SPATIAL ASSESSMENT OF NITRATE IN THE STORMWATER ECOLOGICAL ENHANCEMENT PROJECT

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Introduction

The Stormwater Ecological Enhancement Project (SEEP) is an ecologically enhanced 3-acre retention pond in UF's Natural Area Teaching Laboratory that treats stormwater from a 39.75-acre watershed[1]. The basin directly drains cultural and academic buildings, parking lots, and athletic fields through a system of campus wide storm drains (Figure 1). These diverse inputs require the SEEP to treat pollution in the form of nutrients, metals, and sediment to improve water quality before recharging the Floridan Aquifer.

Nitrate is a nutrient of concern in the SEEP wetland as nitrate concentrations above background levels can cause a shift in the established vegetative community, algal blooms, and hypoxia. In 1998, the former retention basin was recontoured to enhance species diversity and improve water quality. At the northern end, the entering stormwater (expected to be high in nutrients and heavy metals) is temporarily impounded to allow treatment (Cell 1, Figure 2). The water is slowly released through a hydrologic control structure (in this case a weir) into a shallow open water marsh for further treatment (Cell 2, Figure 2). Lastly, the water reaches two deep-water ponds (Cell 2, Figure 2) before slowly exiting the SEEP by recharging groundwater[1].

This report assesses the spatial variability of nitrate in the SEEP basin: inputs from stormwater drains and treatment within the wetland. To measure nitrate concentrations

across the basin instantaneously during base flow and storm flow conditions, an optical nitrate sensor was used. The Submersible Ultraviolet Nitrate Analyzer or SUNA (Satlantic Inc., Halifax, NS, Canada) is a chemical free method of measuring nitrate in situ in real time. The benefit of these sensors over traditional sampling methods is the high spatial and temporal resolution of nitrate variability capable of being measured.

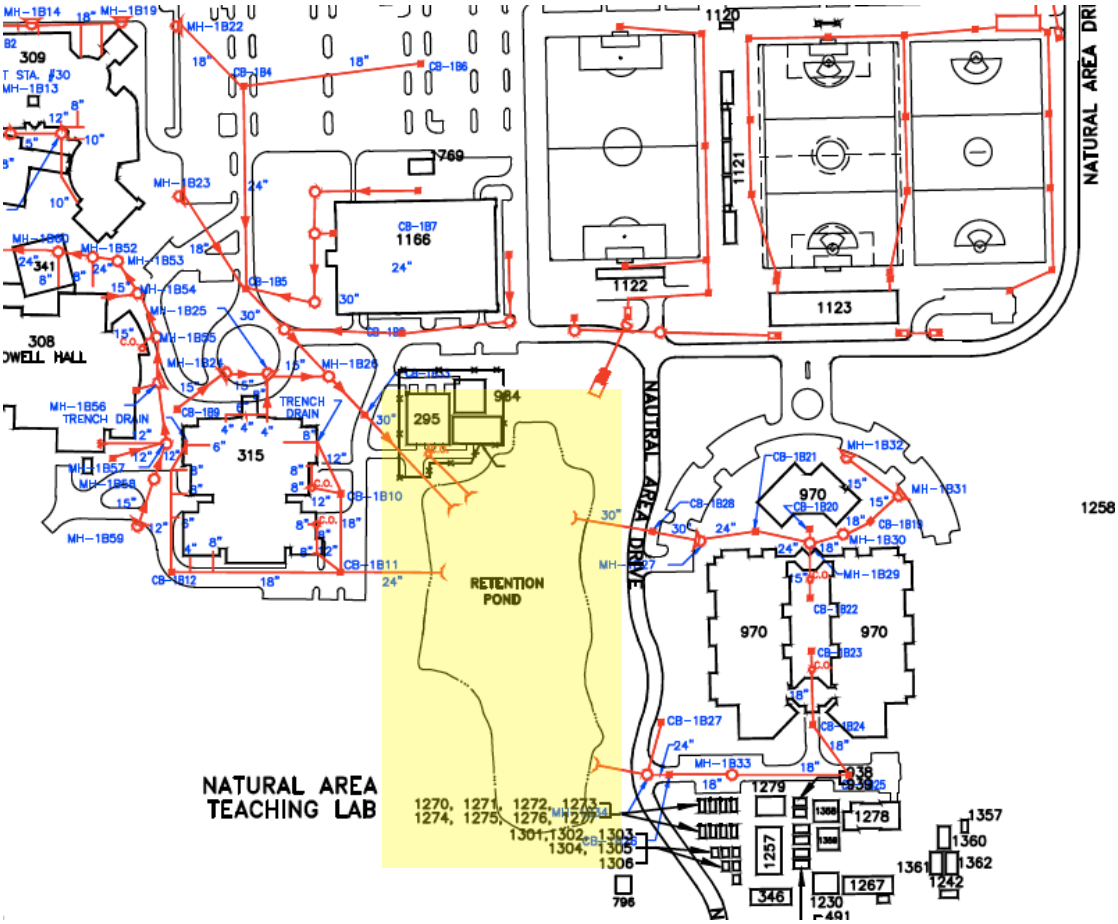

Figure 1: Storm drainage inputs for the Stormwater Ecological Enhancement Project

Materials and Methods

Nitrate was measured at eight locations in the SEEP with a SUNA (Satlantic Inc., Halifax, NS, Canada) on three separate events, August 15, 2013, August 16, 2013, and October 13, 2013. Four locations were monitored in Cell 1, three were positioned at the

discharge of storm drains and one was positioned on the upstream side of the weir. Two locations were monitored in Cell 2, one on the downstream side of the weir and one at the discharge point of the southern most storm drain. Two locations were monitored in Cell 3, one in each deep-water pond (Figure 2).

The SUNA was operated in continuous mode, measuring for three minutes at each location. The reported nitrate concentration is an averaged value from the continuous reading output.

Daily precipitation measurements were obtained for Alachua from the Florida Automated Weather Network[2] (University of Florida Institute of Food and Agricultural Sciences) to quantify base flow and storm flow conditions.

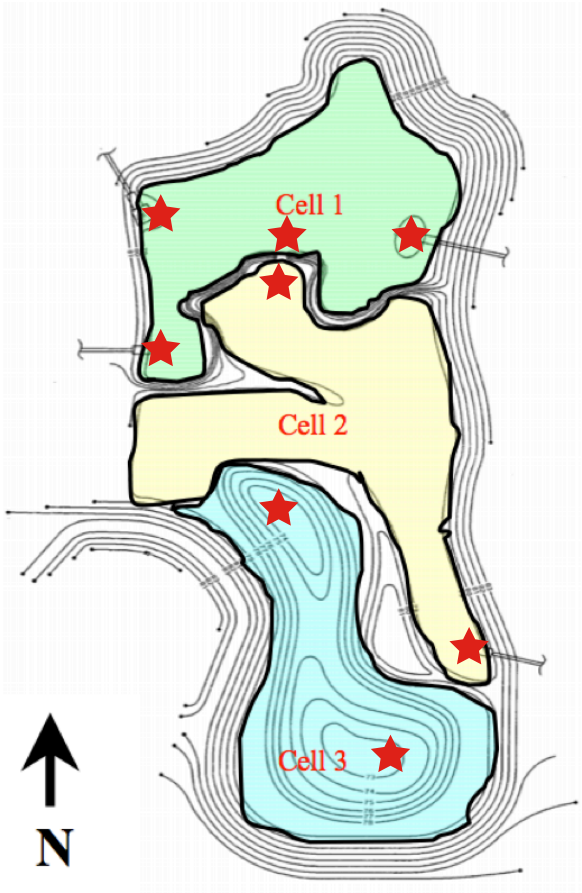

Figure 2. Locations of nitrate measurements (8) in the SEEP wetland

Results and Discussion

Nitrate was measured in the SEEP on August 15, 2013 to mirror base flow conditions (6 previous days had a cumulative precipitation of 0.05 inches). Nitrate was then remeasured on August 16, 2013 to demonstrate flow conditions post storm event (0.43 inches of precipitation from a 1 hour storm event). Due to the dynamic nature of storm events and flows during the summer, nitrate was measured on October 13, 2013 (when the last storm event was 6 days prior) to demonstrate a variety of conditions (Table 1).

Table 1. Summary of storm events for sampling dates (UF IFAS FAWN *fawn.ifas.ufl.edu*)

Sampling Date	Number of Events	Timeframe	Cumulative Precipitation
August 15, 2013	3	Previous 6 days	0.05 inches
August 16, 2013	1	Previous 1 day	0.43 inches
October 13, 2013	0	Previous 5 days	0.00 inches

Nitrate measurements across the SEEP basin on August 15, 2013 (base flow conditions) measured concentrations ranging from 0.0 to 0.8 mg N L^{-1}; the majority of the basin logged nitrate concentrations less than 0.2 mg N L^{-1}. One hotspot was observed at the southwest storm drain in Cell 1, where nitrate concentrations reached 0.8 mg N L^{-1} (Figure 3). A possible cause for this hot spot is the storm drain might deliver water from a recently fertilized and irrigated lawn by the Center for Performing Arts.

Nitrate measurements across the SEEP basin on August 15, 2013 following a 0.43 inch precipitation event ranged from 0.0 to 0.2 mg N L^{-1} with the majority of the basin logging nitrate values of less than 0.14 mg N L^{-1}. The same southwest storm drain that was observed to be a hotspot during base flow conditions was found to have a higher than average nitrate concentration (0.14 mg N L^{-1}), yet was not the source of the highest nitrate concentration in the basin. The northeast storm drain in Cell 1 was observed as a

hot spot during storm flow conditions (0.18 mg N L^{-1}). The southeast storm drain in Cell 2 also logged a higher than average nitrate concentration (0.14 mg N L^{-1}). While three of the four measured storm drains had nitrate concentrations elevated above the basin average during storm flow, the range of nitrate concentrations across the basin was one quarter the range during base flow conditions (Figure 4).

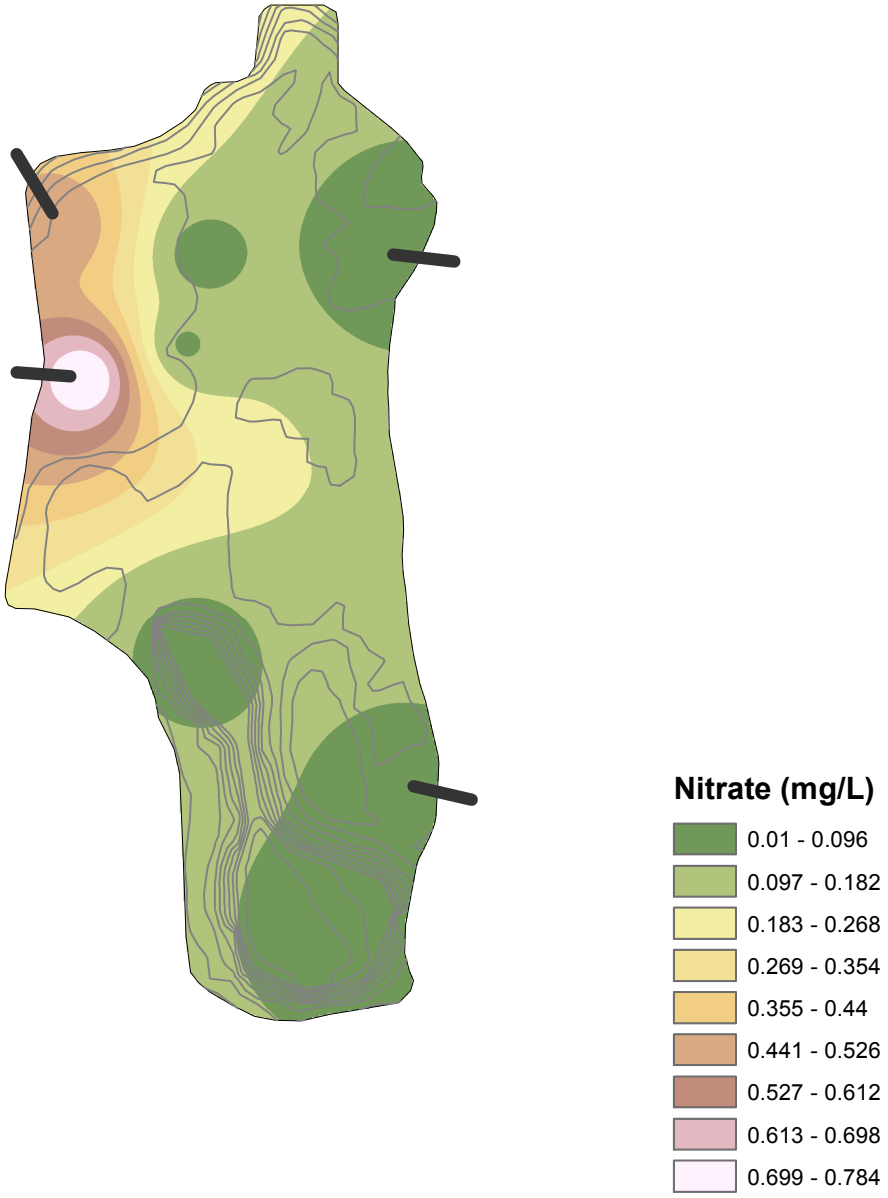

Figure 3. Spatial distribution of nitrate in the SEEP on August 15, 2013 (base flow conditions)

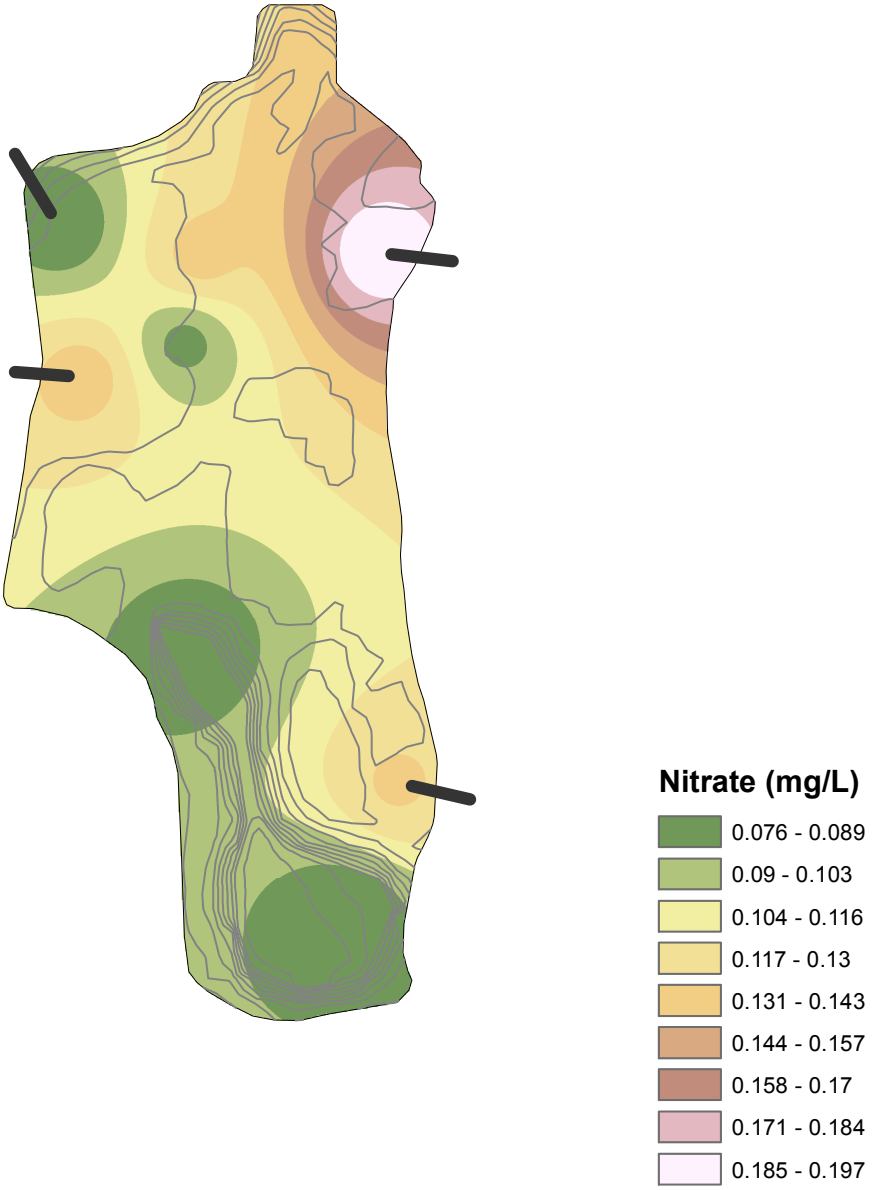

Figure 4. Spatial distribution of nitrate in the SEEP on August 16, 2013 (storm flow conditions)

Nitrate measurements on October 13, 2013 were collected with the intention of validating the base flow and storm flow conditions. Instead of validating the previous results, October 13, 2013 measurements showed the dynamic nature of the SEEP basin with extremely elevated concentrations. The basin ranged from 0.0 to greater than 10.0 mg N L^{-1}. Average nitrate concentrations across the majority of the basin ranged from

0.0 to 1.2 mg N L^{-1}. The northeast storm drain in Cell 1 was delivering water to the SEEP with nitrate concentrations greater than 10.0 mg N L^{-1}, acting as an extreme hotspot of nutrient inputs into the basin. While the difference in nitrate concentrations between this October monitoring period and the August monitoring period is not definitively known, a few explanations can be suggested. The last precipitation event was five days prior to the October monitoring, making irrigation the likely source of water from the hot spot storm drain. The point source of that extremely elevated nitrate concentration can be located on the figure of drainage structures entering the SEEP (Figure 1). The likely cause is a direct fertilizer application or other anthropogenic nitrate input into the storm drain that terminates at that location in the SEEP.

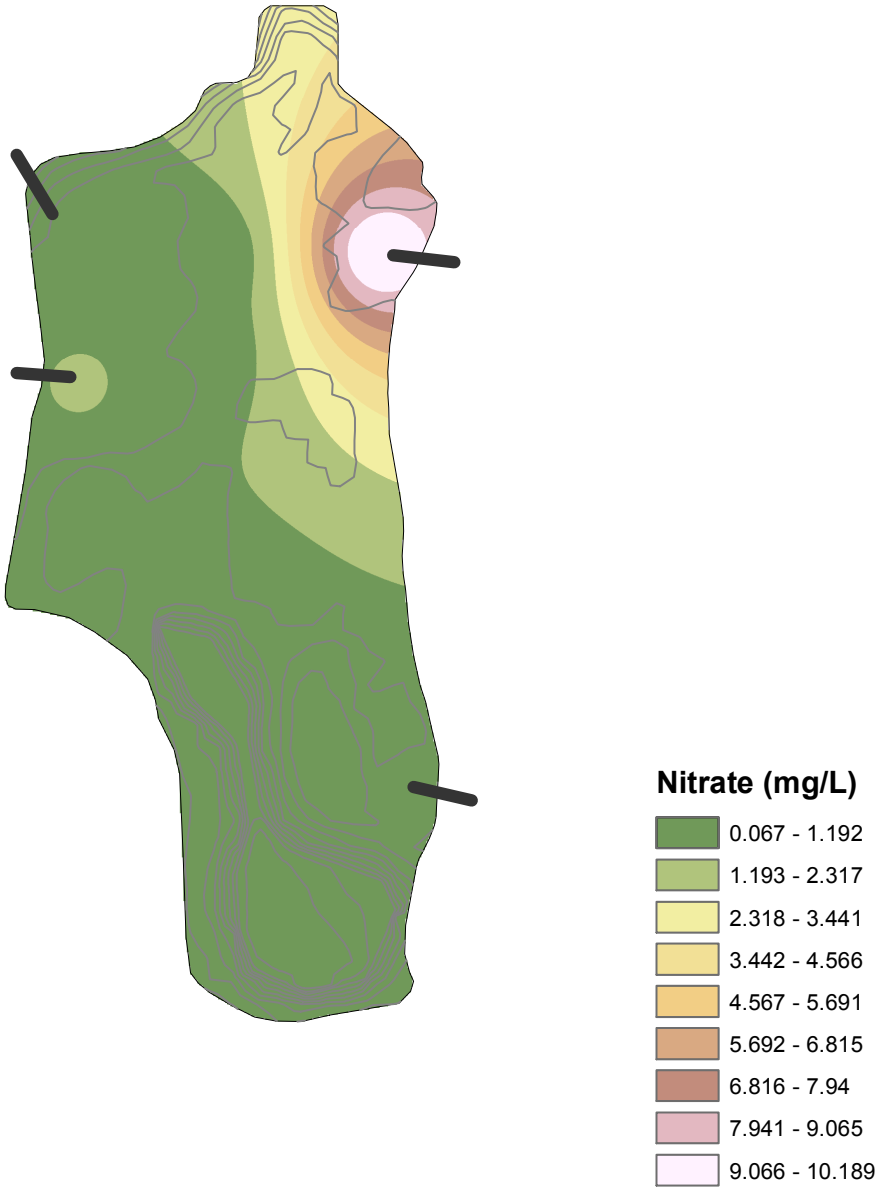

Figure 5. Spatial distribution of nitrate in the SEEP on October 13, 2013

Conclusions

This study demonstrated the spatial variability of nitrate in the SEEP under different flow conditions. The advantages of measuring nitrate in real time with an optical sensor are clear with the identification of different storm drains as nitrate hotspots and point sources under different flow conditions.

References

[1] Stormwater Ecological Enhancement Project: A project of the Wetlands Club. University of Florida Natural Area Teaching Laboratory. http://natl.ifas.ufl.edu/seep.php.

[2] FAWN - Florida Automated Weather Network: Archived Weather Data. University of Florida IFAS Extension. http://fawn.ifas.ufl.edu/data.