WWF

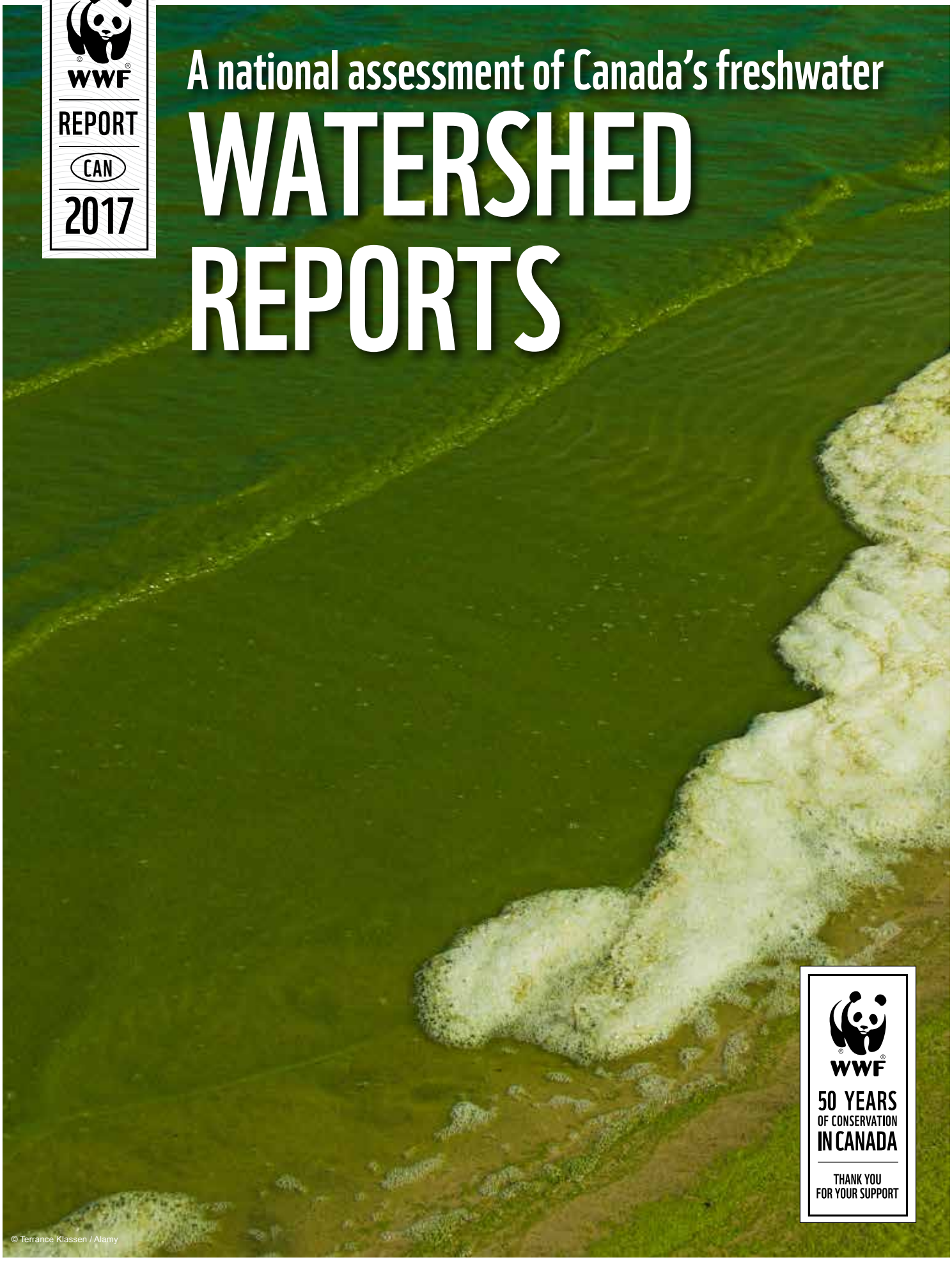
REPORT

CAN

2017

A national assessment of Canada's freshwater

WATERSHED REPORTS



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OF CONSERVATION
IN CANADA

THANK YOU
FOR YOUR SUPPORT

ACKNOWLEDGEMENTS

WWF-Canada is grateful to all those who supplied data for these reports

ACAP-Humber Arm

ACAP-Northeast Avalon

Agence de Gestion Intégrée des Ressources

Alberta Biodiversity monitoring Institute

Alberta Environment and Sustainable Development, Government of Alberta

Alberta Environment and Water

Alberta Fisheries and Wildlife Management Information System

Alberta Sustainable Resource Development

Arctic Great Lakes Observatory

Arrow Lake Environmental Stewardship Society (ALESS)

Banque de données sur la faune aquatique et son environnement (BDFAE)

Banque de données sur la quality du milieu aquatique (BQMA)

BC-Apex Creek Study

BC-Beaver River Study

BC-Glacier/Howser Study

BC-Goldstream River Sampling Study

BC-IM Red Chris Baseline Golder Study

BC-Koch Creek Study

BC-Max Molybdenum Mine Study

BC-Omineca Study

BC-Skeena BC Timber Sales Study

BC-Springer Study

Bedeque Bay Environmental Management Association

Benthic Information System for the Yukon, Yukon Environment, Government of Yukon

Bluenose Coastal Action Foundation

British Columbia Environmental Monitoring System

British Columbia Fish Information Summary System (FISS)

British Columbia Ministry of Environment

CABIN-Atlantic Study

CABIN-BCMOE-Kootenay Region Study

CABIN-BCMOE-Okanagan Study

CABIN-DFO-Mackenzie Study

CABIN-EC Columbia Study

CABIN-EC Okanagan Study

CABIN-EC Pacific Rim Western Vancouver Island Study

CABIN-EC-BISY Study

CABIN-Geoscience Study

CABIN-GovNWT Study

CABIN-IPY Study

CABIN-rivière St-Maurice Study

CABIN-SISY Study

CABIN-UWO Study

CABIN-Vancouver Island Region Study

CABIN-Windermere Study

CABIN-Yukon Territorial Government Study

Canada-Alberta Oil Sands Environmental Monitoring System

Canadian Aquatic Biomonitoring Network (CABIN)

Canadian Dam Association

Canadian Data Report of Fisheries and Aquatic Science

Canadian Rivers Institute, University of New Brunswick

Cape Breton Highlands National Park

Centre de bassin versant de la rivière Matapédia (CBVRM)

Centre d'expertise hydrique du Québec

Centre for Community Mapping

Centre La Pocatière

Centre St-Laurent

Clean Nova Scotia

Columbia Basin Water Network (CBMN)

Columbia Basin Water Quality Monitoring Program (CBWQMP)

Comité de bassin de la rivière Chaudière (COBARIC)

Comité de bassin de la rivière de Mars

Comité de bassin de la rivière Etchemin (CBE)

Comité de bassin versant de la rivière Kamouraska (COBAKAM)

Community Based Environmental Monitoring Network

Conservation and Water Stewardship, Government of Manitoba

CREATE H2O

Credit Valley Conservation (CVC)

CURAH2O

Department of Communities, Land and Environment, Government of Prince Edward Island

Department of Fisheries and Oceans, Government of Canada

Department of Indigenous and Northern Affair Canada, Government of Canada

Department of National Defense, Gagetown

Department of Natural Resources, Government of New Brunswick

Department of the Environment and Local Government, Government of New Brunswick

Ducks Unlimited

East Shore Freshwater Habitat Society (ESFHS)

Ecology Action Centre

EcoSpark

Elk River Alliance

Environment Canada

Experimental Lakes Area

Fish and Wildlife Enhancement Fund

Fish and Wildlife Management Information System

Fish Inventories Data Queries (FIDQ)

Fisheries Information Summary System (FISS)

Fisheries Information Summary System Yukon (FISS-Yukon)

Flowing Waters Information System (FWIS)

Freshwater Invertebrate Reference Network on Northern Ontario (FIRNNO)

GIRB

Government of Alberta

Government of the Northwest Territories

Government of the Yukon

Gros Morne National Park

Groupe d'éducation et d'écosurveillance de l'eau (G3E)

Gwich'in Renewable Resource Board

HYDAT, Water Survey of Canada

Hydro Manitoba

Hydro Manitoba's CAMP

Hydro-Québec

Imperial Oil Resources Ventures Limited

Indian Bay Ecosystem Corporation

Joint Oil Sands Monitoring (JOSM)

Kelligrews Ecological Enhancement Program

Kouchibouguac National Park

Lake Winnipeg basin Information Network

Lakehead University

Land Information Ontario (LIO) - Ontario Geospatial Data Exchange

Lower Raritan Watershed Partnership

Lake Simcoe Region Conservation Authority (LSCA)

Mainstreams

Department of Sustainable Development, Government of Manitoba

Ministère des forêts, de la faune et des parcs (MFFP)

Ministère du développement durable, de l'environnement et de la lutte contre les changements climatiques (MDDELCC)

Ministry of the Environment, Government of Ontario

Mochnaz, Backhouse, Bajno and Reist

North Bay-Mattawa Conservation Authority (NBMCA)

Northwest Territories-Delta Study

Nova Scotia Environment, Government of Nova Scotia

NWT-Wide Community-Based Water Quality Environmental Monitoring Program

OBV St-Maurice

Oatthill Lake Conservation Society (OLCS)

Ontario Benthos Biomonitoring Network (OBBN)

Organisme de bassin versant (OBV) du Saguenay

Pacific Water Quality Monitoring Service, Government of Canada

Pacific Yukon Water Quality Monitoring Project

Parc National du Mont Tremblant

Parks Canada

Petitcodiac Watershed Alliance

Provincial Water Quality Monitoring Network, Government of Ontario

Regional Aquatic Monitoring Program (RAMP)

Regroupement des intervenants pour la valorisation et l'aménagement global et écologique (RIVAGE) de la rivière du Moulin

Regroupement des organismes de bassin versants du Québec (ROBVQ)

Sackville River Association

Salmo Watershed Streamkeepers Society (SWSS)

Slocan Lake Stewardship Society (SLSS)

South Central Eco Institute

Southeast Environmental Association

Suncor Energy Fluvarium

Surface Water Quality Monitoring Network Data, Government of Nova Scotia

The Manuels River Experience

Torngat Mountains National Park

Toronto and Region Conservation Authority (TRCA)

Triton Environmental Consultants

University of Manitoba

Upper Thames River Conservation Authority (UTRCA)

Vale Living With Lakes Centre

Waste and Water Department, City of Winnipeg

Water for Life Program, Government of Nova Scotia

Water Quality Management Section, Department of Conservation and Water Stewardship, Government of Manitoba

Water Resource Management Divison, Government of Newfoundland and Labrador

Water Security Agency of Saskatchewan

Wildsight Golden

Wildsight Regional

Yukon River Inter-Tribal Watershed Council

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INTRODUCTION

Canada's interconnected rivers and lakes provide the essentials of life for wildlife, people and ecosystems.

We observed significant evidence of disruption, whether from hydropower dams, agricultural runoff, pulp and paper processing, fragmentation, urbanization, pipeline incidents, oil and gas development, or other activities.

In a thirsty world, freshwater quality and quantity are already top concerns for conservationists, economists and security experts alike. Freshwater scarcity and resulting food price hikes, migration and violence are expected to be exacerbated by population growth, increased urbanization and climate change. Biodiversity loss is on the rise: WWF's 2016 *Living Planet Report* found that, since 1970, freshwater species' abundance has declined globally by 81 per cent.

As home to 20 per cent of the world's freshwater supply, Canada has a duty to get it right. In 2012, we envisioned our water in good condition by 2025 for wildlife and communities, but quickly discovered Canada lacks a comprehensive nationwide monitoring system to track both the health of our freshwater ecosystems and the impact human activity is having on watersheds and freshwater wildlife. It's true that assessments have been performed at local and watershed scales. But the fact is, wildlife doesn't adhere to municipal or provincial water-management boundaries, especially as the climate changes and populations migrate in search of more suitable living conditions.

Freshwater management must be co-ordinated and national in scope, and should begin with a baseline picture of health — a fact not lost on other jurisdictions that have completed similar assessments. With that in mind, in 2013 we launched scientifically rigorous health and threat assessments of Canada's rivers. The health assessment looked at river flow, water quality, fish and benthic invertebrates. The threat assessment looked at stressors, including pollution, habitat loss, fragmentation, water use, invasive species, alteration to water flows and climate change.

Over the past four years, we worked with community organizations, water agencies, First Nations, researchers, governments and industry to gather data. As results poured in, we discovered Canada doesn't collect and share enough data to assign a baseline health score to the majority of the 167 sub-watersheds that make up Canada's 25 watersheds. We also discovered that sufficient data for all 11 key health and threat indicators is being collected in only 14 of our 167 sub-watersheds; at the watershed level, 15 of 25 watersheds are data deficient.

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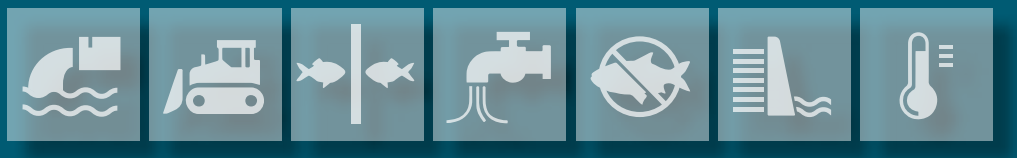
Furthermore, when it comes to stressors, we observed significant evidence of disruption, whether from pipeline incidents, oil and gas development, hydropower dams, agricultural runoff, pulp and paper processing, fragmentation, urbanization or other activities — contradicting the widely held vision of Canada as a nation of pristine and abundant freshwater. But, until we fill in the data gaps on the health side of the equation, we won't be able to say with certainty the impact human activity is having on freshwater ecosystems. Until this point, we have been operating on assumptions, not facts, about the state of our most valuable resource. Only with standardized, accessible national monitoring will Canadians be able to make evidence-based decisions for a healthy future for fish, frogs, turtles, freshwater mussels and people, too.

ABOUT THE ASSESSMENTS

WWF-Canada's Watershed Reports help identify priority actions to ensure all waters in Canada are in good ecological condition by 2025.

The health assessment uses short- and long-term trend data from on-the-ground organizations and governments to provide the current state of freshwater ecosystem health. The four metrics in the health assessment framework — flow, water quality, fish and benthic invertebrates — were chosen to represent key elements of healthy aquatic ecosystems that are also commonly monitored in most Canadian jurisdictions.

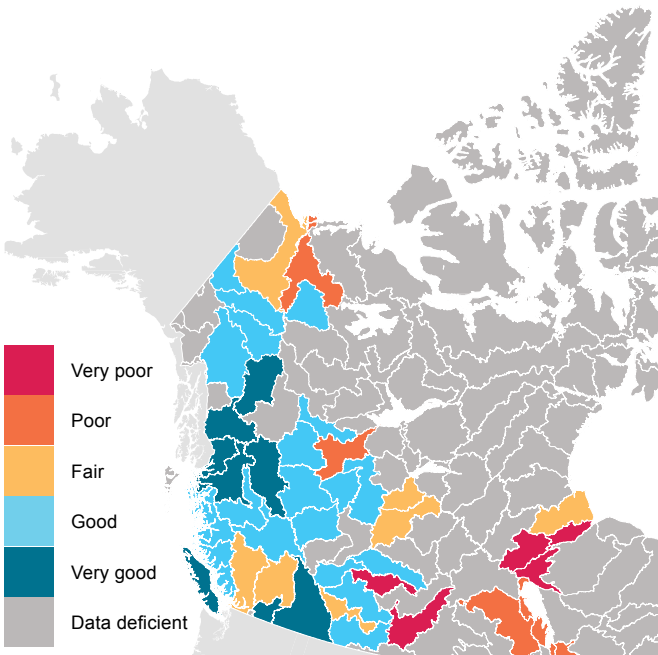
The threat assessment (which looks at stressors) leverages national databases that monitor human change on aquatic habitats at a national scale to help us understand why a watershed is in a particular state. The seven threat indicators — pollution, habitat loss, fragmentation, water use, invasive species, alteration of flows and climate change — were developed in accordance with current literature on threats to freshwater systems, including Environment and Climate Change Canada's report on *Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada* (Environment and Climate Change Canada, 2001). The climate change indicator was developed using Canadian Gridded Temperature and Precipitation Anomalies, a dataset with a reference period of 1961-1990 from Environment and Climate Change Canada (2014). Four sub-indicators were used for this indicator: summer maximum temperature anomaly; winter mean temperature anomaly; spring precipitation anomaly; and summer precipitation anomaly. The framework was reviewed and vetted by a group of leading experts and academics who aided in the process of refining our methodology in accordance with current analysis techniques in freshwater hydrology, ecology and geomorphology. Together, using a scientifically credible methodology, the framework provides a broad-scale, comparative analysis and classification of current impacts and stresses on freshwater systems.



For an in-depth look at our methodology, please visit wwf.ca/watershedreports

HEALTH

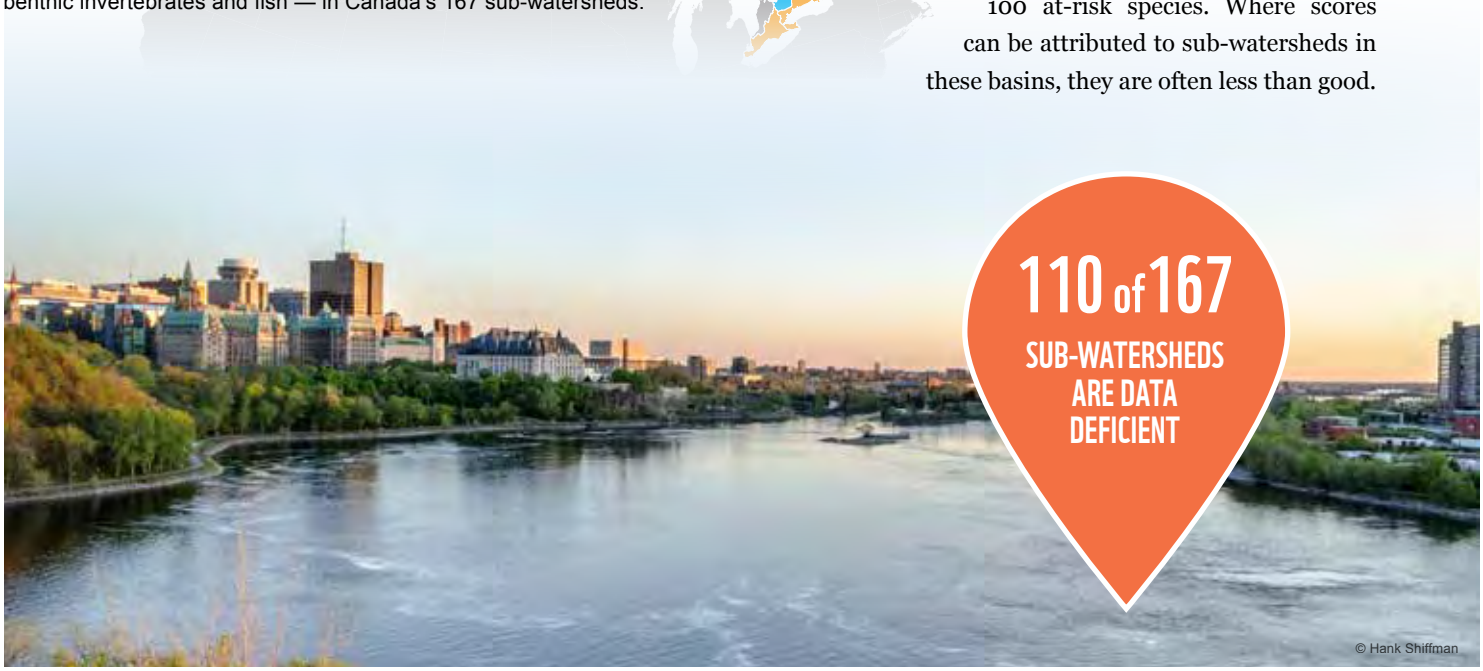
Across Canada, data deficiency is a serious obstacle to understanding the health of our freshwater ecosystems.



Overall health assessment — rate of water flow, water quality, benthic invertebrates and fish — in Canada's 167 sub-watersheds.

Of the 167 sub-watersheds in this country, fully 110 are lacking the data necessary to paint a baseline picture of watershed health. In those sub-watersheds, we were unable to assign a score for at least two of the four health metrics. For the most part, the deficiencies involve benthic invertebrates (bugs) and fish.

Certain areas stand out as being of particular concern: The North and South Saskatchewan prairie watersheds, as well as the Peace-Athabasca, have many sub-watersheds with worrisome scores for multiple indicators. And data is simply inaccessible or unavailable to make firm conclusions about the overall watershed-level health of the Great Lakes and Ottawa — surprising considering these watersheds are home to a significant portion of the country's population, industry, agriculture and well over 100 at-risk species. Where scores can be attributed to sub-watersheds in these basins, they are often less than good.



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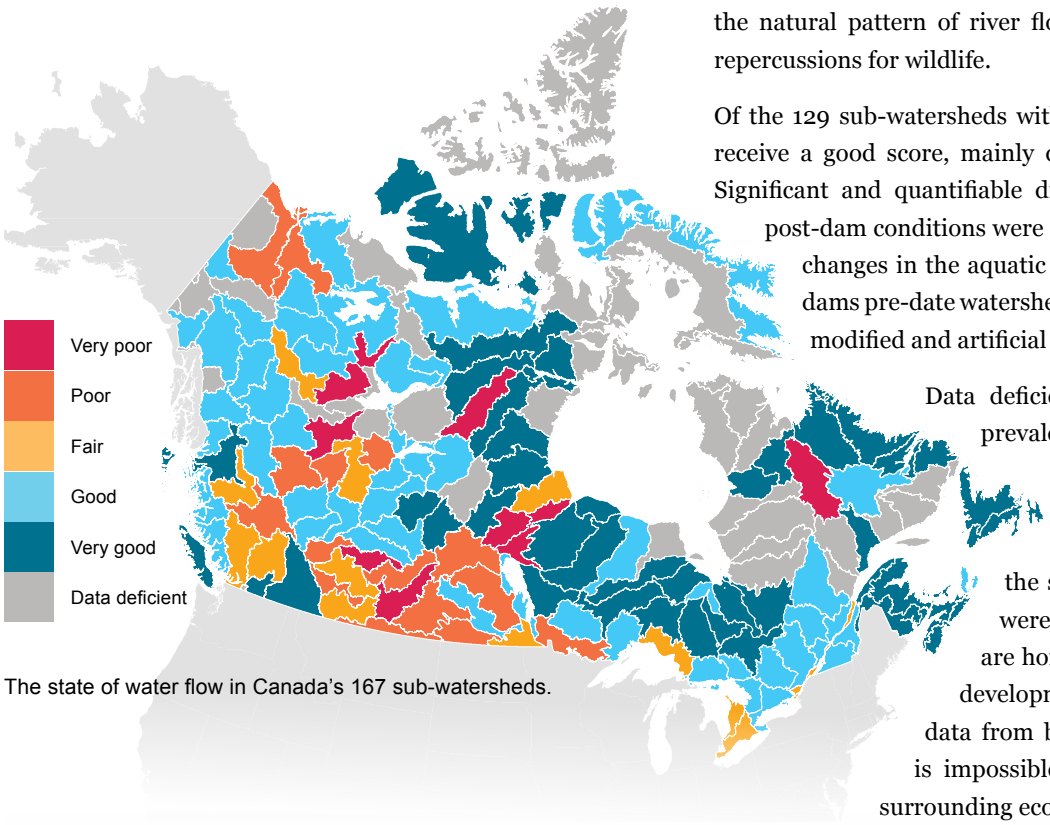
FLOW

The rate of water flow in a river, the volume of water, and changes to both are crucial to ecosystem health.



The state of water flow in Canada's 167 sub-watersheds.

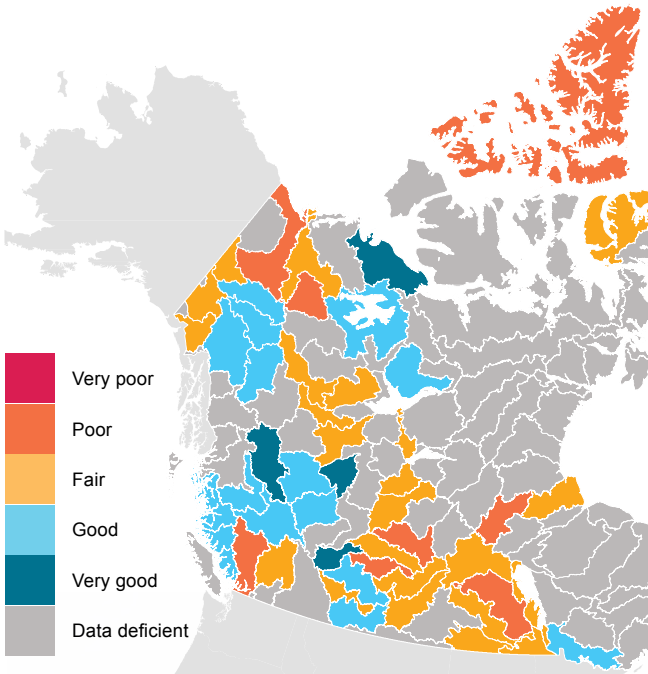
Withdrawing, holding back or diverting water disrupts the natural pattern of river flows, which can have serious repercussions for wildlife.

Of the 129 sub-watersheds with available data, 37 failed to receive a good score, mainly due to the impacts of dams. Significant and quantifiable differences between pre- and post-dam conditions were evident, indicating important changes in the aquatic environment. In some cases, dams pre-date watershed monitoring, creating highly modified and artificial systems.

Data deficiency for hydrology is more prevalent in more remote areas. However, just because an area is remote doesn't mean it is healthy: Many of the sub-watersheds for which we were unable to attribute a score are home to significant hydropower developments. Without long-term data from before dam impoundment, it is impossible to quantify the impact on surrounding ecosystems.

WATER QUALITY

Data deficiency is a major hurdle to attributing water quality scores all across Canada.



The state of water quality in Canada's sub-watersheds.

Only 67 sub-watersheds have available water quality indicator data, and of those, 42 were found to have either poor or fair water quality. In some areas, water quality is undermined by agricultural contaminants such as phosphorus and nitrogen; elsewhere, quality is affected by metals like aluminum or iron, either naturally present or introduced through mining and industry.

In the 100 sub-watersheds without data, deficiency was mainly driven by a lack of spatial diversity (not enough sites) or temporal diversity (not enough recent sample dates). However, low numbers of assessed parameters also played an important role. To prevent attributing a score based on only a small number of parameters, the *Watershed Reports* requires at least 10 parameters measured for at least 10 per cent of the samples of the most recent five years — where this minimum criterion was not met, a score of data deficient was attributed.

BENTHIC INVERTEBRATES

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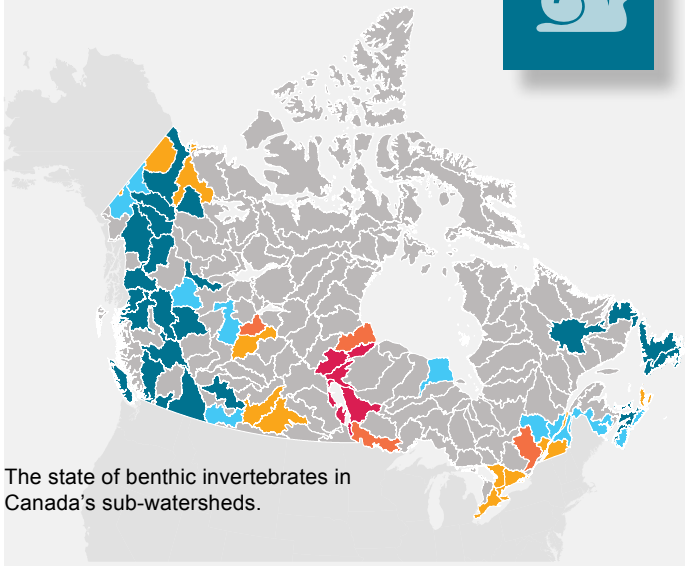
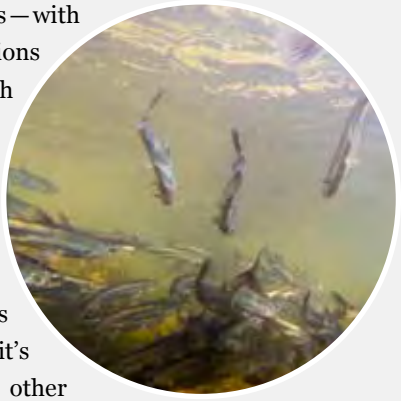
Flies, beetles, aquatic worms, snails and leeches are extremely sensitive to changes in water quality. These and other benthic macro-invertebrates that live at the bottom of the river are an important link in the aquatic food chain, and speak volumes about the health of a freshwater system. If species sensitive to ecological disturbance are missing from an ecosystem, that may indicate poor aquatic health. Across Canada, the benthic indicator is one of the most data deficient, regardless of whether the sub-watershed being assessed is in a remote or heavily populated area. Monitoring programs simply don't cover large portions of the country, and benthic invertebrates are among the more intensive indicators to monitor, in terms of required sampling efforts, taxonomic identification and knowledge of sensitivity to disturbance. Fully 112 sub-watersheds are data deficient. For those with available data, 35 have good or very good benthic invertebrate health (the other 20 fall below that threshold).



The state of benthic invertebrates in Canada's sub-watersheds.

Very poor
Poor
Fair
Good
Very good
Data deficient

FISH



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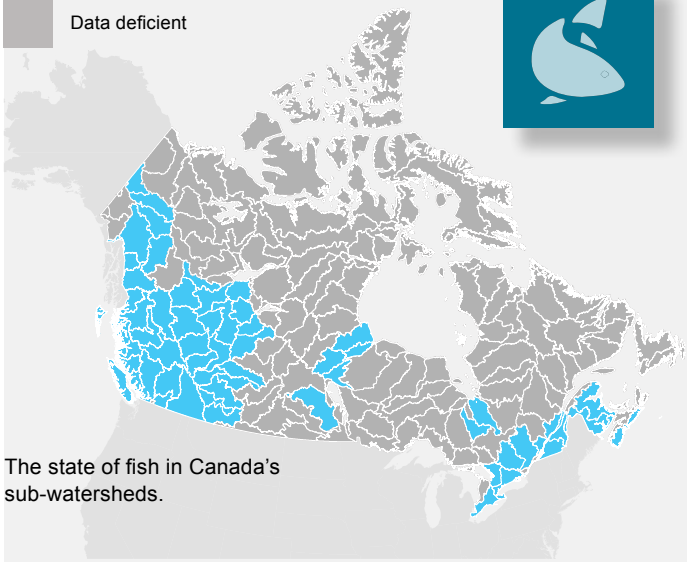
Surprisingly, given the importance of recreational and commercial fisheries, we know very little about the health of fish in our freshwater ecosystems — with the exception of some jurisdictions with good monitoring in British Columbia. Of the 56 sub-watersheds with data, all were found to be in good health. However, because we lack enough long-term data to identify trends in species presence and abundance, it's impossible to arrive at any other conclusion — leading us to conclude that this grading may not be representative of conditions on the ground. Localized assessments could complement this analysis to confirm these results, however.



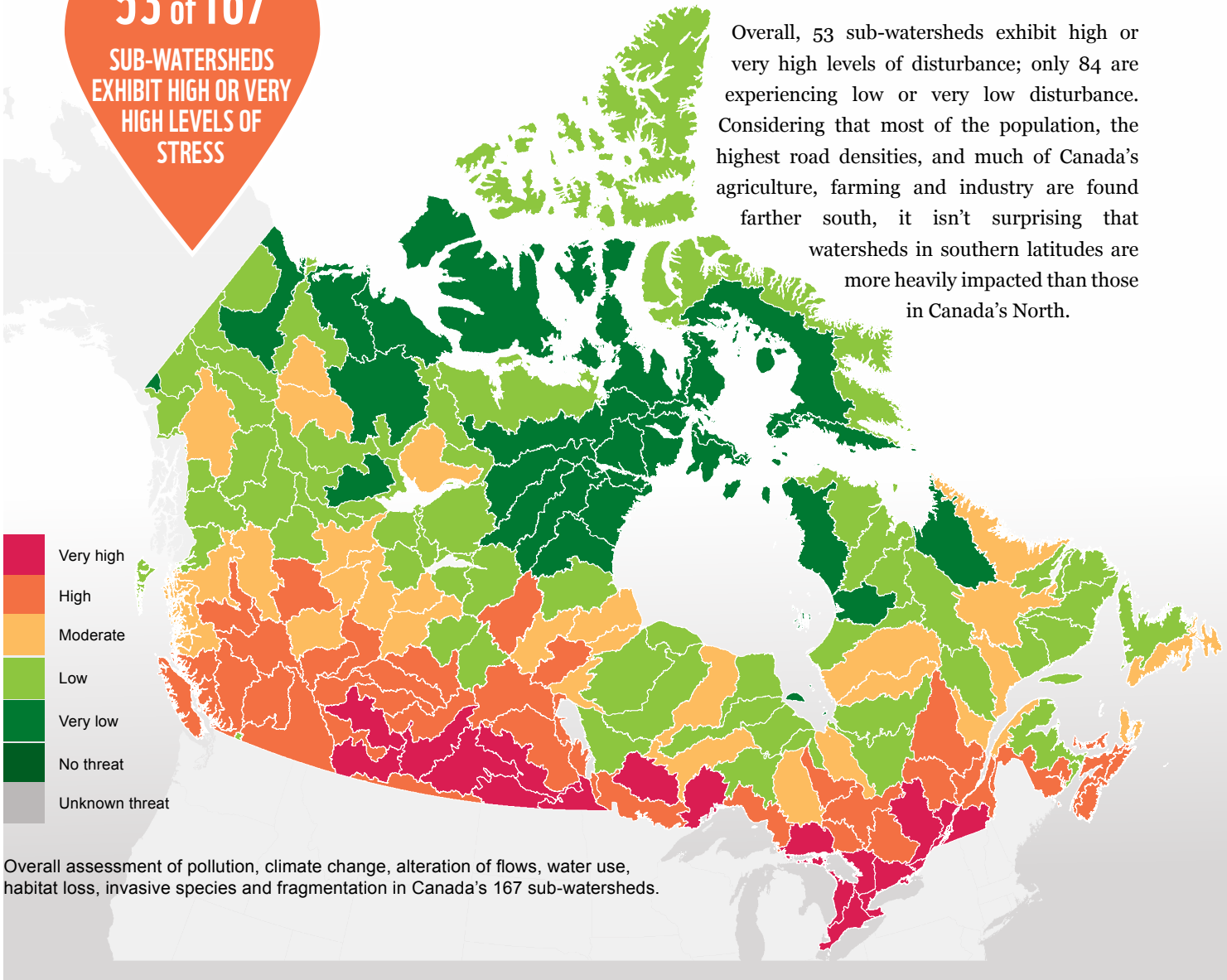
The state of fish in Canada's sub-watersheds.

STRESSORS

None of Canada's 167 sub-watersheds are immune to all of the seven threats to watershed health: pollution, climate change, alteration of flows, waters use, habitat loss, invasive species and fragmentation.

53 of 167
SUB-WATERSHEDS EXHIBIT HIGH OR VERY HIGH LEVELS OF STRESS

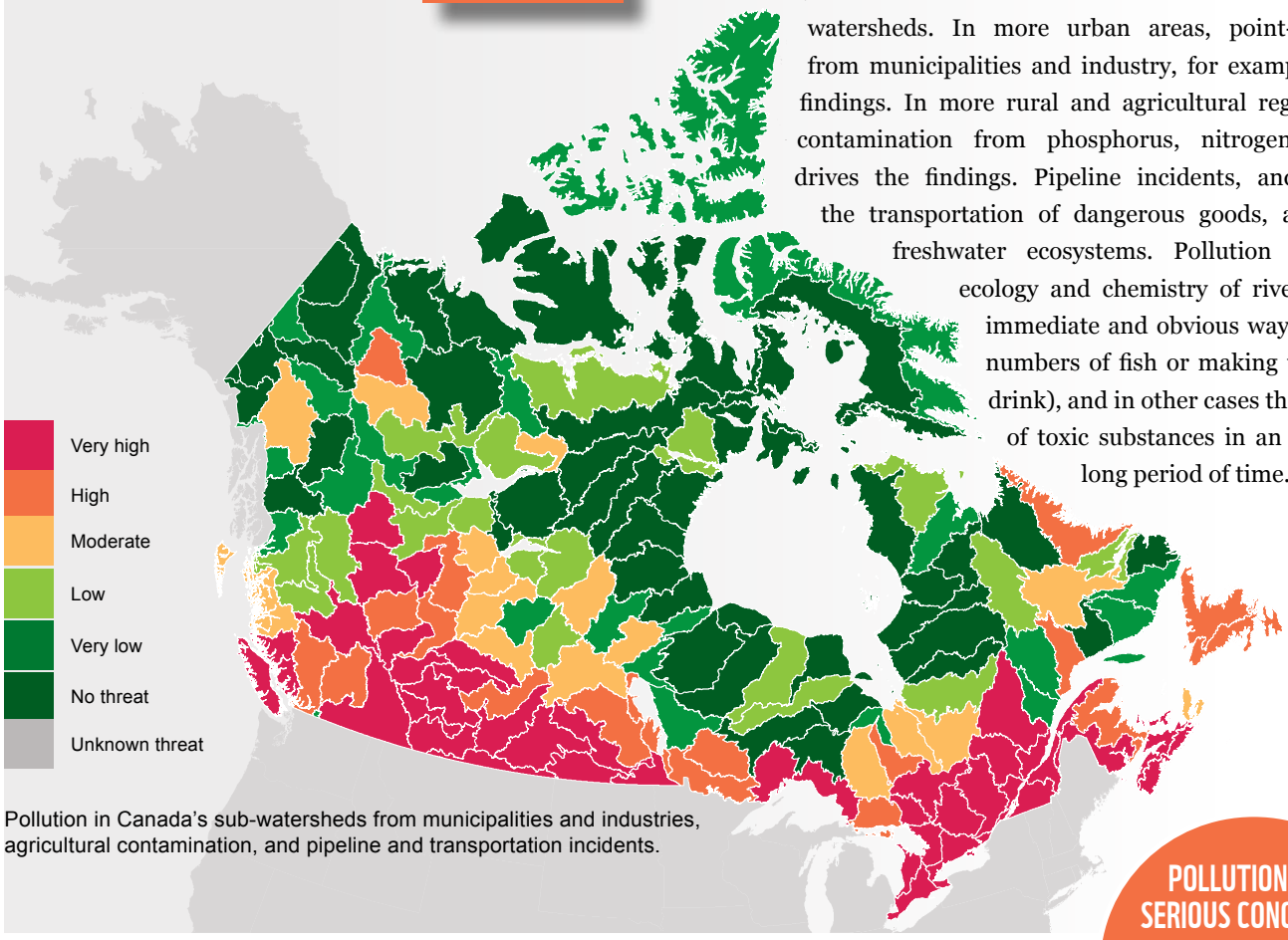
Overall, 53 sub-watersheds exhibit high or very high levels of disturbance; only 84 are experiencing low or very low disturbance. Considering that most of the population, the highest road densities, and much of Canada's agriculture, farming and industry are found farther south, it isn't surprising that watersheds in southern latitudes are more heavily impacted than those in Canada's North.



Overall assessment of pollution, climate change, alteration of flows, water use, habitat loss, invasive species and fragmentation in Canada's 167 sub-watersheds.

POLLUTION

Pollution is a serious concern in 60 of Canada's 167 sub-watersheds. In more urban areas, point-source pollution from municipalities and industry, for example, is behind the findings. In more rural and agricultural regions, agricultural contamination from phosphorus, nitrogen and pesticides drives the findings. Pipeline incidents, and incidents from the transportation of dangerous goods, are also affecting freshwater ecosystems. Pollution can change the ecology and chemistry of rivers, sometimes in immediate and obvious ways (by killing large numbers of fish or making the water unfit to drink), and in other cases through the buildup of toxic substances in an ecosystem over a long period of time.



Pollution in Canada's sub-watersheds from municipalities and industries, agricultural contamination, and pipeline and transportation incidents.

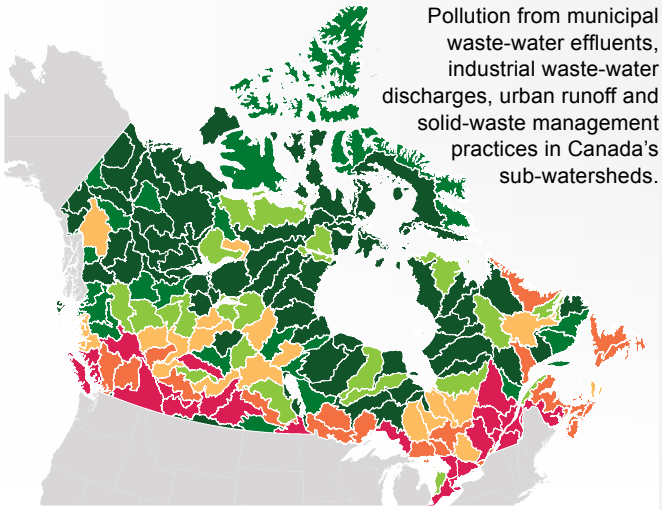
POLLUTION IS A SERIOUS CONCERN IN 60 of 167 SUB-WATERSHEDS

© Robert Rangeley

POLLUTION SUB-INDICATORS

POINT-SOURCE POLLUTION

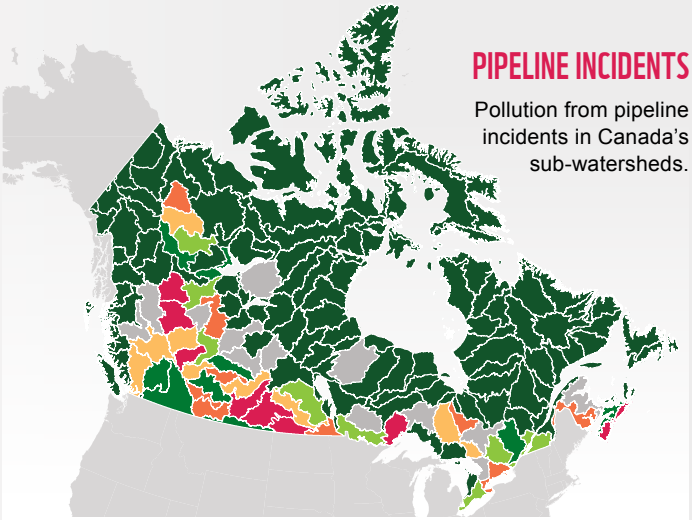
Pollution from municipal waste-water effluents, industrial waste-water discharges, urban runoff and solid-waste management practices in Canada's sub-watersheds.



Source: National Pollutant Release Inventory, *2014.*
Threat measured as a weighted score of location in the sub-watershed and total emissions to land and water, 1990-2012; classified using natural breaks.

PIPELINE INCIDENTS

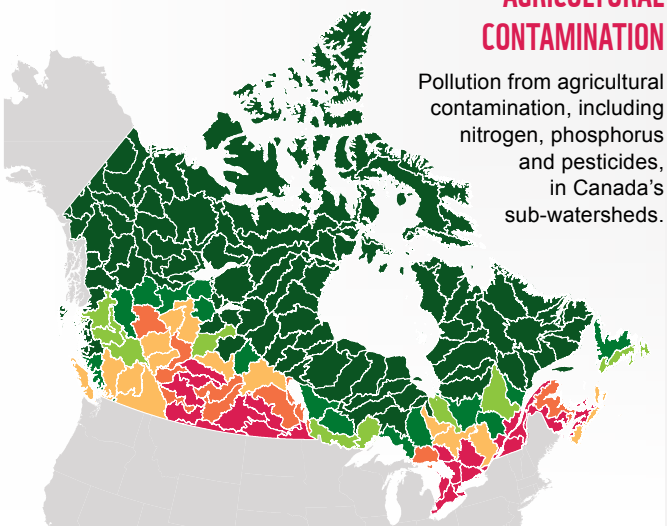
Pollution from pipeline incidents in Canada's sub-watersheds.



Sources: NEB pipeline incident database, Jan. 1, 2000-Nov. 21, 2012; Canadian Regulated Pipeline: Rupture Excel spreadsheet, Transportation Safety Board Investigation reports, Reportable Liquid Releases Jan. 2008-April 2013.
Threat from pipeline incidents was determined as the total volume released per event and summed per sub-watershed area. Results were classified using percentiles. Known events with no documented volume of release were classified as "unknown threat."

AGRICULTURAL CONTAMINATION

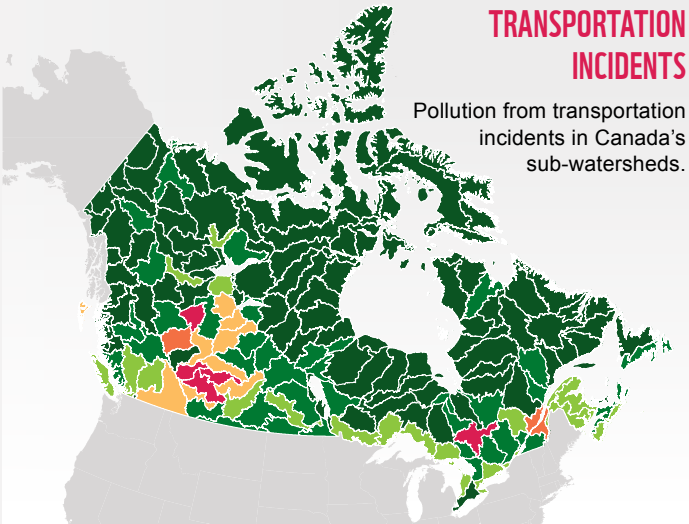
Pollution from agricultural contamination, including nitrogen, phosphorus and pesticides, in Canada's sub-watersheds.



Source: Agriculture and Agri-Food Canada, 2013.

TRANSPORTATION INCIDENTS

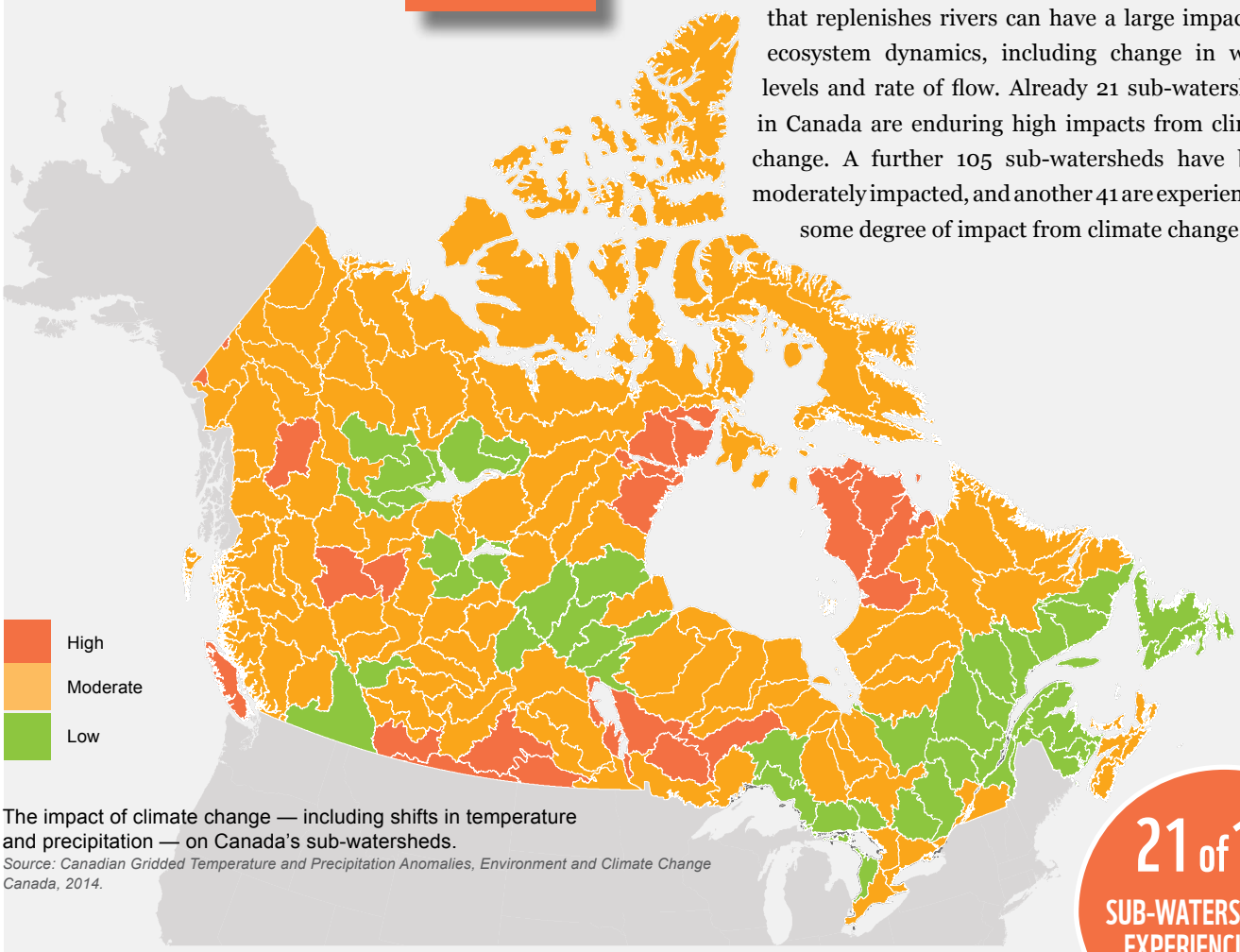
Pollution from transportation incidents in Canada's sub-watersheds.



Source: Transport Canada, 2015.
The risk of each incident was classified from minor to catastrophic by Transport Canada. Threat from transportation incidents was determined as a weighted score of potential risk of each incident. Weightings were summed per sub-watershed area. Results were classified using natural breaks.

CLIMATE CHANGE

Even small shifts in temperature and the precipitation that replenishes rivers can have a large impact on ecosystem dynamics, including change in water levels and rate of flow. Already 21 sub-watersheds in Canada are enduring high impacts from climate change. A further 105 sub-watersheds have been moderately impacted, and another 41 are experiencing some degree of impact from climate change.



The impact of climate change — including shifts in temperature and precipitation — on Canada's sub-watersheds.
Source: Canadian Gridded Temperature and Precipitation Anomalies, Environment and Climate Change Canada, 2014.

21 of 167
SUB-WATERSHEDS ARE EXPERIENCING HIGH IMPACTS FROM CLIMATE CHANGE

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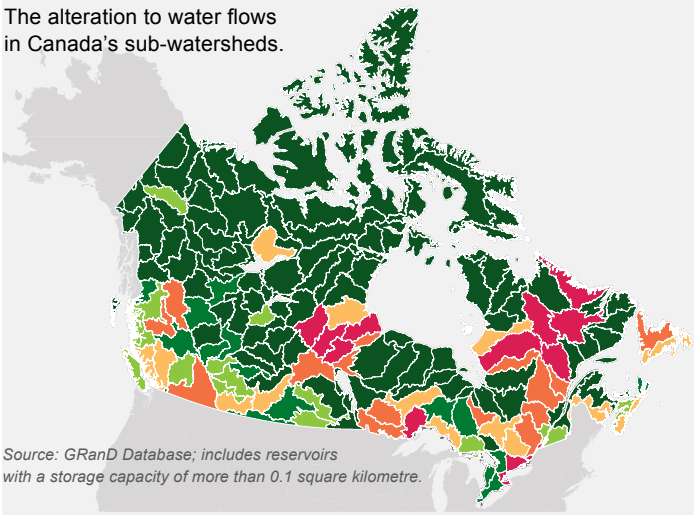
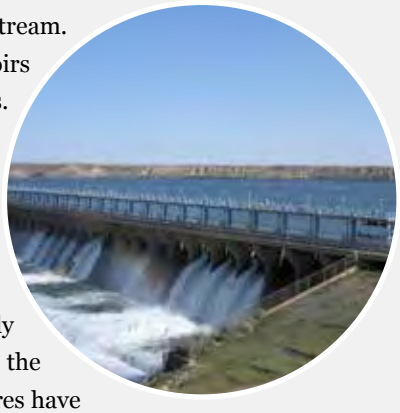
ALTERATION OF FLOW

The alteration to water flows in Canada's sub-watersheds.



Source: GRanD Database; includes reservoirs with a storage capacity of more than 0.1 square kilometre.

Changes in the natural flow of a river disrupt the natural flooding cycles and alter shoreline habitat both upstream and downstream. Large dams and reservoirs significantly alter flow regimes. While more than half (96) of Canada's sub-watersheds are not impacted in this way, due to there being no large dams present, 27 sub-watersheds have been highly or very highly altered. Not coincidentally, the areas with high alteration scores have large dams, including the Churchill basin in Manitoba, the Northern Quebec basin, as well as the Labrador portion of the Newfoundland and Labrador basin.



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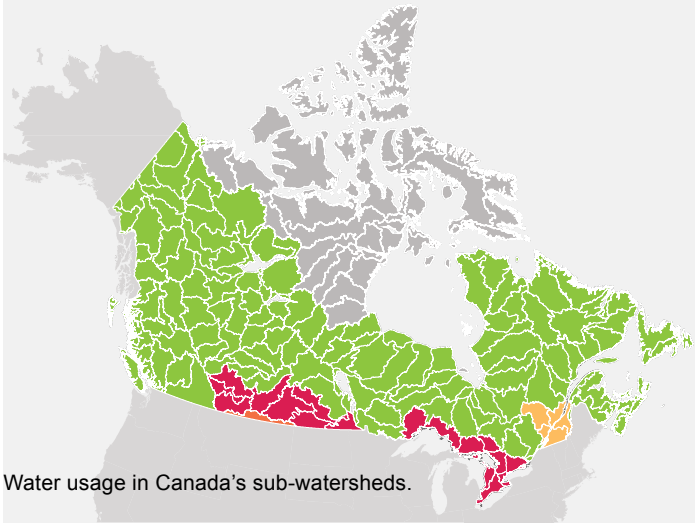
WATER USE



Water usage in Canada's sub-watersheds.

The removal of large amounts of freshwater can reduce a watershed's ability to sustain vital ecosystem processes, wildlife and habitats. For most of Canada, sub-watersheds are not being harmed by overuse of water. However, in 17 sub-watersheds, overuse is high or very high, indicating a skewed ratio of water use to water yield. The areas of highest concern are those with important agricultural production, including the Prairie provinces and the southern Ontario portion of the St. Lawrence basin.

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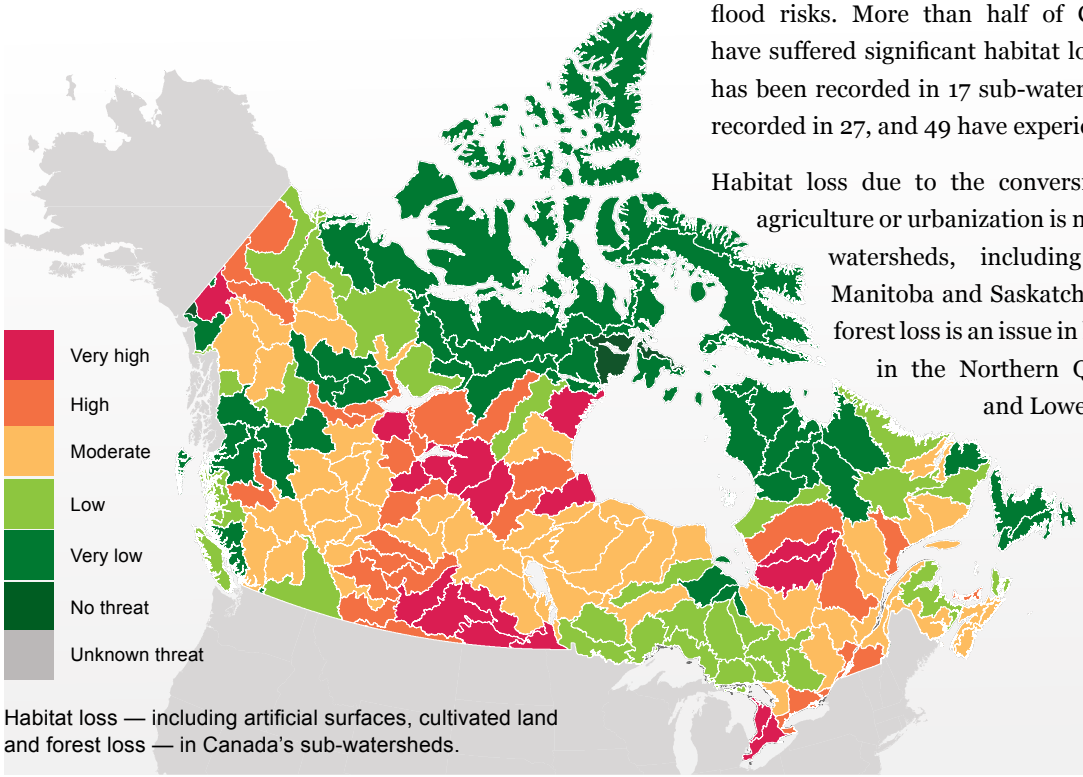
HABITAT LOSS

The conversion of ecosystems for farmland, residential areas or other built environments, and forestry destroys areas that fish, waterfowl and other wildlife use for breeding, feeding and migrating, and can increase downstream pollution and flood risks. More than half of Canadian sub-watersheds have suffered significant habitat loss. Very high habitat loss has been recorded in 17 sub-watersheds, high loss has been recorded in 27, and 49 have experienced moderate loss.

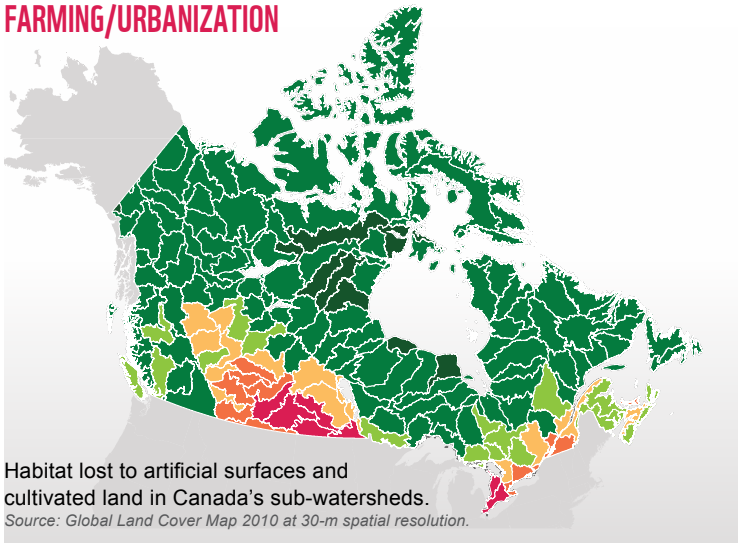
Habitat loss due to the conversion of natural spaces to agriculture or urbanization is more prevalent in southern watersheds, including in southern Ontario, Manitoba and Saskatchewan. Habitat loss due to forest loss is an issue in higher latitudes, including in the Northern Quebec, Churchill, Yukon and Lower Mackenzie watersheds.



Habitat loss — including artificial surfaces, cultivated land and forest loss — in Canada's sub-watersheds.

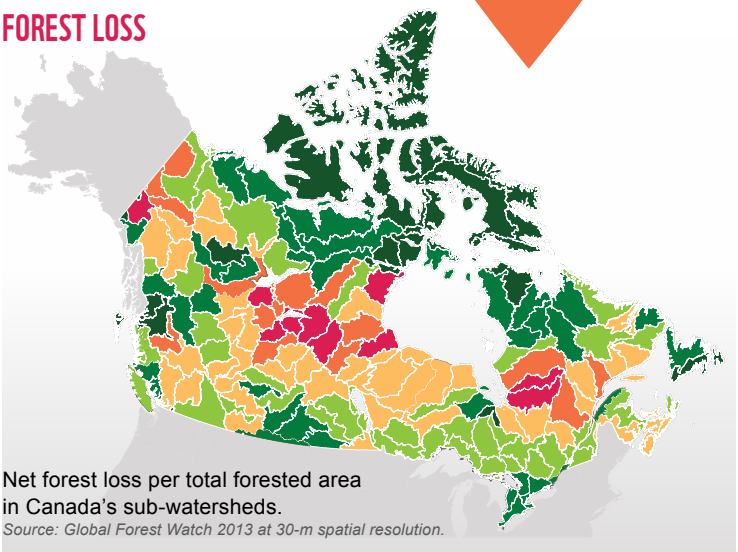
93
SUB-WATERSHEDS HAVE EXPERIENCED SIGNIFICANT HABITAT LOSS

FARMING/URBANIZATION



Habitat lost to artificial surfaces and cultivated land in Canada's sub-watersheds.
Source: Global Land Cover Map 2010 at 30-m spatial resolution.

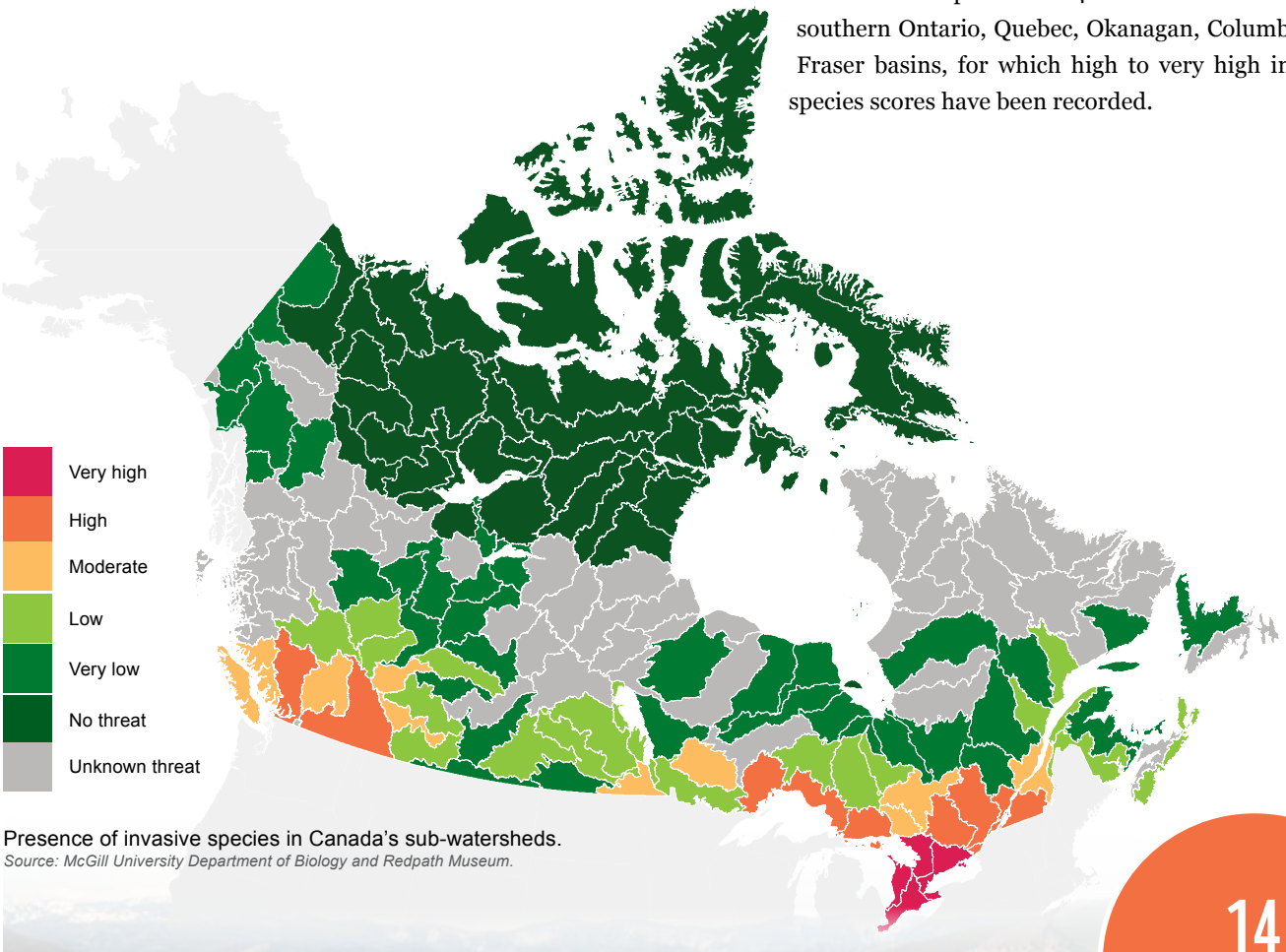
FOREST LOSS



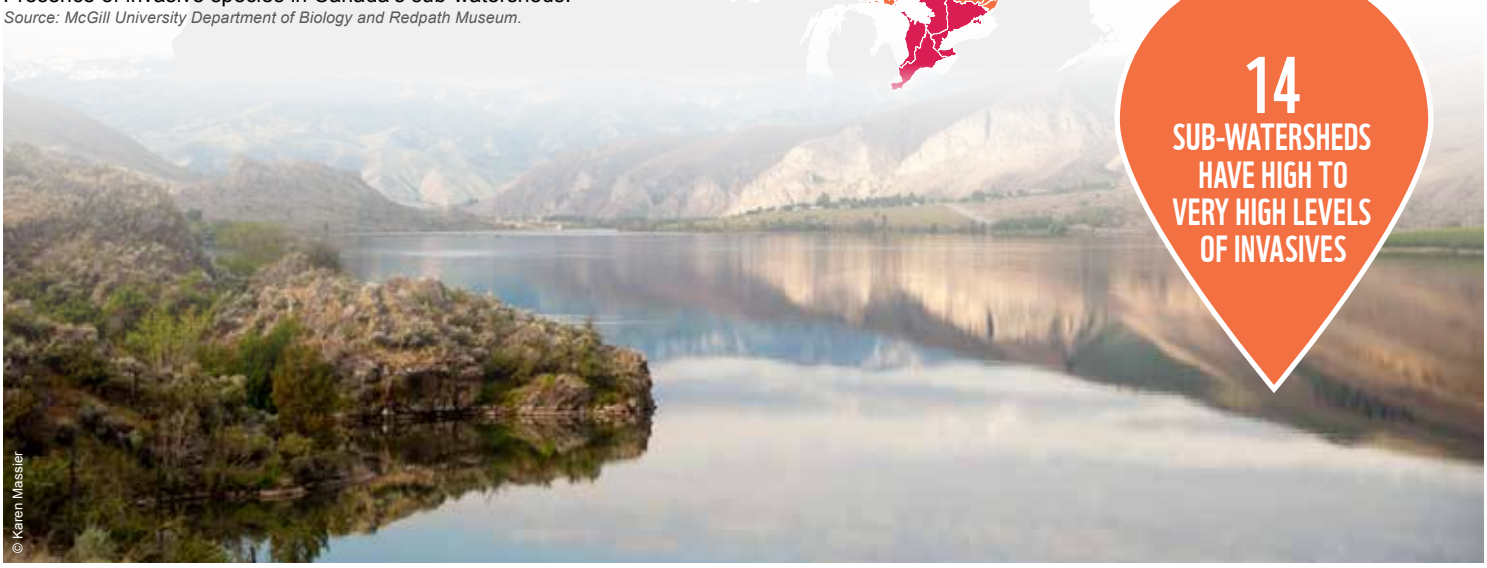
Net forest loss per total forested area in Canada's sub-watersheds.
Source: Global Forest Watch 2013 at 30-m spatial resolution.

INVASIVE SPECIES

Invasive species can alter environments and food chains and drive down biodiversity. We did not find evidence of invasive species in most sub-watersheds (particularly in the North), with the exception of 14 sub-watersheds in the southern Ontario, Quebec, Okanagan, Columbia and Fraser basins, for which high to very high invasive species scores have been recorded.

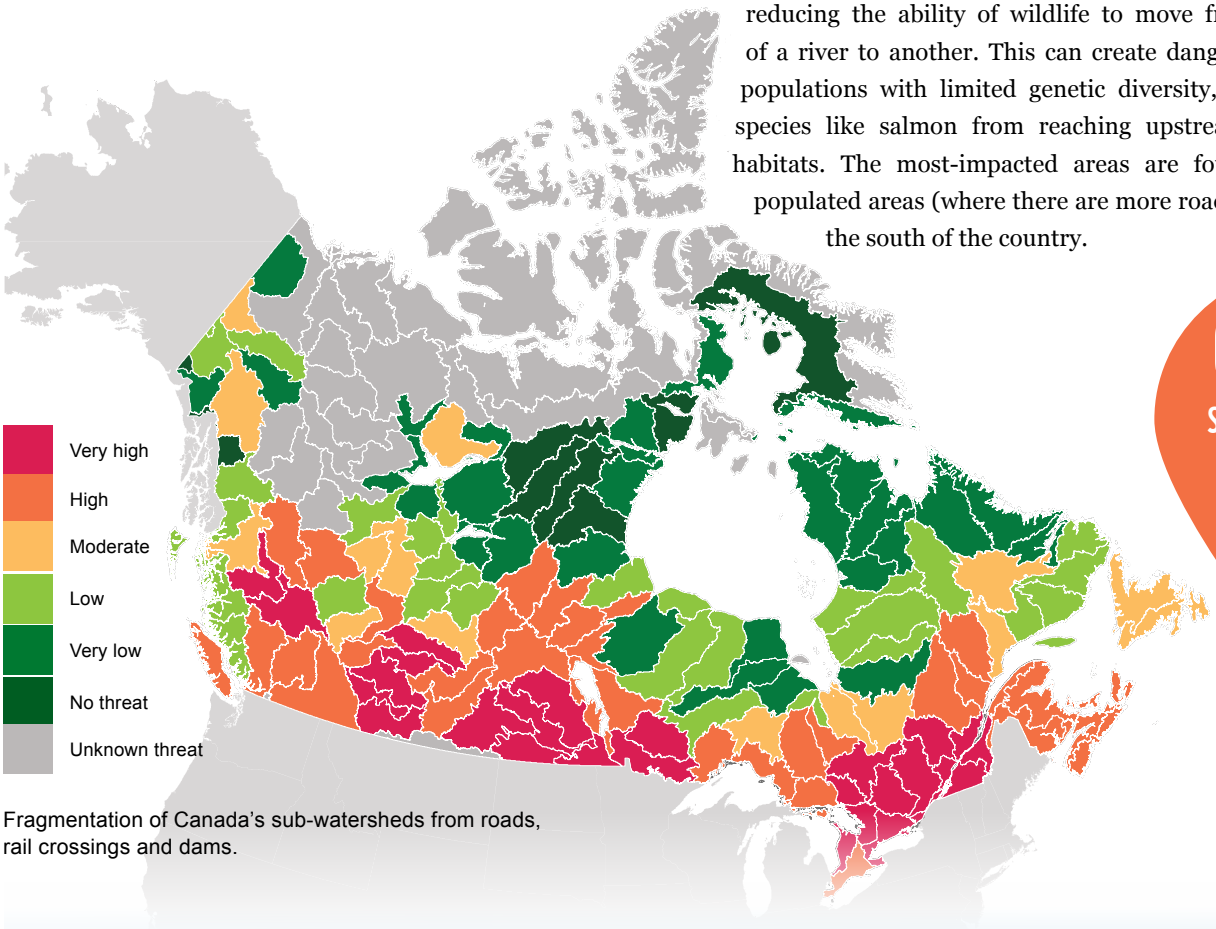


Presence of invasive species in Canada's sub-watersheds.
Source: McGill University Department of Biology and Redpath Museum.



FRAGMENTATION

Road and rail crossings and the presence of dams create a loss of connectedness between freshwater habitats. Of 167 sub-watersheds, 61 are highly or very highly fragmented, reducing the ability of wildlife to move from one part of a river to another. This can create dangerously small populations with limited genetic diversity, and prevent species like salmon from reaching upstream spawning habitats. The most-impacted areas are found in more populated areas (where there are more roads), usually in the south of the country.



Fragmentation of Canada's sub-watersheds from roads, rail crossings and dams.

61 of 167
SUB-WATERSHEDS ARE HIGHLY OR VERY HIGHLY FRAGMENTED

WATERSHEDS

For a closer look at each of Canada's 25 watersheds, please go to wwf.ca/watershedreports.

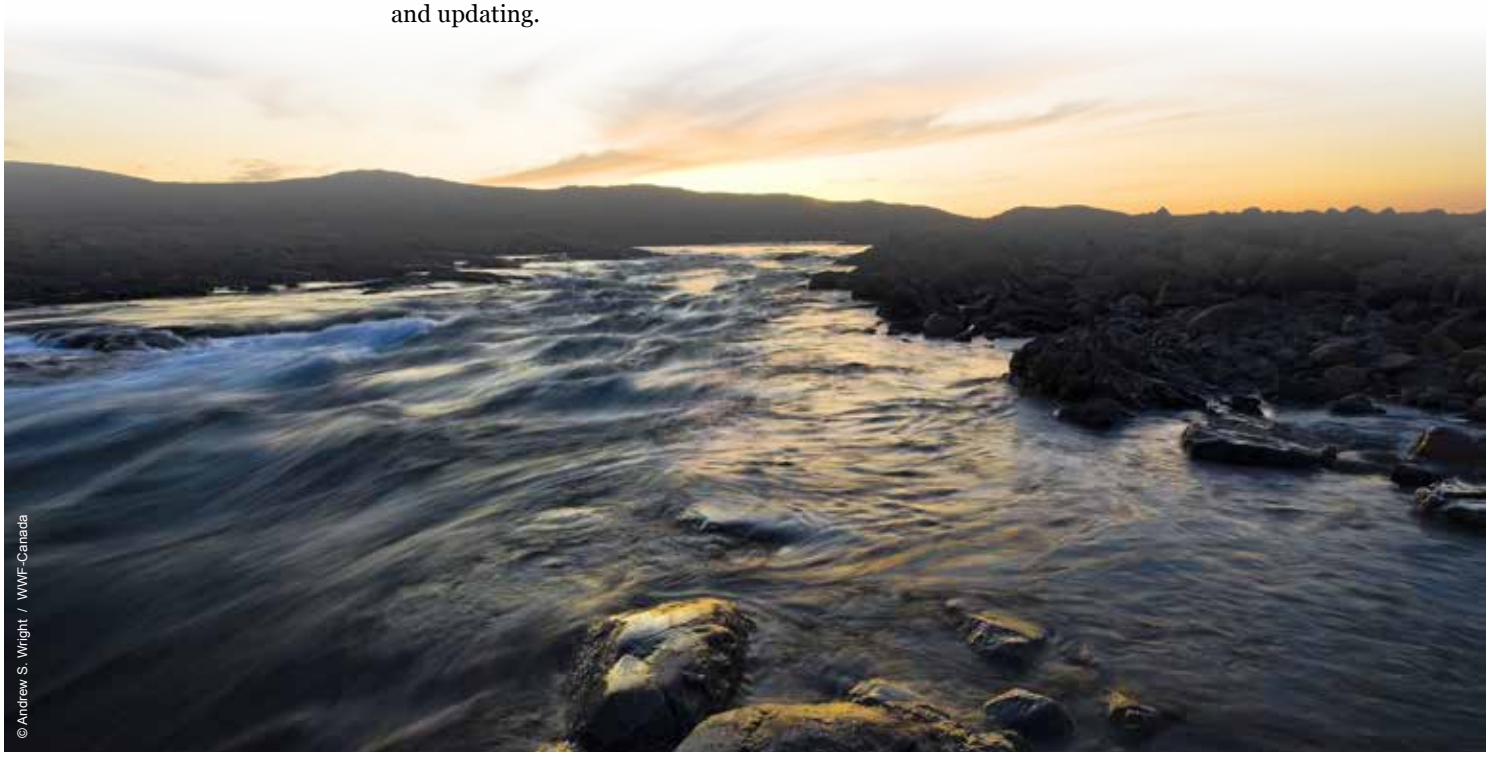
MODERNIZING FRESHWATER MANAGEMENT

The popularly held belief that Canada is a nation of pristine lakes and rivers has been dispelled. Pollution, overuse, habitat loss and fragmentation, alteration of flow, climate change and invasive species are taking a toll on the country's freshwater supply.

Decades of funding cuts at all levels of government have led to shrunken monitoring programs, and despite the valiant efforts of community-driven groups and organizations across the country, we are left with rampant data deficiencies. As a result, we can't say with certainty to what extent these stressors are harming freshwater on a national scale, nor can we track national trends. Consequently, we are not positioned to make evidence-based decisions about our most precious resource.

We can't say with certainty to what extent these stressors are harming freshwater on a national scale.

It doesn't have to be that way. We can modernize freshwater management to address existing problems and ready ourselves for the incredible challenges ahead. WWF-Canada has identified four areas in need of immediate improvement: data collection, analysis, sharing and updating.



1. COLLECTION OF DATA

Community-driven groups and organizations have taken on greater responsibilities as they strive to add more spatial and temporal variability to monitoring programs. These groups, however, often lack consistent funding and support. Without long-term support, programs risk being disjointed or discontinued, resulting in loss of data or spatially or temporally insufficient monitoring over time. Current funding commitments are not conducive to building long-term capacity and continuity.

Concern over the declining availability and accessibility of data is mounting. For a variety of reasons, including the aforementioned cutbacks, it is increasingly difficult to find and use certain data. Many large areas across the country, both remote and close to urban centres, are either lacking sufficient data or have data that is unobtainable. In some places, historical data is available, but due to cutbacks, those sites weren't recently monitored, meaning a current picture of aquatic health could not be documented. There are other situations where a large and geographically varied area is represented by a small number of monitoring sites — implying the state of aquatic health by using a small number of samples may not lead to a representative understanding of conditions.

Renewed monitoring efforts and programs must be collaborative and holistic, involving First Nations, governments, academia, industry and communities.

Efforts must be made to support long-term monitoring to ensure continuity. This must be done in a comprehensive and organized way, so monitoring doesn't become sporadic or fragmented in the future. Any renewed monitoring efforts and programs must be collaborative and holistic, involving First Nations, governments, academia, industry and communities.

Lack of community-based monitoring

Citizen science, or community-based monitoring, is underutilized in Canada. Detailed community-level data could be used to fill data gaps and monitor freshwater. Long-term baseline data collection and quick response following environmental crises have substantial value. There is an opportunity to "build a proactive, collaborative agenda to engage the public in environmental science" (EPA, 2016). Through technological advances, this is becoming more of a possibility. The ability to share data, information and stories is amplified. Tools exist to support data collection, literacy, management and distribution.

Uneven coverage and representation

Existing monitoring sites and stations are not representative geographically. Current coverage is based on historical quality concerns and is often focused in areas where humans have historically lived (e.g. the Maritimes, along the St. Lawrence, the Great Lakes, British Columbia's Lower Mainland). This has resulted in minimal coverage in areas such as Saskatchewan, Nunavut, northern Ontario, northern Quebec and other more remote areas.

More monitoring is not necessarily better, or always possible. There needs to be, however, a focus on extending coverage in certain areas at risk. Northern Ontario's Ring of Fire region is an example where significant development is proposed, but where very little is known of the current baseline, pre-development conditions. Identifying areas where monitoring needs to be a priority, other than regions of important population, would lead to better representation across the country.

Furthermore, water interactions are transboundary and multifaceted. There is limited ability and merit to reaching conclusions about an entire watershed with river data alone. The

addition of a threats (impacts) assessment to the *Watershed Reports* has helped to highlight interconnections. However, many other metrics and data types (vegetation, cumulative impacts, existence of protective policies, lakes, groundwater interactions, etc.) could and should also be considered when talking about watershed health. *Watershed Reports* currently focuses on rivers, and four metrics of health and seven metrics of threats. There is an opportunity to expand to other indicators, as well as other water bodies, and to include Traditional Knowledge and cumulative effects assessments for a holistic approach.

Canada needs to invest in an ongoing national monitoring system to track the state of freshwater now and in years to come as climate change and increased population put more and new pressures on this resource.

Models, hubs and scaling up

There are examples across the country of hubs, of networks of groups working together to monitor their areas of interest and collaborate by sharing data. Many pilot projects have been tried and tested. However, the challenge is in replicating and scaling up for greater coverage. There is a need to share successes and progress stories to promote and adapt successful initiatives in other regions. There is an opportunity to promote, transfer and extend successes via co-ordinating hubs acting as "networks of networks." It is important to share successes and challenges to build the most effective networks possible.

The solution

Canada needs to invest in an ongoing national monitoring system to track the state of freshwater now and in years to come as climate change and increased population put more and new pressures on this resource. To fully capture existing conditions and future developments across this geographically diverse country, a national monitoring system must include

a) Multiple approaches to water monitoring, including citizen science.

b) Collection of data for all aspects of freshwater health taking into account local conditions (such as metals that naturally occur in higher concentrations in some areas, for example), building in real-time, monthly and annual reporting, and including as many indicators and contaminants as possible.

c) Standardized reporting of data through the creation of nationally-linked regional hubs.

The priority at first should be on areas where little baseline information is available and significant resource development is proposed.

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2. ANALYSIS OF DATA

Across Canada, a multitude of organizations, communities and governments work on monitoring freshwater. Though these groups all play an incredibly important role, hurdles often prevent ideal integration and co-operation between them, making it difficult to incorporate different datasets into broad-scale analyses.

Inconsistent protocols

Monitoring of freshwater can include a variety of metrics. As mentioned, WWF-Canada's *Watershed Reports* look at flow, water quality, benthic invertebrates and fish as metrics of freshwater health. Each of these metrics can be measured using a variety of indicators, using a variety of methodologies. For example, our *Watershed Reports* uses benthic data that was collected using the Canadian Aquatic Biomonitoring Network protocol. This protocol uses a very specific methodology when it comes to obtaining samples in streams. There are, however, other ways to collect benthic samples. Unfortunately, these methodologies are not always compatible and comparable, meaning they cannot be used within the same study, sometimes limiting the usable data.

Guidelines don't consider local conditions where some parameters might be naturally higher than the recommended maximums.

Inconsistent guidelines

For our assessment, we have used provincial and federal water quality guidelines to help us determine the state of our water quality parameter. However, these guidelines aren't always representative. The guidelines don't consider local conditions where some parameters might be naturally higher than the recommended maximums, or naturally lower, leading to overly permissive thresholds. For example, water found in the Canadian Shield often has naturally occurring higher concentrations of metals, simply because of the bedrock.

Diversity of partners, varied reliability levels

Building on the issue of inconsistent monitoring protocols, having diverse groups of data partners can also lead to having a variety of reliability levels. While different groups might monitor water quality in the same way, there might be a difference in how they analyze the concentrations within a given sample, and which tools and equipment are used. While some groups might send their samples to a laboratory for analysis, others might try and analyze for certain parameters themselves, minimizing costs. While the results can be comparable within an organization's dataset, it becomes difficult to compare when combining datasets from different groups.

The number of indicators/parameters at different scales

Certain governments and organizations have created models and indicators to represent aquatic health at a local or watershed scale. These models consider local particularities, land uses and the geology of the area to assess whether a watershed is healthy or not. When doing this for water quality, for example, it is possible to only analyze for a small number of parameters. It is difficult to do the same for a broad-scale analysis, however. Because our country is so diverse, using a one-size-fits-all model considering only a few parameters would not accurately portray current health conditions. Therefore, our approach looks to maximize the number of parameters and contaminants we incorporate. However, not all monitoring groups analyze for many parameters, either because of the existence of localized models or

simply due to lack of resources. What might work at local scales isn't always appropriate at medium or larger scales. Data collected at different scales isn't always easy to assimilate. When compiling our broad-scale dataset, certain watersheds stood out for having too few analyzed parameters for us to attribute a score. These areas had a good number of sampling sites and sampling events, but it was impossible for us to attribute a score based on so few measured parameters.

Assessment methodology must account for regional differences, require consistent protocols on analysis to guarantee reliability, and be standardized so it can integrate diverse datasets.

Real time vs. monthly or annual reporting

The issue with scale, mentioned above, is also seen temporally. Some data are available for a specific sample date, while other data are a monthly or annual median or average. It becomes difficult to assimilate and compare data collected at different scales. This is especially true for our water quality indicator where we are looking at exceedances, which are often small in number and would get lost when doing a monthly median.

Importance of standardization

Standardized monitoring and data collection for all aspects of freshwater health — spatially, temporally and methodologically — would facilitate the creation of reports such as this one, which incorporate datasets from a variety of sources. Mitigating these hurdles would allow for greater local-regional-national integration, and comparison across regions.

The solution

To allow for consistent, evidence-based conclusions about freshwater health at a national scale, the assessment methodology must account for regional differences, require consistent protocols on analysis to guarantee reliability, and be standardized so it can integrate diverse datasets. This will eliminate the problem of a patchwork of inconsistent datasets that can't be integrated.

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3. SHARING DATA

Even when adequate data exists, it can often be a challenge to access. There is a continued fear of data being misinterpreted or misused. This is understandable. Organizations, having spent significant amounts of money creating and maintaining their monitoring programs, are hesitant to simply give their data away, without knowing who will be using it and why. To address this, some organizations ask for data-sharing agreements to be signed, legally protecting themselves. Others require special insurance or a verification of skill to gain permission. This has led to tiered accessibility, with special permissions and skill verifications serving as barriers.

Through our experiences, data can be classified in four different tiers. Data is either

- Open: accessible online for download and mapped visually.
- Known: but only available by direct email request via interpersonal contacts.
- Not open: known but inaccessible, at a cost, proprietary or not in a usable format.
- Unknown: not shared publicly.

Freshwater is a public resource, and as such, freshwater data should be open.

There is worldwide movement toward open data. This is becoming easier to do with a variety of user-friendly ways of sharing and accessing publicly available data. Here in Canada, governments are becoming amenable to sharing data, which is a step in the right direction. However, there is always room for improvement. Along with publicly sharing data, more can be done to improve the ability of Canadians to analyze, communicate and visualize open data — in short, to reduce the barriers to access and understanding for all.

The solution

Freshwater is a public resource, and as such, freshwater data should be open, publicly available and accessible — whether collected by government (including data used in assessments required through the Canadian Environmental Assessment Act), academia or industry — in a usable format that allows for the integration of a wide range of sources, metrics and indicators.

4. DATA CURRENCY

To be considered representative of current health conditions, data needs to be up to date. Data soon becomes outdated and can only be considered as a snapshot in time. Monitoring needs to be continuous to sufficiently portray health conditions through time.

The solution

To provide critical information in decision-making and policy formation, to understand trends over time and ensure long-term continuity, it's essential all levels of government commit to conducting standardized freshwater assessments every three to five years.

NEXT STEPS:
FROM DATA TO ACTION

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All the best data collection and integration in the world won't on its own resolve the disconnect between data and action.

With access to open, reliable, consistent data, water stewardship advocates across Canada will be in a position to make evidence-based policy and behavioural change suggestions. Decision-makers will feel confident making tough decisions knowing they are based on solid data and analysis.

WWF-Canada is committed to several efforts moving forward:

1. Ongoing assessment: We now have a baseline assessment. We will continue to assess watersheds as data becomes available.
2. Investing in access to information: Over the next three to five years, we will work toward supporting and establishing a culture of open and shared data. We will continue to
    - Make our findings and methodology open and accessible by sharing it online for all, and we will share our analysis scripts when requested.
    - Work with partners to build accessible regional databases across the country and integrate those databases with the Watershed Reports.
    - Increase the accessibility of our own methodology by working with others so they can apply the methodology to their data at their own scale, with the goal of providing an assessment tool built into government.
    - Work with regional networks to mitigate hurdles, enabling greater local-regional-national integration and comparison across regions.
3. Monitoring for the 21st century: WWF-Canada is working toward getting all waters in healthy condition. We are working with Canadians across the country to help get the data to understand Canada's freshwater health. WWF-Canada, to date, has identified 15 of 25 watersheds as data deficient. To address that, we're working with a range of partners to develop a national citizen science program. We're using citizen scientists because, given the complexities of the impacts on freshwater, as well as Canada's immense size and geographic diversity, citizen scientists are far more nimble and able to do this work.
4. Improving Canada's freshwater: We will use updated Watershed Reports to identify the most pressing issues undermining the well-being of freshwater wildlife and build solutions to ensure the health of freshwater ecosystems across Canada.

Evaluating the health and threats to all of Canada's watersheds would not be possible without the help of people and companies that believe that our waters should be clean and full of fish, turtles, birds and more. We are proud to recognize their support.

Supported by

HSBC

Thanks to support from HSBC's 150th anniversary community fund, Canadians can see, for the first time ever, a complete picture of watershed health nationwide. WWF-Canada is proud to be part of HSBC's global commitment to protect freshwater, a vital resource for building healthy communities.

Estate of Edward Robert Hogarth,
in memory of
Elaine Estelle and George Austin Hogarth.

Ted Hogarth believed in protecting the habitats of species at risk, and acted on the vital need to provide a sustained level of freshwater for wildlife.

AGF Management Limited
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