Canada's Rivers at Risk

Environmental Flows and Canada's Freshwater Future

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Canada's River's at Risk

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KEY TERMS

Average discharge: A measure of the long-term average volume of water flowing out of a river or stream. The Mackenzie River has an average discharge of 9,020 cubic metres per second (m^3/s) – equivalent to approximately 3.5 Olympic swimming pools draining every second. In contrast, the Grand River, with its average discharge of 34 m^3/s, drains the equivalent of 0.014 Olympic swimming pools per second.

Boundary river: A river that *forms* a political border. Borders can be between countries or within countries (in Canada, between provinces or between provinces and territories). See also **transboundary river**.

Canadian Heritage River: A river recognized nationally for its importance to Canada's river heritage. Upon review by the board of the Canadian Heritage River System (CHRS), ministers responsible designate, by formal proclamation, nominated rivers that satisfy the selection criteria and successfully pass the approval process.

COSEWIC: The Committee on the Status of Endangered Wildlife in Canada. COSEWIC is group of wildlife experts that assesses the status of species at risk in Canada. The Canadian Endangered Species Conservation Council (CESCC) uses COSEWIC assessments to develop species conservation strategies.

Floodplain: The flat land adjacent to a stream or river that is inundated by water during high-flow periods.

IJC: The International Joint Commission. The IJC is an independent, binational organization that aims to prevent and resolve water-related disputes between Canada and the United States and provide counsel on the effective management of shared water resources.

Important Bird Area: A site that Bird Life International – a global partnership of conservation organizations – recognizes as providing critical habitat for bird populations.

Interbasin diversion: The unnatural movement of water (e.g., through a pipe or a canal) from one basin (or watershed) to another.

Mainstem: The principal river in a watershed into which water from smaller streams and rivers (i.e., tributaries) in the basin eventually flow.

Ramsar wetland site: A wetland identified as being of international importance, especially as waterfowl habitat, under an intergovernmental treaty – the Convention on Wetlands – commonly referred to as the Ramsar Convention.

Transboundary river: A river that *intersects* (flows across) at least one political border. Borders can be between countries or within countries (in Canada, between provinces or between provinces and territories). See also **boundary river**.

UNESCO World Heritage site: A site that the United Nations Educational, Scientific and Cultural Organization World Heritage Committee (UNESCO) recognizes as having great cultural or natural significance.

Watershed: An area of land that collects and drains precipitation through streams, rivers, and other outlets into a common body of water. It is also known as a basin, catchment, drainage basin, or river basin.

Summary

Canada is among the world's most water wealthy nations. But missing from this story is a critical component of freshwater health: *flow*. Evaluating the health of our freshwater resources from the perspective of river flow and nature's needs, as opposed to raw quantities, yields a more sobering picture of fresh water in Canada. It also provides insight into key threats, and the actions needed to avert a crisis and maintain Canada's most precious natural resource.

A river's flow regime – its natural pattern of high and low flows – is much like blood pressure in the human body: a vital indicator of overall ecosystem health. If we wish to maintain the many social, cultural, and economic benefits that rivers provide – a reliable water supply, fish and other foods, water purification, and spiritual and recreational values – then we must maintain the flow regimes that support these benefits. The science of environmental flows provides a framework for better understanding flow regimes and the tools needed for protecting and restoring river health.

Given the mounting pressures on the planet's finite fresh water, maintaining river flows is a growing challenge. Many of the world's rivers are at risk from the impacts of producing more food, generating electricity, fuelling industry, and quenching the thirst of expanding cities. Climate change further compounds these problems by introducing new threats and uncertainties.

Canada's Rivers at Risk assesses how these many pressures are affecting environmental flows in 10 of the nation's rivers. Overall, their status is troubling, and the forecast less certain than we might expect. Three primary threats to freshwater flow emerge:

Flow regulation and fragmentation by dams, locks, and weirs have altered flows and water levels, and species are suffering;
Water withdrawals and diversions for cities and agriculture are drawing down rivers, some to dangerous levels;
Climate change is altering the entire context of water management, as glaciers melt, precipitation patterns shift, and droughts and floods become more frequent and intense.

Flow regimes in some of Canada's most important rivers, such as the South Saskatchewan and the St. Lawrence, have been modified to the extent that ecosystems are in serious trouble. Soon many others – including some of the planet's increasingly scarce large, free-flowing rivers like the Skeena, the Athabasca, and the Mackenzie – could be in trouble as well, as demands on their waters grow and climate change intensifies.

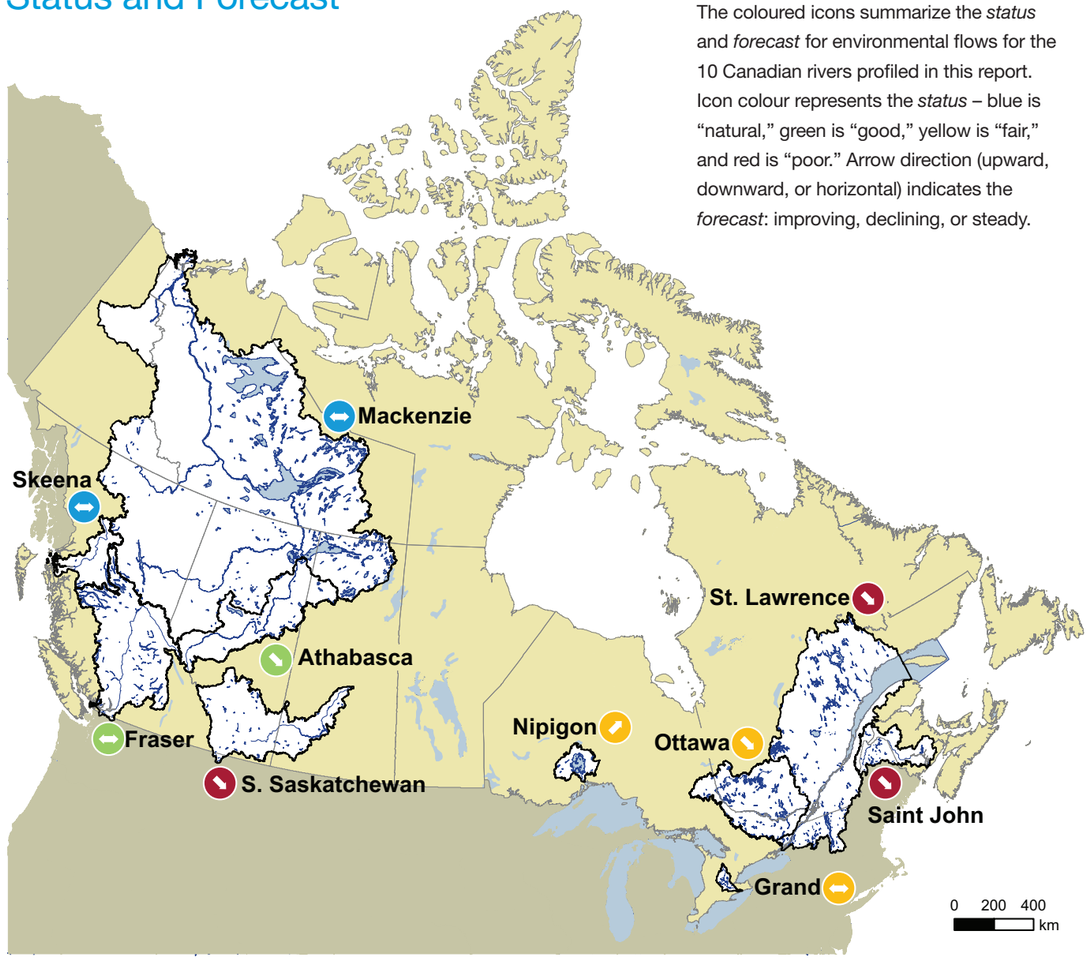
Yet Canada, unlike many countries, still has the opportunity to avert a national water crisis by keeping rivers flowing, for nature and for people – but only if we take immediate action:

Take aggressive action on climate change. Be part of the global solution to stopping climate change by helping to create and implement a fair, effective, and science-based global agreement, while reducing Canadian emissions and protecting rivers here at home as the climate changes.
Keep water use within nature's limits. Maintain water withdrawals within each watershed's sustainable limits and prohibit interbasin transfers that move water from one watershed to another.
Change the flow. Design and operate dams and other instream infrastructure to better balance nature's needs (the flow regimes required to sustain healthy rivers) with human needs for hydropower, navigation, flood control, and water storage.

Acting on these three key steps will require changes to how we manage fresh water in Canada. We will need to focus on whole watersheds, applying the principles of Integrated River Basin Management to ensure coordination of the conservation, management, and development of fresh water. Federal and provincial governments must lead the way, collaborating with a broad range of stakeholders, to protect and restore environmental flows and river health as a foundation of a secure freshwater future for Canada.

Environmental Flows in Canada's Rivers: Status and Forecast

The coloured icons summarize the *status* and *forecast* for environmental flows for the 10 Canadian rivers profiled in this report. Icon colour represents the *status* – blue is "natural," green is "good," yellow is "fair," and red is "poor." Arrow direction (upward, downward, or horizontal) indicates the *forecast*: improving, declining, or steady.



The 10 rivers assessed in *Canada's Rivers at Risk* and their watersheds

Why These 10 Rivers?

The 10 rivers included in *Canada's Rivers at Risk* represent a range of geographical regions and ecosystems within the country's major drainage basins (Pacific, Arctic, Hudson Bay, and Atlantic). The rivers range from pristine and free flowing to highly modified and managed systems. They are rivers of national significance – a number cross or form international or interprovincial/territorial borders, many are critical to Canada's primary industries, such as fishing, mining, or forestry, and some are of particularly high national conservation value. The intent in focusing on these rivers is to draw attention to the diversity of existing and potential threats to environmental flows in Canada's rivers, and to highlight examples of where efforts have been made to mitigate these issues and where they remain unaddressed.

Introduction

Nothing, perhaps not even climate change, will matter more to humanity's future on this planet over the next century than the fate of our rivers.

– Fred Pearce, *When the Rivers Run Dry*

Nowhere on the planet are fewer people stewards of such vast freshwater resources as in Canada. The country ranks among the world's top nations in terms of renewable water supply and shares the planet's largest freshwater ecosystem – the Great Lakes. Such global treasures make Canada enviable in an increasingly thirsty and warming world.

But this perspective is misleading. Water is constantly moving, and it is this constant motion – *the flow of water* – that provides much more insight into the availability of fresh water and the health of freshwater ecosystems than do national statistics or global rankings based on volume alone. Focusing on flow draws attention to the scale that matters most when it comes to fresh water – the watershed. Nature's boundaries, not political boundaries, define when and where water flows, and how much is available, both for nature and for people.

Healthy rivers provide many goods and services that we tend to take for granted: a reliable water supply, fish and other foods, water purification, and cultural, spiritual, and recreational values. If we wish to maintain these vital functions and values, then we must maintain the river flows that are fundamental to them. In this sense, water flow is much like blood pressure: a vital – but not the sole – indicator of ecosystem health.

The concept of environmental flows provides the scientific foundation for defining how much water a river needs to remain healthy and productive. It is based on the understanding that there are limits to the degree to which we can modify natural water flows, by withdrawing and diverting water or building dams and other instream infrastructure, before freshwater ecosystems – and the many social, cultural, and economic benefits they provide – become compromised. Put differently, the concept of environmental flows changes fundamentally the perspective and question underlying fresh water management. It forces us to look at water use from ecosystem outward – to answer the question of *how much water we can use* by first asking *how much water the river can give*.

READING THE REPORT CARDS:
STATUS & FORECAST

The *status* and *forecast* of environmental flows for the 10 rivers are shown in coloured icons that summarize the information included in individual report cards for each river.

Blue indicates a ***natural*** status; flows are not noticeably altered from the natural regime, and key species and ecosystems that depend on natural flows are generally healthy. The horizontal arrow indicates a ***steady*** forecast.

Green indicates a ***good*** status; flows are slightly altered from the natural regime, but key species and ecosystems remain generally healthy. The downward arrow indicates a ***declining*** forecast.

Yellow indicates a ***fair*** status; flows are increasingly altered from the natural regime and there is evidence of negative impacts on key species and ecosystems. The upward arrow indicates an ***improving*** forecast.

Red indicates a ***poor*** status; flows are substantially altered from the natural regime, and key species and ecosystems that depend on natural flows are significantly affected. The downward arrow indicates a ***declining*** forecast.

What Are Environmental Flows?

The Brisbane Declaration, a widely endorsed global call to action to protect the world's rivers, provides the most common definition of environmental flows:

> *Environmental flows describe the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems*.

Every river exhibits its own natural flow regime that is an expression of the local and regional climate interacting with the geology, soils, and vegetative cover in the river's watershed. The flow regime includes the variable pattern of high and low flows that occur in any given year and across many years. River scientists agree that flow regime is a fundamental determinant of the health of a river. But addressing environmental flows is as much a social process as it is scientific study. Science plays an important role in assessing the impacts of human water use on river health, but effectively addressing environmental flows ultimately depends on a range of stakeholders with various interests deciding together to take action.

About the Report

Canada's Rivers at Risk assesses the *status* of environmental flows in 10 Canadian rivers, and provides a *forecast* of likely future conditions. The report focuses on the impacts of three key threats to environmental flows – *flow regulation and fragmentation*, *water withdrawals and diversions*, and *climate change* – and identifies actions to address these threats. It is based on scientific information drawn from publications by academics, governments, industry organizations, and environmental NGOs, complemented by interviews with 22 experts from these sectors who have detailed knowledge about specific rivers. The full technical study on which this report is based is available online at ***wwf.ca/rivers***.

Environmental flow assessments are summarized in individual report cards for each of the 10 rivers. In the top right corner of each report card is a coloured icon that represents the status and forecast for each river (the icons are described above). The *status* is based on evaluation of the cumulative impacts of the key threats noted above. The *forecast* indicates the likely trajectory of the status of environmental flows in each river, based on evaluation of potential future threats, such as increased water withdrawals or construction of new dams, as well as current and proposed measures aimed at protecting and restoring environmental flows.

Environmental Flows:
Threats and Impacts

Threats to environmental flows in Canada are the same as those affecting rivers around the planet. *Modification of flows by dams and other instream infrastructure, growing water withdrawals and diversions, and the pervasive threat of climate change* can result in grave consequences for the integrity and biodiversity of rivers, and often for the communities and economies that are so intimately linked to them.

Flow Regulation and Fragmentation

Flow regulation and fragmentation by dams and other instream infrastructure such as locks, weirs, and dikes are significant threats to environmental flows in the world's rivers. In 2000, there were 849 large dams and thousands more smaller dams in Canadian rivers and streams. While the era of dam building in Canada was once thought to be over, growing demand for low-carbon energy supply (e.g., hydropower) is now driving new construction. New proposals and projects of various sizes – from small-scale projects to large-scale developments – are emerging across Canada.

Dams and other instream infrastructure affect freshwater ecosystems by altering flow patterns and severing connections between different parts of a river, by disconnecting rivers from floodplains and wetlands, and often by storing water that would naturally flow freely downstream.

Withdrawals and Diversions

Globally, freshwater withdrawals – the removal of water from ecosystems for use in agriculture, industry, and municipalities – have risen 35-fold in the past 300 years and have increased by 20% per decade since 1960. In Canada, the five main water users are thermal power generation, manufacturing, municipalities, agriculture, and mining. Some water uses are more consumptive than others. Consumptive use removes water from a river system and makes it unavailable for further use downstream, posing a greater threat to environmental flows than do uses that return water directly into the same water body or watershed. Irrigation is the largest consumptive use of water; according to Environment Canada, 94% of water withdrawn for agriculture in Canada in 2005 was consumed.

Diversions – when water is artificially moved between watersheds – can cause a decrease or an increase in river flows; both can have negative impacts. Canada diverts more water from one watershed to another than any other country on earth.

Withdrawal and diversion of large amounts of fresh water can significantly alter the quantity and timing of river flows. *When* water is withdrawn or diverted is as important as *how much*. Taking water during low flows and droughts typically has a greater impact on river health than does taking water during other periods.

Cumulative Impacts at the Watershed Scale

Taken individually, *flow regulation and fragmentation*, *withdrawals and diversions*, and *climate change* can have significant impacts on environmental flows and river health. Watersheds are complex systems, however, and rarely does a single threat occur in isolation. What matters most – and what typically garners the least attention – is how these pressures come together at the watershed scale. Urban planning, proposals for new dams and infrastructure, and applications to withdraw or divert more water are typically considered individually, through different regulatory and decision-making processes. The key challenge, then, in effectively addressing environmental flows is to consider the cumulative impacts on rivers of multiple stresses – both existing and potential – and to understand how threats interact with one another and possibly result in magnified impacts and unexpected consequences.

Climate Change

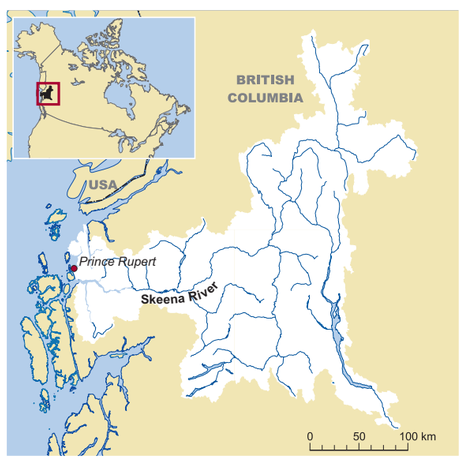
Evidence shows that climate change will result in – and indeed is already causing – significant changes to water cycles globally and locally. Even small changes in temperature and precipitation can result in relatively large changes in the magnitude and timing of flow, and the intensity of floods and droughts. In a recent review of worldwide changes in river flows, scientists concluded that the traditional assumption of "stationarity" – which assumes that river flow data from the past can be used to predict the availability of water in the future – is almost certainly wrong in this new era of climate change.

Studies show that maximum river flows are generally decreasing across most of Canada and that spring runoff is occurring earlier than in the past. These effects of climate change are expected to persist and intensify in the foreseeable future, and will be particularly problematic in regions where other stressors are already affecting environmental flows. Climate change is also likely to intensify competition for water resources, making protection of environmental flows even more challenging in the future.

Skeena River

AT A GLANCE

Length: 580 km
Average Discharge: 1,760 m^3/s
Watershed Area: 54,432 km^2
Major Drainage Basin: Pacific Ocean
Jurisdiction: British Columbia



Skeena River Watershed

Flowing unimpeded from its headwaters in northern British Columbia, the Skeena River rushes southwest through the Coast Mountains to meet the Pacific Ocean south of Prince Rupert. The river and its watershed support incredible biodiversity and natural resources, most notably the salmon that begin life here and return years later to spawn in its pristine waters.

Rugged mountains, dense forests, grizzlies, and ancient totem poles characterize the Skeena watershed. Numerous fish species inhabit the river, including oolichan, lake and cutthroat trout, Dolly Varden, and five salmon species. The regional economy and culture depend significantly on the Skeena. Its natural flows sustain Canada's second largest wild salmon fishery, worth almost $110 million annually. Salmon are the foundation of the rich First Nations culture of the watershed, where fishing continues in the traditional way today as it has for millennia.

Development has not yet compromised environmental flows in the river but soon could. Proposed mines, coal bed methane fields, oil and gas pipelines, and run-of-river hydropower projects, all of which could negatively affect flow regime, are examples of the recent unprecedented development interest in the Skeena watershed.

ENVIRONMENTAL FLOWS
STATUS: **Natural**
FORECAST: **Steady**

Flow Regulation and Fragmentation
- The mainstem is free flowing and unaffected by flow regulation and fragmentation

Withdrawals and Diversions
- Relative to total flow, withdrawals from the mainstem are not a major concern
- Because of low flows in tributaries, withdrawals for agriculture in the interior of the watershed are cause for some concern

Climate Change
- Average air temperature in the watershed is expected to rise by 2.4 to 6.4˚C by the 2050s

- There are eight current licences and seven active applications for run-of-river hydropower projects in the watershed
- An area the size of Vancouver Island in the headwaters has been licensed for coal bed methane extraction; such development could reduce important groundwater contributions to river flow
- A combination of low rainfall and increasing water withdrawals is raising concern over low flows, which prevent salmon from reaching spawning beds in Maxan Lake
- Average annual and late summer flows have declined in the interior of the watershed since the 1930s
- A 56% decrease in snowpack is expected by 2050, which will cause lower summer flows

Looking Ahead

In the Skeena, we have the opportunity to protect one of the continent's scarce wild rivers. However, an independent scientific review panel recently expressed concerns that current regulations and existing water management are inadequate for safeguarding wild salmon habitat from the cumulative impacts of development projects in the watershed.

Concern is growing over the future of the Skeena. NGO advocacy and a two-year protest and blockade by members of the Tahltan First Nation helped gain a moratorium on coal bed methane development in the river's headwaters. Opposition is growing to a proposed pipeline that would bring oil from the Athabasca oil sands through the Skeena watershed to a potential supertanker port on the B.C. coast. Local residents and others advocating responsible development of independent power projects are closely watching development of run-of-river hydropower. But emerging changes to provincial policy may improve protection of environmental flows. The B.C. government's Living Water Smart initiative states that by 2012 water laws will improve ecosystem protection, and that legislation will recognize the flow requirements of ecosystems and species.

Protecting the Skeena will require proactive steps to ensure that development occurs in a sustainable way. Watershed scale governance based on principles of ecosystem based management is emerging as a promising approach to securing a vibrant and thriving Skeena watershed for future generations.

Mackenzie River

AT A GLANCE

Length: 1,738 km
Average Discharge: 9,020 m^3/s
Watershed Area: 1,800,000 km^2
Major Drainage Basin: Arctic Ocean
Jurisdictions: NWT, Yukon, British Columbia, Alberta, Saskatchewan

Mackenzie River Watershed

Named *Deh Cho*, or "big river," by the Dene people, the Mackenzie River flows northward from Great Slave Lake through pristine wilderness to the Arctic Ocean. One of the world's few large wild rivers, the free-flowing Mackenzie is a remarkable ecosystem of continental and global importance.

Draining 20% of Canada's land mass and gathering waters from British Columbia, Alberta, Saskatchewan, Yukon, and NWT, the Mackenzie watershed intersects many political boundaries. Approximately 7,800 people, 70% of whom are Aboriginal, live near the river in 13 communities.

At its mouth, the river deposits vast quantities of sediment, forming the magnificent Mackenzie Delta, which supports numerous species of land and marine mammals, fish, and birds. Seven internationally recognized Important Bird Areas occur near the Mackenzie's shores. One of the most productive ecosystems in northern Canada, the Mackenzie Delta depends on the river's flow regime to feed its more than 50,000 lakes. The river provides 11% of freshwater flow into the Arctic Ocean, playing a significant role in regulating ocean circulation and Arctic climate systems. As climate change and development in northern Canada intensify, protection of environmental flows will be critical to securing the health of the river as well as the species and people that depend on it.

Flow Regulation and Fragmentation

- Flow regulation and fragmentation moderately affect the river
- The mainstem is free flowing; a large dam alters flows of a major tributary, the Peace River

Withdrawals and Diversions

- Relative to total flow, withdrawals from the mainstem are not a major concern
- Large withdrawals for oil sands development are taken from the Athabasca River, a major tributary of the Mackenzie

Climate Change

- Average air temperature in the Mackenzie Delta region has increased by 1.7˚C over the past century – more than anywhere else in Canada
- The Arctic is warming faster than anywhere else on earth

ENVIRONMENTAL FLOWS

STATUS: **Natural**
FORECAST: **Steady**

- The W.A.C. Bennett Dam on the Peace River has reduced seasonal flow variations in the Mackenzie River
- Summer flow in the Slave River declined by 35% between 1950 and 2005 due to the combined effects of the W.A.C. Bennett Dam and climate change
- Spring runoff is beginning earlier; warmer temperatures could reduce flow in the Mackenzie and negatively affect its fragile delta ecosystem
- Climate change is expected to magnify the negative impacts of the growing Athabasca oil sands development on the quantity of water flowing downstream
- Warming of the Arctic is expected to result in changes to the hydrology of northern rivers like the Mackenzie; the scope and magnitude of these changes remain uncertain

Looking Ahead

Protecting one of the planet's few remaining large free-flowing rivers will require long-term planning, given the dramatic changes expected due to climate change and the growing interest in developing the Mackenzie's water resources.

The foundations for such planning already exist, and there is growing recognition of the importance of environmental flows. The NWT government and the federal Department of Indian and Northern Affairs are developing a water resources management strategy for the territory. *Northern Voices, Northern Waters*, the discussion paper framing the strategy, proposes an objective aimed at protecting environmental flows.

Many of the threats to environmental flows in the Mackenzie, however, originate in upstream jurisdictions outside NWT. Recognizing the need to address transboundary water management issues, the governments of Canada, B.C., Alberta, Saskatchewan, Yukon, and NWT developed the Mackenzie River Basin Transboundary Master Agreement, which came into effect in 1997. It commits its signatories to a set of principles under which neighbouring jurisdictions are to negotiate bilateral agreements to manage shared waters. Unfortunately, to date only one bilateral agreement is in place.

Protecting the Mackenzie's environmental flows will depend on strong bilateral agreements between neighbouring provinces and territories. Legal analysts point to the need for stronger federal government participation to ensure that such agreements are reached. Without federal leadership upstream jurisdictions are likely to delay negotiations, or agree to only modest commitments, so as not to constrain their own future uses of the shared waters of the Mackenzie watershed.

Fraser River

AT A GLANCE

Length: 1,375 km
Average Discharge: 3,972 m^3/s
Watershed Area: 234,000 km^2
Major Drainage Basin: Pacific Ocean
Jurisdiction: British Columbia

Fraser River Watershed

The Fraser River is the lifeblood of a vast watershed that stretches from the high Rockies to the Pacific. Having sustained Aboriginal cultures for thousands of years, the watershed is now home to two-thirds of British Columbians and contributes 80% of the province's economic output.

The Fraser River fishing industry is worth over $300 million annually. The Fraser is one of the world's greatest salmon rivers, producing more salmon than any other river on earth. White sturgeon, North America's largest freshwater fish, which COSEWIC lists as endangered, also live in the river. Along the lower Fraser, extensive diking and drainage for flood control and agriculture have altered flows and reduced the extent of wetlands and habitat, negatively affecting freshwater life. Salmon are highly sensitive to changes in water flows and temperature, and have recently declined markedly in the river. Sockeye returns from 2007 to 2009 were the lowest observed in 30 years. Habitat degradation and the damming of tributaries also coincided with significant recruitment failure (a major decline in the number of fish reaching adulthood) in white sturgeon.

The mainstem of the Fraser River remains free flowing. However, flow regulation and fragmentation of tributaries, and demand for water for agricultural and urban uses will all continue to make management of flows on the river challenging.

Flow Regulation and Fragmentation
- Flow regulation and fragmentation moderately affect the river
- The mainstem is free flowing; dams on tributaries alter flow regimes

Withdrawals and Diversions
- Relative to total flow, withdrawals from the mainstem are not a major concern
- The Kemano Diversion moves two-thirds of the Nechako average flow from the Fraser watershed to the west coast for industrial hydropower generation

Climate Change
- Average air temperature is expected to rise by up to 1.7°C by 2050
- Spring runoff is occurring earlier than in the past 85 years

ENVIRONMENTAL FLOWS
STATUS: **Good**
FORECAST: **Steady**

- Downstream of the dam and interbasin diversion on the Nechako River, a Fraser tributary, summer flows have decreased by up to 60%, coinciding with recruitment failure in endangered white sturgeon
- Large water withdrawals in the interior of the watershed, especially during dry periods, have led to localized low flows and stressed freshwater species
- Record low flows and water levels have occurred in the interior due to lower snowpack, earlier melt, and warm, dry weather; these conditions are expected to persist
- Where flows have declined, water temperatures often exceed the optimum for salmonids and routinely reach lethal levels above 25°C
- If flows continue to decline, Fraser salmon may have difficulty accessing and navigating migration routes and could be seriously threatened

Looking Ahead

Keeping the Fraser free flowing and healthy is vital to a healthy and prosperous B.C. Efforts to protect the salmon and preserve the ecosystem are critical to the provincial economy and culture. A combination of provincial policy initiatives and innovative organizations provide a promising platform for protecting the river well into the future.

The B.C. *Fish Protection Act* includes provisions for prohibiting new dams on "sensitive" rivers, including a number in the Fraser watershed. B.C. Hydro has completed water-use plans for most of its generating facilities, including several on Fraser River tributaries, with the goal of balancing water use for hydropower generation and the flow requirements to maintain healthy freshwater ecosystems. More recently, provincial agencies, in collaboration with the federal Department of Fisheries and Oceans, published guidelines for evaluating the flow needs of fish as they relate to hydropower proposals, and the B.C. government, through its Living Water Smart initiative, aims to include provisions for environmental flows in revised water legislation.

Local and regional organizations are crucial to the success of these initiatives. At the watershed scale, the Fraser Basin Council is a unique partnership of public and private interests that emphasizes an integrated approach to realizing social, economic, and environmental benefits. Other innovations in water management are occurring on a smaller scale. In the Nicola sub-watershed a successful community-led process has resulted in the Nicola Water Use Management Plan, which specifies how water will be managed to balance the needs of people and ecosystems.

Athabasca River

AT A GLANCE

Length: 1,538 km
Average Discharge: 784 m^3/s
Watershed Area: 155,000 km^2
Major Drainage Basin: Arctic Ocean
Jurisdiction: Alberta

Athabasca River Watershed

The Athabasca River runs unimpeded from its source in the Columbia Icefields to the west side of Lake Athabasca. It provides the largest direct inflow of water to the Peace-Athabasca Delta – the world's largest boreal freshwater delta – which is highly sensitive to changes in natural variability in river flows and water levels.

The Athabasca supports over 30 species of fish and its upper section in Jasper National Park, designated as a Canadian Heritage River, is a popular destination for recreation. The Peace-Athabasca Delta is one of the most important waterfowl nesting and staging areas in North America; a million or more birds use the ecosystem each year during fall migration. It is recognized internationally as a Ramsar wetland site and is a significant part of Wood Buffalo National Park, a UNESCO World Heritage site. The Athabasca Chipewyan and Mikisew Cree First Nations, and Fort Chipewyan Métis rely on the river and the delta for cultural and spiritual values, as well as for commercial and subsistence fisheries.

While the upper Athabasca remains largely undisturbed, downstream the river's waters are a primary input to the world's largest energy project – the Athabasca oil sands. The rapidly increasing water demand for oil sands mining poses a serious threat to environmental flows in the lower Athabasca, particularly given the declining river flows anticipated as a result of climate change.

ENVIRONMENTAL FLOWS

STATUS: **Good**
FORECAST: **Declining**

Flow Regulation and Fragmentation

- The mainstem is free flowing and unaffected by flow regulation and fragmentation

Withdrawals and Diversions

- Oil sands operators are licensed to withdraw 441 million m^3 of fresh water from the Athabasca each year – more water than the City of Toronto uses in one year
- Water use by oil sands operations is projected to increase by more than 200% by 2015

Climate Change

- Average air temperature in the region is expected to rise by up to 4˚C by 2050
- Regional climate warming is three times the global average

- Oil sands operations are permitted to withdraw large volumes of water from the river, even during low-flow periods when fish and fish habitat are most threatened
- Only 3.3% of the water withdrawn is returned to the river; the rest ends up in toxic tailings ponds because it is too polluted to be returned to the ecosystem after use
- Summer flows in the Athabasca declined by 19.8% between 1958 and 2003, and by almost 30% since 1970
- Studies indicate that annual runoff may decline a further 30%, with minimum flows in the Athabasca declining a further 7 to 10%
- If flows decline as predicted, water supplies may be insufficient to sustain both the rapidly expanding oil sands production and the integrity of the river and the Peace-Athabasca Delta

Looking Ahead

Protection of environmental flows in the Athabasca is at the centre of one of Canada's most important freshwater decisions – the development of a new water management framework to regulate withdrawals from the river by the oil sands industry.

Phase 1 – the current, interim framework – specifies how much water industry is allowed to withdraw for different ranges of river flow in an effort to manage water use in ways that better respect the natural flow regime. While a good approach, the Phase 1 framework has been criticized for being unenforceable, not establishing incentives for industry to reduce water use, and neglecting the impact of climate change on future river flows. Importantly, it fails to establish an "ecosystem base flow" – a flow threshold below which no further withdrawals are permitted.

The Phase 2 framework – currently under development – must establish a much more robust approach to protecting environmental flows in the Athabasca. A committee representing the federal and provincial governments, industry, First Nations, Métis groups, and NGOs – including WWF-Canada – is weighing environmental, social, and economic values as it develops recommendations for the Phase 2 framework, to be submitted to government regulators by December 2009.

To effectively protect river flows and the Peace-Athabasca Delta, the Phase 2 framework must establish an ecosystem base flow, consider the effects of climate change on future river flows, and be legally enforceable. Such a framework would set a precedent for protection of environmental flows in Alberta and in Canada. Ensuring that it does ultimately depends on the leadership and cooperation of federal and provincial regulators.

Nipigon River

AT A GLANCE

Length: 51 km
Average Discharge: 330 m^3/s
Watershed Area: 24,650 km^2
Major Drainage Basin: Atlantic Ocean
Jurisdiction: Ontario

Nipigon River Watershed

The Nipigon River drains the rugged boreal landscape of Ontario's remote Lake Nipigon basin. Harnessing the river for hydropower has drastically altered environmental flows in the Nipigon, creating serious consequences for freshwater ecosystems.

The Nipigon is the largest river flowing into Lake Superior, discharging its waters to the newly created Lake Superior National Marine Conservation Area. Forty-six fish species inhabit the Nipigon River system, including rare species of sturgeon and cisco along with the largest remaining population of "coaster" brook trout, which are unique to Lake Superior. Historically found throughout Lake Superior tributaries, coasters have declined dramatically due to habitat and flow changes. Today they live in only a few tributaries, including the Nipigon.

The once turbulent Nipigon has been tamed to a series of lakes with few stretches of rapids between them. Dams constructed to generate hydropower for local needs have significantly altered river flows, but one of the most dramatic changes is a result of demand for electricity over 1,000 kilometres away in southern Ontario. The Ogoki Diversion, constructed in 1943, diverts water that naturally flowed north to James Bay southward through the Nipigon system into the Great Lakes to increase hydropower generation at Niagara Falls. Over 60 years later, the resulting increased flows continue to cause significant erosion of river banks and large landslides along the length of the river.

Flow Regulation and Fragmentation

- Flow regulation and fragmentation strongly affect the river and its tributaries
- Three hydropower dams regulate flow along almost the entire river's length

Withdrawals and Diversions

- Relative to total flow, withdrawals from the mainstem are not a major concern
- The Ogoki Diversion into the Nipigon basin has significantly changed watershed flow

Climate Change

- Average air temperature in northwestern Ontario has increased by 1 to 1.5°C over the past 100 years
- Precipitation is predicted to decline by up to 20% by 2090

ENVIRONMENTAL FLOWS

STATUS: **Fair**
FORECAST: **Improving**

- Only 3 metres of the river's original 95-metre vertical drop remains unharnessed by dams
- From the 1960s to the late 1980s, river levels fluctuated by as much as 3 metres daily, stranding fish and their eggs and drying out spawning beds
- The Ogoki Diversion increased water levels in Lake Nipigon by 0.62 metres and increased average flows in the Nipigon by 50%, significantly destabilizing the river channel
- Warmer temperatures are expected to cause earlier snowmelt and runoff, decreased summer runoff, and reduced water volumes in the watershed
- Reduced flow volumes and warmer surface water temperatures, due to climate change, could put unique brook trout at risk and alter species distributions

Looking Ahead

The Nipigon River ecosystem and its fish populations have begun to recover in recent years, as improved operations of hydropower dams have restored environmental flows to more natural conditions.

Early efforts to remediate water-level fluctuations in the river set a precedent for management of environmental flows in the province. In 1990, local Ministry of Natural Resources staff approached Ontario Hydro about modifying dam operations to reduce the extreme and frequent variations in flow that affect brook trout. An interim flow agreement was established in September 1990. Concurrently, the provincial and federal governments, Ontario Hydro, and local citizens formed the Nipigon River Management Committee.

In 1994, the interim agreement was expanded into a watershed management plan that gave the flow needs of fish high priority. The plan remains in place today, and enormous improvements in the river have been observed since the plan was established. With extreme flow fluctuations reduced, brook trout and pike populations have rebounded. A 2002 amendment to Ontario's *Lakes and Rivers Improvement Act* now requires water management plans for all dams and water-control structures. The plans must specify flow and water-level options that recognize multiple needs, including those related to fisheries, hydropower, and the environment.

Restoration of more natural flow regimes in the Nipigon demonstrates that, where the will exists, positive change is possible.

Grand River

AT A GLANCE

Length: 300 km
Average Discharge: 80 m^3/s
Watershed Area: 6,800 km^2
Major Drainage Basin: Atlantic Ocean
Jurisdiction: Ontario

Grand River Watershed

Flowing through lush agricultural land and expanding cities, the Grand River was once described as a sewer. It is now recognized as a Canadian Heritage River and is one of only two Canadian rivers to receive the prestigious International Thiess Riverprize.

The Grand River has changed enormously since European settlement began in Ontario. The draining of wetlands and clearing of forests reduced the watershed's ability to retain water and moderate high flows. The consequences were spring flooding and summer drought, which spurred an era of infrastructure development that left a legacy of numerous dams, reservoirs, and control structures throughout the watershed.

The Grand is a hard-working river. The river and its watershed are an important source of drinking water, assimilate waste from 28 water treatment plants, support a productive agricultural sector, and provide abundant recreation opportunities. Fly fishing alone contributes more than $1 million to the local economy each year. There are 82 species of fish in the watershed, representing about 50% of all fish species in Canada. Six of the 29 fish species COSEWIC lists as vulnerable, threatened, or endangered live in the Grand River.

Although the Grand's status remains fair, years of river modification and increasing water withdrawals for agriculture and urban development continue to pose challenges to securing environmental flows in the river.

Flow Regulation and Fragmentation

- Flow regulation and fragmentation strongly affect the river and its tributaries
- The watershed is highly regulated by more than 100 dams and control structures

Withdrawals and Diversions

- Withdrawals in the watershed are among the highest from any watershed in Ontario
- Demand for water is expected to grow by 57% between 2001 and 2031

Climate Change

- Average air temperature in the watershed is expected to rise by 2.6 to 5.6°C over the next century
- Precipitation is predicted to increase by 11 to 18% by 2090

ENVIRONMENTAL FLOWS

STATUS: **Fair**
FORECAST: **Steady**

- Regulation has provided flood control and flow augmentation, but has also modified the natural flow regime extensively
- Dams have fragmented the watershed and curtailed high flows that would naturally flush nutrients and sediment downstream
- Withdrawals peak when flow is at its lowest; the provincial government classifies the lower Grand as a "high use" watershed during summer low-flow conditions
- At peak demand, in the middle Grand as much as 20% of flow is withdrawn; in the Whiteman's Creek sub-watershed, permitted withdrawals exceed summer mean flows
- Warmer winters could lower water supply and reduce flows; a predicted 10% reduction in spring peak flow will decrease flushing and further reduce water quality

Looking Ahead

Managing environmental flows in the Grand River demonstrates the challenge of addressing multiple and sometimes competing interests in the waters and other resources of Canada's rivers. It also reveals that society's demands – for flood control, water supply, or electricity generation – need not undermine objectives to maintain healthy freshwater ecosystems.

A number of efforts at various scales are aimed at improving environmental flows in the Grand. Fisheries management projects include removing and retrofitting dams and reservoirs to improve fish habitat and restore free-flowing water. To better manage the impacts of water withdrawals, the provincial government has decided not to accept new applications for withdrawals during low-flow periods in "high use" watersheds such as the lower Grand. As well, the Grand River Conservation Authority has established, in collaboration with water users, a low-water response team to coordinate efforts to conserve water and keep it in the river during dry periods.

Challenges remain, however. The increasing demand for water from rapidly expanding urban centres along the Grand is a growing concern. While many municipalities in the watershed are recognized as leaders in urban water conservation, proposals to build a pipeline to bring more water inland from Lake Erie persist as local demand outstrips local supply. Discharging additional water into the Grand from beyond the watershed will have unknown effects on the flow and integrity of the river ecosystem.

Ottawa River

Flow Regulation and Fragmentation

- Flow regulation and fragmentation strongly affect the river and its tributaries
- Over 50 major dams alter flows of the Ottawa and its tributaries

Withdrawals and Diversions

- Relative to total flow, withdrawals from the mainstem are not a major concern

Climate Change

- Average air temperature has increased by 0.5°C since 1945 and is expected to rise by 4 to 5°C by 2100
- Precipitation has increased 13% since 1939 and is predicted to increase further by 5 to 17% by 2075

ENVIRONMENTAL FLOWS

STATUS: **Fair**
FORECAST: **Declining**

- Dams and reservoirs store spring runoff, reducing the magnitude of peak flows; regulation decreased the ratio of maximum to minimum flows from about 10:1 in 1870 to only 5:1 by 1930
- Dams and regulation have significant negative impacts on Ottawa River lake sturgeon populations, blocking migration routes, altering flow regimes, and disturbing spawning habitat
- Dams and development have altered floodplains; unique vegetation communities adapted to flooding and drying are now rare
- Only one set of large rapids on the lower section of the Ottawa River, the Deschênes Rapids, remains intact and mostly unaffected by dams or regulation
- Studies predict that higher temperatures and increased evaporation will reduce river flow by 1 to 8%

AT A GLANCE

Length: 1,271 km
Average Discharge: 1,950 m^3/s
Watershed Area: 146,300 km^2
Major Drainage Basin: Atlantic Ocean
Jurisdictions: Quebec, Ontario

Ottawa River Watershed

Severely fragmented by hydropower dams in both the Quebec and Ontario portions of its watershed, the Ottawa River is one of the most regulated river systems in Canada. Its natural flow regimes have been dramatically altered, compromising habitat and the diversity and distribution of the river's fish and shoreline vegetation.

Historically significant, the Ottawa provided a travel route for First Nations peoples and European explorers, fur traders, settlers, and log drivers. For 580 kilometres the river forms the Quebec–Ontario border, and the nation's capital is on its shores. The Ottawa provides drinking water for more than a million people, and numerous major dams in its watershed generate over 4,000 megawatts of hydropower and control flooding. Eighty-five fish species inhabit the river, including river redhorse and lake sturgeon – both of which COSEWIC has listed as species of special concern. The shorelines of the Ottawa provide habitat for the nationally significant wood turtle and the endangered musk turtle, and its wetlands and floodplains support more than 300 bird species, as well as rare vegetation types adapted to its cycles.

Because no comprehensive plan is in place for integrating environmental flows into hydropower operations, the river is likely to continue its decline, which climate change will only intensify.

Looking Ahead

A comprehensive, watershed-based plan to revise the operation of dams to better balance environmental objectives and hydropower generation could reverse the continuing decline of the Ottawa. As with all boundary rivers, the challenge in developing and implementing an effective water management plan lies in effective collaboration among the relevant governments, partners, and interests.

The federal, Ontario, and Quebec governments established the Ottawa River Regulation Planning Board in 1983 to ensure integrated management of dams and reservoirs in the watershed, and to minimize flooding while acknowledging the various interests of river users. The board, however, has no clear mandate to integrate environmental flows into dam operations. Each operator develops its own criteria within the constraints its respective government (Ontario or Quebec) sets out, and provincial regulations differ greatly on each side of the river. In Ontario, for example, water management plans developed by Ontario Power Generation and the Ontario Ministry of Natural Resources for the Madawaska and Bonnechere Rivers, two tributaries of the Ottawa, show how dams can be operated to better address environmental flows. However, this approach is far from the norm in the watershed.

The Ottawa is expected to be designated as a Canadian Heritage River in 2009, which may facilitate discussion of the need for an integrated management strategy for the river as a whole. Only Ontario is supporting the nomination so far, limiting the potential for a full watershed scale approach to maintaining environmental flows.

South Saskatchewan River

AT A GLANCE

Length: 1,392 km
Average Discharge: 280 m^3/s
Watershed Area: 148,000 km^2
Major Drainage Basin: Hudson Bay
Jurisdictions: Alberta, Saskatchewan

South Saskatchewan River Watershed

Heavy exploitation and an arid climate have made the South Saskatchewan River Canada's most threatened river in terms of environmental flows. In some areas, more water is allocated for use than is available and the river almost runs dry.

Flowing steeply from its headwaters in the Rocky Mountains eastward across the dry plains of Alberta and Saskatchewan, the South Saskatchewan supports hydropower, a growing population, and most of Canada's irrigated agriculture. Mountain whitefish and rainbow and cutthroat trout are found near its source in the Rockies, and threatened populations of lake sturgeon live in warmer downstream waters. Cottonwood forests in the riparian zone rely on cyclic changes in river flow, but numerous dams and reservoirs and extensive withdrawals have substantially altered flow regimes in the South Saskatchewan system. Droughts are a persistent risk in the river basin, which is located in the semi-arid Palliser Triangle region, and are expected to increase in frequency and duration due to climate change.

Flows in the South Saskatchewan have declined to crisis levels. In 2006, Alberta made the unprecedented decision to place a moratorium on new applications for water withdrawals from the Bow, Oldman, and South Saskatchewan rivers.

Flow Regulation and Fragmentation

- Flow regulation and fragmentation strongly affect the river and its tributaries
- The basin contains 13 large hydropower dams and hundreds more smaller dams

Withdrawals and Diversions

- In the basin, water allocations are the highest for any Canadian river, totalling 70% of the natural river flow

Climate Change

- Climate change is already causing warmer average air temperature and drier conditions
- The size of source glaciers decreased by 50% between 1975 and 1998

ENVIRONMENTAL FLOWS

STATUS: **Poor**
FORECAST: **Declining**

- On the Bow River, up to 90% of flow is diverted for irrigation; dramatic flow reduction sometimes makes it possible to walk across the riverbed below the Eastern Irrigation District Dam
- Rapid water-level fluctuations due to dams cause habitat instability and limit fish production; moderation of floods by dams causes a decline in riparian cottonwood forests
- Studies show that maintaining ecosystem integrity requires 85% of natural flow, yet only 30% of it is currently unallocated
- Downstream of the Gardiner Dam, summer flows have declined by 84% since the early 20th century
- Climate change will have severe impacts in the region, already the driest in Canada; the water supply is predicted to decline by 8.4% by 2050

Looking Ahead

Restoring environmental flows in the South Saskatchewan, a transboundary river, can be achieved only if Alberta and Saskatchewan work together, along with the federal government, to manage water use along its entire length.

In 2008, Alberta announced that it would review its century-old water allocation system. The review is an unparalleled opportunity to spur restoration of environmental flows in the South Saskatchewan. Water policy advocates are urging the government to set water aside specifically for the environment, and to establish legally enforceable objectives for environmental flows, supported by water management plans. Such modifications would set a new standard for water allocation systems in Canada. Downstream in Saskatchewan the story may be different. A 2004 study titled *Water Wealth: A Fifty-Year Water Development Plan for Saskatchewan* proposed the construction of four more major dams on the South Saskatchewan, which would effectively "drown" the river under a series of artificial reservoirs.

These disparate proposals reveal the challenges encountered with respect to transboundary rivers. The Prairie Provinces Water Board, and the Master Agreement on Apportionment it administers, provide a forum for addressing such challenges in the South Saskatchewan. While the agreement has served as an effective mechanism for apportioning shared water, it makes no provisions for environmental flows to support nature's water needs. Given the growing pressures of climate change, rising water demands, and new dam proposals in the watershed, modernizing the existing apportionment agreement to integrate environmental flows would benefit nature and people over the long term.

St. Lawrence River

AT A GLANCE

Length: 1,197 km
Average Discharge: 16,800 m^3/s
Watershed Area: 1,030,000 km^2
Major Drainage Basin: Atlantic Ocean
Jurisdictions: Quebec, Ontario, New York

St. Lawrence River Watershed

Flow regulation and fragmentation have dramatically altered the flow of the mighty St. Lawrence River. Climate change will further alter river flows, potentially causing dramatic consequences for economies and communities that depend on it.

Draining the Great Lakes – the world's largest freshwater system – the St. Lawrence forms a natural route inland from the Atlantic Ocean. The river sustained the Algonquin and Iroquois peoples who populated its shores, and guided European colonists and fur traders upstream to Upper and Lower Canada. It is a river of national and continental importance economically, culturally, and ecologically.

River otters, beluga whales, and more than 100 species of fish populate the river, and it provides a vital seasonal staging area for virtually all of the world's snow geese. Its watershed includes internationally recognized wetlands designated as UNESCO World Heritage and Ramsar sites. The health of these species and wetlands depends on sufficient outflow from the Great Lakes and maintenance of seasonal changes in water levels.

The St. Lawrence system has been dammed to generate hydropower, and diverted and dredged to form the St. Lawrence Seaway, which is one of the world's busiest shipping corridors. Water flows and levels have been highly modified; 20 or more of the animal and plant species that inhabit the system are listed as vulnerable, threatened, or endangered by federal, state, or provincial governments.

Flow Regulation and Fragmentation
- Flow regulation and fragmentation strongly affect the river
- Numerous dams, locks, and canals alter the flow of the St. Lawrence and its tributaries

Withdrawals and Diversions
- Relative to total flow, withdrawals from the mainstem are not a major concern

Climate Change
- Average air temperature in the St. Lawrence basin has increased by 0.5˚C since 1948 and is expected to rise by 2.2 to 4.0˚C in the next 100 years

ENVIRONMENTAL FLOWS
STATUS: **Poor**
FORECAST: **Declining**

- The magnitude of spring flooding has been reduced to protect shoreline properties; low flows have been augmented to allow for passage of shipping traffic
- The Moses-Saunders Dam near Cornwall, Ontario, which controls water levels on the upper St. Lawrence, has reduced natural variability in water levels by 70%
- Spring flows have been reduced by 2,000 m^3/s, and flows between September and March have increased by 300 to 900 m^3/s
- Flow regulation has dramatically affected wetlands: since the 1950s, meadow-marsh and emergent floating vegetation have been reduced by 50%, and wetland bird species have declined
- Modeling suggests that climate change could decrease flows from Lake Ontario into the St. Lawrence by 4 to 24% annually by 2050, and lower water levels at Montreal by 0.2 to 1.2 m

Looking Ahead

Given the poor status of the St. Lawrence and the declining forecast, restoration of environmental flows is a top priority. Evidence suggests that the supply of water reaching the upper Great Lakes (Superior, Huron, Michigan, and Erie) is declining, primarily due to reduced precipitation related to climate change. This may lead to calls for more flow-control structures in the upper Great Lakes, which could further reduce flows down stream in the St. Lawrence.

The IJC establishes operating plans for the infrastructure that controls water levels and flows in the St. Lawrence and in 1963 implemented the current plan – Plan 1958-D. Focusing on managing the river for commercial navigation and hydropower, the plan does not explicitly address environmental flows.

In 2000, the IJC commissioned a study to review Plan 1958-D and develop alternatives that consider environmental flows. Released in 2006, the study recommended three new regulation options. Of these, Plan B+, allowing for more natural variability in flows, was considered the best for restoring the health of the St. Lawrence. A majority of IJC study board members, along with environmental groups and governments in Canada and the United States, endorsed this plan. Despite support for Plan B+, the IJC announced a new option that basically represents a "business as usual" approach. The public backlash was intense, and the IJC instead agreed to postpone plan implementation and instigated a one-year review and revision process, originally scheduled to conclude by mid 2009. No public report has been released, so whether the restoration of environmental flows envisioned in Plan B+ will indeed be a priority remains to be seen.

Saint John River

AT A GLANCE

Length: 673 km
Average Discharge: 1,110 m^3/s
Watershed Area: 55,000 km^2
Major Drainage Basin: Atlantic Ocean
Jurisdictions: New Brunswick, Quebec, Maine

Saint John River Watershed

The Maliseet people called the Saint John River *Wolastoq*, or "beautiful river." Dams and impoundments have so severely disturbed the river – the longest in Atlantic Canada – that its once thriving Atlantic salmon population is now endangered.

In its upper reaches, from west of Edmundston to Grand Falls, the Saint John forms the Canada–United States border. From there it flows southeast through the provincial capital, Fredericton, and reaches the Bay of Fundy at the Reversing Falls in the city of Saint John. The floodplain of the lower Saint John encompasses Atlantic Canada's largest wetland, portions of which are designated as a protected area, a national wildlife area, and an Important Bird Area. The productivity of the wetland depends on the annual inundation of its marshes and grassy floodplains.

Three major hydropower dams on the mainstem of the Saint John – the Grand Falls, Beechwood, and Maqtaquac dams – have significantly altered its natural flow regime. In 2009 COSEWIC listed all populations of wild Atlantic salmon as "high priority candidates." Salmon in the Saint John are particularly threatened. In parts of the river the number of adult fish needed to maintain a viable, self-sustaining population is well below minimum requirements.

Currently, no plan exists to manage or restore environmental flows in the Saint John. Until one is established, the health of the river, its important habitats, and its salmon populations are likely to continue to decline.

ENVIRONMENTAL FLOWS

STATUS: **Poor**
FORECAST: **Declining**

Flow Regulation and Fragmentation

- Flow regulation and fragmentation strongly affect the river and its tributaries
- The watershed has 11 major dams; the 3 dams on the mainstem have very large impoundments

Withdrawals and Diversions

- Relative to total flow, withdrawals from the mainstem are not a major concern

Climate Change

- Average air temperature is expected to rise by 4 to 5°C over the next century
- Snowpack in New Brunswick has decreased by 25 to 50% in the past 30 years

- Large fluctuations in flow occur below dams; at one site, flow changes by up to 91% in a 24-hour period, sometimes dewatering portions of the riverbed and killing young fish
- Dams have created reservoirs that constitute nearly half of the river's length in the middle section of the watershed
- The decline of Atlantic salmon is strongly correlated with the presence of hydropower dams; in comparison to the number of salmon that returned to the Mactaquac Dam historically, only 2.7% returned in 2002
- Warmer temperatures and wet winters are expected to cause earlier spring thaws and potentially higher peak flows in the northern part of the watershed
- Higher temperatures may result in a reduction in river discharge and available water resources in southern New Brunswick

Looking Ahead

Restoration of environmental flows in the Saint John and the salmon that depend on them will require a coordinated, basin-wide plan to re-establish a more natural flow regime that better balances nature's water needs with those of hydropower generation and other uses.

The provincial *Clean Water Act* enables the Minister of Environment to regulate hydropower projects and dams, including those required to maintain a designated rate of river flow. While some dams in New Brunswick are operated to ensure minimum flow levels in rivers, generally these levels are defined arbitrarily rather than scientifically. While the Department of Fisheries and Oceans regulates a base flow requirement, current operating plans do not require dam operators to consider more specific requirements related to natural flow regimes.

Although the Saint John River is an international transboundary river, currently, no IJC committees or boards guide water management over the entire watershed, and no management vehicle exists for considering water quantity or environmental flows from a transboundary perspective. The Saint John appears to be an excellent candidate for the expansion of the IJC's International Watersheds Initiative (IWI). Already operating in the St. Croix, another New Brunswick river shared with Maine, the IWI forms boards to advance an integrated, ecosystem approach to issues in transboundary waters through enhanced local participation and strengthened local capacity.

Charting the Course Ahead

Who Is Responsible for Sustaining Canada's Freshwater Flows?

In Canada, legal responsibility for the protection and management of fresh water is shared by the federal and provincial governments. Each province has its own system of water law and policy governing allocation of water rights, development and operation of instream infrastructure, water quality, and ecosystem protection. The federal government has important constitutional responsibilities related to fisheries and fish habitat, boundary and transboundary waters, navigation, and water on First Nations land and in the northern territories. Many activities that are protected as Aboriginal rights, such as fishing, hunting, gathering, and spiritual practices, are closely tied to the health of freshwater resources. The federal government has a duty to act in the best interests of Aboriginal peoples when activities such as water withdrawals or dam development interfere with these rights.

This shared responsibility for fresh water makes protecting and restoring environmental flows particularly challenging in Canada. In some cases, it results in cooperation and collaboration; in others, it leads to tension and potential for conflict. The challenge is likely to grow as pressure on Canada's fresh water, and the rivers in which it flows, increases.

Environmental Flows and Canada's Freshwater Future

Demands on the planet's – and Canada's – fresh water are mounting. Producing more food, generating electricity, fuelling industry, and quenching the thirst of expanding cities are placing increasing pressure on Canada's rivers. As well, climate change is bringing new problems and future uncertainties in the form of melting glaciers, altered precipitation patterns, and more frequent and intense droughts and floods.

Despite these significant challenges, Canada, unlike many countries, still has the opportunity to avoid a freshwater crisis, but only if serious and sustained actions are taken to keep the country's rivers flowing, for nature and for people:

Take aggressive action on climate change. Canada must play a positive role in creating and implementing a fair, effective, and science-based global agreement to fight climate change, and implement a credible national action plan to reduce emissions. Assessing vulnerabilities and developing response strategies to adapt to the inevitable effects already under way or expected from climate change will be critical to securing healthy rivers and watershed communities. Improving the efficiency of water use is an important approach to conserving environmental flows in a changing climate.

Keep water use within nature's limits. Securing environmental flows for healthy rivers requires keeping water withdrawals within the sustainable limits of each watershed. This will mean investing in science to establish environmental flow objectives for Canada's rivers, and modifying water rights and allocation systems to clearly indicate when a river's water needs take precedence over withdrawals. Prohibiting interbasin transfers that move water from one watershed to another is fundamental to keeping water use within a watershed's sustainable limits.

Change the flow. Opportunities exist to change how dams and other instream infrastructure are managed to better balance the environmental flows required to sustain healthy rivers with needs for hydropower, navigation, flood control, and water storage. Modifying operating procedures for existing facilities can restore flow regimes in the rivers they affect to more natural conditions. Incorporating environmental flow objectives into new project proposals can prevent future conflicts and ensure that nature's water needs are considered at all stages of project development, including regulatory approvals processes, siting and design, operating procedures, and performance monitoring.

Addressing the cumulative impacts of existing and potential pressures on environmental flows and river health requires a focus on the scale that matters most – the watershed. Integrated River Basin Management (IRBM) provides a framework for coordinating the conservation, management, and development of fresh water within a watershed to advance the protection and restoration of environmental flows. As freshwater issues become more acute, IRBM will become increasingly important - particularly for boundary and transboundary rivers - as a means for avoiding conflict over fresh water and securing the economic, social, and ecological health of Canada's watersheds.

The water we use – when we turn on the tap for a drink, generate electricity, or grow food – is water that we share with all life on earth. The challenge for Canada, as one of the world's water-wealthy nations, is to protect and restore the nation's rivers while playing a leading role in feeding and fuelling an increasingly thirsty and warming world.

Federal and provincial governments must rise to the challenge by taking a leadership role on freshwater conservation in Canada, in collaboration with a broad group of stakeholders, including NGOs and watershed organizations, business and industry, local and Aboriginal governments, and citizens. The future health of Canada's rivers, and the cultures, communities, and economies that depend on them, hangs in the balance.

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