Executive Summary: GIS Analysis and Tree Inventory for Indiana University Sustainability Task Force

Introduction
In order to properly manage the natural resources on campus, it is essential to know what those resources are, their abundance and how they can be measured. This is especially true for maintaining biodiversity of the forest resources on campus, because without proper management certain species can begin to dominate the landscape at the expense of others. Additionally, no cost-benefit analysis involving natural features on campus would be complete without considering the broad array of benefits provided by the local trees.

Inventory and Data Investigation
Several components of the universities GIS database were analyzed for applications in sustainability. Additionally, all of the trees inside a predetermined study area (South of 7th, North of 3rd and in between Jordan and Indiana) were inventoried using handheld computers and iTREE Urban Forest Management software. Three distinct inventories, one for the non-donor (naturally occurring) trees, one for the donated trees, and an estimated inventory of the heavily forested areas on campus were created for this analysis to reduce error and for purposes of data transfer and the existing GIS shapefiles. The three inventories were then combined for environmental benefit and total population statistics.

Population and Environmental Benefit Analysis
The 5 most abundant trees on campus are Sugar maple, Black cherry, Red maple, Northern red oak, Ash, Spruce (red or variant), American beech, Black walnut, Black locust, and Crabapple, respectively. These 10 species account for 1,474 individual trees, or more than half of the total number of trees in the inventory.

The most manageable species are those that have a large percentage of middle aged trees, such as Black walnut, Spruce, and red maple. Sugar maple has a consistent distribution of trees across all size classes and consequently will remain dominant with little management. However, Northern red oak are most abundant in the large age classes and new Northern red oaks will need to be planted to ensure this species’ success. Notably, the greatest concentration of large trees is located directly south and East of the Lily Library. This area is composed almost entirely of high-quality Northern red oak. Other areas with great abundances of large trees are directly west of the Memorial Union, and along third street in front of Swain, Rawles and Myers Halls. Based on the DBH data in the inventory, STRATUM estimated the current canopy cover to be 1,786,103 ft$^2$, or 41 acres.

As for wood and leaf damage, only 4% (11 total) of the trees inventoried had any wood related problems, and only 1% had a rating of poor. Leaf health was even better, with only 2% of the trees having any visible problems. The overall forest system in the study area appears to be in good heath.

Six benefits including reduced energy consumption, reduced stormwater runoff, Carbon sequestration, carbon storage, diminished air pollution, and aesthetic value, were calculated by the STRATUM software interface. For this analysis, the total annual benefit from the trees in the study area is 158,006$. The breakdown of this net value is shown in Table 5.
## Net Benefits of IU Trees

<table>
<thead>
<tr>
<th>Energy ($)</th>
<th>CO₂ ($</th>
<th>Air Quality ($)</th>
<th>Stormwater ($)</th>
<th>Aesthetic/Other ($)</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>49,853</td>
<td>9,532</td>
<td>12,915</td>
<td>14,336</td>
<td>71,370</td>
<td>158,006</td>
</tr>
<tr>
<td>Mwh</td>
<td>Therms</td>
<td>lbs</td>
<td>O₃, NO₂, PM₁₀, SO₂</td>
<td>Gallons</td>
<td>Property value, wildlife</td>
</tr>
<tr>
<td>375.3</td>
<td>51,812</td>
<td>1,270,982</td>
<td>3,895,506</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Conclusions

The results from this analysis indicate that with respect to trees in the study area, the GIS files that the engineers office currently has are out of date, as many trees have since been removed or died. However, a majority of the trees are still in tact and were found to be in good health and in need of minimal immediate maintenance. Similarly, very few of the trees have caused or are in danger of causing any damage to infrastructure such as sidewalks and overhead wires, and the majority of trees are planted in plots that are large enough for their continued success. The trees that do have problems are now identified and can be mapped for maintenance crews. Of the 58 species identified within the study area, Sugar Maple, Black Cherry, and Red maple dominate. These trees are widely distributed around the study area, and appear to dominate several age classes. Sugar maple and Red maple are shade tolerant species and consequently, can outcompete other species in forested areas. Black cherry, listed as the second most abundant species, prefers sunlight and will be limited in areas such as Dunn Woods at the expense of the shade tolerant species there. Thus, it would make sense to either manage the more abundant species’ populations, or concentrate on the more limited species in any future planting campaigns.

The trees within the study area provide a broad range of benefits beyond their aesthetic value; energy, stormwater, air quality and carbon storage benefits exceed 150,000$ per year. This value may be slightly skewed due to the iTREE software’s emphasis on increased home value, but the value provides some idea of the services they provide in real dollar terms. Additionally, the total amount of canopy cover calculated by the inventory was the same as calculated for the total greenspace, which included grass and other forms of non-tree cover, an apparent overestimate.

This study was not without its limitations. While relatively user friendly, the learning curve for the STRATUM software is fairly steep in the beginning, and general use will likely require some training program. However, as with any new program (iTree was released in 2006), the burden of working out the kinks is largely placed on the user’s shoulder. In time, the network of users will surely grow, and data transfer issues will hopefully be resolved soon after.

For future work, it would seem that the best use of anyone’s time in regard to this project would be to go back into the field and expand the inventory to the extent of the campus boundary. This would provide a more accurate representation of the campus-wide species and age distribution, as well as a whole number figure of the benefit. It would also make sense to do a complete inventory of the wooded areas, as opposed to the sample generated population used in this analysis. This would require use of a GPS to identify tree locations within the forest boundary. Following collection of that data, the GIS file could be appended. At present, the file still contains trees that are no longer there, and is missing new trees that were identified in this preliminary study. However, it would seem that the information contained within this report warrants further exploration. An expansion of this project would provide more beneficial insight into the universities valuable tree resources, and would provide a valuable learning experience for future interns.
This map illustrates the areas on campus with an abundance of older trees. Using DBH as a proxy variable for age, the study area was coded such that areas with high concentrations of trees with relatively larger DBH’s appear more red.
This map illustrates the largest trees of each species present on campus. A similar map could be used in the future for a published or virtual walking tree tour. In total, 47 trees are detailed in the map.
IU Tree Maintenance Issues

Legend

- Omitted Forest
- Construction Zone
- Study Area/Parking
- Sidewalk Damage
- Dead or Severely Damaged Wood
- Dead or Severely Damaged Leaves

This map illustrates tree maintenance issues on campus identifying individual trees causing sidewalk damage, as well as trees that need to be pruned, reduced or removed. Maps like this one could be used for walking tours of notable trees.
This map illustrates all of the permeable surface on campus South of 7th, North of 3rd and in between Jordan and Indiana Ave. The total permeable area amounts to 2,618,332.5 square feet (60.1 acres), or 56.6% of the total 4,625,909 square feet (106.2 acres) in the study area.
This map illustrates all of the impermeable surface on campus South of 7th, North of 3rd and in between Jordan and Indiana Ave. The total impermeable area amounts to 2007576.5 square feet (46.1 acres), or 43.4% of the total 4625909 square feet (106.2 acres) in the study area.
This map demonstrates an estimate of the total area within the study boundary that requires mowing. Of the 2,618,332.5 square feet that are in greenspace, 2,008,536.5 (41.1 acres) are in low cover or mowed regularly, while 609,796 square feet are in dense cover, and do not require regular lawn maintenance. The exact amount of grass area is probably less than the total green space above, but this map serves as an estimate.