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.

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.

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.

Between 1810 and 1960, 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.

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 Earth’s 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.

**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

<table>
<thead>
<tr>
<th>Time (min.)</th>
<th>Soil Temp. (°C)</th>
<th>Water Temp. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn off heat lamp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
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<tr>
<td>32</td>
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<td>36</td>
<td></td>
<td></td>
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<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

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 2 J 3KL. 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

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

**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.

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.
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**.

In the presence of light and chlorophyll

\[
\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6
\]

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:**

<table>
<thead>
<tr>
<th>Autotrophs (Producers)</th>
<th>Herbivores (Primary Consumers)</th>
<th>Carnivores (Secondary, tertiary, etc. consumers)</th>
<th>Decomposers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Spruce Cones</td>
<td>Red Squirrel</td>
<td>Newfoundland Marten</td>
<td>Decomposers</td>
</tr>
</tbody>
</table>

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.

**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)
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.

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 Berkeley. 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.
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.”

- Dali Lama

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.

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.

**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.](image)

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.

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**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.
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.

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.

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
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 (dichloro-diphenyl-trichloroethane) 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.

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
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.

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.

**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.’”

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

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.

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**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.

- **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:

- **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.

• 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.
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.