

# ENVIRONMENTAL 2020 MIND 2020 GRIND



**SEVENOAKS**  
SHOPPING CENTRE





Think before you print.

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Welcome to the 2020 Environmental Mind  
Grind.

This event provides an opportunity to learn  
about our local environment and share  
innovative ideas for a greener future.

If you have yet to register your team, please  
visit [AbbotsfordMissionRecycling.ca](https://AbbotsfordMissionRecycling.ca) for  
further information.

Thank you for participating and good luck!

The image shows a close-up, top-down view of parched, brown soil. The ground is covered in a dense network of irregular, dark brown cracks that form a mosaic-like pattern. The soil has a rough, textured appearance. In the upper right quadrant, a small, tufted green plant with thin blades is growing out of the cracked earth. The overall scene conveys a sense of extreme dryness and environmental hardship.

# Climate Change

# Climate Change



## What is Climate Change?

Perhaps you have heard that the world's glaciers have lost 279 billion tons of ice since 2002, or that polar bears are dying at alarming rates. Environmental tragedies such as these are a result of climate change. But what is climate change exactly? The official definition of climate change is 'a long term shift or alteration in the climate of a specific location, region, or planet.' Climate change is not the same thing as **global warming**, though the terms are often inaccurately interchanged.

Global warming implies a steady, gradual, and uniform increase in temperature across the earth. Such terminology is confusing, and does not accurately describe the global crisis. **Climate change** is a more accurate term; it refers to the changes in average day-to-day weather and seasonal patterns of an ecosystem, taking into account natural variation. Perhaps an even better phrase may be climate disruption, as it specifies a negative impact or change.

## Vocabulary

**Global Warming:** a term commonly misused instead of climate change, implying a gradual and uniform increase in temperature across the earth.

**Climate Change:** refers to the changes in average day-to-day weather and seasonal patterns of an ecosystem. In some places it has gotten warmer, in some places wetter.

**Greenhouse Effect:** the process of greenhouse gases trapping the sun's energy to maintain a warm and stable enough temperature for life on earth.

**Greenhouse Gases (GHGs):** the gases in the atmosphere such as CO<sub>2</sub> which trap energy from the sun.

**Carbon Cycle:** the processes through which carbon molecules are used, moved, and reused through the environment.

**Photosynthesis:** a part of the carbon cycle in which plants and other organisms use sunlight, carbon dioxide, and water to create their food.

**Fossil Fuels:** fuel such as coal or gas, formed from the remains of living organisms pressurized in the earth's crust for thousands of years.

**Carbon Sinks:** environments which can absorb carbon dioxide from the atmosphere.

**Carbon Sequestration:** the process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form.

**Phytoplankton:** microscopic ocean plants that are great at carbon sequestration.

**Anthropogenic Emissions:** Human caused pollution.

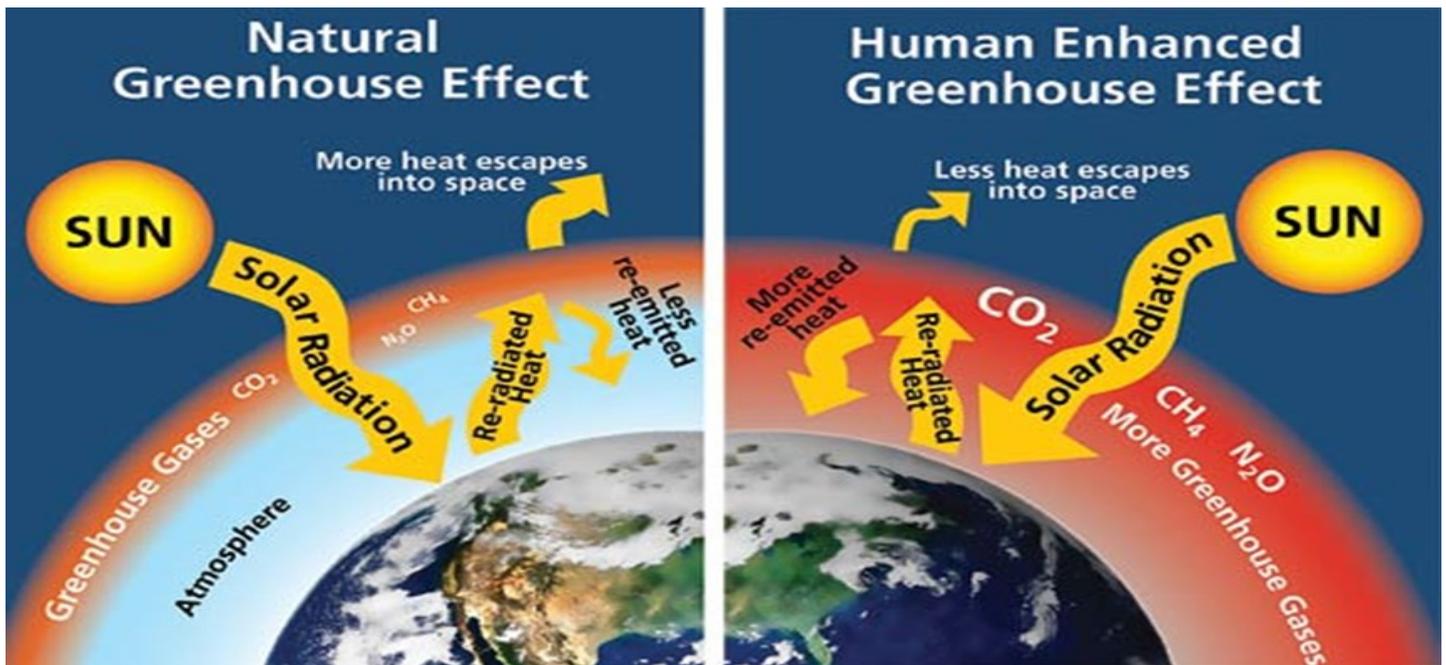


Diagram of natural and human enhanced greenhouse effect sourced from: <https://socratic.org/questions/how-is-the-greenhouse-effect-related-to-global-warming>

## Earth's Natural Greenhouse Effect

The atmosphere is what keeps earth at a livable temperature. The atmosphere is made up of many layers or regions of gases. These gases trap energy from the sun, maintaining a warm enough temperature for us to survive. This process is called the **greenhouse effect**. While these **greenhouse gases** in the atmosphere are important to our livelihood, they become dangerous when in surplus. An excess of energy absorbing gases is one of the greatest causes of climate change. The three most common greenhouse gases are carbon dioxide, methane, and nitrous oxide.

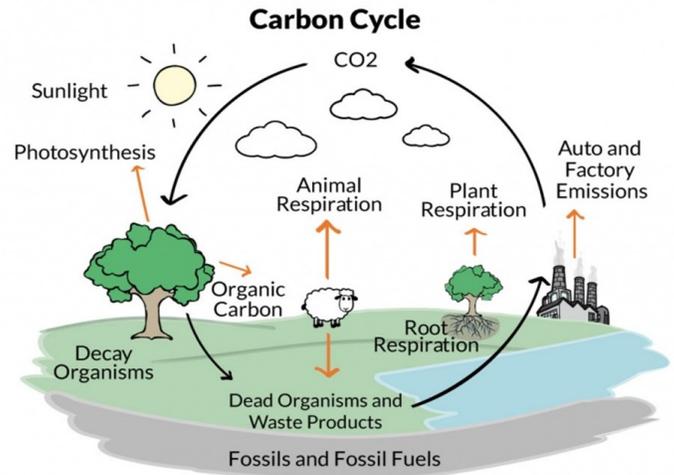
## Climate VS Weather:

To understand climate change we must first understand the difference between climate and weather. Weather refers to the conditions of the atmosphere over a short period of time, such as precipitation or wind; climate is the patterns of weather over relatively long periods of time. Therefore, climate change is the disruption of the pattern.



# Climate Change

# Climate Change

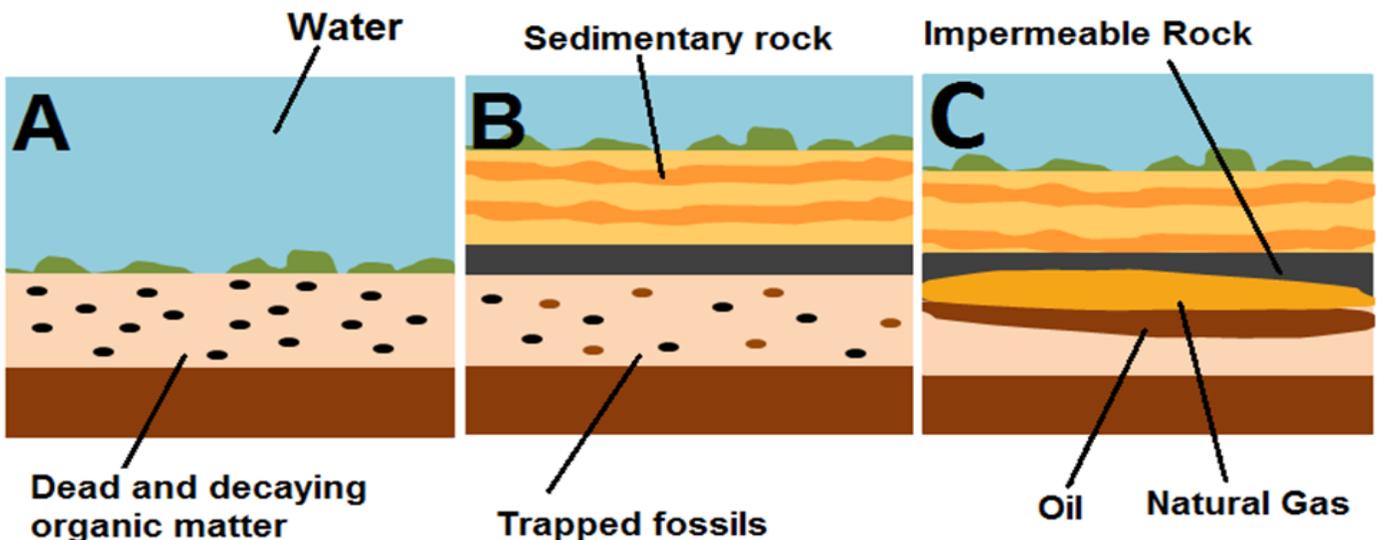


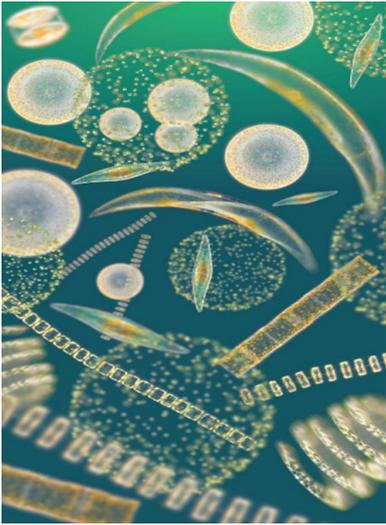
## The Carbon Cycle

Carbon is a chemical element needed to sustain life; all living organisms contain carbon. It also is the most influential of all the greenhouse gases. All life on earth interacts in the sharing and moving of carbon through a process called the **carbon cycle**.

Carbon occurs most frequently in the form of CO<sub>2</sub>, or Carbon dioxide. Humans and animals produce CO<sub>2</sub> when we breathe. Plants do the opposite; they take CO<sub>2</sub> from the atmosphere and store it as carbohydrates through **photosynthesis**.

Humans and other animals then eat these plants to gather the stored energy. But our waste byproducts release CO<sub>2</sub> and other greenhouse gases into the environment. Plants that are not eaten are sometimes buried under rock and earth. Pressure of this rock and earth, eventually turns them into **fossil fuels**. This process takes place over thousands of years. Since the industrial revolution, we have been mining fossil fuels to power our lives. We burn them, releasing CO<sub>2</sub> that has been stored for millions of years back into the atmosphere. Though plants do remove CO<sub>2</sub> from the atmosphere and store it, they are not the earth's best **carbon sinks**.





Rather, oceans are capable of much more carbon storage. Currently the world's oceans absorb about 50% of carbon released into the atmosphere.

This grand capacity for **carbon sequestration**, the

absorption and storage of CO<sub>2</sub>, is primarily because of the microscopic marine organism, phytoplankton. **Phytoplankton** are often called the “biological pump” because they have facilitated the process of storing more than 99% of the Earth's carbon in sedimentary rock in the depths of the ocean.

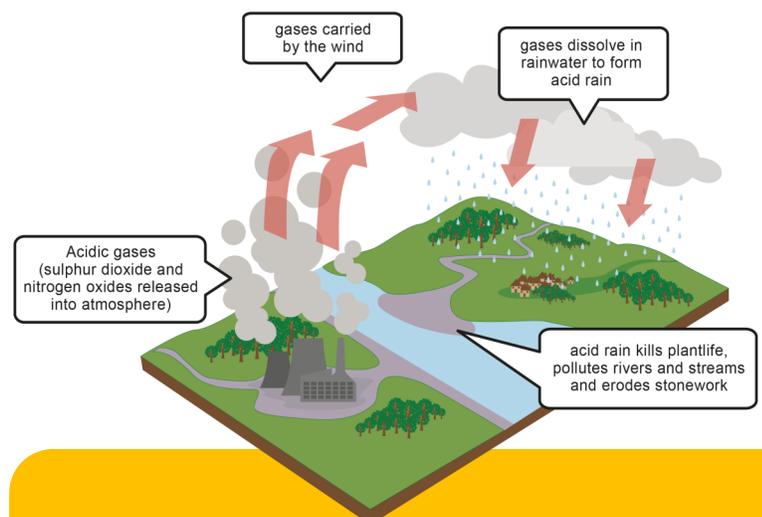
The natural carbon cycle is supposed to keep the Earth's carbon in balance. However, because of massive amounts of **anthropogenic emissions**, which is the carbon dioxide produced by human activity, the cycle is becoming rapidly unbalanced. We are producing CO<sub>2</sub> at much faster rates than can be absorbed. Carbon is measured by ppm, or, parts per million. Though scientists debate about the upper limit of a sustainable amount of carbon in the atmosphere, it is agreed that the current production of carbon is unsustainable. As shown in the diagram opposite, in the last 50 years the amount of carbon in the atmosphere has increased dramatically. Currently, we have a surplus of about 18 gigatonnes of CO<sub>2</sub> produced every year, which cannot be absorbed back into the earth.

## Acid Rain

Acid rain is another product of human activity, and is negatively impacting ecosystems around the world. Acid rain occurs when sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) are released into the atmosphere and transported by wind and air currents. The SO<sub>2</sub> and NO<sub>x</sub> react with other chemicals such as water or oxygen to form sulfuric and nitric acids. These compounds then combine with water before falling to the ground.

While small amounts of SO<sub>2</sub> and NO<sub>x</sub> are emitted naturally by volcanoes, most comes from the burning of fossil fuels. The major sources of SO<sub>2</sub> and NO<sub>x</sub> in the atmosphere are:

- Burning of fossil fuels to generate electricity. Two thirds of SO<sub>2</sub> and one fourth of NO<sub>x</sub> in the atmosphere come from electric power generators.
- Vehicles and heavy equipment.
- Manufacturing, oil refineries and other industries.



# Climate Change

# Climate Change



## Glaciers and Rising Sea Levels

Glaciers are nature's water reserve. The water is stored in solid frozen form over the winter. Then in spring and early summer, as temperatures increase, small amounts of the water is released, replenishing streams. In recent years, however, extensive geological surveys have alerted people to the fact that these reserves are dwindling. In B.C. the Rocky Mountains have decreased by 25% in glacial cover over the past 100 years.

When mountain glaciers recede, there are many cascading effects. One that is most worrisome to coastal British Columbia is the potential rising sea levels. World oceans have, in the 20th century, risen 1-2 millimeters per year. This means up to 20 cm in the century. This causes harm not just to marine life, but to coastal communities as well.

Glaciers in B.C are currently losing 22 cubic kilometers of water every year. This is similar to the other glacier losses in other large mountain ranges around the world.

Over the past decade, the end of the Castle Creek Glacier in The Cariboo Mountains has receded over 200 meters. That is 15 meters per year! Even more shocking, over the 2015 summer the melting rate increased dramatically, by about two and a half times. Look at the difference in the glacier shown in the pictures below, taken in the same spot only 5 years apart!



Images from: <https://www.cbc.ca/news/canada/british-columbia/multimedia/glacier-melt-in-b-c-mountains-reaches-shocking-levels-1.3259647>

## Government Action

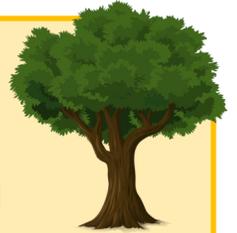
British Columbia is taking action to combat climate change. One way in which BC does this is through carbon tax. The tax was introduced in 2008 to encourage people to re-think their carbon footprint and decrease their use of fossil fuels. The chart below displays the current carbon tax rates for different fossil fuels.

Fuel	Tax Rate Based on \$35/ Tonne of Emissions
Gasoline	7.78 ¢/litre
Diesel (light fuel oil)	8.95 ¢/litre
Natural gas	6.65 ¢/cubic meter

As a country, Canada is also working to mitigate the damage of climate change. In fall 2017, Canada co-founded the [“Powering Past Coal Alliance”](#) to help accelerate clean energy growth and climate protection through the rapid phase-out of traditional coal-fired electricity. In the section on energy you will learn about some of the alternate forms of energy in which Canada is investing.

## Climate Change Impacts in BC:

Despite these efforts, our climate change has already begun and will continue. While we can try to minimize damage we cannot stop it entirely. Some changes we may see in BC could include the following:



### Did you know?

“There is no pure political conflict anymore.” Climate change influences everything. It is a primary driver of humanitarian crises. Weather-related events accounted for 23.5 million displaced persons in 2016. Likewise, the majority of refugees originate, and live in “climate change hotspots.”

1. A temperature increase of 1.3 to 2.7 °C by 2050. This will allow for longer growing seasons, but frequent and severe droughts. It will also cause a rise in new infectious diseases and pests impacting human health, agriculture, and ecosystems. In addition we will experience more frequent and severe heat waves resulting in increased heat-related illnesses.
2. Average annual rainfall is expected to increase from 2% to 12% by 2050 though summers will be drier. This will cause damage to buildings and infrastructure, as well as increasing the risk of wildfires and disease outbreaks.

# Climate Change

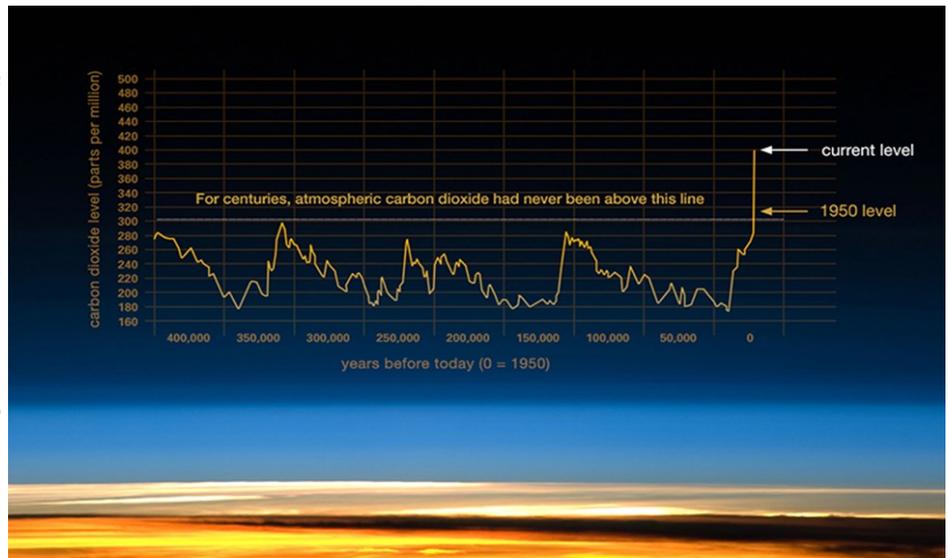
# Climate Change

- Up to 70% of our glaciers may disappear by 2100. This will change river flow and temperatures, affecting fish habitats, and hydroelectric power, as well as drinking water quantity and quality.
- Sea level is expected to continue to rise along most of B.C.'s coast, causing frequent and severe flooding which damages coastal ecosystems and communities. Sea level rise will also strain drainage and sewage systems contaminating water supplies. The rise will also make low-lying agricultural lands too salty for farming.

## Did you know?



Your carbon footprint is the amount of carbon emissions with which you are both directly and indirectly associated. It includes emissions you might not think about such as heating, transportation and food. You can calculate your carbon footprint with a carbon calculator online.



## What Can You Do?

We can start by assessing our own behaviour to help mitigate climate change and slow down its effects as well as help our environment cope with current changes.

- Explore sustainable transportation options—ride your bike, take the bus or walk.
- Change the way you eat — eat less meat and dairy. Eat local, organic and/or fair trade foods.
- Investigate the energy efficiency of your home/school/work—switch to energy-saving compact fluorescent light bulbs (CFL's), lower the heat and/or conserve water.
- Go for Green Energy: fundraise for a solar hot water heater for your school; lobby your government for green energy infrastructure development; check out solar panel stoves for your next camping trip.



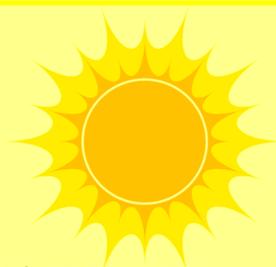
# Energy Conservation

# Energy Conservation

While electrical energy occurs in nature, in events such as lightning, it is not easily harnessed. Thus, we must convert other forms of energy. There are two overarching categories of energy that we use: **renewable energy**, such as wind or solar, is derived from a source that can easily be replenished, whereas **non-renewable energy**, such as coal, cannot.

## Electricity, Energy and Power

Everything needs **energy** to survive; our bodies and the bodies of all living organisms depend on energy. The scientific definition of energy is the capacity to do work. All energy on earth originates from the sun's **radiant energy**. Plants turn this energy into matter through photosynthesis. This energy then travels through the food chain to feed animals, including humans. However, the way we live life today requires energy not just for fuel for our bodies, but for our cars, our homes, to cook, for our electronics and so many other things. The energy to power all these things also comes from the sun, but rather than being converted into food matter it is converted into electrical energy. **Electrical energy** involves the transfer of charged elements called electrons. This charge is passed through a wire in currents, causing what we call electricity.



### Did You Know?

**All energy on earth originates from the sun!**

## Vocabulary

**Energy:** matter's capacity to perform work.

**Radiant Energy:** energy in the form of electromagnetic waves, which can travel through space. It is most commonly recognized as heat from the sun.

**Electrical Energy:** energy that can be used to move charged particles through a wire. It is the most useful form of energy for humans.

**Renewable Energy:** energy taken from a source that can easily be replenished such as wind or solar.

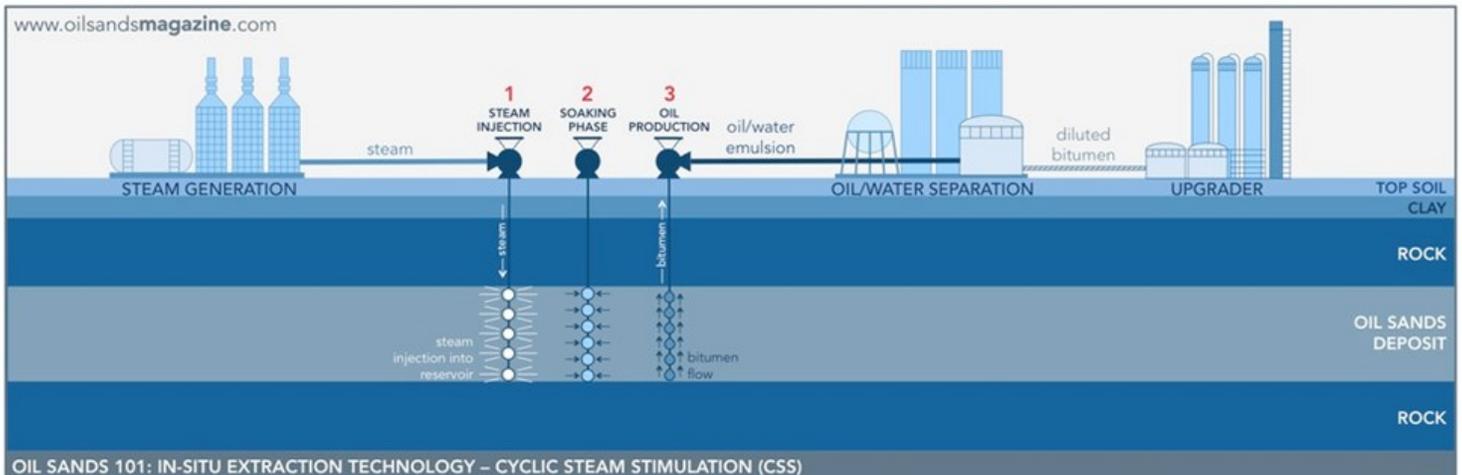
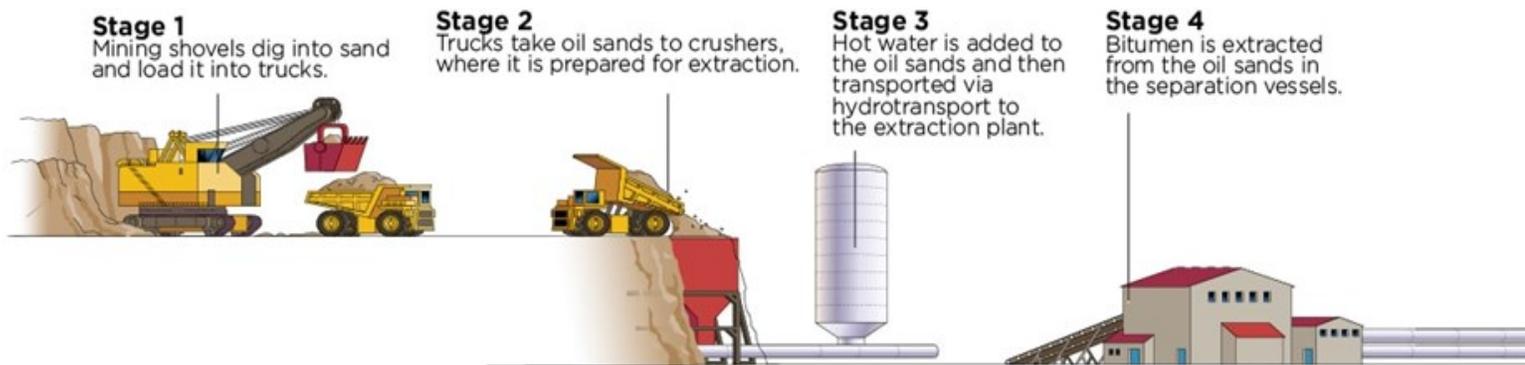
**Non-Renewable Energy:** taken from a source that cannot easily be replenished such as oil or coal.

**Bitumen:** a black viscous mixture of hydrocarbons which acts as a natural oil hold.

**In-situ:** the process of extracting oil in place using steam.

**Hydrocarbons:** organic compounds made up entirely of hydrogen and carbon.

**Kinetic energy:** energy derived from motion or movement.



Top: surface bitumen mining sourced from <https://www.canadasoilsands.ca/en/what-are-the-oil-sands/recovering-the-oil>  
 Bottom: in-situ bitumen mining sourced from <http://www.oilsandsmagazine.com/technical/in-situ>

## Sources of Energy in Canada

### I. Crude oil and Petroleum

Oil is a non-renewable resource, meaning there is a limited amount of it in the earth, and is not replaceable within human lifetimes. Currently, in Canada, oil from **bitumen** is our primary source of energy. Most of this bitumen is found in the oil sands in Alberta. Because of how deep the bitumen reserves are buried, they cannot be mined. Thus, 80% of Alberta's oil must be extracted in-place (or **in-situ**) using steam. In in-situ mining the bitumen is heated and pumped out of the ground, leaving most of the solids behind. In-situ extraction has a smaller footprint than traditional surface mining, which makes up the other 20% of Alberta's oil production.

However, it is less productive than its traditional counterpart. Once oil is harvested, it is refined into products such as diesel and gasoline. It can also be used to make plastics. The above diagrams show both surface and in-situ mining processes. Some advantages of oil are that it is cheap and easily transportable. However, when it is burned it produces greenhouse gases. Oil drilling can also have drastic effects on the environment including habitat destruction, toxic leaching and water pollution.

# Energy Conservation

# Energy Conservation

advantages of coal is that it is cheap, and there is a lot of equipment that can work with and use it. However, its mining destroys environments and habitats, and the burning of coal releases even more greenhouse gases than oil.

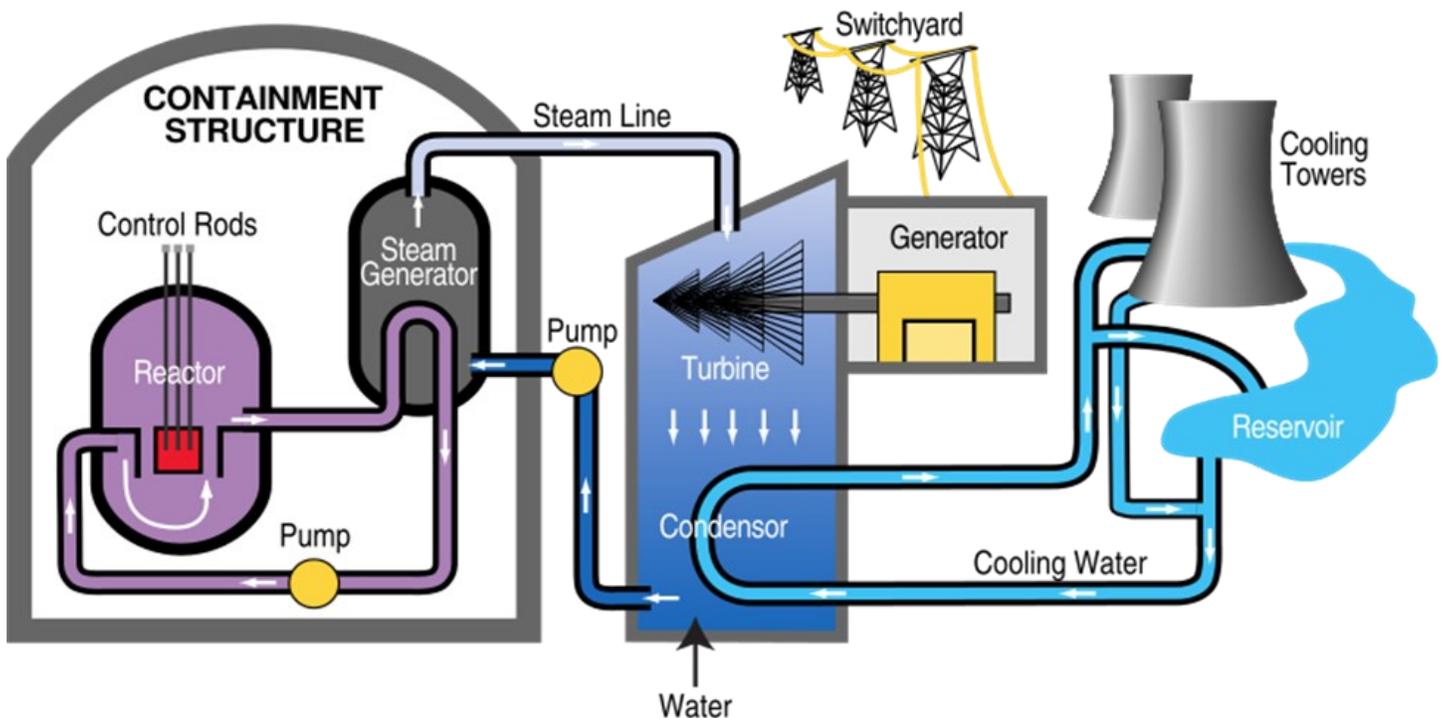


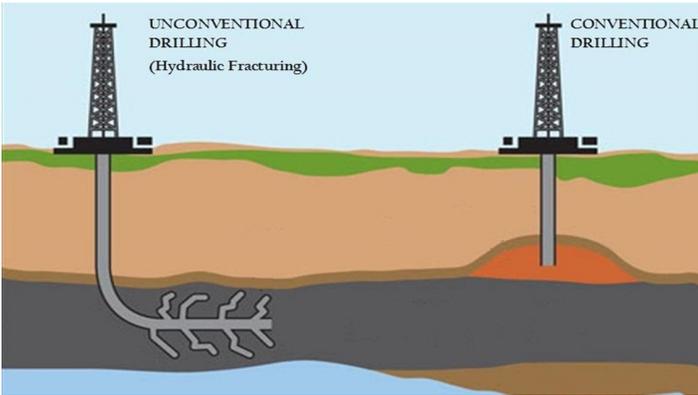
## 2. Coal

Coal has been used as a source of fuel for hundreds of years. It is sourced from deposits in the ground through mining. We derive energy from it by burning, using the heat as a source for electricity. While coal is not used much within BC, it is one of our largest exports. Some of the

## 3. Natural Gas

Natural gas is a fossil fuel made up primarily of methane ( $\text{CH}_4$ ) and some smaller quantities of other hydrocarbons. Natural gas formed thousands of years ago when organisms died and their skeletal structures were buried and crushed by sedimentary rock. It is extracted through drilling wells or **fracking**. Fracking uses high pressure water to create cracks deep in the ground to make pathways for gas to flow. While natural gas carbon emissions are approximately half of those of coal, methane, the natural gas most commonly used, is a greenhouse gas itself. Burning methane contributes to climate change, and it can leak during the harvesting (extracting) process.





creates no greenhouse gases or other byproducts. Wind is also easily accessible and the equipment to harness wind power has minimal effects on habitats compared to other options. However, wind is not consistent. It blows at different strengths and speeds at different times and in different places. This variability means power generation from the wind can be inconsistent. Some people also complain that wind turbines are noisy and unaesthetic.

#### 4. Nuclear

Nuclear power uses radioactive elements to heat up water in order to make electricity. About 15% of Canada’s electricity is from nuclear power. However, there are currently no nuclear power plants in BC. The Provincial government prohibited nuclear power plants and uranium mining under the Clean Energy Act in 2010 due to the health and safety concerns associated with radioactive materials . Nuclear power does not emit any greenhouse gases, however it does produce radioactive waste that is difficult to dispose of . Likewise, nuclear plants have a limited lifespan and the materials involved are dangerous; incorrect handling can bring disastrous results.

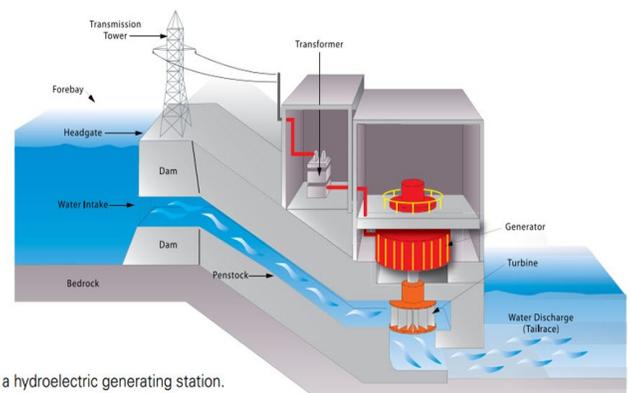


Diagram of a hydroelectric generating station. hydro dam sourced from: <http://natureforfreeenergy.hydroelectricity.html>

#### 5. Wind

Wind power converts kinetic energy (energy derived from mass and motion) into usable energy, either mechanical from windmills or electrical from turbines. Though it is the fastest growing renewable energy industry worldwide, wind still only accounts for a small portion of global energy use. Wind is a fairly sustainable form of energy. It is essentially pollution free as it



#### 6. Hydroelectric

Hydroelectric power, often called hydroelectricity, converts the kinetic energy of moving water into electric energy through a turbine-powered generator. This form of energy is a good option because it is cost-competitive, reliable, and pairs well with other energy sources. However, even hydroelectricity has its drawbacks. The installation of dams used to harness the water energy changes ecosystems, blocking fish passageways and causing flooding.

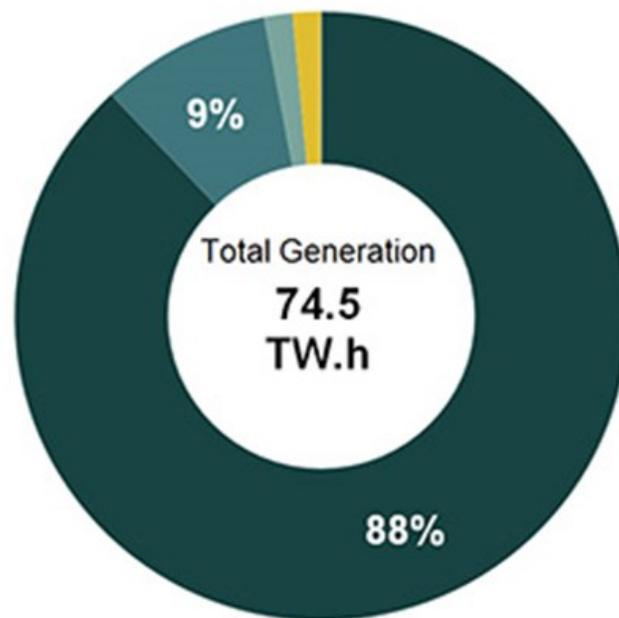
Nuclear reactor sourced from: <https://commons.wikimedia.org/>

# Energy Conservation

# Energy Conservation

some drawbacks. Its disadvantages include large solar farms causing land disturbance, and the fact that even the best solar cells currently work at 30% efficiency. Likewise weather variation make for inconsistent power production.

It can also trap organic material under water causing them to create and emit greenhouse gases. Hydro is the primary source of electric power for the City of Abbotsford and the District of Mission.



## 8. Solar

Solar power converts radiant energy directly from the sun to electricity using solar cells combined in solar panels. In Canada and the United States solar power is most commonly used for heating swimming pools.

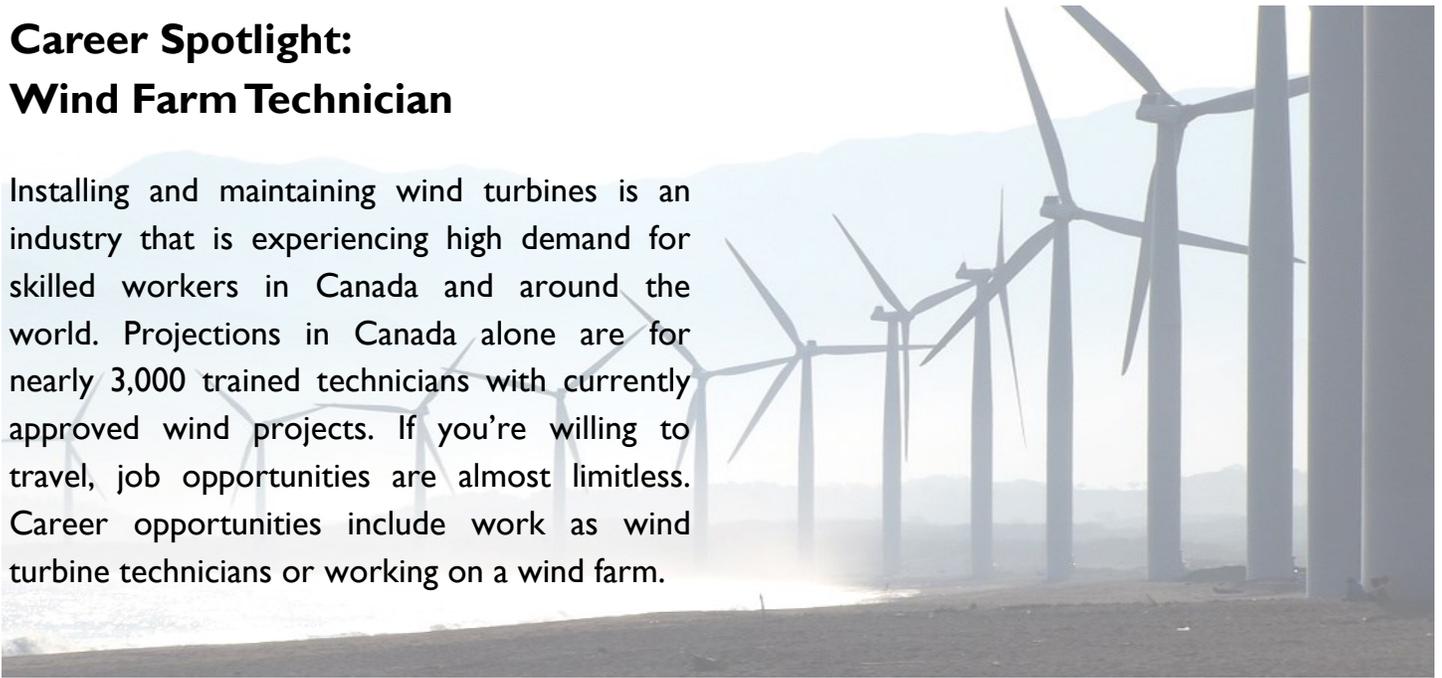
Solar power is virtually free after initial infrastructure. The sun is also an unlimited resource, it will keep shining until the end of the earth. Solar is especially good for off grid and remote locations. Yet even solar energy has

## Energy Sources in BC

The pie graph above shows British Columbia's sources of energy as of 2016. As you can see the vast majority of our power comes from a renewable resource, Hydro-electric power! Compared to the rest of Canada we already use a lot less non-renewable energy. What are some ways that you think we could continue to reduce our use of non-renewable energy?

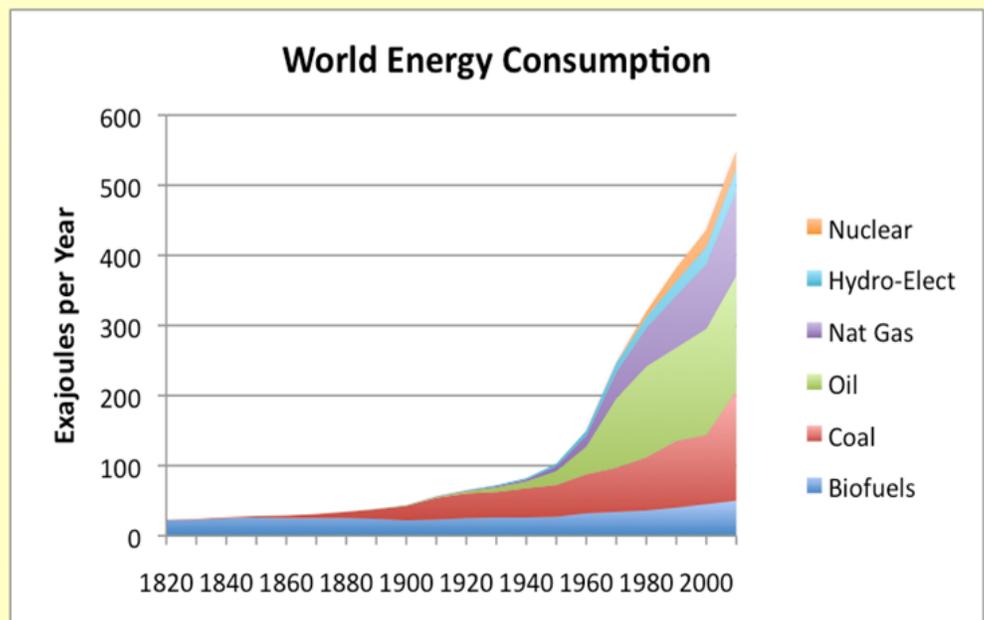
## Career Spotlight: Wind Farm Technician

Installing and maintaining wind turbines is an industry that is experiencing high demand for skilled workers in Canada and around the world. Projections in Canada alone are for nearly 3,000 trained technicians with currently approved wind projects. If you're willing to travel, job opportunities are almost limitless. Career opportunities include work as wind turbine technicians or working on a wind farm.



### Did You Know?

In the last two hundred years, due to global development and population growth, world energy consumption has increased more than twentyfold. All of the world's clean energy sources, i.e., hydro, wind etc., only make up roughly 20% of global energy production; oil and gas still account for almost 80% of world energy consumption, releasing stored carbon into the atmosphere as CO<sub>2</sub>. These types of energy are all sources of anthropogenic emissions which contribute on a large scale to climate change.



# Energy Conservation

# Energy Conservation



## What Can You Do?

**Our world is changing, we cannot stop the change but we can mitigate its impacts and slow the rate of change. Changing the way we think and use energy is a step in the right direction.**

Turn off appliances, video game consoles, computers, monitors and televisions when not using them.

Unplug chargers when they are not in use — they use power even when we don't need them!

Turn off the lights and use energy efficient light bulbs.

Wear a sweater instead of cranking up the heat.

Turn the heat down at home during the day.

Don't idle. Turn the car off when you're parked.

Look into alternative energy sources. Check out handheld solar chargers for phones, iPods, or laptops. Invest in a small windmill for your home. Even easier: use your own power and walk or bike places!



# Forests

# Forests

## Forest Country

Canada, as a country, has always been defined by her landscapes; long before European settlement, Indigenous peoples celebrated and found their identity in the shapes and forms of the land. Today, Canada's vast geography has become a source of pride for Canadians, and has come to shape our industry and values. Yet, from the oceans to the plains and mountains, no geographical feature is as unique or important to Canada as her forests. This is particularly true of British Columbia, where more than two thirds of the land is considered forest.

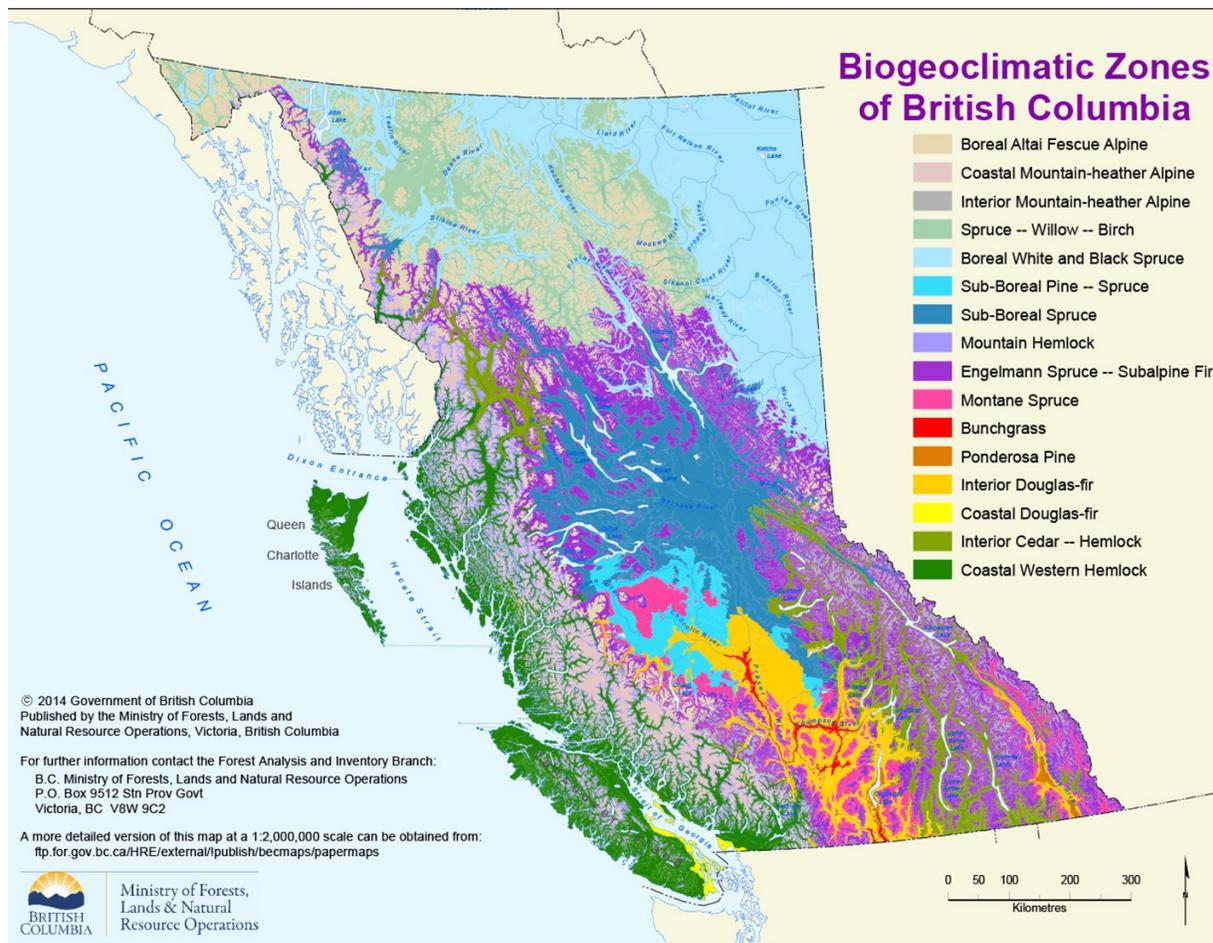
## Vocabulary

**Old-Growth Forest:** a forest that has attained great age without significant disturbance.

**Saplings:** young, baby trees usually with a thin trunk.

**Non-Timber Forest Products (NTFPs):** are any product or service other than timber that is produced in forests including but not limited to fruits and nuts, vegetables, fish and game, medicinal plants, resins, essences, barks and fibers such as bamboo, palms and grasses.

**Prescribed Fires:** a fire set intentionally by professionals for purposes of forest management, farming, prairie restoration or greenhouse gas reduction.

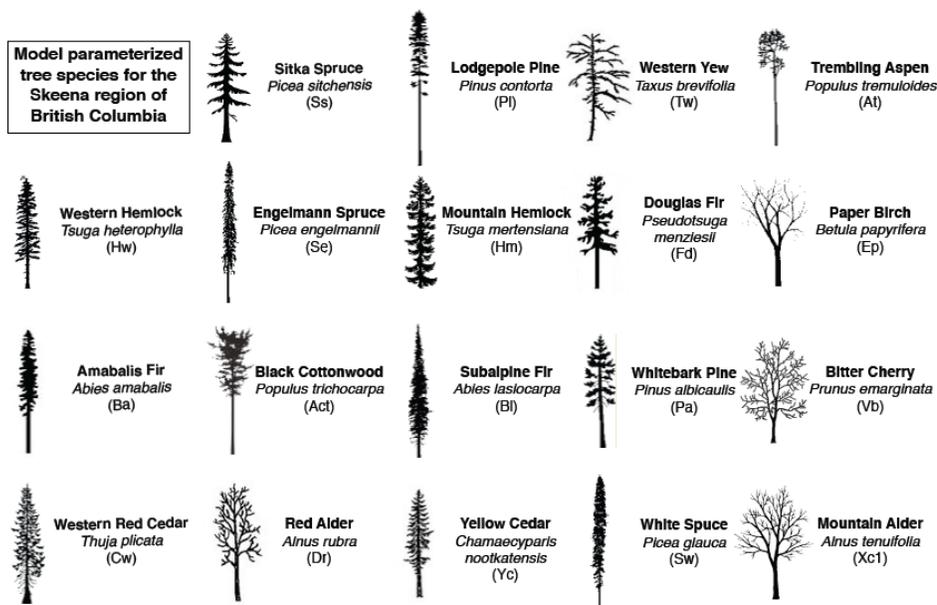


## Forest Regions in BC

The diagram on page 22 shows the forest regions of British Columbia coded by their dominant tree type. Each range has a unique climate, providing a home for different species and contributing to the vast biodiversity of the province. The range of the Coastal Western Hemlock covers the Great Bear Rainforest which will be discussed in the “Species and Spaces” chapter. BC is the province with the most diverse forests as well of some of the oldest trees.

You can learn to identify trees with Tree Book, the BC specific tree guide. The ebook is available for free at <https://www.for.gov.bc.ca/hfd/library/documents/treebook/treebook.pdf>

Below is an example of the types of trees that can be found in the Skeena region of BC, the northern coastal region. As we are in the lower-mainland coastal region we would have some different and some similar trees. As you can see on the map from pg. 22, our predominate trees are the Coastal Western Hemlock and Coastal Douglas Fir.



<sup>1</sup><http://www.for.gov.bc.ca/hfp/silviculture/Compendium/> and <http://www.pennine.demon.co.uk/Arboretum/Alte.htm> (Oct 12 2010)

## Old-Growth Forests

Along the Pacific Coast, scientists consider a forest **old-growth** when most of the trees are more than 250 years old. In the Interior, where trees typically have shorter life spans and wildfires are more common, old-growth forests tend to have a lot more standing dead trees. While all forests are important, old-growth forests are special because they contain trees at all stages of their lifecycle. This includes **saplings** as well as trees that are dead and dying. This range in tree age provides specialized habitats that play a significant role in maintaining biological diversity. While one may think that standing dead trees are not important, they actually provide crucial habitats for numerous species including small mammals and many birds. Likewise, once they fall to the ground, they provide nutrients for fungi to flourish and contribute to the regeneration process of the forest floor. Also, as discussed in the chapter on climate change, old growth forests are carbon sinks helping to eliminate greenhouse gases and clean the air we pollute.

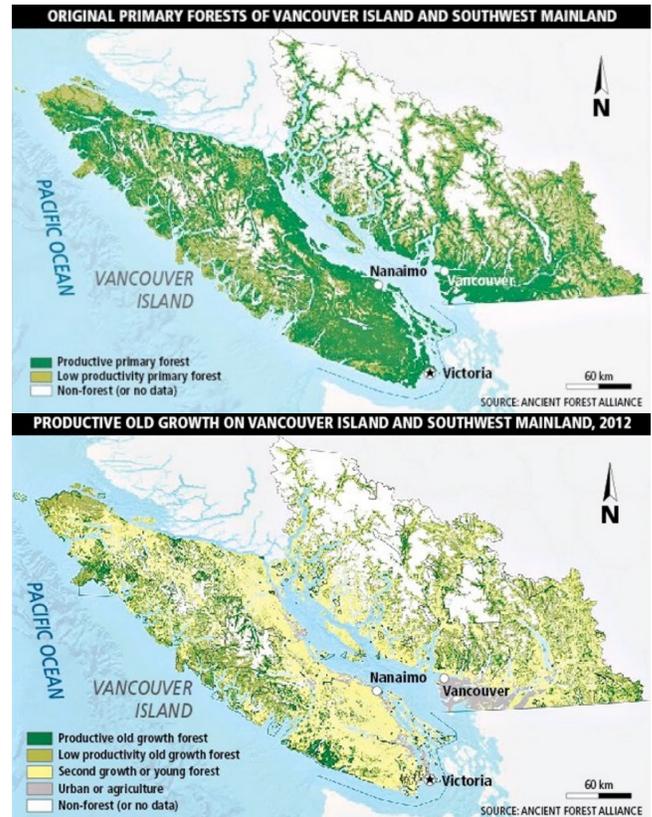


# Forests

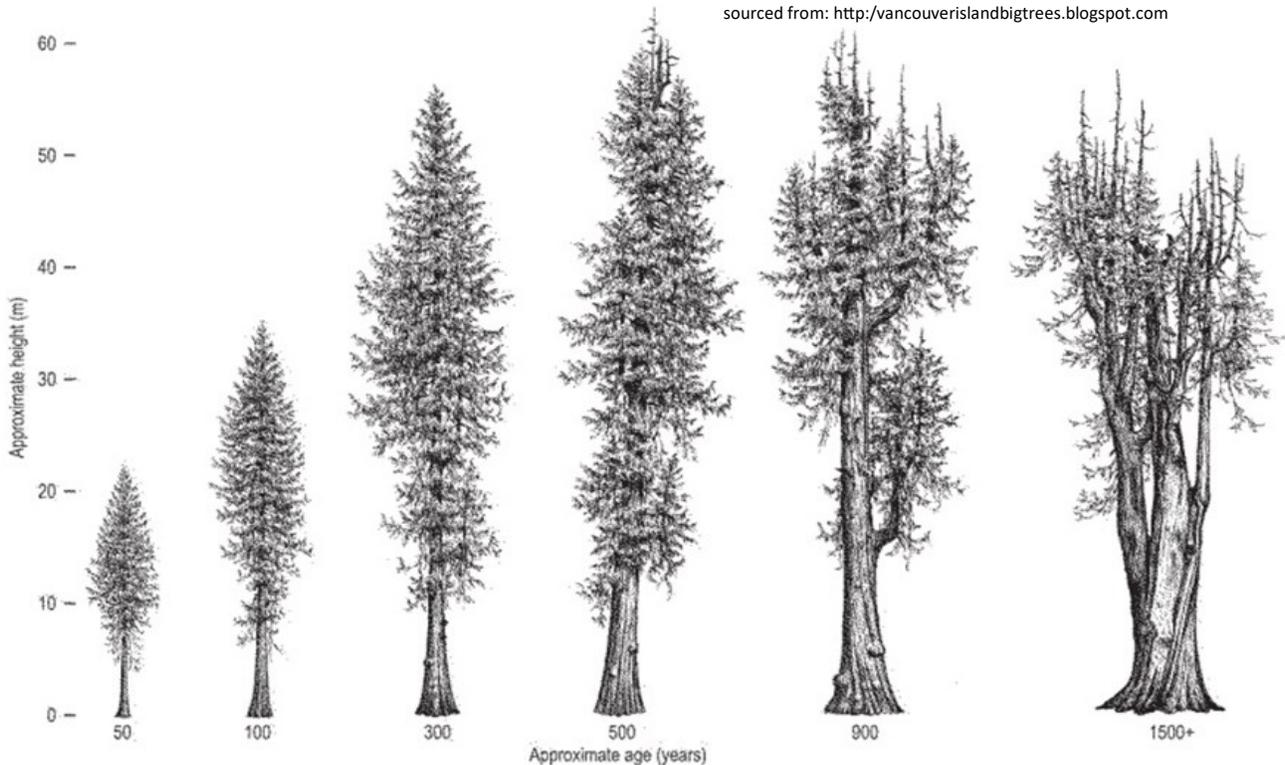
# Forests

As the trees in old-growth forests can be over 1000 years old, they contain carbon stored from centuries ago. When these trees are burned all that carbon is released back into the air. However, though it does not fully replace the ancient trees, replanting can help offset this carbon release; thus wood is a more sustainable fuel than coal or fossil fuels. Much of BC's old-growth forests were lost in the 20th century from clear cut logging. Conserving old-growth has since become an important component of long term resource management planning in BC.

The images below show the depletion of old growth forests on Vancouver Island and southwest mainland regions as of 2012.



sourced from: <http://vancouverislandbigtrees.blogspot.com>



The image above shows the life cycle of the Western Red Cedar, one of Canada's largest and longest living trees. It is found in BC's coastal old-growth forests.

Image from: <https://washingtondnr.wordpress.com/2015/07/20/the-western-red-cedar-a-1500-year-old-giant/>

## Forest Resources

Trees play an important role in British Columbia's economy. Often the industry most closely associated with British Columbia's natural resources is forestry or logging. The forestry industry provides jobs for many people and exports wood resources worldwide. It has many economic benefits and seeks to be as sustainable as possible. While this might be the first industry to come to mind, timber is not the only resource that forests provide.

BC's forests also have a lot of other resources to offer. These resources are considered **Non-Timber Forest Products (NTFPs)**. NTFPs are natural resources derived from forests that are not wood. NTFPs in British Columbia include various mushrooms and berries. Most of these products have commercial value and are sold for cash soon after harvest. NTFPs are also often collected for personal or community uses; they can be used for decorations and crafting. Some NTFPs are also used as natural medicine. Indigenous people have ancient sacred wisdom and knowledge about many of these resources.

Morel mushrooms (to the right) are one great example of an NTFP. They grow naturally every year from late May through June in the interior forests of BC. They grow best in damp and ashy environments. Thus, the year after a large forest fire the harvest is most abundant. Pickers camp and forage on crown land. They sell their mushrooms to buyers who dry them and then sell to commercial markets and restaurants.



### Did you know?

You can tell how old a tree is by the number of rings on its trunk! The thickness of each individual ring can also be used to indicate the amount of rainfall, and char can provide evidence of a fire.



# Forests

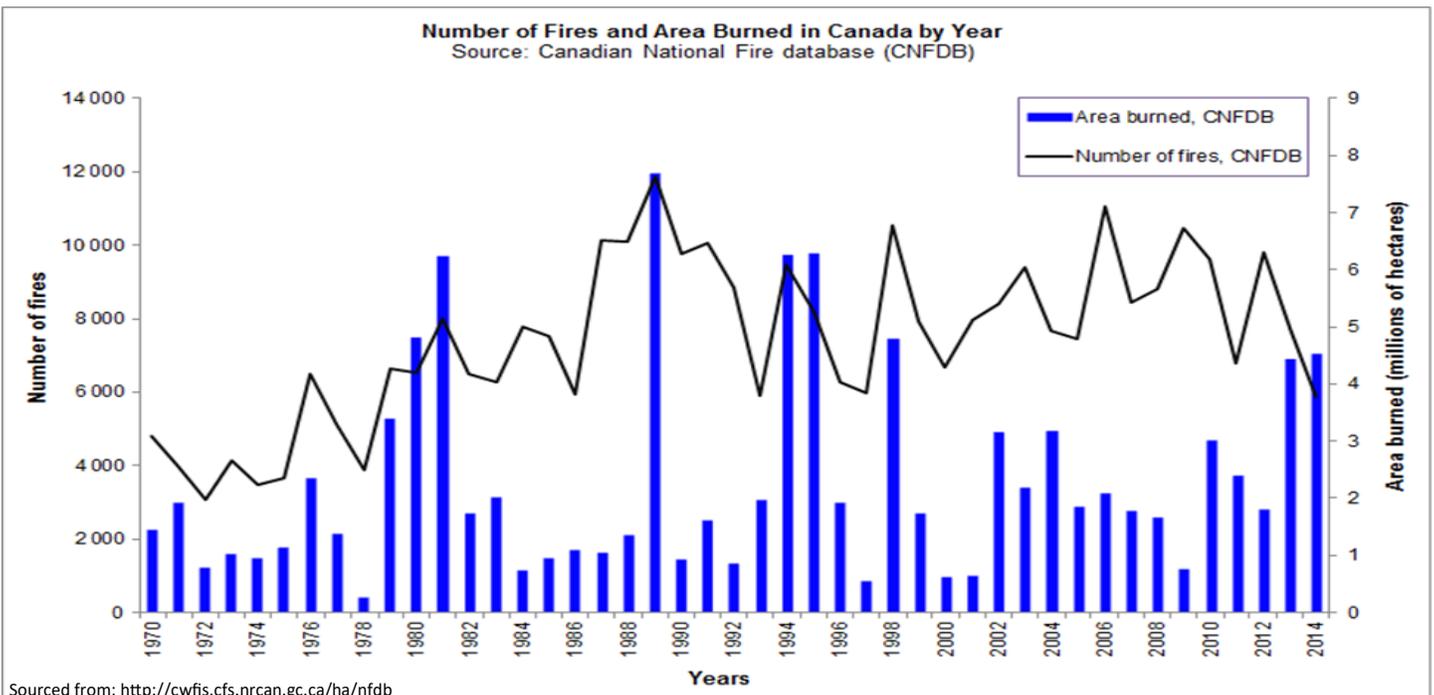
# Forests



## Forest Fires

While the forest fires might be great for the Morel market, they are devastating to many BC residents and the forests themselves. The 2017 forest fire season displaced 65,000 BC residents from their homes and burned over 894,491 hectares of forested land. Climate change is increasing the number and the impact of forest fires. This graph provides data only up to 2014 and thus does not include more recent statistics, as wildfire season has been getting progressively worse in BC.

Overall, however, the graph clearly expresses an increase in both the average amount of forest fires and area burned. Despite their dangers, wildfires are a natural part of the forest ecosystem and are essential for maintaining the health and diversity of forests throughout Canada. In some cases fires need to be left to burn or controlled **prescribed fires** are set in order to reboot the forest's natural composting processes and get rid of the build up of fuel (excess dry leaves and dead trees).



## Career Spotlight: Forestry Technician

While their duties vary from job to job, Forestry Technicians are trained to gather data to inform decisions about forestry management. For example, when forests burn they

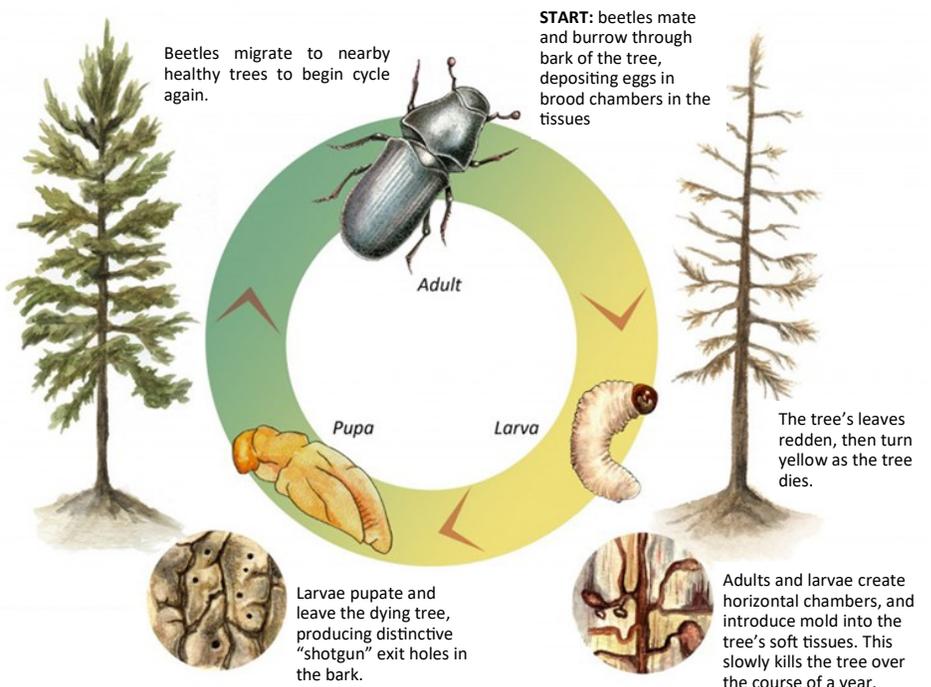


survey the fire site; they take photographs and record descriptions of the damage done to the trees and ecosystem. They may take soil samples, look for new growth and make observations about the wildlife. Their job is to assess the intensity of the fire and determine the best course of action to assist the forest in its recovery. Data collected is used to help provide recommendations for future management of the area including reforestation plans.

## Pine Beetle

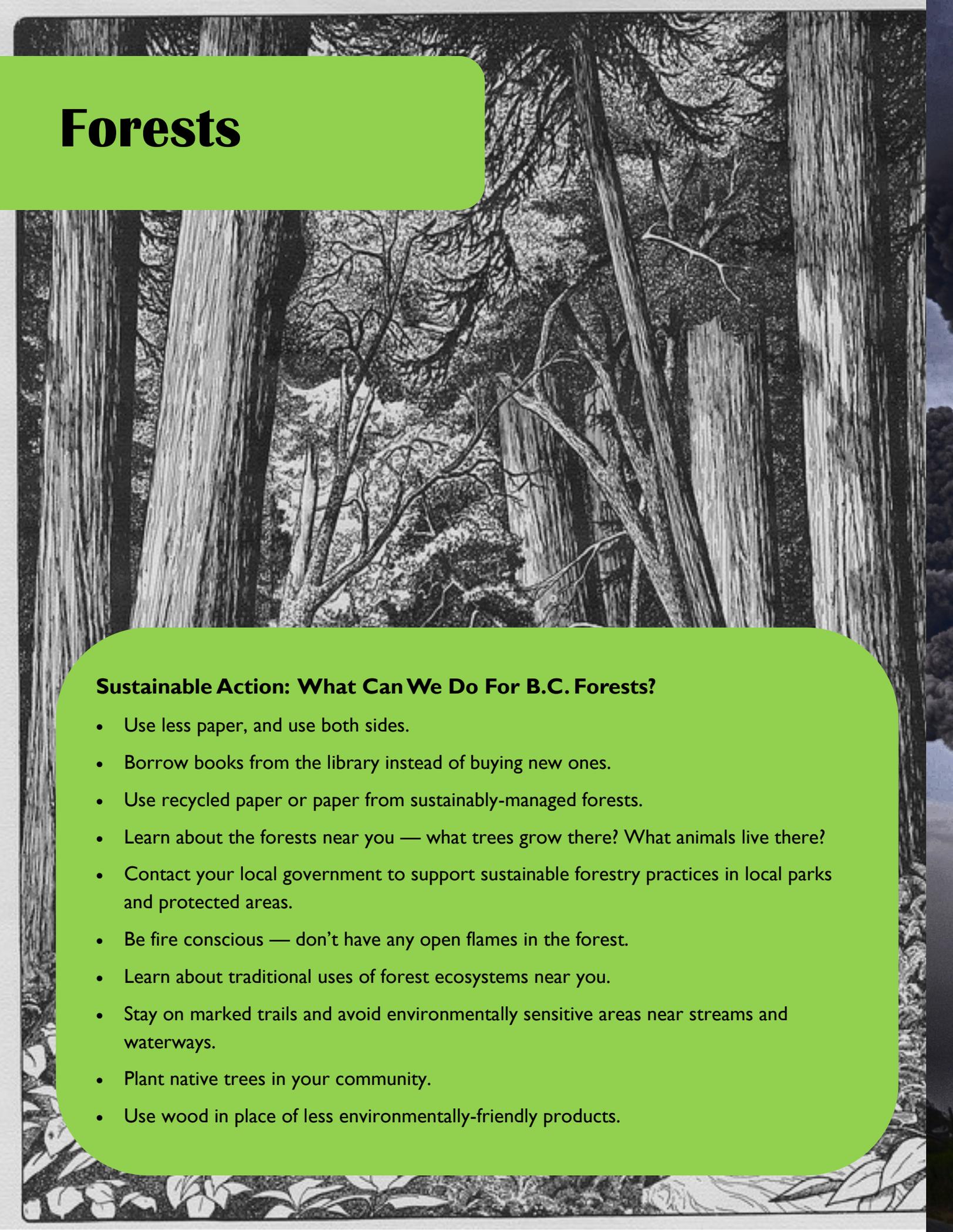
The mountain pine beetle is a naturally occurring insect of the Rocky Mountain ecosystem. Though it is not an alien species, from 1999-2015 it destroyed millions of hectares of BC forests. Several relatively warm winters resulted in a massive outbreak of the beetle. Usually the beetle is killed by the cold of the winter, allowing them to live only a single year minimizing the damage that they can do. The warmer winters allow the beetles to live longer which enables them to kill more trees. This in turn contributes to the greater and faster spread of forest fires.

Life Cycle of Mountain Pine Beetle, *Dendroctonus ponderosae*



# Forests

# Forests



## **Sustainable Action: What Can We Do For B.C. Forests?**

- Use less paper, and use both sides.
- Borrow books from the library instead of buying new ones.
- Use recycled paper or paper from sustainably-managed forests.
- Learn about the forests near you — what trees grow there? What animals live there?
- Contact your local government to support sustainable forestry practices in local parks and protected areas.
- Be fire conscious — don't have any open flames in the forest.
- Learn about traditional uses of forest ecosystems near you.
- Stay on marked trails and avoid environmentally sensitive areas near streams and waterways.
- Plant native trees in your community.
- Use wood in place of less environmentally-friendly products.



# **Transportation & Air Quality**

# Transportation & Air Quality



## Understanding Atmosphere and Air Quality

The **atmosphere** is a protective layer of gases around the earth's surface. Scientists divide the atmosphere into four layers. The layer closest to earth's surface is called the troposphere; this is where all weather happens. Next is the stratosphere which is often referred to as the ozone layer. It is primarily responsible for blocking out ultraviolet radiation from the sun. Then, at about 50 km above the earth's surface is the mesosphere. The outermost region is the thermosphere.

## Vocabulary

**Atmosphere:** a layer of gases surrounding the earth which protect it and keep it in a livable condition.

**Particulate Matter:** a complex mixture of extremely small particles and liquid droplets in the air. When inhaled these particles can have serious negative health effects.

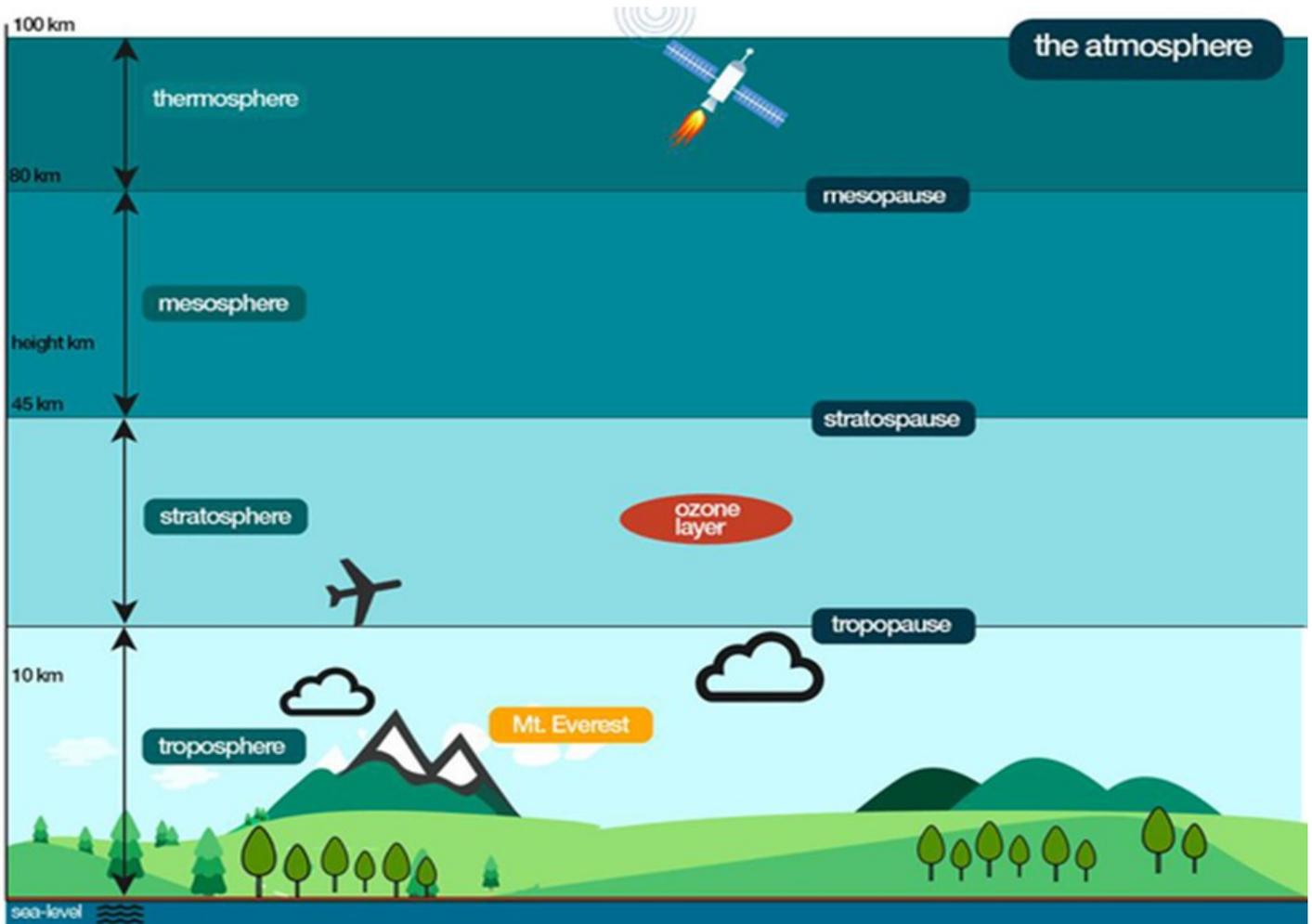
**Ground-Level Ozone:** a hazardous gas found near earth's surface, which is of the same chemical make up as the natural occurring ozone layer. It is formed from other pollutants interacting with sunlight.

**Nitrogen Oxides (NO<sub>x</sub>):** one of the toxic pollutants which causes ground-level ozone. Made of combinations of nitrogen and oxygen.

**Volatile organic compounds (VOC):** toxic chemicals that can cause ground-level ozone. They are any organic compound that can easily evaporate at room temperature and will interact will sunlight.

**Smog:** air pollution, named for the mixture of smoke and fog in the air. Smog results from large amounts of coal burning in an area and is caused by a mixture of smoke and sulfur dioxide. It is now commonly used to refer to multiple types of pollution.

**Urban sprawl:** the expansion of human populations away from central areas into low-density, car-dependent communities.



These regions of the atmosphere gradually become less dense as their distance from earth increases eventually melding into space. The diagram above displays the levels of the atmosphere. The diagram shows that good ozone, the kind that helps us by contributing to the earth's natural greenhouse effect which we learned about in the chapter on climate change, is found in the stratosphere.

As our disposable consumerist lifestyle pollutes the air, it changes the atmosphere. In this chapter we will look at how the atmosphere is affected by our choices, and how we can make a difference.

### What is Air Pollution?

Air pollution is defined as a significant presence of toxic chemicals or compounds in the air,

enough to pose a health risk. There are many different types of air pollution. The two most common types in the Fraser Valley are **particulate matter** and **ground-level ozone**.

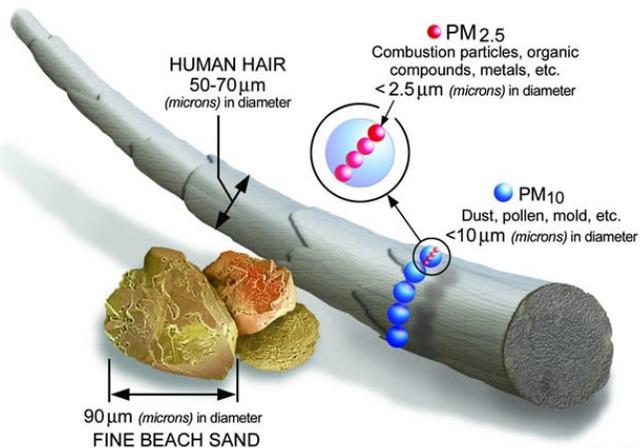
Particulate matter (PM) is made up of tiny solid particles and liquid droplets that float in the air. Some particles are big enough to be seen as smoke, soot or dust. Others are so small that they can only be detected with an electron microscope.

# Transportation & Air Quality

# Transportation & Air Quality

There are two different types of particulate matter or PM. One is PM 10 and PM 2.5. PM 2.5 is the worst air pollution-related health problem in BC as it can settle deep in the lungs, causing bronchitis, asthma, emphysema, pneumonia, and heart disease. Because of its small size it takes significantly longer than PM 10 to settle out of the air, weeks rather than hours or days.

The diagram below shows the size difference between PM 2.5 and PM 10 in comparison to the size of a human hair.

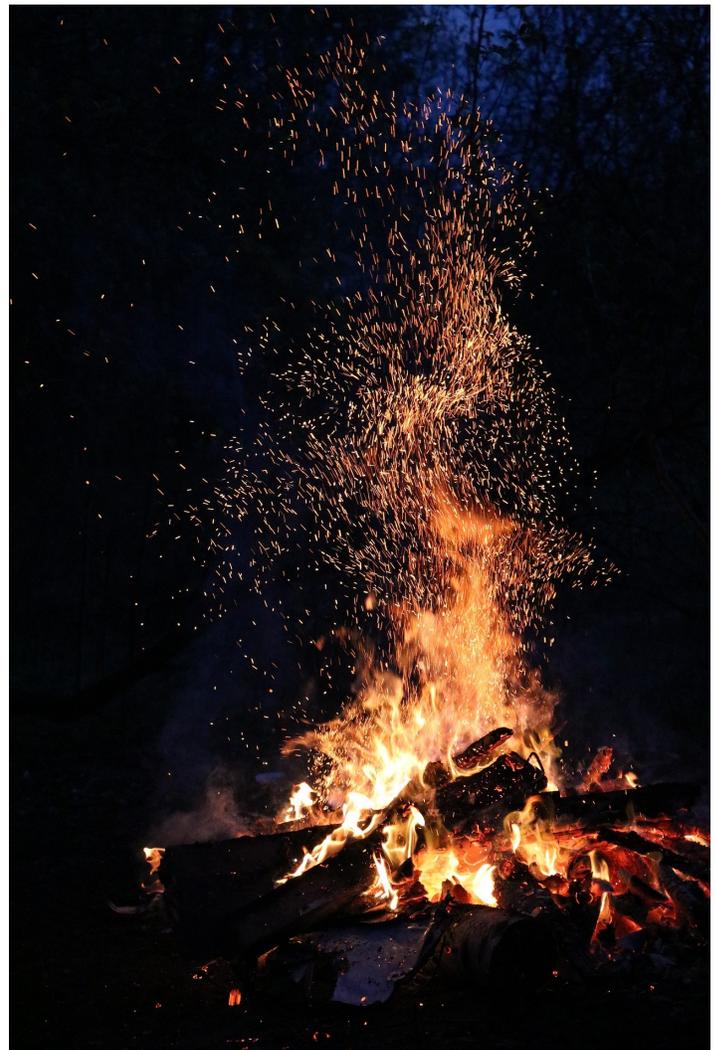


The second greatest pollutant in our region is ground-level ozone ( $O_3$ ). While ozone found high in the earth's atmosphere helps protect us from the sun's rays, at ground level it is detrimental to human health and is the main ingredient in smog. Ground-level ozone forms when **nitrogen oxides** (NOX) and **volatile organic compounds** (VOC), react in the

presence of sunlight. Ozone can irritate the eyes, nose, and throat. It can also decrease lung function and contribute to asthma. Ozone is one of the primary factors in **smog**.

## Causes of Air Pollution

Air pollution is primarily caused by humans. Industries including agriculture, farming, mining, and production release large quantities of toxic emissions into the air. However, individuals also have an impact. Backyard burning is an individual action that impacts air quality. While backyard burning may seem like a good way to get rid of extra junk it is often illegal and can be dangerous.





Products such as tires, treated wood, paper, plastics and cardboard give off harmful chemicals. Only burn 100% untreated wood or manufactured fireplace logs.

A better way to get rid of materials is by using the municipal recycling and compost programs. If you do not receive curbside pickup you can bring recycling to the depot and begin a backyard compost for your food waste. There is more information on material disposal in the chapter on waste (p 36-42).

## Transportation

Transportation is one of the greatest sources of air pollution in Canada. Thus, how you get around matters.

You don't have to use your own car. You can take the bus, bike, walk, carpool with friends, rollerblade, hover board, skateboard etc. There are so many alternatives to vehicles that we don't even consider.

While non-vehicle or public transportation is an ideal way to reduce your personal emissions, because of **urban sprawl** such modes of movement are not always feasible. Because of this, you can consider vehicles that are powered in more eco-friendly ways opposed to traditional fuels.

## Urban Sprawl

Canadian cities are among the most spread out, car dependent cities on earth. Cars have made living in suburbs possible, but the suburbs have made us even more reliant on cars. This cycle of the spread of suburbia is called Urban Sprawl. Dependency on cars leads to a higher demand for low parking rates and expectations for low-density housing development away from city cores. These changes in turn lead to further automobile dependency and increase the cost of providing public transit services to outlying areas. The resulting lack of growth in transit service or infrastructure for alternative transportation (bike lanes and trails, walking paths, etc.) then, again, reinforces car use.



**Biodiesel** is an alternative to traditional diesel. It is a vegetable and animal-fat based fuel that can be combined with traditional diesel. Biodiesel can be made from used recycled cooking oil. Abbotsford Mission Recycling Program collects used cooking oil to be made into biodiesel. However, while the production of biodiesel is more sustainable than traditional diesel, it does still produce pollutants when burned for fuel.

# Transportation & Air Quality

# Transportation & Air Quality



**Hybrid vehicles** are another good alternative to gasoline engine vehicles. They run on both electricity and gasoline. They can travel 20-80 km on a full charge. Once the battery is used up, a gasoline engine or generator turns on for an additional 500+ km of gasoline range. Plug-in Hybrids can do everything gas cars can do with the added benefit of providing all-electric driving for most day to day needs.

Fully **electric cars** are a more recent innovation, and are getting better every year. They are powered 100% by an electric motor and battery. Fully electric cars do not run on gasoline or diesel and have zero tailpipe emissions; they don't even have a tailpipe. Most fully electric cars can travel 200-250 km on a full charge, but some are capable of 400+ km. They can be quite expensive to buy upfront, but you never have to buy gasoline.

Natural causes such as volcanoes and forest fires are also contributors of air pollution. As mentioned in the forest section, the dry summers in BC create an environment where forest fires become a major issue. Because of the fires, much of the province sits under air quality advisory warnings for extended periods of time. Yet, anthropogenic emissions are still the greatest cause of air pollution. Look back to page 33 for some ways you can reduce your transportation emissions.



## Career Spotlight: Environmental Planner

Environmental planners are responsible for developing short and long term plans for land use. Their plans inform the regulations that dictate how urban and rural spaces can be used. Their job is to consider social, economic, and environmental impacts of city growth and building projects. Environmental planners influence a vast range of fields of interest including commercial and industrial development, heritage, tourism, and integrated resource planning.





Waste

# Waste



## The 4 R's?

From childhood we are trained with the ammunition of the “3 Rs” to address the issue of waste. **Reduce. Reuse. Recycle.** The order of the words is important. While recycling is an important part of caring for the earth, it is not the ultimate solution. In reality, “by the time waste gets recycled 95 per cent of the environmental damage has already occurred – in manufacturing, in oil extraction, in the poisoning of our rivers and air ...[and] the output of carbon.” Thus, recycling is the last R; it keeps useful materials out of the landfill, stopping the production of new ones, but is not a cure-all. However, even with the first two Rs, Reduce and Reuse, waste remains a problem. This is because waste is a systemic issue; we live in a disposable culture, one that encourages waste. However, we can combat this by learning to **RETHINK** our ideas about what we purchase and what waste really is. Rethinking makes the 3Rs more effective.

## Vocabulary

**Reduce:** to make or use a smaller amount of something.

**Reuse:** to use an item again for the same or a different purpose.

**Recycle:** to use a material again for a new purpose after a process of breaking down and rebuilding.

**Compost:** the process through which organic materials decompose and can be used to fertilize plants.

**Municipal Solid Waste:** Municipal solid waste is what we commonly call garbage. It includes from the day to day trash from industry, institutional and residential sources.

**Extended Producer Responsibility:** a policy under which producers are responsible for the treatment or disposal of their products.

**Plastic:** a synthetic material made from a wide range of polymers, that can be cheaply made, but will never bio-degrade.

## Recycling

Abbotsford Mission Recycling Program provides recycling services for the City of Abbotsford and District of Mission. Previously, the program marketed all the recycling collected directly to market. As of April 3, 2017, the City of Abbotsford and District of Mission became participating members of the provincial Recycle BC program. This program is responsible for the recycling of residential printed paper and packaging. To see a complete list of items accepted in the program, please visit the Recycle BC website.



Many people in the City of Abbotsford and the District of Mission receive curbside pickup for their recycling. Household recycling materials are put out at the curb on a weekly schedule to be picked up by a recycling truck. The materials that are accepted at the curb in your recycling are:

- Cardboard and boxboard: boxes for shipping, groceries, pizza, tissues, cereal, frozen entrees, desserts and carrier trays; paper towel and toilet paper rolls etc.
- Paper: office paper, newspaper, flyers, phone books, magazines, gift wrap, egg cartons, paper cups, tetra packs, construction paper
- Tin and Aluminum: cans from soup, coffee, pet foods; empty aerosols; aluminum foils, foil plates
- Plastic Containers: jugs, trays, lids, cups, shampoo bottles, milk jugs, pop bottles, yogurt cups, peanut butter containers, cleaning supplies etc.

A lot of the materials that are not accepted curbside can be brought to the recycling depot.

These materials include:

- Glass bottles and jars: food jars only. No window glass or dishware. Note: in Mission this is accepted curbside in special designated bins.
- White and coloured foam packaging: food containers, foam cushion packaging. No foam peanuts.
- Retail Film Plastics: bread bags, shopping bags, overwrap. No zipper-lock bags or plastic food wrap.
- Other: batteries, appliances, electronics, used cooking oil, lighting fixtures, lightbulbs, toilets etc.
- Other Flexible Plastic Packaging, (the “crinkly,” multi-laminate types of plastic): granola bar wrappers, stand-up pouches, zipper-lock bags, woven/net plastic produce bags etc.



# Waste

# Waste

Materials must be clean. A little bit of contamination can ruin a whole load of recyclables. For example, if paper gets wet it is no longer recyclable—so be sure to scrape out the last of your peanut butter from the container before putting it in the recycling! At the depot, materials run through conveyor belts and are hand sorted into different material types.



Above: Materials are hand-sorted at the Abbotsford Mission Recycling Depot located on Valley Road in Abbotsford.

Below: Baled materials ready for shipping



Once sorted, the recyclables are either baled or loaded loose into shipping containers and sent to markets for processing. Each material goes through a different process as it is recycled. Plastics for example, are shredded and melted into pellets to be sold, whereas paper is washed and then added to other materials directly to produce something new.

The images below show some of the new items old materials are made into.



**Glass Bottles And Jars**



**Cardboard**



**Plastic Beverage Bottles**



**Plastic Milk & Juice Bottles**



**Plastic Detergent Bottles**

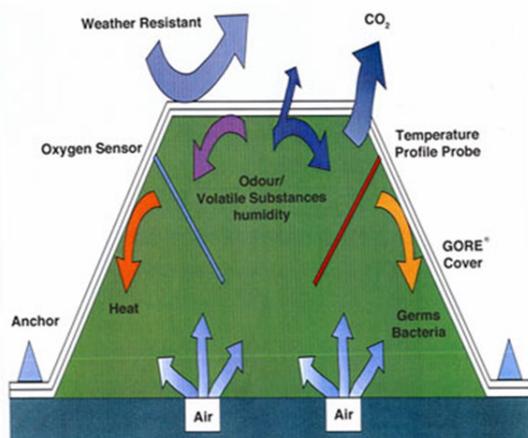
## Compost

The average Canadian throws out 308 lbs. of food waste a year. When this food waste goes into the landfill it does not break down properly. Rather, it creates toxic methane gas. If this food waste were to be composted it could be used in gardens reducing the need for commercial fertilizers. There are a couple of different methods of composting:

**Municipal compost program:** Just like your recycling and garbage, the City of Abbotsford and the District of Mission offer curbside pickup for residential food and yard waste. In Abbotsford the collected compostables are taken to NET ZERO WASTE where the gore cover system is used to reduce smell and aid in the composting process.

In Mission the compost is processed at the Mission Landfill (Minnie's Pit), using the hot rot method. This method has a four month processing period during which the compost is heated up to 55 degrees Celsius. If you don't receive curbside pick-up, compostables can be brought to either of these facilities.

These facilities accept both yard and kitchen waste. For more info on what is accepted go to the City of Abbotsford or District of Mission websites.



Source: W.L. Gore & Associates GmbH

**Backyard compost:** Backyard composting is slightly different than municipal compost. You can purchase a compost bin or make your own. Because backyard composts do not generate the same amount of heat as large scale municipal composts, the types of material that can go in a backyard compost is different. Likewise the materials are divided into two categories: green and brown. Green material is nitrogen-rich and includes fruit and vegetable peelings, fresh leaves, and grass clippings, greenery, tea bags, coffee grounds, pet manure from rabbits, gerbils, guinea pigs, sheep, and horses or cows (herbivories). Brown material is carbon-rich and includes dry leaves and grass clippings, straw, shredded newspaper, paper bags, paper towels and napkins, corn cobs and stalks. Layers of green and brown materials need to be alternated. Chop up large materials to speed up the decomposition process. Compost should be mixed every week or two. This will help aerate the material and generate heat again to encourage faster decomposition.



# Waste

# Waste

Compost is generally ready to use in about 2-3 months; however, it is recommended for the compost to age for an additional 1-2 months. Bones, meat and citrus should not be put in backyard composts.

## Municipal Solid Waste

There are still some materials that cannot be composted or recycled. Non-compostable and non-recyclable materials as well as items put in garbage that should have been recycled or composted are considered municipal solid waste.

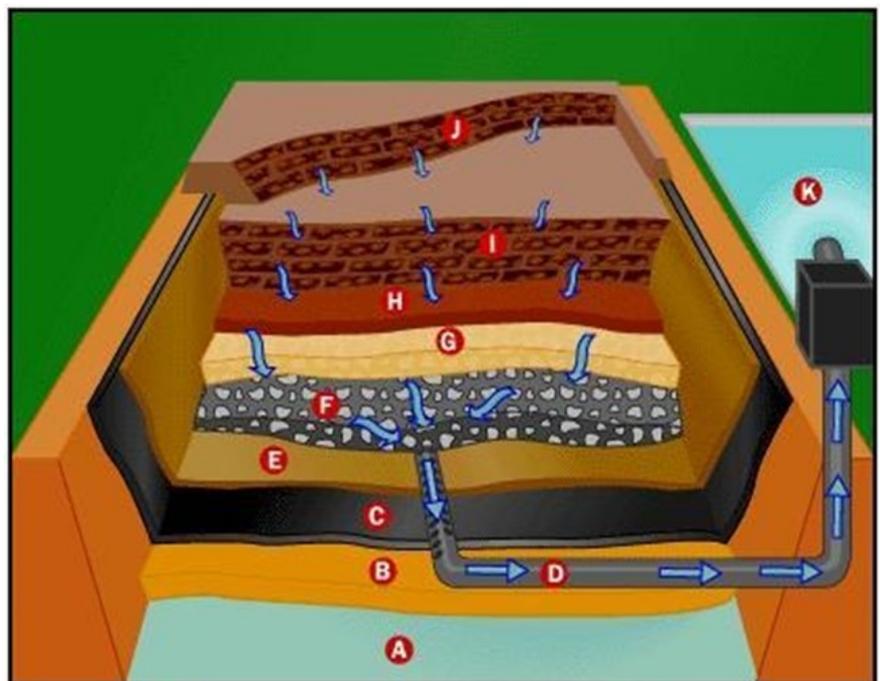
Municipal solid waste is what we commonly call garbage. It includes trash from both industry and civilian based sources. However, it does not include hazardous waste, biomedical waste, agricultural waste, motor vehicles or components, or contaminated soil. In 2016, BC disposed of approximately 2.3 million tonnes of municipal solid waste.

## Where Does Our Garbage Go?

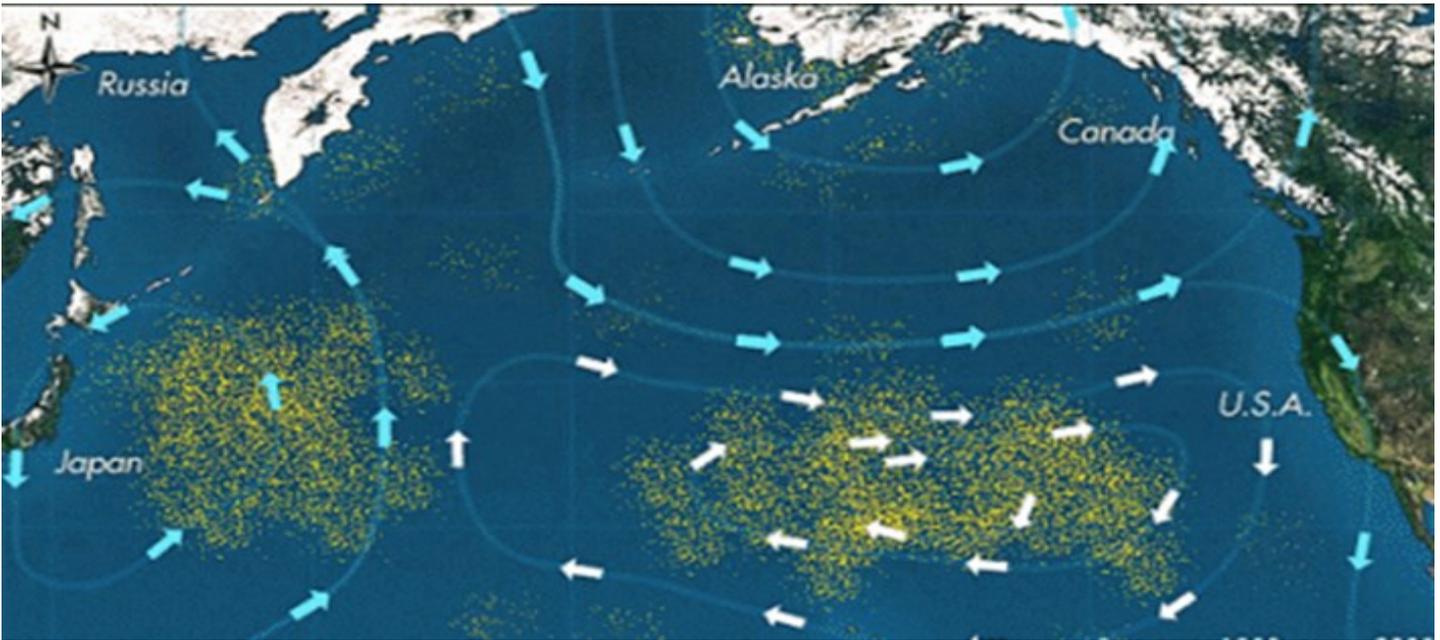
All this garbage has to go somewhere, and because we can't really do anything with it most of it sits in

landfills. Landfills have been used since the time of the ancient Romans as a form of waste management. Landfills are built as deep holes in the ground. To protect the environment from toxic garbage run off known as **leachate**, one of the first layers in a landfill is a plastic liner. The liner is followed by layers of clay and gravel, then a leachate collection system. These layers work to reduce the chances of the toxic leachate from making its way to the earth underneath. Canada is home to about 2,400 active landfills (large and small, public and private). Did you know that Rotary Stadium in Abbotsford is built over top of an old landfill?

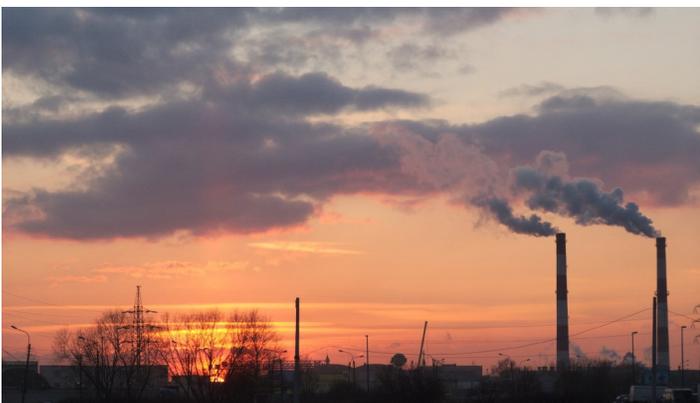
**Incineration:** Another way we deal with large scale waste is with waste-to-energy facilities. These facilities are power plants that burn municipal solid waste rather than depositing it in a landfill. They use the waste as fuel to produce



- |                                   |                         |
|-----------------------------------|-------------------------|
| <b>A</b> Ground Water             | <b>G</b> Drainage Layer |
| <b>B</b> Compacted Clay           | <b>H</b> Soil Layer     |
| <b>C</b> Plastic Liner            | <b>I</b> Old Cells      |
| <b>D</b> Leachate Collection Pipe | <b>J</b> New Cells      |
| <b>E</b> Geotextile Mat           | <b>K</b> Leachate Pond  |
| <b>F</b> Gravel                   |                         |



heat and electricity, instead of using fossil fuels such as coal, oil or natural gas. In B.C the COVANTA BURNABY RENEWABLE ENERGY facility converts 285,000 tons of municipal solid waste from Metro-Vancouver into 940,000 tons of steam and up to 17,000 MWh of electricity per year. Incineration is a great way to reduce the amount of garbage going into a landfill and eliminates the spatial issues associated with landfilling. However, incinerators are a large source of air pollution and, as we know from the last section, air quality is something to be protected. The second issue is that once built, you need to continue to feed the incinerator! Thus, as the operation of an incinerator is co-dependent on waste generation, it encourages people to keep producing waste.



## Plastic Oceans

Even though you may never see a plastic bottle once you dispose of it, that does not mean that the bottle no longer exists! Thanks to strong ocean currents, known as gyres, waste from all over the globe amasses in patches. Over the past five decades waste has accumulated until these garbage patches look like little islands of trash. The North Pacific Subtropical Gyre, which is the patch of floating garbage and plastic closest to B.C, is estimated to be twice the size of Texas. Over 90% of this waste is plastic and will not biodegrade! This has massive health risks for humans and animals alike. Over 80% of ocean plastic comes from land sources. For example trash left on the banks of the Great Lakes is taken up by the water, propelled by currents up the tributaries, into the Saint Lawrence River, and into the ocean.

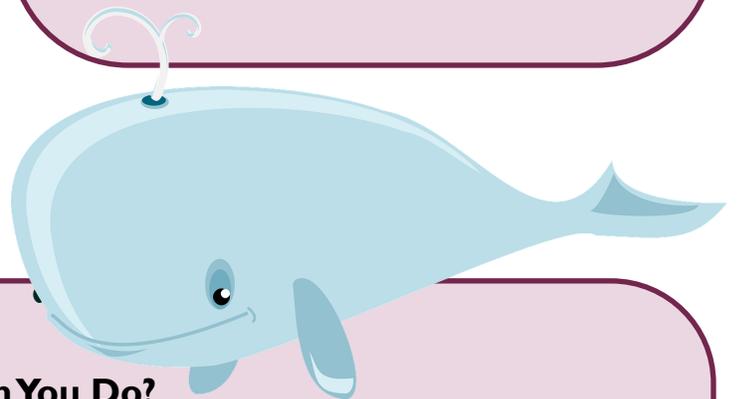
# Waste

# Waste



About 8 million tons of plastic gets dumped into the ocean each year. In the Western Mediterranean the ratio of plastic to plankton is 1:2. Many marine animals survive on plankton and they cannot tell the difference between plankton and floating micro-plastics. Often they eat the micro-plastics, the plastic fills up their stomach and does not break down, which can cause them to starve.

**Recycle BC** is an Extended Producer Responsibility (EPR) program. This means that the producer of a product is responsible for it from its creation to its end of life. Companies often create products that are designed to be disposable. Additionally, chemicals are used in manufacturing that can have long term health effects if not disposed of properly. EPR forces companies to think about these long term consequences rather than relying on the government to open more landfills or deal with toxic waste. Producers do not have to become collectors and recyclers themselves, but they must arrange for these services and pay for them individually or collectively with other companies. British Columbia is recognized as one of the leaders of EPR in North America.



## What Can You Do?

- Be aware of what is and is not recyclable in your community! This way you can be sure to recycle everything.
- Make sure you participate in the composting program or make your own.
- Make a purchase check-list that integrates waste reduction into the parameters (i.e. how much packaging? Can I purchase a larger container instead of individual packets? Is this more than a single-use object? etc.)
- Use reusable plastic or glass containers for lunches, eliminate straw use or purchase a reusable glass or metal straw and bring your own coffee mug/ water bottle when you go out.

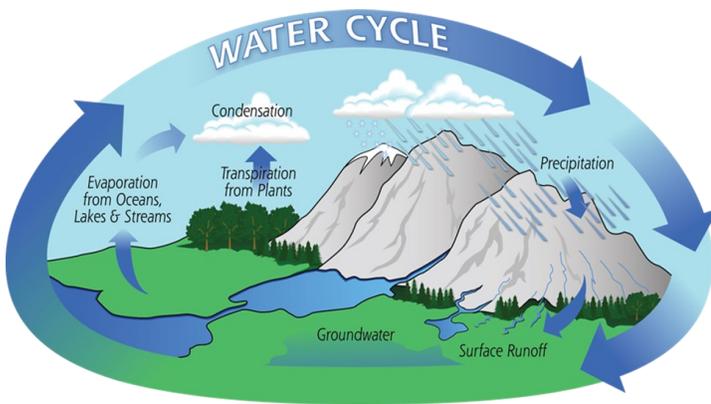


**Water**

# Water

## The Water Cycle

Though in the Fraser Valley it may not seem like usable water is a relatively rare resource, only 3% of Earth's waters are freshwater (without salt). Of that 3%, only 1% is actually accessible; 99% of freshwater is either frozen in glacial fields, or deep underground.



All this water is carried around the earth through the **hydrologic cycle**. The hydrologic cycle is a continuous loop in which water evaporates, travels through the atmosphere, and then falls back to the ground. As the sun heats the surface of the ocean, it causes huge amounts of water to evaporate. The process of **evaporation** uses heat energy from the sun to break the bonds between individual water molecules, allowing them to escape the vast expanse of ocean and be lifted into the air. These water molecules then clump together, collecting dust particles to form clouds as they travel across the sky propelled by air currents.

## Vocabulary

**Hydrologic cycle:** the process through which water is moved around the earth's surface.

**Evaporation:** when a liquid uses heat energy to break bonds between molecules thereby transitioning into a gaseous state.

**Condensation:** the process through which water vapor in the air is changed into liquid.

**Surface Runoff:** water from rain, snowmelt, or other sources that flows over the surface of the earth.

**Water Table:** an area below ground which is saturated with water.

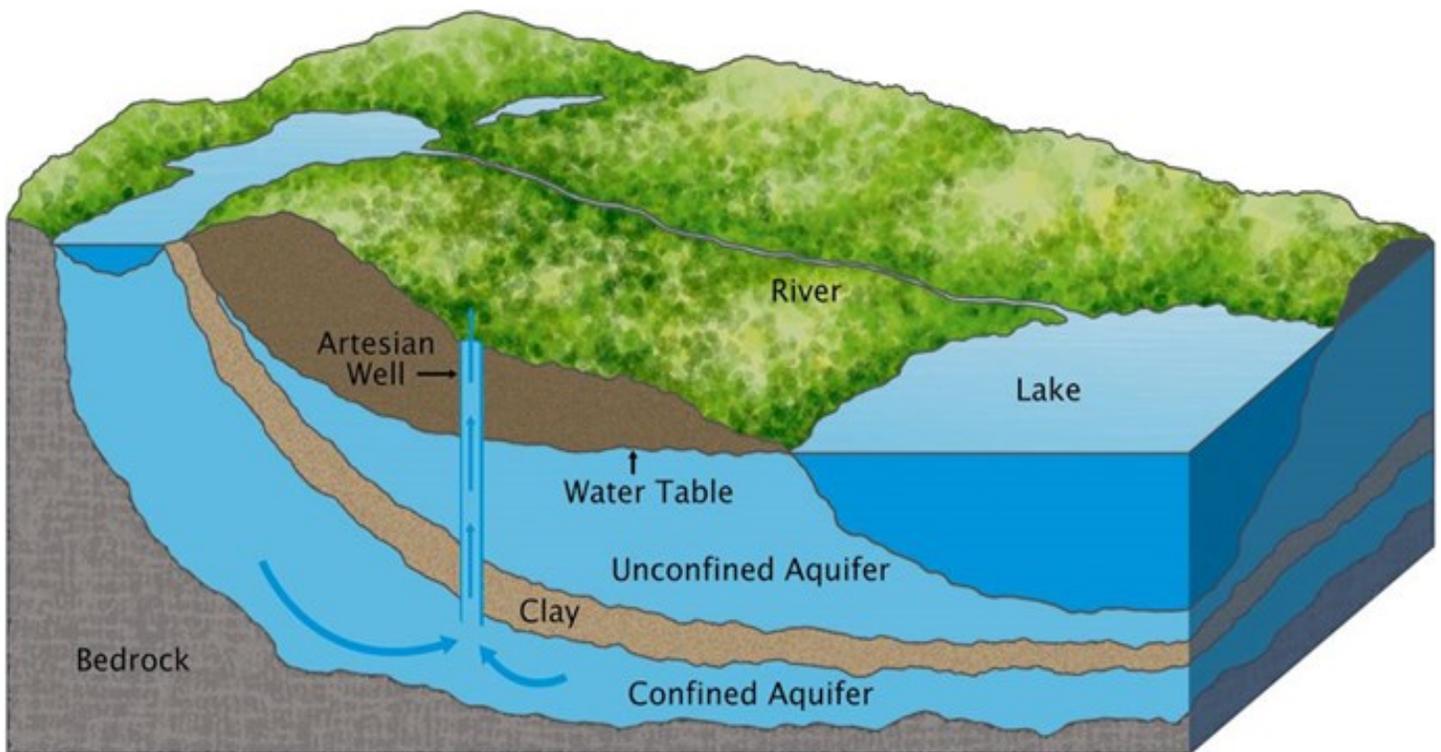
**Groundwater:** water stored underground in soil or in the pores and crevices of rock.

**Aquifer:** a body of permeable rock that can hold groundwater.

**Non-point Source Pollution (NPS):** pollution collected from many sources leading into lakes and rivers. Usually brought into the water by surface runoff.

This process is known as **condensation**. When the collections of water become too heavy to hang in the air, the water falls back down to the ground as precipitation in the form of rain, snow, or hail. This water is either frozen, absorbed by the ground or becomes **surface runoff**, travelling along the ground to the topographical low points where it eventually meets a body of water.

# Aquifer



## Ground Water

When water appears to be absorbed by the ground, it begins to percolate through the visible rocks and soil deep into the earth. Water moves downward at various rates, depending on the material it meets; if it is travelling through sand, it could move several meters in a single day, but if it is traveling through a more densely packed material, it may move less than a few centimeters in a century.

The water molecules will continue to flow downward until it meets a **water table**, an area of ground which is already saturated by water. Everything below the water table is considered **groundwater**. This groundwater is held in what is known as an **aquifer**, an area of porous material which holds a significant amount of water.

## Did you know?

Since 2008, when the BC government issued a call to action with a program named, “Living Water Smart,” the province has been moving towards living more sustainably. In 2016 the Water Sustainability Act came into effect, providing regulations to protect our waters.



# Water

# Water

There are three main types of aquifers:

Artesian aquifers are found between layers of dense materials such as clay or rock.

Unconfined aquifers are not contained by layers of impermeable material, but rather their upper boundary is the water table. This water is likely to be both easily replenished and contaminated as it is generally found quite close to the surface.

Fractured aquifers are found under solid rock. The water trickling down reaches the aquifer through cracks in the rock, often carving out channels and caverns.

## Our Local Water

Water is often described as renewable; however, this is not fully true. Likewise many Canadians are proud that our country holds 20% of earth's freshwater, but only a third of this water is renewed by precipitation. 60 % of it flows northward, away from the population. In

reality our usable freshwater is only about 2.6% of the world's total.

It is also important to note that sewage can be a problem for our water. Environment and Climate Change Canada estimates that 150 billion liters of untreated or undertreated sewage are dumped into our river systems every year.

### Did You Know?

Public health authorities report that on any given day there are approximately 1,500 drinking water advisories in place across the country.



Rural communities, particularly those of First Nations peoples are often the greatest sufferers.

In 2015 CBC did an investigative report which showed that two thirds of First Nations in Canada had been under a water advisory between 2004 and 2014. Some of these communities have had an advisory for over 20 years.



Dam in Mission image collected from:  
<https://www.bchydro.com/energy-in-bc/operations/our-facilities.html>



## Where Does Your Water Come From?

Mission's drinking water is sourced from two surface sources, Cannel Lake and Norrish Creek. This water is treated at the Ruskin Townsite Water System and distributed throughout both Mission and Abbotsford.

Abbotsford is unique because it also collects some of its water from the Abbotsford-Sumas aquifer. Most of BC relies on surface water rather than groundwater. This aquifer lies under the border between Canada and the US. We share this water source with the entire state of Washington. It is used not just for drinking, but also fisheries and agriculture.

## Our Uses of Water

Though humans cannot survive more than three days without drinking water, drinking consists of a small amount of our total water consumption.

Factory farming is on the rise in Canada. These large scale farms are dependent on the use of

pesticides that trickle into the very lakes from which they collect their water. Likewise, the copious amounts of animal waste from large scale corporate farms, which contain bacterial and viral pathogens, follow the same pattern ending up in nearby water sources. Such water pollution encourages massive growth of cyanobacteria that release toxins into the water causing sickness. Then these bacteria, which have a very short lifespan, die quickly, creating toxic environments called dead zones where no life is sustainable. Also, at this point 70% of all freshwater drawn is for farming irrigation. Likewise, all water used to produce food is considered consumptive, the water used is not returned to its source. In Canada, we see the results of large scale farming in Alberta, which is running out of water.

# Water

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## Water For Electricity

As you learned in the chapter on energy, Canada uses water as a source of power. Hydroelectricity is one of our largest uses of water. British Columbia currently has 31 hydro generating stations sending electricity along 75,000 kilometers of power lines. We divert rivers through dams. Forced re-directing of water has massive effects on the environment.

## Your water footprint



By now you should understand what your carbon footprint is, but do you know that you also have a water footprint ? The average Canadian uses 274 liters of water a day, and British Columbians are even worse, using an average of 353 liters a day. Most of this comes from practices that we don't even think of. For example, toilets and washing machines account for about 50% of residential water use.



## Water Pollution

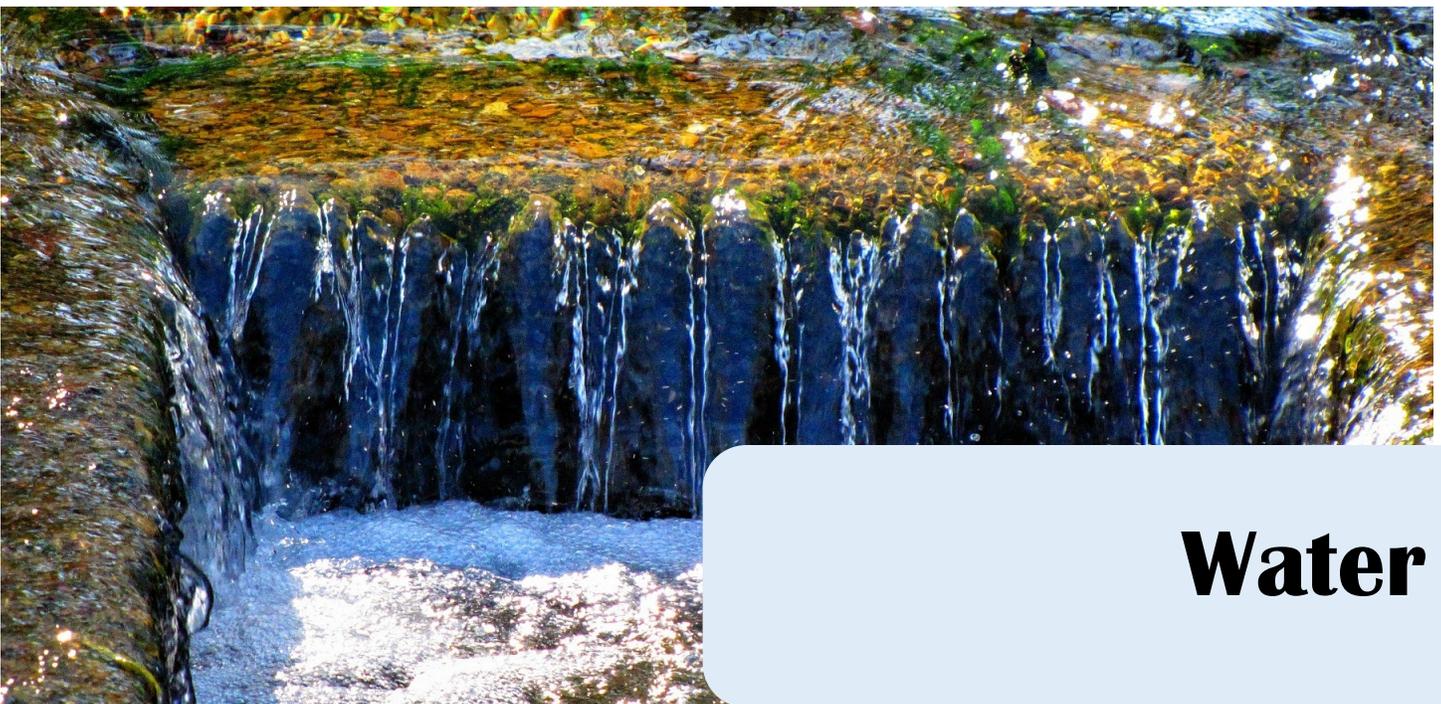
Our water is polluted in many ways. We usually divide all the pollution into two categories: Point source and **Non-point source pollution**. Non-point source pollution (NPS) is any pollution that comes from more than one source. It usually enters water through surface runoff, but sometimes, as in the case of acid rain, which you learned about in “Climate Change” (p.9), it falls directly into water sources. Some sources of NPS include:

1. Land Development
2. Agriculture
3. Stormwater Runoff
4. On-Site Sewage Systems
5. Forestry and Range Activities
6. Atmospheric Deposition
7. Boating and Marine Activities

NPS pollution changes the condition of the water leading to fish habitat loss and reduced water quality.

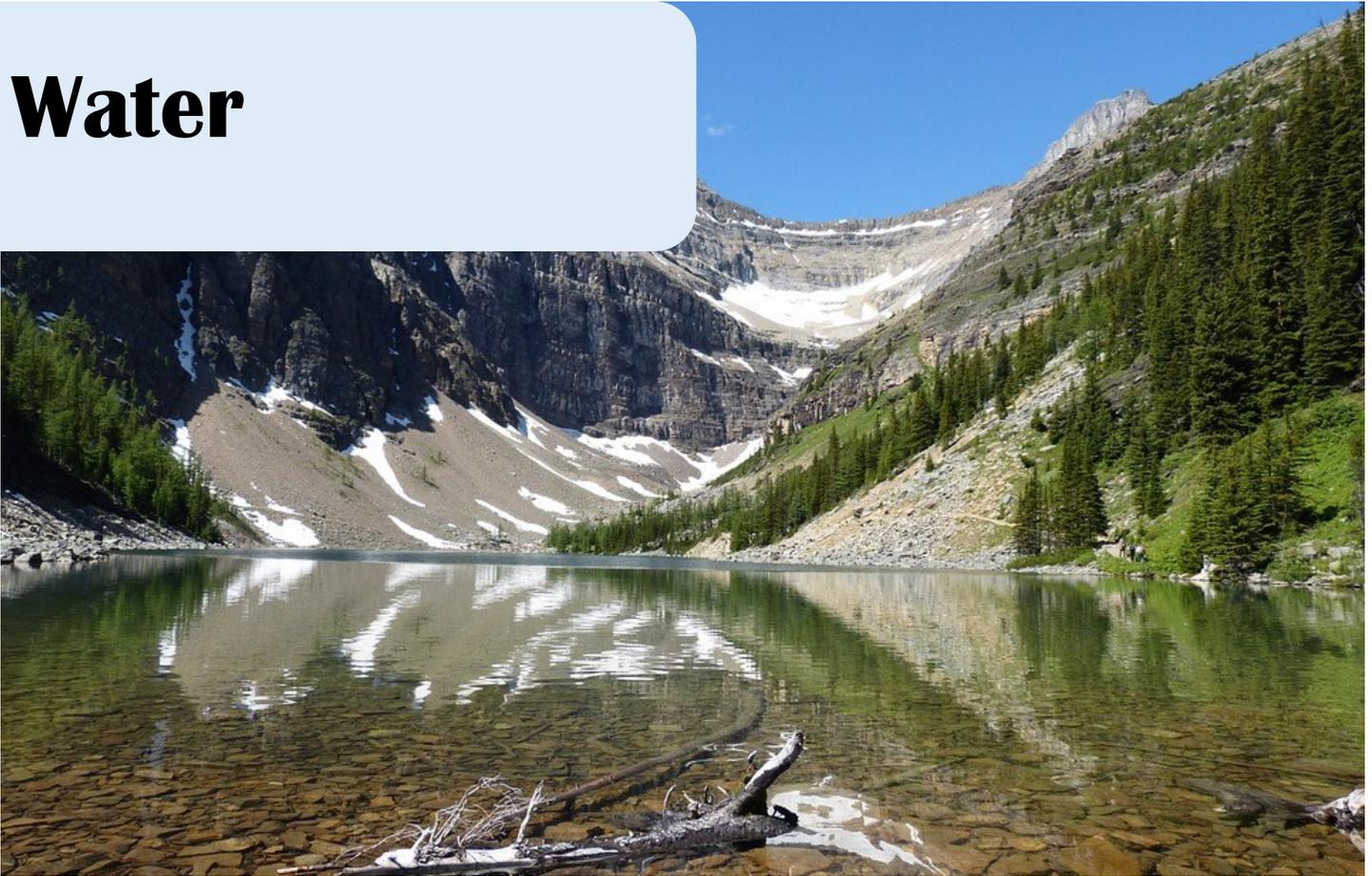
### The Yellow Fish

Be on the lookout for storm drains! Water from these drains go straight into our streams and other water sources. Pollution in these drains effect our whole water systems and is very harmful to the fish that live in the rivers and streams where the drains pour. Volunteers with the yellow fish road, a nation-wide pollution awareness program, are working to paint yellow fish on or beside storm drains to encourage awareness.



# Water

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## What Can You Do?

- Eat less meat! A medium sized beef burger has a water footprint of 2,350 liters; 2 pounds of beef has a water footprint of 15,400 liters
- Shop at thrift stores! An average pair of jeans has a water footprint of 8,000 liters, a complete outfit usually has a water footprint of 20,000 liters. By buying used clothing you require less to be produced, reducing your water footprint.
- Take shorter showers; a 10 minute shower uses 160-190 liters of water.
- Drink more (tap) water! While this may at first seem counter intuitive, it actually does make sense. A 500ml bottle of cola has a water footprint of 175 liters, and a tiny 4 ounce glass of orange juice has a footprint of 200 liters. Likewise, bottled water has a large footprint caused by its transportation, treatment, and plastic production. It also is up to 10,000 times more expensive than tap water and is more loosely regulated, meaning it has a higher risk of contamination.
- Get a rain barrel; collect the water that is already available in our climate.
- Install a low-flush toilet, and flush only when necessary. The City of Abbotsford and District of Mission have a rebate program to help you purchase one!



# Species & Spaces

# Species & Spaces



## Sharing the Planet

In order for us, as humans, to preserve our home, planet earth, we must understand the situations of the species with which we share our planet. It is biodiversity that sustains our life. As learned in Chapter One, human activity is the primary cause of climate change. Human activity is also primarily responsible for the drastic decrease in global biodiversity. In this chapter we will look at some of the species and spaces unique to British Columbia and the ways in which they are changing.

There are tens of thousands of animals and plants living in B.C, and while we may have a beautiful, ecologically diverse province, many of our species are not thriving. Habitats are threatened by urban sprawl, deforestation, unbridled development, alien species introduction, pollution and climate change.

## Vocabulary

**Biodiversity:** a large variety of plant and animal species within a specific environment.

**Alien Species:** a species introduced into an area or environment outside its normal habitat.

**Endemic:** a native species found only in a specific country or region.

**Endangered:** a species at risk for extinction.

**Keystone Species:** a species on which other species in an ecosystem depend; if it were to be removed the ecosystem would change drastically.

**Extinction:** the state or process of a species, dying off until no living samples of the species remain.

**Ecosystems:** biological communities of interacting organisms and their physical environments.

**Habitat Degradation:** a process, usually human caused, in which the quality of a species-specific habitat declines so that the population experiences have reduced survival and/or reproductive success.

**Invasive Species:** an alien species which takes over and harms the new environment that it has entered.

**Ecozones:** the broadest scientific classification of a region based on its plant types.

**Biome:** a major ecological community characterized by distinctive plant and animal species.



Every time a forest is cleared to build a highway or a subdivision, species are displaced. The effects of human disruption are not limited to the locus of the activity. Rather, every interruption creates a ripple effect disturbing ecosystems near and far. For example, erosion from clear-cutting sends debris into streams where salmon spawn. Because of such debris, the spawning process is made more difficult, and less young fry will survive into adulthood. This decreases the salmon population, which then means less food for predators such as bears and large ocean mammals. The clear cutting is not just destroying the habitats of species that lived where the trees once were, but can also put other species, as far away as the ocean, at risk.

## Biodiversity in BC

The province of BC has more native biological diversity than any other province in Canada. This includes:

- 1,258 vertebrates
- 3,190 vascular plants
- 4,500 marine invertebrates
- over 35,000 insects

Likewise, three-quarters of Canada's mammal species are found in BC, including 24 which are **endemic**, or exclusive to our province. One of these endemic species is the Vancouver Island

Marmot; sadly, this animal is red-listed, or, critically endangered.

One of the best ways to see if an ecosystem is healthy is to look at its **keystone species**. Keystone species are often the dominant predator, but not always. The presence of the keystone species influences the population of all other species in the ecosystem. When a keystone species is not doing well, or the population is less than usual, it indicates that there are problems with other species lower down on the food chain.



Image from: <https://foodninfo.com/2017/09/29/>



Migration patterns of Pacific Sockeye Salmon.

Image from: <https://www.hakai.org/research/salmon-ecosystems>

# Species & Spaces

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## Causes of Extinction

There are three main causes of extinction.

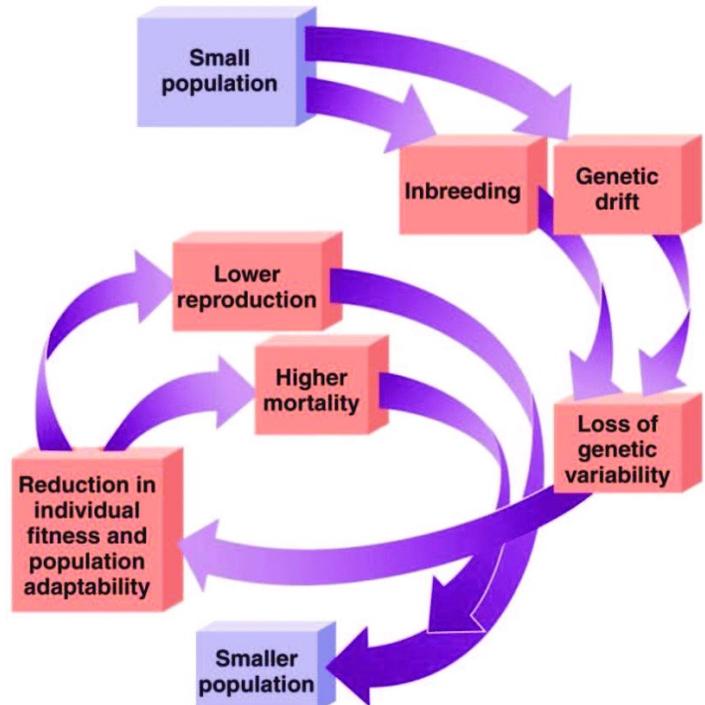
1. The largest of these is **habitat degradation**.

Salmon are an example of a local keystone species. Their habitats stretch from spawning grounds in mountain streams to the middle of the ocean. More than 130 different species of plants and animals depend on salmon abundance for their survival.

## Extinction

Species have been going extinct since life first began due to natural selection and survival of the fittest. However, the causes of **extinction** are no longer the same. The dramatic rise of extinction levels across the globe provides evidence that humanity is speeding up the extinction process. As species become ecologically extinct, they are no longer contributing to their ecosystem, thereby changing its food chain and natural structures. All life on earth is part of a web thus when one ecosystem is damaged, all life must adjust. At a certain point, no matter how durable a species is, it will no longer be able to adapt. When this happens the species will become extinct. The way we currently treat our planet, humans will eventually become endangered in our own environment.

This process of increased extinction is often called the extinction vortex. As more of a population declines, the greater the impact of any disturbance is on the population. This causes greater population decline; the repletion of the cycle eventually leads to extinction. The diagram to the right shows how the process works.



Extinction vortex diagram.

Image from: researchgate.net

Human activity causes both physical and chemical change in habitats, leaving them broken and unstable. Logging is an example of a physical change; pollution is an example of chemical change. Pollution is the second largest cause of endangerment of freshwater species in Canada.

2. Predator control, the targeted killing of animals that seek the same resources as humans, also has a huge impact on the endangerment of species.

3. Overharvesting: humans taking too much of a species for our own benefit is another cause of extinction. While overharvesting primarily happens when we seek food, sometimes overharvesting is caused by the demand for



Vancouver Island Marmot. Image from: pfla.bc.ca



Great Blue Heron, a blue listed species.

captive species. Collecting of endangered species can be financially profitable, for example, some Canadian species of falcons can fetch thousands of dollars on the international market. Though there are regulations which try to limit such trade, poaching continues to be a problem.

## Levels of Endangerment

As we track and monitor different species, we are able to calculate their risk of extinction. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) publishes a list of all species that are in threat of going extinct or being extirpated. Threatened species are those listed as Critically Endangered, Endangered, or Vulnerable.

**Critically Endangered** means a species is facing an extremely high risk of extinction in the wild. An **Endangered** species is considered to be facing a very high risk of extinction in the wild, whereas a **Vulnerable** species is facing a high risk of extinction in the wild.

BC ranks the level of endangerment by colour. Red list means critically endangered, blue list is endangered, and yellow list is vulnerable.

BC is home to more endangered species than any other province, yet, we are one of only two provinces that have virtually no legal protection for species at risk. Only five percent of B.C.'s endangered species are protected by law.

The Vancouver Island Marmot is an example of a **red listed** species. The Great Blue Heron is an example of a **blue listed** species. All varieties of Salmon are currently **yellow listed**.

## Invasive Species

The second major change in BC **ecosystems**, and part of what is causing native species to become endangered, is the introduction of **invasive species**. With today's global trade, international travel, and waterway engineering, new species are easily carried into ecosystems in which they do not belong.

Not all species introduced to a new ecosystem are considered invasive. Instead, the general term given to a species introduced to a new

# Species & Spaces

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## Invasive Species in BC

environment is **alien species**. An alien or non-native species is only considered invasive when they begin to cause harm. If an alien species is causing damage to the environment, economy, or human health, it is invasive. Many of the plants we put in our gardens are not native, but as long as they do not escape cultivation they will not become invasive. However, of the over 800 alien plant species established in the province, over 175 are invasive. Plants make up 86.6% of all the alien species in BC.

Hawkweeds, often confused with dandelions are an invasive species in BC. There is a number of invasive species of yellow hawkweeds including the whiplash hawkweed (*Hieracium flagellare*), and the mouse ear hawkweed (*Hieracium pilosella*). Hawkweeds compete with desirable native species and interfere in agricultural lands, resulting in decreased crop production and forage quality. They also drive out native flora and fauna, and rare protected species. Hawkweeds also spread rapidly as they propagate both from seeds, which are produced in large quantities and can travel long distances, and root fragments. They also germinate very easily. Mowing before flowers bloom is an effective way to reduce seed production and population spread.





Terrestrial eozones of Canada

Image from: <https://www150.statcan.gc.ca/n1/pub/16-002-x/2008002/map-carte/5212684-eng.htm>

You can also hand-pull this plant, however, it is important to ensure that roots and root parts are removed, or, the plant may come back.

The Japanese Beetle is also invasive in BC. Adult beetles feed on plants, destroying crops and gardens. The beetle larvae destroy lawns as they eat the roots of turf-grass. Though adult beetles live only a number of weeks, the females can lay more than 60 eggs. These eggs hatch two weeks after being deposited into the soil and begin to feed on roots right away. They dig deeper into the dirt to wait out winter and then emerge as adults in the spring. For more invasive species and information on them go to <https://bcinvasives.ca/invasive-species>.

## Control and Management of Invasive Species

Government agencies, such as BC's Inter-Ministry Invasive Species Working Group (IMISWG) and the Invasive Species Council (ISC), and Forests, Lands & Natural Resource Operations Invasive Plant Program (FLNRO) work to monitor and control invasive species. Every species requires a unique management strategy. You can help by using the report-a-weed, and report-invasives-BC apps to report invasive species when and where you see them.

# Species & Spaces

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## The Great Bear Rainforest

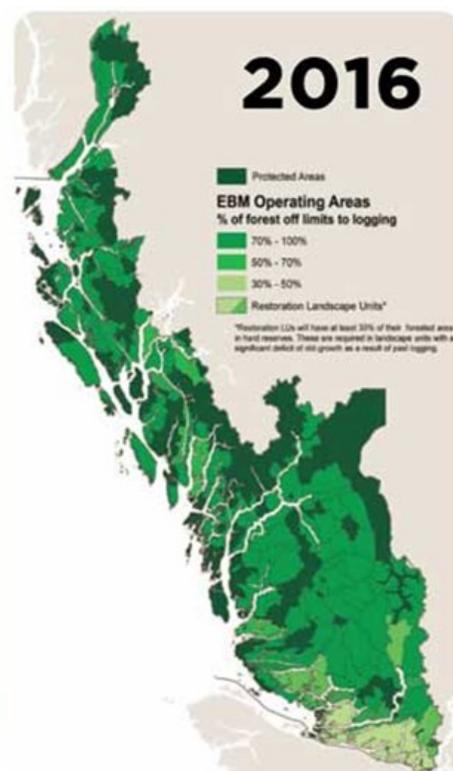
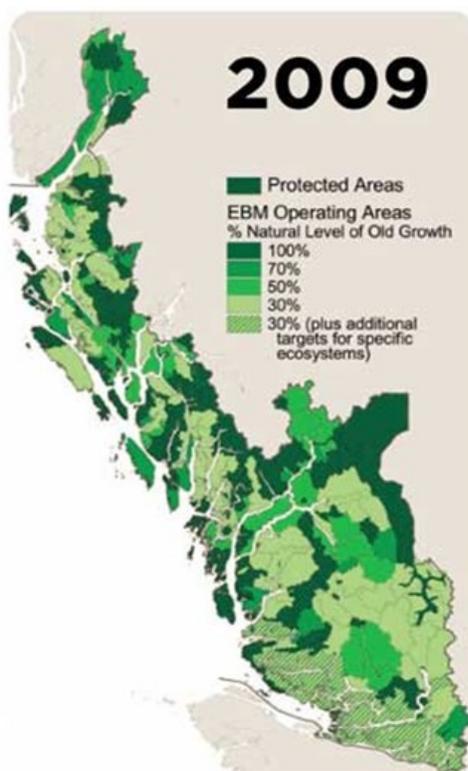
The Great Bear Rainforest, found in BC's pacific maritime ecozone, is the largest intact temperate rainforest in the world. 20 years ago, less than 5% of the forest was protected from clear cutting. Today, and for the next 250 years, 85% of the forest is safe from industrial logging.



The streams and rivers of the Great Bear Rainforest support over 20% of the world's total wild salmon population. Despite these improvements, the Great Bear Rainforest is still in danger; trophy hunting of large predators such as wolves and bears continues, making the ecosystem unstable.

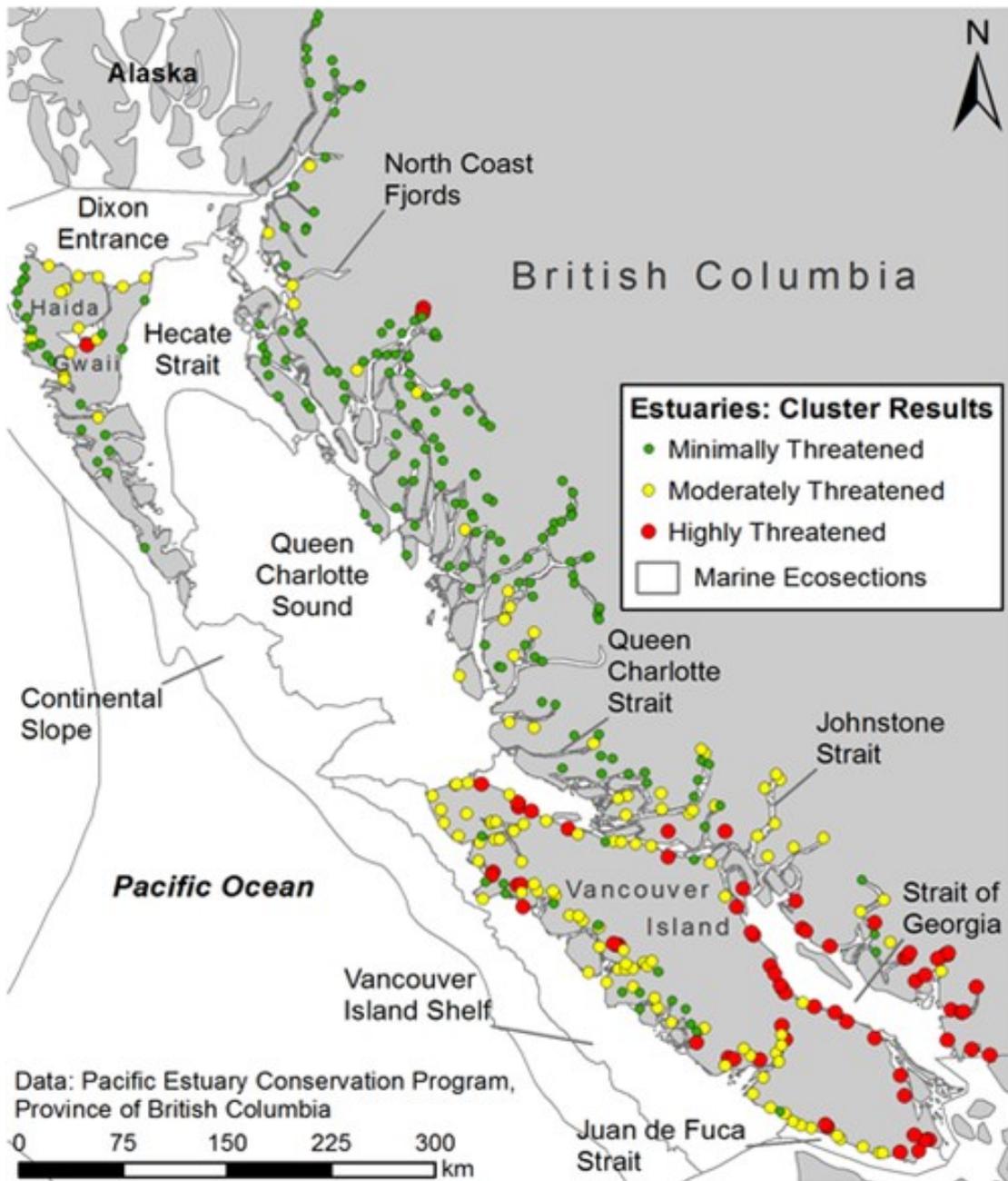
## Unique Spaces of BC

The vast biodiversity found in British Columbia is caused by our unique variety of **ecozones** and **biomes**. An ecozone is a group of similar ecosystems which have the same dominant vegetation and animal communities. A biome is a larger classification; it may contain multiple ecozones as it groups ecosystems together based on plant structure and response to environment, rather than genus or species. Canada has 15 terrestrial ecozones, and 5 aquatic ecozones. BC has 5 ecozones. The map on the previous page displays all the terrestrial ecozones of Canada.



Protected areas of Great Bear Rainforest

Image from: <https://coastfunds.ca/great-bear-rainforest/>



Estuaries of BC

Image from: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0099578>

80 percent of all coast wildlife. Estuaries have been called the “nurseries of the sea” for their important role in providing sheltered habitat and food for juvenile fish such as salmon, sea-run cutthroat trout and herring. In these protected environments, young fish can quickly grow and gradually become accustomed to salt water. These habitats provide critical staging, feeding and roosting areas for migrating birds and other wildlife along the Pacific Coast.

In recent years these special spaces, which are integral to the lifecycle of numerous

organisms, have become endangered. Rising sea levels caused by climate change and urbanization are putting estuaries, and all the life they contain, at risk.

## Estuaries

Estuaries, where river meets ocean, are a naturally rare occurrence. Estuary species occupy different intertidal zones (upper, middle and lower) depending on their ability to tolerate salt concentration (salinity), wave action, river flow, tidal changes and sedimentation levels.

Although estuaries make up only 2.3 percent of B.C’s coastline, they are used by approximately

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## Wetlands

Wetlands, another endangered ecosystem, cover 7% of the province of BC. They are important because they buffer environmental extremes and work as filters cleaning out sediments, pollutants and excess nutrients from the groundwater that they recharge. Wetlands also help maintain stream flows, control runoff, and store floodwaters. Wetland is an umbrella term used to refer to bogs, fens, swamps and marshes. Some local protected wetlands open to the public are the Maclure Wetlands, the Great Blue Heron Reserve, and the Silverdale Wetlands.



Great Blue Heron Reserve in Chilliwack BC

Image from: <https://www.chilliwack.com/main/page.cfm?id=210>

## Career Spotlight: Wildlife Biologist

Wildlife biologists examine the impact of environmental change (both human made and natural) on species survival. This means they analyze the growth and death rates of specific species populations as well as looking at the interactions between specific wildlife and their ecosystems. Wildlife biologists help to maintain and conserve Canada's wildlife populations through studying the factors that affect wildlife such as disease, nutrition, habitat relationships and population dynamics. They use the information that they gather to predict impacts on wildlife and the ecosystems on which they depend and to inform protection regulations.

## What Can You Do?

- Visit parks and protected areas—take nothing but pictures, leave nothing but footprints.
- Learn about endangered species in the region, find out what their habitat needs are.
- Join organizations who are working to protect species and spaces, like the Fraser Valley Watershed Coalition and Fraser Valley Conservancy.
- Help restore degraded habitats—plant native species.
- Choose products that recognize ecologically-friendly forestry practices. Even better, switch to cloth napkins, kitchen towel and handkerchiefs.
- Eat non-threatened fish species by using SeaChoice's Canada Seafood Guide.
- Do what you can in your yard and neighborhood—put up bat boxes or birdhouses.



## Species & Spaces

# References

## Climate Change

- Acciona. "What are carbon sinks?" Sustainability. June 7, 2017. <https://www.youtube.com/watch?v=OoW2PlvMpZs>.
- Borenstein, S. "Allergies, glaciers, and pikas: climate change in action." CTV News. June 19, 2018. <https://www.ctvnews.ca/sci-tech/allergies-glaciers-and-pikas-climate-change-in-action-1.3979540>.
- Brown University (Producer), & Holdren, J. P. (Speaker). "Meeting the Climate Change Challenge" [video lecture]. February 23, 2018. [https://www.youtube.com/watch?v=u4I2\\_p\\_yWLw](https://www.youtube.com/watch?v=u4I2_p_yWLw).
- "Climate." NASA Content Administrator (ed). 2005. [https://www.nasa.gov/mission\\_pages/noaa-n/climate/climate\\_weather.html](https://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html).
- "Coal phase-out: the Powering Past Coal Alliance." Government of Canada. April 23, 2018. <https://www.canada.ca/en/services/environmentweatherclimatechange/canada-international-action/coal-phase-out.html>.
- Dearden, P., & Mitchell, B. *Environmental Change and Challenge*. 4th ed. 2012. Don Mills, Ontario: Oxford UP Canada.
- "Impacts of Climate change." Province Of British Columbia. 2018. <https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/Impacts>.
- Klein, N. *This Changes Everything*. 2015. Toronto, ON: Vintage Canada.
- Mcclearn, M. Rising seas and climate change: Everything you need to know." The Globe and Mail. March 14, 2018. <https://www.theglobeandmail.com/canada/article-sea-change-primer/>.
- Norwegian University of Science and Technology. "Unlocking the secrets of marine carbon cycling." 2013. <https://www.ntnu.edu/news/2013-news/ocean-certain>.
- TedEd (Producer), & Manning, N. (Speaker). "The Carbon Cycle." <https://ed.ted.com/lessons/the-carbon-cycle-nathaniel-manning>.
- United States Environmental Protection Agency. "What is Acid Rain." March 1, 2017. <https://www.epa.gov/acidrain/what-acid-rain>.
- World Government Summit. "Climate Change: A Threat Multiplier". WGS 2018. February 12, 2018. <https://www.youtube.com/watch?v=ozUzRhMEYY>.

# References

## Energy Conservation

Advantages and disadvantages of nuclear power.” Nuclear Energy. October 15, 2014. <https://nuclear-energy.net/advantages-and-disadvantages-of-nuclear-energy.html>.

Brown University (Producer), & Holdren, J. P. (Speaker). “Meeting the Climate Change Challenge” [video lecture]. February 23, 2018. [https://www.youtube.com/watch?v=u4I2\\_p\\_yWLw](https://www.youtube.com/watch?v=u4I2_p_yWLw).

Dearden, P., & Mitchell, B. *Environmental Change and Challenge*. 4th ed. 2012. Don Mills, Ontario: Oxford UP Canada.

“Geothermal 101.” Student Energy. May 17, 2015. <https://www.youtube.com/watchv=DFQrE9IkZwk> .

Hendry, Jim M., Wassenar, Leonard I., Barbour, s. Lee, et al. “Assessing the fate of explosives derived nitrate in mine waste rock dumps using the stable isotopes of oxygen and nitrogen.” *Science of The Total Environment*. Vol 640. p 127-137. May 30, 2018. <https://doi.org/10.1016/j.scitotenv.2018.05.275>

“Hydro Power 101.” Student Energy. May 17, 2015. <https://www.youtube.com/watchv=q8HmRLCgDAI> .

“In-situ Bitumen extraction.” Oil Sands Magazine, 2018. <http://www.oilsandsmagazine.com/technical/in-situ>.

Judd, Amy. “Facts About Coal Mining.” Global News. June 12, 2013. <https://globalnews.ca/news/628929/20-facts-about-coal-mining-in-b-c/>.

Natural Resources Canada, “Energy Fact Book 2016-2017.” [https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook\\_2016\\_17\\_En.pdf](https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf)

Rosei, Federico, & Rosei, Renzo. “Can 100% renewable energy power the world?” TedEd. December 7, 2017. <https://ed.ted.com/lessons/can-100-renewable-energy-power-the-world-federico-rosei-and-renzo-rosei>.

Seal, Thomas “The Ooze: a documentary on the Alberta Tar Sands.” October 2015, retrieved from <https://www.youtube.com/watch?v=-07sfg0m9io>.

## Forests

“B.C. year in review 2017: wildfires devastate the province like never before.” Global News. December 25, 2017. <https://globalnews.ca/news/3921710/b-c-year-in-review-2017-wildfires/>.

Dearden, P., & Mitchell, B. *Environmental Change and Challenge*. 4th ed. 2012. Don Mills, Ontario: Oxford UP Canada.

“Forestry Technician/Technologist.” Eco Canada. 2018. <http://www.eco.ca/career-profiles/forestry-technician-technologist/>

Little, Simon, & Yuzda, Liza. “2017 officially B.C.’s worst ever wildfire season.” Global News. August 16, 2017. <https://globalnews.ca/news/3675434/2017-officially-b-c-s-worst-ever-wildfire-season/>.

# References

- “Mountain Pine Beetle in B.C.” Province of British Columbia. 2018. <https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/bark-beetles/mountain-pine-beetle>
- “Old-growth forests 101.” Nature Conservancy Canada. 2018. [http://www.natureconservancy.ca/en/what-we-do/resource-centre/101s/old-growth\\_forests\\_101.html](http://www.natureconservancy.ca/en/what-we-do/resource-centre/101s/old-growth_forests_101.html).
- Olivotto, G. G. “Understanding Non-timber Forest Products Activity on the Land Base.” Ministry of Forests and Range Forest Science Program. 2009. <https://www.for.gov.bc.ca/hfd/pubs/docs/lmh/Lmh62.pdf>.

## Transportation and Air Quality

- “Air Pollutants & Sources.” Fraser Valley Regional District. 2018. <http://www.fvrd.ca/EN/main/services/AirQualityandClimate/AirQualityandClimate/air-pollutants-and-sources.html>.
- “Common Air Pollutants.” Province of British Columbia. 2018. <https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-pollution/pollutants/common#pm>
- Dearden, P., & Mitchell, B. *Environmental Change and Challenge*. 4th ed. 2012. Don Mills, Ontario: Oxford UP Canada.
- “What is Air Pollution?” Environmental Pollution Centers. 2017. <https://www.environmentalpollutioncenters.org/air/>.
- “Sources of Pollution: Transportation.” Government of Canada. 2017. <https://www.canada.ca/en/environment-climate-change/services/air-pollution/sources/transportation.html>.

## Waste

- “A Guide to Backyard Composting.” City of Abbotsford. <https://www.abbotsford.ca/Assets/2014+Abbotsford/Engineering/Garbage+Recycling+and+Compostables/A+Guide+to+Backyard+Composting.pdf> .
- Daly, Natasha. “For animals plastic is turning the ocean into a minefield.” National geographic. May 16, 2018. <http://www.nationalgeographic.com.au/nature/for-animals-plastic-is-turning-the-ocean-into-a-minefield.aspx> .
- Net Zero Waste .2018. <http://www.netzerowasteabbotsford.com/#home-2-1>.
- “Sustainability.” Environmental Reporting BC. May 2018. <http://www.env.gov.bc.ca/soe/indicators/sustainability/municipal-solid-waste.html>
- Weber, Bob. “Canada among heaviest food wasters on planet, report says.” Global News. April 3, 2018. <https://globalnews.ca/news/4121195/canada-food-waste-report/>.
- Wilkins, Charlie. “Canada’s Dirty Secret.” Canadian Geographic. November 4, 2017. <https://www.canadiangeographic.ca/article/canadas-dirty-secret>.

# References

Ruxton, J., & Leipzig, A. (Producers), & Leeson, C. (Director). (September 22 2016). *A Plastic Ocean* [motion picture]. United Kingdom: Plastic Oceans.

## Water

Abbotsford Mission Water and Sewer Services. "Our Water Matters." Rebate Programs. 2016. <https://www.ourwatermatters.ca/rebate-programs>.

Barlow, M. *Boiling Point: Government Neglect, Corporate Abuse, And Canada's Water Crisis*. 2016. Toronto, ON: ECW Press.

BC Hydro. "Our Resources." BC Hydro Power Smart. 2018. <https://www.bchydro.com/energy-in-bc/operations/our-facilities.html>.

Brooymans, H. *Water in Canada: A Resource in Crisis*. 2011. Edmonton, AB: Lone Pine Publishing.

Dearden, P., & Mitchell, B. *Environmental Change and Challenge*. 4th ed. 2012. Don Mills, Ontario: Oxford UP Canada.

"Groundwater." City of Abbotsford. 2018. <https://www.abbotsford.ca/community/environment/groundwater.htm>.

Leahy, S. *Your Water Footprint: The Shocking Facts About How Much Water We Use to Make Everyday Products*. 2014. Richmond Hill, ON: Firefly Books.

Ministry of Environment. "Tackling Non-Point Source Water Pollution in British Columbia: An Action Plan." Province of British Columbia. March 1999. [https://www.for.gov.bc.ca/hfd/library/ffip/BCMoeI1998\\_C.pdf](https://www.for.gov.bc.ca/hfd/library/ffip/BCMoeI1998_C.pdf).

Pentland, R., & Wood, C. *Down the Drain: How We Are Failing to Protect our Water Resources*. 2013. Vancouver, BC: Greystone Books.

"Water." District of Mission. 2016. <https://www.mission.ca/municipal-hall/departments/engineering/water/>.

## Species and Spaces

"Biomes & Protocol Descriptions." Province of British Columbia. 2018. <http://www.env.gov.bc.ca/bcparks/partnerships/Item/biomes.html>.

Cannings, Dick "Biodiversity in BC: An Overview". In Klinkenberg, Brian. (Editor) 2017. Biodiversity of British Columbia [www.biodiversity.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver.

Danson, T. *Oceana: Our Endangered Oceans and what We Can Do to Save Them*. 2011. New York, NY: Rodale Books.

# References

- Dearden, P., & Mitchell, B. *Environmental Change and Challenge*. 4th ed. 2012. Don Mills, Ontario: Oxford UP Canada.
- Environmental reporting BC. *Plants and Animals*.” Province of British Columbia. 2015. <http://www.env.gov.bc.ca/soe/indicators/plants-and-animals/invasive-species.html>.
- “Great Bear Rainforest and Haida Gwaii.” Coast Funds. 2018. <https://coastfunds.ca/great-bear-rainforest/>.
- Invasive Species Council of BC. “Yellow Hawkweeds.” *BCinvasives.ca*. 2017. [https://bcinvasives.ca/documents/Yellow\\_Hawkweeds\\_TIPS\\_2017\\_WEB.pdf](https://bcinvasives.ca/documents/Yellow_Hawkweeds_TIPS_2017_WEB.pdf).
- Invasive Species in the Pacific Northwest*. Boersma, P.D., & Reichard, S. H., & Van Buren, A. N. (Eds). 2006. Seattle, WA: university of Washington Press.
- “Japanese Beetle Pest Alert.” Province of British Columbia. 2018. <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/nursery-and-ornamentals/japanese-beetle>.
- Klein, N. *This Changes Everything*. 2015. Toronto, ON: Vintage Canada.
- Lymbery, P. *Dead Zone: Where The Wild Things Were*. 2017. New York, NY: Bloomsbury Publishing.
- Meener, M. (ed). “Keystone Species Report to British Columbia.” Pacific Salmon Foundation. 2011. [https://www.PSF\\_2011\\_AR\\_keystonespecies.pdf](https://www.PSF_2011_AR_keystonespecies.pdf).
- Mitchell, A. *Seasick: Ocean Change and the Extinction of Life on Earth*. 2009. Chicago, IL: University of Chicago Press.
- Pearson, M., & Healy, M. C. “Species at Risk a primer for British Columbia.” Stewardship Centre for BC. 2012. <http://www.speciesatriskbc.ca/>.
- Pearson, R, PhD. (*Driven to Extinction: The Impact of Climate Change on Biodiversity*. 2011. New York, NY: Sterling Publishing.
- Wong, R., & Mochizuki, C. *Perpetual*. 2015. Gibsons, BC: Nightwood Editions.

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**Environmental Mind Grind Coordinator**  
tel: 604.850.3551 ext. 106  
e-mail: [recycling.education@archway.ca](mailto:recycling.education@archway.ca)  
website: [abbotsfordmissionrecycling.ca](http://abbotsfordmissionrecycling.ca)