Ecological Restoration

Volume 29 ▪ Number 4 December 2011

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to thank the Morton Arboretum in Lisle, Illinois, and Emmett's Alehouse in Downers Grove, Illinois, for donating the leaf mold and brewery waste products, respectively. Finally, special thanks to Mary Ann Feist, Jean Mengelkoch, and Chris Reyes for their helpful edits to improve this note.

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Assessing Urban Wetland Soils for Reed Canary Grass Management (Minnesota)

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Reed canary grass (*Phalaris arundinacea*) thrives in urban watersheds where stormwater increases nutrient concentrations, water level fluctuation, and sediment inputs (Wilcox et al. 2007, Stiles et al. 2008). Although managers have attempted to control reed canary grass using a variety of methods, results have been generally negative (Adams and Galatowitsch 2006). Limited public funds and personnel further inhibit effective reed canary grass management, warranting the development of cost effective strategies for prioritizing the restoration of reed canary grass impacted wetlands.

As a case study, the Ramsey-Washington Metro Watershed District (RWMWD) actively manages native plant communities in 30 urban wetlands and stormwater ponds. All of these systems have populations of reed canary grass and receive stormwater inputs. Generally, our management (i.e., herbicide application, mowing, and burning) has resulted in relatively low populations, less than 10% cover site wide, of reed canary grass in created ponds and wetlands with mineral soils. Conversely, we have had very limited success controlling reed canary grass in wetlands with organic soils. From 2000 to 2010, our wetland restoration maintenance records indicate significantly higher labor hours ($p<0.05$, Wilcoxon rank-sum test) associated with

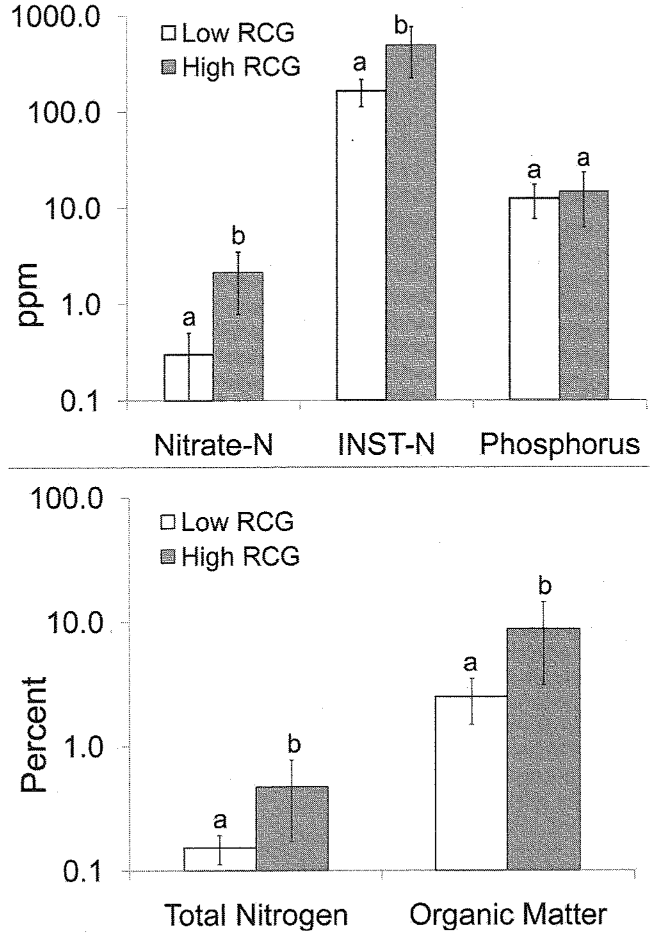

Figure 1. Mean Nitrate-N, INST-N, total phosphorus, total nitrogen, and organic matter concentrations (± 1 SD) for wetlands with low (<10% cover) and high (>90% cover) reed canary grass (RCG) abundance in the Ramsey-Washington Metro Watershed District (Minnesota). For each sampling date, different letters indicate significant (p>0.05) differences.

controlling reed canary grass in wetlands with organic soils ($\bar{x}$ = 31 hr/ha/yr) versus created wetlands and ponds with mineral soils ($\bar{x}$ = 5 hr/ha/yr). To investigate differences in invasion potential between organic and mineral soil wetlands, we compared reed canary grass abundance, soil organic matter (OM), and soil nitrogen (N) in wetlands throughout our watershed. Nitrogen has been identified as a primary catalyst of reed canary grass expansion in wetland systems (Green and Galatowitsch 2002). Because of these findings and our long-term field observations, we focused on soil N and OM in our assessment. To keep the approach cost effective, we used inexpensive agricultural soil tests. Our working hypothesis was that higher soil N and OM would be detected in systems dominated by reed canary grass. If supported, this guideline could be a first step in assessing wetland soils in relation to reed canary grass management. A practical assessment approach may be useful in gauging management requirements and ranking urban wetlands for restoration priority.

We sampled 16 urban wetlands and stormwater pond transitional zones (henceforth called wetlands) within the

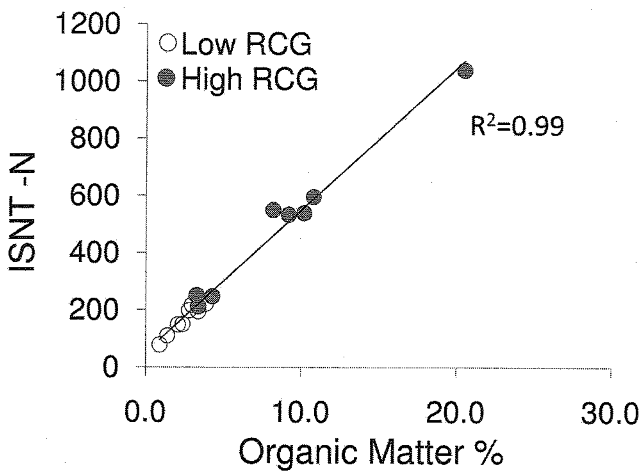

Figure 2: Regression plot of ISNT-N and percent organic matter for both low (<10% cover) and high (>90% cover) reed canary grass (RCG) abundance wetlands (y = 51.2 + 49.7x).

boundaries of the RWMWD, which encompasses a portion of St. Paul (Minnesota) and several first ring suburbs (www.rwmwd.org). Over 95% of the watershed is in urban-residential land use, and all the study wetlands receive stormwater. On a watershed scale, land use and stormwater inputs were consistent across all wetlands. Visual estimates of reed canary grass cover in transitional zones (defined as an area with a predominance of wetland species and soils that are saturated during normal hydrologic conditions) indicated that 8 created wetlands had low reed canary grass abundance (< 10% cover), and 8 wetlands (4 natural and 4 created) had high reed canary grass abundance (> 90% cover). The created wetlands selected for this study were between 6–10 yr old. These systems were excavated, seeded, and/or planted with a variety of herbaceous wetland species and receive periodic (usually 3 visits/yr) invasive plant control.

We conducted soil sampling in November 2010. At each wetland, we identified a random 10-m^2 patch of vegetation in the transitional zone. Using a hand auger, we collected 3 soil cores (30 cm depth) at 3-m intervals in each patch and combined the cores to produce a composite soil sample for each wetland. We air dried each sample for 1 wk, thoroughly ground and mixed the soil, and then divided it into 2 subsamples. We sent the soil subsample sets to 2 laboratories for analyses. The University of Minnesota Soil Testing Laboratory analyzed for soil percent OM, extractable phosphorus, nitrate, and total N ($25 per sample). Organic matter was determined as loss by weight during ignition at 360°C for 2 hr in a muffle furnace. Extractable phosphorus was measured using the Bray 1 method. Nitrate was determined by using a continuous flow analyzer with the cadmium reduction method (0.01 *M* $CaCl_2$ extracting solution). Total N was determined by the Dumas method on a LECO® FP528 analyzer (St. Joseph, MI). A & L Great Lakes Laboratories (Fort Wayne, IN) performed the Illinois Soil Nitrogen Testing (ISNT-N) at $25 per sample. This test determines readily mineralizable soil organic N by using 2 *M* NaOH and 5 hr of 48 to 50°C heat to liberate amino sugar-N as gaseous NH_3. The NH_3 is collected in H_3BO_3–indicator solution and then determined by acidimetric titration. We used the Wilcoxon Rank Sum Test to analyze the soil data.

We first compared soil data from the natural (N = 4) and created (N = 4) wetlands with high reed canary grass abundance. Means were similar (p>0.05) for all assessment parameters. Therefore, we pooled these data and compared mean values between high (N = 8) and low (N = 8) reed canary grass abundance wetlands.

We found that total N and OM concentrations were significantly higher (p<0.05) in the high reed canary grass wetlands (Figure 1). It seems plausible that these differences were related to the type of soil used in wetland construction. The low reed canary grass abundance wetlands with significantly lower percent OM and total N were created systems that mainly relied on mineral soils in construction. Being between 6 to 10 yr old, we believe that these wetlands did not have an opportunity to accumulate appreciable quantities of OM. This is consistent with the findings of Craft and others (1988) that reported initially low soil organic content in newly created marshes. The created wetlands with high reed canary grass abundance that we sampled were originally constructed with organic wetland soils. This most commonly occurs when an existing wetland is excavated and re-contoured with the objective of increasing water storage.

Detecting elevated nitrate levels in high reed canary grass wetlands (Figure 1) is consistent with results from controlled experiments. Green and Galatowitsch (2002) found that reed canary grass populations expanded under high available N levels which led to reduced native wetland plant community growth. Our results also agree with an Illinois field study that reported a positive correlation between reed canary grass cover and soil nitrate concentrations in created and restored wetlands (Matthews et al. 2009). This work and our study both found that wetlands with relatively high reed canary grass cover had soil nitrate concentrations of at least 0.6 ppm.

The ISNT-N was developed as an agricultural soil test to be used to formulate N application rates to crop fields. This test measures the fraction of organic N potentially mineralized to available N during the growing season. As far as we know, this test has not been used in any prior wetland soil studies. As with total N, elevated ISNT-N values were recorded for wetlands dominated by reed canary grass (Figure 1). Our finding that ISNT-N was highly correlated with soil OM (Figure 2) is consistent with the findings of Laboski and colleagues (2006). In a resource management context, evaluating soil OM content and nitrate rather than dedicating additional resources for ISNT-N testing may be a reasonable approach.

With this being a narrow observational field study, we are aware that there are limitations in our data set. For instance, the created wetlands with low reed canary grass abundance were constructed with mineral soils most likely devoid of reed canary grass seed and propagules. In contrast, the created wetlands with organic soils are more likely to have reed canary grass seed banks. It could be hypothesized that low reed canary grass abundance was the result of these systems still being relatively young, and reed canary grass was still early in the invasion process. Also, it is possible that reed canary grass, upon decomposition, enhanced soil nutrient levels. Consequently, relatively high soil N levels in our high reed canary grass abundance wetlands may have been the result of this invasive grass accumulating N over time (Stiles et al. 2008).

Although preliminary, our evaluation detected positive correlations with soil N, OM, and reed canary grass abundance. This finding complements our field maintenance records that show greater resource allocation put towards reed canary grass control in wetlands with organic soils. We believe that assessing soils for N and OM can be a useful component in guiding wetland management and restoration, especially in urban watersheds.

Some have argued that land managers should not put resources into wetlands that continually receive stormwater due to the burden of reed canary grass control (Wilcox et al. 2007). However, highly developed wetlands are rarely free of urban runoff, and it is important to effectively manage these wetlands for continued effectiveness as stormwater retention basins and wildlife habitat. In these circumstances, managers should consider using soil type as a cost effective component in prioritizing wetlands for restoration. Wetlands with low soil N may still have high restoration potential, even with stormwater inputs. Data from this study and another field investigation point to manageable levels of reed canary grass in urban wetlands with soil nitrate levels of less than 0.6 ppm. Based on available field data, this soil nitrate level seems to be a practical working threshold to consider in management and to test in future studies.

Soil assessment may also be useful in selecting materials used in urban wetland creation. In wetland projects conducted in the 1990s, RWMWD often used highly organic peat soils in creating wetland transitional zones. This has generally resulted in a quite favorable habitat for reed canary grass. Presently, we take into account soil N and OM when choosing materials for shorelines and wetland transitional zones. When practical, we choose mineral soils relatively low in soil N. Our data suggest that this practice will minimize our reed canary grass maintenance requirements over the long-term.

As more field data become available, we will continue to test the relationships between reed canary grass abundance and soil N and OM and consider the possibility of formalizing a wetland soil assessment method for urban watersheds.

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