One Leaf at a Time: Leaf Pack Assembly at Red Bug Slough

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Photographs by Emily Saarinen

This is the pond nearest to the neighborhood at Red Bug Slough. Notice the concrete drainage area which might be a conduit for contaminated runoff from the neighborhood.

It was a stormy afternoon on October 3rd at New College of Florida. Black clouds and lightning loomed in the distance, threatening to strike any moment as we boarded the van to Red Bug Slough. Safely stowed away in the back of the van are eleven oyster bags. These bags, transformed into leaf packs, were jam-packed with fallen leaves and a single rock. Each were fastened with every good ecologist's favorite tool: the zip tie.

We were racing the storm in order to deploy these bags, which would become a home for a diverse array of organisms, given water quality at Red Bug Slough. Sloshing through puddles, we arrive on the site with two very different pond locations. Red Bug slough is made up of a grassy open space flanked on one side by sparkling water and quaint homes on the other. The two worlds are connected by a single culvert draining water and runoff from the houses adjacent to the slough. Dragonflies were busy flying about, finding mates, food and a safe place to deposit their eggs. Frail palm trees and saplings lined the shore, creating a lush habitat for vertebrates and invertebrates alike. The still water was constantly being disturbed by insects flying to and fro trying to avoid the hunters lurking within the waters.

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The pond nearest to the neighborhood should show greater levels of nitrogen and phosphorus due to runoff from fertilized lawns and gardens. These nutrients can adversely affect the number of organisms present. Previous studies show that the greater the nutrient level, the more eutrophic or blanketed with algal growth the water body should be. Photosynthesis requires oxygen inputs in addition to nitrogen and phosphorus for plants to make their own food. Algae and other aquatic plants absorb dissolved oxygen from the surrounding aquatic environment. Adding extra nitrogen and phosphorus to an aquatic system increases the ability of algae to photosynthesize more, grow and take up more oxygen. This can prevent other aerobic organisms from thriving in these areas simply because there is not enough oxygen to support respiration. If algal growth absorbs a significant amount of oxygen, it can create a dead-zone where no other organisms can live.

The other pond, a short walk away, was deemed restored through planting native vegetation around it. The native vegetation chosen for this system includes pickerelweed, fire flag and soft rush. All of these plants thrive in wet marsh areas surrounding open water. They function as nutrient vacuums, using up nitrogen and phosphorous for their own photosynthetic processes. The lack of available nutrients discourages algal growth and results in a more dissolved oxygen healthy system. Outwardly, the two ponds looked similar in lack of visible algal growth. What would be revealed under the surface?

"Let's think about where we want these bags to go?" asked Dr. Emily Saarinen, our professor and group leader. Overwhelmed by our options, Dr. Saarinen suggested sinking five bags into the restored pond and the remaining five into the pond adjacent to the neighborhood in the main slough. Such organism assemblies describe the health of the ecosystem in question, given abiotic, biotic and dispersal conditions. Therefore, we expected to see differences in the community assemblies of each site as a result of water quality.

The goal of this experiment was to determine which pond would yield the most species diversity; the restored pond was hypothesized to have more species diversity because there is no culvert draining runoff into it, therefore it would have less of a nitrogen input, and less of a human impact overall. Abiotic data was taken at each pond to see if differences exist between the two bodies of water. These abiotic factors can impact the role, or niche, an organism can fill in the environment. For example, if an environment is lacking in dissolved oxygen or nitrogen, the organism may not be able to survive or find sufficient food to eat. If the organism is an herbivore, the abiotic conditions for its plant food are specific and if changed, might have negative effects on other species in the environment. We measure this abiotic data to determine what conditions might be favorable given the organisms and their roles in the ecosystem.

We set up the first five bags in the pond nearest to the neighborhood. Checking to make sure they reached the bottom, we scouted out various locations throughout the main water body to sink the bags. We wanted to get a clear idea of the spectrum of life in the slough. The best way to go about this was arranging the bags in different areas around the ponds to sample species assemblies across the systems. After locations were agreed upon by professor and student alike, the bags were deployed to start collecting data.

After a short walk, the restored pond came into view. This water body was much smaller, and more densely lined with vegetation. As with the main slough, the locations to deploy the bags once again had to be determined. A quick discussion was held, all while looking over our shoulders and keeping an eye on the storm. We dispersed into groups, and the bags were safely deployed and anchored to nearby saplings. Small yellow flags were hidden among the foliage so we could easily find the bags again in two weeks time. With our task finally completed, we headed back to the college as the storm finally let loose its furious anger.

Cat and Gabi deploying a bag at the restored portion of Red Bug Slough

Two weeks passed before we returned; enough time for nature to do its work. This time, there was no storm looming and threatening to stall the experiment, in fact, conditions couldn't have been better. The class split into small groups to collect the bags and abiotic data. We collected abiotic data on dissolved oxygen levels, fecal coliform, phosphate, nitrate, pH, total dissolved solids, salinity and conductivity. This data is necessary in any body of water as it tells scientists about the health of the system, and can be used to predict which organisms may be found there.

Once all the bags were collected they were taken back to the lab for analysis. Each site yielded the same species richness, showing that 15 species were represented in both ponds. The fact that both systems had similar species richness is expected given the proximity of each water body to one another. Also, the majority of these species can fly so dispersing their eggs among these two ponds is not an obstacle.

Calculating diversity, or the variety of species present in an area, is essential for determining ecosystem health. Even knowing biological diversity in a few areas can tell us about the overall ecosystem health. When comparing two systems, a lack of diversity may tell of some imbalance of organisms or abiotic factors. A community with high diversity level may be a system with a complex array of species present. The Shannon diversity index measures both the abundance and evenness of species in a community. Looking at the total number of individuals and how close the number of individuals per species reveals how much species diversity is present in the community. The index score must be transformed into a Shannon evenness value for interpreting diversity results. The closer the value is to one, the closer the community is to evenness and less diversity is present. A smaller value indicates that many species are present with varying abundances, reflecting a less even and more diverse community. The evenness result is strikingly similar for both the neighborhood and restored pond. Both systems had an evenness value around 0.45. The neighborhood pond had a slightly lower score, meaning that it had more diversity present than the restored area.

As far as species abundances are concerned, midge fly larvae were the most abundant organism collected at the pond nearest to the neighborhood. Midge flies are a harmless insect that explode in abundance over spring and fall months. Masses of ruby red larvae result in swarms of flies that contribute to the community dynamics. Adults lay eggs on the surface of the water, and their eggs attach to debris or sink to the bottom. After the larvae hatch, they burrow into the bottom layer of mud and consume organic matter. Due to the fall timing of this study and the bags being laid at the bottom of the lake, it is not surprising that the midge fly larvae were the most abundant species present in the bags. However, we are unsure how the abiotic factors at the two ponds may have had an effect on the abundance of midge fly larvae.

Snails were another common organism found in the bags at the pond nearest the neighborhood. Certain species of snail can be good water quality indicators, as they are sensitive to certain chemicals in the water. They are also an important food source for vertebrates, especially juvenile fish. Snails themselves feed on decaying matter, so it is no surprise they would be found at the bottom where all the detritus falls. The placement of our decaying leaf bags at the bottom of the pond was the ideal place for a snail to feed.

Dragonflies were another common organism found in the leaf packs at the pond nearest the neighborhood. Dragonfly larvae are aquatic and predatory, feeding on other live organisms as they grow. We provided the ideal snack pack for dragonfly larvae to feed on invertebrates and grow, which would account for their high abundance in this pond.

The main abiotic data that we wanted to look at was nitrogen levels and how they compared at the two locations. We predicted that the neighborhood pond would have higher nitrogen levels due to increased human impacts from fertilization runoff. We also thought that the water would be more acidic (lower pH), because fertilizers are known to make soil in water more acidic. Surprisingly, neither of these abiotic factors differed at the two locations. In fact, the tests showed the exact same values for the two locations. This was not expected, but it agrees with our diversity results. The diversity at the neighborhood pond was slightly higher, but there was not a significant difference between the two locations, so we can assume that they are about the same.

Another important factor to consider is the weather; when we went to collect the bags and take our abiotic measurements, the slough had just received a good amount of rain. This could have had some major effects on our abiotic conditions. One possible effect is that the rain could have increased the potential runoff into the neighborhood pond. Alternatively, the rain may have diluted the water, possibly changing the abiotic factors by either raising or lowering the pH, changing the dissolved oxygen in the water, or raising or lowering the amount of nitrogen in the system. We think this could be a possibility because there is more water to the same amount nitrogen.

Overall, this experiment allowed us to explore leaf pack community assembly and abiotic factors in Red Bug Slough. The species mosaic of this freshwater system reveals the diverse array of leaf pack organisms. With every fallen leaf, a community is born. □

The leaf pack deployment crew: Gabi, Alex, Kevin, Kelsey, Cat, Rachel, Dr. Saarinen and Danielle