NATURE

NATURE

Weather and climate shape the physical environment. As a result, changes in climate should be clearly reflected in changes to our seas, lakes, rivers, and lands.

Changes in climate also affect plants and animals. However, the effects on Canada's forests, on freshwater fish habitat, or on the spread of natural pests, for example, are harder to interpret because living things vary in their ability to adapt to different climates. They may be affected by other stresses as well, such as habitat loss or pollution.

The six indicators selected for this section focus on physical features and living things that have shown a very clear sensitivity to changes in climate. They are:

- Sea Level Rise
- Sea Ice
- River and Lake Ice
- Glaciers
- Polar Bears
- Plant Development

Rising sea levels are making Canadian coasts more vulnerable to flooding and erosion.

Rising sea levels threaten familiar shoreline environments. Coastal wetlands, which are important ecosystems and barriers against shoreline erosion, gradually disappear. Bluffs and beaches are more exposed to erosion by waves, groundwater is more likely to become contaminated by salt water, and low-lying coastal areas may be permanently lost. In addition, wharves, buildings, roads, and other valuable seaside property face a greater risk of damage as a result of flooding from storms.

Although global sea levels have been rising since the last ice age, a changing climate is causing them to rise faster. That's mainly because a warmer climate causes sea water to expand as it warms, but water from melting glaciers and polar ice caps is also contributing to the rise. Over the past century, these factors have raised the average level of the world's oceans by between 10 and 20 cm.

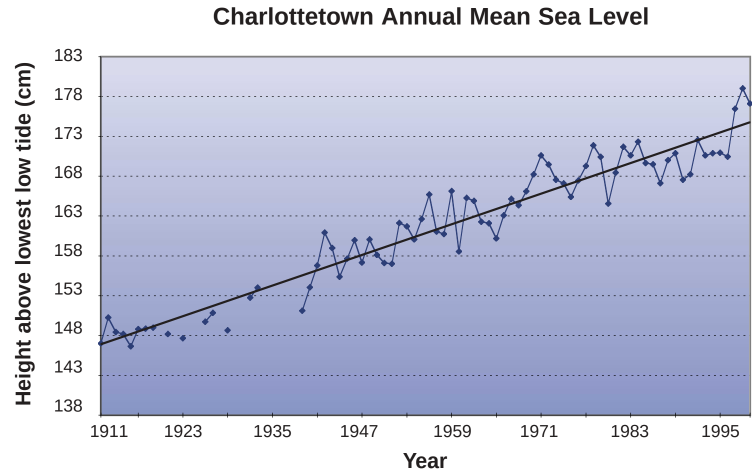
Local movements of the land as it adjusts to post–ice age changes can affect sea level too. Along coasts where the Earth's crust is rising, sea levels will increase more slowly or may even fall. Where the Earth's crust is sinking, sea level rise will be greater. As a result, changes in sea level can vary considerably from place to place.

FOCUS: Charlottetown, P.E.I.

Charlottetown is seriously threatened by rising sea levels. Much of its historic core lies just a few metres above the sea, and over the past century the city's average sea level has risen by nearly 30 cm. About 20 cm of that increase is probably the result of local sinking of the land after the last ice age. The rest can be linked to global sea level changes resulting from a warmer climate.

Charlottetown is not about to disappear permanently under the ocean, but higher sea levels are increasing its exposure to severe flooding from storm surges. Storm surges are caused by low air pressure and onshore winds and can temporarily raise the local water level a metre or more above normal. When a large storm surge occurs at the same time as very high tides, extensive flooding occurs.

Between 1911 and 2001, seven storm surge events were large enough to flood the Charlottetown waterfront. But as the sea continues to rise, increasingly smaller storm surges will cause flooding, and large storm surges will reach further inland if the land is not protected. If the sea had been at its present level throughout the twentieth century, storm surges would have flooded the city's waterfront on two more occasions.



Source: *Adapted from Parkes et al., 2002*

The annual sea level at Charlottetown between 1911 and 1998 is shown here in centimetres above the lowest expected low tide level. As well as contributing to long-term increases in sea level, climate also contributes to seasonal and year-to-year variations.

THE BIGGER PICTURE

With the longest coastline in the world, Canada is threatened on several fronts by rising sea levels. However, the possible impacts vary considerably from one place to another. In Atlantic Canada, coastal areas face the possibility of more frequent storm-induced flooding and greater rates of erosion. In Quebec, there is a growing risk that seaside roads along the North Shore of the Gulf of St. Lawrence, on the Gaspé Peninsula, and on the Îles-de-la-Madeleine will be damaged by coastal erosion and landslides.

Another highly vulnerable area is the Beaufort Sea coast – one of the few parts of the Arctic where sea levels appear to be rising. Coastal erosion there is made worse by the melting of sea and ground ice and is already causing the loss of town waterfront and structures in places such as Tuktoyaktuk.

In B.C. much of the coast is too steep and rocky to be seriously affected by sea level rise. Nevertheless, Prince Rupert, the highly urbanized Fraser Delta, and many low-lying areas of ecological and archaeological interest on Vancouver Island, the Queen Charlottes, and the Gulf Islands face a growing risk of flooding and erosion as a result of higher sea levels.

Source: *Natural Resources Canada*

Sea levels on both the Atlantic and Pacific coasts are rising but they are falling along much of the Arctic coast. The possible impacts of sea level rise depend not only on the rate of increase but on the coastline's sensitivity to higher sea levels. Sensitivity is determined by such factors as the height of the shoreline, its resistance to erosion, and the force of incoming waves.

THE GREAT STORM SURGE OF JANUARY 21, 2000

The storm rolled in from the Carolinas, walloping Atlantic Canada with up to 54 cm of snow and a 1.4-metre storm surge that reached parts of the Canadian coast just as unusually high tides were nearing their peak. The maximum water level exceeded the previous record by almost 40 cm in Charlottetown and even more along parts of the New Brunswick coast. As the storm passed through, massive chunks of ice piled up against the shore and the sea rushed in, flooding streets and buildings.

In Charlottetown, ice damaged wharves and knocked a lighthouse off its foundations. Much of the downtown core was flooded, power supplies were threatened, and city workers made makeshift dikes out of snow to hold back the incoming water. At the city's largest hotel, floodwaters came within metres of the underground parking garage.

Buildings were flooded and several people had to be evacuated from homes in seaside communities around P.E.I. and across the Northumberland Strait in New Brunswick and Nova Scotia. In Shediac, New Brunswick, boats and a backhoe were pressed into service to rescue stranded residents. At Malagash Point, Nova Scotia, two cottages were lifted off their foundations and carried several hundred metres down the beach. The storm also brought severe damage to the island of Newfoundland. High waves battered homes in Port aux Basques, while in Lamaline, on the Burin Peninsula, several houses were flooded and a breakwater was destroyed. Residents described it as the worst flooding to hit the village since the tidal wave of 1929. Miraculously, no lives were lost, but the storm left millions of dollars of damage in its wake.

> ***"The sea ice, which is like land to us Inuit, has started to change…"***

Sea ice is essential to the survival of many Arctic animals, and people in northern communities depend on it for hunting and fishing. It protects sensitive coastlines from wave erosion, and it influences local air and water temperatures and the changing of the seasons. It is also a danger to offshore oil rigs and an obstacle and hazard to shipping. Sea ice occurs along more than 90% of Canada's coastline. Only the Pacific coast is ice-free all year.

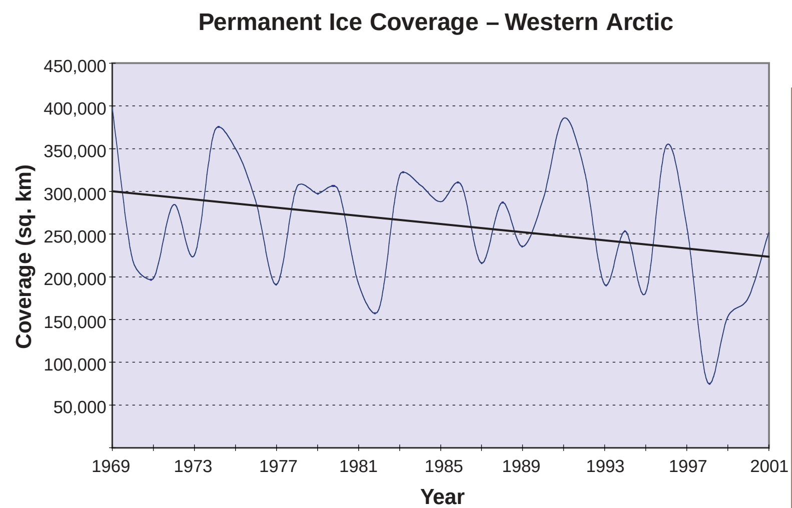
Canadian Arctic waters are almost completely ice covered in winter, but the ice normally begins to melt in July and doesn't refreeze until October. Some more southerly areas, like Hudson Bay and the Beaufort coast, become almost completely ice free in August and September. Other areas retain some or even quite a bit of ice cover throughout the year.

Sea ice is affected not only by air temperature but also by wind, snow cover, sunshine, the temperature and saltiness of the sea, and ocean currents. Changes in any of these factors can cause large year-to-year variations in the extent and thickness of sea ice and in the length of the ice season. Over the longer term, though, changes in air temperature are one of the most important influences on the amount of sea ice.

FOCUS: The Western Arctic

The western Arctic warmed considerably during the latter half of the twentieth century. It is therefore an area where we might expect to see a decrease in the amount of sea ice as a result of more melting in summer. That, in fact, appears to be happening. Over the past three decades, the area covered by sea ice throughout the year has shrunk by an average of about 80,000 square kilometres. That's an area slightly larger than New Brunswick and about a quarter of the area covered at the end of the 1960s.

The ice may also be getting thinner, but estimates of how much thinner are difficult to obtain. American scientists, using data collected by submarines, concluded that the average ice thickness in the Beaufort Sea at the end of September had decreased by about 45% between 1958–1976 and 1993–1997. Those results, however, were based on only a small number of submarine tracks. A more recent Canadian Ice Service study suggests that the ice may have thinned by only a quarter of that amount. Ongoing research suggests that the answer may lie somewhere between these estimates.



Source: *Environment Canada*

Permanent sea ice is ice that doesn't melt in the summer but remains throughout the year. In the western Arctic, the area covered by permanent sea ice has decreased by about 25% since 1969. Because these records cover only a few decades, however, we can't be completely sure whether this trend is the result of natural variations in the Arctic climate or longer-term climate change.

An ice road crosses the frozen Beaufort Sea.

THE BIGGER PICTURE

Sea ice coverage has decreased in the eastern Arctic as well and at about the same rate as in the west. In Hudson Bay, the ice-free season is now more than a week longer than it was 30 years ago. Along the Atlantic coast and in the Gulf of St. Lawrence, however, no clear trend has developed. In 2002, ice coverage in the Gulf hit its lowest level in more than 30 years, but ice accumulations in the area have varied considerably from one decade to another.

Changes in Arctic sea ice are now making it harder for some polar bear and seal populations to survive. For many Northerners, travel over the ice has also become more dangerous and less reliable, and hunting on the ice has become more difficult. In addition, sensitive coastal areas along the Beaufort coast and in the Gulf of St. Lawrence face a higher risk of erosion as longer ice-free periods increase the exposure of shorelines to high waves from storms.

In the Arctic, the season open to shipping is becoming longer, promising easier access to northern resources and renewing interest in trans-Arctic shipping routes. As other nations become more interested in these routes, however, Canada's sovereignty over its Arctic waters may be challenged.

Less sea ice can also mean more climate change. Ice, like snow, reflects much of the sun's energy back to space. When less ice covers the oceans, more of the sun's energy is able to warm the Earth's surface and temperatures rise higher and faster, particularly in polar regions in the spring.

Seal pups are born on the ice and must stay there until they can swim. In early 2002, many harp seal pups were lost in the Gulf of St. Lawrence when a mild winter resulted in a lack of sea ice.

SEA ICE AND THE INUIT

The Inuit, who rely on the ice for hunting and fishing, have an extensive knowledge of past and present ice conditions. The changes reported by the Inuit observers below not only provide further evidence of sea ice loss but also show how Inuit life is being affected.

"We used to go on the sea ice with dog sleds to hunt seals – now we have to use boats....We used to go a long way out – now we hunt close to shore."

Andy Carpenter (Sachs Harbour, Northwest Territories)
Sea Ice Variability and Climate Change Workshop, University of Winnipeg, 2002

"The sea ice, which is like land to us Inuit, has started to change its characteristics. The sea ice now shears off, and once it starts to melt there is no stopping it."

Larry Audlaluk (Grise Fiord, Nunavut)
Elders' Conference on Climate Change, Cambridge Bay, 2001

"Thin ice is now the norm in Frobisher Bay....Even in what we used to call early spring, the sea ice is now precarious and downright unnavigable by snowmobile in some areas."

Pauloosie Kilabuk (Iqaluit, Nunavut)
Elders' Conference on Climate Change, Cambridge Bay, 2001

"Now, even before the end of May, the sea ice has broken away. We have had a few cases where Inuit had to be rescued by boat, as a whole coastline had become ice-free. We may no longer be able to harvest seals or polar bears."

Zach Novalinga (Sanikiluarq, Nunavut)
Elders' Conference on Climate Change, Cambridge Bay, 2001

Freeze-up and breakup times are changing, and northern communities are worried about the consequences.

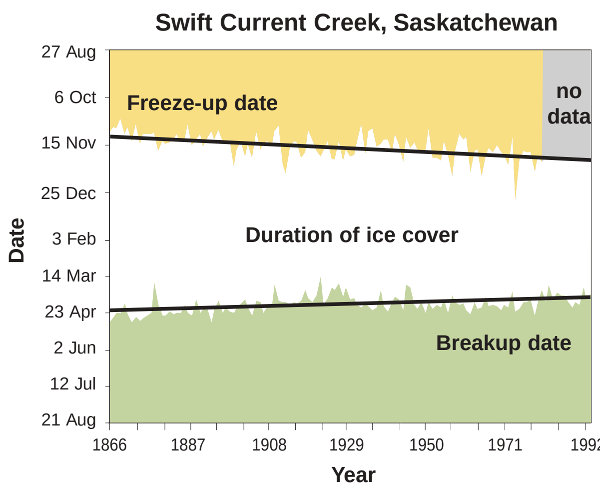
The formation and breakup of ice on rivers and lakes marks not only the changing of the seasons but also a change in the way that water can be used for travel, fishing, and recreation. It has important consequences for fish and other aquatic life too, because ice blocks the transfer of oxygen from the air to the water. In addition, changes in the duration of ice cover can affect the food supply for aquatic life, while changes in freeze-up and breakup times can cause birds to change their migration patterns. Spring breakup on rivers also brings a risk of floods caused by ice jams and damage to bridges and other structures from floating ice and debris.

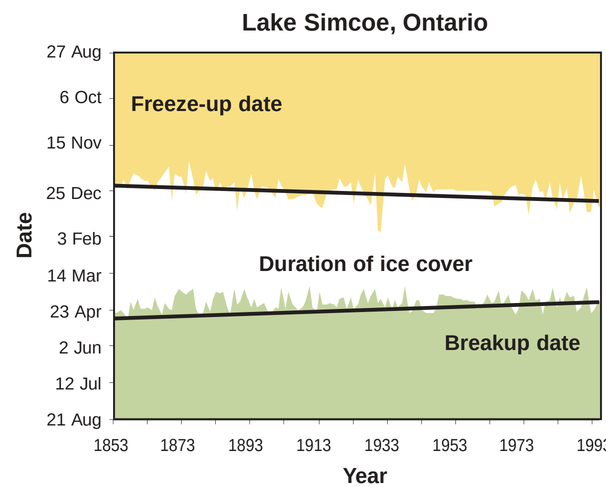
The timing of freeze-up and breakup depends on a number of things, including precipitation, wind, sunshine, and various features of the water body itself, such as its size and the characteristics of its currents. Spring breakup times are more variable because they are also influenced by the amount of snow cover and the coldness of the preceding winter. Air temperature, however, is particularly important for both freeze-up and breakup, and changes in the timing of these events provide a good reflection of trends in fall and spring temperatures.

FOCUS: Saskatchewan and Ontario

Over the years, many people other than scientists have kept surprisingly good records of freeze-up and breakup dates. Where such records are available, freeze-up and breakup times can sometimes be traced back a century or more. In the case of the two locations shown here – Swift Current Creek in southwestern Saskatchewan and Lake Simcoe in south-central Ontario – the records date from the 1860s and 1850s respectively. They show that the average freeze-up date for Lake Simcoe is now about 13 days later than it was 140 years ago, and the average breakup date is about 4 days earlier. For Swift Current Creek, over a period of about 115 years, the change is more dramatic. Freeze-up is now about 24 days later and breakup about 14 days earlier.

These results are what might be expected from the temperature record of the past century, which shows more warming in southern Saskatchewan than in southern Ontario.





Source: *M. Futter/Ecological Monitoring and Assessment Network*

Over the past century and a half, Swift Current Creek and Lake Simcoe have been freezing later in the fall and breaking up earlier in the spring.

THE BIGGER PICTURE

An international team of scientists recently used various historical records to compile freeze-up and breakup dates for 39 rivers and lakes in Europe, Asia, and North America. They found that over the past 150 years, these lakes and rivers were freezing later in the fall and breaking up earlier in the spring. They concluded that across the Northern Hemisphere freeze-up is now occurring an average of 5.8 days later than it did a century ago, while breakup is happening 6.5 days earlier. In Canada the few rivers and lakes for which we have long historical records – like Swift Current Creek and Lake Simcoe – tend to fit the pattern of later freeze-up and earlier breakup.

Our most extensive and reliable source of scientific data for Canada, however, covers only the past 30 to 50 years and reveals a more complex pattern. It shows breakup starting earlier in the spring almost everywhere in the country except in the Atlantic region – but it also shows a widespread tendency towards earlier freeze-up dates in the fall. The net result is that there has been an increase during this period in the amount of time that most Canadian rivers and lakes remain ice-covered. The largest increase – more than a month – has been in Atlantic Canada.

These results match up well with the way that temperatures have changed in different seasons and different parts of the country over the past half century. Although they differ from the longer-term results, they don't contradict them. They merely reflect the fact that different patterns may show up when climate is viewed over shorter and longer periods.

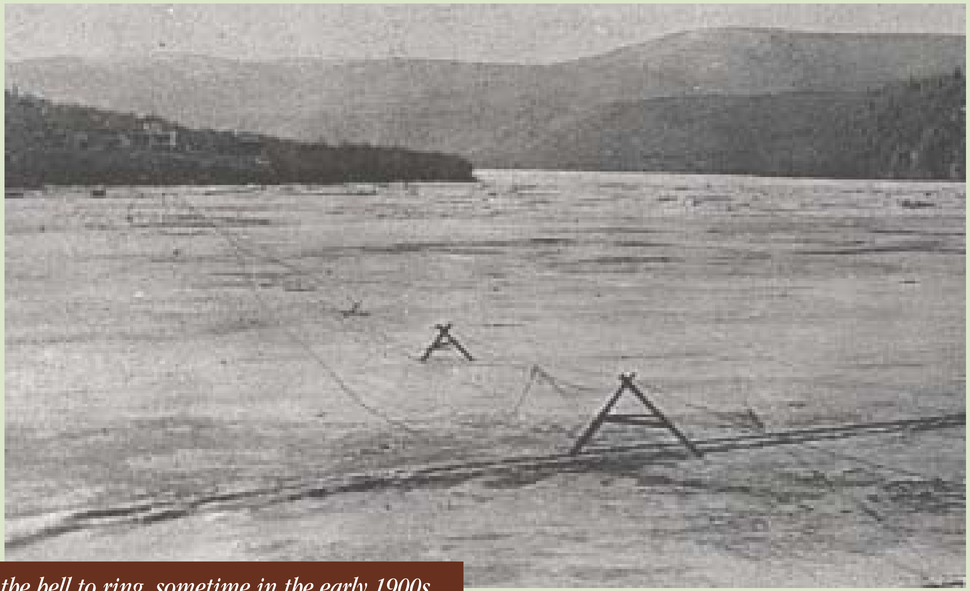
As a result of a recent string of warm years, there has been increasing concern about the difficulties that a shorter or more unpredictable ice season might bring to isolated northern settlements. Frozen lakes and rivers are essential to winter travel in the North. Hunters and trappers depend on them. So do whole communities whose supplies are trucked in from the south on winter roads that are built in part over frozen rivers, lakes, and bogs.

Manitoba, for example, builds about 2400 km of these roads every winter, and more than 25,000 people in 29 settlements rely on them. In 1997–1998, when the winter road season was unusually short, the provincial government had to supply these communities by air. The additional costs reached $14 million, or about three times the cost of building the winter road system. During the winter of 2001–2002 a number of the roads did not open until February, and one did not open at all.

BETS AND BELLS ON THE YUKON – SPRING BREAKUP AT DAWSON CITY

Thanks to the gambling instincts of a few prospectors, breakup records for the Yukon River at Dawson City go back to 1896. That spring, after betting on the exact minute when the breakup would start, the men set a series of wooden tripods across the middle of the river, ran a cord from them to a bell on the shore, and waited for it to signal the first shifting of the ice.

The bell has been set up every year since. It has rung as early as April 9 and as late as May 28. For most of the twentieth century, breakup was a May event, but since the mid-1980s April breakup dates have been more common. The average spring breakup date now arrives about 6 days earlier than it did a century ago.



Waiting for the bell to ring, sometime in the early 1900s.

Glacier shrinkage is changing the landscape and threatening water supplies.

Glaciers are powerful tourist attractions, but they are also a significant source of water for many rivers and streams. They therefore have a great influence on stream flow and the things that depend on it, such as power generation, irrigation, municipal water supplies, fish and other forms of aquatic life, and recreation.

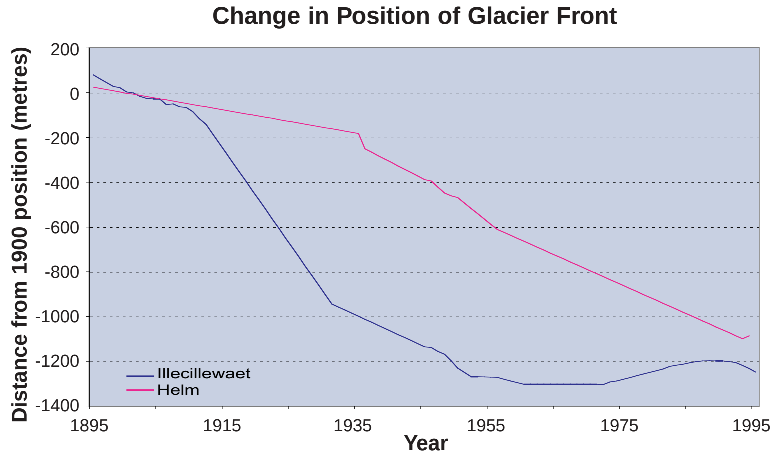
The total size of a glacier is closely linked to two climate-related phenomena: the amount of snow that falls on it in the winter and the amount of snow and ice lost to melting in the summer. Growth or shrinkage of the glacier eventually causes its front to advance or retreat, although the position of individual glacier fronts can change at different rates because of differences in the glaciers' elevation, length, speed of movement, and other factors.

Warmer temperatures increase the rate at which a glacier melts, and so does more rainfall. More snowfall, on the other hand, adds to a glacier's growth. In most areas, however, warmer temperatures are having a greater effect on glacier size than changes in either rain or snow.

FOCUS: British Columbia

Most of the glaciers and icefields in British Columbia have lost substantial amounts of ice over the twentieth century. The indicator presented here records what is happening to two mountain glaciers in different parts of southern B.C. – the Helm Glacier in Garibaldi Provincial Park north of Vancouver and the Illecillewaet Glacier in Glacier National Park near the Alberta border.

As the graph shows, both glaciers shrank by more than a kilometre between 1895 and 1995, although they have done so at different rates. The Helm Glacier has shrunk fairly steadily, but the Illecillewaet Glacier has changed more erratically, shrinking rapidly in the early part of the last century but then advancing in the 1970s and 1980s before staring to shrink again. The temporary growth was probably a result of a period of increased snowfall at higher elevations that offset the melting at lower levels.



Source: *Adapted from B.C. Ministry of Water, Land and Air Protection, 2002*

The graph plots the distance in metres between the positions of the glacier fronts in 1900 and their positions in other years. The minus values indicate that the glacier front has shrunk from its position in 1900.

Illecillewaet Glacier, 1999

THE BIGGER PICTURE

Since 1950, the greatest warming in Canada has occurred in the west and the northwest. Most glaciers in these regions are also shrinking rapidly. The 1300 or so glaciers on the eastern slopes of the Rockies, for example, are now about 25% to 75% smaller than they were in 1850. The area of warming also covers many of the High Arctic islands in Nunavut, where glaciers such as the Melville Island South Ice Cap have been shrinking gradually since at least the late 1950s. In eastern Nunavut, however, the situation is more complex: some glaciers are shrinking, while others are growing.

The melting of glaciers is a concern for Alberta, Saskatchewan, and Manitoba. Farmers depend on glacier-fed rivers like the Saskatchewan and the Bow for irrigation water, and cities like Edmonton, Calgary, and Saskatoon rely on them for municipal water supplies and recreation. At The Pas in Manitoba, reduced flows on the Saskatchewan could interfere with the native fishery and hydroelectric power generation.

Although the early stages of glacier shrinkage from melting are likely to increase the water supply to rivers, the flow of meltwater will eventually decrease as glaciers get smaller. The loss of water could be substantial. In a dry August, for example, about 25% of the water in the Bow is glacial. Recent evidence indicates that the amount of glacier water entering the Prairies' largest river, the Saskatchewan, has already begun to decrease.

What's happening in Canada is happening in other parts of the world. According to the World Resources Institute, the total size of the world's glaciers has decreased by about 12% during the twentieth century.

Source: *Adapted from Canadian Geographic, 1998, and National Atlas of Canada*

Areas with glaciers and ice caps, shown here in blue, are found in B.C., Alberta, Yukon, the Northwest Territories, and Nunavut.

GLACIER FACTS

- Put them together in one place and Canada's 200,000 square kilometres of glaciers and icefields would cover an area about half the size of Newfoundland and Labrador. After Antarctica and Greenland, Canada has more glacier ice than any other part of the world.
- Meltwater from glaciers along the Alberta–B.C. border ends up in all three of Canada's oceans – the Pacific, the Arctic, and the Atlantic (through Hudson Bay).
- The Thompson glacier on Axel Heiberg Island in the Canadian High Arctic is growing while the neighbouring White glacier is shrinking. Both have been affected by earlier cooling and more recent warming, but the smaller White glacier has responded faster to the warming.
- Glaciers trap air, and all the chemicals in it, when they freeze. Air bubbles trapped in the ice are a valuable source of information about past climates and environments. More recently, glaciers have become a resting place for toxic chemicals deposited from the air. When the glaciers melt, these chemicals are released into rivers and lakes. Toxic chemicals that were once stored in the ice of Bow Glacier have now been detected in the waters of Bow Lake in Banff National Park.
- Alpine ice patches – mini-glaciers just a few hundred metres long or wide – are disappearing rapidly from Yukon mountain ridges. Their disappearance is producing a treasure trove of ancient human and animal artifacts. Because the ice is vanishing so rapidly, however, archaeologists are having trouble investigating all the new discoveries before the material decays or is disturbed.
- Wedgemount Glacier near the resort town of Whistler, B.C., has shrunk hundreds of metres in just the past two decades.

Wedgemount Glacier

Polar bears are superbly adapted to the frozen Arctic environment. But can they survive in a warmer world?

Polar bears spend most of their lives on a frozen sea. This harsh environment is critical to their survival, because it is on the sea ice that they find the seals that are their main source of food.

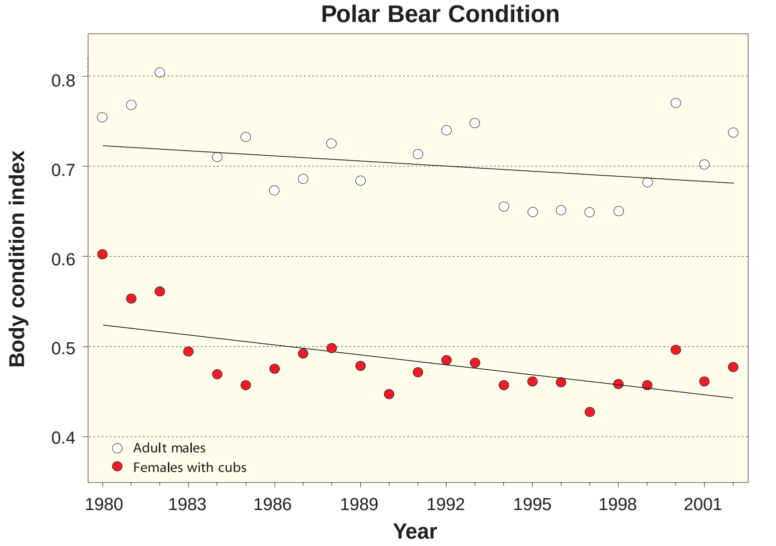
Climate change is expected to reduce the extent and thickness of sea ice in many parts of the Arctic and cause it to break up earlier. A shorter ice season would not only make it more difficult for polar bears to hunt but could also affect the abundance of their prey. These changes, if they continue, could eventually threaten the survival of polar bears in many, though not all, parts of Canada's North.

FOCUS: Western Hudson Bay

Polar bears in the northern Arctic can stay on the ice year-round, but on Hudson Bay the sea ice breaks up in the summer and is half gone by late June or mid-July. Although the bears stay on the ice as long as possible, they eventually come ashore, usually by late July or early August. While on land they eat very little, living mostly on fat reserves built up during their last few months on the ice. The later they leave the ice, the fatter they are, and the better their chances of survival. If the ice breaks up early, the bears must survive longer on less fat.

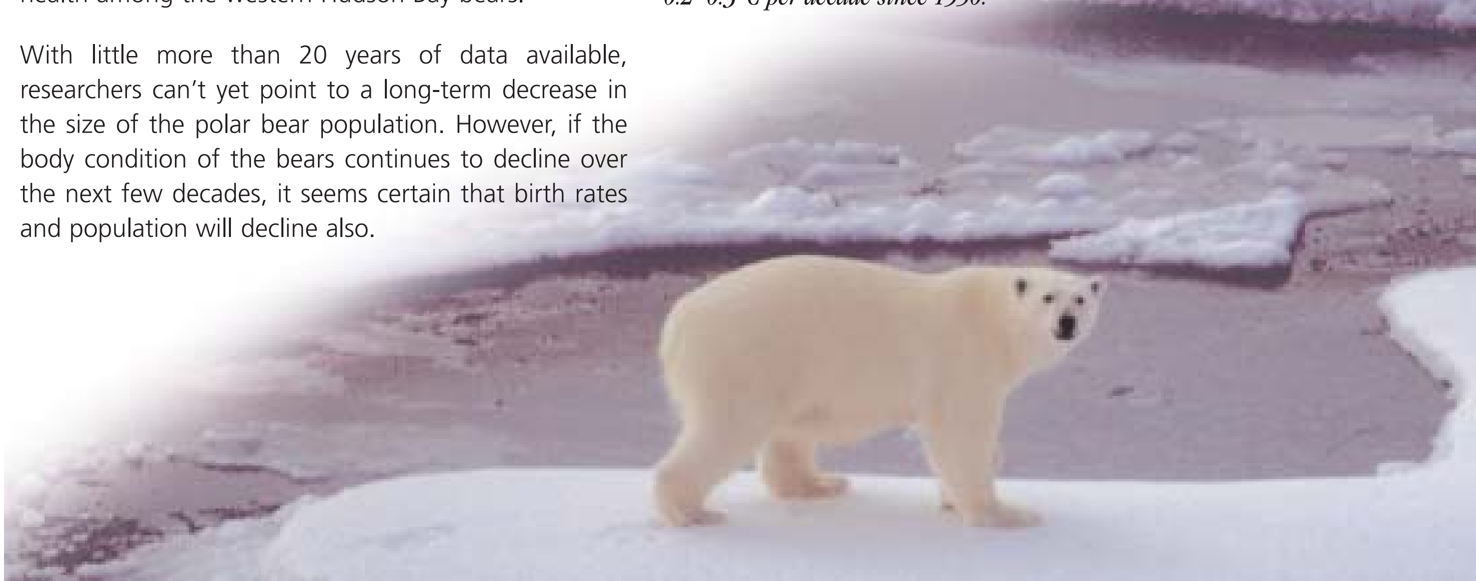
The timing of breakup varies considerably from one year to another, but by the late 1990s the ice on the western side of the bay was breaking up about two weeks earlier on average than it had in the late 1970s. According to scientists who have been studying polar bears in the region during those same years, the trend towards an earlier breakup has been matched by a decline in the physical condition of the bears. The animals have been getting thinner during their stay ashore and their birth rate has fallen. Although other factors can affect the health of polar bears, earlier breakup of the sea ice is the most likely cause of poorer health among the western Hudson Bay bears.

With little more than 20 years of data available, researchers can't yet point to a long-term decrease in the size of the polar bear population. However, if the body condition of the bears continues to decline over the next few decades, it seems certain that birth rates and population will decline also.



Source: *Adapted from N. Lunn and I. Stirling, Environment Canada*

The body condition index (which measures the relationship between weight and body length) provides good evidence of the general health of polar bears. The higher the index number, the healthier the bears. The decline in body condition since the early 1980s appears to be caused by a trend towards earlier breakup of the sea ice. That trend, in turn, is related to an increase in spring air temperature, which has risen at an average rate of 0.2–0.3°C per decade since 1950.



THE BIGGER PICTURE

There are as many as 25,000 polar bears in the world, and most of them, about 15,000, are in Canada. None, however, have been studied as long as those of western Hudson Bay. As a result, not much is known about how bears in other regions may have been affected by changes in climate. Nevertheless, the Hudson Bay evidence does raise concerns about the possible fate of other populations in the southern Arctic if the tendency towards shorter ice seasons continues.

Seals also depend on the sea ice, especially as a place to raise their young until they are old enough to swim and feed on their own. A study by scientists and Inuit hunters in the Beaufort Sea area has shown that seal pups born during short ice seasons are in poorer than average condition, perhaps because of later birth or earlier weaning. A trend towards shorter ice seasons could therefore result in a declining seal population. That, in turn, could create further survival problems for polar bears.

CHANGING ECOSYSTEMS

As climate changes, different plants and animals are affected in different ways. Some may benefit and expand their range and population. Others may migrate to areas where the environment is more favourable. If they don't, or can't, they face a more difficult existence or even extinction. As a result, changes in climate are altering and reshaping many of Canada's ecosystems. These changes are most evident in the North, but they are happening in other parts of the country too.

- New species are being seen in the western Arctic. Salmon have recently been reported in the Mackenzie River, while robins have been sighted on Banks Island. The bird is so rare in the area that there is no name for it in the local Inuvialuit dialect.
- Until recently, ring-necked ducks ranged no farther north than central B.C. In 1980 they were sighted in the northern Yukon and are now frequently seen in the area.
- The arctic fox can be found from Ellesmere Island to James Bay, but it is disappearing from the southern part of its range. Meanwhile, its southern cousin, the red fox, is advancing northwards.
- Until the 1980s, the Virginia opossum was unknown in southern Ontario. Milder winters now allow it to thrive as far north as Georgian Bay.
- Milder winters are also keeping long-tailed ducks in southern Ontario throughout the year. Because their feeding areas ice over less often, they now winter on the Lake Ontario shore instead of migrating further south.
- A comparison of fish surveys done in southern Ontario's Grand River watershed in 1983 and 1996 shows that many warm-water species are now colonizing the upper portions of the system, while many coldwater species have become less common.
- Since the mid-1990s, the explosion of the mountain pine beetle population in B.C. has resulted in the devastation of billions of dollars worth of timber. Warmer temperatures may be making it easier for the beetles to survive and multiply.
- In Manitoba, butterflies are appearing up to 12 days earlier in spring than they did 30 years ago.
- Red squirrels in southwestern Yukon now breed 18 days earlier on average than they did 10 years ago.

An arctic fox in its winter coat.

Major stages in the development of plants, such as budding, leafing, and flowering are triggered by seasonal changes in temperature, moisture, and the amount of light. In southern Canada, plants begin to develop rapidly when average daily temperatures reach and stay above certain critical levels.

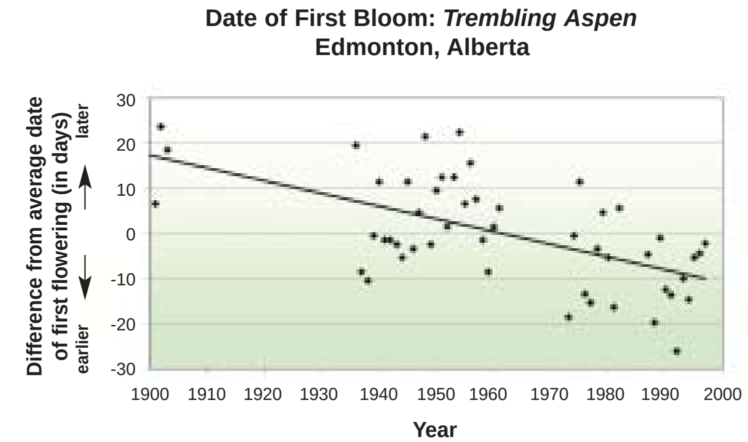
As a result, the timing of plant development varies from year to year with changes in weather conditions. The early arrival of warm weather results in plants developing sooner, while their development is slower if warm weather is delayed. Over the longer term, these changes in the timing of plant development make a good indicator of changes in climate. Farmers, ranchers, and gardeners are especially interested in these changes because of their effects on the way that crops, livestock, and garden plants have to be managed.

As our climate has changed, spring across much of the country has been getting warmer earlier. That should give most plants a head start on their development and result in the earlier arrival of noticeable events like budding and flowering.

FOCUS: Edmonton

At various intervals over the past 100 years, observers in the Edmonton area have recorded the flowering date for a common North American tree, the trembling aspen. Researchers from the University of Alberta put four of these sets of observations together to see if there had been any noticeable change in the flowering dates during the twentieth century. They found that between 1901 and 1997 the average date of flowering had advanced by about 26 days – from early May at the beginning of the century to early April at the end.

The trend towards earlier flowering coincides with warmer springs on the Prairies. During the twentieth century, daily high temperatures in spring increased, on average, by more than 2°C, and overnight lows increased even more. The city of Edmonton has warmed more than nearby rural areas, mainly because it has less green space and more asphalt and buildings. This "urban effect" may have also influenced the earlier flowering of the trembling aspen in the area.



Source: *Adapted from Beaubien and Freeland, 2000*

The graph shows the difference between the average first-flowering date of trembling aspen in Edmonton (the zero line) and the flowering date for specific years between 1901 and 1997. Over the century, the first-flowering date advanced by about 26 days. Because flowering dates are not available for every year, this value is only approximate.

An aspen in full bloom.

THE BIGGER PICTURE

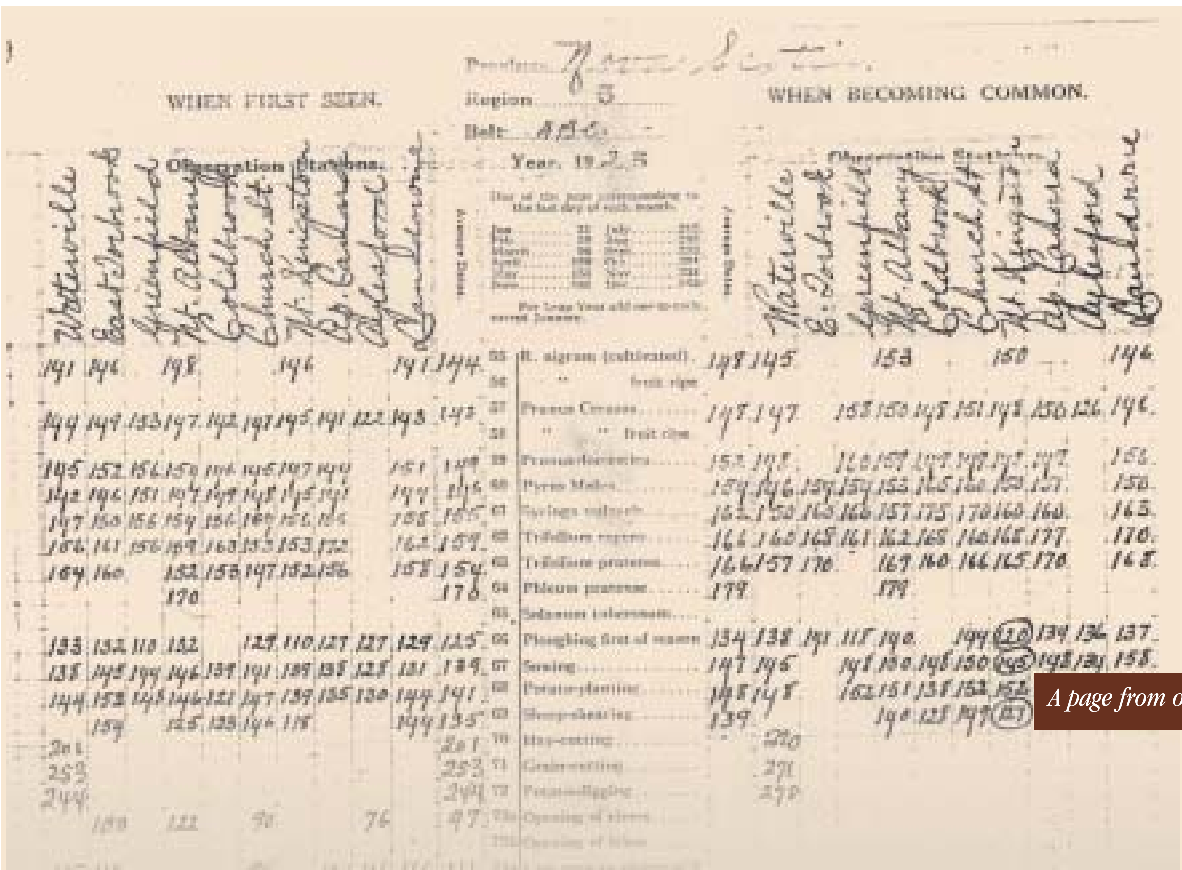
Most studies of plant development in Canada cover periods of about 20 years or less. Nevertheless, these and the few long-term studies that are available agree with what was seen in Edmonton – most plants are reaching major stages in their development earlier in the spring. Since 1937, for instance, the average date of full bloom for McIntosh apple trees in Summerland B.C. has advanced by about 5 days. Similarly, the average date when lilacs come into leaf in the United States and southern Canada advanced by 5–6 days between 1959 and 1993. In Europe, where more data covering longer periods are available, the trends are even stronger. Satellite observations also show an earlier greening of the Northern Hemisphere. Northern forests are now coming into leaf several days earlier and losing their leaves several days later than they did in the early 1980s.

These changes could have important consequences for ecosystems, agriculture, and human health. Earlier development means a longer growing season, which creates opportunities for growing new crops and improving farm yields. However, disease-carrying and crop-eating insects could become more of a problem since their breeding and growth are also affected by temperature. Hay fever sufferers could find their miseries starting earlier too. In addition, complex ecological relationships could be upset if interacting species, like plants and the insects that pollinate them or birds and the insects they eat, respond at different rates to climate change.

NOVA SCOTIA'S THOUSAND EYES

Between 1900 and 1923 hundreds of Nova Scotia students took part in a unique project that recorded more than 200 different seasonal natural events. It was the brainchild of Dr. Alexander MacKay, an innovative educator and naturalist and the province's superintendent of schools. The students recorded events as diverse as the flowering of plants, the emergence of butterflies, the return of migrating birds, and the occurrence of thunderstorms. Their observations were sent to Dr. MacKay and recorded in large, handwritten ledgers, which now provide an invaluable record of the seasonal behaviour of Nova Scotia wildlife in the early twentieth century.

A century later, Dr. MacKay's initiative has been revived as the Thousand Eyes Project. Once again, students are observing and recording natural phenomena, although this time other Nova Scotians can participate too. The project also uses the power of computers and an interactive web site to coordinate activities and to collate and report observations. As observations accumulate, it will be possible to compare today's results with those from 100 years ago. From these comparisons, scientists hope to get new insights into how Nova Scotia's climate is changing and how nature is responding.



A page from one of Dr. MacKay's ledgers, 1923.