Stream Suspended Sediment and Phosphorus Response to Wildfire in a Montana Watershed, and Implications for TMDL Development

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DEQ MONTANA

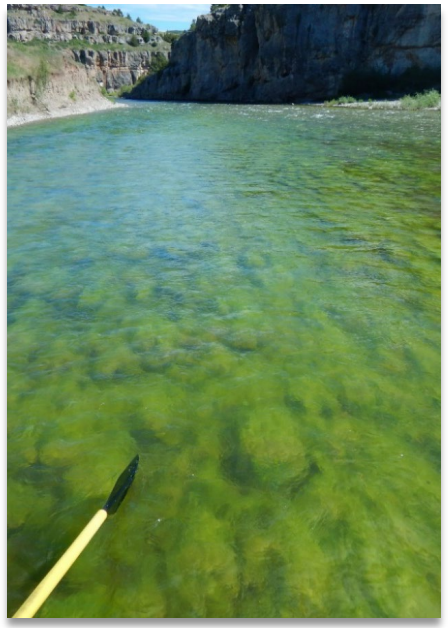
USGS science for a changing world

Disclaimer

These data are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data have not received final approval by the U.S. Geological Survey (USGS) and are provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data.

Study Background

- The Smith River—one of Montana's most popular floating rivers—began having undesirable attached algae blooms (*Cladophora*) in mid 2010s



- As part of its investigation, in 2020 DEQ quantified phosphorus loads from **Camas Creek**, a major tributary to the Smith River

Study Background: Camas Cr 2020 (Pre-Fire)

Deployed YSI sonde and ISCO sampler at a new USGS streamflow gage near mouth of Camas Creek

YSI sonde collected turbidity every 15 min

Collected event-driven (ISCO) and routine (grab) samples for TSS, TP, SRP, Bioavailable P

Camas Creek at Gage 06076600

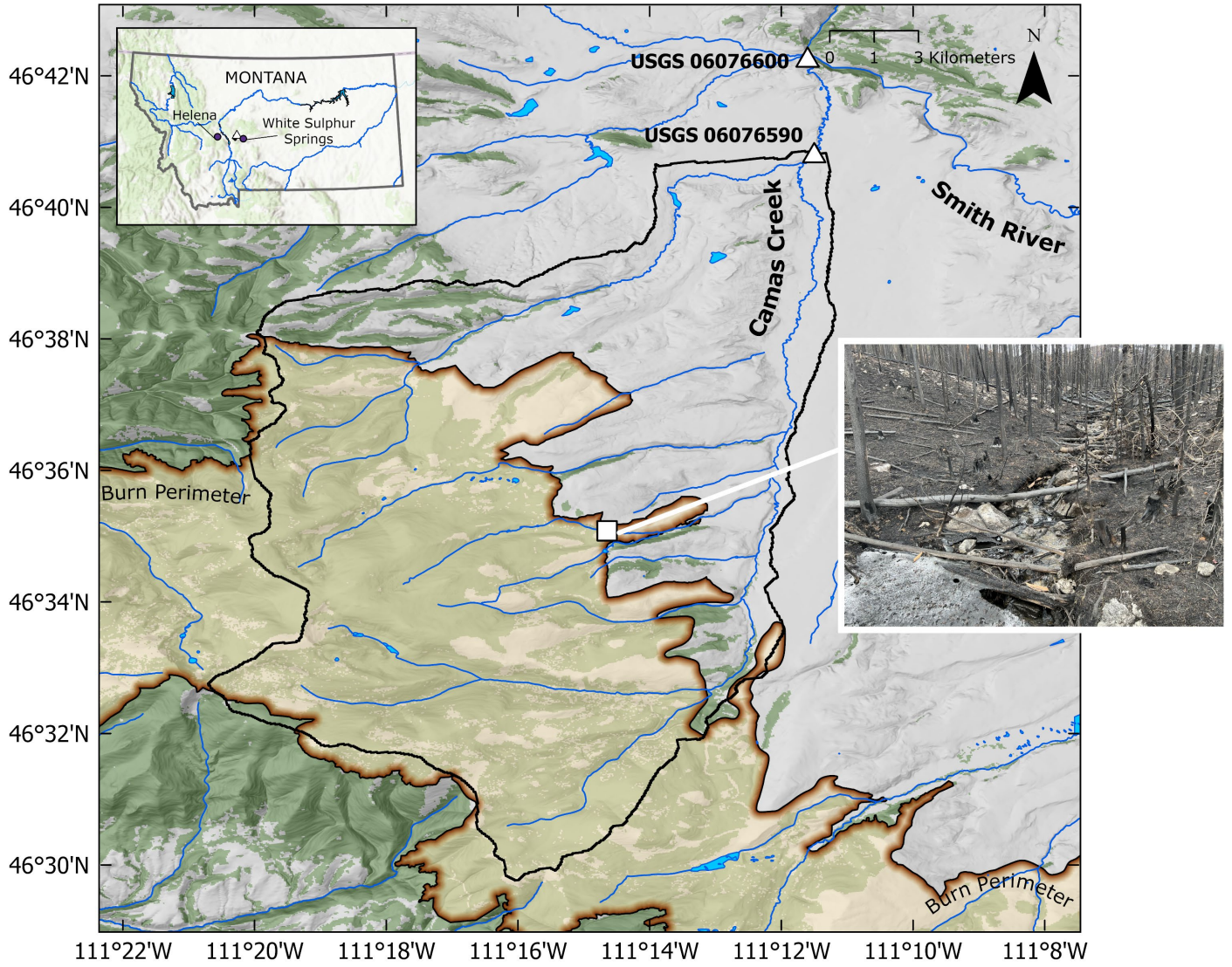
Study Background: Camas Cr Watershed 2021 (Wildfire)

Lighting-ignited in July, burned 56,000 acres

91% contained by Sept 1, 2021

Overall burn severity estimates:

- 40% low
- 33% moderate to high
- 27% unburned



Camas Creek Post-Wildfire, 2022-2023

Resumed data collection analogous to 2020 at a site 3.4 km upstream of the original (access issues)

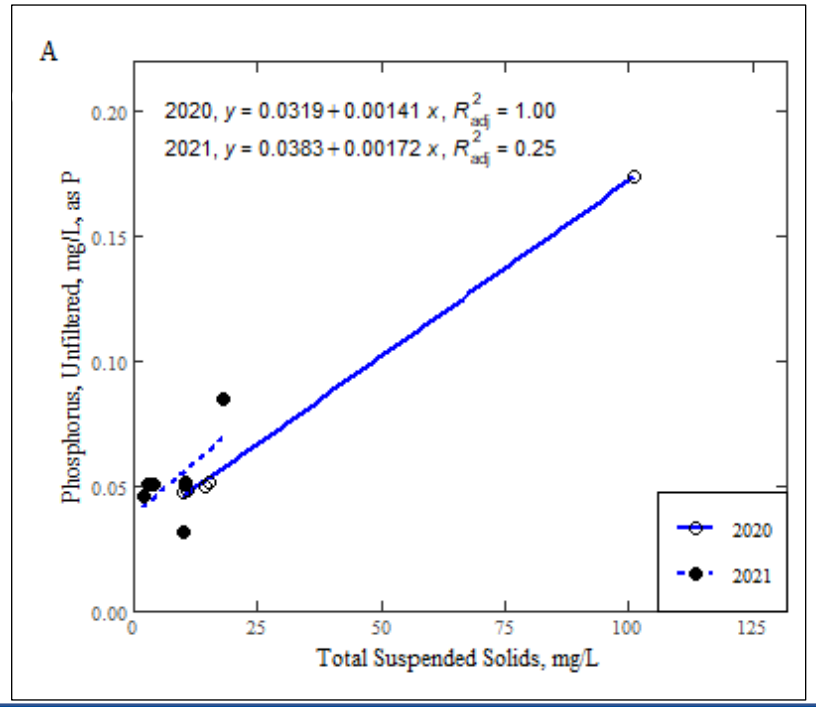
Data collected to assess comparability of the two sites

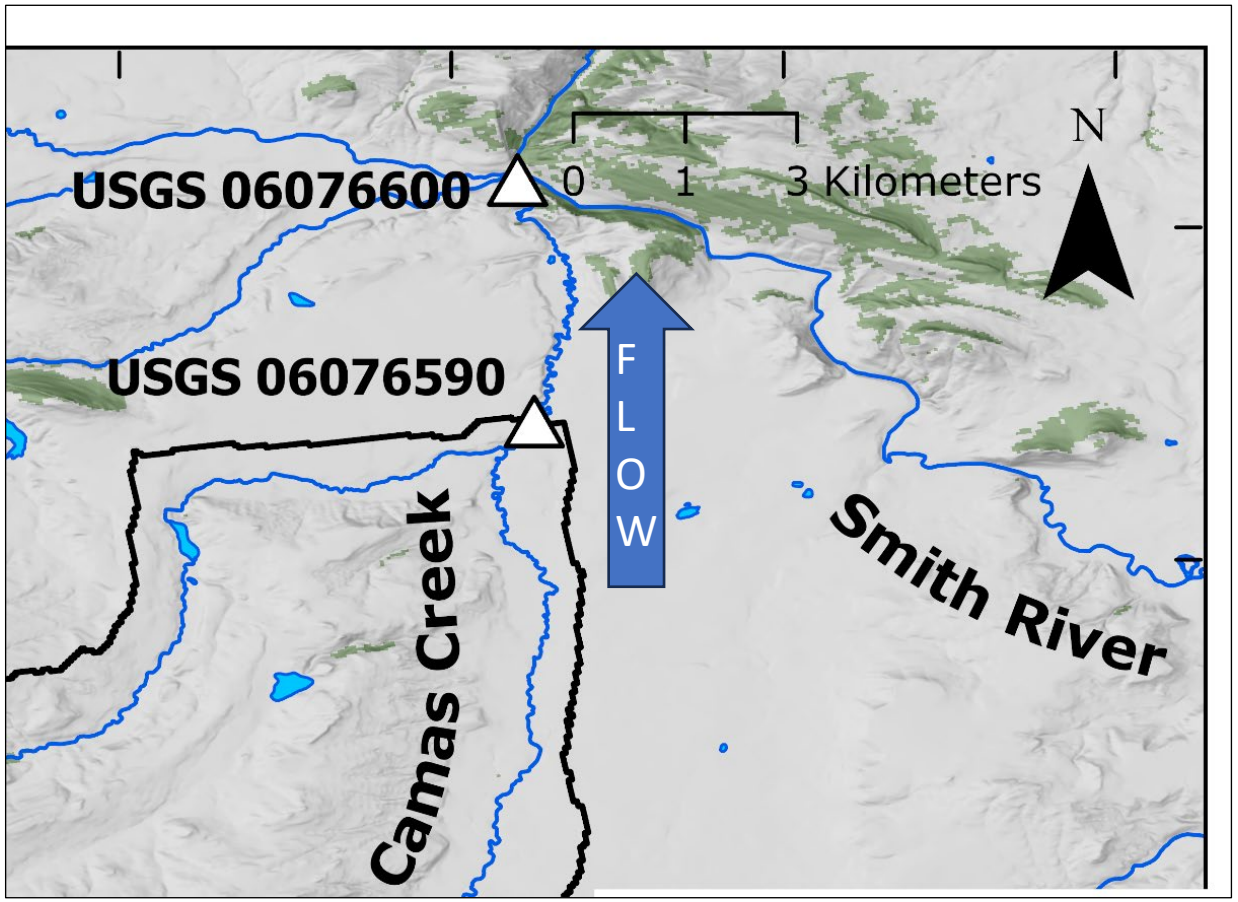
Research Question: *How did wildfire affect suspended sediment and phosphorus patterns in Camas Creek runoff?*


Camas Creek at Gage 06076590

Results: Comparability of Sites

Moving the site upstream did not introduce a significant treatment effect. Per ANCOVA, there is a significant relationship between TSS and TP but no significant difference in the TSS-TP relationship between the two sites (p = 0.23, n = 13)

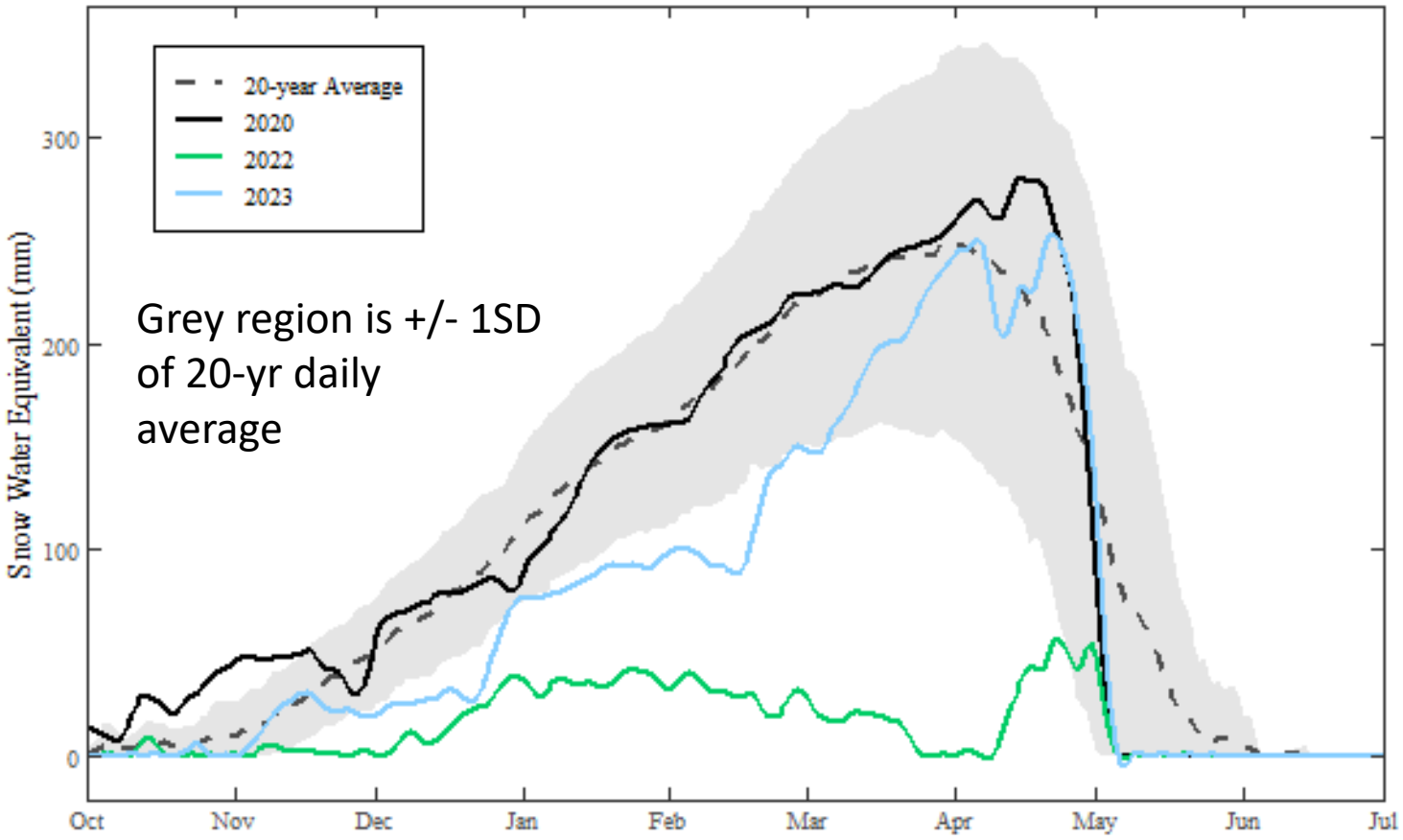




Results: Snow Water Equivalent (Pickfoot SNOTEL Station)

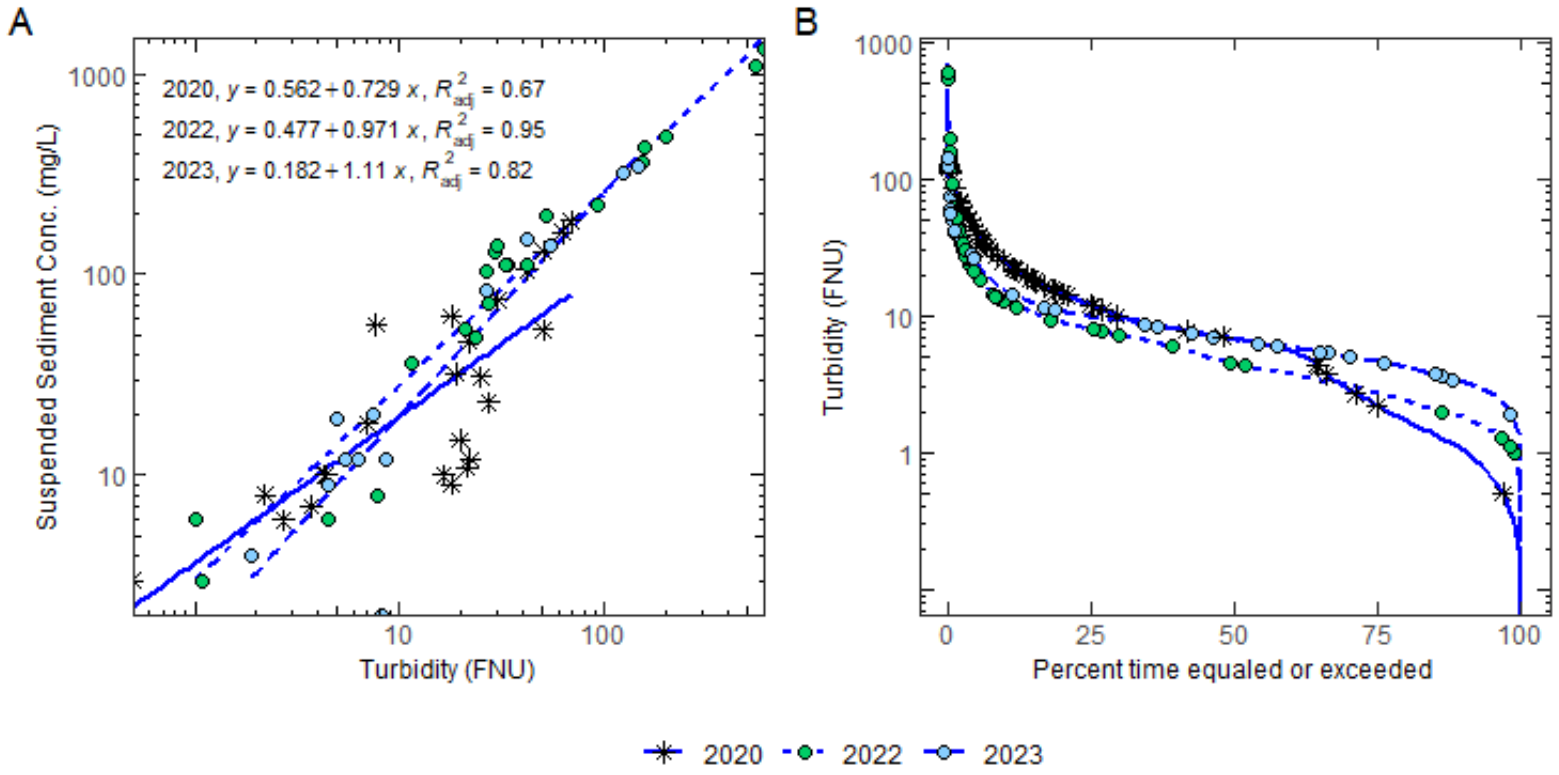
Observed stream flows corresponded well with snow water equivalent records from Pickfoot

2022—the first year after the fire—was a historically low snowpack



Results: Turbidity-Suspended Sediment Relationships

Pre-fire and Post-fire Year 1 were significantly different (ANCOVA, p = 0.005)



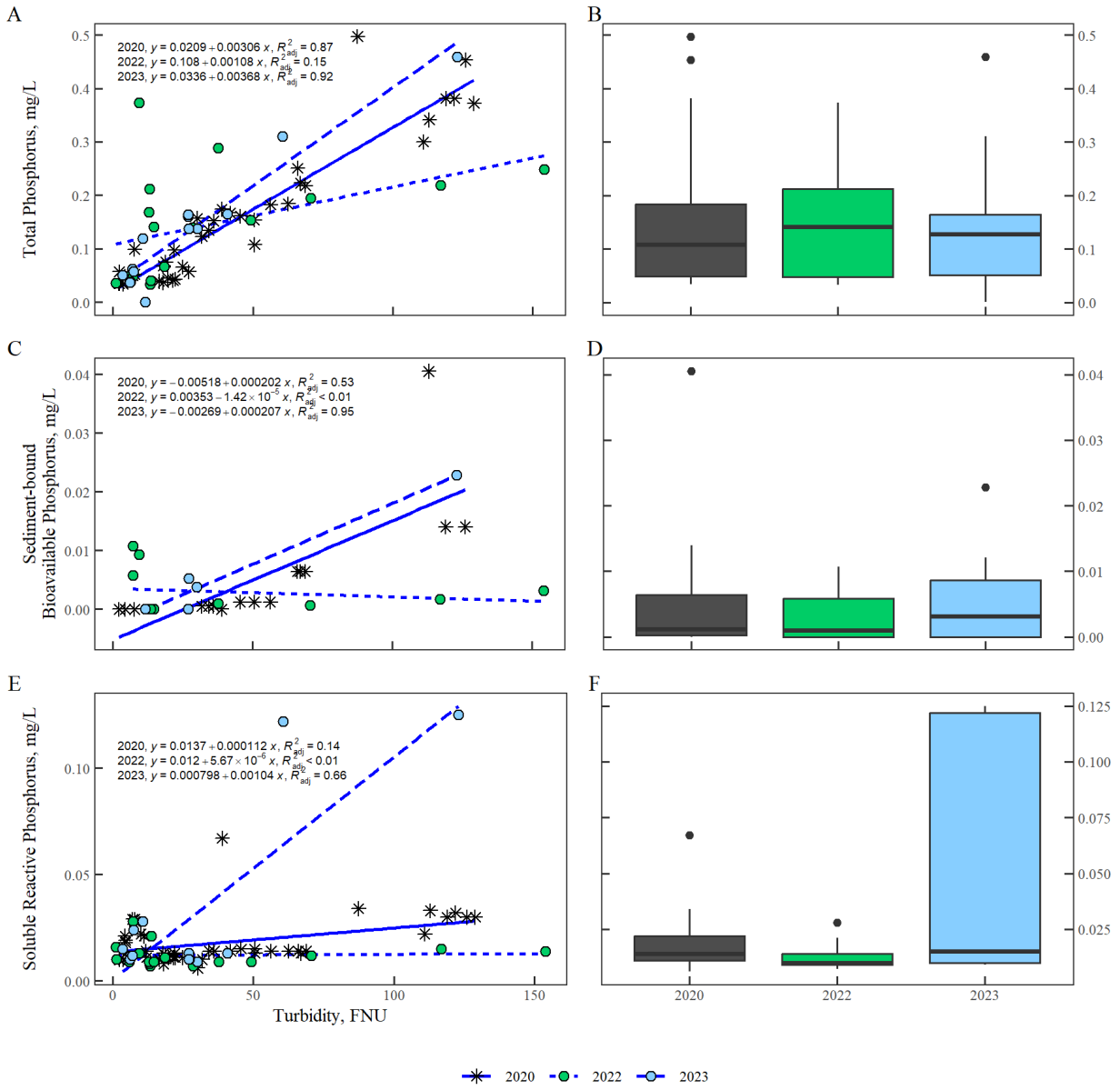
Results: Total P, Bioavailable P, and SRP

Fire did <u>not</u> significantly alter:

- Turbidity vs. Total P
- Turbidity vs. Sediment-bound bioavailable P

Fire significantly altered:

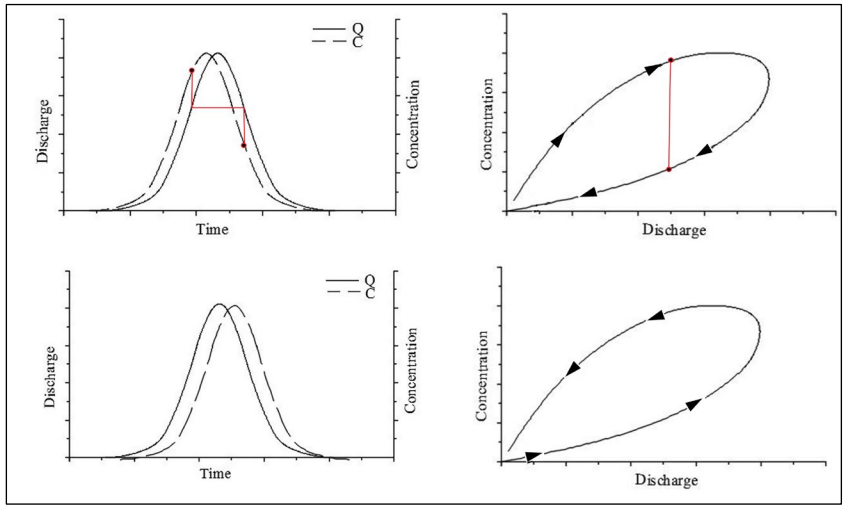
- Turbidity vs. SRP, between the two years <u>after</u> the fire and between the Pre-Fire year (2020) and the 2nd year after the fire occurred (2023)

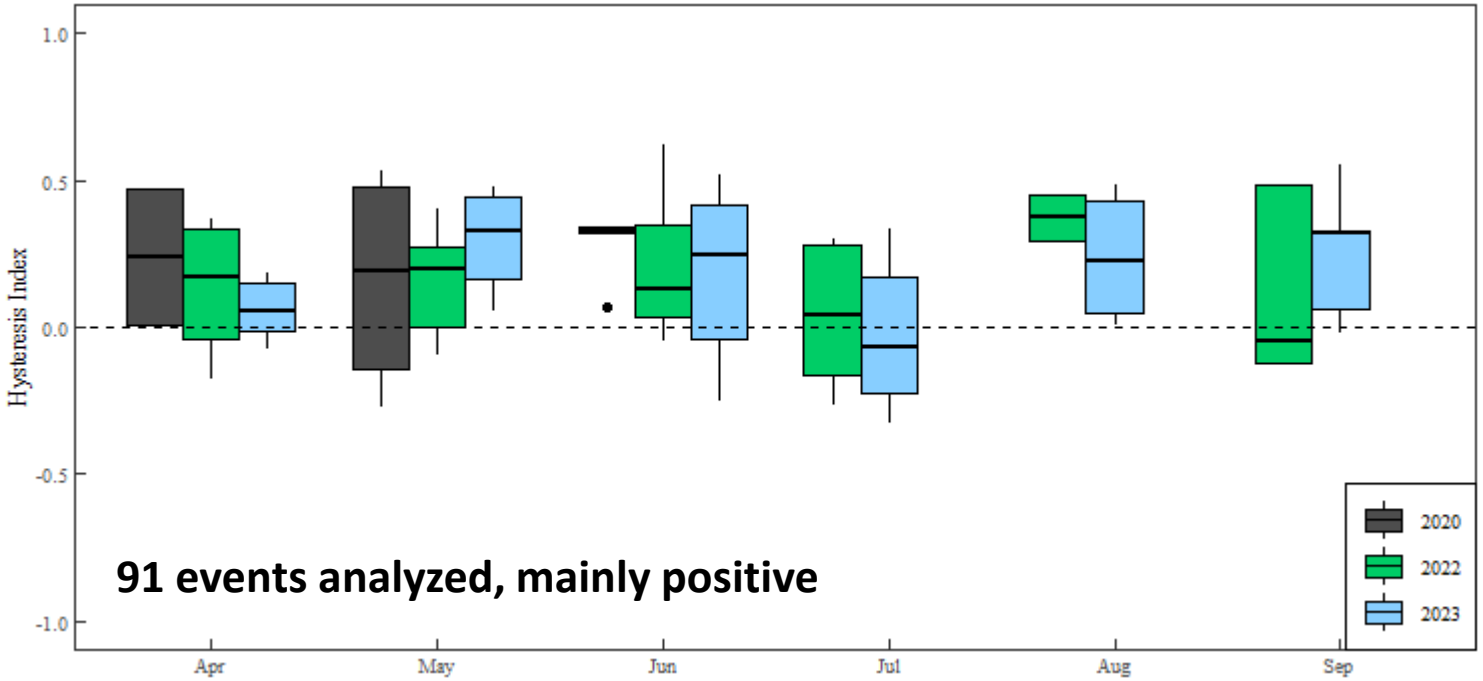


Results: Hysteresis of the Camas Creek Watershed

Positive hysteresis of the turbidity-streamflow relationship indicates the supply of sediment is exhausted or interrupted before peak streamflow—attributable to sediments mainly sourced from the riparian area or within channe

Results may indicate a degree of hillslope to channel dis-connectivity where hillslope sediments propagate towards the watershed outlet in a lagged response relative to streamflow and precipitation.





Preliminary
not for distribution.

Findings/Conclusions: Wildfire in Camas Cr Watershed

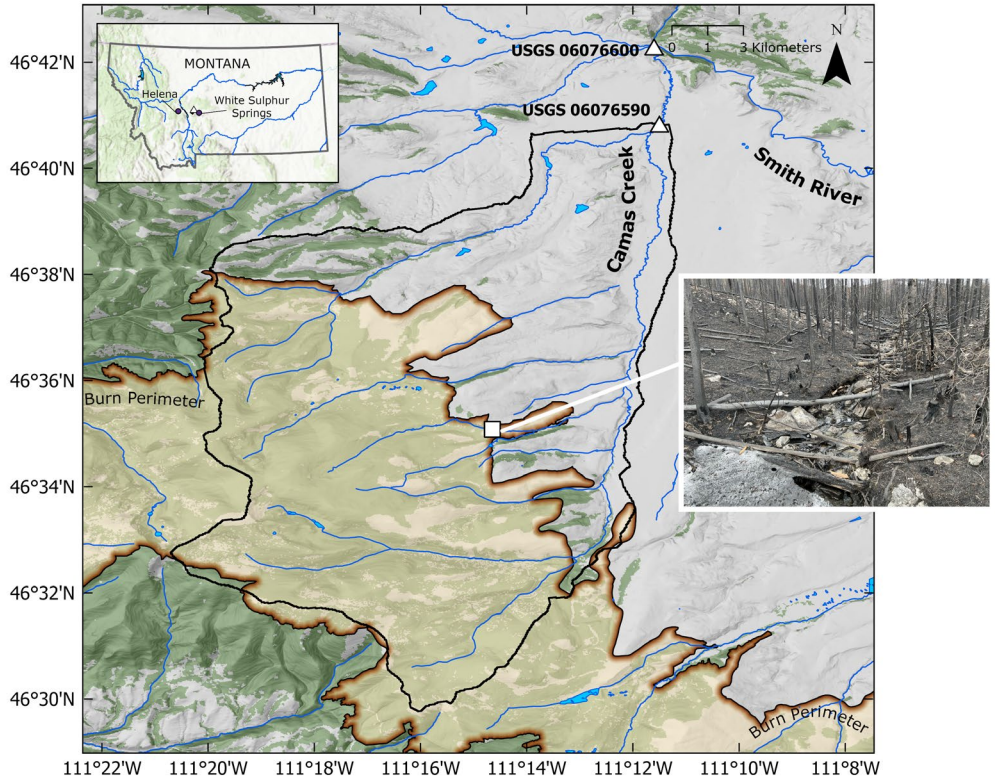
Fire did <u>not</u> significantly alter:

- Turbidity vs. Total P
- Turbidity vs. Sediment-bound bioavailable P

Fire significantly altered:

- Turbidity vs Suspended Sediment (Pre-Fire vs. 1st year after the fire)
- Turbidity vs. SRP, between the two years <u>after</u> the fire and between the Pre-Fire year (2020) and the 2nd year after the fire (2023)

The muted effect of the fire on phosphorus was likely a combination of the historically low snowpack in the year following the fire and a lagged watershed response (as shown by hysteresis) and sediment retention in the channel.



Atypical; a synthesis of fire effects on stream water quality (globally and in western U.S) show wildfire typically increases all P concentrations downstream of fire-burned areas in the years that follow.

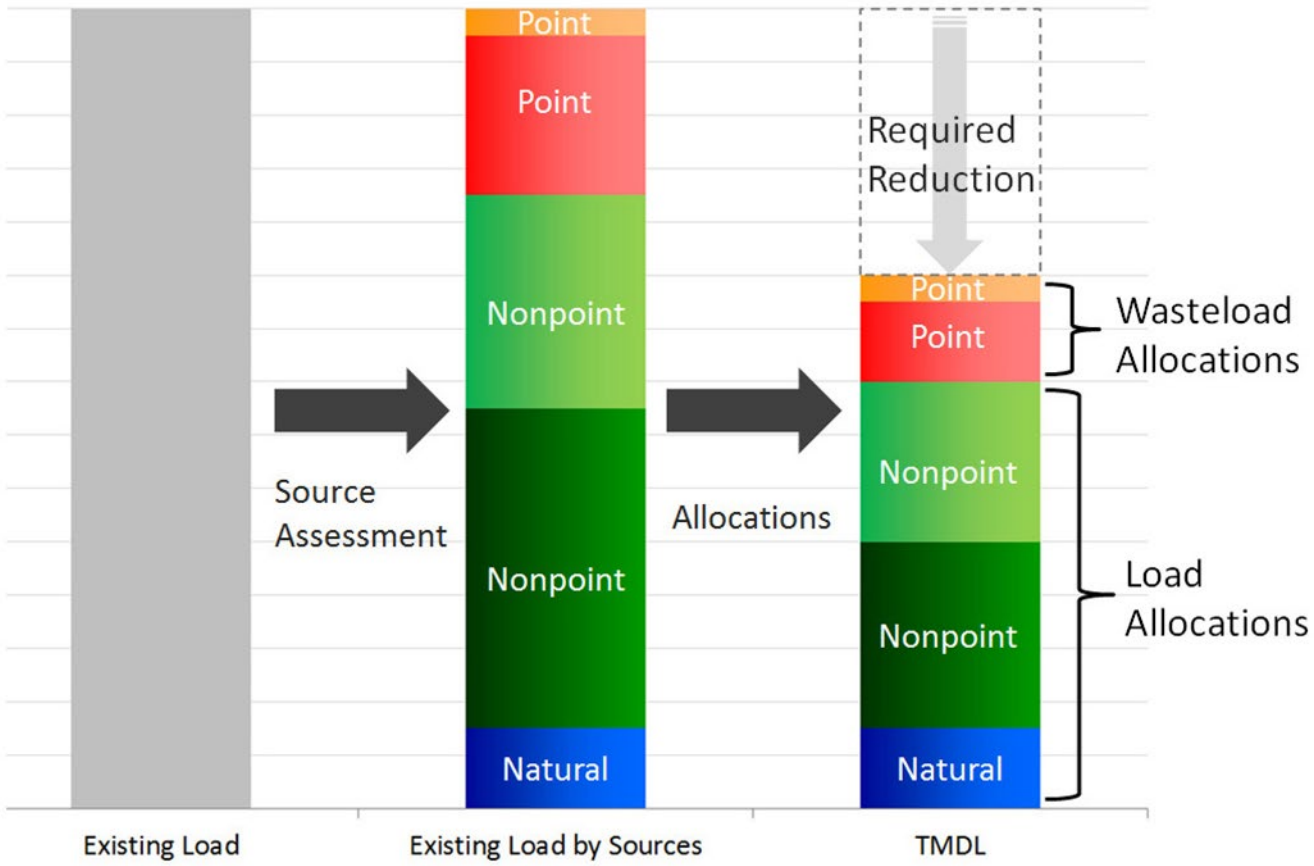
Accounting for Wildfires in TMDLs

*Rye Creek Fire 2000

*Aspen Fire 2003

Accounting for Wildfires in TMDLs

- TMDLs are written for normal conditions
  - Average background conditions with human impacts
  - Reduce pollutants to levels below assimilative capacity; not to natural conditions
- Loading impacts from wildfires are hard to quantify
  - Wildfires can increase background loading
  - Effects the stream health are usually short term

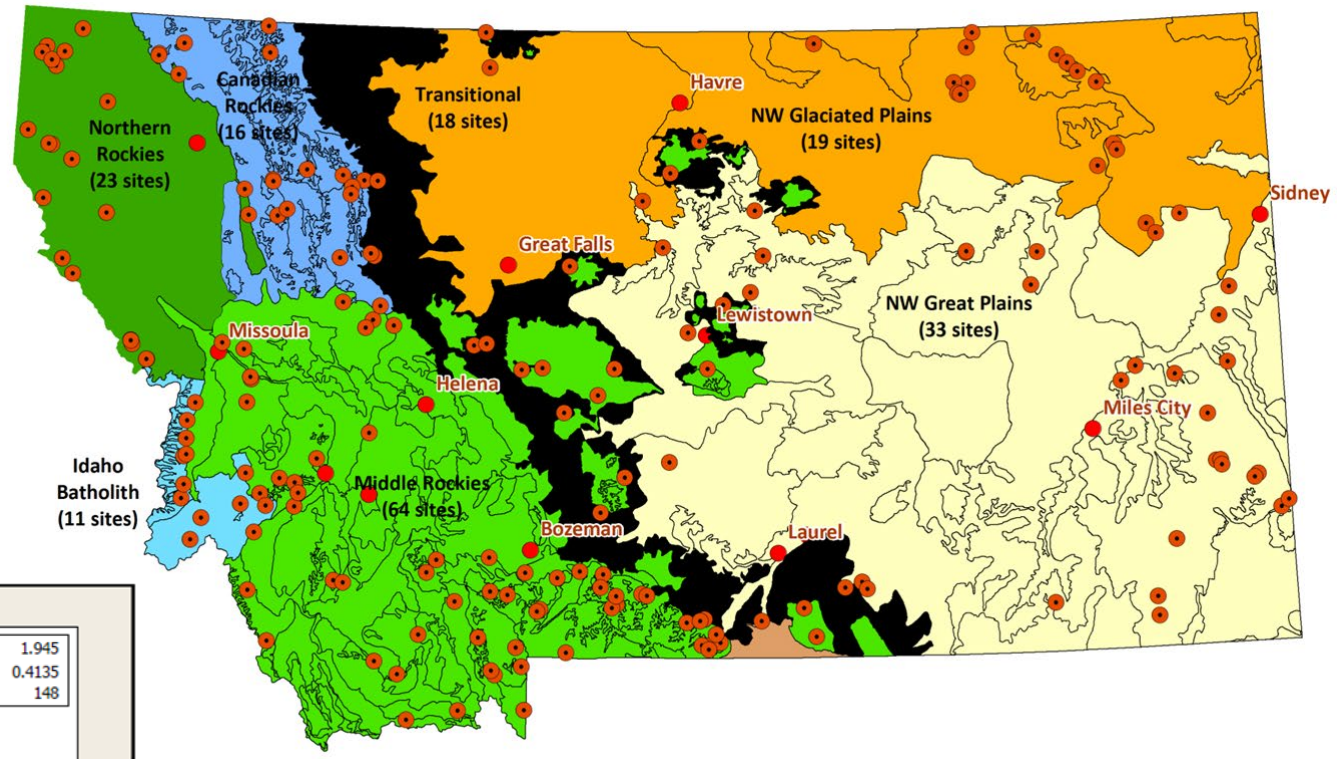


"All three nutrient TMDLs are written for a "normal" watershed condition not significantly influenced by wildfire."

-Boulder-Elkhorn Nutrient, Sediment, & Temperature TMDLs

Natural Background Loading Estimates

- Reliance on reference data set
- Median values taken from reference data may capture wildfire/beetle kills/etc.



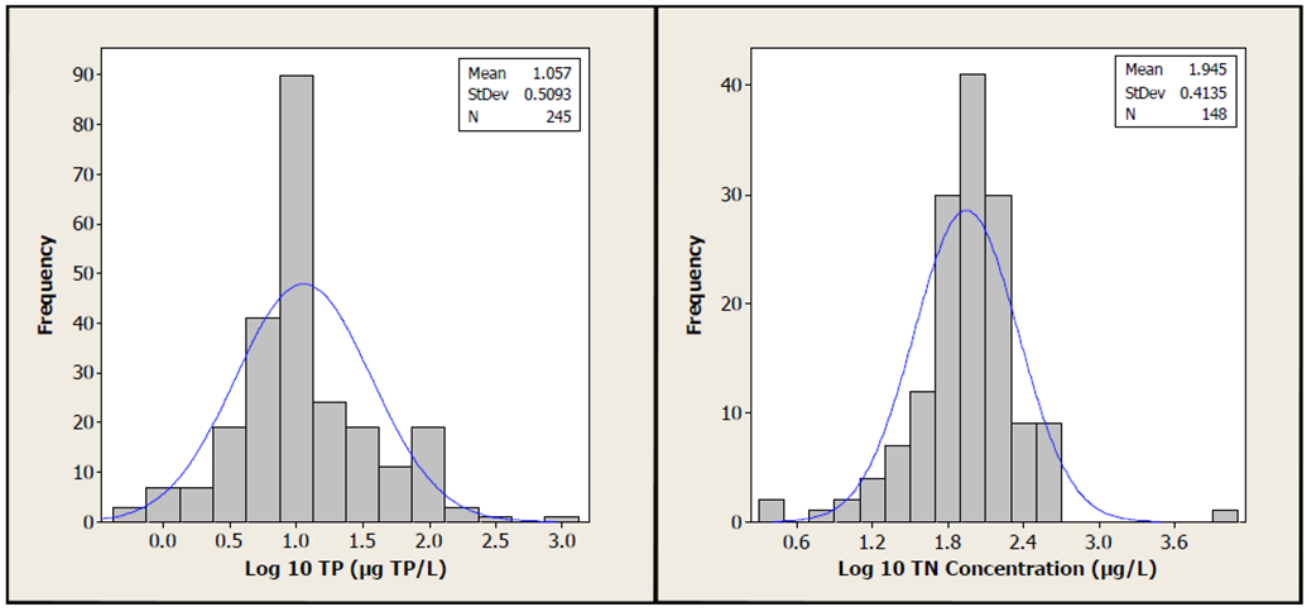


Figure 3-3. Nutrient concentrations from reference streams in the Middle Rockies ecoregion.

Madison Sediment and Temperature TMDLs: Cherry Creek source assessment

- Used GIS tools to investigate how much of the watershed was below the TMDL target
- Excluded area containing suspected wildfire/beetle kill
  - Assuming natural processes would restore shade

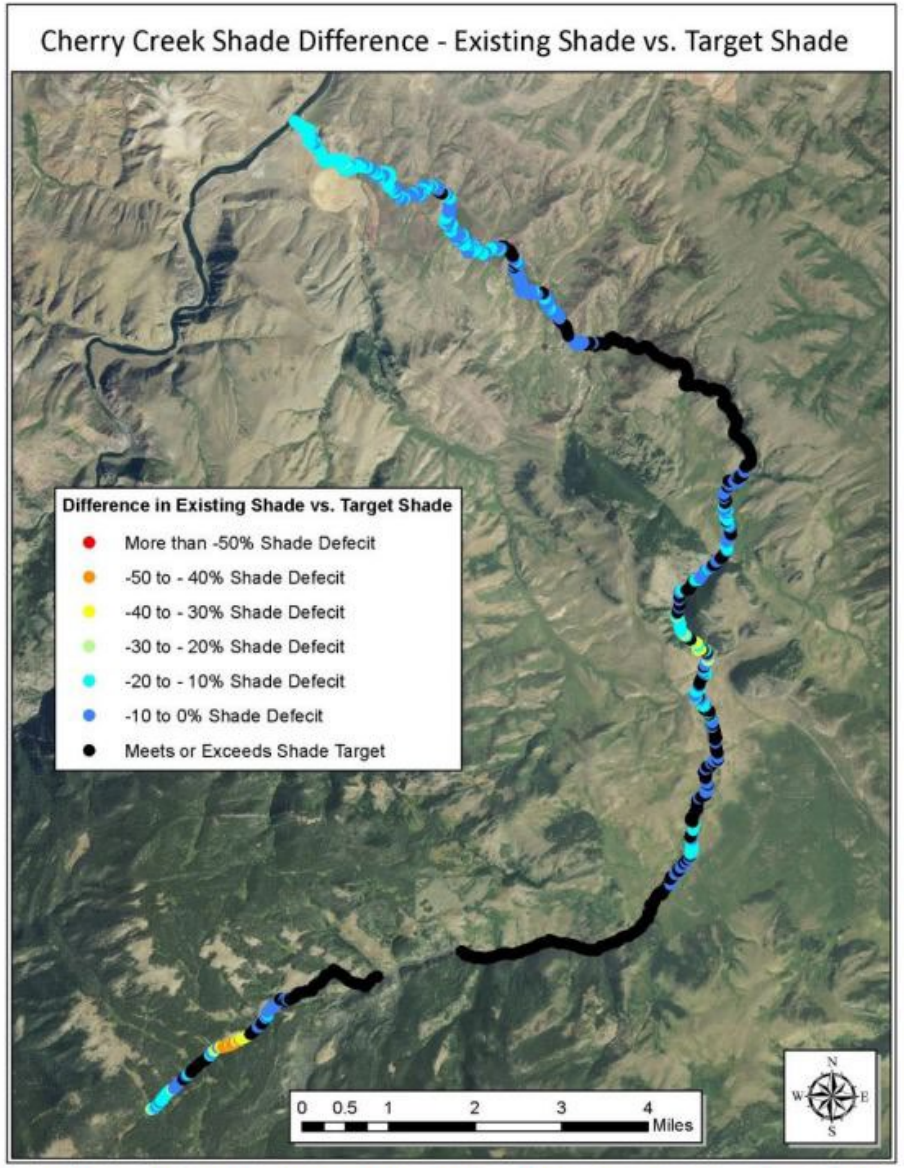
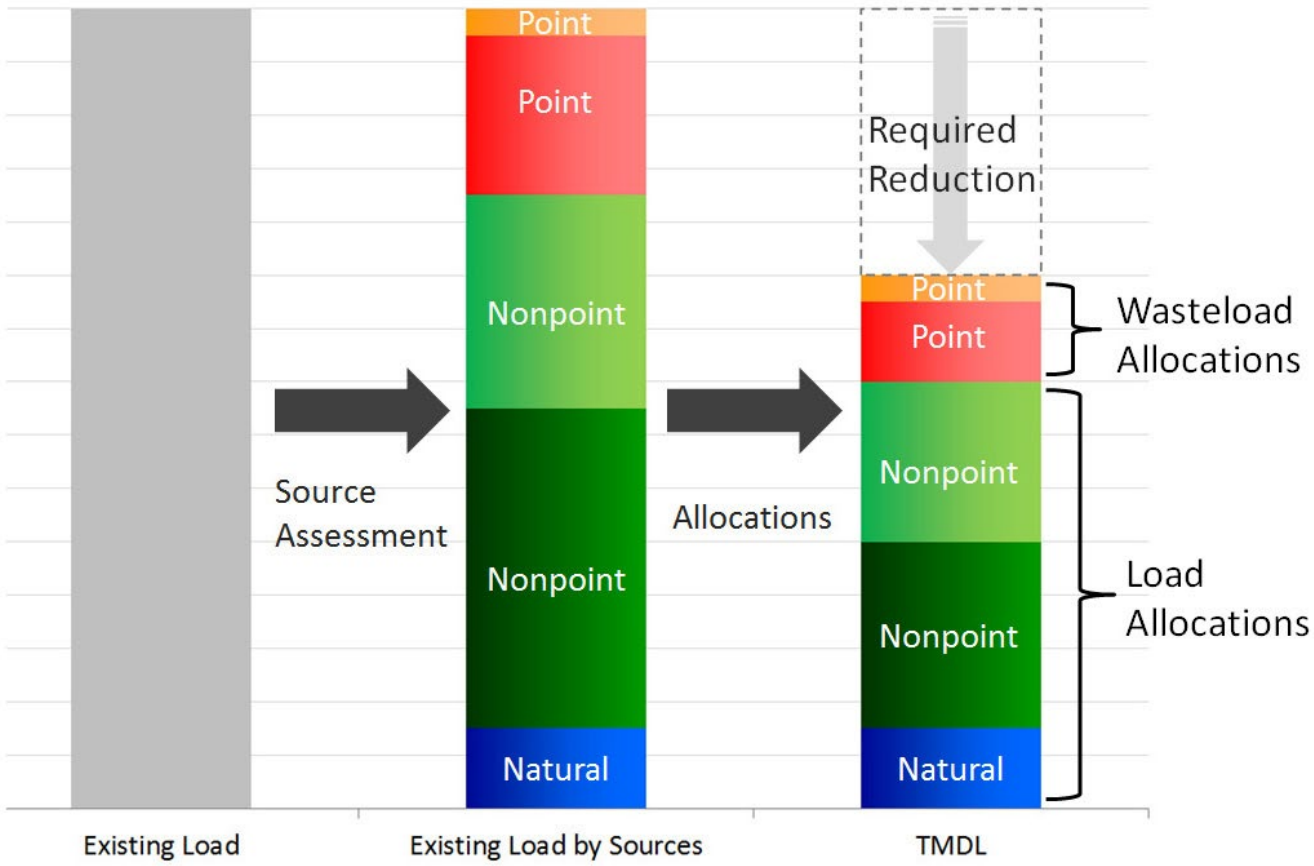


Figure 6-17. Map of Difference in Effective Shade between Existing Condition and Shade Targets for Cherry Creek

Including Wildfire in a TMDL

Impacts from wildfire should be acknowledged throughout the TMDL

- Watershed Characterization: Identify wildfires within the watershed; area burned and date
- Targets for Natural Background Loading: Reference data collected or interpreted from literature values
- Source Assessment: assess whether the contributions are significant
- Load Allocations: TMDLs are written for normal conditions



"Wildfire is a natural process in the ecosystem, and the DEQ cannot allocate a load reduction, although it should be noted that activities within the watershed should not alter recovery time from a fire or contribute to the severity of the impacts from a fire"

-Boulder-Elkhorn Nutrient, Sediment, & Temperature TMDLs

Camas Creek Study

Help inform future expectations of fire effects in this watershed

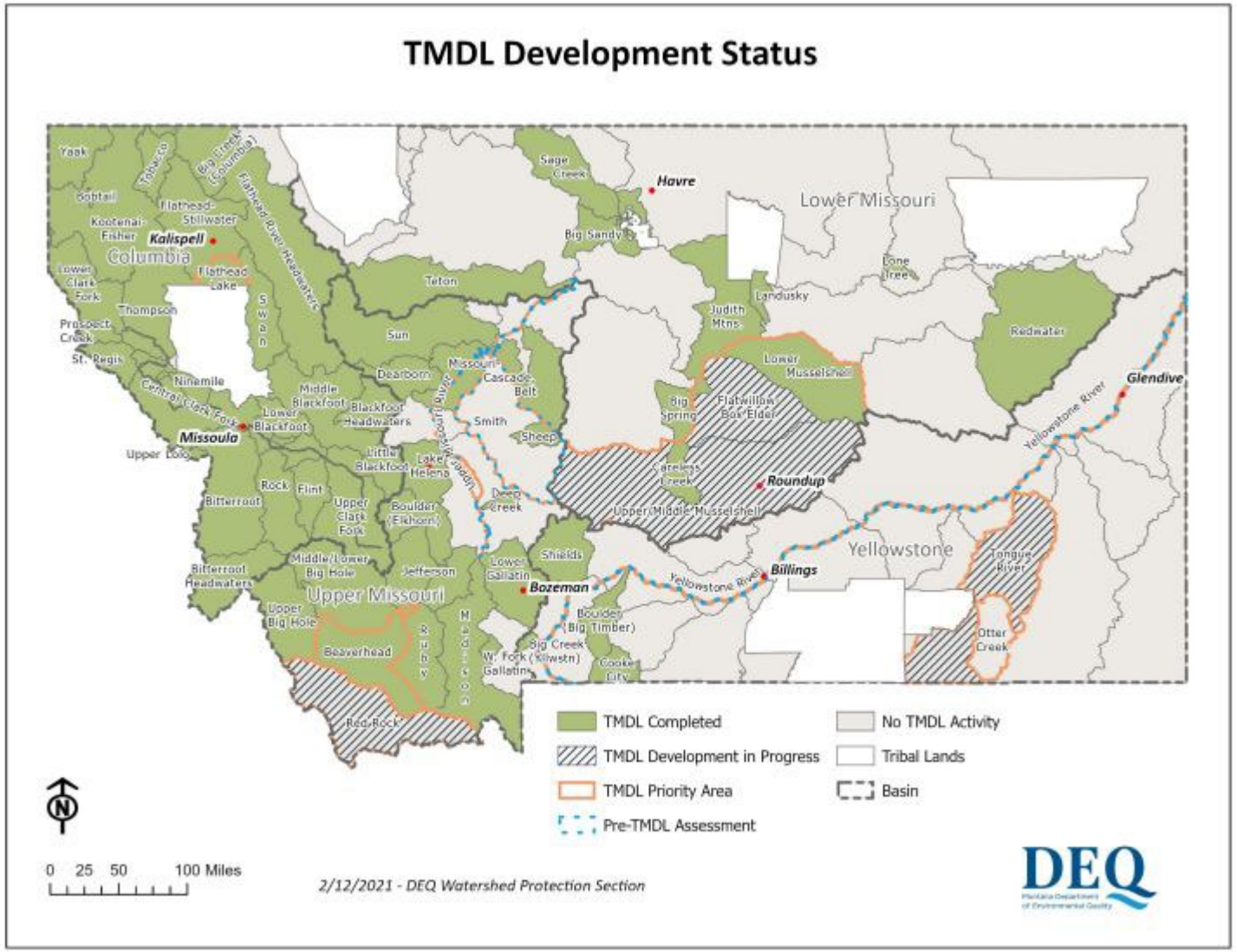
- Useful, given algal bloom issues in the downstream Smith River
- Help rule out wildfire impacts during source assessment

*Such information is watershed specific, slow to acquire, and not easily transferable to other areas

Montana DEQ TMDL Webpage

https://deq.mt.gov/water/Programs/tmdl

- Madison Sediment and Temperature TMDLs and Water Quality Improvement Plan
- Sediment, Nutrients, and Temperature TMDLs and Water Quality Improvement Plans for the Boulder-Elkhorn Planning Area



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