

# Minimum Flows Development in a Spring System Displaying Increased Flows

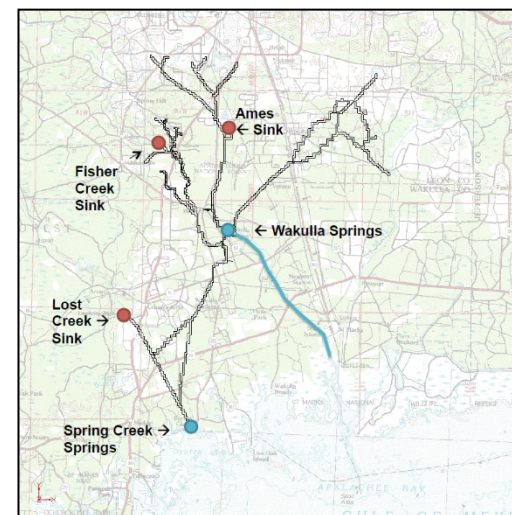


Paul Thurman, PhD



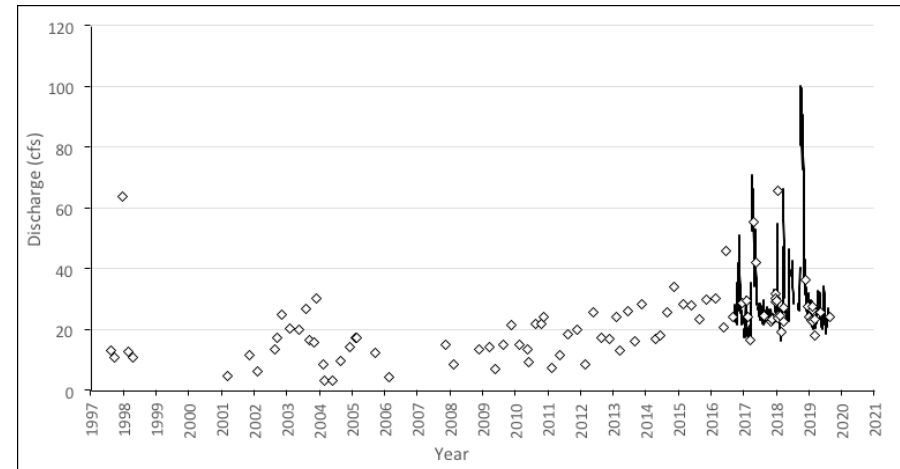
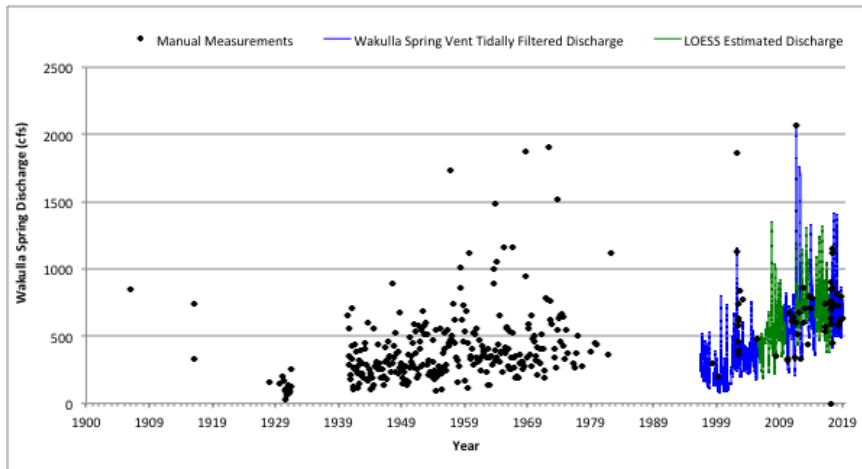
# Wakulla and Sally Ward Spring System Minimum Flows (MFLs) Project

- Study area extends from spring vents to the confluence of the St. Marks and Wakulla Rivers
  - Wakulla Spring (575 cfs)
  - Sally Ward Spring (23 cfs)
- System Characterized by Extremely Complicated Hydrology and Changing Conditions
  - Numerous sinking streams, lakes and conduits
  - Periods of significant surface water inputs
  - Increasing Flows



# Wakulla Spring Flow Data

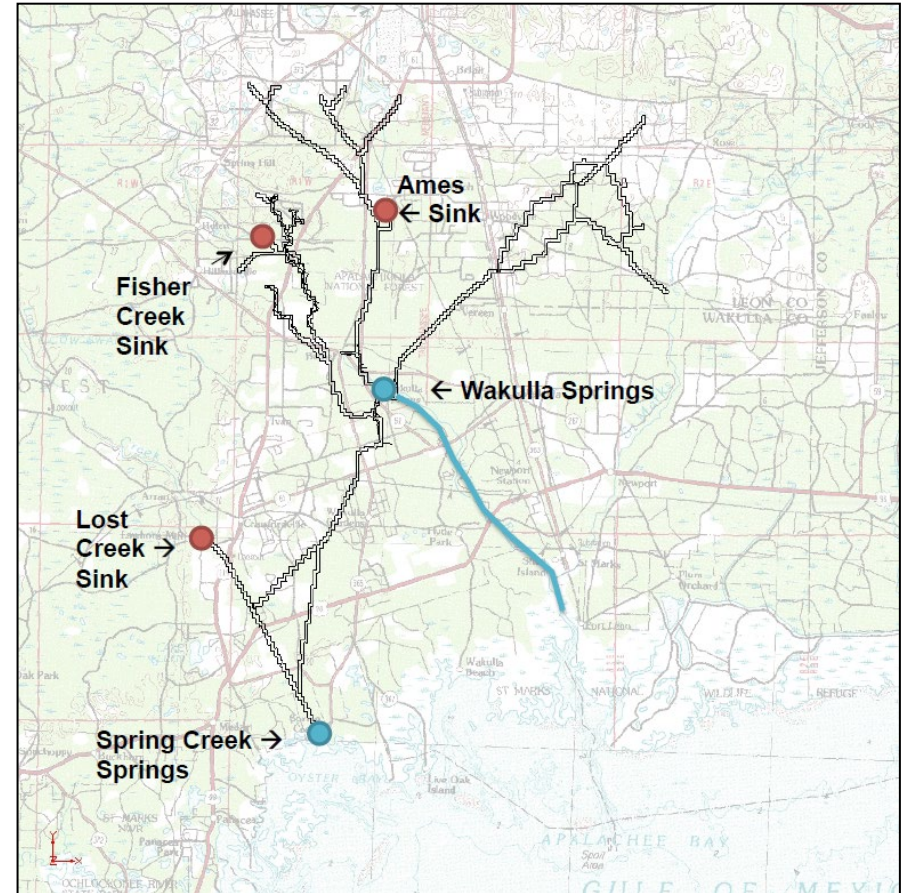
- Wakulla Spring Discharge
  - Discrete data between 1907 and present (2019)
  - Continuous data available from 1997 through present (2019)
- Sally Ward Spring Discharge
  - Discrete data between 1997 and present (2019)
  - Continuous data from 2016 through present (2019)
- Both Springs Displayed Increasing Flows



# Changes in Head Gradients

## Wakulla/Sally Ward Spring System and Spring Creek Springs Group

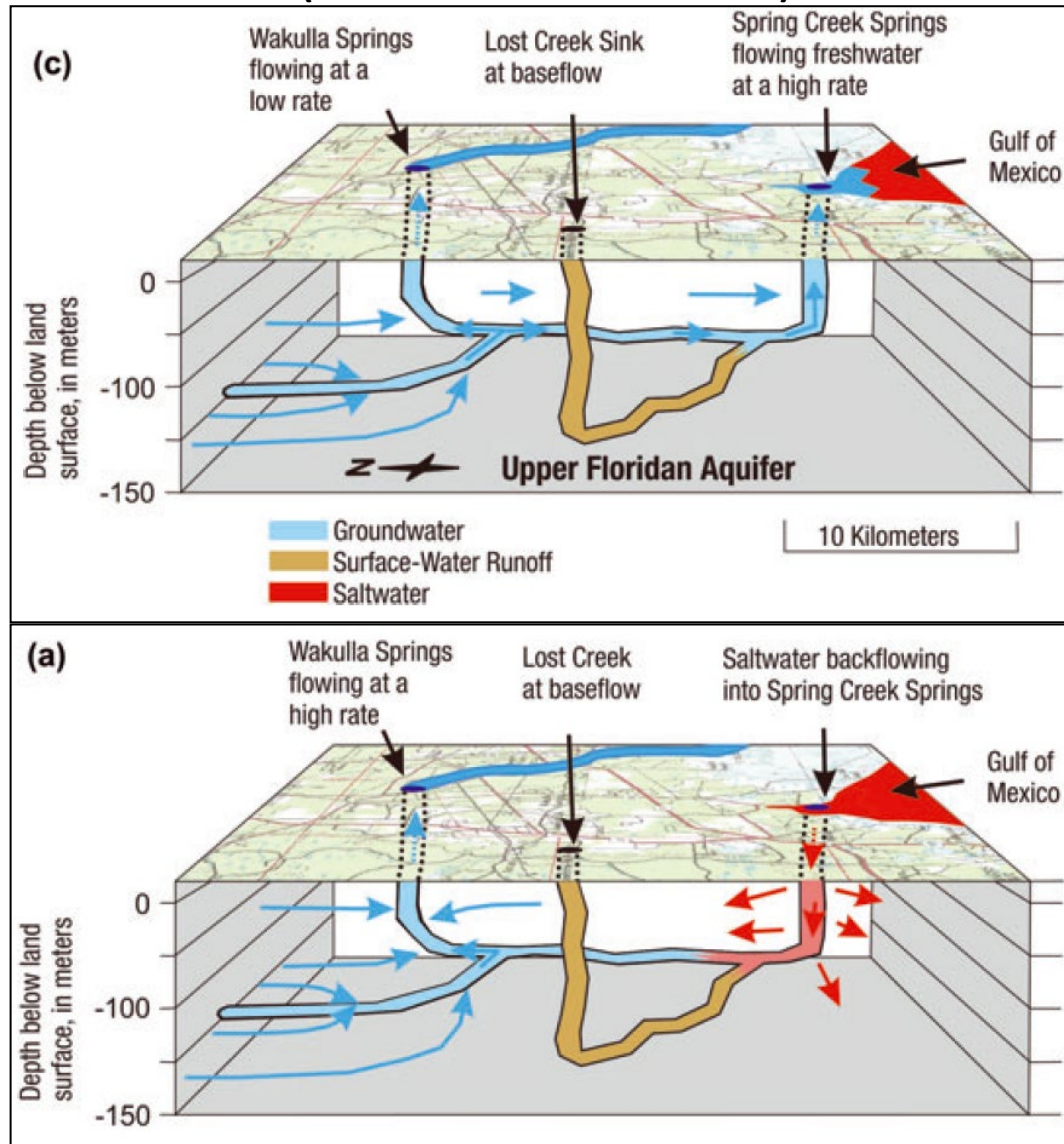
- Sea Level Rise is Reducing Head Gradients between the systems
- Diverting freshwater flows from Spring Creek to Wakulla Spring





# Conceptual Model

(from Davis and Verdi 2014)

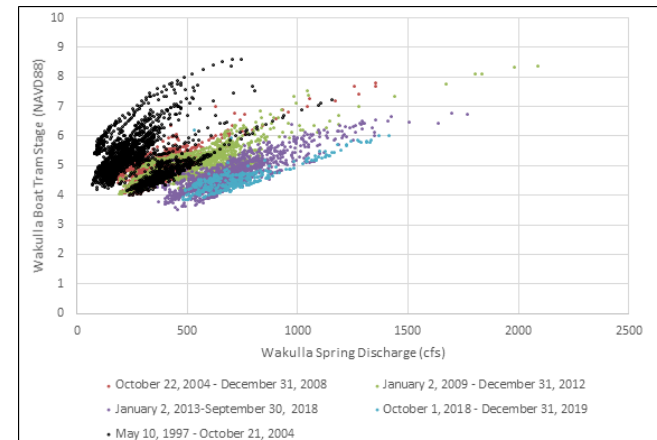
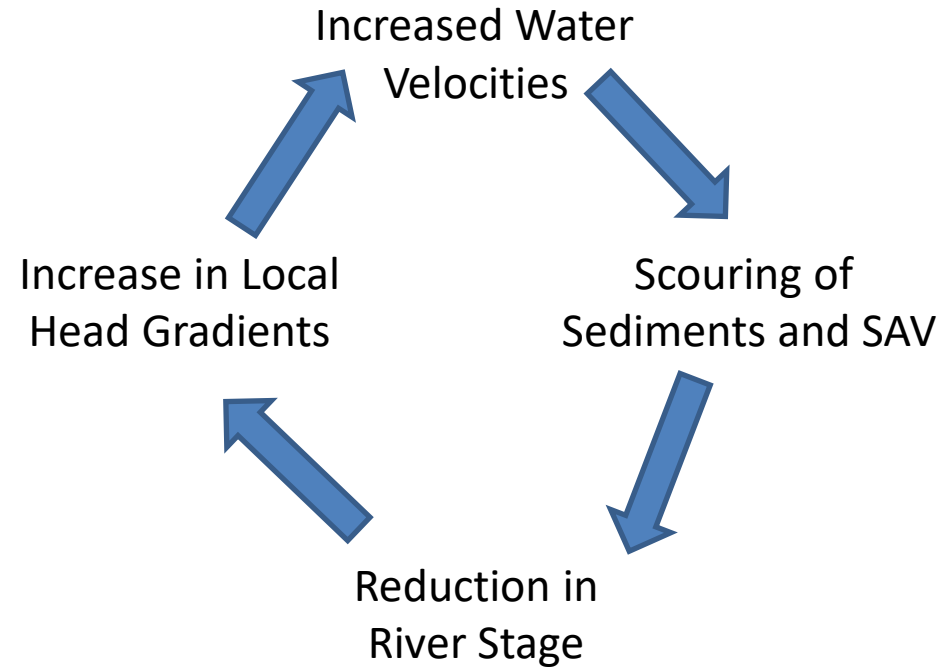


Davis, H. and R. Verdi. 2014. Groundwater Flow Cycling Between a Submarine Spring and an Inland Freshwater Spring. *Groundwater*. 52 (5): 705-716.



# Cascading Effects of Changes

- What is the Baseline Time Period?
- Increased water velocities resulted in scouring of sediments and reduction in river stage.
- Changing stage/discharge relationship
- Riparian wetlands, etc. no longer supported by out of bank flows
- Manatees are now capable of accessing spring pool
- Large volume of discharge results in large reductions of water resulting in little change in quantifiable metrics



# Wakulla and Sally Ward Spring System 1997 through 2004

- Period characterized by heavy hydrilla presence
- Elevated water levels, lower spring flows
- Beginning in 2002, herbicide treatments to reduce hydrilla
- River conditions determined to not be representative of natural conditions and unlikely to return
- Stage discharge relationship changed significantly during that time
- Period not used in MFL Analysis



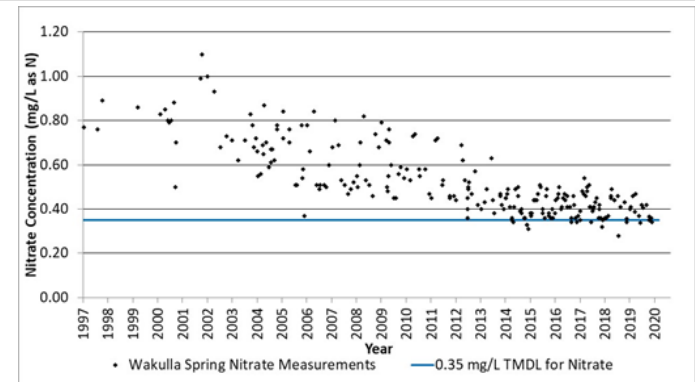
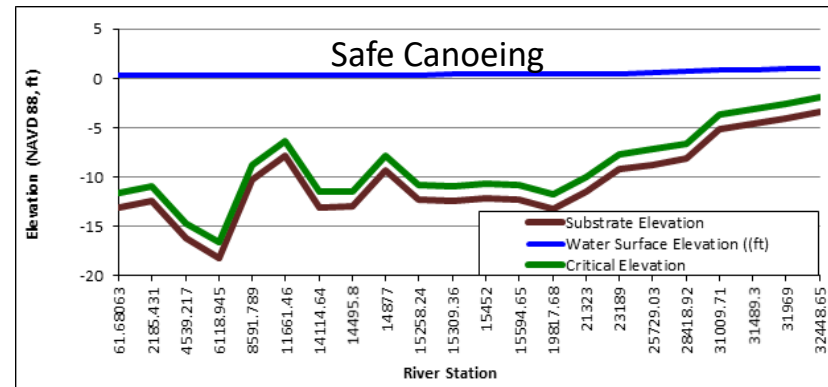
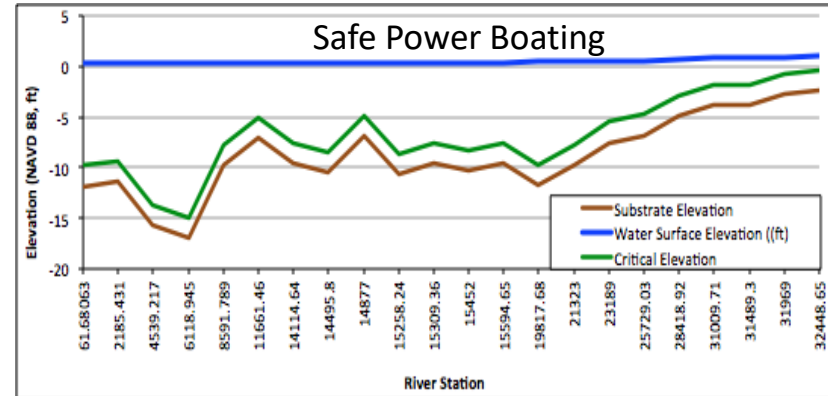
Wakulla Spring



# WRV Metrics and Results

Most metrics not sensitive to spring flow reductions

- Wakulla boat tour, canoe/kayak, public power boating, and fish passage
  - Water depths exceeded under all flows
- Oligohaline and Manatee thermal refuge habitats
  - 30% spring flow reduction did not result in a 15% reduction of habitat
- Water Quality
  - Allowable spring flow reduction of 15 percent, did not result in a change in nitrate concentration significantly different from 0 mg/L.

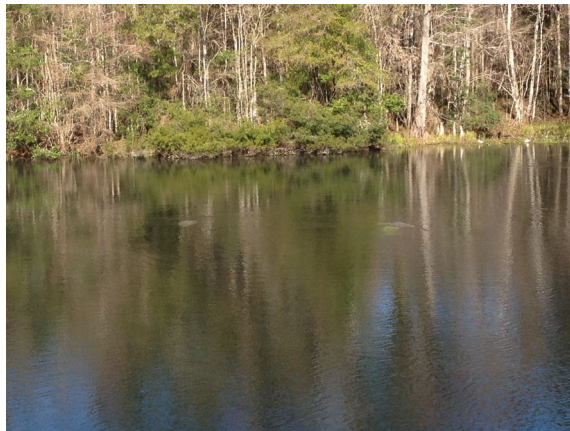




# Results

## Manatee Thermal Refuge

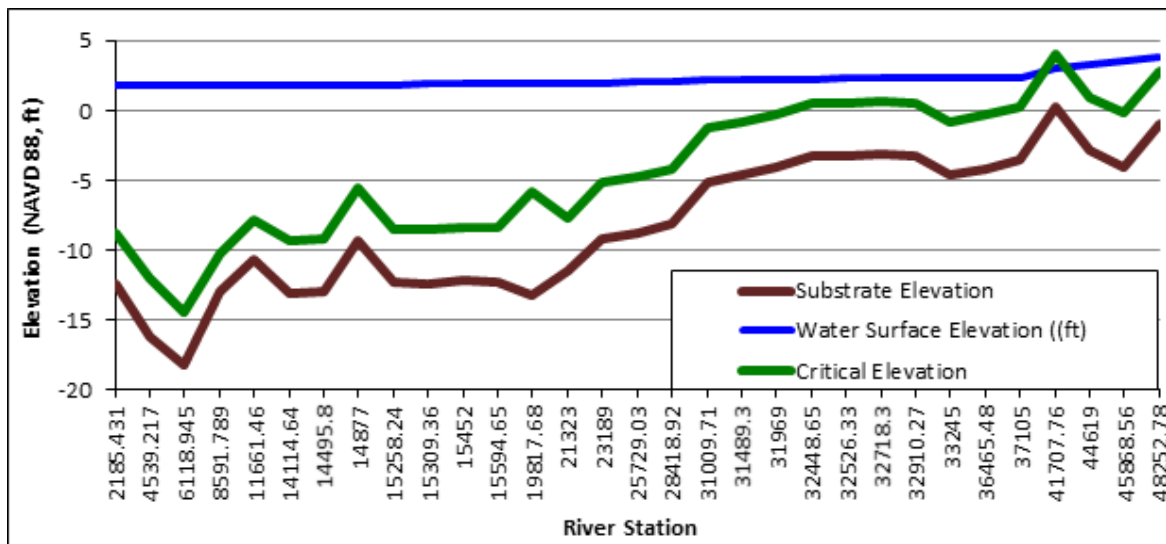
- No Acute Temperature Criteria (<15 °C for Four Hours) observed
- Chronic Criteria - Less Than 20 °C for more than three days
  - High flows create large areas of thermal habitat
  - Under reduced spring flow conditions, > 1,900 manatees supported during the most limiting climatic conditions
  - Often reduced flows resulted in increased thermal habitat
    - Spring water naturally remained <20 °C after air temperatures increased
- Metric determined to not be limiting



# Results

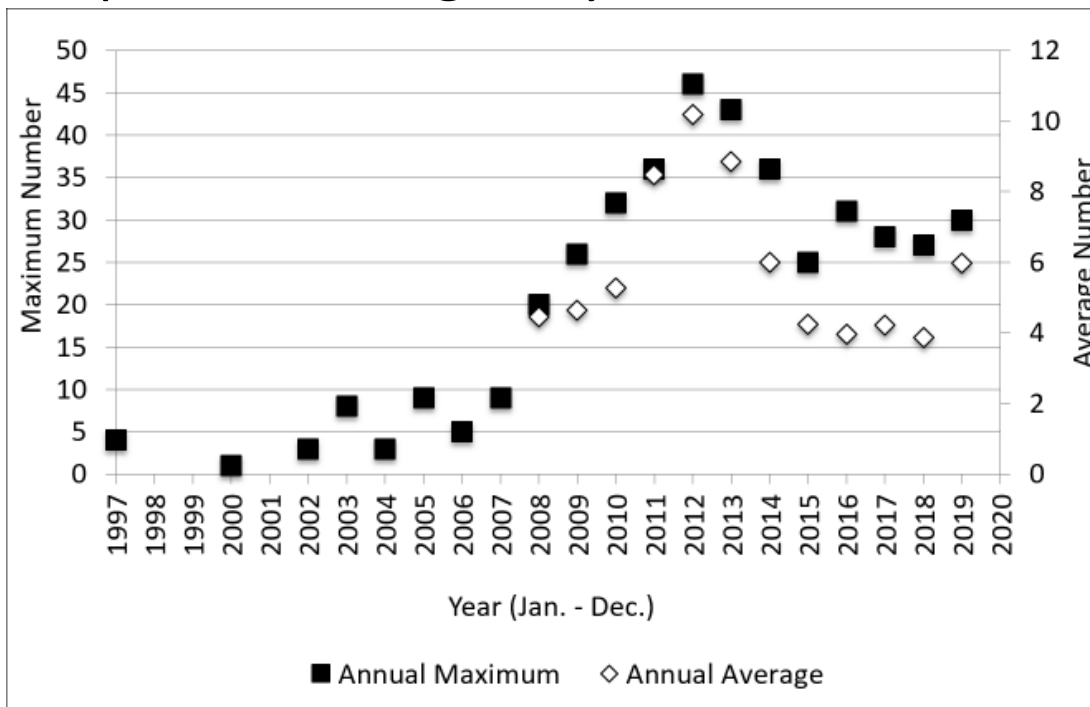
## Safe Manatee Passage

- Depth and width of 3.8 feet based on manatee dimensions
- One transect was limiting (station 41707.76) along Wakulla River due to shallower depths
- Allowable spring flow reduction of 59.21 cfs (38.3 mgd) corresponds to 15% reduction in days per year of passage
  - Reduction in stage of 1.7 inches
- FWC stated 2.5 ft of depth required for safe manatee passage



# Manatee Use at Wakulla Spring

- Historically, manatee use was limited at best
  - First observations during July 1983
  - Few individuals during summer months
  - Sporadic until 2002
- Increased flows and scouring allowed manatees to access spring pool more regularly





# Wakulla and Sally Ward Spring System

## Results Summary

Metric	Flow Percentile	Baseline Spring Flow (cfs)	Allowable Reduction in Total Spring Flow, cfs (MGD)	Allowable Spring Flow Reduction (%)
Safe Manatee Passage	34	520	59.21 (38.3)	10.2
Manatee Thermal Refuge	na	575	>172.5 (111.5)	>30%
Estuarine Resources	na	575	>172.5 (111.5)	>30%
Fish Passage	Metric Not Sensitive			
Canoe/Kayak Passage	Metric Not Sensitive			
Public Power Boat	Metric Not Sensitive			
Wakulla Tour Boat	Metric Not Sensitive			
Water Quality - Nitrate	Metric Not Sensitive			



# Thank You

**Paul Thurman**

**Program Manager, Minimum Flows and Levels**

**[Paul.Thurman@nfwwater.com](mailto:Paul.Thurman@nfwwater.com)**

**850-539-2620**

**The MFL Technical Assessment Report and Appendices are Available  
for Download on the District Website at:**

**[https://www.nfwwater.com/Water-Resources/Minimum-Flows-  
Minimum-Water-Levels](https://www.nfwwater.com/Water-Resources/Minimum-Flows-Minimum-Water-Levels)**