Subsurface Controls on Stream Intermittency in a Semi-Arid Landscape: A Case Study in Gibson Jack Creek, Pocatello, ID

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Why should we care about intermittent streams?

- Intermittent streams occur where surface water periodically ceases to flow
- They likely comprise greater than 50% of the global river network[1] and are expected to increase globally over the next several decades[2]
- These streams provide many important ecosystem services including water and water quality provisioning
- **A mechanistic understanding of stream intermittency is needed to:**
  1) **predict how changes in climate and land use will affect flow regimes**
  2) **improve management of water resources[1,3]**

Links between surface and subsurface flow

- "A stream is a dynamic expression of local groundwater conditions"[4]
- Surface disconnection and reconnection reflect the capacity of the subsurface to accommodate flow[5]

References and acknowledgements

[1]Datry et al. (2014), BioScience, doi: 10.1093/biosci/bit027
[2]Acuna et al. (2014), Science, doi: 10.1126/science.1246666
[3]Smakhtin (2001), Journal of Hydrology, doi: 10.1016/S0022-1694(00)00340-1
[4]Bencala et al. (2011), Water Resources Research, doi: 10.1029/2010WR010066
[5]Godsey and Kirchner (2014),Hydrological Processes, doi: 10.1002/hyp.10310
[9]Ward et al. (2013), Water Resources Research, 10.1002/wrcr.20434

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How do vertical, lateral, and longitudinal water connections in the subsurface change at transitions in surface and subsurface flow?

Continuous Surface Flow

Intermittent Surface Flow

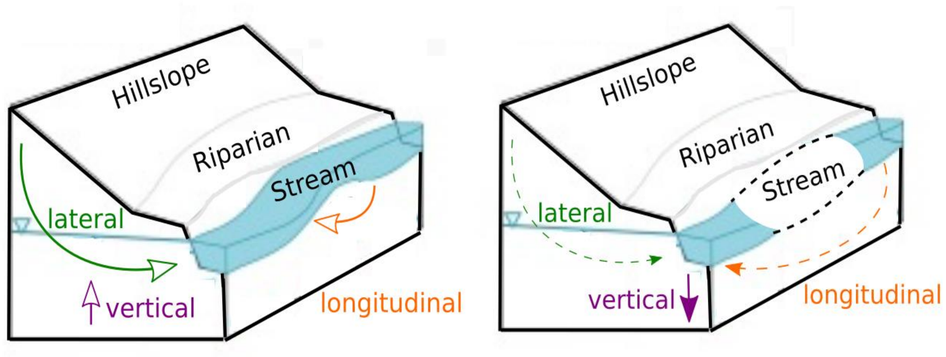

Figure 1. Conceptual model of the subsurface controls impacting groundwater input to stream flow. Left: With continuous surface flow, we generally expect significant lateral input to the stream, shorter longitudinal flowpaths, and vertical flow to be predominantly upward. Right: With intermittent surface flow, we generally expect low lateral input, longer longitudinal flowpaths, and vertical flow to be predominantly downward. Adapted from Ward et al. (2013).

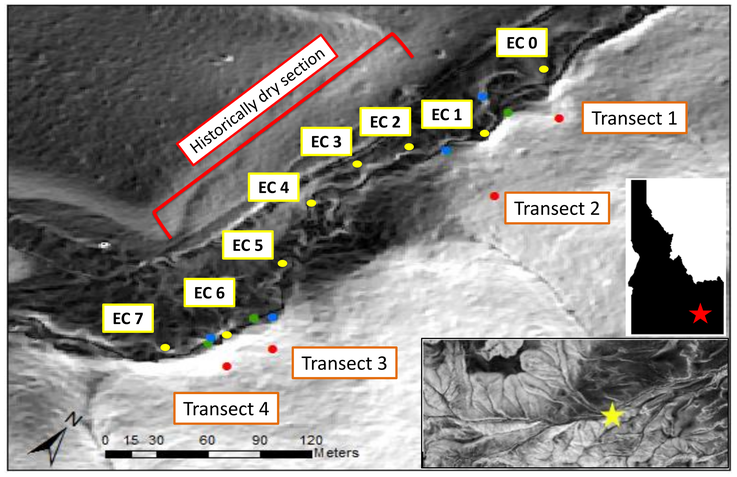

Figure 2. Site Instrumentation in the Gibson Jack watershed (red star), in southeastern Idaho. Inset indicated location of study reach (yellow star), observed to be intermittent. Historically dry section indicated by red bracket. Dots: Red – hillslope wells, Green – riparian wells, Blue – in-stream piezometers, Yellow – in-stream electrical conductivity loggers.

Vertical and longitudinal stage and hydrochemistry patterns show diel evapotranspiration controls, coupled geologic controls

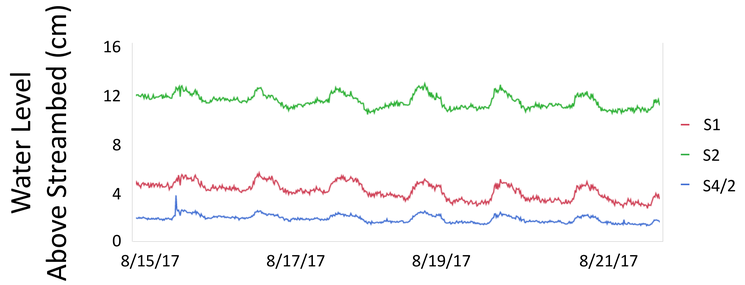

Figure 3. Zoomed-in section of a time series of the stage from the streambed. Diel patterns are similar between intermittent sections (S2) and continuously flowing sections (S1 and S4).

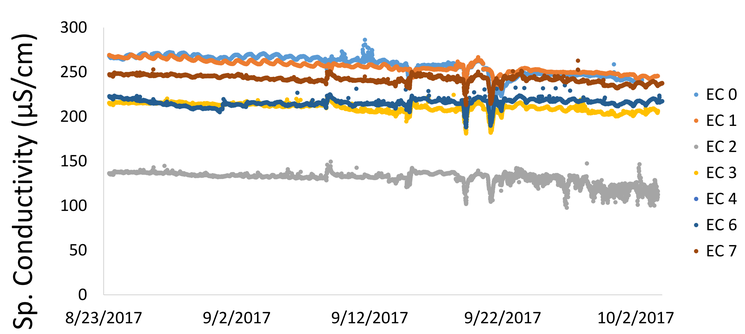

Figure 4. Time series of in-stream electrical conductivity throughout the study reach. Instruments are named with increasing numbers moving from downstream to upstream (see Figure 2 for locations).

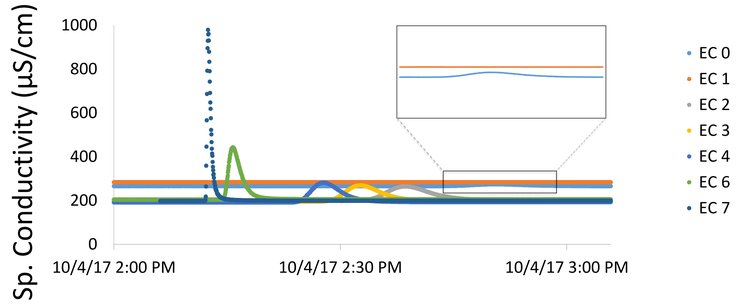

Figure 5. Salt injection test, with the salt release located ~6m upstream from EC7. Peaks in specific conductivity decrease with distance from release point. EC1 has a particularly muted signal (inset), likely resulting from an influx of groundwater emanating from the riparian zone.