

on thin ice

WINTER SPORTS AND CLIMATE CHANGE



David
Suzuki
Foundation

SOLUTIONS ARE IN OUR NATURE

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On Thin Ice: Winter Sports and Climate Change

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PHOTO: RANDY LINCKS

Winter sports are a crucial part of Canada's economy, culture, and identity

Canadians playing pond hockey on the prairies, skiing down the powdery faces of the Canadian Rockies, skating along the Rideau Canal, cross-country skiing through Quebec's forests, building snow forts in communities across the country – these are just some of the images that define the Canadian identity. Winter and winter sports are a large part of who we are.

Winter sports events and tourism are also an important source of income for many of Canada's cities and rural communities. Canada's ski sector contributes about \$839 million to the economy every year while winter tourism, including festivals and cultural events, provides an estimated \$5 billion.

What would it mean to Canada if we could no longer play outdoor hockey for most of the winter? Or if opportunities to ski and snowboard were to diminish across Canada? What if a growing number of winter festivals had to be cancelled because of a lack of natural snow? For communities that depend on winter sports culture, it could be as devastating as the loss of an automobile manufacturing plant to an industrial community.

And it could be the harsh reality for Canada's winter sports culture if we don't take international action to reduce global warming. The good news is that there are affordable solutions that offer new jobs and investment in the emerging green economy. However, the window for action is short and bold leadership is required.

This report examines how the decisions we make now about our response to climate change, including choices to reduce carbon dioxide (fossil fuel-based) emissions and implement adaptive measures, will ultimately affect the future of winter sports and the role they play as part of Canada's identity, natural heritage, and economy. The report concludes with recommendations about how winter sports stakeholders can take action on climate change and begin to adapt to the changes in Canadian winters already underway.





Key findings in this report are presented in two global-warming scenarios: a lower-warming and a high-warming scenario. However, even the lower-warming (lower-emission) scenario is very likely to cause the global average temperature to rise more than 2°C from pre-industrial levels. This 2°C increase in temperature is a threshold that many scientists and governments consider dangerous to crucial ecosystems and the global economy. As a northern country, Canada would likely experience temperature increases several times higher than the global average.

There is a silver lining. If Canada were to act with other nations to reduce greenhouse gas emissions to safe levels, keeping the global average temperature below the 2°C threshold, Canada's winter sports and culture could be healthier than predicted even in this report's lower-warming scenario.

Winter sports are extremely vulnerable to global warming

Hotter temperatures, caused by the build-up of heat-trapping carbon dioxide emissions in the atmosphere, have significant effects on ice and snow. Warmer winter temperatures mean rising snow lines, reduced snow cover, thinner lake ice, and shorter ice and snowfall seasons. Global warming directly threatens the length of the winter recreational season, the quality of the experience, and the variety of sports and activities available. And it's already having an effect.

Along with rising global temperatures, snowfall patterns are changing. Globally, the permanent, late-summer snow line in mountainous regions has retreated uphill by about 200 metres since the early 1960s while glaciers are shrinking three times faster than in the 1980s.

Closer to home, Canadian winters have experienced the greatest increase in temperature of any season. Environment Canada data show that the snow season in Eastern and Western Canada has decreased by nearly two and five weeks respectively over the past 50 years. At the same time, ice-cover duration for Canadian rivers and lakes – where hockey was born – has been getting shorter too. For Canada's ski areas, the risk of warmer winter temperatures jeopardizes favourable snow conditions, with shorter snow seasons and greater reliance on expensive and energy-intensive snowmaking operations.

Fate of winter sports, ecosystems, and global economy depends on choices we make today

If heat-trapping greenhouse gas emissions are not significantly cut, global warming stands to wipe out more than half of Canada's ski season later this century with few exceptions. Even with massive snowmaking efforts, many ski resorts would experience fewer than 100 days of reliable conditions each year, widely considered as the minimum threshold for financial viability, and would likely be forced to close. By 2050, the complete wipe-out of today's 94-day average cross-country ski season in southern Quebec and Ontario could be a reality should emissions continue at mid to high levels, the current emissions path we're on. A high-emission future would also threaten to eliminate the majority of Canada's outdoor skating season, jeopardizing the origin of our hockey culture and winter tourism attractions. Scientists estimate that under this scenario the ice-skating season on Ottawa's Rideau Canal would be reduced to just one week a year by the end of this century.

Low-emissions future with adaptation measures can protect Canada's winter sports (and festivals), depending on near-term action

Significant action to reduce carbon emissions to levels that limit the average global temperature increase to less than 2 °C from the pre-industrial levels, in combination with adaptation strategies such as increased snowmaking, would likely protect most of Canada's ski areas and allow them to remain open for the majority of their winter seasons. For ice skating and pond hockey on the Rideau Canal, aggressive action to reduce emissions could likely preserve more than 70 per cent of the existing outdoor skating season. By adapting cross-country ski race track setters to work with a reduced snowpack, more than 80 per cent of the cross-country ski season likely could be preserved over this century.

Winter tourism and cultural events are important to Canadians for both economic and social reasons

Today, winter tourism in Canada generates an estimated \$5 billion a year and supports more than 110,000 jobs from events like New Brunswick's World Pond Hockey Championships and the Quebec Winter Carnival. Vancouver will host the 2010 Winter Games with a vision to achieve "a stronger Canada whose spirit is raised by its passion for sport, culture and sustainability." But future greenhouse gas emission levels will dictate the magnitude of global warming and will determine whether Canada's winter sports can be sustained at all, no matter how strong our passion for skiing, hockey, and other winter sports. If global warming is allowed to intensify, it will become more and more difficult, and eventually unfeasible, to organize and host these important events.

Solutions exist to protect both the planet and Canada's winter sports culture

A recent United Nations study led by a team of economists and energy experts concludes that even sweeping measures to reduce global emissions to safe levels are affordable and could deliver multiple co-benefits like increased energy security, better air quality, modern energy systems, and more pedestrian- and transit-friendly communities.

A groundbreaking study by M.K. Jaccard and Associates, one of Canada's leading economic and environmental firms, concludes that Canada's economy can still grow by almost 20 per cent over the next decade while the country reduces its greenhouse gas pollution to 25 per cent below the 1990 level. The study shows that Canada could take decisive action and still continue to enjoy strong net job growth and other economic benefits. By 2020 Canadians would save more than \$5.5 billion each year at the gas pump because of more efficient vehicles, more public transit, and shorter commutes.

We can't leave it just to scientists or economists to solve global warming

Implementing these solutions will require comprehensive action and strong leadership from every sector of Canadian society. Winter sports athletes and enthusiasts can play a key role in galvanizing action as these athletes – from professional hockey players to Olympic skiers and ice skaters – are admired by millions of Canadians, political leaders, and businesspeople. And the athletes, along with recreational retailers and tourism-industry operators, have a lot at stake. Some winter athletes have already started to take responsible action, but even more bold leadership and action are urgently needed.



PHOTO: QUÉBEC WINTER
CARNIVAL 2009



PHOTO: JUSU TOIVONEN

Because of the scale of problem, governments must play a key role in the solution

To reduce carbon-dioxide emissions to safe levels, significant effort is needed from all sectors of the economy. As a result, governments must play a critical role in solving global warming. Scientists say to avoid dangerous levels of global warming, concerted international action is required and industrial countries such as Canada need to take significant first steps, as developed countries are primarily responsible for the problem.

Strong action on climate change can provide Canada new economic opportunities in the emerging green economy

Strong government action through pricing carbon emissions and targeted investments, along with binding regulations, is essential to spur innovation and, most importantly, to get clean, renewable energy and sustainable transportation technologies into use in Canada. This offers an exciting opportunity for Canada to be the “build it” nation when it comes to solutions to global warming versus being the “buy it” nation of clean technologies if action is delayed. Furthermore, the most comprehensive economic study on climate change projects the global market for low-carbon energy technologies will be worth at least US\$500 billion annually and perhaps much more by 2050.

Adaptation measures will also be required but are limited and costly

The emission choices we make today can largely limit the degree of global warming and its consequences. But emissions building up from current activities will intensify global warming to some degree in the future. As a result, some level of adaptation to climate change will be required for winter sports, including cultural events and tourism. These adaptive strategies include the use of new technologies and practices, changes to winter-event and tourism planning, and even business and financial strategies. But the ability for Canada’s winter sports and culture to adapt and deal with the symptoms of global warming is limited and costly and therefore must be combined with government policies to reduce the root cause of the problem, greenhouse gas emissions.

Government plays a key role managing adaptation

Government can assist Canada’s winter-sport sectors and event planners by providing the best available information on the science and risk of global warming by region so that proper planning and decisions for adaptation strategies can be made. In addition, government must ensure that safeguards are in place to protect the environment and minimize the potential negative impacts created by adaptation measures. For example, without proper regulation and management, the potential increase in artificial snow-making could lead to massive water extractions from sensitive watersheds or community water supplies.

Conclusion

Concerted international action to reduce global warming and keep the global average temperature below the 2°C threshold, coupled with adaptation measures by Canada’s winter outdoor sector, will enable us to protect the majority of the winter-sports seasons. But the window of opportunity is small. Delaying or postponing action to reduce carbon emissions and put in place adaptive measures would likely wipe out most of Canada’s winter sports culture. For the sake of winter sports and Canada’s culture, we must act now.

See page 34
for a full set of
recommendations.

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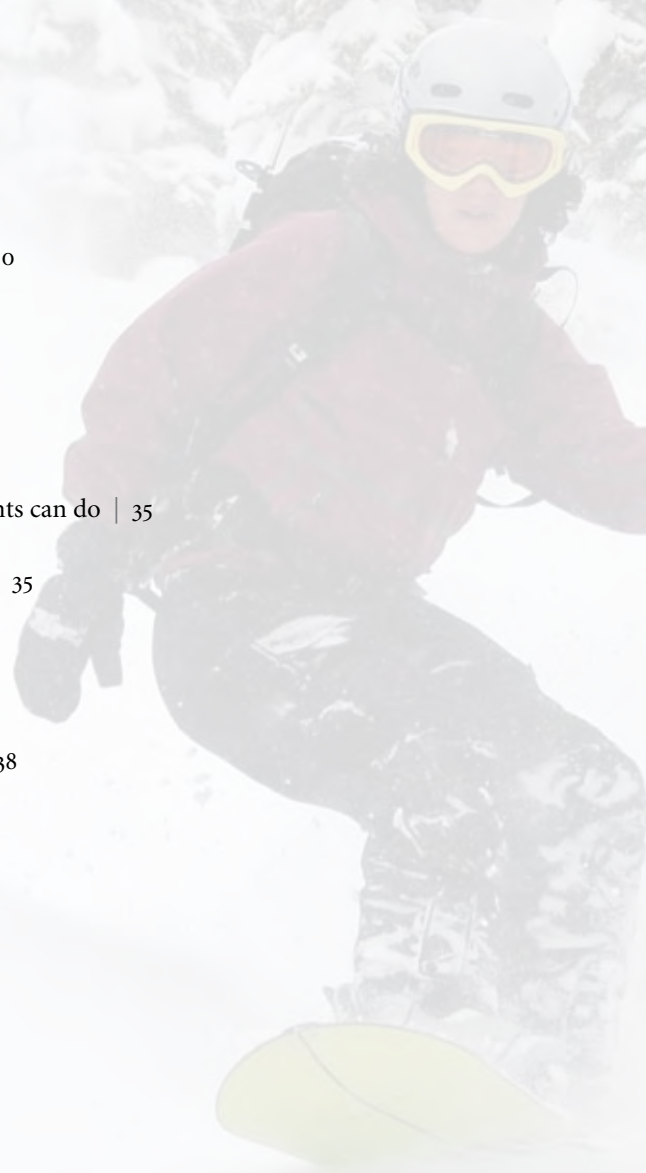
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A person is seen from behind, skiing down a vast, white, snow-covered mountain slope. The skier is leaving a trail of tracks in the snow. In the background, a dark, forested ridge or mountain peak rises against a pale, overcast sky. The overall scene is serene and emphasizes the winter sports environment.

About this report

Opportunities to participate in winter sports and enjoy the culture they support hinge upon reliable ice and snow conditions. Ice and snow depend on cool winter temperatures and are extremely sensitive to increases in temperature. This defining feature of ice and snow is one reason scientists have spent decades studying what these natural indicators are telling us about global warming, the future of our climate system, and the implications of climate change on our society. This report examines how the decisions we make now about our response to global warming, including choices to reduce carbon dioxide emissions and implement adaptive measures, will ultimately affect the future of winter sports and the role they play as part of Canada's identity, natural heritage, and economy.

The following chapters examine the science, the risks, and the solutions to global warming and their influence on Canada's winter sports culture.



PHOTO: PAUL MORRISON

Introduction

“Being in a winter sport, and a Canadian at heart, I simply love the winter. I can’t imagine growing up without snowball fights, downhill skiing, sledding, snow forts, and so much more. That is why going carbon neutral is important to me – I want to see my children enjoy the splendour that is winter.”

– KELLY VANDERBEEK, MEMBER, CANADIAN ALPINE SKI TEAM
AND DAVID SUZUKI FOUNDATION’S *PLAY IT COOL* MEMBER



Canadians playing pond hockey on the prairies, skiing down the powdery faces of the Canadian Rockies, skating along the Rideau Canal, cross-country skiing through Quebec’s forests, ice fishing on Lake Simcoe, building snow forts in communities across the country – these are just some of the images that define the Canadian identity. Winter and winter sports are a large part of who we are.

What would it mean to Canada if we could no longer play outdoor hockey for most of the winter? Or if opportunities to downhill ski and snowboard were to diminish across Canada? What if a growing number of cross-country ski races had to be cancelled because of a lack of natural snow?

This could be the harsh reality for Canada’s winter sports culture unless we take international action to reduce global warming.

During the past few years, concern about global warming has captured the attention of Canadians. Some of the most dramatic news came in 2007 with the release of a series of reports by the United Nations’ Nobel Prize–winning scientific body on climate change, the Intergovernmental Panel on Climate Change. The panel warned that unequivocal scientific evidence points to human activities as the primary cause of global warming. These human activities – mainly burning fossil fuels to heat our homes, run our industries, and transport people and goods – are disrupting the Earth’s natural climate balance. The large amounts of coal, oil, and natural gas we burn and activities such as deforestation are rapidly increasing

the levels of carbon dioxide in the atmosphere. This build-up of carbon dioxide emissions is surrounding the Earth like a blanket and trapping heat. Normally, a significant amount of heat is allowed to rise off the Earth's surface into space. But the build-up of this carbon dioxide blanket has altered the Earth's natural temperature control and caused global temperature to rise significantly, altering weather patterns and subjecting human societies to a dangerous threat. Some experts estimate that if climate change is left unaddressed, it could mean subjecting society to risks on a scale similar to those associated with the great wars and the economic depression of the 1930s.¹

Science of Climate Change

DEFINITIONS

"Global warming" as it is commonly used refers to the increase of the Earth's average surface temperature, due to the human-caused build-up of greenhouse gases in the atmosphere.

"Climate change" is used in a broader context and refers to the disruption in long-term weather patterns due to global warming, including changes to average temperature and precipitation, as well as increasing extreme weather events.

THE CAUSE: HEAT-TRAPPING BLANKET OF CARBON DIOXIDE

Burning fossil fuels to heat our homes, run our industries, and transport people and goods is disrupting the Earth's natural climate balance. The large amounts of coal, oil, and natural gas we burn and activities such as deforestation are rapidly increasing the levels of carbon dioxide in the atmosphere. This build-up of carbon dioxide emissions is surrounding the Earth like a blanket and trapping heat. Normally, a significant amount of heat is allowed to rise off the Earth's surface into space. But the build-up of this carbon dioxide blanket has altered the Earth's natural temperature control and caused global temperature to rise. Since the start of the industrial era, levels of atmospheric carbon dioxide have increased 35 per cent² and have exceeded any natural levels seen over the past 800,000 years.³

THE EFFECT: HOTTER GLOBAL TEMPERATURES AND MAJOR CLIMATE DISRUPTIONS

This harmful build-up of greenhouse gases is intensifying our atmosphere's natural heat-trapping ability, a process that has accelerated over the past decade.⁴ And the effects around the world have been profound. The build-up of carbon dioxide has increased global temperatures, causing major



disruptions in long-term climate patterns such as increased frequency and severity of extreme weather events like heat waves, flooding, and altered precipitation patterns. Over the past century, the average global temperature has risen 0.74°C. The United Nations' Nobel Prize-winning scientific body on climate change, the Intergovernmental Panel on Climate Change, predicts that without significant action to reduce greenhouse gas emissions, average global temperatures are likely to rise between 1.8°C and 4°C this century, three to seven times the temperature increase of what the planet has already experienced this past century.⁵

DID YOU KNOW?

Scientists believe the substantial decrease in snow and ice during the last few decades – especially pronounced in the Northern Hemisphere including the western U.S. and large parts of Canada – has mainly been caused by hotter temperatures from the build-up of carbon dioxide emissions in the atmosphere. Scientists estimate that human activities that emit heat-trapping greenhouse gases emissions will be the most significant external influence on ice and snow conditions this century.⁶

FACT: Eleven of the last 12 years (1995–2006) rank among the warmest years in the instrumental record of global surface temperature.⁷

Exceeding the 2°C global average temperature threshold is dangerous, scientists say

The ability to forecast future consequences and risks has improved with the growing scientific understanding of global warming. Many leading climate scientists predict that without deliberate international action to reduce global warming, atmospheric carbon dioxide emission levels will double⁸ within decades and push the planet's climate system past a very dangerous threshold, with irreversible consequences. Doubling greenhouse gas concentrations would very likely cause the global average temperature to rise more than 2°C from pre-industrial levels, intensifying global temperatures at least three times the temperature increase the planet has already experienced with climate change this past century. If emission levels more than double, global average temperatures could rise much higher, up to seven times this magnitude.⁹ The ecosystems that support life on the planet would be subject to this temperature increase at an alarming rate – within the span of a human life. Scientists and most governments conclude the result would be catastrophic for human society, many ecosystems, and the global economy¹⁰ including the winter sports industry.

The need to limit global warming to less than 2°C is strikingly clear. Scientists conclude that exceeding this 2°C threshold would put millions of people at risk from extreme weather events such as heat waves, severe drought and water shortages, flooding, intensified smog episodes, and the risk of extinction for many plant and animal species. Recent scientific studies suggest that even warming of less than 2°C could be enough to trigger the loss of summer Arctic sea ice and the eventual meltdown of the Greenland ice sheet, raising global sea levels by several metres and jeopardizing tens of millions of people.¹¹

In this context, protecting winter sports culture may not seem to be a priority. But winter sports are significant nonetheless – a vital part of Canada's economy and identity.

There are solutions to protect both the planet and Canada's winter sports culture. Scientists say to avoid dangerous levels of global warming, concerted international action is required and industrial countries such as Canada need to take significant first steps, as we are primarily responsible for contributing to the problem.

Moreover, leading economists and energy experts have concluded that affordable clean-energy solutions can dramatically reduce global warming emissions to the levels required¹², as shown in Chapter 3. In fact, the world's most comprehensive study on the economics of climate change, authored by the World Bank's former chief economist, Lord Stern, estimates that failing to act on climate change could result in damages equivalent to losing 20 per cent



Scientists estimate that human activities that emit heat-trapping greenhouse gases emissions will be the most significant external influence on ice and snow conditions this century.

PHOTO: COURTESY IISD



Canadian winters have experienced the greatest increase in temperature of any season, a 2.3°C increase – nearly double the average annual temperature increase over the past 50 years.¹⁸

PHOTO: LINDA BILY

of global GDP annually or more. The study concludes that by acting early with major investments in clean energy and other measures, the costs can be limited to around one per cent of global GDP each year.¹³

But we can't leave it to scientists or economists to solve global warming or push Canada to act. An effective response requires action from every sector of Canadian society. Winter sports athletes and enthusiasts can play a key role in galvanizing action as these athletes, from professional hockey players to Olympics skiers and ice skaters, are admired by millions of Canadians. And the athletes have a lot at stake. Strong leadership from the winter sports sector is a natural fit – these athletes, enthusiasts, and businesses have a strong story to tell as their lifestyle may be among the next casualties of climate change unless significant measures are taken.

Effects of climate change are amplified in Canada

The effects of climate change around the world have been profound. Over the past century, the average global temperature has risen 0.74°C.¹⁴ In Canada, we've experienced about double the average global temperature increase during the past century, in part because global warming is magnified at or near the North and South poles¹⁵ (as well as in high elevation/mountain regions of the continents¹⁶). This intensification in temperature increase near the poles is largely the result of the loss of ice and snow coverage. Snow and ice cover wield a significant influence on climate. As local temperatures rise, ice and snow start to melt. Snow or ice that once reflected sunlight back into space is then replaced by dark ground, ocean, or rock. These newly exposed dark surfaces absorb rather than reflect solar radiation, and this process further increases warming and melting of the surrounding ice and snow.

These effects underscore the risks to the future of winter sports, as Canadian winters have experienced the greatest increase in temperature of any season.¹⁷

The following chapters look at what could be in store for Canada's winter sports culture depending on whether the world continues to rely on polluting fossil fuels for energy or whether Canada acts in concert with the rest of the world to reduce global warming.

Exposure of Winter Sports to Global Warming

PHOTO: CHRIS JOSEPH

Many Canadians can remember that giddy feeling as nights grew longer and temperatures dipped below zero and their parents got out the hose and flooded the garden to create a backyard hockey rink. It's how one of Canada's greatest hockey stars, Wayne Gretzky, got his start. And it's just one of the things that made us look forward to winter.

Winter sports have shaped Canada's culture and established many of our country's traditions. Most Canadians identify hockey as one of our country's defining national symbols.¹⁹ Winter recreation also plays a significant role in the health of Canadians as 4.3 million Canadians actively participate in winter activities like alpine or cross-country skiing or snowboarding.²⁰ Winter sports and tourism are also an important source of income for many of Canada's cities and rural communities. Canada's ski sector boasts more than 250 ski resorts²¹ with over two million Canadians skiing or snowboarding each year. Winter tourism for downhill skiing brings in about \$839 million²² every year.

Warmer temperatures caused by the build-up of heat-trapping emissions in the atmosphere will significantly affect ice and snow, causing shorter winter seasons, a shrinking area of snow cover, a shift in snow lines up mountainsides, and decreased water supplies due to less summer runoff into rivers and streams. Global warming threatens the duration and quality of the winter recreational seasons and the variety of winter sport activities available.²³ And it's already having an effect. (See Figure 1)

"The most painful thing for me is watching local glaciers in Western Canada shrink. I've spent a lot of time in the backcountry and also on the Whistler glaciers and it's distressing to see them retreat every summer."

— JUSTIN LAMOUREUX, MEMBER, CANADIAN SNOWBOARD TEAM

Canada's ski sector contributes about \$839 million to the economy every year.



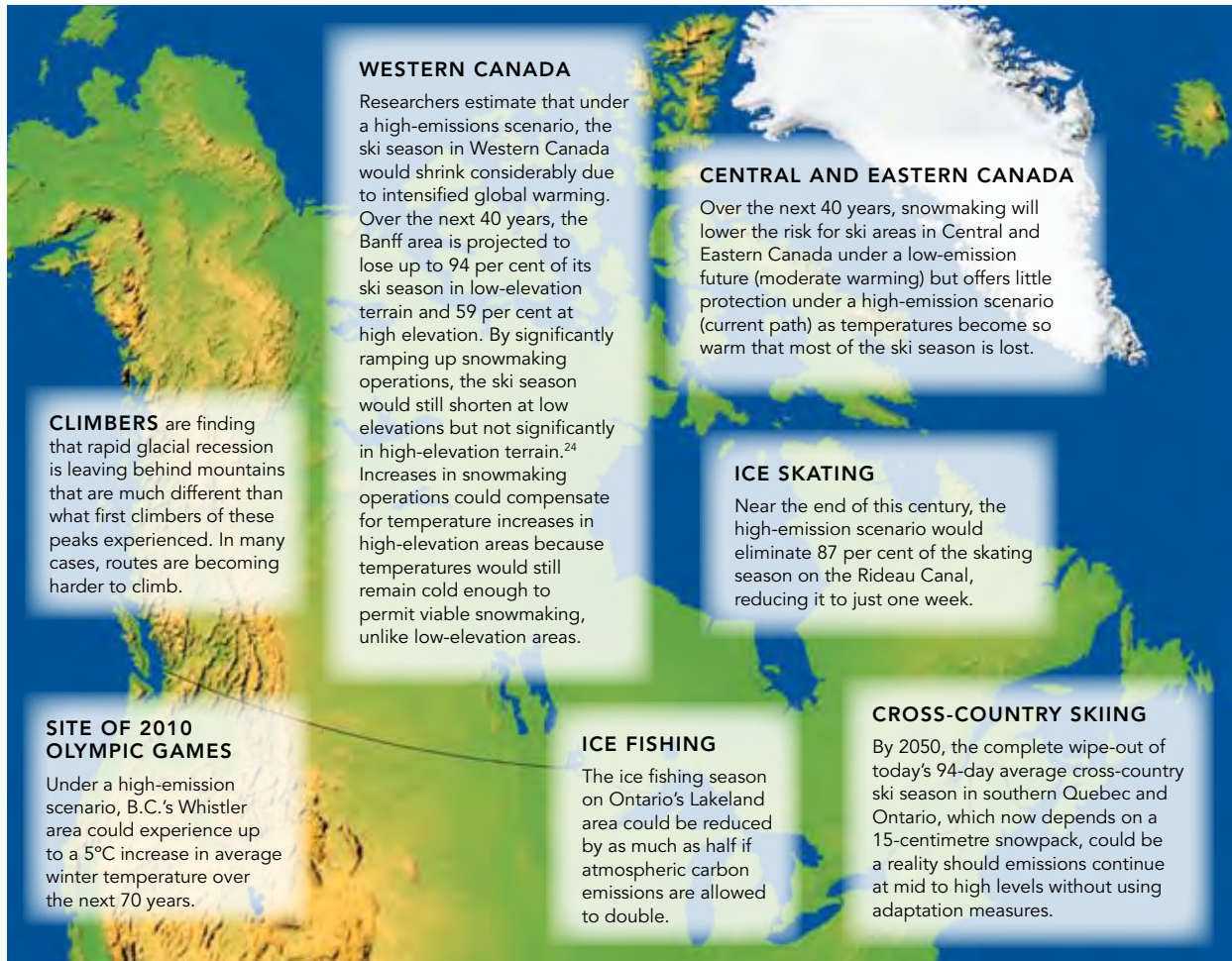


FIGURE 1. Summary of predicted climate change impacts on winter sports across Canada under high-emissions future

Snow sports: Alpine skiing and snowboarding

Under business as usual, the future of alpine skiing is heading downhill ... fast

During early winter of 2006-07, above-average temperatures and a lack of snow in many ski areas around the world sent shockwaves throughout the skiing and snowboarding community. In Europe, several World Cup alpine ski races scheduled for November and December were cancelled as the warmest November on record led to a lack of snow in many regions in the Alps. This led the International Ski Federation to describe the situation as "critical".²⁵ The famous Haute Route six-day backcountry ski traverse from Zermatt, Switzerland, to Chamonix, France, had so little snow in April that many sections of the traverse had to be done on foot.²⁶ Blue Mountain, Ontario's largest ski resort, laid off 1,300 workers after shutting down its ski operations in the heart of the winter season – a first in the ski area's 65-year history.²⁷

This start of the 2008-09 ski season has been described by Canadian Ski Team member Patrick Biggs during a European tour as “an odd start to the winter, stricken with strange weather, copious amounts of snow, and strong winds.” Intense storm events accompanied with high winds in high-elevation ski areas forced the cancellation of two World Cup ski events in France and Switzerland in December 2008.²⁸ Some areas of Canada have also experienced erratic weather patterns, including intense snowstorms at the start of the 2008-09 winter season followed by unusual dry spells. For example, as of mid-winter the snowpack in Canada’s southwestern mountain region was about 25 to 40 per cent below normal levels.²⁹

But just as the career of a professional hockey player isn’t based on performance in a single game but rather a collection of games played over years and decades, weather patterns must also be analyzed using long-range data. Neither a single warmer winter with very little snowpack or a single cold winter with lots of snow is an indication of the long-term future for Canada’s winter sports culture.

We need to look at the 2006-07 ski season and the erratic and intense snowstorms at the start of the 2008-09 season in the context of longer-term weather patterns, known as climate³⁰, which is exactly what climate scientists are doing. Scientists warn that some of Canada’s most cherished sports, like hockey and skiing, face a bleak future if global action to radically reduce greenhouse gas emissions is not taken. Planning for the future and putting in place adaptation measures is also necessary to help protect winter sports from some unavoidable degree of climate change, but it’s not a substitute for reducing emissions, as the following research clearly shows.

VULNERABILITY AND PREDICTED IMPACTS: WHAT’S IN STORE FOR SKIING AND SNOWBOARDING?

Worldwide

Skiing is a vital economic contributor to many mountain and hill regions in North America, South America, Europe, and Asia.³² Globally, it’s estimated this industry generates US\$9 billion in revenues each year.³³ According to a recent United Nations study, ski resorts and other winter-tourism industries worldwide will be hit hard by climate change. The report observes, for example, that costs to Switzerland’s winter-tourism industry could be upwards of US\$1.6 billion annually by 2050 – making it the hardest-hit Swiss economic sector³⁴. The significance of these findings is staggering considering Switzerland’s ski areas are thought to be Europe’s least vulnerable to climate change because of their relatively high elevation.

In 2007, the Organization for Economic Cooperation and Development (OECD) released a report showing that climate change is already threatening Europe’s ski industry, a key economic contributor for many alpine countries, generating some 160 million “skier days” in France, Austria, Switzerland, and Germany each year. For example, half of Austria’s total tourism alone is linked to the skiing sector, making up 4.5 per cent of the country’s national economy. Climate change presents a serious risk to the snow reliability of Europe’s ski industry and the mountain communities that depend on the jobs and tourism dollars it generates.



Globally, the permanent late-summer snowline in mountainous regions has retreated uphill about 200 metres since the early 1960s – about the height of a 50-storey skyscraper.³¹

PHOTO: JUSU TOIVONEN

Globally, the downhill ski industry generates US\$9 billion in revenues each year.

RISK OF GLOBAL WARMING TO EUROPEAN SKI RESORTS

Analyzing 666 ski areas in Austria, France, Germany, Italy, and Switzerland, the Organization for Economic Co-operation and Development (OECD) concludes that 90 per cent of Europe's ski areas normally support reliable snow conditions for at least 100 days a year. Roughly 10 are operating under marginal snow conditions. The study found that rising emissions and corresponding winter temperature increases could eliminate the number of ski areas by 25 per cent with a 1°C increase, 40 per cent with a 2°C increase, and 70 per cent with a 4°C rise.

Germany's ski areas are the most vulnerable to global warming, with a 1°C warming leading to a 60 per cent decrease in naturally snow-reliable ski areas. A 4°C warming would wipe out nearly all of Germany's naturally snow-reliable areas.

Switzerland was found to be the least vulnerable, with a 1°C warming leading to a 10 per cent decrease in naturally snow reliable areas. But a 4°C warming would result in the loss of half of Switzerland's ski resorts.

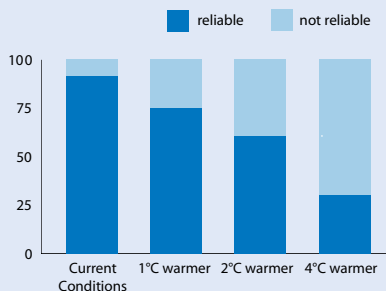


FIGURE 2. Ratio of resorts with natural snow reliability under warmer conditions (%)³⁷

Global warming is magnified in alpine areas and is more pronounced at elevation; the Alps are now warming at nearly three times the global average.³⁵ Scientists predict that if emissions are left unchecked, average winter temperatures in the Alps will rise roughly between 1° and 3 °C from 1990 levels by 2050, with each degree Celsius in warming resulting in the snowline retreating 150 vertical metres up the mountainsides – jeopardizing snow conditions at many of Europe's ski areas.³⁶ Experts estimate that without a major increase in snowmaking, the impact of global warming on ski areas in the Alps would get progressively worse according to the degree of global warming allowed to occur. (See Figure 2)

In the U.S., a team of 50 scientists and economists analyzed the effects of global warming on nine Northeast states and concluded that under a high-emission future, winters in the U.S. Northeast could warm by about 4°C to 7°C³⁸ above historic levels by late century. This could cut the ski season in the north of this region by half, leaving only western Maine and high-elevation ski areas of Vermont³⁹ with a reliable ski season by the end of the century. However, if action is taken to significantly reduce global greenhouse gases, reliable ski seasons could also be expected throughout this century in part of northern New York state and parts of Vermont and New Hampshire.⁴⁰

In the Sierra Nevada of California, a high-emissions scenario could leave the ski and snowboard season 15 weeks shorter by 2080.⁴¹ Global action leading to lower atmospheric levels of greenhouse gas emissions could save eight weeks of the ski season in California's mountains over the same period. Adaptive measures like snowmaking would further reduce the consequences of climate change in this region.⁴²

Did you know? Estimates show that snow-based recreation in the U.S. – including alpine skiing, cross-country skiing, snowboarding, and snowshoeing – contributes \$66 billion to the U.S. economy every year and supports more than half a million jobs.⁴³

Canada

Winter forecast for Canada if global warming is left unchecked

Canada's ski culture is vulnerable to global warming and could experience increasingly challenging climate conditions from the build-up of heat-trapping carbon emissions. Scientists predict that under a high-emissions future, winter average temperatures this century could increase in the range of about 3°C to 5°C inland, and roughly 2.5°C to 4°C along the coast. Canada's Arctic is predicted to be hardest hit, with average winter temperature increasing by 7°C, with the potential maximum temperature increase a whopping 10°C.⁴⁴ Under this scenario, where global warming is left unchecked, the winter forecast for Canada includes decreased snowpack as a result of snowfall building later in the winter and melting sooner, along with increased rain versus snow. Increasing global warming is expected to bring more precipitation (because hotter air holds more

moisture) on average for Canada. Because some regions of Canada's Arctic and possibly some high mountainous areas will likely continue to maintain winter temperatures below freezing, precipitation will occur in the form of snow, leading to an increase in snowpack for these regions. However, most climate models forecast a widespread decline of snowpack overall for Canada, including the Rocky Mountains.⁴⁵

For Canada's ski areas, the risk of warmer winter temperatures jeopardizes favourable snow conditions, with shorter snow seasons and greater reliance on expensive and energy-intensive snowmaking operations. This combination of shorter snow seasons and higher snowmaking costs is a key factor in putting the economic feasibility of many of Canada's ski areas at risk from climate change.⁴⁶ But the severity of global warming that winter sports will face is mostly governed by near-term emission choices such as whether or not we switch to cleaner (low-emission) renewable energy sources.

High- and low-warming scenarios used in this report

In Canada, the most authoritative research on the vulnerability of winter sports from global warming has been conducted by researchers at the University of Waterloo, although this research⁴⁷ does not cover all regions of Canada. Many of the findings outlined in this report are based on this research and show the degree of risk to Canadian winter sports and culture, from alpine and cross-country skiing to outdoor ice skating and winter festivals.

The University of Waterloo research is presented in two global-warming scenarios: a low-warming and a high-warming scenario. However, even the low-warming (lower-emission) scenario is based on the assumption that global atmospheric greenhouse gas emissions would more than double from pre-industrial levels by 2100, but would be dramatically lower than the high-emission (high-warming) future that we will see if we continue on our current emissions path. The build-up of heat-trapping emissions in the low-emission scenario would very likely exceed the 2°C global average temperature threshold that many scientists and governments consider to be extremely risky.⁴⁸ As discussed in the previous chapter, this 2°C threshold is a global average temperature increase. Because Canada is a northern country, we would most likely experience temperature increases several times higher than the global average.

There is a silver lining. If Canada were to act with other nations to reduce greenhouse gas emissions, Canada's winter sports and culture could be healthier than predicted in even the report's low-warming scenario. And it's in our best interest to do so considering the other severe and irreversible consequences to our communities and the global economy if we allow emissions to build up to a point that causes global average temperature to surpass the 2°C threshold.

To assess the vulnerability of alpine skiing to global warming, the Waterloo research team investigated the predicted effects of climate change on the duration of the ski season for the ski regions of Quebec and Ontario – Canada's largest domestic ski market – and Alberta's Rocky Mountains. Unique to the analysis, researchers analyzed snow requirements for ski operations and included the potential for ski resorts to increase the use of snowmaking as a means to reduce the vulnerability of their operations to climate change,

THE FATE OF DOWNHILL SKIING AND SNOWBOARDING IS IN OUR HANDS

Even with potentially costly adaptive measures such as a major increase in snowmaking, which some Canadian ski regions will most likely require in any case, the ultimate fate of skiing and snowboarding will depend on the future levels of greenhouse gases emitted over this decade and beyond. The levels of carbon emissions (whether high or low) and the resulting implications on warming will largely be decided by government policies and actions put into place over the next few years (see Chapter 3 – Solutions). As a society, this decision is ours to make.

According to the latest scientific evidence, global greenhouse gas emissions are building up faster than expected. Scientists report this will result in the hotter range of predicted global temperature increases and are therefore urgently calling for governments to take concerted action to cut emissions now. In other words, under current emission trends, we're heading toward the worst-case scenario for Canada's skiing and snowboard future – threatening to wipe out the ski seasons for most regions this century unless timely action is taken.

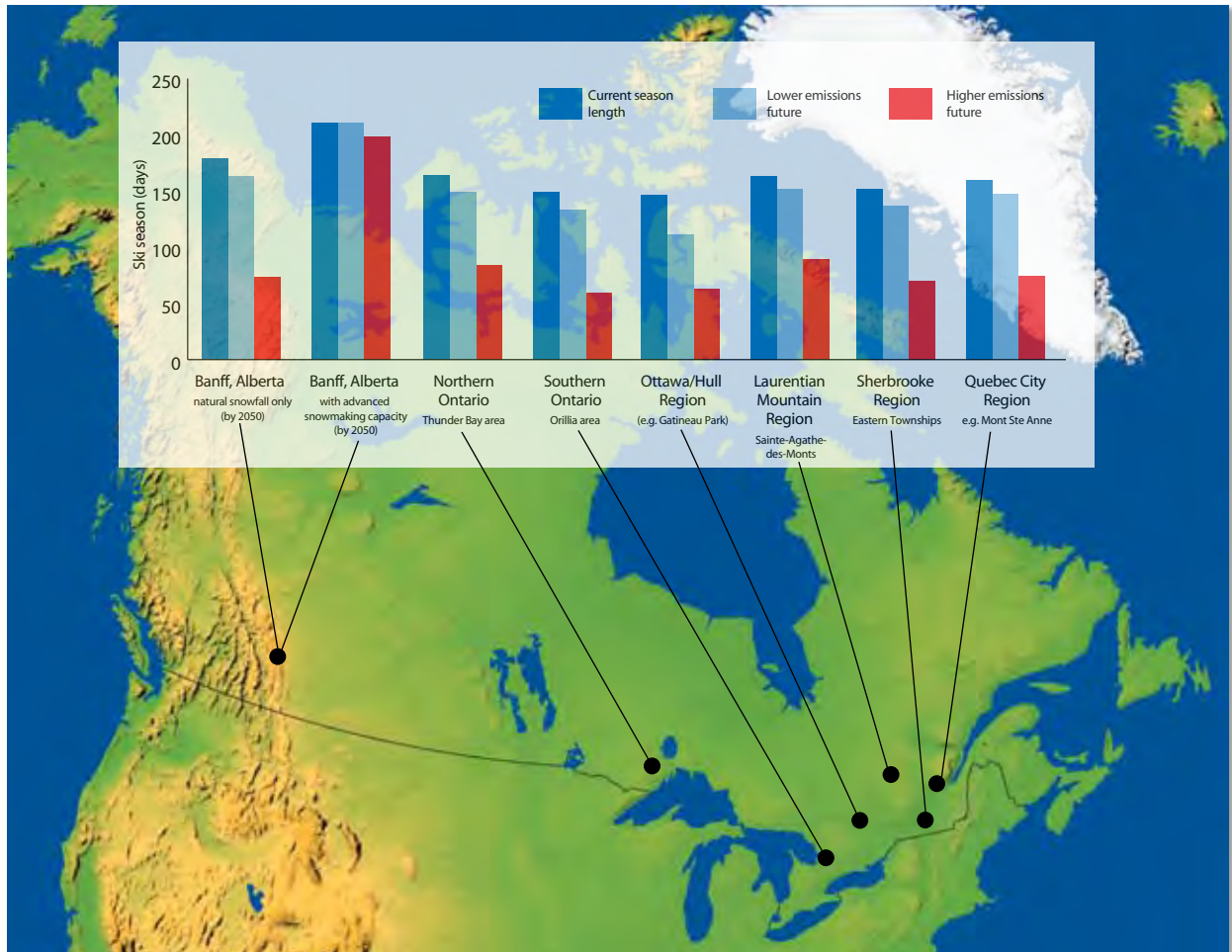


FIGURE 3. Predicted ski seasons for Canada under lower-emission and high-emission scenarios by 2080 (with increased snowmaking) Sources: Scott and Jones, (2006); Scott et al. (2005)

thereby reducing their reliance on natural snowfall only. The researchers then merged this data with the two global-warming scenarios, high- and low-warming. The results for 2050 are summarized in Table 1 and on the following page.

A. Maximum warming, high-emission future (current path for 2050)

Researchers estimate that under the high-emission scenario, even with a significant ramp-up of snowmaking, ski areas in northern Ontario could lose 36 per cent of skiable days over the next 40 years, southern Ontario could lose nearly half (46 per cent) of its ski season, and southern Quebec could lose 39 per cent (see Table 1), whereas Quebec's Laurentian Mountains would experience a 32 per cent decline by 2050. Low-elevation areas of the Rocky Mountains are expected to lose between 12 and 43 per cent of their ski season, although high-elevation terrain will likely not be as affected. More research and monitoring are required to assess the vulnerability of Western Canada's mountain regions to the effects of climate change. Although under a high-emission scenario, climate models predict that the

B.C.'s Whistler area could experience up to a 5°C increase in average winter temperature over the next 70 years.⁴⁹ In nearly all regions studied, with the exception of high-elevation mountain areas in Western Canada, the ski season would experience such a dramatic decline under intensified global warming that many ski areas would likely be forced to close.

B. Lower warming, lower-emission future

With concerted global action to reduce global warming emissions and achieve the lower-emission scenario, ski areas in Northern Ontario would preserve seven additional weeks of the ski season beyond the high-emission future. The combination of action to reduce



Quebec has the most ski resorts of any province and the highest number of skier visits, representing 34 per cent of Canadian ski visits.

TABLE 1

Predicted ski season losses including significant ramp up of snow making under high- and low-emission future (Adapted from Scott and Jones^{50, 51})

SKI REGION	PREDICTED SKI SEASON LOSS FOR 2050 UNDER LOW- AND HIGH-EMISSION SCENARIOS		ADAPTIVE MEASURE: SNOWMAKING INCREASE REQUIRED TO MAINTAIN THE SHORTENED SKI SEASON IN 2050
	A. HIGH-EMISSION FUTURE (CURRENT PATH)	B. LOWER WARMING LOWER EMISSION FUTURE	
Northern Ontario	-36% (59 days)	-4 % (7 days)	+40% to +161%
Southern Ontario	-46% (68 days)	-7% (11 days)	+62% to +151%
Gatineau Park Ottawa/Hull area ⁵²	-41% (60 days)	-8 % (11 days)	+20% to +103%
Southern Quebec/ Eastern Townships	-39% (59 days)	-7% (11 days)	+18% to +150%
Quebec City region	-34% (54 days)	-5% (8 days)	+18% to +150%
Quebec Laurentians (Ste Agathe des Monts)	-32% (52 days)	-4% (7 days)	+18% to +150%
Rocky Mountains (low elevation, i.e. 1,600 m)	-12% to -43%	0 to -9%	Not available
Rocky Mountains (high elevation, 2,600 m)	No change to -6%	Little effect	Not available

TABLE 2

Predicted ski season losses for the Canadian Rocky Mountains relying only on natural snowfall (Adapted from Scott and Jones^{50, 51})

SKI REGION	PREDICTED SKI SEASON LOSS FOR 2050 UNDER LOW- AND HIGH-EMISSION SCENARIOS	
	HIGH-EMISSION FUTURE (CURRENT PATH)	LOWER WARMING, LOWER-EMISSION FUTURE
Banff low-elevation base area, 1,600 m (without adaptive snowmaking measures – i.e., reliant on natural snowfall only)	-94%	-66%
Lake Louise low-elevation base area, 1,600 m	-87%	-31%
Banff high-elevation, 2,600 m summit area	-59%	-9%
Lake Louise high-elevation base area, 2,600 m summit area	-19%	-2%



global emissions and ramping up snowmaking measures would limit the impact to the ski and snowboard season to only a four per cent decline over the next 40 years in Northern Ontario. Much of the ski season would also be protected for both Southern Ontario and Southern Quebec, with an estimated reduction to their ski season of seven per cent (a week and a half) by 2050, whereas the ski season in Quebec's Laurentian Mountains is expected to be less affected, declining only four per cent.

As previously discussed, the good news is that if Canada acts in concert with the world to reduce greenhouse gas emissions toward zero and prevent global temperatures from exceeding the 2°C threshold, Canada's winter sports and culture could be healthier than predicted in this lower-warming scenario.

Low emissions with adaptation measures can help ensure a longer ski season: the Canadian Rockies

Under the low-global-emission scenario but without additional snowmaking capacity, low-elevation areas of the Rocky Mountains would likely face significant impacts, losing between 31 and 66 per cent of the ski season by 2050. Yet, combining a low-emission future with adaptive snowmaking measures is predicted to result in a negligible effect, with a nine per cent reduction. High-elevation areas are expected to experience little effect under the lower-emissions future with adaptive strategies. Yet, without these adaptation measures the loss of the ski season at high elevation could reach up to nine per cent in some areas.

Climate change threatens regions where most Canadians learn to ski

Research suggests that the Rocky Mountains and Quebec's Laurentian Mountain region could be less vulnerable to climate change than Southern and Northern Ontario. But Southern Ontario, one of Canada's most vulnerable ski regions, is also where most Canadians live. This is where the largest number of Canadians learns to ski and snowboard and is an important recruiting area for Canada's next generation of skiers and snowboarders. A quarter of Ontario skiers and snowboarders are beginners or first-time participants. Ontario also has the largest share of young participants, with seven per cent of participants under the age of 14.⁵⁴

Climate change models suggest Quebec's more vulnerable ski areas include the resorts around the Gatineau Park/Hull area and the Eastern Townships, versus the Laurentian Mountains or Quebec City region.

Future of skiing and snowboarding depends on near-term action

If heat-trapping emissions are not significantly cut, global warming stands to wipe out nearly half of Canada's ski season later this century, with few exceptions.⁵⁵ Even with massive snowmaking efforts, many ski resorts would experience fewer than 100 days of reliable conditions each year, widely considered as the minimum threshold for financial viability, and would likely be forced to close. However, if action is taken to significantly reduce global greenhouse gases to levels that keep temperatures below the global 2°C threshold⁵⁶, reliable ski seasons would likely be expected throughout this century across most of Canada, as long as adaptive strategies are also adopted.⁵⁷

If Canada acts in concert with the world to reduce greenhouse gas emissions and prevent global temperatures from exceeding the 2°C threshold, Canada's ski industry could be healthier than predicted in this low-warming scenario.

Cross-country skiing

“Throughout my 15-year career as an Olympic cross-country skier I have experienced the impacts of climate change firsthand. The seasons have become less predictable and, in general, there is less natural snow. World Cup racing depends on snowmaking, whereas 20 years ago snowmaking didn’t exist. It is common to race in green pastures with a white trail made from snow that was blown on a mountaintop and then trucked down to the ski site. When these extraordinary efforts fail, race organizers are forced to cancel World Cups. Cancelled races are common.

— SARA RENNER, OLYMPIC CROSS-COUNTRY SKI MEDALIST FOR TEAM CANADA

Cross-country skiing has been part of Canada’s culture at least since confederation in 1867, and it’s still an important winter activity for health and fitness enthusiasts. Our athletes share the Olympic podium with the world’s best. Today, more than 870,000 Canadians participate in the sport. Two thirds of these skiers are from Central Canada, with the majority from Quebec.⁵⁸

Although cross-country skiing requires less snow than alpine skiing, it relies principally on natural snowfall. This dependency on natural snow combined with the fact that the majority of trails are found at lower-elevation areas makes cross-country skiing even more vulnerable to the effects of global warming than alpine skiing and snowboarding.⁵⁹

In Canada and globally, rising temperatures have affected snowfall patterns. Satellite data show that the extent of winter snow cover in the Northern Hemisphere has decreased about eight per cent during the last 80 years⁶⁰, while spring snow cover has decreased even more, shrinking 10 per cent since the mid 1960s⁶¹. Here at home, Environment Canada data show that over the last 50 years the snow season in Eastern and Western Canada has decreased by nearly two and five weeks respectively.

Warmer winter temperatures caused by climate change are projected to reduce the natural snowpack in Canada, with some exceptions such as the Arctic and high-elevation mountain areas. The graph below shows what is projected for cross-country skiing in the Ottawa/Hull region (Gatineau Park) under the high- and low-emission scenarios for the 15-centimetre snowpack needed to accommodate a race-regulation ski track.⁶⁴

High-emission future puts ski season in jeopardy

Under a high-emission, severe-warming scenario, the consequences are stark for cross-country skiing, which now depends on a 15-centimetre snowpack⁶⁶. By as early as 2020, the average cross-country ski season in Quebec’s Gatineau Park could be cut in half, losing nearly seven weeks. By 2050, the complete wipe-out of today’s 94-day average cross-country ski season in southern Quebec and Ontario could be a reality should emissions continue at mid to high levels, the current emission path we’re on.

Lower emissions ensure future for winter sports

However, with action to achieve a low-emission future, nearly five weeks of the cross-country ski season could be protected (for the required 15-centimetre average snowpack)



PHOTO: MORTEN BYSKOV

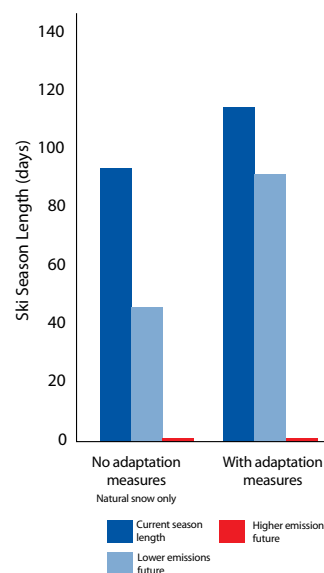


FIGURE 4. Projected cross-country ski season in Gatineau Park, Quebec, under high- and low-emission scenarios.⁶⁵



by 2020 versus the high-emission scenario. During this period, 86 per cent of the ski season would be preserved (a 14 per cent decline). But by the 2050s, ski conditions become very challenging as the average cross-country ski season is expected to decline by half (51 per cent), resulting in a season of about seven weeks.

Low emissions with adaptive measures can help protect majority of ski season: new track-setting techniques for cross-country skiing

Because it will be challenging to maintain the 15-centimetre snowpack required to set an official regulation cross-country ski track for the Keskinada Loppet Nordic ski race in the Ottawa/Hull region, ski-track setters are now being developed to require less snow. This adaptation measure will produce a ski track that will allow organizers to host these races over the next 20 years without problems, but insufficient snow conditions under a high-emissions future would hinder the ability to hold the race within 40 years. However, by taking concerted global action to reduce heat-trapping emissions combined with this new ski-track setting



FIGURE 5. Map of snow season trends – a snapshot of Canada

technology, which can work with a reduced eight-centimetre snowpack, researchers estimate that more than that 80 per cent of the cross-country ski season in the Ottawa region could be preserved over this century (2080s), which would average 92 days.⁶⁷

Snowshoeing

Snowshoeing has a long history in Canada, with the first snowshoes developed and used by First Nations for winter transport. Today, snowshoeing to maple-syrup shacks in Quebec or exploring our country's boreal forests or mountainous areas is a part of our culture, and has increased greatly in popularity in recent years as an accessible form of winter recreation.⁶⁸

Snowshoeing also faces significant risks from climate change. Like cross-country skiing, it depends on natural snowfall. With a few exceptions, such as the Far North and some high-elevation areas, winter snowpack is expected to diminish from the western mountain regions to the Maritimes. Under a high-emissions scenario, much of Canada's snowshoeing opportunities would likely vanish later this century⁶⁹ and the quality of the experience would be greatly compromised with more rain-on-snow forecast from climate change.

Research assessing a high-emission scenario shows that the length of seasons with snow conditions adequate to support snowshoeing and cross-country skiing would likely be dramatically reduced by 2050 across most of Ontario and southern Quebec, with the potential that some areas may see no season at all.⁷⁰ The most vulnerable areas of Central Canada (the main region where the risk has been assessed) are predicted to be Southern Ontario and the Eastern Townships of Quebec.

Outdoor ice skating and pond hockey – avoiding thin ice

For a large number of Canadians, playing pond hockey is an essential, and memorable, part of childhood. It's how many of our hockey stars got their start. Without pond hockey, we probably wouldn't have what has become the modern game of hockey. From the Rockies to the East Coast, pond hockey has been a key part of Canada's history and has strongly shaped Canada's identity. As a result, most Canadians identify hockey as one of the country's defining national symbols.⁷¹

This crisp sound of steel blades slicing ice can be heard on frozen lakes and rivers during New Brunswick's *World Pond Hockey Championship*, on outdoor rinks across the Prairies, and on backyard rinks where young Canadians across the land follow in Wayne Gretzky's skate tracks. But these natural ice surfaces are very sensitive to climate change. That's why ice duration in river and lakes is considered a good indicator or natural barometer of global warming, with temperature playing a dominant role in the timing of ice freezing and melting. Globally, scientists report that the ice-cover season of rivers and lakes appears to have shortened by about two weeks this past century.⁷²

Canada hasn't escaped this global trend. Over the past 50 years, ice-cover duration for Canadian rivers and lakes has been getting shorter as overall air temperature increases. The shorter ice-season trend is mainly linked to earlier springs that cause earlier melting and ice break-up, while autumn freeze-up dates of lakes have shown little change over most of the



PHOTO: DAN HARPER



PHOTO: BRIAN SMITH
PHOTOGRAPHIC



New Brunswick's World Pond Hockey Championship. With high-emissions future, global warming threatens to eliminate the majority of Canada's outdoor skating season, leaving the origin of our hockey culture on thin ice.

PHOTO: BRIAN SMITH
PHOTOGRAPHIC

country. This trend is particularly pronounced in Western Canada, which also experienced decreased snow coverage (based on satellite data)⁷³ and greater warming in winter during the same period. Ice on the lakes experiencing the most pronounced change is breaking up and melting about 10 to 15 days earlier than 30 years ago.⁷⁴ Another recent study using satellite data shows a similar two-week reduction in ice cover of Canadian lakes over the same period (50 years), but including both later freezing (six days later) and earlier melting (nine days earlier).⁷⁵ Based on the longest data record for lake ice in Ontario, Lake Simcoe now freezes 13 days later than 140 years ago, and melts four days earlier.⁷⁶

The safe winter use of frozen rivers and lakes for skating, hockey, snowmobiling, and other recreational activities depends largely on ice thickness. For example, ice-fishing operators on Lake Simcoe in Ontario generally consider 15 to 25 centimetres a safe ice thickness for placing fishing huts.⁷⁷ To date, there is insufficient data on the effect of global warming on maximum ice thickness of Canadian lakes and rivers, but climate models indicate that ice thickness is not just a consequence of temperature but is also significantly influenced by variation in the amount of snowfall⁷⁸. This is because more snow cover provides a protective layer of insulation, shielding the ice during warmer weather days and reflecting sunlight. This allows the ice to remain cooler and thicken. With a general trend of decreasing snowfall predicted for Canada, lake and river ice may be more vulnerable to melting and may therefore not thicken to reliable levels for skating, pond hockey, ice fishing, and other recreational uses.

Scientists estimate that a long-term average increase of 2 to 3°C in spring air temperature cuts the river-ice season in Canada by 10 to 15 days.⁷⁹ The most detailed research on the risk of global warming on ice skating in Canada was conducted for the Ottawa's Rideau Canal Skateway – the world's largest natural skating rink – using a high- and low-emissions scenario for the future (same scenarios as done for alpine skiing). The results are presented below.

High-emission future puts pond hockey on thin ice, but low emissions can protect its future

The study predicts that, under a high-emissions scenario, the Rideau Canal's winter skating season, historically about 61 days long (nearly nine weeks), would shrink by 29 per cent (2.5 weeks) by 2020, and lose 67 per cent of its skating days (41 days) by 2050. Near the end of this century, the high-emission scenario would eliminate 87 per cent of the skating season, reducing it to just one week.

"As hockey players, most of us grew up playing shinny on an outdoor rink. We know it's important to protect winter so today's kids don't miss out on these experiences. We're in a position to help raise awareness about climate change, and the NHLPA Carbon Neutral Challenge shows that we all can make a difference. I'm doing my part to set a good example for my kids, while also hoping to inspire fans to take action in their own lives."

- WILLIE MITCHELL, VANCOUVER CANUCKS DEFENSEMAN



PHOTO: COURTESY GETTY IMAGES

ICE FISHING: A CANADIAN TRADITION

Ice fishing is a big part of Canada's natural heritage. Anglers now spend about 4.5 million days ice fishing each year. Ice fishing is also important to the economies of many towns and villages. If ice fishing's contribution to the Canadian economy is proportional to angling activity, it contributes about \$528 million in direct investments and goods and services each year.⁸¹ Scientists studying the potential effects of climate change on ice-covered lakes in the U.S. with similar winter season conditions as Ontario's Lakeland area project ice-cover days could be reduced by as much as half if atmospheric carbon emissions are allowed to double. Not only would warmer winters result in shorter seasons but also in thinner lake ice, thus



threatening safety.⁸² But assuming the climate change risk to ice fishing is on a similar scale to the risk to ice skating, it's likely that most of the ice-fishing season could be unharmed if significant global action is taken to reduce global warming. In February 2009, 150 ice fishermen had to be rescued and one perished after high winds and rising temperatures caused an ice floe to break away and strand them on Lake Erie.⁸³

However, with a low-emission future, the impacts from climate change can be reduced significantly. A low-emission future is predicted to result in a 15 per cent (nine days) decline in the number of skating days by 2020 and a 19 per cent (12 days) decline by 2050. Yet with deep emission cuts, more than 70 per cent of the existing outdoor skating season could remain intact over this century, averaging around 42 days.⁸⁰

Ice climbing and winter mountaineering

On many mountains around the world, climbing routes are changing in response to warmer temperatures. Alpine permafrost – the glue that literally holds mountains together – is melting, and this has been blamed for an increase in climbing fatalities due to higher frequencies of rockfall. In the Swiss Alps during a summer heat wave of 2003, an entire rock face of the Matterhorn's most popular route fell off, stranding more than 70 climbers and leading to one of the biggest mass rescues in mountaineering history.⁸⁴ Elsewhere, today's climbers are finding that rapid glacial recession is leaving behind mountains that are much different than what first climbers of these peaks experienced. In many cases, routes are becoming harder to climb. Once considered a straightforward and popular climb for the developing mountaineer, the North Face Route of Mount Athabasca in the Canadian Rockies has changed dramatically over the past several decades. While subject to year-to-year variations, the steep snow and ice of this route has on average become harder and more polished, while the rock band separating the face from the summit snowfield has become a more difficult and daunting obstacle to negotiate.⁸⁵



PHOTO: CHRIS JOSEPH



PHOTO: LINDY BILY

Glaciers⁸⁶

Considered one of the “canaries in the coal mine” for our climate system, glaciers seem to be sending us some sobering messages about global warming. With few exceptions, glaciers are melting faster than ever. Worldwide, glaciers are shrinking three times faster than in the 1980s.⁸⁷ In Europe, the Alps have lost half their glacial ice in the past 150 years, with most of the melting having occurred during the past two decades as melting intensifies.⁸⁸ If ongoing emission trends continue, global warming may lead to the complete deglaciation of many mountain regions this century.⁸⁹

Canada, renowned for its winter landscapes and rugged mountains, has more glacier cover than any other country in the world, except Greenland (Denmark). Over the last century, the southern Canadian Rocky Mountains have lost at least 25 per cent of their glacier cover^{90,91} and some glaciers have lost up to 75 per cent of their volume⁹². Although some of this ice loss can be attributed to drier winters caused by natural climate cycles^{93,94}, recent hot summers have contributed to some of the most extreme ice loss on record, and the melting trend appears to be accelerating.⁹⁵ Scientists studying glaciers in B.C.’s Coast Mountains⁹⁶ around the Whistler area have reported that the recent rate of glacier loss has approximately doubled over the last two decades⁹⁷.

WATER TOWERS OF THE WEST

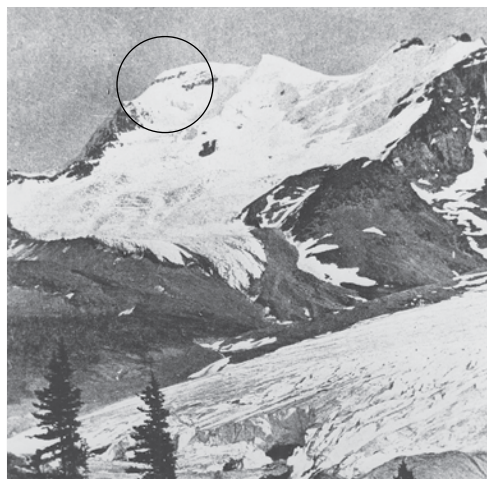
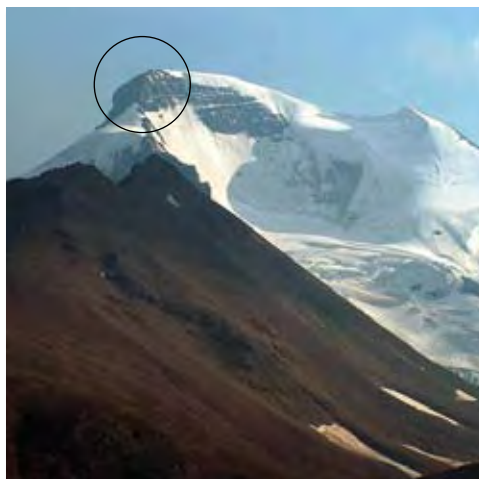
Slow-moving rivers of ice, glaciers are a crucial source of water and support important ecosystems in Western Canada. In numerous mountain headwaters, glacier melt regulates river flow and keeps water temperatures cool enough for species like bull trout and Pacific salmon to survive their long upstream migration to spawning beds. Many mountain and prairie communities, along with the hydro-power and agricultural sectors, also depend on the summertime water flows from the melting snow and ice of the Rocky Mountains, particularly when other water sources are scarce or in decline. Glaciers also play an important role for water storage. They act like a bank account, storing snow and ice during cool, wet weather and releasing water when we need it most, during hot, dry summers or years of drought. However, global warming is cashing in on a bank account that has been built over thousands of years but isn’t being replenished. Scientists are reporting that late summer water flows in many mountain-fed rivers on the Prairies and southern B.C. are decreasing, in some cases declining nearly 40 per cent in the past 50 years alone. The cause of this reduction has been linked in part to the drastic reduction in glaciers over the last century. As glaciers continue to recede, their melt-water contributions to rivers and streams are expected to diminish further, which will result in a long-term trend of declining flows and warmer river temperatures.¹⁰⁰

Illecillewaet Glacier, B.C. 1902 versus 2004



Scientists estimate that B.C.’s glaciers are losing 22 cubic kilometres of ice per year.⁹⁸ That’s as much water as all of Canada’s homes, farms, and factories use every year.⁹⁹

PHOTOS: WHYTE MUSEUM OF THE CANADIAN ROCKIES (V653-NG4-452 BY VAUX FAMILY); MAS MATSUSHITA

1917: Snow slope climb to peak**Today:** Climbers are met with a rock wall

Changing alpine route in the Canadian Rockies: Mount Athabasca in 1917 and today

PHOTO: ATHABASKA GLACIER, JASPER NATIONAL PARK, CA. 1917; DOW WILLIAMS

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Winter recreation cultural events and tourism

Winter tourism and cultural events are important to Canadians for both economic and social reasons.¹⁰¹ From the 1988 Calgary Winter Olympic Games to the upcoming 2010 Winter Games in Vancouver to New Brunswick's World Pond Hockey Championships to Quebec City's Carnaval d'Hiver to Ottawa's Winterlude festival, these cultural events have shaped Canada's identity, attracted millions of tourists, and provided important economic and social benefits. Today, Canada generates an estimated \$5 billion a year and supports more than 110,000 jobs from winter tourism.¹⁰² Vancouver will host the 2010 Winter Games with a vision to achieve "a stronger Canada whose spirit is raised by its passion for sport, culture and sustainability."¹⁰³ But future greenhouse gas emission levels will dictate the magnitude of global warming and will determine whether Canada's winter sports can be sustained at all, no matter how strong our passion for skiing, hockey, and other winter sports. If global warming is allowed to intensify, it will become more and more difficult, and eventually unfeasible, to organize and host these important events.

Ottawa region's Winterlude¹⁰⁴

Founded in 1979, Ottawa's Winterlude is one of the largest winter festivals in North America, with outdoor ice skating, ice sculptures, tobogganing, and cross-country ski racing. In 2000, Winterlude attracted more than 1.5 million tourists and contributed more than \$143 million to the capital region's economy. The most popular Winterlude attraction is Ottawa's famous Rideau Canal Skateway – the world's largest outdoor ice-skating rink. (See: Ice-skating impacts.)



Canada generates an estimated \$5 billion a year from winter tourism.



PHOTO: QUÉBEC WINTER CARNIVAL
2009

Weather conditions determine the success of Winterlude in attracting visitors. Cool temperatures and adequate snowpack are required to maintain ice and snow quality and festival activities including ice sculptures, outdoor skating, snow slides, and cross-country ski racing. The effect of warm weather can be disastrous. In 2002, above-average winter temperatures delayed the opening of the Rideau Canal Skateway and resulted in one of the shortest skating seasons on record, lasting only 34 days. Only half as many ice skaters took part in the festival as in previous years. Researchers have determined that average winter temperatures colder than -8°C produce skating seasons of at least 50 days, whereas warmer winter mean temperatures exceeding -5°C lead to much shorter seasons. Temperatures between -10 and -20°C are considered ideal for supporting the winter activities and ensuring good attendance.

High emissions would close the door on Winterlude

Climate models under a high-emission future project that by late this century, the number of days cool enough in February (during the 21-day event) to maintain the foundation of Winterlude's ice and snow conditions would be reduced dramatically. The models project that after 2020, it would be challenging to maintain the festival's cross-country ski races unless adaptive measures were taken to set the ski track using less than the 15-centimetre regulation snow depth. (See: Cross-Country Ski section.)

Under mid- to high-emission scenarios, the projected natural snow depth would be less than 10 centimetres during the February festival by 2050, a decrease of more than two-thirds. Researchers also estimate that under mid- to high-emission levels, the 2,000-participant cross-country ski race held in late February could have too little snow to operate by as early as 2050. This could mean inadequate snowfall that would force the cancellation of cross-country ski racing and likely many other festival activities. By 2080, under the high-emission scenario, the average maximum temperature is expected to rise during February from -5°C now to $+4^{\circ}\text{C}$ later this century, cutting the days suitable for preserving ice sculptures in half and possibly even eliminating snowmaking as even an option for snow slides and skiing. By 2080, this severe warming could reduce the skating season on the Rideau Canal to just one week.

However, researchers estimate that a low-emissions future would help protect the climatic conditions needed to host the winter activities of the festival, if combined with some adaptive measures. For example, the low-emission scenario would continue to support an ample snowpack depth during Winterlude, likely averaging more than 15 centimetres throughout this century. This would help save festival activities such as cross-country ski racing and the snow slides. The low-emission scenario could also save more than 70 per cent of the existing outdoor skating season on the Rideau Canal over this century.



PHOTO: MAIRIE DE PARIS

Solutions

Fate of winter sports, ecosystems, and global economy depends on near-term choices

Successfully confronting global warming will require comprehensive action and strong leadership from every sector of Canadian society. Winter athletes, sports enthusiasts, and winter recreational retailers and tourism industries have a lot to lose as their lifestyles and livelihoods could be among the first victims of global warming unless carbon emissions are cut significantly.

Winter sports athletes and businesses have a vested interest in taking action, and they are also in an excellent position to show leadership by inspiring others to act. They are influential role models for millions of fans and sports enthusiasts, as well as political leaders and other businesses. Some winter athletes have already started to take responsible action,¹⁰⁵ but even more bold leadership and action are urgently needed. This chapter describes where we can make a difference to put global warming on ice.

Avoiding thin ice – need to keep global average temperature below 2°C threshold

As discussed in Chapter 1, many leading scientists and even governments such as the European Union have concluded that to avert dangerous levels of global warming, worldwide efforts must ensure that global average temperatures do not exceed a 2°C increase from pre-industrial levels.

The United Nations recently called for an agreement to reduce global greenhouse gas emissions by more than half of today's levels by mid century. An important distinction based on international law and fairness is that rich, industrialized nations such as Canada would have to cut their domestic emissions more than poorer developing countries, as industrialized countries like Canada are more responsible for fuelling the global warming problem and have better capacity to develop clean-energy technologies.¹⁰⁶ Industrialized countries, representing less than one fifth of the world population, are responsible for about 75 per cent of the harmful build-up of greenhouse gas emissions in the Earth's atmosphere since the start of the industrial era.¹⁰⁷



A recent UN report outlining the level of effort for an effective global response to climate change suggests that industrialized countries should take responsible action and cut emissions in the range of 25 to 40 per cent below 1990 levels by 2020 and at least 80 to 95 per cent by 2050.¹⁰⁸ This global effort to reduce emissions would help protect our communities and the global economy from catastrophic impacts such as severe storm events that cause flooding or severe droughts and water shortages. In fact, a recent report by an international team of economists and energy experts concluded that even sweeping measures to reduce global emissions to the level required are affordable and could deliver multiple co-benefits like increased energy security, better air quality, and modern energy systems to the world's poorest countries.¹⁰⁹

One of the biggest misconceptions in Canada's debate on climate change is that strong action would harm our economy. Canada's leading economists disagree. In 2008, more than 200 of Canada's top economists wrote to federal political leaders with key economic solutions. They recommended, above all, putting a price on carbon emissions and stated, "Canada needs to act on climate change now."¹¹⁰ Furthermore, a groundbreaking study by one of Canada's leading economic and environmental firms (commissioned by the David Suzuki Foundation and the Pembina Institute) concluded that Canada's economy can still grow by almost 20 per cent in the next decade while the country reduces its greenhouse gas pollution to 25 percent below the 1990 level.¹¹¹ The study shows that Canada could take decisive action and still continue to enjoy strong net job growth and other economic benefits. By 2020 Canadians would save more than \$5.5 billion each year at the gas pump because of more efficient vehicles, more public transit, and shorter commutes. To achieve the emission target, Canada would require a significant price on global warming (carbon) emissions as well as targeted regulations and investments to expand the use of clean technology.



"With both a direct impact to our sport, and our own contributing behaviour, responsibility for action begins with us. I want my children and grandchildren to enjoy the sport as much as I do. That means action begins with this generation, not shifting the burden to the next."

- DAN ROYCROFT, MEMBER, CANADIAN CROSS COUNTRY SKI TEAM

Reducing Emissions

Because of the scale of problem, governments play a key role in the solution

Because of the scale of carbon-dioxide emissions that need to be reduced to limit the atmospheric build-up to reasonably safe levels and the concerted effort needed from all sectors of the economy, governments play a critical role in solving global warming. The federal and provincial governments have the power to put in place binding regulations, energy-efficiency (consumer) standards, and green financing. Moreover, economic signals from the energy and transportation sectors can reduce our dependence on fossil fuels and help with the transition to a clean, renewable energy-based economy. Local governments also have a crucial role in reducing emissions through the design and planning of cities and communities to minimize the distances needed to move people and goods. Municipalities can use land-use zoning to influence where people live, work, and play. Municipal

Key federal and provincial government policies needed to reduce global warming:

- 1 Implement an action plan to meet our international commitments** and set binding targets to reduce Canada's (and provincial) greenhouse gas emissions by at least 25 per cent below 1990 levels by 2020, and at least 80 per cent below 1990 levels by 2050. Developed countries must meet these science-based targets to avoid dangerous climate change.
- 2 Put a price on carbon emissions** through both a carbon tax and cap-and-trade system. Economic studies conclude that putting a price on carbon emissions will spur innovation and use of clean, renewable-energy solutions as well as create new economic opportunities in the growing global green-energy sector. These policies address one of the fundamental problems fuelling Canada's contribution to global warming: The atmosphere is treated as a free waste dump for harmful, heat-trapping greenhouse gas emissions. Both a carbon tax and an emission cap-and-trade system provide strong incentives for companies and households to pollute less by investing in clean-energy technologies and adopting greener practices.¹¹²
- 3 Enforce binding regulations** that put a hard cap on carbon emissions from large industrial emitters (cap-and-trade system) such as the oil and gas and electricity sectors, which currently account for half of Canada's carbon dioxide emissions. The industrial emission cap should be reduced steadily over time at rates that fall in line with science-based emission targets.
- 4 Adopt stringent fuel-efficiency standards**, such as the California standard or better, for personal vehicles as well as commercial and industrial trucks.
- 5 Implement ambitious targets and timelines** to transform Canada into a global leader in the manufacturing and use of renewable energy systems including solar and wind power. These targets should be achieved by applying long-term federal and provincial financial incentives for renewable energy generation. Renewable energy incentives known as "feed-in tariffs" have made Denmark, Germany, and Spain leading global renewable-energy generators, manufacturers, and exporters. For effective results, this strategy should be combined with strong workforce training programs and access to low-interest financing so Canadians can apply a wide variety of renewable-energy technologies in their homes, public spaces, and businesses.
- 6 Set strong national targets** for electricity conservation and energy-efficiency standards in order to reduce absolute electricity needs over time. This should include pursuing electricity-conservation opportunities, strengthening energy-efficiency standards for new appliances, and enhancing energy-efficiency codes for new homes and buildings. State-of-the-art home, hospital, and office-building design can achieve significant use of green heat, lighting, and cooling technologies.
- 7 Scale-up funding for a sustainable transportation network** across Canada including investments in high-quality infrastructure for public transit, walking, biking, and a more efficient rail network for goods-movement. A green goods-movement strategy should shift container shipments from heavy diesel trucks to more efficient rapid rail, and require ships in port to plug into clean electricity sources instead of running heavily polluting engines.
- 8 Phase out dirty and unsustainable power sources** such as coal-fired and nuclear power. A first step should be to phase out public subsidies to both sectors. For example, subsidies to the oil and gas industries are estimated to be more than \$1.4 billion a year.¹¹³ Nuclear subsidies include publicly backed accident insurance and financial guarantees provided by government¹¹⁴. Yet these costs do not include long-term disposal of nuclear waste, a problem that has yet to be solved.
- 9 Require that all government infrastructure proposals include a transparent analysis** of the global warming emission implications and life-cycle costs. Only low-emission options should be chosen for investment and construction.
- 10 Create a provincial fund** to support municipal government investment in measures to reduce emissions and adapt and plan for the future. This funding would be allocated to yearly budgets and long-term plans for capital expenditures.
- 11 Assist municipalities** in implementing growth-management strategies to prevent urban sprawl. Legislation should ensure that the vast majority of new growth comes from properly managed infill development, resulting in more compact and pedestrian-friendly communities.
- 12 Put in place strong targets** to reduce municipal waste and require landfills to capture methane and use it for heat and electricity generation.



governments can also shape the layout of transportation systems like public transit but depend on upper levels of government for much-needed infrastructure funding.

Spurring Canadian ingenuity and innovation in the fight against global warming

Strong government action through financial signals (both incentives and disincentives) and binding regulations is essential to spur innovation and, most importantly, to get clean, renewable energy and sustainable transportation technologies into use in Canada. This offers an exciting opportunity for Canada to be the “build it” nation when it comes to solutions to global warming versus being the “buy it” nation of clean technologies if we continue to delay action. By placing the full potential of Canadian ingenuity into this new economic direction, Canada can create thousands of new jobs and new investment in the rapidly growing clean-energy sector.

Industrialized countries such as Germany that have been taking the lead in renewable energy are already experiencing significant economic benefits and jobs while achieving large reductions in emissions. In the past two years, Germany’s renewable-energy sector has grown nearly 50 per cent and now employs over 236,000 workers¹¹⁵. In 2006 alone, the deployment and operation of renewable energy technologies in Germany generated \$36 billion (22.9) and is estimated to have reduced Germany’s greenhouse gas emissions by 44 million tonnes¹¹⁶, equivalent to removing 8.8 million cars from the roads. Furthermore, the most comprehensive economic study on climate change projects the global market for low-carbon energy technologies will be worth at least US\$500 billion annually and perhaps much more by 2050.¹¹⁷

In addition to government policies to reduce the root cause of the problem, global warming emissions, many adaptation measures for winter sport activities and cultural events are necessary. These adaptive strategies include the use of new technologies and practices, changes to winter-event and tourism planning, and even business and financial strategies. The following chapter discusses how these measures will need to be implemented or ramped up with some continued degree of climate change.

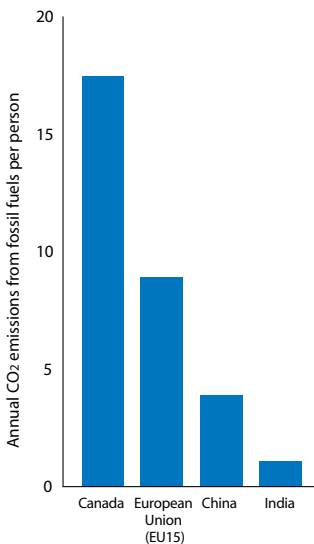


FIGURE 6. Canada’s annual carbon dioxide emissions per person compared to other countries.

Source: World Resources Institute (2009)
CAIT 6.0

Canada is falling behind on global warming action

Canada has one of the worst records of any industrialized country on confronting climate change, as greenhouse gas emissions have been allowed to rise more than 22 per cent since 1990 (more than 29 per cent above Canada’s international obligations under the Kyoto Protocol).¹¹⁸ One of the fundamental problems behind Canada’s contribution to global warming is that our country has treated the atmosphere as a free waste dump for harmful, heat-trapping emissions. The OECD has criticized Canada for failing to account for these costs by pricing carbon pollution (using the polluter-pay principle) in our economic system and for largely

relying on voluntary measures to reduce our emissions.¹¹⁹

The federal government has yet to put a significant cost or firm limit on carbon pollution. For example, it has offered no strong financial measures such as an emission tax or regulations to reduce pollution from large industrial emitters, firms, and households. In 2007, several prominent studies evaluated the federal government’s proposed plan on climate change and concluded that the policies are ineffective and that Canada’s overall carbon dioxide emission levels are unlikely to decrease at all unless stronger policies are adopted.¹²⁰



Adapting to Climate Change

As shown previously, the emission choices we make today can largely limit the degree of global warming and its consequences. Although it is critical that we lessen the degree of global warming by reducing emissions now and in the future, preventing global warming entirely is not an option. This is because the effects of emitting and accumulating heat-trapping greenhouse gases in the atmosphere are not instantaneous. Emissions building up from current activities will intensify global warming to some degree in the future. As a result, some level of adaptation to climate change will be required for winter sports including cultural events and tourism.

Below, options and examples are explored that can help shield Canada's winter sports culture and the communities that rely on winter conditions from the future effects of unavoidable climate change.

Adaptation examples – Downhill ski and snowboarding areas

Ski areas, although some unintentionally, have already started to prepare and adapt their operations to shorter winter seasons and rising snow lines brought on by global warming. Efforts so far appear to be focused on reactive adaptation using technology options versus proactive changes in behaviour or planning.¹²¹ Many ski resorts are adapting to changing winter conditions by investing millions of dollars in energy-intensive snowmaking technology to reduce their vulnerability and increase the potential average ski season. In Europe, ski-area operators spend a significant share of revenue, 8.5 per cent, on maintaining and operating snowmaking systems (\$219,000 is the average cost to cover one hectare with machine-made snow in Europe¹²²). In Austria, nearly \$1.3 billion has been spent on artificial snowmaking systems since 1995.¹²³ Projections show that, under the business-as-usual high-emissions scenario, snowmaking in some regions of Canada will have to increase by more than 160 per cent by 2050 to temporarily maintain ski opportunities.¹²⁴

We used to go above the Arctic Circle in Scandinavia for early-season snow, and now we find temperatures that are too warm to make snow. It has become common practice for Nordic skiing hotspots to stockpile man-made snow in the middle of winter. In the spring, they cover the snow with woodchips to keep it insulated until they spread it out in November. Then the entire World Cup community, sometimes more than 500 people, flocks to the three-kilometre loop.

– SARA RENNER, OLYMPIC CROSS-COUNTRY SKI MEDALIST FOR TEAM CANADA



Whistler Blackcomb ski resort recently built a \$52 million gondola – the most expensive ski lift in North America – to link two high-elevation ski areas that were previously accessible via low-elevation ski terrain. The new lift allows skiers to avoid skiing to valley bottom where snow conditions are more vulnerable to global warming and serves as year-round tourist attraction.¹³¹

PHOTO: PAUL MORRISON

Even so, under this high-emissions scenario, some regions would likely lose ski and snowboarding opportunities entirely. There are significant economic and environmental costs. Snowmaking is energy-intensive and can be environmentally harmful as it consumes large amounts of water from local watersheds and ecosystems. In the European Alps, snowmaking equipment is estimated to consume the same annual amount of water as a city of 1.5 million people.¹²⁵ Additional stress on water resources can also be met with political opposition. Recently, concerned citizens and local mayors in B.C. urged government to halt, or hold a comprehensive public hearing, on a water licence that would allow a ski resort to remove the equivalent of up to 30,000 swimming pools of water from a river listed as endangered.¹²⁶

Furthermore, snowmaking costs are estimated to increase substantially as average winter temperatures rise and physical and economic constraints are reached.¹²⁷ Currently, most snowmaking systems require an outdoor temperature of -2°C or lower to be effective. Chemical additives can raise this snowmaking temperature threshold to 0°C , but a recent study has shown that these additives may affect plant growth and suggests that more research is required to assess the long-term environmental impacts.¹²⁸

Other adaptation options for the ski industry include grading slopes and removing rocks and stumps so that less snow coverage is needed for reliable skiing. However, these techniques can increase the risks of considerable damage by rock and landslides, flash flooding, habitat degradation, and soil runoff into fish habitat.¹²⁹

More environmentally friendly landscaping techniques are available to prolong the snowpack. Retaining and planting trees to partially shade ski runs can extend the snow required by up to 30 days. Putting up snow fences on wind-exposed slopes that capture moving snow can lengthen the ski use by 15 days. Daily cleaning and maintaining ski runs can add seven days to the ski season by increasing the snow's ability to reflect sun rays.¹³⁰

Some ski resorts are seeking to expand their operations or are proposing to build new areas in less vulnerable terrain at higher elevation or on north-facing slopes. But while these areas may have a longer snow seasons, they may also face constraints and undesirable ski conditions as intensified global warming at high elevation is predicted to cause more extreme precipitation and higher winds, which could result in a greater risk of avalanche from unstable snowpacks. Not only is this a costly adaptation strategy, it can be met with significant local resistance as some ski areas have been proposed for parks or sensitive wildlife-protection areas.

At the extreme, to preserve glacier skiing in Switzerland, white plastic sheeting has been spread over some glaciers to reflect solar rays and reduce melting during the summer months. However, this tactic will not prevent the eventual disappearance of glaciers if global warming is allowed to significantly intensify.

Financial adaptation strategies: Winter event organizers may glean lessons from Europe's ski industry

Recently, ski resorts in Europe that rely on tourism have adopted financial adaptation strategies through the use of weather insurance and marketing incentives. These financial

strategies could also be used for winter cultural events and festivals as a means to shelter their bottom lines from potentially severe economic losses due to unseasonably warm winters that force the cancellation of events.

Weather insurance is a contract whereby an insurance company will pay a winter operator (e.g., ski resort) if unfavourable weather or snow conditions occur during a period in the winter. The contracts can be flexible and can be based on a series of weather conditions or timing criteria.¹³² During the 1999-2000 ski season the Vail Resorts ski corporation in Colorado bought snow insurance and was paid nearly US\$14 million due to a lacklustre season with few skier visits.

However, with growing public understanding of the risk of climate change, the financial sector has increased insurance premiums to a threshold so high that even large ski corporations such as Intrawest and Vail resorts no longer purchase weather insurance.¹³³ Although weather insurance can help reduce the financial losses of a ski resort from sporadic snow-deficient winters, it cannot protect against a systematic long-term trend toward warmer winters.¹³⁴

Some ski areas, especially in Europe and Australia, are now experimenting with marketing incentives to lure skiers to book ski holidays or visits when uncertain ski conditions may loom. This strategy involves providing flexible ticket and accommodation pricing whereby the final price is linked to the percentage of ski terrain or number of ski lifts open.

Adaptation example: New business models and the diversification of tourism revenues

One response to climate change, whether deliberate or unintentional, concerns the potential for ski areas or winter-tourism destinations to reduce costs and business risk by co-operating or merging with other businesses or communities. In these cases, ski areas may choose this adaptation strategy as a means to reduce costs by sharing equipment and staff, conducting joint marketing activities, or forming a regional network of ski resorts under a single ski pass. More drastic measures like ski-area mergers are aimed at achieving similar results, such as reducing competition by increasing market share, benefiting from synergies, and increasing the diversity of regions and activities, or tourist packages offered. Another business model includes a resort company or ski conglomerate that offers a wider range of services, such as hotel bookings, travel, restaurant services, and winter sports activities, owning ski areas in different locations and countries. These large corporations have better access to capital, marketing resources, and regional diversification and therefore tend to have better adaptive capacity to climate change.¹³⁵ However, some communities have resisted this approach as they feel they may lose local control to large business interests over community planning and decision-making.

Adaptation example: Backcountry skiing

Backcountry skiing and snowboarding have grown in popularity over the past decade in Canada. Whether in Quebec's Chic-Choc Mountains or B.C.'s Coast Range, backcountry ski enthusiasts enjoy the solitude and wilderness experience and the opportunity to escape busy lives in the cities.



To preserve glacier skiing in Switzerland, white plastic sheeting has been spread over some glaciers to reflect solar rays and reduce melting during the summer months.

PHOTO: HANS SCHREIER, UBC



Many ski resorts in Canada are diversifying their revenues by offering summer activities such as mountain biking to their business model.



To get drier and deeper snowpack conditions, backcountry skiers and snowboarders will likely have to put out more energy to get to higher-elevation terrain.

PHOTO: CHRIS JOSEPH

But backcountry skiing and snowboarding are more vulnerable to global warming because they rely on natural snowfall. That said, backcountry enthusiasts have more options to adapt to the changing conditions than skiers at fixed-location resorts. For example, backcountry skiers can plan to ski in regions less vulnerable to warmer temperatures or choose areas nearby at higher elevation. To get drier and deeper snowpack conditions, skiers and snowboarders will likely have to put out more energy to get to higher-elevation terrain.

Adaption for tourism events: Winterlude Festival, Ottawa region

In the Ottawa region, Winterlude event organizers have reduced vulnerability to warmer winters by managing the timing of the festival. By rescheduling the festival dates from a continuous 10-day event to hosting it over three consecutive weekends, organizers were able to ensure a higher likelihood of favourable winter conditions for at least part of the new 21-day window, which provided added flexibility for event programming.¹³⁶

Because ice skating on the Rideau Canal is the primary attraction during Winterlude, and ice conditions are highly sensitive to increased winter temperatures, organizers are considering building an artificial outdoor ice rink. The proposed rink would be able to operate up to temperatures of +15°C. It should be noted that this will be a costly and energy-intensive adaptation measure if pursued.

IMPLICATIONS OF ADAPTATION FOR GOVERNMENTS

Government plays an increasingly important role in the promotion and management of climate change adaptation measures for the winter-sports sector. Foremost, government can assist Canada's winter-sport sectors and event planners by providing the best available information on the science and risk of global warming by region so that proper planning and decisions for adaptation strategies can be made.

But another critical government responsibility that will only increase with time will be to ensure proper environmental and social safeguards are in place to protect the environment from the potential negative impacts created by the implementation, or over-implementation, of adaptation measures¹³⁷. For example, without proper government regulations and management, the potential increase in artificial snowmaking could fuel massive water extractions from sensitive watersheds or community water supplies.

In addition, the effects of global warming on Canada's winter-sport regions, or between small and large businesses and communities, will not be equal. Lower-elevation ski areas will face greater adaptation challenges than higher-elevation resorts. Small business or community-owned ski areas or winter sport festivals have fewer resources and less financial capacity to invest in costly adaptation measures than large corporations and businesses.

Because the impacts of climate change will be felt disproportionately and a significant disparity in adaptive capacity exists for different communities, governments should identify vulnerable communities that depend on winter sports culture for their economic livelihoods and assist these communities in developing adaptation strategies and diversifying their local economies. This support could come in the form of financial assistance to implement adaptation strategies or transition local economies, or training programs to create new jobs.

In any case, government policy should aim to support sustainable adaptation strategies that protect winter sports culture to the best degree possible while providing long-term, environmentally sustainable economic opportunities.

LIMITS OF ADAPTATION

As we have seen, there are options and planning tools to help protect our winter sports culture and festivals from the future effects of unavoidable climate change already set in motion from past emissions. But the ability for Canada's winter sports and culture to adapt and deal with the symptoms of global warming is limited and costly.

In Canada's ski areas, once temperatures reach a certain threshold, snowmaking becomes too expensive and difficult to be viable. For skiing, glaciers can be covered in the summers with plastic sheeting to help minimize melting. But this will not prevent their disappearance should temperatures continue to increase dramatically. Weather insurance can help reduce the financial losses of a ski resort from sporadic snow-deficient winters but cannot protect against systematic long-term trends toward warmer winters. With significant action to cut carbon emissions, new cross-country ski-track-setting technology that requires less snow depth is expected to preserve 80 per cent of the ski season in southern Ontario over this century. But a high-emission future would likely wipe out the cross-country ski season in this region within the next 40 years.

Despite the need to plan and adapt to some level of unavoidable global warming, we must reduce greenhouse gas emissions from fossil fuels and other sources of emissions such as deforestation to achieve a low-carbon future. Only with concerted efforts to reduce emissions and put in place adaptation plans will we be able to avert the most severe consequences of climate change and protect the future of winter sports and our communities.





Spurring Action with Leadership

Winter-sports athletes, businesses, communities, and sporting-event organizers can all play an influential role in galvanizing government and Canadians into action to reduce global warming. Below are some examples, and in some cases opportunities, where those involved in winter sports can show leadership that can spur others to act.

2010 Olympic Winter Games, Vancouver, B.C.

“Climate Change is at the top of our environmental agenda, having set an early goal of a carbon neutral Games.”

– VANOC CEO JOHN FURLONG

Olympic Winter Games rely on ice and snow. But they also generate significant volumes of heat-trapping carbon emissions that cause global warming. These emissions result from the substantial energy used to heat buildings, make snow, freeze ice sheets and sliding tracks, and transport athletes and spectators from around the world.

The Vancouver Organizing Committee for the 2010 Olympics (VANOC) stated in its bid commitments that it would “move towards a zero emissions Games”, and top VANOC executives have reiterated the goal of a “carbon neutral” Olympics in public statements. The International Olympic Committee (IOC) has also officially recognized “environment” as the “third pillar” of the Games along with sport and culture, suggesting that environmental concerns like climate change are a critical issue to be addressed by Olympic organizers. VANOC has adopted this vision, but the challenge is for VANOC to make its commitment a reality.

According to initial estimates by the David Suzuki Foundation in a report commissioned by VANOC, *Meeting the Challenge*, the amount of greenhouse gases associated with the activities of the Vancouver 2010 Winter Olympics will total approximately 330,000 tonnes.¹³⁸

This is the equivalent of adding 66,000 cars to our roads for a year¹³⁹.

Recent Winter Games (Salt Lake City 2002 and Turin 2006) attempted to limit greenhouse gas emissions produced by improving public transit and by accounting for emissions from events (e.g., torch relay) and venues. But so far no Winter Olympics organizing committee has come close to taking responsibility for its overall climate change impact to become “carbon neutral” with a net zero emission footprint.

Other large sporting events, including the FIFA World Cup Soccer, and even the Super Bowl, have gone carbon neutral. The most recent FIFA World Cup Soccer event held in Germany in 2006 demonstrated leadership and set a precedent by using Gold Standard carbon offsets. The FIFA World Cup organizers accounted not just for direct emissions with their purchase of carbon offsets, but also for a portion of emissions associated with spectator travel.¹⁴⁰

To achieve a carbon neutral Winter Games, VANOC will need to measure its emissions, reduce emissions by investing in energy conservation, renewable energy, and public transit solutions, and purchase high-quality carbon offsets for emissions that cannot be avoided. To fund the program, VANOC could actively solicit a sponsor for the carbon offsets, in particular, as it has done in many other product categories.

At the time of writing this report, VANOC had made progress in reducing its emissions; for example, by building many of its venues to high environmental standards (Leadership in Energy and Environmental Design Standard). However, VANOC has not yet confirmed that it will fulfill its bid commitment and hold a carbon-neutral Games.

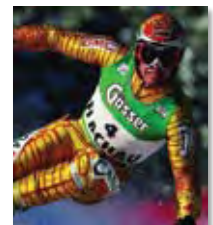
VANOC – and Canada – have the opportunity to host the first carbon-neutral Winter Games in history. (See Chapter 5 - Recommendation for 2010 Winter Games.) With more than a quarter of a million spectators expected to attend, and three billion to watch the event on TV, the 2010 Winter Games can demonstrate responsible solutions to global warming to a vast audience. In an unprecedented action, more than 70 of Canada’s top athletes wrote to the VANOC organizers in February 2009, urging them to champion a carbon-neutral 2010 Winter Games. The athletes also called on other Canadians to write to VANOC and voice their own support for a carbon-neutral Games. (See www.davidsuzuki.org/Climate_Change/Projects/Olympics/.)

Olympic athletes “Play It Cool” to stop global warming

“The sports we love are threatened by global warming. And what’s happening in the mountains is just an early warning of more climate impacts to come if we fail to take action. If we continue business as usual, scientists say we’re going to live in a world quite different from the one we are used to.”

– THOMAS GRANDI, CANADIAN ALPINE SKI TEAM

After witnessing first-hand the threat of global warming on their sport and culture, Olympic athletes have teamed up with the David Suzuki Foundation to promote action on climate change and environmental responsibility. These athletes are led by Canadian alpine skiing





Whistler recently installed a sustainable-energy system to heat an entire neighbourhood – the Athletes' Village for the 2010 Games. The district energy system will capture heat from a nearby wastewater treatment plant and supply 95 to 99 per cent of the space heating and hot-water needs of more than 35,000 square metres – equivalent to more than 300 homes. Moreover, the project will reduce the carbon footprint for heating by about 65 to 75 per cent while saving 12 to 20 per cent on energy bills.

PHOTO: WHISTLER 2020
DEVELOPMENT CORPORATION

stars Sara Renner (Olympic silver medalist) and Thomas Grandi, and today include more than 70 top athletes and Olympic medallists from alpine, freestyle, and cross-country skiers to speed skaters and snowboarders. This innovative program has also attracted summer athletes and Olympic medallists including kayaker Adam van Koeverden, the entire men's eight rowing team, and mountain bikers. The appeal of going carbon neutral is widespread among Canada's national team athletes, from windsurfers and wrestlers to skiers and speed skaters.

The initiative involves the David Suzuki Foundation calculating their travel and hotel emissions, individual athletes reducing their carbon emissions, and athletes purchasing high-quality carbon credits to offset the carbon footprint produced by their extensive travel schedule. To ensure environmental integrity, only Gold Standard carbon offsets will be purchased through this program.¹⁴¹

The popularity of the program is evidence of athletes' commitment to tackling climate change and highlighting positive solutions. Play It Cool provides a platform for them to demonstrate action and integrity.

Hockey players put global warming on ice

Hockey players are also fighting global warming by teaming up with the *Play It Cool* program. Led by Boston Bruins' defenceman Andrew Ference, the NHLPA Carbon Neutral Challenge was launched in 2007 as a partnership between the National Hockey League Players' Association (NHLPA) and the David Suzuki Foundation. Participating players take action by offsetting the greenhouse gas emissions associated with playing professional hockey and are also encouraged to make changes in their personal lives. More than 500 NHL hockey players signed up in the first year of this player-driven initiative. Their commitment to account for their full climate impact sends an important message to athletes, fans, other sporting organizations and government, that leadership and action are required to protect pond hockey – the grassroots of one of Canada's most cherished sports.

U.S. ski industry launches "Keep Winter Cool"

In an effort reduce the risk of global warming and protect future opportunities for skiing and snowboarding, more than 60 U.S. ski resorts, along with the Natural Resource Defense Council, have launched "Keep Winter Cool", an initiative to raise visibility and public understanding of global warming and advance existing solutions to the problem. The program combines political action and green-energy purchases to fight global warming.

Today, 64 ski resorts power all or part of their operations with clean, renewable energy – reducing emissions by the equivalent amount of avoiding 196,000 round-trip flights between Fredericton, N.B. and Vancouver, B.C. Of these 64 resorts, 34 are 100 per cent green-powered. In May 2007, the U.S. ski industry wrote the U.S. government calling for "aggressive" bi-partisan action with a mandatory cap to reduce greenhouse gas emissions from major sectors such as industry and transportation to safe emission levels.¹⁴²

In Canada, the ski industry as a whole has yet to launch a climate change action strategy, although several ski resorts are purchasing green power. Moreover, the Resort Municipality of Whistler, joint host of the Vancouver 2010 Winter Games, has been actively working toward its global warming emission-reduction targets since 1997, and developed the first integrated energy, air quality, and greenhouse gas management strategy in Canada (2003). Even though Whistler has experienced rapid growth, the community has achieved a nine per cent decrease in greenhouse gas emissions from levels in 2000. The local government in Whistler has also committed to detailed annual corporate carbon and energy emissions inventories, a dedicated carbon busters (action) team, and substantial energy-conservation investments on key municipal building assets.

What does carbon neutral mean?

Going carbon neutral is an easy way to take responsibility for the greenhouse gases we create every time we burn fossil fuels to power our cars or heat our homes. Foremost, we should reduce our emissions wherever possible. But for any remaining emissions that may be difficult to reduce, we can effectively counter them by purchasing what are known as “carbon offsets”.

WHAT IS A CARBON OFFSET?

Carbon offsets are a means to counteract carbon dioxide emissions by investing in projects that reduce the amount of carbon emissions in the atmosphere by an equivalent amount. Projects can include wind farms, solar installations, or energy-efficiency projects. However, not all carbon offset projects have tangible environmental benefits, which is why high-quality standards must be put in place to ensure that key environmental criteria have been met by offset projects. These standards include ensuring emissions reductions are real and measurable and that the offsets are invested in projects that wouldn't have happened without the funding.

WHAT IS A “GOLD STANDARD” CARBON OFFSET? ¹⁴³

In response to these concerns and others, an international standard for carbon offsets, known as the “Gold Standard”, was developed. Gold Standard is supported by more than 50 environmental organizations as it employs the best practices contained within the Kyoto Protocol and ensures that all projects that get approved are verified by reputable third parties.

As with any purchase, buyers need to choose their carbon emission offsets carefully. For example, although quite popular, offsets from tree-planting projects are particularly problematic for a number of reasons, including their lack of permanence and the fact that these projects do not address the root cause of global warming, reducing our dependence on fossil fuels. This is why tree-planting projects are explicitly excluded by the Gold Standard label. But one thing must be clear: carbon offsets aren't a substitute for the need to reduce emissions with concerted government and individual action.



Recommendations

PHOTO: VISION QUEST

One of the most important things we can do at home, at work, and in our personal lives is to show our friends and community that action on global warming is important and encourage them to act. The good news is that there are effective actions that various groups can do to protect the future of Canada's winter sport culture and communities.

What federal and provincial governments can do:

1. Implement an action plan to meet Canada's international commitments by reducing emissions to safe levels as supported by science (25 per cent below 1990 levels by 2020, and at least 80 per cent below 1990 levels by 2050).
2. Introduce a price on carbon emissions through both a carbon tax system and cap-and-trade system to spur innovation and clean-energy solutions.
3. Adopt stringent fuel-efficiency standards, such as the California standard or better, for personal vehicles as well as commercial and industrial trucks.
4. Implement ambitious targets and timelines to transform Canada into a global leader in the manufacturing and use of renewable-energy systems including solar and wind power.
5. Scale up funding for a sustainable transportation network across Canada including investments in high-quality infrastructure for public transit, walking, biking, and a more efficient rail network for goods-movement.
6. Phase out dirty and unsustainable power sources such as coal-fired and nuclear power.
7. Assist municipalities in putting into place growth-management strategies to prevent urban sprawl.

(For more recommendations, see Chapter 3 – “Solutions”.)

What winter tourism communities and municipal governments can do:

1. Conduct detailed annual greenhouse gas emissions and energy inventories of municipal operations and infrastructure. These analyses will identify areas with the greatest potential to reduce emissions and save on energy, while also demonstrating informed leadership.
2. Develop an integrated energy, air-quality, and greenhouse gas management strategy and create a dedicated staff team to carry out the necessary measures to reduce community-wide emissions and energy consumption.
3. Make substantial investments in energy-conservation initiatives for key municipal building assets. This will reduce local government emissions and quite often substantially reduce long-term operating costs.
4. Develop a land-use and transportation plan with the aim of building transit and pedestrian-friendly communities where residential areas are close to areas where residents work and play.



What VANOC and the 2010 Winter Games can do:

1. Commit to making the 2010 Winter Games carbon neutral (i.e., net zero greenhouse gas emissions).
2. Ensure that all major emissions from the Games are measured, and reduced where possible, or offset, including emissions resulting from spectator air travel.
3. Use only high-quality carbon offsets. In recognition of the international nature of the Olympics, VANOC could use a portfolio of high-quality offsets from B.C. and Canada, and also at least 20 percent from international offset projects that meet the Gold Standard, the highest standard in the world for carbon offsets. Using carbon offsets from renewable-energy and energy-efficiency projects will help promote sustainable energy use in Canada and in less developed countries.
4. Implement a high-profile public outreach campaign for the Games that describes VANOC's climate initiatives and engages athletes, officials, sponsors, spectators, and the general public, and leaves a legacy of climate solutions in the region.

What winter sport businesses and tourism operators can do:

1. Learn how to manage your business's greenhouse gas emissions with the David Suzuki Foundation's new how-to guide, *Doing Business in a New Climate*. See: www.davidsuzuki.org/Publications/Doing_Business_in_a_New_Climate.aspx
2. Power your business and operations with clean, renewable energy. Many electricity utilities offer green power or sell renewable energy, and also offer programs to help you conserve electricity or switch to more energy-efficient equipment for your business.



Some ski resorts are building and generating renewable energy on-site.

PHOTO: VIKKI FAIRBANK

3. Provide bike lockers and facilities for employees and customers and set-up an employee transit-pass program.
4. Encourage all levels of government to take responsible action to reduce global warming in order to protect the future of winter sports in Canada.

What ski resorts can do:

1. Develop a national climate change action strategy for Canada's winter tourism and ski industry to advance government climate change policy as well as solutions for the industry such as required targets for renewable energy power. A first step should be to pledge support for the principles of the Tourism Industry Association of Canada's "Canadian Charter of Sustainable Tourism".
2. Develop a climate change action plan to measure and reduce greenhouse gas emissions associated with all resort operations (find helpful tips in the David Suzuki Foundation's new how-to guide, *Doing Business in a New Climate* listed above). Set greenhouse gas emission targets for your business to support what leading scientific institutions such as the UN's expert scientific body are calling for.
3. Invest in energy-efficiency and renewable-energy initiatives as part of your operating budget and long-term investment strategy. Commit to using renewable power for at least 50 per cent of your energy needs.
4. Inform guests (e.g., through signs, brochures) of actions they can take to reduce their carbon emissions.
5. Provide lift-ticket discounts for those skiers and boarders who take sustainable transportation, such as the bus, to the hill. If a bus service or car-pool network is not readily available, work with local municipalities to make sure sustainable transportation options are a top priority.
6. Set up a website that can help facilitate skiers and snowboarders to carpool from home to the hill and back, and offer priority parking for those who carpool to the hill.

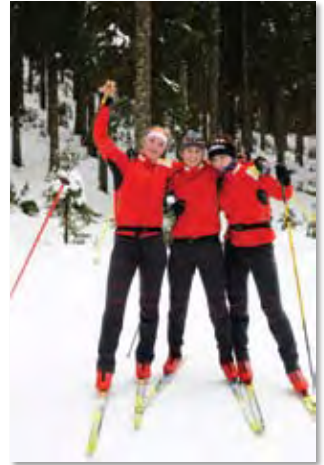
What winter sport clubs can do:

1. Make climate change science and solutions a key part of your club's educational and advocacy mandate.
2. Host a presentation as part of your next club meeting on the solutions to climate change. Request a climate change presentation from The Climate Project Canada, an affiliated group of Al Gore's initiative to raise public awareness. Visit www.climateprojectcanada.org
3. Include personal tips on climate change solutions in every club newsletter or on the club's website, and update them regularly.
4. Urge your club to examine its carbon emission footprint and implement strategies, targets, and timelines to decrease it. Consider offsetting any remaining emissions with high-quality Gold Standard carbon offsets.

5. Ask your club's executive board to write a letter to all levels of government calling for stronger action to reduce Canada's greenhouse gas emissions in order to protect the future of Canada's winter sports culture.

What winter athletes and the general public can do:

1. Take a picture that celebrates your winter sport and email it to your MP with a call for stronger action to reduce Canada's global warming emissions in order to protect the future of Canada's winter sports culture. (Find your MP's email www.parl.gc.ca)
2. Go carbon neutral (see Resources below).
3. Minimize your climate change impact when enjoying winter sports – for example, by carpooling or taking the bus with friends to the ski hill or mountains.
4. Professional athletes and Olympic athletes can consider joining programs like Play It Cool, which work to share solutions to global warming.
5. Visit the David Suzuki Foundation's website for an up-to-date action list of what you can do. See: www.davidsuzuki.org/Climate_Change/What_You_Can_Do





Conclusion

Future of winter sports and Canada's culture in our hands

As shown in this report, winter sports and the culture they support in Canada are highly vulnerable to the effects of global warming. The emission choices we make today will result in profoundly different climate futures and consequences over the next few decades and for the next generation. These decisions will not only have profound implications for winter sports and its culture in Canada, but will dramatically determine the health of our communities, our economies, and our ecosystems. Practical solutions exist, but large-scale, global concerted action from government, business, and individuals is urgently required in the near term.

Canada can play an important role in spurring international action to reduce global warming, but in order to do so we must demonstrate leadership by putting in place policies to drastically reduce emissions here at home. By following through with these efforts and joining the legions of other countries and jurisdictions around the world that are taking action, Canada can help galvanize the international action required to address this serious problem while creating new economic opportunities in green-energy solutions and technologies.

But rapid action is needed. Winter sport athletes, businesses, and event organizers, such as the Vancouver 2010 Winter Games, can play influential roles to help inspire Canadians toward a far-reaching and effective response. Through their leadership, winter-sports enthusiasts can assist through education about the solutions to climate change and by encouraging all levels of government to put in place the policies needed.

Only with concerted international action to reduce global warming and keep the global average temperature below the 2°C threshold, coupled with adaptation measures by Canada's winter outdoor sector, will we be able to protect the majority of the winter-



sports seasons. But the window of opportunity is small. Delaying or postponing action to reduce carbon emissions and put in place adaptive measures would likely wipe out most of Canada's winter-sports culture.

For the sake of winter sports and Canada's culture, we must act now.

"It is hard to beat taking a deep breath of cool, clean, crisp winter air when I am out on the pond skating or hiking up a hill to get some fresh powder. To me, keeping the air and water clean and our environment healthy is priority number one, without it nothing else matters. This is why I try to do all I can in my life, including going carbon neutral, to ensure that my kids and future generations can experience the beauty and wonder that is our natural world."

— ANDREW FERENCE, BOSTON BRUINS DEFENSEMAN



PHOTO: COURTESY
OF NHLPA

RESOURCES

Play It Cool

www.playitcool.ca

NHL Players' Association Carbon Neutral Challenge

www.davidsuzuki.org/Climate_Change/Play_it_cool/NHLPA/

Meeting the Challenge

www.davidsuzuki.org/Publications/Meeting_the_challenge.asp

Melting Mountains

www.davidsuzuki.org/Climate_Change/Mountains.asp

Go Carbon Neutral

www.davidsuzuki.org/Climate_Change/What_You_Can_Do/carbon_neutral.asp

Keep Winter Cool

www.keepwintercool.org

Going, Going Green – Sports Illustrated

sportsillustrated.cnn.com/2007/writers/alexander_wolff/07/05/eco0312/index.html

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NOTES

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- 40 *Ibid.* p. 86-88.
- 41 IPCC (2007b), p. 634.
- 42 *Ibid.*
- 43 Scott and Dawson (2008).
- 44 IPCC (2007a) Ch. 11, p. 889-890.
- 45 IPCC (2007a) Ch. 11, p. 891.
- 46 Scott and Jones (2006) p. 11.
- 47 See Scott and Scott et al. listed in "References".
- 48 Rodenhuis et al. (2007) p. 67. By 2100 the CO₂ equivalent global greenhouse gas concentration is roughly 600ppm for the low-warming scenario, and 1250 ppm for the high-warming scenario. Note: Scientists estimate that atmospheric concentrations of greenhouse gas emissions (CO₂ equivalent) must be kept below 400 parts per million (ppm) to avoid the risk that global average temperatures exceed 2°C above the pre-industrial level – a threshold that if exceeded is defined as "dangerous" climate change by many scientists and governments including the E.U. See David Suzuki Foundation and Pembina Institute (2005) *The Case for Deep Reductions: Canada's Role in Preventing Dangerous Climate Change*
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- 53 Scott and Jones (2005)
- 54 Canadian Ski Council (2006) and (2008)
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- 98 *Ibid.*
- 99 Calculated using *Water Use Data* from Environment Canada (2005).
- 100 Demuth and Pietroniro (2003); and Stahl and Moore (2006).
- 101 Scott et al. (2005). p. 1.
- 102 This estimate was calculated based on the assumption that winter tourism expenditures account for approximately 17 per cent of total Canadian tourism expenditures. [Source: Wilton and Wirjanto (1998). In 2007, year-round tourism generated \$28.6 billion (GDP) and provided 653,400 jobs in Canada. [Source: Canadian Tourism Commission (2007). Year-in-Review, Facts and Figures.]
- 103 See: <http://www.vancouver2010.com/en/Sustainability>.
- 104 Scott et al. (2005).
- 105 See: http://www.davidsuzuki.org/Climate_Change/Projects/Olympics/.
- 106 For more information on the Principle of Common but Differentiated Responsibilities see: http://www.cisd.org/pdf/brief_common.pdf
- 107 World Resources Institute (2008). Note: From the period 1850 to 2004, industrial nations (Annex I countries of the UNFCCC) have been responsible for 75 per cent of the human-caused build-up of greenhouse gas emissions in the atmosphere, whereas developing countries, representing 79 per cent of the population, have contributed 24 per cent to the problem.
- 108 UNFCCC (2007). and IPCC (2007c), Ch. 13, box 13.7, p.776.
- 109 IPCC (2007c). Summary for Policy Makers.
- 110 New Release (October 6, 2008) *220+ of Canada's leading economists call for action on climate change* <http://www.newswire.ca/en/releases/archive/October2008/06/c3777.html> (accessed February 8, 2009).
- 111 M. K. Jaccard and Associates (2008). See: http://www.davidsuzuki.org/files/reports/preliminary_en.pdf
- 112 Stern (2007). and IPCC (2007c).
- 113 Taylor et al. (2005). Note: These oil and gas industry subsidies include accelerated tax write-offs for capital expenses, subsidies for building, upgrading, or maintaining roads used for resource extraction, and reduced royalty rates.
- 114 Winfield et al. (2006); Note: The costs of decommissioning Ontario's existing reactors have been estimated at \$7.474 billion
- 115 German Federal Ministry for the Environment (2007) available at www.erneuerbare-energien.de
- 116 *Ibid.*
- 117 Stern (2007).
- 118 Environment Canada (2008).
- 119 Organization for Economic Co-operation and Development (2004); Note: Canada's revenues from environmental charges are equivalent to 1.3 per cent of GDP, the second lowest of OECD countries and well below the OECD average of 2.5 per cent. See David Suzuki Foundation/SFU (2005) *The Maple Leaf in the OECD* www.davidsuzuki.org/files/WOL/OECD-English.pdf
- 120 Jaccard and Rivers (2007). And Bramley (2007).
- 121 Agrawala et al. (2007).
- 122 *Ibid.* p. 46. Based on an exchange rate of € Euro = \$1.61 CAD.
- 123 *Ibid.* p.
- 124 Scott and Jones (2006).
- 125 Agrawala et al. (2007). citing CIPRA.
- 126 See media release: <http://www.boundaryalliance.org/big%20white%202008.pdf>.
- 127 Scott and Jones (2006). p. 11.
- 128 Agrawala et al. (2007). p. 46.
- 129 *Ibid.*
- 130 *Ibid.* p. 37.
- 131 Ebner, D., Globe and Mail (December 6, 2008) *Just because it's rad*
- 132 Scott et al. (2005). p. 55.
- 133 Agrawala et al. (2007). referencing Scott (2006).
- 134 *Ibid.*
- 135 *Ibid.*
- 136 Scott et al. (2005).
- 137 Agrawala et al. (2007).
- 138 Carlson and Lingl (2007). Note: This estimate is based on greenhouse gas emissions associated with energy use during the 2010 Winter Games and has been audited by Price Waterhouse Coopers. This figure does not include emissions associated with the construction of venues or activities associated with the preparation for the 2010 Winter Games.
- 139 Assuming one car produces approximately five tonnes of CO₂e per year.
- 140 See: <http://www.oeko.de/oekodoc/292/2006-011-en.pdf>.
- 141 More information on going carbon neutral and the "Play It Cool" campaign can be found on the David Suzuki Foundation website at: http://www.davidsuzuki.org/Climate_Change/What_You_Can_Do/carbon_neutral.asp.
- 142 See National Ski Areas Association web site: http://www.nsaa.org/nsaa/environment/climate_change/.
- 143 See: http://www.davidsuzuki.org/Climate_Change/What_You_Can_Do/carbon_offsets.asp.

Canadians playing pond hockey on the prairies, skiing down the powdery faces of the Canadian Rockies, skating along the Rideau Canal, cross-country skiing through Quebec's forests, building snow forts in communities across the country – these are just some of the images that define the Canadian identity.

This report examines how the decisions we make now about our response to global warming, including choices to reduce carbon dioxide emissions and implement adaptive measures, will ultimately affect the future of winter sports and the role they play as part of Canada's identity, natural heritage, and economy.

The David Suzuki Foundation is committed to achieving sustainability within a generation in Canada. A healthy environment is a vital cornerstone of a sustainable, prosperous future.



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