The influence of climate-induced alterations in dissolved organic matter on metal toxicity and UV radiation in Rocky Mountain streams

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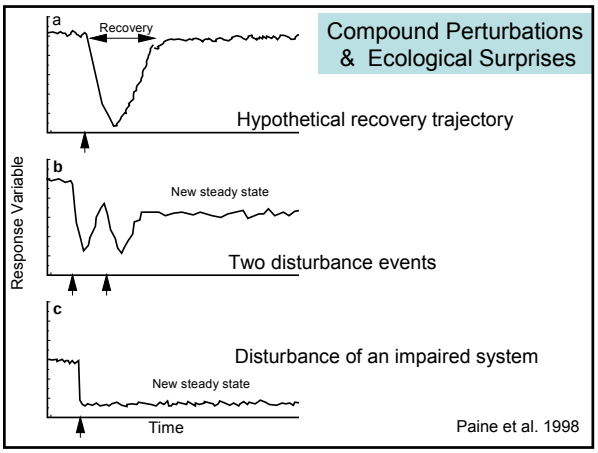
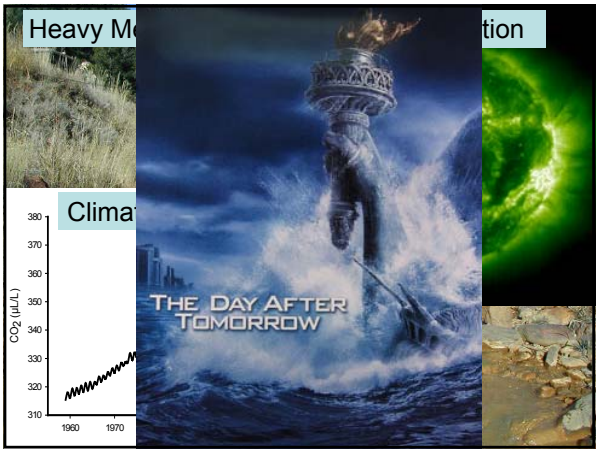
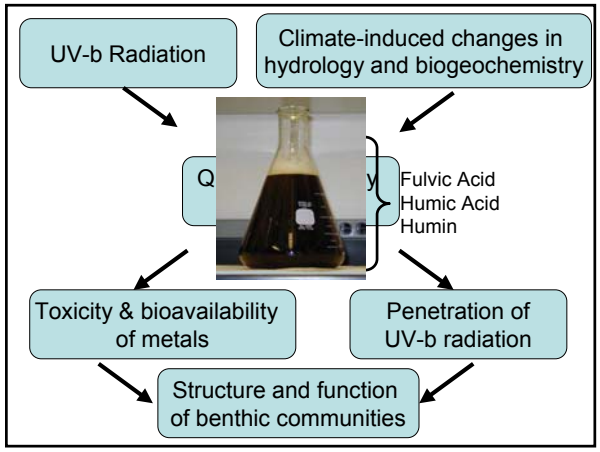






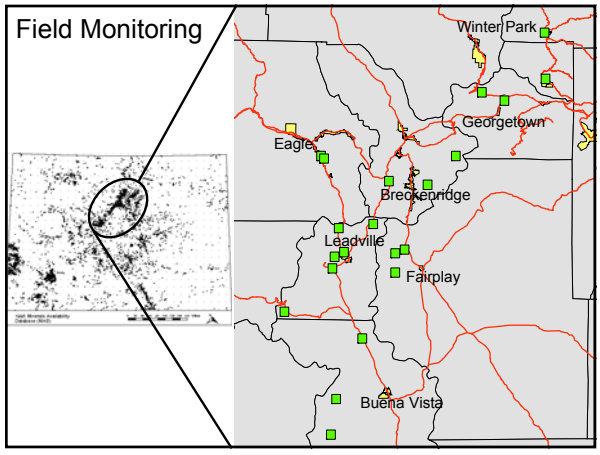
Field Monitoring

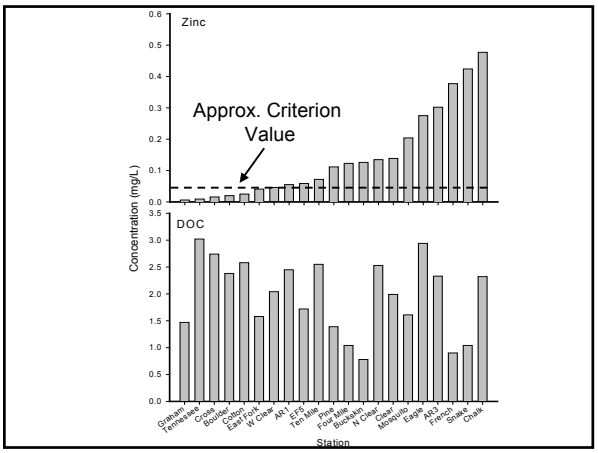
Spatiotemporal variation in physicochemical characteristics of 21 Colorado streams along a gradient of metal contamination

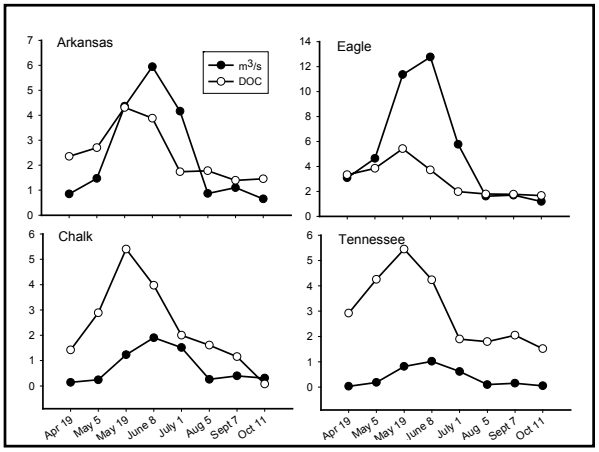
Assess the relationship between discharge and DOC quality/quantity

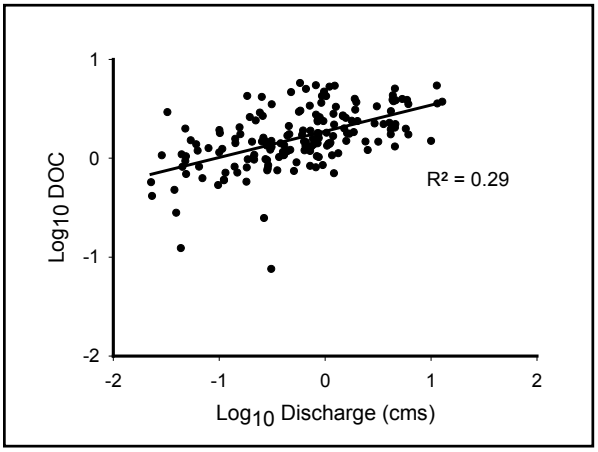
Characterize the influence of DOC on UV-b attenuation

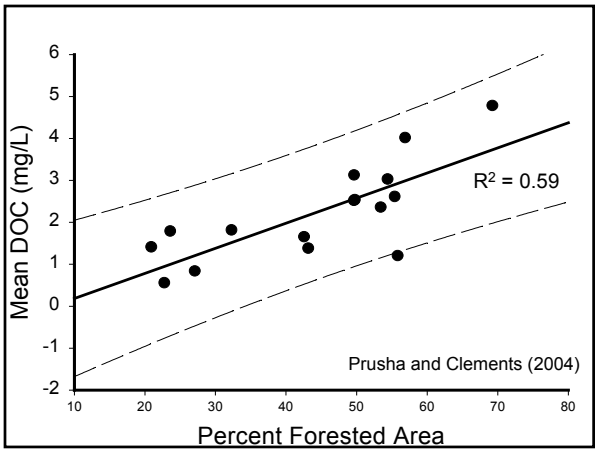
Measure effects of photobleaching on DOC quality/quantity

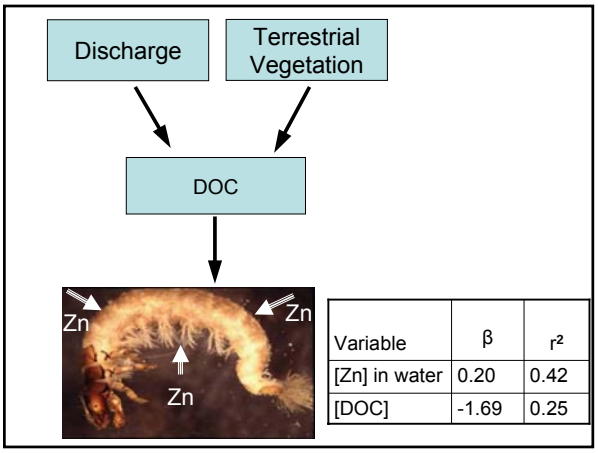






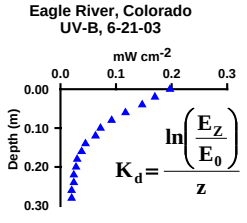


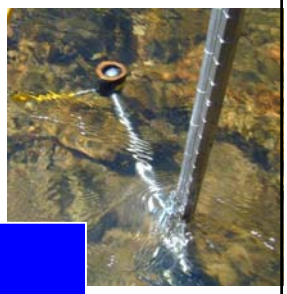




Variable	β	r²
[Zn] in water	0.20	0.42
[DOC]	-1.69	0.25

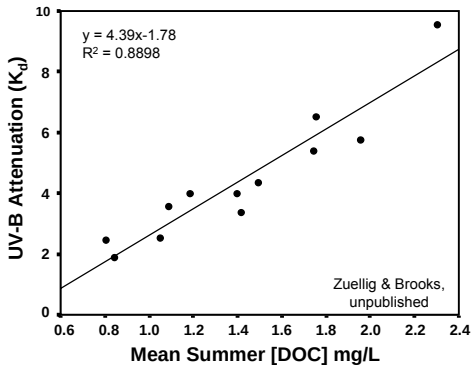
Vertical attenuation coefficients (K_d)





Where: z = depth
E_z = irradiance at depth
E_0 = irradiance at surface
K_d = vertical attenuation coefficient

DOC and UV-b Attenuation

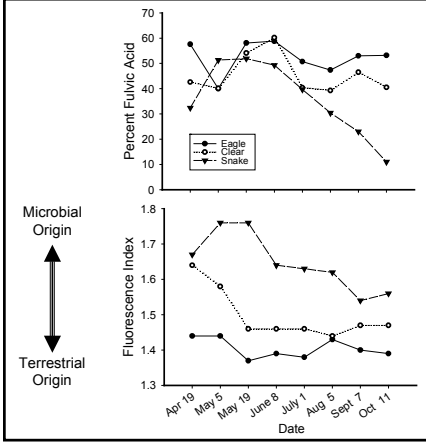


Spatiotemporal variation in DOM quality

Fractionation (XAD-8 resin) to determine quantity of fulvic acids

2-D fluorescence (Fluorescence Index) to determined source (ie., allochthonous vs. autochthonous

DOM Composition

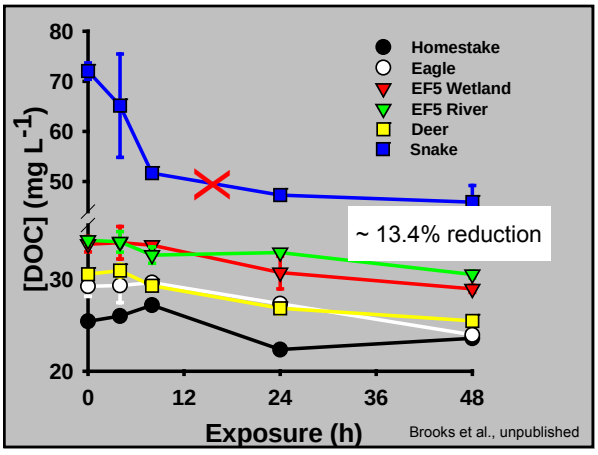


Appel & McKnight, unpublished

Photobleaching DOM

Concentrated with RO

Irradiated with Solar Simulator



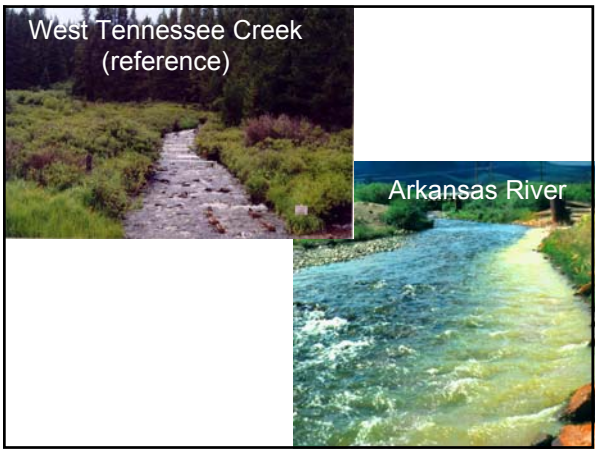
Microcosm Experiments

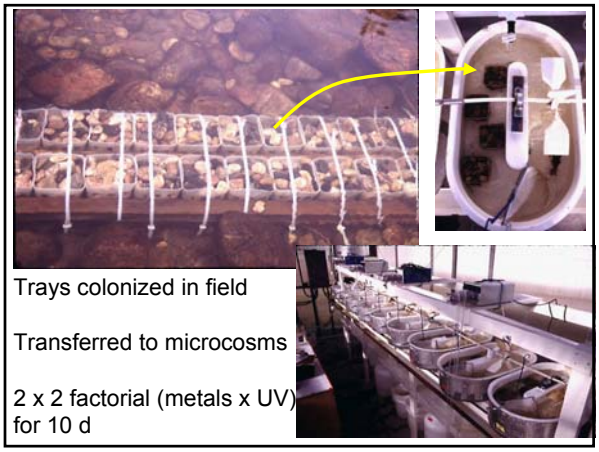
Assess effects of UV radiation and metals on benthic communities with different metal exposure histories

Hypotheses:

Effects of UV-B radiation + metals will be greater than either stressor alone

Effects of metals will be greater on naïve communities (ie., no prior metal exposure)

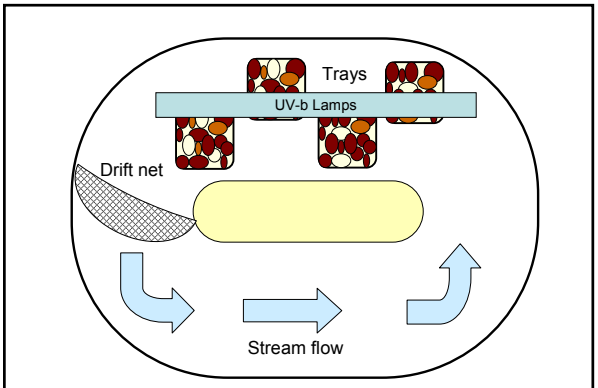




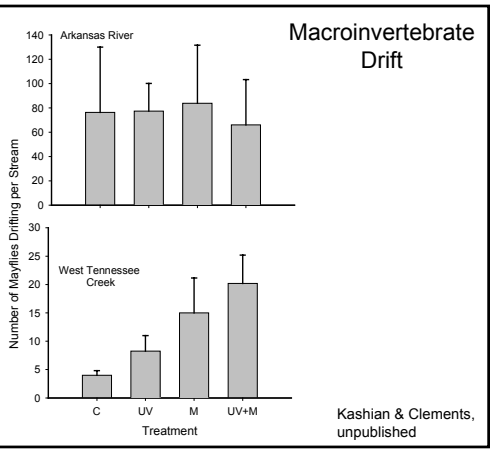
Trays colonized in field

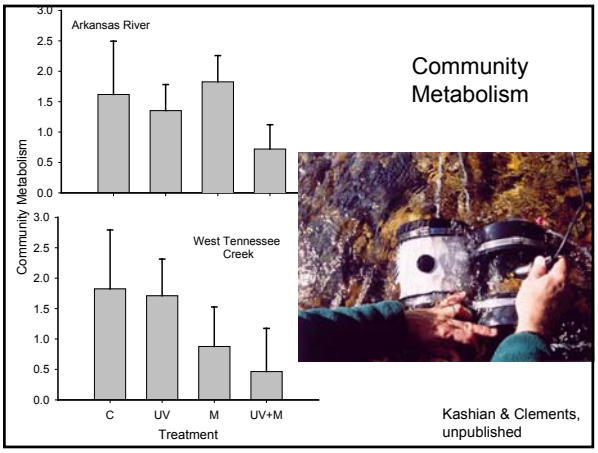
Transferred to microcosms

2 x 2 factorial (metals x UV) for 10 d



Measured drift, metabolism, community structure





Field Experiments

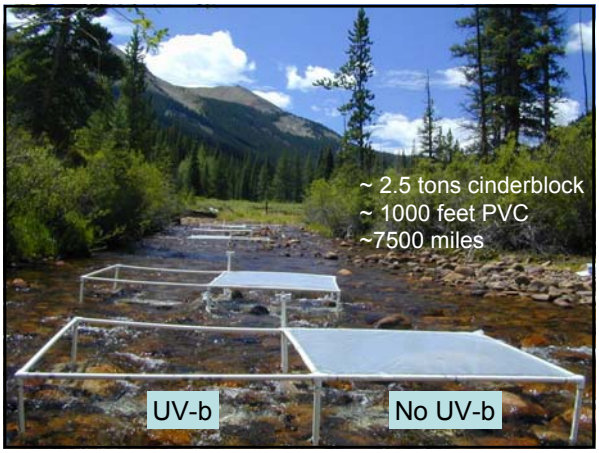
Hypothesis:

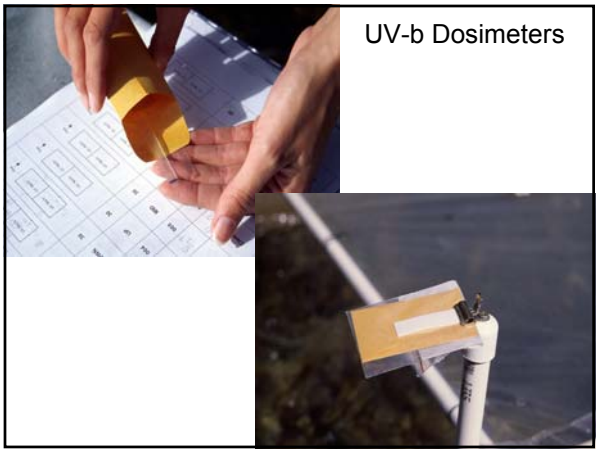
Benthic communities from metal-polluted streams are more susceptible to ambient UV-b radiation than those from unpolluted streams

Study Design

12 sites

- Split plot: UV-B excluded and ambient
- 60-day duration (July-September)
- Estimated UV-B exposure at stream bed
- Chlorophyll a and community structure

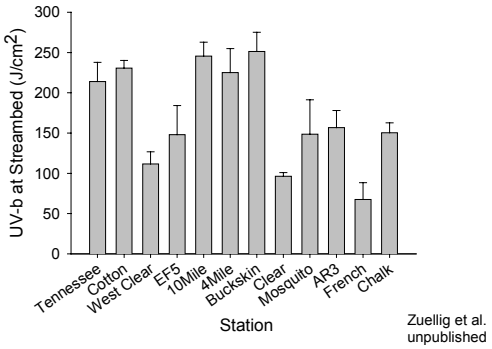




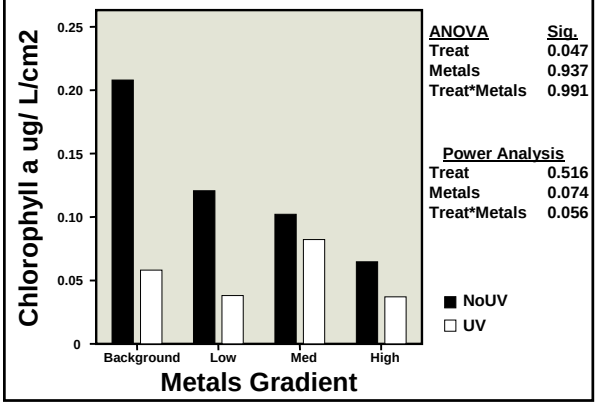
UV-B Quantification

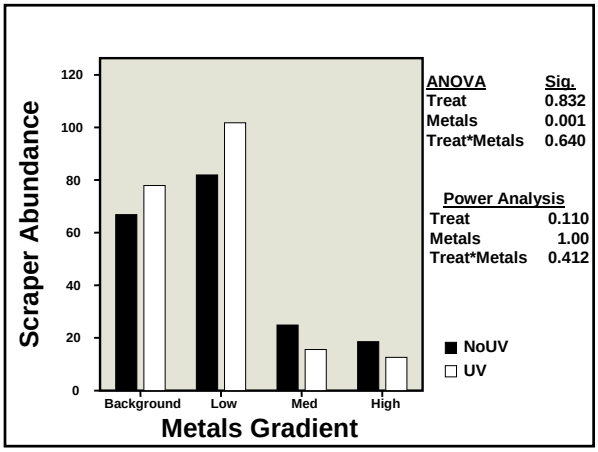
- Dosimeters replaced every 4 to 6 days
- Absorbance calibrated to UV-B exposure
- Measured depth, DOC, and K_d
- Estimated total UV-B exposure at streambed

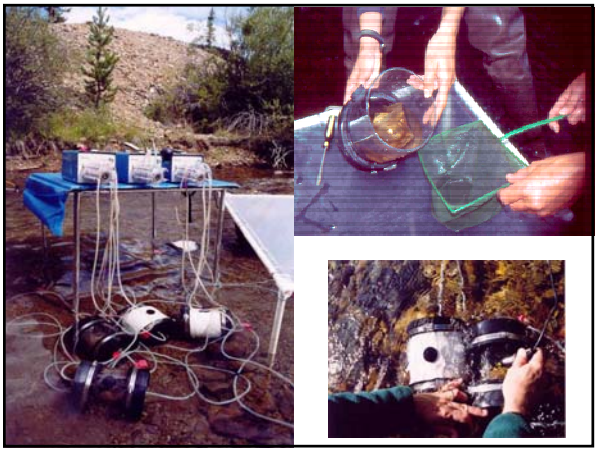
UV-B at the streambed

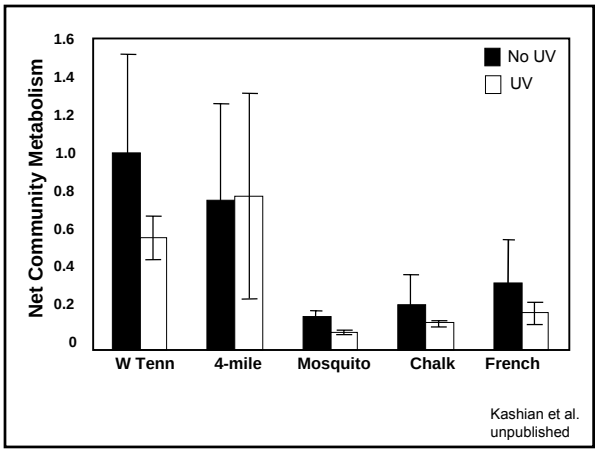


Zuellig et al. unpublished









Kashian et al. unpublished

Summary- Monitoring Results

- DOC increased with discharge & vegetation
- DOC strongly influenced UV-B attenuation
- Spatial and temporal variation in DOC quality
- Photobleaching reduced [DOC]

Summary- Microcosm Experiments

- Metal effects greater on communities with no history of metal exposure
- Drift in reference communities responded to UV-b and metals
- Effects of metals & UV-b greater than either stressor alone

Summary- Field Experiments

- Chlorophyll a increased when UV was eliminated at reference sites
- Macroinvertebrate response to UV was weak → low statistical power
- Community metabolism responded to both metals and UV-b

Implications

- Benthic communities in shallow, alpine streams exposed to intense UV-b
- Climate-induced changes in DOC are likely to increase UV-b exposure & metal bioavailability
- Potential for interaction between metals and UV-b in structuring benthic communities

Future Research

- Model relationship between climate change, stream hydrology and DOC
- Photodegradation of DOC and metal bioavailability
- Larger scale experiments to address statistical power