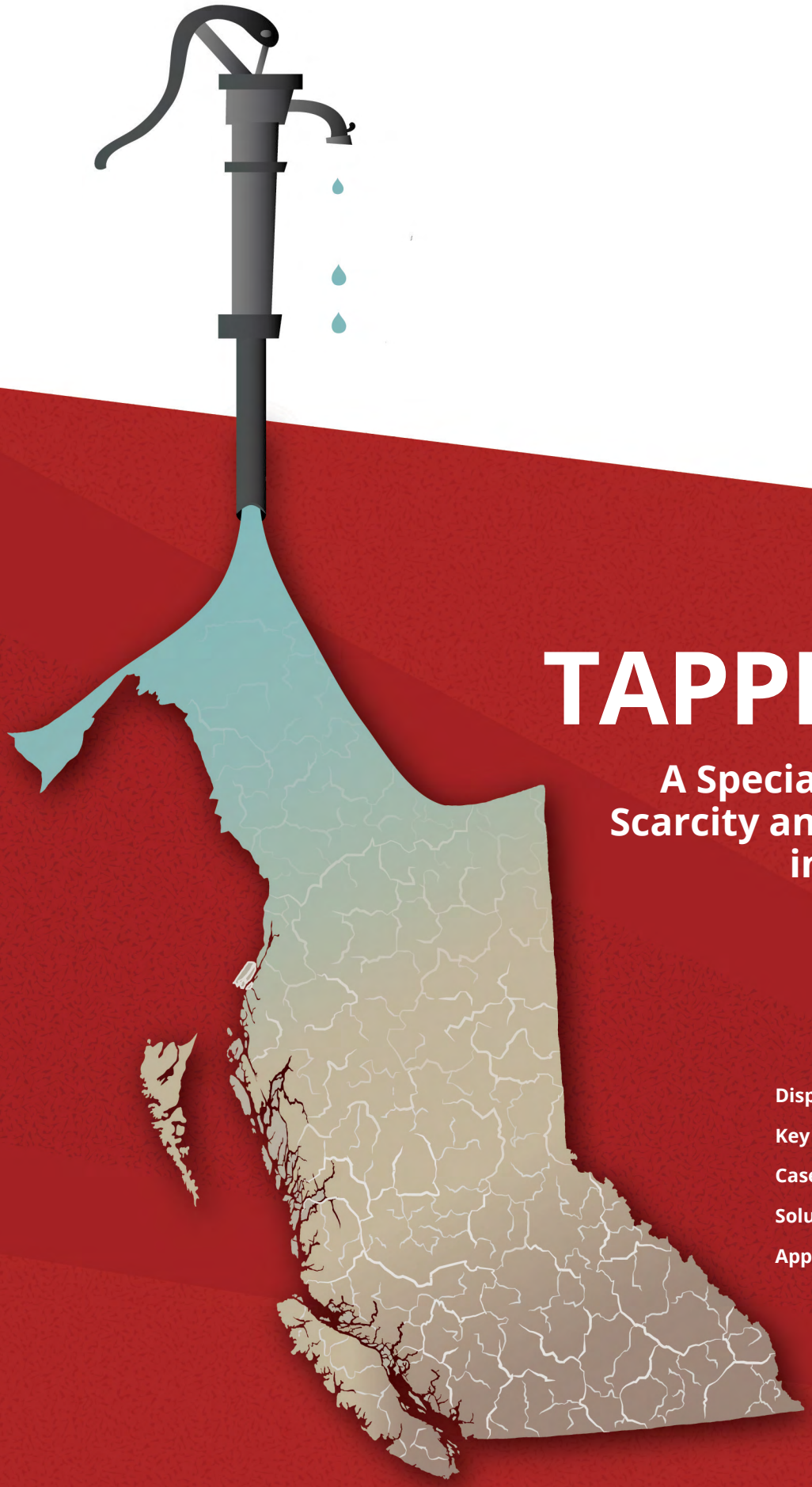

WATERSHED WATCH SALMON SOCIETY

TAPPED OUT

A Special Report on Water Scarcity and Water Solutions in British Columbia

Contents

About this Special Report

Tapped Out was developed by Watershed Watch Salmon Society for provincial water managers, community water champions, and concerned citizens. It was developed to highlight the pressing issue of water scarcity in British Columbia, and to demonstrate the need for rapid implementation of provincial-scale solutions.

Acknowledgements

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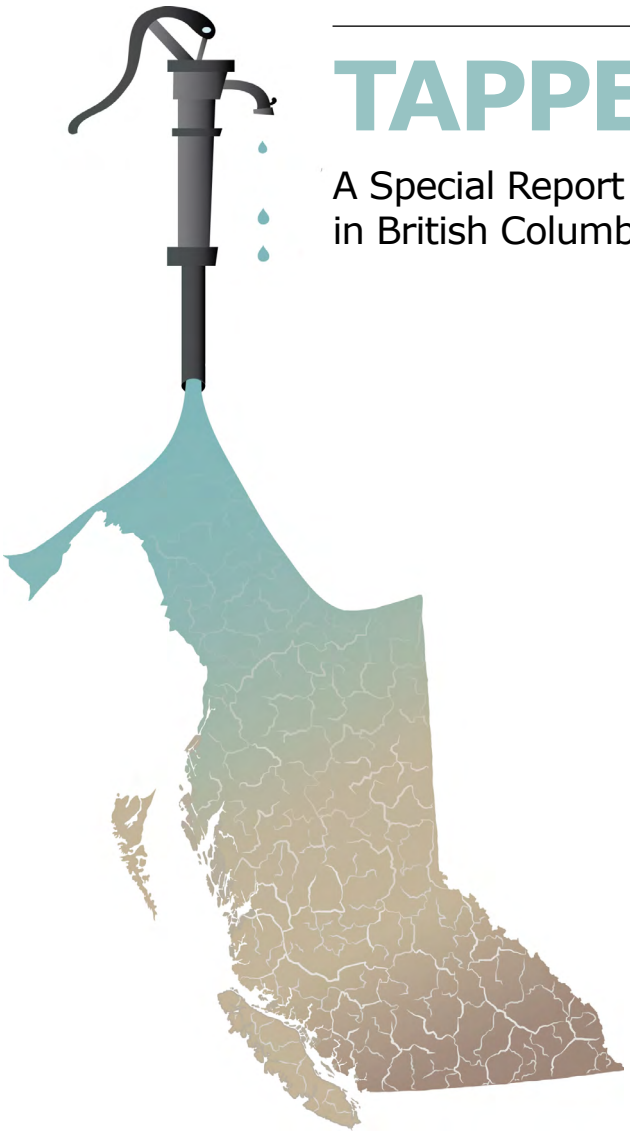


TAPPED OUT

A Special Report on Water Scarcity and Water Solutions in British Columbia

SUMMARY OF KEY FINDINGS

1. Water scarcity is a serious problem in British Columbia

- Approximately 63% of B.C.'s population (2.9 million people) live in water-stressed areas, as defined by the Province's "fully recorded" designations used to support water licensing decisions.
- The areas with the highest levels of water stress cover only 3.7% of the province, but 23% of B.C.'s population lives in these places.
- BC's population is growing significantly, and some water-stressed areas have higher-than-average growth rates.

2. There is a significant data deficit for water availability and water scarcity in B.C.

Our methodology used the best available information, but our results are only an approximation of B.C.'s water conditions. A better understanding of B.C.'s waters is a prerequisite to effective water management, and this will require increased monitoring and reporting. Currently, water users do not measure or report their use, groundwater use is only partially integrated into B.C.'s licensing regime, and unauthorized water uses are not tracked in any way.

Dispelling the Myth of Abundance

British Columbia has always been described as a place of abundant water and bountiful salmon. However, in many areas of the province, this no longer holds true. Water scarcity has become a serious issue affecting British Columbians, aquatic ecosystems, and the economy.

Summertime increasingly means droughts, water restrictions and wildfire smoke for British Columbians. The most populated areas of B.C. have more demand for surface water and groundwater than can be sustained during dry periods, with more frequent and severe droughts worsening the situation.[1] With a growing population and water sources already at their limits, B.C. is increasingly vulnerable to water shortages. Shortages are already affecting the many B.C. farmers who need more water during increasingly warmer summers. They also affect businesses and communities who depend on salmon populations returning to rivers with dangerously low flows. Even in B.C.'s northeast, drought conditions over the last three summers have triggered requirements for the oil and gas industry to suspend water use from most rivers, streams and lakes.

At the same time, we have a major opportunity to improve the way water is managed. B.C.'s 2016 *Water Sustainability Act* makes it possible to address drought and water scarcity, to build ecological and economic resilience. Many opportunities are also available to advance reconciliation with Indigenous peoples through working in partnership to better manage water and the life that it supports.

We propose that improved water management will include the following measures to minimize the economic, social and ecological upheaval caused by water shortages:

- *monitoring, measuring and reporting on the state of our waters;*
- *implementation of groundwater licensing;*
- *development of an Environmental Flow Needs Regulation; and,*
- *provision of adequate, stable funding for water management and water governance.*

By examining provincial data on water use restrictions and by highlighting case study watersheds, this report highlights water scarcity issues facing British Columbians in the short and long term, and demonstrates the need for more rapid implementation of improved water management in B.C.

[1] Ministry of Environment and Climate Change Strategy (2019). Preliminary Strategic Climate Risk Assessment for British Columbia. Report prepared for the Government of British Columbia, Victoria, BC. Accessible at: https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/risk-assessment

The connection between surface water, ground water and human use

Surface water and groundwater are connected, and both are affected by human water use and climatic effects. The cumulative impacts of water extraction, population growth and climate change are affecting water supplies for people and ecosystems in many areas of British Columbia.

Assessing Water Stress: The Methodology

What are Water Restrictions?

This analysis uses administrative designations called Water Restrictions as a proxy for water scarcity. Two of five categories were used: "fully recorded," and "fully recorded with exceptions." These provincial designations are defined as follows:

- ***Fully Recorded:*** based on the information available at the time of the last inspection, no further licenses should be considered on this stream.
- ***Fully Recorded with Exceptions:*** this designation is the same as "fully recorded," except that licenses may be considered for specified purposes and/or quantities. This designation typically allows for domestic uses.

These designations are not legally binding, but they are important for alerting decision-makers to current or potential future water allocation concerns when new water license applications are being reviewed. Provincial water managers will use additional, up-to-date information to decide whether to grant new licences on these waterways.

A full list of water restriction categories is found in Appendix 1.

British Columbia has no provincial–scale data to describe water availability or scarcity. Nor has it completed "state of our water" reporting promised in the 2008 provincial water policy, *Living Water Smart*.[2] An effective management regime relies on effective data collection—you can't manage what you don't measure.

In the absence of data, we have used water restrictions—an administrative tool used by government to manage water licences—to identify places where water scarcity may challenge our communities and aquatic ecosystems.

This report defines a water–scarce area as a watershed in which the provincial government has designated one or more[3] surface water sources as "fully recorded" or "fully recorded with exceptions" in order to inform decisions on any future water licences. An additional definition proposed for "fully recorded" is that there is a water shortage at least once every five years.[4]

[2] Province of British Columbia. 2008. Living Water Smart: British Columbia's Water Plan. Accessed at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-planning/livingwatersmart_book.pdf

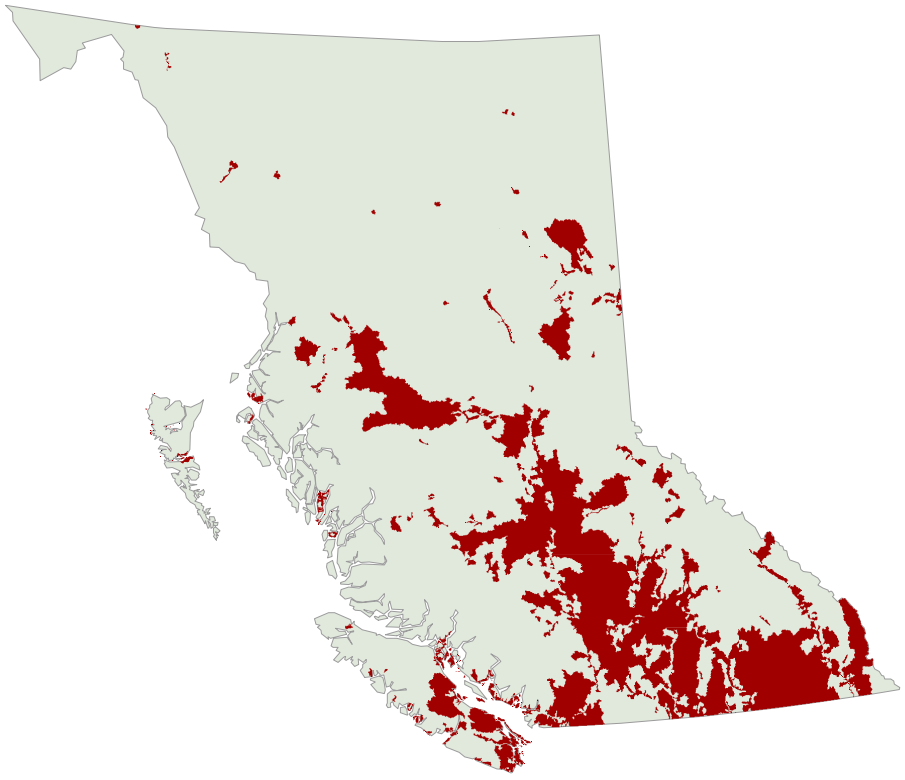
[3] See Appendix 1 for the detailed methodology.

[4] Rosenau, M.L and M. Angelo. 2003. Conflicts between People and Fish for Water: Two British Columbia Salmon and Steelhead Rearing Streams in Need of Flows. Prepared for the Pacific Fisheries Resource Conservation Council.

Key Findings

1. WATER SCARCITY IS A SERIOUS PROBLEM IN B.C.

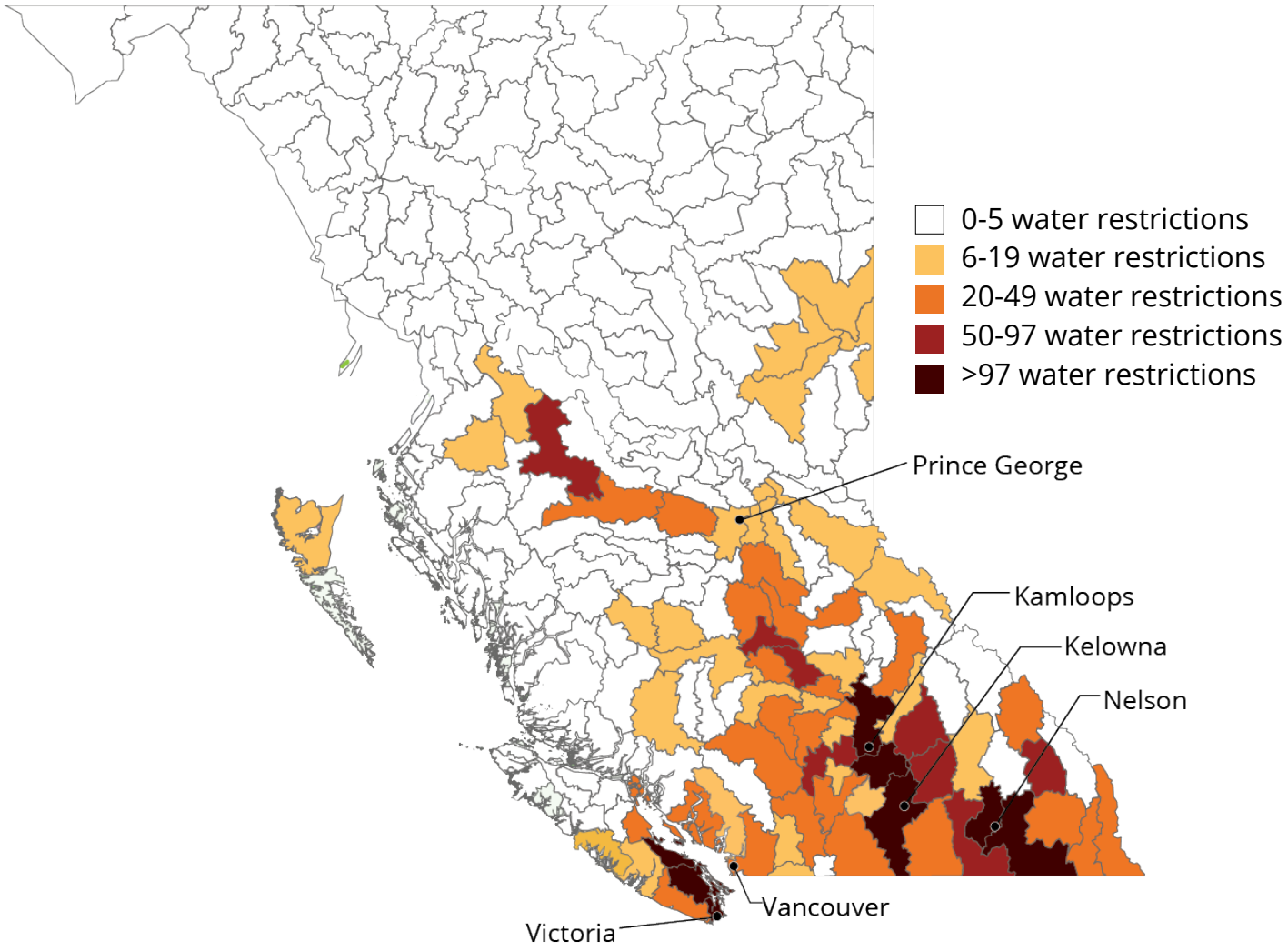
According to our analysis of water restriction and census data, approximately 63% of B.C.'s population (2.9 million people) live in water-stressed (i.e. water-scarce) areas (Map 1).



Map 1: The areas of B.C. affected by water restrictions (i.e., "fully recorded" and "fully recorded with exceptions") are indicated in red. The mapping is based on watersheds that include water bodies with one or more of these restrictions (Appendix 1).

Most British Columbians live in south and central B.C., areas showing the most water stress. And, although the areas with the highest levels of water stress cover only 3.7% of the province (Map 2), 23% of B.C.'s population lives in those regions. Moreover, B.C.'s population has doubled since the 1970s, and some of the most water-stressed areas have higher-than-average population growth (Table 1).

In the areas of B.C. highlighted in maps 1 and 2, new water licences are not necessarily available to support new farms and businesses. Even the established water users in these areas may be affected by scarcity, if they can't access their share of water during droughts.



Map 2: Major B.C. watersheds or regions categorized by numbers of water restrictions (Fully Recorded and Fully Recorded with Exceptions). The darkest areas are the most water stressed and encompass 3.7% of the province.

Table 1: Population growth rates between 2006 and 2016 for the most water-stressed watersheds/regions. Population growth in B.C. and Canada is included for comparison. The listed watersheds are those with 98 or greater restrictions, in order from most to least restrictions. The detailed methodology is described in Appendix 1.

Watershed or region with high water stress	Population growth 2009-2016
Victoria	15.6%
Kootenay Lake	6.7%
Okanagan River	14.8%
S. Thompson River	11.1%
Slocan River	4.6%
Parksville	19.5%
Lower N. Thompson River	10.8%
Cowichan River	9.2%
British Columbia	**13.0%**
Canada	**11.2%**

How does climate change affect water availability?

Climate change affects precipitation and water flow patterns, and the resulting seasonal water shortages will cause increasing competition between various water users. In British Columbia, the annual amount of precipitation is forecasted to increase, but summers will be (and have been) drier and longer, with more frequent and severe droughts. In the fall and winter, heavy rainfall will cause floods and damage to infrastructure. The amount of water stored as snowpack has already decreased in some areas of southern B.C., and this trend is predicted to continue. Snow is a temporary storage system for winter precipitation. A smaller snowpack thus affects the amount of water that is stored over the winter and then released to streams and aquifers in the spring and summer. Losing this water source can have a major negative impact on summertime stream flows and stream temperatures. Glaciers are another important source of streamflow in the summer months, but in B.C., up to 70% of glaciers are predicted to disappear by the year 2100.

Sources:

Province of B.C. *Climate Impacts.* Accessed September 5, 2019 https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/impacts

British Columbia Ministry of Environment. 2016. Indicators of Climate Change for British Columbia: 2016 Update

Many B.C. streams have extremely low flows in the summer months, a problem likely to worsen with climate change and increasing extraction pressures. Low flows threaten the survival of salmon populations in part by leaving them vulnerable to predators (including humans) and lethally-high water temperatures. Low flows can also prevent adult salmon from migrating to their spawning grounds.

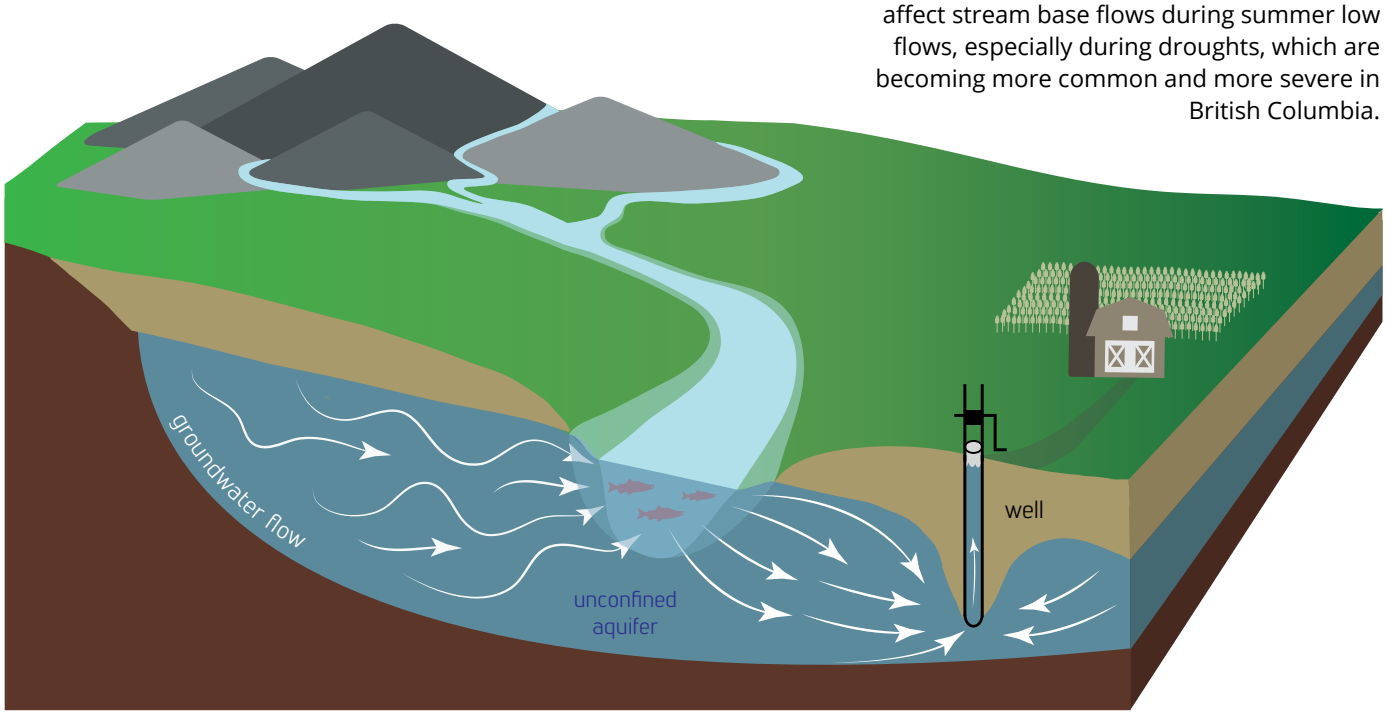
During times of year with extremely low flows, which often coincide with salmon migration and spawning, provincial water managers will encourage voluntary reductions in water use for some streams. When voluntary measures are insufficient, the provincial government may require mandatory water use reductions or a complete cessation of water use. Losing access to water can cause serious economic hardship and uncertainty, but the alternative is the elimination of salmon stocks from some B.C. streams and rivers.

2. THERE IS A SIGNIFICANT DATA DEFICIT FOR WATER AVAILABILITY AND WATER SCARCITY IN B.C.

Water restriction designations were not designed to monitor water availability in B.C. We need watershed-specific information, including climate-related changes in precipitation and streamflow patterns, to understand water availability. For water use, British Columbia has very little data. Most water users do not measure or report their use, and groundwater use is only partially integrated into B.C.'s licensing regime. Unauthorized water uses (i.e. uses that require a license and do not have one, and users who are taking more than their licensed amount) are not tracked in any way. Unauthorized water uses need to be quantified, as they can have a significant effect on water supply.

Increased monitoring and reporting are needed to provide an adequate understanding of the overall state of B.C.'s freshwater. This work should be considered an immediate priority, with adequate resources and funding designated to address it.

Groundwater and surface water are connected through shallow aquifers that exchange water with streams and other waterways. Extraction from groundwater can affect stream base flows during summer low flows, especially during droughts, which are becoming more common and more severe in British Columbia.



Groundwater, salmon and the data deficit


Andrew S. Wright

Groundwater is critically important for ecological health, and supports multiple water uses in B.C. Up to one million British Columbians use groundwater, and hundreds of groundwater aquifers provide water for industries, municipalities, farms, and rural homeowners in B.C. In rural areas, a significant amount of agricultural water comes from groundwater.

Groundwater and surface water are connected. Groundwater maintains water flows in streams and other water bodies during dry periods, often keeping water temperatures within a range tolerable for B.C.'s cool-water salmon species. Many wells tap into the same aquifers providing groundwater flows to salmon streams. In shallow, connected aquifers—common in the populated valleys of B.C.— well pumping can directly affect surface flows.

In periods of high temperatures and low rainfall, when demand for irrigation water is also high, extracting groundwater can further lower flows and increase water temperatures, devastating salmon populations and other aquatic life.

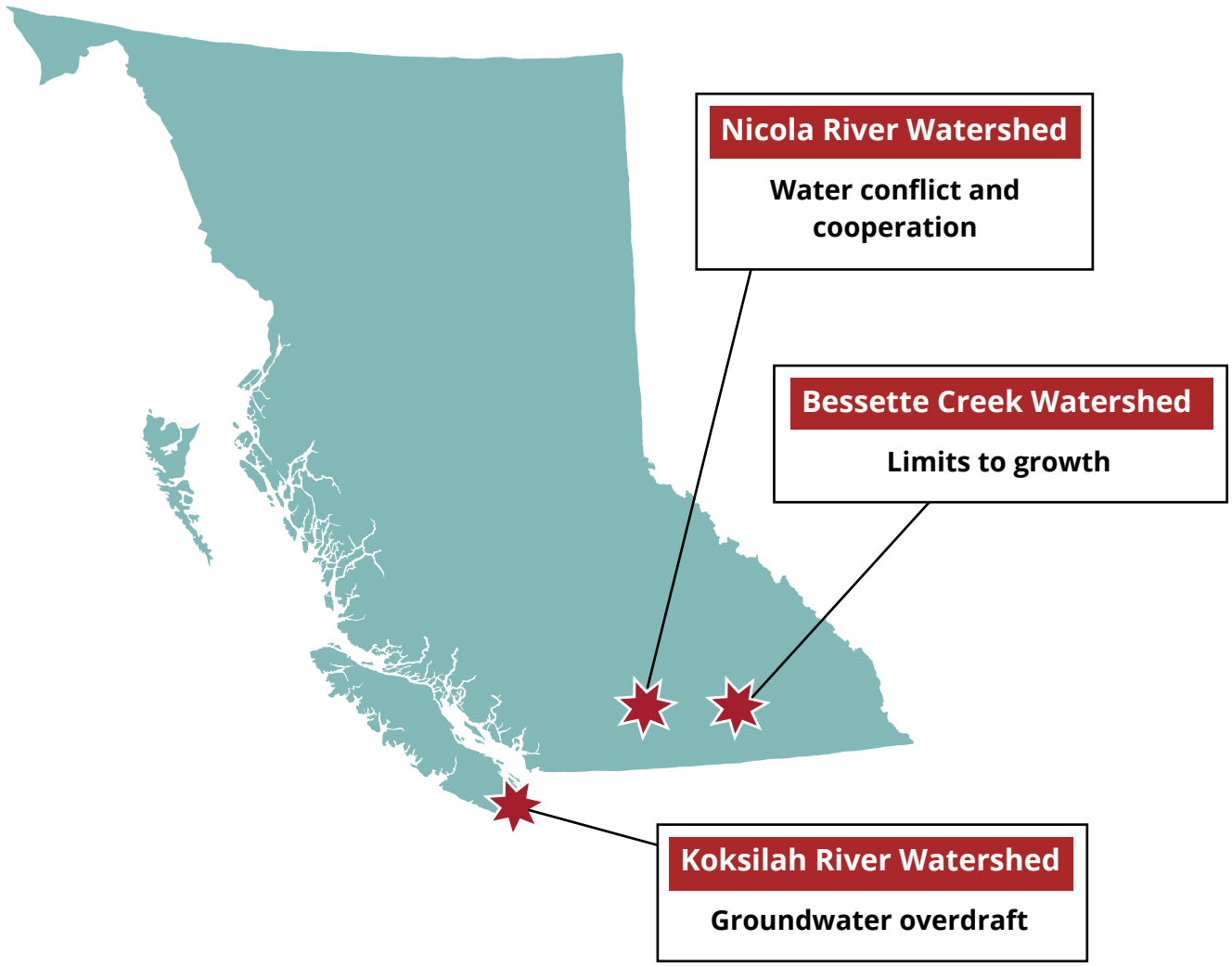
The lack of provincial-scale data on water availability, water use, and environmental flow needs is partly due to the exclusion of groundwater from B.C.'s water licensing system before the introduction of the *Water Sustainability Act*. Before 2016, groundwater was available to any landowner, with no authorization required. As a result, there are an estimated 20,000 licenses that landowners must apply for, and these groundwater uses must then be reviewed and incorporated into the system.[5] Progress has been slow, in part because better communications and education are required to reach existing groundwater users. In 2019, most groundwater use remains unquantified. This delay means that the provincial government is not yet able to manage surface water and groundwater as one connected resource.

Under the *Water Sustainability Act*, provincial managers have new tools to curtail water use during droughts, including groundwater use. However, these tools require data on surface water and groundwater availability and use, including how much water is needed to sustain aquatic life. Much more work is needed to understand the water budget and environmental flow needs, particularly in B.C.'s most water-stressed watersheds.

[5] Province of British Columbia. 2019. Blog Post #27 - Groundwater Licensing Update. February 19, 2019. Accessed at: https://engage.gov.bc.ca/watersustainabilityact/2019/02/19/blog-post-27-groundwater-licensing-update/

Case Studies

The following case studies describe conditions in three B.C. watersheds where water stresses are particularly acute. While each watershed is unique, they share problems of surface and groundwater over-extraction, stress on aquatic ecosystems, and shortages for human needs. Each illustrates the repercussions of water scarcity and some possible water management responses. The solutions and lessons from these places need to be applied to the many similarly stressed watersheds across B.C.



Bessette Creek Watershed

Limits to growth

Bessette Creek is a stream in B.C.'s southern interior that flows into the Shuswap River, a tributary of the Fraser. It provides critical spawning and rearing habitat for threatened Interior Fraser River coho salmon and endangered chinook salmon populations, as well as supporting resident fish species including rainbow trout. This area has been used for agriculture for over a century (the first water license for irrigation in Bessette Creek was issued in 1893), and surface water rights were designated "fully recorded" in 1965. Flows regularly drop to levels that threaten the viability of Bessette Creek's fish populations.

Having enough water for aquatic ecosystems and species is the cornerstone of water sustainability. In 2017, Bessette Creek became a test case for the environmental flow needs provisions of the *Water Sustainability Act*, after a license application for a new agricultural well was denied. Even though the incremental impact was small, the pumping of groundwater for a new hay operation was not permitted because groundwater pumping would have depleted instream flows that were already below ecological thresholds.

What does this case study tell us?

The Bessette Creek example illustrates that water scarcity can create hard limits to economic growth, and it indicates to property owners that new wells will not necessarily be approved. This decision, which was upheld by the Environmental Appeal Board, acknowledges surface water and groundwater are connected, and that the requirement to consider aquatic ecosystems in licensing decisions is being implemented as planned under B.C.'s *Water Sustainability Act*. These changes to water rights may seem drastic, but are the predictable result of B.C.'s history of water management, which addressed only surface water, and which was done with limited understanding of water availability, surface water and groundwater interaction, and environmental flow needs.

Koksilah River Watershed

Connectivity between groundwater and surface water and the problem of groundwater overdraft

The Koksilah River is a salmon stream on Vancouver Island that discharges to the ocean just south of Duncan, B.C. It supports chinook, coho and chum salmon populations, in addition to resident species such as steelhead and cutthroat trout. In 1980, the river was designated as "fully recorded" except for domestic uses, in response to concerns about serious stress on salmon populations.[6] Unfortunately, the Koksilah has since become a notable example of water over-allocation and water scarcity.

The North Arm of the Cowichan River (the watershed adjacent to the Koksilah) in fall 2012.

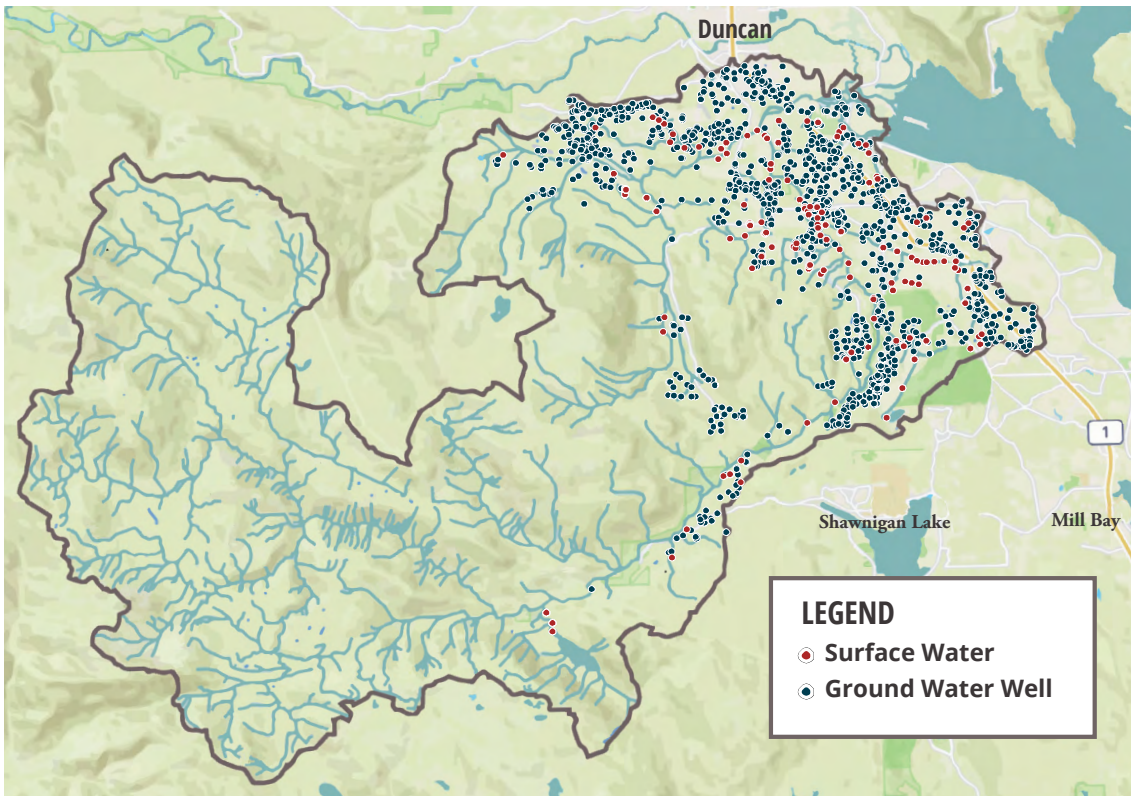
As in many B.C. watersheds, groundwater extraction in the Koksilah watershed is essential for farms, businesses, and rural homes. Our analysis estimates that approximately 70% of the water used in the Koksilah watershed today comes from groundwater, with the remainder coming from licensed surface water uses.

Advances in drilling technology and a growing population caused the number of wells in the Koksilah watershed to increase significantly beginning in the 1980s, at a time when groundwater extraction was not regulated in any way. The withdrawal of additional groundwater would have reduced flows into the Koksilah river. Groundwater extraction has the most impact during low flow times of the year, when salmon depend on cooling groundwater inflows for their survival. If wells are drawing from shallow aquifers closely connected to the river, groundwater extraction will immediately reduce instream flows.

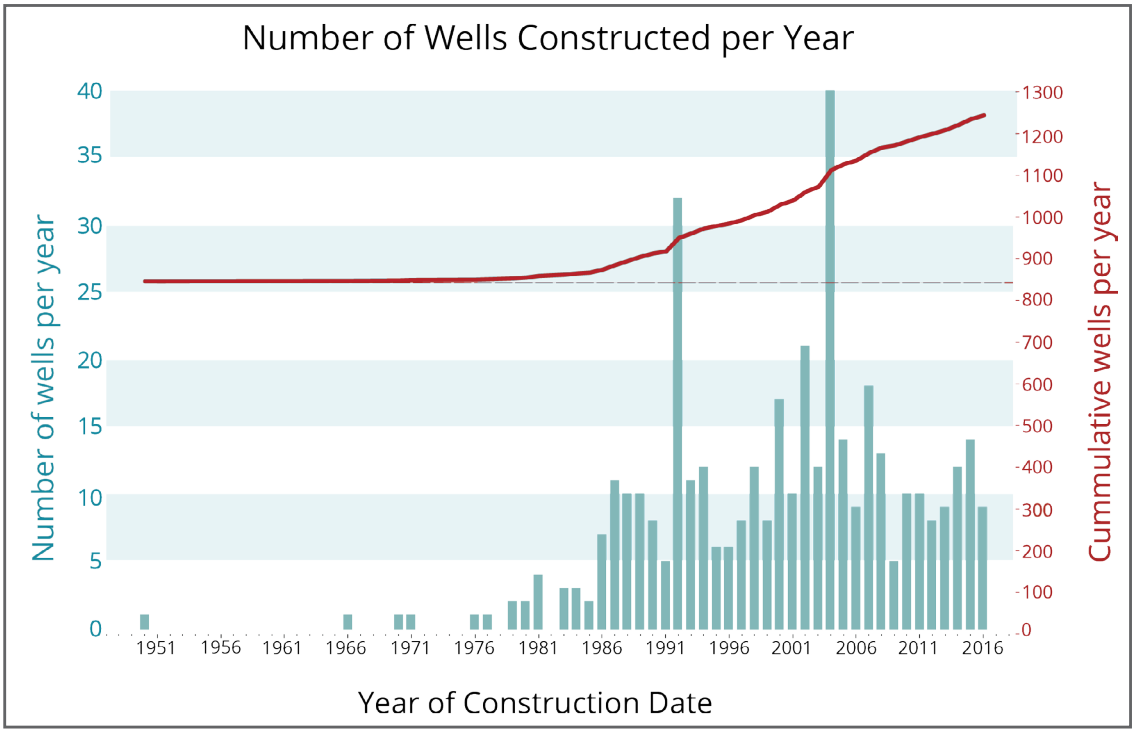
In 2017, 2018 and 2019, instream flows in the Koksilah were forecast to become dangerously low, and provincial managers requested voluntary reductions in water use. In each of these years, an order to cease water diversion was under preparation

[6] Tutty, B.D. 1984. The Koksilah River: Streamflows and Salmon production. Canadian Manuscript Report of Fisheries and Aquatic Science No. 1822.

in case voluntary efforts were not enough. In August 2019, a Fish Population Protection Order was issued under the *Water Sustainability Act*. This order required the specified water users—surface water licensees and (as-yet) unlicensed groundwater users—to cease all use until September 30, or until further notice. The targeted users were those that were expected to be affecting instream flows to the greatest degree. To minimize the economic impacts to agricultural businesses, irrigators of hay and corn were targeted and irrigators of other crops such as vegetables were excluded.



The Koksilah watershed has many points of water extraction. Most water comes from wells.



The number of wells in the Koksilah watershed increased significantly beginning in the 1980's. Many wells were drilled before records were being kept in the 1950's.

What does this case study tell us?

Losing access to water has serious economic impacts for farms and businesses. Every effort should be made to prevent this scenario. Instead, a more proactive and collaborative water management system needs to be developed for overdrawn watersheds like the Koksilah, to protect aquatic life, manage conflict between water users, prioritize water uses, and recognize Aboriginal rights and title. This can only be accomplished through water planning.

Water planning is done at a watershed scale, and requires meaningful First Nations co-leadership as well as representation from water users, local governments, local watershed protection groups and community partnerships. For the Koksilah watershed, the Cowichan Watershed Board[7] is providing leadership for sustainable water management, and is a leading example of effective partnerships between local government and First Nations. Due to the acute water challenges in these adjacent watersheds and the local leadership that has been developed in response, the Koksilah and the Cowichan are prime candidates for a Water Sustainability Plan[8] under the *Water Sustainability Act*. Among other important tasks, this planning must find ways to provide minimal environmental flows to maintain the function of aquatic ecosystems during low flow times of the year. Planning for the required minimum environmental flow will help prevent flows from dipping to a point where a Fish Population Protection Order or Critical Environmental Flow Protection Order is required.

In addition to the challenge of low instream flows, the Koksilah case study highlights a pressing problem in implementing the *Water Sustainability Act:* existing groundwater users may already be taking too much water, but these water uses will now be included in B.C.'s licensing scheme, perpetuating the over-allocation problem. This issue is of particular concern to many B.C. First Nations, because Aboriginal title and rights are not addressed in the *Water Sustainability Act*, though Indigenous water uses clearly predate B.C.'s first in time, first in right, legal scheme.[9] Water planning is a way to begin to address this issue. An important action to support water planning is to ensure all existing non-domestic groundwater users are incorporated into B.C.'s licensing scheme as soon as possible, so that provincial and local water managers have the necessary information for an effective plan.

[7] Cowichan Watershed Board. 2018. Pathways and Partnerships: A Framework for Collaboration and Reconciliation in the Cowichan Watershed.
[8] Curran, D. and O.M. Brandes. 2019 *in prep*. Water Sustainability Plans: Potential, Options and Essential Content. Prepared by University of Victoria Environmental Law Centre and the POLIS Project on Ecological Governance.
[9] Phare, M.S, 2009. Denying the Source: Crisis of First Nations Water Rights. Surrey, B.C. Rocky Mountain Books.

Nicola River Watershed

Water conflict and cooperation to find new solutions

The Nicola watershed offers a prime example of the complexities and conflicts of water management in B.C. It also breaks new ground for water solutions. The Nicola watershed surrounds the town of Merritt, one of the driest and hottest parts of British Columbia. With the exception of pink salmon, all sea-going salmon populations in the Nicola system are of serious conservation concern. Steelhead and chinook populations have been designated as "endangered", and coho as "threatened" by the Committee on the Status of Endangered Wildlife in Canada.

The Nicola watershed was developed for ranching and agriculture beginning in the 1800s. Conflicts between water extraction for agriculture and fisheries likely began shortly after water began to be diverted for agriculture.[10] In more recent times, Fish Protection Orders were issued under the former B.C. *Fish Protection Act* in 2009 and 2015, to keep salmon populations alive in the Coldwater and Nicola Rivers.[11] The Fish Protection Orders required reductions in water diversion for agriculture in both years. In 2015, all irrigation from the Coldwater River (a tributary of the Nicola River) was first reduced, then ordered to cease altogether from August 11 to September 18 unless flows improved. Fortunately, flows did improve, and limited irrigation was allowed again beginning a week later.

While the Nicola exemplifies the conflict between water needs for ranching versus evironmental flow needs, it also highlights other human water use conflicts, including between ranchers and the growing urban and rural population, whose water needs are driving new well-drilling in the Nicola watershed.

[10] Rosenau and Angelo 2003

[11] Province of British Columbia. 2015. Water Use Reduction Order to Protect Fish. Media Release accessed at: https://news.gov.bc.ca/releases/2015FLNR0218-001222

What does this case study tell us?

Water users in the Nicola have long recognized that collaboration is the only way to solve their water conflicts. The first water management plan was crafted in 1983, though little progress was made on the implementation of its recommendations. In more recent years, population growth and the effects of climate change have increased the urgency to find better solutions for water management. Starting in 2004, community stakeholders, government agencies and local representatives collaborated on water planning, culminating in a water management plan presented to the Province of B.C. in 2010.[12] This plan was not implemented, though its supporting studies and its recommendations remain highly valuable.

In 2018, a watershed governance pilot was launched through a partnership between five Nicola First Nation bands and the Province of B.C., with the overarching goal of creating sustainable management and improving the health of the Nicola watershed.[13] It is based on a co-governance agreement that recognizes First Nations traditional knowledge, water laws and authority, with a goal of access to safe, clean water for people, fish and wildlife, now and for future generations. The work in the Nicola watershed is demonstrating that government-to-government forums and new approaches are essential to addressing major water issues. This work could be an example for many regions across the province.

[12] Nicola WUMP Multi-Stakeholder Committee. 2010. Nicola Water Use Management Plan: A water use management plan for the Nicola watershed. March 2010.

[13] Province of British Columbia. 2018. MOU to address water governance in the Nicola watershed. Media release accessed at: https://news.gov.bc.ca/releases/2018ENV0012-000484

Solutions

Lurching from crisis to crisis is costly, inefficient and unproductive. With strong, innovative water management, B.C. can build resilience and steer clear of a serious water crisis—despite predictions of a warmer climate and extreme swings between too little and too much water. In a world where major cities and entire regions are literally running out of water, British Columbians must ensure that our water wealth is secured for future generations. It is the role of our government to lead and support efforts to address systemic problems of water overuse, depletion, and degradation.

Watershed Watch, together with a wide array of B.C. experts and freshwater advocates,[14] agree that the following are essential actions to address water scarcity and the data deficit:

1 State of our water reporting

British Columbia needs to dedicate significant resources towards improved monitoring and measuring. To complete comprehensive state of our water reporting, data gaps must be filled, and governance systems developed, including:

- mandatory water use measuring and reporting by all licenced users;
- integration of data collected by community-based organizations and appropriate and respectful bridging with Indigenous knowledge;
- a systematic approach to checking compliance with authorized water uses, including estimating the extent of unauthorized water use; and,
- development of publicly accessible data and reporting.

[14] Watershed Watch is allied with other water leaders to advance freshwater protection in British Columbia; see: https://poliswaterproject.org/files/2018/12/WaterLeadersLetterAndStatement.pdf

2 Improve implementation of groundwater licensing

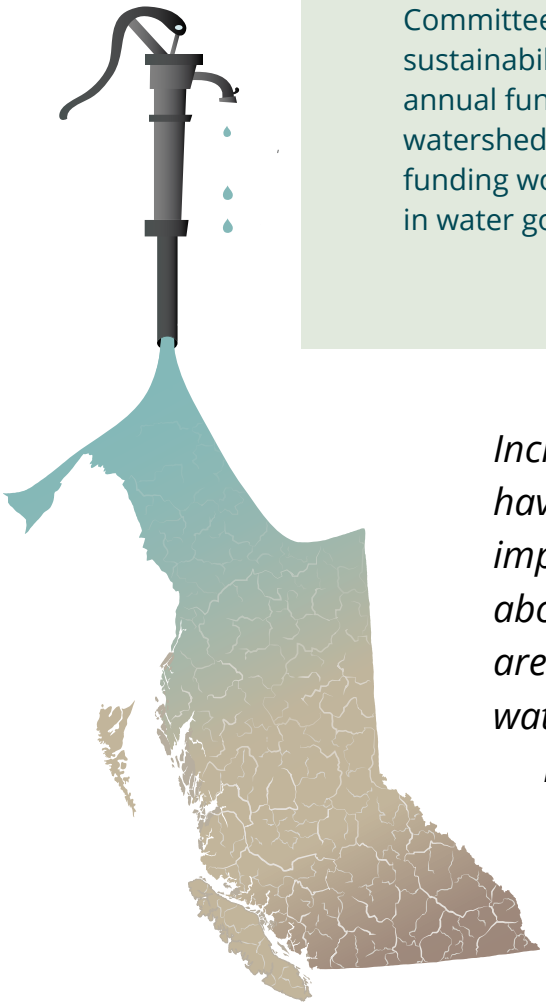
More resources and a renewed strategy are needed for licensing and managing existing groundwater users, so that all users are in compliance by the 2022 deadline for license applications. The success of this action depends on a critical shift in approach over the short term, including a fully resourced implementation plan and an effective communications program. We recommend extra effort be applied in areas of known water stress, including those identified in this report.

3 Establish an environmental flows regulation

A province-wide legally-enforceable environmental flows regulation must be developed under the *Water Sustainability Act*. This will be the primary precautionary approach for managing the effects of drought on salmon, and for maintaining healthy watersheds. While river-specific flow thresholds are preferable, this detailed work has not yet been completed for most B.C. watersheds. Waiting for this work to occur will delay the protection of environmental flows and create a risk of water over-allocation. We recommend that the development of an environmental flows regulation become a short-term priority within the ongoing implementation of the *Water Sustainability Act*.

4 Provide adequate, stable funding for water management and water governance

It is essential that additional resources be dedicated to water management in BC. While implementation of the *Water Sustainability Act* continues to be a major initiative, key measures have been slow to unfold. Given the time-sensitive nature of efforts such as monitoring, measuring and groundwater licensing, it is urgent that more resources be made available soon. In addition to increasing resources for government implementation of the WSA, the province should implement the 2020 budget recommendation made by the Select Standing Committee on Finance and Government Services to: "advance water sustainability in British Columbia by providing a dedicated, sustainable, annual funding source for First Nations, local government, local watershed protection agencies and community partnerships." This new funding would include support for local development of and participation in water governance forums and water planning.



Increased water stress and demand are having real social, ecological, and economic impacts to British Columbia, and decisions about how to allocate B.C.'s water resources are becoming increasingly difficult. Improved water management is essential for effectively responding to climate change, maintaining and restoring wild salmon populations, ensuring water security, and supporting economic prosperity.

Appendix 1: Water Scarcity Methodology and Background Information

For the purposes of this report, a water-stressed (or water-scarce) area is defined as a watershed where the provincial government has designated waterways as "fully recorded" or "fully recorded with exceptions" (e.g. for certain purposes or quantities such as domestic use). These and other water restriction categories (see Table 1) are management tools rather than a scientific classification. Water Stewardship Division (WSD) staff place water allocation restrictions on streams to alert other WSD staff of current or potential future water allocation concerns. This information is considered, along with all other relevant information when making future water allocation decisions.

The analysis done for this report revealed that approximately 2,900 surface water sources across British Columbia are designated as being "fully recorded" or "fully recorded with exceptions."

Table 1: Water Restriction Categories in British Columbia[15]

- **RNW: Refused No Water** indicates a previous application for a water licence was refused because there was insufficient water in the stream to grant the application.
- **PWS: Possible Water Shortage** indicates that this stream is nearing the "fully recorded" stage and there is the potential for periods of insufficient water.
- **FR: Fully Recorded** indicates that based on the information available at the time of the last inspection, no further licences should be considered on this stream.
- **FR-EXC: Fully Recorded** except for indicates that based on the information available at the time of the last inspection, no further licences should be considered on this stream except for licences for the specified purposes and/or quantities.
- **OR: Office Reserve** indicates this specialized comment should be taken into consideration before making any water allocation decisions regarding this stream.

[15] Province of British Columbia. 2005. What is a Water Allocation Restriction? Accessed at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-rights/water_allocation_restrictions.pdf

Water license applications can still be made for waterways with restrictions. However, if a waterway is "fully recorded", there is a reasonable likelihood that the application will be denied, restricted to winter months, include a fish flow clause, or require storage of water for the dry months. Under B.C.'s former *Water Act*, decisions were made based on the first in time, first in right (FITFIR) principle, where new water licenses were issued only if there was a reasonable expectation they would not affect existing water licenses. The FITFIR principle has continued in the *Water Sustainability Act*, with an important change to consider the need for instream flows before new water uses. Unfortunately, the FITFIR scheme has not yet been amended to address aboriginal uses and related rights, which of course came first in time.[16]

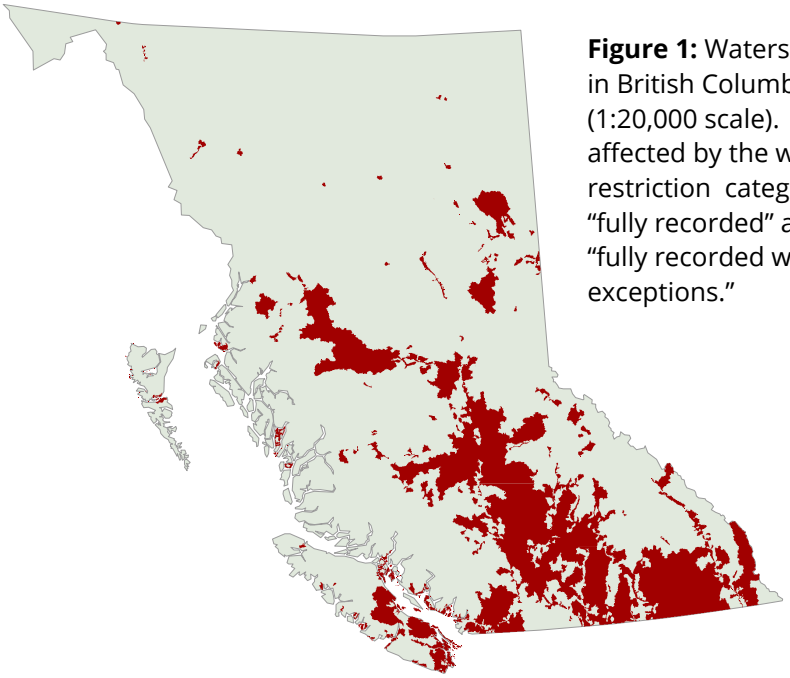


Figure 1: Watersheds in British Columbia (1:20,000 scale). affected by the water restriction categories "fully recorded" and "fully recorded with exceptions."

Figure 1 shows all watersheds in British Columbia with waterways that have the water restrictions "fully recorded" and/or "fully recorded with exceptions". The other three water restriction categories were excluded from the analysis as they were not seen as reliable indicators of scarcity. The methodology for creating Figure 1 relied on the following key assumptions:

- Streams and other water bodies that are designated fully recorded or fully recorded with exceptions for the purpose of issuing surface water licenses are water scarce.
- Watersheds that contain streams and/or other water bodies that are fully recorded or fully recorded with exceptions are water scarce. This includes upstream areas of watersheds in which the downstream linear waterway is restricted, even if the tributaries themselves do not have water restrictions. This assumption reflects the precautionary principle as well as the reality that waterways are sustained by inflows from their tributaries.
- Lakes, springs and other nonlinear water bodies are not necessarily directly connected to upstream watersheds, and thus their upstream sub-watershed areas were not included in the analysis, to ensure that the affected area was not over-estimated. Their immediate watershed was included in the analysis.

[16] Phare, M.S, 2009. Denying the Source: Crisis of First Nations Water Rights. Surrey, B.C. Rocky Mountain Books.

METHODOLOGY TO PRODUCE FIGURE 1

The following steps were undertaken to produce Figure 1:

1. Joining watersheds at the 1:20,000 scale (polygon features) with restriction points (point features) to extract a watersheds layer that presents which watersheds contains restriction point(s) and which watersheds do not. Watershed boundaries were taken from B.C.'s Freshwater Atlas.[17] Watersheds with at least one restriction point were labeled "WR- watershed" and watersheds with no restrictions were labeled "Null-watershed" (see Figure A).
2. Categorizing the type of water bodies with water restrictions into two groups:
   a. Class 1: includes linear water bodies such as streams, creeks, rivers, and brooks.
   b. Class 2: includes lakes, ponds, meadows, marshes, springs, and others (well, reservoir).
3. Identifying the boundary of the upstream watersheds of "WR-watershed" which contain at least one Class 1 restriction, so as not to underestimate the boundary of the watershed where the restriction is occurring (see Figure B).
4. Identifying only the "WR-watershed" (and not any upstream watershed), that contains a Class 2 restriction, so as not to overestimate the watershed area involved in the restriction (see Figure C).

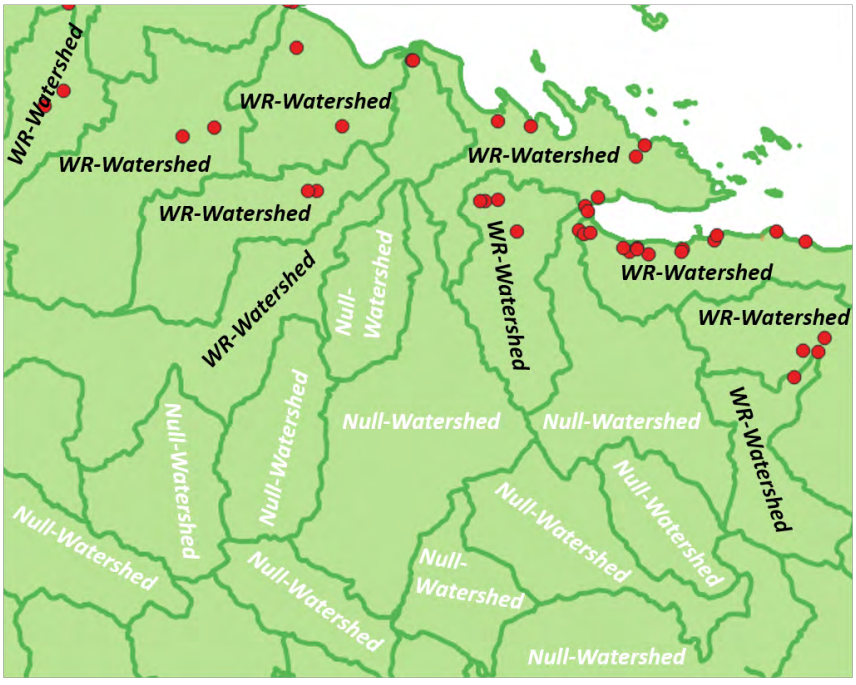


Figure A: Watersheds with at least one restriction point (WR-Watersheds) and those without (Null-Watersheds)

[17] Province of British Columbia. Freshwater Atlas. Accessed at: https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/freshwater

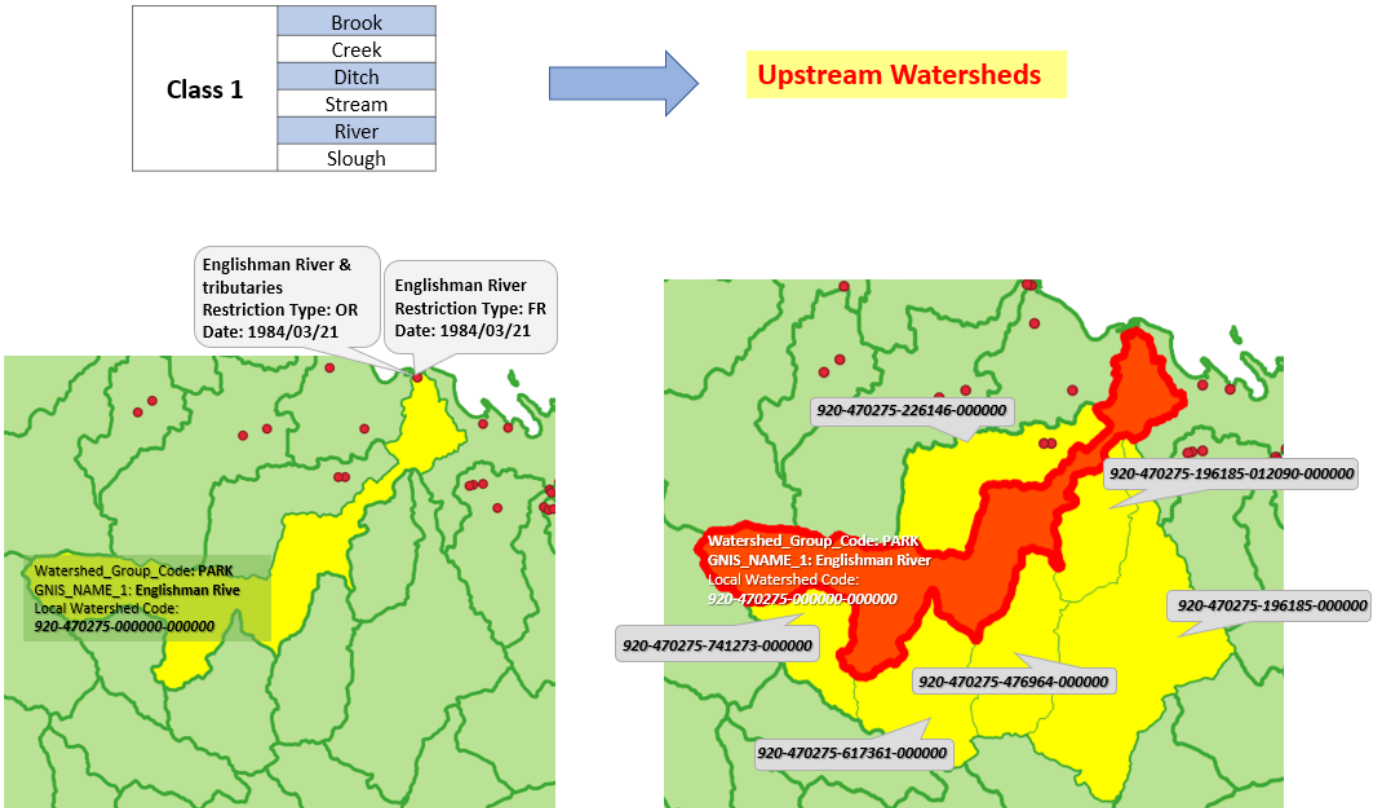


Figure B: Illustration of a watershed with a Class 1 restriction.

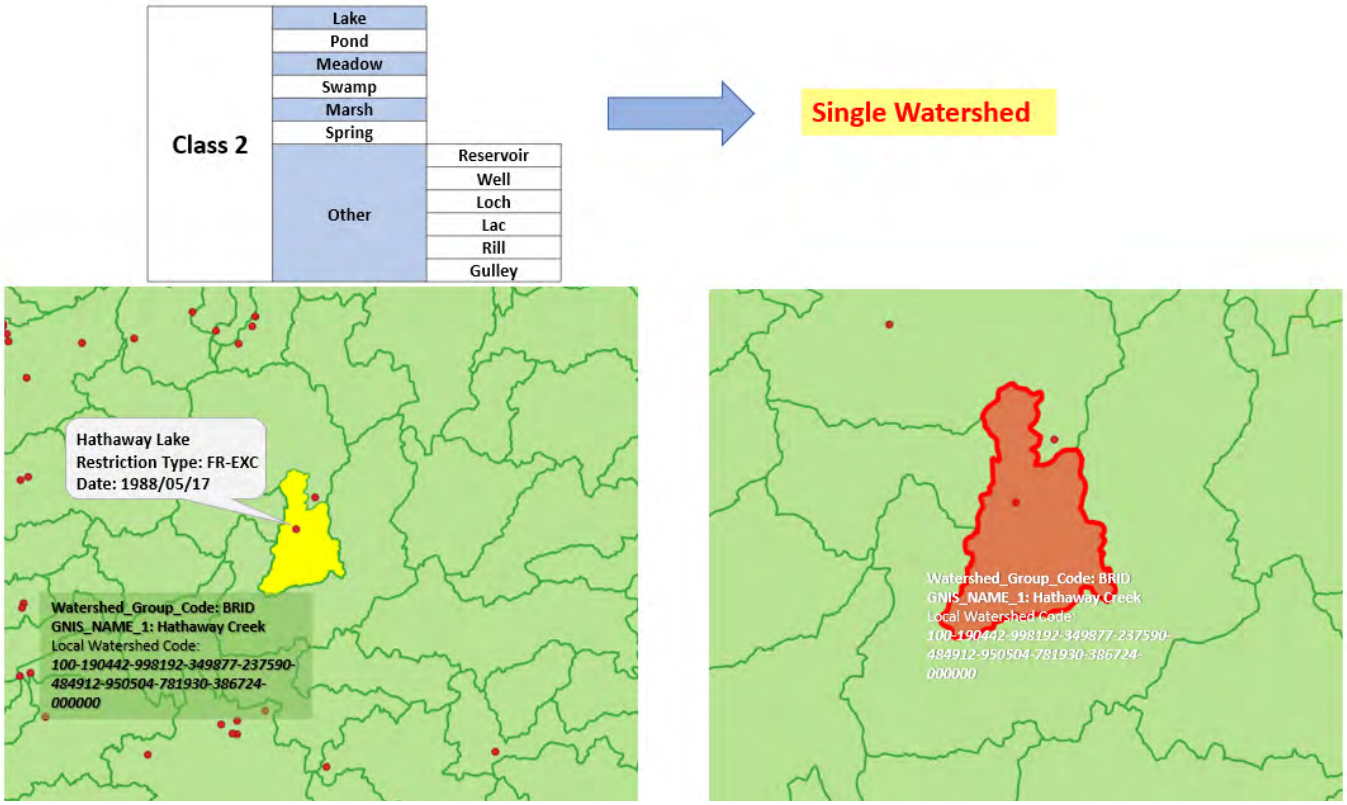


Figure C: Illustration of a watershed with a Class 2 restriction

Methodology to Determine Population Living in Water Scarce Area:

Data from the Census of Canada (2016)[18] were used to estimate the size of the population potentially affected by the water restrictions. Census data were converted into population density within jurisdictional boundaries at the scale of census dissemination blocks. Population density was then used to estimate the population living within the boundaries of the affected watersheds shown in Figure 1. In addition, the extrapolated population density was used to create population estimates for larger-scale watersheds with 97+ water restrictions (see Figure 2).

METHODOLOGY TO PRODUCE FIGURE 2

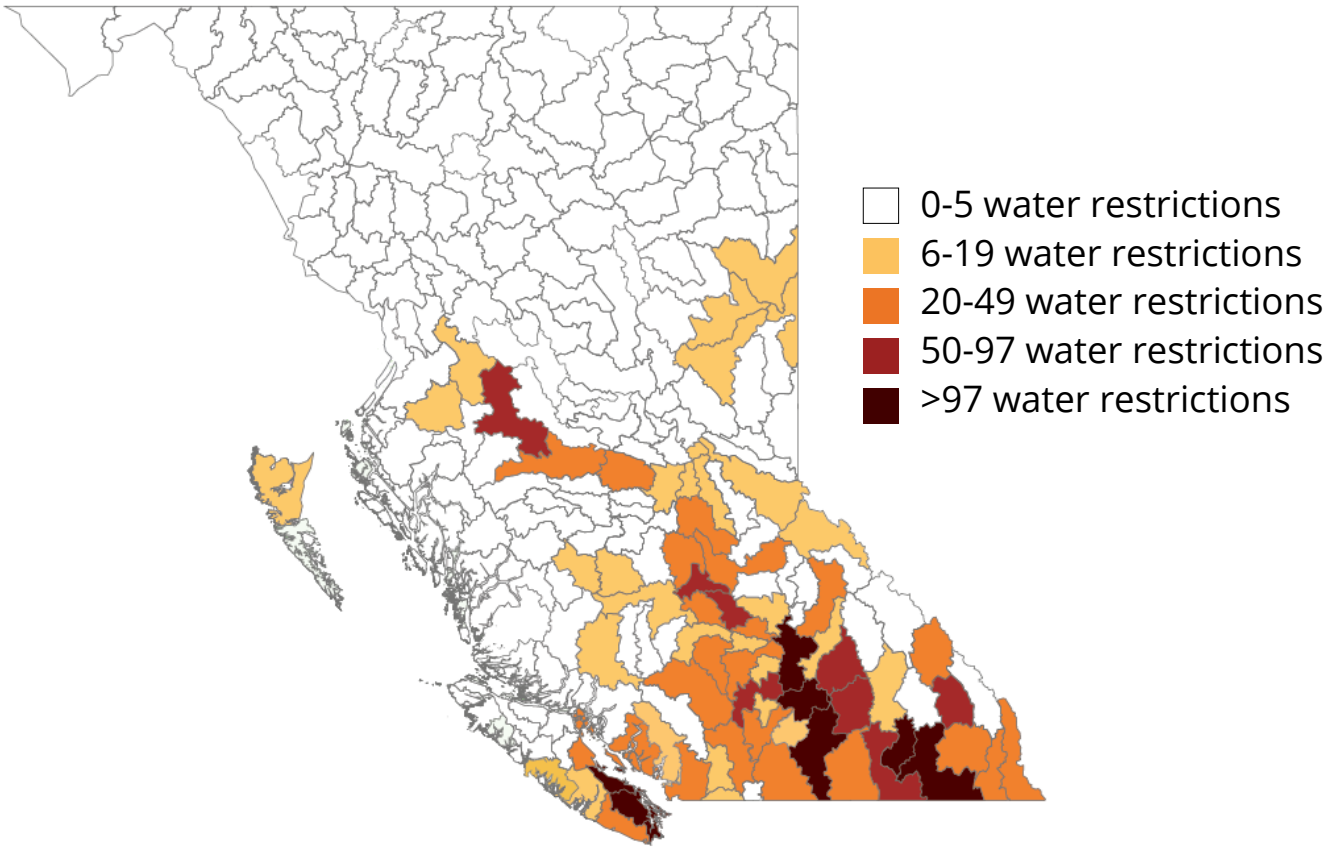


Figure 2: Large scale watersheds categorized by number of water restrictions (FR and FR-EXC)

[18] https://www12.statcan.gc.ca/census-recensement/index-eng.cfm

The analysis that was used to create Figure 2 is predicated on the assumption that the degree of water scarcity within large-scale watersheds is indicated by its number of water restrictions. However, some sub-watersheds within these large watersheds may have few to no issues with water scarcity. Our analysis was at a coarse level of resolution and is intended to reveal patterns of water scarcity in BC in the absence of other provincial-scale data.

Watershed boundaries were derived from the "Watershed Groups" layer of the BC Freshwater Atlas, which is based on smaller scale watersheds grouped into a collection of drainage basins.

The water restrictions used in the analysis were FR and FR-EXC.

An estimate of the area of BC which is the most water scarce was made by determining the area of all watersheds within the >97 water restriction category. This translates to 3.7% of the province.

Methodology to produce population growth statistics within water scarce areas depicted in Figure 2:

Data from the Census of Canada (2006, 2011 and 2016) were used to determine the change in population size in the eight large-scale watersheds/regions affected by more than 97 water restrictions. Census data were converted into population density within jurisdictional boundaries at the scale of census dissemination blocks. Population density was then used to estimate the population living within the boundaries of the watersheds/regions shown in Figure 2 in dark red and listed in Table 2.

Watershed or Region	Population growth 2009-2016	Number of Water Restrictions (FR, FR-EXC)
Victoria	15.6%	263
Kootenay Lake	6.7%	227
Okanagan River	14.8%	199
S. Thompson River	11.1%	168
Slocan River	4.6%	105
Parksville	19.5%	104
Lower N. Thompson River	10.8%	101
Cowichan River	9.2%	98
British Columbia	**13.0%**	**2900**
Canada	**11.2%**	**n/a**

Table 2: Population growth rates between 2006 and 2016 in B.C.'s most water-stressed watersheds/ regions Population change for BC and Canada is included for comparison. The number of water restrictions is also shown.