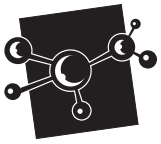
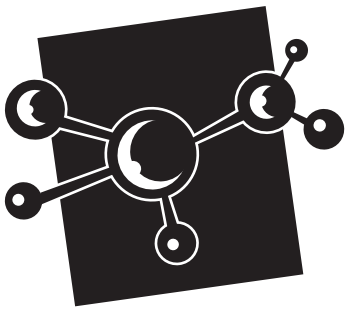
plantwatch

connections
and activity suggestions





Science

Plantwatch provides opportunities to explore science from elementary school to university levels. By integrating science activities (such as biology, ecology, weather and climate) with geography, mathematics, computer skills, language arts, social studies and fine arts, Plantwatch can form the basis for an integrated thematic study.

Relationships between the indicator plants, people, and wildlife (including herbivores and pollinators) are explored, as well as the plants' adaptations to cope with changes in light, water or temperature. As blooming occurs largely in response to heat, weather calculations can permit predictions of bloom timing. Shifts to earlier bloom in some areas have been noted, and tracking this spring timing can provide a focus for studies of climate change issues.

SCIENCE CONCEPT ONE: plants

Plantwatch is complementary to a number of elementary school science topics. The following concepts are expanded using some of the Plantwatch species as examples.

1. **Plants are important to humans**
   - Lilac is a beautiful garden shrub. Of all the horticultural woody plants, lilac has the most **cultivars**.
   - Aspen poplar bark was used as famine food by First Nations people and aspen leaves were used to relieve the itch of insect stings. Canoe paddles and teepee poles were commonly made from aspen wood.
   - Saskatoon berries were the most important plant food for the Blackfoot, a prairie First Nations people.
   - Saskatoon berries are now used both commercially and by individuals for pies, jams, syrups and wines.

2. **Plants are an important part of the natural environment**
   - Plants make oxygen. All green plants, when exposed to light, produce oxygen while consuming carbon dioxide in a process called **photosynthesis**. At night when the light is gone, they use oxygen to respire (see *Respiration* in glossary). However, plants produce a lot more oxygen than they consume, providing all living things on Earth with the oxygen they need to live.
   - Plants play an important role in preventing soil erosion. Plants such as prairie crocus, saskatoon, and purple saxifrage have deep roots to ensure that even in dry years they can find enough moisture. If a forest or grass fire sweeps through and kills the part of the plant above the ground, the roots push up new buds in prairie crocus or new **suckers** in saskatoon and aspen poplar. These roots do a good job of holding the soil together and absorbing water in times of heavy rain.

ALL WORDS HIGHLIGHTED IN BLUE CAN BE FOUND IN THE GLOSSARY (APPENDIX 1).

- **Pollination**

  Plant flowers are important to insects such as bees both as a source of **nectar** (sugar) and **pollen** (rich in protein and fat). In turn, the insects move pollen to different flowers. Watch bees and look for yellow or orange balls of pollen being carried on their legs. This **cross-pollination** is necessary in some plant species for seeds to develop. Pollination is an example of a way that plants and insects help each other.

  How are the Plantwatch species pollinated? Lilacs are often visited by swallowtail butterflies. Bees love dandelions. Small flies likely pollinate bunchberry (though tiny insects can even be damaged by the explosive pollination!). Wind moves the pollen on aspen and larch trees.

  Most flowers have male and female parts. In at least two of our Plantwatch species, prairie crocus and purple saxifrage, the female parts (**stigmas**) of the flowers are ready for action first. If the stigmas receive pollen from another flower (cross-pollination), the **stamens** (male parts) will still ripen and release pollen, which can fertilize another flower. However, if pollination by insects does not occur, the flower can fertilize itself.

  In poplars, the male trees can start to release pollen before many female trees' catkins are receptive or ready for pollination.

  In **self-fertilization**, no mixing of genes occurs. Therefore, self-fertilization results in less genetic variability in the population and a decreased ability to withstand more extreme conditions (less **hybrid vigour**). However, it does ensure continuation of a species when conditions are not favourable for cross-pollination.

3. Plants have special parts and adaptations that help them survive and thrive in certain habitats

- The Plantwatch species have unique characteristics that students can observe, identify and discuss. For example, you may wish to ask the students the following questions:

Why is the bark of aspen poplar green inside?

ANSWER: The thin layer of green tissue just under the bark allows the tree to convert light to food or sugar by the process of photosynthesis. Even before the leaves emerge, the tree can take advantage of spring warmth and light. To protect the bark from sun scald, the south-facing side of the tree often has a white powder on it that acts as a sunscreen.

Why is the prairie crocus so furry?

ANSWER: The hairs protect the plant from insects (e.g., caterpillars, beetles) and some larger herbivores (e.g. deer, elk) that might eat the plant. The hairs contain a stinging substance that can be irritating. However, perhaps because prairie crocus is one of the earliest appearing plants after the long winter, some animals (e.g. elk, ground squirrels) eat the crocus flower, ignoring the stinging hairs.

Hairs also provide a heat trap for rays of sunshine, and provide protection from moisture loss in the dry, spring winds. You could compare the prairie crocus to a camel-riding, nomadic person who travels the desert well wrapped in robes.

Why do prairie crocus and white dryad flowers turn to face the sun?

Answer: The prairie crocus blooms in the early spring, a cold time of year. White dryad blooms in mountains and the north where temperatures are low. The cup-shaped flowers are shaped like satellite dishes and act as solar collectors, concentrating the sun's warm rays on the

centre of the flower. Heat is necessary to help the flower parts develop (for example, for stamens to grow; for pollen grains to mature and be released) and for pollination to occur.

Inside a prairie crocus it is often 10°C warmer than outside, making it a cozy place for spring pollinators (e.g., bees, flies) to visit. Some insects spend cold nights and stormy days inside the flower, protected from the wind and predators.


KIRK HAROLD

Why do trilliums flower so early?

ANSWER: In eastern North America, trilliums grow early in the spring before maples, beech, and other leafy trees unfurl their leaves. In the West, trilliums grow beneath big-leaf maple and Douglas-fir. They take advantage of the bright, sunny spring to put on a spurt of growth, forming leaves and flowers. Once the leaf canopy above closes, the forest floor becomes very shady. The fully grown trilliums persist for a few months, ripening their fruits and storing nutrients for next year's growth.

Why do purple saxifrage and white dryad plants stay so small?

ANSWER: These plants rarely grow higher than 5 cm (2 in.) above the ground surface. Their small size allows them to hide from the cold, drying wind that is so common in arctic and mountain landscapes.

How does bearberry make the most of the sun?

ANSWER: Bearberry has small clear windows around the top of each hanging flower which function much like the panes of glass in a greenhouse. Sunshine enters the flower and strikes the dark purple reproductive organs. The purple pigments convert the light to heat and speed up the development of pollen and later, seeds.

4. Plants have essential requirements that need to be satisfied in order for them to grow and thrive

- **Plants need space**

  How close together do you find the individuals of aspen poplar, prairie crocus, saskatoon, bunchberry, trillium, etc.?

- **Each plant has a temperature range in which it grows best**

  Spring flowering perennials need a certain amount of heat to bloom.

  How does temperature seem to affect these plants? (Students could calculate the heat necessary to get their chosen plants to bloom using the growing degree summation exercise described in Mathematics Activity 1, Connections - Math, Page 3-27).

- **What are the local conditions (the habitats) where the plants are growing?**

  (e.g., flat/hilly, sandy/clay soil, open/wooded, sunny/shaded?)

- **Are the plants like others in the same area? How are they different?**

5. Plants use different techniques to make sure their seeds are moved to good growing sites

- Compare the seed dispersal of aspen poplar, dandelion, prairie crocus or white dryad (seeds travel on the wind) to that of saskatoons, bunchberry, bearberry, or trilliums (seeds are eaten/transported by birds, mammals or insects.)

6. Plants go through different growth stages. A complete sequence of growth stages is called a life cycle.

- Observe and describe (in words and/or drawings) the growth stages of a Plantwatch plant.

overview:

One of the fundamental principles of ecology is that everything is connected to everything else. Every plant, animal and person is connected to other living things and to other parts of the natural environment. As people, we depend upon the air we breathe, the water we drink, and the plants and animals that provide us with food. We use plants for building materials, medicines and a variety of other useful products. Our actions have an impact on the environment and other living things. We are a part of the "web of life."

SCIENCE activity one

ELISABETH BEAUBIEN

Plants and Ecology: All My Relations

explore/investigate

1. Create large web diagrams on the chalkboard to show some of the connections or relationships between the plants featured in Plantwatch and other organisms or parts of the natural environment. The teacher can encourage students to identify some connections and can provide additional examples using the following two Plantwatch species: prairie crocus and saskatoon. See page 3-6 for Background Information.
2. Have the students look for evidence of these connections or relationships when they visit their plants.
3. Have the students create drawings that illustrate some of the relationships that their Plantwatch plants have with other parts of the natural environment (e.g., the soil, air, water, sunlight, other plants, insects, birds, mammals).
4. Introduce students to local First Nations peoples' perspectives on nature and traditional uses of native plants. There are several useful background resources for teachers on this subject. You might share some short readings or, if possible, invite an elder to visit your class to talk about the relationships that First Nations peoples have with the land, plants and animals in your area.

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background information

Prairie Crocus

Relationships with Other Parts of the Web of Life

The prairie crocus is a member of the buttercup family along with other flowers like the Canada anemone or the prairie buttercup.

Bees and other insects **pollinate** the flowers of the prairie crocus.

Ground squirrels, deer, elk, pocket gophers and voles eat the flowers, roots and/or leaves of the prairie crocus.

The prairie crocus sometimes grows in large patches in pastures that have been overgrazed by cattle.

People often enjoy the blossoms of the prairie crocus as one of the first signs of spring. Some First Nations peoples used parts of the prairie crocus to stop bleeding or treat rheumatism.

The prairie crocus flower turns slowly to keep facing the sun as it moves across the sky. This movement helps the flower capture the most heat energy possible.

As moisture levels change, the seed of the prairie crocus twists and turns its way deeper into the soil, thus improving its chances of survival.

The prairie crocus blooms when the air temperature becomes warm in the spring.

Saskatoon

Relationships with Other Parts of the Web of Life

The saskatoon is a member of the rose family.

People often enjoy the fruit of this plant in jams, muffins and pies. Some First Nations peoples used the wood of this plant to make arrows, pipe stems and basket rims.

Mule deer often browse on the twigs of saskatoon bushes in the winter.

Saskatoon bushes often grow alongside clumps of aspen poplar trees.

Many birds and animals eat saskatoon berries and scatter the seeds in their droppings.

Saskatoon bushes provide protection for small animals like rabbits. The bushes provide places to hide from predators, as well as shade in summer and shelter from the wind in winter.

The saskatoon plant is pollinated by insects.

Saskatoons bloom when the air turns warm in the spring.

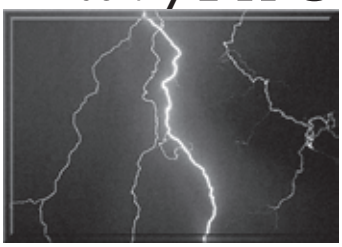
definition of Phenology

The study of the seasonal timing of life cycle events.

Phenology was common knowledge for First Nations peoples whose daily activities were closely tied to the natural rhythms of the land. When Samuel de Champlain landed at Cape Cod in 1605, he was told by the First Nations people he met that corn should be planted when the white oak leaves were the size of a red squirrel's footprint.

SKETCH BY LAURA FROST

SCIENCE
activity two



Weather

skills

Outdoor measurement of temperature and precipitation

materials

Thermometers (maximum/minimum is best type), compass to determine slope aspect (i.e. direction the slope faces), daily newspaper.

preparation

Review Mathematics Activity 1, *Growing Degree Summation* (Connections - Math, page 3-27)

Concepts and skills developed through the Plantwatch program:

explore/investigate

1. **Weather data measurement, recording and interpretation**

   Have students measure and record temperature, day length and precipitation in order to investigate how each of these conditions affects flowering times.

   Spring plants flower mainly in response to temperature. If a winter has been milder than average and the spring warm, then flowering will happen earlier than usual. The amount of precipitation does not seem to change the timing of the beginning of bloom, although the time between the start of flowering and full bloom tends to be shorter in drought periods. Day length becomes a more important factor after midsummer in determining when summer-flowering plants will bloom and fruits will ripen, as well as when leaves turn colour and fall to the ground. Day length also affects how much of the sun's warmth a plant is exposed to during the day.

   Time of sunrise and sunset, and daily high and low temperatures can be found in most newspapers. Use the verified temperature records given for the previous day, rather than

ALL WORDS HIGHLIGHTED IN BLUE CAN BE FOUND IN THE GLOSSARY (APPENDIX 1).

the predicted values for the current day.

Weather data submitted under *Comments* on the Plantwatch Data Form gives a research scientist additional valuable information about flowering conditions.

2. Predicting the timing of bloom in warmer and colder locations

Plantwatch scientists request that, if possible, observers report dates for plants growing in a relatively flat area. However, comparing the flowering times of one type of plant growing under different conditions can provide a concrete example of the effect of temperature on plant growth. For a **microclimate** study, the class could also tag individual plants of one species (e.g. saskatoon bushes) in a variety of locations. Locations could include the top of a hill, a valley bottom and slopes facing opposite directions such as north and south, or northwest and southeast.

Plants located in a warmer site should bloom earlier than the same species in a colder site. If maximum/minimum thermometers are available, install one in each location in the shade (e.g., on the north-facing side of a tree or shrub, about 1 m [3 ft.] above the ground) and take daily readings. If using standard thermometers, take temperatures in the early morning and in the late afternoon during the two weeks before blooming.

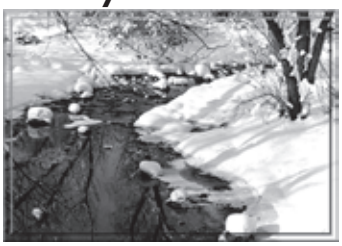
In what areas is the temperature the highest? The lowest? Where do you expect flowering will be earliest? In the northern hemisphere, the sun rises in the east, swings through the southern sky, and sets in the west. Therefore, south-facing slopes collect the most intense solar energy and should have the highest temperatures. North-facing slopes should be the coolest. But after the winter, you may notice in urban areas that east-facing, grassy slopes seem to green up first. They show earlier plant growth because they are the first areas to catch the warm morning sunshine after cold spring nights, and enjoy high temperatures for more hours than west-facing slopes. The flowering of plants at the base of valleys is often several days later than flowering on slopes or hilltops because cold air drains down the slopes at night and collects at the valley bottom.

3. Students can use their temperature data to calculate heat units *(see Mathematics Activity 1, page 3-27)*.

Growing degree summation (GDS) is very useful in agriculture to describe how much warmth (measured in heat units) a particular crop **variety** needs to develop. For example, two types of canola available for seeding on the prairies have different requirements. The Argentine variety needs 1040-1100 heat units to grow, and the Polish variety only needs 860-920 units. Knowing the current spring's progress in heat units can potentially assist a farmer in selecting the right variety of a crop for a certain location; in predicting planting dates for wheat, canola, barley and forage crops; in predicting the rate of water consumption of different crops; and in predicting the ripening times for crops. For instance, alfalfa needs 500 heat units before the first cut. In central Alberta this usually occurs the last week in June, but the timing varies depending on the weather conditions.

Because plant flowering is also in response to heat units, bloom dates could also be used for all the above predictions. How many heat units does it take for your observed plant to flower? (See Mathematics Activity 1 for calculations.)

SCIENCE activity three



Reading about Climate Change

Climate change is a reality!

Climate change will touch the lives of all Canadians. Changes in sea levels, storm patterns and average temperatures may drastically alter the environment that we live in and depend on. Decisions that are made today will have an impact on the communities of today and on future generations of Canadians. Every Canadian has a role to play to ensure that the planet is hospitable to life, and the time for action is now.

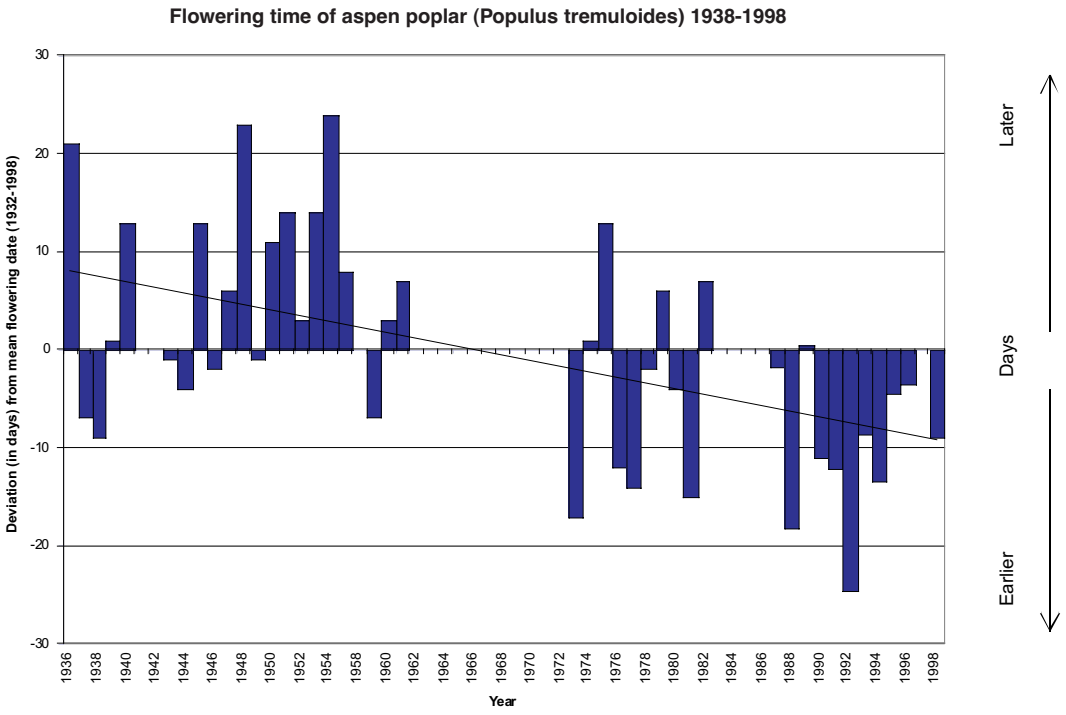
Effective action requires a drastic shift in North American attitudes and lifestyles. By taking action now we can create the momentum required to make such a shift possible. Early action is similar to an insurance policy that may protect us from negative effects in the future. The benefits of responding quickly include reduced pollution, increased air quality, a more efficient economy and job creation from the implementation of new technologies.

See the summary of the Declaration of the National Forum on Climate Change <www.nrtee-trnee.ca/climatechange/>.

Plantwatch and Climate Change

In the temperate parts of the world where there are strong seasonal changes, temperature is the main factor controlling the timing of spring development. Warmer temperatures in the winter and spring lead to earlier spring flowering and leafing of perennial plants. The plant phenology data for central Alberta shows a dramatic shift towards the earlier development and flowering of aspen poplar trees over the last 45 years by about 0.2 days per year. Overall, spring is occurring about a week earlier now than it was in the 1950s.

Fig. 1



Long term trend towards earlier first flowering of trembling aspen (*Populus tremuloides*) in the area of Edmonton, Alberta (1936-1998).

Figure 1 (based on data from Edmonton, Alberta) shows that the first bloom of aspen is now earlier than the average bloom date, shown on this graph as 0 on the y axis or the line running horizontally in the middle of the graph. The length of the bars indicates how many days earlier (towards the bottom) or later (towards the top) flowering has been in a given year. Recent analysis shows that aspen poplar bloom in Edmonton, Alberta now happens almost a month earlier than it did a century ago! (See Beaubien and Freeland 2002, Figure 3.)

Other phenology surveys also show trends to earlier flowering. To see more information on these trends to earliness, check out the global phenological monitoring network website at <http://www.student.wau.nl/~arnold/gpmn.html>.

Here is something that you and your students can do to help with the problem of climate change: join Plantwatch! Have your students track how plants are responding to the weather and climate. Their data would be a precious contribution to monitoring environmental change.

Here is some background on climate change.

What is Climate Change?

Over time the Earth has experienced much variation in climate. There have been extremely hot periods, when large areas of the planet were like deserts, as well as ice ages, when much of the globe was covered in large sheets of ice. When dinosaurs were in their prime (during the Jurassic) there was very little ice at the north and south poles, the oceans were much higher, and it was extremely hot. Less than 20,000 years ago, most of North America (probably including the area where your school is today) was covered in a large sheet of ice called the Laurentide Glacier. These different conditions are produced by natural cycles in the earth's climate. Scientists refer to these cycles in climate as climate change.

Today, many scientists believe that the planet's temperature is rising in response to increased human pollution of the atmosphere. Such an increase in temperature is called "global warming." Scientists believe that this pollution will cause an increase in the naturally occurring greenhouse effect (see below).

Predictions of global warming worry many people because of the effects rising temperatures may have on the natural environment. Not everyone agrees with these predictions though, as you can see from the following newspaper article.

Letter to the Editor

Facts contradict the claims global warming is happening

(Reprinted from the Edmonton Journal, November 26, 1998 [p. A21])

In a recent letter to the editor, an individual asked for proof that global warming is not occurring. Below are some facts that will contradict the environmentalists' claims. Most of the temperature increase occurred prior to 1940 and only 0.2˚C to the present of which only 0.05˚C may be attributed to humankind.

Temperatures have been decreasing in the lower troposphere since 1979 to 1997 according to both satellite and balloon temperature readings. Actual observations show there has been an average decrease of 0.04˚C.

This contradicts the IPCC computer models' predictions of increasing temperatures. Computer models cannot take into account the many variables that can occur in our atmosphere such as El Niño, La Niña, volcanic activity, solar activity and water vapour.

Temperature readings in rural areas have actually decreased or been about the same since 1940, while urban center temperatures have risen due to the high concentrated use of concrete and asphalt thus creating urban heat islands.

This has been proven by studies in the U.S., Australia and South Africa. This is only the very basic of facts, but science is contradicting environmentalists' claims.

Coal Committee, USWA Local 9113
Tumbler Ridge, B.C.

(Note: IPCC means Intergovernmental Panel on Climate Change)

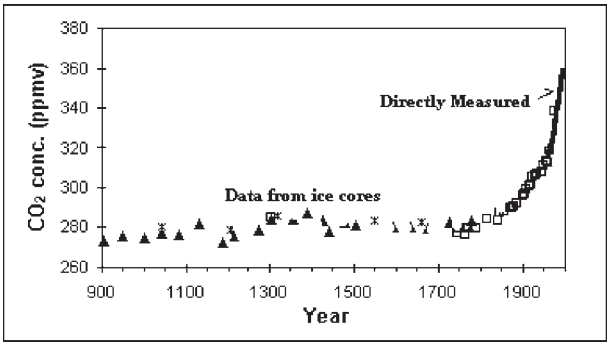
What is the Greenhouse Effect?

The greenhouse effect is a naturally occurring process that regulates the Earth's temperature. The Earth is warmed by light energy that comes from the sun. When the energy in the sun's rays reaches the planet, some of it is reflected away from the ground. As this energy (heat) travels back towards space it is absorbed by gases in the atmosphere and by clouds. This absorption keeps the planet at an average temperature of around 15˚C (60˚F). If this energy was all reflected back into space, the planet would be about 30˚C (86˚F) colder, and life would be impossible.

Greenhouse gases (gases in the Earth's atmosphere that absorb heat) such as water vapour, carbon dioxide, methane, ozone, chlorofluorocarbons (CFCs) and nitrous oxide, act something like the insulation in a house. By absorbing the sun's reflected energy as heat, they keep the planet at a temperature that allows plants to grow.

As you have probably heard, we have been increasing the amount of greenhouse gases in our atmosphere for about 150 years. For example, burning fossil fuels (in cars, home furnaces, coal-fired electrical plants and factories) releases carbon dioxide into the atmosphere. As you can see from the accompanying graph (Figure 2), the amount of carbon dioxide in the atmosphere has increased substantially, especially in the last 50 years. You can also see that from the year 900 to about 1750 the amount of carbon dioxide in the

Fig. 2. Amount of Carbon Dioxide in the Atmosphere from 900 to 2000

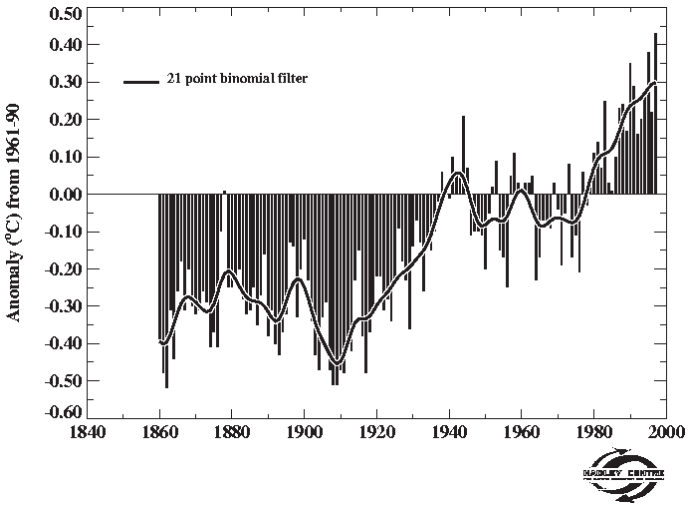


atmosphere did not change very much. (Scientists measure the amount of carbon dioxide in the past atmosphere by examining the amount of carbon dioxide in dated layers of glacier ice cores. More recently, atmospheric carbon dioxide levels have been measured directly.)

Refrigerators and spray cans both increase the amount of CFCs in the atmosphere. Methane, much of which comes from decomposing garbage, is also rising in concentration. Many scientists believe that the increase in these greenhouse gases will magnify the amount of heat from the sun trapped by the atmosphere. This additional heat may affect the climate by raising the Earth's temperature and, thereby, changing the planet's weather patterns.

The graph below (Figure 3) shows just how dramatic the warming of the Earth has been in the last 150 years. The y-axis (vertical axis) shows how different the annual temperatures (measured in °C) have been from the current meteorological "normal" (average global temperature for the period of 30 years–1961-1990). This average temperature is plotted as zero (0.00) on the y-axis. The x-axis (horizontal axis) shows the years in which the planet's global temperature was measured.

Fig. 3. Combined global land, air and sea surface temperatures, 1860-1997 (relative to 1961-1990 average)



I Thought That Scientists Didn't Agree about Global Warming

The concept that naturally-occurring greenhouse gases such as water vapour and carbon dioxide cause a warming of the Earth's atmosphere is over 100 years old. There is agreement among scientists that this process is what keeps the earth within the temperature range required for life. However, the more recent idea that increased concentrations of greenhouse gases will accelerate this natural global warming is not universally accepted. There are a few scientists who argue that there is currently not enough evidence to support this idea. Many of these people also maintain that we do not presently know enough to act to reduce production of greenhouse gases. Industrial lobby groups and some media have greatly emphasized this skepticism, often citing it as evidence that the scientific community is divided on the issue of accelerated global warming and, consequently, that scientists do not know enough to direct policy.

What the media and industrial lobbyists often fail to mention is that the root of this controversy centres not around whether climate change is occurring, but rather around the impact that climate change will have on the environment, and the rate at which the changes will occur.

Contrary to the picture the media often paints of a divided scientific community, most scientists agree that climate change is a reality. Furthermore, a large body of scientific evidence is showing us that the dangers associated with climate change are very real. Most scientists agree that increased concentrations of greenhouse gases will cause a warming of the earth's atmosphere. This idea is supported by studies of past climates that indicate that naturally occurring greenhouse gases were at low concentrations during glacial periods and high concentrations during interglacial periods.

Many of the climate models that scientists use to predict how quickly warming will occur and how hot it will get are still quite simplistic. The models cannot accurately predict exactly how

quickly climate will change and how these changes will affect local and regional climates. However, this uncertainty does not affect the evidence that global warming is a reality.

Some people argue that, because scientists do not agree on how quickly the planet will warm up or on what the exact nature of the consequences will be, we cannot act now. Not taking action is comparable to a bank manager, knowing that her bank will be robbed, refusing to take any action because she has no idea how much money the robbers will take or exactly how negative the heist will be for the bank.

We must take action on global warming now to protect our planet, its occupants and its resources.

The Local Effects of Global Warming

The consequences of a rise in global temperature will not be known at a local or regional level until the change actually occurs. However, there is scientific evidence that shows the overall consequences of global warming will include the following: rising sea levels (which will cause catastrophic flooding and land loss), an increase in summer convective storms (such as tornadoes, thunderstorms and hailstorms) caused by warmer surface temperatures, more summer rain but with longer dry periods in between, and fewer winter storms overall but an increase in the number of severe winter storms.

The Consequences of Global Warming

If the average temperature of the planet increases by even a few degrees there will be many far-reaching and, in many instances, unpredictable consequences. These changes can be expected to affect all forms of life on Earth.

One possible effect of climate change is an increase in the intensity of severe weather conditions, including heat waves and droughts. Rising sea levels caused by melting of the large sheets of ice at the north and south poles could threaten coastal cities and settlements all over the world. One of the most frightening possibilities is that global warming will be so rapid that many plant and animal species will not be able to adjust quickly enough to survive.

So . . . Has It Been Warmer Lately?

When they hear about global warming, many people wonder if a long-term warming trend will affect the weather they will know in their lifetime. Although there is a great deal of year-to-year variation, recently, the weather has been hotter than usual. The average surface temperature of the earth in 1998 was the highest ever recorded, almost 0.5°C higher than the average temperature between 1961 and 1990. According to the Canadian Institute for Climate Studies, the temperature changes in the last century are four times greater than in the previous four centuries. Furthermore, 1998 was the twentieth year in a row in which the average temperature has been higher than the 1961-1990 average.

Here is a summary of an article previously available on the Internet at <http://go2.guardian.co.uk/science/912000568-disast.html:>

Global Warming and Dr. Strangelove

In the movie *Dr. Strangelove,* Russia builds a Doomsday device that will destroy all the life on earth if Russia is attacked with nuclear weapons. A deranged army commander in the United States decides that he should bomb the Russians, thereby activating the doomsday machine, which, as predicted, does destroy all life on earth. This movie does not have a happy ending!

In December 1998, at a meeting in Paris, France, scientists tried to decide if Mother Nature has built a doomsday machine, like Dr. Strangelove's, that will be activated by global warming. These scientists are worried that the increased temperatures caused by global warming will start many events, which will in turn accelerate global warming. Chain reactions, where one event increases a second event, which acts to intensify the first event and ultimately the whole process, are referred to as positive feedback mechanisms. Scientists are concerned that higher global temperatures will melt permafrost (areas of the ground that are frozen year-round) in northern regions and release the methane gas that is trapped within. Because methane is a greenhouse gas, an increase in the amount of methane in the atmosphere will magnify the greenhouse effect, raise temperatures and speed

up the melting of permafrost in the north. Scientists also fear that higher atmospheric temperatures will increase the temperature of the oceans and result in large quantities of methane gas presently trapped beneath the surface being released. Scientists are also concerned about a change in the circulation of the Gulf Stream, a decline in the health of tropical forests and the destruction of the West Antarctic ice sheet.

When these problems are considered together, they are not very different from Dr. Strangeglove's doomsday machine. All of the factors that speed up global warming, as discussed in Paris, make it a lot like a bomb that could explode suddenly.

Conclusion

As you can see, the current warming trend we are experiencing has some very frightening implications for the future of life on earth. Although there are varying opinions about the exact effects of this warming, it is clear that the current warming is real and that it will have some negative effects on us all. Climate change is a reality, despite the claims that climate change is a myth, perpetuated by a small number of scientists. The action that is taken today will have a profound impact on the climate of the future, and acting now is the only way to begin to slow climate change. Plantwatch (in addition to activities that can be found at many of the following websites), is an excellent way to contribute valuable data to monitor the effects of climate change.

Websites

Environment Canada
The CO_2 Calculator
www.ns.ec.gc.ca/co2/worksheet.html
Students answer simple questions about their use of fuels, electricity and cars to calculate how much CO_2 they help to produce every year.

The Green Line Climate Change Page
www.ec.gc.ca/climate/primer/main_e.htm
This address gives you Environment Canada's web page on climate change – a great site for background on climate change, and news about global warming.

Government of Canada
Climate Change Site
http://climatechange.gc.ca
This site contains information on climate change activities, programs, resources and events.

National Round Table on the Environment and the Economy
www.nrtee-trnee.ca/climatechange/
National Forum on Climate Change

Natural Resources Canada
www.nrcan.gc.ca/geos/Vol1_2/content.htm
A special issue of *Geos* is devoted to climate change. *Geos* is Natural Resources Canada's quarterly Internet publication devoted to understanding the earth's resources.

The Pembina Institute.
www.pembina.org
In addition to a page filled with climate protection solutions and practical information on how to reduce greenhouse gas emissions, this site contains information on how to obtain the Pembina Institute's climate change teaching resource package. This amazing package contains 14 student activities on climate change in both French and English.

Sierra Club
Protecting Canada's Climate
www.sierraclub.ca/national/climate/climprot.html
This web page contains a wealth of information on simple changes that all Canadians can make at home, school, work and in their community to help to protect Canada's climate.

World Wildlife Fund
Climate Change Site
www.panda.org/climate/climate.htm
Climate change issues around the world are discussed on this site.