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Implications of Planting Southern Live Oak Trees in the Wrong Urban Space in East Baton Rouge, Louisiana United States

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Abstract

Afforestation has been observed as a green trend in urban areas. The incorporation of trees in urban infrastructure is highly recommended to act as a solution to outlined environmental problems such as global warming. However, it has been precipitously introduced in cities, towns, and metropolitans. The introduction of the green practice was so abrupt that it became devoid to meeting the essential needs for tree growth, thus, failing to bring out the desired effects. Inappropriately selecting and planting trees in urban spaces has resulted in stressed trees that are deficient at reaching up to the calculated goals and in the long run end up being problematic. The main objective of this study is to evaluate the implications of planting southern live oak (*Quercus virginiana*) trees in the wrong urban space so as to aid in recommending sustainable green solutions for the urban community. By studying southern live oaks planted in Howell Community Park and three randomly selected areas in Southern University Baton Rouge Campus, this study analyzes how the selection of these tree species in the urban spaces influenced their growth and general well-being. These urban spaces were randomly drafted based on accessibility and availability of several southern live oaks. Planting approaches in the four study areas were explored and the general health condition of the trees was determined using the tree appraisal method presented by the i-tree model: my tree. ArcGIS collector was used to collect the GPS coordinates of the trees and ArcMap was used to generate the maps of the study areas. ArcMap software geolocated the coordinates of the southern live oaks in all the four-study areas. The software was used to generate shapefiles of the four study areas and their location in East Baton Rouge. The analysis of the results proved that none of the southern live oaks had an excellent health condition and most of the trees experienced different issues due to planting

them in the wrong urban spaces.

Keywords

Southern Live Oak, Tree Species, Urban Space, Wrong Urban Space

1. Introduction

Trees have proven to be beneficial in one way or another and have always played a significant environmental role. Tracing their benefits back from medieval times, trees were used as a source of fuel, food, and medicine. Their uses have evolved from period to period until now, where their benefits have diversified to positively affect the wellbeing of people. Tree planting was globally popularized in the 20th century, after environmental research demonstrated beyond doubt that trees were the solution to the devastating effects of global warming. In urban areas, they are considered as the remedy to the island heat effect, carbon emissions, storm water management and mitigation to the effects of global warming (Alliance for Community Trees, 2011; Önder & Akay, 2014).

Tree planting in urban areas is also one of the preeminent ways of rejuvenating natural ecological processes. Since the inception of Agenda 21 by the United Nations in the year 2003, there was an emergence of several programs, such as the "One Billion trees" which supported urban forestry programs with the aim of planting one billion trees to promote greening in urban and suburban areas in different cities in the United States. Regardless of having an ambitious long-term effect on climate change, the programs ignored most environmental criteria that would have guided the selection process. The degree of sustainability is important in preserving biological diversity. According to Hasan et al., (2016) and Hasan et al., (2017), an urban tree planting process should start with careful consideration of tree species selection. Particular attention should be given to planting the right tree at the right place in order to get the full benefits of the trees. Lord et al., (2003) further propose multiple policy developments and planning projects related to green infrastructure in urban areas, which clearly implies that most planners in urban areas tend to plant any tree in the provided space without evaluating the long-term effects and tree species needs and specifications.

In addition, air temperatures are higher in urban areas than in rural areas and provide an additional stress factor on urban vegetation. Interactions between plants and urban ambient conditions must be taken into account in all efforts of creating "naturopolises". Shifting the focus of urban greening programs from the restoration of a historical ecological system to the creation of a coupled natural-human ecosystem will lay the groundwork for sustaining the quality of life on earth (Churkina et al., 2015). Despite all these benefits, most urban areas are characterized by stressed trees because of unfamiliarity with the concepts of ur-

ban forestry. Stressed trees are not as effective as healthy trees. Safford et al. (2013) explain that the compromised health of the trees consequently affects ecological processes which later precipitate the inability of trees to protect biodiversity and offer the expected benefits to the urban community.

Southern live oaks (*Quercus virginiana*) are a popular tree species in East Baton Rouge, Louisiana (Coder, 2010). They are easily identified by simple, leathery, evergreen leaves and a dark-brown furrowed bark. Mature trees are characterized by resurrecting ferns and wide spreading crown. The tree species are long living and have wide crowns. They are mostly known for their evergreen aesthetic views and beautiful low-lying branches. According to Qi et al., (2006), southern live oaks are greatly adored in the Southeastern USA. The tree species are preferred by most landscapers for their aesthetic symbols and other environmental benefits they offer. A mature live oak tree could tremendously contribute to carbon sequencing, air filtration, buffer systems, storm surge, reduction of water runoff, reduction of utility bills as well as increase in property value.

The tree species are being incorporated in urban areas especially in parks, residential homes, commercial places, and other institutions. In East Baton Rouge where anthropogenic gas emissions are high and the city is characterized by flooding, the southern live oaks are contemplated as part of the solution to these negative effects of urbanization. Besides these, the tree species could take up to 1000 gallons of water per day making them suitable for water retention during flooding events that are frequently experienced in East Baton Rouge.

Planting live oaks in urban spaces seems easier when the trees are envisioned to grow up to their juvenile stage. Yet, live oaks at maturity occupy large spaces. Owing to the fact that the tree is big and could grow up to 80 feet in height, 13 feet d.b.h., and 85 feet crown radius (Coder, 2010), it is mostly planted in urban spaces that cannot accommodate its physiological features. Southern live oaks cannot be as environmentally efficient as described by different scholars because the designed urban spaces are not accommodative enough to ensure the proper growth of southern live oaks. In East Baton Rouge, southern live oaks are observed to have been planted close to buildings, roads, parking lots, sidewalks, and other high traffic areas. Consequently, affecting the health of the tree. Inaccurate selection of urban spaces for the gigantic tree species has increased stress levels of the trees and over time the stressed trees fail to provide the calculated benefits. They also cause damage to the surrounding infrastructure and become more problematic depending on the presented issues.

Urban forest restoration is incontrovertibly seen as a remedy to the implications of urbanization, but it requires cautious forethought and design so as to restore the richness of the initially fragmented natural systems (Lord et al., 2003). Urban forests restoration projects advocate for planting of trees in urban areas to restore the canopy cover and in the long run benefit the entire community. Integrating the southern live oak in an urban environment requires a lot of forethought. Southern live oaks have been planted in different urban spaces with little regard on how gigantic the tree gets with maturity.

Most studies focus on the popularization of the tree planting concept but fail to put a sufficient degree of emphasis on the right urban space. The focal point in most urban forest research is how beneficial trees are to the urban community. Software such as my-tree falls short in looking into soil compaction and other space related issues to determine the health of a tree. This article highlights the deficiency of urban designs in capturing physiological components in tree planting. Indeed, it is beneficial to plant a tree but adequate urban spaces for the trees are equally important. There is a need to plant the right tree in the right urban space and come up with a consistency in the available resources in order to accord landscapers and urban planners with the insight to choose suitable tree species for the provided urban spaces. Urban planning and greening projects that propose to plant southern live oaks in urban spaces should premeditate over the presented urban spaces and the features of the trees (Hassan & Elhassan, 2020).

Careful consideration while planting trees could yield maximum benefits for the adjacent urban community. This study brings forth the correlation between tree health and urban spaces. Perceiving the general idea of physiology and space specifications will aid in the efficient execution of tree planting projects in urban areas. It will also aid urban planners and landscapers to better adjudicate urban designs. This is not limited to southern live oaks in East Baton Rouge but also other tree species with the potential of thriving in urban areas.

2. Methodology

2.1. Study Area: East Baton Rouge, Louisiana

According to United States Census Bureau (2023) East Baton Rouge is in the southeastern part of Louisiana and measures approximately 470 sq. miles (**Figure 1**). It is the most populated parish in Louisiana and hosts the city of Baton Rouge which is the capital of Louisiana. The parish borders the Mississippi river on the west, which explains the increased industrial activities in the region. The parish experiences subtropical climatic conditions based on its proximity to the Gulf of Mexico. East Baton Rouge also accommodates various urban forests restoration and greening projects. The urban environment is not only characterized by infrastructure but also a diversity of tree species.

2.2. Data Acquisition

The first data collection strategy entailed the random selection of the study areas. To meet the requirements, the area had to be characterized by a high number of planted southern live oaks, display southern live oak planting initiative and be accessible to the public. The four study areas include: Howell Community Park, Helen M Barron Avenue, Pelton G Clark Center parking lot and Swan Avenue and Henry E Cobbs area. Planting approaches in the selected areas had to unveil the need to incorporate trees in urban spaces for their benefits.

During the field visits, ArcGIS collector software was used to collect live GPS coordinates of the southern live oaks. The selected southern live oaks were

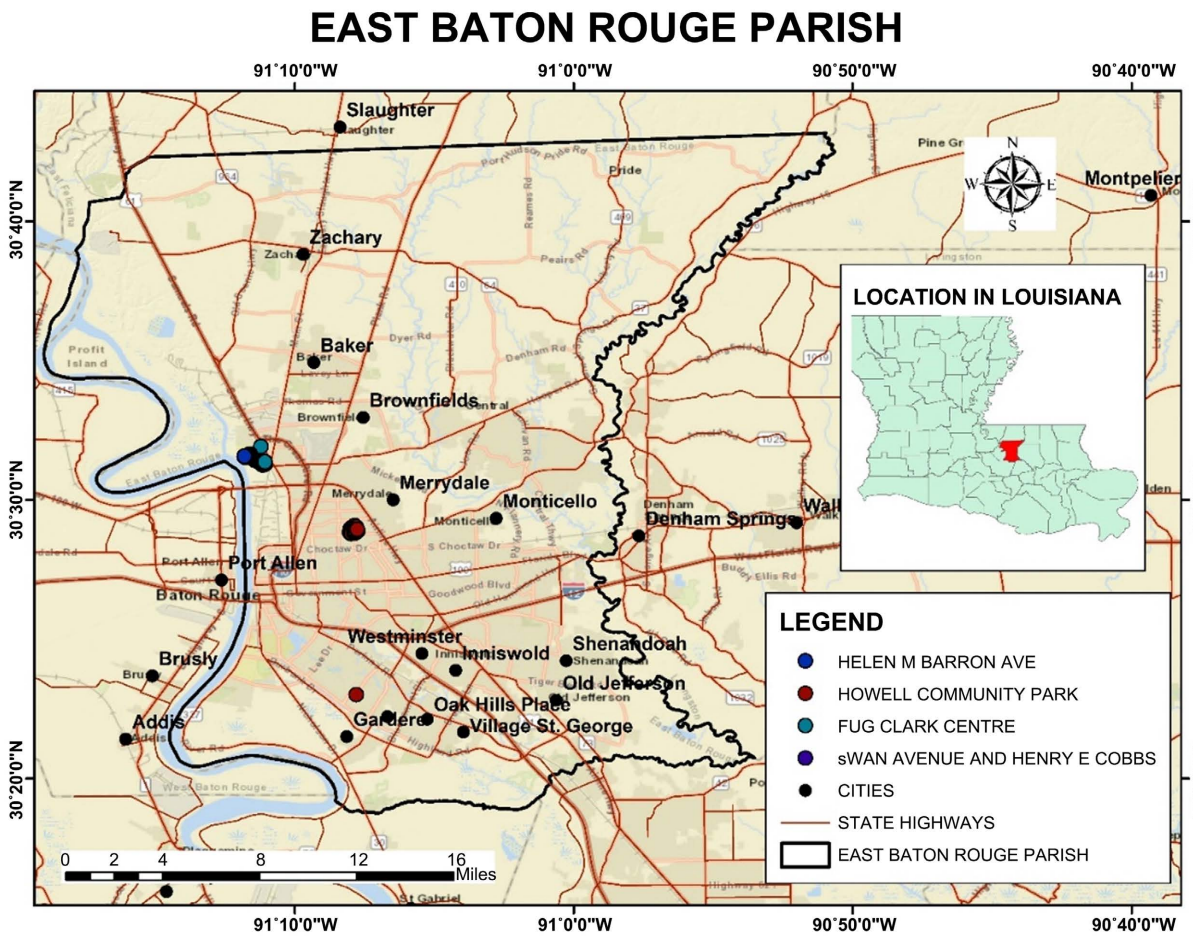

Figure 1. Map of East Baton Rouge displaying the selected field areas.

appraised to determine their d.b.h., foliage percentage, obstructions, exposed roots, soil compaction and lastly general tree condition. The trees' health condition was appraised based on i-tree model: my tree software and other additional factors such as foliage percentage, degree of root exposure, and wood damage. The grading scale had different categories as follows:

- Excellent: Tree has less than 1% of its leaves missing.
- Good: Tree is missing 1% - 10% of its leaves.
- Fair: Tree is missing 11% - 25% of its leaves.
- Poor: Tree is missing 26% - 50% of its leaves.
- Critical: Tree is missing 51% - 75% of its leaves.
- Dying: Tree is missing 76% - 99% of its leaves.
- Dead: Tree is missing all of its leaves.

The above methods were selected because they were cost-effective, and the data obtained using the software depicted the overall state of the live oak trees in each field study area. This increased the accuracy of results. The information was entered into excel sheets and converted into text delimited files. The data was later extracted using ArcMap software and used to generate the maps of the study areas. The location of the areas was identified in East Baton Rouge and the selected

southern live oaks were displayed. The results were then analyzed and were used to determine whether the environmental expectations were being met or not.

3. Results

3.1. Howell Community Park

Southern live oaks in Howell Community Park were planted to offer both aesthetic views to the park and provide desired social benefits. Figure 2 displays the trees tactically placed in different spaces acting as the central points while some provided cool shades on the sidewalks.

All southern live oaks in Howell Community Park were mature with an average d.b.h. of 26.3 inches. The maintenance practices of the trees explained their health conditions, which ranged from good to fair. Good arboriculture practices such as pruning and crown reduction were effectively done but none of the trees achieved excellent health conditions due to other underlying problems such as root exposure, crown transparency and soil compaction.

3.2. Helen M Barron Avenue

Figure 3 puts in view the planting strategy of southern live oaks in Helen M Barron Avenue. The tree species were planted beside the road and sidewalk to offer a beautiful view while driving along the road and provided shade for pedestrians, drivers, and parked vehicles. The tree species were intentionally planted to directly benefit the adjacent community.

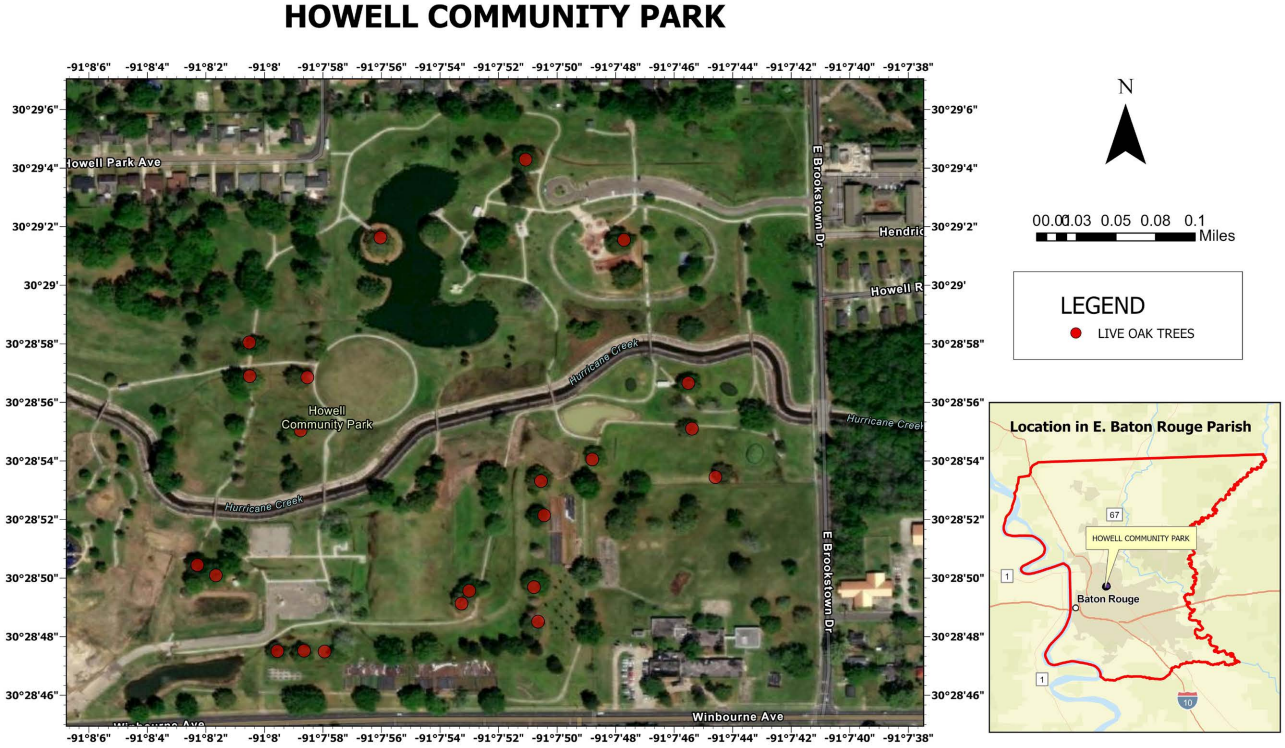

Figure 2. Selected southern live oaks in Howell Community Park.

Figure 3. Selected southern live oaks Helen M Barron Avenue.

Southern live oaks in this field study area were mature and had an average d.b.h. 18.9 inches. The maintenance practices in this field study area were lacking by the nature of the ground cover and foliage loss. The tree species exhibited various problems, the major being obstruction, root exposure and soil compaction.

3.3. Pelton G Clark Centre

Figure 4 vividly shows that the southern live oaks at Pelton G Clark Center parking lot were planted to provide a fascinating aerial view and perhaps provide shade to vehicles in the parking lot. The trees were juvenile and had an average of 12.8 inches d.b.h.

The design of the planted trees is captivating, but the juvenile trees are characterized by many issues that are affecting their growth and health. Human induced issues such as poor pruning and heavy concrete are highly noticeable. Other issues such as broken branches, obstruction, soil compaction, exposed roots and poor ground cover affected the trees.

3.4. Swan Avenue and Henry E Cobbs Area

In **Figure 5**, southern live oaks planted in this study area were closer to buildings and beside roads. They added the attractiveness of the site and shaded buildings. All the southern live oaks in this study area were mature and had a mean of 26 inches d.b.h.

The trees experienced different issues based on the location. The problems ranged from obstruction to damage of the trees' critical root area. The live oaks

in this study area exhibited diverse health conditions depending on the observed issues.

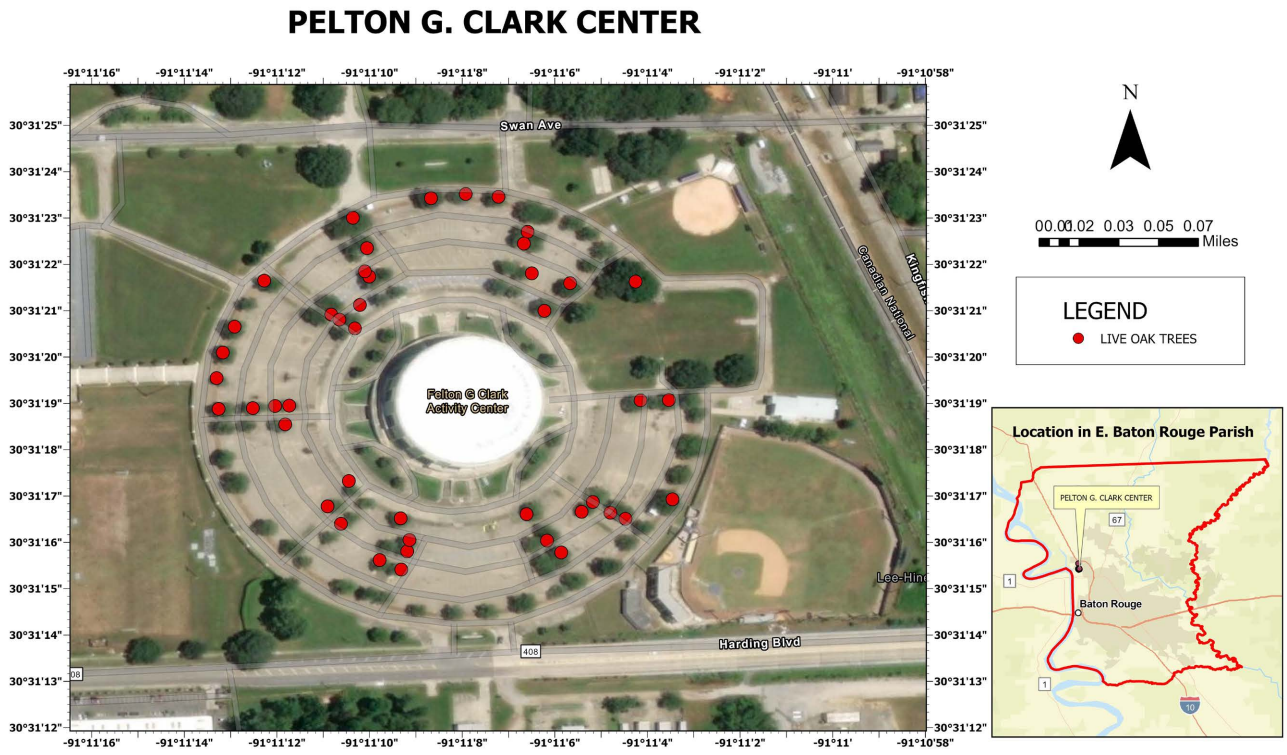

Figure 4. Selected southern live oaks in Pelton G Clark Centre.

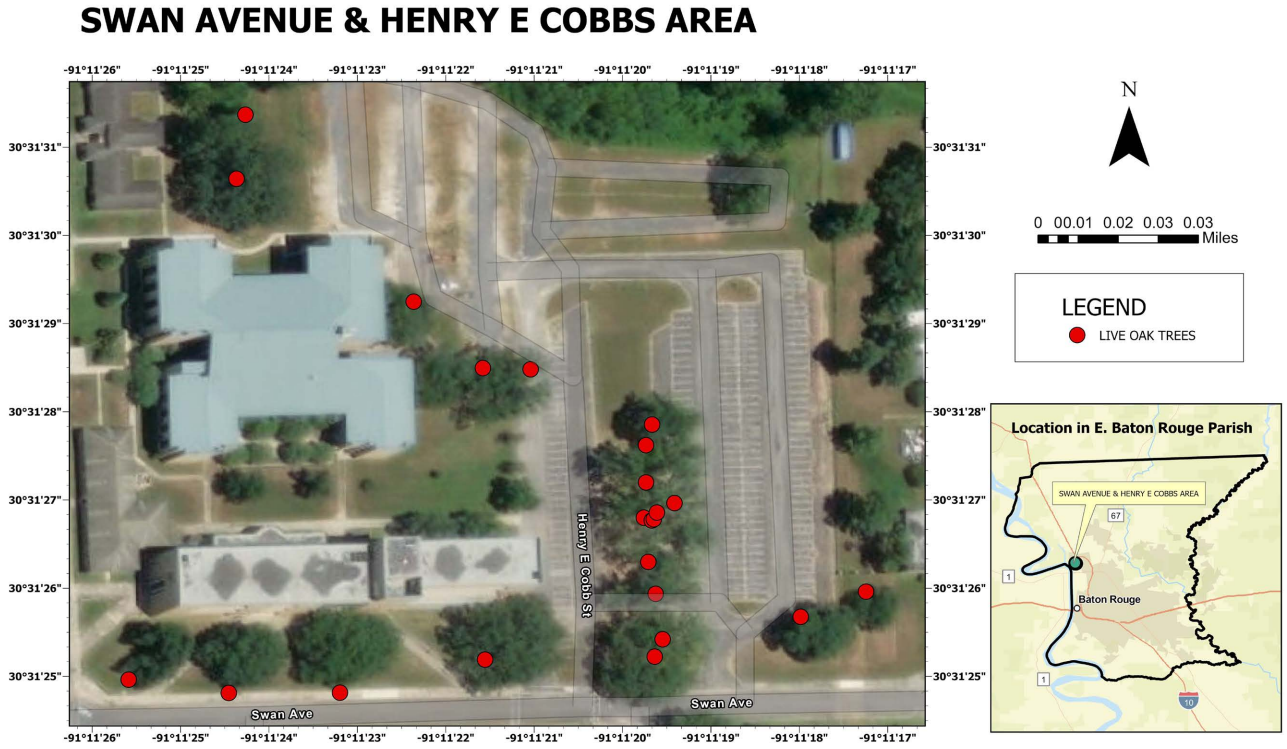

Figure 5. Selected southern live oaks in Swan Avenue & Henry E Cobbs area.

3.5. General Health Condition

According to the tree health analysis in Figure 6, 3 southern live oaks had critical health conditions, 30 had poor condition, 67 had fair, 10 had good and none of the trees had excellent health conditions. The differentiation in tree health condition could be affected by management practices. However, in the field areas, the selection of urban spaces influenced the health condition of the tree.

Southern live oaks in Howell Community Park exhibited better health conditions compared to the other trees in three field study areas. The trees were given ample growth space and most of them were distant from high traffic areas. All mature trees did not face any canopy obstruction and branches were not over pruned. The data collected proved that Howell Community Park had better tree management practices compared to other field study areas. Proper pruning practices were used in the live oaks in Howell Community Park. There was less percentage of root exposure compared to other study areas.

Swan Avenue and Henry E Cobbs area had three southern live oaks in critical health conditions. Overall, most trees had dying branches, the critical root areas were compromised and had very poor ground cover. Obstructions were too close to the trees which affected their growth potential. These trees lacked sufficient

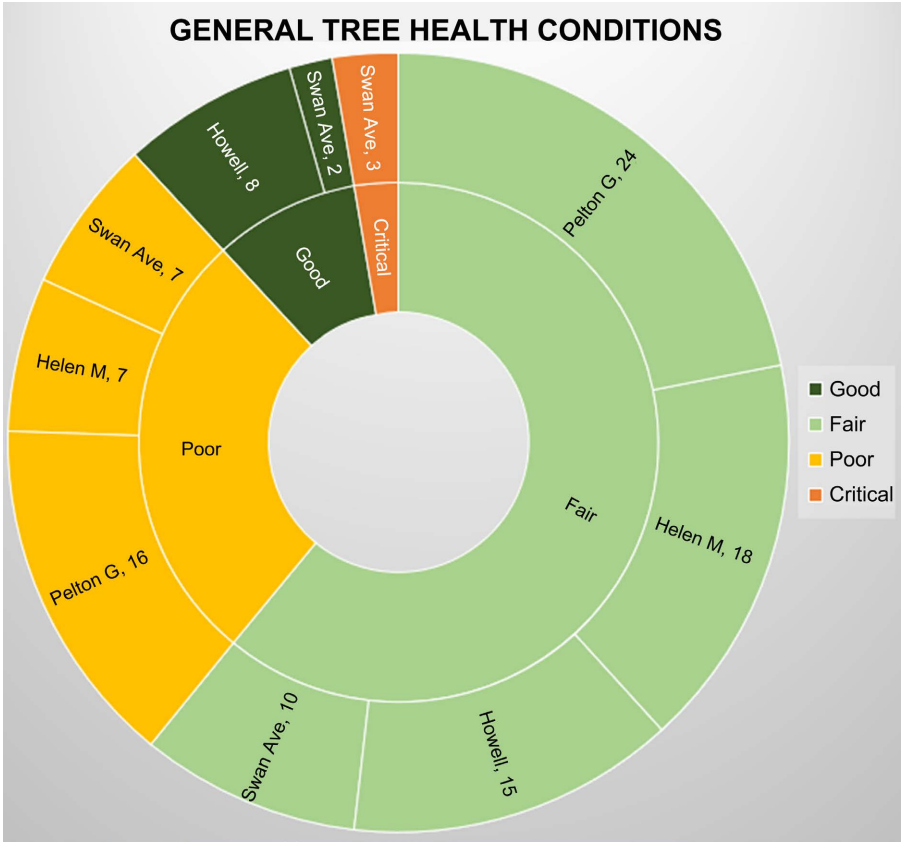

Figure 6. Sunburst exhibiting tree health in the four field study areas according to the selected grading criteria.

growth space which reflected in their vigor. Southern live oaks in Helen M Barron Avenue and Pelton G Clark Centre also experienced the same issues. The trees had a low vigor and there was a high crown transparency compared to the southern live oaks in Howell Community Park. The parking lots, pavements, and roads in the two field study areas had multiple cracks due to the live oaks' extensive roots. In the three field study areas, most trees had healing scars either from improper pruning, or branch/twig breakage. The growth of most trees was obstructed by either roads, sidewalks, parking lots or other infrastructure. Furthermore, all trees had exposed roots which indicated the possibility of compact soil and poor mulching practices. The root flares in all trees were above the ground.

4. Discussion

Management practices could be questioned in such scenarios, yet the environment of a tree is very crucial for its performance and general functioning. A tree would be healthy or exhibit stress depending on its ecophysiology. The environment a tree is planted in is the first determinant whether the tree will survive and for how long (Peper et al., 2010). Planting a tree in the wrong urban space not only affects the tree but also the adjacent environment. Infrastructure damage presented in two field study areas is a result of planting southern live oak trees too close to the roads. It is key to understand that southern live oaks have extensive roots, and they grow through obstructions to achieve strong and proper anchorage. In the two field study areas, the extensive root growth resulted in multiple cracks on pavements, roads, and parking lots which will later require a substantial amount of financial resources to fix.

All southern live oaks had exposed roots. Root exposure is a characteristic of soil compaction. Compact soil prevents the roots of the live oaks from penetrating into the soil therefore roots are exposed as they grow. The root exposure in trees in all the four field study areas implied the trees were growing in compact soils. The more the root exposure, the more compact the soil is likely to be. Soil compaction is a recurring problem in all the studied southern live oaks. It is a logical indication that urban areas are characterized by soil compaction due to heavy traffic and infrastructure. Compact soil prevents the roots from penetrating deep in the soil leading to root exposure and cracking pavements, roads, and parking lots. It also causes lack of aeration and prevents proper absorption of nutrients. To prevent soil compaction, individuals involved should be careful to give the recommended proximity between trees and urban infrastructure. This will avert traffic from the trees and prevent further soil compaction. Averting traffic from the trees increases aeration, retention of ground cover, nutrients and soil moisture and additionally prevents root exposure.

To further put a stop to root exposure, mulching to the root flair is essential on an occasional basis. Heavy traffic around the critical root area should be prevented and soil compaction management practices should be practiced. Manag-

ing root exposure prevents root damage and other root stresses. The health of the root in a tree is a key determinant for the entire tree's health.

None of the trees had 100% tree foliage. Although foliage is an important determinant in the general tree health condition, it is entirely impossible to achieve 100% of a tree foliage in an urban setting. Healthy foliage is mostly achieved through proper pruning, healthy roots and sufficient nutrient and water absorption.

All the southern live oaks that were involved in the studies had either one or more identified problems which confirmed that none of them had an excellent health condition. The root cause of these problems tracks down to the selection of the southern live oaks and planting them in urban spaces that cannot accommodate their physical structure. Improper knowledge regarding the choice tree species will later lead to unexpected economic expenses due to the destructive aspect of the process.

Generally, trees are highly beneficial to the urban community when they are planted in the right space. McHale et al. (2007) and Lord et al. (2003) discuss that appropriate tree planting is a top cream in dealing with urbanization related problems such as heat island effect, global warming, and pollution. Rapid urbanization has led to a shift in the surface energy balance hence causing an urban heat island and other negative environmental impacts (Önder & Akay, 2014). Tactical urban tree planting culture can be used to generate multiple benefits a single urban tree can offer. Urban trees directly capture carbon (IV) oxide from the atmosphere and store it in the form of carbon. In order to maximize carbon sequestration and other benefits of urban trees, large and long-living shade tree species such as southern live oak should be planted in suitable urban areas. More carbon will be stored and the maximum number of benefits from urban trees can be achieved (Churkina, et al 2015). Other considerations such as decomposition of dead and pruned trees, and maintenance procedures must be considered in order to come up with a comprehensive picture of carbon dioxide reductions that result from tree planting (McPherson & Simpson 2003).

Moreover, the location of urban trees in strategic places can provide cover for buildings and obstruct winter winds thus reducing the high costs of heating and cooling buildings: in the long run lowering carbon dioxide emissions by individuals, households, and organizations (Nowak & Dwyer, 2007). McPherson and Simpson (2003) further explain how trees help in conserving energy and eventually, saving energy costs for the urban community. Conversely, cities remain a high emitter of green-house gases globally due to energy and resource consumption and transportation demands. With energy being elemental in sustaining economic augmentation and the quality of life, its conservation becomes important. Using trees to shed buildings can potentially reduce the need to put up new power plants.

Planting trees to provide shade shields for both buildings and paved surfaces reduces the amount of heat that is absorbed and stored by built surfaces. Other

processes like evapotranspiration also use the heat that would otherwise have resulted in heated air to the conversion of water into water vapor. Wind speed reduction reduces the infiltration of outside air into interior spaces, especially where conductivity is relatively high (McPherson & Simpson, 2003). Trees and other vegetation on individual building sites may lower air temperatures by 5°F compared with sites outside the green space (Bowler et. al., 2010). Tactical placement of trees can ultimately increase energy efficiency. Consideration of the sun and shade direction is important if effective cooling of buildings is to be achieved through shading.

Most importantly, tree species selection is dependent on the canopy size and the water use in relation to the specified area. Churkina et al., (2015) suggest the reference to numerous sources of literature that fully document different tree species and their ecological services they provide. Most urban greening programs are spoken about very positively, yet they are deficient of accommodating the possibility of applied urban tree species and the correlated management practices leading to highly stressed urban trees.

According to Alliance for Community Trees (2011), urban trees are essential to both humans and the environment at large: trees in urban forests help in the filtration of air and water. They act as a buffer to noise, wind, and dust, they conserve energy and greatly control stormwater. Certainly, urban tree planting practice is highly beneficial be it socially, economically, and aesthetically (McHale et al., 2007); but it requires proper discernment and expertise in the fundamentals of dendrology, urban forestry, and conservation biology.

Healthy live oaks improve the quality of life in urban areas. The tree species support several bio-diversities which positively contribute to the quality of life. The tree species also contribute towards carbon sequencing, air filtration, soil texture and storm water retention. With time, urban properties with southern live oaks become an investment due to the increase of property value and aesthetics. Through the collected data, there is a necessity to improve the planting and management practices of the southern live oak in urban areas. Southern live oaks in the selected field study areas depicted several problems which implied that the calculated benefits are not met. Identified problems such as soil compaction, root exposure, lack of 100% foliage and poor pruning practices have led to tree stress impeding the ability of trees to effectively perform their functions.

All urban trees should be maintained using best management practices and standards outlined by the International Society of Arboriculture and the American National Standards Institute. Since trees require a strong structure for proper development, future green infrastructure projects should follow stipulated guidelines with regard to promoting healthy urban tree growth to yield maximum benefits from the trees. Moreover, the implementation should be done with the mastery of urban forestry and its disciplines. A mature southern live oak is huge and takes up to 1000 gallons of water per day. Therefore, the tree species should be planted in a large and highly moist urban space to accommo-

date its vital requirements.

5. Conclusion

Planting southern live oaks in limited urban spaces consequently distresses the wellbeing of the tree species. In all the four field study areas, most of the trees exhibited a health strain due to the improper space preference. The improper selection of tree species in these urban spaces further led to the damage of roads and footpaths: (McPherson & Peper, 1995) which implies that future management costs in these areas will be higher than anticipated. This knowledge is highly applicable in urban forestry tree planting projects. It will augment proper decision making and strategic planting of southern live oak trees in the right urban space and other tree species as well. It can be quite demanding for arborists and urban foresters to discern the concept behind every tree species growth specification and physiological aspects. Yet, on the brighter side, the appropriate implementation of this urban forestry proficiency will actualize the envisioned community benefits from urban trees and generate a sustainable green solution for the urban community.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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