Post-fire Sediment Connectivity and Phosphorus Response in Two Central Montana Watersheds

Montana AWRA 2024

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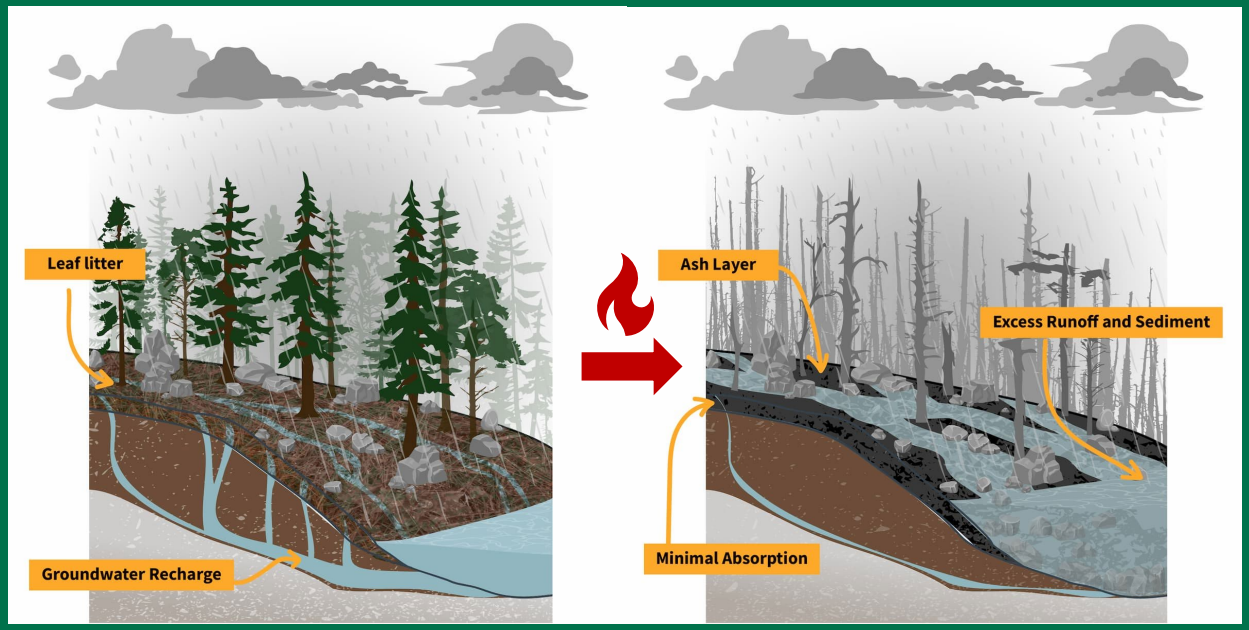
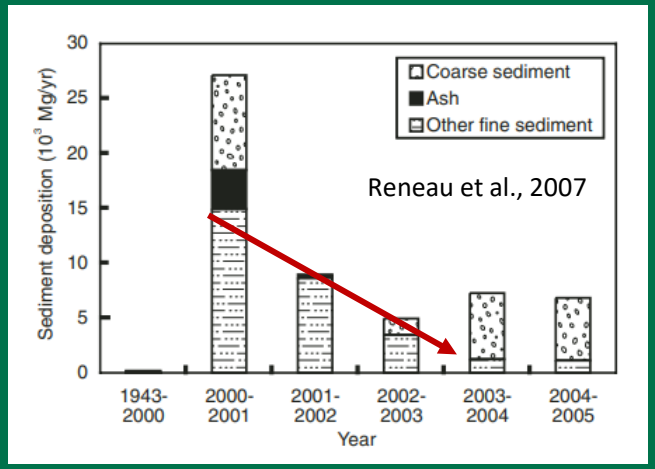
High Burn Severity Increases Sediment Availability



- Reduced Canopy and Groundcover
- Soil Hydrophobicity
- Decreased Aggregate Stability
- Ash production



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Questions and Objectives

- What does an increase in sediment supply mean for phosphorus and its availability in burned watersheds?
- How can we use the sediment-discharge relationship to quantify and understand sediment transfer and deposition in burned watersheds?

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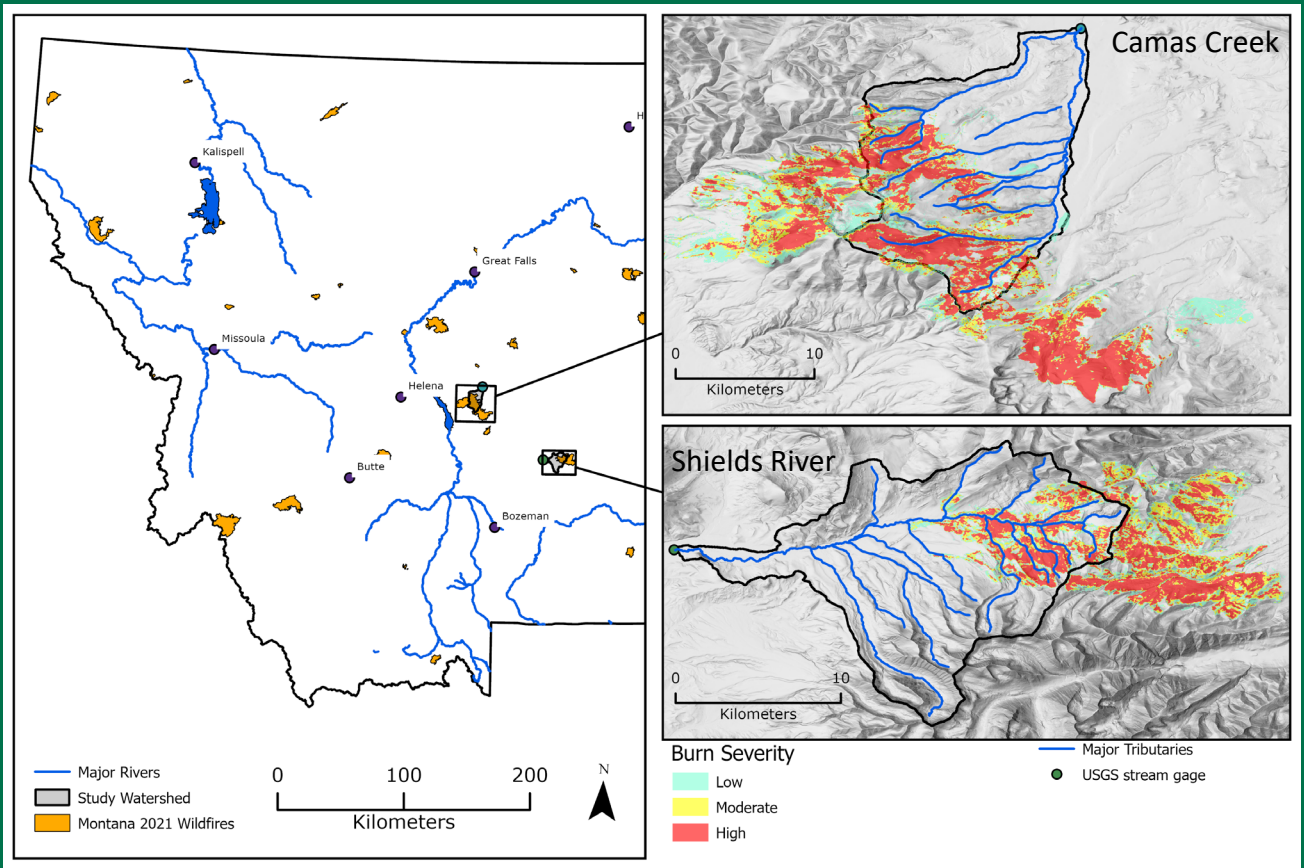
Study Watersheds



Camas Creek, Meagher Co.
USGS-06076590
Prefire data available from
USGS-06076600

Woods Creek Fire
55,845 Acres
Affected 41% of Camas Cr
Watershed

Shields River, Park Co.
USGS-06192980

American Fork Fire
19,768 Acres
Affected 18% of Shields R.
Watershed

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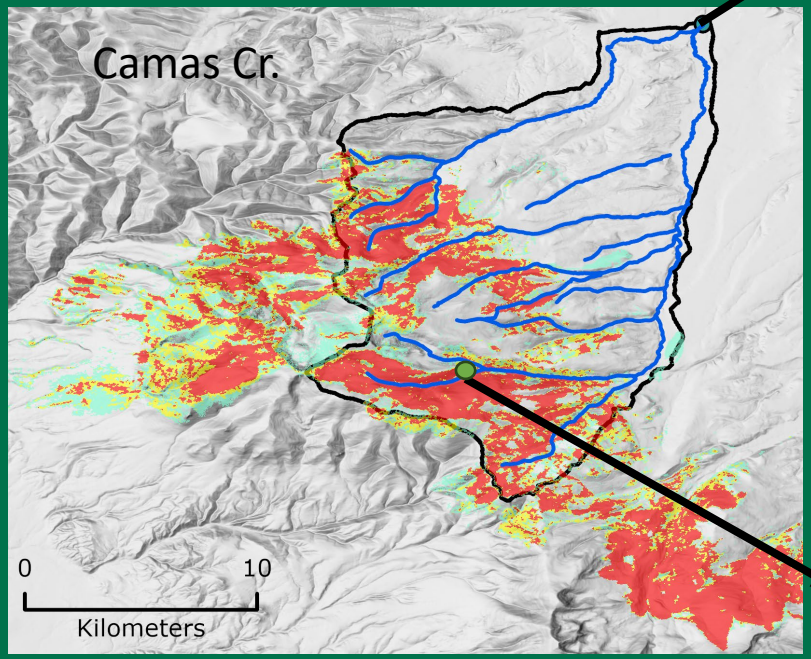
Monitoring Network and Instrumentation



Stream Gage
- Continuous Sonde
- Automatic Sampler
- Stage and Discharge
- Tipping Bucket

Headwaters Atmospheric Gage
- Weighing Bucket for Precipitation Accumulation

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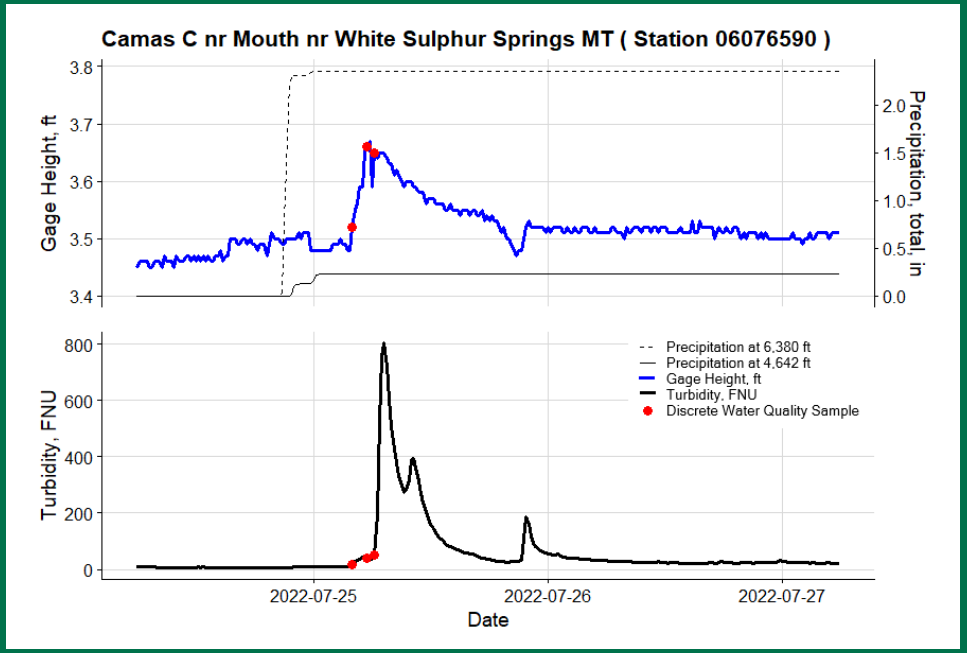
Experimental Design:
Pairing Continuous and Discrete Data

<u>Continuous Data:</u>
Examine turbidity-streamflow dynamics to interpret source area contributions and connectivity at the event scale

<u>Discrete Data:</u>
Routine and event-based sampling

Samples processed for
- Sediment Concentration
- Sediment % <0.063mm
- Total Phosphorus
- Orthophosphate



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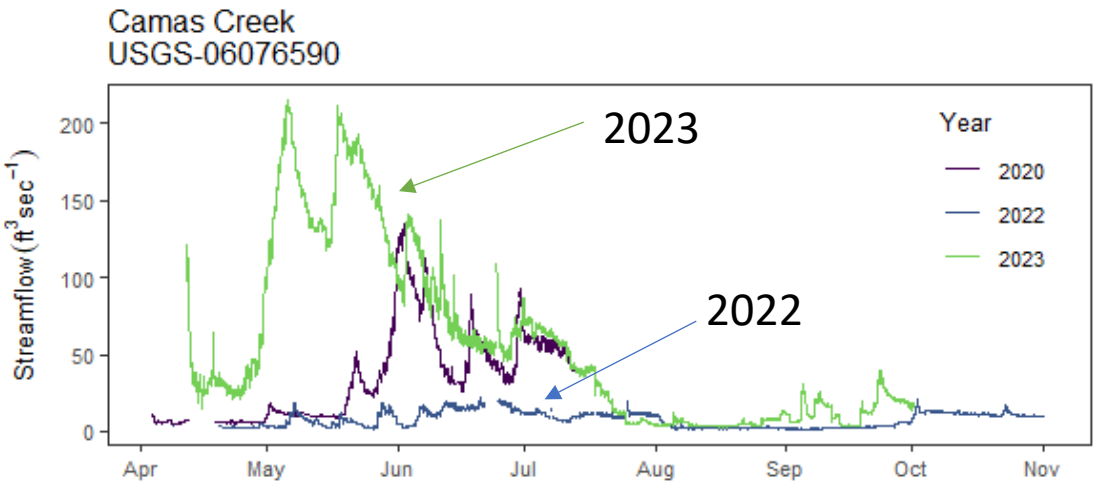
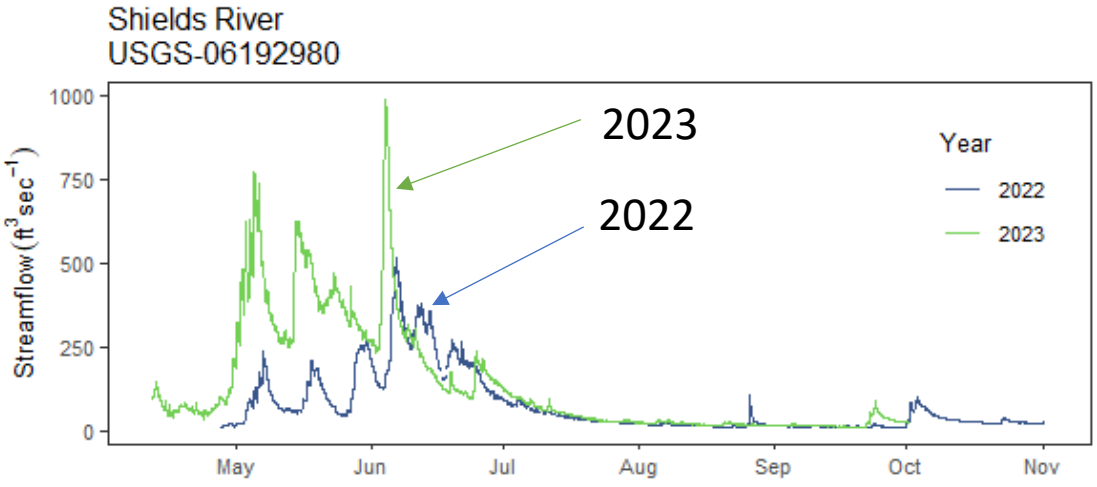
Streamflow





Hydrographs are snowmelt driven punctuated with frontal and convective storms

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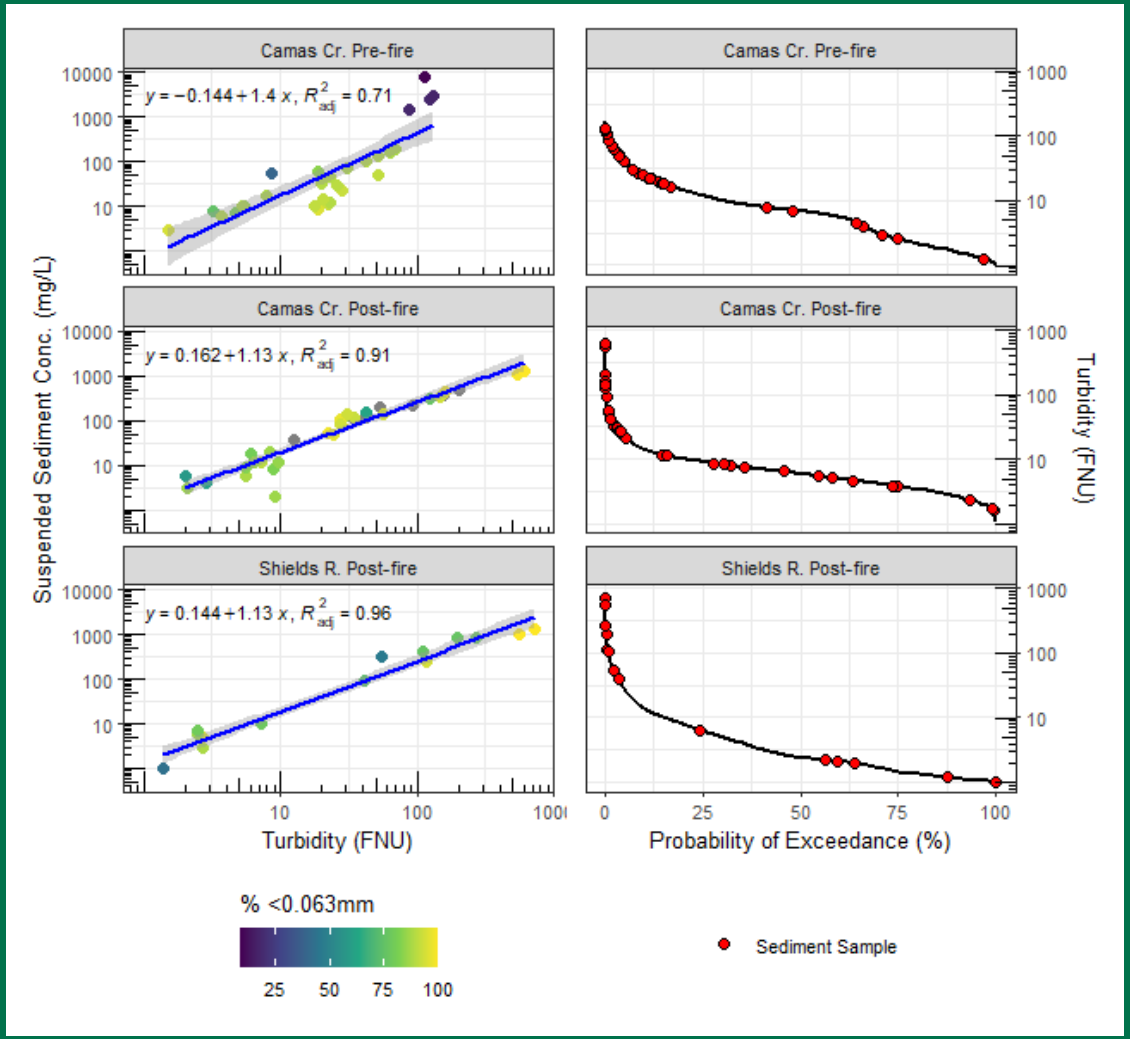
Turbidity correlates strongly with suspended sediment and is an effective surrogate



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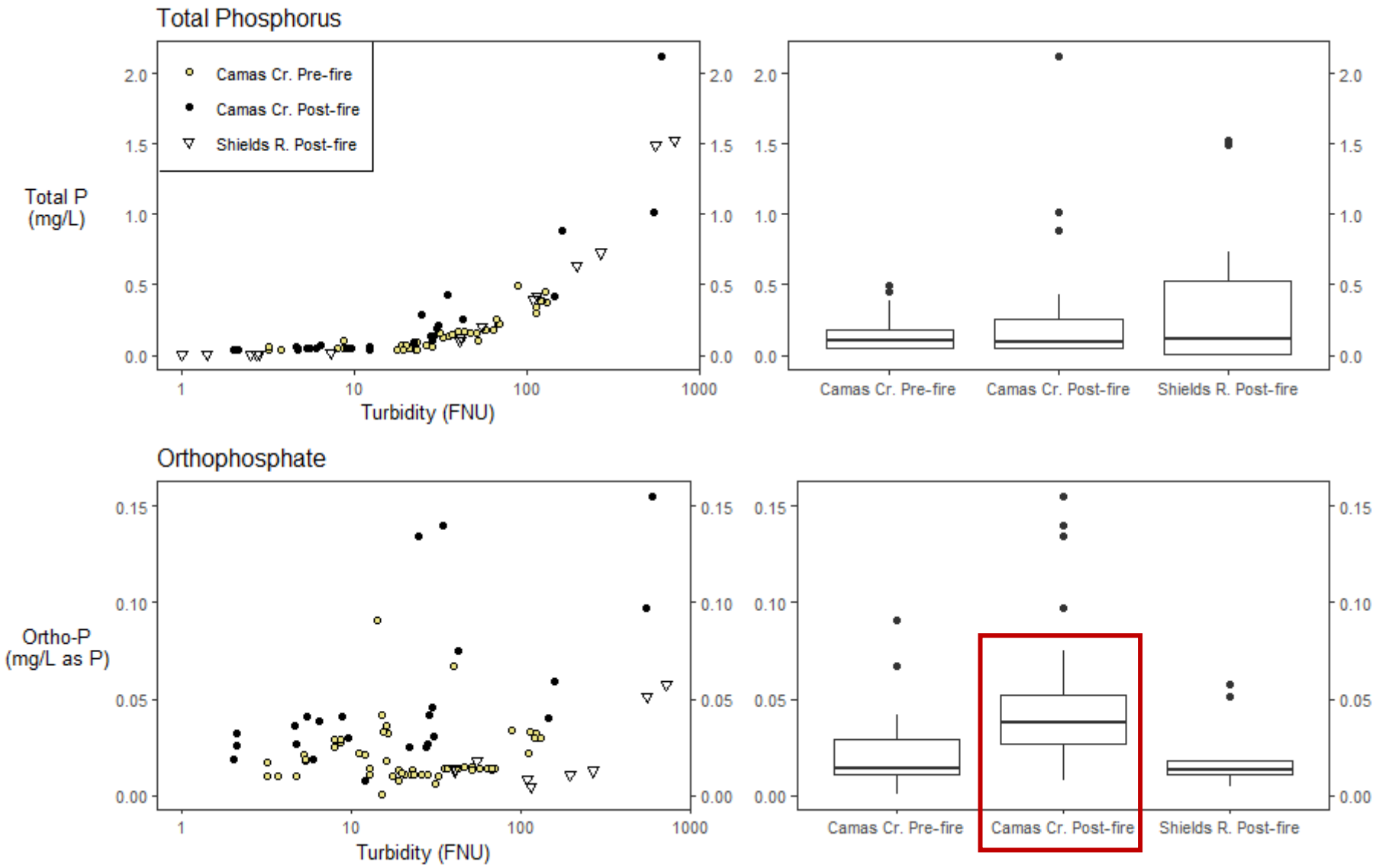

Orthophosphate and Total Phosphorus can be elevated after fire

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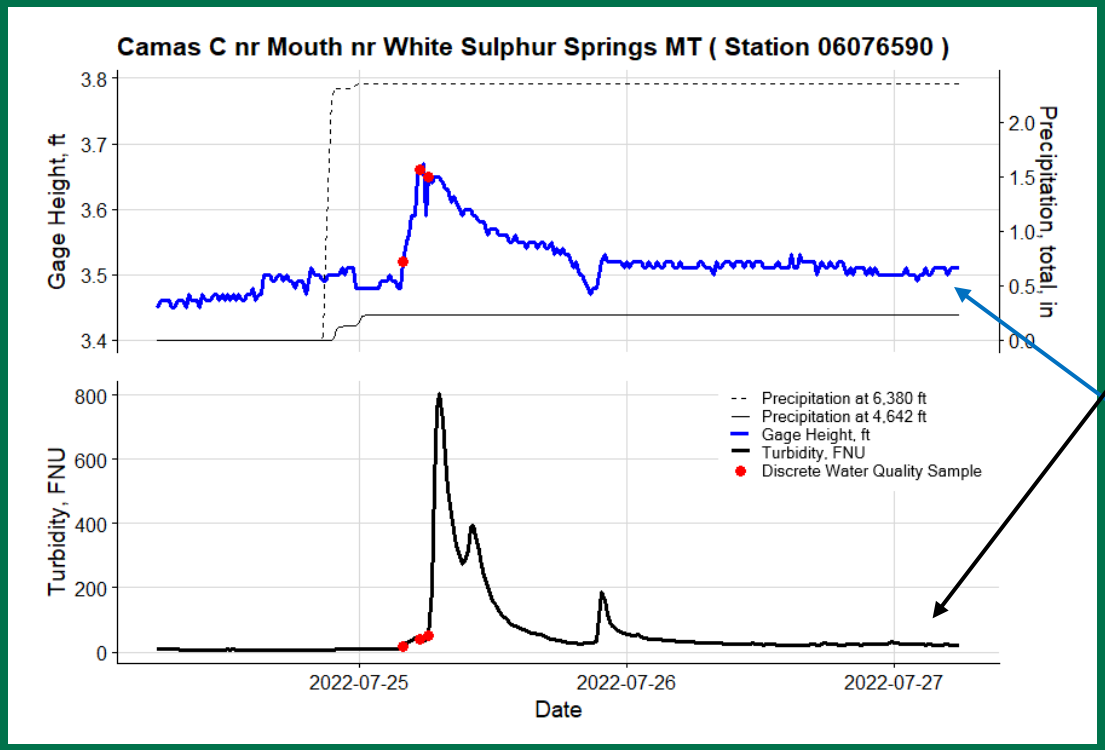
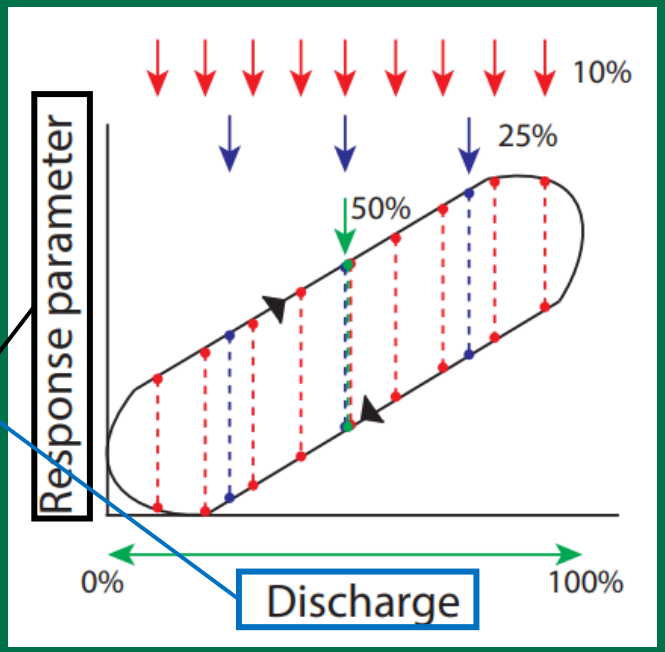
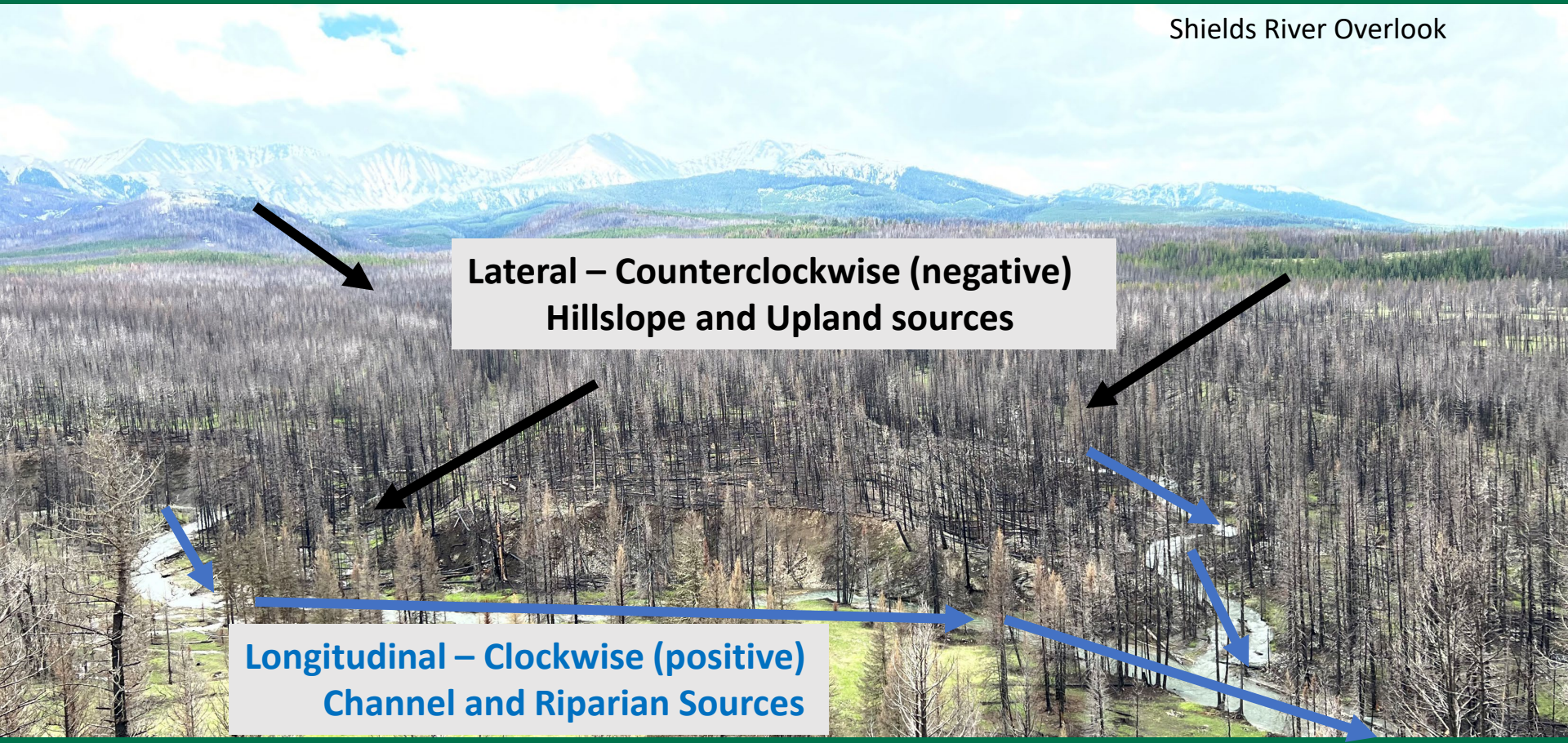
What is sediment hysteresis and what does it tell us?





Lloyd, C. E., Freer, J. E., Johnes, P. J., & Collins, A. L. (2016). Testing an improved index for analysing storm discharge–concentration hysteresis. Hydrology and Earth System Sciences, 20(2), 625-632.

Hysteresis reflects sediment connectivity



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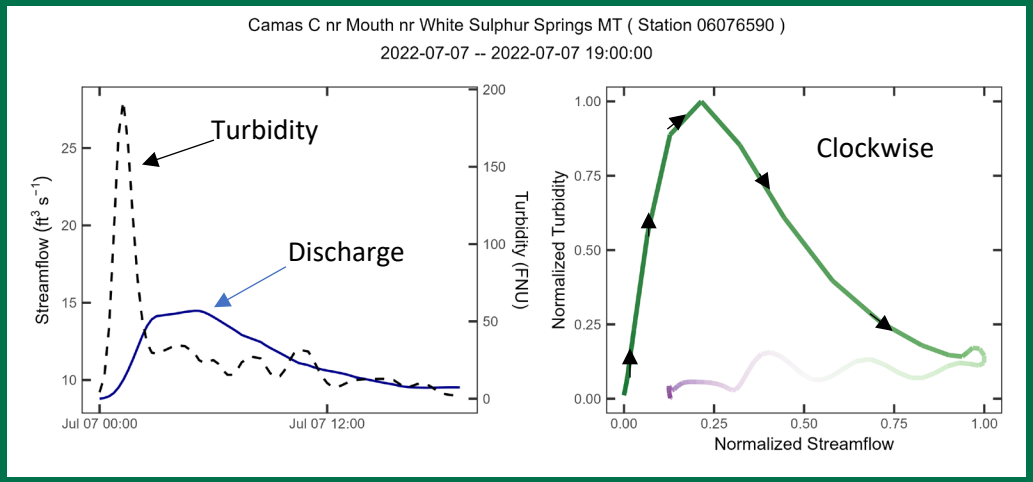
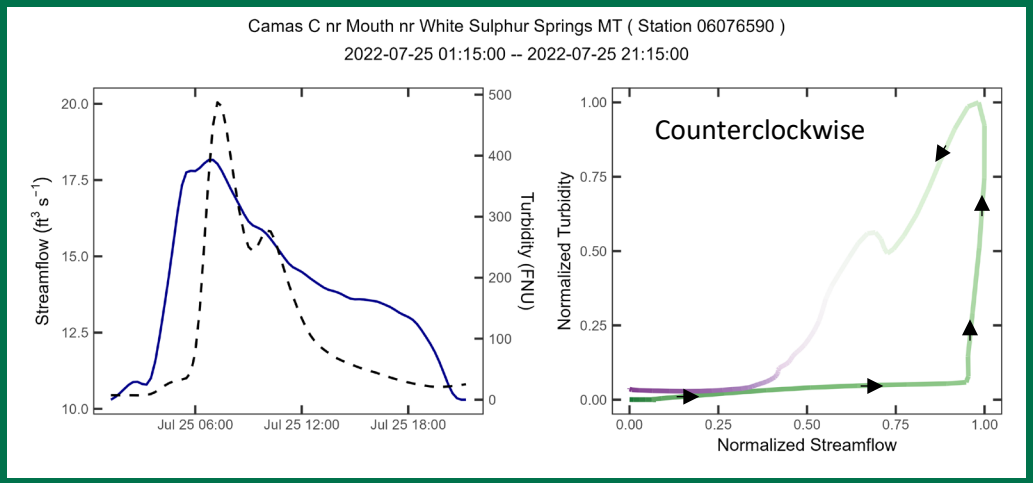
Interpreting Source Areas



Clockwise:
Channel/Riparian



Counterclockwise:
Hillslope/Upland

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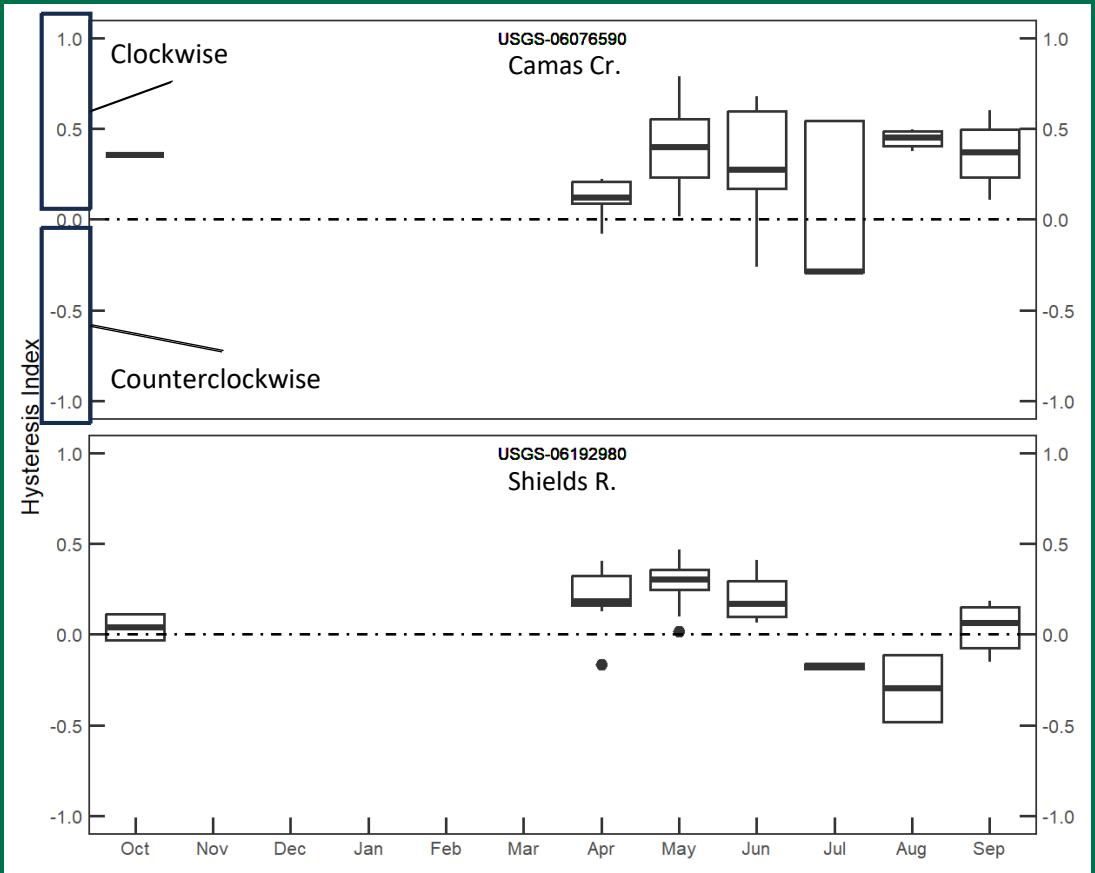
Sediment sources can vary seasonally and between watersheds



Camas Creek
USGS-06076590

- Channel-Riparian areas dominate for much of the year
- Lateral dis-connectivity
- Fire related phosphorus and sediment is mostly retained within the watershed

Shields River
USGS-06192980

- Channel-Riparian areas dominate snowmelt (Apr-Jun)
- Hillslopes-Upland areas dominate summer (Jul-Aug)
- Stronger Lateral Connectivity
- Fire related phosphorus and sediment is flushed from watershed.

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Key Findings and Takeaways

- Wildfire sediment transfer (export or storage) is controlled by watershed sediment connectivity.
- Sediment connectivity can be characterized using the concentration-discharge relationship during dynamic storm events.
- Sediments stored within the watershed may contribute to elevated Orthophosphate concentrations.

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Acknowledgements

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US Geological Survey Water Resources Mission Area

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Questions?
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PRECIPITATION GAGE
U.S. GEOLOGICAL SURVEY