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Abundance and Habitat Preferences of Introduced Muscovy Ducks (Cairina moschata)

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by

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ABSTRACT

Muscovy ducks are native only to Central and South America, Mexico, and parts of southern Texas and are considered invasive in some areas outside of their native range. Although they have been introduced worldwide, they remain largely unstudied. The primary focus of this study was to relate Muscovy duck abundance to habitat characteristics of wetlands in Tampa, Florida. Muscovy abundance was measured using point count methods at 21 wetland sites that occur within an eight km radius of the University of South Florida's main campus. Habitat features at these sites were assessed using field methods and Geographic Information Systems (GIS) (Arc 10.1v). Mann-Whitney U tests and Chi-squared tests were performed to identify significant differences between quantitative data groups. A Chi-squared test determined that there was not a positive correlation between Muscovy abundance and fountains or water regime, yet identified a significant relationship between Muscovy abundance and fencing, in which Muscovies did not frequently occupy ponds with fencing. Mann-Whitney U tests did not identify significances between Muscovy abundance and other habitat groups. Since Muscovy ducks are listed as an invasive species, identifying habitat preferences and deterrents will assist land managers and property owners with habitat modifications in preventing or controlling nuisance Muscovy populations.

CHAPTER ONE:

INTRODUCTION

The number of translocated species continues to rise with expanding global commerce, trade, and travel, causing homogenization of biodiversity. The International Union for the Conservation of Nature (IUCN) has developed the Global Invasive Species Database (GISD) and currently red-lists 100 species as the worst invasive species worldwide that have had the most devastating ecological and/or economic impacts. Whether intentionally or unintentionally introduced, species that became invasive, such as the Black rat (*Rattus rattus*), Lionfish (*Pterois volitans*), Kudzu (*Pueraria lobata*), and Ruddy duck (*Oxyura jamaicensis*), have decimated populations of native species through predation, competition, disease transmissions, or hybridization (GISD; Grant-Hoffman et al., 2009; USFWS 2010).

The wild Muscovy duck is native to South and Central America, Mexico, and parts of southern Texas. Muscovies are large, territorial birds and have distinguishing iridescent color patterns and red, fleshy facial caruncles (Fig. 1). Domesticated and introduced Muscovies tend to be larger in size, display white or pied black color patterns, and have more pronounced facial caruncles than their native counterparts. (Woodyard & Bolen 1984; Stahl 2005). The species is commonly raised for meat, and its popularity as a food source can be attributed to their size, non-fixed breeding season, prolific egg production,

precocial hatchlings, and relative resistance to less contagious disease than other fowl (Stahl 2005). The escape or intentional release of domesticated Muscovies resulted in successful establishment of large and sometimes dense, populations in novel environments. Aside from recent work by Downs et al. (2013, 2017), the Muscovy is not well studied outside of its native range. The purpose of this study is to relate Muscovy duck abundance to habitat characteristics of wetlands in Tampa, Florida

Figure 1: Introduced Muscovy ducks. (A) Male. (B) Female. Males are typically larger with darker, more pronounced facial caruncles.

The literature review in this chapter will give a brief overview of what is known about the life history of the Muscovy duck in its native range, as well as the reproductive phenologies determined in wild and agricultural settings. The literature review further discusses results from our previous studies about Muscovy habitat use and briefly examines general impacts of invasive species, specifically those directly related to Muscovy ducks, such as disease transmission, water quality degradation, and hybridizing with members of the same genus. Research objectives are listed at the end of this chapter as well. Chapter 2 describes the study area and outlines how it was selected, Chapter 3

describes the methods implemented for each research objective and postulates a framework for data collection and analysis, Chapter 4 describes the results, and lastly, Chapter 5 provides a discussion about the results, illustrates the significance of the research and its implication for land managers, the limitations of the study, and future work.

Literature Review

The Muscovy Duck (Cairina moschata)

The wild Muscovy duck is native to South America, Central America, Mexico, and parts of southern Texas and is commonly domesticated and raised for meat across the globe. Their popularity as a food source can be attributed to their size, non-fixed breeding season, prolific egg production, precocial hatchlings, and relative resistance to less contagious disease than other fowl (Stahl 2005). Little literature exists on both wild native, and introduced feral Muscovies, and most information on the species is discussed only in general terms. Woodyard and Bolen (1984) offer the most comprehensive biological study on the wild Muscovy in its native range, in which food habits, nest-box utilization, duckling growth, and endoparasite occurrence were examined at various locations in Mexico. Their results suggest that Muscovies are opportunistic food generalists and are adaptable to a variety of local conditions. They found Muscovies along the shorelines of slow moving riverbanks and streams, natural and man-made ponds, swamps, and lagoons. The species tends to remain close to trees, shrubs and bushes, nesting in tree cavities and nest boxes erected near water sources. Muscovies are opportunistic eaters, forging on the seeds,

stems, and roots of aquatic plants, termites and other insects, small reptiles and invertebrates, and agricultural crops (Stahl 2005; Woodyard & Bolen 1984).

Markum and Baldassarre (1989) further examined the nesting biology of wild Muscovy in Mexico, addressing average clutch size, egg size, nesting phenologies, and length of nesting season. Nest boxes were also used in this study to determine the aforementioned parameters. However, data was restricted to nest boxes, and Muscovies utilized only 13 of 407 nest boxes built for the study. Areas around the study sites were not surveyed for nests that may have occurred under shrubs or in natural cavities. The authors determined the average clutch size to be 13.6, and incubation lasted 30 days. Most eggs were observed to be glossy white in color, averaging 66.4 g in weight and 61.25 x 44.55 mm in length. Overall, it was determined that the nesting season spanned late April to early September and averaged 135 days. Muscovies were also informally observed to nest in October in Mexico and in December, February, and May in South America (Markum & Baldassarre, 1989). Such a wide range may indicate a correlation between nesting and the rainy season, as suggested by Johnsgard (1975). However, long-term records would be needed to determine this relationship. Muscovies do not appear to have a fixed migration pattern, and appear to move due to fluctuating water conditions (Johnson & Hawk 2012; Stahl 2005). Therefore, it is possible that nesting and breeding occur year-round.

Downs et al. (2017) systematically surveyed behaviors and habitat use patterns of introduced Muscovy ducks in Tampa, Florida. The findings suggest that like their indigenous counterparts, introduced Muscovies are highly adaptable, specifically to urban locations and to human activity. Introduced Muscovies occupy a variety of land cover types, including open water ponds and wetlands, grass, trees and shrubs, and urban land. Open

water was used mostly for swimming, bathing, and foraging, and the pond shorelines were used primarily for roosting and resting. Muscovies were found to forage predominantly in grass and tree-covered habitats, while shrubs and urban habitats were used primarily for resting and comfort activities. Introduced Muscovies have not been found to nest in tree cavities, but rather nest on the ground under bushes and shrubs near the water source and along-side buildings (Downs et al., 2017).

Escaped or intentionally introduced Muscovies have established widespread, global populations. In the United States, naturalized Muscovies are often considered a nuisance, and they are legally recognized as an invasive species due to their potential threats to other species and the environment (USFWS 2010). Muscovies have been known to compete with native wildlife for resources, degrade water quality, interbreed with other species native waterfowl, and transmit various diseases to native birds and domestic poultry (Downs et al., 2013).

Invasive Species Impacts

Competition

Invasive species have the potential to out-compete native wildlife for territory and food resources. In Singapore, the House Crow (*Corvus splendens*), White-vented Myna (*Acridotheres javanicus*), and Common Myna (*Acridotheres tristis*) have been known to outcompete native birds for nesting sites, and attacks and predation on smaller birds, their nests, and eggs have been observed (Yap et al., 2004). The Eurasian collared-dove (*Streptopelia decaocto*) has also been observed displaying aggressive feeding behaviors

towards Mourning doves (*Zenaida macroura*) in Europe and North America (Lim et al., 2003).

The Muscovy has become accustomed to living in close proximity to humans. Florida residents specifically have raised concerns over the escape or intentional release of domesticated Muscovy populations and over Muscovy competition with other waterfowl species (USFWS 2010). Muscovy ducks are described as prolific breeders, commonly outnumbering other waterfowl species at community ponds and wetlands and have been observed to display aggressive behavior when frequently fed by humans. In the Tampa Bay area, Muscovy ducks have been observed chasing away White Ibis and smaller duck species (USFWS 2010).

Water Quality

Waterfowl are important non-point sources of fecal contamination in water and are known carriers of *E. coli, Salmonella spp., Staphylococcus spp., Streptococcus spp*., and the protozoan Cryptosporidium (Swallow & Huffman 2010). Fecal matter also contains organic waste, nitrogen, and phosphorus, which can immediately threaten public health where water is used for drinking or recreational activities. Large concentrations of waterfowl can potentially cause an increase in bacteria and fecal coliform density. For instance, Canada geese (*Branta canadansis*) can defecate from 28 to 92 times per day, with wet weights of the fecal material averaging from 1 to 3 lbs. (Swallow & Huffman 2010; Williams 2015). It has been suggested that degradation water quality in areas with Muscovy abundance poses health hazards to humans and domestic animals (Johnson & Hawk 2012), although this has not been formally tested.

Disease Transmission

Invasive species are potential disease vectors and may threaten the health of native wildlife populations, as well as the general public and domestic animals. Dense populations of waterfowl tend to form in areas where humans frequently feed them, such as at parks and recreational sites. Many diseases that can be carried by waterfowl are not generally transmissible in the wild. When supplemental feed is scattered, waterfowl are eating where they defecate; thus combined with overcrowding conditions, greatly facilitates the spread of disease (Stop Feeding Waterfowl 2016). For example, most waterfowl die-offs in New York occurred due to the conditions created from artificial feeding. Over 2000 Mallards, Black ducks, and other waterfowl were killed from an outbreak of Duck Viral Enteritis (DVE/duck plague), Aspergillus infections from moldy feed, and Avian Botulism (Stop Feeding Waterfowl 2016). There are also cases where diseases have been transmitted to humans, such as Swimmer's Itch and Avian Influenza (H5N1). The H5N1 virus continues to circulate in birds and has spread to more than 60 countries. Specifically, the H5 and H7 subtypes are highly pathogenic, causing systemic illness and death in both avian and mammalian species, including humans. H5N1 is lethal to chickens and gallinaceous poultry, but often causes asymptomatic infection in some species of domestic and wild ducks (Kim et al., 2009). Muscovies are known to be susceptible to both H5 and H7 AIV subtypes (Phuong et al., 2011; Niqueux et al., 2014), DVE (Campagnolo et al., 2016), Parvovirus (Hess & Paré 2004), and the protozoa *Haemoproteus nettionis* (Sibley & Werner 1984).

Hybridization

Introduced waterfowl have been known to hybridize with native waterfowl. Perhaps the most well known case is that of the Ruddy duck, which is regarded as highly invasive in Europe. The Ruddy duck threatened the native, White-headed duck (*Oxyura leucocephala*) with extinction through hybridization and competition. Genetic studies revealed the extent of hybridization within white-headed duck populations and influenced eradication campaigns throughout Europe. Britain implemented a control program through three, regional control trials in 1992 and consisted of trapping and shooting of Ruddy ducks on a voluntary basis. Culling on breeding, post breeding, and wintering sights was significant enough to reduce their numbers regionally (Hughes et al., 2006). The UK received funding from EU-Life and managed to reduce their Ruddy duck numbers by 98% as of 2013. This case study illustrates successful control efforts originating in the UK based on the estimation of hybrid prevalence and declining White-headed duck numbers through genetic testing. It is unclear what, if any, socio-political factors influenced the eradication campaign.

There have been instances of hybridization between male Muscovy drakes and females of other species of ducks, predominantly Mallards (USFWS 2010) (Figure 2). However, the prevalence of hybrids has not been thoroughly studied or quantified. Although the offspring from such pairings results in sterile mule ducks, Muscovy that are hybridized with species regulated under the Migratory Bird Treaty Act can only be controlled under federal regulation, which has raised concerns that this will impede government efforts to control Muscovy populations (USFWS 2010).

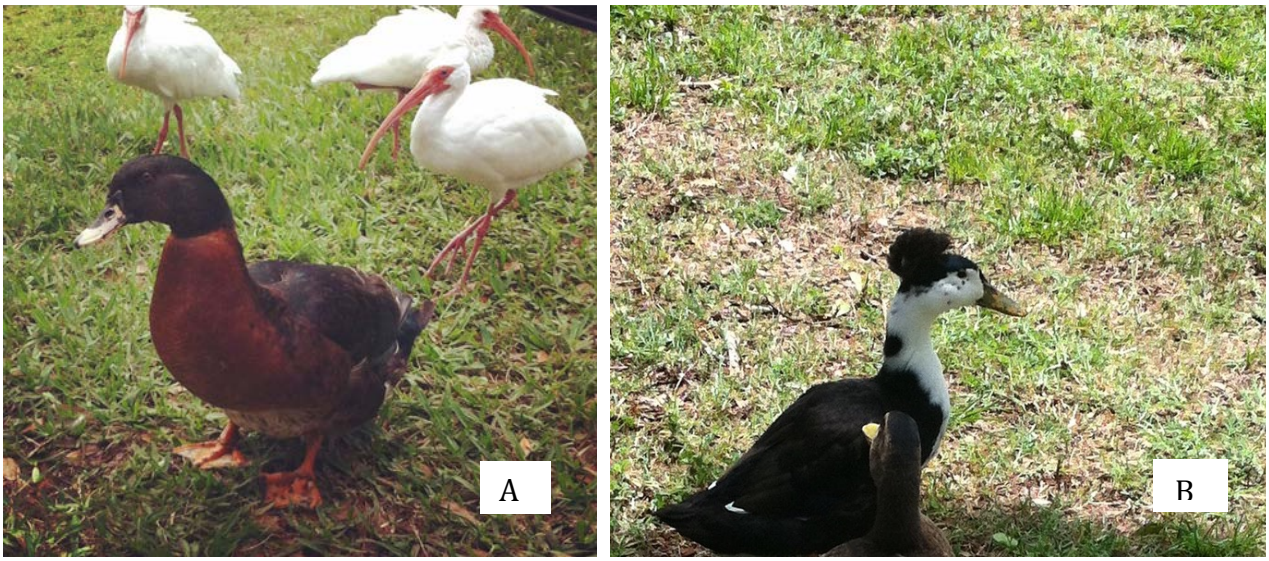


Figure 2: Hybrids observed during study. A) Muscovy-Mallard hybrid. B) Muscovy-Crested duck hybrid.

Habitat Modifications and Managing Nuisance Birds

Urbanized areas tend towards low avian species diversity, but are usually dominated by a small number of species with large populations (Møller et al., 2012; Haythorpe et al., 2014; Møller et al., 2015). Like other generalists, Muscovies have been able to take advantage of the distinct conditions of urban landscapes (Johnson & Hawk 2005). Anthropogenic variables, such as modified land use for agriculture, urban structures, and vegetation structure appear to have a direct correlation to both establishment success and distribution (Bonter et al., 2010). Population studies of the house crow (*Corvus splendens*), common myna (*Acridotheres tristis*), European starling (*Sturnus vulgaris*), and Eurasian collared-dove (*Streptopelia decaocto*) suggest both rate of population growth and overall abundance are tied to rates of urban development (Lim et al., 2003; Yap & Sodhi, 2004).

Habitat modifications to reduce human-bird conflicts are site specific, yet have been advocated as the proper way in managing species in general (Doncaster & Keller 2016). However, this strategy requires comprehensive, biological information about a species (Yap et al., 2004) and may adversely affect other species within the ecosystem, regardless of how minor those modifications are, and would require an ecological assessment. Singapore's efforts to control the common myna, an equally prolific species to the house crow, initially consisted of poisoning, scaring, and thinning/removing trees, and the solution was only short-term and partially effective (Yap et al., 2004). A multi-faceted approach was recommended for adopting long-term basis of control measures, integrating bioacoustics deterrents, canopy thinning, increasing garbage control in food centers, avoiding plantation of mono-specific rows of tall trees near and in urban areas, and public education (Yap et al. 2004). On a local scale, community led culling of the common myna in Canberra, Australia has proven to be effective, but culling efforts are not intense enough to have wide spread reductions on abundance (Grarock et al., 2014). Due to the common myna's adaptability, Grarock et al. (2014) also suggest that complementary methods, such as nest box culling, would greatly reduce abundance.

Urban populations of Canada geese have grown rapidly over the last 30 years, resulting in frequent conflicts with humans. It was determined that 94 percent of filed damage complaints against Canada geese occurred during the three month brood-rearing period (Cooper 1998). Reducing forage quality and availability, modifying the shoreline and its vegetation, and installing fences during this period were effective short-term solutions in discouraging geese from these sites. Proposed habitat modifications in the fall and winter included reduced mowing of grassland areas and planting tall growing trees.

However, unkempt grasslands reduce aesthetics, and trees conflict with human activities at airports, sports fields, and golf courses (Cooper 1998).

As of 2010, the USFWS allows landowners and government agencies to remove or destroy Muscovies, their eggs, and nests anywhere outside of their native range (USFWS 2010). Addling of eggs and contraception are recommended as humane ways to control nuisance feral populations. The contraceptive nicarbazin has been used in controlling Canada geese and is regulated and available for use in Muscovy ducks with a migratory bird permit. The extent to which egg addling or contraceptive bait traps have been used as population control measures is not currently documented. However, employing habitat deterrents has been shown to achieve varying degrees of success with many nuisance bird species.

As few studies have been conducted on Muscovy ducks outside their native range, there remains a need to document aspects of their life history in order to inform management decisions. Though it has been established that Muscovy ducks occupy ponds or other wetland habitats (Downs et al. 2017), the types of water bodies they prefer remain largely unknown and unstudied. Accordingly, this study aims to determine which wetland habitat features encourage or discourage use by Muscovy ducks.

Objectives

The goals of this study were to: (1) measure Muscovy duck abundance at various wetlands in Tampa, Florida and (2) relate abundance to habitat characteristics. Identifying habitat preferences enables land managers to modify or create ponds on their respective properties that discourage use by Muscovy ducks. This may be the most cost-effective, long term, and humane way to reduce feral population densities and deter establishment.

Specific objectives under goal (1) include:

- measuring Muscovy abundance at wetlands using point count methods

Specific objectives under goal (2) include:

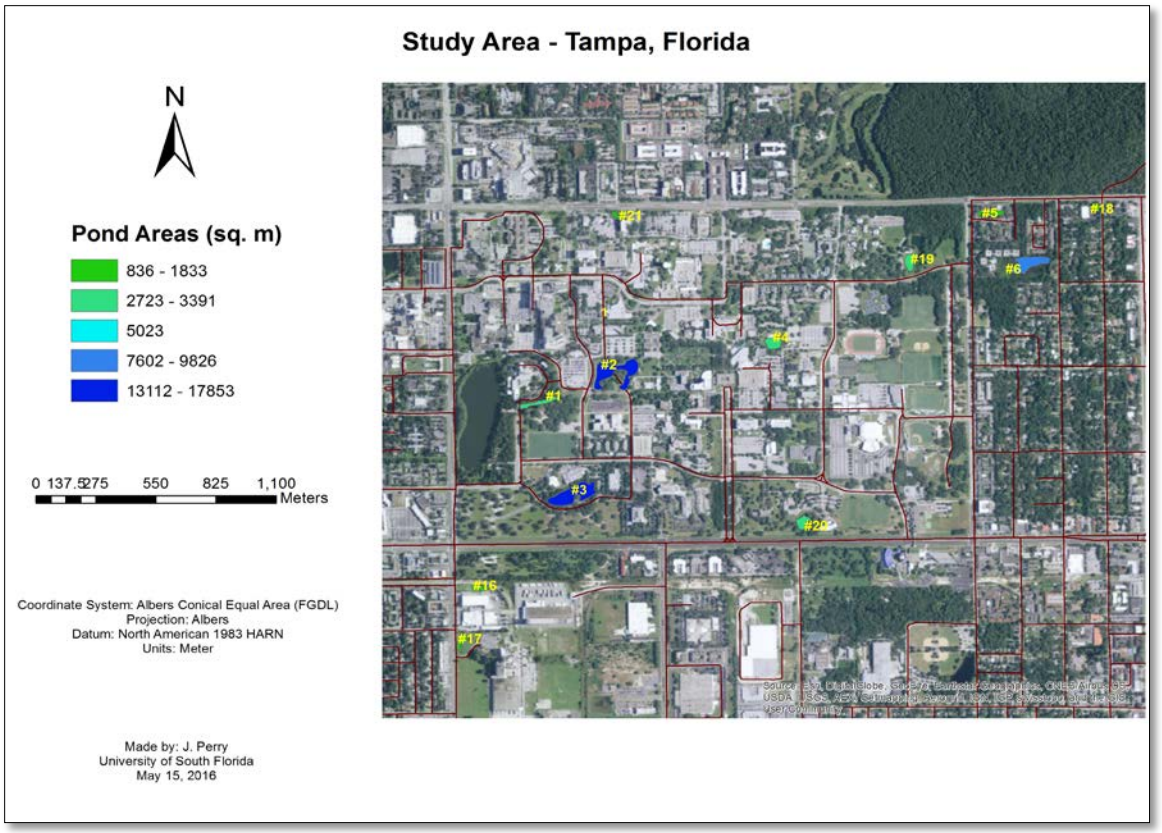
- assessing habitat features of wetlands using field methods and GIS
- identifying relationships between Muscovy numbers and habitat and geospatial features using Chi-squared and Mann-Whitney U tests.

CHAPTER TWO:

STUDY AREA

Research was conducted at 21 ponds in Tampa, Florida. Tampa has a subtropical climate with hot, rainy summers and mild, dry winters. All waterbodies surveyed for this study occur in developed or urban landscapes, where introduced Muscovies are frequently found, with a variety of land cover types, including: grass and lawns, shrub and tree cover, lakes, ponds, wetlands and reservoirs, and urban land cover (roads, sidewalks, parking lots, and buildings) (Table 1). Ponds ranged in size from 701 m^2 to 19614 m^2 and were located to the nearest street intersections and addresses using GIS. Pond maps were generated using GIS to provide an aerial view of their perimeters, vegetation, and nearby land use/cover, and buildings for spatial reference.

Seven waterbodies from the study were located on the main campus of the University of South Florida, approximately 5 km^2, which supports a population of breeding Muscovy ducks (Fig. 1). Fourteen waterbodies from the study occurred within a 8-kilometer radius (5 miles) of the University of South Florida Tampa campus, bounded north and south by Fletcher Avenue and Busch Boulevard, and bounded east and west Bruce B. Downs Boulevard and I-75. Two of these 14 waterbodies appeared to be naturally occurring and one of these is deemed a wildlife sanctuary (Fig. 3).



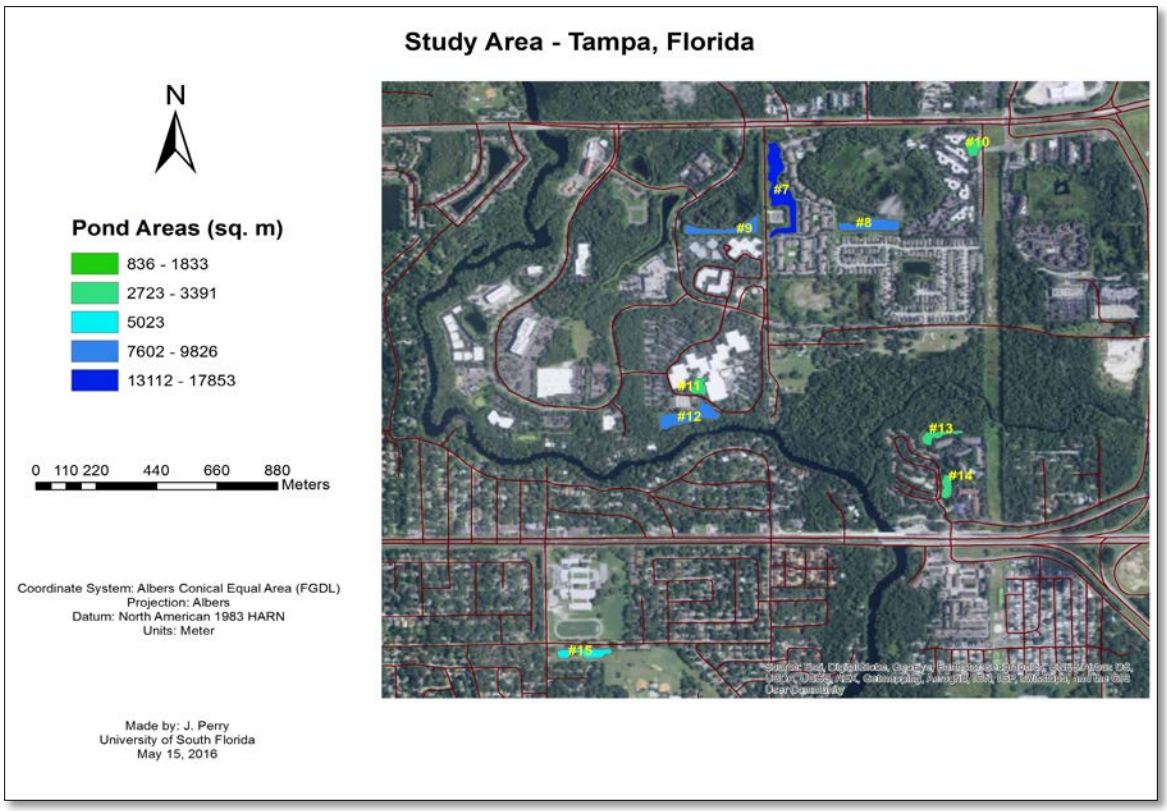


Figure 3: Maps of Study Area.

CHAPTER THREE:

METHODS

Data Collection

Habitat Assessments

Habitat assessments were performed for each of the 21 ponds from October 2013 through January 2013, then from February 2014 through October 2014. More assessments were performed during the wet season to document noticeable fluctuating water levels. The date, time, weather conditions, presence of people outside of the study, and other additional information such as the presence of other water fowl or if ducks were being fed by humans were recorded for each survey visit. Field assessment criteria consisted of fencing and type (none, partial, full and chain link, iron, block, etc.), fountains (yes or no), shoreline vegetation (percentage of shoreline within nine meters (10 yards) that is trees/shrubs, grass, rock, dirt/sand, or paved), aquatic vegetation (percentage of the aquatic environment that is open water, emergent or floating plants), and mean slope expressed in degrees. Ponds that experienced varying degrees of seasonal inundation were considered to have intermittently exposed (IE) water regimes, and ponds with consistent water levels were considered to have permanently flooded (PF) water regimes. Photographs of each pond were taken for visual reference with respect to slope, shoreline and aquatic vegetation, known nesting sites, and surrounding land cover within nine

meters (10 yards) of the shoreline. Photographs of Muscovy ducks, ducklings, and hybrids were also taken for general reference.

Muscovy Duck Point Counts

The 21 ponds were surveyed for Muscovy ducks on a biweekly or weekly basis for one year (not including January 2014), resulting in 1052 surveys. Each survey lasted between 5-15 minutes depending on the size and perimeter of the pond. Binoculars were used if pond access or navigation was difficult. Direct counts of Muscovy ducks and ducklings were conducted at each location, noting other waterfowl presence or possible Muscovy hybrids.

GIS Analysis

Google Earth was used to pin the 21 waterbodies to create a KMZ file for import into a GIS (ArcGIS v10.1). Each pinned point corresponded to the pond numbers given to each pond at the beginning of the survey period. A World Imagery satellite base map was imported from the Arc database, and the KMZ pinned points were then imported into GIS. Satellite images of each pond were zoomed to a scale of 1:5215. A new shapefile was created in GIS, and ponds were digitized in order to determine their areas and perimeters in square meters. Ponds were then classified by area ranges in square meters and assigned a color scheme for the study area maps (Fig. 3). GIS was also used to capture surrounding land use/ cover within a 100 meter buffer, and to measure the surveyed ponds' nearest neighbor, second nearest neighbor, distance to nearest road, distance to nearest major road, and average annual daily traffic of nearest major road (AADT). Land use/ cover, and

pond/wetland type were classified using the Florida Land Cover Classification System. Hillsborough county census data was used to determine human population density, and the amount of surface area covered with water (AWATER10) within each pond's census block group.

Average monthly rainfall data for Hillsborough County was taken from the USF Water Atlas, and was used to create histograms for each pond to illustrate possible relationships between average monthly rainfall and Muscovy abundance.

Statistical Analysis

Data for direct point counts of adults, ducklings, and total number were entered into an Excel spreadsheet for each survey at the end of each round-trip. A habitat assessment table was created using the measurements of the habitat parameters of each pond site on a seasonal basis, with more assessments performed during the wet season.

Total, mean, minimum, and maximum numbers of Muscovy ducks observed at each location were calculated, and presence/absence (i.e., % of visits where Muscovy presence ≥ 1) was quantified to determine which ponds Muscovy ducks frequently occupied. Ponds where Muscovies were observed at least 30 percent of the time were considered 'frequently occupied', and less than 30 percent was considered 'infrequently/ never occupied'. Chi-squared tests were performed using a contingency table created with binary habitat data to determine relationships between categorical variables: Muscovy abundance and fencing, Muscovy abundance and fountains, and Muscovy abundance and water regime. Mann-Whitney U tests were also performed to identify significant differences between habitat measurements (aquatic vegetation, shoreline types, and slope) and GIS variables.

CHAPTER FOUR:

RESULTS

Habitat Assessments

From October 2013 through October 2014, Hillsborough County experienced average monthly rainfall between 0.89 to 11.53 inches (Figure 4, Supplemental Information). Six ponds in this study were determined to experience intermittently exposed water regimes, while 15 ponds experienced permanently flooded water regimes (Table 1). Ponds that experienced marked seasonal water level fluctuations were classified as intermittently exposed (IE), and ponds with consistent inundation were classified as permanently flooded (PF). Seven ponds were either partially or completely fenced within nine meters (10 yds.) of their shorelines, and six ponds had fountains (Table 1). Six-foot tall, chain link fencing was used at six of these ponds, and one pond was enclosed partially in three-foot tall, iron bar fencing. There were no gaps between the ground and the bottom of the fences. Of the shoreline vegetation, the percent of trees/shrubs and grass varied widely among the ponds, ranging from five percent to 95 percent in both categories (Table 1). Rocks made up between five and 10 percent of shoreline vegetation for two of the ponds, dirt/sand made up between 5 and 35 percent of shoreline vegetation for three ponds, and paved surfaces made up between 5 and 35 percent of shoreline vegetation for five of the ponds (Table 1).

Table 1: Habitat assessment values and Muscovy count statistics

	Muscovy Counts			Shoreline Vegetation (%)							Aquatic Vegetation (%)				
Pond	Min	Max	Mean	Fencing	Fountain	Trees/ Shrubs	Grass	Rock	Dirt/ Sand	Paved	Open Water	Emergent	Floating	Slope (°)	Water Regime
1	0	3	0.5	none	no	60	40	0	0	0	80	20	0	21.8	PF
2	10	47	24.4	none	yes	15	45	5	35	0	100	0	0	16.7	PF
3	0	20	5.8	none	no	40	60	0	0	0	50	50	0	16.7	IE
4	5	44	25	none	yes	15	75	0	10	0	95	5	0	11.3	PF
5	0	0	0	none	yes	20	35	10	0	35	50	30	20	14	PF
6	0	2	0.1	partial	no	65	35	0	0	0	60	40	0	21.8	IE
7	0	3	0.5	none	no	40	60	0	0	0	70	30	0	26.6	PF
8	0	0	0	partial	no	25	75	0	0	0	90	10	0	21.8	PF
9	0	0	0	none	no	95	5	0	0	0	65	35	0	11.3	PF
10	0	0	0	partial	no	40	60	0	0	0	10	20	70	2.5	PF
11	0	0	0	partial	yes	65	25	0	0	10	100	0	0	11.3	PF
12	0	0	0	none	no	55	45	0	0	0	50	30	20	21.8	PF
13	0	0	0	partial	no	45	45	0	5	5	100	0	0	16.7	PF
14	0	0	0	none	no	25	70	0	0	5	100	0	0	21.8	PF
15	0	1	0	complete	no	10	90	0	0	0	20	80	0	26.6	IE
16	0	0	0	complete	no	90	10	0	0	0	0	100	0	21.8	IE
17	0	14	0.4	none	yes	15	85	0	0	0	70	30	0	1.2	PF
18	0	14	5.8	none	yes	15	80	0	0	5	90	10	0	21.8	PF
19	0	0	0	none	no	5	95	0	0	0	45	55	0	21.8	PF
20	0	13	1.9	none	no	30	70	0	0	0	85	15	0	19.2	IE
21	0	2	0.3	none	no	5	95	0	0	0	60	40	0	8.5	IE

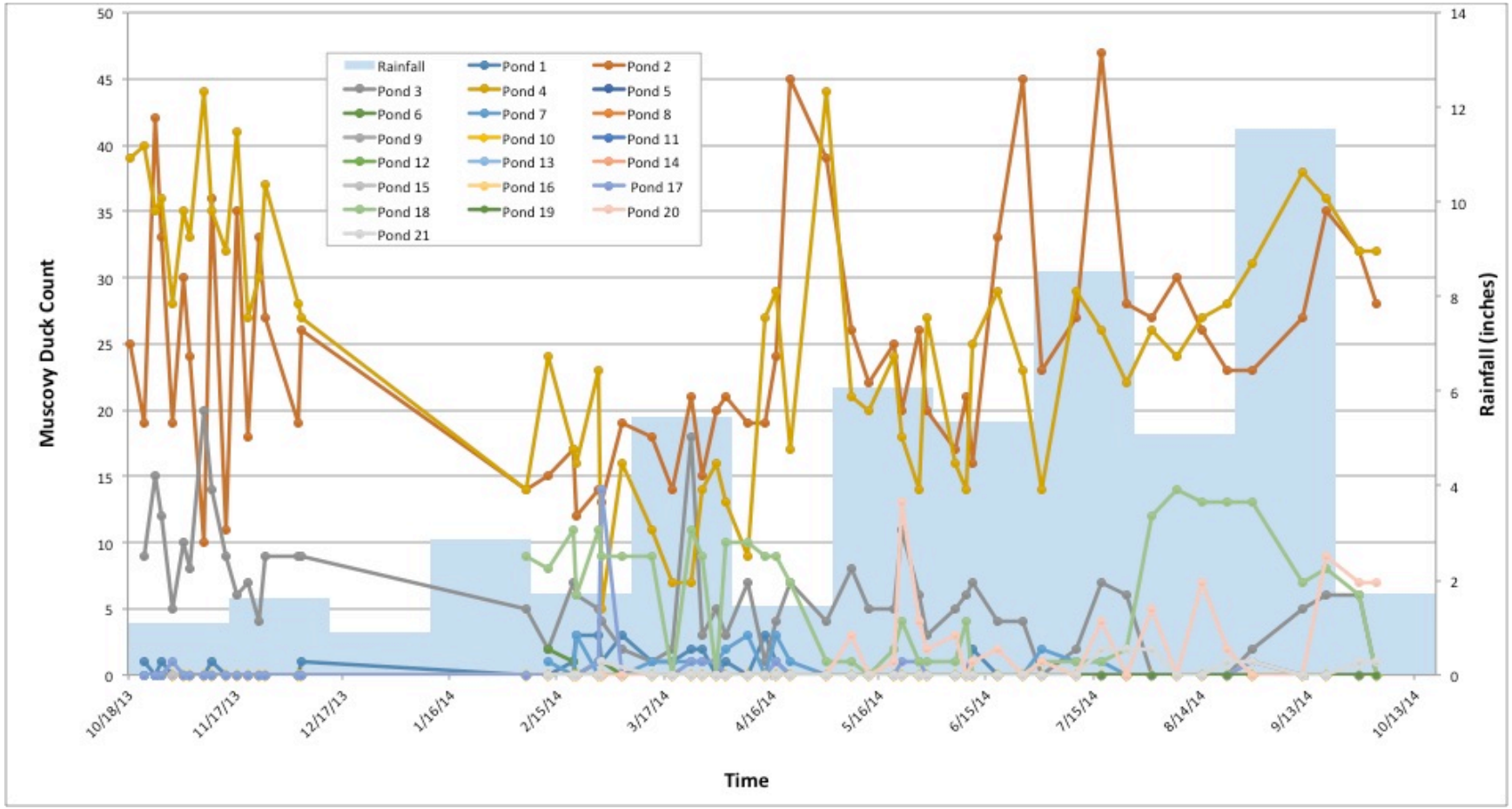


Figure 4: Seasonal histogram of total Muscovy duck counts and rainfall over one year

Three ponds had floating vegetation present, predominantly species of lilies (*Nymphaeaceae*) or Devil's Ivy (*Epipremnum aureum*), ranging from 20 to 70 percent coverage of surface waters (Table 1). Seventeen ponds had emergent vegetation, ranging from five to 100 percent coverage, percent open water ranged from 10 to 100 percent, and shoreline slope values ranged from 1.2° to 26.6° (Table 1).

Muscovy Duck Point Counts

Muscovy ducks were observed at 11 of the 21 ponds in the study, and their total numbers ranged from one to 1452 ducks over one year (Figs. 4 & 5, Table 2). Ducks were observed at least 30 percent of the time at seven ponds, and these ponds were classified as 'frequently occupied'. Ponds where Muscovy ducks were observed less than 30 percent of the time were classified as 'infrequently/never occupied' (Table 2). Ponds with frequent Muscovy occupancy experienced a mean occupancy of 68% and averaged 510 ducks over the year. Ponds with infrequent or no Muscovy occupancy experienced a mean occupancy of 4% and averaged 3 ducks over the year. Frequently occupied ponds had a minimum of 22 ducks and a maximum of 1452 ducks over one year. Infrequently/never occupied ponds also had a minimum of zero ducks, yet a maximum of 14 ducks over one year (Table 2, Figs. 4 & 5).

Table 2: Summary of pond mean percent occupancy.

		Occupancy	**Counts**		
Ponds	***N***	**Mean (%)**	**Min**	**Mean**	**Max**
Frequently Occupied	7	68	22	510	1452
Infrequently or Never Occupied	14	4	0	3	14

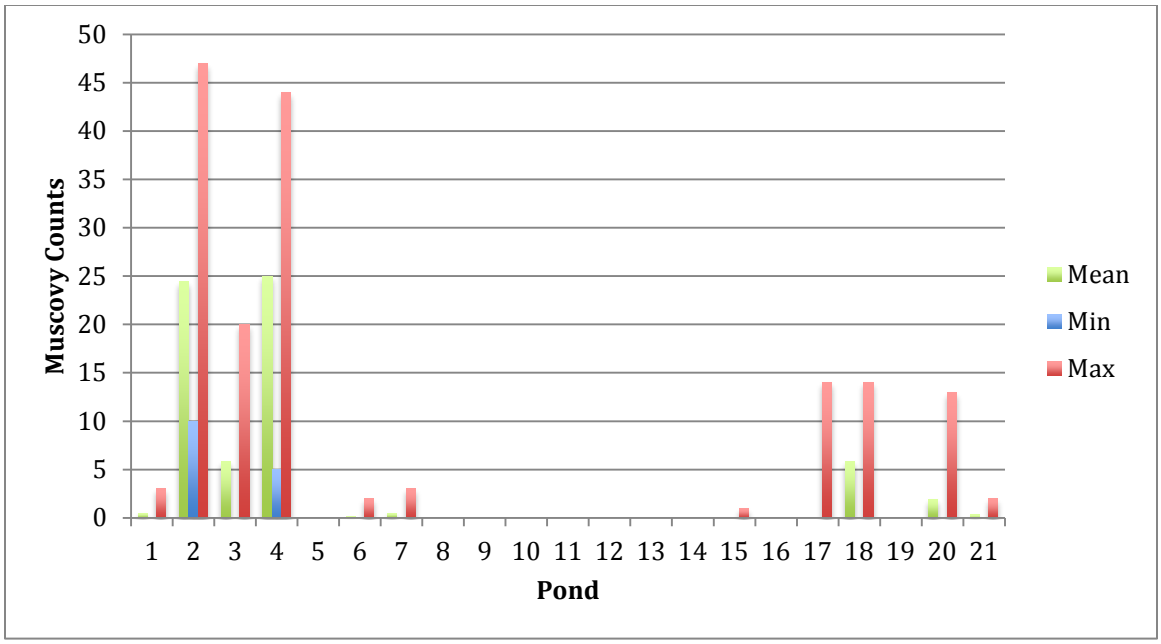


Figure 5: Minimum, Mean, and Maximum point counts for each pond.

During the wet season, Muscovy numbers tended to increase at ponds that were infrequently occupied, especially at ponds that became completely inundated during this time (Figure 3, Supplemental Information).

GIS Analysis

Based on state categorization of wetland type and land use/cover data, all ponds in this study are classified as Cultural-Lacustrine, Non-Vegetated Wetland, or Freshwater Non-Forested Wetland. Ponds are subcategorized as Artificial Impoundments/Reservoirs, Non-Vegetated Wetland, or Floating/Emergent Aquatic Vegetation, and occur in High Intensity Urban land use/cover or Mixed Hardwood-Coniferous land use/cover, and are subcategorized within Institutional, Residential-High Density, Residential-Medium Density, Commercial and Services, Industrial, or Mixed Hardwood-Coniferous land use/cover (Table 3).

Table 3: Wetland type, land use, and land cover classifications.

Pond	Wetland Type (Site)	Wetland Type (State)	Land use (w/in 100m buffer)	Dominant Land cover (Site, w/in 100m buffer)
1	Artificial Impoundment/Reservoir	Cultural - Lacustrine	P/QP	Institutional
2	Artificial Impoundment/Reservoir	Cultural - Lacustrine	P/QP	Institutional
3	Non-vegetated Wetland	Non-Vegetated Wetland	SMU-6	Institutional
4	Artificial Impoundment/Reservoir	Cultural - Lacustrine	P/QP	Institutional
5	Artificial Impoundment/Reservoir	Cultural - Lacustrine	R-20, ESA, ROS	Residential, High Density
6	Floating/Emergent Aquatic Vegetation	Cultural - Lacustrine	P, R-20, R-18	Mixed Hardwood-Coniferous
7	Artificial Impoundment/Reservoir	Cultural - Lacustrine	UMU-20	Residential, High Density
8	Artificial Impoundment/Reservoir	Cultural - Lacustrine	UMU-20	Residential, Medium Density
9	Artificial Impoundment/Reservoir	Cultural - Lacustrine	RCP	Commercial and Services
10	Floating/Emergent Aquatic Vegetation	Freshwater Non-Forested Wetlands	UMU-20	Residential, High Density
11	Artificial Impoundment/Reservoir	Cultural - Lacustrine	RCP	Commercial and Services
12	Artificial Impoundment/Reservoir	Cultural - Lacustrine	RCP	Commercial and Services
13	Artificial Impoundment/Reservoir	Cultural - Lacustrine	R-18	Residential, High Density
14	Artificial Impoundment/Reservoir	Cultural - Lacustrine	R-18, UMU-20	Residential, High Density
15	Artificial Impoundment/Reservoir	Cultural - Lacustrine	R-4, P	Residential, Medium Density
16	Artificial Impoundment/Reservoir	Cultural - Lacustrine	HI	Industrial
17	Artificial Impoundment/Reservoir	Cultural - Lacustrine	HI	Industrial
18	Artificial Impoundment/Reservoir	Cultural - Lacustrine	OI, R-18, ESA	Commercial and Services
19	Artificial Impoundment/Reservoir	Cultural - Lacustrine	P/QP	Institutional
20	Artificial Impoundment/Reservoir	Cultural - Lacustrine	P/QP	Institutional
21	Artificial Impoundment/Reservoir	Cultural - Lacustrine	P/QP, RMU-35, R-20	Institutional

Ponds' surrounding land use consisted of public/semi-public (P/QP), suburban or urban mixed use (SMU-6, UMU-20), research/corporate park (RCP), heavy industrial (HI), office/institutional (OI), environmentally sensitive areas (ESA), recreational/open space (ROS), and various residential use (R-4/18/20, RMU-35) (Table 3, Supplemental Information). The distance from a pond to its nearest road ranged from 0.5m to 159.7m. The distance from a pond to its nearest major road ranged from 11.5 m to 665 m. Based on distance to nearest major road (roads considered major with thru traffic), ponds occurred where average annual daily traffic (AADT) ranged from 4800 to 51500 (Table 4).

Based on manual measurements in ArcGIS, thirteen ponds' nearest neighbor (NN) was a pond in the study, and eight ponds' nearest neighbor was a pond outside of the study. In addition, thirteen ponds' second nearest neighbor was a pond in the study, and eight ponds' second nearest neighbor was a pond outside of the study (Table 4). Ponds occurred in census block groups that contain between 5442 and 256039 square meters of surface water (AWATER10) (Table 4) and occurred within a census block groups containing human population density ranging from 2.6 to 11 people per square mile (Table 4).

Statistical Analysis

Fencing was not associated with more occupied ponds. Based on preliminary observations, Chi-squared tests confirmed a significant relationship between Muscovy abundance and fencing, X^2 (1, N=21) = 5.25, p=0.02, and no relationship between Muscovy abundance and fountains, X^2 (1, N=21) = 1.05, p=0.31, or Muscovy abundance and water regime, X^2 (1, N=21) = 0.07, p=0.79 (Table 5).

Table 4: Geospatial measurements and census data (* incomplete data)

Pond	Dist. nearest road (m)	Dist. nearest major road (m)	AADT	Nearest Neighbor	2nd NN	Pop. Density (per sq. mile)	AWater10
1	5.6	312.5	43000	other - 105.7m	Pond 2 - 305m	2.8	144904
2	9	665	43000	Pond 1 - 174.4m	other - 566m	2.8	144904
3	5.4	177	62000	other - 362.2m	Pond 1 - 458m	2.8	144904
4	23.5	638	41500	Pond 2 - 722m	Pond 19 - 706m	2.8	144904
5	42.8	42.8	41500	Pond 6 -297.5m	Pond 19 - 404m	11	5442
6	38.9	137	4800	Pond 5 - 297m	other - 414m	11	5442
7	5.8	60.5	41500	other - 220m	Pond 9 - 279m	3.6	256039
8	49.7	372.5	41500	other - 234m	Pond 7 - 380m	3.6	256039
9	15.8	351.3	41500	other - 212m	Pond 7 - 256m	3.6	256039
10	1.6	56.3	41500	other - 352m	other - 359m	3.6	256039
11	97.5	551.6	51500	Pond 12 - 138m	Pond 9 - 626m	3.6	256039
12	159.7	430.4	51500	Pond 11 - 138m	Pond 9 - 754m	3.6	256039
13	46.1	348.4	51500	Pond 14 - 205m	other - 667m	2.6	36636
14	0.5	143	51500	Pond 13 - 205m	other - 872m	2.6	36636
15	15.8	414.2	51500	Pond 12- 996m	Pond 11- 1142m	4.9	0*
16	73.5	82.7	43000	other - 136m	Pond 17 - 274m	2.7	47561
17	9.1	13.6	43000	Pond 16 - 286m	other 332m	2.7	47561
18	4.7	21.2	41500	Pond 6 - 443m	Pond 5 - 486m	11	5442
19	4.9	162.5	41500	Pond 5 - 405m	Pond 6 - 491m	2.8	144904
20	30.8	33.6	62000	Pond 4 - 884m	other - 1030m	2.8	144904
21	4.4	11.5	41500	other - 366m	other - 606m	2.8	144904

Nonparametric Mann-Whitney U tests were performed to determine significant differences between Muscovy abundance and other groups of habitat data since the values were not normally distributed, and revealed no significant results among groups. Median values for each group were reported (Table 6), and U-values among groups ranged from 29.5 to 46, with critical values of U=22 for all groups, revealing insignificant results at $p < .05$. Z-Scores among groups ranged from -1.42 to 0.75, and corresponding *p*-values ranged from 0.16 to 0.85, revealing insignificant results at $p < .05$.

Table 5: Summary table for Chi-squared test using binary pond occupancy and habitat data.

	Fencing		**Fountains**		**Water Regime**	
Ponds	**Partial or Complete**	**None**	**Yes**	**No**	**Permanent (PF)**	**Intermittent (IE)**
Infrequently or Never Occupied	7	7	3	11	10	4
Frequently Occupied	0	7	3	4	5	2

Table 6: Summary table of pond occupancy and median habitat data reported from Mann-Whitney U test.

		Shoreline Vegetation (%)					**Aquatic Vegetation (%)**			
Ponds	**Value**	**Trees/ Shrub**	**Grass**	**Rock**	**Dirt/ Sand**	**Paved**	**Open Water**	**Emergent**	**Floating**	**Slope (°)**
Infrequently or Never Occupied	Median	32.5	52.5	0	0	0	60	30	0	21.8
Frequently Occupied		30	60	0	0	0	85	15	0	19.2
	U-value	42.5	44	46	37.5	41	29.5	34.5	38.5	34
	Z-Score	0.45	-0.34	-0.19	-0.82	-0.56	-1.42	1.04	0.75	1.08
	p-value	0.66	0.73	0.85	0.41	0.58	0.16	0.3	0.45	0.28

CHAPTER 5:

DISCUSSION

Explanation of Results

Based on observations and confirmed by a Chi-squared test, Muscovy ducks preferred ponds without fencing. Although no significant relationship was found between Muscovy abundance and water regime, ponds that experienced infrequent/no Muscovy occupation that did not have fencing saw an increase in Muscovy numbers when they became completely inundated during the wet season. This was especially evident at Pond 20 and Pond 21. In addition, these ponds did not experience changing aquatic vegetation values. It may be important to note that during the wet season, Muscovy ducks were seen leaving a pond in the study for a nearby neighboring pond outside of the study during multiple surveys, which occurred at Pond 1 and Pond 18. The ponds were all within 50m of the study sites and were small retention areas that accumulated rainfall or surface runoff.

Mann-Whitney U tests did not reveal any significant relationships between Muscovy counts and other habitat data. Based on a previous study and observations throughout the length of this study, shoreline slope and shoreline vegetation appeared to influence Muscovy occupancy. Ponds with high, frequent Muscovy abundance had slopes below 20° and shorelines unobstructed by vegetation at the water's edge. Some ponds that were frequently occupied by Muscovy ducks experienced varying degrees of shoreline slope.

Muscovies were seen congregating at more gentle-sloping shores, and were not typically observed near steep or unstable banks. Reclassifying slopes and shoreline vegetation, and quantifying the percent of vegetation obstruction at the water's edge may reveal a significant relationship between abundance these habitat parameters.

Hillsborough County facilities that are government owned or public use, such as schools, utilities, and hospitals, as well as private establishments that are open to the public, such as parks, recreational facilities, and churches operate on land categorized as P/QP. Four of the seven ponds frequently occupied by Muscovy ducks occur in Public/Quasi-Public (P/QP) land use/cover, and these ponds maintained breeding populations of Muscovy ducks. Muscovies also frequented pond 18, which occurred within Office/Institutional (OI) land use/cover and lies within 50 m of an outpatient reproductive facility. Staff members were regularly seen feeding Muscovies on their lunch breaks. It may be useful to further research to document the types of facilities or structures within a certain radius of each pond in order to gain more insight into anthropogenic factors that influence Muscovy abundance and population establishment.

Management Implications

This study quantified habitat parameters within nine meters (10 yards) of the shoreline. Ponds enclosed in fencing at this distance, either partially or completely, appeared to deter Muscovy ducks. However ponds with fencing in this study did not have gaps between the ground and the bottom of the fences. Outside of the study, Muscovy ducks were observed maneuvering under the gaps of an iron fence to get to a pond.

Vegetation that obstructed the shoreline near the water's edge also appears to deter Muscovy ducks, as Muscovies were never seen at ponds with heavily obstructed shorelines. Although this study did not address this particular parameter, the data can still be applied for a continuing study by revisiting the shoreline habitat categories. Planting tall grasses and sedges where the shore meets the water may deter Muscovy ducks from accessing ponds and breeding nearby, and that management strategy should be explored in future studies.

Throughout the study, various used nest sites and clutches were observed within 50m of the shoreline at ponds with frequent Muscovy occupation, specifically ponds 2,3,4, 7, and 18. Nest sites occurred on the ground under dense shrubs and palm fronds and under shrubs along the sides of buildings. Broods of varying ages were seen at least once at frequently occupied ponds 2,3,4,7,18, and 20, and at the infrequently occupied pond 21, where one duckling was observed on multiple occasions with the same female. It can be inferred that certain types of vegetation near the shoreline encourages Muscovy population establishment. Limiting certain vegetation types within a certain radius of the pond may deter population establishment. However, future study is required to quantify known nesting habitat features and identify vegetation species.

People outside of the study were regularly seen at ponds with greatest Muscovy abundance, specifically ponds 2,4, and 18, where picnic tables and other seating arrangements were provided within 50m of the shorelines. Humans were regularly seen feeding Muscovy ducks at these locations, which supports the observation that the species is human commensal. Reducing human-Muscovy interactions in such a way could reduce abundance and deter population establishment.

Limitations

Ponds were grouped into 'frequently occupied' and 'infrequently/never occupied' based on observed natural breaks in the data. It is possible that the use of these groupings in determining Muscovy abundance could be concealing relationships with habitat variables. Habitat data was not normally distributed, thus, correlation and regression analysis was not appropriate. Assessing habitat parameters differently may yield different results and identify significant relationships that have been observed anecdotally. All of the ponds in the study had the required, and similar habitats nearby, such as open grassy areas for grazing and tress/shrubs for cover and resting, so there were no statistical differences recorded. Separating trees and shrubs into their own categories could prove useful, as well. Quantifying the percent of adequate or commonly used shrubs for nesting, as well as quantifying percent of vegetation strata, rather than combing coverage, may well reveal significant relationships between these parameters and abundance.

Reclassifying pond slopes and utilizing a different buffer for surrounding habitat characteristics may produce data that is more linear, making correlation or regression analysis possible and granting better insight into habitat preferences. It is possible that many of the habitat features may be significant, but this study was unable to capture them.

This study did not address the Muscovy's ecological or interspecies relationships, which may affect abundance and breeding biology. Whether or not people were present outside of the study was recorded on each survey, but was not quantified. Adding this categorical data would offer more insight into levels of consistent abundance. Whether or

not a pond maintains a breeding population (i.e. multiple broods) in addition to frequenting adults may also say more about habitat preferences than previously considered and may be a more useful, straightforward way in classifying ponds that are 'frequently occupied'.

Future Work

As mentioned previously, it would be necessary to assess and quantify habitat characteristics differently to achieve clearer results, specifically breaking up surrounding vegetation strata into separate groups, and including the percent of shoreline that is obstructed by vegetation. Re-analyzing the raw slope data may be beneficial as well, yet the process has yet to be determined. Pond sizes were measured, but not incorporated into the analysis. Area and perimeters varied greatly; therefore, it may be helpful to study ponds with similar measurements.

Four of the seven ponds frequently occupied by Muscovy ducks occurred in areas with consistent human presence. Based on these observations, Muscovy ducks prefer ponds in urban or suburban settings and only confirm the species is very human commensal. It would be useful to look at the types of buildings within a certain radius of the ponds to gauge which human activities may be affect Muscovy abundance. It would also be useful to determine how many of the Florida Fish and Wildlife Commission's annual Nuisance Waterfowl Reports contain Muscovy duck complaints, and where these complaints occurred.

Correlation between water quality and Muscovy abundance was not formally tested, but testing may be useful. Runoff with elevated levels of nutrients may promote a pond's

surrounding vegetation growth and colonization of macro invertebrates and insects, all of which are staples of Muscovy diets. In addition, Muscovies are not diving ducks, and frequently occupied ponds that periodically become highly eutrophic did not see a decrease in Muscovy numbers. A decrease in the a amount of aquatic plants and organisms due to the effects of eutrophication would not seem to deter Muscovies from a pond.

Monitoring the nearest neighbors and possibly the second nearest neighbor of the frequently occupied ponds in this study may be beneficial for future habitat comparisons and home range studies. Nearby ponds outside of the study may have experienced drier or wetter conditions than ponds in this study, which may have contributed to an increase or decrease in Muscovy numbers, respectively. Thus, it would be helpful to identify other ponds with Muscovy presence and compare habitat and geospatial characteristics to those of the frequently occupied ponds in this study.

Modifying habitats requires careful consideration with respect to ecological impacts, and adding known and observed deterrents to ponds with Muscovy presence might not always be possible. Fencing may deter Muscovy ducks, but it is also possible that it may negatively impact desirable or native species of wildlife. Other shoreline modifications, like those documented in the case of the Canada goose, may have positive or negative effects. Many types of emergent plants support nests for a variety of waterbirds, small fish, and amphibians. A more inclusive ecological study that identifies relative species abundance at different trophic levels could lend valuable information when it comes to decision-making, as well as density dependent factors that affect local Muscovy populations, such as predation. Therefore, future work is necessary to identify the Muscovy's ecological and interspecific relationships.

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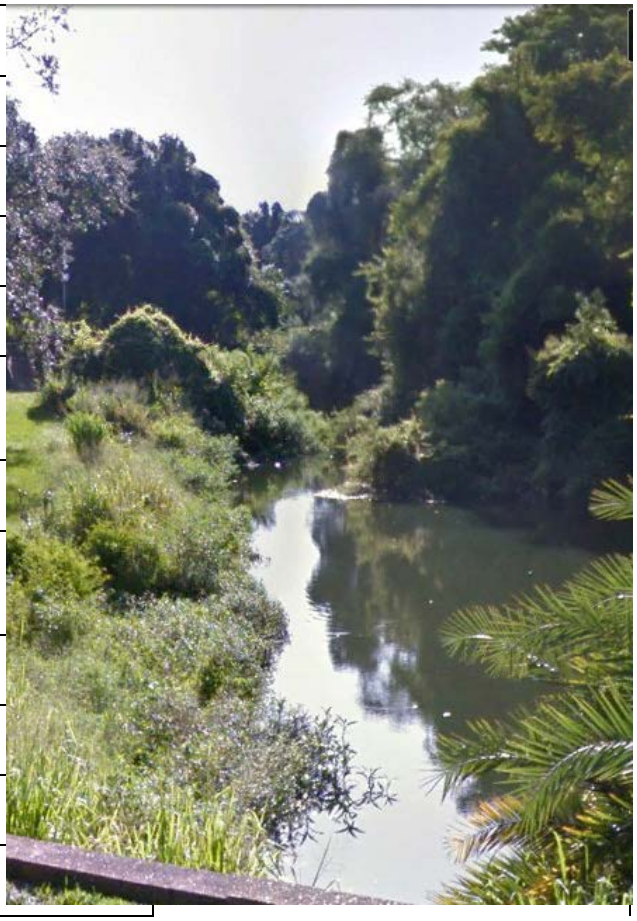
SUPPLEMENTAL INFORMATION

Pond 1

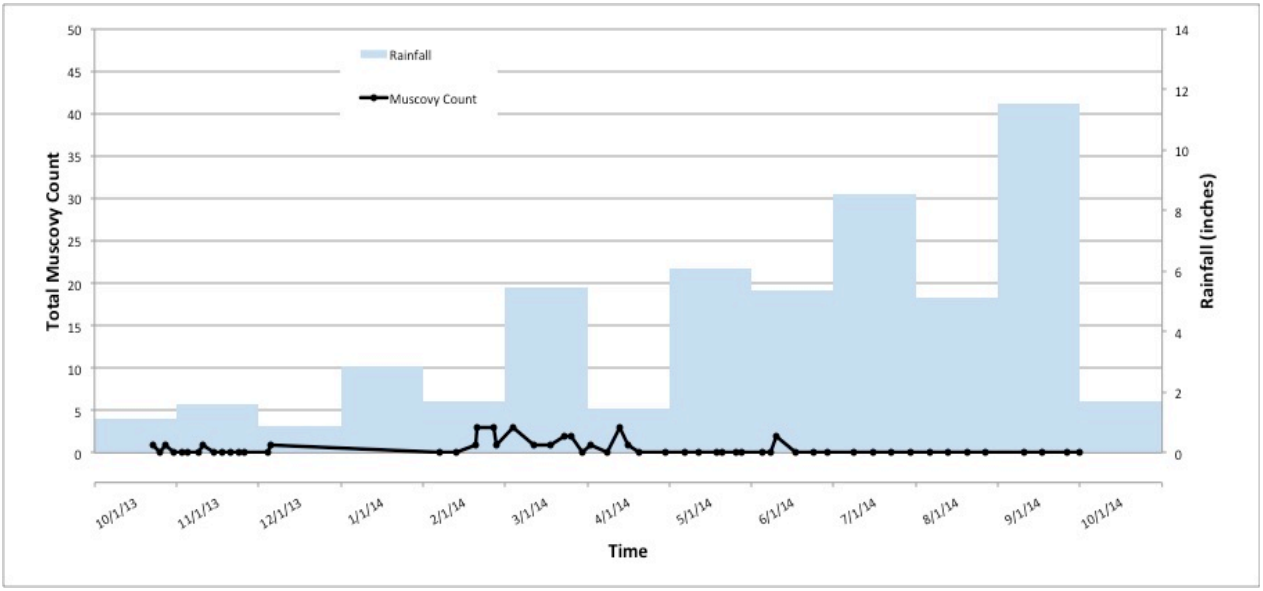
Dry Season

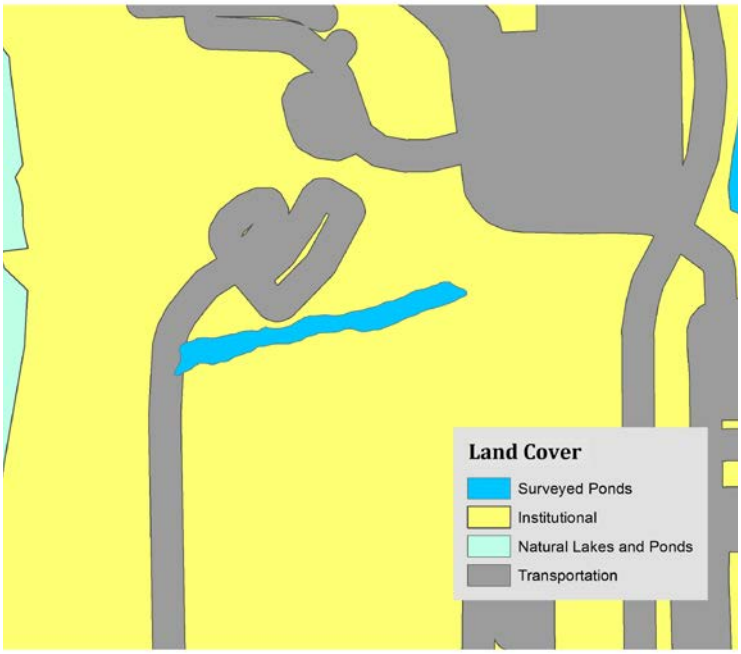
Wet Season

Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	60
Shoreline Vegetation (%) grass	40
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	80
Aquatic Vegetation (%) emergent	20
Aquatic Vegetation (%) floating	0
Slope rating (x°)	21.8
Water Regime	PF



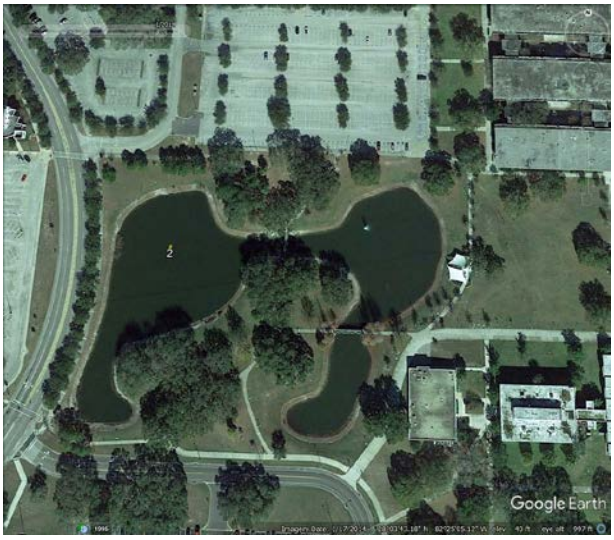
Pond 1



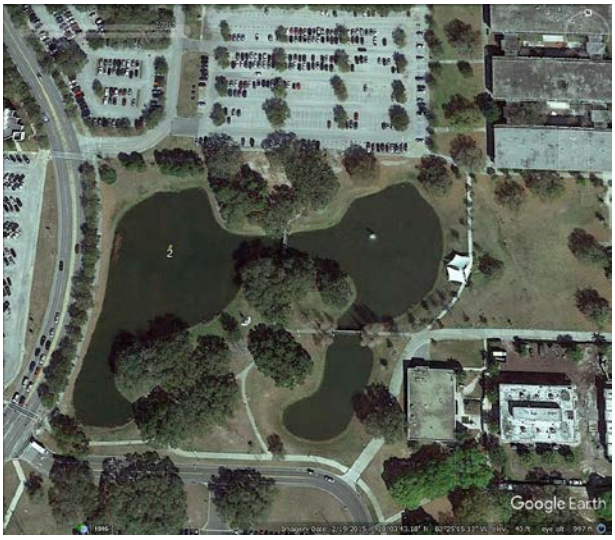


Area (m^2)	2406
Perimeter (m)	408
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	P/QP
Land cover (Site)	Institutional
Land cover (State)	High Intensity Urban
Nearest Neighbor	105.7m
Nearest Neighbor 2	305m
Dist. Nearest Road	5.6m

Pond 2



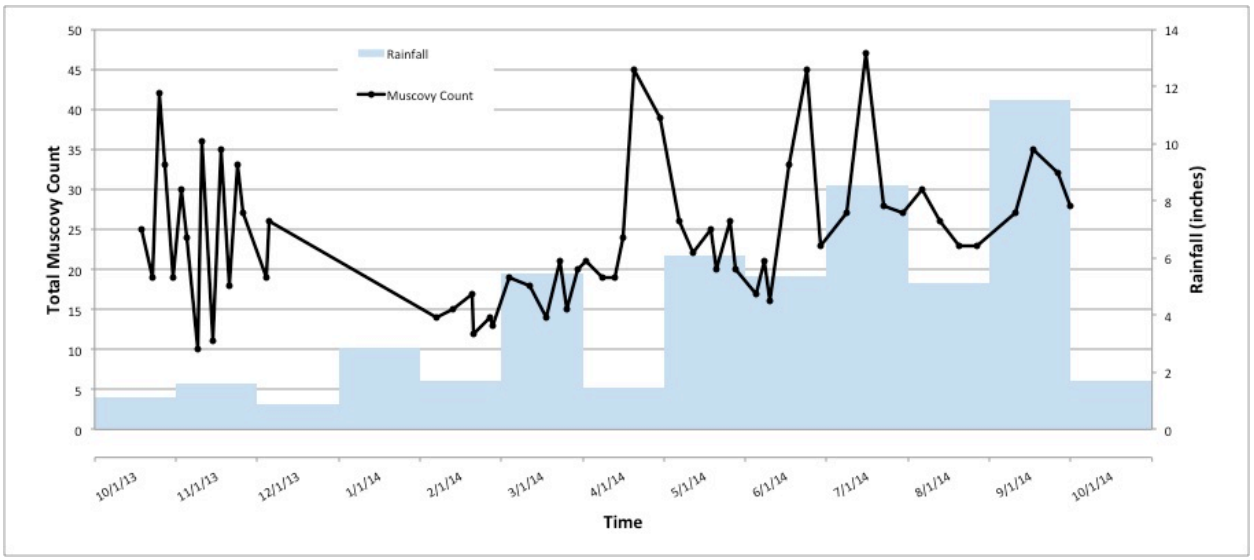
Dry Season

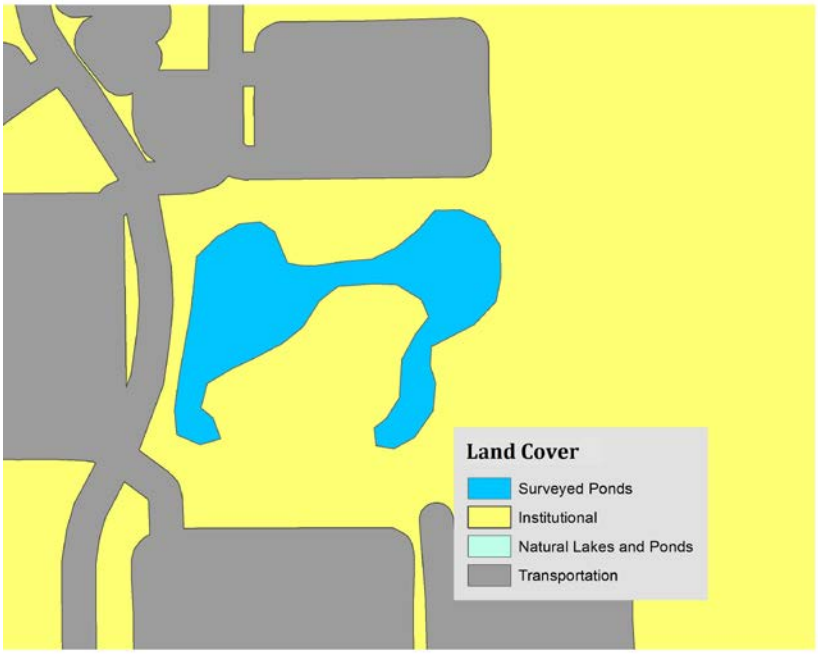


Wet Season

Fencing/type	none
Fountain	yes
Shoreline Vegetation (%) trees	15
Shoreline Vegetation (%) grass	45
Shoreline Vegetation (%) rock	5
Shoreline Vegetation (%) dirt/sand	35
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	100
Aquatic Vegetation (%) emergent	0
Aquatic Vegetation (%) floating	0
Slope rating (x°)	16.7
Water Regime	PF

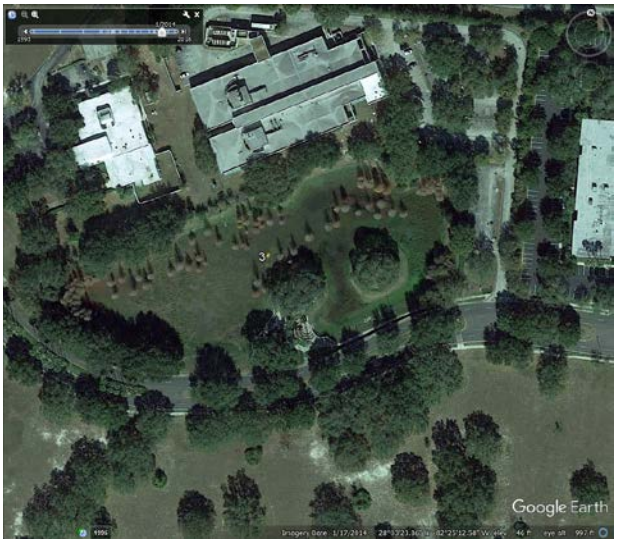
Pond 2



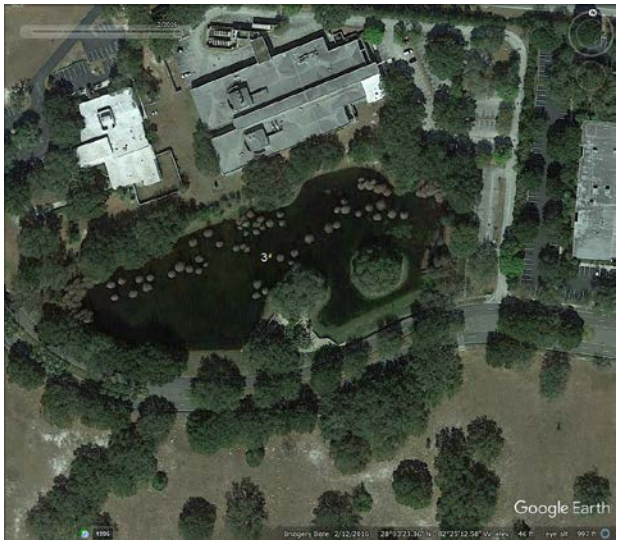


Area (m^2)	11363
Perimeter (m)	806
Wetland Type (Site)	Artificial Impoundment Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	P/QP
Land cover (Site)	Institutional
Land cover (State)	High Intensity Urban
Nearest Neighbor	174.4m
Nearest Neighbor 2	566m
Dist. Nearest Road	9m

Pond 3



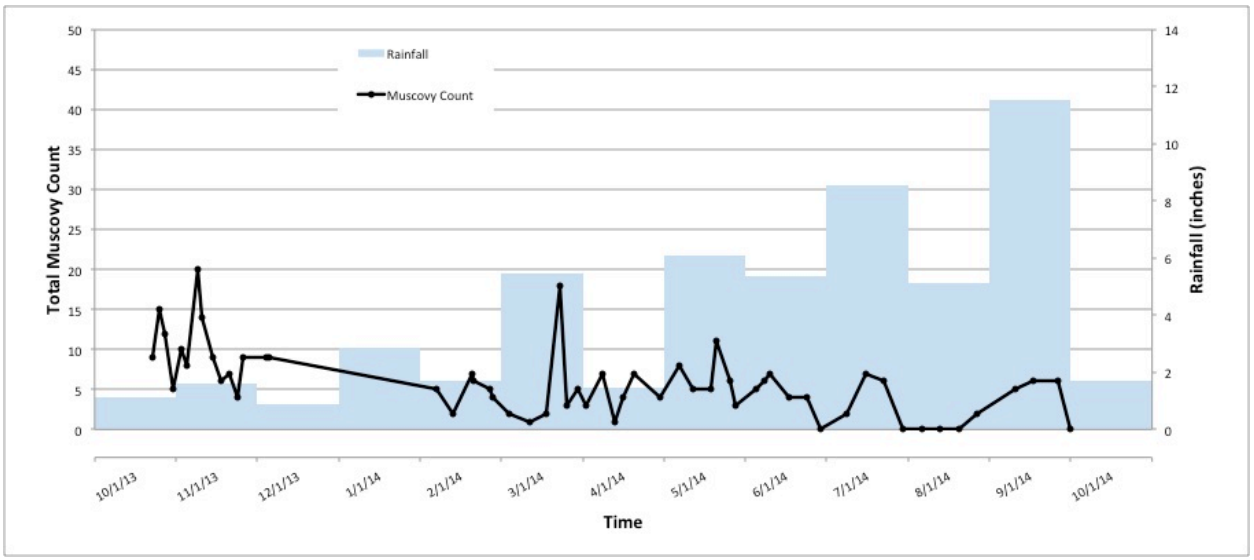
Dry Season

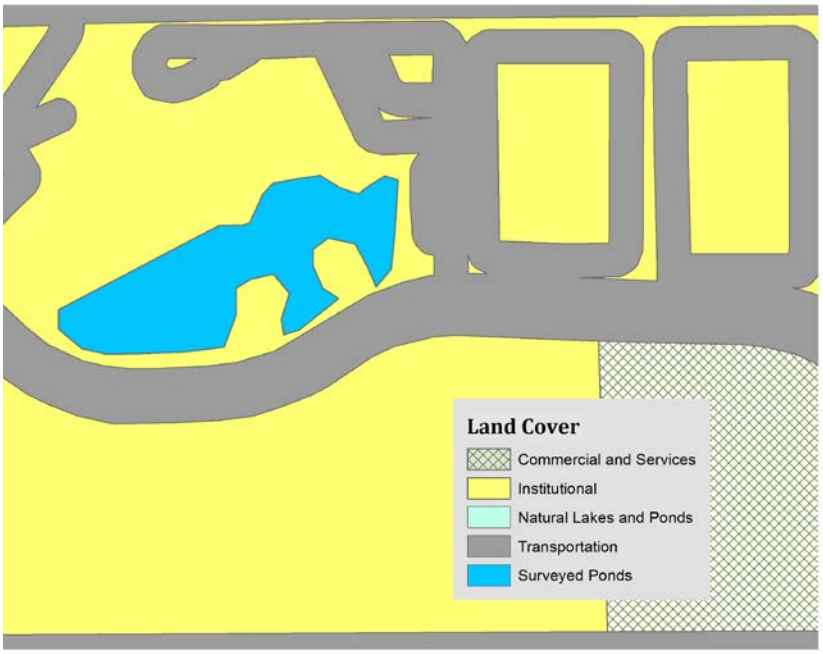


Wet Season

Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	40
Shoreline Vegetation (%) grass	60
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	50
Aquatic Vegetation (%) emergent	50
Aquatic Vegetation (%) floating	0
Slope rating (x°)	16.7
Water Regime	PF

Pond 3

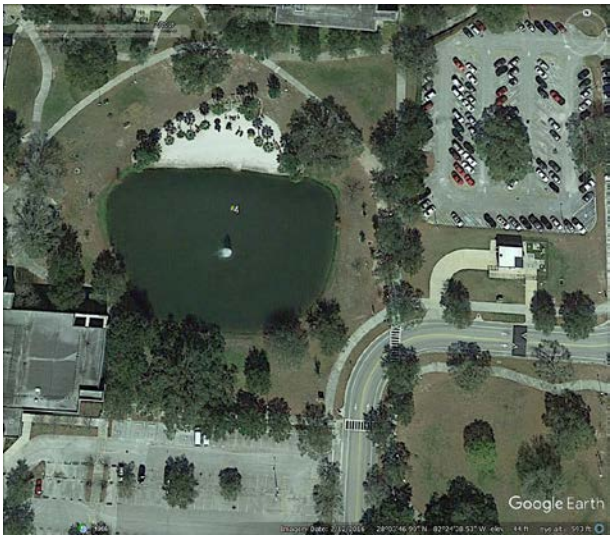




Area (m^2)	10441
Perimeter (m)	648
Wetland Type (Site)	Non-vegetated wetland
Wetland Type (State)	Non-vegetated wetland
Land use	SMU-6
Land cover (Site)	Institutional
Land cover (State)	High Intensity Urban
Nearest Neighbor	362.2m
Nearest Neighbor 2	458m
Dist. Nearest Road	5.4m

Pond 4

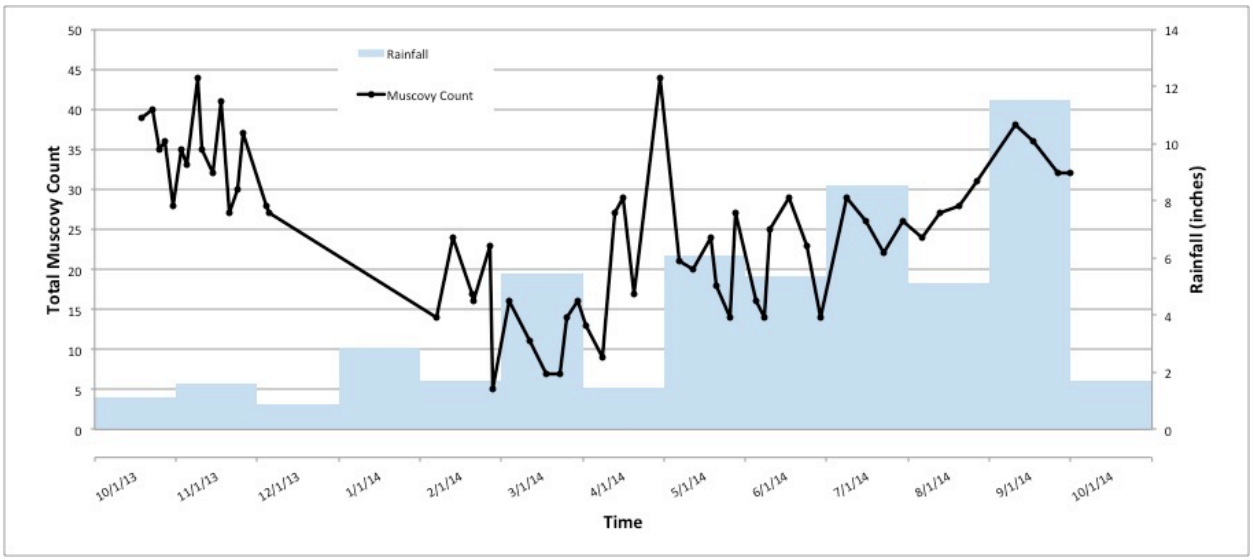
Dry Season

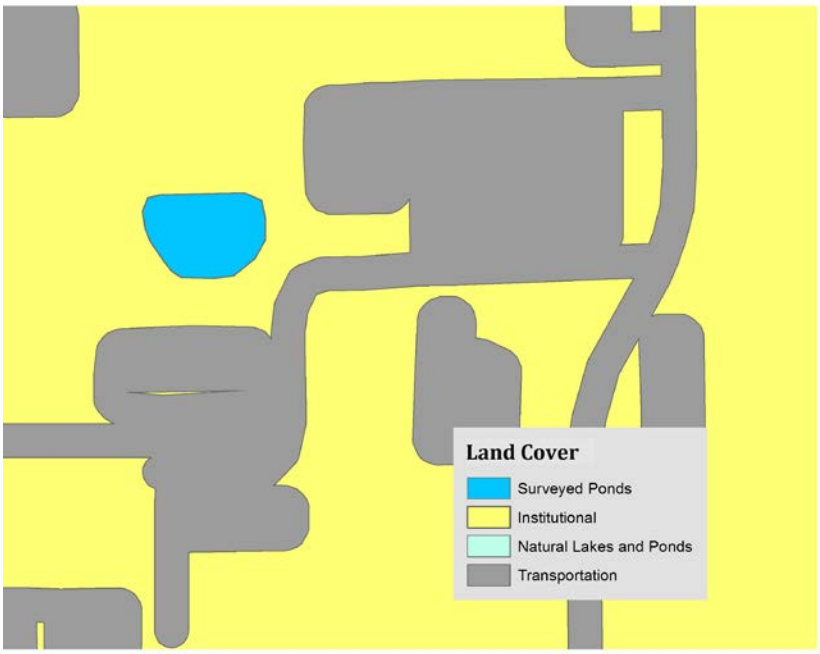


Wet Season

Fencing/type	none
Fountain	yes
Shoreline Vegetation (%) trees	15
Shoreline Vegetation (%) grass	75
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	10
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	95
Aquatic Vegetation (%) emergent	5
Aquatic Vegetation (%) floating	0
Slope rating (x°)	11.3
Water Regime	PF

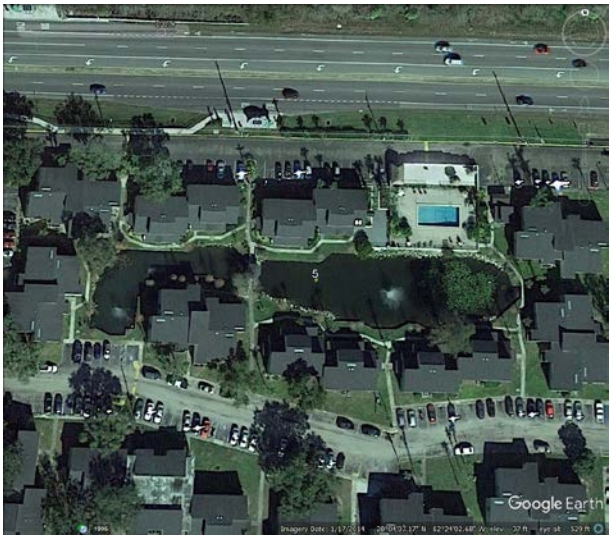
Pond 4



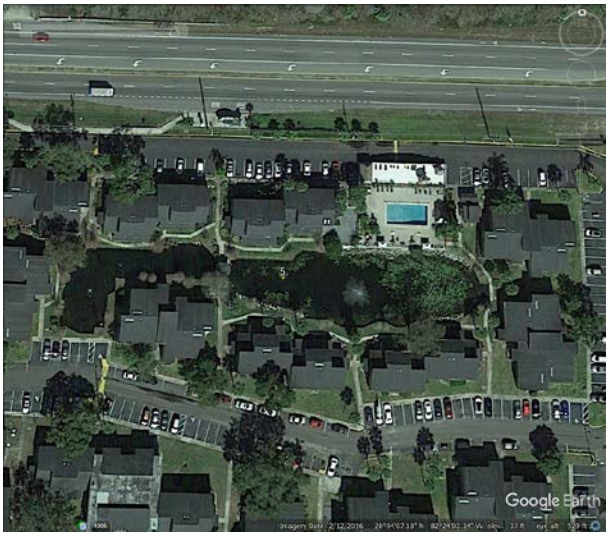


Area (m^2)	2406
Perimeter (m)	3093
Wetland Type (Site)	Artificial Impoundment Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	P/QP
Land cover (Site)	Institutional
Land cover (State)	High Intensity Urban
Nearest Neighbor	722m
Nearest Neighbor 2	706m
Dist. Nearest Road	23.5m

Pond 5



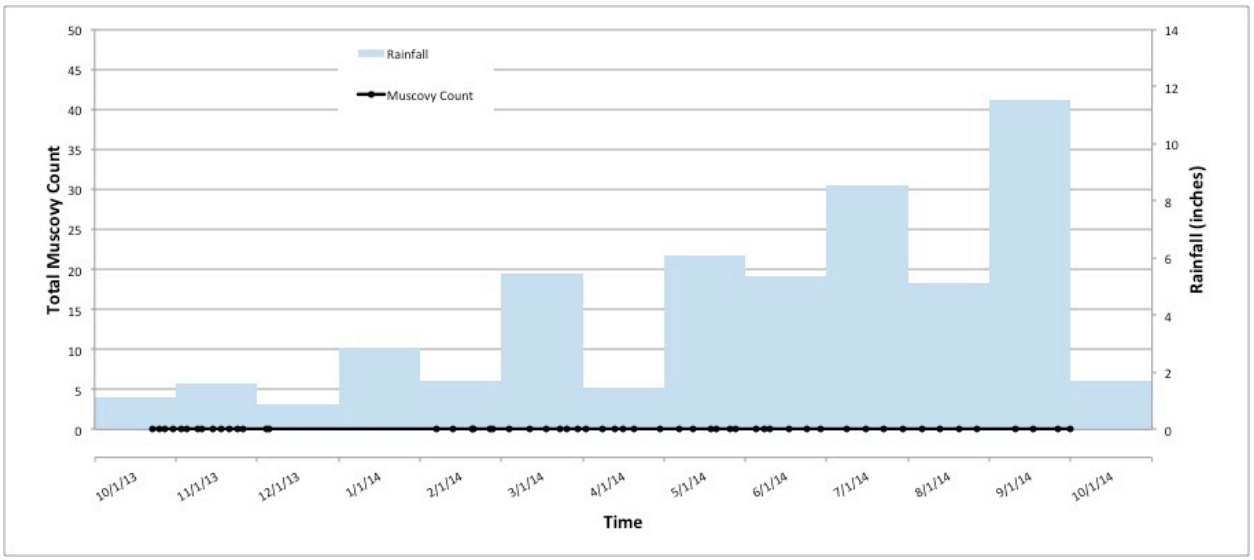
Dry Season

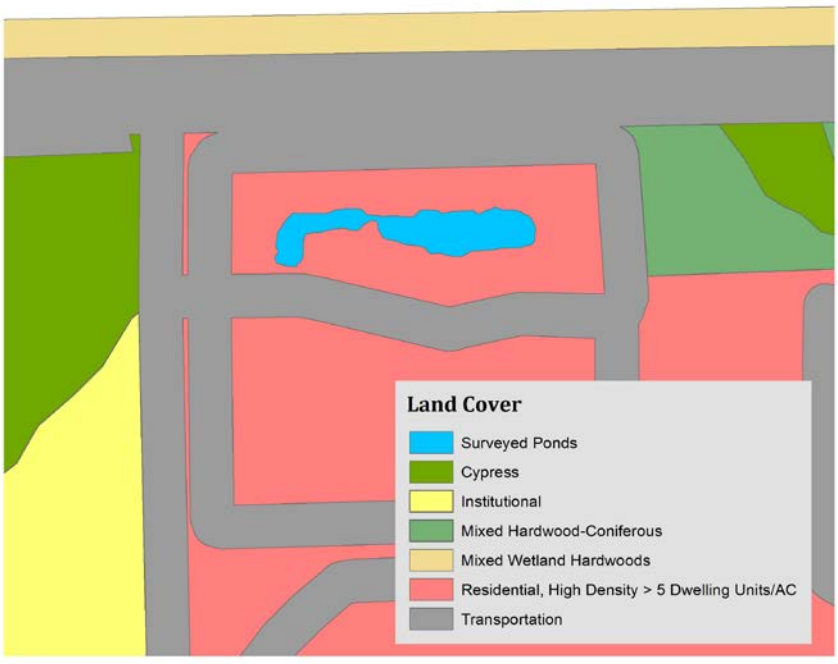


Wet Season

Fencing/type	none
Fountain	yes
Shoreline Vegetation (%) trees	20
Shoreline Vegetation (%) grass	35
Shoreline Vegetation (%) rock	10
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	35
Aquatic Vegetation (%) open water	50
Aquatic Vegetation (%) emergent	30
Aquatic Vegetation (%) floating	20
Slope rating (x°)	14.0
Water Regime	PF

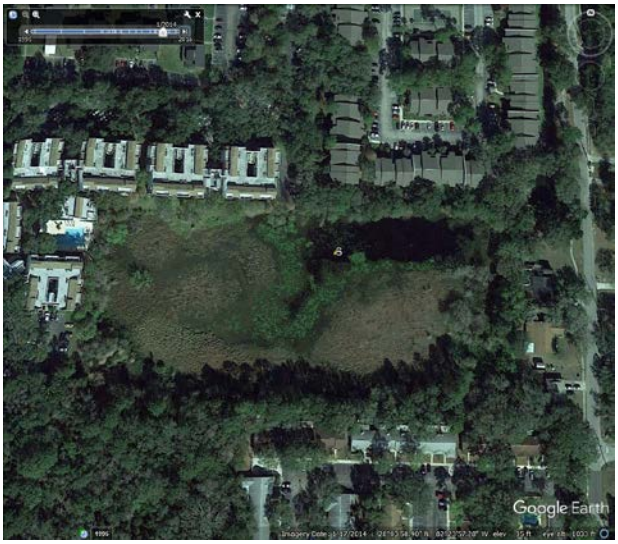
Pond 5





Area (m^2)	1716
Perimeter (m)	297
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	R-20, ESA, ROS
Land cover (Site)	Residential, High Density
Land cover (State)	High Intensity Urban
Nearest Neighbor	297.5m
Nearest Neighbor 2	404m
Dist. Nearest Road	42.8m

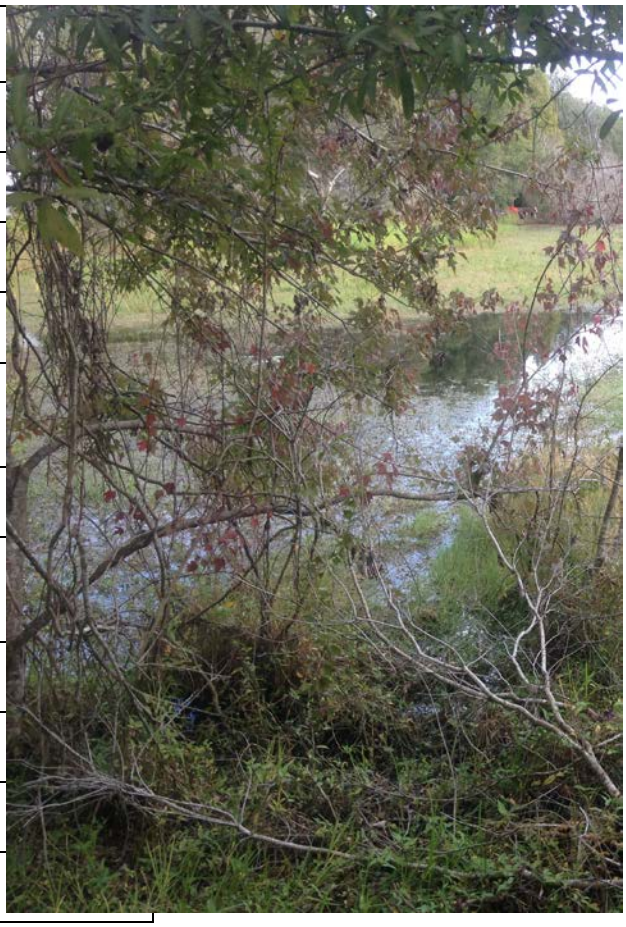
Pond 6



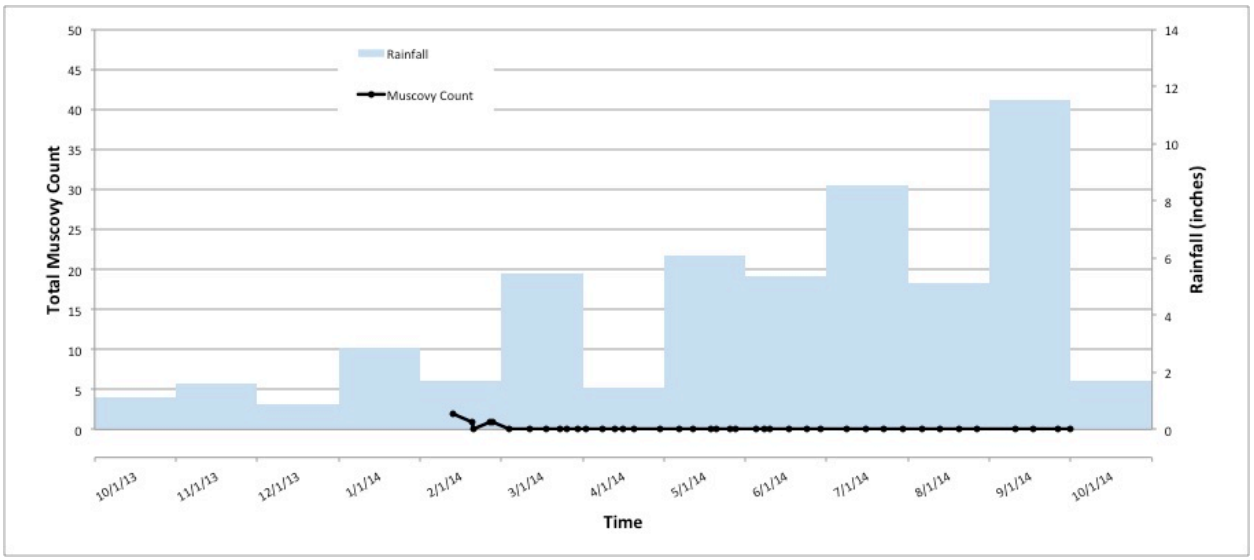
Dry Season

Wet Season

Fencing/type	partial/ chainlink
Fountain	no
Shoreline Vegetation (%) trees	65
Shoreline Vegetation (%) grass	35
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	60
Aquatic Vegetation (%) emergent	40
Aquatic Vegetation (%) floating	0
Slope rating (x°)	21.8
Water Regime	IE

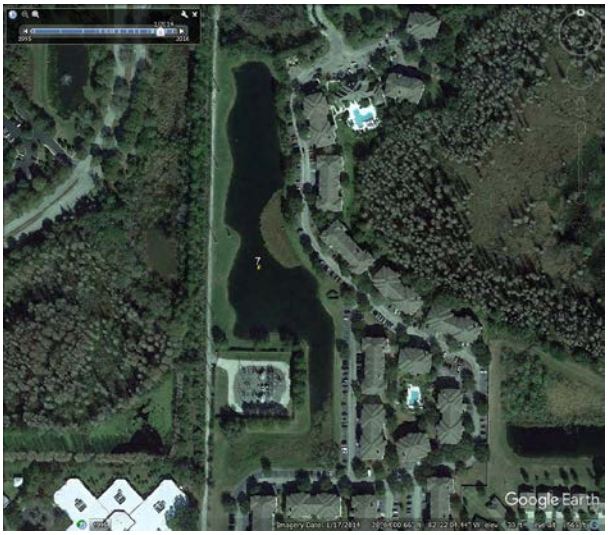


Pond 6

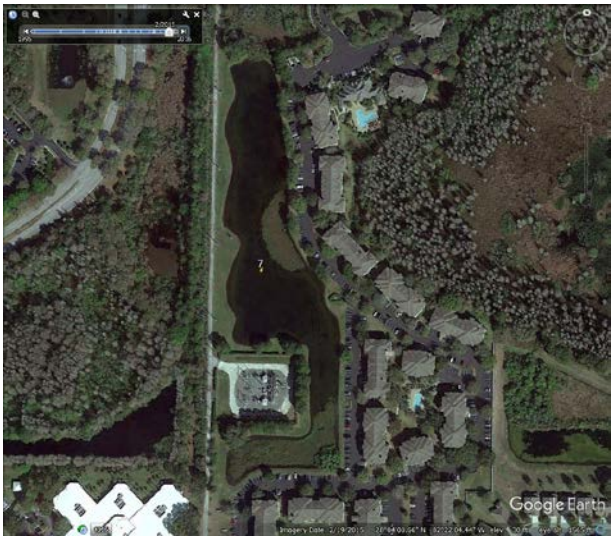


Area (m^2)	19614
Perimeter (m)	629
Wetland Type (Site)	Floating/Emerg. Aquatic Veg.
Wetland Type (State)	Cultural-Lacustrine
Land use	P, R-20, R-18
Land cover (Site)	Mixed Hardwood-Conif
Land cover (State)	High Intensity Urban
Nearest Neighbor	297.5m
Nearest Neighbor 2	414m
Dist. Nearest Road	38.9m

Pond 7



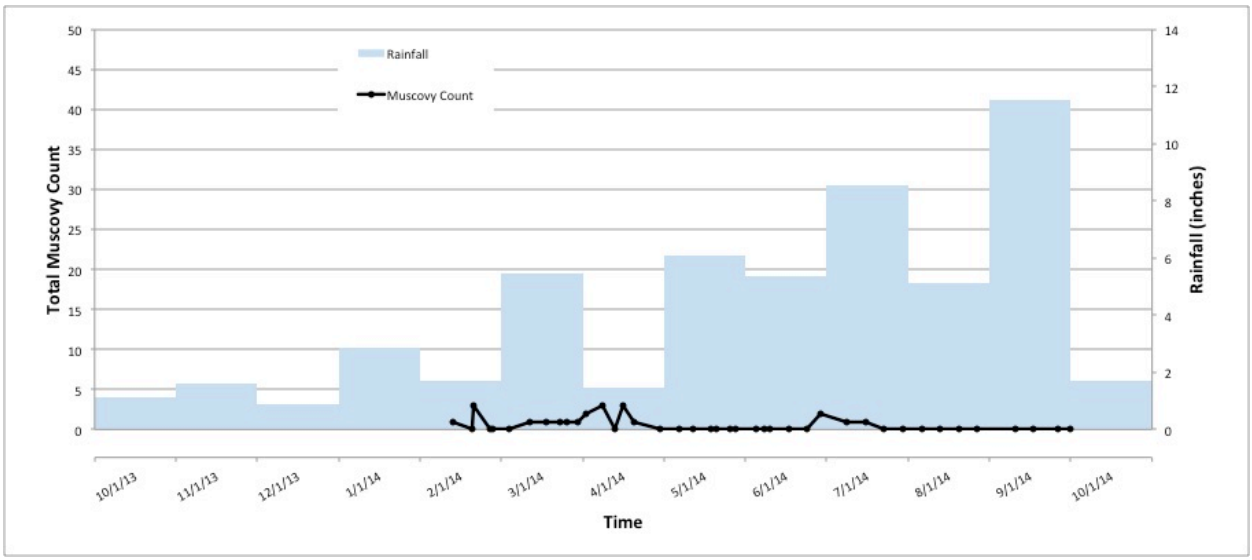
Dry Season

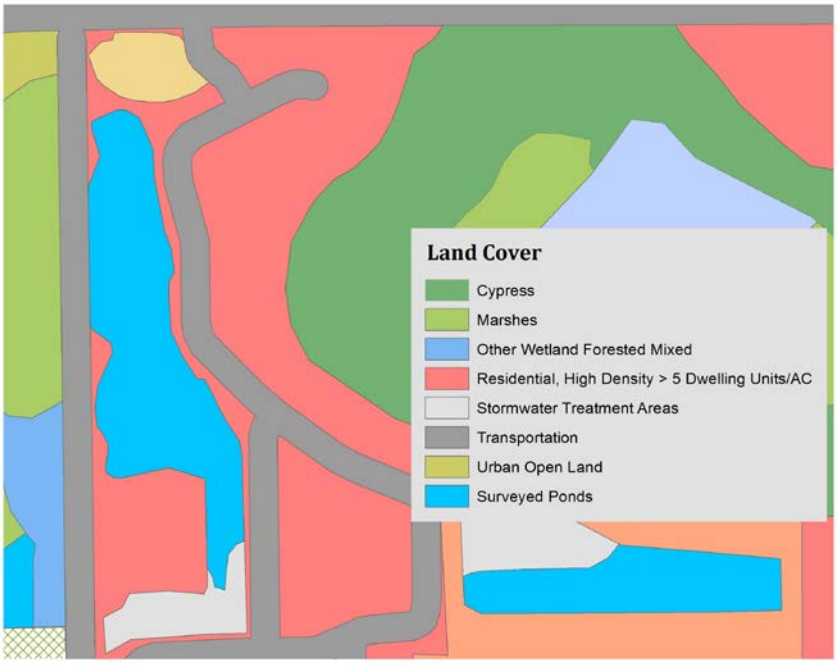


Wet Season

Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	40
Shoreline Vegetation (%) grass	60
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	70
Aquatic Vegetation (%) emergent	30
Aquatic Vegetation (%) floating	0
Slope rating (x°)	26.6
Water Regime	PF

Pond 7

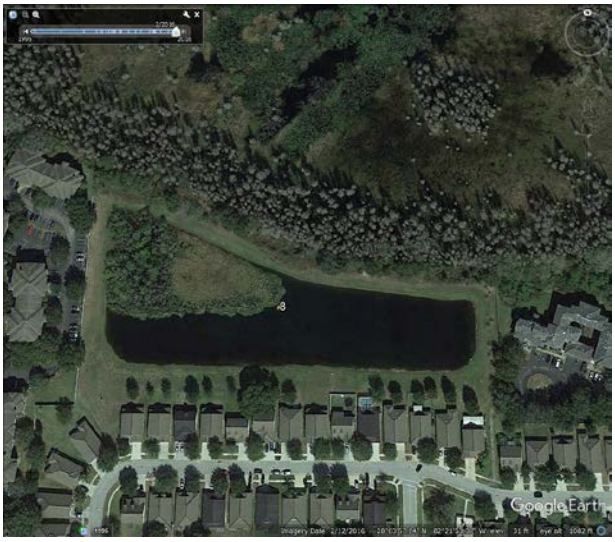




Area (m^2)	16414
Perimeter (m)	799
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	UMU-20
Land cover (Site)	Residential, High Density
Land cover (State)	High Intensity Urban
Nearest Neighbor	220m
Nearest Neighbor 2	279m
Dist. Nearest Road	5.8m

Pond 8

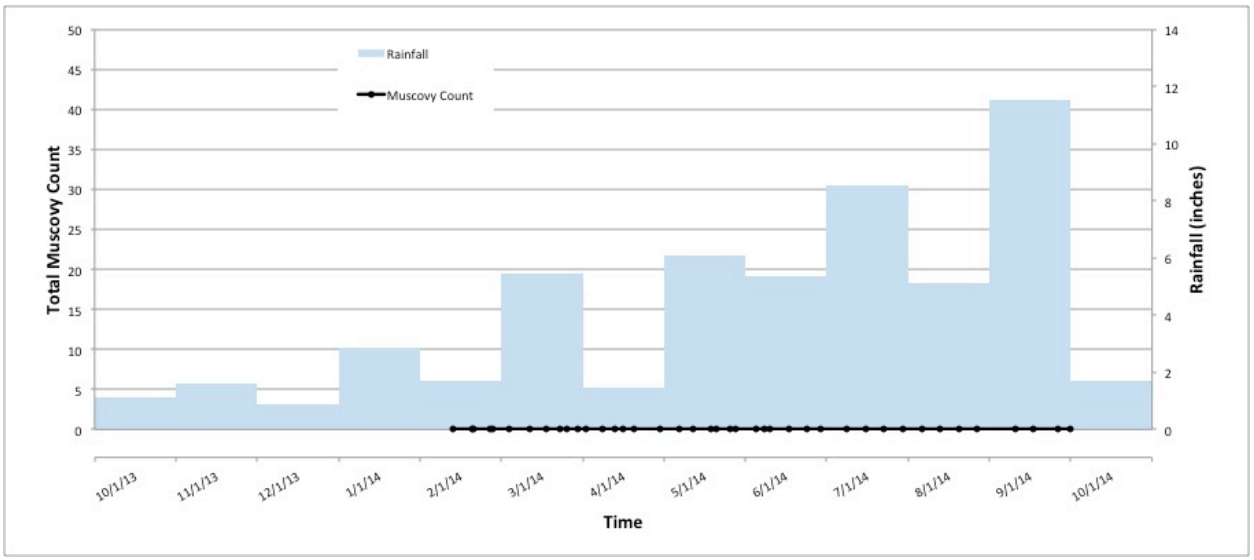
Dry Season

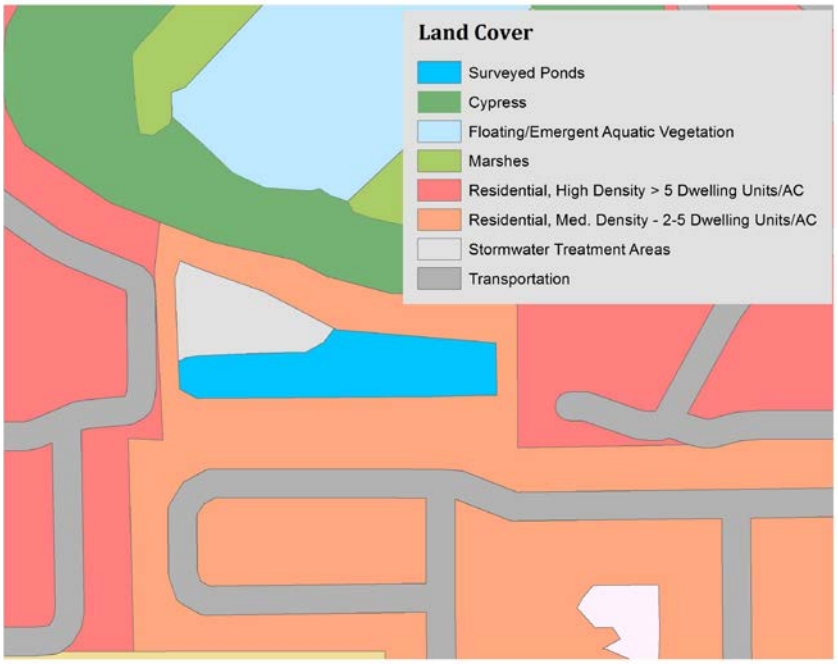


Wet Season

Fencing/type	partial/ chainlink
Fountain	no
Shoreline Vegetation (%) trees	25
Shoreline Vegetation (%) grass	75
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	90
Aquatic Vegetation (%) emergent	10
Aquatic Vegetation (%) floating	0
Slope rating (x°)	21.8
Water Regime	PF

Pond 8





Area (m^2)	8015
Perimeter (m)	503
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	UMU-20
Land cover (Site)	Residential, Medium Density
Land cover (State)	High Intensity Urban
Nearest Neighbor	234m
Nearest Neighbor 2	380m
Dist. Nearest Road	49.7m

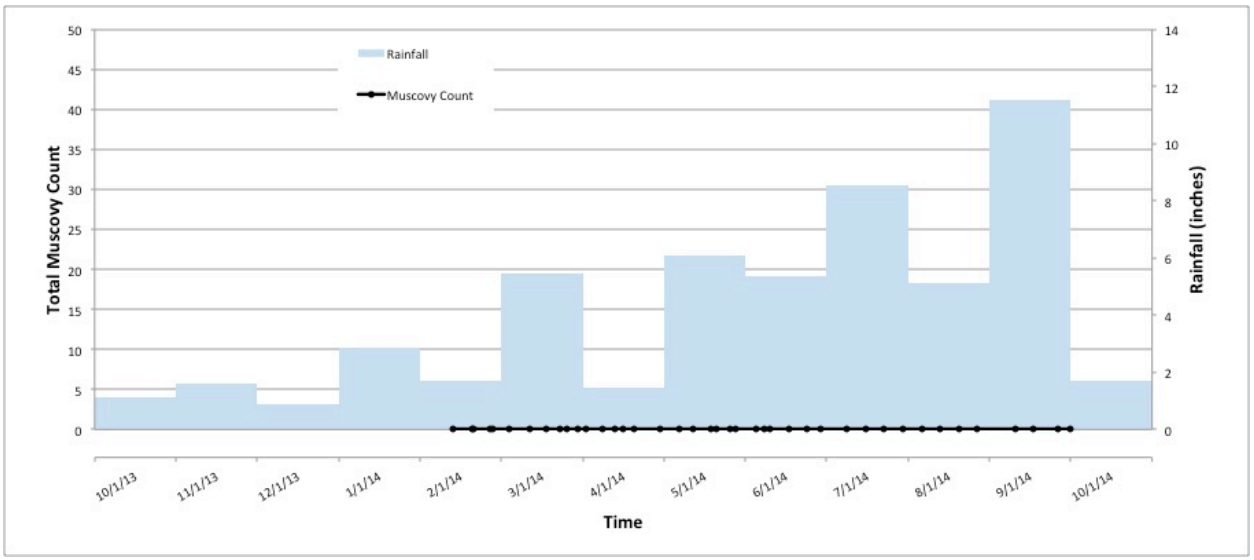
Pond 9


Dry Season


Wet Season

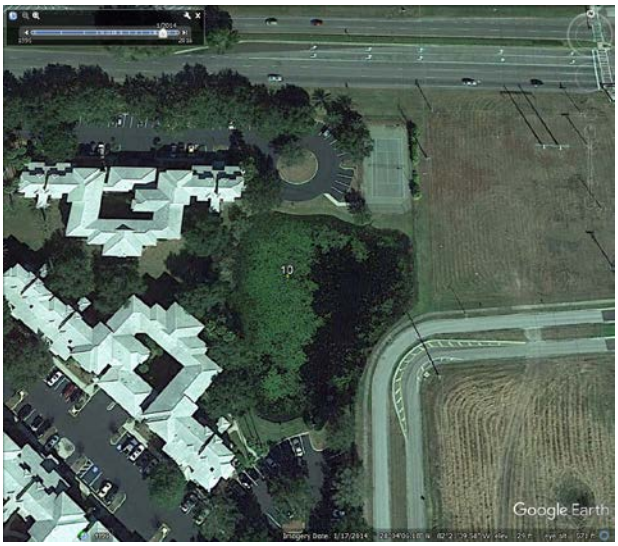
Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	95
Shoreline Vegetation (%) grass	5
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	65
Aquatic Vegetation (%) emergent	35
Aquatic Vegetation (%) floating	0
Slope rating (x°)	11.3
Water Regime	PF

Pond 9



Area (m^2)	7024
Perimeter (m)	637
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	RCP
Land cover (Site)	Commercial/ Services
Land cover (State)	High Intensity Urban
Nearest Neighbor	212m
Nearest Neighbor 2	256m
Dist. Nearest Road	15.8m

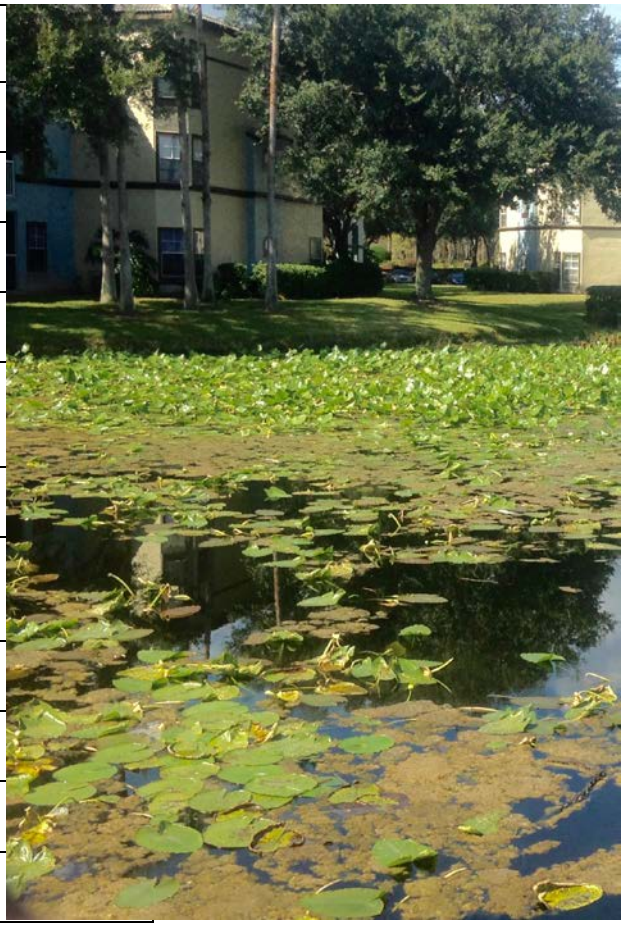
Pond 10



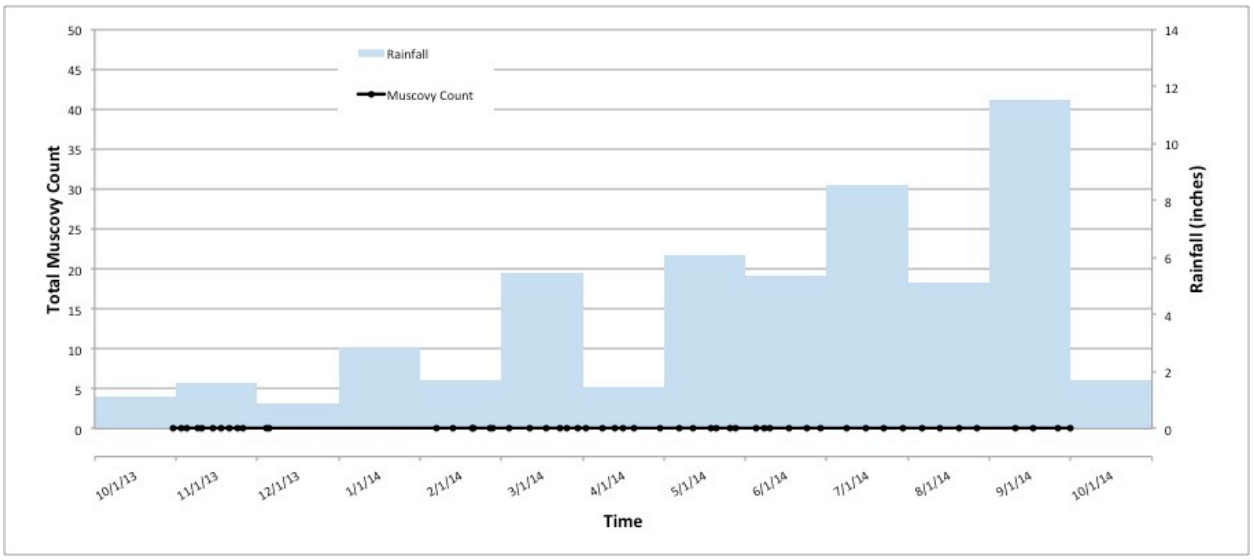
Dry Season

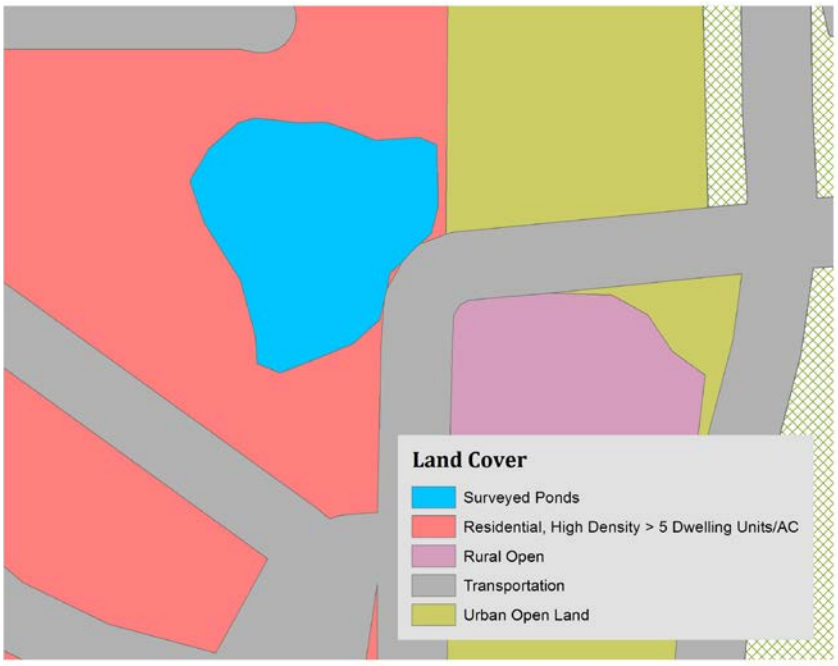
Wet Season

Fencing/type	partial/ chainlink
Fountain	no
Shoreline Vegetation (%) trees	40
Shoreline Vegetation (%) grass	60
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	10
Aquatic Vegetation (%) emergent	20
Aquatic Vegetation (%) floating	70
Slope rating (x°)	2.5
Water Regime	PF



Pond 10





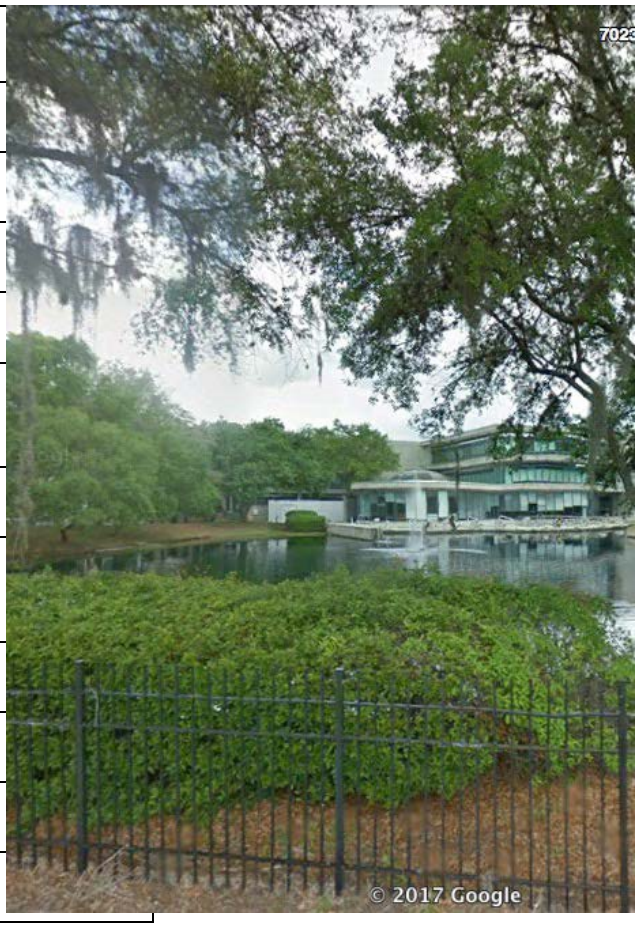
Area (m^2)	3541
Perimeter (m)	234
Wetland Type (Site)	Floating/Emerg. Aquatic Veg.
Wetland Type (State)	Freshwater Non-Forested
Land use	UMU-20
Land cover (Site)	Residential, High Density
Land cover (State)	High Intensity Urban
Nearest Neighbor	105.7m
Nearest Neighbor 2	252m
Dist. Nearest Road	359m

Pond 11

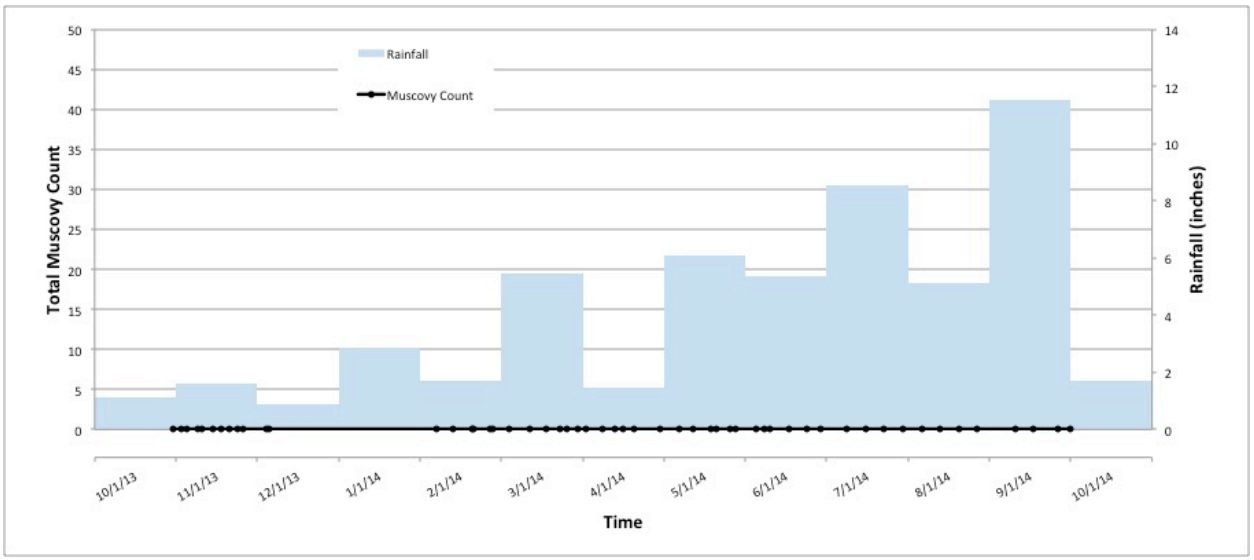
Dry Season

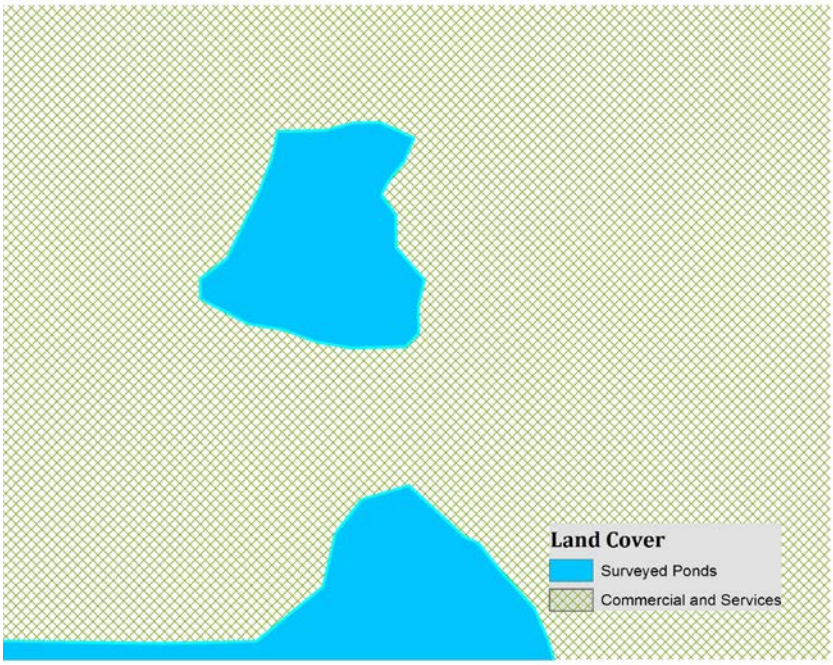
Wet Season

Fencing/type	partial/ iron bar
Fountain	yes
Shoreline Vegetation (%) trees	65
Shoreline Vegetation (%) grass	25
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	10
Aquatic Vegetation (%) open water	100
Aquatic Vegetation (%) emergent	0
Aquatic Vegetation (%) floating	0
Slope rating (x°)	11.3
Water Regime	PF



Pond 11





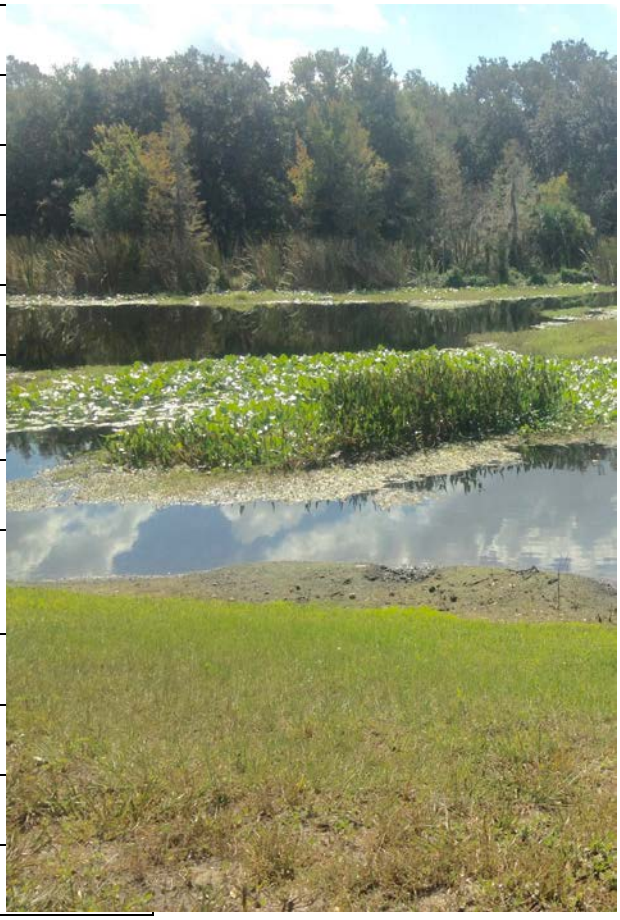
Area (m^2)	2516
Perimeter (m)	212
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	RCP
Land cover (Site)	Commercial/ Services
Land cover (State)	High Intensity Urban
Nearest Neighbor	138m
Nearest Neighbor 2	626m
Dist. Nearest Road	97.5m

Pond 12

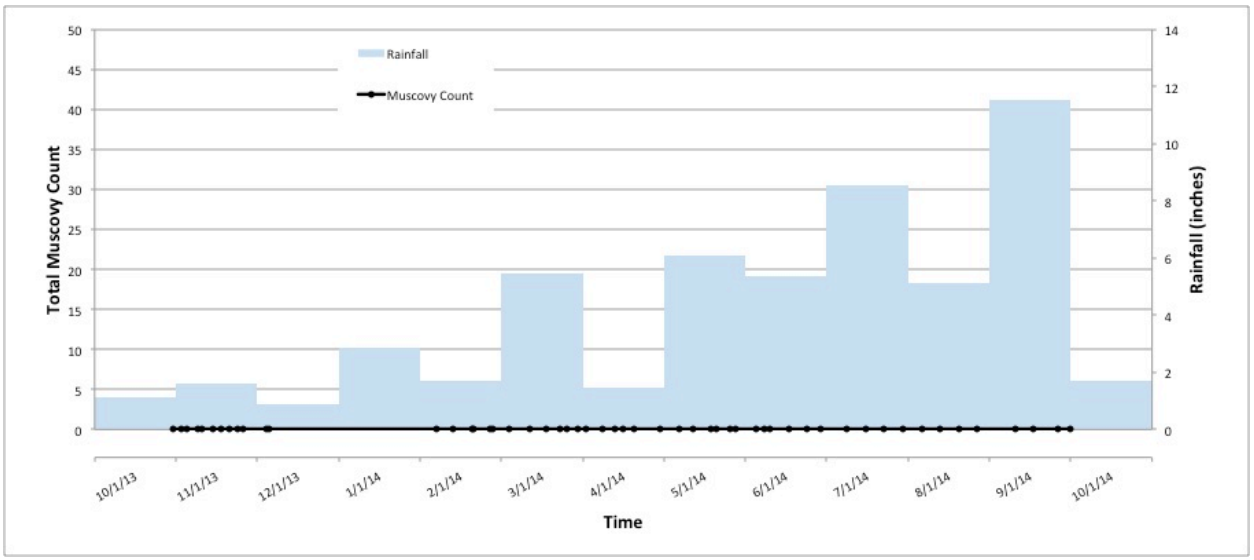
Dry Season

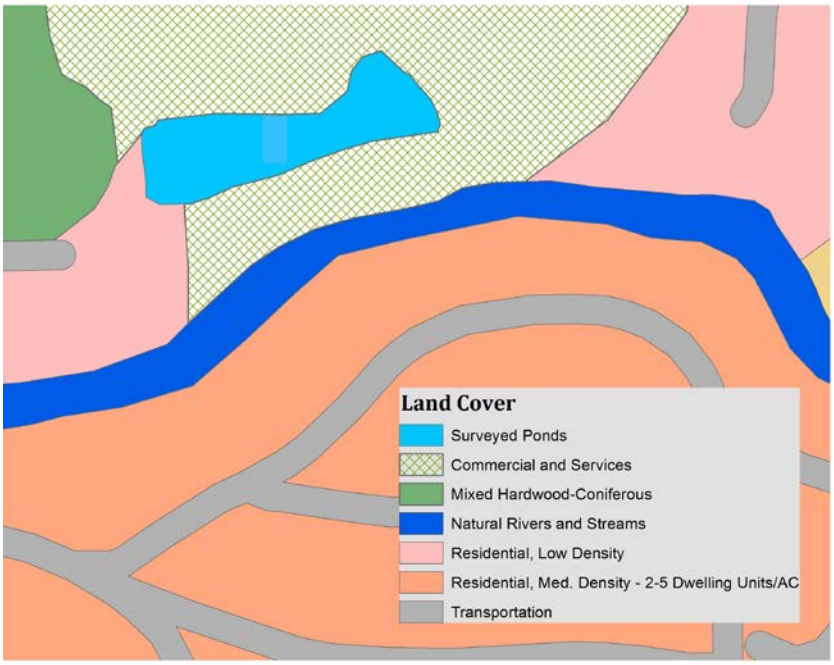
Wet Season

Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	55
Shoreline Vegetation (%) grass	45
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	50
Aquatic Vegetation (%) emergent	30
Aquatic Vegetation (%) floating	20
Slope rating (x°)	21.8
Water Regime	PF



Pond 12

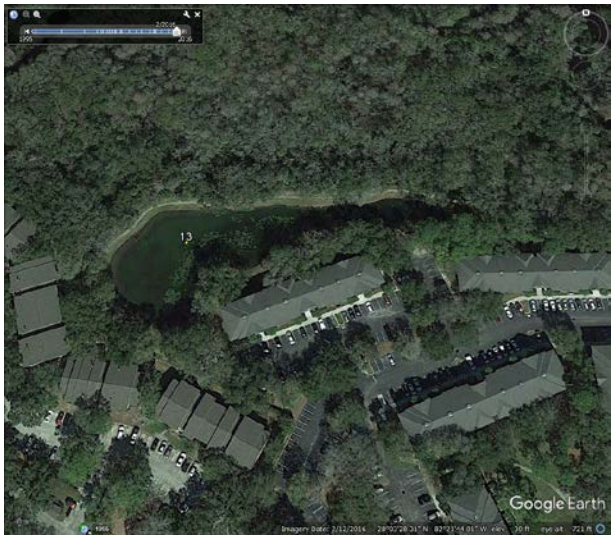




Area (m^2)	9131
Perimeter (m)	508
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	RCP
Land cover (Site)	Commercial/ Services
Land cover (State)	High Intensity Urban
Nearest Neighbor	138m
Nearest Neighbor 2	754m
Dist. Nearest Road	159.7m

Pond 13

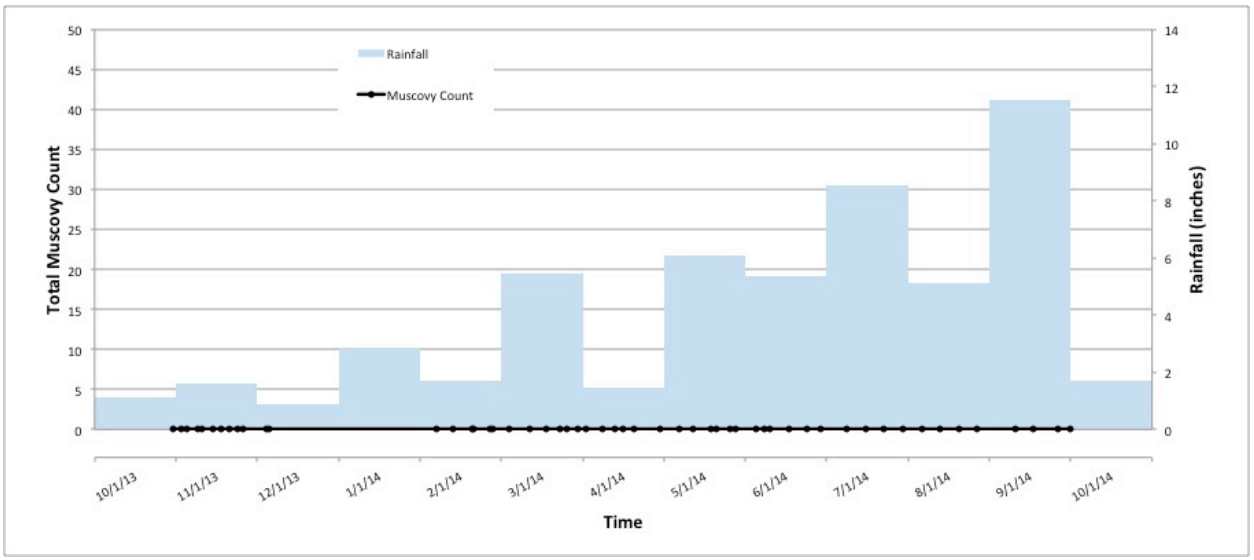
Dry Season

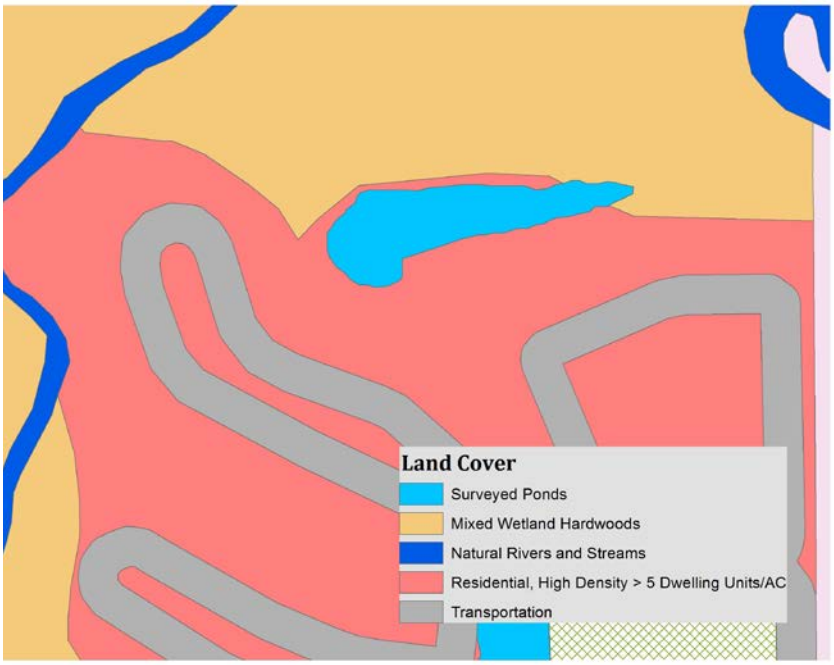


Wet Season

Fencing/type	partial/ chainlink
Fountain	no
Shoreline Vegetation (%) trees	45
Shoreline Vegetation (%) grass	45
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	5
Shoreline Vegetation (%) paved	5
Aquatic Vegetation (%) open water	100
Aquatic Vegetation (%) emergent	0
Aquatic Vegetation (%) floating	0
Slope rating (x°)	16.7
Water Regime	PF

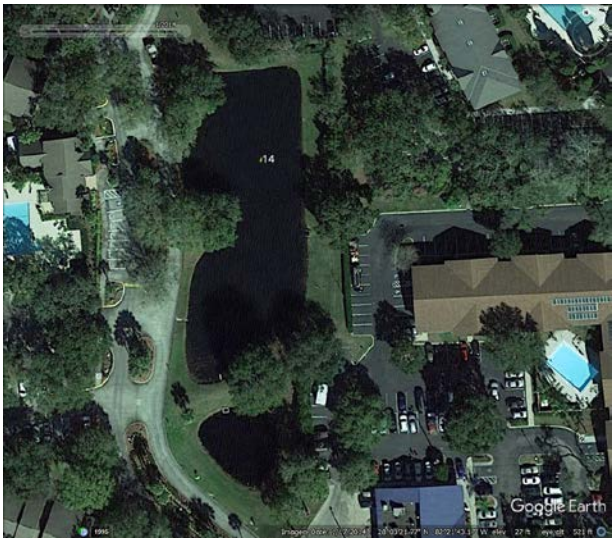
Pond 13



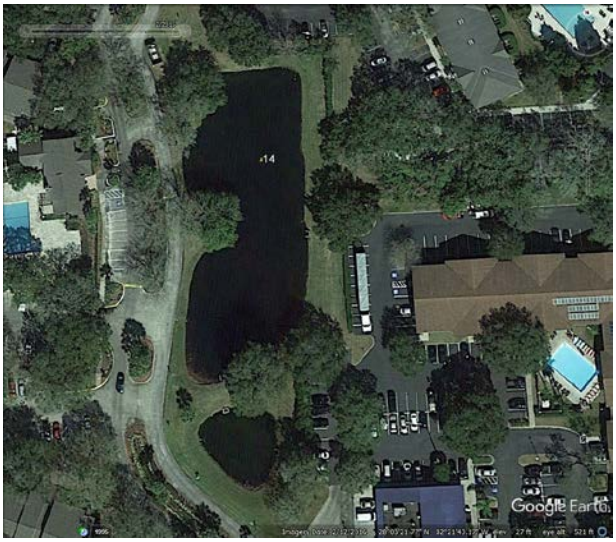


Area (m^2)	4016
Perimeter (m)	360
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	R-18
Land cover (Site)	Residential, High Density
Land cover (State)	High Intensity Urban
Nearest Neighbor	205m
Nearest Neighbor 2	667m
Dist. Nearest Road	46.1m

Pond 14



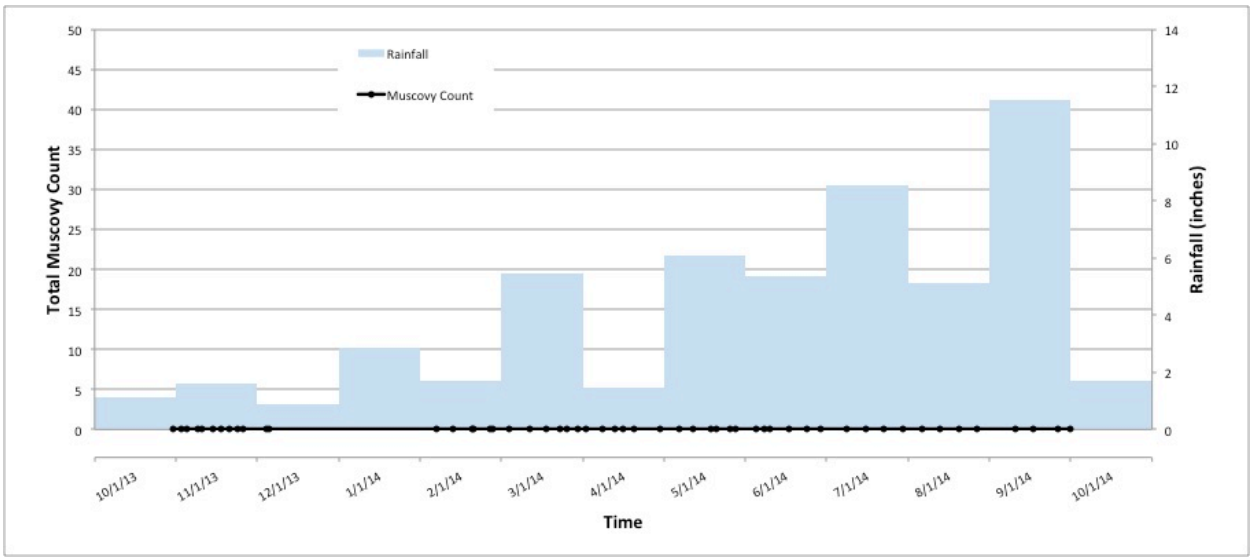
Dry Season

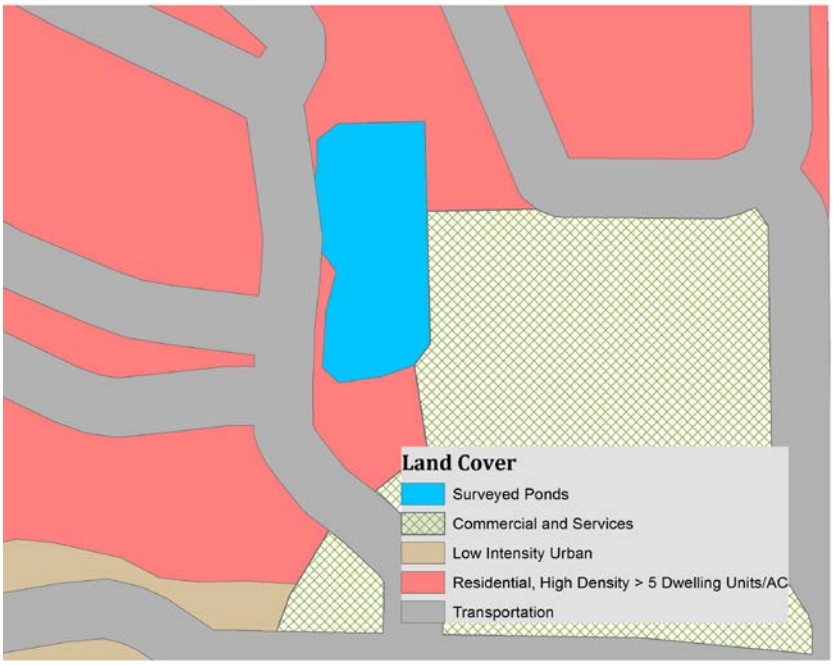


Wet Season

Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	25
Shoreline Vegetation (%) grass	70
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	5
Aquatic Vegetation (%) open water	100
Aquatic Vegetation (%) emergent	0
Aquatic Vegetation (%) floating	0
Slope rating (x°)	21.8
Water Regime	PF

Pond 14





Area (m^2)	3079
Perimeter (m)	235
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	R-18, UMU-20
Land cover (Site)	Residential, High Density
Land cover (State)	High Intensity Urban
Nearest Neighbor	205m
Nearest Neighbor 2	872m
Dist. Nearest Road	0.5m

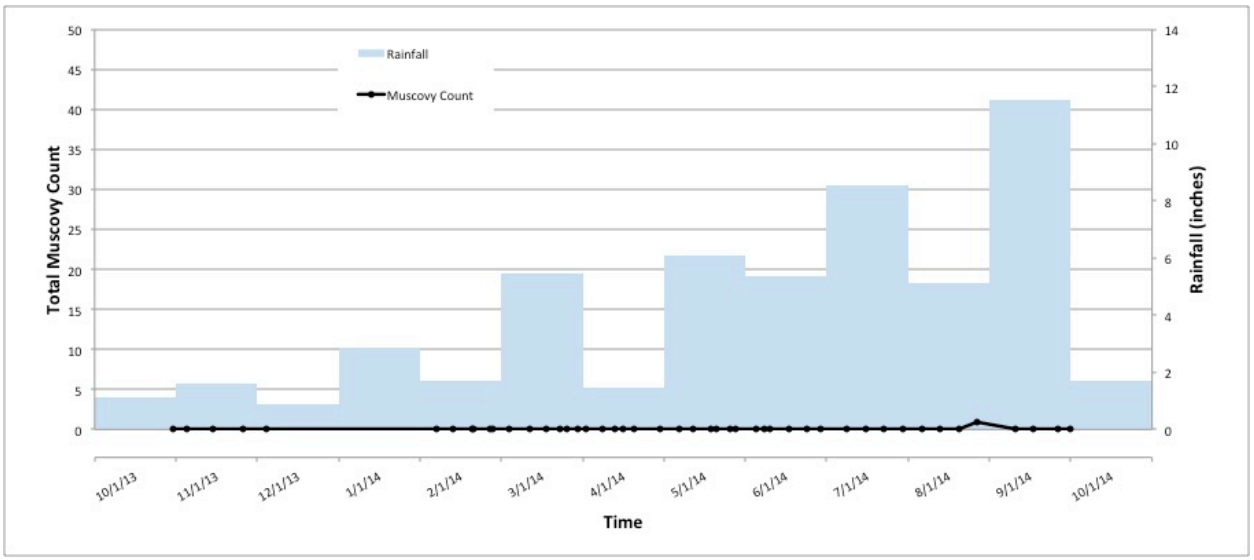
Pond 15

Dry Season

Wet Season

Fencing/type	complete/ chainlink
Fountain	no
Shoreline Vegetation (%) trees	10
Shoreline Vegetation (%) grass	90
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	20
Aquatic Vegetation (%) emergent	80
Aquatic Vegetation (%) floating	0
Slope rating (x°)	26.6
Water Regime	IE

Pond 15



Area (m^2)	3855
Perimeter (m)	462
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	R-4, P
Land cover (Site)	Residential, Medium Density
Land cover (State)	High Intensity Urban
Nearest Neighbor	996m
Nearest Neighbor 2	1142m
Dist. Nearest Road	15.8m

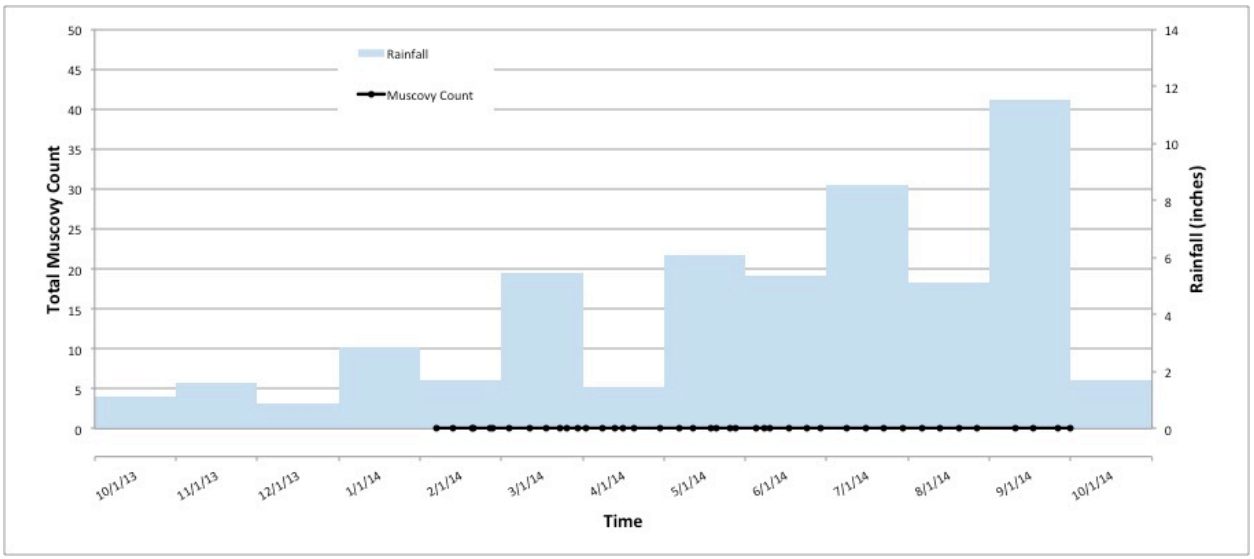
Pond 16

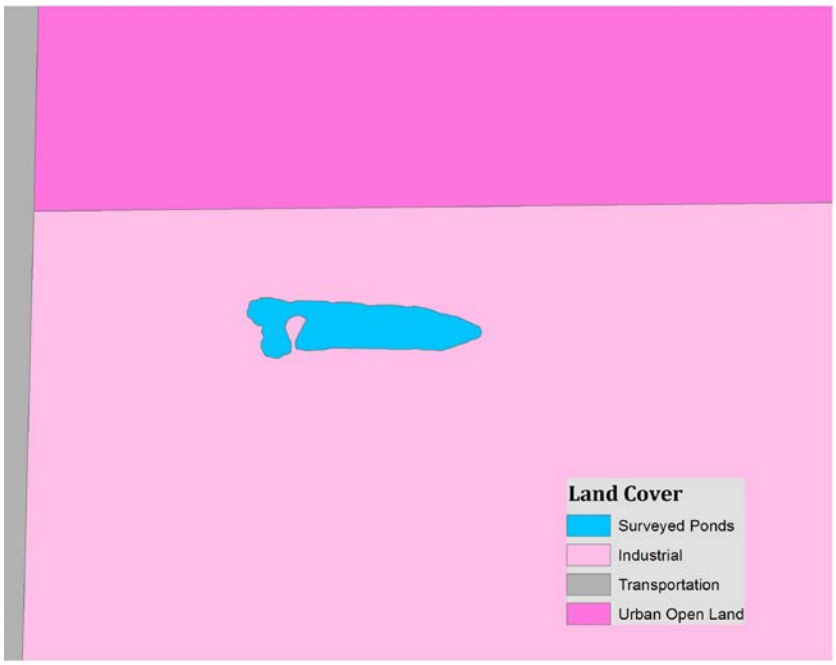
Dry Season

Wet Season

Fencing/type	complete/ chainlink
Fountain	no
Shoreline Vegetation (%) trees	90
Shoreline Vegetation (%) grass	10
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	100
Aquatic Vegetation (%) emergent	0
Aquatic Vegetation (%) floating	0
Slope rating (x°)	21.8
Water Regime	IE

Pond 16





Area (m^2)	1055
Perimeter (m)	208
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	HI
Land cover (Site)	Industrial
Land cover (State)	High Intensity Urban
Nearest Neighbor	136m
Nearest Neighbor 2	274m
Dist. Nearest Road	73.5m

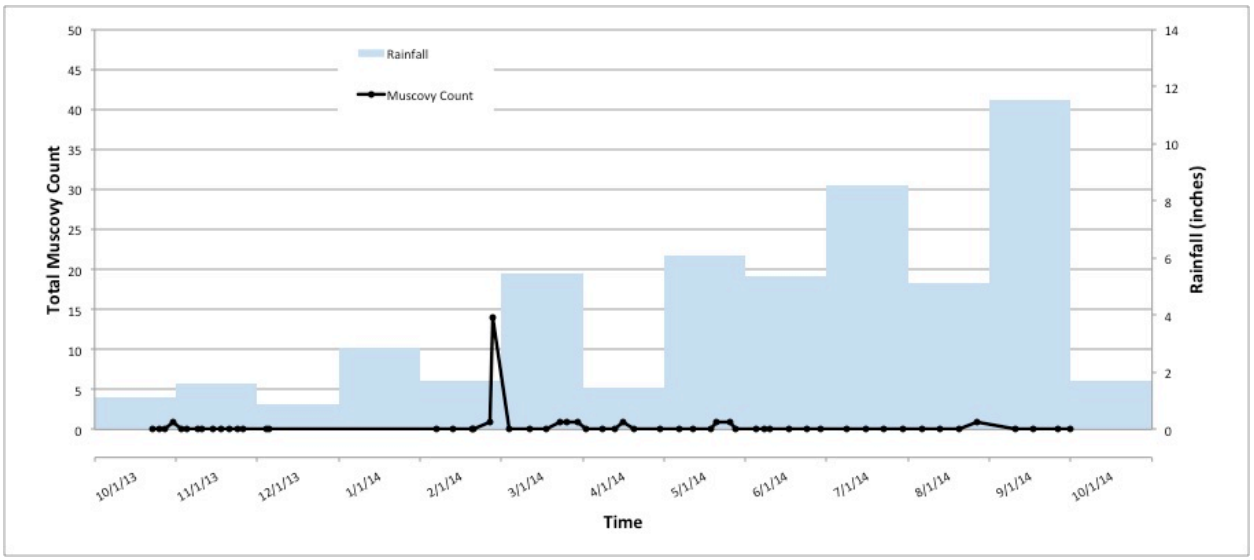
Pond 17

Dry Season

Wet Season

Fencing/type	none
Fountain	yes
Shoreline Vegetation (%) trees	15
Shoreline Vegetation (%) grass	85
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	70
Aquatic Vegetation (%) emergent	30
Aquatic Vegetation (%) floating	0
Slope rating (x°)	1.2
Water Regime	PF

Pond 17



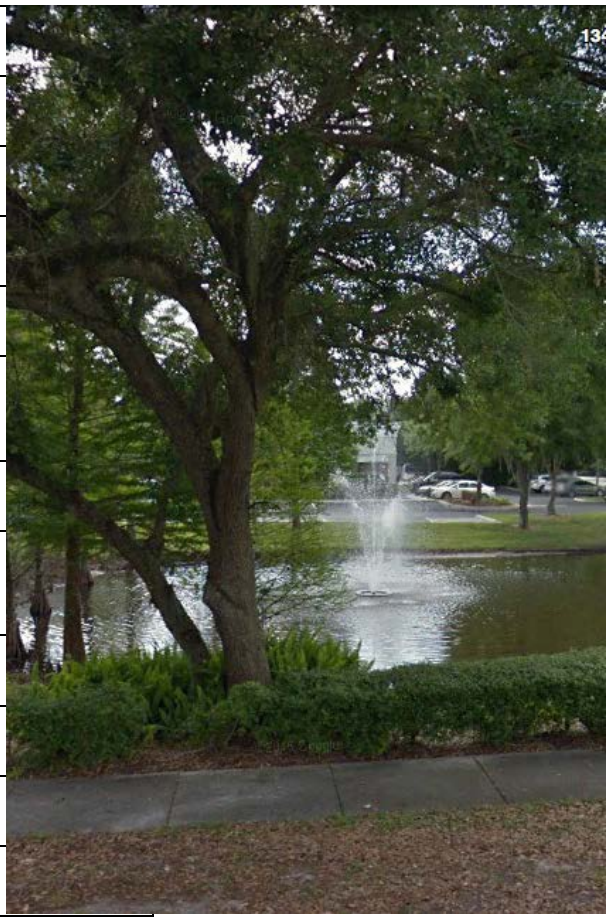
Area (m^2)	1602
Perimeter (m)	271
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	HI
Land cover (Site)	Industrial
Land cover (State)	High Intensity Urban
Nearest Neighbor	286m
Nearest Neighbor 2	332m
Dist. Nearest Road	9.1m

Pond 18

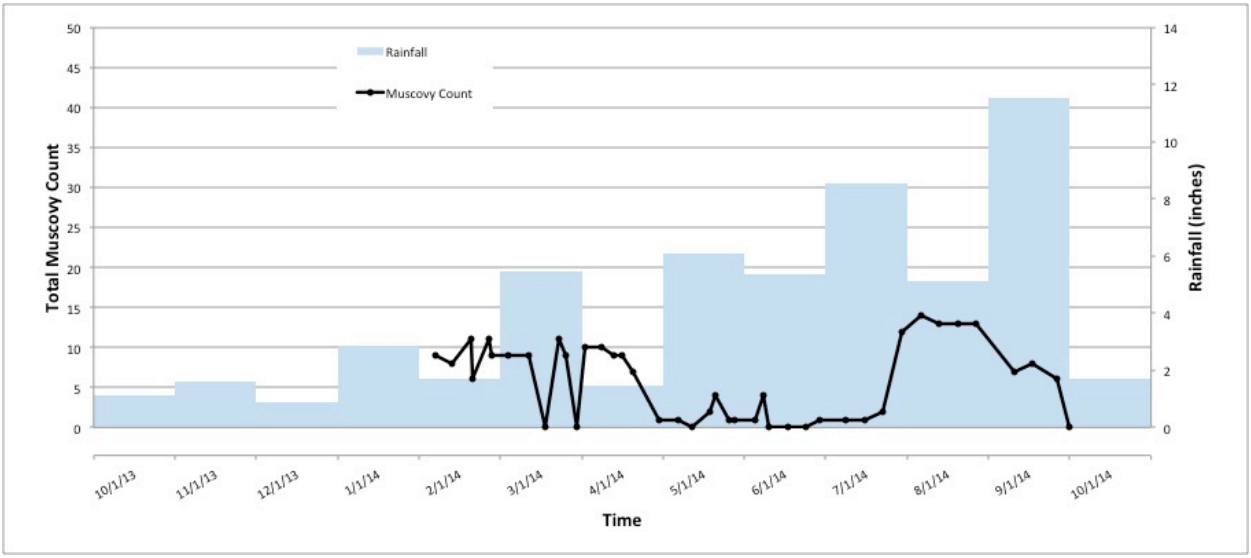
Dry Season

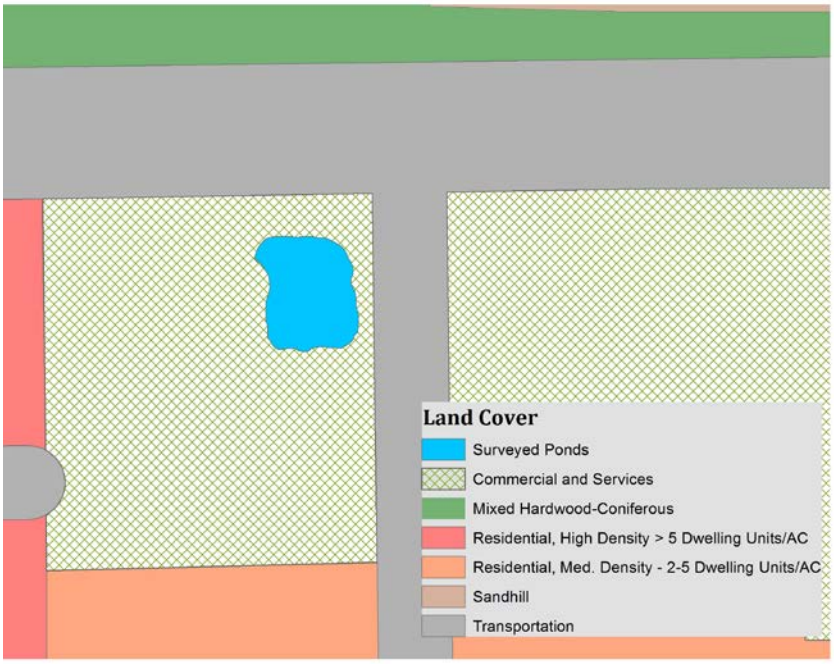
Wet Season

Fencing/type	none
Fountain	yes
Shoreline Vegetation (%) trees	15
Shoreline Vegetation (%) grass	80
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	5
Aquatic Vegetation (%) open water	90
Aquatic Vegetation (%) emergent	10
Aquatic Vegetation (%) floating	0
Slope rating (x°)	21.8
Water Regime	PF



Pond 18





Area (m^2)	701
Perimeter (m)	104
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	OI, R-18, ESA
Land cover (Site)	Commercial/ Services
Land cover (State)	High Intensity Urban
Nearest Neighbor	443m
Nearest Neighbor 2	486m
Dist. Nearest Road	4.7m

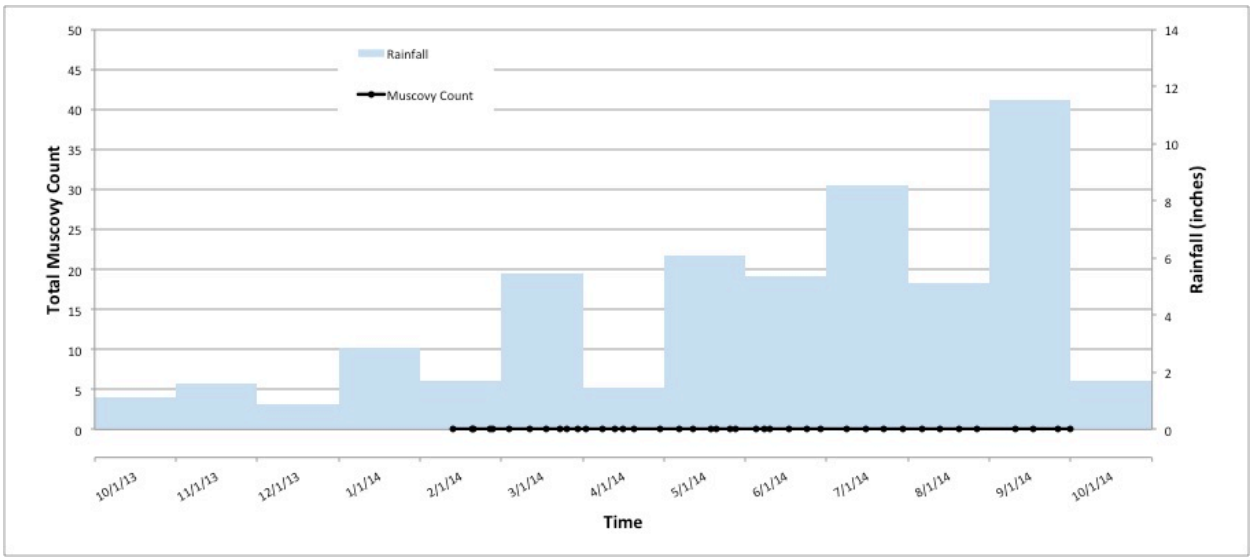
Pond 19

Dry Season

Wet Season

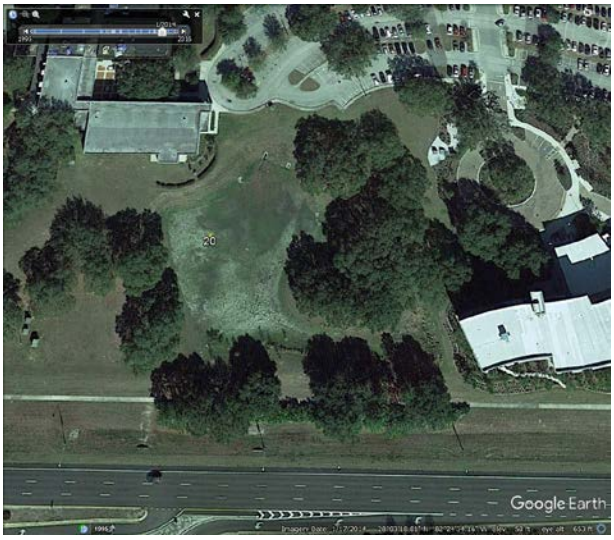
Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	5
Shoreline Vegetation (%) grass	95
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	45
Aquatic Vegetation (%) emergent	55
Aquatic Vegetation (%) floating	0
Slope rating (x°)	21.8
Water Regime	PF

Pond 19

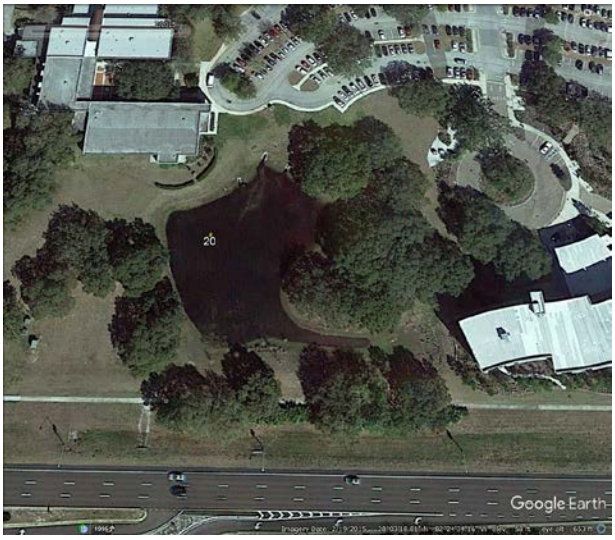


Area (m^2)	5995
Perimeter (m)	441
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	P/QP
Land cover (Site)	Institutional
Land cover (State)	High Intensity Urban
Nearest Neighbor	405m
Nearest Neighbor 2	491m
Dist. Nearest Road	4.9m

Pond 20



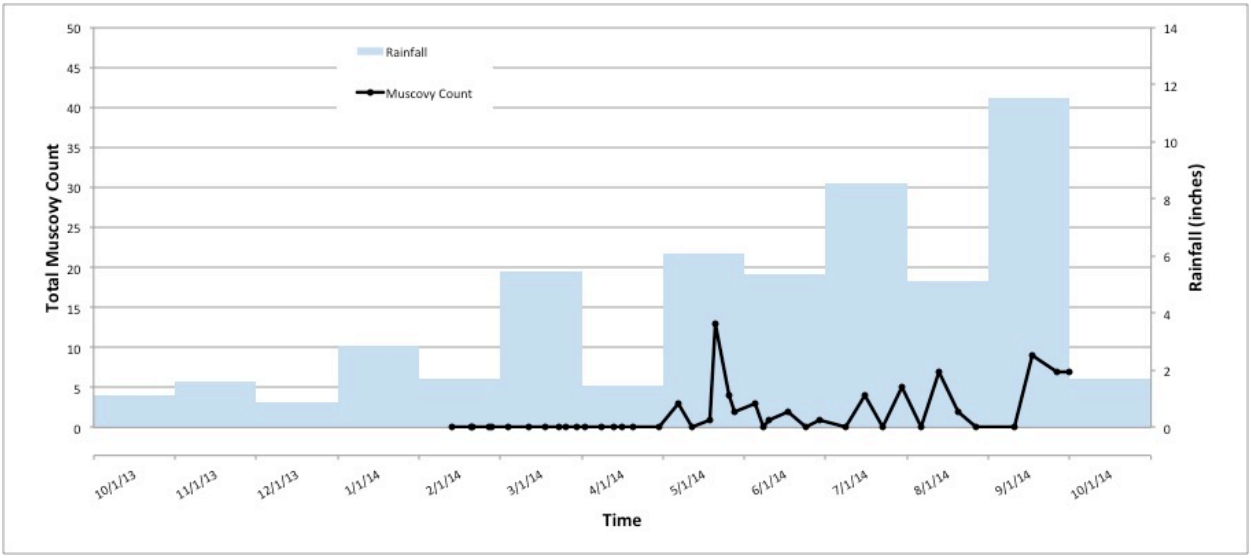
Dry Season



Wet Season

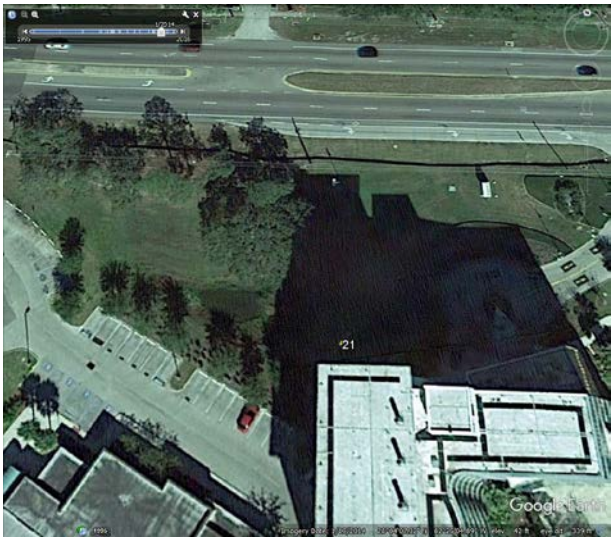
Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	30
Shoreline Vegetation (%) grass	70
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	85
Aquatic Vegetation (%) emergent	15
Aquatic Vegetation (%) floating	0
Slope rating (x°)	19.2
Water Regime	IE

Pond 20

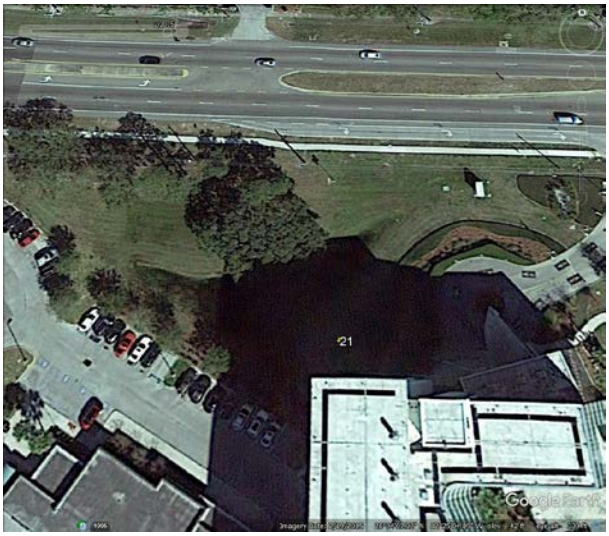


Area (m^2)	3969
Perimeter (m)	341
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	P/QP
Land cover (Site)	Institutional
Land cover (State)	High Intensity Urban
Nearest Neighbor	884m
Nearest Neighbor 2	1030m
Dist. Nearest Road	30.8m

Pond 21



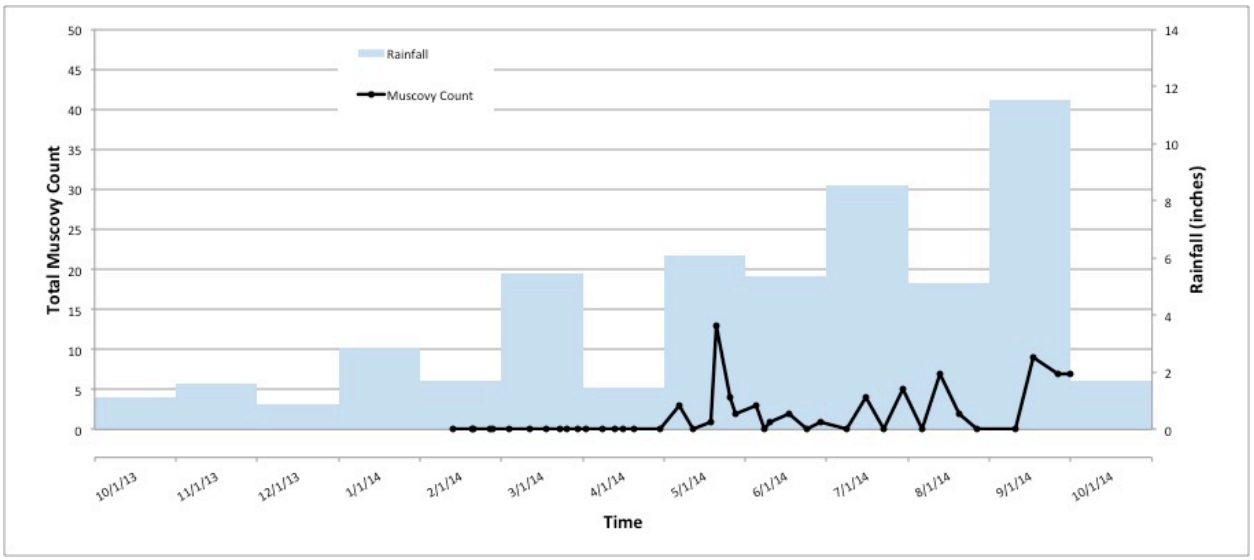
Dry Season



Wet Season

Fencing/type	none
Fountain	no
Shoreline Vegetation (%) trees	5
Shoreline Vegetation (%) grass	95
Shoreline Vegetation (%) rock	0
Shoreline Vegetation (%) dirt/sand	0
Shoreline Vegetation (%) paved	0
Aquatic Vegetation (%) open water	60
Aquatic Vegetation (%) emergent	20
Aquatic Vegetation (%) floating	0
Slope rating (x°)	8.5
Water Regime	IE

Pond 21



Area (m^2)	1164
Perimeter (m)	217
Wetland Type (Site)	Artificial Impoundment/ Reservoir
Wetland Type (State)	Cultural-Lacustrine
Land use	P/QP, RMU-35, R-20
Land cover (Site)	Institutional
Land cover (State)	High Intensity Urban
Nearest Neighbor	366m
Nearest Neighbor 2	606m
Dist. Nearest Road	4.4m