Tree Canopy Assessment
Crystal River, Florida

LEGACY ARBORIST SERVICES

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Tree Canopy Cover: Past & Present

Tree canopy is defined as the layer of leaves, branches, and stems of public and private trees that cover the ground when viewed from above. Tree canopy provides many benefits to communities by lowering city temperatures, reducing air pollution, improving water quality, saving energy, enhancing property value, providing wildlife habitat, as well as providing social and aesthetic benefits. Establishing a tree canopy goal is crucial for communities seeking to improve their green infrastructure and environmental quality. The first step towards setting a canopy goal is conducting a tree canopy assessment to estimate the amount of tree canopy present in a city as well as the amount of tree canopy that could potentially be established.

LAS was hired to conduct the tree canopy assessment for Crystal River in 2015. The canopy assessment was performed with *i-Tree Canopy*. *i-Tree* is a state-of-the-art, peer reviewed software suite from the US Forest Service that provides urban and community forestry analysis and benefits assessment tools. The application within this software suite, called *i-Tree Canopy* offers a quick and easy way to produce statistically valid estimates of cover types (e.g. tree cover) using aerial images. *i-Tree Canopy* can be used to not only estimate tree canopy cover, but to monitor canopy changes over time.

The City's objective was to determine the current (2015) and past (2005) tree canopy coverage. This past and present analysis provides the City with an opportunity to examine the trend of the canopy coverage over the past ten years and serves as baseline data for establishing tree canopy goals for the next decade.
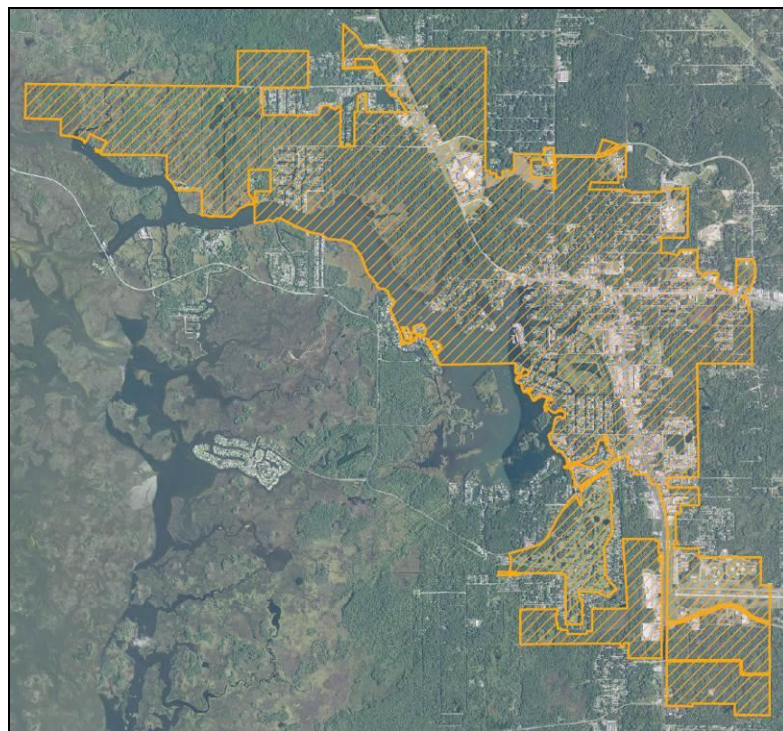

Figure 1 - City of Crystal River Boundary.

Methodology

To assess the 2015 canopy coverage, LAS used *i-Tree Canopy*, to analyze 1800 random sampling points within the City boundary.
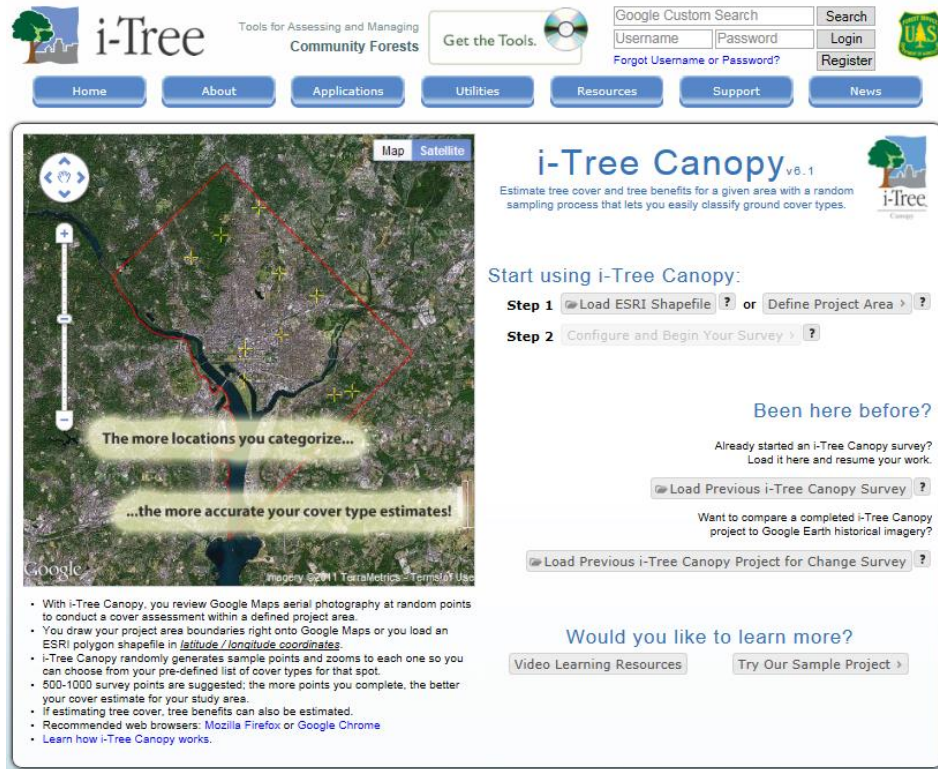

Figure 2 - i-Tree Canopy can be accessed at itreetools.org.

The software randomly distributes points onto *Google Maps* 2015 aerial imagery and the LAS interpreter classifies which cover class each point falls upon.
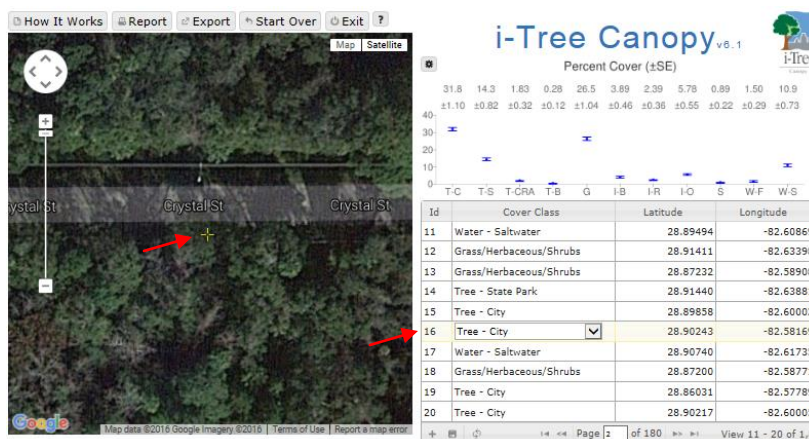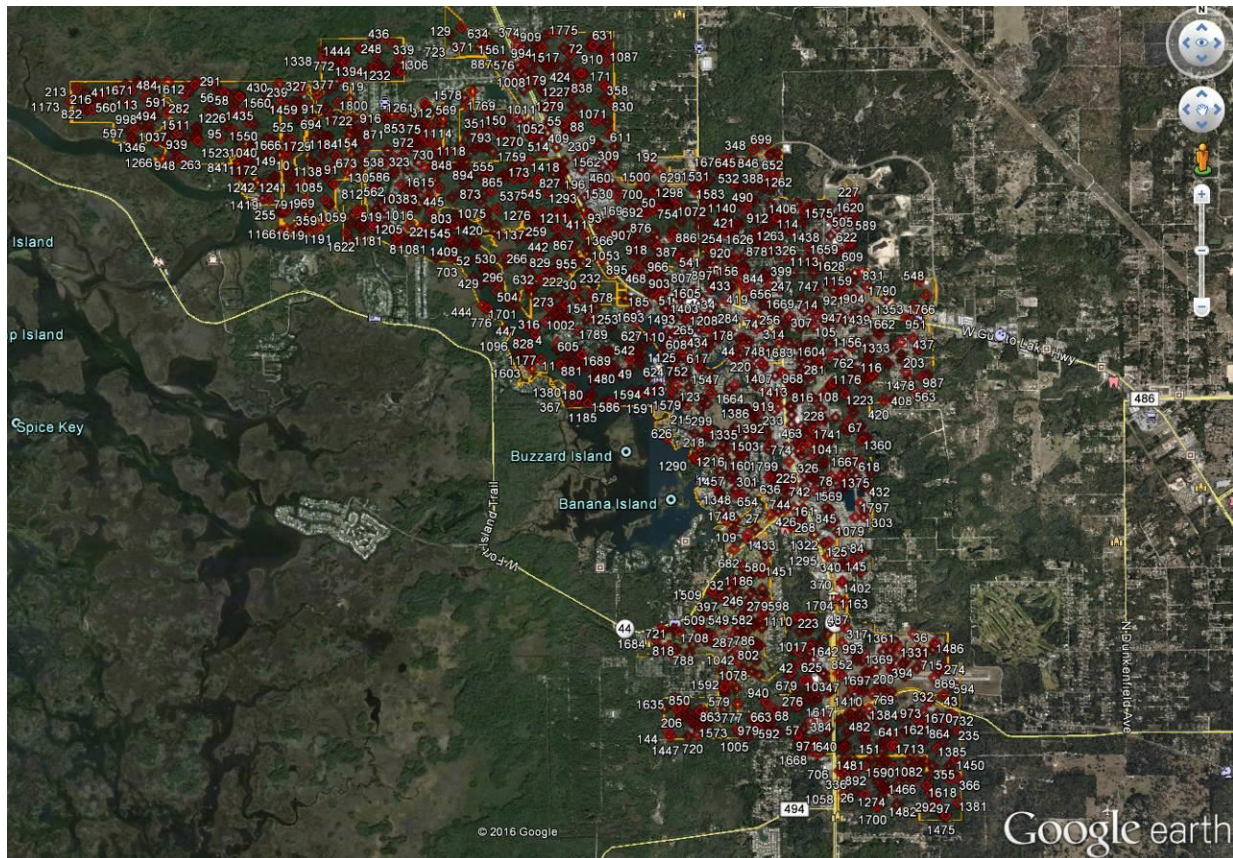

Figure 3 - Snapshot of Pt. 16. It is classified as Tree - City.

To assess the past canopy coverage the 1800 points were exported into *Google Earth* and the December 31, 2005 aerial imagery was utilized to reclassify each point's cover class.


Figure 4 - Illustration of 1800 data points utilized to conduct canopy analysis for the City of Crystal River.

LAS defined eleven potential cover class types:
- Tree – City
- Tree – State Park
- Tree – Community Redevelopment Area (CRA)
- Tree – Bicentennial Park
- Grass/Herbaceous/Shrubs
- Impervious – Building
- Impervious – Road
- Impervious – Other
- Soil/Bare Ground
- Water – Freshwater
- Water – Saltwater (tidally influenced)

The four tree cover classes were broken out as per the request of the Tree Board so the percentages of these specific canopy coverages could be identified.

The city boundary for Crystal River is unique in that it encompasses Crystal River State Park and a portion of Crystal River and Kings Bay.
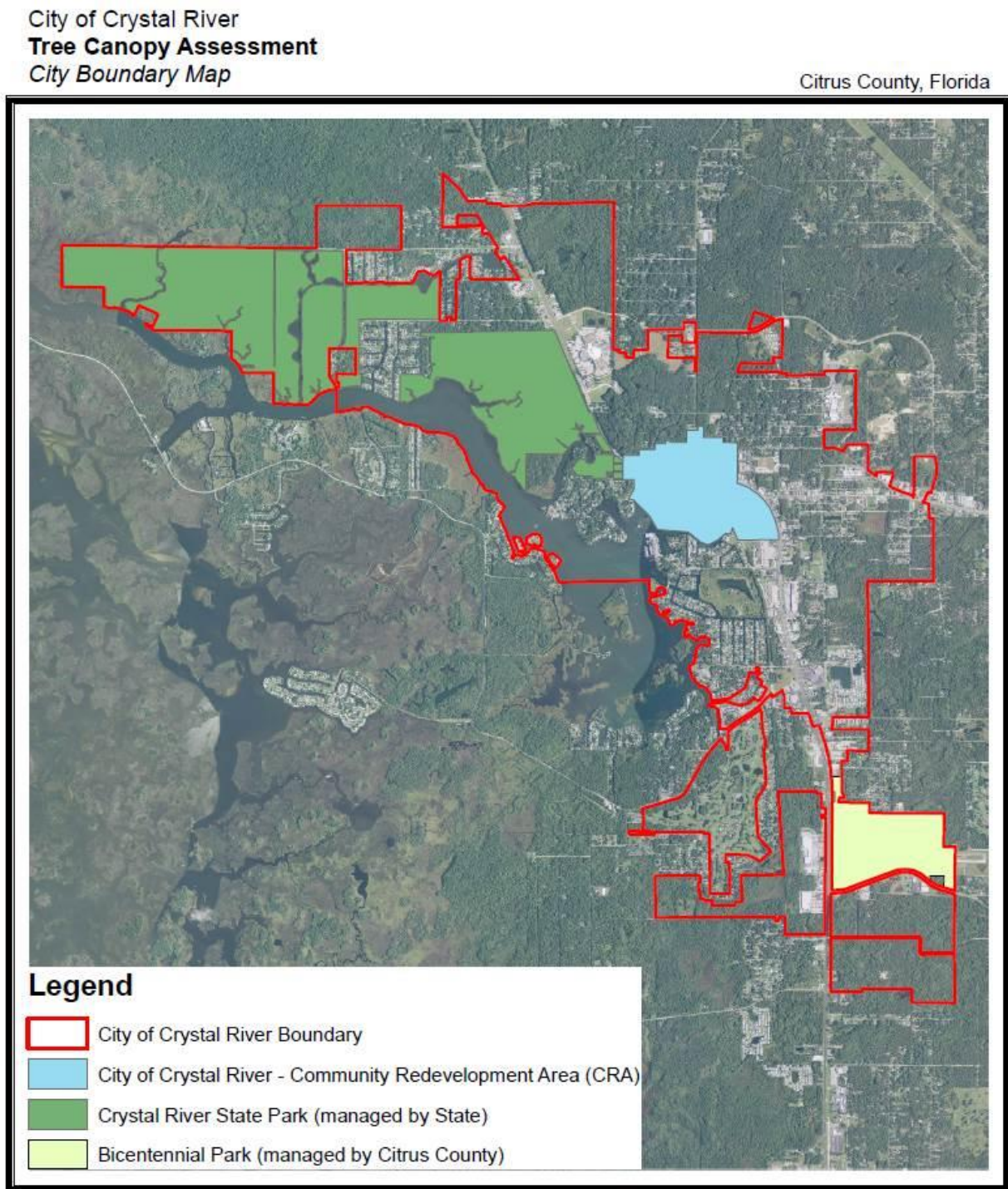
Figure 5 - Tree Canopy Assessment study area for the City of Crystal River. Note: Tree canopy coverage was divided into four types: trees within Crystal River State Park, trees within the Community Redevelopment Area (CRA), trees within Bicentennial Park, and trees in the remainder of the city boundary.

Tree Cover Types

Tree canopy coverage was divided into four types: trees within Crystal River State Park, trees within the Community Redevelopment Area (CRA), trees within Bicentennial Park, and trees in the remainder of the city boundary. This separation allows the City to determine the *overall* tree canopy coverage in Crystal River and the proportion of the canopy coverage that falls within these other areas of interest within the city boundary (e.g. Crystal River State Park, Community Redevelopment Area (CRA), and Bicentennial Park). For management purposes it also allows the City to determine the percent tree canopy coverage managed by City staff and Crystal River's residents versus the tree canopy coverage that is in Crystal River State Park and managed by the State's Natural Resource Department or in Bicentennial Park and managed by Citrus County.

🌳 The *tree* cover types represent the current tree canopy coverage.

Grass/Herbaceous/Shrubs

The grass cover class comprises all understory (non-tree) vegetation within the City boundary, including herbaceous plants and shrubs. This includes maintained grass, such as in the City parks or residential yards. It also includes natural vegetation such as the grassy marshes in the Crystal River State Park.

🌳 The *grass/herbaceous/shrub* cover type represents potential areas to increase canopy coverage.

Impervious Cover Types

Impervious cover types were divided into three types: *building, road, and other*. The *impervious other* cover type includes driveways, sidewalks, parking lots, pools, patios, recreational areas (e.g. basketball and tennis courts), and railroads.

🌳 The *impervious* cover types represent areas that are not currently plantable.

Soil/Bare Ground

The soil/bare ground cover type describes areas that are devoid of vegetation.

🌳 The *soil/bare ground* cover type represents potential areas to increase canopy coverage.

Water Cover Types

The two water cover types were separated as freshwater and saltwater. Water bodies within the land area such as ponds, retention areas were considered freshwater. Kings Bay, Crystal River, and canals that are tidally influenced were considered saltwater (even though the water salinity may be minimal).

🌳 The *water* cover types represent areas are not plantable.

All of the cover class percentages for the City of Crystal River were calculated to illustrate both land and water cover percentages. Afterwards, the tree canopy coverages were calculated based on the land cover percentages only. The "land" cover percentages exclude water from the dataset so the cover estimates can be based on *city land area* (where potential trees canopy could theoretically exist), not on city total area.

The percentage of each cover class (p) was calculated as the number of sample points (x) hitting the cover attribute divided by the total number of interpretable sample points (n) within the area of analysis (p= x/n). The standard error of the estimate (SE) was calculated $SE = \sqrt{p \times (1-p) / n}$. This method has been used to assess canopy cover in many cities (e.g., Nowak et al., 1996). The *i-Tree Canopy Technical Notes* is included in the Appendix for a more detailed explanation of the calculations performed.

Results

The results from this canopy analysis indicated that in 2015 the City of Crystal River has 74% tree canopy and grass, 12% impervious surface, 1% soil/bare ground, and 12% water, see Figure 6 below.
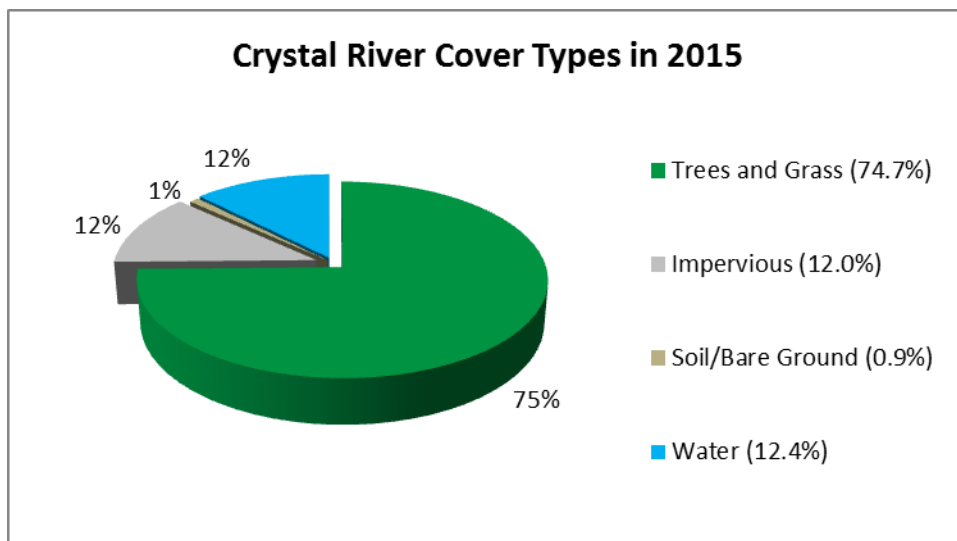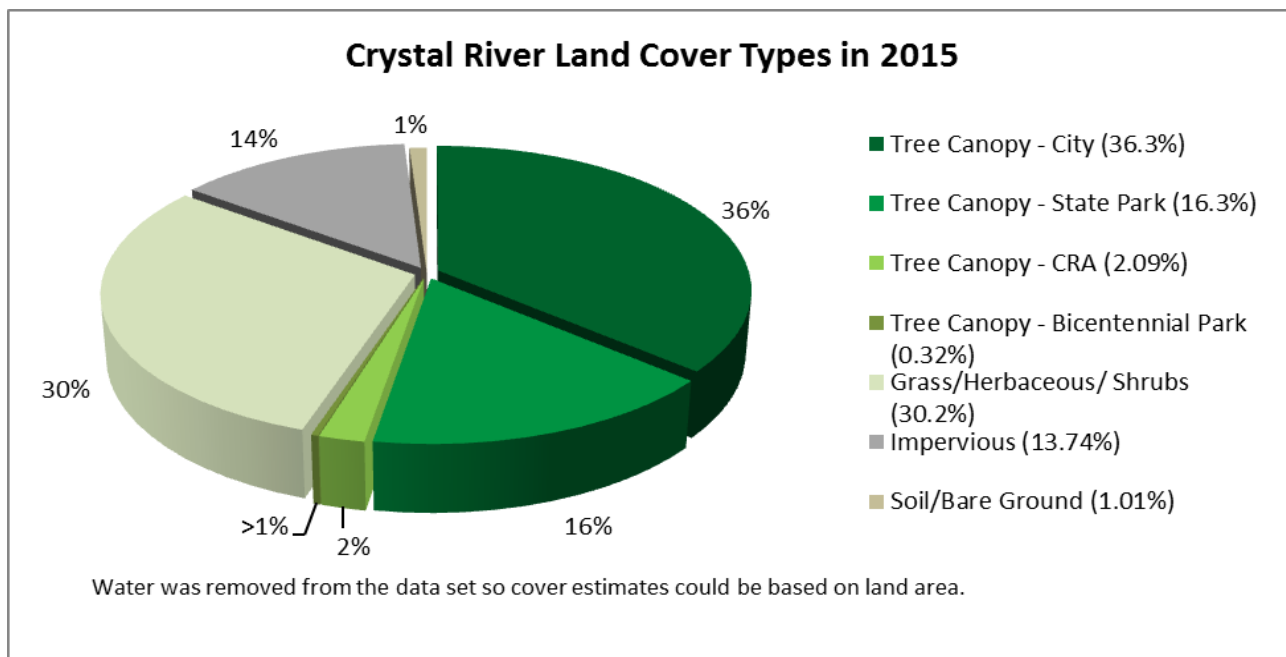

Figure 6 - Cover types for Crystal River (including water).

The overall tree canopy cover (*based on land cover percentages*) is 55%, covering approximately 4.98 mi^2 or 3,187 acres. Almost one-third of the overall canopy cover is comprised of trees within the Crystal River State Park.

Figure 7 - Land cover types for Crystal River (excluding water).

The tree canopy cover in the urban areas (managed by the City and Crystal River residents) is **39%**; this excludes the trees within Crystal River State Park (managed by the State) and trees within Bicentennial Park (managed by Citrus County), see Figure 7.

Over the last ten years, Crystal River's urban tree canopy coverage (*Tree Canopy – City*) has increased by **0.2%.** Tree canopy coverage in Crystal River State Park has decreased by **1.1%**. The grass cover has increased by almost **1%**. Impervious surfaces (building, road, and other) increased by **0.7%**, and soil/bare ground decreased by **0.8%**.

Table 1 provides the land cover percentages for 2005 and 2015. Figure 11 illustrates the changes over the past ten years. Both are located on page 11.

Discussion

Tree cover is constantly changing due to natural and anthropogenic (human-related) forces.

- *Natural* causes for increases in tree canopy can be due to regeneration or tree growth while decreases can be due to tree mortality from insects or diseases or old age.
- *Anthropogenic (human-related)* factors that positively influence tree cover include tree planting, following Right Tree, Right Place, and proper tree maintenance. Negative human-related impacts on tree cover include tree mortality or removal due to direct or indirect human actions such as land development, improper tree maintenance, and/or harmful air pollution.

The overall tree canopy cover (based on land cover percentages) is **55%**. This canopy coverage is high for an urban city and likely due to the presence of the Crystal River State Park within the City Boundary. Remember, almost one-third of the overall canopy cover is comprised of trees within the Crystal River State Park.

Additionally, there are a large amount of wooded privately-owned land holdings within the City boundary (see Figure 8 below). Future development has the potential to reduce the canopy coverage in these areas and decrease the City's future canopy coverage. Hence, there is a strong need for collaborative efforts to be made with private land owners to preserve and protect the City's tree canopy.
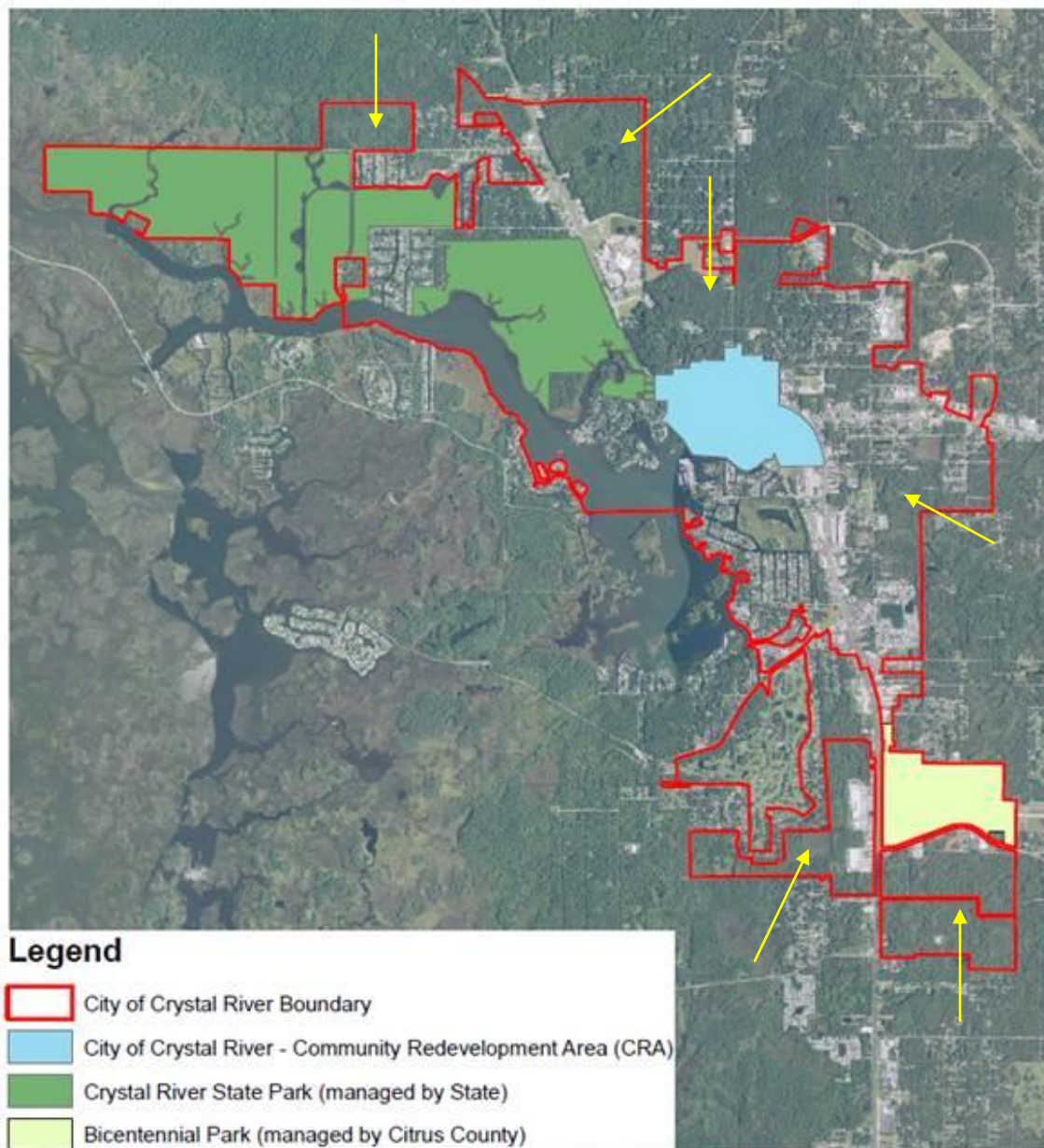
Figure 8 - Yellow arrows highlight large land-holdings that greatly influence the City's tree canopy coverage.

The tree canopy percentages (with the exception of the State Park) for the 2005 and 2015 tree cover types are very similar, with minimal differences (see Table 1). This does not mean that changes to the tree canopy have not occurred. It means that various changes have balanced each other out. For example, tree removals that have been made in the last ten years have been offset by the growth of the remaining trees. Figure 9 illustrates the growth of three trees over the past ten years.

Figure 9 - The 2005 (left) and 2015 (right) imagery illustrate the canopy growth of the trees over the past 10 years.

The tree canopy coverage in Crystal River State Park has decreased by 1%. This was due to the conversion of tree canopy to grass due to tree mortality or timber harvest. Tree mortality could be due to age, storms or disease (see Figure 10). This information should be shared with the State's Natural Resource Department to assist with their land management efforts.


Figure 10 - The 2005 (left) and 2015 (right) imagery illustrate the canopy loss over the past 10 years in the Crystal River State Park.

Impervious cover did not change much (0.7%), but a portion of the increase was due to new building construction.

In review of the land cover percentages in 2015, the tree canopy could potentially cover an additional 31% of the City's land area (grass and soil/bare ground cover types). However, it is important to note that these areas encompass both public and private land. Additionally, not all of these areas can be planted due to site constraints. As promoted by the Arbor Day Foundation, the right species need to be planted in the right place (Right Tree, Right Place). Identify and providing adequate planting spaces for different tree species is very important in the long term success of future plantings.

Table 1- Average percentage of land cover changes from 2005 to 2015, including Standard Error percentages.

Land Cover Class Type	Average Percentages			Standard Error Percentages	
	2005	2015	Change	2005	2015
Tree Canopy - City	36.1	36.3	0.2	1.21	1.21
Tree Canopy - State	17.4	16.3	-1.1	0.95	0.93
Tree Canopy - CRA	2.1	2.09	0.0	0.36	0.36
Tree Canopy - Bicentennial Park	0.44	0.32	-0.1	0.17	0.14
Grass/Herbaceous/ Shrubs	29.3	30.2	0.9	1.14	1.16
Impervious - Building	4.23	4.43	0.2	0.51	0.52
Impervious - Road	2.78	2.72	-0.1	0.41	0.41
Impervious - Other	5.94	6.59	0.6	0.59	0.62
Soil/Bare Ground	1.77	1.01	-0.8	0.33	0.25
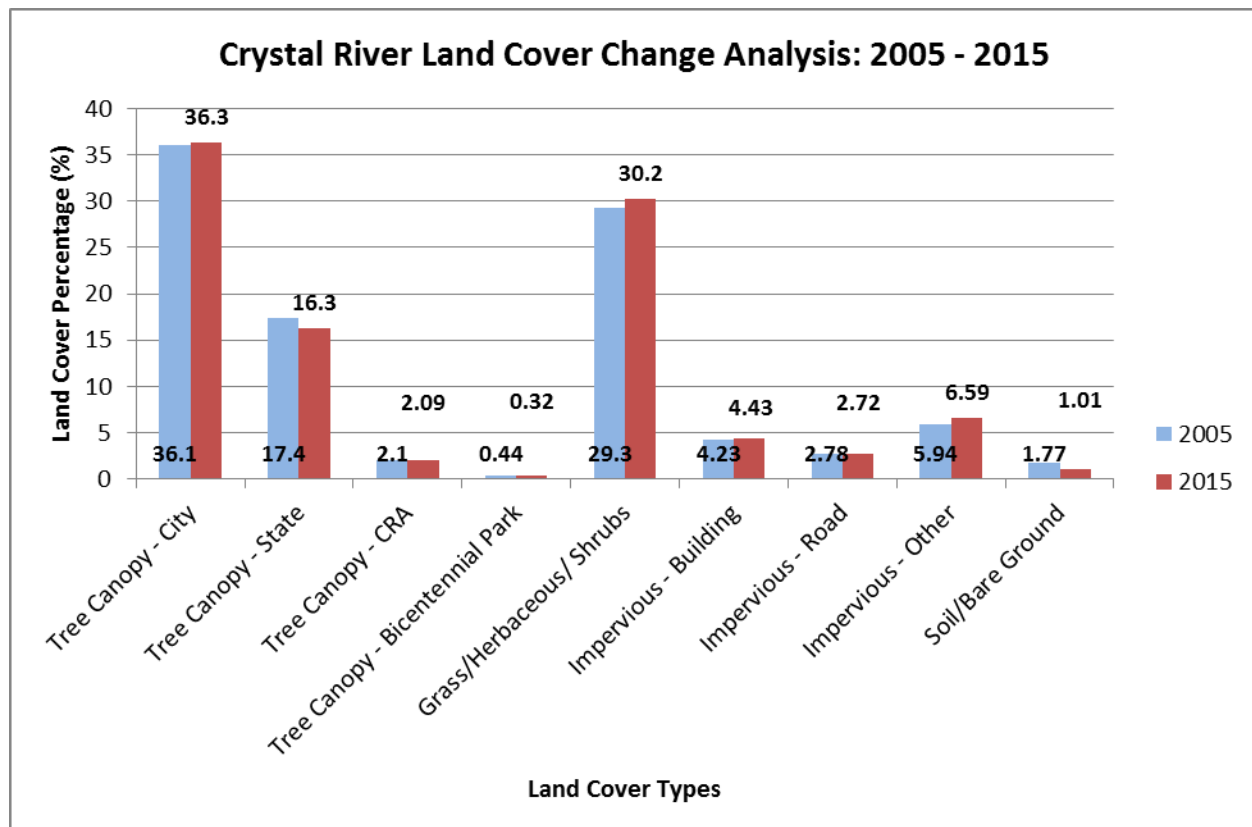
Figure 11 – Crystal River's tree canopy coverage managed by the City and Crystal River residents has increased by 0.2%.

Future Action Items

There is no set tree canopy percentage that would be considered "optimal" everywhere. Each community has a number of considerations that are unique to its particular circumstances, including climate, geography, land cover, previous land use patterns, available resources, local priorities, and other factors.

 🌳 The City has two alternatives in regards to the future management of the City's overall tree canopy: no action vs. action.

If the City does not take proactive measures (no action), it is likely that the areas identified in Figure 8 will be developed. The rate of development (and tree removal) will exceed the rate of tree canopy growth and will result in a decrease in canopy coverage.

If the City wants to take action and protect the current canopy coverage, then this canopy assessment can assist the City with setting goals for the future urban tree canopy. Effective urban tree canopy goal setting requires involvement and commitment by municipal leaders and staff, local business community, neighborhood groups and citizens. The following three steps are recommended:

1. **Assess Possible Urban Tree Canopy**

    - Identify opportunities on public and private land.

2. **Adopt Goals Based on Assessments**

    - If possible, institutionalize goals in appropriate ordinances, policies, or community master plans.

3. **Develop Implementation Plan**

    - Identify strategies to meet goals based on available resources, political climate and stakeholder needs. Produce timeline and identify parties responsible for each strategy.

Below is a checklist for implementing urban tree canopy goals:

❖ **Protect & Maintain Existing Trees**

 🌳 Develop and maintain tree protection ordinance and conservation easements.

 🌳 Ensure proper pruning in utility corridors.

❖ **Minimize & Restore Urban Tree Canopy Lost to Age, Mortality & Land Conversion**

  ○ Specify strategies within a Comprehensive Land Use Plan

  ○ Adopt subdivision, zoning, and landscape ordinances.

❖ **Promote Public Education & Awareness**

  ○ Promote tree benefits (e.g., community website, newsletter, water bill insert)

  ○ Promote proper tree planting (e.g., Arbor Day, workshops)

  ○ Develop or participate in tree planting campaigns

❖ **Plant New Trees**

  ○ Identify and prioritize planting sites community-wide

  ○ Assess species diversity needs.

  ○ Identify how trees will be maintained.