Adding wood to the Raging River: Looking for effects on habitat and temperature

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Wood in Pacific Northwest Streams

• Important
  – sediment dynamics
  – channel configuration
  – habitat

• Wood large and abundant in undisturbed systems

• In others, wood rare and small

• Restoration often includes adding wood
Raging River

- 93 logs added in 2009
- Chinook salmon stream
- Mitigation for work downstream
- Logs unanchored
- All within 300 m

Added wood:
Mean length = 25 feet
Mean diameter = 14 inches

Increase in wood density:
>10x in the 300-m reach
~2x in the 1-km reach
Questions: In 2015...

• Greater complexity associated with wood?

• Any cooling associated with wood?
Raging River is HOT! (for a river in the Pacific NW)

- In 2015, at the mouth:
  - Daily minimum $>16^\circ$C
  - Max $=26^\circ$C

- River at base flow in July due to drought

King County 2016. *Hot Water and Low Flow: The Summer of 2015 in the Snoqualmie River Watershed.*
- Reach ~1 km
- Salt tracer reaches ~100 m
- Distributed temperature sensor ~1 m
- Piezometers ~<1 m
#6: relatively complex
Wood and Complexity

- Wood and complexity correlated
- Greater transient storage in reaches with wood
Questions: In 2015...

• Greater complexity associated with wood?
  – *Yes, wood and complexity correlated*

• Any cooling associated with wood?
Upwelling of cool water in some piezometers

Gendaszek and Optaz 2016
Fiber optic distributed temperature sensor (FO-DTS)

• Deployed for 1 week
• Recorded temp each meter, every 30 minutes
• Covered ~1-km reach
Summer 2009 wood placements
Channel spanning log jam
Channel spanning log jam

7/12/15
12:00 a.m.

7/10/15
12:00 a.m.

7/8/15
12:00 a.m.

Reach meter (distance downstream)

Day, time

Temperature, in degrees Celsius

Gendaszek and Optaz 2016
July 9, 2015: mean temperature

\[ y = 0.0007x + 15.832 \]
\[ R^2 = 0.6855 \]
Temps rise in pools and side channels

+2°C
Coho and trout densities
Questions: In 2015...

• Greater complexity associated with wood?
  – Yes, wood and complexity correlated

• Any cooling associated with wood?
  – Isolated upwelling of cool water
  – Some cooling along sections of reach
  – But cooling not associated with wood
  – Warming in pools and side channels
  – Other factors (bedrock geology) more likely affecting hyporheic exchange
Implications

Adding wood may increase habitat complexity but will not likely cool the Raging River substantially.
Thank You!

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  • USGS
    – Chad Opatz
July 9, 2015: mean and max temperatures

- Mean daily temperature (°C): $y = -0.0004x + 18.697$, $R^2 = 0.1458$
- Max daily temperature (°C): $y = 0.0007x + 15.832$, $R^2 = 0.6855$
Mean daily temperatures
Raging River July 2 - September 24, 2015

Date (in 2015):
6/30, 7/10, 7/20, 7/30, 8/9, 8/19, 8/29, 9/8, 9/18, 9/28

Temperature (°C):
8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Legend:
- blue diamond: downstream
- red square: side channel - downstream
- green triangle: side channel - upstream
- purple x: tributary
- cyan plus: upstream
Maximum daily temperatures
Raging River July 2 - September 24, 2015

Date (in 2015)
Wood and Complexity

- Greater transient storage in complex reaches
Wood and Complexity

• Greater transient storage in complex reaches
Between 2009 and 2015:
- Logs moved
- Formed new jams
- Recruited to existing jams
Longitudinal and Vertical Stream Temperature Profiles during Summer Baseflow (2015)

• Longitudinal profiles of stream temperature continuously measured for ~ 1 week using a >1,000-m Fiber-Optic Distributed Temperature Sensor

• Vertical profiles of surface and subsurface temperatures measured along pool-riffle sequences

Gendaszek and Opatz (2016)
https://pubs.er.usgs.gov/publication/ds983
Geomorphic Influences on Hyporheic Exchange

- Hyporheic processes vary across spatial scales as a result of geomorphic and geologic conditions.
- During summer, hyporheic water is cooler than surface water and has less diurnal variability.

Tonina and Buffington (2009)
Longitudinal Temperature Profile: Fiber-Optic Distributed Temperature Sensor (FO-DTS)

Temperature calculated from Anti-Stokes: Stokes Ratio

~ 0.1° C accuracy
~ 1-meter resolution
Deployment in the Raging River

- Deployed for 1 week
- Recorded temp each meter, every 30 minutes
- >1,000-m reach
July 2015
Longitudinal
Temperature Profile
Upwelling of consistently cool water in some piezometers...
Vertical Temperature Profiles

... but not in others.