Nutrient Analysis of Stream Sediment in the Red Cedar Watershed & Mitigation Strategies

Bailey Kramer
University of Wisconsin- Stout

Sarah Mack
Kean University

Arthur Kneeland, M.S.
University of Wisconsin-Stout

Sediment Traps

Sediment traps are often built in constructed ditches around agricultural land. These traps help **prevent sedimentation downstream** that can be destructive to aquatic life and habitat. They are also an **effective means of reclaiming sediment** for other uses, like as a soil amendment. However, the sediment may require treatment before use.

Fish Exclusions

Excluding carp from part or all of the lake will allow for the **restoration and introduction of native plant species**. This will increase lake biodiversity which leads to a system that is more resilient and effective at controlling cyanobacterial blooms.

Carp Extraction

Common carp have been shown to cause large scale destruction of habitat in shallow lake ecosystems, with particularly negative effects on aquatic vegetation and water fowl. Removal of fish like common carp has led to **reductions in soluble phosphorus concentrations, chlorophyll a, turbidity, and suspended solids**.

The Story of Phosphorus

Phosphorus (P) is a widely used additive to agricultural fields because it is an **essential nutrient** for plant growth. It is only present in the earth as **nonrenewable mineral** deposits which must be mined and manufactured into fertilizers. Once P is applied to the field **80 to 85% of it is immobilized** by a reaction with Ca, Fe, or Al ions present in the soil making that P unavailable to plants. Often this leads to **additional fertilizer use and more phosphorus loss**.

After application P can be **mobilized through surface flow**, which is one of the main ways P moves from agricultural systems to surface water. A major source of surface flow is **row crops** due to the large amount of **bare soil** that is exposed for a majority of the year. Insoluble P is bound to eroded soil particles. When rain falls on bare soil it detaches soil particles and causes additional erosion via runoff. Both **runoff water and soil are unavailable to plants**. While not readily available to most organisms, insoluble P can become a **long-term source of soluble P** once it has entered **aquatic systems**.

Unlike many other nutrients essential to plant life that have an atmospheric pathway as part of their biogeochemical cycle, the **phosphorus cycle is strictly geologic** in nature. Once P has found its way into a system it is very hard for the system to balance it out. In aquatic environments the element phosphorus is often a limiting factor to plant growth. However, **in the Red Cedar Watershed P has become abundant**. This has led to ongoing water quality issues like algal and cyanobacterial blooms that pose hazards to both human health and ecosystem integrity.

Aim

We analyzed stream sediment to determine its composition and viability for different mitigation strategies focusing on phosphorus as well as potassium, soluble salts, and regulated heavy metals.

Methods

- This study focused on Wilson and Eighteen Mile Creeks in the Red Cedar Watershed of Wisconsin.
- Subsamples were taken at 200 meter intervals with each subsample composed of three collection efforts: one from the middle and one from each side.
- All of the samples were air dried and then sifted to eliminate particles bigger than 2 mm in size.
- Samples were analyzed for nutrient content, soluble salts, and heavy metals.
- Water samples were taken from each site and analyzed for soluble reactive phosphorus.

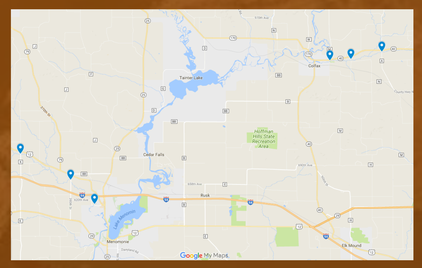

Figure 1. Map of 6 study locations along Wilson and Eighteen Mile Creeks. Blue pins indicate sites.

Results

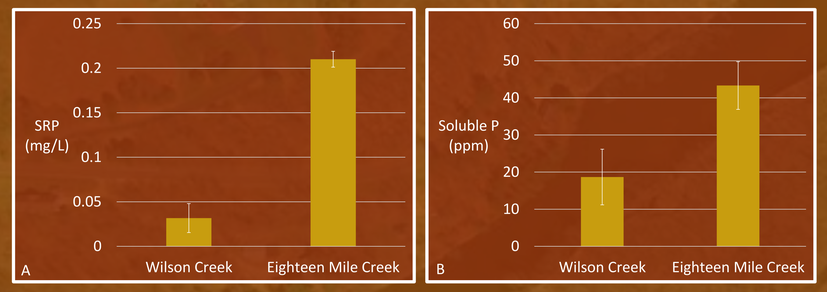

Figure 2. Differences in phosphorus content in Wilson and Eighteen Mile Creeks. Error bars represent standard deviation. **A.)**Average amounts of soluble reactive phosphorus (SRP) in the water of both creeks. **SRP was significantly greater in Eighteen Mile Creek than in Wilson Creek** ($p<0.05$, 1-way ANOVA). **B.)** Average amounts of soluble P in stream sediment of both creeks**. Soluble P was significantly greater in Eighteen Mile Creek than in Wilson Creek** ($p<0.05$, 1-way ANOVA) .

Metal	EPA Limits (ppm)	Wolske Bay % Limit	Wilson Creek % Limit
Arsenic	75	1.18	2.29
Cadmium	85	0.18	0.04
Copper	4300	0.23	0.15
Lead	840	0.75	0.85
Molybdenum	75	-	0
Nickel	420	1.07	1.97
Zinc	7500	0.22	0.33

Table 1. Heavy metals (ppm) found in sediment sampled from Wilson Creek and Wolske Bay shown as a percentage of EPA ceiling concentrations for the application of biosolids to agricultural land.

Soil Characteristics	Wilson Creek	Eighteen Mile Creek
Average Soluble Salts (dS/m)	0.05	0.03
Salinity Class	Non-saline	Non-Saline
Average Soluble P (ppm)	18.67	43.33
Soil Test Category for P	Optimum	Excessively High
Average Soluble K (ppm)	19.33	16.33
Soil Test Category for K	Very Low	Very Low

Table 2. Average values of soluble salt, P, and K for Wilson and Eighteen Mile Creeks with expected categories for corn (*Zea mays*) growth based on soil test interpretation material provided by UW-Madison.

Discussion

- The levels of **heavy metals were below the ceiling limits** set by the EPA. This indicates that sediment collected from the two streams could be safely applied to land as a soil additive.
- While the sediment in both streams **has sufficient amounts of soluble P** for corn growth further work must be done to determine its feasibility as a nutrient additive in other areas.

- Physically removing sediments from the Red Cedar Watershed is not the only method of P mitigation**. Other methods are discussed briefly in the side panels.**

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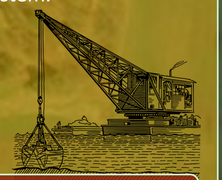
Matt Kuchta ❖ Steve Nold ❖ The City of Menomonie

Floating Islands

Plants grown on floating islands have been shown to **uptake many types of water pollutants** including P and other nutrients, toxins produced by cyanobacteria, and heavy metals. Growing plants on the lakes like this and harvesting the biomass could be an **effective way to improve water quality**.

Constructed Wetlands

Wetlands can be utilized to sequester P, especially in particulate form, for the short and long term. These systems can be constructed artificially to receive eutrophic lake water and **act as a filter for the system to increase water quality**. Constructed wetlands have also been shown to aid in flood control, provide ecological habitat, and help increase biodiversity, all of which leads to a healthier system.



Dredging

Dredging is an **expensive restoration method** that requires the treatment and disposal of the sediment removed and can have a **negative impact on the diversity** of the lake. While sediment can be used as fertilizer and sold to offset costs, it must be monitored for contaminants. Dredging has been shown to be effective when P is no longer coming into the lake system.

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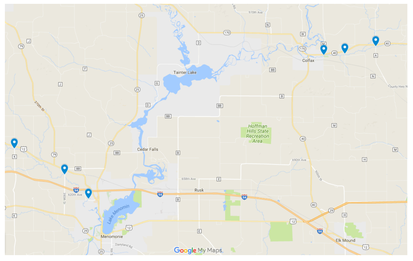

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