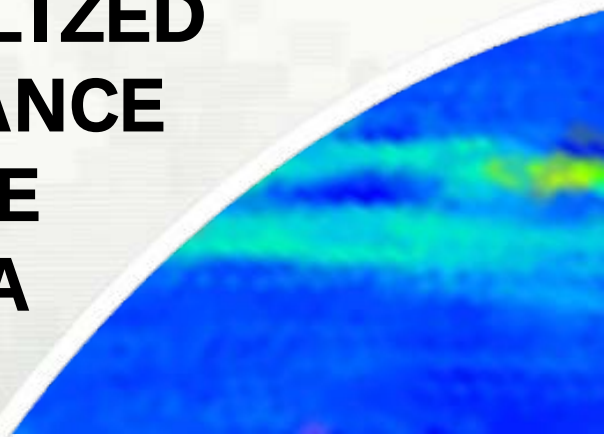
# ENVIRONMENTAL BENEFITS REALIZED DURING NAVIGATION MAINTENANCE DREDGING: A CASE STUDY IN THE INDIAN RIVER LAGOON, FLORIDA



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**14 June 2016**


ERDC
Engineer Research and Development Center

# Outline

- **Background**
  - Significantly impacted lagoon system with increasing awareness
  - Opportunity to monitor navigational dredging to quantify environmental benefits in impacted waterbody
  - Collaboration between: USACE Jacksonville District and ERDC-CHL, Florida Institute of Technology (FIT), Florida Inlet Navigation District (FIND), and the Indian River Lagoon Research Institute (IRLRI)
- **Dredging Operations**
- **Nutrient Removal Efficiency**
- **Measuring of Sediment Movement**
- **Environmental Monitoring**
- **Summary**
- **Acknowledgments**

# Location




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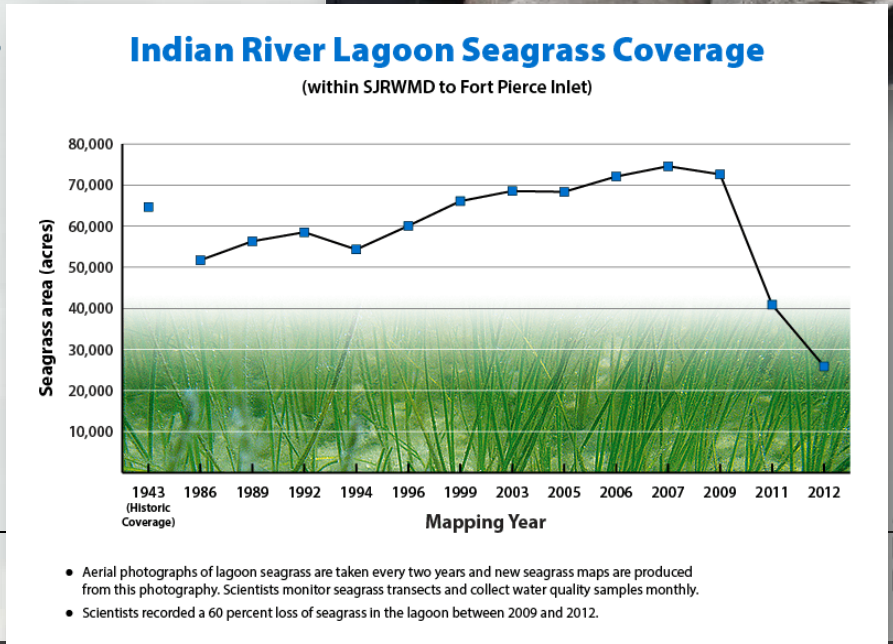
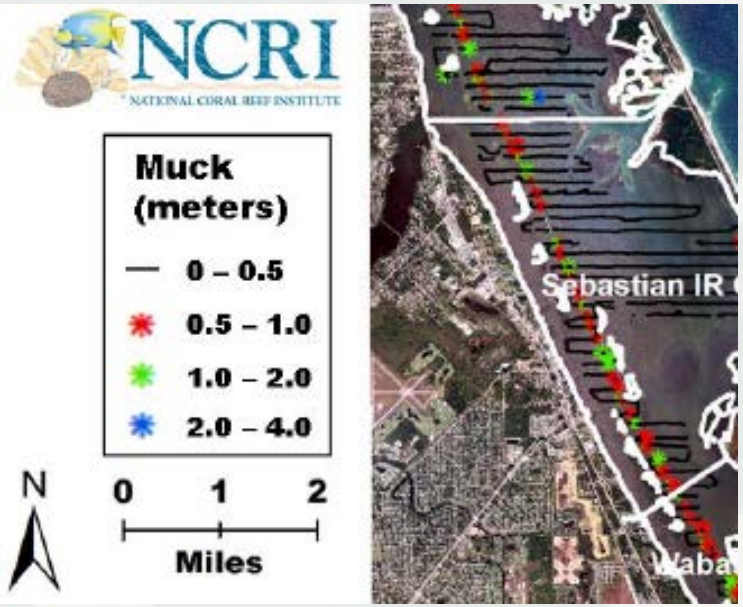
# Indian River Lagoon (IRL)

- 2010 Bloom - cyanobacteria, diatoms, and dinoflagellates
- 2011 “Superbloom” -
  - Marine mammals impacted
  - Die off of benthos
  - Near complete loss of seagrass
- Cascading impacts
  - Decreased light penetration
  - Reduced drift algae
  - Increased nutrients
  - Muck deposits



# Indian River Lagoon

- The U.S. Army Corps dredged northern 5 miles of the Intracoastal Waterway (IWW) for FIND
- This portion of the IWW has not been dredged since 1957
- IWW 12 ft deep to MLLW and 125 ft wide
- State appropriated $60+M in 2014-2016 to dredge and monitor the IRL to improve WQ
  - $4M to FIT
  - $20M to SJWMD
  - $37.5M to Brevard County



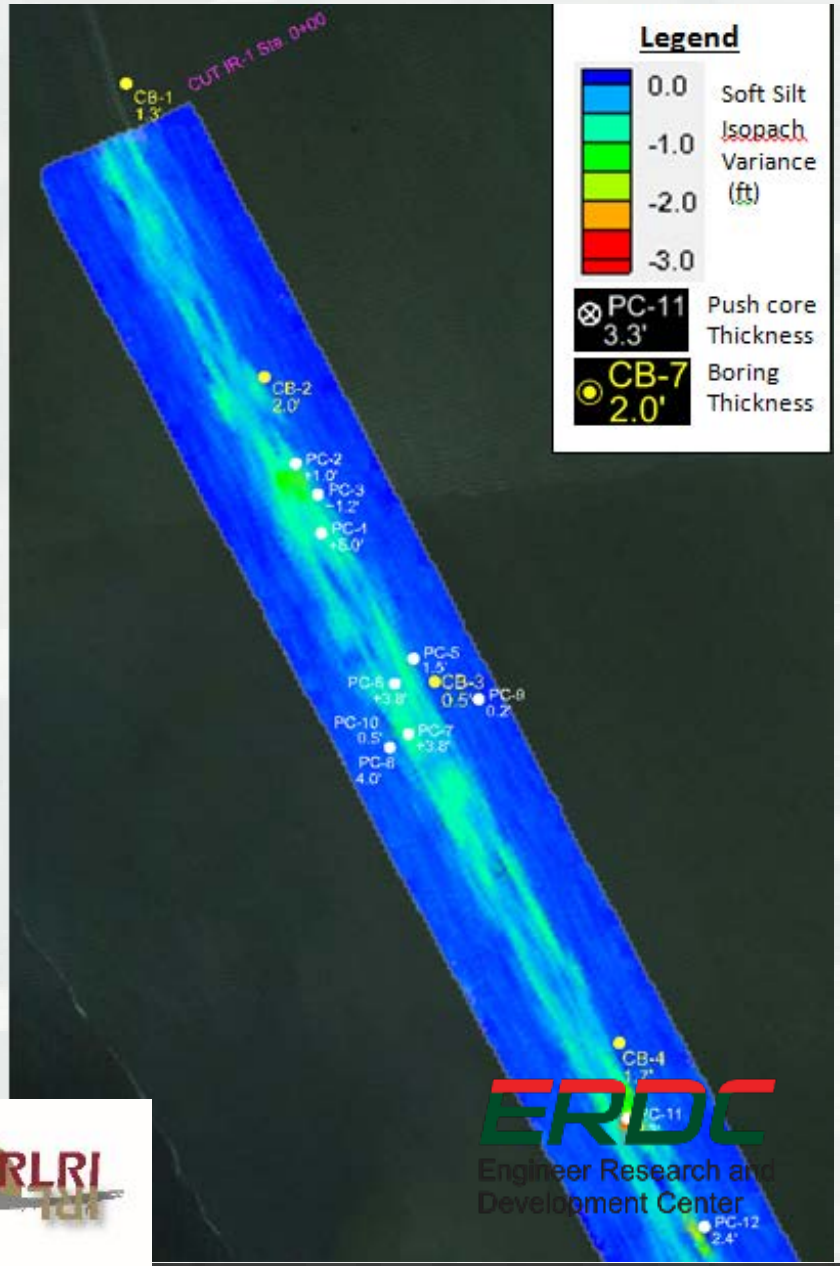
# Dredging Operations

- Dredging occurred January - June 2015
  - 211,000 m3 (276,000 cy) removed
  - Confined Placement Area (PA) retained all dredged material
  - 3-5 days of discharge at the beginning
  - no controlled release after initial testing
- Water left PA via
  - Percolation
  - Evaporation


# Hydrosurvey Hi and Low Frequency Isopach

- Utilized SAJ single beam hydrosurvey data to map soft sediment thickness
- Performed push cores to verify hydrosurvey findings
- Cores and survey data matched well

| Average Thickness of soft silt | in. | cm |
|---|---|---|
| 12 ft channel and side slopes | 5.3 | 13.4 |
| Outside of channel and slopes | 3.1 | 7.9 |



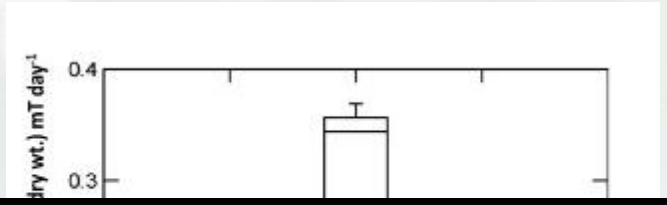
# Isopach Volumes & Mass

| Pre-dredge Survey | Soft Silt (CY) | Soft Silt (m3) | Mass* (S. Tons) | Mass* (Tons) |
|---|---|---|---|---|
| **Channel bottom at 12 ft depth** | 15,085 | 11,534 | 19,579 | 17,762 |
| **Channel bottom at 14 ft depth** | 31,255 | 23,896 | 40,564 | 36,799 |
| **Channel and side slopes at 12 ft depth** | 32,096 | 24,539 | 41,657 | 37,790 |
| **Channel and side slopes at 14 ft depth** | 62,790 | 48,007 | 81,494 | 73,930 |
| **Outside of channel and side slope** | 34,350 | 26,262 | 44,582 | 40,444 |

* Insitu measured bulk density of 1.54 g/cm$^3$ conversion of 2,596 lbs/CY

# Flux of Mud and Muck Movement

- 24 sondes deployed each collection event 4 horizontal & 4 vertical at 3 transect locations

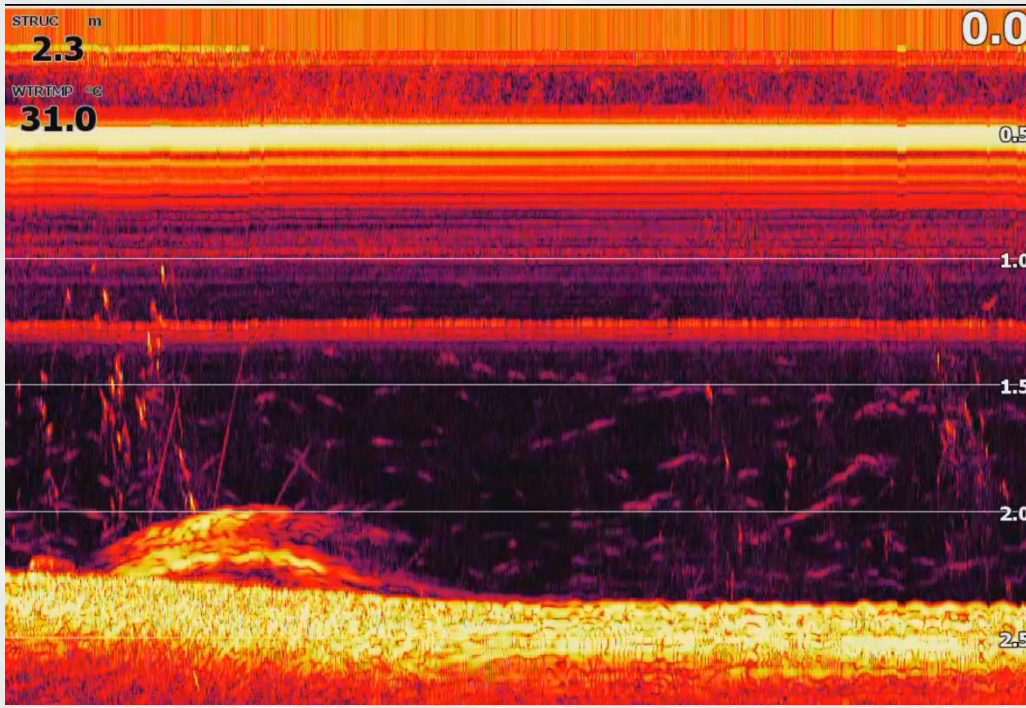




Transect 4 – Bottom 0.5 m Cross Sectional Area Dry Wt. Flux (lb/day)

| Channel location | Pre-dredging | During | Post-Dredging |
|---|---|---|---|
| West | 36 | 760 | 390 |
| Mid | 340 | 810 | 550 |
| East | 51 | 230 | 510 |
| Relative Flux | 1 | +4.5 | +3.4 |

# Flux of Mud and Muck Movement

- Acoustic fan beam 455 KHZ fixed station image recording of a current induced resuspension event in the turbid bottom nepheliod layer at Transect 2, August, 2015. Demonstrates natural increases in bottom turbidity due to bottom boundary layer currents.




0 Time +

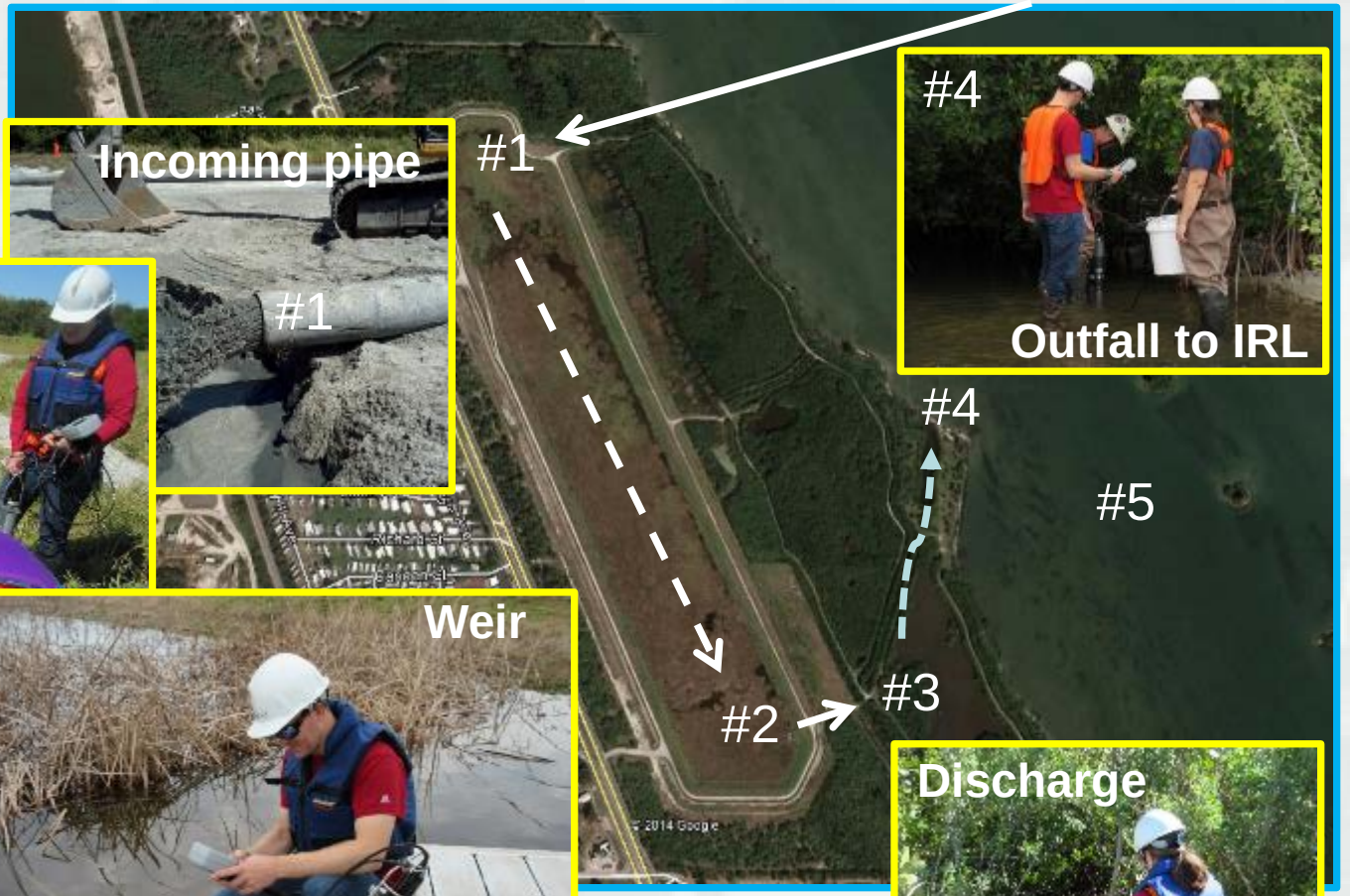
# Removal Efficiency for Nutrients and Fine-Grained Sediments during Dredging and Dewatering

- How efficient is the PA at trapping fine-grained sediments and dissolved and particulate nutrients (Nitrogen and Phosphorus) that are carried in from the IRL via the dredge pipe?
- Water analyzed for
  - Salinity, Temperature, pH, O2, Total Suspended Solids (TSS),
  - Dissolved phosphate, ammonia, nitrate-nitrite, organic carbon, Fe, Mn
- Suspended Particles and Bottom Sediments were analyzed for
  - Al, Si, Fe, organic C, Total N, Total P

Photo Credit: Vero Beach Press Journal

# Sampling for Removal Efficiency

**Water Sampling during 2015 Feb 19, Mar 25, Apr 21, May 6, Jun 9**



# Sampling of Solids

#1

From dredge pipe

TSS = 280,000 mg/L

Outfall to IRL

TSS = 11 mg/L

#4

19,000-fold reduction in suspended solids from dredge pipe to weir

At weir, inside DMMA

#2

TSS = 13 mg/L
(1.7 to 36 mg/L)

TSS = Total Suspended Solids

# Sampling for Removal Efficiency

| | Suspended Sediments (mg/L) | Dissolved N (mg/L) | Particulate N (mg/L) | Dissolved P (mg/L | Particulate P (mg/L) |
|---|---|---|---|---|---|
| Incoming Pipe (#1) | 280,000 (±50,000) | 5 (±5) | 380 (±40) | 2.6 (±2.2) | 300 (±50) |
| Weir (#2) | 15 (±16) | 4.7 (±0.5) | 2 (±3) | 0.3 (±0.2) | 0.1 (±0.1) |
| IRL (#4/5) | 8.8 (±5.0) | 4.7 (±0.5) | 0.6 (±0.4) | 0.3 (±0.3) | 0.06 (±0.05) |
| Decrease during transit in DMMA | 99.99% | 6% | 99.5% | 88% | 99.97% |

Concentrations of dissolved Nitrogen decreased slightly and dissolved Phosphorus decreased greatly during transit from dredge pipe to the weir.
Lagoon water in, lagoon water out.

Suspended solids and particulate Nitrogen and Phosphorus are greatly decreased during transit from the dredge pipe to the weir.
Suspended solids trapped in DMMA.

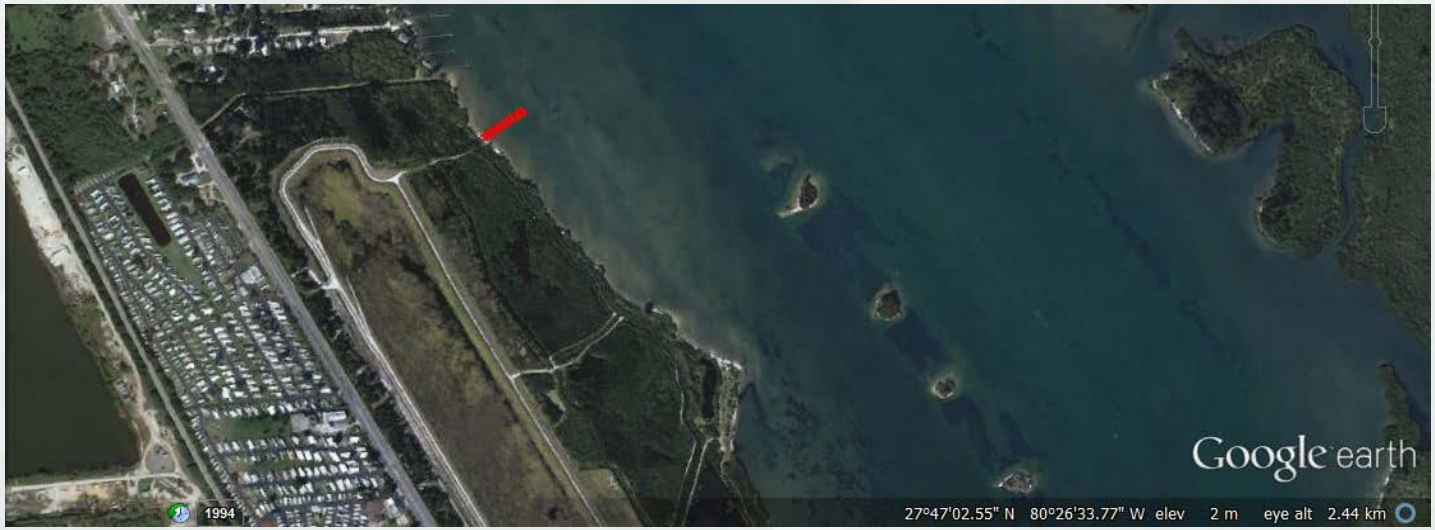
# Sampling Results

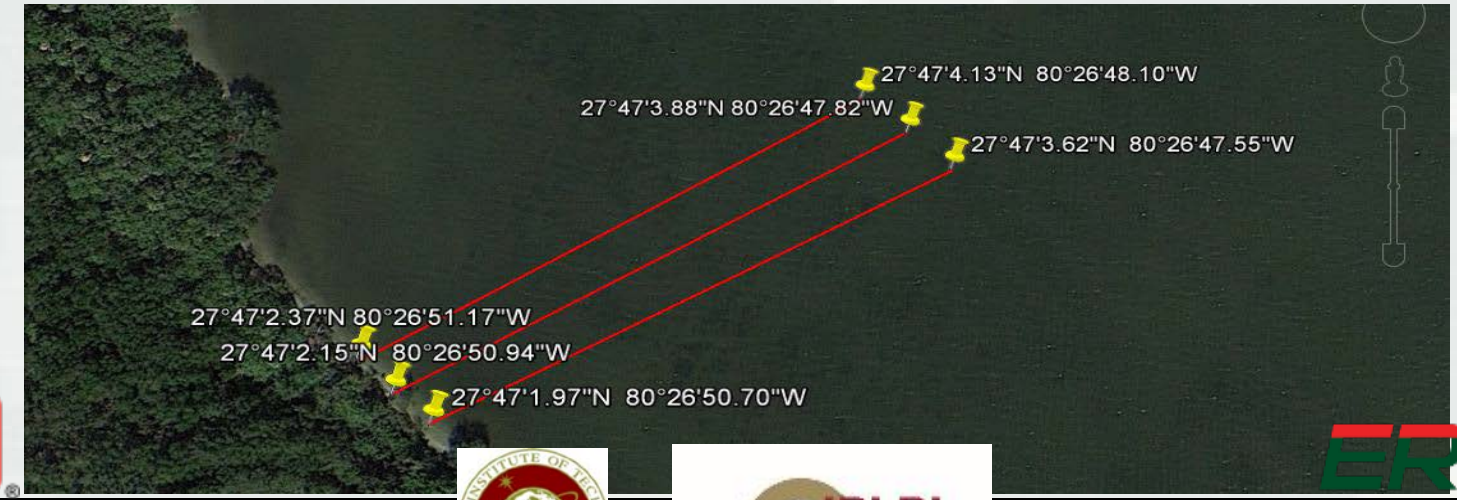
- Navigational dredging removed
  - 156,000 metric tons of dry sediment (140,000 tons)
  - 230 metric tons of nitrogen (210 tons)
  - 120 metric tons of phosphorus (110 tons)

* Insitu measured bulk density of 1.54 g/cm$^3$ conversion of 2,596 lbs/CY

# Environmental Monitoring

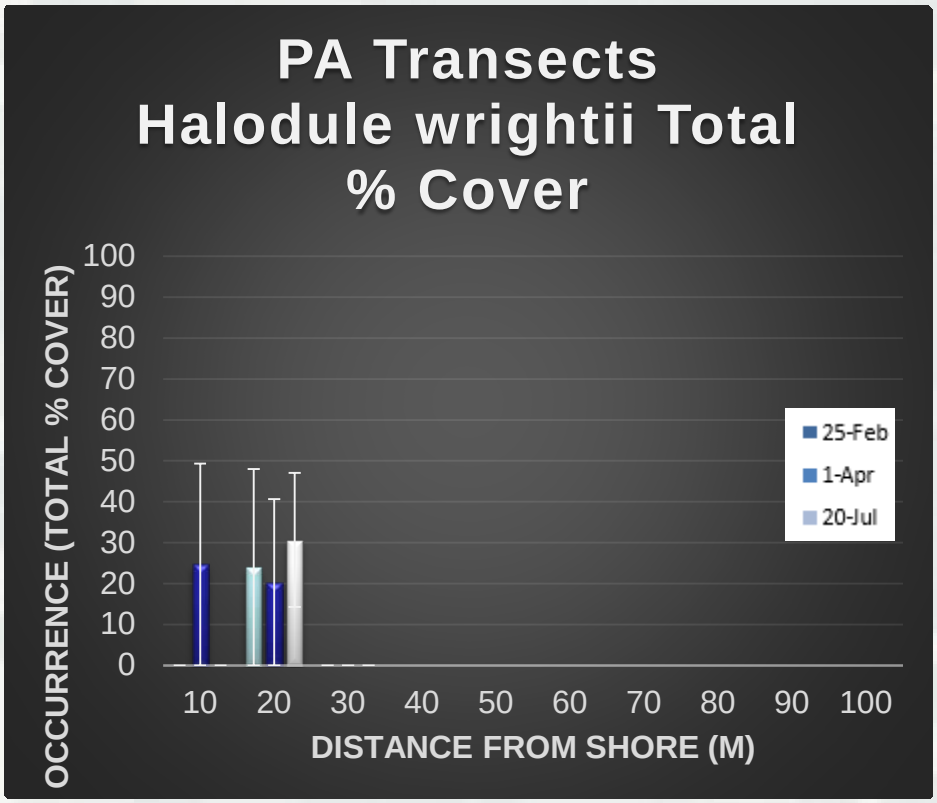
- Seagrass Transect Halodule wrightii (Shoal Grass)

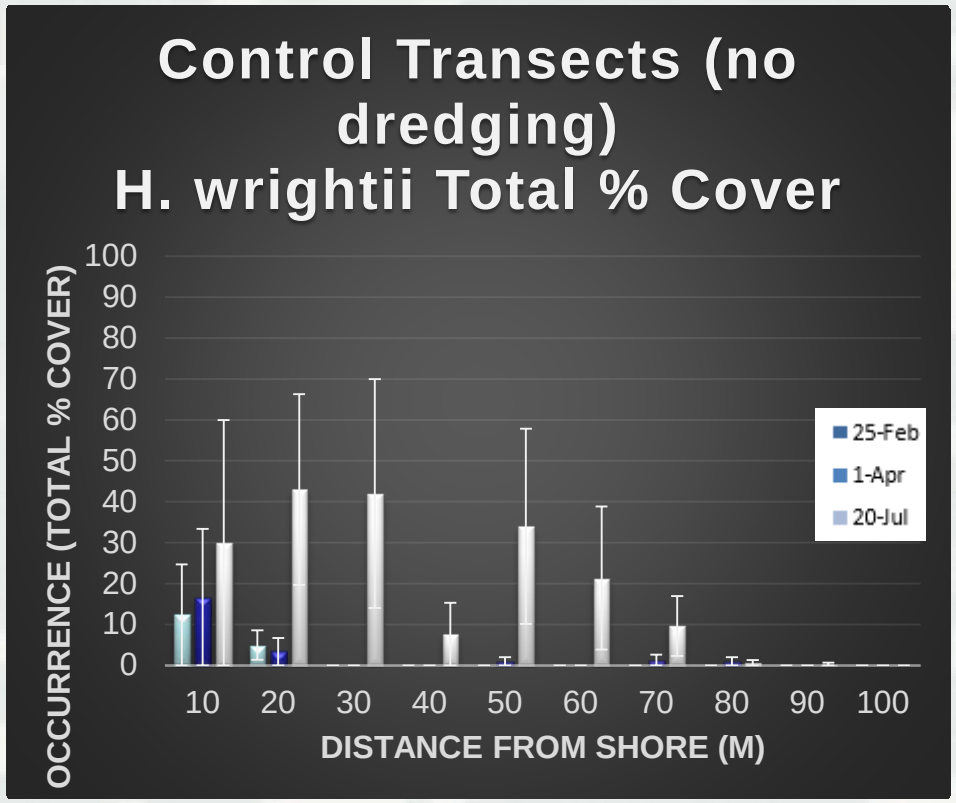


# Environmental Monitoring

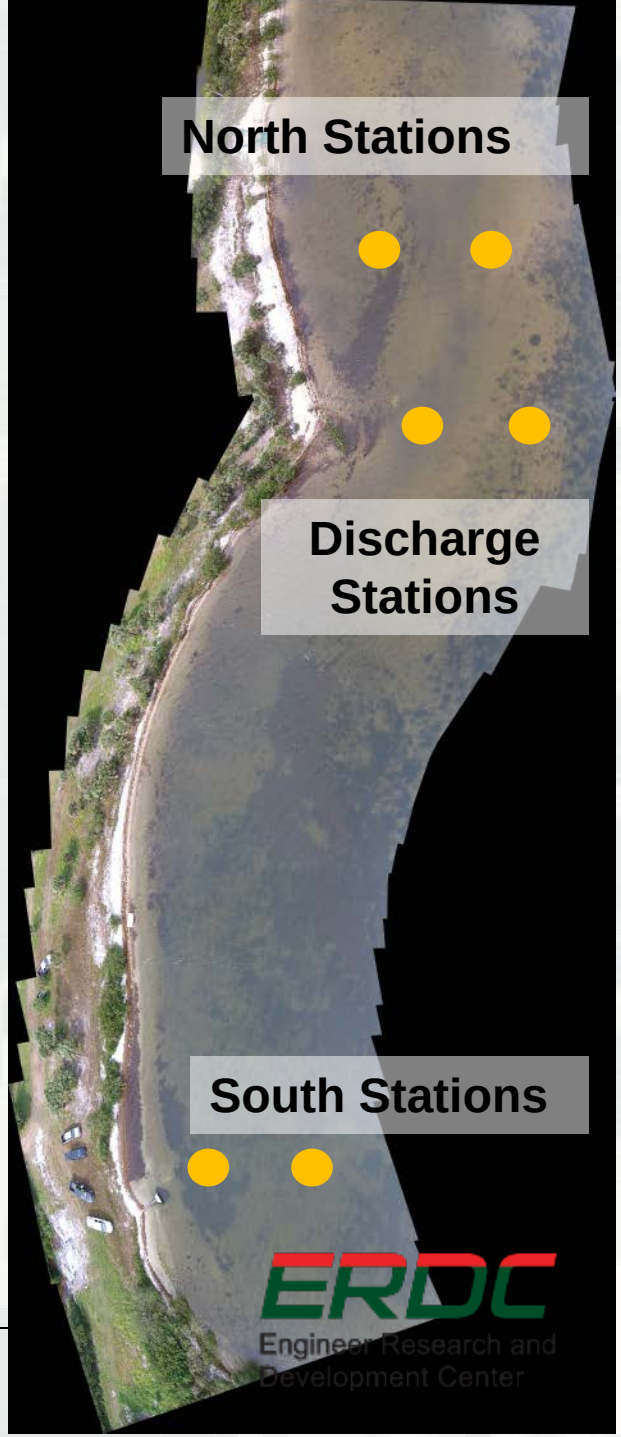
- Seagrasses near PA and control site



# Environmental Monitoring

- Fish populations in the adjacent IRL
  - Seine samples (using FWC protocols) were collected from 6 stations during:
    - March (pre-dredging)
    - May (dredging)
    - July (post-dredging).
  - UAV (drone) flights were made on each sampling date to determine distribution of submerged vegetation (primarily the red alga Gracillaria).
  - This image is “stitched” from a video taken with the drone at an altitude of 400 feet.



# Summary

- Dredging Operations
  - Efficient material removal with minimum turbidity
  - Cattails provided good filtering medium
  - With large enough placement area, navigational dredging removes nutrients from the system.
    - 230 metric tons of nitrogen (210 tons)
    - 120 metric tons of phosphorus (110 tons)
  - No return of nutrients to the IRL
- Biological responses in the region adjacent to the PA cannot be attributed to dredge operations
  - Seagrass: No significant difference from northern control sites
  - Fish: Spatial/seasonal variations, not related to dredging

# Further Research Needs

- Shoaling rate
- Muck Migration
  - Does muck within the IRL migrate due to with wind and wave events?
  - Need to correlate volumes measured with meteorological events to get a handle on this
  - Is the movement post dredging indicative of muck migrating to the bottom of the IWW channel?
  - Need to revisit the site in 6 months (high and low freq. survey)
  - Is muck resuspeneded by vessel traffic?
- Nutrient Reduction
  - Water left the DMMA through evaporation and percolation, did any of the dissolved nutrients return to the IRL through groundwater seepage?
  - Was the overall water quality measurably improved

# Acknowledgments

Florida Inlet Navigation District (FIND) – for funding the IRLRI and FIT

Florida Institute of Technology – for coordinating field data collections and processing samples and diligent efforts

USACE Jacksonville District – Survey team for providing quantity surveys and the Project Delivery Team

Taylor Engineering – for endorsing the effort as valuable

USACE Engineer Research and Development Center – Dredging Operations and Technical Support program, Coastal and Hydraulics Laboratory – Coastal Engineering Branch and Field Data Collection Branches

Cavache Dredging – for providing information and imagery

# Thank You!

# Questions?

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