Everglades Cooperative Invasive Species Management Area

21st Annual Summit

Leveraging remote sensing and machine learning to detect Brazilian peppertree in the Everglades National Park

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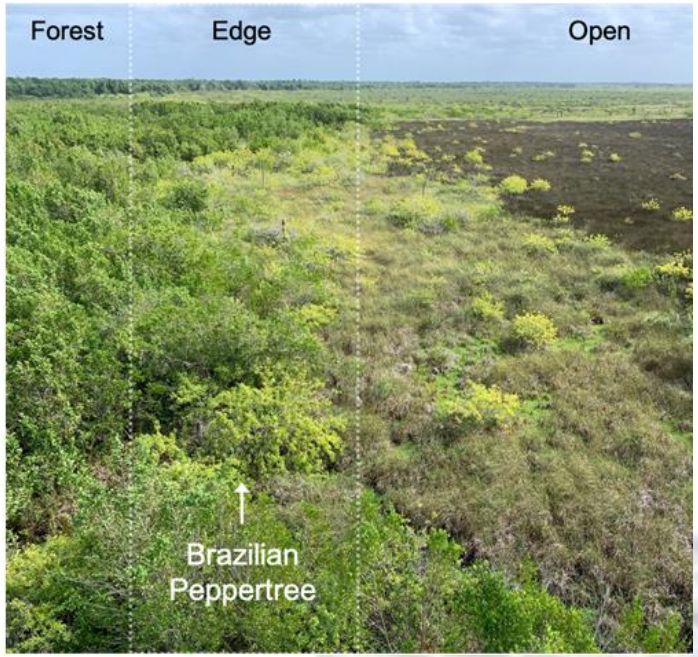
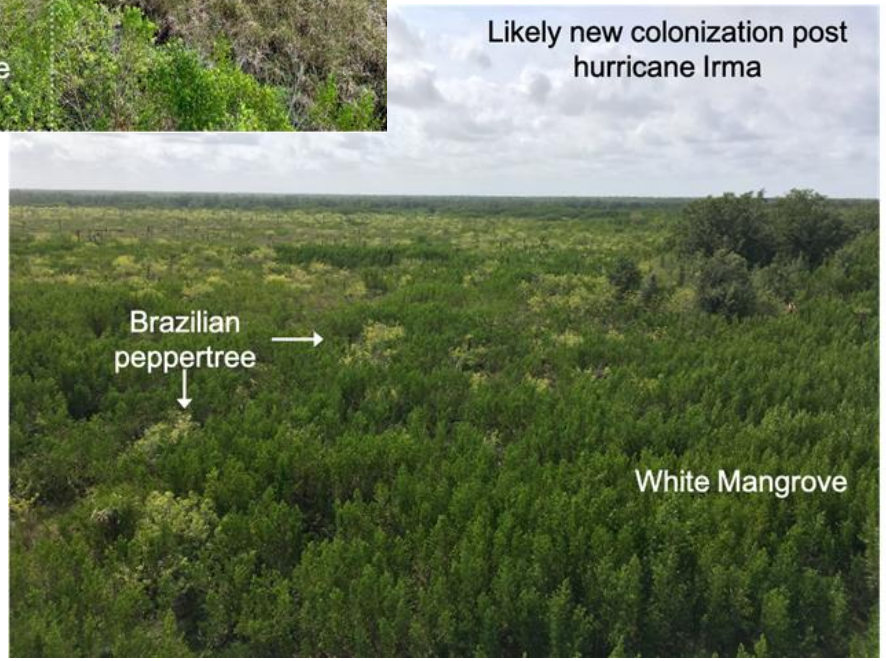
Brazilian peppetree is a *highly* effective colonizer

- Broadleaf evergreen shrub or small tree that forms dense thickets

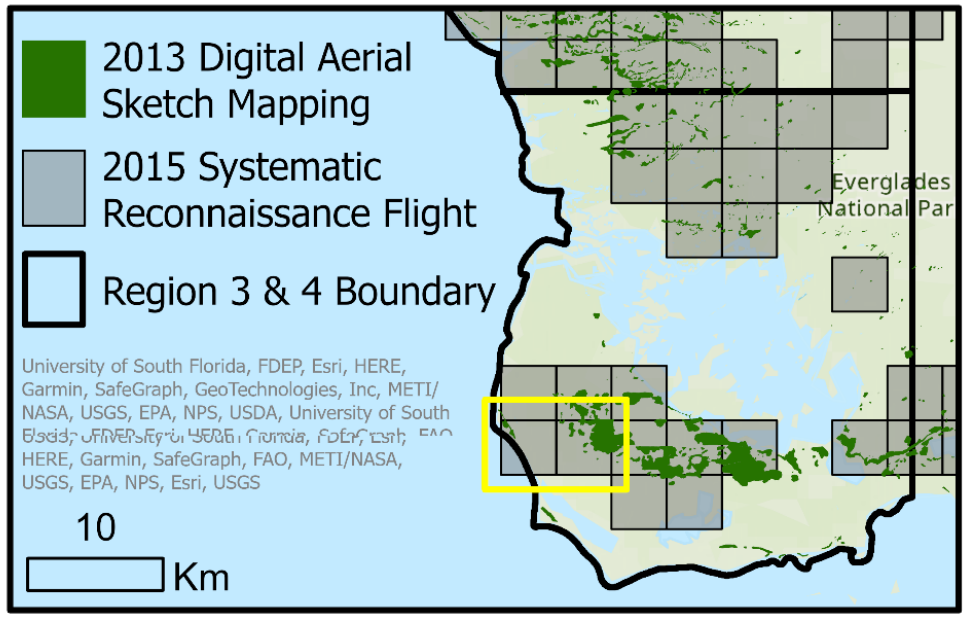
- Crowd out native species due to …
  - Rapid growth
  - Numerous seedlings
  - High germination rate
  - Allelopathic compounds
    - Even after removal, soils fail to support native flora

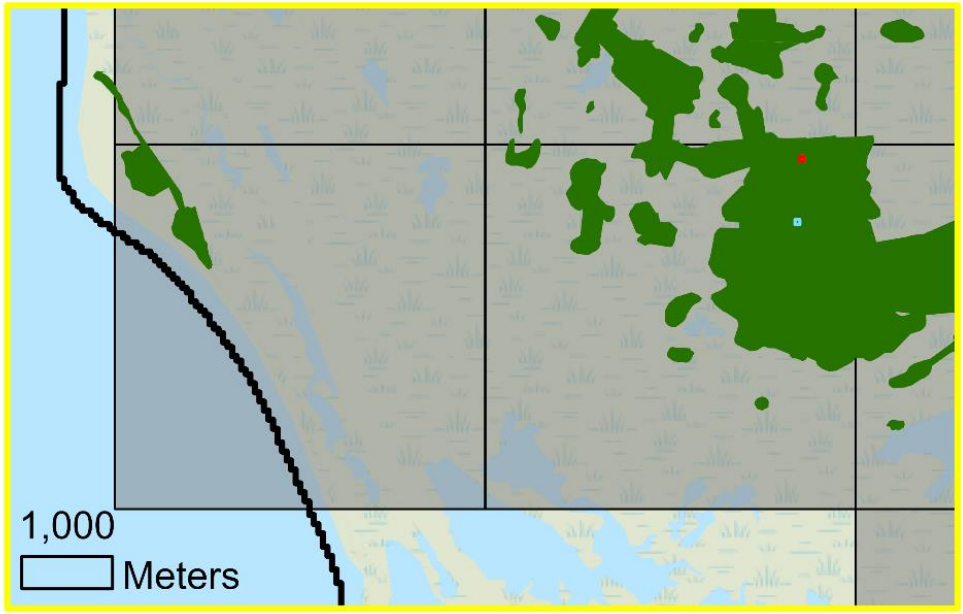
- Efficient colonizer of disturbed areas
  - Fires
  - Hurricanes



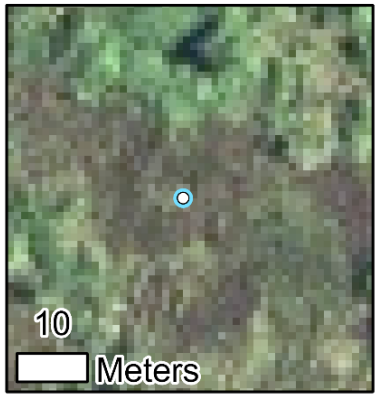


Management is challenging in part due to tracking datasets

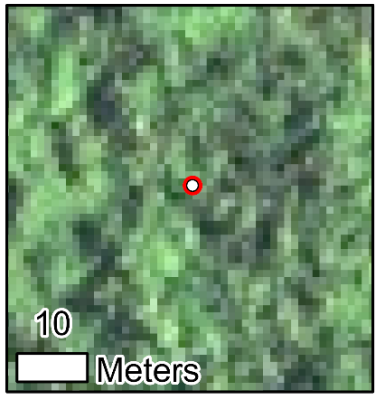




Brazilian Peppertree Not Present



Brazilian Peppertree Present

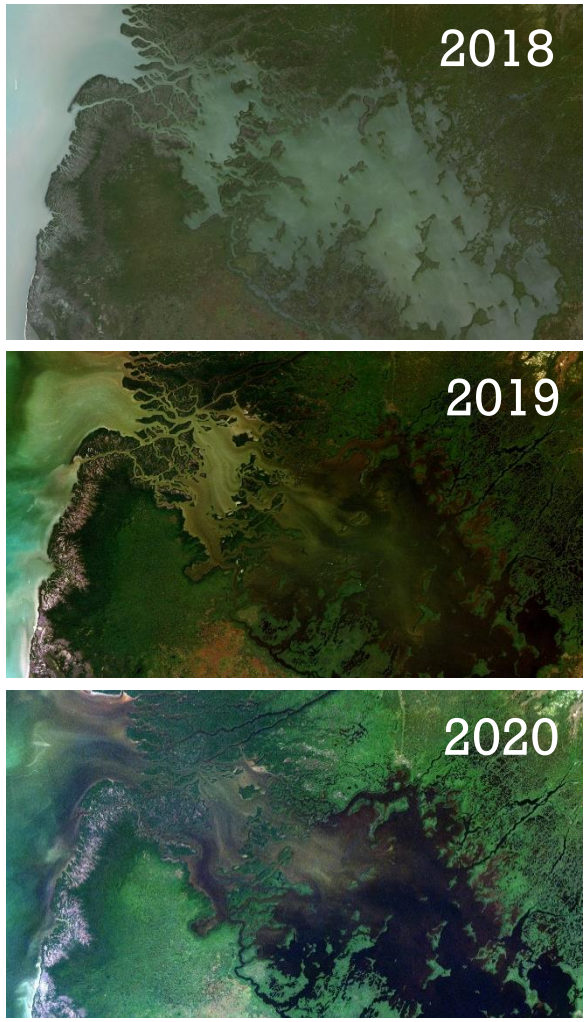


Datasets are out of date or not at a useful management scale

Remote sensing can be cost-effective way to monitor invasives

Inaccessible Locations

Repeat Visits



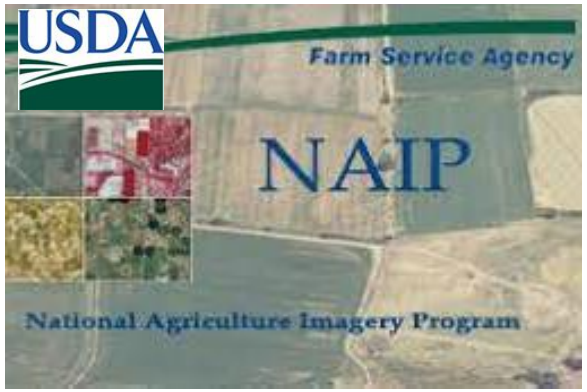
Broad Areas

Research Objectives

- To what extent can we detect Brazilian peppertree using remote sensing? Is accuracy impacted by the pixel size and number of bands?

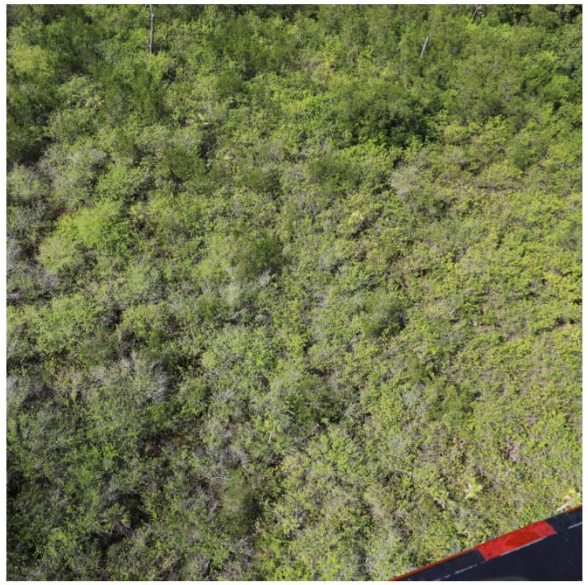
Increasing spatial & spectral resolution →

Resolutions	NAIP	RapidEye	Landsat 8
Pixel Size	1 m	5 m	30 m
# of Bands	4 bands	5 bands	7 bands

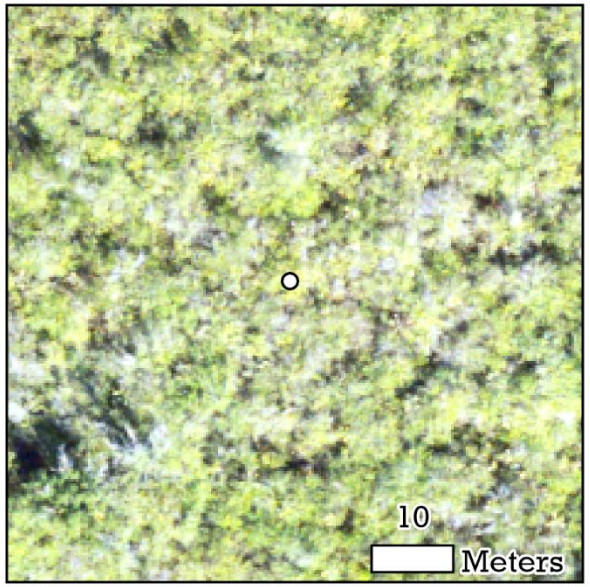


What does an invasive look like in remote sensing imagery?

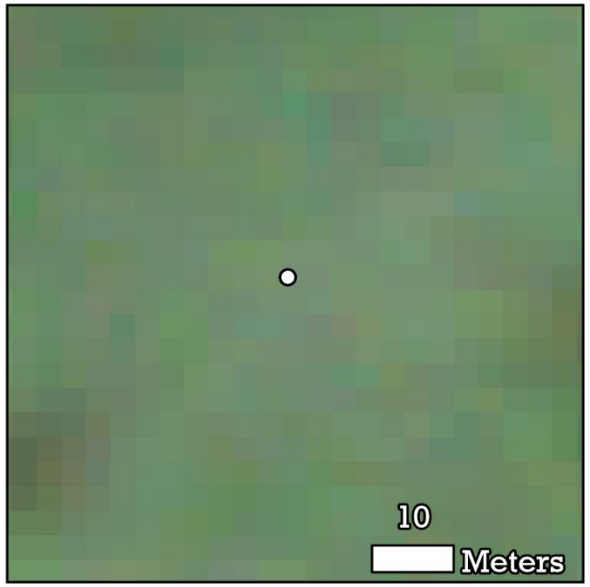
Helicopter



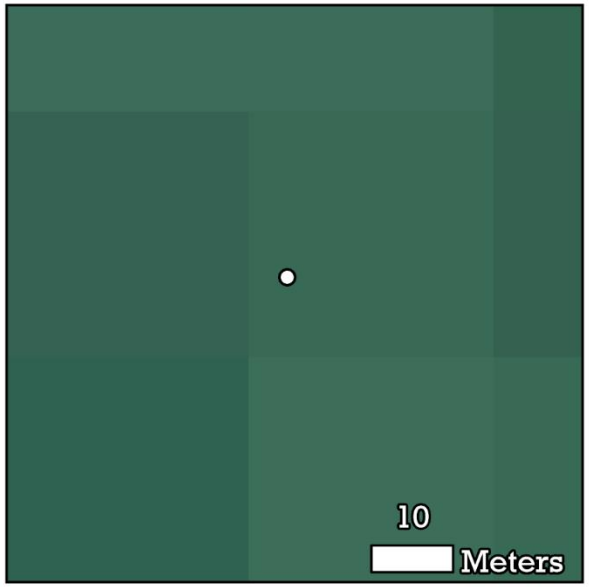
1 m

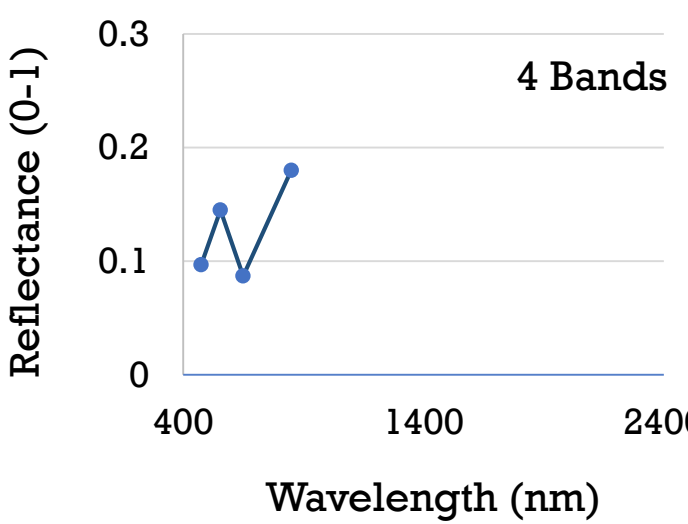


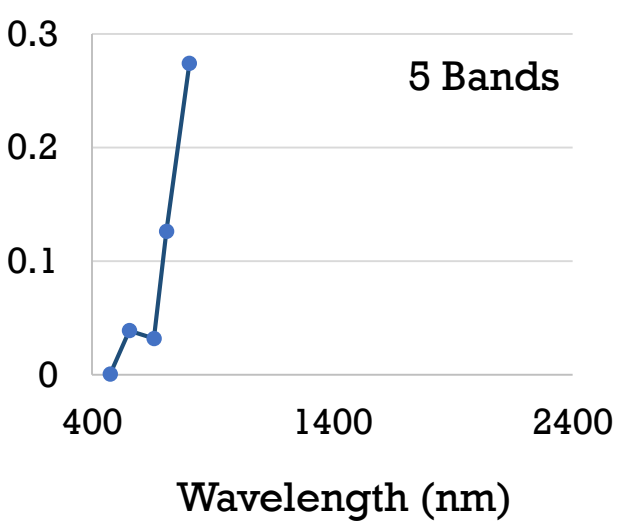
5 m

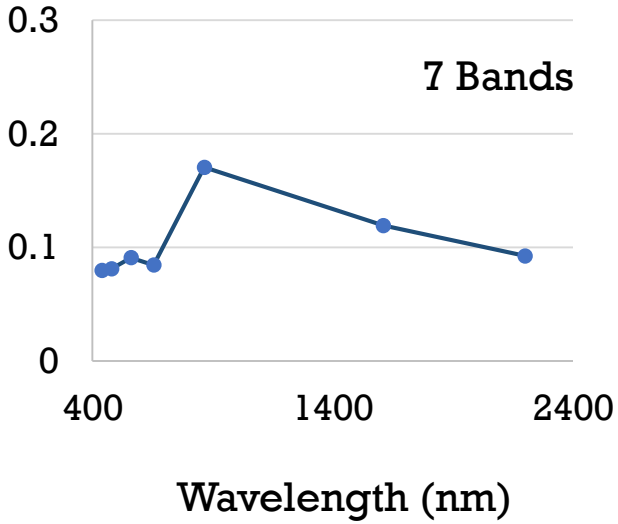


30 m





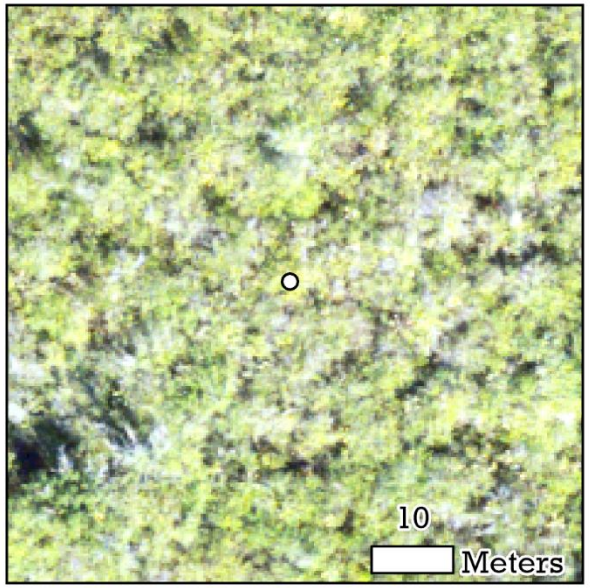




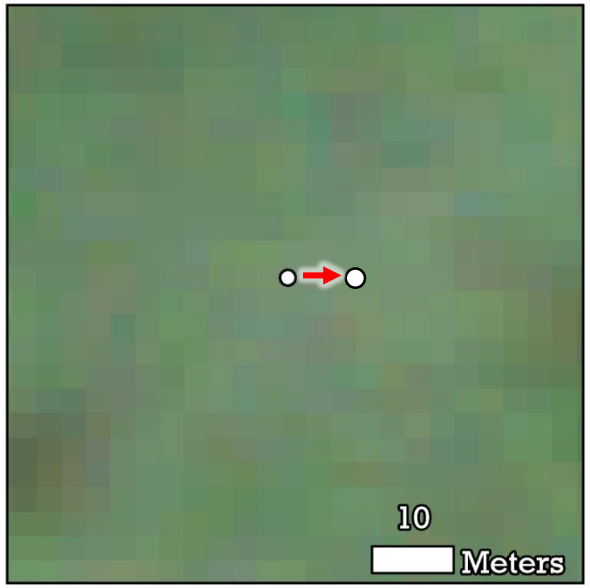
Matching ground to imagery is inherently challenging.

Helicopter

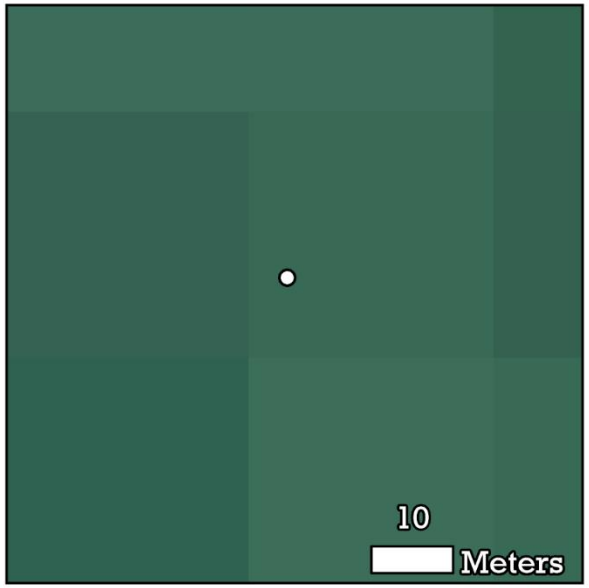
1 m



3 m



30 m

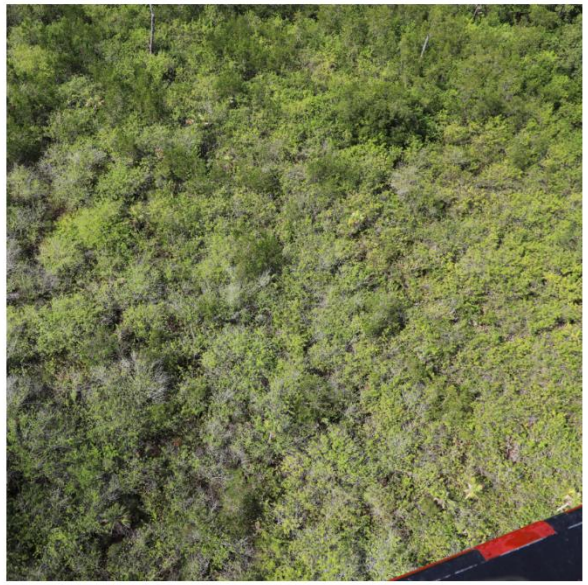


Location Error

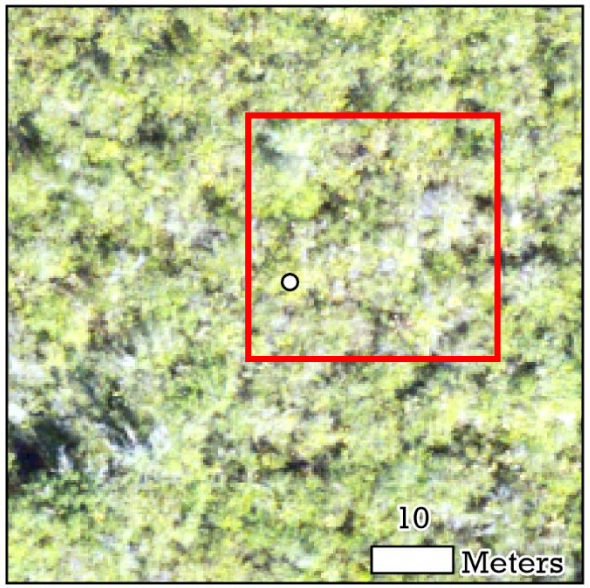
A mismatch of the location on the ground and the spatial coordinates that were recorded.
Results in selecting the wrong pixel that may or may not be invasive.
This is particularly challenging in the Everglades because we collect training data from helicopters

Matching ground to imagery is inherently challenging.

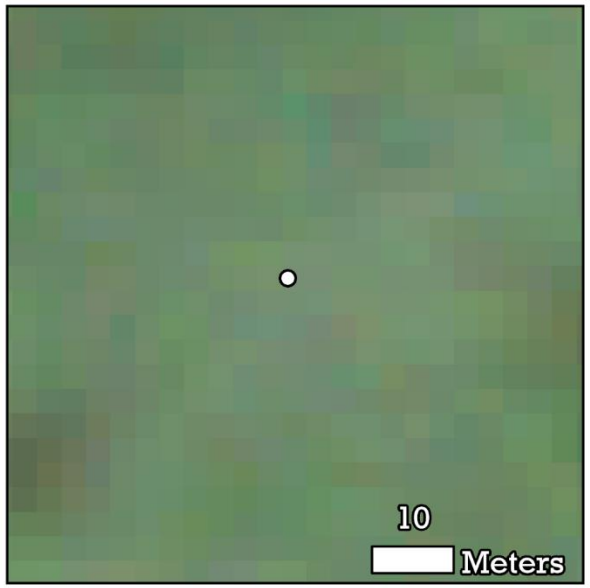
Helicopter



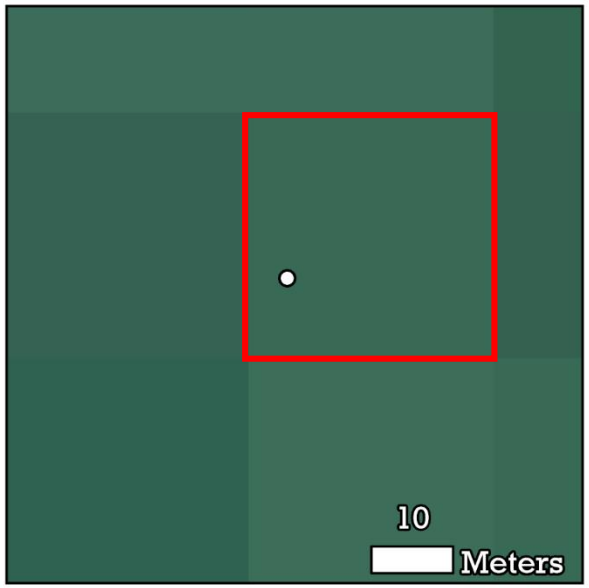
1 m



5 m



30 m

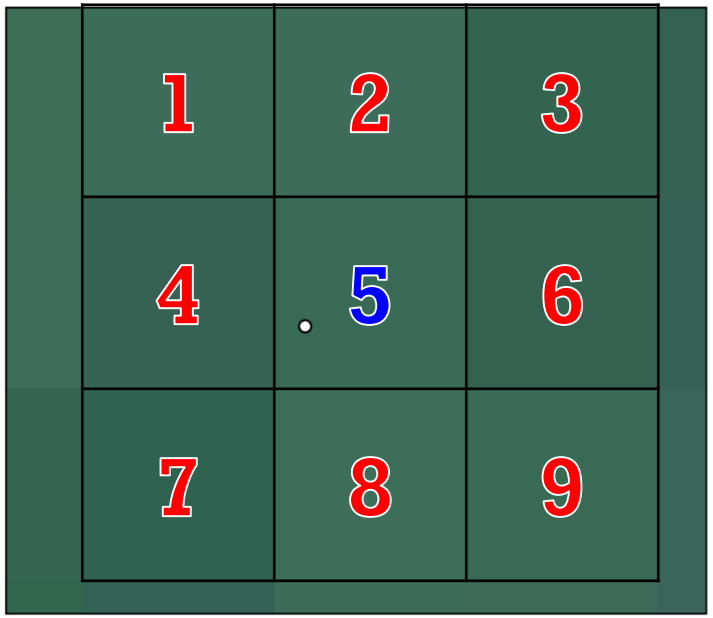


Mixed Pixels

The pixel is a mix of all surfaces (e.g., water, native plants, soil, invasive).
This is especially difficult with invasives because they not often monotypic.

Multiple Instance Learning

An algorithm that learns with imprecision and uncertainty in training labels



Standard Classification

Pixel	Label
x_1	0
x_2	0
x_3	0
x_4	0
x_5	1
.	.
.	.
.	.

Meerdink et al., 2019

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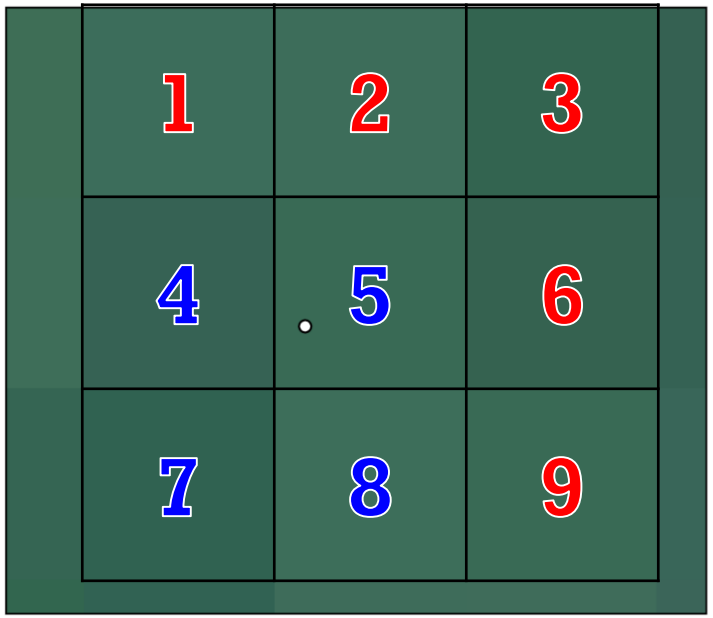

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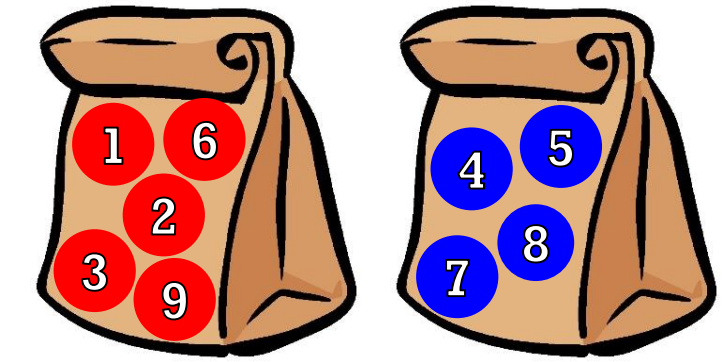
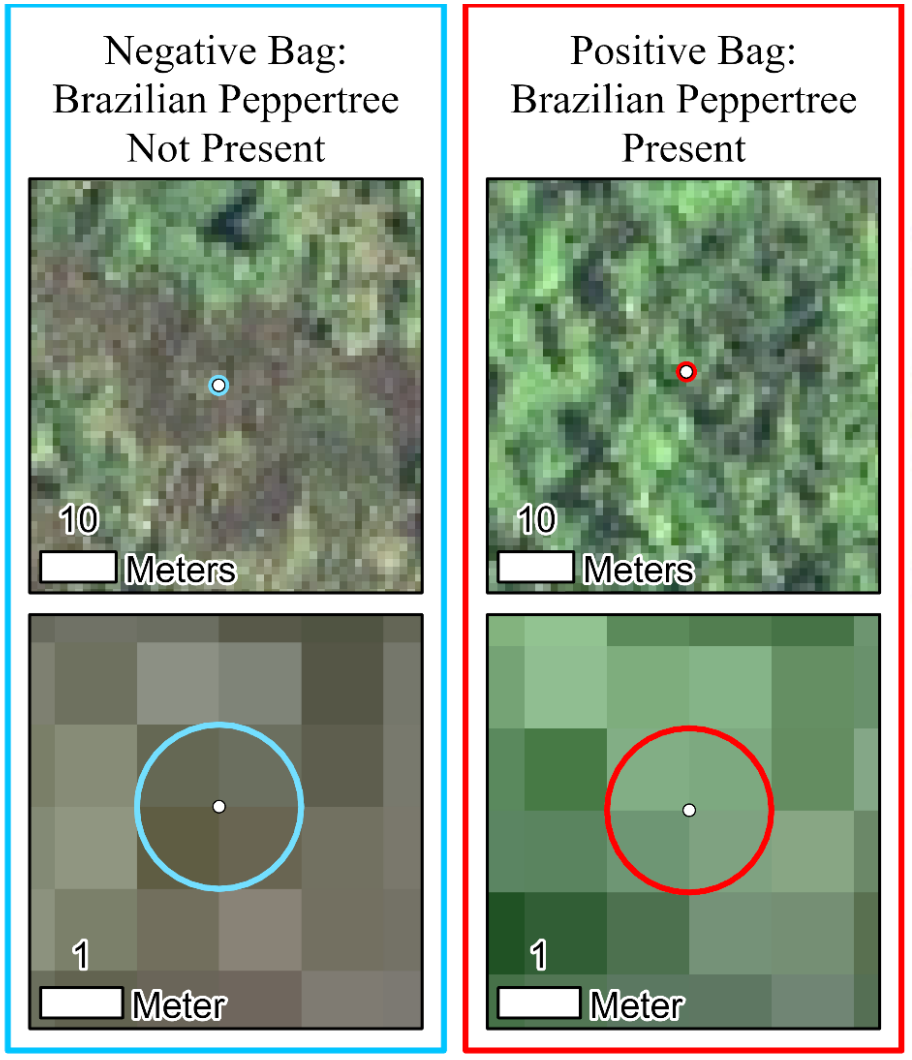


Meerdink et al., 2019

Multiple Instance Learning in the Everglades National Park

Bayhead Swamp Scrub with Brazilian Peppertree not present



Buttonwood & Red Mangrove with Brazilian Peppertree present

Training locations from the 2015 Everglades National Park and Big Cypress National Preserve Vegetation Mapping Project

349 Positive Bags (Brazilian peppertree present)
3,268 Negative Bags (Other vegetation, soil, water)

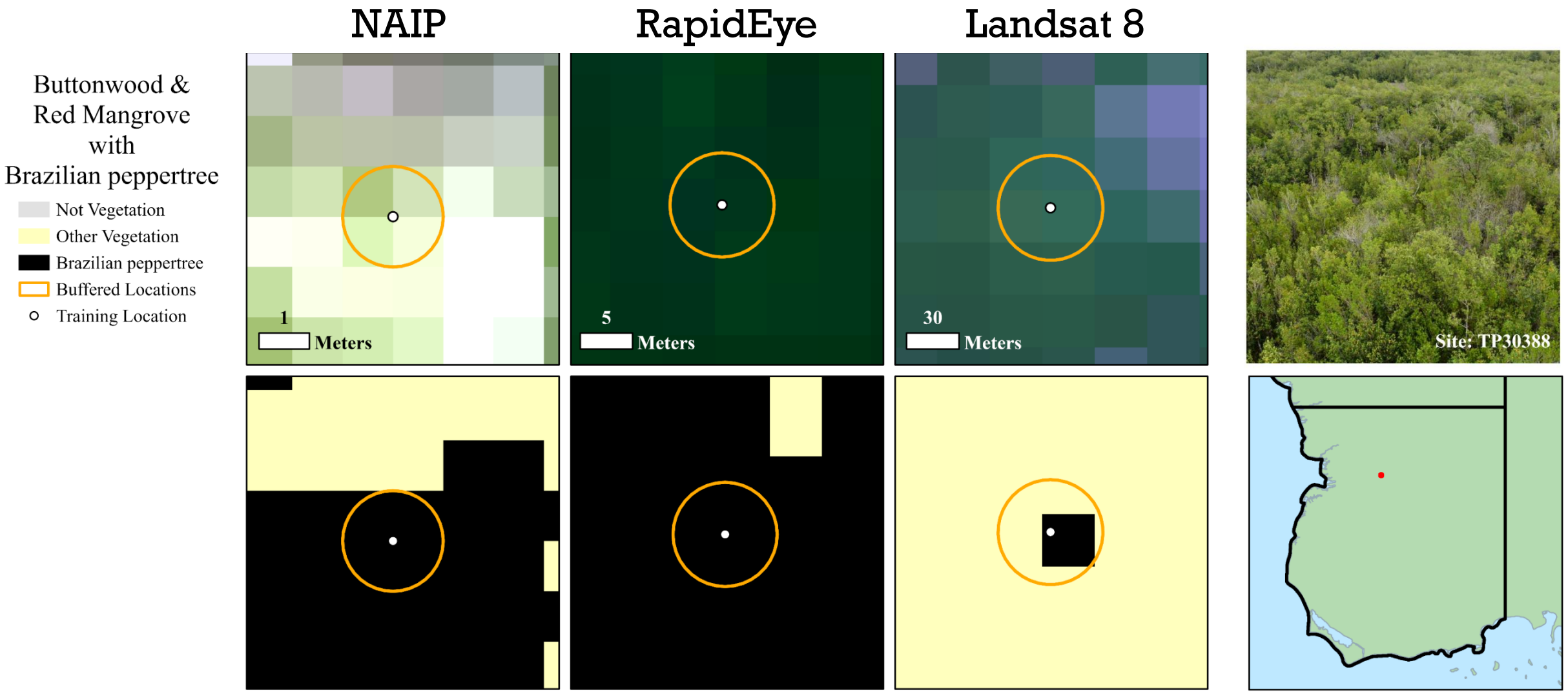
Higher spectral resolution improve detection of invasives

Accuracy	NAIP	RapidEye	Landsat 8
Overall	73.6%	88.8%	90.9%
Producer	22.1%	45.5%	27.6%
User	51.3%	36.6%	58.7%

Increasing spatial & spectral resolution →

Producer Accuracy: how often invasive is correctly shown on the classified map
User Accuracy: how often invasive will actually be present on the ground

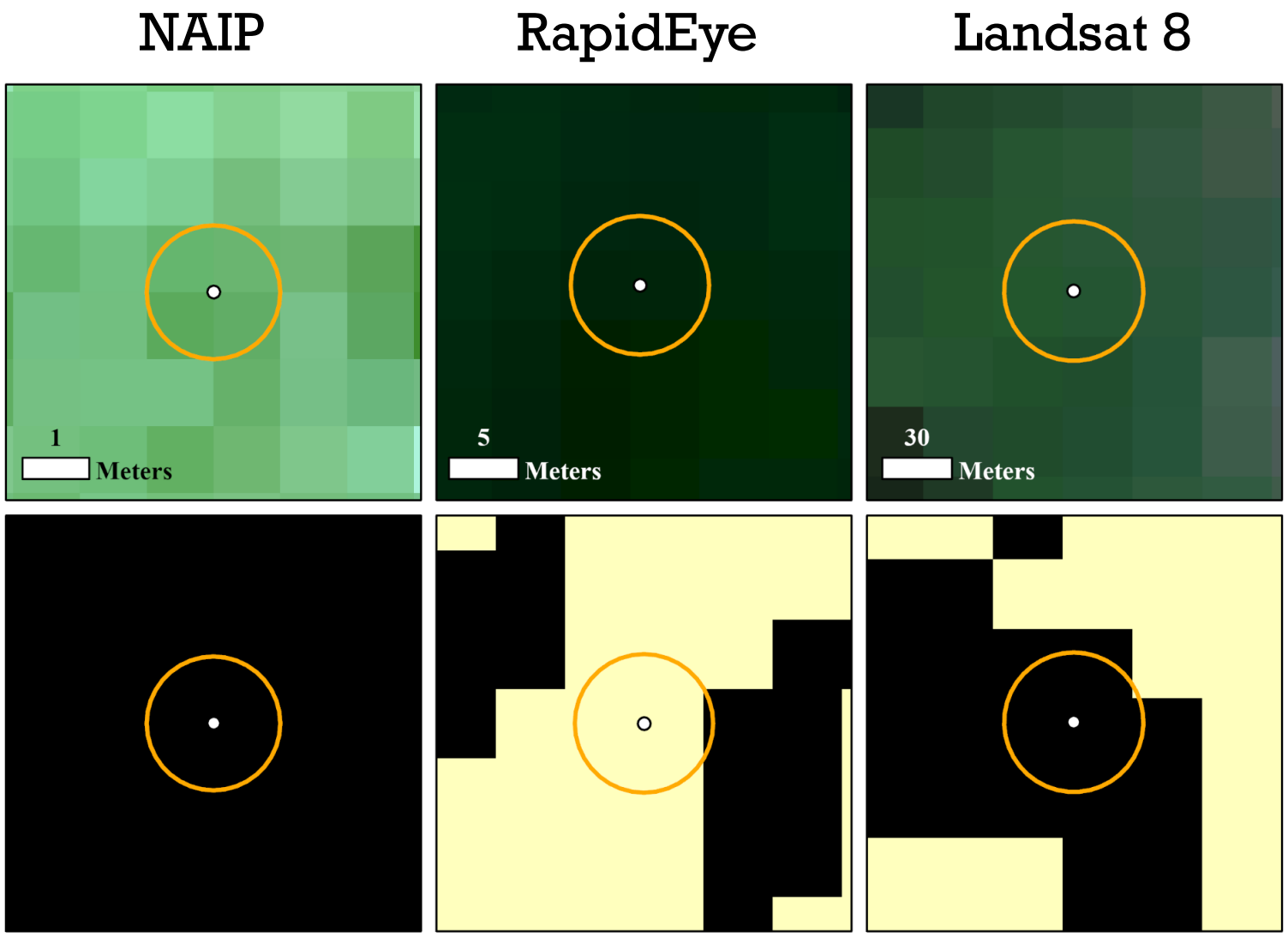
High detection in homogenous vegetation communities

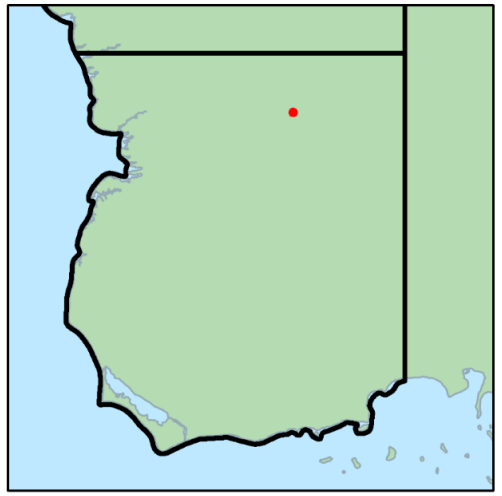


Confusion in heterogenous vegetation communities

Red Mangrove Shrubland should not have Brazilian peppertree

- Not Vegetation
- Other Vegetation
- Brazilian peppertree
- Buffered Locations
- Training Location





Take Aways

- Landsat's 30-meter pixel size performed the best with the 2015 dataset
- While coarse, it is a huge improvement over existing surveying approaches
- With a 28% producer and 59% user accuracy, there is still some room for improvement.
- Next steps, try new satellites with more bands or add in seasonal imagery

Everglades Cooperative Invasive Species Management Area

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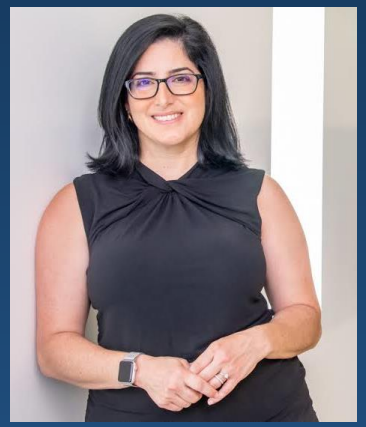
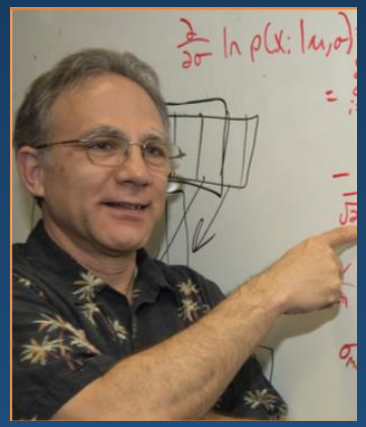
National Park Services



Alina Zare
UF Professor



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UF Professor

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CISMA

FISP Florida Invasive Species Partnership

Think Locally, Act neighborly
invasive species know no boundaries!