Analysis of Chemical Water Quality at Nahant Marsh

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Aims of Study

Last year, this project was meant to get a snapshot of the overall water quality of the marsh. This year, we are placing our focus on areas of interest:

- Biological and chemical relationships occurring in the marsh
- Variable oxygen levels within the marsh
- New equipment testing

Introduction

Marshes are classified by the United States EPA as wetlands that are frequently inundated with water, with emergent soft stemmed vegetation adapted to saturated soil conditions. Nahant Marsh, a 382 acre urban wetland preserve, located in Davenport, Iowa, fits this definition perfectly. As an important natural feature, Nahant Marsh performs needed functions like recharging groundwater and streams, slowing flood waters, and filtering out pollutants. Because of this, it is important to monitor the water quality of the marsh and understand the occurring dynamics. In the past, water quality testing at Nahant was done using older methods. This year, Nahant Marsh is operating with the same equipment used by the Army Corps of Engineers. With the overall upgrade in equipment, being more accurate and having higher resolution, my project aims to understand the complex physical and biological processes happening within the Wetland Marsh.

Methodology

Water quality was assessed at 12 sites across Nahant Marsh (***Fig. 5***), chosen to capture a range of marsh settings: six along the main flow path from the inlet creek to the Mississippi, four in separate wetlands north of the marsh, and two on Carp Lake, a spring-fed lake across I-280 near a slag pit. At each site, a YSI ProDSS measured temperature, conductance, ODO, and pH weekly for six weeks, generally on Wednesdays. Along with this, test strips were used to sample nitrates, nitrites, chlorides, and ammonia, and a 120 cm turbidity tube was used to measure water clarity. A permanently deployed YSI EXO2 sonde at the Catwalk site logged ODO, pH, conductivity/temperature, turbidity, and phycocyanin hourly over the same period. Orthophosphate grab samples were collected weekly for five weeks and analyzed with the DR850 colorimeter, using the ascorbic acid method (EPA 365.1). BOD_5 samples were collected for four weeks by slowly filling a Nalgene bottle to minimize aeration, then transferring the sample into a BOD bottle, and analyzed following EPA 405.1 (Standard Methods 5210 B). Heavy metals (Al, As, Cd, Cr, Cu, Pb, Mo, Ni, Se, Ag, Zn) were sampled from 7 sites, some repeated, for 10 total samples, and analyzed by the Davenport Water Pollution Control Plant.

Figures & Interpretations

Figure 1

- Oxygen swings from low to high from dawn to afternoon
- Algae peaks just before oxygen
- Photosynthesis driven cycle
- Hourly measurements from 6/4 - 7/16

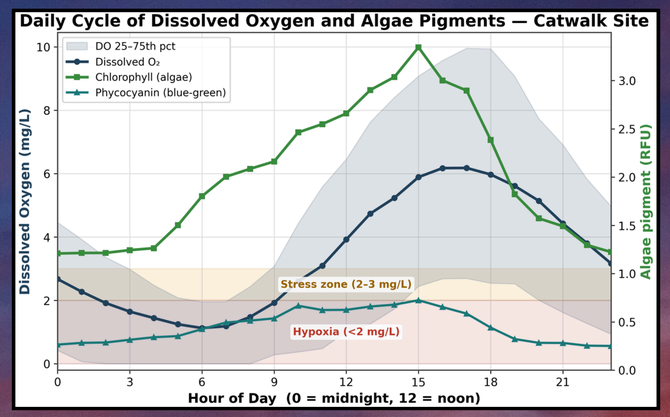
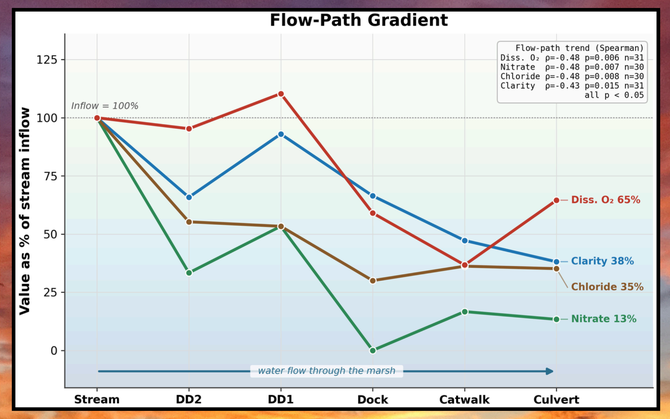


Figure 2

- Oxygen, nitrates, chlorides, and clarity decline downstream
- The processes of the marsh changes the concentration of nutrients in the water
- 6 flow path sites, weekly grab samples from 6/3 - 7/10



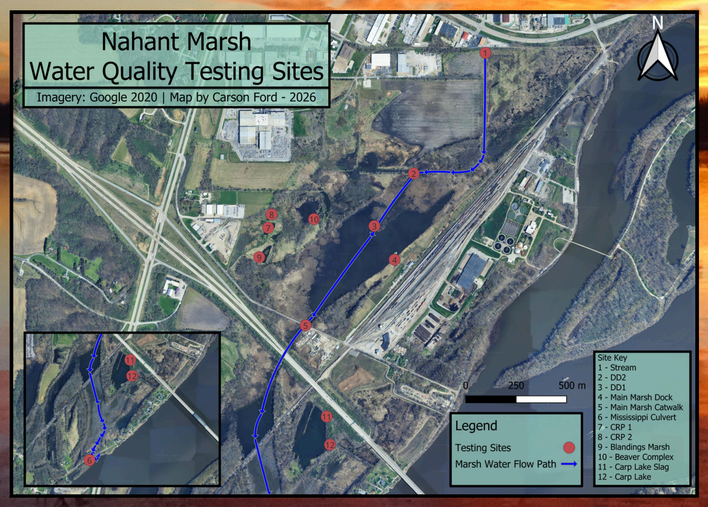
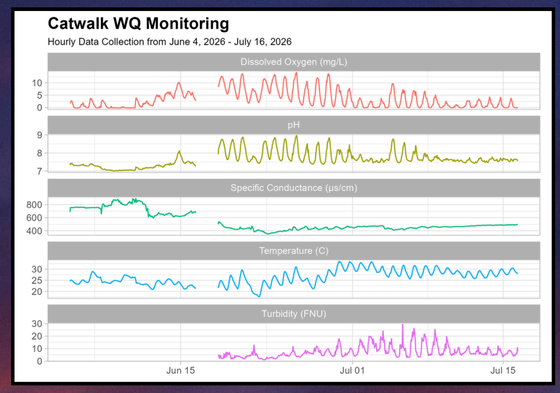


Figure 3

- Full continuous record from 6/4 - 7/16 (Sonde was undeployed from 6/16 - 6/18 for maintenance)
- The turbidity probe was added to the Sonde on 6/18
- Dissolved oxygen ranges from 0 - 14 mg/L, very large daily oscillations
- pH and dissolved oxygen track each other

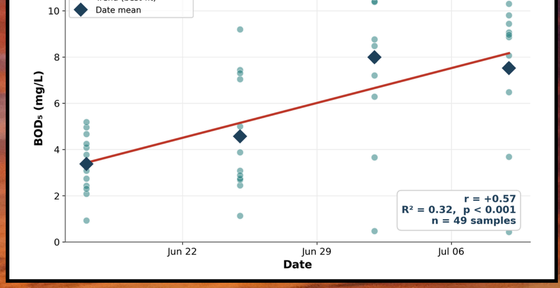


Catwalk WQ Summary Statistics

Parameter	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 75	Max
Dissolved Oxygen (mg/L)	952	3.44	3.65	0.00	0.31	5.60	14.25
Dissolved Oxygen (% sat)	952	42.61	45.62	0.00	3.85	67.75	190.80
Temperature (C)	952	26.41	3.19	17.57	24.03	28.82	33.45
pH	952	7.65	0.42	7.01	7.41	7.77	8.97
Specific Conductance (us/cm)	952	532.52	142.00	352.80	437.53	633.65	893.70
Turbidity (FNU)	670	7.46	4.66	1.05	4.38	9.22	29.48

Figure 4

- 4 weekly BOD5 samples from 6/17 - 7/9
- No significant differences between most sites
- Stream has much lower BOD5 than other testing sites
- Average BOD5 doubles over the 4 weeks



BOD_5 by Site — One-Way ANOVA

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Between sites	11	83.6	7.60	0.79	0.644
Residuals (within sites)	35	334.6	9.56		
Total	46	418.2			

Figure 5

- Map showing the 12 testing sites and the 382 acres of Nahant Marsh
- 6 testing sites follow the water flow path from the Stream (1) to the Mississippi Culvert (6)
- Carp Lake (sites 11 and 12) is a spring-fed lake

Conclusion

Continuous, high-resolution water monitoring at the Catwalk site revealed water-quality dynamics weekly grab samples could not have captured alone. The wetland at Nahant Marsh is a highly productive, nutrient enriched ecosystem: dissolved oxygen swings dramatically each day, reaching its peak in the afternoon, up to 14 mg/L, and falling into hypoxia every night, <2 mg/L. pH follows this trend as it rises and falls with oxygen. This points to intense daytime photosynthesis and nighttime oxygen respiration. While the Sonde's Algae-PC sensor captured planktonic algae peaking mid-afternoon, the size of the oxygen and pH swings imply that macrophytes and periphyton, which the probe cannot detect, are major drivers of the productivity in the marsh as well. Spatially, water quality changed along the flow path: nitrate, oxygen, chloride, and clarity all declines significantly from the stream inflow to the outlet into the Mississippi river. This shows the marsh is actively transforming the water that travels through it. Biochemical oxygen demand was consistently higher in the marsh than the inflow, and approximately doubled over the summer, showing a rise in organic load as temperature climbed. These results show the marsh undergoes recurring plant-algae driven oxygen stress, and show the benefits of high resolution testing equipment

Acknowledgements

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