Case Study: Recommendations to the City of Bloomington based on 2018 Re-Inventory of Trees in the IU Health Hospital Deconstruction Zone and Surrounding Areas

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Urban Forest Management
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Introduction

Bloomington, Indiana has an Urban Forestry Plan establishing the goals for maintaining the health and benefits of the city's street trees through increasing species diversity and ensuring that all available planting spaces are occupied (Bloomington Urban Forestry Plan 2014-2019). An inventory of street trees is performed every 10 to 15 years to monitor the condition of the City's urban forest. The inventory follows the Bloomington Street Tree Inventory Guidelines, which sets out several categories to be collected during inventory, including information like diameter at breast height (DBH), species, tree condition, tree lawn width, etc. The last completed inventory of Bloomington's street trees was performed eleven years ago in 2007. Since that last inventory, the Bloomington Street Tree Inventory Guidelines underwent several changes, which will be discussed in the Results and Discussion sections.

IU Health recently began construction on a new hospital site located on the IN-45/45 Bypass. On April 18th, 2018 the Common Council voted 9-0-0 on Resolution 18-06 – [To Approve an Agreement between the City of Bloomington and IU Health for the purchase of the Current Bloomington Hospital Site and Surrounding Outlots – Re: Parcels Located in and around the 400-800 Block of West 1st and West 2nd Street, Bloomington, Indiana]. The City of Bloomington has decided to purchase Parcel A and deconstruct the hospital property within this area. The remaining three parcels, B, C and D, are not set for deconstruction in 2021, but will be vacant once the hospital relocates to the new location (Figure 1).

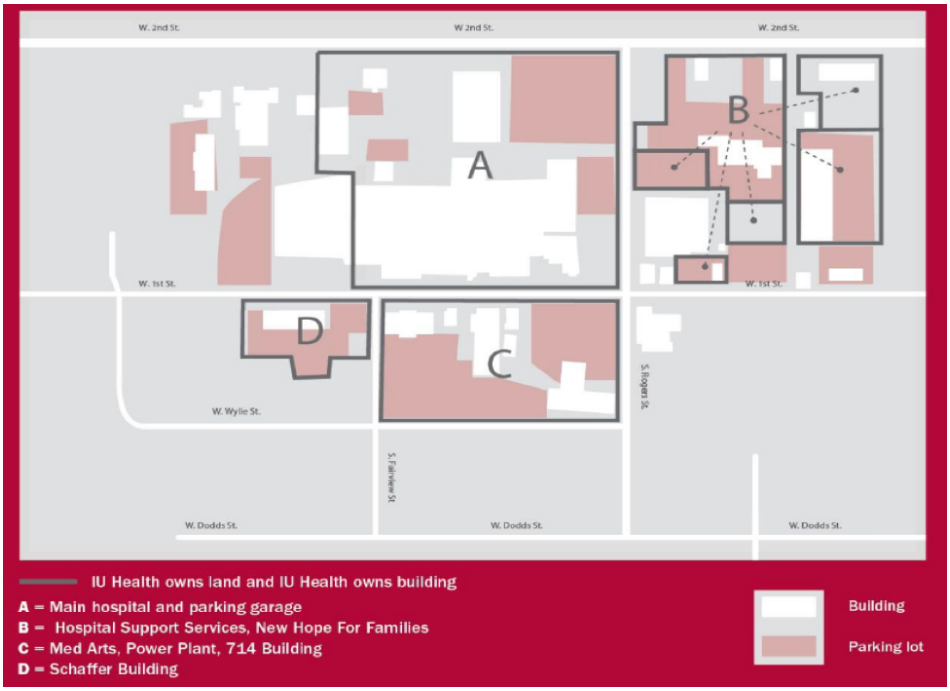


Figure 1. Map of hospital deconstruction zone (A). Parcels B, C, and D will not be deconstructed, but will be vacant post-construction of parcel A in 2021

The purpose of this report is to provide an analysis on the urban forest surrounding the current hospital location. This information is compiled by the graduate and honor students in Dr. Burnell Fischer's Urban Forest Management course. The group re-inventoried the City's street trees within a three block radius of the IU Health Hospital. The removal of the hospital will immediately affect the McDoel and Prospect Heights neighborhoods and their urban forests.

This report identifies the changes to the urban forest compared to the 2007 tree inventory, if these changes were positive or negative to the overall canopy cover in Bloomington, and how the hospital deconstruction will impact the surrounding neighborhoods. Lastly, we make recommendations to the City of Bloomington for how they can improve the urban forest in the vicinity of the hospital before deconstruction occurs and what the City should do with the remaining parcels.

Materials and Methods

A street tree inventory was performed in the area of IU Health Bloomington Hospital deconstruction zone, including a portion of the McDoel and Prospect Heights neighborhoods. Four teams of 3-4 graduate and honors undergraduate students subdivided the affected neighborhoods and deconstruction zone by street to facilitate inventory. Information gathered from street trees included; species, address location, DBH, condition of tree, tree lawn width, maintenance needs, nearby presence of utilities, and whether the tree existed in or was planted since the 2007 inventory. Unoccupied planting sites were noted, as well as any relevant comments that might affect the longevity of the tree.

Tree data gathered from the re-inventory was assessed in Microsoft Excel to determine species diversity within the inventory area. A cover assessment and tree benefits report was completed using iTree Canopy v6.1 online tool. To conduct the cover assessment, i-Tree Canopy uses Google Maps aerial photography and randomly generates sample points which are classified as a pre-defined data point. For the analysis, points were classified as either tree, non-tree or green space to represent areas where trees could be planted. Non-tree points represent impervious surfaces such as roads, parking lots and structures. One thousand random points were used in the analysis. In addition to identifying canopy cover, the i-Tree Canopy tool estimates tree benefits related to the removal or sequestration of criteria pollutants.

Results

Species Diversity Analysis

The tree diversity within the deconstruction zone and surrounding areas from the 2007 inventory demonstrated that the most represented species in the area was Red Maple, present as 25.35% of trees in the area (Figure 2). Sugar Maples and Ginkgos were the next most populous trees, both present as 11.06% of trees in the area. Silver Maples, Callery Pears, Crab Apples, Norway Maples, White Ash, and Little Leaf Linden made up less than 8% of trees in the area

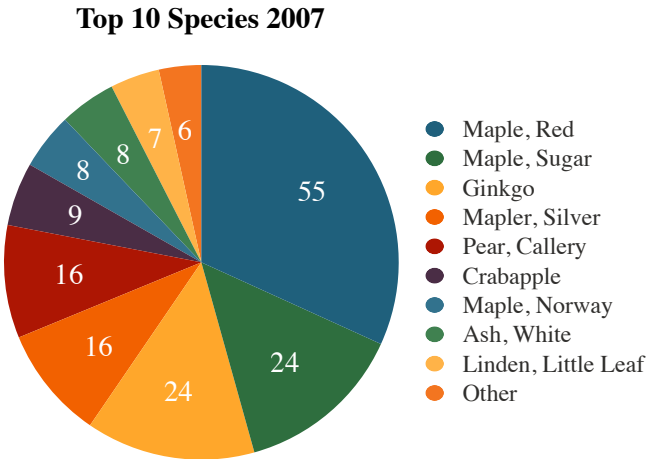
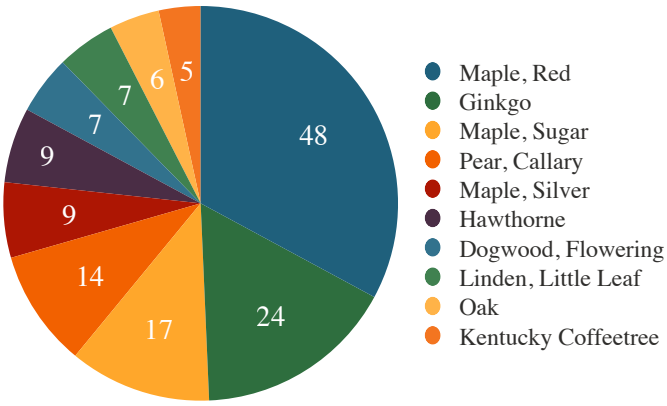


Figure 2. The 10 most abundant species found in the hospital deconstruction zone and surrounding areas from the 2007 inventory. Numbers given represent number of trees of the given species

Species diversity analysis of re-inventoried trees from 2018 can be seen in Figure 3. Red Maples are still the most populous trees in the area at 32.87%. Sugar Maples and Ginkgos were still the next most represented trees at 16.43% and 11.64% respectively, with Callery Pear close behind at 9.59%. Silver Maple, the Little Leaf Linden, Oak, Kentucky Coffeetree, Hawthorne, and Flowering Dogwood made up less than 6% of the area.



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i-Tree Canopy Analysis

The i-Tree Canopy analysis of the sample area concluded that the trees in the deconstruction zone and surrounding areas provide a total of $147,955.44 of environmental benefits (Table 1). Results from the canopy cover analysis indicated that tree canopy within the deconstruction zone and surrounding areas covers roughly 26.3% of the area, with the majority of the area (58.7%) being considered impervious surfaces, and less so (15.0%) of open green space (Table 2).

Table 1. i-Tree Canopy results of trees benefits in the hospital deconstruction zone and surrounding areas

Abbr.	Benefit Description	Value (USD)	SE	Amount	SE
CO	Carbon Monoxide removed annually	$2.61	±0.14	52.57 lb	±2.78
NO_2	Nitrogen Dioxide removed annually	$3.57	±0.19	196.97 lb	±10.48
O_3	Ozone removed annually	$136.91	±7.25	1,413.28 lb	±74.80
$PM_{2.5}$	Particulate Matter less than 2.5 microns removed annually	$350.76	±18.56	84.66 lb	±4.48
SO_2	Sulfur Dioxide removed annually	$0.89	±0.05	159.82 lb	±8.46
PM_{10}	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$83.44	±4.42	386.06 lb	±20.43
CO_{2seq}	Carbon Dioxide sequestered annually in trees	$4,640.34	±245.60	131.62 T	±6.97
CO_{2stor}	Carbon Dioxide stored in trees	$142,736.92	±7,554.65	4,048.66 T	±214.28

Table 2. i-Tree Canopy results of cover classes in the hospital deconstruction zone and surrounding areas

Cover Class	Description	Points	% Cover
Tree	Tree, non-shrub	263	26.3 ±1.39
Non-Tree	Impervious surfaces	586	58.7 ±1.56
Green Space	Grass or potential planting areas	150	15.0 ±1.13

DBH Analysis

We created a size assessment of the total trees in the 2007 inventory using set DBH classes from Portland State University (2010) to show expected growth and benefits into the future (Appendix A). The vast majority of trees in the 2007 inventory were saplings, suggesting very few mature trees, translating to less current benefits. Additionally, we created a size assessment of all the trees in the 2018 inventory using the same set DBH classes that were used to assess the 2007 trees. While there are still a large amount of saplings as there were in 2007, there are now a greater number of medium and large trees.

Since the number of mature trees is higher, these trees are offering more benefits than they were in 2007. This also suggests that the City of Bloomington has performed sufficient monitoring and tree care of newly planted trees since 2007 to increase their survivability into 2018. Figure 4, located below, shows how the class distribution has changed from 2007 to 2018.

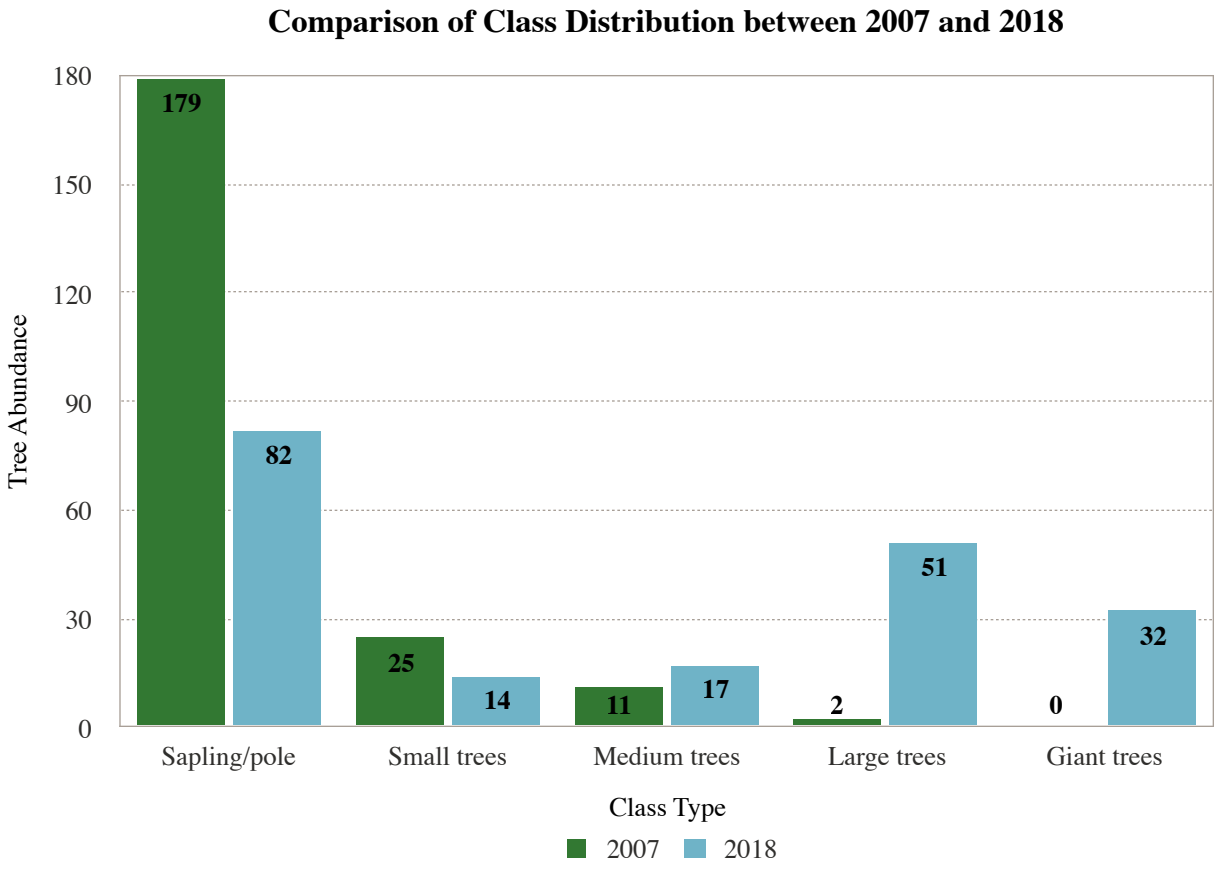

Figure 4. Class size assessment of trees in Hospital deconstruction zone and surrounding areas from 2007 and 2018 inventory

Discussion

Potential Sources of Error

When comparing the data collected between the 2007 inventory and our 2018 inventory it is important to note some factors. Our plant site size data was not as specific as the previous inventory and we are not experts at tree identification, which means there might be some errors in the 2018 tree inventory data.

Trees planted in the years after the last inventory along intersections and street corners were potentially double counted if the group assigned to either intersecting street believed the tree to be on their assigned street when it actually fell upon another. It is also entirely possible that a new tree could have been omitted if it fell upon one group's assigned area but the surveying group believed it to be within the bounds of another.

It was also noted that multiple street trees had been maintained or even planted by private residents, believing that the street tree was actually within their private property. Additionally, there were a number of trees that seemed to straddle the line between public area and private residence. If these trees were at all hazardous or burdensome to the resident, they could have been removed by the resident without first consulting the city. This is also problematic for future inventories if residents aggressively prune street trees and end up permanently damaging or killing the tree.

Trees having this same boundary characteristic could have also been inadvertently added as a new tree if the surveying group was at all unsure about whether the tree was public. Finally, the entire 2007 inventoried parcel was broken down into a smaller section which we assigned to groups to re-inventory. We could have possibly mis-assigned 2007 data to the new smaller parcel and missed some of the trees.

Changes from 2007 to 2018 Inventory Guidelines

Changes from "location" to "lot side", "species" to "genus species common name", and "date" to "inventory date" don't seem to be helpful nor harmful to inventory guidelines. Conversely, "tree cell" seems less descriptive than "location number" as titled under the 2007 inventory guidelines. The change from "wire" to "utility" may be helpful for the new inventory, as "utility" can include more than just overhead wires. The loss of "council district" and "neighborhood" categories could be detrimental to the 2018 inventory guidelines, as this information can help in analyzing tree information about specific areas and neighborhoods, and would be particularly useful when performing a neighborhood analysis as was done in this report.

Comparison of 2007 and 2018 Tree Inventory

Although the city's top ten abundance of tree species has shifted since 2007, the top three conditions of "good," "fair," and "poor" have remained constant (Appendix B). The 2018 inventory notes that the abundance of both White Ash and Red Maple has decreased, the former most likely due to a combination of senescence and intentional efforts to abstain from continued planting. In this respect, the city should pay close attention in the coming years to condition of its aging large Maples. The decrease of White Ash is not unique to Bloomington and is most likely attributed to preventative removals of this species due to presence of Emerald Ash Borer. The 2018 inventory also suggests that the City should be concerned about the abundance of Callery Pear. Although there have been recent efforts to urge the public to not plant this species due to its invasive characteristics, we acknowledge that, historically, this tree has been prioritized for its aesthetic qualities in Spring that contribute to the beautification of the city's corridors and common areas.

The deconstructed hospital area has a large representation of Maple patches that should be preserved in consideration of the tree benefits to this area. Tree patches are more significant for increasing and maintaining tree canopy, even if Maples are over-represented as a whole throughout the rest of the city. Overall, identifying and maintaining city forest patches should be prioritized.

Recommendations

We recommend that the deconstruction crew take extra steps to protect larger, well established trees surrounding the site. In addition to simple comforts like shaded walkways, canopy size is the number one factor in catching airborne particulate matter. In Table 1. we see Bloomington's current canopy cover catches 386.06 pounds annually, which translates to $83.44 in damages saved. While no trees are particularly cheap to plant, replacing sapling/pole sized trees is less costly than finding equal replacements for large, established trees. Most likely the city would replant newer, smaller trees leading to an immediate decrease in annual benefits.

As new trees are planted post-deconstruction, diversity should be a priority. Red Maples grew from 25.35% to 32.87% in the 11 years between tree inventories. Overrepresentation of a single tree species makes an ecosystem less resistant to environmental disturbances. Indiana is already feeling the effects of Emerald Ash Borer as it tears through the state's Ash trees. With growing evidence of climate warming and general uncertainty about its long-term effects, investing into only one species, no matter how iconic, is a poor plan. As an informal rule of thumb the city should strive towards planting no more than 10% of one species in each cohort. Bloomington should ensure they do not plant any non-native trees that haven't been tested in Indiana and avoid known invasives like Callery Pear.

Recommendation for Neighborhoods Surrounding Hospital

Our team offers three recommendations for the neighborhoods surrounding the hospital parcels: plant more trees, increase species diversity, and maintain older/legacy trees in the area. The inventory we conducted found many planting sites from the 2007 inventory still empty. Also, we added a number of new planting sites during the re-inventory. Bloomington is known to be partial to particular genuses, which is evident in the distribution shown in Figure 2 above. However, variability has improved in the past eleven years. With the re-inventory data, we show that the trees that were planted after or slightly before the 2007 inventory had grown considerably. Increasing species diversity is the best way to strategically plan for possible climate changes impacting Bloomington in the future. Our final recommendation is to maintain the large trees found in the neighborhoods surrounding the hospitals. Large trees provide the most benefits, but those benefits are reduced if the tree is not properly maintained.

Parcel A Recommendation

Our team's inventory of Parcel A of the hospital property found a group of trees of particular interest for suggested preservation. These trees are located on a lawn on the southeast corner of the property, near the intersection of Rogers Street and 1st Street. The trees, all of which appear to be in good condition, include three mature Sweetgums nearing three feet in diameter, an Oak tree, a large Pine tree, several Red Maples, a Dogwood, and four Spruce. The Spruce, Maples, and Dogwood trees are all trees dedicated in memory or in thanks of loved ones or donors to the hospital. The sizes, conditions, and human value of these trees give us good reason to recommend steps are taken to preserve them during the demolition process on the property. While adding aesthetic and environmental value to the hospital area, many of these trees also offer a glimpse of the history of the property as they have memorial plaques installed. If future use of Parcel A of the current hospital site allows, we would recommend additional plantings in this area to increase overall canopy cover and tree diversity in the studied site. Additionally, we recommend considering tree family/genera/species that, while being underrepresented in Bloomington's current inventory, also could adapt well to the challenges of climate change. An example of a tree family to consider could be Oak.

Parcel B Recommendation

Parcel B is located between South Morton Street and South Rogers Street. There were roughly 22 mature trees located in this hospital lot. These trees varied in species and were located throughout the parking lot and around the hospital administration building. We are unsure if this portion of the hospital will be deconstructed in 2021 or after, but we recommend the city preserve the building, land, and trees in this area. One potential solution could be to redesign the purpose of the building into a new

function that best fits the city's needs, which can prevent the unnecessary removal of the trees within this area.

Parcel C and D Recommendation

If this area were to be deconstructed in 2021 or after, we do not believe that it would negatively impact the overall tree canopy cover within Bloomington or cause problems to the surrounding neighborhoods. The only area that might be negatively impacted is a line of eight Sugar and Silver Maples located along the north side of 1st street. These trees were planted following the 2007 inventory and are relatively small, thus not yet providing substantial benefits. Losing these trees would not be detrimental to the area's species diversity, especially considering that the City of Bloomington has been trying to reduce the number of Maples being planted as street trees.

Of the 99 trees and planting spaces we inventoried within these parcels in 2018, 3 trees were Callery pears, which we recommend be removed. In addition, 28 planting spaces were identified, in which we recommend planting new trees like drought-tolerant Oaks.

Conclusion

The deconstruction of the hospital has the potential to shift the tree canopy cover of the surrounding areas in a negative way. We hope this report will allow for the City of Bloomington to account for potential tree loss within their decision making and to create a plan of action on how the City plans to address this issue.

References

City of Bloomington, Indiana (2014) Bloomington Urban Forestry Plan (2014 - 2019) bloomington.in.gov/about/trees/urban-forestry-plan.

Portland State University (2010). “Protocol: Measuring Tree Diameter, Class Size, and Average Species Diameter.” Ecoplexity, ecoplexity.org/?q=node%2F236.

Appendix A

Portland State University DBH Class Distribution 2018

DBH Class Distribution 2018		
Class Name	**Class Size**	**Count**
Regeneration	< 3 inches	20
Sapling/pole	0 - 9 inches	82
Small Trees	10 - 14 inches	14
Medium Trees	15 - 19 inches	17
Large Trees	20 - 29 inches	51
Giant Trees	> 29 inches	32
Total (Sapling -Giant)		196

Appendix B

Comparison of 2007 and 2018 Tree Condition