



Wetland Mapping in Central Florida

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1. Department of Geosciences, Florida Atlantic University (FAU)

2. St. Johns River Water Management District (SJRWMD)

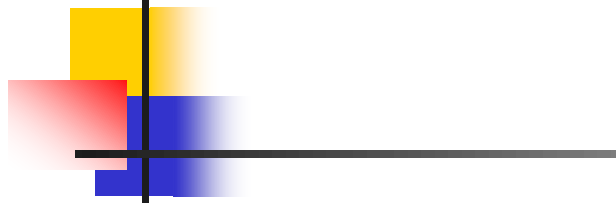
3. Florida Fish and Wildlife Conservation Commission (FWC)



Project Background

- Historical maps and datasets were produced from manual interpretation of aerial photography
- SJRWMD and FWC want to develop automated methods to map wetland plant communities using modern machine learning satellite image classification techniques
- SJRWMD Contract with FAU
 - Phase 1 (2020-2022): mapped over 50,000 acres
 - Phase 2 (2022-2025): mapping over 300,000 acres
- FWC Contract with FAU
 - 2023-2026: mapping 130,000 acres over Lake Okeechobee wetlands for years 2023, 2024, 2025

Project areas



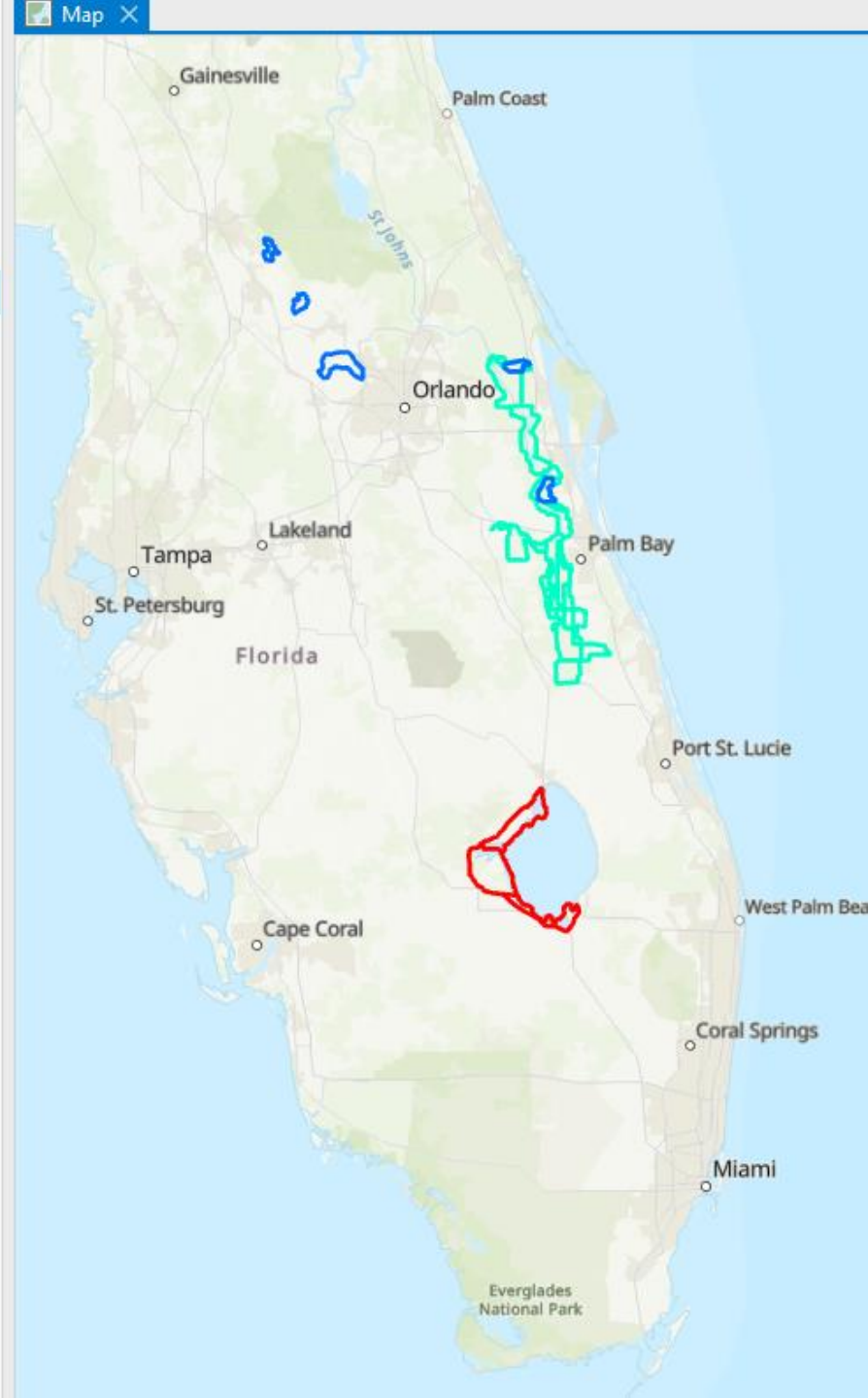
- SJRWMD
 - Phase 1 (blue): 50,000 acres
 - Phase 2 (green): 130,000 acres
- FWC (red): 130,000 acres

Contents

Search

Drawing Order

- Map
- FWC
- SJRWMD-Phase 1
- SJRWMD-Phase 2
- World Topographic Map
- World Hillshade



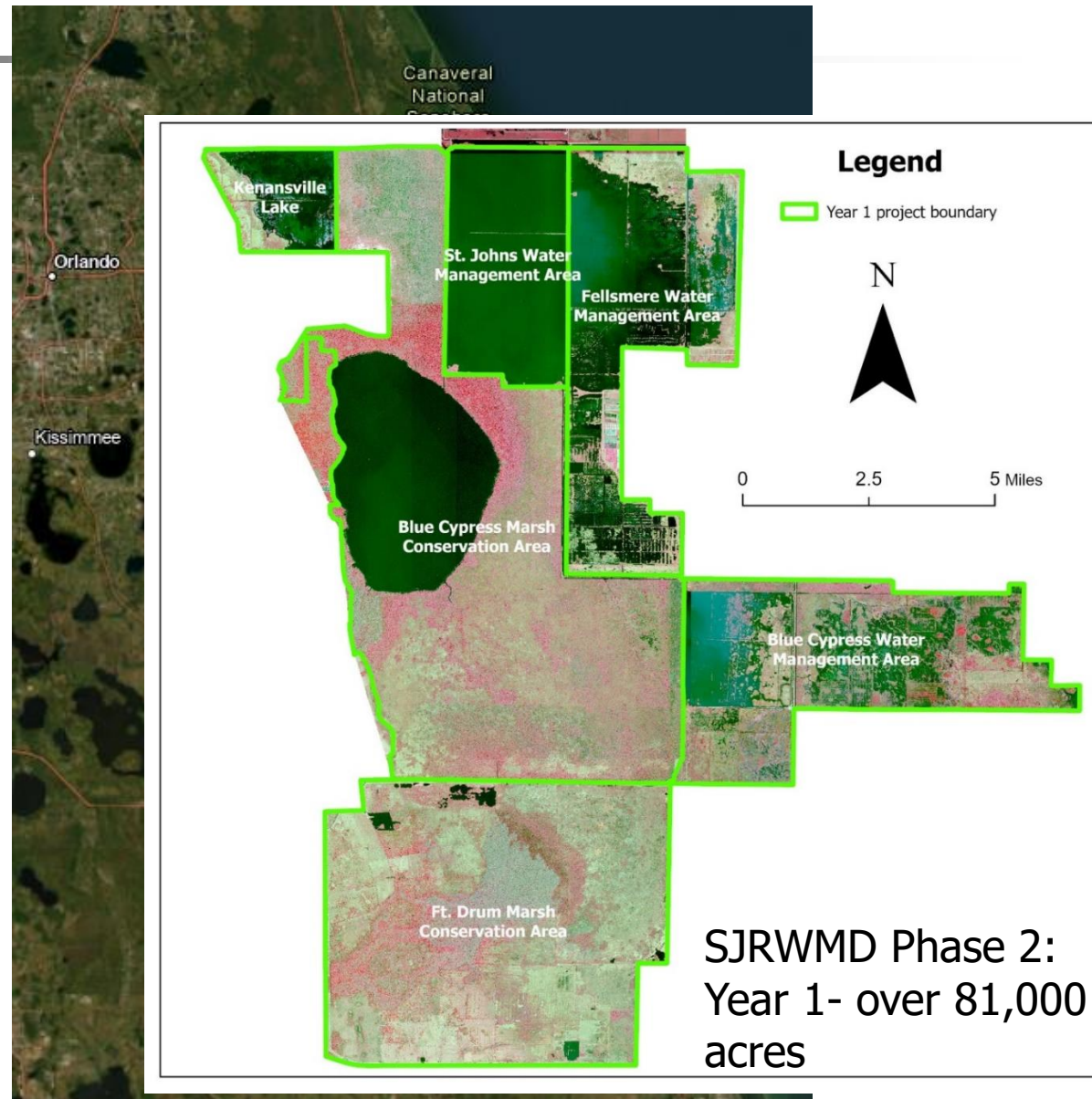
Project data: SJRWMD-Satellite imagery

Datasets

- WorldView-2 satellite products, lidar DEMs
- Historical maps, aerial imagery
- Newly collected field point samples, imagery-based interpreted references

WorldView 2/3 pansharpened imagery product

- 8 bands covering visible and infrared
- 0.5 m by fusing multispectral sensor and panchromatic imagery products

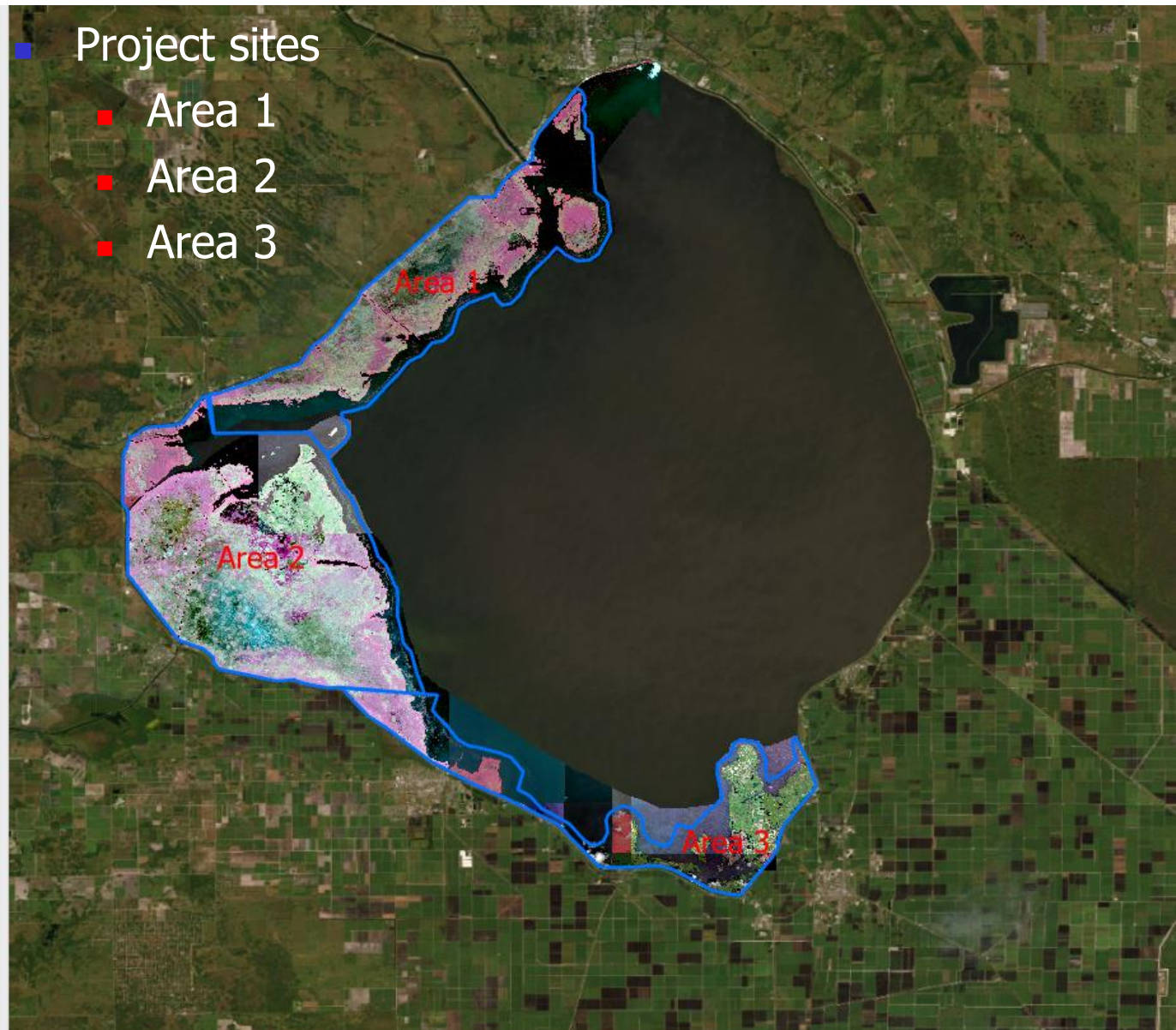


Project data: FWC-Satellite imagery

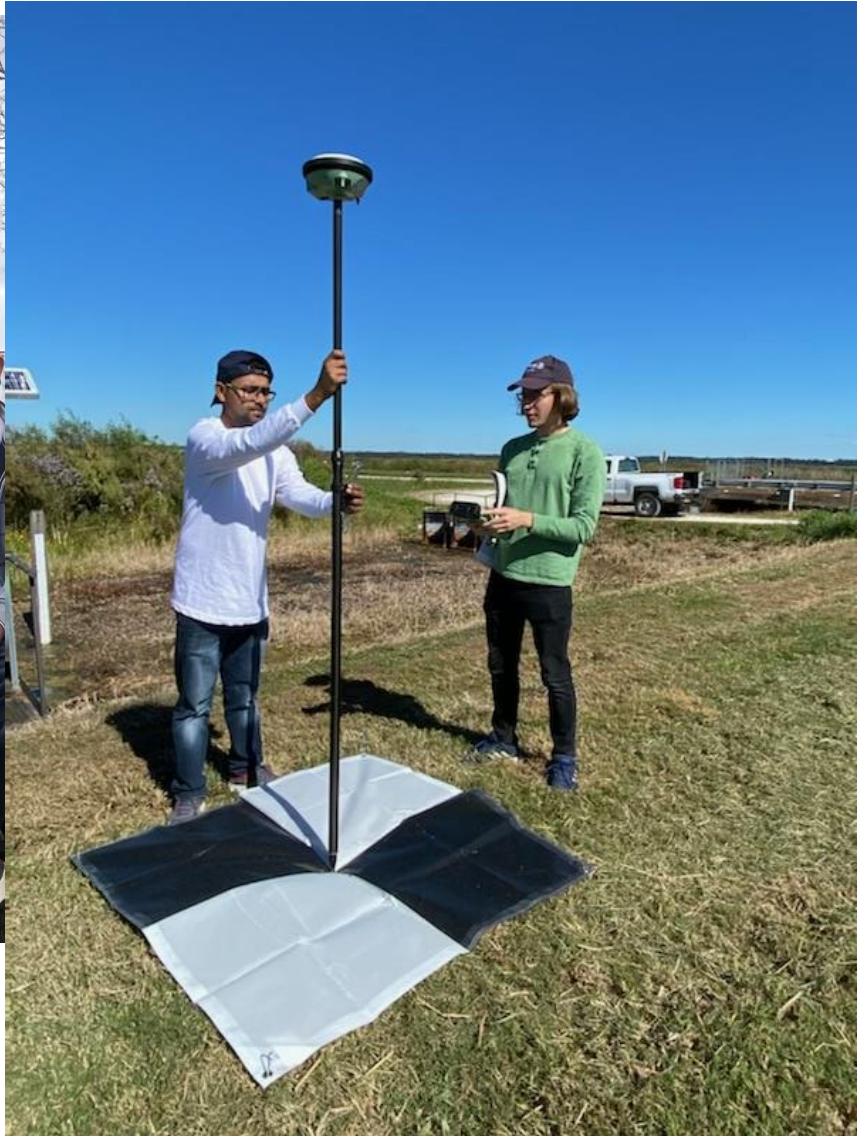
Search

Drawing Order

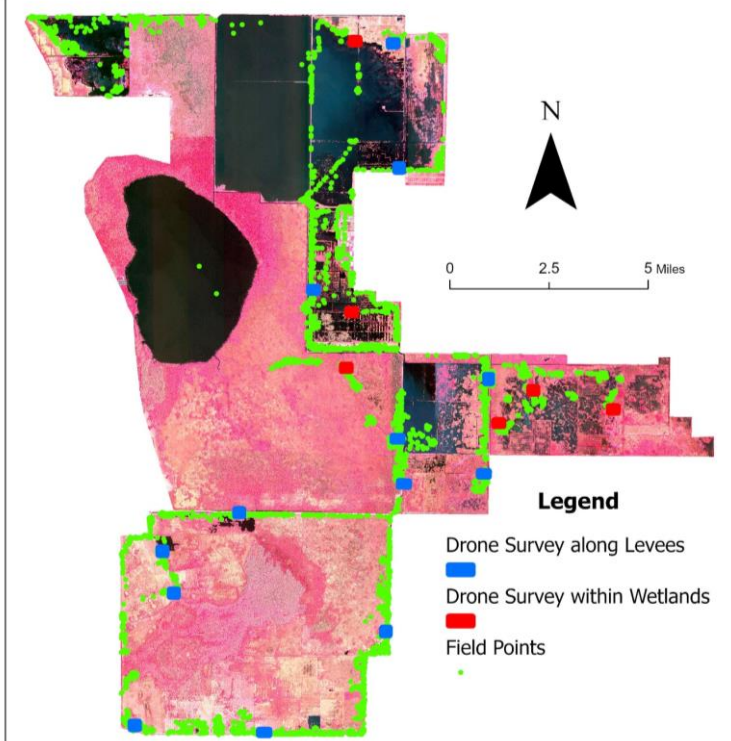
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 - Area2_Mapping
- merged_Area2
 -
- Area2_Seg_V2
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- 24MAR12155303-M3DS_R1C1-017292609020_01_P00...
- 24MAR12155303-M3DS_R4C3-017292609010_01_P00...
- 24MAR12155303-M3DS_R1C1-017292609010_01_P00...
- 24MAR12155303-M3DS_R1C2-017292609010_01_P00...
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Field data collection-2021



Field data collection-2022

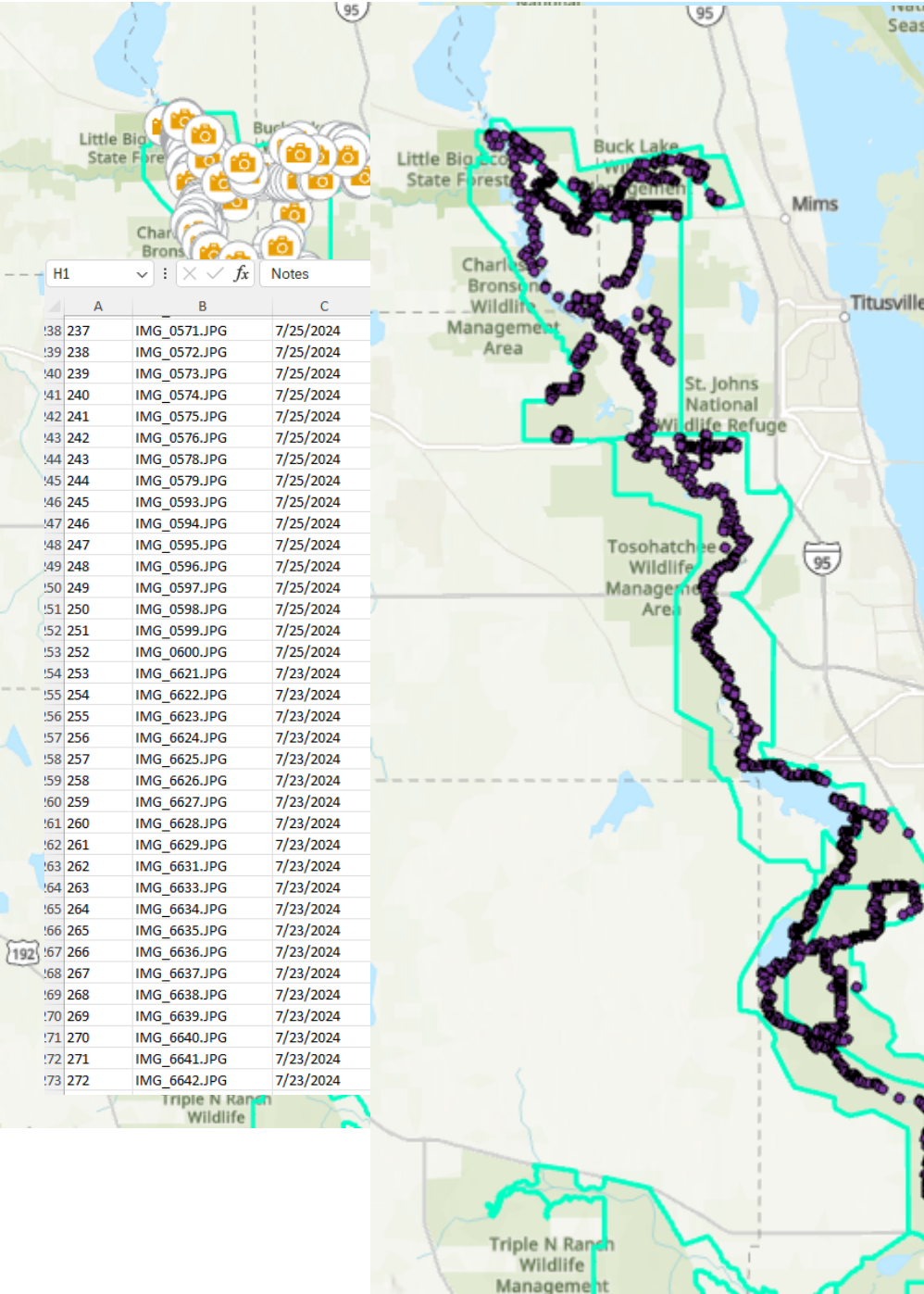


Field data collection-2023



Field data collection-2024





H1 Notes

	A	B	C
138	237	IMG_0571.JPG	7/25/2024
139	238	IMG_0572.JPG	7/25/2024
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145	244	IMG_0579.JPG	7/25/2024
146	245	IMG_0593.JPG	7/25/2024
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161	260	IMG_6628.JPG	7/23/2024
162	261	IMG_6629.JPG	7/23/2024
163	262	IMG_6631.JPG	7/23/2024
164	263	IMG_6633.JPG	7/23/2024
165	264	IMG_6634.JPG	7/23/2024
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171	270	IMG_6640.JPG	7/23/2024
172	271	IMG_6641.JPG	7/23/2024
173	272	IMG_6642.JPG	7/23/2024

Pop-up

- FieldPoints_V1 (26)
 - 7/22/2024
 - 7/22/2024
 - 7/22/2024
 - 7/22/2024

FieldPoints_V1 - 7/22/2024

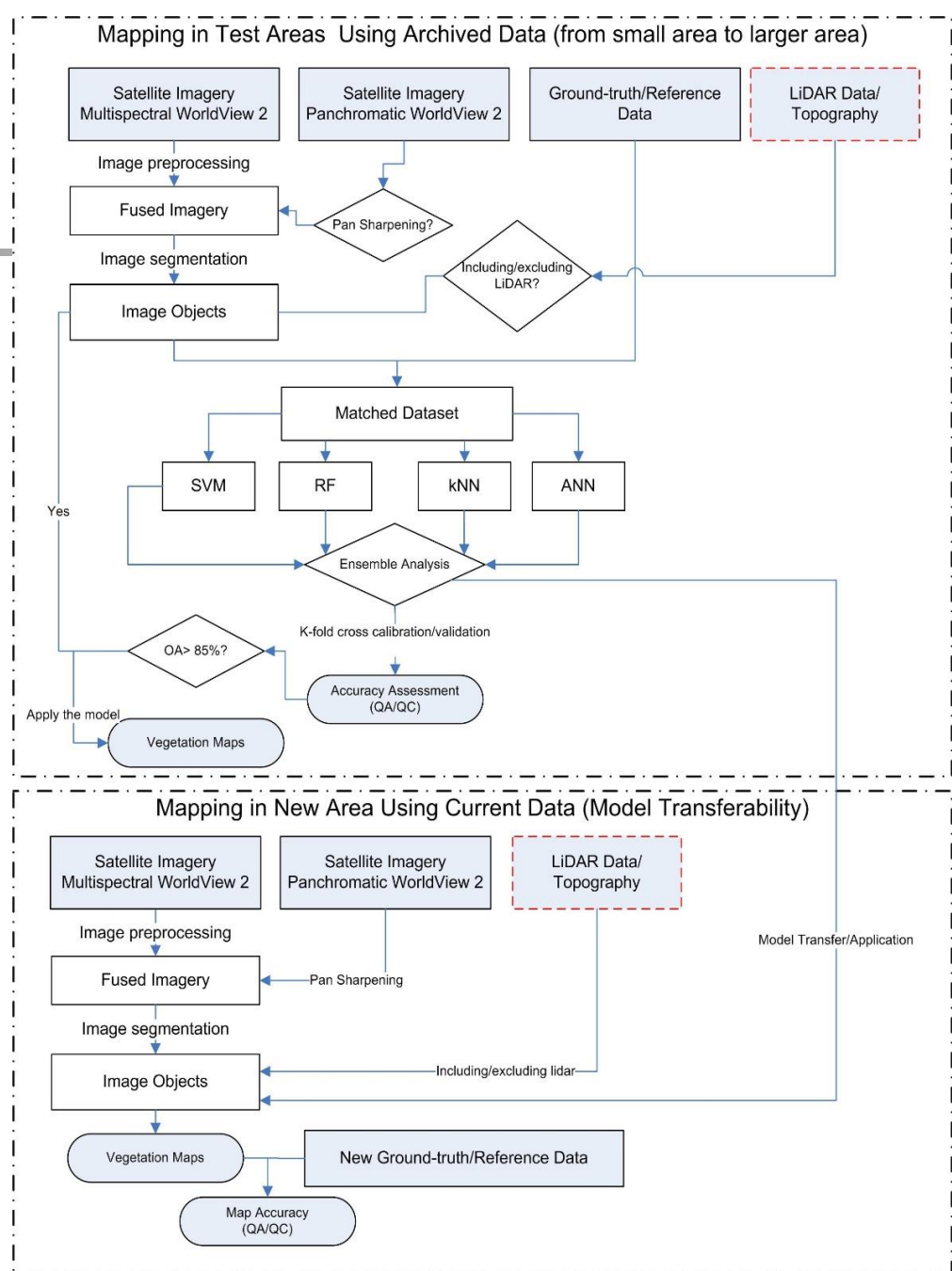
FID	37
CreationDa	7/22/2024
Creator	srijal2023
EditDate	7/22/2024
Community	Upland Hardwood
Code	12

◀ 1 of 26 ▶ 501,109.55E 3,157,117.15N m



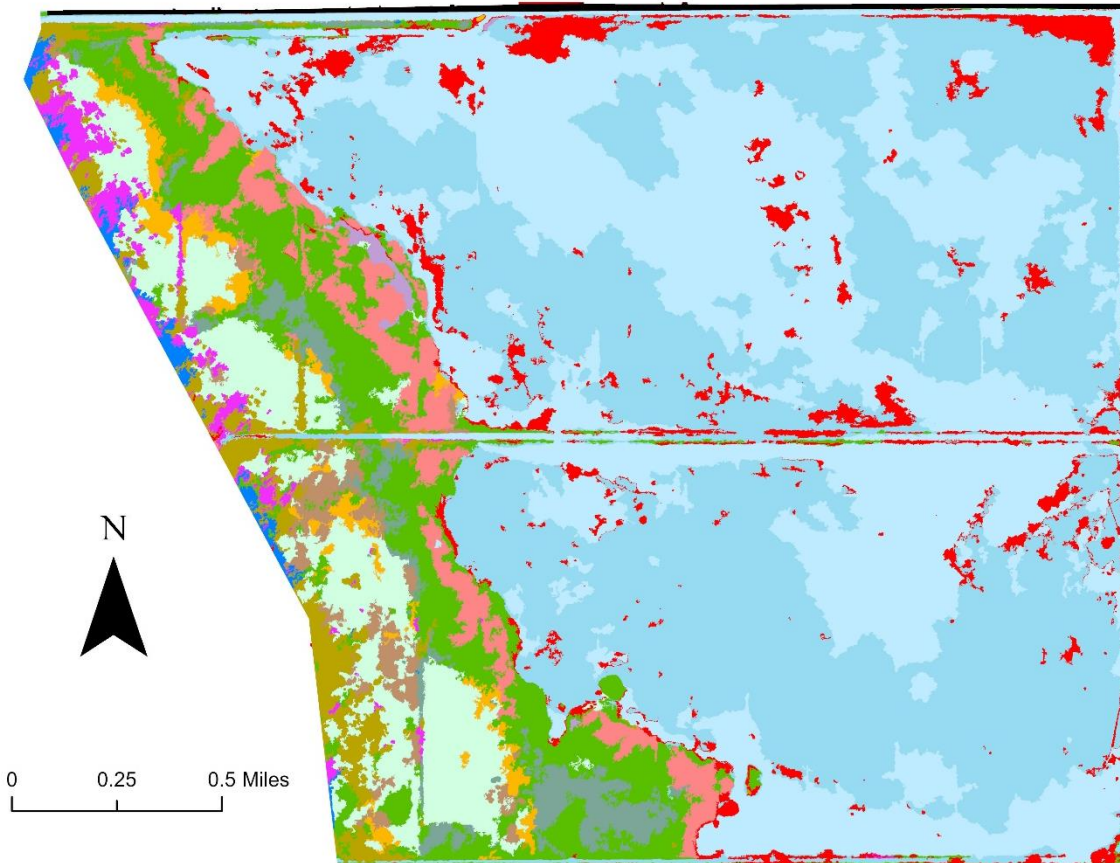
Methodology

- Image segmentation
- Fusing LiDAR with imagery
- Training sample selection
- Machine learning training and classification: SVM, RF, and ANN
- Ensemble analysis
- Map refinement
- Accuracy assessment
- Software: ArcGIS Pro, eCognition, R script



Results: KENAN

Overall accuracy: 0.88

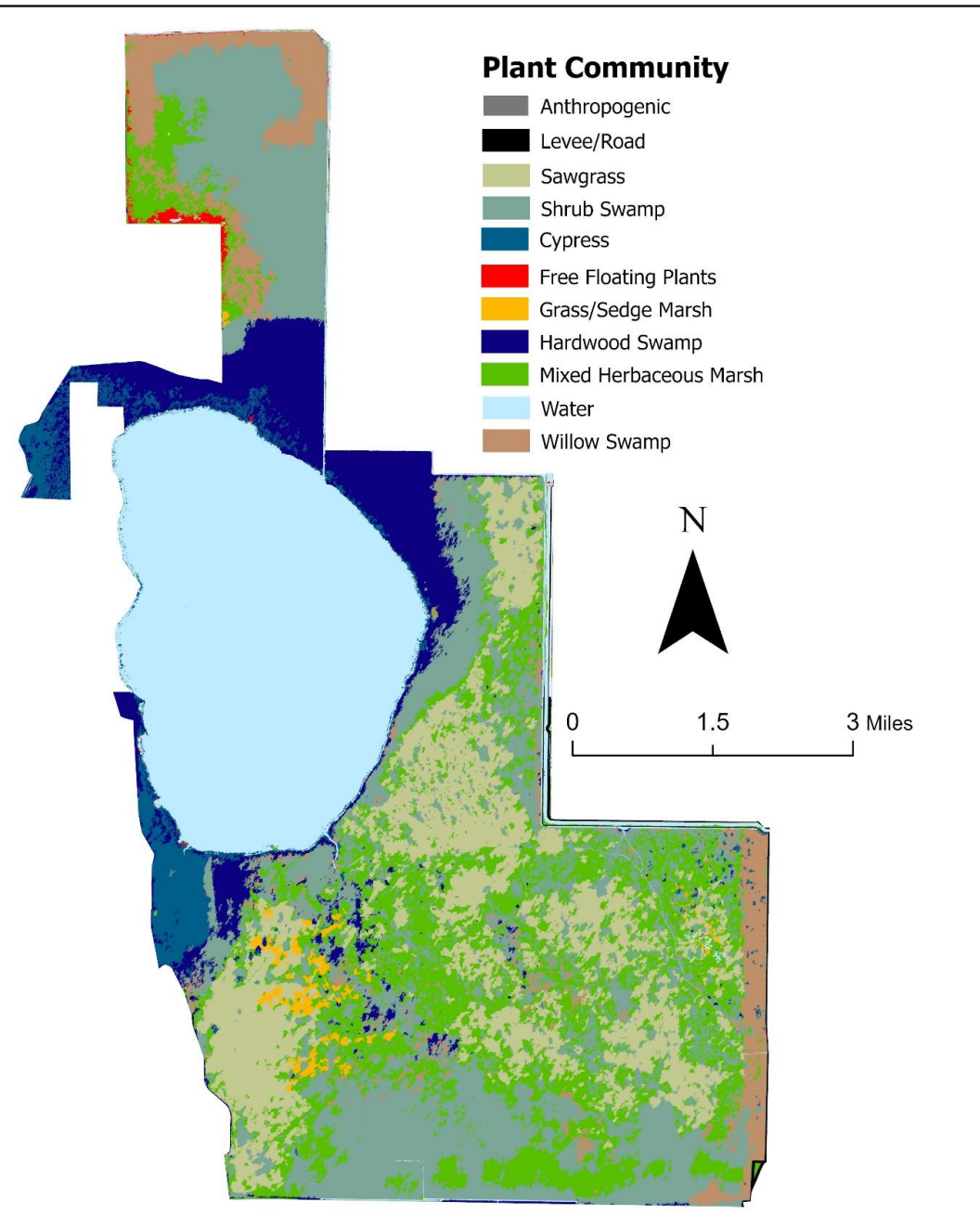


Plant Community

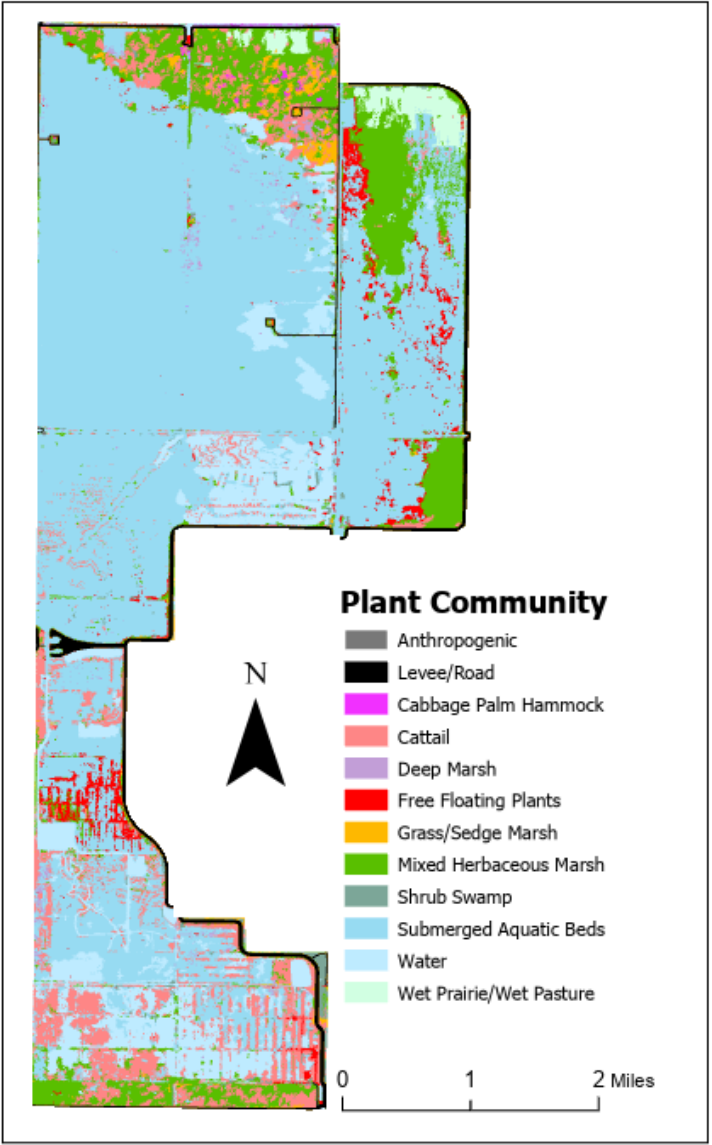
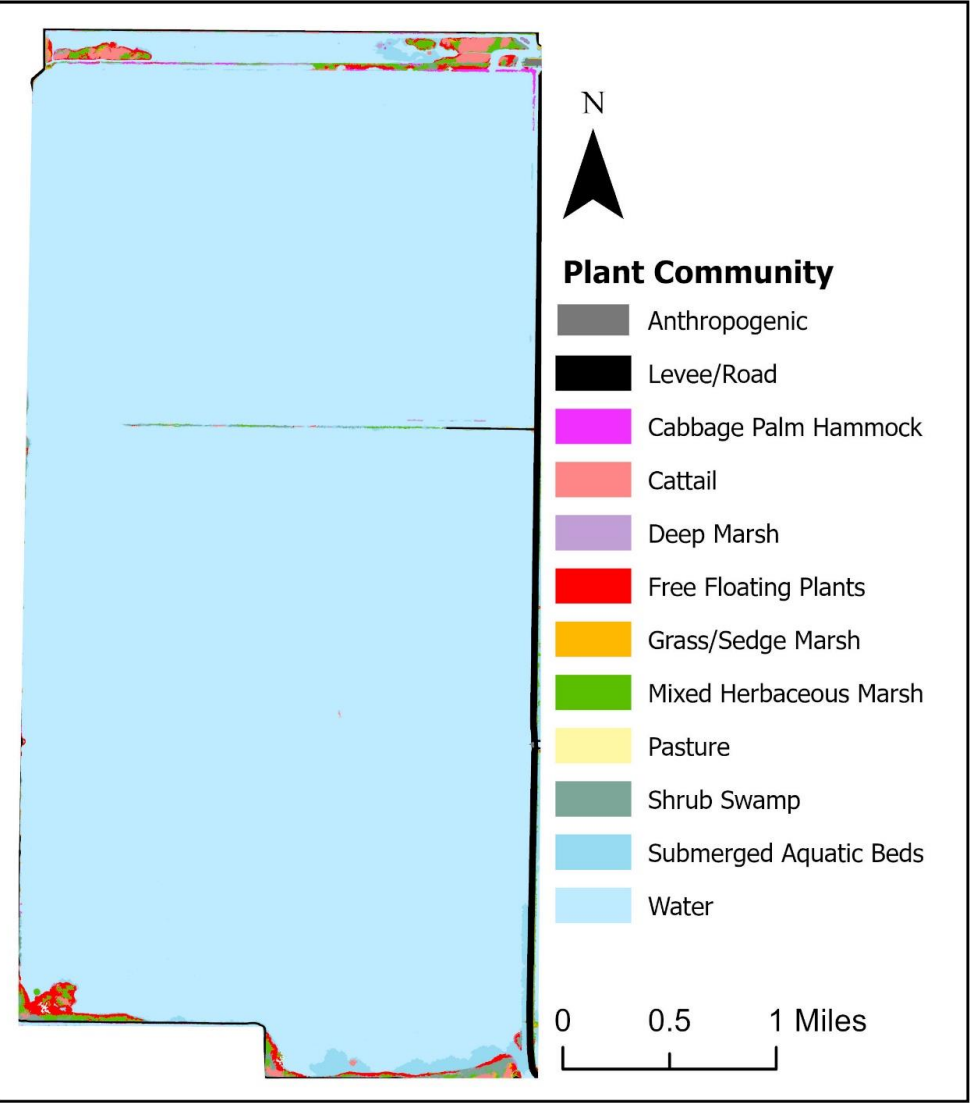
- | | | |
|----------------------|------------------------|-------------------------|
| Levee/Road | Grass/Sedge Marsh | Upland Hardwood |
| Cabbage Palm Hammock | Mixed Herbaceous Marsh | Water |
| Cattail | Mixed Shrub | Wet Prairie/Wet Pasture |
| Deep Marsh | Shrub Swamp | Willow Swamp |
| Free Floating Plants | Submerged Aquatic Beds | |

Results: BCMCA

Overall Accuracy: 0.89

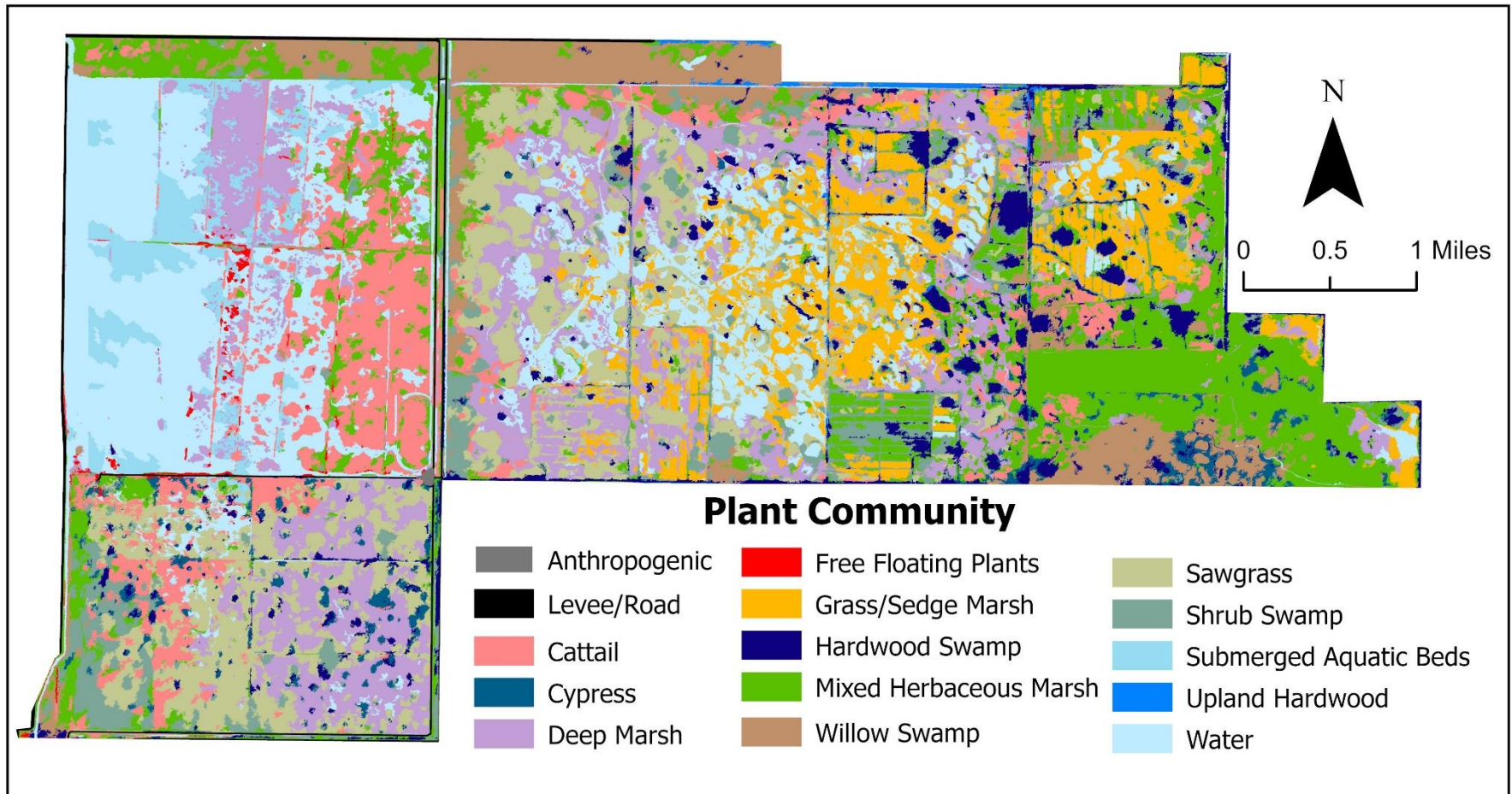


Results: SJWMA and FWMA



Overall Accuracy: 0.82

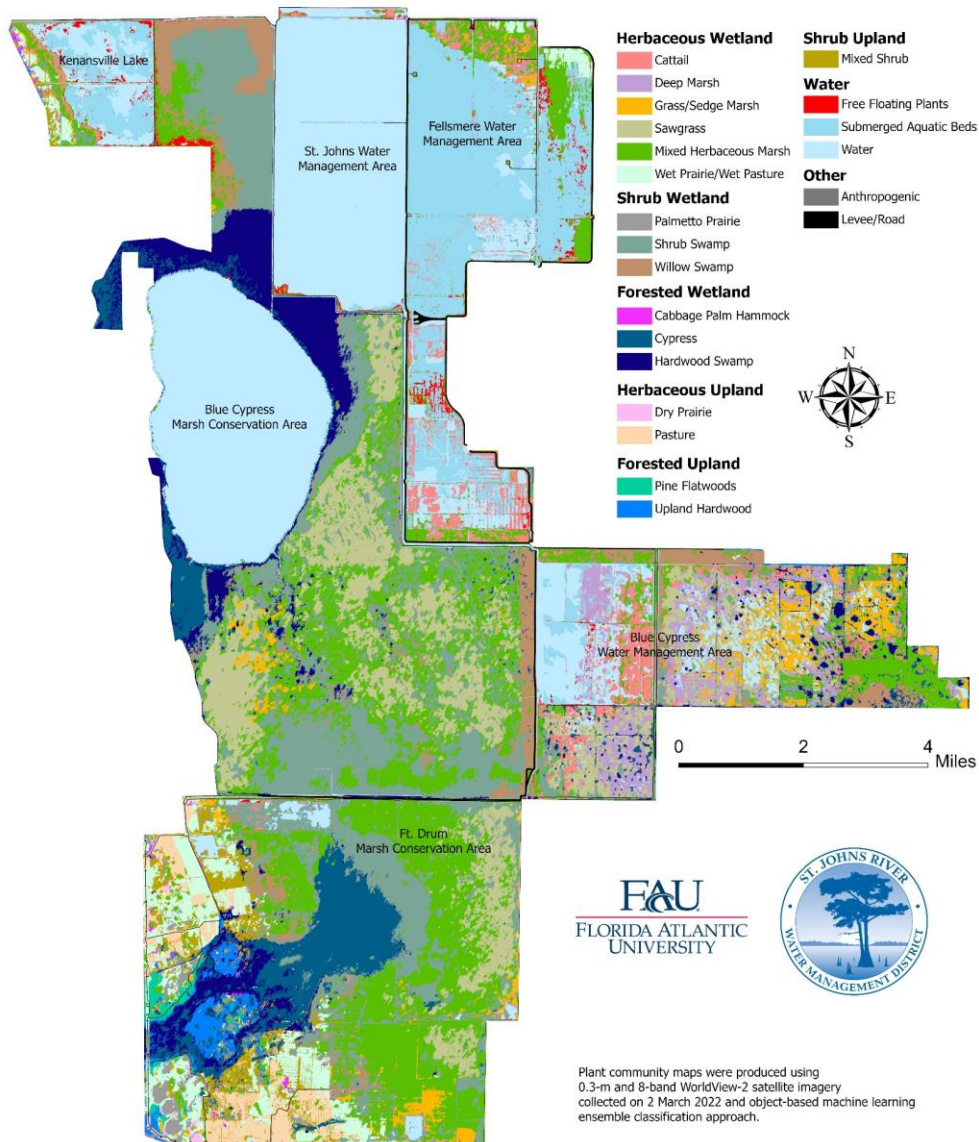
Results: BCWMA



Overall Accuracy: 0.84

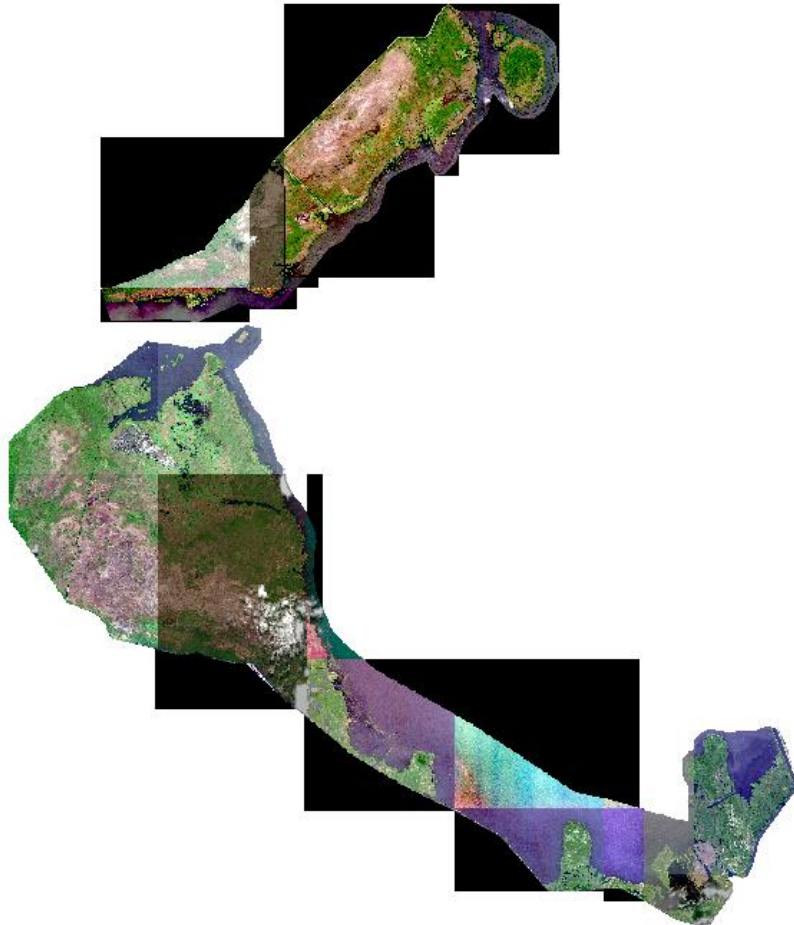
2022 Plant Communities Upper St. Johns River Basin Florida Turnpike to Fellsmere Grade

Combined
map product
for Year 2022



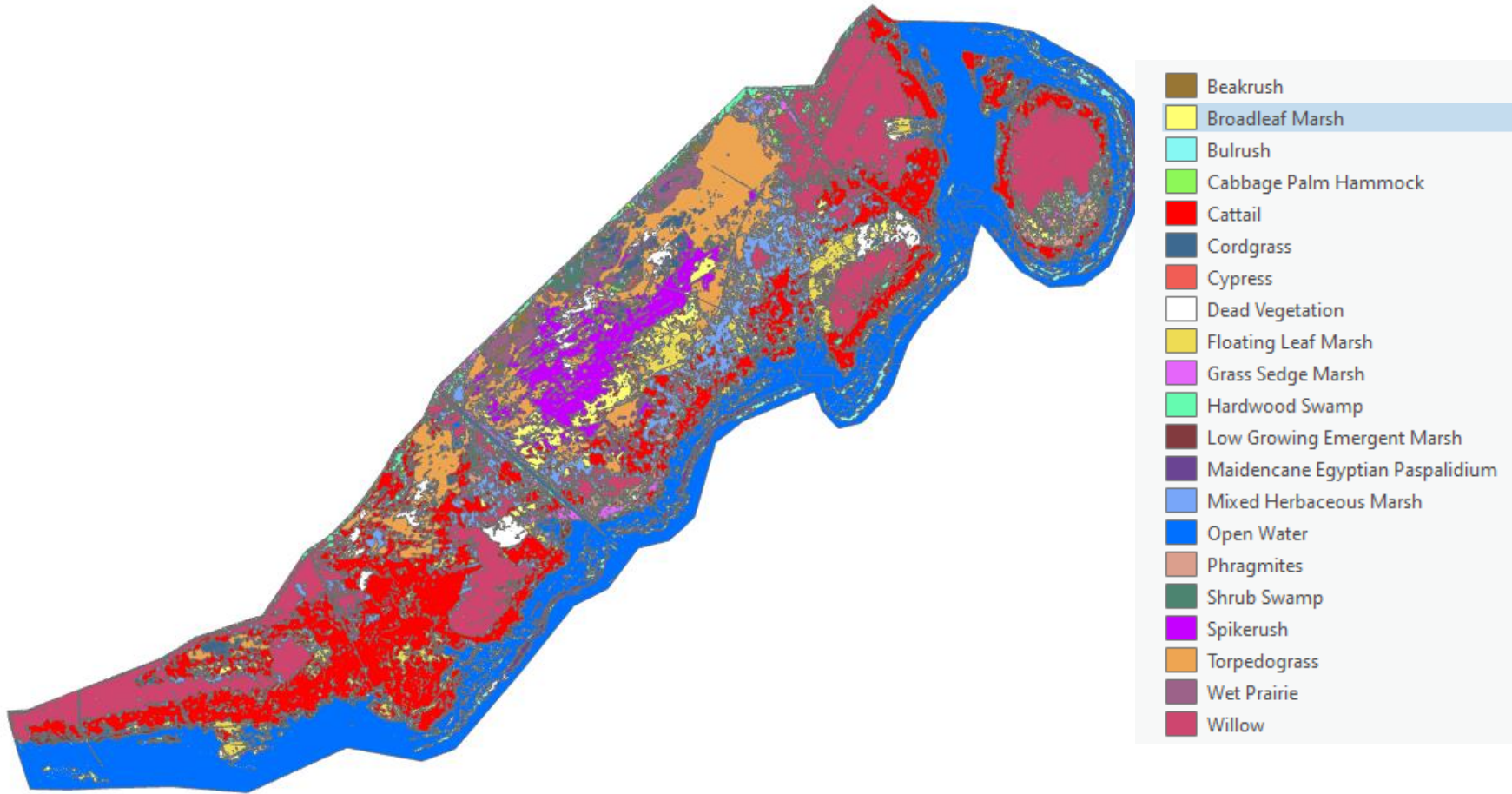
Plant community maps were produced using 0.3-m and 8-band WorldView-2 satellite imagery collected on 2 March 2022 and object-based machine learning ensemble classification approach.

FWC-Lake Okeechobee, 2023



- Successfully imagery products were acquired for May 18, 23 with less cloud contamination

Area 1: map product

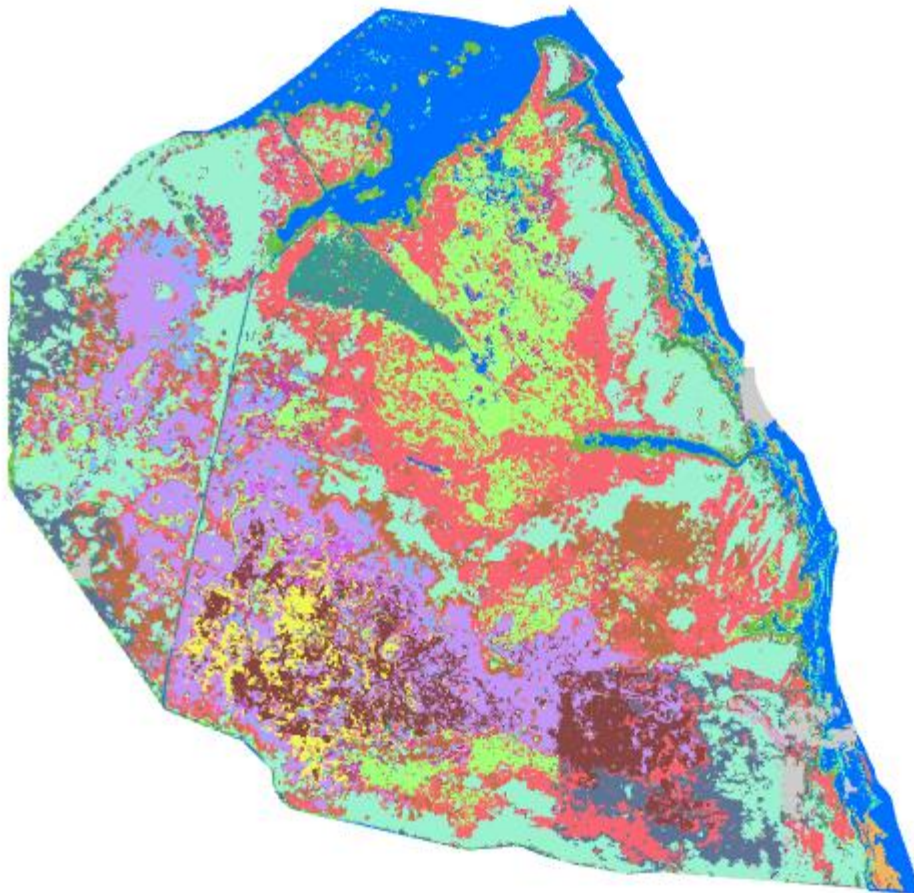


Results: classification accuracies

Area 1: Overall accuracy: 90%

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1		BL	BU	CA	FL	GS	LG	HM	PH	TG	ME	SR	BR	CG	WP	SS	WI	CP	CY	HS	OW	DV	Column Total	UA	
2	BL	69	1	2	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	2	78	0.885	
3	BU	0	83	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	84	0.988	
4	CA	2	3	300	1	0	0	0	3	0	0	0	0	1	0	1	1	0	0	0	0	1	313	0.958	
5	FL	1	0	0	219	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	224	0.978	
6	GS	0	1	6	0	56	0	0	1	2	0	0	0	0	0	1	0	0	0	0	0	0	67	0.836	
7	LG	0	0	0	0	0	107	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	108	0.991	
8	HM	4	0	17	2	1	0	30	1	1	0	6	0	0	0	2	0	1	0	2	0	0	67	0.448	
9	PH	1	0	8	1	1	0	0	51	0	0	0	0	0	0	1	0	0	0	0	1	1	65	0.785	
10	TG	0	0	0	0	0	0	0	0	269	0	7	0	2	1	0	0	0	0	0	0	3	282	0.954	
11	ME	0	1	0	0	0	0	0	0	0	69	0	0	0	0	0	0	0	0	0	0	0	70	0.986	
12	SR	2	0	0	0	0	0	0	0	11	0	152	0	0	2	0	0	0	0	0	0	0	167	0.91	
13	BR	0	0	0	0	0	0	0	0	0	0	4	12	0	3	0	0	0	0	0	0	1	20	0.6	
14	CG	0	0	3	0	0	0	0	0	5	0	2	0	24	6	0	0	0	0	0	0	0	40	0.6	
15	WP	1	0	0	0	0	0	0	0	5	0	9	2	2	36	1	0	0	0	0	0	0	56	0.643	
16	SS	0	0	5	1	0	0	3	2	2	0	0	1	0	0	34	0	2	0	1	0	0	51	0.667	
17	WI	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	282	0	0	4	0	0	288	0.979	
18	CP	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	1	21	0	8	0	0	33	0.636	
19	CY	0	0	4	0	0	0	0	2	4	0	0	0	0	1	0	0	0	3	0	0	0	14	0.214	
20	HS	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	4	6	0	57	0	1	71	0.803	
21	OW	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	136	0	138	0.986	
22	DV	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	83	88	0.943	
23	Row Total	80	89	346	225	58	111	39	60	303	70	181	15	29	49	43	290	30	3	72	137	94	2324		
24	PA	0.863	0.933	0.867	0.973	0.966	0.964	0.769	0.85	0.888	0.986	0.84	0.8	0.828	0.735	0.791	0.972	0.7	1	0.792	0.993	0.883			
25	Overall Accuracy	0.901																							
26	Kappa	0.892																							
27																									

Area 2: map products



- Bare Soil
- Beakrush
- Broadleaf Marsh
- Bulrush
- Cattail
- Cloud
- Cordgrass
- Dead Vegetation
- Floating Leaf Marsh
- Grass Sedge Marsh
- Hardwood Swamp
- Low Growing Emergent Marsh
- Maidencane Egyptian Paspalidium
- Mixed Herbaceous Marsh
- Open Water
- Phragmites
- Sawgrass
- Shrub Swamp
- Spikerush
- Torpedoglass
- Willow

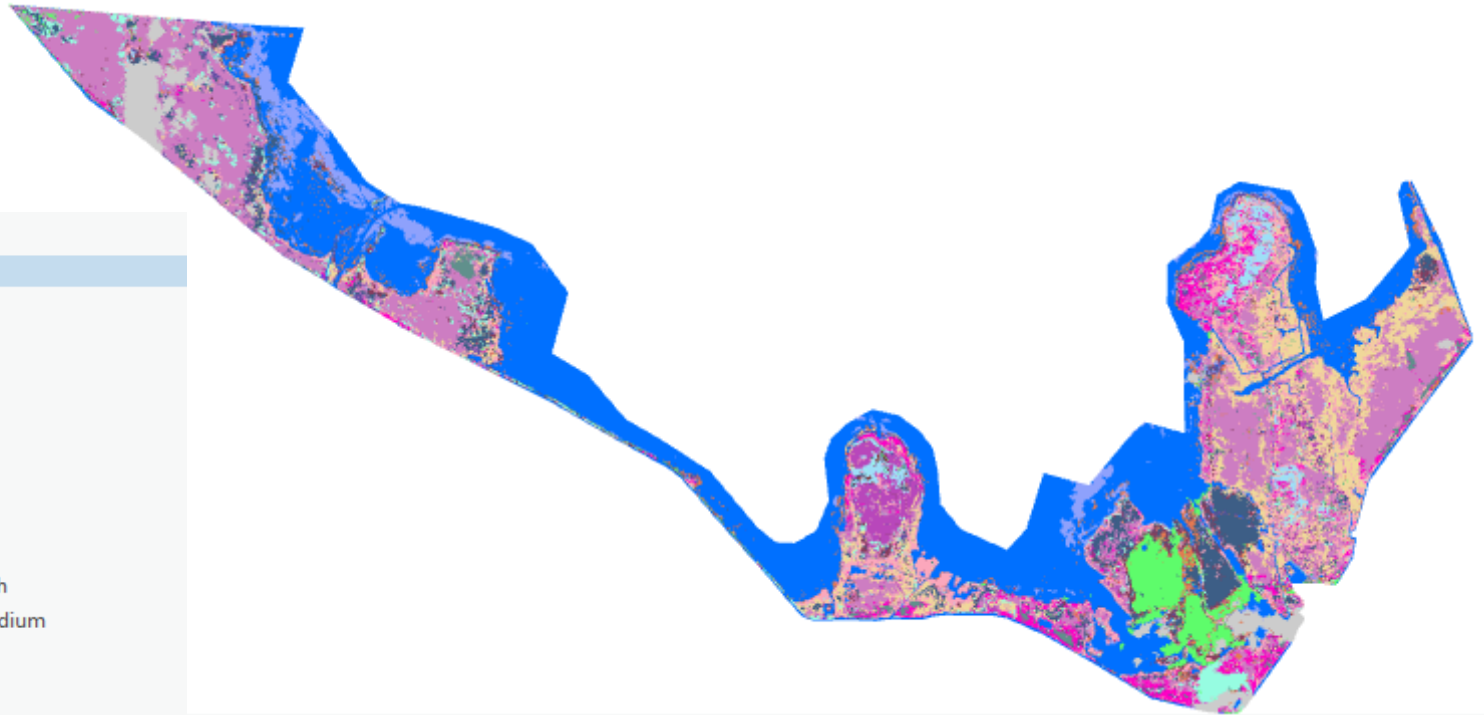
Areas 2, 3

- Overall accuracy: 82%

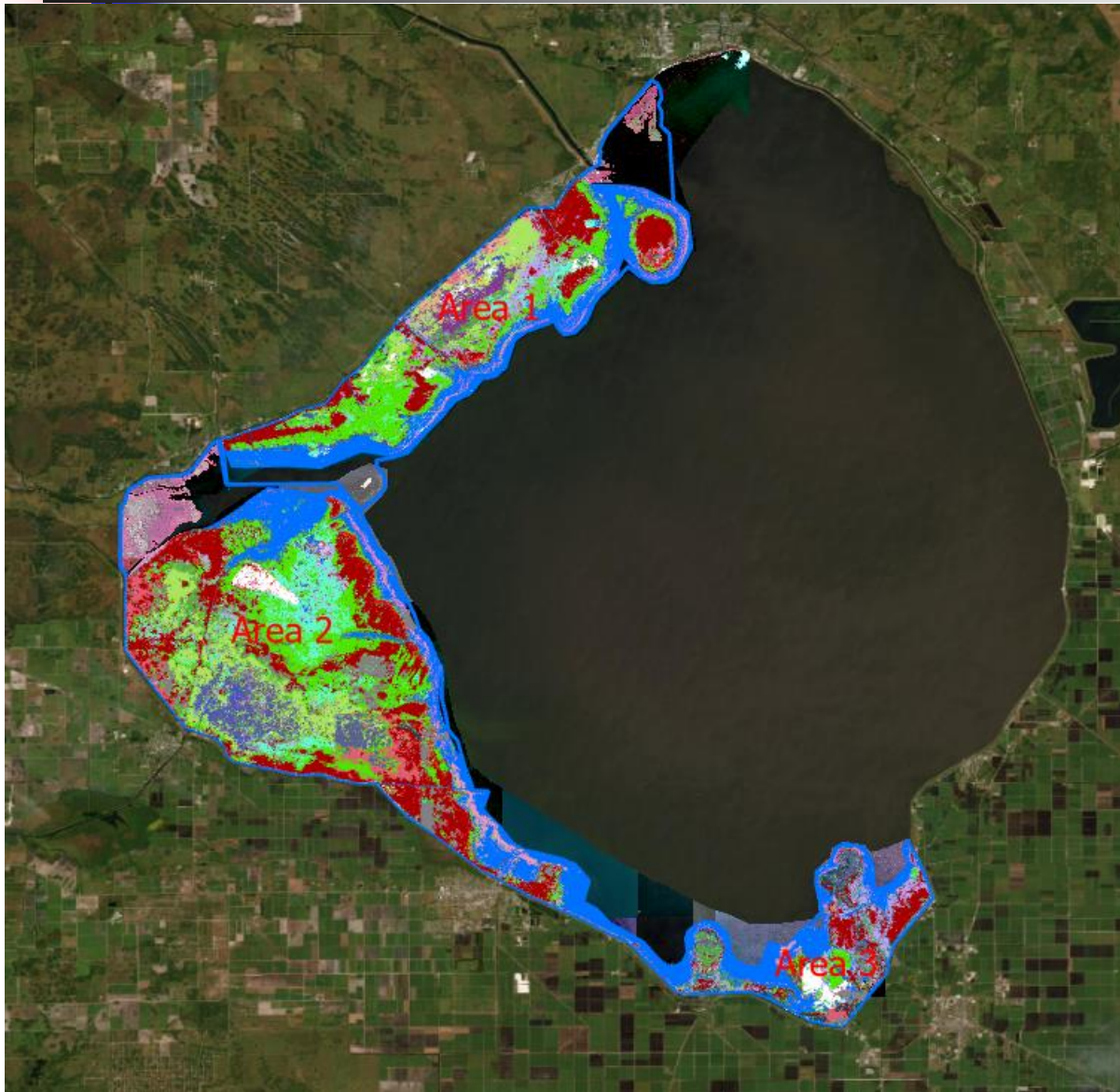
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1	BL	BU	CA	FL	GS	LG	HM	PH	TG	SG	ME	SR	BR	CG	SS	WI	HS	PA	OW	DV	BS	Column Total	User's Accuracy			
2	BL	140	0	11	8	1	0	16	0	19	7	0	0	0	2	0	6	3	0	0	0	1	214	0.654		
3	BU	0	160	5	3	0	2	9	2	0	0	17	0	0	0	1	0	1	0	2	1	1	204	0.784		
4	CA	7	10	709	0	2	1	17	14	6	17	11	0	0	0	3	16	1	0	0	2	0	816	0.869		
5	FL	0	5	8	739	0	35	14	3	0	1	0	0	0	0	5	6	3	0	0	2	0	821	0.9		
6	GS	1	1	2	3	152	6	5	2	29	0	0	0	6	16	0	4	0	1	0	0	0	228	0.667		
7	LG	1	2	2	37	0	461	21	6	0	0	0	0	0	0	7	11	3	0	0	0	0	551	0.837		
8	HM	9	1	23	11	2	23	234	7	2	13	4	0	0	0	7	15	2	0	0	0	1	354	0.661		
9	PH	0	1	53	2	0	3	6	152	3	0	1	0	0	0	0	3	1	0	0	1	0	226	0.673		
10	TG	9	0	7	0	9	0	3	2	405	0	1	0	5	5	0	0	0	0	0	0	0	446	0.908		
11	SG	12	0	22	4	0	0	10	1	1	64	0	0	0	0	0	4	0	0	0	0	0	118	0.542		
12	ME	0	11	8	0	0	0	0	2	0	0	234	0	0	0	0	1	0	0	5	0	0	261	0.897		
13	SR	1	2	2	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	12	0		
14	BR	0	0	0	0	6	0	0	0	2	0	2	0	39	2	0	0	0	0	0	0	0	51	0.765		
15	CG	3	0	1	0	17	0	0	0	11	0	0	0	0	44	0	0	0	0	0	0	0	76	0.579		
16	SS	0	0	3	5	1	9	4	4	0	0	0	0	0	0	135	37	16	0	0	0	0	214	0.631		
17	WI	2	3	2	8	0	11	18	0	0	0	1	0	0	0	10	564	6	0	0	0	0	625	0.902		
18	HS	0	0	3	2	0	5	2	1	0	0	0	0	0	0	11	5	82	7	0	0	0	118	0.695		
19	PA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	43	0	0	0	55	0.782		
20	OW	0	3	2	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	253	0	263	0.962		
21	DV	0	1	3	4	0	0	2	0	1	0	3	0	0	0	0	2	0	0	0	138	0	154	0.896		
22	BS	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	53	0.943		
23	Row Total	185	200	867	826	190	559	361	196	486	102	278	0	50	69	179	674	130	51	260	144	53	5860	0		
24	Producer's	0.757	0.8	0.818	0.895	0.8	0.825	0.648	0.776	0.833	0.627	0.842	0	0.78	0.638	0.754	0.837	0.631	0.843	0.973	0.958	0.943	0	0		
25	Overall Acc	0.819	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
26	Kappa	0.802	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
27																										
28																										

Area 3: map products

- Bare Soil
- Broadleaf Marsh
- Bulrush
- Cattail
- Cloud
- Cordgrass
- Dead Vegetation
- Floating Leaf Marsh
- Grass Sedge Marsh
- Hardwood Swamp
- Low Growing Emergent Marsh
- Maidencane Egyptian Paspalidium
- Mixed Herbaceous Marsh
- Open Water
- Phragmites
- Pond Apple
- Sawgrass
- Shrub Swamp
- Spikerush
- Torpedoglass
- Willow

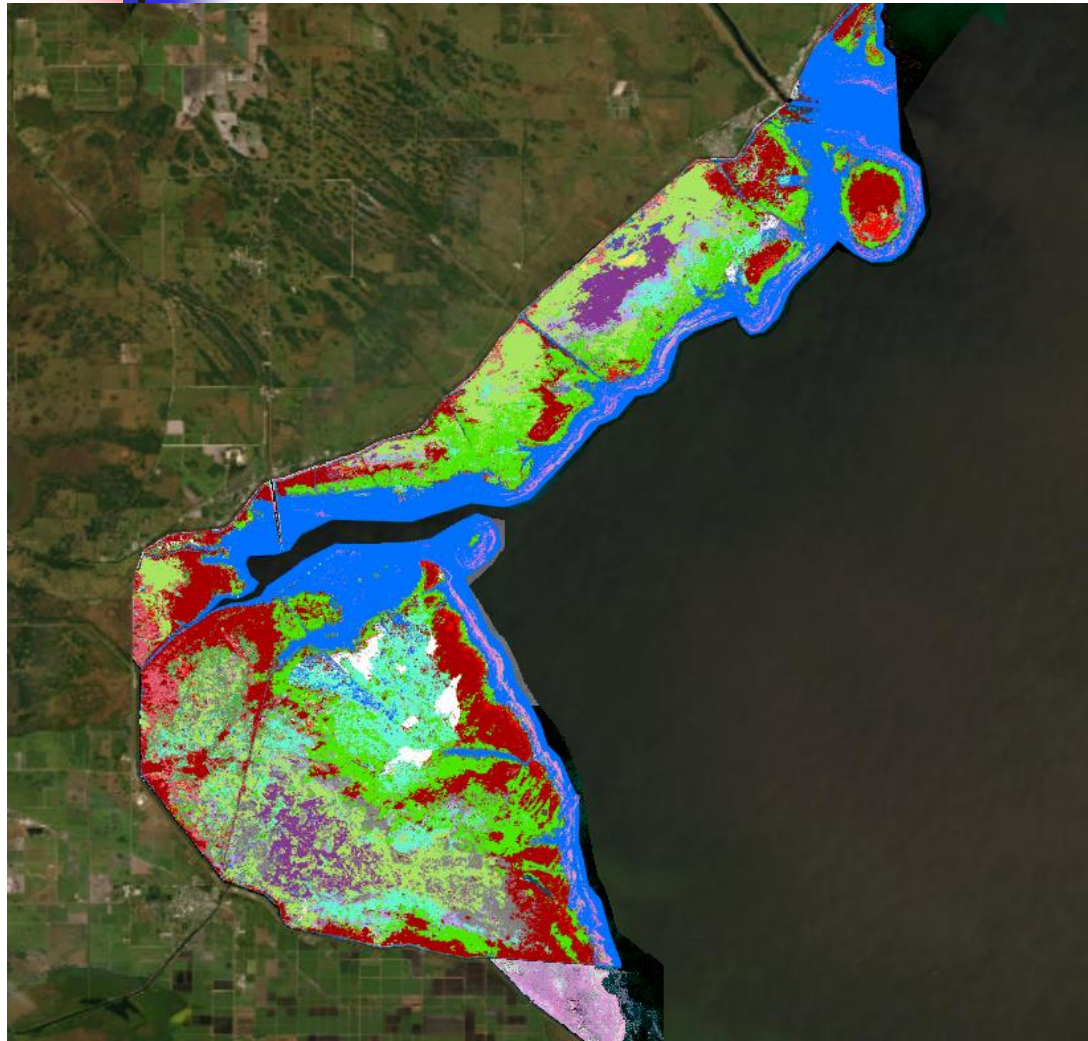


Lake Okeechobee area-2023



- Broadleaf Marsh
- Bulrush
- Cabbage Palm Hammock
- Cattail
- Cordgrass
- Cypress
- Dead Vegetation
- Floating Leaf Marsh
- Grass Sedge Marsh
- Hardwood Swamp
- Low Growing Emergent Marsh
- Maidencane Egyptian Paspalidium
- Mixed Herbaceous Marsh
- Open Water
- Phragmites
- Shrub Swamp
- Spikerush
- Torpedoglass
- Wet Prairie
- Willow

Lake Okeechobee area-2024



- Broadleaf Marsh
- Bulrush
- Cabbage Palm Hammock
- Cattail
- Cordgrass
- Cypress
- Dead Vegetation
- Floating Leaf Marsh
- Grass Sedge Marsh
- Hardwood Swamp
- Low Growing Emergent Marsh
- Maidencane Egyptian Paspalidium
- Mixed Herbaceous Marsh
- Open Water
- Phragmites
- Shrub Swamp
- Spikerush
- Torpedogross
- Wet Prairie
- Willow

Overall accuracy: ~85%



Challenges and Solutions

- Segmentation
 - Scale selection, too small leads to over-segmentation, too big leads to under-segmentation
 - **Solution: split the big project area into smaller areas and set site-specific scale**
 - Time consuming segmentation process
 - **Solution: batch and tile processing in eCognition**
- Post-classification map refinement: shadows, confusion of shrub swamp with willow swamp, hardwood swamp with upland hardwood, etc., manual refinement is time-consuming
 - **Solution: collecting adequate training samples for major communities, and manually classify small communities such as upland hardwood**



Conclusions

- The designed object-based machine learning ensemble mapping procedure using high resolution satellite imagery products is successful to effectively catch wetland community patterns
- Efficiency and time saving:
 - For mapping Lake Okeechobee (130,000 acres): 2-3 weeks if field reference samples are ready

Acknowledgement

- **District personnel:** Dianne Hall, Kim Ponzio, Christy Akers, Jodi Slater, Jonny Baker, Doug Voltolina, Chris O'Hara, and Ken Snyder

- **FWC:** Alyssa Jordan

- **Graduate students:** David Brodylo, Mizanur Rahman, Sandip Rijal, Abdullah Ai-Fazari, Fiona Benzi, Rabindra Parajuli, David Ramirez, and Madan Thapa Chhetri



The End

