

# Examining Spatial & Temporal Changes to the Littoral Zone of Lake Okeechobee using Otsu's method

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# Lake Okeechobee

- Large (1,730 km<sup>2</sup>), shallow (2.7m) eutrophic lake
- 3 regions of the lake
  - Littoral Zone
  - Nearshore Zone
  - Pelagic Zone

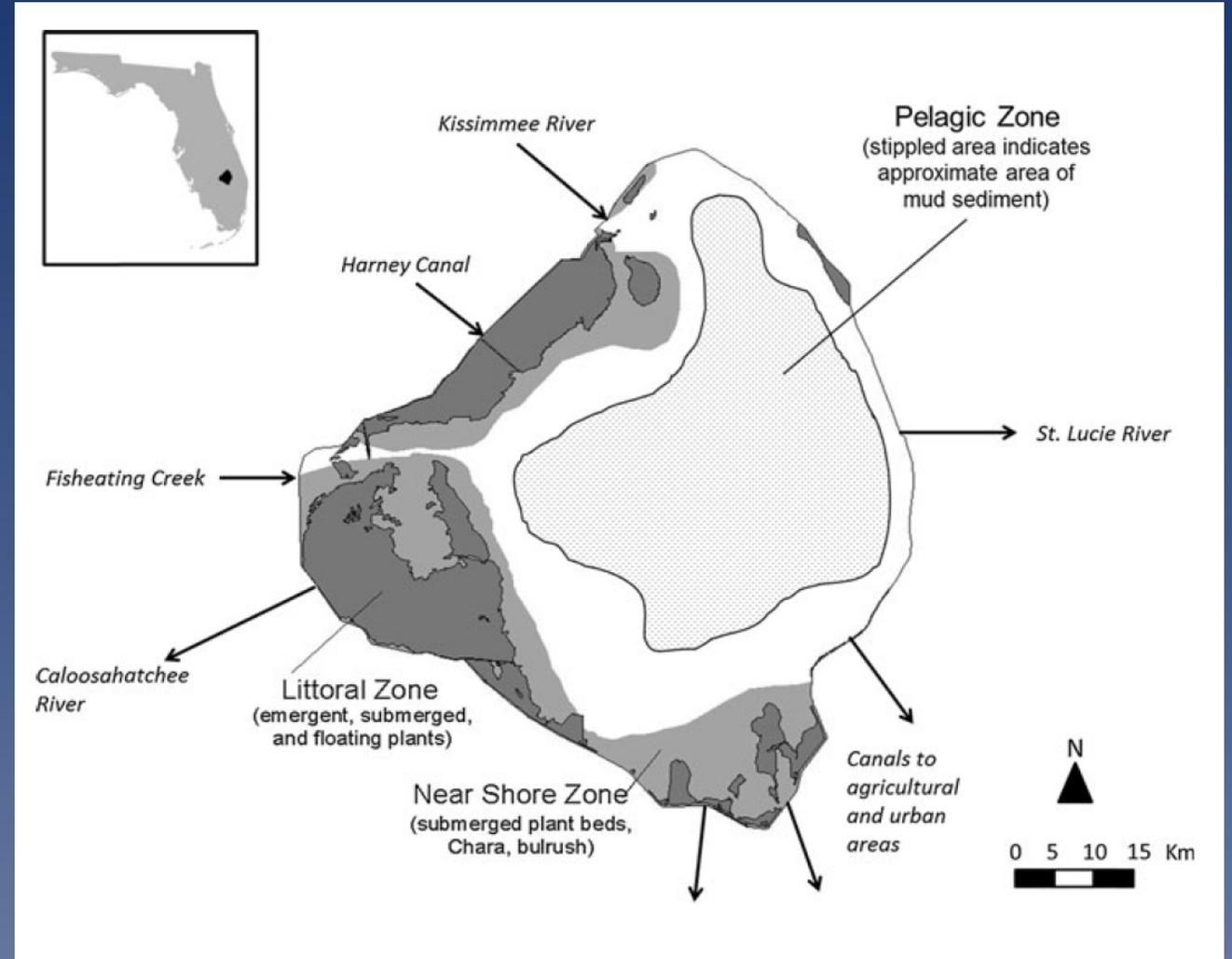
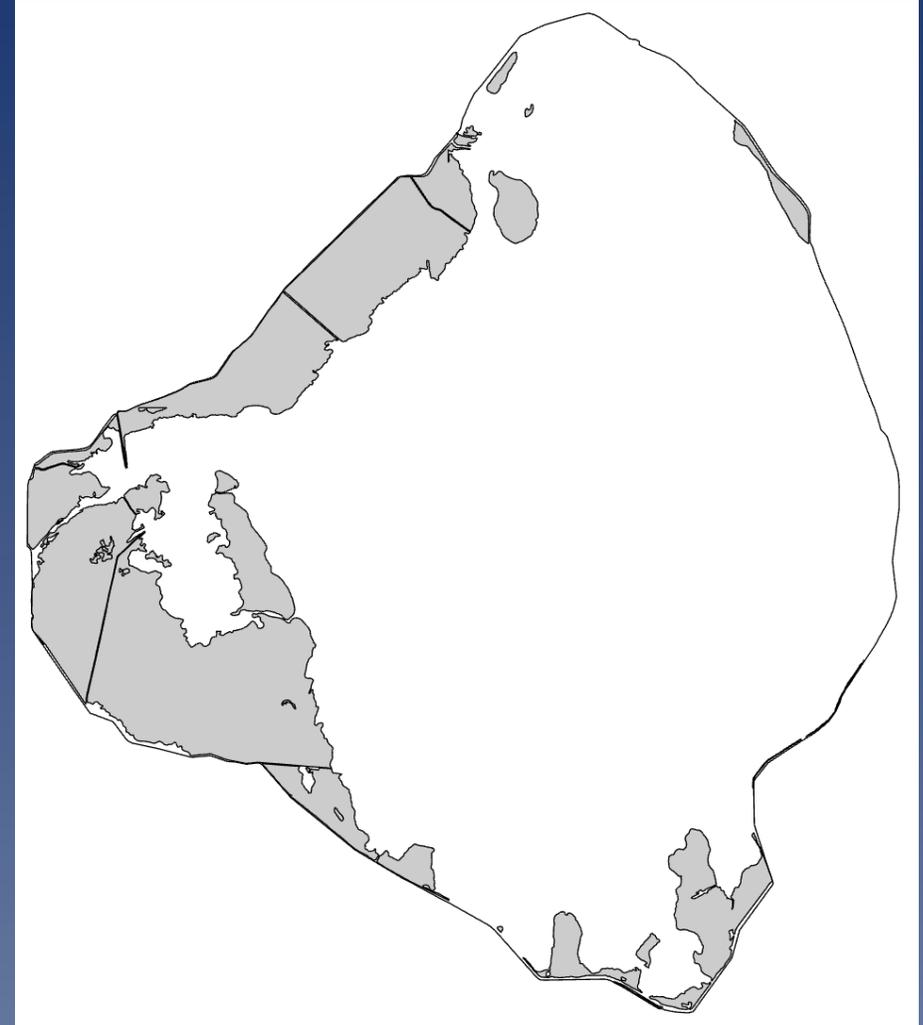


Figure 1: Havens & Steinman, 2013

# Littoral Zone

- ~400 km<sup>2</sup>, covering ~25% of total surface area
- Supports biodiversity of several plants and animals
  - Spawning and nursery habitat for fish
  - Habitat to migratory water birds
  - Emergent, submergent, & floating vegetation
- Highly influenced by changes in water level (hydroperiod & water depth)



# Emergent Vegetation

- Distribution of native and exotic plants determined by hydroperiod & water depth
- Prolonged flooding conditions reduce biomass & alter diversity
  - Giant Bulrush barrier in western marsh
  - Sawgrass die off, Cattail (*nuisance*) expansion
- Low water levels promote expansion
  - Torpedograss (*invasive*)



Cattail



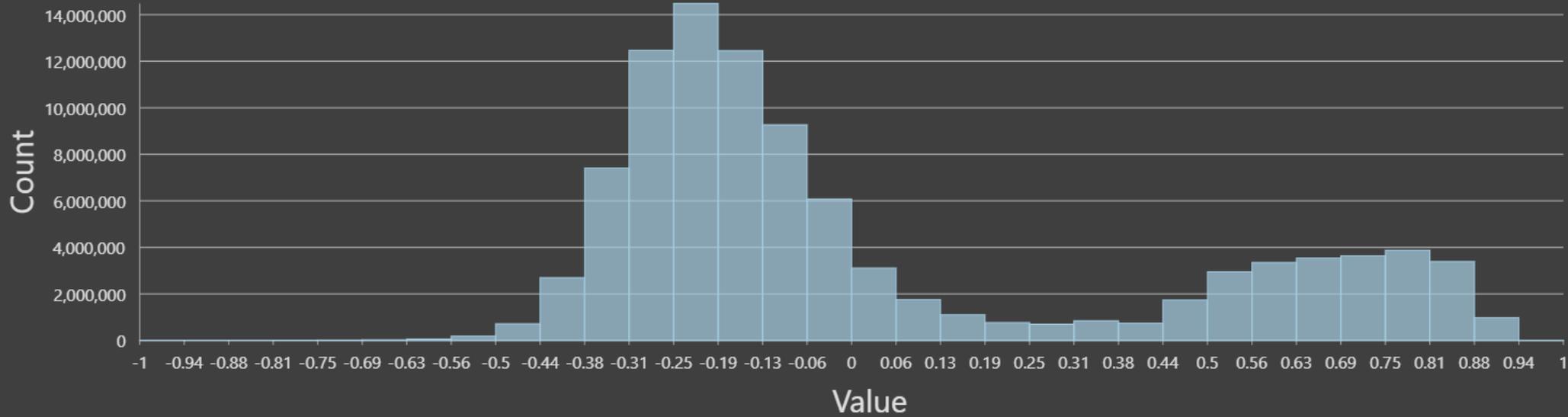
Sawgrass

# Otsu's Method

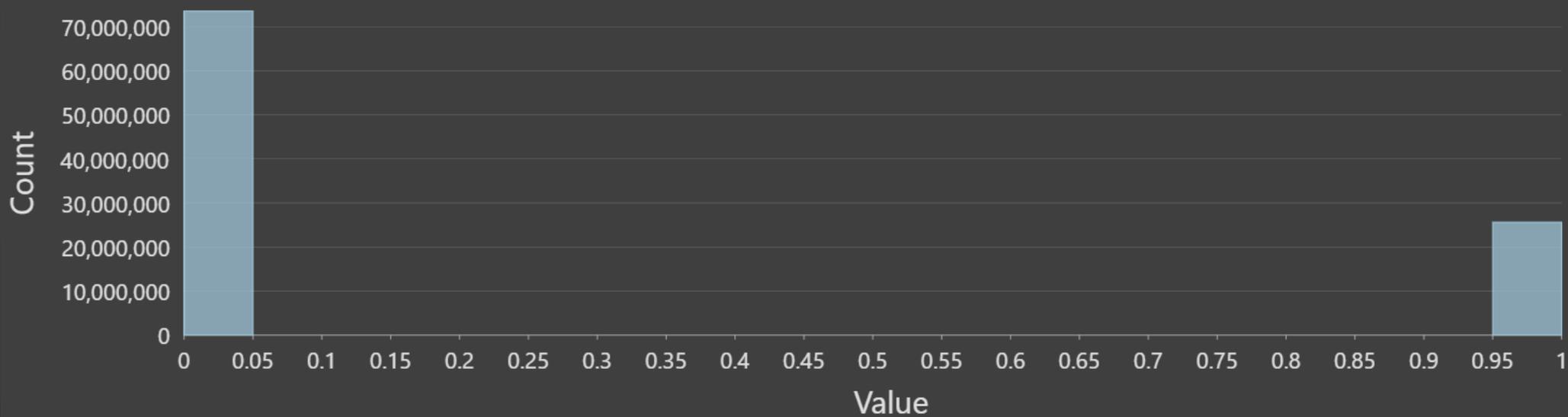
- Method named after Nobuyuki Otsu, 1970s
- Commonly used method for binary classification
  - Separating background & foreground pixels based on an image's grayscale histogram
- Minimizes variance between 2 sets of pixels (background & foreground) to establish optimal threshold
- Used in ArcGIS Pro 3.1.2/3.3.2



Lake Okeechobee - NDVI



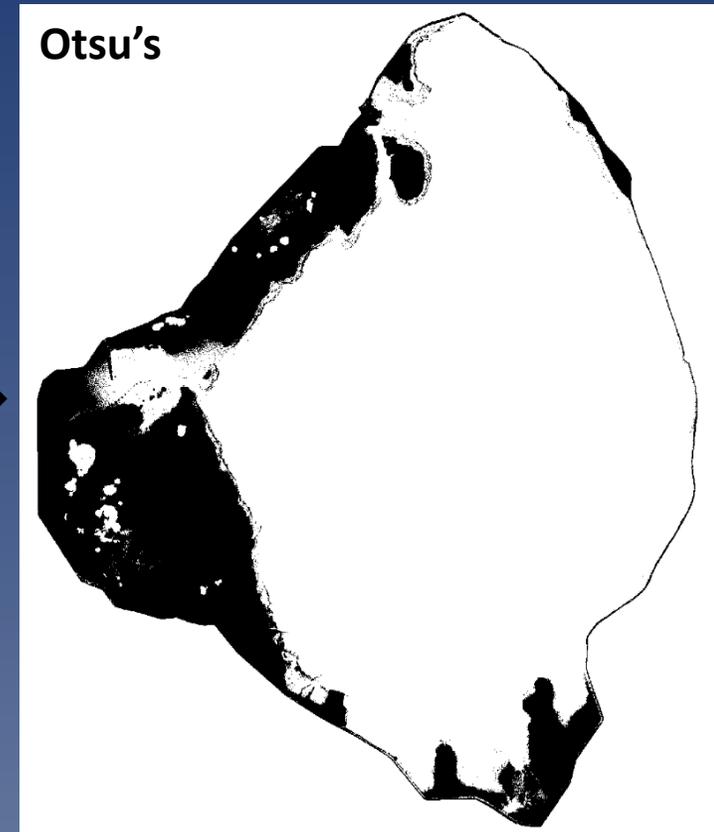
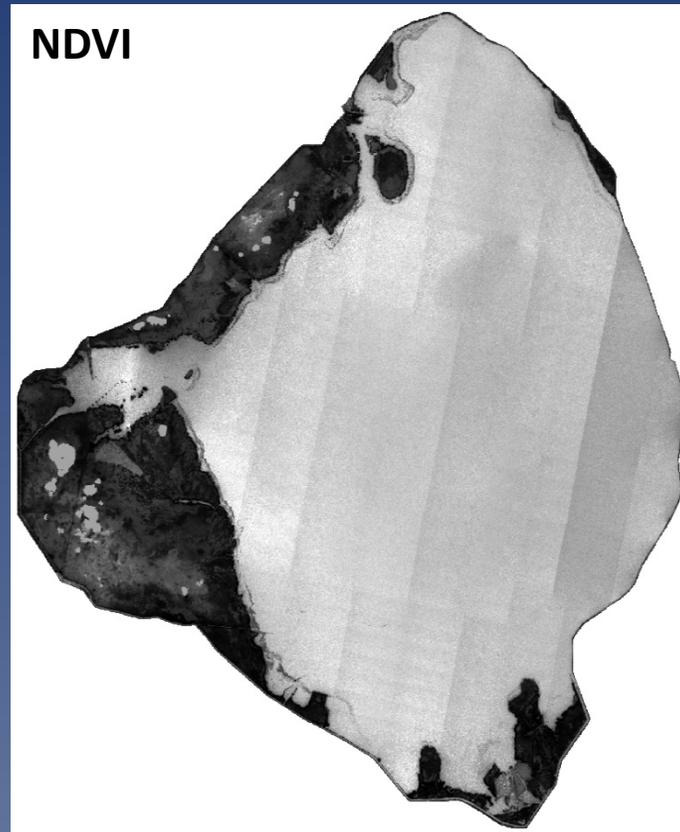
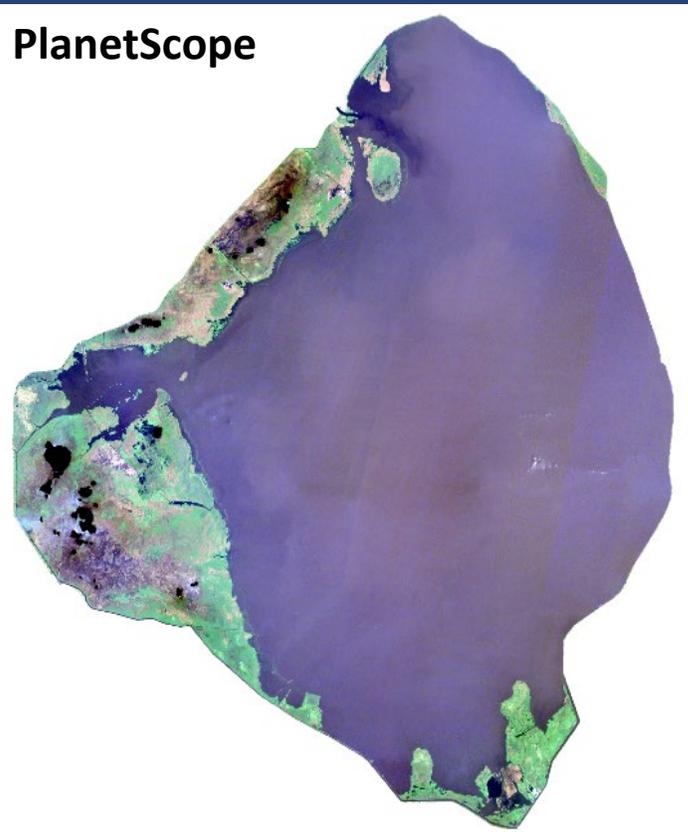
Lake Okeechobee - Otsu's method



# Imagery

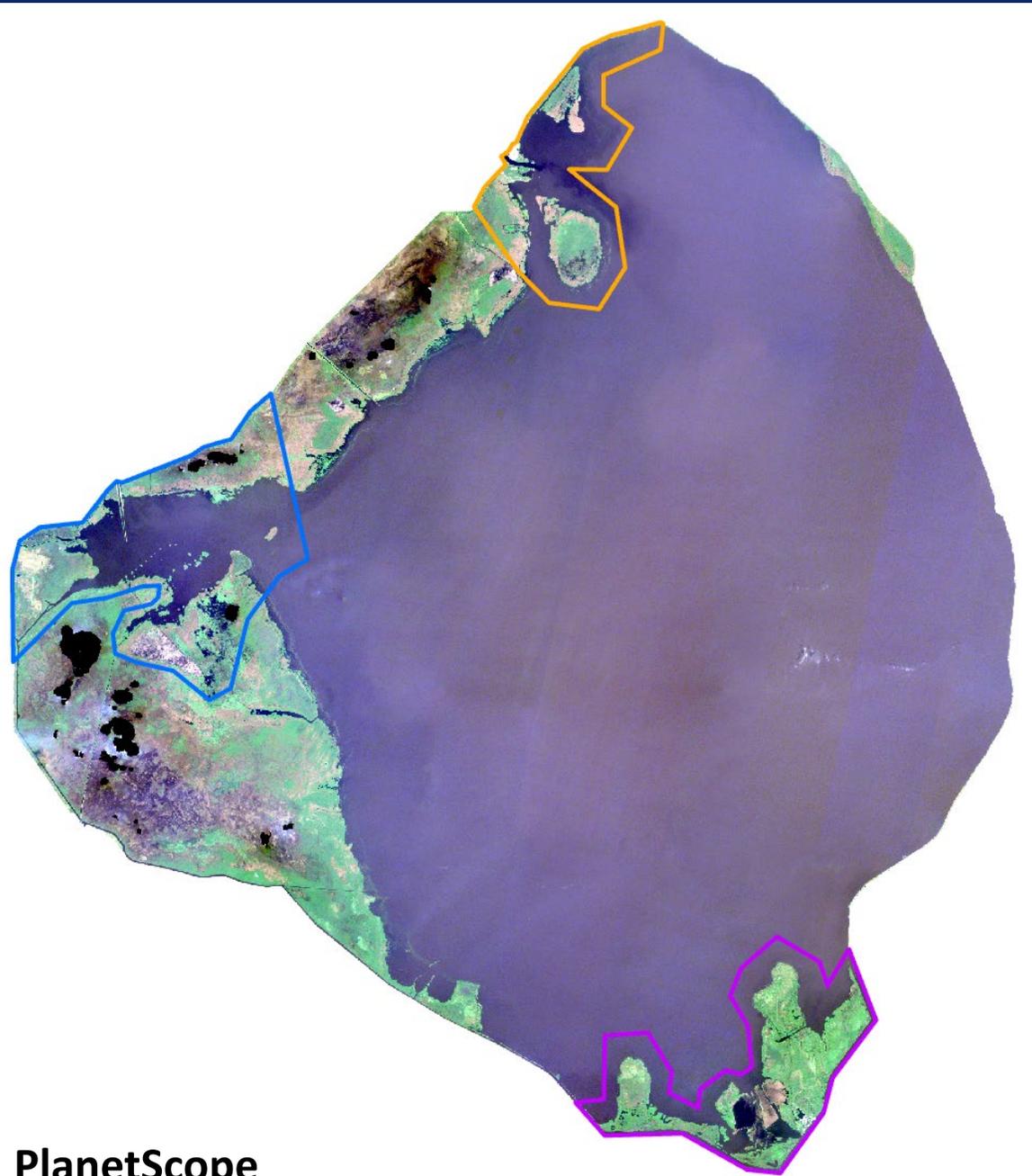
- PlanetScope, satellite
- 4-5m Resolution
- True Color, 9 Bands
  - 6 – red, 4 – green, 1 - blue
- Sept 2022 – August 2023
  - Feb 20 – March 6, 2023
- Image collection every 3-5 days
- National Agriculture Imagery Program (NAIP), aerial
- 0.2-0.3m Resolution
- Color Infrared (CIR), 3 Bands
  - 1 – NIR, 2 – red, 3 - green
- Jan –Feb 2023
- Image collection every 2-3 years

# Verify consistency of Otsu's method



# Areas of Interest (AOI)

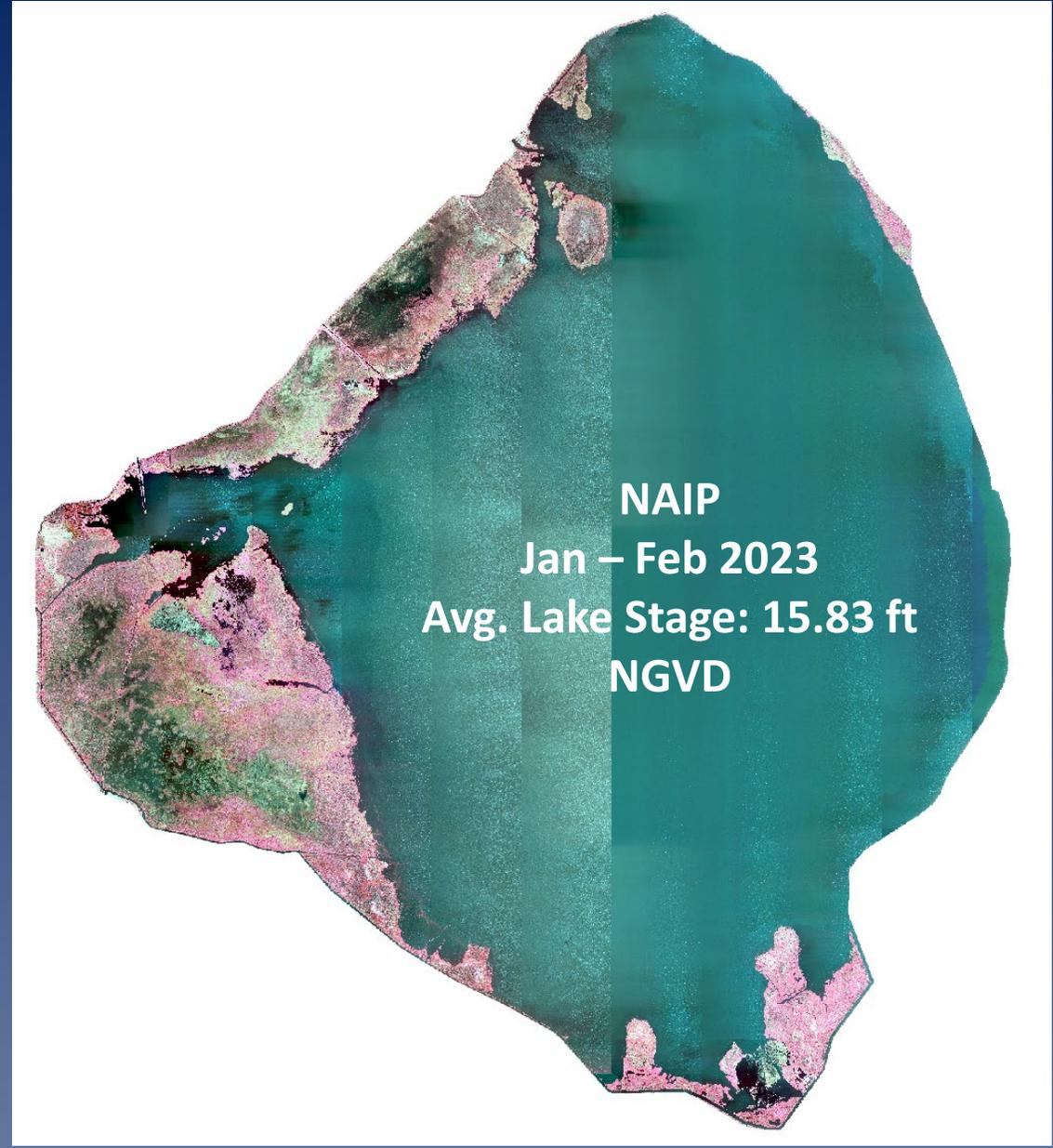
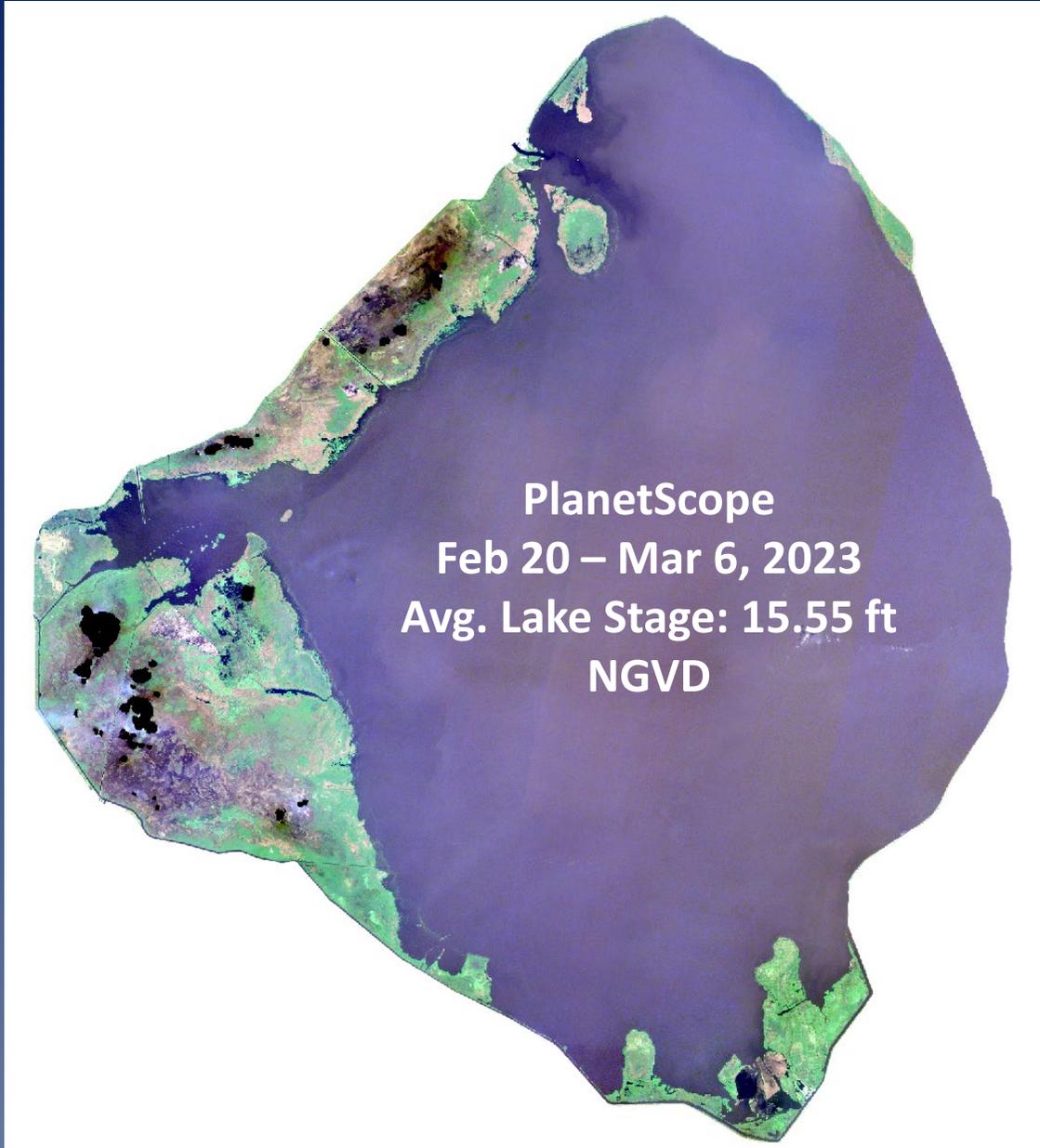
Fisheating Bay

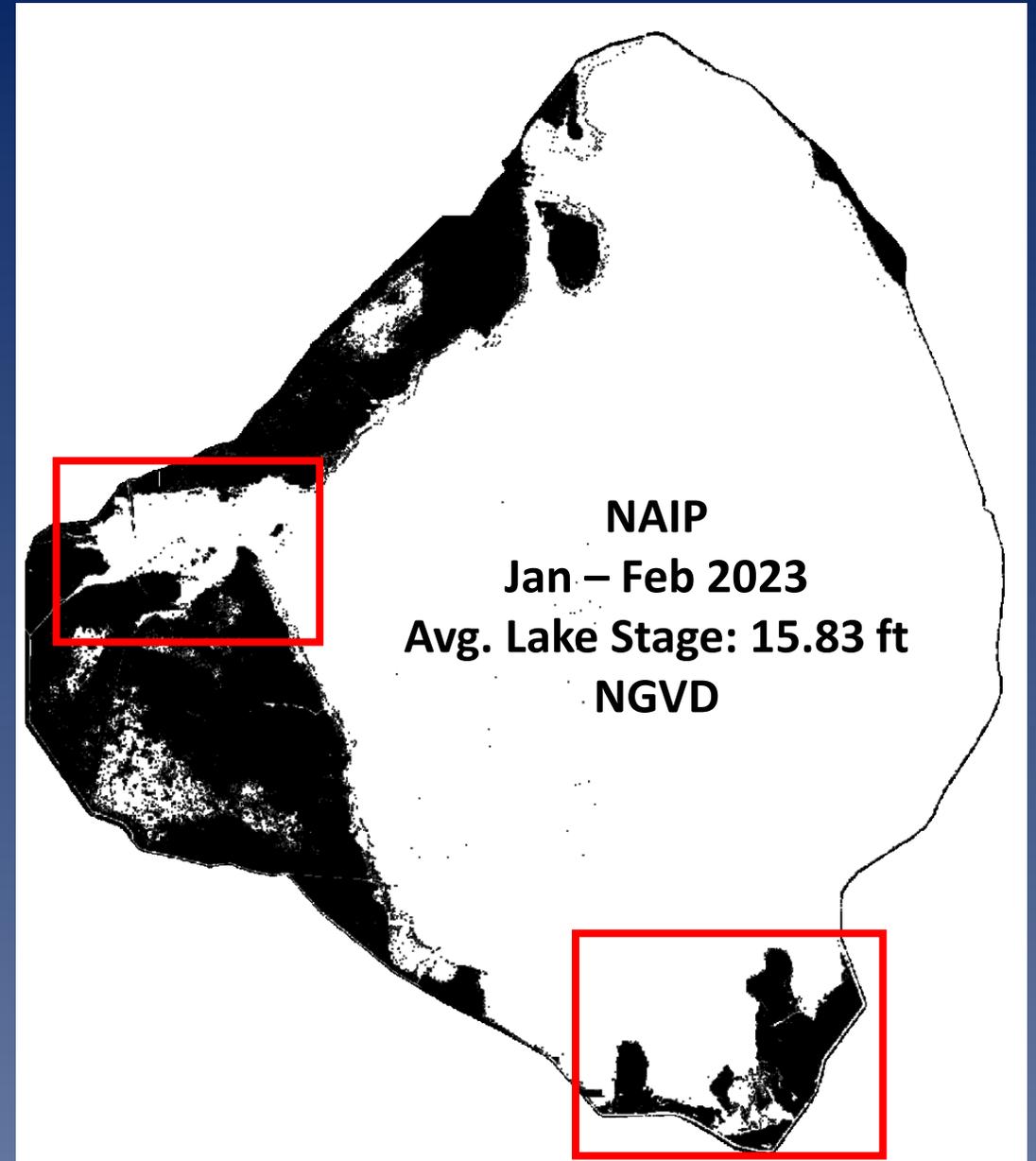
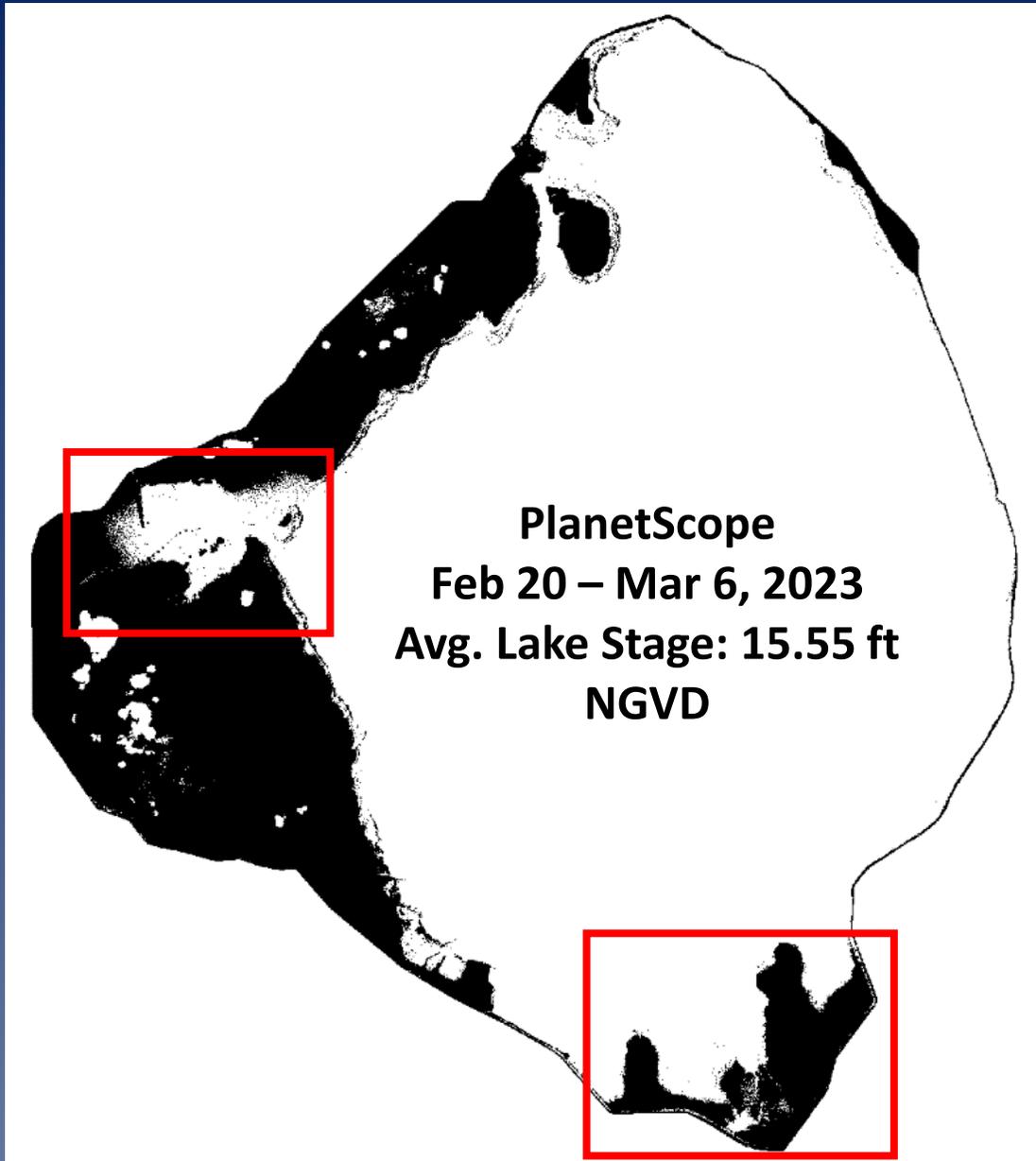


King's Bar & Eagle Bay

South Bay

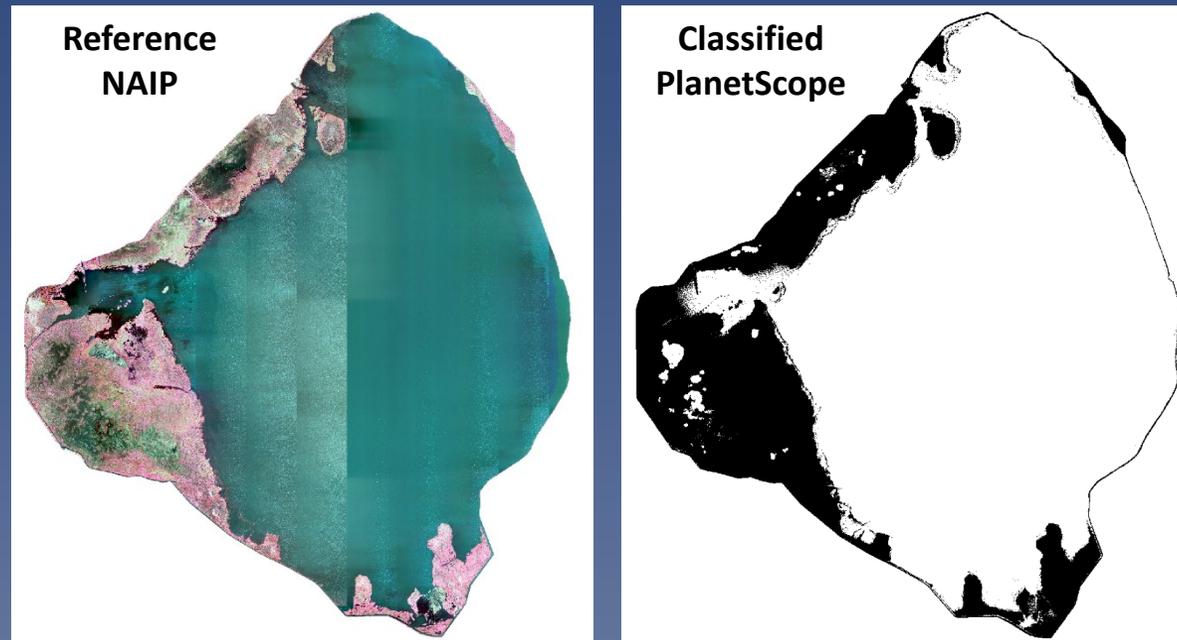
PlanetScope



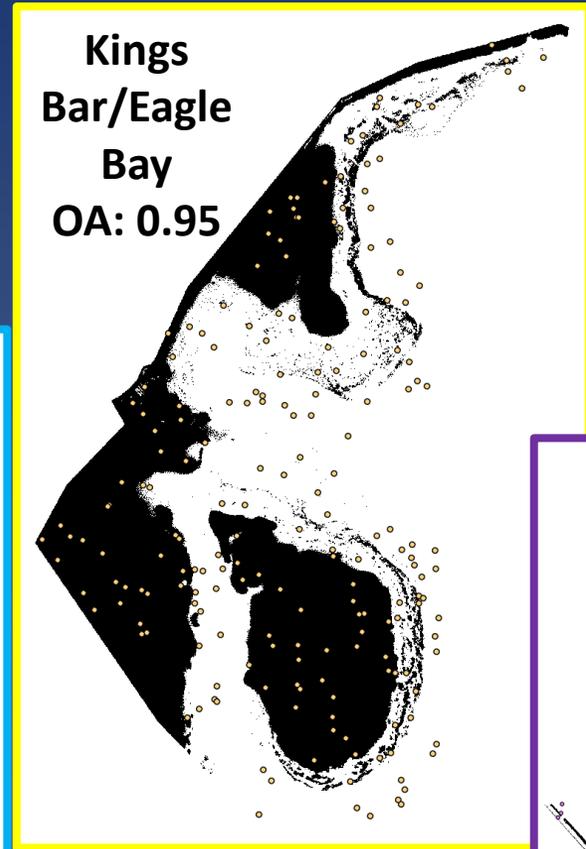
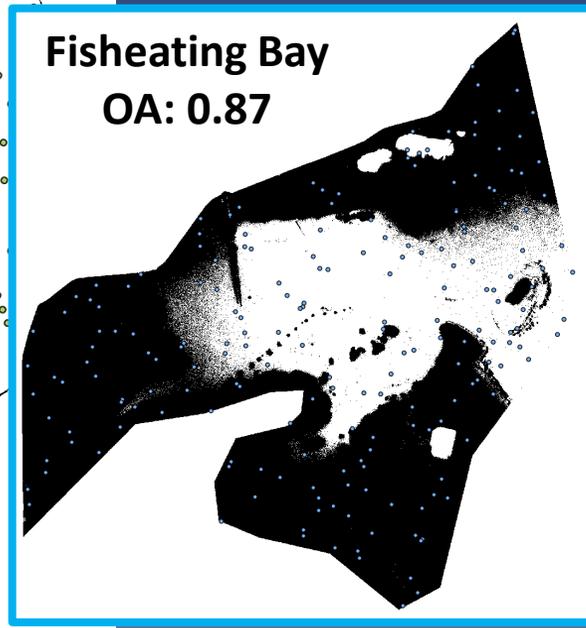
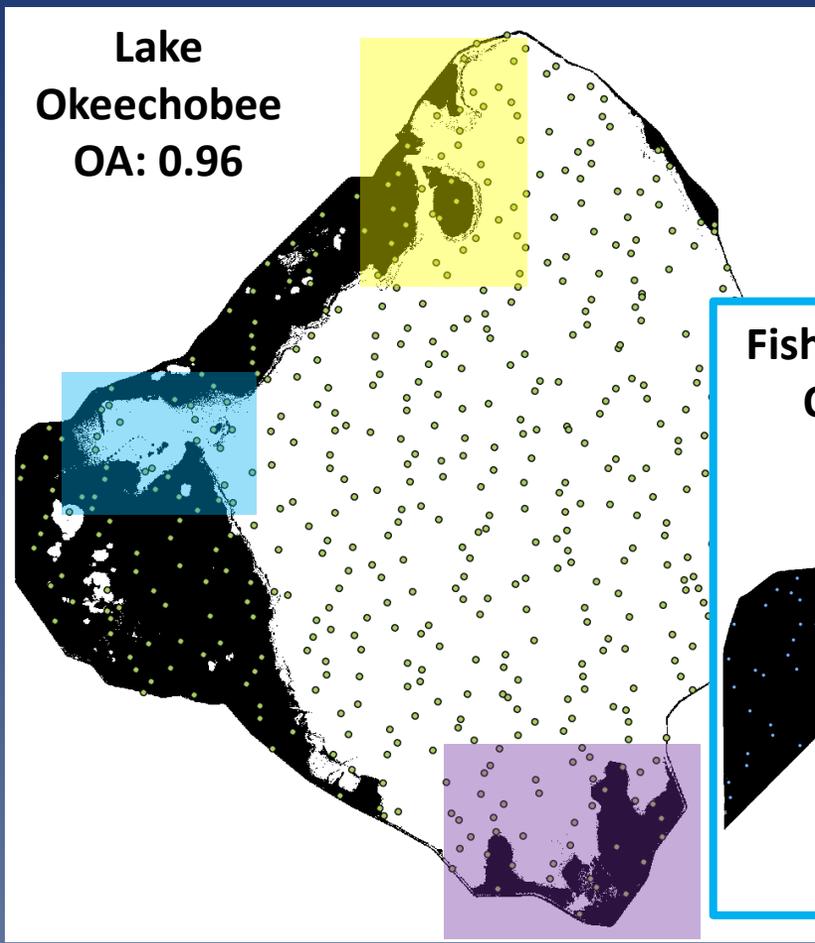


# Accuracy Assessments

- Used to determine accuracy of classification results (Otsu's)
- Compares reference data (ground truth) to classified result in the same schema
- Results compiled into a Confusion matrix



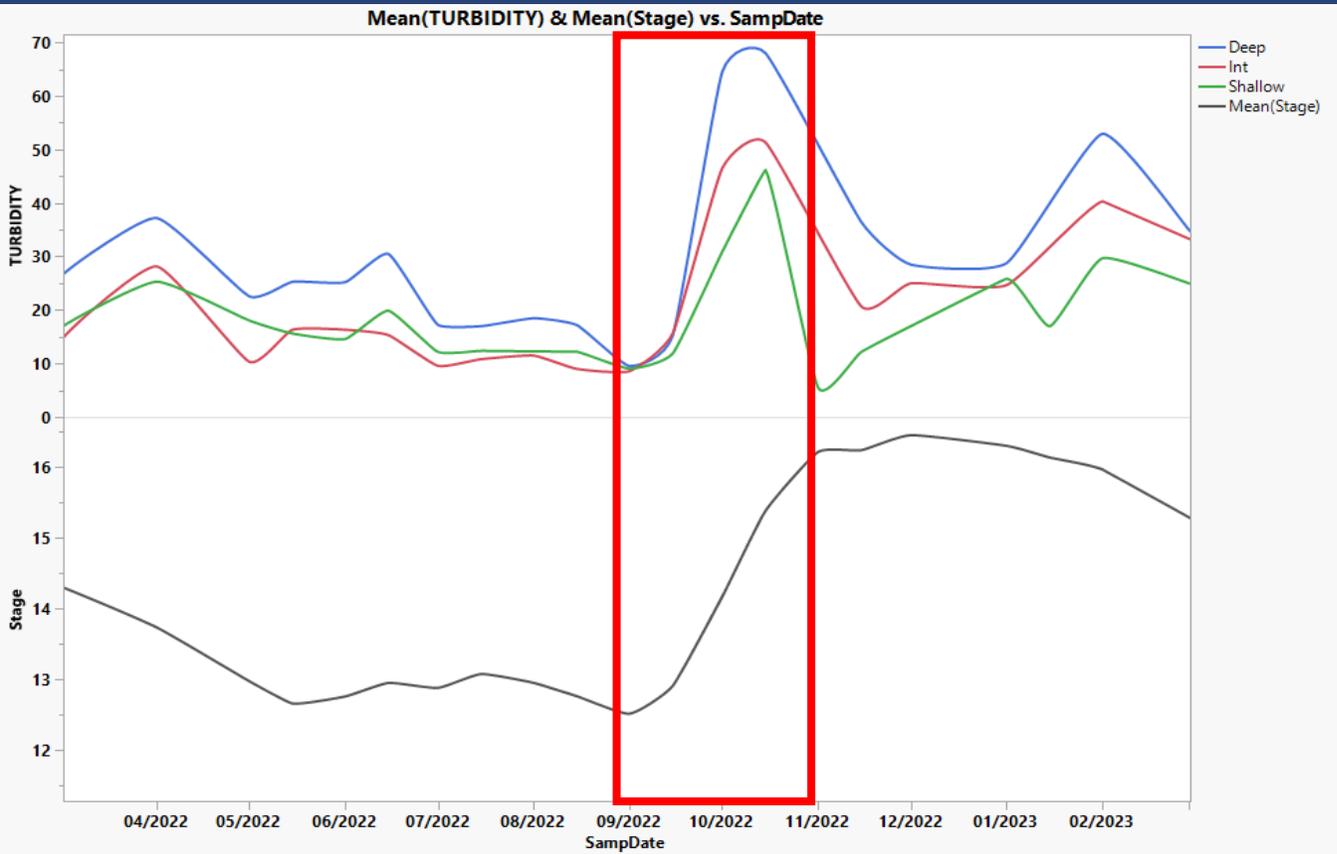
# Accuracy Results



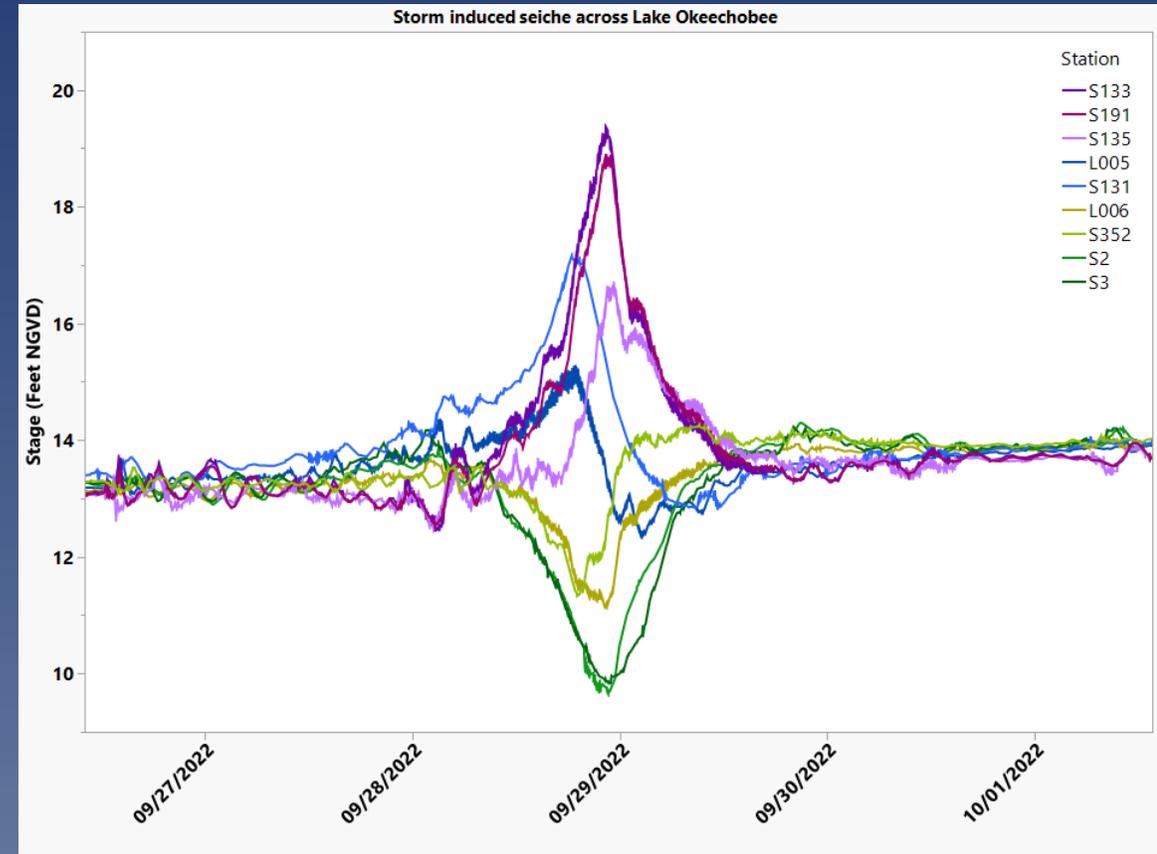
# Hurricane Ian

September 23 – 30, 2022

Lake Okeechobee Turbidity



Lake Okeechobee Seiche

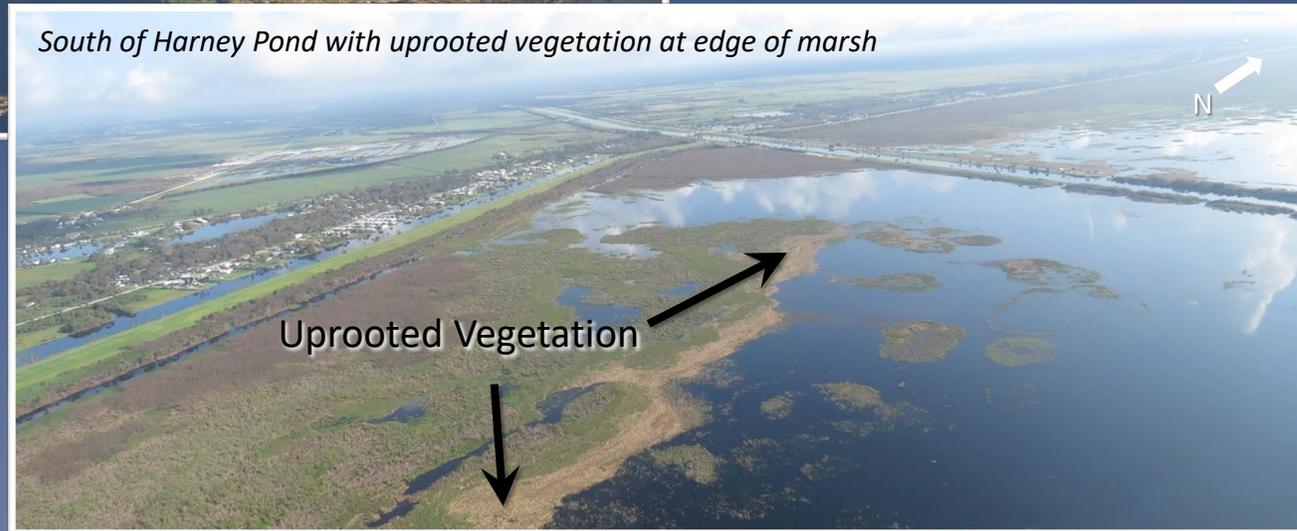
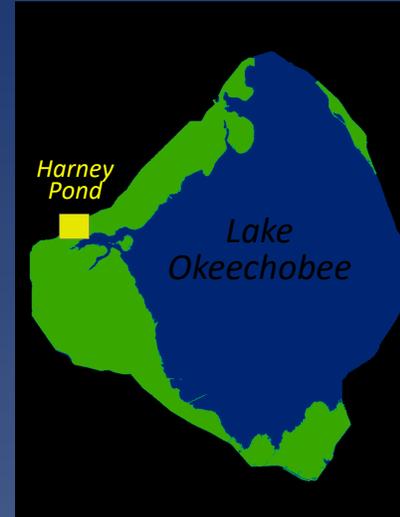


# Lake Okeechobee

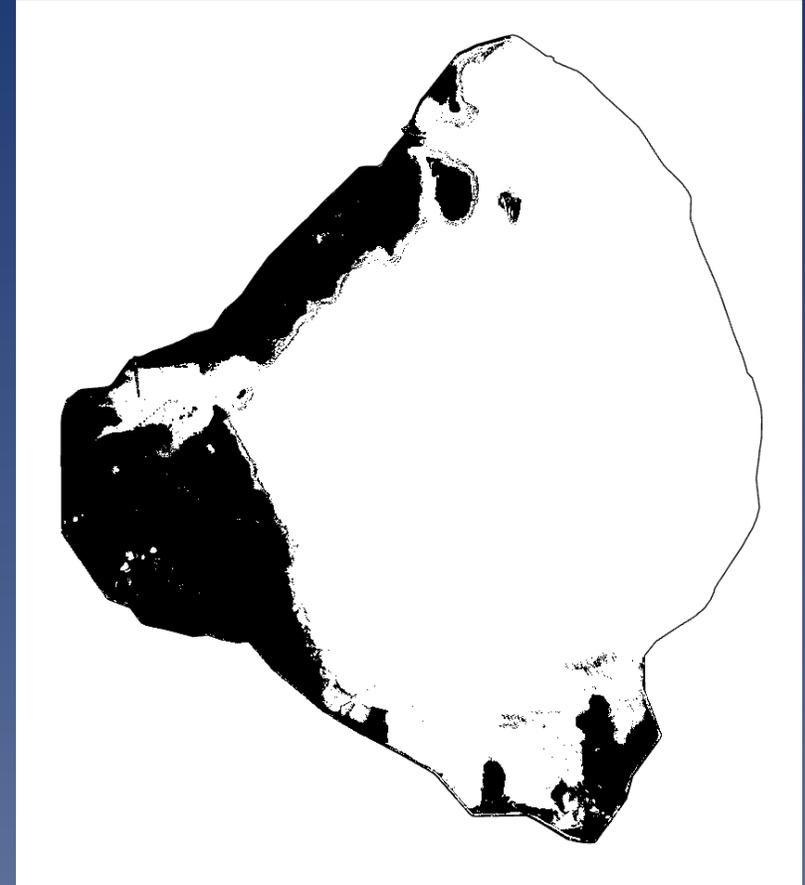
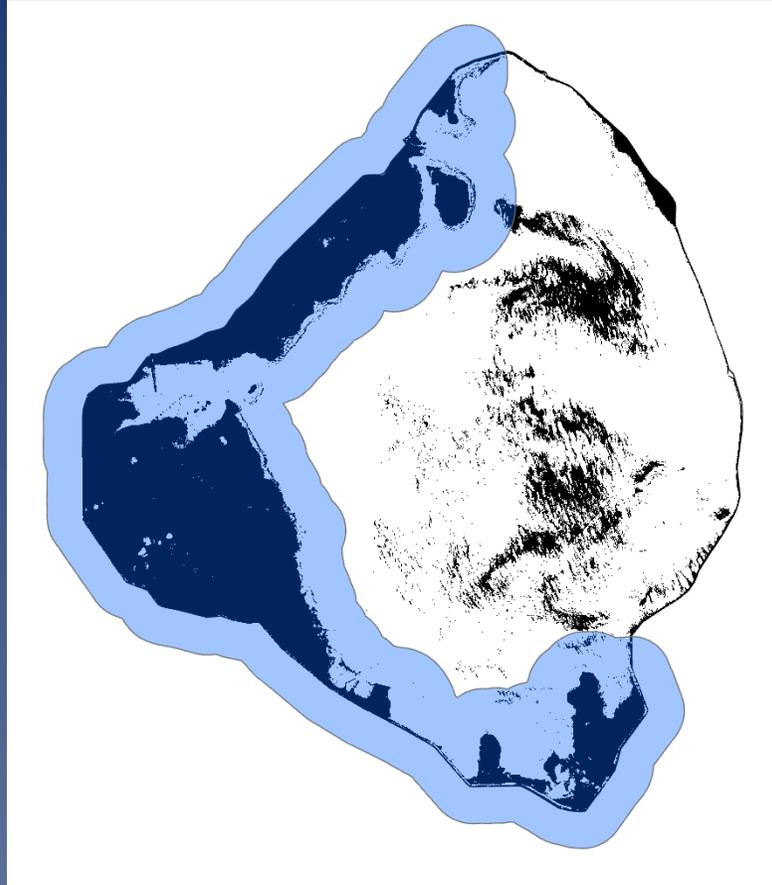
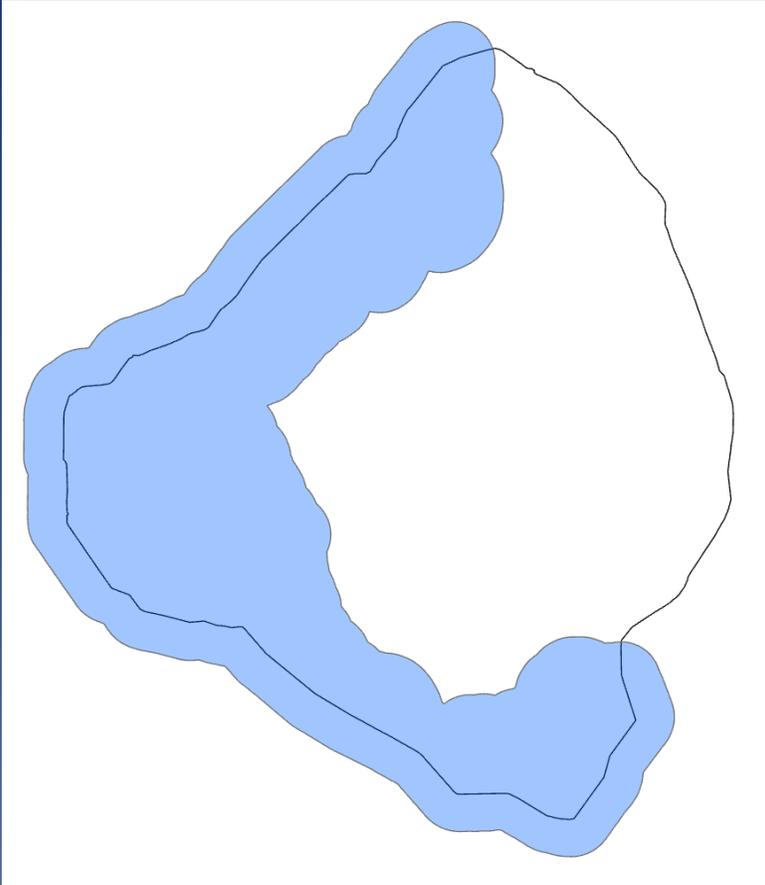
## Harney Pond post Hurricane Irma



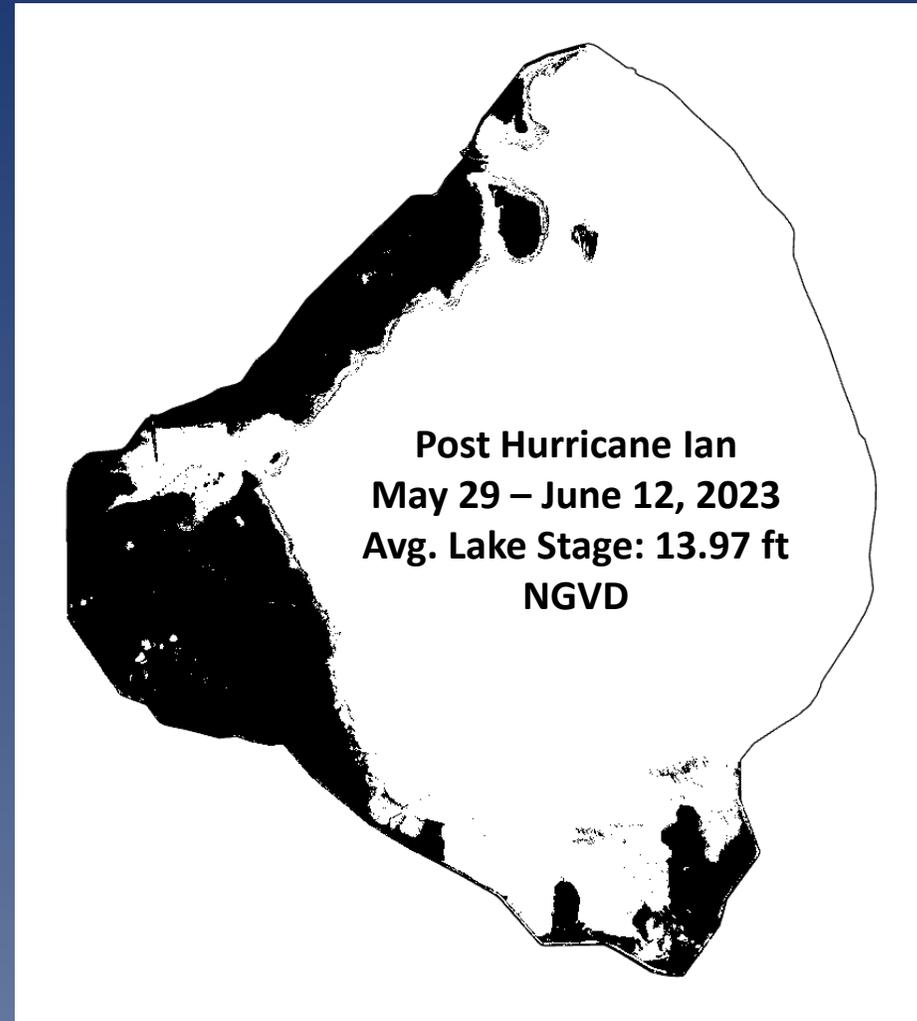
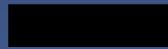
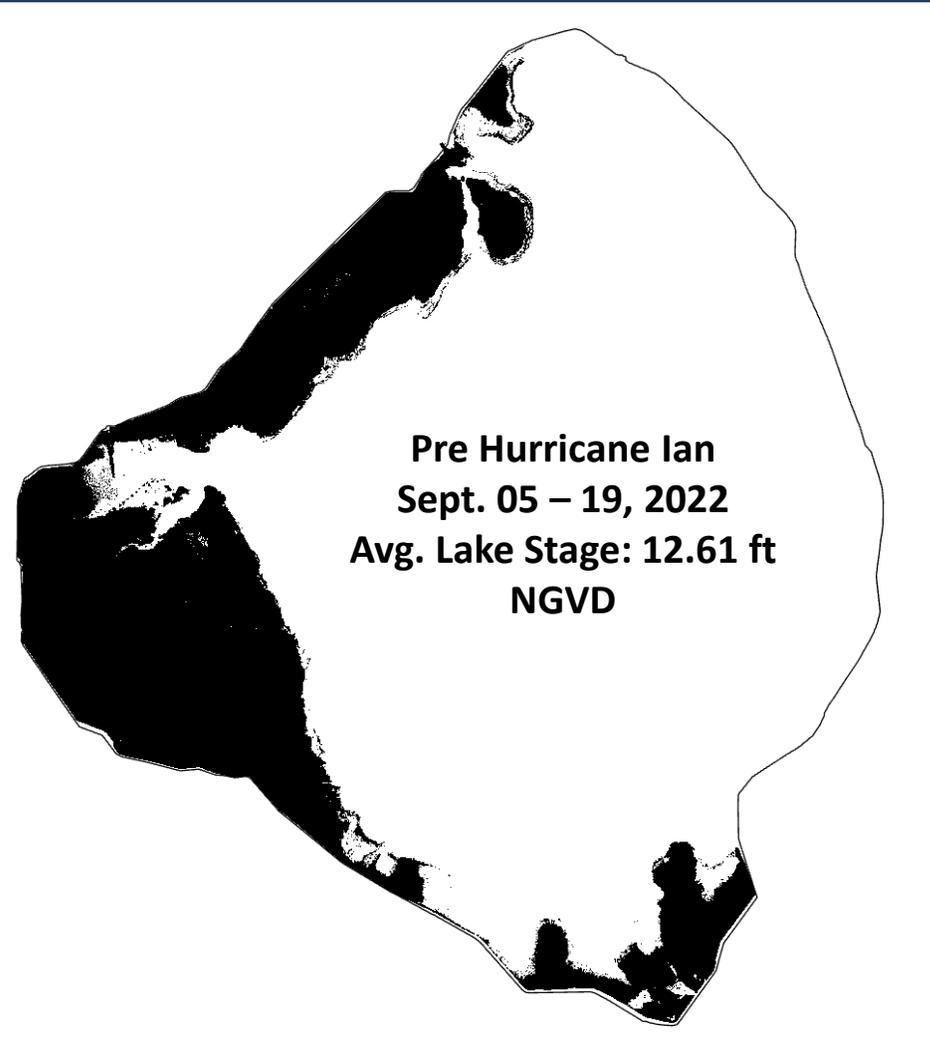
Photographs taken September 14, 2017



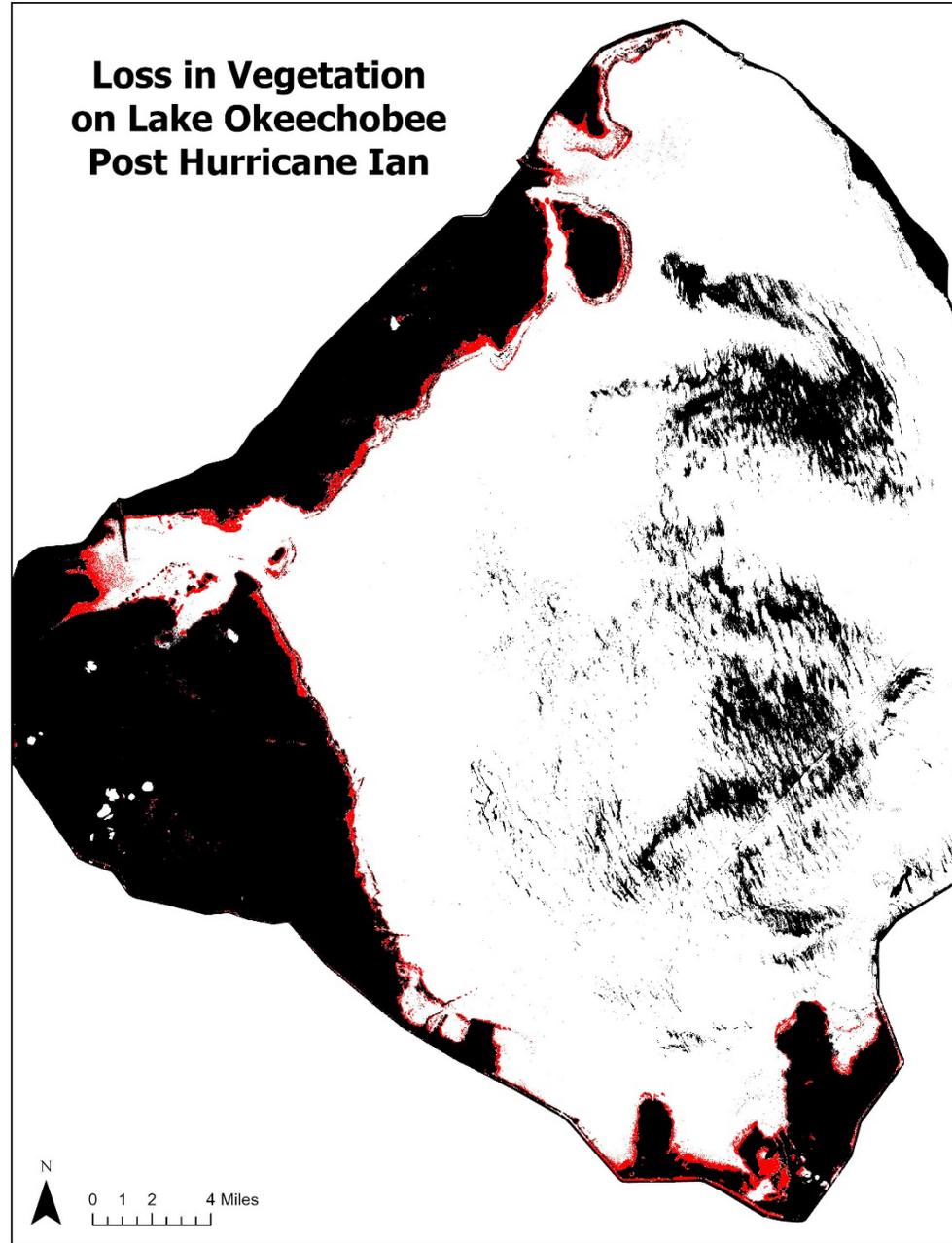
# Lake Okeechobee AOI



# Raster Calculation



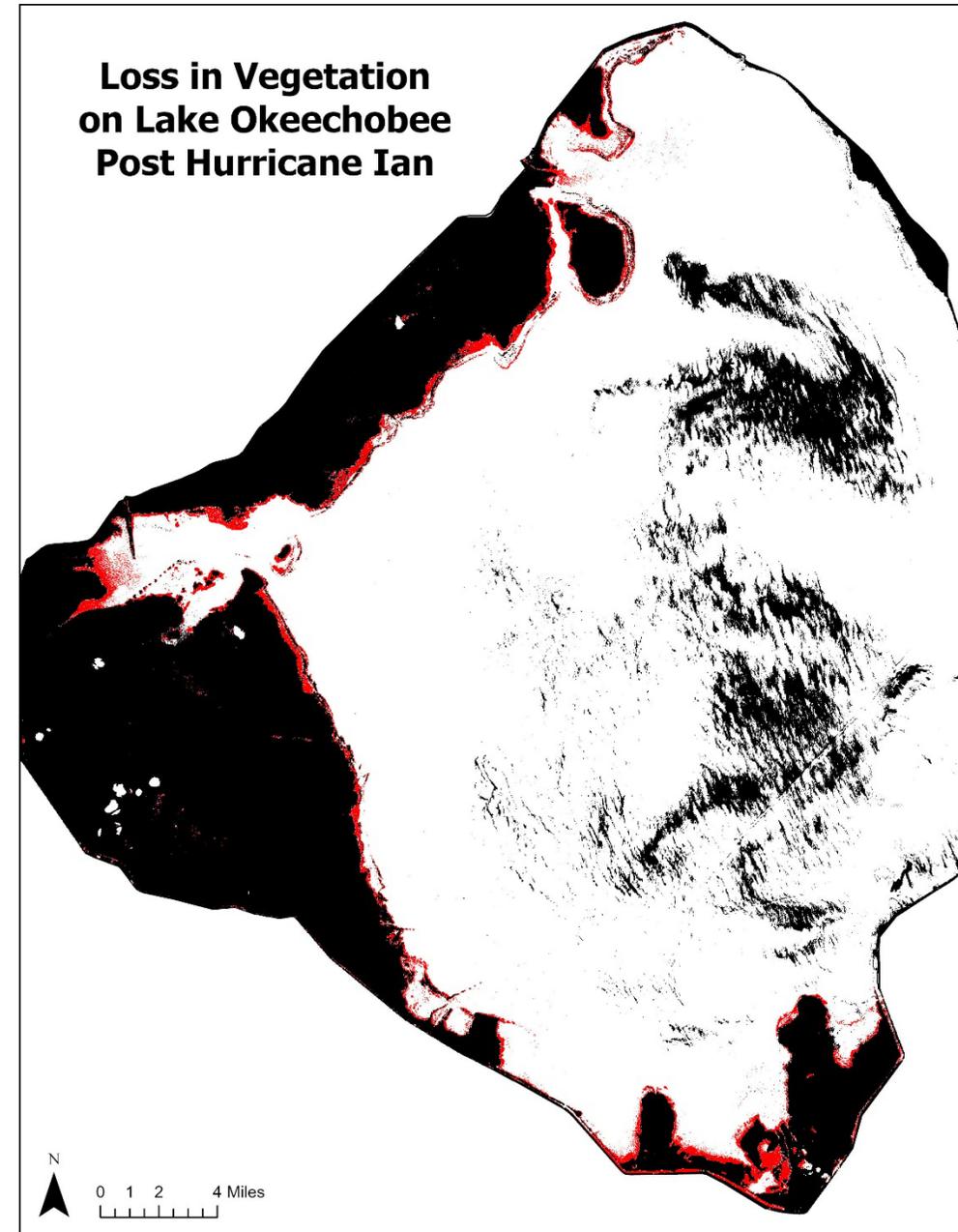
Vegetation Lost:  
10,911 Acres



## Accuracy Results

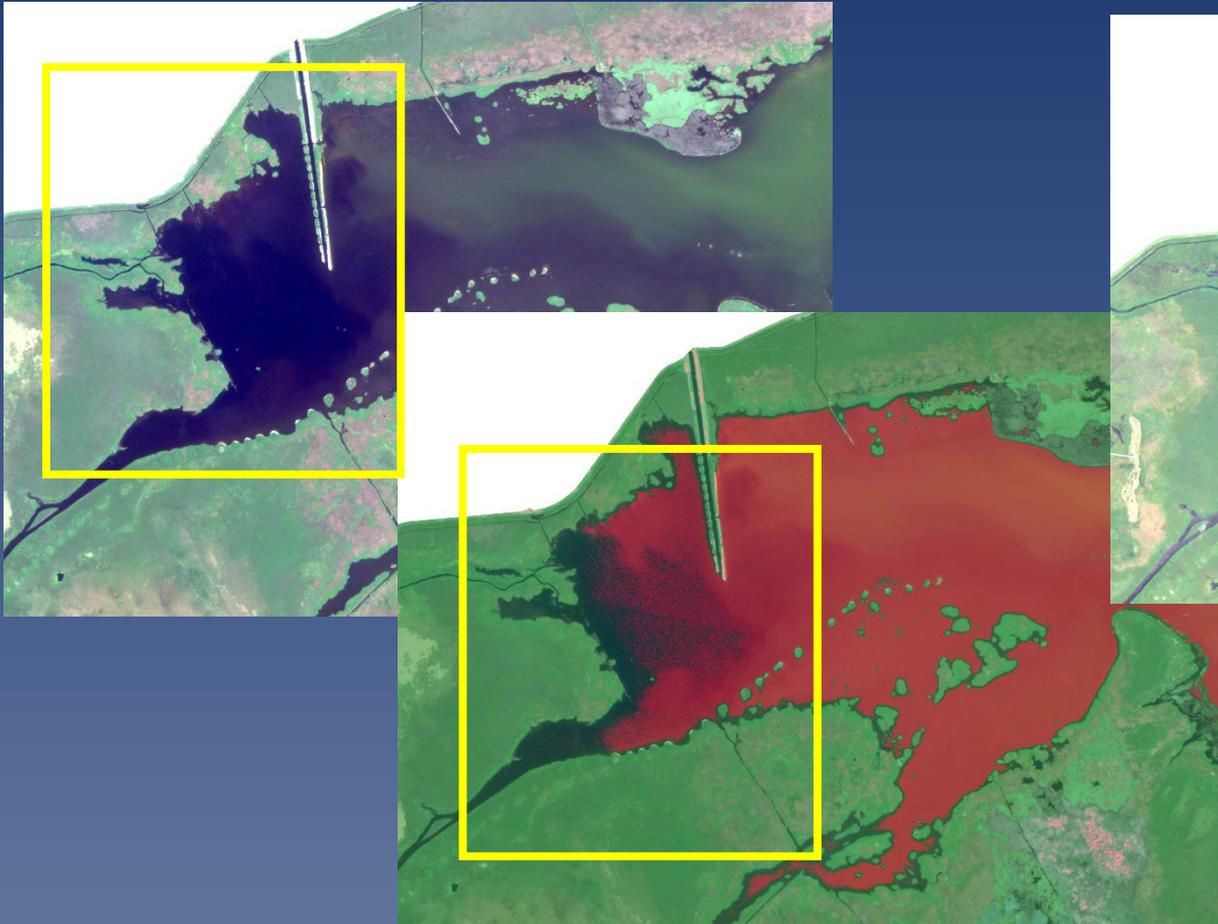
- 212 total points
- Overall Accuracy = 52%
- Errors of Omission
- False Negatives
  - Pixels classified as a loss in vegetation were inaccurately marked
  - Points ground truthed as 'No Change' in water pixels

~~Vegetation Lost:  
10,911 Acres~~

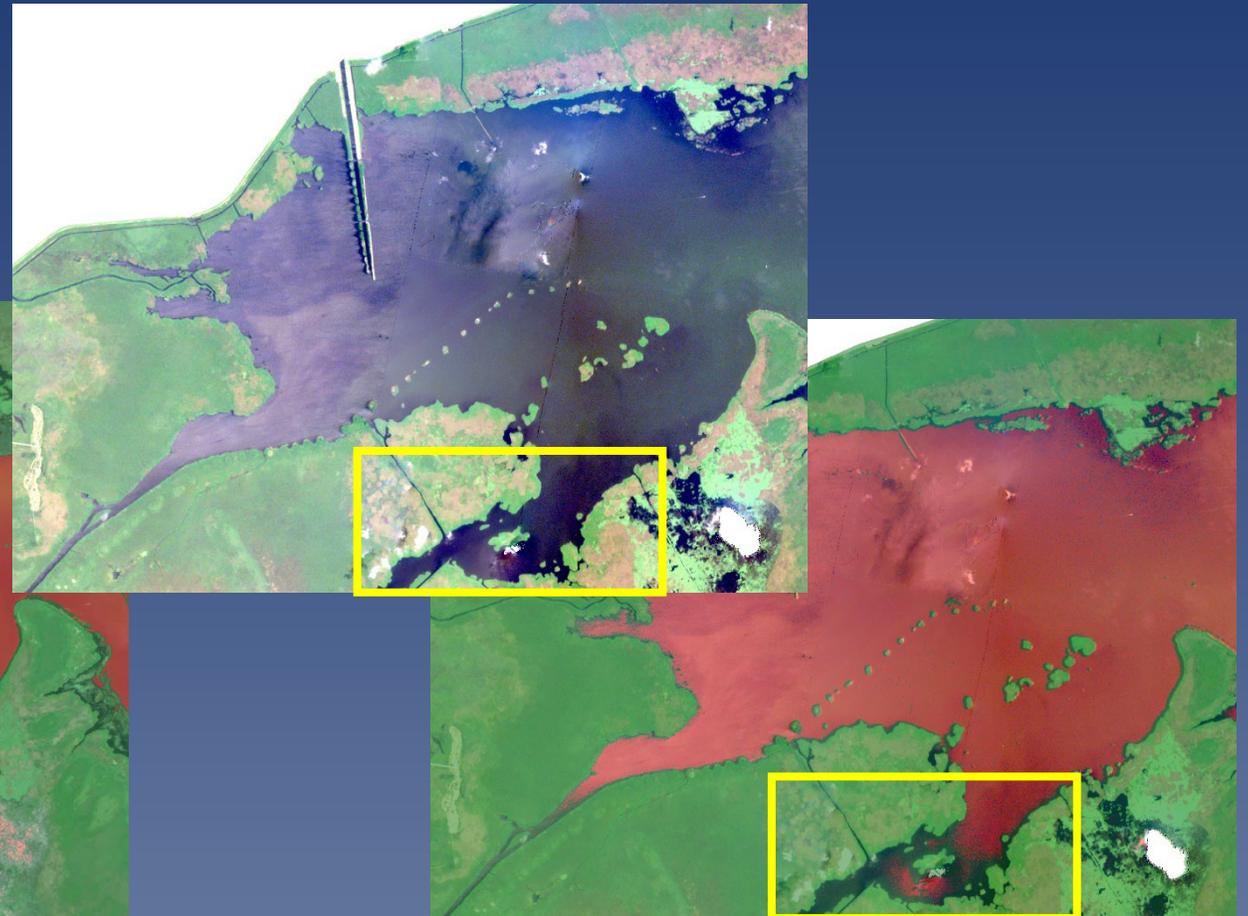


# Limitations

Sept. 05 – 19, 2022



May 29 – June 12, 2023

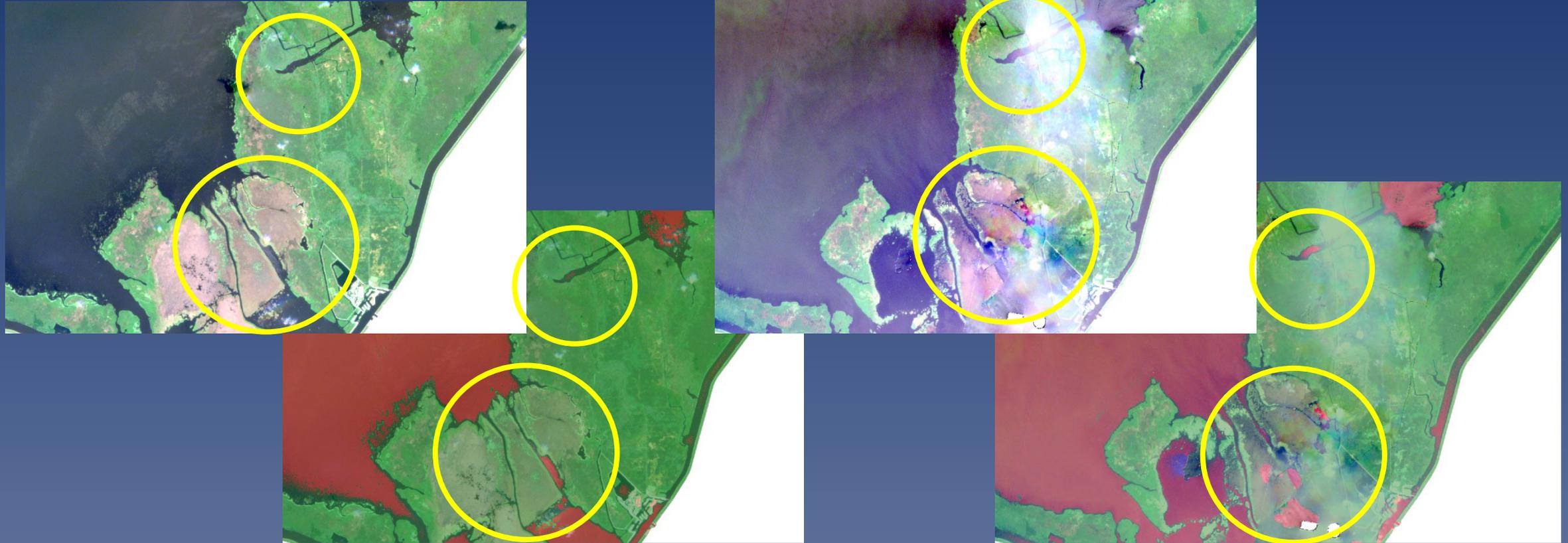


Otsu's method output: Green – vegetation; Red - water

# Limitations

Sept. 05 – 19, 2022

May 29 – June 12, 2023



Otsu's method output: Green – vegetation; Red - water

# Conclusions & Next Steps

- Raster calculation tool in ArcGIS Pro led to an overestimation of vegetation lost.
- Errors likely attributed to quality of imagery.
  - Glint/glare
  - Turbidity, water mixing
- Assessing accuracy of individual sets of imagery (pre & post Hurricane Ian) to better pinpoint the potential cause of errors.
- Utilize Otsu's method on imagery of moderate resolution (Landsat or Sentinel) and possibly cleaner quality.

# Acknowledgements

- South Florida Water Management District
  - Applied Science Bureau - Lake & River Ecosystems
    - Camille Carroll, James Leary
  - Geospatial Department
    - Madelyn Rinka, Allison Lamb, Bob Wu

