Urban Forestry: Benefits to The Economy, The People, and The Environment

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Introduction:

Urban forests are an increasingly valuable component of the urban environment. Recent scientific studies have found that between 1969 and 1994, urban areas have doubled in the United States and continue to expand through urban sprawl (Nowak et al. 2002). According to research, urban forests are likely to be the most influential forest of the 21st century (Nowak, et al. 2002). With about 80% of our population living in urbanized areas, it is critical to learn more about the important resources and the value urban forests provide to our society (Nowak et al. 2010). An *urban forest* can be defined as all the vegetation, primarily trees, that surrounds human population centers. Urban forests also encompass the sum of all street trees, residential trees, park trees, and greenbelt vegetation.

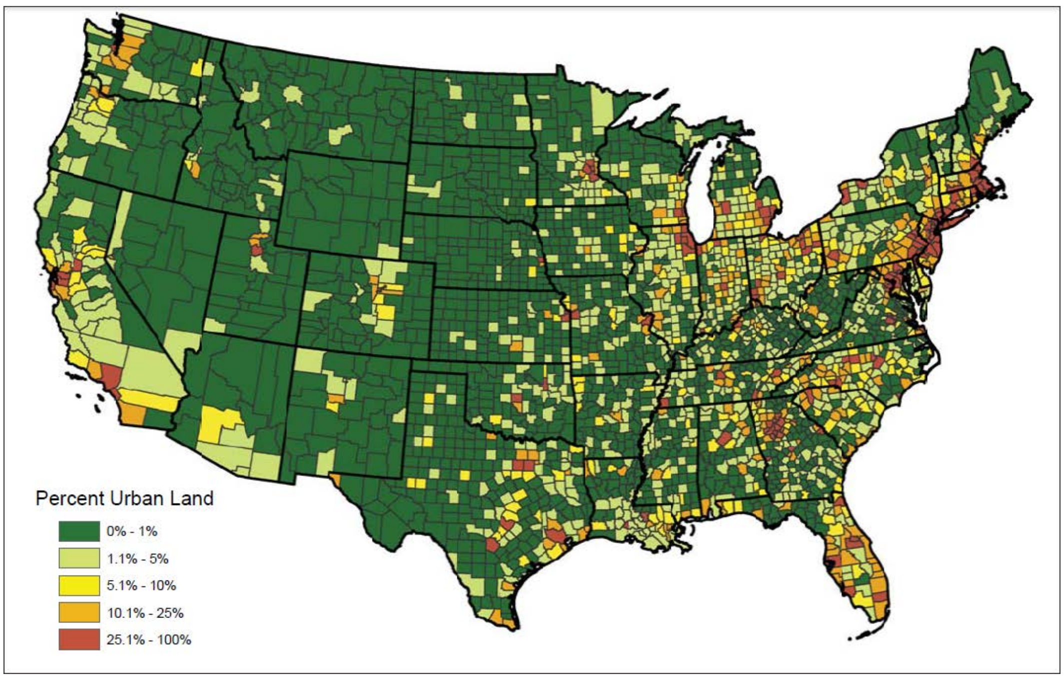

Figure 1: Percent Urban Land by County (Nowak et al. 2010).

The purpose of this project is to examine the University of Central Florida's (UCF) urban forests that have been surveyed by The Davey Resource Group in 2005 and reevaluate the data to determine how the density of the forests have changed. Only the forests contained within the

Gemini Blvd. loop will be surveyed. The forests contained within this loop are the most urban forests on campus. We hypothesize that the UCF campus will have improved its canopy density within Gemini Blvd. loop.

Often urban forests are identified into four distinct zones from city center outward; urban, suburban, exurban, and rural. Characteristics of an urban forest are usually areas with commercial districts, miscellaneous buildings, the lowest amount of land, and few trees (Miller 1988). In this experiment the urban plots will be located within Gemini Blvd. of UCF. By also studying the most urban area of campus UCF can better understand how an urban forest can benefit its urban core.

Increasing tree canopy is also an important component of the University of Central Florida's Sustainability Plan and Climate Action Plan that the Landscape and Natural Resources department established in 2004. It is UCF's goal to create an exemplary and unique urban campus environment that promotes outdoor comfort, security, sustainability, and a regional sense of place (UCF LNR 2010). This experiment will help to accomplish UCF's mission and target goals. More specifically, UCF plans to be carbon neutral by 2050. This experiment will provide data for future studies to address specific benefits of urban forests, including carbon sequestration. From the data collected UCF will be able to quantify the role of urban forest density to successfully sequester carbon. *Carbon Sequestration* is defined as the process through which carbon dioxide (CO_2) from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and stored as carbon in biomass (tree trunks, foliage and roots), soil and oceans (Environmental Protection Agency 2011). According to research, presently urban forests in the United States store about 800 million tons of carbon (Rowntree 1998). It is estimated that if the

United States increased urban tree cover by 5% in the next 50 years urban forests could store 150 million more tons of carbon (Rowntree 1998).

Triple Bottom Line:

The *triple bottom line* is the idea that to be truly sustainably, collectively, people and corporations must act in a way that benefits the economy, the environment, and people (The Economist 2009).

Social Benefits of Urban Forestry:

Social benefits associated with urban forests include more pleasant environments for a wide range of activities, improvement in the aesthetics of the environment, relief from stress, enhanced feelings and moods, increased enjoyment of everyday life, and a stronger feeling of connection between people and their environment (Gatrell 2002). Many studies state that there are numerous psychological benefits from urban forests, especially for individuals. Most documented benefits of living, working or playing in areas where a higher number of trees are recorded have shown improved worker productivity, reduced domestic violence, shorter healing times and reduced driving frustration and aggression (Westphal 2003). Other social benefits from urban forests include offsetting pollutants from car exhaust and industries that pose major health hazards to citizens.

Children also benefit greatly from urban forests. Playing in places with trees and vegetation can support children's development of skills and cognitive abilities and lessen the symptoms of Attention Deficit and Hyperactivity Disorder (ADHD) (Westphal 2003).

Benefits also extend beyond individuals into the society. Societal benefits include community empowerment, promotion of environmental responsibility and ethics, and enhanced economic development. From an organization standpoint, the benefits from urban forestry create more active involvement within the community.

Table 1. Potential benefits from urban greening.

	Passive experience of a green environment	Active involvement in greening the environment
Individual	Shorter hospital stay, improved cognitive function	Sense of accomplishment, food security
Organization	Stronger business districts	More members, stronger ties to politicians
Community	Reduced crime	More external resources

Table 1: Potential benefits from urban greening (Westphal 2003).

Environmental Benefits of Urban Forestry:

Living in an urban area can often be overwhelming. Trees provide a varying natural barrier dependent on their characteristics. By designing landscapes with sound in mind, we can create a barrier from some of the noises of city life. This has also been referred to as a *soundscape* (Bucur 2009). Also urban forestry can play a major benefit to the ecology of the disturbed urban landscape. Urban forests not only buffer airborne pollutants, but also buffer water pollutants through their leaf and root surfaces. Water savings can occur when native landscaping designs are implemented. These native areas also provide a habitat for wildlife, which helps with fragmentation (Gatrell 2002).

Fragmentation is a huge issue in areas that are transitioning between rural to urban, like the relationship we have here at UCF between Gemini Circle's urban core and the rural forest outside of it. Forest fragmentation occurs when forest ecosystems become fragmented through human impact. This sectioning of forests causes reduction in biodiversity, making it harder for species to find food and breed (Environmental Protection Agency, 2003). Forests also provide filtration of water and breaking these ecosystems up with roads and human settlements causes derogation to our water supply (Environmental Protection Agency, 2003).

Since Florida is prone to hurricanes, it is important to consider urban forestry as a protective measure for our environment and society. Many plant species, both native and non-native, have been shown in South Florida to protect and withstand high winds. By adding urban forests to an area biodiversity is more likely to increase. As biodiversity increases, so does the health and protection capacity of the ecosystem (Rowntree 1998).

Economic Benefits of Urban Forestry:

Trees and forested areas both increase property value and provide energy savings. Trees provide a cooling effect to homes, a canopy layer that shades out the understory. This allows for major savings in Florida, where the sun is out for much of the year. Property values of homes with access to forested areas increase about 4.5-5% (Gatrell 2002). In order to effectively study urban forest, a cost benefit analysis must be taken into account to accurately understand how and why urban forests are essential to our environment.

An *urban heat* island describes built up areas that are hotter than nearby rural areas (Heat Island 2011). Heat islands are a negative influence on communities because they raise summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality (Heat Island 2011). Urban forests reduce the heat island effect saving money in the process.

Methodology:

The purpose of this study is to determine the urban tree canopy for the University of Central Florida's urban core (designated as everything within the Gemini Blvd. loop), and how this has changed since 2005. The data can then be used to determine if UCF has increased its urban tree canopy, and if that value is in an optimal range. Our hypothesis is that the UCF campus will have experienced an increase in its canopy density since 2005. We will test this hypothesis by conducting a field survey of random plots and compare it to data from 2005.

Required Materials:

- Arc GIS
- Microsoft Excel
- Google Earth
- Campus GIS data
- Trimble device
- Survey tape
- DBH tape
- Results from 2005 Davey Campus Tree Survey

The following methods were undertaken to analyze current urban forest tree canopy. 20 random plots with an individual radius of 37.5 feet were created (Table 2) using Arc GIS. See Appendix I Figures 1-2 for specific locations. 20 plots were chosen due to time constraints, we only had a two month time frame. This experiment required two different methods to determine canopy cover for the years 2005 and 2011. In 2005 the Davey Resource Group completed a tree inventory of the UCF campus. In this survey they identified the trees on campus and recorded their DBH (diameter at breast height) and general condition. Since canopy cover was not specifically measured, DBH had to be used to solve for canopy cover because it was the only quantitative data available from the Davey survey. Aerial imagery analysis was courted as an alternative method but the imagery from 2005 was of poor quality.

Point #	Location:
1	Between Lake Claire Apartments Parking Lot and Visual Arts
2	Community Garden
3	Between Parking Garage A and Education
4	Performing Arts Centre Theatre Parking Lot
5	Environmental Initiative Office
6	Student Union
7	Arboretum
8	Reflecting Pond
9	Between Engineering and Health and Public Affairs
10	Parking Garage H
11	Library
12	Parking Garage C
13	Performing Arts Centre
14	Parking Garage D
15	CREOL
16	Alpha Delta Pi Sorority House
17	Visual Arts
18	Student Union
19	Visual Arts Parking Lot

20	Parking Lot Next to Parking Garage B

Table 2: Locations of randomly generated plots.

The first step was to determine canopy cover for 2011. After the plots were created they were then located in the field using a Trimble device and then the trees existing in the plots were identified and their DBHs and canopies were measured. DBH is a tree's trunk diameter measured at 4.5 ft. above ground level (Swiecki 2001). It is measured using DBH tape and recorded in centimeters. For multi trunk trees all relevant trunks were measured and summed together. Canopy was recorded by measuring the diameter of a tree's canopy (from drip line to drip line) in feet using survey tape. To determine the area of the canopy the area of a circle was used: πr^2, where r is the radius of the diameter. If a tree's canopy was not circular (e.g. pine tree) two perpendicular diameters were recorded and the average of those two values was used as the diameter in the area of a circle equation.

Figure 2: Measuring a tree's canopy diameter.

Once all DBHs and canopy diameters were recorded for the year 2011, Microsoft Excel was used to perform regression analyses to find a linear relationship between DBH and canopy diameter.

Only the species that existed in the plots in 2005 needed

Figure 3: Measuring tree DBH.

regression analysis. The resultant linear equations were used to find trees' canopy diameter from their DBHs recorded in 2005. Additional trees outside of the study plots were measured to provide data for the regression. Then for each plot the sum of all of the trees canopy areas were divided by 4417.86 sq. ft. (total area of the plot) to determine what percent of the plot consisted of tree canopy. To determine the total canopy for all 20 plots each plot canopy area was added together and divided by the total area of all the plots. This was done for 2005 and 2011. Then this data was extrapolated to determine the total canopy cover for the whole Gemini Blvd. loop using the following equation: (Total plot canopy cover/Total plot area) = (Gemini Blvd. Canopy Cover/Gemini Blvd. Area). Google Earth was used to estimate the area of the Gemini Blvd. loop: 247.05 acres or 10761701.54 feet^2.

Results and Outcomes:

Overall our data supported our hypothesis that the University of Central Florida's urban forest experienced an increase in canopy growth since 2005.We came to this conclusion based on the following results. Appendix II 1 shows the DBH and canopy area data recorded for 2011. Then GIS data from the UCF Tree Inventory Workbook (Davey survey) was referenced to determine which species existed in our plots in 2005. The species existing in 2005 were Chinese Elm (*Ulmus parvifolia*), Crape Myrtle (*Lagerstroemia sp.*), Laurel Oak (*Quercus laurifolia*), Longleaf Pine (*Pinus palustris*), Pond Cypress (*Taxodium ascendens*), and Pond Pine (*Pinus serotina*). Appendix II 2 lists recorded DBH and canopy area for these species. The data was derived from the 2011 plot data and trees randomly found inside the Gemini Blvd. loop.

Appendix III consists of all of the scatter plots and regression lines created for each species. Since a large sample size was not used some regression lines have low R^2 values (Table

3). In regression analysis, the coefficient of determination (R^2 value) is a measure of goodness-of-fit (i.e. how well or tightly the data fit the estimated model) (Statistics 2011). Low R^2 values will affect the accuracy of the equations. The equations were then used to determine canopy area of trees in 2005 from DBH (Appendix II 2).

Species:	Line of Best Fit:	Coefficient of Determination (R^2):
Chinese Elm	y=0.5578x+11.743	0.6098
Crape Myrtle	y=0.2401x+3.2314	0.3382
Laurel Oak	y=0.4207x+7.066	0.7903
Longleaf Pine	y=0.7087x+3.6278	0.9757
Pond Cypress	y=0.676x+0.6033	0.6705
Pond Pine	y=0.7699x+6.955	0.8729

Table 3: Regression analysis for tree species existing in 2005.

Table 4 shows the urban tree canopy from 2005 and 2011. According to this data total campus tree canopy rose from 5.94% to 14.62%, or a 8.68% total increase. For individual plots there was mostly an increase in canopy or no change. The plots that experienced no change were located in parking lots, parking garages, or buildings. This occurred a lot due to the urban nature of the environment. A large source of error with this data is the fact that a lot of trees were not recorded by the Davey Resource Group. We were under the assumption that the Davey survey was a 100% survey.

Point #	Location:	% Canopy Area (2005)	% Canopy Area (2011)	% Change
1	Between Lake Claire Apartments Parking Lot and Visual Arts	20.83	23.68	2.85
2	Community Garden	16.45	9.04	-7.41
3	Between Parking Garage A and Education	14.78	36.07	21.29

4	Performing Arts Centre Theatre Parking Lot	0.00	0.00	0.00
5	Environmental Initiative Office	25.44	53.12	27.68
6	Student Union	0.00	74.64	74.64
7	Arboretum	0.00	18.70	18.70
8	Reflecting Pond	4.55	20.70	16.15
9	Between Engineering and Health and Public Affairs	2.29	12.11	9.82
10	Parking Garage H	0.00	0.00	0.00
11	Library	0.00	0.00	0.00
12	Parking Garage C	0.00	0.00	0.00
13	Performing Arts Centre	11.32	0.00	-11.32
14	Parking Garage D	0.00	0.00	0.00
15	CREOL	0.00	0.00	0.00
16	Alpha Delta Pi Sorority House	0.00	4.92	4.92
17	Visual Arts	0.00	0.00	0.00
18	Student Union	1.50	17.74	16.24
19	Visual Arts Parking Lot	0.00	12.46	12.46
20	Parking Lot Next to Parking Garage B	6.30	9.32	3.03
	Total	5.94	14.62	8.68

Table 4: Comparison of canopy change from 2005 to 2011 for UCF's urban forest.

Even though our data supports our hypothesis we believe because of incomplete tree data from 2005 and the process used to find canopy for 2005 that the hypothesis should be cautiously accepted. It is logical to think there would be canopy increase because of general tree growth in the six year interval between surveys and the efforts by UCF's Landscape and Natural Resources Office but we think the increase is too dramatic when much of the campus has been altered by new construction (parking garages, buildings, etc.).

There were four specific plots that stood out the most as being erroneous. Plots 6 and 18 are located inside the Cypress Dome located alongside the Student Union yet there was zero or minimal tree data recorded for these plots in 2005. Aerial imagery confirmed for us that trees did exist here in 2005. Plot 10 also has no data for 2005, we believe it would have shown a canopy loss since a parking garage has replaced the forest system that was there. Also plot 7, located alongside the arboretum, was lacking any data from 2005 when aerial imagery proved otherwise. Figure 4 shows just how dramatic the increase in canopy area was based on our data.

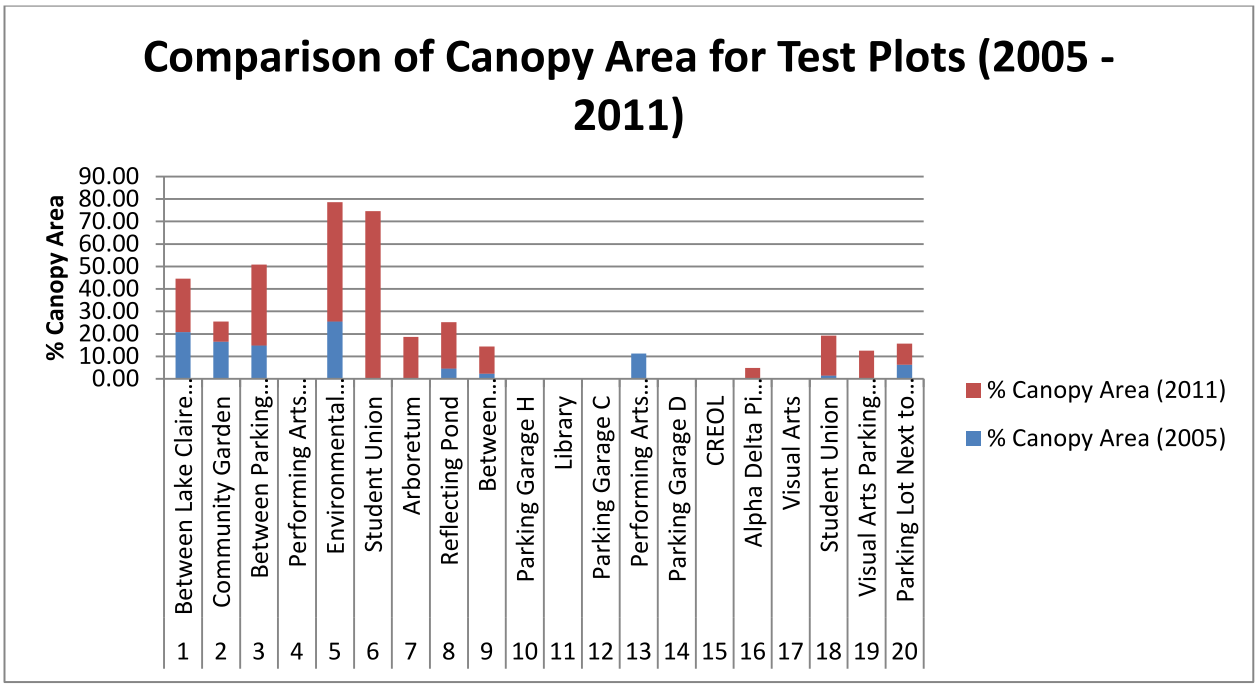

Figure 4: Plot canopy area % for 2005 and 2011.

We decided to omit the four plots in question: plots 6, 7, 10, and 18. This changed our data as shown in table 5. According to this data, total campus tree canopy rose from 7.33% to 9.86%, or a 2.53% total increase. These values appear to be more realistic, but regardless of which plots used the end result was that there was an increase in canopy from 2005 to 2011, supporting our hypothesis.

	20 Plots:	16 Plots:
Total Plot Canopy % for 2005	5.939807%	14.62473%
Total Plot Canopy % for 2011	7.33095%	9.858714%
Total Gemini Blvd. Canopy in Sq. Ft. (2005)	639224 sq. ft.	788934.5 sq. ft.
Total Gemini Blvd. Canopy in Sq. Ft. (2011)	1573870 sq. ft.	1060965 sq. ft.

Table 5: Comparison of canopy % and total canopy between 20 and 16 plots.

If UCF has experienced the drastic canopy increase we have recorded it still does not mean that the urban forest located on campus is optimal. An increase is a step in the right direction but for UCF's canopy to be optimal it must meet the needs of the people and organisms that use it while staying cost effective.

Optimal Density:

Optimal density for UCF is also dependent on the triple bottom line: social equity, economics, and the environment. When UCF creates a denser urban forest on campus they need to consider each of these elements thoroughly. Not enough trees can cause negative effects in all three areas, and too many could also do the same.

Currently open areas like UCF's Memory Mall provides a space for game day tailgating and playing recreational sports with friends at any time. Trees would provide environmental benefits like shading and carbon sequestration along the border of Memory Mall, but planting the entire field would take away a valuable social space for students to commune.

Optimal density is also dependent on economics, this being UCF's budget. Looking at the budget and the allotment towards UCF's Land and Natural Resource department will help to decide how many and what kind of trees are most viable. It also may be beneficial for UCF to allot more money to the Land and Natural Resources Department if certain areas see decrease in energy spending due to tree shading.

The final element up for consideration is the environmental aspect. Fragmentation is a huge issue especially regarding urban forestry. Here at UCF we do have fragmentation because of parking garages, classrooms, and other facilities. Ideally we could have more spaces on campus like the Cypress Dome, which create a dense ecosystem within a small space. There will still be some fragmentation; however, less if we can create more biodiversity ecosystems on campus.

Social:

Configuring optimal density for an urban forest has yet to be determined. Many researchers and scientists are still working on ways to tangibly quantify how many trees in an area will determine optimal density for different urban environments.

One reason as to why optimal density is so difficult to determine is because there are many different ways to define optimal density. One could define optimal as the cost of management an urban forest needs or how much carbon trees sequester in that area. Social benefits can also be used to quantify optimal density.

According to a study titled "Public Preference for Tree Density in Municipal Parks" performed by Herbert

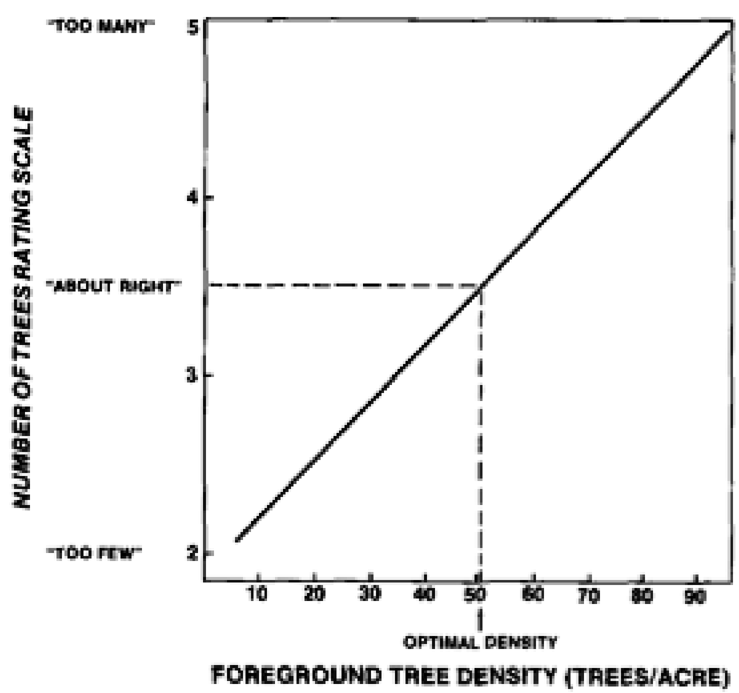

Figure 5: Optimal density based on aesthetics (Schroeder 1985).

W. Schroeder and Thomas L. Green, optimal density of urban forests were determined by asking public groups to rate photographs of a park. There were several different methods used, including, showing the public photographs of trees and asking the participants to rate the number of trees on a six-point scale with endpoints labeled “too many” or “too few”. From this study, the authors were able determine that an optimal density for urban forest from a social perspective is about 40 to 50 trees per acre (Schroeder 1985).

Environmental:

Optimal urban forest density in regards to the environment has not been quantified. There are many factors in forest systems and it is also ecosystem specific. Coming up with a broad scale figure for optimal urban forest density seems very improbable unless ecosystem specific. An optimal number corresponding to UCF’s ecosystem should take into consideration fragmentation. UCF is home to many birds, small mammals, and deer and other large mammals. The campus consists of an urban core surrounded by forested lands. Gemini Blvd. is largely responsible for this separation. Optimal density for the Gemini Blvd. loop should address Gemini’s role in fragmentation.

Economic:

Since there are so many factors that contribute into managing and investing in an urban forest, it takes a little more time to access the actual number that would make an optimal density of urban forestry exist in the real world. The best we can do is research and take a look at all the factors that play their role. Also useful information would include what budget you are dealing with. Once you find out what budget spending is available, an allocation decision can be made.

Since UCF has other priorities besides maintaining and improving its urban forests, decisions must be made on where the money gets spent. This is true for all forests and is a major problem in urban centers (Richards 1992).Rather than striving for maximum density clear guidelines need to be set to optimize the stocking of urban trees (Richards 1992).

UCF currently spends $14 million USD annually in electricity costs (Central Florida Future). The city of Gainesville spends approximately $1,559,932 to care for their public urban forests or approximately $10.57 per public tree (Escobedo et al. 2008). UCF most likely spends an amount below this value.

UCF could increase its urban forest tree canopy to save money on their electricity bill. Since trees help cool the air around them and reduce the urban heat island effect, much of our campus savings could be made in reduced cooling costs. So we look at how much trees reduced the urban temperature: Electric demand of U.S. cities increases about 1 to 2 percent per degree F (3-4% per °C) increase in temperature, approximately 3 to 8 percent of current electric demand for cooling is used to compensate for this urban heat island effect (McPherson and Rowntree 1993). Increased funding towards increasing urban forest tree canopy will reduce the urban heat island effect causing UCF to save more than it is spending, due to reduced power consumption.

Barriers

Most of our barriers were in relation to the 2005 Davey Tree Survey data. The data collected by Davey was incomplete. The survey was supposed to be 100% of UCF’s urban core, but it failed to measure dense forest systems including but not limited to the Cypress Dome. This initially caused inaccuracies in our results by portraying a huge increase in canopy cover, when really the data was just never recorded for those plots in 2005.

The 2005 Davey survey only studied DBH and not canopy cover, which was also a difficulty. To remedy this challenge we performed regression analyses to determine a linear relationship between DBH and canopy cover.

Our final barrier was time. Our group worked over the five-hour minimum almost every week, and we still felt as though we fell short of time. In a semester time frame we studied and collected data from 20 urban plots, calculated missing data, researched optimum density, and much more. We overcame many barriers and had to think on our feet. Needless to say, we learned a lot.

Improvements

This study should be revisited now that there is canopy data to reference. Using linear equations to determine canopy is an inaccurate method to say the least. Aerial imagery analysis is a fast, cheap, and accurate method for determining tree canopy. I recommend future researchers utilize this method if planning on continuing this study.

If the method outlined in this study is used more test plots, and more time will be needed to ensure an accurate study. If regression analysis is used again a larger sample size will be demanded.

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Appendix I

Appendix I Figure 1: Map of 20 randomly generated plots inside the Gemini Blvd. loop (2005 imagery).

Appendix I Figure 2: Map of 20 randomly generated plots inside the Gemini Blvd. loop (2011 imagery).

Appendix II

	Species:	Average DBH (cm)	Canopy Diameter (ft)	Avg. (for irregular canopies)	Tree Canopy Area	Plot Canopy Area	Plot Canopy Area %
Point 1	Longleaf Pine	48.50	36.50	-	1046.35	0.236844	23.68444
Point 2	Pond Pine	34.00	23.9, 17.0	20.45	328.46	0.09	9.039156
	Sand Pine	9.00	9.50	-	70.88		
Point 3	Longleaf Pine	40.50	36.5, 31.6	34.05	910.59	0.360664	36.0664
	Longleaf Pine	33.50	29.1, 27.6	28.35	631.24		
	Crape Myrtle	46.50	8.10	-	51.53		
Point 4	No Trees					0	0
Point 5	Red Cedar	20.50	15.20, 17.0	16.10	203.58	0.531213	53.12129
	Unidentified (b)	7.50	9.70	-	73.90		
	Pond Pine	38.00	31.30, 9.50	20.40	326.85		
	Pond Pine	52.50	32.20, 35.90	30.90	749.91		
	Pond Pine	51.00	35.55	-	992.59		
Point 6	Pond Cypress	34.50	25.70	-	518.75	0.746389	74.63893
	Pond Cypress	21.00	13.40	-	141.03		
	Pond Cypress	6.00	2.70	-	5.73		
	Buckthorn	5.50	8.50	-	56.75		
	Buckthorn	31.40	12.00	-	113.10		
	Pond Cypress	9.60	7.50	-	44.18		
	Pond Cypress	10.00	6.70	-	35.26		
	Pond Cypress	31.80	16.30	-	208.67		
	Pond Cypress	10.30	7.00	-	38.48		
	Pond Cypress	29.30	16.80	-	221.67		
	Pond Cypress	16.50	10.00	-	78.54		
	Pond Cypress	29.90	17.00	-	226.98		
	Pond Cypress	7.00	4.70	-	17.35		
	Pond Cypress	11.30	4.80	-	18.10		
	Pond Cypress	23.20	27.40	-	589.65		
	Pond Cypress	24.10	29.30	-	674.26		
	Buckthorn	2.00	4.00	-	12.57		
	Buckthorn	6.60	4.60	-	16.62		
	Buckthorn	7.00	8.20	-	52.81		
	Cabbage Palm	46.00	17.00	-	226.98		
Point 7	Willow	10.50	14.4, 14.0	14.20	158.37	0.186958	18.69582
	Willow	7.00	15.00	-	176.71		
	Willow	13.50	15.00	-	176.71		

	Willow	11.00	20.00	-	314.16		
Point 8	Southern Magnolia	63.50	28.00	-	615.75	0.206978	20.69778
	Chinese Elm	11.00	19.50	-	298.65		
Point 9	Laurel Oak	31.00	26.10	-	535.02	0.121104	12.1104
Point 10	No Trees					0	0
Point 11	No Trees					0	0
Point 12	No Trees					0	0
Point 13	No Trees					0	0
Point 14	No Trees					0	0
Point 15	No Trees					0	0
Point 16	Crape Myrtle	21.00	6.30		31.17	0.049177	4.917733
	Crape Myrtle	22.00	6.60		34.21		
	Crape Myrtle	11.75	5.30		22.06		
	Crape Myrtle	44.70	11.15		97.64		
	Crape Myrtle	17.00	6.40		32.17		
Point 17	No Trees					0	0
Point 18	Red Bay	12.00	20.3, 12.5	16.40	211.24	0.17736	17.736
	Red Maple	11.00	13.80	-	149.57		
	Pond Cypress	14.00	8.50	-	56.75		
	Juniper	13.50	21.00	-	346.36		
	Pond Cypress	10.00	5.00	-	19.63		
Point 19	Crape Myrtle	34.25	17.00	-	226.98	0.124638	12.46382
	Crape Myrtle	41.30	20.30	-	323.65		
Point 20	Laurel Oak	23.50	22.90	-	411.87	0.093228	9.322844

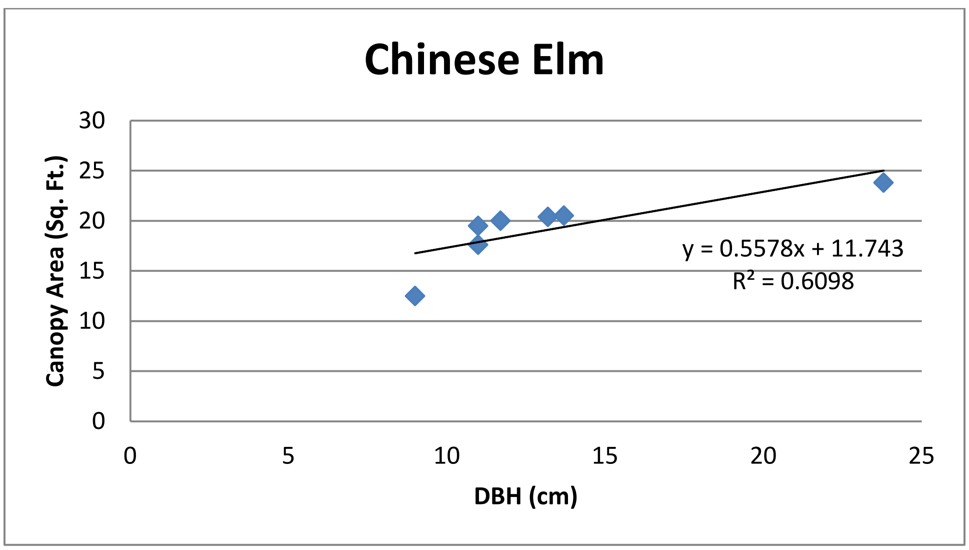
Appendix II 1: Raw data for plots from 2011.

	Species	DBH (in)	DBH (cm)	Canopy Diameter (ft)	Tree Canopy Area	Plot Canopy Area	Plot Canopy Area %
Point 1	Longleaf Pine	17.00	43.18	34.22947	920.22	0.208294	20.82945
Point 2	Pond Pine	12.00	30.48	30.42155	726.86	0.164528	16.45281
Point 3	Longleaf Pine	14.00	35.56	28.82917	652.76	0.147755	14.77549
	Longleaf Pine	11.00	27.94	28.82917	652.76		
	Crape Myrtle	4.00	10.16	5.670816	25.26		
Point 4	No Trees					0	0
Point 5	Longleaf Pine	19.00	48.26	37.82966	1123.97	0.254415	25.44148
Point 6	No Trees					0.00	0
Point 7	No Trees					0.00	0

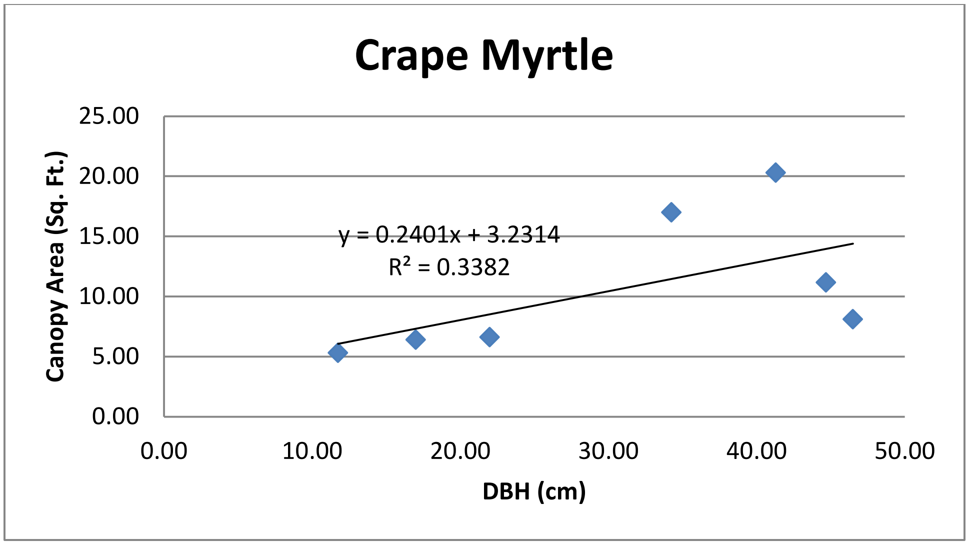
Point 8	Chinese Elm	3.00	7.62	15.99344	200.90	0.045474	4.547378
Point 9	Laurel Oak	4.00	10.16	11.34031	101.00	0.022863	2.28627
Point 10	No Trees					0.00	0
Point 11	No Trees					0.00	0
Point 12	No Trees					0.00	0
Point 13	Laurel Oak	17.00	43.18	25.23183	500.02	0.113181	11.31813
Point 14	No Trees					0.00	0
Point 15	No Trees					0.00	0
Point 16	No Trees					0.00	0
Point 17	No Trees					0.00	0
Point 18	Pond Cypress	5.00	12.70	9.1885	66.31	0.01501	1.500952
Point 19	No Trees					0.00	0
Point 20	Laurel Oak	11.00	27.94	18.82036	278.19	0.06297	6.296993

Appendix II 2: Raw data for plots from 2005.

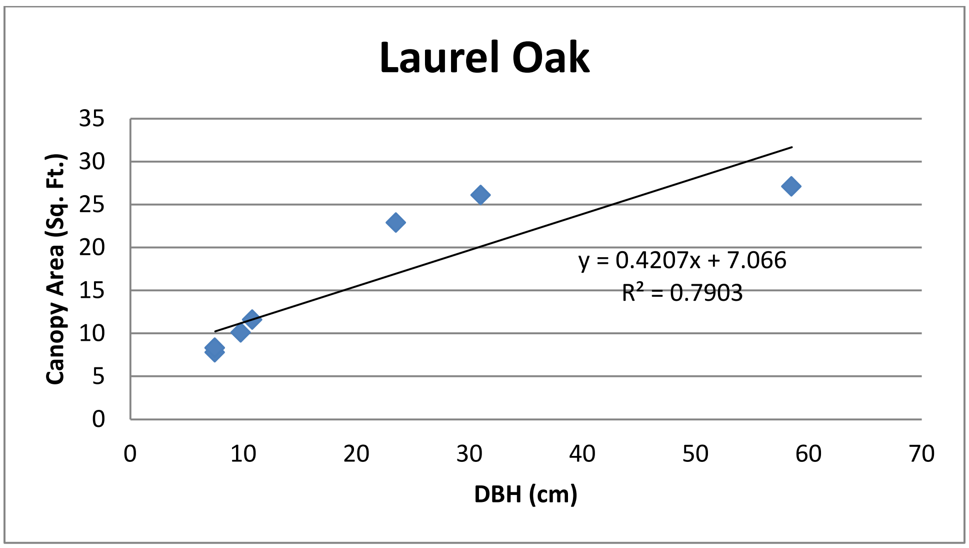
Appendix III



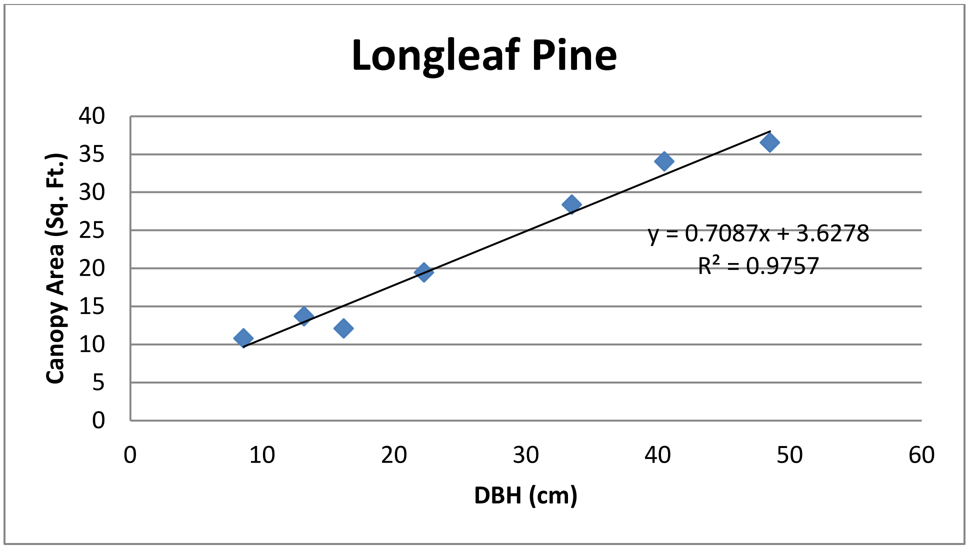
Appendix III 1: Regression analysis for Chinese Elms.



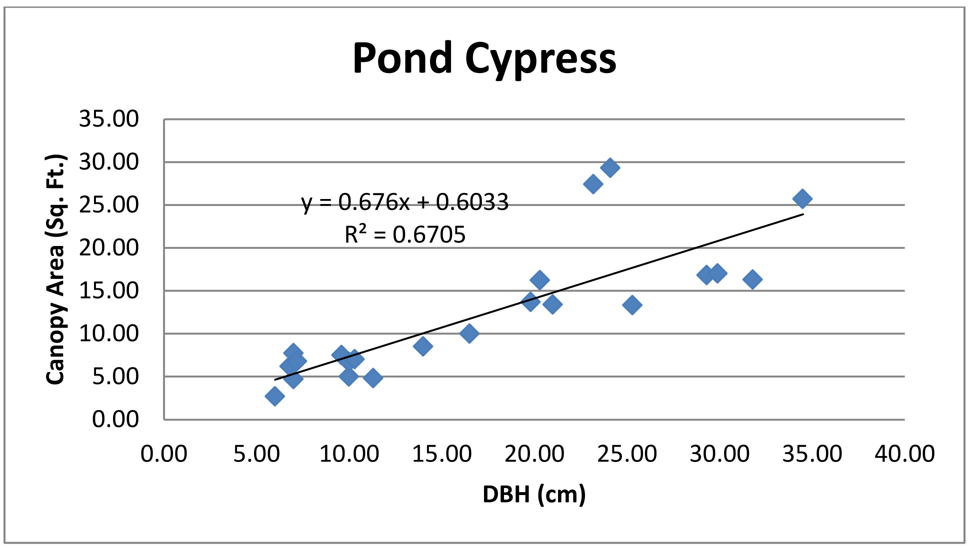
Appendix III 2: Regression analysis for Crape Myrtles.



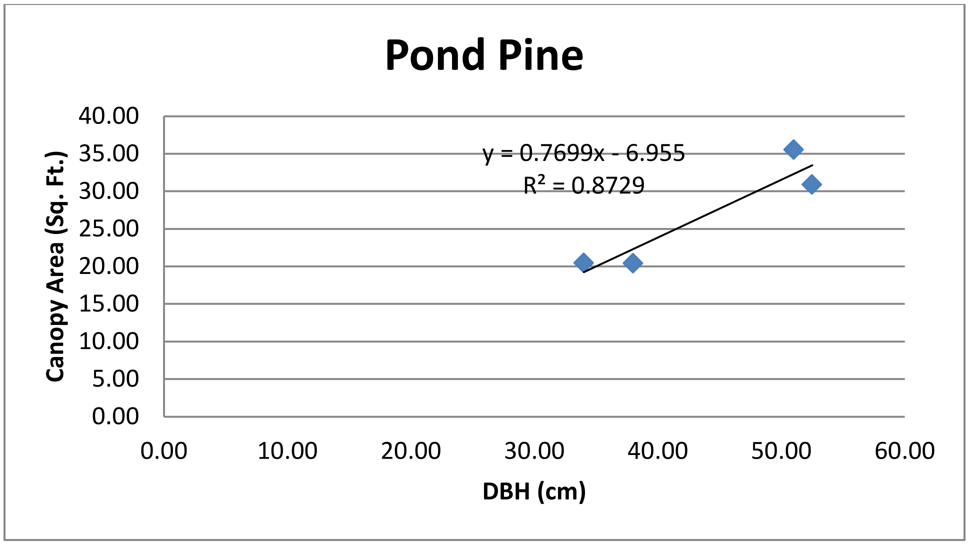
Appendix III 3: Regression analysis for Laurel Oaks.



Appendix III 4: Regression analysis for Longleaf Pines.



Appendix III 5: Regression analysis for Pond Cypresses.



Appendix III 6: Regression analysis for Pond Pines.