Comparative Analysis on Man-Made versus Natural Wetland Water Systems Final Report

Regarding nutrient filtration and water quality of the water systems on the University of Central Florida campus

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Analysis of wetland construction variability with respect to nutrient and pollution handling will contribute further insight into potential trends and cost benefits from wetland/retention modifications, as well as positive social and environmental contributions.

Introduction

Historically, Florida landscape was once covered with a majority of wetland areas that served as natural floodwater retention areas and habitat. More than 200 million acres of wetlands existed in the lower 48 states during colonial times. Less than half remain today largely due to conversion to agricultural, urban, or suburban land (Environmental Protection agency 1996). Florida alone has witnessed over half of its original wetland habitat lost. Since wetlands serve as a habitat for diverse biological life, they are considered some of the most important ecosystems in the world (Gu 2008). Wetlands also serve a variety of biological functions and help facilitate several biogeochemical cycles (Dreschel 2008). Biogeochemical cycles are the movement of matter within or between ecosystems, and are caused by living organisms, chemical reactions, or geological forces. As a result of urban development however, man-made water retention has been utilized as a replacement for wetland areas to account for storm water accumulation and runoff. These man-made systems include the retention ponds and canals that are seen throughout developed areas. Traditionally, these structures have been utilized for containment, transfer and storage of access water, and have failed as serving as efficient nutrient and pollutant filters. They are often aesthetically unattractive, devoid of biological diversity, and serve only a limited function as a rain water runoff containment source.

According to the Miami chapter of the Sierra Club, "The number one source of today's water pollution stems from storm water which leads to combined sewer overflows and urban runoff [and] as a result, water quality is lowered, threatening human health and endangering the vitality of our ecosystems." Many recent studies over the last several decades have continued to provide evidence in the added value and efficiency gained from modifying these retention areas into constructed wetlands to serve as buffers against pollution runoff and act as nutrient sinks (Sim 2007). Nutrient sinks are storage areas in an ecosystem that contain the organic matter and nutrients within that ecosystem. Seeping water from wetlands can recharge ground water supplies. Unaltered wetlands in a floodplain can reduce flooding. The natural water filtration and sediment control capabilities of wetlands help maintain surface and ground water quality (EPA 1996). Wetland water quality can be impacted by many of the same sources that affect other surface water resources, including fertilizer, pesticide, herbicide, and sediment runoff. As a result of wetland depletion, nutrient sensitive habitats have become exposed to ever increasing nutrient pollution including river and estuary ecosystems. As a result of eutrophication, or excess nutrient loads that cause depletion in dissolved oxygen, this has created an increasing interference to maintaining healthy aquatic habitats. By instituting best management practices (BMPs), which would utilize appropriate planting and spacing techniques in retention areas, we should be able to make a marketable reduction in our overall nutrient deposition, facilitating decreased nutrient extremes and greater homeostasis for our local ecology.

Methods

- Collect and analyze pond data.
  - Go to a local natural wetland area and observe the thriving plant and animal species (**Appendix A**)
  - Formulate a plan as to how to implement this on the University of Central Florida campus. See **Figure 1** for a map of the retention ponds at UCF.
- Put together a Plant Database.
  - Include Florida native plants that would be beneficial for future planting of the UCF ponds.
  - Include parameters of the plants, such as pH range, water use, and size the plant will grow to.
- Survey select retention ponds at UCF.
  - Include plants from the Plant Database.
  - Include where these plants will have the most beneficial impact for that specific retention pond.
- Take water samples of the surveyed retention ponds.

    - Analysis will include water quality parameters such as nitrogen, phosphorus, oxygen, copper, and lead.
    - Also take measurements of pH, dissolved oxygen and conductivity (**Table 1**)
- Create a plan of action for future Sustainability Water Systems group members.

Outcomes and Results

- Baseline water measurements for campus retention ponds were collected and logged. Samples were also collected and stored for future composition analysis of orthophosphate, nitrate, nitrite, and chlorophyll. Points locations referenced in Figure 2.

UCF Water Quality Monitoring Data

Site	**ID**	**Collection Date**	**Time**	**pH**	**Temp (deg C)**	**Cond (uS/cm)**	**DO (mg/L)**	**Ambient Conditions**	**Flow Conditions**
W5-N	W5-N	12/2/2010	9:15 AM	6.83	13.7	195.8	7.39	SUNNY	SLIGHT
4-R	4R-O	12/2/2010	9:45 AM	7.66	19.4	169.4	8.6	SUNNY	VERY SLIGHT
W-9	W9-O	12/2/2010	10:23 AM	6.88	13.9	197.3	7.5	SUNNY	MODERATE
2-H EXT	2H EX-BL	12/2/2010	10:38 AM	7.14	19.8	199	6.77	SUNNY	SLIGHT
2-H	2H-O	12/2/2010	1:26 PM	7.2	19.9	236	7.45	SUNNY	SLIGHT
LkClr	LC-DK	12/2/2010	11:25 AM	7.27	20	150.8	8.34	SUNNY	NA
1-D	1D-O	12/2/2010	11:34 AM	7.34	20.6	220	8.05	SUNNY	NONE
3-A	3A-O	12/2/2010	11:49 AM	8.18	19.4	209	8.65	SUNNY	NONE
LkLee	LL	12/2/2010	12:00 PM	6.83	20.4	140.4	7.98	SUNNY	NA
BCrk	BC-I	12/2/2010	12:15 PM	6.81	19.4	154.3	6.35	SUNNY	NONE
4-M	4M-O	12/2/2010	12:25 PM	7.58	19.9	195	7.74	SUNNY	SLIGHT
4-L	4L-O	12/2/2010	12:30 PM	7.14	20.1	205	7.4	SUNNY	SLIGHT

Table 1

- An excel spreadsheet was compiled for use as a GIS database file which was compiled to contribute to future and ongoing studies of campus natural land. It includes plant species parameters such as pH range, watering demands, max. growth height, suggested planting density, etc. (**Attached File "Campus Plant Database"**)
- A hard copy field guide was compiled which describes the planting parameters for plant species within our database. See "Wetland Plant Database".
- Current plant species composition at retention ponds 4-B were surveyed and logged into GIS and digitized onto campus maps. These surveys, when completed for the remaining campus, will provide a database of current species diversity. This will allow for easier determination of future pond modification sites, as well as provide a baseline for potential future campus plant species monitoring.
- Planting locations were identified for pond 2-H and digitized into ArcGIS to serve as a guide for project execution. **Figure 3**
- We were able to successfully plant and execute modifying retention pond 2-H with 72 native Florida tree and shrub species.

Plants Used

Scientific Name	**Common Name**	**Quantity**	**Price**	**Total**
Pinus palustris	Longleaf Pine	10	$2.00	$20.00
Pinus elliottii	Slash Pine	2	$1.75	$3.50
Gordonia lasianthus	Loblolly Bay	6	$6.00	$36.00
Ilex cassine	Dahoon holly	12	$5.50	$66.00
Persea palustris	Swamp Bay	11	$6.00	$66.00
Baccharis halimifolia	Salt Myrtle	3	$4.50	$13.50
Callicarpa americana	American Beauty Berry	1	$4.50	$4.50
Rhus copallina	Shining Sumac	4	$5.00	$20.00
Serenoa repens	Saw Palmetto	3	$3.50	$10.50
Vaccinium corymbosum	Highbush Blueberry	3	$10.00	$30.00
Vaccinium myrsinites	Shiny Blueberry	2	$3.00	$6.00
Lyonia lucida	Shiny Lyonia	2	$2.50	$5.00
Myrica pusilla	Dwarf Wax Myrtle	2	$5.00	$10.00
Rhododendron serrulatum	Swamp Azalea	12	$5.00	$60.00
	Total	73		$351.00

Changes from Proposal

At the initial onset of our project, we had planned on accomplishing at least two wetland modification sites where wetland vegetation species would be planted around similar pond types. The barriers we encountered forced us to deviate from our original proposed actions. In order to have successfully implemented our intended proposal in a timely manner we needed more planting, plant variation and water nutrient measurements. Originally, we had constructed a specific plant list of species that was typical of a Florida wetland marsh system for the UCF ponds. Unfortunately, the availability of plants at the time was limited to more Zone A upland species, so we adopted a new summery of vegetation that reflected these changes[1]. The planting zones were also changed due to plant availability, which altered the diversity of species we had planned. Initially it was stated that we would pursue plantings at three ponds and compare that data to a control pond. We were only able to accomplish one planting event around pond 2-H as of the construction of this final paper, and only baseline data was able to be compiled. We will not be able to compile further water quality data as part of this class study.

Other adaptations to our barriers include the scope and timeline for delivering future pond modifications and monitoring. Instead of just a one semester, one time study, our new goal became to compile research and resources, and to establish a standard of practice for conducting habitat restoration on campus so that future students could utilize our data and research, in an effort to ease future project complications.

Although we did not arrive at the final product, we have gathered research, GIS mapping data, and wetland plant attributes to easily extend the project into the Spring of 2011.

[1] Zone A: This zone of plants acts as a buffer between the retention pond and the outside area around the pond. This zone filters rainwater that might flow into the pond over the topsoil, and also discourages grass mowing right up against the pond, typically 1-2 feet above water line. Also see Wetland Plant Database field guide.

Barriers Encountered and Solutions

We ran into a few barriers as we started to undertake the goals we set out in our proposal. Our initial ideas were to have a few planting events that mainly focused around aquatic species. It turned out that there were no aquatic plants available to us this semester, but there was a list of upland plants that our group had for use. Our solution was to expand our scope to include aquatic and shoreline buffer vegetation for a more comprehensive approach to the ecosystem restoration. Other influential barriers we ran into were in our water quality sampling efforts. The equipment available to us through UCF Landscape and Natural Resources (LNR) was not stored properly and the calibration solutions necessary for the devices to give accurate readings were not available to us. We also planned on a partnership with Orange County Environmental Protection Division (EPD) to process some other water quality data. It was more difficult to accrue their cooperation than expected. There were several individuals within the bureaucracy that we needed approval from before we could get our samples processed. Our EPD contact also fell ill at a crucial time, along with new EPA numeric nutrient analysis regulations that were going into effect which posed a potential complication from regulatory and permit agencies. We were finally able to come to an agreement with the EPD to process the necessary data from the ponds. They were also able to supply us with test kits to find pH and dissolved oxygen to account for the unusable water quality devices.

Suggestions for Project Improvement

The execution of restoring man made retention ponds into sustainable ecosystem relies heavily on subsequent generations of students. By proposing the need for better water quality, increased plant biomass, and an overall renewed understanding of sustainable habitats we create a legacy for others to follow. Researching and discovering the source of natural wetland vitality has allowed us to implement similar practices for the University of Central Florida’s retention ponds. This, however, is only the beginning. Improvements would include: continued planting for other UCF ponds; establishment of plant biomass for all wetland zones including aquatic vegetation; and further data from the results of establishing these new ecosystems. By continuing this project, nature not only benefits from the outcome but so does the public. It is intended that people should find a new respect for their environment as they begin to see the progress and change we can create. By improving scientific results and expanding planting zones, the final product of pond renewal can be fulfilled.

<u>Works Cited</u>

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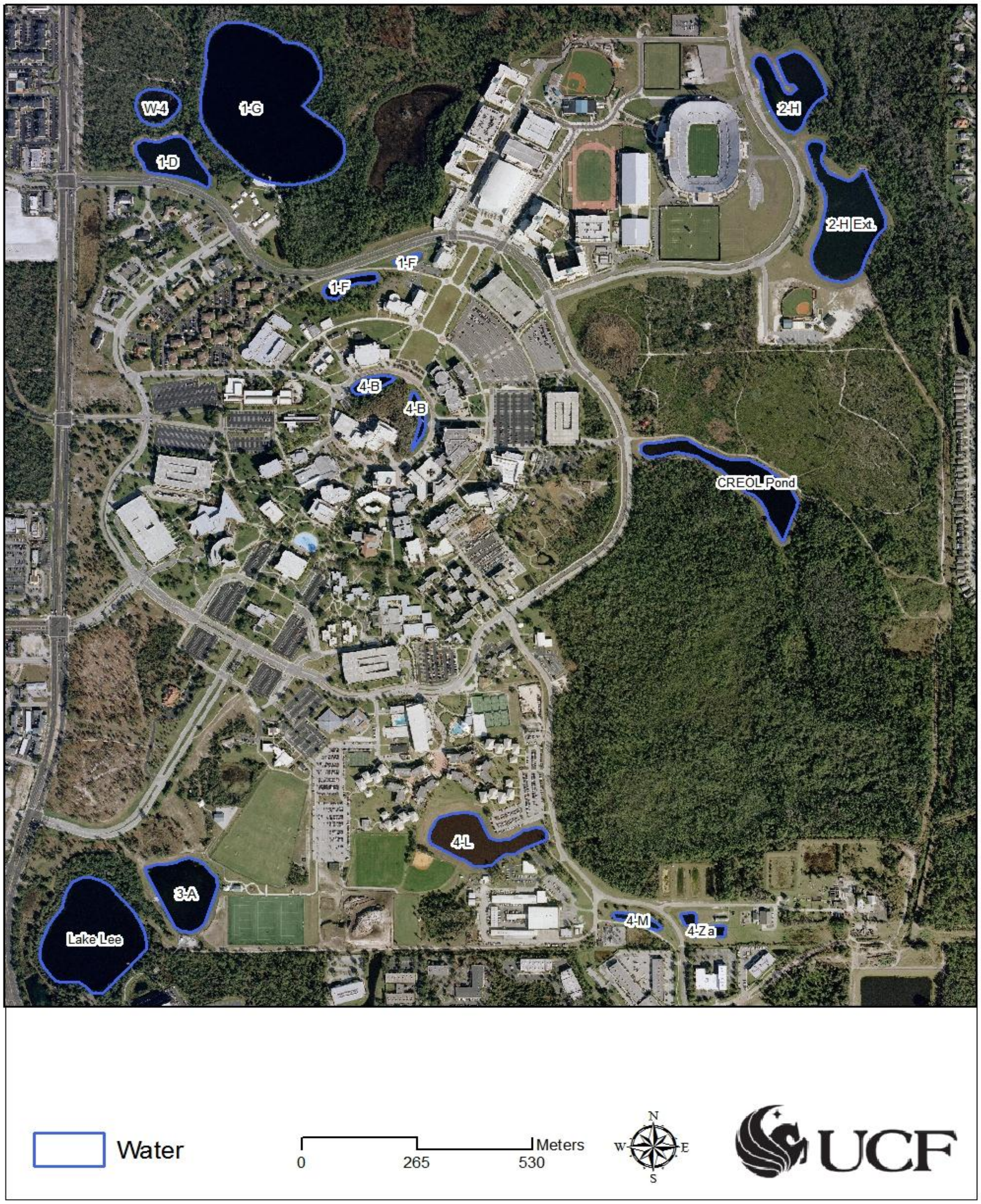
Figure 1.



UCF Retention Ponds

Figure 2

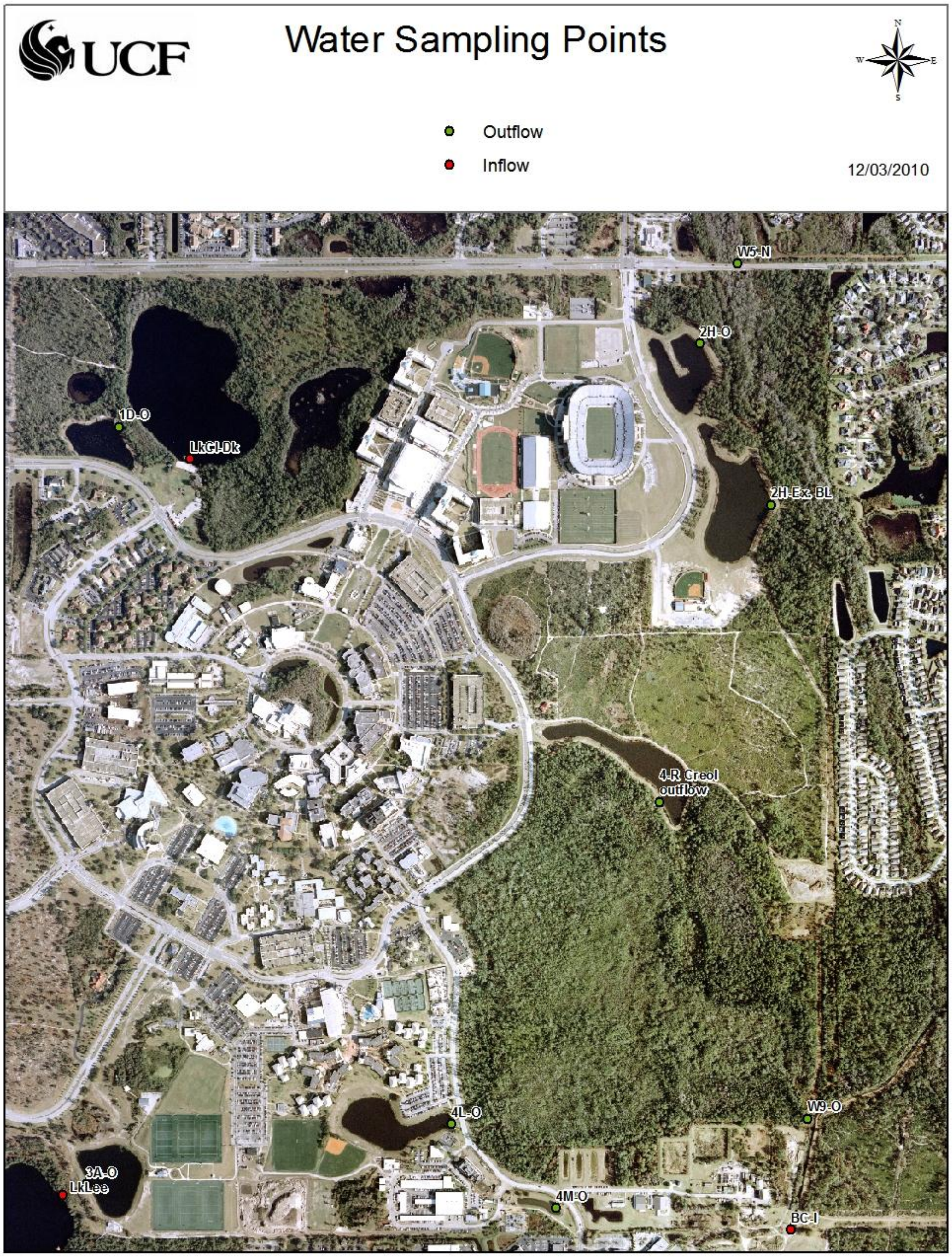
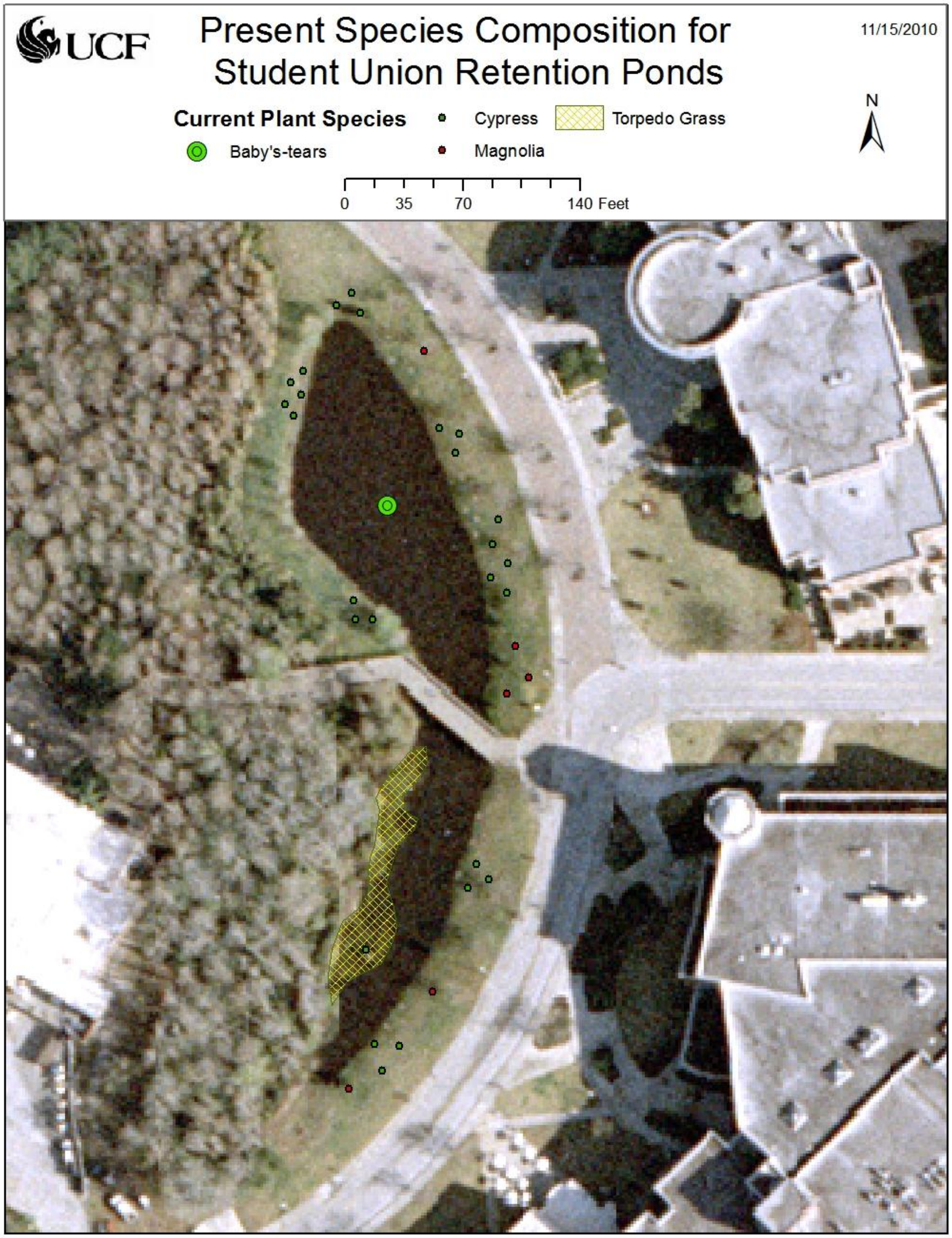

UCF
Water Sampling Points
N
W
E
S
Outflow
Inflow
12/03/2010
W5-N
2H-O
1D-O
LkGl-Dk
2H-Ex. BL
4-R Creol
outflow
4L-O
W9-O
3A-O
LkLee
4M-O
BC-I

Figure 3


UCF
Present Species Composition for
Student Union Retention Ponds
11/15/2010
Current Plant Species
Cypress
Torpedo Grass
Baby's-tears
Magnolia
N
0
35
70
140 Feet

Appendix A

Entering UCF mitigation bank McKay Tract wetland.

Maple canopy within the McKay Tract.


Typical hydrology of wetland systems requires high moisture saturation for prolonged periods.


Prolonged changes in hydrology affect plant mortality and species diversity.

Wetland hydrology supports numerous and diverse plant species.