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PAH Removal, Fate and Transport in Stormwater Bioretention Systems Amended with Biochar and Fungi

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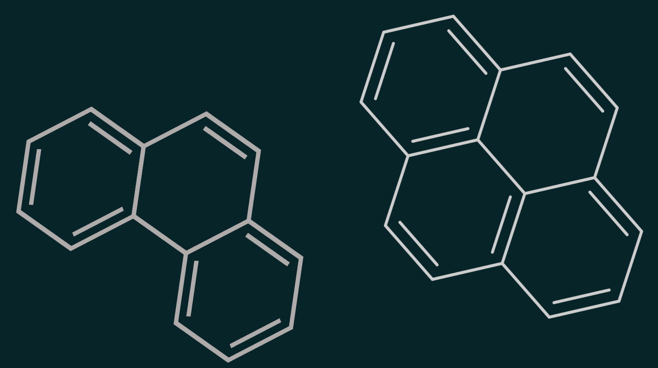
PAH Transport and Fate in Bioretention Amended with Biochar and Fungi



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INTRODUCTION

Current WDOE recommended stormwater BMPs do not address treatment of polycyclic aromatic hydrocarbons (PAHs). PAHs are ubiquitous in stormwater because of their release from vehicle emissions, petroleum leaks and tire particles. Many PAHs are known carcinogens and have harmful effects on humans and other organisms.

Reliable treatment PAHs in stormwater is needed for restoring the Puget Sound.

This study:

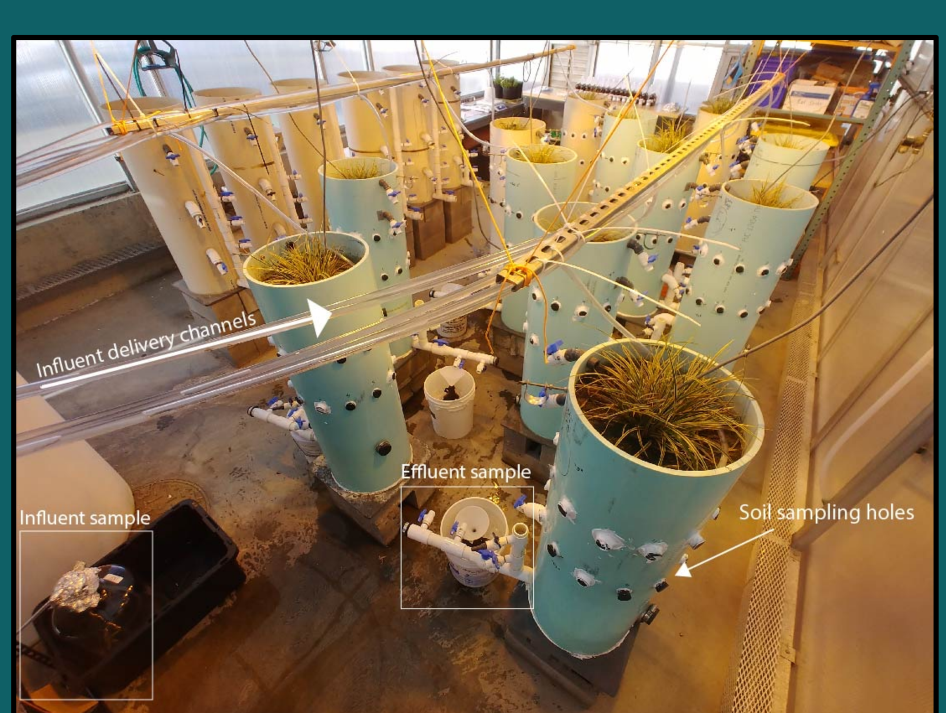
- Evaluate current and novel bioretention formulations for their treatment of PAHs.
- Novel amendments: **biochar** and **fungi.**
- Track PAH fate in bioretention media.

METHODS

- Dosed columns with highway runoff collected from I-5 in Tacoma, WA.
- 8 storms over 14 months.
- Measured 23 PAHs, TSS, and DOC in influent and effluent.

Table 1. Bioretention media mixtures used in study.

Treatments	n	Description
BSM	3	60% sand; 40% compost
BSM + biochar	3	60% sand; 20% compost; 20% biochar
BSM + fungi	3	60% sand; 40% compost; *Stropharia rugosoannulata*
BSM + biochar + fungi	3	60% sand; 20% compost; 20% biochar; *Stropharia rugosoannulata*



Fungi

Biochar

Bioretention columns in greenhouse at WSU Puyallup

RESULTS

1 Influent TSS vs. influent ∑PAHs

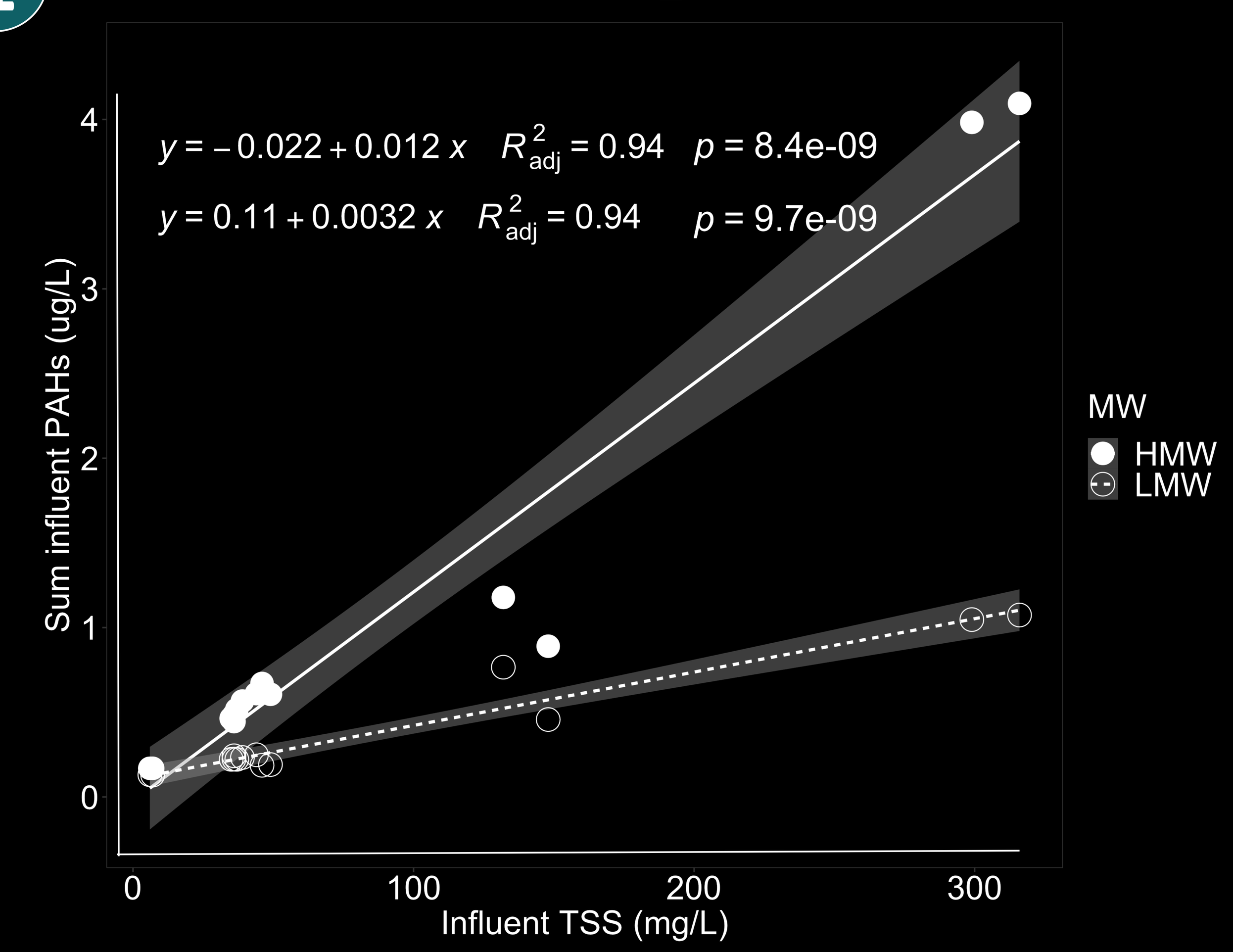


Figure 1. Correlation between influent TSS concentrations and influent PAH concentrations for high molecular weight (HMW, 4-6 rings) and low molecular weight (LMW, 2-3 rings) compounds.

2 PAH source fingerprinting - media

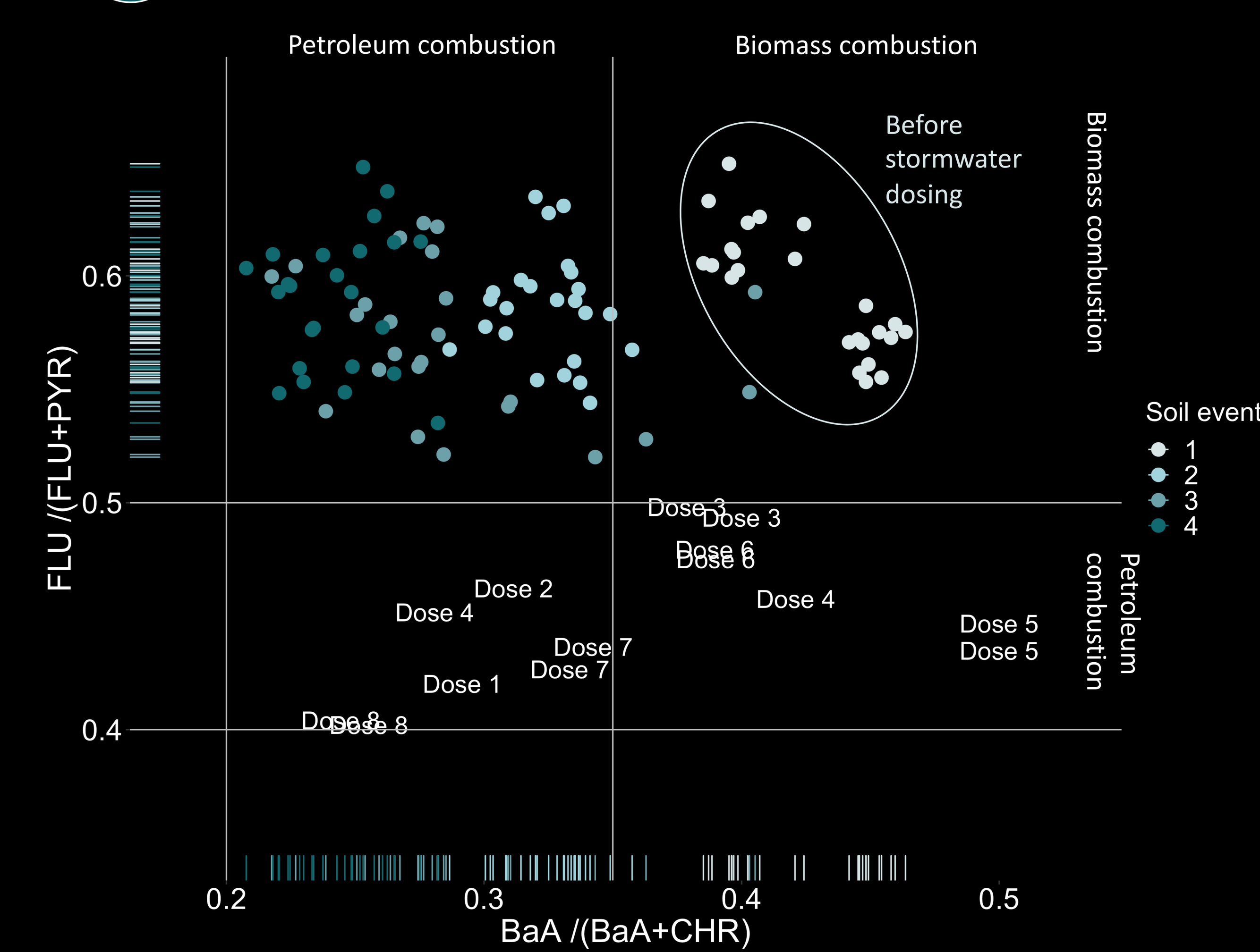


Figure 2. Diagnostic ratios of benzo(a)anthracene/chrysene and fluoranthene and pyrene for soil samples taken across 4 soil sampling events (points) and for influent samples across all dosing events (text). Duplicate influent samples are plotted.

3 ∑PAH mass balance

Mean ∑PAH removal
99.3% (sd 4.3%)
No difference between treatments

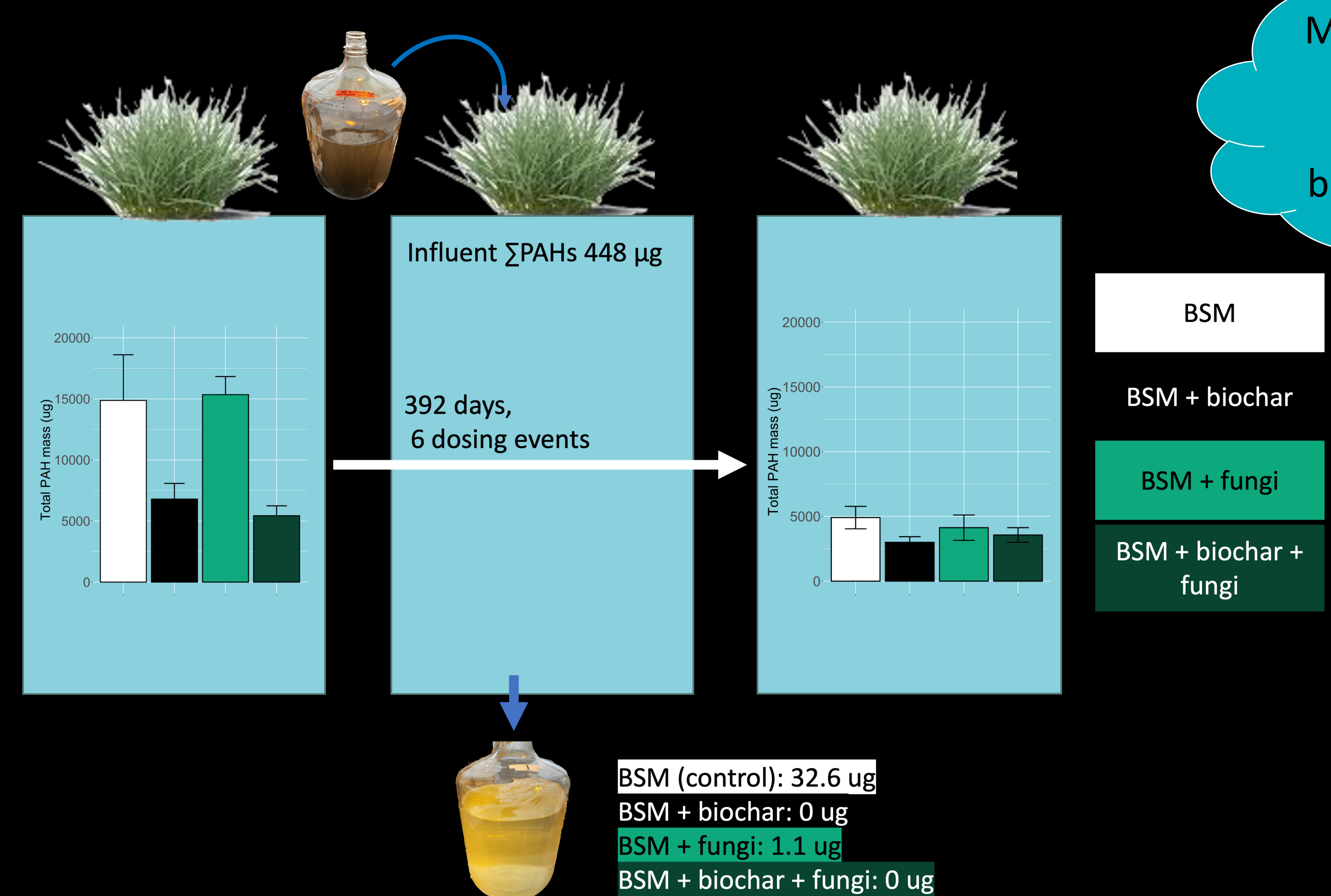


Figure 3. Mass balance of ∑PAHs calculate from PAH concentrations in influent, effluent, and bioretention media.

RESULTS

1. PAHs in runoff were highly correlated with TSS concentrations – especially high molecular weight (HMW) compounds.
2. Soil samples taken prior to stormwater dosing have a fingerprint indicative of biomass combustion.
   - Soil PAH fingerprints shifted towards petroleum combustion over time. This doesn't appear to be explained by the input of influent which had a fingerprint spanning the range of BaA/(BaA+CHR) values.
3. Influent ∑PAH concentrations were negligible compared with media concentrations.
   - Treatments with 20% compost and 20% biochar had half the initial ∑PAH concentrations of those with 40% compost.
   - ∑PAHs in media declined by 38-72% over 14 months.

CONCLUSIONS

- PAHs were transported by TSS in runoff.
- Biomass combustion is a potential source of the PAHs associated with compost.
- All mixes provided near complete ∑PAH removal.
- Stormwater ∑PAHs did not increase media concentrations.
- Compost was the primary source of PAHs in the media.
- Microbial degradation and/or plant uptake are likely responsible for the observed loss of PAHs in the media.
- Bioretention systems are likely to maintain PAH adsorption sites over time because of this in situ bioremediation.

ACKNOWLEDGMENTS

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