine, weasel, beaver,

Deciduous Forest

Plants: Aspen, Ash, Oak trees, ferns, shrubs, grasses
Animals: skunk, fox, coyote, garter snake, woodchuck, whitetailed deer, raccoon

Grassland -

Plants: grasses (Big Bluestem, Turkey Foot, Sedges), shrubs such as Saskatoon, Bearberry, Dogwood,
Animals: Gophers, Red Fox, Ground Squirrels, Coyotes, Badgers, Garter Snakes

2. BIOTIC FACTORS INCLUDE: plants, animals, fungi, bacteria,
ABIOTIC FACTORS INCLUDE: air, rocks, soil, water

3. THE BOREAL FOREST COVERS ABOUT HALF OF MANITOBA. IT IS IMPORTANT AS :
   - source of income, jobs
   - recreation
   - wildlife habitat
   - source of oxygen
   - protects our soil resource by preventing erosion
   - cleans our water by filtering water in a watershed

4. TREES IN THE BOREAL FOREST HAVE THE FOLLOWING ADAPTATIONS TO HELP THEM SURVIVE THE HARSH CONDITIONS:
   - needles, rather than leaves, have less surface area from which water can evaporate
   - needles have a waxy coating of resins that further prevent evaporation
   - the spire-like point of their shape helps to shed heavy snow from their boughs to prevent damage to their limbs

5. BIOACCUMULATION TAKES PLACE WHEN A TOXIC SUBSTANCE IS TAKEN IN BY TINY PLANTS AND ANIMALS IN THE FOOD CHAIN. (i.e. minnows). THESE ORGANISMS THEN BECOME FOOD FOR ANIMALS HIGHER UP THE FOOD CHAIN. THE SUBSTANCE IS CONCENTRATED IN THE BODIES OF THE SMALLER ORGANISMS, SO THEY EVENTUALLY BUILD UP IN HIGHER CONCENTRATIONS IN THE LARGER ORGANISMS, PARTLY BECAUSE THE PREDATORS EAT SO MANY OF THEM (i.e. pike eating many contaminated minnows). THESE TOXINS CAN BUILD UP IN HIGH CONCENTRATIONS YEAR AFTER YEAR OF EATING THE SAME CONTAMINATED FOOD SOURCE.

6. ANIMALS HAVE MANY UNIQUE ADAPTATIONS TO THE HARSH CONDITIONS OF THE BOREAL FOREST. SOME INCLUDE:
   - camouflage: to escape detection
   - hibernation: to avoid the cold and lack of food
   - migrate: leave the area ie. Waterfowl such as ducks and geese
   - lower their metabolism: i.e whitetailed deer
   - have fewer young:
   - become nocturnal: ie. Owls that hunt at night when prey is active

7. PLANTS ON THE FOREST FLOOR ARE QUITE SMALL BECAUSE THERE IS LESS SUNLIGHT AVAILABLE TO THEM. THEREFORE THERE IS LESS PHOTOSYNTHETIC ACTIVITY. LESS PHOTOSYNTHESIS = LESS POTENTIAL FOR GROWTH.

CONCEPT FRAME

Concept

Animal Adaptations

Characteristics

- Passed down from generation to generation.
- Gives an advantage in the struggle for survival.

Examples

- Migrations
- Camouflage
- Lowering of metabolism
- Being nocturnal

What is it like?

It is like a special skill for example if a goalie had fast reflexes they would have fewer goals scored against them.

What is it unlike?

It is not like other traits that are passed down, like reddish fur in foxes. It is a special feature.

Can you illustrate it?

Definition

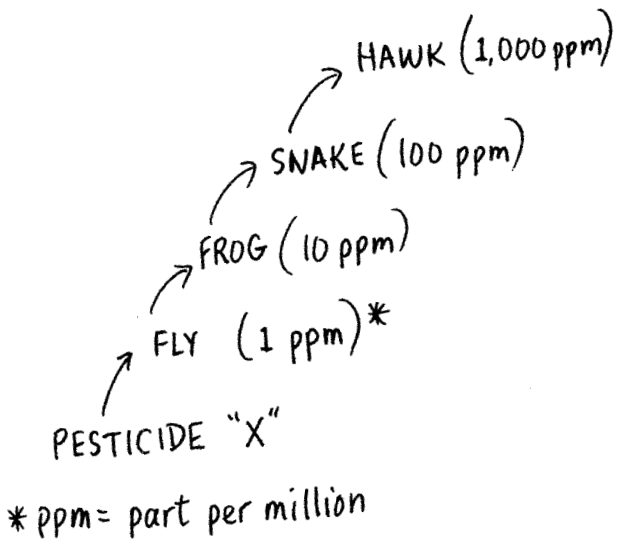
Special feature or characteristic of an animal that helps it survive.

CONCEPT OVERVIEW

Concept

Bioaccumulation

Draw a figurative representation.



Write down two questions about the concept.

1) What happens when scavengers eat dead animals. Do they become ill also?

2) How do scientists measure the amount of toxins?

Write an explantion or defintion in your own words. You will be paraphrasing.

The buildup of toxic material in the tissues of living things.

List facts (at least five).

- Can occur in water or on land
- May take years to show up in the food chain.
- May have serious effects on life forms
- Buildup is higher as you go up the food chain
- Top of the food chain carnivores at greatest risk.

Create an analogy

It's a bit like being a sponge. A larger sponge (the hawk) can soak up more material than a smaller sponge (the fly).

CONCEPT RELATIONSHIP FRAME

Problem/Solution Either/Or Compare/Contrast Cause/Effect

Make the distinction between:
Coniferous and Deciduous trees

Coniferous	Deciduous
• Softwoods • Have needles • Retain their needles all year • Seeds contained in cones	• Hardwoods • Have broad leaves • Lose their leaves each year • Seeds not contained in cones

Write a summary statement:

Strands of trees can be pure coniferous (i.e. all Jack Pine or Black Spruce), pure deciduous (i.e. all Poplar), or growing together in a mixed wood stand, such as Poplar and White Spruce.

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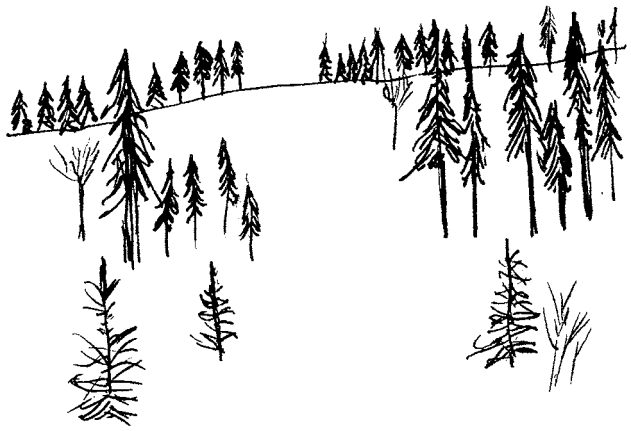
CONCEPT FRAME

Concept

Boreal Forest

Draw a figurative representation.



Write down two questions about the concept.

1) Why don't all countries have a Boreal Forest?

2) Is there an advantage to their pointy shape?

Write an explanation or definition in your own words. You will be paraphrasing.

The forest type found in higher latitudes, or higher altitudes, generally in a climate of long cold winters, and short, cool summers.

List facts (at least five).

- Half of Manitoba is covered by the Boreal Forest.
- A renewable resource which provides us with paper, lumber, and other products.
- 30% of the world's Boreal Forest is found in Canada
- Provides habitat for many animals
- Made of conifers such as spruce, pine and fir.

Create an analogy

"Aurora borealis" means "Northern Lights". and the Boreal Forest means the "Northern Forest" like the kind we see when we drive up north to Thompson or The Pas.

CONCEPT FRAME

Concept

Ecosystem

Draw a figurative representation.

Write down two questions about the concept.

1) Do ecosystems change or do they always stay the same?

2) What kinds of things can affect an ecosystem?

Write an explanation or definition in your own words. You will be paraphrasing.

A large area of the earth with similar climate, vegetations, soils, and life forms.

List facts (at least five).

- Made of living and non-living things.
- Examples are tundra, grassland, boreal forest.
- Functions as a "system" with energy flows and cycles of matter.
- Usually affected by some form of human activity
- Ecology is a branch of science that studies them.

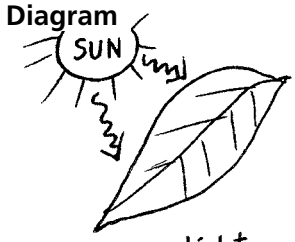
Create an analogy

An ecosystem is like a machine because is needs energy to run.

Definition	Word or Concept	Diagram
A group of animals or plants of the same species.	**Population**	
	Synonym/Example All moose in the forest make up the moose population.	

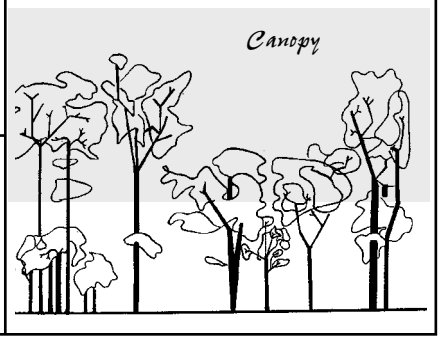
Definition	Word or Concept	Diagram
The specific place where a plant or animal lives.	**Habitat**	
	Synonym/Example The rabbit's habitat consists of dense shrubs and young trees.	

Definition	Word or Concept	Diagram
An animal that is a carnivore. It hunts and kills its prey.	**Predator**	
	Synonym/Example The wolf is a predator that feeds on moose.	

Definition	Word or Concept	Diagram
A process in plants which uses sunlight to produce energy, sugar and other compounds.	**Photosynthesis**	 $CO_2 + H_2O$ + sunlight = sugar + oxygen + energy
	Synonym/Example	

Definition	Word or Concept	Diagram
Animals which feed on plants.	**Primary Consumers**	
	Synonym/Example Rabbits, beavers, and mice are primary consumers.	

Definition	Word or Concept	Diagram
Animals which feed on plant eaters.	**Secondary Consumers**	
	Synonym/Example The fox is a secondary consumer because it eats mice.	

Definition	Word or Concept	Diagram
The part of the forest made up of the tops of the trees.	**Canopy**	
	Synonym/Example Most photosynthesis takes place in the canopy.	

Definition	Word or Concept	Diagram
A layer of dead leaves, twigs, and other debris on the forest floor.	**Litter Layer**	
	Synonym/Example The litter layer will decompose and form soil.	

Teacher's Lesson Planning Notes

CHAPTER TWO

THE CHANGING FOREST ECOSYSTEM
SILENT FORCES AT WORK

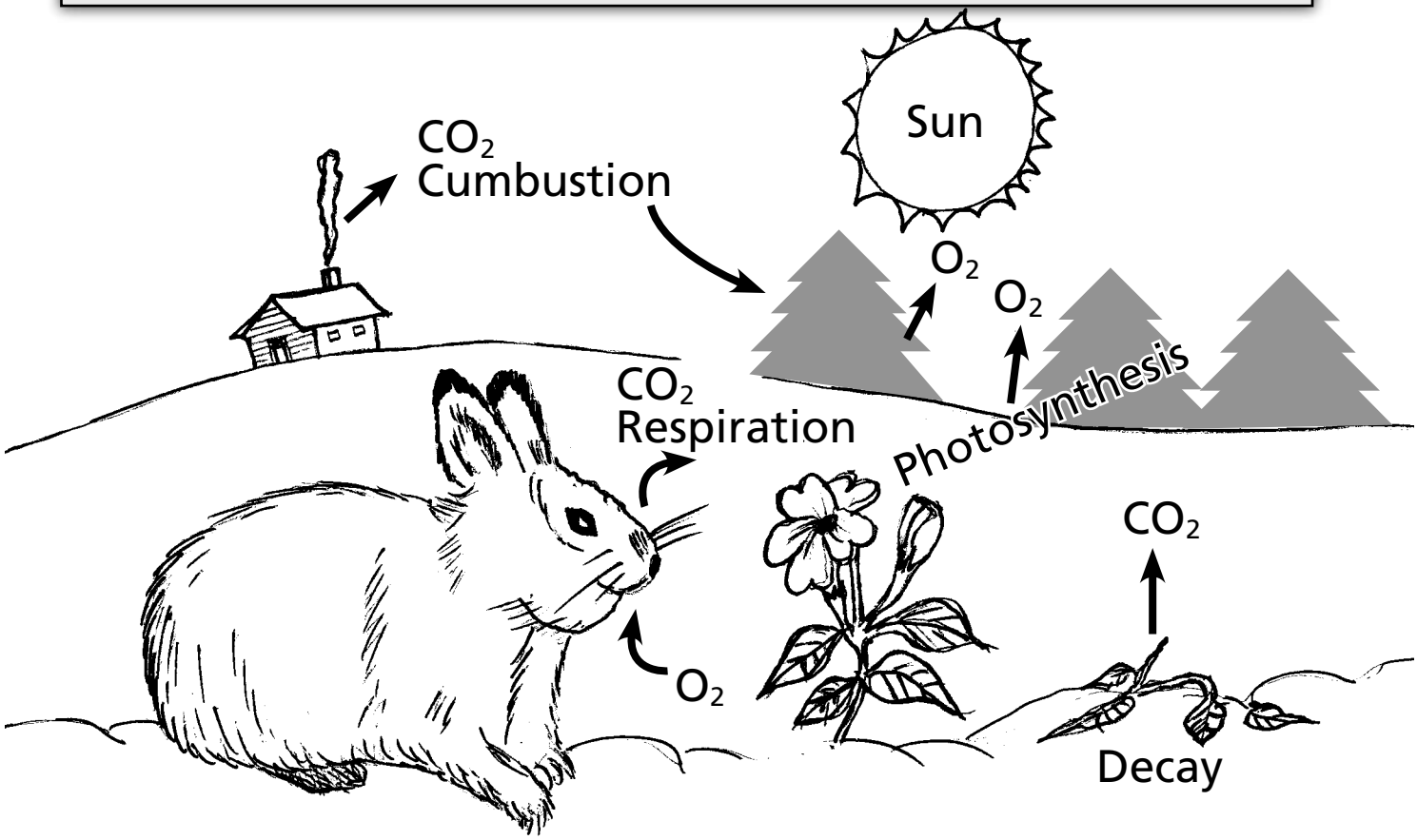
2.1 CYCLES OF MATTER

Our planet is made of matter, which forms all solids, liquids, and gases. The tiniest particles of matter are called **ATOMS**. Since there is no new matter added to our planet, the same **ATOMS** are recycled over and over. (Scientists think a very tiny amount of matter is added when a meteorite strikes the planet, but its mass is insignificant). A process which re-uses matter over and over is known as a **CYCLE**. Let us examine two of the largest and most important cycles found in any ecosystem.

A. THE CARBON-OXYGEN CYCLE:

In any ecosystem, plants and animals depend on each other. Animals give of CO_2 as they breathe, and plants absorb it. When plants take in the CO_2, they use it in a complex chemical event called **PHOTOSYNTHESIS**. Oxygen is released as a by-product of photosynthesis. This exchange of gasses is part of a cycle known as the **CARBON-OXYGEN CYCLE**, which supports life in all ecosystems on our planet (figure 2a).

Figure 2a: Basic elements of the carbon - oxygen cycle. The Carbon in a CO_2 molecule is the building block of plant life. A kilogram of wood has about 500 grams of carbon in it. Forests play an extremely important role in carbon uptake, therefore reducing greenhouse gas emissions.



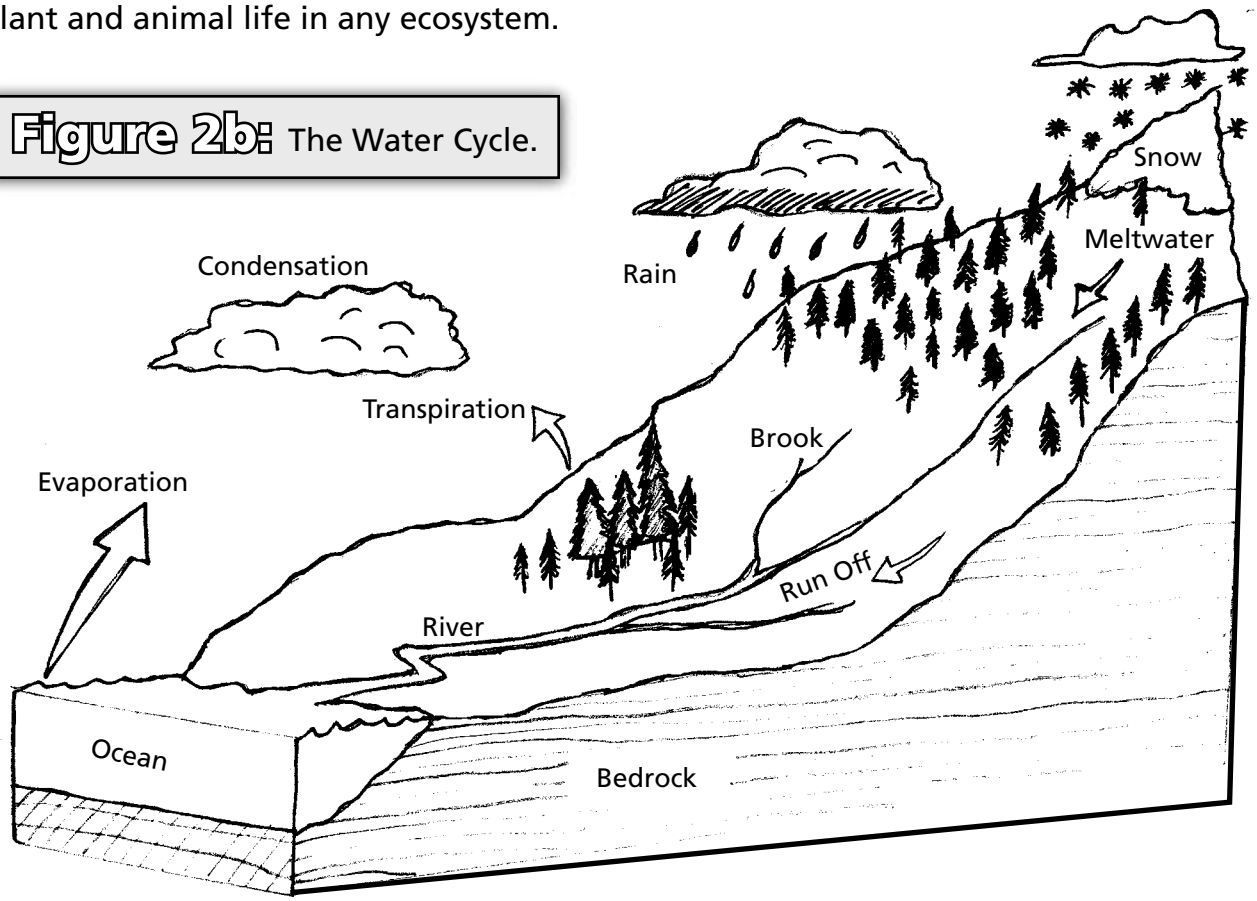
B. THE WATER CYCLE:

Water is essential to life. About two thirds (65%) of the human body is water. Water molecules are used over and over as it recycles through the ecosystems of the world.

Water enters the atmosphere from the earth in one of two ways. **EVAPORATION** occurs as water molecules enter the air as water vapour. **TRANSPIRATION** occurs as water enters the roots of plants and exits through leaf tissues. Water returns to the earth from the atmosphere as a result of **CONDENSATION** and **PRECIPITATION**. Precipitation can be in the form of rain, snow, sleet, or even hail. The entire process is driven by the power of the sun, which causes water to evaporate into the atmosphere (see figure 2b).

Entire ecosystems rely on the water cycle. Too much at one time can cause severe **FLOODING**, while not enough can cause **DROUGHT**. Both can have devastating effects on plant and animal life in any ecosystem.

Figure 2b: The Water Cycle.



The area drained by rivers is called a **WATERSHED**. Forests protect water quality in a watershed by holding snow in the winter, and slowly releasing it into rivers and streams as it melts in the spring. This prevents sudden runoff which can cause serious flooding. In the summer, rain hits forest vegetation, reducing its force and decreasing the tendency to wash away the soil. Forests, therefore, anchor and protect the soil, preventing erosion. This is especially important along the banks of rivers and streams, called the **RIPARIAN ZONE (figure 2c)**. The shade provided by trees along rivers and streams is also beneficial to aquatic life forms, since water remains fairly cool, and cool water can hold more dissolved oxygen than warm water.

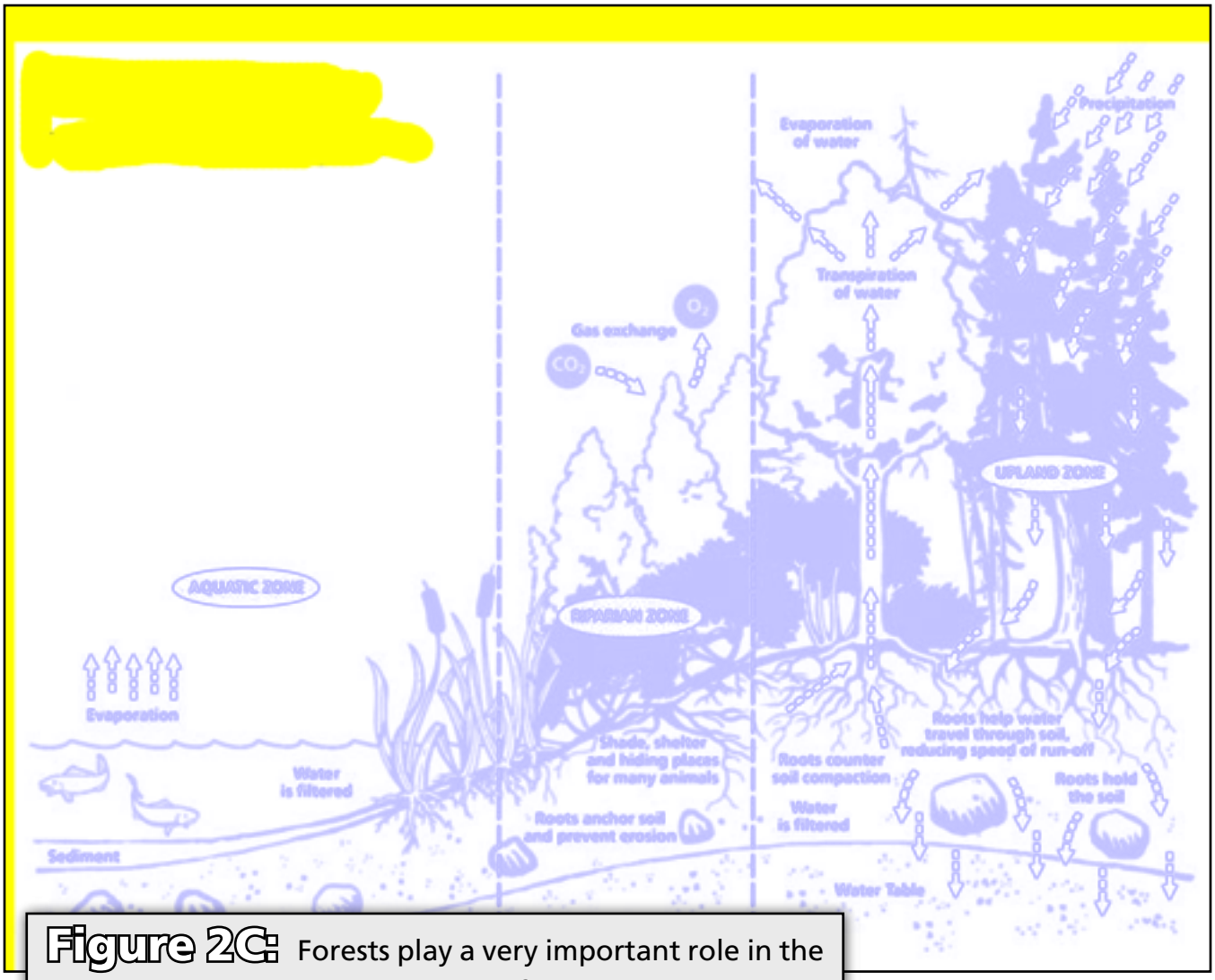
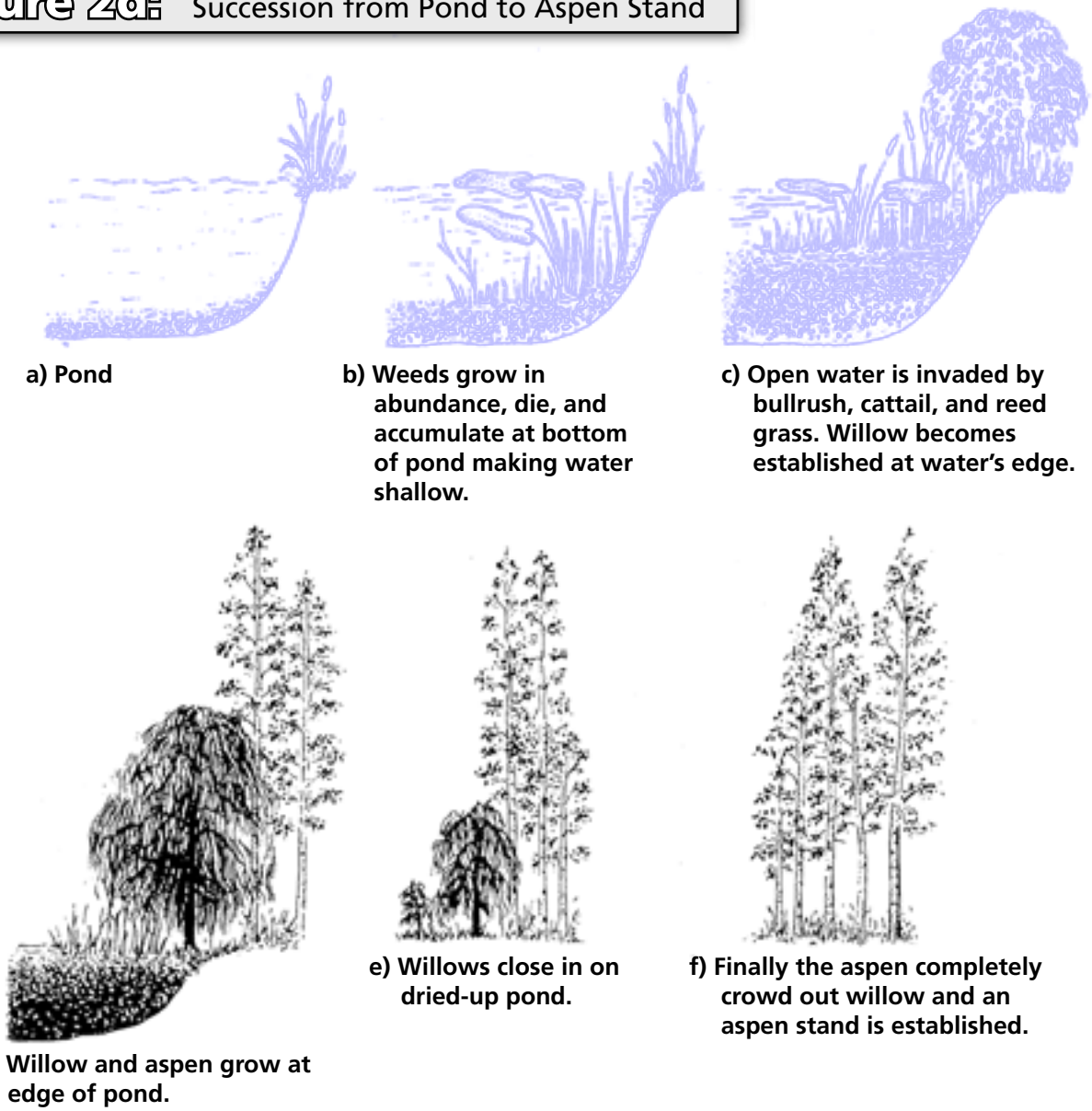


Figure 2C: Forests play a very important role in the collection, storage, and recyling of water in ecosystems. BUFFER ZONES or RIPARIAN ZONES along waterways in Manitoba are managed to assist in the maintenance of water quality.

2.2 SUCCESSIONAL CHANGES

Ecosystems never stay the same. They are always changing, even though we cannot always see the changes. Most of these changes happen slowly, as in the process of **SUCCESSION**. During this process, plant communities succeed one another until a final stage called a **CLIMAX COMMUNITY** is reached. Figure 2d explains this process in detail.

Figure 2d: Succession from Pond to Aspen Stand



a) Pond

b) Weeds grow in abundance, die, and accumulate at bottom of pond making water shallow.

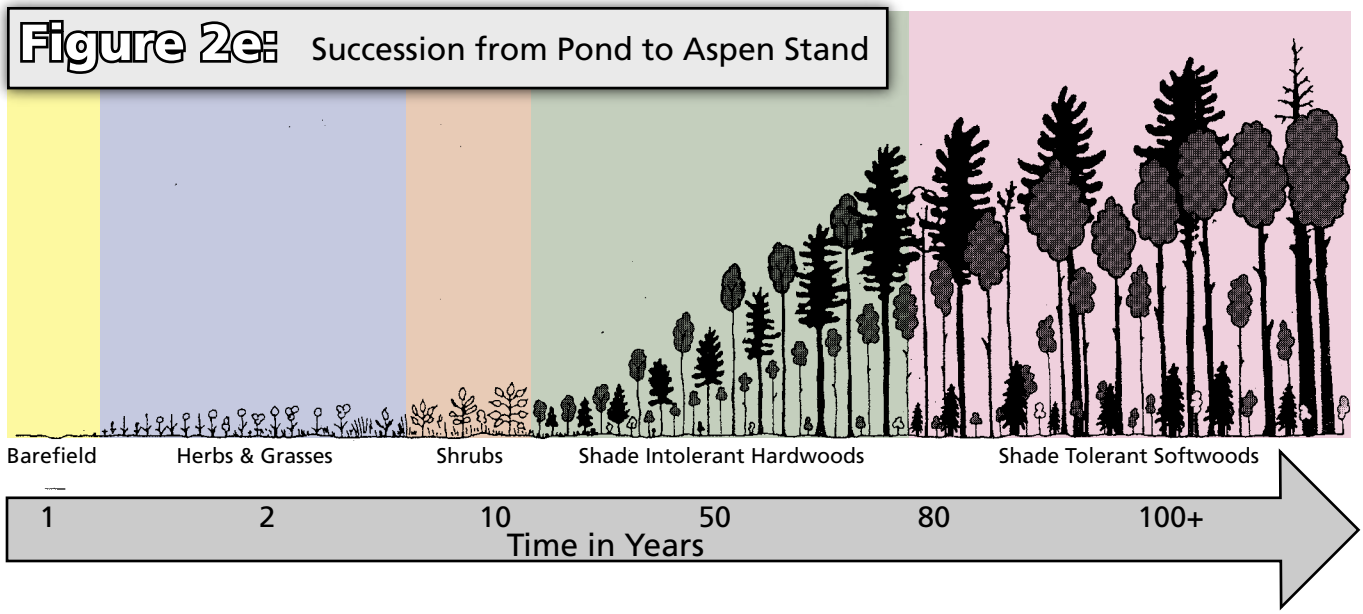
c) Open water is invaded by bullrush, cattail, and reed grass. Willow becomes established at water's edge.

d) Willow and aspen grow at edge of pond.

e) Willows close in on dried-up pond.

f) Finally the aspen completely crowd out willow and an aspen stand is established.

If the climax community is disturbed, a process called **SECONDARY SUCCESSION** takes place. For example, a farmer may have used heavy equipment to clear some land, such as a stand of trees in figure 2d above. If the land was then left alone, vegetation would quickly become established. In the first year, the **PIONEER SPECIES**, such as weeds and grasses, would begin to grow. Later, as time passed, seeds would be blown in from the surrounding forest into the sunny opening, and shrubs and trees that cannot tolerate shade (called **SHADE INTOLERANT**) would begin to grow, such as aspen and willow. The new vegetation would shade the ground, creating ideal conditions for the **SHADE TOLERANT** species to grow, such as spruce. Soon a young forest becomes fully established and will continue to grow until the next disturbance occurs, such as fire, logging, or a beaver flood. When the beaver has destroyed all the nearby trees, or when the pond fills in with silt, they move on. The abandoned dam disintegrates, and trees will regrow again. Figure 2e illustrates successional changes through time.



2.3 GROWTH AND SURVIVAL IN THE FOREST

For plants and animals, survival is a daily struggle. For animals, "survival of the fittest" is a law of nature that determines if they live or die. The only measure of success is whether or not an organism can meet its needs for food, water, and cover. It must avoid predators each day. For the survival of a species, they must live long enough to pass on its traits to the next generation in its **GENES**, and then there needs to be enough offspring to replace those that fall prey to disease, predators, accidents, and natural disasters such as fire, flooding, or severe weather. For example, many songbirds return to the Boreal Forest in the spring to raise their young. A late spring snowstorm can destroy many young birds in an entire region. In this intense struggle for survival, only the strong will survive.

When competition takes place between different species (such as foxes and owls competing for mice), it is known as **INTER-SPECIES COMPETITION**. When members of the same species compete for food, water, or shelter, it is known as **INTRA-SPECIES COMPETITION**. For example, many rabbits may compete for the same tender, new growth in a clearing in the spring.

Similarly, competition can occur between trees in a forest. In a young forest, as many as 10,000 seedlings may grow on a hectare of land (a **HECTARE** is an area of land 100 meters x 100 meters). After 30 years, there may only be 500 trees per hectare. The majority of young trees perished due to inadequate amounts of sunlight (required for photosynthesis), water, or nutrients. Some seedlings will have been eaten or trampled by animals. Others may have succumbed to insects, disease, or fungal infections.

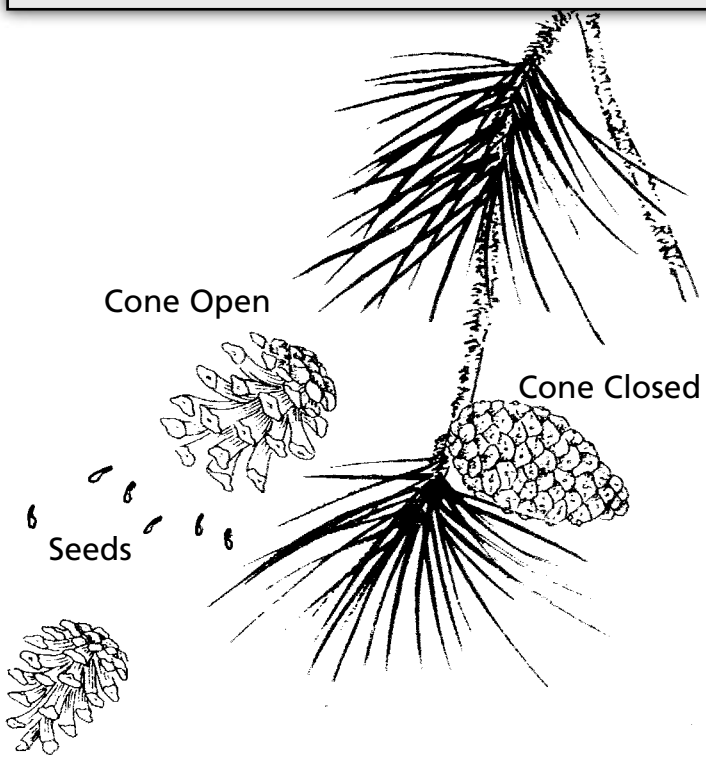
2.4 INSECTS, FIRE, AND DISEASE

The forest, like all ecosystems, is dynamic. This means that it is always changing. There are small day to day changes that take place, such as a branch on a certain tree breaking off and falling to the ground on a windy day, or some pine cones that fall to the ground. There are also large scale changes that take place over large areas. These changes are called **NATURAL DISTURBANCES**, and are a normal part of the birth, life and death of a forest.

Natural disturbances of the forest involve four main forces: weather, insects, disease and fire.

Severe weather, including drought, flooding, ice storms, and wind storms, can cause damage over large areas of forest. Storms can uproot trees, or break off large portions of the trunk and crown, permanently damaging them. Long term drought or flooding can weaken the trees to the point where they can no longer grow or defend themselves against fungi or other diseases. Dead trees will eventually fall over, decay, and return their nutrients to the soil. If the trees were old enough to produce seeds, a young forest will eventually begin to grow. Nothing is wasted in an ecosystem.

Figure 2f: Pine cones open when exposed to heat. the tiny winged seeds then disperse in the wind, a distance of up to 2 -3 times the height of the tree.



Insects can also cause severe damage to a forest. One such species is the Spruce Budworm, a common insect found in the Boreal Forest. The Budworm feeds on new growth of needles in the spring;, and can destroy a large tract of trees if they are infested several years in a row. The Forest Tent Caterpillar attacks deciduous (broadleaf) trees such as Poplar. Poplar trees can usually withstand one growing season of **DEFOLIATION** (complete loss of leaves) but several years of severe infestation can kill them.

Tree diseases can also cause widespread damage in a forest. **DUTCH ELM DISEASE** is caused by a fungus carried from tree to tree by beetles. This fungus chokes the transporting tubes in the tree trunk, choking off the supply of water and nutrients to the leaves. This affects only mature Elm trees. **ROOT ROT** is another fungal disease which attacks the roots of trees and eventually weakens them at the base, causing them to blow down or break off at the stump.

The dominant ecological force shaping the forest is **FIRE**. Fire is a force of destruction, and one of renewal. Fire can destroy thousands of hectares of forest in a day or two, and cause severe loss of life, as well as economic and social losses. Most fire in populated areas are caused by humans (70% of the time, and lightning 30% of the time). Better fire detection and suppression means that fewer hectare are destroyed than in the past.

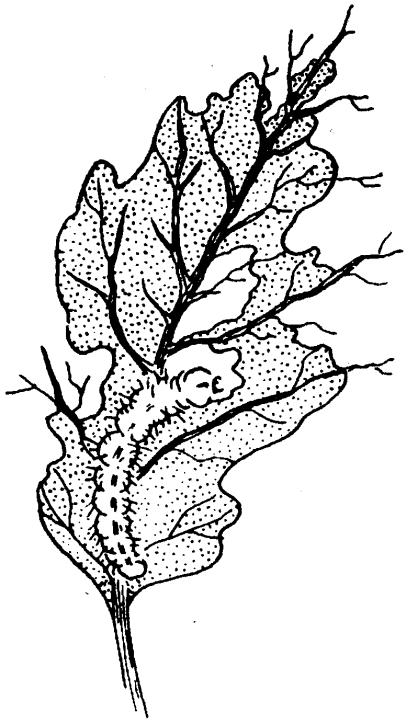
The Boreal Forest has co-evolved with fires over millions of years. Some species, such as Jack Pine, require fire to open their cones and release their seeds. These seeds then germinate in the nutrient rich soil after the fire.

The fire history in the Boreal Forest shows that fire occurs about every 75-100 years. A stand that does not burn may live to be 120 years old. However, by that time, growth has nearly stopped, and the trees are often in a state of decline. They are vulnerable to attack by insects and disease.

The role of natural disturbances in a forest system is to create openings on the forest floor where the dead trees will decay, and where young seedlings will germinate and grow into a healthy new forest. This is a normal part of any ecosystem. Birth, life, and death occurs over and over in all ecosytems, whether in the ocean's depths, in a wetland , or in dense stands of spruce in the Boreal Forest. Plants and animals in any ecosystem are like tiny whirlpools of life, sucking up matter such as nutrients (carbon, phosphorous, calcium etc.) while they are alive, but quickly returning them to the earth after they die.

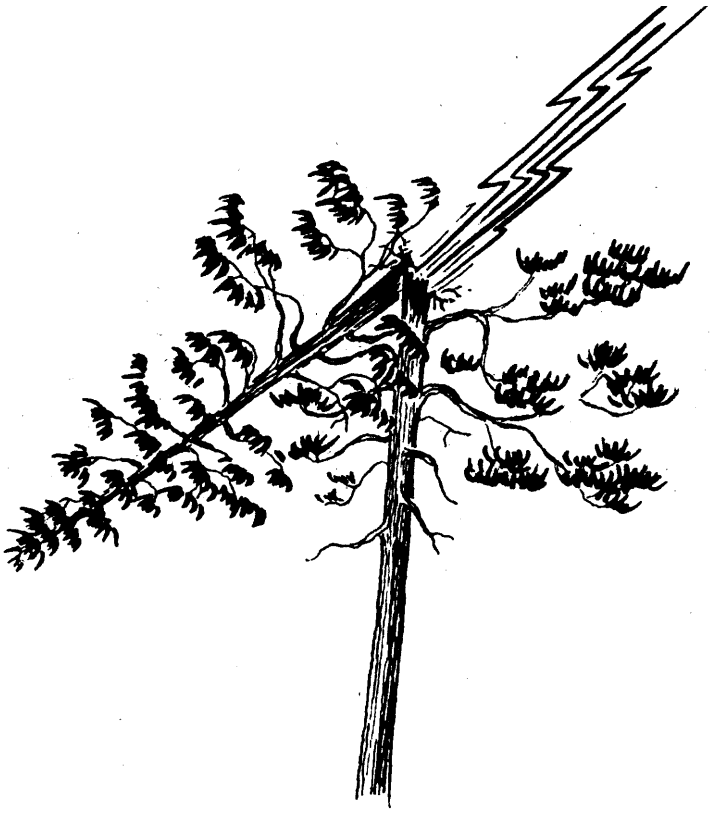
Figure 2g: These clearings, created by logging, imitate openings made by wildfire. A new forest will grow when the heat of the sun opens the cones, releasing the seeds.

Figure 2h: Agents of change in the forest. Other natural forces include ice storms, wind storms, and landslides.

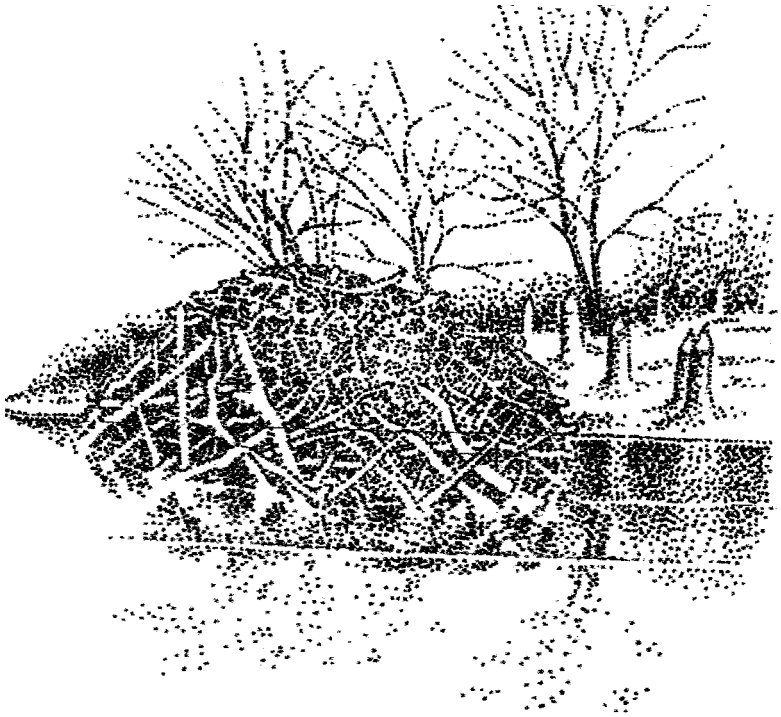


Insect Infestations

Fungal Infection



Lightning and Fire



Beaver Dams / Flooding

2.5 DECAY AND RECYCLING – "ROTTEN LUCK"

Every day in the forest, living things die. Leaves, needles, twigs, and branches continually fall to the forest floor. Even large trees will fall over or get blown down. This matter, known as BIOMASS, accumulates on the forest floor. But it does not stay there forever. Tiny life forms, known as MICROBES, attack the debris on the forest floor. This is known as the **LFH LAYER** (LITTER FERMENTING INTO HUMUS). This explains the unique odor created when you disturb the soil in the forest. Most of these microbes are **BACTERIA**. They will break down plant and animal matter, and make the nutrients available to other plants, thereby recycling them back into the ecosystem. If there was no decay, think about how thick the layer of debris would become over centuries of accumulation.

All ecosystems, including the forest, change with time. These changes may not be visible on a day to day basis, but over the years have contributed to shaping the forest as we see it today. Our landscape has changed due to human activities such as urbanization, road building, and agriculture (see figure 2h). In some areas, only small pockets of forest cover remain. These small **WOODLOTS** are often the last remnants of the original forest cover. They are extremely important for providing wildlife habitat, soil conservation, water conservation, and oxygen. They also help beautify the landscape, and provide recreational opportunities such as hiking and birdwatching.

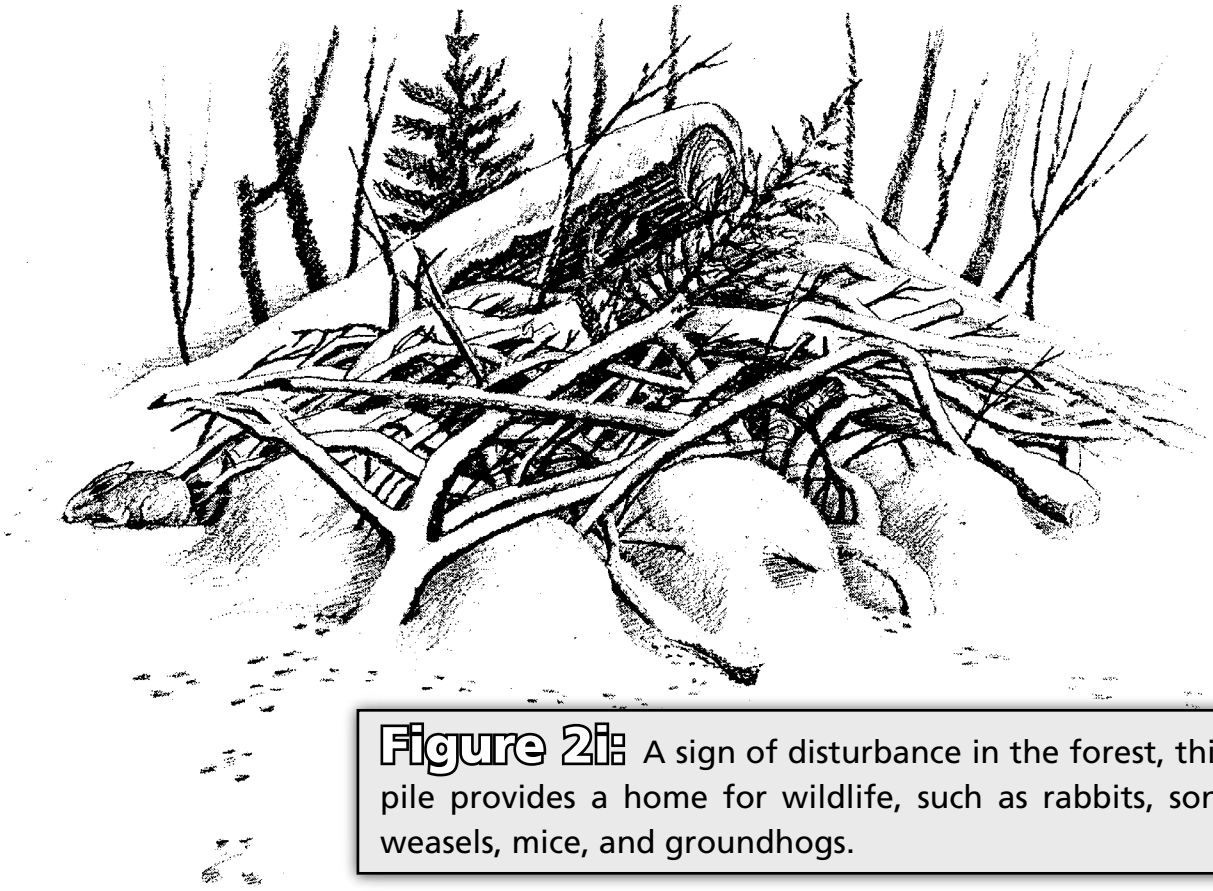


Figure 2i: A sign of disturbance in the forest, this brush pile provides a home for wildlife, such as rabbits, songbirds, weasels, mice, and groundhogs.

CHAPTER TWO ACTIVITIES

ACTIVITY 2.1: DIGGING DEEPER INTO SOIL

(OUTCOME 7-1-03: Identify abiotic and biotic components of ecosystems that allow particular organisms to survive.)

SUMMARY: Students will have an opportunity to demonstrate that plants need nutrients for continued growth.

MATERIALS NEEDED:

- 6 – 9 clear planting containers (i.e. clear drinking cups)
- paper towels
- sand
- water
- 2 litres soil (preferably black soil from the forest floor)
- pea, bean, or corn seeds
- pie plate

PROCEDURE:

1. hand each student a seed and ask what they need for growth
2. soak a handful of seeds in a pie plate lined with wet paper towel
3. prepare multiples of 3 sets of clear containers – one set filled with paper towels, one set filled with sand, and one filled with black soil.
4. ask students to predict the height to which the plants will grow after 3 weeks
5. keep all variables the same (i.e. water, light , and temperature)
6. after 3 weeks, discuss the differences in growth rates, and why they turned out the way they did. Draw conclusions regarding what seedlings need after germination.

FOR FURTHER RESEARCH: Find out why certain trees grow the best in certain soils. For example, hardwoods such as oak and ash prefer a rich, black, clay soil, while the jack pine can grow in very sandy soil. Explore possible theories why one tree species thrives in soil that would not support other species.

ACTIVITY 2.2: FIGHTING FOREST FIRES (figure 2i)

(OUTCOME 7-1-05: Identify and describe positive and negative examples of human interventions that have an impact on ecological succession or the makeup of ecosystems)

SUMMARY: Manitoba's forests are extremely important. They provide jobs, oxygen, wildlife habitat, as well as numerous timber and non-timber forest products. Our forest resource is attacked by insects, fire, and a variety of diseases.

Fire is a natural part of the Boreal Forest ecosystem. In this activity you will find out more about the various causes, effects, and prevention of forest fires.

PROCEDURE: Divide the class into 5 groups. Assign one topic for each group, and have them research the following:

GROUP 1: Using library resources and a computer with an Internet connection, find out the main causes of forest fire in Canada, and in Manitoba. Compare using a pie graph.

GROUP 2: How can forest fires actually improve a forest? Using the example of "controlled burns", find out how a forest ecosystem can be improved. Research what happened in Yellowstone National Park when a controlled burn ran wild.

GROUP 3: Find out how a forest fire can become so large and intense that it can create its own weather patterns. Use a poster to illustrate this to the class.

GROUP 4: Find out about the "FIRESMART" Program, which originated in Alberta. Explain the steps landowners can take to help make their property less vulnerable to a wildfire.

GROUP 5: Using the website www.gov.mb.ca/conservation/fire, find out about the current fire situation. Draw the current Fire Hazard map. Try to explain it using the precipitation map. Does it match the conditions found in your area. (If studying this unit in winter, select June 30 of the current school year and report on the conditions that existed at that time).

Figure 2i: Water Bomber in action.

2.3 WATER UPTAKE AND TRANSPIRATION IN PLANTS

(OUTOME 7-1-03: Identify abiotic and biotic components of ecosystems that allow particular organisms to survive.)

PURPOSE: To observe how plants absorb and give off water. This process, called TRANSPIRATION, is an important part of the Water Cycle, which transfers water from the atmosphere to earth and back.

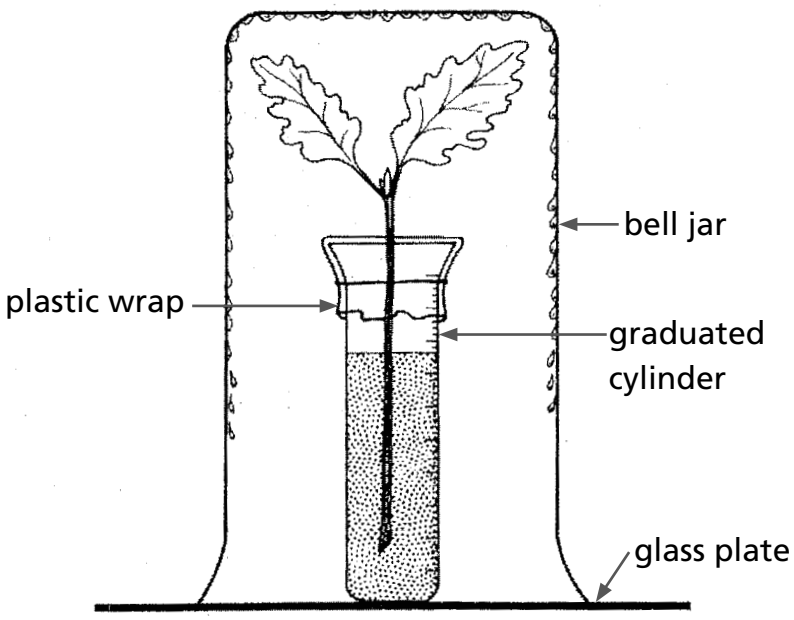
MATERIALS NEEDED: one stem of a leafy plant, such as geranium, graduated cylinder, bell jar, plastic wrap, rubber band, glass plate, petroleum jelly

METHOD:

1. Fill the graduated cylinder with water and tightly stretch a plastic wrap over the top. Fasten the wrap tightly with a rubber band.
2. Push a leafy stem carefully through the plastic wrap into the water. Record the level of the water
3. Place the cylinder and stem on a glass plate and seal a bell jar over them with petroleum jelly. Leave the apparatus in a sunny location
4. Record the level of water in the cylinder at intervals of an hour. Note and record any changes in the appearance of the leaves and/or the bell jar.

QUESTIONS:

1. Plot the changes in the water level on a graph.
2. How do you account for the changes in the water level?
3. If the leaves have grown, can you draw any conclusions about the role of water in plant growth?
4. Why might it seem cooler when you walk into a forest, woodlot, or stand of trees?



2.4 FOREST FIRES AND CLIMATE CHANGE

(OUTCOME 7-1-06: Identify environmental, social, or economic factors that should be considered in the management and preservation of ecosystems.)

PURPOSE: Students will look at the relationships between forest fires, the formation and health of the forest, and weather and climate change. Students will:

a. recognize that fire occurs naturally and affects the health and formation of forests.
b. look at how weather conditions affect forest fires and from this, investigate the possible effects of climate change on forest fires.
c. depict some of the changes fire brings about in a forest.

BACKGROUND INFORMATION: Forest fires, the health of Canada's forests, and climate change, are all closely related.

- Climate change may lead to more forest fires due to warmer and drier weather, and increases in lightning storms.
- Canada's forests play an important role in helping to reduce the amount of carbon in the atmosphere and in doing so, reduce carbon dioxide which is one of the main greenhouse gases.
- Changes in the frequency of fires will change the carbon cycle and increase the release of $C0_2$ to the atmosphere.

Although research in conducted on all of Canada's forests, the Boreal Forest which occupies much of the northern hemisphere plays an important role in climate change. As part of these studies, the International Geosphere-Biosphere Program has established permanent study areas in North America, Europe, and Asia with researchers from the CFS (Canadian Forest Service) and many other organizations participating. Some of the many questions that they are seeking to answer include:

- What are the past and present fire and weather patterns?
- How much carbon is lost during and after a fire due to direct burning and subsequent decay?
- After a fire, when does a forest turn from a source of carbon back into a "carbon sink" (absorbs carbon from the air)?
- How will this affect the overall global climate budget?
- How will fires and climate change affect the forest and its distribution?

Answering these questions will help scientists in many ways. Understanding historical climate/fire relationships will provide insight when projecting future patterns under a warming cycle, and in understanding the ways fires might develop and behave on a large scale. On a smaller scale, understanding future fire patterns may help in making local forest management decisions and in planning for human safety in communities in high-risk areas.

THE FOLLOWING WEBSITES WILL ASSIST STUDENTS IN THEIR RESEARCH:
www.msc-smc.ec.gc.ca/ccrm/bulletin
www.nofc.cfs.nrcan.gc.ca/fire/frn/English/frames.htm

QUESTIONS:

1. As a class, discuss the causes of forest fires. (examples: campfires, sparks from trains, cigarettes...)
2. Outline the positive and negative effects of forest fires on an ecosystem.
3. Access climate records to see if there is a correlation between weather and forest fire frequency (see figure 2j).
4. Create a mural showing the ways that a forest changes after a fire. A few ideas to get started:
   a. squirrels and owls nest in old, large trees that are often left standing after a fire
   b. many young tree seedlings grow up quickly after a fire, nourished by the newly released nutrients
   c. deer and other wildlife eat the tender young shoots of trees and bushes that sprout after a fire
5. Find out more about the Earth's carbon budget, i.e. how much is added into the ecosystem, and from what sources, and how much is taken out of the ecosystem, and by what sources.

Figure 2j: Climate change may increase the frequency and intensity of forest fires.

CHAPTER TWO ASSIGNMENT

1. WHAT IS MATTER?
2. IN ONE PARAGRAPH EXPLAIN HOW CARBON AND OXYGEN ARE CYCLED IN AN ECOSYSTEM.
3. IN ONE PARAGRAPH EXPLAIN HOW WATER IS CYCLED IN AN ECOSYSTEM.
4. WHAT IS A WATERSHED? WHY ARE FORESTS SO IMPORTANT TO WATERSHEDS?
5. WHAT IS A RIPARIAN ZONE? WHY IS IT IMPORTANT?
6. WHAT HAPPENS IN THE PROCESS OF SUCCESSION? GIVE AN EXAMPLE OF HOW SUCCESSION CAN CREATE A FOREST. (see figure 2k)
7. WHAT HAPPENS IN SECONDARY SUCCESSION? GIVE AN EXAMPLE.
8. WHAT IS THE DIFFERENCE BETWEEN A SHADE TOLERANT AND A SHADE INTOLERANT SPECIES? WHICH ONE APPEARS FIRST DURING SUCCESSION?
9. HOW DOES COMPETITION HELP CREATE A HEALTHY FOREST?
10. HOW LONG CAN TREES LIVE IN THE BOREAL FOREST?
11. WHY DOES THE BOREAL FOREST NEED FIRE TO REGENERATE?
12. NAME TWO INSECTS THAN CAN HARM THE FOREST.
13. NAME TWO DISEASES THAT CAN ATTACK TREES IN THE FOREST.
14. HOW DOES SOIL FORM IN THE FOREST?

Figure 2k: New life returns to a forest after the fire.

Definition	Word or Concept	Diagram
	Photosynthesis	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Transpiration	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Watershed	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Riparian Zone	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Inter-Species competition	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Intra-Species competition	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Hectare	
	Synonym/Example	

Definition	Word or Concept	Diagram
	LFH layer	
	Synonym/Example	

CONCEPT OVERVIEW

Concept

Water Cycle

Draw a figurative representation.

Write down two questions about the concept.

Write an explanation or definition in your own words. You will be paraphrasing.

List facts (at least five).

Create an analogy

CONCEPT OVERVIEW

Concept

Succession

Draw a figurative representation.

Write down two questions about the concept.

Write an explantion or defintion in your own words. You will be paraphrasing.

List facts (at least five).

Create an analogy

CONCEPT OVERVIEW

Concept

Carbon - Oxygen Cycle

Draw a figurative representation

Write down two questions about the concept.

Write an explantion or defintion in your own words. You will be paraphrasing.

List facts (at least five).

Create an analogy

CHAPTER TWO ANSWER KEY

1. **WHAT IS MATTER?** Matter is the substance that makes up the universe. It is made of atoms and molecules, and takes the form of solids, liquids, or gases.

2. **IN ONE PARAGRAPH, EXPLAIN HOW CARBON AND OXYGEN ARE CYCLED IN AN ECOSYSTEM.**
    - CO2 is produced by animals, through respiration, and decay
    - CO2 is also produced by plants at night, and by combustion (forest fires) and decay
    - C02 is taken in by plants during photosynthesis
    - 02 is taken in by animals during respiration, and by combustion processes, such as in forest fires, engines etc.

3. **IN ONE PARAGRAPH EXPLAIN HOW WATER IS CYCLED IN AN ECOSYSTEM.**
    - Water enters the ecosystem through evaporation and transpiration
    - Water vapour (a gas) condenses on tiny particles of matter called condensation nuclei, and become liquid
    - Water falls to earth as precipitation (rain, fog, drizzle, hail, snow etc.)
    - Water then runs off into streams, rivers, lakes, and eventually the ocean
    - Water slowly seeps into the ground as ground water

4. **WHAT IS A WATERSHED? WHY ARE FORESTS SO IMPORTANT IN WATERSHEDS?** A watershed is an area of land drained by a river. Forests are so important to watersheds because trees hold the soil together with their roots, which prevents soil erosion. The forests also protect the forest floor from the force of heavy rain, and provides ideal conditions for rainfall to slowly filter into the soil, rather than run off quickly. These factors prevent silt from entering the river. Silt is very harmful to fish and other forms of aquatic life.

5. **WHAT IS A RIPARIAN ZONE? WHY IS IT IMPORTANT?** A riparian zone is an area of land adjacent to a river, creek, or wetland. It is important because it provides a home for many life forms – amphibians such as frogs, toads,

and salamanders, as well as reptiles, such as turtles. Land dwelling mammals need habitat in riparian areas, such as mink, beavers, and muskrats. Many species of birds such as waterfowl and songbirds (red-winged blackbird, bittern, Great Blue Heron, etc.) nest and feed in the riparian zone. This creates plenty of Biodiversity, one sign of a healthy ecosystem. There is evidence that riparian zones provide shade for creeks and rivers, which keeps them cool in the summer. Cool water can hold more dissolved oxygen than warm water, so it benefits all forms of aquatic life.

6. **WHAT HAPPENS IN THE PROCESS OF SUCCESSION?** During succession, conditions are created for the establishment of a series of plant and animal communities. Each step along the way helps the establishment of the next community, until a final "climax community" develops. This community will remain in place until it is disturbed by fire, human activity, or some other event. Succession will then start over again.

7. **WHAT HAPPENS IN SECONDARY SUCCESSION?** In secondary succession, a climax community is destroyed, for example by fire. Plants then invade the disturbed area. Seeds are blown in or drop to the ground from adjacent forests. Sometimes animals bring in seeds on their fur or in their feces. These seeds germinate, along with the ones already in the soil to create a new plant community. The plants will grow and mature, new ones will appear, until a new climax community is formed.

8. **WHAT IS THE DIFFERENCE BETWEEN SHADE TOLERANT AND SHADE INTOLERANT SPECIES? WHICH ONE APPEARS FIRST DURING SUCCESSION?** Shade intolerant species must have full sunlight in order to grow. These are the first to appear in a sunny clearing following a fire, logging, or other disturbance. Poplar and birch trees are shade intolerant. When they are a few feet tall, they shade the ground and create conditions for the shade tolerant species, such as black spruce. These trees grow in the shadows of the taller poplar trees. When the poplar trees become over-mature, they die and fall down, which leaves the black spruce as the dominant species until the next disturbance. This cycle repeats itself over and over as the trees grow, mature, and undergo disturbances.

9. **HOW DOES COMPETITION HELP CREATE A HEALTHY FOREST?** Competition is an ongoing struggle for species to meet their needs. Trees compete for sunlight, moisture, space, and nutrients. If they do not meet their needs, they may eventually die, fall to the forest floor, and release their nutrients to the soil. This helps nurture the surviving healthier trees. The healthiest

trees will survive the competition and pass their traits to the next generation. Healthy trees can withstand a certain amount of disease and insect attack.

10. **HOW LONG CAN TREES LIVE IN THE BOREAL FOREST?** Trees can live from 80 to 120 years depending on the species.

11. **WHY DOES THE BOREAL FOREST NEED FIRE TO REGENERATE?** Fire is a necessary force in the boreal forest because certain pine cones, such as those found on jack pine, need a heat source to open. Fire can also clean up insect infestations and disease outbreaks that destroyed the forest stand in the first place, allowing a new healthy forest to become established.

12. **NAME TWO INSECTS THAT CAN HARM THE FOREST.** Two insects that can harm the forest are the Spruce Budworm and the Forest Tent Caterpillar.

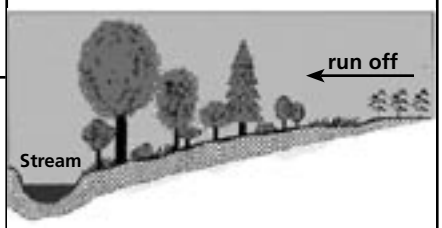
13 **NAME TWO DISEASES THAT CAN ATTACK TREES IN THE FOREST.** Two diseases that can attack trees in the forest are Root Rot, and Canker.

14. **EXPLAIN HOW SOIL IS FORMED IN THE FOREST.** Organic matter or biomass constantly falls to the forest floor. This includes leaves, branches, bark and other debris. Bacteria in the soil attack this matter, turning it into a rich humus, which eventually changes to soil as bacteria cause it to decay.

Definition	Word or Concept	Diagram
A process carried out by plants, in which the sun's energy is used to make glucose and other compounds.	**Photosynthesis** Synonym/Example Photo = light Synthesis = to make	

Definition	Word or Concept	Diagram
The movement of water through a plant. Moisture enters the roots, and exits through the leaves.	**Transpiration** Synonym/Example The air is cool and humid in a forest because of transpiration.	

Definition	Word or Concept	Diagram
The area of land drained by a river.	**Watershed** Synonym/Example The Red River watershed drains into Lake Winnipeg.	

Definition	Word or Concept	Diagram
The area of land along a creek, river or wetland.	**Riparian Zone** Synonym/Example	

Definition	Word or Concept	Diagram
Competition for food, water and shelter between different species.	**Inter-Species competition** **Synonym/Example** Moose and caribou competing for same vegetation.	

Definition	Word or Concept	Diagram
Competition for food, water and shelter between different members of the same species.	**Intra-Species competition** **Synonym/Example** Two moose competing for the same vegetation.	

Definition	Word or Concept	Diagram
An area of land 100 meters by 100 meters (10,000 square meters)	**Hectare** **Synonym/Example** 1 heatare = 2.47 acres	

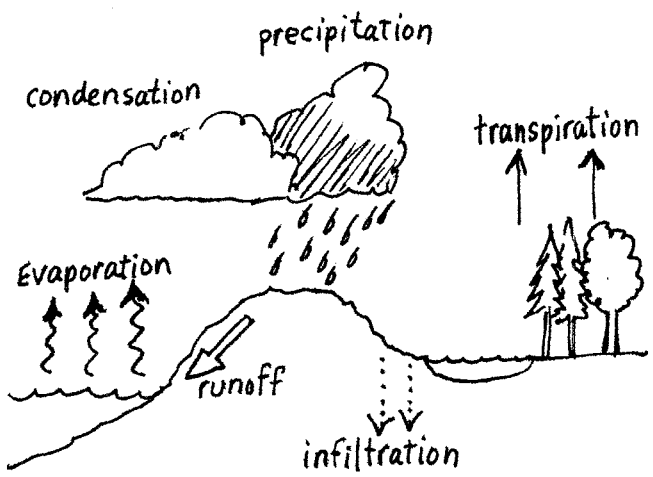
Definition	Word or Concept	Diagram
Uppermost layer of organic matter on the forest floor. Litter, fermenting into humus.	**LFH layer** **Synonym/Example** The "earthy" smell of soil in a forest is given off by the LFH layer	

CONCEPT FRAME

Concept

Water Cycle

List facts (at least five).



Write down two questions about the concept.

1) What is the name of the force that powers the entire cycle?

2) Why do rainfall amounts vary so much?

Write an explantion or defintion in your own words. You will be paraphrasing.

This is how water is exchanged between the earth and its atmosphere. Water leaves the earth by evaporating or transpiring from plants. Water returns to the earth in many forms as precipitation.

Can you illustrate it?

- Precipitation can be in many forms i.e. rain, snow, hail, etc.
- Rainfall amounts vary widely around the planet
- Wind patterns, air masses and fronts determine where the rain will fall.
- Some rain evaporates and never reaches the ground (virga).
- Too much or too little causes flooding or drought.

Create an analogy

The water cycle is like gravity. What goes up must come down.

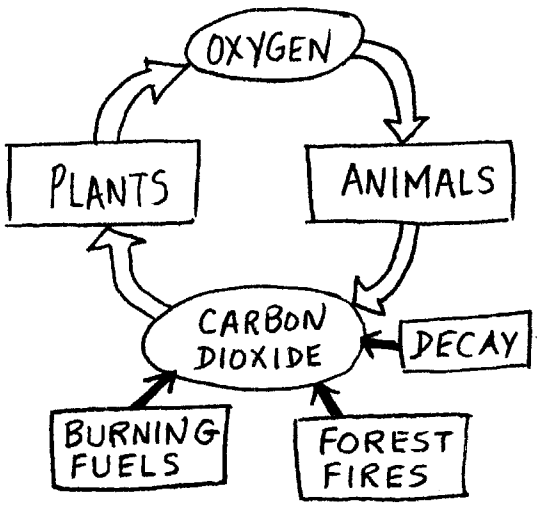
Concept Overview: Used by permission of Lynda Matchullis and Bette Mueller, Nellie McClung Collegiate, Pembina Valley S.D. No. 27.

CONCEPT OVERVIEW

Concept

Carbon - Oxygen Cycle

Draw a figurative representation.



Write down two questions about the concept.

1) Will the earth ever run out of oxygen?

2) Can some life forms live without oxygen?

Write an explantion or defintion in your own words. You will be paraphrasing.

The carbon-oxygen cycle is a natural process in which gasses are exchanged between plants, animals and the atmosphere.

List facts (at least five).

- There is much more oxygen in the atmosphere (21%) than carbon dioxide (0.3%).
- Some CO_2 is absorbed by the ocean. It is then absorbed by some marine animals and stored in their shells as calcium carbonate.
- At night, plants take in O_2 and release CO_2
- Trees store large amounts of carbon and release CO_2 when they burn or decay.
- CO_2 is a "Greenhouse Gas".

Create an analogy

Animals are like a "whirlpool" as they go through life. They suck up one substance (oxygen) and release it as carbon dioxide (CO_2).

CONCEPT OVERVIEW

Concept

Succession

Draw a figurative representation.

- Succession can begin on bare rock with the growth of moss and lichen.
- It takes 60 - 100 years for succession to reach the Climax Stage
- Each stage creates conditions
- Succession can also take place in an aquatic environment; a shallow lake can be "grown in" with vegetation and become a marsh.
- Disturbances such as fire or logging can set the stage for secondary succession.

Write down two questions about the concept.

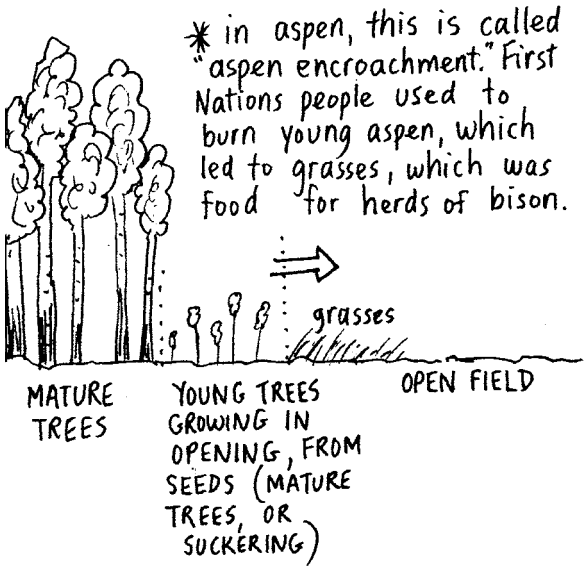
1) Does it happen in all ecosystems?

2) Can humans influence succession?

Write an explantion or defintion in your own words. You will be paraphrasing.

Succession is a process which creates conditions for plants to grow in successive stages, beginning with Pioneer Species, which are the first to become established and gradually changing to favor the Climax Species, which is the final one to appear.

List facts (at least five).



Create an analogy

Succession creates change, just as humans change as they grow.

Teacher's Lesson Planning Notes

CHAPTER THREE

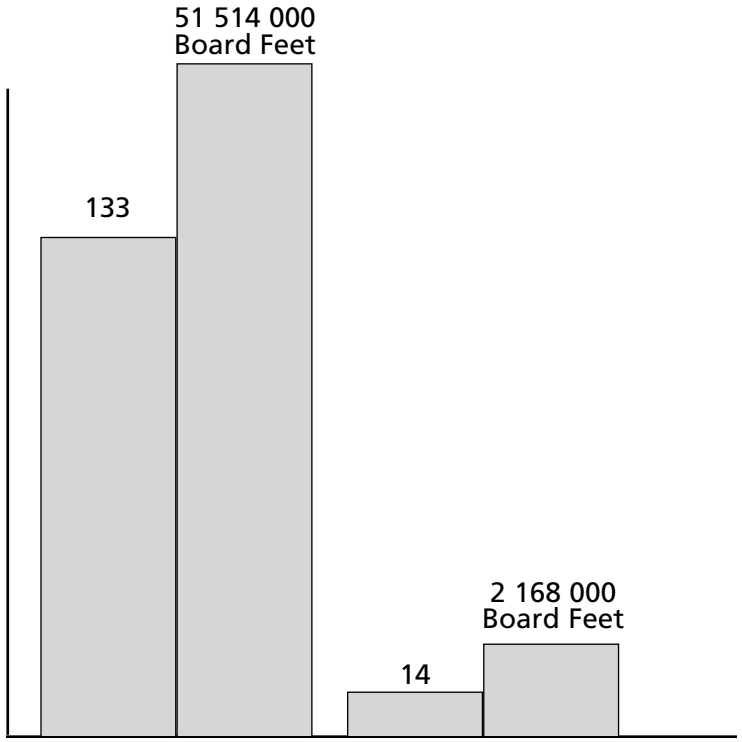
KEEPING IT GOING:
SUSTAINING THE FOREST ECOSYSTEM FOR THE FUTURE

3.1 HOW HUMANS USE THE FOREST

First Nations people relied on the forest for many things. Animals such as moose, deer, rabbits, and muskrats were used for food and their hides were used for clothing. The bones were used for making tools. Plants on the forest floor were used for medicine. Parts of trees such as roots were used for making rope, and the bark was used for making dye. Food such as berries, nuts, and even maple syrup was obtained from trees. Firewood was the only source of fuel for heating and cooking. Even though First Nations people obtained these things from the forest, there was little impact on the Boreal Forest because of its vast size.

When settlers began arriving in Canada from European countries, the forest began to change. Forests were cleared for agriculture in Eatern Canada. The British Navy used the large, straight White Pine trees to make masts for their ships. The railway consumed huge amounts of timber for railway ties, bridges, and telegraph poles. To the early Canadians, the forests were thought to be inexhaustible, hence little thought was given to their conservation.

As civilization proceeded west, more forested land was converted to farmland. Industrial growth in the middle part of the 20th Century saw the forests of Canada under increased harvesting pressure. The growing population in Canada required more and more lumber for homes and firewood to heat them, and pulp to make paper. The harvest of the forest was largely unmanaged (figure 3a).



Today, sustainably managed forests provide lumber, pulp and paper, and many other products to countries around the world (see figure 3b) . This careful management ensures that harvesting can occur for all future generations. This harvestable amount is called the **ANNUAL ALLOWABLE CUT** (it's like living on the interest on your bank account, and not touching the principle). Fire and insects destroy more forest cover than humans actually harvest.

Figure 3a: Loss of Sawmills in three Ontario counties (Middlesex, Oxford and Perth) reflects the rapid deforestation in eastern Canada as settlement took place.

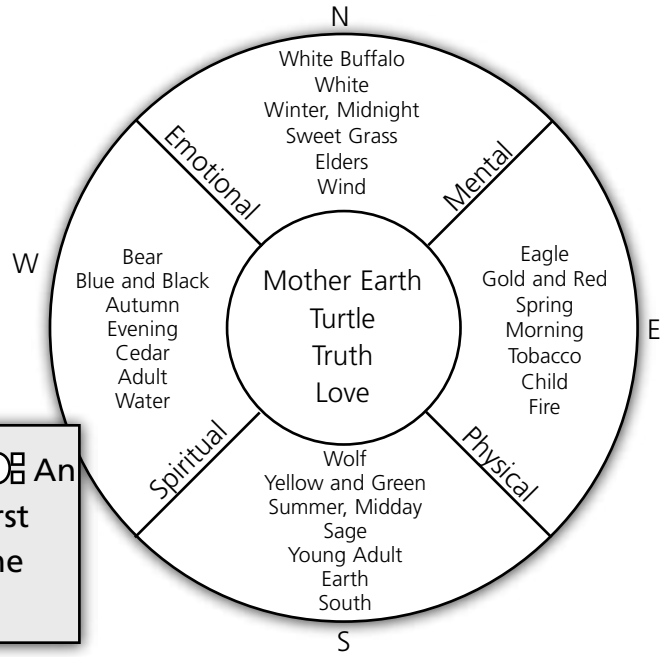
"We the trees are like stitching in fabric – we hold the parts that clothe the Earth together"
a vision by Small Buffalo, Tatanka Hunkesi, July 25, 2000

Depending on where they lived in North America, First Nations people had a variety of ways of interacting with their forest ecosystem. In the Grasslands, home to tribes such as the Sioux and the Dacotah, young forests tended to invade the grasslands as poplar stands encroached into the sunny openings. Fires were set to stop forest growth and to encourage the regrowth of grasses, which provided food to roaming herds of bison and wapiti (elk).

In the Boreal Forest, home to the Ojibwe and Cree Nations, the forest was utilized for firewood, poles for building tipis, as well as a source of food – berries, mushrooms, and wild game. When game was harvested, all parts of the animals were used, as shown in diagram 3b.

A wide variety of plants from the Boreal Forest were used. Parts of plants were used for very specific purposes. Some berries were used for food, or boiled to extract dye. Roots of some trees such as tamarack, were used for making rope, while other roots were dried and used as medicine (wiki). Bark from the willow tree was used to make an aspirin-like medicine (willow bark contains acetylsalicylic acid, the main ingredient in Aspirin). Leaves from plants such as Labrador Tea were used to make a blood tonic. Other plants such as Sweetgrass were burned while ceremonial practices were carried out.

Because First Nations people were so dependent on their surroundings for their survival, they became keen observers of natural cycles, seasonal changes, and animal behaviour. Hunting, trapping, and fishing sustained them for many generations. The diagram below illustrates a "Medicine Wheel", which shows the interconnections between natural events.



This Medicine Wheel reflects traditional values of First Nation People. It shows directions that reflect earth's daily pattern's ie. sunrise, sunset, seasons, etc. as well as life patterns ie. child -> young adult -> adult -> elder. At the centre is Mother Earth that supports all life (Turtle Island). Each element has symbolic meaning for all of life's daily activities ie. all entry into sweat lodges would be from the east. (courtesy of Garry Raven, Elder, Hollow Water First Nation)

Figure 3b: An example of a First Nations Medicine Wheel.

Figure 3c: The Moose is a sacred animal to all First Nation people, especially to those belonging to the Moose clan. All parts of the moose were used.

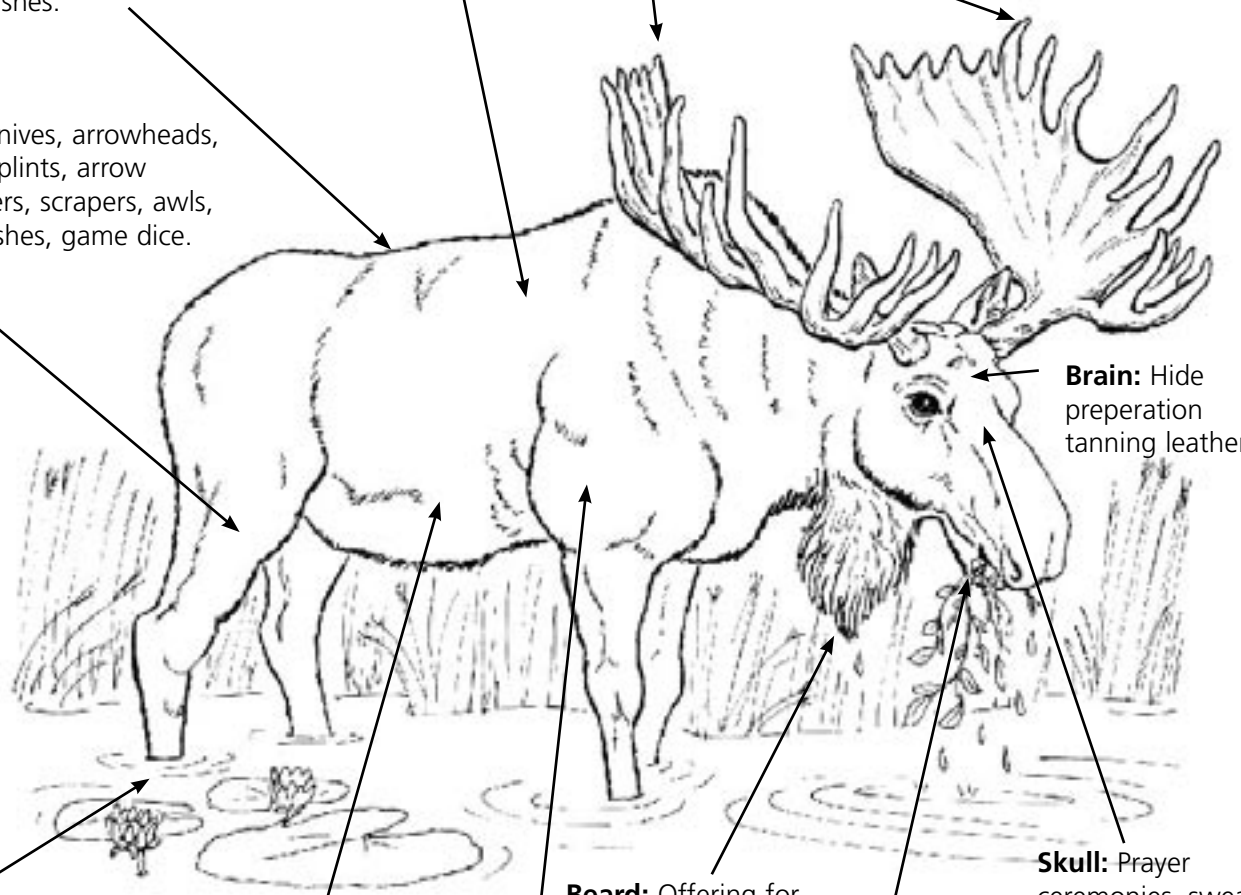
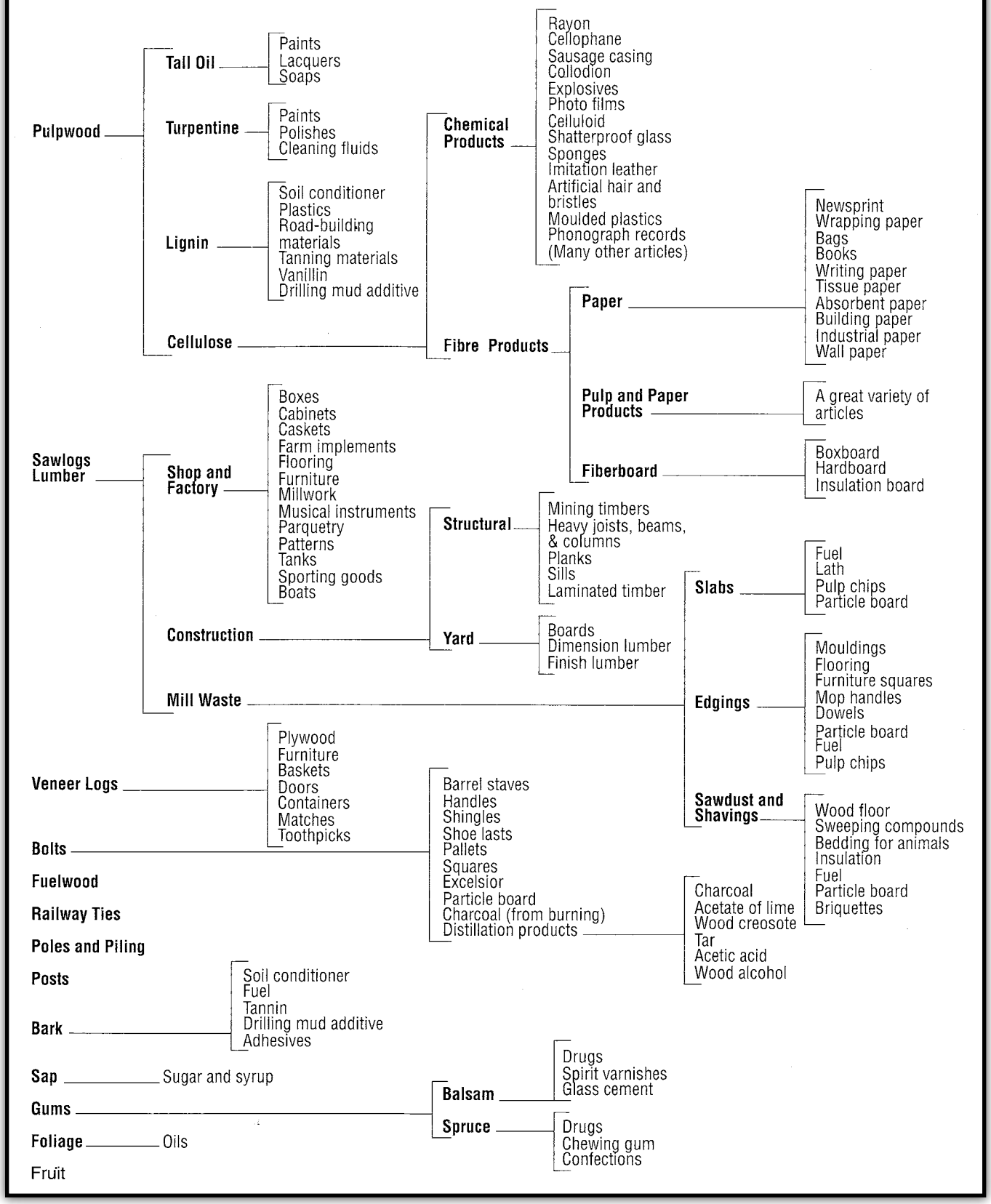


Figure 3d: Products from Canada's Forests



(Reprinted. with permission, from Morrison, G.R. A forestry Manual for ontario secondary School Teachers. Willowdale: Ontario Forestry Association, 1983)

3.2 HOW HUMANS MANAGE THE FOREST

Forests are a renewable natural resource. Resources such as oil and minerals are **NON-RENEWABLE**, since they do not replenish themselves when used. **A RENEWABLE RESOURCE**, such as the forest, will **REGENERATE** or grow back after a fire or logging.

Forests regenerate in several ways. One way is to let the trees grow back on their own. This is called **NATURAL REGENERATION**. Some trees, such as poplar, will send out **SUCKERS** from their roots when the mature trees are cut down. Other trees, such as birch, send out SUCKERS from their stumps in a process called **COPPICING**. Other trees, such as the conifers or cone-bearing trees, will release seeds from the **CONES** which litter the ground after a harvest or fire. These seeds will **GERMINATE** into tiny seedlings and will eventually create a new forest.

The second way to regenerate a forest is called **ASSISTED REGENERATION**. In this process, **SITE PREPARATION** is done with large machines, which are used to expose the mineral soil on the forest floor. Next, a group of people will hand plant small seedlings which were raised in a **NURSERY**. Strict government regulations are in place to ensure that the forest is returned to its original species mix after a harvest. These regenerating sites are inspected at year 7, and at year 14 to ensure that they are growing to government standards. If these areas are not regenerating properly, they sometimes need to be replanted.

A great deal of planning is done before a single tree is cut. The steps outlined below illustrate the complete process of forest management. With proper management, our forests can continue to provide us with lumber, paper, and other products. Proper management of our forests will also provide for the needs of wildlife, maintain our water quality, and preserve the soil. This new approach to forestry is called **ECOSYSTEM BASED MANAGEMENT**. Lets take a closer look at the steps involved in managing a forest

Figure 3e: This forest worker is thinning the forest to reduce competition for sunlight, moisture, and nutrients.

STEP 1: PRE-HARVEST PLANNING:

- Forests belong to the people of Manitoba (except for about 5% which is held by private landowners).
- companies manage the "Crown Owned" forests on behalf of the citizens of Manitoba.
- The timber or sawmill company must prepare a set of plans for the government to approve (plans are examined by Government of Manitoba - Manitoba Conservation) (Forestry Branch)
- plans must meet the needs of other forest users, such as wildlife. The following items must be considered when harvest plans are made:
    - A. water issues, such as where to cross a stream
    - B. fish habitat
    - C. biodiversity
    - D. recreation (trails, campgrounds, cottages)
    - E. First Nations (spiritual sites, traditional hunting and gathering areas)
    - F. aesthetics (visual effects of logging on the landscape)
    - G. special wildlife areas such as calving sites for moose or caribou
- These plans must be presented to the public at open meetings.

STEP 2: HARVEST

- A harvest system is then selected. The areas is marked or flagged for harvest.
- Large machinery is used, such as a skidder , or feller buncher to cut, move, and stack the trees in a place called the landing.

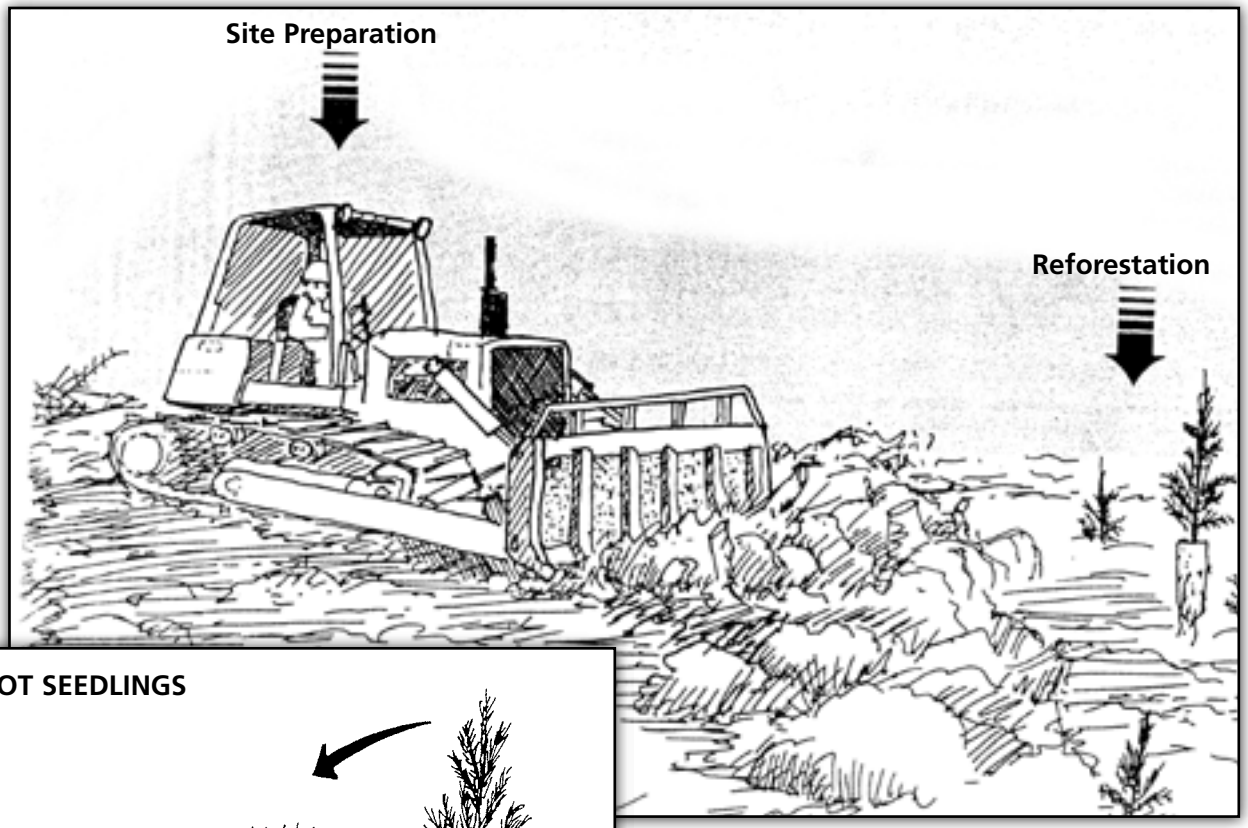
Skidder

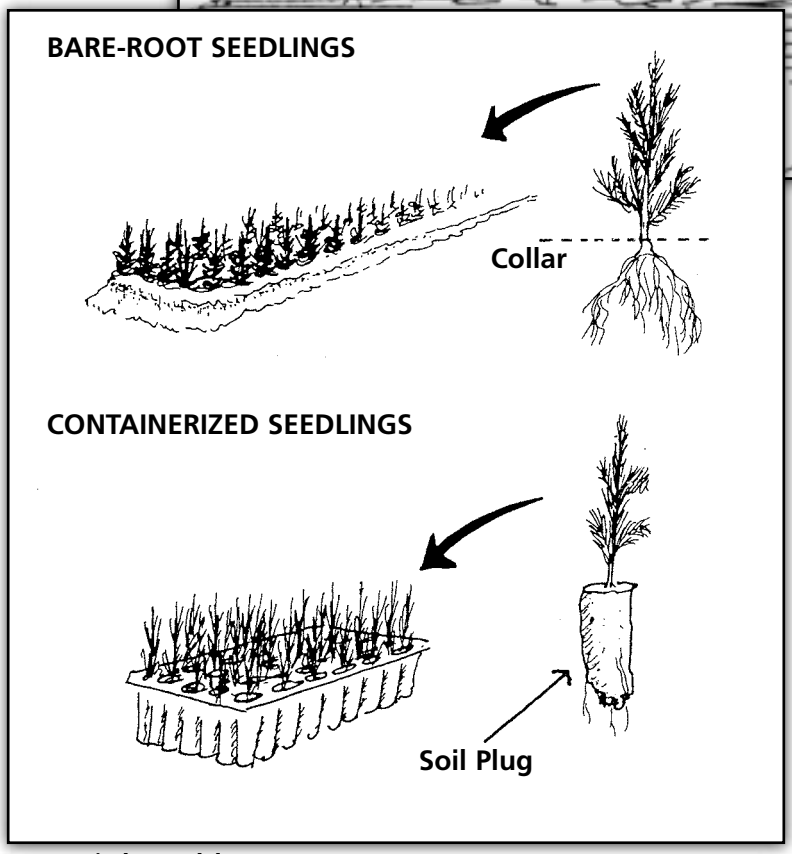
Forwarder

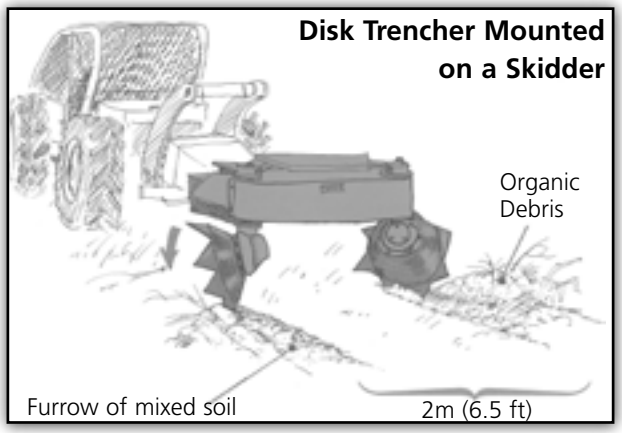
Feller-buncher

STEP 3 FOREST RENEWAL

- Site preperation is done to create a seedbed for the new seedlings
- site preparation also spreads out branches and limbs, which will decay into soil. It also exposes the mineral soil to promote good germination of the seeds
- this is known as REFORESTATION, and can be NATURAL, where the trees grow from seeds and cones left after harvest, or ASSISTED REGENERATION, a process where humans plant seedlings
- when planting is necessary, seedlings are purchased from a tree nursery. Most companies use containerized planting stock. They MUST plant the same species that was harvested from the site





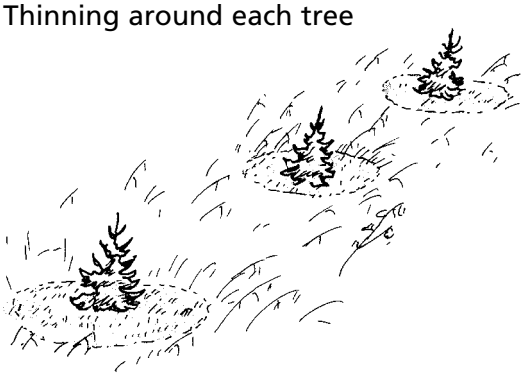


STEP 4 BRUSH CONTROL OR WEEDING:

- the young seedlings will face competition from the grasses, shrubs, and other vegetation
- this competing vegetation is sometimes controlled with a light application of hebicide. They are designed to control the vegetation competing with the conifers. the herbicide glyphosate is commonly used, since it is known to break down very quickly in the soil.
- young conifer seedlings are monitored for growth until they reach the "FREE TO GROW" stage, when they are taller than the competing vegetation, usually in about 14 years. A new healthy forest has been established.

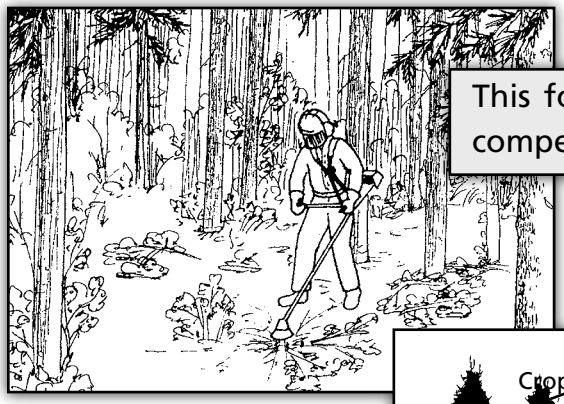
Thinning in strips

Thinning around each tree

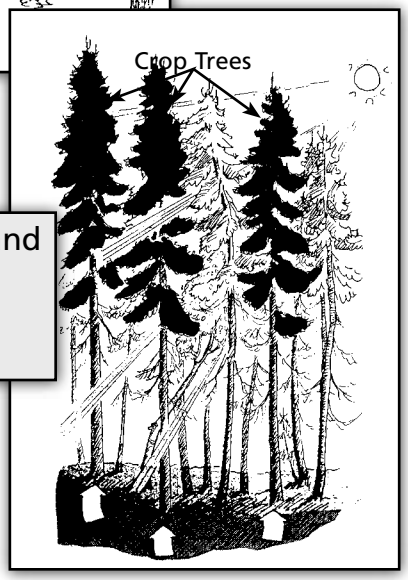


STEP 5 SPACING AND THINNING

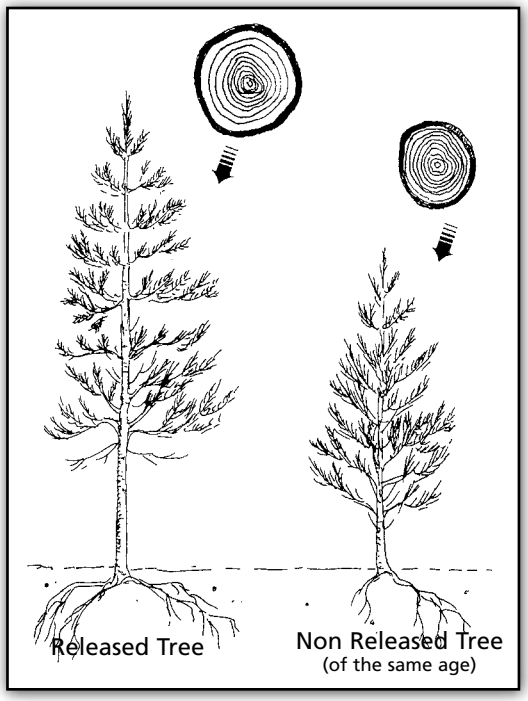
- young trees may be spaced too close together
- these young trees may be thinned to reduce competition, and increase diameter growth, similar to thinning carrots in the garden



This forest worker is thinning the forest to reduce competition for sunlight, moisture, and nutrients.



Crop trees are selected and poorly formed trees are removed.



STEP 6 PROTECTION FROM FIRE, INSECTS, AND DISEASE

- the forest is constantly monitored for problems such as insects (spruce budworm) and disease such as Dwarf Mistletoe

Figure 3f: Types of damage found in the forest.


Mechanical Damage


Canker


Terminal Weevils


Armillaria Root Rot


Spruce Budworm


Insect Galls


Forest Tent Caterpillars

DAMAGE CAUSED BY FOREST INSECTS AND DISEASES

Cause	Parts of tree affected		
	Foliage	Trunk	Other Parts
Insects	• Leaves turned red • Leaves curled up • Leaves discolored • galls	• Holes and tunnels • Resin secretion	• Sticky substance on foliage • foamy, viscous liquid (like spittle) • withered leading shoot
Diseases	• Leaves discolored • Leaves stained • Leaves turned red or yellow • Loss of Leaves	• Fungi • Resin secretion • Cankers • Rot	• Dead branches

3.3 THE FUTURE OF THE FOREST

There are more than 6 billion people on our planet. Each and every person uses a variety of resources as they go through life; water, energy from a variety of sources, food, and fibre. Cotton fibre is made into clothing. Synthetic or man-made fibre, such as polyester, is a product made from crude oil, a non-renewable resource. Wood fibre can be turned into paper, lumber, cellulose, turpentine, medicine, and hundreds of other products (figure 3b).

Forests also provide us with oxygen, recreation, and a variety of other **NON-TIMBER FOREST PRODUCTS** such as nuts, berries, mushrooms, maple syrup, and even Christmas trees.

Our forests could easily supply our own nation with all the forest products it needs. In fact, some foresters have calculated that all of our sawmills and pulpmills could meet our entire nation's demand in about 3 weeks, and would then have to shut down. Most of our forest products are exported to other countries. This creates many jobs and helps Canada maintain a healthy balance of trade.

But is this sustainable? Our forests lose more area to fire, insects, and disease, than the area logged. In Canada, we harvest less than 1% of our nation's forest each year. In other words, one HECTARE of forest out of every 100 is designated for harvest. In as little as 60 - 100 years, it can be harvested again. That does not mean, however, that we can be careless with our forest resource. There are many forces which threaten our natural forest such as:

1. **LAND CONVERSION:** Once a forest is cleared for urban expansion or agriculture, or roads and highways, it will probably never grow back.

2. **INVASION OF EXOTIC SPECIES OF TREES**: Some trees have "invaded" Canada from other countries, such as the Russian Olive and Siberian Elm. These trees may create competition with our natural trees for sunlight, moisture, and nutrients. Some of our **NATIVE TREES** (those trees originally found in Canada) my suffer due to this competition from the invasive species.

3. **NEW INSECTS ARRIVING:** Insects such as the Asian Longhorn Beetle arrived in Canada by ship, probably in wooden crates used for packaging goods. This beetle is capable of devastating entire stands of forests.

4. **CLIMATE CHANGE:** Computer models are predicting hotter, drier summers, and an increase in the frequency and intensity of forest fires. The Boreal Forest is at a much higher risk than the more southerly hardwood forests. We must monitor the health and productivity of our forests. The Canadian Forest Service uses satellite surveillance from space in order to spot areas of concern. They are also researching new methods of pest and fire management in order to protect our forest resource.

Other steps are being taken to improve our forests. Healthy seedlings are grown in nurseries to give them a greater chance of survival. New approaches to insect control mean that only the target species, such as the Spruce Budworm, are affected. Research into forest regeneration is searching for ways to grow better trees in a shorter period of time. New species, such as Hybrid Poplar, are being grown to absorb carbon dioxide and other greenhouse gasses, as well as to supply forest products when the trees mature.

Individuals can help with the sustainability of our forest resource in several ways. Being careful with fire in parks and wilderness areas is very important. We should also avoid damaging or removing the bark of trees when hiking or camping in wooded areas. Use care when operating ATV's or machinery in forested areas to avoid damaging seedlings. Even recycling paper, cardboard, and old lumber reduces the demands on our forests. Being involved in a tree planting program in your community is a way of enhancing our forest resource. Practicing stewardship for our resources will ensure they will be present for future generations.

Canada's forests are so vast that they can sometimes be taken for granted. We must never forget the things they provide for us. As the earth's population grows, our forests will be harvested to provide for our needs. With proper management, we can help our forests to be productive and healthy – today and into the future.

Forest ecosystems are **DYNAMIC** – always changing. Natural forces such as fire, insects, and disease, as well as ice storms and wind storms can cause severe damage to an ecosystem. Human activity such as mining, agriculture, logging, road building, and urban sprawl can bring harm to any ecosystem. Sometimes the damage is not easily seen. Air pollution and a changing climate can also harm ecosystems, although the impact may not be felt for many years. This is why we need to create management plans, regulations, and policies to take care of our forests – now , and into the future.

CHAPTER THREE ASSIGNMENT

1. HOW DID FIRST NATIONS PEOPLE USE THE FOREST?
2. HOW DID EARLY SETTLERS USE THE FOREST?
3. HOW DOES NATURAL REGENERATION DIFFER FROM ASSISTED REGENERATION?
4. WHAT IS ECOSYSTEM BASED MANAGEMENT?
5. LIST SEVERAL NON-TIMBER FOREST PRODUCTS.
6. DESCRIBE 4 THREATS TO OUR NATURAL FOREST.
7. WHAT STEPS ARE BEING TAKEN TO IMPROVE OUR FOREST RESOURCE?
8. HOW CAN INDIVIDUAL CANADIANS HELP IMPROVE THE SUSTAINABILITY OF OUR FORESTS?
9. WHY IS A FOREST ECOSYSTEM DESCRIBED AS “DYNAMIC”?

Definition	Word or Concept	Diagram
	Renewable Resource	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Non - Renewable Resource	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Regenerate	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Site Preparation	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Non - Timber Forest Products	
	Synonym/Example	

Definition	Word or Concept	Diagram
	Native Trees	
	Synonym/Example	

CONCEPT OVERVIEW

Concept

Forest Renewal

Draw a figurative representation

Write down two questions about the concept.

Write an explantion or defintion in your own words. You will be paraphrasing.

List facts (at least five).

Create an analogy

CONCEPT RELATIONSHIP FRAME

Problem/Solution Either/Or Compare/Contrast Cause/Effect

Make the distinction between:
Renewable and non-renewable resources

Renewable	Non-Renewable

Write a summary statement:

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COMPARE & CONTRAST FRAME

Unit _____ Topic _____

COMPARE

How are natural regeneration and assisted regeneration alike?

CONTRAST

How are natural regeneration and assisted regeneration different?

Write a statement to compare and contrast the two terms, concepts, or events.

Concept Overview: Used by permission of Lynda Matchullis and Bette Mueller, Nellie McClung Collegiate, Pembina Valley S.D. No. 27.

CHAPTER THREE ANSWER KEY

1. **HOW DID FIRST NATIONS PEOPLE USE THE FOREST?** First Nations used the forest in a variety of ways – as a source of food (hunting and gathering, fishing, trapping), firewood, building materials, spiritual purposes, source of medicine, etc.

2. **HOW DID EARLY SETTLERS USE THE FOREST?** Early settlers used the forest as a source of building material (logs for log homes), as well as firewood, and a source of food.

3. **HOW DOES NATURAL REGENERATION DIFFER FROM ASSISTED REGENERATION?** In natural regeneration, the trees come from seeds, or cones, or suckering out of the stumps. In assisted regeneration, humans plant the seedlings.

4. **WHAT IS ECOSYSTEM BASED MANAGEMENT?** Ecosystem based management is an approach to natural resource management in which all elements of an ecosystem are considered before any resource extraction takes place or any development occurs. The water, soil, wildlife, and vegetation are examined for any potential impact.

5. **LIST SEVERAL NON-TIMBER FOREST PRODUCTS**. Several examples are mushrooms, berries, craft items, maple syrup, and firewood.

6. **DESCRIBE 4 THREATS TO OUR NATURAL FOREST**. Four threats are climate change, invasive species of trees, land conversion such as urban sprawl, and new insects arriving such as the Asian Longhorn Beetle.

7. **WHAT STEPS ARE BEING TAKEN TO IMPROVE OUR FOREST RESOURCE?** Our forest resources are being improved by the development of healthy seedlings for reforestation, new methods of insect control, and the research into ways of growing trees faster in a shorter rotation. We are also growing hybrid trees for wood fiber to reduce the demand for trees in the boreal forest.

8. **HOW CAN INDIVIDUAL CANADIANS HELP IMPROVE THE SUSTAINABILITY OF OUR FORESTS?** Canadians can help by being good stewards of the land, being careful on ATV's, being very careful with fires, and recycling paper. They can also take part in tree planting programs, and not damage trees in parks or campgrounds.

9. **WHY IS A FOREST ECOSYSTEM DESCRIBED AS "DYNAMIC"?** It is said to be dynamic because it is always changing.

Definition	Word or Concept	Diagram
Any natural resource that can be replenished.	**Renewable Resource**	
	Synonym/Example Trees are a renewable resource	

Definition	Word or Concept	Diagram
Any natural resource that can not be replenished.	**Non - Renewable Resource**	
	Synonym/Example oil, minerals	

Definition	Word or Concept	Diagram
To grow back.	**Regenerate**	
	Synonym/Example Forests can regenerate	

Definition	Word or Concept	Diagram
Preparing the soil for tree planting or natural regeneration	**Site Preparation**	
	Synonym/Example	

Definition	Word or Concept	Diagram
Products from the forest other than logs, pulpwood, etc.	**Non - Timber Forest Products**	
	Synonym/Example Maple syrup, berries, craft items, mushrooms	

Definition	Word or Concept	Diagram
Trees that have always been present in Canada.	**Native Trees**	
	Synonym/Example • White Spruce • Poplar • Oak • Ash	

CONCEPT OVERVIEW

Concept

Forest Renewal

Draw a figurative representation

Write down two questions about the concept.

1) Which species of trees are used in reforestation?

2) Who pays the costs of forest renewal?

Write an explantion or defintion in your own words. You will be paraphrasing.

Forest renewal is also known as forest regeneration.

List facts (at least five).

- The site must be prepared before planting starts.
- Seedlings are started in a nusery, then transplanted.
- Trees planted must be the same species that were harvested.
- Their survival is monitored
- Must be replanted if they fail to grow.

Create an analogy

Forest renewal is like gardening. Gardens are planted, and then harvested every year. Forests are harvested, and then replanted.

CONCEPT RELATIONSHIP FRAME

Problem/Solution Either/Or Compare/Contrast Cause/Effect

Make the distinction between:
Renewable and non-renewable resources

Renewable	Non-Renewable
• Can be replenished • Examples: trees can be replanted, fish can be restocked. • Can be "managed" in such a way that the resource is sustainable i.e. timber quota; possession limit on fish.	• Can not be replenished • Once used up, cannot be replaced i.e. fossil fuels, but some can be recycled such as used motor oil. • Only a fixed amount exists on the planet i.e. gold, platinum

Write a summary statement:

Renewable resources will be available to future generations if they are managed wisely.

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COMPARE & CONTRAST FRAME

Unit 3 Topic 3.2 How Humans Managage the Forest

COMPARE

How are natural regeneration and assisted regeneration alike?

They are both methods of renewing the forest

CONTRAST

How are natural regeneration and assisted regeneration different?

- no trees planted by humans
- little or no cost
- trees grow in at random

- humans plant the trees
- tree planting crews are costly
- trees spaced 6 feet apart

Write a statement to compare and contrast the two terms, concepts, or events.

Both regeneration systems are used to replace trees removed by logging, or destroyed by fire.

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Appendix 1

FOREST-RELATED CAREERS

PURPOSE: STUDENTS WILL BRAINSTORM THE WIDE RANGE OF JOBS DEPENDENT ON CANADA'S FORESTS AND WILL PRODUCE A VISUAL CAREER WEB TO SHOW THEIR RELATIONSHIPS.

BACKGROUND INFORMATION: It is estimated that, directly or indirectly, one in sixteen Canadians is employed in a forest-related job. Direct employment would include jobs in pulp and paper, solid wood products, logging, Christmas tree growing, and maple syrup production. These include not only the traditional occupations, for example cutting, hauling, and processing forest products, but numerous jobs in planning and managing the forest in a sustainable manner. Foresters, biologists, GIS technologists, silviculturalists, researchers and others bring together their skills to manage forest resources. Others are employed in support services, for example, nursery workers who grow seedlings, tree planter, forest fire fighters, pilots who spray for spruce budworm, etc.

There are careers that relate to other forest values, for example, the conservation officer who enforces regulations to protect wildlife, the park workers who maintain trails for hikers, or the outfitter who leads anglers to fish in remote areas. Smaller forest-based industries may include traditional First Nation careers such as wild rice harvesting and trapping, or other careers, for example, producers of natural handicrafts such as woven baskets or log furniture.

The link between these careers and the forest industry are clear. Less clear, however, are the jobs that depend more indirectly on Canada's forests. For example, 350 Canadian communities are forestry based and the people who work there require food, housing, clothing, and support services. The waitress in a restaurant located near a paper mill, the factory worker who manufactures safety boots, or the educator who teaches local children each depend, to differing degrees, on the forest, or forest industry.

QUESTIONS:

1. Read through the enclosed career profiles. As a class, discuss each career and generate a list of the type of skills and training that each would require. Discuss the kinds of things that you imagine this person might do as part of their job.

2. Select one of the career profiles to look at in greater depth. Based on the profile, brainstorm the types of people and services that relate to that person's forest-related job. (example: The biologist would work with a forester to do planning but she might also need safety boots and binoculars; the local sawmill employs a hundred people – what services would they need? Mechanics? Maintenance staff? The GIS researcher needs a computer and software, and so on.

3. Create a virtual career web on large poster or mural. Illustrate the web with clippings from magazines, newspapers, or create your own illustrations.

4. Discuss what would happen to the forest resource if it were not managed.

5. Technology changes many jobs. Discuss which jobs are most likely to change. Which ones will likely remain the same.

6. Arrange to have a guest speaker come into the class and explain their forest-related job, and how it interconnects with other jobs from the Career Web.

APPENDIX 2

GLOSSARY OF GENERAL FORESTRY TERMS

A

Abiotic: referring to the absence of living organisms

Adaptation: genetic changes in a population by natural selection in response to change in the environment

Afforestation: establishing a forest in an area that previously had no trees growing on it

Agroforestry: the practice of establishing trees and agricultural products such as forage and livestock on the same area at the same time

Age Class: a category of trees in a stand with the same age

Annual Allowable Cut (AAC): the volume of wood which may harvested annually under sustained yield management. Roughly equal to the amount of new growth produced by the forest each year including minus deductions for losses due to fire, insects, and disease.

Annual Ring: a line appearing on tree cross sections marking the end of the growing season and showing the volume of wood added during the year.

Artificial Regeneration: establishing a new forest by planting seedlings or by direct seeding, as opposed to natural regeneration

B

Biome: an ecological community of plants and animals extending over a large natural area

Biosphere: the life zone of the earth

Biotic: pertaining to life and living organisms

Boreal Forest: forest ecosystem in Canada dominated by conifer species including pine, spruce, fir, and tamarack. The southern edge contains a mixture of deciduous trees including poplar and birch.

Broadleaf: a tree with flat leaves and flowers that produce fruit when fertilized. Deciduous trees have broad leaves, and shed them each fall.

Buffer: a strip of land adjacent to roads, trails, water, or recreation areas where disturbances such as logging are not allowed.

C

Cambium: a single layer of cells between the woody part of the tree and the bark. When cambium cells divide, diameter growth of the tree occurs through formation of wood cells (xylem) and inner bark (phloem).

Canopy: the forest cover made of foliage and branches found in the crowns of the trees

Cellulose: a sugar based molecule that forms the walls of plant cells, and makes up the bulk of wood fibres in trees

Coniferous: cone-bearing trees having needle-like leaves, known commercially as softwoods

Conk: a hard, spore producing fungus found on decaying trees

Conservation: wise management of natural resources

Crown: upper part of a tree supporting the main branches and foliage (leaves)

D

DBH: diameter of a tree at breast height (1.4 meters above the ground)
Deciduous: term applied to broadleaf trees that shed leaves annually, commercially known as hardwoods
Decomposer: organism that breaks down organic matter, such as bacteria and fungi
Dominant tree: tallest tree in a stand that reaches above all others to get maximum sunlight
Duff: organic matter littering the forest floor

E

Ecosystem: interacting system of living and non-living things linked by the flow of energy and nutrients
Even-aged forest: a forest in which all of the trees present are essentially the same age

F

Feller-buncher: a harvesting machine that cuts a tree with shears or a saw then piles it
Firebreak: area of less flammable fuel such as a road or wetland separating areas of greater fire hazard
Forest: a plant community composed mainly of trees and shrubs
Forest inventory: a survey of forest area to collect such data as age of forest, condition, timber volume and species, for purposes of managing for sustainability
Forest Management License: a contractual agreement between the province and timber company to provide a wood supply to its processing plants. It ensures that the forests on such lands are harvested and reforested to produce successive crops of timber on a sustainable-yield basis.
Fungus: an organism that obtains its nourishment from the breakdown of other organisms, causing decay

G

Galls: growths on plants resulting from insects, fungi, or injury
Girdling: to kill a tree by damaging the cambium layer and interrupting the flow of food between the leaves and the rest of the tree

H

Habitat: the environment where a plant or animal lives, and where it meets its needs for food, water, and shelter
Hardwood: a term used to describe broadleaf, deciduous trees such as birch, poplar, and ash
Harvest: the removal of timber for use, including its felling,extraction, and sometimes processing
Heartwood: the inner core of a woody stem composed of non-living cells and usually differentiated from its outer core (sapwood) by its darker color
Humus: decomposing plant and animal matter on the forest floor. This will eventually decompose into soil

I

Increment borer: a hollow auger-like tool used to extract a cylinder of wood containing a cross section of the tree's growth rings.
Integrated resource management: the management of a forest area taking into account all aspects of the ecosystem, such as soil, water, and wildlife, and all its values, such as recreation, etc.

L

Lateral bud: a bud that develops on the side of a stem

Lignin: a complex organic molecule that holds wood fibers together

Litter layer: the uppermost layer of organic debris on the forest floor. It is slightly decomposed and consists mainly of bark, twigs, and leaves (sometimes known as LFH layer – litter, fermenting into humus)

M

Mast: nuts, fruit, or berries produced by trees and shrubs, ie acorns in an oak forest

Mensuration: branch of forestry dealing with forest measurement – volume, growth, and development of individual stands and their products and values

Merchantable timber: a forested area that contains trees of sufficient size, quality, and volume to make it suitable for harvesting

Microclimate: a small area which exhibits different conditions from the surrounding area, for example, the cool damp conditions on the north side of a tree upon which moss will grow

N

Natural regeneration: the renewal of a forest by natural means such as seeds germinating or sprouts emerging from tree roots

Nutrients: substances required for growth and development. The level of soil nutrients such as nitrogen determine the fertility of the soil

O

Organic: a term referring to substances containing carbon, and generally meaning living or at one time having been alive

Old growth: a forest of mature or overmature trees that are past its peak growing years. In the life span of trees, this is the stage where they begin to decline in vigour, and diseases and decay are usually present

Overstory: portion of the trees forming the upper crown cover

P

Pest: an organism capable of causing damage, such as an insect or disease

pH: a measurement of the alkalinity or acidity of a substance, often determining which kinds of plants can grow in a certain area, ie. Black spruce growing in acidic soils of a bog

Phloem: the outer layer of tree tissue that conducts sap (sugars and water) from the leaves to the stem and roots

Photosynthesis: the process in a plant that converts sunlight, water, and carbon dioxide into sugar (food energy)

Pioneer plant: a term for plants capable of invading bare, recently disturbed sites such as newly exposed soil after a burn. Usually needs bright, full sun conditions.

Pith: central core of a stem or roots representing the first year's growth and consisting of mainly soft tissue

Pruning: the process of removing branches from a tree to improve its shape, prevent disease from spreading, or enhance growth

R

Reforestation: re-establishing a forest in an area where trees have been removed
Residual trees: trees left standing after a harvest
Respiration: process by which tissues and organisms exchange gases with their environment i.e. in the carbon-oxygen cycle
Rotation age: the age at which a stand is considered mature and ready for harvesting
Rot: trees in a state of decay
Roundwood: trees that are relatively unprocessed, such as logs, poles, and pulpwood

S

Sanitation cut: the removal of damaged or diseased stems to prevent the spread of insects or disease to the rest of the stand
Sap: the liquid, consisting of water and minerals, that rises from the roots of the tree. In the spring it contains sugars to provide energy for new growth
Sapling: a small tree, usually defined as being between 5 and 10 cm. dbh
Sapwood: the outer layers of wood in a tree that contain living cells that transport nutrients
Scaling: measuring the lengths and diameters of logs and calculating deductions for defects to determine volume
Scarification: a method of seedbed preparation that consists of exposing mineral soil through mechanical action such as chain dragging
Seedling: a young tree, usually defined as less than 5cm dbh
Selection harvesting: a harvesting method in which trees are harvested individually or in small groups at relatively short intervals.
Shade tolerant: the capacity of a tree to grow in the shade of, and in competition with other plants. E.g. ash trees
Shade intolerant: the inability of a tree to grow in the shade of, and in competition with other plants, e.g. poplar trees need full sunlight to grow
Shrub: a low growing perennial plant with a woody stem i.e. willow, alder
Silvics: the study of the life cycle and characteristics of trees
Silviculture: the art and science of cultivating a forest based on a knowledge of the silvics of the species
Site class: the measurement of the relative productivity of a site for a particular stand of trees based on the expected height at a certain age
Site preparation: disturbing the topsoil and ground vegetation to create conditions suitable for regeneration
Skidder: a wheeled or tracked vehicle used to drag logs from the stump to the landing
Slash: the residue left on the ground after felling, including uprooted stumps, broken tops, and branches. This will decay and provide nutrients for the next generation of trees
Snags: a standing dead tree that has begun to decay. Very valuable as wildlife habitat for a variety of species including owls, squirrels, and insects.
Sprout: a shoot that has grown from the base, stump, or root of a tree
Stand: a community of trees sufficiently uniform in species, age, or condition to be distinguishable as a group from the forest or other trees in the area
Stomata: tiny openings in plant leaves that control the exchange of gases between a leaf and the atmosphere
Stumpage: price paid to the provincial government for timber harvested on Crown land
Succession: the replacement of one plant community by another until ecological stability is achieved
Sucker: sprouts growing from the root system as opposed to coppice shoots from the stump or root collar

Suppressed trees: trees experiencing slow growth as a result from being shaded by other trees

Sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their needs

Sustained yield: the management of a resource for continuous production with the aim of achieving a balance between net growth and harvest

T

Terminal bud: a bud at the end of a stem from which new growth emerges the following year

Thinning: cutting an immature forest stand to reduce tree density. This creates conditions which accelerates growth in the remaining trees

Timber cruising: collection of field data on forests by measuring and recording information from sample plots within the stand

Transpiration: the movement of water through plant tissue, usually as a vapour

Tree: a woody plant having a well defined stem and definite crown, and usually attaining a height of at least 3 meters

U

Understory: the portion of trees or other vegetation in a forest stand below the main canopy level

Uneven-aged forest: a forest in which there are considerable differences in ages of trees

V

Veneer log: a log of suitable size, species and quality for peeling on a lathe into thin sheets of wood for the manufacturing of products such as plywood

W

Watershed: an area of land that collects and discharges water into a single main stream through a series of smaller tributaries

Witches'broom: an abnormal tufted growth of small branches on a tree or shrub caused by disease such as Dwarf Mistletoe

Wolf tree: an older, larger, branchier tree in a stand. It has a short trunk a large spreading crown due to plenty of sunlight. Not needing to compete in a stand for sunlight, its growth spreads laterally rather than vertically.

X

Xylem: the main water-conducting tissue and chief supporting tissue of trees

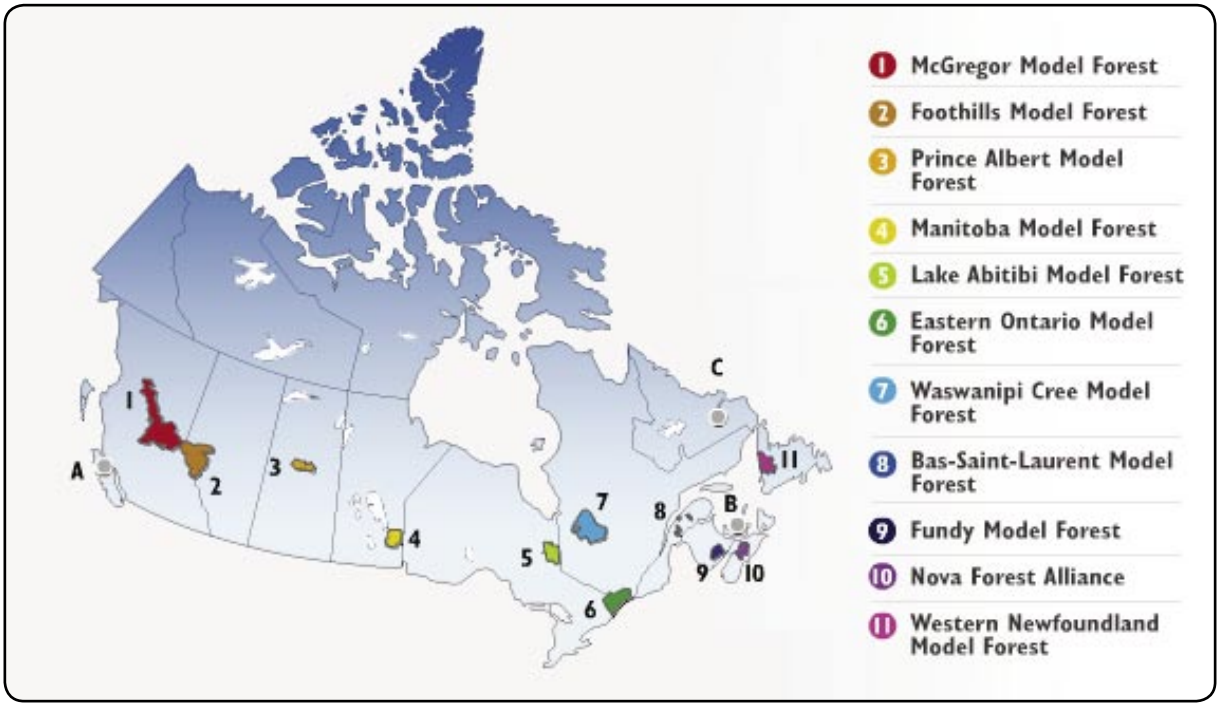
APPENDIX 3

WHAT IS A MODEL FOREST?

A Model Forest is a place where the best sustainable forest management practices are developed, tested and shared across the country. Each model forest is run by a not for profit organization, and, except for a small administrative staff, all those involved in the model forest not only donate their time and expertise, but usually bring additional financial support.

At the heart of the model forest is a group of partners having different perspectives on the social, economic, and environmental dynamics within their forest – perspectives that are necessary to make more informed and fair decisions about how to manage the forest. The real "model" in these forests is the way the different partners – logging companies, Aboriginal communities, community associations, hunters, trappers, maple syrup producers, woodlot owners, parks, environmentalists, universities, government agencies, recreational groups – have integrated their own interests into their common goal of developing approaches to sustainable forest management that do not sacrifice one interest for another.

Although the model forest organization itself does not have jurisdiction over the land it uses as a testing ground, those who do have jurisdiction must be participants. By being involved from the outset in developing new on-the-ground approaches and solutions for sustainable forest management, those with land management responsibilities are increasingly adopting many of the model forest suggestions.



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