EFFECT OF MUSHROOM GROWTH ON RUNOFF OF NITRATES AND PHOSPHATES

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INTRODUCTION

Importance of Nitrogen and Phosphorus:

- Increasing agricultural demand supplemented by use of chemical fertilizers and animal[1]
    - Delivers excess nitrogen and phosphorus to the soil needed for plant growth
- Nitrogen[2]:
    - Constituent in the formation of chlorophyll
    - Amino acids used to create proteins for growth
    - Needed for cellular function, ATP production
    - Nucleic acids formation and plant germination
- Phosphate[1,3]:
    - Energy transformations of ATP, cellular function
    - Protein synthesis, strengthen stalk and facilitate root growth
    - Improves disease resistance and crop quality

Various Forms of Nitrogen and Phosphorus

- Exist naturally and artificially in soil
- Nitrogen:
    - Exists naturally in three general forms
        - Organic nitrogen compounds, ammonium ions, and nitrate
    - Nitrates are most readily available to plants and least resistant to runoff
        - Soluble form
- Phosphorus:
    - Exists in both organic and inorganic forms
    - The soluble forms of both organic and inorganic phosphorus are susceptible to runoff

Fungal Absorption of Nitrogen and Phosphorus:

- Mushroom have been seen to mobilize different forms of inorganic and organic phosphate
- Ectomycorrhizal genera is most effective for phosphate absorption
- *Pleurotus ostreatus* had the highest rate of nitrogen absorption

Experiment Background

- How does presence of mushrooms affect nitrate and phosphate absorption from runoff
- How does rainfall intensity affect the runoff concentrations of nitrates and phosphates

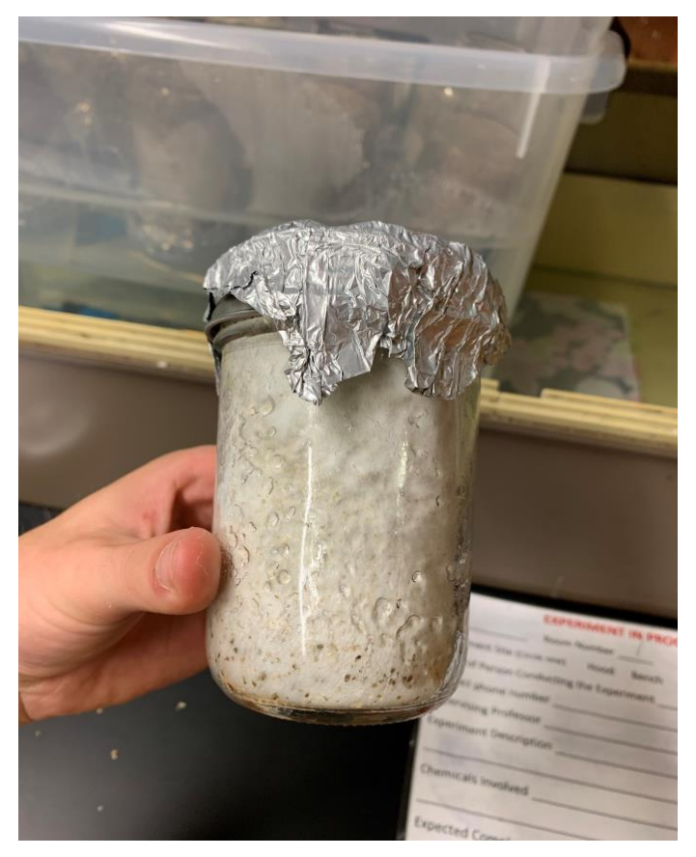
METHODS

Experimental Design:

- Independent variables
    - Spiked Concentrations of nitrate and phosphate in experimental flow
        - 1, 2.5, 5, 7.5, and 10 parts per million
    - Presence of *Pleurotus ostreatus* within soil sets
    - Simulated rainfall intensity
        - Low Flow or High Flow
            - 160mL per 15 minutes for an hour
            - 450mL per 15 minutes for an hour
- Dependent variables:
    - Concentration of nitrate and phosphate in runoff

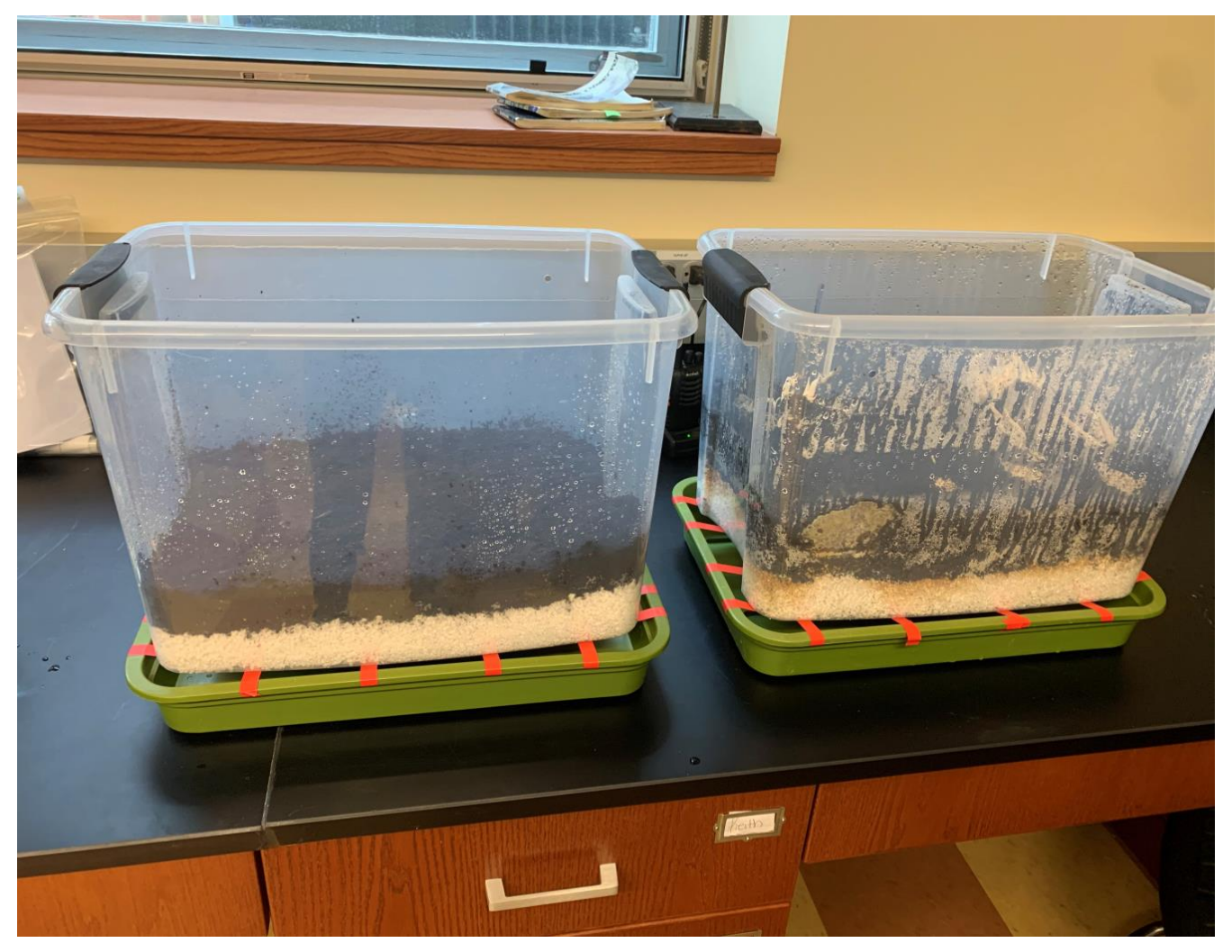
Growing Phase:

- Substrate jar inoculation
    - Sterilization
- Monitored growth in controlled environment
    - 78 degrees Fahrenheit; above 95% humidity
- Dunking to rehydrate the fungal cakes



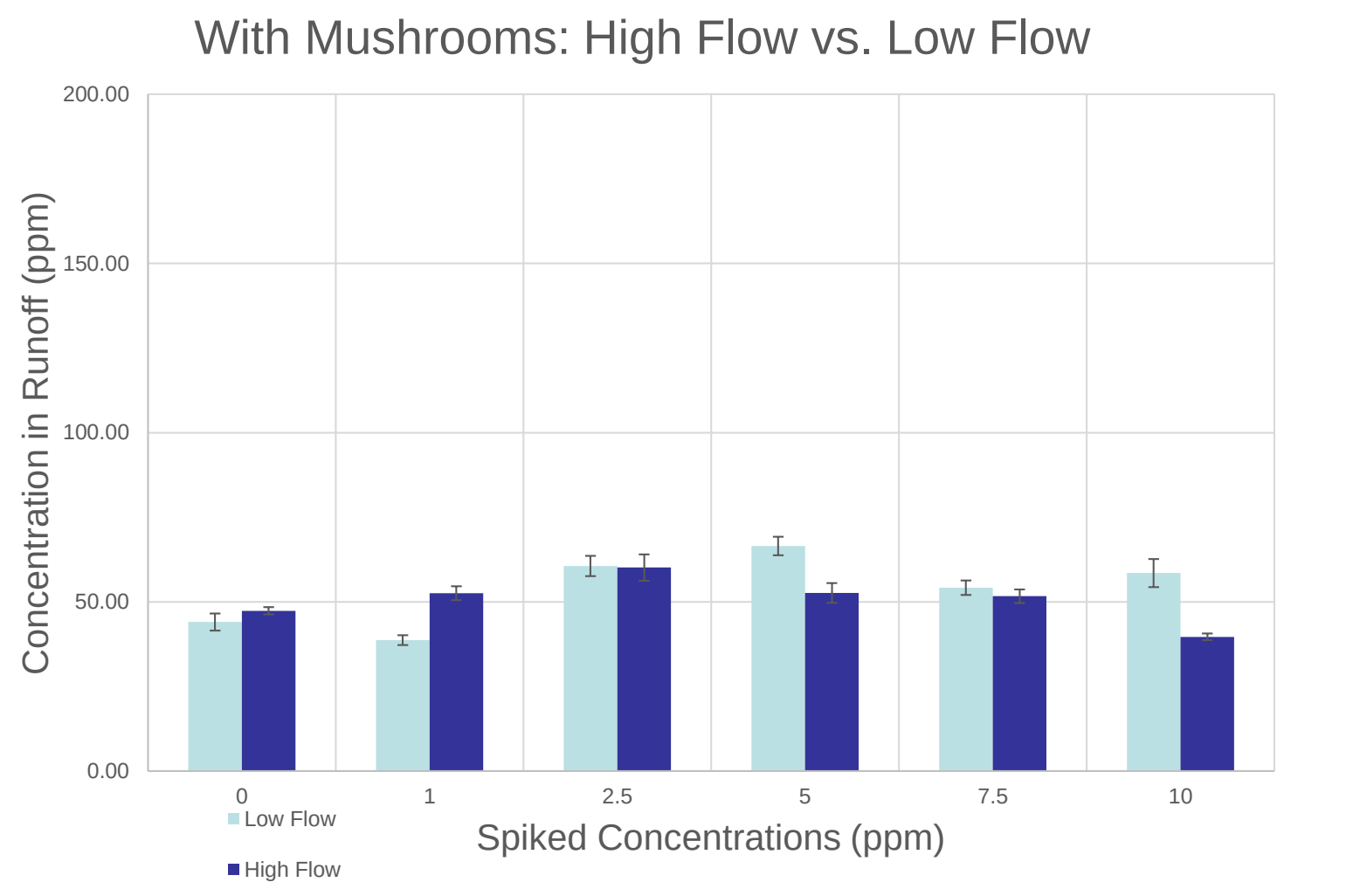
Sample Collection:

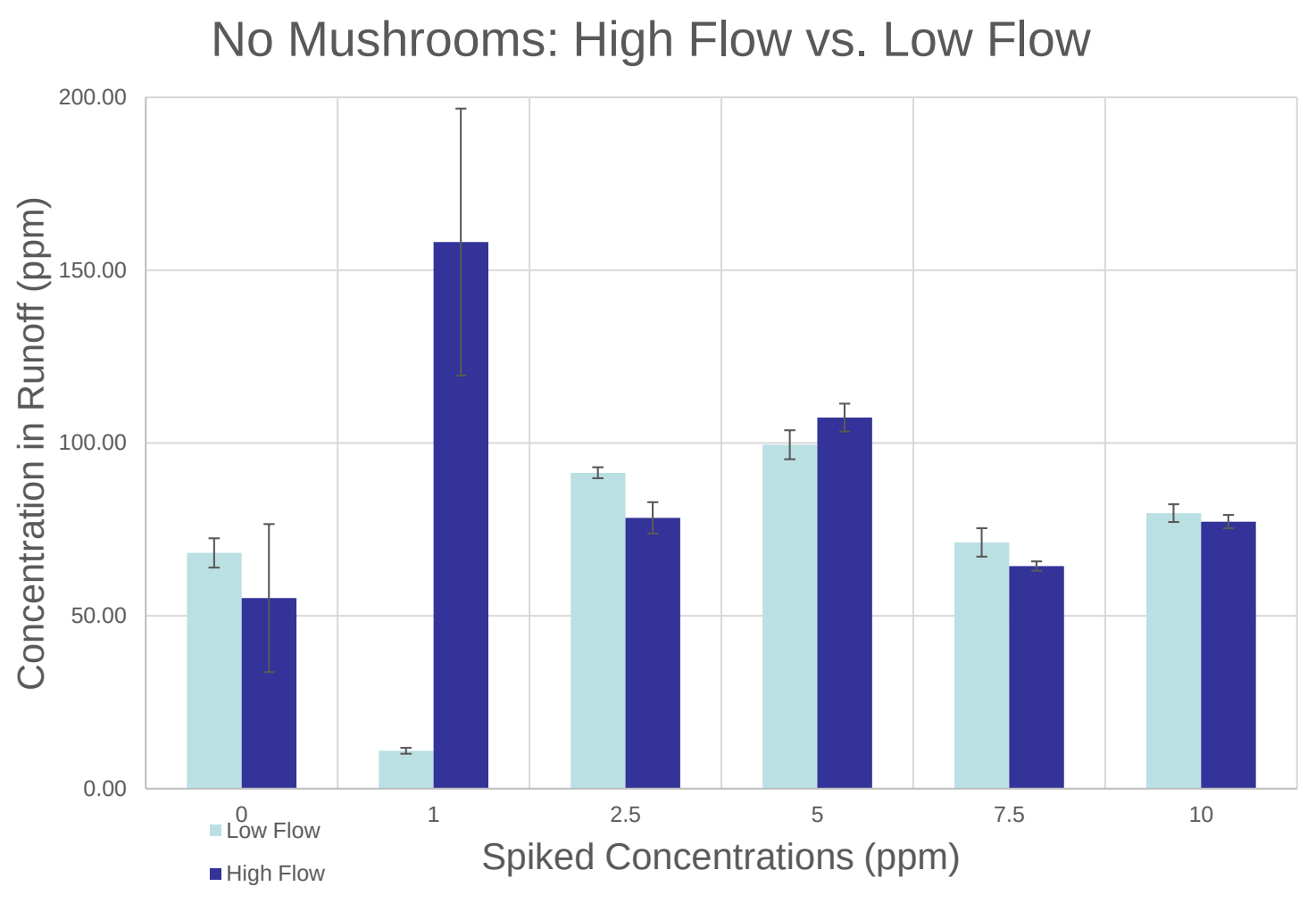
- Control set – soil with no mushrooms
- Experimental set – soil with mushrooms
    - Both sets of soil were treated with each spiked concentration at both flow rates
        - 450mL of 160mL added for every 15 minutes for a total of 1 hour
    - After the soil sets were treated, 3 runoff sample replicates taken, filtered using a 250 micrometer



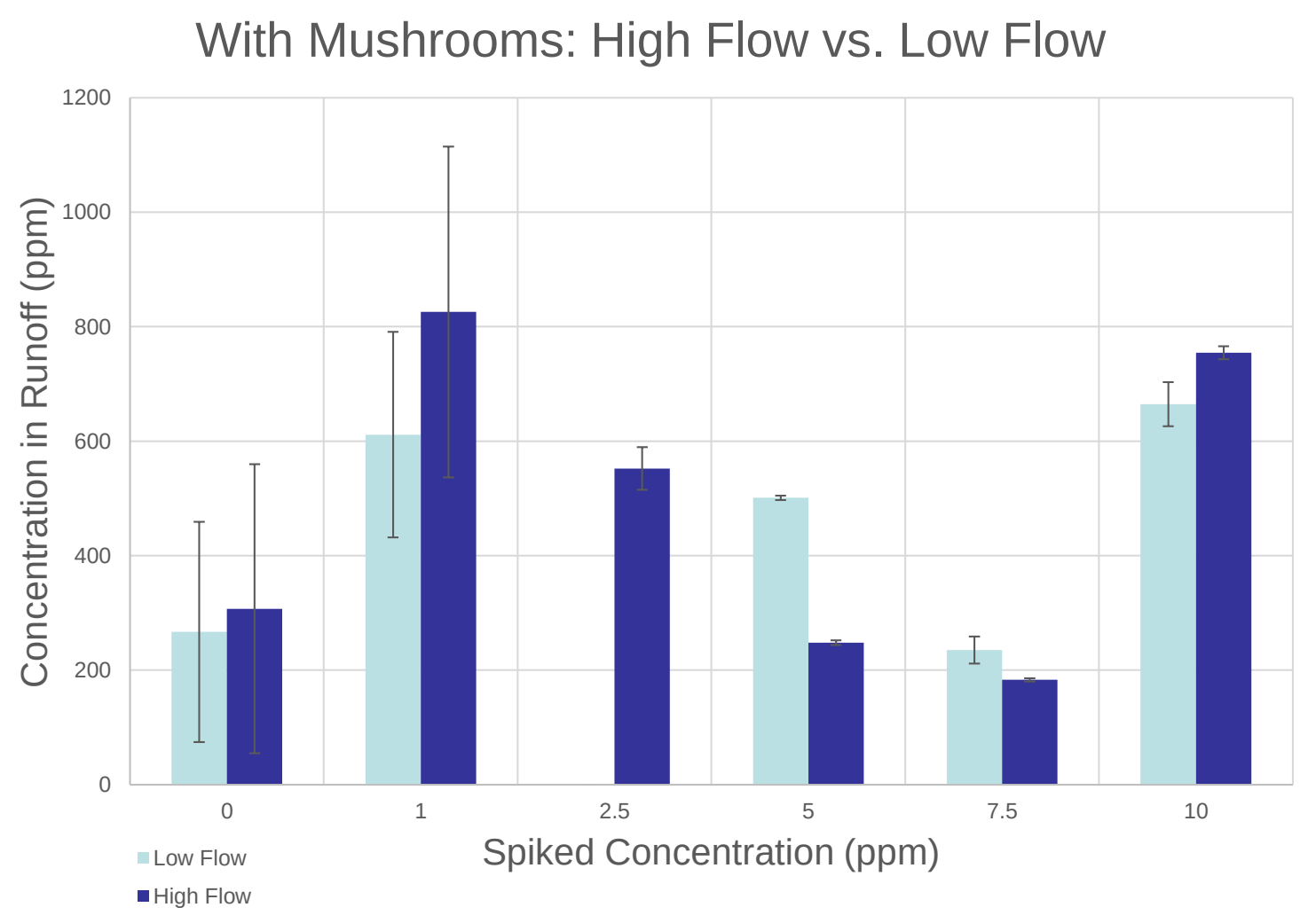
RESULTS

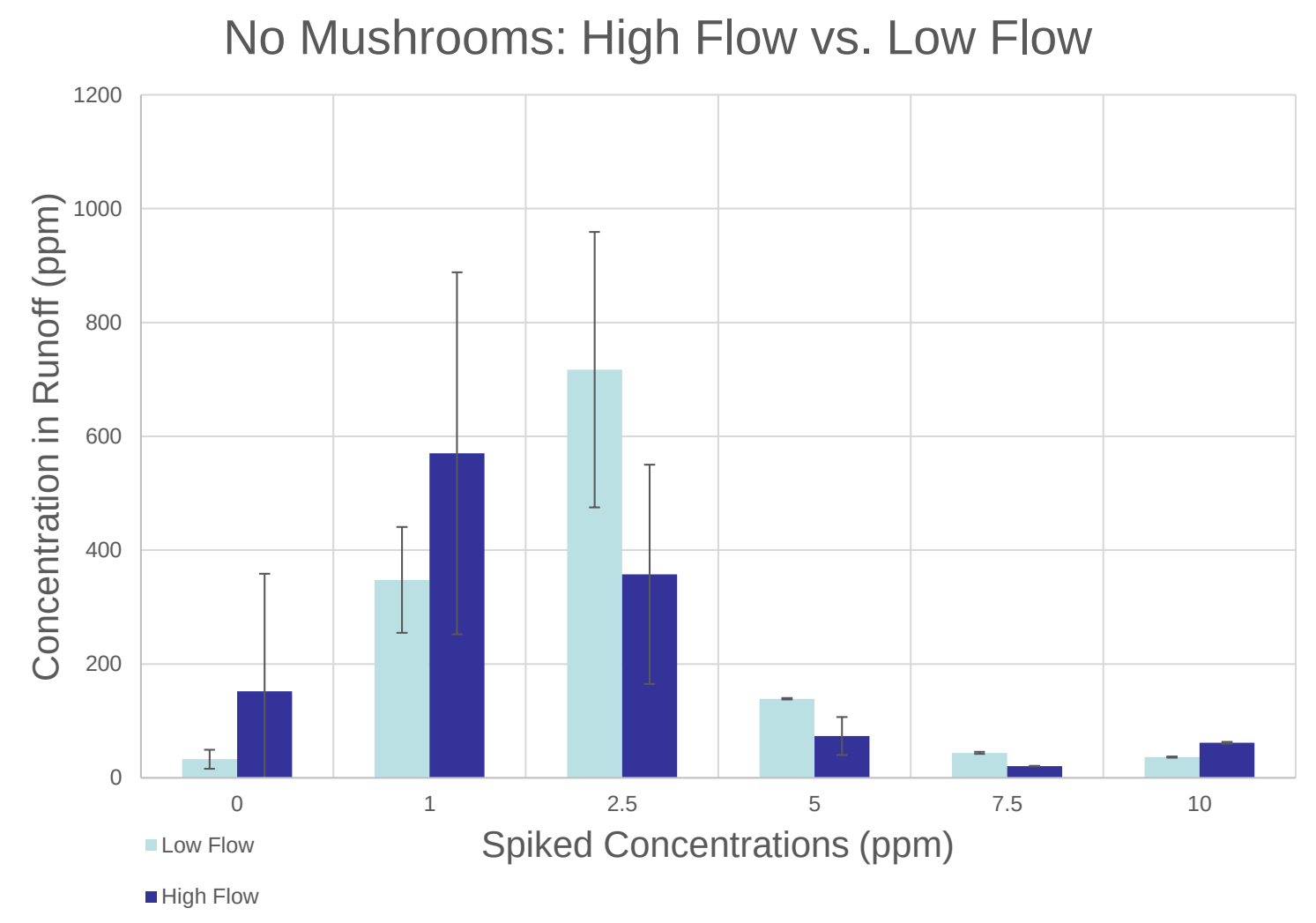
Phosphate Data





Nitrate Data





T-test Results

Phosphates		Nitrates	
Experiment	**P-value**	**Experiment**	**P-value**
Low Flow: Mushrooms vs. Control	0.25	Low Flow: Mushrooms vs. Control	0.32
High Flow: Mushrooms vs. Control	0.03	High Flow: Mushrooms vs. Control	0.08
Mushrooms: Low Flow vs. High Flow	0.56	Mushrooms: Low Flow vs. High Flow	0.53
Control: Low Flow vs. High Flow	0.34	Control: Low Flow vs. High Flow	0.33
Percent Runoff: High Flow	0.09	Percent Runoff: High Flow	0.77
Percent Runoff: Low Flow	0.47	Percent Runoff: Low Flow	0.16

CONCLUSION

- Nitrate data was very inconsistent with very high relative standard deviations
    - This correlates to how nitrate reacts within soil
- There are no graphical trends represented in the data
    - Experimental soil sets seem to have lower concentrations for phosphate at low flow
- Phosphate runoff at high flow showed a statistically lower concentration in runoff when compared to control
        - With a 95% confidence interval
    - This was the only scenario that showed a statistical difference with the control

BIBLIOGRAPHY

Cohen Y, R., et al. “Biotechnological Applications and Potential of Wood-Degrading Mushrooms of the Genus Pleurotus.” Applied Microbiology and Biotechnology, vol. 58, no. 5, 2002, pp. 582–594., doi:10.1007/s00253-002-0930-y.

Daniel, T. C., et al. “Agricultural Phosphorus and Eutrophication: A Symposium Overview.” Journal of Environmental Quality, vol. 27, no. 2, 1998, pp. 251–257., doi:10.2134/jeq1998.00472425002700020002x.

Dass, S. B., et al. “Extracellular Proteases Produced by the Wood-Degrading Fungus Phanerochaete Chrysosporium under Ligninolytic and Non-Ligninolytic Conditions.” Archives of Microbiology, vol. 163, no. 4, 1995, pp. 254–258., doi:10.1007/s002030050201.

Gregory, Stanley V., et al. “An Ecosystem Perspective of Riparian Zones.” BioScience, vol. 41, no. 8, 1991, pp. 540–551., doi:10.2307/1311607.

Hill, Alan R. “Nitrate Removal in Stream Riparian Zones.” Journal of Environmental Quality, vol. 25, no. 4, 1996, pp. 743–755., doi:10.2134/jeq1996.00472425002500040014x.

Marco-Urrea, Ernest, et al. “Potential of Non-Ligninolytic Fungi in Bioremediation of Chlorinated and Polycyclic Aromatic Hydrocarbons.” New Biotechnology, vol. 32, no. 6, 5 Jan. 2015, pp. 620–628., doi:10.1016/j.nbt.2015.01.005.

Smolders, Alfons J. P., et al. “How Nitrate Leaching from Agricultural Lands Provokes Phosphate Eutrophication in Groundwater Fed Wetlands: the Sulphur Bridge.” Biogeochemistry, vol. 98, no. 1-3, 2009, pp. 1–7., doi:10.1007/s10533-009-9387-8.