URBAN TREE CANOPY

ASSESSMENT

PINELLAS COUNTY, FLORIDA

NOVEMBER | 2022

Pinellas County

PlanIT Geo™
developers of TreePlotter

AN ASSESSMENT OF
URBAN TREE CANOPY IN

PINELLAS COUNTY, FLORIDA

> **To be without trees would, in the most literal way, to be without our roots.**
>
> **-Richard Mabey**

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COMPLETED

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67,207
ACRES OF CANOPY

39%
OF PINELLAS COUNTY WAS COVERED BY TREE CANOPY IN 2021

EXECUTIVE SUMMARY

PURPOSE OF THIS ANALYSIS

Located on the west central coast of Florida, Pinellas County is approximately 281 square miles, or 179,890 acres, in size. It is home to nearly 1 million residences despite being the second smallest county in the state of Florida. The urban forest in Pinellas County is a valuable asset providing residents and visitors with many environmental, social, and economic benefits. This assessment mapped urban tree canopy (UTC), possible planting area (PPA), and tree canopy changes from 2010 to 2021 and analyzed how they are distributed throughout Pinellas County and its single member districts, tree planting zones, municipalities, basins, and census block groups.

PROJECT METHODOLOGY

The results, based on 2021 and 2010 imagery from the USDA's National Agriculture Imagery Program (NAIP), provide a current and historical look at land cover in Pinellas County and will allow the County to revise and develop existing and new strategies to protect and expand the urban forest. This study used modern machine learning techniques to create land cover data that are more reproducible and will allow for a more even comparison the next time tree canopy and land cover are assessed.

PINELLAS COUNTY'S URBAN FOREST

In 2021, Pinellas County had 39% urban tree canopy cover and 18% possible planting area, not including any surface water bodies within the County. The County's urban tree canopy percentages above are based on land area only since water bodies are not suitable for planting new trees without significant modification.

Land cover percentages are calculated with the county's total area, which includes water bodies. The County's total land cover contained 37% tree canopy, 21% non-canopy vegetation; 1% soil/dry vegetation; 37% impervious surfaces, and 3% water. The 67,207 acres of tree canopy in Pinellas County provide a multitude of economic, environmental, and social benefits, valued at just over $82.7 million annually, as well as $430 million in carbon storage.

OVER 11,000 ACRES
OF PLANTABLE SPACE IS
IS LOCATED IN UNINCORPORATED AREAS

Of the 24 municipalities, in Pinellas County, the city of Oldsmar had the highest canopy coverage at 59% of its 5,624 land acres. However, unincorporated areas within the county contained the most canopy, overall, containing 28,724 acres or 43% of all canopy in the County. Unincorporated areas also contained the greatest potential for canopy expansion, offering 11,705 acres (19% PPA by area and 38% of the County's total plantable space).

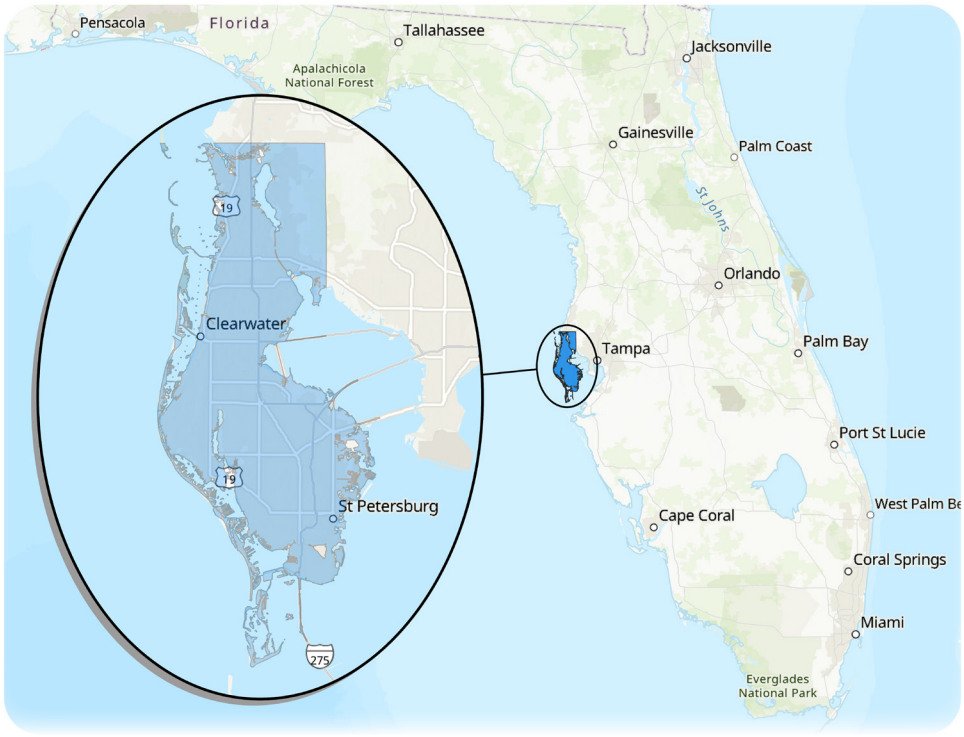


Figure 1. Pinellas County occupies approximately 281 square miles in central Florida.

URBAN TREE CANOPY CHANGE

Results from this assessment found that canopy cover changed from 31% to 39% from 2010 to 2021 (+8% or 13,513 acres) within Pinellas County. All municipalities had an increase in canopy coverage. Canopy cover also increased over all four single member districts. District 4 experienced the greatest increase with 5,553 acres, or +19%, between 2010 and 2021.

RECOMMENDATIONS

The results of this analysis can be used to develop a continued strategy to protect and expand Pinellas County's urban forest. This study revealed that countywide canopy has grown by over 13,500 acres. With 31,106 acres of possible planting area, Pinellas County has the opportunity to continue to increase urban tree canopy coverage on both public and private property. Nearly 38% of the county's PPA falls within unincorporated areas. With partnerships, education, and outreach programs to private landowners, Pinellas County can aim for larger gains in the countywide canopy numbers. It is important for the County to use this assessment to inform future investments in the urban forest so that all those who live, work, and play in Pinellas County can benefit from the urban forest. The County must proactively work to protect the existing urban forest and replenish the canopy with additional trees. Through management actions, strategic plantings, and protections for existing canopy informed by the UTC, PPA, and change metrics included in this report, Pinellas County has an opportunity to expand its current urban tree canopy to its fullest potential.

39%
URBAN TREE CANOPY

18%
POSSIBLE PLANTING AREA

37%
IMPERVIOUS SURFACE

Figure 2. Based on an analysis of 2021 high-resolution imagery, Pinellas County contains 39% tree canopy, 18% areas that could support canopy in the future, and 37% total impervious areas.

PROJECT

METHODOLOGY

Land cover, urban tree canopy, and possible planting areas were mapped using the sources and methods described below. These data sets provide the foundation for the metrics reported at the selected geographic assessment scales.

DATA SOURCES

This assessment utilized high-resolution (60-centimeter) multispectral imagery from the U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP) collected in 2021 to derive the land cover data set. The NAIP imagery was used to classify all types of land cover. For canopy change analysis, 1-meter resolution NAIP imagery collected in 2010 was used to classify the 2010 tree canopy.

MAPPING LAND COVER

The land cover data set is the most fundamental component of an urban tree canopy assessment. Tree canopy and land cover data from the EarthDefine US Tree Map (https://www.earthdefine.com/treemap/) provided a six class land cover data set. The US Tree Map is produced using a modern machine learning technique to extract tree canopy cover and other land cover types from the latest available 2021 NAIP imagery. These six classes are shown in Figure 3 and described in the Glossary found in the Appendix. EarthDefine also provided 2010 tree canopy classification metrics used for canopy change analysis.

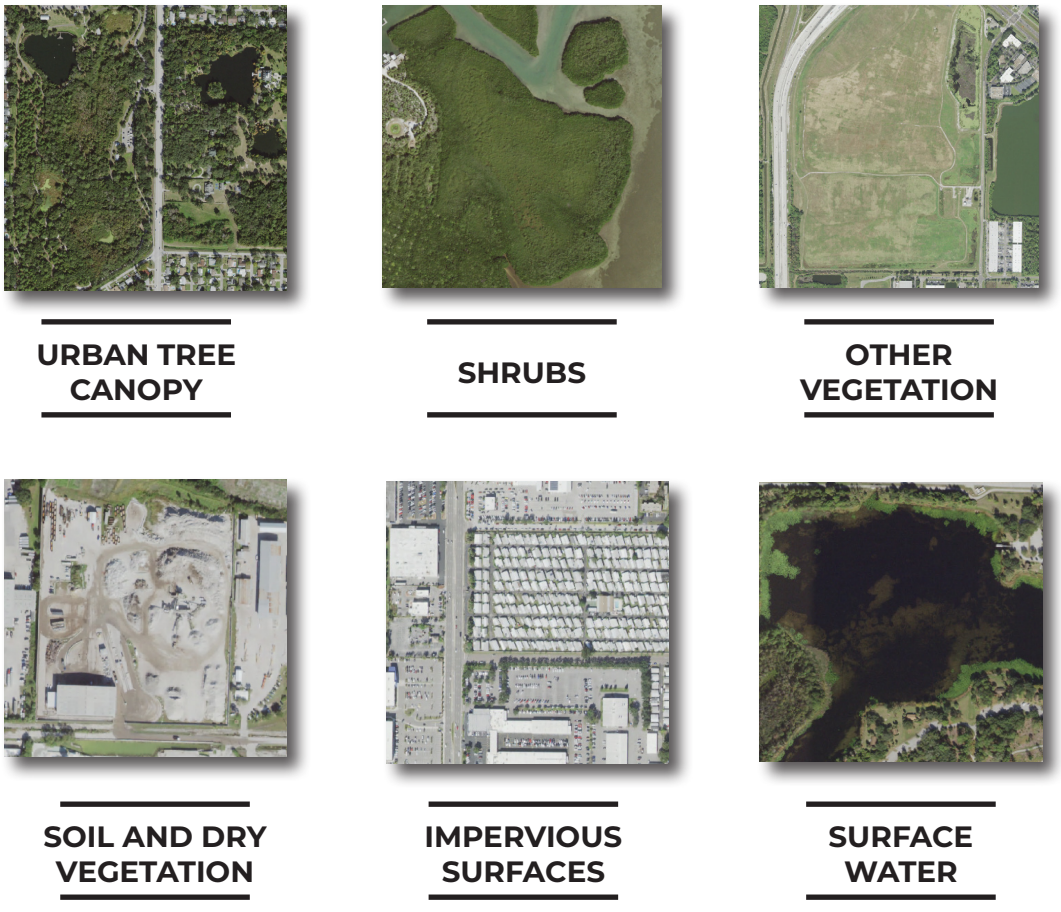


Figure 3. Six (6) distinct land cover classes were identified in the 2021 tree canopy assessment: urban tree canopy, shrubs, other vegetation, bare soil and dry vegetation, impervious surfaces, and water.

IDENTIFYING POSSIBLE PLANTING AREAS AND UNSUITABLE AREAS FOR PLANTING

In addition to quantifying Pinellas County's existing tree canopy cover, another metric of interest in this assessment was the area where tree canopy could be expanded. To assess this, all land area in Pinellas County that was not existing tree canopy coverage was classified as either possible planting area (PPA) or unsuitable for planting.

Possible planting areas were derived from the "other vegetation" layer. Unsuitable areas, or areas where it was not feasible to plant trees due to biophysical or land use restraints (e.g., golf course playing areas, recreation fields, utility corridors, etc.) were manually delineated and overlaid with the existing land cover data set (Figure 4). The final results were reported as PPA Vegetation, Unsuitable Vegetation, and Water.

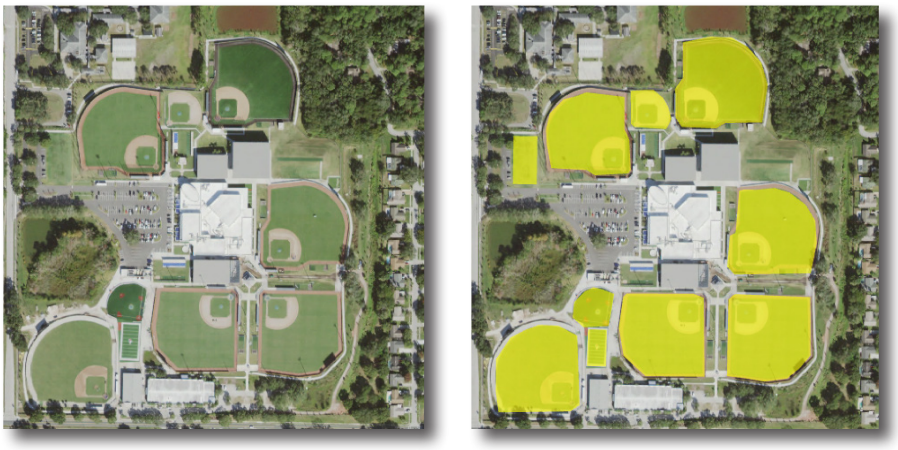


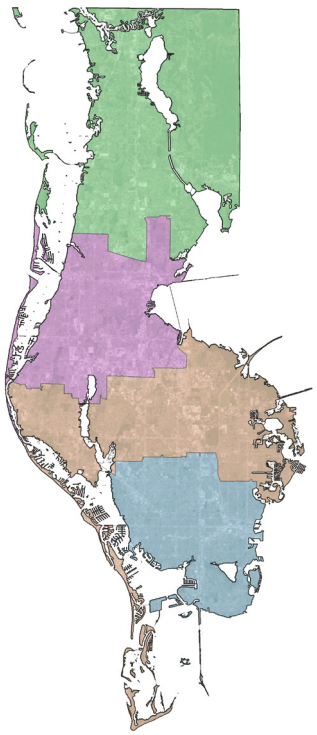
Figure 4.
Vegetated areas where it would be biophysically feasible for tree plantings, but undesirable based on their current usage (left) were delineated in the data as "Unsuitable" (right). These areas included recreational sports fields, golf courses, and other open space.

DEFINING ASSESSMENT LEVELS

In order to best inform Pinellas County's various stakeholders, urban tree canopy and other associated metrics were tabulated across a variety of geographic boundaries. These boundaries include the county boundary, Pinellas County Board of County Commissioners Single Member Districts, tree planting zones, municipalities, water basins, and census block groups.

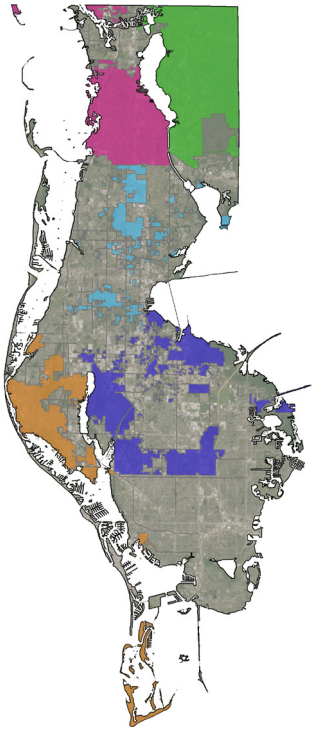
PINELLAS COUNTY

Pinellas **County** boundary is the one (1) main area of interest over which all metrics were summarized.



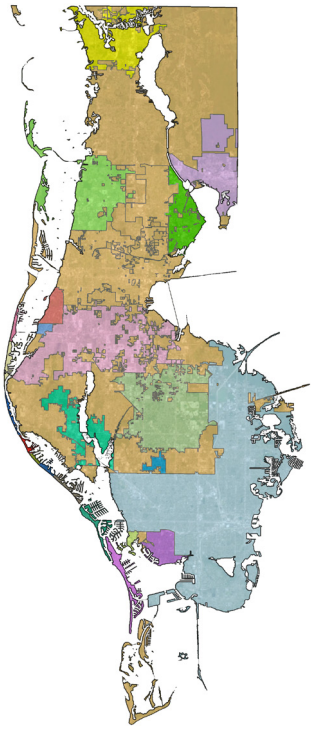
SINGLE MEMBER DISTRICTS

Four (4) **single member districts** were assessed to inform the elected officials and citizens residing in each individual voting district.



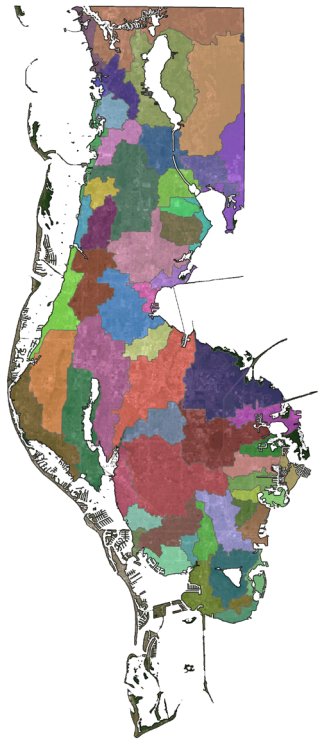
TREE PLANTING ZONES

To better understand the distribution of tree planting potential, five (5) **planting zones** located within unincorporated areas were assessed.



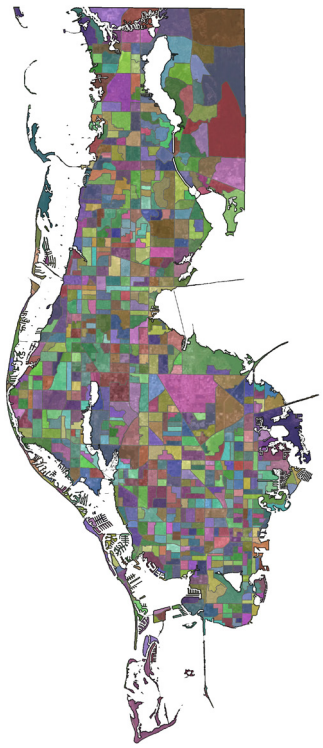
MUNICIPALITIES

Twenty-four (24) **municipalities** and the county's unincorporated area were assessed to further dissect urban tree canopy within different communities.



WATER BASINS

Since trees play an important role in stormwater management, sixty-three (63) **water basins** were assessed.



CENSUS BLOCK GROUPS

Seven hundred and thirty-seven (737) **census block groups** were assessed to show the relationship between tree canopy and socio-demographics and highlight potential environmental justice issues.

Figure 5. Six (6) distinct geographic boundaries were explored in this analysis: Pinellas County boundary, single member districts, tree planting zones, municipalities, water basins, and census block groups.

STATE OF THE CANOPY AND KEY FINDINGS

The results and key findings of this study, including the land cover map and canopy change analysis results, are presented below. These results can be used to design a strategic approach to identifying existing canopy and future planting areas. Land cover percentages are based on the total area of interest while urban tree canopy, possible planting area, and unsuitable percentages are based on land area. Water bodies are excluded from land area because they are typically unsuitable for planting new trees without significant modification.

In 2021, tree canopy constituted 37% of Pinellas County's land cover; shrub was 1%, other vegetation was 20%; soil/dry vegetation was 1%; impervious was 37%; and water was 3%. These land cover results are presented below in Table 1 and Figure 6.

Table 1. Land cover classes in acres and percent in Pinellas County.

Pinellas County, FL	Acres	% of Total
Pinellas County	179,890	100%
Tree Canopy	67,207	37%
Shrubs	2,199	1%
Other Vegetation	35,604	20%
Impervious Surfaces	67,124	37%
Soil & Dry Vegetation	2,135	1%
Water	5,620	3%

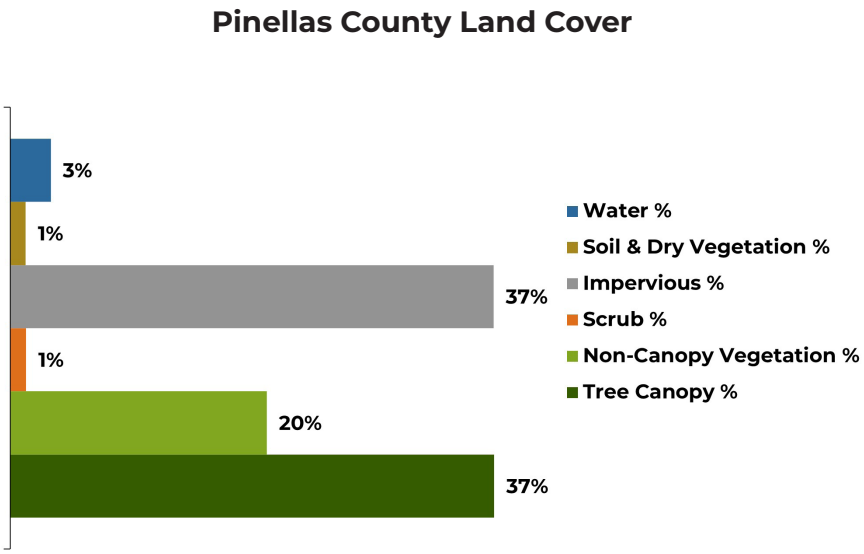


Figure 6. Land cover classification results (percentages based on total area of Pinellas County).

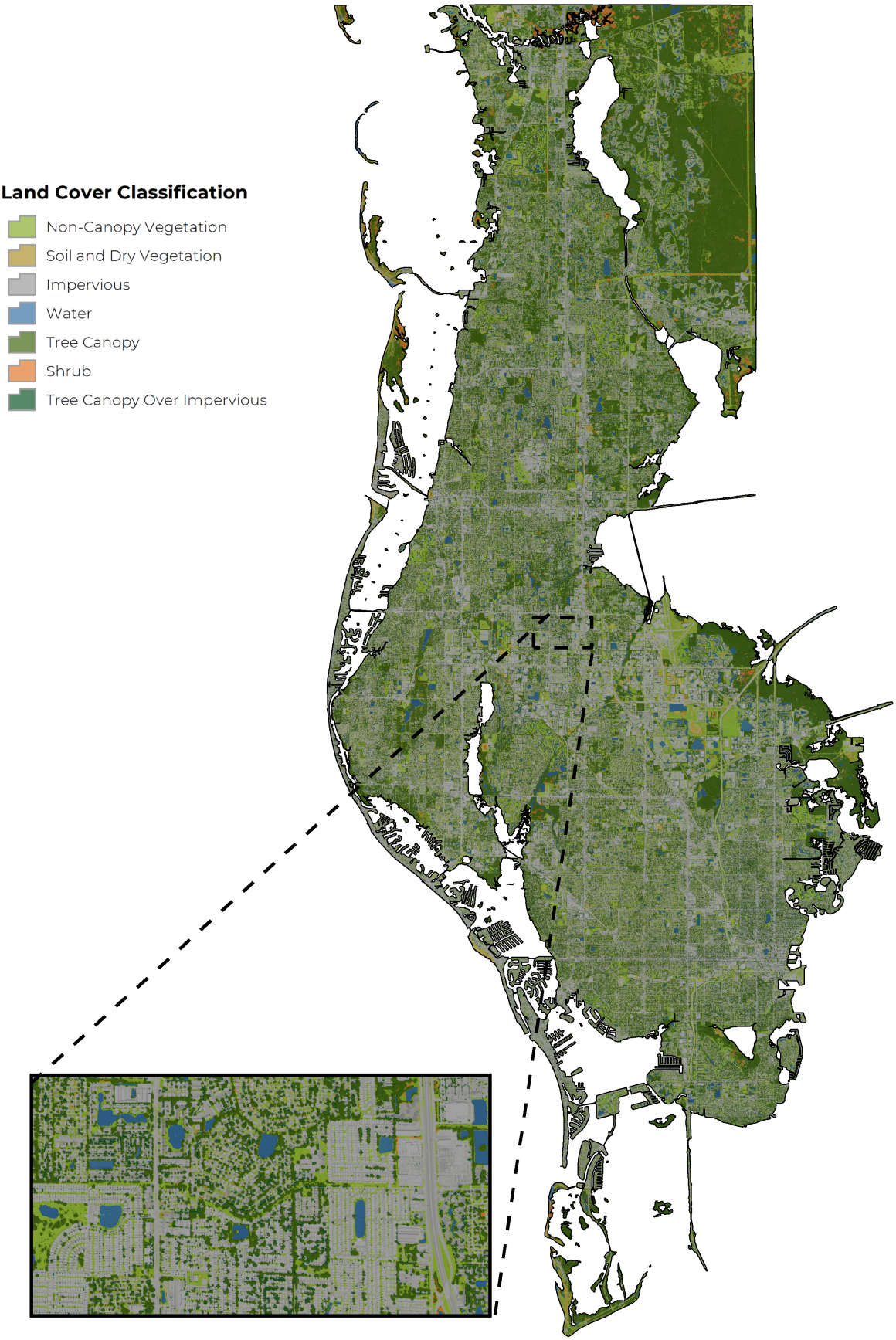
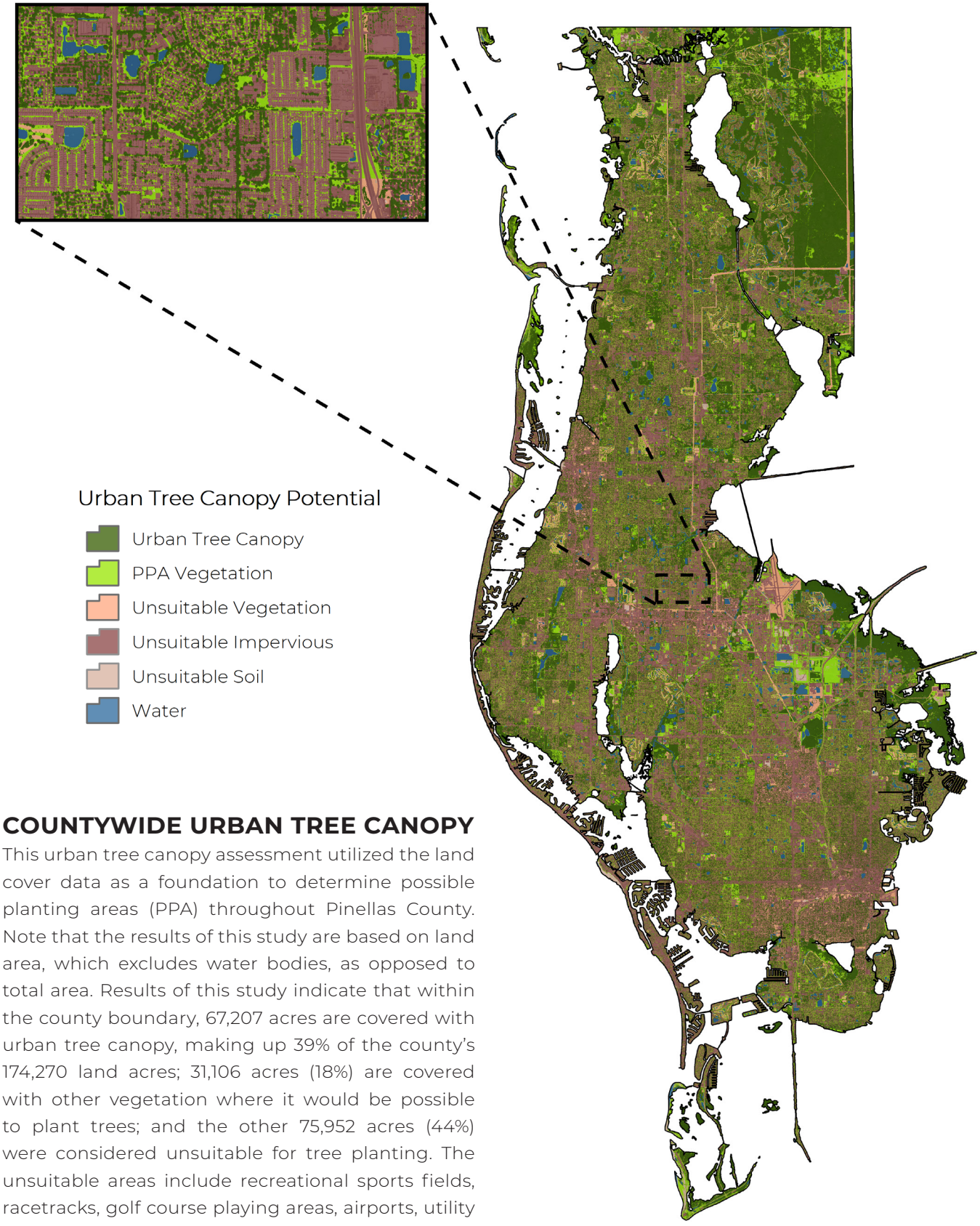


Figure 7. Distribution of land cover throughout Pinellas County.



COUNTYWIDE URBAN TREE CANOPY

This urban tree canopy assessment utilized the land cover data as a foundation to determine possible planting areas (PPA) throughout Pinellas County. Note that the results of this study are based on land area, which excludes water bodies, as opposed to total area. Results of this study indicate that within the county boundary, 67,207 acres are covered with urban tree canopy, making up 39% of the county's 174,270 land acres; 31,106 acres (18%) are covered with other vegetation where it would be possible to plant trees; and the other 75,952 acres (44%) were considered unsuitable for tree planting. The unsuitable areas include recreational sports fields, racetracks, golf course playing areas, airports, utility corridors, areas of bare soil and dry vegetation, and impervious surfaces.

Figure 8. Distribution of existing and potential urban tree canopy throughout Pinellas County.

The county's 67,207 acres of urban tree canopy were further divided into subcategories based on whether the canopy was overhanging pervious or impervious surfaces. Tree canopy overhanging an impervious surface can provide many benefits through ecosystem services such as localized cooling provided by shading and increased stormwater absorption. Results indicated that 91% of Pinellas County's urban tree canopy overhung pervious surfaces, while 9% extended over impervious surfaces.

Table 2. Urban tree canopy assessment results by acres and percent (percentages based on land acres).

Pinellas County, Florida	Acres	%
Total Area	179,890	100%
Land Area	174,270	99%
Urban Tree Canopy	67,207	39%
Total Possible Planting Area	31,106	18%
Total Unsuitable Area	75,952	44%

COUNTYWIDE URBAN TREE CANOPY CHANGE

Over the 11-year study period, there was an increase in Pinellas County's urban tree canopy. Tree canopy increased by 13,513 acres countywide, an 8% raw increase since 2010 (25% relative to 2010 acreage). This increase in canopy can be attributed to crown growth of maturing trees and growth of newly planted trees since 2010. Current levels of urban tree canopy in Pinellas County can continue to be improved with careful planning and planting efforts. See Table 4 for more details.

Table 3. Detailed urban tree canopy classifications.

Pinellas County, Florida	Acres	%
Overhanging Pervious Surfaces	61,058	91%
Overhanging Impervious Surfaces	6,149	9%
Totals	**67,207**	**100%**

Pinellas County Urban Tree Canopy Potential

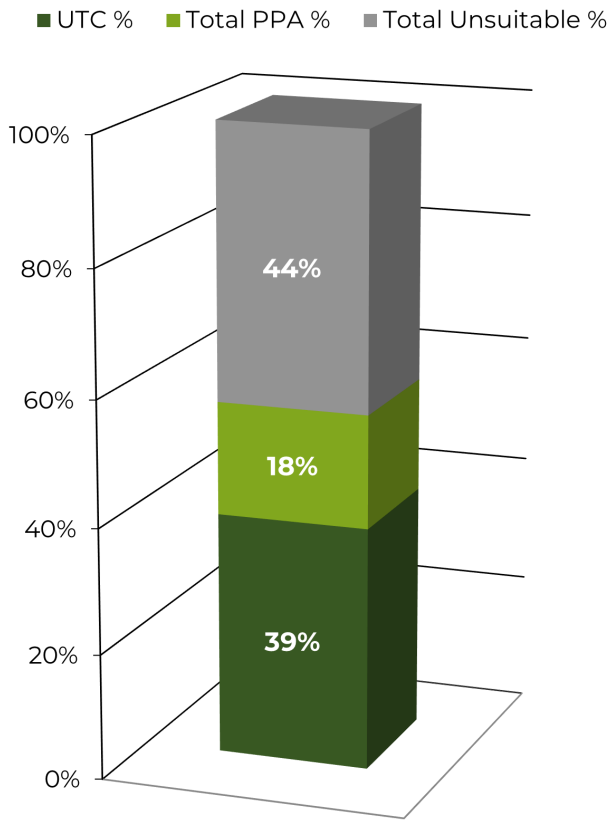


Figure 9. Urban tree canopy, possible planting area, and area unsuitable for UTC in Pinellas County.

Table 4. Countywide urban tree canopy change in Pinellas County.

Pinellas County, Florida	*Total Area*	*Land Area*	*2010*		*2021*		*UTC Change*	
	Acres	*Acres*	Acres	%	Acres	%	Acres	%
Urban Tree Canopy	179,890	174,270	53,694	31%	67,207	39%	13,513	8%

URBAN TREE CANOPY BY SINGLE MEMBER DISTRICTS

UTC and PPA were assessed across Pinellas County's Board of County Commissioners four single member districts. District 4 covered 34% of the county's land area and had the highest UTC (49%) of the districts. It also contributed the highest UTC (44%) and PPA (36%) towards the countywide totals. District 6 followed with the second greatest countywide percentages of UTC and PPA, with 24% and 31%, respectively. District 7 had the lowest percentage of UTC with 31% canopy cover within its boundary. Possible planting area was highest in District 6, with 20% of its land area available for tree planting. The next highest PPA was within District 4, which contained 19% PPA.

URBAN TREE CANOPY CHANGE BY SINGLE MEMBER DISTRICTS

Dividing the urban tree canopy change results by single member districts offered some additional insights as to how Pinellas County's canopy has changed across electoral boundaries. All four single member districts within Pinellas County experienced tree canopy gains between 2010 and 2021. District 4 experienced the greatest increase with +9%, or a gain of 5,553 acres, over the 11-year study period. This gain was closely followed by the increases of the other three districts. District 5 increased by 8%, or 2,740 acres, and District 6 increased by 7%, with 3,438 acres. A 6% increase in canopy cover occurred in District 7, translating to a gain of 1,759 acres.

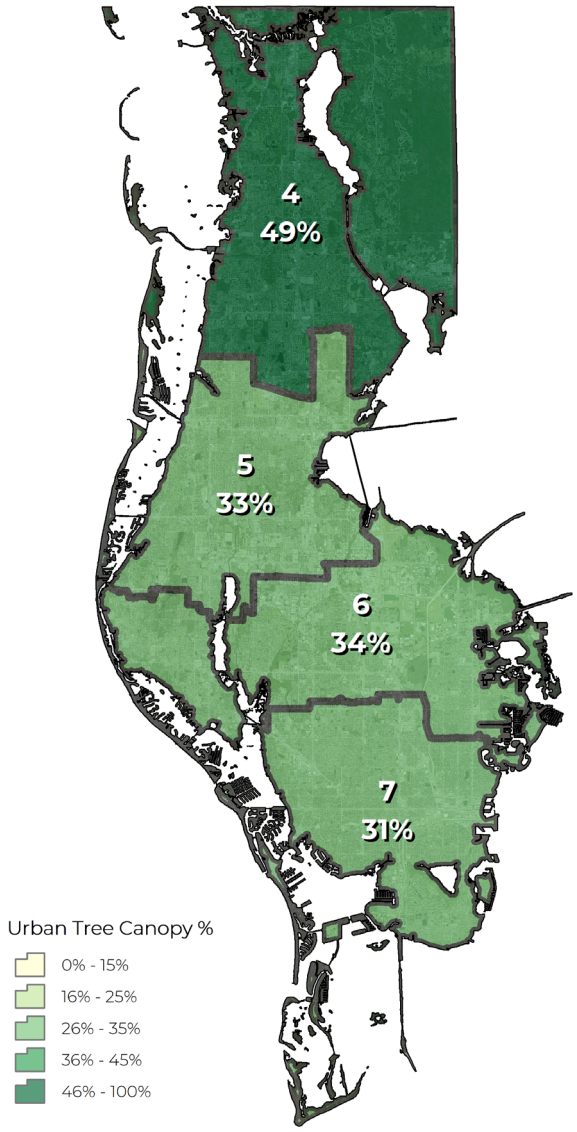


Figure 10. Urban tree canopy percentages in Pinellas County's single member districts.

Table 5. Urban tree canopy change by single member districts.

Single Member Districts	*Land Area*		*2010*		*2021*		*UTC Change*	
	Acres	*Dist.*	Acres	%	Acres	%	Acres	%
4	59,576	34%	23,832	40%	29,385	49%	5,553	9%
5	35,066	20%	8,936	25%	11,676	33%	2,740	8%
6	47,989	28%	12,794	27%	16,233	34%	3,438	7%
7	31,448	18%	8,077	26%	9,836	31%	1,759	6%
Totals	**174,079**	**100%**	**53,639**	**31%**	**67,130**	**39%**	**13,490**	**8%**

URBAN TREE CANOPY BY TREE PLANTING ZONES

Urban tree canopy metrics were also assessed for Pinellas County's five tree planting zones. All five planting zones will within the county's unincorporated areas. In 2021, Zone 2 had the highest percentage of urban tree canopy with 64%, or 11,827 acres. Zone 2's UTC accounted for 41% of unincorporated area's total tree canopy. Zone 1 had 43% UTC coverage within its boundary and contributed 18% to the unincorporated area's entire canopy cover.

All tree planting zones had similar levels of PPA, between 17 and 20%. Zone 2 contained 18% PPA (28% of total PPA for the unincorporated area's acreage), the highest of all zones. Zone 4 had 20% PPA within its total land acreage (20% of the unincorporated areas boundary). Despite having the lowest UTC percentage of 9%, Zone 3 contained 19% PPA. Zone 1 also had 19% PPA. Additionally, Zone 5 contributed 22%, or 2,651 acres, to the unincorporated area's PPA.

Tree Planting Zone 2

28% of all plantable space within the unincorporated county

URBAN TREE CANOPY CHANGE BY TREE PLANTING ZONES

All five tree planting zones within the unincorporated county experienced tree canopy gain between 2010 and 2021. The greatest tree canopy acreage gain occurred in Zone 2, adding 1,807 acres, or an increase from 54% in 2010 to 64% in 2021. Zone 4 experienced the greatest raw change with a 12% increase, and gaining 1,359 acres of tree canopy over the 11-year study period.

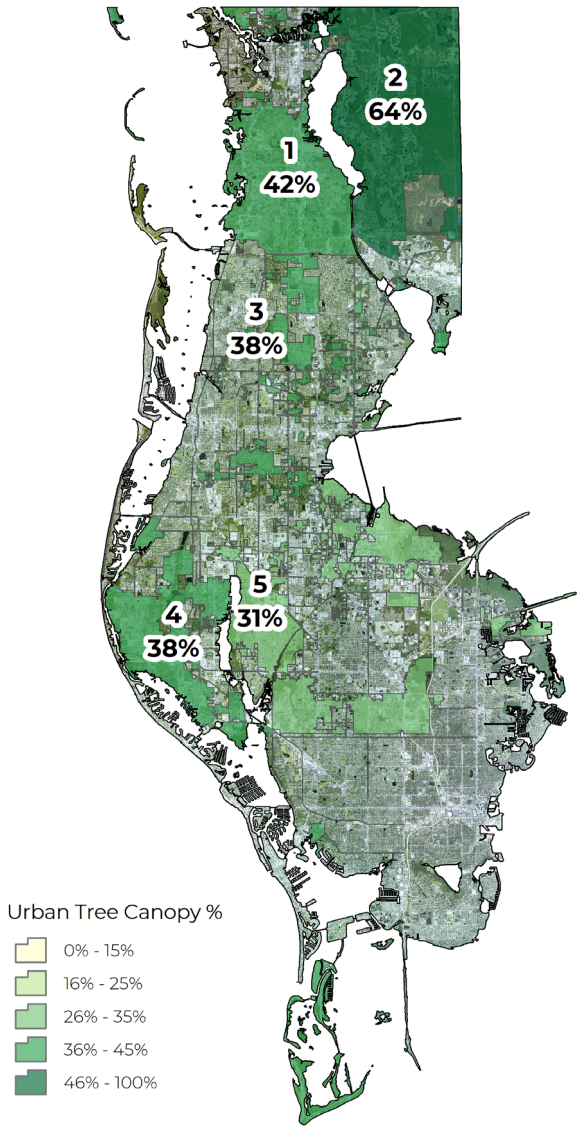


Figure 11. Tree planting zones and urban tree canopy percentages in Pinellas County.

Table 6. Urban tree canopy, possible planting area, and tree canopy change by Pinellas County's five tree planting zones.

Tree Planting Zones	*Land Area*		*Urban Tree Canopy*			*Possible Planting Area*			*UTC Change*	
	Acres	*Dist.*	Acres	%	Dist.	Acres	%	Dist.	%	Acres
1	12,428	19%	5,282	43%	18%	2,410	19%	20%	8%	1,031
2	18,565	29%	11,827	64%	41%	3,304	18%	28%	10%	1,807
3	6,867	11%	2,616	38%	9%	1,332	19%	11%	9%	585
4	11,441	18%	4,386	38%	15%	2,286	20%	19%	12%	1,359
5	15,683	24%	4,808	31%	17%	2,651	17%	22%	6%	954
Totals	**64,984**	**100%**	**28,919**	**45%**	**100%**	**11,983**	**18%**	**100%**	**9%**	**5,736**

Table 7. Urban tree canopy and countywide distribution by municipalities.

Municipality	*UTC %*	*PPA%*	UTC Change %
Belleair	34%	20%	7%
Belleair Beach	20%	17%	13%
Belleair Bluffs	31%	16%	10%
Belleair Shore	29%	16%	21%
Clearwater	33%	16%	7%
Dunedin	41%	20%	9%
Gulfport	33%	21%	7%
Indian Rocks Beach	25%	11%	15%
Indian Shores	21%	11%	17%
Kenneth City	23%	23%	3%
Largo	32%	14%	8%
Madeira Beach	14%	13%	9%
N Redington Beach	15%	14%	9%
Oldsmar	59%	16%	13%
Pinellas Park	23%	23%	4%
Redington Beach	20%	15%	10%
Redington Shores	12%	12%	9%
Safety Harbor	45%	18%	6%
Seminole	34%	19%	8%
South Pasadena	16%	15%	7%
St Pete Beach	16%	13%	8%
St Petersburg	36%	17%	6%
Tarpon Springs	39%	23%	11%
Treasure Island	16%	13%	10%
Unincorporated	45%	19%	9%

URBAN TREE CANOPY BY MUNICIPALITIES

UTC and PPA were assessed for Pinellas County's 24 municipalities, in addition to the county's unincorporated areas. Oldsmar had the highest percentage of UTC within its boundary, with 59% canopy cover, or 3,294 acres. Unincorporated areas and Safety Harbor had the next highest tree canopy coverage with 45% UTC in each. The 28,724 acres of tree canopy that falls within Unincorporated areas made up 44% of all of Pinellas County's tree canopy despite these areas only making up about 36% of the county's land area. Unincorporated areas also contribute the greatest PPA (38%) to the entire county. St. Petersburg contained 17% PPA within its boundary, and contributed 21% to the county's total PPA. Other municipalities with notable tree canopy coverage include Clearwater, Dunedin, and Pinellas Park. Clearwater had 33% UTC and 16% PPA. Dunedin had 41% UTC, and its 2,744 acres of canopy contributed 4% to the county's total. Similarly, Pinellas Park's 2,404 tree acres accounted for 4% of Pinellas County's total UTC. Pinellas Park also contained the greatest PPA per land area, with 23%, or 2,320 acres, of PPA.

Redington Shores had 12% UTC, the lowest of all municipalities. This translates to 25 acres of tree canopy within the town's boundary.

URBAN TREE CANOPY CHANGE BY MUNICIPALITIES

Dividing the urban tree canopy change results by the County's municipal boundaries offered some additional insights as to how Pinellas County's canopy has changed between 2010 and 2021. While canopy gains occurred in all municipalities, the greatest percentage of canopy gains occurred in two of the smaller municipalities: Belleair Shore and Indian Shores. Belleair Shore's canopy increased by 21% within its small area of approximately 30 acres. Indian Shore, with 204 of land acres, increased its canopy coverage by 14%. Unincorporated areas increased 5,688 acres of tree canopy. Larger cities such as St. Petersburg and Clearwater, also had significant gains, adding 2,191 acres (+6%) and 1,145 acres (+7%), respectively, over the 11-year period.

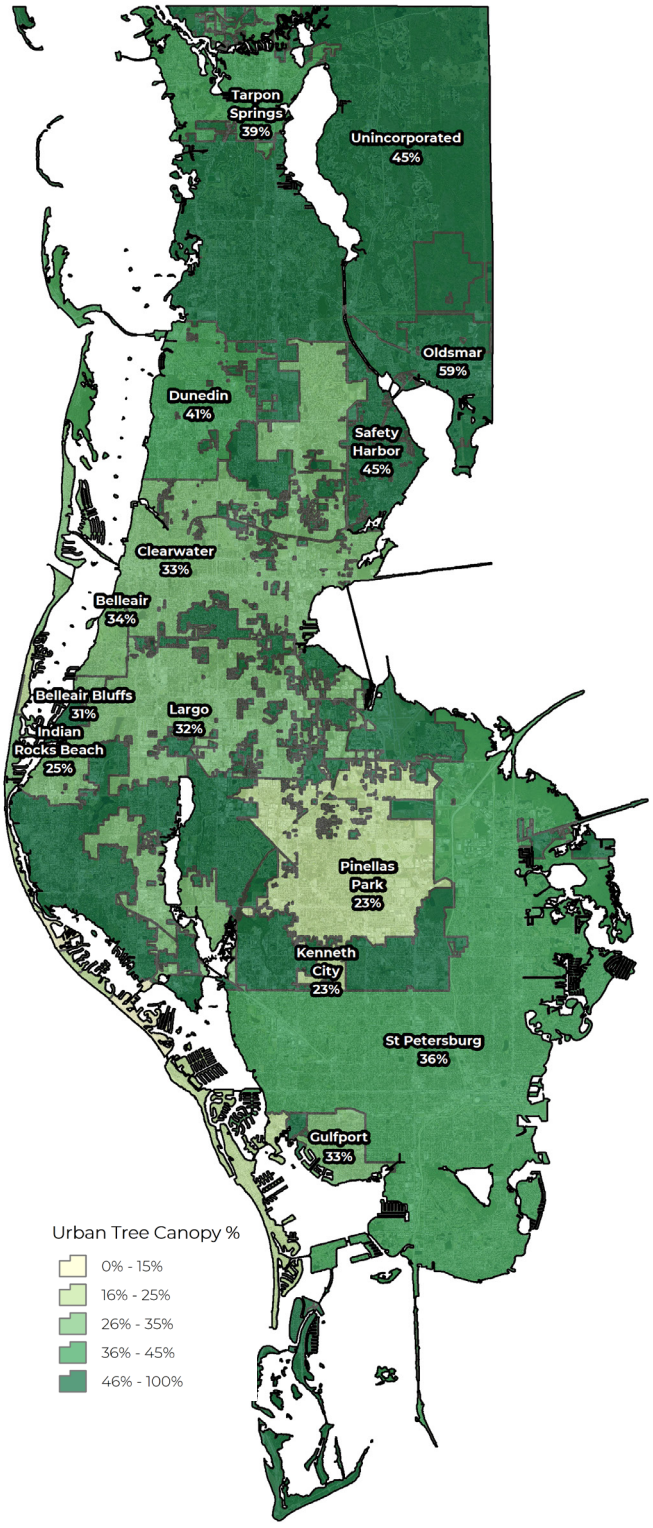


Figure 12. Urban tree canopy percentages in Pinellas County's municipalities.

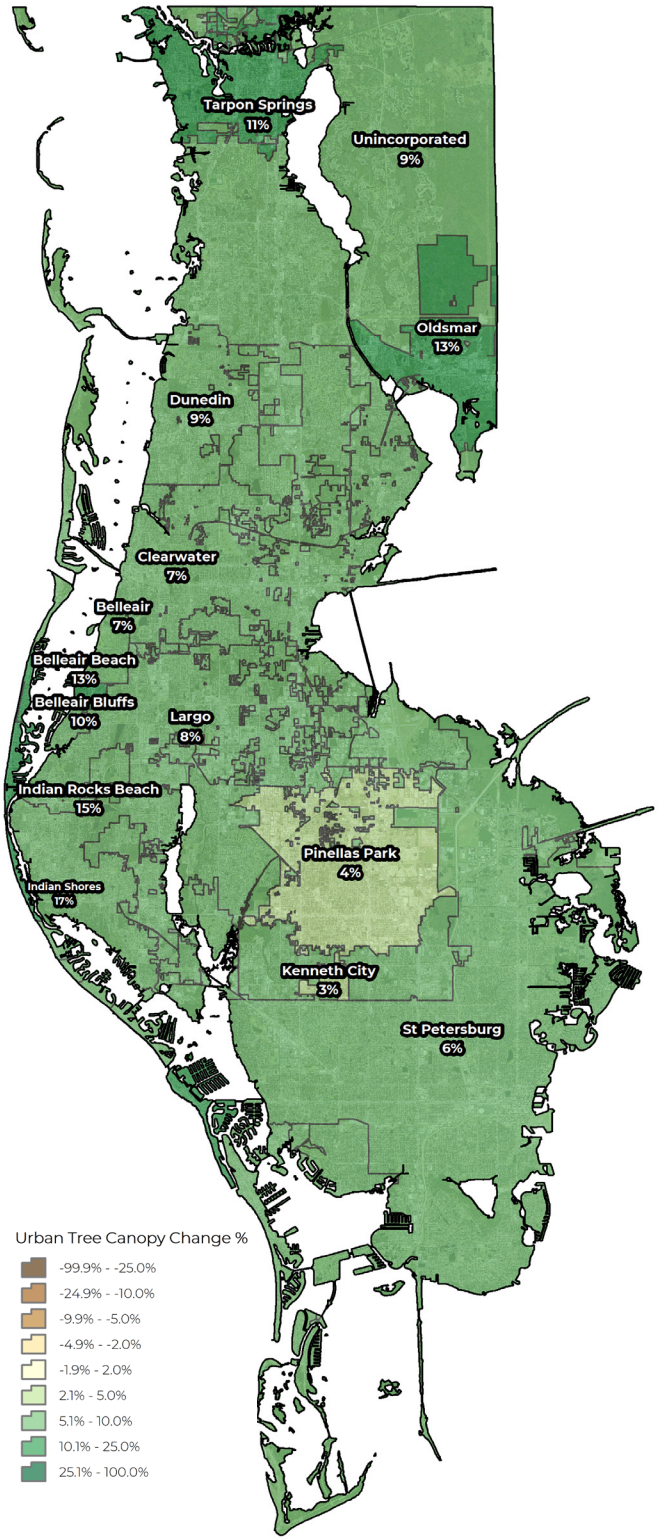


Figure 13. Urban tree canopy change percentages in Pinellas County's municipalities.

URBAN TREE CANOPY BY WATER BASINS

Due to their benefits for regulating stormwater runoff, reducing flooding, and maintaining a healthy water cycle, urban tree canopy metrics were also assessed by water basins. Trees planted within these areas can help to intercept and absorb stormwater runoff that may otherwise carry unhealthy pollutants into Tampa Bay and the Gulf of Mexico. 63 water basins cover Pinellas County. Brooker Creek basin had the highest tree canopy per land area with 71% UTC. These 7,020 acres of canopy contributed 11% to the county's entire tree canopy - the most of any basin. Hillsborough County basin had the lowest tree canopy percent with 9% UTC, but this basin also contained the greatest proportion of PPA with 71%. Anclote River basin had the highest distribution of PPA across the county, with 7%, or 2,154 acres of plantable space. Joe's Creek and Roosevelt Creek basins followed closely behind with 6% of the entire county's PPA.

URBAN TREE CANOPY CHANGE BY WATER BASINS

All 63 water basins experienced increases to tree canopy acreage. Clearwater Harbor North basin had the largest percent increase of tree canopy, sustaining a 21% gain. The second and third highest gains occurred in St. Joseph Sound basin and Hillsborough County basin, where tree canopy increased by 17% and 14%, respectively.

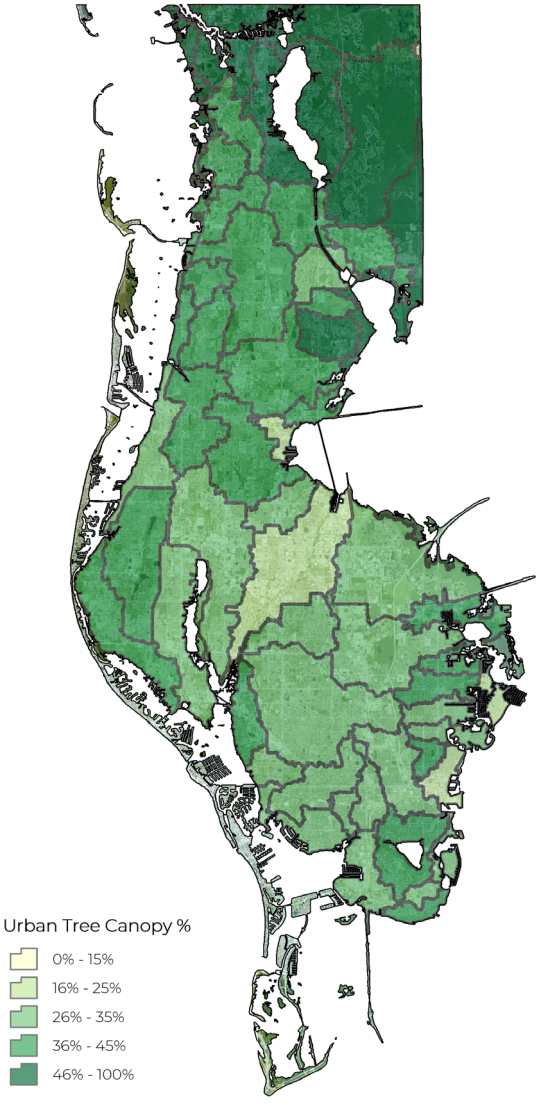


Figure 14. Urban tree canopy by Pinellas County's water basins.

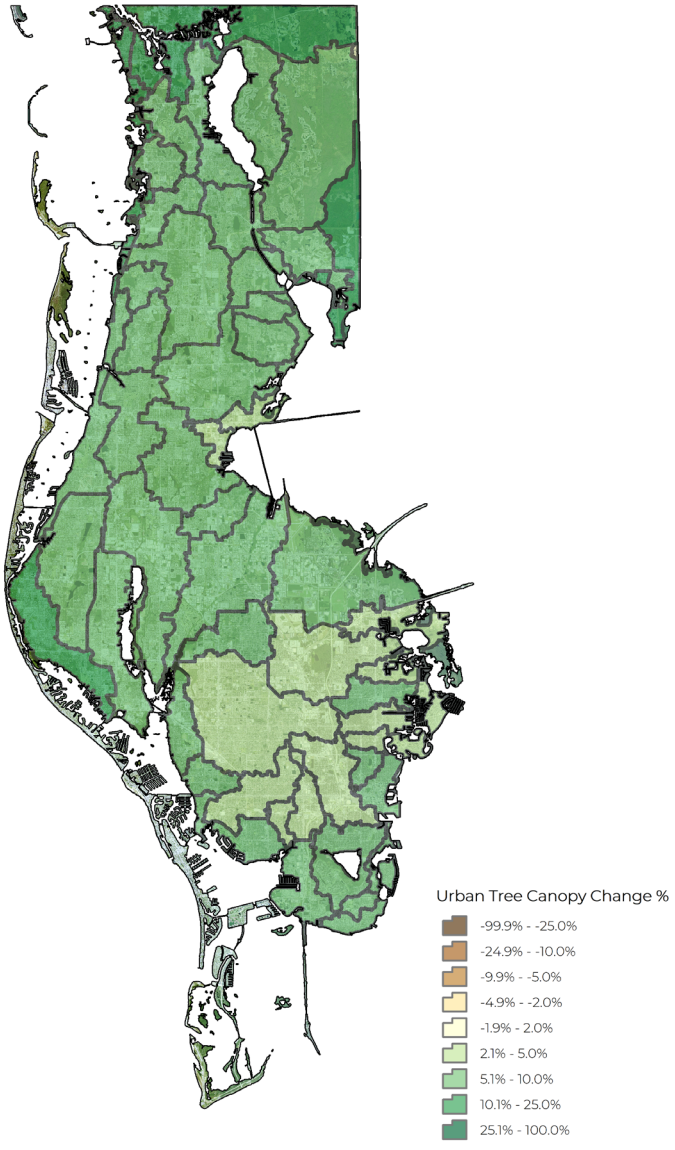


Figure 15. Urban tree canopy change by Pinellas County's water basins.

URBAN TREE CANOPY BY CENSUS BLOCK GROUPS

UTC and PPA were assessed at the census block group level. Census block groups are divisions of census tracts, and bound census blocks. Block groups are the second smallest geographic unit of measure at which the U.S. Census publishes statistical data within a state and represents between 600 and 3,000 people. Census block groups are particularly valuable for assessing the equitable distribution of tree canopy throughout the county, as they are linked to demographic and socio-economic data.

Results indicated that more than half of Pinellas County's 737 census block groups contained greater than 30% canopy cover. Only 14 census block groups contained between 0 and 10% canopy cover. Most census block groups had between 10-20% and 20-30% PPA. Only one census block group exceeded 40% PPA.

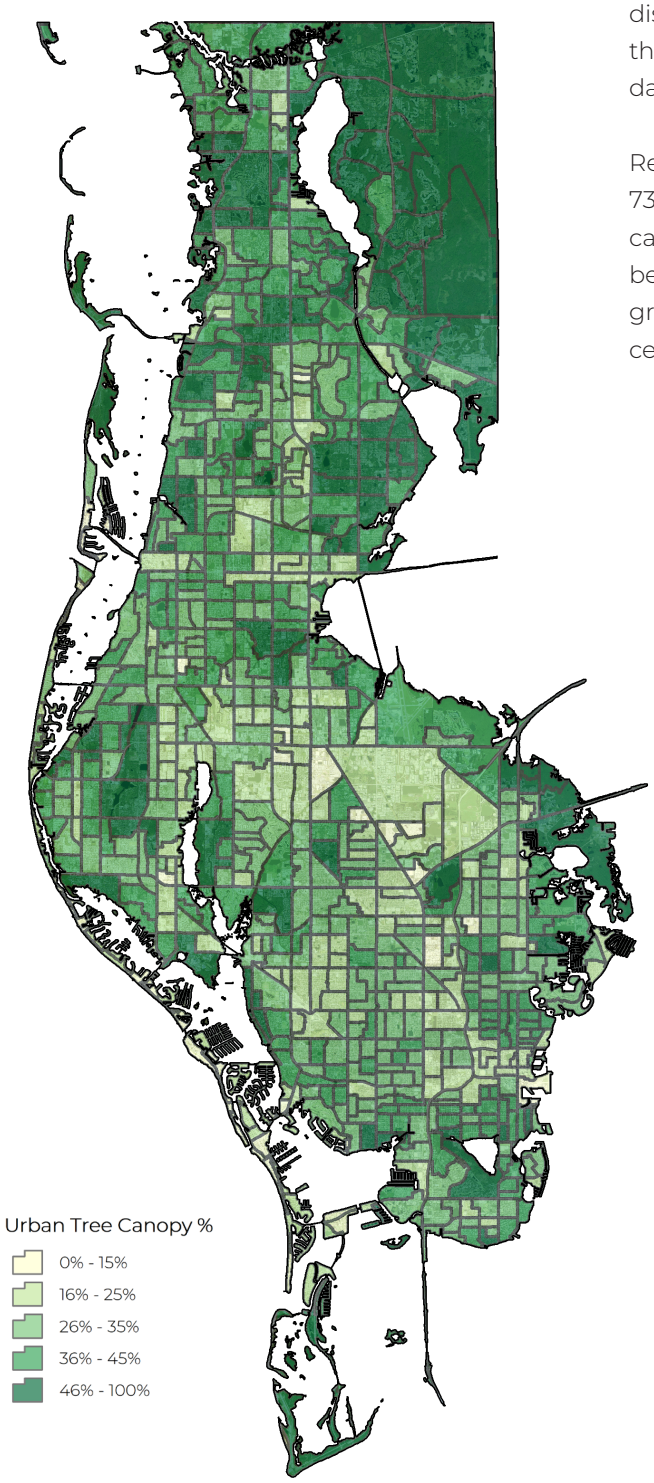


Figure 18. Urban tree canopy by Pinellas County's census block groups.

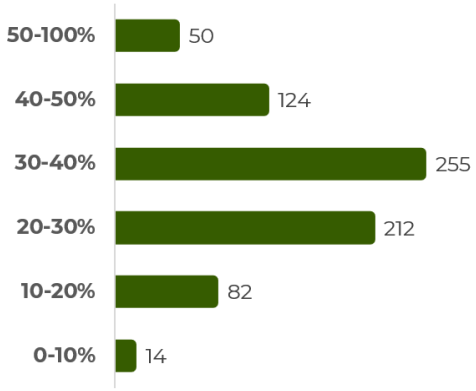


Figure 16. Number of census block groups with percent canopy cover ranges.

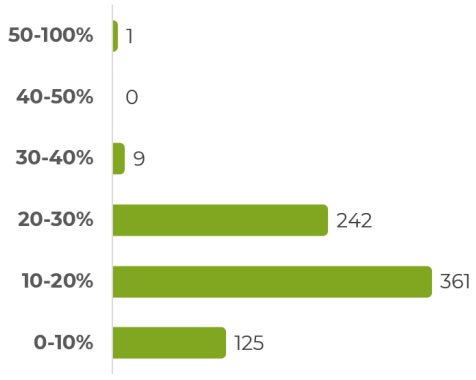


Figure 17. Number of census block groups with percent possible planting area ranges.

URBAN TREE CANOPY CHANGE BY CENSUS BLOCK GROUPS

Of Pinellas County's 737 census block groups, 12 experienced a UTC gain of 20% or more. The highest change within a single census block group was +28%. Only a total of 12 census block groups experienced any loss of tree canopy over the study period. The greatest decrease within a block group was -9%. Due to the small area of these boundaries, the 9% decrease translated to approximately 10 acres lost. Greater gains in canopy were generally distributed to the northeast and west areas of Pinellas County.

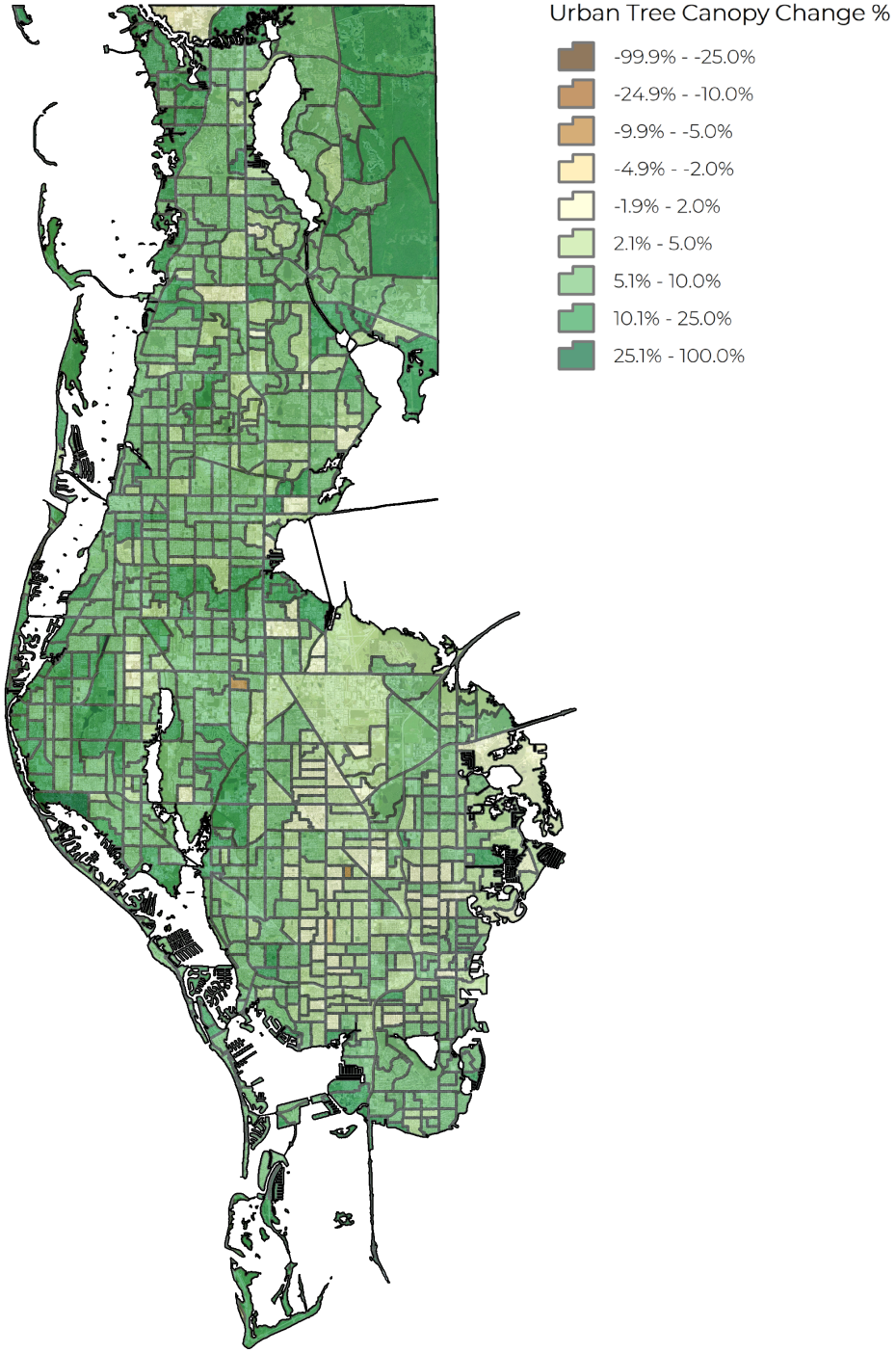


Figure 19. Urban tree canopy change by Pinellas County's census block groups.

ASSESSMENT OF ECOSYSTEM BENEFITS

Using the best available science from i-Tree tools, values were calculated for some of the benefits and functions provided by the urban tree canopy in Pinellas County, and its unincorporated areas. The urban forest holds millions of dollars of savings in avoided infrastructure costs, pollution reduction, and stored carbon. The following values were calculated using the USDA Forest Service's i-Tree Landscape tool with countywide and unincorporated total acres of urban tree canopy as the input data.

AIR QUALITY

Trees produce oxygen, indirectly reduce pollution by lowering air temperature, and improve public health by reducing air pollutants which cause death and illness. The existing tree canopy in Pinellas County removes approximately 5,820,000 pounds of air pollution annually, valued at over $43 million. The tree canopy within the unincorporated areas alone removes approximately 2,487,00 pounds of air pollution annually, valued at over $18 million.

STORMWATER AND WATER QUALITY

Trees and forests mitigate stormwater runoff which minimizes flood risk, stabilizes soil, reduces sedimentation in streams and riparian land, and absorbs pollutants, thus improving water quality and habitats. The countywide tree canopy absorbs 1.9 billion gallons of water per year, and canopy in unincorporated areas absorbs 813 million gallons of water per year. This means that unincorporated area' s tree canopy contributes $7.2 million to the overall county's $17,000,000 annually in stormwater benefits.

CARBON STORAGE AND SEQUESTRATION

Trees accumulate carbon in their biomass; with most species in a forest, the rate and amount increase with age. Pinellas County's trees store approximately 5 billion pounds of carbon, valued at over $430 million, and each year the tree canopy absorbs and sequesters approximately 261 million pounds of carbon dioxide, valued at over $22 million. Unincorporated areas store approximately 1 million tons of carbon ($183 million) and absorbs and sequesters approximately 55,000 tons of carbon dioxide ($9.5 million).

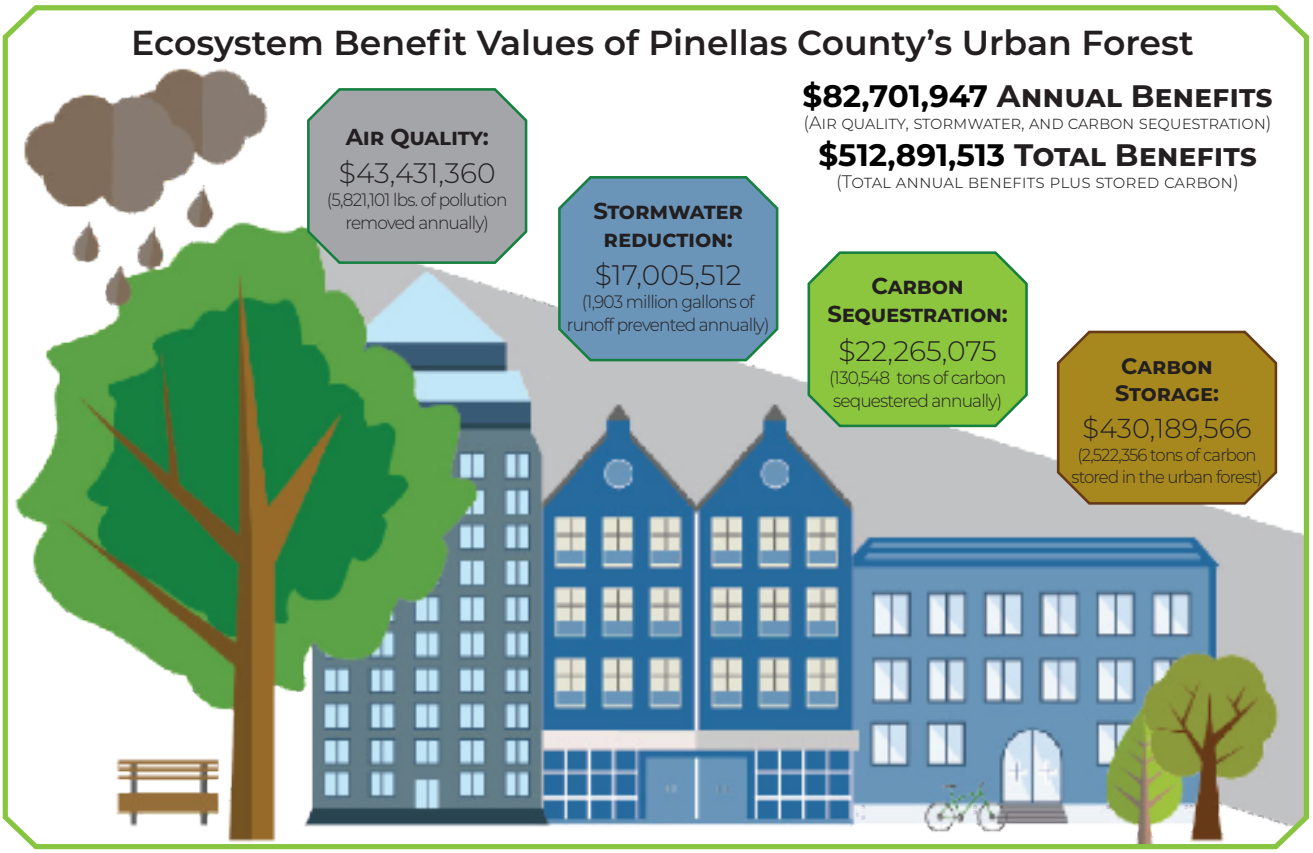


Figure 20. Eco-benefits of Pinellas County's urban forest.

TREE PLANTING

PRIORITIZATION

PRIORITIZATION CRITERIA DESCRIPTIONS

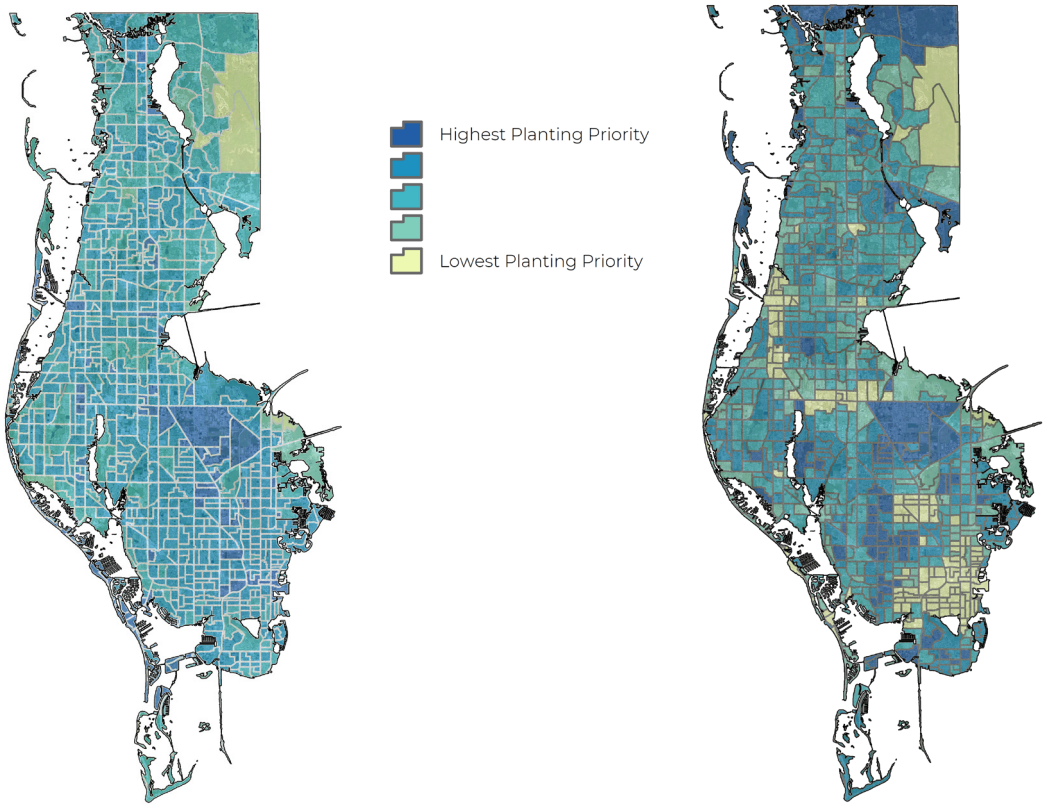
Urban tree canopy supplies a multitude of direct and indirect benefits. To provide the most complete understanding of where those benefits are lacking, tree planting priorities were identified based on environmental, socio-demographic, and public health data sets.

Tree planting prioritization ranking is needs-based and designed to rank census block groups on each area's need for a particular benefit that trees can provide. Rankings are sorted from highest priority (dark blue) to lowest priority (light yellow) and were calculated for each individual criteria as well as overall to show where multiple needs overlap. Viewing combined ranks show where tree canopy benefits can have the greatest impact by addressing multiple needs.

LAND COVER

- **Areas with Low Existing Tree Canopy:** This indicator highlights census block groups with low percentages of existing canopy cover. This criterion prioritizes areas with higher percentages of area that are not covered by tree canopy.

- **Possible Urban Tree Canopy:** Identifying areas that can support tree plantings is the first step to expanding urban tree canopy cover in the future. This indicator shows the percentage of total area available for planting within each census block group. This criterion prioritizes areas with higher percentages of possible planting areas.

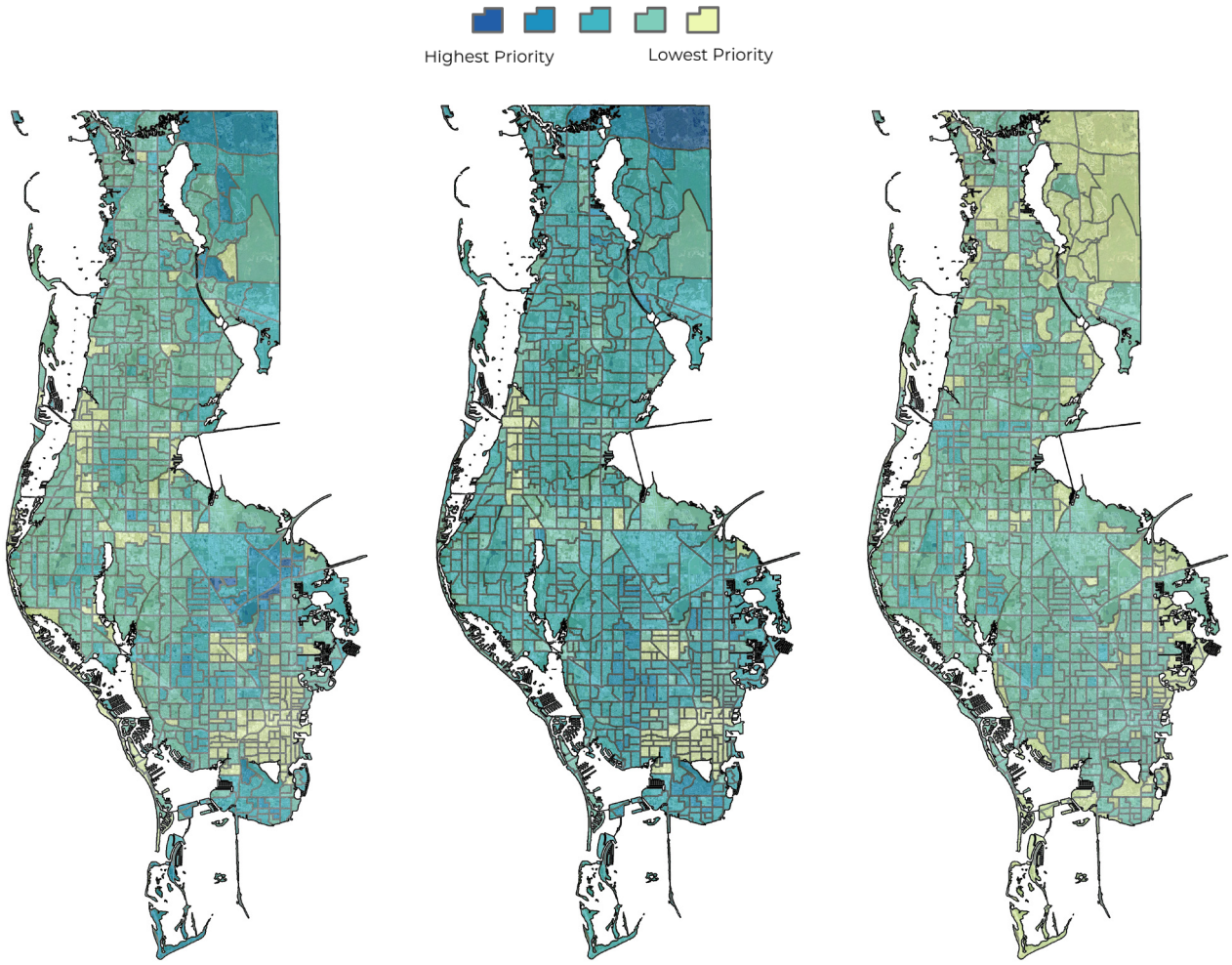


Low Existing Tree Canopy

Possible Urban Tree Canopy

LAND USE

- **Right-of-Way:** Trees planted along roads provide valuable benefits to improve air quality, reduce stormwater, and calm traffic. This criterion highlights census block groups with a greater amount of plantable space within the right-of-way as high priority for tree planting.



Right-of-Way **Stormwater Reduction** **Urban Heat Island**

ENVIRONMENTAL

- **Stormwater Reduction:** This indicator uses available planting area within 100 feet of all surface water bodies and impervious surfaces to identify areas with plantable space that will reduce stormwater runoff. Areas with high PPA close to water bodies and impervious surfaces were considered high priority planting areas.

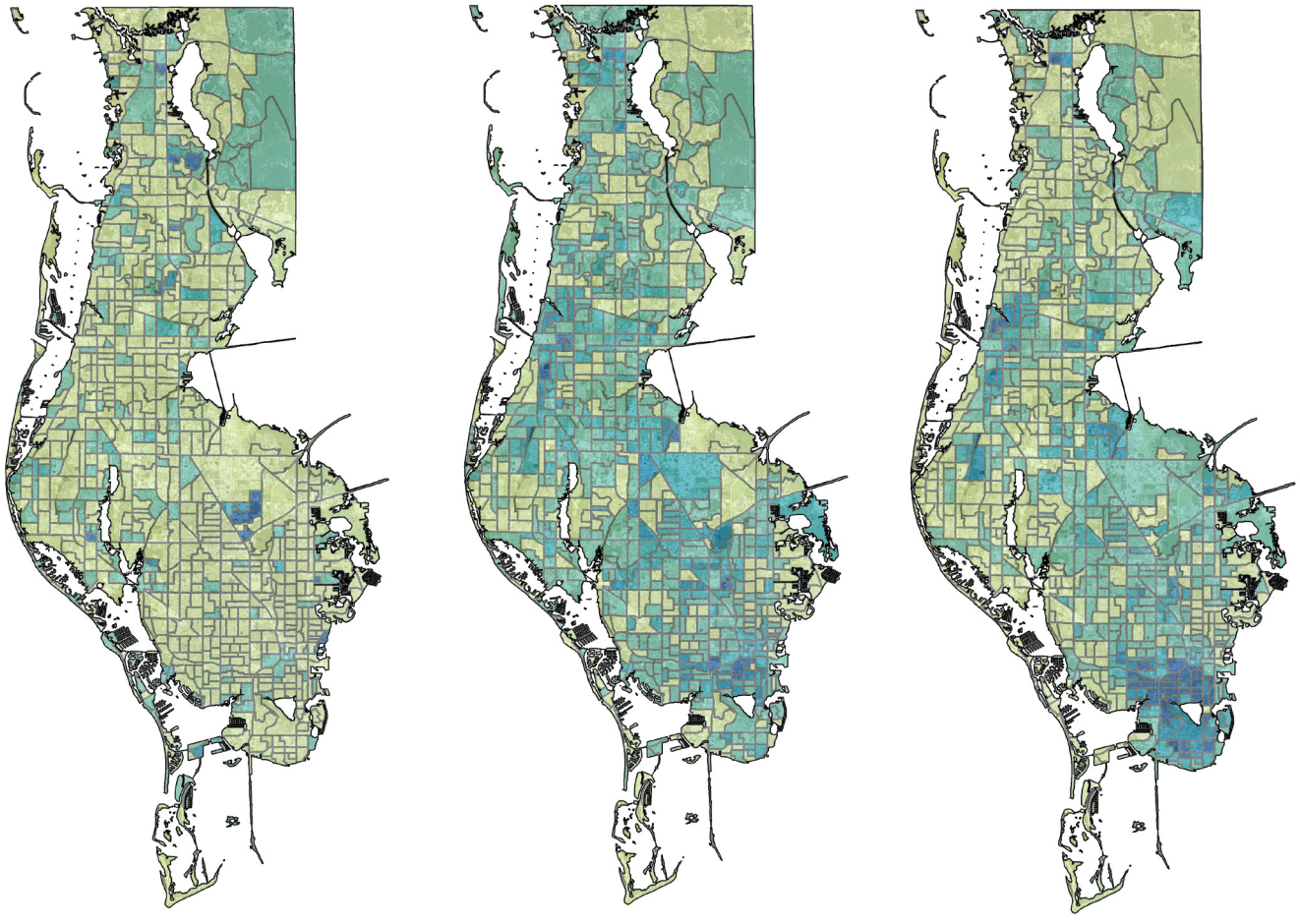
- **Urban Heat Island:** The average relative heat severity value within each feature. Urban heat severity data from the Trust for Public Land derived using the thermal band of a Landsat 8 satellite image were used. Areas with hotter surface temperatures were considered high priority for tree planting.

SOCIO-DEMOGRAPHIC

- **Vulnerable Populations:** Trees provide many environmental and health benefits to its residents. This indicator shows the ratio of residents under the age of 18 or over the age of 65 compared to the working-age population. This criterion prioritizes areas with larger ratios of vulnerable populations.

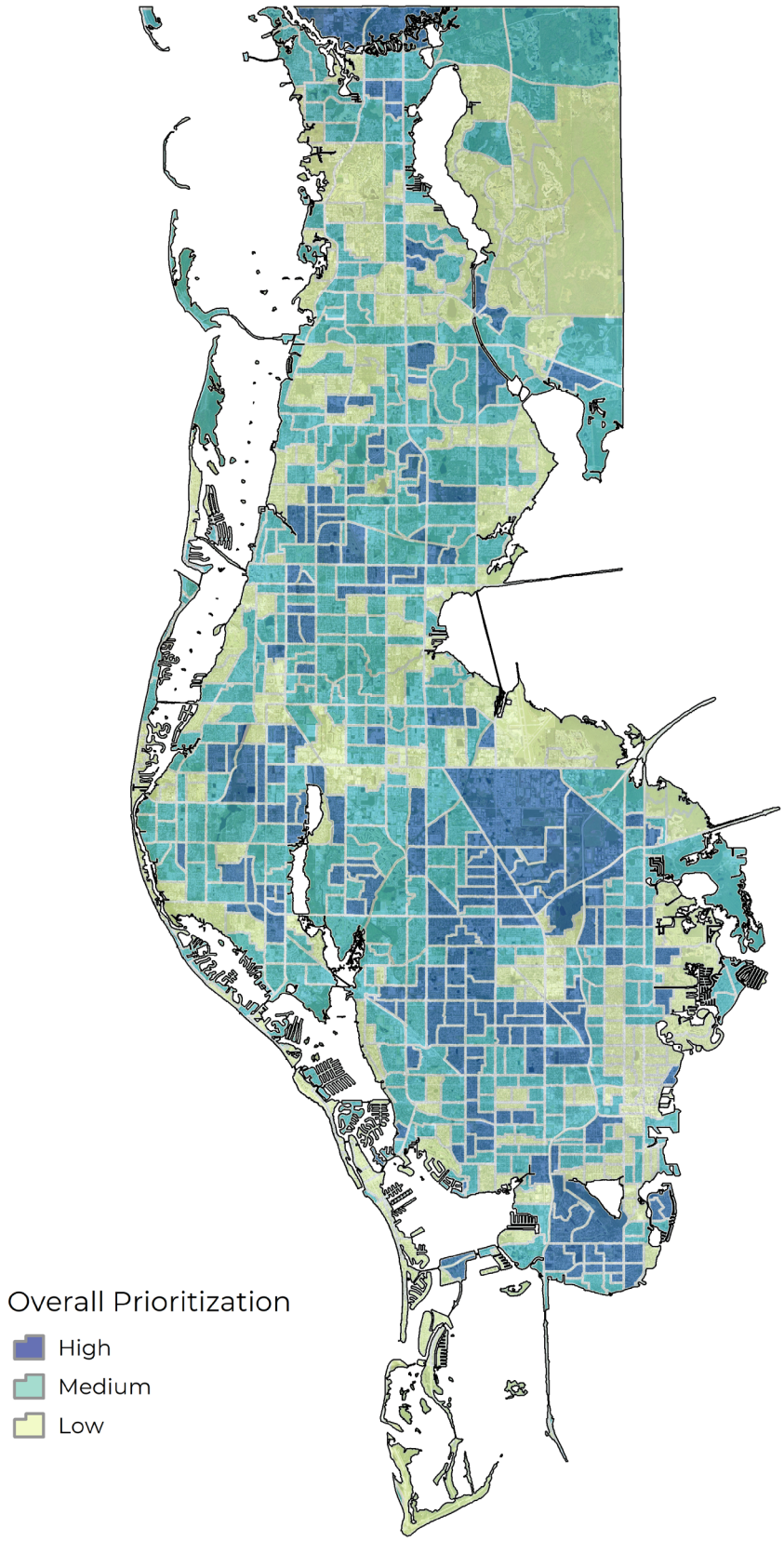
- **Underserved Populations:** Income inequality often occurs with environmental inequality where lower-income residents live in highly impervious areas with limited numbers of trees, parks, and other greenspaces. This criterion shows the percentage of residents living below the poverty level, as reported by the U.S. Census American Community Survey 5-year estimates. Areas with the highest percent of residents below poverty level were considered high priority for planting.

- **People of Color Populations:** Tree canopy is often negatively correlated with the percentage of residents of color. Planting trees in communities with higher percentages of people of color can support environmental equity. The greater percent of people of color within a census block group, the higher the planting priority.



Vulnerable Populations **Underserved Populations** **People of Color**

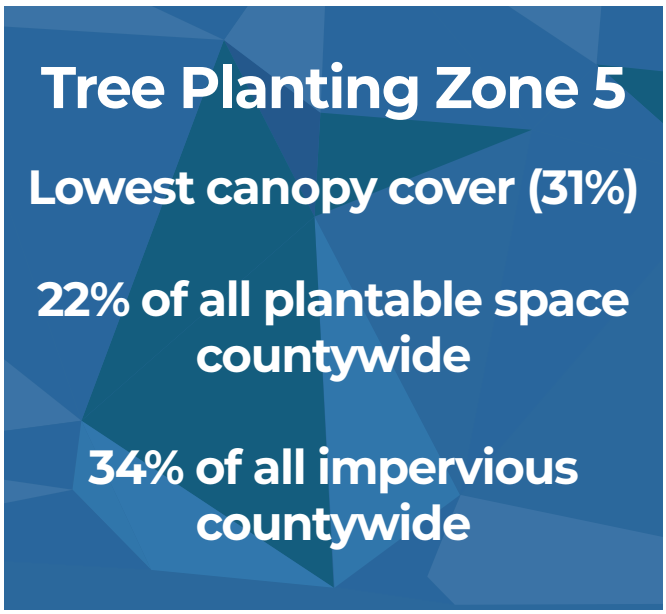
- **Overall:** The overall suitability for tree planting score based on an equally weighted formula that includes all planting prioritization categories. The weights of priority criteria can be adjusted and customized with the TreePlotter™ CANOPY application.



Overall Prioritization

CONCLUSIONS AND RECOMMENDATIONS

Pinellas County has demonstrated that it values its natural resources and wants to maintain a healthy and sustainable urban environment. Recurring assessments of the county's tree canopy represent important steps in ensuring the long-term health of its urban forest. A greater percent of canopy cover can be achieved with proper planning, investment, and care of existing trees. The County should continue to monitor the health of the urban forest and implement the following recommendations to ensure the urban forest is considered during future county planning and development to sustain and enhance the benefits that trees provide to the community.



To preserve, protect, and maintain Pinellas County's tree canopy, the County should continue to have a tree canopy assessment performed at regular intervals through a TreePlotter™ CANOPY subscription or continuing regular projects. As the County grows, they will be able to use these data to ensure that their urban forest policies and management practices prioritize its maintenance, health, and growth. The County's urban forest provides Pinellas County with a wealth of environmental, social, and even economic benefits which relate back to greater community pride and interest in countywide initiatives and priorities. These results can be used to identify where existing tree canopy cover should be preserved, where there are opportunities to continue to expand the County's canopy cover, and which areas would receive the greatest benefits from the investment of valuable time and resources into Pinellas County's urban forest.

1. Leverage the results of this assessment to promote the urban forest

The results of this assessment should be used to encourage investment in urban forest monitoring, maintenance, and management; to prepare supportive information for local budget requests/grant applications; and to develop targeted presentations for county leaders, planners, engineers, resource managers, and the public on the functional benefits of trees in addressing environmental issues. The land cover, tree canopy, and urban tree canopy change data should be disseminated to diverse partners for urban forestry and other applications while the data are current and most useful for decision-making and implementation planning. The information from this study can help establish new canopy cover goals for the short- and long-term to continue to expand Pinellas County's urban forest.

2. Use the urban tree canopy change data to identify areas to prioritize canopy expansion

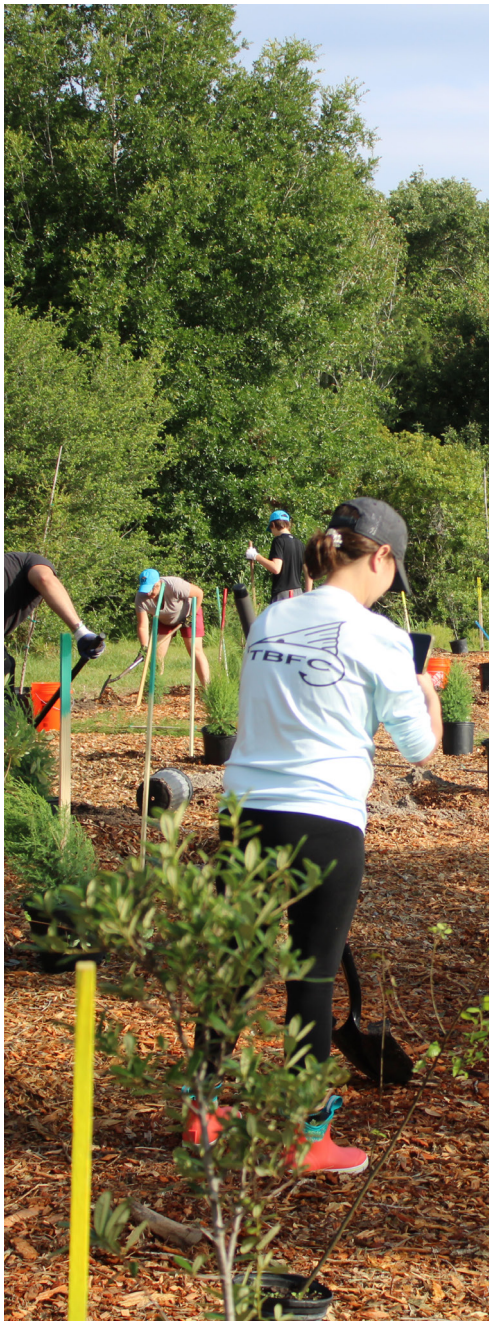
The County and its various stakeholders can utilize the results of the UTC, PPA, and urban tree canopy change analyses to identify the best locations within municipalities and unincorporated areas to focus future tree planting and canopy expansion efforts. Trees can play a large role in improving public health by improving air quality, reducing temperatures, and addressing climate change. The County can acquire parcels for public use as part of redeveloped neighborhoods to be used as carbon sinks to address community access to nature, climate, human health, and equity. Plantable space in the right-of-way is often found close to high concentrations of impervious surfaces. Focus on planting the right tree in the right place and planting large-species trees where appropriate to maximize ecosystem services. Planting trees near impervious surfaces can offset the urban heat island effect, stormwater runoff, and energy consumption. The priority

planting analysis should be used to identify planting opportunities adjacent to high concentrations of impervious surfaces in these areas. The County can continue to improve their street tree maintenance program within the county's unincorporated rights-of-way, ensuring healthy trees are distributed equitably across the county.

38%
OF ALL PLANTABLE SPACE IN PINELLAS COUNTY IS LOCATED IN UNINCORPORATED AREAS

3. Develop outreach programs towards private landowners

In Pinellas County, 38% of PPA is found in unincorporated areas outside of local municipality jurisdiction. The County should focus on community outreach and education programs to better inform citizens and private landholders in these areas and elsewhere of the environmental, health, social, and financial benefits that trees provide and consider other strategies to help preserve existing trees and grow the tree canopy in the nearly 11,705 acres of plantable space within its unincorporated boundaries. The County should explore options to develop grant programs for tree maintenance or removal of hazard or invasive trees on private property to remove barriers for overburdened communities which lack tree canopy. Tree giveaways, tree planting programs, and tree maintenance events can help to promote new tree plantings. To promote new plantings, expand the partnership with local contractors to plant more trees on redeveloped or newly developed property focusing on low-canopy and underserved neighborhoods. The County should also continue to develop partnerships with Community Based Organizations and individual champions throughout neighborhoods to build stewardship at the community level. In addition, the County should continue to conduct volunteer tree planting and tree maintenance events to increase awareness levels in the community.



4. Use TreePlotter to identify areas in need of tree canopy, prioritize planting efforts, and continue to monitor the urban forest

To maximize impact, see greater return on investment, and provide the greatest number of benefits to the community, we recommend that the County focus planting and management efforts in areas with high weighted priority rankings. Planting priority maps and data, displayed in TreePlotter™ CANOPY, show land cover metrics and the areas of highest priority collectively and individually for all planting prioritization criteria. The County should also use the GIS data provided to create unique weighted scenarios to focus efforts in targeted areas that meet specific criteria. For instance, the County could find areas that have both low UTC and high PPA or would offer the greatest benefits to improving air quality and reducing summertime temperature. Focusing urban forest management resources on expanding and maintaining tree canopy in areas like these will have positive impacts on multiple factors that the County has deemed important. Efforts should focus on outreach to the residents of these neighborhoods, as well as local business and landowners, in order to promote new tree plantings and continued maintenance of existing trees.

REPORT

APPENDIX

ACCURACY ASSESSMENT

Classification accuracy serves two main purposes. Firstly, accuracy assessments provide information to technicians producing the classification about where processes need to be improved and where they are effective. Secondly, measures of accuracy provide information about how to use the classification and how well land cover classes are expected to estimate actual land cover on the ground. Even with high resolution imagery, very small differences in classification methodology and image quality can have a large impact on overall map area estimations.

The classification accuracy error matrix illustrated in Table A1 contain confidence intervals that report the high and low values that could be expected for any comparison between the classification data and what actual, on the ground land cover was in 2021. This accuracy assessment was completed using high resolution aerial imagery, with computer and manual verification. No field verification was completed.

THE INTERNAL ACCURACY ASSESSMENT WAS COMPLETED IN THESE STEPS:

1. Seven hundred fifty sample points, or approximately 3 points per square mile area in Pinellas County (281 sq. miles), were randomly distributed across the study area and assigned a random numeric value.
2. Each sample point was then referenced using the NAIP aerial photo and assigned one of five generalized land cover classes ("Ref_ID") mentioned above by a technician.
3. In the event that the reference value could not be discerned from the imagery, the point was dropped from the accuracy analysis. In this case, no points were dropped.
4. An automated script was then used to assign values from the classification raster to each point ("Eval_ID"). The classification supervisor provides unbiased feedback to quality control technicians regarding the types of corrections required. Misclassified points (where reference ID does not equal evaluation ID) and corresponding land cover are inspected for necessary corrections to the land cover.[1]
5. Accuracy is re-evaluated (repeat steps 3 & 4) until an acceptable classification accuracy is achieved.

SAMPLE ERROR MATRIX INTERPRETATION

Statistical relationships between the reference pixels (representing the true conditions on the ground) and the intersecting classified pixels are used to understand how closely the entire classified map represents Pinellas County's landscape. The error matrix shown in Table A1 represent the intersection of reference pixels manually identified by a human observer (columns) and classification category of pixels in the classified image (rows). The blue boxes along the diagonals of the matrix represent agreement between the two-pixel maps. Off-diagonal values represent the number of pixels manually referenced to the column class that were classified as another category in the classification image. Overall accuracy is computed by dividing the total number of correct pixels by the total number of pixels reported in the matrix (274 + 151 + 271 + 8 + 18 = 722 / 750= 96%), and the matrix can be used to calculate per class accuracy percentages. For example, 274 points were manually identified in the reference map as Tree Canopy, and 284 of those pixels were classified as Tree Canopy in the classification map. This relationship is called the "Producer's Accuracy" and is calculated by dividing the agreement pixel total (diagonal) by the reference pixel total (column total). Therefore, the Producer's Accuracy for Tree Canopy is calculated as: (274/284 = .965), meaning that we can expect that ~96% of all 2021 tree canopy in Pinellas County, FL study area was classified as Tree Canopy in the 2021 classification map.

Conversely, the "User's Accuracy" is calculated by dividing the total number of agreement pixels by the total number of classified pixels in the row category. For example, 274 classification pixels intersecting reference pixels were classified as Tree Canopy, but 5 pixels were identified as Vegetation and 3 were identified as impervious in the reference map. Therefore, the User's Accuracy for Tree Canopy is calculated as: (274/282 = 0.972), meaning that ~97% of the pixels classified as Tree Canopy in the classification were actual tree canopy. It is important to recognize the Producer's and User's accuracy percent values are based on a sample of the true ground cover, represented by the reference pixels at each sample point. Interpretation of the sample error matrix results indicates this land cover, and more importantly, tree canopy, were accurately mapped in Pinellas County in 2021. The largest sources of classification confusion exist between tree canopy and vegetation.

1 Note that by correcting locations associated with accuracy points, bias is introduced to the error matrix results. This means that matrix results based on a new set of randomly collected accuracy points may result in significantly different accuracy values.

Table A1. | Error matrix for land cover classifications in Pinellas County, FL (2021).

Classification Data	Reference Data: Tree Canopy	Vegetation	Impervious	Soil / Dry Veg.	Water	Total Reference Pixels
Tree Canopy	274	5	3	0	0	282
Vegetation	4	151	8	0	0	163
Impervious	6	1	271	0	0	278
Soil / Dry Veg.	0	0	0	8	0	8
Water	0	1	0	0	18	19
Total	284	158	282	8	18	750

Overall Accuracy = 96%

Producer's Accuracy	
Tree Canopy	96%
Veg. / Open Space	96%
Impervious	96%
Bare Ground / Soil	100%
Water	100%

User's Accuracy	
Tree Canopy	97%
Veg. / Open Space	93%
Impervious	97%
Bare Ground / Soil	100%
Water	95%

ACCURACY ASSESSMENT RESULTS

Interpretation of the sample error matrix offers some important insights when evaluating Pinellas County's urban tree canopy coverage and how well aligned the derived land cover data are with interpretations by the human eye. The high accuracy of the 2021 data indicates that regardless of how and when it was achieved, Pinellas County's current tree canopy can be safely assumed to match the figures stated in this report (approximately 37%).

GLOSSARY/KEY TERMS

Land Acres: Total land area, in acres, of the assessment boundary (excludes water).

Non-Canopy Vegetation: Areas of grass and open space where tree canopy does not exist.

Possible Planting Area - Vegetation: Areas of grass and open space where tree canopy does not exist, and it is biophysically possible to plant trees.

Soil/Dry Vegetation: Areas of bare soil and/or dried, dead vegetation.

Total Acres: Total area, in acres, of the assessment boundary (includes water).

Unsuitable Impervious: Areas of impervious surfaces that are not suitable for tree planting. These include buildings and roads and all other types of impervious surfaces.

Unsuitable Planting Area: Areas where it is not feasible to plant trees. Airports, ball fields, golf courses, etc. were manually defined as unsuitable planting areas.

Unsuitable Soil: Areas of soil/dry vegetation considered unsuitable for tree planting. Irrigation and other modifiers may be required to keep a tree alive in these areas.

Unsuitable Vegetation: Areas of non-canopy vegetation that are not suitable for tree planting due to their land use.

Urban Tree Canopy (UTC): The "layer of leaves, branches and stems that cover the ground" (Raciti et al., 2006) when viewed from above; the metric used to quantify the extent, function, and value of the urban forest. Tree canopy was generally taller than 10-15 feet tall.

Water: Areas of open, surface water not including swimming pools.

NOVEMBER | 2022

URBAN TREE CANOPY

ASSESSMENT

PINELLAS COUNTY, FLORIDA

Pinellas County

PlanIT Geo™
developers of TreePlotter