COLLABORATIVE SCIENCE FOR ESTUARIES

WEBINAR SERIES

Brandon Puckett
NOAA National Centers for Coastal Ocean Science

Whitney Jenkins
North Carolina National Estuarine Research Reserve

Cristiana Falvo
Duke Marine Robotics and Remote Sensing Lab

Justin Ridge
Duke Marine Robotics and Remote Sensing Lab

Brittany Morse
North Inlet – Winyah Bay National Estuarine Research Reserve

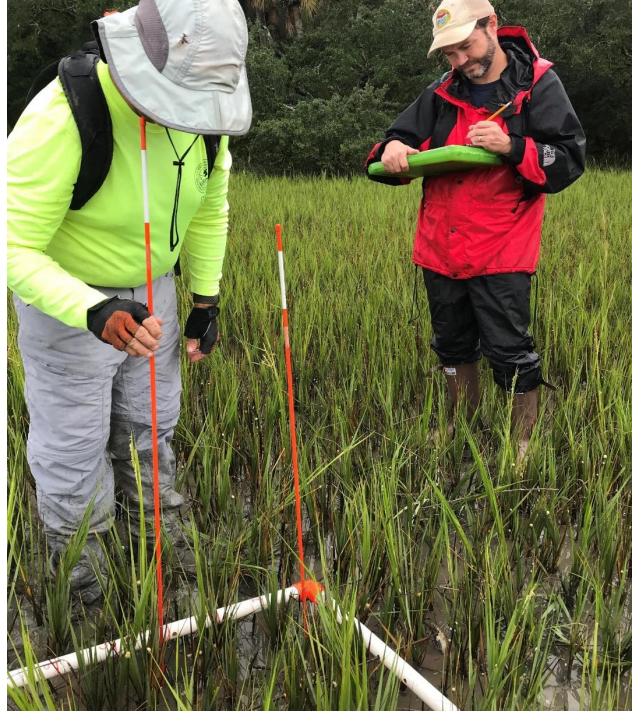
Allix North
Guana Tolomato Matanzas National Estuarine Research Reserve

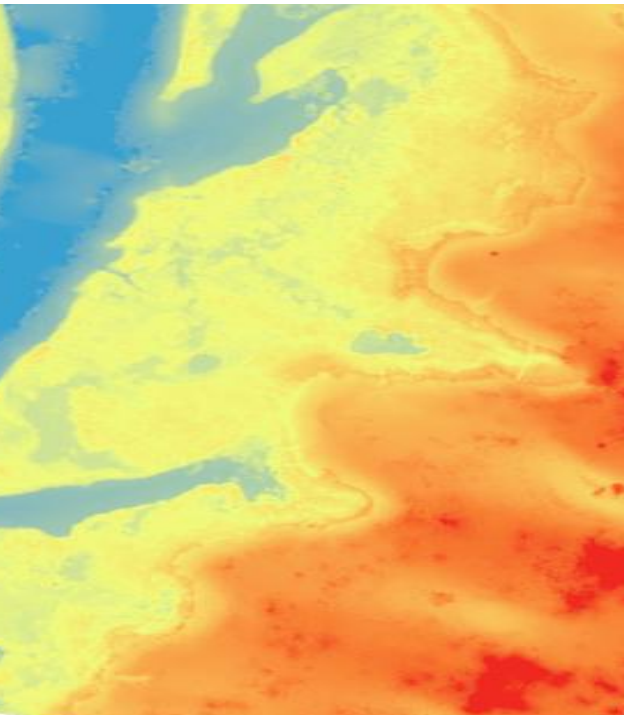
Erik Smith
North Inlet – Winyah Bay National Estuarine Research Reserve

Drone the SWMP: Assessing the Utility of Drones for Monitoring Coastal Wetlands

National Estuarine Research Reserve System
Science Collaborative

Date: Wednesday, June 29, 2022
Time: 3:00-4:00 PM ET





Assessing the utility of drones for monitoring coastal wetlands

(aka Drone the SWMP)

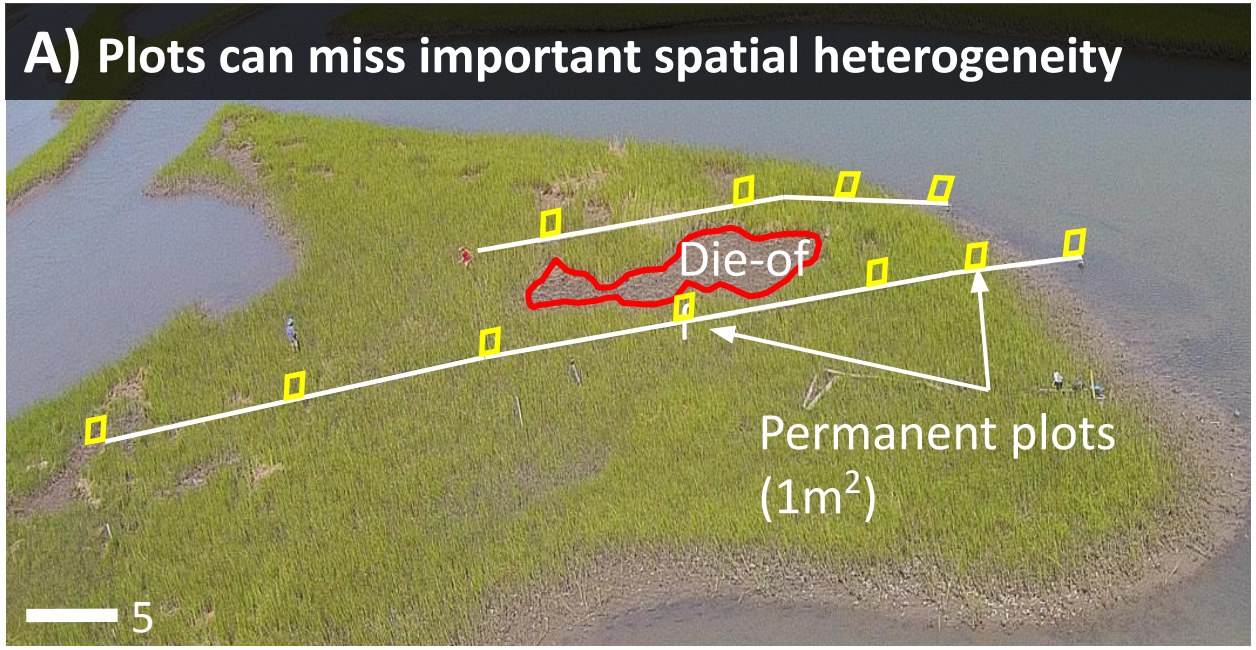
Brandon Puckett
NOAA National Centers for Coastal Ocean Science

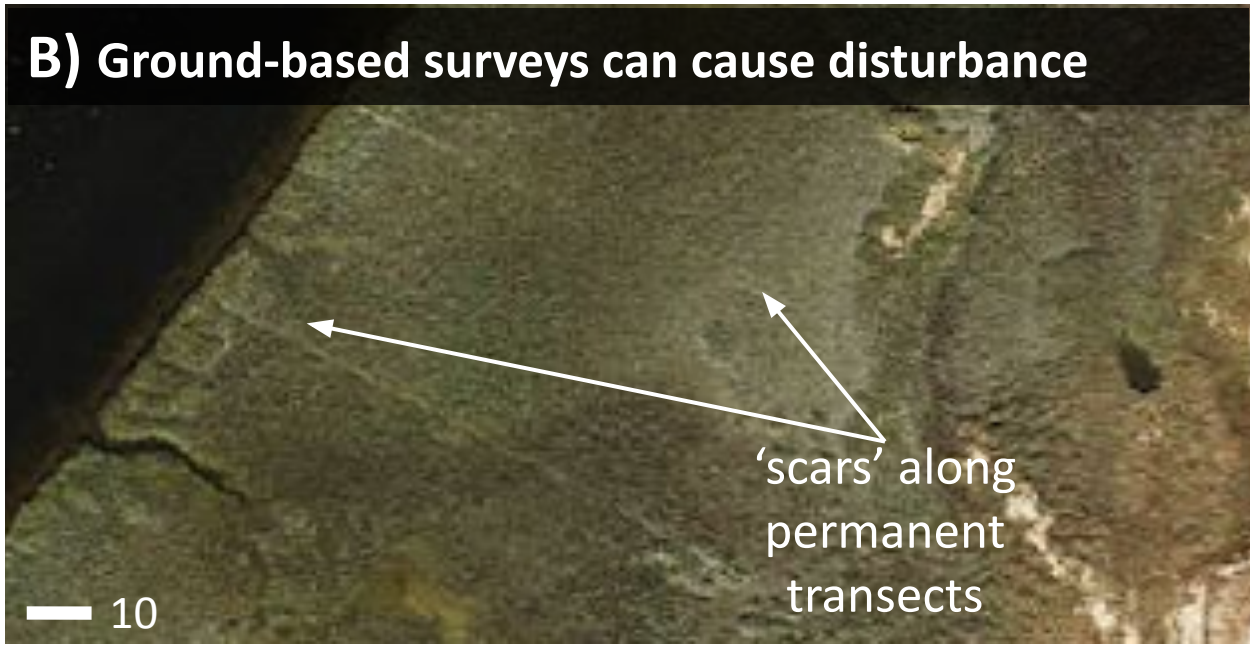
National Estuarine Research Reserve System Science Collaborative

Wetlands—sentinels of change

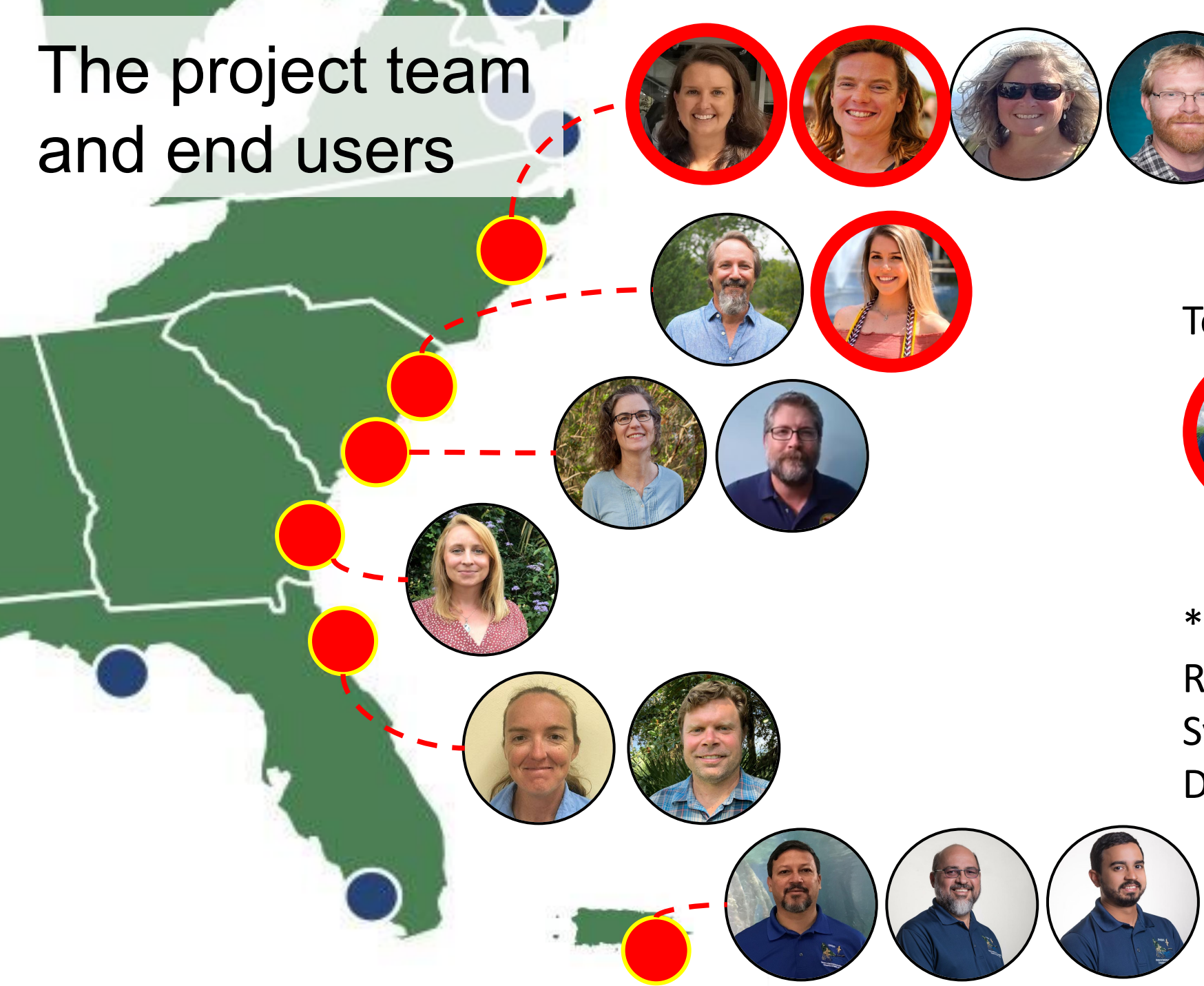
Photo: Mike Greene

Monitoring: quadrats and satellites





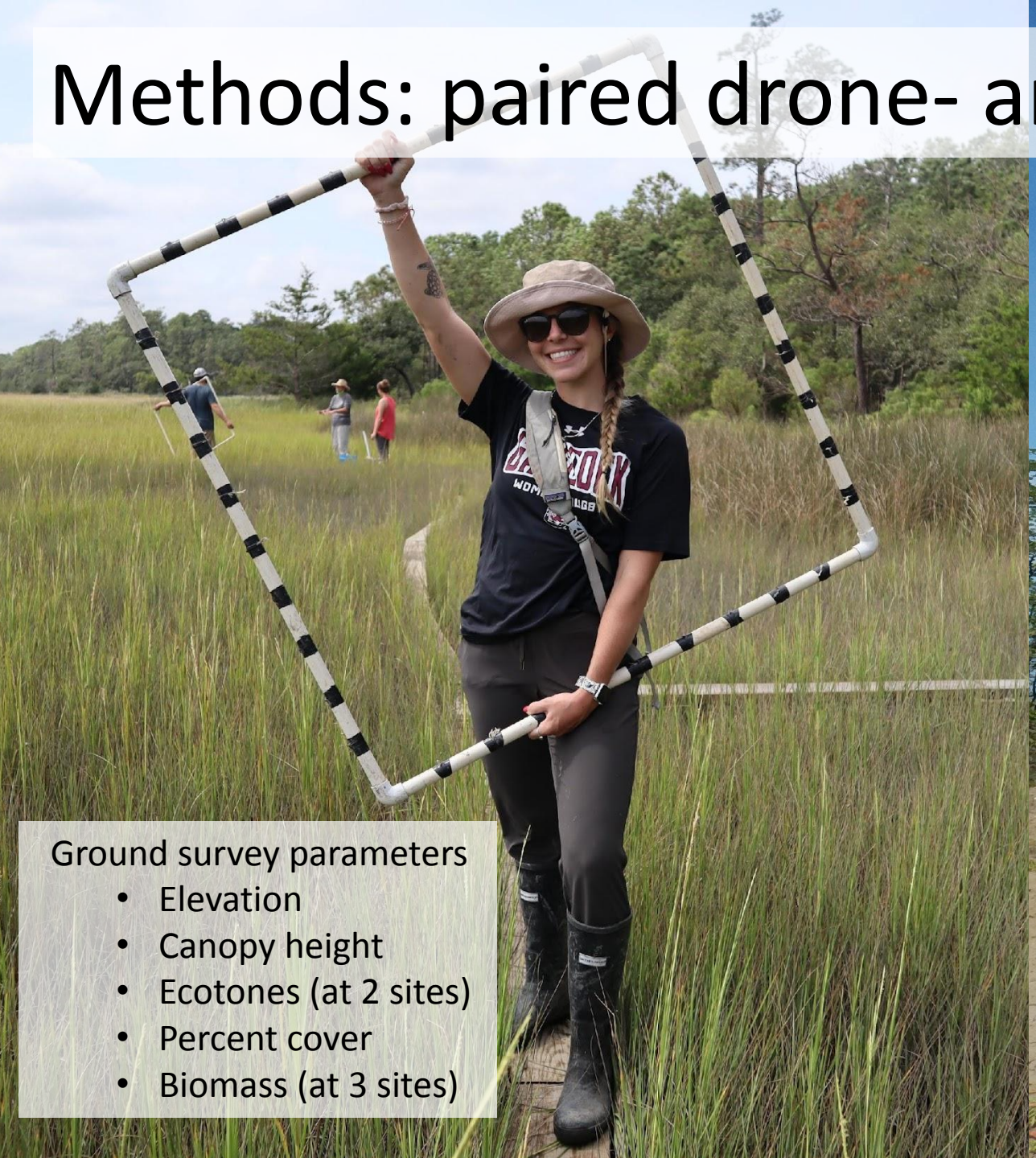
The project team and end users



Technical experts

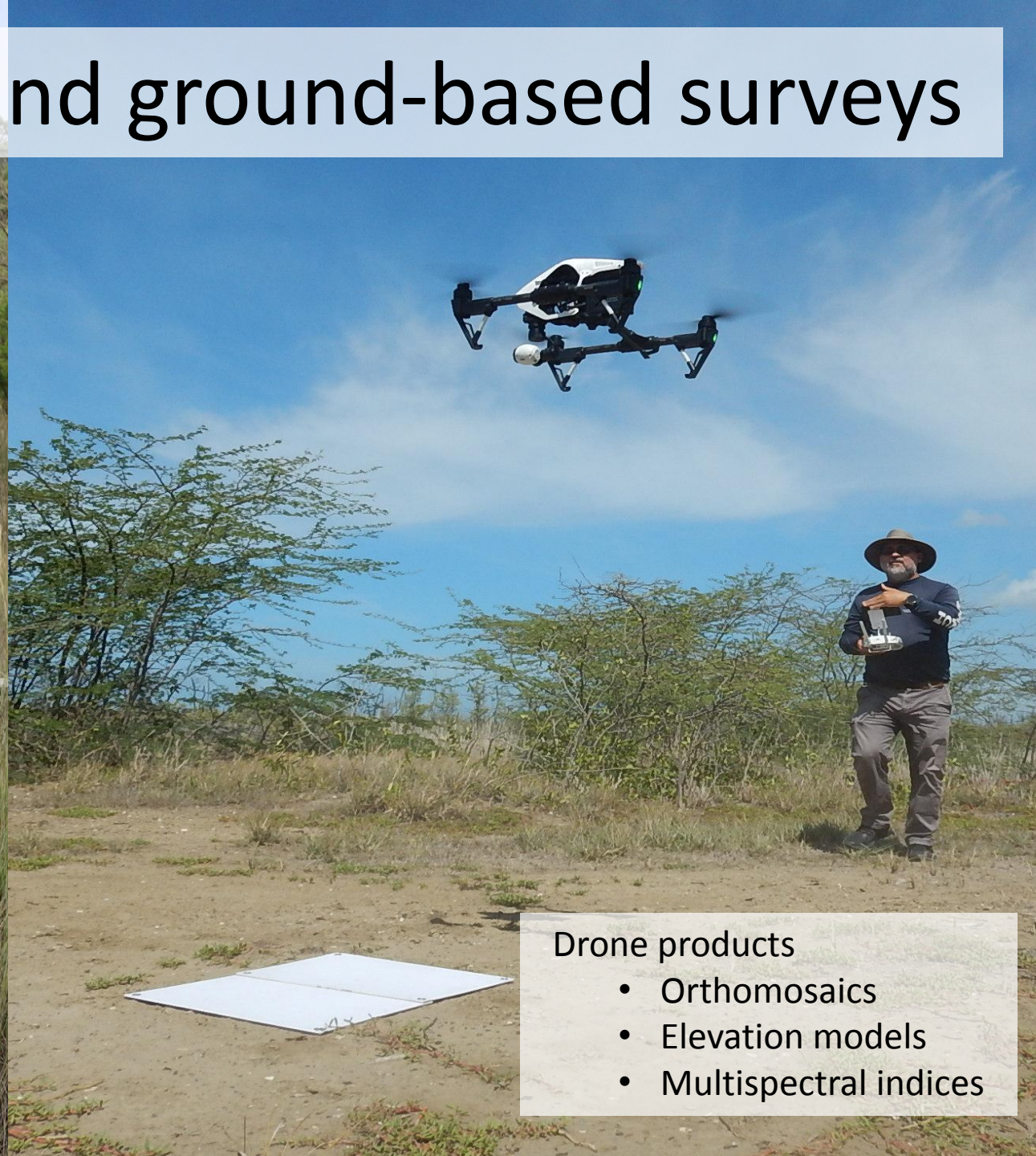
*NOAA Office of Atmospheric Research Unmanned Aircraft Systems Program (PI: Jenny Davis, NOAA NCCOS)

Methods: paired drone- and ground-based surveys



Ground survey parameters

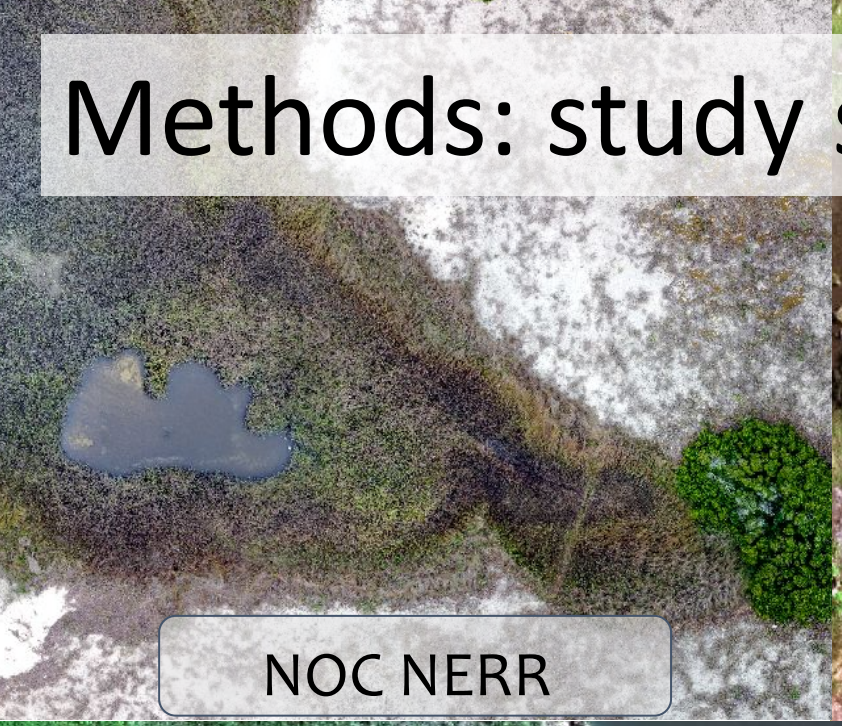
- Elevation
- Canopy height
- Ecotones (at 2 sites)
- Percent cover
- Biomass (at 3 sites)

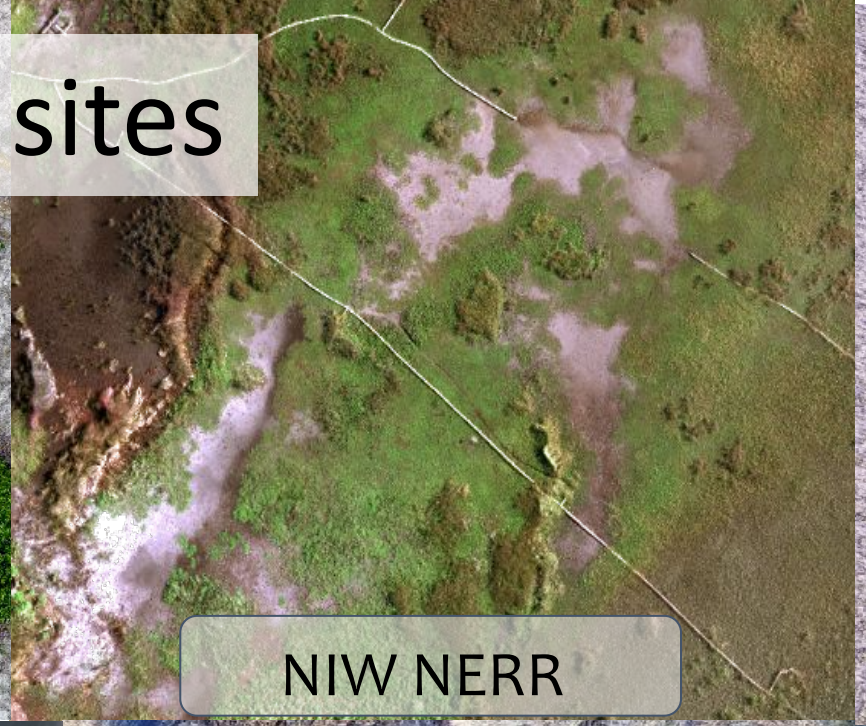


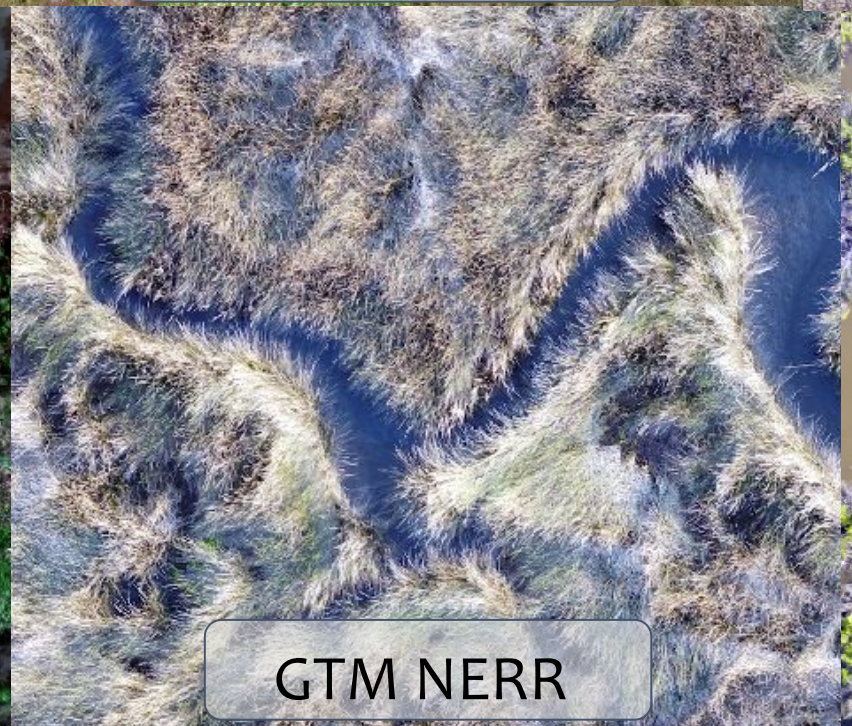
Drone products

- Orthomosaics
- Elevation models
- Multispectral indices

Methods: study sites



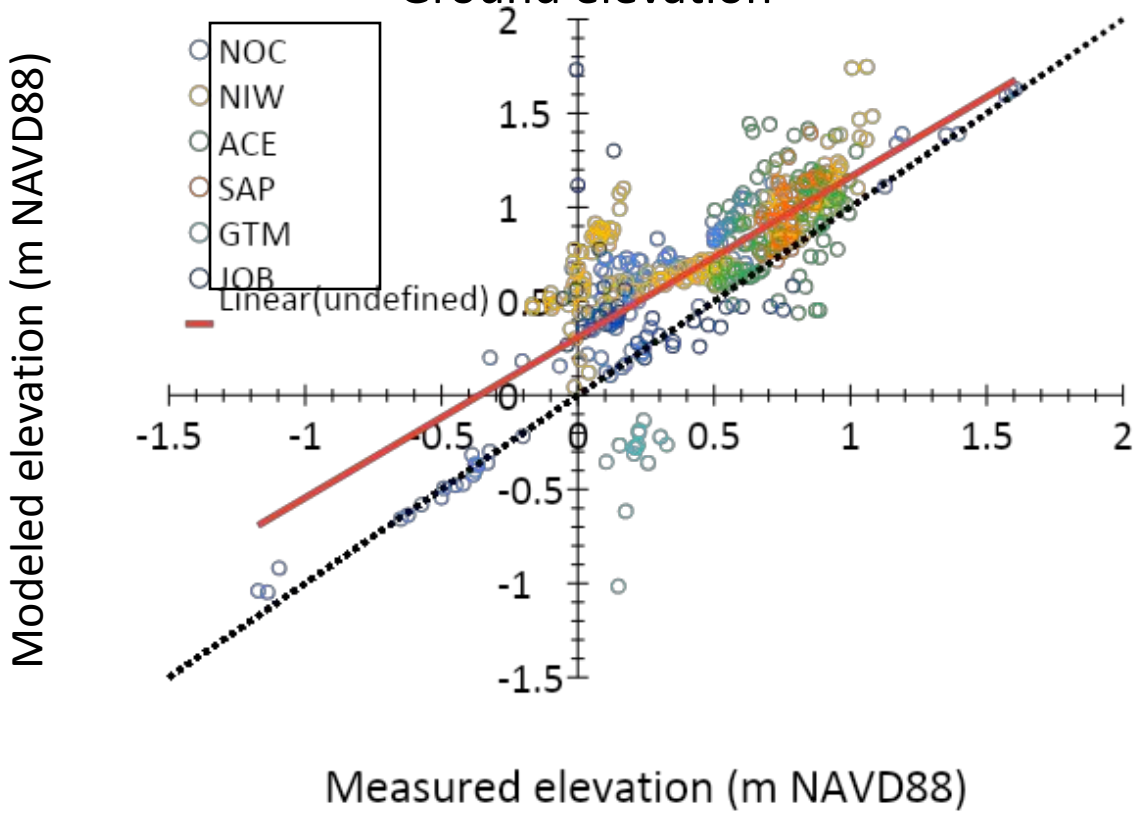




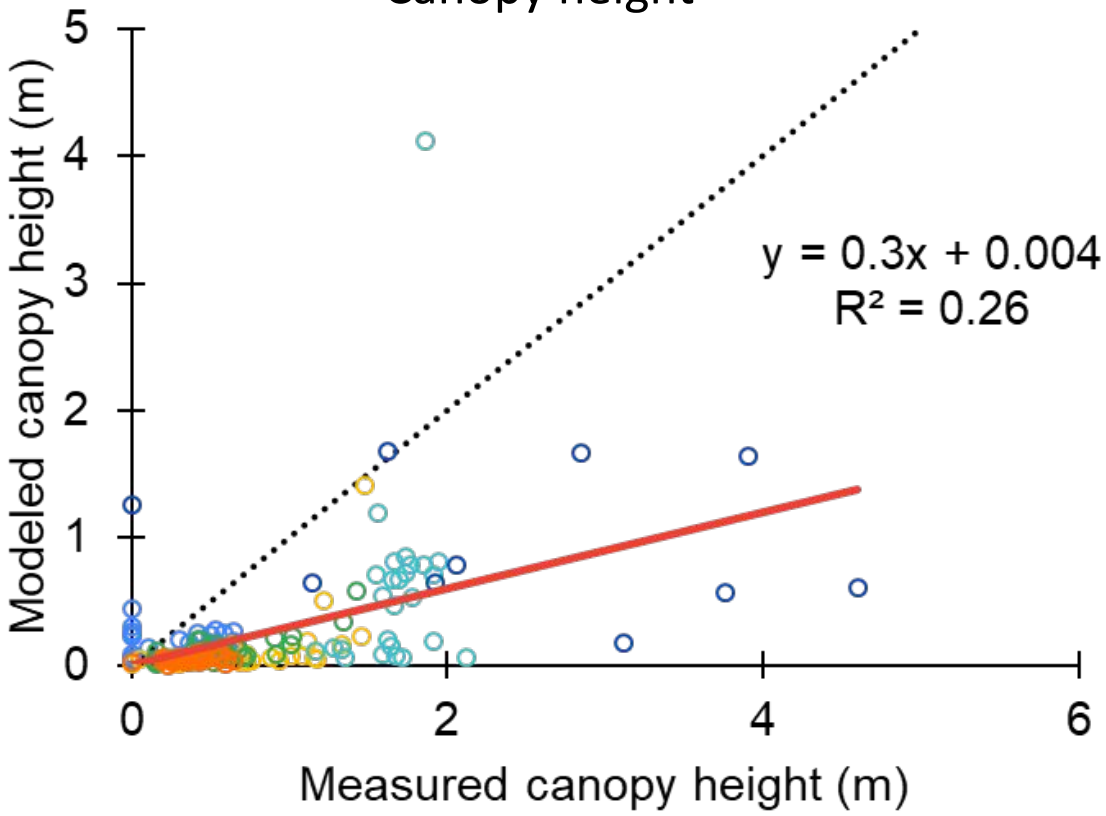
Results: elevation and canopy height

- Digital terrain models (bare earth) generally overestimated elevation
- Modeled canopy height (DSM-DTM) generally underestimated

Ground elevation

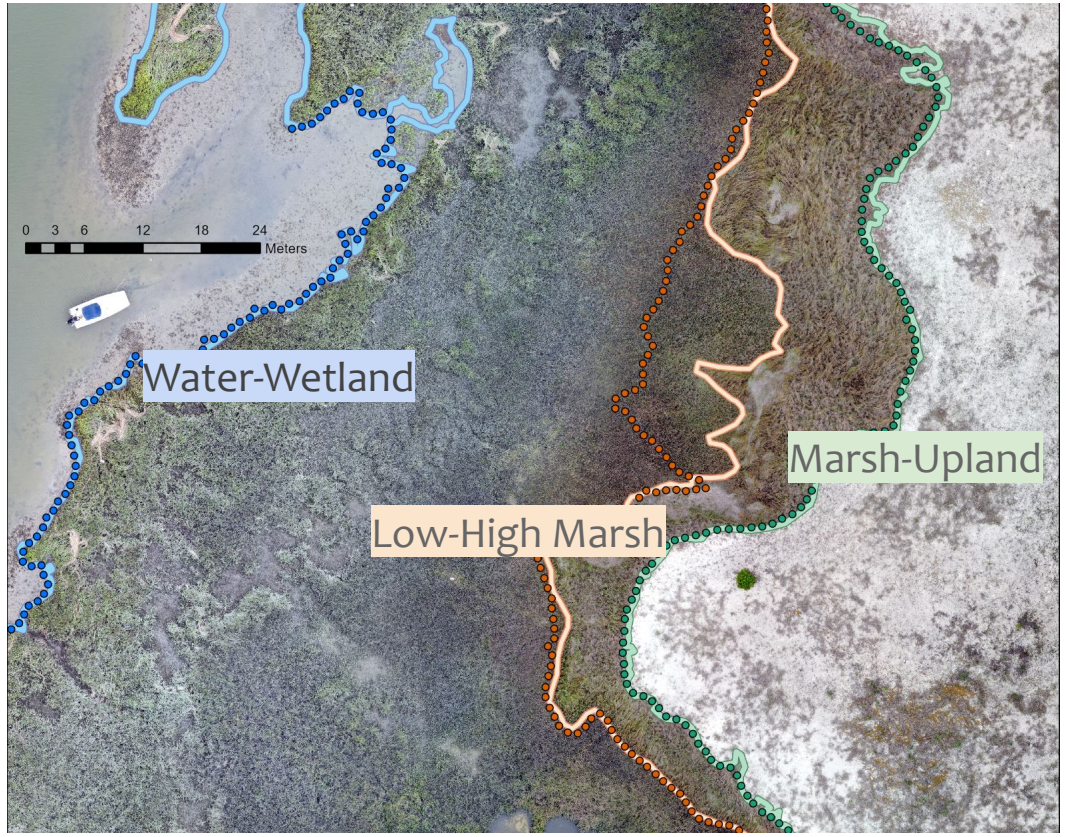


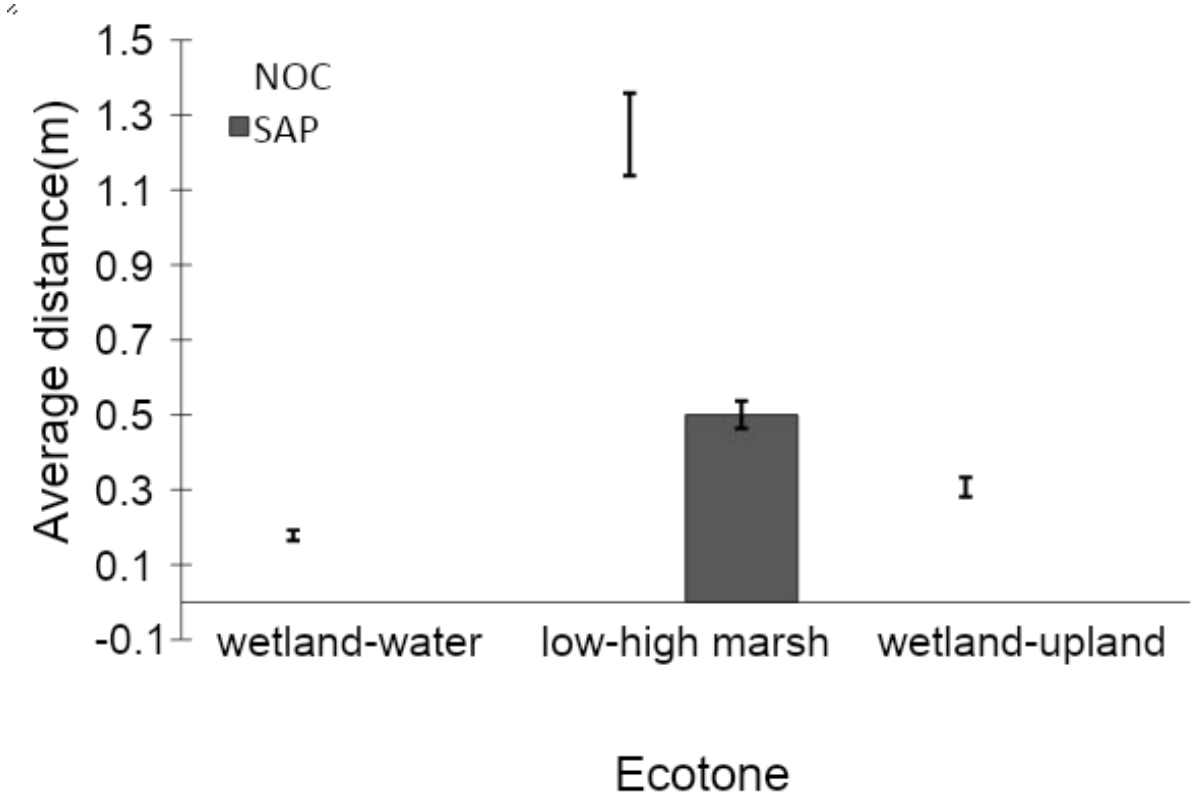
Canopy height



Results: ecotones

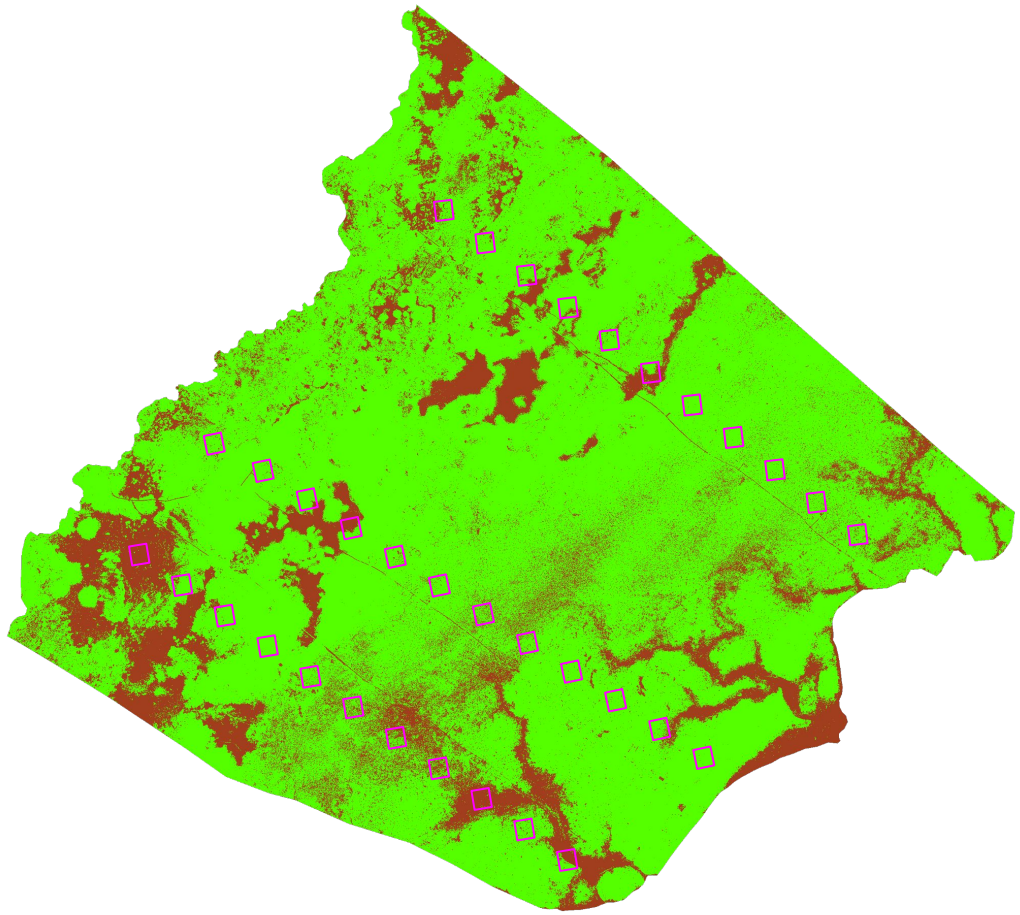
- Accuracy of ecotone delineation varied by ecotone

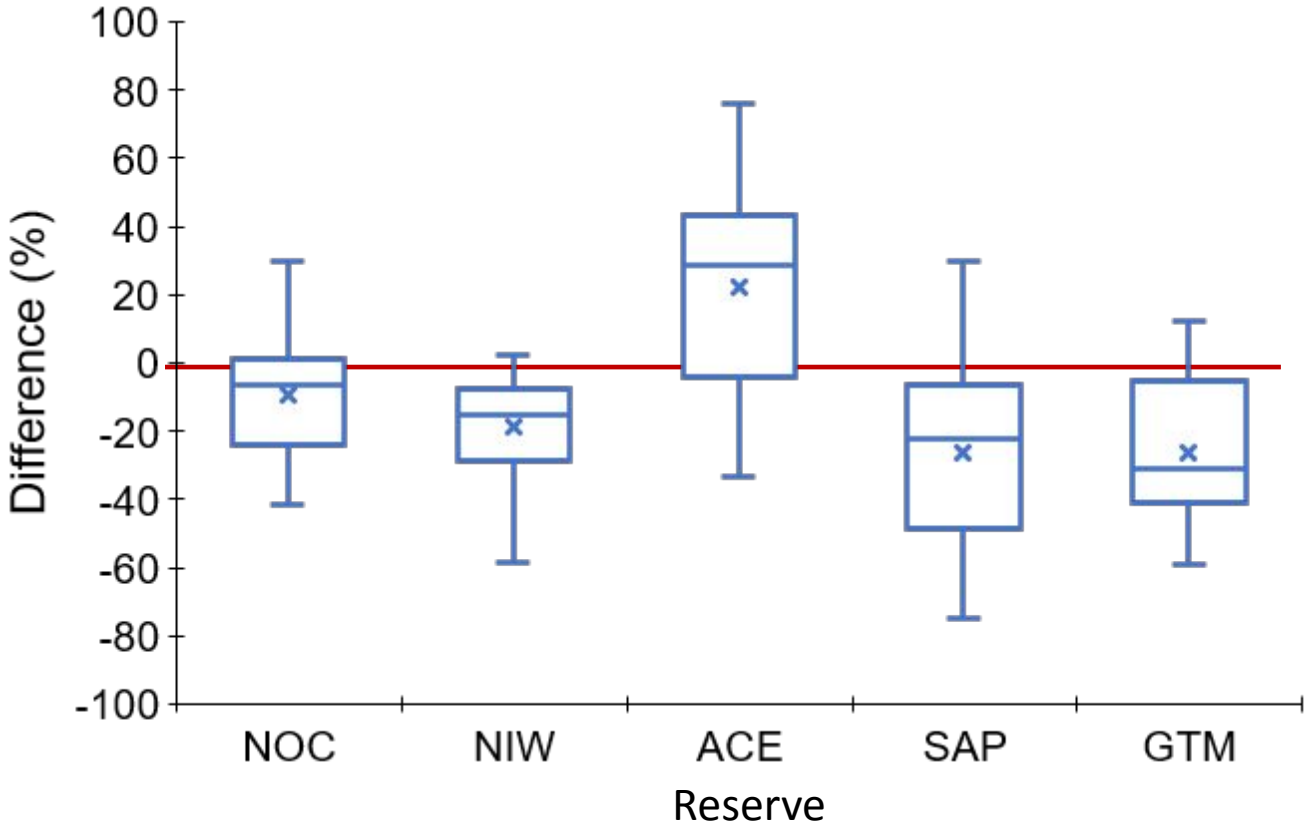




Results: total percent cover

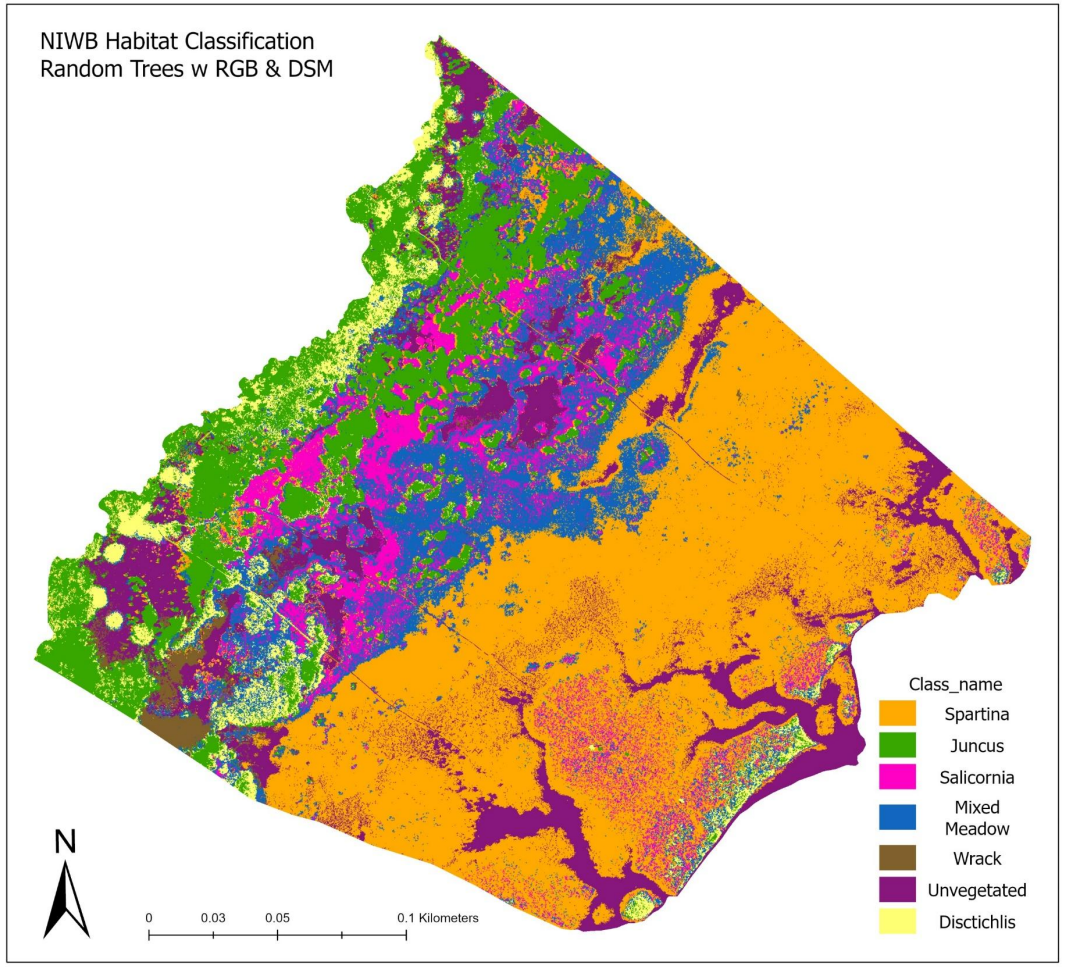
- Average overall classification accuracy ~85%
- Image-based estimates of vegetation cover generally overestimated

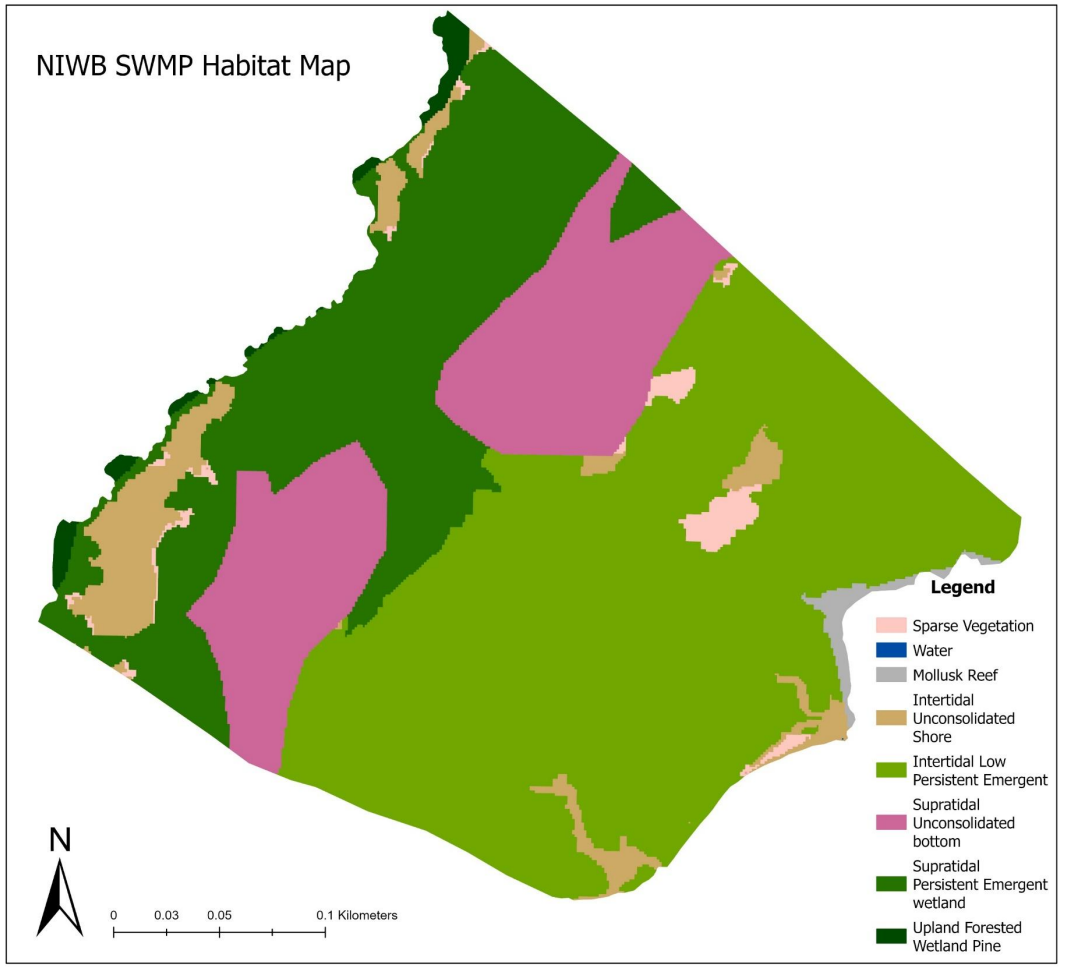




Results: species-specific percent cover

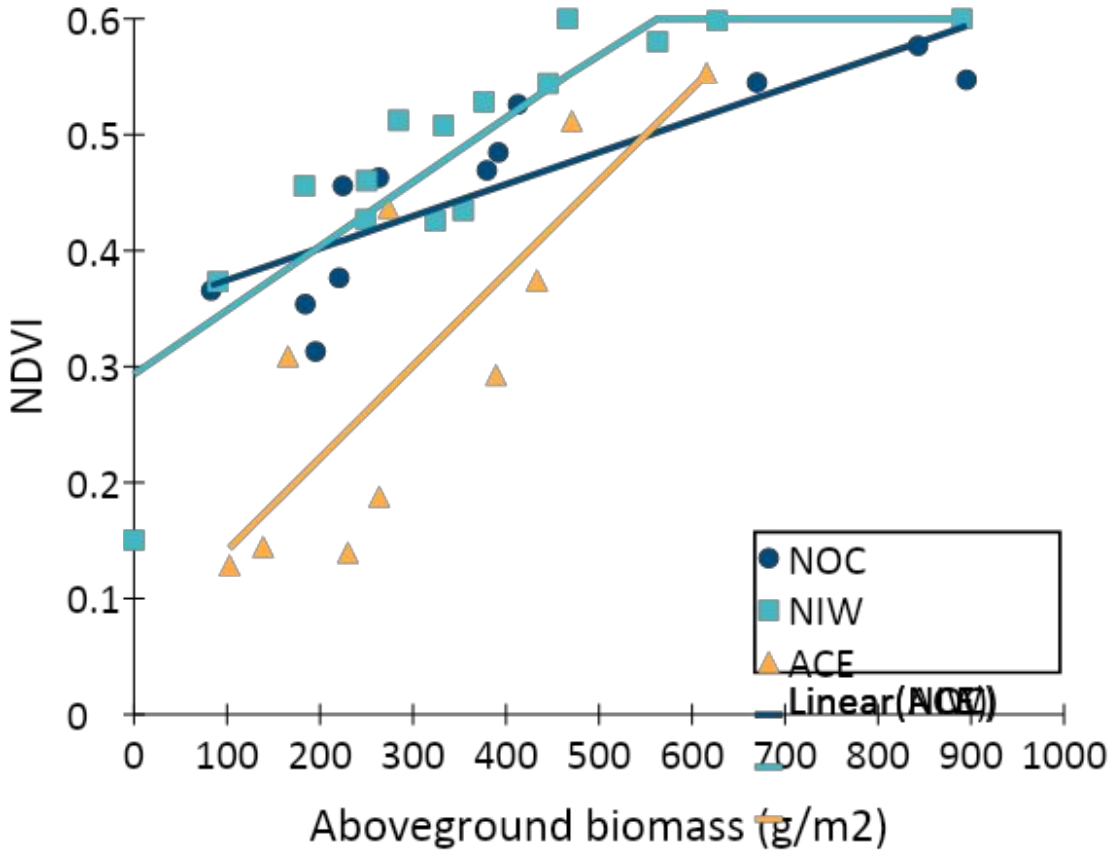
- Average overall classification accuracy ~74%
- Low accuracy of image-based estimates of species-specific percent cover

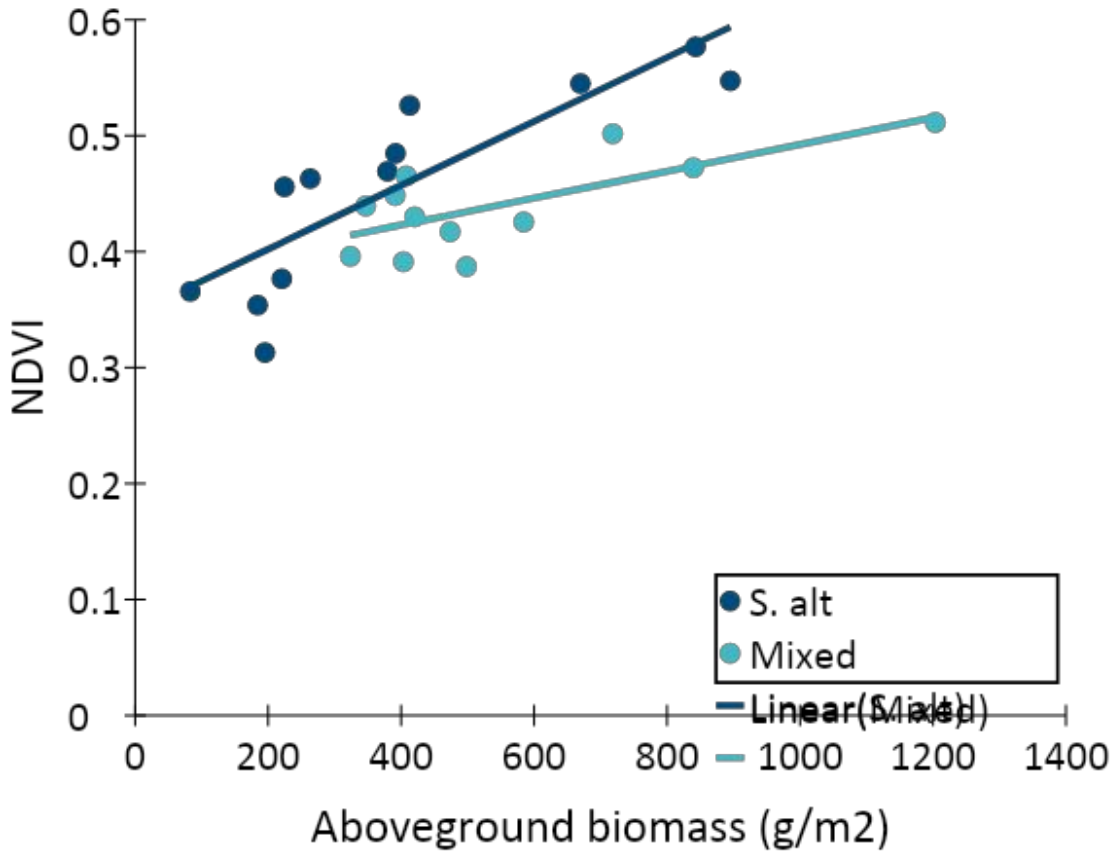




Results: aboveground biomass

- NDVI strongly correlated with *S. alterniflora* aboveground biomass
- Correlation weaker in mixed species assemblages



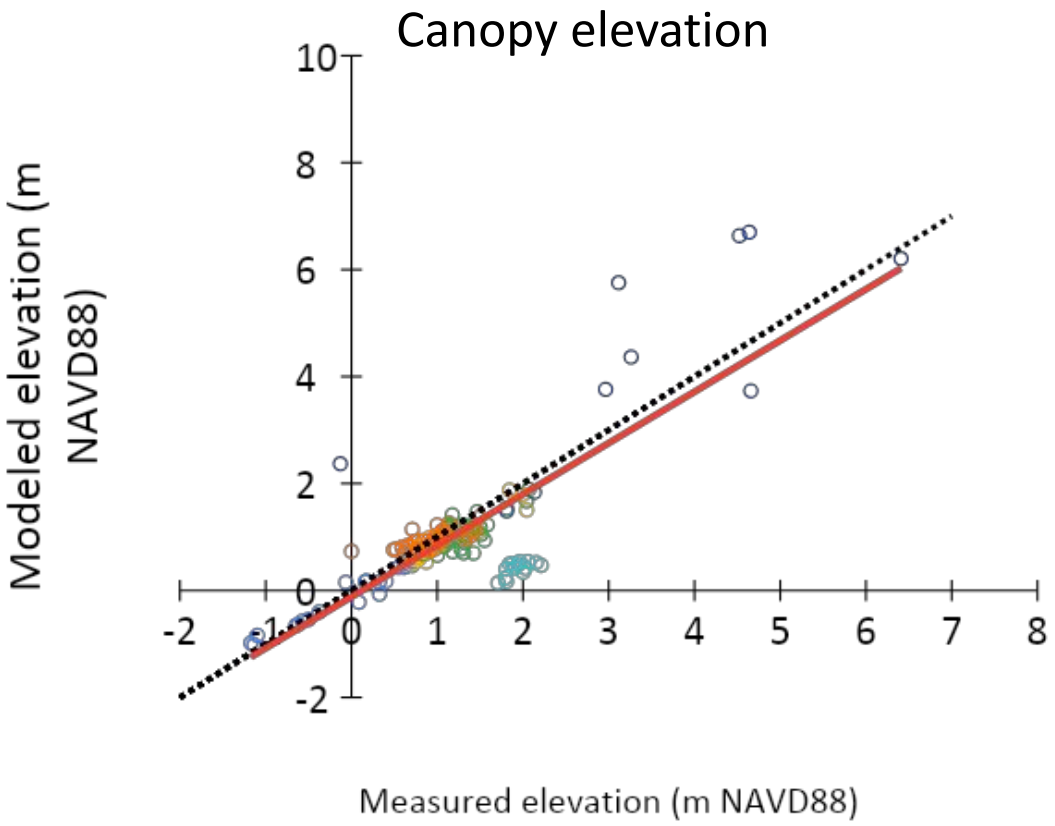


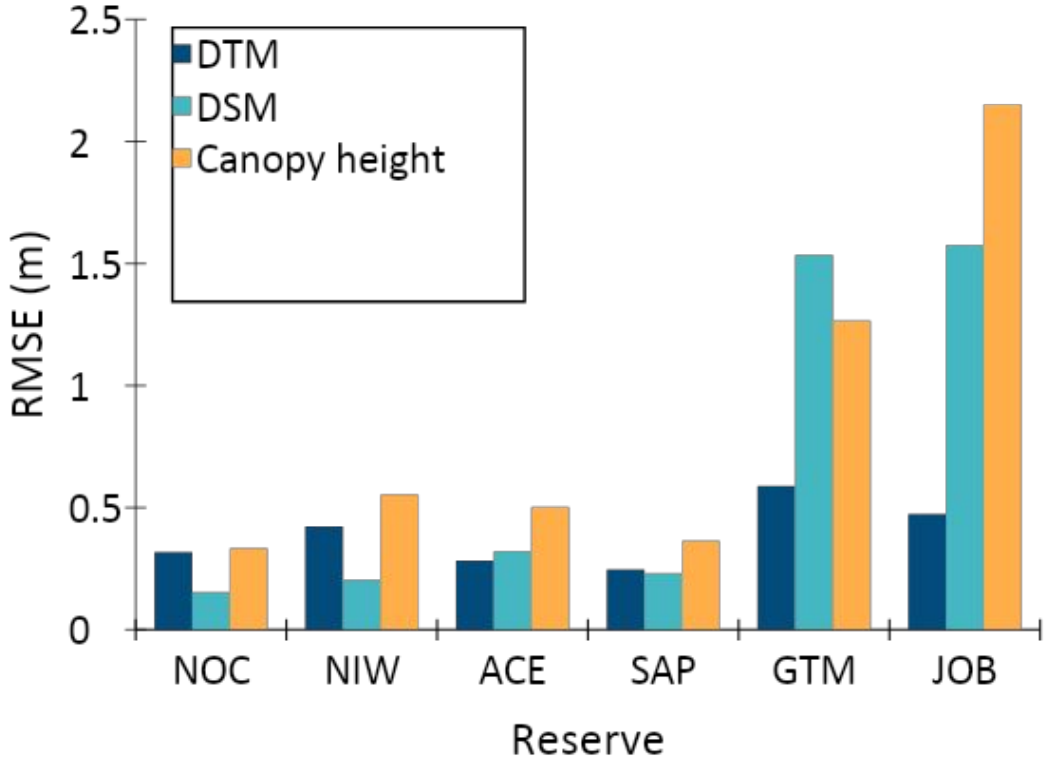
Summary & conclusions

Parameter	Low	Med	High
Elevation and Canopy Height			
Ecotones			
Habitat classification			
Percent cover			
Biomass			

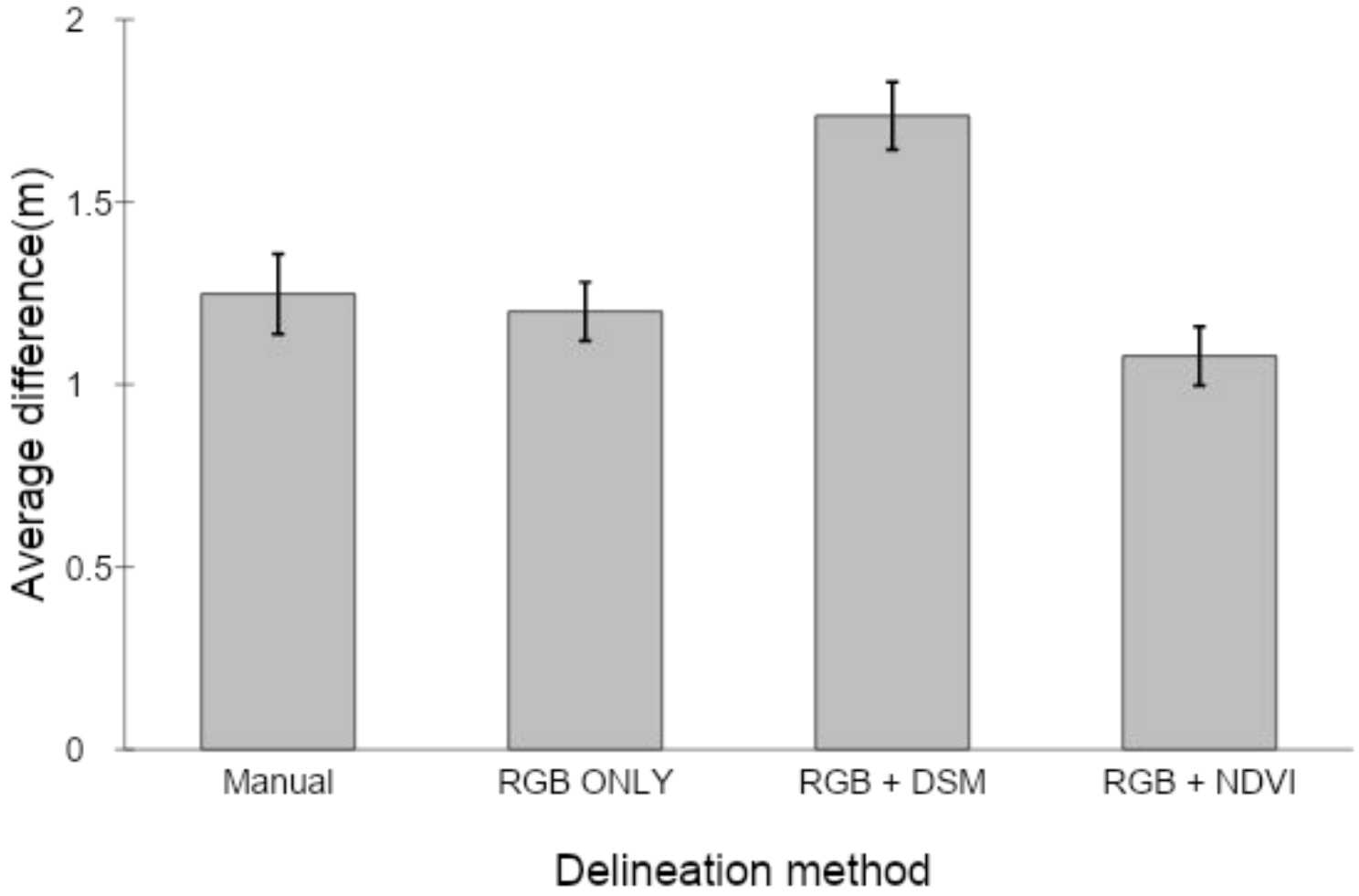
- Protocol for monitoring coastal wetlands with drones
  - Detailed workflows for image acquisition, processing and analysis

Elevation and canopy height

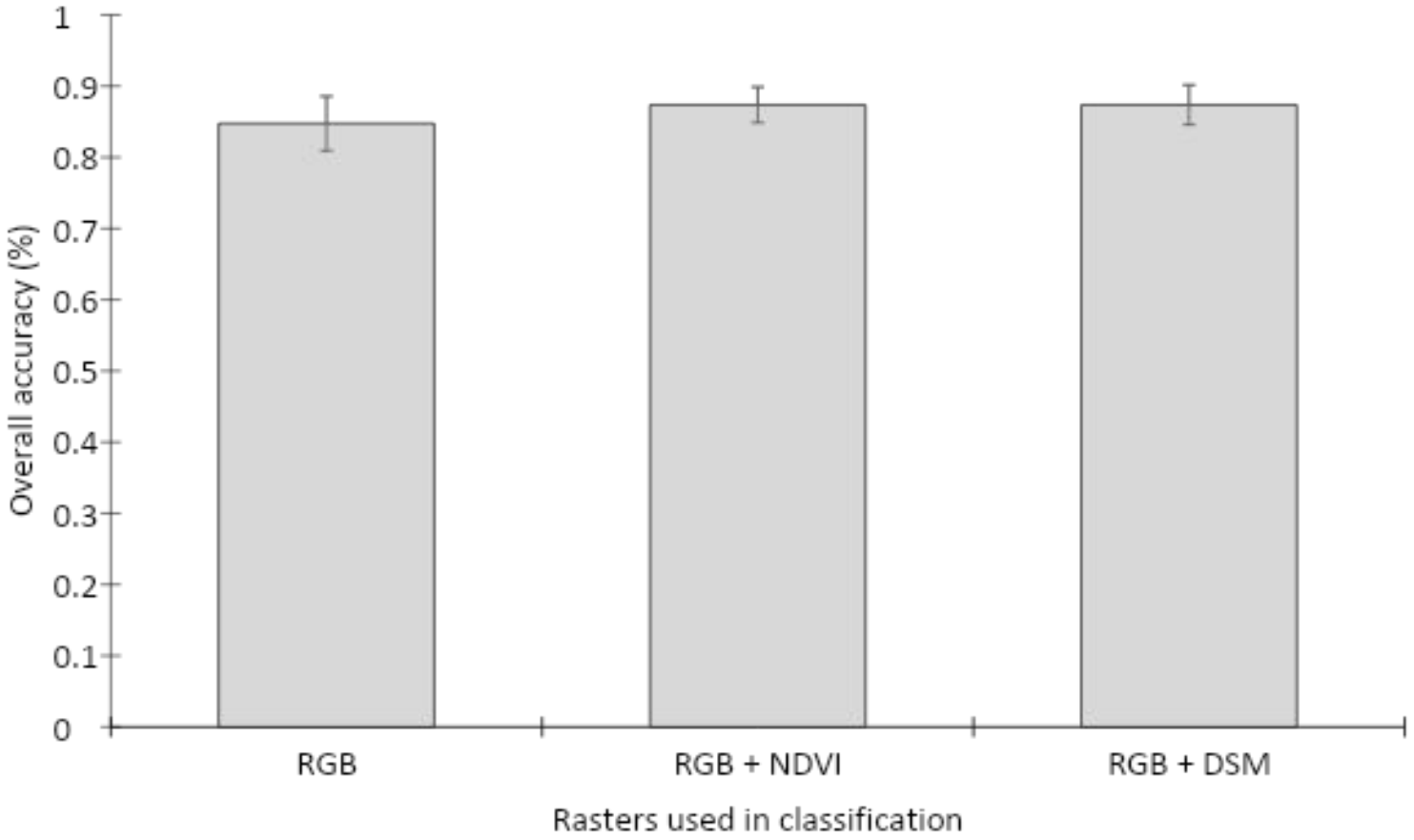




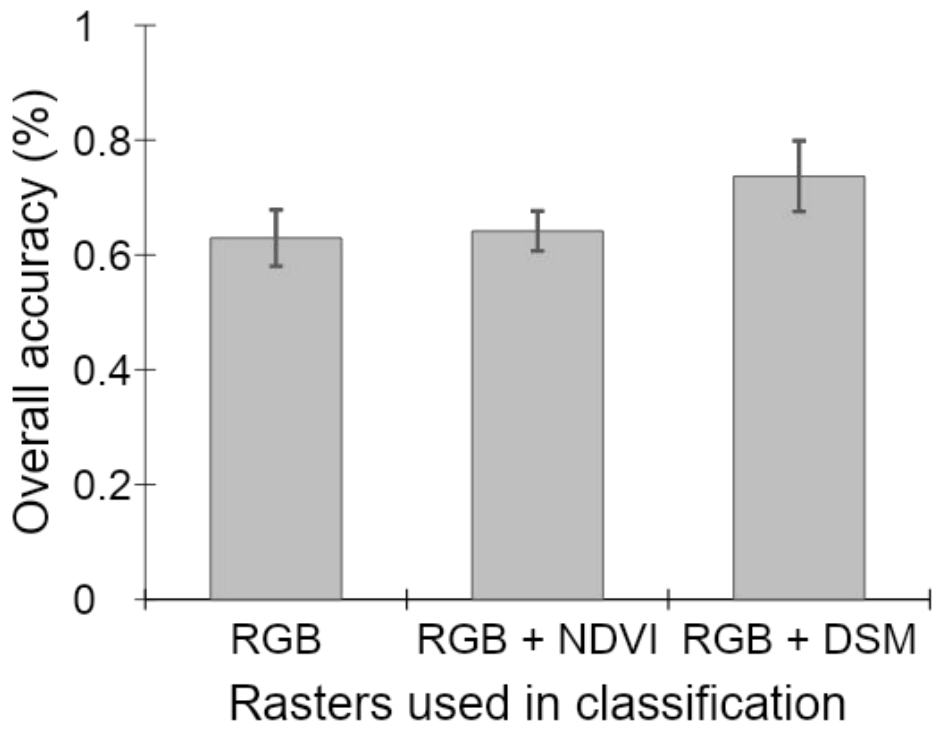
Ecotones

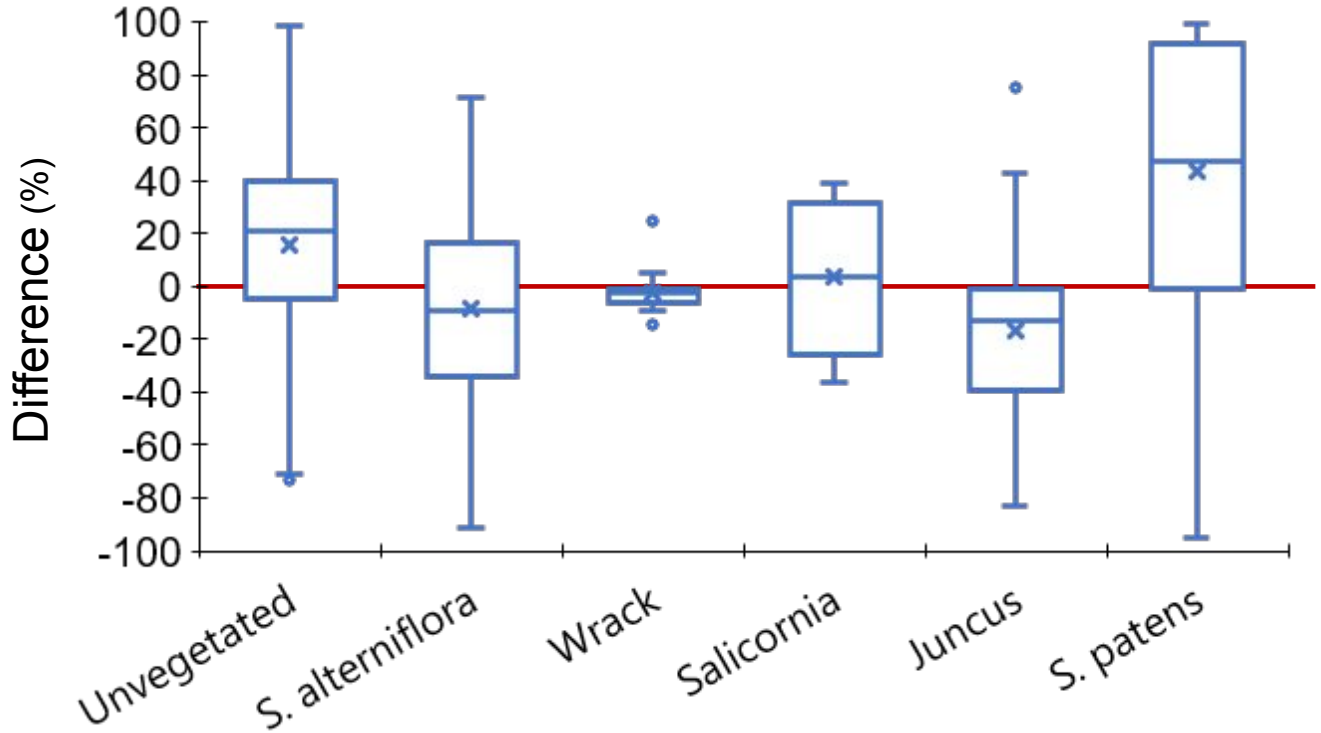

2
1.5
1
0.5
0
Average difference(m)
Manual
RGB ONLY
RGB + DSM
RGB + NDVI
Delineation method

Total percent cover

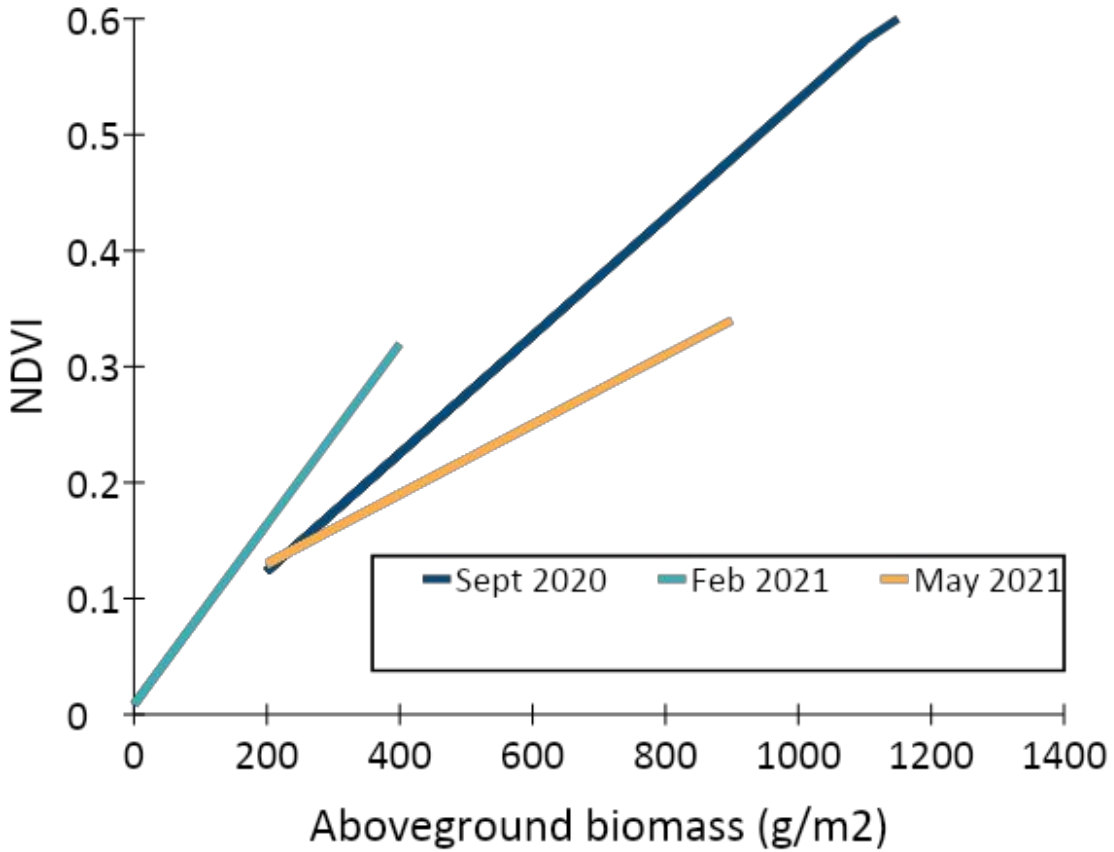


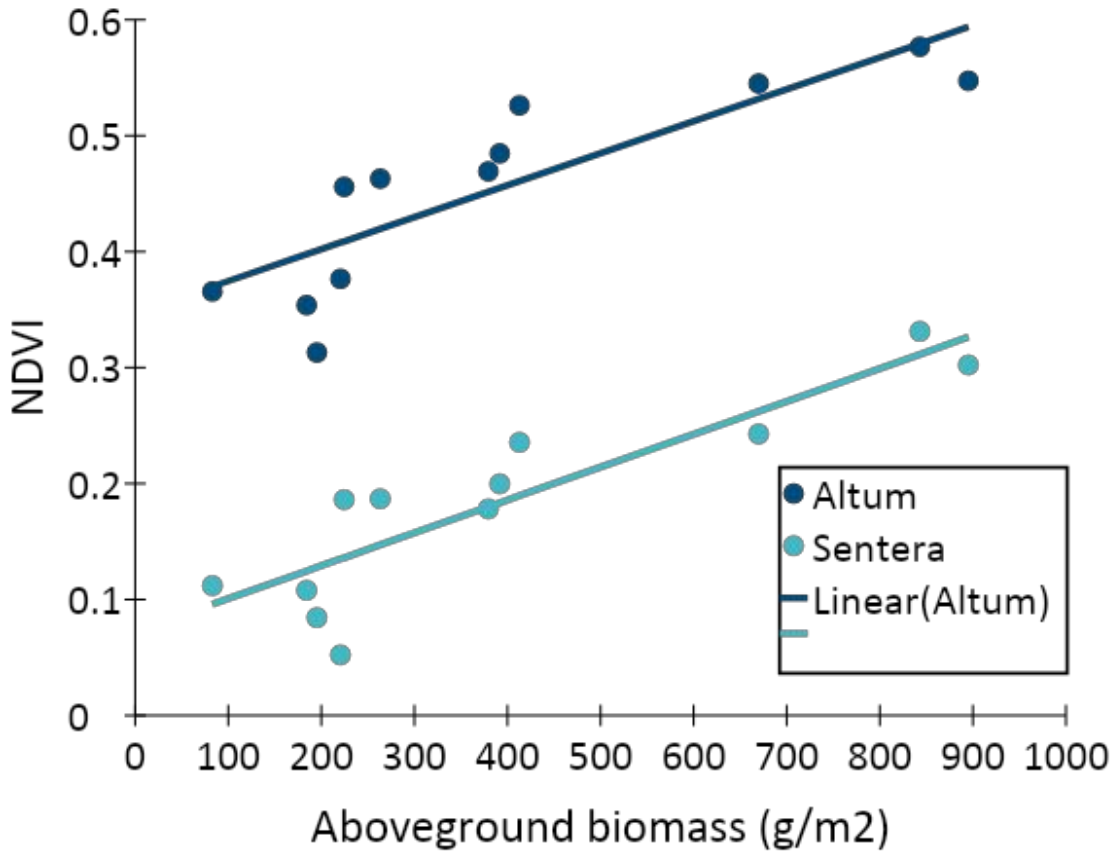
Species-specific percent cover





Results: above-ground biomass





Q&A

Q: Did you consider using other manufacturer's sensors, especially those that account for LED degradation?

- **A**: No, our project was specifically interested in testing the YSI sensors at multiple reserve sites, but that would be a good next step for future work.

Q: Have you needed to develop site-specific relationships between grabs and sondes?

- **Erik** - Yes, we showed there was a site interaction in the overall model, and so the relationship varied across site including the degree to which interfering substances impacted the model.
- **Nikki** - each of us only looked at individual sites, each of us will now need to go to our other sites and do the same thing.

Q: Based on your experience, could we establish a list of lakes/reservoirs that are suitable (i.e., lower TSS, CDOM) for such monitoring with in situ chlorophyll-a sensors?

- **A**: We talked about that a little bit. We did end up recommending a threshold of about 2 micrograms per liter. If you have really low chlorophyll, we think there's probably too much noise-to-signal ratio to predict extracted chlorophyll.

Q: How does the cost of adding a fluorescence sensor package compare to increased grab sampling, say going from 1/month to 4/month?

- **A**: It depends on whether you do your chlorophyll analysis in-house or pay a lab to do it. Ultimately, there's no way you're going to get anywhere close to the frequency you get with these sensors if you're collecting by hand; not to mention having access blocked by storms or other events.

Q: Can you explain more about what "light history" is and why it might be an interference in this study?

- **A**: Phytoplankton cells can reduce chlorophyll if there is a lot of light, and vice versa, to adapt to their conditions. We don't think it was a significant source of interference in our project as we had everything acclimated to dark tanks when we did our lab based comparisons.

Q: For the consideration of measurements, was consideration of the turbidity categorized (i.e. differentiating between soil particles, algae, microbes, etc.)?

- **A**: That digs a bit deeper than we could do in this first cross-system assessment. Our goal is really to use a standard, albeit natural, source of turbidity to get a first cut and see how it varied across systems.

Q&A

Q: What was the study design for the ground control points? What was the approximate #/acre and placement in the study area?

- **A**: A minimum of 3 GCP's are required in an image set for photogrammetry software to include them in image processing. A minimum of 5 GCP's is recommended in order to see a significant increase in the absolute accuracy of the project. Having at least 5 GCP's minimizes the measurement inaccuracies and helps to detect mistakes that may occur when inserting the points. For our project we aimed for 1 GCP per hectare (~2.5/ac), but 2 per hectare (5/ac) is preferable. Beyond that, there does not seem to be much increase in accuracy of image-derived models. Of course additional CGPs can serve as checkpoints, which can be quite useful at further assessing the accuracy of image-derived models. Distribution of GCPs should be uniform, not linear or clumped distribution. Best results are typically obtained when adhering to a quincunx pattern (i.e., how dots are arranged on the 5-side of a die) for GCP distribution to capture corners and center of the landscape. We had one site use 3 GCPs in a linear pattern, and the resulting models were of poor quality.

Q: Did you say what classification type was used for cover? Also, for the plots, did you look at variability of percent cover estimates between staff?

- **A:** We used supervised object- based image analysis using the Classification Wizard in the ArcGIS Pro Image Analyst extension that involved stretching and segmenting the RGB orthomosaic, developing training samples, and then classifying. We attempted three supervised classifiers: Random trees, support vector machine, and maximum likelihood. Details included in the protocol document starting on page 37.
- We did not look at variability of percent cover among staff in the field. Generally speaking, if there are two staff working a quadrat, its a come to consensus process. There is certainly subjectivity in visual estimates of percent cover and I wonder how consistent estimates are between staff and over time by the same staff. I would argue that, while percent cover generated from imagery may not be an accurate depiction of what is measured in the field, it probably is more consistent and reproducible over time than field-based measures.

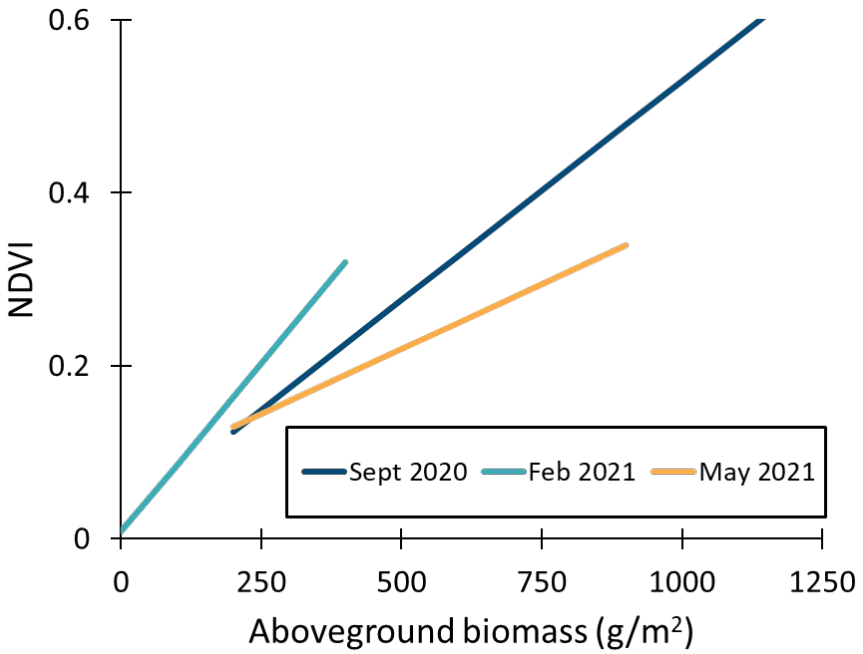
Q: Do you look at tidal channel bathymetry with the drones at all? If so, do you implement any soft of water refraction correction?

- **A:** We did not as part of this project.

Q&A

Q: How did the site-specific relationships between NDVI and aboveground biomass change across the growing season?

- **A**: The North-Inlet Winyah Bay site has developed a single seasonal calibration curve with strong predictive power. At the North Carolina site, the slopes and intercepts of the relationship varied between Feb (lowest biomass), May (intermediate biomass) and September (peak biomass). See figure:



Q: How did you differentiate the 'ecotones' using the imagery? I have found that spartina can map as saltgrass in certain locations

- **A:** We used a couple of approaches–one was via manual (i.e., 'heads up digitization). For some ecotones that is doable simply with RGB orthomosaics. For others, where species are hard to distinguish, it's useful to be able to toggle on/off RGB orthomosaics, 3D digital surface models, and normalized difference vegetation index (NDVI) rasters to identify the transitions. Site knowledge is certainly important. We also attempted to automate delineation of ecotones using species-specific habitat classification maps and this resulted in modest improvement in accuracy relative to manual delineation. Of course accuracy of the automated delineation is dependent on the accuracy of the habitat classification map.

Q: Did the team experience any difficulties with Drone2Map in terms of coordinate systems?

- **A**: Yes, the coordinate system available, particularly vertical coordinate systems, are quite limiting in drone2map. We included a detailed way to resolve vertical coordinate systems in the protocol document, starting on page 54.

Q: What level of system precision and accuracy would you say is acceptable when using drone based lidar for bare earth elevation models?

- **A:** Largely depends on the application. I would say accuracies of 5cm or better would be needed for most applications.

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Q&A

Q: Do you have many problems with birds in the area?

- **A:** We did not have any interactions with birds, although we generally keep an eye out for raptors (e.g., osprey) and are sensitive to not disturb nesting birds where possible. There can be difficulties obtaining permits at sites where birds, particularly nesting birds, are prevalent.

Q: Can the panel comment on the ability of drones to identify and monitor internal marsh breakup within a wetland complex (e.g. increased standing water on marsh surface)?

- **A:** We purposefully targeted image acquisition around low tide when the marsh platform had drained (except for ponds). I do think you can use the techniques we applied (habitat classification, ecotone delineation) to look at expansion of ponds and pannes, and perhaps increased fragmentation of vegetation via change maps over subsequent flights.

Q: Do you carry out Image classification or any other image processing on the acquired images/products

- **A**: We used supervised object- based image analysis using the Classification Wizard in the ArcGIS Pro Image Analyst extension that involved stretching and segmenting the RGB orthomosaic, developing training samples, and then classifying. We attempted three supervised classifiers: Random trees, support vector machine, and maximum likelihood. Details included in the protocol document starting on page 37.

Q: Are there any employment opportunities available?

- **A**: Funny you should ask, recruiting a research scientist to, among other things, continue some of the work we presented on. Job advertisement: https://jobs-css.icims.com/jobs/2303/coastal-ecologist/job.