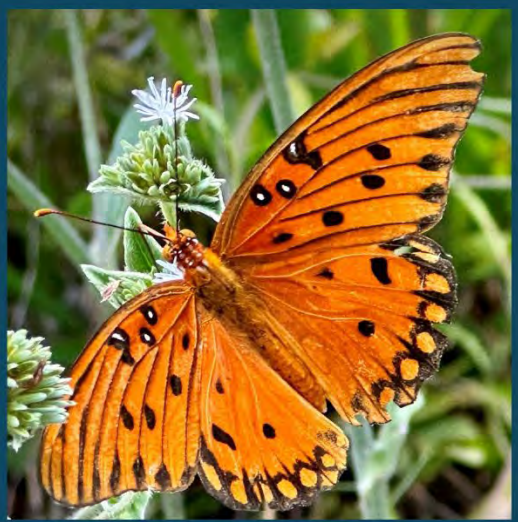
The Loxahatchee River

National Wild and Scenic River

Management Plan Update 2024



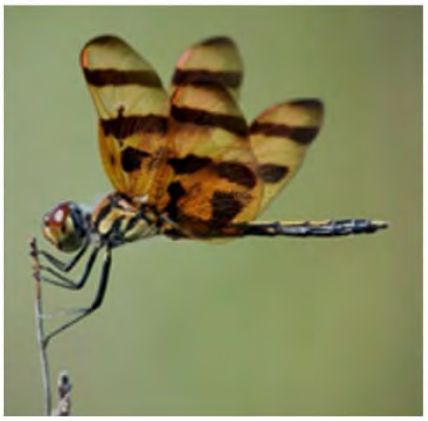
Sunrise on the Loxahatchee River (Photo by SFWMD).

Photos Credits: Aerial images provided by SFWMD. Wildlife photos by Brian Garret and SFWMD (roseate spoonbill only). Bald cypress and wildflower photos by Elizabeth Salewski.

Cover: Osprey, Bald cypress, roseate spoonbill, Gulf fritillary butterfly, and southern leopard frog.

Author Page: (top) Savannah sparrow, yellow milkwort, Halloween pennant dragonfly, and Feay's palafox; (bottom) Florida ribbon snake, West Indian manatee, American alligator, and Osceola turkey.






South Florida Water Management District
Florida Department of Environmental Protection

Editors: Barbara Herrmann Welch
Elizabeth Salewski, Ph.D.

NATIONAL WILD AND SCENIC RIVERS SYSTEM




Loxahatchee River Management Coordinating Council
c/o South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

November 7, 2024

Drew Bartlett, Executive Director
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

Dear Mr. Bartlett:

The Loxahatchee Wild and Scenic River Designation and Preservation Act (Chapter 83-358, Florida Statutes) designated a portion of the Loxahatchee River as Wild and Scenic. The Act requires the South Florida Water Management District (SFWMD) and the Florida Department of Environmental Protection (DEP) to develop a management plan for the Wild and Scenic portion of the river and update the plan every ten years. It also established the Loxahatchee River Management Coordinating Council, which is responsible for providing advisory recommendations to both agencies on issues related to the river and updates to the management plan.

The 2024 Loxahatchee River National Wild and Scenic Management Plan Update is a revision of the previously approved 2010 plan. This update is the required revision to guide both agencies in the restoration, protection, and enhancement of the ecological health and outstanding values of the Loxahatchee River, including the Wild and Scenic Northwest Fork. The updated plan has been revised by SFWMD staff and has undergone extensive review by the Council.

At the Council's meeting on September 30th, 2024, the Council unanimously voted to approve the final draft of the 2024 Loxahatchee River National Wild and Scenic Management Plan. With this approval, the Council is recommending the adoption of the updated plan and its submission to the federal level for final posting.

Sincerely,

Jonathan Ricketts, Chair
Loxahatchee River Management Coordinating Council

Loxahatchee River Management Coordinating Council
c/o South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

November 7, 2024

Shawn Hamilton, Secretary
Florida Department of Environmental Protection
3900 Commonwealth Boulevard, M.S. 49
Tallahassee, FL 32399

Dear Mr. Hamilton:

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Sincerely,

Jonathan Ricketts, Chair
Loxahatchee River Management Coordinating Council

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

March 21, 2025

Mark Foust, SE Regional Director
U.S. National Park Service
Interior Region 2, South Atlantic-Gulf
100 Alabama Street SW
1924 Building
Atlanta, GA 30303

Subject: Loxahatchee River National Wild and Scenic River Management Plan, 2024 Update

Dear Mr. Foust:

On behalf of the South Florida Water Management (SFWMD), I am pleased to formally approve the Loxahatchee River National Wild and Scenic River Management Plan Update 2024. As in the previous plans, the 2024 plan continues to meet the requirements of Chapter 83-538, Laws of Florida. This law requires the Florida Department of Environmental Protection and SFWMD to jointly develop, update, administer, and implement a Wild and Scenic River Management Plan for the Loxahatchee's 1985 federally designated Northwest Fork. SFWMD finds that this document's goals, objectives, and action plans to restore, improve, preserve, and protect the Loxahatchee Rivers Northwest Fork are consistent with SFWMD policies for environmental management and stewardship.

I would like to thank SFWMD editors, chapter co-authors, contributors, and Loxahatchee River Management Coordinating Council members, along with other stakeholders, for their input in the development and approval of this final draft of the 2024 Management Plan Update for the federally designated Northwest Fork's National Wild and Scenic River.

SFWMD will continue to work with its state and local partners to improve, restore, preserve, and protect the outstanding values of the Loxahatchee Rivers National Wild and Scenic River and recommends the replacement of the previous 2010 Plan with the 2024 Plan Update.

Sincerely,

Drew Bartlett
Executive Director

c: Frank Lands, Deputy Director, NPS
Jaime Doubek-Racine, Project Director, Florida

Attachment: *2024 LRNWSMP*

FLORIDA DEPARTMENT OF
Environmental Protection

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, FL 32399

Ron DeSantis
Governor

Alexis A. Lambert
Secretary

April 7, 2025

Mark Foust, SE Regional Director
U.S. National Park Service
Interior Region 2, South Atlantic-Gulf
100 Alabama Street SW
1924 Building
Atlanta, GA 30303

RE: Loxahatchee River National Wild and Scenic River Management Plan – Update 2024

Dear Mr. Foust:

The Florida Department of Environmental Protection's (DEP) has reviewed the 2024 Plan Update and finds that its goals and strategies to restore, preserve and protect the Wild and Scenic portion of the Loxahatchee River are consistent with DEP's efforts to protect and manage our state's natural resources.

This management plan update meets the requirements of Chapter 83-358, Laws of Florida, which require the DEP and the South Florida Water Management District to jointly develop, administer and implement a Wild and Scenic River Management Plan. Approval of the 2024 Loxahatchee River National Wild and Scenic River Management Plan Update does not constitute an exemption from complying with the appropriate local, state or federal agencies.

The DEP recommends replacing the 2010 Plan with the 2024 Plan Update and appreciates the Loxahatchee River Management Coordinating Council's collaborative efforts and continued coordination between the 25 local, state, and federal partners represented on this council.

Sincerely,

Alexis Lambert
Secretary

Cc: Frank Lands, Deputy Director, NPS
Jaime Doubek-Racine, Project Director, Florida

Loxahatchee River Management Coordinating Council

City of Palm Beach Gardens – **M:** Carl Woods; **A:** Dana Middleton

Florida Department of Agriculture and Consumer Services – M: Rebecca Elliott, Environmental Consultant[CR]

Florida Department of Environmental Protection – **M:** Jon Moore; **A:** Inger Hansen[R]

Florida Department of Transportation – **M:** Ann Broadwell, Environmental Manager, District 4[CR]; **A:** Kristin Williams

Florida Farm Bureau – **M:** Jake Fojtik[R]

Florida Fish and Wildlife Conservation Commission – **M:** Tom Reinert, Ph.D., Regional Director – South Region[CR]; **A:** James Erskine, Everglades Coordinator

Jupiter Inlet District – **M:** Tom Howard, Commissioner; **A:** Gail Whipple, Commissioner

Landowner Representative – **M:** Pat Magrogan; **A:** Tom Boyhan

Local River User Group: Palm Beach Pack & Paddle Club – **M:** Inke Sunila, Ph.D.; **A:** Christina Gray

Loxahatchee River Environmental Control District – **M:** D. Albrey Arrington, Ph.D., Executive Director[CR]; **A:** Clinton Yerkes, Board Member

Martin County – **M:** Harold Jenkins, County Commissioner; **A:** Michael Yustin, Project Manager, Public Works Department[CR]

Martin County Environmental and Conservation Group – **M:** Richard Roberts[Au,R]; **A:** Greg Braun[CR]

Northern Palm Beach County Improvement District – **M:** Jonathan Ricketts, P.E.

Palm Beach County – **M:** Maria Marino, Palm Beach Vice Mayor District 1; **A:** Deb Drum, Palm Beach County Environmental Resources Management (ERM)[CR]

South Florida Water Management District – **M:** Cassondra Armstrong, Ph.D., Bureau Chief, Applied Sciences [R]; **A:** Justin Nolte, Section Administrator, Land Stewardship

South Indian River Water Control District – **M:** W. Chad Kennedy[CR]; **A:** Susan Kennedy

Town of Jupiter – **M:** Cameron May, Town Councilor; **A:** Amanda Barnes, P.E., Director of Utilities[R]

Treasure Coast Regional Planning Council – **M:** Thomas Lanahan, Executive Director[R]; **A:** Jessie Seymour

U.S. Department of Interior, Bureau of Land Management – **A:** Peter DeWitt, Jupiter Inlet Lighthouse Outstanding Natural Area

U.S. Fish and Wildlife Service – **M:** Andrew Eastwick, Biologist, Everglades Restoration Program[R]

Village of Tequesta – **M:** Marjorie G. Craig, P.E.; **A:** Jeremy Allen, ICMA-CM

M: Member; A: Alternate

Superscripts = Au: Author, C: Contributor, R: Reviewer

Acknowledgments

The 2024 update is the result of the support and commitment of the LRMCC who provided content and reviewed the document throughout the process: many thanks for your encouragement and patience in completing the 2024 management plan update.

The 2024 Loxahatchee River Management Coordinating Council: From left to right (back row) Amanda Barnes, Cameron May, Tom Howard, Albrey Arrington, Tom Lanahan, Cassondra Armstrong, Mike Yustin, Chad Kennedy, and Kristin Williams; (front row) Jonathan Ricketts, Pat Magrogan, James Erskine, Deb Drum, Inke Sulina, Marjorie Craig, Rebecca Elliott, Dick Roberts, Susan Kennedy, and Inger Hansen. (Photo by J. Todd).

The editors wish to express special gratitude to Richard “Dick” Roberts (retired FPS/JDSP) and Marion Hedgepeth (retired SFWMD). From the beginning of the plan update process, they have given many hours of their uncompensated time to provide guidance, historical knowledge, research, and project summaries. They are an invaluable resource of information, subject matter clarity, and overall support for us throughout the writing process. We truly appreciate their passion for the Loxahatchee River and their significant contributions to the 2024 Loxahatchee River National Wild and Scenic River Management Plan update.

Special thanks to Allison Lamb and Madison Machado in SFWMD’s Geospatial Services for creating and revising the many GIS maps provided throughout this document.

Appreciation is extended to the chapter co-authors and contributors, and the following non-council individuals who took the time to review chapters and provide helpful comments and suggestions throughout the process: Rob Rossmanith (FPS/JDSP), Patti Gorman (retired SFWMD), James Schuette (SFWMD), Allen Trefry, Melissa Tolbert (PBC DERM), and Ben Rayls (DEP).

Special Recognition of Bob Graham

(1936 – 2024)

(Left) Richard Roberts and Bob Graham on the Loxahatchee River and (right) Bob Graham at the dedication ceremony at Jonathan Dickinson State Park.

Born Daniel Robert "Bob" Graham, son of a state senator, was raised on a cattle and dairy farm deep in the Everglades. He became a political servant and activist early in his life. After graduating from law school in 1966 he won a seat in the Florida House of Representatives and later moved on to the Florida Senate in 1970. In 1978, he became the thirty-eighth governor of Florida, serving two terms.

As governor of Florida, a key legacy for Bob Graham was obtaining the protection needed for the Northwest Fork of the Loxahatchee River. He charged the Florida Department of Natural Resources and the South Florida Water Management District to write the first proposed Loxahatchee River Wild and Scenic River Management Plan in 1984. Graham's goal was to apply to the U.S. Secretary of the Interior for portions of the Northwest Fork of the Loxahatchee River to be included in the National Wild and Scenic River System and become Florida's First National Wild and Scenic River. As a result of Graham's efforts, the Loxahatchee River was designated a National Wild and Scenic River on May 17, 1985, by the U.S. Secretary of the Interior. A river dedication was held on December 14, 1985, which Bob Graham celebrated with a canoe trip on the Loxahatchee and a ceremony at Jonathan Dickinson State Park.

From 1987 to 2005, Bob Graham was nominated to the U.S. Senate where he became known for his devotion and initiatives to save and restore the Everglades. Senator Graham brought the environmentalists and agricultural industry together to begin the restoration of the "River of Grass". His passion for Everglades Restoration and his tenacity secured the state and federal resources marking a major turning point for Everglades restoration policy. In 2000, Everglades restoration was estimated at $7.8 billion and was labeled as the largest and "most ambitious environmental restoration program in the world". Graham's perseverance and hope for restoring the Everglades continues today through the Comprehensive Everglades Restoration Plan (CERP) and the Florida Forever program. The Florida Forever program is key to the conservation of Florida's natural and cultural heritage and is one of the largest public land acquisition programs in the United States.

Acronyms, Abbreviations, and Units of Measurement

AHRES	Aquatic Habitat Restoration/ Enhancement Section
ASR	Aquifer Storage and Recovery
BAV	Beach Action Value
bgs	Below Ground Surface
BMAP	Basin Management Action Plan
BMP	Best Management Practices
℃	degrees in Celsius
CERP	Comprehensive Everglades Restoration Plan
cfs	Cubic Feet per Second
DBHYDRO	South Florida Water Management District's environmental database
DEM	Digital Elevation Model
DEP	Department of Environmental Protection
DOH	Florida Department of Health
DOT	Department of Transportation
DRP	Division of Recreation and Parks
EC S/m	Electrical conductivity Siemens per meter
ENCON	now Loxahatchee River Environmental Control District
EPA	U.S. Environmental Protection Agency
℉	degrees in Fahrenheit
FAC	Facultative
FACU	Facultative Upland
FACW	Facultative Wetland
FDACS	Florida Department of Agriculture and Consumer Services
FDHR	Florida Division of Historical Resources
FDNR	Florida Department of Natural Resources (now FL DEP)
FE	Federally listed as Endangered
FLEPPC	Florida Exotic Pest Plant Council
FLUCCs	Florida Land Use and Cover Classification System
FNAI	Florida Natural Areas Inventory
FPAN	Florida Public Archaeology Network
FPS	Florida Park Services
FT	Federally listed as Threatened
FWC	Florida Fish and Wildlife Conservation Commission
GPS	Global Positioning System
GWP	Grassy Waters Preserve
HSLCD	Hobe St. Lucie Water Control District
ISMP	Imperiled Species Management Plan

IWQT	Interim Water Quality Targets
JB	Juno Beach
JDSP	Jonathan Dickenson State Park
JID	Jupiter Inlet District
LEC	Lower East Coast Water Supply Plan
LRECD	Loxahatchee River Environmental Control District
LRMCC	Loxahatchee River Management Coordinating Council
LRPI	Loxahatchee River Preservation Initiative
LRWRP	Loxahatchee River Watershed Restoration Plan
LULC	Land Use Land Cover
LW	Loxahatchee Watershed
MC	Martin County
MFL	Minimum Flows and Levels
MS4	Municipal Separate Storm Sewer System
NELAP	National Environmental Laboratory Accreditation Program
NEXRAD	Next Generation Weather Radar
NGVD29	National Geodetic Vertical Datum of 1929
NNC	Numeric Nutrient Criteria
NOAA	National Oceanic and Atmospheric Administration
NPBCCWMP	Northern Palm Beach County Comprehensive Water Management Plan
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NTU	Nephelometric Turbidity Unit
NW	Northwest Fork
OBL	Obligate
ORV	Outstanding Remarkable Value
PAR	Photosynthetically Active Radiation
PBC	Palm Beach County
PBC ERM	Palm Beach County Environmental Resource Management
PBI	Palm Beach International Airport
PM	Performance Measure
PRP	Pollution Reduction Plan
PWS	Public Water Supply
RC	River Corridor
RM	River Mile
S/A	Threatened due to Similarity of Appearance
SAP	Species Action Plan
SAV	Submerged Aquatic Vegetation
SFWMD	South Florida Water Management District
SIRWCD	Southern Indian River Water Control District
SOR	Save Our Rivers
SR	State Road
SSC	Species of Special Concern
ST	State listed as Threatened

SW	Southwest
TBD	To Be Determined
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UPL	Upland
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VEC	Valued Ecosystem Component
WaSh	Watershed model
WBID	Water Body Identification
WMA	Wildlife Management Area
WQ	Water Quality

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Highlights

The plan update provides an overview of the changes within the Loxahatchee River Watershed between 2011 to 2020, including a synopsis of the National Wild and Scenic designation, monitoring summaries of the Outstanding Remarkable Values, and projects planned and implemented to preserve and restore the Northwest Fork of the Loxahatchee River.

Chapter Contents

Chapter 1 is the Executive Summary.

Chapter 2 provides an overview of the hydrological, land acquisitions and management histories of the River, and how land use, demographics, and demands on the watershed have changed since 2010.

Chapter 3 reviews the Wild and Scenic Rivers Act, the designation of the Loxahatchee River, and the classifications of the river.

Chapters 4 and **5** summarize the monitoring of the **outstanding remarkable values (ORVs)** within the watershed, including drainage and hydrology, water quality, biological communities, historical, cultural, and recreational resources, and outreach and education activities throughout the Northwest Fork of the Loxahatchee River.

Chapter 6 features ongoing and planned projects within the Loxahatchee River watershed and the Northwest Fork of the river.

Outstanding Remarkable Values

- The watershed hydrology was evaluated using the WaSh model that showed no change in surface water drainage paths over the past two decades.
- Renovations of several water control structures were completed to improve water flow and levels throughout the River.
- Water quality was highly variable throughout the river. The Wild and Scenic segment of the river maintained desirable salinity and total nitrogen levels while the total phosphorus, ammonia, dissolved oxygen, and turbidity levels were beyond their critical thresholds which supported the need for continued monitoring and improvements.
- The annual number of days below 35 cfs has declined compared to flows between 2000 and 2011, indicating that operational changes since 2011 are benefiting the River, though salinity MFL exceedances still occur.
- Freshwater vegetation has shifted towards salt-tolerant species in the lower and upper tidal reaches while floodplain vegetation in the riverine reach suffers from too little freshwater inundation beyond the river channel.
- The Kitching Creek floodplain supported the most bald cypress seedlings and shrubs due to high fresh groundwater levels.
- Between 2017 to 2020, about 2300 bald cypress saplings were planted across 23 acres to support the bald cypress stands within the river floodplain.
- In 2020, a replanting project for American eelgrass, *Vallisneria americana*, was planned to restore some of the eelgrass lost in 2017 due to Hurricane Irma.
- Over 50,000 acres were treated to target 38 invasive vegetation species including climbing fern, Brazilian pepper, melaleuca, and earleaf acacia.
- Sixteen threatened and endangered species were identified within the Loxahatchee River Watershed and Corridor.
- Sixty-nine historical and cultural sites have been identified and ten were eligible for the National Register of Historic Places.
- Recreational resources within the River area include hiking, boating, and wildlife encounters with an ongoing need to continue outreach, education, and stewardship.

Ongoing and Future Watershed Improvement Projects

- There are over 100 ongoing and/or planned projects within the watershed and Northwest Fork that include hydrologic and habitat restoration, non-native removal, water management practices, research and outreach to address the Management Plan goals and objectives.
- Planning for the CERP LRWRP was completed in 2020. LRWRP aims to restore and sustain freshwater to the Northwest Fork, increase hydrologic connectivity to the natural areas and improve seasonal timing and distribution of water to restore drained wetlands.

Chapter 1: Executive Summary

Barbara H. Welch and Elizabeth Salewski

SFWMD

The Northwest (NW) Fork of the Loxahatchee River received the federal designation of a Wild and Scenic River in 1985 which identified sensitive natural areas in need of protection. The designation entailed the preservation and management of the NW Fork's unique natural resources. The Loxahatchee River Management Coordinating Council, established in 1983 (F.S. 83-358), serves as an advisory council to the Florida Department of Environmental Protection (DEP) and the South Florida Water Management District (SFWMD), the agencies appointed to manage and protect the river. The DEP and SFWMD are responsible for updating the management plan with collaboration and contributions from other agencies and stakeholders, as well as the recommendations and approval of the LRMCC.

The Loxahatchee River National Wild and Scenic River Management Plan update provides an overview of the enacted legislation and policies and the natural resources within the NW Fork. Assessments of river hydrology, water quality, and the biological communities facilitated refinements to existing goals and objectives based on the results of monitoring efforts and restoration progress from 2011 to 2020. The plan identifies the roles and responsibilities of the managing and participating agencies responsible for implementing adaptive management practices, coordinating multi-agency efforts, and promoting improvements to maintain and enhance natural river flow conditions for the preservation and protection of river resources.

Insufficient freshwater flows degraded the water quality, fragmented the natural hydrologic landscape, and damaged the habitats throughout the NW Fork ecosystem over time. Hydrological alterations that supported urban and agricultural development reduced the natural connectivity within the watershed and compromised the biological diversity. Increasing urbanization escalated the demands on the watershed prompting land protection and management practices to preserve natural resources and improve freshwater flows. To date, 76,046 acres of land within the watershed are in public ownership which enabled the planning and implementation of restoration projects to protect, conserve, and manage natural resources.

The natural ecological resources including watershed drainage, hydrology, water quality, biological communities (vegetation, fish, and wildlife), historical and cultural, and recreational resources were identified for protection by the National Wild and Scenic designation as Outstanding Remarkable Values (ORV). The ORV criteria were refined in the 2006 Restoration Plan for the NW Fork by the application of a resource-based management strategy identified as Valued Ecosystem Components (VEC). The VECs were identified as specific species (e.g., bald cypress, white and red mangroves) or communities (i.e., bald cypress swamp) based on their complex ecological composition, and environmental factors such as hydrology, soil conditions, and exposure to fire, non-native plants and animals, and saltwater intrusion. The ORVs were evaluated through assessments of specific VECs to determine possible stressors, recommend monitoring and mitigation, and provide a predictor of the ecological effects of human activities.

Many ORVs, including VECs, were found within, contributed to, or composed the habitats of the NW Fork ecosystem. These habitats were classified as environmentally sensitive lands due to the

biological diversity and the endemic, rare, and endangered species of the upland, wetland, and aquatic communities. Protection of the riverine habitats required the maintenance of minimum freshwater flows to the NW Fork to reduce saltwater intrusion. The SFWMD developed Minimum Flows and Levels (MFL) criteria for the NW Fork (Rule 40E-8.221) that legally required a minimum volume of water flowing over the Lainhart Dam (e.g., 35 cfs) to meet the needs of the river system. As a result of continued MFL violations, recovery strategy plans like the Lower East Coast Water Supply Plan, Northern Palm Beach County Comprehensive Water Management Plan, and Comprehensive Everglades Restoration Plan Loxahatchee River Watershed Restoration Plan (CERP LRWRP) were initiated to achieve the MFL requirements. In addition to the MFL, renovations to water control structures within the watershed were completed to improve the hydrology of the NW Fork. Lainhart and Masten Dams and several other water control structures (i.e., S-46 structure) were among the improvements made between 2011 and 2020. The structure renovation improvements over the last decade (2011 to 2020) contributed to a 29% increase in flow rates over the Lainhart Dam compared to the previous decade.

Watershed drainage, hydrology, and water quality were monitored regularly by multiple agencies to document when minimum flow levels and water quality standards were not met. Parameters like salinity, turbidity, phosphorus, nitrogen, and fecal coliform were evaluated against the Interim Water Quality Targets and/or Numeric Nutrient Criteria to determine the ecological health of the river and identify water quality issues. Water quality monitoring showed that the freshwater tributaries Kitching Creek, Cypress Creek, and Moonshine Creek, were loading phosphorus and nitrogen and increasing turbidity in the NW Fork. The water quality in the Wild and Scenic portion of the river showed a slight increase in phosphorus levels and lower ammonia and nitrogen levels compared to the tributaries. In the spring and summer months from 2018 to 2020, the daily average salinities exceeded the threshold of 2 at Lainhart Dam due to flows not meeting the minimum established MFL criteria to maintain the freshwater habitat in the Wild and Scenic river segment. Overall water quality in the NW Fork and tributaries was a mix of good and less desirable over the last decade.

Monitoring the biological communities further informed on the health of the NW Fork ecosystem and identified areas of concern before, during, and after restoration projects. Floodplain vegetation, submerged aquatic vegetation, fish and wildlife, and non-native species were evaluated between 2011 and 2020. Groundwater wells and river channel stations were used to monitor the influence of groundwater levels and salinity on the vegetation communities in the river's floodplain. Three distinct reaches throughout the floodplain were identified as riverine, upper tidal, and lower tidal zones based on the vegetation. The riverine reach was characterized by fresh groundwater, unaffected by salinity, and supported bald cypress trees; however, this reach was affected by historically reduced inundation periods beyond the river channel. The upper tidal reach had a mixed freshwater/brackish groundwater habitat composed of pond apple, pop ash, and a few bald cypress trees in the upper floodplain closer to fresh groundwater sources. The estuarine environment of the lower tidal reach experienced regular intervals of tidal flooding and was dominated by 75% or more mangrove species. The freshwater vegetation (e.g., bald cypress) in the lower tidal and portions of the upper tidal reaches was outcompeted by more salt-tolerant species like mangroves and pond apple. Bald cypress, a keystone species within the floodplain forest, was diminished due to hydrological impacts, saltwater intrusion, and historical logging.

Due to the extensive loss of bald cypress over time, approximately 2,300 bald cypress saplings were planted across 23 acres of river floodplain between 2017 and 2020.

Vegetation surveys conducted in 2003, 2007, 2009, 2010, and 2016 cataloged thirty-eight non-native plant species including seven canopy trees, 27 shrubs and groundcover plants, and four vine species. Non-native plants like Old World climbing fern, Brazilian pepper, melaleuca, and downy rose myrtle continued to threaten native biological communities within the NW Fork. Seed dispersal possibly contributed to the success of these non-native plants within this ecosystem and was most likely accomplished by birds, mammals (e.g., squirrels and humans), water, and wind. The persistence of non-native plant species within the watershed and NW Fork floodplain was managed through manual removal, herbicide treatments, and prescribed fires as part of the land management duties. Since 2011, approximately 50,000 acres have been treated to remove invasive species including, climbing fern, Brazilian pepper, and melaleuca.

Submerged aquatic vegetation, *Vallisneria americana* (American eelgrass), within the NW Fork provided essential fish and nursery habitats, a foraging resource for manatees, fish, turtles, and invertebrates as well as nutrient cycling, sediment stability, and water clarity. Eelgrass extent increased from 1 acre in 2010 to 13 acres in 2012. The presence of eelgrass habitat significantly increased habitat utilization in the NW Fork, with vegetated habitats averaging 4.5 times more fauna and 30% greater diversity than bare habitats. Unfortunately, eelgrass beds were reduced greatly coinciding with Hurricane Irma in 2017. In 2020, a planting project was initiated to restore eelgrass beds to address the loss of aquatic vegetative habitat within the NW Fork.

Wildlife within the river included a variety of native and non-native species. Through anecdotal observations, amphibious vertebrates including frogs, turtles, snakes, and alligators were the most frequently observed animals throughout the watershed area. At least 24 different avian species were noted, including raptors (e.g., osprey swallow-tail kite, barred owl), songbirds (e.g., Carolina wren, American redstart), and wading birds (e.g., little blue heron, white ibis). Several fresh- and saltwater fish species as well as the marine mammal, the West Indian manatee were observed within the river. Sixteen threatened (e.g., Florida scrub jay, wood stork, gopher tortoise) or endangered (e.g., red-cockaded woodpecker, Everglade snail kite) species protected under the Threatened and Endangered Species Act were observed within the watershed or along the river corridor. In addition to native species, non-native vertebrates like wild boar and Cuban tree frogs posed a threat to native plant and animal populations. Though minimal studies on the native and non-native faunal communities were conducted between 2011 and 2020, the revised objectives of the updated plan included additional monitoring to assess the impacts of restoration projects and the management of land, water, and non-native species on these communities.

The ORVs extended beyond the biological communities and natural resources of the NW Fork and included the rich cultural and archeological history of the river. The Loxahatchee River watershed was highly investigated, providing insights into the early settlers and two historic battles of the Loxahatchee. Since 1989, a total of 69 protected archaeological and historic sites were identified, some that were not so obvious and others like the Battlefield at Riverbend Park and the Trapper Nelson Interpretive Site at JDSP that can be experienced by recreational visitors and history enthusiasts alike.

Successful management, preservation, and restoration of the National Wild and Scenic Loxahatchee River was critically dependent upon active public outreach and environmental

education programs. An important function of the river's management plan included objectives for continued monitoring and management of recreational use to not only achieve the plan objectives but to prevent or reduce damage to the river resources. Recreation activities from hiking and biking to boating and paddling provided opportunities to observe nature and wildlife. The Elsa Kimbell Environmental Education and Research Center, the Loxahatchee River District's River Center, and the exploration of historic sites like Trapper Nelson's Interpretive Site provided opportunities to learn about the rich cultural history of the area.

Between 2011 and 2020, over 100 restoration projects within the NW Fork watershed were proposed and implemented to improve freshwater flow and water quality, protect the surrounding habitats, and provide education and outreach opportunities. Restoration projects included hydrologic restoration, stormwater drainage improvements, septic to sewer conversions, ditch plugging, additional culverts, water control structures, and highway enhancements that improved drainage and water quality. This update of the plan followed the completion of the Comprehensive Everglades Restoration Plan (CERP) planning efforts for the Loxahatchee River Watershed Restoration Project (LRWRP) in 2020.

The LRWRP was aimed at restoring river flows to the NW Fork and sustaining freshwater in the floodplain and wetlands of the Loxahatchee River. The primary goal of the LRWRP focused on the improvement of the timing and distribution of freshwater. Aquifer storage and recovery (ASR) wells, enhancements to existing water retention areas and control structures, and improving the connection between Grassy Waters Preserve and the Loxahatchee Slough were among several restoration components outlined in the LRWRP to achieve restoration targets. The elements of this restoration plan would reduce over-drainage, restore hydroperiods throughout the watershed, and encourage the connectivity between the natural areas and the hydrology, flora, and fauna of the river. The LRWRP CERP project was federally authorized in the Water Resources Development Act of 2020 which enabled the United States Army Corps of Engineers (USACE) and the SFWMD to move the project into the construction phase with the need for appropriations to provide funding.

The current management plan update provides an overview of the changes within the Loxahatchee Watershed, a synopsis of the National Wild and Scenic designation, and monitoring summaries of the ORVs over the last decade (2011 to 2020). The goals, objectives, and action plans were revised to reflect the needs of the ecosystem for the next ten years and are consistent with the authorized CERP project. An important function of the plan included the monitoring and management of all ecosystem services to achieve the plan objectives and to minimize damage to the river's resources. Continued monitoring of the ORVs identifies future monitoring and restoration needs and facilitates adaptive management practices to safeguard the ecological and recreational values of the NW Fork. Regular updates to the plan will enable the reevaluation and future revision of the objectives based on management outcomes and new scientific results from monitoring and research efforts.

Chapter 2: Introduction to the Loxahatchee River and Watershed

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The Northwest (NW) Fork of the Loxahatchee River has experienced significant changes throughout history. Some of these changes have added protections to areas within the watershed while other changes have negatively altered the ecological landscape and natural flows throughout the watershed. Increased population and infrastructure and land use changes have increased demand for available water resources. Since the late 1960s, public land acquisitions have provided the opportunity to plan and implement projects through state and local government partnerships to protect and restore the area. Currently, the Loxa-Lucie Headwaters Initiative (ongoing since 2019) is an alliance between three nonprofit organizations with a mission to conserve, protect, and restore water resources of two rivers (Loxahatchee and St. Lucie Rivers) and the natural ecosystems in Martin County. The initiative aims to acquire the remaining undeveloped headwater areas for conservation and create an ecological corridor between two state parks (Jonathan Dickinson and Atlantic Ridge).

2.1. Hydrological History of the River

Humans inhabited the Loxahatchee River watershed approximately 5,000 years ago, possibly longer, as evident through several archaeological sites predating European contact discovered near the river. Before modern development, the Loxahatchee River and Slough provided the only direct aquatic connection from the Indian River watershed to the Everglades and Lake Okeechobee. Early Native Americans used the river and its tributaries extensively for subsistence and travel using dugout canoes through this waterway. Other than the construction of shell and sand mounds along the riverbanks, their impact on the hydrology was minimal. The early Native Americans (e.g., Jobe) eventually disappeared by 1763 due to European diseases and occupational pressures (Wheeler, 1992).

Pioneer settlement of the Jupiter area began around 1885 with homesteads set up along the Loxahatchee River and its tributaries to aid in transportation and agriculture (DuBois, 1981). Most pre-1900 pioneers were engaged in growing pineapples and the earliest citrus groves in the region were established c.1895 in what is now Riverbend Park (DuBois, 1981). Cypress logging on the NW Fork and Kitching Creek occurred during this period, primarily by B. K. Hunt. During this time, the construction of a one-lane sand road from Jupiter to Indiantown bisected the northwestern part of the watershed diagonally and impacted sheet flow (DuBois, 1981).

The first major and deliberate alteration of the watershed occurred in the 1890s with the construction of the Florida East Coast Canal. Completed in 1897, the canal connected the

Loxahatchee River to Lake Worth and bypassed or channelized most of Lake Worth Creek (Liller, 2021a). Lake Worth Creek did not naturally connect to Lake Worth, resulting in the modern Palm Beach Gardens falling originally within the Loxahatchee River watershed. Later in the 1920s, the Florida land boom resulted in the early development of Jupiter Farms and the creation of the South Indian River Water Control District (Snyder and Liller, 2019). Numerous small canals were constructed to promote vegetable farming and cattle ranches which altered drainage in the area further. Lainhart and Masten Dams were built during this time in the upper NW Fork to support local agriculture (Snyder and Liller, 2019). The Seaboard Air Line Railroad was built through the southwestern watershed between Indiantown and West Palm Beach that obstructed sheet flow. The development of Loxahatchee Farms and Groves as an agricultural, and later a residential community, and the digging of the West Palm Beach Canal for flood control began the process of largely cutting off the Everglades and upper Loxahatchee Slough from the Loxahatchee River (Snyder and Liller, 2019).

The first bridge across the Loxahatchee River was the Florida East Coast Railway in 1894 followed by a county road parallel to the railroad in 1911. The bridges were replaced with earthen causeways in the late 1920s which narrowed the river at the bridge crossing areas (Snyder and Liller, 2019). The narrowing of the river combined with the remnant pilings from the 1911 bridge provided a stabilized substrate for the formation of sandbars and oyster bars in the area (Snyder and Liller, 2019).

Jupiter Inlet was a natural inlet prone to frequent closing due to shifting beach sand, adverse winds, and periods of low rainfall. J.W.G. De Brahm, a German cartographer and engineer, conducted the first accurate survey of the inlet and embayment in 1769 (de Vorsey, 1971). However, the watershed remained largely unexplored until the Seminole Wars of the late 1830s (de Vorsey, 1971). Over the next century, visitors noted the Jupiter Inlet's frequent openings and closings but generally failed to document the river. Residents had to reopen the inlet by hand at least seven times between 1885 and 1919. Frustration with the inlet led to the creation of the Jupiter Inlet District in 1921 and the construction of the modern inlet from 1922 to 1923 (Snyder and Liller, 2019; Liller, 2021b). The manmade inlet required dredging to remain navigable and insufficient maintenance resulted in its shoaling closed in 1942 (Figure 2.1; Snyder and Liller, 2019; Liller, 2021b). The Jupiter Inlet was partly reopened by hand, then reopened permanently to navigation by dredge in 1947 (Snyder and Liller, 2019; Liller, 2021b). Further improvements and alterations to the inlet and its jetties occurred in the 1960s and 1990s in addition to almost yearly dredging (Liller, 2021b).

Figure 2.1. The ephemeral Jupiter Inlet closed in 1946 (Photo provided by the Jupiter Inlet District).

The U.S. Army Corps of Engineers (USACE) widened the Intracoastal Waterway in the 1930s, further channelizing Lake Worth Creek, the South Indian River, and the Loxahatchee River near the inlet (Snyder and Liller 2019). In 1942, the federal government acquired over 8,000 acres for Camp Murphy, an Army Signal Corps training camp during World War II. The population of the camp substantially exceeded the rest of the watershed's population and runoff from the camp's wastewater treatment plant contributed to river pollution, especially with the inlet being closed during that time (Snyder and Liller 2019). Camp Murphy closed in 1944, and the state purchased the property in 1947, opening Jonathan Dickinson State Park (JDSP) in 1950 (Snyder and Liller 2019).

The Jupiter area underwent substantial growth in the 1950s resulting in numerous impacts on the river, slough, and watershed (Snyder and Liller 2019). In 1958, the Central and Southern Florida Flood Control District dug the C-18 and C-18 Spur Canals through Loxahatchee Slough and into the Southwest Fork (Snyder and Liller 2019), and Jones Creek was channelized for residential development. John D. MacArthur began developing Palm Beach Gardens and acquired much of

the remaining Loxahatchee Slough area south of Jupiter Farms, including parts of the Northwest Fork corridor (Snyder and Liller 2019). The Florida Turnpike, Beeline Highway (SR 710), and the modern alignment of Indiantown Road (SR 706) bisected the watershed and impacted sheet flow substantially (Snyder and Liller 2019).

Agricultural and residential development continued to impact the river in the 1960s. The digging of the Hobe Grove Canal resulted in flows that shoaled the NW Fork to the NW Fork extent of closing the river at low tide to boat traffic. Kitching Creek, north of JDSP, was channelized for development in western Hobe Sound during this time. In 1965, a dredge and fill project for the NW Fork above the county line triggered a backlash against the development and brought about the first significant efforts to preserve the river, especially the undeveloped NW Fork areas. in the late 1960s a massive Rotonda development in the northwestern part of the watershed of approximately 18,000 acres of mostly swampy land sold for up to $6,000 an acre. The planned development never progressed beyond some canals despite lengthy legal battles due to strict county building and zoning codes. The project included a planned canal that would have connected the St. Lucie Canal to the Loxahatchee River but was opposed by the community and rejected by the USACE.

An independent special district was created by the Florida Legislature in 1971 at the request of concerned citizens and the Loxahatchee Council of Governments. The created Loxahatchee River Environmental Control District (LRECD, previously ENCON) was charged with the mission to preserve and protect the Loxahatchee River. The LRECD began the process of sewage and wastewater management paving the way for modern practices to improve and protect public health and the health of the river.

2.2. Land Acquisition and Management

Early land acquisitions along the NW Fork protected the natural areas from urban sprawl. The natural areas within the NW Fork are classified as environmentally sensitive lands which include the natural upland and wetland communities that support endemic, rare, and endangered species, water resources, and natural outstanding features. In 1947, the Game and Fish Commission (now the Florida Fish and Wildlife Conservation Commission), purchased approximately 52,000 acres of land used previously for timber harvesting and cattle grazing from the Southern States Land and Timber Company and renamed the area after the former commissioner, James Wiley Corbett. Jonathan Dickinson State Park (JDSP) was also acquired in 1947 by the state of Florida from federal ownership. Both land purchases helped pave the way for future land purchases for the protection and preservation of the natural areas. Later in the 1960s (Figure 2.2), agencies such as Florida Park Service (on behalf of JDSP), Palm Beach County (PBC), Martin County (MC), and South Florida Water Management District (SFWMD) partnered to purchase parcels of land that continued the process of restoring the natural water flow and preserving the wildlife corridor. The 1981 Florida Resource Rivers Act, known as "Save Our Rivers", established the Water Management Lands Trust Fund which provided state funding to acquire, restore, protect, and manage environmentally sensitive lands for water resource purposes (Supplemental 1 and 2). Over six decades, approximately 12,000 acres of land (Figure 2.3) have been acquired to plan and implement projects necessary to ensure the conservation and management of natural resources in the Loxahatchee watershed (Figure 2.2).

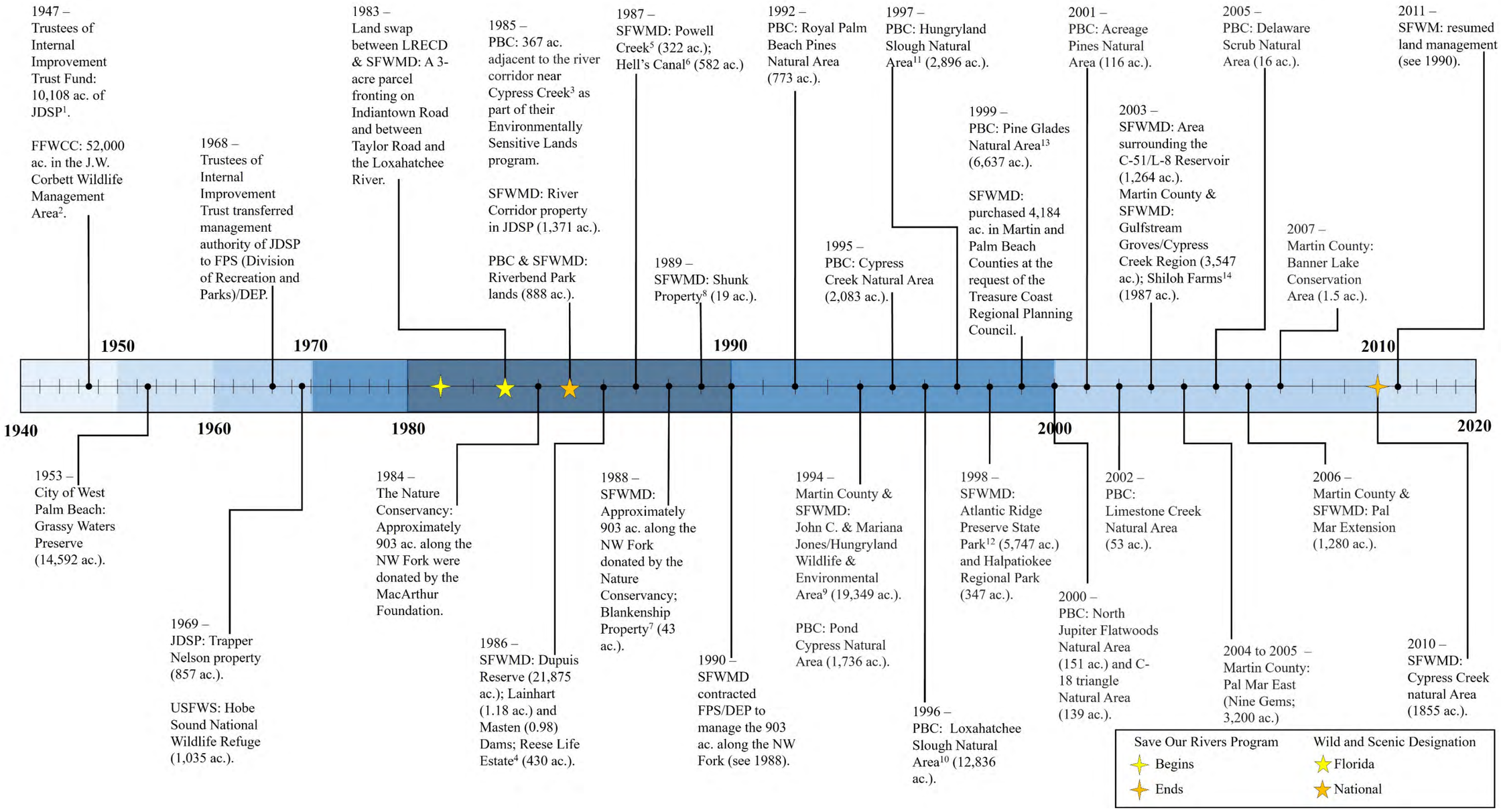

Figure 2.2. Timeline of major land acquisitions and management within the NW Fork from 1940 to 2020. Superscripts correspond to numbered lands in Figure 2.3.

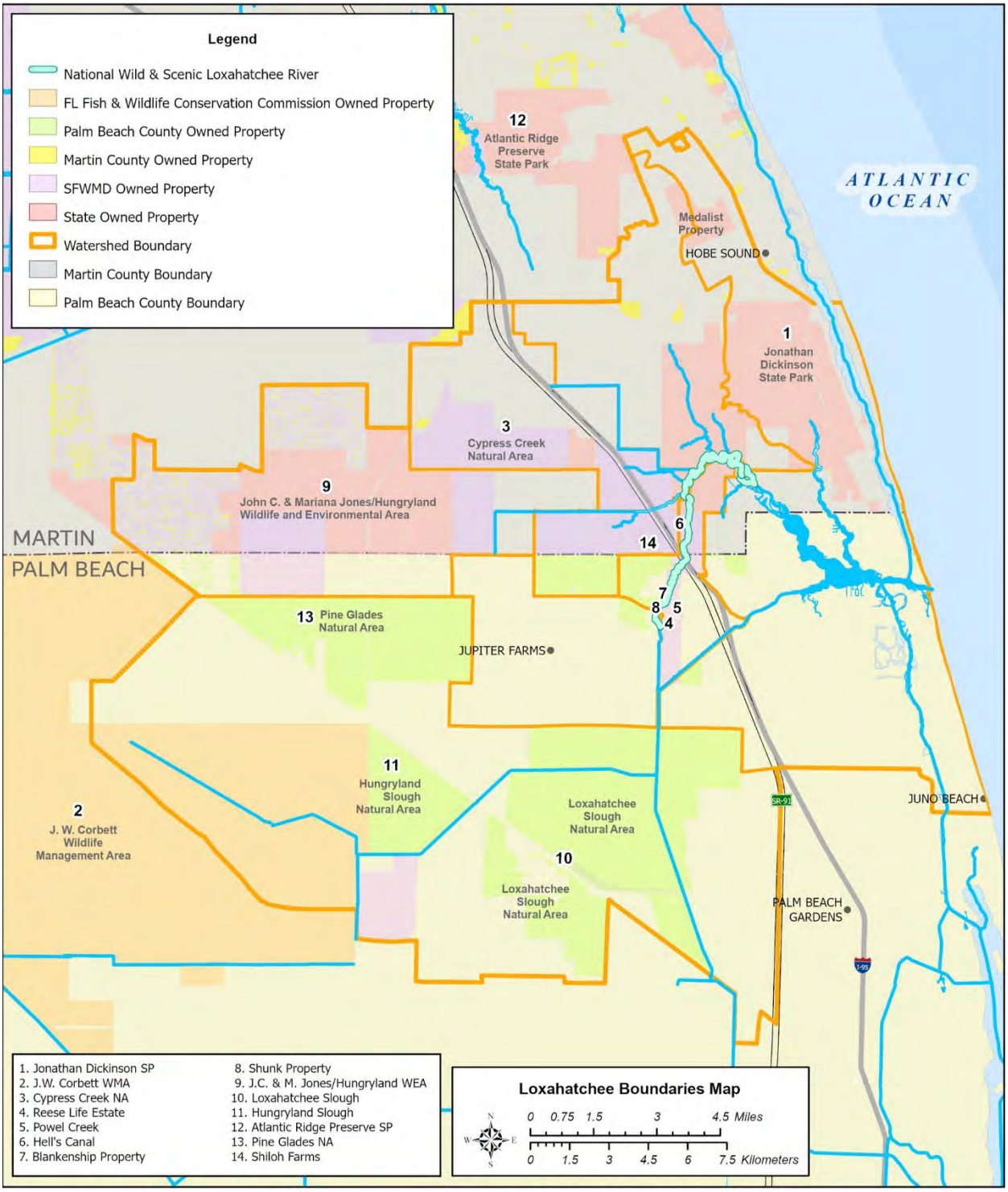

Figure 2.3. Federal, state, and local government-owned and managed public lands within the Loxahatchee Watershed. See the timeline for additional information.

2.3. Land Use Changes within the Loxahatchee Watershed

The geographical area of the Loxahatchee River Watershed covers approximately 240 sq. mi. (660 km^2) and consists of 12 defined drainage basins (Figure 2.4) across portions of Martin and Palm Beach counties. Individual basin boundaries vary in size from 5 to 100 sq. mi. and are divided based on hydrology, land use, topography, permit information, and aerial imagery.

Figure 2.4. The Loxahatchee River watershed.

Land Use/ Land Cover was described by the Florida Land Use and Cover Classification System (FLUCCs) codes, the classification system used to describe the landscape in an area. The four levels in the classification system provided a general to detailed breakdown of land use and cover. Level 1 Land Use Land Cover (LULC) data was defined by Level 1 FLUCCs codes to describe the land use land cover in a large area (Table 2.1). The Level 1 LULC descriptions identified eight general categories throughout the Loxahatchee Watershed using the available aerial imagery for the 2011 to 2020 review period (Figure 2.5).

Table 2.1. The defining features of Level 1 land cover and land use (LULC) categories (FDOT, 1999).

LULC Categories	Definition
Agriculture	Lands that are cultivated to produce food crops and livestock; Cropland and pastureland, tree crops, nurseries, specialty farms, feeding operations, woodland pastures, horse farms, fallow cropland, ornamentals, tree nurseries, dairies, unimproved pastures, row crops, citrus groves, field crops, cattle feeding operations, sod farms.
Barren Land	Lands with very little or no vegetation and limited potential to support vegetative communities; bare soil or rock, disturbed land, dikes, and levees.
Infrastructure	Communications, utilities, transportation, electrical power transmission lines, water supply plants - including pumping stations, roads and highways, electrical power transmission lines, sewage treatment, electrical power facilities, and airports.
Upland Forests	Areas that support a tree canopy closure of 10% or more; includes upland coniferous forests, upland hardwood forests and upland mixed forests, pine flatwoods, live oak, sand pine.
Upland Non-Forested	Herbaceous, upland shrub and brushland, mixed rangeland.
Urban and Built-Up	Areas of intensive use with much of the land occupied by man-made structures: residential low-medium-high densities, commercial and services, industrial, institutional, recreational, and open land.
Water	Streams and waterways, lakes, reservoirs, bays and estuaries, major streams, ocean, and gulf.
Wetlands	Areas where the water table is at, near or above the land surface for a significant portion of time; includes marshes, mudflats, emergent vegetation areas and swamps.

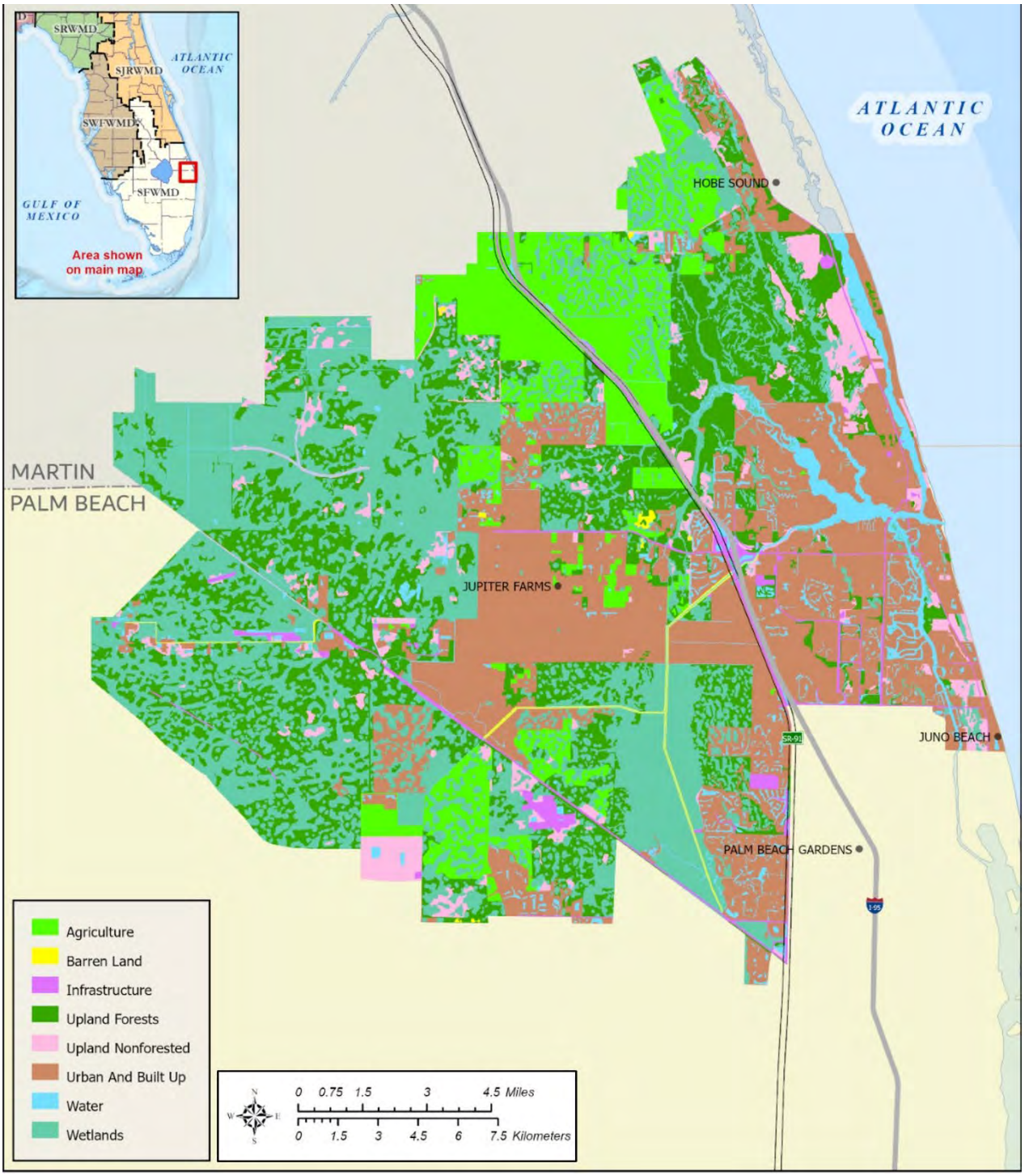

Figure 2.5. Loxahatchee River watershed land cover and land use categories for 2017 and 2019. The minimum mapping unit acquired is 0.5 acres for wetlands and 5 acres for uplands.

Sixty-two percent of the acreage within the watershed was designated as wetlands, upland forests, non-forested uplands, and water bodies (Figure 2.6). Agriculture, urbanized, and infrastructure areas comprise 37% of the watershed. The agricultural area was reduced by approximately 5% between the 2000 to 2010 and the 2011 to 2020 decades. The acreage of the water category shows a reduction of approximately 63% from 1999 to 2009 and has remained at 4% of the total watershed acreage over the last decade. The upland forest acreage increased slightly from 19% between 2000 and 2010 to 20% of the total watershed area from 2010 to 2020. Urban and built-up areas increased by 2%, though no changes were noted in wetlands and barren land categories between the two decades. Changes in LULC may be attributed to land purchases for reclamation and restoration purposes and increased human population and urban sprawl.

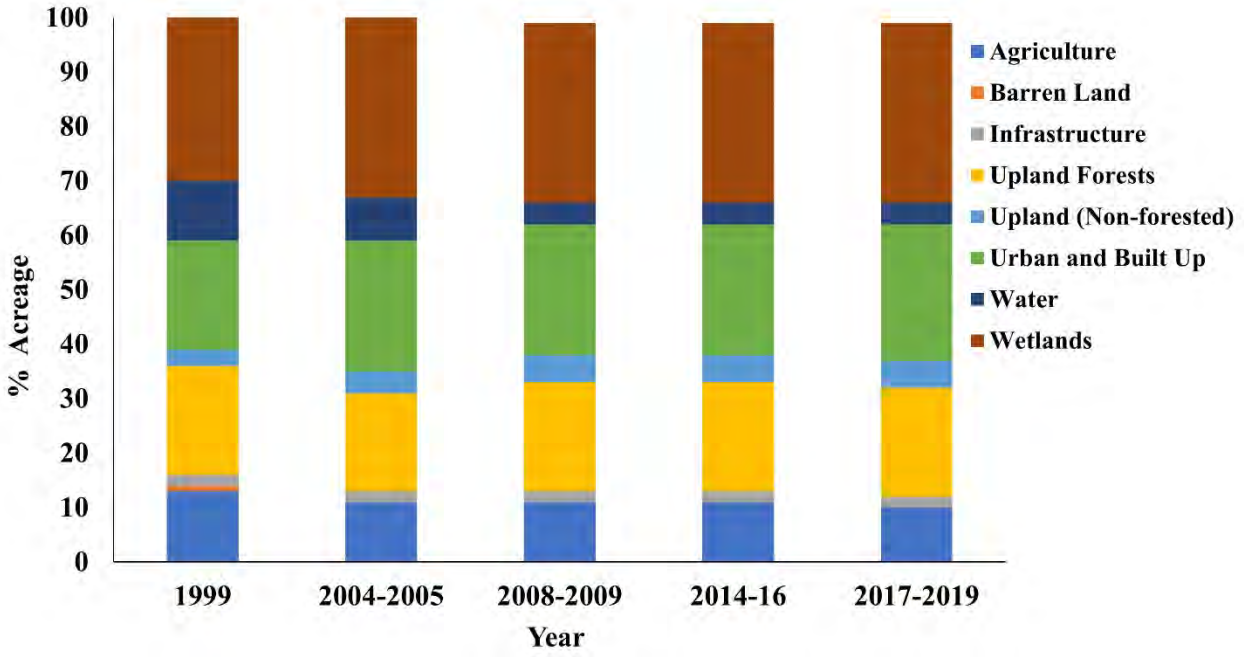

Figure 2.6. The percent acreage of land use dynamics from 1999 to 2019.

2.4. Demographics of the Loxahatchee Watershed

Urban sprawl has modified the land areas throughout the watershed as population increases required urban expansion and fueled the need for new homes, businesses, and necessary infrastructure (Figure 2.7) Population changes were documented over the last decade within the Loxahatchee watershed. According to the U.S. Census Statistics from 2000 and 2010, the population increased by 15.5% in Martin County and 16.7% in Palm Beach County (Table 2.2). Populations continued to increase in both counties from 2010 to 2020, with more than 12, 000 and 172,000 individuals moving to Martin and Palm Beach counties, respectively (Table 2.2). Population estimates were available only for the counties and were not estimated for the Loxahatchee watershed alone. Increased population density can put additional strain on the land and water resources of the region, likely changing the dynamics of the ecosystem.

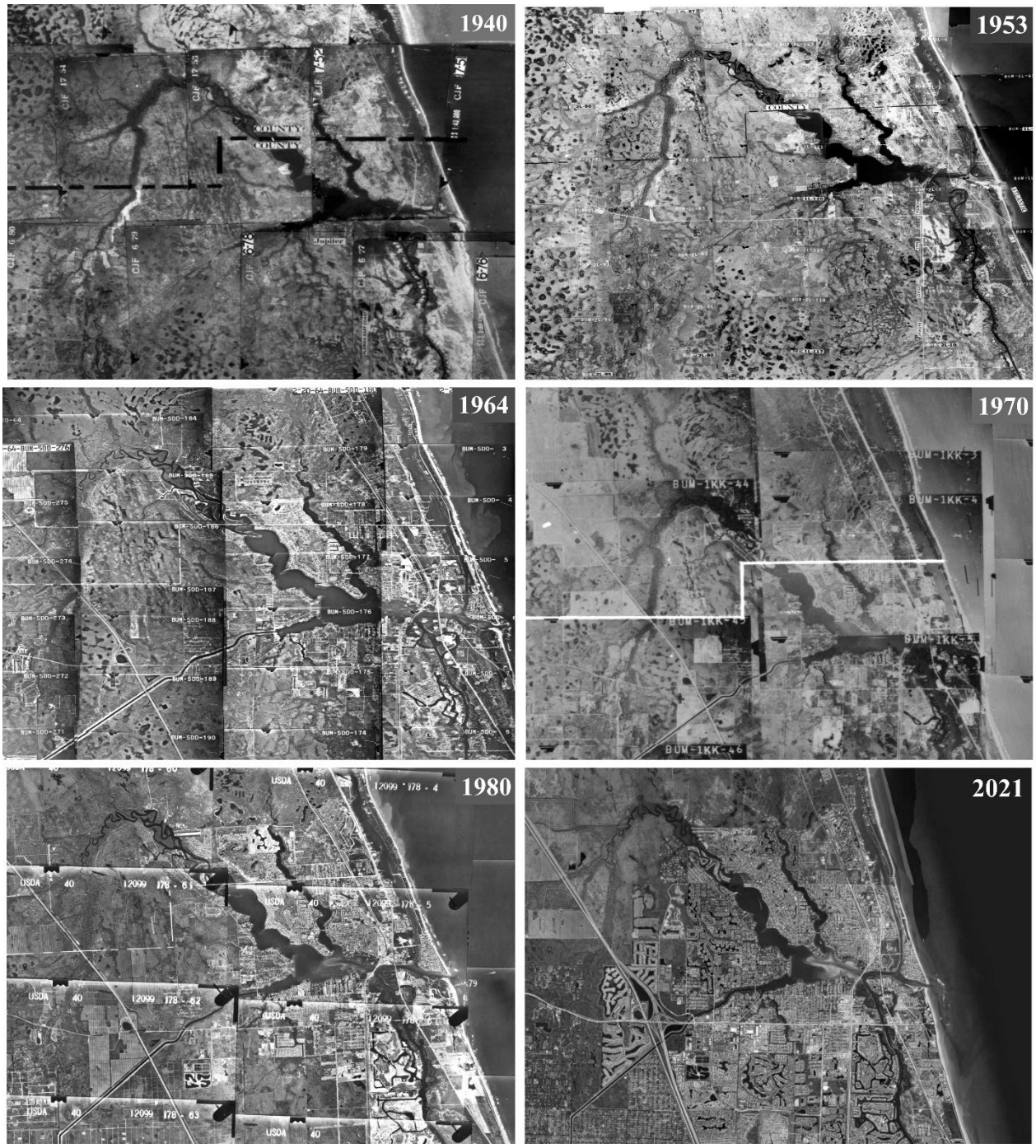

Figure 2.7. Historical maps (1940 to 1980) and 2021 imagery show the changes in the landscape and urban sprawl within the watershed over time.

Table 2.2. Population and land area based on Florida census data. Seasonal population increases are not included in these estimates.

County	2000[1]	2010[1]	2020[2,3]
Martin (543.5 sq. miles)	126,731	146,318	158,431
Palm Beach (1,964.30 sq. miles)	1,131,184	1,320,134	1,492,191
Total	**1,257,915**	**1,466,452**	**1,650,622**

1. Florida Center for Instructional Technology, Florida Census
2. Martin County Census
3. Palm Beach County Census

Tourism, a major driver of Florida's economy, peaked during the winter months when many visitors and "snowbirds" (overwintering) from the north stayed in the area (FCIT, 2002). Though the exact number of visitors to this area was not available, it was estimated that over 87 million visitors came to Florida in 2020 (Turner, 2021). Due to the COVID-19 pandemic, 2020 estimates did not increase as expected and were near 2010's roughly 83 million visitors (Turner, 2021). The river draws locals and visitors to the area for recreational activities like boating, fishing, and the natural subtropical landscape, with more than 65% of their outdoor activities occurring on public lands (Seidel et al., 2017). The publicly owned Loxahatchee's National Wild and Scenic River is a valuable economic and ecological resource to Florida's southeast region.

2.5. Water Resources of the Loxahatchee River System

The Loxahatchee River watershed system is comprised of groundwater resources, natural tributaries, and man-made canals that flow into the river. Rainfall, runoff, and groundwater seepage are freshwater sources for the river and surrounding wetlands and canals. Surface water and groundwater interact with one another as water enters the watershed. The rate of that interaction is highly dependent on seasonality and the conditions in the watershed and alters the water exchange between the river and the underlying aquifer.

The Loxahatchee River flows above two major aquifers: the shallow surficial aquifer (100 to 300 ft. deep) and separated by impermeable clay (VanArman, 2002) the deeper Floridan aquifer (~1000 ft. deep) (SFWMD, 2002; SFWMD, 2012). The surficial aquifer is recharged by surface water that supplies base freshwater flows to the river and maintains the surrounding wetlands. As water levels decline during the dry season, groundwater seepage from the surficial aquifer provides freshwater to the river. The primary source of potable water for the watershed is obtained from the surficial aquifer. Withdrawals from the surficial aquifer affect groundwater availability for the river and influence water levels in adjacent wetlands (SFWMD, 2002). To limit the demands on the surficial aquifer and allow more water for the environment, the Floridan Aquifer, though highly saline, can be another water supply source. For example, the Town of Jupiter, Village of Tequesta (VanArman, 2002), and South Martin Regional Utility utilize a desalinization treatment process for water withdrawn from the Floridan Aquifer to supplement their water supply. Water withdrawals from the groundwater-rich Floridan Aquifer system do not influence the groundwater supply to the river (VanArman, 2002).

Historically, water flowed into the NW Fork from the Loxahatchee and Hungryland Sloughs. The Loxahatchee Slough is the primary source of freshwater in the NW Fork due to the addition of infrastructure in the late 1950s (Figure 2.8A). The Loxahatchee Slough is a combination of a mesic/hydric hammock, mesic/wet flatwoods, wet prairie marshes, and strand/dome swamps that provide natural filtration before entering the NW Fork. Water leaving the Loxahatchee Slough flows into the C-18 canal providing the river headwaters. Seven watershed basins surround the NW Fork (approximately 220 sq. mi.; Figure 2.8A) and provide additional freshwater through tributaries draining directly into the river.

Surface water enters the NW Fork from the wetlands in northern Palm Beach County. Additional surface water enters the river through the upstream tributaries: Cypress Creek, Hobe Grove Ditch, Moonshine Creek, and Kitching Creek (Figure 2.8B). Over time, major wetland systems were drained for agricultural and urban development (Van Arman, 2005) though much of the watershed remained in a natural undeveloped state. The extensive freshwater wetlands and intact natural areas within the watershed include Jonathan Dickinson State Park, Cypress Creek Natural Area, Jones/Hungryland Wildlife Environmental Area, J.W. Corbett Wildlife Management Area, Loxahatchee and Hungryland Sloughs, Pine Glades Natural Area, Riverbend County Park, and Grassy Waters Preserve/Water Catchment Area (Figure 2.8B).

The C-18/Corbett Basin is the largest in the watershed (103 sq. mi.) and is in northern Palm Beach County. Much of the area is protected publicly owned land encompassing most of the western watershed. Sixty-nine percent of the land was categorized as marsh wetlands, including the Loxahatchee and Hungryland Sloughs, a portion of the J.W. Corbett Wildlife Management Area (WMA), and assorted agriculture and residential communities. Water from this basin drains into the C-18 Canal (Figure 2.8A) where flow is diverted to the NW Fork through the C-14 canal controlled at the G-92 structure or to the Southwest (SW) Fork. The G-92 structure was built in 1975 to improve the flow connectivity of the Loxahatchee Slough to the NW Fork through the C-18. The C-18 is the largest conveyor of freshwater to the NW Fork, allowing 51-56% of the flow to the river channel. The S-46 structure at the downstream end of the C-18 maintains canal water levels during the dry season and discharges excess water under wet conditions to the SW Fork.

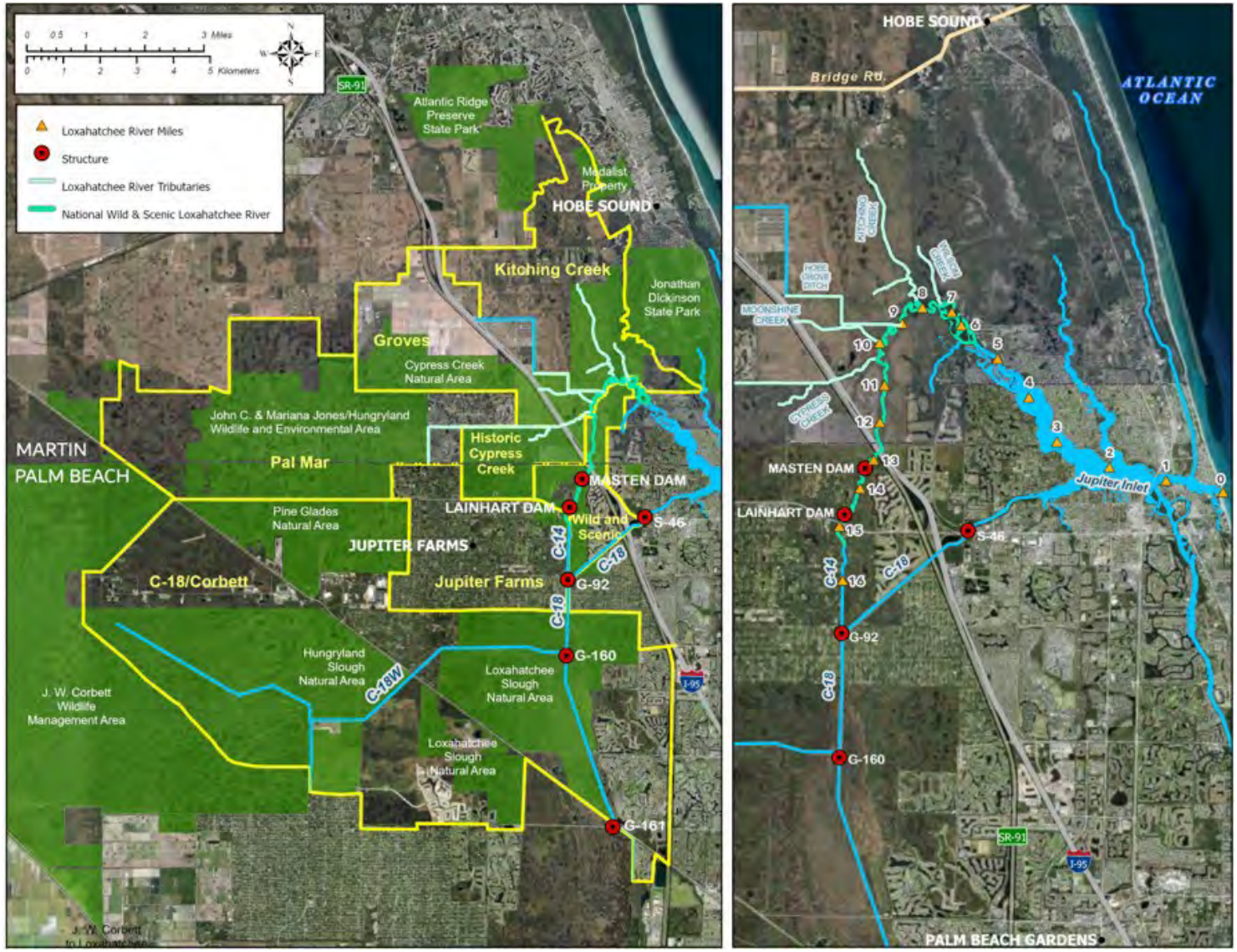

Figure 2. 8. (A) Basins surrounding and (B) tributaries of the NW Fork.

The Jupiter Farms Basin area is over 16 sq. mi. with approximately 91% (9,359 acres) of this basin classified as urban land (Figure 2.8A. The extensive stormwater drainage canal system is controlled by gravity control structures and is managed by the South Indian River Water Control District. Discharges from these canals flow directly into the NW Fork at the north end of the C-14 canal, directly into the C-14 canal, or south into the C-18 canal.

The Wild and Scenic Basin covers over 6.8 sq. mi. with 59% of the area composed of wetlands (Figure 2.8A). The basin is divided into two upstream sections: Riverbend County Park at the southern end and the "Wild and Scenic" portion of the NW Fork in the downstream area to the north. Water from the upstream section of the basin discharges into the upper end of the Loxahatchee River at the G-92 structure into the C-14 canal.

The Historic Cypress Creek Basin, the smallest basin serving the NW Fork, covers 5.6 sq. mi. with 84% in wetlands. Much of this basin was purchased for restoration and preservation and is publicly owned. Water from this basin drains into Cypress Creek at the southeastern portion of the Pal Mar and Grove West basins. The Cypress Creek tributary enters the river from the west, downstream from the Trapper Nelson Interpretive Site within JDSP. Cypress Creek (RM 10.3) the second largest contributor of freshwater to the river, provides 26% to 32% of the total flow to the NW Fork (Figure 2.8A).

The Pal Mar Basin is in southern Martin and northern Palm Beach counties. The western portion of the watershed covers 35.4 sq. mi. with 86% of the basin located in the wetland of John C. and Mariana Jones/Hungryland Wildlife and Environmental Area (Figure 2.8A) linking J.W. Corbett Water Management Area and JDSP. Most of the land remains in a natural state with roughly 70% of the land under public ownership with some rural developments along the eastern flow-way. The natural wetland areas in Pal Mar Basin are a major freshwater contributor to the NW Fork as the headwaters of Cypress Creek flow through the Historic Cypress Creek Basin.

The Groves basin is roughly 17 sq. Mi. with 50% of the area previously farmed for citrus and vegetables (Figure 2.8B). Water from this basin flows into Hobe Groves Ditch, Moonshine Creek, and Cypress Creek, draining to the NW Fork (Figure 2.8B). Hobe Grove Ditch provides roughly less than 5% of the freshwater flow into the NW Fork through a water control structure operated by the Hobe St. Lucie Conservancy District. Though the hydrology in this basin was altered to support agriculture, the land provides a valuable greenway corridor for wildlife utilization within the watershed.

Kitching Creek Basin is located at the northeastern portion of the Loxahatchee River watershed north of and within JDSP (Figure 2.8A). The 36 sq. mi. basin is the least developed of all the basins draining to the NW Fork and contains a large water retention area. Runoff from this basin originates in a natural forested wetland where a portion of surface and groundwater flows into the Kitching Creek tributary and contributes 12% of the flows to the NW Fork.

2.6. Demands on the Loxahatchee Watershed

The Loxahatchee River ecosystem supports a wide range of ecological habitats including riverine floodplain vegetation (e.g., bald cypress) and saltwater tidal vegetation (e.g., mangroves). The NW Fork contains one of the few remaining natural subtropical riverine cypress swamps in southeast Florida (SFWMD, 2004a; Van Arman, 2007). Protection of this riverine habitat requires

the maintenance of minimum freshwater inflows to the NW Fork to reduce the occurrence of saltwater intrusion, which is lethal to seedling cypress trees, and mangrove invasion within the critical upstream cypress habitat (SFWMD, 2002). Freshwater of sufficient quantity, quality, and appropriate timing is essential to maintain the unique and diverse native plants and wildlife communities. Changes to the river corridor, surrounding lands, and watershed have increased the demands on the river threatening the upstream environments.

In 2002, the SFWMD developed Minimum Flows and Levels (MFL) criteria for the NW Fork that defined the legally required minimum flow of water over the Lainhart Dam to meet the needs of the river system and avoid significant harm to the riverine ecosystem. As a result of repeated MFL violations, recovery strategy plans ((Lower East Coast Water Supply Plan (LEC), Loxahatchee River Watershed Restoration Plan (LRWRP), a component of the Comprehensive Everglades Restoration Plan (CERP), and the Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP)) were initiated to meet the MFL requirements and achieve the restoration goals.

Agricultural practices, increasing urban sprawl, and necessary infrastructure have impacted the wetland communities within the watershed, fragmenting the natural hydrologic landscape. The manmade boundaries (i.e., infrastructure) such as the C-18 canal, Florida Turnpike, Interstate 95, SR 710, Bridge Road, and extensive secondary canals further divided the basins. Anthropogenic modifications have also detached greenway connections resulting in the loss of some wildlife habitat.

Drainage canal network (e.g., canals and water control structures) modifications and upgrades throughout the watershed have contributed to environmental impacts over time. For example, the western portion of the Cypress Creek basin was composed of mesic/wet flatwoods, depression marshes, and wet prairies as an important freshwater reservoir. The Cypress Creek basin experienced reduced water levels due to canal construction and improvements. Though much of these wetlands remained intact, the eastern flow-ways leading to the creek were disturbed by rural development prompting state and local governments to purchase most of the basin area.

Groundwater resources withdrawn from the surficial and Floridan aquifers were a major source of consumptive water use, including public water supply (PWS) (Figure 2.9). Consumptive water use permits were issued selectively as consumptive use removes water from a resource making it unavailable for other uses. Permits issued for PWS (i.e., drinking water) and private needs included irrigation (e.g., agricultural, nursery, and golf courses), dewatering, and power but did not cover domestic usage (see SFWMD ePermitting). Irrigation permits to utilize surface water resources and groundwater withdrawals were the first restricted during drought conditions. The SFWMD monitored wells and consumptive water use permits to ensure compliance and adequate aquifer conditions and prevent resource exhaustion and saltwater intrusion.

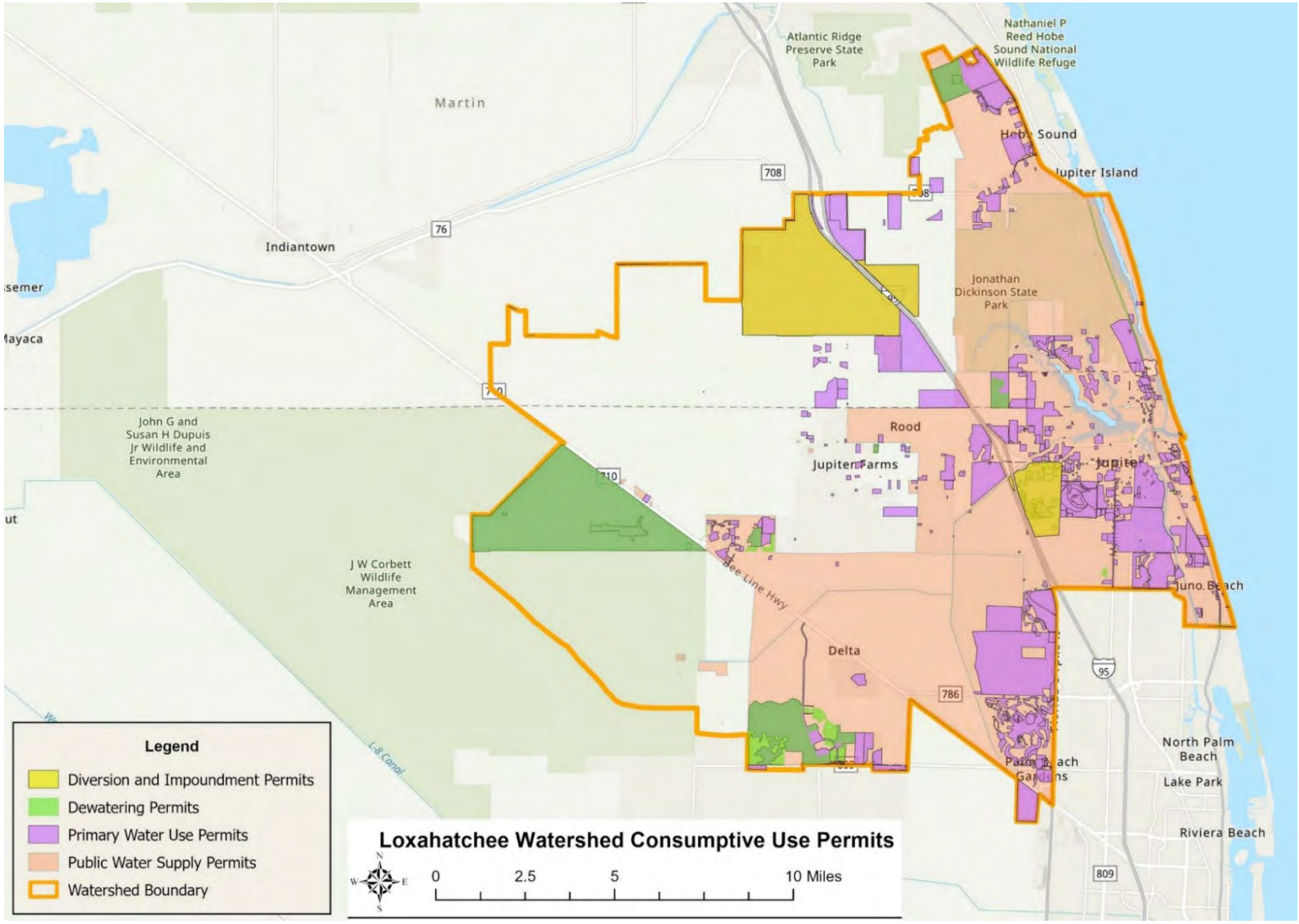

Figure 2.9. Consumptive water user issued permit areas within the Loxahatchee watershed.

Population size impacted the demand on the PWS within the watershed. In 2020, Palm Beach County's population was approximately ten times greater than the population of Martin County. An estimated total water usage (per water use permit) withdrawn from the watershed for Martin County was 12.6 million gallons/day (mgd) compared to Palm Beach County's usage of 66 mgd (Table 2.3). Public water supply in Martin County accounted for 5% of the total consumptive water use withdrawn from the watershed. In Palm Beach County, 9% of the total water use withdrawn from the watershed was used for public water supply. Approximately 61 mgd was withdrawn from the watershed for consumptive use in 2020 (Table 2.3).

Table 2.3. Water usage (per issued permits) by county and within the Loxahatchee Watershed as of 2020.

County	Population Size (# of individuals)	Total County Water Use (mgd)	Total Loxahatchee Watershed Water Use (mgd)	Total County PWS Water Use (mgd)	Total Loxahatchee Watershed PWS Water Use (mgd)
Martin	158,431	88.93	12.63	20.65	4.59
Palm Beach	1,492,191	659.46	66.29	278.15	56.69
Total	1,650,622	748.4	78.92	298.8	61.28

Over the last decade (2011 to 2020), numerous restoration projects within the NW Fork watershed were proposed, with some implemented, to improve freshwater flow and protect the surrounding habitats. Several restoration projects included hydrologic restoration, stormwater drainage improvements, ditch plugging, added culverts, and water control structures. Anticipated highway enhancements will improve drainage and water quality while adding wildlife crossing areas (i.e., corridors) to protect local wildlife populations. Moving into the next decade, federally approved projects within CERP's Loxahatchee River Watershed Restoration Project (LRWRP) to improve and regulate flows through the NW Fork have begun. The overall purpose of the LRWRP is to improve the quantity, quality, timing, and distribution of freshwater to the National Wild and Scenic NW Fork. The LRWRP aims to restore natural water flows to the river, reconnect the fragmented wetlands and drainage basins that were once the headwaters of the NW Fork, and minimize the impacts of the anthropogenic demands on the watershed. In 2022, the SFWMD drafted a technical document supporting amendments to the consumptive use permitting criteria to protect water resources made available by the LRWRP.

Chapter 3: The National Wild and Scenic Designation of the Loxahatchee River

Barbara H. Welch and Elizabeth Salewski

SFWMD

3.1. The Wild and Scenic Rivers Act

Enacted in 1968 by Congress, the Wild and Scenic Rivers Act protects over 13,400 miles of rivers and streams throughout the United States and is the most powerful way of preserving the nationally designated free-flowing rivers in the country. The Act required a comprehensive management plan to protect the values and resources of each river, including the adjoining lands, facilities, and user capacities. The management plan was prepared by the state and local governments with contributions from the concerned public and is published in the Federal Register.

Rivers listed under the Wild and Scenic Rivers Act provided special protections that include:

- Protection of the river's outstanding remarkable values and free-flowing character.
- Protection of the existing uses of the river.
- Forbids federally licensed dams or other federally assisted water resource projects if the project will negatively impact the river's outstanding values.
- Establishes, at a minimum, a quarter mile protected riparian buffer corridor on both sides of the river.
- Requires the creation of a cooperative river management plan that addresses resource protections, development of lands and facilities, user capacities, etc.

To qualify for the national designation, a river must be free-flowing and possess outstanding remarkable values (ORV). "Free-flowing" was defined by the Wild and Scenic Rivers Act as existing or flowing in the natural condition without impoundment, diversion, straightening, riprapping, or other waterway modifications. The act identified ORVs as the categories that specified the river's worthiness of special protection and national recognition and included scenic, recreational, geologic, fish and wildlife, historic, and cultural values. These ORVs were required to be unique and rare compared to other rivers and must contribute to the function of the river ecosystem or owe their existence or location to the presence of the river.

3.2. The Loxahatchee River Designation

The Wild and Scenic Rivers Act offered two methods for obtaining the federal designation: by Congress or the Secretary of the Interior. Congress would designate a river, typically on federal lands, and assign a managing agency. For the Secretary of the Interior process, however, two conditions were required: a river must be designated by an act of the state legislature and administered as wild, scenic, or recreational by an agency of the state. If both secretarial conditions were met, the Governor may apply for designation to the Secretary of the Interior.

The designation process for the Loxahatchee River's Northwest (NW) Fork began in 1965 after local communities expressed the need for state and federal government intervention to protect the river. Public concern prompted the NW Fork to be included in the National Parks and Recreation Act of 1978. The qualification process for the NW Fork designation began in July 1982 with a draft of the Wild and Scenic River Study Environmental Impact Statement (EIS; NPS, 1984). The EIS identified 7.5 miles of the river in the NW Fork that met the criteria to be included in the National Wild and Scenic River System:

> The Loxahatchee River as a subtropical river-swamp ecosystem would make a unique addition to the National Wild and Scenic Rivers System. This scenic southern river flows through an interesting vegetative landscape which supports a wide range of aquatic and terrestrial fish and wildlife species. The river also provides for an abundance of bird species. There are currently no rivers within the National System which even approximate the character of this unique subtropical coastal plain river (NPS, 1984).

In January 1983, the office of the Governor adopted a resolution endorsing the designation and directed the development of a management plan. As required by the Secretary of the Interior, the Florida Loxahatchee River Wild and Scenic Rivers Designation and Preservation Act 1983 (Chapter 83-358 Laws of Florida) was enacted the following June. The Act required the Florida Department of Environmental Protection (DEP) and the South Florida Water Management District (SFWMD) to lead and jointly develop, administer, and implement the required management plan. The Act specified a permanent management coordinating council, the Loxahatchee River Management Coordinating Council (LRMCC), to oversee the river's protection.

Governor Bob Graham petitioned the Secretary of the Interior in December 1984 to add the NW Fork of the Loxahatchee River to the National System. The first river management plan was completed by the Florida Department of Natural Resources (January 1985), approved by the Governor, and sent to the Secretary of the Interior. In May 1985, the Loxahatchee River received the National Wild and Scenic River designation protecting approximately 7.6 miles between Riverbend Park to the downstream end of Jonathan Dickenson State Park (Federal Register, 50(100), 1985).

3.3. The Protected Corridor and River Area Classifications

A river corridor is defined as where water flows through the landscape and includes part of the surrounding riparian vegetated areas. The extent of the Loxahatchee River corridor included the maximum upland extent of the floodplain's wetland with a 100 ft. buffer on both sides or 350 ft on both sides from the center of the river channel. River corridor delineations were important to preserve wildlife habitat, control erosion and river sedimentation, and protect recreational areas. The delineated protected areas within the NW Fork corridor (Figure 3.1) were defined by the 1983 Rivers Act and explained in the original management plan of 1985 based on three criteria: 1) sufficient width to include all natural areas identified as outstanding, remarkable, or warranted by the National Park Service (NPS), 2) be accessible for land management responsibilities and 3) lies within state-owned lands (Chapter 83-358 Laws of Florida).

According to the National Wild and Scenic River System Act, rivers were classified as Wild, Scenic, Recreational, or a combination of the three (Public Law 90-542). River segments classified

as "Wild" were described as areas with uncontaminated watersheds, free of impoundments, and were generally inaccessible except by trails. Wild areas represented the vestiges of primitive America. "Scenic" areas were free of impoundments, with shorelines or watersheds largely primitive and undeveloped and have limited road access. "Recreational" sections were portions of the river that were readily accessible by infrastructure, may have some development along their shorelines, and may have undergone some impoundment or diversion in the past. Regardless of the classification of the river areas, the goal was to protect and enhance the outstanding remarkable values that support the Wild and Scenic designation.

Figure 3. 1. River classification areas by segment and the river corridor.

The Loxahatchee River's NW Fork was classified into four segments (Figure 3.1). The original 7.6 miles designated in 1985 was increased to 9.75 miles in 2003 with the use of Global Positioning System (GPS) to map the river more accurately (SFWMD, 2006), though the expansion did not include the end of the natural river corridor at the start of the C-14. The river classifications and updated extent of the four segment areas were described below:

> Segment 1, the smallest segment, is classified as Recreational and begins within Riverbend Park at RM 15.5. Segment 1 continues north for about 0.4 miles to RM 14.9 where Indiantown Road crosses above the river.
>
> Segment 2 is classified as Scenic and begins at Indiantown Road crossing at RM 14.9 and continues 2.2 miles to RM 12.8 just north of the FL Turnpike crossing.
>
> Segment 3 is classified as Wild and starts at RM 12.8 just north of the FL Turnpike crossing. Segment 3 continues north for approximately 2.3 miles to RM 10.5 at the Trapper Nelson Interpretive Site.
>
> Segment 4 is classified as Scenic and is the longest segment. Segment 4 begins at RM 10.5 and continues for 4.6 miles to RM 5.75 at the southern boundary of Jonathan Dickenson State Park.

Management of this National Wild and Scenic River and its corridor is the responsibility of the Florida DEP and the SFWMD in cooperation with other state and local government agencies. Florida DEP management of the river was directed under the Jonathan Dickinson State Park's Unit Management Plan and included regulatory and resource management, law enforcement, and emergency response (DEP, 2012). The SFWMD is responsible for water resource management activities including exotics control to protect and assist in addressing management plan objectives from Indiantown Road to the JDSP boundary. The SFWMD responsibilities include regulating the quantity, quality, and timing of water entering the river from historical wetland inflows, tributaries, and the drainage basins and ecosystem restoration within the Loxahatchee Watershed.

In addition to affording protections to NW Fork, the Wild and Scenic River Act (Chapter 83-358 Laws of Florida) established the LRMCC, which consisted of 25 representatives from federal, state, regional, and local entities (Supplemental 3). The Council served as an advisory council to the lead agencies and identified and facilitated inter-governmental coordination on issues related to the Loxahatchee River system. The Council enhanced communication between the agencies and stakeholders and ensured that the objectives of the management plan were attained through interagency assistance, collaboration, and management. Further, the Act required Florida DEP and SFWMD to jointly develop, administer, implement, and update the management plan. The first management plan was approved in 1985 with subsequent updates to the plan occurring in 2000 and 2010 at the request of the LRMCC. In 2014, Florida enacted Statute F.S.253.034(5) that required managers of conservation lands to provide the Florida Division of State Lands with an update to management plans at least every ten years. The Loxahatchee River National Wild and Scenic River Management Plan will now be updated every ten years.

Chapter 4: Management and Protection of the Outstanding Remarkable Values

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The Wild and Scenic Rivers Act of 1968 focused on preserving and protecting the river's resources. In 1985, the Loxahatchee River Northwest (NW) Fork was nationally designated as a Wild and Scenic River. The designation identified Outstanding Remarkable Values (ORVs) as the categories that specified the river's worthiness of special protection and national recognition. The ORVs were further defined in the 2006 Restoration Plan (SFWMD) for the NW Fork by applying a resource-based management strategy identified as Valued Ecosystem Components (VECs). These VECs included specific species or communities based on their complex ecological composition and environmental factors like hydrology, soil conditions, and exposure to fire, non-native plants and animals, and saltwater intrusion. The specific VECs were the criteria that the ORVs were evaluated to identify possible stressors, recommend mitigation, and provide a better predictor of the ecological effects of human activities.

The five ORVs of the Loxahatchee River and the National Wild and Scenic NW Fork were considered resources worthy of special protection and management. These ORVs are:

4.1 Watershed Drainage and Hydrology
4.2 Water Quality
4.3 Biological Communities
4.4 Historic and Cultural
4.5 Recreation and Outreach

The following subsections of the management plan provided information on each identified ORV. Each section was organized as follows:

1. Assessment
   Scope – brief description of the ORVs including VECs, and what was managed.
   Background – narrative description of the ORVs, including VECs.
   Conditions – the status of the ORVs, including VECs, from 2011 to 2020 and a comparison to previous conditions (from 2000 to 2010).
2. Goals and Objectives
   For each value, one or more goals were established for management and protection. Each goal had at least one objective that, if achieved, would contribute to accomplishing the goal.

3. Action Plan

   Each objective had at least one action presented in a table at the end of each section. A priority level was identified for each objective. Priority levels were determined by the Loxahatchee River Management Coordinating Council (LRMCC) using the following criteria:

   1. Legally required, planned, or funded; action will be taken within the 10-year planning period.
   2. In planning, may or may not be funded; action may not happen within the 10-year planning period.
   3. Not planned or funded; action not expected to start within the 10-year planning period.

Priorities were subject to change based on the needs of the LRMCC and available resources. The responsible entities and expected duration were identified for each action item. Entities assigned to a particular action may vary based on the direction or resources of the participants. The duration was noted as once or ongoing, though it may be appropriate to repeat certain actions if conditions change. Implementation of the Action Plan for each objective depended upon the availability of resources and based on the needs of the LRMCC.

4.1. The Loxahatchee River Watershed, Drainage, and Hydrology

The Loxahatchee River watershed, drainage, and hydrology were assessed to investigate the movement, distribution, and management of water above and below (groundwater) the surface throughout the watershed. The watershed consisted of drainage basins within different land areas that conveyed water and converged into a common area. Temperature, rainfall, and weather patterns contributed to the drainage and hydrology relating to land dynamics within the watershed.

4.1.1. Assessment

Scope

The scope of the watershed, drainage, and hydrology assessment is to provide an overview of the Loxahatchee River watershed and document any changes within the 2011 to 2020 decade, offering a comparison to the previous (2000 to 2010) decade. The assessment encompassed the water flow through the watershed, temperature and rainfall, groundwater resources and floodplain groundwater levels, and improvements to water control structures throughout the NW Fork drainage basin. Further, floodplain inundation and water residence times were evaluated for 2011 to 2020 and future sea level scenarios.

Background

The Loxahatchee River Watershed

The Loxahatchee River watershed (Figure 4.1), located within northern Palm Beach and southern Martin counties, covers an area of approximately 240 square miles (660 km^2) and drains into the Atlantic Ocean through the Jupiter Inlet. The Loxahatchee River has three major tributaries: the Northwest (NW) Fork, the North Fork, and the Southwest Fork. The three tributaries drain to the

central embayment ultimately discharging into the Atlantic Ocean via the Jupiter Inlet (SFWMD, 2006). The watershed's hydrology includes 12 basins that drain into the Loxahatchee River with seven of these basins draining directly into the NW Fork. From 2011 to 2020, changes occurred within the watershed, including renovations to the dams and other water control structures, climate and precipitation, land use, groundwater resources, and river hydrology, but the overall boundaries of the watershed have remained the same.

Figure 4.1. The Loxahatchee River watershed.

Conditions from 2011 to 2020

Air Temperature

Hydrology throughout the watershed may be impacted by air temperature. Air temperature influences the rate and the amount of water evaporated from the ground and transpired by vegetation (evapotranspiration). Higher air temperatures may increase evapotranspiration, decreasing water availability to the river (Luo et al., 2013) and disrupt the hydrology throughout the watershed. Air temperature data within the northern and southern borders of the Loxahatchee watershed were obtained and summarized from three main weather stations within the watershed: JDSP (JDWX), Juno Beach (JB), and Palm Beach International Airport (PBI). Data from the JDWX were obtained from SFWMD's DBHYDRO and the Juno Beach and PBI data were obtained from NOAA from 2000 to 2020.

Annual daily average temperatures were consistent throughout the two decades and were similar between JB and PBI. Median daily average temperatures remained approximately 24℃ (75.2°F) in JDSP and 29℃ (84.2°F) in JB and PBI throughout both decades (Figure 4.2). Temperatures in JB and PBI were warmer, approximately 4.8°C to 6.7°C from 2000 to 2010 and 4.3°C to 8.1°C from 2011 to 2020 than temperatures at JDWX (Figure 4.2) most likely due to the urbanization within the JB and PBI regions.

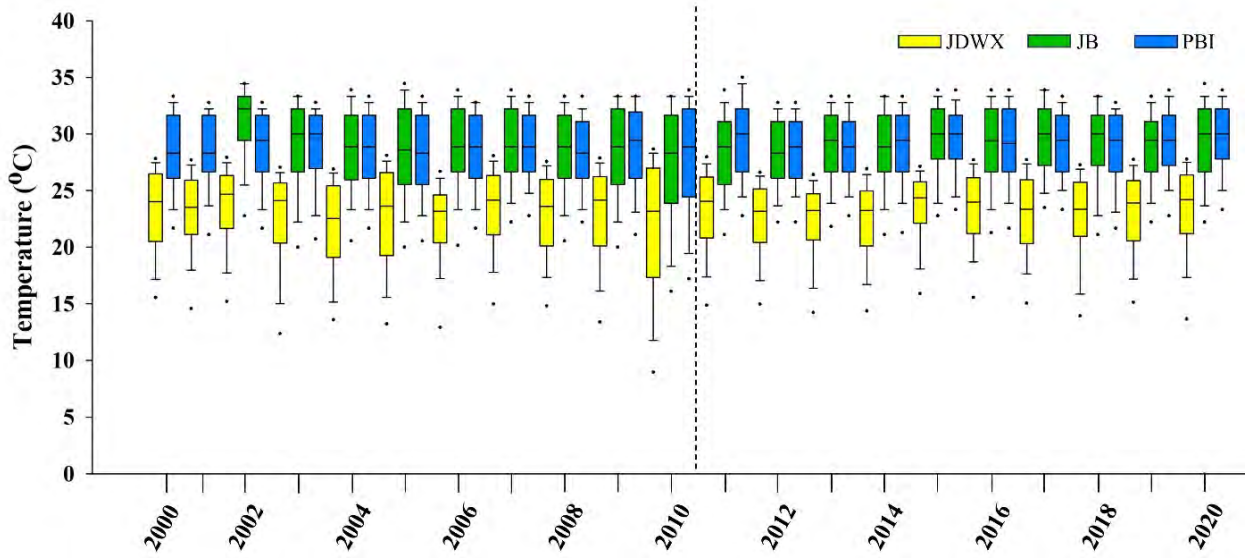

Figure 4.2. The range of daily average air temperatures (℃) at the Jonathan Dickinson State Park (JDWX), Juno Beach (JB), and Palm Beach International (PBI) weather stations. The center line within each box represents the median daily average temperature between the first and third quartile temperatures. The maximum and minimum average daily temperatures are represented by the capped lines (whiskers) and the dots represent extreme values for the average daily temperatures.

Daily maximum temperatures were similar within each month and across all stations monitored but varied slightly between months (Figure 4.3). At the JDSP station, daily maximum temperatures were between 28.0°C (82.4°F) to 30.2°C (86.4°F) from 2000 to 2010 and 27.3°C (81.1°F) to 29.6°C (85.3°F) from 2011 to 2020. JB and PBI daily maximum temperatures from 2000 to 2010 ranged from 33.9°C (93.0°F) to 37.2°C (98.9°F) and 33.9°C (93.0°F) to 36.7°C (98.1°F), respectively in the 2011 to 2020 decade. The highest maximum daily temperatures were observed in June through September in both decades across all monitored stations (Figure 4.3). Though daily maximum temperatures were similar across months and stations, most of the daily variation in average air temperatures could be attributed to the variability in the daily minimum temperatures. Minimum daily temperatures were typically lower at JDSP than at JB or PBI, with cooler temperatures observed in November through March across all stations (Figure 4.3). The lowest daily minimum temperatures were observed in January and December of 2010 dropping below 0°C in all regions, specifically -1.9°C (28.5°F) in JDSP in December 2010 (Figure 4.3). Extreme air temperature events not only affect the ecology of the river but may impact the river's hydrology by altering the rate of evapotranspiration. Continued monitoring of air temperature and extreme events will be imperative as the threats of climate change increase with time.

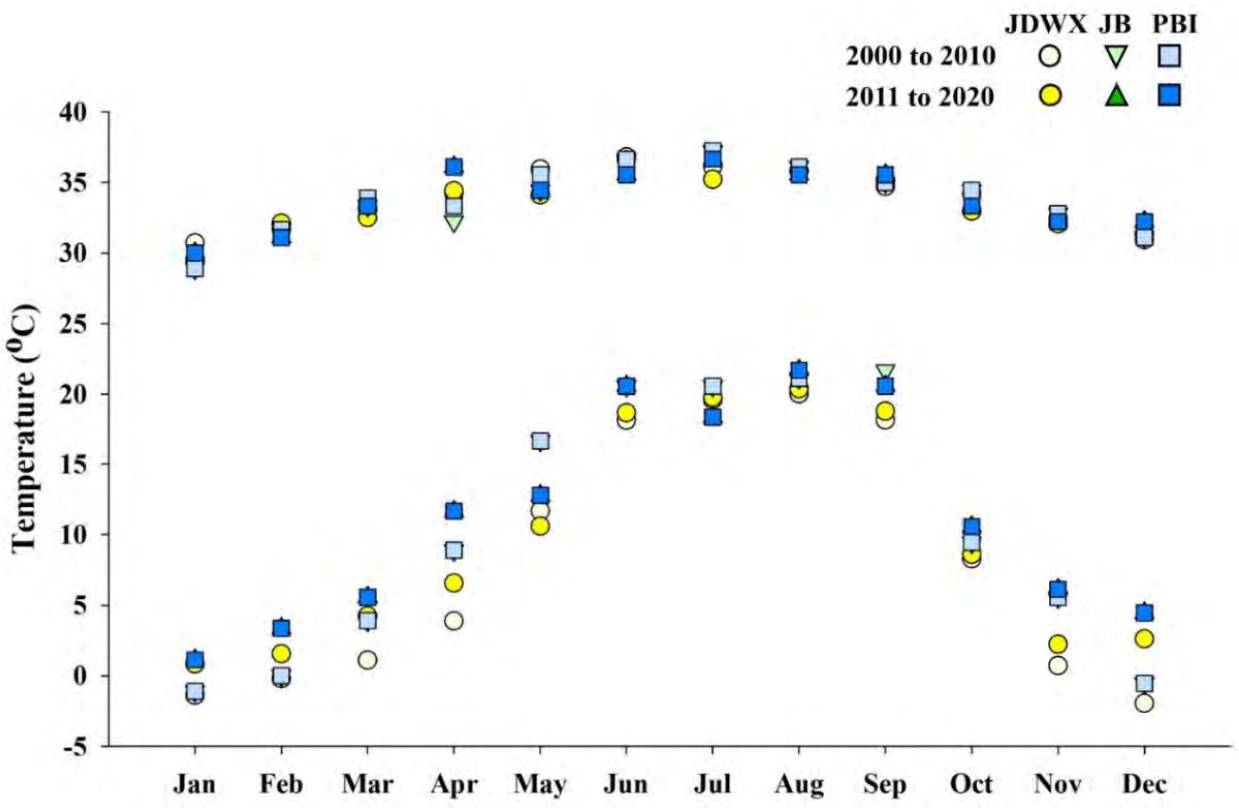

Figure 4.3. Monthly maximum and minimum temperatures (°C) for both decades at Jonathan Dickinson State Park (JDWX), Juno Beach (JB), and Palm Beach International Airport (PBI). Note that the maximum and minimum temperatures were similar between JB and PBI stations and some symbols may be obscured.

Rainfall

The Next Generation Weather Radar (NEXRAD) data from the South Florida Water Management District (SFWMD) were used to explore temporal and spatial rainfall patterns over the Loxahatchee River watershed. Mean monthly rainfall patterns varied by year (Figure 4.4A), though the overall mean for the period of record remained at 5 in (12.7 cm). A slight increase in the monthly mean (Figure 4.4A) was noted in the 2010 to 2020 decade compared to the 2000 to 2010 decade.

From 1998 to 2020, the Loxahatchee watershed generally experienced seasonal rainfall patterns with a wet season from May through October and a dry season from November through April (Figure 4.4B). A clear separation was apparent between the wet and dry with each season lasting approximately six months. Mean monthly rainfall during the dry season was approximately 2.75 in. (7 cm), though rainfall more than doubled to 7 in. (17.8 cm) during the wet season (Figure 4.4B).

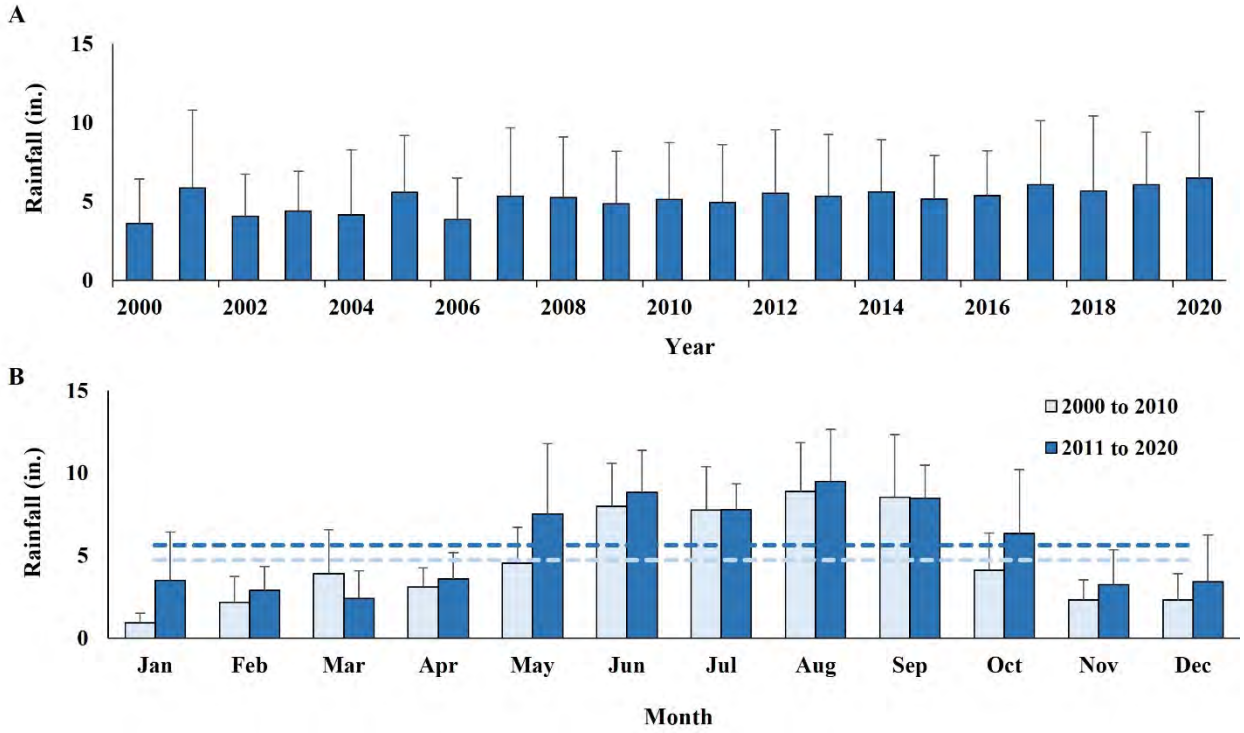

Figure 4.4. (A) Mean monthly (+ standard deviation) rainfall across the watershed per year based on SFWMD NEXRAD date and (B) Monthly rainfall (mean + standard deviation) across the watershed from January to December. The dashed blue lines show the mean across both decades.

Total annual rainfall varied across all basins throughout both decades, though it was greater in the 2011 to 2020 period (Figure 4.5). From 2000 to 2010, total rainfall ranged from 45.9 in (116.6 cm) to 53.2 in. (135.1 cm). The Loxahatchee South Coastal (4) and the South Loxahatchee Estuarine (5) basins had the highest total rainfall, 53.2 in. (135.1 cm) and 51.7 in. (131.3 cm), respectively (Figure 4.5). However, during the 2011 to 2020 decade, rainfall increased by six to thirteen inches across all basins, ranging from 56 in. (142.2 cm) to 62 in. (157.5 cm) (Figure 4.5). Basins Grove (7), Historic Cypress Creek (6), Jupiter Farms (#10), Kitching Creek (#1), Loxahatchee Wild and Scenic (#8), and the South Loxahatchee Estuary (#5) all had approximately 62 in of total annual rainfall (Figure 4.5).

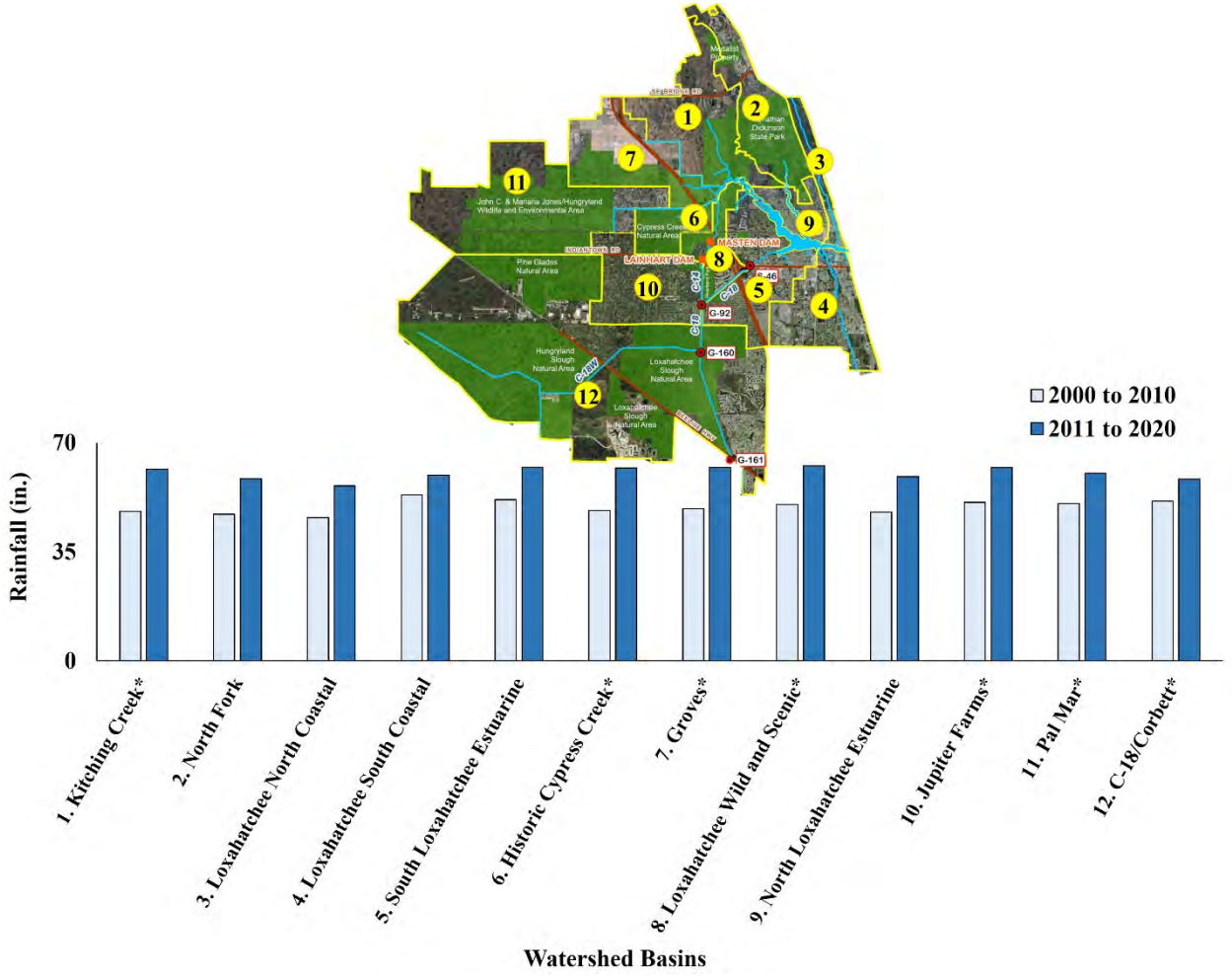

Figure 4.5. Mean total annual rainfall by basin in the Loxahatchee watershed (JDSP JDWX) per decade. The " * " denotes the seven watershed basins that support the NW Fork.

Major storms, defined as events that produce greater than two inches of rainfall in a single day, contributed to the variation in annual rainfall patterns throughout the watershed. Major storm events for Martin (Table 4.1) and Palm Beach (Table 4.2) counties were compared between 2000 and 2020. Eighteen major storms including five named storms (e.g., tropical storms, hurricanes) lasted 1 to 2 days in Martin County from 2000 to 2010 (Table 4.1). Between 2011 and 2020, 15 major storms, including five named storms, occurred in Martin County (Table 4.1). Tropical Storm Fay (August 2008), Hurricane Isaac (August 2012), and Hurricane Irma (September 2017) produced the highest rainfall, > 6in., over two days within their respective decades (Table 4.1).

Table 4.1. Storm and hurricane events for Martin County that produced >2in. of rain in a single day from 2000 to 2020. The " * " denotes consecutive days of storm and rain events.

Month	Inches	Storm	Month	Inches	Storm
September 18, 2000	2.35		October 9, 2011	2.16	
October 4, 2000	2.76		October 19, 2011	2.41	
March 30, 2001	2.09		August 27, 2012*	6.84	Isaac
August 3, 2001	3.03		January 10, 2014	3.45	
September 5, 2004	3.43	Frances	September 17, 2015	2.08	
September 21, 2004	3.22		January 28, 2016	2.53	
September 26, 2004	4.65	Jeanne	May 18, 2016	3.68	
March 18, 2005	2.47		October 7, 2016	2.33	Matthew
June 4, 2005	2.06		June 7, 2017	2.19	
October 25, 2005	3.61	Wilma	September 10, 2017*	8.61	Irma
November 2, 2005	2.14		October 29, 2017	2.87	Philippe
November 20, 2005	3.77		May 20, 2018	2.99	Alberto
June 2, 2007	3.61	Barry	January 28, 2019	2.07	
October 2, 2007	2.59		May 26, 2020	2.6	
August 19, 2008*	8.46	Fay	June 3, 2020	3.24	
December 18, 2009	2.77				
March 13, 2010	2.07				
April 26, 2010	2.16				

More major storms impacted Palm Beach County than Martin County in the 2000 to 2010 decade with 24 major storms, including six named storms, reported (Table 4.2). Hurricane Gabrielle (September 2001) and Tropical Storm Barry (June 2007) produced the highest rainfall within a single day in PBC, though neither storm exceeded 6 in. of rain. Fifteen major storms occurred between 2011 and 2020, including four named storms. Hurricanes Isaac (August 2012) and Irma (September 2017) produced over 5 in. of rainfall over two days, though Tropical Storm Philippe delivered over 6 in. of rainfall in one day (Table 4.2). Increased rainfall and the prolonged duration of storm events increased water volume, flow rates, and groundwater and river stage levels.

Table 4.2. Storm and hurricane events for Palm Beach County that produced >2 in. of rain in a single day from 2000 to 2020. The " * " denotes consecutive days of storm and rain events.

Month	Inches	Storm	Month	Inches	Storm
October 4, 2000	4.69		November 29, 2011	3.21	
November 26, 2000	2.19		August 27, 2012*	7.74	Isaac
March 20, 2001	3.23		May 3, 2013	2.59	
July 24, 2001	2.72		May 21, 2013	2.03	
August 3, 2001	3.06		January 10, 2014	3.09	
September 13, 2001*	5.3	Gabrielle	March 1, 2015	2.07	
September 29, 2001	2.26		January 28, 2016	3.42	
July 21, 2002	2.38		April 24, 2017	2.22	
May 23, 2003	2.21		June 7, 2017	4.98	
May 28, 2003	2.42		September 10, 2017*	5.79	Irma
February 26, 2004	2.3		October 29, 2017	5.11	Philippe
September 5, 2004	4.7	Frances	May 14, 2018	3.04	
September 26, 2004	4.48	Jeanne	May 20, 2018	2.86	Alberto
March 10, 2005	2.5		May 26, 2020	2.24	
December 15, 2006	3.84		November 9, 2020	2.79	
June 2, 2007	5	Barry			
June 29, 2007	2.15				
October 17, 2007	2.22				
February 13, 2008	2.3				
August 19, 2008	4.5	Fay			
September 5, 2008	2.43				
December 18, 2009	2.5				
March 12, 2010	3.15				
September 29, 2010	2.06	Nicole			

Watershed Modeling Tools

The surface water drainage paths, or flow lines, of the watershed were generated using the WaterShed (WaSh) model graphical user interface (Figure 4.6). WaSh, a time-dependent model that coupled hydrologic and hydraulic data and simulated surface water and groundwater hydrology in the watershed with high groundwater tables and dense drainage canal networks. It included a representation of basic surface hydrology, groundwater flow, surface water flow, point sources and losses, and the transport and fate of water quality. The WaSh model graphical user interface assigned elevations in the digital elevation model (DEM) to the model grid cells and specified the surface water drainage paths, referred to as "flow lines", using topographic gradients based on the cell elevations. The surface water drainage paths (arrows; Figure 4.6) were created using the 2016 DEM. The raster (pixelated grid cells) dataset represented a 4-ft resolution digital elevation model of bare-earth ground surface that covered Martin and Palm Beach Counties. The

raster served as a reliable source of ground elevation for a variety of purposes including emergency preparedness, engineering, planning, modeling, and analysis.

The WaSh model was developed using the 1000ft resolution for the 2007 DEM and the 4ft resolution 2016 DEMs to compare the surface water drainage paths (Figure 4.6). It was not possible to evaluate the change in surface water drainage paths between the two DEMs due to the different resolutions. The WaSh model results showed no major changes in the elevation within the watershed between the two assessment periods, 2000 to 2010 and 2011 to 2020.

Figure 4.6. The WaSh model generated flow lines/flow paths. The arrows indicate the surface water flow direction.

Landscape topography and varied weather conditions affected the drainage and hydrology of the Loxahatchee watershed. Understanding the impacts of rainfall, temperature, and weather patterns on the river's hydrology can facilitate effective water management, ensuring the availability of water resources and mitigating floods.

Groundwater Resources

Direct rainfall and surface and groundwater flows are the main water sources for the Loxahatchee River. Groundwater has a significant role in the variation of hydrology, water chemistry, and biological communities. Examining groundwater well data shows the temporal and spatial distribution of groundwater throughout the watershed and the groundwater contributions to river hydrology. The groundwater levels change depending on the season, topography, aquifer and water table, and other hydrogeological characteristics. Further, aquifers vary in depth, composition, and location which contributes to the deviation in groundwater levels across the landscape. Groundwater flow is generally a reflection of the topography and is influenced by variations in soil permeability and nearby water bodies such as ponds, drainage ditches, and canals (DEP and SFWMD, 2010).

Four shallow groundwater wells, PB-565, M-1234, M-1083, and PB-689, were monitored continuously to understand the spatial variability of groundwater resources within the watershed (Figure 4.7). There is a slope of the water table, or hydraulic gradient, from west to east in the wells monitored within the watershed. For instance, elevation at PB-689 (furthest inland) is on average 7.5 m (24.5 ft.), and at PB-565 (closest to the coastline) elevation decreases to approximately 1.4 m (4.5 ft.) above sea level. Data from all four U.S. Geological Survey wells were obtained from the SFWMD DBHYDRO database to compare between the decades. Well M-1234 data were used in the assessment instead of well M-140 (DEP and SFWMD, 2010) which was discontinued in October 1989.

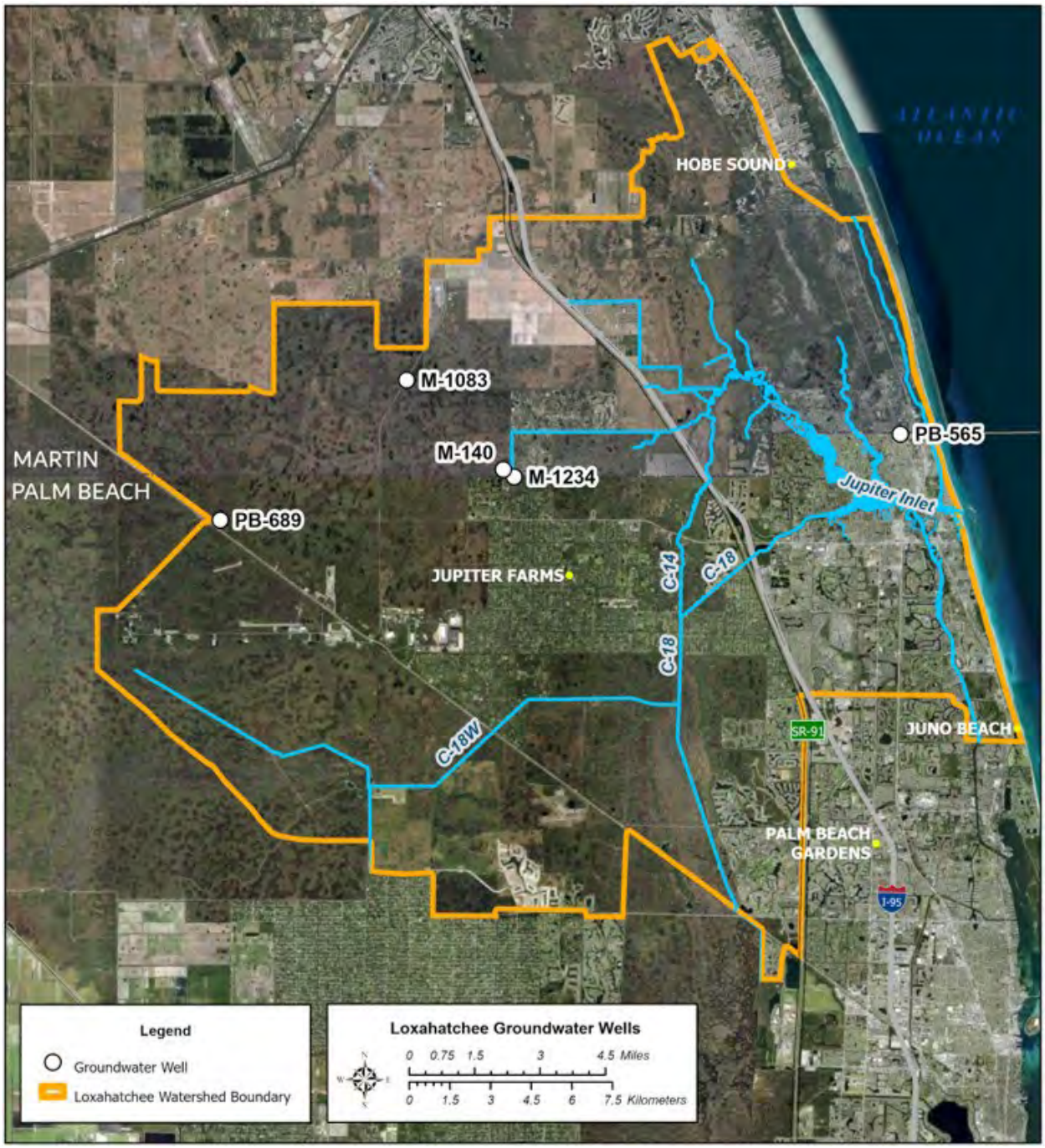

Figure 4.7. Groundwater wells located within the watershed.

Groundwater levels at PB-565 indicated depths ranged from -0.4 m (-1.2 ft.) to 2.9 m (9.4 ft.) (Figure 4.8). Negative values at the PB-565 station in 2005 reflected water levels below sea level, likely due to dry environmental conditions (Figure 4.8). There was a slight increase in mean groundwater levels from 0.9 m (3.1 ft.) in 2000 to 2010 to 1.2 m (3.8 ft.) during 2011 to 2020 in well PB-565 (Figure 4.8). This well was established on the saline side of the saltwater intrusion

line, though salinity (i.e., chlorides) has not been measured since 1994. The groundwater levels in the M-1234 well varied from 3.9 m (12.9 ft.) to 6.8 m (22.4 ft.) (Figure 4.8). The mean groundwater level in the M-1234 was 4.7 m (15.4 ft.) during both decades. Fluctuations in groundwater levels at the M-1083 well ranged from 5.9 m (19.2 ft.) to 7.2 m (23.5 ft.) between 2005 and 2010, and 5.8 m (18.9 ft.) to 7.2 m (23.6 ft.) from 2011 to 2020 (Figure 4.8). Note that the data for the M-1083 well was available only from 2005 to 2020. The groundwater levels in PB-689 were the deepest of the four wells with depths ranging from 6.5 m (21.2 ft.) to 7.9 m (25.8 ft.) (Figure 4.8). Overall, the groundwater levels in all wells were relatively consistent across the two decades though a slight decrease in groundwater levels of 0.008 m/yr (0.026 ft/yr) was observed.

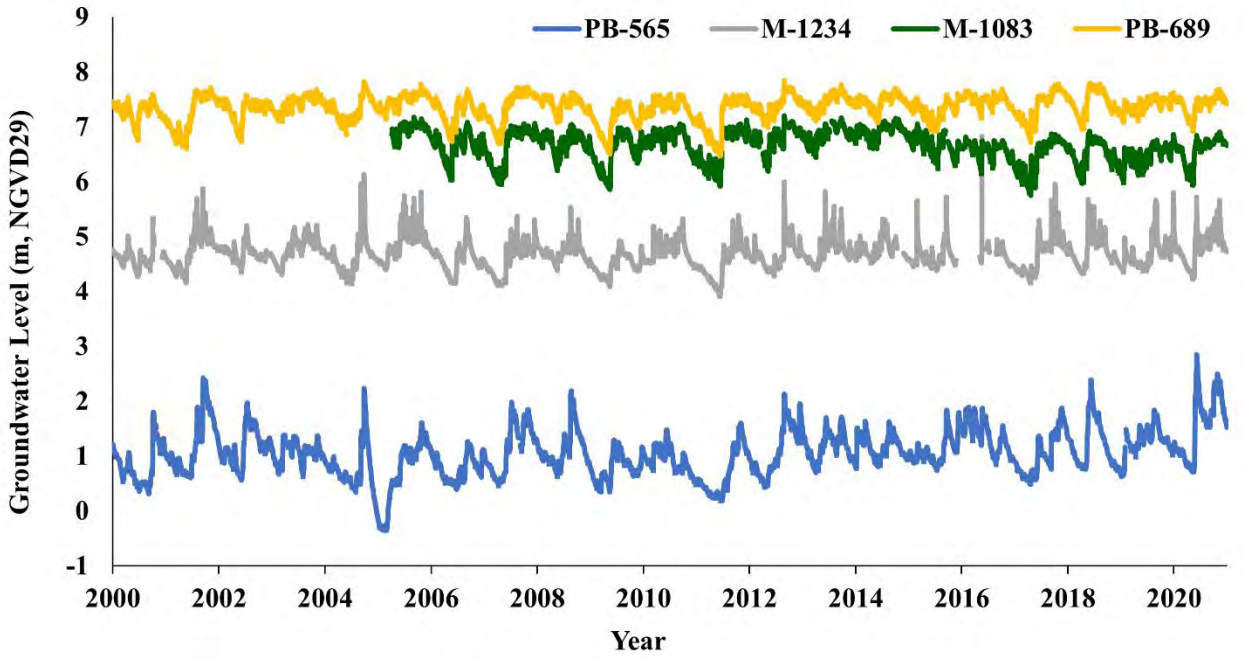

Figure 4.8. Groundwater level (NGVD29) was measured at M-1234, PB-565, PB-689, and M-1083 groundwater wells in the Loxahatchee watershed.

River Floodplain Groundwater Levels

Anthropogenic activities, with climate change and sea level rise, resulted in adverse impacts on the ecosystem, including increased saltwater intrusion and undesired vegetation changes in the floodplain. Saltwater intrusion and the resultant alteration of the vegetation community structure to salt-tolerant species changed the ecosystem dynamics and the natural salt-to-freshwater gradient within the floodplain (see Vegetation Section). Floodplain vegetation degradation along the Loxahatchee River was induced partly by diminished freshwater input from surface and groundwater sources to the river as groundwater helps maintain the hydrological conditions necessary for wetland habitats (Hancock et al., 2009). Understanding the influence of groundwater levels on the ecological processes within the NW Fork provides insight into the physiological requirements of the vegetation community.

The Loxahatchee floodplain groundwater well (Figure 4.9) network was established in 2003 to monitor groundwater levels and the effect of salinity on floodplain vegetation. Floodplain well monitoring began in 2005 to measure water levels, temperature, and conductivity within the well

every 15 to 20 minutes. The groundwater well network was positioned within monitored vegetation transects along the salinity gradient throughout the NW Fork (Figure 4.10; see Vegetation Section). Five of the vegetation transects are in the Wild and Scenic portion of the river and have one to four associated groundwater wells along the transect (Figure 4.10). Each well along a transect provides water table elevation data at varying (perpendicular) distances from the river to inform on the extent of the impacts of saltwater intrusion and inundation. These strategically placed wells enable data collection to better understand the floodplain conditions local vegetation experienced. Due to logistical constraints data collection from the transect groundwater wells was paused from 2018 to 2020, though it was resumed after 2020.

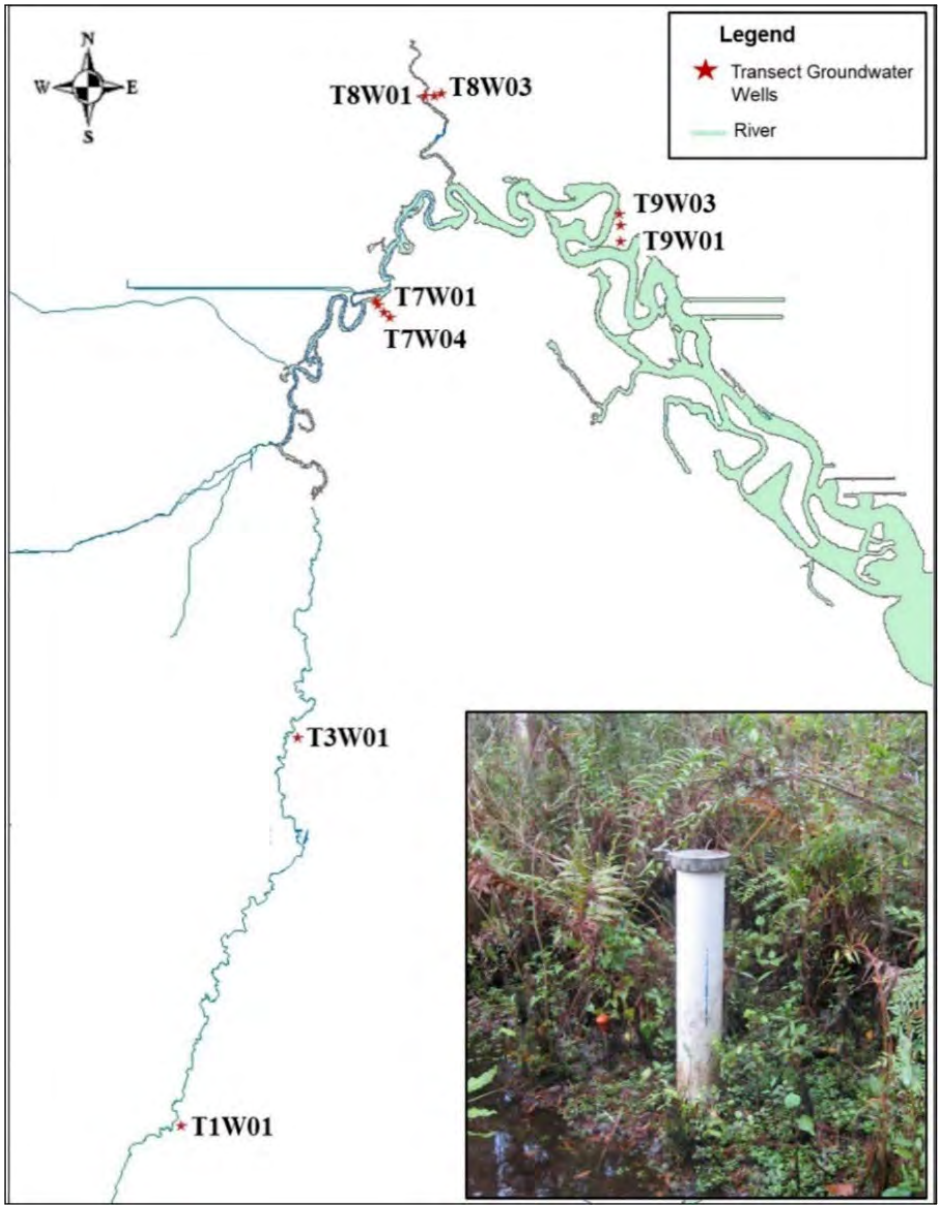

Figure 4.9. Transect groundwater well locations throughout the NW Fork. Inset shows an example of a floodplain groundwater well at each location.

Average groundwater table depth (depth of water below the surface) remained relatively consistent across both decades at most wells (Figure 4.10). Groundwater depth for T3W01, T7W04, and all three wells at transect T-8 varied between decades, particularly at T8W02 and T8W03. Water table depth was greater at T7W04 and T8W03 between 2005 and 2010 and decreased in the subsequent decade (Figure 4.10). The opposite trend was observed with an increase in water table depth at T3W01 and T8W02 during the 2011 to 2020 period (Figure 4.10). Groundwater depths were subject to fluctuations brought about by a range of natural (precipitation, infiltration, evapotranspiration, seasonal shifts) and anthropogenic (alterations in land use, groundwater withdrawals) influences. The observed variability in water table depth may be attributed to local evapotranspiration, the process of water evaporation from the soil and vegetation, though specific data on evapotranspiration were not evaluated. Warmer climates in south Florida have the potential to increase evaporative demands (Condon et al., 2020). The largest groundwater declines occur in the Eastern U.S., consistent with the areas with the largest increase in evapotranspiration (Condon et al. 2020). Evapotranspiration throughout the NW Fork, though not directly measured, most likely varied with well depth and position along the river in response to soil, vegetation, temperature, rainfall, freshwater, and tidal input.

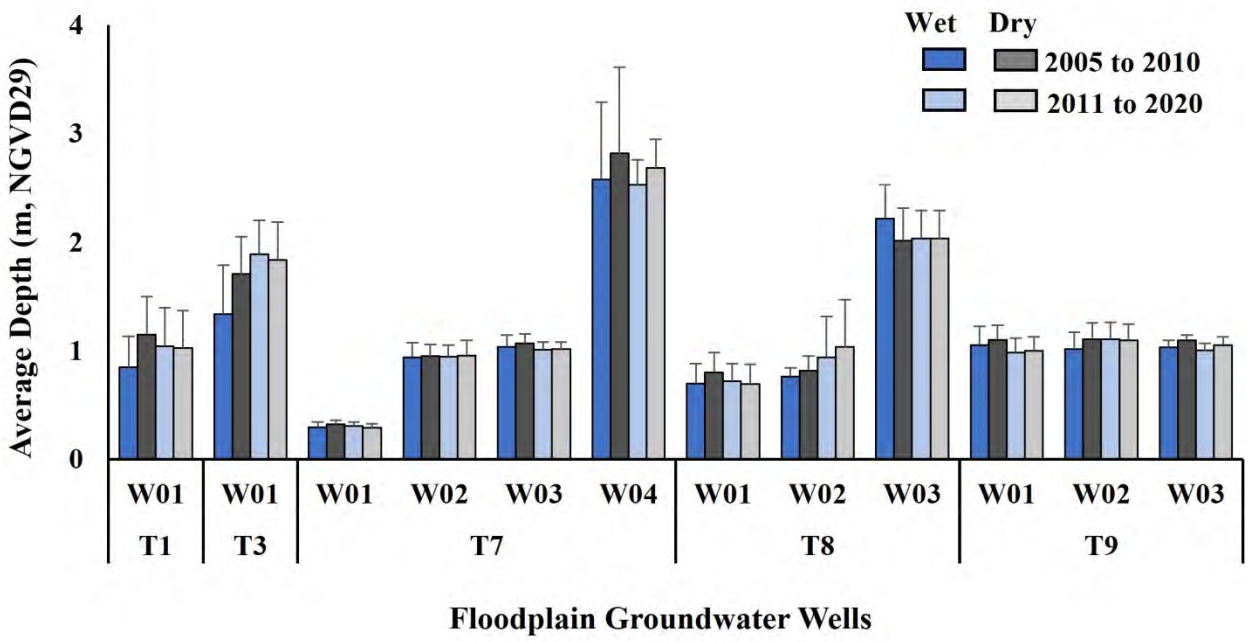

Figure 4.10. Average groundwater table depth for transect wells from 2005 to 2010 and 2011 to 2020 period. Wells are presented from upriver to downriver.

The T-1 (1 well) and T-3 (1 well) transects, located in the upper riverine floodplain of the NW Fork are just downstream of the Lainhart and Masten Dams, respectively (Figure 4.11). Both wells receive continuous freshwater flows from the upstream regulated G-92 structure and the surrounding riverine floodplain (Figure 4.11). T-1 is 50 m (164 ft.) from the riverbank and protected from tidal influence by the Masten Dam (Figure 4.11B). T-3 is 95 m (311.7 ft.) from the riverbank (Figure 4.11C) and downstream of the Masten Dam, though it is not highly affected by tides approximately 13 miles from the river mouth. Despite the differences in well position, well

depths were similar, approximately 1.8 m (5.8 ft.) below ground surface (bgs) (Figure 4.11B and C). Water table depth varied between the two wells ranging from -0.1 m (0.2 ft.) to 2.0 m (6.5 ft.) at T-1 and 0.4 m (1.3 ft.) to 2.9 m (9.4 ft.) at T-3 (Figure 4.11D). The variation in water table depth between these two riverine wells is due to the depth of the wells and the distance and elevation from the riverbank.

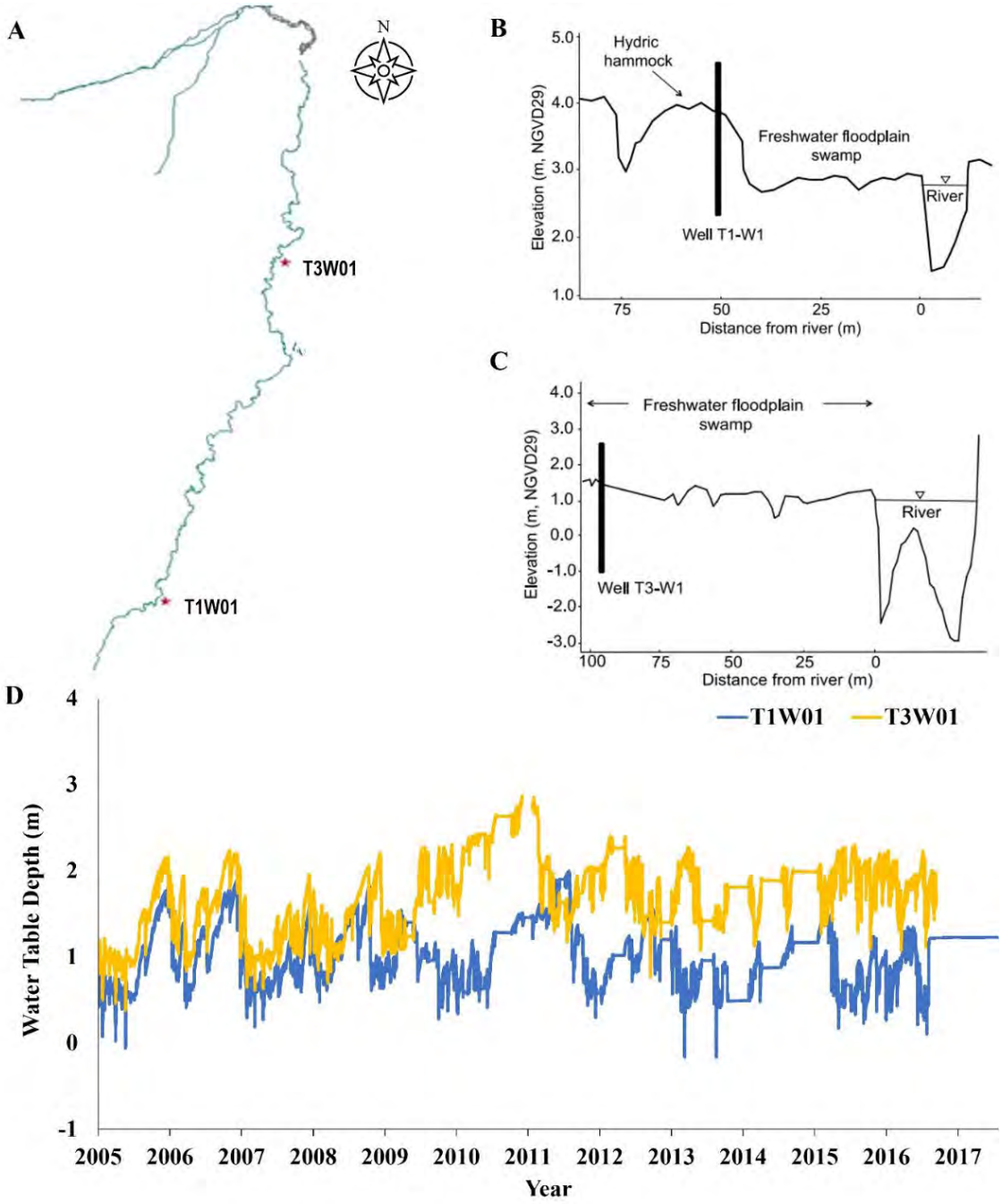

Figure 4.11. (A) Vegetation transect wells T-1 and T-3 positioning along the riverbank and (B and C) the topographic cross-sections of the floodplain groundwater wells (Kaplan et al., 2010). (D) Daily water table depth for T1 and T3.

The four wells at T-7 (T7W01 to T7W04) are in a transitional tidal area of the river located approximately 9 miles from the river mouth. T-7 experiences daily tidal flooding, subjecting the vegetation to regular intervals of saltwater intrusion. Well distance from the riverbank ranged from 2 m (6.6 ft.) (W01) to 150 m (492 ft.) (W04) (Figure 4.12A) and well depths ranged from 1.7 m (5.5 ft.) bgs. (W01) to 3.7 m (12.1 ft.) bgs. (W04) (Figure 4.12B). Water table depth was notably deeper at W04 than at W01 to W03 (Figure 134.12C). Well water depths at wells W01, W02, and W03 ranged from 0.2 m (0.7 ft.) to 1.4 m (4.67 ft.) between 2005 and 2010, and 0.2 m (0.7 ft.) to 1.6 m (5.4 ft.) from 2011 to 2020 (Figure 4.12C). Water well depth at W04 was considerably greater than the other wells due to a higher elevation and ranged from 1.3 m (4.2 ft.) to 4.5 m (14.9 ft.) in 2005 to 2010, and 1.8 m (5.5 ft.) to 4.8 m (15.8 ft.) in 2011 to 2020.

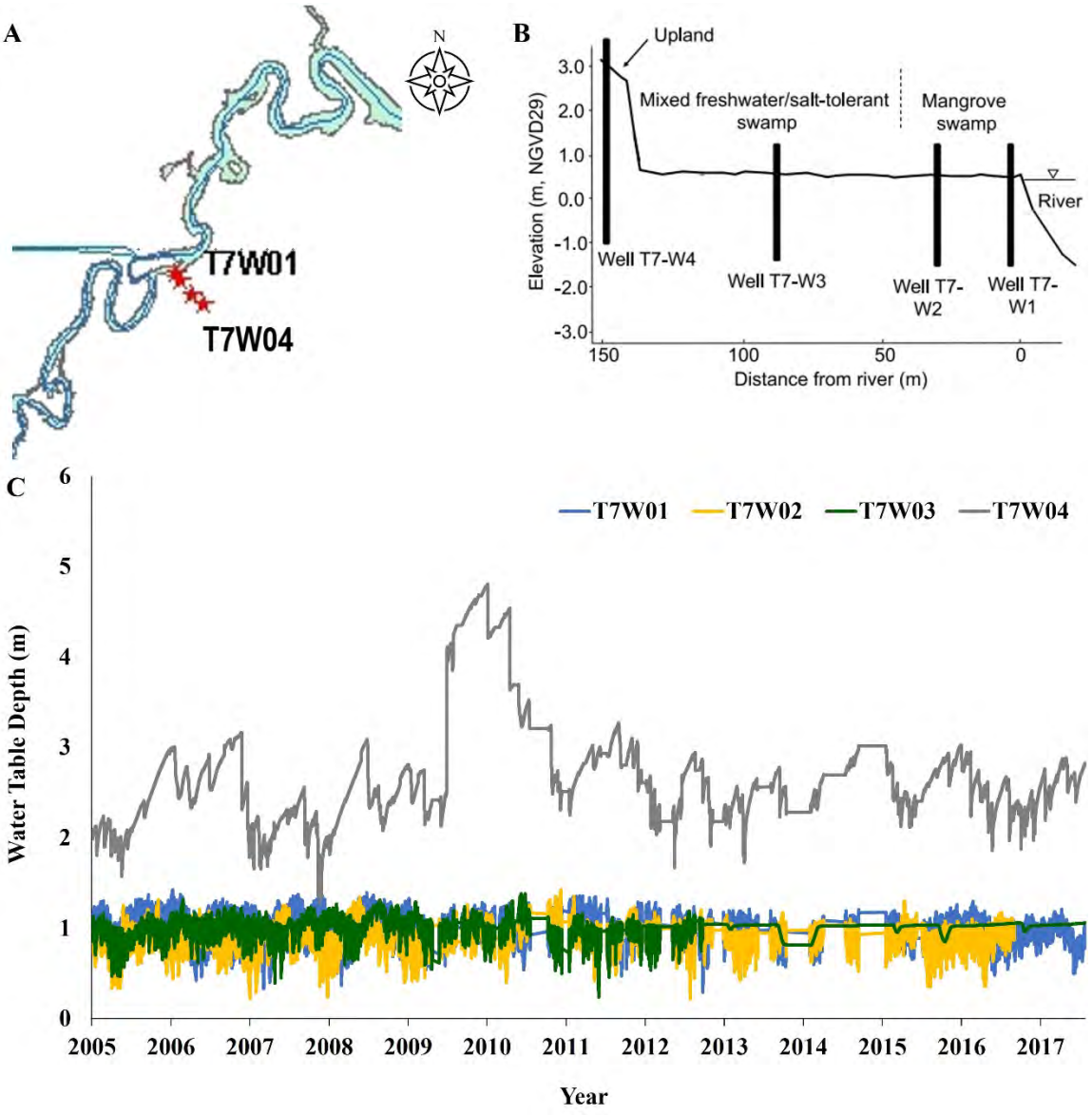

Figure 4.12. (A) Vegetation transect wells T-7 positioning along the riverbank and (B) the topographic cross-sections of the floodplain groundwater wells W01 to W04 (Kaplan et al., 2010). (C) Daily water table depth for T-7.

The three T-8 wells (T8W01 to T8W03) are in a transitional tidal area approximately 0.1 mile upstream near the confluence of the river channel and Kitching Creek. Roughly 8 miles from the river mouth (Figure 4.13A) these wells experience daily tidal flooding. The well distance from the riverbank ranges from 5 m (W01) to 125 m (W03) (Figure 4.13A) with well depths ranging from 1.6 m (5.2 ft.) bgs. (W01) to 2.6 m (8.5 ft.) bgs. (W03) (Figures 4.13B). Water table depth varied considerably across all wells within each decade, ranging from -0.01 m (-0.3 ft.) bgs. (W01) to 3.0 m (9.98 ft.) (W03) in 2005 to 2010 and -0.05 m (-0.18 ft.) (W01) to 2.6 m (8.39 ft.) (W03) from 2011 to 2020 (Figure 4.13C). Much of the variation between wells along T-8 is because of the well distance from the riverbank and the higher elevation of W03 compared to the other two wells (Figure 4.13).

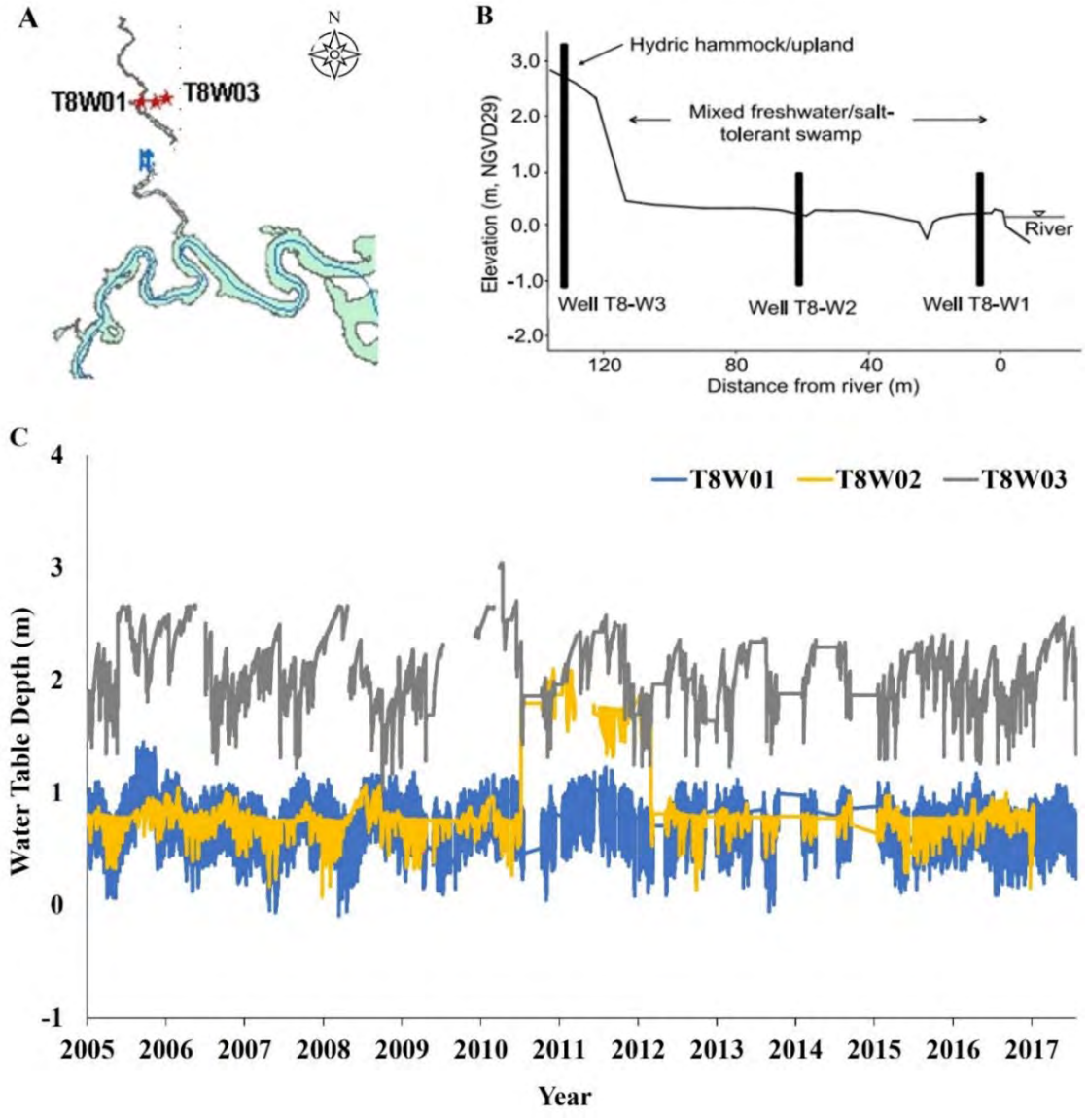

Figure 4.13. (A) Vegetation transect wells T-8 positioning along the riverbank and (B) the topographic cross-sections of the floodplain groundwater wells W01 to W03 (Kaplan et al., 2010). (C) Daily water table depth for T-8.

The three wells of T-9 (T9W01 to T9W03) are in a tidal area located 6.5 miles upstream from the river mouth. Transect T9 is unique as the transect groundwater wells are located on a peninsula in the NW Fork and are frequently exposed to tidal inundation. All three wells have the shortest distance from the riverbank of all transect wells, except for T7W01 and T8W01, ranging from 40 m (131 ft.) (W01) to 180 m (591 ft.) (W03) from the riverbank (Figures 4.14A and 4.14B). Well depths range from 1.9 m (6.2 ft.) bgs. (W01 and W02) to 4.2 m 13.85 ft.) bgs. (W03) (Figure 4.14B). Water table depths of these three wells ranged from 0.28 m (0.91ft). to 1.55 m (5.07ft.) from 2005 to 2010, and 0.25 m (0.81ft.) to 1.61 m (5.27ft.) from 2011 to 2020 (Figure 4.14C). Because of a berm surrounding the peninsula, water table depths were consistent across all wells between decades (Roberts et al., 2008) (Figure 4.14B).

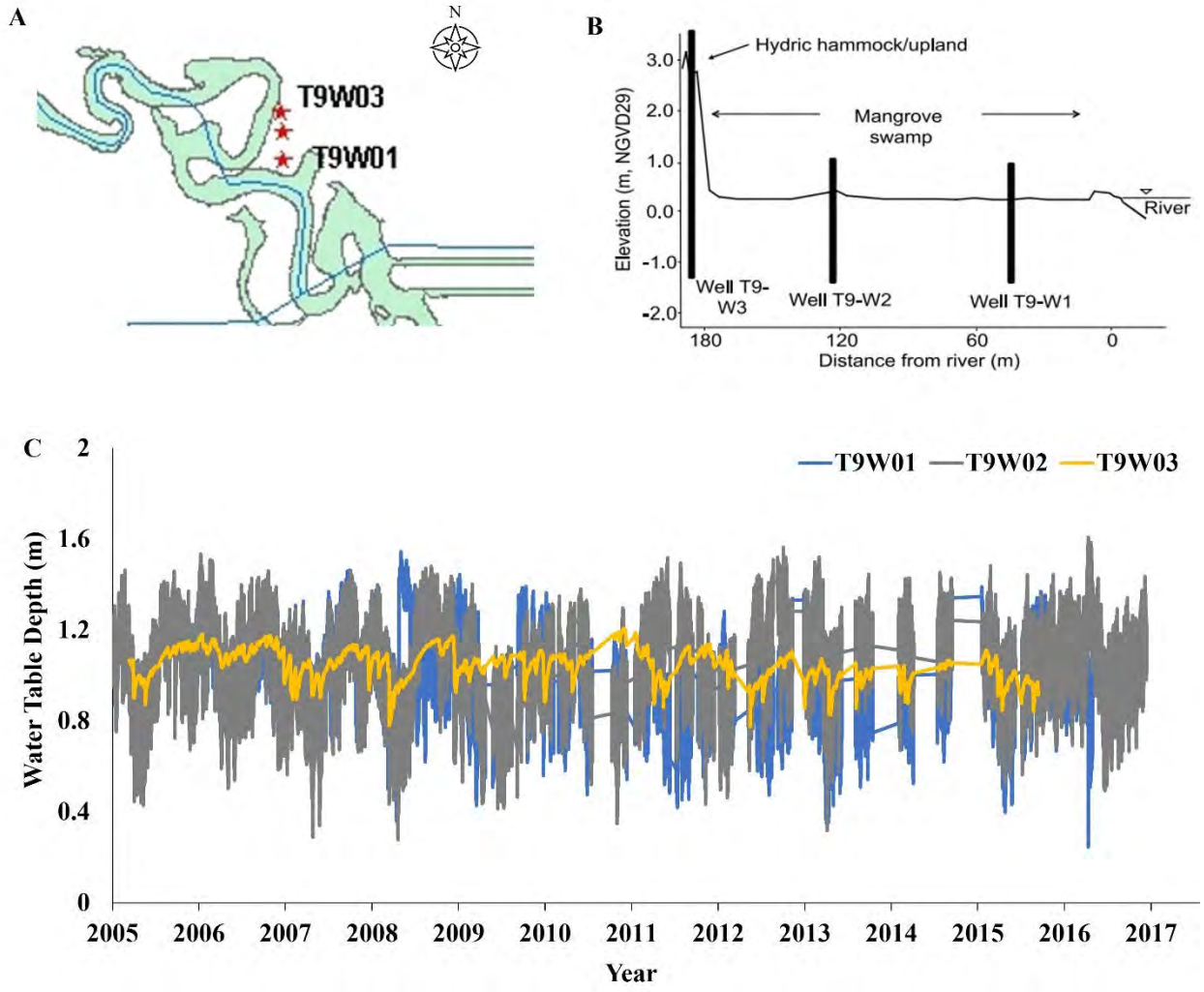

Figure 4.14. (A) Vegetation transect wells T-9 positioning along the riverbank and (B) the topographic cross-sections of the floodplain groundwater wells W01 to W03 (Kaplan et al., 2010). (C) Daily water table depth for T-9.

Groundwater contributes freshwater to the river and various places across the floodplain. As an important natural resource, monitoring groundwater levels provides a status of its quantity and interaction with surface water and floodplain vegetation. A groundwater study found that seepage provided a notable source of freshwater to the river with ground elevations contributing to the movement of groundwater flow (Swarzenski et al., 2006, SFWMD, 2012). The highest terrain elevations occurred at T-1 (4.19 m) followed by T7W4 and T9W3 (both at 3.38 m), with the lowest elevations at T8W1 (1.03 m). Groundwater seepage rate into the NW Fork was 3.9 cfs to 14.6 cfs (Swarzenski et al., 2006) and most groundwater was discharged from the Kitching Creek (T-8) area (Orem et.al., 2006). Understanding how groundwater seepage relates to groundwater levels could assist in managing the hydrological drainage network (SFWMD, 2012). Further, monitoring the wells along the vegetation transects provides insight into the inundation hydroperiods and salinity levels the floodplain vegetation is exposed to and may explain the shifts in community structure.

Watershed Water Control Structures

The headwaters of the NW Fork were located historically in the marshes of the Loxahatchee and Hungryland Sloughs in Palm Beach County, and in what is now Grassy Waters Preserve. The Loxahatchee Slough once extended south to the Grassy Waters Preserve (West Palm Beach Water Catchment Area) though increased urbanization and agricultural changes over time altered the natural drainage patterns. As urbanization increases, the river's riparian area and channel can change. Direct modification of the river's channel alters the hydrology and physical habitat. water control structures manage water resource allocations to ensure the NW Fork receives enough freshwater and to protect urban areas from flooding.

Several types of water control structures (e.g., culverts, spillways, and weirs) within the Loxahatchee Watershed help manage the flow of water (Figure 4.15). that are managed and operated manually or remotely by the SFWMD. The SFWMD manages and operates these structures to protect the local water supply, provides the required flows to the NW Fork, and controls the upstream water levels for wetland hydration. Water control structures also serve as a barrier to saltwater intrusion and provide flood protection. The main control structures operated in the watershed are on the C-18 canal and include the G-92 culvert (Figure 4.15B), S-46 spillway (Figure 4.15C), G-160 culvert (Figure 4.15D), and G-161 spillway (Figure 4.15E). Additionally, the South Indian River Water Control District (SIRWCD) manages stormwater runoff through managed canals and water control structures that serve several communities to the east and west of the C-18 and C-14 canals.

C-18 Canal

From 1957 to 1958 the USACE constructed the C-18 Canal (Figure 4.15A) through the central portion of the Loxahatchee Slough as a component of the Central and Southern Florida Project. The C-18 canal improves drainage and provides flood protection for adjacent agriculture, residential, and industrial lands, and the J.W. Corbett Wildlife Management Area. Construction of C-18 drained a large portion of the Loxahatchee and Hungryland Sloughs, the natural wetland areas at the headwaters of the NW Fork. The C-18 redirected water from the NW Fork to the Southwest (SW) Fork where it could be discharged to tide through S-46 (Figure 4.15A), reducing

the freshwater flows to the NW Fork. Today the C-18 drains over half of the surface area of the Loxahatchee River watershed.

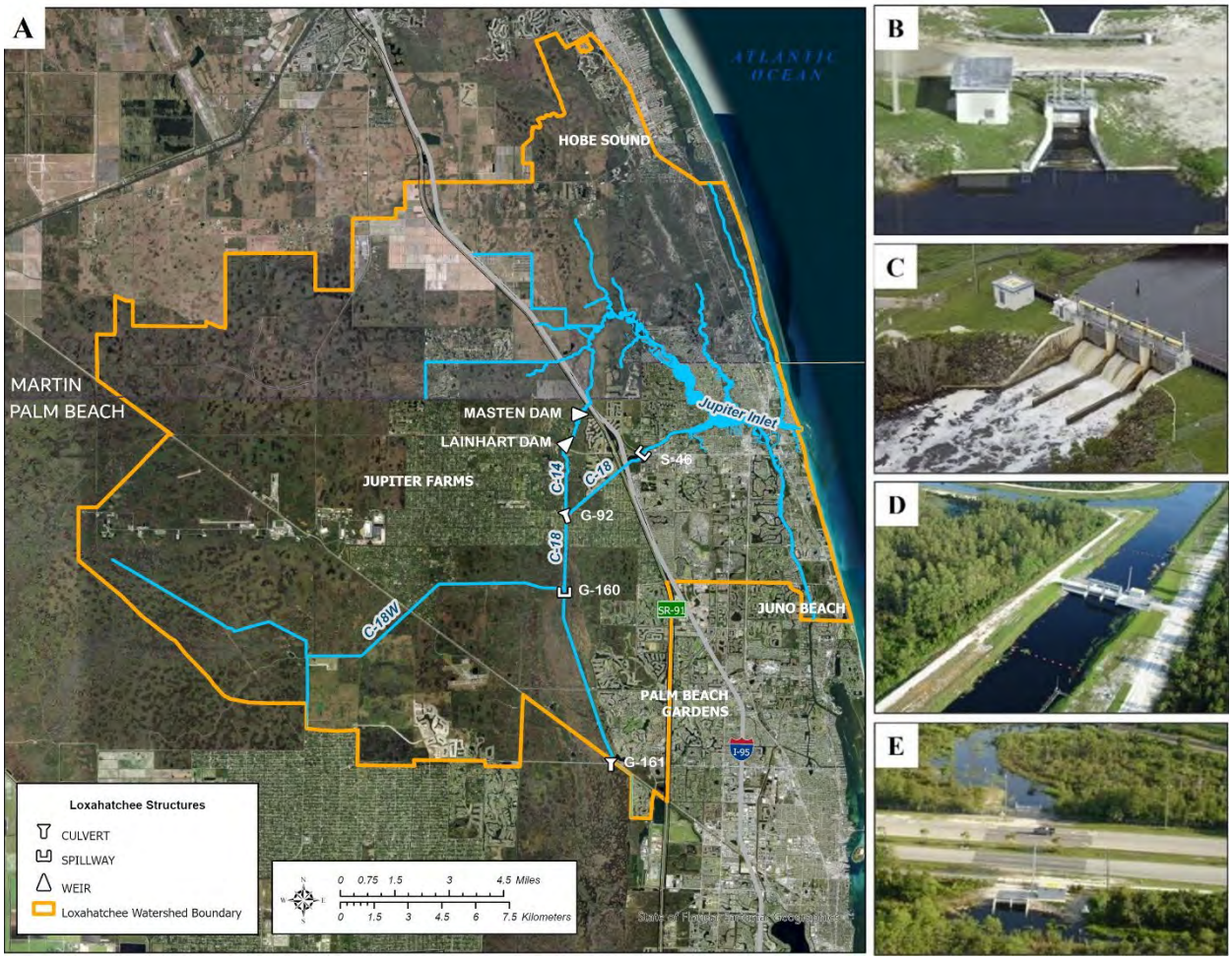

Figure 4.15. (A) The canals and structures of the Loxahatchee River; (B) G-92; (C) S-46; (D) G-160; and (E) G-161.

G-92

Originally constructed in 1975, the G-92 culvert (Martens Culvert) was designed to improve water flow from the Loxahatchee and Hungryland Sloughs to the NW Fork through the C-18 canal (Figure 4.15B). From the G-92 culvert, water is diverted into the C-14 canal, and into the NW Fork. The G-92 culvert was later updated in 1987 to a single-barreled, bi-directional concrete box culvert with an operated sluice gate (to control flow rates) that allowed 50 to 100 cfs of water into the NW Fork. The upgraded G-92 functions were to: (1) provide base flows into the NW Fork; (2) divert flows to the SW Fork when capacity is high; or (3) divert extremely high flood flows from C-14 back into C-18 under a proposed agreement between the SFWMD and the Loxahatchee River Environmental Control District (LRECD). In 1989, a consent agreement between the SFWMD and the South Indian River Water Control District (SIRWCD) allowed for the conveyance of flows to the NW Fork for environmental enhancement and flood protection outlined in the original LRWSMP. The agreement required the SFWMD to operate and maintain

the G-92 structure, provide a minimum flow of 50 cfs to the NW Fork, when available, and move excess water back into the C-18 canal for flood protection during extremely wet storm events.

The original G-92 culvert was demolished and replaced in 2009 (Figure 4.15B) to meet the water demands of the NW Fork. The new structure features a larger single, gated concrete box culvert, a control building with a generator, a fuel tank, and steel sheet pile wingwalls. The upgraded structure provides improved control of discharges to the NW Fork up to 400 cfs via the C-14 conveyance canal through manual or remote operation of the G-92 culvert by the SFWMD. During flood conditions, the G-92 can reverse flows from the C-14 and Jupiter Farms drainage canals and back into C-18 (Supplemental 4).

S-46

The S-46 structure (Figure 4.15C) was constructed in 1958 by the USACE to control upstream stages in the C-18 Canal with a discharge rate of 3420 cfs. The three-bay reinforced concrete gated coastal spillway had a steel sheet pile cutoff and wing walls with rubble riprap as downstream scour protection. The operation of S-46 was later modified in 1981 to provide freshwater storage in the C-18 canal, reducing the amount of freshwater lost due to tidal fluctuation.

In 1996, observed upwelling on the downstream side of the structure indicated the potential for sediment transport issues and instability of the S-46. Continued field investigations, repairs, and monitoring demonstrated the need to reduce the hydraulic gradient across the structure with a tailwater weir. Renovations on the upstream sheet pile section of the tailwater weir created a stilling basin as scour protection before discharging to the SW Fork. Additional renovations were completed in 2016 and included: the construction of a new steel sheet pile tailwater weir, replacement of existing carbon steel vertical lift roller gates with new stainless-steel gates, rehabilitation of the corroded gate hoist platform assemblies, armored canal bottom with riprap and marine mattress, constructed walkway stilling wells, stabilizing the embankments, and installing passive cathodic protection. The S-46 spillway maintains higher levels of freshwater in the C-18 and backfilling portions of the weir were designed to accommodate limited recreational fishing.

G-160 (Loxahatchee Slough Spillway)

Historically, the Loxahatchee Slough remained flooded for much of the year. The completion of the C-18 Canal in 1958 bisected the Loxahatchee Slough, reducing the inundation capacity of the Slough's wetland by as much as 3.05 m (10 ft.) (NPS, 1984). Constructing the canal changed the natural habitat and drainage, reducing the flows to the NW Fork. In December 2002, the SFWMD Governing Board adopted a 35 cfs Minimum Flows and Levels (MFL) as the first step of the Loxahatchee Slough Restoration project. To meet the MFL criteria, spillway G-160 (Figure 14.15D) was constructed in 2003 by Palm Beach County and SFWMD with operations beginning in 2004. The primary purpose of the G-160 structure is to enhance dry season and base flows to the NW Fork (SFWMD, 2004b). Secondarily, the structure helps to increase water levels in the southern leg of the C-18 Canal and improve hydroperiods in adjacent wetlands to maintain the ecological integrity of the vegetation communities (SFWMD, 2004b).

The gravity-flow G-160 spillway structure was built on the C-18 Canal at the confluence C-18W to maintain water elevations that allow a natural hydroperiod during average rainfall. The structure

is opened when the Loxahatchee Slough stage exceeds 4.7 m (15.5 ft.) in the dry season, rising to 5.3 m (17.5 ft.) in the wet season. The G-160 structure has a maximum capacity of 2,000 cfs to maintain levels of flood protection (Supplemental 4). Other design features of the G-160 Loxahatchee Slough Spillway included remote operation through the SFWMD's telemetry system, a control building with an emergency generator, and a canoe portage.

G-161 (Grassy Waters Preserve Outflow Station)

The G-161 gated culvert (Figure 4.15E) is a quarter mile west of Northlake Boulevard and SR 710. The structure was built in 2007 to convey regional water to the NW Fork, support the rehydration of the Loxahatchee Slough, and maintain ecologically beneficial water stages in the Grassy Waters Preserve (GWP) (SFWMD, 2020). Under certain flood conditions, the G-161 can release water from GWP to the C-18 Canal. For example, when water is available in the GWP during the dry season and the downstream capacity of the C-18 allows, the G-161 can release up to 100 cfs to the north for flood relief (Supplemental 4). The SFWMD began operation of the G-161 structure during the early 2009 dry season to deliver supplemental flows through the C-18 canal to the NW Fork.

Both the G-160 and G-161 structures are components of the Loxahatchee River Watershed Restoration Project (formerly the North Palm Beach County Part 1; LRWRP) of the CERP). The two water control structures provide a link between the historic headwaters (GWP) and the river which is necessary to deliver needed restorative dry season flows to the NW Fork (SFWMD, 2020). Both structures can be operated concurrently and are designed to restore a more natural hydroperiod to the Loxahatchee Slough while increasing flows to the NW Fork (SFWMD, 2020). These two structures are operated to convey the maximum amount of stormwater flows during hurricanes and other heavy rainfall events to ensure flood protection of existing communities during emergency events.

Florida Department of Transportation (FDOT) PGA Boulevard Bridge

Historically, State Road 786/PGA Blvd. acted as a barrier to surface water movement from the south to the north causing road flooding. The old culverts were insufficient to move the existing volume of water. To alleviate flooding of the road, FDOT District 4 constructed a new bridge and roadway in 2016. The project provided a Blueway Recreational trail, a wildlife crossing opportunity, and delivered additional water to the Loxahatchee River. The new roadway elevation was increased from 16 ft. to 20 ft. allows water to flow from the south to the north (Figure 4.16) and water to stage up on the north side of the road in the Palm Beach County Loxahatchee Slough Natural Area.

Figure 4.16. (A) Aerial and (B) ground view perspectives of the PGA Blvd. Bridge project. (Photos by FDOT).

Lainhart and Masten Dams

The Lainhart (Figure 4.17A) and Masten (Figure 4.17B) Dams are north of Riverbend Park in northern Palm Beach County at approximately River Mile (RM) 14.8 and RM 13.5, respectively (see Figure 15A). This area of the NW Fork is the scenic classified section known for its natural river channel surrounded by cypress and other native trees. The two weirs were constructed in late 1920s through the 1930s by local property owners to prevent over draining of the upstream reach and provide water for agricultural (irrigation) purposes.

The original dams were first renovated in 1986 by adding sheet pile walls to confine overflow to the concrete weir behind the cypress logs. In 2017, complete renovation of both the Lainhart and Masten Dams were necessary to correct abutment erosion, scouring, seepage, and the degradation

of the portage areas alongside the weirs. The deteriorated dams caused discrepancies in stage and flow data, which are used for water management practices. Repairs to the dams included soil stabilization under and around the dams to reduce seepage issues and a complete redesign and replacement of the canoe/kayak portages. A requirement of the dam renovations was to preserve the historical cypress log appearance (Figure 4.17). With each renovation a new calibration was needed to appropriately measure the flows over the dam.

Figure 4.17. (A) Downstream and (B) upstream views of Lainhart Dam and downstream views of Masten Dam during (C) typical and (D) low river stages after the 2017 renovations. (Photos A, B, and D by SFWMD; photo C by A. Arrington).

Currently, both weirs continue to maintain a higher water stage to alleviate potential adverse effects (i.e., over drained wetlands) on the adjacent floodplain. The Lainhart Dam (Figure 17A) has served as a crucial stage and flow monitoring station since 1973 by USGS (Land et al., 1973) and by SFWMD since 1989. Fixed staff gauges are located upstream and downstream of the dam to monitor water levels in addition to continuous flow recorders. A stage-discharge relationship is used to estimate discharge quantities into the NW Fork. It is essential to accurately measure river stage elevations and discharge flow quantities in accordance with the Minimum Flows and Levels (MFL) Rule (SFWMD, 2003) to comply with Chapter 40E-8 of the Florida Administrative Code. The MFL criteria were developed based on monitoring conducted in the NW Fork. Results from these studies indicated that sufficient flow must be provided over the Lainhart Dam to protect and preserve the Wild and Scenic portions of the Loxahatchee River against harm. Modeling results suggested that discharge flows below 35 cfs at Lainhart Dam should not persist for more than 20 consecutive days at a frequency of more than once every six years.

Freshwater Inflows

MFL criteria were developed in 2002 to secure the sustainability of water resources, protecting the VECs of the NW Fork from significant harm caused by further freshwater withdrawals. Once adopted in 2003, the MFL criteria could not be met specifically for the dry season and a Recovery Strategy was required. The recovery strategy prompted a commitment by the SFWMD and DEP along with LRECD assistance to develop a Restoration Plan for the NW Fork. The 2006 restoration plan provided data for model development and identified constraints, assumptions and alternative flow scenarios to meet the MFL criteria. It outlined the structural, operational, and regulatory requirements and goals needed to provide restorative flows to the NW Fork. It also outlined environmental projects and necessary research to assess the VECs (SFWMD, 2006). Projects identified in the recovery strategies included increased storage and conveyance to provide more water to the NW Fork and were part of the approved Lower East Coast Plan, the Northern Palm Beach County Comprehensive Water Management Plan and CERP. Research conducted between 2006 and 2011 validated the 2006 Restoration Plan recommended flow scenarios which were later included in the 2012 Addendum to the Restoration Plan (SFWMD, 2012). The MFL criteria, 2006 Restoration Plan and 2012 Addendum summarized restoration goals and a strategy to provide the restorative flows to the NW Fork. In 2020, the LRWRP a component of CERP was tasked with restoring and maintaining the quantity, quality, timing, and delivery of freshwater to the NW Fork.

The Lainhart Dam is the largest contributor of freshwater to the NW Fork (SFWMD, 2006). Flows from Lainhart Dam into the NW Fork are monitored by the SFWMD and USGS. Monitoring daily flows over Lainhart Dam are a requirement to assure compliance with the established MFL for the NW Fork and to document exceedances or violations to the MFL Rule. Daily freshwater flow rates over the Lainhart Dam were obtained from SFWMD DBHYDRO database. A slight increasing trend in flows was noted at Lainhart Dam over the last 20 years (Figure 4.18). On average, daily flow from 2011 to 2020 was 111 (cubic feet per second (cfs), a 29% increase from the flows (86 cfs) between 2000 to 2010 (Figure 4.18).

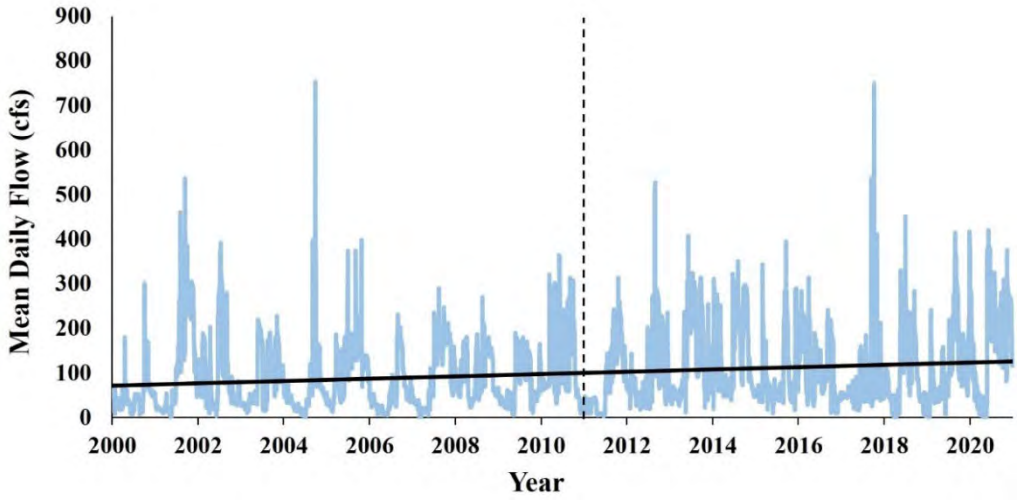

Figure 4.18. Mean daily freshwater flows for Lainhart Dam between 2000 and 2020. The solid trendline shows the increase in daily flows across the decades. The dashed vertical line separates the decades.

During the 2000 to 2010 period, a peak flow of 753 cfs was recorded on September 26, 2004, after Hurricane Frances (September 5, 2004) and as Hurricane Jeanne (September 26, 2004) (Figure 4.18) made landfall in the area. Both storms produced between 7 to 12 in. of rain to the watershed that year (see Tables 4.1 and 4.2). The peak flow recorded between 2011 and 2020 was 749 cfs on October 6, 2017 (Figure 4.18). Possible reasons for increased flows can be attributed to higher rainfall due to major storm events (see Table 4.1). Hurricane Irma (September 10 to 11, 2017) produced a total of 14.4 in. of rain in both Martin and Palm Beach Counties. Prior to the 2017 restoration, deterioration of Lainhart Dam may have caused an underreporting of flows over the compromised dam which may have increased the redirected flows during the 2010 to 2020 decade.

Freshwater flow rates varied between wet and dry seasons. In most years, mean flows were 75% higher during the wet season compared to the dry season of both decades (Figure 4.19). Between decades, flow rates increased by 29% in the wet season and 30% in the dry season between 2011 and 2020 compared to the previous decade (Figure 4.19). The higher flow rates may be the result of more rainfall from 2011 to 2020 (see Figure 4.5), improved infrastructure and water management practices.

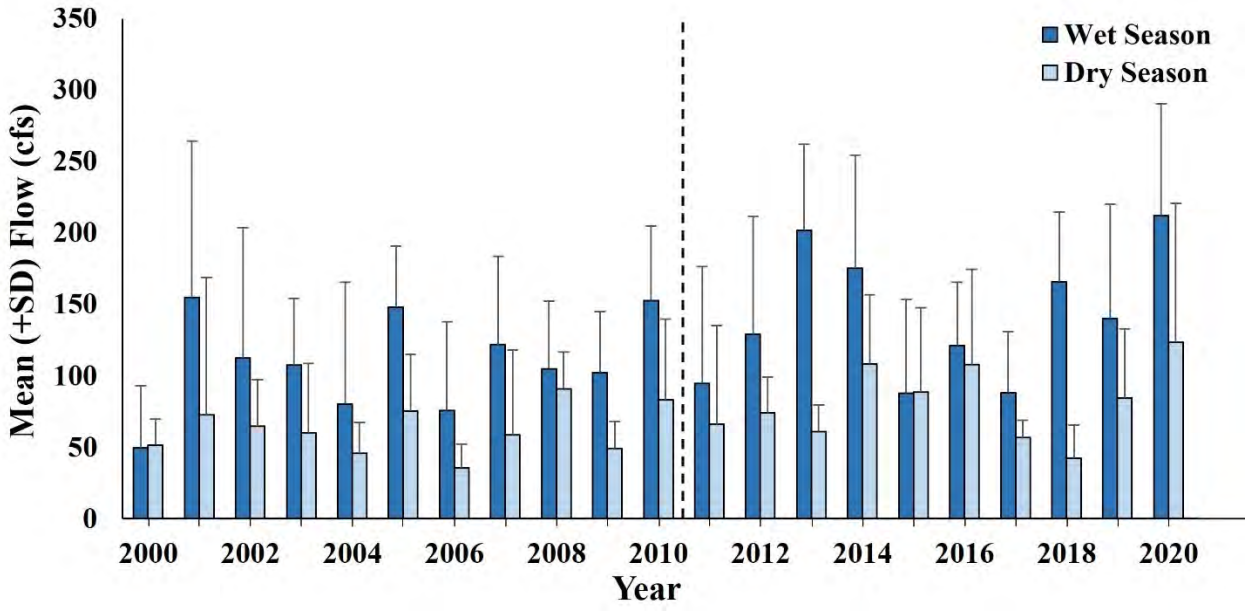

Figure 4.19. Mean (+ standard deviation) flows at Lainhart Dam during the wet and dry seasons of each year. The dashed vertical line separates the decades.

Greater freshwater flows during the period of record (2011 to 2020) indicated more freshwater available within the NW Fork compared to the previous decade. Summarizing flow data as the annual number of days below the 35 cfs minimum flow target provides insight into the trends of general low flow conditions (Figure 4.20) and the associated saltwater intrusion. This metric differs from the 20 consecutive days of flows below 35 cfs incorporated in the MFL rule because it is not subject to day-to-day variations in flow that can reset the 20-day count. The annual number of days below 35 cfs has declined relative to the period of significantly more days with low flows between 2000 and 2011 (Figure 4.20). While the volume of rainfall is a factor in these observations, clearly, operational changes by water managers since 2011 are providing significant

benefits to the river and watershed by reducing the frequency of low flow conditions and the associated saltwater intrusion.

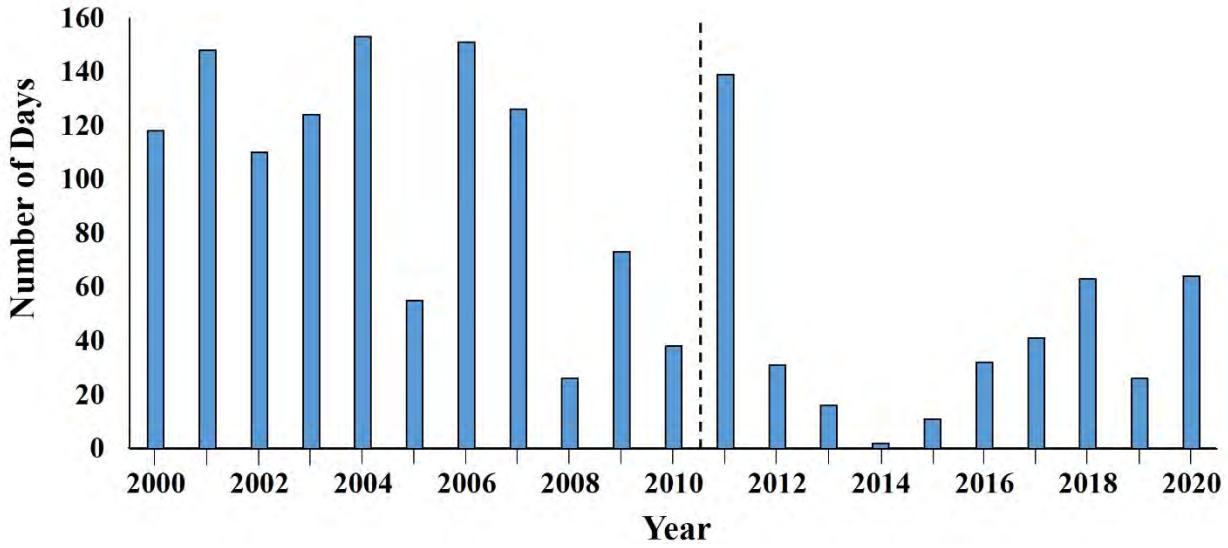

Figure 4.20. Annual number of days river flow was below 35 cfs measured at Lainhart Dam. Data from USGS. The dashed vertical line separates the decades.

Several structure renovations and management modifications have occurred in the last decade to better manage and improve flows to the NW Fork and enhance flood protections in the watershed. Improvements to the water control structures over the last decade reduced the annual number of days river flow was below the minimum required flow and had a positive effect on river stage levels.

River Stage

River stage is the depth of the water at a given area in the river channel upstream and downstream of a structure and is referenced to an established gauge datum (zero point). Stage depth changes over time due to conditions resulting from drought, rainfall, stormwater runoff, groundwater seepage and flow deliveries. Stage and flow continue to be measured by SFWMD and USGS at both Lainhart Dam and Kitching Creek.

In 2008, separate data loggers were installed to measure stage level (Figure 4.21) downstream of Lainhart and Masten Dams. Stage data loggers are positioned along the river at the end of two vegetation transects (T-1 and T-3; see Figure 4.9) to collect stage data every 15 minutes. These data were used to determine the necessary river stage to hydrate the floodplain at each transect. Using LIDAR (remote sensing methods) and field measurements it was determined that a 3.0 m (9.9 ft) NGVD29 stage was needed to inundate the T-1 transect and a 1.2 m (3.79 ft.) NGVD29 stage at T-3 (SFWMD, 2012).

Figure 4.21. A SFWMD scientist measuring the water stage at Transect T-3 downstream of Masten Dam.

River stage at T-1 and T-3 was recorded between 2008 and 2014. Daily stage at T-1 ranged from 2.2 m (7.2 ft.) to 4.0 m (13.1 ft.) between 2008 and 2010, and 2.1 (6.9 ft.) m to 3.7 m (12.1 ft.) between 2011 and 2014 (Figure 4.22). Daily stage at T-3 was 0.3 m (0.9 ft.) to 1.9 m (6.2 ft.) and 0.1 m (0.3 ft.) to 2.3 m (7.5 ft.) (Figure 4.22). The variation in river stage was most likely due to the differences in river elevation between the two sites, though the fluctuations do follow a similar trend (Figure 4.22). Equipment malfunctions and logistical constraints resulted in data gaps over the period of record, though efforts have been made to replace equipment and continue stage monitoring.

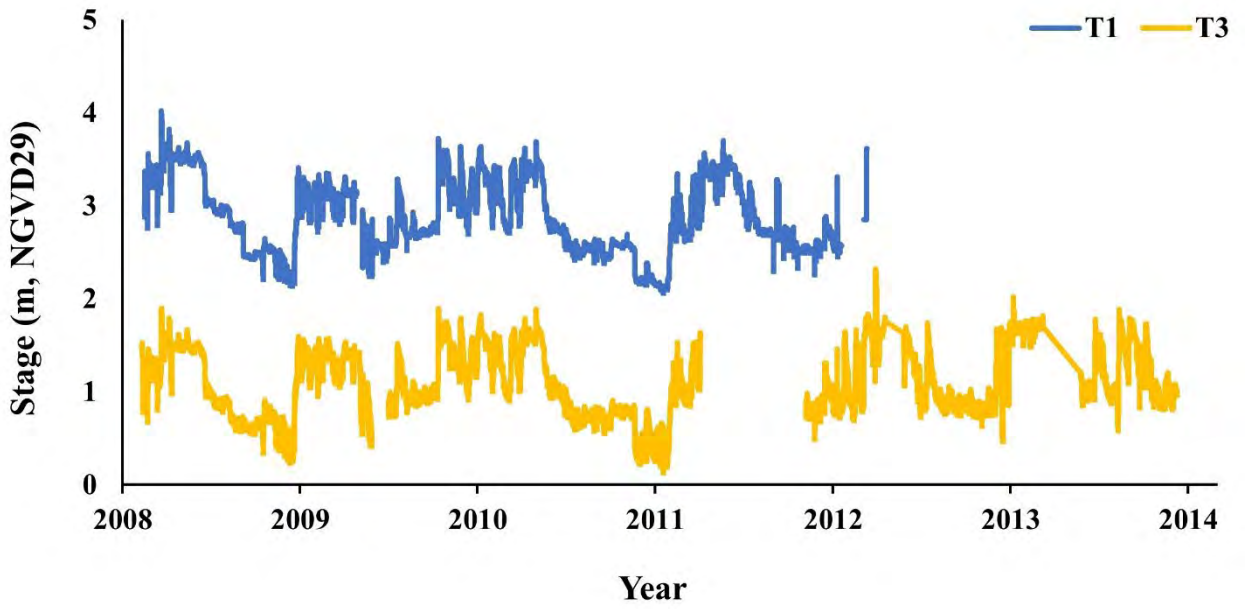

Figure 4.22. Average daily stage measured at T-1 from July 2008 to August 2012 and T-3 from July 2008 to May 2014.

Stage elevations required to inundate the floodplain are determined by the relationship between river stage and flow at the Lainhart Dam. Recommended flows over the Lainhart Dam are required to meet stage elevations for floodplain inundation and vegetation hydroperiod (length of inundation time). Based on the flow-stage relationship, hydrologic performance measures (PM) related to the hydroperiods, and stage required for the floodplain swamp and hydric hammock communities were established in the 2006 Restoration Plan (SFWMD, 2006).

Swamp forests are usually permanently inundated and require minimally 180 to 300 days per year (June to November) of inundation with 18 to 30 inches of above ground water levels (SFWMD, 2006). Hydric hammocks are low, flat wet areas that require an inundation period of 30 to 60 days with 2 to 6 inches of above ground water levels (SFWMD, 2006). If the established stage elevations and inundation duration for the hydrologic PM are not met, shifts in the vegetation community could occur. For example, hydric species could change to more upland species resulting in the hydric species diminishing over time.

The flow at Lainhart Dam and the stage data at T-1 showed that 85 to 300 cfs over the Lainhart Dam was needed to sufficiently hydrate the floodplain at T-1. At T-3, a flow of 85 to a maximum of 300 cfs was needed to inundate the T-3 transect (SFWMD, 2012). For the period of record, average daily stage levels were calculated from stage data collected at 15-minute intervals and regressed with daily flows measured at the Lainhart Dam. The regression was performed using a third order polynomial fit in Excel. The flow-stage relationships were strong for both sites with a R^2 value of 0.86 and 0.93 for T-1 and T-3, respectively, suggesting a strong positive relationship between flow and stage levels for these two floodplains (Figure 4.23).

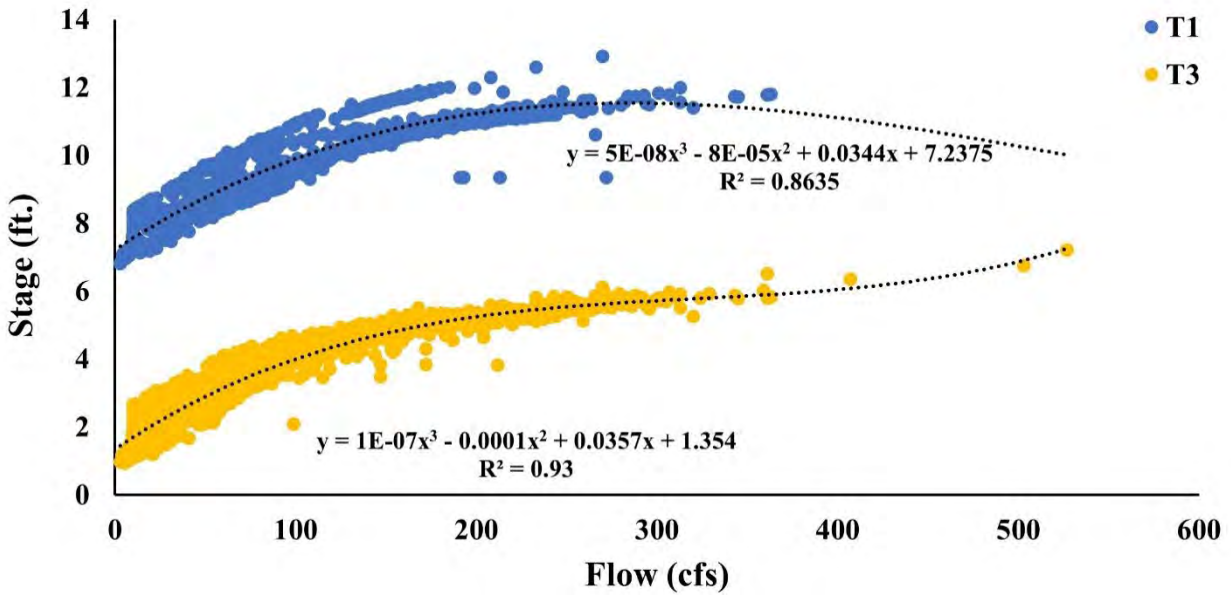

Figure 4.23. Daily flow at Lainhart Dam vs daily stage at T-1 and T-3. Regression performed with a third order polynomial function fit.

The regional hydrologic conditions and flow deliveries over the Lainhart Dam affect the environmental stability of the riverine floodplain and the types of vegetative communities that can be supported (USACE, 2020). Evaluating the stage flow relationships for these two sites is important for understanding the changes in the floodplain vegetation communities and can assist with the planning of needed restoration efforts (CERP, LRWRP) to improve flows to the NW Fork. Routine monitoring of the stage data is important to keep refining the stage flow relationship as sea level affects this area over time.

Modeling Floodplain Inundation, Circulation, and Residence Time Under Changing Tide and Sea Level Conditions

In the last decade, Sullivan et al. (2020) conducted a study to provide information on how accelerated sea level rise threatens coastal land and water resources. As saltwater intrusion and sea level rise risks increase for the Loxahatchee River floodplain, there was a need to better understand how surface water flows affected floodplain hydroperiods. Sullivan et al. (2020) assessed the relative influence of floodplain topography and tides on overall circulation, floodplain inundation and water residence times (the amount of time water spends in one spot) under current and future sea level scenarios. Previous sea level rise scenarios estimated a 3 mm/yr. increase, though portions of southeast Florida exceeded 5 mm/yr. (Obeysekera et al., 2011, Meeder et al., 2017, Valle-Levenson et al., 2017).

To assess the influence of floodplain topography and tides on inundation and water residence times, a tracer was released upstream, and water levels and tracer concentrations were monitored at three locations near RM 9.1 (Figure 4.24). Collected data was entered into a digital elevation model (DEM) with additional analyses using the Delft3D Flow Simulation Package to further evaluate the effects of 0.2 m and 0.5 m increases in mean sea level (projected by the year 2100, Sweet et al. 2017)).

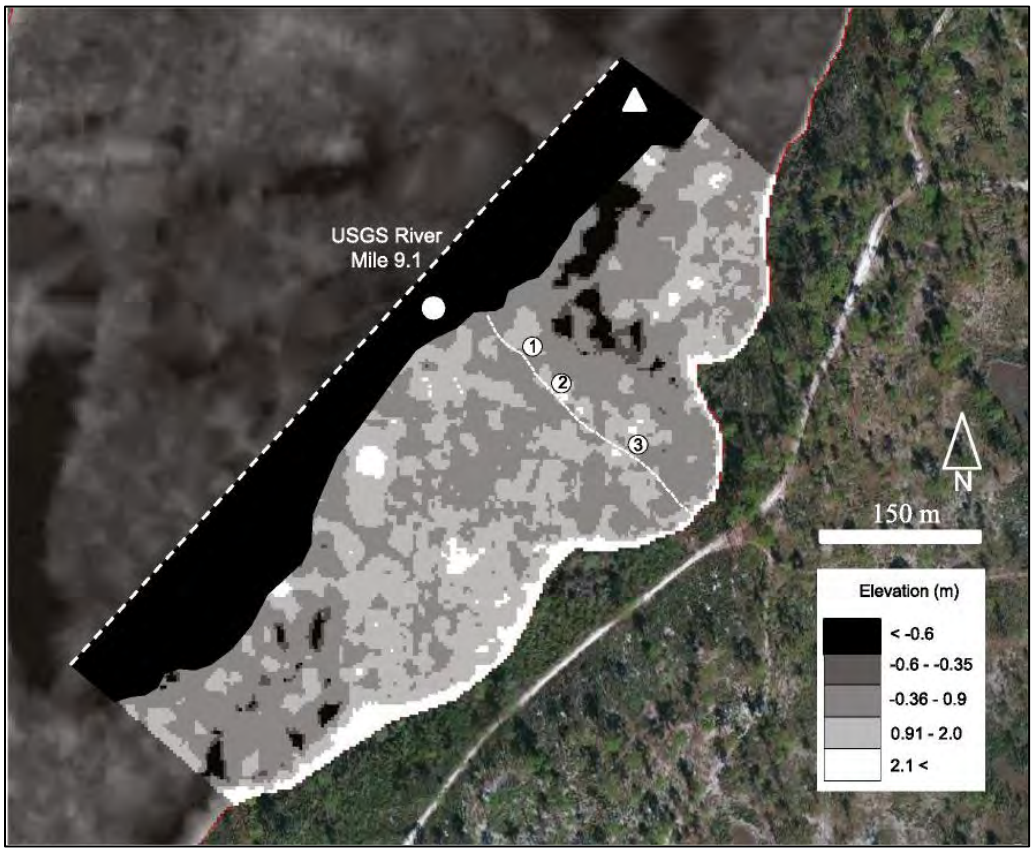

Figure 4.24. The DEM of the floodplain study area at RM 9.1 on the NW Fork of the Loxahatchee River. A grayscale was used to highlight elevation relative to NAVD88 and the boundaries of the model domain. The river surface depressions are shown in black, shades of dark to light gray highlight areas low and high floodplain, respectively, and white areas represent hammocks (Sullivan et al., 2020).

The model showed that earlier and prolonged inundation of the floodplain surface, up to 23% and 27% during low and intermediate tidal stages were evident for 0.2 m and 0.5 m, respectively, compared to the existing conditions. A 0.5 m increase in mean sea level would result in 57% more of the higher floodplain areas and 21% more of the hammock areas would be underwater. When the mean sea level increased by 0.5 m, retention times were 20% longer at all stations than the existing conditions. These findings on the effects of sea level rise on floodplain inundation and associated water residence times are important because they underscore the relative influence of topography and tides on water storage and exchange across the floodplain system.

This study highlighted the effect of subtle floodplain topography on how, when, and where areas of the floodplain will be impacted by sea level rise. Sullivan et al. (2020) revealed a 20% increase in water retention times on the floodplain surface with an increase in mean sea level of 0.5 m exacerbated saltwater encroachment into the floodplain, increasing the extent of inundation and prolonged hydroperiods. The impact of increased salinity and inundation under future sea levels on the health of existing freshwater communities, especially bald cypress, as well as their recruitment is of major concern for the NW Fork. To assist in the assessment of restoration benefits

from CERP, Sullivan et al. (2020) recommended additional efforts be devoted to modeling salinity structure in the Loxahatchee River and floodplain system under future sea level changes.

Watershed, Drainage, and Hydrology Summary

Hydrologic conditions varied throughout the watershed between the last two decades. The most notable difference was a 33% (dry season) and 14% (wet season) increase in rainfall between 2011 and 2020 compared to the previous decade. Increased rainfall and water control structure renovations provided greater freshwater flows to the NW Fork during the period of record. Flow rates at the Lainhart Dam were used to determine the flow-stage relationship to better understand changes in the floodplain vegetation communities and the potential impacts of sea level rise. Modeling efforts suggested that a 0.5 m increase in mean sea level would increase floodplain inundation and exacerbate the impacts saltwater intrusion, comprising the health of the freshwater communities, especially cypress trees. Additional modeling, including the WaSh model, is recommended to detect changes in the water flow throughout the Loxahatchee River watershed and determine the impacts of longer floodplain inundation and saltwater intrusion under future sea level changes.

4.1.2. River Watershed, Drainage, and Hydrology Goal and Objectives

The following objectives for the River Watershed, Drainage, and Hydrology goal are prioritized in the Action Plan (4.1.3). An effort to implement one or more objectives may be part of a program already in-progress.

Goal: To protect and improve overall river hydrology and water quantity throughout the NW Fork of the Loxahatchee

Objectives:

A. Implement the federally approved 2021 Loxahatchee River Watershed Restoration Project (LRWRP) plan expeditiously.

B. Coordinate with stakeholders to implement interim efforts to achieve river restoration benefits.

C. Improve within-basin water storage on publicly owned lands to improve the ability to meet MFL and restoration flows.

D. Improve the hydrologic connectivity and wildlife corridors within the watershed to achieve restoration benefits (Florida Wildlife Corridor Act 259.1055).

E. Coordinate the continuation of hydrological monitoring programs needed to evaluate the health and restoration of the river.

4.1.3. River Watershed, Drainage, and Hydrology Action Plan

Key to the Action Plan Table (Table 4.3):

- Priority of the objective was determined by the LRMCC using the following criteria:
    1. Legally required, planned, or funded; action will be taken within the 10 year planning period.
    2. In planning, may or may not be funded; action may not happen within the 10 year planning period.
    3. Not planned or funded; action not expected to start within the 10 year planning period.
- Responsibility of each action was determined by the LRMCC and often shared among several agencies (listed by acronyms (see pg. vii)).
- Duration of the action is either a discrete action ("Once") or continuous action ("Ongoing")

NOTE: The ability to carry out these activities will be dependent on the priorities of the responsible agencies and the availability of funds.

Table 4.3. River Watershed, Drainage, and Hydrology Action Plan.

Goal: To protect and improve overall river hydrology and water quantity throughout the NW Fork of the Loxahatchee.		
Objective	**Priority**	
A. Implement the federally approved 2021 Loxahatchee River Watershed Restoration Project (LRWRP) plan expeditiously.	**1**	
Actions	**Responsibility**	**Duration**
i. Accelerate LRWRP elements (e.g., land acquisition, system design).	SFWMD, DEP	10 years
ii. Design and construct Mecca stormwater reservoir to provide supplemental flows to the NW Fork to avoid MFL violations.	SFWMD, DEP	10 years
iii. Expedite design, construction, and testing of Aquifer Storage and Recovery (ASR) wells included in the LRWRP.	SFWMD, DEP	10 years
iv. Kitching Creek Restoration and Hydration: Construct spreader canal at north end of JDSP to facilitate sheet flow and rehydrate Kitching Creek.	SFWMD, DEP	10 years
v. Kitching Creek Restoration and Hydration: Construct a gated culvert in Jenkins Ditch upstream of Kitching	SFWMD, DEP	10 years

Creek channel to allow flood-discharge through Jenkins Ditch.		
vi. Moonshine Creek and Gulfstream East Restoration: Re-grading and backfilling of drainage ditches within ~460-acre fallow citrus grove.	SFWMD, DEP	10 years
vii. Moonshine Creek and Gulfstream East Restoration: Construct fixed weir at the eastern terminus of Hobe Grove Ditch to divert water to the NW Fork via Moonshine Creek.	SFWMD, DEP	10 years
viii. Pal-Mar East Restoration: Routing water from the Culpepper Ranch through Pal Mar East (Nine Gems Property), the former orange groves west of I-95 and east of Ranch Colony, where it will eventually flow into the Cypress Creek (Ranch Colony Canal).	SFWMD, DEP	10 years
ix. Gulfstream West Flow-through Marsh: Construct a 740-acre shallow flow-through marsh.	SFWMD, DEP	10 years
x. Gulfstream West Flow-through Marsh: Construct a new pump station to pump water from the HSLCD drainage canal into the flow-through marsh at the north end of the property.	SFWMD, DEP	10 years
xi. Gulfstream West Flow-through Marsh: Construct a perimeter levee to ensure elevated surface water is held on-site.	SFWMD, DEP	10 years
xii. Gulfstream West Flow-through Marsh: Remove the existing drainage ditches and grade the property to promote flow in a southern direction.	SFWMD, DEP	10 years
xiii. Gulfstream West Flow-through Marsh: Straighten the existing HSLCD discharge canal on the western edge of Gulfstream West to use as a bypass canal.	SFWMD, DEP	10 years
xiv. Gulfstream West Flow-through Marsh: Construct outflow structure, a notched weir located downstream of spillway S-112, to control discharge from flow-through marsh into Cypress Creek Canal.	SFWMD, DEP	10 years
iv. Draft a Memorandum of Understanding between the LRD, SFWMD, City of West Palm Beach, and other necessary partners to codify an operational approach and limitations to delivering supplemental flows through Grassy Waters (# days of supplemental flows provided to NW Fork through G-161).	SFWMD, DEP	10 years

Objective	**Priority**	
B. Coordinate with stakeholders to implement interim efforts to achieve river restoration benefits.	**2**	
Actions	**Responsibility**	**Duration**
i. Pepper Farm Restoration Project.	SFWMD	
ii. Culpepper Berm Restoration Phase II.	MC	1 year
iii. Eastern flow-way Kitching Creek.	MC	4 years
iv. Cypress Creek Hydrologic Floodplain Restoration Project.	MC	4 years
Objective	**Priority**	
C. Improve within-basin water storage on publicly owned lands to improve the ability to meet MFL and restoration flows.	**1**	
Actions	**Responsibility**	**Duration**
i. Restore natural wetland habitats within the watershed.	TBD	TBD
ii. Identify areas where storage could be constructed.	TBD	TBD
Objective	**Priority**	
D. Improve the hydrologic connectivity and wildlife corridors within the watershed to achieve restoration benefits (Florida Wildlife Corridor Act 259.1055).	**1**	
Actions	**Responsibility**	**Duration**
i. TBD as available.	Landowners; DOT	TBD
Objective	**Priority**	
E. Coordinate the continuation of all hydrological monitoring programs needed to evaluate the health and restoration of the River.	**1**	
Actions	**Responsibility**	**Duration**
i. Conduct real-time hydrologic flow and stage monitoring at S-46, Lainhart Dam, G-92, G-160, G-161; stage at transects T-1 and T-3; salinity/conductivity at RM 9.1; monitor electrical conductivity and soil moisture along the poles of each vegetative transect using soil and groundwater conductivity probes.	USGS, SFWMD, JDSP	10 years

4.2. Water Quality in the NW Fork of the Loxahatchee River

Water quality (WQ) describes the condition, including the chemical and physical characteristics within a designated water body. Factors contributing to water quality consist of, but are not limited to, salinity, flow, dissolved oxygen, nutrients, and turbidity. Maintaining healthy water quality conditions within a water body allows the aquatic and surrounding floodplain habitats to preserve and support the natural ecosystem within the watershed.

4.2.1 Assessment

Scope

The WQ assessment provides an overview and analysis of the water quality over the last two decades using data collected by LRECD monitoring programs along the river. A few of the major parameters discussed include salinity, suspended solids, turbidity, phosphorus, nitrogen, and fecal coliform. Results, exceedances, and analyses were summarized for the two decades.

Background

Over the past 22 years, water quality conditions, including spatial and temporal variability, within the Loxahatchee River watershed have been characterized by the LRECD's Wild Pine Ecological Laboratory. Through this monitoring effort portions of the Loxahatchee River were identified by the DEP as impaired river segments. As of 2022, DEP classified seven segments of the NW Fork using Water Body IDs (WBIDs) with four of the seven segments graded as "Impaired" or contaminated by pollutants. Stakeholder involvement has led to restoration efforts to address areas characterized as polluted.

The Florida Department of Environmental Protection (DEP) worked with local stakeholders to develop an alternative restoration plan to address water quality issues and a Category 4e assessment of the Loxahatchee River. A Category 4e Plan (Ongoing Restoration Activities) was established because recently completed and ongoing restoration activities will likely restore designated uses of the waterbody. Local stakeholders, including the LRMCC, worked through a public process to draft the approved voluntary Pollutant Reduction Plan (4e PRP). The PRP was established to reduce water quality impairments prior to the development of a total maximum daily load (TMDL) and subsequently a basin management action plan (BMAP). The PRP was initiated to remedy water quality impairments without a state prescribed TMDL or a basin management action plan (BMAP). The benefit of the 4e PRP enables stakeholders to focus on implementing projects and fixing problems, not on the TMDL process itself. If stakeholders are unable to reach the water quality targets with voluntary efforts, DEP could develop and adopt a TMDL. Nutrient management activities (e.g., septic to sewer conversions, stormwater system improvements, wetland restoration), either in effect or to be implemented, will make meaningful progress toward attaining the desired water quality.

The goal of water quality monitoring is to document the ecological health of the river and to determine the location and extent of water quality issues that need to be addressed throughout the watershed. LRECD's Datasonde and RiverKeeper programs actively monitor water quality throughout the watershed. Data generated by LRECD, and partner agencies were used to characterize water quality in the NW Fork and how local conditions such as rainfall and freshwater inflow directly impact water quality throughout the Loxahatchee River.

Conditions from 2011 to 2020

LRECD Datasonde Program

The LRECD Datasonde monitoring program collects water temperature and salinity every 15 minutes continuously at various locations throughout the river. LRECD has collected data from datasondes located in the NW Fork at Kitching Creek (RM 8.02), near surface/top (0.5 meters from surface) and bottom (0.5 meters from bottom) since January 2005. Average daily salinities exceeded the established salinity threshold of 2 more frequently in the bottom waters (Figure 4.25A, dark blue) than the surface waters (Figure 4.25A, light blue). The average monthly salinities at Kitching Creek exceeded the salinity threshold of 2 at the surface (Figure 4.25B, light blue) less frequently than bottom waters. The bottom water at Kitching Creek had much higher magnitude of salinity exceedances (up to 18) (Figure 4.25B, dark blue), which can be attributed to the estuarine salt wedge.

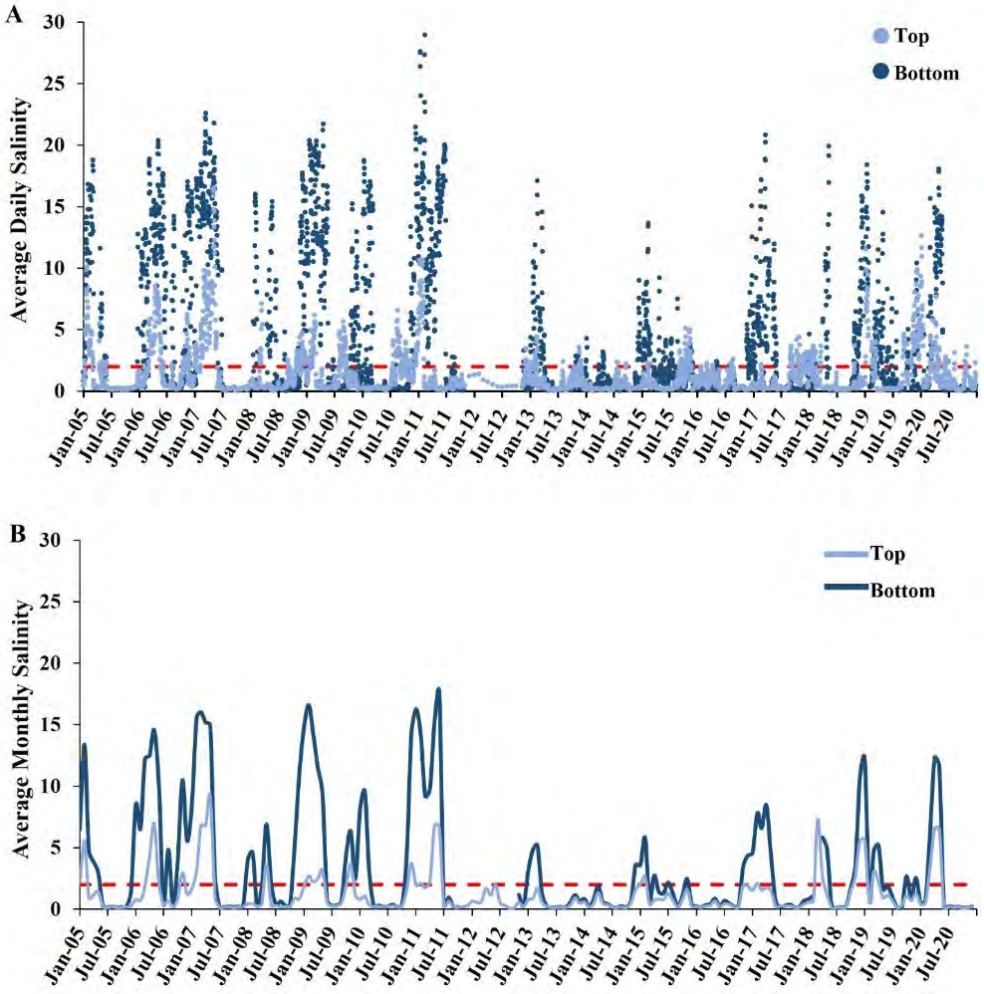

Figure 4.25. (A) Daily average salinities and (B) monthly average salinities from LRECD datasondes located at Kitching Creek Top (light blue) and Bottom (dark blue) at River Mile 8.02 in the NW Fork. Dashed red lines indicate a salinity of 2, the minimum salinity level known to harm floodplain vegetation.

Like LRECD's Datasonde program, United States Geological Survey (USGS) maintains a real-time salinity monitoring station upstream of the Kitching Creek location. The USGS station is located at RM 9.1 and is the critical location for salinity limits defined in the Minimum Flow and Levels (discussed below). Daily average top and bottom salinities were below the 2 salinity threshold from July 2007 through spring of 2018 at RM 9.1 (Figure 4.26A). Between spring and summer months, daily average salinities exceeded the salinity threshold in 2018 through 2020 (Figure 4.26A). The 20-day rolling average salinities, used to identify the Minimum Flow and Levels at Lainhart Dam (discussed below), remained below the salinity threshold from July 2007 through spring of 2018 (Figure 4.26B).

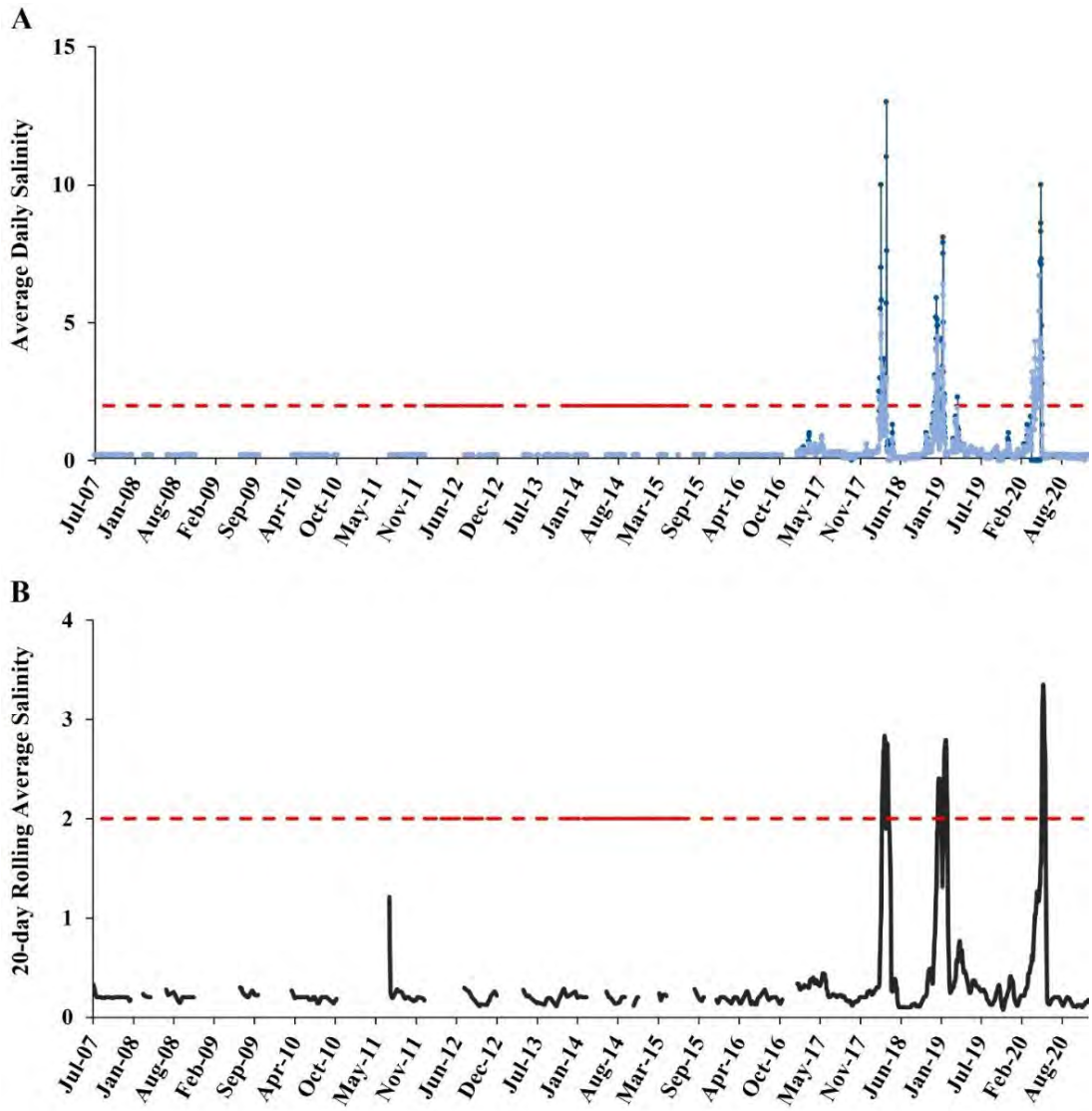

Figure 4.26. (A) Average daily salinity from USGS Kitching Creek station (RM 9.1) in the NW Fork from the top (light blue) and bottom (dark blue) and (B) 20-day rolling average of both top and bottom salinity values used to determine the minimum flows and levels at Lainhart Dam. Dashed red lines indicate a salinity of 2, the minimum salinity level known to harm floodplain vegetation.

Minimum Flows and Levels (MFL) Rule

Florida agencies are bound by the Florida Administrative Code (FAC) 40E-8.221. Minimum Flows and Levels (MFLs): Surface Waters (Supplemental 5). A Minimum Flow and Level (MFL) rule was established by SFWMD in 2002, setting the minimum flow levels and salinity threshold to prevent significant harm to water resources and ecology including critical habitats, such as stress to cypress trees and seedlings, in the NW Fork of the Loxahatchee River (Chapter 40E-8.221(4), F.A.C.). The ruling states:

> MFL exceedance occurs in the NW Fork of the Loxahatchee River when: (1) flows over Lainhart Dam fall below 35 cfs for more than 20 consecutive days; or (2) average daily salinity (measured at 0.5 meters below the surface and 0.5 meters above the bottom) expressed as a 20-day rolling average exceeds 2 at river mile 9.1 (latitude 26.9839, longitude 80.1609). MFL violations occur when an exceedance occurs more than once over a six-year period.

The 2006 Restoration Plan provided restoration alternatives for the NW Fork and set forth criteria for wet and dry season flow targets. The criteria established a restoration flow target for the wet season (August through November) to 110 cfs for a minimum of 120 days and dry season restorative flows between 50 and 110 cfs (mean monthly flow of 69 cfs over Lainhart Dam). Furthermore, the 2006 Restoration Plan set a minimum threshold of 35 cfs for Lainhart Dam to maintain freshwater habitat in the Wild and Scenic portion of the river, with 50 cfs used as the minimum 'restorative flow' target, setting the criteria required to maintain historical flows (SFWMD, 2006).

The total number of days of MFL violations due to flow and/or salinity exceedances occurred more than once over a 6-year period since monitoring began in 2000 (Figure 4.27). Tracking the days of MFL exceedance we can see that although MFL flow exceedances (blue) have decreased over time since 2006, salinity exceedances have increased (red) since 2007, and the events of both salinity and flow MFL exceedances are rare (white shown in 2007 and 2011; Figure 4.27B). The NW Fork MFL has been violated frequently since 2002, though were fewer violations occurred between 2011 to 2020 due to better management of flows (Figure 4.27B).

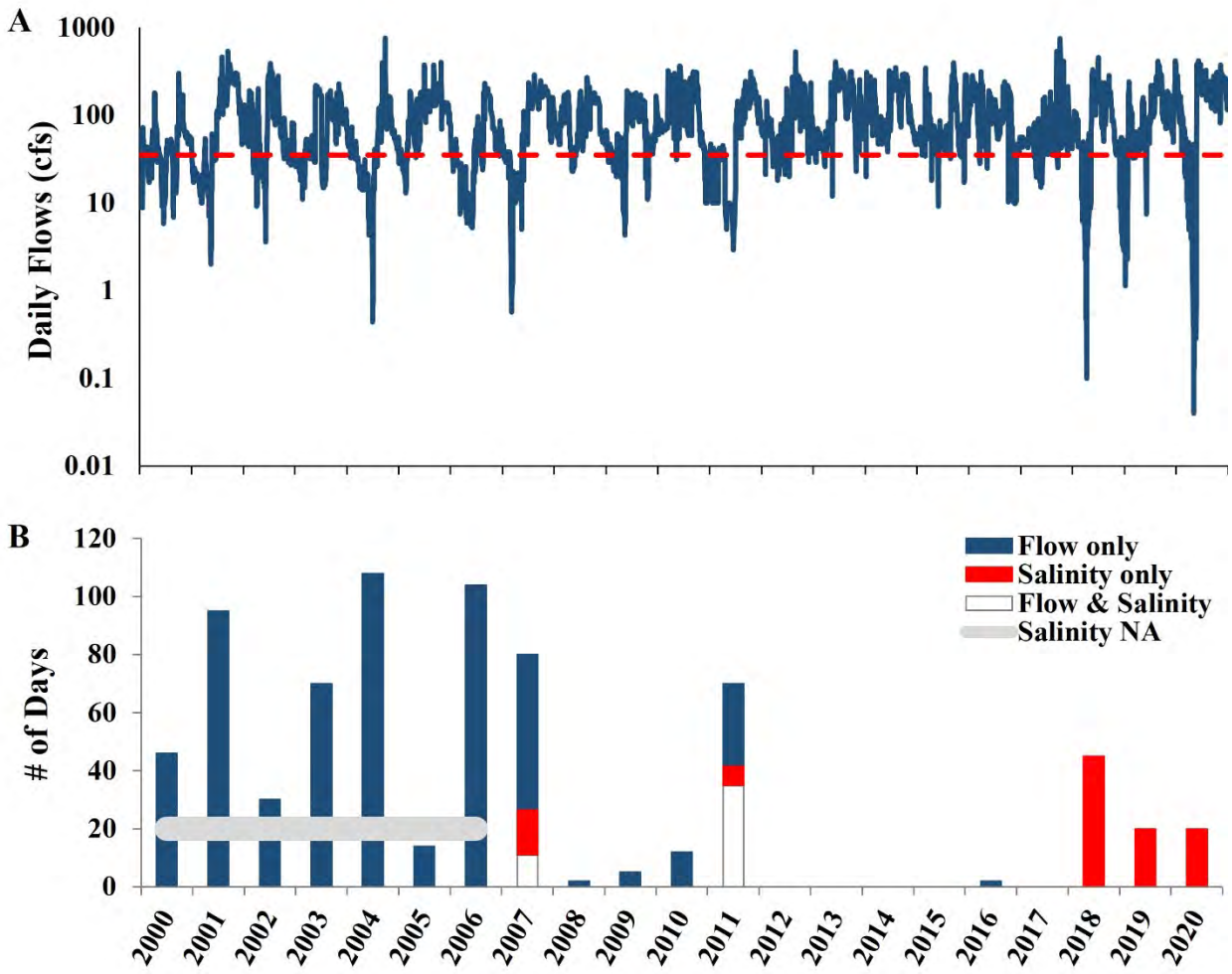

Figure 4.27. (A) Average daily flow measured at Lainhart Dam from 2000 to 2020 shown on a log scale. The dashed red line indicates the 35 cfs MFL flow criteria for reference. (B) Total days of MFL exceedances by flow only (blue) and salinity only (red), and both salinity and flow (white); the gray bar indicates years (before 2007) where the 20-day rolling average salinity data were unavailable.

The relationship between 20-day rolling average salinity at Kitching Creek and 20-day cumulative flows at Lainhart Dam differs for each salinity exceedance event (i.e., individual salinity exceedance events have unique slopes; Figure 4.28) during the MFL salinity exceedances. A negative relationship between 20-day rolling average salinity and 20-day cumulative flows at Lainhart Dam was observed as salinity generally decreases with increased flows (Figure 4.28).

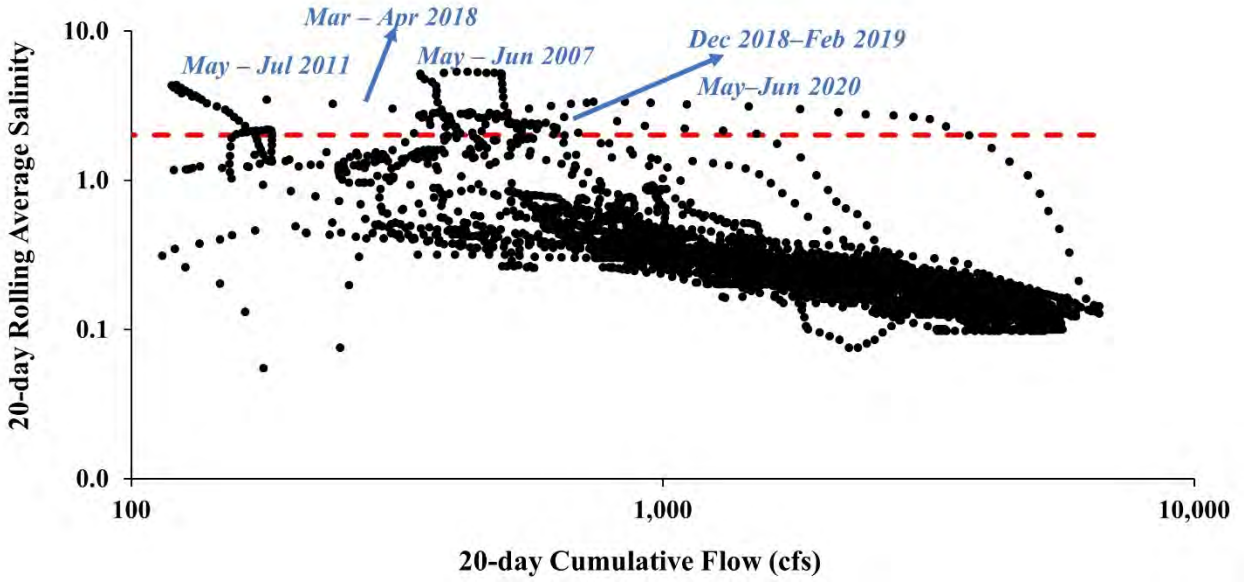

Figure 4.28. The 20-day rolling average salinity plotted against 20-day cumulative flows at Lainhart Dam on a log scale. Red line highlights the 2 salinity threshold with individual MFL salinity exceedances labeled in blue.

Further examination of the daily flows at Lainhart Dam and MFL salinity exceedances highlighted the changes in water management practices. For example, MFL flow exceedances occurred consistently from early March through June 2007 (Figure 4.29A). Flows below 35 cfs for prolonged periods of time (e.g., flows below the red dashed line March to May 2007 and April to July 2011) led to salinity 20-day rolling averages greater than 2 (shown in gray boxes in 2007 and 2011 (Figure 4.29), which contributed to flow and salinity MFL exceedances in 2007 and 2011 (Figure 4.27B). Both instances in 2007 and 2011 correspond to low rainfall periods (Figure 4.4) which resulted in prolonged periods of reduced flows from Lainhart Dam (Figure 4.29).

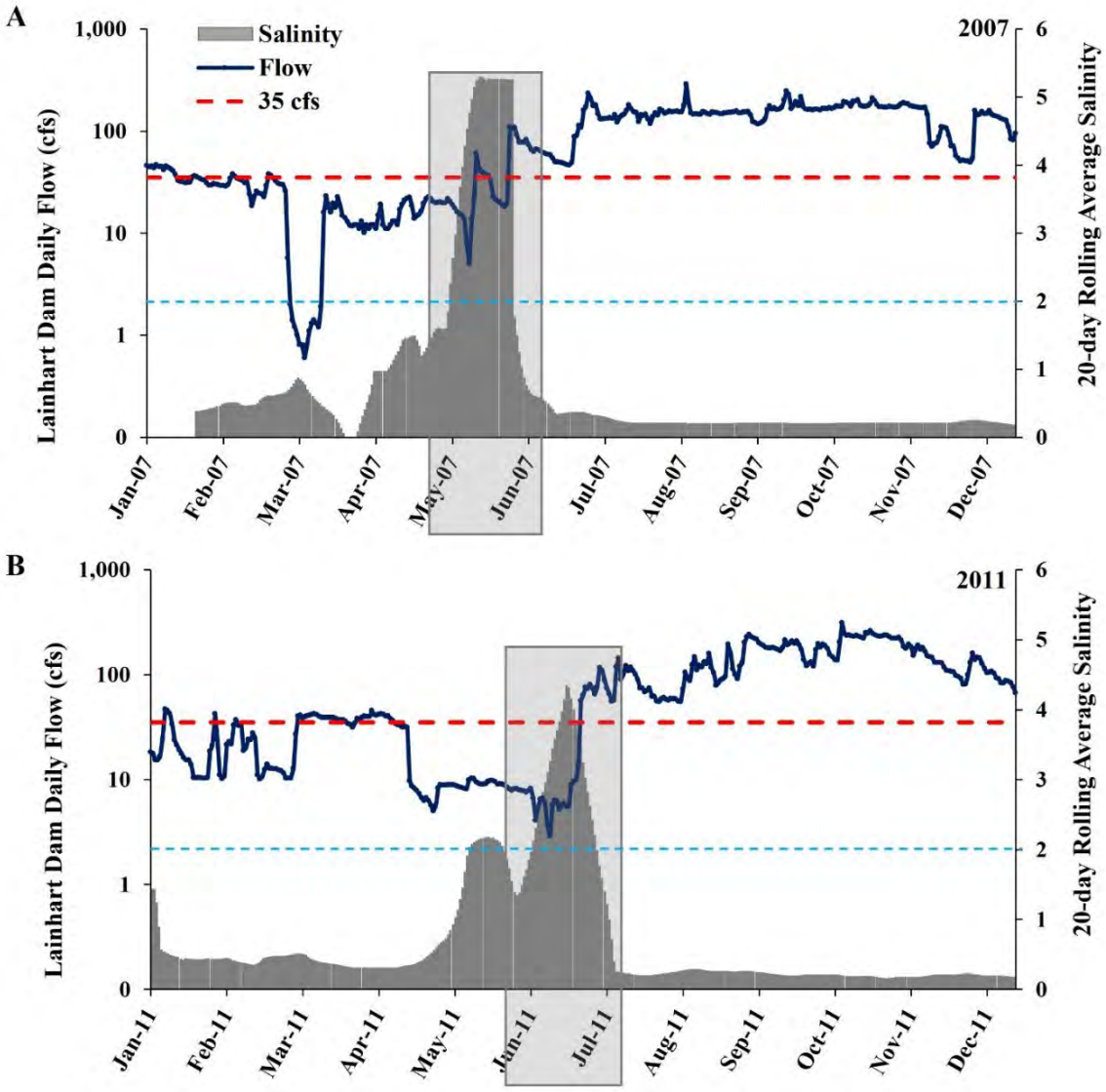

Figure 4.29. Daily flows at Lainhart Dam (dark blue lines, primary y-axis) and 20-day rolling average salinity (gray bars, secondary y-axis) plotted over time for each MFL salinity exceedance. Red lines denote the 35 cfs minimum flow threshold, with MFL salinity exceedances highlighted in gray boxes in (A) 2007 and (B) 2011.

In contrast, above average rainfall occurred over the past 3 years, with above average rainfall May to October and below average rainfall occurring outside of the rainy season 2018 to 2020 (see Figure 4.4). Pulsed releases of freshwater from Lainhart Dam were documented in dry months 2018 to 2020, resulting in weekly flows slightly above and below 35 cfs (Figure 4.30). The management practice of pulsed releases eliminated MFL flow violations, yet MFL salinity exceedances still occurred (Figure 4.30 and Figure 4.28B). These observations emphasized that the amount and duration of freshwater released must be considered to maintain desired salinity regimes throughout the NW Fork.

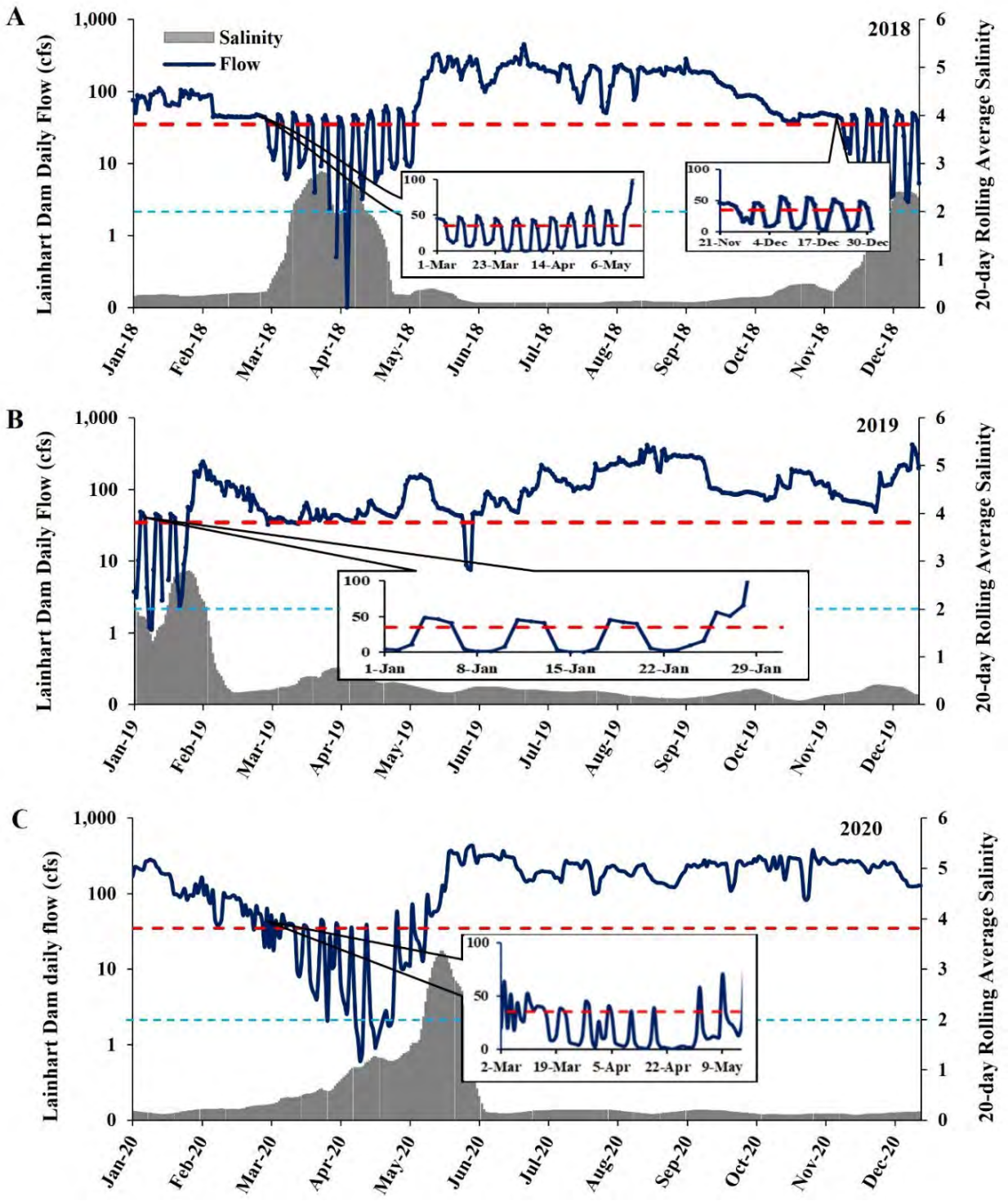

Figure 4.30. Daily flows at Lainhart Dam (dark blue lines, primary y-axis) and 20-day rolling average salinity (gray bars, secondary y-axis) plotted over time for each MFL salinity exceedance. Red lines denote the 35 cfs minimum flow threshold. Insets magnify the flow patterns during MFL salinity exceedances in (A) 2018, (B) 2019 and (C) 2020.

The MFL is defined as the minimum flow at which further loss would cause significant harm to the water resources or ecology of the area. The overall goal of the MFL is to ensure the sustainability of water resources in the NW Fork and protect the freshwater floodplain vegetation communities like bald cypress swamps. Continued monitoring of salinity at RM 9.1 (Kitching Creek) and flows across Lainhart Dam enable tracking of MFL exceedances which guides water management practices to ensure the MFL criteria are met. Further, periodic assessments of the vegetation communities will inform on the status of the floodplain habitat.

LRECD RiverKeeper Program

RiverKeeper is LRCED's surface water quality monitoring program to evaluate spatial and temporal changes in water quality in the NW Fork. Samples are collected monthly at 11 sites upstream to downstream in the NW Fork to Jupiter Inlet, and quarterly at 15 sites throughout the watershed. Through the RiverKeeper program, surface water grab samples are collected and analyzed by LRECD in their certified National Environmental Laboratory Accreditation Program laboratory for nearly 20 parameters (e.g., dissolved oxygen, pH, specific conductance, total nitrogen, orthophosphate, fecal coliform bacteria, chlorophyll *a*). The primary goal of the RiverKeeper program is to identify anthropogenic activities leading to degradation of water quality and document deviations in water quality conditions. This includes deviations from the Interim Water Quality Targets (IWQT) established in 2004 by the LRECD, SFWMD and JDSP for the NW Fork (SFWMD, 2006).

In addition to the IWQT, the Florida DEP and the U.S. Environmental Protection Agency (EPA) Numeric Nutrient Criteria (NNC) developed for estuarine regions in Florida and the Surface Water Quality Criteria Table for Class III Recreational Waters (see FAC 62-302.530) were used for benchmark comparisons. Generally, the NNC is used to assess state waterbodies to determine if water quality standards are met. Each year water quality results were assessed relative to the established target water quality conditions by comparing the median condition of a given year against the median condition of the 1998 to 2002 period, i.e., the Interim Water Quality Targets (IWQT) (Appendix A) or the state's set NNC. Water quality monitoring results were used to evaluate the effectiveness of water management strategies and preserve critical habitats in the Loxahatchee River.

The Loxahatchee River spans an estuarine gradient and for the purpose of evaluating water quality was subdivided into river segments based on salinity (Stoner and Arrington, 2017). These river segments were monitored to evaluate the overall health of the river. Twenty-five water quality stations were grouped into analysis zones based on salinity and freshwater inflows: freshwater tributaries (squares), canal (triangle) and river channel segments (circles) (Figure 4.31; Appendix B). Freshwater tributaries to the NW Fork include: Kitching Creek (yellow), Moonshine Creek (peach), Cypress Creek (orange) and Jupiter Farms (red) and the C-18 canal (blue) (Figure 4.31). River segments derived from Stoner and Arrington (2017) were evaluated based on salinity: Wild and Scenic (green), Oligo/Mesohaline (light purple), Polyhaline (gray), and Marine (white) (Figure 4.31).

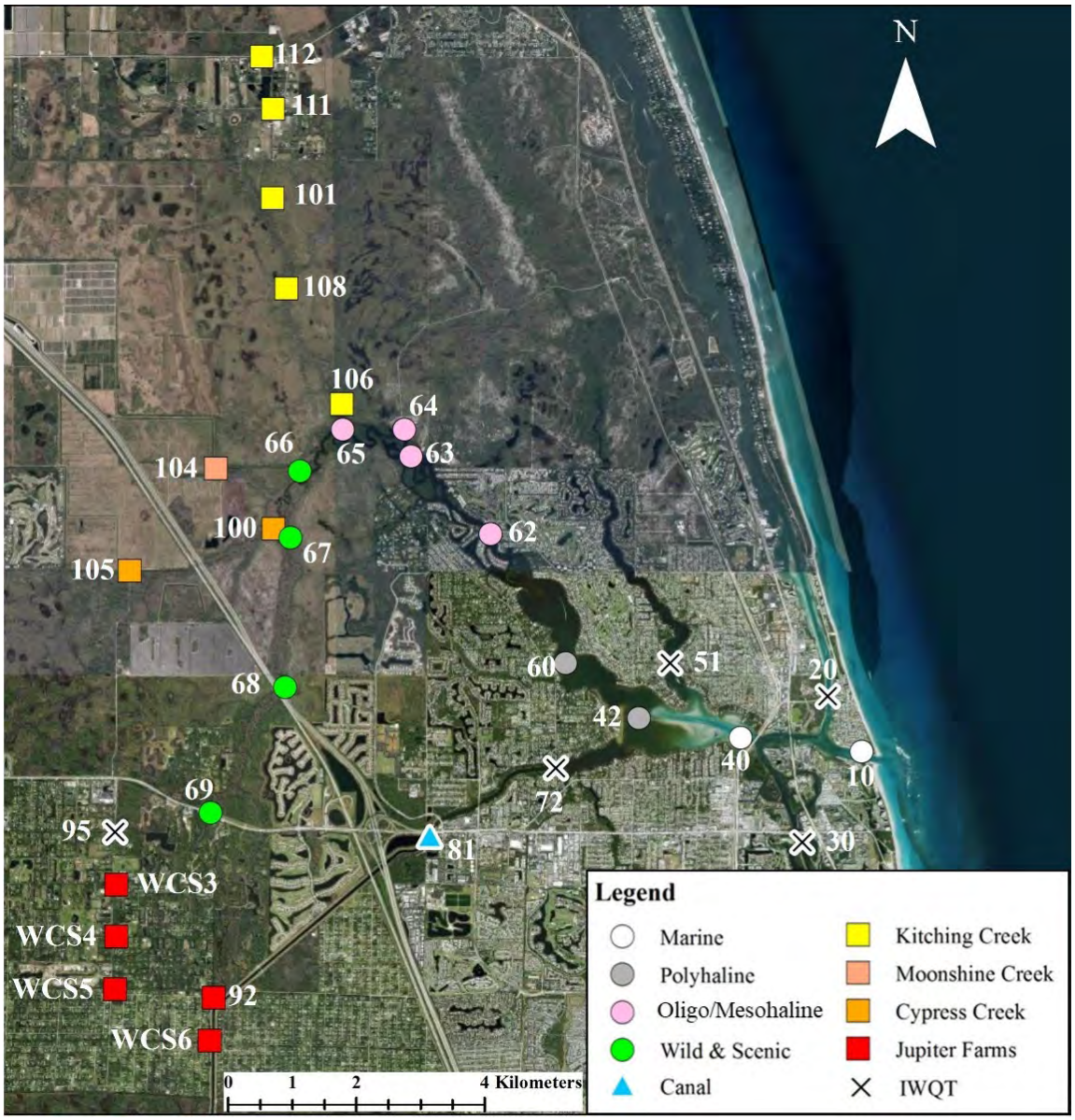

Figure 4.31. LRECD's Water Quality monitoring stations used in the current report showing freshwater tributaries (squares), water control structure (triangle), river channel samples (circles), and additional stations used for IWQT (black x) in the Loxahatchee River.

Here, water quality was compared to either the IWQT or NNC value, whichever was more stringent (Table 4.4). For example, the IWQT for total phosphorus (TP) in the polyhaline region is higher than the NNC, whereas the NNC is more conservative than the IWQTs for the oligo/mesohaline and freshwater reaches (Table 4.4; Appendix A). In contrast, for total nitrogen (TN), the NNC in the oligo/mesohaline and freshwater reaches are more stringent than the IWQT (Table 4.4; Table Appendix A). In 2016, the state moved from using fecal coliform bacteria to *E. coli* to evaluate bacteria in freshwater and enterococci in brackish/marine waters. For this update, the most conservative value (IWQT or NNC) was used as a benchmark for comparison (Table 4.4; Appendix A).

Table 4.4. Annual averages compared to the Interim Water Quality Targets (IWQT) or Numeric Nutrient Criteria (NNC, indicated by †), whichever criteria is most conservative. Values in red are equal to or exceed the IWQT or NNC (page 1 of 4).

Water Quality Parameter	Analysis Period	Estuarine Reach		Tidal Floodplain	Riverine Floodplain	
		Marine	Polyhaline	Oligo/ Mesohaline	Wild & Scenic	Freshwater Tributaries
IWQT		**25.4**	**25.4**	**24.3**	**24.1**	**24.4**
Temperature (◦C) (max.criteria value)	**1998-2002**	25.6	24.6	24.3	23.7	24.0
	2003-2007	25.5	25.7	25.2	24.5	24.2
	2008-2012	25.3	25.4	25.1	24.5	24.1
	2013-2017	26.1	26.2	25.6	25.0	24.4
	2018-2020	26.2	26.2	25.8	25.6	25.4
IWQT		**7.83**	**7.69**	**7.56**	**7.37**	**7.44**
pH (IWQT ± 1 range)	**1998-2002**	7.83	7.68	7.58	7.48	7.31
	2003-2007	8.00	7.82	7.42	7.38	7.18
	2008-2012	8.03	7.92	7.49	7.47	7.35
	2013-2017	7.94	7.83	7.41	7.28	7.15
	2018-2020	7.84	7.72	7.56	7.30	7.27
IWQT		**117**	**115**	**135**	**159**	**146**
Alkalinity (mg/L) (min.criteria value)	**1998-2002**	118	125	142	163	146
	2003-2007	121	125	150	171	147
	2008-2012	122	128	151	164	169
	2013-2017	120	124	136	143	163
	2018-2020	121	128	144	157	153
IWQT		**31.5**	**23.9**	**7.6**	**<0.5**	**0.5**
Salinity (freshwater max. and saline min. criteria values)	**1998-2002**	31.5	25.6	11.4	1.7	3.3
	2003-2007	33.2	26.4	11.1	1.2	1.5
	2008-2012	34.0	29.1	8.7	0.3	0.3
	2013-2017	35.3	29.9	8.2	0.7	0.5
	2018-2020	32.2	22.0	7.4	0.3	0.3
IWQT		**48.2**	**37.7**	**12.1**	**0.5**	**0.5**
Specific Conductivity (mho/cm) (max.criteria value)	**1998-2002**	48.1	39.4	13.5	0.7	0.8
	2003-2007	50.7	40.8	14.3	0.7	0.8
	2008-2012	51.7	44.7	14.3	0.6	0.7
	2013-2017	53.6	45.6	12.3	0.6	0.7
	2018-2020	49.1	34.9	12.2	0.6	0.6

Table 4.4. Annual averages compared to the Interim Water Quality Targets (IWQT) or Numeric Nutrient Criteria (NNC, indicated by †), whichever criteria is most conservative. Values in red are equal to or exceed the IWQT or NNC (page 2 of 4).

Water Quality Parameter	Analysis Period	Estuarine Reach		Tidal Floodplain	Riverine Floodplain	
		Marine	Polyhaline	Oligo/ Mesohaline	Wild & Scenic	Freshwater Tributaries
IWQT		**18**	**46**	**61**	**64**	**63**
Color (PCU) (max.criteria value)	**1998-2002**	20	43	62	66	84
	2003-2007	12	34	58	64	98
	2008-2012	13	34	58	60	91
	2013-2017	11	37	60	59	84
	2018-2020	16	39	57	62	91
IWQT		**6.8**	**6.1**	**4.2**	**4.1**	**4.4**
Total Suspended Solids (mg/L) (max.criteria value)	**1998-2002**	6.6	5.5	4.7	4.3	5.2
	2003-2007	10.4	6.2	4.5	3.8	6.3
	2008-2012	3.8	3.7	3.2	2.5	5.5
	2013-2017	6.9	4.9	3.6	2.3	5.4
	2018-2020	6.7	6.0	4.8	1.9	8.0
IWQT		**2.7**	**3.0**	**2.1**	**2.3**	**2.5**
Turbidity (NTU) (max.criteria value)	**1998-2002**	2.7	2.7	2.5	2.6	3.3
	2003-2007	5.2	3.3	2.9	3.0	4.3
	2008-2012	2.1	2.6	2.6	2.1	4.0
	2013-2017	3.0	2.8	2.9	2.1	4.6
	2018-2020	2.7	3.2	4.0	2.3	6.9
IWQT		**1.74**	**1.27**	**1.39**	**1.10**	**1.26**
Secchi Disc (Meters) (min.criteria value)	**1998-2002**	1.40	1.19	1.39	0.76	0.70
	2003-2007	1.71	1.15	1.30	0.86	0.71
	2008-2012	2.51	1.45	1.37	1.33	1.02
	2013-2017	2.59	1.50	1.37	1.38	0.99
	2018-2020	2.49	1.56	1.38	1.19	0.99
IWQT		**61.7**	**40.1**	**21.6**	**NA**	**NA**
P.A.R. @ 1M (%) (min.criteria value)	**1998-2002**	57.8	40.0	23.6	20.2	16.00
	2003-2007	53.7	28.7	18.4	19.2	18.74
	2008-2012	57.7	35.1	17.8	20.3	20.72
	2013-2017	51.7	29.0	14.5	15.3	13.10
	2018-2020	NA	NA	NA	NA	NA

Table 4.4. Annual averages compared to the Interim Water Quality Targets (IWQT) or Numeric Nutrient Criteria (NNC, indicated by †), whichever criteria is most conservative. Values in red are equal to or exceed the IWQT or NNC (page 3 of 4).

Water Quality Parameter	Analysis Period	Estuarine Reach		Tidal Floodplain	Riverine Floodplain	
		Marine	Polyhaline	Oligo/ Mesohaline	Wild & Scenic	Freshwater Tributaries
IWQT/NNC		**0.025**	**0.030†**	**0.056**	**0.046**	**0.051**
Total Phosphorus (mg/L) (max.criteria value)	**1998-2002**	0.023	0.041	0.057	0.046	0.068
	2003-2007	0.025	0.043	0.066	0.058	0.069
	2008-2012	0.018	0.034	0.059	0.048	0.066
	2013-2017	0.017	0.036	0.061	0.048	0.067
	2018-2020	0.018	0.036	0.062	0.052	0.079
IWQT/NNC		**0.63†**	**0.80†**	**1.26†**	**0.99**	**1.03**
Total Nitrogen (mg/L) (max.criteria value)	**1998-2002**	1.44	1.83	1.32	1.00	1.19
	2003-2007	0.49	0.80	1.45	1.23	1.41
	2008-2012	0.25	0.47	0.89	0.96	1.12
	2013-2017	0.25	0.47	0.80	0.89	1.06
	2018-2020	0.30	0.52	0.80	0.87	1.07
IWQT		**0.058**	**0.072**	**0.065**	**0.087**	**0.077**
Ammonia Nitrogen (mg/L) (max.criteria value)	**1998-2002**	0.050	NA	0.069	0.075	0.100
	2003-2007	0.068	0.103	0.115	0.118	0.154
	2008-2012	0.051	0.063	0.072	0.085	0.117
	2013-2017	0.034	0.041	0.052	0.070	0.115
	2018-2020	0.055	0.075	0.069	0.082	0.149
IWQT/NNC		**1.8†**	**4†**	**4.74**	**2.94**	**4.79**
Chlorophyll-a (ug/L) (max.criteria value)	**1998-2002**	2.97	5.62	4.92	3.18	10.24
	2003-2007	3.66	7.44	7.57	4.39	11.08
	2008-2012	3.32	7.76	7.95	5.15	9.99
	2013-2017	2.86	7.08	6.34	3.35	10.97
	2018-2020	2.91	6.11	6.34	3.89	11.62

† Numeric Nutrient Criteria (NNC)

Table 4.4. Annual averages compared to the Interim Water Quality Targets (IWQT) or Numeric Nutrient Criteria (NNC, indicated by †), whichever criteria is most conservative. Values in red are equal to or exceed the IWQT or NNC (page 4 of 4).

Water Quality Parameter	Analysis Period	Estuarine Reach		Tidal Floodplain	Riverine Floodplain	
		Marine	Polyhaline	Oligo/ Mesohaline	Wild & Scenic	Freshwater Tributaries
IWQT		**6.53**	**6.41**	**5.54**	**5.30**	**6.21**
Dissolved Oxygen (mg/L) (min.criteria value)	**1998-2002**	6.60	6.25	5.37	5.53	5.05
	2003-2007	6.51	6.08	4.78	4.88	4.42
	2008-2012	6.75	6.24	4.94	4.67	4.43
	2013-2017	6.23	5.70	4.70	4.40	4.36
	2018-2020	6.31	6.06	5.28	4.72	4.52
IWQT		**94.8**	**89.2**	**67.5**	**63.5**	**70.7**
Dissolved Oxygen Saturation (%) (min.criteria value)	**1998-2002**	96.0	86.7	66.5	65.4	53.0
	2003-2007	97.2	87.1	60.7	56.8	51.9
	2008-2012	99.8	89.7	62.5	55.2	52.2
	2013-2017	95.0	84.0	60.0	52.7	51.8
	2018-2020	93.8	85.1	67.3	57.4	54.6
IWQT		**17**	**99**	**211**	**282**	**325**
Fecal Coliform Bacteria (indv./100mL) (max.criteria value)	**1998-2002**	14	121	307	363	312
	2003-2007	22	83	152	154	237
	2008-2012	15	54	161	223	202
	2013-2017	9	48	101	103	172
	2018-2020	46	72	178	143	272
NNC		**NA**	**NA**	**410†**	**410†**	**410†**
E. coli Bacteria (indv./100mL) (max.criteria value)	**1998-2002**	NA	NA	NA	NA	NA
	2003-2007	NA	NA	NA	NA	NA
	2008-2012	NA	NA	NA	NA	NA
	2013-2017	NA	NA	132	123	196
	2018-2020	NA	NA	184	139	197
NNC		**130†**	**130†**	**130†**	**130†**	**130†**
Enterococci Bacteria (indv./100mL) (max.criteria value)	**1998-2002**	NA	NA	NA	NA	NA
	2003-2007	NA	NA	NA	NA	NA
	2008-2012	14	32	66	NA	NA
	2013-2017	11	48	67	NA	NA
	2018-2020	40	45	88	98	670

† Numeric Nutrient Criteria (NNC)

Salinity varied between river segments and tributaries throughout the period of record. Median salinity values were above the recommended IWQTs for most regions prior to 2008 (Figure 4.32; Table 4.4). Since 2008, median salinity remained below the IWQT for all tributaries and the Wild and Scenic and oligo/mesohaline portions of the river (Figure 4.32; Table 4.4). The reduced salinity in these areas, specifically the Wild and Scenic segment, corresponds to the decrease in MFL flow exceedances since 2007. The upstream Wild and Scenic (stations 66, 67, 68, and 69) segment salinity was compared to the MFL salinity values from River Mile 9.1. The decrease in salinity over time in the Wild and Scenic portion of the river (Figure 4.32; Table 4.4) contrasts with the pattern of increased MFL salinity exceedances observed but was likely the result of the consolidation of all observations during the analysis period and differences between sample sites. Additionally, only data collected from monthly samples in surface waters were described, whereas the MFL salinity data was based on continuous measures of data collected from both the top and bottom of the water column. Despite optimum salinities in the surface waters of the river (Figure 4.32; Table 4.4), salinity MFL exceedances driven by saltwater moving upstream along the bottom of the channel still occurred. Higher bottom salinities were most likely due to inadequate freshwater supply to displace to salt wedge downstream during that period.

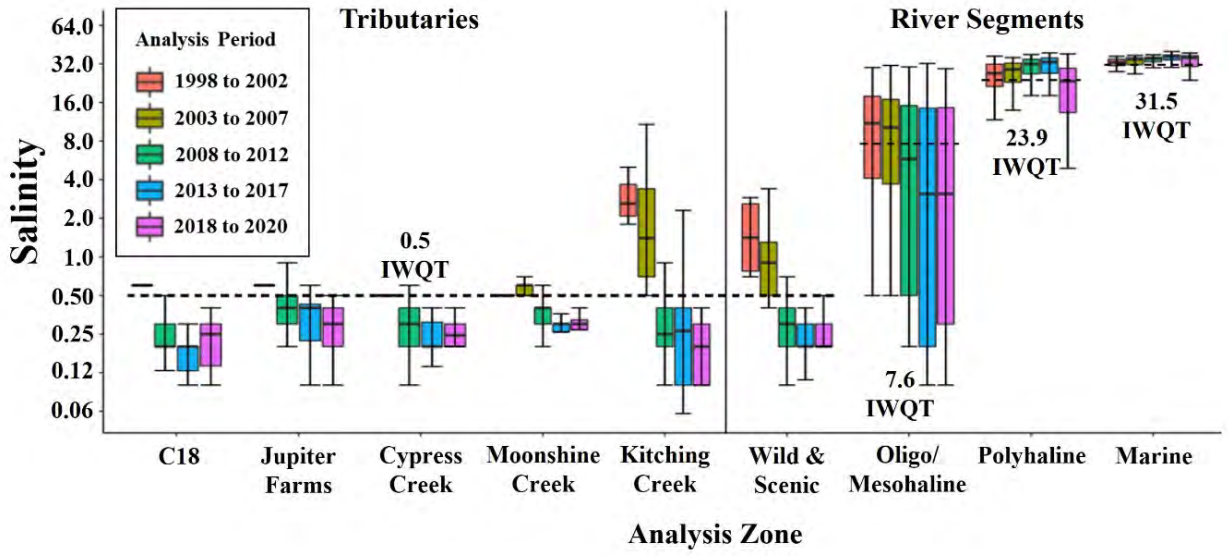

Figure 4.32. Spatial and temporal variation in salinity. Lines in boxes showing 50% median values, boxes showing lower 75% and 25% interquartile range, and whiskers showing upper and lower range (1.5* interquartile range). Analysis periods with n=2 per river segment show only 50% median, analysis periods n<2 not shown. Black dashed lines showing Interim Water Quality Target (IWQT).

Surface water turbidity exceeded the IWQT in most tributaries except C-18, over time (Figure 4.33, Table 4.4). Upon closer examination there were no seasonally dependent patterns in turbidities (i.e., average turbidity is not consistently higher any month). The combination of increased sample counts (1998 to 2002: n=550; 2003 to 2007: n=672; 2008 to 2012: n=977; 2013 to 2017: n=957; 2018 to 2020: n=417) and targeted sampling in tributaries to document turbidity events (e.g., Cypress Creek, Moonshine Creek and Kitching Creek), likely contributed to the higher documented turbidity measured in recent years. Nevertheless, measured turbidity in the

tributaries reflected real conditions that can degrade downstream system health (e.g., survivorship of submerged aquatic vegetation) and warrants further investigation and remedial action.

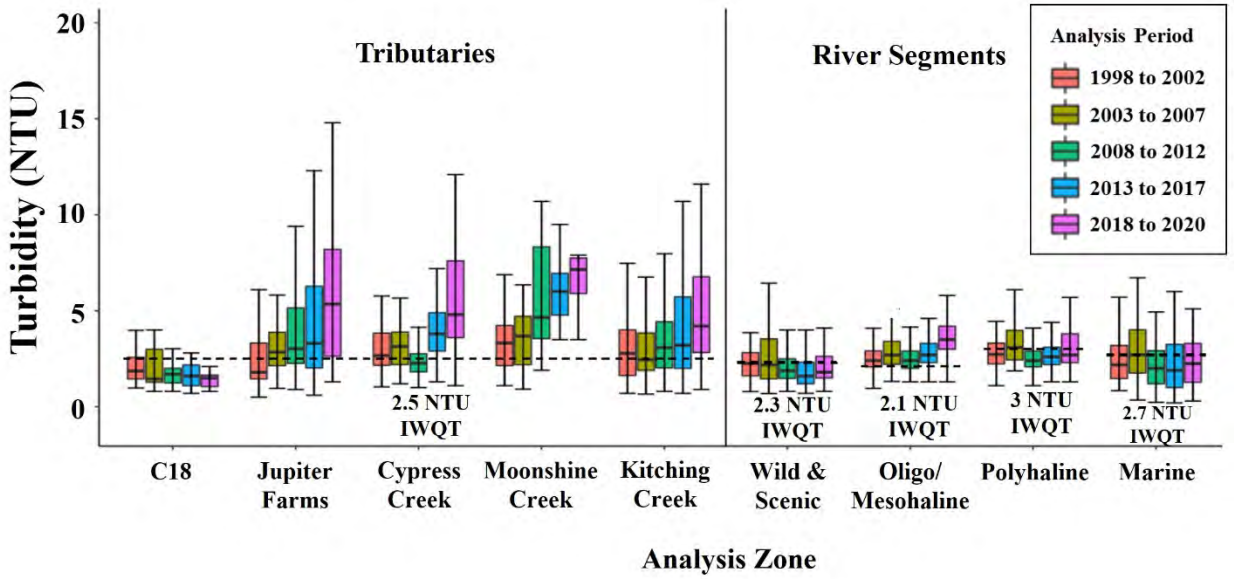

Figure 4.33. Spatial and temporal variation in turbidity. Lines in boxes showing 50% median values, boxes showing lower 75% and 25% interquartile range, and whiskers showing upper and lower range (1.5* interquartile range). Analysis periods with n=2 per river segment show only 50% median, analysis periods n < 2 not shown. Black dashed lines showing Interim Water Quality Target (IWQT).

Median annual fecal coliform bacteria generally fell below IWQTs (Figure 4.34, Table 4.4) despite enterococci bacteria in surface waters downstream often exceeding the recommended Beach Action Values (BAV) used by the Florida Department of Health (DOH). This is most likely a consequence of the tidal flushing at these monitoring stations. Based on the IWQT benchmarks alone, fecal coliform bacteria exceeded the IWQT in the marine river segment. However, acceptable levels of enterococci bacteria in recent years were attributed to the well flushed sample sites (stations 10 and 40) included in the marine segment. Between 2018 and 2020, the marine river segment did not exceed the enterococci bacteria NNC of 130 enterococci per 100 mL (Figure 4.34, Table 4.4), nor the more stringent Beach Action Value (BAV) of 71 enterococci per 100 mL used by the Florida DOH to evaluate the recreational use of marine waters in the state of Florida. The highly urbanized areas closer to the coastline, and therefore the marine monitoring stations, may be subjected to higher levels of wastewater inputs from point (e.g., wastewater treatment plant effluents) and non-point (e.g., leaky infrastructure) discharges. Impervious surfaces (e.g., paved roads and parking lots) increase surface runoff, resulting in the delivery of stormwater and associated contaminants into the river. If additional sampling sites closer to the shoreline were monitored weekly for enterococci there would be more exceedances (see LRECD weekly bacteria results).

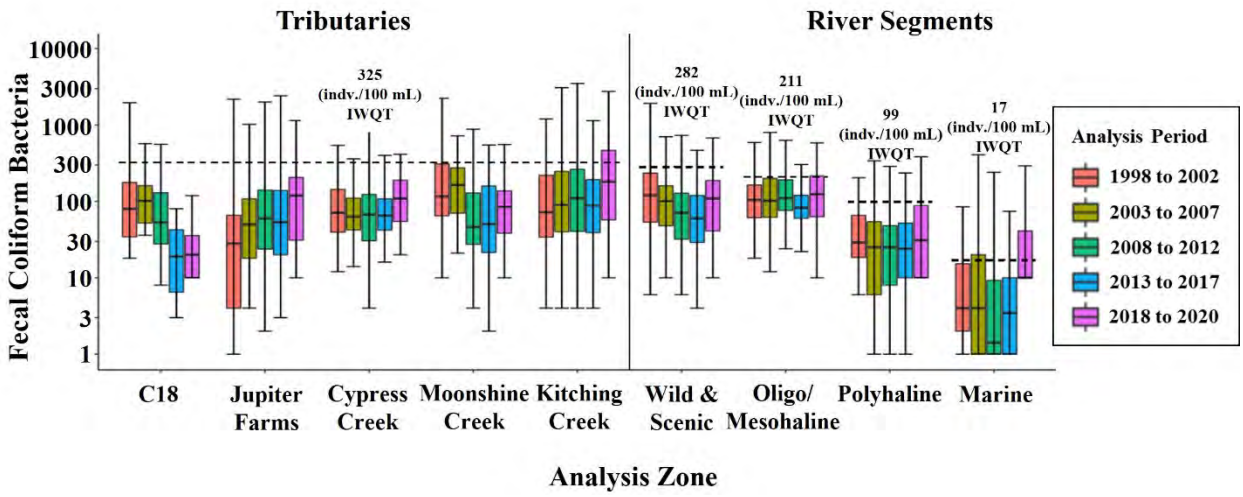

Figure 4.34. Spatial and temporal variation in fecal coliform bacteria. Lines in boxes showing 50% median values, boxes showing lower 75% and 25% interquartile range, and whiskers showing upper and lower range (1.5* interquartile range). Analysis periods with n=2 per river segment show only 50% median, analysis periods n < 2 not shown. Black dashed lines showing Interim Water Quality Target (IWQT).

Total nitrogen, total phosphorus, and uncorrected chlorophyll-a were examined in 5-year increments across the tributaries and river segments. Total nitrogen was highest between 1998 to 2002 in the polyhaline region, followed by the oligo/mesohaline region and Kitching and Moonshine Creeks before 2008 (Figure 4.35). Throughout the river, total nitrogen decreased over time (tributaries, wild and scenic, oligo/mesohaline, polyhaline, marine) since 2003 (Figure 4.35). Results suggested that the freshwater tributaries, particularly Kitching Creek, Cypress Creek, and Moonshine Creek, were loading nutrients into and increasing turbidity of the NW Fork between RM 9 and RM 11.

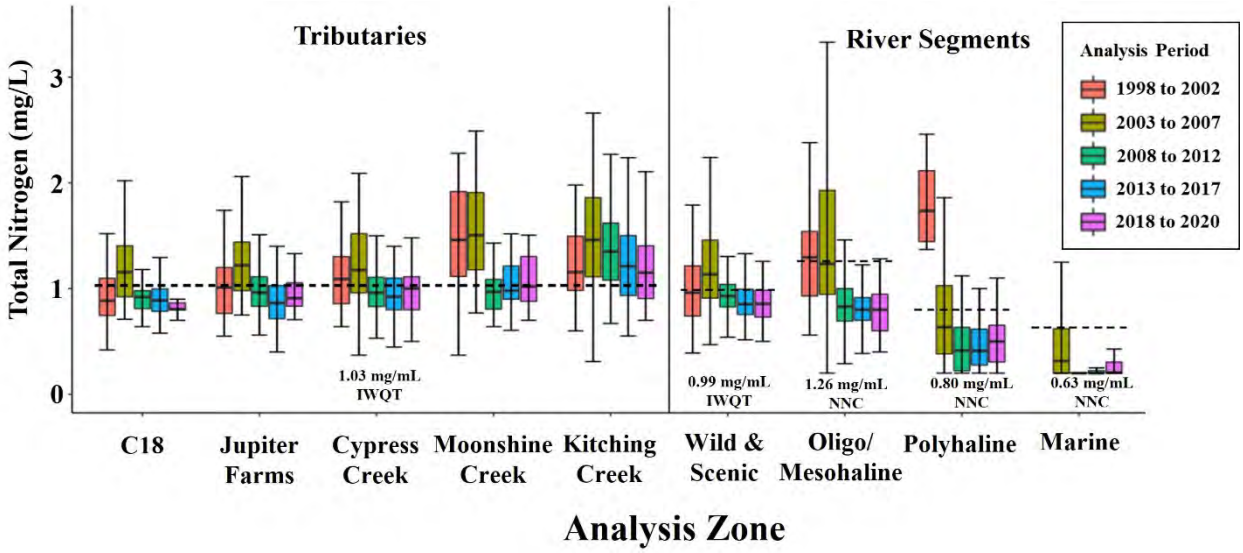

Figure 4.35. Spatial and temporal variation in total nitrogen. Lines in boxes showing median values, boxes showing lower 75% and 25%, and whiskers showing upper and lower range (1.5* interquartile range). Analysis periods with n=2 per river segment show only 50% median, analysis periods n < 2 not shown. Black dashed lines showing Interim Water Quality Target (IWQT) or Numeric Nutrient Criteria (NNC).

A subtle decrease in total nitrogen, total phosphorus, and chlorophyll-a were observed in the downstream river segments (oligo/mesohaline, polyhaline, marine), though total phosphorus and chlorophyll-a do not follow similar trends in the tributaries (Figures 4.36B and C). The highest total phosphorus and chlorophyll-a values were measured in Moonshine Creek and Kitching Creek (Figures 4.36B and C). Downstream of where these tributaries enter the NW Fork, elevated phosphorus and chlorophyll levels were noted in the oligo/mesohaline and polyhaline segments between RM 2 and RM 8. Previous studies noted elevated nutrient and chlorophyll concentrations at the oligo/mesohaline segments of the river between RM 5 and RM 8 (Stoner and Arrington, 2017). While the degraded water quality from the tributaries may affect the downstream segments, further investigations into tidal regime and nutrient dynamics are necessary to fully understand the higher concentrations in the oligo/mesohaline and polyhaline segments of the river.

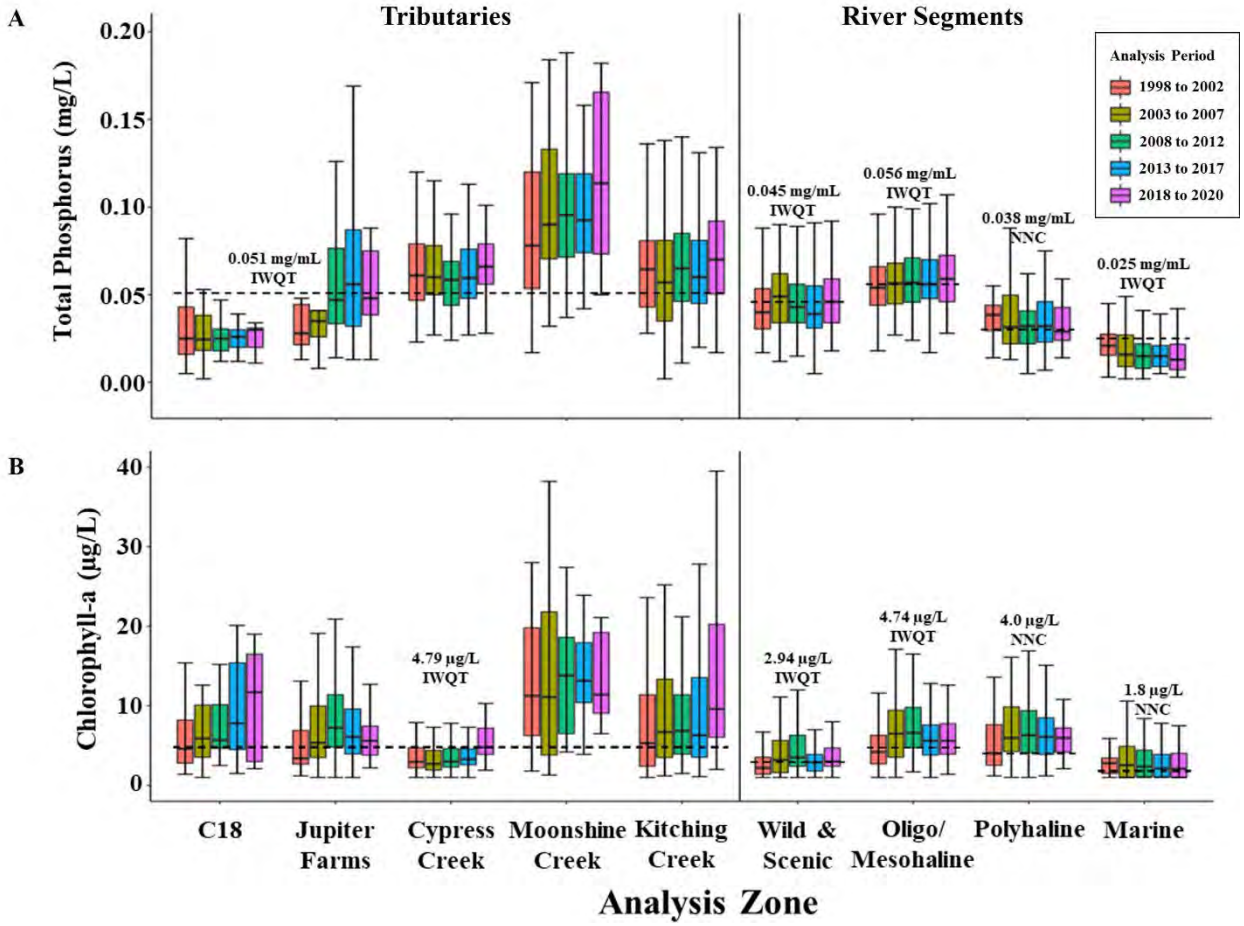

Figure 4.36. Spatial and temporal variation in (A) total phosphorus and (B) chlorophyll-a concentrations. Lines in boxes showing median values, boxes showing lower 75% and 25%, and whiskers showing upper and lower range (1.5* interquartile range). Analysis periods with n=2 per river segment show only 50% median, analysis periods n < 2 not shown. Black dashed lines showing Interim Water Quality Target (IWQT) or Numeric Nutrient Criteria (NNC).

The hydrologic data indicated higher than usual rains fell over the watershed from 2017 through 2020. Though the frequency of MFL exceedances were lower between 2011 and 2020, continued exceedances indicate a need to reassess the operational protocols of pulsed flows as salinity violations persist. Freshwater flows also influence water quality throughout the river. Water quality within the NW Fork and its freshwater tributaries was highly variable over the past two decades. Salinity and total nitrogen levels were within the desirable target ranges while total phosphorus, ammonia, dissolved oxygen, and turbidity levels exceeded threshold (NNC and IWQT) targets. Persistent water quality exceedances support the need for continued water quality improvements, particularly in the freshwater tributaries of Moonshine, Cypress, and Kitching Creeks.

4.2.2. Water Quality Goal and Objectives

The following objectives for the Water Quality goal are prioritized in the Action Plan (4.2.3). An effort to implement one or more objectives may be part of a program already in progress.

Goal: To protect and improve overall water quality in and to the NW Fork of the Loxahatchee.

Objectives

A. Fully achieve goals and objectives established in the Loxahatchee River Pollutant Reduction Plan.

B. Identify and reduce point sources of pollution to the watershed affecting the NW Fork of the Loxahatchee.

C. Increase stormwater retention and improve stormwater treatment within the NW Fork portions of the Loxahatchee.

D. Improve water quality in the NW Fork with demonstrated poor water quality.

4.2.3. Water Quality Action Plan

Key to the Action Plan Table (Table 4.5):

- Priority of the objective was determined by the LRMCC using the following criteria:
    1. Legally required, planned, or funded; action will be taken within the 10 year planning period.
    2. In planning, may or may not be funded; action may not happen within the 10 year planning period.
    3. Not planned or funded; action not expected to start within the 10 year planning period.
- Responsibility of each action was determined by the LRMCC and often shared among several agencies (listed by acronyms (see pg. vii)).
- Duration of the action is either a discrete action (“Once”) or continuous action (“Ongoing”).

NOTE: The ability to carry out these activities will be dependent on the priorities of the responsible agencies and the availability of funds.

Table 4.5. Water Quality Action Plan Table.

Goal: Protect and improve overall water quality in and to the NW Fork of the Loxahatchee.		
Objective	**Priority**	
A. Fully achieve goals and objectives established in the Loxahatchee River Pollutant Reduction Plan.	**1**	
Actions	**Lead Agency**	**Duration**
i. LRECD to manage annual project updates.	LRECD	Ongoing
Objective	**Priority**	
B. Identify and reduce point sources of pollution to the watershed affecting the NW Fork of the Loxahatchee.	**2**	
Actions	**Lead Agency**	**Duration**
i. Remove point sources of pollution to the NW Fork of the Loxahatchee.	TBD	As needed
Objective	**Priority**	
C. Increase stormwater retention and improve stormwater treatment within the NW Fork portions of the Loxahatchee.	**2**	
Actions	**Lead Agency**	**Duration**
i. Identify areas additional stormwater retention (e.g., Ranch Colony Canal and Palm Beach Country Estates).	All MS4 Permittees	Ongoing
ii. Rehabilitate existing and outdated stormwater systems to improve retention and treatment of stormwater (e.g., Jupiter Farms).	All MS4 Permittees	Ongoing
Objective	**Priority**	
D. Improve water quality in the NW Fork with demonstrated poor water quality.	**1**	
Actions	**Lead Agency**	**Duration**
i. Monitor water quality within the NW Fork.	LRECD	Ongoing
ii. Identify anthropogenic sources of turbidity and collaborate with local agencies to reduce turbidity concentrations to historic background levels flowing into the NW Fork from tributaries (e.g., Moonshine Creek, Hobe Grove Ditch, and Cypress Creek).	LRECD	Ongoing
iii. Improve water quality using BMPs in the remaining agricultural areas surrounding the NW Fork in accordance with the Loxahatchee. River Pollutant Reduction Plan, Water Quality Objective A.	FDACS	Ongoing
iv. Water quality concerns TBD through ongoing monitoring.	LRECD	Ongoing

4.3. Biological Communities

The NW Fork provides essential habitats that support an array of ecological resources including freshwater riverine and tidal floodplain vegetation, and freshwater and estuarine fishes and wildlife. The riverine floodplain of the NW Fork can be enhanced by sufficient floodplain inundation to discourage the intrusion of transitional, upland, and non-native plant species and increase the utilization of the floodplain by desired terrestrial and aquatic species. Regular monitoring of all biological communities ensures the documentation of changes over time and enables timely action to address unfavorable conditions. The biological communities ORVs include vegetation, fish, and wildlife throughout the NW Fork.

4.3.1. Vegetation Communities

Vegetation communities are groups of recurring plants within an ecosystem interacting with wildlife and their shared environment. Ecosystems are usually defined by the presence of a keystone species that shapes the community through its strong interactions with other species. Keystone species are depended upon by other species within the ecosystem so much so that if a keystone species were removed, the ecosystem would be severely compromised and eventually collapse. Three keystone species, the freshwater bald cypress and two saltwater tolerant mangrove species are found within the Wild and Scenic corridor. Decreased hydroperiods have caused the vegetation communities of these keystone species to shift drastically. The lack of inundation in the riverine reach has encouraged the growth of native transitional, upland, and non-native plant species within the floodplain. Freshwater flows decreased due to anthropogenic activities over time resulting in saltwater intrusion and mangrove encroachment into the upstream bald cypress community along the river and into the floodplain.

4.3.1.1. Assessment

Scope

The vegetation assessment provides an overview of the floodplain vegetation community, non-native plant management and control, and studies on submerged aquatic vegetation and cypress seedling plantings. The distinct river reaches and the associated changes to the floodplain vegetation community were summarized for the last two decades (2003 to 2016).

Background

Vegetation Resources

The floodplain of the Loxahatchee River is well known for its blend of tropical and temperate vegetation, including cypress swamps and mixed hardwood forests (Figure 4.37). Prior to the 1940s, the Jupiter Inlet periodically opened and closed (see Figure 2.1) to the Atlantic Ocean with natural storm events allowing saltwater to enter the Loxahatchee River. As a result of the stabilization of Jupiter Inlet in 1947, the lower portion of the river has become a highly valued estuarine system with its forests of red and white mangroves lining much of the river shoreline. After 1947, marshes of predominantly salt-tolerant cordgrass (*Spartina spp*.) formed, however, they were eventually replaced by mangroves (SFWMD and FPS, 2009).

Figure 4.37. An example of the vegetation community along the NW Fork.

River hydrology, floodplain vegetation, and soils were used to identify three distinct reaches (riverine, upper tidal, and lower tidal) with boundaries established by the distribution of canopy species (SFWMD and FPS, 2009). The riverine reach on the Loxahatchee River extended from Riverbend Park to RM 9.5 on the NW Fork and was generally unaffected by salinity. The riverine reach was dominated by 80% or more bald cypress (*Taxodium distichum*), pop ash (*Fraxinus caroliniana*), or water hickory (*Carya aquatica*). The upper tidal reach extended from RM 9.5 to RM 8.13 and was exposed to mixed freshwater/brackish water. It was dominated by 60% pond apple (*Annona glabra*), pop ash, and bald cypress. The lower tidal reach was from RM 8 to Jupiter Inlet and supported primarily salt-tolerant species. The canopy of the lower tidal reach was dominated by 75% or more mangrove species with pond apple less than 10% of the canopy. Overall, five plant community types were identified including swamps, bottomland hardwoods, hydric and mesic hammocks, and uplands (wet flatwoods) with a tropical hammock that was not surveyed.

The natural hydrological system of the NW Fork has changed over the last 50 years resulting in a significant shift from freshwater to more salt-tolerant vegetation (Roberts et.al. 2008, SFWMD and FPS, 2009). The construction and operation of drainage canal systems further altered the natural pattern of freshwater flow and inundation of the floodplain (SFWMD and FPS, 2009). In the riverine reaches of the river, inadequate hydroperiods (depth and duration) resulted in the loss of native canopy trees and the invasion of transitional, upland, and non-native plant species within the floodplain plant communities. In the tidal reaches, higher soil, and surface water salinity, along

with increases in tidal inundation were largely responsible for vegetative changes. Continued vegetation studies to monitor changes in the community, surface water, and soil types were recommended to ensure that hydrologic conditions were maintained for the long-term health of the floodplain communities (SFWMD and FPS, 2009).

Keystone Species: Bald Cypress and Mangroves

The NW Fork is one of the last remaining mature bald cypress swamps in southeast Florida. Bald cypress (Figure 4.38) is a long-lived keystone species in the unique ecosystem of the NW Fork of the Loxahatchee River with some trees over 300 years old (Liu et al., 2011). In this location, the bald cypress is not just a keystone species defined by Paine (1995) as one that has a disproportionately large effect on its environment relative to its abundance, but one that has an added dimension of ecological importance (plant diversity), wildlife utilization (food and nesting sites), and hydrological importance (seedling germination and salinity impacts).

Early floodplain studies using aerial photography and field analysis on the Loxahatchee River by Alexander (1967) and Crook (1973 and 1975) documented the decline of the bald cypress forest and increases in mangrove communities at RM 6.46. It was concluded that the cypress forest decline was the result of saltwater intrusion brought on by the lowering of the water table, increased salinity and decreased freshwater flows to the Loxahatchee River (Alexander, 1967, Crook, 1973, Crook, 1975).

Figure 4.38. Bald cypress (*Taxodium distichum*) along the NW Fork (Photo: A. Arrington).

Once the dominant tree bordering the upper blackwater Loxahatchee River and its tributaries, bald cypress was diminished by logging, hydrological impacts, and saltwater intrusion within the river's floodplain forest (Roberts et al., 2006). The loss of bald cypress resulted in the reduction of the vertical structure for other organisms (e.g., ferns, orchids, bird nests), micro-habitats (e.g., fallen logs, tree cavities, standing snags), and floodplain stability (i.e., erosion prevention) (Light et al., 2002). Future impacts of sea level rise on floodplain vegetation will prolong saltwater residence time, especially in the braided channels. Saltwater inundation will jeopardize the health of the bald cypress and other freshwater species. The fecundity (reproduction potential) of freshwater plant communities will be diminished severely as each tidal cycle increases the salinity of the floodplain.

Mangroves play an important role in stabilizing the shoreline, increasing land elevation, and may dampen storm waves and surges in coastal habitats. Extensive root systems of mangroves prevent erosion by trapping and stabilizing sediments from the uplands. Like cypress trees, mangroves provide vertical structure (e.g., roosting sites) and microhabitats (e.g., spaces between prop roots). Mangrove forests exhibit tremendous variation in community structure depending on species and location in the floodplain (Odum et al., 1982). On the Loxahatchee River, mangroves are found in the tidal floodplain near Jupiter Inlet to just downstream of the Trapper Nelson Interpretive Site (RM 10.5) and within the North Fork, Southwest Fork, and lower portions of Kitching Creek. Mangrove swamps dominated by red mangrove *(Rhizophora mangle)* have been identified as lower tidal swamp forest type (LTsw1) (SFWMD, 2012). A predominately white mangrove (*Laguncularia racemosa*) (Figure 4.39) swamp with infrequent pond apple (*Annona glabra*) and red mangrove were identified as a LTsw2 swamp forest type which are found at higher elevations than the LTsw1 forest type (SFWMD, 2012). Black mangroves (*Avicennia germinans*) grow at a slightly higher elevation than red mangroves and a lower elevation than white mangroves and are rare because of the limited intermediate tidal zones within the floodplain. Except for pond apple and cabbage palm (*Sabal palmetto*), no other canopy species have outcompeted bald cypress in the riverine reach or white and red mangroves in the lower and upper tidal reaches of the river.

Figure 4.39. Red mangrove (*Rhizophora mangle*) among bald cypress along the NW Fork (Photo: A. Arrington).

Canopy trees are long-term indicators of the floodplain hydrological conditions. Bald cypress and mangroves are keystone species within the NW Fork that are highly impacted by fluctuations in floodplain inundation and salinity. For example, prolonged periods of saltwater intrusion reduce seed production and germination and sapling survival of bald cypress, limiting the recruitment of new trees. The lower tidal and portions of the upper tidal reaches of the river in the NW Fork have experienced a loss of bald cypress trees and a shift towards more salt-tolerant species like red and white mangroves and pond apples.

Conditions from 2011 to 2020

Floodplain Hydrologic Conditions for Vegetation

Floodplain hydrology and freshwater flows shape the vegetation community structure. As mentioned in this chapter (see Hydrology and Water Quality), rainfall influenced the amount of freshwater and groundwater available and affected salinity in both the river and floodplain. Total rainfall (NEXRAD), average annual freshwater flows at Lainhart Dam, salinity at RM 9.1, and groundwater levels at three wells (T-1, T-7, and T-9) were evaluated to determine the hydrologic

conditions of the floodplain during the vegetation study (2003 to 2016) (Figure 4.40). Average groundwater elevations reflected the extent of floodplain hydration during the survey.

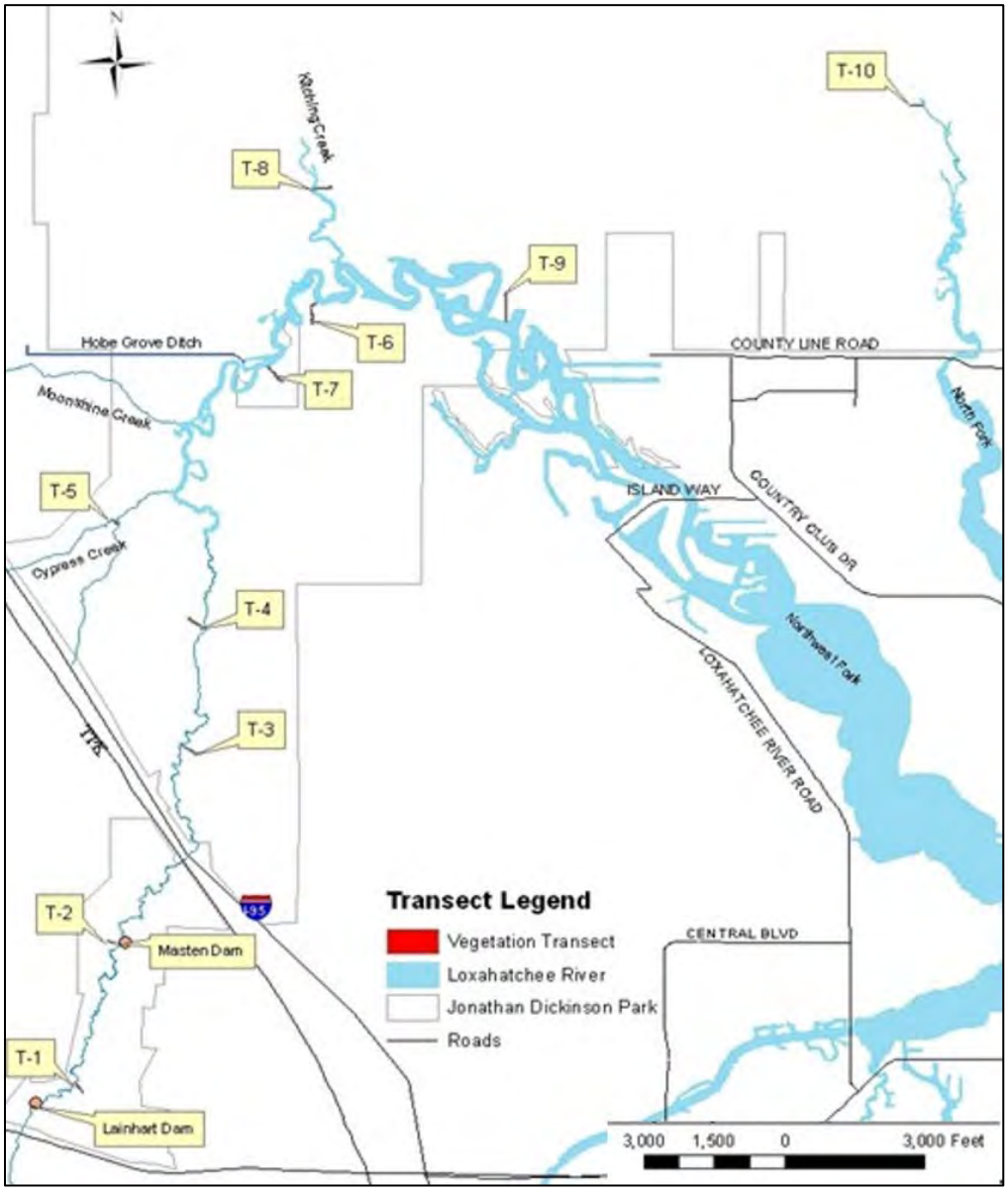

Figure 4.40. Location of the 10 vegetation transects throughout the NW Fork.

Total rainfall varied seasonally and annually, which affected floodplain conditions during the vegetation surveys (2003, 2007, 2010, and 2016). The lowest total annual rainfall was noted in 2007 at 44.4 in. and 50.5 in. in 2003 (Figure 4.41A). The drought conditions in 2007 most likely contributed to the reduced flows over Lainhart Dam (Figure 4.41B). Despite drought conditions in 2007, salinity at RM 9.1 increased slightly though remained within the oligohaline range (0.5 to 5.0) (Figure 4.41C). In subsequent years, average salinity stayed below 0.27 (Figure 4.41C) probably because of the increased rainfall and flows. Annual rainfall was highest in 2010 (69.5 in.) and 2016 (67.5), with both years having considerably wet dry seasons (Figure 4.41A).

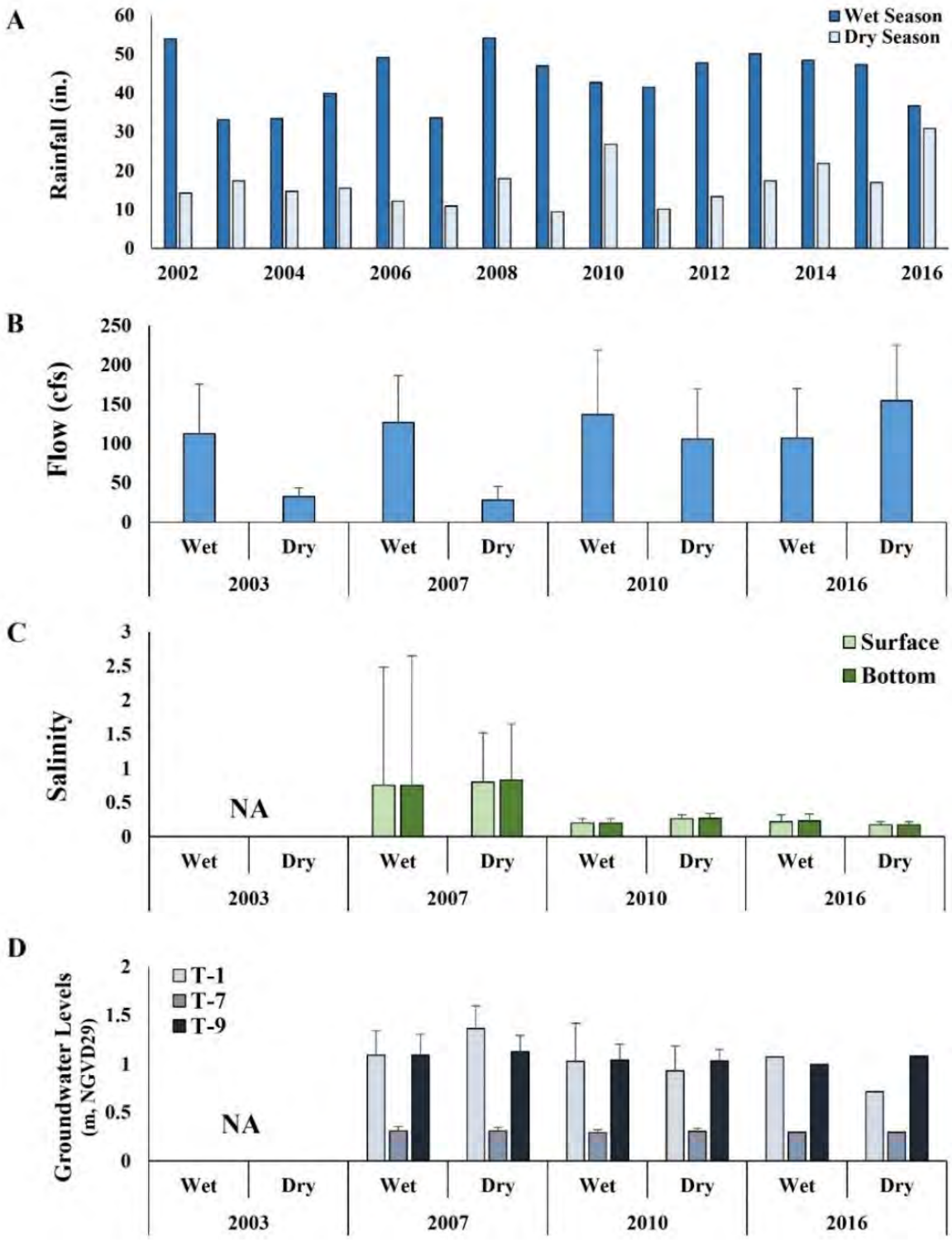

Figure 4.41. A) Total seasonal rainfall by water year; (B) freshwater flows at Lainhart Dam; (C) surface and bottom salinities at RM 9.1; and (D) groundwater levels (at T-1W01, T-7W01, and T-9W01) during the floodplain vegetation surveys by season and survey year. Salinity and groundwater level data were not available (NA) in 2003.

Average groundwater levels were greater than expected in 2007 (Figure 4.41D), most likely because of the high rainfall in 2006 (Figure 4.41A). Groundwater levels remained consistent during the vegetation surveys, though varied between the well locations (see River Floodplain Groundwater Levels). Though rainfall did not appear to impact groundwater levels during the vegetation surveys, increased rain resulted in higher Lainhart Dam flows and lower salinity at RM 9.1. could have influenced the floodplain vegetation communities.

Floodplain Vegetation

The Loxahatchee River floodplain supports a mixed tropical and temperate forest with a species-rich understory. The elevation and hydrologic conditions of the floodplain determine the vegetation community through the interaction between water levels (e.g., river stage and groundwater) and rainfall. During low rainfall conditions, freshwater flows decrease, allowing saltwater (Figure 4.41 B and C) to invade the upper tidal portions changing the species composition in the floodplain environment. The dry, more saline environment shifted the floodplain community from freshwater vegetation to more salt-tolerant species. Understanding the effects of floodplain hydrology on the vegetation community will inform water and species management decisions and facilitate restoration efforts throughout the watershed.

Floodplain vegetation monitoring began in 2003 to determine the community composition and structure (vegetation arrangement and characteristics) along the North and NW Forks, including Cypress Creek and Kitching Creek. Between 2003 and 2016, the Loxahatchee River floodplain surveys identified approximately 220 plant taxa (Supplemental 6) from 12 different floodplain forest types (SFWMD and FPS, 2009 SFWMD, 2012). Vegetation community composition and vegetation type were assessed on ten permanent 10 m wide belt transects perpendicular to the river and partitioned into 10 m x 10 m (100 m^2) quadrats (Roberts et al., 2008). All vegetation species (Supplemental 6) were identified to the lowest possible taxa and sorted into three types, canopy, shrub, or groundcover (Table 4.6). Total and relative abundance and basal area were determined for all canopy species. Percent cover was estimated for all shrub and groundcover species, and total stem counts were determined for groundcover species only. All vegetation species were assessed, though the three keystone species were highlighted here.

Table 4.6. Definitions and metrics for characterizing vegetation types. DBH = diameter at breast height.

Vegetation Type	Definition
Canopy	Taller than 1 m with a DBH ≥ 5 cm
Shrub	Taller than 1 m with a DBH < 5 cm
Groundcover	Shorter than 1 m; seedlings

Canopy Species

Canopy species are trees taller than 1 m with a diameter at breast height (DBH) ≥ 5 cm. The total abundance and total basal area (tree circumference at ~ 4 to 4.5 above ground) of canopy species within each 100 m^2 intercept plot were determined every six years in 2003, 2009, and 2016. The relative abundance of canopy species was calculated to identify common and rare canopy species

within surveyed areas. Canopy relative basal area was estimated to determine the growing space within the plot used by each species.

Canopy surveys identified approximately 33 species within the transects between all survey years (Appendix C). The dominant canopy species was the white mangrove (*Laguncularia racemosa*) followed by the red mangrove (*Rhizophora mangle*) and pond apple (*Annona glabra*) (Figure 4.42). Pond apple and white mangroves increased in abundance every survey year. Red mangroves increased between 2003 and 2009, but the canopy decreased slightly in 2016 (Figure 4.42A). Bald cypress (*Taxodium distichium*) abundance ranged between 156 and 166 total trees (Figure 4.42A). Seventeen of the 33 species had a total abundance of five trees or less throughout the survey, including four non-native species (Figure 4.42A). Relative abundance varied between the three keystone species from 2003 to 2016. White mangrove relative abundance increased, though bald cypress and red mangroves decreased slightly (Figure 4.42B).

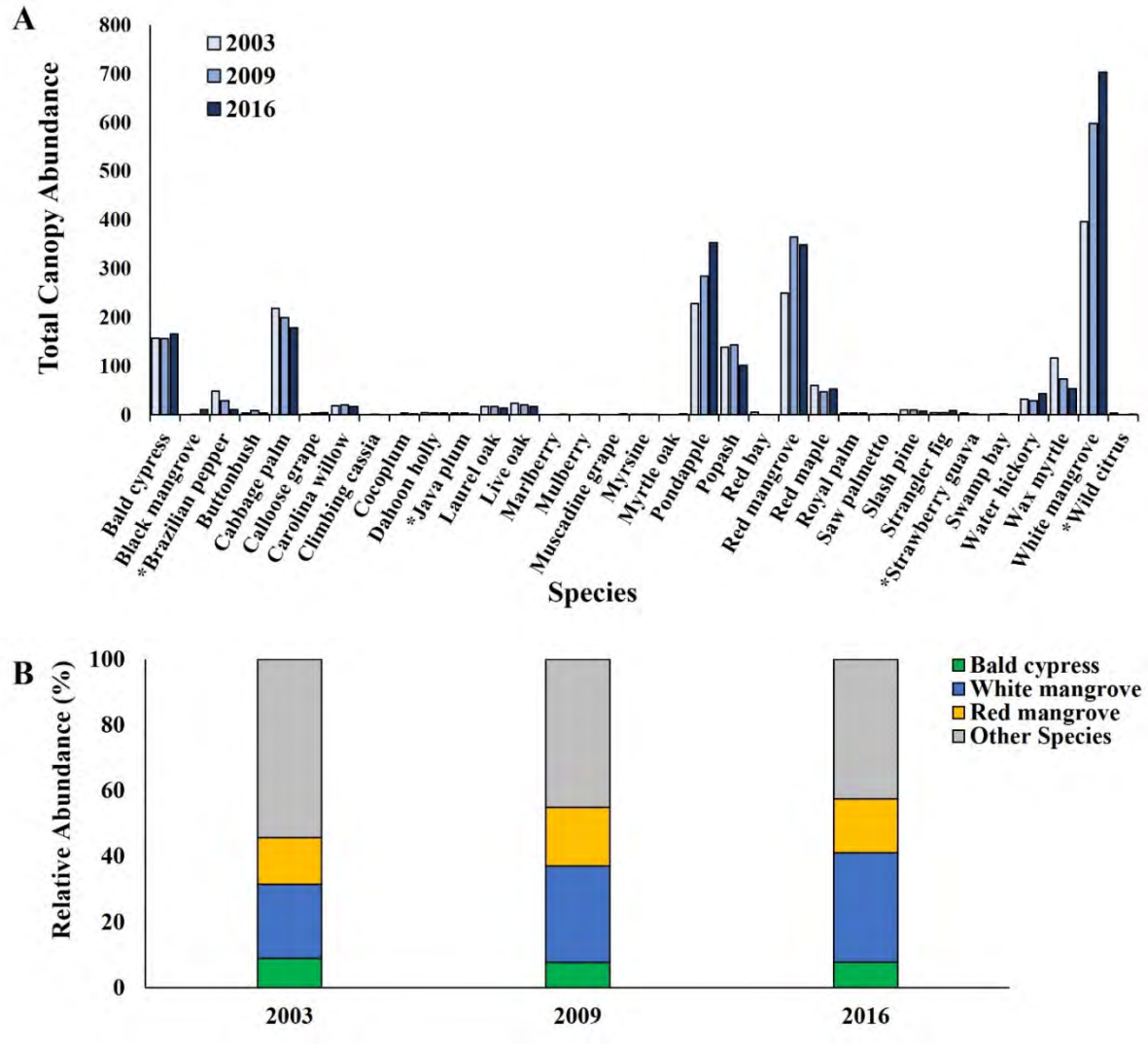

Figure 4. 42. (A) Total canopy abundance and (B) keystone species relative abundance within the NW Fork floodplain in 2003, 2009, and 2016.

Unlike tree abundance, basal area more accurately reflects the actual aerial coverage of canopy species within the floodplain, particularly fast-growing species with multiple trunks like mangroves and pond apples. On the floodplain, the canopy basal area was composed of primarily two species: bald cypress and cabbage palm, followed by white mangrove and water hickory (*Carya aquatica*) (Figure 4.43A). Basal area steadily increased for bald cypress and red mangroves between 2003 and 2016 while cabbage palm declined slightly in 2009, though recovered in 2016 (Figure 4.43A). White mangrove basal area increased slightly from 2003 to 2009 and increased by 31% in 2016 (Figure 4.43A). Bald cypress had the largest total and relative basal area compared to the other two keystone species (Figure 4.43B). Bald cypress increased in basal area between 2003 and 2009 and was similar between 2009 (45.9%) and 2016 (44.3%). White and red mangrove basal area increased throughout the study (Figure 4.43B).

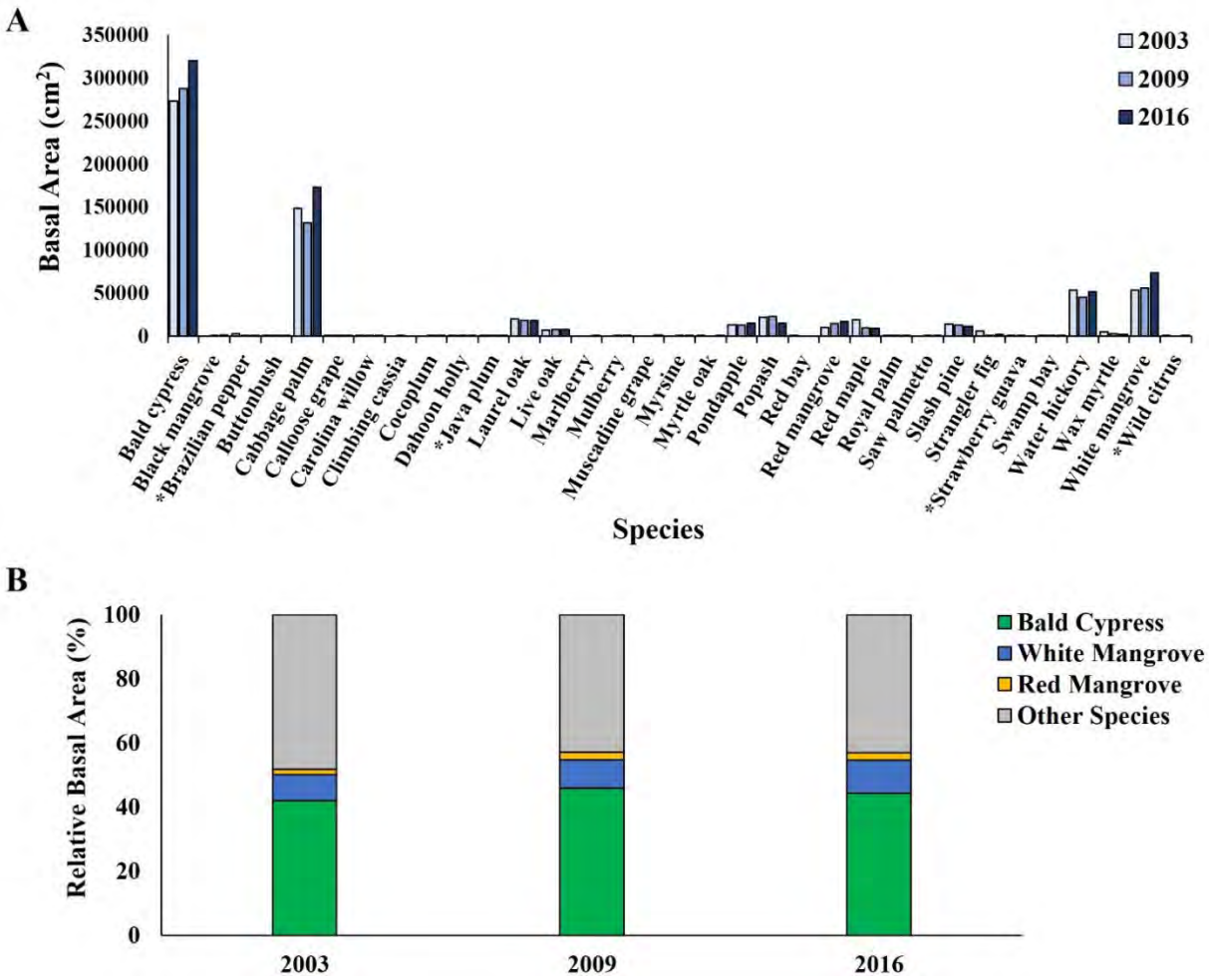

Figure 4.43. (A) Overall basal area for all canopy species and (B) the relative basal area for the three keystone species in 2003, 2009, and 2016.

Shrub and Groundcover Communities

Shrub and groundcover communities are short-term indicators of forest health and respond to changes in temperature, hydrological conditions, and floodplain elevation. While shrub-layer plants show more of an intermediate response to changes, groundcover plants indicate acute changes, particularly with hydrological conditions. Shrub cover observations included species taller than 1 m with a DBH < 5 cm (Table 4.6) within each 100 m^2 quadrat. Percent shrub cover was monitored every three years in 2003, 2007, 2010, and 2016, and may exceed 100% due to overlapping branches and canopies.

Shrub cover communities varied between the transect locations over time. White and red mangrove shrubs were present only on the lower and upper tidal reaches and not in the freshwater reach of the river during the survey period. White mangroves had the highest percent cover of the three keystone species, increasing from 41% in 2003 to 49% in 2016 (Figure 4.44). Red mangrove shrub percent cover decreased from 56% in 2003 to 49% in 2016 (Figure 4.44). Shrub cover for both mangrove species was the lowest in 2007, most likely due to drought conditions that year. White mangrove shrubs recovered in 2010 to a cover of 43%, while red mangrove shrub cover remained at 35% until 2016 (Figure 4.44). Although bald cypress shrubs had the lowest cover of the keystone species and were completely absent during the 2003 survey, shrub cover increased to 6% by 2016 (Figure 4.40). Bald cypress shrubs were found in five of the ten transects but were most productive in the Kitching Creek (T-8) area.

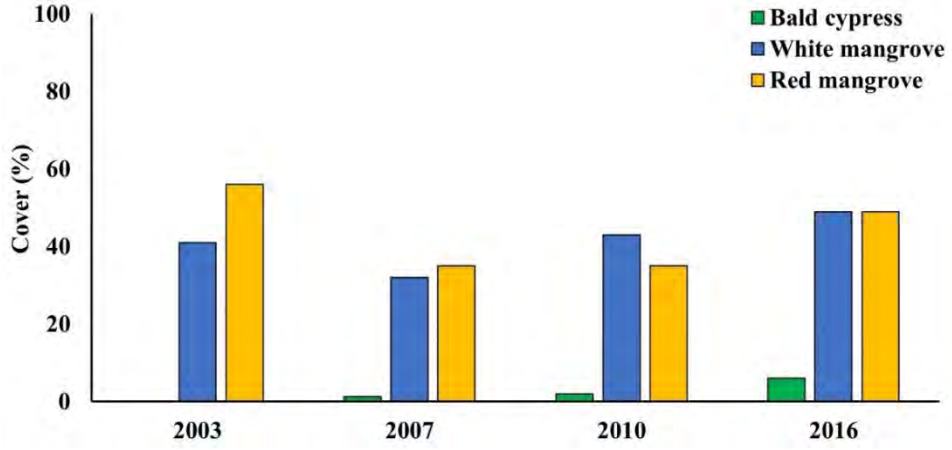

Figure 4.44. Percent shrub cover for the three keystone species.

Groundcover vegetation monitoring included all herbaceous and woody species under 1 m (Table 4.6) observed in three 1 m^2 subplots within each 100 m^2 intercept plot. Percent cover and stem counts were monitored every three years in 2003, 2007, 2010, and 2016. Bald cypress seedlings were present on all the transects except for T-1 and T-10 between 2003 and 2016 with Kitching Creek (T-8) as the most productive area. The recruitment of bald cypress was highest in the upper tidal reach and lowest in the lower tidal and riverine reaches. Bald cypress percent groundcover percentages were small, ranging from 0.3% to 9.3% (Figure 4.45A). Percent groundcover for white mangroves increased from 38.5% in 2003 to 82.5% in 2007, though it decreased to approximately 21.5% in 2016 (Figure 4.45A). Red mangrove groundcover declined to 9.2% in 2010 from 20% in 2007. The highest percentage of red mangrove groundcover seedlings was observed in the lower and upper tidal reaches.

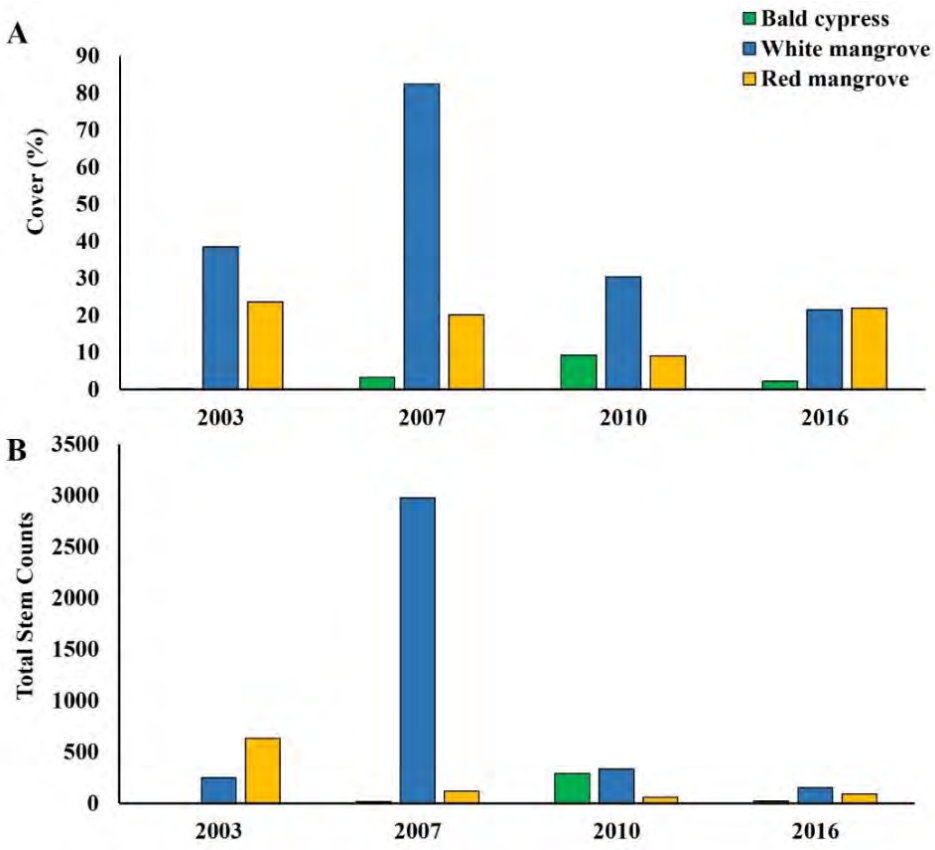

Figure 4.45. (A) Percent groundcover and (B) total stem counts for the three keystone species.

Groundcover total stem counts were obtained to examine future recruitment into the shrub and canopy layers of the floodplain. Bald cypress seedling stem counts were low over the survey period though peaked in 2010 (Figure 4.45B), particularly near Kitching Creek (T-8). White mangrove stem counts were the greatest of the three species evaluated and were most abundant on the five lower and upper tidal transects during the 2007 survey. The largest stem count of red mangrove groundcover was observed during the 2003 survey and declined throughout the survey (Figure 4.45B). There was low recruitment of red mangrove seedlings near Kitching Creek (T-8) and on T-9 throughout the survey period.

Floodplain Vegetation Monitoring Summary

Downstream of the Lainhart Dam at transect T-1, the flow-stage relationship indicated that 110 cfs is needed to inundate the mid-section of the transect at 9.9 ft NGVD29 (SFWMD, 2012). The swamp plots in T-1 (upstream of Lainhart Dam) consisted of some of the largest bald cypress trees along the river. However, seedling production and survival from groundcover to shrub layer was minimal. New recruitment of bald cypress was found primarily in the upper tidal reaches of the river where inundation occurs twice a day. The heavy rainfall and runoff from the 2004 and 2005 hurricanes damaged existing canopy species. Additionally, the hurricanes eroded and deepened the Cypress Creek channel diminishing floodplain inundation. The reduced floodplain hydrology modified the vegetation community from swamp to upland canopy species allowing pockets of

non-native species to establish in the understory. Further, the lower tidal reach and portions of the upper tidal river reach experienced a loss of freshwater vegetation (i.e., bald cypress), shifting towards more salt-tolerant species like red and white mangroves and pond apple. The preferred restoration scenario proposed in 2006 would push the saltwater front from near RM 9.5 at Hobe Grove Ditch to between RMs 8 and 7.5, downstream of Kitching Creek (SFWMD, 2006) to support the freshwater vegetation. Continued monitoring and analyses are needed to determine the causal relationship between floodplain hydrology and vegetation.

Cypress Sapling Plantings

The loss of bald cypress trees from the NW Fork floodplain has been well documented (Roberts et al., 2006). To boost the bald cypress population, JDSP and FWC planted roughly 23 acres of river floodplain with approximately 2300 bald cypress saplings between 2017 and 2021. Sapling sizes ranged between 3 gal. and 25 gal. and were planted at varied locations along the riverbank to the upland edge of the floodplain from RM 6.5 to RM 8.5. A mix of local, regional, private, and government-run nurseries were used to purchase plants. Funding for the project came from several sources, including small donations from private citizens to contracted work done by the FWC Aquatic Habitat Restoration/Enhancement Section (AHRES) and the Fish and Wildlife Foundation of Florida. Volunteers donated their time to assist with the actual planting. The total cost to date is about $49,000 or roughly $2,000/acre for 100 cypress saplings/acre.

The most successful planting efforts used larger saplings in the floodplain area near the mouth of Kitching Creek. These areas were co-located with mature, sparsely distributed (~1 mature tree/acre or less) bald cypress trees were established with few saplings and intermixed within dense canopies of mangroves. The long-term plan is to continue monitoring the planted saplings to assess their survival and growth and plan for the possibility of future plantings. Accessible sites along the river continue to be surveyed at least quarterly with more hidden or remote sites visited once per year. Some planted sites are no longer monitored due to low survival.

Non-Native Vegetation

Disturbance of natural areas has long been a part of South Florida's environment, providing an opportunity for non-native species to spread into new areas. With human activities and multiple plant introductions, these species have invaded altered sites, often adversely affecting the natural complexity of the community (Roberts and Flanner, 2010). In Florida, 1,555 of the introduced flora have become so pervasive that 165 were listed by the Florida Exotic Pest Plant Council (FLEPPC) as invasive pest plants (Wunderlin et al., 2024, FLEPPC, 2019).

Non-native plant species were documented within the Loxahatchee River's floodplain during vegetation transect monitoring between 2003 and 2016. Species were classified by their vegetation type: canopy tree, shrub, groundcover (including aquatic plants), or vine, and their wetland status and non-native threat, if applicable (Table 4.7). The wetland status indicates vascular plants occur in wetlands from the wettest (obligate) to the driest (upland). A Category 1 non-native species threat are non-native plants that transform native plant communities by displacing native species. Category 2 species have not shown the extent of displacement as those in Category 1. For example, *Lygodium microphyllum*, the Old World climbing fern, is a facultative vine with a Category 1 non-native threat (Table 4.7).

Table 4.7. Non-native plants with their respective wetland status and non-native threat observed between 2003 and 2016.

Non-Native Species	Common Name	Vegetation Type	Wetland Status / Non-Native Threat	% Canopy Basal Area (2003 / 2009 / 2016)	Total Shrub % Cover (2003 / 2007 / 2010 / 2016)	Total Groundcover % Cover (2003 / 2007 / 2010 / 2016)
Bischofia javanica	Bishop wood	Tree	___ / 1			0.1 / 0 / 0 / 0
Citrus x aurantium	Orange	Tree	FACU / _	7 / 0 / 1		
Ficus microcarpa	Indian laurel ficus	Tree	UPL / 1		2 / 27 / 2 / 1	
Psidium cattleianum	Strawberry guava	Tree	FACU-FAC / 1	0 / 1 / 0	13 / 7 / 6 / 1	2 / 1 / 2 / 1
Schinus terebinthifolia	Brazilian pepper	Tree	FAC / 1	43 / 17 / 6	32 / 55 / 15 / 8	3 / 6 / 2 / 1
Senna pendula var. glabrata	Climbing cassia	Tree	FAC / 1		0 / 0 / 12 / 0	0.2 / 0 / 0 / 0
Syzygium cumini	Java plum	Tree	UPL-FAC / 1	2/ 2 / 1		2 / 3 / 4 / 3
Ardisia elliptica	Shoebutton Ardisia	Shrub	FAC / 1			0 / 0 / 0.2 / 0
Colocasia esculenta	Wild taro	Shrub	OBL / 1		0 / 6.3 / 0 / 0	0.2 / 0.1 / 18 / 13
Crotalaria pallida	Mucronate rattlebox	Shrub	FACU / _			0 / 7 / 0 / 0
Ludwigia peruviana	Peruvian primrose willow	Shrub	FACW-OBL / 1		0 / 8 / 0 / 0	0 / 2 / 0 / 0
Melinus repens (Rhynchelytrum repens)	Natal grass	Shrub	UPL / 1			0 / 0 / 0 / 0.7
Pennisetum purpureum	Napier grass, Elephant grass	Shrub	FACU-FAC / 1		0 / 25 / 1 / 1	0 / 0 / 0.3 / 10
Urochloa maxima (Panicum)	Guinea grass	Shrub	FAC / 2		0 / 92 / 1 / 2	0 / 0 / 0.3 / 10
Urochloa mutica	Para grass	Shrub	FACW / 1			0 / 0 / 1 / 21
Ageratum houstonianum	Blue mink	Groundcover	FACU / _			0 / 2 / 2 / 0.1
Alternanthera philoxeroides	Alligator weed	Groundcover	OBL / 2			0.2 / 3 / 22 / 1.8
Alternanthera sessilis	Sessile joy weed	Groundcover	OBL / _			0 / 0.3 / 0.2 / 0
Commelina diffusa	Common dayflower	Groundcover	FACW / _		0 / 2 / 0 / 0	18 / 27 / 1 / 17
Desmodium tortuosum	FL Beggar weed	Groundcover	FAC / _			0 / 0 / 3 / 0
Desmodium triflorum	Three flower beggarweed	Groundcover	FACU / _			0.3 / 0 / 0 / 0
Hygrophila polysperma	Indian swamp weed	Groundcover	OBL / 1			0.1 / 2.1 / 14 / 60
Limnophila sessiliflora	Asian marsh weed	Groundcover	OBL / 2			0.2 / 23 / 16 / 1
Myriophyllum spicatum	Water milfoil	Groundcover	OBL / 2			0 / 0 / 0 / 11.1
Nephrolepis cordifolia	Tuberous sword fern	Groundcover	FAC / 1			0 / 0 / 0 / 0.9
Pistia stratiotes	Water lettuce	Groundcover	OBL / 1			0 / 0 / 0.1 / 0.4
Pouzolzia zeylanica	Pouzoulz's bush	Groundcover	FAC / _		0 / 1 / 0 / 0	0 / 2 / 3 / 0
Ruellia blechum (Blechum blechum)	Green shrimp plant	Groundcover	FACW / 2			0 / 0.3 / 0 / 0.6
Salvinia minima	Water spangles	Groundcover	OBL / 1			0 / 0 / 0.1 / 0.1
Spermacoce verticillata	False button weed	Groundcover	___ / 2			0 / 1.4 / 1 / 0
Sphagneticola trilobata	Creeping oxeye	Groundcover	FAC / 2			0.2 / 0 / 0 / 0.1
Sporobolus indicus	Smut grass	Groundcover	FACU / _			0 / 10 / 2 / 0.1
Thelypteris dentata	Downy shield fern	Groundcover	FACW / _		0 / 1 / 2 / 7	20 / 3 / 7 / 1
Urena lobata	Caesar weed	Groundcover	FAC / 1		8 / 12.3 / 7 / 2	14 / 8 / 14 / 17
Abrus precatorius	Rosary pea	Vine	UPL / 1		0 / 1 / 3 / 0	6 / 3 / 2.1 / 1.5
Lygodium microphyllum	Old World climbing fern	Vine	FACW / 1		11 / 19.4 / 23.5 / 7	11 / 32 / 29 / 17
Momordica balsamina	Balsam apple	Vine	UPL / 2			0 / 0 / 0 / 0.1
Syngonium podophyllum	Arrowhead	Vine	___ / 1			0.4 / 0.3 / 1.4 / 0

A total of 38 non-native plant species were observed during the 2003 to 2016 surveys (Table 4.7) Of the 38 species, seven were categorized as canopy trees, eight shrubs, 19 groundcover, and four vine species. Five species were classified as occurring almost always in the upland (UPL) while eight species were identified as obligates (OBL) occurring almost always in wetlands under natural conditions. Twenty-two species were identified as facultative, a mixture of facultative/upland, or facultative/wet. Twenty species were identified as a Category 1 non-native threat, and eight were identified as a Category 2. Five additional plants pose a serious threat to the native vegetation, four of which are listed on FLEPPC: (java plum (FLEPPC), Pouzoulz's bush (Not FLEPPC listed), alligator weed (FLEPPC), strawberry guava (FLEPPC) and Peruvian primrose willow (FLEPPC, Category 1).

Four non-native canopy tree species (wild citrus, strawberry guava, Brazilian pepper, and java plum) were observed in 2003, 2009, and 2016 (Table 4.7). Brazilian pepper, percent total basal area steadily decreased over the study period from 43% in 2003 to 6% in 2016. The percent basal area of wild citrus plants decreased from 7% in 2003 to 1% in 2016 showing signs of herbicide treatment (Table 4.7). Strawberry guava (1% in 2009) and java plum (2%) were rare, demonstrating that previous management activities and herbicide application by contractors and JDSP were effective on these species.

Four of the eight species included in the shrub cover estimates were classified as non-natives. The most prolific were Guinea grass, Brazilian pepper, Old World climbing fern, Indian laurel ficus, and Napier grass. Non-native shrub percent cover was highest during the 2007 survey, a major drought year (Table 4.7). For example, Guinea grass had 92% cover in 2007 which declined to 2% in 2016 (Table 4.7). Brazilian pepper cover increased to 55% in 2007 but was reduced to 8% in 2016 through managed treatments (Table 4.7). In 2007, wild taro, common dayflower, Peruvian primrose willow, Pouzoulz's bush, and climbing cassia were only present as shrubs. Guinea grass, Napier grass, and Pouzoulz's bush were only found on T-5 (Cypress Creek). Rosary pea, wild taro, common day flower, Peruvian primrose willow, Pouzoulz's bush, and climbing cassia shrubs were not observed during the 2016 survey. All but one shrub species, the downy shield fern, declined by 2016 indicating non-native plant management activities worked.

Groundcover vegetation, species shorter than 1 m, responds rapidly to changes in hydrological conditions and can be affected by freshwater flow, inundation, and droughts based on their position within the topographical gradient of the floodplain. Thirty-one species were included in the percent groundcover estimates and 19 of the non-natives found in the plots were classified as groundcover plants. Two species, downy shield fern (20%) and Caesar weed (14%), had the highest percent cover in 2003, though both species declined by the 2007 survey (Table 4.7). The common day flower (27%) had the greatest percent cover of all species observed across all years in 2007. Wild taro (18%), alligator weed (22%), and Indian swamp weed (14%) all increased in percent cover in 2010. By 2016, all but five groundcover species (Napier grass, Guinea grass, para grass, Indian swamp weed, and Caesar weed) declined in percent cover, including the arrowhead vine, a major non-native weed within the SFWMD's portion of the floodplain. New groundcover species, however, were observed during the 2016 survey and included balsam apple, water milfoil, tuberous sword fern, and natal grass.

As non-native plants spread throughout the floodplain, restoration and management efforts become more challenging. For example, arrowhead vine is a dominant non-native that overtakes all other

vegetation in some areas of the floodplain. This plant, among others, is a serious threat to native vegetation. Continued monitoring and treatment of non-native vegetation are recommended to control the proliferation of these plants and to promote the recovery of native plant species.

Non-Native Vegetation Management and Control

Non-native plants can have a strong foothold in many of the plant communities along the NW Fork. The seeds of these non-natives are distributed by water, birds, wind, or humans. Some invasive plants have aggressive root systems that spread large distances from a single plant. The root systems of these non-native plants can often grow so densely that they smother the root systems of surrounding native vegetation. Efforts to keep the non-natives eradicated and/or under control are accomplished through manual removal or chemical herbicide treatment and prescribed fires. Non-native plant management is a continuous yearly cost to agencies and one that is critical to maintaining the natural area of the NW Fork. Both the SFWMD and JDSP are responsible for the management of non-natives on the state owned and managed lands within the river corridor.

SFWMD manages a large portion of the NW Fork's Wild and Scenic areas from the Trapper Nelson Interpretative Site to Indiantown Road. The SFWMD continues to implement prescribed burns and chemical treatments as part of the continued restoration efforts to reduce the spread of non-native plants in the Loxahatchee River. Between 2010 and 2020 the SFWMD treated a total of 41,596 acres using chemical applications (Table 4.8) and burned 8,938 acres through prescribed fires (Table 4.9). Non-native species targeted for treatment included Old World climbing fern (*Lygodium microphyllum*) (Figure 4.46), Brazilian pepper (*Schinus terebinthifolius)*, melaleuca (*Melaleuca quinquenervia*), earleaf acacia (*Acacia auriculiformis*), downy rose myrtle **(***Rhodomyrtus tomentosa*), para grass (*Urochloa mutica*), and cogon grass (*Imperata cylindrica*).

Table 4.8. SFWMD non-native treatments by chemical herbicide application within the watershed.

Fiscal Year	Loxahatchee River	Cypress Creek	9 Gems	Culpeper Ranch	Total Acres
2012	358	1,536			1,895
2013	754	403	1,096	1,294	3,547
2014	1,087	879	3,079	1,294	6,338
2015	1,077	2,835	3,931	1,142	8,985
2016	1,736	4,064	4,993	110	10,903
2017	298	1,119	286		1,703
2018	359	1,329	1,090		2,778
2019	885	982	820		2,687
2020	359	692	990	718	2,760
Grand Total	**6,913**	**13,840**	**16,285**	**4,558**	**41,596**

Table 4.9. SFWMD non-native treatments by prescribed burns within the watershed.

Fiscal Year	Loxahatchee River	Cypress Creek	Hungryland	Total Acres
2010			433	**433**
2012		1,897		**1,897**
2013	239	597		**836**
2014	345	125	992	**1,462**
2015		656	844	**1,500**
2016	40	628	1,212	**1,880**
2017	46			**46**
2018		83		**83**
2020	40	762		**802**
Grand Total	**709**	**4,747**	**3,482**	**8,938**

Figure 4.46. (A) Old World climbing fern and (B) a prescribed burn to help control non-native plants within JDSP.

Jonathan Dickinson State Park also manages non-native vegetation control (Figure 4.46) to limit their continued spread within the Park's boundaries and especially within the corridor of the NW Fork. Non-native control was accomplished through chemical herbicide treatments and prescribed burns. The primary focus of JDSP's non-native treatments has been the removal of Old World climbing fern (*Lygodium microphyllum*), downy rose myrtle (*Rhodomyrtus tomentosa*), melaleuca (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus terebinthifolius)* and java plum (*Syzygium cumini*). Treatments also included eradicating strawberry guava (*Psidium cattleianum*) and shoebutton ardisia (*Ardisia elliptica)* as allowed and needed. Over the last decade (2011 to 2020) JDSP treated a total of 29,205 acres by prescribed burns and 22,462 acres by chemical application (Table 4.10).

Table 4.10. Non-native vegetation treatment within JDSP (2011 to 2020).

Year	Prescribed Acres	Treated Acres
2011 to 2012	3088	3074
2012 to 2013	3090	737
2013 to 2014	3630	2116
2014 to 2015	3890	4872
2015 to 2016	3446	942
2016 to 2017	1101	3783
2017 to 2018	3296	1948
2018 to 2019	5532	3480
2019 to 2020	2132	1510
Total Treated	**29,205**	**22,462**

Plant management activities continue to significantly reduce the number of large stands of non-natives along the river particularly Brazilian pepper, Old World climbing fern, and Java plum. Continued management and treatment of these non-native plants are crucial to maintaining healthy native populations.

Submerged Aquatic Vegetation and Faunal Utilization

The native submerged aquatic vegetation (SAV), *Vallisneria americana* (Figure 4.47), is a dominant plant species throughout South Florida river systems and is an important element of Florida's freshwater ecosystems. *Vallisneria americana*, known as tape grass, wild celery, or American eelgrass, is a rooted aquatic plant with wide, flat leaves that can grow up to several feet in length. Eelgrass grew unexpectedly in the NW Fork during 2010, possibly spurred by increased rainfall during the 2009/2010 dry season and stabilized salinities due to water management practices. The expansive bed of SAV provided an opportunity to study *V. americana* habitat utilization. Historically deemed to be a freshwater-restricted species, *V. americana* can tolerate a wide range of salinities (optimal salinity range is 0 to 8) however, the SAV can tolerate salinities up to 18 for brief periods (Tootoonchi et.al., 2020).

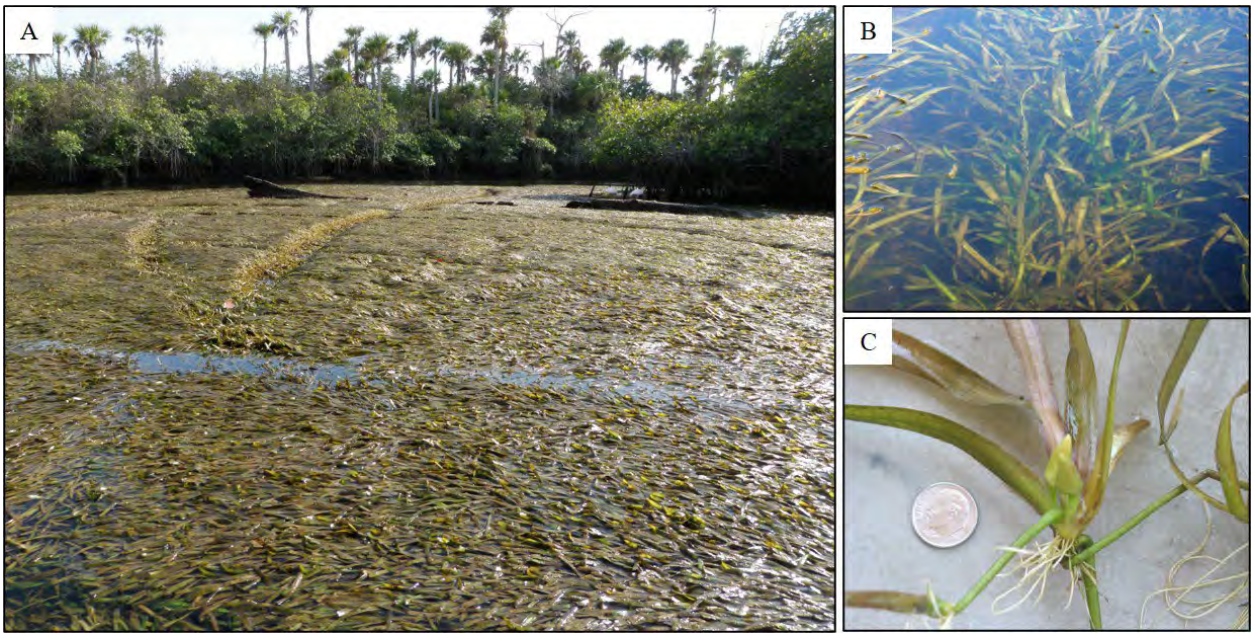

Figure 4.47. (A) *Vallisneria americana extent* and (B) density within the NW Fork; and (C) beginning to flower (U.S. dime for scale).

Between 2011 and 2017, the SFWMD initiated a study within the *Vallisneria americana* beds in the NW Fork. The objective was to determine the species composition and abundance of fish and decapods utilizing the SAV and to understand its influence on biodiversity. This study provided information applicable to restoration and management efforts of *V. americana* to maintain biodiversity and the SAV ecosystem services throughout South Florida. Study sites were located between the Trapper Nelson Interpretive Site (RM 10.5) and the mouth of Kitching Creek (RM 7.8) (Figure 4.48). Surveys were conducted in the summer/fall of 2013, spring/summer of 2014, and spring of 2015. Fish and macroinvertebrates were sampled with a throw trap swept with dipnets to remove organisms (Figure 4.49), while SAV was sampled with a ponar grab. Subsamples of *V. americana* were examined for shoot length, width, and percent cover estimates for above- and belowground standing biomass. Salinity, flow, water temperature, dissolved oxygen, geographical gradient, and bare versus vegetated habitats were also noted.

From 2011 to 2017, extensive eelgrass beds covered 10 to 15 acres and were found from RM ~10.2 to RM ~7. The habitat structure provided by *V. americana* was determined to be a valuable ecosystem component, providing essential fish nursery habitat and refugia grounds, nutrient cycling, sediment stability, and improving water clarity. In 2017, the eelgrass beds disappeared completely from the river in the period coinciding with Hurricane Irma (September 2017). However, the eelgrass beds remained intact in areas upstream of Riverbend Park.

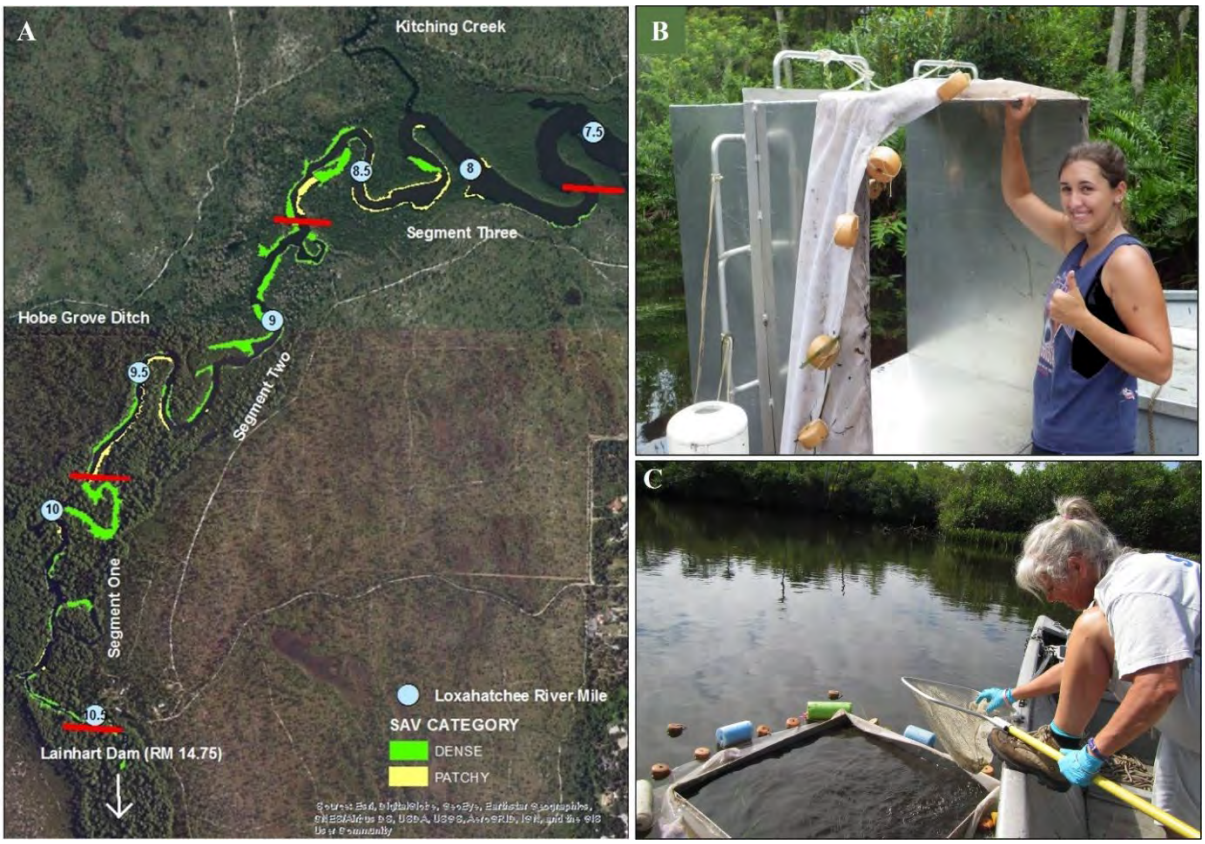

Figure 4.48. (A) Map of *Vallisneria americana* monitoring areas of the river. Scientists sampling the *V. americana* beds via (B) throw trap and (C) dip net for fish and macroinvertebrates.

During the study period, salinities ranged from 0.12 to 0.37, flows at Lainhart Dam ranged from 170 cfs to 351 cfs, and water temperatures ranged from 24.2 ˚C to 28.3˚C. Dissolved oxygen among seasons was significantly lower in the summer than in the spring or fall, though levels observed were within suitable range for organisms.

Vallisneria americana extent within the NW Fork reached approximately 13 acres in 2012. Among vegetated sites, aboveground biomass was significantly higher in spring than summer though not significantly different along the geographic gradient. No significant differences, however, were observed in belowground biomass between seasons, nor among geographic locations.

Habitat usage was determined by the abundance of organisms within the *V. americana* beds. Vegetated habitats averaged 4.5 times more individuals and 30% greater diversity than bare habitats. A total of 2,750 individual fish and 2,344 macroinvertebrates, comprising 24 families and 54 species, were collected over the six sampling events. Eighty-eight percent of the captured organisms consisted of *Dormitator maculates* (fat sleepers), *Eleotris amblyopsis* (large scale spiney cheek sleepers), caridean shrimp (family Palaemonidae), mud crabs (family Panopeidae), and Portunid crabs (swimming crabs, family Portunidae). Faunal abundance was highest in the spring, corresponding with the increased aboveground biomass. Although eelgrass biomass did not vary along the upstream-to-downstream gradient, faunal abundance and diversity were lower in the upstream sites compared to the downstream sites.

The study concluded that *V. americana* significantly increased faunal abundance in the NW Fork, demonstrating the importance of SAV ecosystem services. Unfortunately, *V. americana* beds have been greatly reduced in the study area after 2017. Annual monitoring, including the mapping of SAV beds, is needed to determine the causes and frequencies of these losses. Additional studies of the drivers behind the geographic gradient in faunal abundance and the effect of patch edge would provide information for improving restoration efforts. Understanding how resident and transient fish use eelgrass beds is especially important since it is a nursery habitat for economically important species. Such information would facilitate management decisions during the CERP LRWRP planning process, future restoration plan updates, and beyond.

Vallisneria americana, when present, is a valuable ecosystem component that provides fish nursery habitat and refugia, nutrient cycling, sediment stability, and water clarity. A separate study was initiated in 2020 by JDSP and FWC AHRES to promote eelgrass recovery in the NW Fork. Eelgrass plugs for this project were collected from the C-18 near SR 710. Fifteen (50 ft. x20 ft.) plots (~2000 plants per plot) were planted between RM ~10.2 and RM ~8.5 from April to May of 2022. Preliminary results showed the eelgrass plantings grew remarkably quickly in locations of sufficient water depth and if the herbivore exclusion fencing remained undamaged. Monitoring of these plots is ongoing.

Vegetation Summary

Several vegetation studies were conducted throughout the watershed, documenting the changes in floodplain and SAV communities within the last two decades. Tidal inundation coupled with saltwater intrusion and the alteration of the natural freshwater flow patterns were the major stressors affecting the ecology of the vegetation communities. Saltwater intrusion negatively impacts both eelgrass and bald cypress communities through physiological stress and enables mangroves to expand into freshwater floodplains, outcompeting bald cypress. The lack of inundation in the riverine reach has encouraged the growth of native transitional, upland, and non-native plant species within the subcanopy. Non-native plants like Old World climbing ferns and others persist along the NW Fork and require ongoing management efforts. Adequate freshwater and groundwater levels are crucial to reducing the threat of non-native plants. Continued studies, monitoring, and management of vegetation in the NW Fork are key to understanding and mitigating changes to the native vegetation communities.

4.3.2. Fish and Wildlife

A wide range of wildlife species can be found throughout the Loxahatchee River Watershed and within the NW Fork corridor. The sub-tropical climate and native plant communities within south Florida provide favorable habitats for numerous invertebrate (spiders, snails, crabs, worms insects and butterflies) and vertebrate (fish, amphibians, reptiles, birds, and mammals) species throughout the river system and floodplain.

4.3.2.1. Assessment

Scope

The fish and wildlife assessment summarizes the native and non-native fish and wildlife species found within the NW Fork corridor and floodplain over the last two decades. As few studies were conducted between 2011 and 2020, much of the information provided has been summarized from the previous 2010 Management Plan, 2006 Restoration Plan, JDSP Unit Management Plan, and SFWMD land manager observations.

Background

Vertebrate Species

A variety of native and non-native vertebrate species reside in the river landscape. Among the most observed native species were the amphibious (using land and water habitats) vertebrates, including several frog species listed in the 2012 JDSP Unit Management Plan (Table 4.11). Numerous amphibious reptiles include the American alligator (*Alligator mississippiensis*), the banded water snake (*Nerodia fasciata),* black swamp snake (*Seminatriy*, *pygaen*), Florida cottonmouth (*Agkistrodon piscivous*), and several turtles like the peninsular cooter (*Pseudemys floridana*), red belly turtle (*Psudemys nelsoi*) and Florida softshell turtle (*Apalone ferox*) species.

Bird species found along the river channel and throughout the floodplain include the osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), swallow-tail kite (*Elanoides forficatus*), barred owl (*Strix varia*), white ibis (*Eudocimus albus*) and little blue heron (*Egretta caeurulea*). Additionally, several songbird species (*Passeriformes spp.*) use the floodplain for breeding and nesting such as the great crested flycatcher (*Myiarchus crinitus*), Carolina wren (*Thryothorus ludovicianus*) and northern parula (*Parula americana*) have been observed within the Loxahatchee River areas. Numerous migratory birds including the red-eyed vireo (*Vireo olivaceus*), blue-gray gnatcatcher (*Polioptila caerulea*) and American redstart (*Setophaga ruticilla*) utilize the area during spring and fall migrations, and others like the grey catbird (*Dumetella carolinensis*) for overwintering in the area.

Several freshwater fish species found within the NW Fork River include the largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), redbreast sunfish (*Lepomis auritus*), warmouth (*Lepomis gulosus*), bowfin (*Amia calva*), gar (*Lepisosteidae* spp.), channel catfish (*Ictalurus punctatus*) and a variety of minnow species. Saltwater fish that use the freshwater areas for spawning include snook (*Centropomus spp.*), tarpon (*Megalops atlantica*), mullet (*Mugilidae spp.*), jack (*Carangidae* spp.), sheepshead (*Archosargus probatocephalus*), sand perch (*Dipelectrum formosum*), grouper (*Serranidae),* snapper (*Lutjandiae* spp.) and flounder (*Paralichthys lethostigma*).

Native mammal species found in the Wild and Scenic segments of the river include white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus*), raccoon (*Procyon lotor*), five species of bats, cotton rat (*Sigmondon hispidus),* West Indian manatee (*Tirchechus manatus*) and the river otter (*Lontra canadensis*).

Table 4.11. Native vertebrate species found throughout the NW Fork (*note this is not an exhaustive list).

Classification	Common Name	Scientific Family	Scientific Name
Avian: Raptor	Swallow-tailed kite	Accipitridae	*Elanoides forficatus*
Avian: Raptor	Bald eagle	Accipitridae	*Haliaeetus leucocephalus*
Avian: Raptor	Osprey	Pandionidae	*Pandion haliaetus*
Avian: Raptor	Barred owl	Strigidae	*Strix varia*
Avian: Songbird	Blue-grey gnatcatcher	Certhiidae	*Polioptila caeruleal*
Avian: Songbird	Grey catbird	Mimidae	*Dumetella carolinensis*
Avian: Songbird	Northern parula	Parulidae	*Parula americana*
Avian: Songbird	American redstart	Parulidae	*Setophaga ruticilla*
Avian: Songbird	Carolina wren	Troglodytidae	*Thryothorus ludovicianus*
Avian: Songbird	Great crested flycatcher	Tyrannidae	*Myiarchus crinitus*
Avian: Songbird	Red-eyed vireo	Vireonidae	*Vireo olivaceus*
Avian: Wading bird	Little blue heron	Ardeidae	*Egretta caerulea*
Avian: Wading bird	American white ibis	Threskiornithidae	*Eudocimus albus*
Fish: Freshwater	Channel catfish	Ictaluridae	*Ictalurus punctatus*
Fish: Freshwater	Bowfin	Amiidae	*Amia calva*
Fish: Freshwater	Redbreast sunfish	Centrarchidae	*Lepomis auritus*
Fish: Freshwater	Warmouth	Centrarchidae	*Lepomis gulosus*
Fish: Freshwater	Bluegill	Centrarchidae	*Lepomis macrochirus*
Fish: Freshwater	Largemouth bass	Centrarchidae	*Micropterus salmoides*
Fish: Freshwater	Gar species	Lepisosteidae	*Lepisosteus spp.*
Fish: Marine	Jack species	Carangidae	*Seriola spp.*
Fish: Marine	Snook species	Centropomidae	*Centropomus spp.*
Fish: Marine	Snapper species	Lutjanidae	*Lutjanus spp.*
Fish: Marine	Tarpon	Megalopidae	*Megalops atlanticus*
Fish: Marine	Mullet species	Mugilidae	*Mugil spp.*
Fish: Marine	Flounder	Paralichthyidae	*Paralichthys lethostigma*
Fish: Marine	Sand perch	Serranidae	*Dipelectrum formosum*
Fish: Marine	Grouper species	Serranidae	*Epinephelus spp*
Fish: Marine	Sheepshead	Sparidae	*Archosargus probatocephalus*
Mammalian: Carnivore	White-tailed deer	Capreolinae	*Odocoileus virginianus*
Mammalian: Carnivore	Bobcat	Felidae	*Lynx rufus*
Mammalian: Carnivore	River otter	Mustelidae	*Lontra canadensis*
Mammalian: Carnivore	Racoon	Procyonidae	*Procyon lotor*
Mammalian: Marine	West Indian manatee	Trichechidae	*Tirchechus manatus*
Mammalian: Rodent	Cotton Rat	Cricetidae	*Sigmondon hispidus*
Reptile: Crocodilian	American alligator	Alligatoridae	*Alligator mississippiensis*
Reptile: Snake	Banded water snake	Colubridae	*Nerodia fasciata*
Reptile: Snake	Black swamp snake	Colubridae	*Seminatrix pygaea*
Reptile: Snake	Cottonmouth	Viperidae	*Agkistrodon piscivous*
Reptile: Turtle	Florida (or coastal plain) cooter	Emydidae	*Pseudemys floridana*
Reptile: Turtle	Florida red-bellied cooter	Emydidae	*Pseudemys nelsoni*
Reptile: Turtle	Florida softshell turtle	Trionychidae	*Apalone ferox*

Many of the abovementioned species have been documented in the watershed areas surrounding the NW Fork and along the river corridor (Table 4.11). Some of these species are listed as endangered, threatened, or species of concern by the FWC, or listed as threatened or endangered by the U.S. Fish and Wildlife Service (USFWS) (Table 4.11).

Non-Native Vertebrate Species of Concern

Non-native wildlife found within the boundaries of the NW Fork includes wild hogs (*Sus scofra*), nine-banded armadillo (*Dasypus novemcinctus*), Cuban anole (*Anolis sagrei*), Cuban treefrog (*Osteopilus septentrionalis*), and the greenhouse frog (*Eleutherodactylus planirostris*). Most of these species and other non-native animals, except for the wild hogs and Cuban tree frogs (Figure 4.49), were not considered an immediate threat to the native plants and animal populations and continue to be left unmanaged. The Cuban tree frog populations warrant concern because of its predation on the native green and squirrel tree frogs.

Figure 4.49. Invasive species, (left) *Sus scofra* (wild boar) and (right) *Osteopilus septentrionalis* (Cuban tree frog).

Since the introduction of the feral, non-native hogs to the state by the Spanish 500 years ago, they have spread into every county throughout Florida. Wild hogs (feral pigs) are an extremely destructive species found throughout the watershed into the floodplains and along the river. The hogs disrupt habitats and cause severe soil and vegetation disturbances (Arrington et al., 1999) in addition to preying on or competing with native wildlife. The disturbed areas made by these feral hogs provide bare patches allowing the possible encroachment of invasive plants.

The wild hog populations are managed through hunting and trapping programs. On SFWMD Save Our Rivers (SOR) managed lands, the Hungryland Wildlife Environmental Area, which includes Culpepper and Nine-Gems, hunting is permitted for all legal species in Florida with some species requiring appropriate licenses and permits with legal limits enforced. Seasons differ based on the type of hunting gear and species season. Licensed hog agents are hired along the river and Cypress Creek areas as the public is prohibited from hunting in these areas (see Hungryland Hunting Regulations).

Conditions from 2008 to 2020

Wildlife Distribution Study

JDSP conducted a wildlife distribution and abundance study along the NW Fork between March 2008 and May 2010. Birds, frogs, and small mammals were observed at six sites within the floodplain. In 2009, American alligators (*Alligator mississippiensis*) were surveyed in the river channel from RM 15 to RM 6. The objectives of the study were (1) to obtain baseline data before hydrological restoration of the river, and (2) to compare wildlife occurrences in the freshwater versus more saline portions of the river.

Overall, birds and small mammals had greater species richness in the upper part of the river compared to the downstream areas. In contrast, frogs were equally distributed in the upper and lower portions of the river though specific frog species were not equally distributed. The study showed that alligators preferred freshwater (< 1 ppt) and were found less frequently in areas with salinity > 1 ppt. Additionally, some of the vertebrate groups studied were found to use the floodplain on a seasonal basis. The data collected in this study provided baseline data to better understand how specific wildlife use the different river reaches and to help document threatened and endangered species. These results will help inform future restoration projects and management efforts.

Threatened and Endangered Species Listing (changes since 2010)

In 2010, the FWC revised how the agency evaluates, lists, and protects imperiled species. The revisions included the development of management plans for species listed as “threatened” by the state and for species being removed from the State Imperiled Species List. The Imperiled Species Management Plan (ISMP) was formally approved by the FWC in November 2016 with rule changes in effect as of January 2017, including changes to the listing status of 23 species. The new system essentially eliminated “species of special concern (SSC)” and “endangered” as categories and settled on one single listing category of” threatened”. Species on the threatened and endangered species list were automatically adopted into Florida rule by their federal listing status.

For state-listed species in the former SSC, threatened and endangered state categories not covered by an existing federal listing, assessments were conducted, and a Species Action Plan (SAP) was created for each species. Species in the SSC category were either retained with the new threatened status or were removed from the list once an approved Species Action Plan was adopted. SAPs detail management efforts to reduce threats and maintain or enhance existing populations to avoid listing in the future. The ISMP represents a significant and successful collaborative effort between FWC, partners, and external stakeholders. Manatees were reclassified as threatened in 2017 by the USFWS.

Table 4.12. Threatened and Endangered Species Listing of Species within the Loxahatchee Watershed (LW) and River Corridor (RC).

Location	Classification	Common Name	Scientific Name	FDACS / FWC	USFWS	FNAI
RC	Reptile	American alligator	*Alligator mississippiensis*	FT/SA	Threatened S/A	--
LW	Reptile	Eastern indigo snake	*Drymarchon corais couperi*	FT	Threatened	S2
LW	Reptile	Florida pine snake	*Pituophis melanoleucus mugitus*	ST	--	S3
LW	Reptile	Gopher tortoise	*Gopherus polyphemus*	ST	--	S3
RC	Avian	Roseate spoonbill	*Platalea ajaja*	ST	--	S2
LW	Avian	Burrowing owl	*Athene cunicularia*	FT	--	S3
LW	Avian	Florida scrub jay	*Aphelocoma coerulescens*	FT	Threatened	S2
LW	Avian	Red-cockaded woodpecker	*Picoides borealis*	FE	Endangered	S2
RC	Avian	Little blue heron	*Egretta caerulea*	ST	--	S4
RC	Avian	Tricolored heron	*Egretta tricolor*	ST	--	S4
LW	Avian	Florida sandhill crane	*Grus canadensis pratensis*	ST	Threatened	S2
RC	Avian	Wood stork	*Mycteria americana*	FT	Threatened	S2
LW	Avian	Audubon's crested caracara	*Polyborus plancus*	FT	Threatened	S2
LW	Avian	Everglade snail kite	*Rostrhamus sociabilis*	FE	Endangered	S2
LW	Avian	Southeastern American kestrel	*Falco sparverius paulu*	FT	--	S3
RC	Mammalian	Florida manatee	*Trichechus manatus*	FT	Threatened	S2

FDACS = Florida Dept. of Agriculture and Consumer Services (5B-40.0055 F.A.C., July 2010 and Division of Plant Industry List 2003).
FWC = Florida Fish and Wildlife Conservation Commission (June 2021).
USFWS = United States Fish and Wildlife Service.
S/A = Threatened due to similarity of appearance.
FT = Federally listed as threatened and adopted by the state.
FE = Federally listed and adopted by state as endangered.
ST = State listed as threatened
FNAI = Florida Natural Areas Inventory
Key to FNAI guide:
S1 = Critically imperiled in Florida because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.
S2 = Imperiled in Florida because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.
S3 = Either very rare and local in Florida (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction of other factors.
S4 = Apparently secure in Florida (may be rare in parts of range).
S5 = Demonstrably secure in Florida.

Non-Native Fish Species of the Loxahatchee River

The Loxahatchee Watershed fish survey was conducted between June and December 2007 through a multiagency effort, including SFWMD, FDEP, Florida Park Service, FWC, Palm Beach County Environmental Resource Management (PBC ERM), USFWS, Student Conservation Association and Continental Shelf Associates International, Inc. Fish sampling gear such as seines, dipnet, backpack electrofisher, cast net, and underwater video cameras were used to observe 40 fish species within the Loxahatchee Watershed. Six non-native species were very common: black acara (*Chichlasoma bimaculatum*), Mayan cichlid (*Cichlasoma urophthalma*), walking catfish (*Clarias batrachus*), brown hoplo (*Hoplosternum littorale*), sailfin catfish (*Pterygoplichthys multiradiatus*) and spotted tilapia (*Tilapia mariae*). Spotted tilapia, Eastern mosquitofish (*Gambusia holbrooki*), and bluegill (*Lepomis macrochirus*) were the three most abundant species observed during the survey. Oscars (*Astronotus ocellatus*) were observed at Lainhart Dam however none were captured. Vermiculated sailfin catfish (*Pterygoplichthys disjunctivus*) have also been observed on the Loxahatchee River. Additionally, FWC captured eight non-native fish species on the river and PBC ERM collected five non-native species from the Loxahatchee Slough. Non-native species were not returned to the waterbodies after capture as they compete with native fish species at all trophic levels for resources. At the end of each sampling day, non-native fishes were donated to the Busch Wildlife Sanctuary in Jupiter, Florida for use as animal sustenance.

The 2012 Addendum to the Restoration Plan recommended that additional fish studies were needed to document changes in species composition and abundance once additional water was delivered to the river and hydroperiods were modified (SFWMD, 2012). The studies would contribute to the state-wide monitoring of non-native and nuisance fish species conducted by FWC. Additionally, fish studies are needed to determine the best management flows when freshwater fishes migrate downstream to survive in mangrove creeks as stage levels fall and higher salinity zones move upstream.

In June 2016, FWC conducted electrofishing in the Loxahatchee River near Riverbend Park. Paperno, et al. (2016) documented five nonnative fish species, listed in decreasing order of abundance: *Tilapia mariae* (spotted tilapia), *Pterygoplichthys multiradiatus* (Orinoco sailfin catfish), *P. disjunctivus* (vermiculated sailfin catfish), *Cichlasoma urophthalmus* (Mayan cichlid), and *Oreochromis* sp. (Mozambique/blue tilapia hybrid).

In 2021, Paperno et al. detailed the juvenile fish community in the St. Lucie and Loxahatchee Rivers. They identified several fish species and groups between 2016 and 2018. The observed species included (in order of decreasing abundance): *Oreochromis* spp. (blue, Nile, Mozambique tilapias or their respective hybrids), spotted tilapia, Mayan cichid, *Pterygoplichthys* sp. (Orinoco or vermiculated sailfin catfish), and *Sarotherodon melanotheron* (blackchin tilapia) (Paperno, et al., 2021).

Wildlife Summary

The watershed and river corridor are home to native and non-native vertebrate species. Native wildlife within the watershed included several fish (fresh and marine), amphibians (frogs), reptiles (snakes, turtles), birds, and mammal (bobcats, manatee) species. Amphibious vertebrates (frogs, alligators, and snakes) were the most frequently observed species. A baseline fish study in 2007 documented 40 different species with six of those reported as nonnative. Many of the native wildlife species documented were protected under the FWC state threatened and endangered species listing that was revised in 2017. Non-native wild hogs and Cuban tree frogs continued to pose the most threat, uprooting native plants and outcompeting native amphibian populations. As few wildlife studies have been conducted within the last decade, additional studies are needed to understand the relationship between the available resources and native and non-native wildlife.

4.3.3. Biological Communities Goal and Objectives

The following objectives for Vegetation, Fish, and Wildlife goal are prioritized in the Action Plan (4.3.4). An effort to implement one or more objectives may be part of a program already in progress.

Goal: Protect and preserve the native wildlife, fish, and vegetation within the Northwest Fork of the Loxahatchee River

Objectives:

A. Promote acquisition of willing-seller parcels within Pal-Mar.

B. Systematically assess bathymetry of the Loxahatchee River, including all three forks, to document sedimentation and erosion.

C. Determine how sedimentation and erosion impact the valued ecosystem components (e.g., submerged aquatic vegetation).

D. Remove or cap excess muck accumulations.

E. Evaluate impact of pulsed flows (during low flow periods) on the ecological health and the impacts to the floodplain and wildlife.

F. Assess spatial and temporal trends in the health, abundance, and distribution of valued ecosystem components (VEC's) (e.g., seagrass).

G. Continue to assess and improve where possible changes in floodplain vegetation.

H. Implement the ACOE wildlife monitoring plan for the LRWRP Plan (2020) where possible to document changes over time.

4.3.4. Biological Communities Action Plan

Key to the Action Plan Table (Table 4.13):

- Priority of the objective was determined by the LRMCC using the following criteria:
    1. Legally required, planned, or funded; action will be taken within the 10 year planning period.
    2. In planning, may or may not be funded; action may not happen within the 10 year planning period.
    3. Not planned or funded; action not expected to start within the 10 year planning period.
- Responsibility of each action was determined by the LRMCC and often shared among several agencies (listed by acronyms (see pg. vii)).
- Duration of the action is either a discrete action ("Once") or continuous action ("Ongoing").

NOTE: The ability to carry out these activities will be dependent on the priorities of the responsible agencies and the availability of funds.

Table 4.13. Biological Communities Action Plan.

Goal: Protect and preserve the native wildlife, fish, and vegetation within the NW Fork of the Loxahatchee River.		
Objective	**Priority**	
A. Promote acquisition of willing-seller parcels within Pal-Mar for habitat and hydrologic restoration.	**2**	
Actions	**Responsibility**	**Duration**
i. Acquire parcels within Pal-Mar Water Control District.	MC, PBC, DEP, SFWMD	Ongoing
Objective	**Priority**	
B. Systematically assess bathymetry of the Loxahatchee River, including all three forks, to document sedimentation and erosion.	**3**	
Actions	**Responsibility**	**Duration**
i. Conduct bathymetric surveys.	JID	Ongoing
ii. Conduct environmental and ecological monitoring to assess potential impacts associated various flow regimes.	FWC, JDSP, SFWMD	Ongoing
iii. Conduct environmental and ecological monitoring to assess spatial and temporal trends in valued	FWC, JDSP, SFWMD, LRECD, USGS	Ongoing

ecosystem components (increase or decrease in acres of habitat).		
Objective	**Priority**	
C. Determine how sedimentation and erosion impact the valued ecosystem components (e.g., submerged aquatic vegetation).	**3**	
Actions	**Responsibility**	**Duration**
i. Monitor changes in terrestrial and aquatic vegetation in response to sedimentation and erosion.	JDSP, SFWMD	Ongoing
ii. Promote living shorelines in lieu of sea walls and bulkheads.	JID, FWC	Ongoing
iii. Monitor changes in submerged aquatic vegetation in response to muck removal.	JID	Ongoing
Objective	**Priority**	
D. Remove or cap excess muck accumulations.	**3**	
Actions	**Responsibility**	**Duration**
i. Map and quantify muck accumulation.	JID	Ongoing
Objective	**Priority**	
E. Evaluate impact of pulsed flows (during low flow periods) on the ecological health and the impacts to the floodplain and wildlife.	**3**	
Actions	**Responsibility**	**Duration**
i. Complete the development of the Loxahatchee River Floodplain Wetland and Salinity Indices using existing 2003, 2009 and 2016 canopy data.	SFWMD	2 years
Objective	**Priority**	
F. Assess spatial and temporal trends in the health, abundance, and distribution of valued ecosystem components (VEC's) (e.g., submerged aquatic vegetation).	**2**	
Actions	**Responsibility**	**Duration**
i. Conduct annual SAV (e.g., *Vallisneria*) mapping and biological monitoring surveys (i.e., blade density and height) in the River and major tributaries to document the distribution and general health of these species.	LRECD, SFWMD	10 years
Objective	**Priority**	

G. Continue to assess and improve where possible changes in floodplain vegetation.	**2**	
Actions	**Responsibility**	**Duration**
i. Conduct planting studies of cypress tree seedlings in the floodplain of the NW Fork and use results and adaptive management to optimize restoration of the historic cypress canopy.	JDSP	10 years
ii. Continue resampling the long-term 10 established floodplain vegetation transects every 3-6 years.	JDSP, SFWMD	10 years
iii. Complete the Floodplain Photopoints Survey: retaking photographs of each of the 128 vegetative plots and comparing them to the previous 2009 photographs to assess physical evidence of changes in the floodplain community. Photographs were to be taken every 10 years.	JDSP, SFWMD	10 years
iv. Assess tree canopy percent cover on each floodplain vegetative plot every 10 years or after significant weather events such as hurricanes.	JDSP, SFWMD	10 years
Objective	**Priority**	
H. Implement the ACOE wildlife monitoring plan for the LRWRP Plan (2020), where possible, to document changes over time.	**2**	
Actions	**Responsibility**	**Duration**
i. Conduct amphibian studies using approved methods.	JDSP	10 years
ii. Conduct reptile (alligator, turtle, snakes, etc.) studies using approved methods.	JDSP	10 years
iii. Conduct bird (wading birds, snail kites, etc.) surveys using approved methods.	JDSP	10 years
iv. Conduct mammal studies using approved methods.	JDSP, FDOT	10 years
v. Conduct fish studies using approved methods.	FWC	10 years

4.4. Historical and Cultural

The value of archaeological sites (adapted from FDHR 2005) clues into past events and previous ways of life remain in backyards, pastures, forests, hammocks, and streambeds across the Loxahatchee Watershed. Pre-European archaeological sites (before A.D. 1500) offer clues to Native American hunting and cooking methods, social organization and family life, artistic and religious expression, and past environments.

4.4.1. Assessment

Scope

The historical and cultural assessment identifies the archaeological, cultural, and historical resources related to the NW Fork.

Background

Cultural History and Chronology

The territory once known as the Loxahatchee River District (not to be confused with the LRCED) is likely one of the oldest occupied landforms in Southeast Florida. The river is the only surviving river of four that existed along coastal portions of what today is Palm Beach County. Early colonial maps depict the Loxahatchee, the Rio Secco (the "Dry River"), somewhere near present-day Hypoluxo or Manalapan, the Spanish River with an outlet by modern-day Red Reef Park near Highland Beach, and lastly, the northern branch of the Hillsboro River forming near Florida Atlantic University (based on 1840's township and range maps) and flowing south into Broward County.

Early settlers performed several jobs from farming and timber to commercial development, and in some cases, engineering (Williams, 1983). The people and their families' histories were directly tied to the Loxahatchee River. These early settlers included: Kitching (1867), Carlin (1871), Potter (1873), Dimick (1876), DuBois (1887-purchased the property known as Stone's Point), Lainhart (1889), Tindall (1892), and Pennock (1902) (Snyder 2003). One of the region's more colorful residents, Vince "Trapper" Nelson, moved to the area in 1931. Born in New Jersey in 1908, Nelson moved around the country and settled in Florida. Because of poor trapping at his original beach settlement near Jupiter, Nelson moved to a wilderness area on the NW Fork of the river (Snyder 2003). Trapper started what was to become Trapper Nelson's Zoo and Jungle Garden after laws restricted him to trapping only on a seasonal basis. The Trapper Nelson Zoo Historic District, now in the National Register of Historic Places, is located at River Mile 10.2 on the NW Fork within JDSP.

From 1942 to 1944 the federal government operated a radar training base, Camp Murphy, taking some of Trapper Nelson's land. After World War II, the State of Florida purchased the property and named it Jupiter State Park. The park was renamed Jonathan Dickinson after a merchant who shipwrecked in the area. After the Jonathan Dickinson State Park (JDSP) opened to the public in 1950, Trapper Nelson continued to operate in the area and later closed his property to the public in the 1960s.

Following his death in 1968, Trapper Nelson's heirs sold approximately 857 acres of his property bordering the NW Fork to Jupiter Hills Club. Jupiter Hills Club and the State of Florida agreed to

swap Trapper Nelson's property for the land they desired for a golf course. The land swap saved the south side of the NW Fork between River Mile 6.0 and 11.0 from being developed. The MacArthur Foundation donated property south of the former Trapper Nelson property to Indiantown Road to the SFWMD in 1985. The donation was made through the Nature Conservancy and extended the protections of the NW Fork to RM 16 on both sides of the river. The SFWMD purchased small land parcels and Palm Beach County worked with other landowners to implement density changes and land exchanges.

Historical and Cultural Sites

The Loxahatchee River corridor is one of the most investigated regions in Palm Beach County. During the 1990s, substantial archaeological investigations were conducted on and around the lands associated with the National Wild and Scenic NW Fork (Kennedy et al., 1991, Kennedy et al., 1993, Kennedy et al., 1994, Carr et al., 1995a, Carr et al., 1995b, Mueller 2007a, b and c, Wheeler et al., 1997).

Archeological and historical investigations conducted around the NW Fork have shed important light on the two battles of the Loxahatchee. This is especially true of work conducted by the Archeological and Historical Conservancy during the Indiantown Road widening project and a survey of the NW Fork. Jesup's military camp and most of the battlefield can now be accurately interpreted as having been on the west side of the river, mostly in Loxahatchee Battlefield Park. The Seminole village can be interpreted as having been on the east side of the river on what became the Shunk tract, the Reese Life Estate, and/or the former Riverbend Trailer Park.

Powell's battle began somewhere around the Eastern Slough of the Loxahatchee and his furthest advance was probably to the Seminole village on the east bank of the river. In addition, archival research has demonstrated that the military trail between Ft. Van Sweringen and Ft. Jupiter passed through lands associated with the National Wild and Scenic River.

Unfortunately, it seems that most of the artifacts from portions of the Seminole and military camps, and the two battlefields have been recovered from the periphery of the original locations within these sites. Development and other disturbances, which have taken place in what is now Cypress Creek Natural Area (Jupiter Ranch Tract) property, Riverbend Park, Loxahatchee River Environmental Control District property, the original and present Sierra Square, and Indiantown Road, have all adversely impacted the main portion of Jessup's battlefield and camp, the Seminole village, and probably a good deal of Powell's battlefield. Nonetheless, portions of all these sites and the military trail have been identified and all have been now subsumed under the site name "Loxahatchee Battlefield." The area of the Loxahatchee Battlefield site is believed to be eligible for listing on the National Register of Historic Places.

As of April 1989, a total of 69 archaeological and historic sites had been identified (Table 4.14). Five of these sites are, or were previously, located near the Jupiter Inlet. An additional site is on the North Fork of the Loxahatchee River. Two sites on the Eastern Slough and the "Seminole Skirmish Line," were destroyed by the widening of Indiantown Road (SR706) west of the Florida Turnpike. The remaining 61 sites are located on lands associated with the NW Fork. Of these sites, 22 are managed completely by JDSP and 39 by Palm Beach County (Table 4.14). One site at Riverbend Park is partially managed by Palm Beach County while other portions of the site are privately owned. Most of the Battle of Loxahatchee site is managed by Palm Beach County.

Table 4.14. Inventory of existing historical and cultural sites within the NW Fork and their eligibility for the National Register of Historic Places (NRHP).

Sites	Number of Sites	Current Conditions	Current Actions
Building remains	2	One site is ineligible for NRHP; Insufficient information for the other site.	Ineligible site is monitored and the other needs testing.
Campsites (Prehistoric)	59	Nine sites are eligible for NRHP; Five sites are ineligible for NRHP; More information is needed on the other 45 sites.	The NRHP eligible sites are avoided; Ineligible sites are being monitoring, and the sites with insufficient data need testing.
Cave/Sink	1	Insufficient information	Needs testing
Prehistoric Earthworks	2	One site is ineligible for NRHP. Insufficient information for the other site.	Ineligible site is monitored and the other needs testing.
Homestead	2	Eligible for NRHP	Avoided
Land (Terrestrial)	2	One site is ineligible for NRHP. Insufficient information for the other site.	Ineligible site is monitored and the other needs testing.
Lumber Mill	1	Insufficient information	Needs testing

Sites within the Town of Jupiter are regulated by the Town's Historic and Archaeological Preservation Ordinance. The Town of Jupiter issued two Certificates to Dig to Palm Beach County in 2007, which provided procedures for subsurface excavation work to be done in conjunction with the development of Riverbend Park. Archaeological monitoring of subsurface excavation work was done consistently with the conditions of the Certificate to Dig from 2007 through 2010. In 2010, three prehistoric sites were recorded as a result of archaeological monitoring during park development.

4.4.2. Historical and Cultural Goal and Objectives

The following objectives for the Historical and Cultural goal are prioritized in the Action Plan (4.4.3). An effort to implement one or more objectives may be part of a program already in-progress.

Goal: Protect and preserve *as possible* the historical and cultural sites and resources within *and around* the NW Fork of the Loxahatchee River.

Objectives:

A. Protect and preserve historic and cultural resources from anthropogenic and natural disturbances.

B. Cultivate opportunities for public understanding on the significance of historic and cultural resources.

4.4.3. Historical and Cultural Action Plan

Key to the Action Plan Table:

- Priority of the objective was determined by the LRMCC using the following criteria:
    1. Legally required, planned, or funded; action will be taken within the 10-year planning period.
    2. In planning, may or may not be funded; action may not happen within the 10-year planning period.
    3. Not planned or funded; action not expected to start within the 10-year planning period.
- Responsibility for each action was determined by the LRMCC and often shared among several agencies (listed by acronyms (see pg. vii)).
- Duration of the action is either a discrete action (“Once”) or continuous action (“Ongoing”).

NOTE: The ability to carry out these activities will be dependent on the priorities of the responsible agencies and the availability of funds.

Table 4.15. Historical and Cultural Action Plan.

Goal: Protect and preserve the historical and cultural sites within the NW Fork of the Loxahatchee River.		
Objective:	**Priority**	
A. Protect and preserve historic and cultural resources from anthropogenic and natural disturbances.	**1**	
Actions	**Responsibility**	**Duration**
i Identify any new sites that need protection and preservation.	PBC, FPAN	Ongoing
ii Routinely monitor and document the condition of historic and cultural sites where possible by qualified individual(s) from a public agency.	JDSP, PBC, FPAN	Ongoing
Objective	**Priority**	
B. Cultivate opportunities for public understanding on the significance of historic and cultural resources.	**2**	
Actions	**Responsibility**	**Duration**
i. Educate the public on the importance of the historic and cultural history of protected sites (both marked and unmarked).	JDSP, PBC	Ongoing
ii. Maintain Trapper Nelson's site to be used for the education on the importance of historic sites.	JDSP, PBC	Ongoing
iii. Promote opportunities to improve the documentation and inclusion of indigenous people and pioneer lifestyles into restoration management plans	JDSP, PBC	Ongoing

4.5. Recreation Resources

The serene natural landscapes of the Nationally Designated Wild and Scenic Loxahatchee River provide Florida residents and visitors with an escape from the urban sprawl with outdoor recreational experiences. A leisurely paddle (Figure 4.50) through the refreshing river waters and hiking under the green tree canopy offers explorers opportunities to observe native flora and fauna in the pristine landscape. A journey into the Loxahatchee River ecosystem allows visitors to experience the natural beauty of wild and scenic Florida.

Figure 4.50. A group of canoers (left) and a kayaker (right) paddle throughout the Loxahatchee River.

4.5.1. Assessment

Scope

The recreation assessment provides recreational resources and summarizes the changes in visitor use over the past two decades.

Background

Recreational resources within the Loxahatchee River area range from hiking, trail (mountain) biking, wildlife encounters, and boating within the river.

An important function of a river management plan includes recreational use monitoring and management to not only achieve the plan objectives but also to prevent or reduce damage to the river resources. Per the *Loxahatchee River Wild and Scenic Designation and Preservation Act* of 1983, Section 5 (3)(c): Management of recreational activities is guided by Palm Beach County Code, Chapter 21.

> *Periodic studies determine the quantity and mixture of recreation and other public uses which can be permitted without adverse impact on the resource values of the river area.*

The relative objective of the *Loxahatchee River National Wild and Scenic Management Plan* is to protect and enhance the natural and cultural values of the river. The protection and enhancement

of natural and cultural values in high public use areas, such as the National Wild and Scenic River, intuitively require management and monitoring of public uses.

Conditions from 2011 to 2020

Accessing the Northwest Fork

Public access to the wild and scenic portion of the NW Fork is available from either Riverbend Park or JDSP. Vessels (canoe, kayak, and stand-up paddleboard) can be brought in or rented at both locations. Boats (row or motorized) can be launched from a paved boat ramp at JDSP or rented from the concessionaire (note: motorized boat access is only available to the Trapper Nelson Interpretive Site due to natural physical barriers upstream). The Lainhart (RM 14.7) and Masten Dams (RM 13.5) provide river portage areas and are popular rest stops for paddlers and hikers along the river. The Tanah Keeta Boy Scout Camp (RM 5.9) located downstream of the NW Fork (RM 5.9) also provides dock and boat ramp access though is used exclusively by the Boy Scouts.

Pedestrian access is available along a portion of the Ocean-to-Lake Hiking Trail, part of the Florida Trail system. In addition to direct access, the Loxahatchee River serves as the central feature in more than 160,000 acres of connected public lands system known as the Jeaga Wildways system. Four main multi-use trails allow pedestrians, equestrians, and cyclists to access over 300 miles of trails within these connected lands.

Riverbend Park

Riverbend Park encompasses more than 700 acres of natural areas, including a half mile of the recreation segment of the NW Fork. Palm Beach County's Park Master Plan constructed major facilities at Riverbend Park for passive recreational use by the public. The park is accessible from the Indiantown Road Park entrance in Jupiter, FL. In addition to opportunities for hiking, biking, and horseback riding, Riverbend Park is the main launching point for paddling trips downriver. Palm Beach County hired concessionaires to offer canoe and kayak rentals intermittently over the last 10 years. Paddlers have the option of exploring Riverbend Park via the C-14 canal or can venture the river north to JDSP. Before 2016, a shuttle service between JDSP and Riverbend Park allowed for one-way trips on the river, though the service was discontinued as demand declined. Now, paddlers who kayak or canoe between parks must make transportation arrangements or make the round-trip journey.

Jonathan Dickinson State Park

Jonathan Dickinson State Park includes a mosaic of diverse ecological communities that span approximately 11,500 acres. JDSP is accessible from U.S. Highway 1 in Hobe Sound, Florida. Public access to the river at the downstream end of the NW Fork has two access points: RM 7.2 and RM 6.4. The JDSP concessionaire (RM 7.2) is a primary launch and take-out point for paddlers. Here, visitors can rent vessels or take a river cruise on one of the three 44-foot pontoon boats (Figure 4.51). The sightseeing pontoon trip takes visitors to the Trapper Nelson Interpretative Site four times daily and is operated by the JDSP-hired concessionaire. Trails, cabins, picnic facilities, and a designated swimming area are located within the park. Adjacent to the JDSP River Campground is another launch area located at RM 6.4.

Figure 4.51. Loxahatchee River Queen sightseeing river journey within JDSP.

The Trapper Nelson Interpretative Site (RM 10.2) within the JDSP is used frequently as a rest stop by paddlers and the destination for the *Loxahatchee Queen* cruises from JDSP. These areas are managed by the park and provide free informational tours of the historic area. Because the road to Trapper Nelson's is private, any overland access is prohibited, so the site does not contribute to the total paddler volume of river usage.

Recreational Vessel Use

One of the main recreational activities on the river is enjoying the natural meandering of the National Wild and Scenic River under a canopy of cypress trees and mangroves. Recreational visitors are classified as commercial or non-commercial based on whether they are using their own vessel, renting or on one of the sightseeing cruises (Table 4.16). Visitors who rent from the concessionaires at either Riverbend Park or JDSP comprise all commercial users. Non-commercial users include private individuals, or groups (e.g., scout troops, church groups, paddling clubs, etc.) who use their vessels. These two categories account for all identified and recorded paddler data on the river.

Table 4.16. Total number of vessels launched from Riverbend Park and JDSP between 2012 and 2020 (as available).

Year	Commercial	Non-Commercial	Shuttle Service
2012	8,844	4,230	433
2013	8,895	3,040	475
2014	10,809	5,020	272
2015	11,349	5,461	268
2016	9,885	5,094	89
2017 [1,2]	*No data*	7,653	*Discontinued*
2018 [3]	*No data*	2,964	*Discontinued*
2019 [4]	7,842	4,815	*Discontinued*
2020 [5]	12,286	3,975	*Discontinued*

1. 2017 data of commercial and non-commercial users were merged and only one number was recorded.
2. Canoe Outfitters closed in July 2017.
3. No commercial concessionaire in Riverbend Pk. during 2018.
4. Jupiter Outdoor Center concessionaire opened In January 2019.
5. January-September data only. Park closed the month of April per COVID.

The management plan has been reporting visitor usage intermittently since 1985 when the river became a National Wild and Scenic River. Survey data were collected at river entry points (Riverbend Park or JDSP) by hired concessionaires. The data collected provided the number of visitors using the river and the type (commercial or non-commercial) of vessel being used. Quantifying the recreational usage to track possible resultant anthropogenic factors affecting the protected areas of the river by users should be monitored regularly so as not to overuse the river resource.

Commercial Vessel Use

The Riverbend Park concession is situated upriver at RM 15.3 and serves paddlers with vessel and equipment rentals. River users can either paddle a short distance and return to Riverbend Park or run the entire length of the wild and scenic portion of the river to JDSP. Paddling the entire wild and scenic portion takes about four to six hours and ends at the JDSP concessionaire area (Figure 4.52) or at the JDSP boat ramp further downstream.

Figure 4.52. Boat concessionaire at JDSP.

Between 2012 and 2013, the Riverbend Park concession reported 17,739 rentals (commercial users) and 22,158 between 2014 and 2015 (Table 17). In the summer of 2016, the shuttle service from JDSP to Riverbend Park was discontinued. Services provided by the Riverbend Park concessionaire were discontinued in 2017. Palm Beach County had no concessionaire on site for vessel renting until 2019. Between 2019 and 2020, 20,128 rentals were logged (Table 4.17).

Table 4.17. Total number of vessels launched from Riverbend Park between 1999 and 2020 (as available).

Year Range	Commercial Usage	Non-Commercial Usage	Total
1999 to 2000 [1]	1,311	478	1,789
2012 to 2013	17,739	7,270	25,009
2014 to 2015	22,158	10,481	32,639
2019 to 2020 [2]	20,128	8790	28,918

[1]1999-2000 a sub-sample of only 56 days.
[2]2020 data is for only 9 months of the year.

Non-Commercial Vessel Use

Over the past 20 years, South Florida has experienced phenomenal growth in the paddle sports industry. In 1985, private (non-commercial) paddler usage was estimated at 364 canoe trips annually on the river (FDNR, 1985). An increase in local paddling clubs and outfitters in South Florida, along with the national designation of the NW Fork, recreational usage increased (Figure 4.53). Current non-commercial vessel use was estimated at 4,000 trips per year from Riverbend Park alone (Table 4.17), though private vessel trips at Riverbend Park or JDSP were not regularly monitored.

Figure 4.53. A special event at JDSP shows the variety of river recreation within the park.

Temporal Use Patterns

Recreational use of the river exhibits both seasonal and daily fluctuations. Recreational usage was influenced by weather and water conditions. During extreme drought, low water levels required more portaging over snags, logs, and sand bars impacting floodplain soils and vegetation along the river. Conversely, high water conditions promoted use by experienced paddlers in the faster-moving waters and possible challenges for the inexperienced all impacting the river. Variations in river usage were concurrent with the seasons (Figure 4.54). River use was higher in Riverbend Park compared to JDSP, though these results may be due to insufficient data (Figure 4.54). Peak visitor attendance was observed from January to June (Figure 4.54). Weather conditions, river stage, and rental availability may contribute to the recreational use of the river.

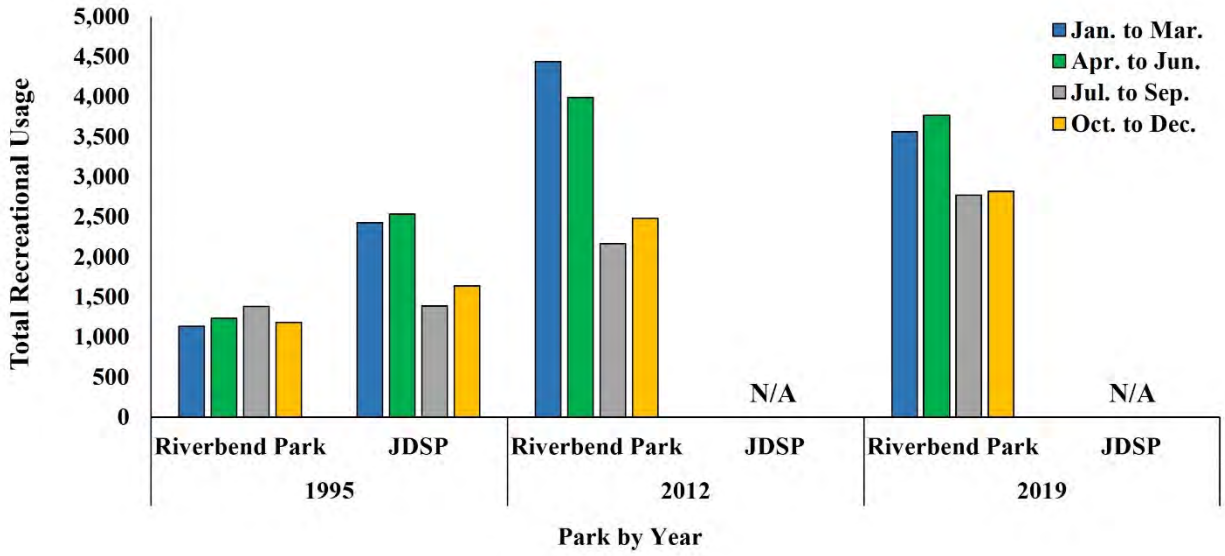

Figure 4.54. Seasonal recreational use (in annual quarters) for 1995, 2012, and 2019. Seasonal data were not available (N/A) for JDSP in 2012 and 2019.

Temporal fluctuations were also observed between weekend and weekday paddling. Increased river traffic occurred on the weekends, particularly during the holidays. Public holidays generating three-day weekends have substantially increased usage over normal weekend usage. The highest levels of holiday use occur over Labor Day, Independence Day, and Memorial Day weekends, and this trend continued through 2020.

Future River Use Patterns

Visitor capacity (previously "carrying capacity") guidelines for river management require surveys to determine the quantity and mixture of recreation and other public uses that can be permitted without adverse impacts on the resource values of the river area (Florida Statue, 83-358). Quantifying the possible impacts of human usage of a river is critical to the management of the river and should be science-based. Visitor capacity is the amount or type of use that an area can accommodate while maintaining and protecting natural resources. It is vital to the sustainability of the NW Fork to understand the magnitude of visitors and their impact on the river. Understanding the volume and type of recreational use helps the Loxahatchee River stakeholders (LRMCC, LRPI, FL DEP Parks, PBC ERM, etc.) make informed management decisions regarding visitor use. Establishing visitor capacity thresholds can be used as a key decision-making tool to ensure the continued protection of sensitive river resources. Monitoring visitor capacity to determine the relationship between river use and its effect on natural resources has been an objective of the management plan since 1985.

4.5.2. Recreation Resource Goal and Objectives

The following objectives for the Recreation Resources goal are prioritized in the Action Plan (4.5.3). An effort to implement one or more objectives may be part of a program already in progress.

Goal: To protect and preserve the natural river and recreational resources within the NW Fork of the Loxahatchee River.

Objectives:

A. Identify and implement management actions to reduce those activities that are harmful and promote uses that minimize recreation-driven impacts.

B. Ensure that monthly data is being collected on kayak, canoe and boat usage within Jonathan Dickinson State Park, Boy Scout Camp, and Riverbend Park.

C. Improve passive outdoor recreation opportunities and connectivity among public-owned properties.

4.5.3. Recreation Resource Action Plan

Key to the Action Plan Table:

- Priority of the objective was determined by the LRMCC using the following criteria:
    1. Legally required, planned, or funded; action will be taken within the 10 year planning period.
    2. In planning, may or may not be funded; action may not happen within the 10 year planning period.
    3. Not planned or funded; action not expected to start within the 10 year planning period.
- Responsibility of each action was determined by the LRMCC and often shared among several agencies (listed by acronyms (see pg. vii)).
- Duration of the action is either a discrete action (“Once”) or continuous action (“Ongoing”).

NOTE: The ability to carry out these activities will be dependent on the priorities of the responsible agencies and the availability of funds.

Table 4.18. Recreation Action Plan.

Goal: Protect and preserve the natural river and recreational resources within the NW Fork of the Loxahatchee River.		
Objective	**Priority**	
A. Identify and implement management actions to reduce those activities that are harmful and promote uses that minimize recreation-driven impacts.	**1**	
Actions	**Responsibility**	**Duration**
i. Increase motivation to work towards practical solutions for known environmental problems impacting the watershed (willingness-to-pay surveys of the public).	LRECD, SFWMD, JDSP, FDEP, MC	Ongoing
ii. Increase opportunities for the public to explore the beauty, complexity, and diversity of the Loxahatchee River watershed.	PBC, MC, JDSP, LRECD	Ongoing
iii. Schedule yearly inspections of the river to note areas of concern that need attention, especially after storms and low water events.	SFWMD, JDSP	Ongoing
Objective	**Priority**	
B. Ensure that monthly data is being collected on kayak, canoe and boat usage within Jonathan Dickinson State Park, Boy Scout Camp, and Riverbend Park.	**1**	
Actions	**Responsibility**	**Duration**
i. Development of visitor use surveys, collected within JDSP, is needed to recognize usage trends.	JDSP	Ongoing
ii. Development of visitor use surveys, collected within Riverbend Park, is needed to recognize usage trends.	PBC	Ongoing
iii. Communicate with the Boy Scout Camp to gather river usage data on a regular basis.	Gulf Stream Council (Boy Scouts)	Ongoing
Objective	**Priority**	
C. Improve passive outdoor recreation opportunities and connectivity among public-owned properties.	**2**	
Actions	**Responsibility**	**Duration**
i. Construct pedestrian, bicycle, and horse path under the Florida Turnpike bridge at the C-18 right-of-way.	FDOT	Ongoing
ii. Explore new connectivity opportunities to support human and wildlife movement within the watershed.	FDOT, MC, PBC, SFWMD, JDSP	Ongoing
iii. Celebrate Loxahatchee River Day by engaging the public.	JDSP, LRECD, PBC, SFWMD	Every 2 years

Chapter 5: Public Outreach and Education

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The successful management, preservation, and restoration of the National Wild and Scenic Loxahatchee River depended upon the active public outreach and environmental education programs that were the critical gateways of information linking science and the public. Public outreach, education, and community engagement fostered awareness and support of the important issues related to this treasured ecosystem. Such programs worked to explain the legal and policy frameworks that protected the river and facilitated the public to experience the river's natural habitats, flora, and fauna. Increased knowledge and awareness promoted continued stewardship to protect this nationally designated river.

5.1. Assessment

Scope

The scope of the public education and outreach assessment provided an overview of the ongoing activities and possible future opportunities to engage the public, the local community, and tourists, in the historical significance, status, and potential threats the river faces.

Existing Outreach Efforts

Information on the status or upcoming events within the Loxahatchee River and its watershed is provided through materials published on the websites and social media platforms of the public, local, and state government agencies, and outdoor recreation organizations. Occasional media stories delivered news on specific events or issues that affected the river corridor and tourism opportunities on the river.

Outreach and education venues were available throughout Martin and Palm Beach Counties (Table 5.1) and offered a variety of opportunities to engage in educational programs.

Table 5.1. Outreach and education venues with hyperlinks to their websites and their addresses.

Outreach and Education Venues (websites)	Address for Public
The River Center (LRECD)	805 N US Highway 1, Jupiter, FL 33477
Jonathan Dickinson State Park (JDSP)	16450 SE Federal Hwy, Hobe Sound, FL 33455
Elsa Kimbell Education and Research Center	within JDSP
Trapper Nelson's Interpretive Site	within JDSP (accessible by water only)
Tanah Keeta Boy Scout Camp	8501 SE Boy Scout Rd, Jupiter 33469
Loxahatchee River-Lake Worth Creek Aquatic Preserve	3300 Lewis Street, Ft Pierce, FL 34981
Riverbend Park	9060 Indiantown Road Jupiter, FL 33478
Loxahatchee River Battlefield Park	9060 Indiantown Road Jupiter, FL 33478
Busch Wildlife Sanctuary	17855 Rocky Pines Rd., Jupiter, FL 33478
Palm Beach County Natural Areas	Several areas; see the website.
Grassy Waters Preserve	8264 Northlake Blvd West Palm Beach, FL 33412

The River Center

Opened in 2008, the River Center (Figure 5.1) is a program of the Loxahatchee River Environmental Control District (LRECD) located in Jupiter, FL with a mission to foster a sense of environmental stewardship for the diverse Loxahatchee River watershed with quality education programs, exhibits, and meaningful events. The River Center features live aquatic tanks, interactive exhibits, and a touch tank that represents the Loxahatchee River system from a freshwater cypress swamp to seagrass-dominated estuary to marine ecosystems. The center provides educational opportunities for school children, adults, visitors, and long-time residents to learn about Florida's first National Wild and Scenic River.

Figure 5.1. The Loxahatchee River Center.

The LRECD's environmental education policy conducts environmental education for the public within the Loxahatchee River watershed. The primary purpose of these environmental education efforts is to foster a sense of stewardship for the river's diverse watershed through quality education programs, exhibits, and related events. The primary focus of these education efforts is to explore the natural aspects of the watershed, provide context about environmental impacts on the watershed, and identify solutions to achieve a healthy community and river. Environmental education programs provide the public with: (1) increased knowledge concerning our local environment and environmental problems; (2) increased awareness of potential solutions to such

problems; and (3) increased motivation to work towards practical solutions for such problems. Successful programs will result in participants exploring, experiencing, and connecting with the Loxahatchee River ecosystem and becoming advocates for the river.

Jonathan Dickinson State Park (JDSP): Elsa Kimbell **Environmental Education and Research Center**

Located within JDSP and opened in 2007, the Kimbell Education Center (Figure 5.2) offers exhibits that focus on the rich natural and cultural resources of the 10,500 acre park. A variety of public and private educational programs are offered here including guided hikes, species-specific programs, and history and research-emersion programs.

Figure 5.2. Elsa Kimbell Environmental Education and Research Center within JDSP.

Jonathan Dickinson State Park: Trapper Nelson Interpretive Site

Jonathan Dickinson State Park offers an opportunity to experience the unique historical site once belonging to the "Wildman of the Loxahatchee", Trapper Nelson (Figure 5.3) along the National Wild and Scenic River corridor. Trapper Nelson Interpretive Site (RM 10.5) can be accessed only by water aboard one of the Loxahatchee Queen riverboats or by boat to the site. The Loxahatchee Queen riverboat tour transports patrons from JDSP and informs them about the river as they travel up to Trapper Nelson's. Once docked, passengers are met by a JDSP Ranger or volunteer who guides them on an interpretive tour through the grounds. Visitors can also enjoy a self-guided tour of the hand-built cabins known as "chickee" shelters and native tropical vegetation and learn about the legendary Trapper Nelson who made this jungle-like area his home in the 1940s.

Figure 5.3. A JDSP Ranger leading a tour at the Trapper Nelson site.

Tanah Keeta Boy Scout Camp

The Tanah Keeta Scout Reservation (Figure 5.4), translated in the Hichiti dialect as "The Gathering Place", is a 640-acre property on the southern edge of JDSP owned by the Gulf Stream Council. The heavily forested property was transferred by an act of the Florida legislature from then Jupiter State Park in 1953 and opened in 1957. The Scout property contains Camp Loxahatchee along the river (River Mile (RM) 5.9) to the western side and Camp Clear Lake to the eastern side. Scouts and campers use the river for pleasure paddling, and canoe/kayak training for badge requirements.

Figure 5. 4. The Tanah Keeta Boy Scout Reservation.

The Tanah Keeta Hymn: by M. E. Gruber

On the river Loxahatchee; lies a haven rare. It's a place where our Council comes together, Fellowship to share.

Tanah Keeta, Tanah Keeta, On your trails we have found, Beauty all should see, you must surely be God's own camping ground.

In the Glades, on the trail, and through the thicket, Woodland life does roam. Scent of wood smoke, the sound of boyhood laughter, This is Scouting's home.

We, the Scouts, the Explorers, and the leaders, Sing our praise to thee, For the fun, and friends and the adventure, We derive from thee.

Sun so bright, and at night the star filled heavens, Grace the skies above. Shelt'ring pines, gently whisp'ring in the breezes, Bless this land we love.

Riverbend Park and Loxahatchee River Battlefield Park

The river passes through both Riverbend and Loxahatchee River Battlefield Parks (Figure 5.5). The two parks are owned and managed by Palm Beach County Parks and Recreation Department. Since acquiring the land, the main goal is to promote stewardship, preserve the natural, archaeological, and cultural significance of these properties, and to provide access and education to the public. Guided kayak tours of the Wild and Scenic Loxahatchee River are available at a cost to learn the history of the river and experience the rich diversity of wildlife and tropical and temperate plants.

Battlefield Park holds a *Living History Day* that focuses on educating the public on the two 1838 Second Seminole War Battles and the life and times of early pioneers and homesteaders. The purpose of this event is for visitors to get a feel of the history and experience of Old Florida.

Figure 5.5. (A) Riverbend and Battlefield Parks on the Loxahatchee River. (B) The 2022 Convocation of Seminole War Historians was hosted by the Loxahatchee Battlefield Preservationists in Loxahatchee River Battlefield Park. (C) Walking trail at Riverbend Park. (Currently managed by Palm Beach County Parks and Recreation; Photos provided by PBC).

Loxahatchee River – Lake Worth Creek Aquatic Preserve

Florida aquatic preserves are managed on behalf of the state by the Florida DEP Coastal Office. The Loxahatchee River-Lake Worth Creek Aquatic Preserve (Figure 5.6), which includes the NW Fork, was designated in November 1970 to address public concern regarding river degradation due to dredge and fill activity in the 1960s. The aquatic preserve is managed locally by the Indian River Lagoon Aquatic Preserve office in Ft. Pierce, FL. Collaboration with the LRECD and JDSP supports education and outreach activities like field studies for students and teachers and training workshops for local citizens and decision-makers (DEP, 2018). Increasing public awareness of the aquatic preserve conveys information, fosters community relationships, and promotes river stewardship.

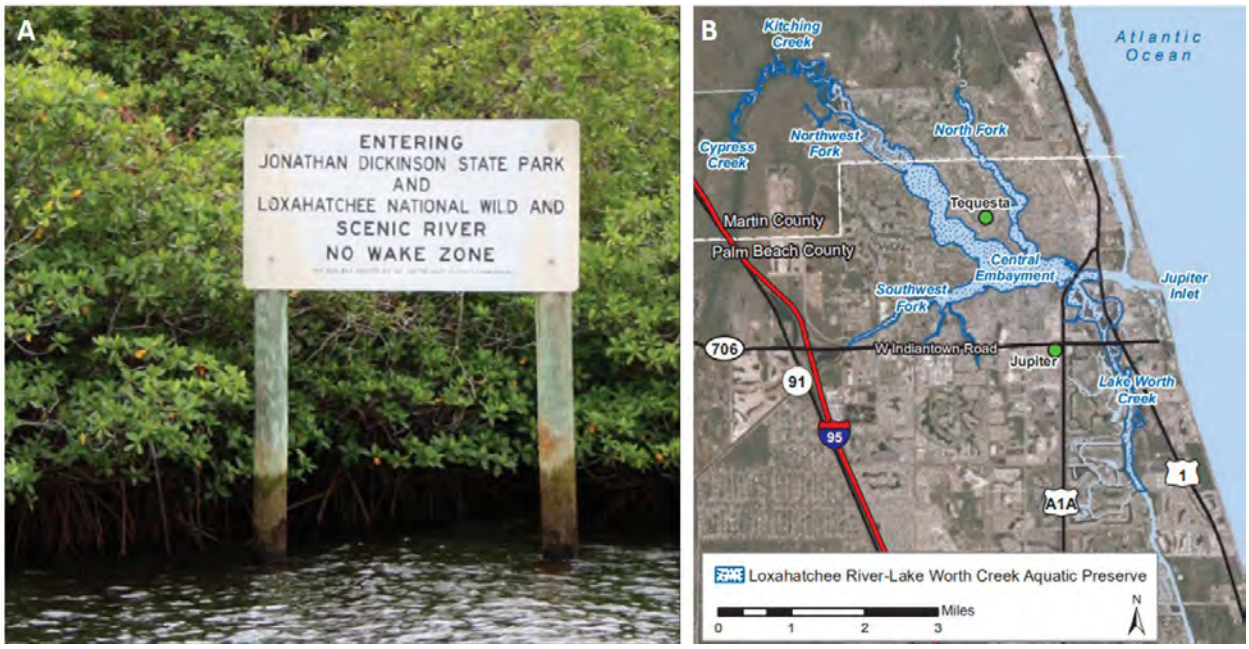

Figure 5.6. (A) Entrance to the National Wild and Scenic portion of the Aquatic Preserve and (B) a map of the designated Loxahatchee River-Lake Worth Aquatic Preserve.

Busch Wildlife Sanctuary

The Busch Wildlife Sanctuary is a non-profit organization within Palm Beach County dedicated to the protection and conservation of wildlife species. For 30 years the sanctuary has provided wildlife rescue, rehabilitation, and the reintroduction of endangered and keystone species back into the environment. Education programs on environmental conservation and protection are included in the sanctuary's mission.

Palm Beach County Natural Areas

Palm Beach County (PBC) manages over 25,000 acres of natural areas within or directly connected to the Loxahatchee River. These natural areas are managed to preserve their native habitats and the wildlife that uses them. For example, PBC Environmental Resources Management (ERM) maintains the Jeaga Wildways, which connects 160,000 acres of public land surrounding the river. The exploration of these lands and others during various public events, PBC ERM engages the public connecting them to the river's watershed.

Grassy Waters Preserve

The Grassy Waters Preserve is a pristine 23 sq. mi. wetland in the northernmost headwaters of the NW Fork. Grassy Water Preserve is owned and operated by the City of West Palm Beach and serves as the freshwater supply for the City of West Palm Beach and the towns of South Palm Beach and Palm Beach Island. The preserve's educational and outreach program is supported by the nonprofit Grassy Waters Conservancy. The preserve's Nature Center provides environmental education on water-related issues and wetland environments teaching over 5000 school children a year through video, virtual programs, and on-site activities. The public has access to various hiking trails and numerous outdoor opportunities including canoeing, kayaking, and "swamp tromp".

Outreach Opportunities

Opportunities for increased education and outreach efforts include but are not limited to:

- Initiate or increase public education about the National Wild and Scenic River through The River Center, JDSP-Kimbell Center, River Bend Park, Tanah Keeta Boy Scout Camp, Camp Welaka Girl Scouts, and Palm Beach County Environmental Resources Management.
- Develop and produce outreach materials through a cooperative effort.
- Create and install signage at access points and dam portage areas that inform about the National Wild and Scenic and its significance.
- Develop interpretive displays at area parks and lands open to the public that explain the importance of protecting and managing the National Wild and Scenic River and the benefits.
- Apply for educational funding grants to engage and connect the community and visitors to the resource. Provide extraordinary and stunning video programs that further connections with storytelling (e.g., Hidden Wild).
- Apply for educational funding grants to assist with the expense of producing signage and educational material.
- Collaborate with teachers, parents, private and public organizations through outreach materials that provide educational information as well as volunteer, citizen science and field exploration activities. Prioritize free or low-cost field engagement opportunities for outdoor education experiences and remove barriers so all youth can participate.
- Expand on the use of social media to promote awareness of the National Wild and Scenic River.

5.2. Public Outreach and Education Goal and Objectives

The following objectives for the Public Outreach and Education goal are prioritized in the Action Plan (5.3). An effort to implement one or more objectives may be part of a program already in progress.

Goal: Increase environmental education and stewardship opportunities within the Wild and Scenic NW Fork of the Loxahatchee River.

Objectives:

A. Increase opportunities for the public to explore the beauty, complexity, and diversity of the Loxahatchee River.

B. Increase opportunities for independent (self-guided) learning (e.g., signage on trails, audio tour, web app).

C. Increase public awareness of the environmental issues impacting the watershed.

D. Encourage public participation/volunteering in environmental assessment and improvement efforts.

5.3. Public Outreach and Education Action Plan

Key to the Action Plan Table (Table 5.2):

- Priority of the objective was determined by the LRMCC using the following criteria:
    1. Legally required, planned, or funded; action will be taken within the 10-year planning period.
    2. In planning, may or may not be funded; action may not happen within the 10-year planning period.
    3. Not planned or funded; action not expected to start within the 10-year planning period.
- Responsibility for each action was determined by the LRMCC and often shared among several agencies (listed by acronyms (see pg. vii)).
- Duration of the action is either a discrete action (“Once”) or continuous action (“Ongoing”).

NOTE: The ability to carry out these activities will be dependent on the priorities of the responsible agencies and the availability of funds.

Table 5.2. Public Outreach and Education Action Plan.

Goal: Increase environmental education and stewardship opportunities within the Wild and Scenic NWF of the Loxahatchee River.		
Objective	**Priority**	
A. Increase opportunities for the public to explore the beauty, complexity, and diversity of the Loxahatchee River.	**3**	
Actions	**Responsibility**	**Duration**
i. Engage relevant groups to participate in events focused on the Wild and Scenic River.	SFWMD, LRECD, PBC, MC, JDSP, FWC, FDOT, FL DEP	Ongoing
ii. Provide naturalist guided tours (e.g., hiking, biking, paddling, and equestrian where appropriate).	LRECD, PBC, JDSP	Ongoing
iii. Conduct aligned environmental outreach and literacy campaigns, including targeted social media posts.	SFWMD, LRECD, PBC, MC, JDSP, FWC, FL DEP	Ongoing
Objective	**Priority**	
B. Increase opportunities for independent (self-guided) learning (e.g., signage on trails, audio tour, web app).	**3**	
Actions	**Responsibility**	**Duration**
i. Provide informative signs at boat launches and historic sites, being sensitive that inappropriately placed signage would degrade the Wild and Scenic experience.	JDSP, SFWMD, PBC	Ongoing
ii. Provide maps (e.g., kiosks, websites) indicating points of interest and safety within the NW Fork for river users.	LRECD, JDSP, PBC, MC, SFWMD	Ongoing
Objective	**Priority**	
C. Increase public awareness of the environmental issues impacting the watershed.	**2**	
Actions	**Responsibility**	**Duration**
i. Increase awareness of the environmental threats affecting the NWF and how public engagement can alleviate the impacts.	LRECD, JDSP, PBC, MC, SFWMD, FWC, FL DEP	Ongoing
ii. Utilize resources (e.g., education centers, news and social media) to increase awareness of environmental issues and to promote protections in place for the NWF.	LRECD, JDSP, PBC, MC, SFWMD, FL DEP, FWC	Ongoing
iii. Provide targeted environmental education programs and exhibits based on known impacts	LRECD, JDSP, PBC, MC,	Ongoing

(e.g., saltwater intrusion, invasive species) to the NWF.	SFWMD, FL DEP, FWC	
iv. Promote "Leave No Trace" values for recreational users within the Wild and Scenic River.	LRECD, JDSP, PBC, MC, SFWMD, FL DEP, FWC	Ongoing
v. Periodically convene Loxahatchee River Science Symposium with public, local, and governmental agencies participation.	LRECD, JDSP, PBC, MC, FWC, SFWMD, FDOT, FL DEP	Every 3 to 5 years
Objective	**Priority**	
D. Encourage public participation/volunteering in environmental assessment and improvement efforts.	**2**	
Actions	**Responsibility**	**Duration**
i. Organize and host clean-up events within the Loxahatchee watershed.	LRECD, PBC, JDSP	Ongoing
ii. Develop citizen scientist monitoring programs (e.g., seagrass mapping, cypress, mangrove planting, etc.) and effectively disseminate findings.	LRECD, MC, JDSP	Ongoing

Chapter 6: Loxahatchee River Watershed Restoration and River Water Quality Projects

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[1]SFWMD; [2]LRECD; [3]Sustainable Ecosystems International; [4]FDACS; [5]JDSP; [6]Martin County

The natural and hydrological resources of the Loxahatchee River watershed and the Northwest (NW) Fork have been altered over time due to land use changes, urbanization, agricultural practices, water control structures, and water management practices. The anthropogenic impacts have changed the natural watershed and altered the flows into the NW Fork. Degraded water quality issues resulted from impacts to the hydrology and unmanaged stormwater and septic issues added to the imperiled state of the river. The National Wild and Scenic River designation provided protections to the NW Fork and enabled the identification of areas in need of improvement within the watershed to support the NW Fork. The necessary improvements and additional protections of the natural and hydrologic resources were addressed and implemented through multi-agency partnership efforts outlined in the previous management plans.

6.1. Loxahatchee River Watershed Project Progress

Projects within the watershed addressed the hydrology, habitat, and water quality issues that compromised the health of the system. The watershed projects focused on the reduction of future anthropogenic impacts and provided efforts to restore the system to more natural conditions. Numerous projects were cost-shared by the Loxahatchee River Preservation Initiative with acquired state appropriation funding for watershed restoration projects. Through the continued partnerships between local governmental agencies over the years, the watershed projects began in 1991 in support of the management plan objectives though were not included in the management plan tasks. Sixty-four (Table 6.1) were ongoing, completed, or planned in the Loxahatchee watershed between 2011 and 2020. Thirty additional projects were completed before 2011 (Supplement 7). All planned, ongoing, and completed Loxahatchee watershed projects (Table 6.1) between 2011 to 2020 were tracked and updated annually by the Loxahatchee River Environmental Control District (LRECD) and provided to the LRMCC for review.

Several projects focused on monitoring and the improvement of water quality throughout the watershed. The LRECD provided monthly water quality (WQ) monitoring and assessments of fixed sites and automated deployed data sondes throughout the river. The LRCED continued to monitor the health of the oyster reefs (2006) and seagrasses (2008) throughout the estuary and in 2008 and 2010 deployed roughly 6,000 acres of oyster shell to enhance the health of the river and estuary. Direct water quality improvement projects included the Jupiter Inlet District and LRECD septic to sewer conversions to reduce leaching pollutants to the river system. The Town of Jupiter completed approximately twenty stormwater improvement projects between 2011 to 2020. In

2013, the Town of Jupiter implemented a fertilizer ordinance that outlined the appropriate timing, rate, and management of vegetative matter and completed the Jones and Sims Creek Water Quality Master Plans to address probable pollutants. The Florida Department of Agriculture and Consumer Services (FDACS) initiated best management practices (BMP) projects that included ongoing cost-share assistance for more effective irrigation systems in the Loxahatchee Basin.

Both Martin and Palm Beach counties completed (6) or planned (2) hydrologic restoration and improvement projects within Cypress Creek. Martin County completed one and planned two additional stormwater projects along with a hydrologic restoration project for Kitching Creek (Table 6.1). Palm Beach County completed hydrologic restoration for Sandhill Crane West and North Jupiter Flatwoods Phases I to III which included a public use component and a hydrological geotechnical engineering and seepage analysis for the Loxahatchee River watershed (Table 6.1). Jonathan Dickison State Park (JDSP) established five projects that provided hydrologic improvements (Table 6.1). The Town of Jupiter conducted outfall replacement and canal stabilization to prevent erosion in Indian Creek. Jupiter Inlet District re-established the historic flow path along Moonshine Creek Oxbow to improve water quality and salinity distribution along the NW Fork.

Other watershed projects included public outreach and education and the management of public lands to control the spread of non-native vegetation. JDSP treated over 6,000 acres to remove non-native vegetation on an annual basis. Jonathan Dickinson State Park also provided public outreach and education through activities, information pamphlets, and its website. The Town of Jupiter continued to promote public education through its annual events: stormwater festival, soil and sediment control training, distribution of hurricane preparedness (stormwater management and drainage maintenance), and National Pollutant Discharge Elimination System (NPDES) education.

Table 6.1. Loxahatchee Watershed Project progress* (page 1 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
1. Florida Department of Agriculture and Consumer Services (FDACS)	Agricultural Best Management Practices (BMPs) - As of March 31, 2017, there are 16 notices of intent that cover 5,495 acres in the Loxahatchee Basin. FDACS provided cost share assistance of $224,827 to convert a seepage irrigation system to a more efficient irrigation system for approximately 2,448 acres of sugarcane production.	Agricultural BMPs		Ongoing
2. Florida Department of Agriculture and Consumer Services (FDACS)	As of Dec 31, 2020, there are 19 notices of intents that cover 9,157 acres in the Loxahatchee Basin. FDACS provided cost share assistance of $279,569 for five BMP projects in water resource protection and irrigation and nutrient management treating 8,492 acres.	Agricultural BMPs	2010	Completed - 2020
3. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - Wild & Scenic River Corridor Habitat Restoration - Exotic vegetation control and hydrologic restoration.	Hydrologic Restoration	2004	Ongoing
4. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - Wild & Scenic River Corridor Exotic Plant Control - Exotic vegetation control.	Exotics Removal	2005	Ongoing
5. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - Non-native Plant Removal - Exotic vegetation control.	Exotics Removal	2014	Ongoing

*Projects completed prior to 2010 are provided in Supplemental 7.

Table 6.1. Loxahatchee Watershed Project progress* (page 2 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
6. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - Ditch Filling - A survey was done in the park of historical, small-scale ditches that no longer served any purpose. External funds were procured for hydrological restoration in wetlands.	Wet Detention Pond	2016	Completed - 2016
7. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - North Fork Loxahatchee - Ditch work to restore and enhance 16 acres of wet prairies and depression marshes via Ditch B22; restore 4 acres of depression marsh and enhance upland sandhill lake via Ditch A7.	Wetland Restoration	2019	Completed - 2019
8. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - Wilson Creek - Ditch work to restore approximately 90 acres of pristine depression marshes.	Wetland Restoration	2019	Completed - 2019
9. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - Education Activities - Information pamphlets and website.	Education Efforts		Ongoing
10. Florida Department of Environmental Protection (DEP) - Florida Park Service (FPS)	Jonathan Dickinson State Park - Kitching Creek Bridge Removal - Remove an aging wooden vehicle bridge and replace it with a low water crossing for land management purposes. Will restore 0.44 acres of the floodplain by removing fill and restoring the original grade.	Floodplain Restoration		Planned
11. Jupiter Inlet Colony	Neighborhood Septic Tank Conversion - Septic to sewer conversion.	Septic To Sewer Conversion	2017	completed

*Projects completed prior to 2010 are provided in Supplemental 7.

Table 6.1. Loxahatchee Watershed Project progress* (page 3 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
12. Jupiter Inlet District	Moonshine Creek Oxbow Restoration - Re-establish the historic flow path along the subject oxbow. Successful implementation will result in improved surface water quality and may improve the salinity distribution along the NW Fork.	Hydrologic Restoration	2016	Completed
13. Loxahatchee River Environmental Control District	Loxahatchee River Water Quality Trends and Standards - Water quality monitoring.	Monitoring / Data Collection	1991	Ongoing
14. Loxahatchee River Environmental Control District	Loxahatchee River Neighborhood Sewering. Since 1975, 5221 septic systems were converted to sewer. 1,577 properties converted from 2010 to 2020.	Septic to Sewer Conversion	2000	Completed – 2021
15. Loxahatchee River Environmental Control District	Datasonde Monitoring in the Loxahatchee River - Automated water quality monitoring equipment to record water temperature, salinity, and water depth.	Monitoring / Data Collection	2004	Ongoing
16. Loxahatchee River Environmental Control District	Loxahatchee River Oyster / Benthic Indicator Monitoring – Assessment of oyster health and spawning/recruitment activity	Monitoring / Data Collection	2006	Ongoing
17. Loxahatchee River Environmental Control District	Loxahatchee River Seagrass and Monitoring - Seagrass monitoring in the Loxahatchee River estuary	Monitoring / Data Collection	2008	Ongoing
18. Loxahatchee River Environmental Control District	Loxahatchee River Oyster Reef Enhancement - in partnership with NOAA and MC installed 5.8 acres of substrate to promote oyster reef development	Creating / Enhancing Oyster Reefs	2010	2010
19. Loxahatchee River Environmental Control District	Environmental Education Programs at the River Center and throughout the watershed (River Center Programs).	Environmental Education and Outreach	2011	Ongoing

*Projects completed prior to 2010 are provided in Supplemental 7.
[§]Project summary provided below.

Table 6.1. Loxahatchee Watershed Project progress* (page 4 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
20. Loxahatchee River Environmental Control District	Evaluating potential impacts of landscape irrigation with reclaimed water (Arrington et al., 2023).	Water Quality Monitoring and Analysis	2011	Completed – 2022
21. Martin County	Cypress Creek Restoration - Culpepper Ranch Wetland Restoration - Ditch plugs and fill berm breaches.	Hydrologic Restoration	2010	Completed - 2011
22. Martin County	Cypress Creek Restoration - Pjilo Farm - Construct control structure and plug upstream ditch to hold water in cypress wetlands.	Hydrologic Restoration	2012	Completed - 2012
23. Martin County	Turtle Creek Weirs - Weir construction.	Control Structure	TBD	Planned
24. Martin County	Kitching Creek - Flora Ave Phase II - Modify and expand stormwater treatment area.	Stormwater Treatment Area	TBD	Planned
25. Martin County⸸	Cypress Creek Restoration - Ranch Colony Culpepper Berm Phase I - Berm construction and culvert replacement.	Hydrologic Restoration	2013	Completed - 2014
26. Martin County⸸	Kitching Creek - Central Flow-way - Construction of 18-acre stormwater treatment area and installation of control structures.	Stormwater Treatment Area	2014	Completed - 2015
27. Martin County⸸	Cypress Creek Weir Project - Weir replacement.	Control Structure	2017	Completed - 2019
28. Martin County⸸	Cypress Creek Floodplain Restoration - Install structure in Cypress Creek to rehydrate adjacent floodplain areas	Hydrologic Restoration	2019	Planned - 2024
29. Martin County⸸	Kitching Creek Eastern Flow-way - Route water east of Powerline Road and South of Bridge Road through private property easements to JDSP where it will be used to rehydrate wetlands and the Eastern Flow-way of Kitching Creek	Hydrologic Restoration	Planned - 2021	Planned - 2026

*Projects completed prior to 2010 are provided in Supplemental 7.
⸸Project summary provided below.

Table 6.1. Loxahatchee Watershed Project progress* (page 5 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
30. Martin County	Cypress Creek Restoration - Ranch Colony Culpepper Berm Phase II - Construct berm on three easements. Install operable screw gates on the control structure for Twin 84.	Hydrologic Restoration	TBD	Planned
31. Palm Beach County	Cypress Creek Phases I-II; Cypress Creek Habitat Restoration - Exotic vegetation control, habitat restoration, and hydrologic restoration.	Hydrologic Restoration	2005	Completed - 2015
32. Palm Beach County	Cypress Creek East - Jupiter Ranch Restoration - Exotic vegetation control and hydrologic restoration.	Hydrologic Restoration	2009	Completed - 2010
33. Palm Beach County	North Jupiter Flatwoods Phases I-III - Public use, exotic vegetation control, and groundwater seepage model for hydrologic restoration.	Hydrologic Restoration	2010	Completed - 2015
34. Palm Beach County	Cypress Creek Hatcher - Hydrologic creation and restoration.	Hydrologic Restoration	2014	Completed - 2015
35. Palm Beach County	Sandhill Crane West - Exotic vegetation control and hydrologic restoration.	Hydrologic Restoration	2014	Completed - 2015
36. Palm Beach County	Loxahatchee River Watershed Hydrological Refinements Phase I - Geotechnical engineering and seepage analysis.	Hydrological Restoration	2020	Planned - 2022
37. Town of Jupiter	Public Education - Items include the annual Jupiter Jubilee (stormwater festival), annual soil and sediment control training, annual distribution of hurricane preparedness information including information on stormwater management and drainage maintenance.	Education Efforts	2008	Ongoing

*Projects completed prior to 2010 are provided in Supplemental 7.

Table 6.1. Loxahatchee Watershed Project progress* (page 6 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
38. Town of Jupiter	Stormwater Quality Improvement Grants (HOA Residential Grants) - Town cost-share program (50/50) with property owner and homeowner associations for storm water quality enhancements within their private systems. 28 grants awarded since 2008. Annual appropriation.	Stormwater System Upgrade	2008	Underway
39. Town of Jupiter	Street Sweeping - Periodic street sweeping to enhance water quality.	Street Sweeping	2008	Underway
40. Town of Jupiter	Land Acquisition - As of June 2017, have acquired 33.23 waterfront acres to be used for dispersed water management. Properties include Fullerton Island, Jones Creek Preserve, Delaware Scrub, Sims Creek Preserve, and Todd Street Preserve.	Land Acquisition	2008	2017
41. Town of Jupiter	Cinquez Park Drainage Improvements I - Construction of drainage system, swales, and roadways (existing roads were shell rock).	Dry Detention	2009	Completed - 2011
42. Town of Jupiter	Jupiter Inlet Village Stormwater Improvements - Construction of exfiltration trenches and stormwater conveyance structures to provide water quality treatment for potential future redevelopment of Inlet Village. A total of 57 acres treated.	Stormwater System Upgrade	2010	Completed - 2019
43. Town of Jupiter	Urban Stormwater Management System Rehabilitation - Phase V - Rehabilitation of swale systems within North Palm Beach Heights.	Stormwater System Upgrade	2010	Completed - 2010
44. Town of Jupiter	Indian Creek Outfall Replacement and Canal Stabilization - Canal stabilization to reduce/prevent erosion of the canal banks.	Canal Stabilization	2012	Completed - 2013

*Projects completed prior to 2010 are provided in Supplemental 7.

Table 6.1. Loxahatchee Watershed Project progress* (page 7 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
45. Town of Jupiter	Maintenance Dredging - Dredging in Rio Vista Waterway.	Muck Removal /Restoration Dredging	2012	Completed
46. Town of Jupiter	Stormwater System Rehabilitation - Removal and replacement of existing Town-owned stormwater systems to ensure continued functionality. Annual appropriation.	Stormwater System Upgrade	2012	Underway
47. Town of Jupiter	Fertilizer Ordinance - Fertilizer ordinance adopted June 18, 2013. Among other items, the ordinance outlines the appropriate timing for fertilizer application, application rate, and appropriate management of grass clippings and vegetative matter.	Regulations, Ordinances, and Guidelines	2013	Completed - 2013
48. Town of Jupiter	Stormwater System Redevelopment Grants - Renewal or improvement of existing privately owned stormwater systems under site redevelopment to ensure continued or enhanced functionality. Annual appropriation.	Stormwater System Upgrade	2013	Underway
49. Town of Jupiter	Urban Stormwater Management System Rehabilitation - Phase VI - Rehabilitation of swale systems within Maplewood Drive and Toney Penna.	Stormwater System Upgrade	2014	Completed - 2014
50. Town of Jupiter	NPDES Public Education - Provided education outreach with a joint NPDES group. Actions included public service announcements, FYN brochures, public information, and outreach.	Education Efforts	2015	Completed - 2016
51. Town of Jupiter	Pine Gardens South Water Quality Improvements - Installation of exfiltration trenches to provide an average of 0.41 inches of treatment in the project area.	Exfiltration Trench	2015	Completed - 2015

*Projects completed prior to 2010 are provided in Supplemental 7.

Table 6.1. Loxahatchee Watershed Project progress* (page 8 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
52. Town of Jupiter	C.R. A1A Stormwater Improvements - Construction of exfiltration trench in excess of the permit requirement for Inlet Village.	Stormwater System Upgrade	2015	Completed - 2016
53. Town of Jupiter	Parkway Street Water Quality Improvements - Construction of stormwater infrastructure improvements.	Stormwater System Upgrade	2015	Completed - 2015
54. Town of Jupiter	Jones and Sims Creek Water Quality Master Plan - Master water quality plan to address probable pollutants	Studies	2015	Completed - 2015
55. Town of Jupiter	Elsa and Paulina Roads Drainage Improvements - Construction of new drainage infrastructure with baffle boxes to provide water quality treatment prior to discharge into the regional system.	Baffle Boxes	2016	Completed - 2018
56. Town of Jupiter	Cinquez Park Drainage Improvements II - Construction of new park stormwater management system to retain runoff.	Stormwater System Upgrade	2016	Completed - 2018
57. Town of Jupiter	Alma's Place Restoration - Clearing of exotic vegetation to provide increased retention and treatment for stormwater runoff prior to discharge to the Lox River.	Wet Detention Pond	2016	Completed - 2018
58. Town of Jupiter	Water Plant Detention Pond Cleanout - Silt removal from wet detention pond located at the water plant.	Muck Removal /Restoration Dredging	2017	Completed - 2017
59. Town of Jupiter	Maplewood Drive Exfiltration Trench Replacement - Restore functionality of existing stormwater management system.	Exfiltration Trench	2018	Completed - 2018
60. Town of Jupiter	Seminole Avenue Drainage Basin Improvements - Construct additional outfall and pump station to reroute discharge to FEC canal.	Stormwater System Upgrade	2018	Completed - 2022

*Projects completed prior to 2010 are provided in Supplemental 7.

Table 6.1. Loxahatchee Watershed Project progress* (page 9 of 9).

Lead Entity	Project Name / Description	Project Type	Start Date	Status
61. Town of Jupiter	Pine Gardens North Water Quality Improvements - Construct exfiltration trenches within existing right-of-way.	Stormwater System Upgrade	2020	Completed - 2021
62. Town of Jupiter	Surface Water Recharge System Improvements II - System to capture and retain up to 10 MGD of excess stormwater runoff from the C-18 basin in lieu of discharging to tide.	Dispersed Water Management		Delayed
63. Town of Jupiter	Pennock Industrial Park Drainage Improvements - Improvements to include additional exfiltration systems to enhance runoff water quality.	Stormwater System Upgrade	Planned - 2021	Planned - 2022
64. U.S. Army Corps of Engineers (USACE) and South Florida Water Management District (SFWMD)	Jonathan Dickinson State Park Kitching Creek Canal - Replace and stabilize existing culvert (it continues to get washed out) and place boards that will allow for retention of water during the dry season.	Wet Detention Pond		Planning Phase (CERP: LRWRP)

*Projects completed prior to 2010 are provided in Supplemental 7.

6.1.1. Completed Projects

The completed project summaries were provided by lead agencies as available. Not all projects completed between 2011 and 2020 were summarized.

Cypress Creek Natural Area Restoration (Completed 2013)

The Cypress Creek Natural Area is a roughly 1,500-acre property between I-95/Florida Turnpike and Mack Dairy Road (Figure 6.1). The property is in Martin County north of the Palm Beach County border. The Palm Beach County-owned and managed Cypress Creek Natural Area is directly south of the Martin County portion of the property. The objective of this project was to enhance and restore lost hydrologic and biological function to a mosaic of flatwoods, wet prairie, depression marshes, and cypress sloughs. The project involved installing a control structure on a 60-inch culvert that extended under Gulfstream Citrus Blvd. This culvert over-drained the headwaters to Cypress Creek, which is one of the most important tributaries to the NW Fork of the Loxahatchee River. The project improved hydroperiods and enhanced wetland functions of several hundred acres of conservation lands in the area.

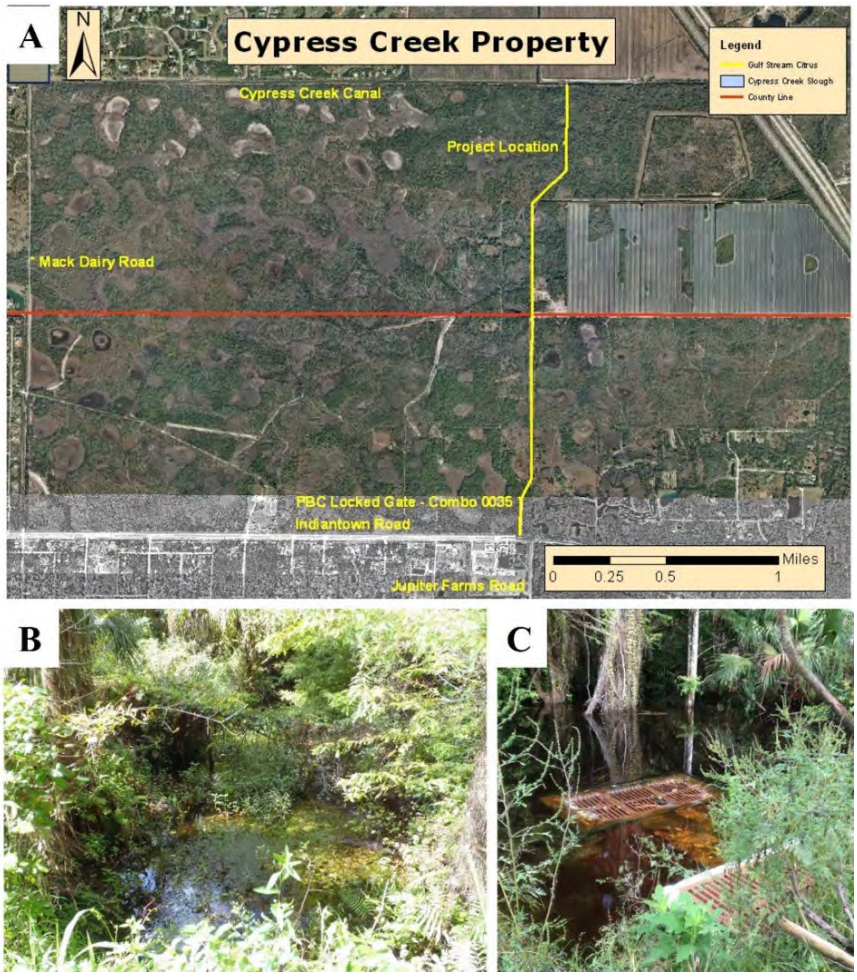

Figure 6.1. (A) Cypress Creek Natural Area. (B) Pre- and (C) post-installation of the Gulf Stream Citrus Structure in the Cypress Creek Natural Area.

Culpepper Berm Phase I Project (Completed 2014)

Culpepper Ranch is a 1,294-acre property between Seminole Pratt Whitney Road and I-95/ Florida Turnpike (Figure 6.2A). The property is in Martin County north of the Palm Beach County border. Culpepper Ranch is within the footprint of Flow-way 3, which is one of the major components of the Loxahatchee River Watershed Restoration Project (LRWRP). The property is important because water from a large portion of Hungryland Wildlife and Environmental Area flows through the Culpepper Ranch property. The objective of the project was to enhance and restore lost hydrologic and biological function to a mosaic of flatwoods, wet prairie, depression marshes, and cypress sloughs. This was accomplished by installing control structures on several culverts that drained into the Ranch Colony Canal (Cypress Creek) (Figures 6.2B and C). To protect adjacent private residents the project included enhancing 1.3-miles of berms along the eastern property line of Culpepper Ranch. The project improved hydroperiods and enhanced wetland functions of several thousand acres of conservation lands in the area.

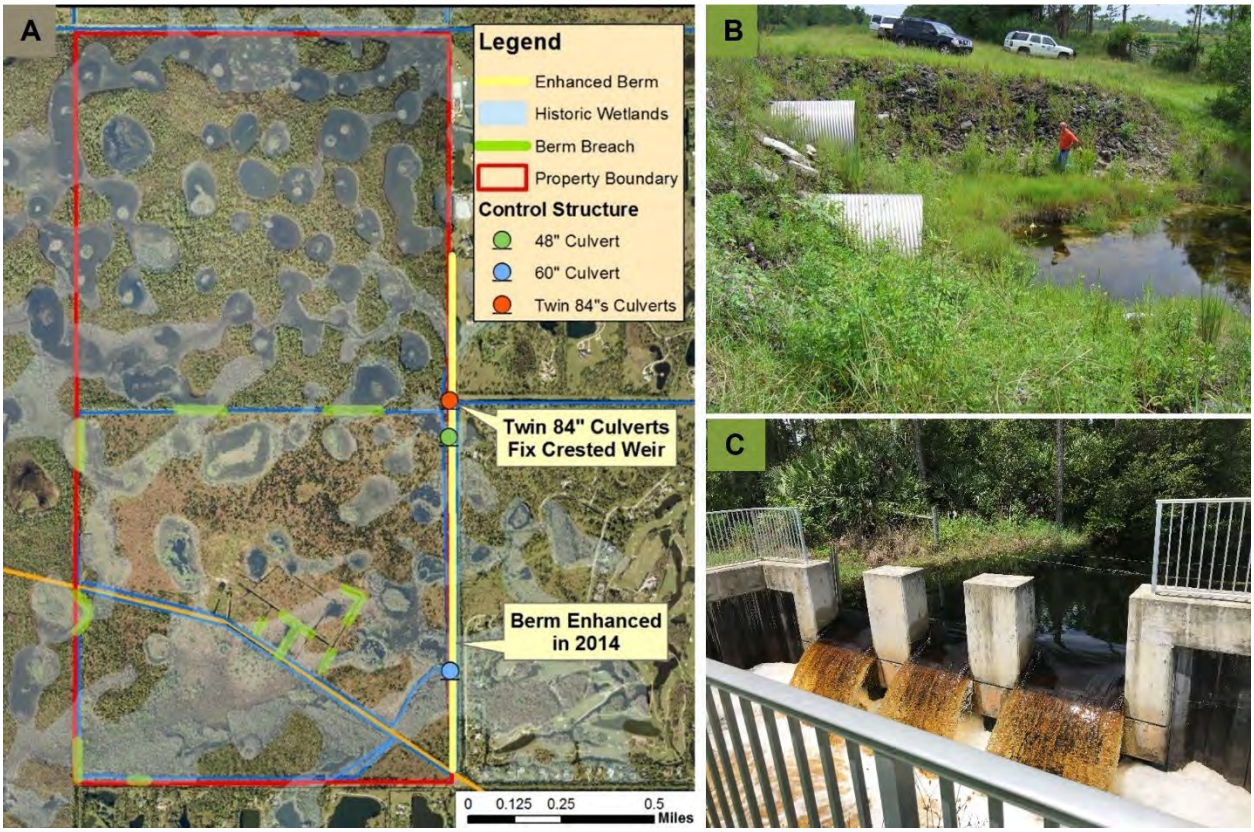

Figure 6.2. (A) Culpepper Ranch property. (B) Culverts draining into Ranch Colony Canal of Cypress Creek before water control structure (C) installation.

Kitching Creek Central Flow-way Project (Completed 2015)

Kitching Creek Preserve is a 51-acre natural area managed by Martin County and is in Hobe Sound, Florida (Figure 6.3). It was acquired by the County in 2009 to help restore the Central Flow-way of Kitching Creek and the Loxahatchee River. Historically, water flowed from the Atlantic Ridge ecosystem south through a series of wetlands and sloughs that formed three flow-ways extending into Jonathan Dickinson State Park and eventually Kitching Creek. The construction of roads, agricultural and residential development, and extensive drainage operations cut off and isolated these wetland areas. The County collaborated with an engineering firm to develop a plan to capture water from a nearby ditch, hold it on-site in a series of lakes and wetlands, and then slowly discharge the water back into Kitching Creek and ultimately the Loxahatchee River. The project constructed a 24-acre lake containing eight acres of shallow marsh/wetland habitat and included the restoration of 12 acres of heavily impacted wetlands.

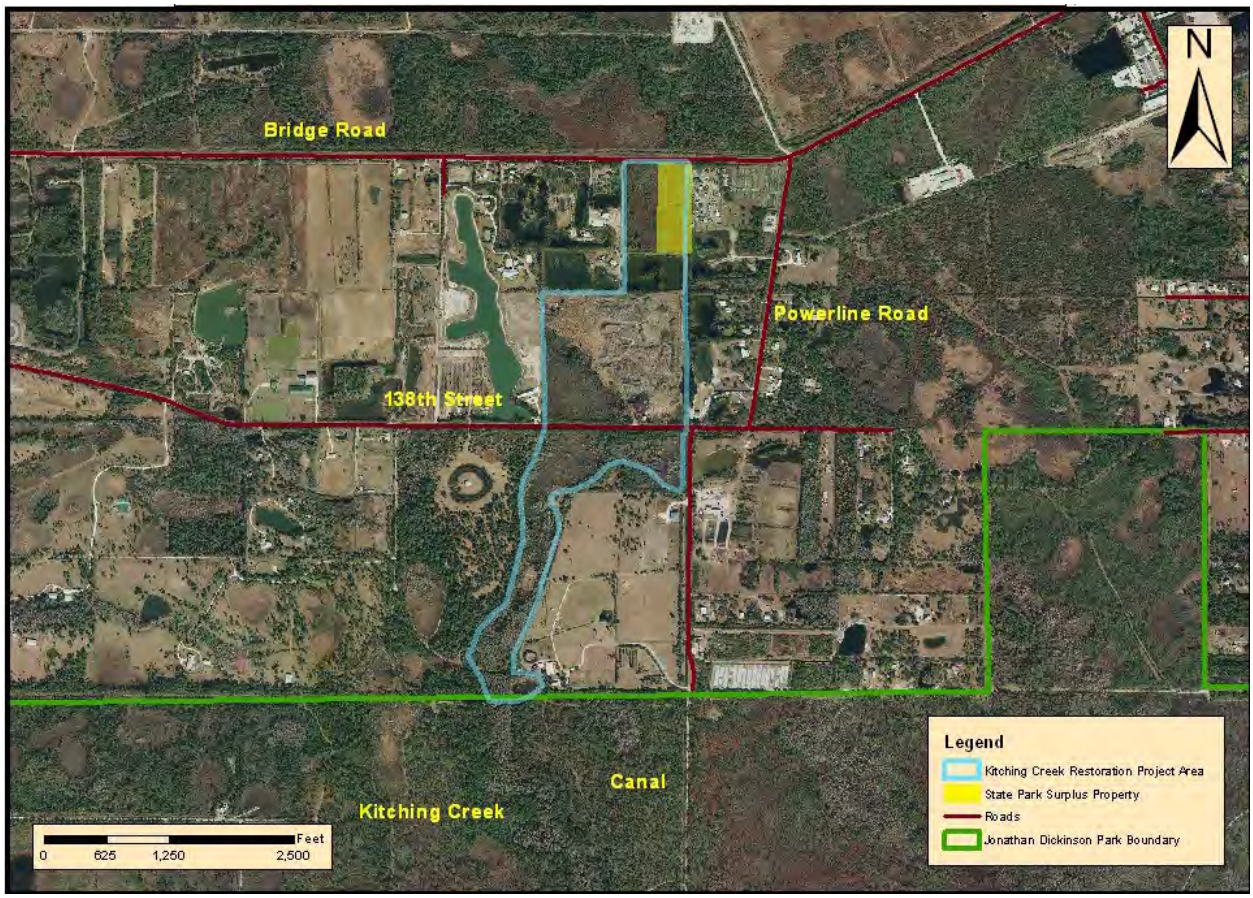

Figure 6.3. Kitching Creek Central Flow-way Project map.

Cypress Creek Weir Project (Completed 2019)

The purpose of this project was to construct a weir in the Ranch Colony Canal (Cypress Creek) (Figure 6.4). The weir helps address many of the hydrologic challenges affecting the Cypress Creek Watershed. The weir slows water movement within the canal. Before the project, the high velocity of water movement caused significant erosion, which resulted in shoaling downstream within the Northwest Fork of the Loxahatchee River. By holding water levels higher in the canal, the project improves the hydroperiod and enhances the wetland function of several hundred acres of wetland habitat in the area.

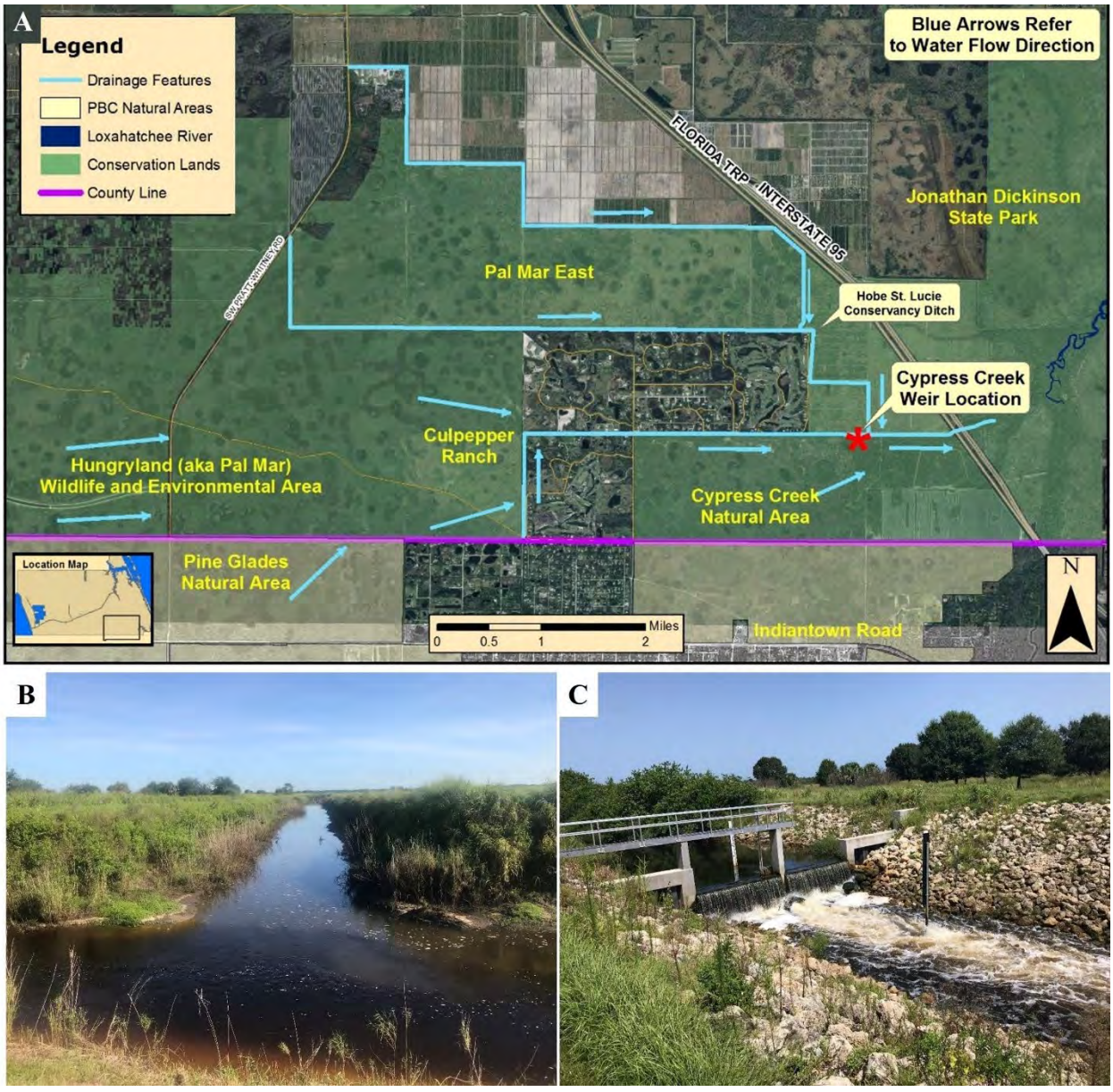

Figure 6.4. (A) Ranch Colony Canal area for the Cypress Creek weir project. (B) Pre- and (C) post-weir construction for Ranch Colony Canal (Cypress Creek).

6.1.2. Planned Projects

Comprehensive Everglades Restoration Plan (CERP) Loxahatchee River Watershed Restoration Plan (LRWRP)

The purpose of LRWRP (Appendix C) is to restore and sustain the overall quantity, quality, timing, and distribution of freshwater to the federally designated National Wild and Scenic NW Fork of the Loxahatchee River for current and future generations. The LRWRP study area is approximately 480,000 acres (750 mi^2). The project aims to restore and reconnect the watershed to the wetlands that form the historic headwaters of the river. These areas include JDSP, Pal Mar East/Cypress Creek, Dupuis Wildlife and Environmental Management Areas, J.W. Corbett Wildlife Management Area (WMA), Grassy Waters Preserve, Loxahatchee Slough, the last remaining riverine cypress stands in southeast Florida in the Loxahatchee River, and the Loxahatchee River Estuary. Other objectives include restoring and/or maintaining oysters, seagrass, and other estuarine communities in the Loxahatchee River estuary and restoring native plant and animal species abundance and diversity in Loxahatchee River watershed natural areas, rivers, and in its estuary.

Four alternative plans and a no-action plan or future without project conditions were evaluated using hydrologic simulation model output, hydrologic performance, and ecological improvements. Alternative 5R (Figure 6.5) was identified as the National Ecosystem Restoration Plan and the Recommended Plan that reasonably maximizes ecosystem restoration benefits in the Loxahatchee River and floodplain as well as the wetlands in the watershed, compared to costs. The recommended Plan will deliver 98% of the wet season restoration flow target and 91% of the dry season restoration flow target for the NW Fork of the Loxahatchee River (USACE, 2020).

Alternative 5R

1. Kitching Creek (Restoration/hydration): (Spreader canal; weir/plug (Jenkins Ditch)
2. Moonshine Creek (MC) & Gulfstream East (GE) Restoration: Connect HSLCD ditch to MC; clear MC vegetation; weir in Hobe Grove Ditch; grade area to historic topography
3. Cypress Creek Canal (CCC) (Reduce over-drainage): Replace CCC weir to raise control elevation, raise berm at Ranch Colony, automate twin 84" culverts; pump and spreader swale; regrade CC southern forks
4. Gulfstream West (GW) (Restoration & reduce over-drainage): Partial backfill & relocate southern end of HSLCD canal; small pump, construct flow through marsh to attenuate flows
5. Pal-Mar East (Restoration & Connectivity): Plug ditches; remove pipes; improve northern berm; construct western berm improve eastern berm; pumps at Thomas Farm to redirect drainage to GW flow- redirect drainage to GW flow-through marsh via north Nine-Gems Canal
6. C-18W Reservoir (9,500 ac-ft. & 4 ASR wells): Above ground reservoir; inflow pump, discharge structure; seepage control; M-O canal connector and pump
7. G-160 Structure (Reduce over-drainage): Improve hydroperiod in Loxahatchee Slough
8. G-161 Structure (Connectivity): GWP water to Loxahatchee Slough
9. GWP Triangle (Connectivity): Grade and reconnect
10. M-1 Pump Station (conveyance): Deliver lower M-1 basin water to M-Canal, GWP and G-161

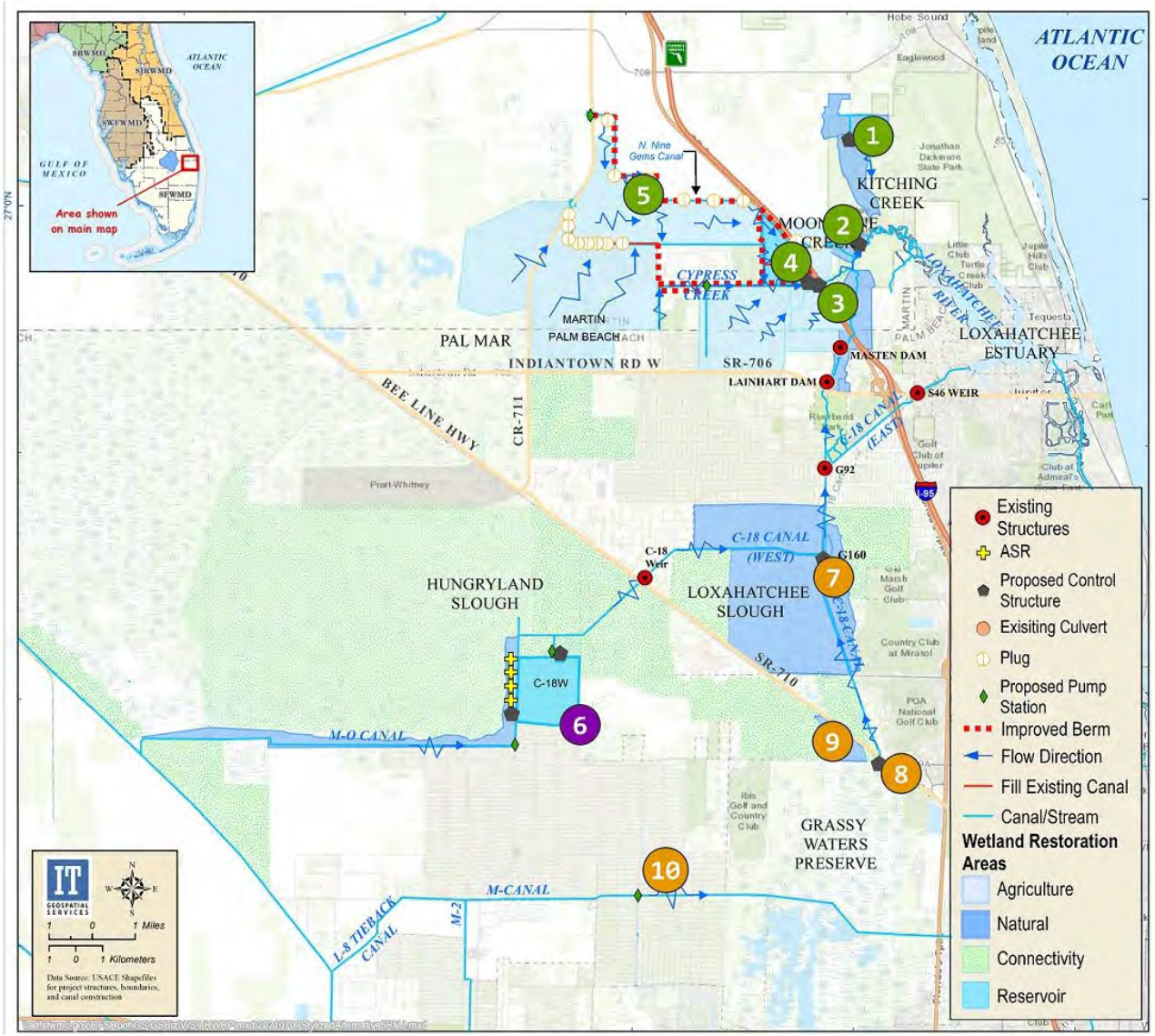

Figure 6.5. Project components and flow-ways of the authorized plan for the LRWRP (USACE, 2020).

Culpepper Berm Phase II Project

Culpepper Ranch is a 1,294-acre property between Seminole Pratt Whitney Road and I-95/Florida Turnpike. The property is in Martin County north of the Palm Beach County border. Culpepper Ranch is within the footprint of Flow-way 3, which is one of the major components of the LRWRP. The property is important because water from a large portion of Hungryland Wildlife and Environmental Area flows through the Culpepper Ranch property. The objective of the project was to enhance and restore lost hydrological and biological functions to a mosaic of flatwoods, wet prairie, depression marshes, and cypress sloughs. Phase II involved installing metal screw gates on a control structure feeding two 84-inch culverts. The screw gates allow for the implementation of an operations schedule for the culverts and to optimize water levels on the property. To protect adjacent private residents the project included enhancing 0.7 miles of berms along the eastern property line of Culpepper Ranch. The project improved hydroperiods and enhanced wetland functions of several thousand acres of conservation lands in the area.

Cypress Creek Floodplain Restoration

The Cypress Creek property is located within the watershed of the Northwest Fork. Water from within the basin flows into Cypress Creek, which then flows into the upper reaches of the Northwest Fork near River Mile 10.3. This project is to design, permit, and build a structure within Cypress Creek to restore the freshwater floodplain of this critical tributary. Cypress Creek is one of the main tributaries to the Loxahatchee River and its restoration is critical to the river's health. The project includes a feasibility study to determine the most appropriate structure, where it would be located, and how to best access the area. Once the feasibility study has been completed, full design will begin. The project will require obtaining a permanent access and maintenance agreement with the Florida Park Service and additional grant funding to offset the costs of design and construction.

Kitching Creek Restoration and Hydration

A spreader canal, C-116, will be constructed to help facilitate sheet flow and rehydration of Kitching Creek. C-116 will be constructed at the north end of Jonathan Dickinson State Park approximately 1,000 ft to the east and 1,000 ft to the west of Kitching Creek. C-116 will help distribute flows to historic Kitching Creek channels instead of directly down Jenkins Ditch. This distribution in flow will reduce peak discharge rates while creating a more natural flow pattern, aiding in the overall restoration and rehydration of wetlands within the area. A gated culvert, S-116, will be constructed in Jenkins Ditch upstream of the main Kitching Creek channel. A telemetry-operated gate on the culvert will allow for varying operation regimes. The gate may be fully opened to allow flood discharge to exit through Jenkins Ditch, like existing conditions, or the gate may be closed to increase water surface elevations upstream in the ditch to aid in the dispersion of water into the spreader canal system.

Moonshine Creek & Gulfstream East Restoration

The Gulfstream East property is located on the east side of I-95 and the Florida Turnpike between Indiantown Road and Bridge Road in Martin County. Historically, run-off from Gulfstream East would flow east towards Moonshine Creek and ultimately to the Northwest Fork. The historical flow pattern of the property was disrupted when it was improved for citrus farming several decades

ago. Restoration of Gulfstream East includes the re-grading and backfilling of drainage ditches within an approximate 460 acre fallow citrus grove to restore a more natural and historic grade to the property. The drainage ditches will be backfilled with material from adjacent citrus beds, and the site will be re-graded to mimic site conditions closer to historical topography. The removal of irrigation pipes and other abandoned farm structures will also be addressed during the restoration effort.

The Hobe Grove Ditch, and a portion of the historic Moonshine Creek, are located within the Gulfstream East property. A new fixed crest weir, S-117, will be constructed at the eastern terminus of the Hobe Grove Ditch to divert water to the NW Fork via Moonshine Creek. The Hobe Grove Ditch and Moonshine Creek are partially separated due to heavy vegetation and sedimentation but will be reconnected to improve hydrologic connectivity. The S-117 will reduce flashy discharge and sediment loading into the NW Fork by diverting flow to Moonshine Creek while maintaining flood control for upstream Hobe St. Lucie Water Control District (HSLCD) canals.

A multi-use pedestrian/equestrian bridge will also be constructed as part of the Moonshine Creek and Gulfstream East Restoration Project. The multi-use bridge will cross the Hobe Grove Ditch and Moonshine Creek to provide connectivity between the Gulfstream East property and Jonathan Dickinson State Park via the Ocean-to-Lake trail. The multi-use trail bridge will be constructed within the vicinity of the existing Ocean-to-Lake trail wet crossing, which passes through Hobe Grove Ditch. The exact location of the multi-use bridge will be determined during the detailed design phase.

Gulfstream West Flow-through Marsh

The Gulfstream West property is located on the west side of I-95 and the Florida Turnpike between Indiantown Road and Bridge Road in Martin County. Like the Gulfstream East project, Gulfstream West was also modified for citrus farming before its acquisition by the South Florida Water Management District (SFWMD) and Martin County. Citrus farming, adjacent residential development, drainage, and flood control measures, and construction of I-95 and the Florida Turnpike have all impacted the historical flow pattern of Gulfstream West. A HSLCD canal, which provides drainage for a farm located to the north of Gulfstream West, doglegs through the property before it discharges into the Cypress Creek Canal. The Cypress Creek Canal runs east to west along the southern boundary of the property.

Restoration efforts for Gulfstream West include the construction of an approximately 740 acre shallow flow-through marsh. The purpose of the flow-through marsh is 1) to divert source water from the HSLCD drainage canal into the constructed marsh, thereby helping control discharge rates and attenuate flow; 2) to provide ecosystem benefits and water quality improvements; and 3) to reduce stages within the HSLCD drainage canal and the Cypress Creek Canal. A new pump station, S-110, will pump water from the HSLCD drainage canal into the Gulfstream West flow-through marsh at the north end of the property. A perimeter levee will ensure that elevated surface water is held on-site. The property will be graded, and the existing drainage ditches will be removed to provide a more uniform topography and slight gradient to promote flow in a southerly direction. Water will flow through a series of collection ditches and spreader berms that will promote sheet flow and rehydration. The existing HSLCD discharge canal that borders the western edge of Gulfstream West will be straightened and used as a bypass canal if runoff exceeds 150 cfs

or when water elevations within the flow-through marsh exceed an average depth of 3 ft. The outflow structure, S-111S, will consist of a notched weir and is designed to discharge at a variable rate depending on the depth of the marsh. The weir will control discharge from the flow through the marsh into the Cypress Creek Canal and will be located downstream of a new gated spillway, S-112, which is planned for the Cypress Creek Canal.

6.2. The 2010 Management Plan Projects: Status and Summary

The National Wild and Scenic Loxahatchee River designation affords the protection and enhancement of the NW Fork and surrounding watershed. Updates to the management plan reemphasize the original 1985 principal guidelines and revise the objectives, strategies, and tasks based on the subsequent observations and outcomes in the management of the river corridor. In previous plan updates (2000 and 2010), the NW Fork focused projects were summarized to document the status during the period of record.

The 2010 Management Plan addressed similar goals as provided in the 2000 plan update though focused on two major objectives: 1) preserving and enhancing the river's natural and cultural values and 2) restoring historical flows to reverse and prevent further damaging saltwater intrusion. Forty-six tasks were identified to meet the two objectives and eight strategies outlined in the 2010 plan. All 2010 objectives, strategies, and tasks within the 2010 management plan were monitored for progress and completion annually by the LRMCC. Twenty-four of the tasks outlined in the 2010 plan are ongoing and 12 were completed by the end of 2020, while 10 tasks have either no status or have not been implemented to date. The 2010 plan objectives (Table 6.2) were revised and incorporated into the Outstanding Remarkable Values Action Plans within Chapters 4 and 5 of the 2024 plan update.

Table 6.2. The Five-Year Project Implementation Schedule from Table 6 (pages 65 – 69) of the 2010 Plan Update (page 1 of 5).

Objectives & Strategies	Tasks	Lead Agencies	Target Completion Date	Current Status	2024 Action Plan Objectives
Objective 1: Preserve and enhance the river's unique natural and cultural values.					
Strategy 1. Prioritize land acquisition, acquire, and manage properties within the National Wild and Scenic Loxahatchee River watershed.					4.1.3; 4.3.3
a.	Acquire a 2,200-acre parcel east of Atlantic Ridge Preserve State Park to connect to Medalist property.	MC, FL DEP	2020		
b.	Acquire remaining private Pal Mar parcels through donations or acquisition of tax deeds.	PBC	As available		
c.	Apply for land acquisition and restoration grants.	All	As available	Ongoing	
d.	Partner with other stakeholders to leverage funds (Jones Creek).	All	Annually	Ongoing	
Strategy 2. Develop and implement resource protection and enhancement management plans.					4.4.3; 4.5.3
a.	Update the Wild and Scenic Management Plan every five years amending strategies, tasks, and schedules as needed	FL DEP, SFWMD	2015	Tabled	
b.	Implement and update restoration targets for the Northwest Fork of the Loxahatchee River Restoration Plan (2006).	SFWMD, FL DEP, LRECD	2011	Updated and Completed - 2012	
c.	Monitor and provide input for management plans of specific properties within the Loxahatchee River watershed and evaluate the effectiveness of agency actions.	LRMCC	Quarterly meetings and special workshops	Ongoing	
d.	Revise the watershed boundary map of the Loxahatchee River watershed.	LRMCC, FL DEP	2012	Completed - 2010	
e.	Involve key state, federal, and local agencies, advisory groups, organizations, and the public in management decisions.	LRMCC	Quarterly meetings and special workshops	Ongoing	
f.	Support replacement of septic systems with sanitary sewers where demonstrated to be beneficial to the protection or enhancement of water quality in the Loxahatchee River (LRECD Ongoing Projects; LRECD Future Projects).	LRECD	2015 - Completed in the urban portion of the watershed.	Ongoing	

Table 6.2. The Five-Year Project Implementation Schedule from Table 6 (pages 65 – 69) of the 2010 Plan Update (page 2 of 5).

Objectives & Strategies	Tasks	Lead Agencies	Target Completion Date	Current Status	2024 Action Plan Objectives
Objective 1: Preserve and enhance the river's unique natural and cultural values.					
Strategy 3. Develop and implement recreation and public use management plans.					5.3
a.	Implement and update the Jonathan Dickinson Park Unit Management Plan (JDSP Unit Management Plan).	FL DEP Parks	Implementation through 2022	Completed - 2012, Scheduled update 2022	
b.	Assess current levels of recreational use on the river	JDSP, PBC	2024	Ongoing	
c.	Develop and implement a recreational public use capacity and management plan.	JDSP, PBC	2022	Ongoing	
d.	Involve key state, federal, and local agencies, advisory groups, organizations, and the public in management decisions.	LRMCC	Quarterly LRMCC Meetings	Ongoing	
e.	Integrate riparian protection with recreational demands.	FL DEP, PBC, SFWMD	2022	Ongoing	
Strategy 4. Ensure relevant local, state, and federal policies, regulations, plans, permits, and approvals are consistent with the objectives of the management plan.					Ongoing
a.	Review and comment on relevant local comprehensive plans.	FL DEP, SFWMD, LRMCC	As needed	Ongoing	
b.	Review and comment on relevant local water supply plans.	FL DEP, SFWMD, LRMCC	As needed	Ongoing	
c.	Review and comment on relevant local stormwater master plans.	FL DEP, SFWMD, LRMCC	As needed	Ongoing	
d.	Review and comment on relevant local park and recreation plans.	FL DEP, SFWMD, LRMCC	As needed	Ongoing	
e.	Review and comment on relevant development regulations, permit applications, and approvals.	FL DEP, SFWMD, LRMCC	As needed	Ongoing	
f.	Review and comment on relevant existing or needed state and local regulations.	FL DEP, SFWMD, LRMCC	As needed	Ongoing	
g.	Review and comment on the Loxahatchee River Watershed Restoration Project (CERP: LRWRP (USACE), CERP: LRWRP Performance Measures (SFWMD).	USACE, SFWMD	Draft PIR Scheduled for 2010	PIR and EIS completed in January 2020.	

Table 6.2. The Five-Year Project Implementation Schedule from Table 6 (pages 65 – 69) of the 2010 Plan Update (page 3 of 5).

Objectives & Strategies	Tasks	Lead Agencies	Target Completion Date	Current Status	2024 Action Plan Objectives
Objective 1: Preserve and enhance the river's unique natural and cultural values.					
Strategy 5. Increase elected officials, key stakeholders, and public awareness of the need to protect and enhance the unique natural and cultural resources in the Wild and Scenic portion of the NW Fork.					4.1.3; 4.2.3; 4.3.4; 4.4.3; 4.5.3; 5.3
a.	Implement and update programs and displays at the Loxahatchee River Center, Jonathan Dickinson State Park's Elsa Kimbell Education and Research Center, Trapper Nelson's Interpretive Site, and Riverbend County Park.	FL DEP, LRECD, PBC	As needed	Ongoing	
b.	Develop and provide information on the river to recreational users and local educational institutions.	FL DEP, SFWMD, LRECD, LRMCC, JID	As needed	Ongoing	
c.	Host river tours for elected officials and legislative delegation members.	LRMCC	Bi-Annually	Ongoing	
d.	Encourage and support local initiatives such as the Loxahatchee River Preservation Initiative (LRPI) and the Northeast Everglades Natural Area (NENA).	LRMCC	As needed		
e.	Update the Homeowners' Guide to the Protection of the Loxahatchee River (Protecting the Loxahatchee (LRECD)).	LRMCC	2012		
Strategy 6. Increase scientific and management understanding of the river's ecosystems.					4.1.3; 4.2.3; 4.3.3
a.	Develop and implement a science plan for the river as identified in the restoration plan for the NW Fork of the Loxahatchee River	FL DEP, SFWMD, LRECD, LRMCC	2010	Completed- 2010	
b.	Support grants to fund watershed research projects.	All	As available	Ongoing	
c.	Encourage agencies to have work peer-reviewed and published. Jud et al., 2011; Layman et al., 2014; Metz et al., 2015; Stoner et al., 2017; Harris et al., 2020; Iliff et al., 2020; Metz et al., 2020; Arrington et al., 2023).	All	As needed	Ongoing	

Table 6.2. The Five-Year Project Implementation Schedule from Table 6 (pages 65 – 69) of the 2010 Plan Update (page 4 of 5).

Objectives & Strategies	Tasks	Lead Agencies	Target Completion Date	Current Status	2024 Action Plan Objectives
Objective 2: Restore the river's historical hydrologic regime and reverse deleterious saltwater intrusion.					
Strategy 1. Improve the quality, quantity, timing and distribution of flows to the NW Fork.					4.1.3; 4.2.3; 4.3.3
a.	Meet minimum flow and level targets set in 2003.	SFWMD	2010	Ongoing	
b.	Implement and update the Restoration Plan for the Northwest Fork of the Loxahatchee River (2006).	SFWMD, FL DEP, LRECD	2011	Completed - 2012	
c.	Implement the recommendations in the Lower East Coast Water Supply Plan for the Loxahatchee Basin.	SFWMD	2015	Updated - 2013	
d.	Establish and implement a water reservation for the Northwest Fork	SFWMD	TBD	Not implemented	
e.	SFWMD will ensure that the Regional Water Availability Rule is strictly enforced.	SFWMD	As needed		
f.	Complete the Cypress Creek East Restoration project.	PBC	2011	Completed	
g.	Complete the North Jupiter Flatwoods Restoration project.	PBC	2015	Completed	
h.	Ensure that all governmental jurisdictions pursue compliance with stormwater management regulations and best management practices with the intent of enhancing the quality of stormwater runoff.	SFWMD, FL DEP	Annually	Ongoing	
i.	SFWMD, Florida DEP Parks, and LRECD will continue to monitor and evaluate results on an annual basis consistent with the 2010 Interagency Loxahatchee River Science Plan (Loxahatchee River and Water Quality Results (LRECD).	SFWMD, FL DEP Parks, LRECD	Annually	Ongoing	

Table 6.2. The Five-Year Project Implementation Schedule from Table 6 (pages 65 – 69) of the 2010 Plan Update (page 5 of 5).

Objectives & Strategies	Tasks	Lead Agencies	Target Completion Date	Current Status	2024 Action Plan Objectives
Objective 2: Restore the river's historical hydrologic regime and reverse deleterious saltwater intrusion.					
Strategy 2. Restore and/or replace natural water storage and conveyance to the NW Fork.					4.1.3; 4.2.3
a.	Acquire select properties adjacent to the National Wild and Scenic River and its tributaries, including, but not limited to Cypress, Moonshine and Kitching Creeks, Pal Mar wetlands and Loxahatchee Slough as identified in the JDSP Unit Management Plan, CARL Priority One List, LRWRP (CERP) Plan, and additional parcels as may be identified.	FL DEP, FWC, MC, PBC, SFWMD	As funds and properties become available		
b.	Develop hydrologic restoration plans for acquired properties (PBC Natural Areas).	FL DEP, FWC, MC, PBC, SFWMD	Various dates		
c.	Complete the Hatcher, Jupiter Indiantown Venture wetland restoration project	PBC	2015	Completed	
d.	Complete a stormwater plan for the Hatcher-Halparin property adjacent to Jupiter Farms.	PBC	2013	Completed	
e.	Complete the C-18W Impoundment Project at the former Mecca Farms property (Loxahatchee River Restoration Local Initiative and Mecca Site Evaluation).	SFWMD	2031	Design (2023 to 2026); Construction (2026 to 2031)	
f.	Complete a survey of Jonathan Dickinson State Park's existing non-functional agricultural and drainage ditches restore to natural hydrology within the park (JDSP Hydrologic Restoration Plan).	FL DEP Parks	2020	Survey complete	
g.	Update the Atlantic Ridge Preserve State Park's survey of existing non-functional ditches and restore to natural hydrology.	FL DEP Parks	2020	Plan in Progress	

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Appendix A: Water Quality IWQT/NNC

Rachel Harris[1,2] and Bud Howard[1]

[1]LRECD; [2]FFWCC

Interim Water Quality Targets (IWQT) based on 1998 to 2002 annual averages as established in the 2006 Restoration Plan for the Northwest Fork of the Loxahatchee River and presented in the 2010 Loxahatchee River National Wild and Scenic River Management Plan Update. Numeric Nutrient Criteria (NNC) for total nitrogen, total phosphorus, and chlorophyll-a in parentheses. Note: IWQT was developed based on stations listed in the table below.

Water Quality Parameter	Estuarine Reach		Tidal Floodplain	Riverine Floodplain	
	Marine	Polyhaline	Oligo / Mesohaline	Wild & Scenic	Fresh Water Tributaries
	Stations: 10, 20, 30	Stations: 51, 60, 72	Stations: 62, 63, 64	Stations: 67, 68, 69	Stations: 81, 95, 100
Temperature (◦C)	25.4	25.4	24.3	24.1	24.4
pH (units)	7.83	7.69	7.56	7.37	7.44
Alkalinity (mg/L)	117	115	135	159	146
Salinity	31.5	23.9	7.6	0.5	0.5
Specific Conductivity (mho/cm)	48.2	37.7	12.1	0.5	0.5
Color (PCU/units)	18	46	61	64	63
Total Suspended Solids (mg/L)	6.8	6.1	4.2	4.1	4.4
Turbidity (NTU)	2.7	3	2.1	2.3	2.5
Secchi Disc (Meters)	1.74	1.27	1.39	1.1	1.26
P.A.R. @ 1M (%)	61.7	40.1	21.6	--	--
Dissolved Oxygen (mg/L)	6.53	6.41	5.54	5.3	6.21
Dissolved Oxygen Saturation (%)	94.8	89.2	67.5	63.5	70.7
Total Phosphorus (µg/L)	25 (32)	38 (30)	56 (75)	46 (120)	51 (120)
Total Nitrogen (mg/L)	0.98 (0.63)	1.31 (0.80)	1.41 (1.26)	0.99 (1.54)	1.03 (1.54)
Ammonia Nitrogen (mg/L)	0.058	0.072	0.065	0.087	0.077
Chlorophyll a (µg/L)	3.45 (1.8)	8.02 (4)	4.74 (5.5)	2.94 (3.2)	4.79 (20)
Fecal Coliform Bacteria (per 100mL)	17 (800)	99 (800)	211 (800)	282 (800)	325 (800)

Appendix B: LRECD River Keeper

Rachel Harris[1,2] and Bud Howard[1]

[1]LRECD; [2]FFWCC

LRECD's RiverKeeper station Identification (ID) numbers site name (general location and description), river zone (used to evaluate numeric nutrient criteria), analysis zone (used in this report), and frequency of sampling. Each station is color-coded by analysis zone and corresponds to the map in Figure 4.31.

Station ID	Site Name	River Zone	Analysis Zone	Frequency
92	C14 - D. stream of G92	FW Canal	Jupiter Farms	Quarterly
WCS3	SIRWCD # 3	FW Canal	Jupiter Farms	Dropped-special project
WCS4	SIRWCD # 4	FW Canal	Jupiter Farms	Dropped-special project
WCS5	SIRWCD # 5	FW Canal	Jupiter Farms	Dropped-special project
WCS6	SIRWCD # 6	FW Canal	Jupiter Farms	Quarterly
106	Kitching Creek	FW Tributaries	Kitching Creek	Quarterly
108	Kitching Creek Flow Site	FW Tributaries	Kitching Creek	Quarterly
111	Kitching Creek @ 138th St.	FW Canal	Kitching Creek	Quarterly
112	Kitching Creek @ Bridge Rd.	FW Canal	Kitching Creek	Quarterly
101	Jenkins Canal	FW Canal	Kitching Creek	Quarterly
104	Hobe Grove Canal	FW Canal	Moonshine Creek	Quarterly
100	Cypress - NW Fork	FW Tributaries	Cypress Creek	Monthly
105	Cypress - Grove Canal	FW Canal	Cypress Creek	Quarterly
66	NW Fork - Hobe Groves	Wild and Scenic	Wild and Scenic	Quarterly
67	NW Fork - Trapper's	Wild and Scenic	Wild and Scenic	Monthly
68	NW Fork - I - 95	Wild and Scenic	Wild and Scenic	Quarterly
69	NW Fork - S.R. 706	Wild and Scenic	Wild and Scenic	Monthly
62	NW Fork - Islandway	Meso/ Oligohaline	Meso/ Oligohaline	Monthly
63	NW Fork - Osprey Nest	Meso/ Oligohaline	Meso/ Oligohaline	Dropped-special project
64	NW Fork - JD Park Beach	Meso/ Oligohaline	Meso/ Oligohaline	Dropped-special project

65	NW Fork - Kitching Cr.	Meso/ Oligohaline	Meso/ Oligohaline	Monthly
42	Pennock Point	Polyhaline	Polyhaline	Quarterly
60	NW Fork - Bay	Polyhaline	Polyhaline	Monthly
10	Jupiter Inlet	Marine	Marine	Monthly
40	River RR Track	Marine	Marine	Monthly
20	ICW - S.R. 707	Marine	Used for IWQT (Intracoastal)	Quarterly
30	ICW - S.R. 706	Marine	Used for IWQT	Quarterly
72	SW Fork - Lox. Riv. Rd.	SW Fork	Used for IWQT (Southwest Fork)	Monthly
51	N Fork - Tequesta Dr.	Polyhaline	Used for IWQT (North Fork)	Quarterly
81	C18 - S.R. 706	FW Tributaries	Used for IWQT Southwest Fork)	Quarterly
95	Canal 1 Jupiter Farms	FW Canal	Used for IWQT (Jupiter Farms)	Monthly

Appendix C: CERP Loxahatchee River Watershed Restoration Project (LRWRP)

Jeff Buck and Barbara H. Welch

SFWMD

Project Description

The LRWRP CERP project will restore and sustain the overall quantity, quality, timing, and distribution of fresh water to the federally designated "National Wild and Scenic" Northwest Fork of the Loxahatchee River. This project also seeks to restore, sustain, and reconnect the area's wetlands and watersheds that form the historic headwaters for the river and northeastern Everglades. The Authorized Plan would deliver 98% of the wet season restoration flow target and 91% of the dry season restoration flow target for the Northwest Fork of the Loxahatchee River. The Authorized Plan also improves wetland hydrology in the Pal-Mar natural area complex and restores 17,000 acres of various types of agricultural land that are part of the historical Greater Everglades. An additional 10,000 acres of natural areas are improved in the J.W. Corbett Wildlife Management Area, Loxahatchee Slough, and Kitching Creek. These habitats collectively include a unique mix of ridge and slough, mesic and wet flatwoods, wet prairie, cypress floodplain, cypress strand, dome swamps, depression marsh, mesic and hydric hammock plant communities. The planned restoration actions will also improve connectivity for over 78,000 acres of natural areas and restored wetlands that benefit many species of flora and fauna both endangered and important recreational species.

The **Water Resources Development Act** (WRDA) is a comprehensive legislative package that provides for the conservation and development of **water** and related **resources.** It authorizes the Secretary of the Army, through the Assistant Secretary of the Army for Civil Works, to conduct studies, construct projects and research activities that can lead to the improvement of rivers and harbors of the United States. WRDA is strictly authorizing legislation; it does not include funding.

Upon congressional authorization in 2000, the Federal Government and the State of Florida entered into a 50/50 partnership to restore, protect, and preserve water resources in central and southern Florida, including the Everglades. The United States Army Corps of Engineers (USACE) is the lead federal agency and the SFWMD is the lead state agency in this effort. A status summary of CERP was provided by the Secretaries of the Army and the Interior in the jointly submitted Five-Year Report to Congress per the Water Resources Development Act (WRDA) of 2000, Section 601(l) and as required by the Programmatic Regulations for the Comprehensive Everglades Restoration Plan (33 C.F.R. § 385.40(d)(1)) (USACE and USDOI 2020) on the progress of achieving benefits for Natural Systems sought by CERP.

The following progress was made between 2015-2020 on the planning of the LRWRP CERP projects.

PROGRESS:

- Completed the PIR (Project Implementation Report)-EIS (Environmental Impact Statement) January 2020
- PIR and EIS: Recommended to Congress for project authorization and funding.
- Chief of Engineers Report signed April 8, 2020

WRDA 2020

The Loxahatchee River Watershed Restoration Project had a signed Chief's Report and was authorized by Congress in the Water Resources Development Act (WRDA) of 2020. This project will restore and sustain the flow of freshwater to the federally designated "National Wild and Scenic" Northwest Fork of the Loxahatchee River and reconnect the wetlands and watersheds that form the historic headwaters of the river.

NEXT STEPS:

- The SFWMD completed the Restricted Allocation Area (RAA) rulemaking in June 2022 to protect the water that's made available by the project, as per WRDA 2000. Protecting the project's water resources and associated project features, is required prior to entering into a Project Partnership Agreement (PPA) with the United States Army Corps of Engineers (USACE).
- A Pre-partnership Credit Agreement (PPCA) was executed in July 2022 following completion of the RAA rule. The PPCA is required in order for the SFWMD to preserve potential credit for the costs associated with early construction, ahead of an executed PPA.
- An Integral Determination Report (IDR), which must be completed prior to executing the PPA, scheduled for completion in Q4 2022. The purpose of the IDR is to provide information to support a determination by the USACE that work proposed or already completed by the SFWMD is integral to the project. This includes design, construction, monitoring, and any adaptive management for all features of the project.
- The Project Partnership Agreement (PPA) scheduled for completion in Q2 2023.
- The SFWMD has acquired most of the project lands that were identified in the PIR either in fee or with conservation easements; however, some land interests remain in Flow-way 3 in the form of canals, easements and small tracts of land. In 2021, the SFWMD assumed design and construction of all project features. The schedule for design, construction and the operational testing and monitoring period (OTMP) for each flow-way is shown in the 2021 integrated delivery schedule (IDS).
- See above bullets for roles and responsibilities of the USACE and SFWMD for real estate acquisition, design, construction, and operations and maintenance.
- Design of Flow-way 3 project features began in Q4 2022. Design of Flow-way 1 and Flow-way 2 project features initiated in 2023.
- Design of the ASR wells in Flow-way 2 will begin after design of the C-18W Impoundment is initiated; however, the exact timing for design of the ASR wells has not yet been determined.

Future LRWRP Project Steps

A project partnership agreement between the USACE and the SFWMD was entered into in September 2022. Multiple project components have been grouped around the three flow-ways in the authorized plan. The current Integrated Delivery Schedule (IDS) for South Florida Ecosystem Restoration expects operational testing to begin in 2028 for Flow-way 1, 2029 for Flow-way 2, and 2030 for Flow-way 3. Beginning with the operational testing and monitoring period, the Northwest Fork of the Loxahatchee should experience beneficial increases in freshwater flows that meet the established MFL criteria. An operational LRWRP will benefit the restoration and management of the overall Loxahatchee River ecosystem.

Project Components and Authorized Plan

Alternative 5R is the authorized plan for the LRWRP. Alternative 5R was selected from an array of alternative restoration plans that were modeled during the plan formulation and evaluation process as described in the PIR-EIS (USACE 2020). Each alternative plan was evaluated according to the USACE's four "Principles and Guidelines" criteria, which includes completeness, acceptability, efficiency and effectiveness. Project benefits and planning level costs were calculated for each alternative plan, and analyses were completed to identify the alternative plans that maximized environmental benefits as compared to costs. The evaluation and comparison of alternative plans led to the selection of Alternative 5R, the authorized plan, for the LRWRP.

The project components of Alternative 5R are grouped into three different flow-ways, which are based on geographic areas. Structural project components include a 9,500 acre-foot reservoir, four aquifer storage and recovery (ASR) wells, a flow-through marsh, new pump stations, canals, culverts, weirs and ditch plugs. Structural project components, along with other management measures and water control modifications, will increase volume and improve timing of water deliveries to the NWFLR while restoring hydrology and ecological connectivity among the surrounding natural areas and over-drained wetlands within the watershed. The authorized plan will achieve 91% of the dry season target restoration flows and 98% of the wet season restoration target flows to the NWFLR as measured at Lainhart Dam (USACE 2020). A total of 27,000 acres of disturbed wetlands will be restored, 17,000 of which are former wetlands that were improved for agriculture and an additional 10,000 acres are existing disturbed wetlands in the J.W. Corbett Wildlife Management Area, Loxahatchee Slough, Culpepper Ranch tract (part of Pal-Mar), Pal-Mar East (Nine Gems tract), Cypress Creek Natural Area, Grassy Waters Preserve and Kitching Creek within Jonathan Dickinson State Park (USACE 2020). These 27,000 acres of restored wetlands will connect with an additional 51,000 acres of other wetland communities to result in 78,000 acres of connected habitat (USACE 2020).

Supplemental 1: Save Our Rivers

Barbara H. Welch, Elizabeth Salewski and Marie Dessources

SFWMD

The 1981 Florida Resource Rivers Act, known as "Save Our Rivers," (SOR) provided state funding for environmentally sensitive lands to be acquired, restored, protected, and managed. Each of the five Water Management Districts in the state of Florida purchased lands for the protection of the water resources within their area. SFWMD land purchases along the East Coast protected many natural areas from development. Purchased lands within the Loxahatchee watershed and along the river enabled water management to improve flows and water quality of the river. The SFWMD manages the SOR properties along Florida's East Coast (Figure S1.1). The management of the SOR properties requires an ongoing commitment to protect water resources, native plant communities, fish and wildlife populations and the natural hydrologic features across the land.

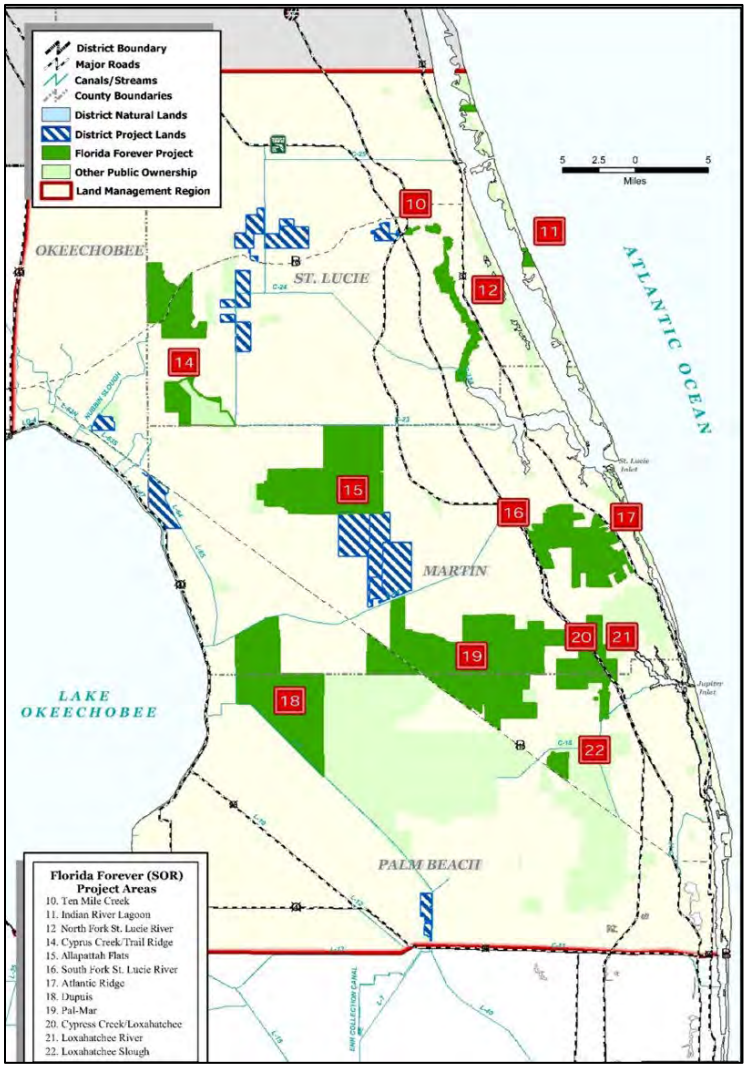

Figure S1.1. SFWMD managed Save Our Rivers lands.

Supplemental 2: Timeline for the Loxahatchee River's Save Our Rivers Property, 1970 to 2012

Richard Roberts[1a], Lorraine Roberts[1b], and James Schuette[2]

[1] FPS [a](retired) [b](volunteer); [2]SFWMD

With the return of the Save Our Rivers (SOR) property to the South Florida Water Management District (SFWMD) in October 2012 from the Florida Park Service (FPS), there was a concern that the history, research, and management decisions made until then would disappear, especially with the retirement of key individuals. This timeline of the river's history is an effort to provide some of this information and provide a better understanding of past considerations, contributions and decisions for the Loxahatchee River Management Coordinating Council and future updates for the Loxahatchee National Wild and Scenic River Management Plan.

The following information is primarily compiled from the 1970 to 2005 Monthly Reports and Volunteer Time Records of Richard E. Roberts:

1970: The river's first Environmental Impact Statement was completed for the proposed route of I-95. Some of the major concerns included impacts to the river's floodplain, increased noise and stormwater retention.

1971: The first meeting with the Indian River Flood Control District (now the South Indian River Water Control District/SIRWCD) took place to allow water to pass from C-18 via C-14 to the river (Lainhart Dam). The first real attempt to provide the river with some status, protection and user safety was its designation as a Florida Recreational Trails System Canoe Trail. At that time, what would be SOR land was in the ownership of private individuals and companies. There were no controls over hunters, homeless people, weekend campers and partyers, with lots of trash. One of the first concerns was the active removal of trees and logs along and within the river's main channel by uninformed groups. The FPS's thought was not to "damage any natural and primitive qualities of the (canoe) trail", but balance river uses to "ensure that the trail remains passable to canoes during times of normal water levels". Recreational use should also have no adverse impact on the floodplain soils and groundcover vegetation.

1973: A study funded by the FPS was initiated by the U.S. Geological Survey that calculated water flows and established a flow monitoring station at the Lainhart Dam. Their 1973 report (*The Loxahatchee – A River In Distress, Southeast Florida*) set the early benchmark of 50 cfs for protecting the freshwater floodplain downstream to Trapper's. In September, one of John D. MacArthur's companies cleared an area 100 feet wide and then constructed a road through the river's floodplain, a definite violation of the law. This impacted area later became part of the I-95 route over the river.

1975: The SFWMD constructed the G-92 water control structure to improve the flow linkage from the C-18 to the C-14 and the Northwest Fork. The first attempt was made at state land acquisition from the Trapper Nelson's tract within Jonathan Dickinson State Park (JDSP) to the C-18 with the

Endangered Lands Program. Helicopter survey, land inspection, etc. resulted in an evaluation report, maps and photographs; however, the endeavor failed.

1978: Nominated by U.S. Congressman "Skip" Bafalis and supported by Assistant Secretary of the U. S. Department of Interior (USDI) Nat Reed, the U.S. Congress authorized a study of the river so it could be considered for the National Wild and Scenic River System.

1980: In an effort to protect the river's floodplain beside Indiantown Road, Palm Beach County, Town of Jupiter and FPS conducted some very interesting land zoning changes and land trades. This included the Blankenship property in 1980 and the "Step Saver" land swap just north and west of Indiantown Road beside the river in 1983.

1981: The USDI reversed their position for land acquisition for the river when President Regan's Secretary of Interior James Watt vowed there would be no more additional federal park lands.

1982: As the second attempt by Florida Department of Natural Resources' (DNR) land acquisition program (Conservation and Recreation Lands Program/CARL) stalled, acquisition was started under the SFWMD's SOR program for the river. In August, the National Park Service recommended that the river should be included in the National Wild and Scenic River System, but it needed to be managed by the State of Florida [a Section 2(a)ii of the Act]. A requirement for federal approval was to draft suitable legislation and develop a management plan.

In a lawsuit, the Florida Wildlife Federation went to count against the SFWMD and DEP concerning flows to the river and operation of the S-46. It resulted in a Consent Decree to provide 50 cfs to the Northwest Fork of the Loxahatchee River, subject to the presence of available water supplies.

1983: The *Loxahatchee River Wild and Scenic Designation and Preservation Act* (Chapter 83-352, Laws of Florida) authorized the Governor to apply for inclusion of the designated portion of the river into the National Wild and Scenic River System. Also, the law established a permanent river management coordinating council (LRMCC) to render its nonbinding advisory opinion to the SFWMD and the DNR (now Department of Environmental Protection/DEP).

In response to an environmental threat to the river, agencies and public supported protection and land swap of the Sierra Square (originally known as the "Step Saver") property on the banks of the Northwest Fork of the Loxahatchee River north of Indiantown Road they wanted to develop. After a public hearing before the Jupiter Town Council on December1, 1981, an agreement was announced between the town, partnership and R, Roberts, representing the Florida Park Service, for a donation of 2.7 river acreage for conservation. Later with further discussions and acquisition resulted in completely reducing this threat. The Loxahatchee River District sold 3.5 acres of their property to the SFWMD for a final land swap that preserved and kept that property on the river from being developed as a shopping center.

1984: A final draft of the river management plan was written and completed in July 1984 by FPS and approved by the Governor and Cabinet on November 27th, 1984. Initial meetings were held by the Loxahatchee River Canoe Portage Design Review Committee to plan for rebuilding of the Lainhart and Masten Dams. After many meetings and field reviews, plans were developed, the dams redesigned and construction commenced in 1988.

1985: The USDI Secretary, Don Hodel, signed the document that gave the Loxahatchee River its National Wild and Scenic River designation on May 17th, with the on-site official Dedication on December 14th and participation by Governor Bob Graham. Also in December, the *Loxahatchee River National Wild and Scenic River Management Plan* was finalized and published by the FPS and SFWMD.

The initial recreational carrying capacity was established for the Northwest Fork of the Loxahatchee River in 1985 by the FPS during the development of the river's first management plan. This was established through surveys and assessments of the maximum public use consistent with the preservation of the river's natural and scenic values. As a part of this plan, a monitoring program was implemented to determine existing levels of use and then find desirable and feasible limits of the number of boats that could be present on the river during a given period. These limits were set to ensure the safety of visitors, the protection of the resource integrity and a quality wilderness experience. Since the initial recreational carrying capacity survey, there have been three other extensive monitoring efforts all conducted by the FPS. The first ran from November 1993 to July 1995, the second from April 1999 to March 2000 and the third extended the survey to April 2001. These three surveys were prepared as reports, presented to the LRMCC and incorporated into the 2000 river's management plan. A survey was not conducted for the 2010 Loxahatchee River National Wild and Scenic River Management Plan.

1986: The first river guidebook, *Canoe Trail Log,* was produced to provide a safety and interpretive booklet for the river user. The first court case (Shunk versus Town of Jupiter) for acquisition of land just east of the Lainhart Dam got under way. In May, the agencies and public proceeded with an Eminent Domain bill with the support of the state's legislative delegation.

1987: The first draft of the river's *Annual Operating Plan* was completed. It was to provide a day to day plan for multiple agency coordination and cooperation. After some discussion, it was never approved by the LRMCC.

1988: At a dedication ceremony in January, the 903 acres of land along the river held by the John D. and Catherine T. MacArthur Foundation and The Nature Conservancy was transferred to the SFWMD. With the SOR property donated or purchased, management tasks began with inspections, inventory of old buildings, vehicles, junk, etc. Then fire roads were selected and housing/maintenance areas planned. Also, grants were written for possible resident housing for interns and park volunteers at the old Italian Farm's barn site.

Because of flooding of the Jupiter Community Park, as a result of the permit to discharge agriculture water onto the SOR property being revoked thus keeping the area water table low, the Town of Jupiter installed a permanent pump for this recreational area. The permit was contested because the water pumping would not allow proper access (roads were flooded) and land management (non-native plant management and prescribe fire) on the SOR property.

1989: The old MacArthur Italian Farms cleanup proceeded with the removal of the old house, barn, derelict vehicles, smaller storage buildings, etc. An agreement between the SIRWCD and the SFWMD provided operational guidelines for 400 cfs flows through G-92 to the river, when feasible, and allowing flood waters to backflow to C-18 under certain conditions.

1990: In February, the SOR land transferred from SFWMD to FPS and commenced with discussion of the agricultural dump, exotic plant control, fencing, access routes, carrying capacity

surveys, culvert requirements, gates and areas to be restored. Photopoints were initially established for non-native pest plants treatments and then expanded in 1993 to cover all resource management blocks.

The Indiantown Road expansion project began at the end of the year and eventually lead to the wildlife crossing under Indiantown Road (via the MacArthur Foundation's donation and support), plans to restore the Shunk property (never implemented due to hydrological issues), archeological surveys (extensive reviews, monitoring and reports completed), plant inventories and removal of the berm (dike) on the Eastern Slough, etc. In 1995, three belt transects (5 x 100 meters) were established within the Eastern Slough by FPS biologists to measure the frequency of occurrence of non-native pest plants, which were then treated with herbicides. The project was never published. Unfortunately, the drainage ditch to the Reese Life Estate (1994) was not allowed to be filled in due to possible flooding of that site.

Using old aerial photographs and infrared images, biological communities within the SOR property were identified and later utilized to complete the *Exotic Plant Management Plan* in 1997.

1991: The old agriculture dump removal on the SOR property was started by the SFWMD, Palm Beach County and Westinghouse Remediation Services. SFWMD (Beth Kacvinski) headed up the project that included the cleanup, road access, boundary road construction, etc. In 1995, gopher tortoise burrows were surveyed, as well as proposals developed once the dump site was restored.

1992: Because of the impact on the SOR property by the neighboring MacArthur Foundation's leased agricultural land (Thomas Brothers), discussions were held about reducing road flooding, impacts on resource management activities, discharges into Outstanding Florida Waters and fish kills. In 2002 this property was sold by the foundation and submitted as a Development of Regional Impact (DRI) by WCI. In both 1992 and 1993, one-week nightly alligator surveys were conducted on the river and within JDSP by FPS and volunteers, but the findings were never published.

1993: The *SOR Fire Management Plan* was completed along with fire roads mowed and a mowing schedule established for the property. Signage was initiated (entering a National Wild and Scenic iver, park rules, alligator safety, restricted areas, etc.). This was the first year we coordinated efforts to revamp a lot of old tree saw cuts beside the river in an attempt to make them appear more natural.

The FPS's *Ward and Roberts Study* was also initiated to compare vegetation to the SFWMD's 1984 survey of six belt transects within the river floodplain (see Appendices G and H in the *2009 Riverine and Tidal Floodplain Vegetation of the Loxahatchee River and Its Major Tributaries* publication). Five of these transects were within the SOR property.

A review was started of the Florida Gas Transmission Company's Phase III Expansion Project's gas line under the river near the Turnpike and culminated in the Florida Gas Line Mitigation Project. It started 1995 and finished in 2000, with the reduction to less than 1% of *Lygodium*, *Epipremnum* and *Syngonium* and a map of the floodplain from the south boundary of the Trapper Nelson tract to Indiantown Road.

1995: A *Loxahatchee River Aquatic Plant Management Plan* was completed by the DEP (Jackie Smith).

1996: During the Loxahatchee River/Indiantown Bridge widening, a temporary parking lot for canoe launching was constructed on the north side of the road beside the river for visitor safety.

1997: To relieve continued flooding at the Jupiter Community Park, the park pumps excess water into the I-95 swales and that water flows into a small stormwater retention pond, which ends up in the river. Concerns were raised to FDOT about this water quality and in general the I-95 swale and scupper system.

1998: There continued to be discussions about possible routes and proposed bridges/cross – walks over the river and I-95 with the Florida Trail Association. The first of several aerial herbicide spraying of the *Melaleuca* areas on SOR sites was initiated.

1999: Funded by the U.S. Environmental Protection Agency and administrated by the Treasure Coast Regional Planning Council, the *Loxahatchee River Basin Wetland Planning Project for Palm Beach County Technical Summary Document* was completed. It provided information about the functions and values of these wetlands using remote analysis based on the interpretation of infrared aerial photographs and a field analysis using a functional assessment methodology (WRAP) developed by the SFWMD. Thirteen of the WRAP chosen sites were within the Cypress Creek Sub-basin.

2000: Throughout the SOR and JDSP, a scent station survey of 13 locations was initiated and continued to 2004. Although the main emphasis was to document the expansion of coyotes into this area, the potential changes in the native meso-predators, including raccoons, bobcats and grey fox were recorded. In June, the *Loxahatchee River National Wild and Scenic River Management Plan* was updated and published by SFWMD and DEP/FPS.

2001: *The Pal/Mar, Cypress Creek and Grove Basin Study* was initiated with SFWMD funding. It was undertaken using a watershed approach to understand more about the hydrology and hydraulics of the basins.

It was determined by the Mrtin County consultants (Raul Mercado and David Hoot) that the I-95 south stormwater retention pond discharging into the river was undersized and the Turnpike doesn't have a swale/berm to capture road runoff leading into the river (report presented to LRMCC on 11/2003).

2002: *The Loxahatchee River Watershed Action Plan* was published. The plan mapped the river's associated sub-basins, listed problems within each sub-basin, water quality questions were identified, and other environmental information compiled from efforts that began in 1996. This was the outgrowth of the Loxahatchee River Preservation Initiative.

The Jupiter Isles Development was the first project that went through lengthy buffers discussions with the FPS and Town of Jupiter. As defined in 2002 by Roberts, Barberi and Roland, these numerous potential impacts included restrictive covenants, buffer widths, resource management assurances, reduction of water quality impacts, floodlight shields, control of dog and cat problems, illegal dumping, etc. They eventually agreed to a buffer larger than what was originally proposed, but still much narrower than research suggested. The advantage of these discussions was it provided a baseline for future talks with the Town of Jupiter for other developers.

The WCI/Parcel 19 was originally proposed as a Development of Regional Impact bordering the southern and eastern boundary of JDSP and the LNWSR. Their project north of the Indiantown Road was planned for a golf course and hotel, but no residential housing. The FPS concerns were water entering the SOR property though a spreader-swale system, width of a buffer between the development and SOR property, lack of fire breaks and access points (March 8, 2004).

2003: The vegetation and groundwater monitoring studies were established for the river's floodplain plant communities and to document hydroperiods, as well as saltwater movement. To survey vegetation, four more belt transects were added to the 1993 research, with canopy examined in 2003 and 2009 and shrub and groundcover layers studied in 2003, 2007 and 2010. Of the ten transects, five are on SOR land. The various vegetational transect studies headed by Roberts and Hedgepeth were published within the following 2006, 2009 and 2012 SFWMD reports.

Twelve shallow groundwater monitoring wells were also installed in 2003 to measure stage, temperature, electrical conductivity, dissolved oxygen, barometric and water pressure. Of the twelve, only two wells are on SOR land.

2004: Since 1988, over 55 gopher tortoises have been captured, measured, marked on the SOR property. Major canal restoration was initiated in this period. The Loxahatchee River Preservation Initiative aiding in the funding of the filling in of Hell's Canal, which extended east of I-95 to the river. The water discharging from old Shiloh Farms was then routed to the South Prong of Cypress Creek. Also, funding was obtained from the Indian River License Plate Grant for the *Northwest Fork of the Loxahatchee River Floodplain Hydrological Restoration Project* to fill in three old canals formerly located on the Thomas Brothers Farm/MacArthur Foundation land, now SOR land.

2006: *The Restoration Plan for the Northwest Fork of the Loxahatchee River* was published by the SFWMD. The plan utilized the best available scientific and technical information to develop practical restoration goals and plan to provide restoration flows to the ecosystem of the river. Also, the *Vascular Plants of Jonathan Dickinson State Park* by Roberts, Woodbury and Popenoe was published in the Florida Scientist. This study extended from 1975 to 2006. A total of 899 taxa, description of the park's fifteen biological communities and herbaria locations of the collected, labeled, and annotated species were documented. The SOR property was also included in the study.

2006 to 2016: Palm Beach County Environmental Resources Management completed 5 restoration projects in the Cypress Creek Natural Area (2,044 acres), a major tributary that contributes a third of the flow to the Loxahatchee River. The restoration projects included exotic vegetation control (mechanical and herbicide), hydrologic restoration (backfilled agricultural ditches and culvert maintenance), and habitat restoration (restored and created wetlands in disturbed uplands and areas that were mined for shell rock by resculpting to more natural contours. These restoration projects have improved the hydrology, wetland habitat functions, water quality, water storage, stormwater attenuation and base flows to the River.

2009: *Riverine and Tidal Floodplain Vegetation of the Loxahatchee River and Its Major Tributaries (Vol. I and II)* was published by the SFWMD and FPS. The purpose of this study was to establish methods of data collection and analysis to be used in the long term monitoring program for the river's floodplain plant communities. It focused on the methods and results of the 2003 vegetational sampling and summarized earlier studies. The SOR land includes five of these transects. The SFWMD in conjunction with CSA International (David Snyder) produced a final report on the *Relationship between Fish Assemblages and Dry Season Flow and Stage Levels on the Riverine Reach of the Northwest Fork of the Loxahatchee River.* This was an electroshocking study that was conducted between river miles 10 and 16 (downstream of I-95 and Lainhart Dam). Bird surveys were conducted along three floodplain vegetation transects (two on SOR land) by Merritt, Channon and Roberts but not published.

2010: The *Loxahatchee River National Wild and Scenic Management Plan* was again updated and published by DEP and SFWMD. Also, published was *The Linking River, Floodplain and Vadoze Zone Hydrology to Improve Restoration of a Coastal River Affected by Saltwater Intrusion* by Kaplan, Munoz-Carpena, Wan, Hedgepeth, Zheng, Roberts and Rossmanith in the Journal of Environmental Quality. This study investigated the soil moistures and porewater salinity dynamics in the river's floodplain, including the SOR property.

In December, the *Loxahatchee River Science Plan* was undertaken as a cooperative effort to obtain the overall management goals to maximize restoration, enhance river and estuarine abiotic conditions and restore and protect riverine and estuarine biotic resources. It was published by SFWMD, FPS and Loxahatchee River District (LRECD).

2011: *Impacts from 2004 Hurricanes Frances and Jeanne on the Floodplain Forest Communities of the Loxahatchee River* by Roberts, Hedgepeth and Gross was published in the Florida Scientist. Half of the study was completed on SOR property.

2012: *The Addendum to the Restoration Plan for the Northwest Fork of the Loxahatchee River* was published by SFWMD, LRECD and DEP/FPS. This addendum is a compilation of new knowledge identified since the 2006 restoration plan was completed. In addition to new vegetation survey information, floodplain fishes were studied from 2007 to 2010 and wildlife species were monitored from 2008 to 2010, including birds, small mammals, frogs and alligators. Due to the budget cuts the SFWMD had to severely reduce their land management contracts, including the one that assisted JDSP in the operation of the SOR property. Therefore, on October 1, JDSP relinquished the operation and management of the SOR land to SFWMD.

Acknowledgments: A draft of this document was presented for comments and suggestion at the September 30. 2013 Loxahatchee River Management Coordinating Council Meeting, with remarks submitted afterwards by Albrey Arrington, Terri Bates, Marion Hedgepeth, Dianne Hughes, David Rotar and Bert Trammell. Written 8/30/2014 and reviewed 12/9/2022.

Supplemental 3: Agency Information and Roles

LRMCC and Barbara H. Welch[1]

[1]SFWMD

Loxahatchee River Management Coordinating Council (LRMCC)

Management of the Wild and Scenic Northwest Fork is accomplished through partnerships and cooperative actions of entrusted federal, state, and local agencies and public stakeholders. The *Loxahatchee River Wild and Scenic Designation and Preservation Act* established the Coordinating Council to ensure the objectives of the management plan were achieved through interagency cooperation and coordination, as well as public stakeholder input. Many of the partnering federal, state, and local agencies and stakeholders serve on the council (see pg. ii).

Role of the LRMCC

The Council serves to advise the Florida DEP and the SFWMD on activities that may affect achieving the Management Plan objectives within their authority as granted in Chapter 83-358. The Council follows the process and procedures as granted in Chapter 83-358 and the accepted bylaws of the Council. The Council also oversees and approves updates to the Loxahatchee River National Wild and Scenic Management Plan. All amendments to the management plan must be approved by the Florida DEP and the SFWMD.

> The Act (FS, Chapter 83-358, Section 5.3[o]) defines the role of the council:
>
> *A permanent management coordinating council composed of one representative from each of the participants provided for in subsection (2). The coordinating council shall review and make recommendations, in the first instance, on all applications for permits required by this act, as well as all proposals for amendments or modifications to the permanent management plan and render its nonbinding advisory opinion to the board* [*Governing Board of the SFWMD] and the department. Each participant shall appoint one member to the coordinating council. The coordinating council shall elect a chairman, vice chairman, and secretary to serve for a term of 1 year. The coordinating council shall adopt bylaws to provide for such other officers as it may deem necessary, election of officers, removal of officers for just cause, meetings quorum, procedures for the conduct of its business, and such other matters as the membership may deem advisable in the conduct of its business. Such professional staff as the coordinating council may require shall be provided by the South Florida Water Management District.*

LRMCC Lead Agencies:

The Florida Department of Environmental Protection (DEP) and the South Florida Water Management District (SFWMD) are the State of Florida's lead agencies responsible for implementing the management program for the National Wild and Scenic Loxahatchee River. In partnership with a multitude of other agencies that include Federal, State, local government along

with stakeholder's involvement. Florida DEP and SFWMD use the management plan to guide actions to manage, protect and enhance the Wild and Scenic River. The following defines the participating agencies, their authority and role in managing the river.

Florida Department of Environmental Protection

Executive authority for administration and management of the National Wild and Scenic Loxahatchee River ultimately lies with the Governor and Cabinet, serving as both the Executive Board of the Florida DEP and as the Board of Trustees of the Internal Improvement Trust Fund (Trustees). The basic authority for planning and implementing a program for managing the river was established in 1983 through the Florida Legislative Public Law, Florida Statute Chapter 83-358, Florida Statutes. which authorizes creation of the Loxahatchee River Management Coordinating Council to develop and periodically amend a river management plan, conduct necessary resource management activities, establish a visitor capacity for recreational use on the river and adopt rules to regulate activities in the designated river corridor area.

The Florida DEP is authorized to manage state-owned parks and recreation areas and to adopt rules for managing these areas, Chapter 258, Florida Statutes. Section 258.034 Florida Statutes, declares the policy to be, in part, to acquire typical portions of the State's original environment for public access and to manage these areas to conserve the natural values which derive from them. In implementing this policy, the Florida DEP is authorized to cooperate with county governments in park and recreation matters of established aquatic preserves (Section 258.041, Florida Statutes) and to negotiate interagency agreements with water management districts to manage district lands reserved for recreational purposes (Section 258.004, Florida Statutes).

Additionally, Florida DEP manages the administrative processes associated with funding of the programs being implemented to protect the greater Everglades ecosystem including the Loxahatchee River in a series of statutes under the Florida Water Resources Act (Chapter 373, Florida Statutes [F.S.]). These statutes authorize the SFWMD to serve as the local sponsor for the majority of regional restoration efforts and direct the roles and responsibilities of the Florida DEP and the SFWMD for plans authorized through the Everglades Forever Act (EFA; 373.4592, Florida Statutes), the Comprehensive Everglades Restoration Plan (CERP; 373.026, 373.1501 and 373.1502, Florida Statutes.), the Northern Everglades and Estuaries Protection Program (NEEPP; 373.4595, Florida Statutes), and the Everglades Restoration Investment Act (373.470, Florida Statutes).

The State of Florida (through Florida DEP and SFWMD), Martin County and Palm Beach County have acquired a portion of the lands that are headwaters for the Loxahatchee River and the three agencies communicate and coordinate land management in the region to ensure the protection of the resource while continuing to encourage public use of the river and the surrounding woodlands. Florida has consistently contributed technical and financial support to local governments to complete a multitude of restoration and public use projects within the Loxahatchee River watershed.

Chapter 258, Florida Statutes, clearly establishes the proprietary overview role of the Board of Trustees of the Internal Improvement Trust Fund (Trustees) in the management of sovereign submerged lands. The Florida Aquatic Preserve Act, (Sections 258.35-258.46, Florida Statutes) authorizes the Florida DEP to establish aquatic preserves on sovereign submerged lands and to

evaluate the use of submerged lands within preserves based on the public interest and on the merits of proposed projects within the context of environmental impact. Chapter 18-20.004, formerly chapter 16Q-20, Florida Administrative Code (FAC), provides for management of sovereign submerged lands within a preserve primarily to maintain essentially natural conditions, promote development of fish and wildlife, and provide opportunities for public recreation, including hunting, fishing, and boating where deemed consistent with the overall purpose of the Aquatic Preserve Act. The Trustees have also granted management authority of certain sovereign submerged lands to the Division of Recreation and Parks (DRP) under Management Agreement MA 68-086.The management area includes a 400-foot zone from the edge of mean high water where a park boundary borders sovereign submerged lands fronting beaches, bays, estuarine areas, rivers or streams. Where emergent wetland vegetation exists, the zone extends waterward 400 feet beyond the vegetation. The agreement is intended to provide additional protection to resources of the park and nearshore areas and to provide authority to manage activities that could adversely affect public recreational uses.

Chapter 403, Florida Statutes, provides for the maintenance and enhancement of water quality and wetlands protection through programs administered by the Florida DEP. Section 403.061, Florida Statutes, authorizes the Florida DEP to perform a variety of functions with regard to air and waters of the State. As far as protection of the National Wild and Scenic Loxahatchee River is concerned, the most important Florida DEP responsibilities involve the establishment of ambient water quality standards, regulation of known sources of pollution and enforcement of rules pertaining to Outstanding Florida Waters. The Florida DEP's administrative rules concerning ambient water quality standards and Outstanding Florida Waters are contained in Chapters 62-4.242 and 62-302.700, Florida Administrative Code (FAC), respectively. Florida passed legislation in 1984 known as the Warren S. Henderson Wetlands Protection Act, authorizing Florida DEP to establish rules concerning water quality criteria for wetlands to enable the State to more effectively regulate use of wetlands under Florida DEP jurisdiction.

The Florida Environmental Reorganization Act of 1993 requires Florida DEP to develop and implement measures to "protect the functions of entire ecological systems through enhanced coordination of public land acquisition, regulatory, and planning programs." Within the Florida DEP, the Division of Recreation and Parks' Florida Park Service Operations Manual provides the guiding management philosophy (Chapter 10, Section 3) it asserts:

> *Chapter 258, Florida Statutes, is understood to mean that, to the extent possible, the goal of natural resource management should be to protect, restore, and maintain functioning representative examples of the full diversity of natural communities within the state, while providing appropriate recreational and educational benefits. Attaining this goal not only requires acquisition and protection of representative lands within the Florida state park system, but also active restoration and maintenance of the natural processes that sustain complex and dynamic biological systems on those lands.*

Florida DEP's Florida Park Service has a two-pronged mission statement (Operations Manual, Chapter 1, Section 3):

> *Provide resource-based recreation while preserving, interpreting, and restoring natural and cultural resources.*

The Board of Trustees of the Internal Improvement Trust Fund (Trustees) hold fee simple title to Jonathan Dickinson State Park, which includes River Mile 5.1 (SE Island Way bridge in Jupiter) to River Mile 11 (the border of the SFWMD river property) along the Northwest Fork of the Loxahatchee River. On January 23, 1968, the Trustees conveyed its management authority of the park to the DRP (more colloquially called the Florida Park Service) under Lease No. 3628 for a period of ninety-nine (99) years and will expire on January 23, 2067. According to this lease agreement with the Trustees, the property must be used for public outdoor recreation and related purposes. Jonathan Dickinson State Park, through which the Loxahatchee River flows, provides Florida's residents and visitors with a high-quality resource-based outdoor recreation experience in what has become a highly urbanized region of Florida. with a high-quality resource-based outdoor recreation experience in what has become a highly urbanized region of Florida. The purpose for acquiring the park was to protect, develop, operate, and maintain the property for public outdoor recreation, conservation, historic and related purposes. The full scope of land management and natural resource management can be found in the 2012 Jonathan Dickinson State Park Unit Management Plan.

South Florida Water Management District

In 1949, the Florida Legislature created the Central and Southern Florida Flood Control District, (the predecessor to the SFWMD) to manage the Central and Southern Flood Control Project; a regional flood control and water supply project being designed and built by the U.S. Army Corps of Engineers. (Section 373.1501, Florida Statutes)

In 1972, with the Florida Water Resources Act (Chapter 373, Florida Statutes), the State created five water management districts, with expanded responsibilities for regional water resource management and environmental protection. In 1976, voters approved a constitutional amendment giving the districts the authority to levy property taxes to help fund these activities.

The Florida Water Resources Act gives the SFWMD authority to provide flood protection, regulate and manage surface water and groundwater supplies, conduct environmental restoration and to acquire property for water management purposes, including the conservation and protection of water resources.

The SFWMD is authorized to participate in the management of the National Wild and Scenic Loxahatchee River by the provisions of Chapter 83-358, Florida Statutes, (Addendum B). Chapter 83-258, Florida Statutes, authorizes the SFWMD to have regulatory authority outside of the designated river area on those activities that may affect the Wild and Scenic River.

The SFWMD is responsible for critical water resources management activities to help achieve the protection and enhancement objectives of the management plan. In summary, relevant activities include:

- Construction, operation, and maintenance of Central and Southern Florida Flood Control Project water control structures and canals,

- Regulation of discharge of surface waters and consumptive use,
- Establishment and implementation of Minimum Flows and Levels,
- Timing, quantity, and quality of water flowing into the Northwest Fork,
- Development and implementation of a Restoration Plan for the Northwest Fork,
- Development and implementation of the Lower East Coast Regional Water Supply Plan,
- Local sponsor for the U.S. Army Corps of Engineers Northern Palm Beach County Comprehensive Everglades Restoration Plan project,
- Land acquisition and management, and
- Review of proposed amendments to local governments' Comprehensive Development Plans, as a commenting agency to Florida Department of Community Affairs.

The SFWMD plays an advisory role to the Department of Community Affairs by reviewing and commenting on amendments to local comprehensive plans. Comprehensive plans are the expression of a local government's authority to designate the type, location, and intensity of development in the Loxahatchee River watershed. State oversight of local land use planning rests with the Florida Department of Community Affairs (DCA) under Chapter 163, Florida Statutes. The SFWMD is one of many resource-protection agencies providing review comments to DCA. The SFWMD also provides technical assistance to local governments on an informal basis.

State Agencies

Florida Department of Agriculture and Consumer Services

The *Clean Water Act* (Section 303[d]) establishes and describes the implementation of the Total Maximum Daily Load (TMDL) program to promote improvements in water quality throughout the country through the coordinated control of point and nonpoint sources of pollution. Section 403.067, F.S. implements the TMDL program in the State of Florida. Sub-section 403.067(7)(c) identifies the Florida Department of Agriculture and Consumer Services (FDACS) as the agency responsible for the development and adoption of best management practices (BMPs) for different agricultural operations. FDACS is additionally responsible for establishing recordkeeping requirements and undertaking site visits to verify the implementation of BMPs. Implementation of adopted BMPs by enrolled producers provides them a presumption of compliance with state water quality standards. Enrolled producers are also eligible for the provision technical and financial assistance to reduce their water resource impacts.

In addition to the development and adoption of BMPs, FDACS is required under Section 570.085, F.S. to promote agricultural water conservation programs to include provisions “for increased efficiencies in the use and management of water for agricultural production …”. BMPs have been developed for irrigation management, and the FDACS Office of Agricultural Water Policy (OAWP) contracts with Mobile Irrigation Labs (MILs) throughout the State to perform no cost efficiency audits to enrolled producers.

Under Section 576.045, Florida Statutes., FDACS has authority to address fertilization-management practices that could be a source of nitrogen and phosphorus residues found in groundwater, surface water and drinking water in various areas throughout the State. The law requires research, incentives, and/or education to promote improved fertilization-management practices that protect the State's water resources and preserve a viable agricultural industry.

In 2015 FDACS revised rule 5E-1.003, F.A.C. on fertilizer content standards for urban settings, limiting the nitrogen and phosphorus amounts applied to lawns and urban turf to only the amount needed to support healthy turf maintenance. This included specifying an application rate and establishing a restricted fertilization period during the winter months. This modification will help protect water quality by reducing the amount of phosphorus and nitrogen runoff from lawns and gardens, which often enters lakes, rivers, estuaries, and other water resources.

Florida Department of Community Affairs

The Florida Department of Community Affairs ensures consideration of the Northwest Fork of the Loxahatchee River in local and regional planning efforts. The Florida Department of Community Affairs is authorized to establish resource planning and management committees, coordinate designation of areas of critical state concern, and administer the review of developments of regional impact by Chapters 380 and 163, Florida Statutes. Section 163.3184 authorizes the Department to coordinate state agency review of local government comprehensive plans.

Florida Department of State, Division of Historical Resources

The Division of Archives, History and Records Management hold title to historical and archaeological resources and artifacts on state-owned lands by Chapter 267, Florida Statutes. The statute provides the Department with the authority to locate and arrange for the protection, preservation, and restoration of historical and archaeological property of other governmental agencies.

Florida Department of Transportation

The mission of the Florida Department of Transportation (FDOT) is to balance natural, human, cultural and physical considerations with sound engineering principles, with the goal of preserving the quality of our environment and communities. The Florida Turnpike and Interstate 95 cross the Loxahatchee River within the boundaries of the wild and scenic designation. The Florida Department of Transportation (FDOT) is authorized to operate and maintain these facilities in a manner that provides for safety and ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of our environment and communities under Sections 20.23(3)(a) and 334.048(3), Florida Statutes.

When considering transportation improvements to these facilities, FDOT is required to coordinate with the National Park Service – Rivers, Trails, and Conservation Assistance (RTCA) Program and follow the Wild and Scenic Rivers Assessment process. This process was established under *Presidential Directive dated August 2, 1979, "Wild and Scenic Rivers and National Trails;" Council of Environmental Quality Memorandum dated August 10, 1980, "Interagency Consultation to Avoid or Mitigate Adverse Effects of Rivers in the Nationwide Inventory;"* and *Federal Register, Volume 47, Number 173 dated September 7, 1982, "National Wild and Scenic*

Rivers System-Final Revised Guidelines for Eligibility, Classification, and Management of River Areas." In order to understand and assess impacts that may occur to the resource, FDOT participates in the Loxahatchee River Management Coordinating Council.

Florida Fish and Wildlife Conservation Commission

The Florida Fish and Wildlife Conservation Commission have administrative, management and enforcement authority with respect to Florida's fish and wildlife by Chapter 372, Florida Statutes. Specific sections which authorize Commission activities in the river management program include Sections 372.07(2) (enforcement of freshwater fishing laws), 372.072(4) (a) (1) (research and management of freshwater/upland species), and 372.77 (implementation of wildlife restoration projects).

The Florida Fish and Wildlife Conservation Commission manage John C. and Mariana Jones Hungryland Wildlife and Environmental Area (12,215 acres) and JW Corbett Wildlife Management Area (60,228 acres), both of which are headwater areas for the various parts of the Northwest Fork of the Loxahatchee River.

The Commission also has a multi-functional Division of Law Enforcement tasked with protection of wild animal and aquatic resources of the State, providing for boater safety, general enforcement of the law, and emergency response.

Federal Agencies

National Park Service

The National Park Service administers the National Wild and Scenic Rivers System in accordance with the *Wild and Scenic Rivers Act* (Addendum 1). Under the broad authority of this act, the National Park Service conducts studies on the eligibility of rivers proposed for designation in the national system and coordinates with states in the development and implementation of management plans for rivers in the system. The National Park Service also reviews permits required by the U.S. Army Corps of Engineers under Section 404 of the *Clean Waters Act* of 1972 for potential environmental impacts on national wild and scenic rivers. Based on the authority of Section 7(a) of this Act, no federal agency may assist by loan, grant, license or otherwise in the construction of any water resources project that would have a direct and adverse effect on any of the resource values of the designated segment of the river.

United States Department of Interior, Bureau of Land Management

Section 202 of the Consolidated Natural Resources Act of 2008 (PL 110-229) charges the Secretary of Interior (through the Bureau of Land Management) with the management of the Jupiter Inlet Lighthouse Outstanding Natural Area (JILONA). JILONA lies within the Loxahatchee River watershed. In addition, the southern boundary of the Outstanding Natural Area is the lower reach of the Loxahatchee River east of U.S. Highway 1. Lastly, PL 110-229 directs the Secretary to include objectives in the management of JILONA to ensure the restoration of native plant communities and estuaries in the Outstanding Natural Area, with an emphasis on the conservation and enhancement of healthy, functioning ecological systems in perpetuity.

United States Fish and Wildlife Service

Section 401 of the *Fish and Wildlife Coordination Act of 1958* (16 U.S. Code 661, as amended), authorizes the USFWS to participate in the review of dredge and fill permit applications. The USFWS‟s participation in this activity is based on its vested interest in the conservation of wetlands as wildlife habitat for federally protected species. In addition, the Service is authorized to administer the *Endangered Species Act* of 1973 (10 U.S. Code 1531, as amended). This Act seeks to ensure the continued existence of endangered species by requiring federal agencies to consult with the Service whenever an agency's actions may be detrimental to an identified species or its habitat.

The *Migratory Bird Treaty Act* of 1918 (16 U.S. Code 703 to 712) and subsequent amendments implemented Conventions between the United States and Canada, Japan, Mexico, and Russia for the protection of migratory birds. Birds and their parts, including eggs, nests, and feathers are protected under this law.

In addition, the *National Wildlife Refuge System Administration Act* of 1966 (16 U.S. Code 668dd-668ee, as amended) provides for the administration and management of National Wildlife Refuges. Hobe Sound National Wildlife Refuge is an example of such a refuge within the Loxahatchee River watershed.

United States Army Corps of Engineers

Section 10 of the *Rivers and Harbors Act of 1899,* (30 Statute 1131, as amended), authorizes the United States Army Corps of Engineers to regulate dredging of obstructions and review proposals for channel construction and improvements in navigable waterways including the Loxahatchee River. This Act, together with Section 404 of the *Clean Waters Act of 1972* (33 U.S. Code 1344, as amended), relating to the regulation of dredge and fill activities in wetlands, involves the Corps indirectly in the management of the National Wild and Scenic Loxahatchee River.

Local Governments:

Palm Beach County

Chapters 125, 162, and 163, Florida Statutes, vests Palm Beach County (PBC) with the authority to regulate the use and development of private property within its jurisdiction, including property within the Loxahatchee wild and scenic river area. Specifically, Chapter 125, Florida Statutes, authorizes PBC to prepare and enforce a Comprehensive Plan for the development of the County; and establish, coordinate and enforce zoning and business regulations necessary to protect the public. Section 125.01(f), Florida Statutes, grants PBC the power to provide parks, preserves, playgrounds, recreation areas, and other recreation and cultural facilities and programs for the benefit of its citizens. Section 125.01 (aa), Florida Statutes, allows the PBC Board of County Commissioners to use ad valorem tax revenues for the acquisition, protection and restoration of natural wetlands and wildlife areas. Additionally, Section 125.01(t), Florida Statutes, allows the PBC Board of County Commissioners to adopt ordinances and resolutions necessary to exercise its powers, and prescribe fines and penalties for violations of adopted ordinances.

Chapter 162 authorizes PBC to establish a code enforcement board. The intent of the code enforcement board is to promote, protect and improve the health, safety, and welfare of the

County's citizens through the use of administrative fines and other noncriminal penalties to enforce county codes and ordinances.

Part II of Chapter 163 (*Community Planning Act*) elaborates on the County's authority to establish and implement comprehensive plan programs to guide and control future development and growth within the County, and preserve, protect, and enhance the County's existing natural resources. The Community Planning Act provides the minimum criteria for the preparation, review, and determination of compliance of comprehensive plans and plan amendments.

The 1989 PBC Comprehensive Plan, as amended, provides for the protection of the County's natural resources and systems through the implementation of the Future Land Use, Recreation and Open Space, Conservation and Coastal Elements. The first three of these elements specifically provide for the protection and conservation of the natural resources within the Loxahatchee River and/or Loxahatchee Slough. Objective 5.4 of the Future Land Use Element directs the County to protect the resources of Jonathan Dickinson State Park and the Loxahatchee River from new development activities. Policy 1.6-e of the Recreation and Open Space Element directs the County to participate in land acquisition and management efforts with other governmental agencies relative to the Loxahatchee River and Slough corridor restoration, as well as other regional projects intended to provide passive public recreational opportunities.

The Loxahatchee Slough and River Corridor is identified as Objective 2.3 within the Conservation Element (CONE) of the PBC Comprehensive Plan. As such, PBC shall coordinate with South Florida Water Management District (SFWMD), Florida Department of Environmental Protection (Florida DEP) and municipalities within the river area to preserve and protect the Loxahatchee Slough and River Corridor. In coordination with the appropriate agencies, PBC shall continue to preserve the natural character of the area and participate in the re-establishment of the historic hydrologic connections. Furthermore, under CONE Policy 2.3-d, the County shall work with other agencies to ensure that public access to the Corridor shall be available, but limited so that the environmental values of the system can be enjoyed, but not overburdened, by users.

A portion of the Northwest Fork of the Loxahatchee River is located within Riverbend Park. The park is a managing partner in the management of the National Wild and Scenic Northwest Fork of the Loxahatchee River. Riverbend Park is managed by the PBC Parks and Recreation Department under the authority of the Board of County Commissioners and PBC Parks and Recreation Ordinance No. 89-34. This ordinance provides for rules and regulations for all recreation areas operated and maintained by PBC. It provides for control of vehicular use, buildings and other property, plant and wildlife protection and preservation, and recreational and other activities within county parks. It also defines prohibited acts, provides for sanitation and pollution control, public utility regulation, park hours, enforcement of traffic regulations, park rules, permit regulations, and for penalties and the prosecution of offenders.

Some of the headwaters of Cypress Creek, which drains into the Northwest Fork of the Loxahatchee River, are located with PBC's Cypress Creek Natural Area. This natural area is managed by the PBC Department of Environmental Resources Management. Cypress Creek Natural Area is managed in accordance with a Board of County Commissioners approved natural areas management plan and the PBC Natural Areas Ordinance, as amended, (Chapter 11, Article XI of the Palm Beach County Code).

Martin County

The general local government statutory authorities identified for PBC also apply to Martin County (MC). In addition to these authorities, the MC Comprehensive Plan prohibits development in wetland areas (since 1982), including the Loxahatchee River, Cypress Creek and Kitching Creek. This plan also applies the requirement for a 50-foot wetland buffer in ecotonal areas adjacent to wetlands as a performance standard for new development (Chapter 9.4.A.7.d.1.e).

Although the land use regulatory methods utilized by MC are similar in many respects to those of PBC, several important differences exist. MC protects all wetlands, regardless of size. However, MC allows wetland impacts in limited situations to prevent a taking of a property. In addition, a requirement for a 75-foot shoreline protection zone has been established in ecotonal areas adjacent to saltwater wetlands. No site alterations, including filling, grading or dredging, are permitted upland from the mean high-water line in these buffer areas. Further, when subdivision approval or zoning exceptions are sought for activities in the vicinity of Cypress Creek, Kitching Creek or the Loxahatchee River, an application review process is used to require mitigation of adverse effects on water quantity and quality. If Planned Unit Development approval is sought, county regulations provide for the transfer of up to one-half of the permitted density for that portion of the property having wetland characteristics.

City of Palm Beach Gardens

Sections six (6) and seven (7) of the City of Palm Beach Gardens' Comprehensive Plan detail the City's goals and objectives toward protection, management, and conservation of wetlands, recreation, and open space lands within the City. Policy 6.1.4.5 of the City's Comprehensive Plan ensures protection of environmentally sensitive areas and listed species by implementing certain criteria; furthermore, wetland habitats are set aside as preserves, and development is prohibited in wetlands except under certain circumstances consistent with the Treasure Coast Regional Planning Council Strategic Regional Policy Plan. The city currently manages Sandhill Crane Park which permits access by water or land around major conservation areas to the Loxahatchee Slough. With such connections, the city has a link with the Florida Trail System and Palm Beach County's Riverbend Park in Jupiter.

Town of Jupiter

The Town of Jupiter is authorized by applicable laws to regulate the use and development of private lands for the public health, safety, and welfare. The Town has adopted a comprehensive plan in accordance with Section 163.3161, FS. This plan designates areas subject to flooding as Conservation Areas and discourages development in these areas. However, there is no ordinance in effect to enforce compliance. All wetlands and environmentally sensitive areas within the Town of Jupiter, especially those subject to flooding, are classified as "Conservation Areas" in the Town's comprehensive plan.

Village of Tequesta

In addition to PBC, MC and the Town of Jupiter, which exercise direct control over portions of the river area, the Village of Tequesta exercises control over land use and development within the vicinity of the National Wild and Scenic Loxahatchee River. The Village of Tequesta

Comprehensive Plan includes a number of objectives and policies that address protection of the Loxahatchee River, including specific reference to the Loxahatchee River National Wild and Scenic Management Plan.

Special Districts:

Jupiter Inlet District

The Jupiter Inlet District has broad authority to construct and maintain an inlet at the mouth of the Loxahatchee River, to deepen and maintain the river where required, and to construct any improvements needed to accomplish these purposes (Chapter 8910, Special Acts of Florida, 1921).

Loxahatchee River Environmental Control District (LRECD)

The Loxahatchee River Environmental Control District (LRECD) is an Independent Special District created by the Florida Legislature in 1971. LRECD's mission is to protect public health and preserve the Loxahatchee River watershed and its natural habitats through innovative wastewater solutions, research, and environmental stewardship.

LRECD's wastewater management responsibilities include operation of a regional wastewater treatment system that serves over 32,500 customers from the municipalities of Jupiter, Tequesta, Juno Beach, and unincorporated areas of northern Palm Beach and southern Martin Counties. LRECD's reuse (Irrigation Quality 'IQ' water recycling) program uses reclaimed water to meet landscape irrigation needs at area golf courses, parks, and residential communities. This innovative water recycling program lowers the demands on natural water resources and preserves untapped water to help meet the needs of the river.

LRECD's WildPine Ecological Laboratory provides the scientific staff, equipment, and professional analysis to conduct research and monitoring throughout LRECD's jurisdiction in the Loxahatchee River watershed. The WildPine Laboratory is accredited by *The NELAC Institute* (TNI) to comply with state and federal quality assurance for water quality monitoring. In 1973, the RiverKeeper program was established to monitor water quality for a comprehensive suite of parameters at locations throughout the Loxahatchee River and watershed at weekly, monthly, and quarterly intervals, depending on location. In 2004, the Datasonde water quality monitoring program was added to provide near-continuous measures of water quality (primarily salinity and temperature) using instrumentation at key locations in the Loxahatchee River. Data from the Riverkeeper and Datasonde programs are reported here and is accessible through data visualization tools available found at the website links: and. The WildPine Lab also conducts ecological monitoring, including seagrasses and oyster reefs, and compiles river flow and rainfall data from the SFWMD and USGS for monitoring flow conditions.

LRECD also operates The River Center, an environmental education center that opened August 23, 2008. The River Center's exhibits trace the Loxahatchee River from its headwaters, through the cypress dominated floodplain in the Wild & Scenic segment, into the central embayment and finally out through Jupiter Inlet into the Atlantic Ocean. Visitors can explore the history of the watershed, its environmental value, modifications and problems associated with ever-increasing human population and development, and programs and projects underway to help preserve and restore this valuable and unique system. LRECD also maintains information for the Loxahatchee River Management Coordinating Council (LRMCC).

Drainage Districts

Under Chapter 298 and various special acts and amendments, the following drainage districts are authorized to levy special taxes and to provide surface water management and control in areas not served by municipal or county agencies. The districts are also authorized to construct and maintain canals, ditches, levees, dikes, pumping plants and other works and improvements. The activities of the districts are subject to state regulation by the Florida DEP and the SFWMD under authority of Section 403.061 and Chapter 373, Part IV, Florida Statutes. Six drainage districts are located within the Loxahatchee River basin.

Hobe-St. Lucie Conservancy District

The Hobe-St. Lucie Conservancy District was created in 1972 and services primarily agricultural areas, but also residential areas (Hobe Sound Polo Club) and public lands. In total, this District provides drainage, irrigation, and road services for approximately 12,000 acres, of which 9,000 acres are located in the Kitching Creek and Cypress Creek watersheds. The balance of the properties covered in this district fall within the C-44 / St. Lucie River watershed.

Indian Trail Water Control District

Indian Trail Water Control District was created in 1957, serves over 40,000 people, and is approximately located from just north of Northlake Boulevard to Southern Boulevard in the south, 110th Ave N in the east, to M2 impoundment area in the west. The District provides drainage and road improvements.

Northern Palm Beach County Improvement District

The Northern Palm Beach County Improvement District was created in 1959 and covers 128 square miles, reaching from A1A west to the L8 canal, south to the Southern Boulevard area, and north to the Palm Beach County line. General responsibilities include waterway maintenance, storm water control, drought protection, roadway construction and utilities construction.

North Palm Beach Heights Water Control District

North Palm Beach Heights Water Control District was created in the late 1950s and its primary responsibility is to maintain canals for storm runoff. The district services the Heights of Jupiter community, an area bounded on the south by Donald Ross Road, on the west by I-95, on the east by Heights Road, and on the north by Egret's Landing.

Pal-Mar Water Control District

Created in the 1960s, the Pal-Mar Water Control District serves an area of more 34 square miles (22,000 acres) in northern Palm Beach County and southern Martin County that was planned to be developed into a residential area called Rotunda. Currently, no one resides within the district, much of the land remains in a natural state and approximately 70 percent of the area is publicly owned while the rest remains in private lots that range in size from .25 to 1.5 acres.

South Indian River Water Control District

South Indian River Water Control District was founded in 1923 and provides road maintenance and water management for approximately 13,000 people in Jupiter Farms, Palm Beach Country Estates, Egret Landing and Jupiter Commerce Park. The South Indian River Water Control District covers 20 square miles and includes approximately 60 miles of canals and approximately 380 miles of swales.

Stakeholders

Treasure Coast Regional Planning Council

Regional Planning Councils are recognized as Florida's only multipurpose regional entity that can plan for and coordinate intergovernmental solutions to growth-related problems on greater-than-local issues, provide technical assistance to local governments, and meet other needs of the communities in each region. The Treasure Coast Regional Planning Council was formed in 1976 through an interlocal agreement between Palm Beach, Martin, St. Lucie, and Indian River counties. Authority for the participation of the Treasure Coast Regional Planning Council in the river management program is based on Sections 186.505 and 163.3184(3) and (4), Florida Statutes. The former enumerates the powers and duties of the Regional Planning Council, including advising on state, regional, and local planning, and growth management matters. The latter provides for the Council review and comment on the content of local comprehensive plans prior to their adoption by local governments. The Council reviews development proposals and planning documents for consistency with the Strategic Regional Policy Plan and the protection of regional resources.

River Users represented by Palm Beach Pack and Paddle Club

Palm Beach County Farm Bureau

Palm Beach County Conservation represented by Florida Native Plant Society

Martin County Conservation represented by Martin County Audubon Society

Supplemental 4: G-92 Culvert, G-160 Spillway, and G-161 Culvert Specifications

South Florida Water Management District

G-92 Culvert Specifications

Description

G-92 (Martens Culvert) is a single-barreled, bi-directional, reinforced concrete box culvert, located through the north bank of the C-18 Canal about two miles southwest of the turnpike crossing of C-18 Canal in northeastern Palm Beach County. The structure is located about 2.8 miles upstream of S-46 spillway and 2.2 miles south of Lainhart Dam in the NW Fork of Loxahatchee River. The control structure consists of one (1) 8.0 feet high by 10.0 feet wide gate. The discharge from this structure is controlled by an electric operated sluice gate. The structure, originally built by the SFWMD in June 1987, was replaced in 2009 with a larger structure to increase its ability to make discharges to the Loxahatchee River. The G-92 gate can either be remotely operated from the SFWMD Operation Control Center or controlled on-site. The structure is currently maintained by the West Palm Beach Field Station.

Purpose

This structure permits flow augmentation of the NW branch of the Loxahatchee River and diverts water between the C-18 Canal and NW Fork of Loxahatchee River or South Indian River Water Control District's (SIRWCD) C-14 Canal.

Operations

This structure operates to supplement flows in the NW branch of the Loxahatchee River during dry periods, to divert flows from the C-18 Canal as long as capacity is available in SIRWCD C-14 Canal, or to divert extremely high flood flows from SIRWCD C-14 Canal into the C-18 Canal in accordance with a 1989 agreement and Minimum Flow and Level (MFL) rules between the SFWMD and the SIRWCD. This agreement has two operational provisions as follows:

<u>Flow Augmentation in SIRWCD C-14</u>

> Releases may be made through the structure so as to maintain a MFL at the Lainhart Dam (about 2.2 miles north of G-92) below the SR 706 bridge over the NW branch of the Loxahatchee River, as long as the headwater stage at G-92 in the C-18 Canal is 12.5 feet NGVD29 or greater. As the headwater stage nears 12.5 feet NGVD29, the discharge will be reduced so as to prolong the period of discharge. The gate will be closed for all headwater stages of 12.0 feet NGVD29 or less.

Flood Control Releases

Whenever S-46 is close to its opening stage criteria, G-92 will be opened so as to release up to 400 cfs as long as the tailwater (north of G-92 on SIRWCD C-14 Canal) does not exceed 14.5 feet NGVD29. If the tailwater stage rises above 14.5 feet NGVD29, with the gate closed it will remain closed until the tailwater exceeds the headwater stage by 0.5 feet, whereupon the gate will be opened full and remain open until the tailwater stage recedes to 14.5 feet NGVD29.

Table S4.1. Discharge characteristics of structure G-92.

DISCHARGE CHARACTERISTICS	
Design Discharge	400 cfs
SPF Discharge	N/A
Design Headwater Elevation (C-18 Canal)	14.82 feet NGVD29
Design Tailwater Elevation	12.60 feet NGVD29
SPF Headwater Elevation	N/A
SPF Tailwater Elevation	N/A
Optimum Headwater Elevation	N/A
Optimum Tailwater Elevation	N/A
Type of Discharge	Controlled submerged
Generator Finished Floor Elevation	21.42 feet NGVD29
Storm Surge - MOM Elevation[1]	N/A

Table S4.2. Description of control structure G-92.

Type: Reinforced concrete gated box culvert

Barrels

Number: 1
Size: 8.0 feet high by 10.0 feet wide
Length: 50 feet
Invert Elevation: 3.0 feet NGVD29
Service Bridge Elevation: 20.0 feet NGVD29
Water Level Which Will Bypass Structure: 20.0 feet NGVD29
Headwall Top Elevation: 20.0 feet NGVD29

Gates

Number: 1
Size: 8.0 feet high by 10.0 feet wide
Type: sluice gate
Gate Control: Local and remote control
Bottom elevation of gate full open: 11.0 feet NGVD29
Top elevation of gate full closed: 11.0 feet NGVD29

Stop Logs N/A

Canal Description (upstream; downstream) C-18; Northwest Fork of Loxahatchee

Bottom width: 50.0 feet
Bottom elevation: -2.0 feet NGVD29; N/A
Side slope (V): (H): 1:2; N/A

Lift Mechanism

Normal Power Source: Commercial electricity
Emergency Power Source: L.P. gas engine driven electric generator
Type: Direct drive electric motor, gear connected to gear box and gate stems

Dewatering Facilities

Storage: West Palm Beach Field Station
Type: Precast concrete needle beam
Size: 3- 4 x 22 aluminum needle beams, spreader beam and 2 corner seals

Hydraulic and Hydrology Measurements

Water Level: Telemetered headwater (HW) and tailwater (TW)
Gate Position: Telemetered gate sensor
Rain Gauge: None

Manatee Protection System None

Date of Transfer: N/ A

Access

Accessible from Turnpike via 2 mile access road on left (NW) bank of C-18 or from SR 710 (Beeline Highway) via 6.5 mile access road on left (NW) bank of C-18.

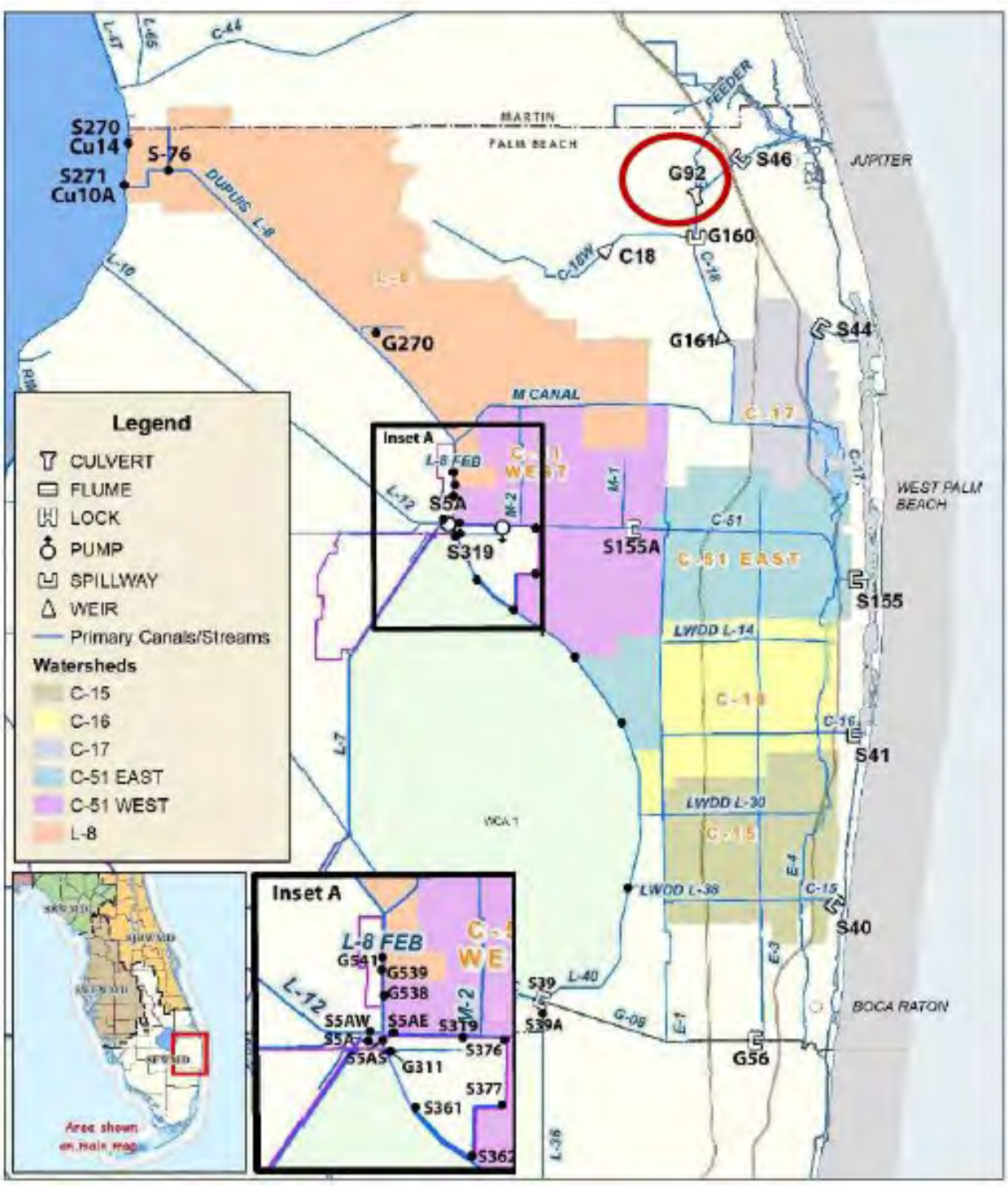

Figure S4.1: Overall view of G-92 location.

Figure S4.2: G-92 upstream and downstream view.

G-160 Spillway Specifications

Description
G-160 is a reinforced concrete gated spillway, located on C-18 Canal just 500 feet south of its junction with C-18W Canal and about 5 miles upstream of S-46 in northeast of Palm Beach County. The structure consists of two (2)
15.0 feet high by 25.0 feet wide gate with sill elevations of 3.0 feet NGVD29. The discharge from this structure is controlled by an electric driven cable drum operated vertical lift gate. The gate can either be remotely operated from the SFWMD Operation Control Center or controlled on-site. The structure is currently maintained by the West Palm Beach Field Station.

Purpose
The main goal of G-160 is to enhance delivery of the Minimum Flow and Level or MFL to the Northwest Fork of the Loxahatchee River and to improve environment in the C-18 Basin. This structure also maintains optimum upstream stages in C-18 Canal. It was designed to pass the flood water from the upstream portions of the drainage area without exceeding upstream flood design stage and restricts downstream flood stages.

Operations
This structure is normally operated according to an agreement between the SFWMD, the City of Palm Beach Gardens, the Northern Palm Beach County Improvement District, and South Indian River Water Control District regarding interim operations of the G-160 structure.

The “dry season” (November 1 to May 31) operating schedule will allow the headwater stage at G-160 to gradually recede to 15.5 feet NGVD29. The G-160 headwater stage may be lowered below 15.5 feet NGVD29 at the discretion of SFWMD to maintain the C-18 Canal stage and to deliver water to the Northwest Fork of the Loxahatchee River when available. When the reach of the C-18 Canal located upstream (south) of the G-160 structure is lowered, the flash boards in the project culverts conveying water from the Loxahatchee Slough (see Fig. 3) will hold water back to prevent further surface water withdrawals from the slough.

The “wet season” (June 1 to October 31) operating schedule will maintain an interim headwater stage of 16.5 feet NGVD29.

In the event of a forecast for a large rainfall event, the SFWMD may, at its discretion, open the G-160 structure, partially or fully, to lower water levels in the C-18 Canal, or may lower the open and close operating levels of the G-160 structure, or a combination of both, to maintain flood protection. Predicted local maximum rainfall of three or more inches (per storm event), as forecast by SFWMD, will warrant pre-storm releases or operational changes or both. The pre-storm drawdown releases from PGA National impoundment may result in pre-storm drawdown operation at G-160. The criteria for pre-storm releases from the PGA National impoundment remain unchanged.

Table S4.3. Discharge Characteristics of Structure G-160

DISCHARGE CHARACTERISTICS	
Design Discharge	2,000 cfs
SPF Discharge	N/A
Design Headwater Elevation (south of the G-160)	16.5 feet NGVD29
Design Tailwater Elevation	16.0 feet NGVD29
Optimum Headwater Elevation	16.3-16.7 feet NGVD29
Optimum Tailwater Elevation	N/A
SPF Headwater Elevation	N/A
SPF Tailwater Elevation	N/A
Minimum Headwater Elevation	N/A
Minimum Tailwater Elevation	N/A
Type of Discharge	Controlled submerged
Generator Finished Floor Elevation	21.0 feet NGVD29
Storm Surge - MOM Elevation[1]	N/A

[1]MOM Elevation is SLOSH (2009-2010) model output corresponding to maximum of MEOW (Maximum Envelope of Water with high tide as initial condition).

Table S4.4. Hydraulic Description of Structure G-160

Type: Fixed crest, reinforced concrete gated spillway

Weir crest: Trapezoidal
Net crest length: 50.0 feet
Crest elevation: 3.0 feet NGVD29
Service bridge elevation: 21.0 feet NGVD29
Water level which will bypass structure: 18.0 feet NGVD29

Gates

Number: 2
Size: 15.0 feet high by 25.0 feet wide
Type: Vertical lift
Gate control: Remote and automatic on-site control
Bottom elevation of gate full open 19.0 feet NGVD29
Top elevation of gate full closed 17.86 feet NGVD29

Apron

Apron elevation: 1.5 feet NGVD29
Apron length: 53.0 feet
End sill elevation: 2.5 feet NGVD29
Riprap Length (downstream): 35.0 feet

Canal Description (upstream; downstream): C-18 Canal

Bottom width: Both 28.0 feet
Bottom elevation: Both 0.0 feet NGVD29
Side Slope (V): (H): Both 1:2

Lift Mechanism

Normal power source: Commercial electricity
Emergency power source: L. P. gas engine driven generator
Type: Electric driven cable drum

Hydraulic and Hydrologic Measurements

Water Level: Telemetered Headwater (HW) and Tailwater (TW)
Gate Position Recorder: Telemetered gate sensor
Rain Gauge: None
Date of Transfer: 2005

Dewatering Facilities

Storage: West Palm Beach Field Station
Type: Aluminum needle beams and needles
Size and No (per bay): (5) 4 x 24’, (2) 2 x 24’ and (2) Spreader Beams

Manatee Protection System: No

Access: Accessible from PGA Boulevard to North via Bluegill Bike Trail which follows a levee along the C-18 canal

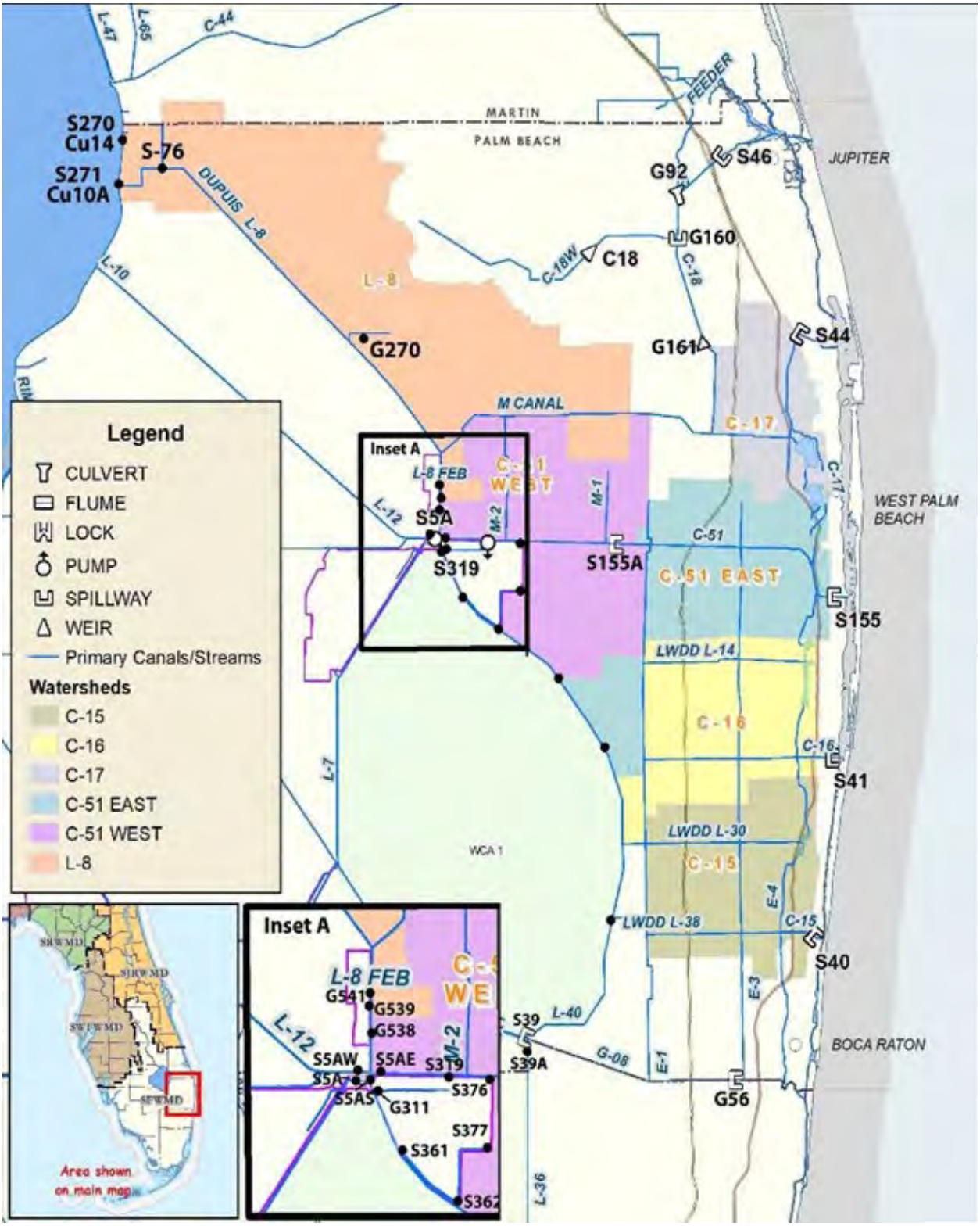

Figure S4.3. G-160 Spillway location.

Figure S4.4. Upstream (top) and downstream (bottom) views of the G-160 spillway.

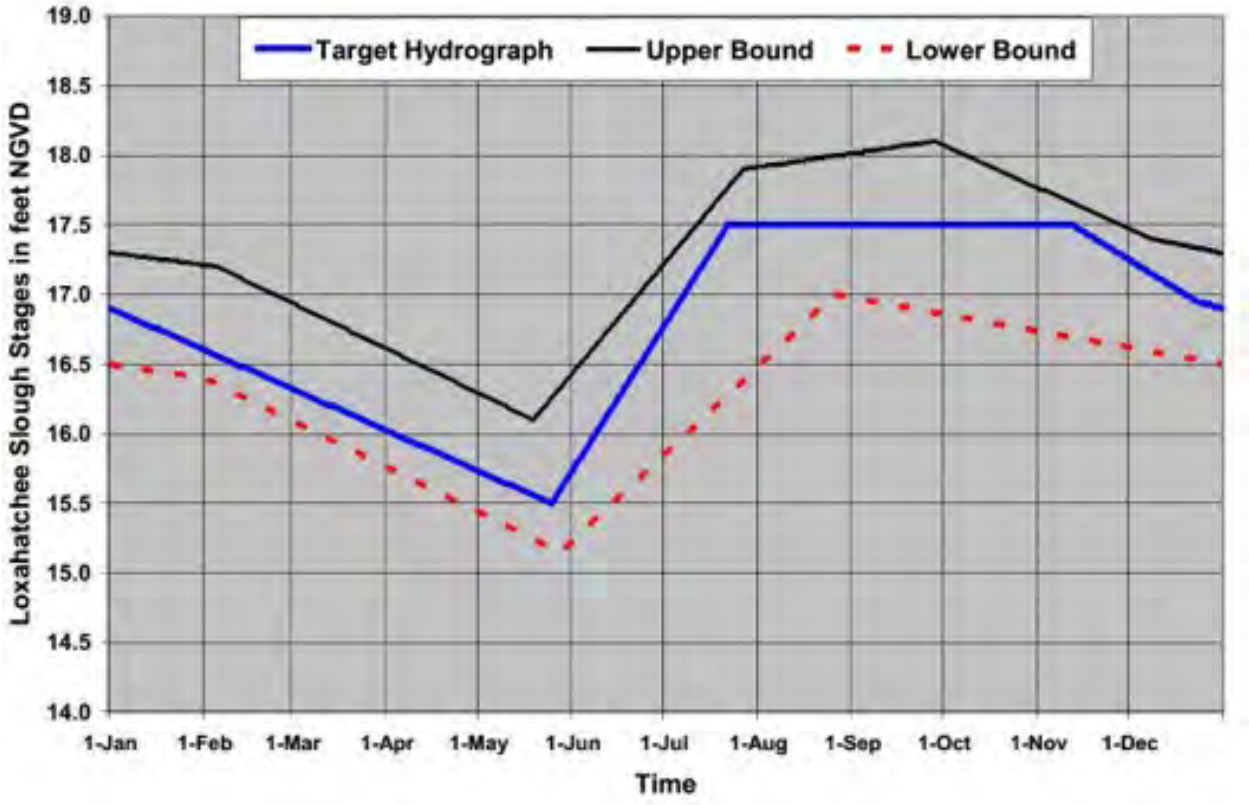

Figure S4.5. The hydroperiod of the Loxahatchee Slough.

G-161 Culvert Specifications

Description

G-161 is a two-barreled steel pipe culvert with reinforced-concrete end sections, located under Northlake Boulevard (County Road 809), about 0.25 mile west of intersection of SR 710 (Beeline Highway) and Northlake Boulevard, in northeastern Palm Beach County. The structure consists of two (2) 5.0 feet high by 5.0 feet wide gate that can either be remotely operated from the SFWMD Operation Control Center or controlled on-site. The structure is currently maintained by West Palm Beach Field Station. G-161 is a component of the Recovery Plan for meeting Minimum Flows and Levels (MFL) for the Loxahatchee River and a future component of the Loxahatchee River Watershed Restoration Project.

Purpose

The primary purpose of the G-161 is to convey water across Northlake Boulevard and Beeline Highway from Grassy Waters Preserve (GWP) to the C-18 Basin and Northwest Fork of the Loxahatchee River in the dry period and maintain ecologically advantageous stages within the GWP.

Operation

In the Interim Operations Plan for the G-161 and Beeline Culverts, which is subject to final Memorandum of Understanding (MOU) between the District, the City of West Palm Beach (CWPB), and Palm Beach County, G-161 and Beeline Culverts are operated in coordination according to the G-161 headwater stages in the GWP, south of Northlake Boulevard. The goal is to maintain the water levels within the CWPB Water Catchment Area (CWPB WCA) similar to the current management plan. The Interim Operation Plan operation schedule, shown in Table below, provides criteria which allow temporary, limited operations of the G-161 structure.

Table S4.5. Interim Operation Schedule for the G-161 Structure

Hydrologic Condition		Action	Constraints
Dry Season Schedule (November 1-May 31)	G-161 structure headwater (1) is above 18.2 feet NGVD29 and the required additional regional water[2] is available at Control Structure No. 2. SFWMD shall provide City of West Palm Beach (CWPB) notification of all releases via the G-161 structure.	G-161 structure may be opened as needed to release up to 100 cfs, subject to regional water availability (at Control Structure No. 2) and downstream capacity. If regional water is not available, and G-161 headwater is greater than 18.0, G-161 discharge shall be limited to what is required to meet Minimum Flows and Levels for the Loxahatchee River. SFWMD may adjust Beeline culvert boards as necessary to ensure water deliveries. The board elevation shall be no lower than 15.5 feet NGVD29.	The following constraints shall apply to the use of G-161 structure for the release of water unless emergency criteria are approved by FDEP: • Discharges at G-161 structure should not cause or exacerbate flooding conditions in the C-18 basin and downstream of G-92. The stage limits will be determined by the SFWMD based on the current conditions. • Discharges through G-161 shall not result in discharges through the S-46 structure larger than 200 cfs. • The G-161 structure headwater is above 18.8 feet NGVD29.
Wet Season Schedule (June 1-October 31)	G-161 Headwater (2) is above 18.2 feet NGVD29. A stage elevation of less than 19.2 feet NGVD29 is desirable, and the system shall be managed to recover to below this stage.	G-161 will be operated as needed to maintain the Triangle hydroperiod and release water from GWP to maintain appropriate stages within the GWP. Adjust Beeline culvert control as necessary to maintain existing level of flood service in the Triangle area.	
Emergency Operation	Based upon rainfall estimates, if basin total rainfall exceeds a total accumulation of 12 inches or more within the previous 30 consecutive days, and existing discharge capability is not able to provide timely flood relief, the City of West Palm Beach may accept additional discharges to the M-Canal.	G-161 structure may be operated to release up to 150 cfs to the north to maintain appropriate stages within the Grassy Waters Preserve The Control 2 pump station shall not be operating. There is a request from the CWPB or SFWMD with concurrence by the CWPB to discharge at G-161 for flood relief. When flood stages return to normal, discharges to the M-Cana I shall cease and the operation of the G-161 structure shall return to normal operation.	

1. As measured on the south side of G-161 structure, in GWP.

2 When the GWP's stage measured at G-161 (G-161 HW) is above 18.2 feet NGVD29 the CWPB staff will consider and manage the stage rise in the GWP to ensure the reproductive success of the apple snail, the preferred prey of the endangered Everglades snail kite. The CWPB, to the extent practicable, will moderate pumping at the CWPB Control 2 and if necessary, request G-161 releases to prevent inundation of the apple snail eggs potentially laid in the GWP. The Apple Snail eggs are generally laid 0.25 feet or higher above the water lev el and take about a month to hatch. Apple Snail recruitment is expected to be successful if the monthly rise is less than 0.25 feet with weekly rises maintained below 0.1 feet per week. G-161 releases are only expected to be required if above average rainfall results in a rise in the GWP above the rate of 0.1 feet per week. Large rainfall events (e.g., more than 4 inches) and accumulative monthly rainfall amounts in excess of 8-inches require no action (reduction in CWPB Control 2 pumping or G-161 discharge) as this is an uncontrolled rise and the actions (reduction in CWPB Control 2 pumping or G-161 discharge) would likely not lower GWP quick enough to benefit the Apple Snails.

The City and the District will coordinate to determine the appropriate ratio for the calculation of "replacement water" (additional water available-to-water—being released) for the City's consumptive use allocation.

Table S4.5. Discharge Characteristics of Structure G-161.

DISCHARGE CHARACTERISTICS	
Design Discharge Rate	150 cfs
SPF Discharge	N/A
Design Headwater Elevation	18.5 feet NGVD29
Design Tailwater Elevation	17.5 feet NGVD29
Optimum Headwater	N/A
Optimum Tailwater	N/A
SPF Headwater Elevation	N/A
SPF Tailwater Elevation	N/A
Design Discharge Flow Type	Controlled submerged
Generator Finished Floor Elevation	20.4 feet NGVD29
Storm Surge - MOM Elevation[1]	N/A

[1]MOM Elevation is SLOSH (2009-2010) model output corresponding to maximum of MEOW (Maximum Envelope of Water with high tide as initial condition). The MOM values represent the single highest surge value expected at the structure from all SLOSH model scenarios, on a per-Category basis.

Table S4.6. G-161 Culvert hydraulic description.

Type: Gated Culvert (Pipe collar and 60 inches RCP at both ends of culvert with 60 inches steel pipe in between)

Barrels

Number: 2
Size (D): 5.0 feet
Length: 240 feet (180 feet 6G-inch steel pipe; 30 feet of 6G-inch RCP culvert on each end of the steel pipe)
Invert Elevation:
Service Bridge Elevation: 20.50 feet NGVD29
Water Level Which Will Bypass Structure: 19.96 feet NGVD29
Headwall Top Elevation: 21.43 feet NGVD29

Gates

Number: 2
Size: 5.0 feet wide by 5.0 feet high
Type: Stainless Steel Vertical Sluice Gate
Gate Control: Local and remote control
Bottom elevation of gate full open 16.10 feet NGVD29
Top elevation of gate full closed 16.10 feet NGVD29

Stop Logs: None

Canal Description (upstream; downstream): M Canal; C-18 Canal

Bottom width: Not available
Bottom elevation: Not available
Side Slope (V): (H): Not available

Lift Mechanism

Normal Power Source: Commercial electricity
Emergency Power Source: Generator with LPG Fuel
Type: Hydraulic cylinder directly connected to gate by gate stem activated by pump and electric motor.

Hydraulic and Hydrology Measurements

Water Level: Telemetered headwater (HW) and tailwater (TW)
Gate Position Recorder: Telemetered gate sensor
Rain Gauge: None
Date of Transfer: N/A

Dewatering Facilities None

Storage: N/A
Type: N/A
Size: N/A

Manatee Protection System: None

Access: To reach the station from the intersection of Interstate 95 and County Road 809A (Northlake Blvd.), go west on County Road 809A for 3.4 miles to the intersection of County Road 809A and State Road 710 (Beeline Hwy), continue west on County Road 809A (Northlake Boulevard) for 0.22 miles to Structure G-161.

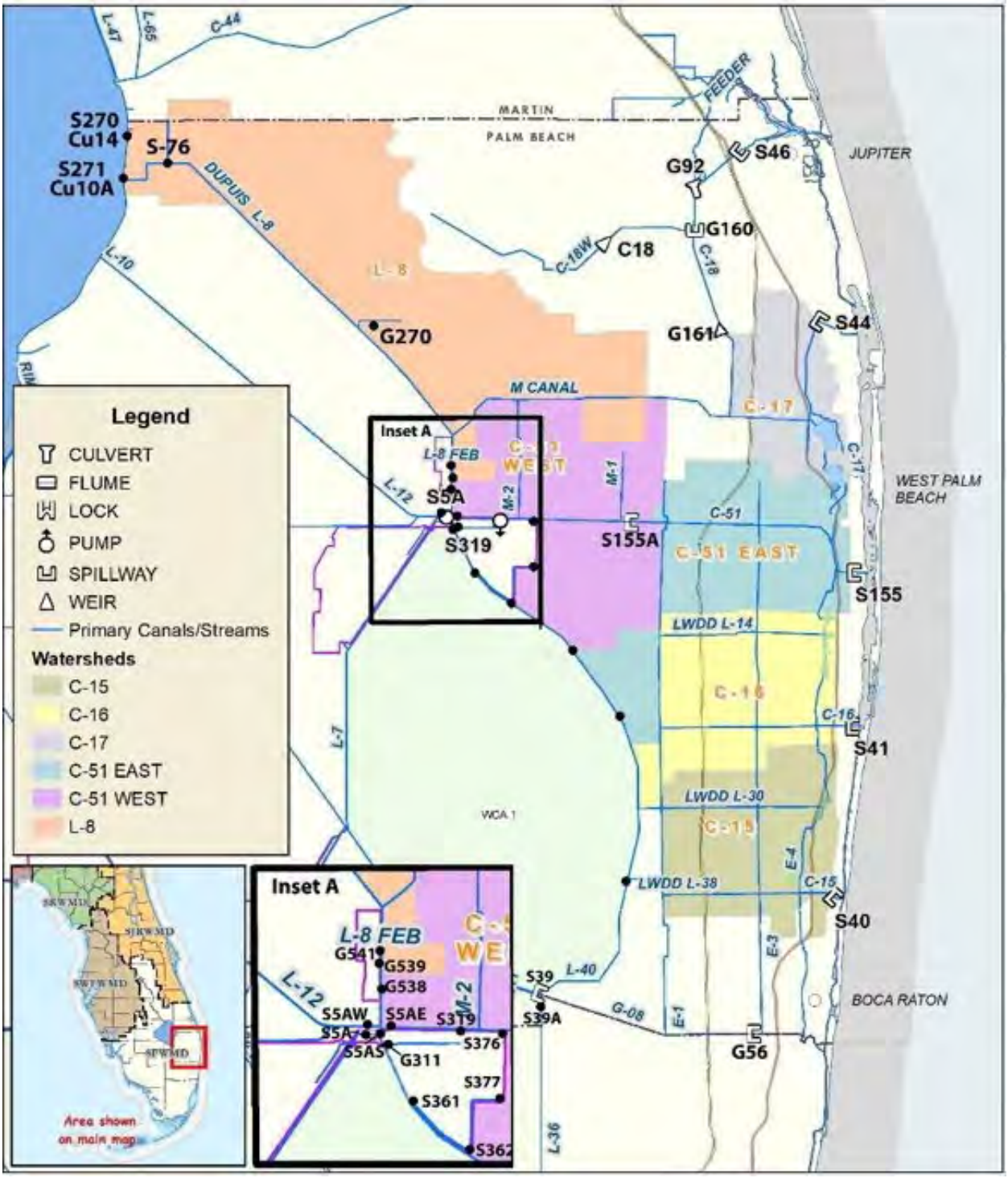

Figure S4.6. Overall view of G-161 location.

Figure S4.7. Closer view of G-161 location.

Figure S4.8. G-161 structure upstream (top) and downstream (bottom).

Supplemental 5: SFWMD Water Protections

Sky Notestein[1,2]

[1]SFWMD; [2]Water and Air Research

Overview

Section 373.709, Florida Statutes (F.S.), requires water management district to develop regional water supply plans based on at least a 20-year planning period and include, among other items, Minimum Flow and Minimum Water Level (MFL) criteria and associated recovery or prevention strategies adopted in the planning area. The Loxahatchee River is a component of the Lower East Coast (LEC) Planning Area and the LEC Water Supply Plan was updated in 2024 (SFWMD, 2024).

Minimum Flows and Minimum Water Levels

The overall goal of Chapter 373, F.S., is to ensure the sustainability of water resources in Florida [Section 373.016, F.S.]. Chapter 373, F.S., provides the water management districts with several tools to carry out this responsibility, including authority to establish MFLs. MFL criteria are flows or levels at which water resources, or the ecology of the area, would experience significant harm from further withdrawals. Significant harm is defined in Subsection 40E-8.021(31), Florida Administrative Code (F.A.C.), as the temporary loss of water resource functions, which results from a change in surface water or groundwater hydrology that takes more than 2 years to recover but is considered less severe than serious harm. Significant harm is more severe than the no-harm standard imposed during the water use permitting process, which is based on a 1-in-10-year drought level of certainty. Therefore, MFLs in a natural system would not be exceeded until rainfall conditions exceeded the 1-in-10 year drought level of certainty permitting criteria. Serious harm, the ultimate harm to the water resources contemplated under Chapter 373, F.S., is defined as long-term, irreversible, or permanent loss to water resource functions. An MFL exceedance means to fall below a minimum flow or level, which is established in Parts II and III of Chapter 40E-8, F.A.C., for a duration greater than specified for the MFL water body [Subsection 40E-8.021(17), F.A.C.].

MFL water bodies approaching their MFL threshold criteria are factors the District Governing Board considers when contemplating water shortage restrictions. However, MFL criteria are not utilized to trigger water shortage restrictions during climatic conditions less severe than a 1-in-10-year drought. The District Governing Board may impose water shortage restrictions if an MFL exceedance occurs, or is projected to occur, during climatic conditions more severe than a 1-in-10-year drought, to the extent consumptive uses contribute to such exceedance.

MFL criteria are applied individually to affected water bodies and define the minimum flows or minimum water levels for surface water bodies, or the minimum water levels for groundwater in aquifers. When establishing MFLs, the District Governing Board considers changes and structural alterations to watersheds, surface waters, and aquifers as well as the effects such changes or alterations have had, and the constraints such changes or alterations have placed on the hydrology of an affected watershed, surface water body, or aquifer [Section 373.0421, F.S.].

Recovery and Prevention Strategies

Section 373.0421, F.S., requires water management districts to adopt and implement a recovery or prevention strategy for water bodies with flows or levels that are below, or are projected to fall within 20 years below, the adopted MFL criteria. Analyses of current and future conditions are conducted for each water body for which MFL criteria are defined. MFL recovery strategies are developed when MFL criteria are violated [Subsection 40E-8.021(25), F.A.C.]. MFL prevention strategies are developed when MFL criteria are not currently violated but are projected to be violated within 20 years of the establishment of the MFL [Subsection 40E-8.021(24), F.A.C.]. Section 373.709, F.S., requires regional water supply plans to contain recovery and prevention strategies needed to achieve compliance with MFLs during the planning period. The recovery or prevention strategy must include a list of projects that develop additional water supplies and other actions. The phasing or timetable for each project must be included in the strategy. Section 373.0421(2), F.S. provides the following:

> The recovery or prevention strategy must include a phased-in approach or a timetable which will allow for the provision of sufficient water supplies for all existing and projected reasonable-beneficial uses, including development of additional water supplies and implementation of conservation and other efficiency measures concurrent with and, to the maximum extent practical, to offset reductions in permitted withdrawals, consistent with this chapter.

Recovery and prevention strategies can consist of multiple components, including capital projects, regulatory measures and requirements, water shortage measures, environmental projects, and other research and monitoring. These components may include development of additional water supplies and implementation of conservation and other efficiency measures. Projects will develop existing water sources or replace them with alternative water supplies to provide sufficient water for all existing and projected reasonable-beneficial uses, consistent with Section 373.0421, F.S.

Northwest Fork of the Loxahatchee River Minimum Flows and Minimum (MFL) Water Levels Criteria

The Loxahatchee River is in Martin and Palm Beach counties (Figure 1), and it flows into the Atlantic Ocean through Jupiter Inlet. The river generally is regarded as the last free-flowing river in southeastern Florida. Approximately 7.6 miles of the river's Northwest Fork were designated as Florida's first Wild and Scenic River in 1985. Downstream segments of the Northwest Fork floodplain contain mangrove forest, while the upper segment contains one of the last native cypress river swamps in southeastern Florida. Over the past century, downstream floodplain wetlands once dominated by swamp hardwoods and bald cypress have changed to mangrove-dominated swamp. This change in vegetation is believed to have occurred because of saltwater intrusion into freshwater areas of the river, caused primarily by human-induced alteration of the watershed, river, and estuarine inlet.

To protect freshwater flows, an MFL was adopted for the Northwest Fork of the Loxahatchee River in 2003 [Subsection 40E-8.221(4), F.A.C.]. The MFL criteria are a minimum flow of 35 cubic feet per second (cfs) over Lainhart Dam and an average daily salinity of less than 2 at river mile 9.2. An MFL exceedance occurs when 1) flows decline below 35 cfs for more than 20

consecutive days; or 2) salinity, expressed as 20-day rolling average, is greater than 2 at river mile 9.2. An MFL violation occurs when an exceedance occurs more than once in a 6-year period.

The MFL criteria protect the freshwater floodplain swamp of the Northwest Fork. The designation of the Northwest Fork as a National Wild and Scenic River identified the floodplain swamp and its associated cypress forest as a resource of outstanding value that needs to be protected. Because cypress trees tolerate a wide range of salinity conditions and are slow to respond to salinity stress, an assemblage of six freshwater tree species that, as a group, are a more sensitive indicator of adverse salinity conditions was identified as characterizing the floodplain swamp (SFWMD 2002). Appendices A through G of the MFL includes review of coastal saltwater intrusion, the effects of salinity on bald cypress, historical and recent characterization of vegetation along the river, statistical analysis of flow and salinity data, Loxahatchee estuary hydrodynamic model, and historic salinity conditions in the estuary. Appendices G through S of the MFL provide additional background information.

Figure S5.1. Northwest Fork of the Loxahatchee River Minimum Flow and Minimum Water Level area (shown in red).

Northwest Fork of the Loxahatchee River Recovery Strategy

The Northwest Fork of the Loxahatchee River did not meet the MFL criteria at the time of adoption. Therefore, an MFL recovery strategy [Subsection 40E-8.421(6), F.A.C.] was adopted simultaneously with the MFL adoption. The MFL criteria are anticipated to be met when these projects are completed and fully operational. The recovery strategy includes the following components:

- Regulatory Activities – SFWMD regulatory program and water shortage plans to ameliorate low-flow conditions.
- Operational Protocols – Providing flows from Lainhart Dam and other sources to meet the MFL (35 cfs) as well as restorative flows greater than 50 cfs.
- Structural Improvements – Construction of the G-160 and G-161 structures (completed and operational) and the Loxahatchee River Watershed Restoration Project (with operational testing beginning in 2028).

Key operational components for managing the Loxahatchee River are continuous salinity monitoring at river mile 9.2 (Figure S5.1), measuring flow across Lainhart Dam, and periodically assessing vegetative communities in the floodplain. This information is used in the operation of water control facilities to deliver a flow of 50 cfs to the river when sufficient water is available from the regional system. This operational strategy is meant to reduce the upstream migration of salt water into the Northwest Fork of the river.

Additional Restrictions on Water Use- Restricted Allocation Areas

Federal law requires natural system water provided by CERP projects to be reserved or allocated before executing cost-share agreements for project construction. The United States Army Corps of Engineers (USACE) has verified that federal requirements have been met for several CERP projects through SFWMD adoption of Water Reservations and establishment of RAAs. Together, these rules protect water resources across substantial portions of the SFWMD.

To facilitate construction of Comprehensive Everglades Restoration Plan (CERP) project components and to ensure the water needed for restoration of the Loxahatchee River is available, a Restricted Allocation Area (RAA) was established in 2007 for the North Palm Beach County/Loxahatchee River Watershed Water Bodies (Chapter 40E-2 F.A.C. and the Applicant's Handbook Applicant's Handbook for Water Use Permit Applications; SFWMD 2021). Net increases in the volume or changes in timing on a monthly basis of direct surface water and indirect groundwater withdrawals from the RAA are prohibited over that resulting from base condition uses permitted as of April 1, 2006. Additional regulatory measures include permit duration criteria (Subsection 1.5.2.B.2) for those applications that identify the C&SF Project canals and dependent groundwater sources as sources of limited availability.

Identification of the Existing Restricted Allocation Area

The RAA includes surface water and groundwater from the Grassy Waters Preserve, Water Catchment Area, Pal Mar property, J.W. Corbett Wildlife Management Area, Loxahatchee Slough, Loxahatchee River, Riverbend Park, Dupuis Reserve, Jonathan Dickinson State Park, Kitching Creek, Moonshine Creek, Cypress Creek, and Hobe Grove Ditch (Figure S5.2). The RAA also includes the integrated conveyance systems that are hydraulically connected to and receive water from the water bodies, such as Central and Southern Florida Flood Control Project (C&SF Project) primary canals and the secondary and tertiary canals that derive water from the primary canals. Net increases in the volume or changes in timing on a monthly basis of direct surface water and indirect groundwater withdrawals from the RAA are prohibited over that resulting from base condition uses permitted as of April 1, 2006. Allocations over the base condition water use are only allowed through sources detailed in Subsection 3.2.1.E.5 of the Applicant's Handbook (SFWMD 2021), such as certified project water, implementation of offsets, alternative water supply, terminated or reduced base condition water use that existed as of April 1, 2006, or available wet season water. The RAA is part of the MFL recovery strategy for the Northwest Fork of the Loxahatchee River.

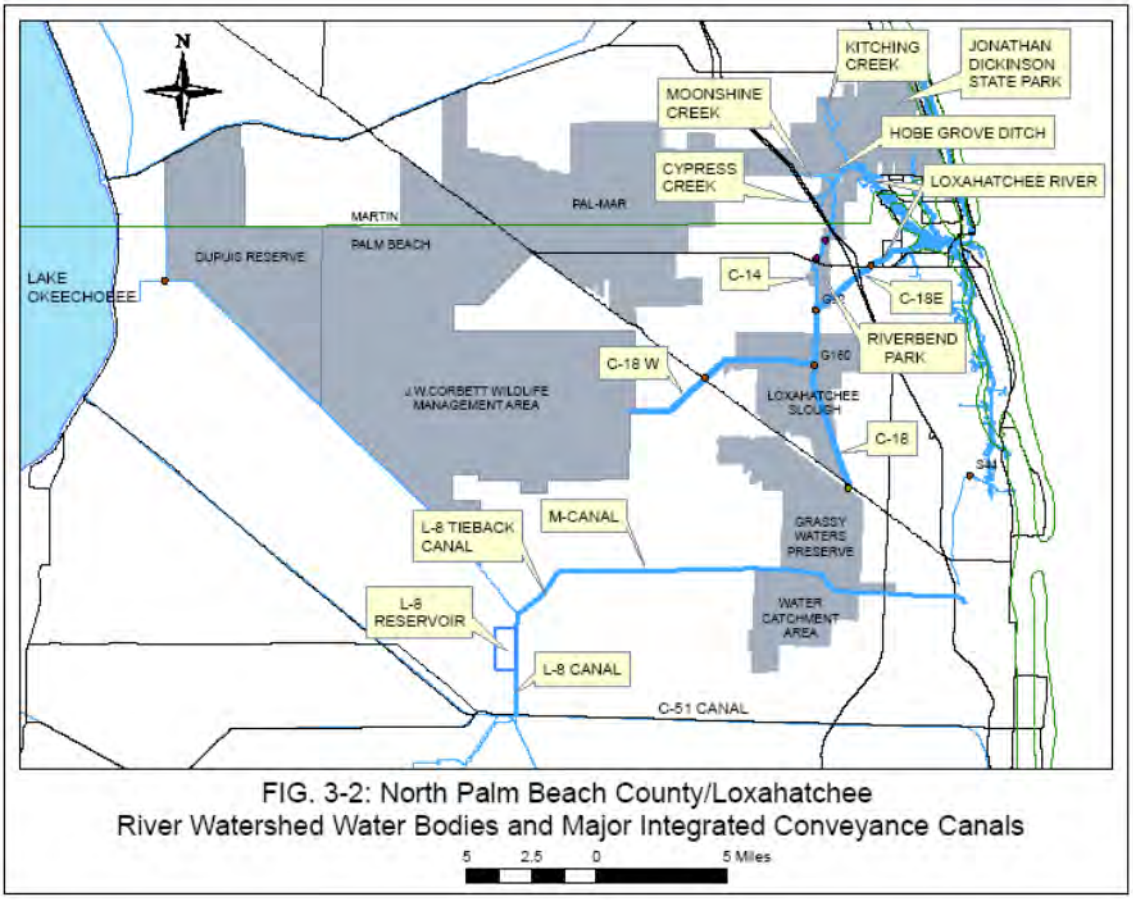

Figure S5.2. North Palm Beach County/Loxahatchee River Watershed water bodies and major integrated conveyance canals (From: SFWMD 2021).

Supplemental 6: Vegetation Species List

Richard Roberts[1] and Marion Hedgepeth[2]

[1] FPS (retired); [2]SFWMD

The Loxahatchee River Floodplain Study (2003 to 2016) identified approximately 220 plant taxa from 12 different floodplain forest types using standard field study procedures and taxonomic references (updated in 2019). Compiled by Richard Roberts and Marion Hedgepeth from published and unpublished research and by Sarah Martin and Craig van der Heiden from their unpublished 2016 study.

Vegetation Type	Scientific Name	Common Name
C	*Citrus xaurantium**	Wild orange
C	*Persea palustris*	Swamp bay
C	*Roystonea regia*[ʃ]	Royal Palm
C	*Vitis shuttleworthii*[†]	Calloose grape
C, S, & G	*Acer rubrum*	Red maple
C, S, & G	*Annona glabra*	Pond apple
C, S, & G	*Ardisia escallonioides*	Marlberry
C, S, & G	*Avicennia germinans*	Black Mangrove
C, S, & G	*Carya aquatica*	Water hickory
C, S, & G	*Cephalanthus occidentalis*	Buttonbush
C, S, & G	*Chrysobalanus icaco*	Cocoplum
C, S, & G	*Ficus aurea*	Strangler ficus
C, S, & G	*Fraxinus caroliniana*	Pop ash
C, S, & G	*Ilex cassine*	Dahoon holly
C, S, & G	*Laguncularia racemosa*	White mangrove
C, S, & G	*Morus rubra*	Mulberry
C, S, & G	*Myrica cerifera*	Wax myrtle
C, S, & G	*Myrsine cubana*	Myrsine
C, S, & G	*Persea borbonia*	Red bay
C, S, & G	*Pinus elliottii*	Slash pine
C, S, & G	*Psidium cattleianum**	Strawberry guava
C, S, & G	*Quercus laurifolia*	Laurel oak
C, S, & G	*Quercus myrtifolia*	Myrtle oak
C, S, & G	*Quercus virginiana*	Live oak
C, S, & G	*Rhizophora mangle*	Red mangrove

C, S, & G	*Sabal palmetto*	Cabbage palm
C, S, & G	*Salix caroliniana*	Carolina willow
C, S, & G	*Schinus terebinthifolius**	Brazilian pepper
C, S, & G	*Senna pendula**	Beach cassia
C, S, & G	*Serenoa repens*	Saw palmetto
C, S, & G	*Syzygium cumini**	Java plum
C, S, & G	*Taxodium distichum*	Bald cypress
C, S, & G	*Vitis rotundifolia*†	Muscadine grape
S & G	*Abrus precatorius*†*	Rosary pea
S & G	*Acrostichum danaeifolium*	Leather fern
S & G	*Ageratum houstonianum**	Blue mink
S & G	*Alternanthera philoxeroides**	Alligator weed
S & G	*Alternanthera sessilia**	Sessile joy weed
S & G	*Alternanthera spp.**	Joy weed spp.
S & G	*Ammannia latifolia*	Koehn's Toothcup
S & G	*Amorpha fruticosa*	False indigo
S & G	*Andropogon spp.*	Blue stem
S & G	*Apios americana*†	Ground nut
S & G	*Ardisia elliptica**	Shoebutton Ardisia
S & G	*Baccharis glomeruliflora*	Silverling
S & G	*Baccharis halimifolia*	Groundsel tree
S & G	*Baccharis spp*	Saltbush
S & G	*Bacopa monnieri*	Water hyssop
S & G	*Bejaria racemosa*	Tar flower
S & G	*Bidens alba*	Beggar ticks
S & G	*Bischofia javanica**	Bishop wood
S & G	*Blechnum serrulatum*	Swamp fern
S & G	*Blechum pyramidatum**	Green shrimp plant
S & G	*Boehmeria cylindrica*	False nettle
S & G	*Callicarpa americana*	Beautyberry
S & G	*Canna flaccida*	Golden Canna
S & G	*Cardamine pensylvanica*	Bitter cress
S & G	*Carex lupuliformis*	Hop sedge
S & G	*Carex spp.*	Hop sedge spp.

S & G	*Chamaecrista fasciculata*	Partridge pea
S & G	*Chromolaena odorata*	Jack-in-the-bush
S & G	*Cissus verticillata*	Possum grape
S & G	*Cladium jamaicense*	Sawgrass
S & G	*Colocasia esculenta**	Wild taro
S & G	*Commelina diffusa**	Dayflower
S & G	*Crinum americanum*	Swamp lily
S & G	*Crotalaria pallida**	Mucronate rattlebox
S & G	*Cyperaceae spp.*	Unidentified
S & G	*Cyperus haspan*	Flat sedge
S & G	*Cyperus ligularis*	False saw grass
S & G	*Cyperus ovatus*	Pine barren flatsedge
S & G	*Cyperus rotundus*	Nut sedge
S & G	*Cyperus spp.*	Sedge seedling
S & G	*Cyperus virens*	Green flat sedge
S & G	*Dalbergia ecastaphyllum*	Coin vine
S & G	*Desmodium tortuosum**	Fla. beggar weed
S & G	*Desmodium triflorum**	Three flower begger weed
S & G	*Dichanthelium aciculare*	Needleleaf witchgrass
S & G	*Dichanthelium commutatum*	Variable witch grass
S & G	*Dichanthelium dichotomum*	Cypress witch grass
S & G	*Dichanthelium ensifolium*	Dwarf cypress witch grass
S & G	*Dichanthelium laxiflorum*	Open flower witch grass
S & G	*Dichanthelium spp*	Witch grass
S & G	*Diospyros virginiana*	Persimmon
S & G	*Eclipta prostrata*	False daisy
S & G	*Eleocharis baldwinii*	Road grass
S & G	*Eleocharis geniculata*	Canadian spike rush
S & G	*Erechitites hieraciifolius*	Fire weed
S & G	*Erythrina herbacea*	Coral bean
S & G	*Eupatorium capillifolium*	Dog fennel
S & G	*Eupatorium compositifolium*	Yankee weed
S & G	*Fern seedling*	Young fern
S & G	*Ficus microcarpa**	Indian laurel ficus
S & G	*Galactia elliottii*[†]	Elliott’s milkpea

S & G	*Galactia spp.*†	Milkpea spp.
S & G	*Galium tinctorium*	Bed straw
S & G	*Gamochaeta antillana*	Caribbean purple cudweed
S & G	*Gamochaeta pensylvanica*	Pennsylvania everlasting
S & G	*Gamochaeta spp.*	Cudweed spp.
S & G	*Hydrocotyle spp*	Pennywort spp.
S & G	*Hydrocotyle umbellata*	Dollarweed
S & G	*Hydrocotyle verticillata*	Whorled marsh pennywort
S & G	*Hygrophila polysperma**	E. Indian swamp weed
S & G	*Hymenocallis palmesi*	Alligator lily
S & G	*Hypericum cistifolium*	Roundpod St. John's wort
S & G	*Hypericum spp.*	St. John's wort spp.
S & G	*Hypericum tetropetalum*	Four petal St. John's wort
S & G	*Hypoxis curtissii*	Yellow stargrass
S & G	*Hyptis alata*	Musky mint
S & G	*Ilex glabra*	Gallberry
S & G	*Ipomoea alba*†	Moon vine
S & G	*Ipomoea indica*†	Blue morning glory
S & G	*Itea virginica*	Virginia willow
S & G	*Leersia hexandra*	Southern cutgrass
S & G	*Limnophilia sessiliflora**	Asian marsh weed
S & G	*Ludwigia alata*	Winged water primrose
S & G	*Ludwigia octovalis*	Mexican primrose willow
S & G	*Ludwigia peruviana**	Peruvian primrose willow
S & G	*Ludwigia repens*	Creeping primrose willow
S & G	*Ludwigia spp.*	Ludwigia spp.
S & G	*Lygodium microphyllum*†*	Old World climbing fern
S & G	*Lyonia fruticosa*	Stagger bush
S & G	*Lyonia lucida*	Fetterbush (Shiny Lyonia)
S & G	*Melanthera nivea*	Square stem
S & G	*Melinis repens**	Natal grass
S & G	*Melothria pendula*†	Creeping cucumber
S & G	*Micranthemum glomeratum*	Baby tears
S & G	*Mikania scandens*†	Hemp vine
S & G	*Mimosa quadrivalvis*†	Sensitive brier

S & G	*Mitreola petiolata*	Lax horn pod
S & G	*Momordica charantia*† *	Balsam apple
S & G	*Myriophyllum spicatum**	Water milfoil
S & G	*Nephrolepis cordifolia**	Tuberous sword fern
S & G	*Nephrolepis exaltata*	Wild Boston fern
S & G	*Oplismenus hirtellus*	Woods grass
S & G	*Osmunda cinnamomea*	Cinnamon fern
S & G	*Osmunda regalis*	Royal fern
S & G	*Panicium maximum**	Guinea grass
S & G	*Panicum rigidulum*	Redtop Panicum
S & G	*Panicum virgatum*	Switch grass
S & G	*Parietaria floridana*	Pellitory
S & G	*Parthenocissus quinquefolia*†	Virginia creeper
S & G	*Paspalum conjugatum*	Sour paspalum
S & G	*Paspalum spp.*	Paspalum spp.
S & G	*Pennisetum purpureum**	Elephant grass
S & G	*Phlebodium aureum*	Golden polypody
S & G	*Phytolacca americana*	Poke weed
S & G	*Pistia stratiotes**	Water lettuce
S & G	*Pityopsis graminifolia*	Silk grass
S & G	*Pleopeltis polypodioides*	Resurrection fern
S & G	*Pluchea odorata*	Marsh Fleabane
S & G	*Pluchea spp*	Fleabane spp.
S & G	*Poaceae spp.*	Unidentified
S & G	*Polygonum hydropiperoides*	Swamp smart weed
S & G	*Polygonum punctatum*	Dotted smart weed
S & G	*Polygonum spp.*	Smart weed
S & G	*Pontederia cordata*	Pickerel weed
S & G	*Pouzolzia zeylarica**	Pouzolz's bush
S & G	*Proserpinaca pectinata*	Combleaf mermaid leaf
S & G	*Psilotum nudum*	Whisk-fern
S & G	*Psychotria nervosa*	Wild coffee
S & G	*Psychotria sulzneri*	Velvet leaved wild coffee
S & G	*Pteridium aquilium*	Bracken fern
S & G	*Pteris tripartita**	Giant brack fern

S & G	*Ptilimnium capillaceum*	Mock Bishop's weed
S & G	*Quercus geminata*	Sand live oak
S & G	*Quercus seedling*	Oak seedling
S & G	*Rhabdadenia biflora*†	Rubber vine
S & G	*Rhus copallinum*	Winged sumac
S & G	*Rhynchospora inundata*	Horned beak sedge
S & G	*Rhynchospora rariflora*	Few flower beak sedge
S & G	*Rhynchospora spp.*	Beak sedge
S & G	*Rivira humilis*	Rouge plant
S & G	*Rotala ramosior*	Tooth cup
S & G	*Rubus cuncifolius*	Sand blackberry
S & G	*Rubus trivialis*	Blackberry/Dewberry
S & G	*Rumex verticillatus*	Swamp dock
S & G	*Sabatia calycina*	Coastal rose gentian
S & G	*Sagittaria lancifolia*	Bull tongue arrowhead
S & G	*Sagittaria latifolia*	Broadleaf arrowhead
S & G	*Salvinia minima**	Water spangles
S & G	*Samolus valerardi*	Pineland pimpernel
S & G	*Sarcostemma clausum*†	White vine
S & G	*Saururus cernuus*	Lizard's tail
S & G	*Schizachyrium sanguineum*	Crimson bluestem
S & G	*Sesuvium maritimum*	Sea purslane
S & G	*Sida ulmifolia*	Wire weed
S & G	*Smilax auriculata*†	Earleaf greenbrier
S & G	*Smilax bona-nox*†	Saw greenbrier
S & G	*Smilax laurifolia*†	Laurel greenbrier
S & G	*Smilax spp*	Greenbrier
S & G	*Solanum americanum*	Common night shade
S & G	*Solidago odora* var. *chapmanii*	Chapman's goldenrod
S & G	*Sonchus oleraceus*	Common sow thistle
S & G	*Spermacoce verticillata**	False buttonweed
S & G	*Sphagneticola trilobata**	Wedelia
S & G	*Sporobolus indicus**	Smut grass
S & G	*Stenotaphrum secundatum*	St. Augustine grass
S & G	*Symphyotrichum carolinianum*†	Climbing aster

S & G	*Syngonium podophyllum*†*	Nephthytes
S & G	*Thelypteris dentata**	Downy shield fern
S & G	*Thelypteris interrupta*	Tri-veined fern
S & G	*Thelypteris kunthii*	Maiden fern
S & G	*Thelypteris palustris*	Marsh fern
S & G	*Thelypteris serrata*	Meniscium fern
S & G	*Thelypteris spp.*	Unidentified
S & G	*Tillandria fasciculata*‡	Cardinal airplant
S & G	*Tillandria setacea*‡	Needleleaf airplant
S & G	*Toxicodendron radicans*†	Poison ivy
S & G	*Triglochin striata*	Arrow grass
S & G	*Tripsacum dactyloides*	Fakahatchee grass
S & G	*Typha domingensis*	Southern cattail
S & G	*Typha latifolia*	Broadleaf arrowhead
S & G	*Urena lobata**	Caesar weed
S & G	*Urochloa mutica**	Para grass
S & G	*Vigna luteola*†	Hairy pod cowpea
S & G	*Vitis aestivalis*†	Summer grape
S & G	*Ximenia americana*	Tallow wood, hog plum
S & G	*Xyris spp.*	Unidentified
S & G	*Zanthoxylum clava-herculis*	Hercules club

*****Non-native
⸸Cultivated
‡Airplant
†Vine

Supplemental 7: Loxahatchee River Watershed Projects Completed Before 2010

Barbara H. Welch[1], Elizabeth Salewski[1], LRMCC, Robin Rossmanith[2], Mike Yustin[3]

[1]SFWMD; [2]FPS JDSP; [3]Martin County

Thirty-one Loxahatchee River Watershed Projects were completed before 2010 (Table S7.1). These projects improved altered hydrology, habitat, and water quality issues, and helped reduce human impacts on the Loxahatchee River and watershed.

Eleven projects were completed related to hydrologic restoration in one or more phases of Jones Creek, Pal Mar East, Delaware Scrub, Limestone Creek, Riverbend Park, Sandhill Crane East, South Loxahatchee Slough, Hungryland Slough, and Sawfish Bay Park. Most of these projects also included non-native vegetation control. Nine projects were completed by either Martin County or the Town of Jupiter and focused on stormwater-related issue (e.g., drainage and water quality) in mostly urban areas. The Town of Jupiter acquired 33 acres of waterfront property used for dispersed water management and completed a surface water recharge improvement project in the C-18 basin. LRECD completed construction of the Loxahatchee River Environmental Center and provided a campaign for a septic tank maintenance program. LRECD also completed an event-based stormwater runoff testing. Improvements were completed for failing public water and wastewater facilities at JDSP.

Table S7.1. Loxahatchee Watershed projects competed before 2010 (⸙Project summary is provided below).

Lead Entity	Project Name / Description	Project Type	Start Date	Year Completed
1. Jupiter Inlet District⸙	Oxbow Restoration - Gaps within the mangrove shoreline were closed at four sites within JDSP.	Hydrologic Restoration	1996	1997
2. Jupiter Inlet District	Jones Creek Restoration Phase II - Hydrologic restoration, reduce sediment loads, exotic vegetation removal, and shoreline access improvements.	Hydrologic Restoration	2007	2007
3. Loxahatchee River District	Improvements at Jonathan Dickinson State Park - Construction of public water and wastewater facilities.	Wastewater Service Area Expansion	2003 & 2005	2003 & 2005
4. Loxahatchee River District	Loxahatchee River Water Quality Event Sampling - Sampling and testing stormwater runoff during and after heavy rainfall events.	Monitoring / Data Collection	2006	2006
5. Loxahatchee River District	Loxahatchee Septic Tank Maintenance Program - Public information campaign for septic tank maintenance and cost-sharing initiative for regularly servicing	Education Efforts	2007	2007
6. Loxahatchee River District	LRPI Public Outreach Phases I-III - Construction of the Loxahatchee River Environmental Center with exhibits and interactive displays.	Education Efforts	2007	2008
7. Loxahatchee River District	Loxahatchee River Oyster Reef Enhancement: 2008-2009 oyster restoration projects beneath 9 residential docks.	Creating / Enhancing Oyster Reefs	2008 & 2009	2008 & 2009
8. Martin County	Kitching Creek - Flora Ave Phase I - Construction of stormwater treatment area and exotic vegetation removal.	Stormwater Treatment Area	2006	Completed
9. Martin County	Little Club Storm Water Quality Retrofit - Construction of stormwater treatment area and installation of weirs	Stormwater Treatment Area	2003	2007

Lead Entity	Project Name / Description	Project Type	Start Date	Year Completed
10. Martin County	Pal Mar East - Plug ditches throughout property that drain wetland areas	Hydrologic Restoration	2009	2009
11. Martin County	Tropic Vista Water Quality Retrofit - Construction of 7.4 acre stormwater treatment area and installation of control structures.	Stormwater Treatment Area	2003	2005
12. Palm Beach County	Delaware Scrub Phases I - II - Exotic vegetation control and public use facilities.	Hydrologic Restoration	2006	2009
13. Palm Beach County	Limestone Creek Phases I-III - Exotic vegetation control, hydrologic restoration, and kayak launch.	Hydrologic Restoration	2005	2008
14. Palm Beach County	Loxahatchee Slough - Lucky Tract - Exotic vegetation control.	Exotics Removal	2003	2004
15. Palm Beach County	Riverbend Park Hydrologic Restoration - Hydrologic restoration of historic flow-ways and exotic vegetation control.	Hydrologic Restoration		2004
16. Palm Beach County	Sandhill Crane East Phases I-II - Exotic vegetation control and hydrologic restoration.	Hydrologic Restoration	2007	2009
17. Palm Beach County	South Loxahatchee Slough and Hungryland Slough Phases II and III - Exotic vegetation control and hydrologic restoration.	Hydrologic Restoration	2003	2007
18. South Indian River Water Control District	Exotic Vegetation Removal - Exotic vegetation control and hydrologic restoration.	Hydrologic Restoration	2006	2006
19. South Indian River Water Control District	Lateral Canal Improvements - Construction, operation, and maintenance of five operable water control structures.	Control Structure	2003	2003

Lead Entity	Project Name / Description	Project Type	Start Date	Year Completed
20. Town of Jupiter	Community Stormwater Retrofits - Improved outfalls and water quality treatment.	Stormwater System Upgrade	2006	2006
21. Town of Jupiter	Hydrological Restoration of Sawfish Bay Park - Erosion control, shoreline stabilization, habitat enhancement, and mangrove restoration.	Hydrologic Restoration	2006	2006
22. Town of Jupiter	Jones Creek Parcel Hydrologic Restoration - Exotic vegetation control, flood plain water quality treatment, and mangrove restoration.	Hydrologic Restoration	2007	2007
23. Town of Jupiter	Jones Creek Phase II Hammock Restoration - Exotic vegetation control, hydrologic restoration, and public access.	Hydrologic Restoration	2005	2005
24. Town of Jupiter	Jones Creek Restoration - Upstream stormwater quality improvements, exotic vegetation control, sediment removal, and bank stabilization.	Hydrologic Restoration	2003	2003
25. Town of Jupiter	Limestone Creek Restoration - South - Sediment removal, exotic vegetation control, bank stabilization, and revegetation.	Hydrologic Restoration	2006	2006
26. Town of Jupiter	Pennock Industrial Park Outfall Upgrades - Water quantity and quality upgrades to the stormwater management system.	Stormwater System Upgrade	2003	2004
27. Town of Jupiter	Surface Water Recharge System Improvements I - System to capture and retain up to 10 MGD of excess stormwater runoff from the C-18 basin in lieu of discharging to tide.	Dispersed Water Management	1990	2007

Lead Entity	Project Name / Description	Project Type	Start Date	Year Completed
27. Town of Jupiter	Surface Water Recharge System Improvements I - System to capture and retain up to 10 MGD of excess stormwater runoff from the C-18 basin in lieu of discharging to tide.	Dispersed Water Management	1990	2007
28. Town of Jupiter	Urban Stormwater Management System Rehabilitation - Rehabilitation of swale systems within Fisherman's Landing and Tidewater Drive.	Stormwater System Upgrade	2006	2006
29. Town of Jupiter	Urban Stormwater Management System Rehabilitation - Phase II - Rehabilitation of swale systems within Choctaw Street, Todd Street, Tidewater Drive, and North Palm Beach Heights.	Stormwater System Upgrade	2007	2007
30. Town of Jupiter	Urban Stormwater Management System Rehabilitation - Phase III - Rehabilitation of swale systems within Maplewood Drive and North Palm Beach Heights.	Stormwater System Upgrade	2008	2008
31. Town of Jupiter	Urban Stormwater Management System Rehabilitation - Phase IV - Rehabilitation of swale systems within Jupiter River Estates.	Stormwater System Upgrade	2009	2009

Jonathan Dickinson State Park Oxbow Restoration (Completed 1996 and 1997)

The Jupiter Inlet District completed its Oxbow Restoration project at four sites within Jonathan Dickinson State Park. Boat traffic had resulted in the destruction of mangrove shorelines and the breaching of narrow divisions between adjacent channels. These breaches effectively straightened the channel by shortcutting historical meanders, thereby allowing more direct tidal influence upon upstream reaches. Closure of the gaps (1) improved water quality in stagnant areas; (2) reduced organic deposition in isolated oxbows; and (3) increased retention time of freshwater runoff in the Northwest Fork and decreased saltwater intrusion. Two of the four gaps were closed in 1996, with the remaining two closed in February 1997.

The gaps were plugged with a barrier of core stone placed upon a geotextile layer. This core was faced with a layer of larger armoring rock. The top of the plug was then planted with mangroves, thus providing a hydraulic barrier that was biologically and aesthetically compatible with the surrounding state park. Project performance has been evaluated through salinity probes in the river, upstream and downstream from the gap closures. Additionally, water quality testing shows the effects of improved flushing resulting from gap closures.

Pal Mar East (Nine Gems) Hydrologic Restoration (Completed 2010)

Pal Mar East is a roughly 2,900-acre property between Seminole Pratt Whitney Road and I-95/Florida Turnpike in southern Martin County (Figure S7.1). The property is included within the footprint of Flow-way 3, which is one of the major components of the Loxahatchee River Watershed Restoration Project (LRWRP). The project involved plugging a series of ditches that over-drained wetlands on the property (Figure S7.2A). The project increased hydroperiods and enhanced wetland functions on approximately 2,400 acres of wetland habitat on the property (Figure S7.2B). By capturing stormwater in the rainy season, the project helps provide dry-season freshwater flows to the Northwest Fork.

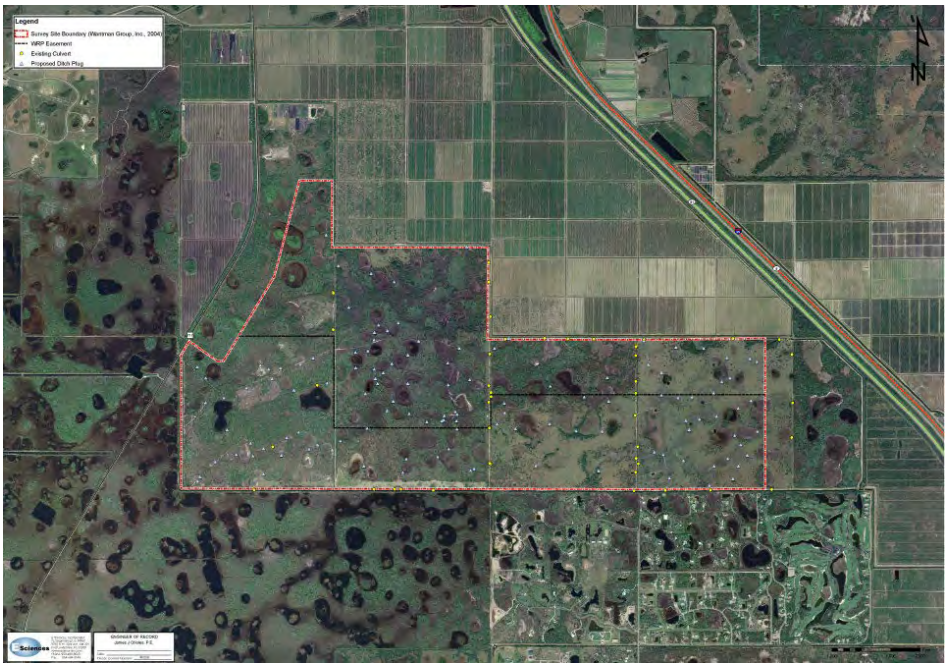

Figure S7.1. Pal Mar East (Nine Gems) hydrologic restoration map.

Figure S7.2. Pal Mar East (Nine Gems) property (A) before and (B) after hydrologic restoration.

Supplemental 8: Relevant Links

1985 Loxahatchee River NWSR Management Plan
2000 Loxahatchee River NWSR Management Plan
2006 Restoration Plan for the Northwest Fork of the Loxahatchee River
2009 Florida Statutes Chapter 373 Section 59
2010 Loxahatchee River NWSR Management Plan
2020 Water Resources Development Act
Busch Wildlife Sanctuary
CERP LRWRP
CERP LRWRP Alternative 5R
CERP LRWRP Performance Measures
DEP Category 4e Assessment
DEP Impaired Waters Listing Process
DEP Surface Water Quality Standards FAC 62-302.530
Early Facts About Rotonda West
Elsa Kimbell Education and Research Center
Federal Register Public Law 90-542
Final Integrated Project Implementation Report and Environmental Impact Statement
FL DOH Healthy Beaches Program
FL Rule 40E-8 MFL
Florida Center for Instructional Technology, Florida Census
Florida Wildlife Corridor Act 259.1055
Grassy Waters Preserve
JDSP Hydrologic Restoration Plan
JDSP Jonathan Dickinson State Park
JDSP Unit Management Plan
Jeaga Wildways
Lower East Coast Water Supply Plan for the Loxahatchee Basin
Loxahatchee River Battlefield Park
Loxahatchee River Designation Chapter 83-358 Laws of Florida
LRECD Datasonde monitoring program
LRECD Future Projects
LRECD Ongoing Projects
LRECD River Center Programs
LRECD RiverKeeper
LRECD Water Quality Results
LRMCC Bylaws

LRPI
LRWRP Rulemaking Technical Document
MC Census
MC Conservation represented by Martin County Audubon Society
National Wild & Scenic Rivers System - Loxahatchee River
Numeric Nutrient Criteria (NNC)
PBC Census
PBC Conservation represented by Florida Native Plant Society
PBC Farm Bureau
PBC Natural Areas
Pollutant Reduction Plan (4e PRP).
River Users represented by Palm Beach Pack and Paddle Club
Riverbend Park
SFWMD 1999 Save Our Rivers
SFWMD DBHYDRO
SFWMD ePermitting
SFWMD NW Fork MFL
State Owned Lands F.S.253.034(5)
Tanah Keeta Boy Scout Camp
The River Center
TMDL
Trapper Nelson's Interpretive Site
Wild and Scenic Rivers Act