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Efforts to improve water quality in Sarasota

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Introduction

Freshwater is a resource all humans need to survive and therefore it is imperative to evaluate the health of our freshwater sources. Even small bodies of freshwater contribute to watersheds that influence our larger water sources, meaning local water body sampling is valuable and necessary. Abiotic testing can be conducted to find pH, salinity, the presence of fecal matter, and other measures of interest. However, testing biotic indicators can give us more insight on water quality. Certainly, research has been conducted that links a fall in biodiversity to declines in our aquifers (Vollmer 2016). Certain communities thrive in healthy freshwater sources, which can serve as indicators to the health of the water source (Davis 1975).

To most properly evaluate the biodiversity and, therefore, health of an area, it is best to measure animals that are both sensitive to water condition changes and that cannot escape the conditions (Vollmer 2016). Large, mobile animals are therefore not ideal. Benthic macroinvertebrates, however, fulfill these conditions. Since the sensitivities and demands of benthic macroinvertebrates are well-known, we can predict populations depending on the health of the water body (Vollmer 2016).

Benthic invertebrates are a diverse group of organisms that all perform different functions within their habitat. For instance, snails are a part of a subgroup called scrapers, so called such by their feeding strategies. Feeding strategies can indicate whether an organism is carnivorous or herbivorous, which can lead us to evaluate how the ecosystem functions as a unit. There are a variety of other subgroups macroinvertebrates can encompass, but what is important to this is the functional redundancy of the system. That is to say, if one species of scrapers were to die from unfit conditions, another species of scrapers should already be present to prevent the system from losing an integral part of its function (Heino 2005).

To examine populations of benthic macroinvertebrates, it is important to know how they interact with their environment. Trees that grow by water sources shed leaves and contribute to detritus; these inputs are referred to as allochthonous, as they originate outside of this aquatic biome. Interestingly, these inputs are imperative to establishing freshwater communities, and are often more important than aquatic inputs (Rounick 1982). As these leaves fall in the same area, they collect and form natural leaf packs where macroinvertebrates settle and live. As this is the primary habitat for macroinvertebrates, it needs to be recreated to accurately survey the species in an area. In the creation of these leaf packs, outside interactions need to be evaluated as well. To avoid undersampling a species that may have been present in large numbers if not for predation, a mesh bag can be used to encase the leaf packs created to deny larger predators access to them.

Background

We surveyed the health of a local freshwater area in Red Bug Slough. In addition to testing for health as indicated by abiotic and biotic testing, we were interested in health differences that may be present depending on human efforts to restore health. As a result, two areas were tested: a freshwater body that is surrounded by residential areas (refereed to as urban site) that may introduce runoff and waste into this system, and a freshwater body further upstream that is maintained as a restoration area (referred to as restored site). By comparing these areas, we hope to determine if restoration areas are useful for mitigating pollutant loads, buffering water quality, and enhancing ecosystem function.

In 1989, the Environmental Protection Agency (EPA) and National Estuary Program (NEP) set forth a cooperative monitoring program in Sarasota Bay with the objective to restore bay water (Estevez 1989). This objective gave rise to many goals that targeted the sea-to-land interactions including stormwater runoff, and point and nonpoint sources of pollutant load (Estevez 1989). Accomplishing these goals was key to ensuring a productive and sustainable fishery, rebounding the tourism industry, and mitigating an ecosystem that was in sharp decline due to limited regulations on pollutant input (Sarasota Bay Estuary Program 2006).

Efforts have been improving the state of the bay as the foundation species of seagrass begin to surge back (Yarbro & Carlson 2016); however, there are still many inland wetland systems that do not meet water quality standards and are listed as impaired water bodies (Sarasota Bay Estuary Program 2006). As of 2006, relevant water bodies listed as impaired or areas of concern included Roberts Bay, Clower Creek, Phillippi Creek, and a series of connecting bodies including Red Bug Slough (Sarasota Bay Estuary Program 2006). The EPA defines impaired water bodies as bodies of water that receive more pollutants than the total maximum daily load. Although restoring a site cannot reduce the load of pollutants entering it, planting native vegetation and incorporating functional species into a water body can mitigate the effects of the pollutant load downstream before entering the Sarasota Bay.

Several taxonomic groups are important to maintain a thriving community that is able to deal with such conditions and to properly mitigate them. Indicator species also play a large role in showing to what degree the pollutants have been buffered by native plants and biotic interactions. Such taxons are sensitive to environmental conditions including beetles, mayflies, and gilled snails (Davis 1975). For that purpose we quantified the taxon richness in both an urban wetland and an adjacent restored wetland to determine the effectiveness of restoration efforts.

Taxonomic abundance was consistently lower in the restored site compared to the urban site (figure 1). Functional redundancy in the restored area was nearly identical to that of the urban area indicated by similar functional richness (figure 2).

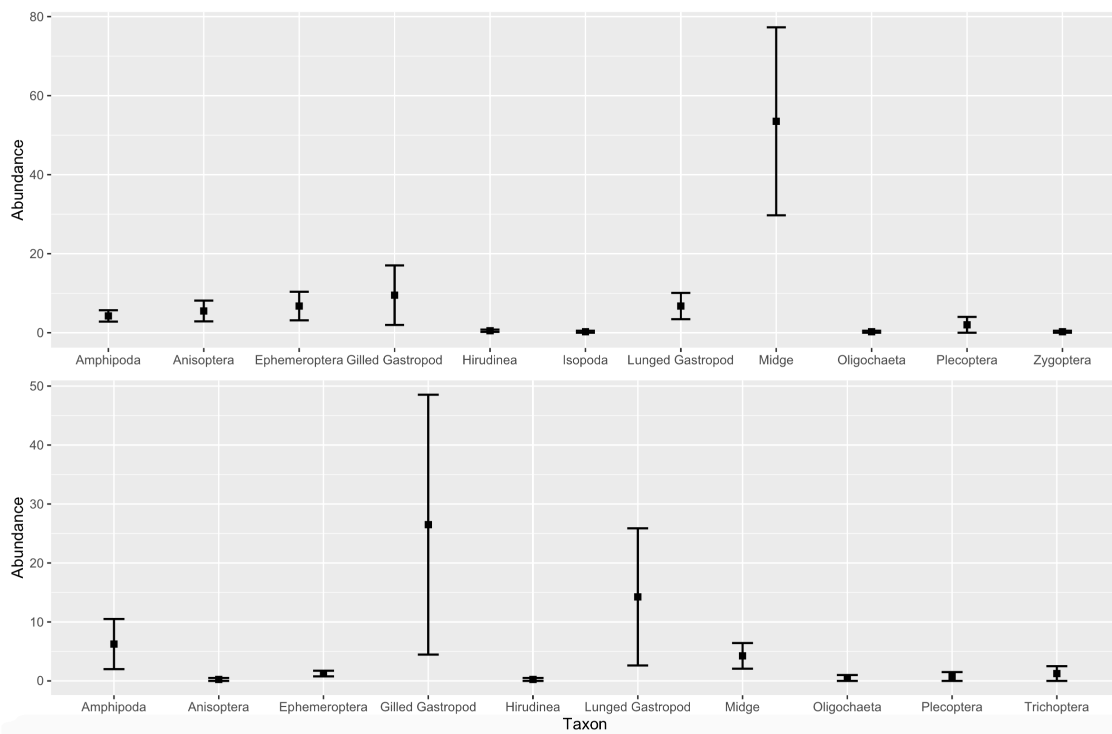

Figure 1 shows the abundance for each taxonomical group at the urban site (top) and at the restored site (bottom). The two major differences shown in this graph is that more gilled gastropods were in the restored site, and there were more midges in the urban site.

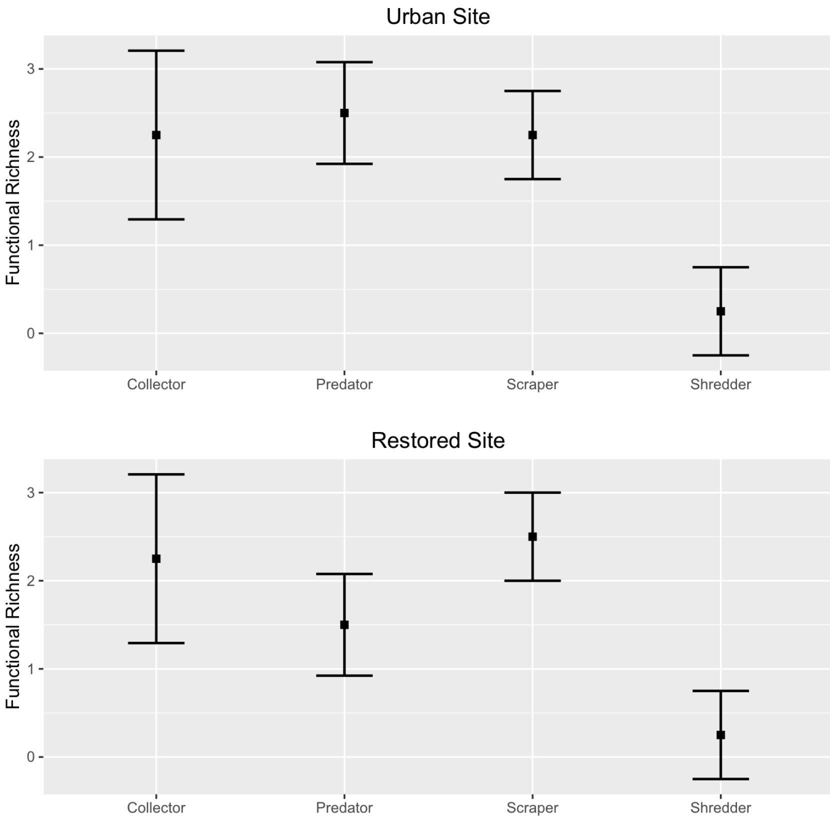

Figure 2 shows the functional richness for the urban (top) and restored (bottom) areas. No functional guild shows a significant difference across sites.

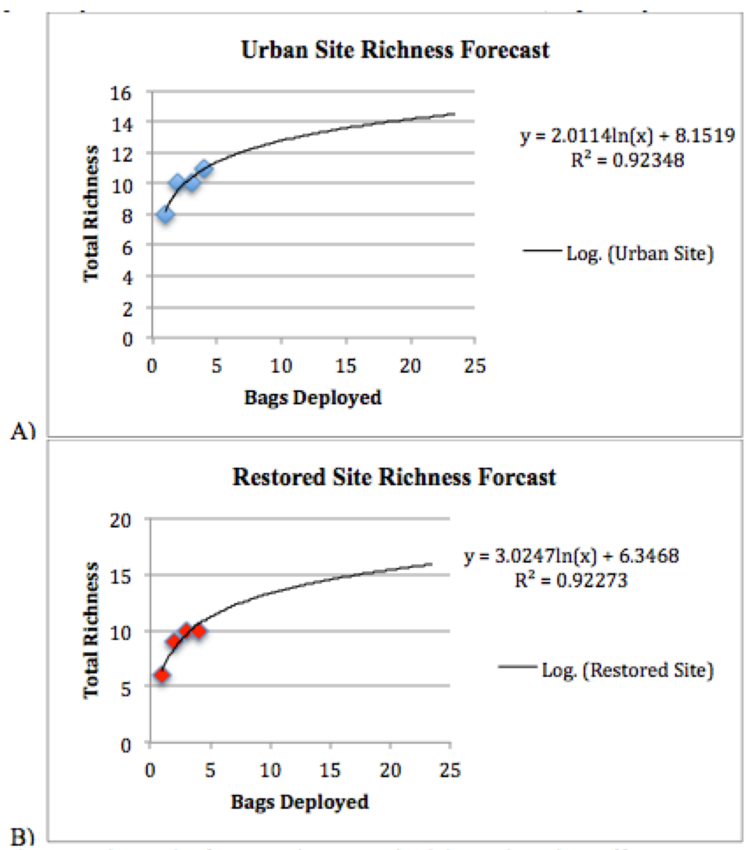

Figure 3 shows the forecasted taxonomic richness based on effort. Forecasts predict a greater taxonomic richness in the restored site than the urban site; however, gathering more data is imperative to achieve precise estimates on richness to advise more proper management techniques.

Effort modeling (figure 3) shows that there is a need for further samples to more precisely indicate the taxonomical richness in each site, especially the restored site.

The Shannon index, a common diversity index, shows that the diversity between sites only differ by 0.06 units. A small difference in diversity and richness shows that the abilities for all species found in this study have the capability to disperse to the preferred habitat.

The environment between sites is similar for nutrients including phosphate, nitrate, and pH; however, dissolved oxygen is 3.35mg/L greater in the restored area, suggesting that the more sensitive taxons such as mayflies and beetles (Davis 1975) can better survive and reproduce in the restored site. Greater abundance in midges, a low-oxygen tolerant member of the Diptera family (Davis 1975) in the urban site shows that dissolved oxygen is probably consistently lower in the urban site than the restored site. The midge (Diptera) is an excellent indicator of water quality in stream and lake ecosystems. Low oxygen, high pollution streams and lakes tend to have higher amounts of these Dipteran larvae as they are very tolerant and outcompete more sensitive species of macroinvertebrates (Wilson and McGill 1977).

Solution

The midge larvae populations in Red Bug Slough between the native restored stream ecosystem and the urban stream ecosystem were evidently different; however, a t-test showed no statistical difference. The urban stream site contained nearly ten times the amount of midge larvae as the native restored environment. Due to the relative youth of the restored site and its proximity to residential areas, abiotic factors between the two sites were relatively close, with the exception of dissolved oxygen content. The restored site had dissolved oxygen content of approximately 9.0 mg/L, while the urban site averaged 5.6 mg/L. Dissolved oxygen content is often one of the first abiotic factors to improve when conservation efforts are enacted in watersheds (Zedler 2000). This can help explain the striking difference in the midge populations. Using the midge as an indicator of water quality, where larger midge populations are considered indicative of lesser water quality, we propose preliminary empirical evidence that the native restored area contains a higher quality water environ than the urban area. Further evidence of this change can be seen in the population of gilled vs. lunged snails. Gilled snails are more vulnerable to polluted water and low-oxygen content than lunged snails (Davis 1975). There were nearly four times as many gilled snails in the restored area as there were in the urban area, providing strong argument for increased water quality in the restored area.

Taking these considerations, we propose the institution of more restored areas throughout Sarasota county watersheds. Using Red Bug Slough as a model, we have demonstrated that there are early indications of increasing water quality in the native restored areas. While there is preliminary evidence to support this conclusion, there is as of yet, no causative and significant data that indicates that the native restored area has significantly cleaner water than the urban area. We acknowledge this, but as Zedler (2000) outlines in their review of wetland restoration, it is nearly impossible to definitively say if restoring a watershed to its native wetland state will result in increased health of the stream ecosystem. However, indicator species, such as midge larvae and gilled snails, are used as early indicators quite often in these cases.

We also acknowledge the limitations of this study, as our species richness forecasts show, we have not reached optimum sampling levels with our current study. Therefore, with more data and sampling, we would be able to better indicate whether or not the reintroduction of native wetlands significantly increase water quality in the Red Bug Slough. If we better understand the effects on water quality of the restoration effort in Red Bug Slough, we can hypothesize the future effect of introducing more restoration sites throughout the Sarasota Bay area.

We therefore propose a three part tentative plan of action in response to the native restoration effort in Red Bug Slough. We first propose the protection of existing restoration sites and the creation of more restored native environs within Red Bug Slough. Second, we propose the allocation of more funding to increase sampling efforts with the goal of obtaining a clearer picture of the implications and effects of restoring native wetland habitats. Third, we propose a county-wide initiative to increase funding for restorations of native wetlands in other protected areas throughout the Sarasota bay front, and increase water quality testing to better understand where and how to implement restoration efforts to maximize the impact on water quality in Sarasota County.

Conclusion

Local water testing is fundamentally important for evaluating the status and health of our freshwater systems. No matter how seemingly insignificant a local freshwater source may seem, it more than likely influences greater freshwater bodies, including those aimed for human usage. Therefore, the wellbeing of these systems indirectly impacts our own wellbeing. Thankfully, testing these systems can be relatively cheap and simple. Water conditions can be quickly assessed through abiotic testing. However, it would be ill-advised to only test abiotic factors without also taking relevant biotic factors into consideration. The communities of organisms that reside in these areas can explain a great deal about the state of the ecosystem. Just like abiotic testing, collecting and assessing macroinvertebrate communities can be relatively inexpensive to perform. Unlike larger organisms, they can be collected and manipulated with comparative ease. These organisms exist within a careful balance of water conditions and biotic interactions. They are extremely sensitive to these conditions, so even small changes can greatly effect species composition and abundance. Macroinvertebrates can also be separated into functional categories based on how they consume their food. Increased functional redundancy, or having multiple individuals in the same category, at a location would be an additional clue to the ecosystem's resiliency to disturbances, like the introduction of pollutants. In addition, indicator species can be especially telling when looking at water conditions; for example, midges typically point to low-oxygen levels (Wilson and McGill 1977).

In order to evaluate the health of a local freshwater system, we went into the Red Bug Slough to sample for both abiotic and biotic factors. The Red Bug Slough is connected to bodies of water that have been defined as an "impaired" systems, which means they receive more pollutants than the total maximum daily input (Sarasota Bay Estuary Program 2006). We evaluated the differences between two ends of the Slough. One end was near a residential area that is affected by human waste and runoff and the other end was a restoration area upstream, that has been preserved with conscious human effort. These restoration efforts could improve the water conditions of the slough by encouraging natural biodiversity in organisms and vegetation, which would ultimately encourage ecosystem resiliency and recovery. We found that functional redundancy, indicated by functional richness, was similar in both locations. Taxonomic abundance was higher overall in the urban area than the restored area. However, the biotic data cannot be evaluated without taking the abiotic data into consideration. We also found that the levels of dissolved oxygen were far lower in urban areas, making the habitat unsuitable for more sensitive species like mayflies and beetles but suitable for low-oxygen tolerant species like midges. One of our most compelling findings was the need for further sampling effort. Our models indicate that the restoration area would have increased taxonomic richness when properly compared to the urban site. We projected through modeling that we would need increased sampling time and effort to accurately evaluate these systems.

This is of significant importance because, as previously stated, the wellbeing of these freshwater systems has implications for our wellbeing. Greater sampling effort must be achieved, and, for that to happen, funding must be available. Indeed, the overall goal of this endeavor was to encourage future research in this area, as well as more restoration projects at the Red Bug Slough and in places like it. There are a multitude of benefits for these initiatives. We can encourage at thriving ecosystem. By restoring and protecting current restoration sites, we have the chance to improve impaired freshwater systems. Increased biodiversity within these communities also conserve useful ecological services, which, if lost, could have dire economic implications. Protecting the ecosystem around areas like the Red Bug Slough could also provide the public with natural parks and recreational areas. On a larger scale, it could even encourage ecotourism. All of this being considered, local water testing measuring abiotic and biotic factors should be prioritized in order to accurately assess our freshwater systems; unfortunately, they are not.

References:

Chaves, H.M.L., and S. Alipaz. 2007. An Integrated Indicator Based on Basin Hydrology, Environment, Life, and Policy: The Watershed Sustainability Index. *Water Resources Management;* **21:** 883–895.

Davis, J.C. 1975. Minimal Dissolved Oxygen Requirements of Aquatic Life With Emphasis on Canadian Species: A Review. *Journal of the Fisheries Research Board of Canada;* **32**(12): 2295-2332.

Estevez, E.D. 1989. A Bay-Wide Monitoring Program Developed for the National Estuary Program. *Mote Marine Laboratory Technical Report;* no 149.

Sarasota Bay Estuary Program. 2006. State of the Bay: Celebrating our greatest natural asset. Retrieved on November 12 2016. http://www.sarasotabay.org/documents/StateOfTheBay_06.pdf.

Vollmer, D., H.M. Reganm and S.J. Andelman. 2016. Assessing the Sustainability of Freshwater Ecosystems: A Critical Review of Composite Integrators. *Epub;* **45**(7): 765-780.

Wilson, R.S., and J.D. McGill. 1977. A New Method of Monitoring Water Quality In a Stream Receiving Sewage Effluent, Using Chironomid Pupal Exuviae. *Water Research*; **11:** 959-962.

Yarbro, L.A., and P.R. Carlson. 2016. Summary Report for Sarasota Bay. *Florida Fish and Wildlife Conservation Commission SIMM Report;* no 2.0.

Zedler, J.B. 2000. Progress in Wetland Restoration Ecology. *TREE*; **15:** 402-407.