Exploring the Impact of the Cedar Creek Fire on Source Water Quality and Treatment

2024 Montana AWRA Annual Conference

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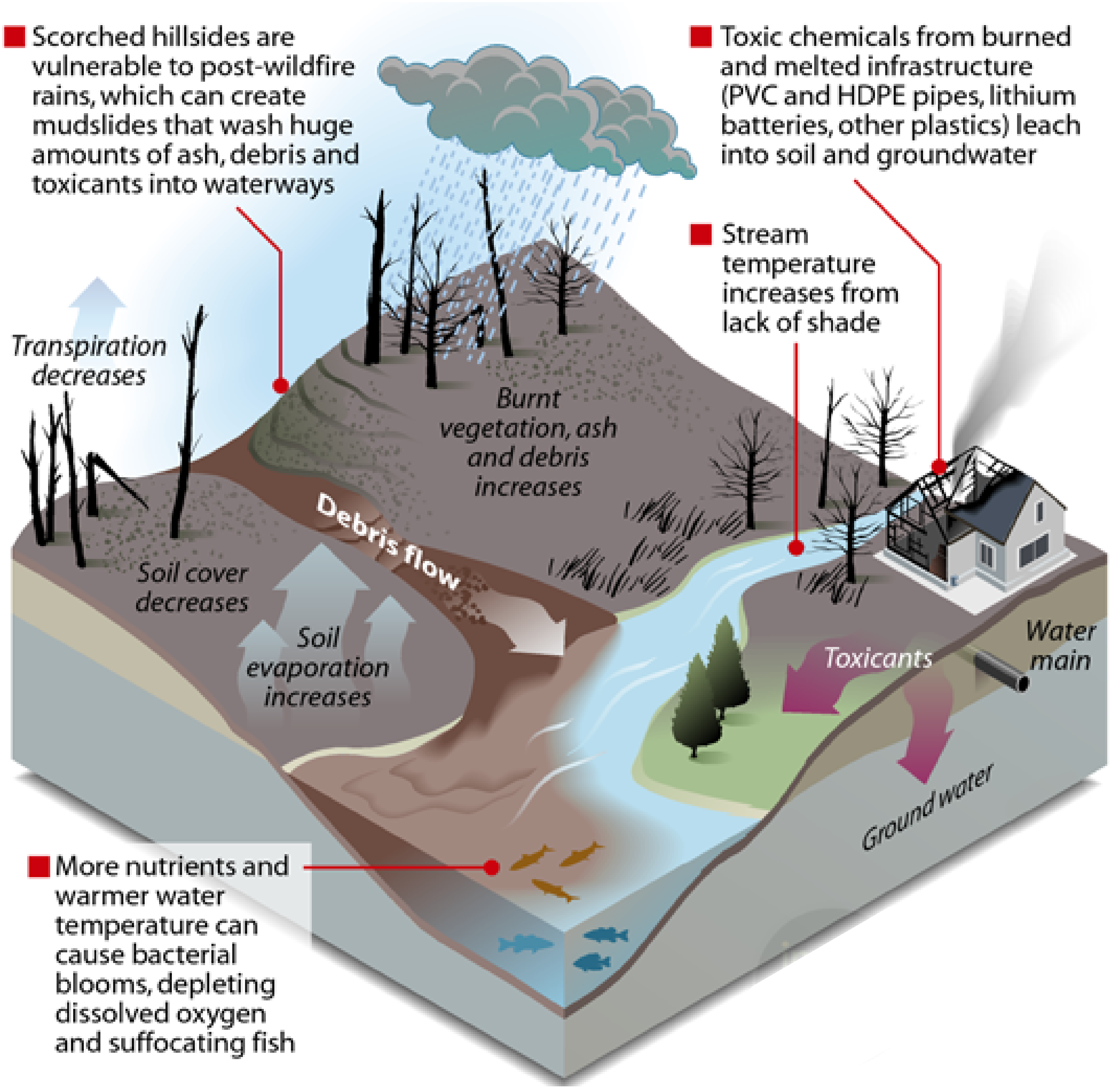
Wildfires and Drinking Water Supplies

- Elevated turbidity and dissolved organic carbon levels from erosion in burned areas can pose water quality and treatment challenges for drinking water systems
- Consequently, drinking water utilities may need to:
  - shut down
  - bypass turbid water
  - seek alternative water sources

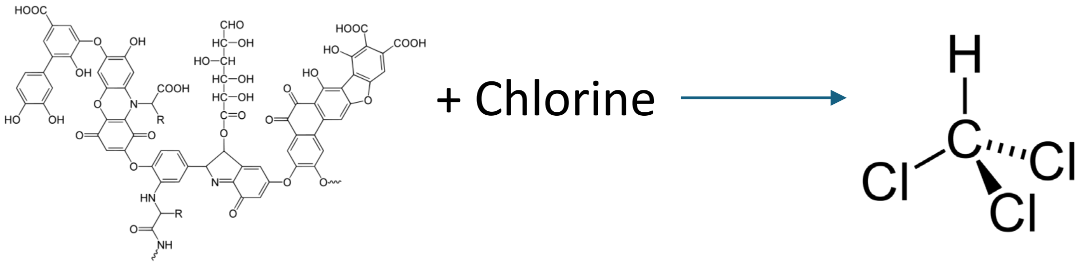


Source: Water Quality Australia; Purdue University

Drinking Water Treatment

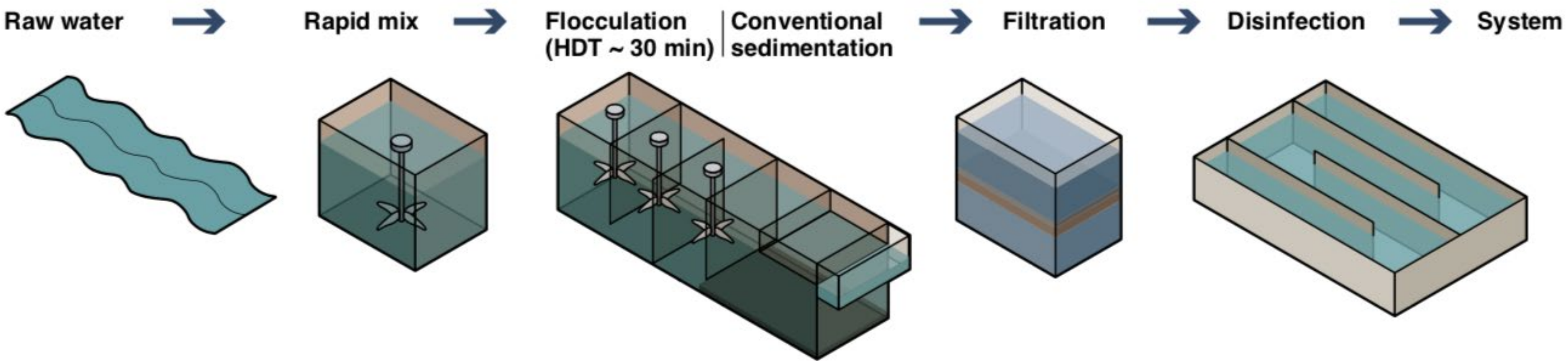
- Safe Drinking Water Act Goals
  - Remove particles (turbidity) & inactivate pathogens
  - Minimize disinfection byproduct (DBP) formation by removing dissolved organic carbon (DOC)

Disinfection Byproduct (DBP) Formation



Dissolved Organic Matter

FIGURE 1 Schematic of a conventional water treatment plant



Wildfires in Western Cascades, OR

- The western Cascade Mountains in Oregon provide high-quality source water to many communities:
  - Portland
  - Eugene
  - Corvallis
  - Salem

- In recent years, several large destructive wildfires have burned municipal watersheds.

MTBS Fire Viewer, 2024

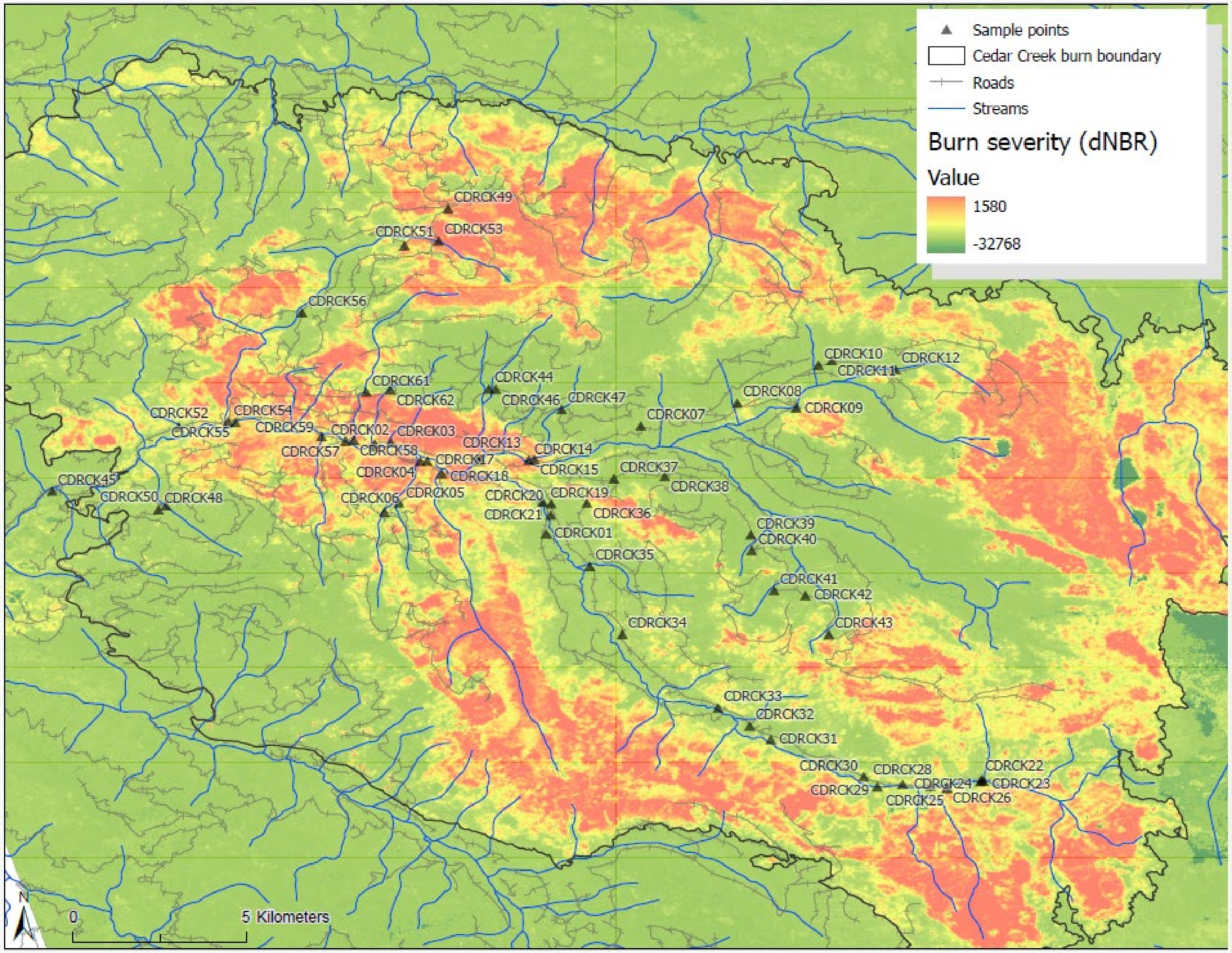
Objective

To explore the spatial variability of post-fire water quality and treatability across a watershed by conducting a seasonal synoptic sampling campaign following the 2022 Cedar Creek fire

Node 1: Source Water Quality
Dr. Kevin Bladon's lab at OSU
Expertise: Forest ecohydrology, watershed science, water quality

Node 3: Drinking Water Treatment
MSU and Gonzaga University
Expertise: Water quality and treatment MSU, GU)

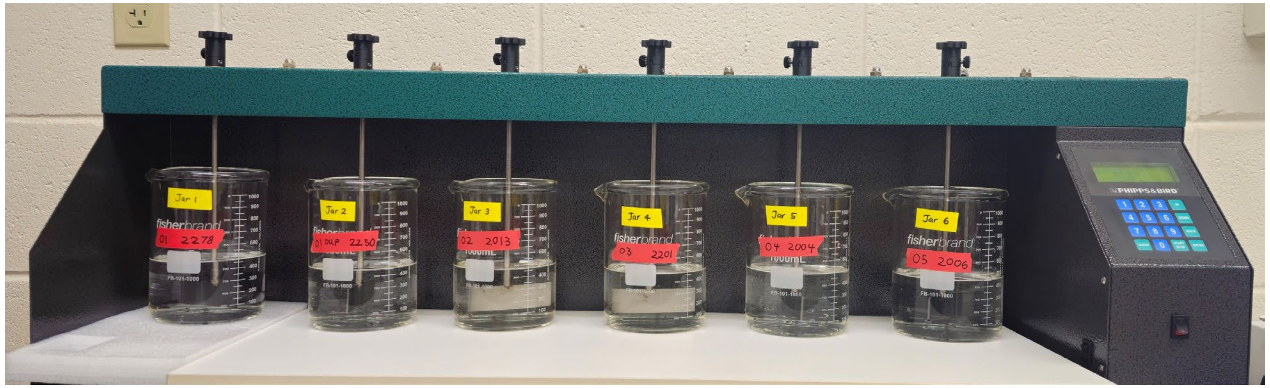
Cedar Creek Fire Synoptic Sampling



- Burned 127,311 acres in the Salmon Creek watershed from August – November 2022
- Synoptic sampling: captures a snapshot in time to understand spatial variability across a watershed and stream networks
- Synoptic samples were collected after storm events
  - Winter: 30 sites
  - Spring: 45 sites

Treatability Experiments

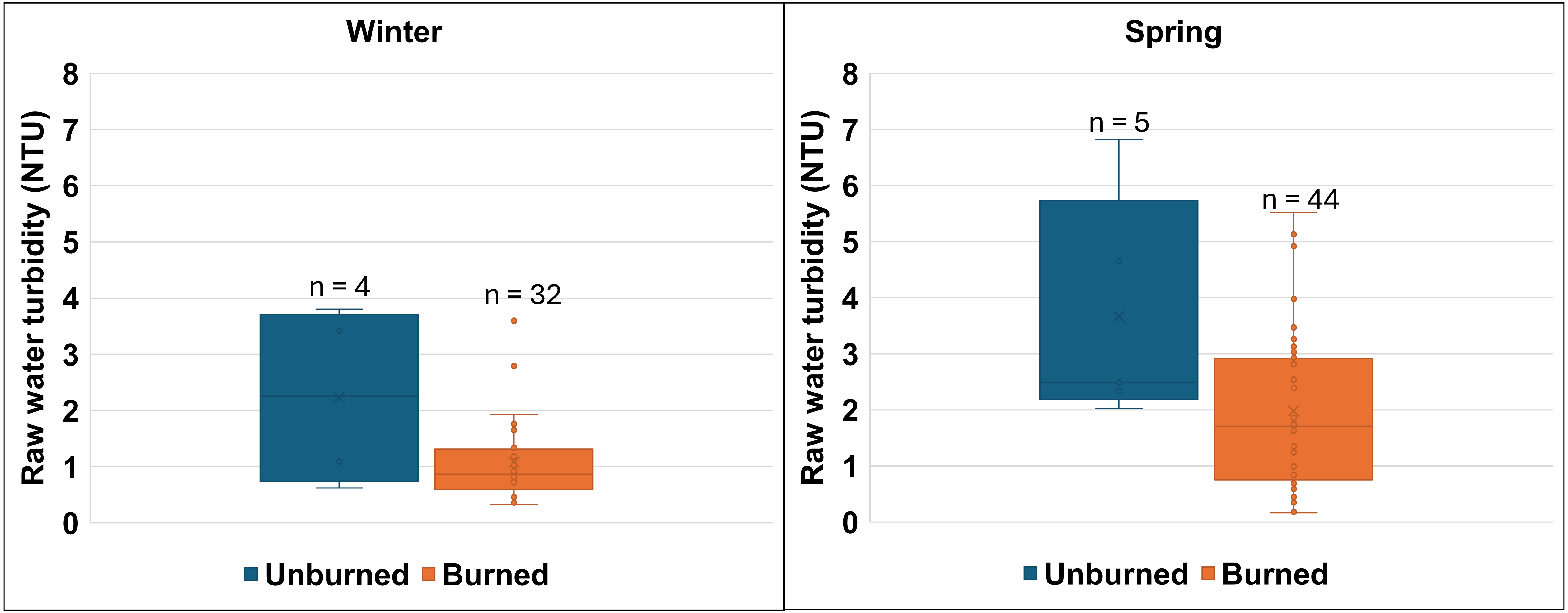
- Bench-scale experiments were conducted with conventional treatment with alum (10 mg/L) using a jar tester



- Raw and treated water samples were analyzed for
  - Turbidity
  - Dissolved Organic Carbon (DOC)
  - Ultraviolet absorbance at 254 nm (UV_{254})
  - Fluorescent dissolved organic matter (fDOM)

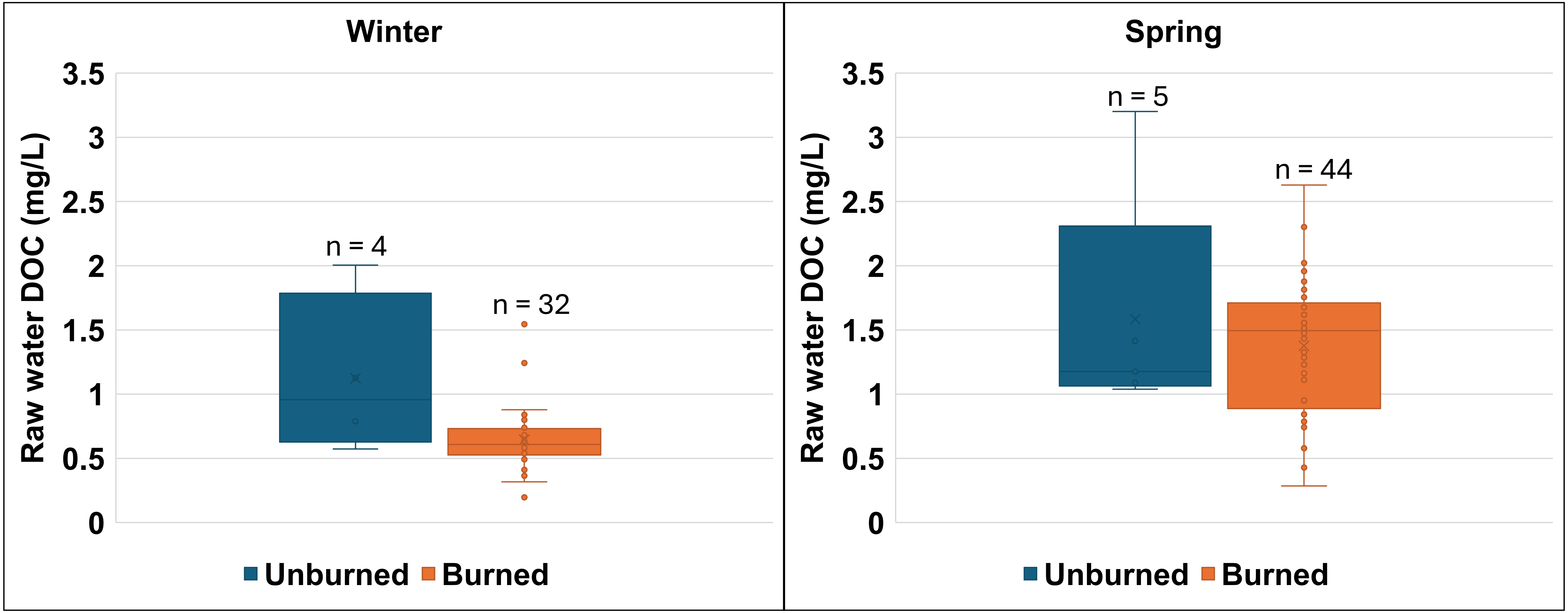
- Raw and treated water samples were chlorinated to determine the disinfection byproduct formation potential (DBPFP)
- Chlorinated samples were analyzed for two groups of regulated DBPs:
  - Total Trihalomethanes (TTHMs)
  - Nine Haloacetic Acids (HAA9s)

Raw Water Turbidity



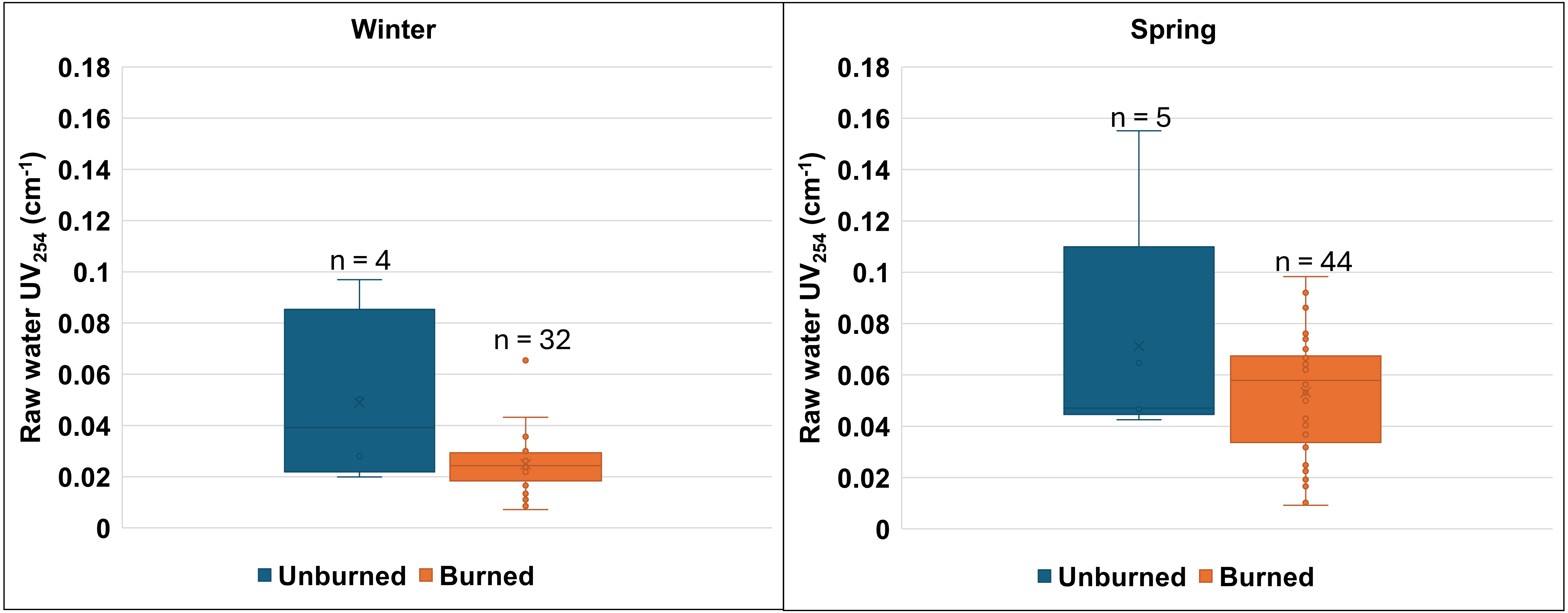
- Raw water turbidity was relatively low across all sites
- Turbidity of spring samples were on average greater than winter samples
- In both seasons, the average turbidity for unburned sites was greater than burned sites

Dissolved Organic Carbon (DOC)



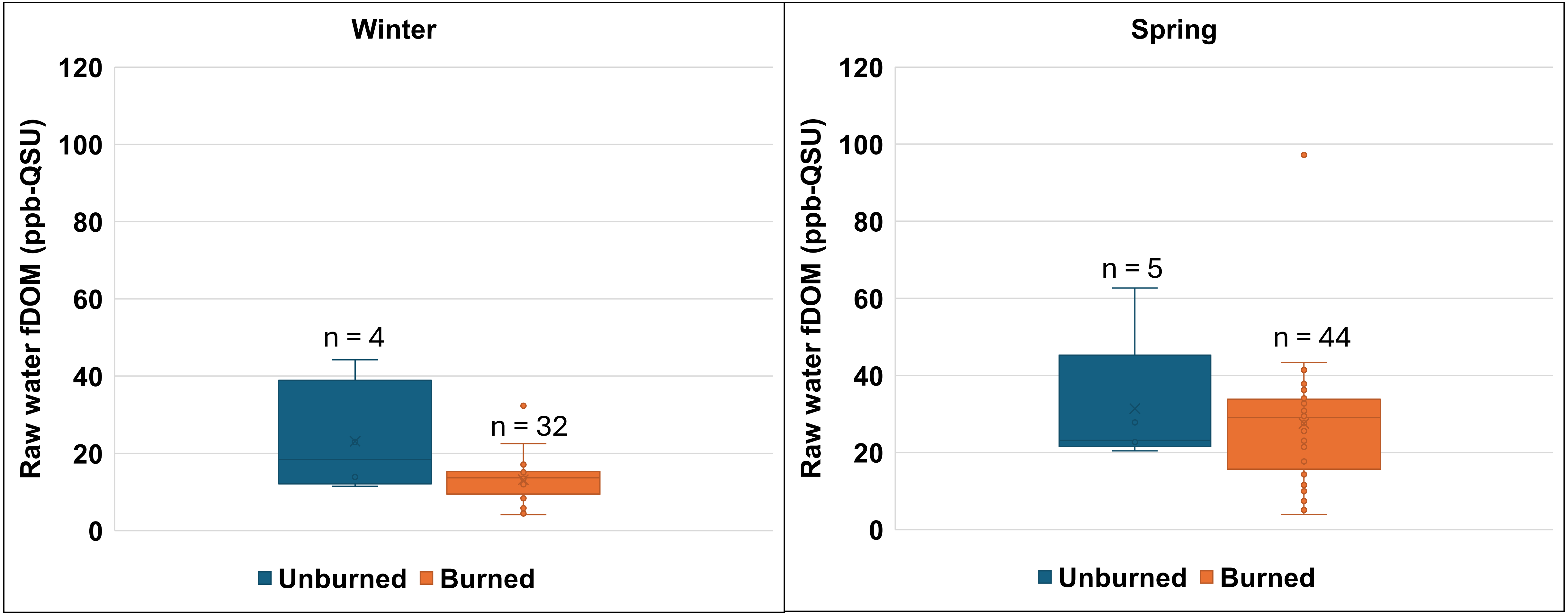
- DOC was greater for spring samples
- Sites draining from unburned areas had greater DOC concentrations
- Lower DOC at burned sites could suggest that for this watershed, the wildfire reduced the amount of dissolved organic matter mobilized to streams, which might be due to vegetation loss or changes in soil composition and the lack of surface runoff

Raw Water UV_{254}



- In both seasons, the average UV_{254} for unburned sites was greater than burned sites, consistent with DOC trends

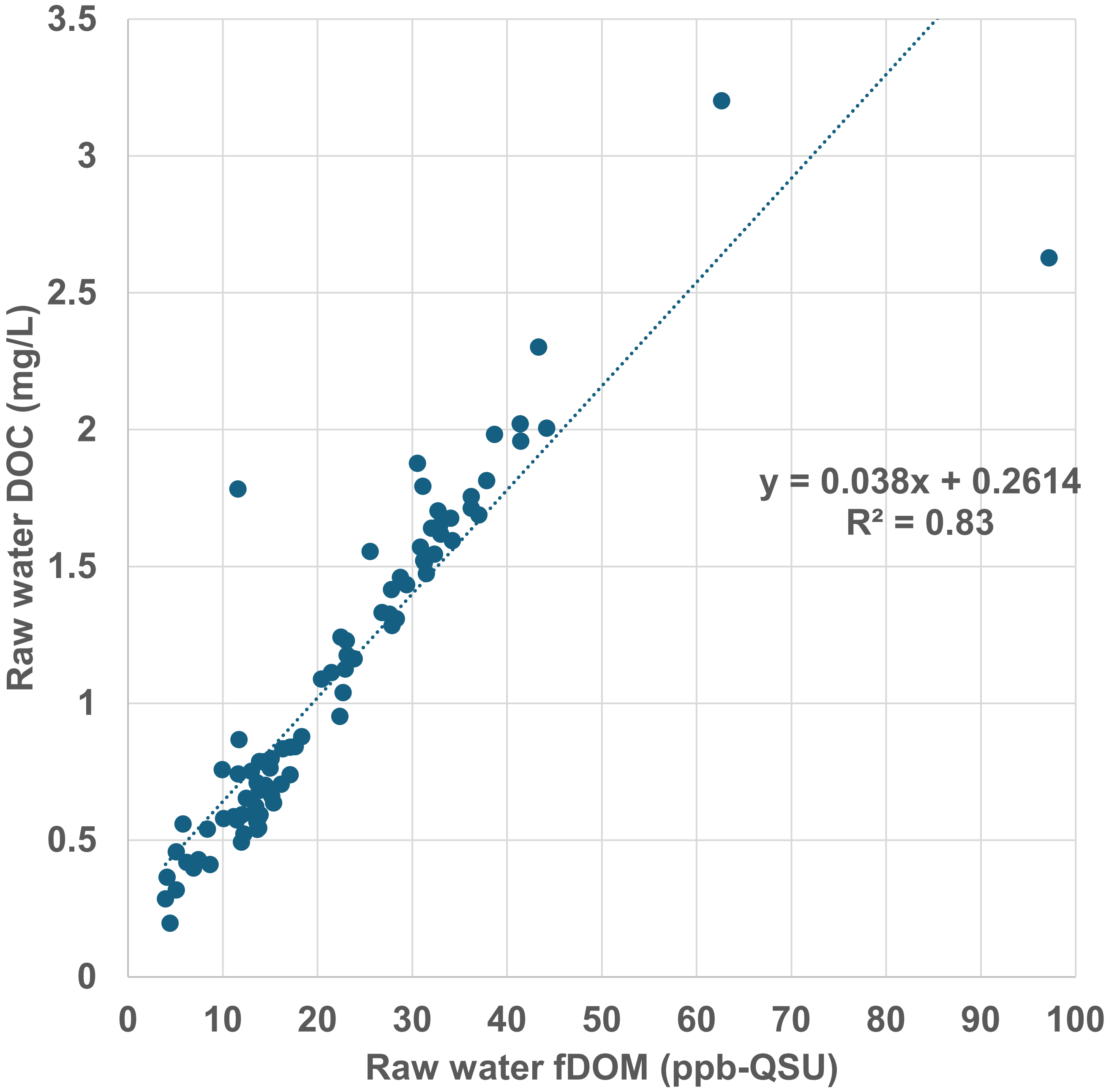
Raw Water fDOM



- In both seasons, the average fDOM was greater for unburned sites than burned sites
- These results are also consistent with the DOC results

fDOM and DOC

- fDOM and DOC showed a positive and relatively strong correlation (R^2=0.83) for all samples (*n*=85)
- Suggests fDOM is a decent proxy for DOC in this watershed
- fDOM can easily be measured in the field:
  - Handheld fluorometers
  - In-stream sensors for 15 minute measurements

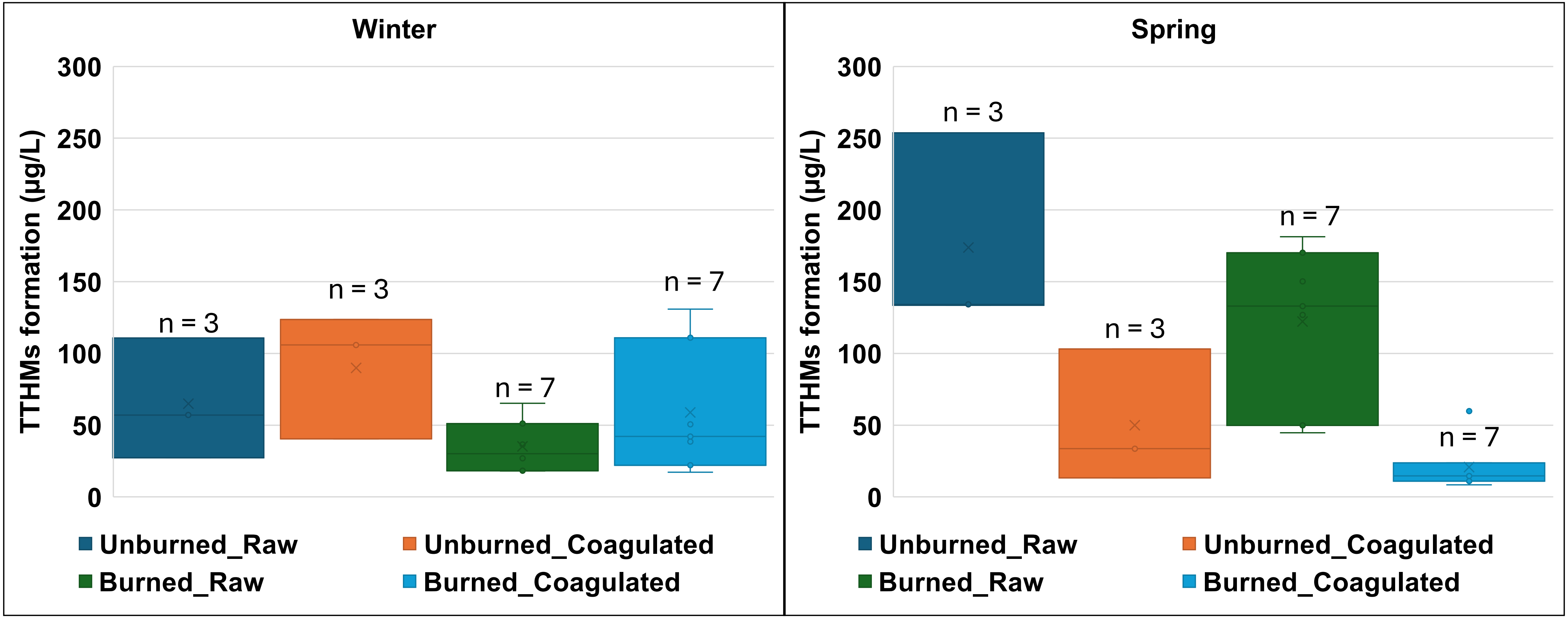


Treatability by Alum Coagulation

Season- Site	Percent Removal (%)			
	Turbidity	DOC	UV_{254}	fDOM
Winter-Unburned	28 ± 18	28 ± 16	42 ± 28	33 ± 18
Winter-Burned	33 ±18	20 ± 24	52 ± 19	42 ± 15
Spring-Unburned	41 ± 8	20 ± 20	26 ± 25	24 ± 11
Spring-Burned	30 ± 46	27 ± 23	43 ± 27	41 ± 18

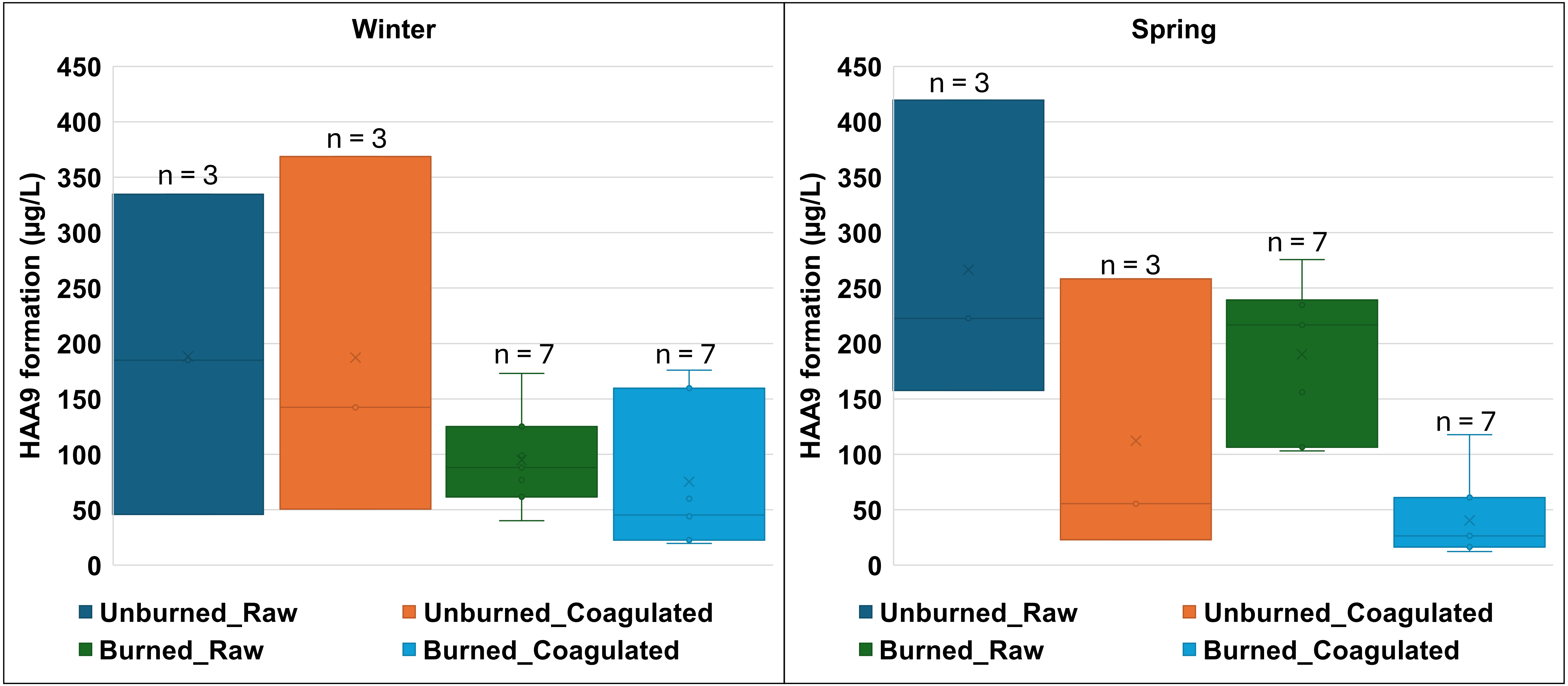
- Raw water turbidity and DOC were very low across all sites, resulting in low and variable removal by coagulation
- UV_{254} and fDOM were more sensitive and reliable measurements
  - The greatest UV254 and fDOM removal efficiencies were recorded for winter-burned sites.
  - In both seasons, greater UV_{254} and fDOM removal was observed for burned sites than unburned sites

Raw and treated TTHM formation



- The burned sites had lower TTHM formation than unburned sites, which is consistent with the raw water DOC trends.
- The coagulation of the spring samples removed TTHM precursors consistently for both unburned and burned sites to levels similar to the winter samples.
- Treatment of winter samples were highly variable with negligible removals of DBP precursors.

Raw and treated HAA9 formation



- A similar trend as TTHM was observed for HAA9 after treatment
- HAA9 concentrations are higher than TTHM, suggesting the studied watershed is rich in HAA precursors relative to TTHM

Summary and Next Steps

- For all parameters measured, greater levels were observed for unburned sites than burned sites
- Burned and unburned sites showed similar treatability responses for turbidity and DOC
- Optical properties were simple, sensitive, and reliable for DOM measurements
- The landscape characteristics and hydrology of Salmon Creek watershed may have some resiliency to post-fire water quality changes, and drinking water treatment impacts may be negligible and manageable
- Deeper analysis of burn severity site classification using composite burn index (CBI) will be conducted and connected to water quality and treatment
- Summer synoptic samples were collected, and a fall sample campaign will occur within the next month

Acknowledgments

- USFS Pacific Northwest Research Station
- Center for Biofilm Engineering – Montana State University

Questions?

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