

Mapping Kissimmee River Floodplain Vegetation: An Approach Using Machine Learning In Small Plots

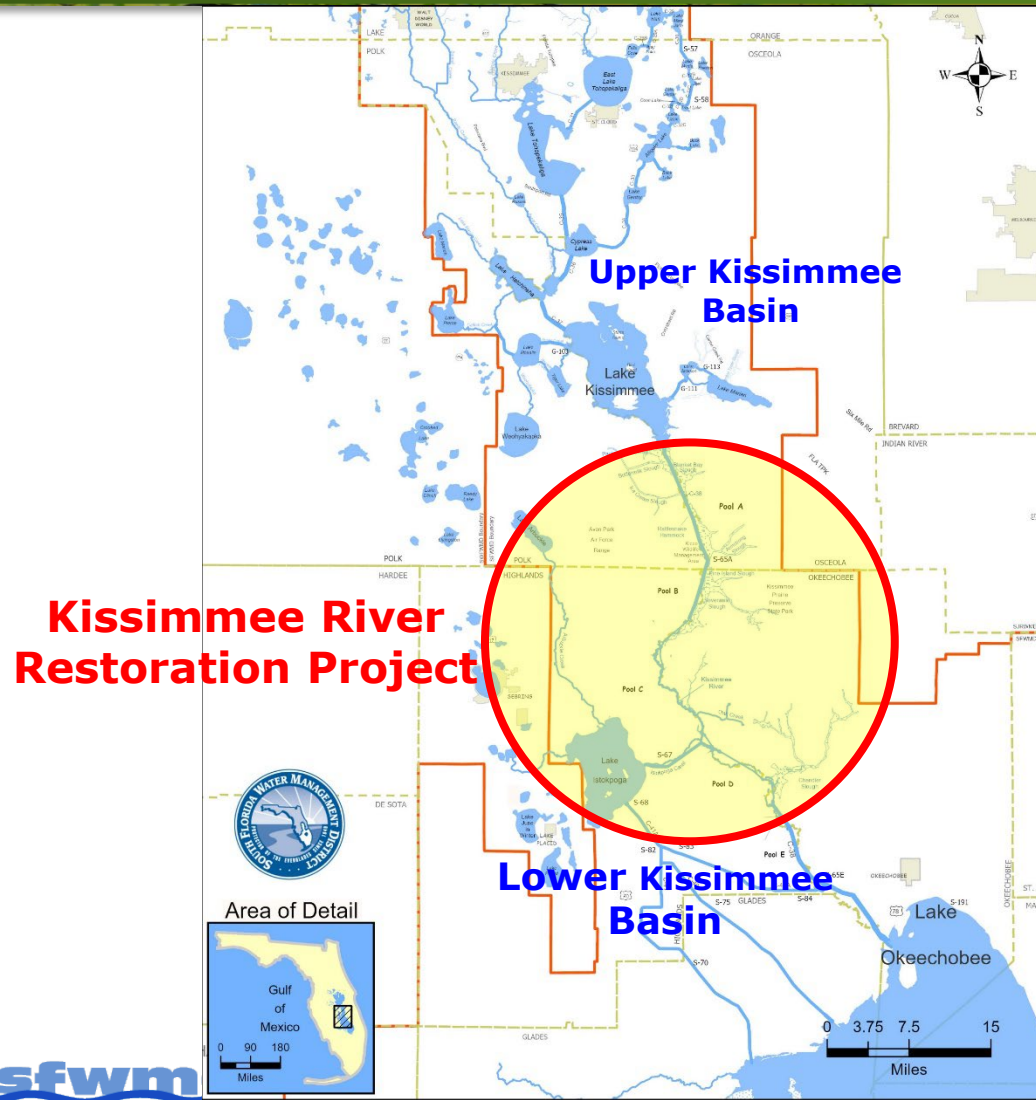
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Lake and River Ecosystems Section
South Florida Water Management
District

Greater Everglades Ecological
Restoration Conference

Coral Springs, FL
April 24, 2025

Kissimmee River Location



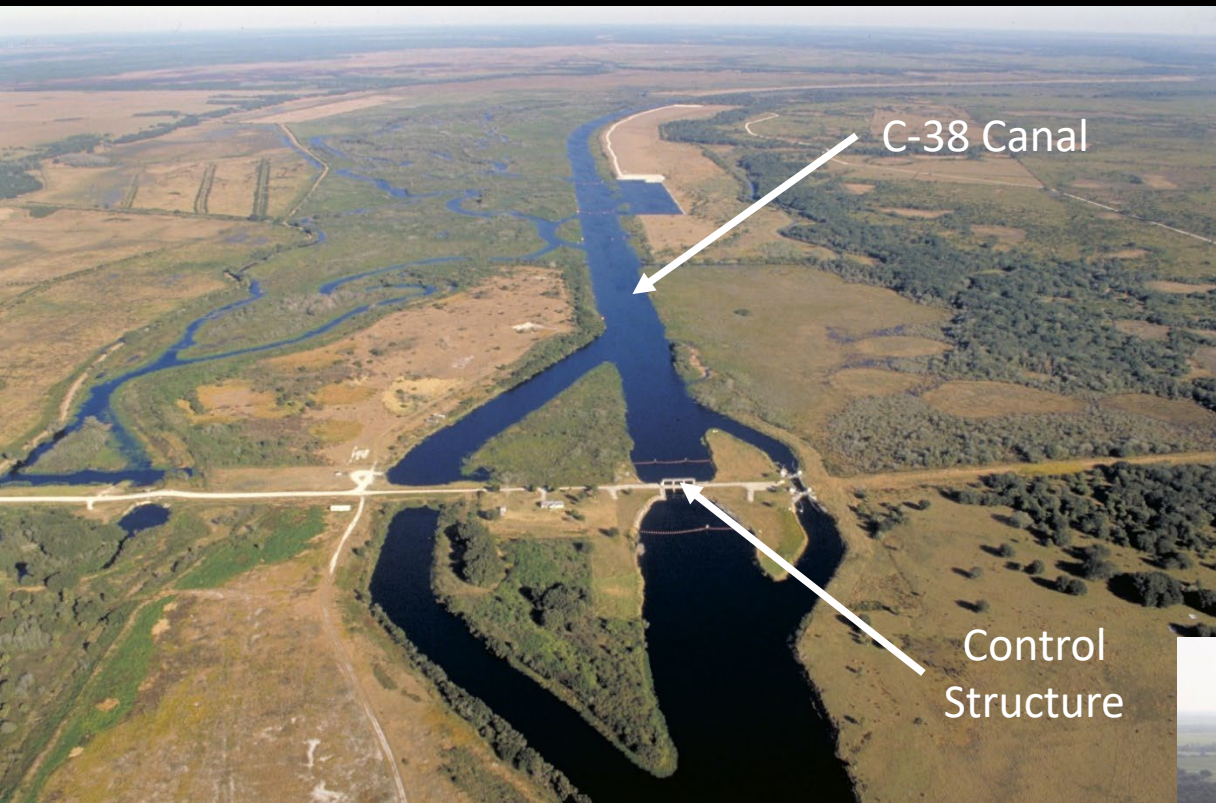
- Location: Central Florida, about 50 miles South of Orlando
- Length: 103 miles
- Drains Lake Kissimmee
- Drains into Lake Okeechobee

An aerial photograph of the Kissimmee River, showing its characteristic meandering path through a vast, flat, and marshy landscape. The river's light-colored water contrasts with the darker, textured ground. The sky is hazy and bright, suggesting a high sun position.

Kissimmee River Circa 1947

Native River:

- Natural flood pulse
- Highly productive and diverse wetlands
- Abundant native flora and fauna



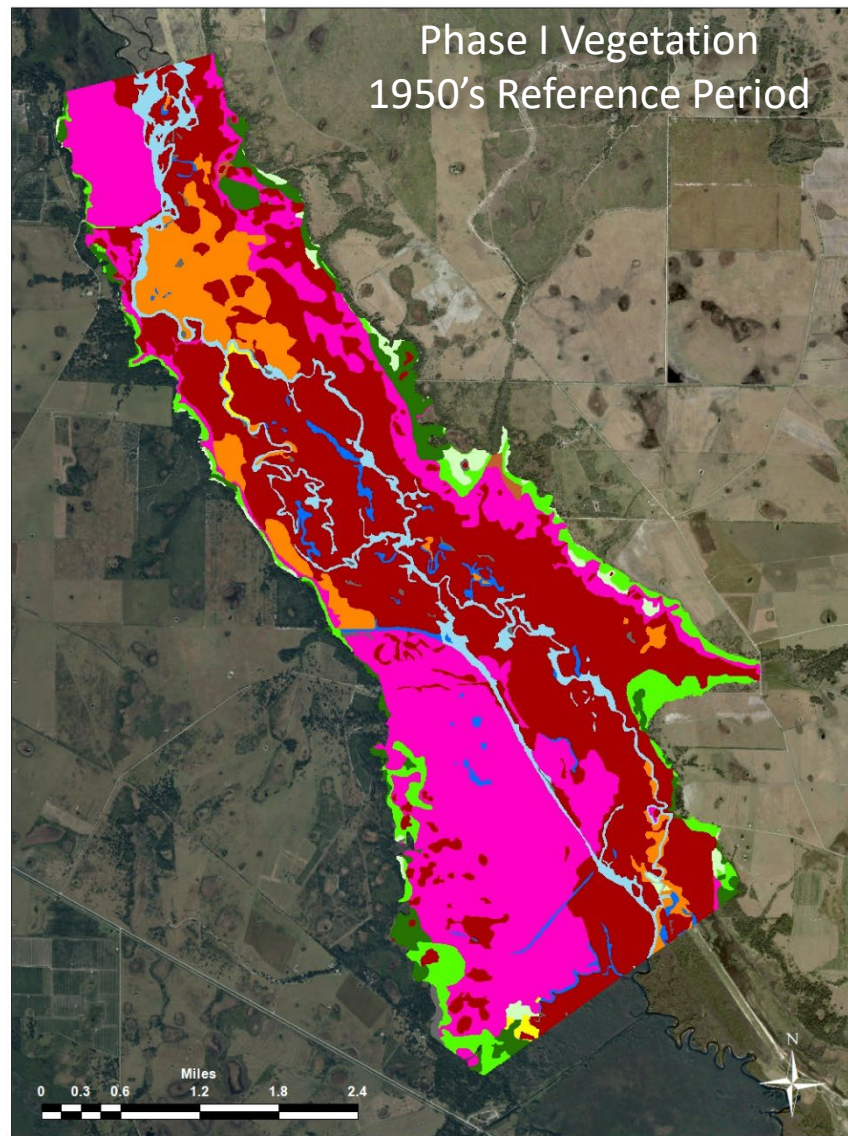
Kissimmee Restoration Project :

- Backfilled one-third of C-38 canal
- Re-established flow to 40-50 miles of river channel
- Potential inundation re-established to roughly 25,000 acres of floodplain area
- Intermittent floodplain inundation re-established

Channelized System:

- Controlled flooding
- Little or no natural inundation
- Drained 60% of wetlands
- Lowered plant, fish, and waterfowl abundance and diversity
- Discussions began immediately about restoring the river





Evaluating Vegetation for KRR

Wetland Vegetation:

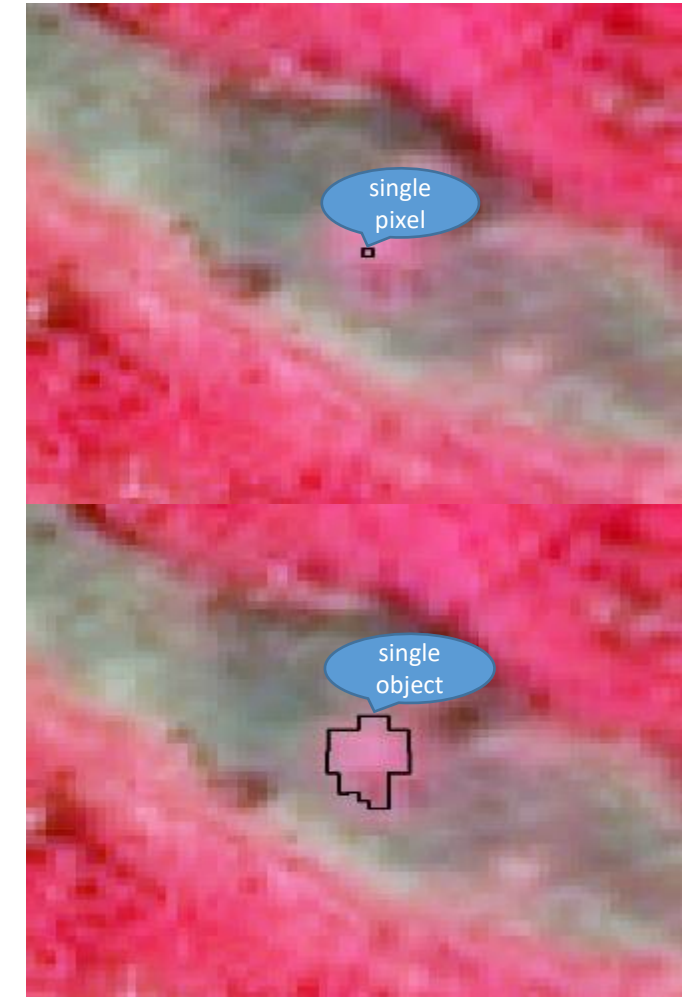
- Evaluated based on “reference conditions” from 1950’s vegetation map:
 - Compare current vegetation map derived from aerial (or satellite) images to reference map
 - Evaluation based on specific performance measures for total wetland area, area of Wet Prairie, and area of Broadleaf Marsh
 - Most recent aerial imagery collected in 2023

I will complete a new vegetation map of the Kissimmee floodplain this year based on 2023 imagery using the methods I discuss in this presentation

Mapping Process

Machine-based Image Analysis:

- **Object Based Image Analysis (OBIA):**
 - A computer joins adjacent pixels with close spectral or other signatures into “**objects**,” which creates entities more similar in size and shape to real-world objects (buildings, water bodies, plant canopies, etc.)
- **Machine Learning (ML)** classification methods:
 - Can use object signatures based on spectral, elevation, or any continuous or discrete characters for training an ML model
 - Once trained, ML methods allow for more flexible machine-based classifications
- Today, I’m discussing combining **ML and OBIA** algorithms developed through both commercial and open-source software products to produce a vegetation map.
- **The benefit of using these methods is a quick turnaround and lower funding requirements, compared to traditional mapping methods or using private mapping contractors.**

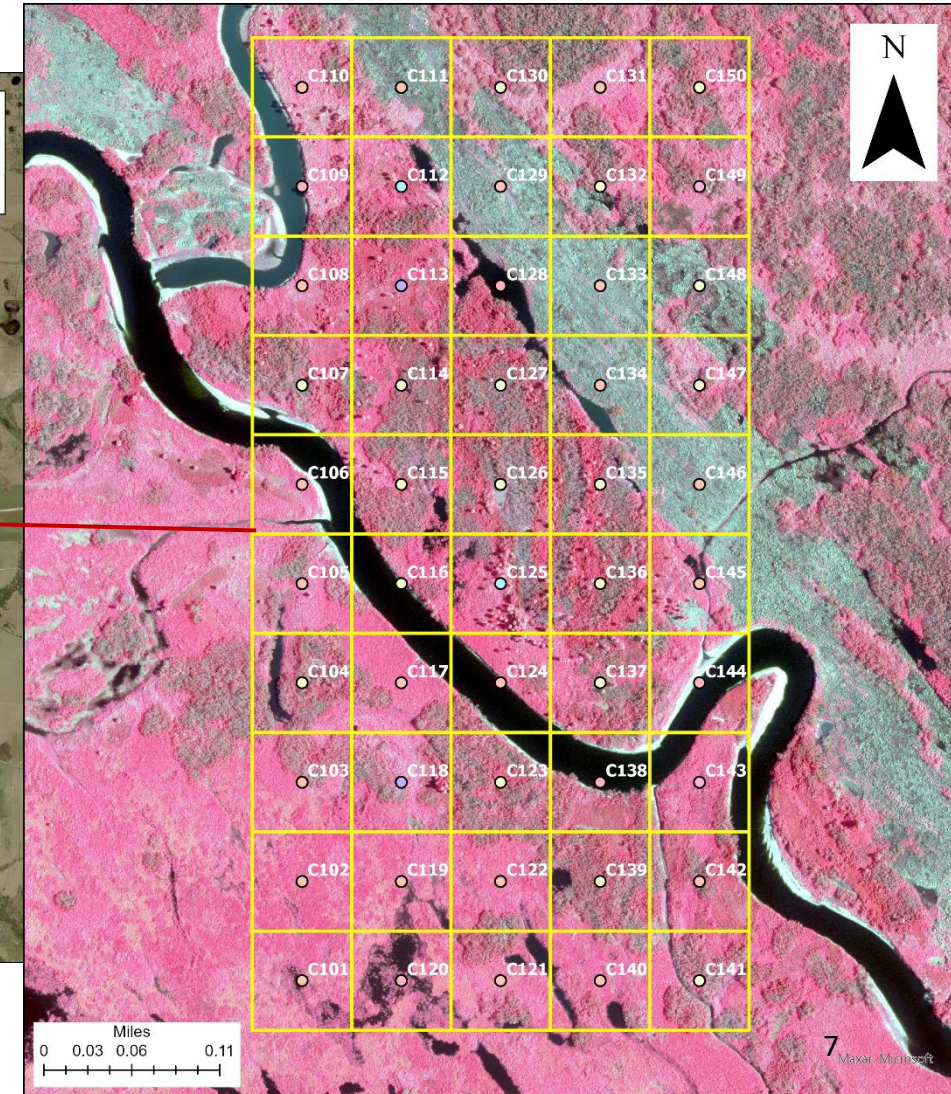
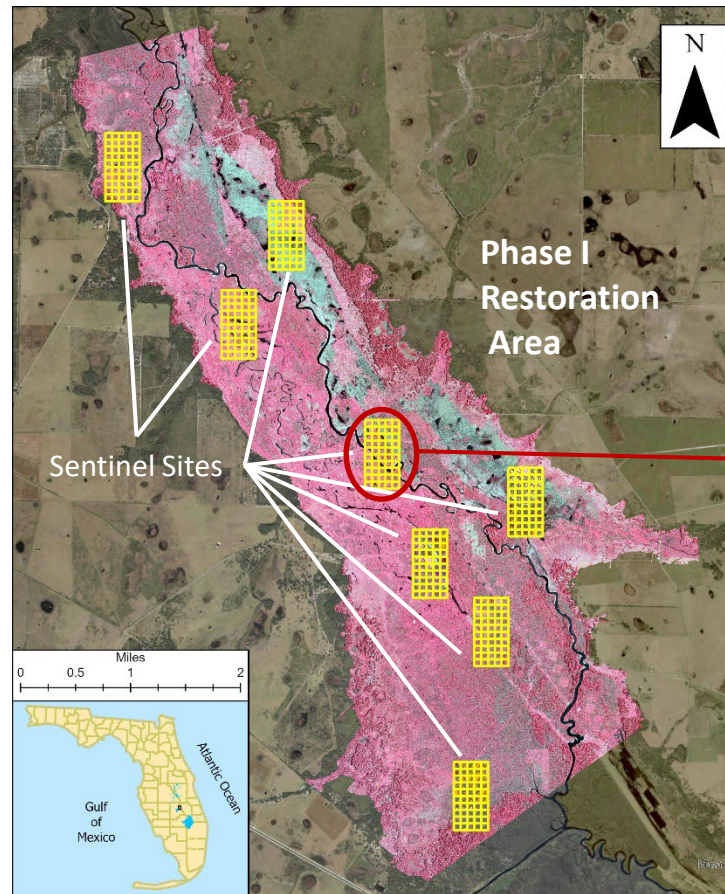


Using Sentinel Sites

A Proof of Concept:

- For 2023 mapping effort, we began using grids of fifty 1-hectare cells (called Sentinel Sites) to collect vegetation signatures by helicopter and airboat
- When in helicopter, we collect GoPro video transects in these grids to maximize the generation of signatures
- Use ML techniques to map these smaller sites
- Then extrapolate to full floodplain extent

2023 Aerial Images in CIR

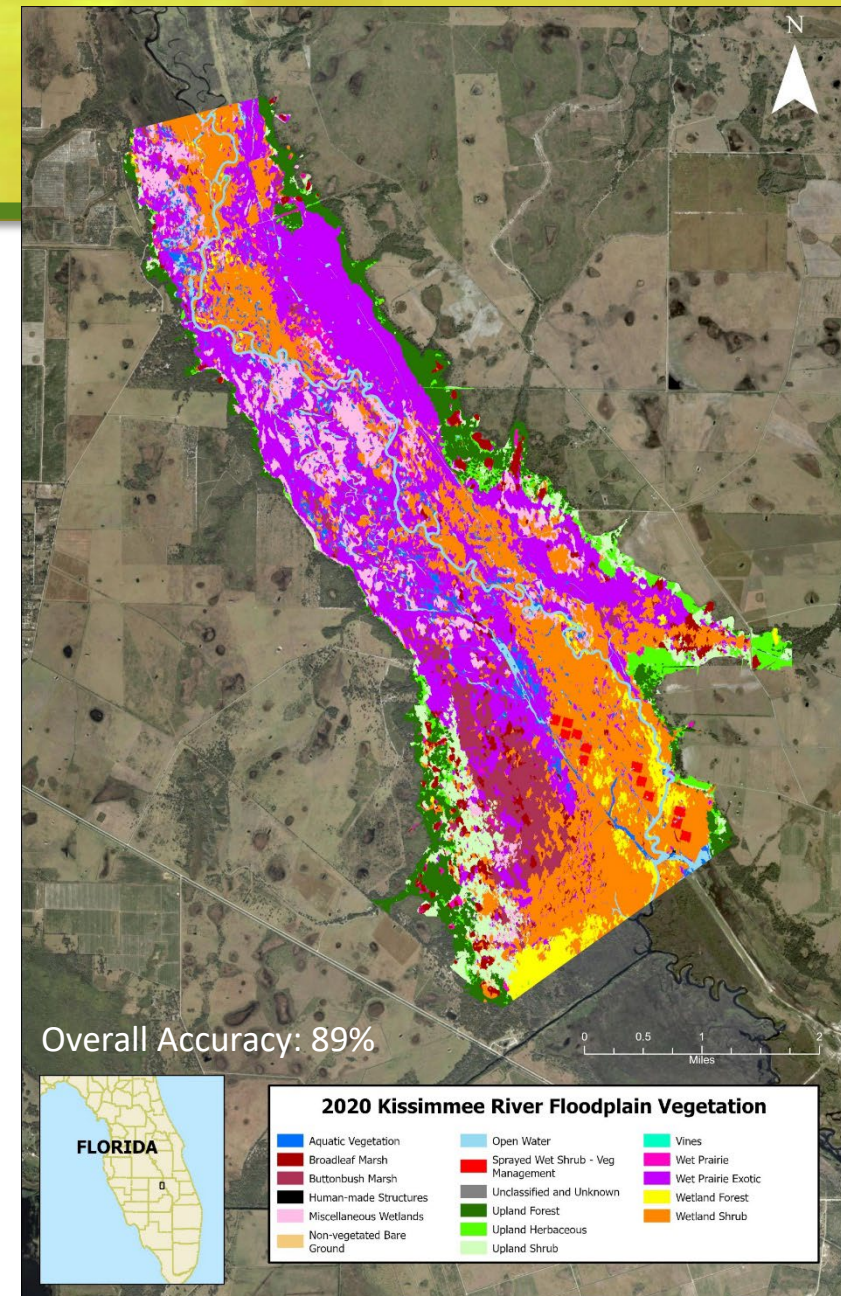


Field Videos



2020 Map Result

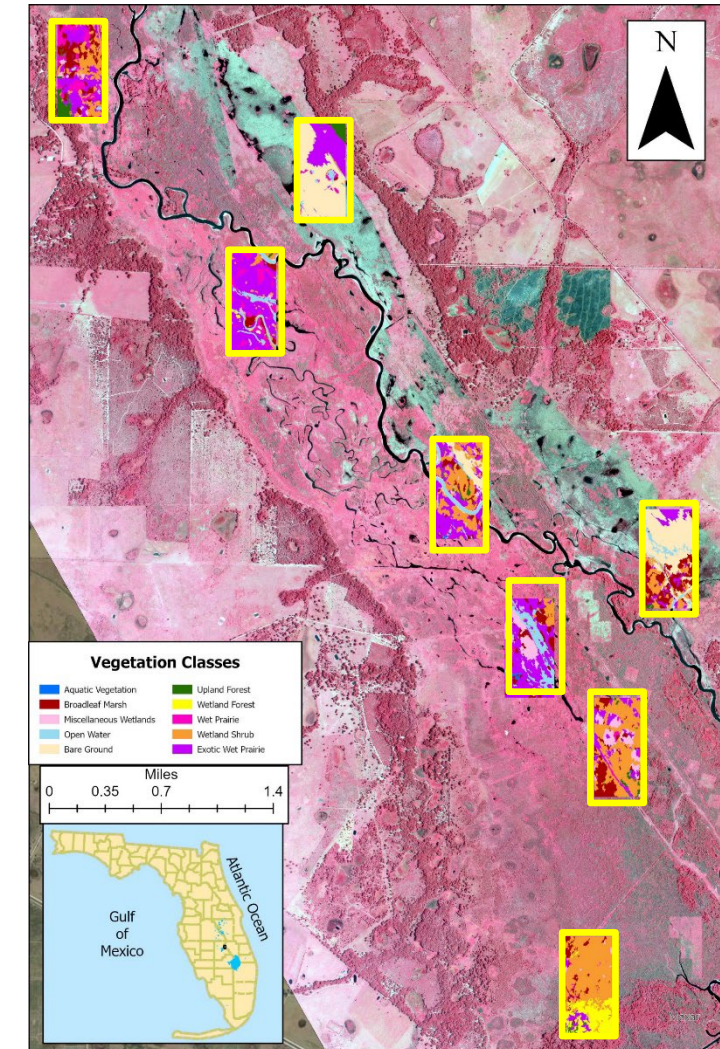
Goal of 2023 mapping effort is to produce a similar map to this one from 2020, but more efficiently



2023 Preliminary Mapping Result

Mapping of eight Sentinel Sites in Kissimmee River Phase I:

- Machine Learning used ~800 signature samples (25-100 signatures per class)
- Map accuracy:
 - Overall Accuracy: 78%
 - Range: 60-80% for all classes
- Most confused signatures:
 - Wet Prairie vs. Exotic Wet Prairie
 - Buttonbush (BLM) vs. Wet Shrub
 - Aquatic Vegetation vs. Wet Prairie



Sentinel Site Mapping Results: Change over Time

Comparisons between 2020 and 2023 Maps: Specific Sites

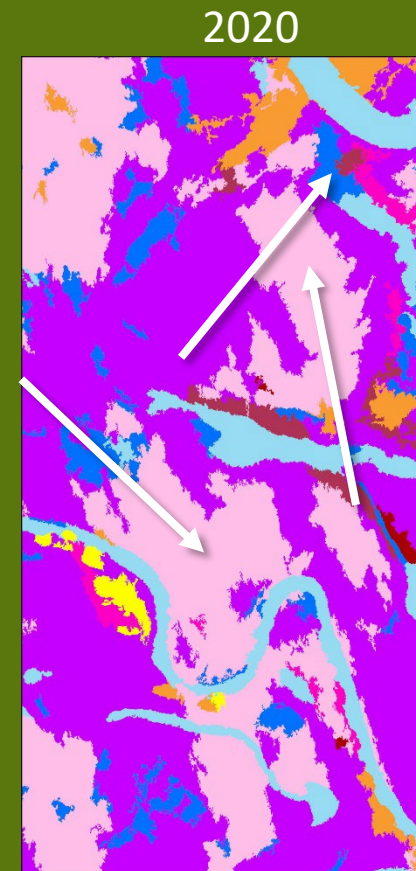
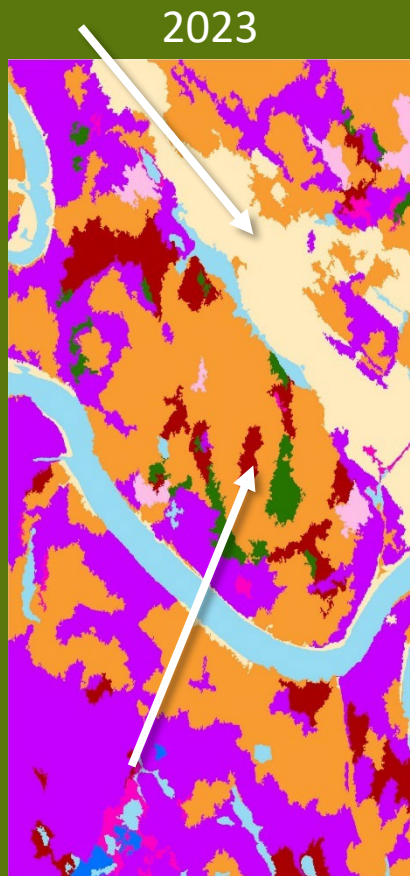
2020 Map Accuracy: **89%**

Comparison Result:

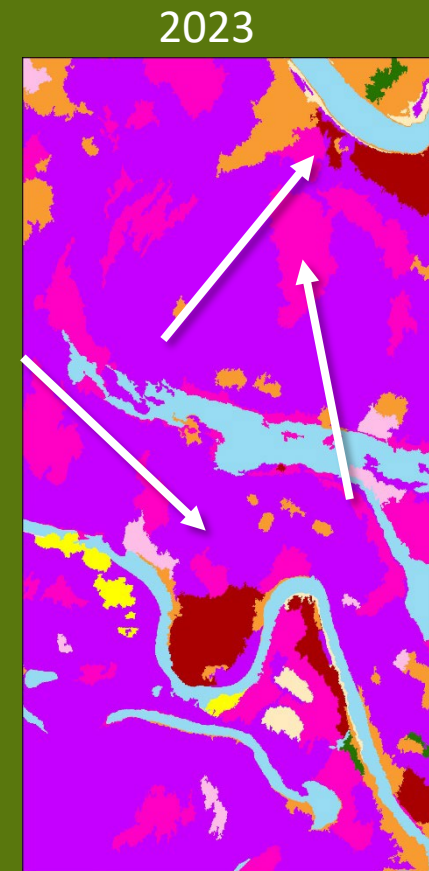
- 2023 generally similar to 2020 map with some apparent differences.
- Herbicide spraying caused increase in bare ground areas.
- Possible confusion between buttonbush and willow apparent here.
- Possible confusion between WP and AQ apparent here.
- Decrease in hibiscus.
- Increase in wet prairie including smartweed and bulrush in some areas.



Site C10



Site C25



Conclusions



Sentinel Sites show promise for improving mapping by allowing concentration on a limited area of floodplain for repeat visits



Video transects from helicopter are useful to collect multiple signatures for the sites from a single visit; allow for increased coverage vs. previous technique (single point ID)



More field signatures necessary for some classes; also improve specificity of low-quality signatures



Consider adjusting locations or addition of Sentinel Sites to cover more of floodplain area

Next Steps

- Develop more (and higher quality) signatures for classes showing relatively low accuracy
- Run ML process for Sentinel Sites with higher number of signatures, perhaps iteratively
- Final Proof of this Concept –
 - Using the Sentinel results as signatures in extrapolation to a wider floodplain area to create 2023 Phase I vegetation map
 - Achieve accuracy comparable to 2020 map (i.e., 85-90%)
- Repeat full process on other restoration phases

Effects of Hurricane Ian?

- Differences in vegetation distribution seem to exist between 2020 and 2023 vegetation maps
- If borne out in final analysis, could these be attributable to effects felt from Hurricane Ian in fall 2022?
- Planet Satellite Imagery is available for before and after Ian
- Using same process, carry out similar ML analysis to see if vegetation changes seem can be linked to hurricane's occurrence

Acknowledgments

Camille Carroll
Steve Bousquin
Rich Botta
Brent Anderson

Contact: ispencer@sfwmd.gov