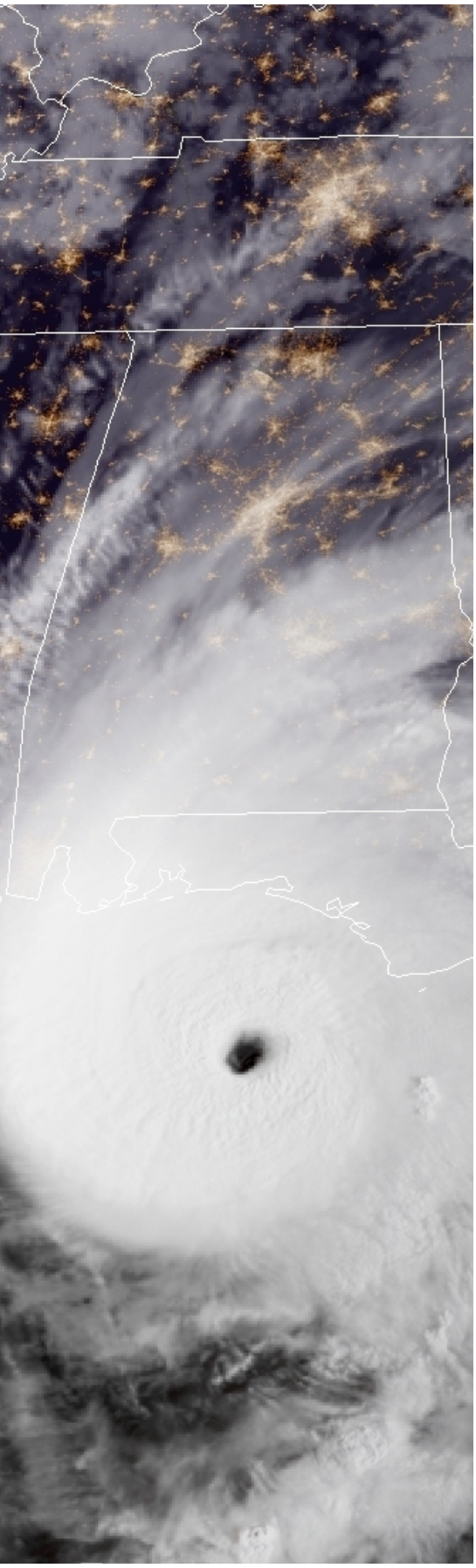
URBAN TREE CANOPY

ASSESSMENT

HURRICANE MICHAEL:
IMPACT IN FLORIDA
SEPTEMBER | 2021

FLORIDA FOREST SERVICE
Agriculture & Consumer Services

PLANIT GEO™
mapping a greener future



IMPACTS OF HURRICANE MICHAEL ON URBAN TREE CANOPY IN

FLORIDA COMMUNITIES

> **Someone is sitting in the shade today because someone planted a tree a long time ago.**
> **-Warren Buffet**

PREPARED BY
PlanIT Geo, Inc. Arvada, Colorado

PREPARED FOR
Florida Forest Service

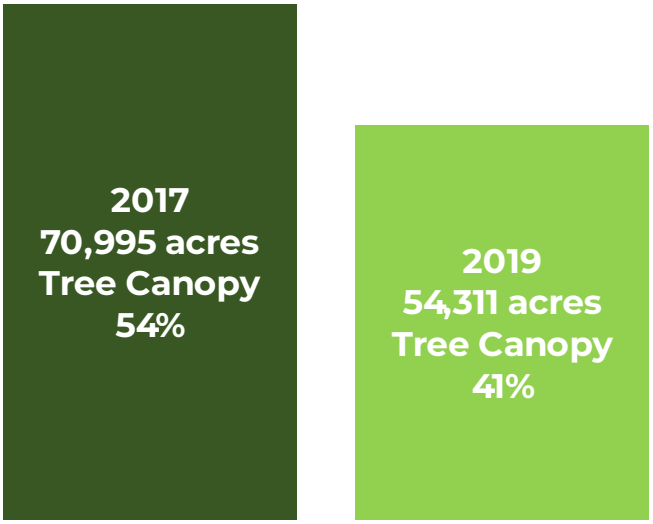
TABLE OF
CONTENTS

PROJECT INTRODUCTION

Hurricane Michael struck the Florida coast near Panama City as a category 5 hurricane on October 10, 2018. The hurricane caused significant damage to beaches, infrastructure, and trees along the Florida coast and inland, impacting a 13-county area in Florida. It was the first category 5 hurricane to make landfall in the continental United States since Hurricane Andrew in 1992. With wind speeds of 160 mph, Hurricane Michael was the third most powerful hurricane on record to strike Florida. Due to the high wind speeds, the storm had a particularly severe impact on trees near the coast and northeast along its path across the Florida panhandle and into southwest Georgia.

Ultimately, Michael caused roughly $25 billion worth of damage in the United States. Although the hardest hit areas were in the Florida panhandle near the coast, the storm caused significant damage to inland areas as well. Seven counties in particular: Bay, Calhoun, Franklin, Gadsden, Gulf, Jackson, Liberty, and Washington, experienced the most severe winds of the storm. 32 cities within those counties were included in the assessment area of this study. Cities were selected using on-the-ground observations and knowledge of the severity of the storm damage in combination with geospatial data of the hurricane's path and wind speeds. Generally speaking, this study looks at the damage that occurred in cities that experienced hurricane force winds, but several other cities that had significant damage are also included. Figure 1 shows the area that experienced hurricane force winds and cities selected for this assessment.

Urban Tree Canopy in the Study Area



With category 5 hurricanes and other damaging storms, there is often significant damage followed by an ongoing recovery period for the impacted areas. In recent years, earth observation tools have become available that can make recovery efforts more effective by providing more accurate, relevant, and timely information to decision makers. Urban tree canopy assessments were first developed in the early 2000's and, in the past 5-10 years, have become a key part of many cities' urban forest management strategies by providing increased understanding of the effectiveness of management activities and the impacts of pests, disease, development, and severe weather events on tree canopy.

Hurricane Michael is the first category 5 hurricane to make landfall in the continental U.S. since tree canopy assessments have become a common practice of urban forestry management. Michael was especially damaging to tree canopy in the impacted region, as results from this assessment show that 26 square miles of tree canopy, within the 217 square mile study area, were lost. This study also provides information to impacted communities that will assist in their recovery. Key information on income levels and racial and ethnic makeup of populations is highlighted to help urban forest managers locate the most important areas to focus their efforts. This project represents a novel approach to recovery efforts of urban tree canopy in storm-affected areas.

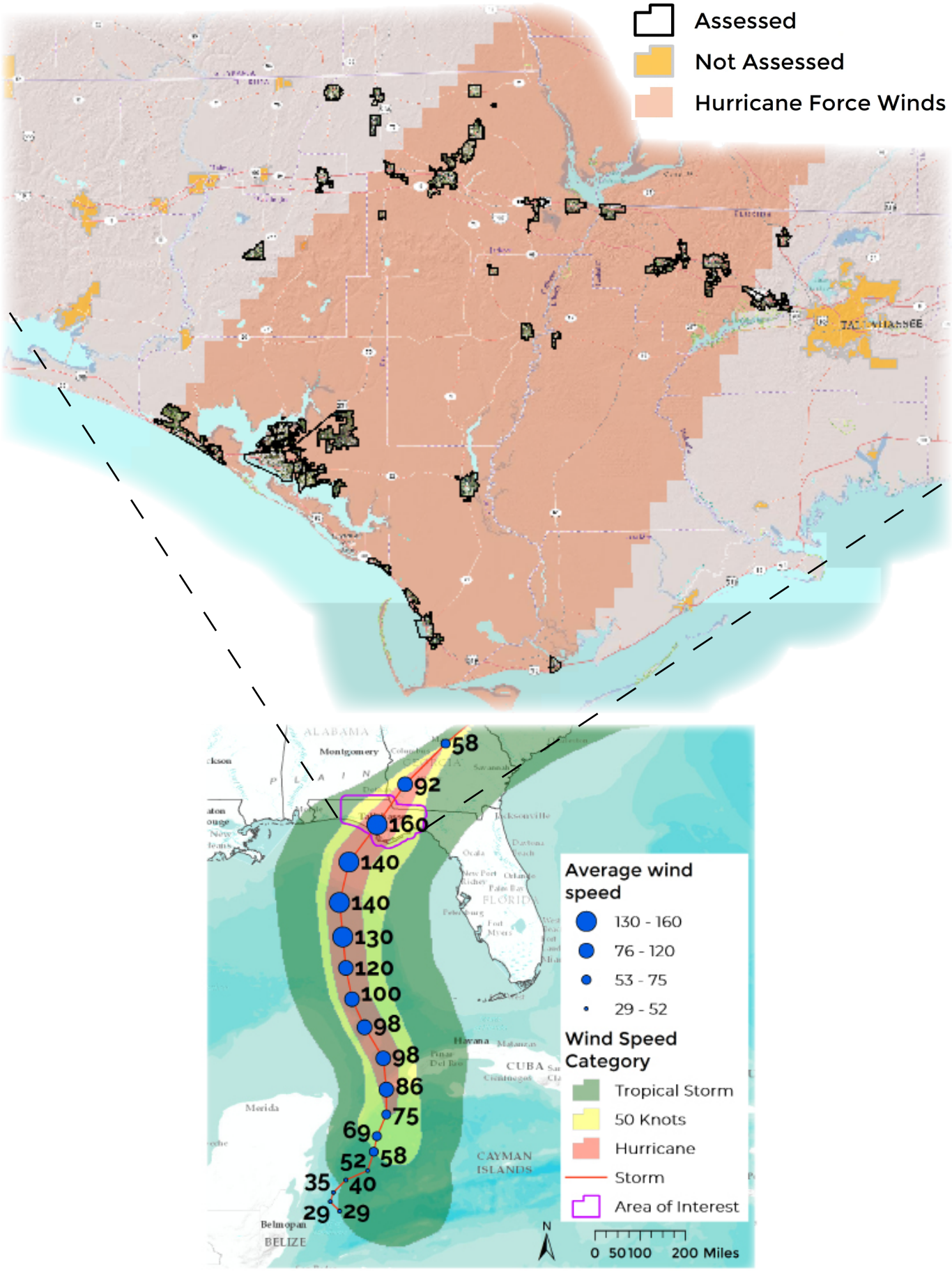


Figure 1. | Project area of interest and cities selected for assessment (top). Hurricane Michael storm path and wind speeds (bottom).

26%
OF PRE-STORM TREE CANOPY IN THE STUDY AREA LOST TO HURRICANE MICHAEL

-16,685
ACRES OF CANOPY

EXECUTIVE SUMMARY

The urban forest is a valuable asset providing residents and visitors with many environmental, social, and economic benefits. In 2018, Hurricane Michael caused severe damage to the Florida panhandle around Panama City and inland areas to the northeast extending into Georgia. The Urban and Community Forestry Grant from the USDA Forest Service as well as Hurricane Michael relief funds allowed the Florida Forest Service to embark on a project to establish the pre-storm tree canopy levels, identify the areas which lost the most canopy, and identify where suitable areas for new plantings exist.

This assessment mapped urban tree canopy (UTC), possible planting area (PPA), and tree canopy changes before and after Hurricane Michael to analyze how tree canopy within the cities most directly in the path of the storm was affected. In total, 32 cities were selected to be included in the Florida study area. The distribution of tree canopy throughout each city was assessed within watersheds, ZIP codes, and census block groups within the city boundary.

The results, based on 2019 and 2017 imagery from the USDA's National Agriculture Imagery Program (NAIP), provide pre- and post-storm information on the state of tree canopy and will allow each city and state managers to revise and develop existing and new strategies to restore, expand, and protect the urban forest. This study used a modern machine learning technique to create tree canopy data for both time periods with identical methods to allow for the most accurate comparison possible.

In 2019, the study area had 41% UTC cover and 36% PPA. not including any surface water bodies in the study area. In 2017, the study area had 54% UTC. In total, Hurricane Michael resulted in a 13% loss in UTC. The most populous city included in the assessment was Panama City which had 54% UTC in 2017 and 26% in 2019 a loss of 28%. The storm caused a 65% decrease of UTC in Mexico Beach and Parker.

To help further understand the distribution of pre- and post-storm tree canopy within the selected cities, UTC, PPA and UTC Change were analyzed within three geographic scales; ZIP codes, watersheds, and census block groups. These provide additional information on the distribution of tree canopy loss and plantable space to further assist city and state officials in their efforts to recover and restore lost tree canopy.

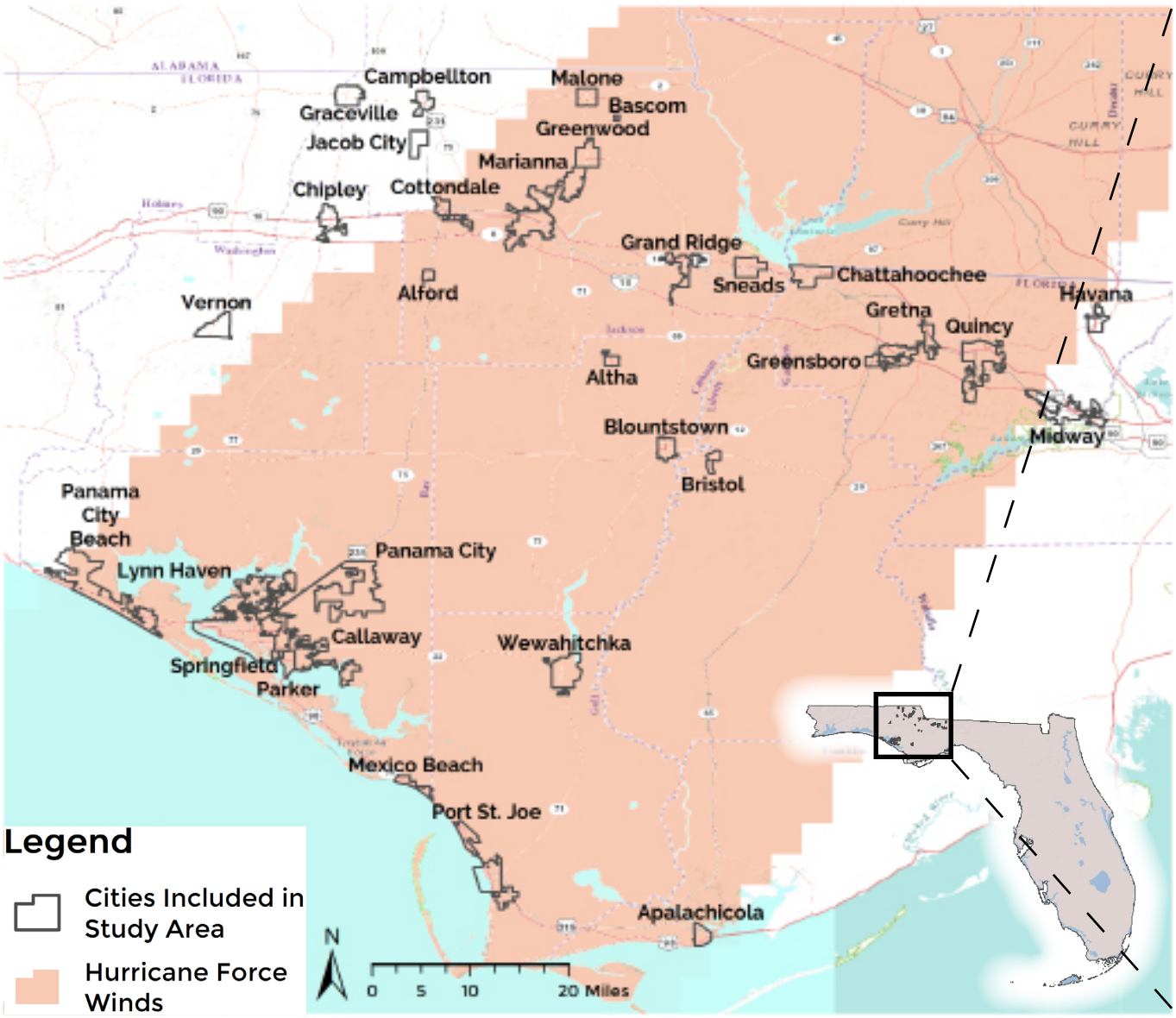


Figure 2. | The study area occupies approximately 217 square miles in the Florida panhandle.

41%
URBAN TREE CANOPY

36%
POSSIBLE PLANTING AREA

23%
UNSUITABLE PLANTING SURFACES

Figure 3. | Based on an analysis of 2019 high-resolution imagery, the study area contains 41% tree canopy, 36% areas that could support canopy in the future, and 23% other surfaces.

PROJECT METHODOLOGY

Urban tree canopy and possible planting areas were mapped using the sources and methods described below. These datasets provide the foundation for the metrics reported at the selected geographic assessment scales.

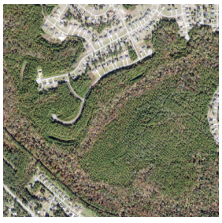
DATA SOURCES

This assessment utilized high-resolution (1-meter and 60-centimeter) multispectral imagery from the U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP), collected in 2017 and 2019, to derive the land cover data sets. The NAIP imagery was used to classify all types of land cover.

MAPPING LAND COVER

An initial land cover dataset was to be created prior to mapping tree canopy. The land cover data set is the most fundamental component of an urban tree canopy assessment. Tree canopy data from the EarthDefine US Tree Map (link: https://www.earthdefine.com/treemap/) were provided. The US Tree Map is produced using a modern machine learning technique to extract tree canopy cover and other land cover types from the highest resolution NAIP imagery. Additionally, an object-based image analysis (OBIA) software program called Feature Analyst was used to classify plantable space features through an iterative approach. In this process, objects' spectral signatures across four bands (blue, green, red, and near-infrared), textures, and pattern relationships were considered. This remote sensing process used the 2019 NAIP imagery to derive the vegetation classification. All surfaces not classified as vegetation or tree canopy were automatically classified as unsuitable for planting. These three classes are shown in Figure 4 and described in the Glossary on page 24.

After manual classification improvement and quality control were performed on the remote sensing products, additional waterbody data from the USGS National Hydrography NHDPlus data set were incorporated to create a 4-class land cover data set.



URBAN TREE CANOPY

NON-CANOPY VEGETATION

UNSUITABLE FOR PLANTING

Figure 4. | Four (4) distinct land cover classes were identified in the 2019 tree canopy assessment: urban tree canopy, other non-canopy vegetation, surfaces unsuitable for planting, and water.

IDENTIFYING POSSIBLE PLANTING AREAS AND UNSUITABLE AREAS FOR PLANTING

In addition to quantifying tree canopy in 2017 and 2019, another metric of interest in this assessment was areas where trees could be planted to restore tree canopy lost to the storm. To assess this, all land area in the impacted cities that was not existing tree canopy coverage was classified as either possible planting area (PPA) or unsuitable areas for planting. Possible planting areas were derived from the non-canopy 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, airports, etc.), were manually delineated and overlaid with the existing land cover data set (Figure 5). The final results were reported as PPA Vegetation, Unsuitable Vegetation, and Total Unsuitable.

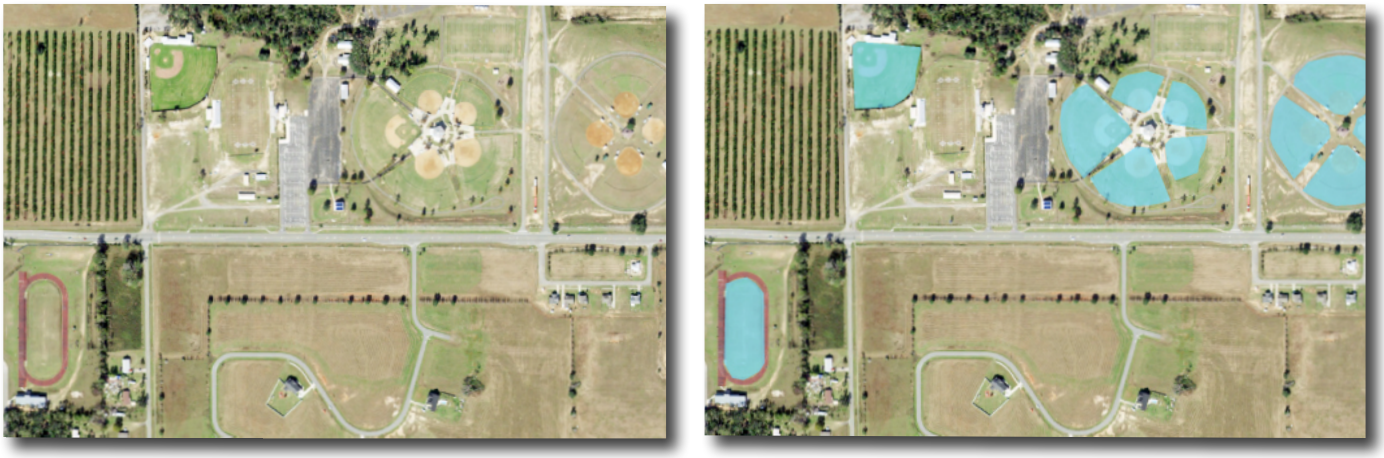


Figure 5. | Vegetated areas where it would be biophysically feasible for tree plantings but undesirable based on their current usage (left) were delineated in the data as "Unsuitable" (right). These areas included recreational sports fields, golf courses, and other open space.

DEFINING ASSESSMENT LEVELS

In order to best inform the Florida Forest Service, city officials, and various stakeholders, urban tree canopy and other associated metrics were tabulated across a variety of geographic boundaries (Figure 6 shows Mariana as an example). These boundaries include the city boundaries, ZIP codes, watersheds, and U.S. Census block groups.

- Thirty-two (32) **city boundaries** are the main area of interest for this assessment, over which all metrics are summarized.
- Fifty-eight (58) **ZIP codes** were assessed to provide insight into different areas in each city in the study area.
- Tree canopy was analyzed for the ninety-five (95) **HUC-12 watersheds**, within the assessment city boundaries, to identify the amount of tree canopy as it relates to stormwater mitigation and water quality.
- One hundred and ninety-three (193) **census block groups** were assessed to provide information at a geographic scale commonly used to track populations. Census block groups are used by the U.S. Census Bureau to assure statistical consistency when tracking populations across the United States and can be valuable indicators of environmental justice as they are directly linked with demographic and socioeconomic data.

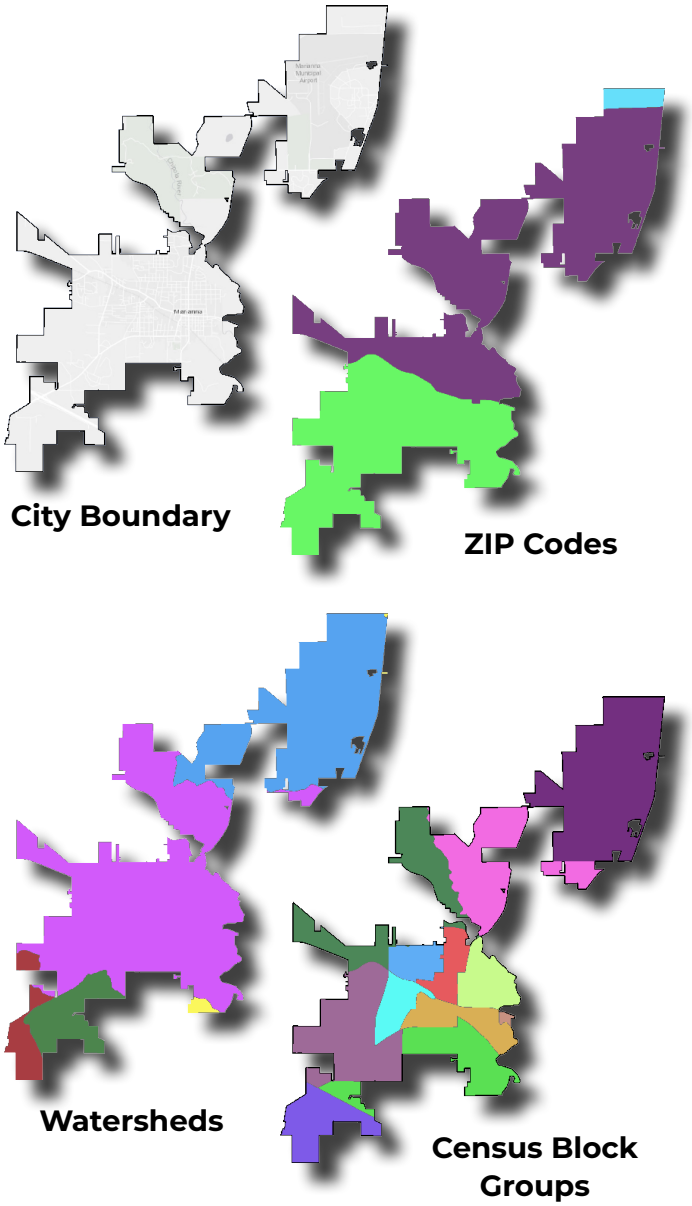


Figure 6. | Four (4) distinct geographic boundaries were explored in this analysis: the full city boundaries, ZIP codes, watersheds, and U.S. Census block groups.

KEY FINDINGS AND CANOPY CHANGE

The results and key findings of this study, including a land cover map of the Panama City area, the most densely populated contiguous area in the study area,and results for all cities are presented below. These results can be used to design strategic approaches to identifying existing canopy, areas of significant canopy loss, and future planting areas. The land cover percentages below are based on the total study area, while urban tree canopy, canopy change, 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.

Table 1. | Land cover classes in acres and percent in the study area.

Land Cover Type	Acres	%
Total Study Area	139,239	100%
Tree Canopy	54,311	39%
Non-Canopy Vegetation	47,612	34%
Impervious and Soil	46,539	33%
Water	8,256	6%

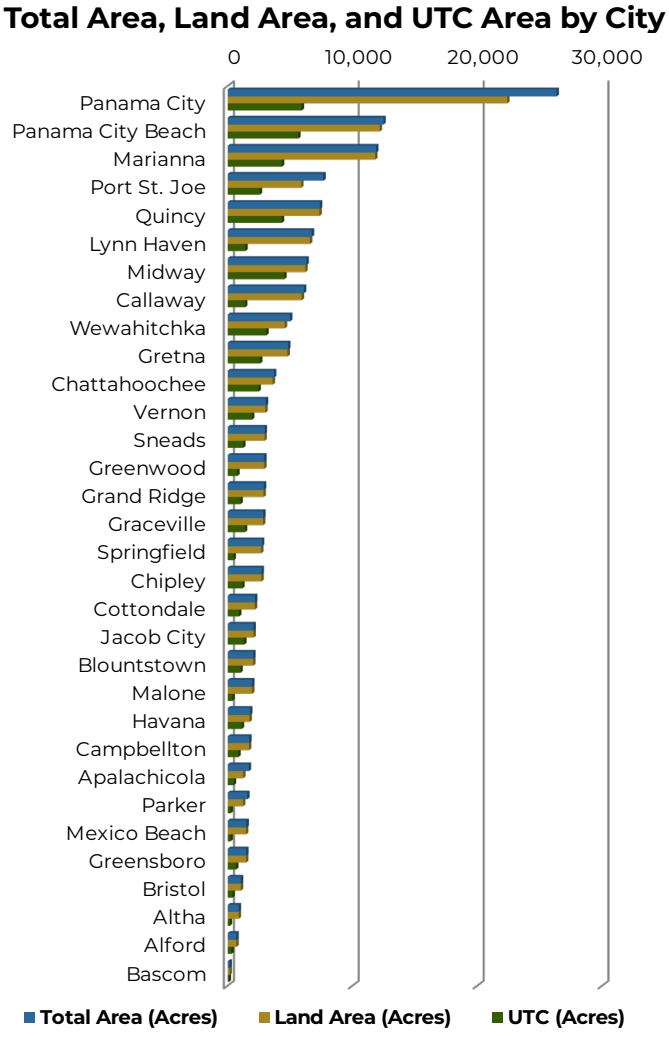


Figure 7. | Urban tree canopy compared to total area and land area, in acres, in the study area by city.

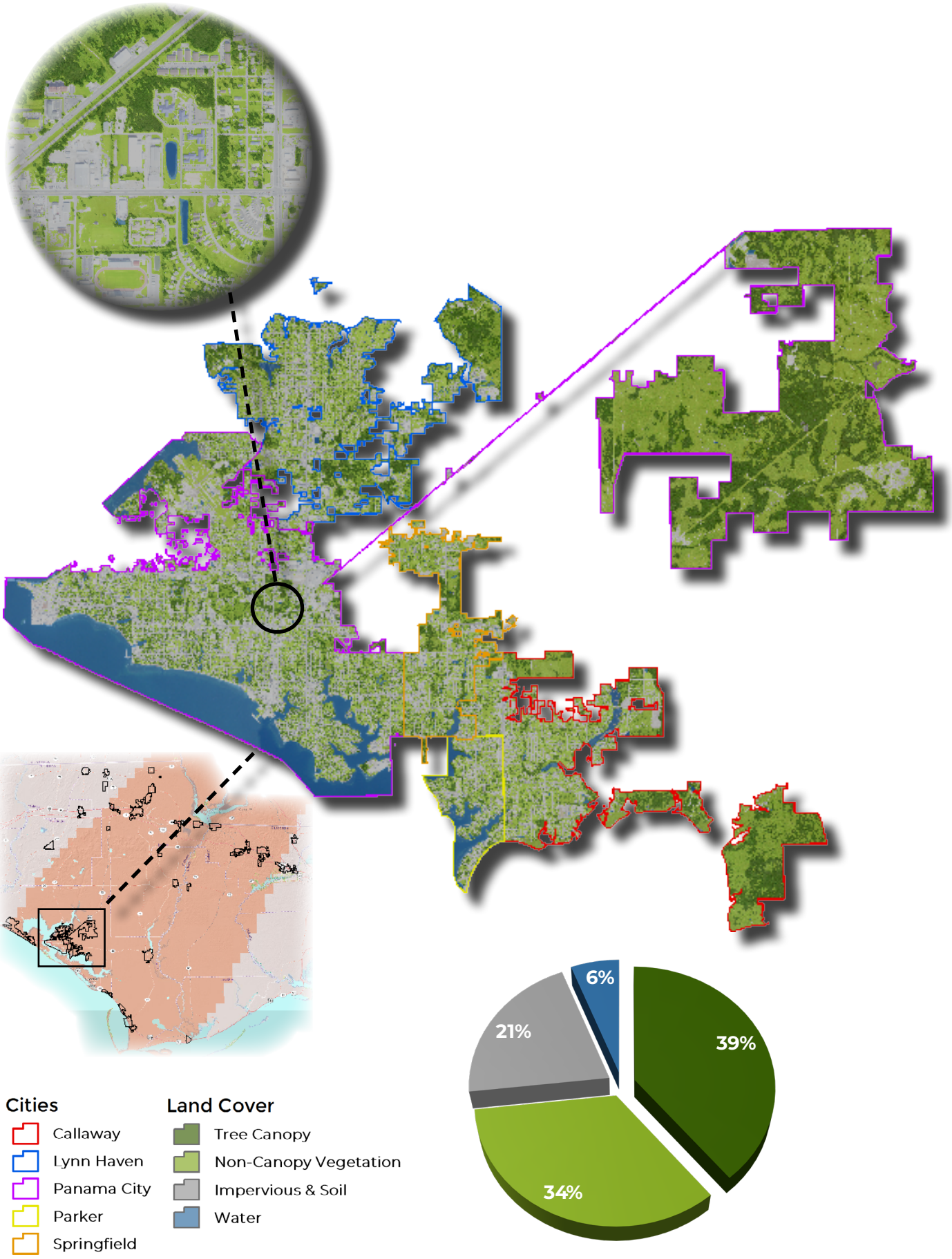


Figure 8. | Land cover in Panama City, Lynn Haven, Springfield, Callaway, and Parker.

STUDY-WIDE URBAN TREE CANOPY

This urban tree canopy assessment utilized the land cover map as a foundation to determine possible planting areas throughout the study area. Additional layers and information regarding land considered unsuitable for planting were also incorporated into the analysis. Note that the results of this study, shown in Table 2, are based on land area, which excludes water bodies, as opposed to total area, which includes water bodies.

Results of this study indicate that within the study area's 32 cities, 54,311 acres are covered with urban tree canopy, making up 41% of the 130,983 land acres in the study area; 46,539 acres are covered with other vegetation where it would be possible to plant trees (PPA), making up 36% of the study area; and the other 30,133 acres were considered unsuitable for tree planting, making up 23% of the study area. The unsuitable areas include recreational sports fields, golf course playing areas, impervious surfaces, and agricultural areas.

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

Study Area	Acres	%
Total Area	139,239	100%
Land Area	130,983	94%
Urban Tree Canopy	54,311	41%
Total Possible Planting Area	46,539	36%
Unsuitable Vegetation	1,073	1%
Unsuitable Impervious	29,060	22%
Total Unsuitable Area	30,133	23%

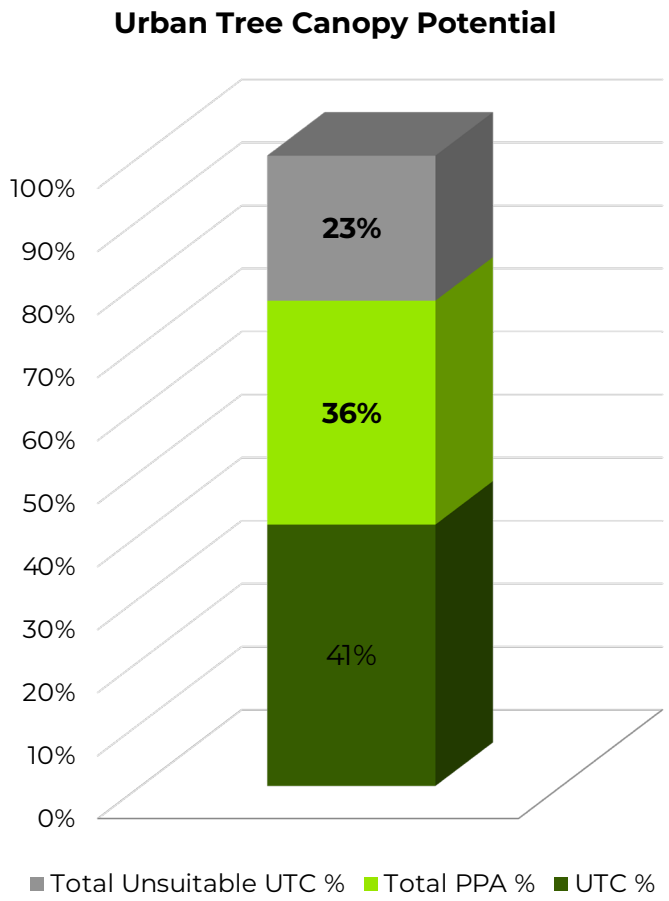


Figure 9. | Urban tree canopy, possible planting area, and area unsuitable for UTC in the study area.

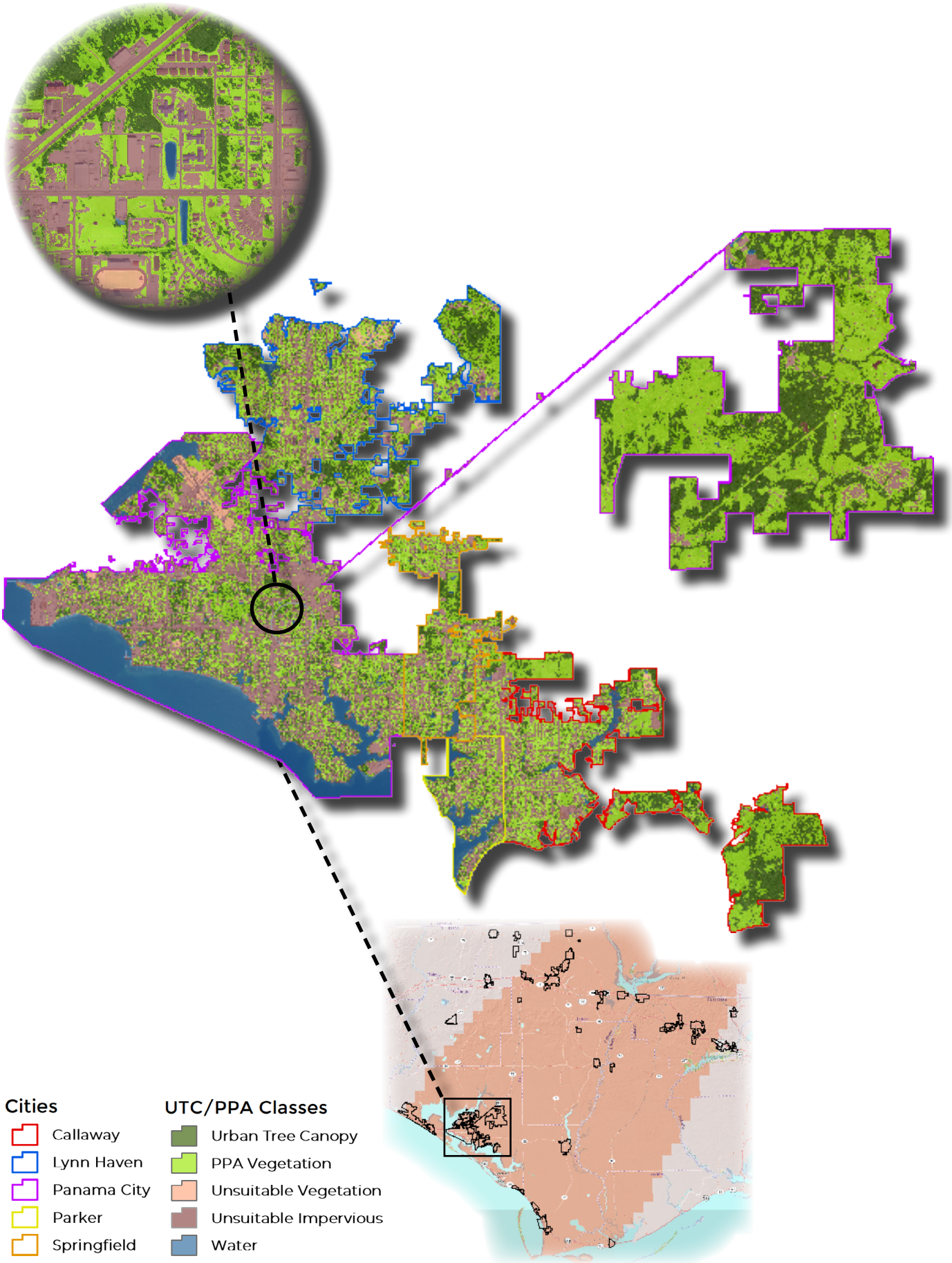


Figure 10. | UTC, PPA and unsuitable planting areas in Panama City, Lynn Haven, Springfield, Callaway, and Parker.

URBAN TREE CANOPY BY CITIES

UTC and PPA were assessed in 32 cities. UTC varied across the cities in the study area. The city with the lowest canopy cover in 2019 was Mexico Beach (19%) and the city with the highest canopy cover was Midway (73%). The average UTC across all cities was 42%. Prior to Hurricane Michael, Mexico Beach had 46% canopy cover. Midway, located largely outside of hurricane force winds, experienced a gain in tree canopy primarily from forest timber growth. PPA levels also vary throughout the studied cities. The lowest PPA was in Chipley (14%) and the highest in Callaway (53%). Panama City covered the largest area of all cities and thus contained the largest portion of UTC and PPA in the study area, containing 11% of all UTC and 22% of all PPA in the study area.

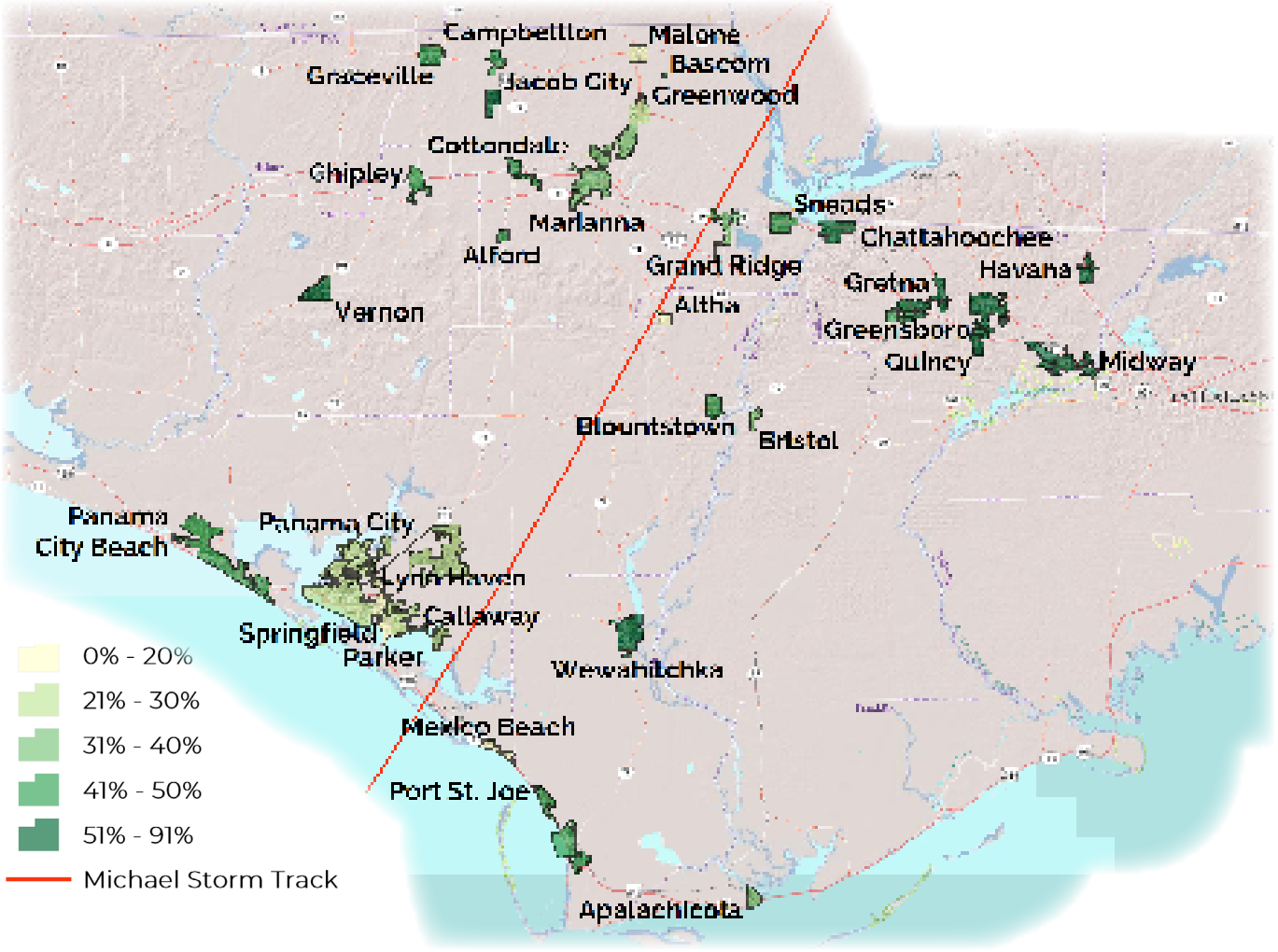


Figure 11. | Map of urban tree canopy by city in the study area.

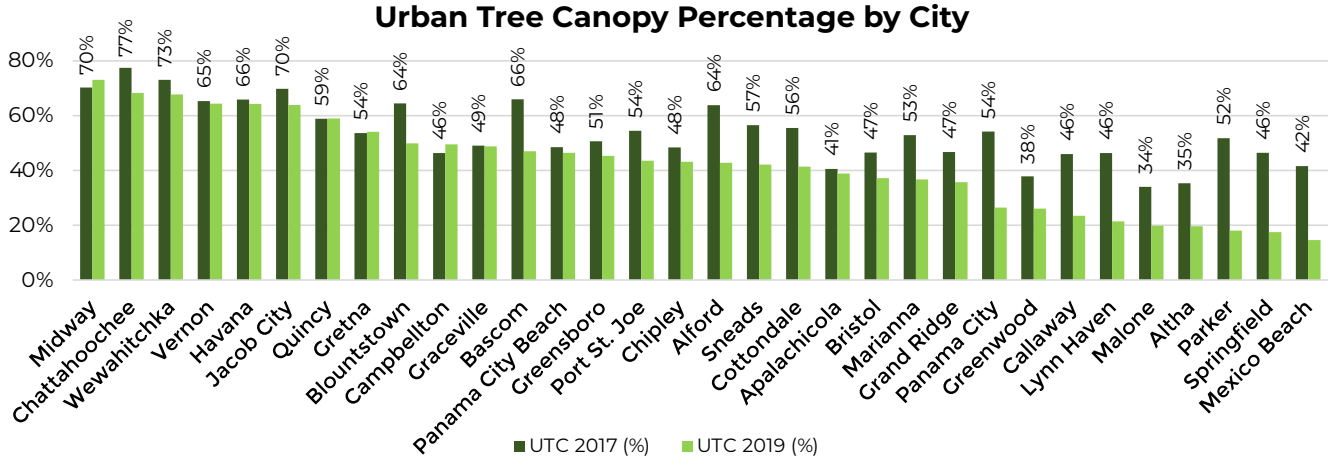


Figure 12. | 2017 and 2019 Urban tree canopy in the study area by cities.

Table 3. | Urban tree canopy assessment results by cities. UTC and PPA results include acres, percent of area covered by UTC or PPA (%), and distribution of each city's total UTC or PPA within the study area.

City Name	Land Area		Urban Tree Canopy			Possible Planting Area		
	Acres	*Dist.*	*Acres*	*%*	*Dist.*	*Acres*	*%*	*Dist.*
Alford	686	1%	294	43%	1%	323	47%	1%
Altha	874	1%	171	20%	0%	401	46%	1%
Apalachicola	1,239	1%	482	39%	1%	428	35%	1%
Bascom	154	0%	72	47%	0%	62	40%	0%
Blountstown	2,038	2%	1,017	50%	2%	681	33%	1%
Bristol	1,045	1%	389	37%	1%	446	43%	1%
Callaway	5,921	5%	1,386	23%	3%	3,163	53%	7%
Campbellton	1,702	1%	843	50%	2%	543	32%	1%
Chattahoochee	3,602	3%	2,460	68%	5%	814	23%	2%
Chipley	2,695	2%	1,162	43%	2%	382	14%	1%
Cottondale	2,169	2%	898	41%	2%	325	15%	1%
Graceville	2,826	2%	1,377	49%	3%	894	32%	2%
Grand Ridge	2,867	2%	1,022	36%	2%	1,419	49%	3%
Greensboro	1,462	1%	662	45%	1%	470	32%	1%
Greenwood	2,919	2%	759	26%	1%	1,106	38%	2%
Gretna	4,785	4%	2,589	54%	5%	1,771	37%	4%
Havana	1,741	1%	1,119	64%	2%	370	21%	1%
Jacob City	2,062	2%	1,318	64%	2%	565	27%	1%
Lynn Haven	6,584	5%	1,407	21%	3%	3,064	47%	7%
Malone	1,943	1%	384	20%	1%	1,004	52%	2%
Marianna	11,808	9%	4,334	37%	8%	4,500	38%	10%
Mexico Beach	1,459	1%	212	15%	0%	511	35%	1%
Midway	6,207	5%	4,532	73%	8%	894	14%	2%
Panama City	22,385	17%	5,920	26%	11%	10,347	46%	22%
Panama City Beach	12,171	9%	5,653	46%	10%	3,039	25%	7%
Parker	1,222	1%	220	18%	0%	489	40%	1%
Port St. Joe	5,883	4%	2,561	44%	5%	2,084	35%	4%
Quincy	7,346	6%	4,330	59%	8%	1,957	27%	4%
Sneads	2,945	2%	1,239	42%	2%	1,303	44%	3%
Springfield	2,669	2%	465	17%	1%	1,300	49%	3%
Vernon	3,012	2%	1,938	64%	4%	738	24%	2%
Wewahitchka	4,565	3%	3,093	68%	6%	1,149	25%	2%
Totals	**130,983**	**100%**	**54,311**	**41%**	**100%**	**46,539**	**36%**	**100%**

STUDY-WIDE URBAN TREE CANOPY CHANGE

All results from this study were then compared to tree canopy assessment results created with imagery collected in 2017, the year before Hurricane Michael made landfall. These assessments mapped tree canopy using identical methods. 1-meter, high resolution NAIP aerial imagery was used for the 2017 and 2019 studies. Changes between both time periods were assessed within each city's boundary, watersheds, ZIP codes, and census block groups.

In 2019, urban tree canopy coverage within the study area. was 41% with 54,311 acres. In 2017, before Hurricane Michael, canopy coverage was 54% with 70,995 acres. A total of 16,685 acres of canopy were lost between 2019 and 2017 or a loss of over 13% across the study area. While there were obvious and significant canopy losses directly due to winds and other damage caused by Hurricane Michael, there was also evidence of tree canopy growth primarily in agricultural plots where young trees gained enough height and canopy size between 2017 and 2019 to classify as tree canopy. These areas contributed to gains seen in small rural communities and rural areas of larger communities.

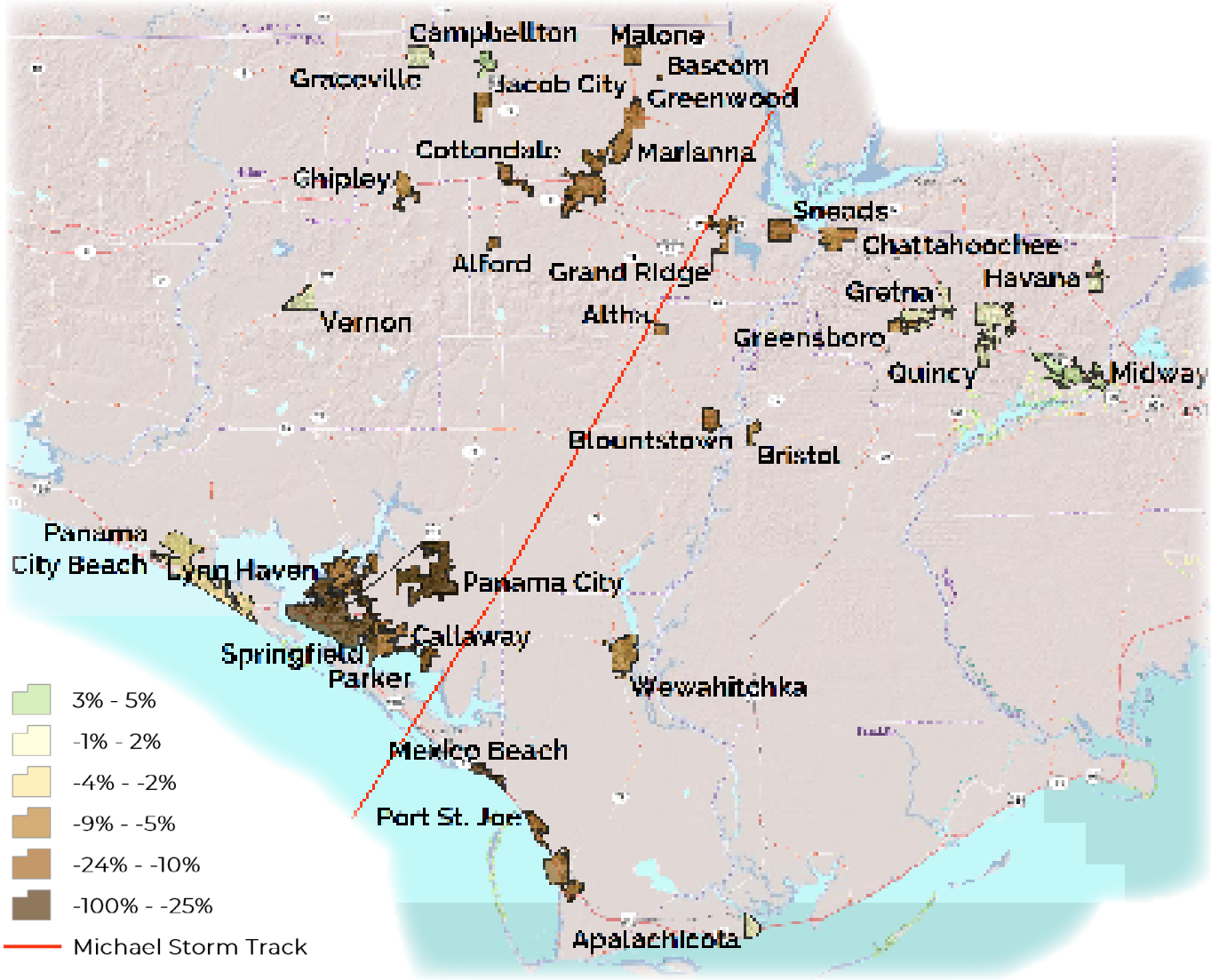


Figure 13. | Urban tree canopy change by cities.

Assessing UTC before and after the hurricane and measuring the change highlights where the storm's impact was most significant. Two cities had measurable increases in tree canopy between 2017 and 2019: Midway and Campbellton. UTC increased by 3% in both cities. Both cities were largely or entirely outside of the hurricane force winds. All 30 other cities experienced losses in canopy or saw no significant change. The city which had the most significant change in canopy was Parker, with a UTC loss of 34%. This city is located along the coast and just west of where Michael's eyewall passed. Panama City, the largest city in the study area in terms of size and population, also lost the largest acreage of tree canopy, with a loss of 6,213 acres of UTC. The four next most populated cities in the study area all had UTC losses greater than 20% and are located in the Panama City–Lynn Haven–Panama City Beach Metropolitan Statistical Area.

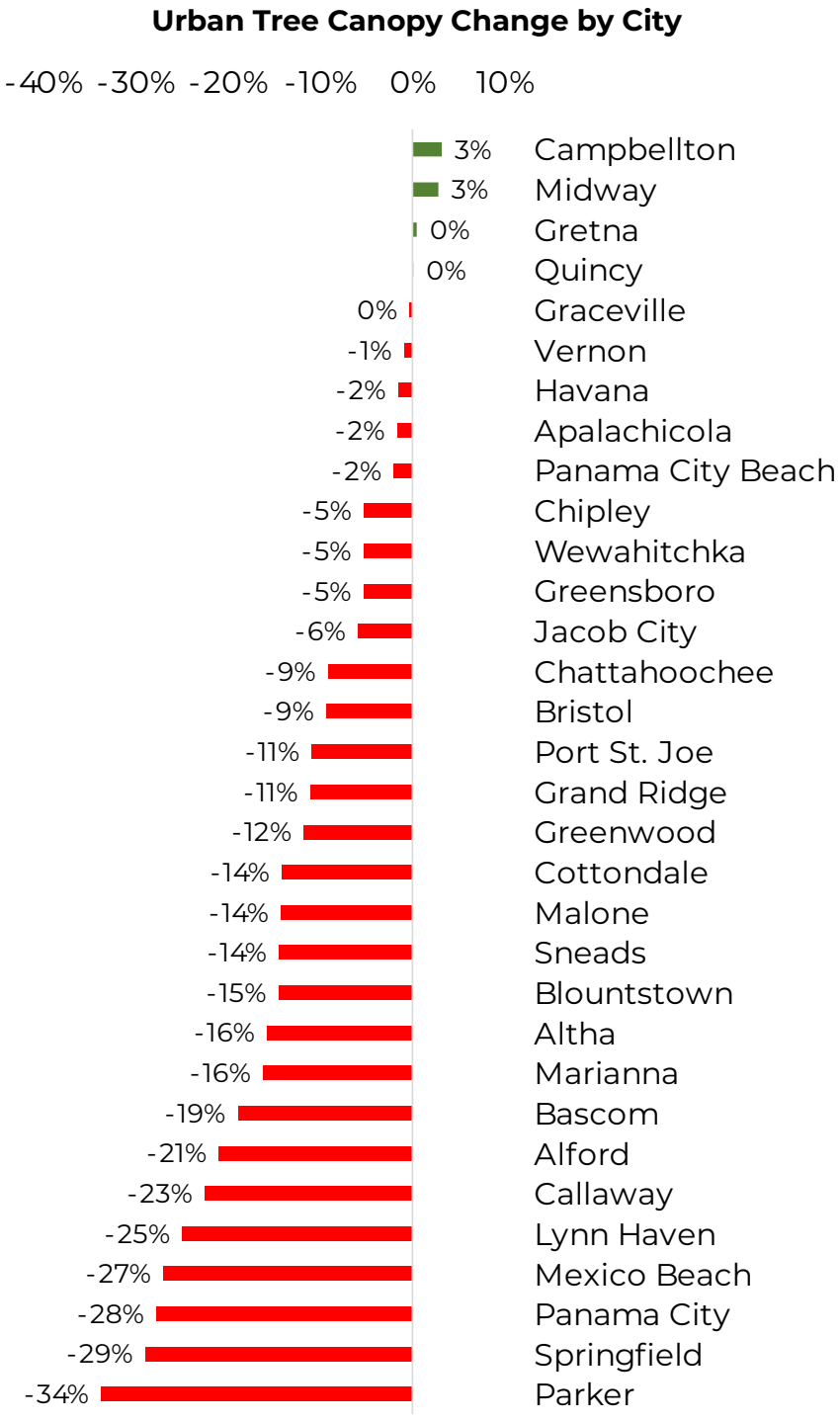


Figure 14. | Urban tree canopy change in the study area by cities.

PANAMA CITY URBAN TREE CANOPY CHANGE

Results showed that citywide Panama City had 54% UTC in 2017 and 26% UTC in 2019. Hurricane Michael caused a 28% loss in tree canopy citywide. Panama City contains forty (40) census block groups which are the smallest geographic boundary at which land cover and canopy change results were assessed. All block groups in Panama City lost canopy after the storm. The losses varied throughout the city with some block groups in Panama City experiencing a 9% UTC loss and others losing 45% UTC.

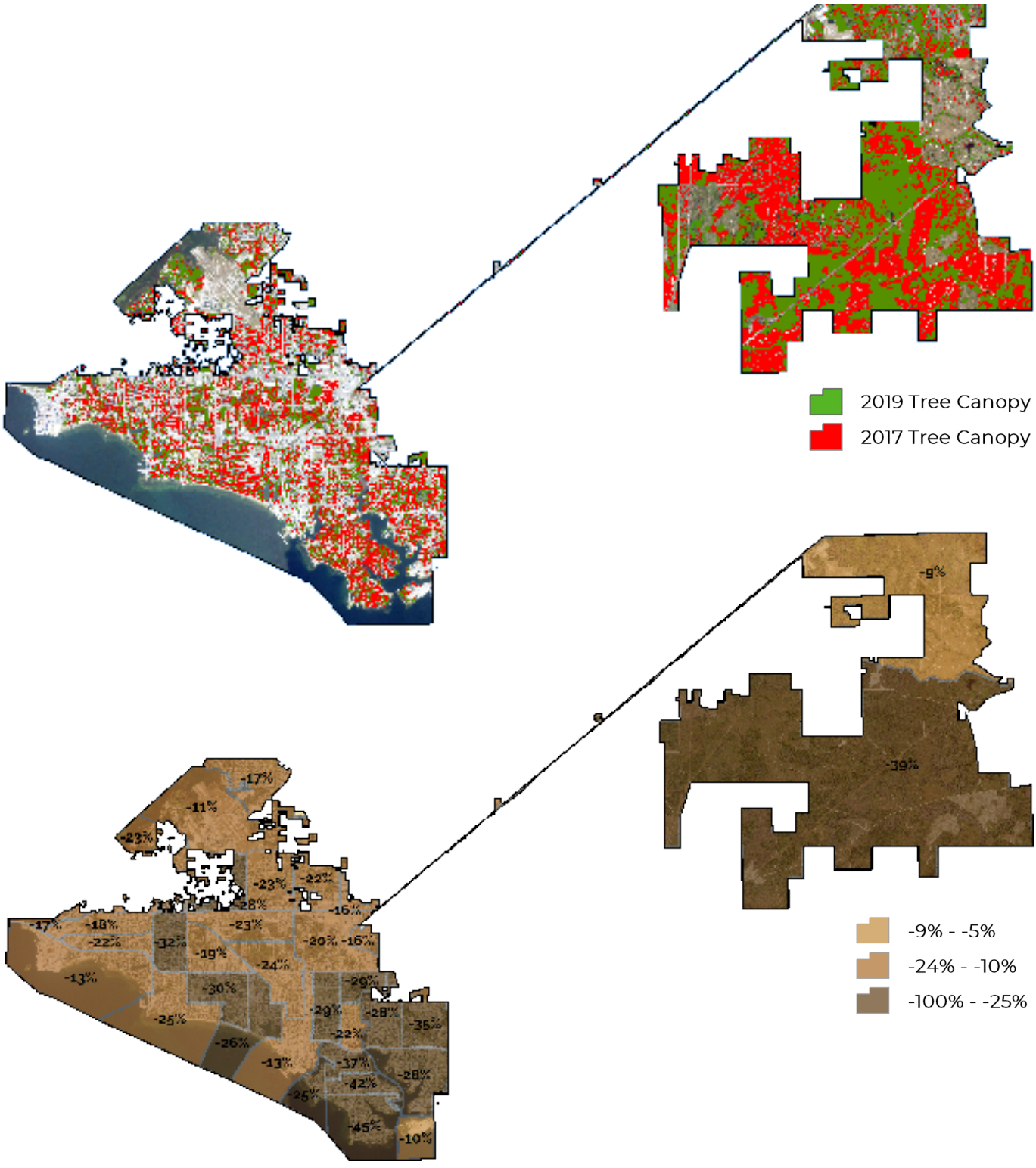
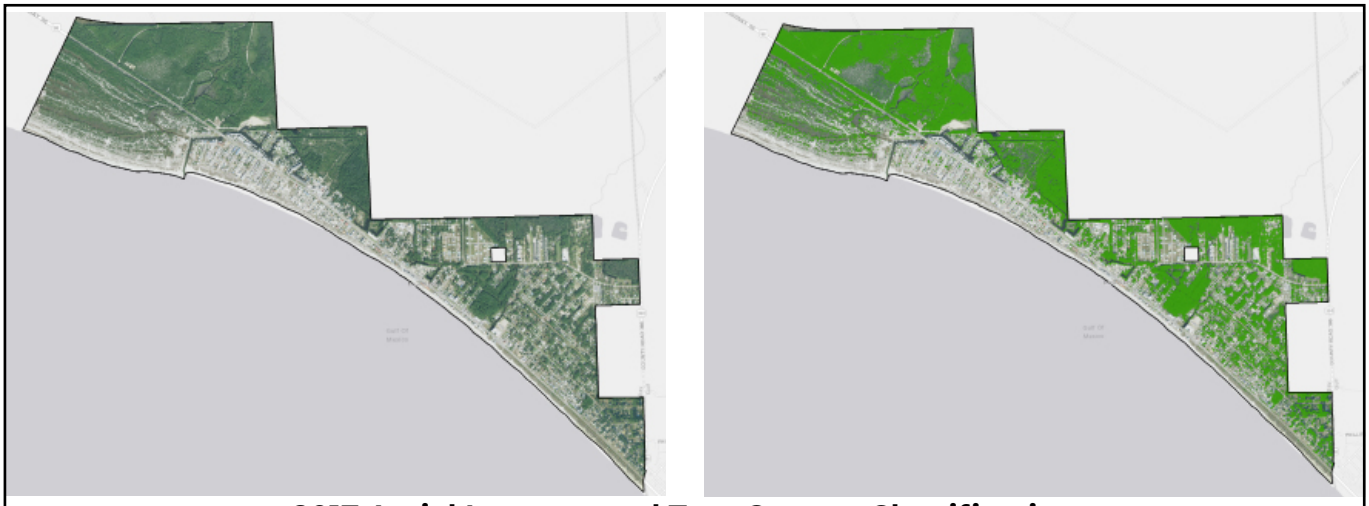


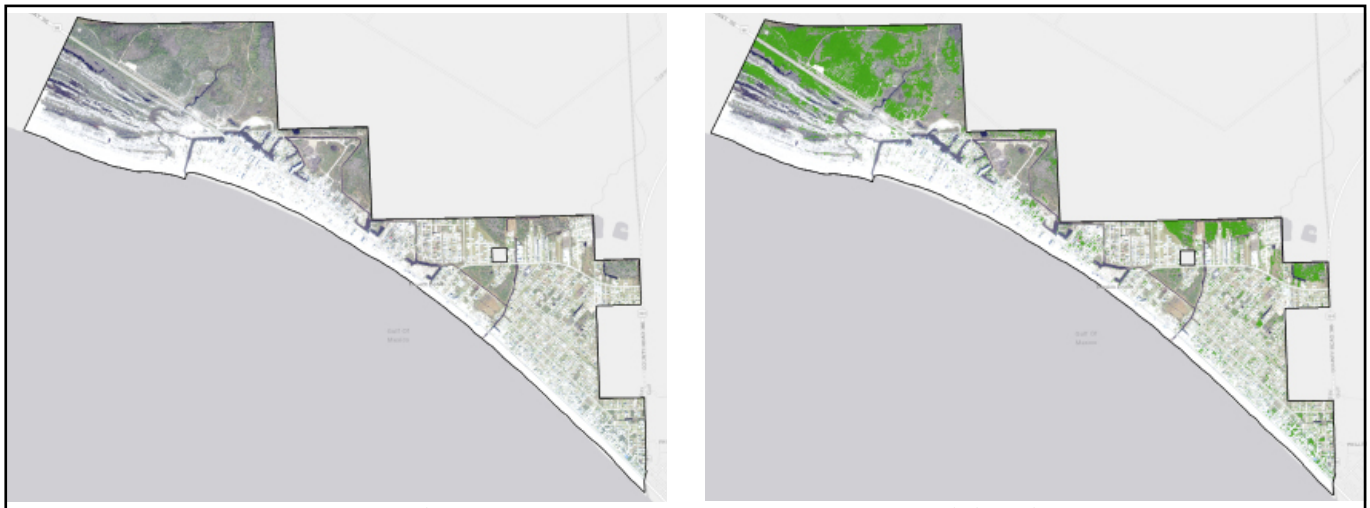
Figure 15. | Urban tree canopy change in Panama City. (Top) Urban tree canopy change by census block groups in Panama City. (Bottom)

MEXICO BEACH URBAN TREE CANOPY CHANGE

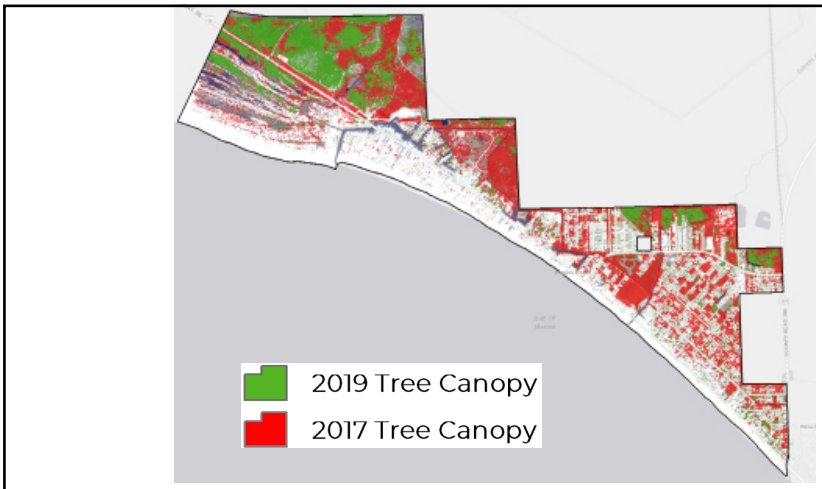
Urban tree canopy change was assessed within the Mexico Beach city boundary. Mexico Beach is often cited as the landfall location of Hurricane Michael and results showed significant tree canopy loss in the city. In 2017, Mexico Beach contained 606 acres of tree canopy or 42% of its land area. In 2019 results showed the City contained just 212 acres of tree canopy equal to 15% of land area. 394 acres of tree canopy were lost or 27% of the land area of Mexico Beach.



2017 Aerial Imagery and Tree Canopy Classification



2019 Aerial Imagery and Tree Canopy Classification



Tree canopy change in Mexico Beach between 2017 and 2019

MARIANNA URBAN TREE CANOPY CHANGE

Results showed that Marianna, located over 50 miles inland, had 53% UTC in 2017 and 37% UTC in 2019. Hurricane Michael resulted in a 16% loss in tree canopy. Of the 12 census block groups within the City's boundary, only one had less than a 10% loss. All other block groups lost between 11% and 36%. Marianna includes five watersheds and the largest, Carters Mill Branch, lost 21% UTC or 1,363 acres. All other watersheds lost between 9% and 18% of their land area in tree canopy.

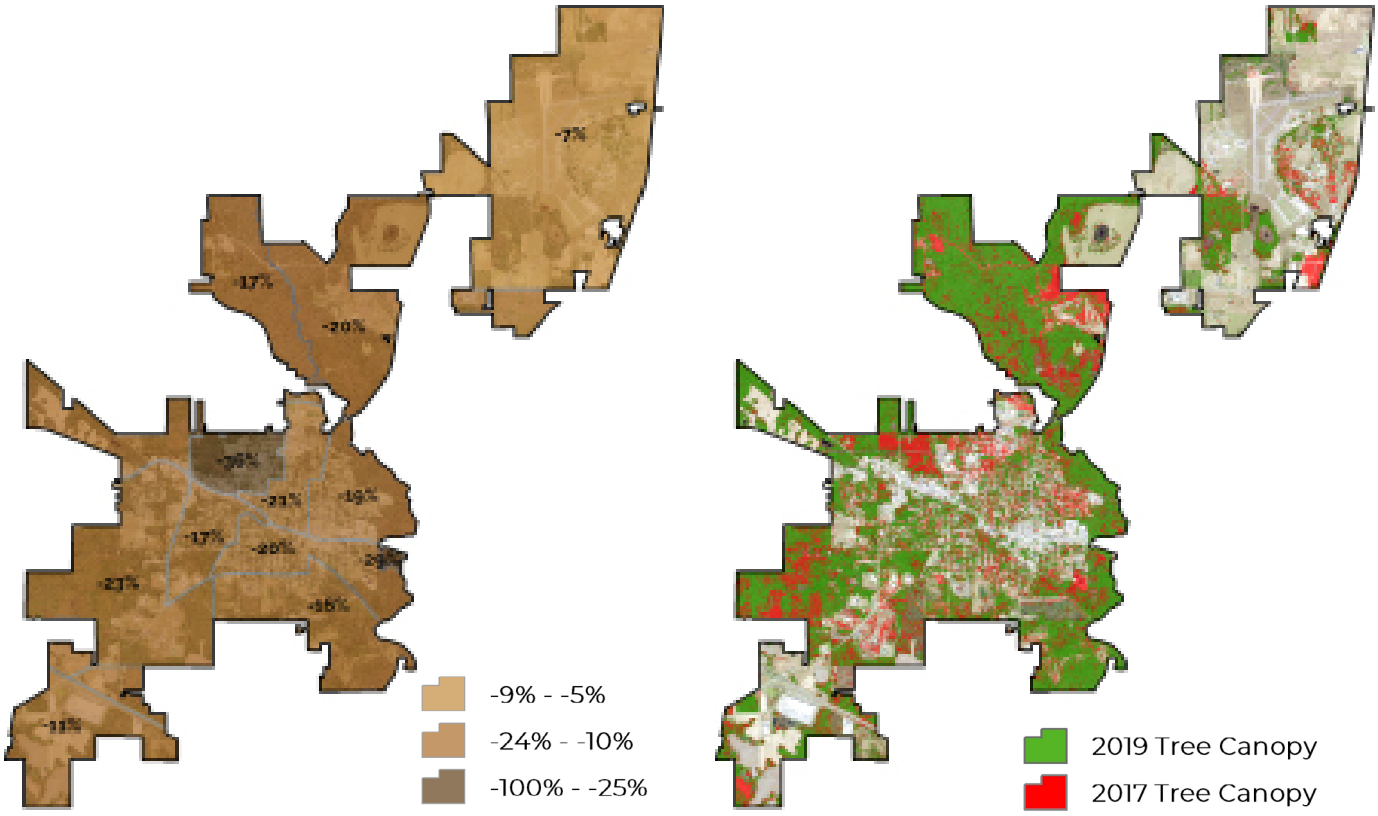


Figure 16. | Urban tree canopy change by census block groups in Marianna, FL (left). Citywide urban tree canopy change in Marianna, FL (right).

Table 5. | Urban tree canopy change results by ZIP codes in Marianna, FL

Marianna ZIP Codes	Land Area		UTC 2017		UTC 2019		UTC Change	
	Acres	*Dist.*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*
32443	249	2%	46	18%	36	14%	-10	-4%
32446	7,023	59%	3,533	50%	2,473	35%	-1,060	-15%
32448	4,536	38%	2,666	59%	1,825	40%	-840	-19%
Totals	**11,808**	**100%**	**6,244**	**53%**	**4,334**	**37%**	**-1,910**	**-16%**

Table 6. | Urban tree canopy change results by watersheds in Marianna, FL

Marianna Watersheds	Land Area		UTC 2017		UTC 2019		UTC Change	
	Acres	*Dist.*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*
Carters Mill Branch	6,622	56%	4,593	69%	3,230	49%	-1,363	-21%
Lower Dry Creek-Chipola River	818	7%	292	36%	187	23%	-105	-13%
Merritts Millpond	78	1%	65	83%	53	68%	-12	-16%
Muddy Branch-Chipola River	3,799	32%	1,056	28%	714	19%	-342	-9%
Upper Dry Creek-Chipola River	491	4%	239	49%	150	31%	-89	-18%
Totals	**11,808**	**100%**	**6,244**	**53%**	**4,334**	**37%**	**-1,911**	**-16%**

QUANTIFYING ECOSYSTEM BENEFITS

Using the best available science from i-Tree tools, values were calculated for some of the benefits and functions provided by trees and forests, both individually for each city and collectively for the whole study area. The urban forest holds millions of dollars worth of savings in avoided infrastructure costs, pollution reduction , and stored carbon. Hurricane Michael had dramatic impacts on tree canopy and the benefits that it provides.

AIR QUALITY

Trees produce oxygen, indirectly reduce pollution by lowering air temperatures, and improve public health by reducing air pollutants, which cause death and illness.

- The existing tree canopy in the study area removes 2,667 tons of air pollution annually, valued at $7.8 million.
- In 2017, tree canopy was removing an estimated 3,490 tons of air pollution annually, valued at $10.2 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.

- On average, each acre of tree canopy in the study area absorbs 7,000 gallons of water. This benefit of avoided runoff is valued at roughly $61.90 per acre/per year. Extrapolated for the whole study area, this means that existing tree canopy provides $3.3 million annually in stormwater benefits. In 2017 trees were providing an estimated $4.3 million in annual stormwater benefits.

CARBON STORAGE AND SEQUESTRATION

Trees accumulate carbon in their biomass; with most species in a temperate forest, the rate and amount increase with age.

- Trees in the study area store approximately 1.7 million tons of carbon, valued at $292 million and each year the tree canopy absorbs and sequesters approximately 89,000 tons of carbon dioxide, valued at $15 million.
- In 2017, the carbon stored by trees in the study area was valued at $382 million and tree canopy sequestered $20 million worth of carbon dioxide.

TREE PLANTING PRIORITIZATION

Urban tree canopy provides a multitude of direct and indirect benefits to residents and visitors alike. Five criteria were analyzed across the study area at the census block group level to understand how the distribution of the benefits of tree canopy was impacted, to assist in the prioritization of future planting efforts, and to ensure the benefits of tree canopy are equitably restored. Planting prioritization criteria were created using the 2019 land cover data set and American Community Survey 5-year estimates. These results represent possible planting areas as determined by remote sensing classification. Possible planting areas have not been evaluated for conflicts between overhead or underground utilities and should be visited to determine site suitability prior to planting.

PRIORITIZATION CRITERIA AND RESULTS

Areas with Low Existing Tree Canopy - It is important to understand the existing distribution of existing tree canopy across the city. This criteria highlights block groups in the study area which have low existing urban tree canopy.

Possible UTC - One of the primary purposes of this study is to identify where to prioritize new tree plantings. This criteria highlights the percent of total area available for future tree planting.

UTC Loss - Tree canopy loss was not uniform across the study area. This criteria highlights the block groups which experienced greater losses. Block groups with greater tree canopy loss were given a higher priority.

Median Household Income - Also referred to as Economic Vitality, the presence of trees typically aligns with increased economic vitality and quality of life in urban areas. This criteria highlights the median household income, as reported by the U.S. Census American Community Survey 2014-2019 5-year summaries.

People of Color - There is generally a negative correlation between tree canopy and the percentage of the population who are people of color. This criteria represents the percentage of people who are Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and includes all people classified as Hispanic reported by the U.S. Census American Community Survey 2014-2019 5-year summaries.

Table 7. | Top ten combined tree planting prioritization scores by census block group.

Block Group	City Name	People of color%	Median Household Income	UTC % Change	Low Tree Canopy %	Possible Tree Canopy	Overall Score
12-005-001600-3	**Panama City**	98%	0	-29%	82%	41%	3.17
12-005-001600-2	**Panama City**	86%	25,833	-29%	86%	41%	2.89
12-005-000803-2	**Callaway**	72%	39,795	-33%	89%	50%	2.88
12-005-001700-2	**Panama City**	84%	27,708	-28%	84%	40%	2.82
12-005-000803-1	**Callaway**	39%	32,472	-31%	88%	55%	2.63
12-005-001000-1	**Parker**	39%	41,964	-37%	93%	45%	2.61
12-005-001302-2	**Springfield**	33%	52,232	-37%	91%	56%	2.58
12-005-001700-1	**Panama City**	55%	51,250	-35%	83%	47%	2.56
12-005-001600-4	**Panama City**	87%	28,427	-22%	80%	32%	2.54
12-005-000803-3	**Callaway**	38%	35,452	-33%	88%	49%	2.53

Results indicated that the majority of the highest combined priority block groups were located in Panama City, Parker, Callaway, and Springfield. Located further inland, Marianna also contained three block groups which were ranked in the top 25 highest priority block groups study-wide. Panama City contains the highest concentration of high priority block groups due to its size, in terms of population and area, and impacts from Hurricane Michael. Panama City also experienced high amounts of canopy loss resulting in lower UTC coverages and higher amounts of plantable space. As a result, there are several block groups which are high priority for planting and contain more than the study-wide average percentage of people of color (34%) as well as a lower than study-wide average median household income ($48,000 or less). Figure 17 highlights block groups with higher than average percentage of people of color and a lower than average median income.

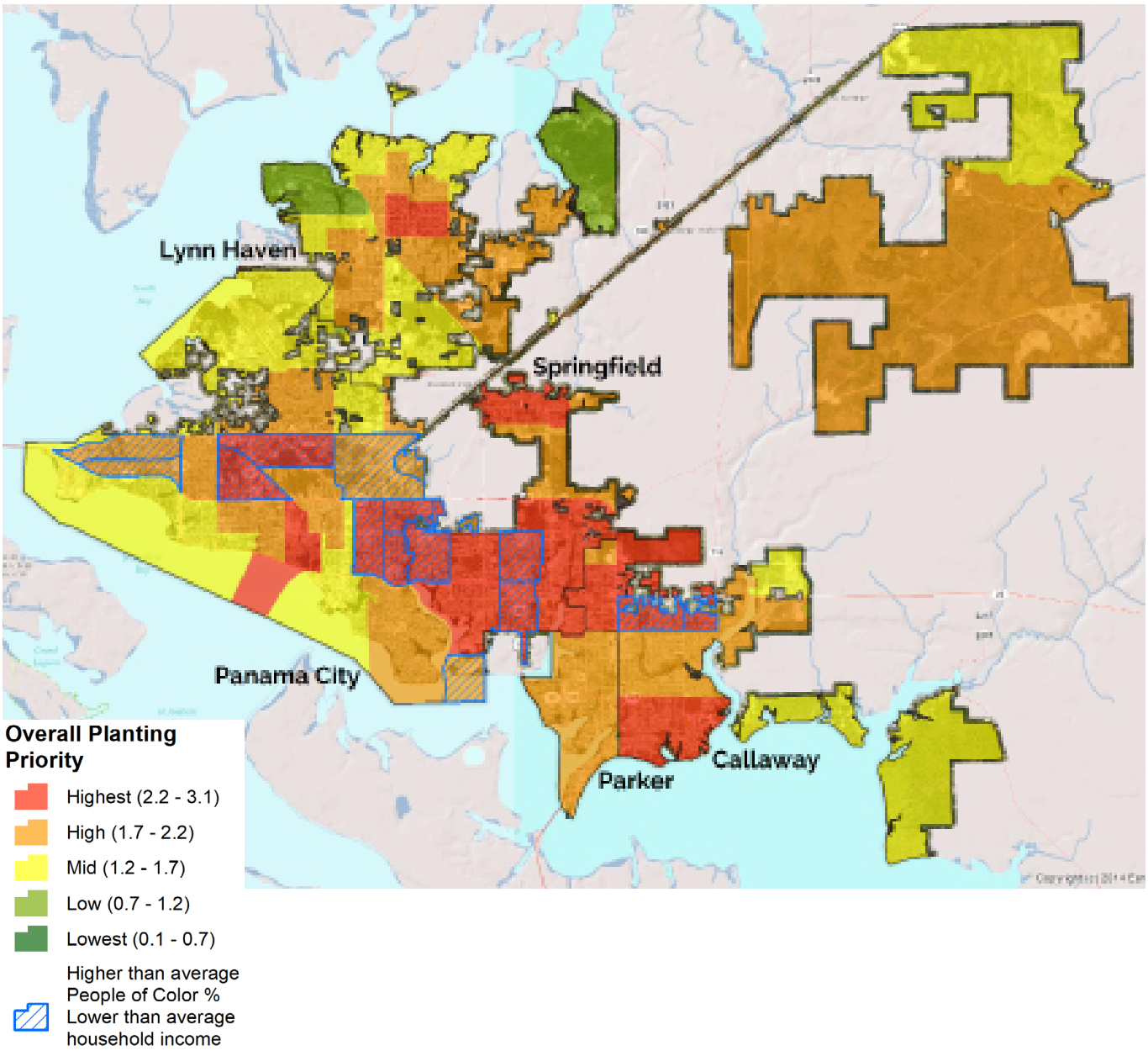


Figure 17. | Overall planting priority by census block groups.

CONCLUSIONS AND RECOMMENDATIONS

The Florida Forest Service has demonstrated that it values its natural resources and is interested in the maintenance of a healthy and sustainable urban environment. Given the difference in size of the largest and smallest communities in this assessment, the implementation of these results will naturally take on different forms for each city and community. It is up to the state and individual cities to take these results and use the resources available to them to continue monitoring the health of the urban forest and to implement the following recommendations to ensure the urban forest is considered during future city planning and development. These results should be used to sustain and enhance the benefits that trees provide to their communities.

The communities Shady Haven and Louis Tract are located in the highest priority block group

To recover from the damage that Hurricane Michael caused to tree canopy and to monitor the success of recovery efforts, cities should have a tree canopy assessment performed on a regular interval. As each city changes, they will be able to use these data to ensure that their existing urban forest policies, or any future policies and management practices, prioritize maintenance, health, and growth. The urban forest provides a wealth of environmental, social, and even economic benefits, which relate back to greater community interest in local initiatives and priorities. These results can be used to identify where existing tree canopy cover should be preserved, where there are opportunities to expand the canopy cover, and which areas would receive the greatest benefits from the investment of valuable time and resources into the 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 city leaders, planners, engineers, resource managers, and the public on the functional benefits of trees in addressing environmental issues. The land cover and planting prioritization 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 canopy cover goals for the short- and long-term.

2. Distribute available project materials and data to city decision makers and residents

The cities and their various stakeholders can utilize the results of the UTC, PPA, and planting site prioritization analyses to identify the best locations to focus future tree planting and canopy expansion efforts. These results are available as geospatial data, spreadsheets, PDF maps, and two-page fact sheets. The fact sheets provide specific information about each individual city and can be used in efforts to engage each community and its stakeholders. Also provided are Excel spreadsheets detailing the assessment results for all geographic scales. The geospatial data is also provided and accessible to all city, county, and state GIS personnel.

3. Develop outreach programs towards private landowners

In addition to the examples above, the provided ArcGIS StoryMap and TreePlotter™ CANOPY software should be distributed to appropriate audiences in order to disseminate information and provide interaction with the assessment results. Online interactive map tools are some of the most accessible ways to share geospatial data because they can be viewed on any desktop or mobile device and provide interactive, easy to absorb visualizations of complex data. First, the story map should be used to contextualize this assessment, understand the process, results, and benefits of tree canopy assessments, and provide a publicly accessible overview of the project. Then, decision makers can explore the TreePlotter™ CANOPY software. CANOPY allows users to visualize existing land cover, canopy growth and loss, and quantify impacts that canopy growth or loss has on air quality, stormwater runoff, and carbon sequestration. Users can explore a wide range of targeted, in-depth planting scenarios based on the prioritization criteria included in this assessment to identify the most equitable locations for tree planting efforts.

USE PRIORITIZATION DATA TO TARGET NEW TREE PLANTINGS

4. Focus new plantings in high priority areas

Results of this assessment, specifically the planting prioritization results, should be used to inform the next steps in planting and recovery efforts. An important part of managing trees and citywide urban tree canopy for many cities is identifying suitable planting sites. Tree canopy in cities is often not distributed equitably across communities with different races and incomes. To identify suitable sites cities should first use the prioritization results to identify areas with high amounts of possible UTC, low median household income, high percentage of people of color and high UTC loss. Then, the highest priority areas should be visited and inspected for suitable sites. Suitable sites should be free of overhead or underground utilities and not near buildings or structures. Guidelines for selecting wind resistant species and managing a wind resistant urban forest can be found on the University of Florida's Trees and Hurricanes website: https://hort.ifas.ufl.edu/treesandhurricanes/index.shtml

REPORT APPENDIX

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.

Possible Planting Area - Total: The combination of PPA Vegetation area and PPA Impervious area. In this project no impervious areas were identifies as plantable.

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.

UTC ASSESSMENT RESULTS TABLES

Tables include 2019 UTC and UTC change (2017-2019) percentages for all features (block groups, watersheds and ZIP codes) within every city included in the study area.

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32420	42%	-22%
32431	47%	-17%
Watersheds		
Stump Creek	43%	-21%
Census Block Groups		
120632111001	43%	-21%
City of Alford, FL	**43%**	**-21%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32423	47%	-19%
Watersheds		
Brenson Pond	47%	-19%
Census Block Groups		
120632101001	47%	-19%
City of Bascom, FL	**47%**	**-19%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32421	20%	-16%
Watersheds		
Graves Creek	10%	-11%
Lower Tenmile Creek	26%	-23%
Mill Creek-Chipola River	20%	-13%
Sutton Lake	18%	-13%
Census Block Groups		
120130101002	20%	-16%
City of Altha, FL	**20%**	**-16%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32320	40%	-2%
Watersheds		
Apalachicola Bay	44%	-3%
East River-Apalachicola River Frontal	38%	-1%
Census Block Groups		
120379703021	15%	-1%
120379703022	47%	-2%
120379703042	45%	-2%
120379703043	37%	-1%
City of Apalachicola, FL	**39%**	**-2%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32424	50%	-15%
Watersheds		
Kelly Branch	46%	-14%
Sutton Creek	49%	-17%
Sutton Lake	59%	-10%
Census Block Groups		
120130103001	21%	-25%
120130103002	58%	-13%
120130103003	57%	-11%
120130103005	36%	-19%
City of Blountstown, FL	**50%**	**-15%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32321	37%	-9%
Watersheds		
Devil's Branch-Telogia Creek	31%	-10%
Kelly Branch	40%	-8%
Mill Branch-Telogia Creek	44%	-9%
Outside Lake	43%	-9%
Census Block Groups		
120779502001	43%	-9%
120779502002	31%	-10%
120779502003	40%	-9%
City of Bristol, FL	**37%**	**-9%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32404	23%	-34%
Watersheds		
California Bayou-Richard Bayou Frontal	47%	-15%
Mill Bayou-Watsons Bayou Frontal	17%	-35%
Pitts Bayou-Lairds Bayou Frontal	19%	-24%
St. Andrews Bay	34%	-13%
Census Block Groups		
120050005001	34%	-26%
120050005002	40%	-10%
120050008031	12%	-31%
120050008032	11%	-33%
120050008033	12%	-33%
120050008034	16%	-24%
120050008041	13%	-28%
120050008051	11%	-29%
120050008052	14%	-29%
120050008061	13%	-30%
120050008062	17%	-33%
120050008063	34%	-11%
120050011001	21%	-26%
City of Callaway, FL	**23%**	**-23%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32426	42%	4%
32440	84%	-3%
Watersheds		
Marshall Creek	53%	4%
Spring Creek-Marshall Creek	25%	-1%
Census Block Groups		
120632102002	50%	3%
City of Campbellton, FL	**50%**	**3%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32324	68%	-9%
Watersheds		
East Lake Seminole	0%	0%
Ham Pond	71%	-7%
North Mosquito Creek	70%	-7%
South Mosquito Creek	58%	-23%
Census Block Groups		
120390204002	69%	-10%
120390204003	66%	-9%
120390204004	71%	-8%
City of Chattahoochee, FL	**68%**	**-9%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32428	43%	-5%
Watersheds		
Alligator Creek-Holmes Creek	43%	-6%
Reedy Branch-Holmes Creek	48%	0%
Census Block Groups		
121339701021	39%	-7%
121339701031	52%	-4%
121339701032	34%	-10%
121339701033	39%	-5%
121339701041	34%	-4%
121339701042	54%	-7%
121339701043	47%	-5%
City of Chipley, FL	**43%**	**-5%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32431	45%	-18%
32446	28%	-2%
32448	25%	4%
Watersheds		
Sapp Bay	36%	-14%
Waddells Mill Creek	48%	-14%
Census Block Groups		
120632104001	40%	-22%
120632104002	54%	-9%
120632104003	37%	-14%
City of Cottondale, FL	**41%**	**-14%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32440	49%	0%
Watersheds		
Big Branch-Holmes Creek	52%	-3%
Double Spring Bay	47%	1%
Census Block Groups		
120632103001	45%	-2%
120632103002	43%	-4%
120632103003	14%	0%
120632103004	52%	5%
120632103005	52%	-3%
City of Graceville, FL	**49%**	**0%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32442	36%	-11%
Watersheds		
Ocheesee Creek	25%	9%
Ocheesee Pond	37%	-12%
Race Pond	24%	-2%
Rocky Creek-Chipola River	14%	-19%
Census Block Groups		
120632110001	14%	-18%
120632110002	35%	-13%
120632110004	39%	-6%
City of Grand Ridge, FL	**36%**	**-11%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32330	16%	-8%
32351	46%	2%
Watersheds		
Indian Springs	45%	-6%
Tallahassee Creek	46%	-5%
Census Block Groups		
120390208001	44%	-7%
120390208003	49%	0%
City of Greensboro, FL	**45%**	**-5%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32443	26%	-4%
Watersheds		
Merritts Millpond	6%	-3%
Muddy Branch-Chipola River	33%	-15%
Census Block Groups		
120632108002	36%	-13%
120632108003	26%	-12%
City of Greenwood, FL	**26%**	**-12%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32324	72%	6%
32332	51%	-2%
32351	55%	2%
32352	35%	-5%
Watersheds		
Indian Springs	64%	-2%
Tallahassee Creek	44%	0.3%
Upper Quincy Creek	32%	-14%
Upper Rocky Comfort Creek	64%	7%
Census Block Groups		
120390203003	46%	-9%
120390203004	58%	3%
120390207012	72%	10%
120390208001	34%	-0.1%
120390208003	59%	0.1%
City of Gretna, FL	**54%**	**0.5%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32333	64%	-2%
Watersheds		
Crab Creek-Upper Little River	77%	-4%
Lower Attapulgus Creek	56%	-2%
Orchard Pond	67%	-1%
Census Block Groups		
120390201011	81%	-7%
120390201012	57%	-2%
120390201021	66%	0%
120390201022	67%	-2%
City of Havana, FL	**64%**	**-2%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32431	64%	-6%
32446	24%	-8%
Watersheds		
Little Scurlock Creek	26%	-71%
Marshall Creek	74%	0%
Waddells Mill Creek	56%	-7%
Census Block Groups		
120632102002	73%	1%
120632104001	58%	-11%
120632104002	24%	-2%
City of Jacob City, FL	**64%**	**-6%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32404	35%	-23%
32405	19%	-20%
32409	23%	-10%
32444	19%	-26%
Watersheds		
Deer Point Lake	21%	-17%
Mill Bayou-Watsons Bayou Frontal	20%	-25%
St. Andrews Bay	41%	-22%
Census Block Groups		
120050002022	23%	-10%
120050004002	35%	-19%
120050013012	22%	-29%
120050013021	25%	-22%
120050014021	13%	-33%
120050014022	16%	-27%
120050014023	14%	-34%
120050014024	12%	-33%
120050014031	17%	-30%
120050014032	13%	-27%
120050014041	11%	-26%
120050014042	32%	-14%
120050014043	11%	-33%
120050014044	17%	-24%
120050015011	13%	-11%
120050015012	2%	-1%
120050015021	3%	-26%
City of Lynn Haven, FL	**21%**	**-25%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32443	15%	-12%
32445	20%	-15%
Watersheds		
Lower Cowarts Creek	20%	-15%
Middle Cowarts Creek	18%	-5%
Census Block Groups		
120632101002	14%	-8%
120632101003	25%	-20%
City of Malone, FL	**20%**	**-14%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32443	14%	-2%
32446	35%	-15%
32448	40%	-19%
Watersheds		
Carters Mill Branch	49%	-21%
Lower Dry Creek-Chipola River	23%	-13%
Merritts Millpond	68%	-16%
Muddy Branch-Chipola River	19%	-9%
Upper Dry Creek-Chipola River	31%	-18%
Census Block Groups		
120632105001	69%	-17%
120632105002	24%	-36%
120632105003	29%	-21%
120632105004	47%	-19%
120632106001	22%	-11%
120632106002	42%	-23%
120632106003	46%	-16%
120632106004	41%	-20%
120632106005	49%	-17%
120632107001	62%	-29%
120632107002	45%	-20%
120632108003	15%	-7%
City of Marianna, FL	**37%**	**-16%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32403	30%	-18%
32456	7%	-31%
Watersheds		
Bell Shoal-Gulf of Mexico	0%	-1%
Harrison Swamp-Intercoastal Waterway Frontal	10%	-35%
Walker Bayou-Fred Bayou Frontal	17%	-24%
Census Block Groups		
120050006001	15%	-27%
City of Mexico Beach, FL	**15%**	**-27%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32401	17%	-29%
32404	37%	-29%
32405	15%	-28%
Watersheds		
Bayou George	39%	-34%
George Creek	25%	-16%
Mill Bayou-Watsons Bayou Frontal	16%	-24%
Pitts Bayou-Lairds Bayou Frontal	43%	-41%
St. Andrews Bay	17%	-8%
Census Block Groups		
120050003003	33%	-9%
120050004002	16%	-30%
120050005001	38%	-39%
120050010002	15%	-10%
120050012001	29%	-16%
120050013011	1%	-11%
120050013012	9%	-24%
120050013022	11%	-25%
120050013023	3%	-1%
120050013024	9%	-16%
120050014044	10%	-3%
120050015011	16%	-11%
120050015012	14%	-17%
120050015021	12%	-22%
120050015022	10%	-28%
120050015023	17%	-23%
120050015024	7%	-23%
120050016001	18%	-20%
120050016002	14%	-29%
120050016003	18%	-29%
120050016004	20%	-22%
120050017001	17%	-35%
120050017002	16%	-28%
120050018001	13%	-28%
120050019001	26%	-25%
120050019002	19%	-42%
120050019003	20%	-45%
120050019004	22%	-37%
120050020001	10%	-13%
120050020002	15%	-24%
120050022001	23%	-19%
120050022002	13%	-26%
120050022003	18%	-30%
120050023001	11%	-32%
120050023002	23%	-25%
120050024001	16%	-22%
120050024002	11%	-18%
120050024003	17%	-13%
120050025001	16%	-23%
120050025002	16%	-17%
City of Panama City, FL	**26%**	**-28%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32333	83%	-2%
32343	70%	2%
32351	75%	-5%
Watersheds		
East Lake Talquin	79%	2%
Holley Branch	65%	2%
Lower Little River-Lake Talquin	80%	4%
Census Block Groups		
120390206001	62%	3%
120390206002	77%	3%
City of Midway, FL	**73%**	**3%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32407	33%	-1%
32408	13%	-1%
32413	52%	-2%
Watersheds		
Alligator Bayou-Botheration Bay Frontal	33%	-2%
Eastern Lake-Phillips Inlet Frontal	47%	-2%
Intercoastal Waterway-West Bay	55%	-1%
Census Block Groups		
120050002021	59%	-3%
120050026052	7%	0%
120050027011	27%	-1%
120050027012	78%	-2%
120050027022	17%	-3%
120050027023	49%	-1%
120050027031	43%	-3%
120050027032	19%	-2%
120050027041	17%	-2%
120050027042	14%	-2%
120050027043	37%	-1%
120050027051	12%	-1%
120050027052	33%	-2%
120050027053	14%	-1%
City of Panama City Beach, FL	**46%**	**-2%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32401	34%	-27%
32404	18%	-19%
Watersheds		
Mill Bayou-Watsons Bayou Frontal	15%	-37%
Pitts Bayou-Lairds Bayou Frontal	19%	-33%
St. Andrews Bay	17%	-27%
Census Block Groups		
120050008062	45%	-7%
120050009001	22%	-35%
120050009002	10%	-29%
120050009003	20%	-37%
120050010001	7%	-37%
City of Parker, FL	**18%**	**-34%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32456	44%	-11%
Watersheds		
Depot Creek	66%	2%
Harrison Swamp-Intercoastal Waterway Frontal	34%	-25%
Searcy Creek	54%	-2%
St. Joseph Bay	38%	-11%
Census Block Groups		
120459602001	44%	-22%
120459602002	39%	-7%
120459602003	19%	-6%
120459603002	62%	-1%
120459603003	23%	-16%
120459603004	38%	-8%
120459603005	69%	-1%
City of Port St. Joe, FL	**44%**	**-11%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32351	59%	0%
32352	47%	-1%
Watersheds		
Lower Little River-Lake Talquin	54%	5%
Lower Quincy Creek	58%	-2%
Lower Rocky Comfort Creek	82%	-1%
Upper Quincy Creek	64%	1%
Upper Rocky Comfort Creek	50%	1%
Census Block Groups		
120390205001	61%	-1%
120390205002	78%	8%
120390205003	67%	-2%
120390205004	55%	0%
120390207011	49%	1%
120390207021	58%	-2%
120390207022	57%	1%
120390207023	84%	-2%
City of Quincy, FL	**59%**	**0%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32460	42%	-14%
Watersheds		
Ham Pond	42%	-14%
West Lake Seminole	40%	-18%
Census Block Groups		
120632109001	52%	-16%
120632109002	30%	-16%
120632109003	49%	-13%
City of Sneads, FL	**42%**	**-14%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32401	20%	-44%
32404	18%	-32%
32405	12%	-24%
Watersheds		
Mill Bayou-Watsons Bayou Frontal	17%	-29%
Pitts Bayou-Lairds Bayou Frontal	20%	-31%
Census Block Groups		
120050005001	31%	-30%
120050010001	14%	-30%
120050010002	18%	-29%
120050011001	20%	-31%
120050011002	15%	-28%
120050011003	14%	-28%
120050012002	19%	-23%
120050013022	9%	-37%
120050013023	9%	-27%
City of Springfield, FL	**17%**	**-29%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32462	64%	-1%
Watersheds		
Cypress Creek-Holmes Creek	31%	3%
Pippin Creek	65%	-1%
Census Block Groups		
121339703021	68%	1%
121339703023	64%	-2%
121339703031	58%	-4%
City of Vernon, FL	**64%**	**-1%**

Assessment Boundaries	UTC % in 2019	UTC % Change
ZIP Codes		
32465	68%	-5%
Watersheds		
Douglas Slough	67%	-6%
Eagle Nest Bayou-Wetappo Creek Frontal	48%	-11%
Lower Dead Lakes	90%	4%
West Arm of Dead Lakes	60%	-7%
Census Block Groups		
120459601001	83%	-8%
120459601002	74%	-3%
120459601003	48%	-11%
120459601004	69%	4%
120459601005	70%	-4%
City of Wewahitchka, FL	**68%**	**-5%**

SEPTEMBER 2021

URBAN TREE CANOPY

ASSESSMENT

HURRICANE MICHAEL: FLORIDA COMMUNITIES

FLORIDA FOREST SERVICE
Agriculture & Consumer Services

PLANIT GEO™
mapping a greener future