Apr 6th, 9:00 AM - 9:15 AM

Groundwater availability for summer low flows: co-production and shared application of hydrogeologic tools and information

Rick Dinicola  
*U.S. Geological Survey, United States, dinicola@usgs.gov*

Lonna Frans  
*U.S. Geological Survey, United States, lmfrans@usgs.gov*

Wendy Welch  
*U.S. Geological Survey, United States, wwelch@usgs.gov*

Follow this and additional works at: [https://cedar.wwu.edu/ssec](https://cedar.wwu.edu/ssec)

Part of the [Fresh Water Studies Commons](https://cedar.wwu.edu/ssec/freshwaterstudies), [Marine Biology Commons](https://cedar.wwu.edu/ssec/marinebiology), [Natural Resources and Conservation Commons](https://cedar.wwu.edu/ssec/naturalresourcesandconservation), and the [Terrestrial and Aquatic Ecology Commons](https://cedar.wwu.edu/ssec/terrestrialandaquaticecology)

Dinicola, Rick; Frans, Lonna; and Welch, Wendy, "Groundwater availability for summer low flows: co-production and shared application of hydrogeologic tools and information" (2018). *Salish Sea Ecosystem Conference*. 459.  

This Event is brought to you for free and open access by the Conferences and Events at Western CEDAR. It has been accepted for inclusion in Salish Sea Ecosystem Conference by an authorized administrator of Western CEDAR. For more information, please contact westerncedar@wwu.edu.
Groundwater Availability for Summer Stream Flows

April 6, 2018

Session 3.1.A: The Application and Creation of Knowledge that Leads to Action to Restore and Protect an Ecosystem

Rick Dinicola (presenter), Lonna Frans, Wendy Welch
US Geological Survey Washington Water Science Center
We readily share visions and words about rivers...

I am a river,
The source or running water.
I end at the sea.
From a permit-exempt well owner: “Just enough to supply my family home”
...but not so much about groundwater

From a farmer:
“Yes, a bit more, but I help to feed my community”
...but not so much about groundwater

Groundwater dreams of a salmon: “Stuff of life!”
...but not so much about groundwater

Or heaven forbid through the eyes of a hydrogeologist!
A shared understanding groundwater is a “wicked problem”

- Generally underground, out of sight
- Big ranges of space and time scales
- Complex language/jargon
- Unwieldy computer models
- Hard to illustrate how it flows
- Much conventional wisdom about groundwater is not wise...
  ...but true wisdom is difficult to gain!

**Today’s Goals**

- Garner interest in developing a shared understanding of groundwater in Puget Sound
- Describe USGS groundwater activities to facilitate such understanding through collaborative work with “science users”
Groundwater availability and summer stream flows

- Groundwater availability includes:
  - Quantity and quality of groundwater
  - Laws, rules, regulations, and socioeconomic factors
- It is intricately tied to availability of surface water
- Groundwater discharge sustains summer low flows
  **Salmon spawn in groundwater!**
- Groundwater also sustains municipal/domestic uses, irrigation, fish hatcheries, drought mitigation...
- Thus, groundwater availability is often at the core of conflict between water use and instream flows
Regionalizing groundwater knowledge across Puget Sound

2016-0103 NTA - Groundwater Budgets and Summer Low Flows (in progress)

• Generate current and future GW budgets for all Puget Sound subbasins
  – Current and future (~2050) monthly recharge, pumpage, groundwater discharge, streamflows
  – Future reflects Δ population, land-cover, climate
• Identify relative resilience of summer low flows
• Collaborate with users how to best compile and deliver information
  – WRIAs or smaller? Uplands and lowlands?
  – Story Maps? Interactive website?

Looking for feedback!

[Diagram of water balance]
Simple annual groundwater budgets

**Explanation**

Height of bar is total recharge

- **Pumpage**
- **Discharge to Puget Sound/Skagit valley**
- **Discharge to streams/lakes**

![Graph showing flux in cubic feet per second for Kitsap and Chambers-Clover regions.](image)

**Lower Skagit Basins**

![Graph showing flux in cubic feet per second for Chinacum, E. Fk. Nookachamps, Nookachamps, Carpenter, and Fisher regions.](image)

GW budgets with refined water use and discharge

**Explanation**

**Pumpage**
- Green: All other wells
- Blue: Domestic wells
- Yellow: Public Supply wells

**Discharge**
- Gray: to Puget Sound
- Orange: to Nisqually River
- Blue: to streams/lakes

**Percent of total Recharge**
- Kitsap
- Chambers
- WRIA 12
- WRIA 11
- WRIA 10
- Chimacum

GW budgets by individual aquifers (Kitsap Model)

- Requires a transient GW flow model (adds complexity)
- Water budgets (in-out-up-down) generated for each aquifer
- Pumpage assigned to specific aquifers, thus...pumping impacts for different aquifers simulated
- Changes in storage over time
- Highlights dynamics and exchanges between all aquifers and surface water

Ref: USGS Scientific Investigation Reports 2016–5052
Variation in annual GW budgets over time (Kitsap model)

Year

Recharge
Discharge to SW
Total pumpage
GW storage

Acre-feet of water

2005 2007 2009 2011

Refs: USGS Scientific Investigation Reports 2016–5052
GW budgets under Δwater-use & climate scenarios (Kitsap Model)

Percent Change in Monthly Freshwater Discharge to Streams

With +15% pumpage

With -15% recharge

Refs: USGS Scientific Investigation Reports 2016–5052
Next steps towards regionalizing GW knowledge

2018-20 Near-Term Action proposals

• Collaborative integration of GW budget data into ESSB 6091 ("Hirst fix") watershed planning/restoration efforts
• Technical support for a Summer Stream Flow Implementation Strategy
• Streamlined modeling approaches focused on pumping and Summer Stream flows

ESSB 6091 Net Ecological Benefits Assessment Process

• More facilitating shared understanding of groundwater

Working towards a comprehensive model for the Puget Sound Regional Aquifer System
Conclusions

• Collaboration with users/stakeholders allows us to chip away at the “wicked problem” of groundwater

• Regionalizing knowledge helps inform where to focus protection/restoration of summer stream flows across Puget Sound

• Findings to date highlight that we are blessed with (relatively) abundant groundwater, but with equally abundant socioeconomic, legal, and cultural challenges

• With our reliable recharge and modest groundwater use, many options are available for sustainable paths forward
Thank you

Fish Trap Creek, Photo by Steve Cox