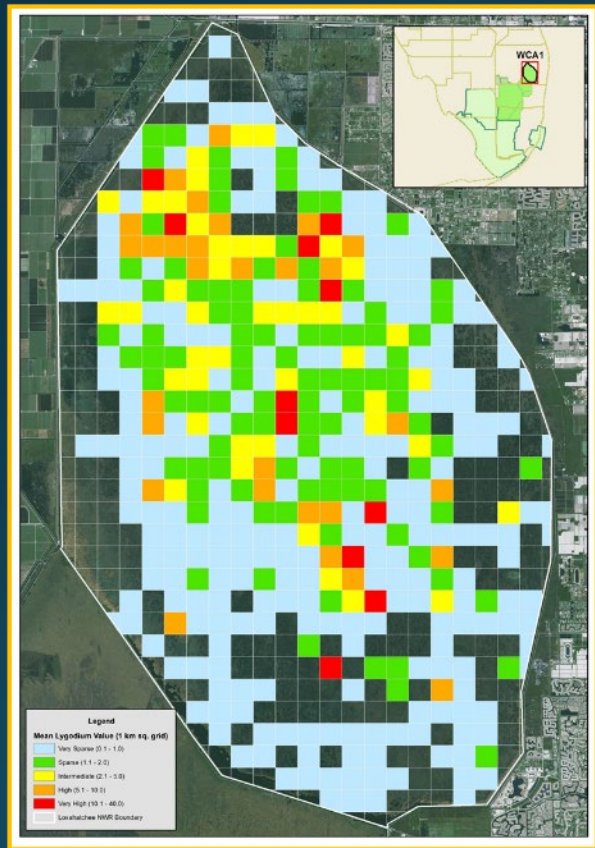# Designing a Monitoring Framework to Inform Invasive Plant Management

Lessons from the A.R.M. Loxahatchee National Wildlife Refuge

LeRoy Rodgers

South Florida Water Management District

GEER 2019

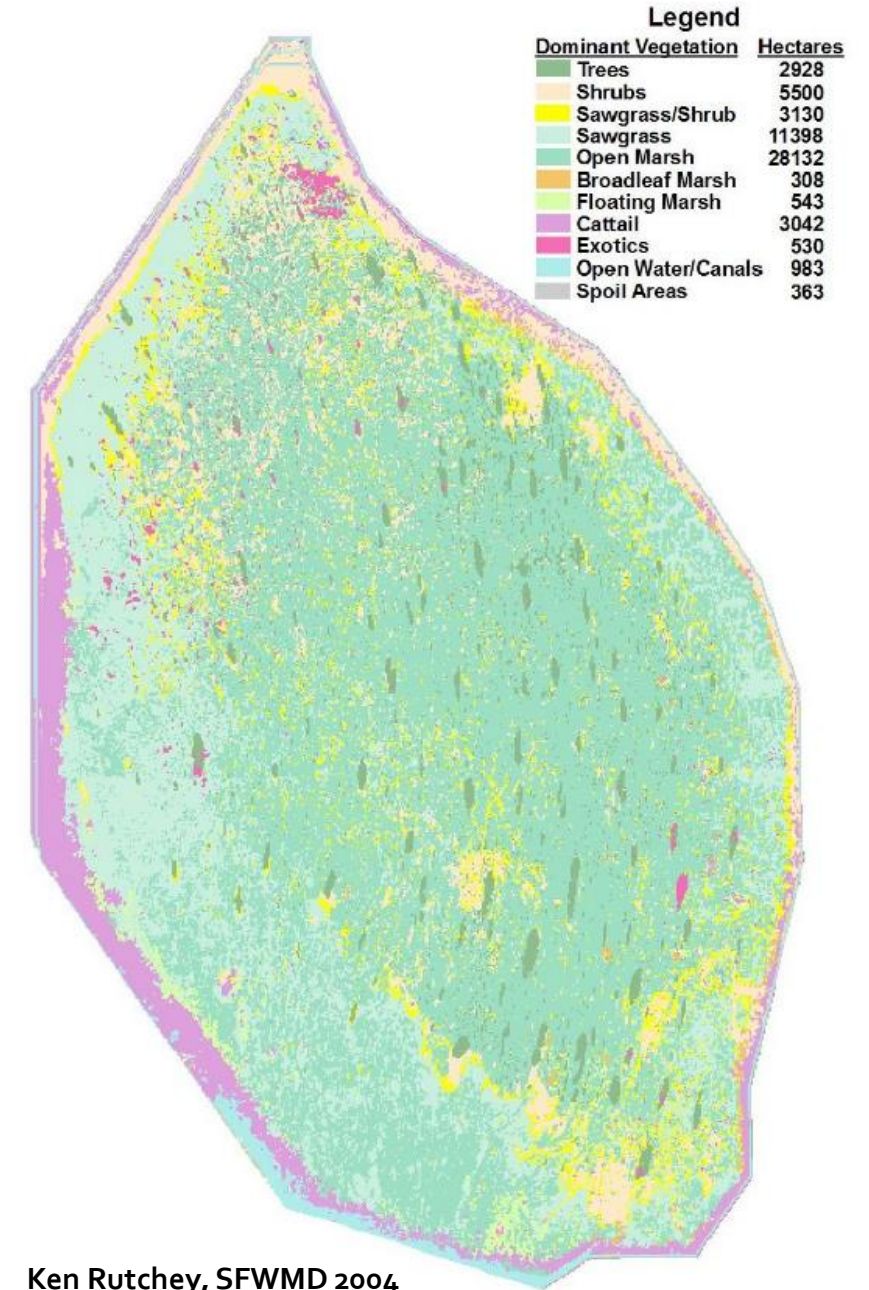# A. R. M. Loxahatchee National Wildlife Refuge

- AKA Water Conservation Area 1
- South-central Palm Beach County
- 221 square miles

Plant Communities

- Heterogenous landscape
    - sawgrass marsh/open water slough
    - scattered, small forested wetlands (tree islands)

Legend	
Dominant Vegetation	**Hectares**
Trees	2928
Shrubs	5500
Sawgrass/Shrub	3130
Sawgrass	11398
Open Marsh	28132
Broadleaf Marsh	308
Floating Marsh	543
Cattail	3042
Exotics	530
Open Water/Canals	983
Spoil Areas	363

Ken Rutchey, SFWMD 2004

Dominant Invasive Plants at Loxahatchee NWR

Melaleuca
(*Melaleuca quinquenervia)*

Old World climbing fern
(*Lygodium microphyllum)*

Intensified Invasive Plant Management Effort

- New License Agreement between FWS and SFWMD
  - FWS manages WCA 1 as NWR
  - SFWMD implements invasive plant management
- Funding support from FWS, FWC and SFWMD
- Funding target = $5 million/ yr. (*contractual services*)

Intensified Questions

- How many acres of weeds are there?
- Where are they, specifically?
- What's been done already?
- What treatment options are there?
- What's it going to cost?

LNWR Monitoring Program

- Objectives
  - Document distribution and abundance
  - Demonstrate progress (short-term)
  - Assess long-term trends
  - Information input for
    - strategies/budget
    - directing control efforts
   - adaptive management
    - improving efficiency

Operations

Oversight

Research

Aerial Reconnaissance and Monitoring

- Observer-based aerial monitoring
  - Since mid-1990's
- GPS-linked mapping computers
  - "on-the-fly" spatial data collection
- Multiple mapping and monitoring strategies
  - Different objectives
  - Scale-dependent designs
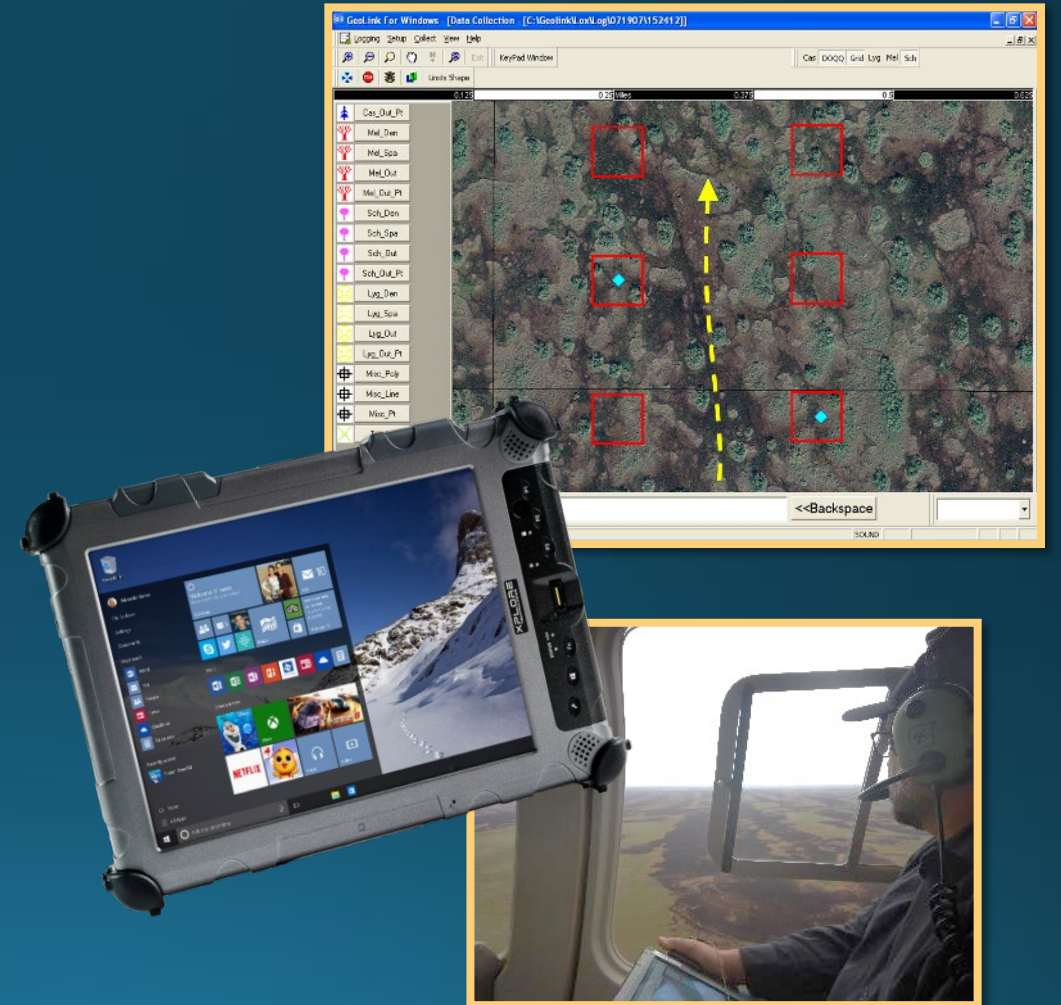
Systematic Reconnaissance Flights

- Long term dataset
  - beginning in 1990's
- Fixed transects, 4 km intervals
- Very cost effective method for assessing landscape-scale distribution and abundance
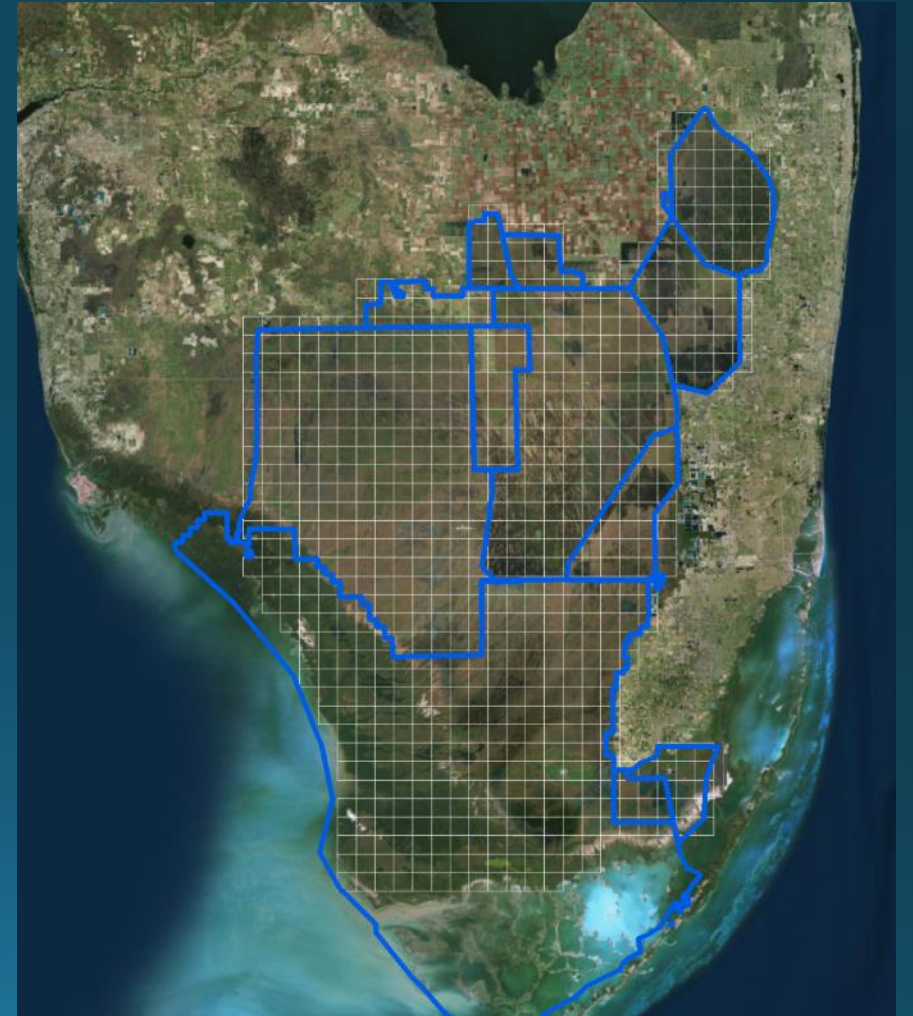
SRF Methodology

- 24 plots (0.4 hectare) per 4km grid cell
- Species assigned abundance class
  - Dense (>50% cover)
  - Scattered (5-50% cover)
  - Outlier (<5% cover)
- Abundance index
  - Based on weighted abundance score
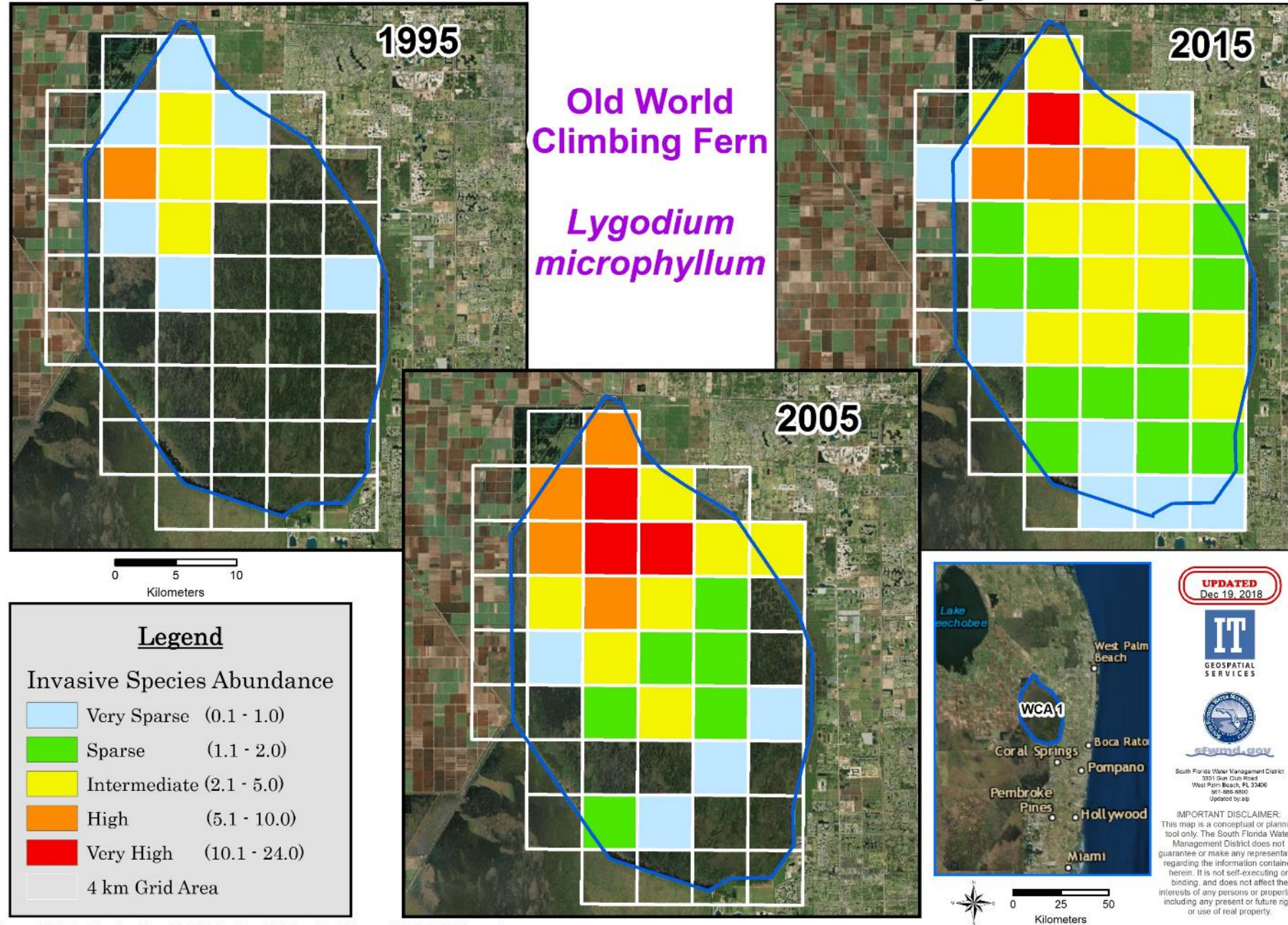 - Abundance$= \sum_{i=1}^{24} x_i\, w_i$

Where $w_{\text{dense}} = 1.0$, $w_{\text{scattered}} = 0.5$, $w_{\text{outlier}} = 0.1$

4 km
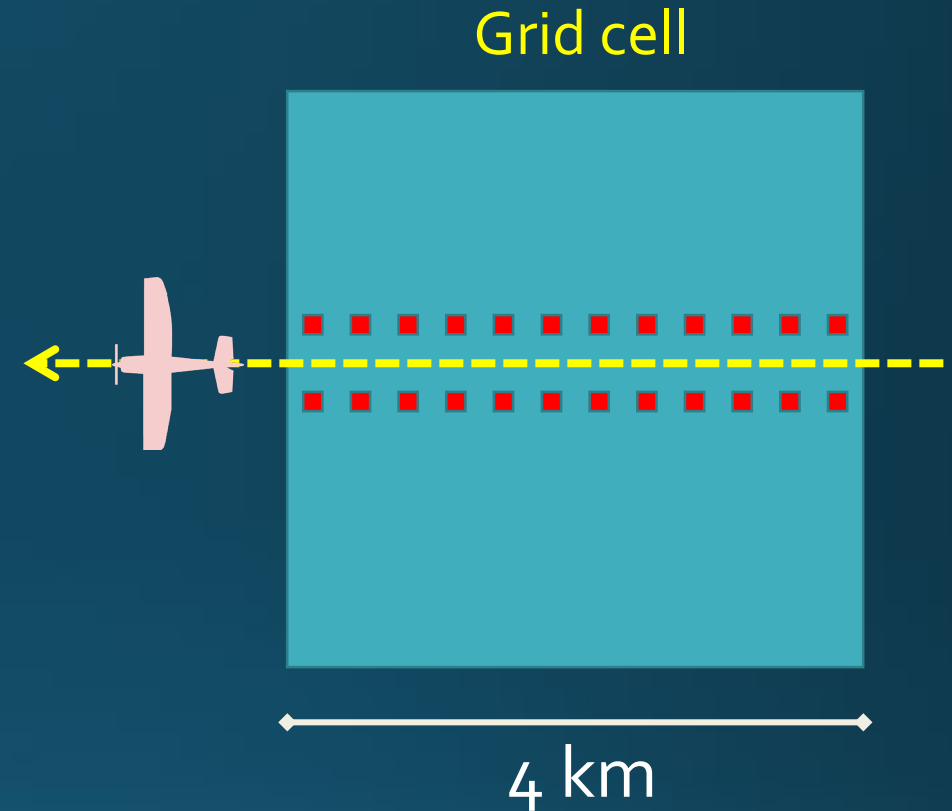
SRF 4K OWCF 1995 - 2015

Sketch Mapping Data Comparison 1995, 2005, & 2015
Arthur R. Marshall Loxahatchee National Wildlife Refuge/WCA 1
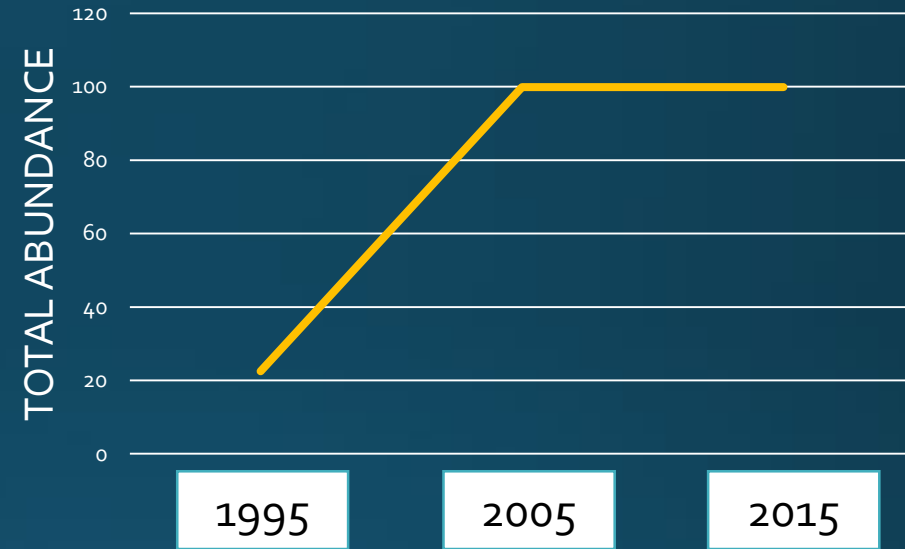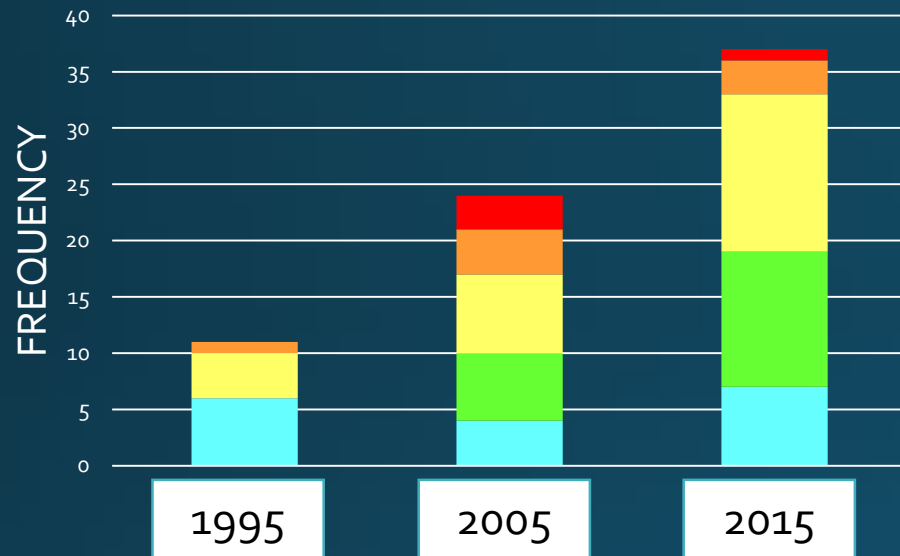
Old World Climbing Fern

Lygodium microphyllum

Legend

Invasive Species Abundance

	Very Sparse	(0.1 - 1.0)
	Sparse	(1.1 - 2.0)
	Intermediate	(2.1 - 5.0)
	High	(5.1 - 10.0)
	Very High	(10.1 - 24.0)
	4 km Grid Area	

SRF 4k: OWCF 1995 - 2015

Invasive Species Abundance

Very Sparse	(0.1 - 1.0)
Sparse	(1.1 - 2.0)
Intermediate	(2.1 - 5.0)
High	(5.1 - 10.0)
Very High	(10.1 - 24.0)

- 236% increase in occupancy (24 – 82%)
- Increases most represented by sparse and intermediate classes
- Drop in "high" and "very high" abundance classes between 2005 and 2015 (43% decline)
- Total Abundance increases in first decade then levels off

Enhanced SRF (1k transects)

- **Increased sample size**

- **1k intervals – 2 year cycle**
 - **1-km grid**
  - **Stratified randomization**
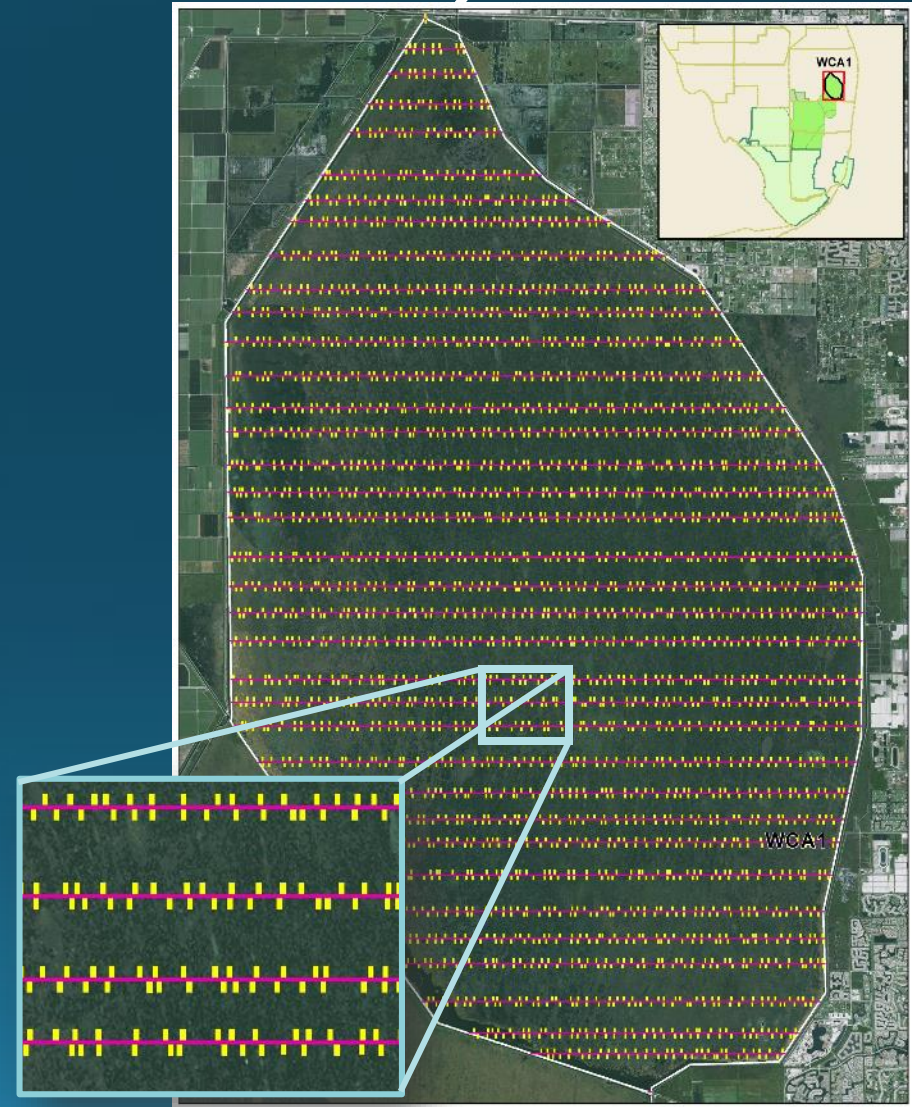
SRF 1K: OWCF

- Low density infestations over 46% of invadable habitat

- Medium density infestations over 21% of invadable habitat

- Only 2% contains high density infestation (>25% cover)

Cover class	Estimated Acres
Low (<2%)	26,414
Medium (2-25%)	12,448
High (>25%)	1,290
Total	40,153
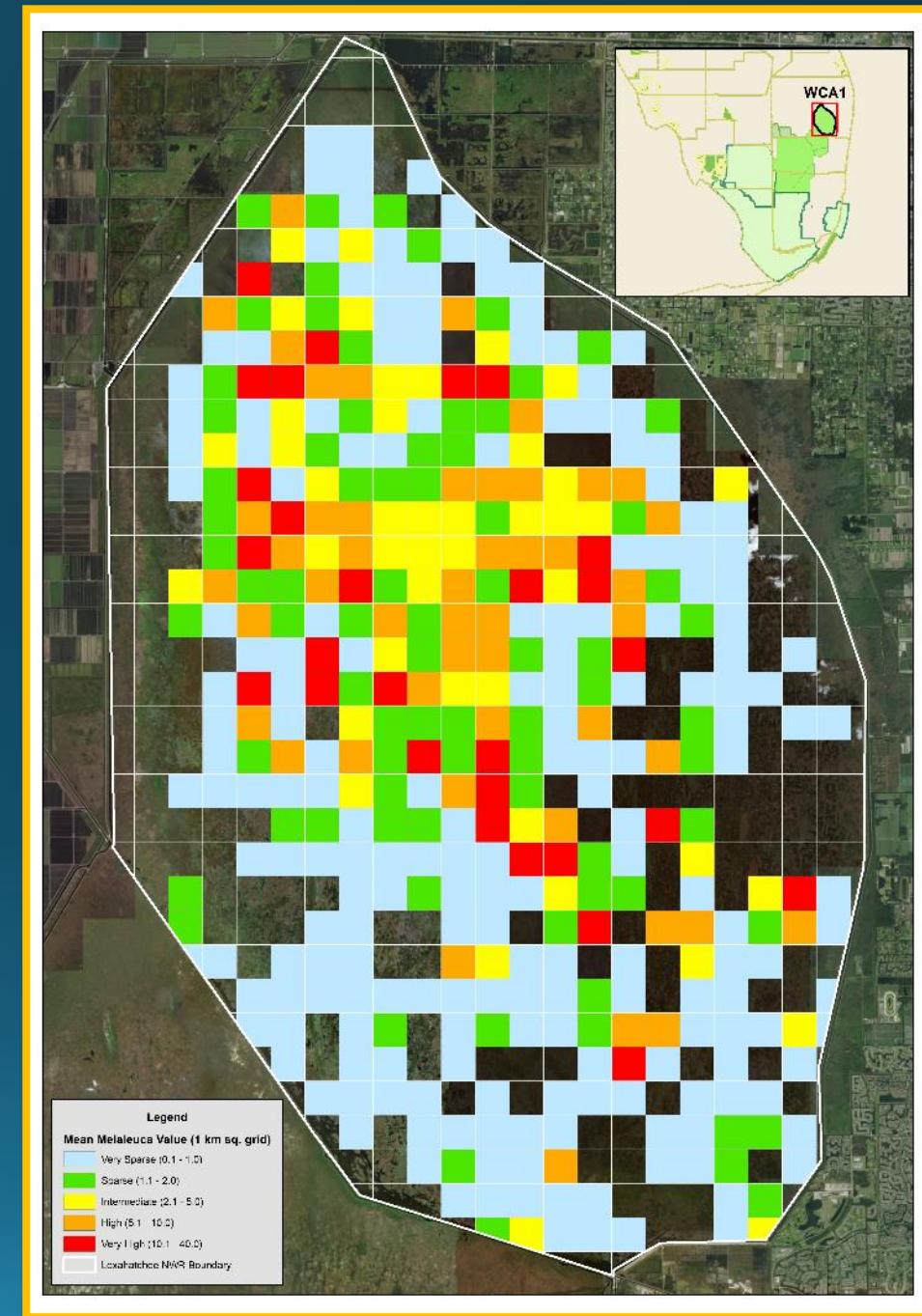
SRF 1K: Melaleuca

- Low density infestations over 54% of invadable habitat

- Medium density infestations over 20% of invadable habitat

- Only 1% contains high density infestation (>25% cover)

Cover class	Estimated Acres
Low (<2%)	70,045
Medium (2-25%)	26,419
High (>25%)	1,827
Total	98,292
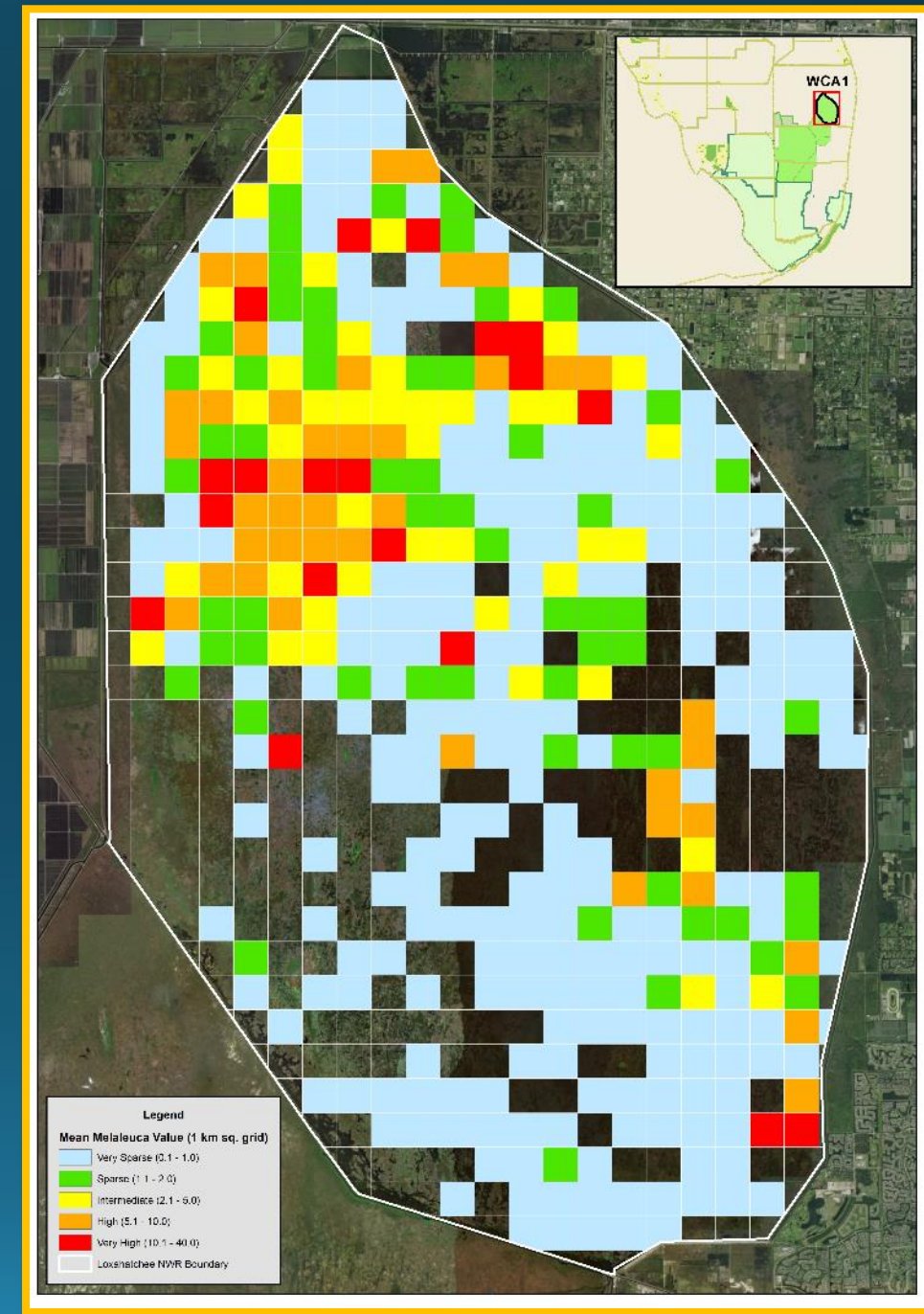
Control Cost Model

- Assumed three primary factors
  - Invasive species abundance
  - Remoteness
  - Ease of perambulation (vegetation type)

- Used test data from recent control costs, abundance estimates from aerial monitoring, and South Florida Vegetation Classification

- Multiple linear regression

Old World Climbing Fern

$$Cost_{OWCF}\ km^{-2} = 1.44(Perambulation) + 169.6o(Abundance)$$

Melaleuca

$$Cost_{Melaleuca}\ km{-2} = 1.53(Perambulation) + 183.37(Abundance)$$
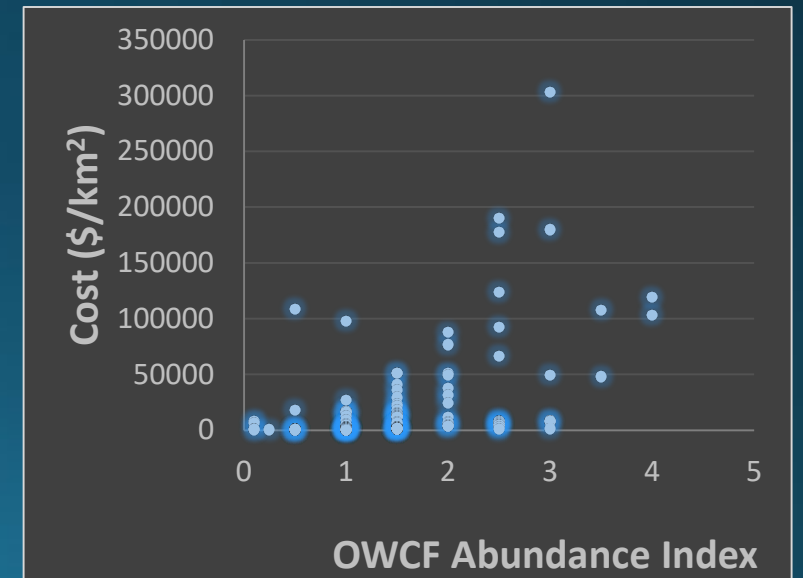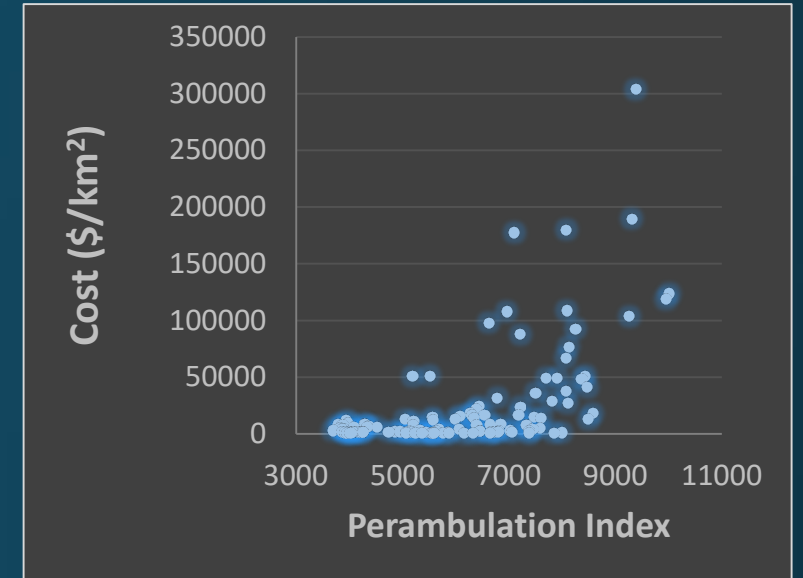
Control Cost Model

- Applied model coefficients to GIS dataset for entire LWNR

Old World Climbing Fern and Melaleuca SRF data
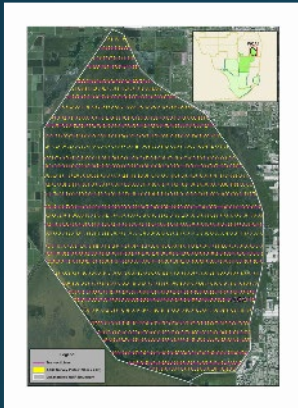
Ease of Perambulation Index South Florida Vegetation Classification
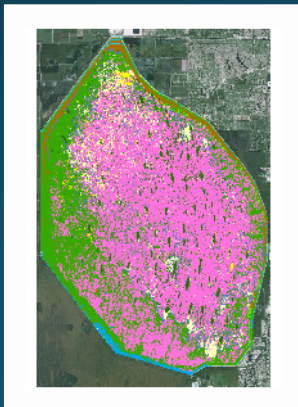
1 km Grid
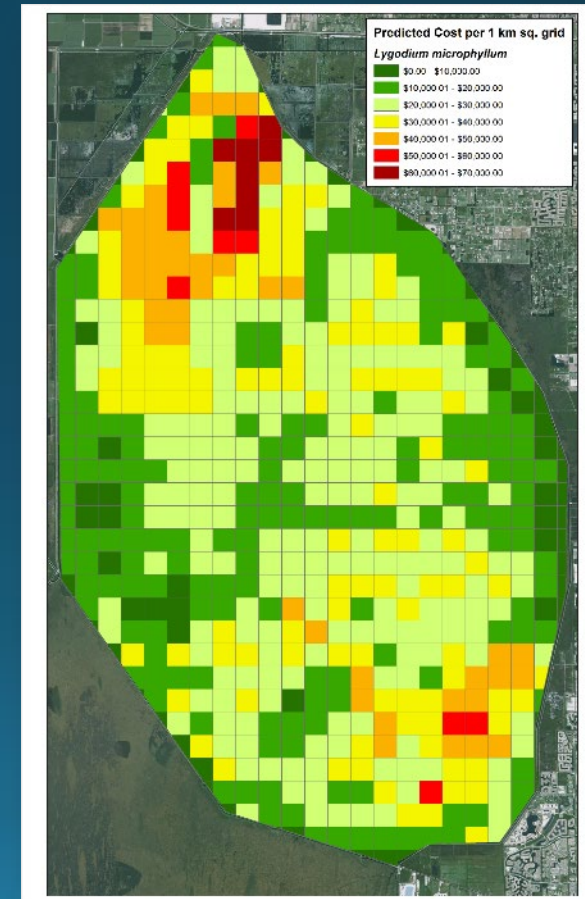
$26.5 million
Initial treatments

Strategy

- Applied data from SRF (1k), tree island mapping, and cost model to develop multi-year plan

- Following systematic containment strategy from Florida's Melaleuca Strategic Management Plan
  - But incorporate strand island triage

- Seasonal access (surface water stage), prescribed fire, and other uncertainties require flexibility.
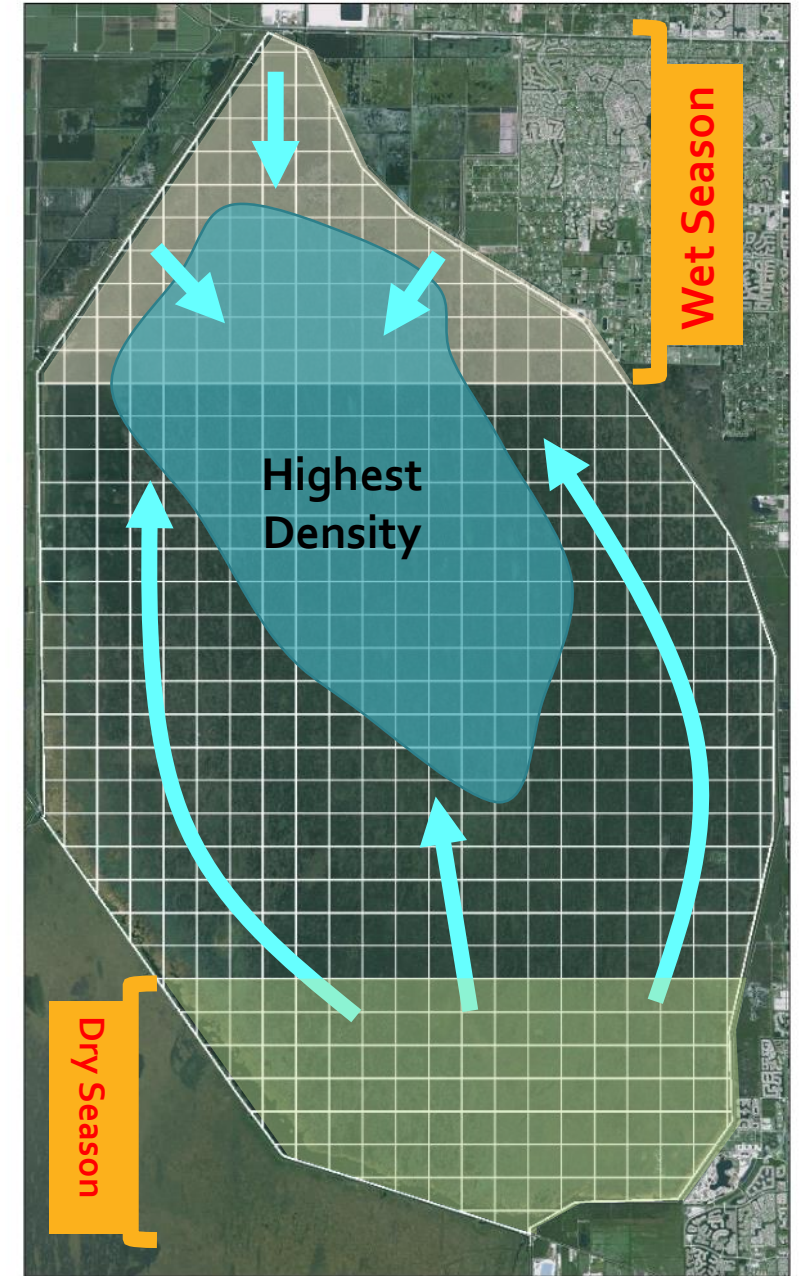
Management Plan

- Example: Planned initial treatment areas through FY 2018

Strand Islands

- **Increased concern of losing additional islands to canopy collapse**

- **SRF 1K sampling resolution insufficient to assess status of large tree islands**

- **"Low & Slow" grid mapping**
  - **100 m**

- **Mapped all strand islands >8 ac.**
  - **Invasive species cover**
  - **Canopy integrity**

Strand Islands

Intact Canopy

Strand Islands

Moderately Impaired Canopy

Strand Islands

Impaired Canopy

Tree Island Monitoring

- 111 tree islands
- Min = 8 ac.
- Mean = 44.5 ac.
- Max = 128.5 ac.

OWCF

Canopy Cover		Acres
<1%		798
1-5%		865
5-15%		1011
15-25%		590
25-100%		1683
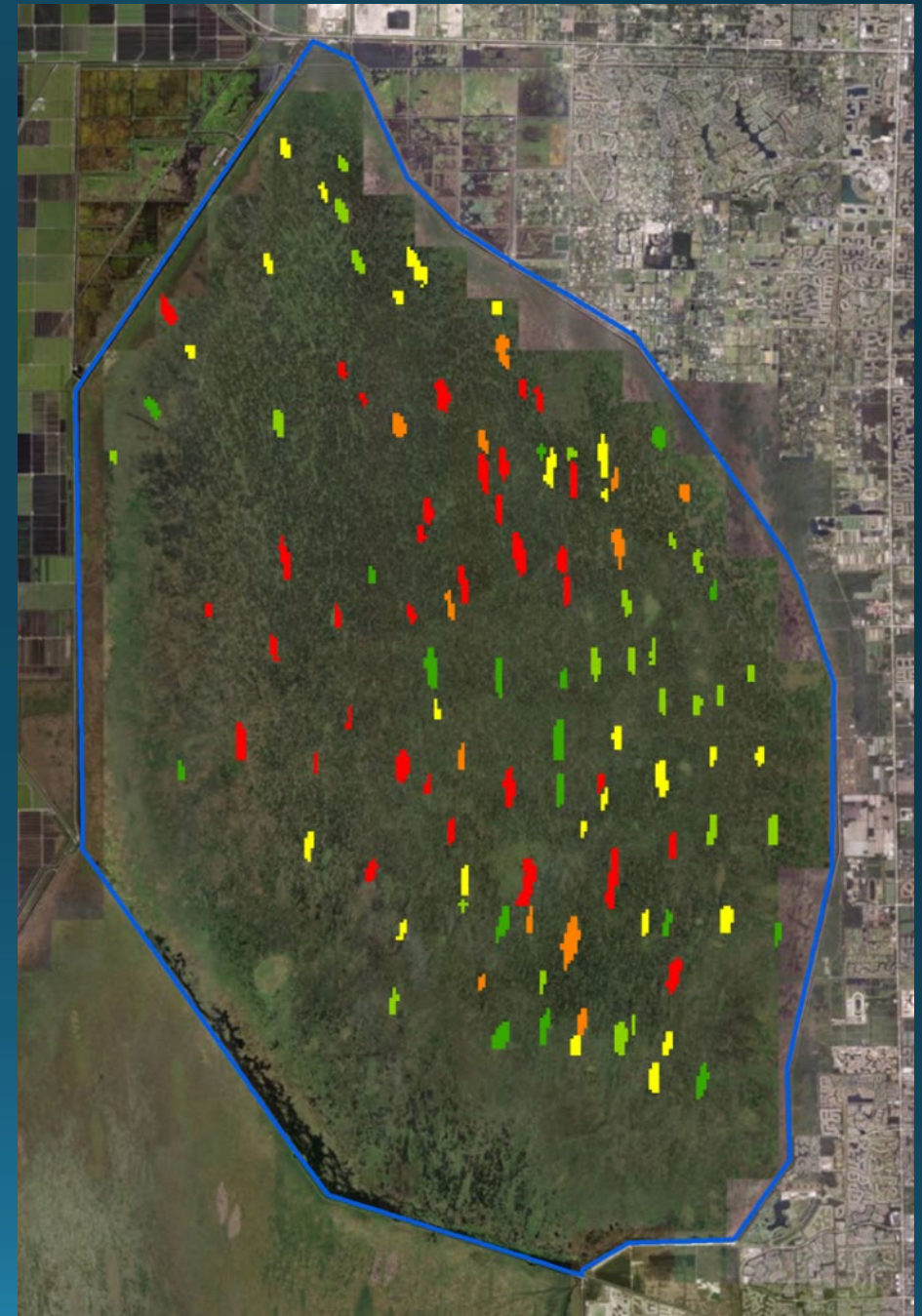
Tree Island Monitoring

- Assessed canopy condition independent of invasive species abundance

- Condition factors
  - Canopy collapse
  - Fire damage
  - Appropriate density

Canopy Condition	Acres (% of total)
Intact	746.2 (15%)
Moderately Impaired	2928.0 (59%)
Impaired	1272.6 (26%)
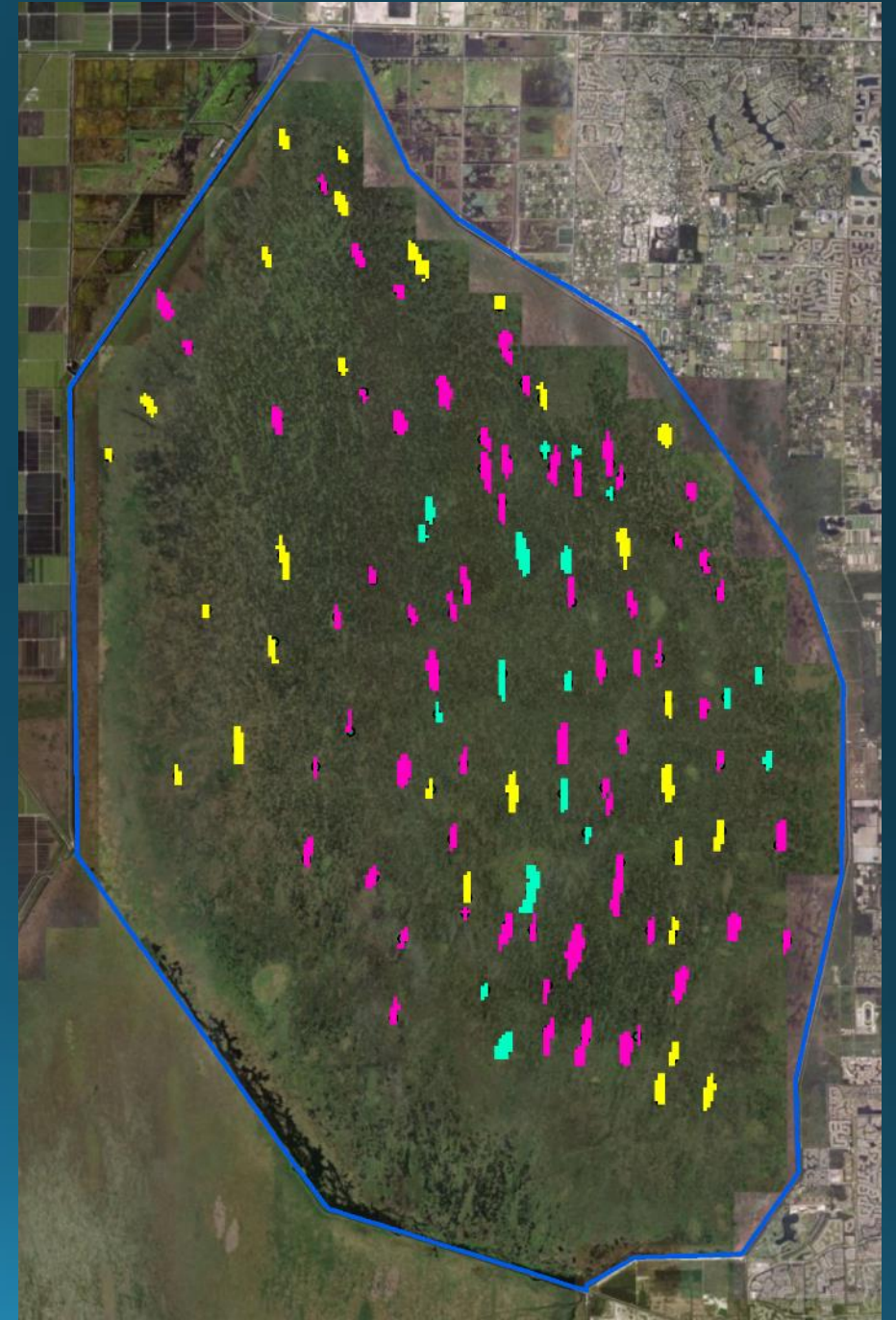
Tree Island Monitoring

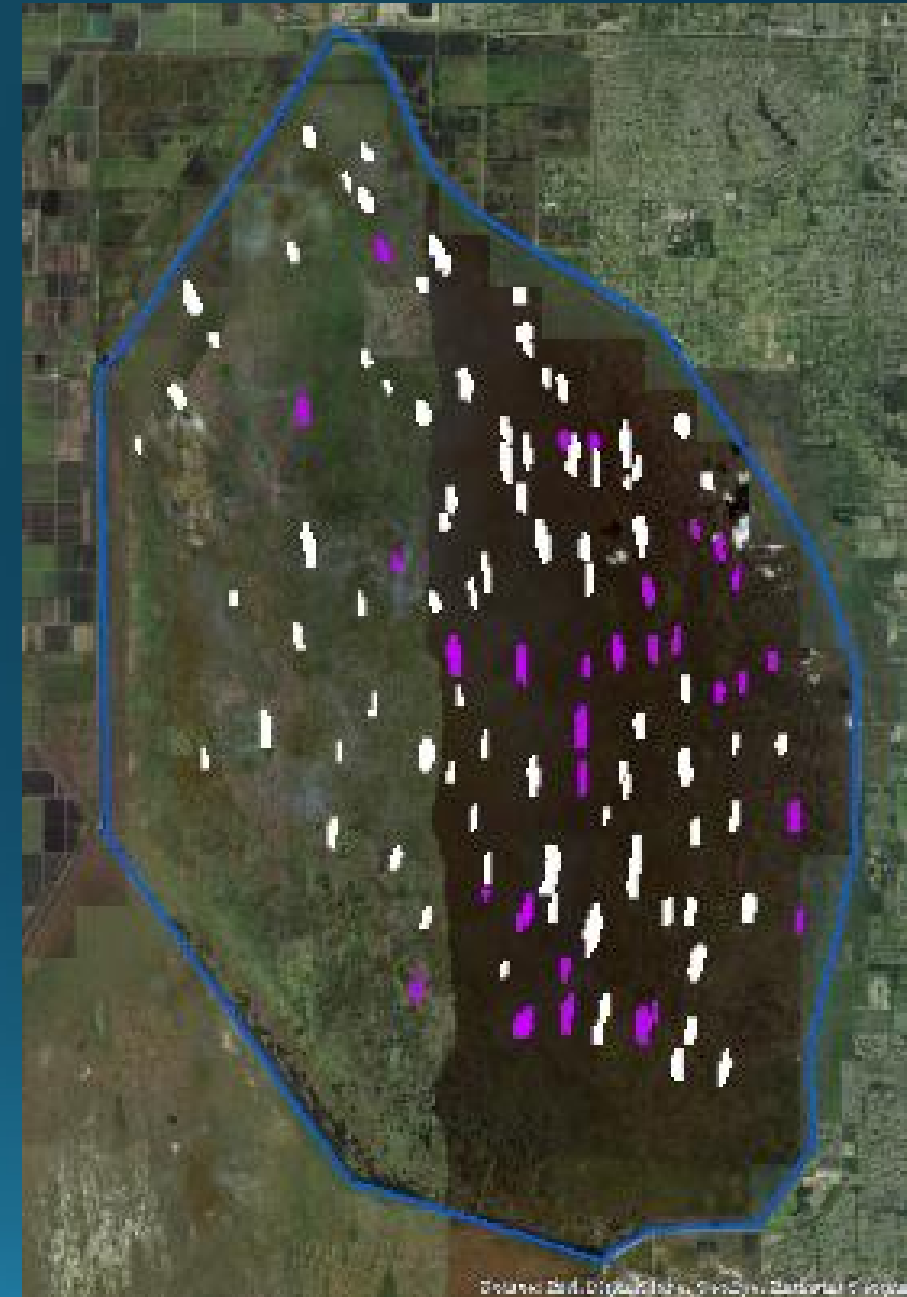| Tree Island Infestation	Tree Island Acres (# of islands)		
	Intact	Moderately Impaired	Impaired
>5%	257 (6)	763 (16)	360 (8)
5-25%	156 (7)	946 (23)	321 (8)
>25%	334 (5)	1218 (26)	591 (12)
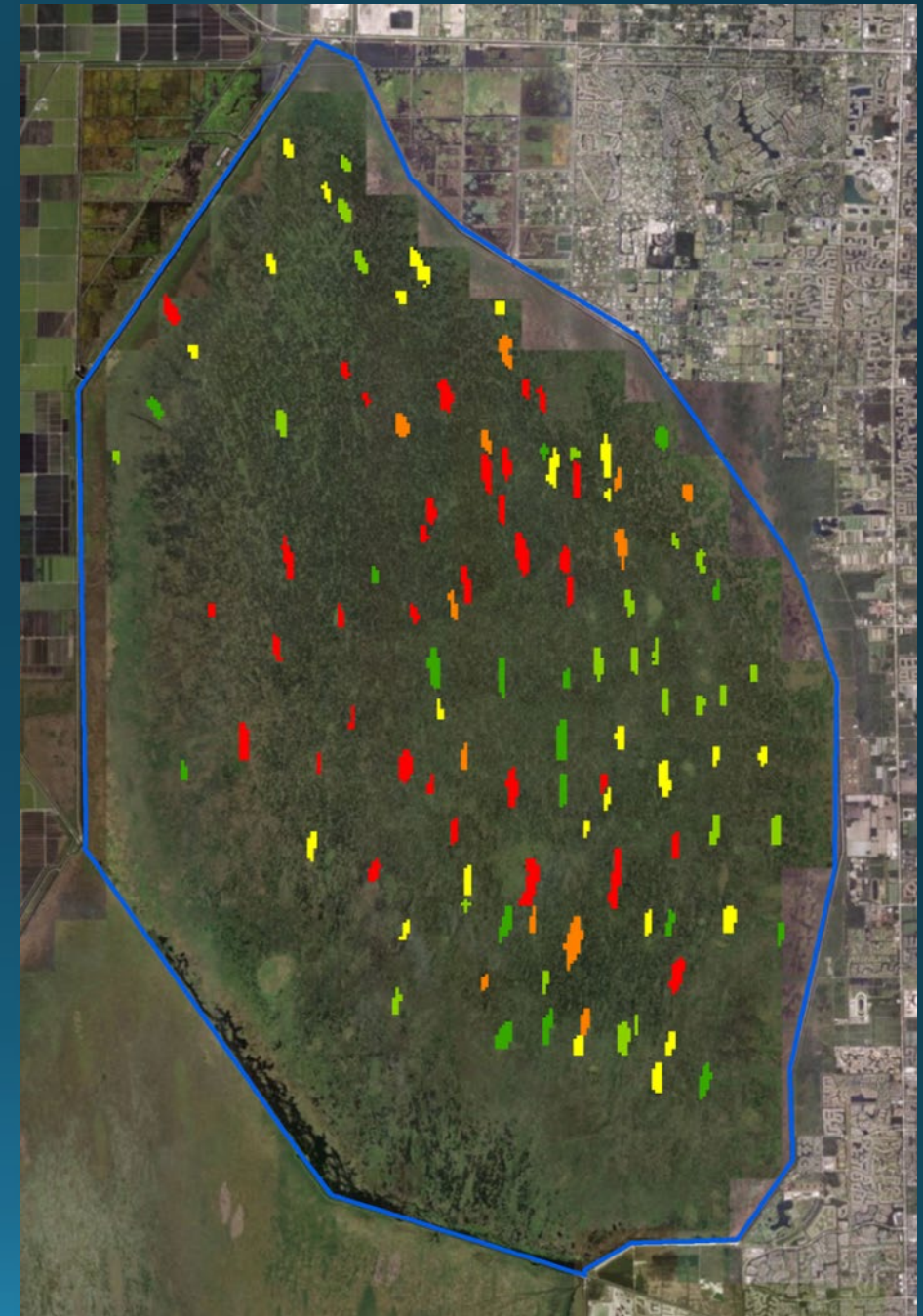
Tree Island Monitoring

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Immediate priority?
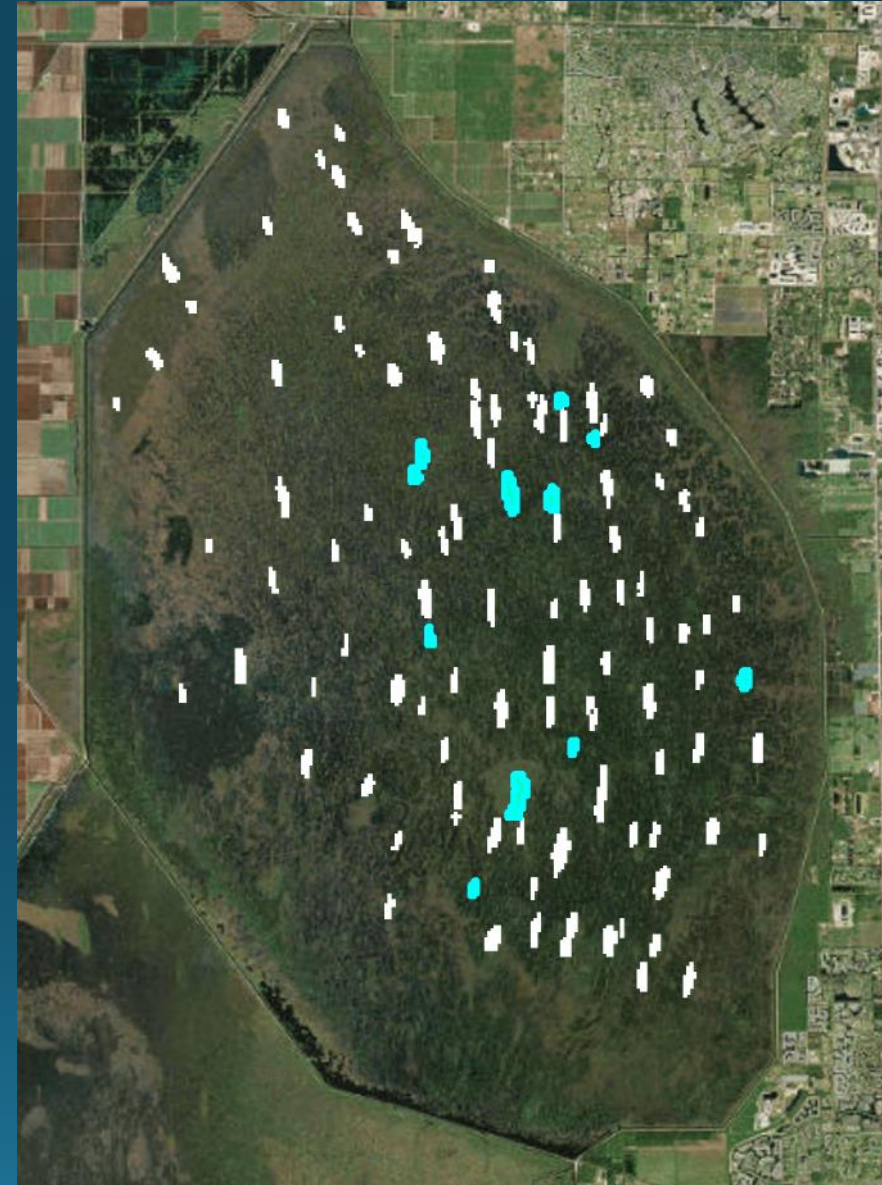
Tree Island Monitoring

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Maintenance priority?

Tree Island Monitoring

Tree Island Infestation	Tree Island Acres (# of islands)		
	Intact	Moderately Impaired	Impaired
>5%	257 (6)	763 (16)	360 (8)
5-25%	156 (7)	946 (23)	321 (8)
>25%	334 (5)	1218 (26)	591 (12)

Future restoration projects?
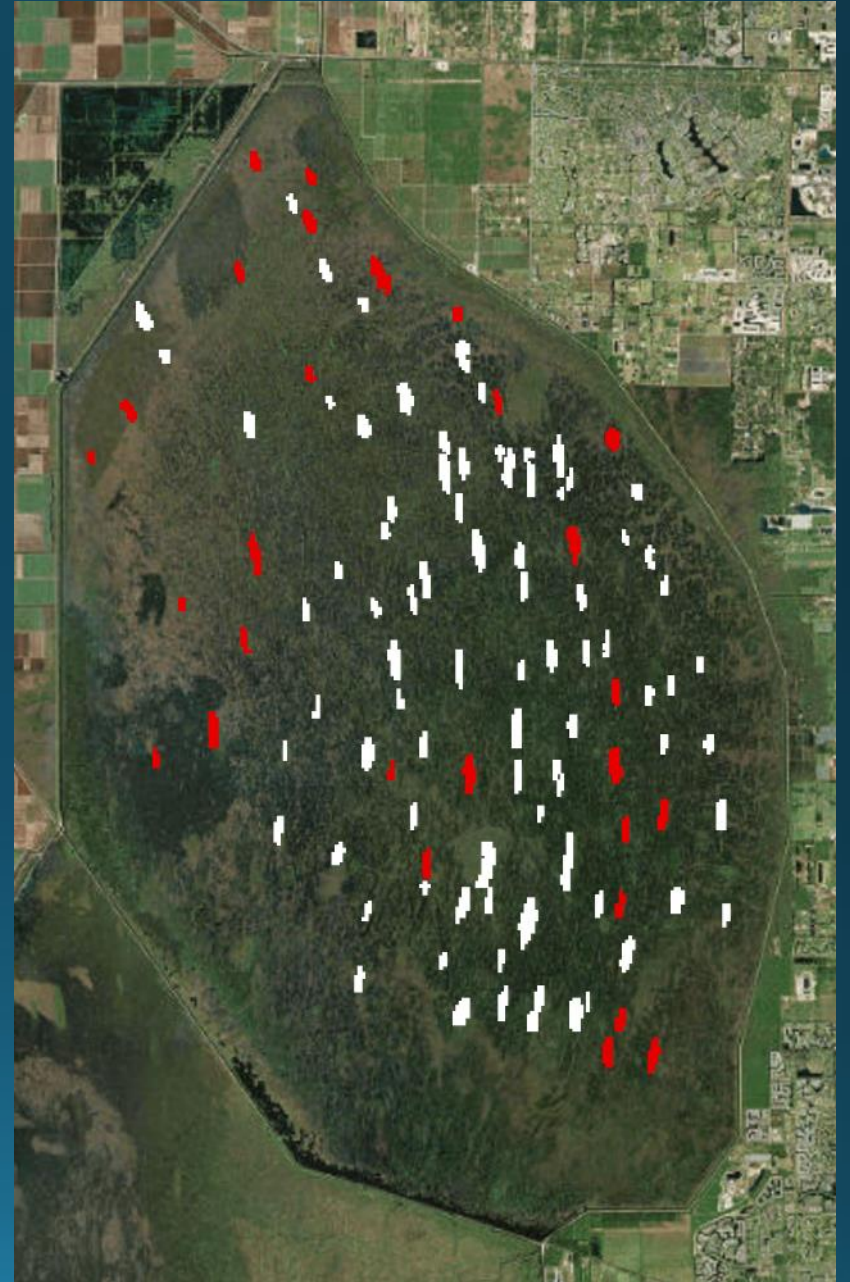
Summary

- Digital aerial sketch mapping provides cost-effective data to support:
  - Strategic planning/prioritization
  - Trend analysis
  - Budgeting
- Integrating sampling designs helps address multiple monitoring objectives and quantify impacts across spatial scales.
- Both Melaleuca and OWCF widespread, but infestations are trending toward low to moderate intensity.
- 25% of strand islands have impaired canopies; 59% are at risk

Many Thanks
Christen Mason
Tony Pernas
Amy Peters
Ellen Allen
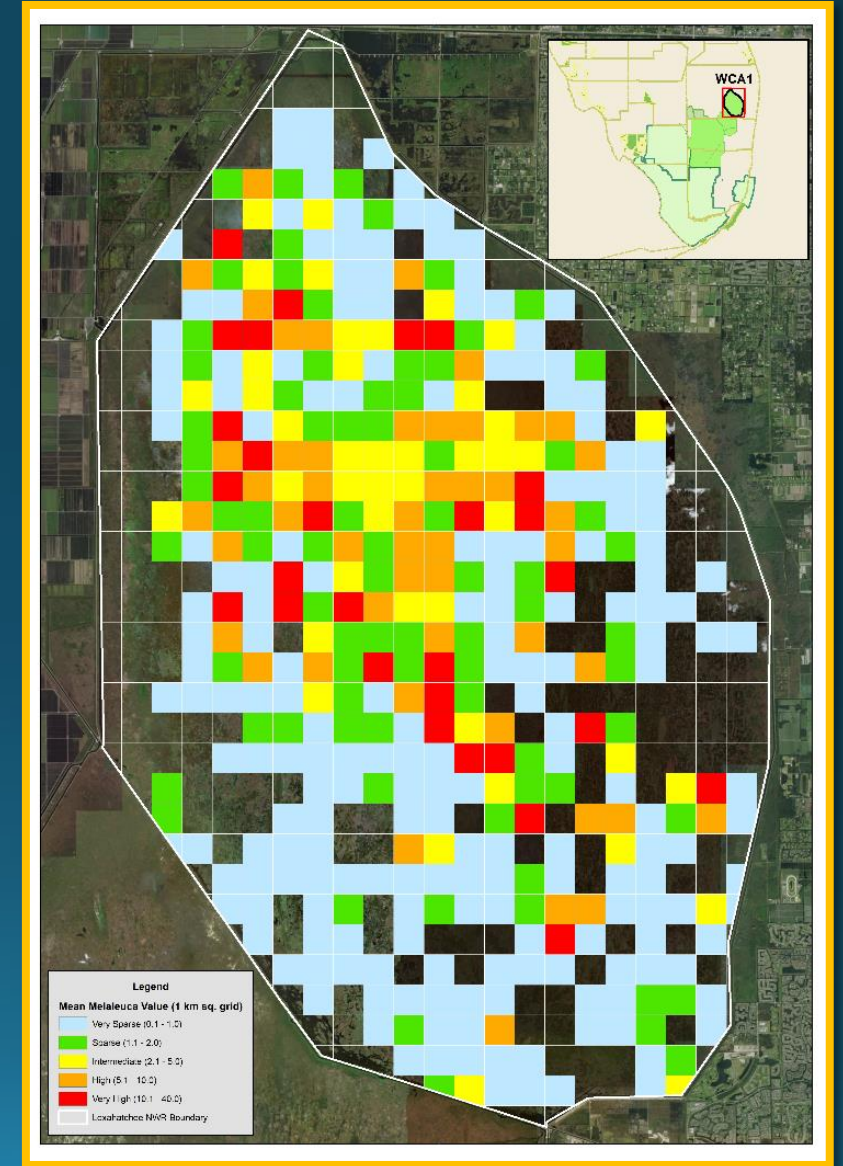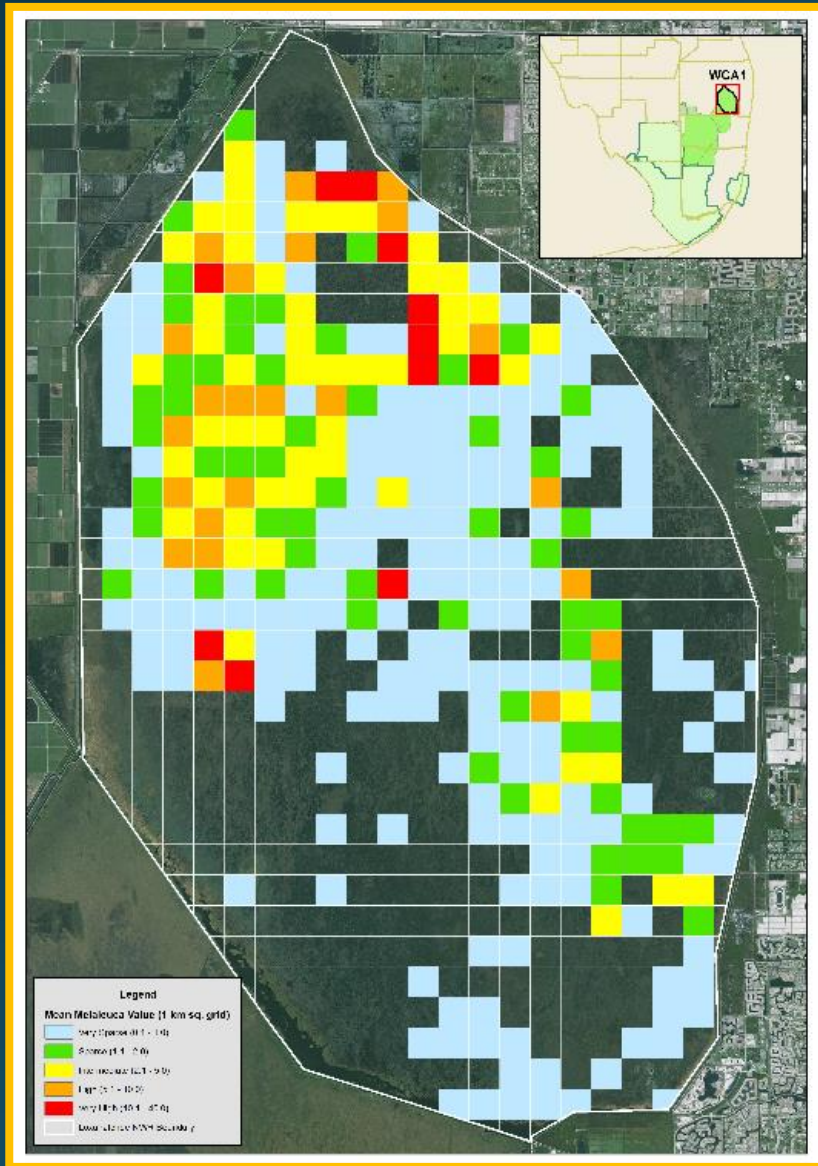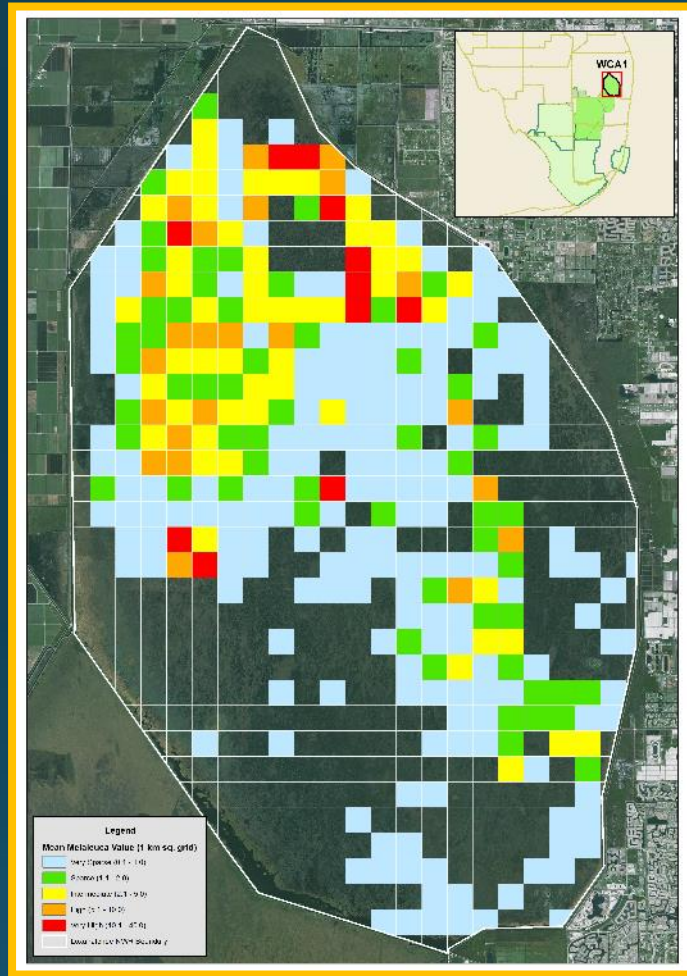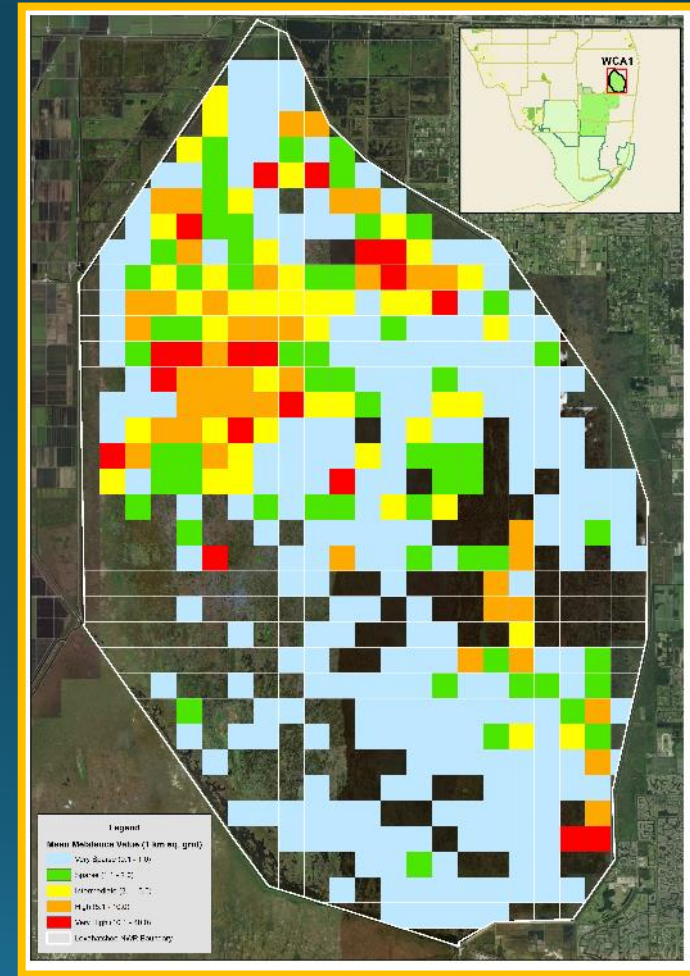Rebekah Gibble
Linda King
Jackie Smith

2016 SRF (1k)

Melaleuca

OWCF

SRF 1K: Melaleuca

2016

2018