TOWARD A SUSTAINABLE FUTURE

Challenges
Changes
Choices

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Newfoundland Labrador

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Preface

Are you familiar with the lyrics as written in the photograph above? Who wrote them? They are from the song "Oh Very Young." How does the song apply to issues of today—environmental or otherwise? To learn the answer to these questions, why not conduct an Internet search for the "cat" who wrote this song? Although this song was written way back in the 1970s, the words are timeless and just as relevant and meaningful today as when they were first written.

Welcome to Environmental Science 3205. Hundreds of people, who are experts in managing natural resources, have worked together on your behalf for more than two years to bring this material together. Thanks to their commitment, this text (as of 2008) has the most current information on aspects of this province's natural resources. In these pages you can find information on all aspects of the environmental science of resource management in Newfoundland and Labrador.

As you work your way through each unit, we hope that you begin to see that the study and application of environmental science is very complex and dynamic. In fact, we believe it is one of the most interesting and relevant courses you will ever study.

The text is broken up into five Units. Each one represents a special field or area of environmental study:

1. Introduction to the Environment: Includes a brief history and evolution of environmental science and an introduction to Protected Areas and Species *At Risk* programs of the province.
2. Recreation and the Environment: Examines the ways we use and abuse our environment and looks at the steps we can take to protect the environment.
3. Land Use and the Environment: Looks at forestry, mining and agriculture and their impact on the environment. (You will do two out of three of these topics.)
4. Water Use and the Environment: Covers both fresh and marine water issues ranging from a discussion of safe drinking water to the fishery and the marine environment.
5. The Atmosphere and the Environment: Addresses issues related to air quality, acid precipitation and climate change.

Environmental Science is very diverse. It is the science of observing and recording or making note of those observations. In this way we ask and answer important questions about the environment. Some studies take a relatively short period of time, while other studies may take a lifetime or longer. There are many ways to get involved in the field of Environmental Science. If you see yourself working outdoors, you could be conducting research, protecting wildlife and the environment. Or if you see yourself working indoors, you could be developing policies and programs, teaching others or working in a laboratory. All of these are key aspects of Environmental Science. They are interconnected and together help us to make responsible decisions so that we can do what is best to protect and sustain our natural resources.

Among the many things you will discover in this course, we hope that some of them will include:

1. Newfoundland and Labrador is a huge province blessed with an abundance of natural resources.
2. Our future lies with choices made by wise individuals with accurate information.
3. Environmental Science is a diverse field with a tremendous amount of opportunity for career choices.

Back to the question asked in the opening paragraph. You are the "young" to whom the song refers. You and your generation will inherit the resources of our province. We hope you will enjoy learning about the topics in this course. We are confident of your ability to make the right choices to ensure that the environment of Newfoundland and Labrador is around for the next group of young people who will inherit these resources from you.

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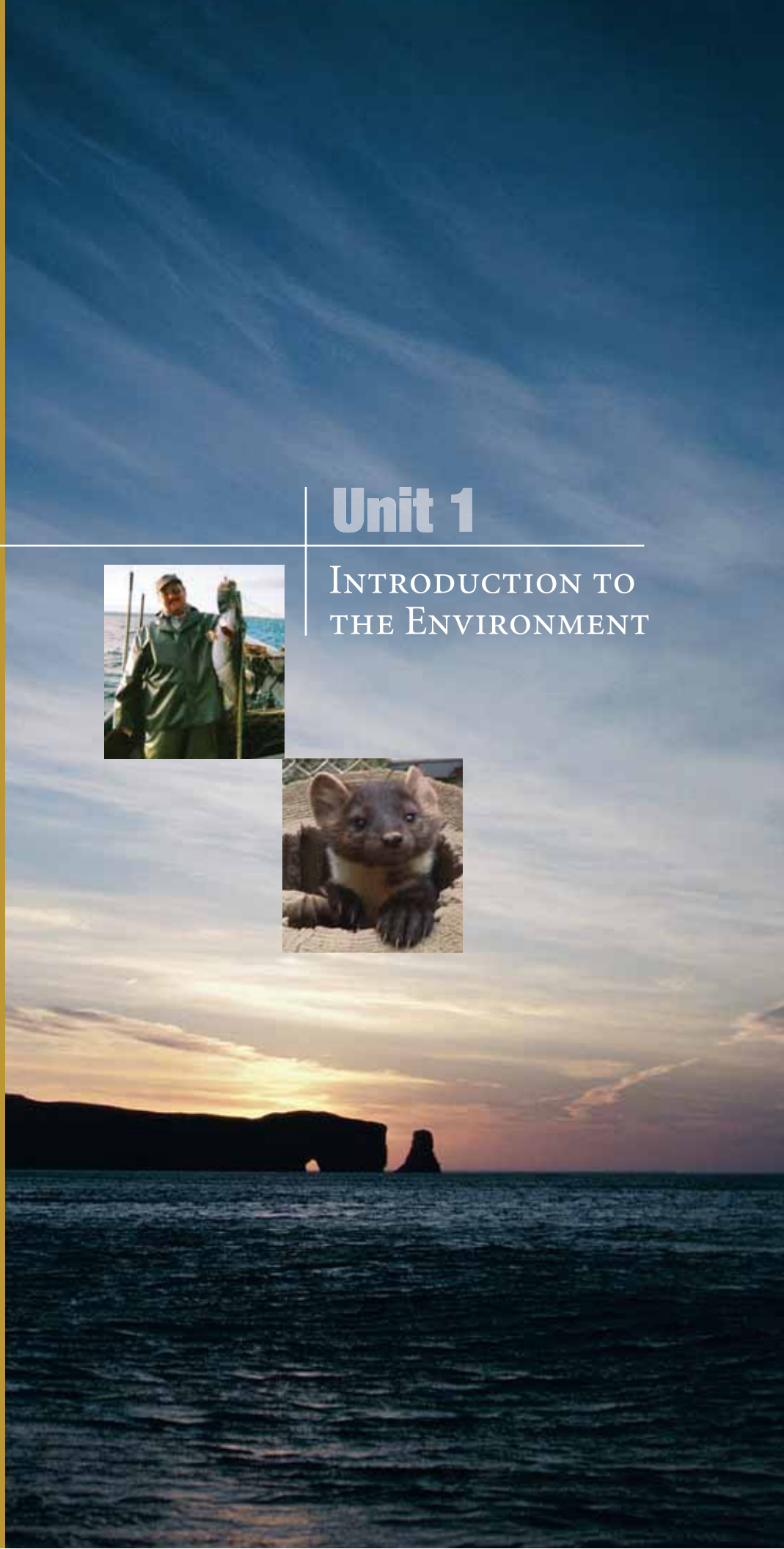


Unit 1

Introduction to the Environment

Chapter 1: An Introduction to Environmental Science

THE EARTH AND ENVIRONMENT

Figure 1.1: Capelin Fishing. *Photo courtesy Department of Natural Resources/Ed Stewart*

It is a clear evening in early July and the cool, rainy days of spring—capelin *(Mallotus villosus)* weather—have yielded to summer. Dozens of people are dragging buckets and nets down to the water at Beachy Cove in Conception Bay. Rumors have been circulating for a week that capelin are "rolling" at other beaches around the province. Local residents have been anticipating the arrival of the schools of these small silvery fish.

Even the younger children know this is the night the beach will come alive. Dark shadows swirl just under the surface of the water, moving parallel with the shore. The seabirds jockey for position and dive into the waves. In the distance humpback whales *(Megaptera novaeangliae)* send loud spouts of spray into the air. These birds and mammals are chasing the schools of small silver capelin as they migrate from deep offshore waters to beaches around the coast of Newfoundland and Labrador. Here capelin by the thousands, follow the tide onto the sand and rocks where the females lay their eggs and where many of them will die, some winding up in the buckets of those who come to witness this natural wonder.

The sun sinks lower. The dark shadows in the water swirl closer to shore. Then it begins. Capelin fill the waves that roll up onto the sand. Children with dip nets, old men with cast nets, and a few teenagers with rods wade in knee deep through the silver flashing water. Soon the beach is sticky and slick with capelin spawn.

This timeless scene could take place at any time in the history of this province. But since the late 1980s one thing has changed—the number of capelin (capelin stocks) declined dramatically. And, as of 2008, they still had not recovered to former numbers. The large offshore cod fishery was proposed as a possible reason for the decline. But the continued decline in capelin stocks after the cod fishery was closed in the mid-1980s makes over-fishing an unlikely explanation. There may have been environmental factors that we do not understand involved in the decline of the capelin.

Did You Know?

The Universe includes all the planets, stars and cosmic debris. The current view is that the Universe is between 12-15 billion years old.

The centre of our solar system is our Sun, a medium-sized star. We know the universe includes hundreds of billions of stars and billions of other solar systems.

Do you think ours is the only solar system that sustains life?

What we do know is that timing of the arrival of capelin inshore is more unpredictable now than in the past, and when they do begin to roll they are smaller in size today than they were. But they do still come here and it is important that they be protected. Newfoundlanders and Labradorians have not forgotten capelin and the joy of their annual return. Today, there is a small inshore capelin fishery in Newfoundland and Labrador that is strictly regulated.

Evolution of Earth

Can you imagine that Earth, and the six billion people protected by its atmosphere, are racing through space at a velocity of 250 kilometres per second? There is no way you can live outside our planet's protective atmosphere without very specialized equipment.

Life on Earth most likely began about four billion years ago in an ancient ocean. As time progressed, organisms within the biosphere formed many dynamic relationships with each other. These relationships helped living organisms to evolve and keep pace with the changing environment and eventually, in all their diversity, to colonize Earth.

Spaceship Earth

The Earth is often compared to a spacecraft—confined, self-sufficient, and traveling through space. It is a closed system: practically nothing comes in with the exception of energy in the form of heat and light from the sun and a small amount of dust from meteorites; and nothing leaves except heat and reflected light. All of the basic elements that Earth and all its living creatures need or can have are already on Earth or in its atmosphere. These basic elements are either renewable or non-renewable. A natural resource is renewable if it is replenished at a rate comparable to its rate of consumption by humans or other users.

As the human population increases, the resources available to sustain them, and all the other species on the planet, will not increase.

Impacts of Human Civilization

Imagine, sometime in the early 1800s, an aboriginal hunter standing at the top of a hill. He looks over the land to see the forest, marshland, and water. Around him are the plants he uses for food, medicine, and shelter. Nearby a herd of caribou grazes on the hillside and a flock of ducks splashes down on the pond below. He remembers the words of his father and mother about the ways of respecting and using the land. He recalls the stories told by the elders of how they came to this big land and how the animals have to be respected.

What this man does not know is that 200,000 years ago in Africa his ancestors began the journey that brought him to this place. They migrated out of Africa to search for food and to escape conflicts with other humans. Researchers in human genetics have tracked the path of the human race. Scientists have shown their migration across the land and the oceans and have established how early humans survived.

Early humans lived in small groups foraging for food—hunting, gathering, and fishing. We call this resource extraction. However, when humans developed new technologies such as tools, clothes, language, and disciplined cooperation, their survival techniques shifted from resource extraction to resource production. The spread of civilization, the domestication of animals, and the development of agriculture changed the human relationship with the environment from one of being controlled by nature, to one of gaining some control over their own lives and surroundings.

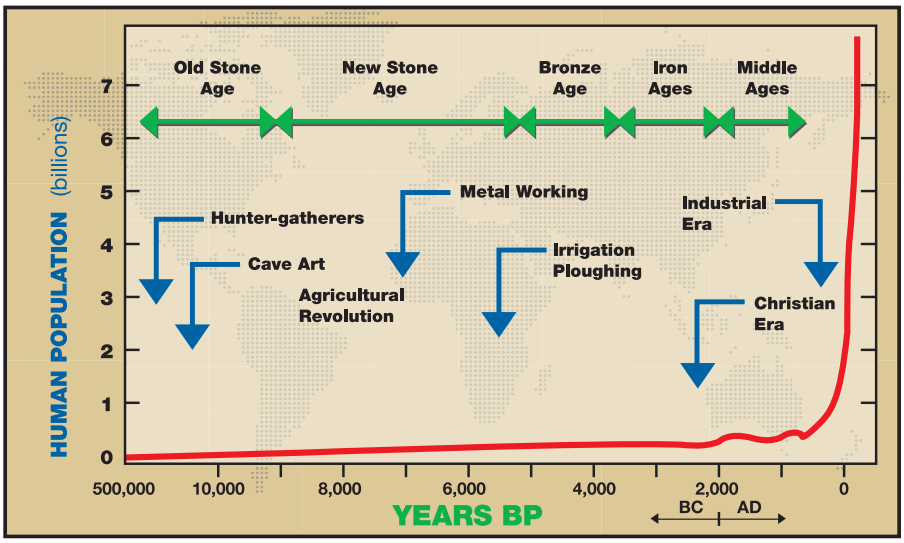


Figure 1.2: Human civilization time line

Based on current scientific knowledge, it is estimated that there were only a few million people on Earth until about 10,000 years ago. That is when farming—agriculture and the domestication of animals—gave humans a more secure source of food and shelter. Records indicate that large human population increases occurred with the emergence of this sustained food production.

In the late 1800s, the beginning of the Industrial Revolution in Britain triggered a major increase in the demand for more of Earth's resources. The development of iron-making techniques allowed better roads and railways. These in turn opened up trade routes. At the same time, steam-powered machinery, fuelled mainly by coal, enabled impressive increases in production capacity. Industrial areas and the

cities that supported them were growing to meet the ever increasing demand for goods from other areas of the world.

Statistics Canada census results show Newfoundland and Labrador's population has declined from 528,000 in 2000 to 517,000 in 2004. Our population is aging, our young families are moving away and fewer babies are being born.

In contrast, the global human population is increasing by approximately 78 million people per year. Ninety per cent of these people are born in the developing nations of Africa, Asia and Latin America.

Between 1810 and1960, due in large part to modern medicine and better food production methods, the human population had a period of **exponential growth** as it increased from one billion people to three billion in just one hundred and fifty years. Since 1960, growth of the human population has continued at a high but steady rate to more than six and a half billion today. The United Nations has estimated that by 2050, the population of Earth will reach 8.9 billion people.

As the human population "explodes" so does our impact on the Earth.

A high growth rate in the human population means increased and intense competition for a share of Earth's water, land, food, fossil fuels, and other resources. The most populated places on Earth are the biggest losers in this competition for resources. According to United Nations statistics, about 100,000 people die from starvation or poverty-related illnesses each day. Most of these people live in the developing world.

Developed nations such as Canada, the United States, Japan and several Western European countries make up only about twenty per cent of the world's population but use about eighty per cent of the world's resources! The rest of the world's people must try to survive on the remaining twenty per cent.

The pressure on Earth's resources, due to population growth, is more severe where populations have become more prosperous. However, increased prosperity is normally accompanied by a lower rate of population growth. Prosperous societies can reduce consumption of many goods, and use renewable resources. But to achieve this in Canada, changes in tax structures are needed and Canadians must undergo a change in values. Canada's cold climate, the distribution of its cities over large distances, and the country's prosperity contribute to its high energy use. In fact, we are among the world's top consumers, using three to five times the world average in energy and other resources.

Along with this sharp rise in the world's population comes a greater demand for goods such as computers, cars, and personal entertainment devices. Canada's

world ranking in total energy consumption is seventh, with the U.S. and China leading the way. The western lifestyle places a greater demand on Earths' resources. For example: the boom in automobile production put demands on finding new and greater sources of oil and minerals; the desire for a healthier lifestyle has indirectly reduced the oceans' fish stocks; the necessity to have more electrical energy has resulted in many flooded areas, thereby reducing natural habitats.

Science and the Environment

Are you a scientist? What makes scientific methods different from other methods of problem solving? Have you ever wondered how many moose *(Alces alces)* and caribou *(Rangifer tarandus caribou)* are in our province? Have you ever made a decision about what to wear after having observed the clouds in the sky or determining the prevailing wind direction? Have you wondered where soil comes from, or where it goes during a heavy rain? Have you ever wondered why the economy of our province is so reliant on natural resources such as mining, forestry, fishing, and petroleum? While you might not be a scientist, if you answered yes to any of these questions, you are thinking like a scientist.

The Nature of Scientific Investigations

Science is concerned with finding consistency between our beliefs and our observations. Over time, scientists have devised many methods to help them find consistent and correct answers to problems. Although different fields of science do this in different ways, all science makes use of experiments, or the gathering of data, to check ideas against observation in nature.

A **scientific method** is a planned, organized approach to solving a problem or answering a question. While the steps taken to solve the problem can vary, the first step involved in scientific problem solving is usually identifying the problem, or determining what it is you want to figure out. Once the problem is defined, a **hypothesis**, or suggested explanation for an observation, is made. In Environmental Science, very few experiments answer questions directly. Therefore, observational methods are more frequently used. These methods may be supplemented with information gathered from experiments such as the mini-lab activity below.

Whether through an **experiment** or natural data gathering, science uses an organized procedure that involves making measurements and observations. A good scientific experiment tests only one **variable**, or changeable factor, at

a time. The **independent variable** in an experiment is the factor that is manipulated by the experimenter. A **dependent variable** is a factor that can change, or respond, if the independent variable is changed. **Constants**, or controlled variables, are factors that do not change during an experiment.

Whenever the methods of science are used, all data, including measurements and observation, are carefully recorded. Once an experiment is complete, the data must be formatted so that it can be studied, or analyzed. Graphs, tables, and charts are commonly used to format and display scientific data. In this format the data is then analyzed and a **conclusion** is reached. Sometimes, the conclusion disproves the original hypothesis. In such a case, because the hypothesis is not supported by the data, the hypothesis must be rejected and a new one developed.

MINI-LAB ACTIVITY

Problem: How do soil and water absorb and release heat?

Hypothesis: Suggest an appropriate hypothesis for this experiment.

Materials: Obtain the following materials from your teacher:

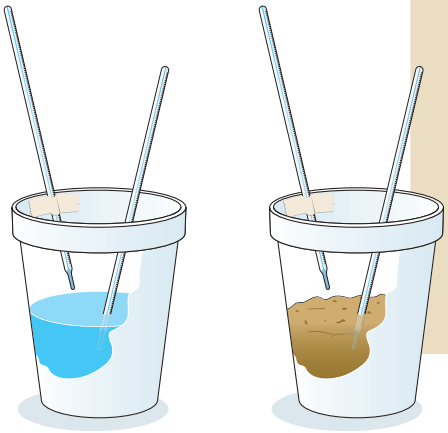
Styrofoam cups	water	soil
thermometers	heat lamp	masking tape

Procedure:

1. Put soil into one Styrofoam cup until it is half full. Put water into the other Styrofoam cup until it is half full.
2. Place one thermometer in the soil so that the bulb is barely covered. Use masking tape to secure another thermometer about one cm from the top of the soil.
3. Repeat step 2 with the container of water.
4. Put the containers an equal distance from the heat lamp. Record the initial temperatures shown on each thermometer. Write these values in a table. Turn on the heat lamp and record temperature readings every four minutes for twenty minutes.
5. After twenty minutes, turn off the heat lamp and immediately record the temperature on each thermometer every four minutes for twenty minutes.

Results:

Complete a data table, similar to the one shown on the next page, in your notebook.



Heat absorption and retention

Time (min.)	Soil Temp. (°C)	Water Temp. (°C)
0		
4		
8		
12		
16		
20		
Turn off heat lamp		
24		
28		
32		
36		
40		
44		

Analyze and Conclude:

1. Which substance absorbed heat faster?
2. Which substance lost heat faster?
3. What was the independent variable? The dependent variable?
4. On graph paper, plot a line graph for this experiment (Use a different color for soil temp. and water temp.).

   Note: The independent variable usually goes on the horizontal axis and the dependent variable on the vertical axis.
5. Referring back to your hypothesis, what conclusion can you make based on your results?

CHECK your Understanding

1. Why do humans, as one of many species on this planet, have the greatest potential to impact all other species?
2. Describe the transition of people in Newfoundland and Labrador, from the early aboriginals to present day, in terms of how they affected their environment.

For Further Discussion and/or Research

3. Why is Earth compared to a space ship? How is it like a space ship? How does it differ?
4. Although scientists are more confident when they get their data from experiments, they frequently use non-experimental data gathering methods. Why do they do this?

WHAT IS ENVIRONMENTAL SCIENCE?

Environmental science is the study of the interactions between the physical, chemical, and biological components of the natural world, including their effects on all types of organisms and how humans impact their surroundings.

Environment is everything that affects an organism during its lifetime. In turn, all organisms, including people, affect many components in their environment. From a human point of view, environmental issues involve concerns about science, nature, health, employment, profits, law, politics, ethics, fine arts, and economies. Therefore, environmental science is by its nature a **multidisciplinary** field. The word *environmental* is usually understood to mean the surrounding conditions that affect people and other organisms.

Some people consider themselves **conservationists**. A conservation ethic focuses on sustainable resource use, allocation, and protection. The primary focus is on maintaining the health of ecosystems and their biological diversity.

Other people may be termed **environmentalists**. The environmental ethic is a diverse scientific, social, and political movement. An environmentalist is someone who actively works to preserve the environment from destruction or pollution. Environmental decision making often involves compromise. A decision that may be supportable from a scientific or economic point of view may not be supportable from a political point of view or vice versa. Generally, the parties involved debate and argue their viewpoints. Ultimately, when decisions are finally made, each party may have given grounds, but hopefully, all parties are willing to accept the compromises they have made.

Figure 1.3: Inshore fishermen fish from small open boats such as these.

For instance, in 1992 the Federal Government of Canada announced a moratorium on the fishery for northern cod. They immediately halted the fishery for Atlantic cod *(Gadus morhua)* in the offshore regions known as North Atlantic Fisheries Organization (NAFO) area 2J3KL. This moratorium meant that more than 20,000 fishers in the Atlantic Provinces no longer had a job in the fishery. An investigation of the events leading up to the closure of this once great cod fishery would show the role that science, politics, and economics play in environmental decision making.

Another instance illustrating the interdisciplinary nature of environmental science is the story of the Lundrigan's Marsh Conservation Project in St. John's. Lundrigan's Marsh is a wetland surrounded by

industrial development. The Nature Conservancy of Canada and Ducks Unlimited, through an Implementation Agreement with the City of St. John's, entrusted the care and preservation of ten hectares of marshland to the City of St. John's in 2004. Lundrigan's Marsh filters water that flows into the Virginia River System and Quidi Vidi Lake. The various stakeholders realized the importance of maintaining this urban greenspace and continue to be active in protecting and monitoring this environment. What are some examples in your community?

Figure 1.4: Lundrigan's Marsh, an urban greenspace. *Photos courtesy City of St. John's*

Review of Key Concepts of Environmental Science

Ecological Concepts

Environmental science was developed from the science of ecology. **Ecology** is the study of the way organisms interact with each other and with their nonliving surroundings. These interactions involve energy and matter. Living things require a constant flow of energy and matter to ensure their survival. If the flow of energy and matter ceases, the organism dies. Ecology deals with the ways in which organisms are shaped by their surroundings, how they use these surroundings, and how an area is altered by the presence and activities of organisms.

All organisms are dependent on other organisms in some way. One organism may eat another one and in this way, use it as a source of energy and raw materials. Or an organism may temporarily use another living thing without harming it. Sometimes organisms may provide a service for another, such as when animals distribute plant seeds or when bacteria break down dead organic matter that is then reused by other organisms.

Figure 1.5: There have been numerous ecological studies of our native Woodland Caribou. The caribou is important ecologically, culturally and economically. *Photo courtesy Parks Canada*

Everything that affects an organism during its lifetime is in its environment. For example, from its birth to its death, a caribou interacts with millions of other organisms (bacteria, food plants, parasites, mates, predators), drinks water, breathes, and responds to changes in temperature and weather conditions. This list only outlines some of the various components that make up a caribou's environment. Because of this complexity, it is useful to subdivide the concept of environment into **abiotic** (nonliving) and **biotic** (living) factors.

Figure 1.6: Black Bear.
Photo courtesy Dept. Environment & Conservation

Abiotic factors can be organized into several broad categories: energy, nonliving matter, and processes that involve the interactions of nonliving matter and energy. All organisms require a source of energy to survive. The ultimate source of energy for the majority of organisms on the planet is the sun. In the case of most plants, the sun directly supplies the energy. Animals get their energy by eating plants or other animals that eat plants. The amount of living material that can exist in an area is determined by the amount of energy that plants, algae, and bacteria can absorb.

The biotic factors influencing an organism include all forms of life with which it interacts. Plants that carry out photosynthesis; animals that eat other organisms; bacteria and fungi that cause decay; bacteria, viruses, and other parasitic organisms that cause disease; and other individuals of its own species, are all part of an organism's biotic environment.

Food Chains

Autotrophs are the foundation of all food sources in the environment. Autotrophs are organisms that produce their own food. Green plants such as spruce trees and pitcher plants, lichens such as caribou moss, and algae such as seaweeds, are the best known and most obvious autotrophs in Newfoundland and Labrador.

In the process called **photosynthesis**, water, carbon dioxide, and light energy are used by all autotrophs to produce sugar (chemical energy). Oxygen is released into the atmosphere as a result of this process. Autotrophs, in this case called **producers**, provide a source of energy in the form of food for **consumers**, such as **herbivores**, that are a source of energy for **carnivores**.

$$CO_2 + H_2O \xrightarrow[\text{light and chlorophyll}]{\text{In the presence of}} O_2 + C_6H_{12}O_6$$

Autotrophs provide food for herbivores such as snowshoe hare *(Lepus americanus)*, sea urchins, or caribou. These consumers in turn provide food for meat eating predators, called carnivores, such as foxes, hawks, wolves, and **omnivores** such as black bears *(Ursus americanus)*. Other species like the bald eagle *(Haliaeetus leucocephalus)* and snow crab *(Chionoecetes opilio)*– called **scavengers** – also help "clean up" the remains. In Newfoundland and Labrador, bald eagles and ravens *(Corvus corax)* sometimes act as predators and sometimes, for example when eating the remains of a moose or caribou, act as scavengers.

When organisms die, their remains are broken down into nutrients by **decomposers** such as insects, snails, fungi, and microscopic organisms. They close the cycle. The resulting nutrients enrich the soils and are used by the vegetation to absorb energy and grow.

Animals typically consume a varied diet and, in turn, serve as food for a variety of other creatures that prey on them. This vital and somewhat complex relationship between decomposers, producers, and consumers is known as a **food chain**. Most food chains are interconnected with other food chains. These interconnections create **food webs**.

Each level of consumption in a food chain is called a **trophic level**.

Food Web Summary:

- Autotrophs (For example: green plants, seaweeds, and lichens) are called producers because only they can use energy to manufacture food from inorganic raw materials.
- This food feeds herbivores, called **primary consumers**.
- Carnivores that feed on herbivores are called **secondary consumers**.
- Carnivores that feed on other carnivores are **tertiary** (or higher) consumers.

This simple food chain can be generalized as follows:

Autotrophs (Producers) →	**Herbivores** (Primary Consumers) →	**Carnivores** (Secondary, tertiary, etc. consumers) →	**Decomposers**

The table below gives a simple example of a food chain in the Newfoundland and Labrador Boreal Forest and the trophic levels represented in it.

Figure 1.7: Sample Food Chain, Newfoundland Boreal Forest

Every organism on Earth plays a role in one or more food webs. When an organism is removed from the web or chain, other species are affected, sometimes in a minor way and sometimes dramatically.

It may be difficult to understand the impact of the loss of even one species, considering that some natural communities, such as tropical rainforests, seem so far removed from everyday life.

Think of the effect of removal of a plant or animal from your local area. Examples you might consider are: blackflies, pitcher plants, and moose.

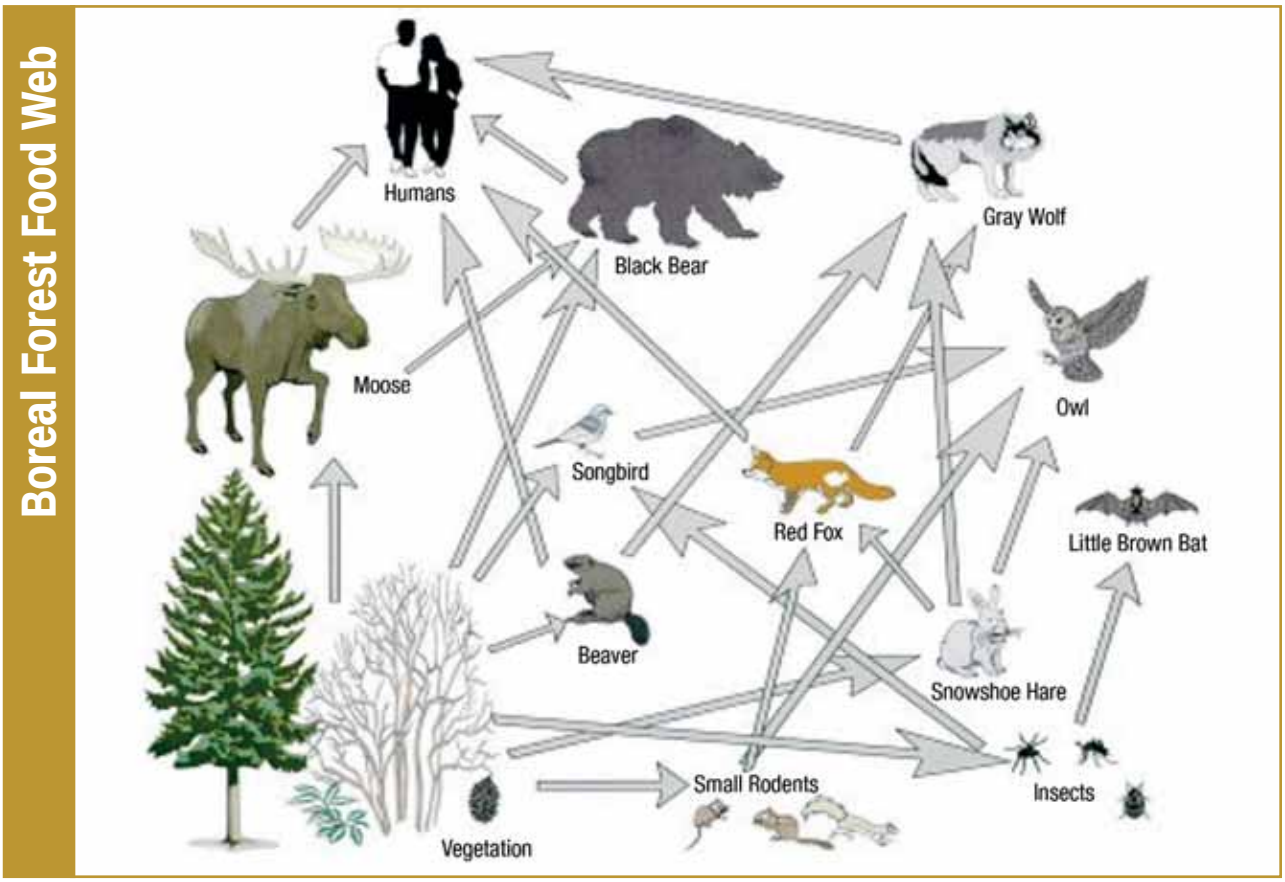


Figure 1.8:
Food web in the boreal forest of Labrador.
Diagram courtesy Parks Canada

Activity:

Refer to the food web above and answer the following questions:

1. Identify the producers, primary consumers, secondary consumers, and tertiary consumers.
2. Which trophic level produces food for the primary consumers?
3. Which organism, if removed from this web, would cause the greatest impact? Justify your answer.
4. Describe the impact of removing the following animals from this food web:
   (a) red fox *(Vulpes vulpes)*
   (b) snowshoe hare
   (c) brown bat *(Myotis lucifugus)*

CHECK your Understanding

1. What is the difference between a food chain and a food web?
2. Sketch a sample food web from the northwest Atlantic Ocean and indicate all producers and consumers. Also indicate the trophic level of each organism. Can one organism occupy several different trophic levels? Give an example.
3. List three predators and their prey in a bog ecosystem.
4. Why does biomass decrease as we ascend the food chain?
5. What are the implications of decreasing biomass in the food chain?
6. What is ecology?
7. Define the term biosphere? In what way is the biosphere considered a closed system?

For Further Discussion and/or Research

8. Human beings are at the top of a great number of food chains. Based on your meals over a week, develop a series of food chains in which you are the final consumer and examine the results. Do you regularly eat from the lower levels of the food pyramid (salads and cereals), or from the upper levels (meat or fish)? What are the environmental implications of your food consumption patterns?

Figure 1.9: Primary consumers, such as beavers, feed on plant materials.

ENVIRONMENTAL ATTITUDES

Introduction

Not too long ago, in the planetary time line, humans were just another animal trying to survive in a hostile, competitive environment. What allowed us to become the top of the animal kingdom? It could be a combination of brain development and the willingness to cooperate with each other. Whatever the reasons, small family groups eventually grew to larger, organized communities that successfully faced the daily challenges of obtaining food, surviving attacks by predatory animals, and countering some of the effects of natural forces like weather and disease.

Although many people think that ancient people lived in harmony with their environment, science has uncovered evidence which contradicts that assumption. What we have discovered is that, while some societies thrived by using appropriate practices, other societies collapsed due to poor use of their environment. By conducting an Internet search, you can find information about the collapse of an ancient society on Easter Island. The challenge for the modern world is to use our knowledge, both ancient and modern, to support the intelligent, sustainable use of our environment.

Modern North America

The modern era in environmental awareness can be broken into two periods, the **awakening** and **global governance**. The awakening period started when people began to realize that we are part of the big biosphere called Earth, and anything we do to it will have a direct or indirect impact upon all of us.

Figure 1.10: Cuyahoga River Fire, 1969.
Photo www.oceanservice.noaa.gov

Part of the *awakening period* involved environmental tragedies, some being disasters, others being less serious but having a social impact which brought people together. For example, in 1969, so much debris and oil had accumulated on the surface of the Cuyahoga River that runs through Cleveland, Ohio, that the river caught fire. This incident forced the United States to take serious action against water pollution.

Another example of the awakening from the United States involved students at Columbia University, New York City and the University of California at Berkley. They held sit-ins to protest plans to replace university parklands with parking lots and buildings. The international attention given these events and many others, helped motivate people at the community level to demand that governments take preventative actions. Senator Gaylord Nelson of Wisconsin believed in this grassroots movement. He organized the first Earth Day which was held April 22, 1970.

Figure 1.11: A pair of demonstrators sit in a street with protest signs among chalk writing during a rally coinciding with the first Earth Day in New York City.

Nelson believed this could be an opportunity for all people to unite in a nationwide demonstration to send a collective message to the government that Earth had to be protected. Today, Earth Day activities take place all around the world.

The *global governance* period began soon after the first Earth Day. Global governance refers to cooperative problem-solving arrangements. These can involve the making of laws or the creation of institutions that regulate groups connected with the environment. This period began with the U.S. government creating the Environmental Protection Agency (EPA) in July, 1970.

In 1971, Canada created a similar agency called Environment Canada. Its mandate is "to foster a national capacity for sustainable development in cooperation with other governments, departments of government and the private sector." These governing bodies ensure that existing industries follow the environmental regulations and that any new developments occur only after an environmental assessment has been conducted.

"It is our collective and individual responsibility to protect and nurture the global family, to support its weaker members and to preserve and tend to the environment in which we all live."

- Dalai Lama

Figure 1.12: A large wind turbine, an example of a sustainable energy resource. St. Lawrence Wind Farm, Burin, NL

The most striking change that has taken place in the environmental movement of the modern era is the **paradigm shift** in attitude about the place of humans in this biosphere. From a belief that all our technologies could solve any environmental problem, we made a paradigm shift to realizing that many problems require changes in our behaviour and in how we work with nature. We also realize that Earth is a fragile place where human activity can cause great harm as well as good. The paradigm shift will be complete when all humans realize that sustainability has to be foremost in our everyday thinking.

Today's Environmental Ethics

There are many different attitudes about how people appreciate and interact with the environment. Most of these attitudes fall under one of three headings:

1. Development ethic.
2. Preservation ethic.
3. Conservation ethic.

The **development ethic** is based on the individual (egocentrism). It assumes that humans should be the master of nature and that Earth and its resources exist for our benefit. This attitude assumes that nature has no inherent value; that is, the environment has value only insofar as humans economically place value on it.

The **preservation ethic** considers nature special in itself. Nature has intrinsic value or worth apart from human reliance on it. Preservationists have varied reasons for wanting to preserve nature. Some have a strong respect for all life and respect the right of all creatures to live, no matter what the social or economic costs. Other preservationists' interest in nature is primarily aesthetic or recreational. They believe that nature is beautiful and should be available for picnics, camping, fishing, or just for peace and quiet. Some preservationists value the scientific importance of nature. They argue that the human species depends on and has much to learn from nature. Rare and endangered species and ecosystems, as well as the more common ones, must be preserved because of their known or assumed long-range practical utility.

The third attitude is referred to as the management or **conservation ethic**. It is related to the preservation point of view, but extends the consideration to the entire Earth for all time. It recognizes the desirability of decent standards of living, but it works towards a balance of resource use and resource availability. The conservation ethic stresses a balance between total development and absolute preservation. It stresses that rapid growth in world population and economics is not sustainable in the long run. The goal of the conservation ethic is humans living together with a good quality of life, but in a way that sustains all life and protects Earth.

Did You Know?

The term **ecosystem** is an abbreviated form of "ecological system." It describes a network of organisms, their environment and all of the interactions that occur in a particular place.

An ecosystem is a region in which the organisms and the physical environment form an interlinked unit. For instance, weather affects plants, plants use minerals in the soil and affect animals, animals spread plant seeds, plants anchor the soil and plants evaporate water, which affects weather.

History of Environmentalism

The environmental movement's roots can be traced back to the beginning of the Industrial Revolution in Britain. The forests were being cleared at a rate too fast for nature to regenerate the trees. Entire villages and towns, and vast expanses of wilderness, were being coated by black soot spewed from the chimneys of factories that burned coal for power. Some individuals began to protest but did little to slow the growth of industrialization. It took a combination of environmental disasters, influential people, and international agreements to launch the movement we know as environmental conservation.

Figure 1.13: Environmental concerns can be traced back to the beginning of the Industrial Revolution.

Environmental conservation is a political and social movement that promotes the protection, improvement and wise use of natural resources according to principles that will assure the utilization of the resources to obtain the highest social benefits.

Influential People

Several individuals, through their writings and actions, have been influential in the environmental conservation movement. The first influential person was American Henry David Thoreau (1817-1862). His book *Walden* (1848) was an exploration of how humans could live in harmony with nature. For a period of time Thoreau lived in a cabin on Walden Pond, Massachusetts and through his experiment of living with nature, he formulated what would be called a "respect for nature" philosophy.

Figure 1.14: John Muir (1902).
Photo courtesy of the Library of Congress: The Evolution of the Conservation Movement, 1850-1920

Similarly, John Muir (1838-1914), a lover of nature, was the first person to suggest that protecting wilderness was important. He spent many weeks living and hiking in the wilds of the Yosemite Valley, California. He became convinced that this area should be protected to keep its inherent beauty so that future generations could experience the value of nature and solitude.

Muir's attempt to have this wilderness area protected met with opposition from timber companies and politicians, but in 1890, Yosemite National Park was created. Then, in 1892, Muir and Robert Underwood Johnson—associate editor of *Century* magazine—created the Sierra Club. It helped to establish future National Parks and a National Wilderness Preservation System and continues today with branches in many countries including Canada. Muir also introduced the concept of "intrinsic value" in nature. That means that nature has the right to exist for its own sake.

Figure 1.15: Sir Clifford Sifton.
Photo courtesy National Archives of Canada (PA 027943)

Sir Clifford Sifton (1861-1929) is considered the father of conservation in Canada. He served as Minister of the Interior for the federal government. He understood the value of forest land and helped to enact regulations to protect forests from uncontrolled clear cutting. After resigning from politics, he was appointed to the chair of Commission for the Conservation of Natural Resources. It provided the current scientific data on conservation of human and natural resources to the government.

"The life of every river sings its own song, but in most the song is long marred by the discords of misuse."

ALDO LEOPOLD

Shortly after the turn of the last century, the movement for environmental conservation had a foothold in North America. For example, the Ecological Society of America (1915) was founded to bring the science of ecology into the public eye. Aldo Leopold (1886-1948), who graduated from Yale Forestry School in 1909, was

Figure 1.16: Aldo Leopold.
Photo Credit: PBS.org

caught up in this new movement. After working for nineteen years with the Forestry Branch, Leopold moved onto independent contract work that focused on wildlife and game surveys throughout the U.S. In 1935, he founded the Wilderness Society, a group that advocated the preservation of wildlife and wilderness areas.

At the time Leopold began his career, a girl was born to the Carson family in a small family farm in Springdale, Pennsylvania. Rachel Carson (1909-1964) spent many hours with her mother walking around their farm. Years later, she recalled how her mother's love of nature and the living world influenced her choice of careers.

In the mid-1940s, the insecticide DDT (*d*ichloro-*d*iphenyl-*t*richloroethane) was being used throughout North America as a proven and effective insecticide. However, Carson was concerned about the use of this poison. In fact, the invention of DDT sparked Carson's research for her most famous book, *Silent Spring*, which is recognized as the starting point for the modern environmental movement. In her book Carson brought to light the devastating effects of DDT on ecological food webs. She revealed how the chemical caused the thinning of egg shells in predatory birds, particularly Bald Eagles, Peregrine Falcons *(Falco peregrinus)* and Brown Pelicans *(Pelecanus occidentalis)*. She also documented the fact that it led to the development of cancer in humans.

Countries still Using DDT:

- Belize
- Brazil
- Costa Rica
- El Salvador
- Guatemala
- Honduras
- India
- Mexico
- Mozambique
- Nicaragua
- Panama

Figure 1.17: Rachel Carson.
Photo Credit: National Oceanic and Atmospheric Administration

Carson was attacked by the chemical companies as a "hysterical woman", but their threats of lawsuits only strengthened her resolve to have this chemical banned. She died in 1964, but thanks in part to her pioneering effort, the Environmental Protection Agency, in 1973, banned the use of DDT throughout the United States. Canada outlawed its use in 1985. DDT is still used in other countries of the world.

It should be noted that Carson was not against all pesticides. She encouraged the careful and responsible use of these chemicals with an understanding of how chemicals impact the entire ecosystem.

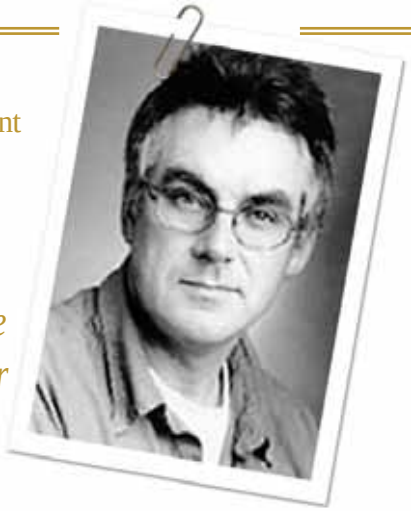
"The more I learned about the use of pesticides, the more appalled I became. What I discovered was that everything which meant most to me as a naturalist was being threatened and that nothing I could do would be more important."

RACHEL CARSON

ECO SPOTLIGHT:

Bernard Martin

Goldman Environmental Prize 1999 Recipient



"When I speak to people in other parts of the world about the collapse of Canada's East Coast fisheries, I like to say, 'If we have nothing else to offer at least take some lessons from us in how not to manage your fisheries. Ultimately, that may be our most valuable fisheries export'."

The collapse of the vast fisheries of the Atlantic off the coasts of eastern Canada and the United States ranks as one of the most devastating environmental catastrophes of the twentieth century. The closure of the fishery on the Grand Banks off Newfoundland in 1992, and Georges Bank off the coast of Massachusetts in 1995, were followed by the closure of a huge section of the Gulf of Maine in January 1999. These closures signaled a crisis of epic proportions in these grounds where cod, haddock *(Melanogrammus aeglefinus)*, and flounder were once abundant.

Figure 1.18: Prior to the collapse of the fishery, cod fish provided the economic basis of many outport communities.

Bernard Martin was raised in the small fishing community of Petty Harbour, Newfoundland. Like his father, grandfather, and great-grandfather before him, Martin chose the life of an inshore fisher.

Petty Harbour's history as a fishing community dates back to the early 1600s. In the late 1950s and early 1960s, European factory trawlers began to indiscriminately ravage the Grand Banks cod fishery. Meanwhile, the Canadian government promoted the modernization of the inshore fishery by introducing monofilament bottom gillnets. Alarmed at the potential impact on their traditional fish stocks, the village of Petty Harbour petitioned the Canadian government and created the ten-mile Petty Harbour/Maddox Cove protected fishing reserve.

In 1983 the Petty Harbour Fishermen's Cooperative was formed; to give fishers control over production and marketing of their own fish for the first time. By resisting destructive fishing techniques in favor of more traditional methods, the protected fishing reserve remained effective for thirty years. But, with continual assault outside its perimeter and compromises within its boundaries, its stocks too were threatened. In July 1992, while Martin and others traveled across Newfoundland speaking out about the devastation of the fish stocks, the once unthinkable came to pass. The seemingly inexhaustible stocks of cod could not sustain the catch levels of the fishing industry. Almost overnight 20,000 people in Newfoundland and Labrador, including Martin, were thrown out of work; the biggest layoff in Canada's history.

From 1986 and 1990, Martin participated in a fishery project sponsored by Oxfam-Canada between Newfoundland and Labrador and Nicaragua. After witnessing the warning signs firsthand, Martin began speaking out against European and Canadian factory trawlers, which indiscriminately "strip mine" the ocean floor.

In 1993, determined that the Grand Banks disaster not be repeated, Martin and others founded Fishers Organized for the Revitalization of Communities and Ecosystems (FORCE). He spoke on behalf of sustainable fishing methods at a UN Conference. In 1993 Martin joined the "Clayoquot Express," a group of environmentalists who traveled by train across Canada to publicize the decimation of fisheries on Canada's east coast and the destruction of the magnificent old-growth forests of the country's west coast. Martin served nine days in prison in 1994 for blockading logging roads in Clayoquot Sound.

Figure 1.19:
Common viewscapes of coastal communities.

Recognizing the alarming patterns of decline among fisheries worldwide, Martin traveled to New Zealand and Eritrea to meet with fishers and assess the problems facing their fisheries. Since 1995, under the community sponsorship of the Petty Harbour Fishers Co-op, he has been involved in the Sentinel Survey, a five-year program to monitor cod stocks on traditional fishing grounds. Martin and others concluded that such vigilance could have prevented the collapse of the northern cod stocks. In 1995 and 1996, he crisscrossed Newfoundland and Labrador, working with the Protected Areas Association to discuss ideas such as no-entry zones, no-take at certain times of the year, and various gear restrictions. He traveled to Alaska to speak about the consequences of collapsed fisheries. Martin spent one year as coordinator of the Newfoundland and Labrador Oceans Caucus and has helped document the history of the protected fishing area of Petty Harbour. He also works to draw attention to the presence of "ghost nets"—lost gill nets that continue to trap marine creatures indiscriminately and indefinitely.

Article Courtesy: The Goldman Environmental Foundation (*www.goldmanprize.org*)
Used with Permission

QUESTIONS

1. What caused the cod fishery to collapse in Newfoundland and Labrador?
2. Why did the federal government impose a moratorium on cod fishing?
3. What social, economic and environmental impacts did the cod moratorium have on Newfoundland and Labrador?
4. Why do you think Bernard Martin got involved with various organizations following the cod moratorium?

Environmental Disasters

Within twenty years after the release of Rachel Carson's landmark book, a series of major environmental disasters further raised the people's consciousness with regard to their place in the environment and their impacts upon it. These disasters can be grouped under the categories of industrial accidents, nuclear incidents, and oil spills.

INDUSTRIAL ACCIDENTS:

- Minamata Bay, Japan (1956):
  A plastics manufacturing company dumped mercury-laden waste water in the bay. After local people consumed fish and shell fish containing the mercury, more than 900 of them died and an estimated 2,955 people suffered irreversible symptoms of Minamata Disease, as it came to be known.

Figure 1.20: Bhopal, India
Photo courtesy http://img.timeinc.net/

- Love Canal, Niagara Falls, New York (1978):
  A chemical manufacturing company used an area as a chemical dump site up to 1952, then covered it over with soil and sold it to the City of Niagara Falls for residential building lots. People who lived in the houses built on this site complained of unusual odours in their homes, illnesses, and unexplained cancers. Pressure by residents forced the U.S. government to relocate their homes.

- Bhopal, India (1984):
  A chemical company accidentally released cyanide into the air. 15,000 people died and an estimated 150,000 to 600,000 people suffered from respiratory problems.

NUCLEAR INCIDENTS:

Figure 1.21: Chernobyl, Ukraine.
Photo courtesy http://youke.web-log.nl/

- Three Mile Island, Harrisburg, Pennsylvania (1978):
  A nuclear reactor at the Three Mile Island Nuclear Power Plant began a meltdown. The incident did not release any nuclear material into the surrounding population but the public outcry helped create a fear of these nuclear facilities. No nuclear power plants have been constructed in the U.S. since this event.

- The Chernobyl disaster, Pripyat, Ukraine (1986):
  A nuclear power plant had a complete reactor meltdown releasing 300 times as much radioactive material into the atmosphere as the nuclear bombing of Hiroshima. Fifty-six people died directly from overexposure to radiation and more than 336,000 people had to be evacuated and relocated. Radioactive fallout from Chernobyl was detected in many distant countries including Canada.

OIL SPILLS

- *Amoco Cadiz (1978)*:
  A super tanker ran aground off the coast of Brittany (Western Europe) spilling 1.6 million barrels of crude oil. The 3,730 km² slick covered 320 km of beaches and damaged important fishing habitats. More than 20,000 dead birds were collected and shellfish continued to die for several months. Economic costs to fishers were enormous.

Figure 1.22: Exxon Valdez
Photo courtesy www.adn.com

- *Exxon Valdez (1989)*:
  After striking a reef in Prince William Sound, Alaska, this tanker spilled 3.5 million barrels of crude oil into the remote region of the sound. Such a remote oil slick was very difficult and costly to clean up: estimated at $1.25 billion dollars. The sensitive ecosystem was severely damaged with thousands of animals perishing immediately including an estimated 250,000 seabirds.

International Agreements

Bringing nations of different environmental backgrounds and attitudes together to discuss important environmental issues is an important component of environmental conservation. At international conferences these groups work towards a plan for solutions to environmental challenges and then agree to a timeline for complying with the terms of the plan.

> *"Our environmental laws are not ordinary laws, they are laws of survival."*
>
> EDMUND MUSKIE

Since the early 1970's when they began, these conferences, though not always successful, have led to important international agreements. Some of the more notable meetings have included the following:

- 1972: United Nations Conference on the Human Environment, which is known as the Stockholm Conference
- 1992: The Rio Declaration on Environment and Development (RDED) often referred to as the first Earth Summit
- 2001: United Nations Environmental Programme (UNEP) in Stockholm, Sweden

At the 2001 UNEP meeting more than 113 countries agreed to take collective action on specific chemicals called Persistent Organic Pollutants (POPs). These chemicals are very stable for long periods of time in the environment and tend to accumulate in food chains. This group of chemicals came to be called "the dirty dozen". It was agreed that these chemicals should be banned and a tracking system be developed to watch out for new POPs being produced.

The 113 countries at the 2001 UNEP conference identified a list of "persistent organic pollutants" (POP) and agreed that these should be banned from use. These chemicals came to be called the Dirty Dozen.

- Aldrin
- Chlordane
- Dieldrin
- Dioxins
- DDT
- Endrin
- Furans
- Heptachlor
- Hexachlorobenzene
- Mirex
- Polychlorinated biphenyls (PCBs)
- Toxaphene

CHECK your Understanding

1. Briefly describe how our attitudes toward the environment have changed in the last fifty years.
2. What was the "awakening period" in environmental awareness?
3. What event(s) triggered the global governance period?
4. Distinguish between "preservation ethic" and "conservation ethic".

For Further Discussion and/or Research

5. John Muir and Aldo Leopold were key figures in the history of conservation. Through research on the Internet, find out more about Muir's and Leopold's contribution to the conservation movement.
6. Although DDT has been banned from agricultural use in most countries since the 1970s, due to its damaging effects on the environment, it continues to be used in limited quantities for public health purposes. For instance, DDT is still used in Africa to stop the spread of malaria. How do you feel about such a "dreaded environmental chemical" that actually saves human lives? Conduct some research and argue for or against the continued use of DDT in the global community.
7. What attempts are being made in your school to reduce energy consumption? Can you think of additional ways in which energy consumption might be reduced? If so, why do you think they have not already been adopted?
8. Name one person in your community, province, or country who could be considered an environmental leader. Explain your choice.
9. Prepare a list of materials that are commonly recycled. Which of them do you as an individual already recycle and which do you dispose of as garbage? What might be the advantages to you and to the environment if you recycled more?
10. Read the lyrics from the song below and in your journal reflect how the writer's views compare with your own views.

Me and this Land

Doug Jackman, Michael Rogers, Ross Strickland
(Pilot teachers: 2007-2008)

I took a walk, in the forest green.
Saw a doe, by a stream pristine.
It touched my soul, sent my spirit free.
Me and this Land, Me and this Land.

I tasted the fruit from my barren land.
Tasted the salt from the ocean spray.
It quenched my thirst, so I could fly.
Me and this Land, Me and this Land.

I climbed the mount, as far as eagles soar.
Felt the cool and ancient rock.
It cleared my mind, as I breathed the air.
Me and this Land, Me and this Land.

I heard the waves, as they kissed the shore.
Heard a whale breech in the cove.
It gave me strength, in the fading light.
Me and this Land, Me and this Land.

Chapter 2: Sustainable Development

CREATING A SUSTAINABLE SOCIETY

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

-Brundtland Commission, 1987

Sustainability was first used as an environmental term in 1970 at the International Conference of Human Environments. The term reflected international awakening to the concept that, while meeting the needs of the human race today, we have a responsibility to ensure that future generations will also have the resources they need. To help achieve that goal, many believe sustainability should also have as a goal the preservation of many of the untouched areas of Earth. By protecting these unspoiled areas, we have a better chance of ensuring that Earth continues as a functioning biosphere. It is important to remember that not all environmental changes are man-made. Some occur naturally. For example, forest fires bring rapid change to forest land but they are important to the ecology of forests.

Figure 2.1: Former Prime Minister of Norway and physician, Gro Harlem Brundtland, chaired the commission that addressed the issue of sustainable development.

Some people believe development and sustainability to be mutually exclusive goals. The challenge of finding a balance among many goals is the foundation of the concept of *sustainable development*. Growing an economy that generates long-term, meaningful employment, protects the health and integrity of our environment, and creates societies with quality lifestyles and standards of living for all people is the goal of sustainable development. In 1987, the World Commission on Environment and Development released the *Brundtland Report*. It defined sustainable development as an activity "that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Increased production of goods and services (For example: harvesting of natural resources) is required to reach and sustain an acceptable standard of living for the rapidly increasing human population. Figure 2.2 illustrates the dramatic increase in population growth that is projected for the near future. It will be very difficult to manage this development so that it does not occur at a rate that exceeds the Earth's ecological capacity to replenish itself. Securing a healthy environment without hindering economic potential will also be difficult.

Population in Major World Regions

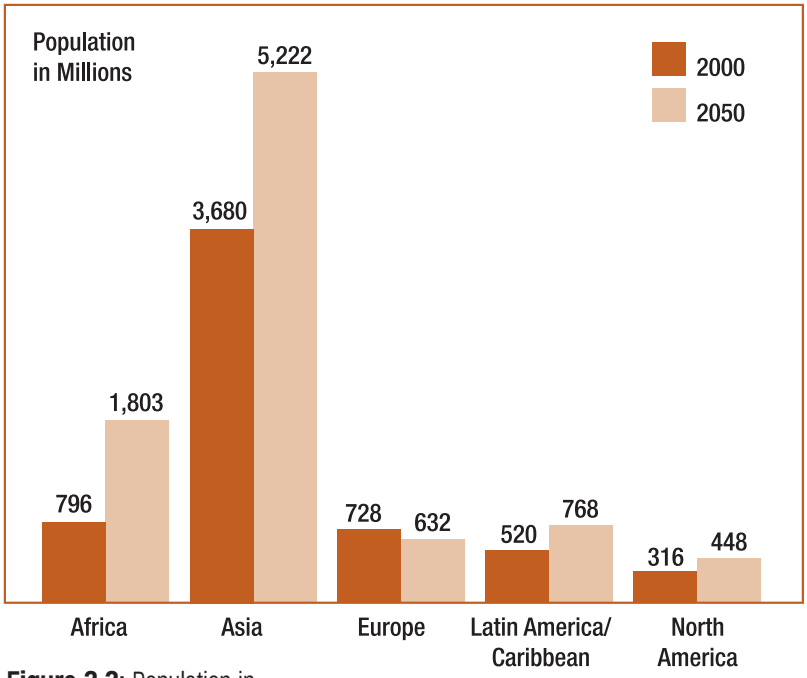


Figure 2.2: Population in Major World Regions, 2000 and Projections for 2050.
Source: UN, World Population Prospects

Many experts agree that if human society is to endure, not just for another century, but for thousands of years, then we must build a sustainable society that:

1. Recognizes the links between population size and resources available.
2. Uses resources wisely.
3. Recycles non-renewable resources.
4. Relies on renewable resources whenever possible.

A growing number of scientists, world leaders, and international celebrities are actively promoting development of such a society. A sustainable society is so different from the way we currently live that it cannot be achieved without considerable effort. And each of us has a role to play. You will learn how you can contribute to a sustainable society as you participate in this course and understand how important your actions are to the global community.

New values are essential to building a sustainable society. Some of the new attitudes we need are obvious. The *frontier mentality* that "there is always more," must be replaced with an attitude that "there is not always more," and the world's resources are limited. Limits are all around us: fossil fuel energy, mineral deposits, and land. Given this finite resource base on which our society is built, technological fixes (new technologies to solve our problems) may not be possible.

Our challenge is to discover and learn to live within the limits set by nature. As we saw in chapter one of this unit, except for energy from the sun, Earth is a **closed system.** All the materials available to us to maintain life must come from within this system and are constantly recycled. We are gambling with life on this planet when we interrupt the natural cycles within this system.

On the Road Again...

Rock and Country music legends Neil Young and Willie Nelson practice sustainability despite their hectic lifestyles. They fuel their tour trucks and buses with biodiesel, a cleaner burning alternative fuel made from renewable vegetable oils.

Biodiesel works in any diesel vehicle and it can be used in pure form or blended with diesel fuel. The most common blend is B20, a mixture of twenty per cent biodiesel and eighty per cent diesel.

Biodiesel significantly reduces harmful emissions. The non-toxic, biodegradable fuel is less irritating to the eyes, nose, and throat, and it reduces the compounds linked with cancer by eighty to ninety per cent compared to petroleum diesel.

Other musicians such as Bonnie Raitt, Korn, Pearl Jam, Alanis Morissette and Indigo Girls have used biodiesel on tour in the past, and the music festival Lollapalooza uses biodiesel (B100) in the generators to power their concerts.

More than 400 major fleets currently use biodiesel commercially in North America. Source: *www.wnbiodiesel.com*

Understanding our environment is essential for anyone who wants the best for humanity and actively seeks to make changes. Changing society's habits, when it comes to consumption, is difficult. It demands cooperation on a global scale. Even then, such a process can take generations as we strive to make the decisions that are right for sustainable development. We must learn ways to respect nature by cooperating with it instead of working against it. For that great task, the study of environmental science is our single most important tool.

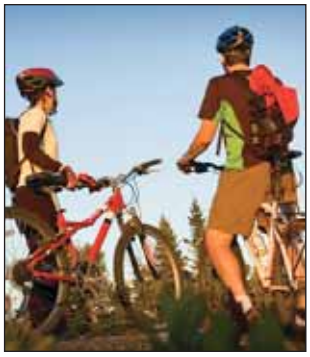
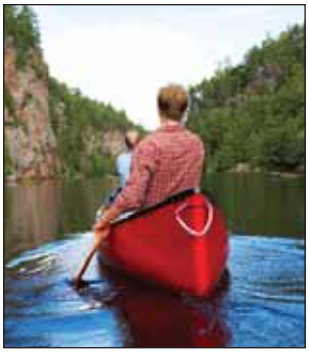



Figure 2.3: Some examples of sustainable use of resources.

FACTORS THAT INFLUENCE SUSTAINABILITY

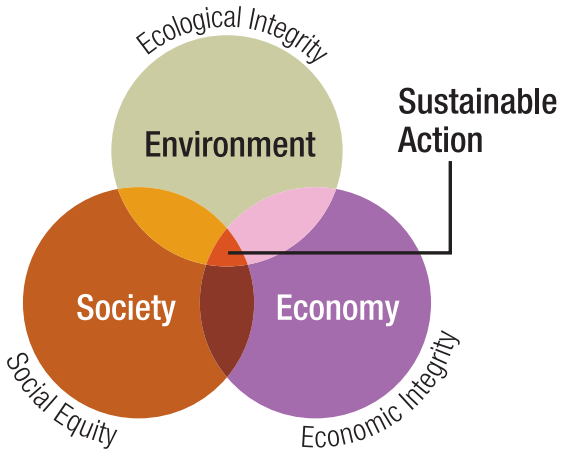
There are three groups of factors which influence sustainability. These factors are linked to our environment, our economy, and our society.

Sustainable development explicitly recognizes the interconnections and relationships between the economy, society, and the environment. These are referred to as three types of capital—economic, social, and natural.

Models of Sustainable Development.

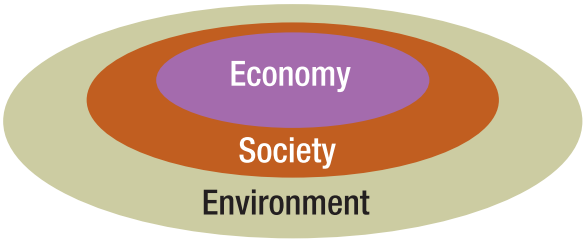
When sustainable development is viewed as three interconnected types of capital, the emphasis is on the linkages between the economy, society, and the environment.

Linkages View of Sustainable Development:



When a systems view is used the emphasis shifts to the environmental limits imposed on the economy and society. Here, the economy and society function within a larger environmental system and are limited by the carrying capacity of the natural environment.

Systems View of Sustainable Development:



The concept of sustainability must consider all forms of capital in decision making but places prime importance on the services of natural capital that are essential to all life on Earth.

Environmental Sustainability

• CARRYING CAPACITY

The **carrying capacity** of an ecosystem is the number of individuals of a species that can survive in that area over time. The carrying capacity for a species changes as disturbance or succession changes the ecosystem. When a particular condition or factor can be identified as a key component that limits the size of the population, it is called a **limiting factor**. For most populations, four categories of limiting factors are recognized:

1. Availability of raw materials.
2. Availability of energy.
3. Accumulation of waste products and their means of disposal.
4. Interactions among organisms.

Sometimes limiting factors are easy to identify. For example, water, oxygen, a source of food, competition from other species, and disease are all clearly limiting factors. But limiting factors may be less obvious. For example, the amount of nutrients or toxins present in the soil is not easy to identify.

A provincial example that illustrates carrying capacity and limiting factors is the introduction of moose to the island of Newfoundland. This species has been the subject of a great deal of research. In the next case study you will investigate the amazing story of how a few animals introduced around the turn of the last century have overpopulated the island in just over a century. The concern for wildlife biologists today is whether the availability of sufficient food will become a limiting factor for the island's moose population.

Figure 2.4: A common sight along the highways and byways of Newfoundland and Labrador.

Figure 2.5: A bull moose in the boreal forest.

CASE STUDY

Population Growth of an Introduced Species

When a new species is introduced into an area suitable for its survival, it often has great potential to increase its population size because there may not be many natural predators or competitors.

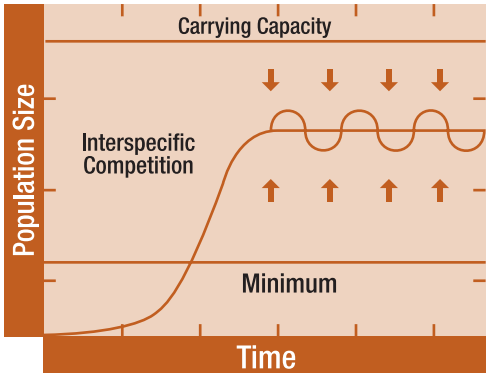
A typical population growth curve (see Figure 2.6 below) starts with the release of a few individuals. Once established, the population increases in number and expands its range. Eventually, the introduced species occupies all suitable habitat and the population stabilizes.

The moose population on the island of Newfoundland is probably the densest in North America. In 2008, the population was estimated at between 120,000 and 150,000 animals scattered across the island. This population originated from two Nova Scotian moose released in Gander Bay in 1878 and four New Brunswick moose released from Howley in 1904. All the moose on the island today are descended from these (although there is some doubt as to whether the 1878 moose survived to breed).

The abundance of moose makes it a commonly hunted animal. The province's first official moose hunting season was in 1930. Approximately 22,000 are harvested in the province each year.

Year	Moose #'s
1905	6
1915	1,000
1925	2,100
1935	4,000
1945	10,000
1955	22,000
1965	50,000
1975	75,000
1985	90,000
1995	106,000
2005	120,000

Figure 2.6:
Population Growth Curve.
Source: NL Department of Environment and Conservation

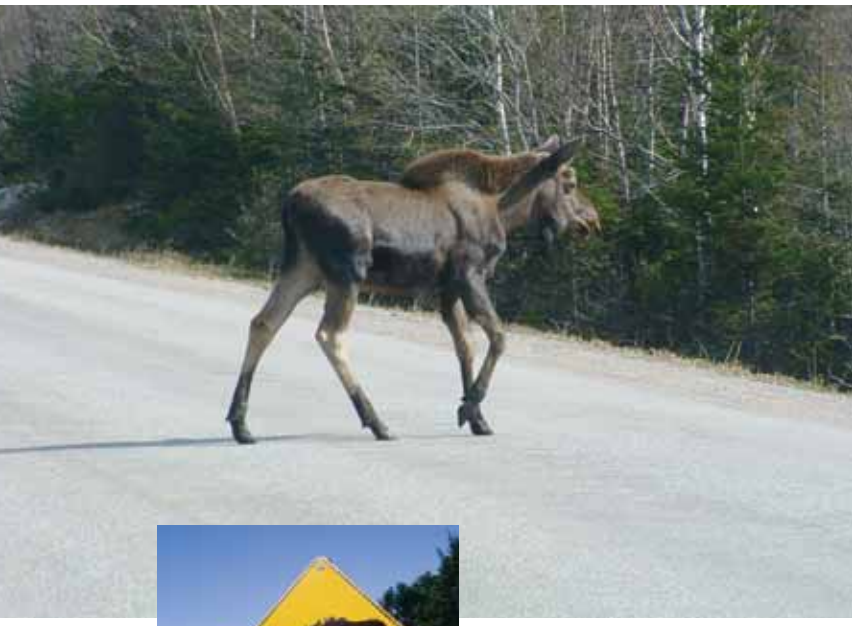


From humble beginnings in 1904, the moose population has exploded. Today, as many as 8,000 of them can be found within the boundaries of Gros Morne National Park. Hungry moose, nipping at the new growth of young trees in the park's boreal forest, are unwittingly pruning them into stands of balsam fir bonsai (dwarf trees).

Estimated moose population: Gros Morne National Park 1971- 98

Year	1971	1974	1976	1977	1991	1995	1998
Estimated Population	271	1016	600	812	2200-3200	6110-9350	6440-9065

The animal's appetite is astounding. An adult moose must eat ten kilograms of plant matter every day. Multiply that by 150,000 moose and you can imagine how such an appetite can have a major impact on forest growth and species diversity. They are eating themselves out of their forest home. By arresting the growth of young trees, the moose are interfering with their growth and the natural growth of the forest canopy. This leaves many birds, small animals, and insects vulnerable to predators and exposure to heat and sun. And they give black spruce *(Picea mariana)* and sheep laurel—which moose do not eat—a competitive advantage by eating the competition.



This replacement of tree species creates a domino effect that impacts many organisms in the forest. Some of the smaller animals like marten and hare will be negatively affected and, in turn, the lynx and weasels that rely on them will be affected.

Figure 2.7: About 700 moose-vehicle collisions occur on the highways of Newfoundland and Labrador every year.

Parks Canada spends much time and effort trying to stop poachers from killing the plentiful moose in Gros Morne. Hunting is not allowed in a national park. One option that has been considered is to re-introduce wolves to deal with the moose overpopulation. But Parks Canada is not keen on that idea; tinkering with the natural balance is too unpredictable. Not only does it go against the philosophy of Parks Canada, but the sentiment is that Newfoundlanders, who see moose hunting as a cultural right, would never accept it.

Some people feel that allowing the moose population to grow unchecked in the national park will cause a loss of forest cover in Gros Morne, and lead to overcrowding of moose; ideal conditions for disease and starvation of the population that would lead to a population crash.

QUESTIONS

1. Construct a line graph representing population growth of moose for Insular Newfoundland. Label Time on the horizontal axis and Number of Moose on the vertical axis.
2. Extrapolate your curve to predict moose populations for 2015 and 2025.
3. What could be some limiting factors influencing moose population numbers in the next twenty years?
4. Imagine you are a Parks Canada biologist and have worked at Gros Morne National Park for the past ten years. During this time, you would have seen an increase in the moose population as well as in the numbers of moose/vehicle accidents in the park. You are concerned about the impact of the moose on wildlife habitat. You would like to find ways to control the moose population. What are some options to consider?
5. Imagine you are a member of the Gros Morne Cooperating Association (Tourism Association). Each year thousands of people come to the park to view the scenery and try to get pictures of moose. It is common to see cars stopped along roads in Gros Morne National Park as people try to get a better look at these large ungulates. You do not support a reduction in the number of animals because you fear it would give the park a bad name and potentially reduce tourism revenues. What are some options to consider?

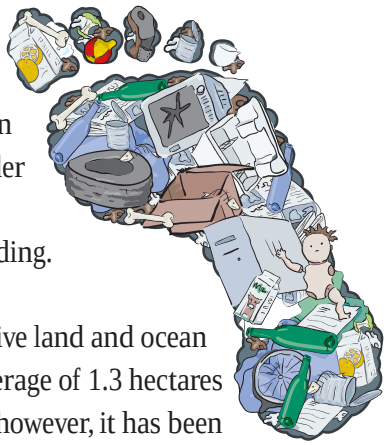
Adapted from: *http://www.pc.gc.ca*
True to our Nature: Too Many Moose on the Loose?
Moose in Gros Morne National Park of Canada, and
http://www.waskesiu.org/journals/endangered_species.html

Figure 2.8: Why is "footprint" a good image to describe the impact we have on our environment?

• ECOLOGICAL FOOTPRINTS

Some people regard sustainable growth as impossible over the long term because we must use ever increasing amounts of goods and services to make our lives more comfortable and enjoyable. These people feel that the escalating use of non-renewable resources and the production of increasing amounts of waste are simply not sustainable.

Two Canadian environmental scientists, Mathis Wackernagel and William Rees, have quantified the different aspects of human life that uses resources or generates wastes, and have translated this into an *ecological footprint* for each individual. An ecological footprint is an estimate of the amount of biologically



productive land and sea area needed to regenerate (if possible) the resources a human population consumes and to absorb and render harmless the corresponding waste, given prevailing technology and current understanding.

The world has 8.1 billion hectares of productive land and ocean to meet the needs of 6.3 billion people, an average of 1.3 hectares per person. At current rates of consumption, however, it has been estimated that the global ecological footprint exceeded its biocapacity by twenty five per cent in 2003. Canada is ranked as having the fourth highest footprint of countries with populations greater than 1 million people

Current estimates show that the ecological footprint of our consumption in food, forestry products, and fossil fuels alone might already exceed global carrying capacity by approximately thirty per cent. About seventy five per cent of the current consumption goes to the 1.1 billion people who live in the developed world, while twenty five per cent of the consumption remains for the other 4.6 billion people. This disparity shows some of the ethical issues for the sustainability dilemma. It raises important questions about the wisdom of economic expansion—and increasing consumerism—as a remedy for poverty.

It is important to remember that the concept of the ecological footprint translates individual actions into environmental consequences at a global scale.

If you would like to decrease your ecological footprint, you might:

- Eat less meat. A plant-based diet generally requires less land, energy, and other resources. Crop-based food requires an average of 0.78 global hectares per tonne of food, compared to 2.1 global hectares required to produce one tonne of animal-based food.

- Drive a more fuel-efficient vehicle and reduce the amount that you drive. Walk, cycle, carpool, or use public transportation.

- Avoid purchasing disposable items with lots of packaging. Reuse items when possible and always recycle items that are recyclable.

- Compost kitchen waste: garbage that is not contaminated with degradable (biological) waste can be more easily recycled and sorted and doesn't produce methane gases (a significant greenhouse gas contributor) when stored in a landfill.

- Plant native and drought-tolerant plants in dry regions to reduce water use.

YOU CAN HELP:
If you need a car buy a fuel-efficient car. It does not have to be an electric car to be more environmentally friendly than conventional cars. Today, some models have a fuel consumption of less than five litre/100 km. This means less pollutant emissions and less greenhouse gas, but it also implies a reduced fuel bill: the environment and your wallet are both winners.

For more information on fuel efficiency, check out this link to the Environmental Protection Agency.
www.epa.gov/autoemissions/

- Be a conscientious consumer—learn about sustainability-friendly products. For example: Buy local produce in season. Teens can make a difference, check out *www.ibuydifferent.org/*

- Share magazines and catalogues by donating them to hospitals, clinics and doctors' offices or by creating an informal program in which you rotate magazines and catalogues among your neighbours.

Adapted from *www.earthday.org*

"It's amazing what a small group of committed people can accomplish to change the world. In fact, it's the only thing that ever has."

MARGARET MEAD

Economics and Sustainability

Since the *Bruntland Report* in 1987, the term sustainable development has been broadened and modified. The term "sustainable" now has an *economic* connotation because of increasing concern over exploitation of natural resources and economic development at the expense of environmental quality.

Bono, the front man for Irish rock band U2, and Microsoft founder Bill Gates, are advocates for debt relief to fight Aids and poverty in the developing world.

They have persuaded the Group of Eight leading industrial countries to commit to forgiving more than $100 billion of debt owed by nations in the developing world.

In addition, Gate's has personally pledged more than $1.0 billion to help fight infectious diseases in Africa.

A sustainable agricultural system, for example, is one that can indefinitely meet the demands for food at socially acceptable economic costs and environmental impacts. Many world leaders today believe that sharing environmentally sound technology with developing nations is the key global action for sustainable development.

This belief is the foundation of the idea that economic growth and environmental well-being are common goals. They must be pursued at the same time if either one is to be achieved. Healthy economies are most likely to provide the necessary financial investments in environmental protection. But unchecked economic growth will undermine the healthy functioning of nature's ecosystems and exhaust this planet's natural resources.

By balancing economic requirements with ecological priorities, human needs are satisfied without endangering the prospects of future generations. A major obstacle to sustainable development in many countries is the social and economic structure that removes people from the effects of their decisions. People are unlikely to be concerned about protecting the environment if they do not experience the negative environmental impact of their actions, and are not held accountable.

Highly industrialized nations can promote sustainable development. They have the resources to invest in research and the expertise and technologies to implement research findings. These nations can also use the same advantages to continue

exploiting the Earth's resources at an unsustainable rate. Serious choices must be made: continued growth of resource use in richer countries, or further development in poorer countries.

Industries and businesses that apply sustainable practices can achieve greater efficiencies, increased investment, and a greater competitive advantage. In addition, applying sustainable practices is a requirement for gaining access to some international markets.

Statistics Canada estimates that by 2021, Newfoundland and Labrador will have the highest proportion of seniors in the country.

Social Sustainability

A socially sustainable society is one that is just, equitable, inclusive, democratic, and provides a decent quality of life for current and future generations. The social dimension of sustainability includes the political, cultural, and people-centred issues. It focuses on ensuring that the basic conditions for human life to flourish are addressed by society. These conditions include:

- Food, shelter, and clothing
- Health care
- Education
- Employment
- Sufficient finances
- Human rights and equal opportunities
- Crime prevention

Some of these factors can be readily measured. For example, employment rates and average incomes are available from official statistics. The Gross Domestic Product (GDP) of a country puts a monetary value on the wealth of the nation. These indicators can give a measure of the standard of living but do not necessarily show the quality of life.

The Precautionary Principle

At a meeting in Racine, Wisconsin in 1998, an international group of government officials, scientists, environmental activists, and lawyers met to develop a definition for the **Precautionary Principle**. What emerged was a consensus definition: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed, and democratic, and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action."

The Rio Declaration, Principle 15, the Precautionary Approach states: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

An attempt is being made to manage several natural resources, such as fish stocks, by the precautionary approach, which is included in Harvest Control Rules (HCR). You will learn more about this later in the course.

CHECK your Understanding

1. Why do some people think sustainable development is a concept that can never be attained?
2. How does carrying capacity affect the sustainability of an ecosystem? Of Earth?
3. How is the economic well being of Canada linked to the goal of sustainable development?
4. Why should we be so concerned about the living conditions of people in the Third World? How are we affected by them?
5. What concerns are associated with sustainable development?

For Further Discussion and/or Research

6. Compare and contrast the three approaches to environmental ethics discussed above. Which is closest to your own? Why? How does, and how could, your ethical stance influence your actions?
7. What does sustainable mean to you? What would it take for human development to be truly sustainable?
8. What responsibilities do we have for future generations? Why not use whatever resources we want right now?
9. Research and compare some indicators of quality of life between rich and poor nations.

CORE LABORATORY ACTIVITY

How Much Earth Do You Need?

Outcomes:

You will be able to:

1. Calculate the amount of land required to produce the food eaten by an individual for one year.
2. Compare the amount of land required to produce animal versus plant products.
3. Visualize the areas of land calculated in outcomes 1 and 2.

Background:

Humans require energy. Their energy comes from food. Energy moves from the sun through the photosynthetic organisms (producers) and then through organisms (consumers) that eat the producers and other organisms. Ninety per cent of the energy captured from the sun is lost in the transition from producers to consumers (respiration, heat loss, animal waste). Because of this loss, land yields fewer kilocalories per square metre per year in animal products than in plant products.

Plants can be divided into two groups, C-3 and C-4, based on how they grow. Under the right conditions C-4 plants, such as sugarcane and corn, photosynthesize two to three times as fast as C-3 plants. Also, C-4 plants don't lose energy during their photosynthetic process, while C-3 plants do. Because the C-3 plants are less energy efficient, the C-3 and C-4 plants are separated on your Analysis Sheet. Note: a kilocalorie (kcal) has the same energy as a food Calorie used by nutritionists.

Materials:

- Calorie counters (online at *www.thecaloriecounter.com/*)
- Metre stick

Procedure:

Part 1: Determine how much space is required to produce our food energy

1. Record the types and amount of food you eat during a twenty four hour period. Be sure to count everything, not just what you eat at meals—include snacks, candy, etcetera.
2. Using the calorie counter references found on the food product labels (or use the online reference), determine the total number of Calories taken in during those twenty four hours. Multiply this amount by 365 to determine the total number of Calories taken in during a year.
3. Divide the total number of Calories (kcal/year) by 500 kcal/m²/year to determine the square metres of land required to support

the individual. (500 kcal/m²/year is an average value based on a typical teenager's diet.)

4. Calculate a class average for the square metres of land required to support an individual.
5. Calculate the amount of land required to support the following groups for one year: your class, your school, your community, your province, Canada.
6. Assuming a Canadian hockey rink is 1,586 m², how many "rinks" does your class need to support them for one year? Assuming a high school basketball court is 390 m², how many basketball-court-sized fields does your class need to support them for one year?

Part 2: Calculate the space required to produce 200 Calories of plant and animal foods

Background:

In this activity, we will assume that an individual takes in 200 Calories of the food product in one meal (your teacher will provide you with an Analysis Table for specific food products).

To calculate the amount of land required to produce the 200 Calories from a specific food, we divide the 200 Calories by the Calorie yield for the product from the Analysis Table. For example, rice yields 1250 kcal/m². Therefore 200 kcal / 1250 kcal/m² = 0.16 m². This indicates that only 0.16 m² was required to produce the 200 kcal of food energy. If we consider beef, then 200 kcal / 130 kcal/m² = 1.5 m². This is nearly ten times as much land as it would take to produce the same amount of food energy from rice.

Procedure:

1. Refer to the Food Energy Analysis Table provided by your teacher. Choose two plant products and two animal products that you would normally eat in your daily diet. Calculate the total land required to produce these products based on 200 kcal per meal.
2. To help you visualize the difference between the amount of space required to produce the same amount of food energy from the plant and animal food you selected, use a metre stick to measure the areas for plants and animal products separately. Do this in a fairly large area such as a field, classroom, gymnasium, or school parking lot. You can repeat this exercise for other plant and animal foods from the Analysis Table.

Analyze and Conclude:

1. Which type of diet would use less land and produce maximum caloric return?
2. Which plant produces the greatest kilocalories per square metre? Which plant produces the least?
3. Which animal product produces the greatest kilocalories per square metre? Which animal products produce the least?
4. What would you consider to be a more effective use of land, farming or animal ranching? Explain.
5. Many developing countries are cutting down their forests for farming and ranching. Suggest why this may or may not be a good practice.

Extension:

6. Use the Analysis table to calculate the land required for as many of these products as possible for one complete week, and then multiply by fifty two to obtain a yearly average requirement.
7. By comparison, corn produces fewer kilocalories per yield than sugar cane, yet much research has gone into producing a genetically modified corn to grow in Newfoundland and Labrador. Is this the best course of action or should more effort be put into growing sugar cane in our province. Explain.
8. Investigate different types of vegetarian diets. Which is the "most environmentally friendly"?
9. Some environmentalists suggest that families eat at least one vegetarian meal a week to help reduce our ecological footprint. Choose a typical meal that your family would eat for supper. For the food energy consumed, how much space was required to produce this food? Describe a vegetarian meal that could replace this supper meal. How much food-producing space would be freed up by eating the vegetarian meal?

Figure 2.9: Corn plants yield a higher number of kilocalories per square meter than do cattle.

Source: Brewer, Richard and M. T. McCann. 1982. *Laboratory and Field Manual of Ecology*. Philadelphia: Saunders College Publishing.

Adapted from: Janis Lariviere, Barbara Mannion, O. Truman Holtzclaw, Randyl Warehime, and Arthur Broga, 1991 Woodrow Wilson Biology Institute: *www.istitutoveneto.it/venezia/divulgazione/pirelli/pirelli_2005_en/Banca_Dati_Ambientale/192.168.10.66/pirelli_new/divulgazione/didattica/lezioni_attivita/how_much_land.pdf*

SUSTAINABLE DEVELOPMENT IN NEWFOUNDLAND AND LABRADOR

The economic and social prosperity of Newfoundland and Labrador is dependent on its abundant natural resources.

The Government of Newfoundland and Labrador is in the process of introducing a *Sustainable Development Act*. The purpose of this Act will be to ensure that the province's renewable and non-renewable natural resources are developed in ways that maximize benefits for all Newfoundlanders and Labradorians, while protecting and conserving our natural environment. The Act intends to ensure that sustainable development values are incorporated within all government policies, programs, and activities.

Resource development generates wealth that supports health, social, educational, and environmental programs that benefit residents of the province.

Renewable resources, such as fish stocks and forests, must be managed so that they are available for generations that follow.

"Recognizing the ties between environment, economy, and culture is at the heart of our government's Sustainable Development Act. It will require consideration of social and cultural needs and a more integrated decision making approach within government and between government, industry, and communities."

"Sustainable Development is about balance. For renewable resources this will require development strategies that do not exceed the biological capacity for renewal. In the case of non-renewable resources it will necessitate measured approaches that extend economic activity to the longest term reasonable, a much greater investment in value-added products, and investing royalties to maximize benefits to all our citizens."

Honourable Danny Williams,
Premier of Newfoundland and Labrador

From the 'Message from the Premier' in Sustainable Development: Discussion Document on A Proposed *Sustainable Development Act*, (2006).

Figure 2.10: Enjoying the outdoors in winter in a sustainable fashion.

For our non-renewable natural resources—such as minerals, oil, and gas—we have a responsibility today to develop and use them productively, efficiently, and in a longterm socially responsible manner.

In Newfoundland and Labrador we have a variety of government legislation and processes that help safeguard the environment, facilitate industrial and economic activity, and promote social well-being. Such efforts, however, deal with one or the other of these issues rather than with all of them in a coordinated way. The Sustainable Development Act will work to ensure that sustainable development values are incorporated into government's policies, programs, and activities, and will ultimately serve to:

- Protect our future
- Provide leadership
- Enhance our roles and responsibilities as global citizens

• PROTECT OUR FUTURE

The natural environment is the foundation for the economy of Newfoundland and Labrador. Billions of dollars are generated annually from our fish stocks, forests, soil, wildlife, water resources, petroleum, and minerals. Our unique culture and the natural beauty of our province draws thousands of visitors here every year. Our connection with the natural environment is an essential part of our character. With the sustainable use of our natural environment, we can help ensure a prosperous, growing economy that builds community capacity and creates a healthy and vibrant people, culture, and society for present and future generations.

Figure 2.11: Protecting our forests and wildlife for future generations. *Photo (right) courtesy Department of Environment and Conservation*

• PROVIDE LEADERSHIP

Government, as the resource steward for all citizens of Newfoundland and Labrador, leads by example, promoting sustainability as a priority. The government must also set the standards for how our resources are used by individuals, communities, businesses, and industry.

• ENHANCE OUR ROLE AND RESPONSIBILITY AS GLOBAL CITIZENS

As part of the global community and environment, we should make every effort to ensure that our actions as a Province contribute to meeting the targets set by national and international agendas such as climate change, water quality, and biodiversity.

ECO-CITIZENSHIP

Our society has started to show concern for the environment, with an increasingly effective combination of regulations and cooperation between governments and citizens. However, without *active* participation by people like you, attempts at sustainable development may fail. We, as consumers and citizens, all have a major role to play in achieving this fundamental societal change. Active citizens in this process are known as eco-citizens.

Without reducing our quality of life, there are many ways we can reduce the resources and energy we use and cut down on the pollution we generate. By living that way we can all work towards a more sustainable society. In Newfoundland and Labrador there are many agencies, both public and private, that promote the responsible use of our natural resources. Are you ready to become an eco-citizen? If you are interested, then why not explore how you can become *empowered*. Then learn how to become *involved*.

Citizen Empowerment

Since the early 1970s, public involvement in environmental decision making has become more widespread. In Canada, there are several ways to inform the public and get them involved in decision making.

• CITIZEN PARTICIPATION

The federal and provincial governments guarantee that citizens may be involved in matters and decisions relating to the human and physical environment where significant impacts due to new developments may occur. The extent of participation depends on the type of development taking place. At the very least it includes participation in public meetings. Consultations are common. For example, this excerpt is from a proposed mink fur farm public bulletin posted on the provincial government website:

> *The undertaking was registered on June 21, 2006; public comments are due by July 26, 2006; and, the Minister's decision is due by August 5, 2006.*
>
> *The Minister encourages all interested parties to become involved and to make comments known. Comments on submitted documents are invited from the public, addressed in writing to the Minister, and are welcome prior to the deadline date shown.*
>
> *Further information may be obtained by contacting the Director of Environmental Assessment at (709) 555-5555 or toll-free: 1-800-555-5555.*

• INFORMATION SHARING

The study of environmental science highlights the adage that "information is power." Large corporations and government agencies have the financial capacity to conduct environmental studies and access information that is unavailable to others. However, certain laws exist to level the playing field for access to information. Access to Information legislation provides an opportunity for the public to request from any government agency specific pieces of information on any subject not deemed "classified." In addition, many government agencies provide data and reports on the Web. These include water use data, weather forecasts, environmental assessments (as seen above), scientific reports, policies, and media releases.

MINI-LAB ACTIVITY

Pollution Watch: How clean is your air?

National Pollutant Release Inventory

In this age of modern technology and rapid access to information, it is possible to determine the types of pollution that influence the environment near your community.

Over the last two decades, there has been increased public awareness about issues such as urban smog, acid rain, and global warming. The quality of the air we breathe depends on the rate that pollutants are sent into the atmosphere, and the ability of the atmosphere to dilute these pollutants. The movement and dispersion of air pollutants is controlled by wind, temperature, and turbulence, and the changes in these elements caused by local topography (mountains and valleys).

The National Pollutant Release Inventory is a key source of information about pollution in Canada. The Canadian Environmental Protection Act (CEPA) requires the federal government to have a "national inventory of releases of pollutants" and requires Environment Canada "to publish the national inventory of releases of pollutants". As such, all industrial companies must report on the types and quantities of pollutants released into the environment.

Time Trends and Facility-to-Facility Comparison

The purpose of this activity is to learn about releases and/or transfers of some specific chemicals, observe changes over time, and compare to other similar facilities.

Goals of this Activity:

1. Identify ten facilities in our province that are the largest polluters;
2. Analyze records and determine which types of chemicals are released by facilities near your community, and determine any affect these chemicals may have on the humans or the environment;
3. Analyze changes over time in releases from selected industrial facilities.

Step 1:

Go to *www.pollutionwatch.org* and enter the first letter of your postal code (For example: A) in the search box.

Figure 2.12: Many human activities affect the quality of the air we breathe.

This will list the different polluters in the province, from highest to lowest. Copy the table below into your notebook and use this data to identify the ten worst polluters* in Newfoundland and Labrador.

*(total release of combined air, water, and land)

Rank Facility	Company Name	Total Amounts (kg)	Rank Facility	
			1997	2000
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Step 2:
For the facility closest to your community, identify the main types of pollutants released into the environment (For example: dioxins and furans, oxides of nitrogen, carbon monoxide, sulphur dioxide, etcetera) and the associated environmental and health impacts. Record this information in your notebook.

Name of Facility: _____

Type of Pollutant(s)	Impact on the Environment and Human Health

Step 3:
To visualize changes over time, determine the rankings of the facilities for 1997 and 2000, and complete the table above. Use the "Pollution Rankings" link.

a) Describe any trends evident in the data.
b) Comment on the possible fluctuations in the amount of pollution produced by the facilities.

Step 4:
Formulate a letter to one of the industrial facilities studied in this activity. Ask them what their company is doing to cut back on harmful pollutants released into the environment. Do they have a long term plan to reduce their emissions? Is there anything that you or your school could do to help?

PollutionWatch

Get answers about pollution in your community

Source: *pollutionwatch.org* (used with permission)

Multi Materials Stewardship Board (MMSB)

In 2001, the government of Newfoundland and Labrador developed a Waste Management Strategy that included five action items. One of the main initiatives of the waste management strategy was to establish the Multi Materials Stewardship Board (MMSB). It is responsible for developing, implementing, and managing waste diversion programs in Newfoundland and Labrador.

Since its inception, MMSB has worked with stakeholders throughout the province to develop and implement recycling and waste diversion programs. Intended to help keep Newfoundland and Labrador "healthy, clean, and green", these include recycling programs for beverage containers, tires, oil, and household hazardous waste. Other MMSB initiatives include the Waste Management Trust Fund, and the public education and information programs for recycling and waste reduction.

When the MMSB started its recycling program in 1997, every soft drink bottle or can had a six-cent recycling fee but you could get back three cents if you recycled at an approved depot. This was later increased to an eight-cent recycling fee with a five-cent return. After one year, the return rate was about fifty per cent. After 2002, the recycling rate jumped to sixty eight per cent, which could indicate an attitude change by our citizens toward reducing wastes in our dumps.

Waste Management Strategy

ACTION ITEM 1:
Increase recyclable materials and reduce wastes going to disposal sites.

ACTION ITEM 2:
Communities can pool their resources and create regional waste management sites.

ACTION ITEM 3:
Reduce the number of waste disposal sites and use management techniques that reduce environmental impact.

ACTION ITEM 4:
Maximize the economic and employment benefits of waste management.

ACTION ITEM 5:
Public Education.

Encouraged by the participation of citizens, and conscious of the need for better waste management, many communities now require householders to separate their recyclable paper from the regular household garbage. Some municipalities have made it compulsory for businesses to recycle their waste paper.

Household Hazardous Waste Collection

What is Household Hazardous Waste (HHW)?

Some householders choose products containing hazardous components for certain activities around the home. These products may include certain paints, cleaners, stains and varnishes, car batteries, motor oil, or pesticides. The used or leftover contents of such consumer products are known as "household hazardous waste."

Household Hazardous Waste includes products that are:

POISON
Pesticides, Chemicals
Rat poison, Bleach
Pharmaceuticals
Cleaning fluids

EXPLOSIVE
Aerosols
Propane cylinders

CORROSIVE
Batteries
Drain cleaner
Oven cleaners

FLAMMABLE
Paints, Solvent
Oils, Gasoline
BBQ starter

Poisonous—can poison or damage living organisms.
Explosive—can react violently when mixed with other agents, or when exposed to heat or pressure.
Corrosive—can eat away at surfaces, including skin.
Flammable—can burn easily.

Canadians generate over 1 million tonnes of household hazardous waste per year. The average home can accumulate as much as fifty kilograms of household hazardous waste in the basement or garage and in storage closets. When improperly disposed of, household hazardous waste can create a potential risk to people and the environment.

What Are the Dangers of Improper Disposal?

There is a right way and a wrong way to get rid of hazardous wastes. Never pour hazardous waste down the drain, on the ground, into storm sewers, or put them out with the trash. The dangers of such disposal methods may not be immediately obvious, but certain types of household hazardous waste have the potential to cause physical injury to sanitation workers, contaminate septic tanks or wastewater treatment systems, and harm children and pets.

Did You Know?

There is an important distinction between storm sewers and sanitary sewers. Sanitary sewers transport human wastes to treatment facilities or disposal areas. Storm sewers collect water from streets and sidewalks and discharge to local drains, rivers, and ponds.

Figure 2.13: Dumping toxic materials in storm sewers will have negative affects on ecosystems many kilometres away.

A significant issue in urban areas of Newfoundland and Labrador is the disposal of toxic materials into storm sewers or drains. These toxins ultimately end up in urban streams and other water bodies, and can kill many fish and other species in the streams and waterways.

Reduce and Recycle

One way to reduce the potential dangers of household hazardous waste is to use non-hazardous or less hazardous products. You can do this by reducing the amount and/or toxicity of products you use and/or by using only the amount needed. Leftover materials can be shared with neighbours or donated to a business, charity, or government agency, or given to a household hazardous waste program. For example, excess pesticide might be offered to a greenhouse or garden center, or left over paint could be offered to local theatre groups.

Recycling is an economical and environmentally sound way to handle some types of household hazardous waste, such as used automobile batteries and oil. Auto parts stores and service stations frequently accept used automobile batteries and eighty per cent of these batteries are currently recycled.

Household Hazardous Waste Collection Days

During the 1980s, many communities started special collection days or permanent collection sites for handling household hazardous waste. On collection days, qualified professionals collect hazardous wastes at a central location to ensure safe waste disposal. Check with your local town council to see if there is a household hazardous waste collection program in your area.

Challenge

If there are no Hazardous Waste Collection days in your community, why not get your school to start one?

Used Motor Oil Collection

Anyone who drives an automobile, ATV, or a snowmobile has a big responsibility—not only for safe operation, but also for protecting the environment.

You probably know that you should change your oil regularly, but did you ever wonder what you should do with the used motor oil after you remove it from your vehicle?

Why Should You Recycle Used Motor Oil?

Oil is a non-renewable resource and should not be wasted. Our province has **Used Oil Disposal Regulations** that came into effect in 2003, under the Environmental Protection Act regarding the disposal of waste oil. Waste oil is insoluble and can contain toxic chemicals and heavy metals. It is slow to degrade and sticks to everything from beach sand to bird feathers, polluting drinking water, and harming humans, wildlife, and aquatic life. The improper disposal of used motor oil from a single oil change can contaminate over 3,700,000 litres of fresh water. That's a year's supply of water for fifty people!

Figure 2.14:
Recycling used motor oil helps protect the environment.

Despite these problems and the legislation, do-it-your-selfers who change their own motor oil dump more than 454 million litres of recyclable motor oil on the ground, down storm drains, and in trash cans.

What Else Can You Do?

It's easy to recycle used motor oil and protect human health and the environment. Just follow these three steps if you or a friend (or even one of your parents) change the oil in a car or ATV.

1. **Remove**: Do not spill any oil on the ground.
2. **Contain**: Put your used oil in a clean plastic container with a tight lid. Never use a container that once contained household chemicals, food, or beverages. Do not mix the oil with anything else, such as paint, gasoline, solvents, cleaners, or antifreeze.
3. **Recycle**: During posted business hours, take used motor oil to a service station, lube center, or automotive store that collects used motor oil for recycling.

If your community has a used oil recycling program, join it. If it does not, why not start one?

Waste Reduction and Composting

Each year, Newfoundlanders and Labradorians generate more than 400,000 tonnes of waste materials. That's approximately two kilograms per person per day. Recycling is a huge step towards conserving natural resources and landfill space. But we can do more to help our environment. We need to think of recycling as one part of a bigger picture: waste reduction!

Figure 2.15: Compost Bin.
Photo courtesy MMSB

We all have a role to play to help reduce the amount of waste generated in the province. Organic waste, which can be composted, makes up as much as thirty per cent of all the waste generated in Newfoundland and Labrador.

Composting is an efficient and effective way to reduce the amount of waste sent to our landfills. Composting is important. It is easy and the rewards are bountiful. Do not throw away your kitchen scraps. Add them to the compost pile. Kitchen scraps are typically high in nitrogen, which helps heat up the compost pile and speed up the composting process. Egg shells, coffee grounds, fruit and vegetable peels, and scraps are all outstanding materials to add. Refer to MMSB's composting information guide for tips.

Waste Reduction Tips at Home

The family that reduces waste in the home helps protect the environment. Help to reduce the household waste your family generates by following these guidelines:

In your Kitchen:

- Avoid disposable items. Use cloth napkins and cleaning towels.
- Reuse plastic containers to store leftovers or for packing lunches.
- Compost kitchen waste.
- Recycle beverage containers by bringing them to a Green Depot. If each person in the province of Newfoundland and Labrador recycled all their beverage containers they could reduce waste by 40,000 tonnes per year.

While Shopping:

- Take your plastic shopping bags back to the grocery store or bring your own cloth shopping bags.
- Buy groceries in bulk rather than in single serve containers.
- Avoid excess packaging when choosing product brands.
- Buy beverages in returnable containers.
- Purchase products that are returnable, reusable, or refillable.

Around your Home:

Figure 2.16: Recycling helps reduce waste.

- Repair or restore used items rather than replacing them.
- Reuse gift bags, wrapping paper, and tags.
- Donate unwanted clothing, furniture, magazines, and other household items to charitable organizations, hospitals, or libraries.
- Call your town council for information about seasonal or designated pickup days for old appliances. This will ensure proper disposal of these items.
- Use rechargeable rather than disposable batteries and recycle your batteries when they are no longer needed. Visit *www.rbrc.org* or call 1-800-8-BATTERY for the location of where to bring rechargeable batteries.

In your Garage:

- Trade in or exchange your old car battery when purchasing a new one.
- Recycle household hazardous wastes (HHW). Contact MMSB or your municipal government for additional information about recycling HHWs.
- Recycle used lubricating oil such as crankcase and gear oil and transmission fluid. Lubricating oil is banned from landfill sites in the province. You can bring lubricating oil to a return facility or point of purchase, free of charge.
- Recycle old tires. Government regulations ban the disposal of tires in municipal landfill sites. Call 1-866-343-TIRE (8473) to locate a drop off location near you.

Recycling in an Apartment Building:

Recycling in multi-unit complexes can present additional challenges. If you live in a multi-unit complex, encourage your building owner or manager to start a recycling program. These are some hints and tips:

- Discuss the idea with the building superintendent.
- Find out how garbage is currently handled.
- Determine if there is storage space for recyclable materials in or outside the building.
- Prepare information for tenants on how the program will operate.
- Place bins and signage in convenient locations.
- Arrange for transportation of material to the Green Depot or contract with a local business to pick up the material.
- Decide what to do with your refund. Donate it to a charity or put the money into the Tenant's Association.

Think about ways to reuse items in your home. Look for ways to reduce the amount of trash you throw in the garbage by making good purchasing decisions and looking for ways to reduce.

Waste Reduction at School

Although *recycling* is an important part of any waste management strategy, the greatest environmental benefits are achieved through *reduction and reuse*. Consider some of the following suggestions to reduce the waste generated by your school. Your efforts may provide the additional benefit of saving money as well. Remember, even small changes can make a big difference! These efforts can easily be attainable if your class initiates an Environmental Science Club. Many hands make light work! Spread the word to teachers and students:

1. Make double-sided copies whenever possible. This can dramatically reduce your paper usage.
2. If applicable, use email instead of making hard copies of all communications.
3. If possible, limit the number of subscriptions to periodicals and have classrooms share them. This will reduce both trash and subscription costs.
4. Arrange to have a vendor collect and recharge empty laser printer toner cartridges. Cartridges can be recharged several times, saving money and reducing waste generation.
5. Encourage teachers and students to reuse paper clips, rubber bands, and brass fasteners. These should be removed before recycling white office paper.
6. Use scrap paper for messages.
7. Require suppliers who deliver products on pallets or in metal drums to take them back.
8. Have your cafeteria switch whenever possible to reusable utensils and crockery instead of throwaways. Investigate the possibility of switching to refillable containers for milk and juice.
9. Encourage students who bring their lunch to use a reusable lunch box and thermos instead of brown paper bags and disposable drink containers.
10. Set up vermicomposting bins in individual classrooms as part of your science program.
11. Replace ball-point or felt tip pens with ones that take refills.
12. Do not purchase envelopes with cellophane windows or self-adhering note pads. If the windows are necessary, purchase the ones which have no covering over the window.
13. Purchase reusable and washable cleaning cloths, aprons, tablecloths, etcetera, rather than single-use disposable products.
14. Buy institutional sizes of cleaning supplies, food products, beverages, etcetera, and repackage into smaller, reusable dispensers.

Sustainability in Waste Management

Our province has made significant progress in waste management. The Province's Waste Management Strategy is intended to divert fifty per cent of waste from our landfills by 2010. To reach this goal, the cities of Corner Brook and Mount Pearl are implementing residential curb side recycling of paper, cardboard, and other fibre waste products.

In addition, the cities of St. John's and Mount Pearl, and the towns of Paradise and Conception Bay South have implemented a mandatory paper recycling program for industrial, commercial, and institutional facilities.

In addition to recycling residential cardboard and paper waste, the Town of Lewisporte has developed a plan to require businesses and institutions to divert their corrugated cardboard.

Towns in the Exploits Valley Region—Bishop's Falls, Grand Falls-Windsor, Botwood, and Northern Arm—are also recycling commercial cardboard waste.

Diverting waste from landfills creates a cleaner environment, encourages increased economic and employment opportunities in the recycling sector, and helps to build healthier, more sustainable communities.

15. Waste from packaging accounts for more than thirty per cent of all the waste generated each year. Use school supplies wrapped with minimal packaging.
16. Save packaging, coloured paper, egg cartons, and other items for arts and crafts projects.
17. Use non-toxic products, inks, and art supplies, such as batteries with less mercury, vegetable-based inks, and water-based paints.
18. If you drive to school, try carpooling or take public transportation. Try walking, biking, or skating. You can prevent wasted fuel, reduce air pollution, and decrease traffic in your community.
19. Borrow or rent your decorations and supplies for parties, dances, and proms. If you buy these supplies, try adopting a theme that can be used from year-to-year, so that you can reuse your decorations and supplies.

CHECK your Understanding

1. Explain how legislation such as the Sustainable Development Act works to
   (i) protect our future
   (ii) provide leadership
   (iii) enhance our role as global citizens
2. Explain how participation and access to information empowers eco-citizens.
3. What are Household Hazardous Wastes?
4. What concerns are associated with Household Hazardous Wastes (HHW)? What steps can be taken to reduce the concerns related to HHWs in your community?
5. What are the social, economic, and environmental benefits of being an eco-citizen?
6. Provide examples of eco-citizenship at the (i) individual, (ii) community, and (iii) provincial levels in NL.

For Further Discussion and/or Research

7. Should governments create laws that will punish people who do not recycle? Explain your reasoning.
8. It has been suggested that, to encourage people to recycle and compost, each household be limited to a maximum of three bags of garbage per week. For every bag over this number, the household would be charged a fee. Do you think this is a good idea? Why/why not? Are there other ways to encourage people to recycle and compost?

Chapter 3: Ecosystems, Ecoregions and Biodiversity

Figure 3.1:
Forest Ecosystem in autumn.
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

Figure 3.2:
Forest Ecosystem in winter.
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

ECOSYSTEMS

Food webs and their related flows of energy and nutrients make up an **ecosystem**. The biosphere is a global ecosystem. Other examples include lake ecosystems, river ecosystems, forest ecosystems, marine ecosystems, and even urban ecosystems.

To better understand ecosystems, let us re-examine the two major components of all ecosystems: abiotic and biotic.

All organisms exist in a given set of physical conditions—their **range of tolerance**. Although the range of tolerance can be wide, most organisms thrive within a narrower range of conditions called the **optimum range**. Cod, for example, generally tolerate a wide range of ocean temperatures, from about -0.5°C to +10°C. However, they usually prefer a much narrower range of temperatures. These preferred ranges can be quite different for different areas.

The biotic components of an ecosystem live in **populations**: groups of the same species occupying a given region. Populations are dynamic groups, changing in size, age, structure, and genetic composition depending on changes in the environment. Populations never live alone in an ecosystem. They always share resources with other species, forming a **community**. A community is defined as all the organisms living in a given area. Terra Nova National Park is a protected area with populations of black bears, moose, coyotes, ravens, ospreys *(Pandion haliaetus)*, salmon, and many other organisms, including dozens of plants, all forming a complex community of living things.

Ecosystems sometimes have fairly distinct boundaries, like a lake, or an island. But sometimes the boundaries of an ecosystem are indistinct, as in the transition from ocean to land.

Wildlife: all living things (except people) that are undomesticated. *www.wordreference.com/definition/wildlife*

Figure 3.3: Ocean/Terrestrial Ecosystem.
Photo courtesy Environment Canada/Andrew Boyne

The **diversity**, or variety, of ecosystems in Newfoundland and Labrador is spectacular: from the oceans surrounding our shores to the island's rugged south coast, to maritime barrens, to boreal forest and lakes, to the Tablelands of Gros Morne, to the windy peaks of the Torngat Mountains, and even to the sub-Arctic tundra of northern Labrador. Each one of these distinct natural regions provides habitat for its own communities of plants and wildlife.

Figure 3.4:
Diversity of Landscapes in Newfoundland and Labrador.
Photos courtesy of Newfoundland and Labrador Department of Environment and Conservation

A diverse ecosystem includes many kinds of organisms at each trophic level. By removing one species from its environment, more than one species may be affected. Diverse ecosystems are more likely to survive changes, such as the loss of a species or an attack by disease, than are less diverse ecosystems. For example, if a predator consumes four species of prey and one of those species dies out, the predator still has three prey species – not as much diversity, but probably enough for the predator to continue to survive in that system. On the other hand, if there is only one species of prey available to a predator and that prey's population declines, or it disappears from the ecosystem entirely, then the predator species will either die out or move on to another ecosystem.

The island portion of our province has a typical island ecosystem. It does not have many of the animals and plants found in other areas of North America. This unique set of plants and animals was influenced by the glaciers which covered the island

during the last ice age. After the glaciers melted the island emerged from beneath the ice devoid of most plant and animal life and was re-colonized by organisms from the nearby mainland.

The predominantly westerly winds carried airborne plant seeds, and lichen, and moss spores onto the island. But not all plant seeds are suitable to spread in this way. So it is no surprise that the island has fewer plant species than the mainland. The lakes and rivers were populated only by those freshwater fish able to survive in seawater.

Birds and flying insects made the journey, as did marine animals and those animals that crossed the sea ice between the island and the mainland during the winter. With the exception of black bears, no hibernating animals crossed to the island (For example: chipmunks, frogs, snakes, etcetera) The native mammals on the island include only fourteen species while Labrador has thirty nine native species of mammals.

Strongly influenced by geology and our location on the edge of the North Atlantic, this rich natural heritage has fed our families, our economy, and our culture for centuries. It continues to contribute to our way of life today. Knowing how important environmental health is to our people's survival and prosperity, safeguarding our environment for the future is an important responsibility.

Did You Know?

The study of **island biogeography** is a field within biogeography that attempts to establish and explain the factors that affect the species diversity of a particular community. In this context the island can be any area of habitat surrounded by areas unsuitable for the species on the island. These are not only true islands surrounded by ocean, but also mountain habitats surrounded by deserts, lakes surrounded by dry land, or even forest fragments surrounded by human-altered landscapes. *en.wikipedia.org/wiki/Island_biogeography*

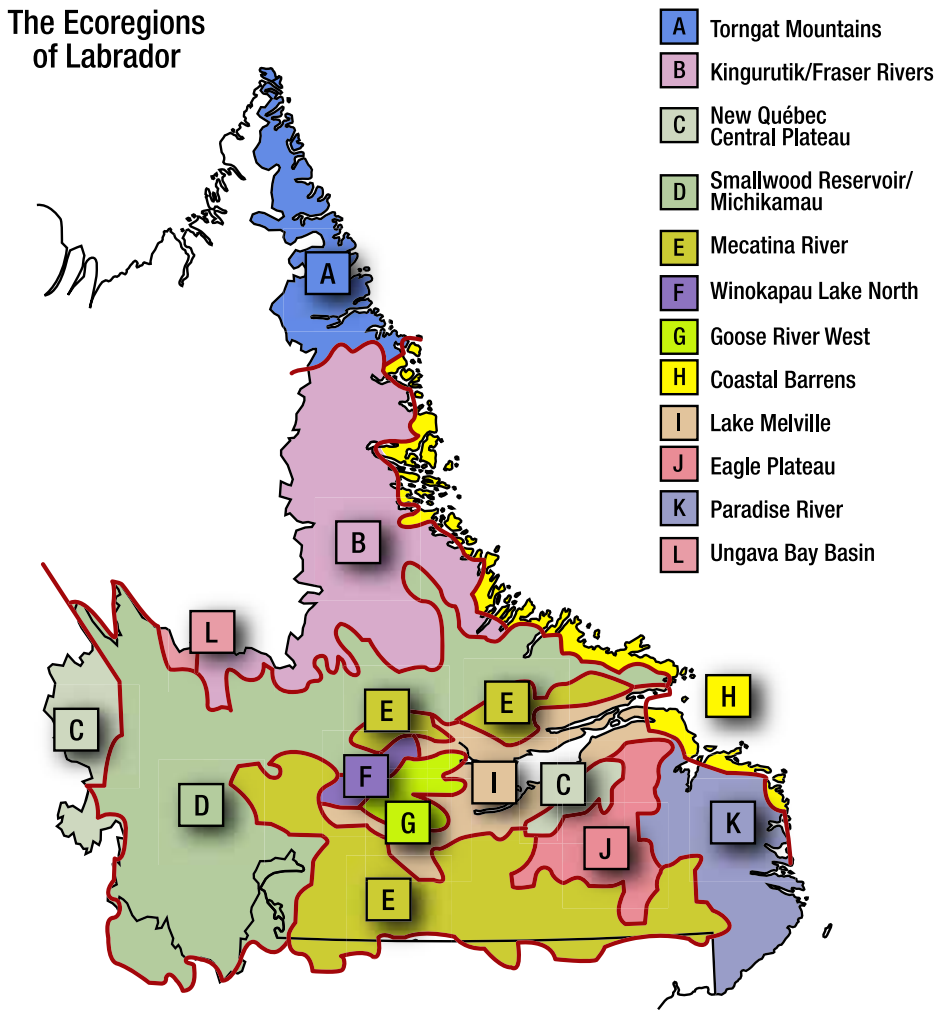
ECOREGIONS

Ecoregions denote areas of general similarity in ecosystems. An **ecoregion** is an area of land or water that contains a geographically distinct collection of natural communities. Ecoregions differ from one another based on climate, soil, geology, topography, flora, and fauna.

Figure 3.5: The atlantic puffin has officially been the provincial bird of Newfoundland and Labrador since 1991.

The Ecoregion Classification System serves as a framework for recognizing terrestrial ecosystems in Newfoundland and Labrador. The Ecoregion Classification system helps us understand and describe the vast diversity of habitat in the province. There are nine defined ecoregions on the island of Newfoundland and twelve in Labrador.

Descriptions of the different ecoregions in Newfoundland and Labrador can be found by searching provincial government websites.



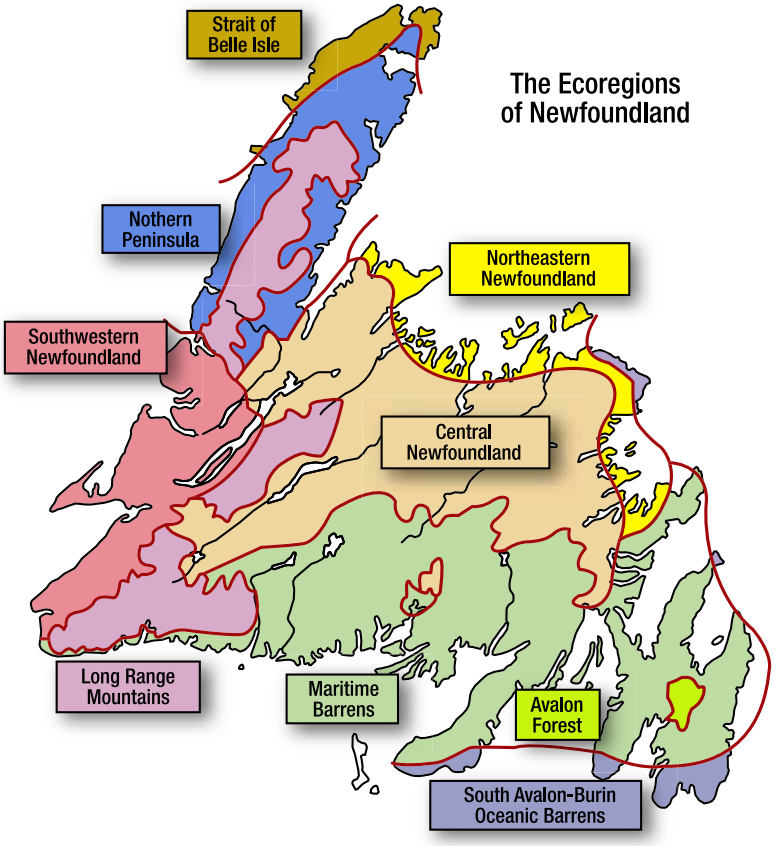


Figure 3.6: Ecoregion Classification System in Newfoundland and Labrador.
Maps by Tina Riche, ©2002, Newfoundland and Labrador Heritage Web Site Project

MINI- LAB ACTIVITY

What Ecoregion Do I Live In?

Background

We are not always as aware of our natural surroundings as we think we are, or as we might like to be. In this activity, see how much you know about the ecoregion in which you live. Then compare your notes with the description of your ecoregion in the text and on the Web.

Purpose

To describe your ecoregion.*

Materials

Notebook

Procedure

1. Based on your past experience, describe the climate of your local ecoregion under the following headings:
    a. Relative length of seasons
    b. Average daily temperatures
    c. Length of growing season
    d. Type of winters
    e. Type of summers
    f. Wind and wind direction
2. Describe the physical characteristics of the land in your area.
3. What are the most common animals (fauna) near your community?
4. Describe the dominant vegetation (flora).

* *Try to do the above based on your own experiences, rather than looking at climate records, etcetera. If you live in a large city, try to get to the outskirts of town to better determine native vegetation types and physical characteristics of the land.*

Analyze and Conclude

1. Does your description of your area match the description of your ecoregion in the text? For a more detailed description of your ecoregion visit the Forestry division of the provincial Natural Resources website: *www.nr.gov.nl.ca/.*
2. Does your description match any other ecoregion?
3. What kind of scientific skills might a person need to adequately describe an ecoregion?
4. Why is it useful to divide the province into ecoregions?
5. What kinds of people or industries might be interested in the information about each ecoregion?
6. Do you feel that you are as aware of your natural surroundings as you could be?
7. What kinds of activities might you or your class undertake to increase your awareness of your natural surroundings?

Activity courtesy D. Murphy

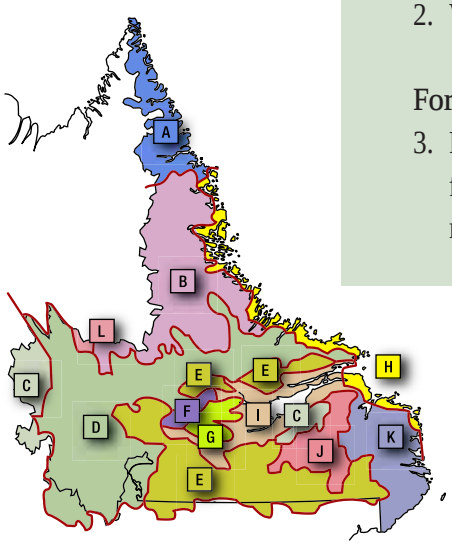
CHECK your Understanding

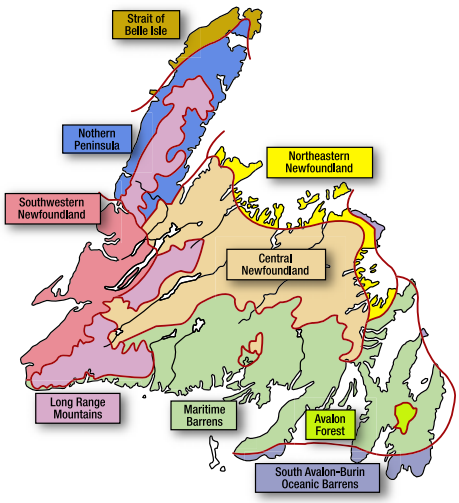
1. Define the term ecoregion. What determines the type(s) of vegetation in an ecoregion? After studying the ecoregion maps in this section, name the ecoregions that you have visited in your lifetime.

2. What is the connection between ecosystems and ecoregions?

For Further Discussion and/or Research

3. Research one of the twenty one ecoregions in our province. Identify five biotic and five abiotic factors of this ecoregion. Explain what makes this ecoregion unique.





BIODIVERSITY

Biodiversity (or *biological diversity*) refers to the variety of life on Earth. It is a measure of variety among ecosystems, species, populations within species, and genetic diversity. Natural biodiversity is a component of healthy ecosystems, and there is a growing recognition that our continued access to Earth's resources including clean air, water, and soil depends on this biological diversity. People often do not consider this living diversity because most of us inhabit human-modified environments where we obtain all of our needs with relative ease. Many of us rarely consider the many ways in which we depend on Earth's biodiversity. It is easy to forget that the things we take for granted, our food, our medicine, clean water, building supplies and much, much more, are taken from the natural world. How often do we stop to consider where the different foods on our dinner plate come from? Or the many steps and processes required to put it there? Human activities, through direct and indirect consequences, are rapidly depleting Earth's biodiversity. Between ten and forty per cent of all species on Earth are currently at risk of extinction!

Three Tiers of Biodiversity

1) Species biodiversity
   Refers to the number of species of plants, animals, and other organisms in a specific area. This is what is most often understood by "biodiversity."
2) Genetic biodiversity
   Describes the range of variation within a species. For example, the Newfoundland marten *(Martes americana atrata)* (found on the island of Newfoundland) is genetically different from the American marten *(Martes americana)* (which lives on the mainland).
3) Community or ecological biodiversity
   Refers to the various communities of interdependent plant and animal life as the "big picture" of biodiversity.

Today, scientists believe the decline of biodiversity is one of the most serious global environmental threats facing humanity. Because we benefit from the natural world, we have important reasons for conserving biodiversity:

- Many of the goods we use every day are derived from biological resources including our food, books and paper, buildings, clothing, and medicine. The natural resources from which these are derived are critical for our survival and our economic well being.
- Healthy ecosystems provide "essential survival services" like oxygen production, nutrient recycling, and climate control, all of which impact food production.
- The environment, and living organisms in it, provides enjoyment during leisure activities such as hiking, fishing, camping, or visiting nature reserves and parks.
- The way we feel and think about our impact on biodiversity is also important, which brings us to the ethical importance of conserving biodiversity. What are the rights of each species to exist? Supporters of the ethical importance of conservation pose the question: Do humans have the right to drive other species to extinction when prevention is possible?

Figure 3.7: Protesters taking demands for change to the street.

The accelerating decline in biological diversity threatens these ecological, economic, spiritual, recreational, and cultural benefits that we derive from Earth's natural resources.

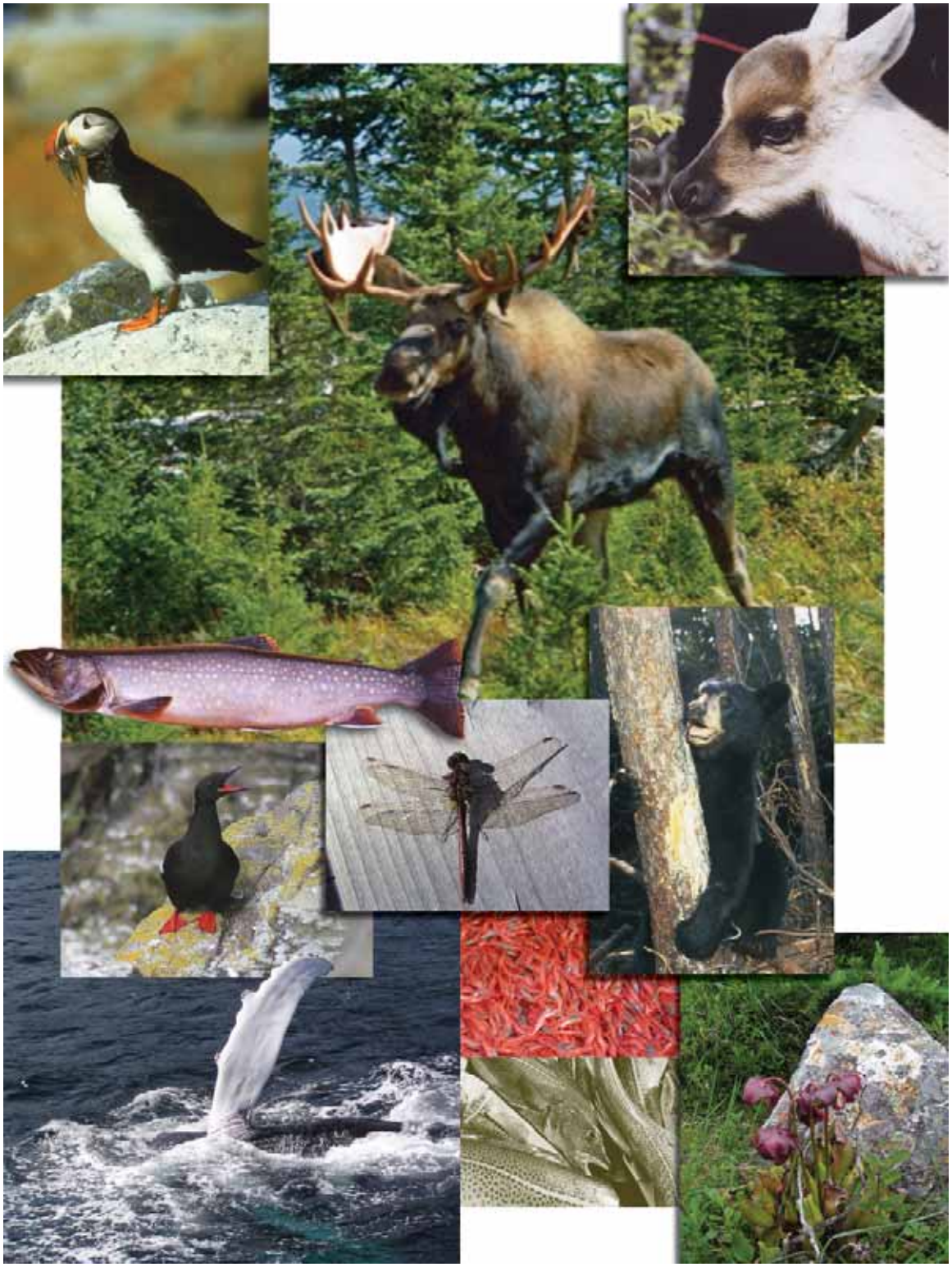


Figure 3.8: The variety of life in Newfoundland and Labrador is vast. This diversity of species keeps our ecosystems functional and healthy.
Photos courtesy Environment Canada/Peter Thomas; Newfoundland and Labrador Department of Environment and Conservation and Department of Tourism, Culture and Recreation

CORE LABORATORY ACTIVITY

Biodiversity – Why is it Important?

Outcomes:

The student will be able to:

- Define biodiversity.
- Identify an area as being high or low in biodiversity.
- Identify the importance of biodiversity in natural environments.
- Recognize that biodiversity is a natural defense against disease in plant populations.

Introduction:

When scientists speak of the variety of organisms (and their genes) in an ecosystem they refer to it as **biodiversity**. Nature tends to increase diversity through the process of **succession**. A biologically diverse ecosystem, such as an old growth forest or tropical rain forest, is healthy, complex, and stable.

The opposite of biodiversity is referred to as **monoculture**, or the growing of one species of organism, such as a lawn, a wheat field, or a corn field. Humans often try to reduce diversity because it is easier to harvest a crop (whether it is wheat, corn, or a secondary forest) if it contains only one species. Because all the organisms are identical in a monoculture, there are no complex food webs. Disease can spread quickly. Monoculture is like a banquet table for disease organisms. As a result, monoculture often requires extensive use of **pesticides** and **herbicides** (to fight nature's tendency to diversify communities) and is very labour and energy intensive (fighting nature is tough).

In the first activity, you will calculate the diversity index of a selected habitat. The closer the biodiversity index is to one, the more diverse and healthy the habitat is. In the second activity, you will learn how biodiversity in an ecosystem can limit the spread of certain diseases.

Activity 1

Biodiversity Index—What does it indicate?

Your teacher will provide you with two containers which represent known ecosystems found on Earth. Each container will contain a variety of items which will represent the various organisms in the "ecosystem." Refer to the key provided which indicates which items represent which organisms.

Your group will analyze each "ecosystem" (container) for the degree of biodiversity and calculate the biodiversity index using the following formula:

$$BI = \frac{\text{Number of different species}}{\text{Total number of organisms}}$$

1. Use the key to identify the different types of organisms present.
2. Using a table, record how many of each organism is present in your simulated ecosystem.
3. Using the Biodiversity Index formula, calculate the BI for each of the simulated ecosystems you have.
4. Match each "group of organisms" with an appropriate ecosystem from a list of ecosystems provided by your teacher.

Activity 2

Biological Diversity - Can it stop the spreading of disease?

A very diverse habitat with a wide variety of species is much healthier and more stable than less diverse habitats. One of the reasons for this is that diseases, which are often species-specific, do not spread as easily in a diverse community. In a biologically diverse ecosystem, if one member of a species gets a disease, fewer members of its species will be exposed because of the variety of other organisms which separate the species. This minimizes the chances that the disease will spread. In areas where there is a reduced biodiversity, and more animals of the same species come in contact with each other, disease can spread quickly.

In this simulation, you will use sets of cards to represent monocultures and diverse ecosystems in a second growth forest ecosystem. The monoculture card set represents an ecosystem where larch trees were planted after an old growth forest was cut down. A disease infects one of the larch, and because of the proximity of the other larch, the disease spreads quickly to other trees.

On the second set of cards a biologically diverse community (a mixed forest) is symbolized. In this scenario, a larch is still infected with a disease, but this time the spread is not as prolific because the other larch trees are more widely dispersed.

For thousands of years boreal forests have undergone natural cycles of disturbance such as fire and insect-induced mortality followed by re-growth. Stands of trees are destroyed and new trees—mostly of similar age—grow up to replace them. This exercise is meant to show how human interference can affect forest growth or other ecosystems where monoculture practices are used.

Part 1

1. Each student gets one card with an L to represent that all students are larch trees.
2. During the time provided, each student is to move through the classroom and meet five other people; write their names on the back of the card. Your teacher will signal when time is up.
3. Everyone remains standing after they write down the names. This represents that "the larch trees", of the larch forest, are in close proximity to each other.
4. Your teacher will "infect" one of the "larch trees" by naming one student. The person named will sit down (they are dead) and read the names on their card. As the names are read, those students also sit since they have been "infected." The teacher will ask another one of those sitting (dead tree) to read the names on their card. This will continue until all, who are sitting, have read the names on their respective cards.

As you perform this activity, consider why the disease spread so quickly and easily.

Part 2

1. Each student gets one card. In this case, not all the cards will be the same. This is in recognition of the fact that, in some forests such as a mixed deciduous forest, there are a variety of trees.

2. Repeat steps 2–6 in Part 1. This time only those students with larch tree cards will sit. Different variety trees don't sit (don't die) even if they are named by a "diseased tree."

As you perform this second activity, consider why the disease did not spread as rapidly this time.

Analyze and Conclude:

1. What does biological diversity mean?
2. Why didn't all the different trees get the disease? (hint - genetics)
3. Why didn't the disease spread as fast among the second population of larch as it did in the first simulation?
4. In which forest would you need to use more chemicals to control disease: the larch forest or the more diversified forest? Why?
5. Summarize what this simulation demonstrates.
6. Which forest would have more diversity of wildlife? Why?
7. a. If you reduce the variety of tree species in a section of forest you owned and replanted with one type of tree, what will happen to some of the wildlife that were adapted to that forest? Explain your reasoning.
   b. Will this fate happen to all the wildlife? Explain.
8. Many species can only live/reproduce in one type of forest. The Newfoundland marten is an example—it can only live and successfully reproduce in old growth forests with big balsam fir trees *(Abies balsamea)*. If these old growth forests are cut down, it's unlikely the Newfoundland marten will survive. Environmentalists call the Newfoundland marten an "indicator species." What does this mean? Should we be concerned about one species? Why or why not?
9. Growing one plant, as is the case of growing only balsam fir, is called monoculture. Give an example of growing one plant:
   a) around your home b) on farms
10. Why would you need to use more insecticides in monoculture? Is this good or bad? Explain.
11. If you wanted to increase wildlife around your home, what landscaping practices or techniques could you use? Describe fully.

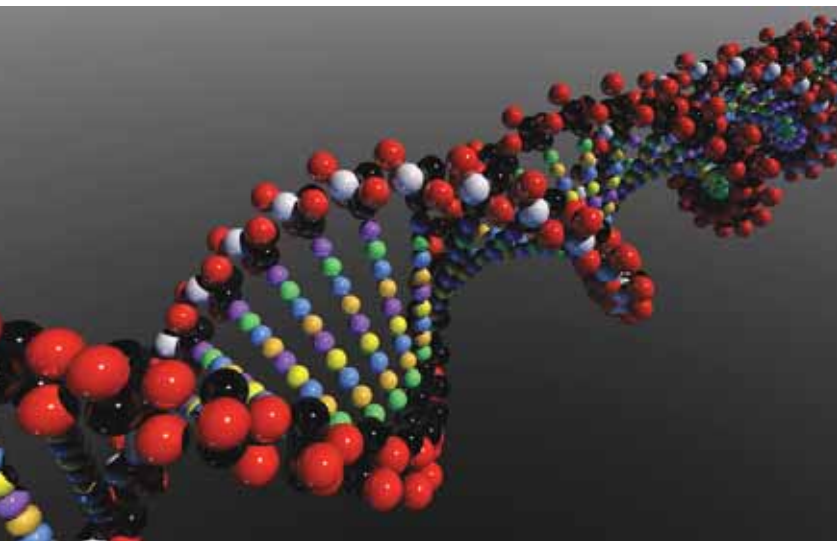


Figure 3.9:
Model of a DNA helix.

Genetic Diversity

The term **inheritance** refers to the transmission of traits from one generation to the next. Genes are the "units of inheritance." They transfer the characteristics of a parent organism to its offspring and determine how an individual will look and behave.

Genes are actually sequences of nucleotides in a DNA molecule, and different sequences transmit different traits to offspring. For example, genes ensure that adult cats have kittens, that humans have babies, and that blueberry plants produce blueberries. Genes are located in the nucleus of every cell and are organized into larger structures called chromosomes. In humans, each chromosome contains thousands of genes that code for different information about who we are, whether we are male or female, the color of our skin, the color of our hair, and which diseases we are at high risk of developing.

Variation within species that is determined by genes is known as **Genetic diversity**.

Figure 3.10: Left: Common Murres *(Uria aalge)* with and without "bridle" around their eye. Bridles can occur in both males and females. Scientists have never determined if the bridle has any significance other than cosmetic.

Right: Arctic Wolf *(Canis lupus arctos)* (centre) and Timber Wolf *(Canis lupus)*—fur color differences within the same species.

Genetic diversity is crucial to the survival of a species. All of the members of a species with little genetic diversity will be susceptible to the same stressor: disease, climate change, or loss of habitat and therefore, if their habitat changes, the species is more likely to become extinct. If there was no genetic diversity and all individuals within a species were genetically identical, then they would all respond the same way to an outbreak of a lethal disease and the species would be in danger of extinction. On the other hand, genetic diversity within a population is more likely to allow some individuals to survive in the face of a changing environment. These would be the ones that go on to reproduce and pass on their resistant genes to their offspring, thereby ensuring species survival.

ENVIRO-FOCUS

Gene Diversity and Evolution

Genetic diversity allows species to adapt or evolve in changing environments. Here are just a few examples:

1. Resistance to pesticides by insects

Figure 3.11: Spraying field with pesticides.

When a farmer uses a new pesticide to kill a certain species of insect, the insecticide typically kills all of those that get a full dose. However, a small number may survive because they have some natural resistance to it and/or get a smaller dose of the pesticide. When these insects breed, they pass on these pesticide resistant genes to their offspring. Eventually, the farmer must either use more of an existing pesticide or find a new one, as larger proportions of the insect population become pesticide resistant.

2. The Newfoundland marten

Figure 3.12: Newfoundland Marten.
Photo courtesy of Newfoundland and Labrador Department of Environment and Conservation

The Newfoundland marten is one of only fourteen native mammals on the island of Newfoundland. For thousands of years the Newfoundland marten has been isolated from mainland martens. During this time, these two groups evolved under different environmental conditions and, as a result, the Newfoundland marten is now recognized as a unique subspecies of marten. One noticeable feature is that Newfoundland martens have evolved to have larger home ranges than mainland marten (a home range refers to an area that a species frequently uses to breed and to find shelter and food). Researchers feel this larger range may in part be a result of the Newfoundland marten adapting to smaller amounts of prey in a more fragmented landscape compared to mainland martens. These features of their island habitat, and the marten's habit of avoiding large open spaces, mean that the animals must defend a larger territory to ensure they have enough food resources.

CHECK your Understanding

1. Define biodiversity.
2. Describe the biodiversity in your area (For example: around your community) or in an area of the province you have visited.
3. Give two reasons why we need to preserve the biodiversity within ecosystems/ecoregions.
4. Why does genetic diversity within a species help the species to survive drastic changes in their environment?
5. Why is it important to protect the diversity of plant and wildlife species in Newfoundland and Labrador?
6. Why is genetic diversity crucial to the survival of a species?

For Further Discussion and/or Research

7. Choose two different ecosystems (For example: intertidal zone and forest). Compare the biodiversity between the two ecosystems.
8. Compare the level of biodiversity in the ecosystem in which you live with one in another part of the province. Which ecosystem would be impacted the most if several plant and animal species disappeared? Explain your reasoning.
9. Species diversity and genetic diversity are important in the maintenance of an ecosystem. Are they equally important or is one more important than the other? Explain your reasoning.

Chapter 4: Protecting Species

INTRODUCTION TO SPECIES PROTECTION

On a warm June third in 1844, two men spy a pair of nesting birds on an island near the coast of Iceland and go ashore to harvest them. After a brief struggle, during which the single egg is crushed, the two birds fall prey to the hunters. That is the last recorded encounter between humans and living Great Auks *(Pinguinus impennis)*.

These large, flightless birds once numbered in the hundreds of thousands on remote locations such as Funk Island off northeast Newfoundland. Valued as a food source by early visitors to North America, the Great Auk was hunted relentlessly. This unregulated harvest continued until the 1830s when the bird population disappeared from Funk Island and all the other locations it had inhabited for countless millennia. Since that day in 1844, humanity has had to live with the results of their actions: a species erased from the planet. As a fitting gesture, Funk Island is today an ecological reserve where other seabird species are protected from human predation.

In Canada, there are currently more than 500 animal species facing imminent extinction, extirpation or serious population reduction due to threats imposed by humans and/or natural events. These are called *At Risk* species and the list continues to grow. In Canada, species are assigned to categories based on the level of risk they face. How these ranks are assigned and what they mean is discussed in this chapter.

Enviro-fact

To the ancient Celts, the Great Auk was known as "pen gwin"—a term meaning white-eye—because of the large white patch on each side of its head. When travelers saw flightless swimming birds in the southern hemisphere that resembled the *pen gwin*, they also named these "penguins", even though these birds were unrelated.

It is a sad irony that the bird we now know as the penguin is so named through a case of mistaken identity, and the original pen-gwin has disappeared from the planet.

Figure 4.1: Great Auk.
Image courtesy Library and Archives Canada Acc. No. 1970-188-2851 W.H. Coverdale Collections of Canadiana

Understanding how wildlife species evolve and the type of threats they face every day is essential to understanding why species become *At Risk* and sometimes become extinct. Throughout this chapter, you will learn why species diversity is important, why some species become *At Risk*, why people are responsible for protecting species, and how people and governments in Canada and around the world work together to protect and recover Species *At Risk*.

When the last individual of a race of living things breathes no more, another Heaven and another Earth must pass before such a one can breathe again.

WILLIAM BEEBE

Did You Know?

A *Biome* is a regional collection of plants and animals that are adapted to the specific natural environment and terrain of an area. Climate, geography, and location on the globe will influence the biome of the area. Depending on the report, book, or web site you review, biomes can be broken down in slightly different ways, but the core of biome classification must include the following habitat types:

1. aquatic
2. forests
3. grasslands
4. deserts
5. tundra

Why do species go extinct?

Extinction is a natural phenomenon. It is estimated that 99.9 per cent of all species that have ever lived are now extinct. Through evolution, new organisms arise and thrive when they are able to find and exploit an ecological niche. Species become extinct when they are no longer able to survive changes in their habitat, when an important food source is eliminated, or when a species cannot defend itself from competition or predation by other species. A great concern in today's world is the current *rate* of species' extinction, which has increased over time. This increase is associated with direct and indirect consequences of human activity rather than natural occurrences or catastrophes.

Figure 4.2: Clear-cut logging results in habitat loss for some species.

Although the current overall rate of species extinction is unknown, recent calculations put it at between 1,000 and 10,000 times greater than it would be if human activities were not impacting species. This extinction rate continues to accelerate. Additionally, it is believed that sixty per cent of the services that ecosystems provide to our societies (such as oxygen production) are being degraded or used unsustainably. More than fifty per cent of six of the world's biomes have been altered (primarily converted to agriculture) and between ten per cent and thirty per cent of the world's mammals, birds, and amphibians are currently threatened with extinction.

Figure 4.3:
Garbage incinerator at a Newfoundland and Labrador landfill site. *Photo courtesy Newfoundland and Labrador Department of Environment and Conservation/G. Dawe*

Although the severity varies from place to place, plant and animal species are threatened in every habitat on every continent on Earth. The primary human-associated factors contributing to extinction are:

1. Habitat loss and degradation
2. Introduced species
3. Overexploitation
4. Pollution

These topics will be discussed in more detail in subsequent sections.

Why do we protect species?

Humans protect species in order to conserve biodiversity. The importance of conserving biodiversity was briefly outlined earlier, including the economic value, ecosystem services, and aesthetic benefits that we derive from the natural world, as well as our ethical and moral obligations. Each species occupies a niche in an ecosystem. Together, organisms interact and each species is directly or indirectly interconnected with all other species in the ecosystem. For example, bees use pollen and nectar from flowers to feed themselves and, in turn, their movements help to pollinate flowers. These types of relationships and the natural link among all species and their environments are sometimes referred to as the *Web of Life*. Although scientists have learned a great deal about the wildlife around us, there are still many unknowns with regard to understanding the interactions among the millions of wildlife species in the world today.

Figure 4.4:
Environment Canada field staff collecting information on forest birds in eastern Newfoundland. *Photo courtesy Environment Canada/ Peter Thomas*

Eliminating one species in a given ecosystem can weaken others that depend upon it for their survival. Sometimes the link between species is not obvious. For example, as Peregrine Falcon numbers declined due to indirect exposure to the insecticide DDT (dichloro-diphenyl-trichloroethane) during the mid-twentieth century, a corresponding drop was observed in the Red-breasted Goose *(Branta ruficollis)* population in Siberia. This species of goose nests on the ground making them vulnerable to foxes and other birds that would eat their eggs and chicks. To

deter these predators, Red-breasted Geese form small breeding colonies near cliffs containing nesting peregrines. While the Peregrine Falcons defend their own nesting territory from predators, they inadvertently shield the nesting geese as well. Without the nearby Peregrine Falcons, the geese became more vulnerable to predators. This is how the effects of DDT usage contributed not only to the disappearance of the Peregrine Falcons in Siberia, but contributed to the unstable future of the Red-breasted Goose as well. The following case studies are examples of why it is important to the people of Newfoundland and Labrador to protect Species *At Risk*.

ENVIRO-FOCUS

Species significance: Woodland Caribou

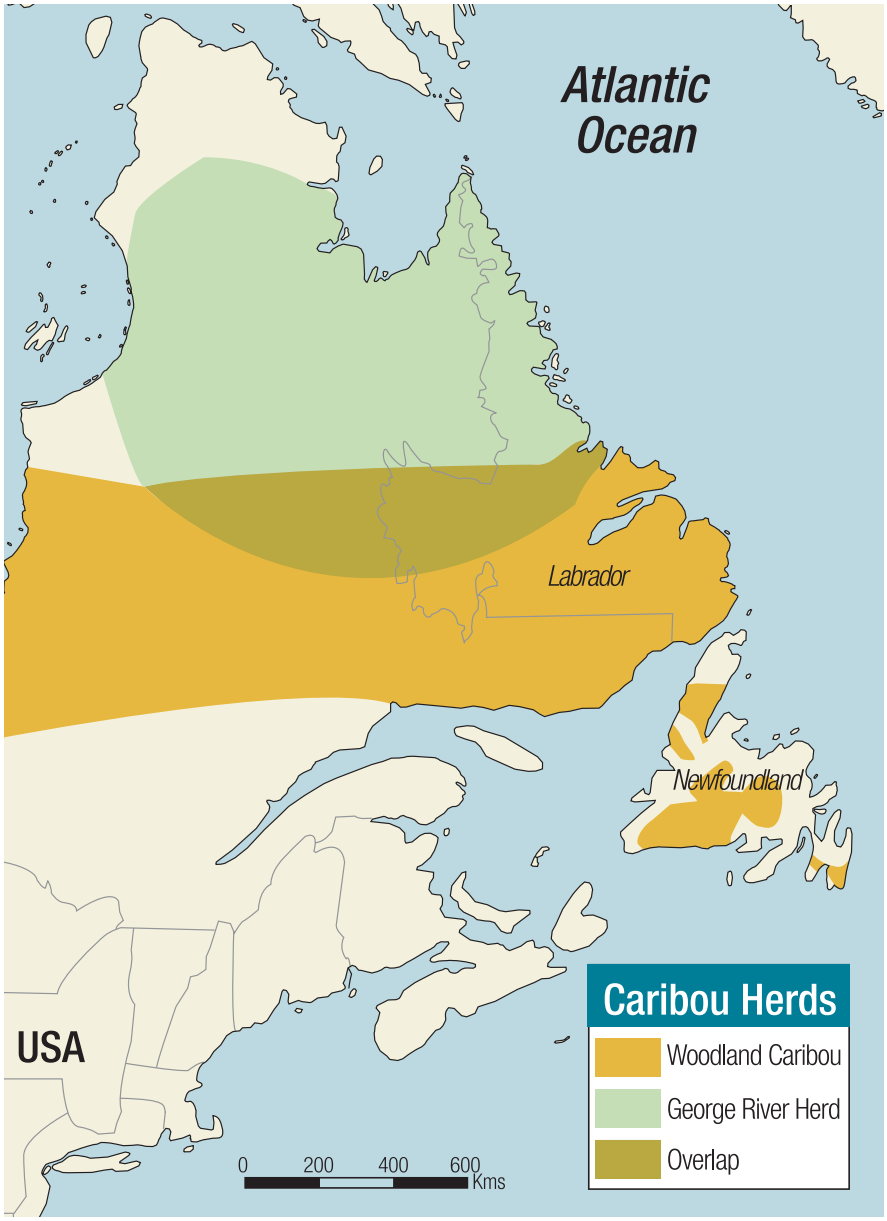
Newfoundland and Labrador is home to Woodland Caribou *(Rangifer tarandus caribou)*. These medium-sized (100-250 kg) members of the deer family are generally dark brown with a white mane and some white on their sides. Both sexes can bear antlers, though some females may lack antlers or have only one. A distinctive characteristic of all caribou is their large, rounded hooves that act like snowshoes to help reduce sinking in snow and wetlands. Their hooves also make good shovels when digging for food under snow.

Figure 4.5: Woodland Caribou.

Caribou eat a wide variety of plants and know how to select small parts of plants with high nutritional value. In summer, they eat sedges, grasses, various flowering plants, lichens, fungi, and the leaves of shrubs, particularly willow. In winter, they eat large amounts of lichens. The loss of any of these plant species may impact the caribou in ways that we have no way of seeing or understanding at this time.

Figure 4.6: Woodland caribou.
Photo courtesy Environment Canada/Peter Thomas

Caribou are herding animals. Woodland caribou herds, found throughout Newfoundland and Labrador, range in size from just a few individuals to thousands of animals. Labrador is also home to a massive herd of hundreds of thousands of migratory barren ground caribou, the George River herd, found in northern Labrador and Québec. Only a few of these populations are considered to be *At Risk* as of 2008. Although presently in serious decline, the Woodland Caribou herds on the island of Newfoundland are not *At Risk*. However, the small caribou herds of the south-central area of Labrador are in jeopardy and are considered *At Risk* under both federal and provincial legislations.



Woodland & George River Caribou Herds

Woodland Caribou have important cultural and economic significance to the people of Newfoundland and Labrador. If these smaller herds of southern Labrador were ever to be extirpated, it would have significant cultural impacts. Caribou have a special spiritual and cultural significance to the Innu, Inuit, and Métis of Labrador and are a traditional source of food and materials for clothing and tools. Recreational hunting of Woodland Caribou and related wildlife tourism are also economically important.

ENVIRO-FOCUS

Marine Species *At Risk*
Wolffish

The Northern Wolffish *(Anarhichas denticulatus)*, the Spotted Wolffish *(Anarhichas minor)*, and the Atlantic Wolffish *(Anarhichas lupus)*, which inhabit the coastal waters of Newfoundland and Labrador, are all considered *At Risk*. All three species have suffered substantial population reductions since the mid-1970s.

The reasons for this decline are not altogether clear. Wolffish have undoubtedly been affected by fishing practices (For example: by-catch) in coastal Newfoundland and Labrador, but these practices may not be the primary contributor to their decline. Wolffish species seek out waters at a very specific temperature range (1.5º–4.5º C) and any change in that water temperature may affect their survival and reproductive potential. Climate change and change in coastal current patterns may be a more significant factor in their decline. Scientists believe that more research on the issue is necessary.

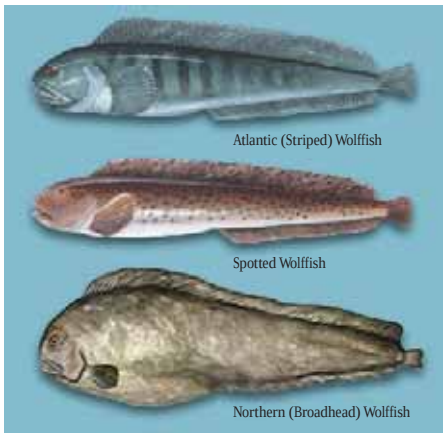


Figure 4.7: While the three species of Wolffish have very distinct features they share many characteristics. *Image courtesy DFO*

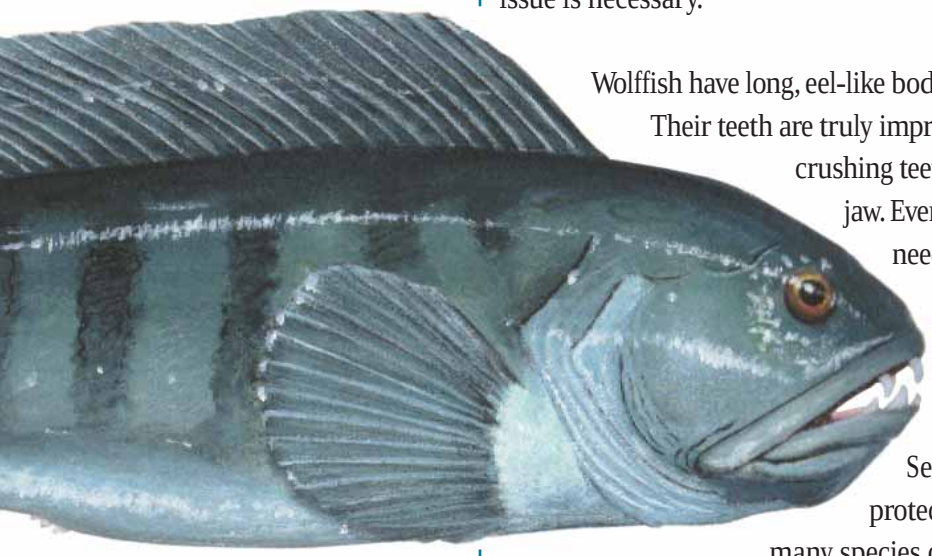


Figure 4.8: Atlantic Wolffish
Illustration courtesy Derek Peddle

Wolffish have long, eel-like bodies and can grow up to five feet in length. Their teeth are truly impressive: huge tusk-like incisors in the front, crushing teeth in the upper jaw, and molars in the lower jaw. Even the throat is lined with teeth! Wolffish need these teeth so that they can play their important role in the ocean ecosystem: eating the shellfish, particularly sea urchins, that makes up much of their diet.

Sea urchins eat kelp and kelp provides a protective habitat for the eggs and young of many species of fish. By eating sea urchins, wolffish therefore help maintain a balance in the ocean ecosystem. Although wolffish are generally not targeted by the Canadian fishing industry, they are often

caught unintentionally as by-catch by offshore fishing vessels. Historically, groundfish trawls accidentally killed or maimed individuals and have since been banned in this province. Bottom trawling for fish and dredging for scallops and clams damage spawning habitat by disturbing rocks and boulders used for shelter and construction of wolffish nests.

Figure 4.9: Jaw of Wolffish.
Photo courtesy Department of Fisheries and Oceans Canada

Under Canada's *Species At Risk* legislation, both the Northern Wolffish and Spotted Wolffish are listed as 'Threatened', while the Atlantic Wolffish is designated as being of 'Special Concern'. The Department of Fisheries and Oceans Canada has developed an educational program for fish harvesters, showing them how to identify the animals and introducing proper ways to release them unharmed back into the ocean from hooks, nets, and other fishing gear.

In Summary

Many wildlife species are threatened by human activities and may become endangered, extirpated or extinct if nothing is done to reverse the factors causing population declines. The loss of each species has a negative impact on *biodiversity*. This term refers to the variety of all life on our planet. It measures variety among ecosystems, species, populations within species, and genetic diversity. Species diversity is an important component of biodiversity and contributes to healthy ecosystems.

Scientists around the world agree that human activities are causing a loss in Earth's biodiversity at an alarming rate. Although we may feel removed from species extinctions, it is important to remember that the loss of these species weakens ecosystems. This increases the chances of losing access to food, energy, building materials, medicines, and suitable living space. We also risk losing important aspects of our cultural heritage. As species disappear, it undermines the relevance of the stories, art, and traditional knowledge associated with them.

In the following sections, we will look at how species are impacted by humans and how governments, organizations, and the general public in Canada and around the world, work to protect species and preserve species diversity .

GOING, GOING, GONE: THREATS TO SPECIES SURVIVAL

Extinction is a natural phenomenon. Species die off primarily because of habitat changes. Human activities are rapidly altering habitats for many species, resulting in the high extinction rates that are of concern today. Habitat disruptions can also create advantages for other species, which puts other species at a disadvantage. When habitats are not managed to respect the needs of all wildlife species, then many species' survival is threatened by change. These threats may be varied and include habitat degradation, introductions of non-native species, over-exploitation, climate change, and isolation. In addition to these threats, there are many other factors that limit species' ability to feed and reproduce, including toxins and pollutants, disease, and invasive species to name just a few.

Let's review some of these threats by considering examples of habitat loss and degradation, introduced species, over-exploitation, and pollution.

Habitat Loss and Degradation

Habitat loss or degradation takes many forms. For example, fragmenting habitat into many disconnected pieces such as clear-cutting large areas of forest can cause species populations to break into smaller, more isolated pockets. This can trigger negative events such as inbreeding which ultimately weakens the population's overall health. The following are a number of examples that pertain to habitat loss or degradation in either terrestrial or aquatic ecosystems.

Impacts on the Land:

Urban and Agricultural sprawl: Demand for housing and roads can severely impact wilderness areas, particularly in countries where the population is growing rapidly. Burning forests to clear the land for farms in the Amazon rain forest, and elsewhere, is destroying an untold number of plant and animal species. The mass introduction of farm animals, particularly cattle, can cause soil erosion and the destruction of wild vegetation. Fecal contamination of local water bodies is also damaging. Some of Canada's richest farm soil has been lost to the lawns and pavement of towns and cities (urban sprawl). In Newfoundland and Labrador, this threat has not been significant to date, but the effects of urban growth are being felt in some areas. For example, St. John's and Corner Brook are growing quickly as more areas are zoned for housing and commercial development. Even recreation, in the form of increased ATV and snowmobile traffic, has had a negative impact on beaches, bogs, and forests.

Figure 4.10: Burning forest to create pasture land in Africa.
Photo courtesy FAO, Roberto Faiduttie, CFU000204

Logging and other Forestry Activities: In Canada, and nations around the world, forests are threatened by demands for firewood, pulp and paper, lumber, and clear-cut land. Forests provide habitat for numerous animals, many of which disappear after the trees are cut down. In Newfoundland and Labrador, forests are harvested for pulp and paper, in addition to lumber, firewood, and other personal needs.

Improper harvesting methods can contribute to soil erosion, which prevents forests from regenerating.

Impacts on Aquatic Environments:

Silting: Many terrestrial disturbances also affect river and lake ecosystems. Erosion of soil into rivers chokes waterways with mud, altering the habitat of fish, water-borne plants, and insects. Silt can also clog the gills of fish like salmon and trout making it difficult or impossible for them to get enough oxygen from the water to survive. This can have a major impact on reproduction, especially of salmon and trout.

Runoff from Sewage and Industrial Wastes: Human activities on land can also affect aquatic ecosystems, spreading disease and harmful chemicals. Sewage and industrial wastes lower the oxygen level in water. This severely impacts the health of many aquatic species.

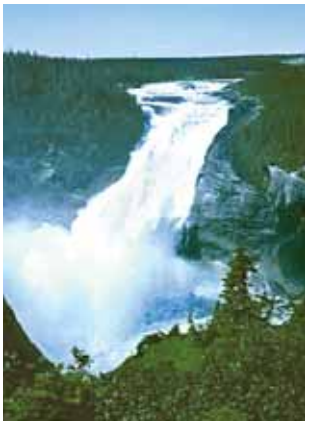
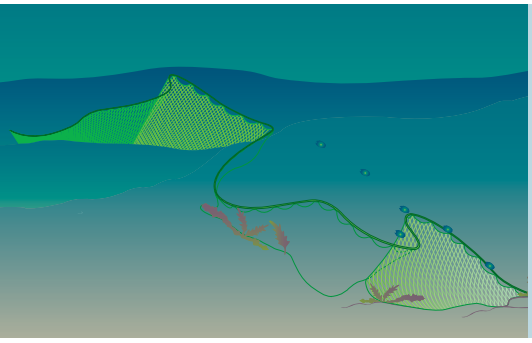


Figure 4.11:
Left: Churchill Falls (Circa 1969) before hydroelectric development. Right: Churchill Falls in June 2006.
Photos respectively with the permission of the Minister of Public Works and Government Services Canada, 2006 and Natural Resources Canada, Geological Survey of Canada. Photo Courtesy Environment Canada/Peter Thomas

Dams: The building of dams for hydroelectric power changes river and lake ecosystems by flooding huge areas of land. Prior to the construction of the Churchill Falls power plant during the 1960s, the massive Smallwood reservoir in central Labrador had been a series of lakes, rivers, and marshlands. This dam diverted water away from the river and into the power generating turbines that, in effect, virtually eliminated a waterfall that once rivaled Niagara Falls in size.

Destructive Fishing Practices: There are many fishing practices that have the potential to impact wildlife. Examples include bottom trawls that scrape the ocean floor to catch bottom dwelling fish. This fishing gear can damage reef and benthic ecosystems while destroying habitats that aquatic species need to survive and reproduce. Also, longliners can sometimes snag unintended species like sea turtles. Snow crab gear and, to a lesser extent, lobster gear can also become entangled around whales. Groundfish gillnets may inadvertently capture species like harbour porpoises *(Phocoena phocoena)* . Gillnets that will continue to catch fish if lost or abandoned are also a problem.



Ghost Nets

Ghost net is a term used to refer to fishing gear, such as nets or pots, which have been left or lost by fishers.

Ghost nets drift around the ocean or tangle in the bottom. Here they continue to catch all species of fish and other aquatic creatures, which then die, decompose, and thus make room to catch more. Depending on the material from which it is constructed, a ghost net can continue to capture and kill fish long after it was lost.

ENVIRO-FOCUS

Habitat loss and degradation: Leatherback sea turtle

There are species of sea turtles in the world's oceans: Loggerhead *(Caretta caretta)*, Green *(Chelonia mydas)*, Hawksbill *(Eretmochelys imbricata)*, Kemp's Ridley *(Lepidochelys kempii)*, Olive Ridley *(Lepidochelys olivacea)*, Flatback *(Natator depressus)*, and Leatherback *(Dermochelys coriacea)*. The Leatherback sea turtle have the most extensive geographic range of any reptile.

They are found in both temperate and tropical waters of the Atlantic, Pacific, and Indian Oceans, and it is one of only two species regularly found in Canadian waters. Although they do not breed as far north as Canada, Leatherbacks are often seen in the waters off Newfoundland and Labrador and the Maritime Provinces during the summer months. In the western Atlantic, Leatherback nesting beaches range from Mexico to New Guinea.

Figure 4.12: Beached Leatherback being returned to sea by Fishery Officers.
Photo courtesy Department of Fisheries and Oceans Canada

Unlike all other species of sea turtles, the leatherback does not have scales or claws. Its carapace (shell) is made of tough, but slightly flexible, cartilaginous tissue. These turtles may grow to have a carapace length of up to two metres and weigh as much as 500 kilograms. The reptile's immense front flippers are often as much as half or more the length of this carapace.

This species is in trouble worldwide. The number of Leatherbacks is declining and this species could become extinct by 2015 (Spotila et *al.* 1996). In Canada, the Leatherback is listed as an Endangered species. Population declines are attributed mainly to habitat degradation of its marine environment and loss of its nesting habitat (terrestrial). Former nesting beaches that are converted to use by humans are no longer suitable for sea turtles. Mechanical raking of beaches and driving off-road vehicles on the sand also destroy nest sites and increase hatchling mortality. Leatherbacks do manage to nest successfully, humans sometimes collect their eggs to sell on the international market.

Figure 4.13: Preparing for a Leatherback necropsy.
Photo courtesy Hugh Whitney

They face human-made dangers in the marine environment as well. Leatherbacks become entangled in fishing gear and cables, where they may be injured or drown. Garbage dumped at sea such as balloons, plastic bags, and the remains of fishing gear, when swallowed by a turtle can block the reptile's gastro-intestinal system and cause death. The waters off our Atlantic coast provide seasonal foraging habitat

Leatherback Seaturtle Range & Breeding Areas in the Atlantic Ocean

Figure 4.14: The dark shaded area indicates the Leatherbacks' range while the dots indicate prominent breeding areas.
Map Courtesy Environment Canada

Figure 4.15: Mechanical raking of beaches can destroy sea turtle nesting sites.

for this creature. However, degradation of our marine environment continues to result in unknown levels of Leatherback sea turtle mortality in Canadian waters.

Because the Leatherback sea turtle is a migratory species covering great distances, international cooperation is necessary to ensure its survival as a species. Some of the species' critical nesting beaches have now been protected as national parks or reserves in the Caribbean and in Central America. This should increase nesting success.

Figure 4.16: Humpback whale entangled in fishing gear. Grand Beach, NL.
Photo courtesy Wayne Ledwell

CHECK your Understanding

1. How can habitat loss or degradation result in a species becoming endangered or extinct?
2. Explain the difference between natural extinctions and anthropogenic (human caused) extinctions. Give examples of each.
3. Give two reasons why humans need to protect species that have been determined to be *At Risk* or endangered.

For Further Discussion and/or Research

4. Identify a species of plant or animal that has become *At Risk* or Extinct in Canada. Why did it reach this status? What would be done (or could have been done) to reverse this situation?
5. Use the internet to research other examples of "web of life" interactions among wildlife species.
6. Use interest resources such as "Peter Russell's World Clock" to investigate the rate at which species are becoming extinct.

Introduced Species

A species that has been either intentionally or inadvertently introduced into a location outside its natural distribution is called an **alien species.** Alien species can be plants, animals, insects, or micro-organisms. When an alien species is introduced into a new habitat it competes for resources with natural or local species. In some cases, introduced species flourish in their new environment and out-compete the local species. These new species can be even more of a problem if they prey on local species or introduce new diseases.

Did You Know?

An introduced species (also known as naturalized species or exotic species) is one that is not indigenous (native) to a given place or area. It has instead been accidentally or deliberately introduced to the new ecosystem by human activity. http://en.wikipedia.org/wiki/Introduced_species

Is the coyote, which arrived on the island of Newfoundland in 1985, an introduced species or a native species? Why/Why not?

Alien species which spread aggressively throughout their new environment are *invasive alien species.* According to the World Conservation Union, invasive alien species are the second most significant threat to biodiversity after habitat loss. Invasive alien species can threaten the environment, the economy, and human life. They do this by weakening local wildlife populations, reducing the numbers of economically important species, and bringing new diseases that affect human health. For example, the West Nile virus, a disease transmitted by infected mosquitoes, was first identified in the west Nile area of Uganda in 1937. It spread into Canada from the USA in 2001.

Figure 4.17: Invasive alien species in Canada. Left: Zebra Mussel. Middle: Purple Loosestrife. Right: Asian long-horned beetle. *Photos respectively courtesy U.S. Geological Survey Archives, U.S. Geological Survey. www.forestry. images.org. Courtesy John D. Byrd, Mississippi State University. www.forestryimages.org. Photo Courtesy FAO, Gillian Allard, FO-5142.*

Examples of invasive alien species in Canada include the Zebra Mussel *(Dreissena polymorpha)*, Purple Loosestrife *(Lythrum salicaria)*, Asian long-horn beetle *(Anoplophora glabripepennis)* and European Green Crab *(Carcinus maenas)*. Some species that are currently threatened with extinction by invasive aliens include Ancient Murrelets *(Synthliboramphus antiquus)*, Island blue butterfly *(Plebejus saepiolus insulanus)*, Golden paintbrush *(Castilleja levisecta)*, Tiger salamander *(Ambystoma tigrinum)*, Northern prairie skunk *(Eumeces septentrionalis)*, American chestnut *(Castanea dentate)*, Eastern flying squirrel *(Glaucomys volans)*, and American ginseng *(Panax quinquefolius)*. The island portion of our province has numerous species of alien plants and

In Bloom

Foliage

Invasive Plants

Some plants are extremely good at growing in areas that have been recently disturbed. Some introduced species can out-compete native plants, upsetting the ecosystem.

Coltsfoot *(Tussilago farfara)* is an invasive non-native plant that has been found throughout the island portion of the province. It is displacing native plants. If the trend continues some native plants will become reduced in numbers and in some cases may disappear altogether.

insects whose arrival is attributed to our European ancestors who brought many plants and animals with them, either accidentally (For example: in animal feed) or intentionally (as garden plants).

(Adapted from www.heritage.nf.ca, Trevor Bell)

Did You Know?

The expansion of coyotes *(Canis latrans)* into New Brunswick, Nova Scotia, PEI, and Newfoundland has occurred naturally (that is, through the animals' own movement), but was aided by the building of new roads, the clearing of forests, and the extirpation of the once-indigenous timber wolf.

Figure 4.18: The Arctic Hare is a native species of Newfoundland and Labrador.

NEWFOUNDLAND MAMMALS

Native	Introduced
1. Caribou	1. Moose (1904)
2. Black bear	2. Bison (1964, unsuccessful)
3. Lynx	3. Mink (1935, through fur farming)
4. Red Fox	4. Eastern Chipmunk (1962)
5. Ermine (Weasel)	5. Red Squirrel (1963)
6. Newfoundland Marten	6. Norway Rat
7. Newfoundland Wolf (extinct)	7. Bank Vole (1967)
8. River Otter	8. Deer Mouse (Prior to 1968)
9. Beaver	9. Red-backed Vole
10. Muskrat	10. House Mouse
11. Meadow Vole	11. Snowshoe Hare (1860-1880)
12. Arctic Hare	12. Masked Shrew
13. Little Brown Bat	13. Coyote
14. Eastern Long-eared Bat	
15. Hoary Bat	

LABRADOR MAMMALS

Native	
1. Caribou	21. Northern Bog Lemming
2. Moose	22. Flying Squirrel
3. Muskoxen	23. Woodchuck (Groundhog)
4. Black Bear	24. Norway Rat
5. Polar Bear	25. Woodland Jumping Mouse
6. Red Fox, Cross and Silver	26. Rock Vole
7. Arctic Fox	27. Red-backed Vole
8. American Marten	28. Red Squirrel
9. Fisher	29. Deer Mouse
10. Mink	30. Meadow Jumping Mouse
11. Otter	31. Ungava Lemming
12. Lynx	32. Porcupine
13. Ermine (Weasel)	33. Snowshoe Hare
14. Wolverine	34. Arctic Hare
15. Wolf	35. Little Brown Bat
16. Beaver	36. Masked Shrew
17. Muskrat	37. Water Shrew
18. Meadow Vole	38. Pygmy Shrew
19. Bank Vole	39. Starnosed Mole
20. Heather Vole	

ENVIRO-FOCUS

Invasive alien species:
Fungal diseases of Newfoundland Red and White Pine

"When sun-rays crown thy pine clad hills:"

So begins the first verse to the *Ode to Newfoundland*. However, while Newfoundland and Labrador's boreal forests do include native pine species, our forests (and hills) are mainly dominated by spruce and fir. White pine and Red pine *(Pinus resinosa)* are native to the island and, although not considered *At Risk* in the province as of 2008, they are negatively affected by an invasive alien species.

Figure 4.19:
White pine near Lloyd's River, Newfoundland and Labrador.
Photo courtesy Newfoundland and Labrador Department of Natural Resources/Basil English

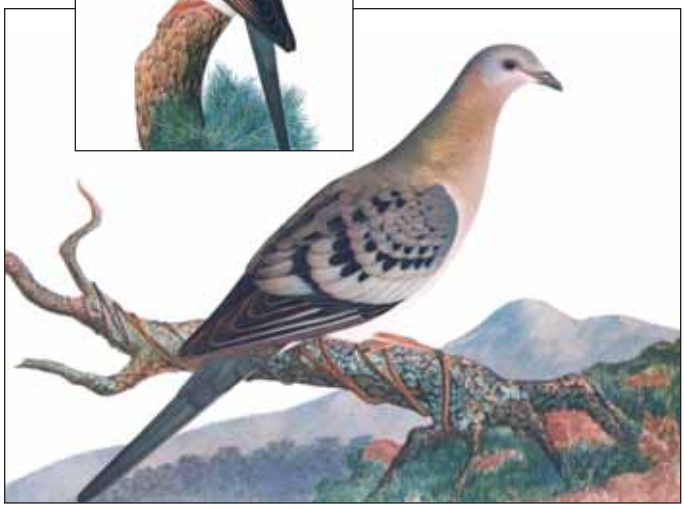
Introduced fungal species known as White Pine Blister Rust *(Cronartium ribicola)* and Scleroderris canker *(Gremmeniella abietina)* result in sickness to White and Red pine trees, respectively. *White Pine Blister Rust* was accidentally introduced into North America in the early 1900s and now covers most of the distribution range of White pines on the island of Newfoundland. The presence of the European race of Scleroderris canker known as *Gremmeniella abietina* var. *abietina* was first reported in North America in 1975 in the northeastern United States and subsequently in southern Québec and Newfoundland and Labrador during the late 1970s, where it quickly became established. Both diseases are implicated in the decline and poor regeneration of native pine in Newfoundland, thus affecting not only the natural ecosystems but the forest industry as well.

Figure 4.20:
White Pine blister rust.
Photo courtesy Newfoundland and Labrador Department of Natural Resources/Basil English

Figure 4.21: White Pine blister rust is caused by a parasitic fungus.
Photo courtesy FAO, Ray Hoff

Over-exploitation

Some Species *At Risk* are in jeopardy because of over-exploitation by humans. This exploitation can include over-harvesting, excessive hunting, and even excessive collecting. A number of species, including the Labrador Duck *(Camptorhynchus labradorius)* , Great Auk, and Passenger Pigeon *(Ectopistes migratorius)* are now extinct due to over hunting.



Many of the world's marine fish populations have declined dramatically since the 1950s due to over-exploitation. In Newfoundland and Labrador, the salmon populations in many of our streams and rivers have been reduced due to excessive fishing.

Figure 4.22: Top Right: Labrador Duck - extinct since 1878. Left: Passenger Pigeons – extinct since 1914.
Labrador Duck photos courtesy of the Canadian Museum of Nature

ENVIRO-FOCUS

Over-exploitation of the Great Auk

The Great Auk is an unfortunate symbol of human exploitation of wildlife. This large flightless bird, once numbering in the millions, lived in huge colonies in coastal regions of Europe from Norway to Spain. It also lived in Iceland, Greenland, and northeastern North America from Newfoundland and Labrador to Nova Scotia. Archaeological evidence shows that these birds once lived as far south as Florida.

Figure 4.23: Great Auk.
Image courtesy Library and Archives Canada, Acc. No. 1970-188-2851. W.H. Coverdale Collection of Canadiana

Great Auks were easy to catch during their summer breeding season and provided a ready supply of meat, oil, and feathers. Intensive unregulated commercial hunting by humans had decimated the Great Auk population by the late seventeenth century.

During the 1770s, attempts were made to protect the Great Auk, particularly in Newfoundland and Labrador where authorities unsuccessfully petitioned Britain to stop the massacre. Magistrates in St. John's penalized those who killed Great Auks or stole their eggs, although the hunting of Great Auk for fish bait was still allowed. In 1785 George Cartwright predicted the imminent extirpation of the species on Funk Island. By 1800, only two isolated colonies remained, one on Funk Island in Newfoundland and Labrador and another in Iceland. But the hunting continued and the Funk Island colony was wiped out during the early

1830s. This was followed by the Iceland population in the mid-1840s. Despite clear evidence that the Great Auk was in trouble, and even in the face of attempts at conservation, the last breeding pair on Earth was killed in 1844 by collectors. Today, all that remains of the millions of Great Auks are eighty mounted skins, twenty four complete skeletons, and seventy five eggs.

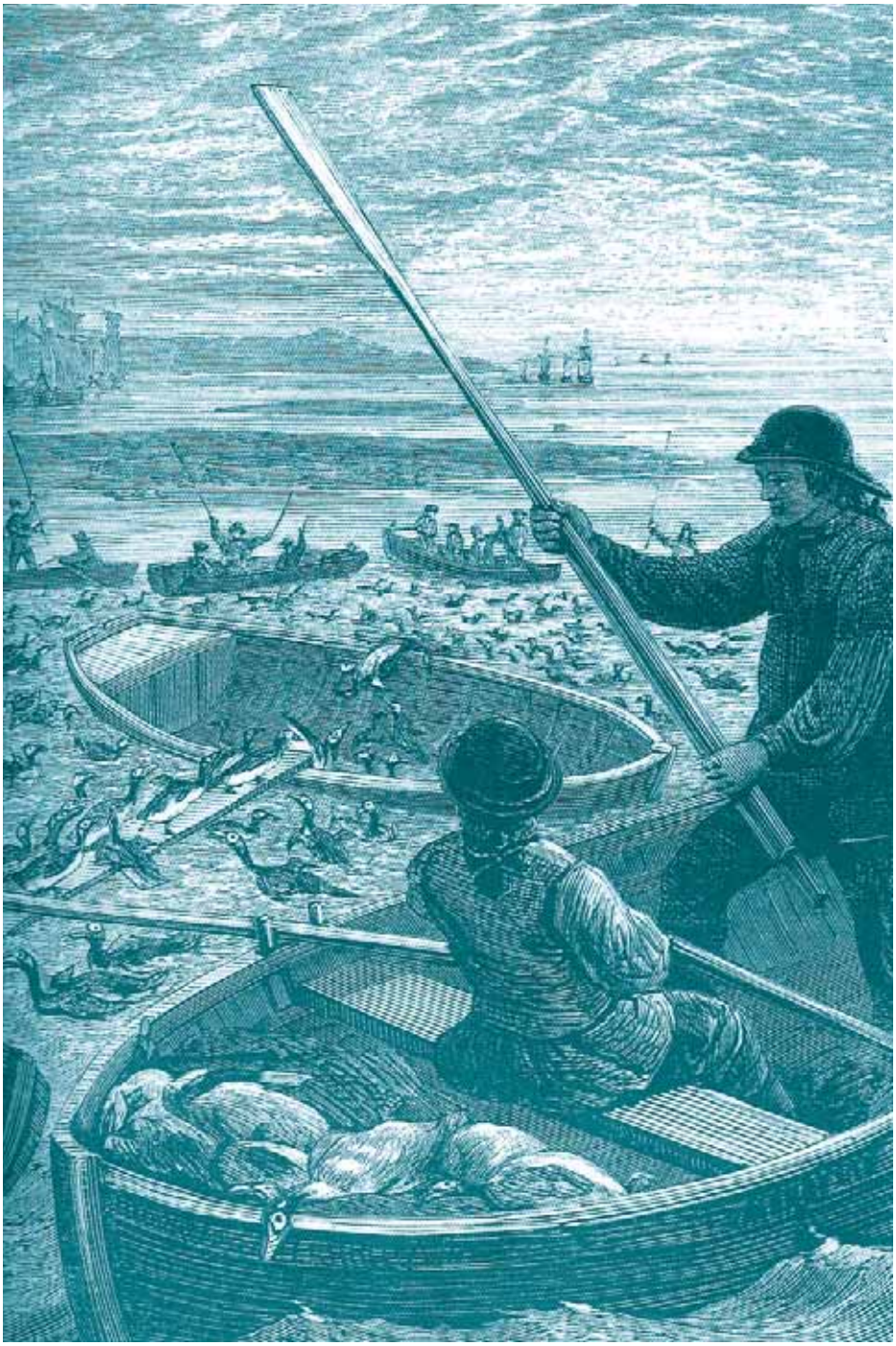


Figure 4.24: Hunters encircling a flock of Auks. Trying to escape, the flightless Auks scramble up the planks and into the empty boats.
Engraving by F.W. Keyl and E. Evans from G. Kearley's Links in the Chain (circa 1880)

Pollution

A pollutant is any substance that, when introduced to the environment, adversely affects a resource or the health of humans, wildlife, or ecosystems. Pollutants include sewage, garbage, chemicals, radioactive material, and other undesirable and hazardous substances.

Figure 4.25: Disposed cars and trucks found along back roads of Newfoundland and Labrador.
Photo courtesy Environment Canada/ Peter Thomas

Many species are negatively affected by toxic chemicals released into their environment. Sometimes this pollution may lead to a species becoming at risk. Among those toxic pollutants are pesticides, industrial chemicals, and metals. Some contaminants are airborne (meaning they travel in the atmosphere from place to place). Some can build up in the soil and others pollute the waters. When airborne pollutants such as sulphur and nitrogen oxides build up in clouds they fall as acid rain. Acid rain can kill aquatic life in ponds and lakes and may be linked to the decline of some waterfowl and amphibians.

Some pollutants may be transferred into the food chain. The ingested pollutants can be stored in the body tissues of animals and eventually some types of pollutants have the potential to cause serious health problems, especially to organisms higher up in the food chain—such as humans. When these pollutants are retained by the body their concentration increases as the organism consumes more of the polluted food over time. This process of accumulating toxins in an organism's body is known as **bioaccumulation**. As these pollutants are passed along the food chain from prey to predator, the resulting increase in concentration is known as **biomagnification**.

Figure 4.26: Landfill site in Newfoundland and Labrador.
Photo courtesy Environment Canada/ Peter Thomas

Other types of pollutants include things like everyday garbage. When not properly disposed of or recycled, they can also impact species. For example, some animals ingest plastic that they cannot digest. This leads to serious health complications or even death.

A serious issue today is that many of our landfill sites, locations where we dump our garbage, are filling up. We either need to find new places to dump our waste or new methods to reduce the amount of waste we produce. The latter is considered our best option because landfill sites have a number of associated problems. These unsightly, foul smelling sites often contain hazardous chemicals that can contaminate nearby ecosystems.

ENVIRO-FOCUS

Effects of pollution on Boreal Lichen

The Boreal felt lichen *(Erioderma pedicellatum)* is a large lichen found in moist *Sphagnum*-rich boreal forests. They are most commonly found on north or east facing slopes that have a constant supply of moisture. Boreal felt lichen is usually found on the trunks or branches of Balsam fir trees, but are sometimes associated with other species as well. The body of lichen is known as a thallus. It is the shape of the thallus that allows biologists to assign lichen to the different lichen classification categories. Because the Boreal felt lichen has a flat, leaf-like structure it is known as a *foliose* lichen. The dry thallus is grayish brown in colour and slate blue when wet.

Figure 4.27: Boreal felt lichen growing on the trunk of a tree. *Photo Courtesy of Nathalie Djan-Chekar*

The Boreal felt lichen is unique. Most of its closest relatives are tropical. These species may be among the oldest of all the foliose lichens, perhaps in excess of 400 million years old. Most likely the Boreal felt lichen was created as a result of a hybridization between an ancestral species and a mutant of the same species in South America.

So how did it get to Newfoundland? It was probably transported on the microcontinent of West Avalonia to what is present day New England, New Brunswick, Nova Scotia, and Newfoundland, and then onto the microcontinent of East Avalonia and what is now the British Isles.

The Boreal felt lichen once existed throughout eastern Canada and in some Scandinavian countries, including Sweden and Norway. The Scandinavian population is now thought to be extirpated, leaving eastern Canada as the last stand for the species.

There are two populations of Boreal felt lichen in eastern Canada, the *Atlantic population* and the *Boreal population*. The Atlantic population, found primarily in New Brunswick and Nova Scotia, is an Endangered species with very few individuals remaining. The Boreal population found in Newfoundland appears not to be endangered, but it is facing serious threats from forestry practices, blow down, insects, development, moose, fire, and air pollution, which is believed to be the cause of the population decline in Maritime Canada.

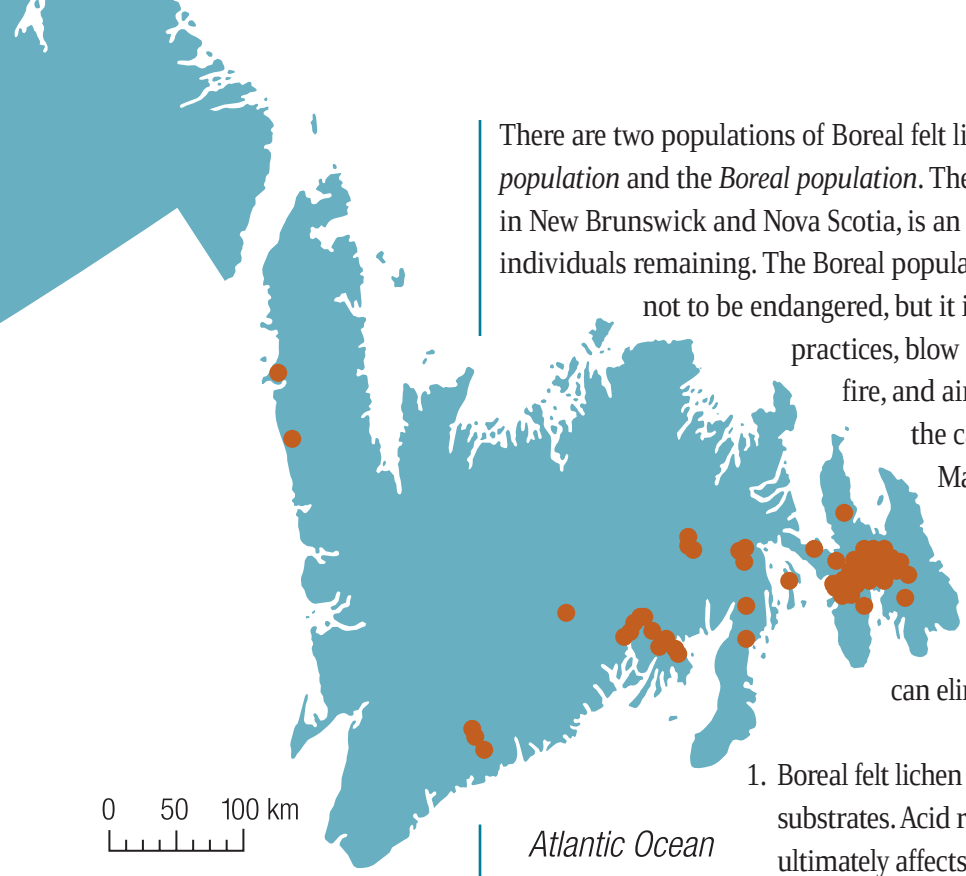


Figure 4.28: Range map of the population of the Boreal felt lichen. *Canadian Wildlife Service. Reproduced with permission of the Minister of Public Works and Government Services Canada*

Air pollution, in the form of acid rain, now threatens the Boreal population on the island of Newfoundland. Acid rain can eliminate sensitive lichens in two key ways:

1. Boreal felt lichen live in an area that has naturally acidic substrates. Acid rain further acidifies the site and ultimately affects the bark of the host trees. This makes it difficult for the lichens that live on that bark to survive.

2. Boreal felt lichen capture and use molecular nitrogen from the air to generate nutrients. However, the enzyme that they use to do this is very intolerant to sulphur dioxide (SO_2), a common air pollutant often emitted from smelters and utilities, especially utility plants for electrical generation.

In addition to acid rain, sensitive plants and lichens also have to withstand acid fog. Acid fog can be even more dangerous than acid rain to lichen because they remain enveloped in fog for extended periods of time. Some studies have actually demonstrated that acid fog in the Bay of Fundy area of Nova Scotia and New Brunswick can have a pH of 3.6, one pH unit lower than the average acid rain pH level in the same area.

Air pollution coming from mainland Canada is considered far less damaging than pollution from local Newfoundland and Labrador sources. Such sources include the Come By Chance oil refinery and the Holyrood Generating Station on the Avalon Peninsula.

Conservation and recovery of Boreal felt lichen includes closely monitoring air quality and rain quality in the areas of high population and working on a local and national level to reduce airborne pollutants.

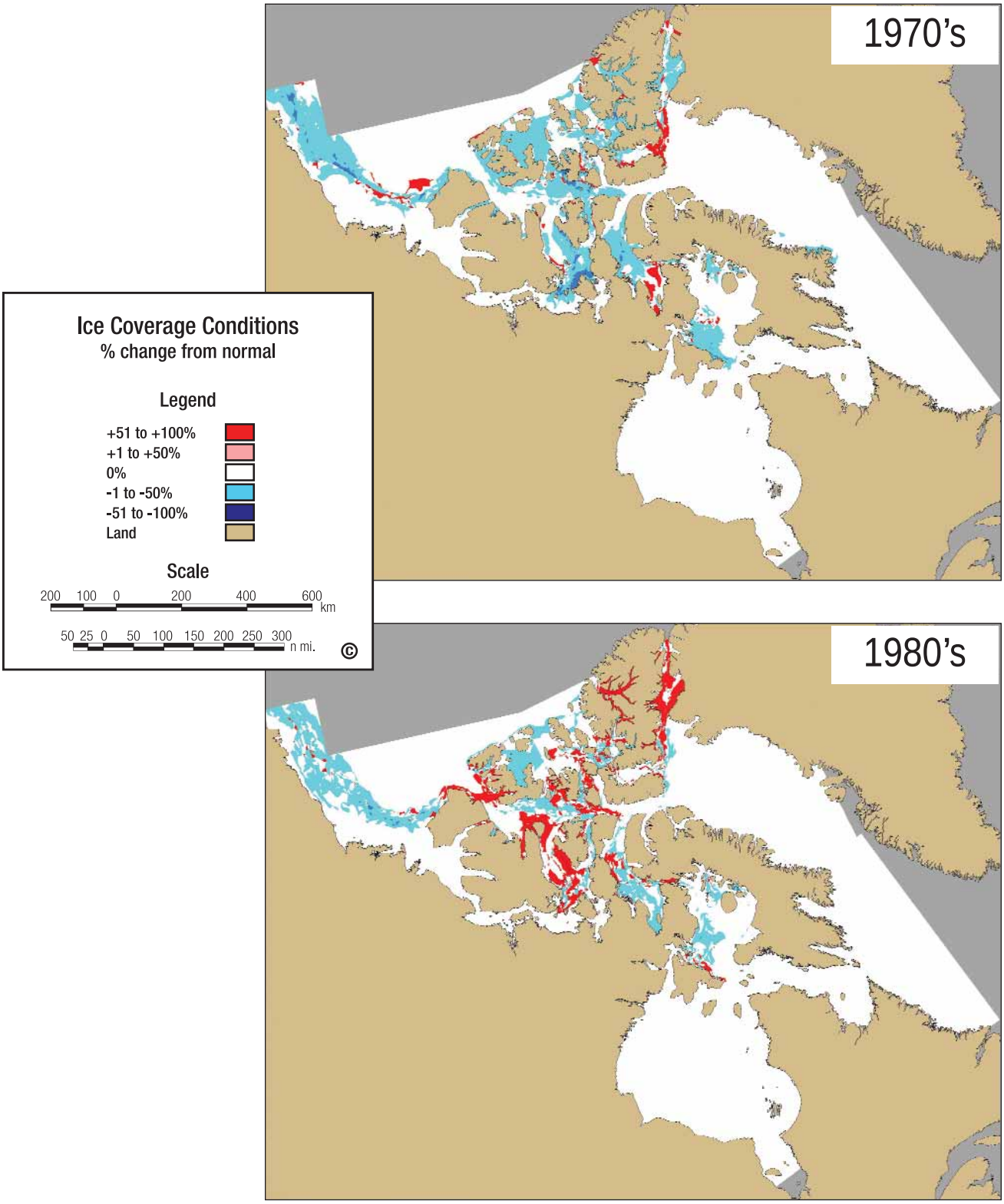
Climate change

In addition to the threats of habitat loss and degradation, introduced species, over-exploitation, and pollution, another concern for diversity and species survival is the recent changes in climate patterns. Evidence is growing that human activities are directly influencing changes in Earth's climate. Globally, temperatures are increasing. The consequences of a warmer planet are serious. They include drought, disease, floods, and rapidly changing ecosystems.

The Arctic is particularly sensitive to climate change as the average temperature in the Arctic has risen at almost twice the rate as the rest of the world in the past few decades. Many scientists view what is happening now in this region as an indicator of things to come. Since 1979, the size of the summer polar ice cap has decreased by more than twenty per cent. The melting of the once-permanent Ward Hunt Ice Shelf is already affecting Inuit communities, wildlife, and plants. When the Ward Hunt Ice Shelf splintered in 2000, the freshwater lake it enclosed, along with its unique ecosystem, drained into the ocean. Polar bears, whales, walrus *(Odobenus rosmarus)* and seals consequently changed their feeding and migration patterns, making it harder for aboriginal people to hunt them. Along Arctic coastlines, entire villages may be uprooted because they are in danger of being flooded. The Inuit view global warming as a threat to their cultural identity and their very survival due to their close proximity to, and dependence upon, the Arctic habitat.

Figure 4.29: Field person taking weather station measurements.

Satellite images show that the area of permanent Arctic ice cover is shrinking at a rate of 9 per cent each decade. Some scientists even predict that by 2020, the Arctic could be ice-free during the summer.



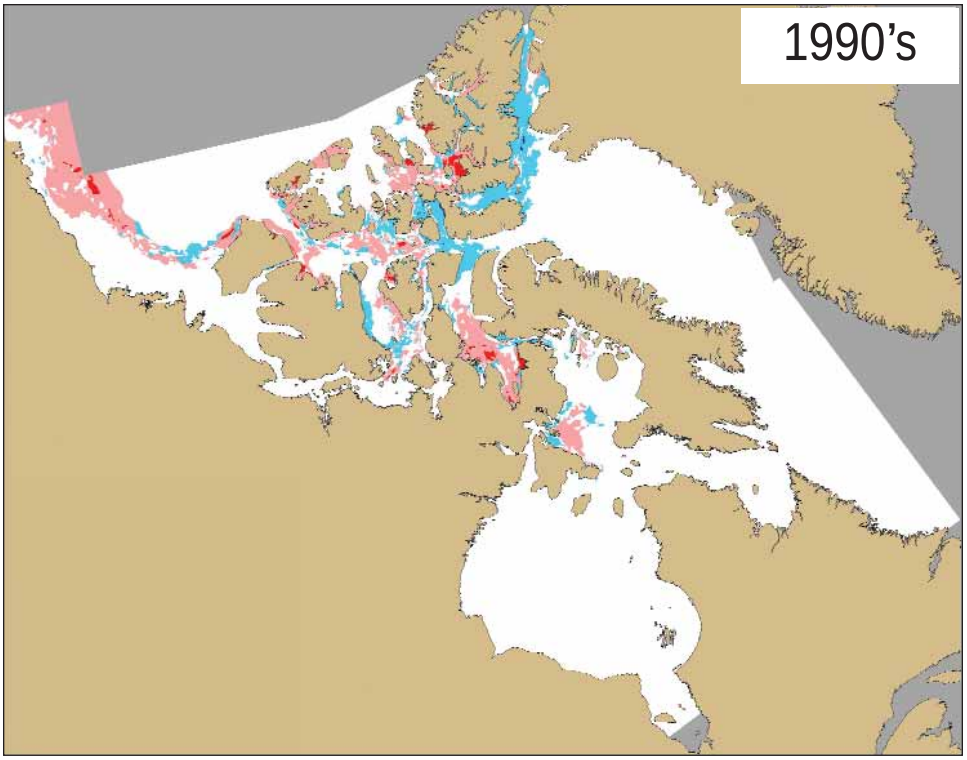


Figure 4.30: Ice patterns for the last three decades.
Images courtesy Canadian Ice Service (CIS)

ENVIRO-FOCUS

Impact of climate change on polar bears

The polar bear *(Ursus maritimus)* is the largest terrestrial carnivore on Earth. Polar bears are a species especially adapted to be at the top of the food chain in one of the world's harshest environments. Their skin is black to absorb heat. They have black claws and even a black tongue. The hollow fur insulates the bears and gives them more buoyancy in the water. They have a long body and neck, a narrow head and small ears. Adult male polar bears are generally between two and three metres long and weigh between 420 and 500 kilograms. Some individuals may weigh as much as 800 kilograms. Females are smaller and usually weigh between 150 to 250 kilograms.

Figure 4.31: Polar bear getting close to a tundra buggy in Churchill, Manitoba.
Photo courtesy Parks Canada/ W. Lynch

Polar bears live throughout the circumpolar Arctic. In Canada, this includes ice-covered areas from Labrador to the Alaskan border and from James Bay to Ellesmere Island. Polar bears are found on landfast ice and pack ice, and along or near coasts and islands, usually following their favourite food—seals. During the summer months, as the Arctic ice cap melts, some bears follow the retreating ice north to continue hunting while other bears spend their summers on land living primarily off stored body fat. When the ice returns in the fall, these bears leave the land to resume life on the sea ice.

Did You Know?

In 2005, an extensive three-year polar bear study was started in the Davis Strait area. It includes the polar bears found in Labrador. Most of the polar bears found in the 2005-2006 seasons in Labrador occurred north of Saglek Fjord.

Figure 4.32: Polar bear feeding on its prey.
Photo courtesy U.S. Fish and Wildlife Service

Figure 4.33: World polar bear Range
Image courtesy Environment Canada

Solitary hunters, polar bears will lie by the breathing holes made in the ice by seals waiting, sometimes for hours, for their prey to appear. During the summers, when food is scarce, polar bears have the ability to slow down their metabolism to conserve energy until food is once again available.

The presence of polar bears throughout their range varies from year to year and depends on the distribution of the seasonal pack ice during winter. Scientists believe there is a cause for concern for the species' survival as the climate warms and polar bears spend more time on land away from their primary food source: seals.

Recently in Nunavut, a hunted polar bear was actually confirmed by DNA testing as a hybrid between a grizzly bear (Ursus arctos horribilis) and a polar bear. Biologists have always speculated that this may be possible as the mating seasons of both species, as well as their territories, often overlap. The white bear with brown patches was shot dead in northern Canada and is the first grizzly-polar hybrid found in the wild.

Prolonging the ice-free period is predicted to increase nutritional stress on the bears until they are no longer able to store enough fat to survive these ice-free periods. Early signs of this would include poor body condition, lowered reproductive rates, increased cub mortality, and increased interactions between humans and bears as the bears become more food stressed. If populations of polar bears decline, humans will also be impacted as harvest quotas (number of bears allowed to be hunted) for native people will likely be reduced or eventually eliminated. Tourism-based viewing in western Hudson Bay and elsewhere across the north may disappear. If the Arctic Ocean

Figure 4.34: Polar bear with cubs
Photo courtesy U.S. Fish and Wildlife Service

Polar bears in Canada's Arctic have always been prized by hunters. However, as concern about declining polar bear populations has increased, hunting has been restricted to a few licensed hunters and the native people of northern Canada. Approximately 500 bears are harvested each year.

Canada's native northern people have strong cultural and spiritual ties with polar bears. In Canada, native hunting is allowed under an international agreement. Each northern community is given a quota but natives are permitted to sell their right to hunt a bear to non-natives.

becomes ice-free for a long enough period, it is even possible that polar bears could be extirpated from parts of their range.

Figure 4.35: Polar bear relocation for safety of animal and human community.
Photo courtesy Department of Environment and Conservation

CHECK your Understanding

1. What are the factors that often lead to species extinctions?
2. What are some reasons for conserving biodiversity?
3. The wolffish is not pretty and seems to serve little purpose in the economy of Newfoundland and Labrador. Why should we spend a great deal of time and money to protect this fish?
4. Explain how pollution can contribute to the disappearance or extinction of species.
5. Why do alien or introduced species often show exponential growth rates soon after they are introduced into a new environment?

For Further Discussion and/or Research

6. You notice that after using pesticides on your farm field that the number of insects declines for a year. However, the next year they come back and you need to reapply the pesticide. This time you notice that there is less of an effect on the insect population. A third application in another year has even less of an effect. What is your hypothesis about what is happening here? Design an experiment to test your hypothesis.
7. Conduct research on the breakup of the Ward Hunt Ice Shelf. How has this breakup affected the natural ecosystems there?

PROCESSES FOR *SPECIES AT RISK* PROTECTION

Figure 4.36: Enjoying the fresh air and winter scenery.
Photo courtesy Environment Canada/Peter Thomas

Critical habitat is defined within SARA as habitat that is necessary for the survival or recovery of a listed wildlife species.

The biological resources of Earth, including clean air, water, and fertile soil, are vital for the human species. Our continued economic and social well-being depends on healthy, functioning ecosystems. Many of the same factors that allow continued access to clean air, water, and soil are responsible for continued biological diversity. Therefore, it is important that we protect this diversity for present and future generations. The global community attempts to ensure long-term management and protection of diversity through the process of "routine" regulations or, if these fail, of designating and protecting species at risk.

Proclaimed in June 2003, Canada's Species At Risk Act (SARA) was created to protect wildlife species from becoming extinct by:

1. providing for the recovery of species at risk due to human activity.
2. ensuring, through responsible management, that species of "Special Concern" do not become "Threatened" or "Endangered."

To accomplish these goals, SARA designates COSEWIC as the scientific body that assesses species' status.

A **stakeholder** is any person or group who is, or can become, affected by an action. For example, in the case of Species At Risk protection, a stakeholder may be someone who owns land that provides habitat for the species in question.

Under SARA, three federal government agencies are directly involved in cooperatively protecting species at risk: Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada. However, SARA also recognizes that no single government, industry or community can completely protect Canadian species at risk on its own. That is why, under the Accord for the Protection of species at risk, SARA is designed to encourage cooperation between governments and stakeholder groups.

Newfoundland and Labrador Endangered Species Act

In addition to fostering the development of SARA, Canada's Accord for the Protection of Species At Risk was also a driving force behind the creation of Newfoundland and Labrador's Species At Risk legislation. Enacted in December 2001, the **Newfoundland and Labrador Endangered Species Act** was developed to be compatible with other national and provincial legislation. It is considered by some to be one of the best provincial Species At Risk legislation in Canada.

Like SARA, the Newfoundland and Labrador Endangered Species Act recognizes species assessments by COSEWIC. Under the authority of the provincial act, the Newfoundland and Labrador Department of Environment and Conservation is responsible for managing the protection and recovery of species at risk in the province. Once it was enacted, the government moved quickly to list the twenty COSEWIC Species At Risk that were in the province at that time.

Species designations under the Newfoundland and Labrador Endangered Species Act are as follows (Species designations under the Newfoundland and Labrador Endangered Species Act are slightly different from those of SARA due to the fact that in the midst of the process to ratify the provincial legislation, COSEWIC modified its designation categories. The provincial government opted to stay with the old designation categories.):

Extinct – A wildlife species that no longer exists;

Extirpated – A wildlife species that no longer exists in the wild in the province, but exists elsewhere;

Endangered – A wildlife species that faces imminent extirpation or extinction;

Threatened – A wildlife species that is likely to become endangered if nothing is done to reverse the factors limiting its survival;

Vulnerable – A wildlife species that has characteristics that make it particularly sensitive to human activities or natural events.

NEWFOUNDLAND AND LABRADOR

***Species At Risk* as of 2006**

Branded Killfish	Newfoundland Marten
Barrens Willow	Peregrine Falcon
Barrows Goldeneye	Piping Plover
Boreal Felt Lichen	Polar bear
Eskimo's Curlew	Porsild's Byrum
Fernald's Braya	Red Crossbill
Fernald's Milk-Vetch	Short-Eared Owl
Harlequin Duck	Tundra Peregrine Falcon
Ivory Gull	Wolverine
Long's Braya	Woodland Caribou (Labrador)
Low Northern Rockcress	

"Listing" Species

HOW DO SPECIES GET ON THE SARA LIST?

In Canada, the group that assesses the *At Risk* status of native wildlife species is the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC was first created as an independent, non-government body in 1977. It arose from the need for a single, scientifically sound, national classification of wildlife species *At Risk*. Although COSEWIC did valuable work, the designations applied were not legally binding.

Did You Know?

"Traditional knowledge" and "local knowledge" are terms that refer to knowledge, beliefs, and traditions that are handed down from one generation to the next. When we talk about "traditional ecological" or "local ecological" knowledge, we include knowledge, beliefs, and traditions about the relationships of living things, including humans, with one another and with their environments. This can include knowledge of the conservation and sustainable use of a resource as gained from generations of living and working within a particular environment. Definitions adapted from www.ceamf.ca and www.eman-rese.ca

Figure 4.37: Wolverine, found in the Labrador portion of the province, is listed as an "Endangered" species.

Today, COSEWIC is an instrument of SARA. It was being re-established within the Act and works within that legislation and its definitions. Currently, this committee has thirty voting members from various backgrounds who have considerable experience with wildlife and biological sciences including aboriginal traditional knowledge, ecology, genetics, management, systematics, and risk assessment, often coupled with years of field experience. Members of COSEWIC are university academics, independent specialists, Aboriginal people and/or government, museum or independent biologists. There are also members from each provincial and territorial government wildlife agency, as well as from four federal agencies (Canadian Wildlife Service of Environment Canada, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership). Finally, there are three members at large who are selected by COSEWIC following open competitions. All members must demonstrate that they possess the required expertise to serve on the Committee.

Figure 4.38: Red Crossbill
Photo courtesy Environment Canada/Peter Thomas

COSEWIC's species status assessment process is divided into three steps:

1. Selection of species that require assessment—this is the Prioritized Candidate list;
2. Compiling data, knowledge, and information into the COSEWIC Status Report;
3. Assessment of a species' risk of extinction or extirpation.

From this process a species is assigned a COSEWIC designation.

The following outlines the process of how a species is assessed and placed on Canada's 'legal' Species At Risk list:

1. A COSEWIC Status Report is prepared outlining historical and current knowledge of the species. This information includes biology, distribution, population numbers, and threats, as well as any other relevant information. A COSEWIC species specialist subcommittee reviews the status report, assesses the information, and recommends a status to COSEWIC. Each specialist subcommittee is targeted for its expertise of a particular wildlife species. The specific taxonomic groups for which there is a separate specialist subcommittee are:
    - Plants and Lichens
    - Mollusks
    - Arthropods
    - Marine Fishes
    - Freshwater Fishes
    - Amphibians and Reptiles
    - Birds
    - Marine Mammals
    - Terrestrial Mammals
2. COSEWIC assigns a status for recommendation based on criteria adapted from the **World Conservation Union**, otherwise known as the **International Union for the Conservation of Nature and Natural Resources (IUCN)**.
3. COSEWIC provides the Minister of Environment with a copy of the assessment and its reasons for the status recommendation.
4. The federal Minister of Environment has ninety days to publish a report confirming that the COSEWIC assessment and proposed status have been received and, in some cases, to indicate how the Minister intends to respond to each COSEWIC assessment. Depending on the species in question or its location, the Minister of Environment may pass the information forward to the Minister of Fisheries and Oceans (aquatic species) or the Minister of Canadian Heritage (national parks, national historic sites or other protected heritage areas).
5. The federal Minister of Environment will then forward the COSEWIC assessments on to the Governor in Council (GIC). The GIC is essentially the federal Cabinet of Canada.
6. The GIC then has nine months (with the *potential* for an additional nine month extension if deemed necessary) before making any decision to accept or dismiss the COSEWIC assessment, or to send it back to COSEWIC in search of more information. During this period, the government must review the potential for listing and conduct further consultation to decide whether or not to add the species to the official list of wildlife Species At Risk. At the end of the nine month period, the government decision is published on the SARA public registry.

COSEWIC Designations

Extinct – A wildlife species that no longer exists.

Extirpated – A wildlife species no longer existing in the wild in a particular area, but occurring elsewhere.

Endangered – A wildlife species facing imminent extirpation or extinction.

Threatened – A wildlife species likely to become endangered if limiting factors are not reversed.

Special Concern – A wildlife species that may become threatened or an endangered species because of a combination of biological characteristics and identified threats.

7. If the COSEWIC recommendation is accepted by the GIC then the species is assigned to the **legal list** of protected Species *At Risk* in Canada. Species on this list are protected by the Species *At Risk* Act (SARA). If the recommendation is not accepted, the species will not be added to the legal list.
8. If the Governor in Council does not take a course of action within nine months (or eighteen if an extension is granted) of receiving the assessment, the Minister of Environment then amends the SARA legal list in accordance with the COSEWIC assessment.

Once a species is legally listed as being *At Risk*, prohibitions under SARA automatically come into effect for those species that are listed as Extirpated, Endangered, and Threatened. These include prohibitions against killing, harming, harassing, capturing, or taking Species *At Risk*. There are also prohibitions against destroying listed species' critical habitats.

Figure 4.39:
Peregrine Falcon is listed as "Threatened" and has an estimated 60-70 nesting sites in Labrador.
Photo (top) courtesy Derek Peddle

How do species get on the Provincial list?

Species assessed by COSEWIC may be added to the official provincial list by law under the Newfoundland and Labrador Endangered Species Act. However, Newfoundland and Labrador legislation also establishes a **Species Status Advisory Committee (SSAC).** When a species in Newfoundland and Labrador is assessed by COSEWIC, the SSAC automatically reassesses the species status on behalf of the provincial Act. The SSAC bases its decisions on the best scientific knowledge available, and on traditional and local ecological knowledge about a species in the province. The SSAC reviews and recommends the designations and re-designations of species within the province regardless of their status elsewhere in Canada, including species not considered by COSEWIC. After the SSAC evaluates a species, they make their recommendations to the provincial minister of Environment and

Conservation (rather than the federal minister). At that time, the provincial Cabinet has ninety days to approve or modify the SSAC's designation or publicly explain why the designation was not approved. Since the scope and focus of SSAC remains within the boundaries of Newfoundland and Labrador, provincial designations may differ slightly from federal designations.

Some examples of SSAC recommendations include:

1. Woodland Caribou (Labrador Herds)
   COSEWIC's national assessment of this species resulted in a status of Threatened and it is listed as such on the SARA legal list. However, in Newfoundland and Labrador, the SSAC designated the species as endangered under provincial legislation because the provincial committee found that designation better represented the status of that species in the province.

Figure 4.40:
Woodland caribou on boardwalk.
Courtesy Environment Canada/ Peter Thomas

2. Mountain Holly Fern *(Polystichum scopulinum)*
   This species is designated as Threatened under SARA. But a review by the SSAC confirmed that it has been fifty five years since this species was last observed in the province. So their recommendation to the provincial minister was not to list this species under the Newfoundland and Labrador Endangered Species Act. This once again illustrates how the listing of a species can differ provincially and nationally.

3. Gray-cheeked Thrush *(Catharus minimus)*
   This species is designated as Vulnerable by the Newfoundland and Labrador Endangered Species Act, but is not listed on the SARA legal list. It was determined that the Gray-cheeked Thrush may be *At Risk* in Newfoundland and Labrador and as a result, the SSAC requested a status report independent of their national status.

Figure 4.41: Mountain Holly Fern.
Images courtesy N.L. Britton and A. Brown. 1913. Illustrated flora of the northern States and Canada

Figure 4.42:
Grey Cheeked Thrush.
Photo courtesy U.S. Fish and Wildlife Service

RECOVERY PROCESS FOR SPECIES AT RISK

Figure 4.43: Memorial University of Newfoundland, Ocean Sciences Centre, Logy Bay

The ultimate goal of the work for species at risk, once a species is designated as *At Risk* under SARA, is to develop and implement a strategy for protection and recovery.

Recovery planning is a legal requirement for species listed under the Newfoundland and Labrador Endangered Species Act. The legislation requires that for all Endangered and Threatened species, a **Recovery Team** be created. The team is composed of government representatives, stakeholders, and species experts who drive the recovery process for the listed species and monitor their success over time.

Although some of the specific requirements in the Newfoundland and Labrador Endangered Species Act differ from those in SARA, the intent and purpose of both acts regarding recovery planning is very similar. The provincial minister must release a **Recovery Plan** for an endangered or threatened species to the public within **one** year (as opposed to three under SARA) from the date when the species is designated.

Recovery Plans are the provincial equivalent to federal recovery strategies and should:

1. Identify measures for the recovery of designated species.
2. Identify habitat that is critical to the survival and recovery of the species.
3. Include timelines for the implementation of the recovery plan's recommendations.

Recovery Teams

A Recovery Team includes people who are interested in fostering the timely recovery of a species determined to be *At Risk*. It is important that team members represent an organization or stakeholder rather than the personal interest of that individual. Recovery team members are most often associated with organizations that:

1. Conduct scientific research on the species.
2. Are associated with an organization that may contribute to its recovery financially or otherwise.
3. May be impacted by recovery efforts. These include federal and provincial government representatives, university academics, and stakeholders who take into account the research, monitoring, education, and socio-economic factors associated with species at risk recovery.

A Recovery Team often aids in the development and implementation of recovery planning documents because they have the knowledge to offer advice and consultation on the development of recovery planning documents as they are being drafted.

Despite the different motivations for stakeholders on the Recovery Team, their role is to cooperate to effect recovery of the species. They do this by:

- Assisting or initiating the development of appropriate recovery planning documents
- Advising governments, directors, land users, developers, stakeholders, the public etcetera on recovery of the species, species group, or ecosystem
- Coordinating recovery activities
- Evaluating the success of recovery efforts through monitoring

Figure 4.44: Monitoring and research is a key part of the At Risk recovery process. *Photo courtesy of Fisheries and Marine Institute of Memorial University of Newfoundland*

The recovery process for species *At Risk* involves a combination of factors including research, monitoring, stewardship, and education. It often incorporates socio-economic factors as well. And, as we have seen above, this process is sometimes facilitated through the formation of Recovery Teams. Now let us turn our attention to the role these factors play in recovery.

Research and Monitoring

After a species is assigned to the SARA legal list, scientific research is the first step in the recovery process. This research identifies species requirements for survival, the factors that threaten its survival and recovery, and what actions are necessary to facilitate species recovery. Research is

often conducted on the socio-economic impacts of species recovery. For example, a species *At Risk* may currently inhabit a forest that is also used for timber harvesting, and species recovery requires that some of the habitat must be protected from cutting. Researchers assess the best ways to recover the species while minimizing any impact to the economy by determining how much forest can be harvested without causing harm to the species that is already *At Risk*.

Monitoring, the long-term continuation of research, is an essential part of research. For example, the population size of a species must be monitored over time to determine the effectiveness of the recovery efforts. Does the population increase, decrease or remain stable?

ENVIRO-FOCUS

The benefits of research and monitoring—the Harlequin Duck

The Harlequin Duck *(Histrionicus histrionicus)* (also known as 'Lords and Ladies' in Newfoundland and Labrador), is a small sea duck that has four populations worldwide: the Pacific, Greenland, Iceland, and eastern North America.

Figure 4.45: The Harlequin Duck is currently listed as "Vulnerable" by SSAC and "Special Concern" by COSEWIC.

Biologists do not know how many Harlequin Ducks breed in eastern Canada. However, during the winter months, Harlequin Ducks congregate in large groups in isolated areas along the coast, and this behaviour makes it easier to assess their population size. The Canadian Wildlife Service estimates that there are less than 3,000 individuals wintering in eastern North America. This is an improvement from estimates in the early 1990s that were less than 1,000 individual birds.

During the spring, Harlequin Ducks fly north to breed on turbulent streams. In late summer and early fall, males can be found in moulting groups along the coast. During the moulting period, the Harlequin Duck becomes flightless as they renew their feathers for the next breeding season. After completing their moult in early autumn, they again migrate to southern Newfoundland, Nova Scotia, New Brunswick, and along the northeastern coast of the United States for the winter months.

In 1990, the Harlequin Duck was designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as *Endangered* due to the small eastern North American wintering population. This listing prompted increased monitoring and research on the species. The extra effort afforded biologists the opportunity to gain more insight and knowledge on the species' movements, distribution, and population size. The results of these efforts led, in 2001, to

improve the listing from **Endangered** to **Special Concern**. Scientific research and population monitoring continues to be an important aspect in the recovery of Harlequin Ducks.

Research: Before 1990, there was very little data available on the Harlequin Duck in eastern Canada. But once COSEWIC designated the duck Endangered, more attention and resources were dedicated to studying this species. Now we know much more about them. For example, in an effort to better understand their movement patterns there were a series of projects using leg bands with satellite transmitters. Once attached to the bird's legs, these transmitters enabled scientists to track the movements of the ducks by satellite. This information helped biologists understand where Harlequin Ducks go to breed, moult, and winter. This valuable information included migration routes, key habitat areas, and breeding patterns. For example, scientists now know that Harlequin Ducks breeding in northern Canada are affiliated with populations wintering along coastal Greenland. That means the eastern North American population was larger than expected. And this in turn means that Harlequin Ducks in eastern Canada are not Endangered and that determination eventually led to the downlisting of Harlequin Ducks from Endangered to Special Concern.
Satellite tracking:

1. *www.atl.ec.gc.ca/wildlife/harlequin/tracking_e.html*
2. *www.qc.ec.gc.ca/faune/sauvagine/html/hd_satellite.html*

Figure 4.46: Harlequin Duck pair. The Male, on the left, has bands on its legs.
Photo courtesy of Serge Brodeur

There have also been more detailed and specific types of research projects. For example, a study was conducted in central Labrador to assess the impacts of low-level flying military aircraft on the behaviour of Harlequin Ducks. This research provided information on how the species may react to disturbance and if such disturbances affect breeding success. An important aspect of Species *At Risk* recovery is understanding all the potential threats to a species and, based on those results, to remove or lessen as many of those threats as possible for improved species conservation.

Monitoring: Another important part of Species *At Risk* recovery is population monitoring so that scientists can stay up to date with population changes and trends. Monitoring also helps them determine other population values such as lifespan, recruitment, and survival. Some monitoring projects established for the Harlequin Duck were:

1. Regular counts at important wintering locations around eastern North America. These counts continue today and are conducted every year in the same areas, in the same way, and at approximately the same time of year. Keeping the survey methods as consistent as possible from one year to the next is important and allows the scientists to more confidently compare population estimates over time.

2. Banding projects started in various parts of eastern North America over many years offers valuable information on important population values like survival times for individual birds, the level of recruitment of young bird into the population, and even aid in determining overall population numbers. In recent years, a population trend survey has been established in Labrador and northern Newfoundland in an effort to assess the population changes in more remote areas of their range.

Figure 4.47: The eastern population of Harlequin Duck breeds mostly in Quebec and Newfoundland and Labrador.

MINI-LAB ACTIVITY

Monitoring of species *At Risk* is important for determining long-term changes in the population. A winter survey was started in eastern North America to monitor population change of Harlequin Ducks at four important wintering locations along the eastern seaboard. The following table gives a sample of the data from those surveys.

Year	The Wolves, NB	Cape St. Mary's, NL	Ile au Haut, ME	Sachuest Point, RI
1992	—	—	—	64
1993	—	—	119	77
1994	—	15	125	61
1995	28	25	147	82
1996	—	28	170	67
1997	22	30	196	76
1998	25	46	172	88
1999	42	76	237	105
2000	40	79	193	93
2001	38	90	126	95
2002	52	100	188	61
2003	—	74	—	—
2004	47	—	254	—
2005	32	242	187	—
2006	—	218	268	—

Table 4.1: Survey data from four important Harlequin Duck wintering areas in eastern North America.
Data reproduced courtesy of Canadian Wildlife Service

Figure 4.48:
Harlequin Duck Range in the Northwest Atlantic Ocean.
Map courtesy Environment Canada

Analyze and Conclude:

1. Is the population increasing or decreasing?
2. What are some possible reasons for the missing data points?
3. What is most important about doing surveys in four different areas that are so far apart?

SUPPORTING GOVERNMENT PROTECTION INITIATIVES

Stewardship

Although governments play a major role in preserving biological diversity, conservation and sustainable use of biological resources must have the support and participation of communities and individual citizens. Cooperation from organizations not directly affiliated with the government, such as Ducks Unlimited and the Protected Areas Association, includes research and stewardship. It is an important part of species assessments, listing, and recovery.

As biologists and wildlife managers conduct research to better understand the needs of a species, it is also important that they prepare for dealing with species recovery from a stewardship perspective.

When it comes to stewardship of species at risk, the problems and their solutions are seldom obvious. Many people do not know how the problem can possibly affect them, or what they can do to help. For example:

- Who really pays any attention to two-inch tall plants on the Great Northern Peninsula of Newfoundland?
- Do people riding ATVs on a beach notice small shorebirds running away from them or see the nest that they may have driven over?

Figure 4.49: Motorized vehicles on the beaches of Newfoundland and Labrador can be deadly to species like the Piping Plover *(Charadrius melodus)*. *Photo courtesy of Environment Canada/ Peter Thomas*

It is obvious to most of us that clean rivers are better than dirty ones. We know that old appliances do not belong in the forest or rivers. Recycling them is the more responsible solution. However, stewardship actions are not so evident for species at risk. It is important to remember that when humans are the cause of a species' decline, humans are also the answer for species' recovery. Before people can become responsible stewards and act in ways that benefit a species or a habitat, we need to:

- Know and care about the species that we may be impacting
- Understand how our activities may be causing a decline in the species population
- Know how to act to help reverse the decline

Figure 4.50: Piles of discarded household appliances in the forest. *Photo courtesy of Environment Canada/Peter Thomas*

This is where education and awareness becomes important to the recovery of species *At Risk*.

Everyone can help!

Here are ten simple and concrete things that you can do to help protect species *At Risk*:

1. Learn as much as you can about species *At Risk*: explore a species *At Risk* web site, join an environmental group, and visit parks, zoos, and botanical gardens that house species *At Risk*.
2. Offer your help to teams working to recover species *At Risk* in your area. They sometimes need a helping hand for specific activities.
3. Install bird feeders, especially in places where there are very few mature trees.
4. Grow native plants in your garden, while making sure to buy them from producers that do not harvest them directly from the wild.
5. Question residential area plans that could destroy the habitats of species *At Risk*.
6. Reduce your contribution to the greenhouse effect: walk, ride a bicycle, or take public transportation to work. Choose an economical car, or carpool.
7. Do not use pesticides around the home.
8. When traveling remember that, without a permit, it may be illegal to bring back souvenirs made from plants and animals.
9. Reduce, reuse, and recycle. Consume less and buy from companies involved in protecting the environment.
10. Respect laws and regulations regarding species *At Risk*.

ECO SPOTLIGHT:

Habitat Stewardship Program

Figure 4.51:
Wolverine—an endangered species in Labrador and northern Quebec.
Photo courtesy Parks Canada/ W. Lynch

The Habitat Stewardship Program (HSP) for species *At Risk* is a partnership-based conservation program sponsored by the federal government of Canada. Its goal is to help Canadians protect native species and their habitats. This program is one of the pillars of species *At Risk* recovery in Canada. HSP is administered by Environment Canada and is managed cooperatively with Parks Canada Agency and Fisheries and Oceans Canada. The program provides financial support to projects targeted toward the recovery and protection of species listed as Endangered, Threatened or of Special Concern under SARA.

There are three key objectives of HSP:

1. To help secure and protect important habitat for species *At Risk*.
2. To help reduce threats to species *At Risk* caused by human activities.
3. To help support the priority activities outlined in Recovery Strategy or Action Plans (see section on Recovery Teams for information on Recovery Strategies and Action Plans).

One project that receives HSP support is the Labrador species *At Risk* Stewardship Program, which is targeted to aid in the recovery of Wolverine *(Gulo gulo)* and Woodland Caribou in Labrador.

This program promotes partnerships among various organizations and communities and encourages people to work together toward recovery and preservation of the natural Labrador landscape and environment.

A strong foundation of stewardship is integral to the conservation of Wolverine and Woodland Caribou populations in Labrador. The stewardship program involves the Innu and Inuit communities of Labrador and promotes a sense of ownership and responsibility to protect and recover these populations. Everyone has a role to play in species recovery—the scientist, the hunter, and the community.

Education

Education and stewardship go hand-in-hand. Education is essential for generating public awareness and support for species *At Risk* recovery. While most of us naturally understand why we want clean brooks, we need to learn why Piping Plovers on a beach in southwest Newfoundland, or plants on the limestone barrens

on the Great Northern Peninsula are important. Good education and stewardship means helping the public to become aware of species *At Risk*. With this knowledge people will come to understand and to care about these organisms. Then we can work together to determine why and how we can change our activities to reduce negative impacts on the environment, not just for the species *At Risk* but for all the organisms with which we co-exist.

Figure 4.52: Natural History Interpretation in Terra Nova National park. Education and public awareness are essential parts of *At Risk* recovery plans. *Photo courtesy Parks Canada*

How can we expect fishers to realize that their current method of drying nets by spreading them on the ground is impacting the rare plants on the Limestone Barrens of the Northern Peninsula? They may have seen these same plants nearly every day of their lives and may not even know that the plants are unique. But if someone tells them that to protect that plant species they need to change their method of drying nets, it is safe to assume that most would attempt to dry the nets another way.

Figure 4.53: Spreading Nets on the ground to dry may impact the plants in an area.

Species *At Risk*, public education, and stewardship takes many forms, many of which can be easily implemented. When people want to spread the message that a species is important to us, action can be as easy as chatting with neighbours or visitors.

The most important component of a stewardship program is to reach the people currently having direct impacts on the species *At Risk*. Any outreach and education must help resource users to become aware and to care about the species they are impacting. Then they are more likely to make an effort to reduce their impacts and to ensure that the species or resource is available for the enjoyment and use of future generations. This is the same reason why many of us now recycle or compost items that we used to throw in the trash.

ENVIRO-FOCUS

Piping Plover and Limestone Barren Plants

Figure 4.54: The Piping Plover is an "Endangered" species.
Photo courtesy Environment Canada/ Peter Thomas

1. Piping Plover

When Piping Plovers nest on the beaches of southwest Newfoundland, it is vital that beachgoers and ATV users be very aware of this little bird. Stewardship programs in the area rely on volunteers to monitor beach areas during nesting and chick rearing time periods. These volunteers talk to beachgoers to educate them and encourage them to responsibly share the beaches with breeding Piping Plovers by avoiding the nesting areas. In this way, both people and plovers can make the most of what these places have to offer.

Figure 4.55:
Piping Plover Habitat in J.T. Cheeseman Provincial Park.
Photo courtesy Environment Canada/ Peter Thomas

2. Limestone Barrens Plants

On the Great Northern Peninsula of Newfoundland, stewardship programs are successfully educating residents about the incredibly unique limestone rock barrens. They harbour rare and specialized plants found nowhere else on Earth.

Figure 4.56: The Limestone barrens of the great Northern Peninsula. *Photo courtesy Environment Canada/ Peter Thomas*

Thanks to targeted stewardship, fishers understand the damage they can cause and know where they should not lay their nets. Many communities use the presence of these rare plants in their tourism promotions. The Burnt Cape Ecological Reserve located on the Great Northern Peninsula of Newfoundland boasts a rich mixture of unique arctic and calcium dependent plants, including Fernald's Braya *(Braya fernaldii)* and Long's Braya *(Braya longii)* (both are *At Risk* species). To steward tourists who could come and trample the very plants they are there to see, these communities also lay out well-planned trails to ensure that these invaluable plants are well protected.

Socio – Economic Factors in Species Recovery

Socio-economic factors, meaning the social and economic benefits and/or consequences to people, must be taken into account for species *At Risk* education. We need to understand how these species are affected by people, as well as how people are affected by these species. For government and non-government organizations to act responsibly about recovering a species *At Risk*, they must understand how people will be affected by rules associated with species protection. For example, if a particular species *At Risk* is an important food source and harvesting this species also employs people, then protecting that species from harvest will seriously impact the people who depend on it for their food and livelihood.

However, it is important to remember that by designating a species as *At Risk* and protecting it, we ultimately help to ensure the long-term survival of the species as well as any industry or people that may depend on its existence.

Did You Know?

Although it was designated as Endangered by COSEWIC, the Newfoundland and Labrador population of cod (cod extending from Cape Chidley to the southern Grand Banks) was not listed under SARA for socio-economic reasons.

Reaching the Goal of Species *At Risk* Recovery

Although the list of species *At Risk* continues to grow, there are success stories. Once a species is listed and more efforts and resources are dedicated to learn about the species and to protect it from danger, some do recover to a point where they can be removed from the species *At Risk* list. For example, a species may be listed as Endangered and once recovery helps reduce threats and increase population sizes, the species may later be reassessed and down-listed to another status such as

Special Concern, or be removed from the list altogether. One example of species that was down-listed due to successful recovery initiatives is the western North Atlantic population of the Humpback Whale. In May 2003, this population was assessed and down-listed to the status of *Not At Risk* by COSEWIC.

Figure 4.57: Breaching Humpback near Bay Bulls, Newfoundland and Labrador. *Photo courtesy Environment Canada/ Peter Thomas*

ENVIRO-FOCUS

Humpback Whale

Humpback Whales are easily recognizable. They are one of the largest whale species, typically reaching lengths of about thirteen metres for males and fourteen metres for females. They have dark dorsal (back) coloration, extremely long pectoral flippers, and they tend to raise their tail flukes above the surface when they dive. Humpbacks are also well known for their frequent acrobatic behaviour. They are the focus of commercial whale watching operations. In Canada, Humpbacks Whales occur on both the east and west coast, extending north to Greenland in the east and into northwestern Alaska in the west (COSEWIC 2003). They are a migratory species and visit Canadian waters primarily to feed.

Figure 4.58: Canadian Range of the Humpback Whale *Courtesy Environment Canada*

Canadian Range of the Atlantic Humpback Whale

In 1982, both the western North Atlantic and North Pacific populations were given a single designation of Threatened by COSEWIC due to decreases in population from over-hunting. In 1985, it was decided to separate these two populations and the western North Atlantic population was down-listed to Special Concern. In 2008, threats to this population still include entanglement in fishing gear, habitat degradation on breeding grounds, and possible resumption of commercial whaling. However, despite these threats and although formerly heavily reduced by whaling, current protection has helped this population to rebound to a substantial proportion of its pre-whaling size. Now neither the North Atlantic population nor any of its breeding sub-populations are considered *At Risk* from current or anticipated human activity in the next few years.

Figure 4.59: Top: A bowhead whale *(Balaena mysticetus)* being cleaned (1910). Bottom: A fleet of small boats heading off to the whaling grounds. *Photos respectively courtesy A.G. McKinnon / Library and Archives Canada / PA-101941, Steffanson-Andersaon / Library and Archives Canada / C-086450*

"Canada is caretaker of both a national and global legacy of wild flora and fauna, some of which exist nowhere else on earth. What remains of this rich natural heritage for future generations of humans and non-humans will be a direct result of what we do today."

- Beazley and Boardman 2001

CHECK your Understanding

1. What is the purpose of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)?
2. What are the seven COSEWIC species status categories?
3. What is the purpose of the Canadian Species *At Risk* Act (SARA)?
4. What is the purpose of a Species *At Risk* Recovery Plan?
5. How does the Species Status Advisory Committee (SSAC) differ from COSEWIC? How are they similar?
6. Describe how we can support government initiatives to protect species *At Risk*.

Chapter 5: Protecting Spaces

WHAT IS A PROTECTED AREA?

Figure 5.1: Northern Gannet *(Morus bassanus)* and Common Murre at Cape St. Mary's Ecological Reserve.

Parks, reserves, marine conservation areas, bird sanctuaries, wilderness areas. What do all these places have in common? They are all protected areas; natural spaces that are legally protected from harmful human use in order to retain their biological diversity.

These areas, on the land and in the sea, are protected to preserve the natural ecosystems. They can be small or large. They can protect habitats, species, or important natural features. Depending on the level of protection, they may also be places for people to enjoy outdoor recreation and experiences, find spiritual significance or links to our heritage, and learn about nature and the world in which we live.

So no matter what level of legal protection an area has, they are all protected so that the benefits will remain—*if* we take care of them—for future generations. Protected areas are created and managed by many levels of government, from local to national. Some are created thanks to the efforts of organizations, corporations and even individuals.

About 1,050,000 km² (or 10.5 per cent) of Canada's territory is protected. The country's forty two national parks count for about one third of that area. In addition, the Canadian Wildlife Service of Environment Canada protects 118,000 km² of wildlife habitat as either National Wildlife Areas or Migratory Bird Sanctuaries.

Did You Know?

In Newfoundland and Labrador, 4.5 per cent of the land area is classified as protected – that includes 7.4 per cent of the area of the Island and 3.3 per cent of Labrador. However, most experts agree that to achieve biodiversity and conservations goals at least 12 per cent of the landmass must be protected.

Using representative natural-area or ecoregion criteria, both the federal government (through Parks Canada) and the provincial government (through Parks and Natural Areas Division) are planning to increase protected areas in Newfoundland and Labrador.

In Newfoundland and Labrador, more than sixty protected areas add up to 18,000 km² or 4.5% of the total land area of this province.

TYPES OF PROTECTED AREAS IN NEWFOUNDLAND AND LABRADOR

In Canada, the Parks Canada Agency, Environment Canada (Canadian Wildlife Service), and the Department of Fisheries and Oceans share responsibilities for federal protected areas.

In Newfoundland and Labrador, provincially protected areas are managed by the Department of Environment and Conservation. The responsible divisions of the department include Parks and Natural Areas, Wildlife, and Lands.

Every province and territory has a different mix of protected areas. The protected areas in Newfoundland and Labrador include the following:

Federal Protected Areas

NATIONAL PARKS OF CANADA

There are three national parks in this province: Terra Nova National Park, Gros Morne National Park, and Torngat Mountains National Park Reserve. As of 2008, a potential fourth, in the Mealy Mountains of Labrador, is under discussion.

These parks are part of Canada's countrywide system of "representative natural areas of Canadian significance." They protect ecosystems that typify each of Canada's natural regions. Recreation in many forms, such as fishing, occurs in National parks. Hunting is normally forbidden. Created for the benefit, education, and enjoyment of all Canadians, these parks are managed by Parks Canada Agency to protect their diversity for future generations.

NATIONAL HISTORIC SITES OF CANADA

These sites protect and celebrate nationally significant places, people, and events. Parks Canada policies also allow for valued natural ecosystems to be protected in national historic sites. In this province, there are two with significant habitat for rare plants: Port au Choix National Historic Site and L'Anse-aux-Meadows National Historic Site.

Figure 5.2: Gros Morne National Park (top) L'Anse-aux-Meadows National Historic Site (bottom).

Figure 5.3: Protected areas help maintain the biodiversity of the province.

MIGRATORY BIRD SANCTUARIES

Environment Canada oversees three migratory bird sanctuaries in the province: Shepherd Island, Ile aux Canes, and Terra Nova. Each sanctuary protects migratory bird habitat such as nesting or wintering grounds. They are governed by the Canada-U.S. *Migratory Birds Convention of 1916 and the Migratory Birds Convention Act* (1917, 1994).

NATIONAL MARINE CONSERVATION AREAS

Environment Canada is also responsible for National Marine Conservation Areas (NMCA). These marine areas are managed for sustainable use and include smaller zones of high protection. NMCAs can include the seabed, the water above it, and any species found there. They can also take in wetlands, estuaries, islands, and other coastal lands.

NMCAs are protected from ocean dumping, undersea mining, oil and gas exploration, and development. Traditional fishing activities are permitted, but those activities are managed with ecosystem conservation as the main goal.

MARINE PROTECTED AREAS

Fisheries and Oceans Canada has designated two Marine Protected Areas in this province, one in Gilbert Bay (Labrador) and another in Eastport (Newfoundland).

Two types of **terrestrial protected areas also include marine areas** inside their boundaries: ecological reserves and migratory bird sanctuaries. L'Anse-aux-Meadows National Historic Site has forty nine km² of marine area including thirty four km of shoreline. This protects the seabed and the nesting seabirds on the coast. It is the largest area of protected marine habitat in the province. Fisheries and Oceans Canada sets regulations for fishing, in consultation with Parks Canada.

Canada is also a Contracting Party to the **RAMSAR Convention on Wetlands.** This intergovernmental treaty provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (*www.ramsar.org/*).

Provincial Protected Areas

WILDERNESS RESERVES

These large protected areas, covering more than 1,000 km², protect the habitat of wide-ranging species such as woodland caribou, as well as representative examples of the province's ecoregions. There are two wilderness reserves on the island portion of the province, the Avalon and Bay du Nord, both of which are managed by the Parks and Natural Areas Division.

ECOLOGICAL RESERVES

There are eighteen ecological reserves in the province that together account for less than 1,000 km². Administered by the Parks and Natural Areas Division, ecological reserves can be divided into four types, each of which serves a different purpose. They are created to protect:

1. Portions of the province's ecoregions or subregions, such as the three subregions in the Little Grand Lake Provisional Ecological Reserve.
2. Rare species, such as the jack pine stands *(Pinus banksiana)* in the Redfir Lake-Kapitagas Channel Ecological Reserve.
3. Unusual biological richness such as the seabird colonies in Witless Bay Ecological Reserve.
4. Unusual natural features such as the important fossils at Mistaken Point Ecological Reserve.

Figure 5.4: The Picture Plant has been the provincial flower since 1954.

PROVINCIAL PARKS

There are thirty two provincial parks in the province. Some, such as the fourteen camping parks, are used mainly for recreation. But they also provide some protection for natural features and species. Provincial parks vary in size and include many types of environments. They are administered by Parks and Natural Areas Division.

Figure 5.5: Wildlife parks serve many purposes including protection of the plants and animals within its boundaries and providing educational opportunities for the public.

WILDLIFE RESERVES

Wildlife reserves protect the habitat of particular wildlife species. The size of these reserves depend on the habitat needs of the wildlife they are intended to protect. The three wildlife reserves in the province include Middle Ridge, Big Barasway, and Little Grand Lake. They are administered by the Wildlife Division.

WILDLIFE PARKS

Salmonier Nature Park on the Avalon Peninsula is the province's only wildlife park. Established for educational purposes, and administered by the Wildlife Division, it has evolved to become a tourist destination. The park has also expanded its role in wildlife rehabilitation and research and in environmental monitoring. Its boundaries include the headwaters of the Salmonier River. Activities permitted within its borders are similar to those in a wildlife reserve.

CROWN/PUBLIC RESERVES

Using the *Lands Act*, the provincial government can set aside areas of Crown land for a wide variety of reasons in Crown or Public Reserves. Glover Island Public Reserve is the only Crown reserve in the province that is considered a protected area. It was created to protect Newfoundland pine marten *(Martes americana atrata)* habitat.

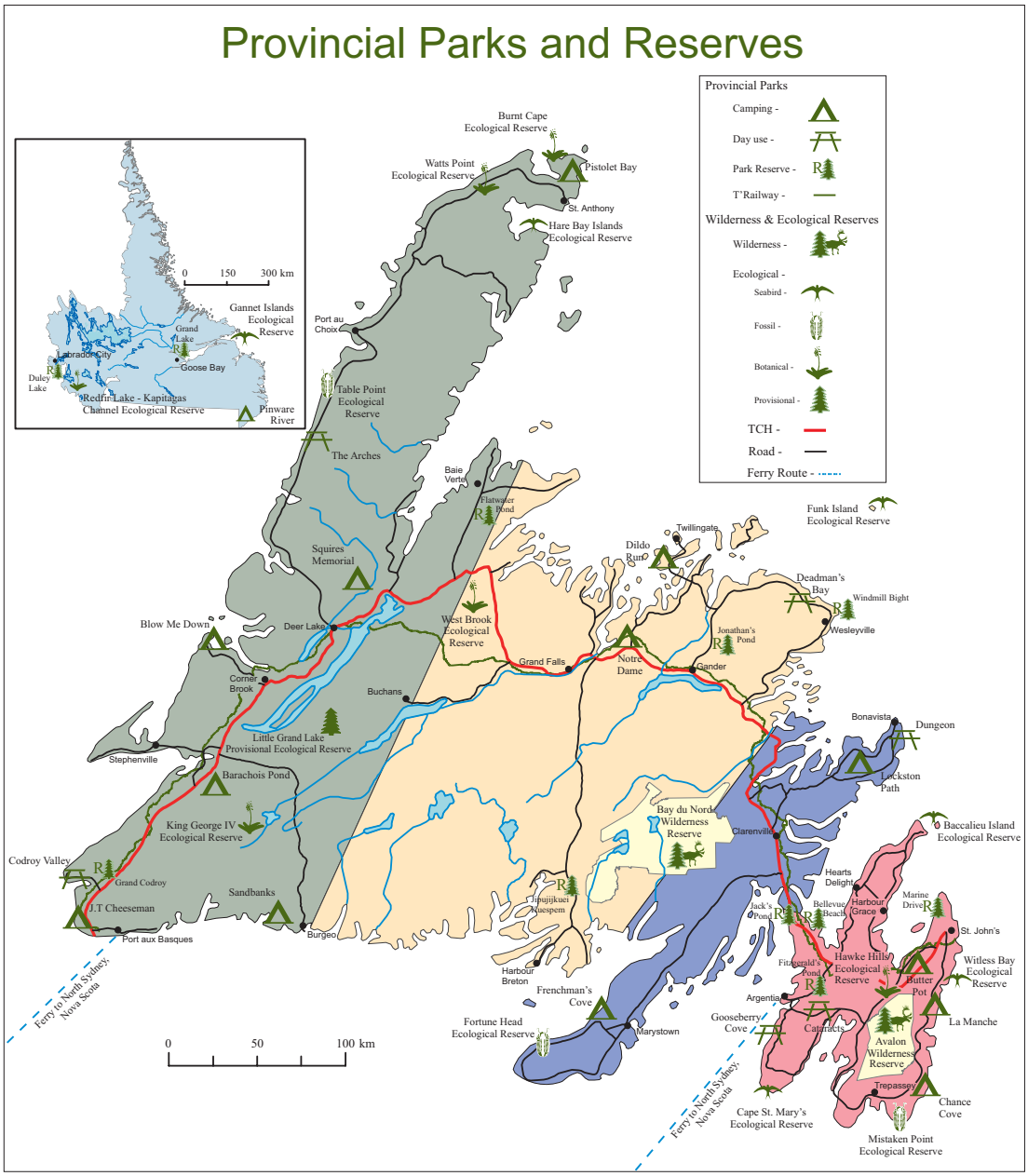


Figure 5.6: Provincial Protected Areas in NL.
Image courtesy Newfoundland and Labrador Parks and Protected Areas Division

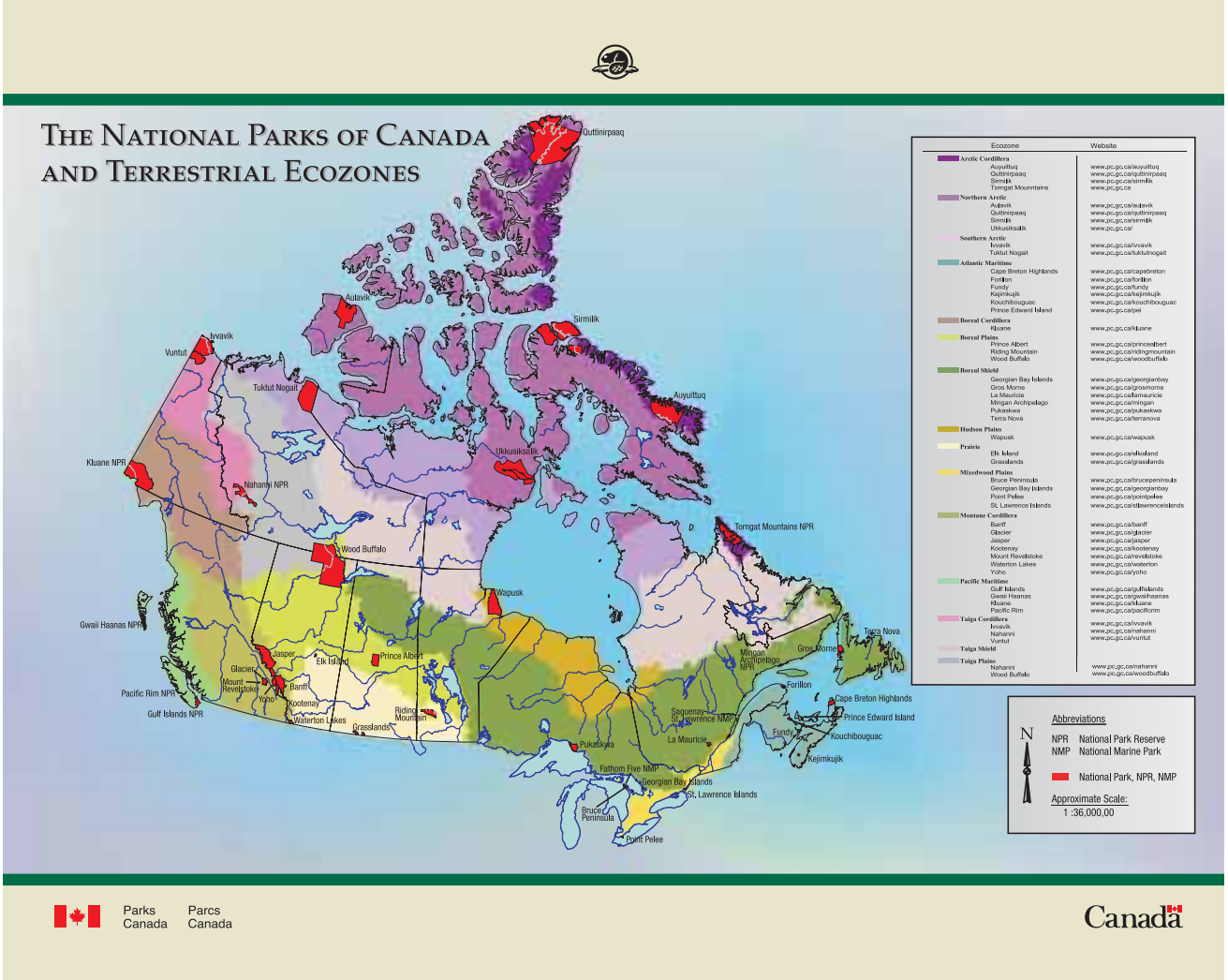


Figure 5.7: Canada's National Park System.
Image sourced from Parks Canada

CHECK your Understanding

1. What is the purpose of creating protected areas?
2. Which government agencies (federal and provincial) are responsible for creating and maintaining protected areas in Newfoundland and Labrador?
3. Which branches of the federal government are responsible for maintaining national protected areas?
4. Which branches of the provincial government are responsible for maintaining provincially protected areas?
5. What are the three main types of protected areas in Newfoundland and Labrador under the jurisdiction of the federal government? Provide an example of each.
6. What are the types of protected areas in Newfoundland and Labrador that are under the jurisdiction of the provincial government? Provide an example of each.
7. What is the main distinction between Wilderness Reserves and Wildlife Reserves?

For Further Discussion and Research

8. Identify areas in the province that are proposed to become protected areas. What is the basis of the proposal? Why is the area special? How long has the proposal been in place? Are there economic or social pressures against protecting the proposed area? Describe the pressures.

WHY PROTECTED AREAS ARE IMPORTANT

Protected areas provide a number of distinct and valuable benefits to society. These include:

1. **Biodiversity protection** – species and systems found within the boundaries of protected areas are managed to ensure greater biodiversity.
2. **Enjoyment** – protected areas are places to enjoy outdoor recreational activities.
3. **Education** – protected areas are outdoor classrooms for students and the public. Many national and provincial parks provide enriching and enjoyable interpretive programs. They build awareness, understanding, and support for key conservation goals such as protecting biodiversity and wilderness and encouraging sustainable development.
4. **Economic benefits**– visitors and businesses that service protected areas contribute to the local economy. Protected areas provide jobs in many fields including tourism, guiding, research, conservation, and interpretation.
5. **Natural experiences** – protected areas are places to simply *be in nature*. From this experience, people may draw deeply personal or spiritual growth.
6. **Places for scientific research** – in protected areas, the wildlife, habitats, and ecosystems function as naturally as possible.

Economic Impact

In 2004, Gros Morne National Park contributed 75 million dollars to the economy of Newfoundland and Labrador.

Source: 2004 Gros Morne National Park Economic Impact Analysis

Protected Areas:
The International View

The World Conservation Union defines a protected area as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources and managed through legal or other effective means."

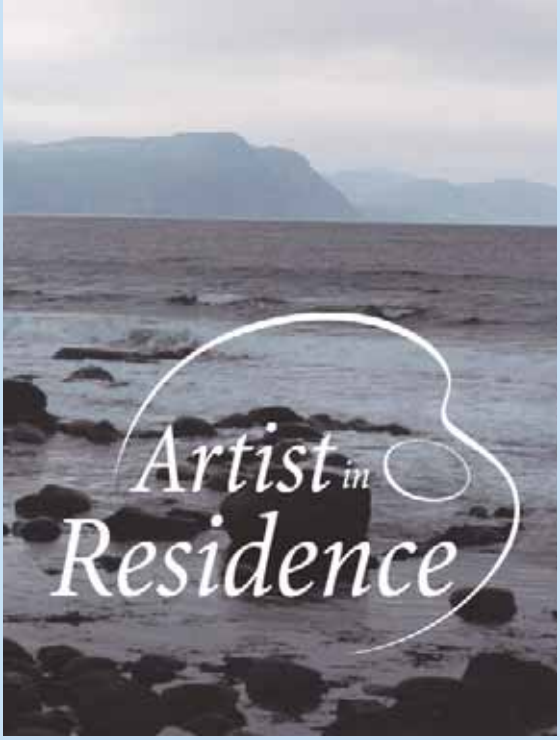
Canada's Biodiversity Strategy

Canada's Biodiversity Strategy has five goals:

1. Conserve biodiversity and use biological resources in a sustainable manner.
2. Improve our understanding of ecosystems and increase our resource management capability.
3. Promote an understanding of the need to conserve biodiversity and use biological resources in a sustainable manner.
4. Maintain or develop incentives and laws that support the conservation of biodiversity and the sustainable use of biological resources.
5. Work with other countries to conserve biodiversity, use biological resources in a sustainable manner, and share equitably the benefits that arise from the utilization of genetic resources.

Creativity and Expression in Protected Areas

Since 1998, Newfoundland and Labrador's Provincial Art Gallery has partnered with Gros Morne and Terra Nova National Parks to offer Artist-in-Residence programs. Each summer, Canadian and international artists stay in the parks for three to six weeks working on their art and interacting with the public. The art inspired by these protected areas helps connect people to the place and build broader awareness of our national parks and their value to Canadians.



Why is it important to protect biodiversity?

- Each species is inherently valuable.
- Economic value to people may come from organisms in ways that are yet undiscovered.
- The interaction of each species in the environment helps create and sustain the necessary conditions for all living creatures to survive. The effect of removing species on interactions cannot be predicted.

PROTECTED AREAS AND BIODIVERSITY

Protected areas are extremely valuable for the contribution they make to the protection of biodiversity and healthy ecosystems. The critical importance of this conservation role continues to grow as our environment comes under greater stress. It is now reflected in how protected areas are designed and managed, and in their emphasis on education and outreach activities.

Let's take a closer look at what is behind this.

The biggest threat facing most species is habitat loss, although over-fishing is considered by many to be the greatest threat to marine species. Every species has unique habitat needs. When plants or wildlife do not have the right habitat their populations decline and disappear. This decrease in biodiversity unbalances the interlinked natural forces that support life on Earth.

Biodiversity loss is happening around the globe at an alarming rate. Scientists estimate that between 10 and 20 million species exist on this planet. (The range in these figures is huge because we have identified only a fraction of species.) Edward O. Wilson, a renowned scientist sometimes called "the father of biodiversity", has predicted that by the year 2100, half of all mammal and bird species will be extinct. This scale of species loss could greatly threaten how natural systems function, which could endanger humanity's well being.

Snapshot:

Canada's Biodiversity

- Longest coastline in the world
- Twenty per cent of the world's remaining wilderness
- Twenty per cent of the world's freshwater
- Twenty five per cent of the world's temperate rainforest
- Thirty per cent of the world's boreal forest
- Thirty three per cent of the world's wolf population
- Fifty per cent of the world's barren ground caribou

Snapshot:

Newfoundland and Labrador's Biodiversity

- 1,185 vascular plant species.
- Newfoundland: thirteen indigenous mammals, plus humans.
- Labrador: thirty eight indigenous mammals, plus humans.
- Seventy three bird species that breed here.
- World's largest Leach's Storm-petrel colony.
- North America's largest Atlantic puffin *(Fratercula arctica)* colony.
- Canada's most southerly caribou herd.

To combat the loss of natural habitat and biodiversity in Canada there are different strategies being applied. One of the most widely used strategies is creating and maintaining a system of protected areas.

Canada's Biodiversity Strategy and Protected Areas

Developing and maintaining a protected areas system is an important part of Canada's biodiversity strategy to foster biodiversity conservation in these ways:

1. **Habitat protection.** Regulations prohibit harmful activities from taking place in some protected areas. This allows natural habitats, plants, and wildlife to enjoy relatively undisturbed conditions in which to survive and evolve.

Figure 5.8: Bakeapple

2. **Scientific benchmarks.** When healthy ecosystems exist, we have standards against which to measure the health of all our natural systems. We can use protected areas as living laboratories to help us assess and improve methods for managing similar areas outside their borders.
3. **Insurance against disaster.** Ecological disasters may cause species loss. Unaffected protected areas can provide places where these threatened species may survive.
4. **Ecological stability.** Intact ecosystems with healthy plants and animals are better able to survive and evolve naturally inside protected areas. This, in turn, provides direct environmental benefits to areas outside their borders. They include:
    - Moderating local and global climates.
    - Improving water quality through watershed protection.
    - Providing a source of pollinators for wild and domestic plants.
    - Improving air quality by absorbing and breaking down pollutants (through natural processes).
    - Maintaining or increasing genetic diversity.
    - Helping to restock surrounding lands or waters with plants and animals through natural regeneration and colonization.

A Vision for Canada

Canada will become "a society that lives and develops as part of nature, valuing all life, taking no more than nature can replenish and leaving to future generations a nurturing and dynamic world, rich in its diversity of life."

Environment Canada

Snapshot:

Protected Areas

Helping Biodiversity in this Province

Funk Island Ecological Reserve protects biodiversity by protecting species. It is home to more than one million Common Murres, as well as Northern Gannet, Northern Fulmar *(Fulmarus glacialis)*, Atlantic Puffin, Razorbill *(Alca torda)*, Thick-Billed Murre *(Uria lomvia)*, Black-Legged Kittiwake *(Rissa tridactyla)* and Herring, and Great Black-backed gulls *(Larus marinus)*.

All 1,805 km² of Gros Morne National Park protects a variety of **ecological communities** including streams, ponds, marshes, taiga, boreal forests, and others. It has **genetically distinct** populations of Brook Trout *(Salvelinus fontinalis)*, Salmon, and Arctic Char *(Salvelinus alpinus)*. These may have evolved after the last Ice Age when newly created waterfalls and other obstacles isolated water bodies such as rivers.

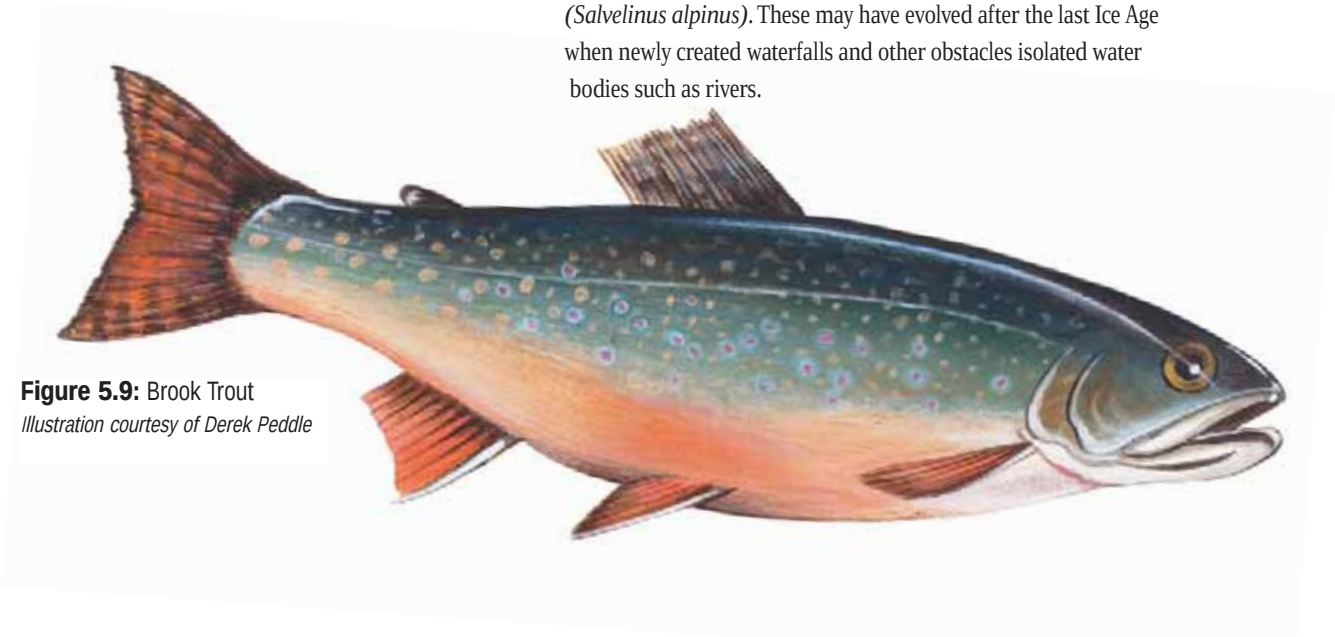


Figure 5.9: Brook Trout
Illustration courtesy of Derek Peddle

CHECK your Understanding

1. If extinction of species is a naturally occurring event that has occurred on Earth for billions of years, then why should we be concerned about extinctions occurring now?
2. Why is the creation and maintenance of protected areas valuable to society?
3. What is the role of protected areas in Canada's Biodiversity Strategy?

For Further Discussion and/or Research

4. Read Environment Canada's "A Vision for Canada" in the side panel box. Have we achieved this vision? Are there roadblocks to achieving it? Can we ever achieve this vision? Conduct research and report your findings to the class.

HOW PROTECTED AREAS ARE CREATED

Protected areas are created through legislation—national, provincial, and municipal. For example, national parks are created by Parliament under the Canada National Parks Act and Marine Protected Areas under the Oceans Act. The province's wilderness and ecological reserves are established by the provincial government using the Wilderness and Ecological Reserves Act.

The Province's Goal

The following vision statement guides Newfoundland and Labrador's Parks and Natural Areas Division in the creation and management of its protected areas:

"To protect, in an unimpaired condition, large wilderness areas, representative areas of all provincial ecoregions and areas which contain rare natural phenomena, so as to preserve the diversity and distinctiveness of the Province's rich natural heritage to support an ecologically sustainable future for the benefit of present and future generations."

When does a Government Use Its Protected Areas Legislation?

Governments create different kinds of protected areas with different kinds of legislation. When and why they choose to do so depends largely on the goals and plans of the agency that will maintain the new protected area.

At the national level, for example, Parks Canada's goal is to commemorate, protect, and present places that are "significant examples of Canada's cultural and natural heritage." In the early 1970s, it created a National Parks System Plan to help fulfill this goal. The plan divides Canada into regions. Each region will one day have a national park. You can check the progress being made toward achieving this goal on the Parks Canada web site.

Figure 5.10: Protected areas help maintain biodiversity.

The Oceans Act gives powers to the federal government to create Marine Protected Areas (MPAs) in order to conserve special areas and species in the marine environment.

At the provincial level, the Parks and Natural Areas Division has a plan for completing a system of reserves based on its official Vision Statement. The Division works with the Wilderness and Ecological Reserves Advisory Council (WERAC) to implement its Natural Areas System Plan.

A New National Park for Labrador?

In 2002, the Federal Government announced it would create ten new national parks across the country. One "area of interest" is in the Mealy Mountains in Labrador. A feasibility study is underway.

Protected Areas Designated in Newfoundland and Labrador since 1992 when the Convention on Biodiversity was signed.

1992	Fortune Head Ecological Reserve (fossil)
	Hawke Hill Ecological Reserve (botanical)
1993	West Brook Ecological Reserve (botanical)
1995	Baccalieu Island Ecological Reserve (seabird)
1997	King George IV Ecological Reserve (botanical)
1999	Redfir Lake–Kapitagas Channel Ecological Reserve (botanical)
2000	Burnt Cape Ecological Reserve (botanical)
2002	Little Grand Lake Provisional Ecological Reserve (ecosystem)
	Little Grand Lake Wildlife Reserve (wildlife)
	Glover Island Public Reserve (wildlife)
	Mistaken Point Ecological Reserve Extension (fossil)
2005	Torngat Mountains National Park Reserve (natural region)

Figure 5.11: Twin flower

Creating protected areas can be a slow, complex process. It may take decades and, depending on the location and type of protected area, the process involves such things as:

- Gathering public and expert support.
- Doing research.
- Identifying proposed water or land boundaries.
- Acquiring land.
- Negotiating with partners and stakeholders.
- Resolving land-use or water-use rights.

In some cases, Aboriginal peoples have rights and cultural and spiritual connections to the proposed area. These must also be considered during the establishment process.

Every protected-area creation process is different because every area is different. Each has its own unique mix of stakeholders, landowners, users, and competing use visions.

Biodiversity Protection and Protected Area Design

To design effective boundaries for a proposed protected area, the area's purpose must be considered. For example, is the protected area meant to encompass the habitat of a caribou herd? A representative example of an ecoregion? A distinct seabird colony or a fish population? Each of these protected areas must be designed differently.

Designing any area that is meant to protect and preserve biodiversity involves scientific study and requires knowledge of wildlife patterns of behaviour, habitat needs, and ecosystem function. No matter what their purpose, protected areas are designed best when the process includes public consultation and support.

Protected areas are not meant to be isolated. They are part of the larger ecosystems that surround and contain them. Plants and animals move across the boundaries and reproduce according to environmental and biological conditions. These facts must be taken into account when protected areas are designed. If the design and management of a protected area is not planned carefully, it could become an island of refuge surrounded by an area that is very different ecologically. This could have serious negative impacts on some species, especially mammals that migrate over large areas.

ECO SPOTLIGHT:

Burnt Cape

The Making of an Ecological Reserve

Burnt Cape is one of the province's most important botanical sites. Situated on the island of Newfoundland at the northwest tip of the Great Northern Peninsula, this rocky limestone peninsula yields a surprising rich variety of flora—within 3.6 km² there are more than 300 species including thirty that are rare.

Figure 5.12:
View of Burnt Cape *Photo courtesy Newfoundland and Labrador Department of Environment and Conservation*

Burnt Cape is the first site in the world where the extremely rare Burnt Cape cinquefoil *(Potentilla usticapensis)* was discovered. It is also the only place on the island of Newfoundland where Dwarf hawk's beard *(Crepis nana)* is known to grow. This cold and windswept area has just the right conditions for plants that otherwise grow only in the Arctic.

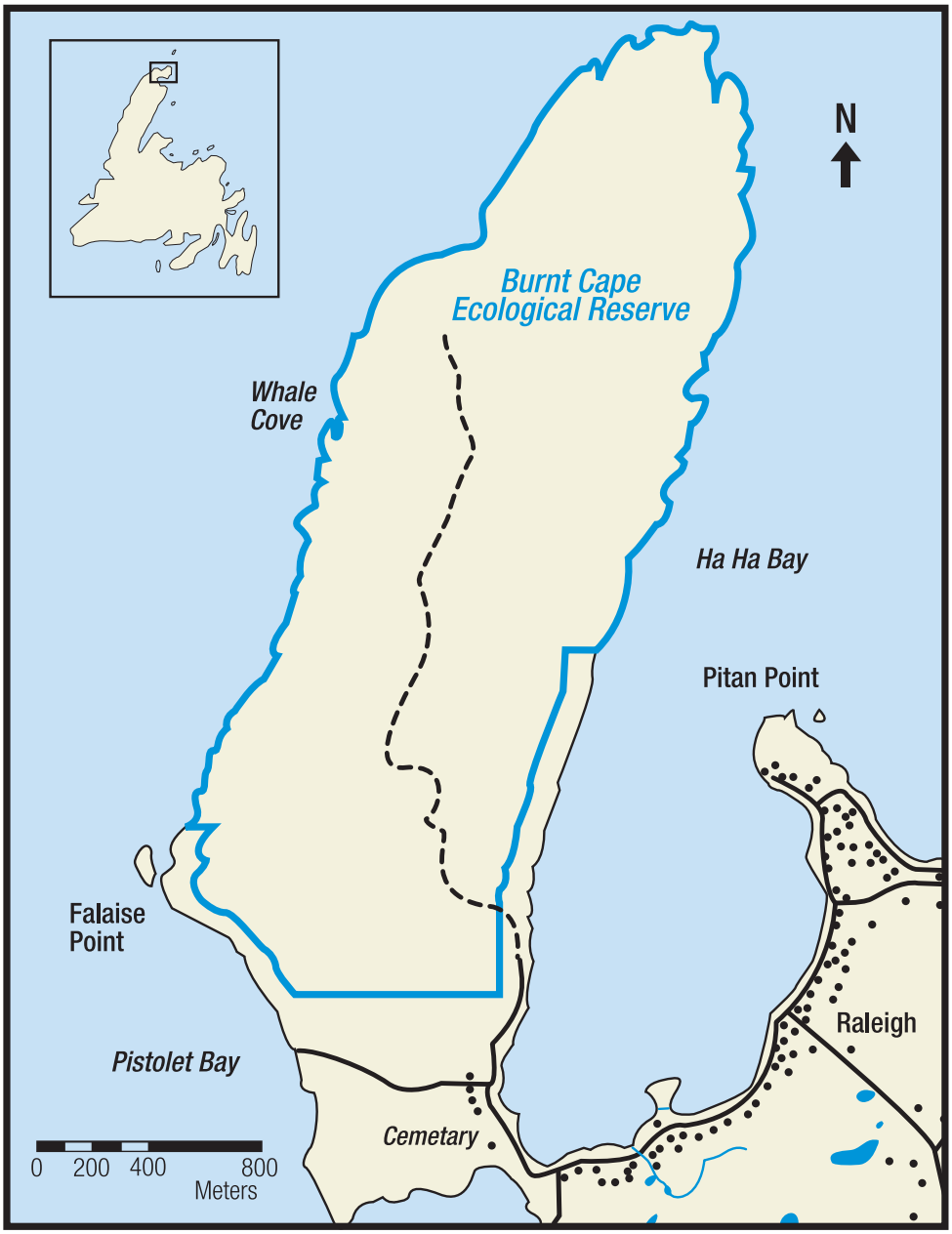


Figure 5.13: Burnt Cape on the tip of the Northern Peninsula

Burnt Cape became an Ecological Reserve thanks to the collective vision of many environmentally conscious people including the people of Raleigh, professional and amateur botanists, provincial and municipal governments, school children, and many other supporters.

Figure 5.14: Dwarf hawk's beard
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

Figure 5.15: Burnt Cape cinquefoil
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

Figure 5.16: Fernald's braya
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

The Burnt Cape Story

Brunt Cape was first recognized by Harvard University botanist M.L. Fernald in the 1920s. Fernald and his team worked hard to raise awareness of the region's plant life among scientists and botanists of his era. However, it was not until the 1970s that the rare plant species and amazing plant diversity of this area was re-discovered. Even then commercial and domestic limestone gravel quarrying continued into the 1980s and seriously threatened the survival of the Capes' rarest plants.

The possibility of species extinction led Memorial University botanist Susan Meades, members of the community of Raleigh, and other concerned people to search for ways to protect the Cape.

The Burnt Cape story demonstrates how concerns for conservation, plus solid communication, research, and stewardship can achieve positive results. People who live near Burnt Cape were involved from the beginning. All those involved in the effort can be confident that Burnt Cape's unique natural diversity will be protected for the future.

Timeline for Creation of Burnt Cape Ecological Reserve

1990s	• The area was named a Crown Land Reserve and the Department of Mines and Energy stopped renewing quarry permits. • Wilderness and Ecological Reserves Advisory Council (WERAC) undertook consultation and public information sessions to investigate the possibility of protecting the Cape with reserve status.
1998	• WERAC recommended to provincial Cabinet that an Ecological Reserve be established. • Nature Conservancy of Canada (NCC), a national conservation organization, funded research to inventory the plant and animal species, began landscape restoration of the quarry and produced a brochure.
1999	• NCC provided funds to hire and train two people from the area to act as interpreters/guardians.
2000	• Burnt Cape Ecological Reserve was fully established.
2002	• Friends of Burnt Cape, a not-for-profit organization, was established to assist with educating people to help protect the Ecological Reserve.
2005	• Burnt Cape Guardians became permanent seasonal employees of the Parks and Natural Areas Division.

Unique Features of Burnt Cape

Burnt Cape has some of the most Arctic conditions on the island of Newfoundland. A limestone peninsula, it stands seventy five metres above the sea, higher than the surrounding terrain. In places it has the barrenness of a moonscape—until you get up close. Then its tiny, hardy botanical wonders can be seen.

Frost Polygons, also known to geologists as sorted ground, are loose stone surface ridges around an open space (polygons). These occur in areas of exposed ground that are subject to intense freeze and thaw cycles when the temperatures fluctuates above and below 0°C in a matter of hours. Over thousands of years, repeated freezing and thawing of groundwater in loose gravel and mud slowly pushes the larger rocks away from the pressure centre of finer grained material where the water is retained. The resulting circles and lines are remarkably perfect geometrical shapes.

Figure 5.17: Frost Polygons
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

Figure 5.18: Sea Caves
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

Sea caves are also found in the reserve. The predominately limestone coast, exposed to westerly prevailing winds and wave action, displays many spectacular caves.

The community of Raleigh is a small fishing community in Ha Ha Bay. The successful pursuit of the inshore cod fishery fostered the growth of permanent settlement. In 2008, approximately 280 people call Raleigh home. It has a school, two churches, souvenir and gift shops, and convenience stores. Since the creation of the Ecological Reserve, the number of visitors to the area is increasing. New businesses have developed including a café, restaurant, and efficiency cabins.

Figure 5.19: Tread Lightly! Endangered plant below.
Photo courtesy Newfoundland and Labrador Department of Environment and Conservation

Eight Key Indicators of Ecological Integrity in National Parks

1. **Native species**—are any being lost?
2. **Focal species**—are any native species losing their ecological role?
3. **Herbivores/predators**—are any food chains being lost?
4. **Productivity/ decomposition**—is there a change in the rate of growth or decay?
5. **Community age/spacing**—how do they compare in plant and animal communities inside and outside a park?
6. **Nutrient cycling**—is this happening at expected rates?
7. **Physical processes**—are landforms or water bodies changing at expected rates?
8. **Stressors**—what is the net effect of human activity on a park?

Parks Canada (Stephen Woodley)

MANAGING PROTECTED AREAS

These days, even the best-designed protected area cannot stay healthy on its own. Environmental "stressors" can cause harm. Some stressors include:

- Habitat loss or fragmentation outside or inside the protected area, which leads to ecological isolation
- Loss, decreasing or increasing populations of large carnivores, which upsets the balance of natural systems
- Air pollution, which can affect water quality and aquatic plant and fish species
- Global warming, which affects many elements in an ecosystem
- Pesticides, the effects of which are spread by wind and water
- Non-native species, which upset natural systems and displace native species
- Visitor use, which could lead to degraded environments or displacement of wildlife

Maintaining ecological integrity in a protected area calls for management that includes ongoing monitoring and research, as well as educational activities, enforcement of regulations, and occasionally intervention in "natural" processes.

Designing appropriate scientific studies, collecting data, and monitoring change play an important role in managing protected areas. Local and traditional knowledge of wildlife and the environment are also key sources of information and insight in this work.

Parks Canada made "maintaining ecological integrity" one of its guiding principles in 1979. In 2000, the new Canada National Parks Act put ecological integrity at the centre of park-management decisions. Each national park must now prepare a State of the Park Report every five years. These reports assess the health of the park ecosystems and how well their ecological integrity is being maintained.

The Oceans Act places important emphasis on ecosystem-based management of Canada's marine waters.

Monitoring Ecosystem Health: A Key Management Tool

How can you tell if an ecosystem inside a protected area is healthy? You do this by monitoring the changes in the area. Long-term monitoring will highlight the changes over time in ecosystems. Such monitoring must be an open-ended activity. It answers questions and identifies new areas that need study.

The monitoring of these protected spaces includes ongoing research that measures the size, age, reproductive success, incidence of disease, and death rate in the naturally occurring plants and animals in the system. Just as important as these measurements is research to determine whether or not the plants and animals are functioning as a naturally sustainable system.

The results of this research provides insight into the health of the natural environment. Armed with this information, managers of protected areas can, if necessary, adjust their activities or devise new methods for combating unnatural changes in the plant and wildlife communities.

Environmental Stressors at Home

These specific concerns need to be addressed in and near Newfoundland and Labrador's terrestrial protected areas:

- **Modification of natural habitat** caused by industrial or logging practices.
- **Habitat fragmentation** caused by new roads, power lines, and bridges.
- **Changes in streams and waterways** from pollution, dumping, and culverts that disrupt natural patterns.
- **Vehicle use** (ATVs, snowmobiles) which can destroy habitat and take humans into areas that cannot sustain the destruction caused by significant human presence.
- **New species**, introduced on purpose or by accident, that can upset natural ecosystem processes.
- **Expanding development** that follows the construction of new access roads.
- **Harmful human activity** such as oil spills, poaching, dumping, and polluting.

Creating a New National Park

The five main milestones to create a new national park are:

1. Identify a representative natural area.
2. Select a potential park area.
3. Assess park feasibility.
4. Negotiate the Park Agreement.
5. Schedule the park in Parliament under the Canada National Parks Act.

Figure 5.20:
Rock Ptarmigan
Photo courtesy Parks Canada

ENVIRO-FOCUS

Balancing Act— How Many Hikers Are Too Many?

In Gros Morne National Park, hikers can climb to the alpine summit of Gros Morne Mountain. The popular trail offers a great view and a chance to see the hardy alpine plants and animals.

For wildlife, the summit of Gros Morne Mountain can be a difficult place to live. Young animals are particularly vulnerable to disturbance by people. Hikers can sometimes cause adult Rock Ptarmigan *(Lagopus mutus)* to become separated from their young and some chicks die as a result. And, when hikers leave the trail they can damage the fragile plants and often create multiple trails (or braiding).

Figure 5.21: Hikers ascending Gros Morne Mountain.
Photo courtesy Ryan Meadus

Park staff understand that visitor use can damage this sensitive habitat and harm wildlife. Monitoring and managing how people use the trail and how many people hike it is important to protect this area.

To limit harm to ptarmigan, the park closes the trail in the spring until the chicks are older and stronger. The park uses electronic counters to monitor the number of people using Gros Morne trail. They also monitor the numbers of ptarmigan and Arctic hare *(Lepus arcticus)*. If changes are observed in these species' populations, trail use is modified.

Monitoring from 1999 to 2005 showed the numbers of hikers increasing to more than 5,000 per season (2003 saw the most traffic with 6,342 hikers). Although Rock Ptarmigan and Arctic hare populations fluctuated within normal ranges during that time, the park conducted restoration work to keep people on the main paths by getting rid of trail braiding.

What Monitoring Reveals

- Five per cent of people using the trail do not follow the marked route.
- When sixty people walk thorough an area that amount of traffic can cause noticeable trampling and measurable soil compaction.
- When seventy people walk through an area that amount of traffic can cause a decline in vegetation cover.
- When ninety people walk thorough an area that amount of traffic can cause measurable damage.
- Ninety people taking a new route for two seasons in a row create a new trail (which is called braiding).

Shaping Human Activity in Protected Areas

Because our actions affect our environment, the people responsible for protecting natural areas must manage our activities in protected areas. By doing so, they help us to ensure that protected areas fulfill their conservation purposes.

Effective management of human activity in protected areas integrates science, education, public outreach, public involvement, and enforcement. It is important that visitors and neighbours understand the importance of the area's contribution to conservation and act to help maintain it. Understanding can help foster a deeper respect for the natural environment and encourage appropriate behaviour.

Regulations are developed specifically for inside the protected area boundaries. Such regulations outline activities such as the following:

- Whether or not hunting and fishing is allowed and where
- Whether traditional activities are allowed
- Whether float planes may land or ATVs may be used
- If fires may be lit and where
- Whether public access is allowed

Every Activity in its Place
National Parks use a zoning system to manage human activity. There are five zones in the system. The highest level of restriction is in Zone 1 (Special Preservation). The guidelines for activities and access become broader through to Zone 4 (Outdoor Recreation) and Zone 5 (Park Services).

These and many other regulations are intended to guide visitor activities and limit or eliminate those actions that might harm species or upset the balance of ecosystems.

Human activity may also help to restore protected areas. Many volunteers and local community groups help monitor and restore natural habitats inside—and outside—the border of protected areas.

Outdoor Education

Parks and conservation agencies share information about natural history in many ways including:

- On-site interpretive exhibits or signs, presentations, workshops, or other guided activities (such as campfire programs and boat tours)
- School programs (curriculum resources, school-group visits, outreach)
- Websites, posters, booklets, movies, and books
- Working with, consulting, and informing neighbours, partners, and stakeholders about activities and issues

Figure 5.22: Interpretation in Terra Nova National Park.

Enriching the visitor experience is often a specific focus of educational programs in parks and protected areas. The goal is to engage the senses and spark the imaginations of visitors. Activities and information highlight the cultural and natural heritage attributes of each area that are relevant to all Canadians. Sometimes this includes getting behind-the-scenes access to management activities within the protected area.

ENVIRO-FOCUS

Community Involvement Helps Salmon Stocks Recover

In the mid-1990s, natural Atlantic salmon *(Salmo salar)* stocks everywhere were in decline. Some rivers were closed to recreational salmon fishing including the Northwest River near the eastern boundary of Terra Nova National Park. Despite this closure, the situation on the Northwest River grew worse until, by 2001, the number of returning stocks were the lowest in Newfoundland and Labrador. The factors suspected in this decline of salmon ranged from illegal fishing to pollution to natural predation.

Clearly, traditional solutions—enforcement of wildlife regulations—were not working. In 2002, Parks Canada, the Department of Fisheries and Oceans, and local residents formed the Northwest River Atlantic Salmon Conservation Working Group to try a new approach. Together they devised and supported a population recovery and conservation plan. Short- and long-term goals were set and an incentive was offered; if enough salmon returned, recreational fishing would be re-opened for the remainder of the year.

The group calculated the number of spawning salmon needed to sustain the river's population. They also calculated how many salmon could be safely harvested. A counting fence (installed in 1995) provided an estimate of the number of salmon returning to the river.

Figure 5.23:
Salmon Fence, Northwest River, Terra Nova National Park.
Photo courtesy D. Cote, Parks Canada

In 2003, the salmon stock had recovered to the point where the river was re-opened to anglers. In 2004, the fence recorded 1,472 salmon—the highest number to that date.

Monitoring and management continues. The last recorded numbers, for 2005, show numbers were still rising.

Only one year after Parks Canada joined forces with local residents and the Department of Fisheries and Oceans, the salmon stock in the Northwest River more than doubled.

Year	Salmon Returns
1995	574
1996	790
1997	521
1998	644
1999	407
2000	353
2001	151
2002	557
2003	1272
2004	1472
2005	1501

Salmon returns Northwest River, Terra Nova National Park

CHECK your Understanding

1. Construct a graph to illustrate the salmon returns from the Northwest River from 1995–2005. On the horizontal axis plot Time (years) and on the vertical axis plot Number (returning salmon).
   a. What factors could account for the poor salmon returns from 1995–2001?
   b. What factors could account for the improved salmon returns from 2002–2005?

   Predict what will happen to salmon returns in the Northwest River for the next five years. Explain your reasoning.

CSI—Crime Scene Investigation

Offences against animal wildlife or their habitat occur inside and outside protected areas. These are criminal acts and require careful investigation. Environmental and forensic science may be used to help identify the criminals and prosecute those crimes in court. In cases where an animal or plant has been poached, the steps involved in solving the crime resemble a murder investigation. Wildlife or Fishery officers must safely and accurately:

- Preserve the crime scene.
- Identify, label, and properly package evidence (including animal parts to be analyzed in a lab).
- Take photographs and notes and make sketches.
- Investigate and interview potential witnesses.
- Prepare reports and court documents that describe the evidence and procedures and provide analysis.
- Work with lawyers to prosecute the case.

Making Connections
Atlantic Canada and southern Quebec have been called the "tailpipe of North America" because they are located downwind from the continent's major urban and industrial regions. Research at Kejimkujik National Park in Nova Scotia reveals that air pollution (which arrives as acid rain) has lowered pH levels in the park's lakes and rivers and decreased the reproductive success in brook trout.

PROTECTED AREAS: CHALLENGES AND OPPORTUNITIES

Evidence is mounting for the critical importance of protecting biodiversity. In response, there are groups taking action (including the creation of more protected areas) and introducing laws and voluntary initiatives at local, national, and international levels. But even as we act, the environmental challenges and pressures are growing stronger:

- Earth's population has doubled in the last forty years. This increases the demand for clean air and water and puts relentless pressure on our lands and seas and the resources found there.
- Industrialized society is polluting land, air, and water and through global warming is causing our climate to change including altered weather patterns, melting icecaps, shifting ocean currents, and changing temperatures.

Closer to home, environmental pressures caused the loss of the codfish stocks that were once considered inexhaustible. This had a broad negative social impact as fishers and plant workers lost their jobs. Despite the evidence to the contrary, many people still think our wilderness areas are vast, healthy, and not in need of protection. This belief is misinformed but, more importantly, it misses the point that our wilderness areas contribute to the health of our provincial environment as well as to the health of the entire planet.

PROTECTED AREAS: PROMOTION AND SUPPORT

What You Can Do to Support Protected Areas

By taking personal responsibility to educate ourselves about the issues and actions that affect our environment and our future, we can be part of the solution.

Recognizing this, parks as well as many other protected areas have programs to help you take action on the environment.

You can also become more knowledgeable by:

- Learning to identify the plants, animals, and birds that share your neighbourhood
- Reading and visiting museums, botanical gardens, and parks
- Talking to older community members who have memories and insights about your natural environment and how it looked in the past
- Taking a walk, a hike, or a boat ride
- When you become aware of how your lifestyle choices affect the environment, then you can live in a more sustainable way that respects the environment

Get Involved:
The Canadian Land Bird Monitoring Strategy
The National Wildlife Research Centre wants to increase public participation in its land bird surveys. Details available online at the Canadian Wildlife Service include: Descriptions of each survey, an outline of the skills required for participation, and directions on how to join in.

How Do "Acting Responsibly" and "Protected Areas" Fit Together?

- Stick to authorized roads, walkways, and trails. This helps limit disturbances to natural ecosystems and protects plants from being trampled.
- Respect the behaviour of wild animals on land or at sea. This helps to keep them (and you) safe. "A fed animal is a dead animal."
- Avoid restricted areas. This gives fragile habitat and vulnerable wildlife enough space to survive.
- Participate in interpretive activities. They can be interesting, enriching, and fun.
- Encourage responsible development that helps everyone in your community make better decisions.
- Become more informed about protected areas to give every species a brighter future.

Figure 5.24:
Keeping to authorized trails helps keep the protected area in pristine condition.

Stewardship

Stewardship involves taking care of things that are valued by all. When litter blows into your backyard, you pick it up and put it in your trashcan because you want a clean yard. This makes you a good **steward** of your backyard, but it is also for your own good and for the good of your neighbours and your community. Conservation and sustainable use of our biological resources requires the support and participation of communities, organizations, and individual citizens.

Environmental stewardship occurs when individuals, groups, and governments come together to take the lead in conservation initiatives such as supporting protected areas.

Non-governmental organizations often help establish protected areas. The Nature Conservancy of Canada, for example, acquires land, helps to secure conservation easements to protect the land, and sometimes holds and manages land itself for conservation purposes. The process of creating the Marine Protected Area in the Eastport area was initiated by concerned fishers.

Figure 5.25:
Environmental Stewardship can support protected areas.

Stewardship in Action: Main River

In 2001, the Main River, on Newfoundland's Great Northern Peninsula, was designated this province's first Canadian Heritage River because of its natural features.

The Main River winds through old-growth forest and the rich plant life and wildlife of the Big Steady before plunging through a gorge to the sea. It passes through terrain that is home to seventy species of birds, and to mammals such as caribou from the Northern Peninsula herd, moose, black bear, and the endangered Newfoundland pine marten. Atlantic salmon and brook trout live in its waters. Many of the plants that grow there are at the northernmost or southernmost extent of their ranges.

The effort to designate the Main as a Canadian Heritage River received widespread support particularly from residents of the communities around White Bay, as well as from Corner Brook Pulp and Paper Limited. Their ongoing support, cooperation, and participation on the Main River Management Advisory Committee help to ensure strong stewardship of the river.

More than ninety one per cent of land in Newfoundland and Labrador is owned by the Crown. Consequently, there are fewer incentives for landowner donations here than in other places where more of the land is privately held. On the other hand, stewardship activity at the community and regional levels make a great contribution to conservation efforts in this province.

There are many examples of stewardship activity in this province. For example, Municipal Stewardship Areas, administered by the Department of Environment and Conservation (under the Eastern Habitat Joint Venture program), designate significant natural areas (wetlands, uplands, critical habitat) within municipal boundaries. These areas are protected through municipal zoning and regulations.

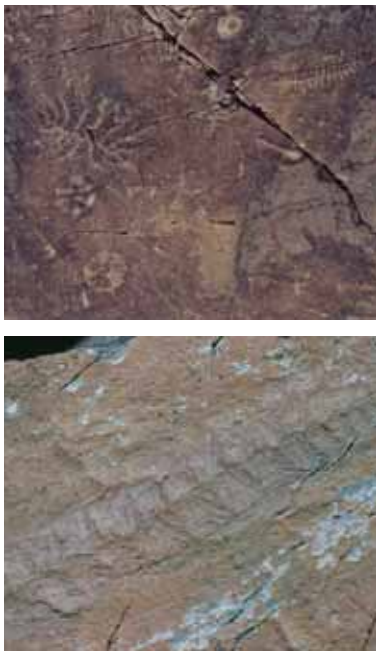


Figure 5.26:
Fossil beds often need to be protected from collectors who damage the beds when they remove the fossil.

Stewardship in Action: Mistaken Point

Mistaken Point Ecological Reserve was created to protect a globally significant fossil bed. It is located on Newfoundland's Avalon Peninsula, fourteen kilometres east of Portugal Cove South on a dirt road to Cape Race.

Community residents and supporters came together in 1998 to form the Cape Race – Portugal Cove South Heritage Inc. The group's goal was to find ways to improve the local economy, which was reeling after the collapse of the cod fishery. The group focused on preserving, developing, and promoting the natural and cultural resources of the Portugal Cove South area. One of their strategies was to build on the tourism potential of the reserve (and the Cape Race Light Station). Their work includes efforts to help protect the remote fossil site by preventing fossil thieves from damaging the site and by providing guided tours of the Mistaken Point Ecological Reserve.

CHECK your Understanding

1. Why do you think the process to create a protected area takes so long?
2. What are the main stressors that affect protected areas?
3. Why is Parks Canada so concerned about the ecological integrity of their protected areas?

For Further Discussion and/or Research

4. Select one of the Terrestrial Protected Areas in this province and conduct research to determine what specific feature of the environment is being protected.
5. The establishment of the Torngat Mountains National Park Reserve is an excellent example of cooperation between various government agencies and citizen groups. Why do you think the Labrador Inuit Association (LIA) was so closely involved in the creation of this protected area?
6. Choose a protected area located close to your community and determine what types of human activity are permitted and what types are prohibited in this area.

CAREER SPOTLIGHT:

Scientist, Fisheries and Oceans Canada

Dave Kulka *(on left in photograph) is a research scientist and section head of Marine Fish Species At Risk of the Science Branch, in the Aquatic Resources Division, of the Department of Fisheries and Oceans Canada (DFO), Newfoundland and Labrador Region. Dave was appointed as an editor for the Journal of Northwest Atlantic Fisheries as a designated expert for two fish species.*

Dave's Job:
As a research scientist for DFO, Dave has many responsibilities. He leads the Species *At Risk* research for non-commercial fish. He is the chair of the Wolffish Recovery Team. He was involved with *Species At Risk* issues even before the *Species At Risk* Act was enacted in 2004. He is also involved in several international committees.

"I think the most satisfying feedback and responses to my work have come from my involvement in international committees."

Dave's Early Influences:
"My father was a prominent researcher of chemistry so I know that had some influence on the paths that I have chosen. However, it was my Masters professors, specifically my principal supervisor, who really encouraged my interest in marine biology and gave me advice on how to shape a career for myself in marine biology," says Dave.

Main Interests:
Dave has always been very interested in marine biology and has done outstanding work. In fact, because of his work, he has received invitations to chair and sit on committees relevant to related fisheries research. In addition to co-chairing the Wolffish Recovery Team, he is vice-chair of the IUCN Elasmobranch Species Specialist Group for the northwest Atlantic.

Outside marine biology, Dave is interested in travel. And a good thing too, because his work and the committees he serves on require him to do a great deal of travel. Dave also plays golf and has helped plan an annual golf tournament for DFO employees. As a high school student, he was an avid curler. In fact, one year his team was one end away from winning the high school provincials in Ontario.

"I enjoy the work I do and feel it is important because it makes a contribution, especially to the work I do with SARA"

Strong Life Influences:
"I think the most satisfying feedback and responses to my work have come from my involvement in international committees. It was a compliment to be asked to be a part of the World Conservation Union. As a conservation network they influence, encourage, and help to conserve the integrity and diversity of nature around the globe. As a member, I have the opportunity to work with other researchers of similar interests from all over the world. The work I do on these committees is important to me and has been influential in both my working and personal life."

Dave's Educational Background:
When he was a teenager, Dave started university unsure of what he wanted to do. He enrolled in microbiology at Guelph University for some time. He even thought he might study to be a brew master on campus. A marine science field course at Huntsman Marine Lab at St. Andrews in New Brunswick focused Dave's interest on marine biology, which he knew would be his life's pursuit. He graduated with a Masters in Marine Biology and taught introductory courses at Guelph. Then in 1977, Dave was considering completing his PhD at McGill University when he was offered a permanent position with DFO. He chose Fisheries and Oceans. One of his first jobs was to set up the Fishery Observer Program—a big change from academic research on the life history of zooplankton. Dave later transferred to the Resource Sampling Section, and finally to the research position at the Marine Fish *Species At Risk* where he works today.

A Typical Day at Work
"Like many of the scientists here, I don't really have a typical day," says Dave. "I really have two job functions: one as a researcher and one as an administrator. I also spend a lot of time traveling and working on projects for my committees," he says.

His specialty is mapping using geospatial information systems (GIS) to analyze and manage data and associated information from precisely defined locations. "For example, I have created maps that spatially relate environmental attributes to biological diversity, and maps that can tell us how a certain species of fish or fishing activities are distributed throughout the ocean," explains Dave.

In terms of research on species at risk, he and his team extract data, examine various biological aspects, and write assessments on particular species of fish to help determine if the species is *At Risk*.

In addition to his research, Dave spends time preparing proposals for funding and providing advice related to SARA issues. "I have also evaluated quite a few COSEWIC species draft assessments. And I am often asked to review scientific papers," says Dave. At times, he helps to organize conferences.

"In recent years I've gotten the chance to sit on the PhD committee for a student at the Institute of Marine Science, at William and Mary University in Virginia. It was enjoyable to watch his development and see that he passed his dissertation."

Importance of the Job

"I enjoy the work I do and feel it is important because it makes a contribution, especially the work I do with SARA," says Dave. Working on the SARA file is very rewarding for him because he found it interesting to be in on the "ground floor of this Act" as it was being developed. "Right now DFO is spending a lot of time fine-tuning the Act and we're finding that it is not as straightforward as those who originally wrote the Act may have thought it would be," says Dave.

He is also grateful for the opportunity to be the co-Chair of the Wolffish Recovery Team, and to work with the prestigious IUCN.

A message from Dave to you, as a student of Environmental Science:
"I think it's very important to consider the job market when thinking about what career you want to pursue. It's easy to get caught up in the popular view of marine biology, so I think it's best to speak with your teachers and with professionals in the field to really learn about the career that you are considering. And if you go to university then talk to your professors as well.

You can have a very enjoyable, interesting, and dynamic career in marine biology. But you must be prepared to put in a lot of work and expect to regularly work more than eight hour days," says Dave.

Figure 5.27: Lobster fisher with catch of the day.

CAREER SPOTLIGHT:

Biologist, Canadian Wildlife Service

Keith Chaulk *is a biologist with the Canadian Wildlife Service. In 2006 he earned his doctorate degree (Ph.D.) in ecology. Keith, who lives and works in Labrador, is of Inuit decent.*

Keith's Job:
Keith's job is to monitor population trends of various migratory birds that breed in Labrador. He uses his research findings to recommend harvest limits and land use management practices that will help ensure these bird populations are maintained over time.

Keith's Childhood Influences:
Keith grew up in North West River, Labrador. Both Keith's parents worked full time, but somehow they managed to regularly get "off on the land" when he was young. They spent many nights, in summer and winter, nestled away in a tent. Labrador tents are not like those you see most people using today. They are canvas tents and the floors are covered with spruce boughs and brush. Keith's family hunted seals in the spring and caught fish in the summer. In the autumn, they hunted ducks, geese, and partridge, and they picked berries. During the winter months, his father set traps along his trap lines to catch furbearing animals.

Main Interests:
While growing up, one of Keith's favourite activities was playing outdoors. Later in his youth he turned to team sports like basketball and volleyball. But he also enjoyed many individual events like snowshoeing, canoeing, running, and weightlifting.

Life influences:
Keith says, with little hesitation, that his greatest influences were within his own family. Both of Keith's grandfathers were "proper" Labrador trappers. This means that they were also hunters and fishers. His father was the same kind of man, except he also worked with wildlife and forestry. And for a while, he was also a prospector.

Just about everyone Keith knew while growing up were taught to respect the older lifestyle of trapping and living on the land. The older people had a great deal of knowledge about the land and wildlife. Even now, after all his education, and his

twelve years as a research biologist, Keith can ask his father and uncle about animals and plants. He admits that he may never know as much as they do when it comes to the natural history of Labrador.

Keith's University Background:
Keith went to Dalhousie University in Halifax, Nova Scotia for his undergraduate degree (Bachelor of Science in biology), Acadia University in Wolfville, Nova Scotia for his Master's of Science degree, and to Memorial University of Newfoundland in St. John's for his Doctorate.

Favourite University Courses:
Psychology courses were some of Keith's favourite. One such course—neuropsychology—involved actual brain surgery on live rats. "It was pretty cool," admits Keith. Another favourite was human anatomy when he worked with cadavers—"that was pretty cool too." He also really enjoyed the courses he took in music.

A Typical Day at Work:
Keith does administration work, writes reports, and analyzes data. But his most rewarding days are in the field conducting biological research. A memorable story in Keith's own words from his Master's research:

"I was studying black bear ecology near Voisey's Bay, Labrador. Another guy and I were tracking a female black bear with cubs. We circled downwind of her hoping to get close for a nice photograph. Next thing I knew she pops out from behind a rock about twenty feet away. Now it's a pretty scary thing to be that close to a female black bear with cubs. The most dangerous mammal is one that is protecting its young. We managed to get out of there and put some distance between us and the bears. It was only later I realized how lucky we were not to have been attacked. We did get some nice photos though!!"

Importance of the Job:
Keith is strongly convinced that his work directly supports the bigger picture of environmental protection. Here are Keith's own words (with the academic references removed) from the introduction of his doctoral dissertation:

"In the 21st century, climate change, habitat loss, over-harvesting and pollution threaten biodiversity and ecosystem functioning. The imminent threat of global ecosystem change has pushed the conservation paradigm to the forefront of ecology. Conservation managers require information on the habitat requirements, population dynamics, spatial distribution of organisms and community interactions in order to make effective conservation decisions. In turn, this

information can be used to assess population status and/or influence land use and harvest policy. It is through these public management processes that otherwise esoteric research can have practical implications.

Unfortunately, not all species are equally studied and often those species that receive the most research attention are not always those which are most threatened. Nevertheless, well studied organisms, populations and/or ecosystems can often provide insight into general ecological processes upon which scientists and managers can extrapolate general principles that can be widely applied in the conservation struggle."

A message from Keith to you, as a student of Environmental Science:
"On a personal level, working as a field biologist can be a healthy lifestyle. For example, walking outdoors all day is a lot better than sitting behind a desk day after day, week after week, and year after year. In addition, once you understand that the work is important in terms of protecting the world in which we live, it can be extremely rewarding.

Having said these things, it is important to know about the other aspects of the work. For example, seventy per cent of my time is still behind a desk either preparing budgets or writing up the data. Plus I am gone from home quite a bit, which in itself has its pros and cons.

Also, the job market is quite competitive. It can be hard to find steady work as an up-and-coming wildlife biologist. It is important that prospective students know this before they invest a lot of money and time in pursuing a career in wildlife biology. But from my end, I can't imagine any job I would rather have."

Figure 5.28: Two animals of the boreal forest. Can you name both?

Summary

When making decisions fundamental to sustainable development, economic, environmental, and social factors must be considered. We must protect and preserve our natural environment and resources and at the same time strive to build a healthy society with quality lifestyles by growing and developing our provincial economy. Only by adopting a sustainable approach can we can achieve this goal for present and future generations of Newfoundlanders and Labradorians.

The main reason terrestrial species are *At Risk* is due to habitat degradation and loss. These negative changes are a result of unsustainable human activity. Urban development, inadequate waste disposal, resource extraction, and clear-cut logging is not compatible with biodiversity. In fresh water too, loss of habitat is a key factor in loss of species, while in marine waters, unsustainable harvesting and poor harvesting practices are the most destructive factors. For too long, generations have advanced their interests without regard to the interests of future generations.

Today, the lives of many people seem removed from nature. We are often not aware of the environmental issues or of the unique natural areas in our region until environmental groups and others react to the threats of development or resource extraction. Laws to protect natural areas and resources may be in place but are not always enforced due to a lack of government personnel.

In the face of the current threats to biodiversity and its potential negative impacts for the region, the country, and the planet, informed individuals are more likely to be motivated to protect species and habitats *At Risk*. Now more than ever before, people need to protect themselves and their communities by developing an awareness of local environmental issues and by taking part in ensuring that all human activity and development is sustainable. This awareness and participation can take many forms:

- At the broad local level, people need to be informed and ready to lobby politicians for adequate legislation as well as resources to enforce existing legislation. The goal is sustainable development within their community. Other activities might include letter writing, phone calls, emails, attending public meetings, and getting involved with volunteer groups focused on the environment.
- At the individual level, you can take responsibility for acting in a way that will have a positive impact on the environment. This could mean something as simple as putting food wrappers in the garbage, buying products that use the least amount of packaging, using alternative cleansers, planting native plants, or even implementing and maintaining a recycling program at home and at school. You can make a difference.

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