Benthic Macroinvertebrates Bioindicators at the Kleinstuck Preserve Wetlands

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INTRODUCTION

Wetland ecosystems host substantial biodiversity; various species are exclusive to wetland systems (Sharma & Jitendra, 2009). Oftentimes, wetland quality and, as a result, biodiversity, are compromised by frequent human interaction with wetland environments (Keleher & Rader, 2008). Considering this, it is important that management personnel develop and institute bioassessment techniques in an effort to quantify and track wetland quality. Benthic macroinvertebrates are tools that enable "rapid bioassessment"; in other words, these are easy, cost-effective, quick assessment strategies to determine ecosystem health (Loeb & Spacie, 1994). Moreover, data produced from such assessments have been proven valid and reproducible (Loeb & Spacie, 1994).

From the 1880s to the 1920s, peat was mined from the pond located on Braggs Farm, a 48-acre plot of land in Kalamazoo, Michigan (Jorth, 2008). In 1922 the property was renamed Kleinstuck Preserve and donated to the Michigan Board of Education to be used for research and educational purposes. Currently, the Kleinstuck Preserve is located in an urban area and is completely surrounded by residential homes and a YMCA. Today, erosion of the hillsides into the marsh area is of particular concern for preserving the ecosystem. Surrounding homes, a decline in the native ground dwelling vegetation, and pedestrian traffic are believed to be contributors to erosion occurring in the Preserve. Erosion can cause catastrophic changes or modifications to an ecosystem, influencing the ecosystem's health (Florsheim et al., 2008).

It is advantageous to caregivers of the Preserve to obtain an initial baseline water quality assessment; in doing so, future studies could be conducted in an effort to quantify water quality over time, particularly in quantifying effects of conservation efforts in the Preserve. Our research centers on the use of benthic macroinvertebrates from various wetland sites in Kleinstuck to determine overall water quality. Since greater access leads to increased erosion, and since erosion can be detrimental to water quality, we hypothesize that high-access areas will host reduced biodiversity. Conversely, areas of low-access will host increased biodiversity as a result of less human interaction and consequential erosion. Thus, we will also investigate differences in water quality at high-access and low-access areas. An additional goal of our study is to catalogue the taxa of benthic macroinvertebrates in the Kleinstuck Preserve, since a catalogue of this information has not yet been created.

STUDY SITE

The presence of benthic macroinvertebrates was surveyed at the Kleinstuck Preserve wetland in Kalamazoo, Michigan, during May 2009. Kleinstuck Preserve is comprised of stagnant water with a range of shoreline areas that are inhabited by an abundance of floating and rooted grass or of leaf litter and branch debris along the marshland floor. A majority of the marsh's shoreline is inaccessible due to dense tree and herbaceous bush growth, but several man-made trails have been created that lead directly to observation points around the marsh shoreline.

METHODS

A uniform survey method was used to sample species richness at six locations around the perimeter of the wetland. Sampling sites were determined by accessibility and the presence of predetermined GPS points. A distance of at least 20 m separated each sampling location. Three sites were categorized as high-accessibility (16, 18, 26) and three sites as low-accessibility (20, 34, 36).

Each site was sampled twice and samples were collected one week apart. Samples were taken using a D-shaped dip net approximately 1.25 m long. Marshland floor samples were collected 1.25 m (one dip net length) away from the shoreline. The dip net was stomped with a forward motion, ten times into the wetland floor. Each stomp was a few inches apart. The contents were drained and transported to the lab for sorting.

Samples were sorted within one day of collection, and were refrigerated for at least 1 hr before sorting and then sifted through. Any observable benthic macroinvertebrates were removed, identified, and species presences were recorded. Water quality was determined by a Species Richness and a Pollution Sensitivity Index based on the Missouri Department of Natural Resource's Volunteer Water Quality Rating Sheet, modified by Dr. Ann Fraser. Water quality ratings were based on a scale of poor, fair, good, very good, and excellent. Sampling thoroughness was assessed through a species accumulation curve. Statistical significance comparing Taxa Richness of low- and high-access areas was determined using a *t*-test.

RESULTS

We found 21 different types of benthic macroinvertebrates in the Kleinstuck preserve (Table I). They ranged from pollution sensitive organisms such as the Mayfly naiad to very pollution tollerant creatures such as the Ramshorn snail.

Table I. Taxa of 21 Benthic Macroinvertebrates catalogued while sampling within the Kleinstuck Preserve, categorized in general groupings of pollution sensitivity.

Very Sensitive	
Mayfly naiad	
	Fly larvae
Somewhat Sensitive	Beetle larva
Caddisfly larva	Mosquito pupa
Dragonfly naiad	Scud (“sideswimmer”)
Damselfly naiad	Whirligig beetle
Water bug	Crawling water beetle
Water scorpion	Flatworm (planarian)
Tolerant	Very Tolerant
Predaceous beetle larvae	Ramhorned snail
Clam – Mussel	Pouch snail
Leech	Round worm
Midge larvae	Segmented worm

The species accumulation curve plateaus by the sixth sample, but two new species were found in the last sample (Fig 1).

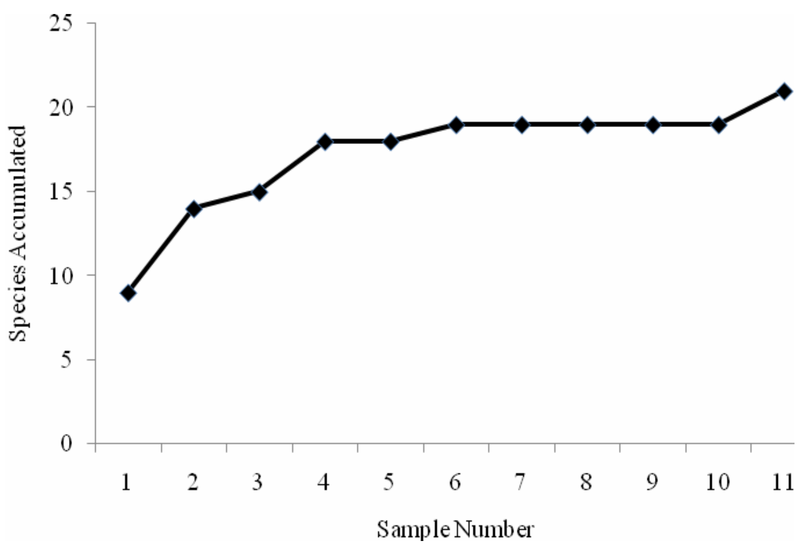

Figure 1. Species accumulation increases and plataeus over 11 samples.

There was a trend that high-access sites (16, 18, 26) were less pollution sensitive than the low-access sites (20, 34, 36) (Fig 2). Pollution sensitivity index was assessed to be 82, which indicated “very good” water quality.

There was no significant difference between average species richness at different locations (*p*=0.067), however these results were nearly significant. There was a non-significant trend for high-access sites (16, 18, 26) to have lower species richness than low-access sites (20, 34, 36) (Fig 3). Water quality of benthic macroinvertebrates based on a taxa richness of 21, indicated “very good” water quality.

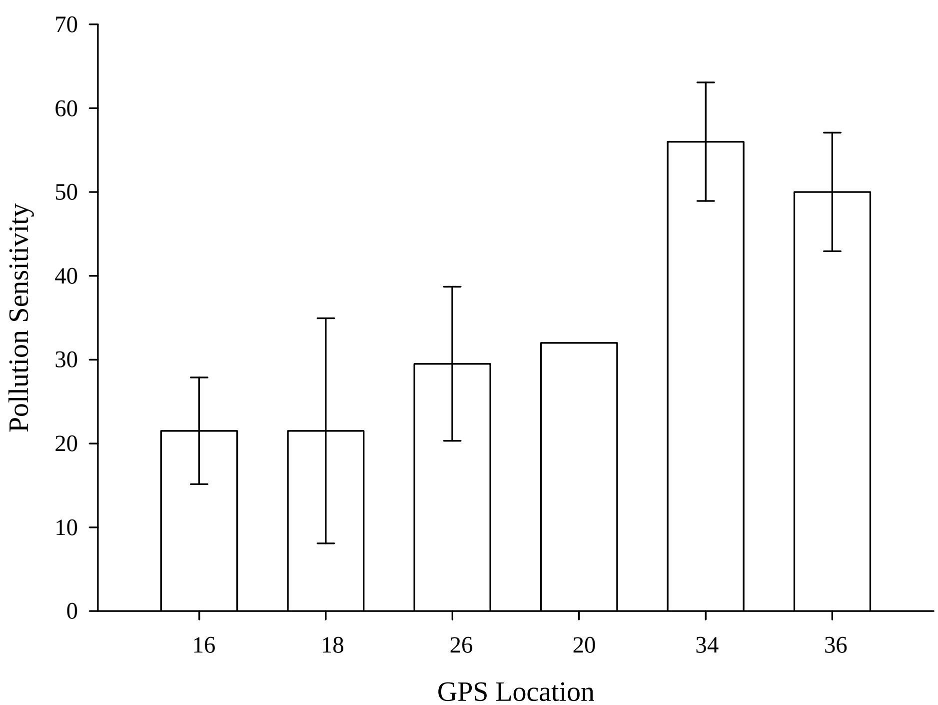

Figure 2. Wetland pollution sensitivity ratings at different GPS locations.

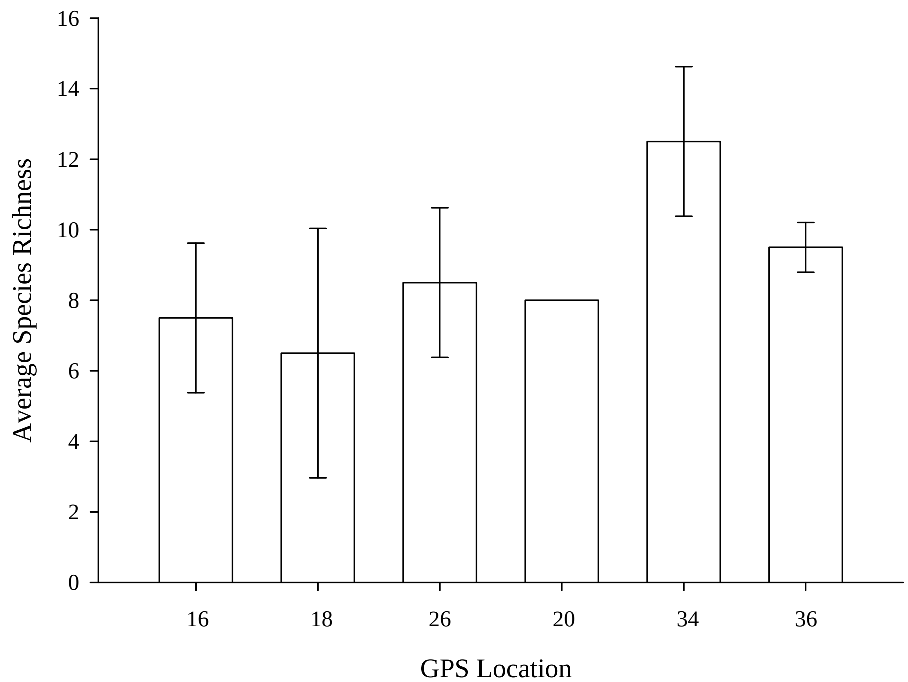

Figure 3. Average species richness at different GPS locations of the wetlands. A *t*-test yielded no significant difference in average species richness between low- and high-access sites (p=0.067).

DISCUSSION

We found that taxa richness and the pollution sensitivity index both indicated “very good” water quality at the Kleinstuck Preserve wetlands. This rating is consistent with our knowledge of the Preserve. The Stewards of Kleinstuck work throughout the year to maintain the ecosystem health by means such as controlling for erosion and raising awareness about pesticide and fertilizer use in the neighborhood surrounding the Preserve. Since these above factors can be detrimental to ecosystem health, the Stewards’ work helps maintain the “very good” water quality. On the other hand, erosion, the Preserve’s history, and urban location of the wetlands could be factors preventing “excellent” water quality at Kleinstuck. Several damaging factors may be the history of human disturbances (such as peat mining) in the wetlands and the

Preserve’s proximity to roads, developed areas (runoff from fertilized lawns) and a sewage pipe. These positive and negative influences suggest our assessment of water quality is plausible.

Although no significant difference was observed between low- and high-access sites, observable trends suggest low-access sites supported higher species richness. Areas of high access consisted of well-traveled trails leading to the water, allowing for high levels of traffic that could induce greater damage to surrounding plants that help prevent erosion. These trails also served as funnels which directed eroded silt into the wetlands during rainfall. Therefore, high-access correlate with greater erosion, resulting in decreased water quality and decreased taxa richness in these areas. These studies could be useful to the Stewards by providing a quantitative assessment of the effects of localized efforts on erosion control in the Preserve.

Even though site 20 was categorized as a low-access site, it did not display a similar pollution sensitivity index score or average taxa richness in comparison to the other low-access sites. These results could be due to sampling error, including a sample too large and dense. Furthermore, too long a lapse between collection and sorting resulted in benthic macroinvertebrate death in the first sample for site 20. Consequently, locating and identifying the critters was extremely difficult. Had we been able to analyze both samples from this location, the results may have been more consistent with results from other low-access areas.

Future studies could expand upon our study in four ways. Firstly, our species accumulation curve appeared to level off, but the last sample collected contained two new species, indicating that there were still uncatalogued species in the Preserve. Completely thorough samplings should result in no new species observed in latter samples. Future studies should sample until the curve completely plateaus. Secondly, the difference between low- and high-access areas was not significant. More extensive sampling between these areas may reveal a significant trend. Thirdly, samples were only collected during mid-spring and certain species may not be active during that time. Sampling throughout spring and summer, would result in different observable taxa richness. Lastly, species abundance could be analyzed. Other studies have taken this approach; for instance, Adams *et al* (2002), in their study of stream ecosystem recovery, assessed water quality by measuring the abundance of key species, as well as measuring taxa richness.

Our study has applied value for the Stewards of Kleinstuck because it provides an assessment of the wetland water quality as well as a catalogue of the benthic macroinvertebrates of Kleinstuck Preserve. Furthermore, the study is easily replicable for exploring changes in the Preserve's water quality over time, and can be conducted by volunteers of varying age. Therefore, the Stewards of Kleinstuck will be able to observe and assess environmental effects of management policies, particularly for erosion into the wetlands. Using bioindicators in assessment of water quality is inexpensive, requires few resources, and relies mostly on volunteer effort. This study could even be used as an educational experience to demonstrate for children and volunteers the magnitude of life which can be found in a small sample.

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