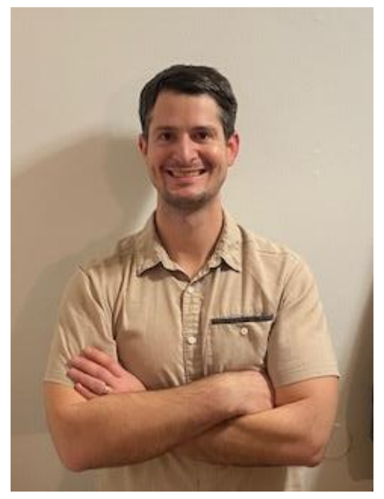
Assessing Performance at an Urban Stormwater Constructed Wetland

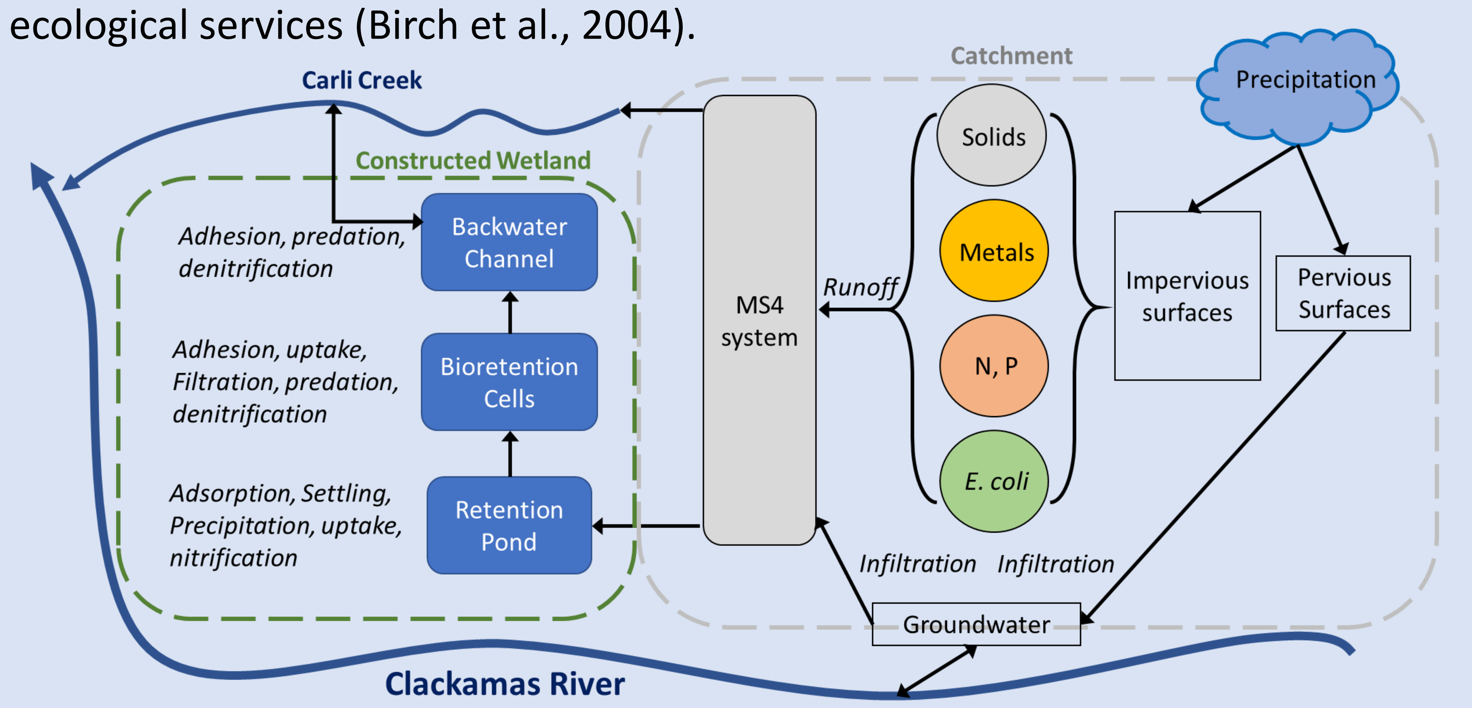


Chris Desiderati, Dr. Yangdong Pan[1], Dr. Eugene Foster[2], and Ron Wierenga[3]

[1]Department of Environmental Science and Management, Portland State University, [2]Oregon Department of Environmental Quality, [3]Clackamas Water Environment Services

Introduction

- **Urban stormwater** negatively impacts local ecosystems via increased runoff and pollutant transport, causing degraded habitat, altered biotic communities, and impairment of beneficial uses (NAP, 2009).
- **The Regional Carli Creek Water Quality (WQ) Treatment facility** is a $3.5 M, three-phase project, completed in Fall 2018, which in part treats stormwater runoff from over 400 acres of a highly impervious (~90%) industrial catchment in Clackamas, OR (1:243 wetland:catchment area ratio).
- Part of the project was the installation of a constructed wetland on a former farm field designed to mitigate development, create habitat, and **improve the water quality** of stormwater discharged to Carli Creek through the county-owned Municipal Separate Storm Sewer System (MS4).
- **Constructed Wetlands (CW)**, as examples of green infrastructure, are man-made, solar-powered water treatment systems that combine biological, chemical, and physical mechanisms for improving water quality while providing additional ecological services (Birch et al., 2004).



Conceptual Model of physical, chemical, and biological processes occurring at the CW, including potential drivers of pollutant concentrations.

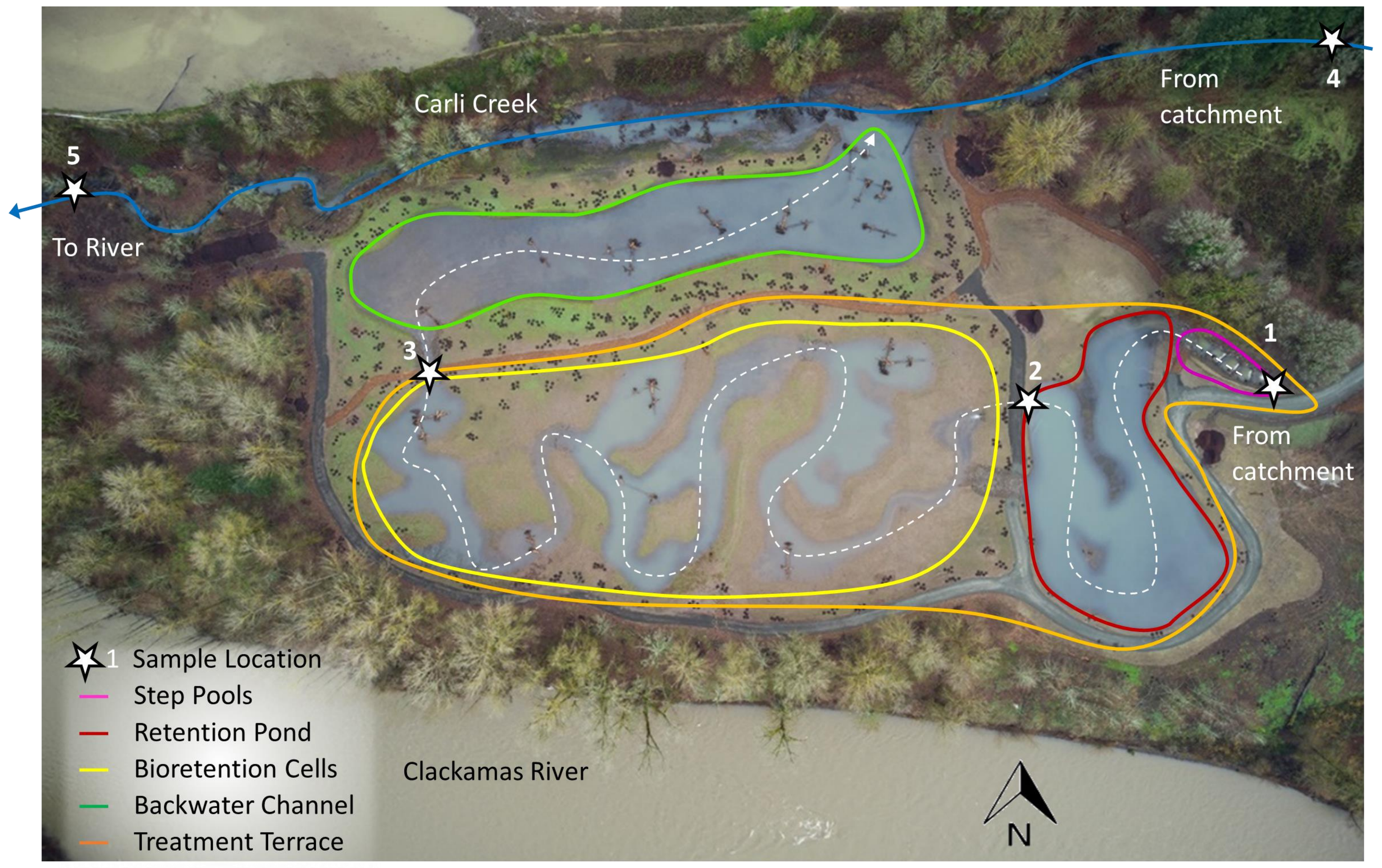
Research Question

Is the constructed wetland **reducing pollutant concentrations**?

Methods and Study Design

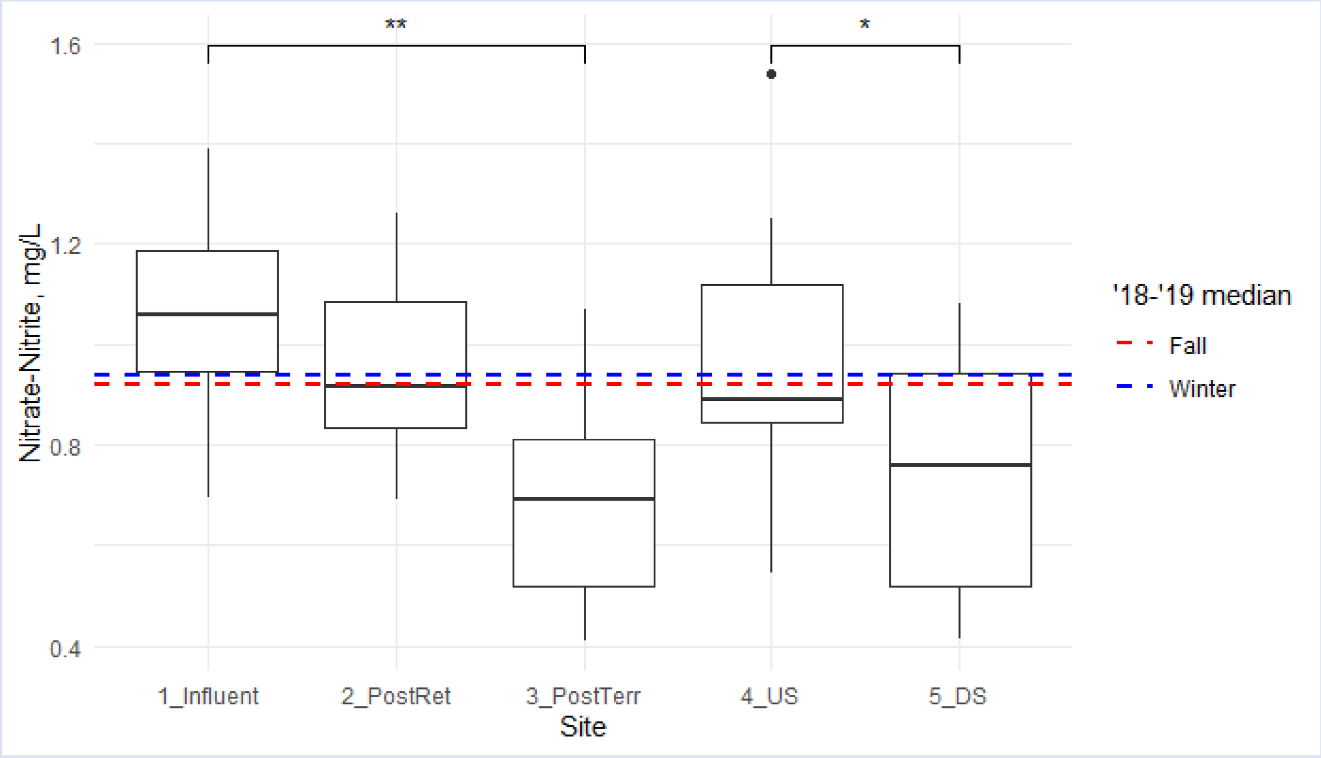
- Stage-discharge curves or area-velocity sensors were installed for flow measurement at open channel and piped sites, respectively.
- WQ parameters were collected as either 24-hour time-composites or grabs and measured in accordance with 40 CFR 136.
- In year 3 Fall/Winter, a total of 7 events (of 14 planned) were sampled concurrently at the 5 sites, spaced ~2 weeks apart.
- Paired t-test or Wilcoxon Signed rank tests were used to determine significant reductions (Terrace: Sites 1–3; Creek: Sites 4–5) at the project.

Site 3 showing solar panel, data logger enclosure, sampler, and sensor infrastructure.

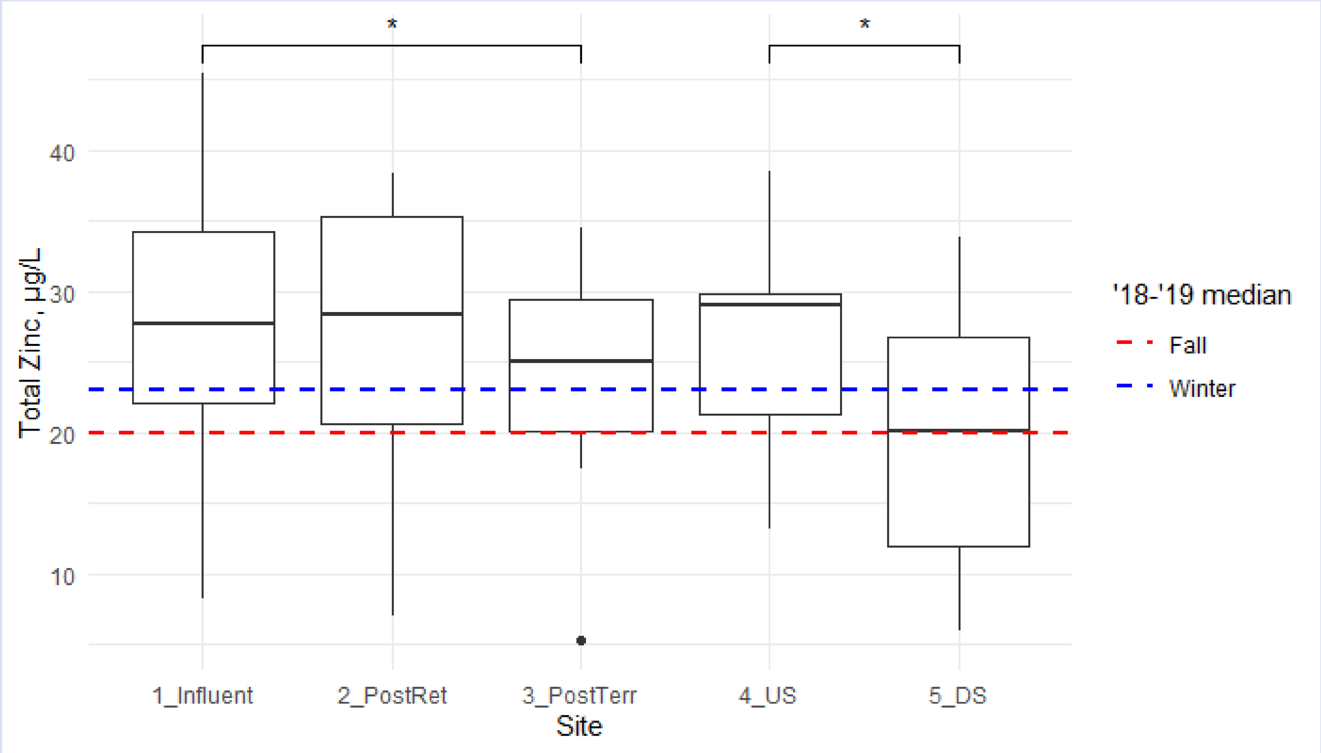


Aerial view of the constructed wetland facility, with adjacent Carli Creek and Clackamas River. Flow direction indicated with arrows.

Results



Significantly lower *(α = 0.05) Nitrate-Nitrite concentration in the treatment terrace (t = 4.54, ** p < 0.01) and between the UpStream and DownStream sites (t = 2.00, * p < 0.05). Prior seasonal WQ characteristics of untreated catchment runoff shown in red and blue dashed lines.*



Significantly lower *(α=0.05) Total Zinc concentration in the treatment terrace (t = 2.11, * p < 0.05) and between the UpStream and DownStream sites (t = 2.35, * p < 0.05). Prior seasonal WQ characteristics of untreated catchment runoff shown in red and blue dashed lines.*

Results

*Difference in medians across the Terrace (S1 – S3, n=7) and across the creek (S5 – S4, n=7) for different parameters collected as 24-hr composite samples. Negative values imply concentration increases. *E. coli collected as grabs.*

Parameters	Units	Difference in Median across Terrace (S1 – S3)	Difference in Medians across Creek (S4 – S5)
Nitrate-Nitrite	mg N/L	0.37	0.13
Total Phosphorous	mg P/L	-0.001	-0.020
Total Copper Dissolved Copper	µg/L	0.19 -0.07	0.35 0.04
Total Lead Dissolved Lead	µg/L	-0.058 0	0.052 0.007
Total Zinc Dissolved Zinc	µg/L	2.7 -0.6	8.9 4.3
Total Solids, mg/L	mg/L	23	-2
*E. coli**	MPN/ 100 mL	72	26

Discussion

- As a somewhat biologically young wetland, early results suggest the wetland terrace is **moderately effective at removing nitrate-nitrite, solids, total Zinc, and *E. coli*** in stormwater runoff, but not dissolved parameters or Total Phosphorous.
- Pending mass reduction analysis may show infiltration plays a WQ-improvement role.
- In Nillson et. al (2020), CWs with emergent plants receiving N-laden groundwater were shown to reduce N early and **sustain high reductions long-term, regardless of plant type,** after "maturity" (7.5-12 yrs), suggesting promising early results here.
- While field work is ongoing, **limitations** of this study design include absence of WQ treatment effectiveness in the growing season, limiting applicability of these findings to wet-season performance.

Riverbank lupine (lupinus rivularis) blooms on treatment terrace, summer year 2

Future Work

- Continue field work (WQ and Flow collection data) to answer other two research questions:
  1) Is there a relationship between green infrastructure performance metrics **(EMC % reduction and mass loading reduction) and climate and River-discharge predictor variables**?
  2) Can a deployed turbidity sensor at the treatment terrace outlet be used to **model the relationship with WQ predictor variables** for potential use as a proxy for performance in the future?
- Develop **wetland management recommendations** to improve or maintain pollution reduction performance.

Acknowledgments

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