

Groundwater & Healthy Salmon Streams *- it's all connected*



**Watershed
Watch** 
**SALMON
SOCIETY**
Watching out for BC's Wild Salmon

1037 Madore Avenue
Coquitlam, BC V3K 3B7
604-936-9474
wwss@telus.net
www.watershed-watch.org



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Watching out for BC's Wild Salmon

Watershed Watch Salmon Society is a science-based charity focused on protecting wild salmon and trout and their habitat. In recognition of groundwater's importance to fish, Watershed Watch has produced a scientific literature review on the topic, and has produced a legal review of First Nation's rights with respect to groundwater and fish habitat. You can see these publications plus a short brochure at: www.watershed-watch.org

BRITISH COLUMBIANS ARE BLESSED WITH A DIVERSITY OF WILD SALMON remarkably well adapted to conditions in their home streams. Resource managers know that logging, fishing, water extraction and development must be thoughtfully managed to care for salmon. But these same managers have only recently acknowledged the importance of groundwater to streams and wild salmon. Streams are connected to groundwater, and water is always moving above and below ground at different scales of time and space. When too much groundwater is taken by humans, water temperature and flow in connected salmon streams are seriously degraded. Given the plight of wild salmon and the various threats to their survival, it is past time to better manage groundwater for salmon.

What is groundwater?

GROUNDWATER IS A HIDDEN RESOURCE that sustains aquatic ecosystems and salmon habitat. Groundwater helps ensure streams flow year-round, and flow at temperatures conducive for fish. This water is also important to people, with one-quarter of BC's households getting their drinking water from wells.

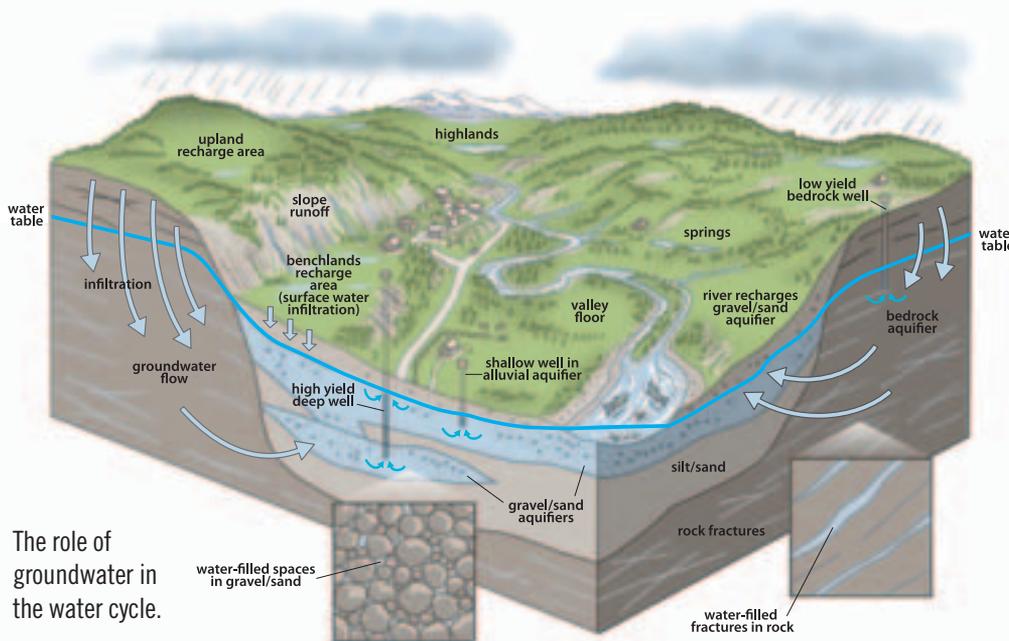
Technically speaking, groundwater is the water stored beneath the earth's surface, found mostly in saturated, permeable geological formations called 'aquifers'. Aquifers can be shallow – often directly

under streams and along valley bottoms – or they can be deep. The depth and type of aquifer determines whether exchanges with water on the surface are measured in terms of minutes, months, or millennia.

Groundwater in the water cycle – a salmon eye's view

STREAMS CONSTANTLY EXCHANGE water with the ground. Some stream sections augment their flow from groundwater, while other parts of the same stream recharge the aquifer below.

These exchanges between surface water and groundwater also vary seasonally and with flow conditions. Groundwater can supply a significant proportion of stream flows, depending on the time of year. Indeed, when some streams are at their lowest in late summer, groundwater can be essential to keeping streams flowing and keeping water temperatures cool enough for salmon to survive.



The role of groundwater in the water cycle.



Small streams offer valuable fish habitat, and often rely on groundwater for a significant proportion of their flows.

Why is groundwater important to fish?

GROUNDWATER SUSTAINS STREAMS – and thus fish. Groundwater augments ‘base flows’ during summer months when rainfall is scarcest and spring snowmelt has run its course. Because it is insulated in the ground, groundwater temperatures are remarkably stable throughout the year, staying close to the average annual air temperature. Groundwater is thus cooler than typical summer temperatures, and warmer than typical winter temperatures, making groundwater all the more valuable for fish, and explaining why fish seek groundwater upwelling zones for egg incubation and overwintering, and through hot summer periods.

Groundwater’s stable temperatures & year-round flow make it essential for healthy fish habitat.

In some parts of the province, cool groundwater inflow is essential for salmon to live long enough to reproduce – providing refuges in water otherwise warm enough to kill. Groundwater is the likely reason that many warm BC Interior streams have had healthy fish populations, even though average water temperatures aren’t always cool enough for salmon.

Groundwater also has different chemical properties than surface water, thanks to minerals it absorbs in its underground journeys. It thus supplies nutrients to streams, nurturing the food web that feeds fish. In many ways, groundwater is an essential “buffer,” helping to

The importance of groundwater to fish¹

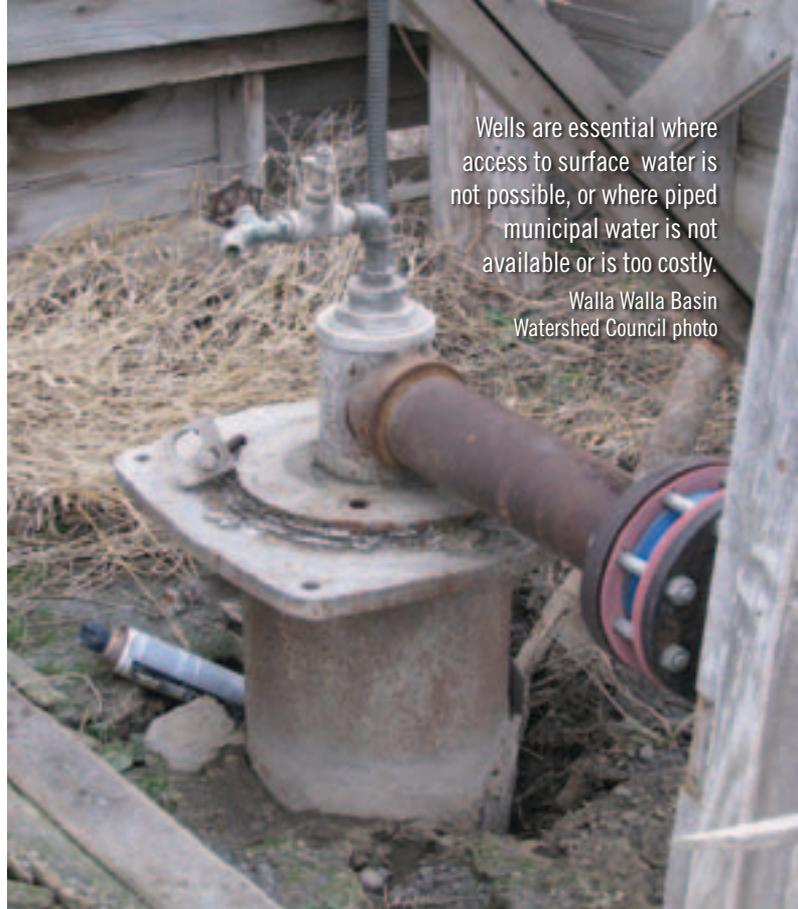
Groundwater role	Fall/Winter	Summer/Fall
Base flows	Maintains free-flowing water, channels, and habitat through winter low flows	Maintains base flows through dry periods
Stream temperature	Prevents/delays ice formation and influences thickness and break-up; provides areas with above-freezing water temperatures	Reduces daily stream temperature fluctuations, delays cooling in the fall
Water quality	Supplies dissolved oxygen and nutrients to stream; buffers water quality changes through groundwater – surface water exchanges	Helps maintain stream productivity through nutrient inputs; stimulates macrophyte growth; and buffers water quality changes through groundwater–surface water exchanges
Habitat	Determines size/quality of winter refugia; affects winter mortality and carrying capacity	Provides protection from lethal temperatures

¹ Adapted from Power, G., R.S. Brown and J.G. Imhof. 1999. *Groundwater and fish – insights from northern North America. Hydrological Process* 13:401 – 422.

maintain and stabilize the habitat value of streams, and adding to the resilience of salmon populations in the face of climate change and other threats.

How does groundwater extraction affect streams?

STREAMS CAN BE DIRECTLY DEPLETED by groundwater pumping, depending on the well location and the local geology. In these cases, turning on a well pump has a short-term, measurable effect on stream flow. Streams are also affected when water making its way to the stream is intercepted by wells, or when groundwater pumping draws down the water table. Because it's all connected, extracting too much groundwater or too much surface water can seriously affect ecosystems and water availability in ways that haven't always been recognized.



Wells are essential where access to surface water is not possible, or where piped municipal water is not available or is too costly.

Walla Walla Basin
Watershed Council photo

Quality matters

GROUNDWATER QUALITY IS IMPORTANT, particularly where wells are used for drinking water. This necessity was highlighted with the Walkerton tragedy in Ontario in 2000, when hundreds of people were sickened and seven died due to contaminated drinking water. Since then, Canadian provinces have been busy ensuring that groundwater quality protections are in place. BC responded by developing the Groundwater Protection Regulation to address water quality. In the future, this regulation may also address the management of water quantity. For now,

it ensures that new wells are properly constructed, all wells are securely capped, and unused wells are sealed, so that contaminants do not have a direct conduit to the aquifer below. BC regulations also address the storage of hazardous or toxic materials near wells. Protecting groundwater quality is particularly important in agricultural areas, where water is subject to contamination from improper handling of livestock manure. In addition to livestock manure, groundwater can be contaminated by careless handling and storage of chemicals and fuels, by pipelines, oil spills, landfills and septic systems, by concentrations of dead animals, and by widespread use of pesticides and fertilizers.

Because of variations in local geology, some surface areas have close connections to the aquifer below. This makes them 'recharge' areas where rainfall soaks into the ground to replenish the aquifer. For maintaining good water quality, these recharge or 'source' areas can be managed to restrict certain land uses or practices, and minimize the chances of contamination.



Agriculture poses a significant threat to groundwater quality in many areas

The big squeeze: development & climate change

BRITISH COLUMBIA'S POPULATION continues to grow, placing ever more pressure on limited resources. At the same time, climate change is making life more difficult for salmon and other species.

When too much groundwater is taken for human consumption, aquatic ecosystems don't get their share. Impacts range

from degraded habitats to complete elimination of groundwater-dependent ecosystems. For salmon relying on cool groundwater inflows, overuse of groundwater could lead to the devastation of local salmon stocks. Taking too much groundwater can also

affect the reliability of surface water supplies for people, since groundwater is often a major contributor to stream flows.

With climate change, cool groundwater inflows become even more important. Even more than now, the cooling influence of groundwater may

The most water is drawn from wells when conditions are hot & dry, creeks are at their lowest & fish desperately need cooling groundwater.

Climate change has serious repercussions for temperature-sensitive species such as salmon.

Michael McMann photo.

Water is needed for new development, and when surface water is not available, water is taken from groundwater wells.



make the difference between life and death for salmon during the hot days of summer.

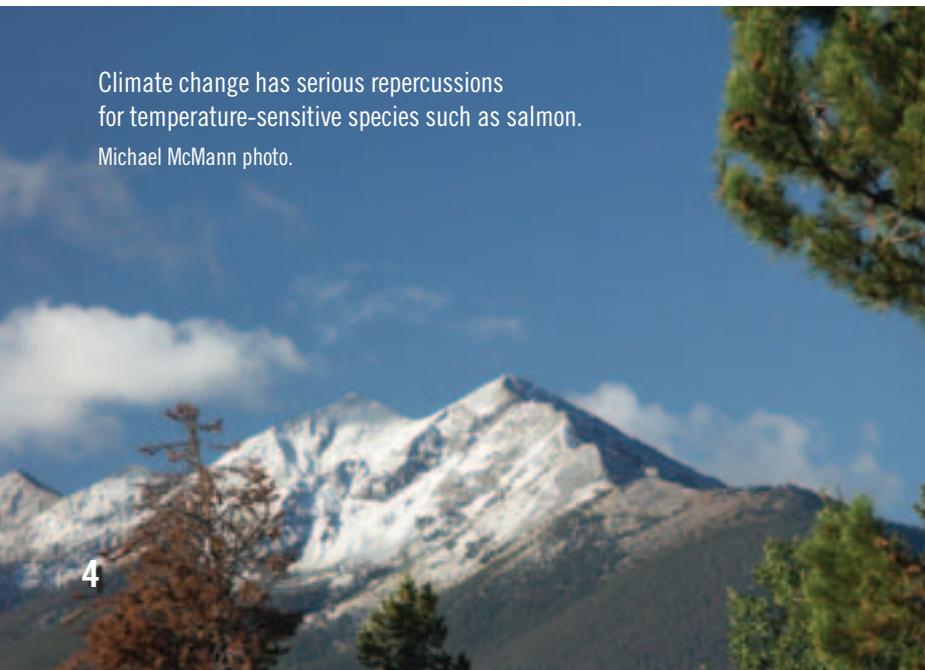
At the same time, overall water availability for people is expected to decrease with climate change, putting yet more pressure on groundwater resources. Another frightening possibility is that the average temperature of groundwater may increase in response to increases in the average air temperature, potentially making many British Columbia streams uninhabitable for salmon.

Salmon streams & BC groundwater policy

SECURING ACCESS TO WATER is an essential step for almost any new development.

In areas where surface water is fully allocated, provincial officials may turn down requests for new water licenses.

This doesn't necessarily stop development, because the landowner can simply drill a well instead. BC's outdated laws don't regulate the taking of groundwater, except for very large uses. Sadly, BC is the sole jurisdiction in Canada that has no general permitting requirements for groundwater extraction, despite the fact that we extract one-quarter of all the groundwater used in Canada.



On the brink: Chinook salmon in the Nicola River

CHINOOK SALMON IN THE NICOLA RIVER are a 'spring' run, meaning that fish start arriving in the river in June but wait until September to spawn. The Nicola River is in the Southern Interior near Merritt, and because of the hot climate, water temperatures can exceed 25°C during summer – crossing a lethal threshold for salmon.

Luckily, groundwater entering the Nicola averages at least 7°C cooler than the surrounding stream water² and fish actively seek these inflows to keep cool. In fact, biologists believe that the returning adult fish survive hot dry summers only because of these local, cooling groundwater inflows.

In some years, Chinook juveniles also depend on groundwater to survive the hot summer days. Juvenile spring Chinook spend a year in fresh water before migrating to sea. Chinook juveniles have been

observed burrowing into gravels in groundwater upwelling areas where temperatures are 16°–17°C, compared to surrounding river temperatures of 23°–25°C. They will remain in these cool areas throughout the day, coming out at night to feed if the stream cools sufficiently.

The Chinook run in the Nicola River may be jeopardized as groundwater extraction increases.

The Chinook run in the Nicola River may be jeopardized as groundwater extraction increases. Large amounts of surface water extraction are also a problem, as the less water there is instream, the less time it takes for the sun to heat it up. The more surface water and cooling groundwater is taken, the poorer the prospects that the Nicola River will sustain a Chinook run into the future.

² Richard Bailey, DFO, personal communication.

Chinook salmon runs in BC's interior depend on cooling groundwater to survive.

Michael Jeffries photo.





There are hundreds of thousands of unregulated wells in BC.

Walla Walla Basin Watershed Council photo

Living Water Smart:
read a description
of BC's water
policies at
livingwatersmart.ca

Depending on where a well is located, it can draw directly from the adjacent stream – creating a legal way to take water from a fully allocated stream. There are hundreds of thousands of unregulated wells in BC, and when considered together they can have significant effects, even causing some streams to run dry during summer. To make matters worse, the most water is drawn from wells when conditions are hot and dry, creeks are at their lowest, and fish stocks most desperately need the cooling influence of groundwater.

What are the consequences of business as usual?

IN MANY JURISDICTIONS, groundwater has not been treated as a limited resource. Historically, groundwater was considered free for the taking, since its hidden nature made it hard to understand where it came from. Many resource managers now understand that groundwater is a critical part of the water cycle, and that its use must be better managed.

Worldwide, groundwater has become a critical focus for water managers, as governments see the effects of its improper management on surface water resources and long-term water availability. All trends indicate that a 'business as usual' approach will have dire consequences for ecosystems and for people. We can look to areas with longer settlement

histories, greater populations and/or drier climates to see what is in store for us if we do not change our ways. In areas of the US and Australia, the long-term viability of settlements and agriculture is coming into question because of short-sighted water management. Streams, ecosystems and fish stocks are in jeopardy or have disappeared as a consequence of too much water being taken for human needs. Fish will always lose when diminishing water supplies must be allocated between ecosystems and people. This makes pro-active stewardship of our water resources essential. Business as usual is not an option, and governments in various jurisdictions are looking to water conservation measures and increased groundwater regulation as solutions.

Stewarding groundwater in British Columbia – Living Water Smart?

CURRENTLY, BC LAGS BEHIND OTHER jurisdictions in regulating groundwater use. This gives us an opportunity to leapfrog ahead and manage surface and groundwater as a single, connected resource. This will mean regulating the drilling of new wells, and the amount of water that can be taken. It will require permitting for all extractions above a certain threshold, and mandatory considerations to protect instream flows. You can't manage what you don't measure, so metering and monitoring will be an important part of any new system.

In 2008, the BC government announced the creation of a provincial water plan, called "Living Water Smart," to improve all aspects of water management. Among other things, it promises changes to provincial policies for groundwater management. The Living Water Smart plan commits to regulation of groundwater use in priority areas, and regulation of large withdrawals. Unfortunately, government does not intend to implement province-wide regulation of groundwater withdrawals, except for large with-

drawals that are usually associated with industrial, agricultural, group water supply or commercial uses. Under the Living Water Smart policy proposals, single domestic wells may only be regulated in priority areas where there is a Water Management Plan in place. Currently, there is only one Water Management Plan underway for the province, for the Township of Langley. Despite an urgent need to manage the extraction of groundwater, it does not appear that the final Langley Water Management Plan will have significant groundwater metering and permitting requirements for private wells. As of October 2009, the Township's final draft Water Management Plan had been endorsed by council and preparations were underway to submit it to the Province for final approvals.

Negative consequences of climate change are predicted to include more frequent and severe fires that can affect salmon habitat and the groundwater cycle



Case Study: Township of Langley takes action to protect its groundwater

IN THE TOWNSHIP OF LANGLEY, WATER MANAGEMENT challenges include stresses on water availability and water quality due to population growth, urbanization, and the intensification of agriculture. Climate change is another management issue for municipalities across BC, as current and predicted climate changes may reduce water availability and increase water use conflicts.

Between municipal water supplies and private wells, most of the water consumed in the Township comes from groundwater. It is now clear that local groundwater levels and stream flows have decreased due to over-extraction. The Township has been developing policies and regulations to protect local groundwater resources for community use and healthy fish habitat. As of October 2009, they are finalizing a provincial Water Management Planning process focused specifically on groundwater.

Langley hosts 700 km of fish streams, some of which are at risk from groundwater extraction. In fact, computer modeling indicates that groundwater extraction has depleted base flows (stream flows coming from groundwater) between 12 and 70% for certain streams supplied by four of the most heavily-used aquifers. If groundwater continues to be over-extracted, at least one creek could begin recharging the aquifer below rather than receiving base flows. If this happens, aquatic habitat quality and quantity would likely decrease,

and in hot dry years, the stream could even dry up.

The Township's Water Management Plan is the first in the province and was enabled by changes to the provincial Water Act. Other municipalities will learn from the Township's experience and may develop plans of their own. As of October 2009, the final draft plan had been approved by the Township's council and was being prepared for submission to the Province. The Plan has been in the works for some time; after the first draft was presented in 2007, it was revised based on council and public feedback to take out measures for i) meter installation, ii) fees for groundwater, and iii) a body to manage the plan.

The second draft plan was finished in 2008, and after further consultation a final draft was produced in 2009. The final draft includes measures to protect groundwater quantity as well as other measures for protecting water quality, for water conservation, and for enforcement and monitoring. It does not include measures to meter or charge fees for water from private wells, though metering of the municipal water supply is included. When the plan is made final by agreement of the Minister of the Environment, it will be with measures that the public, Township Council, and the BC Ministry of Environment all support.

More information is available from the Township of Langley at: www.tol.bc.ca/watermanagementplan

The public will need to be informed and involved as Living Water Smart policies are fleshed out, to ensure that any new laws will bring about sustainable management of groundwater and surface water resources.

Groundwater education

MOST PEOPLE KNOW LITTLE ABOUT where groundwater comes from and how it is connected to streams. In contrast, resource managers' understanding of the issues has been increasing over the past decade. Important information about water shortages, water conflicts and ecosystem impacts is now available, as are various tools to improve our water management. To make the needed changes, managers require public support, and the public will need to know what's at stake. A better educated and more vocal public is needed to create political support for changes in the way that groundwater is managed.

How can we help BC's salmon stocks?

EXCESSIVE SURFACE AND GROUNDWATER extraction are just some of the threats that BC's salmon stocks face. Sustaining BC's salmon will

require concerted efforts to regulate and manage water extraction, as well as action on other fronts.

Our provincial politicians need public support to bring in groundwater laws that protect salmon streams and long-term water availability. Making changes can be difficult, particularly when it means an increase in government oversight and regulation. Preserving and increasing groundwater for salmon stocks will require public support and an understanding that development must be balanced with instream flow needs.

You can provide support for change by:

- ✓ **CONTACTING** your elected representatives (local and provincial) to describe the issues and the importance of sustainable solutions.
- ✓ **LEARNING** about groundwater and other water management issues and sharing your knowledge with others.
- ✓ **SUPPORTING** provincial water policy development by attending forums and giving your feedback.
- ✓ **GIVING** financial support to a group you trust to represent you.



Summary

RESOURCE MANAGERS NOW understand that surface water and groundwater are connected, and that proper management means considering them as a whole. The importance of groundwater to salmon and other fish is also clear. BC currently lacks any significant form of groundwater management, and doesn't manage groundwater and surface water as a unit. BC also lacks effective mechanisms for meeting the needs of fish and ecosystems in water allocation decisions. However, our water management is likely to change as new policies are developed. It will be important to ensure that ecosystem needs and surface/groundwater connectivity are properly addressed in any new policies and legislation.

Good water management ensures water for human needs while still meeting ecosystem needs. In contrast, unsustainable use will result in scarcity for all, and our environment will be the biggest loser. In some parts of the world it's possible that settlements will be abandoned and irrigated agriculture cease, due to a lack of water. In many of these areas, rivers and fish are already in deep trouble, and climate change is worsening the situation. We are not yet at that juncture in British Columbia. If we act now we can preserve our heritage of healthy rivers and groundwater-dependant salmon stocks. Our managers and politicians will need our support as we enter a new era of water management in BC.

Contact Watershed Watch Salmon Society for more information: wwss@telus.net or visit www.watershed-watch.org

Learn about provincial water management policy at: www.LivingWaterSmart.ca





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