Final

COASTAL RIVERS BASIN SURFACE WATER IMPROVEMENT AND MANAGEMENT (SWIM) PLAN

Aucilla River
Wacissa River
Econfina River
Fenholloway River
Steinhatchee River
Waccasassa River

Prepared for Suwannee River Water Management District

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List of Acronyms

Acronym	Term
ADOC	Alternative Dissolved Oxygen Criteria
ALB	Airborne LiDAR Bathymetry
BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CFU	Colony Forming Units
Chl-a	Chlorophyll-a
CLC	Cooperative Land Cover
District	Suwannee River Water Management District
DO	Dissolved Oxygen
EAV	Emergent Aquatic Vegetation
EPA	U.S. Environmental Protection Agency
F.A.C.	Florida Administrative Code
F.S.	Florida Statutes
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FE	Federally Endangered
FF	Florida Forever
FNAI	Florida Natural Areas Inventory
FT	Federally Threatened
FT/(S/A)	Federally Threatened due to similarity of appearance
FWC	Florida Fish and Wildlife Conservation Commission
GPD	Gallons per Day
GEBF	Gulf Environmental Benefit Fund
ISMP	Imperiled Species Management Plan
MF	Membrane Filtration
MFLs	Minimum Flows and Levels
MPN	Most Probable Numbers
MSL	Mean Sea Level
NGO	Non-Government Organization

Acronym	Term
NH_3	Ammonia
NNC	Numeric Nutrient Concentration
NO_3^{-2}	Nitrate
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
OFW	Outstanding Florida Water
RMs	River Mile
SAPs	Species Action Plans
SAV	Submerged Aquatic Vegetation
SB	Senate Bill
SMZs	Special Management Zones
SRP	Suwannee River Partnership
SSC	State Species of Concern
ST	State Threatened
SWIM	Surface Water Improvement and Management
TAG	Technical Advisory Group
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TPTV	Ten Percent Threshold Value
UF/IFAS	University of Florida's Institute of Food and Agricultural Sciences
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WBIDs	Waterbody Identification
WBMP	Wildlife Best Management Practices
WMA	Wildlife Management Area
WQBEL	Water Quality Based Effluent Limit
WRV	Water Resource Value
WWTP	Wastewater Treatment Plant

Executive Summary

This document constitutes the updated Surface Water Improvement and Management (SWIM) Plan for the Coastal Rivers Basin, which includes the following water bodies and their respective watersheds within the State of Florida:

- Aucilla River
- Wacissa River
- Econfina River
- Fenholloway River
- Steinhatchee River
- Waccasassa River.

This SWIM Plan updates the previous SWIM Plans for these water bodies with current status and trends information related to land use, water quantity, water quality, and natural systems. Another important goal of this update is to identify restoration and management priorities and related projects for integration into Florida's Gulf Environmental Benefit Fund (GEBF) Restoration Strategy.

This document has been prepared to meet or exceed with all applicable requirements of Section 373.451, Florida Statutes (F.S.), and 62-43.035, Florida Administrative Code (F.A.C.), specified for SWIM Plans. Section 1 provides an introductory overview of the study area; Section 2 presents a detailed status and trends analysis; Section 3 describes ongoing and proposed management actions; and Section 4 lists ongoing and proposed projects to address the issues identified.

Background

In 1987, the Florida Legislature passed the SWIM Act. The SWIM Act, Section 373.451, F.S., directed each of the state's five water management districts to identify and prioritize degraded surface waters within their respective boundaries, and to develop plans and programs for the improvement and management of those surface waters. It also directed the water management districts and others state agencies to conduct research to provide a better scientific understanding of the causes and effects of surface water pollution and of the destruction of natural systems in order to improve and manage these resources. The implementation of the SWIM Act is codified in 62-43.035, F.A.C.

The Florida Legislature originally funded the SWIM program annually, matched by funds raised by the water management districts; however, dedicated annual funding was ended after the 1997-98 fiscal year. Between 1988 and 1995 the Suwannee River Water Management District (District) developed and adopted SWIM Plans for six priority surface waters. These existing SWIM Plans and their respective dates of adoption included:

- Alligator Lake – 1988;
- Suwannee River – 1991;
- Aucilla River – 1991;
- Waccasassa River – 1991;
- Santa Fe River – 1995; and
- Coastal Rivers – 1995.

Updates of these SWIM Plans, and the development of new plans, by the District essentially ceased due to funding limitations. However, with the passage and implementation of the RESTORE Act in 2012, as well as other legal settlements and resulting funding streams associated with the "2010 *Deepwater Horizon*" oil spill, there is now an unprecedented opportunity to identify, prioritize and implement restoration projects in Gulf of Mexico coastal watersheds. Taking advantage of this opportunity, the District was awarded a grant from the National Fish & Wildlife Foundation's GEBF, through FWC, to update and consolidate the original six SWIM Plans into two SWIM Plans, as summarized in the table below.

Existing SWIM Plans	Updated/Consolidated SWIM Plans
Suwannee River	Suwannee River Basin
Santa Fe River	
Alligator Lake	
Aucilla River	Coastal Rivers Basin
Coastal Rivers	
Waccasassa River	

More so than other parts of Florida, the economy of the Big Bend region of Florida is largely dependent on the quality and sustainability of its natural resources. Accordingly, the District occupies a critically important niche at the intersection of environmental conservation and economic growth. Sound management of sustainable water resources and natural systems is not just the mission of the District, but also the underpinnings of future economic growth in the region. Perhaps the greatest challenge facing the District in this regard is the balancing of increasing consumptive water use demands and pollutant loads associated with the expansion of more intense agricultural and urban land uses with the maintenance of regional environmental quality and natural systems. Furthermore, due to the unique geology of the Big Bend region, surface, ground, and coastal water resources are all closely interconnected.

Land Use

Managed forests (silviculture) and other forested uplands constitute 43 percent of the Basin, while wetlands (both forested and herbaceous) encompass 44 percent of the Basin. Combined, these two land use classes constitute 87 percent of the Basin area. Urban land development has increased slightly, mostly as growth around existing urbanized areas, but still only constitutes a little over three percent of the Basin land area. Due to the extensive coverage of forested uplands and wetlands in the Coastal Rivers Basin, habitat fragmentation is relatively minimal compared to other areas in Florida. In addition, the rivers and streams in the Basin remain almost entirely free flowing, with few impoundments or dams. Therefore, conservation and management of existing natural systems, including the maintenance of flows and water quality, offer the best means to prevent further habitat loss, fragmentation, and/or degradation in the Basin.

Water Quantity

Water resources in the Coastal Rivers Basin are generally healthy. There are extensive conservation lands, and the Basin remains mostly rural in nature, with relatively little urban development or intense agriculture. In addition, the rivers and streams in the Basin remain almost entirely free flowing, with few impoundments or dams. Despite the current status, recent analyses identified small magnitude changes in trends for flows or water levels at some locations in the Basin. Primary threats to the hydrology of the systems within the Coastal Rivers Basin include excessive surface-water withdrawals or diversions, groundwater withdrawals, and modifications of natural drainage patterns.

Public supply, agriculture, commercial and industrial entities, and other users, both within and outside District boundaries, create multiple demands on the water resources of the District. The Coastal Rivers Basin is mostly underlain by an unconfined or poorly confined Upper Floridan aquifer. This lack of a distinct confining layer gives rise to the numerous artesian springs in the region and allows for more rapid recharge of groundwater from infiltration; however, the lack of a continuous confining layer also makes the aquifers in this region highly vulnerable to water quality and quantity impacts from activities conducted on the land surface. There have been extensive modifications made to the natural drainage patterns of these watersheds over the years; large areas of the headwater wetlands have been ditched and drained for timber production, resulting in higher peak flows and quicker response following major rainfall and storm events.

To address these potential threats, the District has identified various management actions and projects/initiatives with the ultimate goal of protecting or restoring natural hydrologic regimes wherever feasible, thus ensuring the protection of critical Water Resource Values therein. Specific goals include actions to increase aquifer recharge and decrease excessive runoff and evapotranspiration. Potential projects to meet these goals include agricultural best management practices (BMPs), hydrologic restoration of over-drained lands, water reuse and water conservation. Because water is an integrated and interconnected resource, many of these management actions, projects or initiatives involve partnerships with other agencies and stakeholders, both within and outside of the District.

Water Quality

Water quality within the Coastal Rivers Basin varies spatially. The Coastal Rivers Basin includes systems that have been used as “reference” locations for regulatory programs, as well as the Fenholloway River, a river with a significant industrial discharge component. The Fenholloway River is undergoing a series of complex and expensive modifications to existing industrial discharges that should allow it to, over the next 5 to 10 years, meet the water quality standards appropriate for its designated use. The extensive conservation lands and the fairly low-impact land use of silviculture are such that most of the rivers themselves are considered healthy, as are the nearshore waters of the Gulf of Mexico into which they discharge (with the exception of the coastal waters near the mouth of the Fenholloway River).

The mostly rural nature of the Coastal Rivers Basin has resulted in the widespread use of septic tank systems as a means of waste disposal. In low enough densities, with adequate separation between the bottom of the drainfield and the wet season water table, septic tank systems can be an entirely appropriate technique for disposing of domestic wastewater. However, various locations have developed over time such that densities and higher water tables might be problematic. Septic tank replacement programs are extremely expensive, but they can also be the most required management action in some locations. Documentation of impacts to pathogen and nutrient loads from septic tank systems should be a near-term focus, to determine those places where conversion to central sewerage would be appropriate. The identification of locations with excessive amounts of pathogens is complicated by the recently shift from the use of fecal coliform bacteria to a combination of fecal coliform bacteria, *Enterococci* bacteria and *E. coli* bacteria.

To address these issues, the District has identified various management actions and projects/initiatives with the ultimate goal to protect or restore the water quality of the Coastal Rivers Basin. Concerns vary, but the majority of concerns have focused on the issues of nutrient (especially nitrogen) enrichment and pathogen abundance. Specific goals include the continuation of efforts to monitor water quality, with regular updates of the status and trends (if any) in water quality across the Basin. In addition, efforts to identify the source(s) of nitrogen to the Wacissa River are called for, as well as the identification of "hot spots" for impacts from septic tank systems. Planned and ongoing efforts to reduce impacts from agricultural land uses are required as well. For the Fenholloway River, stakeholders in the watershed need to continue to implement the projects that have been determined to be required to allow the river to meet Class III freshwater standards.

Natural Systems

The natural systems of the Coastal Rivers Basin comprise valuable ecological, aesthetic, recreational, cultural, and economic resources. Primary threats to natural systems include:

- Land use changes (and corresponding habitat loss and fragmentation);
- Declines in water quality and quantity;
- Introduction of non-native and invasive species; and
- Climate change.

For example, conversion from upland silviculture to higher intensity row crops results in loss of forested habitat and connectivity among habitats important to numerous species. Due to the extensive coverage of forested uplands and wetlands in the Coastal Rivers Basin, habitat fragmentation is relatively minimal compared to other areas in Florida; however, fragmentation is increasing and has become an issue for larger megafauna (e.g., black bear).

Other examples include: disturbance and loss of native SAV in springs due to excessive recreational use and/or algae proliferation due to increased nutrient concentrations; loss of fish habitat due to reduced flows and exposure of formerly inundated floodplains; loss of marsh habitat due to lowered groundwater levels as a result of water withdrawals; disturbance of habitat by invasive species such as wild hogs and subsequent invasion of nonnative and invasive plant species; and loss of salt marsh habitat due to sea level rise and inundation. Climate change and sea level rise in particular are expected to impact Florida's fish and wildlife across all terrestrial, freshwater, and marine habitats; and combined with other stressors, reduce the long term viability of species and associated ecosystems.

Equally important is proper management and maintenance of habitats that historically were fire maintained, such as sand pine scrub, sandhills, prairies, and wetlands. Prescribed fire is used to reduce shrub layer vegetation, initiate seeding in some species, and improve and maintain habitats for deer, quail, turkey and many other wildlife species. Some of Florida's rare, fire-adapted plants and animals that inhabit fire maintained communities include the red-cockaded woodpecker, Sherman's fox squirrel, gopher tortoise, eastern indigo snake, and Florida scrub-jay.

Finally, continued monitoring, data collection, and research to track native habitats and species and improve our understanding of how they may be impacted by land use changes, water quantity and quality, non-native and invasive species, and climate change, are important to managing natural systems in the Coastal Rivers Basin.

Management Actions and Projects

While the rivers and coastal waters along Florida's Big Bend coastline are often viewed as being in a close to pristine condition, the analysis of status and trends presented herein indicate that there are natural resource management issues that need to be address. The primary issues potentially affecting the surface waters and ecology of the Coastal Rivers Basin, both now and in the future, include:

- Increase in silviculture and more intense agricultural and urban land uses;
- Alterations to natural hydrology;
- Decreasing river and spring flows in some locations;
- Increasing nitrogen concentrations in river and springs flows in some locations;
- Habitat fragmentation due to land development and road construction;
- Loss of natural oyster bars; and
- Climate change and sea level rise.

This SWIM Plan includes proposed management actions and projects addressing various aspects of the key focus areas of water quantity, water quality, and natural systems, as summarized below.

Water Quantity

- Monitoring, Data Collection, and Research
- Water Supply Planning
- Minimum Flows and Levels (MFLs)
- Water Resource Development and Aquifer Recharge
- Conservation

Water Quality

- Monitoring, Data Collection, and Research
- Implementation of Total Maximum Daily Loads (TMDLs) and Basin Management Action Plans (BMAPs)
- Wastewater and Stormwater Infrastructure

Natural Systems

- Habitat Conservation
- Habitat Restoration
- Recreation Management.

A total of 33 projects are proposed to address the improvement and management of the Coastal Rivers Basin.

1.0 Introduction

This document constitutes the updated Surface Water Improvement and Management (SWIM) Plan for the Coastal Rivers Basin, which includes the following water bodies and their respective watersheds:

- Aucilla River
- Wacissa River
- Econfina River
- Fenholloway River
- Steinhatchee River
- Waccasassa River.

This SWIM Plan updates the previous SWIM Plans for these water bodies with current status and trends information related to land use, water quantity, water quality, and natural systems. Another important goal of this update is to identify restoration and management priorities and related projects for integration into Florida's Gulf Environmental Benefit Fund (GEBF) Restoration Strategy.

This document has been prepared to meet or exceed with all applicable requirements of Section 373.451, Florida Statutes (F.S.), and 62-43.035, Florida Administrative Code (F.A.C.), specified for SWIM Plans. Section 1 provides an introductory overview of the study area; Section 2 presents a detailed status and trends analysis; Section 3 describes ongoing and proposed management actions; and Section 4 lists ongoing and proposed projects to address the issues identified.

1.1 The SWIM Act - Purpose and Intent

In 1987, the Florida Legislature passed the SWIM Act. The impetus for the SWIM Act was the Legislature's finding that the water quality of many of the state's surface waters had been degraded, or was in danger of becoming degraded, and that the natural systems associated with many surface waters had been altered and were no longer performing the important functions that they once provided, including:

- Aesthetic and recreational pleasure for the people of the state;
- Habitat for native plants, fish, and wildlife, including listed species;
- Safe drinking water to the growing population of the state; and
- Attracting visitors and accruing other economic benefits.

Furthermore, the Legislature found that: factors contributing to the decline in the ecological, aesthetic, recreational, and economic value of the state's surface waters included point and nonpoint source pollution, and the destruction of the natural systems which purify surface waters and provide habitats; that the declining quality of the state's surface waters has been detrimental to the public's right to enjoy these surface waters; and that it is the duty of the state to enhance the environmental and scenic value of surface waters.

The SWIM Act, Section 373.451, F.S., directed each of the state's five water management districts to identify and prioritize degraded surface waters within their respective boundaries, and to develop plans and programs for the improvement and management of those surface waters. It also directed the water management districts and others state agencies to conduct research to provide a better scientific understanding of the causes and effects of surface water pollution and of the destruction of natural systems in order to improve and manage these resources.

Under the Act, water management districts identify priority water bodies for inclusion in their SWIM program based on their regional significance and their need for protection and/or restoration. This process is carried out in cooperation with the Florida Department of Environmental Protection (FDEP), the Florida Fish and Wildlife Conservation Commission (FWC), the Florida Department of Agriculture and Consumer Services (FDACS), and local governments. Upon the designation of a SWIM waterbody, a SWIM Plan must be adopted by the water management district's governing board and approved by FDEP. Before the SWIM Plan can be adopted, it must undergo a review process involving the required state agencies.

The implementation of the SWIM Act is codified in 62-43.035, F.A.C. Pursuant to this rule, SWIM Plans are required to include the following information:

- Description of the waterbody system, its historical and current uses, its hydrology, and a history of the conditions which have led to the need for restoration or protection.

- Identification of all government units that have jurisdiction over the waterbody and its drainage basin within the plan area, including local, regional, state and federal units (Appendix A).

- Description of land uses within the plan area and those of important tributaries, point and nonpoint sources of pollution, and permitted discharge activities.

- List of the owners of point and nonpoint sources of pollution that discharge into each waterbody and tributary thereto and that adversely affect the public interest (by causing or significantly contributing to violations of water quality standards). This list shall include separate lists of those sources that are operating without a permit, operating with a temporary operating permit, and those presently violating effluent limits or water quality standards, and include recommendations and schedules for bringing all sources into compliance with state standards when not contrary to the public interest (Appendix B).

- Description of strategies for restoring or protecting the waterbody sufficient to meet Class III standards or better.

- List and current status of active restoration or protection projects for the waterbody (Appendix C).
- List of studies that are being or have been prepared for the waterbody (Appendix D).
- Description of the research and feasibility studies which will be performed to determine the particular strategy or strategies to restore or protect the waterbody.
- Description of the measures needed to manage and maintain the waterbody once it has been restored and to prevent future degradation.
- Schedule for restoration or protection of the waterbody.
- Estimate of the funding needed to carry out the restoration or protection strategies.

This SWIM Plan has been prepared to meet and exceed these informational requirements. Several Appendices accompany this document which provide specific information as required in the development of this SWIM Plan. All documents referenced within this document are provided in Appendix D.

1.2 SWIM in the Suwannee River Water Management District

The Suwannee River Water Management District (District) is one of five regional water management districts in Florida, created by the Florida Legislature through passage of the Water Resources Act of 1972. The District is the smallest of the state's water management districts in terms of geographic area, population served, tax base, and agency staff. The service area of the agency includes:

- 7,640 square miles;
- All or part of 15 counties in north-central Florida;
- 13 river basins; and
- A population of 320,000.

Figure 1 below shows the geographic location and extent of the District's boundaries. For the purposes of this document, the term "basin" refers to the overall study area, while the term "watershed" refers to the drainage areas for each of the individual river systems addressed in the Plan.

Figure 1. District Boundary

1.2.1 Previous SWIM Plans

The District began implementing the SWIM Act in 1987 utilizing a three-step process to develop and execute their SWIM program. First, an evaluation of the District's surface waters was conducted to develop a priority list of those systems most in need of restoration or protection. Second, SWIM Plans were prepared for priority surface waters to guide the restoration and/or protection of water quality. Third, key policies, projects, and other actions identified in the SWIM Plans were implemented and monitored, including annual evaluations and modifications, as required under the SWIM Act.

The development of a priority surface waters list was first undertaken by the District in the fall of 1987. Early in the process, the District established a SWIM Technical Advisory Group (TAG) to identify regional management issues, prioritize surface water bodies, exchange data and information, and review management proposals. The TAG was comprised of representatives from the review agencies (listed in 62-43.035, F.A.C.), university staff, and appropriate federal agencies. Using the criteria developed by FDEP, water bodies were prioritized by the District in cooperation with FDEP, FWC, local units of government, and other interested parties and stakeholders.

In order of priority, the first six SWIM priority waters were the Upper Suwannee River, Lower Suwannee River, Santa Fe River, Steinhatchee River, Alligator Lake, and Falling Creek. In later years, the priority list was revised to include the Upper and Lower Suwannee River and Falling Creek into an overall Suwannee River System. In addition, during the same year the Steinhatchee plan was expanded to include the entire Coastal Rivers Basin, as well as the addition of the Aucilla and Waccasassa rivers. All SWIM rivers include coastal waters to the state water limit in the Gulf of Mexico (nine nautical miles seaward of the shoreline). In all, the District adopted SWIM Plans for six priority surface waters. These existing SWIM Plans and their respective dates of adoption are as follows:

- Alligator Lake – 1988;
- Suwannee River – 1991;
- Aucilla River – 1991;
- Waccasassa River – 1991;
- Santa Fe River – 1995; and
- Coastal Rivers – 1995.

Given the rural nature of the Suwannee River region, the six original SWIM Plans were predominantly “preservation” rather than “restoration” oriented, and primarily addressed public land acquisition priorities as well as the need for ongoing monitoring programs related to land cover, water quality, and aquatic resources. However, several restoration projects were identified in the SWIM Plans and ultimately implemented. The status of prior SWIM Plan projects and programs is summarized in Appendix C.

Throughout the development and execution of its SWIM program, the District has advocated for a regional watershed approach to resource management, which recognizes that surface water bodies, groundwater aquifers, and their related natural systems are not confined to political jurisdictions. The land area that drains to a surface waterbody - defined as the watershed or basin - often includes the jurisdictions of many levels of government, each of which has different interests, responsibilities, and capabilities. Accordingly, the District has promoted interagency coordination and cooperation between the various jurisdictions within its boundaries to improve resource protection and management.

Land use is an important determinant of surface water quality, and the authority to regulate land uses in Florida - including land use allocation, density, and intensity controls through land use planning - lies principally with local units of government. However, local governments within the District boundaries are mostly small and rural, and lacking in staff and fiscal resources. Therefore, in recognition of these challenges, the District has focused on providing technical and planning assistance to local governments within in its jurisdiction to identify public land acquisition priorities, and to promote land use planning practices that are compatible with sound water resource management across multiple political boundaries.

Finally, the District has developed effective non-regulatory partnerships with other agencies, private landowners and key economic interest groups within its jurisdiction. Agricultural and forestry land uses are predominant within the District boundaries, and these land uses are typically less regulated than more intense urban land uses with respect to water quality.

1.2.2 SWIM Plan Update and Consolidation

The Florida Legislature originally funded the SWIM program annually, matched by funds raised by the water management districts; however, dedicated annual funding was ended after the 1997-98 fiscal year. Since then many SWIM water bodies around the state have benefited from significant individual legislative appropriations throughout the years, associated with the Community Budget Issue Request water project funding process under Section 403.885, F.S. Furthermore, the water management districts and FDEP continue to use the SWIM planning process and plans to guide their resource management efforts.

In recent years, the identification of water quantity issues has been led by Florida's various water management districts through the Minimum Flows and Minimum Levels (MFLs) program, while issues related to water quality have been the focus of FDEP led efforts to develop Total Maximum Daily Loads (TMDLs) and the subsequent Basin Management Action Plan (BMAP) program. The TMDL program is meant to identify pollutant load reductions necessary to restore impaired waterways, while the BMAP program is meant to guide the implementation of load reductions identified in the TMDL process.

With the passage and implementation of the RESTORE Act in 2012, as well as other legal settlements and resulting funding streams associated with the "2010 *Deepwater Horizon*" oil spill, there is now an unprecedented opportunity to identify, prioritize and implement restoration projects in Gulf of Mexico coastal watersheds. Taking advantage of this opportunity, the District was awarded a grant from the National Fish & Wildlife Foundation's GEBF, through FWC, to update the original six SWIM Plans. GEBF was established in early 2013 as a result of the plea agreements resolving the criminal cases against BP and Transocean after the oil spill. The agreements required a total of $2.544 billion to be paid to GEBF over a five-year period with $356 million allocated for projects within Florida. The funds are to be used for projects that remedy harm to natural resources injured by the oil spill. To bring a more consistent and comprehensive planning focus to the SWIM Plan updates, the District decided to consolidate the six original SWIM Plans into two SWIM Plans, as summarized in Table 1 below.

Table 1. Existing SWIM Plans to Be Consolidated into Two SWIM Plans

Existing SWIM Plans	Updated/Consolidated SWIM Plans
Suwannee River	Suwannee River Basin
Santa Fe River	
Alligator Lake	
Aucilla River	Coastal Rivers Basin
Coastal Rivers	
Waccasassa River	

The primary goal of this effort is to update the existing SWIM Plans with current status and trends information related to land use, water quantity, water quality, and natural systems in the greater Suwannee River and Coastal Rivers Basins. Another important goal of this effort is to identify restoration priorities and projects for integration into Florida's GEBF Restoration Strategy, which is being developed by the District as the deliverable under their GEBF grant. Restoration projects identified in the SWIM Plans and submitted to the state project portal at www.deepwaterhorizonflorida.com will be considered for future "2010 *Deepwater Horizon*" funding (e.g., Natural Resource Damage Assessment, GEBF, and/or RESTORE funds). Specific parameters will be applied for each funding stream to determine eligibility of projects.

1.2.3 Integrating Water Management and the Economy

The geographic region encompassed by the District is a land of working farms, forests, rivers, springs, and estuaries where the local economy is dependent upon the services provided by the natural resources of the region. The Big Bend coastal region has the most extensive contiguous stretch of undeveloped coastline along the U.S. Gulf of Mexico, which provides important nursery habitat for a variety of commercially and recreationally important species of finfish and shellfish. As such, the people of this rural region rely more on the natural systems for their livelihood and recreation than most Floridians. The region has not experienced the dramatic increases in population growth that have characterized other regions of Florida, and the landscape mostly reflects the dominant land uses of forestry and agriculture. It is also important to recognize that this region is not homogeneous, either in terms of its natural systems or economic drivers. The Suwannee River Basin is dominated by intense agricultural land uses including crops and livestock; whereas the Coastal Rivers Basin is characterized by managed forest lands, small coastal communities, and aquaculture operations.

Many of the community leaders in the region are seeking economic growth, but they also recognize that growth is dependent on the protection of the areas' natural resources. To ensure economic growth, mature industries such as farming, forestry, and natural resource-based manufacturing (e.g., paper) must continually innovate to stay competitive while also sustaining the natural resources upon which they rely. Aquaculture is a growing industry in the region and offers great potential for expansion, both geographically and in terms of product diversity. Similarly, aquaculture is also dependent on the maintenance of pollution free coastal waters. Finally, nature-based and experiential tourism, especially focused on the regions' numerous springs, can also capitalize on the rich natural systems so long as they are adequately protected, accessible, and the appropriate tourism infrastructure exists.

In preparing the SWIM Plan updates, the District conducted an extensive public outreach program to identify issues of concern as well as priorities and projects for the preservation, conservation and restoration of water resource and natural systems. Through this public outreach process several key themes were identified, and are summarized below and in Appendix E.

1.2.3.1 Preserving Working Forests to Protect Water Quantity and Quality

The Big Bend region includes some of the most heavily forested areas in Florida. The majority of these areas are managed pine and hardwood forests that are periodically harvested for timber production. Although silviculture – the term for managed timber production - is a form of agriculture, forestry BMPs are generally considered to be compatible with the maintenance of healthy water resources, supporting clean rivers, creeks, and springs, fish and wildlife habitat, and drinking water (Ursic and Douglass 1978). Forested lands serve as natural filters reducing nutrient and sediment loads, benefitting receiving waters and downstream coastal estuaries.

FDEP and FWC have recently raised concerns about increased nutrient loads from the Suwannee River Basin impacting seagrass coverage in the Big Bend Seagrasses Aquatic Preserve. Reducing nutrient loads in the both the Suwannee River Basin and the Coastal Rivers Basin will not only directly benefit receiving waters, but will also benefit the downstream health of the Big Bend coastal estuaries, including the extensive seagrass beds that characterize the region. Furthermore, sustaining forest lands in the Big Bend region will continue to provide a buffer between Gulf coastal waters on the west and more intense agriculture on the east. Undeveloped land area will allow for habitat adaptation to rising sea levels, thus maintaining the coastal resiliency of the region.

Properly managed forested lands can also benefit water quantity. FDACS and University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS), with funding support from the five water management districts, is two years into a four-year research project to quantify the water yield benefits of different forest management techniques to local and regional water resources. Preliminary results indicate that reducing biomass and leaf area of conifers through different management techniques, like thinning or prescribed fire, will reduce forest water losses through evapotranspiration, thus increasing water yield to surface water bodies and aquifers. Some species, such as the Sherman's fox Squirrel (a state species of special concern), rely on regular fire management to ensure habitat maintenance.

These forests are critical to the regional economy and quality of life. Big Bend forests form the basis of the strong timber, paper, and wood products industries that employ many of the area's residents. Forestry, and forest product manufacturing, generated over $2 billion dollars in economic output for the region and directly supported over 12,000 jobs in 2013 (Hodges 2013). Over 6,500 of those jobs are in Taylor County alone. The new Klausner sawmill in Suwannee County will also employ 350 people, and create over 700 jobs in construction and related supply chains (Van 2014). Although it is unlikely that the acreage of working forests in the region will expand significantly in the future, steps should be taken to maintain and protect existing managed forest lands through the development of stronger partnerships between the state, the District and forest-based industries in the region. Such partnerships will support economic growth, markets, and jobs, as well as sound water resource management.

Industry leaders stress the importance of scientifically-sound and continually-improving silviculture BMPs, as well as the need for reforestation acres to equal or exceed harvest acres to ensure long-term silviculture resource sustainability. However, there are increasing regional economic pressures to convert managed forest lands into more intense agricultural uses, including row crops and livestock operations, due to higher short-term returns. If the conversion of managed forest lands to other land uses increases beyond a presently unknown “tipping point” related to silviculture (i.e., if available land for forest products becomes limiting to local mill operations), then such land use conversions could be accelerated. Finally, the conversion of managed forest lands to more intense agriculture and urban land uses west of U.S. 19 could potentially threaten coastal water quality and aquatic resources. Measures to sustain managed forest lands in the Coastal Rivers Basin will limit further land use impacts to natural systems protection.

1.2.3.2 Improving Water Quality to Promote Aquaculture in Coastal Communities

The Big Bend coastal region of Florida is characterized by long stretches of undeveloped shoreline and extensive salt marshes punctuated by a few small coastal residential communities, including Cedar Key, Suwannee, Steinhatchee, Horseshoe Beach, and Keaton Beach. While these uniquely isolated communities have largely retained their rural character and maritime culture, they offer great potential for emerging aquaculture industries. The quality of coastal waters, and the sustainability of marine resources, in the region is largely dependent on the quality and quantity of waters discharged from the major regional rivers, with the Suwannee River being by far the most important in terms of total discharge volume.

Cedar Key has enjoyed an economic renaissance, largely due to its burgeoning hard-shell clam aquaculture industry. Prior to 1990, the seafood industry in Cedar Key was limited to local wild oyster harvests and net-caught fish. However, in 1990 the U.S. Food and Drug Administration closed the area’s commercial oyster harvest in the Suwannee Sound due to high and persistent levels of sewage-borne bacteria seeping from local septic tanks. Then in 1994 Florida voters approved a commercial net ban which essentially shut down the local mullet fishing industry. Beginning in 1992, the Cedar Key Water and Sewer District was created and multiple infrastructure upgrades to replace septic tanks with a central sewage treatment facility were initiated. The District was a partner in this effort, contributing significant funds for improvements to wastewater and stormwater treatment facilities on Cedar Key. Completed in 2003, the Cedar Key wastewater treatment plant (WWTP) now treats up to 180,000 gallons per day (GPD) of domestic wastewater, and produces a high quality treated effluent that is distributed as reclaimed irrigation water on the island. These infrastructure upgrades, and the resulting improvements in coastal water quality, were critical to the emergence of the Cedar Key shellfish industry.

Following the fishing net ban in Florida, the UF/IFAS and Sea Grant programs began working with local investors to develop a clam aquaculture industry using northern quahog clams (*Mercenaria mercenaria*) transplanted from the Florida east coast. With improved local water quality conditions, the shallow, well-flushed, muddy bottomed waters around Cedar Key proved to be ideal habitat for clams. Today, the clam aquaculture industry generates an annual economic impact of about $53 million, which far exceeds that of other shell fishing industries in Florida. Due to the Cedar Key success, UF/IFAS/Sea Grant is now exploring the feasibility of farming the Venus sunray clam, a species native the Florida Gulf coast, as well as oyster aquaculture.

Given its extensive miles of shallow undeveloped coastline and excellent water quality, the coastal Big Bend region, Suwannee Sound and the Cedar Keys, in particular, are ideal for shellfish aquaculture. The aquaculture industry has benefited from prior public-private partnerships to protect and restore water quality so that the industry can continue to thrive. In addition to providing a substantial economic impact to the region, shellfish farms also provide significant environmental benefits. As active filter feeders, clams constantly strain surface water, removing particulate matter that shades light penetration that is required by seagrasses. Through projects ranging from wastewater infrastructure improvements and land acquisitions, to living shoreline and artificial reef projects, the District continues to work with public and private partners to improve water quality in the Big Bend coastal region, benefiting the coastal industries. This emerging market offers a tremendous economic opportunity that is both environmentally and culturally compatible with the coastal communities of the region.

1.2.3.3 Preserving Wild and Scenic Coastal Rivers

The coastal rivers within the District are some of the most pristine natural resources in Florida. The Aucilla and Wacissa Rivers are both designated by the state as Outstanding Florida Waters (OFW), and with much of the land along the rivers in public ownership, these rivers remain highly scenic. As true ecotourism destinations, coastal rivers are home to a vast array of wildlife and offer recreation opportunities for birding, canoeing, kayaking, and nature photography.

The coastal corridors are of historic and cultural importance as well. The Aucilla River watershed contains archaeological treasures, including one of the only sites in the world for studying early human settlement in the Western Hemisphere. Located on the southern edge of Florida's Red Hills Region, the Page-Ladson archaeological dig has attracted exploration by scientists since the 1960s. Recent discoveries have confirmed this site to be the oldest known location of human life in the southeastern United States, with artifacts dating back over 14,500 years. In the January 2015 issue of National Geographic Magazine an article includes Page-Ladson as one of only ten sites for studying early human settlement in the Western Hemisphere.

The Wacissa River is a large, spring-fed stream located in south-central Jefferson County, Florida. Its headwaters are located about a mile south of the town of Wacissa, where the river emerges crystal clear from a group of large limestone springs. From its headsprings, the river flows approximately 12 miles (19 km) south through a broad cypress swamp before breaking into numerous braided channels which join the Aucilla River a few miles further south. This is where the historic "Slave Canal" is found. This canal was an attempt to join the two rivers to move cotton to the coast during antebellum times. Although the canal was not successful in transporting cotton, it now is a popular destination for experienced paddlers. Preserving these unique systems is a major priority for the District.

1.2.3.4 Innovative Agricultural Practices to Promote a Sustainable Regional Economy

As stated above, FDEP and FWC have recently raised concerns about increased nutrient loads in Suwannee River Basin impacting seagrass coverage in the Big Bend Seagrasses Aquatic

Preserve. Reducing nutrient loads in the both the Suwannee River Basin and the Coastal Rivers Basin will not only directly benefit receiving waters, but also the downstream health of the Big Bend coastal estuaries, including the extensive seagrass beds that characterize the region.

The District was key in the formation and implementation of the Suwannee River Partnership (SRP). Through the SRP, the District works with state, federal, and regional agencies, local governments, and agricultural operations to reduce nutrient loading and conserve water use through the voluntary implementation of BMPs. Now with 64 partners, the coalition has mobilized 89 percent of the dairies and 94 percent of the poultry farms in Florida's Suwannee River Basin to participate in a voluntary program to reduce nutrient loadings and to conserve water use throughout the region. The SRP works closely with FDACS to assist producers in enrolling in the FDACS BMP program.

Through agricultural cost-share programs, the District and FDEP partner with agricultural producers to increase irrigation efficiency, water conservation, and improve nutrient management. Cost-share funding is available for various projects including irrigation retrofits, soil moisture probes, fertigation systems, pump upgrades, and dairy wastewater system and nutrient management improvements. In July of 2016, FDEP awarded $6 million in springs grant funding for the Sustainable Suwannee Pilot Program, which will offer financial incentives for agricultural producers to transition to less intensive, low input cropping systems, or possibly permanent conservation easements. The Pilot Program will also offer financial assistance for implementing advanced water quality improvement technologies that can cost effectively reduce nutrient inputs. Potential technologies may include pump and treat processes, permeable reactive barriers, wood chip bioreactors, or denitrification and treatment wetlands. The goal of the Sustainable Suwannee Pilot Program is to reduce nutrient impacts on water resources while maintaining a strong, sustainable agricultural industry and private land ownership.

Continuing to work collaboratively, the District, FDEP, FDACS, UF/IFAS and UF Water Institute partnered together in 2015 to study advanced irrigation management technology and management strategies for row and field crops. This study will develop improved irrigation and fertilizer management practices to guide producers in the Suwannee River Basin. Field demonstrations will replicate various irrigation schedules and fertilizer regimes, and will examine and evaluate water savings and the potential nutrient movement across soil types specific to this region with corn, peanut, and cotton rotations. Each plot is equipped with a sensor that monitors key parameters at multiple depths. The measurements are captured and reported in real time. This information will be used to automate irrigation schedules and assist with fertilizer application schedules. Nutrient leaching will be measured using special meters and soil borings from the land surface to the top of the water table. Outcomes of this pilot project will provide producers research-based irrigation scheduling based on soil moisture sensor readings. These data will be used across the District to reduce groundwater demand and nutrient loading to water bodies. The results will help reduce water use and leaching of nutrients to the environment and potentially increase net farm income.

Agriculture in the District is changing rapidly due to market forces, technological advancements, and growing regulatory constraints (e.g., MFLs). Considering these changes, continuing research and implementation of technologies and innovative agricultural practices, through programs like the Sustainable Suwannee Pilot Program, are key to meeting the challenge of protecting water resources and sustaining the region's agricultural economy.

1.2.3.5 Springs-Based Recreation and Tourism

The District encompasses a region defined by world-renowned springs, including the highest concentration of springs in Florida and the highest concentration of first-magnitude springs in the United States. Springs provide habitat for wildlife and plant species, as well as natural, recreational, and economic value. Recreational use of springs supports ecotourism in the region providing opportunities for swimming, fishing, diving, kayaking and canoeing, and wildlife viewing.

In addition to some of the ecosystem services mentioned above, a study completed in 2014 by the UF concluded that recreational use of springs constitutes a significant economic driver to the region (Borisova et al. 2015). The estimated total economic benefits associated with recreational use (due to direct spending, supply chain activity and income re-spending) supported over 1,000 full and part-time jobs and generated $94 million annually in economic output. This economic impact is expected to increase as a growing Florida population discovers the unique treasures of the regions' springs.

Springs in the District are vulnerable to increased nutrient loading and declining flows. Long-term preservation of this international resource is a major priority of the District, and this objective has recently been underscored by the Legislature which designated 14 springs and springs groups within the District as Outstanding Florida Springs. Significant legislative appropriations for springs projects have helped make this commitment a reality. The District is putting these funds to work by partnering with various agencies, local governments, landowners, and organizations through cost-share programs and projects to conduct restoration activities at numerous springs. Many of these projects are designed to restore groundwater levels and to reduce nutrient loading within priority water bodies and springsheds throughout the District. Springs preservation and restoration will continue to be a major priority of the District. With the passage of Senate Bill (SB) 552, it is anticipated that funding levels for springs protection and restoration initiatives will be significant for years to come. Through these initiatives the District will continue to work with FWC to ensure that springs-dependent species are adequately protected.

1.2.3.6 Hydrologic Restoration and Aquifer Recharge

The Big Bend region of Florida is unique regarding the extent and degree of interaction between surface water and groundwater. In most parts of the state, the deeper Floridan aquifer is confined from the surficial aquifer and surface waters via layers of clay and other impervious strata. However, in almost the entire Coastal Rivers Basin, the confining layer is thin and discontinuous or absent altogether. This lack of a distinct confining layer gives rise to the numerous artesian springs in the region and allows for more rapid recharge of groundwater from infiltration, but also makes the aquifers in this region highly vulnerable to water quality and quantity impacts from activities conducted on the land surface. Accordingly, the District has identified hydrologic restoration and aquifer recharge as a priority. Hydrologic restoration projects in the District re-establish and improve natural systems such as wetlands, floodplains, native ecological communities. Aquifer recharge areas provide valuable water resource functions including: water quality treatment, water supply, flood water conveyance, attenuation, fish and wildlife habitat, and recreation.

The District initiated the Mallory Swamp restoration project in Lafayette County in 2002. For over 50 years the land was used for timber production, and water was drained off the property through a network of canals and ditches that were periodically dredged and kept free of silt and vegetation. Nearly 30,000 acres of the swamp were acquired by the District with the objective of reversing the impacts of these hydrologic alterations. Funding was provided by the District and the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). A large portion of the funds were spent on the installation of 311 culverts and 57 ditch blocks to restore natural drainage patterns and increase the ability of the property to store water as it did prior to the alterations; thus rehydrating wetlands, recharging the aquifer, and enhancing both spring flows and water supplies. The District is committed to continuing its efforts to address issues through hydrologic restoration.

Additionally, as a component of its Fenholloway River water quality restoration plan, the owner of the pulp mill in Perry, Florida, Foley Cellulose LLC, initiated a headwater hydroperiod enhancement project to restore the hydrology of the freshwater portion of the Fenholloway to more natural/background conditions. This project involved the enhancement of a roughly 6,748-acre wetland site by removal of the pine plantations and installation of 71 ditch blocks and 40 low water crossings to restore natural drainage patterns and increase the ability to store water.

1.2.3.7 Summary

As discussed above, the economy of the Big Bend region of Florida is largely dependent on the quality and sustainability of its natural resources. Accordingly, the District occupies a critically important niche at the intersection of environmental conservation and economic growth. Sound management of sustainable water resources and natural systems is not just the mission of the District, but also the underpinnings of future economic growth in the region.

Perhaps the greatest challenge facing the District in this regard is the balancing of increasing consumptive water use demands and pollutant loads associated with the expansion of more intense agricultural and urban land uses with the maintenance of regional environmental quality and natural systems. Furthermore, due to the unique geology of the Big Bend region, surface, ground, and coastal water resources are all closely interconnected.

The identification of stressors, summarized in Section 2, has led to the development of quantifiable objectives and recommended programs and projects designed to protect and/or restore the water resources of the Coastal Rivers Basin, as presented in Sections 3 and 4.

1.3 Coastal Rivers Basin Planning Area Description

The Coastal Rivers Basin SWIM Plan area encompasses approximately 3,637 square miles, as well as approximately 154 linear miles of shoreline along the Gulf of Mexico. Figure 2 shows the boundaries of the Coastal Rivers Basin SWIM Plan area.

The Coastal Rivers Basin encompasses all or parts of Jefferson, Taylor, Dixie, Levy, Gilchrist, Madison, and Lafayette counties, exclusive of the Suwannee River watershed. Appendix A identifies of all government units that have jurisdiction over the Coastal Rivers Basin, including local, regional, state, and federal units. Five river systems drain the Coastal Rivers Basin: Aucilla, Econfina, Fenholloway, Steinhatchee, and Waccasassa Rivers. These systems are briefly summarized below:

- The **Aucilla River** originates from artesian springs in South Georgia and flows south approximately 89 miles to the Gulf of Mexico, flowing through marshes and lakes in north Florida, karst limestone east of Tallahassee, and sinks. The tannin-colored blackwater river disappears below the Cody Scarp and rises at Nutall Rise, the only known major spring on the Aucilla, before flowing into the Gulf of Mexico. The Wacissa River, a tributary of the Aucilla River, is a spring-fed river flowing approximately 12 miles through a broad cypress swamp before breaking into numerous braided channels which join the Aucilla. Twelve major springs feed the Wacissa River as it flows through swampy lowlands in the Aucilla Wildlife Management Area (WMA). The combined drainage area of the Aucilla and Wacissa watersheds comprises 731 square miles.
- The **Econfina River** begins in Madison County, Florida in the San Pedro Bay swamp. It flows for approximately 40 miles through Taylor County, where it then discharges into the Gulf of Mexico. The Econfina River has several small, but no major, springs and flows as a blackwater river through swampy lowlands.
- The **Fenholloway River** is a 36-mile long blackwater river in Taylor County, Florida, and like the Econfina, originates in the San Pedro Bay swamp. It is a blackwater river, and also receives freshwater input from springs. A paper mill discharges about 40 million GPD of treated wastewater into the Fenholloway River 24.6 mi upstream of the mouth of the river. At this location, these discharges contribute up to 90 percent of the flow in the river (Sousa et al. 2002). In order to restore the river to Class III standards, the facility is upgrading its wastewater treatment, and the point of discharge will be relocated to a location 1.5 miles upstream of the mouth of the river no later than March 2021.
- The **Steinhatchee River** is a blackwater river that begins in Lafayette County in Mallory Swamp, south of the Town of Mayo, and flows approximately 35 miles before discharging into the Gulf of Mexico. There are two priority springs that contribute to the discharge of the Steinhatchee River, Steinhatchee Rise and TAY76992. The Steinhatchee River supports commercial and sports fishing and recreational scalloping along the coast. The combined drainage area of the Coastal Rivers Basin encompassing the Econfina, Fenholloway, and Steinhatchee watersheds comprises 1,859 square miles.
- The **Waccasassa River** is a scenic and relatively undeveloped river within Florida. The river begins in the southern end of the Waccasassa Flats, a broad complex of swamps and pine flatwoods located in central Gilchrist County and becomes a named river in extreme southern Gilchrist County (District 2006). The river flows through multiple channels, swamps, and has areas of sheet flow (i.e., Devil's Hammock in northern Levy County). The river becomes tidal with a wide floodplain before it empties into a broad,

shallow estuary known as Waccasassa Bay. Major tributaries include Cow Creek, Tenmile Creek, Wekiva River, and McGee Branch. Wekiva Springs and Levy Blue Springs are important sources of baseflow to the Wekiva and Waccasassa rivers, respectively. The drainage area of the Waccasassa watershed comprises about 820 square miles.

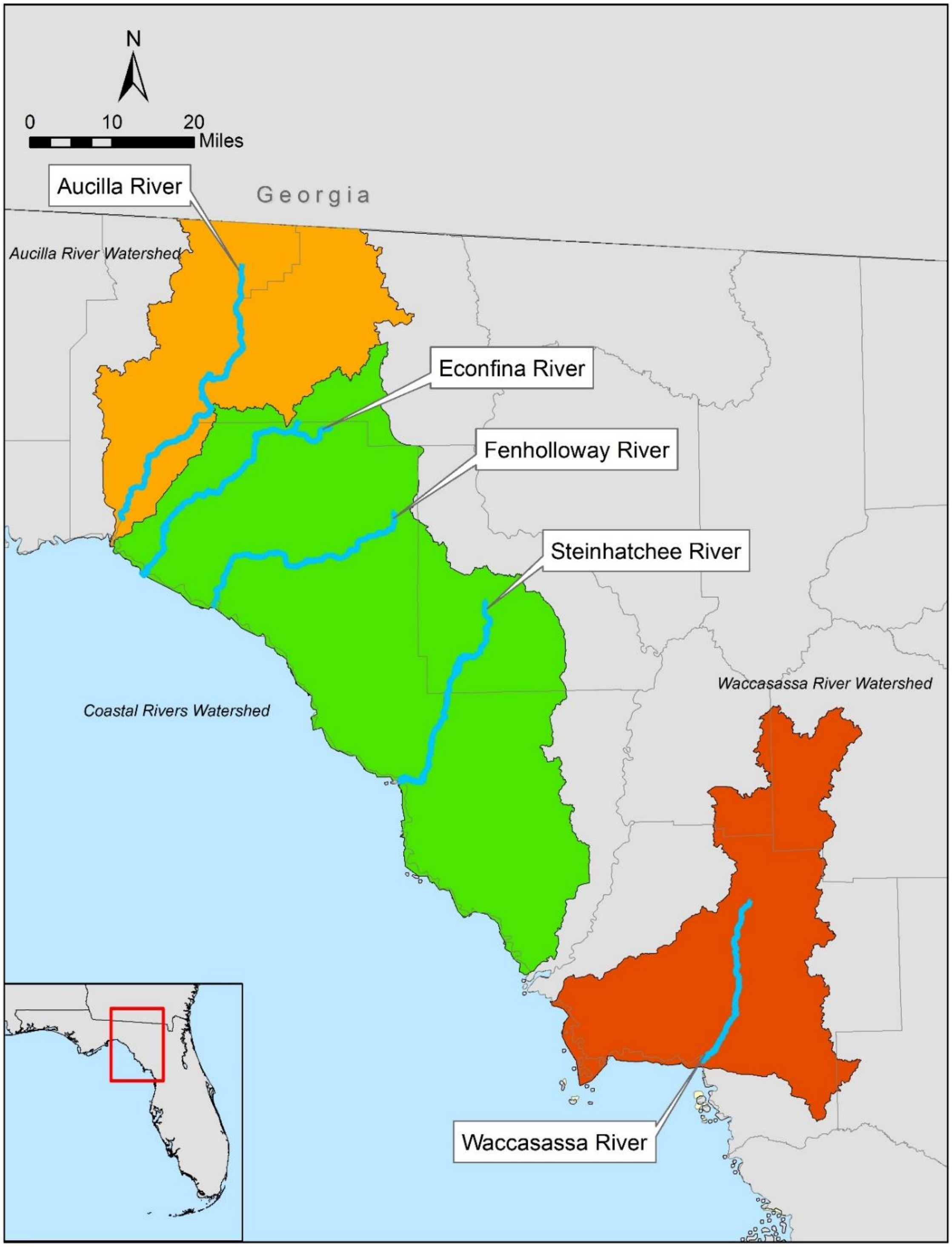


Figure 2. Consolidated Coastal Rivers Basin SWIM Plan area

The rivers in the Coastal Rivers Basin are small when compared to the Suwannee River. Only the Aucilla River extends more than 50 miles inland and crosses the Cody Scarp into the Northern Highlands Physiographic Province. These rivers are fed partly by springs discharging groundwater from the Floridan aquifer system, and partly by surface water runoff from their drainage watersheds. Surface runoff dominates the hydrology of these rivers during high or flood flows, while groundwater inflow from springs predominates during low or base flows.

The District (2000) identified 56 springs in the Basin in 2000, only 24 of which were previously cataloged. Of the 56 springs, there were three first-magnitude springs, 29 second-magnitude springs, 17 third-magnitude springs, and four fourth-magnitude springs. Three springs were not visited due to lack of access.

1.3.1 Physiography and Topography

The Coastal Rivers and Waccasassa watersheds lie predominantly within the Gulf Coastal Lowlands and Coastal Swamp geomorphic regions, which are characterized by low physical relief and poor drainage (Figure 3). The inland, upstream portions of the watersheds lie on older marine terraces that gradually step down to more recent terraces along the coast. The extensive headwater swamps (e.g., San Pedro Bay and Mallory Swamp) are “perched” on these higher terraces. Surface waters coalesce into defined, but braided, stream channels along the upper portions of the watershed. As these small, intermittent streams move down toward the coast, the rivers are formed. The middle portion of Aucilla River watershed is located within the Tallahassee Hills geomorphic regions while the upper reaches extend into the Northern Highlands region.

Elevations within the area range from 140 feet mean sea level (MSL) in Madison County to sea level at the coast. Variations are subtle, as evidenced by the extensive wetlands systems that cover the watershed. Some of the more pronounced topographic features within the watershed are relic dunes located inland from the shoreline. These relic dunes rise up to 30 feet above the surrounding flatwoods in some areas.

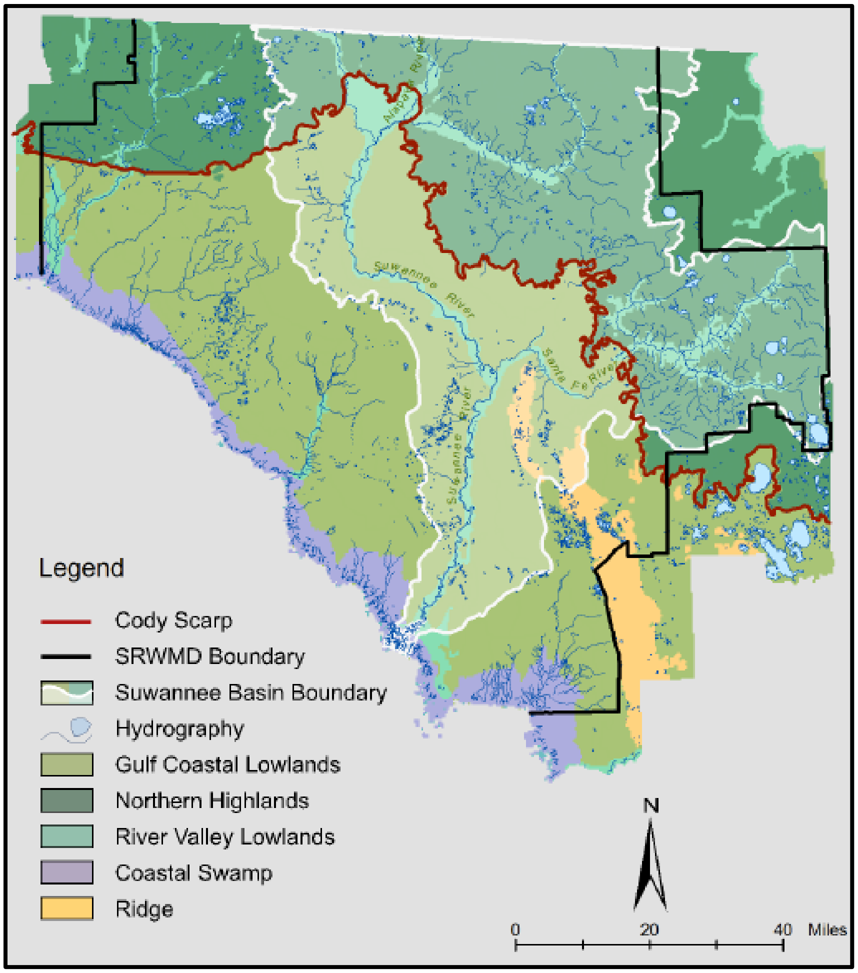


Figure 3. Physiographic Regions of the District (District 2010)

1.3.2 Hydrogeology

The Floridan aquifer system is mostly unconfined and open to the surficial aquifer in the Coastal Rivers and Waccasassa watersheds (Figure 4). The uppermost geologic unit of the aquifer in the area is either Suwannee or Ocala limestones. The limestones are porous and permeable, and overlain by a thin layer of sandy soil. This allows rainfall to percolate rapidly to the aquifer and as a consequence makes the aquifer vulnerable to contamination. Wetlands areas in the upper watershed, such as San Pedro Bay and Mallory Swamp, exist because they are generally underlain by less permeable soils. The Floridan aquifer system is semi-confined within the upper reaches of the Aucilla watershed (Figure 4). As such, aquifer recharge is constrained due to the lower permeability of overlying materials.

The coastal area inland several miles is a discharge area for the Floridan aquifer system. Otherwise, most of the watershed has moderate to high recharge potential for the aquifer (Figure 4). Areas where the aquifer is close to or at the land's surface, during normal or high groundwater levels, have low recharge potential because storage space in the limestone or soil is limited and rainfall is forced to run off to the nearest surface waterbody. Areas with a thicker overburden of sands and lower relative groundwater levels have more storage space and a correspondingly high recharge potential.

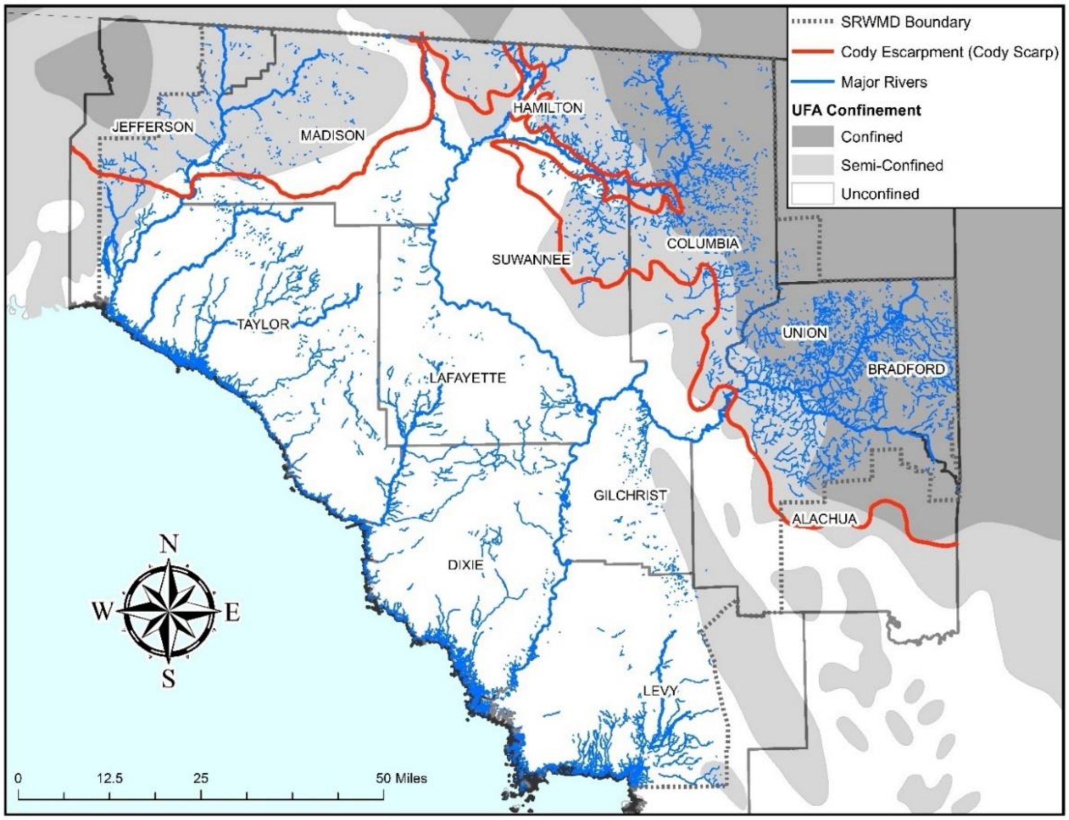


Figure 4. Confinement Conditions of the Upper Floridan Aquifer within the District (confinement conditions from Miller, 1986)

Interaction of surface and groundwater is an important hydrologic feature of the area. Because of the relatively thin overburden between the land's surface and the aquifer, there is a high degree of interaction between surface and groundwater. In fact, in much of the watershed surface and groundwater can be considered the same resource. River corridors are especially important, because they tend to occupy fracture zones and are where the greatest interaction of surface and groundwater occurs. Springs are almost always found along the river corridors, and serve as a conduit between surface and groundwater.

1.3.3 Hydrology and Water Chemistry

The rivers and streams of the Coastal Rivers Basin all generally exhibit similar characteristics. All originate from headwater swamps that have naturally acidic, highly-colored water low in dissolved oxygen (DO). Flows are highly variable, depending for the most part on surface water runoff, although groundwater input does play a minor role in maintaining base flow. These rivers typically have their highest discharge in late winter and early fall, with lowest flows usually in early summer and late fall.

There have been extensive modifications made to the natural drainage patterns of these watersheds over the years by the timber companies that own most of the land. Large areas of the headwater wetlands have been ditched and drained for timber production, resulting in higher peak flows and quicker response following major rainfall and storm events. The Steinhatchee River exhibits the most variability in flow, which may be due to past hydrologic alterations in the headwaters combined with relatively greater urbanization near the coast. Recent modifications to some of these drainage features have attenuated peak flows to more closely emulate natural drainage conditions.

Water quality conditions in rivers of the Coastal Rivers Basin are generally excellent with most meeting or exceeding all standards for Class III waters. The Fenholloway River begins as a small, winding blackwater stream that, during dry periods, has very little to no flow. However, the river below mile 24.6 receives treated effluent that results in poor water quality from low DO, high biochemical oxygen demand (BOD), high conductivity, and other symptoms of high organic loading. During low flow periods, nearly the entire flow of the river at the discharge point is effluent from the mill. FDEP has established an Administrative Order with the Foley Cellulose mill to improve wastewater treatment and relocate the point of discharge farther downstream. Once fully implemented, these actions are expected to allow the Fenholloway River to meet standards for Class III waters. The river also receives treated wastewater effluent from the City of Perry, via Spring Creek.

1.3.4 Natural Systems

Natural systems are communities of plants and animals that are generally associated with a specific hydrologic regime. In the Coastal Rivers Basin natural systems include:

- Upland habitats;
- Freshwater habitats; and
- Marine/estuarine habitats.

These natural systems are briefly discussed below, using terminology of the Florida Natural Areas Inventory (FNAI 2010). A more detailed presentation on the natural systems in the Coastal Rivers Basin, including habitat for species designated as threatened or endangered, either by the State of Florida or the U.S. Fish and Wildlife Service (USFWS), and threats to habitats and species, are provided in Section 2.3.

1.3.4.1 Upland Habitats

Natural upland habitats in the Basin include communities such as upland hardwood forest, upland pine (e.g. longleaf pine and scrubby flatwoods), upland mixed forest, mesic hammock, and sandhill and scrub communities that provide habitat for numerous wildlife species. The transition between upland and wetland communities is characterized by habitat ecotones that reflect changes in soil, hydrology, and vegetation.

- Hardwood forested uplands may be mesic or xeric, dominated primarily by deciduous or deciduous/evergreen upland species such as American beech (*Fagus grandifolia*), southern magnolia (*M. grandiflora*), dogwood (*Cornus sp.*), and others. Mesic hammocks are characterized by a closed evergreen canopy of species such as live oak (*Quercus virginiana*), southern magnolia, pignut hickory (*Carya glabra*), and saw palmetto (*Serenoa repens*). Xeric hammocks include a closed canopy of evergreen hardwoods such as sand live oak (*Quercus germinata*) and saw palmetto.
- High pine and scrub occur on elevated areas or hills characterized by mesic or xeric forest or shrublands of pine or pine mixed with deciduous hardwoods. These forests can be mixes of southern red oak (*Quercus falcata*), longleaf or shortleaf pine, and other mixed hardwoods; upland pine savannas of longleaf pine (*Pinus palustris*), loblolly pine (*Pinus taeda*), and/or shortleaf pine (*Pinus echinata*), and wiregrass (*Aristida stricta*); sandhill forests with longleaf pine and turkey oak (*Quercus laevis*) on high sandy areas; scrub, also sandy, with sand pine (*Pinus clausa*) and scrub oaks (*Quercus ilicifolia*) with or without Florida rosemary (*Ceratiola ericoides*).
- Mesic flatwoods and dry prairies are flatland areas with scattered pines over saw palmetto, long leaf pine, saw palmetto, and wiregrass. In the absence of trees (due to frequent fire), dry prairies may occur, supporting a low cover of shrubby live oak, wiregrass, stunted saw palmetto, and broomsedge bluestem (*Andropogon virginicus*).
- Shell mounds on the Cedar Keys in Levy County on the Gulf coast are also northern-most habitats outposts for tropical species.

1.3.4.2 Freshwater Habitats

Freshwater habitats include vegetated wetlands, lakes, seepage slopes, wet prairies, and floodplain wetlands dominated by flood tolerant species such as cypress trees, as well as spring systems and lakes. These wetland resources fulfill a variety of functions including fish and wildlife habitat, flood storage, runoff filtration, coastal storm surge buffering, and nursery areas for economically important species (commercial and recreational fisheries and game species).

- Forested wetlands occur along rivers, in the floodplain, or depressions and may be dominated by various types of evergreen hardwoods (including sweet bay, *Magnolia virginiana*, southern magnolia and loblolly bay, *Gordonia lasianthus*); various types of deciduous hardwoods (oaks, gum trees, river birch, red maple); swamps dominated by cypress (*Taxodium distichum*) and swamp tupelo (*Nyssa sylvatica*) trees; hydric hammock of live oak, cabbage palm (*Sabal palmetto*), red cedar (*Juniperus virginiana*) and mixed hardwoods; wet flatwoods with slash pine (*Pinus elliotti*), pond pine (*Pinus serotina*), cabbage palm, and wiregrass.
- Marshes are characterized by herbaceous plant species and range from sedge bogs to wet prairies (vegetated with pickerelweed (*Pontedaria),* arrowhead (*Sagittaria* spp.), sawgrass and other sedges) to permanently flooded marshes dominated by floating leaved aquatics such as *Nymphaea* and *Nuphar*. Ponds and lakes are inundated depressions deep enough to limit light penetration over most of the waterbody and limit emergent vegetation to primarily the shallower perimeter.

- Springs and spring-run streams occur as perennial flow ways with clear water from deep aquifer headwaters, often with a limestone bottom with submerged aquatic vegetation (SAV). Submersed and emergent aquatic vegetation (EAV), occur, but this habitat is based on the presence of the spring rather than dominant vegetation.

1.3.4.3 Marine/Estuarine Habitats

Marine and estuarine systems are influenced most strongly by salinity and tidal inundation from the sea and occur landward or upstream until soil or water salinities are less than 0.5 ppt (and are therefore considered freshwater systems). Marine and estuarine systems are described based on substrate, fauna, or vegetation, depending on the dominant features.

- Hard bottom is subtidal, intertidal, and supratidal area of relatively hard, naturally formed mineral matter (e.g., coquina limerock and relic reefs); it includes corals, algae, blue-green mat-forming algae, and can include sparse seagrasses, if present. Soft bottom habitat is composed of unconsolidated substrates in subtidal, intertidal, and supratidal areas of loose mineral matter such as gravel, marl, sand and shell, or mud, with corals, algae, and possibly seagrasses.
- Oyster reefs occur in subtidal or intertidal areas formed by oysters that build and grow on successive generations of oysters. The reefs may be subtidal or intertidal and are dominated by the American oyster.
- Seagrass beds may occur across subtidal or intertidal areas, and are characterized by rooted vascular macrophytes. Florida's Big Bend encompasses the largest contiguous seagrass bed in the state. Dominant seagrass inshore includes shoal grass (*Halodule wrightii*), widgeon grass (*Ruppia maritima*), and Engelmann's seagrass (*Halophila engelmannii)*. Offshore areas are dominated by manatee grass (*Syringodium filiforme*) and turtle grass (*Thalassia testudinum*), as well as red drift algae (*Gracilaria spp., Digenia simplex, Laurencia poitei*).

1.3.5 Land Use

Land use conversions from native habitats to farming by humans were recorded as early as 1562 when the French encountered the Timucuans along the Big Bend coast (Thom et al. 2015). After the near-eradication of aboriginal populations by disease and slavery, Europeans settlers began farming the land as early as the 1800s. The Coastal Rivers Basin remains mostly rural in nature, with relatively little urban development and intense agriculture. Table 2 summarizes 1995 and 2011 land use distribution in acres, and shows the net change in the various land use categories over this time period. Figures 5 and 6 show the distribution of land uses in 1995 and 2011, respectively. It is important to note that the District 1995 and 2011 land use data are not available for the entirety of the Aucilla or Waccasassa watersheds. The net change in land use categories between 1995 and 2011 are based upon the Coastal Rivers Basin where data are available for both years.

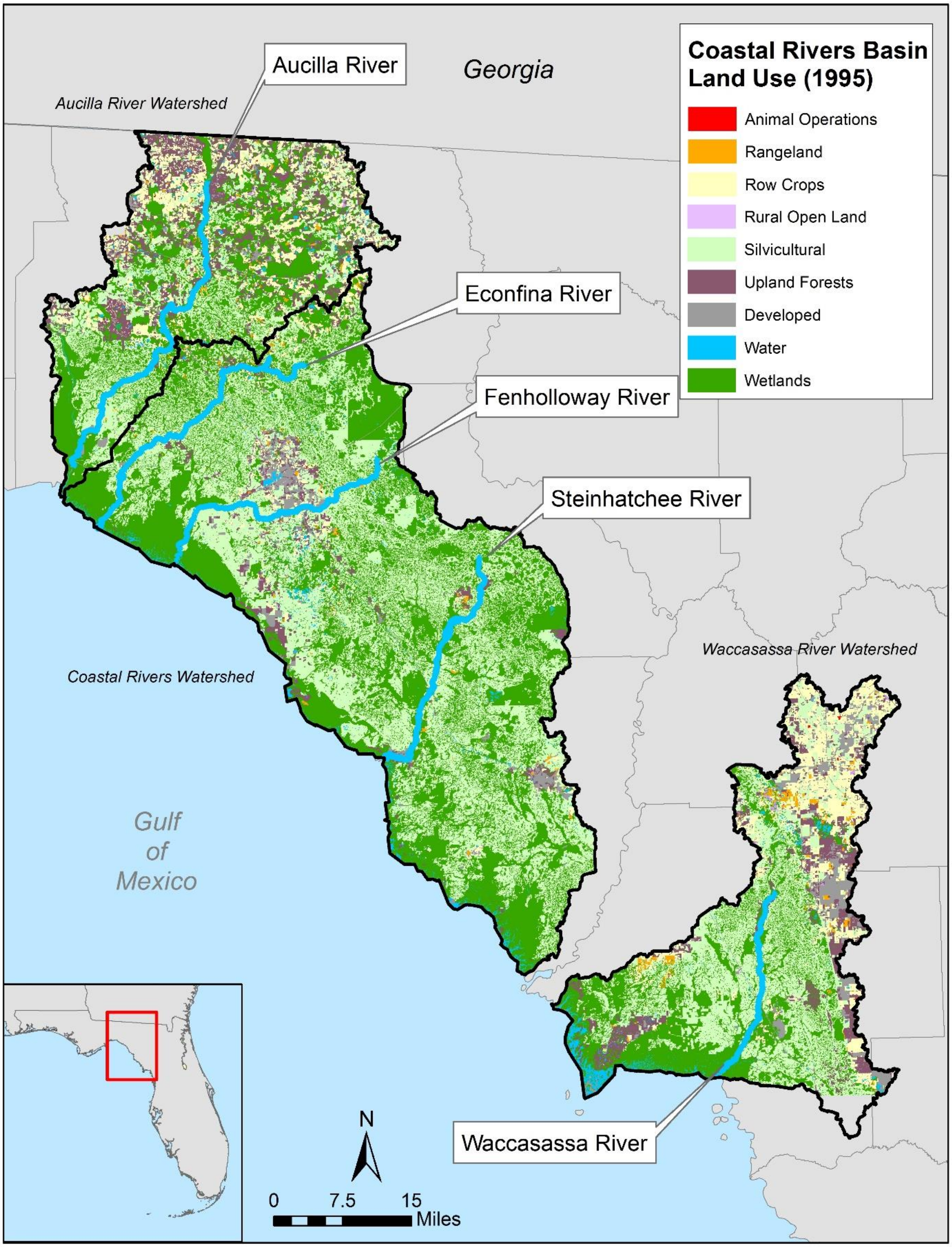


Figure 5. Land use in the Coastal Rivers Basin in 1995 (Note: The watershed boundary extends beyond the District land use coverage available)

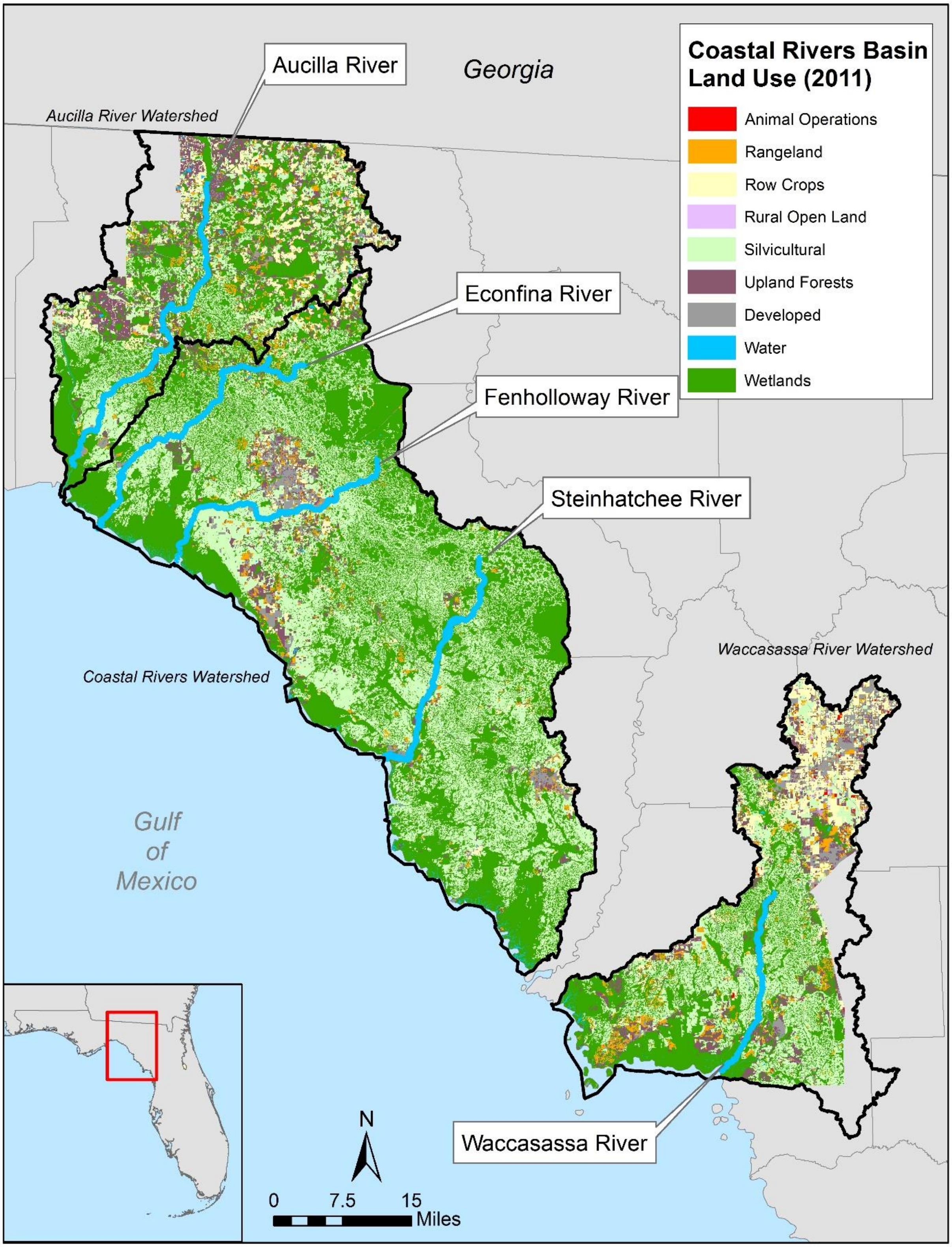


Figure 6. Land use in the Coastal Rivers Basin in 2011 (Note: The watershed boundary extends beyond the District land use coverage available)

Table 2. Land Use Changes in the Coastal Rivers Basin 1995 to 2011

Land Use Category	1995 Acres	2011 Acres	Net Change Acres
Animal Operations	406	1,289	883
Rangeland	14,276	69,483	55,207
Row Crops	145,419	110,980	-34,439
Rural Open Land	2,486	3,121	635
Silviculture	833,947	719,655	-114,292
Upland Forests	135,464	159,843	24,379
Developed	67,101	69,104	2,003
Water	23,253	11,399	-11,854
Wetlands	826,846	904,135	77,289

As with any land use mapping effort, accurate photointerpretation is critical, and classification errors can lead to misleading conclusions. In the Coastal Rivers Basin, the distinction between silviculture and natural upland forests can be difficult. Nonetheless this analysis shows that over the 15-year period between 1995 and 2011 forested lands dedicated to silviculture operations have declined, mostly giving way to cleared rangeland for cattle grazing and livestock operations. In addition, row crops in the Coastal Rivers Basin have declined over this time period. This analysis also shows a significant decrease in open water which is likely explained by excessive standing water at the time aerial photography was taken in 1995. Most of the decrease in open water between 1995 and 2011 appears to be in the Mallory Swamp area, which the District has subsequently restored to improve aquifer recharge.

Conversely, both wetlands and other upland forests (non-silviculture) have increased substantially. The large increase in wetlands could potentially be explained by the clearing of forested wetlands for timber production in areas that were previously classified as silviculture (the loss of trees reduces evapotranspiration and increases surface water which may be mapped as wetlands). However, these increases could also reflect public land acquisition over this time period. The District's Florida Forever (FF) 2016 Update reports more than 204,061 acres of uplands and wetlands have been acquired for conservation through outright purchases or conservation easements in the Basin since 1995, including approximately 304 river miles (RMs). The total area of publicly-owned lands within the Coastal Rivers Basins in 2016 is approximately 443,811 acres. Figure 7 shows the current extent of publicly owned conservation lands in the Coastal Rivers Basin.

In all cases, agriculture (including silviculture) alters the water budgets (Blann et al. 2009), the volume and timing of runoff, and the existing vegetation (e.g., reduced erosion, nutrient uptake) in natural watersheds. However, the hydrologic impacts of agriculture vary substantially based on the intensity of land disturbance. The impact of agriculture operations involving only land clearing (e.g., cattle grazing) tend to be less severe than those that also involve the alteration of natural drainage patterns and groundwater levels (e.g., row crops). Silviculture for timber production is by far the most dominant type of agriculture in the Coastal Rivers Basin; and modern silviculture utilizing various adopted BMPs is a type of agriculture that is both sustainable and consistent with the sound management of water resources and natural systems (Ursic and Douglass 1978).

In summary, managed forests (silviculture) and other forested uplands constitute 43 percent of the Basin, while wetlands (both forested and herbaceous) encompass 44 percent of the Basin. Combined, these two land use classes constitute 87 percent of the Basin area. Urban land development has increased slightly, mostly as growth around existing urbanized areas, but still only constitutes a little over three percent of the Basin land area. Due to the extensive coverage of forested uplands and wetlands in the Coastal Rivers Basin, habitat fragmentation is relatively minimal compared to other areas in Florida. In addition, the rivers and streams in the Basin remain almost entirely free flowing, with few impoundments or dams. Therefore, conservation and management of existing natural systems, including the maintenance of flows and water quality, of the best means by which to prevent further habitat loss, fragmentation, and/or degradation in the Basin.

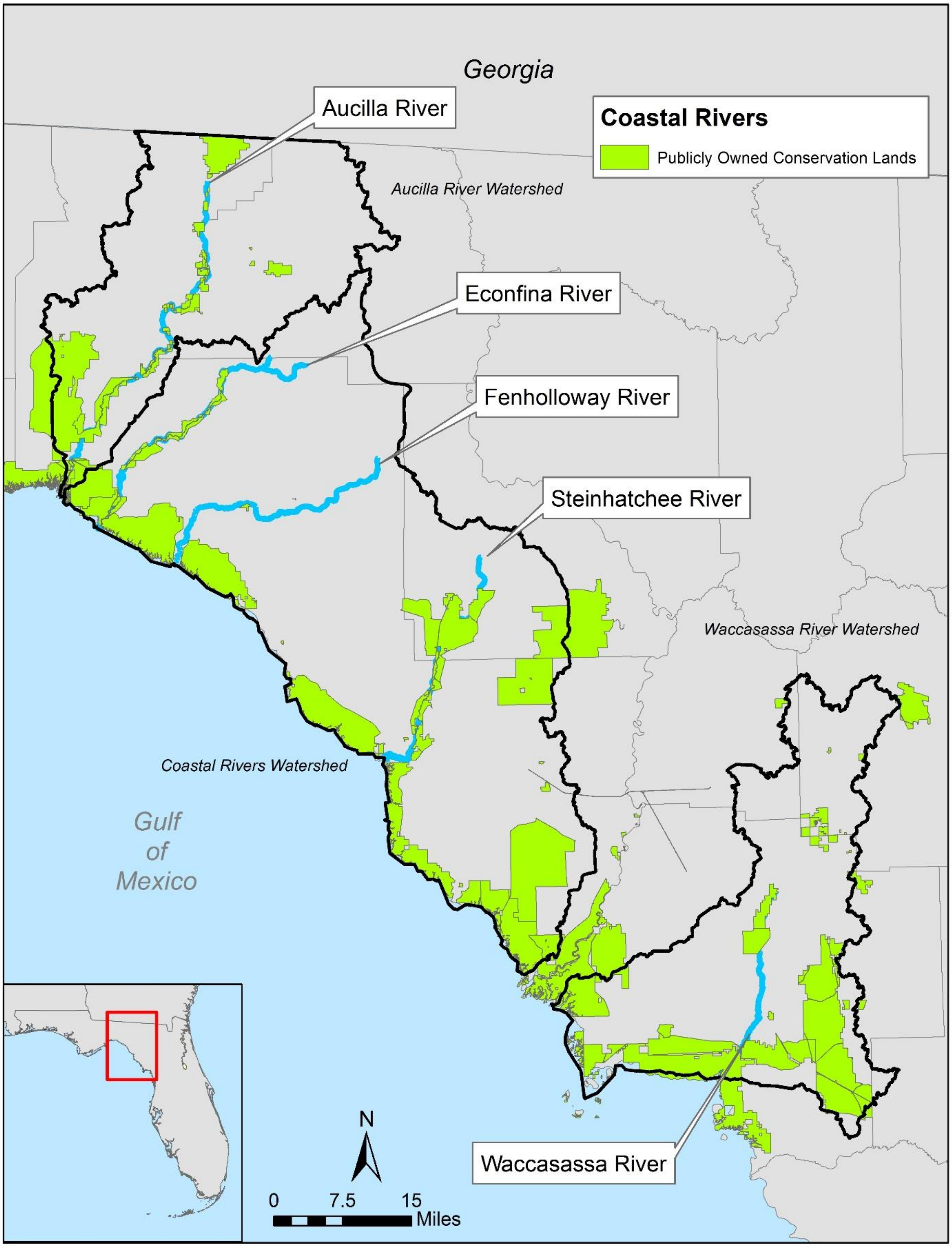


Figure 7. Extent of publicly owned conservation lands in the Coastal Rivers Basin

2.0 Issues and Drivers

As discussed in Section 1.2.3 above, the economic vitality of the Coastal Rivers Basin is tied to the health of its natural systems. While this region of Florida is often viewed as being in a close to pristine condition – especially along the coastline – it also contains the Fenholloway River, which has been identified as highly polluted for decades. In the case of the Fenholloway, ongoing and planned modifications to industrial wastewater treatment discharges are anticipated to be capable of restoring the river to Class III standards by the spring of 2021. In addition to changes in water quality, the issues potentially affecting the ecology of the Coastal Rivers Basin include changes in streamflow and freshwater discharge, and changes in the health of various natural system components; both on the landscape, and in the springs, rivers, and coastal waters. A description of the primary issues affecting the health of the Coastal Rivers Basin is included in this chapter to provide the reader with sufficient background information to understand the basis for the various management activities and projects that are proposed in this SWIM Plan.

The trends and primary factors influencing streamflow are discussed in Section 2.1, which focuses on water quantity; Section 2.2 focuses on primary factors affecting water quality within the Basin; while Section 2.3 addresses the status and trends of natural systems of the Coastal Rivers Basin.

2.1 Water Quantity

Ensuring that sustainable natural systems are maintained while meeting a full range of water needs is a strategic priority of the District. This section provides an overview of the major coastal rivers, their status, and current and future challenges facing water supply. This information provides the basis for the management activities and projects proposed in Sections 3 and 4.

Flow in natural systems can be altered by climate patterns, consumptive use of water, and the type and intensity of land uses in spring recharge areas and river drainage watersheds. Seasonal differences in precipitation intensity, along with longer-term (decadal and longer) oscillations in climate alter the magnitude and/or timing of precipitation and the volume of spring and river flow in the District (Cao 2000, Kelly and Gore 2008). Flow can also be altered by the consumptive use of groundwater and human alterations to the landscape. Groundwater withdrawals may reduce spring flow, and diminish natural discharge from the aquifer to rivers. Land use alterations such as ditching and draining, or the addition of impervious surfaces may increase the rate and magnitude of surface runoff to rivers, and diminish natural storage and aquifer recharge. The result is more rapid peak flows following storms and diminished flow in rivers during low flow periods. Projects to enhance and restore natural flow regimes will be a priority for the District in reaching its long-term sustainability goal.

2.1.1 Regulatory Framework

As stated in the District's Strategic Plan for 2017-2022, the District's mission is to protect and manage water resources using science-based solutions to support natural systems and the needs of the public. To meet this mission, the District's regulatory efforts include establishing MFLs for priority water bodies within the District and implementing multi-district water supply planning and complimentary regulatory practices. Details on these regulatory efforts are provided below.

2.1.1.1 Minimum Flows and Minimum Water Levels (MFLs)

The District is currently establishing and implementing, through its regulatory authority, environmental flows and levels for all priority water bodies within the District. Environmental flows and levels, known as MFLs under Florida statutes, are established by determining a baseline hydrology and assessing the allowable flow reduction from the baseline hydrologic regime that will prevent significant harm to the water resources or ecology of the system.

The District's MFLs program is a means to protect water resources from significant harm. The District's adopted MFLs can be found in 40B-8, F.A.C. Established MFLs are used as a basis for imposing limitations on withdrawals of groundwater and surface water, for reviewing proposed surface water management and storage systems and stormwater management systems, and for imposing water shortage restrictions (40B-8.011(4), F.A.C.). Computer simulation models are used to evaluate the effects of existing and proposed consumptive uses and the likelihood they might cause significant harm. Regardless of whether there is an established MFL, to obtain a water use permit, the use may not cause harm to the water resource (40B-2.301(2)(g), F.A.C.). Additionally, the use will not be permitted if it will cause any MFL to be violated. Information on MFLs adopted to date by the District and their status and trends is provided above in Sections 2.1 and 2.1.1.

Priority water bodies, including rivers, springs, and lakes, are identified on the District's MFLs Priority List and Schedule, which is reviewed and updated annually (District 2016). In developing MFLs, current State Water Policy (62-40.473, F.A.C.) provides that consideration be given to natural seasonal fluctuations in water flows or levels, non-consumptive uses, and environmental water resource values (WRVs), including:

- WRV 1 - Recreation In and On the Water
- WRV 2 - Fish and Wildlife Habitats and the Passage of Fish
- WRV 3 - Estuarine Resources
- WRV 4 - Transfer of Detrital Material
- WRV 5 - Maintenance of Freshwater Storage and Supply
- WRV 6 - Aesthetic and Scenic Attributes
- WRV 7 - Filtration and Absorption of Nutrients and other Pollutants
- WRV 8 - Sediment Loads
- WRV 9 - Water Quality
- WRV 10 - Navigation

MFLs are the primary benchmark for evaluating the status of riverine health from a quantity perspective. The basis for establishing and adopting protective MFLs on each priority waterbody, or group of priority water bodies is detailed in the MFL technical documents. Rules specifying these MFLs are established for use by the District's Resource Management Division in evaluating consumptive use permits. The status of priority waterbodies is evaluated as MFL rules are adopted and monitored thereafter. If MFLs are below, or projected to fall within 20 years below, the applicable MFL, a MFL Prevention or Recovery Strategy must be developed in compliance with Section 373.0421, F.S., to recover the system. Details on the status of each coastal river are included below.

2.1.1.2 Consumptive Use

The District also conducts Water Supply Assessments that evaluate regional-scale groundwater availability and water supply demand to determine whether adequate water is available to meet water demands while protecting natural systems. Estimates of current use and projections of future demands over a 20-year planning horizon are prepared for six categories: Public Supply, Domestic Self-Supply, Agriculture, Commercial/Industrial/Institutional, Power Generation, and Landscape/Recreational/ Aesthetic. These current and future demands are evaluated against established MFLs or interim constraints, where MFLs are not yet complete on priority waterbodies, to identify regions where the use of fresh groundwater to meet current or future demands could cause a negative impact to natural systems. Regional water supply plans are subsequently developed to address identified future resource constraints. Water Supply Assessments are updated on a five-year cycle to incorporate changing trends, additional MFLs, and improved statistical and modeling tools to estimate impact.

The District completed a Water Supply Assessment in 2010, with the planning period through the year 2030 (District 2010). The assessment included low-range and high-range demand projections for six water-use categories ranked from highest to lowest pursuant to 2010 volumes:

- Agricultural;
- Industrial Commercial and Institutional;
- Public Supply;
- Domestic Self Supply;
- Thermo-Electric Power Generation; and
- Landscape/Recreation/Aesthetic.

The District also reviews and issues Consumptive Water Use permits as a means to control and maintain public and private water use in a manner consistent with Water Supply Assessment projections.

2.1.2 Status and Trends

This section provides an overview of the hydrology of each sub-watershed in the Coastal Rivers Basin, as well as proposed or adopted MFLs (and associated priority WRVs) for water bodies in the Basin. Updated analyses of long-term trends in river/spring discharge were performed, and a description of these analyses and results are provided in Appendix F1.

2.1.2.1 Aucilla and Wacissa Rivers

The Aucilla River is a blackwater river system located in the western-most portion of the District, on the border of Taylor, Madison, and Jefferson Counties in Florida. The river flows generally southward from Georgia until it eventually drains into a series of sinks north of the Florida coastline. Nutall Rise serves as the major resurgence of the river, flowing from this point downstream towards the Gulf of Mexico. A major tributary, the Wacissa River, is a spring-dominated river that drains into the Aucilla River at multiple locations due to its braided nature (Figure 8). Both the Aucilla and Wacissa Rivers are classified by FDEP as an Outstanding Florida Water (OFW) and "special waters" within the OFW designation.

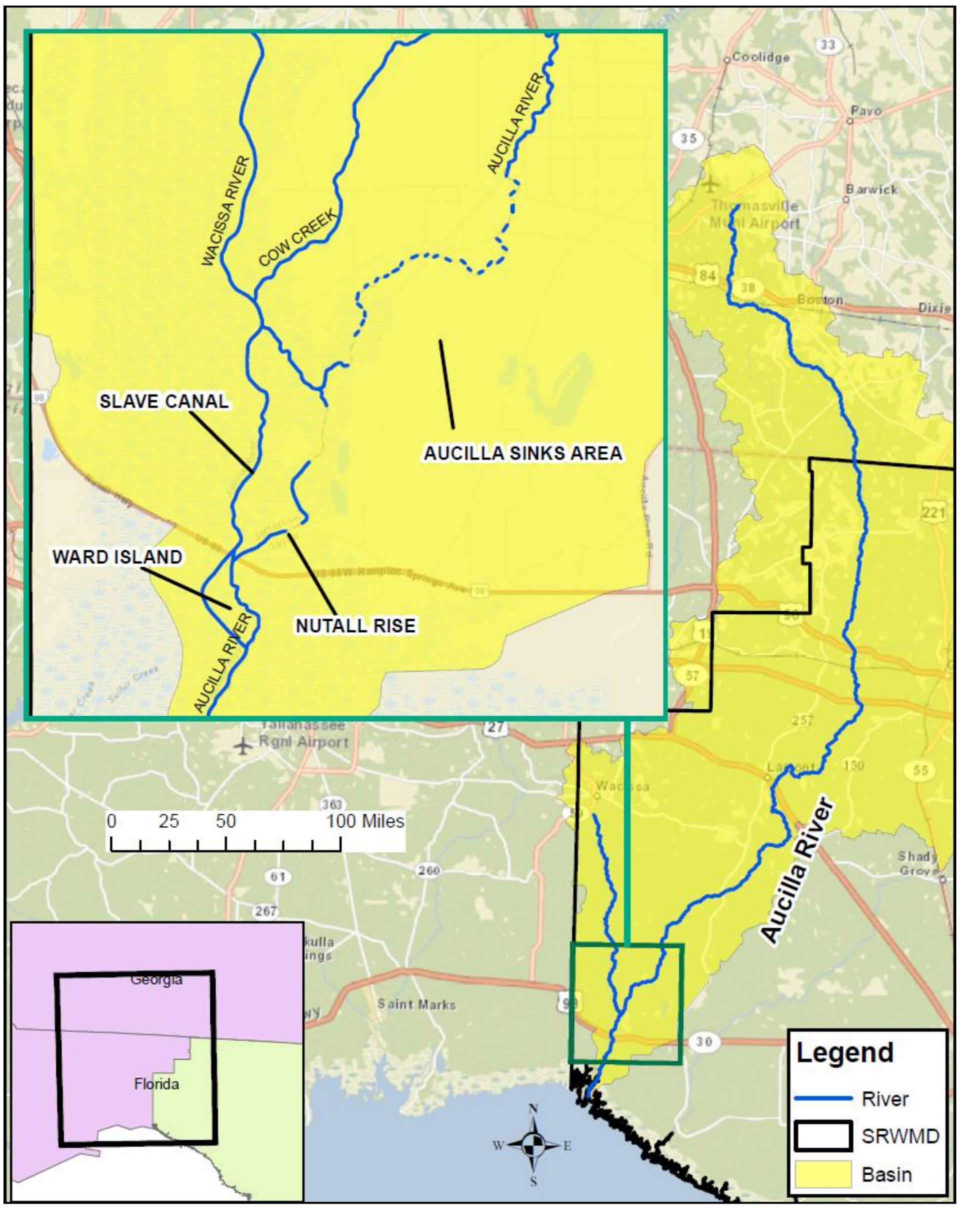


Figure 8. Features on the Aucilla and Wacissa Rivers

The District's MFL report (District 2016) defined the baseline flow regime for the Aucilla River system. Based on an analysis of the relationship between rainfall and flow, there is no evidence of persistent anthropogenic impacts on the streamflow during the baseline period. The report also specified a maximum flow reduction due to withdrawals from the baseline long-term hydrologic regime to avoid significant harm to the water resources or the ecology of these systems. In doing so, the District determined impacts of flow reduction on the 10 WRVs. Recreation In and On the Water (WRV 1), Fish and Wildlife Habitats and the Passage of Fish (WRV 2), and Estuarine Resources (WRV 3) were closely investigated using available literature and data to identify the relationship between baseline flow and the impacts of flow reduction.

The Wacissa River MFL recommended two successively higher flow regimes referenced to the index gage near Wacissa: a lower percent reduction allowable in moderate to low flows for the protection of recreation activities including boating, and a larger percent allowable reduction in higher flows that is protective of instream habitat.

For the Aucilla River three successively higher flow regimes were recommended and referenced to the Lamont gage: a smaller allowable reduction percentage during low to moderate flows for the estuarine salinity regime protection, a second percent allowable reduction in mid-range flows for the protection of bank habitat, and a higher allowable percent reduction in higher flows for floodplain protection. Collectively, these MFLs are considered protective of the estuarine habitat on the Aucilla River. The MFL was adopted into rule in 2016.

2.1.2.2 Econfina River

The Econfina River watershed encompasses 216 square miles from its headwaters in Madison County to its mouth at Apalachee Bay; the total length of the river is approximately 40 miles (Figure 9). Both the river and its watershed lie entirely within the District boundary in Florida, east of the Aucilla River.

An MFL study for this river was completed in 2015 (District 2015). The focus of the MFL study area was a 3.5-mile stretch of river from the confluence with the Gulf of Mexico upstream beyond the community of Econfina (Figure 10).

The District's MFL report defined the baseline flow regime for the Econfina River MFL. The period of record is characterized by a wide range of meteorological conditions and the resulting wide range of river flows. There is little water use in the Econfina River watershed and as a result the river flows can be viewed as relatively unaffected by water withdrawals.

The MFL report also presented a summary of the current baseline hydrologic regime and specified a maximum flow reduction from the baseline to avoid significant harm to the water resources or the ecology of these systems. Recreation In and On the Water (WRV 1), Fish and Wildlife Habitats and the Passage of Fish (WRV 2), Estuarine Resources (WRV 3), Maintenance of Freshwater Storage and Supply (WRV 5), and Water Quality (WRV 9) were closely investigated using available literature and data to identify the relationship between baseline flow and changes caused by potential flow reductions. These five WRVs were pared to two (WRVs 2 and 3) due to the lack of data relating recreation and freshwater supply to flow. The water quality parameter explicitly addressed was the relationship between river flow and salinity.

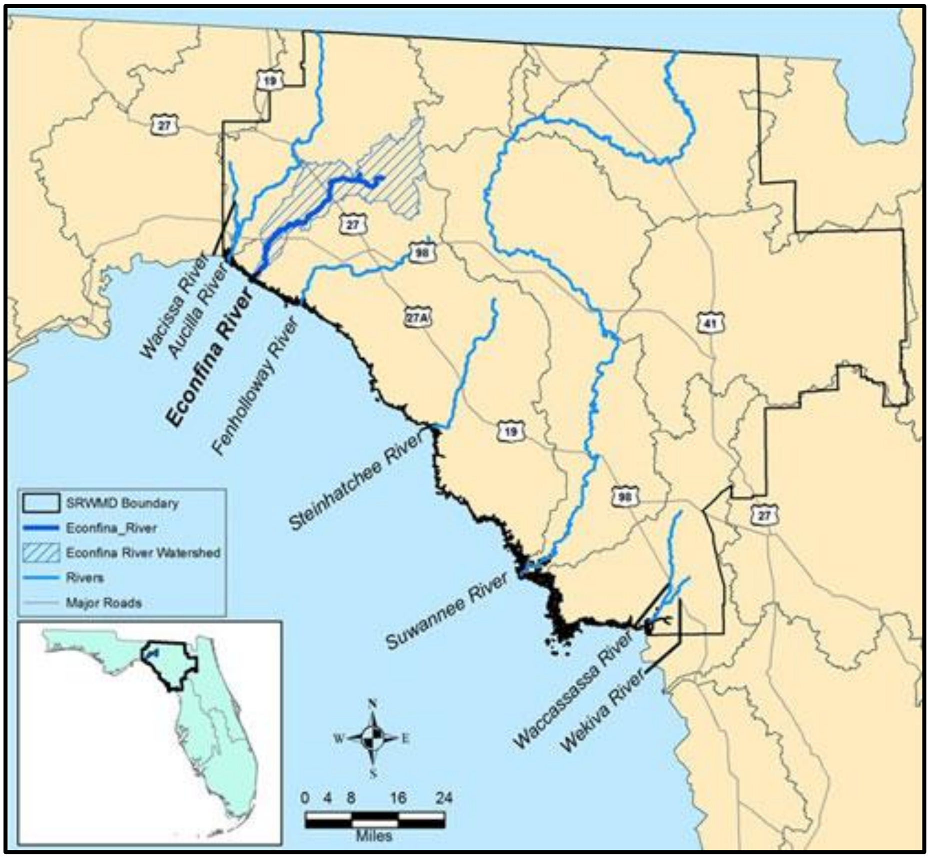


Figure 9. Location of the Econfina watershed within the District boundary

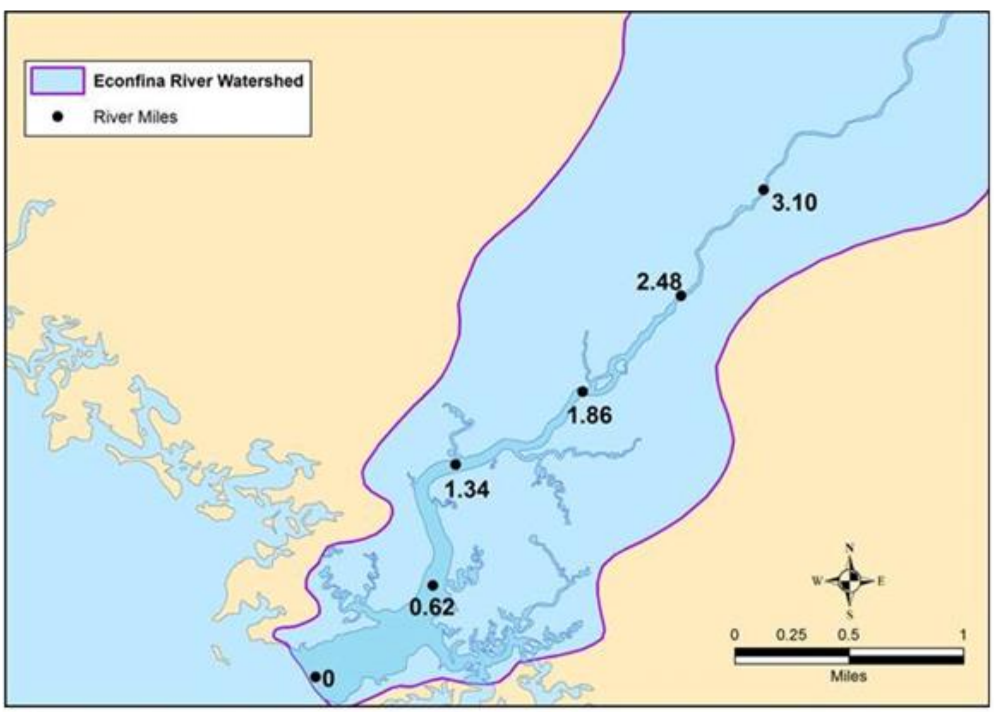


Figure 10. Location of the Econfina River MFL study area

Two MFLs for the Econfina River were recommended. A higher allowable reduction percentage during the low to moderate flows was proposed for the protection of salinity distributions in the lower Econfina River. Additionally, a smaller percent allowable reduction in the higher flow ranges based on the frequency of out-of-bank flows was proposed. Both of these MFLs were also considered protective of fish passage as well as water quality in the river. The MFL was adopted into rule in 2016.

2.1.2.3 Fenholloway River

The Fenholloway River lies east of the Econfina River in Taylor County. It begins in San Pedro Bay and has a 35-mile course to the Gulf of Mexico, passing the city of Perry. The upper river is a small, winding blackwater stream that, during dry periods, has very little to no flow. As the river passes Perry, the natural flow is affected by the operation of a Foley Cellulose mill under state and federal permits. The mill uses groundwater from a wellfield near the river and discharges treated effluent to the river.

In 1947, the Florida Legislature classified the Fenholloway River as a Class V waterbody for industrial and other purposes. In 1998, the Fenholloway River was re-designated as a Class III waterbody, necessitating the implementation of certain actions to attain designated uses and water quality criteria including manufacturing and wastewater treatment improvements, headwater hydroperiod restoration, and the relocation of the mill's industrial discharge to a location on the river approximately 1.5 miles from the mouth. Approvals for these changes have been obtained by the mill and are currently being put into effect.

There is no adopted MFL for the Fenholloway River. In Chapter 373.0421(1)(b)1, F.S., the Florida Legislature recognized that certain water bodies potentially subject to establishment of MFLs may no longer serve their historical hydrologic function and that, for said water bodies, recovery to historical hydrological conditions may not be economically or technically feasible. Accordingly, a governing board may determine that setting a MFL for such a waterbody based on its historical condition is not appropriate. Given the planned changes in effluent discharge location and the resultant effect of this on the flow patterns of the lower river, the District's Governing Board considered, and approved, a resolution removing the Fenholloway River from the Priority List. Projects to improve the hydrology of the Fenholloway River, given funding, are possible and should receive due consideration. As a component of the Fenholloway Water Quality Restoration Project, Foley Cellulose has initiated a headwater hydroperiod enhancement project to restore the hydrology of the freshwater portion of the Fenholloway River to more natural/background conditions. This project involves the enhancement of a roughly 6,748-acre wetland site in the San Pedro Bay.

2.1.2.4 Steinhatchee River

The Steinhatchee River is located east of the Fenholloway River near the center of the Big Bend region of Florida (Figure 11). Originating in Lafayette County, Florida, and flowing about 30 miles to the Gulf of Mexico, the lower half of the river forms the boundary between Taylor and Dixie Counties. Much of the Steinhatchee River flow is provided by surface runoff; however, some baseflow is provided through small springs and seeps. The Steinhatchee River is a sluggish, generally tannic stream, widening near the coast as it enters the coastal salt marshes.

The lower Steinhatchee River is characterized by developed areas primarily on the northern shore and extends to expansive tidal marshes marked by numerous tidal creeks. The developed shoreline extends northward from the Gulf about eight RMs.

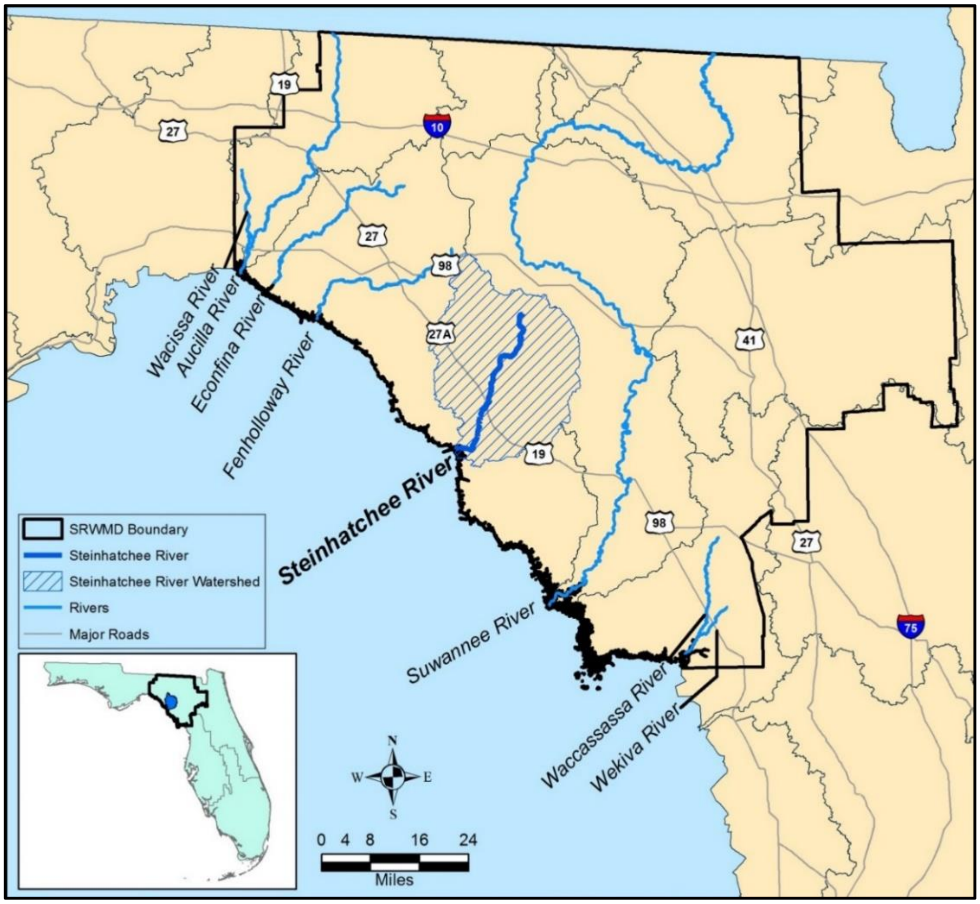
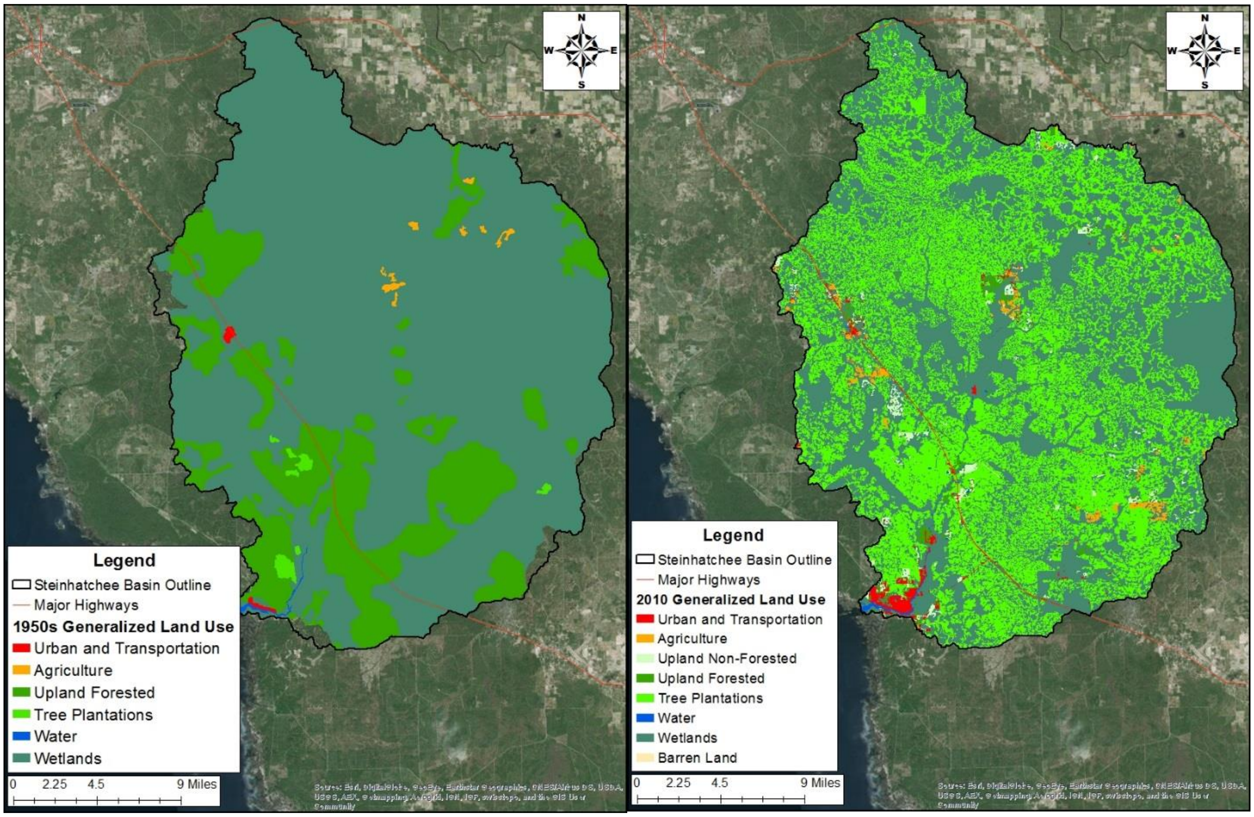


Figure 11. Location of the Steinhatchee River Watershed

Above RM 8, much of the channel falls within a more undeveloped area. Near RM 10 is a park at Steinhatchee Falls. This is a frequently visited area on the river. The channel is approximately 60 feet across, with a drop in the channel bottom of approximately two to three feet. A series of shoals are located between RM 12 and RM 15. Above the Falls the river flows underground for a one-mile stretch near the community of Tennille. The underground portion of the river's route is mirrored at the surface by a topographic valley containing only intermittent flow.

Above this point, the river channel divides into multiple sub-basins draining lands with historic conversion of significant areas from native forests to silviculture (Figure 12), concomitant with forestry road development and accompanying adjacent drainage networks.



A. B.

Figure 12. Land use within the Steinhatchee River Watershed over time: (A) 1950s, and (B) 2010. (Source: Draft Steinhatchee MFL document, 2016)

A study commissioned by the District in 1989 (KBN Engineering et al. 1990) produced an assessment of the impact of land use changes on the flow of the Steinhatchee River through the 1980s. The cumulative effect of these alterations was found to have increased the peak runoff by an estimated 38 percent in the watershed from 1953 to 1988. The result has been a river that discharges more water faster than would otherwise be under natural conditions, potentially affecting biological systems downstream in the watershed. Concerns expressed about commercial and recreational fishery utilization regarding excess peak flows to the estuary prompted the study. The District has worked with landowners in the watershed to facilitate modifications for improvement of the system to more effectively mimic natural conditions. There is no adopted MFL for the Steinhatchee River; however, the river is included on the District MFL Priority List with MFL development and adoption anticipated in 2017.

2.1.2.5 Waccasassa River and Levy Blue Spring

The Waccasassa River is a relatively undeveloped river, flowing through woodlands and swamps with a drainage system consisting of multiple channels and extensive areas of sheet flow. The river becomes tidal southwest of US 19 in Levy County, having a wide floodplain before it empties into a shallow estuary known as the Waccasassa Bay (Figure 13). The Waccasassa River is designated as an OFW and is widely regarded as having high conservation value. The Waccasassa estuary includes the Waccasassa Bay Preserve State Park and is also part of the Big Bend Seagrasses Aquatic Preserve. The river encompasses two major spring systems: Wekiva and Levy Blue Springs.

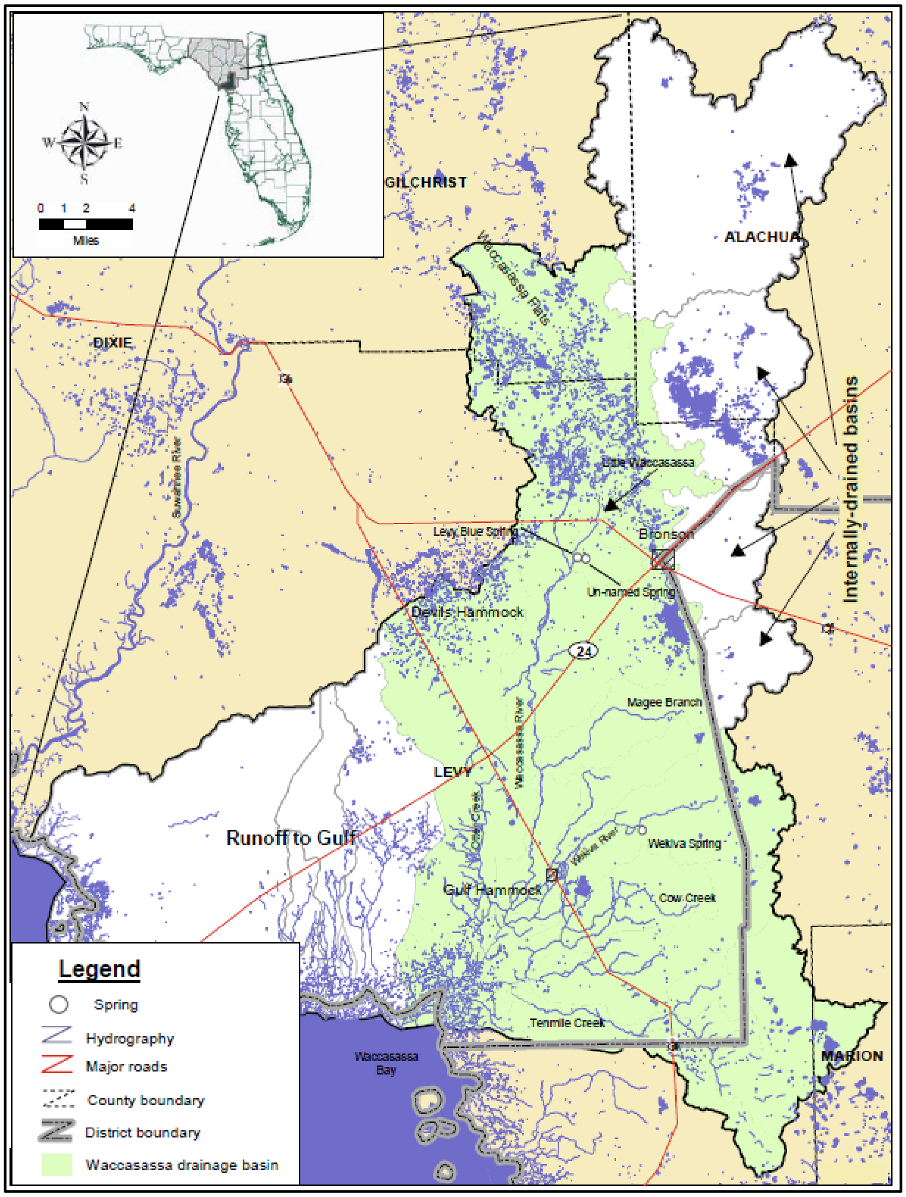


Figure 13. Location of the Waccasassa River and watershed

For the Waccasassa River, Fish and Wildlife Habitats and the Passage of Fish (WRV 2), Estuarine Resources (WRV 3), Maintenance of Freshwater Storage and Supply (WRV 5), Aesthetic and Scenic Attributes (WRV 6), and Water Quality (WRV 9) were closely investigated to identify the limiting conditions for MFL development. The final MFL was solely based on WRV 3. This is partly in recognition of the value of the estuary as habitat and partly because protection of flow sufficient to maintain the estuary appears to protect the other resources. The MFL flow duration curve for the Waccasassa River was set to protect estuarine resources, including benthic invertebrates, nekton, and vegetative communities.

For Levy Blue Spring, Recreation In and On the Water (WRV 1), Maintenance of Freshwater Storage and Supply (WRV 5), Aesthetic and Scenic Attributes (WRV 6), and Water Quality (WRV 9) were closely investigated to identify the limiting conditions for MFL development for Levy Blue Spring. The most limiting WRV to be protected from a significant adverse impact for Levy Blue

Spring was WRV 5. The MFL was set to ensure the protection of the low flow contribution to the Waccasassa River. The Waccasassa River, estuary, and Levy Blue Spring MFLs were adopted in 2007.

2.1.3 Regulatory Issues

The District's 2010 Water Supply Assessment identified one potential constraint on the availability of fresh groundwater in the coastal rivers, the Aucilla River at Lamont. Detailed analysis as the MFL was established determined that the resource was not at or near its MFL constraint. None of the coastal systems detailed in this report are in water supply planning regions, however hydrologic restoration and augmentation of available freshwater supplies to sustain natural systems remains a priority.

2.1.4 Threats to Water Quantity

Water resources in the Coastal Rivers Basin are generally healthy. There are extensive conservation lands, and the Basin remains mostly rural in nature, with relatively little urban development or intense agriculture. In addition, the rivers and streams in the Basin remain almost entirely free flowing, with few impoundments or dams. Despite the current status, recent analyses identified small magnitude changes in trends for flows or water levels at some locations in the Basin (see Appendix F1). Primary threats to the hydrology of the systems within the Coastal Rivers Basin include excessive surface-water withdrawals or diversions, groundwater withdrawals, and modifications of natural drainage patterns.

Public supply, agriculture, commercial and industrial entities, and other users, both within and outside District boundaries, create multiple demands on the water resources of the District. The Coastal Rivers Basin is mostly underlain by an unconfined or poorly confined Upper Floridan aquifer. This lack of a distinct confining layer gives rise to the numerous artesian springs in the region and allows for more rapid recharge of groundwater from infiltration; however, the lack of a continuous confining layer, also makes the aquifers in this region highly vulnerable to water quality and quantity impacts from activities conducted on the land surface. There have been extensive modifications made to the natural drainage patterns of these watersheds over the years; large areas of the headwater wetlands have been ditched and drained for timber production, resulting in higher peak flows and quicker response following major rainfall and storm events.

To address these potential threats, the District has identified various management actions (Section 3) and projects/initiatives (Section 4) with the ultimate goal of protecting or restoring natural hydrologic regimes wherever feasible, thus, ensuring the protection of critical WRVs therein. Specific goals include actions to increase aquifer recharge and decrease excessive runoff and evapotranspiration. Potential projects to meet these goals include agricultural BMPs, hydrologic restoration of over-drained lands, water reuse and water conservation. Because water is an integrated and interconnected resource, many of these management actions, projects or initiatives involve partnerships with other agencies and stakeholders, both within and outside of the District.

2.2 Water Quality

Water quality refers to the chemical, and to a lesser extent the physical and biological characteristics of water. It is primarily a measure of the chemical condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed.

2.2.1 Regulatory Framework

The State of Florida's approach to managing water quality involves a multi-step process. In the first step, water quality data are compared to standards, which vary as a function of the designated use classification of the waterbody (e.g., public water supply, shellfish harvesting, or recreational use). If the waterbody does not meet water quality criteria appropriate for its designated use, then it is designated as "impaired" with respect to those constituents for which criteria are not met. The development of a TMDL is most often the next step in the process. A TMDL is a determination of the maximum amount of a given pollutant that a waterbody can be receive the waterbody to exceed the water quality standards for its designated use. After a TMDL is established, local stakeholders typically work together to come up with a BMAP to allocate load reductions so that the TMDL can be implemented. It should be noted that the FDEP has the statutory authority in the State of Florida to regulate and manage water quality. The State's water management districts provide additional support to the FDEP primarily with regard to water quality data collection and reporting, and the implementation of projects aimed at improving water quality.

2.2.2 Status and Trends

This section investigates status and trends in the water quality of the Coastal Rivers, and provides a summary of regulatory issues including TMDLs and BMAPs. Status and trends include an exploration of new data, summary of data from technical reports, and information from TMDL and BMAP documents. It should be noted that other, more localized impacts to water quality can occur, and may not be captured in this assessment. Localized impacts to water quality can include issues with turbidity, toxic substances and/or sediments.

It is important to note that there are different regulatory standards for nutrient concentrations in the Coastal Rivers Basin: numeric nutrient concentration (NNC) criteria for streams and spring vents and TMDL site-specific criterion. Rule 62-302.531(2)(c), F.A.C., establishes the NNC for Total Nitrogen (TN) of 1.03 mg/l for streams in the eastern portion of the panhandle, including the Coastal Rivers Basin. The NNC for Total Phosphorus (TP) in streams in the eastern portion of the panhandle is set at 0.18 mg/l. The Waccasassa River is included in the peninsular region. The NNC for TN in the peninsular region is 1.54 mg/l and .012 mg/l for TP. The NNC for spring vents for nitrate-nitrite of 0.35 mg/l. Under 62-302.531(2)(a), F.A.C., if site-specific numeric criteria, such as TMDLs, have not been adopted for a waterbody, the NNC apply. In the Coastal River Basin, FDEP has established a TMDL for nitrate (NO_3^{-2}) of 0.20 mg/l for the Wacissa River (62-304.406, F.A.C.).

2.2.2.1 Nitrogen

Trends in the concentration of TN are shown in Figure 14, while Appendix F2 contains detailed information on trends in nutrient-related water quality parameters for a number of streams within the boundaries of the District.

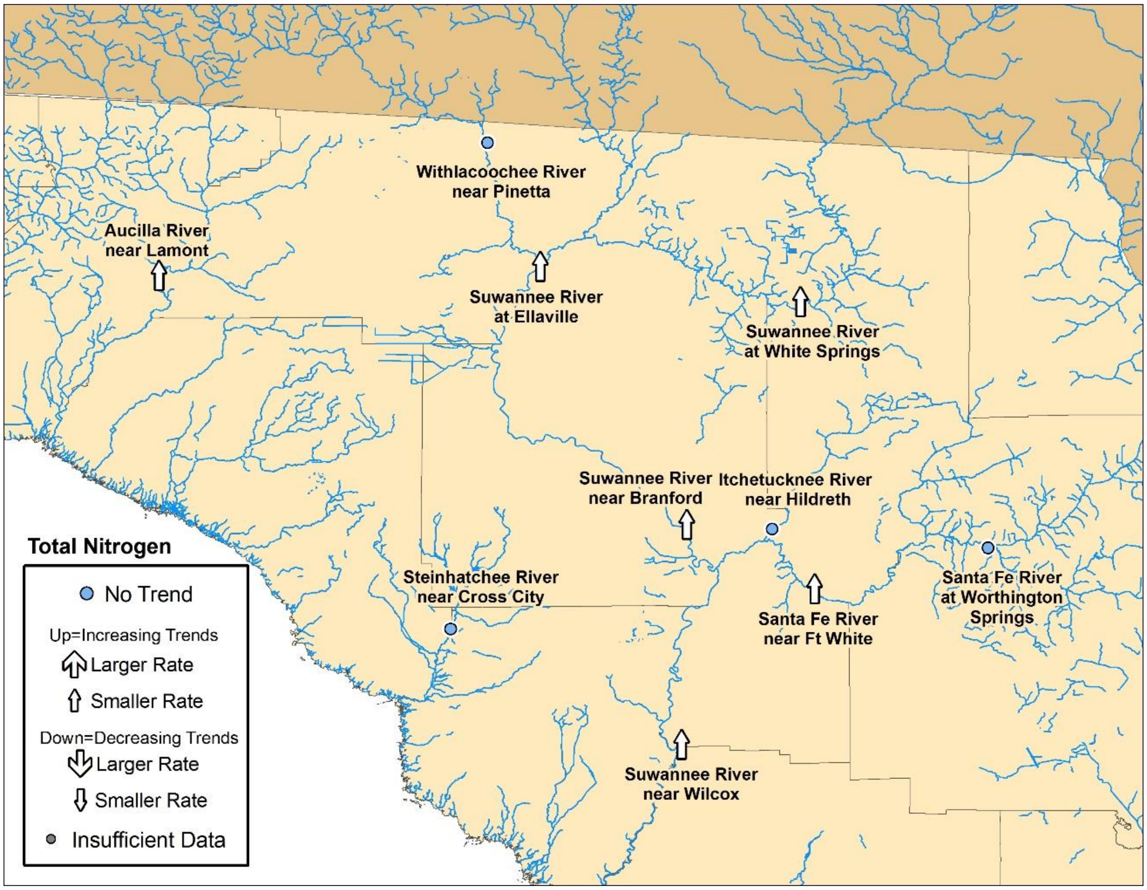


Figure 14. Spatial distribution of TN trends in rivers and streams in the District, including the Aucilla River and the Steinhatchee River

For TN, increasing trends in the Aucilla River matches similar trends seen in Suwannee River at long-term monitoring sites in White Springs, Ellaville, Branford and Wilcox, and also for the Santa Fe River near Fort White. In contrast, the Steinhatchee River showed no trend over time in TN concentrations. When compared to NNC, the Aucilla and Steinhatchee Rivers exceeded NNC for TN on occasion over the past 20 years, as illustrated in Figures 15 and 16, respectively.

For streams, exceedance of NNC criterion does not, in and of itself, mean that the river is considered by FDEP to have a nutrient imbalance. The water quality parameters of TN and/or TP need to be accompanied by a similar finding of a floral imbalance (e.g., chlorophyll-a (Chl-a) exceedance, algal mats, etc.) for a stream to be considered impaired for nutrients. For example, the TMDL for the Wacissa River and Spring complex (FDEP 2016) is based on the determination that the excessive amount of algae in the Wacissa River was due to the elevated NO_3^{-2} levels; a floral imbalance (algal mats) was cited as justification of the need to reduce NO_3^{-2} concentrations emanating from the spring.

The intermittent nature of NNC exceedances in the Aucilla and Steinhatchee Rivers suggest that climatic phenomena may play an important role in terms of water quality in both systems; if anthropogenic activities (or the lack of such) were the dominant influences on water quality, both rivers would be expected to exceed (or not exceed) NNC criteria on a more regular basis than was found.

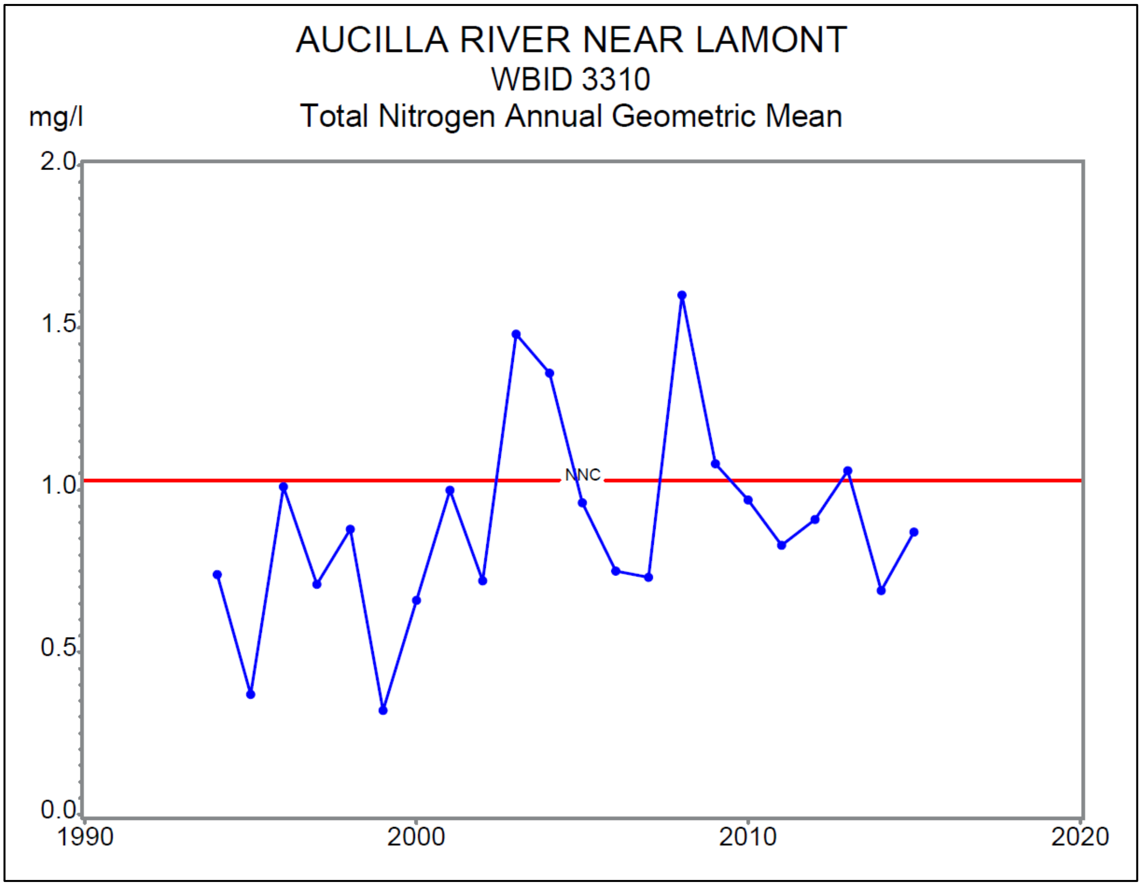


Figure 15. TN trend for the Aucilla River near Lamont. Annual geometric means compared against NNC criteria (as per 62-302.531, F.A.C.)

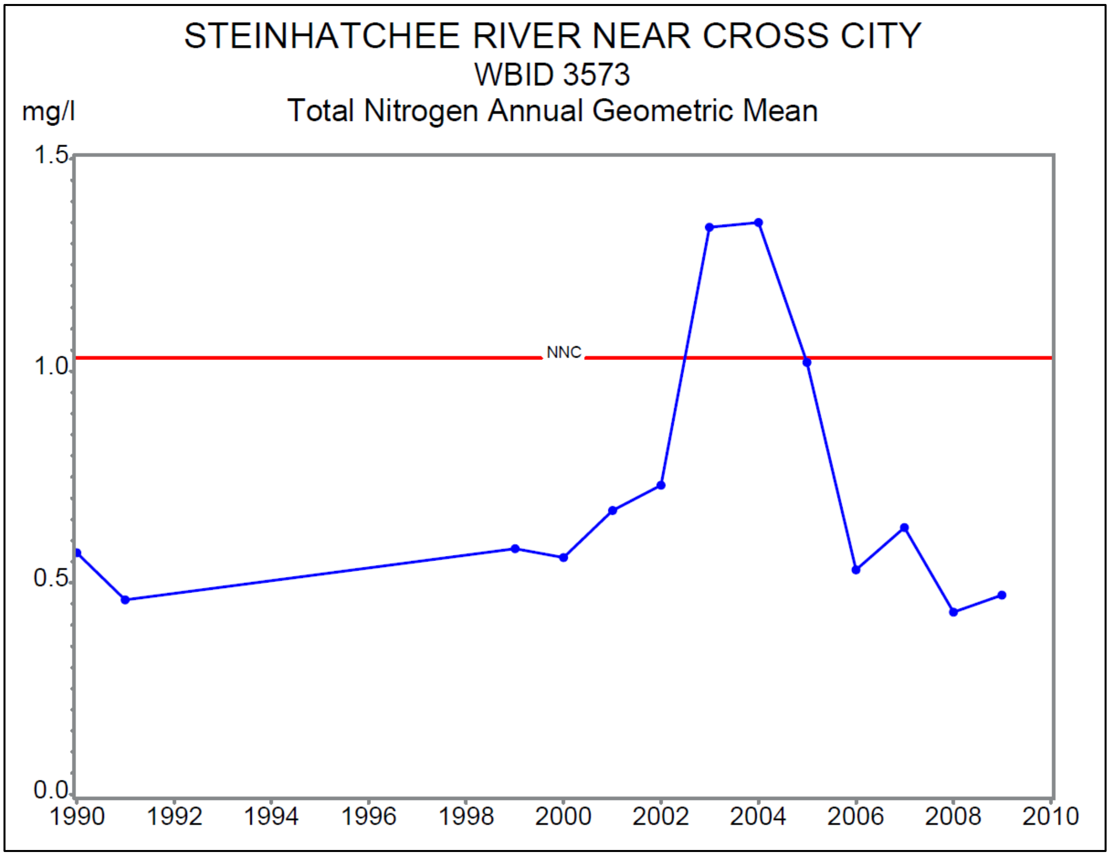


Figure 16. TN trend for the Steinhatchee River near Cross City. Annual geometric means compared against NNC criteria (as per 62-302.531, F.A.C.)

2.2.2.2 Phosphorus

For TP, the lack of trend in TP in the Aucilla and Steinhatchee Rivers matched the similar lack of trends seen in most stations in the Suwannee and Santa Fe Rivers (Figure 17). For the Aucilla and Steinhatchee Rivers, levels of TP fall well below NNC, as seen in Figures 18 and 19, respectively.

The findings that TP concentrations in the Coastal Rivers appear to be both non-trending and well below NNC is good news for those portions of the Gulf of Mexico influenced by their discharges. Mattson et al. (2007) concluded that while there appeared to be issues related to water quality in the nearshore waters off the mouth of the Suwannee River, as well as the well-documented problems in nearshore areas off of the Fenholloway River, the nearshore waters in the Springs Coast region (which includes Waccasassa Bay) are thought to be phosphorous-limited, vs. the nitrogen-limited waters offshore of the Suwannee River. Therefore, while increased NO_3^{-2} levels in the Suwannee River could potentially adversely impact water quality (and thus seagrass meadows) in coastal waters under its influence, if the waters offshore of the Steinhatchee, Aucilla and Econfina Rivers are phosphorus-limited, then the lack of evidence of problematic phosphorus concentrations in those systems is good news.

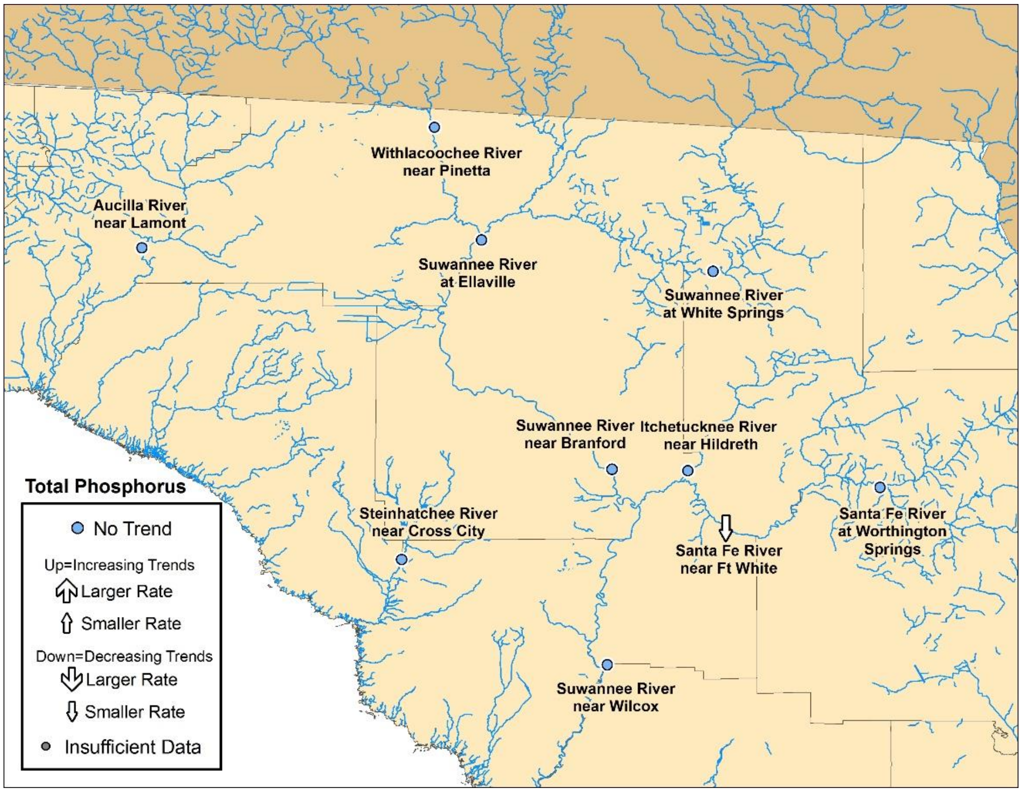


Figure 17. Spatial distribution of Total Phosphorous (TP) trends in rivers and streams in the District, including the Aucilla River and the Steinhatchee River

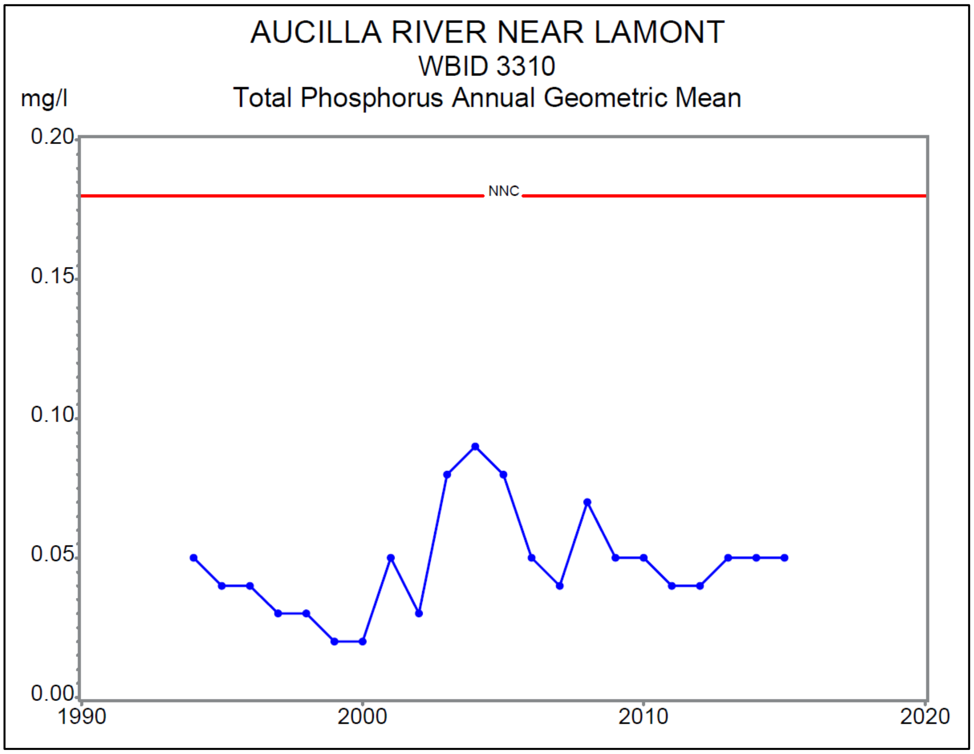


Figure 18. TP trend for the Aucilla River near Lamont. Annual geometric means compared against NNC criteria (as per 62-302.531, F.A.C.)

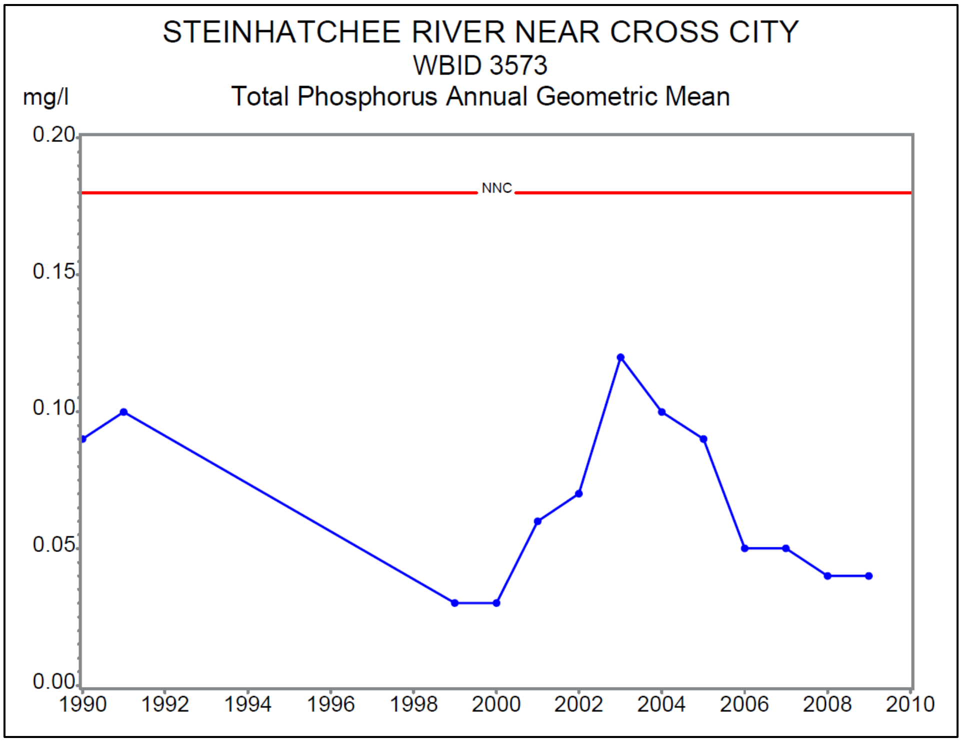


Figure 19. TP trend for the Steinhatchee River near Cross City. Annual geometric means compared against NNC criteria (as per 62-302.531, F.A.C.)

2.2.3 Regulatory Issues

This section provides a discussion of water quality regulatory issues related to impairments, TMDLs and BMAPs, and changes in regulatory standards applicable to the Coastal Rivers Basin.

2.2.3.1 Impairments

While much of this stretch of the Florida coast is thought of as pristine with respect to water quality, there are a number of water quality impairments related to these river systems (Figure 20).

In the Waccasassa River, FDEP's 2014 Comprehensive Verified Impaired List shows 22 waterbodies (WBIDs) with water quality impairments. Of the 22 impairments, 18 of them refer to bacterial impairments. Of the 18 bacterial impairments, many of them refer to exceedance of the Class II standard for downstream tidal waters that states that no more than ten percent of samples taken in a given month shall exceed 14 colony forming units (CFU) of fecal coliform bacteria per 100 ml. However, the upstream and freshwater portions of the Waccasassa River also have been declared impaired for bacteria, even with the higher effective threshold criteria of 400 CFU / 100 ml for fecal coliform bacteria. Other impairments are for nutrients for the nearshore regions of the Gulf of Mexico (WBID 8037B) and the waters around Cedar Key (WBID 8037C) – both of which were listed due to exceedance of the chla-a criteria of 11 µg / liter.

In the Steinhatchee River, both Bevins (aka Boggy) Creek and the river itself are listed as impaired for bacteria in FDEP's 2014 Comprehensive Verified Impaired List. The impairment is the exceedance of the Class III freshwater criteria of 400 CFU / 100 ml for fecal coliform bacteria.

For the Fenholloway, FDEP's 2014 Comprehensive Verified Impaired List shows a total of six WBID-impairment combinations. Three WBIDs are listed as impaired for DO. The impairment threshold for DO used in the 2014 Verified Impaired list is shown as 4 mg DO / liter for the Fenholloway River at the Mouth of the River, and 5 mg DO / liter for the river both below and above the Foley Cellulose mill. Also on the 2014 Verified List, the Fenholloway River below the Foley Cellulose mill is listed as impaired for both specific conductance (values not to be increased above 1,275 µmhos/cm) and also for unionized ammonia (values not to exceed 0.02 mg NH_3 (as N) /liter). Additionally, Spring Creek (located within the Fenholloway watershed) was listed as impaired for exceeding the Class III freshwater criteria of 400 CFU / 100 ml for fecal coliform bacteria.

In the Econfina River, there are no WBIDs listed as impaired by FDEP in its 2014 Verified Impaired List. In the Aucilla River watershed, the Little Aucilla River is listed as impaired for DO, based on the criteria of 5 mg DO / liter, with nitrogen identified as a potential causative factor. Also in the Aucilla River watershed, both Wacissa Spring and the Wacissa River are listed as impaired for "nutrients" based on what was determined to be excessive amounts of algae.

A complicating factor, however, in terms of prioritizing actions to protect and/or improve water quality is that many of the impairments of water quality in the Coastal Rivers Basin are based on water quality criteria that have since been updated by FDEP. The implications, if any, of changes in water quality criteria are discussed below for DO and bacteria.

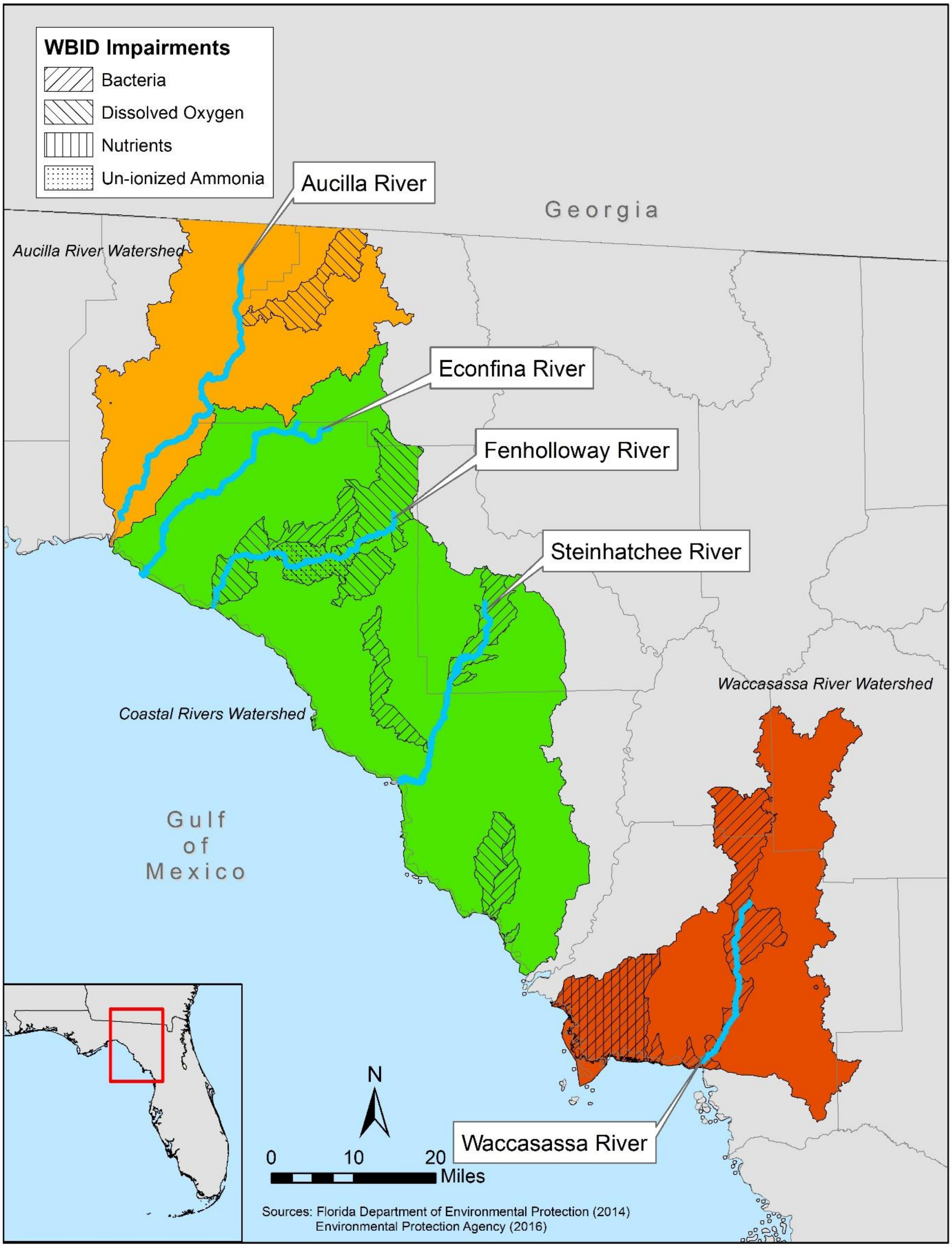


Figure 20. Map showing WBID-impairment combinations in the Coastal Rivers Basins. See legend for basis for impairment

2.2.3.2 Potential Effect of Revisions to Water Quality Standards

While there is a general scientific consensus that outside of the Fenholloway River, water quality conditions are not overly problematic in most of the Coastal Rivers Basins, many of the water quality impairments listed by FDEP in their 2014 Comprehensive Verified Impaired List are based on prior criteria that have since been updated by FDEP.

Dissolved Oxygen (DO)

Both the Fenholloway River and the Little Aucilla Rivers are listed as impaired for DO in FDEP's 2014 Verified Impaired List; these impairments are based on DO criteria that have since been updated by FDEP.

On September 9, 2013, the U.S. Environmental Protection Agency (EPA) approved revisions to FDEP's DO criteria, as part of the Triennial Review of surface water quality standards. The revised DO criteria then came into effect for both FDEP and EPA. As of February 17, 2016, the relevant and revised criteria for DO (62-302.533, F.A.C.) are that in the Class III freshwater portions of these coastal rivers, no more than 10 percent of the daily average percent DO saturation values shall be below 34 percent saturation (for the Big Bend Region). For rivers and streams in the Coastal Rivers Basins, there are no depth-related restrictions as to sampling protocols, but "…the daily average freshwater DO level shall be calculated as the average of all measurements collected in the water column at the same location and on the same day." Despite the changes in the DO criteria, neither the Fenholloway nor the Little Aucilla Rivers have been de-listed by FDEP in their 2017 revisit of impaired waters in the region.

Bacteria

For those WBIDs classified as impaired for bacteria in FDEP's 2014 Comprehensive Verified Impaired list, the characterization of such waterbodies as impaired may vary with proposed modifications to FDEP's criteria. At the July 26, 2016 meeting of FDEP's Environmental Regulation Commission, FDEP proposed new criteria that would eliminate the reliance on fecal coliform bacteria, and replace it (for Class III freshwater systems) with criteria based on the species *Escherichia coli*. The proposed criteria for *E. coli* would be based on counts not exceeding a monthly mean quantity of 126 CFU/ 100 ml of water. As this standard applied for monitoring programs that collect at least ten samples per month, most water bodies would likely be reviews based on the higher "Ten Percent Threshold Value (TPTV)" of 410. If a single value of *E. coli* exceeds 410 CFU / 100 ml, then the waterbody would be in violation of bacteria standards. This criteria change could be relevant for the impairment determination for Bevins Creek, in the Steinhatchee River, as well as those freshwater portions of the Waccasassa River listed as impaired for bacteria.

The revised bacteria standard for Class III freshwater of *E. coli* of 410 CFU / 100 ml is almost identical to the prior quantity for fecal coliform bacteria of 400 CFU / 100 ml. Since *E. coli* bacteria are a subset of the larger grouping of "fecal coliform" bacteria, it is likely that the number of bacterial impairments will decrease if the proposed criteria are adopted by both FDEP and EPA.

For those waters classified for shellfish harvesting (Class II) such as in the lower reaches of the Waccasassa River and nearshore portions of the Gulf of Mexico, FDEP has proposed that the bacteria criteria remain the same. Fecal coliform bacteria would remain the indicator of choice, with criteria dependent upon sampling frequency and whether or not quantification involves the use of Most Probable Numbers (MPN) or Membrane Filtration (MF). For Class II waters, bacterial criteria are that "…a median value of 14 with not more than ten percent of the samples exceeding 43 (for MPN) or 31 (for MF), nor exceed 800 on any one day. To determine the percentage of samples exceeding the criteria when there are both MPN and MF samples for a waterbody, the percent shall be calculated as 100*(nmpn+nmf)/N, where nmpn is the number of MPN samples greater than 43, nmf is the number of MF samples greater than 31, and N is the total number of MPN and MF samples." For all effective purposes, a Class II waterbody would be determined to be impaired if any sample exceeded 43 CFU / 100 ml for fecal coliform bacteria, since most sampling programs are on a monthly time-step, and a single value higher than 43 is functionally the same as "more than 10 percent" of samples exceeding 43 CFU / 100 ml.

For Class III marine waters, FDEP has proposed that fecal coliform bacteria no longer be used, but that the biological indicator of the genus *Enterococcus* is used. More specifically, FDEP has proposed that the new Class III marine standard be such that "MPN or MF counts shall not exceed a monthly geometric mean of 35 nor exceed the TPTV of 130 in 10 percent or more of the samples during any 30-day period. Monthly geometric means shall be based on a minimum of 10 samples taken over a 30-day period." Since most sampling programs will likely continue to be at monthly time-steps, the effective criteria would be 130 *Enterococci* (MPN or MF) per 100 ml of water, since a single value higher than 130 is functionally the same as "more than 10 percent" of samples exceeding that criteria.

The widespread change in bacterial abundance guidance, particularly in Class II and Class III marine waters should be monitored to determine if the new criteria increase, decrease or do not affect, the likelihood of a waterbody being listed as impaired.

2.2.3.3 Total Maximum Daily Loads (TMDLs)

FDEP develops and adopts TMDLs for waterbodies identified as impaired. The spatial extent of areas covered by established TMDLs in the Coastal Rivers Basins are illustrated in Figure 21.

Fenholloway River

The most significant water quality concern in the Coastal Rivers Basin is associated with the Fenholloway River. The Final TMDL for the Fenholloway River (EPA 2007) is based on the determination by EPA that the Fenholloway River was impaired for DO, BOD, dioxin, nutrients and unionized ammonia (NH_3).

That portion of the TMDL for the Fenholloway River that addresses DO is based on criteria (62-302.530, F.A.C.) that DO "…shall not be less than 5 mg / liter and normal daily and seasonal fluctuations above these levels shall be maintained." This DO "target" for the Fenholloway River TMDL is higher than values found in the Econfina River, which was used as a reference site for the TMDL (EPA 2007). In the Econfina River, DO levels as low as 0.9 mg / liter were recorded, which were determined to be (EPA 2007) "…representative of normal healthy blackwater systems."

Figure 21. Map showing areas covered by TMDLs in the Coastal Rivers Basins

Thus, the Final TMDL for the Fenholloway River is based in part on maintaining a DO level that is not met by the reference system, the Econfina River. This apparent disconnect is noted in the TMDL (EPA 2007) which states that "…development of an alternative DO criterion appears to be warranted for streams in the Econfina River Basin, including the Fenholloway River. However, until FDEP establishes an alternative DO criterion for the river, and EPA approves that alternative criterion, the applicable DO water quality criterion used in this TMDL is the statewide value of 5 mg / liter."

Recognizing the importance of this issue, the TMDL for the Fenholloway River (EPA 2007) includes load reduction estimates to meet not only the existing (at that time) DO criteria that no value shall fall below 5 mg DO / liter, it also derived load reduction estimates to meet an Alternative Dissolved Oxygen Criteria (ADOC) that mirrored the existing (at the time) DO criteria for Class III marine waters. The ADOC value in the TMDL (EPA 2007) was that DO values shall be such that "…a minimum DO concentration of 4 mg / liter and a daily average of 5 mg / liter …"

In January of 2009, the USEPA established a TMDL for nutrients in the Fenholloway River, and four years later, FDEP (2013) established a Level II Water Quality Based Effluent Limit (WQBEL) for both TN and TP for the Fenholloway River Estuary. These documents provide detailed guidance on the specific steps needed to restore the Fenholloway River's water quality to Class III standards.

As noted above, in September 2013, the EPA approved revisions to FDEP's DO criteria, and the revised criteria then came into effect for both FDEP and EPA. As of February 17, 2016, the relevant criteria for DO (62-302.533, F.A.C.) are that in the Class III freshwater portions of these coastal rivers, no more than 10 percent of the daily average percent DO saturation values shall be below 34 percent saturation. Subsequently, the number of DO impairments in the Fenholloway River watershed could be lower, and TMDL obligations lower, perhaps, if the newly revised DO criteria differ in terms of the frequency of "false positives" for detecting water quality problems.

The historical impacts of poor water quality in the Fenholloway River are not restricted to the river itself. In nearshore waters of the Gulf of Mexico off the Fenholloway River, the discharge of waters with high levels of colored dissolved organic matter were determined to be responsible for changes in the quantity and quality of light reaching the bay bottom, and such changes had measurable and negative impacts on seagrass meadows (Livingston 1984). As such, activities to improve water quality in the Fenholloway River have the potential to benefit those portions of the Gulf of Mexico adversely impacted by those same discharges.

In its most recent water quality review (Group 4, Cycle 3) FDEP removed impairments (de-listed them) for dioxin, BOD, unionized NH_3, and nutrients. For dioxin, FDEP concluded that "Recent fish tissue data indicate that fish are now below advisory thresholds." For BOD, FDEP concluded that "This parameter is being delisted from the 1998 303(d) List and Verified List based on a flaw in the original analysis." For unionized NH_3, FDEP noted that the original impairment for the Fenholloway River at the Mouth (WBID 3473A) was in error, as the criterion for unionized NH_3 "only applies to freshwater." The de-listing of the Fenholloway River below the mill's discharge for nutrients was due to "…the annual average chla-a values are below the IWR threshold of 20 µg/L."

Wacissa River

There is a large discrepancy between NO_3^{-2} targets set by FDEP for the Wacissa River and the Suwannee and Santa Fe Rivers. The TMDL for the Wacissa Spring and River system, (62-304.406, F.A.C.), sets a NO_3^{-2} target of 0.20 mg NO_3^{-2} (as N) per liter for the Wacissa River, which is 43 percent lower than the NO_3^{-2} target upon which the TMDL for the Suwannee and Santa Fe Rivers is based (0.35 mg NO_3^{-2} (as N) / liter; FDEP 2008). The target NO_3^{-2} level for the spring itself is slightly higher, 0.24 mg NO_3^{-2} (as N) per liter. To meet the NO_3^{-2} target for the river, the NO_3^{-2} target for the spring must be met as well, which would require a 38 percent reduction in NO_3^{-2} concentrations in discharges from the spring vent (FDEP 2016).

The NO_3^{-2} concentration in the Wacissa River listed for "existing mean concentration" in the TMDL (FDEP 2016) is 0.33 mg NO_3^{-2} (as N) per liter, a value below the default NNC criteria of 0.35 mg NO_3^{-2} (as N) per liter used as the "target" NO_3^{-2} value for the Suwannee and Santa Fe Rivers (FDEP 2008). The "existing mean concentration" of NO_3^{-2} listed for Wacissa Spring is listed as 0.39 mg NO_3^{-2} (as N) per liter, a value approximately 11 percent higher than the NO_3^{-2} target of 0.35 mg NO_3^{-2} (as N) per liter in the TMDL derived for the Suwannee and Santa Fe Rivers (FDEP 2008). In the TMDL, two of the spring systems in the Wacissa watershed with "background" NO_3^{-2} concentrations also are characterized as having abundant algal biomass. Therefore, it appears that FDEP has identified the Wacissa Spring and River system as a highly nitrogen-sensitive waterbody in need of more stringent standards.

Bacteria

Prior bacteria TMDLs produced for waterbodies in the District jurisdictional boundaries were completed for both the Santa Fe and Suwannee River watersheds, systems with much more water quality data than the impaired WBIDs with bacterial TMDLs in the Coastal Rivers Basin. Despite being much more data-rich, the TMDLs for bacteria in the Santa Fe and Suwannee Rivers (FDEP 2014b and FDEP 2014c) did not attribute loads to any sources or watersheds, but rather conclude that stormwater discharges should not exceed 400 CFU / 100 ml criteria, and that point source discharges should be at levels that "meet permit limits." Therefore, it is likely that future TMDLs for bacteria impaired WBIDS in the Coastal Rivers Basin will have similar requirements.

2.2.4 Threats to Water Quality

Water quality within the Coastal Rivers Basin varies spatially. The Coastal Rivers Basin includes systems that have been used as "reference" locations for regulatory programs, as well as the Fenholloway River, a river with a significant industrial discharge component. The Fenholloway River is undergoing a series of complex and expensive modifications to existing industrial discharges that should allow it to, over the next 5 to 10 years, meet the water quality standards appropriate for its designated use. The extensive conservation lands and the fairly low-impact land use of silviculture are such that most of the rivers themselves are considered healthy, as are the nearshore waters of the Gulf of Mexico into which they discharge (with the exception of the coastal waters near the mouth of the Fenholloway River).

The mostly rural nature of the Coastal Rivers Basin has resulted in the widespread use of septic tank systems as a means of waste disposal. Figure 22 shows the locations of permitted septic tanks in the Basin. In low enough densities, with adequate separation between the bottom of the drainfield and the wet season water table, septic tank systems can be an entirely appropriate technique for disposing of domestic wastewater. However, various locations have developed over time such that densities and higher water tables might be problematic. Septic tank replacement programs are extremely expensive, but they can also be the most required management action in some locations. Documentation of impacts to pathogen and nutrient loads from septic tank systems should be a near-term focus, to determine those places where conversion to central sewerage would be appropriate. The identification of locations with excessive amounts of pathogens is complicated by the recently shift from the use of fecal coliform bacteria to a combination of fecal coliform bacteria, *Enterococci* bacteria and *E. coli* bacteria.

To address these issues, the District has identified various management actions (Section 3) and projects/initiatives (Section 4) with the ultimate goal to protect or restore the water quality of the Coastal Rivers Basin. Concerns vary, but the majority of concerns have focused on the issues of nutrient (especially nitrogen) enrichment and pathogen abundance. Specific goals include the continuation of efforts to monitor water quality, with regular updates of the status and trends (if any) in water quality across the Basin. In addition, efforts to identify the source(s) of nitrogen to the Wacissa River are called for, as well as the identification of "hot spots" for impacts from septic tank systems. Planned and ongoing efforts to reduce impacts from agricultural land uses are required as well. For the Fenholloway River, stakeholders in the watershed need to continue to implement the projects that have been determined to be required to allow the river to meet Class III freshwater standards.

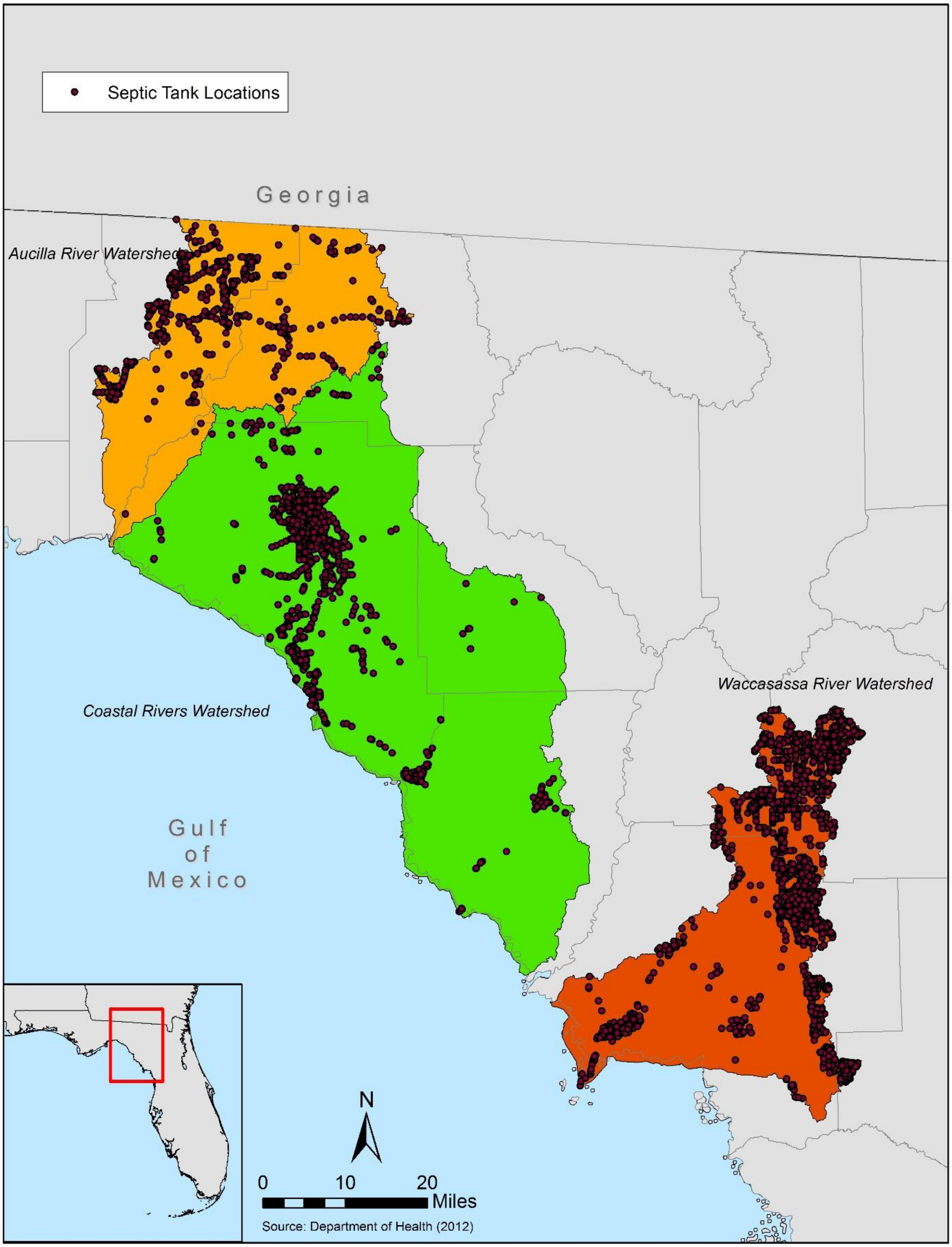


Figure 22. Permitted septic tanks within the Coastal Rivers Basin

2.3 Natural Systems

The 1987 SWIM Act identified habitat for native plants, fish and wildlife, including listed species, as resources affected by water quantity and quality. Therefore, SWIM Plans are required to address "natural systems" as a component of strategies to improve and manage surface waters. Natural systems in the Coastal Rivers Basin include aquatic, and wetland habitats – both freshwater and marine/estuarine, and upland habitats; and the biological communities and species that comprise and utilize these habitats. This section discusses the natural systems in the Coastal Rivers Basin using summary data from technical publications and reports, and other information available from resource management agencies.

Habitats in the Coastal Rivers Basin also support numerous rare, endemic and protected species, including the threatened frosted flatwoods salamander (*Ambystoma cingulatum*), the eastern indigo snake (*Drymarchon couperi*), the Gulf sturgeon (*Acipenser oxyrinchus desotoi*), and the West Indian manatee (*Trichechus manatus latirostris*). The Big Bend Seagrasses Aquatic Preserve along the Gulf Coast of the District is the largest aquatic preserve in the state, and includes over 984,000 acres of submerged lands (FDEP 2014a). The preserve is home to over 2,000 native species of plants and animals, including threatened and endangered species such as the West Indian manatee, the Atlantic hawksbill sea turtle (*Eretmochelys imbricata*), and the Kemp's Ridley sea turtle (*Lepidochelys kempii*) (FDEP 2014a). These and other species are referenced, as appropriate, in the natural systems descriptions presented below.

Numerous species rely on these systems for nesting, roosting, spawning, foraging and other uses throughout or during different stages of their lives. Natural systems in the Coastal Rivers Basin are grouped into:

- Upland habitats;
- Freshwater habitats; and
- Marine/ coastal estuarine habitats.

The rivers in the Coastal Rivers Basin are small when compared to the Suwannee River, and only the Aucilla River begins far enough inland that it crosses the Cody Scarp. The rivers include both surface and groundwater contributions and only three of the 56 springs in the Coastal Rivers Basin are first magnitude. These natural systems are briefly discussed below, using information from FNAI (2010), previous District reports, and other relevant literature. Continued mapping of these systems provides a means of tracking changes in land cover, habitat, and fish and wildlife.

Habitats for listed animal species are specifically addressed by FWC, and conservation of many of these species is also included in FWC's *Florida's Imperiled Species Management Plan* (ISMP), approved in November 2016. The ISMP combines Species Action Plans (SAPs) addressing individual species needs with Integrated Conservation Strategies benefiting multiple species and shared habitats. Habitats are presented in this section of the Coastal Rivers SWIM Plan with reference to associated listed species. A complete listing of state and federally threatened and endangered species in the Basin is presented in Section 2.3.4.

Wetland classes, as defined by the National Wetland Inventory (NWI), in the estuarine portions of these rivers include non-tidal palustrine forest, intertidal estuarine forest, intertidal estuarine emergent and subtidal estuarine aquatic bed. SAV and oyster reefs characterize the aquatic estuarine portions of the Basin. Tidal salt marshes extend upstream to the extent of the influence of salinity and are then replaced by freshwater tidal marshes. As salinity and tidal influence decrease, trees tolerant of infrequent salinity encroachment due to, for example, storm events, appear in the lower tidal river but are subsequently replaced by freshwater tidal and floodplain forests farther upstream. Isolated wetlands and some lakes occur in the Basin (e.g. Sneads Smokehouse Lake in the upper Aucilla River watershed is an important freshwater fisheries lake (FWC 2011)). Uplands include hydric/coastal hammocks, pine flatwoods, hardwood forests and pine scrub. Freshwater springs and SAV occur in the upper reaches of these coastal rivers. The various habitats of the Coastal Rivers Basin are discussed in the section below using FNAI (2010) terminology.

2.3.1 Upland Habitats

Upland habitats in the Coastal Rivers Basin occur along or near streams, rivers, springs, and wetlands, or high on sandy “hills”. Above the tidal influence and the influence of river flooding, upland habitats in the Coastal Rivers Basin include hardwood forests (mesic or xeric forests dominated mainly by hardwood trees), high pine and scrub (hills with mesic or xeric woodlands or shrublands; canopy, if present, open and consisting of pine or a mixture of pine and deciduous hardwoods), and pine flatwoods and dry prairie (mesic or hydric pine woodland or mesic shrubland on flat sandy or limestone substrates, may have a hard pan that impedes drainage).

Natural upland habitats in the Basin have historically been dominated by pine flatwoods of slash, longleaf or loblolly pine (the species depending largely on soil type and degree of wetness) (District 1995). Smaller areas of the Basin are vegetated with more xeric plant communities such as xeric hammocks, sand pine scrub and mixed upland forests. The landward edge of forested wetland areas typically includes live and laurel oak (*Quercus laurifolia*), pignut hickory, loblolly pine, cedar and cabbage palm. Landward of the coastal marshes, transitional areas are vegetated with sand cordgrass (*Spartina bakeri)*, various sedges, cabbage palm, red cedar, slash pine, salt bushes (*Baccharis spp*.), and wax myrtle (*Morella cerifera)* (District 1995). For example, relic dunes inland from the coast around Cedar Key and Gulf Hammock as high as 30 feet occur among the surrounding flatwoods.

Upland habitats are important to numerous species, for example, Sherman’s fox squirrel (*Sciurus niger shermani*), a state listed species of special concern, inhabits open, fire-maintained longleaf pine, turkey oak, sandhills and flatwooods. Loss of upland habitat also affects habitat for state threatened Florida burrowing owl (*Athene cunicularia floridana*), southeastern American kestrel (*Falco sparverius paulus*), and Florida scrub jay (*Aphelocoma coerulescens*) as well as the federally endangered red-cockaded woodpecker (*Picoides borealis*); all use upland habitat for nesting and foraging. Reptiles similarly threatened due to loss of upland habitat include the state threatened gopher tortoise (*Gopherus polyphemus*), short-tailed snake (*Lampropeltis extenuata*), and pine snake (*Pituophis melanoleucus*), and the federally threatened eastern indigo snake. Some upland habitats are used for particular life stage. For example, the federally threatened frosted flatwoods salamander leaves its upland burrow to deposit eggs in ephemeral wetlands.

Agricultural lands provide a valuable benefit to the conservation of fish and wildlife, including many of the State's Imperiled Species which are integral to the overall ecosystem. This Wildlife Best Management Practices (WBMP) for State Imperiled Species Manual (FDACS 2015) has been developed to enhance agriculture's contribution to the conservation and management of freshwater aquatic life and wildlife in the state, and to provide guidance to landowners and others who choose to implement these important practices. However, this manual addresses only State Imperiled Species in Florida and not those federally listed by USFWS. Fish and wildlife species currently on the State Imperiled Species list were evaluated for the potential for incidental take to occur during agricultural activities. Based on current knowledge, 16 of the State Imperiled Species were determined to occur in areas where agricultural activities have the potential to influence habitat that supports essential behaviors or directly impact individuals.

Designated State Imperiled Species addressed in the WBMP and included in the Coastal Rivers Basin include the gopher tortoise, Florida burrowing owl, little blue and tricolored herons (*Egretta caerulea* and *Egretta tricolor,* respectively), Florida sandhill crane (*Antigone canadensis pratensis)*, and the southeastern American kestrel, and Barbour's map turtle (*Graptemys barbouri)*. While all the BMPs that prevent erosion, sedimentation, groundwater contamination and protect stream geomorphology are important, the most practical and effective are those associated with maintaining adequate vegetated Conservation Buffers and Stream Crossing. Upland plant species that are state listed as endangered include Florida flame azalea (*Rhodendron austrinu*), scrub stylisma (*Stylisma abdita*), and browneyed susan (*Rudbeckia triloba*). Upland plant species identified as threatened: Chapman's sedge (*Carex chapmanii*), Florida beargrass (*Nolina atopocarpa*), and giant orchid (*Pteroglossaspis ecristata*).

Natural upland habitats in the Basin include communities such as upland hardwood forest, upland pine (e.g. longleaf pine and scrubby flatwoods), upland mixed forest, mesic hammock, sandhill, and scrub communities that provide habitat for numerous wildlife species. The transition between upland and wetland communities is characterized by habitat ecotones that reflect changes in soil, hydrology, and vegetation.

- Hardwood forested uplands may be mesic or xeric, dominated primarily deciduous or deciduous/evergreen upland species such as American beech, southern magnolia, dogwood, and others. Mesic hammocks are characterized by a closed evergreen canopy of species such as live oak, southern magnolia, pignut hickory, and saw palmetto. Xeric hammocks include a closed canopy of evergreen hardwoods such as sand live oak and saw palmetto.
- High pine and scrub occur on elevated areas or hills characterized by mesic or xeric forest or shrublands of pine or pine mixed with deciduous hardwoods. These forests can be mixes of southern red oak, longleaf or shortleaf pine, and other mixed hardwoods; upland pine savannas of longleaf pine, loblolly pine, and/or shortleaf pine, and wiregrass; sandhill forests with longleaf pine and turkey oak on high sandy areas; scrub, also sandy, with sand pine and scrub oaks with or without Florida rosemary.
- Mesic flatwoods and dry prairies are flatland areas with scattered pines over saw palmetto, long leaf pine, saw palmetto and wiregrass. In the absence of trees (due to frequent fire),

dry prairies may occur, supporting a low cover of shrubby live oak, wiregrass, stunted saw palmetto and broomsedge bluestem.

- Shell mounds on the Cedar Keys in Levy County on the Gulf coast are also northern outposts for tropical species most likely brought in by migrating birds.

Notable among the high pine forests are the longleaf pine forests. Although longleaf forests and savannas once dominated the southeastern coastal plain, they have been drastically reduced from an estimated 90 million acres to less than three million, largely due to urbanization, over-utilization, conversion to other land uses and exclusion of natural fire regimes. Longleaf pine ecosystems are among the most diverse in North America, supporting a large array of herbaceous plant species as well as rare animal species such as red-cockaded woodpeckers and gopher tortoises. Much of the remaining acreage exists as fragmented stands in varying degrees of isolation. In Florida, long leaf pine is primarily in the northern Panhandle in the clay-rich soils north of the Cody Scarp (Myers 1990) from the western Florida boundary to at least Hamilton County. Long leaf pine is extremely limited in the Coastal Rivers Basin and occurs only in patches along the Aucilla, Econfina, Steinhatchee and Waccasassa river corridors as well as within Goethe State Forest in Levy County.

Upland pine is a woodland of widely spaced pines with a sparse to moderate shrub layer and a dense, species-rich groundcover of grasses and herbs, occurring on gently rolling terrain. The canopy is dominated by longleaf pine; shortleaf pine may also be present. Upland hardwood forest occurs in the Florida Panhandle south to the central peninsula (Schwartz 1988, USFWS 1999). Characteristic canopy trees include southern magnolia, pignut hickory, sweetgum (*Liquidambar styraciflua)*, Florida maple (*Acer saccharum ssp. floridanum*), and loblolly pine. Species commonly found in Florida Panhandle and northern peninsula but not farther south includes American beech, white oak (*Quercus alba*), and spruce pine (*Pinus glabra,* Nelson 1994).

The Big Bend region includes some of the most heavily forested areas in Florida, in the heart of Florida's "woodbasket"- the area north of Orlando where counties have at least 50 percent forestlands. Jefferson, Taylor, Dixie and Levy counties all have more than 60 percent forest cover, and Taylor County is nearly 90 percent forested. BMPs for silviculture operations are published by the FDACS (2008). The BMP practices are designed as the minimum standards necessary for protecting and maintaining the State's water quality as well as certain wildlife habitat values, during forestry activities (FDACS 2008).

For example, Special Management Zones (SMZs) are a BMP which consist of a specific area associated with a stream, lake or other waterbody that is designated and maintained during silviculture operations to protect water quality by reducing or eliminating forestry related inputs of sediment, nutrients, logging debris, chemicals and water temperature fluctuations that can adversely affect aquatic communities. SMZs provide shade, streambank stability and erosion control, as well as detritus and woody debris which benefit the aquatic ecosystem in general. In addition, the SMZ is designed to maintain certain forest attributes that will provide specific wildlife habitat values. Snags, den and cavity trees as well as mast producing trees, left in the SMZ, are necessary to meet habitat requirements for certain types of wildlife. More specific activities within an SMZ may include prohibited harvest, prohibited clearcutting, selective harvest, protection of large or old trees or tree snags, prohibited road clearing and prohibited mechanical site preparation. BMPs are specific to wetlands, streams, canals, waste disposal wet weather, and other locations and/or conditions.

Silviculture practices in the southeastern U.S. have been shown to have minor water-quality problems relative to other land uses (Ursic and Douglass 1978), although roads without BMPs are the major source of sedimentation (Sun et al. 2004). Native pine and hardwood forests maintain the health of water resources, supporting clean rivers, creeks, and springs, fish and wildlife habitat and drinking water (FNAI 2010). However, uplands are typically desirable for development and those that remain are altered by reduced fire regimes due to urbanization, increases in non-native and invasive species, and often fragmented due to proximate development and roads. Upland activities can adversely affect wetlands and other surface waters. For example, land clearing can result in greater and more rapid stormwater runoff to wetlands, increasing sediment loads and turbidity in wetlands and open waters, and potentially increase floodwater levels. BMPs are implemented to reduce impacts to adjacent lands and protect water quality and provide flood storage, runoff filtration, coastal storm surge buffering, and nursery areas for economically important to the maintenance of many upland habitats.

Uplands in the Coastal Rivers Basin range from pine flatwoods to longleaf pine and turkey oak, to sandhills and scrub pine; and are home to numerous species, including many listed species. Appropriate management of these habitats is necessary if listed species are to be protected and/or delisted.

2.3.2 Freshwater Habitats

The USFWS National Wetlands Inventory (NWI) is a publically available data source of wetlands in the U.S. In the Coastal Rivers Basin, NWI data indicate that freshwater marshes (freshwater emergent) and freshwater forested wetlands are the dominant freshwater wetland (Figure 23). These wetlands are typically associated with rivers, spring runs, and springs, although they are also associated with the few lakes and ponds that appear in the Basin. Springs and spring runs are typically characterized by SAV due to the clear water, and often have adjacent marshes due to the light penetration at the spring or wide spring run. In the Coastal Rivers Basin, the primary rivers include the Wacissa and Aucilla rivers in Jefferson and Taylor counties, the Econfina and Fenholloway in Taylor County, the Steinhatchee in Taylor and Dixie counties, and the Waccasassa River in Levy County, with varying degrees of groundwater influence. As described in earlier sections, all but the Aucilla and Wacissa rivers have headwaters in swamps, and all but the Wacissa River, which is dominated by spring flows, are blackwater rivers that flow to the Gulf. Much of the headwaters in the Basin have been ditched and drained for timber production. Consequently, the freshwater habitats in the Basin include the springs and spring runs that contribute to flows in the rivers, freshwater marshes, and predominantly forested wetlands and floodplain along the rivers.

Freshwater wetlands along the rivers begin in the headwaters and end where the Gulf waters meet flows from the river and the 0.5 ppt isohaline is the downstream boundary of wetlands characterized by species intolerance of persistent salinities. Freshwater vegetation includes trees, shrubs, persistent emergent plants, and emergent mosses or lichens. Freshwater habitats for the

Coastal Rivers Basin include springs and spring runs, freshwater and estuarine marshes, and forested wetlands. Springs and spring runs are not as conspicuous in this Basin when compared with the Suwannee and only three of the 56 springs in the Basin are first magnitude and freshwater marshes are not extensive. The rivers vary somewhat in each of the basins and forested wetlands are described for each river watershed.

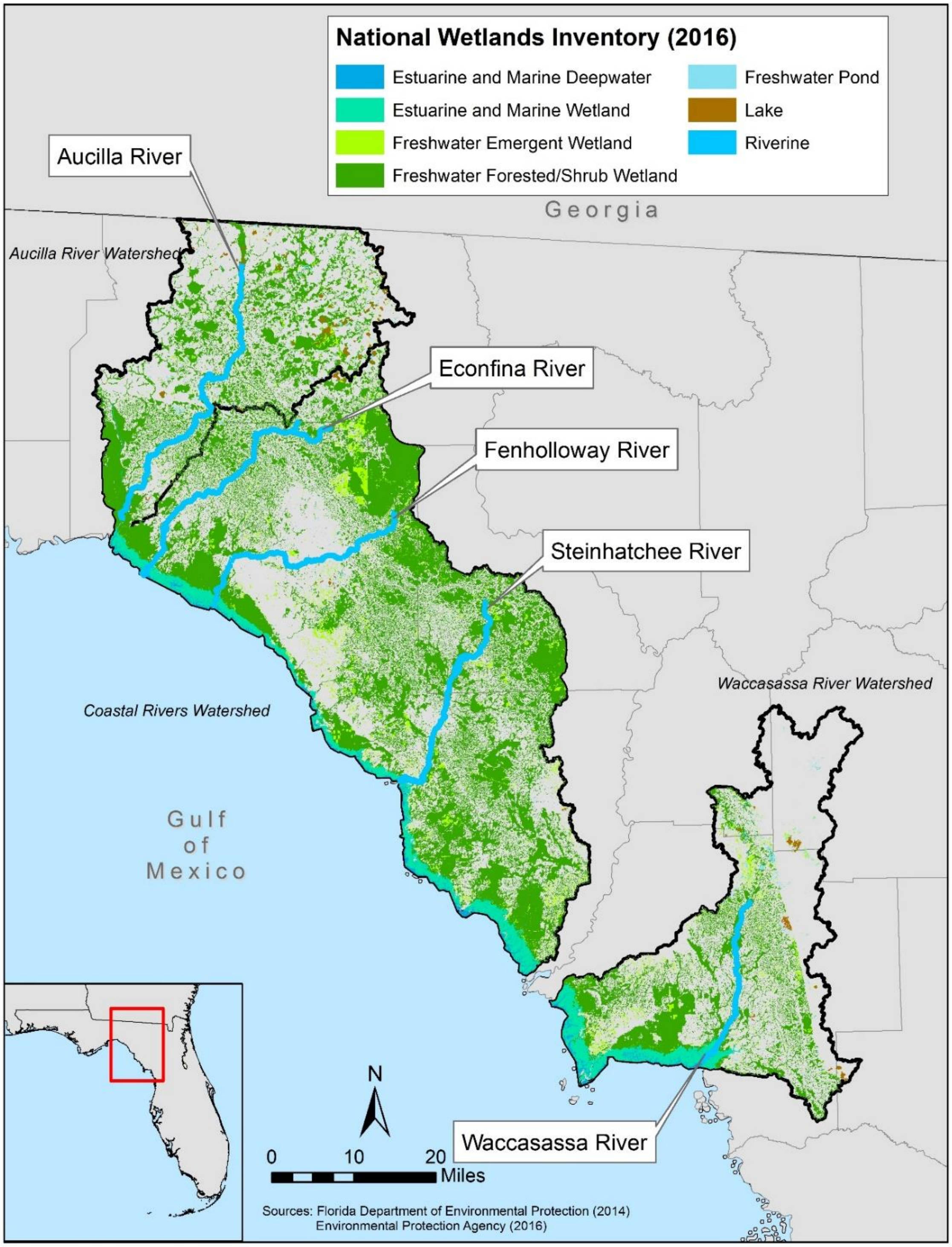


Figure 23. NWI map of the Coastal Rivers Basin

District activities focused on protecting these natural wetland systems are important to the numerous ecological, and economic, benefits to the region, including (FDEP 2011):

- Providing food for numerous species such as oysters, crabs, fish and wildlife;
- Providing protective habitat for migratory fish and juveniles of many commercial fishery species;
- Providing feeding, breeding, spawning and nesting habitat for waterfowl and migratory birds, state and federally listed threatened and endangered species, and many species (commercial and recreational fisheries and shellfish; game species).
- Maintaining the biodiversity of native species with sufficient space and community health;
- Improving water quality by absorbing sediment loads and filtering pollutants;
- Influencing climate through evaporation and transpiration;
- Protecting human life and property by reducing floodwater flow and volume; and
- Enhancing human community resilience by buffering environmental conditions (e.g., hurricanes, floods, climate and sea level rise), reducing erosion and providing groundwater recharge areas.

Freshwater habitats support many animal species designated as threatened or endangered due to loss of habitat and approximately 85 percent of riverine fish species use the floodplain and swamp for some part of their life history (Leitman et al. 1991, Burgess et al. 2013). Some species reside permanently in freshwater, such as the state threatened Barbour's map turtle that is limited to freshwater rivers and streams in the panhandle of Florida, including the Aucilla River. However, many species use both freshwater and estuarine/marine habitats including: the federally threatened Gulf sturgeon that lives in the Gulf and returns to natal freshwater rivers and streams, the federally threatened West Indian manatee that lives and travels along the Gulf coast and seeks refuge in freshwater springs in the winter, the federally threatened American alligator (*Alligator mississippiensis)* (due to similarity in appearance to the federally threatened American crocodile (*Crocodylus acutus)*) that inhabits freshwater and estuarine waters, and the federally threatened wood stork (*Mycteria americana*), which can be found from estuarine tidal marshes to spring runs, to sandhill lakes. Other fish and wildlife species should also be identified as using these habitats such as the following wading birds: great egret (*Ardea alba*), white ibis (*Eudocimus albus*), little blue heron, snowy egret (*Egretta thula*), tricolored heron, black-crowned night-heron (*Nycticorax nycticorax*), yellow-crowned night-heron (*Nyctanassa violacea*) and glossy ibis (*Plegadis falcinellus*).

Loss of wetland habitats such as seepage slopes can affect numerous plant species, for example, 16 plant species identified as endangered or threatened by the State of Florida inhabit seepage slopes in the Coastal Rivers Basin. Species such as the state endangered Florida willow (*Salix floridana*) in spring runs and hydric hammocks and the state threatened Curtiss' sandgrass (*Calamovilfa curtissii*) in wet prairies and marshes (Appendix G lists all 63 species and associated habitat).

2.3.2.1 Springs and Spring Runs

Springs and spring-run streams in Florida occur as perennial flow ways of clear water from deep aquifer headwaters, often with a limestone bottom. Springs are almost always found along the river corridors in the Coastal Rivers Basin, and connect surface and groundwater. When surface water levels exceed groundwater levels, recharge to the aquifer usually occurs, and a land bridge may occur between where the water disappears into the ground and reemerges. For example, when flow in the Steinhatchee is below 500 cubic feet per second upstream of the US 19/98 bridge, the water goes to the Floridan aquifer system and resurfaces just downstream of the bridge. The Econfina River also has a small land bridge below US 19. The Fenholloway River also “loses” water to the aquifer during normal to low flows as a result of the cone of depression associated with large groundwater withdrawals for Foley Cellulose mill (District 1995).

The District includes more than 300 springs, representing one of the highest concentrations of freshwater springs in the United States, and includes 18 of the state's 33 first-magnitude springs (springs with flows equal to or greater than 100 cubic feet per second, or 64 million gallons a day). The Aucilla River has a single spring at Nutall Rise, which is the primary contributor of freshwater to the river, while its tributary, the Wacissa River, has 12 major springs contributing to its flow through swampy lowlands in the Aucilla WMA. There are several coastal springs between the Econfina and Steinhatchee, but in the Coastal Rivers Basin, the Steinhatchee is the only river with a number of springs throughout its length. These streams in the Coastal Rivers Basin flow due partly to springs discharging groundwater from the Floridan aquifer system and partly due to surface water runoff from their drainage basins (Mattson et al. 2007). Surface runoff dominates the hydrology of these rivers during high or flood flows, while groundwater inflow from springs predominates during low or base flows.

Individual springs are stable systems, with very little change in water temperature, water flow or chemical composition, but those characteristics can vary from one spring to the next. The bottoms of spring runs are generally sand or exposed limestone along a central, stable channel. Vegetation in spring and spring run habitats consist of SAV, aquatic algae covering limestone outcroppings, and species such as tape grasses, wild rice (*Zizania aquatica*), and giant cutgrass (*Zizaniopsis miliacea)* located in the spring runs (FWC 2016b). Submersed and emergent vegetation are typically present, but this habitat is based on the presence of the spring rather than dominant vegetation. Freshwater springs and SAV occur in the upper reaches of many of the rivers of the Coastal Rivers Basin. Freshwater SAV provides habitat for benthic macroinvertebrates, fish and other aquatic wildlife. Benthic substrates in the rivers vary widely, ranging from fine grained muck sediments to generally sand, limestone shelves with pebbly gravel and exposed large rock, and bedrock. SAV in the rivers, springs, and spring runs with adequate water clarity include dense growth of rooted aquatic plants, species such as spring tape grass (*Sagittaria kurziana*), tape grass (*Vallisneria americana*), and pondweed (*Potamogeton illinoensis*) are common, along with infestation by such invasives as Hydrilla (*Hydrilla verticillata)*. Wild rice is typical of the river edges, with species of rooted or floating aquatic vegetation such as lily pads like yellow pond-lily (*Nuphar lutea)* and American white waterlily (*Nymphaea odorata)*, pickerelweed, and duck potato (*Sagittaria lancifolia*) in the deeper areas.

Issues associated with springs include physical disturbance of SAV beds in spring runs, caused by heavy recreational use. Boating, diving, paddling and other types of recreation can disturb SAV, resulting in in the erosion and disturbance to springs and channels, and adversely affect habitat and associated species. Combined with increased nutrient concentrations, physical disturbances can also create conditions for the proliferation of undesirable rooted aquatics (e.g., Hydrilla) as well as filamentous algae mats composed of invasive species, primarily *Lyngbya spp*.

The FWC lists the hammock fern (*Blechnum occidentale var minor*), which occurs in sinkholes in the Waccasassa River watershed, as endangered in the State of Florida. None of the listed animal species are limited to the springs in the Coastal Rivers Basin.

2.3.2.2 Freshwater Marshes

Freshwater marshes occur in shallow wetlands and along portions of rivers with adequate light and velocities that are low enough that vegetation can become established rather than scoured by currents. Marshes are characterized by herbaceous plant species and range from sedge bogs to wet prairies (vegetated with *Pontedaria, Sagittaria* spp., sawgrass and other sedges) to permanently flooded marshes dominated by floating leaved aquatics such as *Nymphaea* and *Nuphar*. Ponds and lakes are inundated depressions deep enough to limit light penetration over most of the waterbody and limit emergent vegetation to primarily the shallower perimeter. For example, isolated wetlands and some lakes occur in the Basin (e.g. Sneads Smokehouse Lake in the upper Aucilla River watershed is an important freshwater fisheries lake (FWC 2011)). Freshwater marshes may be associated with river edges, typically on inside meander of rivers where flow velocity slows and deposition occurs, and herbaceous species can become established.

Emergent freshwater marshes are directly influenced by river flooding on an annual or semi-annual basis where most of the marsh is inundated from approximately 120 to 350 days per year (Toth et al. 1998). Marsh species are typically herbaceous (Cowardin et al. 1979 classify marshes as having less than 40 percent tree cover) and may include sawgrass (*Cladium jamaicense)* and maidencane (*Panicum hemitomon*) as dominant plant species, but various other species occur over a hydrologic gradient (FNAI 2010).

Farther upstream, freshwater marshes are important habitat for black rail (*Laterallus jamaicensis*), limpkin (*Aramus guarauna*), bald eagle (*Haliaeetus leucocephalus*), and wading birds such as the great egret, white ibis, snowy, black-crowned night-heron, yellow-crowned night-heron and glossy ibis. Freshwater marshes are home to numerous species of animals and plants, some of which are threatened due to loss or degradation of this habitat. The state threatened tricolored heron and reddish egret (*Egretta rufescens*) occur in freshwater marshes and salt marshes, as well as most waters of coastal lowlands, including estuarine conditions. State threatened Barbour's map turtle occurs in flowing rivers, spring runs, streams and swamps. The state threatened Florida sandhill crane occurs in marshes, swales, and wet and dry prairies.

2.3.2.3 Forested Wetlands

Forested wetlands are the primary habitat type along the rivers in the Coastal Rivers Basin. These wetlands occur along the rivers, in the floodplain, or depressions and may be dominated by various types of evergreen hardwoods including: sweet bay, southern magnolia, and loblolly bay; various types of deciduous hardwoods (oaks, gum trees, river birch, red maple); swamps dominated by cypress and tupelo trees; hydric hammock of live oak, cabbage palm, red cedar and mixed hardwoods; and wet flatwoods with slash pine, pond pine, cabbage palm, and wiregrass. Coastal swamps occur at the most downstream freshwater influence along the coast, but tidal swamps are not as developed here as they are along the Suwannee River, where freshwater flows are much larger support an extensive floodplain.

Forested systems occur upstream of salinity influence with the exception of species tolerant of storm and infrequent saltwater flooding such as sabal palms and junipers. Seeds and seedlings of tree species are intolerant of salt, although adult trees can tolerate infrequent exposure. Isolated wetland systems (those present in the Basin but not hydrologically connected with the river or its tributaries) are also an important component of the wetland resources of the Coastal Rivers Basin and may include various types of forest wetlands (District 1995):

- Forested wetlands dominated by needle-leaved deciduous trees, bald or pond cypress (*Taxodium distichum* or *T. ascendens*, respectively), and forested wetlands dominated by an overstory of needle-leaved evergreen trees (typically slash pine or loblolly pine)

- Forested wetlands dominated by various types of broadleaf evergreen hardwoods (including sweet bay, southern magnolia, and loblolly bay)

- Forested wetlands dominated by various types of broad-leaved deciduous hardwoods (oaks, various gums, river birch, red maple).

- Bottomland forests on terraces and levees in riverine floodplains and in shallow depressions also occur, with species such as sweetgum, spruce pine, and loblolly pine prevalent. Nearly all bottomland forests have been impacted from timbering operations and some have been converted to pine plantations. Sweetgum is often favored by disturbance due to its ability to sprout following damage to the tree. A wide variety of wetland types occur the rivers, often depending on the amount of spring flow and the land surface drainage.

Flooding is critical to fish access to the floodplain for forage, and the rich organic debris is essential to the functional integrity of downriver ecosystems such as estuaries. In floodplain swamps located within tidal influence, flooding patterns, tidal range, and storm events are major driving factors. These swamps are subject to daily freshwater inundation associated with tidal fluctuations (Day et al. 2007). Virtually all cypress/tupelo stands in Florida are second growth, having been intensively logged by the first half of the 20th century. Individual river watersheds are described briefly, below:

Aucilla River. The Aucilla River is a blackwater river due to its origin in acidic swamps and flatwoods. Swamps and poorly defined channels along the river are dominated by tree species tolerant of extended inundation in the upper river, such as cypress, swamp tupelo, ash (*Fraxinus spp.*), and red maple (*Acer rubrum*) along a poorly defined channel as it flows south to the US 90 bridge.). Hardwood species become prevalent farther from the river and include sweet bay magnolia, swamp bay (*Persea palustris*), laurel oak and the closely related diamond leaf oak (*Q. obtusa*), water oak (*Q. nigra*), sweetgum, hackberry (*Celtis laevigata*), American elm (*Ulmus americanus*), and American hornbeam (*Carpinus caroliniana*). Downstream of the US 90 bridge, the river becomes more defined and the channel deepens and has steep banks, and river birch (*Betula nigra*) becomes common. The Aucilla River disappears underground at Aucilla Sinks and flows for about eight miles underground as it flows to the Gulf. Nuttall Rise is the only major spring reported for the Aucilla River, where the river reappears and flows to the Gulf (Lenz 2006).

Wacissa River. The Wacissa flows southward until it disappears into a group of small streams and river swamps known as "The Warriors" or "Western Sloughs" located west of the Aucilla River (HSW 2016 MFL for Aucilla). The Wacissa is a clear, spring fed river. The river emerges from several large-volume springs and forms a perennial river from its beginning to its confluence with the Aucilla River. The river is classified by FNAI Florida Cooperative Land Cover (CLC) Map version 3.0 as a "Spring-run Stream", a perennial watercourse with deep, clear aquifer headwaters and often a solid limestone bottom (FWC 2014). Consequently, there is little change in water level along the river and the riparian vegetation is characterized by hydric hammock, contrasting it sharply with the swamps and bottomland hardwoods along the Aucilla River.

Econfina, Fenholloway, and Steinhatchee Rivers. The Econfina River is a blackwater river that begins in Madison County and flows for approximately 40 miles through Taylor County, where it then discharges into the Gulf of Mexico. The river picks up tannins from decaying vegetation and acquires a black tint as it flows south. There are no major springs that feed the Econfina River as it flows through swampy lowlands. All three rivers are characterized by low physical relief and poor drainage, reflected in the extensive headwater swamps where the rivers originate (e.g., San Pedro Bay and Mallory Swamp) that are "perched" on higher geomorphic terraces. In the upper watersheds, surface water flows into defined, braided, stream channels that form rivers as they flow to the Gulf. The rivers are all relatively short in length and other contributing surface waters include Sanders Creek, Spring Warrior Creek, and Rocky Creek. Riparian swamps along these rivers tend to be dominated by oak (*Quercus spp.*), sweetgum, ash, bays and other hardwoods, cabbage palm, and red cedar, rather than cypress. Lacustrine (lake) systems are present but not a major type of aquatic ecosystem in the watershed, but are found along the watershed boundaries in Dixie and Lafayette counties and as relict lagoon lakes along the coast. Some of the relict lagoon lakes are unusual in that they are almost completely vegetated with a dense cover of sawgrass with sparse, scattered "hummocks" of wax myrtle and cypress, giving these systems an appearance strikingly like that of the Everglades.

Waccasassa River. The Waccasassa River flows through river channels, swamps, and also occurs as sheet flow (i.e., Devil's Hammock in northern Levy County), until farther downstream where flows from Blue Springs contribute enough water to form a defined channel. The watershed includes few surface water features, with a mixture of perched wetlands interspersed with sandhills (District 1995). The lower reaches of the river are characterized by poorly drained swamps. Tributaries include Magee Branch, Wekiva River, Otter Creek, and Cow Creek (each of which has many smaller tributaries). The Wekiva and Waccasassa Rivers receive significant inflows from two named springs. Riparian forests along the Waccasassa River and most of the major streams in the Coastal Rivers Basin tend to be dominated by oak, sweetgum, ash, bays and other hardwoods, cabbage palm, and red cedar, rather than cypress. These forests contribute leaf litter, an important basic food source in the aquatic food chain, to the river. Southwest of US 19 in Levy County, the river becomes tidal with a wide floodplain before flowing into Waccasassa Bay. Tidal forests, also known as coastal swamps, occur along the Gulf, characterized by low, swampy areas and drowned karst topography (White 1970). In this region, drainage is mainly toward the Gulf through numerous tidal creeks and tidal-flat areas. The coastal swamps are a major discharge zone for the Floridan Aquifer in the Waccasassa River watershed (Water Resource Associates et al. 2006).

Lakes are a minor habitat component in the Waccasassa River watershed. Two major lakes are Watermelon Pond in Alachua County and Chunky Pond south of Bronson. Other smaller ponds are present in the Waccasassa Flats area of Gilchrist County that include herbaceous marsh vegetation.

The Suwannee alligator snapping turtle (*Macrochelys suwanniensis*) occurs in rivers, lakes, swamps, and sometimes in brackish lagoons. The federally threatened frosted flatwoods salamander is an upland species except during spawning, when it uses ephemeral ponds associated with flatwoods.

2.3.3 Marine/ Estuarine Habitats

Marine and estuarine habitats follow the entire coastline in the Coastal Rivers Basin (Figure 23) and include primarily tidal marshes, tidal flats, coastal scrub, and oyster reefs. Marine and estuarine systems are influenced most strongly by salinity and tidal inundation from the sea and occur landward or upstream until soil or water salinities are less than 0.5 ppt (and are therefore considered freshwater systems). Marine and estuarine systems are described based on substrate, fauna, or vegetation, depending on the dominant features. The dominant wetland systems along the Big Bend coast are estuarine marshes, followed by tidal swamps farther upstream within the influence of tide, and then floodplain swamps. Freshwater flows are critical to the maintenance of these freshwater systems.

Potential loss or degradation of marine and estuarine habitats are of particular importance to the federally endangered Hawksbill, Kemp's Ridley, and leatherback sea turtles (*Dermochelys coriacea)*, and federally threatened green and loggerhead sea turtles (*Chelonia mydas* and *Caretta caretta,* respectively), which spend their lives in open water and in seagrasses and coral reefs in the Gulf. Seagrass beds also provide important habitat for the federally endangered Florida manatee. The most common physical destruction to seagrasses is damage and loss due to boat propellers and vessel groundings on shallow seagrass beds (FNAI 2010).

Estuarine and marine tidal marshes in the Coastal River Basin are also important to two plant species designated as endangered by the State of Florida, Godfrey's spiderlily *(Hymenocallis godfreyi*) and beaked spike rush (*Eleocharis rostellata*), and one as threatened, corkwood (*Leitneria floridana*) (Appendix G).

2.3.3.1 Tidal wetlands

Tidal wetlands in the Coastal Rivers Basin include primarily coastal forests and marshes. Coastal swamps occur at the most downstream freshwater influence along the coast, but tidal swamps are not as developed here as they are along the Suwannee River, where freshwater flows are much larger and support an extensive floodplain.

Coastal Forests

As the influence of salt water increases downstream, hydric hammocks dominate the shoreline, with red cedar and cabbage palm becoming more dominant in the canopy of this community type and cypress no longer appearing. These tidal swamps provide important nesting habitat for swallow-tailed kites (*Elanoides forficatus)* in the region (Sykes et al. 1999). Coastal hydric hammock can be found on scattered islands within the tidal marsh, and on a low chain of discrete, slightly elevated islands along an ecotone that separates the high salt marsh from interior plant communities and is tolerant of Gulf waters. Coastal islands are scattered throughout the marsh, consisting of cabbage palm, red cedar, and Christmas berry (*Lycium carolinianum*) which is the more heavily marine-influenced hammock portion of the islands. The center of an island may consist of wet mesic flatwoods (slash pine, saw palmetto) or an oak-dominated xeric hammock community.

Salt and Estuarine Marshes

As the influence of salinity is diminished along rivers by freshwater flows from upstream, saltmarsh cordgrass (*Spartina alterniflora)* and black needle rush (*Juncus roemerianus)* along the coast are replaced by sawgrass dominated marshes that are exposed to higher salinities of up to 12-15 ppt during extreme droughts (Clewell, 2000). These result in loss of freshwater plant taxa in oligohaline marshes intolerant of these salinities, but species such as sawgrass, three-square bulrush (*Scirpus americanus)*, and lizard tail (*Saururus cernuus)* persist (Clewell, 2000). Freshwater tidal marsh plant species include pickerelweed, softstem bulrush (*Scirpus validus),* cattails *(Typha* spp.), false nettle (*Boehmeria cylindrica)*, and other plants common in the estuary marshes in salinities ranging over 3-7 ppt.

Slightly salt-tolerant herbaceous plants such as sawgrass and bulrush (*Scirpus spp.)* appear as the conditions shift from freshwater tidal to estuarine. Near the river mouth, salt marsh becomes the dominant vegetation community type, with black needle rush, and salt-meadow cordgrass (*Spartina patens*) and the marshes dissected by numerous tidal creek branches and drainages from interior freshwater seepage areas (FDEP 2006).

Along the Big Bend, low energy salt marshes, affected by tides and seawater and protected from large waves, either by the broad, gently sloping topography of the shore, by a barrier island, or by location along a bay or estuary, represents the greatest salt marsh acreage in Florida. Salt marshes are a conspicuous feature along the coastal portions the Coastal River Basin and are vegetated by saltmarsh cordgrass, needlerush, and salt-meadow cordgrass. These wetland resources provide fish and wildlife habitat and nursery areas for economically important species (commercial and recreational fisheries and game species). For example, the estuarine tidal marsh at the mouth of the Econfina River is similar to much of the fringing marshes from Wakulla County southward through Pasco County. Common plant species in this area include black needle rush, saltgrass (*Distichlis spicata*), and cordgrass, marsh elder (*Iva spp.)* (FDEP 2006).

Salt marshes are some of the most biologically productive natural communities (FNAI 2010). The base of the food chain is supported by vegetation as well as algae and detritus plants, on the sediment surface, and suspended in the water column of tidal creeks. Commercial marine species that spend all or part of their life cycle in tidal creeks include mullet (*Mugil spp*.), spot (*Leiostomus xanthurus*), blue crabs (*Callinectes sapindus*), oysters, and shrimp (*Penaeus spp*.). The smaller minnows and juvenile fish in tidal creeks provide food for many recreationally important predatory fish, such as tarpon (*Megalops atlanticus*), snook (*Centropomus undecimalis*), red drum (*Sciaenops ocellatus*), and spotted seatrout (*Cynoscion nebulosus*) (Montague and Wiegert 1990). In addition, the federally endangered Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*) is known to use a specific type of saltgrass as habitat, indicating even greater importance of this particular salt marsh. Potential impacts of SLR on salt marshes have also been investigated.

The abundance of fiddler and shore crabs in these swamps offer forage habitat for crab-feeding birds, such as yellow-crowned night heron and little blue heron, and mammals such as raccoons and the federally endangered salt marsh vole.

Many wading birds occur in estuarine marshes, such as the state threatened Marian's marsh wren (*Cistothorus palustris marianae*) and Scott's seaside sparrow (*Ammodramus maritimus peninsulae*). Others prefer coastal wetlands but also occur in freshwater forests and marshes, such as the state threatened little blue heron. Birds such as the federally threatened piping plover (*Charadrius melodus*) and state threatened American oystercatcher (*Haematopus palliatus*) prefer coastal sands or unconsolidated substrates along shorelines.

2.3.3.2 Hard and Soft Bottom Habitats

Hard and soft bottom habitats are marine systems that may be vegetated, e.g., seagrasses, or occupied by organisms such as oysters, scallops, and clams. Along the coast of the Big Bend, these areas support oyster reefs, seagrasses and scallops, and farmed clams.

Oyster Reefs

Oyster reefs are an important part of the hard bottom habitat along the Big Bend coast, while clams occur in the soft bottom habitats. Oyster habitats, dominated by eastern oysters (*Crassostrea virginica*) which occur patchily along the Big Bend coast, are the main structural habitat feature in Suwannee Sound and have both ecological value as habitat and economic value as a commercially harvested resource (Mattson 2002). Oyster reefs are an important part of the hard bottom habitat along the Big Bend coast, while clams occur in the soft bottom habitats (described previously under aquaculture). In contrast, scallops occur in seagrass beds along the coast. Restoration efforts focused on shellfish and their habitat have increased on the Gulf coast of Florida due to the loss of these resources from overharvesting, habitat loss or degradation, and competition and disease (Gaffney 2006, Leverone 2010). Leverone (2010) also attribute this increased effort to better understanding of the role of shellfish in the ecology and economy of coastal habitats (Shumway et al. 2003). Ecological benefits from successful shellfish restoration include improved water clarity resulting from the removal of phytoplankton and suspended particles by shellfish; restoration of keystone species; the creation of habitat for other species; and, in the case of reef-building species, shoreline protection through wave dampening. The economic benefits to coastal communities that depend upon the harvest, culture, and processing of shellfish seafood products are numerous (Shumway et al. 2003, Leverone 2010).

Oyster reefs are present along the entire Big Bend coast and are associated with the rivers in the Coastal Rivers Basin, although the reefs have a different form in the Waccasassa Estuary. The oysters themselves are a harvestable and sustainable economic resource. In addition to their economic importance, oyster habitat is also important to estuarine invertebrates and fishes (Bahr and Lanier 1981, after District 2006). In addition to a food source, the benefits of oysters include greater catches of fish and other organisms that use oyster reefs for food and habitat, buffer from coastal erosion and flooding and water quality improvements due to nutrient removal by oysters (Kroeger 2012). However, the historic distribution of oyster reefs throughout the U.S. has been reduced by an estimated 85 percent, more than any other marine habitat (Kroeger 2012).

The primary causes for the decline in oyster reefs are overharvesting and destructive harvesting practices (dredging, trawling), disease (often associated with non-native oysters used in aquaculture), alteration of shorelines, changes in salinity as a result of alterations of freshwater inflows, and increased loadings of sedimentation, nutrients and toxins (National Research Council 2010). Consequently, water management actions that reduce these impacts would benefit oysters, oyster habitat, and associated ecological and economic benefits.

Oyster reefs are present along the entire Big Bend coast and are associated with the rivers in the Coastal Rivers Basin, although the reefs have a different form in the Waccasassa Estuary. The oysters themselves are a harvestable and sustainable economic resource. In addition to their economic importance, oyster habitat is also important to estuarine invertebrates and fishes (Bahr and Lanier 1981, after District 2006). Reef structures formed by oysters are complex and provide refuge for hundreds of other species, including the juvenile stages of several fishes.

The bulk of eastern oyster harvesting in Florida occurs on the Gulf coast, primarily in the Panhandle and Big Bend regions. The Suwannee River estuary and Suwannee Sound are the only commercial oyster harvest areas in Florida other than Apalachicola Bay. Along the Florida Gulf coast, spat settlement occurs throughout the spring and summer (Patillo et al. 1997) and freshwater flows that maintain salinities of approximately 22 ppt in Suwannee Sound (where most of the oyster coverage is found) during this time and maximum salinities in the Sound of approximately 35 ppt during low flow seasons have been recommended (Livingston 2000).

Most of Florida's production of eastern oysters occurs on the Gulf coast (97 percent of the landings by weight), primarily in counties in the Florida Panhandle and Big Bend regions. Only about 3.4 percent of commercial oyster harvest was landed on the Atlantic coast during 2013 and Gulf landings averaged about 5 million pounds during 1982–1985. Since then, landings have declined by more than 60 percent, reaching 1.4 million pounds in 1996 and increasing to about 2.6 million pounds in 2001 before declining again to 1.4 million pounds in 2005. Landings increased substantially to nearly 3 million pounds in 2007 and recently declined to 1.3 million pounds in 2013.

Trends in oyster habitat along Florida's Big Bend coastline (Gulf of Mexico coast from Crystal River to Apalachee Bay) were assessed by Seavey et al. (2011) for the period between 1982 and 2011 and indicated a 66 percent net loss of oyster reef area (124.05 ha) in the region. Losses were more concentrated offshore (88 percent) than nearshore (61 percent) and inshore (50 percent) reefs and the oyster reefs were found to be moving landward. The investigators suggest, based on multiple lines of evidence, that the losses are due primarily to reduced survival and recruitment, likely a result of reduced freshwater inputs that increase reef vulnerability to wave action and sea level rise, although "it seems most likely that increasing human uses of freshwater inland may be an important factor resulting in habitat loss". The authors conclude by recommending additional monitoring to further evaluate trends in oyster habitat along the Big Bend. Consistent with these recommendations, the Gulf States Marine Fisheries Commission regional management plan for the eastern oyster fishery and oyster production in Florida (FWC 2014) includes: increased cultch planting; restoration of freshwater flows; encouragement of aquaculture and replanting; size, gear, season, and area restrictions; limited access; and quota and bag limits (Berrigan et al. 1991).

Clams

The northern quahog hard clam burrows shallowly in sediments of either mud or sand. It is among the most commercially important species of invertebrates along the Big Bend coast. On the Gulf of Mexico side though, only Sunray Venus (*Macrocallista nimbosa)* clams are native, and not in abundance. Their population was nearly extinguished in the early 1900s by over-collecting. However, the hard clam is grown for commercial purposes, primarily in the Cedar Key area.

The commercial hard clam industry in Florida includes more than 300 shellfish growers on submerged land leases totaling over 2,100 acres (Adams and Sturmer 2012). While not a reef species, two species of hard clam are found in sandy or muddy bottoms throughout Florida: the northern quahog and the southern quahog (*Mercenaria campechiensis*). Historically, clams served as a food source and currency for Native Americans (Thom et al. 2015) and approximately 71 percent of the landings of wild harvested clams were made on the Gulf coast, primarily in the Cedar Key area of Levy County, and there are no known recreational or subsistence landings of hard clams in Florida.

Following the commercial net ban in 1994, the UF/IFAS and Sea Grant program began working with local investors to develop a clam aquaculture industry using northern quahog clams transplanted from the Florida east coast. With improved local water quality conditions, the shallow, well-flushed, muddy bottomed waters around Cedar Key proved to be ideal habitat for clams. UF/IFAS reports that today, the clam aquaculture industry in the State of Florida generates an annual economic impact of about $53 million (includes growers, hatcheries, boat builders, harvesting, processing, and other activities and employment), which far exceeds that of other shell-fishing industries in Florida. Due to the Cedar Key success UF/IFAS/Sea Grant is now exploring the feasibility of farming the Venus Sunray clam, a species native the Florida Gulf coast, as well as oyster aquaculture.

The responsibilities for monitoring hard clam aquaculture now reside with FDACS, and reporting to the FWC on trip tickets of aquacultured clams is voluntary. In 2000, aquaculture operations produced 538,000 pounds of clams. Gulf coast landings (wild harvest) of hard clams were historically low and the wild harvest dropped to essentially zero from 2000-2009. Commercial catch rates for wild-caught hard clams on the Gulf coast, (FWC 2014) were “essentially non-existent from 2004-2008,” although more recently, there has been a small increasing trend.

Scallops

Bay scallops (*Argopecten irradians*) are found in seagrass beds that support numerous other organisms, as described above and are impacted by stormwater runoff and river discharges. Scallops support a major recreational fishery along the Big Bend; however, the economic value of this recreational fishery has not been calculated. Maintaining good water quality and seagrass beds are important to scallops and recreational scalloping. Due to their sensitivity to pollution, bay scallops are considered to be excellent biological indicators of ambient water quality conditions.

Bay scallops and are easily distinguished from other bottom-dwelling animals by their numerous blue eyes along the edge of their shells (Figure 24). They “swim” by opening and closing their shells rapidly to generate thrust, which allows them to move under changing conditions.

Figure 24. Photo of scallop in (left) grass bed and (right) showing numerous blue eyes (photos by Florida Sea Grant)

Historically, bay scallop abundances in Florida were better than one scallop per square meter, and capable of supporting a commercial fishery. The number of scallops declined so much by the early 1990s that all commercial harvesting was banned after 1994 and recreational harvesting was limited to coastal areas north and west of the Suwannee River between July 1st and September 10th (FWC 2016). Following the implementation of restoration programs by FWC, the Florida Marine Research Institute, and the University of South Florida, scallop populations increased in some areas, and in 2002 the coastal area between the Suwannee River and the Weeki Wachee River was reopened for recreational harvesting between July 1st and September 10th (FWC 2016). In the last 20 years, however, the greatest average density observed at a study site in a given year was 0.50 scallop per square meter. FWC (2016) reports that in most years, populations within the open harvest areas have been stable or vulnerable, with only occasional collapses, typically attributed to major environmental events such as an El Niño (1998), hurricanes (2004), or tropical storms (2010).

Although closely related to bay scallops, calico scallops (*Argopecten gibbus*) live in deeper, offshore waters along the east and west coasts of Florida. Calico scallops are found on sandy or shelly bottoms. No formal stock assessment of the Florida's calico scallop stocks is available at the present time. Since 1989, the statewide landings have ranged from zero to about 7.0 million pounds. Calico scallops are infrequently landed along the Gulf coast of Florida except in "boom" years, e.g., 1994, 1998, 1999.

2.3.3.3 Seagrass Beds

Along the Big Bend coast of Florida (from Anclote Key north to Apalachee Bay), seagrass coverage is extensive (3,000 km^2 or 1,158 mi^2, see Zieman and Zieman 1989, Mattson, 2000). In fact, seagrass beds are often the dominant structural feature in the shallow, subtidal estuaries and nearshore, coastal waters in the region (Mattson et al. 2002). As such, seagrasses provide essential refuge and forage habitats for a myriad of ecologically and economically important fauna. Approximately 85 percent of the recreational and commercial fishery species in Florida spend some portion of their life in estuaries (Comp and Seaman 1985), and many of these species are considered obligate seagrass inhabitants. Blue crabs and bay scallops, for example, are largely dependent on seagrass resources (Orth and van Montfrans 1987, 1990). The Big Bend region accounts for between 25 and 33 percent of the total commercial blue crab fishery landings in Florida and supports the largest recreational scallop fishery in the State. Seagrass beds are considered essential to the ecological integrity and health of Florida's estuarine and nearshore coastal ecosystems.

Over half of the entire Big Bend region is part of the Big Bend Seagrasses Aquatic Preserve, managed by FDEP. The Coastal Rivers Basin includes portions of the Lower Suwannee National Wildlife Refuge (NWR) and the Cedar Keys NWR, Econfina River State Park, Cedar Key Scrub State Reserve, and Waccasassa Bay State Preserve. Extensive areas of the fringing intertidal marshes bordering the Big Bend coastal waters have been acquired by the State of Florida and are State WMAs (e.g., Hickory Mound, Jena, Snipe Island, Spring Creek, and Tide Swamp). The immense seagrass ecosystem that forms a part of these conservation areas is one of the key components of their natural value. The lower and nearshore estuary and coast is a mix of salt marsh, tidal creeks, and mudflats. Seagrasses are less abundant where highly colored surface water discharges into the estuary and limits light penetration (Bledsoe 1998), for example, at the mouth of the Fenholloway River and Suwannee Rivers.

Figure 25 and 26 show 2006 seagrass distributions in the northern and southern Big Bend region, respectively, while Figure 27 shows 2001 seagrass distribution in Suwannee Sound, Cedar Keys, and Waccasassa Bay (after Yarbro and Carlson 2011). While the northern Big Bend and the Springs Coast showed stable seagrass cover and species composition, seagrass cover in the southern Big Bend region declined between 2001 and 2006, and historical change analyses indicate that losses occurred over the past 25 years as well. In 2006, seagrasses covered 56,146 acres, mostly as continuous beds (44,109 acres) (Carlson et al. 2010). Between 2001 and 2006, the southern Big Bend experienced a net loss of about 3,500 acres (6 percent) of seagrass, which reflects the deterioration of 7,100 acres of continuous beds into 3,600 acres of patchy beds. Seagrass density in beds has also declined sharply in the past 10 years throughout the region, and the occurrence of shoal grass dropped sharply over the same period (Carlson et al. 2010).

Figure 25. Seagrass cover along the Northern Big Bend (after Yarbro and Carlson 2011)

Figure 26. Seagrass cover along the Southern Big Bend (after Yarbro and Carlson 2011)

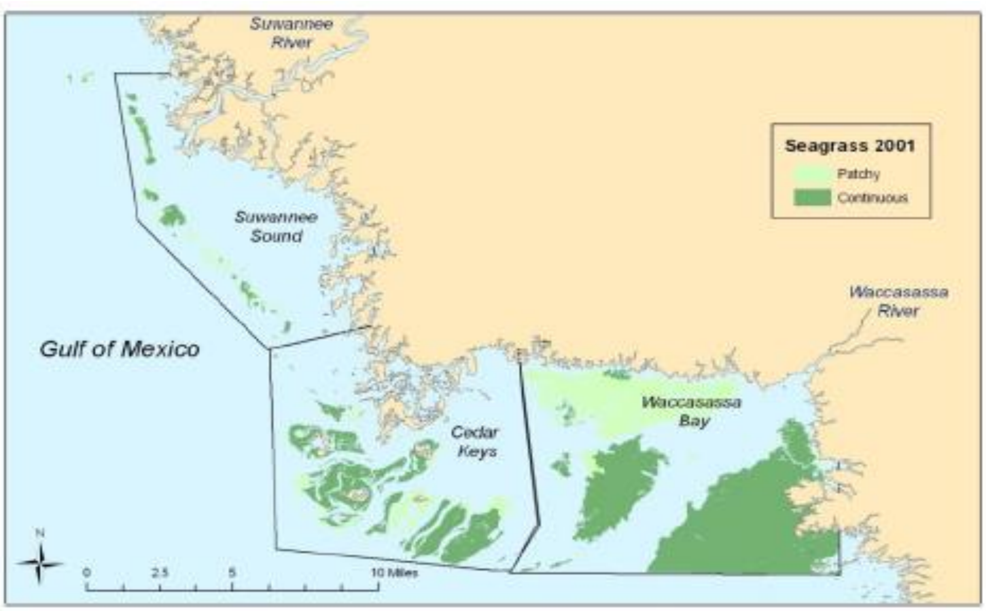


Figure 27. Seagrass cover in the Suwannee Sound, Cedar Key, and Waccasassa Bay in 2001 (after Yarbro and Carlson 2015)

Stressors include reduced optical water quality, which has resulted from elevated phytoplankton concentrations and increased water color in the region, as well as variable salinity over seagrass beds due to heavy rainfall events each year since 2012. Tropical storms Debby and Andrea in early summers of 2012 and 2013, respectively, and heavy rains in July 2013 caused local rivers to discharge large volumes of darkly colored, nutrient-rich waters, reducing water clarity and dramatically increasing phytoplankton levels in the coastal region during the remainder of the growing season.

Downstream limits of SAV species correspond to patterns of mean salinity and salinity variability, while upstream limits are based on the availability of shallow substrata suitable for SAV and the greater influence of freshwater. Distributions of estuarine SAV in rivers in the Coastal Rivers Basin are expected to be similar to those found for the Suwannee River, except that freshwater flows in these rivers are much lower than in the Suwannee River and habitats could be affected more quickly or more extremely given the lower freshwater flows. The most abundant SAV are tape grass, spring tape grass, and Eurasian water milfoil (*Myriophyllum spicatum)*. Estevez 2002 concluded that permanently reduced flows in the coastal rivers could cause an upstream retreat and overall reduction of SAV beds, similar to that described for the Suwannee River. Reduced flows in the Coastal Rivers could potentially have a similar effect. Aquatic habitats with salinities of <10 ppt may be critical for recruitment of many fish taxa (District 2015) and low-salinity creeks (< 5 ppt) are important nursery habitat for commercial and recreational fishery species (Rozas and Hackney 1984). The 5 ppt oligohaline zone is considered a high degree of sensitivity to habitat alterations.

2.3.3.4 Freshwater SAV

Monitoring SAV condition can also help identify trends in water quality and flows. MFLs in the Ichetucknee River require water levels of sufficient depth to protect the SAV and riverine ecosystem as well as recreation. Recreational activity has probably been the most important factor affecting the health of the Ichetucknee River and associated SAV beds from the 1970s to present (PBS&J 2004, District 2005). Physical disturbance of SAV beds in spring runs caused by heavy public use can result in the erosion and destruction of native species. Combined with increased nutrient concentrations, physical disturbances can create conditions for the proliferation of undesirable rooted aquatics (e.g., Hydrilla) as well as filamentous algae mats composed of invasive species, primarily *Lyngbya spp*.

2.3.4 Listed Species

Listed species are one of the natural resource components addressed by the District's SWIM Plan and come under review by the FWC per Section 373.453(3), F.S. and the USFWS The ISMP presents an approach for the conservation of state-listed species that outlines the threats and conservation approaches for 57 animal species in Florida that are state listed species and have not undergone a Biological Status Review in a decade (61 species), sans four species that have a draft plan or became federally listed. The ISMP includes SAPs that outline the management actions necessary to minimize the impacts of known threats, improve habitat conditions, and streamline efforts to conserve and recover imperiled species in the state. Therefore, the ISMP can be referenced for identified threats and proposed conservation actions for species and their habitats.

Federally and state listed species and their corresponding habitats are detailed in Appendix G and numbers of state and federally listed species in the Coastal Rivers Basin are summarized in Table 3. Numerous listed species occur in the District and may be affected by activities that alter the amount or quality of water available to them and their habitats. For example, the frosted flatwoods salamander is federally threatened due to loss of seasonally wet ponds (uninhabited by predatory fish) required for breeding and egg laying. Other federally listed species include the West Indian manatee, hawksbill sea turtle, wood stork, and the striped newt (*Notophthalmus perstriatus)*. Threats to species include habitat loss and fragmentation caused by conversion of habitat to development, agriculture, silviculture, and associated fire suppression (FWC 2016, Dixon et al. 2006, Hoctor et al. 2000). Over-use or recreational use of a site, disturbance by anthropogenic activities and/or invasive species, and inadequate management can also have adverse effects on listed species.

Table 3. Numerical summary of species listed as federally endangered (FE), federally threatened (FT), federally threatened due to similarity of appearance (FT/(S/A)), state threatened (ST), or species of special concern (SSC) in the Coastal Rivers Basin

Status Designation	Fish	Amphibians	Reptiles	Birds	Mammals	Invertebrates	Total
FE	0	0	3	1	1	0	5
FT	1	1	3	3	1	0	9
FT (S/A)	0	0	1	0	0	0	1
FXN	0	0	0	0	0	0	0
ST	0	0	4	10	0	0	14
SSC	0	0	2	0	1	0	3
Total	1	1	13	14	3	0	32

Two federally threatened plant species are listed in the Coastal River Basin: Godfrey's butterwort (*Pinguicula ionantha*) and Florida skullcap (*Scutellaria floridana*), which occur in wet flatwoods and prairies and seepage slopes in the Basin. An additional 61 plant species are designated as threatened or endangered by the Florida's Division of Plant Industry, FDACS, which regulates endangered, threatened and commercially exploited plants of Florida.

2.3.5 Threats to Natural Systems

The natural systems of the Coastal Rivers Basin comprise valuable ecological, aesthetic, recreational, cultural, and economic resources. Primary sources of threats to natural systems include (Thom et al. 2015, Katz and Raabe 2005):

- Land use changes (and corresponding habitat loss and fragmentation);

- Declines in water quantity and quality;
- Introduction of non-native and invasive species; and
- Climate change.

For example, conversion from upland silviculture to higher intensity row crops results in loss of forested habitat and connectivity among habitats important to numerous species. Due to the extensive coverage of forested uplands and wetlands in the Coastal Rivers Basin, habitat fragmentation is relatively minimal compared to other areas in Florida; however, fragmentation is increasing and has become an issue for larger megafauna (e.g., Florida black bear (*Ursus americanus floridanus)*).

Other examples include: disturbance and loss of native SAV in springs due to excessive recreational use and/or algae proliferation due to increased nutrient concentrations; loss of fish habitat due to reduced flows and exposure of formerly inundated floodplains; loss of marsh habitat due to lowered groundwater levels as a result of water withdrawals; disturbance of habitat by invasive species such as wild hogs and subsequent invasion of nonnative and invasive plant species; and loss of salt marsh habitat due to sea level rise and inundation. Climate change and sea level rise in particular are expected to impact Florida's fish and wildlife across all terrestrial, freshwater, and marine habitats; and combined with other stressors, reduce the long term viability of species and associated ecosystems.

Equally important is proper management and maintenance of habitats that historically were fire maintained, such as sand pine scrub, sandhills, prairies, and wetlands. Prescribed fire is used to reduce shrub layer vegetation, initiate seeding in some species, and improve and maintain habitats for deer, quail, turkey and many other wildlife species. Some of Florida's rare, fire-adapted plants and animals that inhabit fire maintained communities include the red-cockaded woodpecker, Sherman's fox squirrel, gopher tortoise, eastern indigo snake, and Florida scrub-jay.

Finally, continued monitoring, data collection, and research to track native habitats and species and improve our understanding of how they may be impacted by land use changes, water quantity and quality, non-native and invasive species, and climate change, are important to managing natural systems in the Coastal Rivers Basin.

2.3.5.1 Land Use Changes

Land uses and land use changes in the Coastal Rivers Basin are described in detail in Section 1.3.5 above. Urban land development has increased slightly, mostly as growth around existing urbanized areas, but still only constitutes a little over three percent of the Basin land area. Due to the extensive coverage of forested uplands and wetlands in the Coastal Rivers Basin, habitat fragmentation is relatively minimal. In addition, the rivers and streams in the Basin are not dammed. Therefore, conservation and management of existing natural systems, including the maintenance of flows and water quality, offer the best means by which to prevent further habitat loss, fragmentation, and/or degradation in the Basin.

Development associated with population growth can alter, fragment, and eliminate habitat and pose direct and indirect threats to individual species and local populations (FWC 2016). The FWC ISMP presents an approach for the conservation of state-listed species that outlines the threats and conservation approaches for 57 animal species in Florida that are state listed species and have not undergone a Biological Status Review in a decade (61 species), sans four species that have a draft plan or became federally listed. Improving habitat connectivity and reducing fragmentation of habitats used by listed and/or imperiled species, especially during critical times (e.g., breeding seasons), is essential to supporting imperiled species populations.

The ISMP identifies habitat loss, degradation, disturbance, and conversion of natural habitat to typically urban, silviculture, or agriculture lands as threats to several listed species, including the state threatened short–tailed snake, Florida pine snake, southeastern American kestrel, American oystercatcher, black skimmer (*Rynchops niger)*, and Sherman's fox squirrel. Species associated with shoreline habitats (e.g., the American oystercatcher) are also susceptible to recreation impacts that can disturb foraging and nesting behavior and result in habitat degradation or loss.

Fragmentation is an issue for many species, especially large mammals, and reductions in fragmentation via greater connectivity and corridors have been proposed (Hoctor et al. 2000, Dixon et al. 2006). Many imperiled species depend on intact coastal, riparian, and streamside habitat to facilitate travel between, and use of, essential feeding and breeding behaviors, therefore restoring habitat connectivity is anticipated to increase resilience to sea-level rise, changes in precipitation, and increasing storm activity (FWC 2016).

Many state listed species in the Coastal Rivers Basin are threatened due to fragmentation that may result from disturbance, habitat loss, fire suppression, dredging and filling, road construction and/or and other anthropogenic activities. For example, while the Florida black bear historically occurred throughout Florida and the southern portions of Georgia, Alabama, and Mississippi, its distribution and abundance were significantly reduced from the 1850s to the 1970s as a result of habitat loss, fragmentation, and overhunting (Dixon et al. 2006). The Florida black bear is presently limited to several fragmented populations due to residential and commercial development throughout the available habitat (Dixon et al. 2006, Maehr et al. 2001). Other species threatened by fragmentation include the state threatened Florida sandhill crane, Marian's marsh wren, Scott's seaside sparrow (often due to dredge and fill activities in wetlands), and the southeastern American kestrel and Florida pine snake, that rely on habitat often converted to agriculture or development. Sherman's fox squirrel (SSC) and the Florida mouse (*Podomys floridana* (imperiled but not listed)) are also threatened by habitat fragmentation due to these same activities.

Conversion of many existing low-intensity agricultural lands to more intensive row crops represents a threat to many of Florida's terrestrial, wetland, and freshwater habitats (FWC 2012) due to direct loss of habitat, as well as water quality and quantity issues associated with irrigation. Conversions include both new conversion of natural habitat to agricultural uses and conversion of existing low-intensity agricultural lands with embedded natural habitat to more intensive agricultural operations. Associated pressures include incompatible agricultural practices, grazing and ranching, and forestry practices; nutrient loads (agriculture, surface water diversion and withdrawal, and management of nature); and addition of water control structures.

2.3.5.2 Declines in Water Quantity and Quality

More so than other areas in Florida, the natural systems in the District are closely linked to the hydrogeology of the region, which is characterized by thick porous carbonate deposits, rapid groundwater movement, high groundwater recharge from surface water, artesian groundwater flows to surface waters, and water chemistry affected by the dissolution of the carbonate deposits. Increased groundwater and surface-water withdrawals can reduce water levels in wetlands and lakes, and reduce spring flows and stream discharges. In addition, fertilizers and other agricultural chemicals can leach rapidly into the porous aquifer and degrade both ground and surface water quality (Tihansky and Knochenmus 2001). Changes in water flows, levels, and quality can in turn substantially impact the ecological integrity of natural systems. Declines in freshwater flows alter salinity regimes in coastal areas, affecting oyster reefs and associated species, such as the state threatened American oystercatcher. Withdrawals for agricultural are greatest during low flows and reduced flows can also alter fish access to floodplains where they forage, or alter fluctuation and salinity patterns that would normally serve as biological cues to fish and wildlife.

The effects of water withdrawals for public water supply can also affect habitat by reducing groundwater levels and resulting in potential threats to habitat of listed species such as the Florida sandhill crane, wading birds (e.g., little blue heron, reddish egret, snowy egret, tricolored heron), Florida gopher frog (*Lithobates capito*), and osprey (*Pandion haliaetus*) (FWC 2016). Flow diversions and withdrawals, altered water level fluctuations, and changes in salinity can all alter habitat for water-dependent species. Identifying and conserving resources such as these and increasing the amount of suitable habitat by restoring hydrology and managing species' habitats provide a means of reducing the threat to endangered and threatened species.

Increased nutrient inputs due to increased runoff from, for example, row crops and urbanized areas, can degrade water quality and affect freshwater and estuarine habitats directly. Increased turbidity associated with runoff from agricultural fields can reduce water clarity and light availability, thereby reducing SAV production. Increased nutrients can also result in phytoplankton blooms that reduce the amount of light available to SAV and may outcompete native algae. For example, reduced optical water quality due to elevated phytoplankton concentrations and increased water color, combined with reduced salinities, have affected seagrass beds following heavy rainfall events since 2012. Tropical storms Debby and Andrea in early summers of 2012 and 2013, respectively, and heavy rains in July 2013 caused local rivers to discharge large volumes of darkly colored, nutrient-rich waters, reducing water clarity and dramatically increasing phytoplankton levels in the coastal region during the remainder of the growing season (Yarbro and Carlson 2016). Local runoff from ditching and draining activities may have similar effects.

2.3.5.3 Introduction of Non-Native and Invasive Species

Florida's state wildlife action plans and ISMP are comprehensive, statewide plans for conserving the state's wildlife and vital natural areas for future generations. The plans identify critical native wildlife and habitats, threats to these species and habitats, and current and future actions to reduce and mitigate threats (FWC 2012, 2016). The introduction of non-native and invasive species is identified as a serious threat to both native habitats and the species that are dependent upon them.

Many introduced species in Florida never become established and have few, if any, negative effects. However, those species that become established and spread, may have both ecological and economic impacts and costs. These species can change community structure and composition, alter hydrological and fire regimes, alter soil sedimentation and erosion processes, and impose direct threats to wildlife through competition, predation and pathogen movement. The influence of nonnative species on Florida's indigenous plant and animal species is undisputed; entire ecosystems are changing and native species are under increasing pressures. In their review of 329 marine invasive species, Molnar et al. (2008) concluded the most common pathway for marine species was shipping (ballast and/or fouling; 228 species, 57 percent of which are harmful), and the second is the aquaculture industry (134 species, 64 percent of which are harmful). Ornamental landscaping and tropical fish trades also result in the escape or release of non-native species into the wild.

Actions that alter the hydrology and/or water quality of native habitats also provide the opportunity for invasive species to become established. For example, hydrilla was introduced into Florida from Sri Lanka in the early 1950s through the aquarium trade. It is a submersed aquatic freshwater plant which grows from shallow waters to water depths of over 20 feet. It is widely distributed in warm areas of the world, spread rapidly throughout Florida in the 1970s and 1980s and is particularly problematic in shallow and nutrient rich lakes, but is a persistent nuisance in flowing waters as well. Since its introduction, hundreds of millions of dollars have been spent controlling hydrilla throughout Florida. Impacts from terrestrial invasive plants and animals can also threaten the integrity of the riverine corridors.

Another example of invasive species in the Coastal River Basin include the lionfish (*Pterois volitans)*, which has a presence along the Gulf of Mexico as far as Apalachicola as of 2010, and continues to be a problem. Other species, such as blue tilapia (*Oreochromis aureus)* and the Mediterranean gecko (*Hemidactylus turcicus*) are not documented as a threat to native wildlife. However, species such as Muscovy duck (*Cairina moschata*) that may transmit disease to and interbreed with Florida's native waterfowl, and wild hogs (*Sus scrofa*) that occur in all of Florida's 67 counties, occur in nearly habitats, root and disturb the soil and ground cover vegetation and leave the area looking like it has been plowed.

Domestic pets that are not controlled pose threats to species such as the Florida pine snake, and fire ants and pets threaten the short-tailed snake (FWC 2016). Feral cats pose the greatest threat to species such as the Florida mouse and also contribute to the status of the state threatened Homosassa shrew (*Sorex longirosris eionis*). Keeping pets indoors and on leashes can substantially reduce these kinds of threats to small animals.

2.3.5.4 Climate Change

Climate change is considered the third greatest threat to native habitats in Florida (FDEP 2011) and one of the primary issues and drivers affecting natural systems along the Gulf Coast (Thom et al. 2015, Katz and Raabe 2005). Climatic changes are expected to impact Florida's fish and wildlife across all terrestrial, freshwater, and marine habitats; and combined with other stressors, reduce the long term viability of species and associated ecosystems (FWC 2016b). FWC has developed an adaptation guide to help the development of adaptation strategies to address the anticipated effects of climate change on species and habitats (FWC 2016b). For example, model predictions indicate many coastal species, such as Scott's seaside sparrow and Marian's marsh wren are expected to lose more than 98 percent of their existing habitat with sea level rise of one to three meters (FWC 2016b).

Natural systems along the coast, e.g., marshes and forested wetlands, provide a means of buffering and delaying the impacts of sea level rise on urban areas. Sea level rise due to climate change is changing natural coastal ecosystems in Florida and presents "challenges to those responsible for maintaining drainage systems, recreational beaches, coastal highways, and emergency preparations", as the state's coastal ecosystems and infrastructure are affected (Florida Oceans and Coastal Council 2010).

Wetlands of the Big Bend provide examples of retreating coastal forests and freshwater swamps that may be replaced by salt-marsh vegetation or open water (Williams et al. 1999, Raabe et al. 2004, DeSantis et al. 2007, after Florida Oceans and Coastal Council 2010). In addition, a decrease in annual freeze events associated with regional warming over the past two decades have extended the range of mangroves (primary the black mangrove, *Avicennia germanens*) on the Florida Gulf coast northward, well into the Big Bend region. This range expansion can be seen in the replacement of salt marshes by mangroves as far north as Cedar Key.

Climate change stressors can include, but are not limited to, changes in distribution, volume and timing of rainfall (increase in northern Florida and increase or decrease in the south), increase in temperatures, and sea-level rise (FWC 2016). Salt marsh species that may be affected by loss of habitat due to sea level rise associated with climate change include Marian's marsh wren, Scott's seaside sparrow, and Florida salt marsh vole.

3.0 Management Actions

As discussed in Section 1.2.3. the economic vitality of the Coastal Rivers Basin is closely tied to the health of its natural resources. And while the rivers and coastal waters along Florida's Big Bend coastline are often viewed as being in a close to pristine condition, the analysis of status and trends presented herein indicate that there are natural resource management issues that need to be addressed. The primary issues potentially affecting the surface waters and ecology of the Coastal Rivers Basin, both now and in the future, include:

- Increase in silviculture and more intense agricultural and urban land uses;
- Alterations to natural hydrology;
- Decreasing river and spring flows in some locations;
- Increasing nitrogen concentrations in river and springs flows in some locations;
- Habitat fragmentation due to land development and road construction;
- Loss of natural oyster bars; and
- Climate change and sea level rise.

Proposed management actions designed to address concerns within the Coastal Rivers Basin are discussed in terms of water quantity, water quality and natural systems. Actions intended to address issues related to spring discharge and/or stream flows are summarized in Section 3.1, which focuses on water quantity. Section 3.2 focuses on actions intended to address issues related to water quality within the Basin. Section 3.3 focuses on activities intended to address issues related to the natural systems of the Coastal Rivers Basin.

3.1 Water Quantity

Adequate water quantity is the basis upon which the ecological integrity of riverine and estuarine systems is built. Both physical and biogeochemical characteristics of the rivers and their watersheds are largely dependent upon river hydrology. The overarching water quantity goal for the Coastal Rivers Basin is to protect and restore the natural hydrologic regimes of surface waters and their contributing watersheds wherever feasible, as measured in terms of: frequency, magnitude, duration, seasonality, and spatial distribution. Meeting this goal will ensure the protection of critical WRVs therein. Table 4 identifies management actions necessary to address these priorities. The lead entity (or entities) that should be primarily responsible for each action has also been identified.

Table 4. Water Quantity Management Actions

Management Actions	Lead Entity
Monitoring, Data Collection, and Research	
Maintain existing and add new river and spring monitoring gages, where appropriate and feasible	District/United States Geological Survey (USGS)
Produce annual reports of flow data with summary reports of flow trends every 4-5 years	District/USGS
Establish a comprehensive groundwater monitoring network to support planning efforts	District/USGS/Other Districts
Work with other agencies to develop a strategy for data collection, data analysis and groundwater modeling to better define current and future regional water resource impacts	District/Other Districts/ USGS/State of Georgia
Water Supply Planning	
Complete Water Supply Assessments	District
Coordinate with FDEP and other agencies to ensure regulatory efforts reflect challenges identified in water supply planning	District//FDEP/Other Districts
MFLs	
Establish MFLs for priority water bodies	District
Maintain MFLs for priority waterbodies with existing MFLs and reassess adopted MFLs on a timely basis	District
Water Resource Development and Aquifer Recharge	
Continue and implement new hydrologic restoration projects, where appropriate and feasible	District/FDEP/Local
Expand use of alternative water supplies	District/FDEP/Local
Conservation	
Educate the public on importance of water conservation	District
Increase beneficial reuse in communities throughout the District	District
Work with partners to increase agricultural water conservation through cost-share and education	Local/District

3.2 Water Quality

Appropriate water quality standards have been developed by the FDEP to correspond with the various designated uses of surface waters. The overarching water quality goal for the Coastal Rivers Basin is to protect and restore water quality in coastal rivers and springs to be compliant with their applicable standards. Regulatory guidance for the Fenholloway River requires significant reductions in loads of dioxin, BOD, unionized NH_3, and nutrients, to restore water quality in this historically polluted surface water. The recent TMDL for the Wacissa River and Springs will require a 38 percent reducing in NO_3^{-2}. In addition, increasing trends in nitrogen and bacteria in some surface waters will require longer-term regional solutions. Table 5 identifies management actions necessary to address these priorities. The lead entity (or entities) that should be primarily responsible for each action has also been identified.

Table 5. Water Quality Management Actions

Management Action	Lead Entity
Monitoring, Data Collection and Research	
Continue to monitor water quality throughout the springs and streams of the Coastal Rivers Basin	District/ FDEP/USGS
Continue to report on the status and trends (if any) of water quality – especially NO_3^{-2} – in the springs and streams of the Coastal Rivers Basin	District/ FDEP/USGS
Determine if bacterial impairment determinations and targets based upon the prior standard using fecal coliform bacteria differ from impairment determinations and targets based upon proposed criteria based on *E. coli* (freshwater Class III) and/or *Enterococci* bacteria (marine Class III and Class II)	District/ FDEP/ Universities
Determine if impairments for DO, based upon older criteria of 4 mg /liter differ from impairment determinations based upon newly adopted criteria based on percent saturation	District/ FDEP/ Universities
Conduct source identification efforts to ensure that source(s) of bacteria are appropriately identified for waterbodies with identified impairments	District/FDEP/Universities
Determine the source(s) of nitrogen load to the springshed of Wacissa Springs and the Wacissa River, to implement the draft TMDL's load reductions	District/FDEP/USGS/Universities
Implementation of BMAPs and BMPs	
Implement reductions required to meet TMDL obligations for the Fenholloway River	Foley Cellulose/ FDEP
Implement the load reductions required to meet TMDL obligations for Wacissa Springs and the Wacissa River	FDACS/FDEP/District
Work with partners on water quality research and education	District/FDACS/UF/IFAS/FWC

Management Action	Lead Entity
Research and evaluate current BMP's success	District/FDACS/UF/IFAS/FWC
Continue Agricultural Cost-Share programs	District/FDACS/UF/IFAS/FWC
Wastewater and Stormwater Infrastructure	
Convert septic tanks to central sewer collection and treatment systems, where needed and practical	Local//FDEP/District
Improve nutrient removal efficiency of wastewater treatment systems, where feasible and practical	Local//FDEP/District
Construct regional stormwater treatment systems, where feasible and practical	District/Local/FDEP

3.3 Natural Systems

Natural systems in the Coastal Rivers Basin include upland, freshwater, and estuarine/ marine habitats which have been degraded, replaced or fragmented, and/or converted to another use due to urban or agricultural development. In addition to direct physical alterations, the integrity natural systems, and the species populations they support, are highly dependent on water quantity and quality. The overarching natural systems goal for the Coastal Rivers Basin is to protect, conserve, and restore native habitats and species populations to maintain the overall ecological integrity of the Basin. Natural systems management actions for the Coastal Rivers Basin directly address the District's core mission and are consistent with the District's strategic plan. Management actions focus on protecting, restoring, and maintaining quality habitats for fish and wildlife in the District, including rivers, springs, wetlands, uplands, SAV, and shellfish habitat. The management actions also address impacts of invasive species and climate change on these priority habitats. Conserving coastal habitats would also contribute coastal economic resilience in the region by protecting developed areas from storms and sea level rise. Table 6 identifies proposed management actions to address threats to natural systems. The lead entities that could be primarily responsible for each action have also been identified.

Table 6. Natural Systems Management Actions

Management Action	Lead Entity
Monitoring, Data Collection, and Research	
Continue and expand monitoring, remote sensing, and mapping of upland, freshwater, and marine/coastal habitats and species, and fish and wildlife species	District/ USFWS/ FWC/ Universities/ FNAI
Improve understanding of trophic dynamics (i.e. food webs) and nutrient cycling in spring and river systems	District/ USGS/Universities

Management Action	Lead Entity
Develop and test restoration techniques for improving fish and wildlife habitat in spring, river, and estuarine systems	District/ USGS/ USFWS/ FWC/ Universities
Continue to monitor and evaluate effects of sea level rise on habitats, e.g., salt marsh vole, Marian's marsh wren	District/ USGS/ USFWS/ FWC/ FDEP/ Universities
Map, monitor status and evaluate human and wildlife impacts to SAV	District/ USGS/ USFWS/ FWC/ Universities
Continue to monitor and develop restoration techniques for long leaf pine habitat	District/ FWC/ Universities/ FNAI/ FDACS
Continue to monitor and test restoration techniques for improving oyster reef habitat	District/ USGS/ USFWS/ FDEP/ FWC/ Universities/ FDACS
Continue to monitor and control nonnative and invasive species	District/ USGS/ USFWS/ FWC/ FDEP/ Universities/ Non-government organization (NGO)/ FNAI/ FDACS
Continue to improve understanding of effects of changes in freshwater flows on habitats and listed species	FWC/ District/ USGS/ USFWS/ Universities
Continue to improve understanding of gear and/or harvest restrictions on listed species	District/ USFWS/ FWC
Continue to improve, develop, monitor, and evaluate the effects of silviculture, crop, and livestock operation BMPs on habitats	District/ USGS/ USFWS/ FWC/ FDEP/ Universities/ FDACS
Develop and disseminate enhanced modeling tools, such as but not limited to suitability models for estuarine habitat restoration/enhancement and for threatened and endangered species habitat within the watershed	District/ USGS/ USFWS/ FWC/ FDEP/ Universities/ FDACS
Communicate monitoring and research results to watershed stakeholders and participating agencies	District/ USGS/ USFWS/ FWC/ FDEP/ Universities/ FDACS
Improve understanding of aquatic cave habitats and species	District/ USGS/ USFWS/ FWC/ FDEP/ Universities/ FDACS
Habitat Conservation	
Maintain and expand land acquisition programs to purchase land throughout the Basin to improve habitat for native species	District/ FWC/ FDEP/ NGO/ FNAI
Develop and refine management plans for acquired lands, including fire management	District/ FWC/ FDEP/ NGO/ FNAI
Develop management standards for shoreline disturbance	District/ FWC/ FDEP/ NGO/ FNAI / FDACS/ Counties

Management Action	Lead Entity
Continue to improve land use planning to reduce fragmentation of habitats	District/ FWC/ FDEP/ Universities/Counties
Improve BMP development and implementation for silviculture, crop, livestock operation, and other agriculture	District/ FDEP/ Universities/ NGO/ FNAI/ FDACS/ Counties
Continue use of Rural and Family Lands Protection Program and other voluntary incentive programs that help keep agricultural lands to a minimum intensity	District/ FDEP/ Universities/ NGO/ FNAI/ FDACS/ Counties
Improve education and outreach to coastal homeowners, recreation organizations, and other stakeholders	District/ FWC/ FDEP/ Universities/ FDACS/ Counties
Improve habitat connectivity through corridors, managed areas, and riparian zones to enhance movement of wildlife	District/ FWC/ FDEP/ Universities/ FDACS/ Counties
Habitat Restoration	
Restore and enhance oyster reef habitat where water quality and hydrological conditions are appropriate	FWC/ FDEP/ Universities
Remove invasive species where appropriate	District/ USFWS/ FWC/ FDEP/ FDACS
Restore and enhance aquatic submerged and/or emergent aquatic vegetation where water quality and hydrological conditions are appropriate	District/ USFWS/ FWC/ FDEP/ FDACS
Restore and maintain long leaf pine habitats where appropriate, including prescribed fire as appropriate	District/ USGS/ USFWS/ FWC/ FDEP/ Universities/ NGO/ FNAI
Restore and maintain riparian habitat where appropriate	District/ USFWS/ FWC/ FDEP
Create, restore and enhance living shorelines where water quality and hydrological conditions are appropriate	District/ FWC/ FDEP/ Universities/ NGO
Continue to develop MFLs for springs, rivers, and aquifers	District/ FWC/ FDEP/ Universities/ NGO
Continue and implement hydrologic restoration projects, where appropriate and feasible	District/ FWC/ FDEP/ Universities/ NGO
Investigate use of permit exemptions and streamlined permitting for restoration projects	District/ USFWS/ FWC/ FDEP
Restore, enhance, and manage tidal marsh where water quality and hydrological conditions are appropriate	District/ FWC/ FDEP/ Universities/ NGO

Management Action	Lead Entity
Integrate restoration efforts across multiple habitats where possible [Applies to above actions involving the creation/restoration/ enhancement of oyster reef, submerged and emergent aquatic vegetation, living shorelines, and tidal marsh habitats]	District/ FWC/ FDEP/ Universities/ NGO
Facilitate native shoreline/estuarine habitat migration along the coastal elevation and latitudinal gradients with anticipated sea level rise, increases in storm frequency/intensity and climate change effects on native vegetation distribution to enhance adaptation capacity and habitat resiliency	District/ FWC/ FDEP/ Universities/ NGO
Develop and implement system-wide shellfish management plans that address sustained provision of ecological, economic and cultural services	District/ FWC/ FDEP/ Universities/ NGO
Implement habitat restoration actions identified in FWC's ISMP for state-listed species in this region	District/ FWC/ FDEP/ USFWS
Recreation Management	
Increase enforcement of existing ordinances/ rules that protect habitat	District/ USFWS/ FWC/ FDEP/ FDACS
Continue to develop, improve, and implement comprehensive recreation management plans	District/ USFWS/ FWC/ FDEP/ NGO/ FNAI/ FDACS
Promote responsible/ low impact recreation activities	District/ USGS/ USFWS/ FWC/ FDEP/ Universities/ NGO/ FNAI/ FDACS

4.0 Projects and Initiatives

One of the main goals of this SWIM Plan is to identify potential projects and initiatives that will, if implemented, help protect and improve water quantity, quality, and natural systems within the Coastal Rivers Basin. The projects and initiatives included in this Plan implement the management actions discussed in the previous section. Project ideas and proposals were solicited from District staff, local governments, state agencies, and other interested stakeholders. Ongoing projects currently being implemented by the District described in Tables 7 through 9, while proposed new projects are described in Tables 10 through 12.

4.1 Ongoing Projects and Initiatives

This section provides a summary of major ongoing projects and initiatives being implemented by the District and/or its partners in the SWIM Plan study area.

4.1.1 Water Quantity

Table 7. Ongoing Water Quantity Projects

Monitoring, Data Collection and Research
Water Quantity Monitoring Lead Entity: District The District currently routinely monitors 273 stations throughout the District for water levels and/or flow. This monitoring effort is focused primarily on freshwater resources and does not currently include coastal monitoring. Cost: $1,000,000 per year approximate
Water Supply Planning
MFLs
Steinhatchee MFL Lead Entity: District Peer review is complete and the Steinhatchee MFL is being finalized.
Water Resource Development and Aquifer Recharge
Conservation

4.1.2 Water Quality

Table 8. Ongoing Water Quality Projects

Monitoring, Data Collection, and Research
Water Quality Monitoring Lead Entity: District The District currently maintains133 groundwater and surface water stations for water quality. Thirteen of these stations are continuous monitoring stations. Cost: TBD
Implementation of BMAPs and BMPs
Wastewater and Stormwater Infrastructure

4.1.3 Natural Systems

Table 9. Ongoing Natural Systems Projects

Monitoring, Data Collection, and Research
Investigating Strategies, Benefits and Stakeholder Preference of "Living Shorelines" to Stabilize and Ecologically Enhance the Coastline around Daughtry Bayou - Cedar Key, Florida Lead Entity: UF/IFAS Nature Coast Biological Station This project will investigate stakeholders' perspective regarding the use of living shorelines to help stabilize shorelines in the area and to investigate various implementation techniques associated with living shorelines. Cost: $41,187
Habitat Conservation
District Land Acquisition Program Lead Entity: District Most District-owned fee and conservation easement lands are located along rivers and streams, headwaters, and water recharge areas. Public ownership of these lands and conservation easements provides a host of benefits including: • Preserving and restoring springs and surrounding areas to protect and improve surface and groundwater; • Preserving floodplain areas to maintain storage capacity, attenuate floodwaters, and mitigate flood risk; • Preserving natural buffers along water bodies where adjacent uses have a high potential to degrade surface water quality; • Protecting groundwater quality by maintaining low intensity land uses; • Providing land for dispersed water storage, restoration, and water resource development projects; and

- Preserving and/or restoring natural communities to support or enhance populations of native species.

The land acquisition program is strictly voluntary — all land acquisition projects are negotiated with willing sellers within the constraints of appraised market value. Landowners desiring to offer lands for sale may submit a Property Offer Form to the District. Lands offered for sale are evaluated by District staff, reviewed by the Governing Board Lands Committee, considered by the Governing Board, and included in the District's land acquisition process if approved by the Board.

Next, staff conducts a detailed assessment of the lands, including inspection, preliminary title examination and appraisal. Following detailed assessment, staff may make an offer and commence negotiations with the landowner. If negotiations are successful, then the Governing Board considers acquisition of the lands. If approved by the Governing Board, staff and the District's Legal Counsel works to close the transaction.

Cost: TBD

Habitat Restoration

Wacissa Springs Water Quality and Habitat Improvement Project

Lead Entity: Jefferson County

Springs restoration and protection project that will provide approximately 200 linear feet of slope protection in eroded areas around the main springs of Wacissa Springs. In addition, the project will remove sediment at Aucilla Springs and Thomas Springs to open non-flowing vents. The project will also replace a dirt parking lot with a 3,500-square yard asphalt and stormwater management facility and a 300-foot boardwalk. The project is anticipated to remove 59,431 pounds of nutrients.

Cost: $517,500

Spring Creek / Rosehead Lake

Lead Entity: City of Perry

The goals of the project are to improve water quality, provide flood protection and improve natural systems including wetlands. The project will accomplish these goals by removing the channelized banks and reshaping the Spring Creek from a channelized ditch into a meandering creek. The floodplain will be reconnected and wetlands will be restored or created. Stormwater interceptors will be installed and a new retention pond constructed to clean the water before it enters the creek.

Cost: $700,000

Levy County Blue Springs Restoration

Lead Entity: Levy County

This project will dredge accumulated sediment in spring vent, removed abandoned septic tanks, pave existing lime rock parking area, construct a stormwater pond, and stabilize the seawall and bank around spring to improve water quality and spring flow.

Cost: $300,000

Prescribed Fire

Lead Entity: FWC and District

The District’s prescribed fire program targets sandhills, upland pine, scrubby flatwoods, mesic flatwoods and wet flatwoods communities for maintenance and restoration purposes. Combined, these targeted communities make up approximately 59,879 acres or 71 percent if the total acres of District Lands that were historically influenced by fire. Over the 2016 fiscal year, there was prescribed burning on 12,528 acres.

Cost: TBD

Non-native Invasive Plant Control Lead Entity: District Over the 2016 fiscal year, 53 invasive plant infestations were monitored and 65 were treated with herbicides, and six infestations were reclassified as inactive. Active infestations are reclassified as inactive when no remaining living plants are observed at/or within close proximity of the infestation for four consecutive years. With funding provided by FWC, 59 acres containing multiple infestations on the Lake Rowell tract in Bradford County were treated. Cost: TBD
Recreation Management
Recreation Management on District-owned Lands Lead Entity: District District lands provide many resource-based recreational opportunities. Over 97 percent of District-owned lands are open to the public for recreation. Planning for public uses and facilities considers the sensitivity of the site, the proximity of similar recreational opportunities, the time and financial requirements to provide the use, and public demand for the particular use. The District has developed facility standards that detail recreational facility, road and trail, sign and kiosk, and fence design, construction and maintenance procedures. These standards ensure that facilities provide a safe, aesthetically pleasing, outdoor environment for the public that can be effectively maintained and minimizes the potential impacts to water resources. Cost: TBD

4.2 Proposed Projects

In preparing this SWIM Plan update, the District conducted an extensive outreach program to identify projects for the preservation, conservation and restoration of water resources and natural systems. Project ideas were solicited from District staff, local governments, state agencies, and other interested stakeholders. In addition, the FDEP *Deepwater Horizon* project portal was accessed and screened for projects relevant to the study area. Through this process, several key projects were identified and are summarized below. It should be noted that the list of projects provided below is fluid is expected to change in future SWIM Plan updates as projects are implemented and/or new priorities are identified.

4.2.1 Water Quantity

Table 10. Proposed Water Quantity Projects

Monitoring, Data Collection, and Research
Quantifying Groundwater Recharge and Discharge to Improve Tools for Protecting Water Supplies and Natural Systems Lead Entity: District The public relies on groundwater models to inform critical decisions affecting water availability and the protection of natural systems. This is particularly the case in Florida, where aquifers are the dominant source of water for public and private water supply, commercial uses, and sustain many critical ecosystems and fisheries.

The predictive accuracy of these groundwater flow models depends on our ability to estimate inputs needed to construct and calibrate these models before they can be applied in a decision-making context. Some of the most critical inputs for model construction and calibration are estimates of groundwater recharge and exchanges of water between aquifers, rivers, and springs. Unfortunately, these components of the water budget are also some of the most poorly understood at present. The objective of this project is to improve estimates of groundwater recharge and aquifer-river-spring water exchanges to reduce the uncertainty associated with important predictions made with groundwater flow models.

Improved estimates of recharge will be sought through several potential approaches. These include (1) the operation of stations for measuring soil moisture and evapotranspiration (or correlated variables such as net solar radiation) for key combinations of crop type, land cover, and soil type; (2) use of data from these stations to validate or improve remotely-sensed estimates of evapotranspiration and soil moisture; (3) analysis of the potential for improving the accuracy of remotely-sensed estimates of evapotranspiration and soil moisture by incorporating higher resolution land-cover, topographic, soil, or hydrographic data; and (4) evaluation of the use of improved land-surface, unsaturated-zone, or rainfall runoff models to estimate recharge.

Improved estimates of exchanges of water between aquifers, rivers, and springs will also be sought through a variety of approaches. These include (1) chemical baseflow separation analyses in which water quality and flow data from stream gages are used to quantify the fraction of the total streamflow that is derived from groundwater (stream 'baseflow'), (2) measurement of flows at springs with limited historical data over a range of hydrologic conditions, and (3) regression or other types of statistical analyses to estimate spring and stream baseflows with explanatory variables such as antecedent rainfall or nearby groundwater levels.

Cost: $900,000

Lower Aucilla River Hydrographic Survey

Lead Entity: District and Jefferson County

The proposed project involves a hydrographic survey to map the water-related features of the area. The area to be surveyed includes about 7 river miles of intermittent open/underground channel, about 5 miles of the current open channel currently located adjacent to the Gulf, and an additional 5 miles along the submerged prehistoric channel of the river out in the Gulf along which numerous archeological artifacts have been found. The project will include establishing a series of precise bench marks along the project to control the bathymetric survey, operation of several water level recorders to gather data regarding the flow of water through the karst subsurface where the river goes underground, and high-resolution multi-beam (or equivalent technology) bathymetric surveys of the river bed controlled by real-time GPS. The bathymetric survey would result in a "point-cloud" of points defining the bed of the river. The resulting data from that survey would be merged with existing digital maps of the surrounding floodplain previously conducted by the District using airborne LiDAR surveys. The net result would be a complete digital model of the hydrography of this complex area which would allow creation of a hydrological model of the Aucilla/Wacissa watershed by the District.

Cost: $200,000

Use of Lidar Bathymetry for Identification of Submerged Freshwater Springs Offshore Jefferson and Taylor County

Lead Entity: District

The proposed project includes the identification and mapping of submerged freshwater springs within the area covered by bathymetric LiDAR imagery in the ARI project. The project includes an analysis of data generated by that project to identify probable springs, the preparation of topo maps of those features, and field investigation of those sites.

Cost: $20,000

Water Supply Planning
MFLs
Water Resource Development and Aquifer Recharge
City of Perry Wastewater Equalization Storage Tank Lead Entity: District The proposed project would fund the addition of treated effluent wastewater storage capacity to the City of Perry (Taylor County) municipal wastewater treatment system. The purpose of increasing the storage capacity would allow an increase in reuse potential for secondary users in and around the city by allowing for an equalization of flow volumes throughout the day. Potential reuse amounts range from low of 500,000 GPD, currently routed to a wastewater spray field, to up to 700,000 GPD by factoring in potential system growth over the next 20 years. Reuse amounts would generally offset pumping from the Floridan aquifer, which is the primary source of all water use types in Taylor County. Cost: TBD
San Pedro Bay and Mallory Swamp Hydrologic Restoration Lead Entity: District The Coastal Rivers Basin contains extensive ‘pocosin swamps’ in its furthest reaches. The largest of these are known as San Pedro Bay in Madison, Taylor and Lafayette counties; and Mallory Swamp in Lafayette and Dixie counties. The Waccasassa Flats area is another similar feature. These swamps were historically ditched and drained in the early-mid 20th century to reduce groundwater saturation of the pocosin soils so that more intensive plantings of pine species for silvilculture could occur. While successful in increasing plantation densities, derivative impacts included declines in the Floridan aquifer system (FAS) underlying the swamps, periodic drying of sand-bottom lakes at the perimeter of the swamps, and increased suspended solids in the canals and eventual riverine systems leading to the Gulf of Mexico. San Pedro Bay and Mallory Swamp constitute both the surface water and groundwater divide between the Coastal Rivers Basin and the MSR watershed and its numerous springs. In the early 2000’s the District purchased nearly 30,000 acres of the interior of Mallory Swamp, and began initial restoration efforts with assistance from the NRCS. Restoration activities included the installation of 311 culverts and 57 ditch blocks to restore natural drainage patterns and increase the ability of the property to store water, thereby rehydrating wetlands and inducing aquifer recharge. However, because the District-owned property did not include the perimeter ditching to the east and extensive drainage features to the south and west of the swamp, overall benefits are less than what is potentially feasible. To date, no such restoration activities have occurred in San Pedro Bay or the Waccasassa Flats. The goal of future hydrologic restoration projects in these critical areas is to restore natural hydrology and thereby improve wetland conditions, enhance aquifer recharge both at the swamp perimeters to aid in perimeter lake level recovery, as well as, to provide increased springflows to major river systems, and to reduce discharge of suspended solids via the extensive remaining canal networks to natural receiving water bodies and eventually the Gulf of Mexico. These goals can be accomplished by the acquisition of large conservation easements within the swamp boundaries and along man-made drainage features to permit construction of and perpetual maintenance access for control structures (culverts, ditch blocks, controlled gates), recharge wells and related conveyances, and other restoration activities. These projects are still in the conceptual design phase, however based on past restoration efforts, expected restoration costs per acre are on the order of $1,000, including a conservation easement estimated value of $500 per acre. An estimated minimum practicable project size would be 4,000 acres. Total acreage within the three swamps is in excess of 400,000 acres. Cost: $4,000,000

Conservation
Determining an Economic Model for Payments Based on Managing Forests for Increased Regional Water Availability Lead Entity: FWC This project is a study to develop a payment structure which will relate the cost savings of deferred or eliminated water resource infrastructure needs and cost of Consumptive Use Permitting to ecosystem service benefits provided by landowners. Additional information on this project can be found at the following link: http://publicfiles.dep.state.fl.us/CAMA/RESTORE Project Forms and Attachments/1443 Multiple_Ecosystem Services Determining an Economic Model for Payments/ Cost: $250,000

4.2.2 Water Quality

Table 11. Proposed Water Quality Projects

Monitoring, Data Collection, and Research
Deep Coastal Wells for Freshwater-Saltwater Interface Monitoring Lead Entity: District Knowing the groundwater distribution between fresh and saline water resources is imperative for coastal community resiliency and habitat restoration. Currently on the Florida gulf coast within the District (Taylor, Dixie, and Levy counties) the depth and stability of the freshwater-saltwater interface is unknown. Establishing the depth of the freshwater-saltwater interface and evaluating the stability of this interface will enable the District to improve regional water supply models and identify threats to the long-term freshwater supply in the region. This data will provide small coastal communities with key information for long-range planning and ensure resiliency to environmental changes. To sample water from the lower Florida the District plans to install four sampling wells across Taylor, Dixie and Levy counties at Rosewood, Horseshoe Beach, Steinhatchee, and Dekle Beach. Rosewood is a few miles inland of Cedar Key and Horseshoe Beach is North of the Suwannee River and Cedar Key on the coast. Dekle Beach is along the coast and approximately 20 miles north of the Steinhatchee river and 40 miles north of Horseshoe Beach. The various well locations will indicate the saline water interface along the North West peninsular Florida coast and aid in monitoring future changes of the fresh-salt water distribution. Monitoring the fresh-salt water interface will enable Florida gulf coast communities to identify locations where mitigation projects will be needed to address groundwater changes in the face of sea level rise. From 1914 to 2006 the MSL rise per year was 1.8 mm at Cedar key (NOAA, 2009). In Florida, the sea level is expected to increase an additional 1.5 to 4.5 feet by 2100 (Jevrejeva. et al., 2012). Due to current and projected sea level rise, monitoring wells are needed to help communities prepare and to mitigate foreseen changes. Monitoring the fresh-salt water interface along the Northwest peninsular coast of Florida will aid and set the basis for project implementation in areas where increases in salt-water and low freshwater flows would harm tidal ecosystems. Each of the four wells will cost approximately $300k where each 1,000-ft. borehole will cost $220k and the FLUTe valve tubing sampling system will cost approximately $80k for five to seven sampling ports in a 1,000-ft. borehole. Cost: $1,200,000

Estuarine Water Quality Assessment Project

Lead Entity: District

This project would expand the District's water quality monitoring program into the coastal river estuaries and near-shore coastal areas which currently have limited water quality data available. This project would identify areas in need of targeted water quality improvement projects, provide data for nutrient cycling models of the estuary, and would be used in conjunction with hydrologic and biological data to assess the health of the tidal river and coastal estuaries. Stations will be established in the near shore area at the mouth of each coastal river to capture the mixing that occurs between river water and the Gulf of Mexico.

Cost: TBD

Implementation of BMAPs and BMPs

Cost Share Program for Implementing Best Management Practices for Agriculture

Lead Entity: District, FDACS and Counties

This project involves the development of a cost share program to implement BMPs for farming water usage. This entails education, planning and implementation of mini-projects on individual enterprises to reduce the amount of water consumed and to improve the quality of groundwater and water runoff from agricultural operations.

Cost: $750,000

Goethe State Forest/2013 Road Restoration Project

Lead Entity: Florida Forest Service and Florida Department of Transportation

The objective of this project is to cap 15 miles of existing open forest roads Florida Department of Transportation grade lime rock to stop the continued erosion of sand into the Waccasassa Bay watershed.

Cost: $550,000

Continued Improvement and Implementation of Agricultural Best Management Practices

Lead Entity: FDACS and District

BMPs describe methods of managing agricultural lands and activities to reduce or prevent water pollution, and to conserve water use. BMPs are voluntarily implemented by farmers and other agricultural entities. FDACS develops, adopts and assists with the implementation of agricultural BMPs. Each fiscal year, FDACS considers proposals for BMP research funding. Proposals are reviewed with the help of a broad-based committee made up of technical experts and stakeholder representatives.

Given the dominance of agricultural land uses in the Suwannee River Basin, and the porous confining layer of the Floridan Aquifer throughout the region, maximum voluntary compliance with current BMPs, and the development of new BMPs to meet changing agricultural practices in the region, are critical to improving and managing surface waters within the District. This project involves increased funding to address the following research priorities:

- Collecting data that lead to new or enhanced agricultural BMPs; and
- Quantifying the positive effects of BMPs on water quality and water conservation.

In addition, this project includes continued education of the agricultural community with regard to the importance of BMPs, and the development of incentives to increase voluntary compliance with BMP implementation.

Cost: TBD

Wastewater and Stormwater Infrastructure
Wastewater Septic to Sewer Conversions in the Big Bend Lead Entity: Counties, Municipalities, FDEP, and District Wastewater has been identified as a significant source of pollution from domestic and industrial sources to groundwater and surface waters. The benefit of these projects is to reduce untreated or poorly treated wastewater effluent discharged to groundwater and surface waters, thus reducing pollutant loads. Efforts to reduce wastewater pollution may include the elimination of small wastewater package plants and septic tanks that have low levels of treatment and redirect the wastewater to larger regional plants with higher treatment levels. Eliminating septic tanks and package plants can be accomplished by installing service connections to existing sanitary sewer collection systems which directly connect to regional WWTP. Costs vary greatly depending on the existence of a collection system and the capacity of the WWTP. If the plant can handle the additional wastewater and the collection system is close by, the scope simply involves pumping out the wastewater, crushing the septic tank, and adding a sanitary sewer service connection line. If grinder pumps are needed project costs will increase. The District will continue to work with local partners to develop wastewater infrastructure upgrades and septic to sewer conversion projects in coastal communities with high septic tank densities. Projects should focus on those areas determined to have failing septic tanks and associated drainfields, and documented pollution impacts to nearby surface waters and groundwater. Project costs will be determined as individual projects are identified. To date, projects have been identified in Jefferson County (upper Aucilla watershed), Dixie County (Horseshoe Beach; Jena; Suwannee), and Levy County (Yankeetown). Cost: TBD

4.2.3 Natural Systems

Table 12. Proposed Natural Systems Projects

Monitoring, Data Collection and Research
Airborne LiDAR Bathymetry for Oyster Reefs Lead Entity: District Conduct airborne LiDAR bathymetry (ALB) data acquisition and processing to support the District's oyster reef/bed mapping and restoration activities. The bathymetric LiDAR sensor is designed to discriminate water depths and land elevations in the coastal zone. The shallow water bathymetry will provide the District with an accurate dataset of the oyster bed and substrate up to ~ 1.5 times Secchi depth, and also including sections of oyster reefs that are exposed at low tide. The ALB data can be used for a variety of purposes such as oyster reef restoration, mitigation, and cultch placement projects to enhance and improve oyster populations. Cost: $100,000 per 30 linear kilometers of existing or relict (needing restoration) oyster reef.
Oyster Restoration and Management to Increase Coastal Resiliency Lead Entity: UF This project will couple state of the art modeling of oyster restoration and management with decision science approaches to promote more desirable ecological and socioeconomic outcomes of oyster resources in Florida and throughout the Gulf of Mexico. Cost: $1,675,000

Culture of Bay Scallops for Research and Population Restoration

Lead Entity: Universities and FWC

The primary objective of this project is to provide a reliable and consistent source of scallop larvae for both research and restoration efforts. Scallops will initially be harvested by FWC Fish and Wildlife Research Institute during their annual scallop surveys, conditioned in controlled temperature and salinity tanks at Florida State University Coastal and Marine Laboratory and spawned to produce scallop larvae, which will be reared to juveniles. Experiments on effects of environmental conditions (temperature, salinity, food quality) on survival, growth and settlement success will be conducted. These data are critical for models of larval dispersal and to predict annual adult population levels, which is important for effective management of the scallop fishery. Juvenile scallops resulting from the culture will be used for both research and restoration of depleted populations. Juveniles will be used for studies on outplanting success in seagrass habitats close to the Florida State University Coastal and Marine Laboratory facilities, where the experiments can be easily monitored. The most successful strategies will be scaled up to larger areas and different habitats. Outplant experiments will be monitored for scallop survival, and environmental conditions will be continuously measured using in situ data loggers. The products of this project will be threefold. 1) consistent supply of bay scallop larvae and juveniles for regional research and restoration; 2) data on effects of environmental variables on growth and survival of early life history stages; 3) optimized strategies for successful bay scallop population restoration. The Florida State University Coastal and Marine Laboratory has facilities and staff to support this project, and scientists from the Florida State University Coastal and Marine Laboratory and FWC Fish and Wildlife Research Institute will collaborate closely to leverage resources and expertise.

Cost: $574,059

Habitat Conservation

Aucilla Corridor Land Acquisition

Lead Entity: District, FDEP and The Nature Conservancy

This project includes four individual land acquisition proposals along the Aucilla River. The proposed acquisitions are surrounded by and connect other parcels in existing public ownership. These proposed acquisitions are part of a large scale effort to protect and preserve the water quality and resources in the Aucilla River and downstream coastal waters. The project supports numerous rare and imperiled species of wading birds and raptors, amphibians and reptiles and a variety of invertebrate species and its freshwater flows play a large role in the productivity of Apalachee Bay and the Gulf. Benefits of the project include protection, management and restoration of important ecosystems in order to enhance significant surface water, coastal, recreational, timber, fish and wildlife resources and to provide areas for natural resource-based recreation.

Cost: $26,400,000

Lyme Gilman Forest Acquisition

Lead Entity: The Conservation Fund

The proposed 22,000-acre +/- Gilman Forest Conservation Easement is an opportunity to protect a vast tract of land in Florida's “woodbasket” region – at a very low per-acre cost (less than $480/acre). Most of the project is located within the San Pedro Bay FF project boundary, and is located near the privately-held San Pedro Bay mitigation bank. FF refers to San Pedro Bay as the largest area of privately owned roadless land remaining in Florida. Much of the property is considered an important functional wetland, and is of interest to the District for potential water resource development projects that will benefit this portion of the Gulf region. Located in the Suwannee, Econfina, and Fenholloway river watersheds, this project will protect water quantity and quality in these rivers and receiving estuaries on the Gulf of Mexico.

Cost: $10,520,000

Freeman Tract Acquisition

Lead Entity: The Conservation Fund

This project is the acquisition of the Freeman Tract within the Big Bend WMA. Located at the mouth of the Steinhatchee River, the tract will protect the water quality of the Gulf and lower Steinhatchee River, preserve habitat for wildlife, and provide recreational opportunities for the public.

Cost: 850,000

FDEP/District Land Acquisition for Habitat Conservation

Lead Entity: FDEP and District

The land acquisition projects listed below are proposed as FF projects led by the FDEP and/or District. FF funding in recent years has been limited; however, supplementation with GEBF funds could make these projects more feasible in the short term. Additional projects may be identified in updates to the District FF Work Plan.

Wacissa/ Aucilla Rivers Sinks Acquisition

FF proposed acquisition in Jefferson and Taylor Counties. The project includes four individual land acquisition proposals along the Aucilla River, approximately 10,151 acres. The proposed acquisitions are surrounded by and connect other parcels in existing public ownership. These proposed acquisitions are part of a large scale effort to protect and preserve the water quality and resources in the Aucilla River and downstream coastal waters.

https://www.dep.state.fl.us/lands/FFAnnual/Wacissa_Aucilla_River_Sinks.pdf

Cost: $42,632,884

Gulf Hammock Acquisition

FF proposed acquisition in Levy County. This project is a 3,652 acre proposed acquisition for public recreation and watershed protection. It would add to the 23,248 acres in the project area currently managed in cooperation with the FWC as a WMA.

https://www.dep.state.fl.us/lands/FFAnnual/Gulf_Hammock.pdf

Cost: TBD

Caber Coastal Connector Acquisition

FF proposed acquisition in Levy County. Land acquisition project acreage (remaining project acres): 7,052. Project area has some areas that are disturbed as a result of silviculture management practices and some that are relatively intact. Restoration will be a high priority for future management, especially in the scrub communities and in other areas that are currently in pine plantations.

https://www.dep.state.fl.us/lands/FFAnnual/Caber_Coastal_Connector.pdf

Cost: $38,805,000

St. Joe Timberland Acquisition

FF proposed acquisition in Taylor and Jefferson counties is part of a 163,459-acre project that includes portions of the Aucilla and Wacissa rivers watersheds. The project may help complete the Florida National Scenic trail and will help preserve large undeveloped areas of land for native plants and animals.

https://www.dep.state.fl.us/lands/FFAnnual/St_Joe_Timberland.pdf

Cost: TBD

Lower Suwannee River and Gulf Watershed Conservation Easement

Lead Entity: The Conservation Fund

This 46,500-acre project is a rare opportunity to protect an expansive tract of land in a critical location. Building on the success of the adjacent 32,000-acre California Lake Conservation Easement, this proposed project is directly adjacent to both the Lower Suwannee NWR and the Big Bend WMA and will vastly expand the protected area along Florida's pristine "Big Bend." This project is a high priority for the State of Florida, USFWS, and Dixie County.

The project will buffer and protect a vast area of conservation lands, creating a contiguous protected area of 196,000 acres. The project will protect habitat for an abundance of wildlife, including Gulf sturgeon, gopher tortoise, eastern indigo snake, Florida black bear, and a host of migratory and resident bird species, including a large population of nesting swallow-tailed kites.

The project consists of a 72 square-mile area that drains into the Suwannee River and the Gulf of Mexico. Freshwater inputs are critical to the health of estuaries, and a large portion of the freshwater entering the Suwannee River's estuary comes from the project site. The site will also protect water quality/quantity within the ±980,000-acre Big Bend Seagrasses Aquatic Preserve, located just offshore, which includes habitat for several species of sea turtles, West Indian manatees, bottlenose dolphins, one of the state's largest populations of wintering American oystercatchers, and numerous other bird and fish species.

Cost: The State of Florida acquired ±8,100-acre easement in 2016; thereby, reducing the unpurchased project acreage to approximately 38,400 acres. The estimated cost to acquire the remaining conservation easement is ±$24 million (subject to appraisal).

Coastal Rivers/Dixie County Land Acquisition

Lead Entity: District and Dixie County

This conservation easement protects wildlife habitat, and improve water quality of freshwater that drains into the Gulf estuaries including the Big Bend Seagrasses Aquatic Preserve. Together with the proposed Lyme Timber conservation easement and existing lands in public ownership, including the California Lake easement, and the Big Bend WMA, this project will protect an extensive amount of land along the Big Bend Region in the Gulf of Mexico.

Cost: $66,784,450

Cedar Key-Waccasassa Bay Acquisition and Restoration Project

Lead Entity: District and FDEP

The State of Florida and the USFWS have made very large investments in the protection of the Big Bend region of Florida's Gulf Coast. Beginning with the St. Marks NWR and continuing south to the Waccasassa Bay Preserve State Park, approximately 250,000 acres have been placed in public ownership along the Gulf of Mexico. In addition, City of Cedar Key has installed a centralized sewer system and made substantial improvements to its stormwater system in order to protect the quality of the adjacent shellfish waters. The potential development of the 3,817-acre project area is a significant risk to water quality in the Waccasassa Bay. Public acquisition of this area will complete a continuous protected corridor joining the Lower Suwannee NWR, Cedar Key Scrub State Reserve, Waccasassa Bay Preserve State Park, and a portion of the Cedar Keys NWR. This additional protection will help to mitigate for impacts suffered elsewhere in the Gulf. This project addresses one of the most significant gaps in this coastal protection framework.

Cost: $19,000,000

Deer Island Acquisition in Lower Suwannee Sound Lead Entity: USFWS, FDEP and District This project is a full-fee acquisition of Deer Island, the northernmost barrier island in the Cedar Key Archipelago. Acquiring and permanently protecting Deer Island will benefit "injured" and at-risk species while also enhancing recreational opportunities within the Big Bend region. It is approximately 80 acres in size (1,300 m long from north to south and is 250 m across at its widest point) and the highest elevation is 14 feet above sea level. Thirty-five acres are considered uplands. The northern tip of the island is already owned by the federal government and is part of the Lower Suwannee NWR. The remainder is a private inholding within the Refuge and the Big Bend Seagrass Aquatic Preserve. The western edge of the island is fringed by a 0.8-mile-long beach that extends above the high tide line. Beach habitat is rare and ecologically important in this part of the Big Bend region. East of the island are extensive salt marshes and mudflats crisscrossed with oyster shoals and shallow channels. Permanent protection of Deer Island will help maintain the natural ecological functions of a barrier island and contribute to the ecological integrity of the Suwannee estuary. It will also be protective of living resources by allowing for the enforcement of federal laws that are protective of wildlife and water quality, and by the implementation of management actions to benefit injured species and other resources of conservation concern. Deer Island and the surrounding salt marshes and seagrass beds provide habitat for numerous species including many that were injured as a result of the *Deepwater Horizon* oil spill. Some injured bird species documented foraging or loafing on the island include the brown pelican, American oystercatcher, Wilsons plover, piping plover, black skimmer, least tern, Caspian tern, reddish egret, roseate spoonbill, little blue heron, snowy egret, tricolored heron and white ibis. the adjacent seagrass beds provide habitat for several federally-listed species including green, loggerhead and kemp's Ridley sea turtles, gulf sturgeon, and West Indian manatee. On the west side of the island is one of the few beaches along the Big Bend to have beach habitat that extends above the high tide line. Consequently, horseshoe crabs nest on the beach and Rufa Red Knots have been observed feeding along the west side and northern tip of the island. The beach also provides habitat for the Cedar Key mole skink, a species petitioned for listing that has only been found on the Cedar Keys, and Ornate diamondback terrapins. This subspecies of diamondback terrapin is endemic to the west coast of Florida and it has been documented to nest on Deer Island. The State has ranked the diamondback terrapin as one of the species of greatest conservation need. Cost: $1,647,500
Waccasassa River Basin Land Acquisition Lead Entity: FDEP and District The Waccasassa River Basin Land acquisition project includes two different proposed land acquisitions in Levy County. Both the Waccasassa Flats-Levy County property and the Cedar Key- Andrews property will protect water quality and enhance and provide additional public recreational opportunities in the Basin. Cost: $2,552,000
Habitat Restoration
Florida Forest Service Gulf Coastal Watershed Reforestation Plan for Florida State Forests Lead Entity: Florida Forest Service This is a reforestation project of slash and longleaf pine on approximately 4,042 acres of state forest land along gulf coastal counties in Florida. The project will include all site preparation and planting activities. Cost: $951,470

Big Bend Oyster Reef Restoration Project(s)

Lead Entity: FWC, Counties, UF, District, and FDACS

This project(s) would restore and enhance oyster reefs which provide ecological benefit to the Big Bend estuarine habitat, including habitat for fish and wildlife species. Reef structures formed by oysters are complex and provide refuge for hundreds of other species, including the juvenile stages of several fishes. Recent studies show oyster bar declines are due primarily to reduced survival and recruitment, likely a result of reduced freshwater inputs that increase reef vulnerability to wave action and sea level rise. This is still a conceptual project and may include the planning and design of multiple reef restorations in the Big Bend. Project areas will focus on Horseshoe Cove, Suwannee Sound, and Waccasassa Bay. The project will evaluate appropriate techniques, such as that used in the Recovery and Resilience of Oyster Reefs in the Big Bend of Florida GEBF funded project, to increase the sustainability of reefs. Further monitoring to evaluate success.

Cost: TBD

Spring Creek Spring Head Restoration (Folsum Creek Spring)

Lead Entity: City of Perry

Restore and protect the spring head of Spring Creek in downtown Perry through bank restoration; removal of muck and invasive plant species; parking area improvements; provide limited recreational entrance/exit to spring head for recreational swimming, thus protecting banks. The City match will provide restroom/changing facilities and a picnic pavilion overlooking spring. Project benefits include 1,100 linear feet bank restoration; 18,900 cubic foot sediment removed; and stormwater management improvements treating 1.1 acres of impervious.

Cost: $489,500

Seagrasses Aquatic Preserve Seagrass Restoration – Phase I

Lead Entity: FDEP

This project will stabilize and restore critical seagrass habitat in the second largest contiguous seagrass bed on the Gulf coast of Florida; which supports one of the most stable population of bay scallops in the state of Florida. Furthermore, this project will aid in the protection of coastal habitats and cultural resources.

Cost: $2,000,000

Enhancement of Oyster Shell Rakes in Cedar Key, FL to Benefit Wintering and Breeding American Oystercatchers

Lead Entity: FWC

This project will restore six Cedar Key oyster reefs used by oystercatchers as high tide roosting or nesting habitats using two new techniques in oyster restoration: (1) use of cultch, limestone and bagged building blocks of living oysters transplanted to create a barrier of instant living reef that is resilient to even heavy wave action and protects growing reef inside the barrier and (2) designing reefs to enhance water flow around reef structure in a way that allows built reefs to naturally expand.

Cost: $958,329

Recreation Management
Big Bend Wildlife Management Area Recreation Improvements Lead Entity: FWC Big Bend WMA is a key coastal WMA that conserves upland habitats and the Big Bend Seagrass Aquatic Preserve just offshore. The WMA provides stunning scenery and a wide variety of recreational opportunities including seasonal hunting, fishing, wildlife viewing, boating, biking, hiking and other recreational activities. Big Bend WMA is a gateway for boaters and paddlers to access many creeks, rivers, tidal marshes and the Gulf of Mexico over a 60-mile stretch of the Florida coast. The proposed improvements to the Freeman House will provide an important environmental education/ecotourism destination in the Jena and Steinhatchee communities. This facility is being jointly operated with Dixie County. This project will also provide improved public access to the Jena Unit in the community of Horseshoe Beach for the first time. These facilities will also support the FWC-managed segment of the Big Bend Saltwater Paddling Trail. Kiosks and interpretive signs will provide visitor orientation to Big Bend WMA at all entrances and will introduce visitors to the abundant opportunities on the Area. Big Bend WMA has been one of the most popular destinations for visitors in the Florida WMA System for many years. Based on traffic counter data estimates, 181,000 visitors annually will benefit from the improved recreation facilities for this area. The proposed improvements to the Freeman House (trails, boat dock, ADA improvements and environmental education displays) will create an important ecotourism destination as well as a recreational amenity for the citizens and visitors to Jena and nearby Steinhatchee. The proposal will develop and enhance a comprehensive system of hiking, boating access and paddling trails and associated primitive camping that will benefit community residents and visitors. Management costs include providing a nature-based recreation program staff person to administer nature-based recreational use on the Big Bend and nearby coastal WMAs. Cost: $2,078,000

End of Document.