Final Report for Shoreline Vegetation Assessment of the Chassahowitzka and Homosassa River Systems

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List of Abbreviations

minimum flow levels	MFLs
aerial photographic interpretation	API
centimeter	cm
ft	foot
kilometer	km
land use land cover	LULC
meter	m
parts per thousand	ppt
practical salinity units	psu
river kilometer	RKm
Southwest Florida Water Management District	District
square kilometer	km^2
Water & Air Research, Inc.	Water & Air

1.0 Introduction

The purpose of this study was to gather data for the Southwest Florida Water Management District (District) to assist in the re-evaluation of the minimum flows and levels (MFLs) for the Homosassa and Chassahowitzka River systems. The District contracted with Water & Air Research, Inc. (Water & Air) to map shoreline and emergent vegetation, compare the collected data to historic data, and review the District's land use land cover (LULC) data to identify notable changes in vegetation over several years in both river systems.

By state statute, the minimum flow for a given watercourse is defined as the limit at which further withdrawals would be harmful to the water resources or the ecology of the area. The recommended minimum flows for the Chassahowitzka and the Homosassa Rivers were detailed in separate reports by the District and Balanced Environmental Management Systems, Inc. (Heyl, et al., 2012) for the Chassahowitzka River, and the District and HSW Engineering, Inc. (Leeper, et al., 2012) for the Homosassa River.

1.1 Geographic Setting

The Chassahowitzka River system is located mostly in southwestern Citrus County, Florida and parts of some of its southernmost tributaries occur within in northwestern Hernando County (Figure 1). The mainstem of the river flows approximately 9 kilometers (km) from a series of springs westward to the Gulf of Mexico (Figure 2). Spring flow includes discharge from the Chassahowitzka mainspring, Chassahowitzka #1, and Chassahowitzka #2, and averages 1.7 cubic meters per second based on USGS data (Heyl, et al., 2012). Springs in the tributary creeks that may contribute flow to the river include Baird Creek (at least five springs), Crab Creek, Salt Creek, Potter Creek (at least two springs), Crawford Creek (at least four springs), and Ryle Creek.

The surface drainage encompasses 230.5 square kilometers (km^2). In addition to the above mentioned creeks, other named marsh drainage creeks within the study area include Johnson, Lone Cabbage, and Twin Creeks along the southern shoreline, and Stevenson Creek on the north shoreline (Figure 2). Gator Creek splits from the river's main stem and rejoins it farther downstream. Little Gator Creek connects Gator Creek to the mainstem of the river.

The Homosassa River system is located within Citrus County and is approximately 10 kilometers north of the Chassahowitzka River (Figure 1). Like the Chassahowitzka River, the Homosassa River is spring fed, originating from three main springs (1, 2, and 3). The river also contains two unnamed springs (1 and 2) and at least 12 named springs (Leeper et al. 2012). The river flows approximately 13 kilometers downstream from its source to the Gulf of Mexico near Shell Island (Figure 3).

The surface water drainage basin of the Homosassa River consists of over 144 km^2 (Leeper et al. 2012). However, the springshed extends over 699 km^2 (Knochenmus and Yobbi, 2001). The Halls River is a spring-fed tributary to the Homosassa River joining the river approximately 2 kilometers downstream near river kilometer (RKm) 11 (Figure 3). The Halls River is approximately 5 kilometers long. Other tributaries of the Homosassa include Price Creek and Salt River to the north, and Battle and Petty Creeks to the south. Price Creek contributes drainage flow to the Homosassa River. However, Battle and Petty Creeks join Mason Creek, connecting these three creeks to the Gulf, south of the mouth of the Homosassa River. The Salt River connects the Homosassa River system to the Crystal River system to the north and to the Gulf of Mexico through other tidal creek systems connecting with the Salt River.

The tides associated with both rivers are semidiurnal and unequal ranging from 0.6 to 1.4 m (meters) (Wolfe, et al., 1990). However, the shallow tidal systems are strongly affected by wind direction, particularly a southwest wind.

The climate of the area is humid subtropical. The presence of the Gulf of Mexico moderates both high and low temperatures. Rainfall averages 137.2 centimeters (cm) annually with highest rainfall occurring from June through September (Leeper et al., 2012).

1.2 River Salinity

Tidal river vegetation responds to the salinity of the water that it is exposed to and in soils along the shoreline where it grows. The District has modeled salinity in the Chassahowitzka and Homosassa Rivers (Appendix). Water & Air requested that the model show recent salinity data to aid in the interpretation of data collected in this assessment. A graphic from the District for each river's salinity model shows the surface water salinities averaged over the last 3 years (2015, 2016, and 2017) to help define the location of the freshwater (<0.5 practical salinity units [psu]), oligohaline (0.5 to 5 psu, and mesohaline (5 to 18 psu) areas of the river systems (Chen, 2018).

No historical comparisons are available for the Chassahowitzka River. However, the updated salinity model helps provide a basis to compare the Water & Air results on the Homosassa River with the PBS&J data (2009) based on salinity environment of the vegetation. The freshwater zone for both the District model (Appendix) and that used by PBS&J remains within river kilometer (RKm) 13. The PBS&J oligohaline zone was restricted to RKm 11 and RKm 12 on the Homosassa and all of the Halls River. In the District's recent modeling, the oligohaline zone extended down to RKm 7 near where Price Creek meets the Homosassa. The mesohaline zone for PBS&J occurred from RKm 10 to RKm 3, whereas the District data extends from RKm 7 to RKm 0. Thus, on average, salinity on the Homosassa River was saltier during the PBS&J vegetation assessment, than that modeled over the last 3 years.

1.3 Historical Shoreline Information

Assessments of shoreline and emergent vegetation have occurred on many of Florida's coastal spring fed rivers in the past. Information on both the Chassahowitzka and Homosassa Rivers is available, although with varying methodologies. The current assessment of these two rivers borrows methods from previous assessments. One of which, is emergent and submergent vegetation mapping of the Crystal River performed by Avineon in 2010 (2009 and 2010). Water & Air used selected portions of the emergent methodology from this past assessment to conduct the current effort. This included mapping of the shoreline in segments (30 feet for the current and 10 meters for the previous).

1.3.1 Chassahowitzka

Vegetation of the Chassahowitzka was characterized in a study of seven tidal rivers along Florida's west coast conducted during 1989 and 1990 (Clewell, et al. 2002). The vegetation data collected in that study focused on herbaceous vegetation cover within and surrounding a 1.5 by 3.0 meter quadrat placed at the shoreline edge with the short axis parallel to the shoreline. Each plant observed was identified and cover visually estimated. The number and distribution of the sampling sites was based on the salinity regime. Generally, four vegetation sites were sampled for every 1 parts per thousand (ppt) of salinity gradient. The Chassahowitzka was sampled most intensively with a ratio of seven sites per 1 ppt of salinity for a total of 86 sites.

The historical vegetation data collected in the Chassahowitzka was generally compared with this survey to determine changes presence and absence of vegetation that may result from salinity changes due to sea level change and/or changes in discharge patterns. This is further described in Section 2.2.2.1.

1.3.2 Homosassa

A survey of the emergent and submergent vegetation of the Homosassa River was conducted in 2008 to assist the District in establishing MFLs for the river (PBS&J, 2009). The emergent shoreline mapping data was collected primarily along the main channel of the Homosassa River. Both natural and altered shorelines were mapped within 5 feet of the water's edge. Natural shoreline vegetation was mapped using a modified Braun-Blanquet cover classification system.

While similar, some adjustment of both data sets was necessary to compare it with the current data set. This is further described in Section 2.2.2.2.

2.0 Methods

2.1 Field Data Collection Methods

The digital shoreline boundaries for each river were provided by the District in ESRI shapefile format (Figures 2 and 3). Consistent with the approved mapping methodology, the digital shoreline boundary was divided into 30-foot (ft) segments and uniquely numbered. For each segment, shoreline information within 5 ft of the water's edge was collected. Segments were classified as either natural, altered, or water. These classifications are further described in Section 3.1.

When compiling vegetation data for a segment, each distinct species was classified as dominant, co-dominant or present to characterize relative abundance. Dominant species were defined as generally covering at least 40 percent or more of a segment with no other species having higher than 25 percent cover. Additionally, if only one species was present in a segment, that species was classified as dominant regardless of abundance. Co-dominant species were defined as multiple (typically two) species within a segment having similar cover of at least 25 percent or higher with no other species in higher abundance. Present species were defined as having at least 1 percent cover and not designated as dominant or co-dominant.

Initially, high-resolution aerial photographic imagery (FDOT, 2018) was used to perform an aerial photographic interpretation (API) of the study areas. The API analysis provided a rough estimate of the shoreline types and vegetative communities for each segment, prior to conducting the field data collection. Information collected during the API analysis included shoreline type (natural or altered and herbaceous or forested), and species dominance or co-dominance. Species presence was not noted during the API analysis. API data was collected on a spreadsheet and joined with the digital shoreline boundary in ESRI ArcGIS.

A shapefile of the shoreline boundary data was created to assist in field data collection and to field-truth the API data. The shapefiles were uploaded to a tablet with GPS capability and overlaid on a recent aerial image. This allowed field teams to identify the segment number, view the API data, and fully characterize the shoreline of each individual segment. The shoreline segments were assessed visually by a field team of ecologists from a small boat or airboat traveling along the shoreline. Shoreline data was recorded by segments or ranges of segments on a fieldsheet. In some areas, unique or unusual species were encountered and field collection of vegetation samples was done for closer examination of plant material or collected for later identification in the lab. The data from the fieldsheets were transferred into a spreadsheet for each river.

Quality control of the API and field data was comprehensive. This included visiting all segments identified during the API, reviewing fieldsheets, and revisiting areas with potential transcription or mapping anomalies. GIS data including tables, maps and metadata were developed using ESRI ArcMap 10.5.

2.2 Data Compilation and Analysis Methods

2.2.1 Shoreline Assessment 2018

For each river, the final 2018 shoreline vegetation data was grouped by RKm. The data was compiled showing number of segments where a species was listed as dominant, co-dominant, or present. This compilation focused on only the most abundant (dominant and co-dominant species by RKm.

2.2.2 Shoreline Change Analysis

2.2.2.1 Chassahowitzka

The historical vegetation data available for the Chassahowitzka River system was limited. As noted in Section 1.3.1, only transect point location data was available for the past study. For those historical transects only species presence data (which focused on herbaceous species) were available.

A subset of data from the current study was used to compare it to the previous study. The subset was assembled in two ways. The first was to associate one transect point from the historical data to the three closest 30-ft segments from the current data set. It should be noted that area of comparison was much larger for the current data set. The historical assessment conducted in 1989 to 1990 used a 1.5-m wide by 3-m deep (5-ft by 10-ft) quadrat at each transect point, whereas the 2018 assessment used 30-ft wide by 5-ft deep linear segments mapped continuously along the shoreline. Therefore, the linear area of shoreline comparison for the 2018 data was much larger than that of the individual 1989 to 1990 transects (90 ft compared to 1.5 m or 5 ft).

Next, the species present in the selected segments were compared to the species listed for the associated transect. When comparing the historical location data it was noted that 4 of the 86 transect points were outside the current survey area. Therefore, data for 82 historical transects were used to compare to the 2018 data (Figure 4).

2.2.2.2 Homosassa

Comparable historical vegetation data for the Homosassa River system was available and was acquired from the District. As noted in Section 1.3.2, some adjustment of both data sets was necessary to allow for a thorough comparison. First, the current shoreline boundary data was clipped to mirror only the area assessed in the previous study. As illustrated in Figure 5 the assessment area for the current study was substantially larger than that of the previous study.

Next, the data from the 2008 study was adjusted for comparison with the subset of 2018 data. In the previous study a modified Braun-Blanquet-type cover classification system was used to characterize species abundance (PBS&J, 2009). Four distinct classifications were defined in 2008 study: 1 to 25 percent cover, 25 to 50 percent cover, 50 to 75 percent cover, and 75 to 100 percent cover. A plan was developed by Water & Air and approved by the District to convert this cover class-type data to the current dominant/co-dominant/present classifications. Conversions were done for each species on a segment by segment basis. Dominant, co-dominant, and present classifications were assigned based on the cover class of species in a segment.

For the 2008 study data, the conversion to dominant, co-dominant or present classifications were conducted based on the species composition and cover within a segment. Dominant species were defined as having the single highest cover classification with no other species within the segment having higher than 25 percent cover. Additionally, if only one species was present in a segment, that species was classified as dominant regardless of abundance. Co-dominant species were defined as multiple (typically two) species having similar cover and no other species within that segment having greater abundance. Present species were defined as having at least one percent cover and not designated as dominant or co-dominant.

Once converted, the data was grouped by RKm and compared. Emphasis was placed on changes in species dominance and co-dominance. A visual assessment of vegetation shifts was done by overlaying the change assessment data on a recent aerial image in GIS. This was conducted to verify changes noted in the data review.

2.2.3 Land Use Land Cover Analysis

Water & Air was tasked to review the District's LULC data to identify vegetative changes in both the Homosassa and Chassahowitzka River systems comparing the 1990, 1999, and 2010 data sets. However, problems were noted early on with the 1990 data set (positional accuracy, mapping methodology differences, etc.). This data set was replaced with the District's 1995 data set, providing an assessment of vegetative changes over 15 years (1995, 1999, and 2010).

The LULC data for this analysis, including shapefiles of the assessment areas for both river systems (Figure 6) were acquired from the District. A change analysis was performed on the three data sets yielding 3-year range comparisons; 1995 to 1999, 1999 to 2010, and 1995 to 2010. Water & Air provided a full set of change data to the District for the LULC analysis. However, only vegetative changes to relevant Florida Land Use, Cover and Forms Classification System (FLUCCS) level III (6xx) classified wetland communities (FDOT, 1999) were analyzed and discussed in this report. The data analysis focused on finding classification shifts related to salinity changes or sea-level rise such as: forested wetlands to saltwater marsh, freshwater marsh to saltwater marsh, and saltwater marsh to open water cover types. Using a minimum mapping unit of 0.1 acre for individual changes, the data was reviewed for any notable losses or gains in acreage of these classification types. Polygons of the individual transition areas were created in GIS and overlaid on a recent aerial photograph to visually assess the changes noted in the data review.

3.0 Results

3.1 Shoreline Assessment 2018

The 2018 mapped shoreline segments were classified as either natural or altered (Figures 7 and 8). When comparing the assessment areas of the two rivers, the percentage of altered shoreline for the Homosassa River (14.5 percent) was much higher than that of the Chassahowitzka River (1.8 percent) (Table 1). Altered shoreline types included seawall, rip-rap, or modified (Figures 9 and 10). The seawall shoreline type was applied to shorelines consisting of solid, concrete seawalls. The shoreline of rip-rap segments was constructed of loose stones or stacked bags of concrete. The modified shoreline type applies to areas where the shoreline is not artificially hardened but does show evidence of maintenance or modification (mowing, pruning, landscaping, etc.), within 5 ft of the water's edge. It should be noted that vegetation was mapped in altered shoreline segments. For seawall and rip-rap areas, vegetation was mapped only if growing waterward of the hardened shoreline. For modified areas, vegetation was mapped waterward of any obvious maintenance activities (mowing, pruning, etc.). Typically, only presence was noted for vegetation mapped in altered areas.

Natural shoreline types included herbaceous, forested, or rock/shell. The herbaceous shoreline type was dominated by non-woody vegetation. Forested segments were dominated or co-dominated by woody species. Rock/shell segments were void of vegetation within 5 ft of the water's edge and were typically comprised of either limerock or oyster shell.

A total of 52 species were identified and mapped on the Chassahowitzka River in 2018 (Table 2). A total of 59 species were identified and mapped on the Homosassa and Halls River in 2018 (Table 3). Of interest, is the relatively high prevalence of cover by the mangrove vegetation in the Homosassa River as compared to the Chassahowitzka River.

3.1.1 Chassahowitzka River and Tributaries

Unlike the Homosassa and Halls River, the 2018 data for the Chassahowitzka River was not clipped to mirror the assessed area in the previous study. The data was grouped by RKm along the mainstem and also included the tributary creeks which lie within the RKm zones (Figure 11). This was done in such a way that no creek, except Gator Creek, was split between RKm's. Gator Creek is not a drainage creek, nor does it have a spring at its upper terminus, but rather it is an alternate pathway of flow for the mainstem of the Chassahowitzka River. There is one creek that could somewhat confound the data understanding in RKm 4 to RKm 3. The upper end of Crawford Creek is in the oligohaline zone due to several springs that contribute flow at its upper end.

The Chassahowitzka River is oligohaline from its uppermost extent at RKm 9 to approximately RKm 5 at the entrance to the National Wildlife Refuge. The most prevalent vegetation community found in the uppermost portions of the river was hydric hammock consisting of a cover of cabbage palm (*Sabal palmetto*), red maple (*Acer rubrum)*, sweetbay (*Magnolia virginiana*), sweetgum (*Liquidambar styraciflua*), swampbay (*Persea palustris*), red cedar (*Juniperus virginiana*) and American elm (*Ulmus americana*). This diverse community type varied in composition depending upon location. In many areas no dominance was easily discernible by observation from the boat partially due the season (winter) and the lack of foliage. Therefore, it was generally mapped as native forest with species presence. In some instances, *Sabal palmetto* was prevalent along the shore and those areas were mapped as such. However, the location of the community is available and presence by species is listed the dataset. For the Chassahowitzka, much of the hydric hammock did not occur at the water's edge, unlike the Homosassa River. Generally, there was a band of emergent, herbaceous vegetation waterward of the forest community. Therefore, in this analysis, some areas that were vegetated by a mixture of hydric hammock trees greater than 5 ft from water's edge will not be accounted for.

For RKm 9 to RKm 5 the dominant vegetation community was hydric hammock, so dominance was not determined in those shorelines where species other than *Sabal palmetto* or *Juniperus virginiana* dominated the edge. In RKm 9 to RKm 8 the most common herbaceous species along this stretch of the river (which includes Crab Creek) were the freshwater stringlily (*Crinum americanum*) and common reed (*Phragmites australis*) (Table 4). At RKm 8 to RKm 7 *Sabal palmetto* had a notable amount dominant and co-dominant segments, owing to the presence of the hydric hammock community and *Sabal palmetto's* shoreline dominance in that vegetation type as well as *Juniperus virginiana*. This river section includes Baird Creek, which was lined with sawgrass (*Cladium jamaicense*) for much of its length and contributed to *Cladium jamaicense* being the most dominant species in this RKm zone. The freshwater species cattail

(*Typha* sp.) and *Phragmites australis* dominated some length of shoreline in this RKm zone as well.

In RKm 7 to RKm 6 *Cladium jamaicense* and *Typha* sp. predominated as the herbaceous shoreline cover while the very high cover of *Sabal palmetto* (623 dominant/co-dominant segments) (Table 4) was indicative of the hydric hammock lined shoreline along the river and Salt and Potter Creeks. Within RKm 6 to RKm 5, *Cladium jamaicense* and *Typha* sp. occurred along margins of the river's shoreline along with *Sabal palmetto*, again indicative of presence of the hydric hammock. There were no creeks included in this stretch of the Chassahowitzka River mainstem.

At RKm 5 to RKm 4, the river becomes saltier with salinities above 5 psu (Appendix). This change to mesohaline conditions changes the predominant vegetation to varieties more tolerant to saltier, brackish water conditions. Vegetation in this section of the river include *Cladium jamaicense*, black needlerush (*Juncus roemerianus*), *Sabal palmetto*, smooth cordgrass (*Spartina alterniflora*), and *Typha* sp*.* in descending order of prevalence. Both *Juncus roemerianus* and *Spartina alterniflora* appear in this river section as dominant or co-dominant shoreline vegetation. This section of the river also includes Stevenson Creek to the north and Johnson Creek to the south, as well as the upstream end of Gator Creek.

Within RKm 4 to RKm 3 the shoreline vegetation is similar to RKm 5 to RKm 4 but includes a notable amount of *Typha* sp. *Sabal palmetto* returns as an important cover. These observations result from the higher freshwater flow emanating from springs in the upstream portions of Crawford Creek. Crawford Creek emerges within the hydric hammock community as springs discharge into the creek. This section of Crawford Creek is in the oligohaline zone, supporting more freshwater plant species indicative of this area such as the hydric hammock community (*Sabal palmetto* and *Juniperus virginiana*) and *Typha* sp. Another species that becomes dominant in this river section is leatherfern (*Acrostichum* sp.) found along the banks of tidal creeks. Two unnamed drainage creeks to the north and south of the river support primarily herbaceous tidal marsh species. At RKm 3 to RKm 2 *Juncus roemerianus*, *Cladium jamaicense*, *Spartina alterniflora*, and *Acrostichum* sp. (in descending order) dominate the banks of the river and tidal creeks including Ryle Creek to the south, and an unnamed creek to the north of the river. Similar species are observed along RKm 2 to RKm 1, except that *Cladium jamaicense* becomes less common than *Spartina alterniflora*. *Acrostichum* sp. tends to dominate smaller sections of the tidal creeks.

3.1.2 Homosassa and Halls Rivers

The assessment of the 2018 data focused on the mainstems of the Homosassa and Halls Rivers, closely mirroring the mapping area of the historical data set for the system

(Figure 12). Therefore, this discussion excludes consideration of the northern tributaries of Price Creek and Salt River, as well as Battle Creek, Petty Creek and Mason Creek to the south. This has the advantage of avoid the confounding conditions that both the north and south creek/river systems independently interconnect with the Gulf of Mexico. Although the data is cleaner this way, the influence of these tributaries on conditions in the mainstem still must be considered. It should be noted that this is an approximation of the mainstem shoreline, since the boundary was clipped to match the historic shoreline data collection. Nevertheless, this provides a reasonable way to view the 2018 data.

Table 5 outlines the relative abundance of shoreline species by RKm that were mapped along the mainstems of the Homosassa and Halls Rivers in 2018. The most prevalent vegetation community found in the uppermost portions of the river was hydric hammock consisting of *Sabal palmetto*, *Acer rubrum*, *Magnolia virginiana*, *Liquidambar styraciflua*, *Persea palustris*, *Juniperus virginiana,* and *Ulmus floridana*. This diverse community type varied in composition depending upon location. In many areas no dominance was easily discernible by observation from the boat. Therefore, it was generally mapped as native forest with species presence. In some instances, *Sabal palmetto* was prevalent along the shore and those areas were mapped as such. However, the location of the community is available and presence by species is listed in the dataset.

Nineteen species showed dominance or co-dominance along the Homosassa River (Table 5). Of these, nine species were woody, 10 were herbaceous. The only species that was dominant or co-dominant in the upper freshwater portion of the river (RKm 13 to RKm 12) was *Crinum americanum.* This RKm zone was the only part of the river where it was found. Moving downstream to RKm 12 to RKm 11, *Sabal palmetto* dominated this stretch of the river, likely occurring as a sporadic dominant along the hydric hammock community shoreline. Areas of forest exist on both shorelines, predominately on the southern shoreline. In RKm 11 to RKm 10, the north shoreline is mostly altered by residential and a few commercial uses, whereas the southern shoreline is mostly forested. Three species occur in this river reach with low linear coverage: *Cladium jamaicense*, *Sabal palmetto*, and *Typha* sp. RKm 11 is near the mouth of Halls River, which will be discussed separately. RKm 10 to RKm 9 shows a similar pattern with a developed shoreline on the north bank of the river and forested hydric hammock along the south shore. Low levels of occurrence of the herbaceous species *Cladium jamaicense* and *Phragmites australis* were noted in this section. In summary, the natural forested shoreline predominates the undeveloped shorelines between RKm 13 and RKm 9 and is marked by occasional patches of *Sabal palmetto* dominance. Scattered occurrences of herbaceous species, tolerant of freshwater or the lower salinity sections of the oligohaline zone, occur in small stretches of the shoreline.

The most notable of these species are *Crinum americanum*, *Cladium jamaicense*, *Typha* sp., and *Phragmites australis*.

In RKm 9 to RKm 8 shoreline dominance and co-dominance increases to six species in descending order of coverage: *Cladium jamaicense* (18 segments), *Juniperus virginiana*, *Sabal palmetto*, *Typha* sp., umbrella plant (*Cyperus involucratus*) and *Phragmites australis* (two segments) (Table 5). All these species have occurred in upriver sections (*Juniperus virginiana* as part of the hydric hammock community) except the exotic, *Cyperus involucratus*. This section of the river is fairly well developed along both banks of the river. From RKm 8 to RKm 7, the north shore of the river is developed, while the south shore is mostly undeveloped herbaceous marsh. Large sections of *Juncus roemerianus*, *Cladium jamaicense*, and *Acrostichum* sp. dominate this shoreline with smaller areas of *Typha* sp., *Juniperus virginiana*, saltgrass (*Distichlis spicata*), Brazilian pepper (*Schinus terebinthifolius*), and buttonwood (*Conocarpus erecta*). RKm 7 to RKm 6 includes long stretches of shoreline dominated by *Juncus roemerianus* and *Cladium jamaicense*. The remaining dominant species in smaller numbers include in descending order: *Juniperus virginiana* (seven segments), red mangrove (*Rhizophora mangle*), *Schinus terebinthifolius*, *Spartina alterniflora*, *Sabal palmetto*, and *Typha* sp. (two segments). Of note, is the first occurrence of *Rhizophora mangle*, and *Spartina alterniflora*. In addition, RKm 6 marks the end of the oligohaline zone of the river.

In RKm 6 to RKm 5 *Juncus roemerianus* dominates the shoreline covering 127 segments. Of note is the presence of *Schinus terebinthifolius*, an invasive exotic, dominant in 39 segments. Numerous other species have intermediate coverages of shoreline including black mangrove (*Avicennia germinans*), *Rhizophora mangle*, *Cladium jamaicense*, *Juniperus virginiana*, and *Conocarpus erectus*.

From RKm 6 of the river to the mouth, both *Rhizophora mangle* and *Avicennia germinans* contribute to important coverage of the river's shoreline. With a third species, *Juncus roemerianus*, these three species help define the dominant species of the river and the mesohaline zone. Species only occurring from RKm 6 to the mouth of the river include *Avicennia germinans*, bigleaf sumpweed (*Iva frutescens*), christmasberry (*Lycium carolinianum*), and Bahaman aster (*Symphyotrichum bahamense*).

Rhizophora mangle is noted from RKm 7 to RKm 0, whereas *Avicennia germinans* occurs from RKm 6 to RKm 0 as dominant shoreline covers. *Juncus roemerianus* occurred farther up river in from RKm 8 to RKm 0. Both the highest shoreline coverages of *Rhizophora mangle* and *Avicennia germinans* occur farthest downstream, RKm 0 to RKm 2, and RKm 0 to RKm 3, respectively. *Juncus roemerianus* alternatively has its highest shoreline coverages from RKm 2 to RKm 4.

Mangrove distribution is not by necessity limited by river salinity. The fluxes of mangrove species (*Rhizophora mangle, Avicennia germinans* and *Laguncularia racemosa*, and to a lesser extent, *Conocarpus erectus*) are driven by freeze tolerances of these more tropical species, and to some degree tidal pulses (extreme tides/storm tides) that allow the floating propagules to reach suitable substrate for establishment. *Avicennia germinans* is the most freeze tolerant. Tolerance between *Lagucularia racemosa* and *Rhizophora mangle* is variable. *Rhizophora mangle* is most frequently the most waterward colonizer, and is protected from freezing somewhat by the presence of warmer spring water. However, if a freeze affects the branch tips throughout the *Rhizophora* tree, it will die, since meristematic tissue only occurs on the branch tips. *Lagucularia* is the least abundant of the three mangroves in the river system and is more often the first affected by low temperatures. However, severe freeze damage may appear to kill the tree, but it has the ability to re-sprout from its roots, unlike *Rhizophora mangle*. During the study, evidence of freeze protection afforded by proximity to the water was observed on a shoreline vegetated with *Conocarpus erectus*. After a period of nighttime freezing temperatures *Conocarpus* developed an obvious horizontal line several feet above the water, where the upper tree leaves were seriously damaged and brown. Below that line leaves appeared green and alive.

The Halls River exists only within the oligohaline zone of the Homosassa River system. The Halls River is mostly undeveloped down to the bridge near the confluence with the Homosassa. The two most common species include *Cladium jamaicense* and *Juncus roemerianus*, both starting in RKm 4 to RKm 3 and continuing to where the Halls River meets the Homosassa River. They make up more than 90 percent of the dominate species associated with the herbaceous shoreline of the Halls River. Like the Homosassa River, areas of the Halls River include native forest (hydric hammock) shoreline. In this analysis, areas vegetated by a mixture of hydric trees will not be considered, although data is available on the shoreline length and composition of this forest.

3.2 Shoreline Change Analysis

3.2.1 Chassahowitzka

A review of the change analysis comparison data showed several notable changes in presence along the Chassahowitzka River (Table 6). One species was noted in 2018 as having a decrease in presence as compared to the historical survey conducted in 1989 to 1990. *Cladium jamaicense* is noted as having decreased in the number of transect locations present between RKm's 1 to 3 (Figure 13).

Four species were noted as having an increase in presence when compared to the historical survey. An increase in presence was observed for *Rhizophora mangle* and

Spartina alterniflora between RKm's 1 to 4. *Rhizophora* was not seen at any of the transect locations during the 1989 to 1990 study. *Cladium* and *Crinum americanum* was noted as having an increase in presence between RKm 7 to RKm 8.

Increases in presence were seen in all river kilometers, most notably in the hydric hammock portions of the river between RKm's 5 to 9. An increase in the presence of many woody species was noted in this portion of the river. This is likely due to differences in the size of assessment areas between the data sets as described in Section 2.2.2.1. The methodology used by Clewell (2002) was not focused on the capture of woody species.

3.2.2 Homosassa

A review of the current survey data showed several vegetative shifts in dominance as compared to the historical vegetation data for the Homosassa and Halls Rivers (Tables 7 and 8). Three species showed increases in the number of segments mapped as dominant or co-dominant in 2018.

Rhizophora mangle increased in total segment occurrence by 1,331. Occurrence is defined as the total number of present, dominant and co-dominant segments for a given species. The number of dominant and co-dominant segments increased by 537. Most of the increase in dominant and co-dominant segments (533) was noted between RKm's 0 to 6 of the Homosassa River (Figure 14).

Avicennia germinans increased in total segment occurrence by 1,087. The number of dominant and co-dominant segments increased by 247. Most of the increase in dominant and co-dominant segments (212) occurred between RKm's 0 to 4 of the Homosassa River (Figure 15).

Cladium jamaicense increased in total segment occurrence by 68. The number of dominant and co-dominant segments increased by 88. Most of the increase in dominant and co-dominant segments (75) occurred within RKm 1 to RKm 2 of the Halls River (Figure 16).

Three species showed decreases in the number of segments mapped as dominant or co-dominant in 2018.

Juncus roemerianus decreased in total segment occurrence by 78. The number of dominant and co-dominant segments decreased by 742. Most of the decrease in dominant and co-dominant segments (714) occurred between RKm's 0 to 4 of the Homosassa River (Figure 17). An increase in dominant and co-dominant segments (53) was observed between RKm's 1 to 3 of the Halls River (Figure 18).

Juniperus virginiana decreased in total segment occurrence by 297. The number of dominant and co-dominant segments decreased by 546. Most of the decrease in dominant and co-dominant segments (370) occurred between RKm’s 2 to 6 of the Homosassa River (Figure 19). A decrease in dominant and co-dominant segments (93) was also observed between RKm’s 0 to 3 of the Halls River.

Typha sp. decreased in total segment occurrence by 126. The number of dominant and co-dominant segments decreased by 150. Most of the decrease in dominant and co-dominant segments (130) occurred between RKm’s 1 to 3 of the Halls River (Figure 20).

Decreases in dominance and co-dominance were noted for *Magnolia virginiana*, *Acer rubrum*, and *Sabal palmetto* between RKm’s 9 to 11 of the Homosassa River (Table 7). However, the total occurrence for each of these species increased in the same areas. This suggests that the change in dominance and co-dominance may reflect a difference in data collection methodology for mapping hydric hammock shorelines.

3.3 Land Use Land Cover Analysis

A review of the LULC analysis data showed very little change over the 15-year review period for both river systems. Change that was noted in the data set was then reviewed in GIS to determine its legitimacy. Most of the changes between relevant vegetation types in each system had a net loss of less than 2 acres over each river LULC assessment area.

3.3.1 Chassahowitzka

An analysis of the LULC data for the Chassahowitzka River and surrounding area revealed no notable changes in the FLUCCS level III relevant vegetative communities.

3.3.2 Homosassa

An analysis of the LULC data for the Homosassa River and surrounding area identified one plausible instance of notable change in level III vegetative communities. When reviewing the 1995 to 2010 analysis data, a net loss in acreage of wetland forested mix (FLUCCS 630) (FDOT, 1999) was noted. Specifically, a total of 36.62 acres of wetland forested mix in multiple locations has transitioned to saltwater marsh (FLUCCS 642) (FDOT, 1999). A review of the GIS data overlaid on a recent aerial photograph confirmed that this shift in vegetative communities is probable. An example of one area that has transitioned from wetland forested mix to saltwater marsh is illustrated in Figure 21.

4.0 Summary of Findings

4.1 Shoreline Assessment 2018

Data from all the Chassahowitzka River and its tributaries show *Juncus roemerianus* (Figure 22) being the most dominant shoreline species covering 2,915 of all dominant or co-dominant shoreline segments, with *Cladium jamaicense* (Figure 23) being a close second covering 2,882 segments (Table 4). However, *Cladium* occurs in slightly more total shoreline segments overall than *Juncus* (5002 and 4257, respectively) (Table 4). The third most prevalent shoreline species river wide is *Sabal palmetto* (Figure 24) reflecting the importance of the hydric hammock community to this river system especially upstream from RKm 5.

Data from the mainstem of the Homosassa River shows the prevailing species as *Juncus roemerianus*, being dominant or co-dominant in 1,168 shoreline segments (Table 5) (Figure 25). *Rhizophora mangle* was the next most dominant species occurring in 1,002 dominant or co-dominant segments (Figure 26). Both of these species occur entirely within RKm's 8 to 0 along the Homosassa River. However, *Juncus roemerianus* is noted as the second most dominant species in the Halls River occurring in 142 dominant or co-dominant shoreline segments (Table 5). The most prevalent species in and along the Halls River is *Cladium jamaicense* occurring in 286 dominant or co-dominant segments from RKm 0 to just above RKm 3 (Figure 27).

4.2 Shoreline Change Analysis

Shoreline and emergent plant species distributions are limited by a combination of salt-stress tolerance and competition (Crain et al. 2004). Both saltwater plants and freshwater plants tend to flourish when grown separately in fresh water. However, when growing together in a fresh water environment saltwater plants were suppressed by the competitively superior freshwater plants. Conversely, saltwater plants outcompete freshwater plants in saltier environments due to their ability to tolerate salt stress better. Therefore, the zonation of plants across a salinity gradient is caused by a combination of competitive displacement in more fresh water reaches and stress tolerance in saltier reaches of the systems.

For the Chassahowitzka River, the most notable changes in presence occurred between RKm's 1 to 3 for *Cladium jamaicense* (Table 6). The decrease in presence at transect locations for *Cladium* was magnified by the noted differences in the mapping techniques between the historical and current study. As explained in Section 2.2.2.1, the larger area of comparison for the 2018 favored an increase in presence. However, the decline in presence of *Cladium* suggests an actual decrease of this relatively more salt intolerant species in the lower river kilometer zones (Figure 13).

Increases were noted for more salt-tolerant species (*Rhizophora mangle* and *Spartina alterniflora*) in the lower river and increases in relatively less salt-tolerant herbaceous species (*Cladium jamaicense* and *Crinum americanum*) in the upper river are similar to trends seen in the Homosassa River. However, given the data collection and mapping differences between the two sets, few conclusions can be drawn from this comparison alone.

For the Homosassa River shifts in vegetative dominance occurred primarily between RKm's 0 to 6 (Table 7). The decrease in dominance of *Juncus roemerianus* (Figure 17) and *Juniperus virginiana* (Figure 19) was overshadowed by the increase in *Rhizophora mangle* (Figure 14) and *Avicennia germinans* (Figure 15) between RKm's 0 to 6. Disparities in these numbers are likely a result of mangroves' tendency to grow further water-ward than other species normally would. During the 10 years between these two assessments, there has been an increase in mangrove growth, which is an indicator of a warmer period and possibly sea level rise (Williams, et al., 1999). Mangroves occur near their northern limit in this area of the Florida coast. The mangrove community's ability to persist is dependent on surviving hard freezes. Moderating affects on freezes include water temperature, tidal cycle at the freeze peek, wind, substrate (limestone), adjacent tree canopy, and freeze tolerance of the individual mangrove species.

In observations of some sections of the Homosassa River, *Rhizophora mangle* was noted as colonizing limestone rock shelves, supplanting *Juniperus virginiana* and *Sabal palmetto* as the most water ward emergent. This is not a true displacement or replacement, but a colonization of a barren rock area, more seaward than the original *Juniperus virginiana* /*Sabal palmetto* association. The actual dynamics are unknown, but invasion resulting from sea level rise is a possibility, as well as the nearby tree canopy buffering young mangroves from killing freezes.

For the Halls River, a shift in vegetative dominance occurred between RKm's 1 to 3 (Table 8). The decrease in *Typha* sp. (Figure 20), a less salt-tolerant species, and the increase in *Juncus roemerianus* (Figure 18) and *Cladium jamaicense* (Figure 16) (relatively more salt-tolerant species) indicates a shift toward a more salt-tolerant plant community in the Halls River system.

Also, in the Halls River, a decrease in dominance of *Juniperus virginiana* was noted for RKm's 0 to 3. However, the total occurrence for this species remained the same or decreased only slightly within the same RKm's. As noted in Section 3.3.2, this suggests that the change in dominance and co-dominance may reflect a difference in data collection methodology for mapping hydric hammock shorelines.

4.3 Land Use Land Cover Analysis

Relatively little credible change was observed over the 15-year time period for the LULC analysis. For the Chassahowitzka River LULC assessment area, any relevant classification shifts were minimal (less than 2 acres total). However, for the Homosassa River LULC assessment area, some relevant vegetative changes were noted and flagged in the data review but were deemed improbable upon further review in GIS. This is potentially due to a lack of consistency in mapping methods between the three mapping years: 1995, 1999, and 2010. These data layers were likely generated using different source materials, with differing positional accuracy, and employing slightly different mapping methodologies.

One example of an improbable vegetative shift was noted in the vicinity of the Halls River. This change was from saltwater marsh to freshwater marsh (FLUCCS 641) (FDOT, 1999) totaling 498.35 acres. After reviewing the area in GIS it was apparent that this shift was not valid. It is likely that different mapping methodologies were used to define these areas, creating a false change between data sets.

Another example was noted in vegetative communities in the outer islands of the Homosassa River. A shift from saltwater marsh to bays and estuaries (FLUCCS 540) (FDOT, 1999) totaling 30.91 acres was noted. However, many of the shifts in this scenario can likely be attributed to mapping errors associated with the differences in mapping between years. In the immediate vicinity of many of the marsh to open water-type changes, the opposite scenario (open water to marsh) has also been mapped, indicating positional shift of the photography between data sets.

The analysis of the LULC data for the Chassahowitzka and Homosassa Rivers did identify one plausible instance of important change in FLUCCS level III classified vegetative communities. A change was observed in the Homosassa LULC assessment area from forested wetland to herbaceous marsh totaling 36.62 acres. This type of change illustrates a possible increase in salinity due to sea level rise (Williams, et al., 1999).

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APPENDIX

THREE-YEAR AVERAGE SURFACE SALINITY STUDY FOR CHASSAHOWITZKA AND HOMOSASSA RIVERS

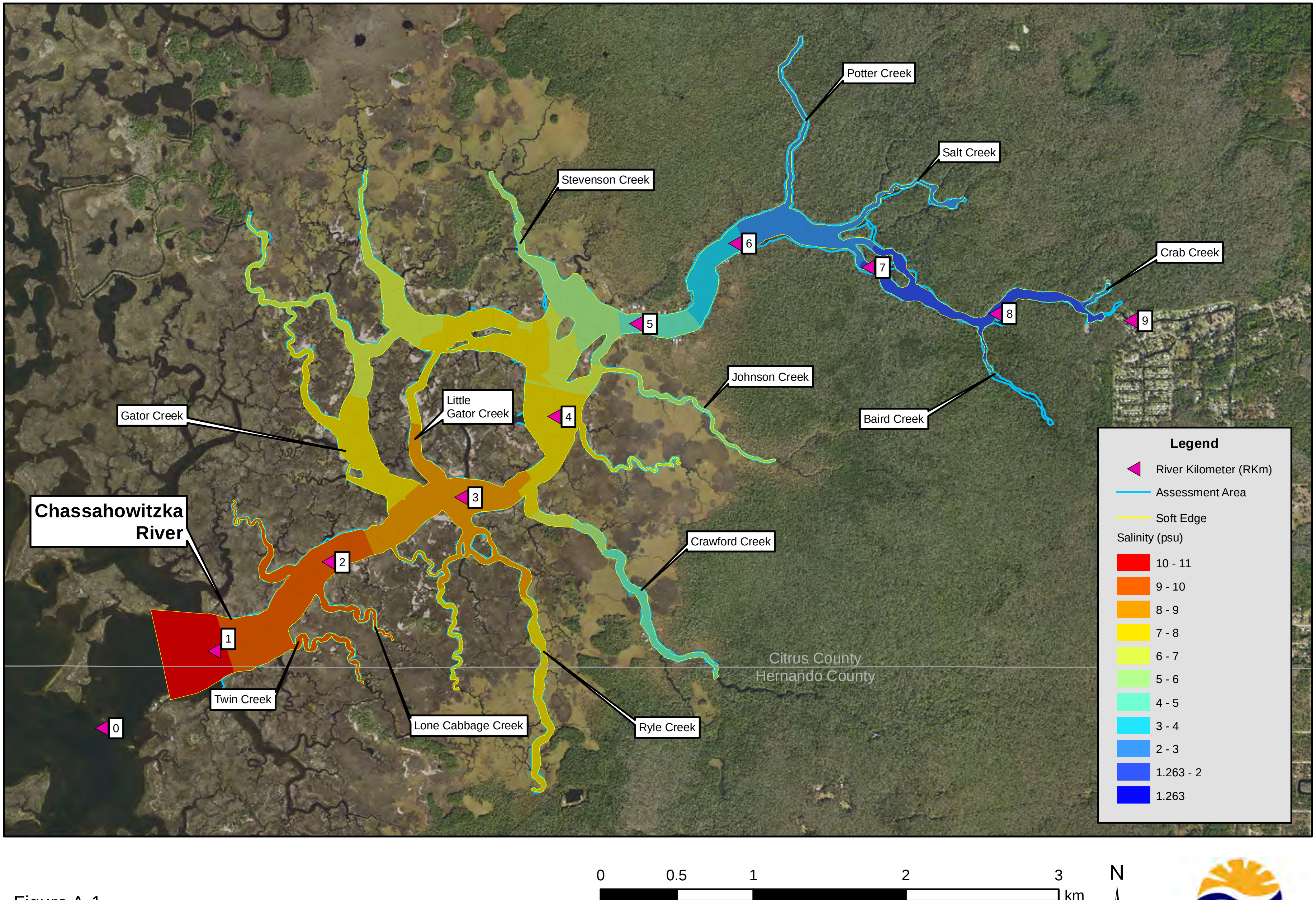

Figure A-1.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing 3-Year Average Surface Salinity
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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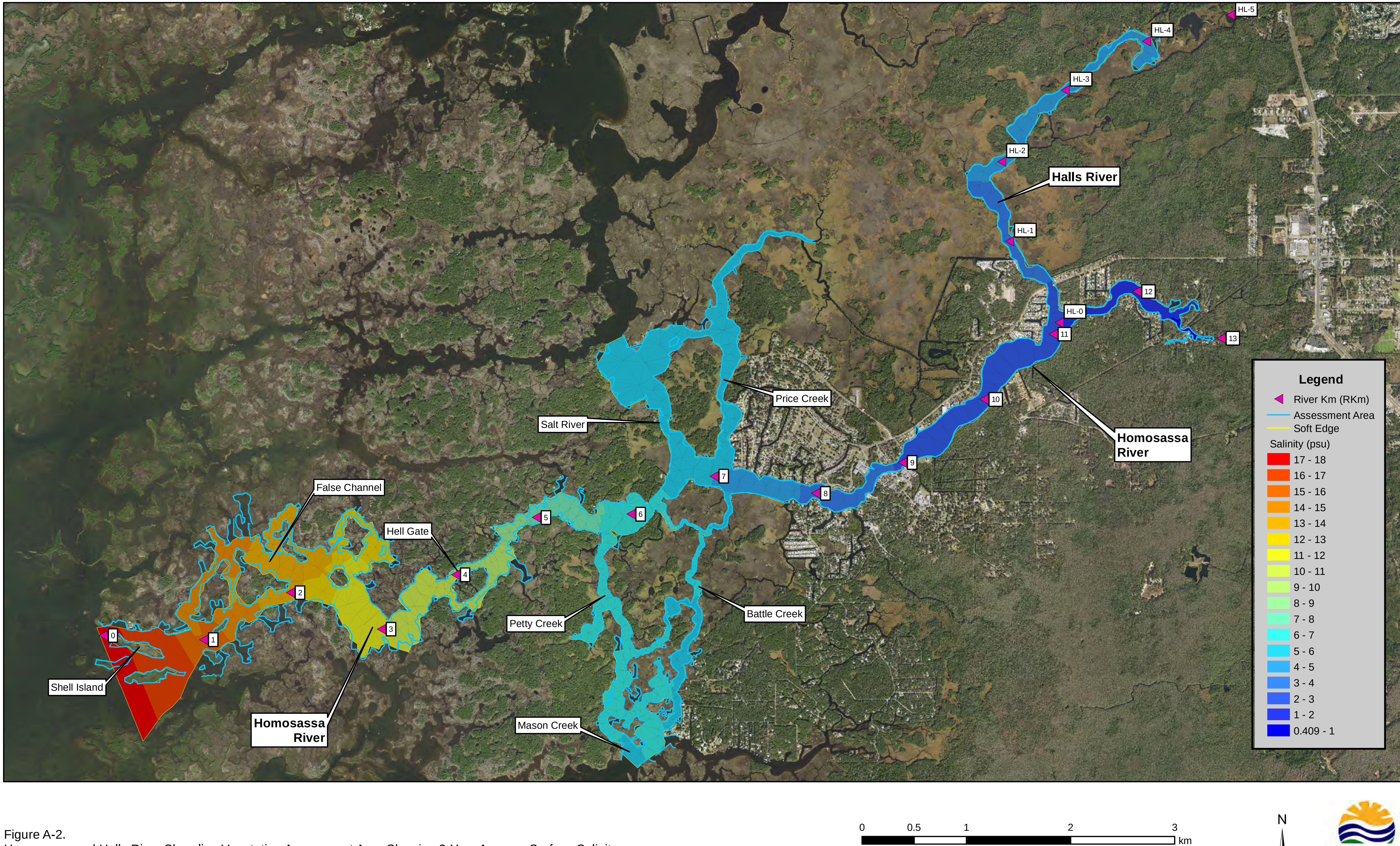

Figure A-2.
Homosassa and Halls River Shoreline Vegetation Assessment Area Showing 3-Year Average Surface Salinity
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

water & air RESEARCH, INC.

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TABLES

Table 1. Comparison of Natural and Altered Shorelines mapped along the Chassahowitzka and Homosassa Rivers in 2018.

	Chassahowitzka			Homosassa		
	Natural Shoreline	Altered Shoreline	Total Shoreline	Natural Shoreline	Altered Shoreline	Total Shoreline
Length (feet)	211254	3780	215034	286670	48655	335325
Percentage	98.2%	1.8%	100.0%	85.5%	14.5%	100.0%

Table 2. List of Mapped Species along the Chassahowitzka River in 2018.

Chassahowitzka Shoreline Species List - 2018	
Binomial	**Common name**
Acer rubrum	Red maple
Acrostichum sp.	Leatherfern
Avicennia germinans	Black mangrove
Baccharis sp.	Saltbush
Blutaparon vermiculare	Samphire
Borrichia frutescens	Bushy seaside oxeye
Carpinus caroliniana	American hornbeam
Celtis laevigata	Sugarberry
Cladium jamaicense	Sawgrass
Cornus foemina	Swamp dogwood
Crinum americanum	Seven-sisters; Spiderlily
Cyperus involcratus	Umbrella plant
Distichlis spicata	Saltgrass
Ilex sp.	Holly
Iris virginica	Virginia iris
Iva frutescens	Bigleaf sumpweed
Juncus roemerianus	Black needlerush
Juniperus virginiana	Red cedar
Laguncularia racemosa	White mangrove
Liquidambar styraciflua	Sweetgum
Ludwigia repens	Creeping primrosewillow
Lycium carolinianum	Christmasberry
Magnolia grandiflora	Southern magnolia
Magnolia virginiana	Sweetbay
Morella cerifera	Wax myrtle
Nyssa sylvatica	Blackgum
Paspalidium geminatum	Egyptian paspalidium
Persea palustris	Swamp bay
Phragmites australis	Common reed
Psychotria nervosa	Wild coffee
Quercus laurifolia	Laurel oak
Quercus nigra	Water oak
Quercus shumardii	Shumard's oak
Quercus virginiana	Live oak
Rhizophora mangle	Red mangrove
Sabal palmetto	Cabbage palm
Sagittaria lancifolia subsp. Lancifolia	Bulltongue arrowhead
Salicornia virginica	Glasswort

Table 2. List of Mapped Species along the Chassahowitzka River in 2018.

Chassahowitzka Shoreline Species List - 2018	
Binomial	**Common name**
Schinus terebinthifolia	Brazilian pepper-tree
Scirpus sp.	Bulrush
Serenoa repens	Saw palmetto
Solidago sempervirens	Seaside goldenrod
Spartina alterniflora	Smooth cordgrass
Spartina patens	Marshhay cordgrass
Symphyotrichum bahamense	Bahaman aster
Taxodium sp.	Cypress
Tilia americana	Carolina basswood
Triglochin striata	Arrowgrass
Typha sp.	Cattail
Ulmus americana	American elm
Unidentified tropical shrub	Tropical shrub
Yucca aloifolia	Spanish bayonet

Table 3. List of mapped species along the Homosassa River in 2018.

Homosassa Shoreline Species List - 2018	
Binomial	**Common Name**
Acer rubrum	Red maple
Acrostichum sp.	Leatherfern
Amaranthus australis	Southern amaranth
Arundo donax	Giant reed
Avicennia germinans	Black mangrove
Baccharis sp.	Saltbush
Blutaparon vermiculare	Samphire
Borrichia frutescens	Bushy seaside oxeye
Carya aquatica	Water hickory
Celtis laevigata	Sugarberry
Cladium jamaicense	Sawgrass
Conocarpus erectus	Buttonwood
Cornus foemina	Swamp dogwood
Crinum americanum	Spiderlily
Cyperus involcuratus	Umbrella plant
Distichlis spicata	Saltgrass
Fraxinus sp.	Ash
Ilex cassine	Dahoon holly
Ilex sp.	Holly
Iris virginica	Virginia iris
Iva frutescens	Bigleaf sumpweed
Juncus roemerianus	Black needlerush
Juniperus virginiana	Red cedar
Laguncularia racemosa	White mangrove
Liquidambar styraciflua	Sweetgum
Ludwigia sp.	Primrosewillow
Lycium carolinianum	Christmasberry
Magnolia virginiana	Sweetbay
Morella cerifera	Wax myrtle
Persea palustris	Swamp bay
Phragmites australis	Common reed
Quercus laurifolia	Laurel oak
Quercus virginiana	Live oak
Rhizophora mangle	Red mangrove
Ruellia simplex	Britton's wild petunia
Sabal palmetto	Cabbage palm
Salix caroliniana	Carolina willow
Salicornia virginica	Glasswort
Schinus terebinthifolia	Brazilian pepper-tree
Scirpus sp.	Bulrush
Serenoa repens	Saw palmetto
Sesuvium portulacastrum	Shoreline purslane
Sideroxylon tenax	Tough bully
Solidago sempervirens	Seaside goldenrod

Table 3. List of mapped species along the Homosassa River in 2018.

Homosassa Shoreline Species List - 2018	
Binomial	**Common Name**
Spartina alterniflora	Smooth cordgrass
Spartina bakeri	Sand cordgrass
Spartina patens	Marshhay cordgrass
Sphagneticola trilobata	Creeping oxeye
Spiranthes sp.	Ladies tresses
Stenotaphrum secundatum	St. Augustinegrass
Symphyotrichum bahamense	Bahaman aster
Symphyotrichum carolinianum	Climbing aster
Thelypteris sp.	Marsh fern
Tripsacum dactyloides	Eastern gamagrass
Typha sp.	Cattail
Ulmus americana	American elm
Unidentified exotic bamboo	Exotic bamboo
Viburnum obovatum	Walter's viburnum
Yucca aloifolia	Spanish bayonet

Table 4. Relative abundance of shoreline vegetation species in number of segments by RK mapped along the Chassahowitzka River and tributaries in 2018.

		1-2			2-3			3-4			4-5			5-6			6-7			7-8			8-9			Total		
Binomial	**Veg Type**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**
Acer rubrum	W	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	107	0	0	150	0	0	165	0	0	429	0	0
Acrostichum sp.	H	151	20	13	842	103	73	464	21	19	194	2	2	104	0	8	639	0	0	288	6	0	158	0	0	2840	152	115
Avicennia germinans	W	116	0	0	190	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	381	0	0
Baccharis sp.	W	2	0	0	52	2	0	170	0	0	66	0	0	41	0	0	167	0	0	258	6	0	174	0	0	930	8	0
Blutaparon vermiculare	W	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0
Borrichia frutescens	W	0	1	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1	0
Carpinus caroliniana	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	38	0	0
Celtis laevigata	W	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Cladium jamaicense	H	133	19	36	585	97	567	394	145	470	200	250	589	40	64	100	388	275	101	285	46	123	95	0	0	2120	896	1986
Cornus foemina	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	74	0	0	144	0	0
Crinum americanum	H	0	0	0	0	0	0	13	0	0	0	0	0	59	0	0	573	4	2	306	14	0	201	0	22	1152	18	24
Cyperus involcratus	H	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	43	0	0	38	0	0	86	0	0
Distichlis spicata	H	143	27	41	275	15	22	94	5	12	48	2	6	0	0	0	22	0	2	8	0	0	0	0	0	590	49	83
Ilex sp.	W	0	0	0	0	0	0	4	0	0	0	0	0	7	0	0	160	0	0	235	0	0	129	0	0	535	0	0
Iris virginica	H	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	137	0	0	0	0	0	12	0	0	162	0	0
Iva frutescens	W	0	0	0	2	0	0	7	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	27	0	0
Juncus roemerianus	H	115	132	506	444	233	1082	259	137	386	409	241	178	87	3	2	28	0	0	0	6	9	0	0	0	1342	752	2163
Juniperus virginiana	W	0	0	0	2	7	0	126	0	25	52	2	0	74	0	0	458	4	0	272	60	62	206	0	0	1190	73	87
Laguncularia racemosa	W	22	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0
Liquidambar styraciflua	W	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	106	0	0	151	0	0	222	0	0	483	0	0
Ludwigia repens	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	15	0	0
Lycium carolinianum	W	14	0	0	148	4	0	43	6	0	24	0	0	7	0	0	0	0	0	0	0	0	0	0	0	236	10	0
Magnolia grandiflora	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	0	0	74	0	0	148	0	0
Magnolia virginiana	W	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	396	0	0	233	0	0	217	0	0	865	0	0
Morella cerifera	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	177	0	0	229	0	0	200	0	0	606	0	0
Nyssa sylvatica	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	38	0	0
Paspalidium geminatum	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	42	0	0	143	0	0	194	0	0
Persea palustris	W	0	0	0	0	0	0	31	0	0	14	0	0	0	0	0	148	0	0	127	0	0	74	0	0	394	0	0
Phragmites australis	H	0	0	0	0	0	0	2	3	0	0	0	0	0	0	3	0	0	2	13	0	9	0	0	9	15	3	23
Psychotria nervosa	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	19	0	0
Quercus laurifolia	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	212	0	0	320	0	0
Quercus nigra	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	38	0	0
Quercus shumardii	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	38	0	0
Quercus virginiana	W	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	183	0	0	278	8	0	227	0	0	701	8	0
Rhizophora mangle	W	493	0	0	1036	0	0	476	4	0	360	0	0	67	0	0	111	0	0	0	0	0	0	0	0	2543	4	0
Sabal palmetto	W	4	2	0	368	11	12	183	24	58	117	30	26	106	64	14	117	263	360	294	47	72	252	0	0	1441	441	542
Sagittaria lancifolia	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	18	0	0
Salicornia virginica	H	22	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	4	0
Schinus terebinthifolia	W	9	0	0	0	0	0	10	0	0	24	0	0	0	0	0	103	0	0	27	0	0	0	0	0	173	0	0
Scirpus sp.	H	54	2	3	215	5	2	38	2	0	0	0	2	16	0	0	53	0	0	0	0	0	0	0	0	376	9	7
Serenoa repens	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	19	0	0
Solidago sempervirens	H	34	1	1	8	0	0	0	0	0	10	0	0	13	0	0	15	0	0	14	0	0	0	0	0	94	1	1
Spartina alterniflora	H	341	78	49	534	129	89	323	55	42	110	13	24	91	0	0	242	4	0	21	0	0	0	0	0	1662	279	204
Spartina patens	H	4	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0
Symphyotrichum bahamense	W	26	0	0	35	0	0	4	0	0	7	0	0	7	0	0	382	0	0	268	0	0	201	0	0	930	0	0
Taxodium sp.	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	29	0	0	126	0	0	168	0	0
Tilia americana	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	74	0	0	101	0	0
Triglochin striata	H	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Typha sp.	H	78	0	0	183	0	17	378	10	25	213	0	23	36	3	11	260	8	70	51	7	19	0	0	0	1199	28	165
Ulmus americana	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	146	0	0	129	0	0	383	0	0
unidentified tropical shrub	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	43	0	0	0	0	0	45	0	0
Yucca aloifolia	H	0	0	0	0	0	0	22	0	0	24	0	0	37	0	0	81	0	0	12	0	0	0	0	0	176	0	0

*For Veg Type, H = herbaceous species, W = woody species.

Note: P = Present, C = Co-dominant, D = Dominant

Table 5. Relative abundance of shoreline vegetation species in number of segments by RK mapped along the mainstems of the Homosassa and Halls Rivers in 2018.

Homosassa River (RK 0-1 to 6-7)

		0-1			1-2			2-3			3-4			4-5			5-6			6-7		
Binomial	**Veg Type***	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**
Acer rubrum	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acrostichum sp.	H	59	0	0	39	7	0	12	0	0	14	10	0	94	19	0	85	0	0	86	0	0
Amaranthus australis	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arundo donax	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avicennia germinans	W	338	103	26	307	81	43	369	43	22	131	4	28	100	5	6	49	33	6	23	0	0
Baccharis sp.	W	25	0	0	33	0	0	15	0	0	3	0	0	17	0	0	22	0	0	42	0	0
Blutaparon vermiculare	W	72	0	0	91	0	0	22	0	0	9	0	0	17	0	0	0	0	0	11	0	0
Borrichia frutescens	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carya aquatica	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0
Celtis laevigata	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0
Cladium jamaicense	H	13	5	0	1	0	0	0	0	0	11	0	7	21	0	0	41	0	11	22	4	32
Conocarpus erectus	W	53	7	0	66	0	0	29	4	7	32	0	0	51	22	4	42	16	2	19	0	0
Cornus foemina	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crinum americanum	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Cyperus involcuratus	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distichlis spicata	H	15	0	0	6	0	0	6	0	0	0	0	0	27	0	0	5	0	0	26	0	0
Fraxinus sp.	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilex cassine	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilex sp.	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iris virginica	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iva frutescens	W	89	7	1	17	0	0	18	0	0	27	0	0	16	0	0	10	0	0	45	0	0
Juncus roemerianus	H	240	42	74	344	61	103	200	78	171	121	93	139	118	22	112	47	6	121	27	2	108
Juniperus virginiana	W	41	0	5	5	0	1	14	0	3	29	0	3	122	2	47	134	5	7	141	5	2
Laguncularia racemosa	W	291	0	0	191	0	0	242	0	0	20	0	0	11	0	0	24	0	0	0	0	0
Liquidambar styraciflua	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ludwigia sp.	W	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
Lycium carolinianum	W	149	1	4	48	0	0	56	0	4	12	0	2	113	0	0	47	0	0	20	0	0
Magnolia virginiana	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Morella cerifera	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Persea palustris	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmites australis	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	10	0	0
Quercus laurifolia	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus virginiana	W	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	36	0	0	52	0	0
Rhizophora mangle	W	182	132	187	191	86	215	316	46	158	274	56	39	218	27	19	168	26	7	139	0	4
Ruellia simplex	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sabal palmetto	W	2	0	0	2	0	0	13	0	0	34	0	0	128	0	0	61	0	0	138	6	0
Salix caroliniana	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salicornia virginica	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schinus terebinthifolia	W	88	6	12	19	0	7	28	0	26	41	0	16	116	0	5	78	21	18	39	1	3
Scirpus sp.	H	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
Serenoa repens	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sesuvium portulacastrum	H	28	0	0	19	0	0	5	0	0	6	0	0	11	0	0	0	0	0	6	0	0
Sideroxylon tenax	W	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0
Solidago sempervirens	H	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spartina alterniflora	H	227	3	0	286	11	0	118	5	0	129	42	2	22	1	0	8	0	0	1	0	3
Spartina bakeri	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Spartina patens	H	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	10	0	0	0	0	0
Sphagneticola trilobata	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiranthes sp.	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stenotaphrum secundatum	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum bahamense	W	92	0	0	41	0	0	53	4	7	51	5	6	158	0	18	82	0	0	57	0	0
Symphyotrichum carolinianum	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thelypteris sp.	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tripsacum dactyloides	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha sp.	H	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	2	2	0
Ulmus americana	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified exotic bamboo	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viburnum obovatum	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yucca aloifolia	H	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0

Homosassa River (RK 7-8 to 12-13, Total)

	7-8			8-9			9-10			10-11			11-12			12-13			Total		
Binomial	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**
Acer rubrum	0	0	0	3	0	0	69	0	0	81	0	0	72	0	0	78	0	0	303	0	0
Acrostichum sp.	44	0	22	74	0	0	62	0	0	81	0	0	99	0	0	94	0	0	843	36	22
Amaranthus australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arundo donax	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	4	0	0
Avicennia germinans	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1323	269	131
Baccharis sp.	6	0	0	14	0	0	91	0	0	92	0	0	80	0	0	81	0	0	521	0	0
Blutaparon vermiculare	0	0	0	12	0	0	49	0	0	0	0	0	0	0	0	0	0	0	283	0	0
Borrichia frutescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carya aquatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0
Celtis laevigata	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0
Cladium jamaicense	28	23	15	40	4	14	91	0	2	83	1	11	52	0	0	14	0	0	417	37	92
Conocarpus erectus	7	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	299	49	15
Cornus foemina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6	0	0
Crinum americanum	0	0	0	0	0	0	0	0	0	0	0	0	47	0	0	141	0	3	190	0	3
Cyperus involcuratus	0	0	0	17	0	3	0	0	0	8	0	0	51	0	0	0	0	0	76	0	3
Distichlis spicata	0	0	3	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	107	0	3
Fraxinus sp.	0	0	0	2	0	0	0	0	0	2	0	0	56	0	0	36	0	0	96	0	0
Ilex cassine	0	0	0	0	0	0	0	0	0	28	0	0	69	0	0	107	0	0	204	0	0
Ilex sp.	0	0	0	0	0	0	62	0	0	42	0	0	0	0	0	0	0	0	104	0	0
Iris virginica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0
Iva frutescens	0	0	0	45	0	0	62	0	0	70	0	0	29	0	0	0	0	0	428	7	1
Juncus roemerianus	47	5	31	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1147	309	859
Juniperus virginiana	25	0	6	10	1	12	84	0	0	53	0	0	41	0	0	3	0	0	702	13	86
Laguncularia racemosa	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	786	0	0
Liquidambar styraciflua	0	0	0	0	0	0	0	0	0	0	0	0	47	0	0	41	0	0	88	0	0
Ludwigia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Lycium carolinianum	20	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	468	1	10
Magnolia virginiana	0	0	0	0	0	0	62	0	0	42	0	0	72	0	0	153	0	0	329	0	0
Morella cerifera	0	0	0	10	0	0	84	0	0	44	0	0	75	0	0	130	0	0	343	0	0
Persea palustris	0	0	0	0	0	0	0	0	0	39	0	0	29	0	0	27	0	0	95	0	0
Phragmites australis	0	0	0	13	0	2	122	0	5	53	0	0	50	0	0	74	0	0	336	0	7
Quercus laurifolia	0	0	0	2	0	0	22	0	0	2	0	0	87	0	0	137	0	0	250	0	0
Quercus virginiana	2	0	0	3	0	0	1	0	0	0	0	0	0	0	0	1	0	0	104	0	0
Rhizophora mangle	104	0	0	72	0	0	55	0	0	8	0	0	29	0	0	0	0	0	1756	373	629
Ruellia simplex	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Sabal palmetto	2	0	0	127	3	7	133	0	0	84	0	8	84	0	34	68	0	0	876	9	49
Salix caroliniana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salicornia virginica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schinus terebinthifolia	5	0	2	15	0	0	91	0	0	42	0	0	0	0	0	0	0	0	562	28	89
Scirpus sp.	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0
Serenoa repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6	0	0
Sesuvium portulacastrum	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81	0	0
Sideroxylon tenax	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0
Solidago sempervirens	0	0	0	0	0	0	0	0	0	39	0	0	44	0	0	59	0	0	144	0	0
Spartina alterniflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	791	62	5
Spartina bakeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Spartina patens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0
Sphagneticola trilobata	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0
Spiranthes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6	0	0
Stenotaphrum secundatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum bahamense	72	0	0	84	0	0	118	0	0	81	0	0	29	0	0	60	0	0	978	9	31
Symphyotrichum carolinianum	0	0	0	0	0	0	0	0	0	39	0	0	99	0	0	59	0	0	197	0	0
Thelypteris sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Tripsacum dactyloides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Typha sp.	40	18	3	73	2	6	118	0	0	55	1	0	0	0	0	0	0	0	303	23	9
Ulmus americana	0	0	0	0	0	0	22	0	0	28	0	0	41	0	0	0	0	0	91	0	0
Unidentified exotic bamboo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	0	0	57	0	0
Viburnum obovatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	16	0	0
Yucca aloifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0

Halls River

	0-1			1-2			2-3			3-4			Total		
Binomial	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**	**P**	**C**	**D**
Acer rubrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acrostichum sp.	30	0	0	115	0	0	104	0	2	11	0	0	260	0	2
Amaranthus australis	0	0	0	7	0	0	0	0	0	0	0	0	7	0	0
Arundo donax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avicennia germinans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sp.	23	0	0	0	0	0	10	0	0	0	0	0	33	0	0
Blutaparon vermiculare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borrichia frutescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carya aquatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Celtis laevigata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladium jamaicense	20	0	46	31	34	109	115	19	65	5	0	13	171	53	233
Conocarpus erectus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cornus foemina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crinum americanum	19	0	0	0	0	0	7	0	0	5	0	0	31	0	0
Cyperus involcuratus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distichlis spicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fraxinus sp.	8	0	0	0	0	0	5	0	0	0	0	0	13	0	0
Ilex cassine	19	0	0	0	0	0	10	0	0	0	0	0	29	0	0
Ilex sp.	19	0	0	0	0	0	0	0	0	0	0	0	19	0	0
Iris virginica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iva frutescens	0	0	0	0	0	0	10	0	0	0	0	0	10	0	0
Juncus roemerianus	16	0	4	99	27	24	33	19	63	24	0	5	172	46	96
Juniperus virginiana	59	0	0	17	0	0	64	0	0	0	0	0	140	0	0
Laguncularia racemosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liquidambar styraciflua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ludwigia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lycium carolinianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnolia virginiana	19	0	0	6	0	0	0	0	0	0	0	0	25	0	0
Morella cerifera	33	0	0	13	0	0	59	0	0	0	0	0	105	0	0
Persea palustris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phragmites australis	20	0	2	5	0	0	0	0	0	0	0	0	25	0	2
Quercus laurifolia	19	0	0	0	0	0	0	0	0	0	0	0	19	0	0
Quercus virginiana	0	0	0	13	0	0	43	0	0	0	0	0	56	0	0
Rhizophora mangle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruellia simplex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sabal palmetto	63	0	0	48	0	0	75	0	0	0	0	0	186	0	0
Salix caroliniana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salicornia virginica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schinus terebinthifolia	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Scirpus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serenoa repens	0	0	0	11	0	0	43	0	5	0	0	0	54	0	5
Sesuvium portulacastrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sideroxylon tenax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago sempervirens	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Spartina alterniflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spartina bakeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spartina patens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphagneticola trilobata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spiranthes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stenotaphrum secundatum	6	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Symphyotrichum bahamense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Symphyotrichum carolinianum	19	0	0	0	0	0	0	0	0	0	0	0	19	0	0
Thelypteris sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tripsacum dactyloides	4	0	0	6	0	0	31	0	0	0	0	0	41	0	0
Typha sp.	20	0	0	62	7	4	21	0	9	0	0	11	103	7	24
Ulmus americana	19	0	0	0	0	0	0	0	0	0	0	0	19	0	0
Unidentified exotic bamboo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viburnum obovatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yucca aloifolia	0	0	0	7	0	0	31	0	0	0	0	0	38	0	0

*For Veg Type, H = herbaceous species, W = woody species.

Note: P = Present, C = Co-dominant, D = Dominant

Table 6. Notable changes in presence of shoreline vegetation species at historical transect locations by river kilometer along the Chassahowitzka River between 1989-1990 and 2018.

			Number of Transect Locations		
Chassahowitzka River Kilometer	Number of Transects in River Kilometer	Binomial	1989-1990	2018	Difference between 1989-1990 and 2018
1-2	12	*Cladium jamaicense*	8	1	-7
		Rhizophora mangle	0	11	11
		Spartina alterniflora	2	12	10
2-3	13	*Cladium jamaicense*	12	0	-12
		Rhizophora mangle	0	13	13
		Spartina alterniflora	0	13	13
3-4	9	*Rhizophora mangle*	0	5	5
		Spartina alterniflora	1	8	7
7-8	9	*Cladium jamaicense*	2	8	6
		Crinum americanum	1	8	7

Table 7. Shifts in the number of segments for shoreline vegetation species by RKm along the Homosassa River between 2018 and 2008.

Homosassa River Kilometer	Binomial	2018 P	2018 CD	2018 D	2018 Occurance Total	2018 D/CD Total	2008 P	2008 CD	2008 D	2008 Occurance Total	2008 D/CD Total	Occurance Total Difference	D/CD Difference
0-1	*Avicennia germinans*	338	103	26	467	129	164	39	57	260	96	207	33
	Juncus roemerianus	240	42	74	356	116	127	137	157	421	294	-65	-178
	Rhizophora mangle	182	132	187	501	319	239	115	83	437	198	64	121
1-2	*Avicennia germinans*	307	81	43	431	124	186	21	2	209	23	222	101
	Juncus roemerianus	344	61	103	508	164	145	78	310	533	388	-25	-224
	Rhizophora mangle	191	86	215	492	301	261	46	97	404	143	88	158
2-3	*Avicennia germinans*	369	43	22	434	65	112	1	18	131	19	303	46
	Juncus roemerianus	200	78	171	449	249	73	73	403	549	476	-100	-227
	Juniperus virginiana	14	0	3	17	3	97	30	19	146	49	-129	-46
	Rhizophora mangle	316	46	158	520	204	204	85	19	308	104	212	100
3-4	*Avicennia germinans*	131	4	28	163	32	0	0	0	0	0	163	32
	Juncus roemerianus	121	93	139	353	232	34	30	287	351	317	2	-85
	Juniperus virginiana	29	0	3	32	3	43	17	44	104	61	-72	-58
	Rhizophora mangle	274	56	39	369	95	146	20	0	166	20	203	75
4-5	*Juniperus virginiana*	122	2	47	171	49	20	51	114	185	165	-14	-116
	Rhizophora mangle	218	27	19	264	46	55	0	0	55	0	209	46
5-6	*Juniperus virginiana*	134	5	7	146	12	22	47	51	120	98	26	-86
	Rhizophora mangle	168	26	7	201	33	46	0	0	46	0	155	33
9-10	*Acer rubrum*	69	0	0	69	0	17	13	0	30	13	39	-13
	Magnolia virginiana	62	0	0	62	0	19	27	17	63	44	-1	-44
	Sabal palmetto	133	0	0	133	0	33	13	0	46	13	87	-13
10-11	*Acer rubrum*	81	0	0	81	0	7	47	0	54	47	27	-47
	Magnolia virginiana	42	0	0	42	0	32	0	4	36	4	6	-4
	Sabal palmetto	84	0	8	92	8	23	59	0	82	59	10	-51

Table 8. Notable shifts in the number of segments for shoreline vegetation species by RKm along the Halls River between 2018 and 2008.

		2018					2008						
Halls River Kilometer	Binomial	P	CD	D	Occurance Total	D/CD Total	P	CD	D	Occurance Total	D/CD Total	Occurance Total Difference	D/CD Difference
0-1	*Juniperus virginiana*	59	0	0	59	0	32	36	0	68	36	-9	-36
1-2	*Cladium jamaicense*	31	34	109	174	143	95	10	58	163	68	11	75
	Juncus roemerianus	99	27	24	150	51	45	0	24	69	24	81	27
	Juniperus virginiana	17	0	0	17	0	0	16	0	16	16	1	-16
	Typha sp.	62	7	4	73	11	82	10	84	176	94	-103	-83
2-3	*Juncus roemerianus*	33	19	63	115	82	55	34	22	111	56	4	26
	Juniperus virginiana	64	0	0	64	0	40	29	12	81	41	-17	-41
	Typha sp.	21	0	9	30	9	92	14	42	148	56	-118	-47

Note: P = Present, C = Co-dominant, D = Dominant

FIGURES

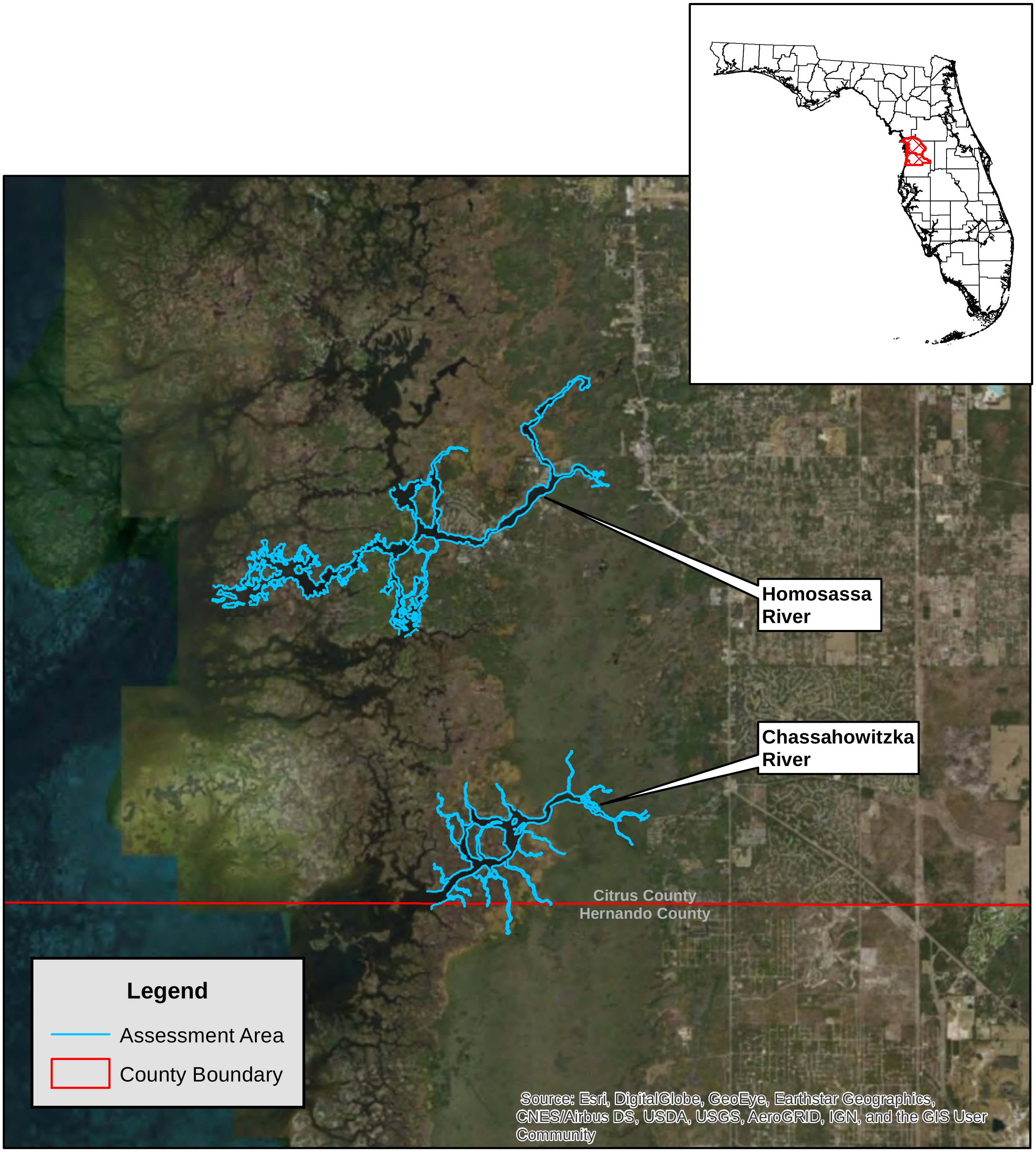

Figure 1.
Location Map of the Chassahowitzka and Homosassa Rivers
Citrus and Hernando Counties, Florida

Source: SWFWMD, 2018; Water & Air Research, Inc., 2018.

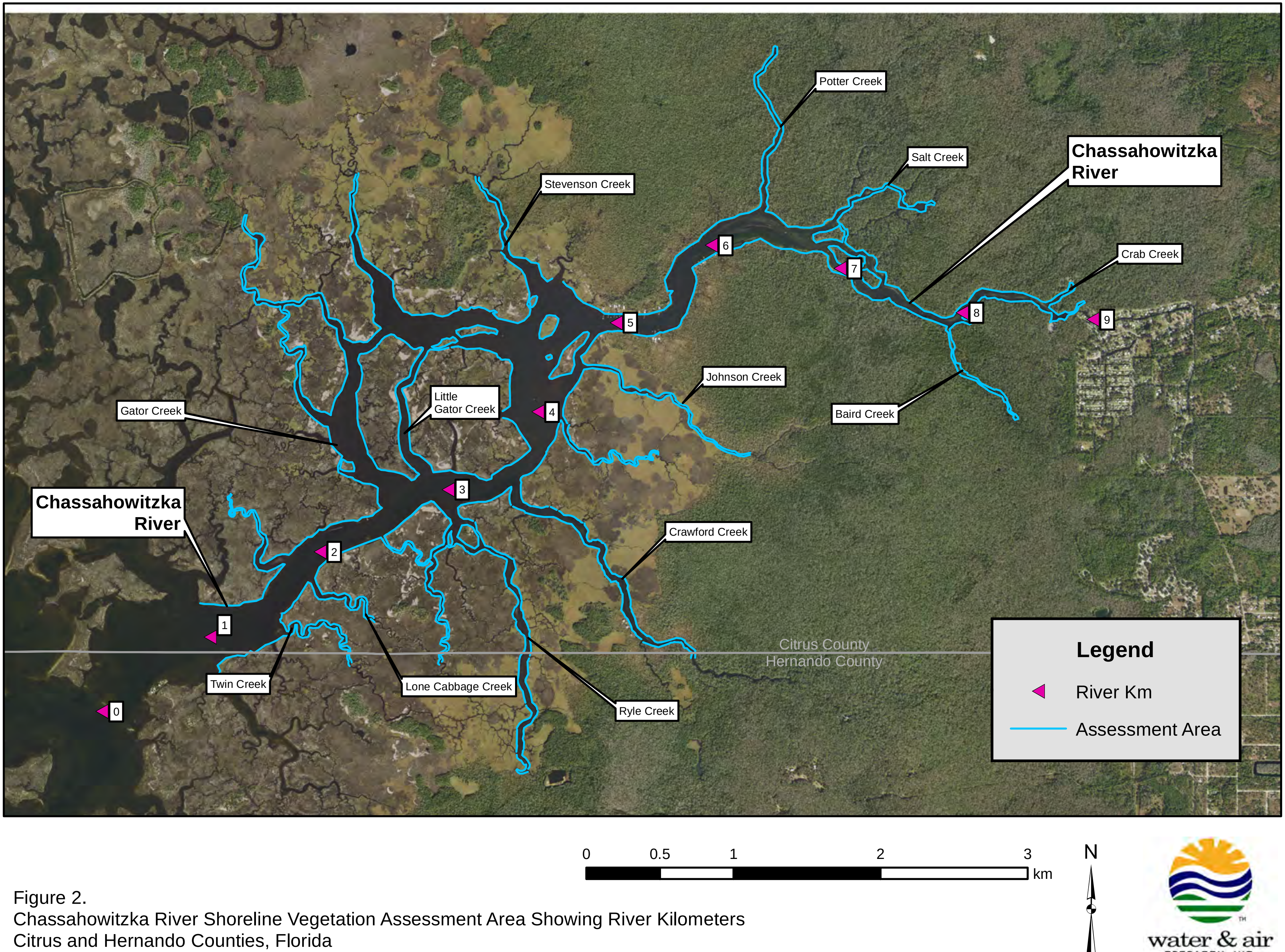

Figure 2.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing River Kilometers
Citrus and Hernando Counties, Florida
Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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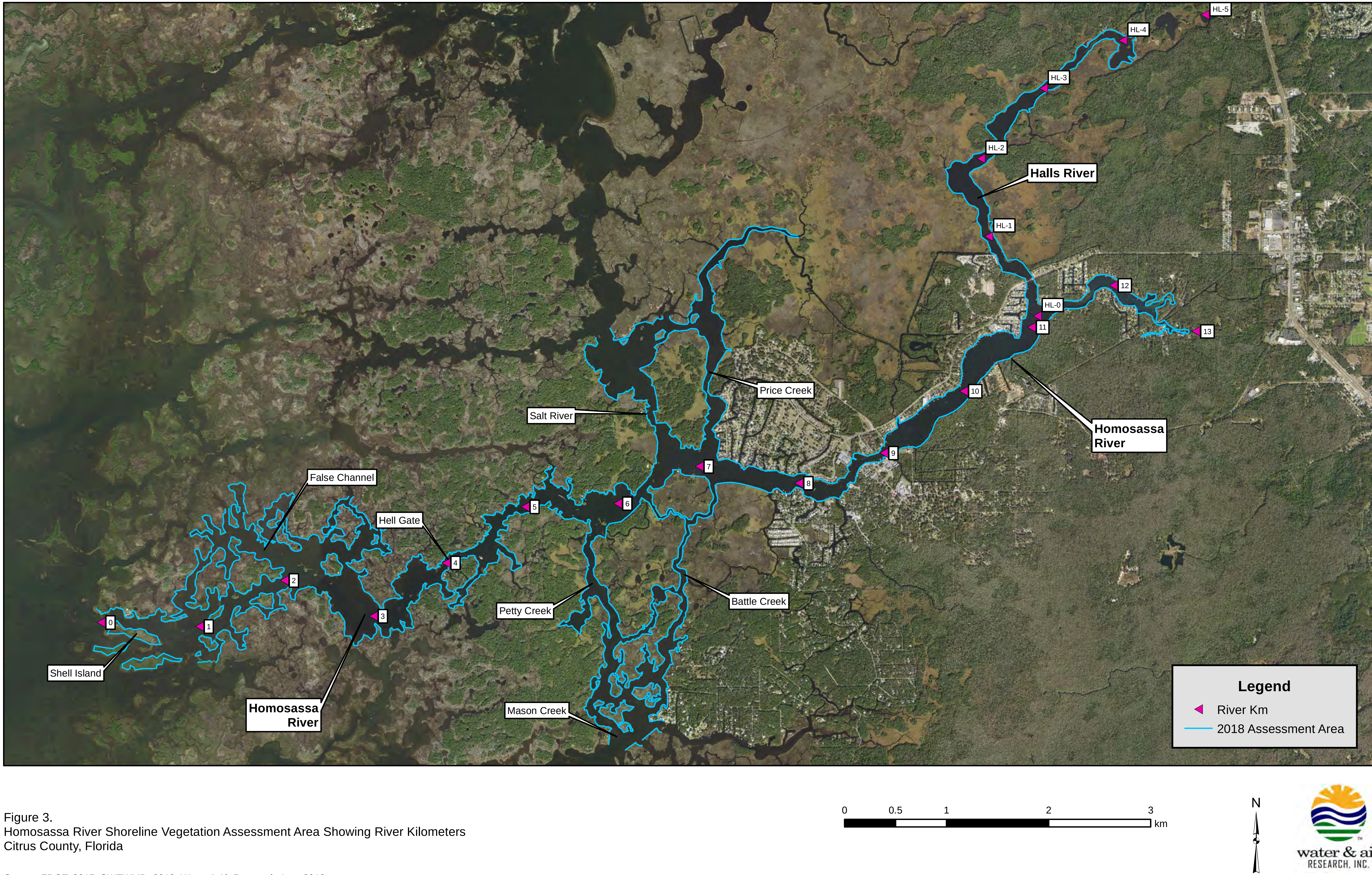

Figure 3.
Homosassa River Shoreline Vegetation Assessment Area Showing River Kilometers
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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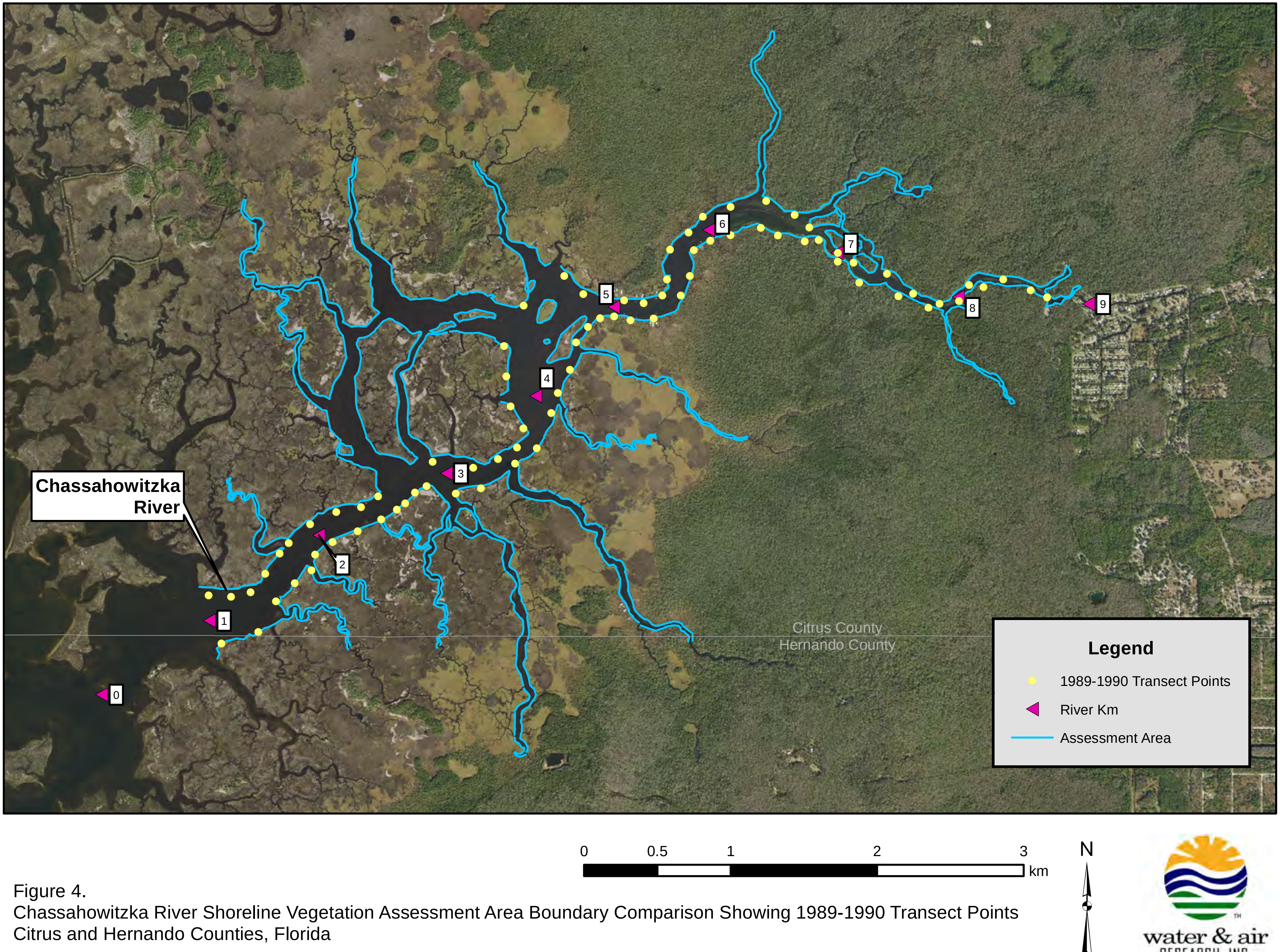

Figure 4.
Chassahowitzka River Shoreline Vegetation Assessment Area Boundary Comparison Showing 1989-1990 Transect Points
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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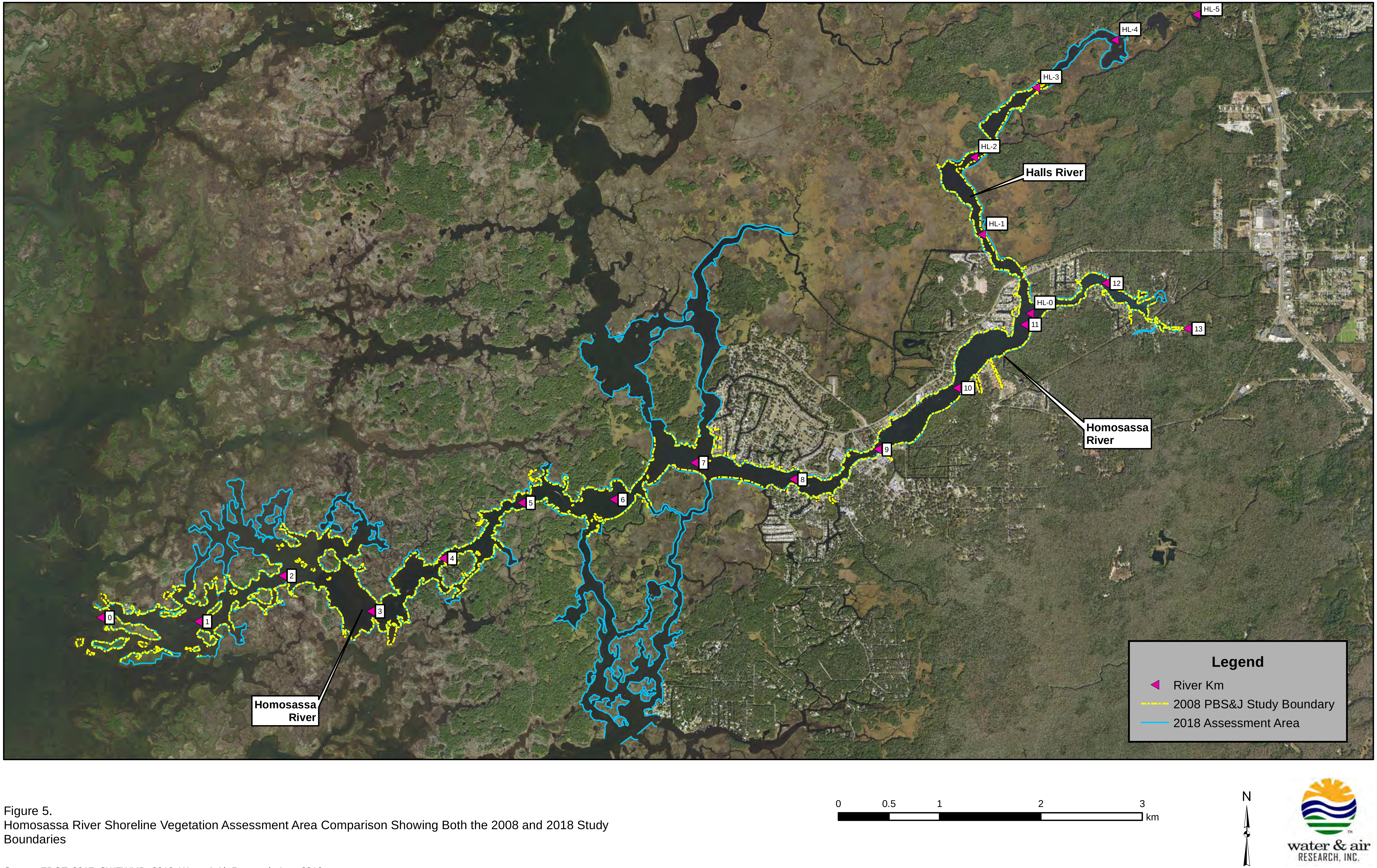

Figure 5.
Homosassa River Shoreline Vegetation Assessment Area Comparison Showing Both the 2008 and 2018 Study Boundaries

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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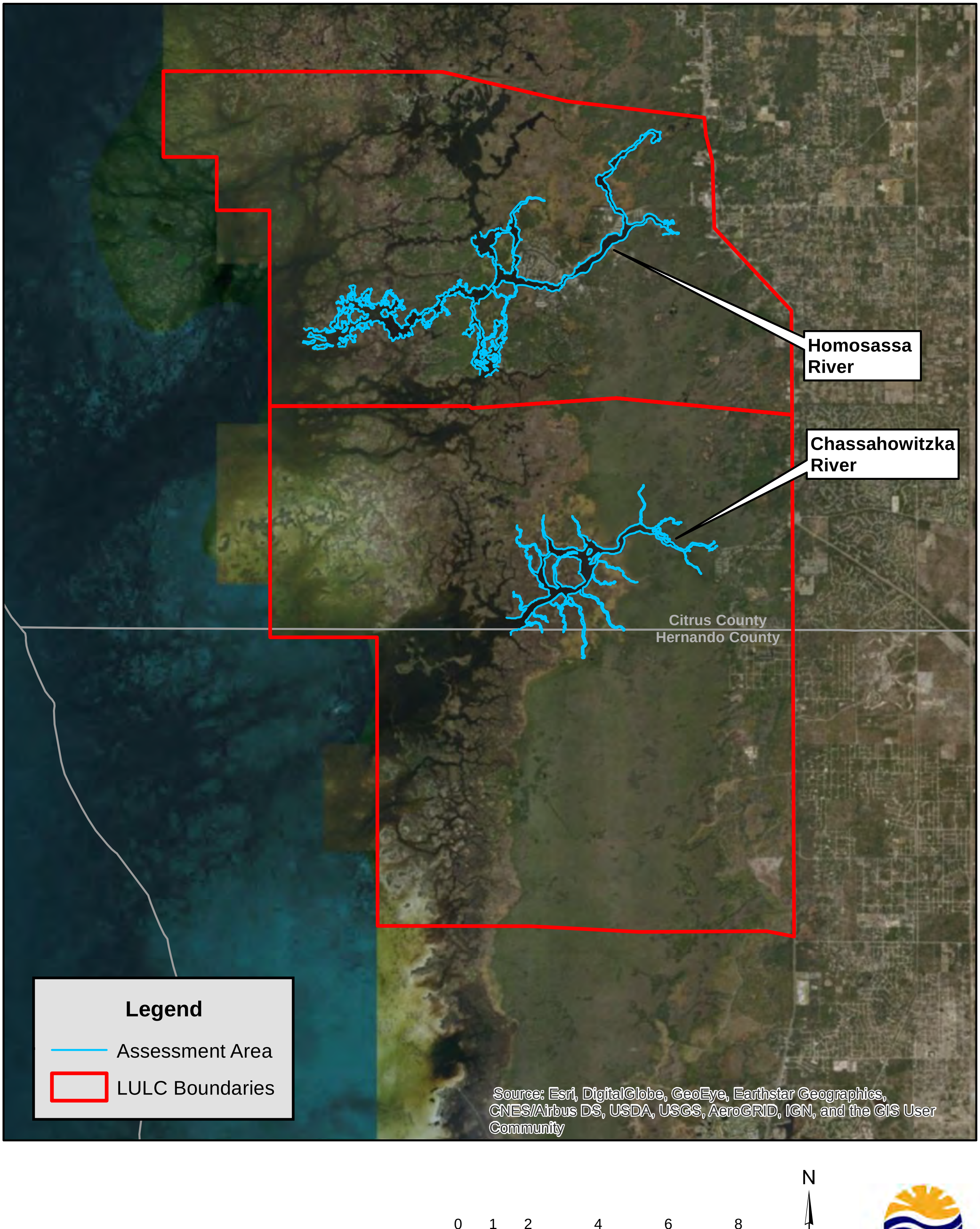

Figure 6.
LULC Boundaries for the Chassahowitzka and Homosassa Rivers
Citrus and Hernando Counties, Florida
Source: SWFWMD, 2018; Water & Air Research, Inc., 2018.

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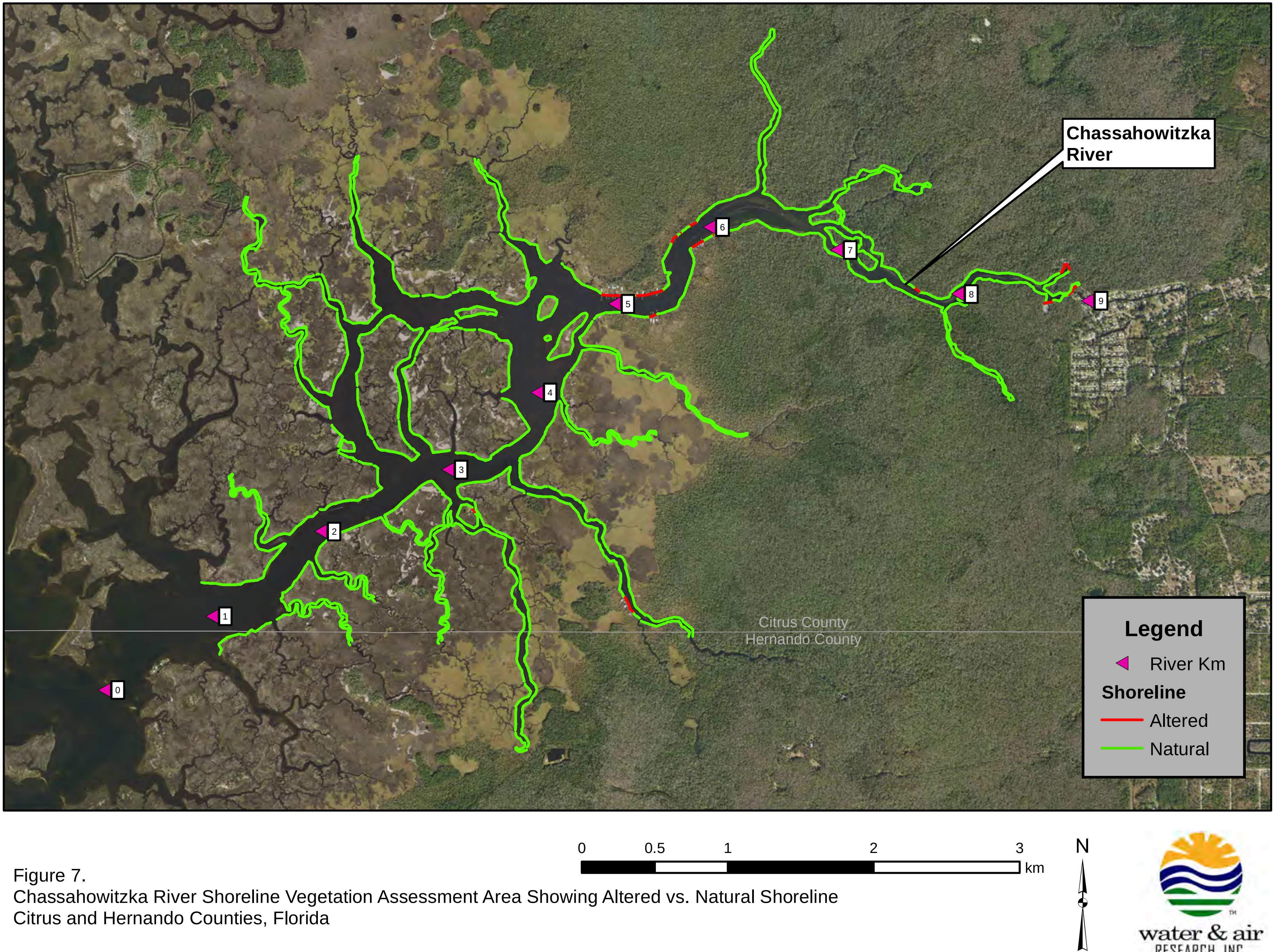

Figure 7.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing Altered vs. Natural Shoreline
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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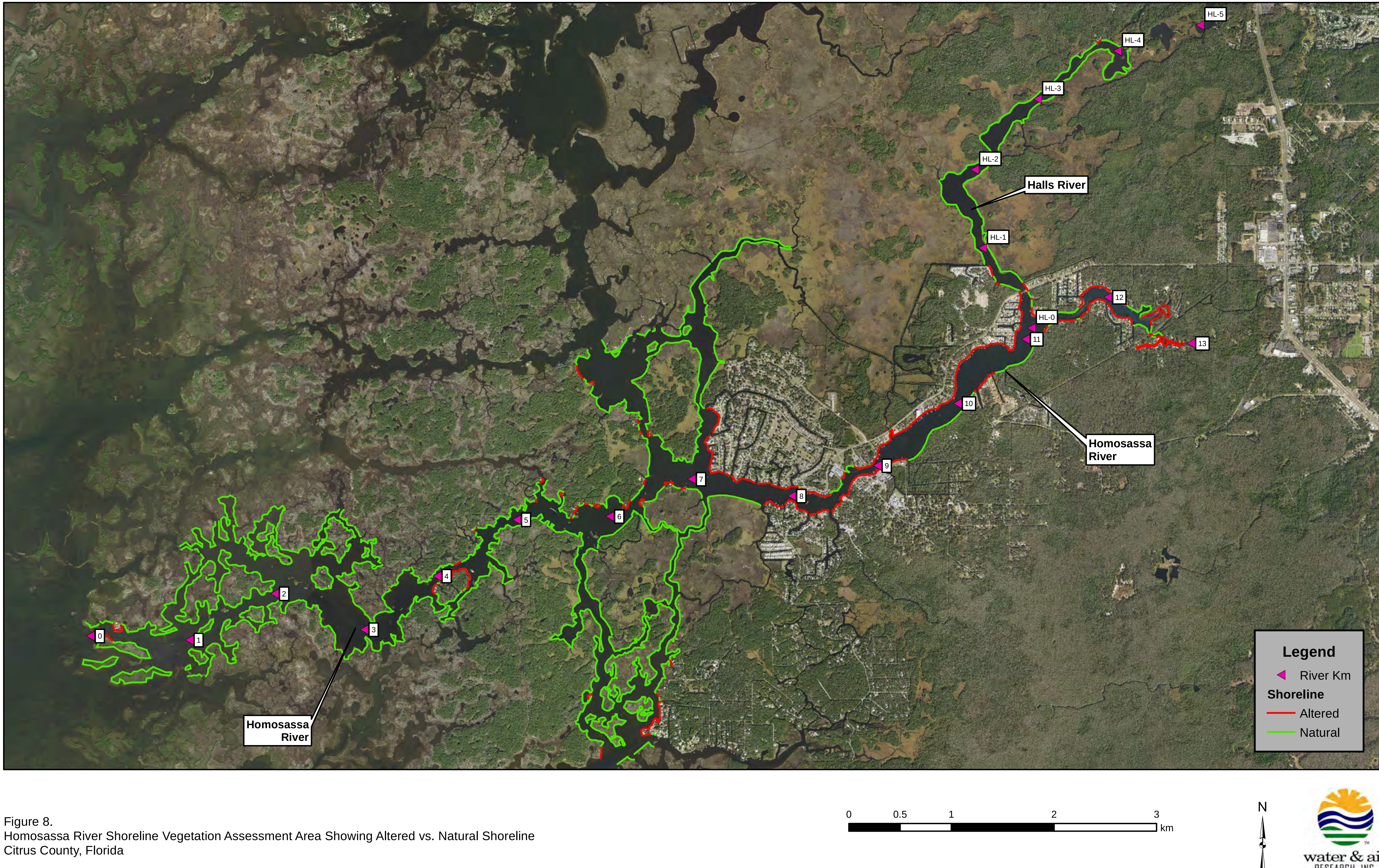

Figure 8.
Homosassa River Shoreline Vegetation Assessment Area Showing Altered vs. Natural Shoreline
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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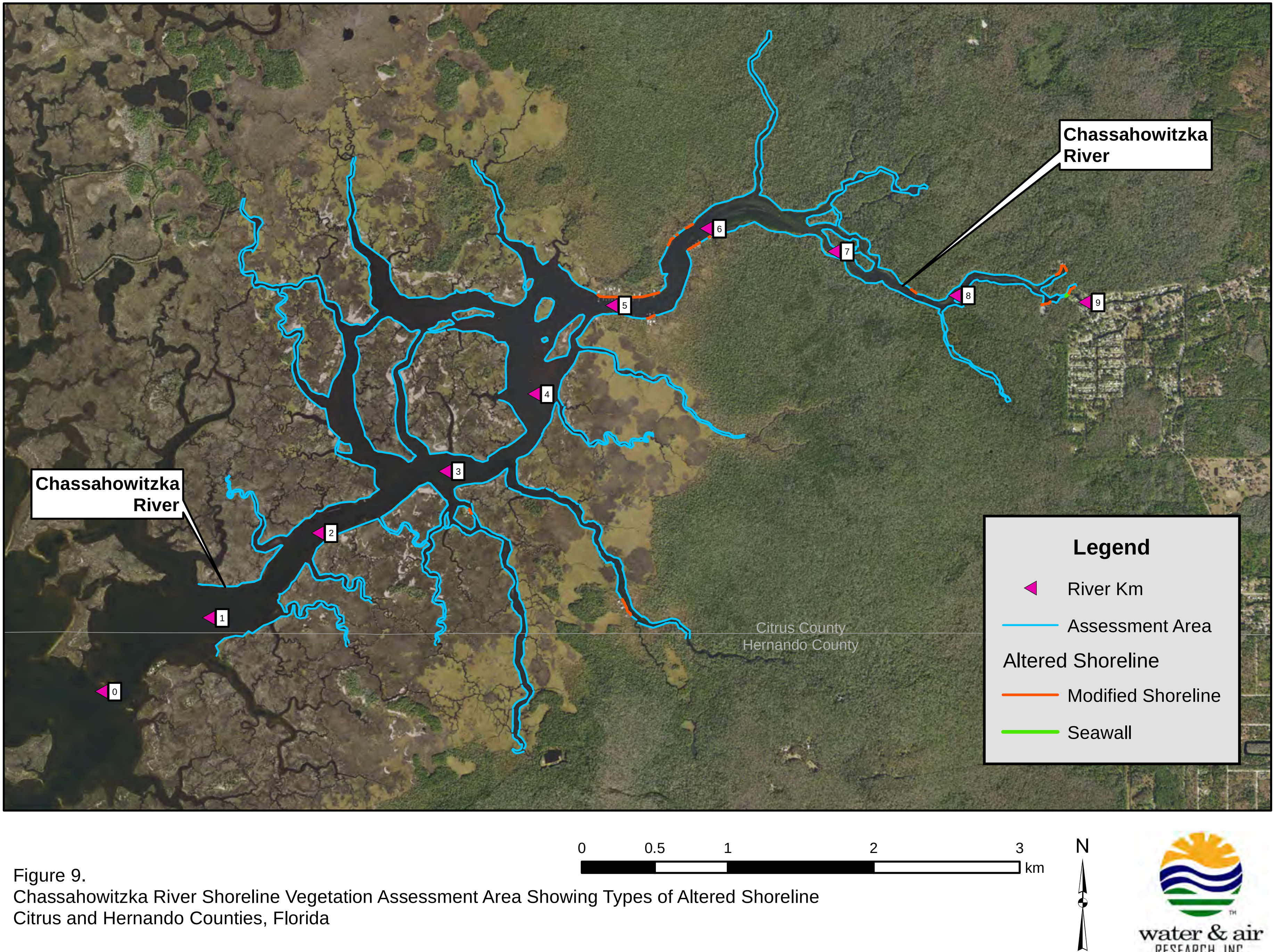

Figure 9.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing Types of Altered Shoreline
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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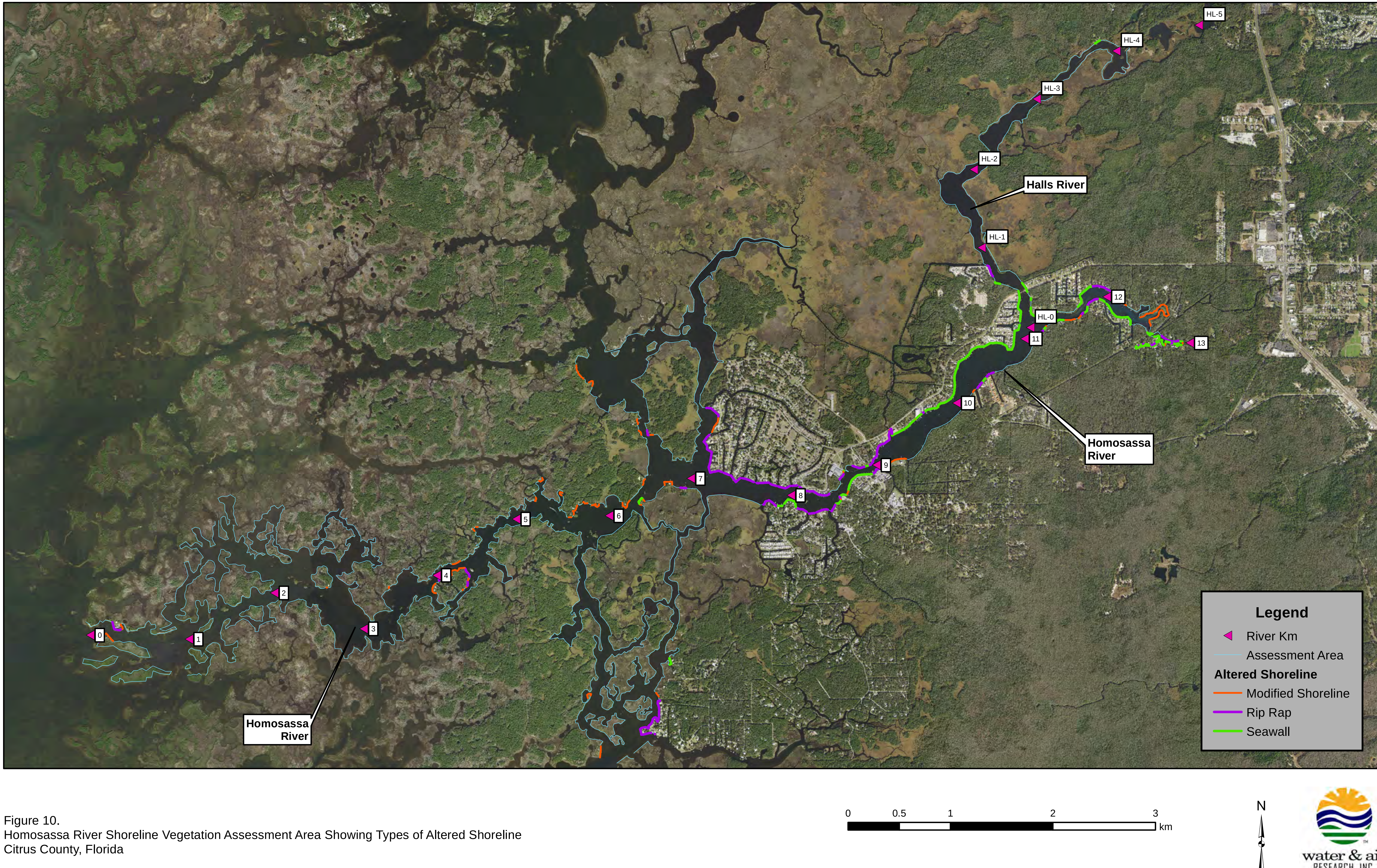

Figure 10.
Homosassa River Shoreline Vegetation Assessment Area Showing Types of Altered Shoreline
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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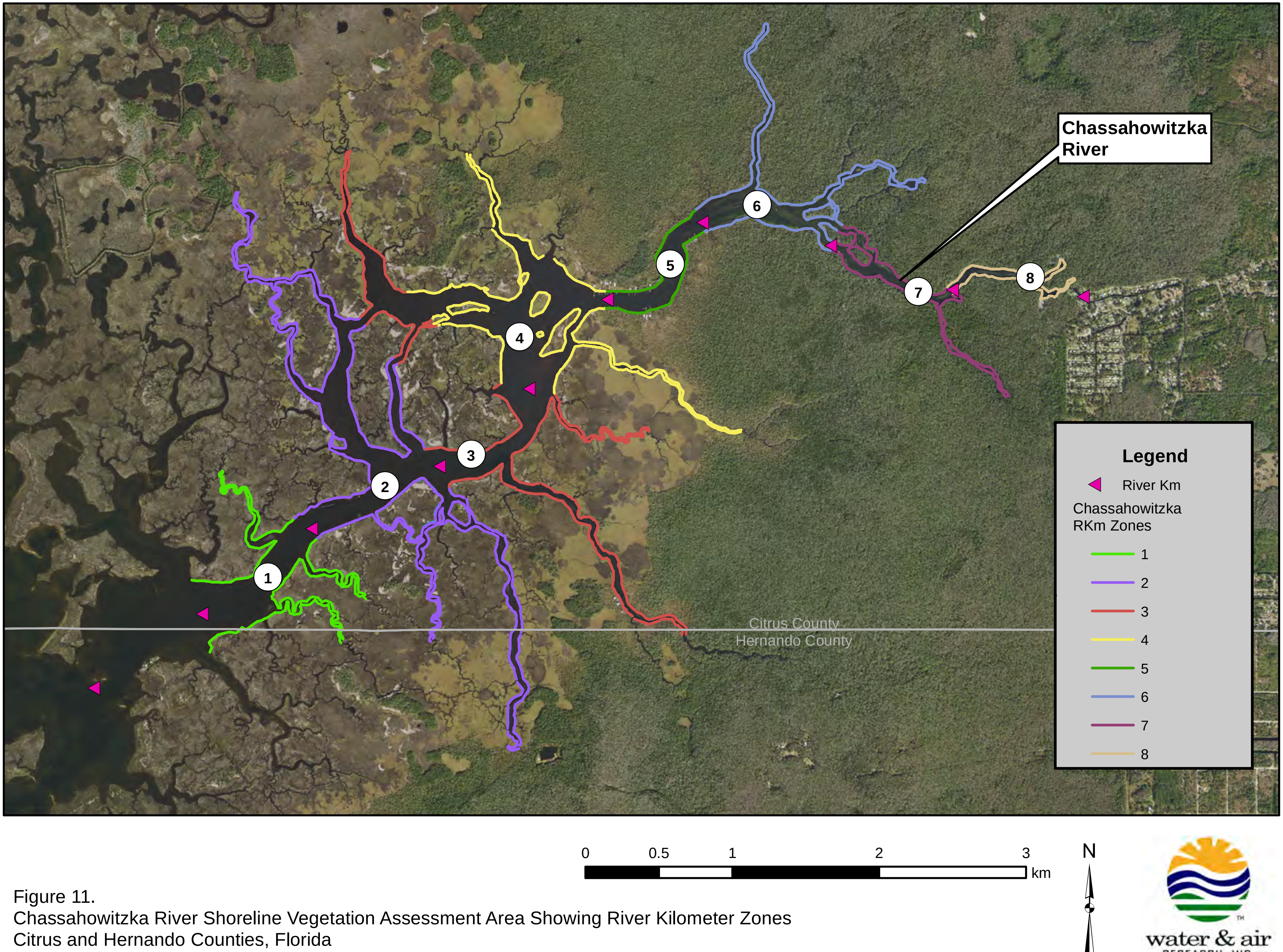

Figure 11.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing River Kilometer Zones
Citrus and Hernando Counties, Florida
Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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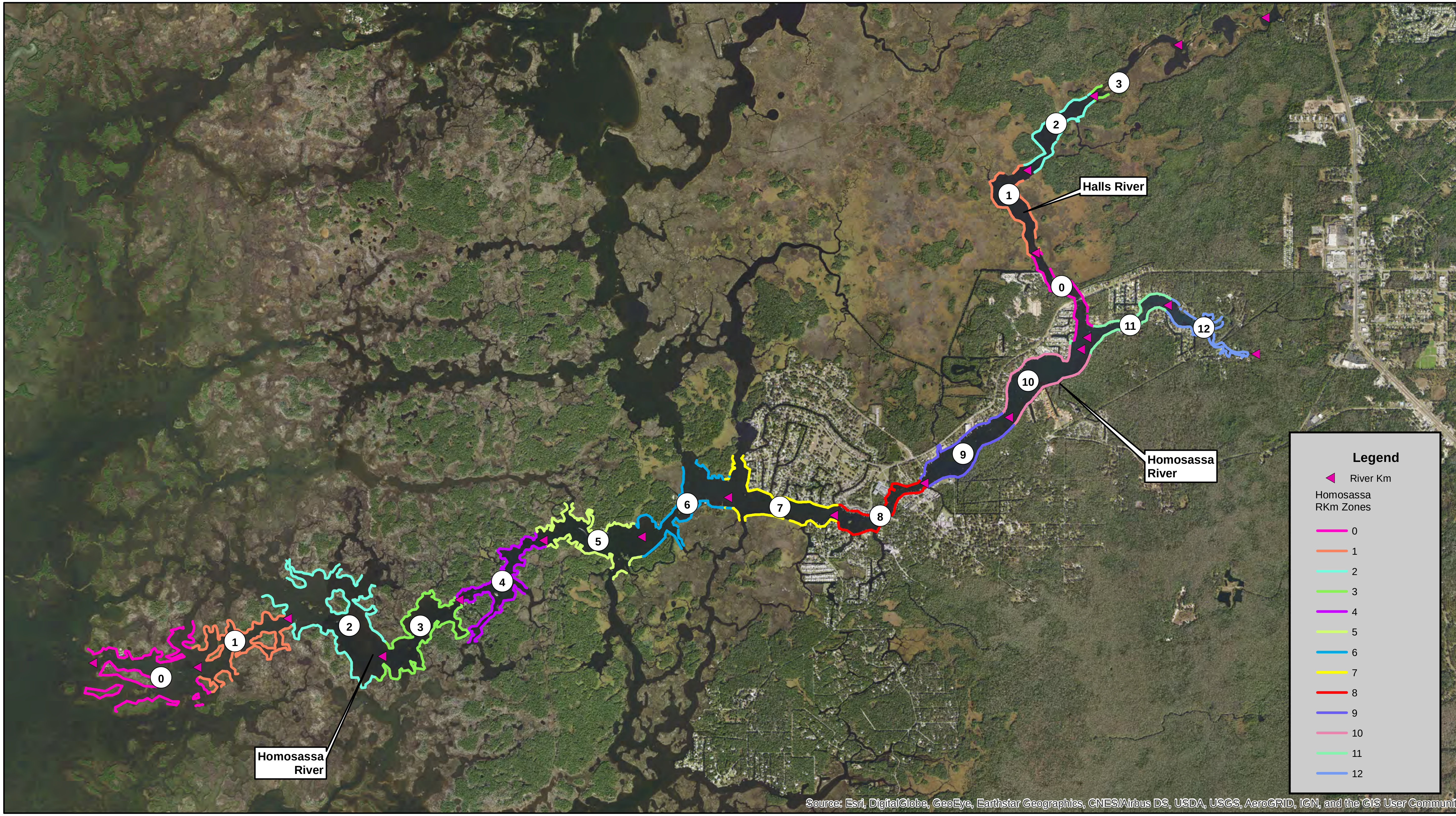

Figure 12.
Homosassa River Shoreline Vegetation Assessment Area Showing River Kilometer Zones
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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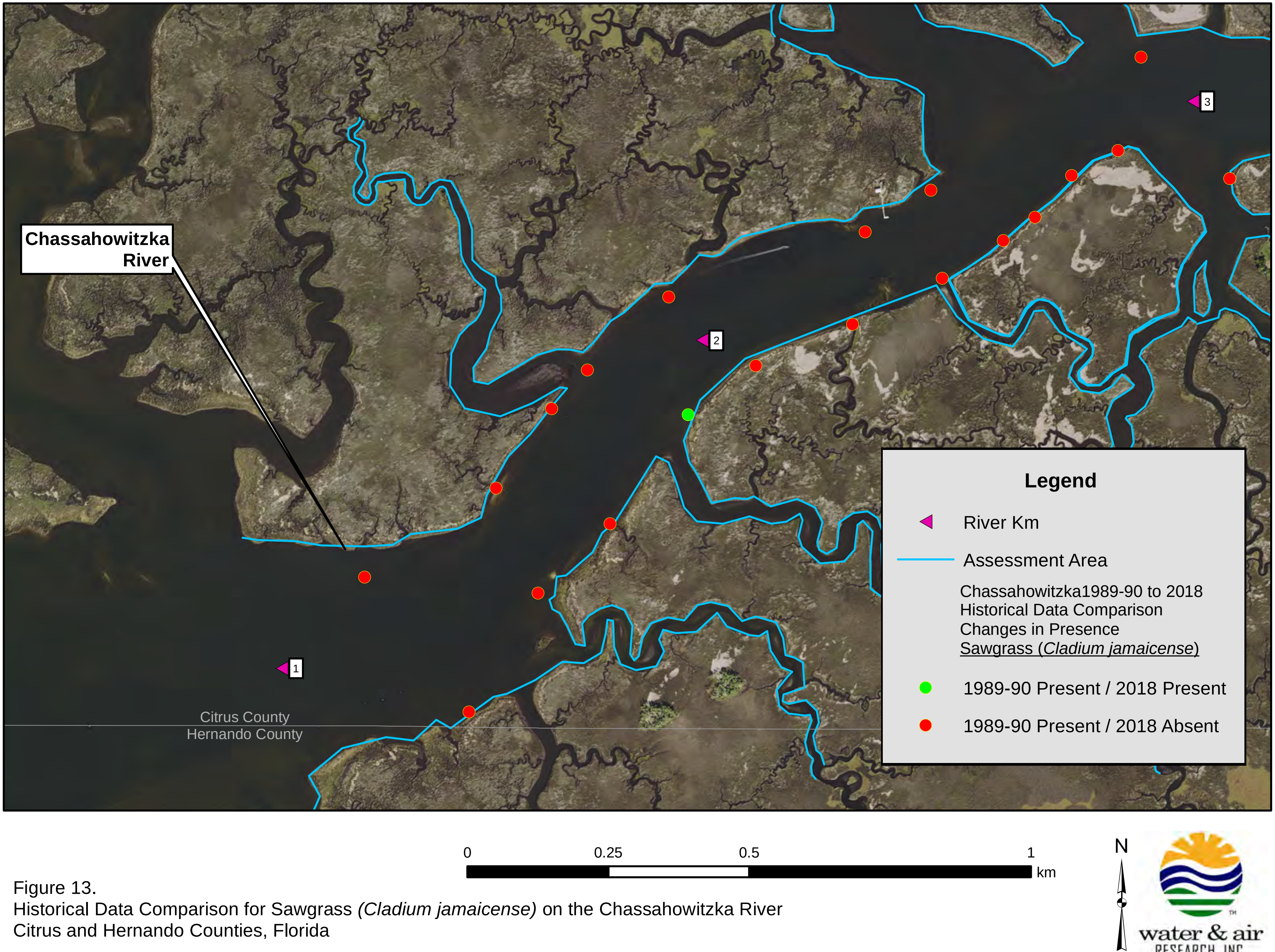

Figure 13.
Historical Data Comparison for Sawgrass *(Cladium jamaicense)* on the Chassahowitzka River
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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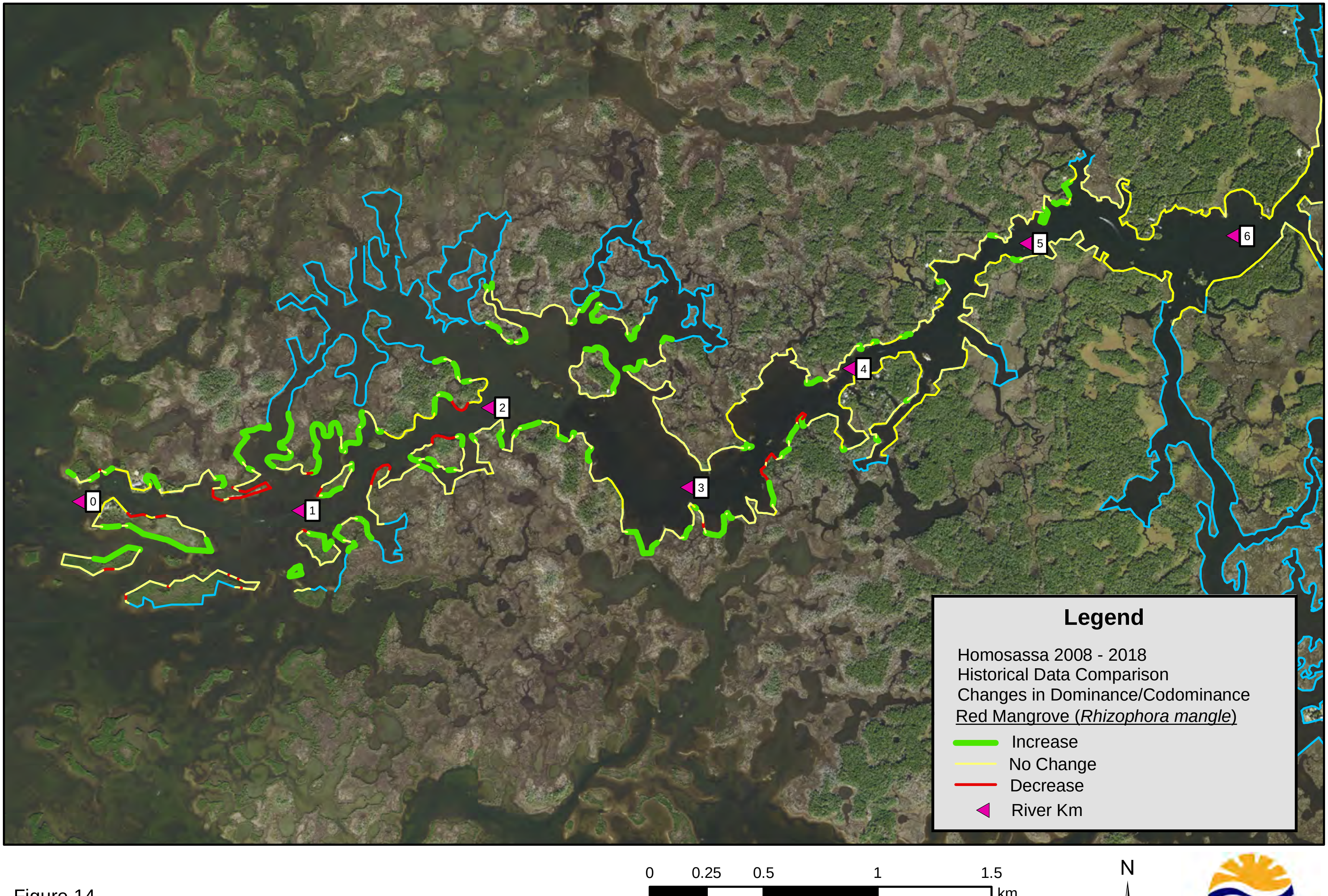

Figure 14.
Historical Data Comparison for Red Mangrove *(Rhizophora mangle)* on the Homosassa River
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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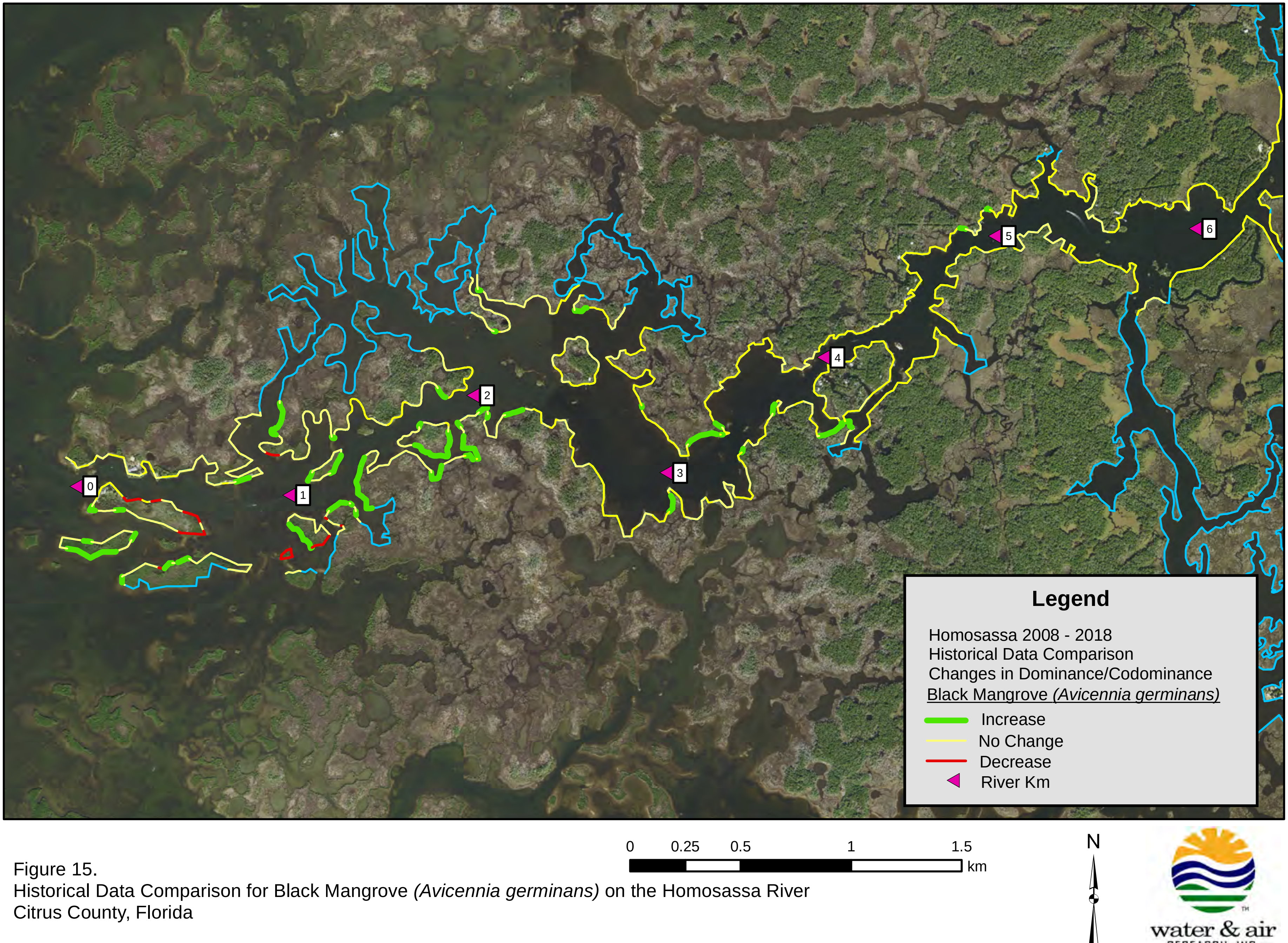

Figure 15.
Historical Data Comparison for Black Mangrove *(Avicennia germinans)* on the Homosassa River
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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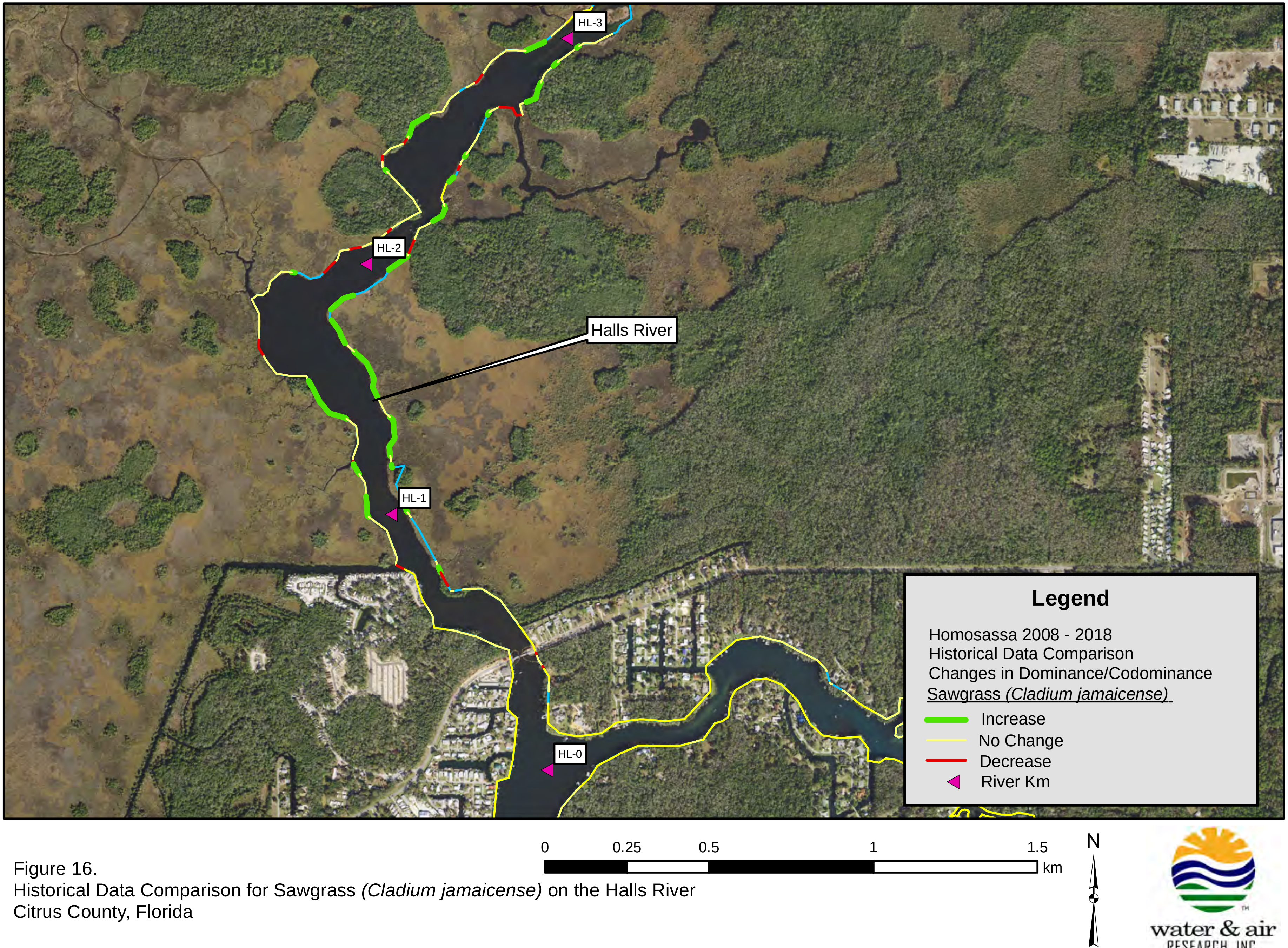

Figure 16.
Historical Data Comparison for Sawgrass *(Cladium jamaicense)* on the Halls River
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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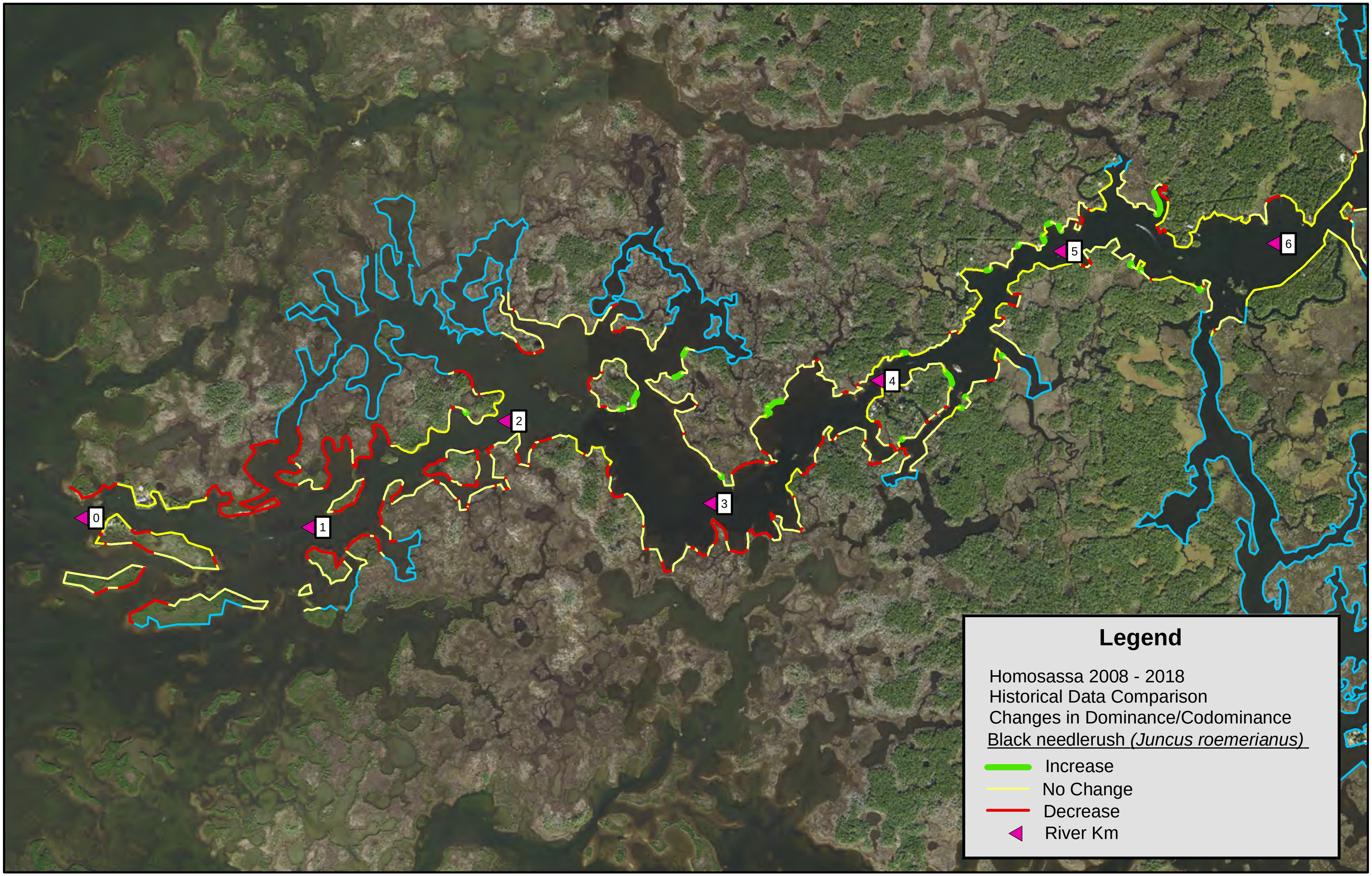

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Figure 17.
Historical Data Comparison for Black Needlerush *(Juncus roemerianus)* on the Homosassa River
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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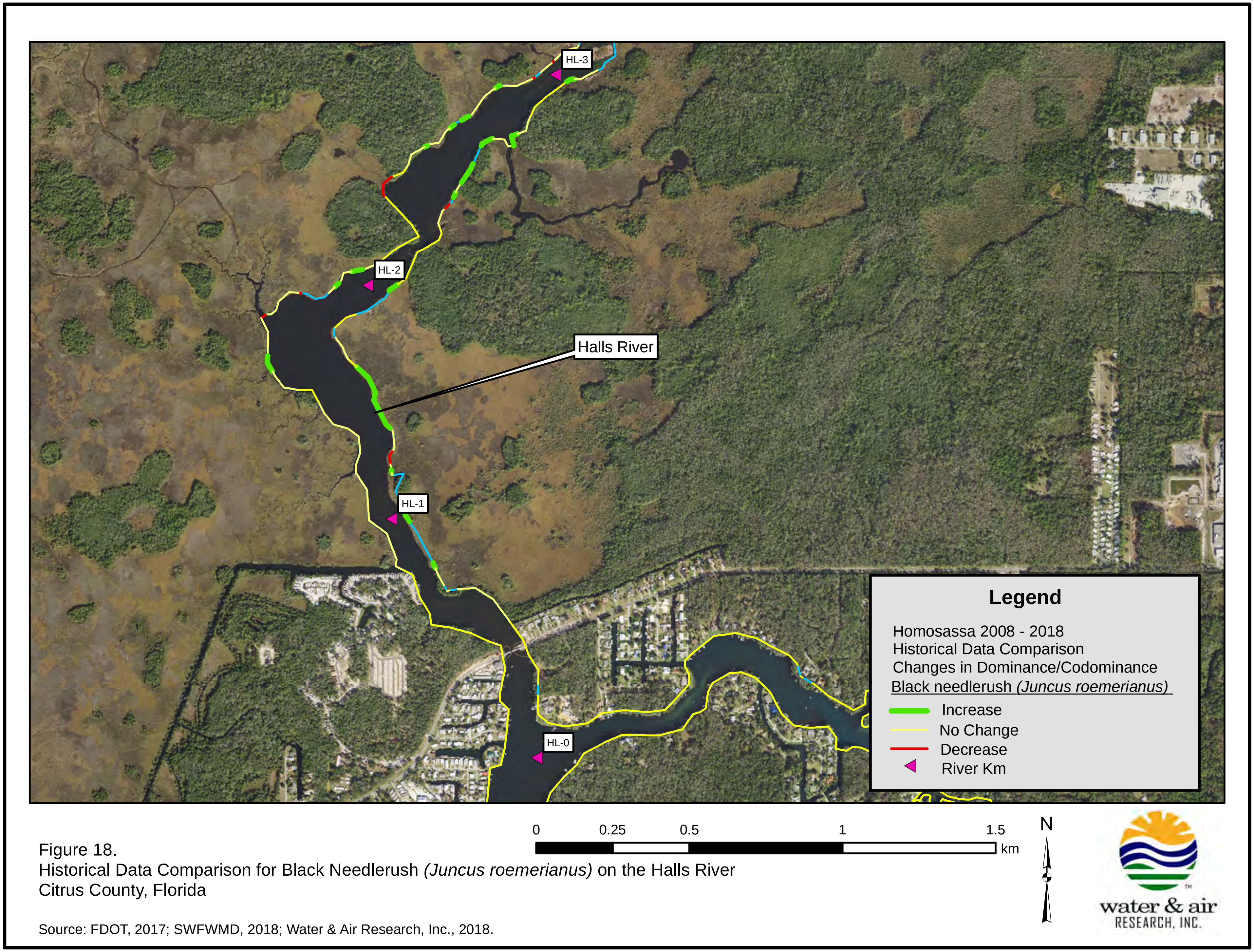

Figure 18.
Historical Data Comparison for Black Needlerush *(Juncus roemerianus)* on the Halls River
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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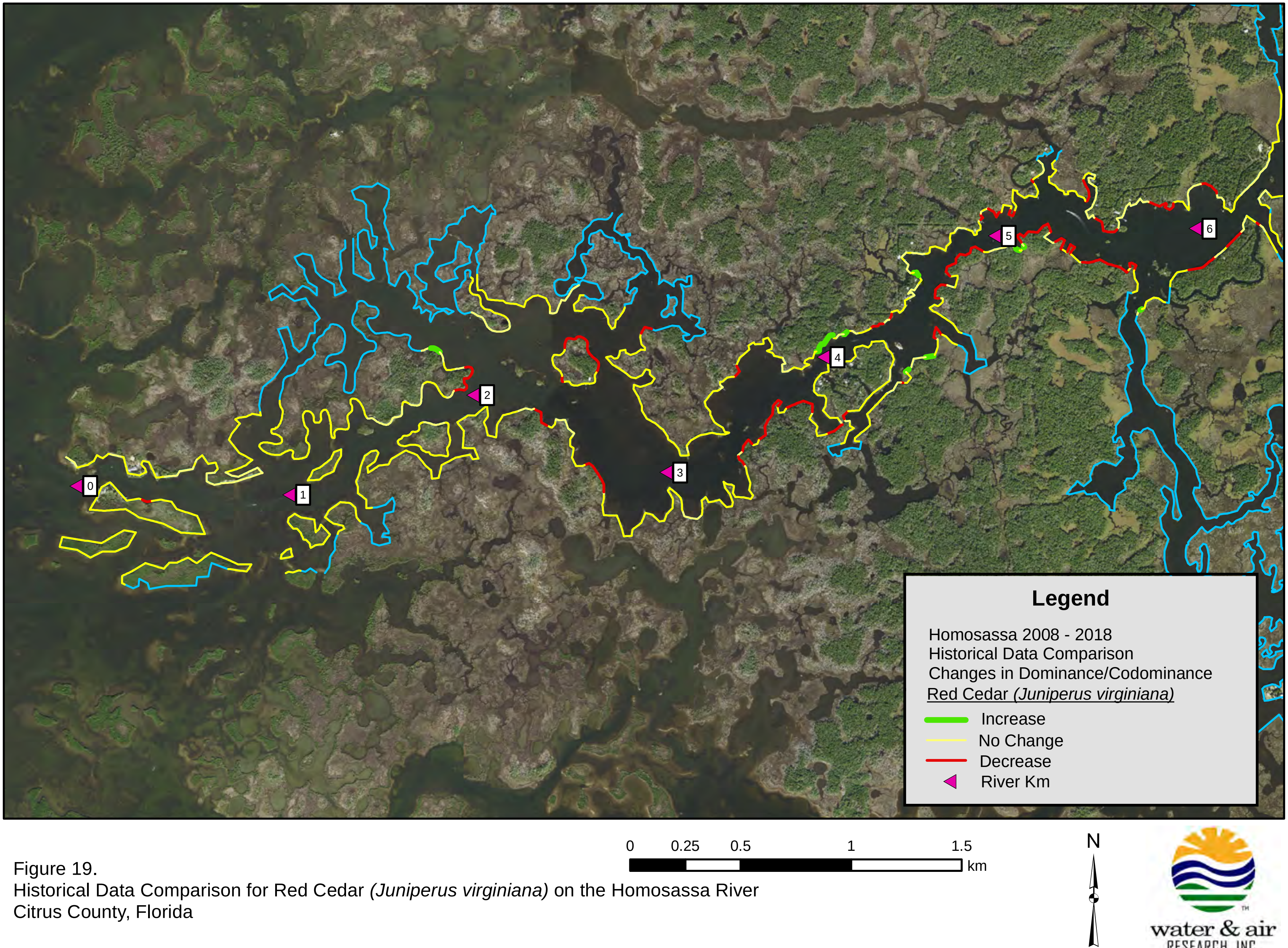

Figure 19.
Historical Data Comparison for Red Cedar *(Juniperus virginiana)* on the Homosassa River
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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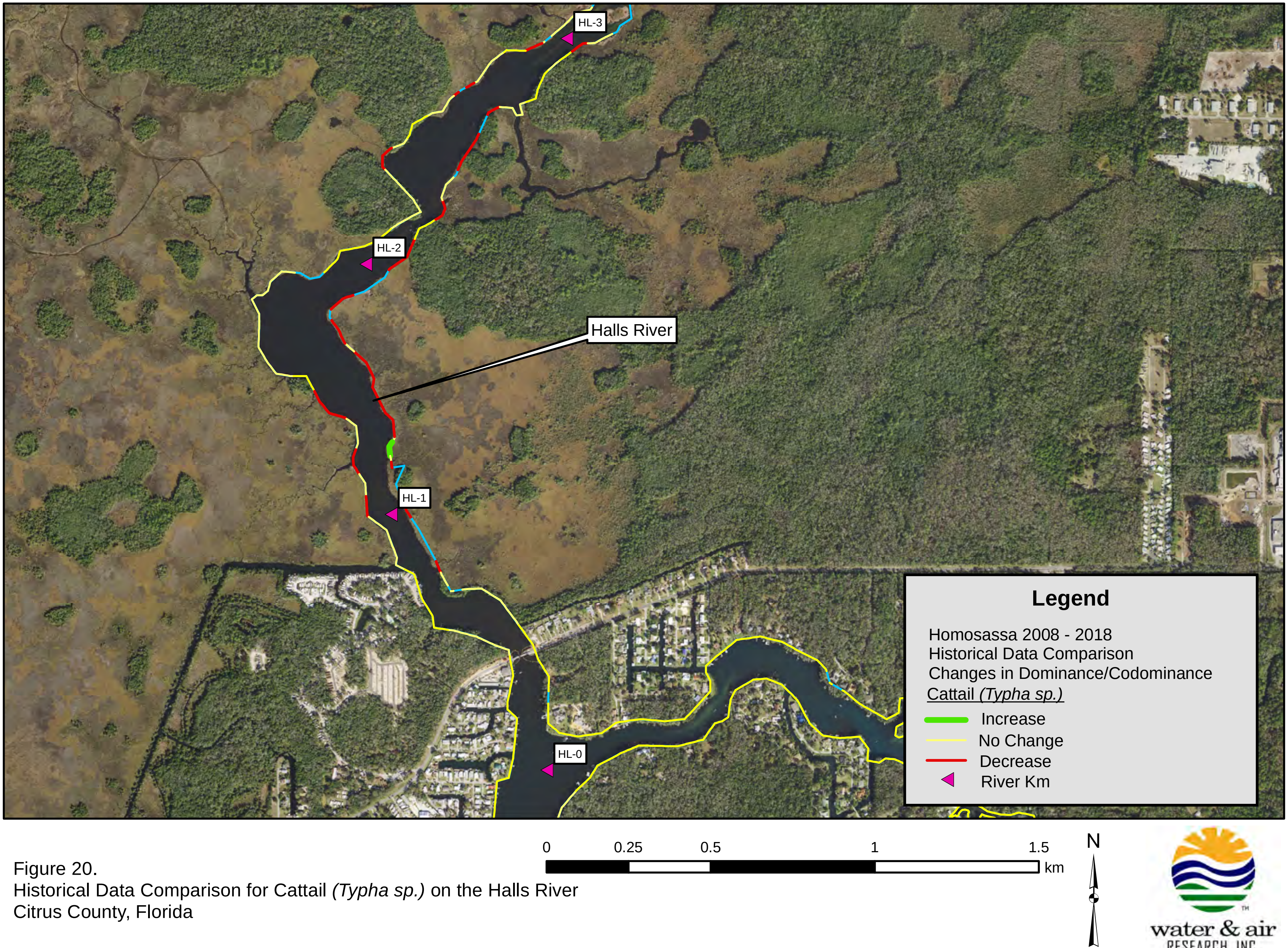

Figure 20.
Historical Data Comparison for Cattail *(Typha sp.)* on the Halls River
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

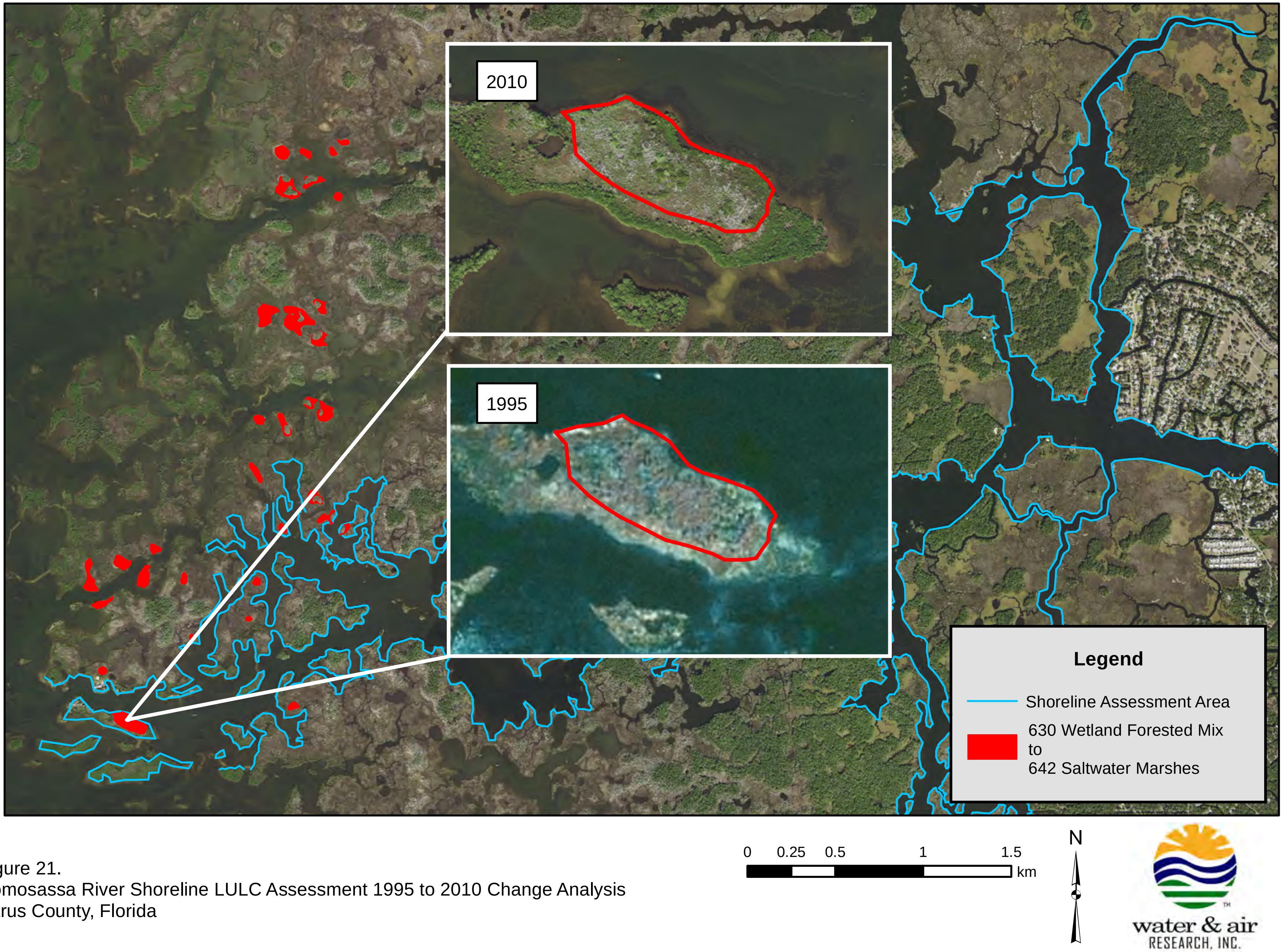

Figure 21.
Homosassa River Shoreline LULC Assessment 1995 to 2010 Change Analysis
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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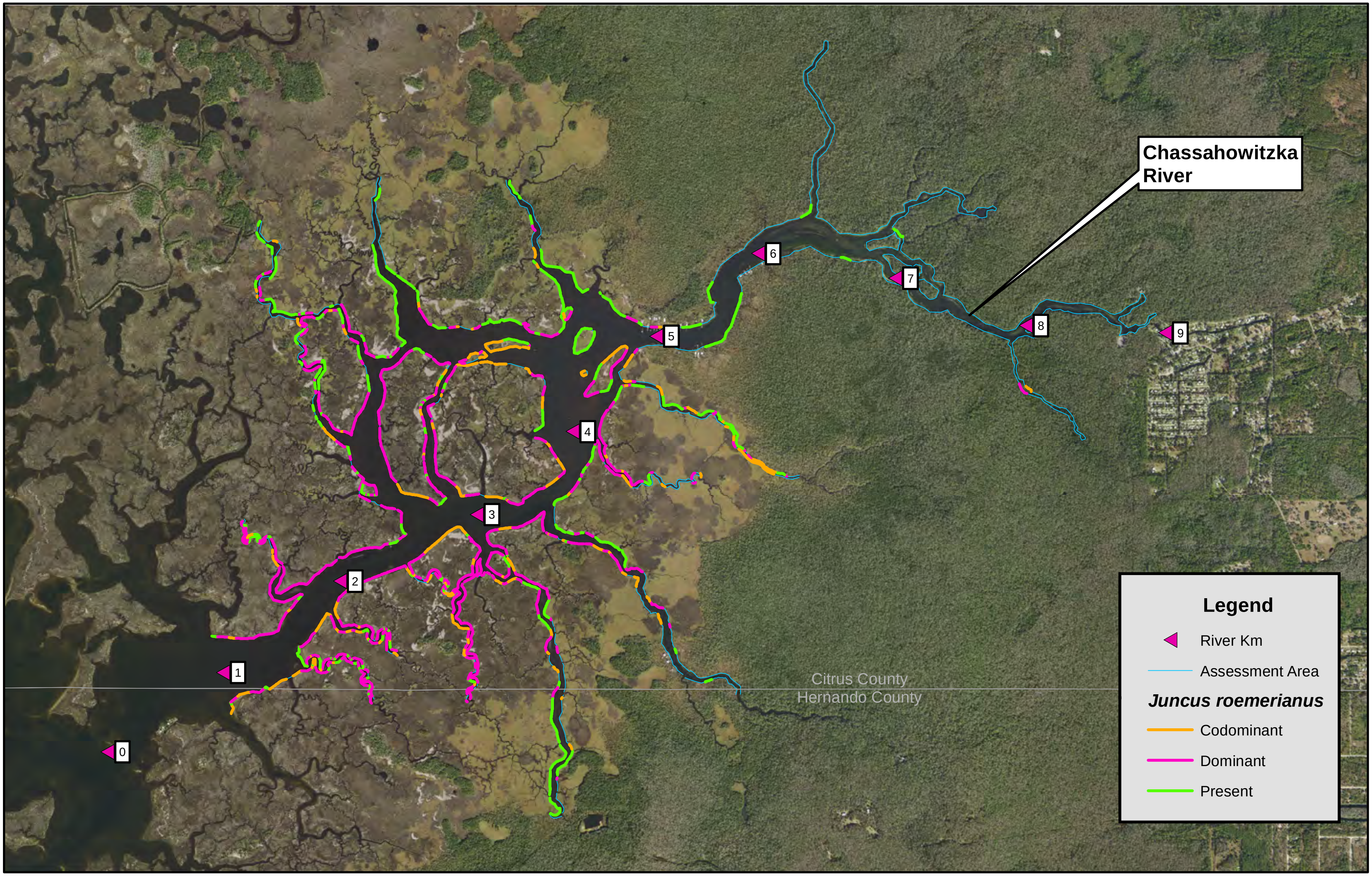

Figure 22.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing 2018 Mapping Results for Black Needlerush *(Juncus roemerianus)*
Citrus and Hernando Counties, Florida
Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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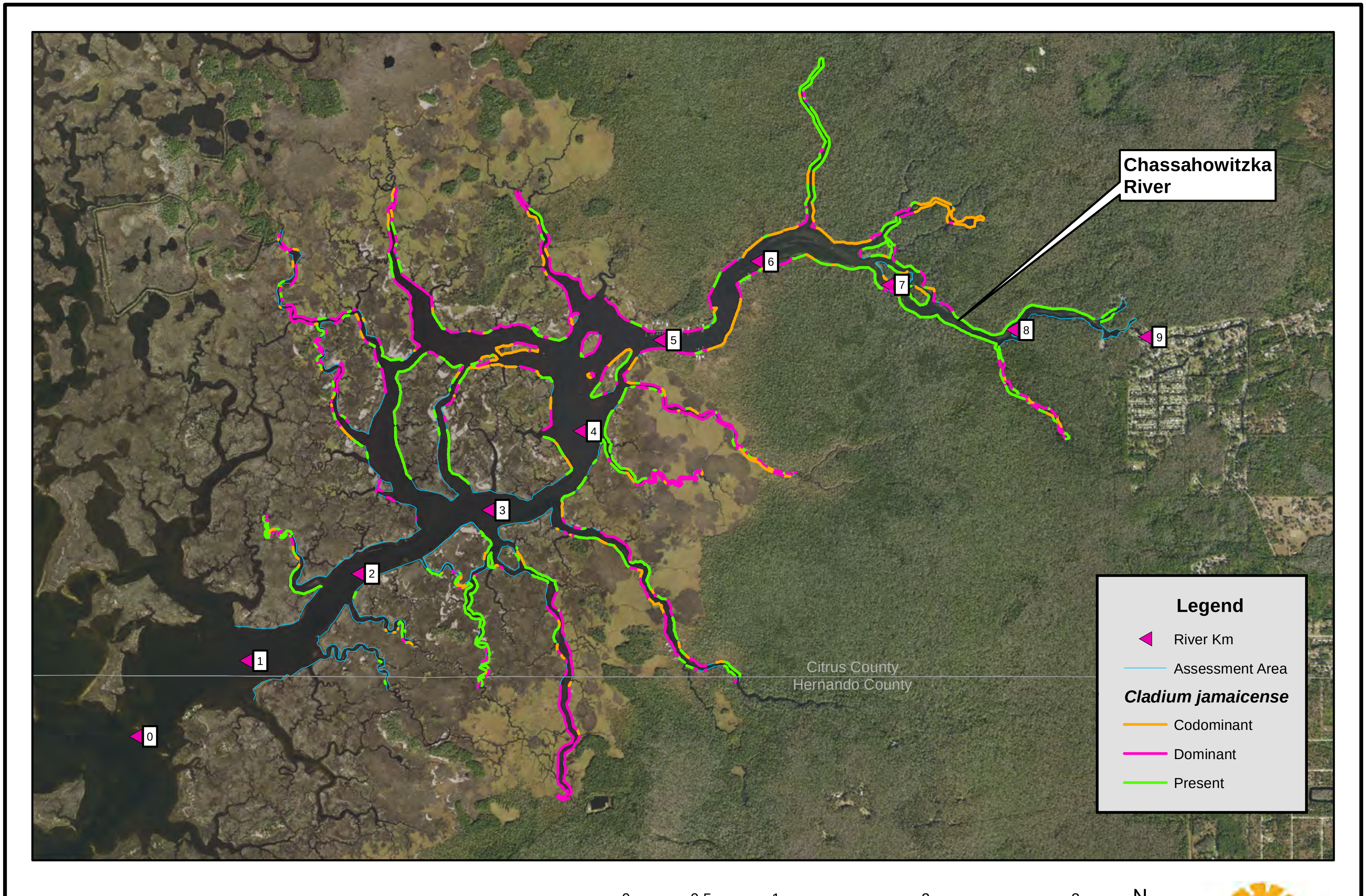

Figure 23.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing 2018 Mapping Results for Sawgrass *(Cladium jamaicense)*
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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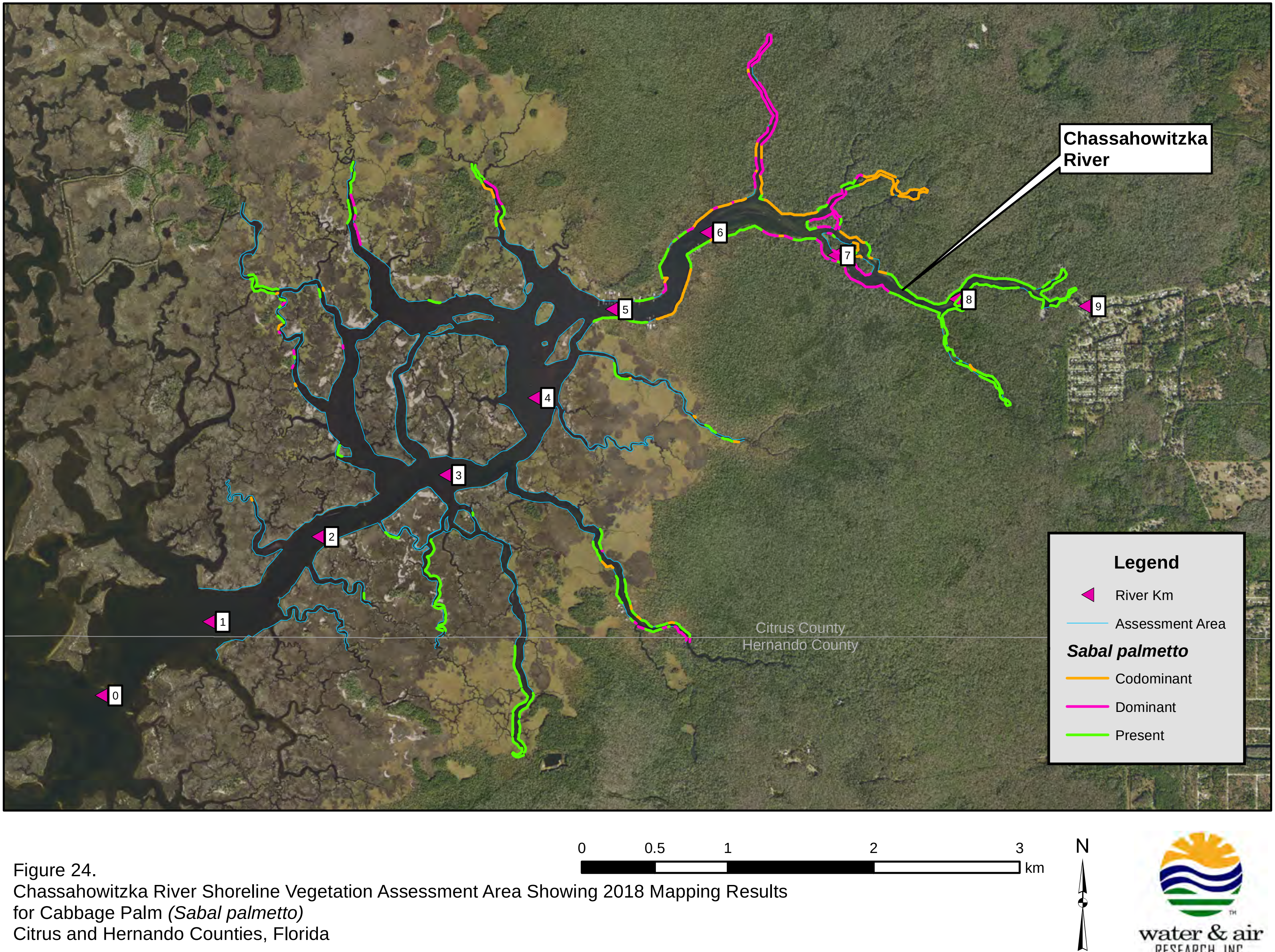

Figure 24.
Chassahowitzka River Shoreline Vegetation Assessment Area Showing 2018 Mapping Results for Cabbage Palm *(Sabal palmetto)*
Citrus and Hernando Counties, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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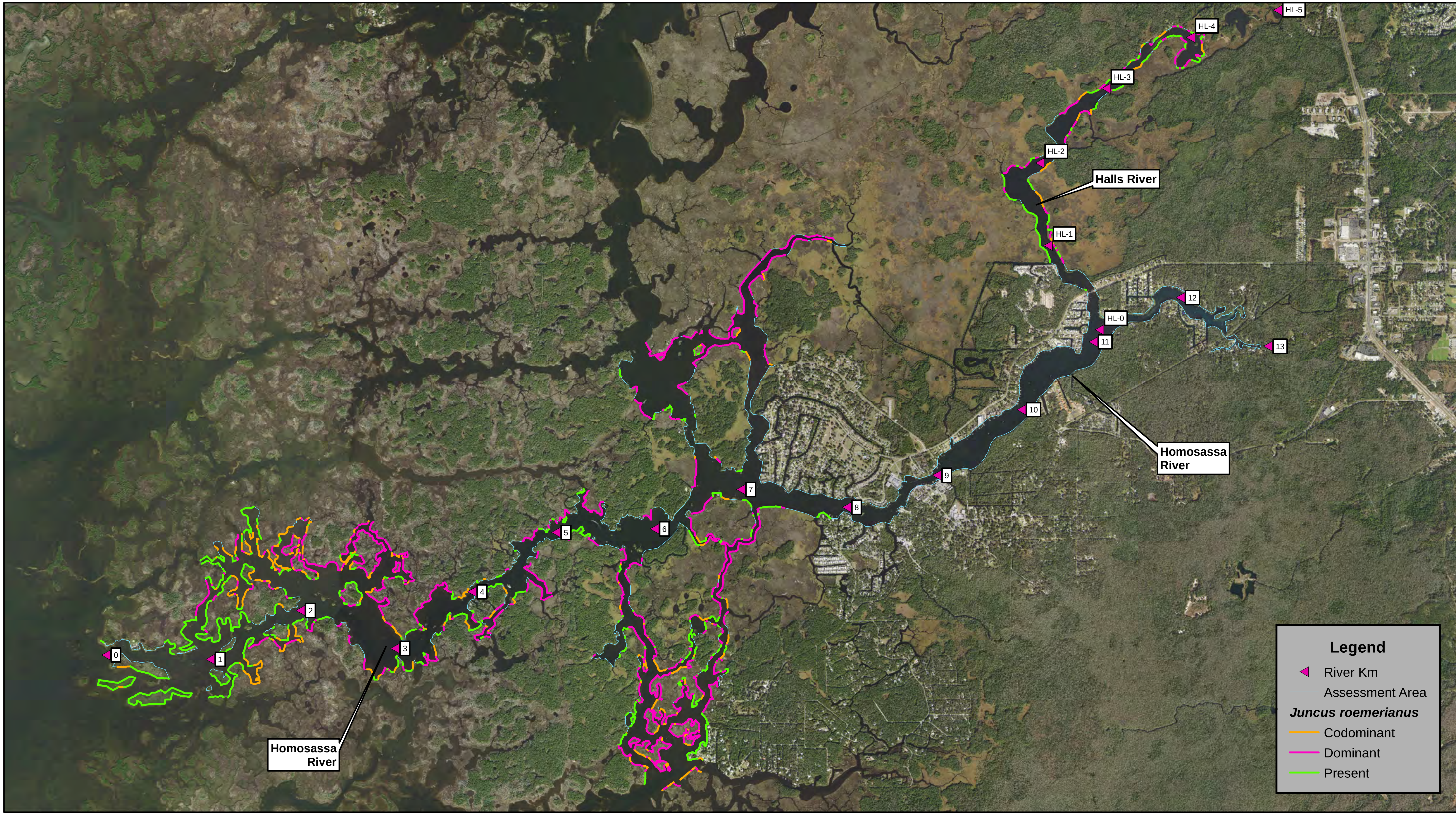

Figure 25.
Homosassa River Shoreline Vegetation Assessment Area Showing 2018 Mapping Results for Black Needlerush *(Juncus roemerianus)*
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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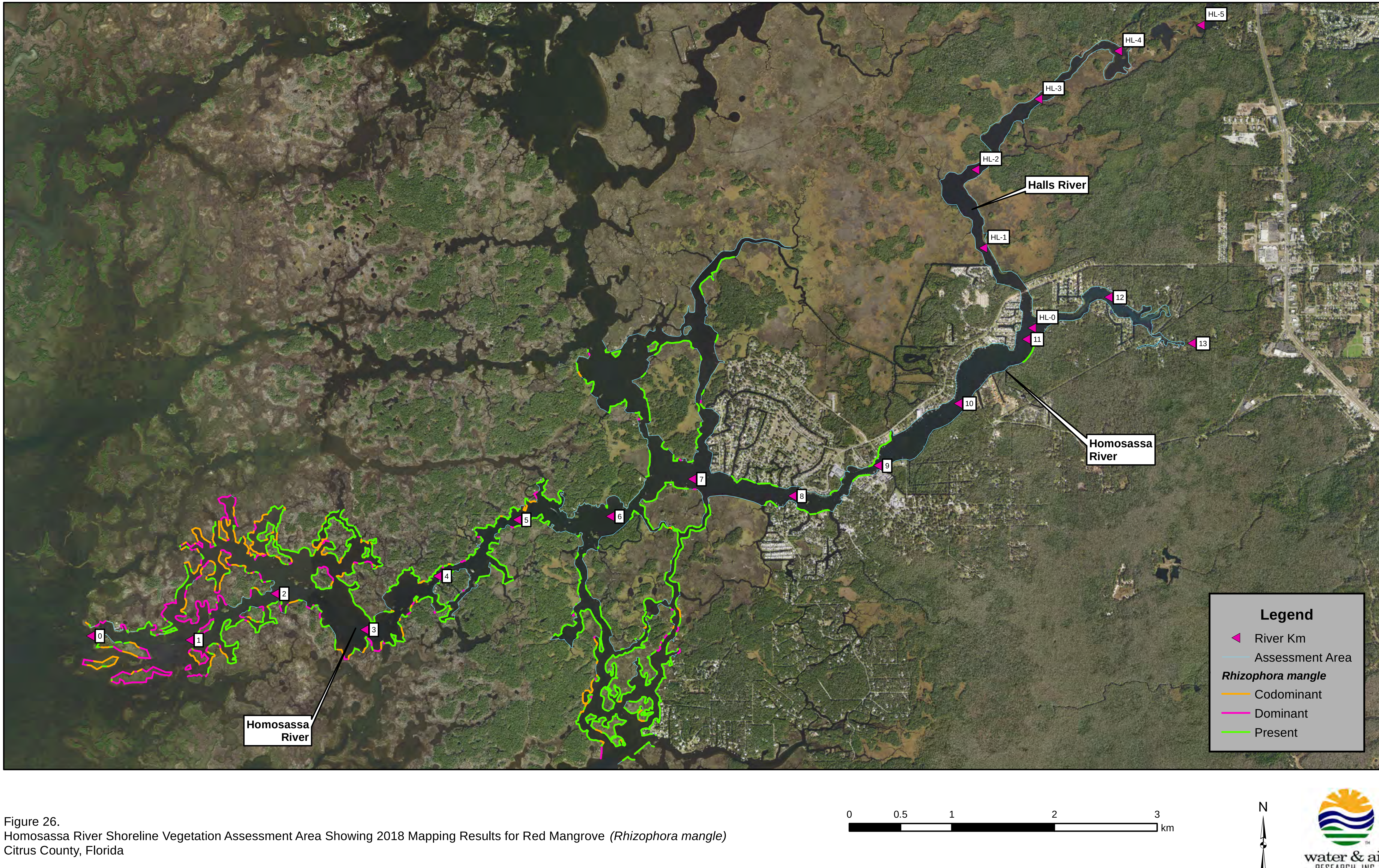

Figure 26.
Homosassa River Shoreline Vegetation Assessment Area Showing 2018 Mapping Results for Red Mangrove *(Rhizophora mangle)*
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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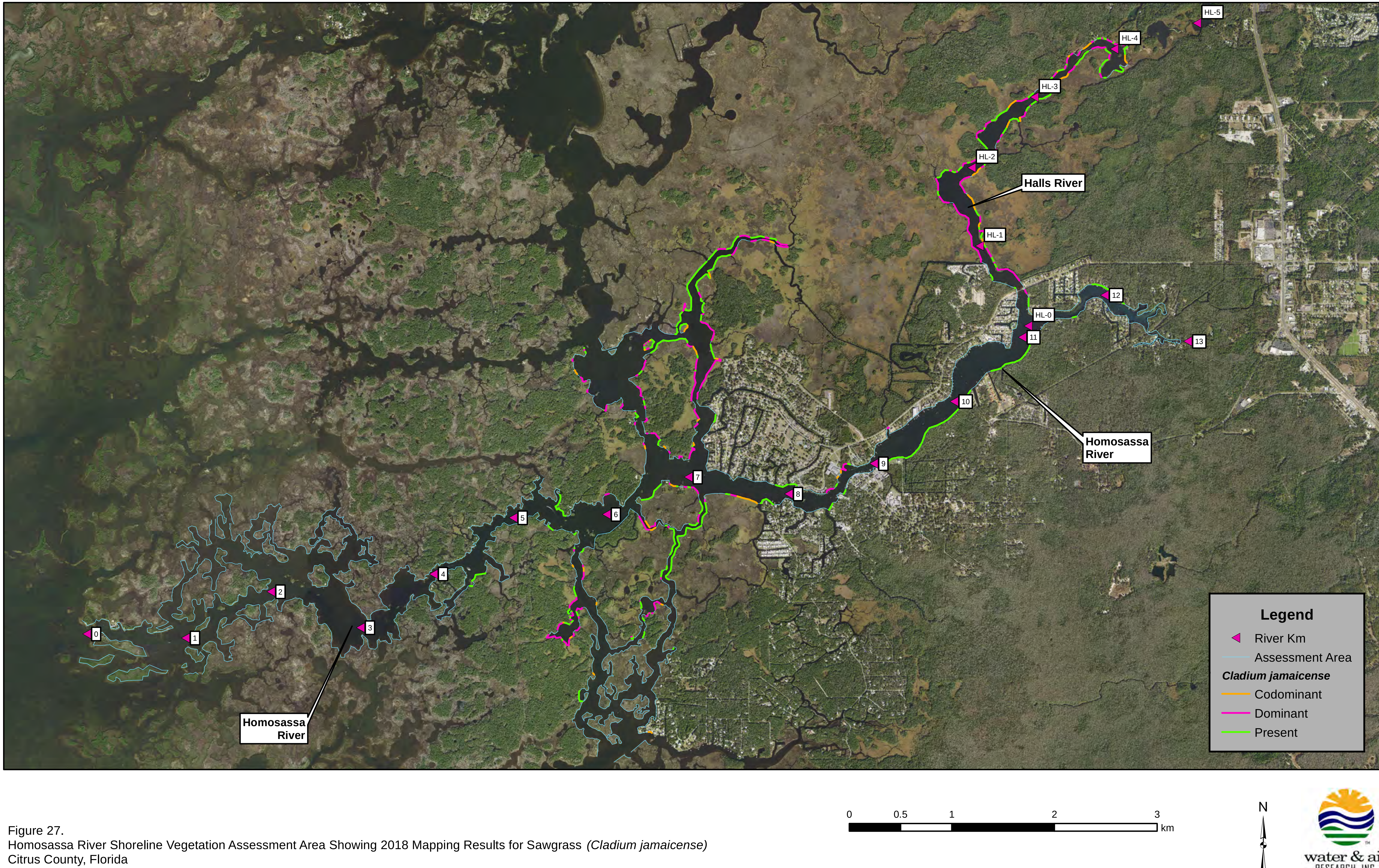

Figure 27.
Homosassa River Shoreline Vegetation Assessment Area Showing 2018 Mapping Results for Sawgrass *(Cladium jamaicense)*
Citrus County, Florida

Source: FDOT, 2017; SWFWMD, 2018; Water & Air Research, Inc., 2018.

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