



LIQUID GOLD: GROUNDWATER

Elevating the Importance

What is Groundwater?

- Easy...water stored underground
- Directly affects surface water by
 - Sustaining stream base flows
 - Providing stable temperature habitat (thermal refuge) in summer and winter
 - Supplying nutrients and inorganic ions
- Surface water replenishes and exchanges with groundwater

Why the Focus on Groundwater?

- **Increasing demand for water** (i.e. where surface water supplies fully allocated or over-subscribed)
- Groundwater depletion is **linked** to surface water; its overuse can affect surface flows
- Important, often **essential, component of wild salmon habitat**

Back to Fish...

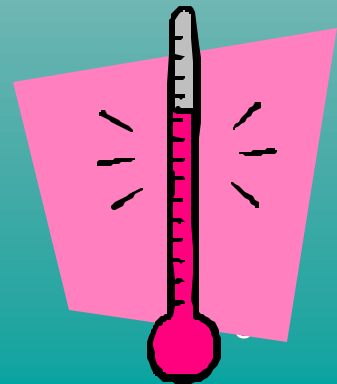
- The role of groundwater to fish changes with the seasons ...

Role of Groundwater	Summer	Fall / Winter
Provide base flows	Maintain min. flows & wetted perimeter/living space through dry periods	Maintain free flowing water, habitat, migratory channels during winter minimal flows
Moderate temperatures	Dampen diel fluxes in temperature, slows/limits seasonal warming, delays cooling in autumn	Prevents/delays ice formation. Provides areas with temps above 0°C. Influences ice thickness/breakup
Influence water quality	Help maintain stream productivity by steady input of nutrients, stimulate macrophyte growth, water quality tempered by hyporheic exchanges	Supplies dissolved inorganic/organic nutrients and oxygen to stream. Water quality tempered by hyporheic exchange
Provide refugia	Provides protection from upper lethal temperatures. May set carrying capacities in hot dry summer weather	Sets size and quality of winter refugia. Influences mortality and may set overwintering carrying capacities

Hot Summers, Cooler Groundwater

- S. Interior of Fraser Basin; semi-arid
- Flows driven by spring snow pack melt
- Peak flows mid May – mid June, rest low flows
- Summer high water use (irrigation) can lead to extreme conditions for fish...

***Lower stream flows,
Higher stream temperatures***



Hot Summers, Cooler Groundwater

- Summer daytime stream temperatures can exceed 25°C
 - Lethal for salmon!
- Some systems extended night time stream temperatures, up to 20°C



Hot Summers, Cooler Groundwater

- Q: If so, how do these fish survive?
- A: **Groundwater upwellings!**



Likely serves a critical function providing cooler water that fish can take refuge in away from the warmer surrounding temps

= Thermal Refuge!

Cold Winters, Warmer Groundwater

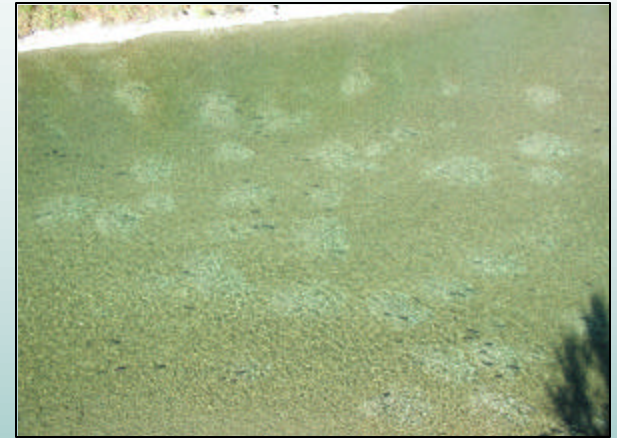


- Low flows in the winter; frigid waters
- But groundwater input is relatively warmer

Cold Winters, Warmer Groundwater

- Spring-run chinook (and other sp.) redd site selection depends on GW upwellings

Theory - allows eggs to properly develop (thermal units) and inhibits anchor ice formation (would otherwise kill eggs)



Nicole Trouton, DFO



Cold Winters, Warmer Groundwater



Sockeye observed spawning on GW upwellings in Adams R.

Cold Winters, Warmer Groundwater

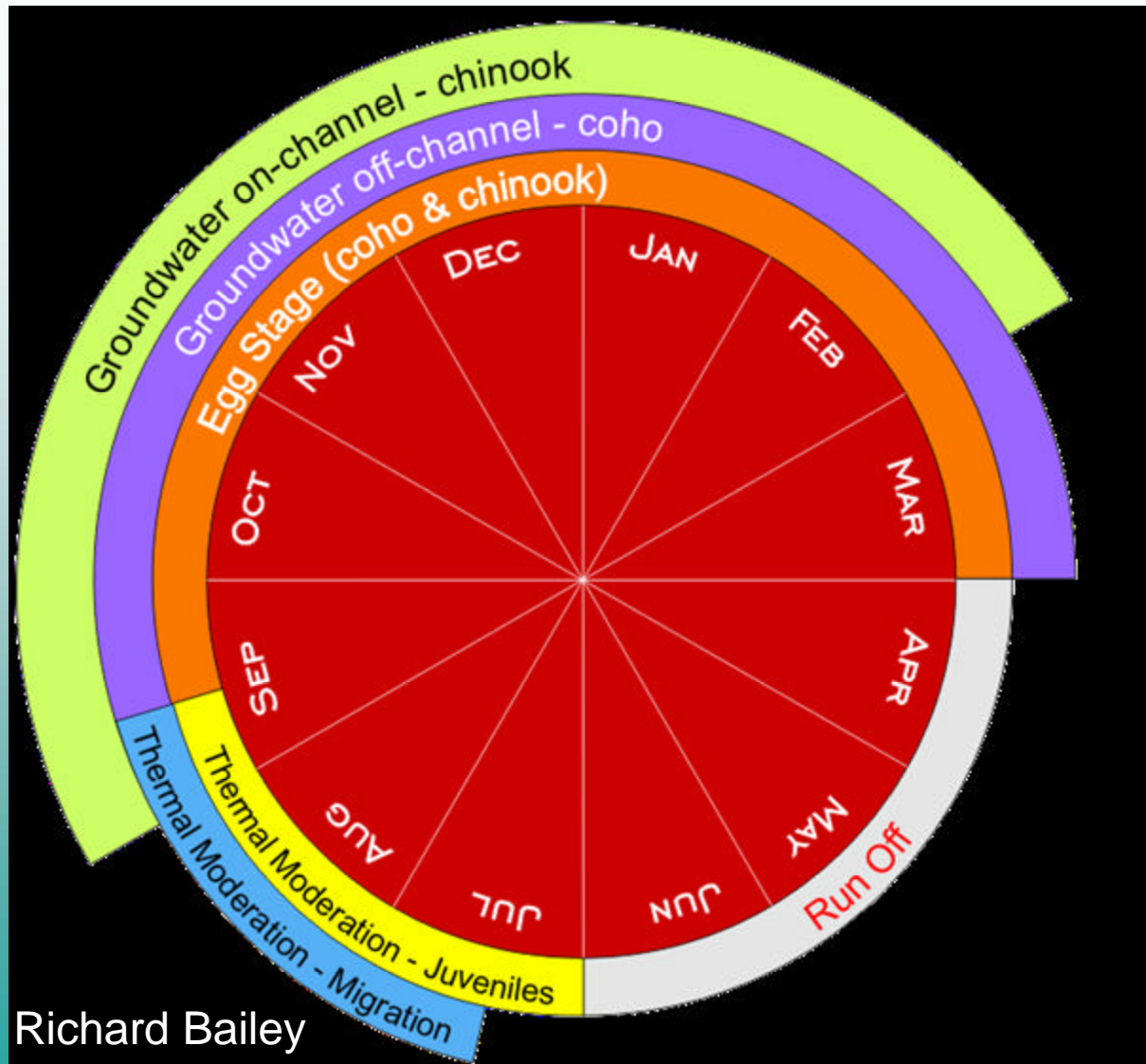
- Chinook, coho parr rely on GW to survive harsh winters (-20°C temp periods)
- use warmer groundwater-fed offchannel habitat
 - Offchannels (7-9°C) versus mainstem (0°C)



More off-channel areas



Thermal Refuge: Where and When?



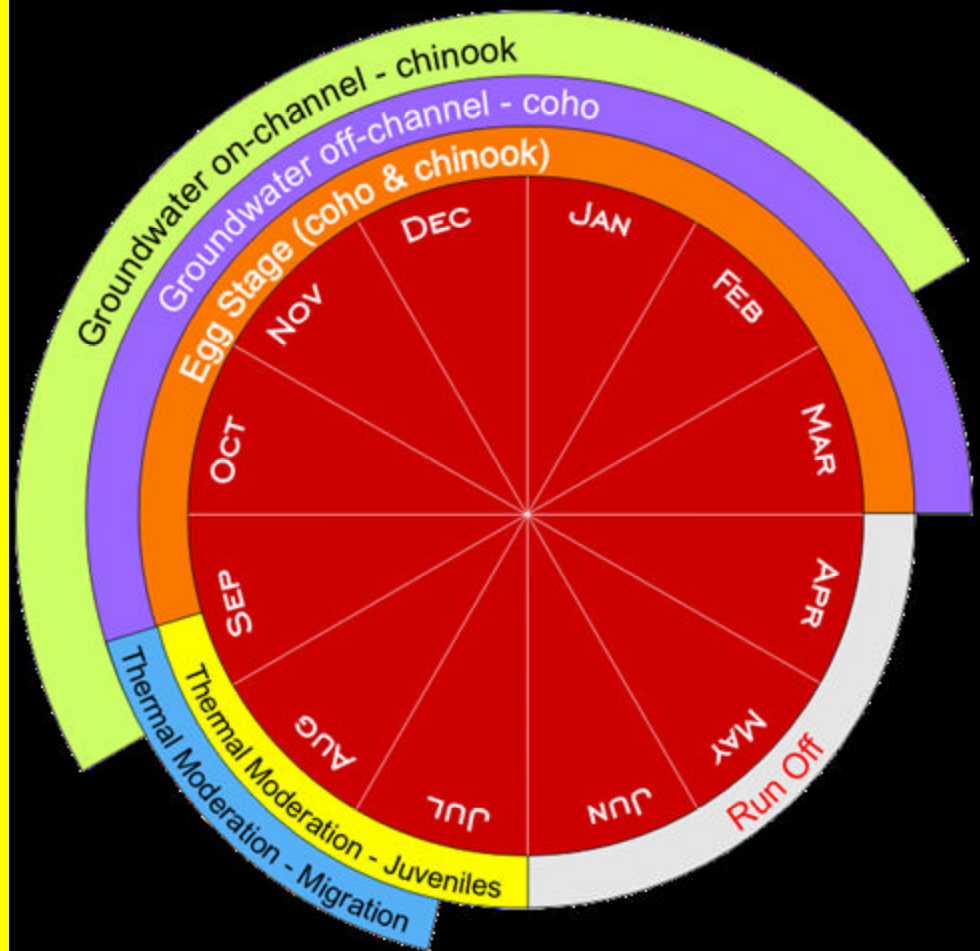
Source: DFO, Richard Bailey

Summer Low Flow Period

Juvenile Rearing

Influent groundwater provides:

- localized cooling.
- refuge from extreme temperature.
- Fry and Parr may burrow into substrate in upwelling areas.

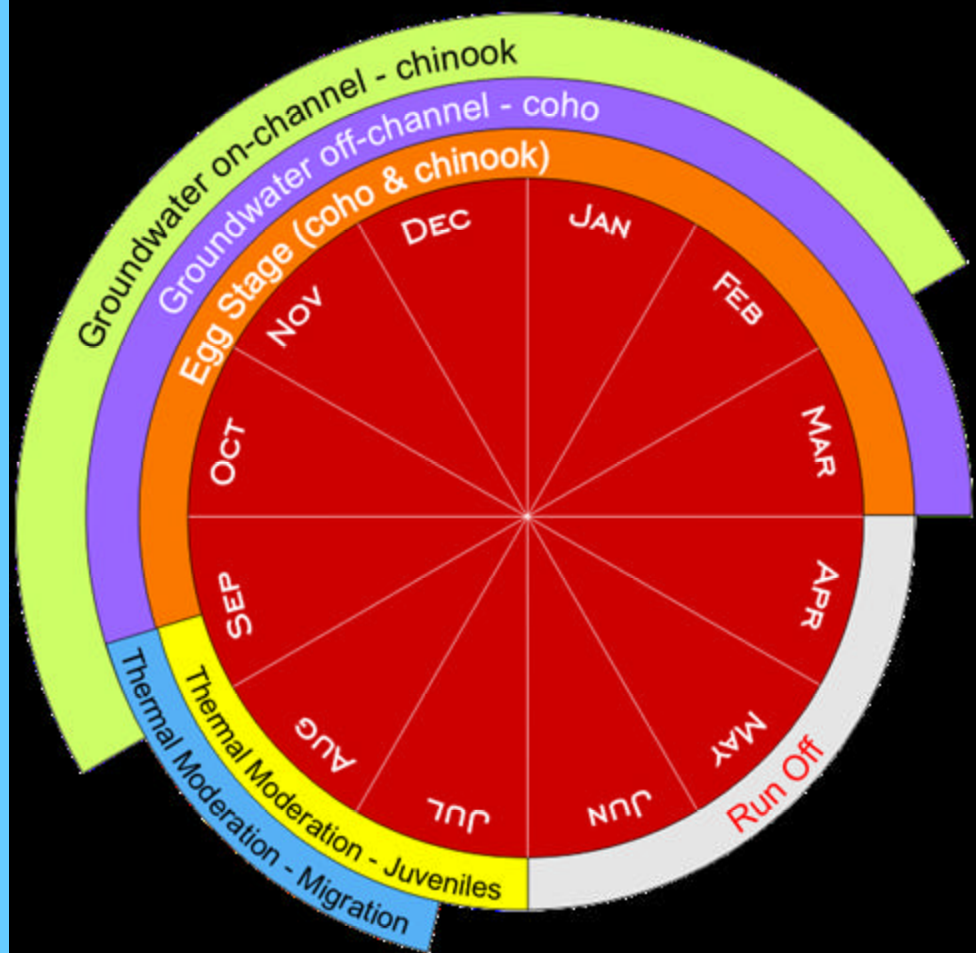


Summer Low Flow Period

Adult Migration

Influent groundwater provides:

- Localized cooling.
- Adults may become confined to areas cooled by GW.
- Without it, migration to extreme terminal area likely not possible in some populations.

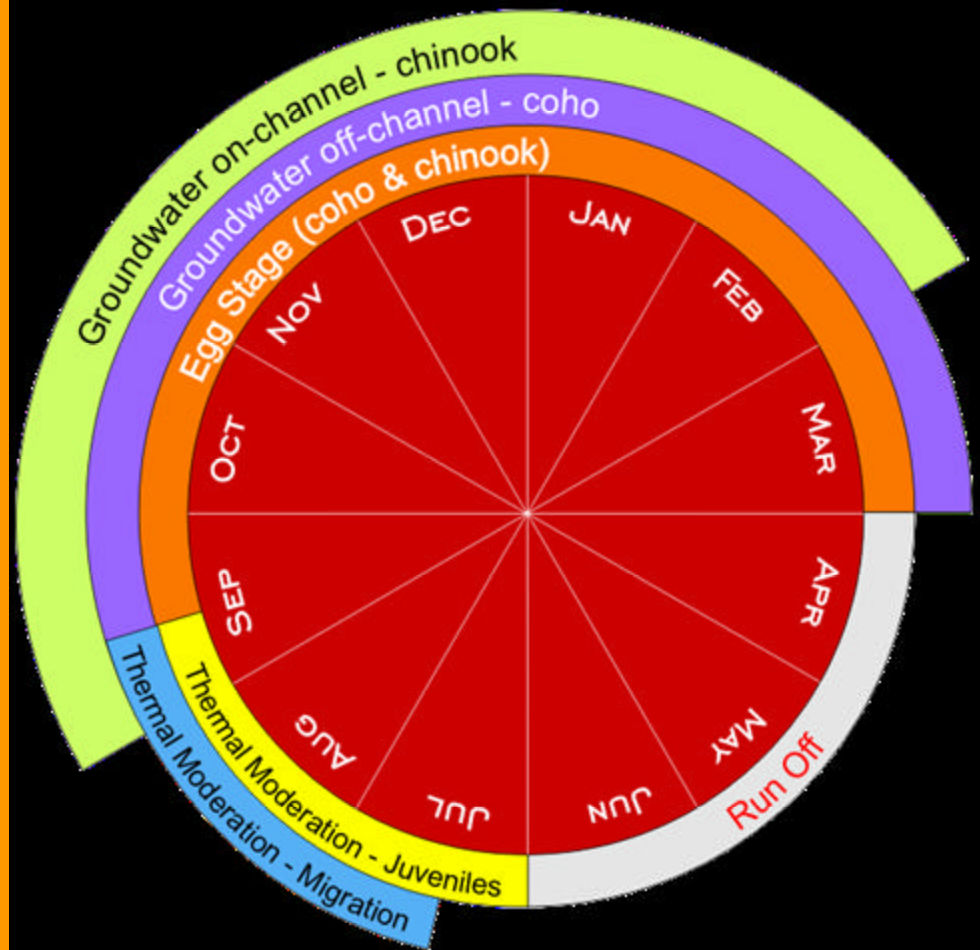


Winter Low Flow Period

Incubation

Influent groundwater provides:

- Warmer so counters anchor ice.
- Eggs kept at stable temperatures.
- Site of redds may be driven by it.

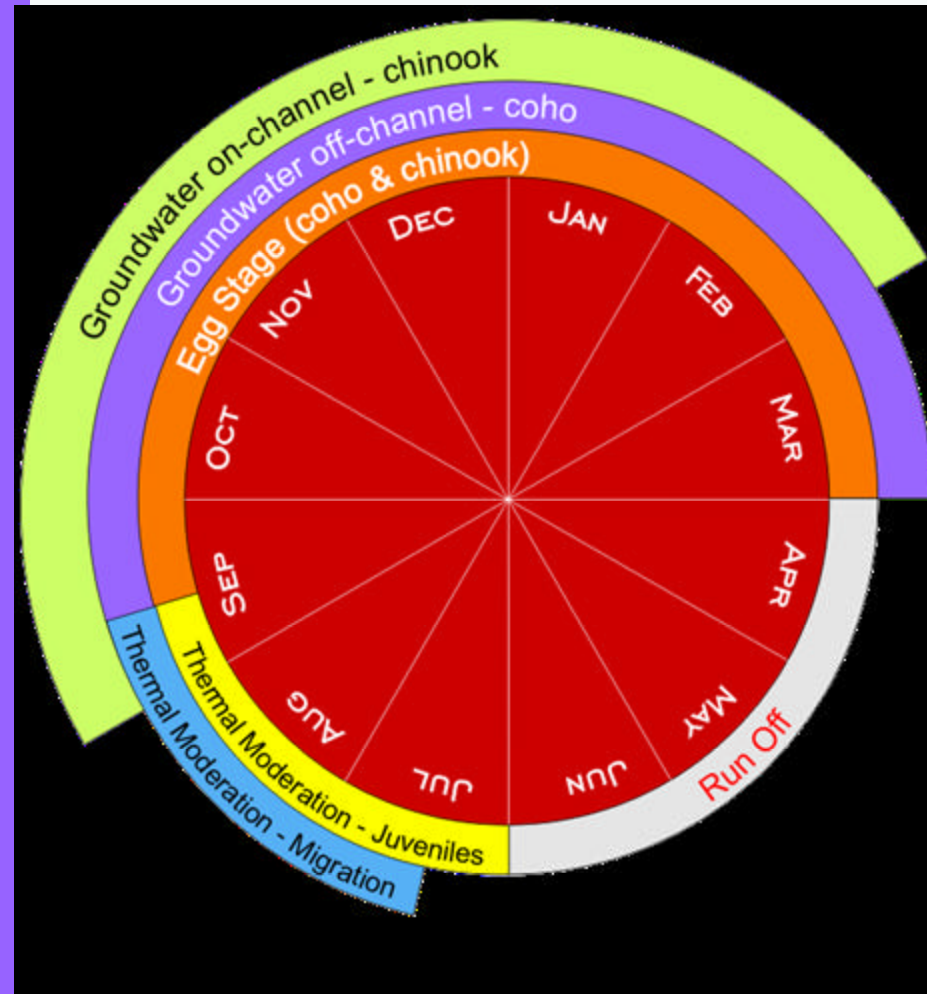


Winter Low Flow Period

Groundwater Off-Channel

Influent groundwater provides:

- Warming counters ice-over.
- Stable over-winter rearing.
- Often warmer than on-channel environment.

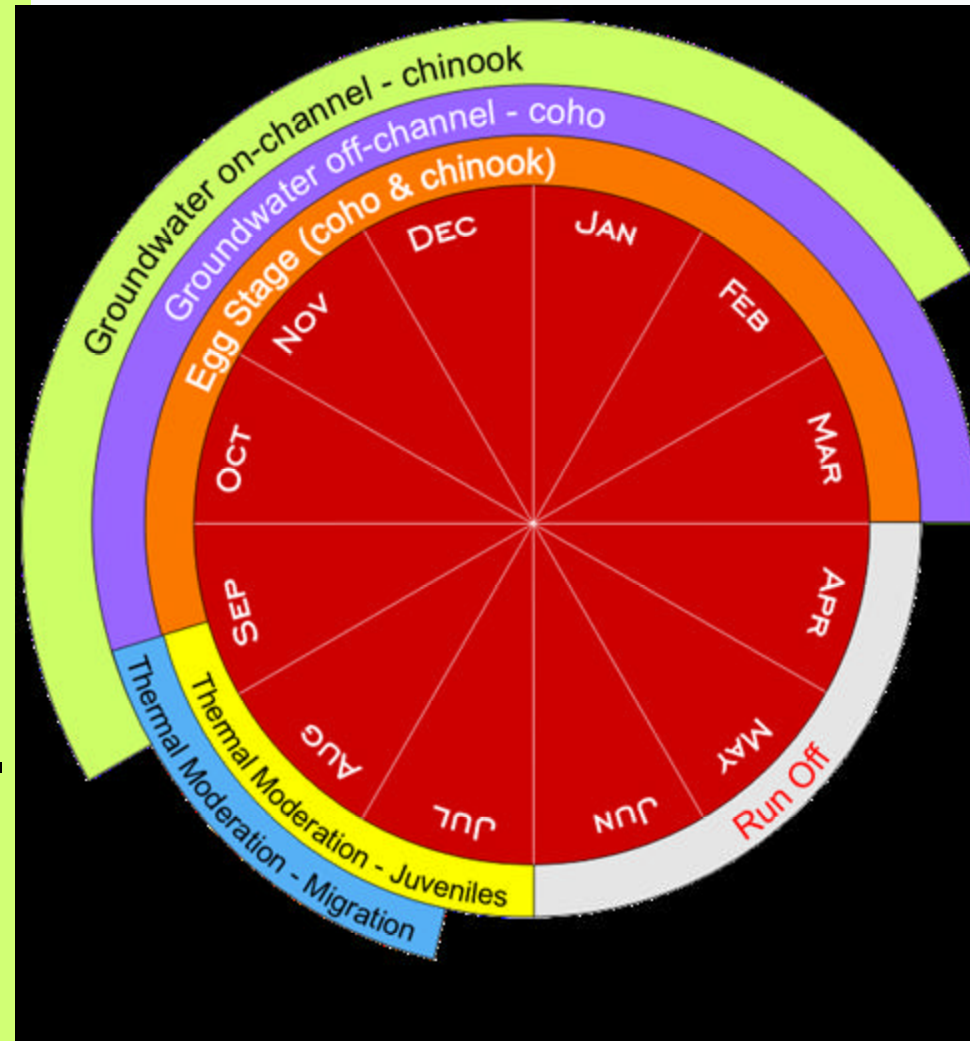


Winter Low Flow Period

Groundwater On-Channel

Influent groundwater provides:

- warming counters anchor ice.
- Over-winter rearing in spaces betw large rock.
- Temperatures warmer than in flow above rocks



Threats to Groundwater

- Increasing demand, Over use
 - Shortterm effect on surface water: reversible
 - Longterm effect of unsustainable levels of well extraction = deeper water table depletion that could eliminate surface flows or groundwater refugia
- Pollution

Threats to Groundwater

■ Climate Change

- warming trend is upon us
- affects stream hydrology and water-thermal regimes in BC
- less water during certain critical times of year for many stream in BC

Fraser: will be more total precip, increased runoff in winter, lower snowpacks, earlier and reduced peak flow spring runoff, subsequent lower baseflows during critical fish rearing low-flow periods in late summer

Threats to Groundwater

- Agriculture
- Urbanization

Threats to Groundwater

- BC has one of least developed GW regulation regimes in North America
 - Exploration/extraction largely unassessed and unregulated
 - province has no way of assessing the full extent of GW usage or surface/groundwater interaction.
 - Only province with no licensing req't for GW use above a defined threshold level (aside from heavy industrial use)
 - Has serious consequences for fish

Threats to Groundwater

- Water policy focuses on surface water issues
- GW management (where present) and use often do not consider wild salmon conservation

Do Existing Acts/Regulations Help?

- Groundwater Protection Regulation (provincial)
 - Aimed at well drilling/construction/closures
 - Benefits drinking water quality NOT GW quantity
 - Serious impacts on stream productivity may occur without any evaluation or oversight

BC's Water Plan says will protect GW with phase 2 & 3 of the GPR, but... lack of transparency and public participation

Do Existing Acts/Regulations Help?

- Fisheries Protection Act (provincial)
 - Considers fish/habitat protection in water licensing decisions but...only surface water licensed so does NOT apply to groundwater
 - Only considers fish/habitat protection when 'water management plans' are created but...
 - Not many completed in BC (i.e. Langley)
 - The draft plan had recommendations for groundwater licensing that were removed due to public protest

Do Existing Acts/Regulations Help?

- Fisheries Act (federal)
 - Can be invoked when GW usage harmfully alters, disrupts, or destroys fish habitat but..
 - Very difficult to link the damage to GW usage
 - DFO does not have the staff or policy to manage for cumulative impacts of groundwater extraction

But There is Hope

- Substantial activity to improve our understanding
 - Groundwater protection
 - Linking management of surface and groundwater
 - Improve water management relative to needs of salmon

But There is Hope

- Watershed Watch Salmon Society, UBC, and 4 First Nations partnered to create...

"Fish Out of Water: Tools to Protect BC's Groundwater and Wild Salmon"

= legal tools to assist in protecting groundwater

In Summary

- Groundwater is an essential thermal moderator for salmonids in thermally-challenging interior watersheds.
- Groundwater is likely important throughout year, except during freshet.
- To date, little understanding of impacts of groundwater extraction on thermal moderation.
- Basin-wide water budget and related temperature modelling is required.

In Summary

- A report that explores legal tools to assist protecting groundwater is available from Watershed Watch Salmon Society

‘Without adequate supplies of groundwater, both salmon and rights are threatened, and we must use these rights, and a suite of tools and tactics, to push for a greater awareness of and action around the threats to water and salmon’ – WWSS 2009.

References

- PFRCC. 2003. Conflicts between People and Fish for Water: Two British Columbia Salmon and Steelhead Rearing Streams in Need of Flows. Prepared by Dr. Marvin L. Rosenau and Mark Angelo.
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- Watershed Watch. 2007. Review of British Columbia's Groundwater Regulatory Regime: Current Practices and Options. Prepared by Randy Christensen, Sierra Legal Defence Fund.
- Watershed Watch Salmon Society. 2006. Literature Review of Groundwater-Salmon Interactions in British Columbia. Prepared by Tanis Douglas.

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