Machine learning integration with remote sensing for reclamation planning and restoration monitoring at mining sites.

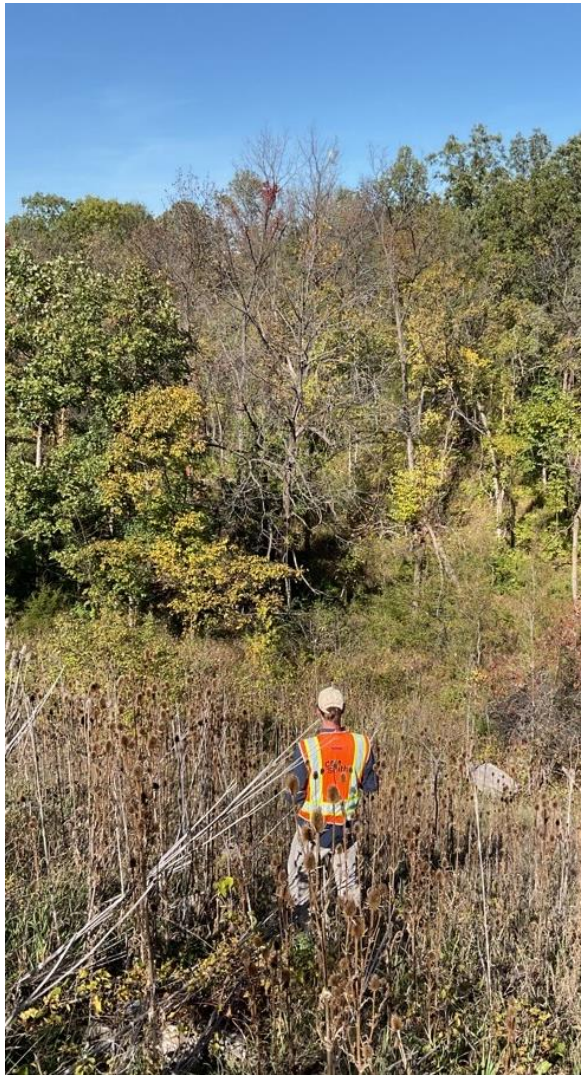
Andrew C. Reicks

June 9th, 2026

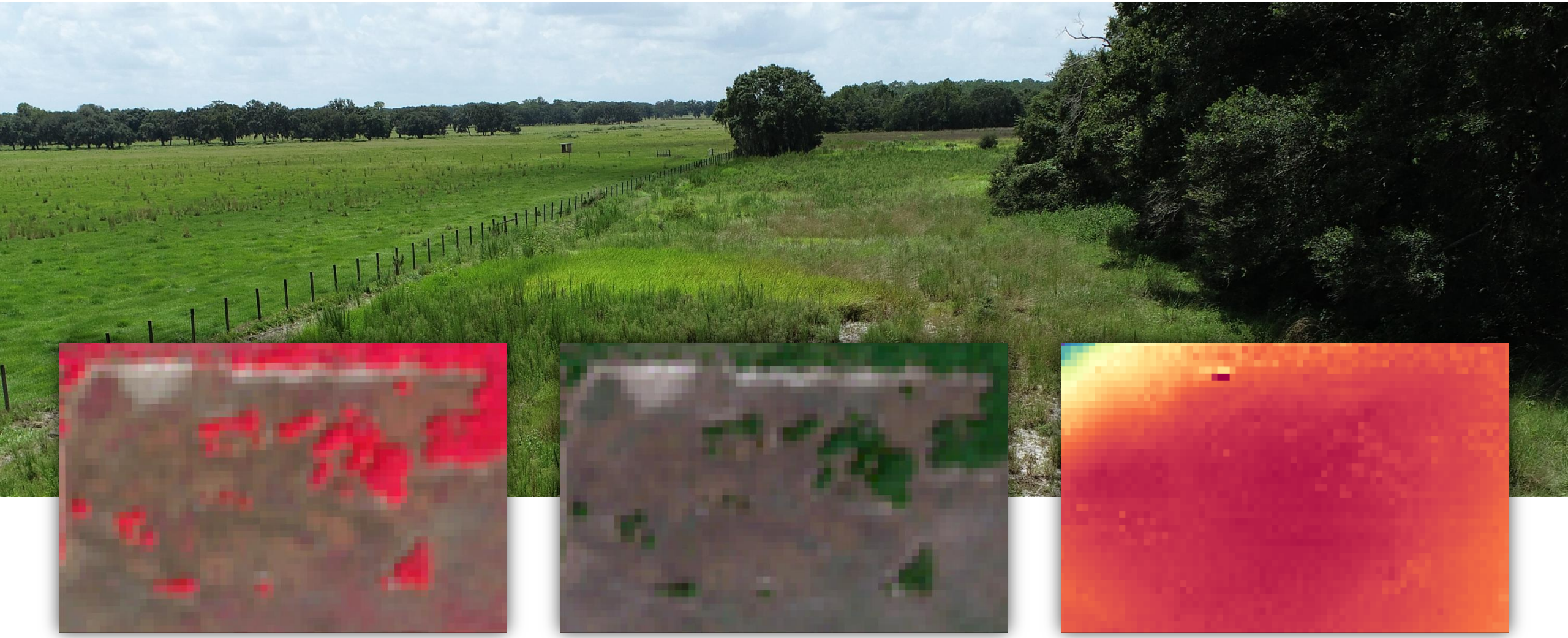
trinnex® a CDM Smith company

sky wave® at CDM Smith

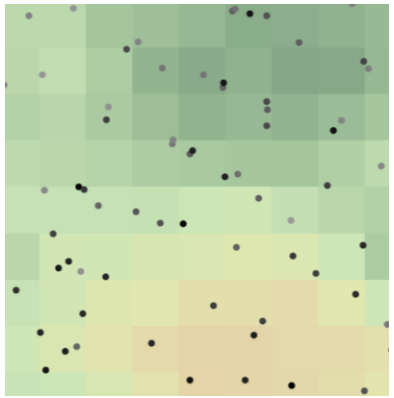
Field work is an invaluable but limiting factor.

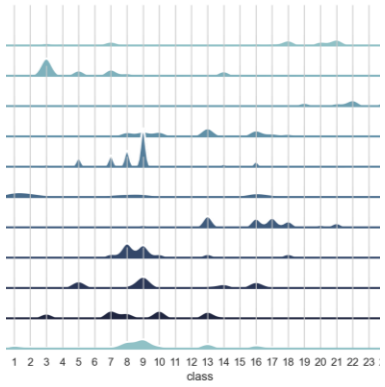


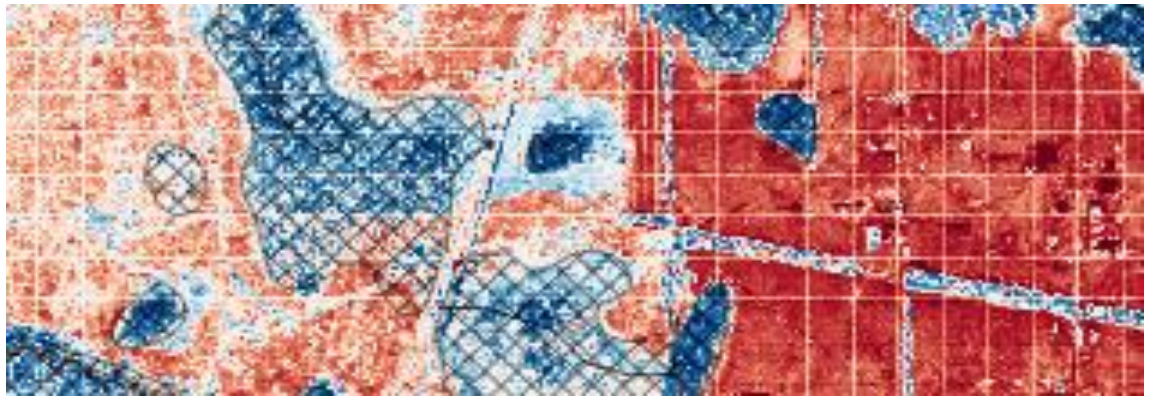
Satellite/plane data is widely available but low spatial or temporal resolution.

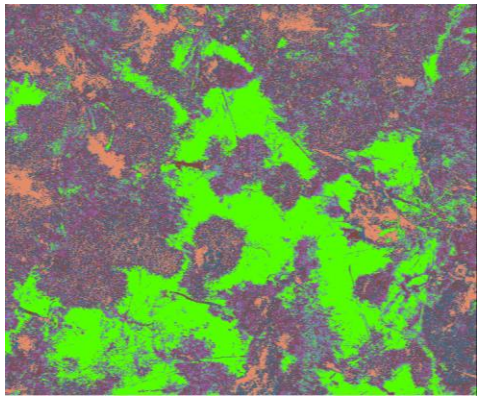


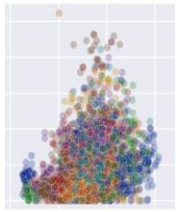
We are finally seeing the promise of machine learning being delivered but environmental applications are lagging.

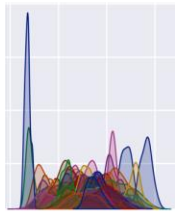


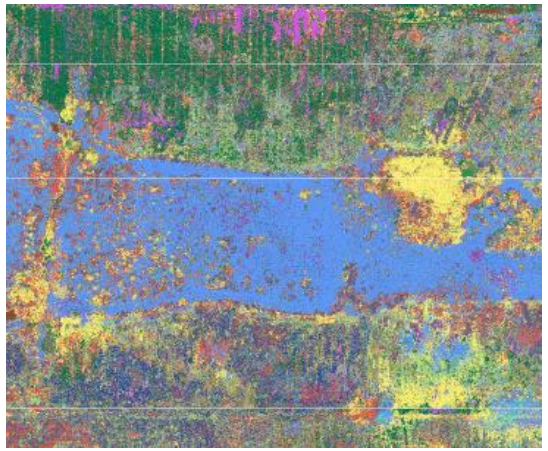


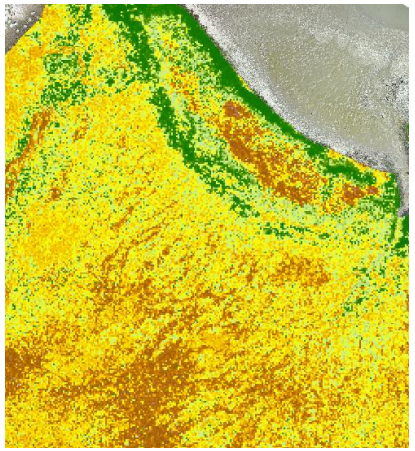


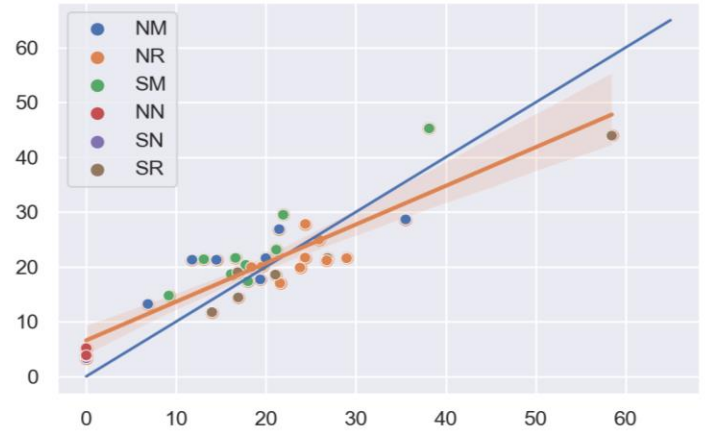


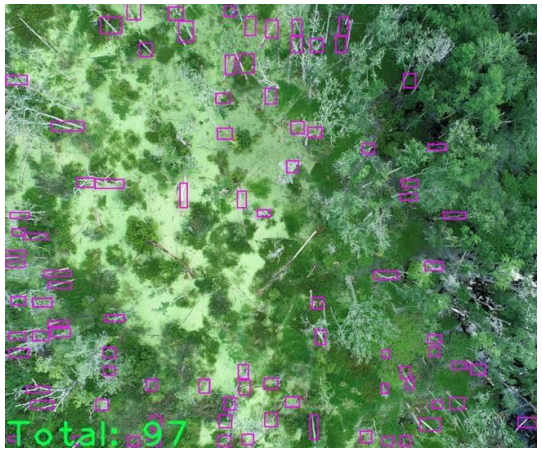






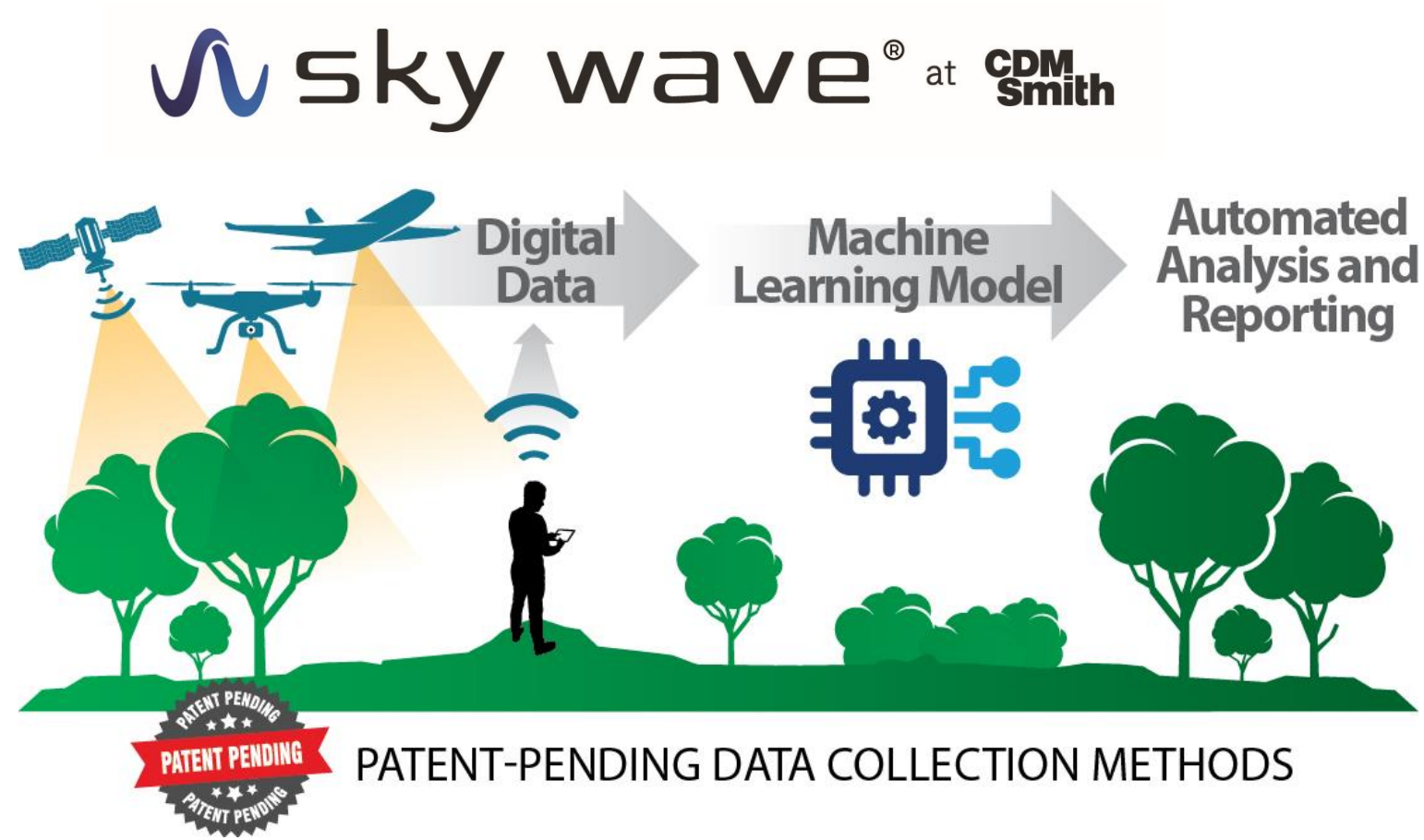






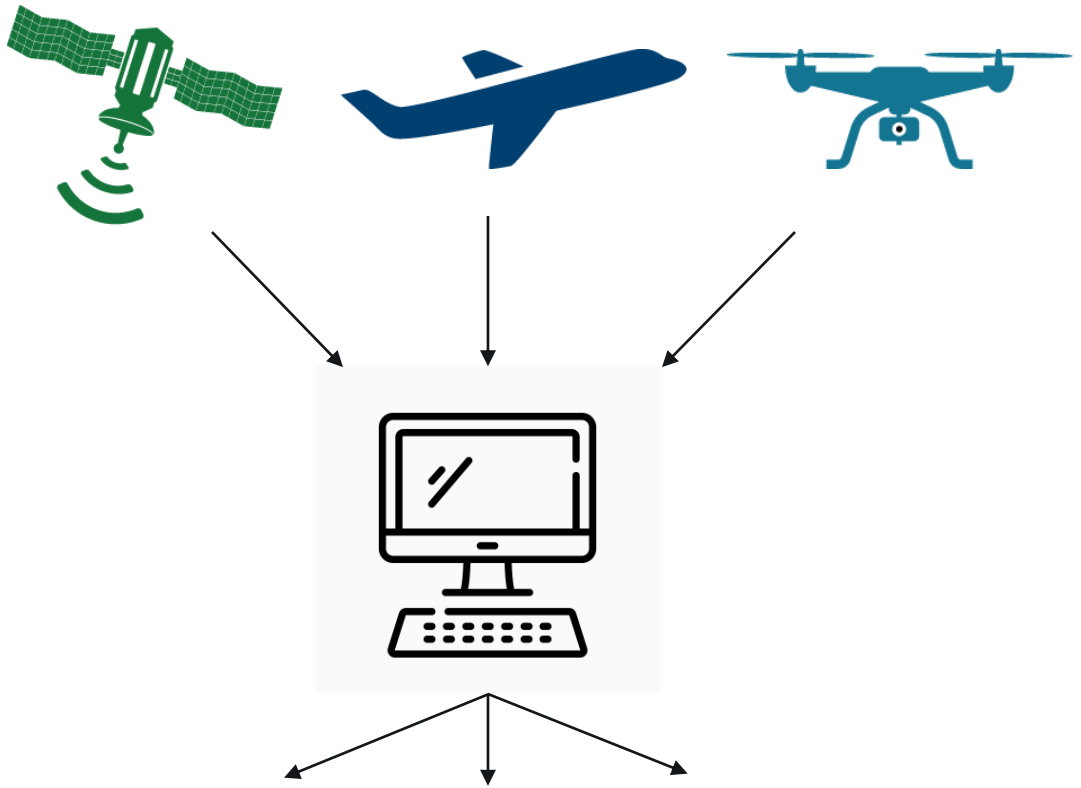
An expert-centered digital pipeline

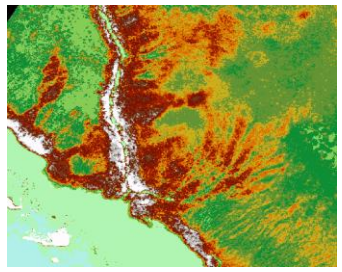
- Professional wetlands scientists
- Data scientists
- Remote sensing
- Surveyors
- Engineers
- Geologists
- FAA-certified drone pilots

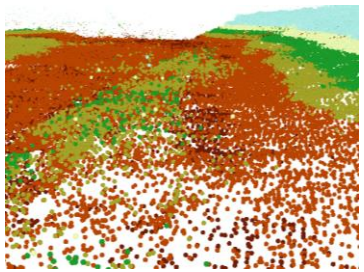


Remote Sensing

- Remote Sensing
  - Measuring something on the earth's surface using an instrument that isn't on the earth's surface
- Common collection methods
  - Satellite, plane, UAVs/drones
- Common sensors
  - RGB camera, multispectral, hyperspectral, SAR, LiDAR

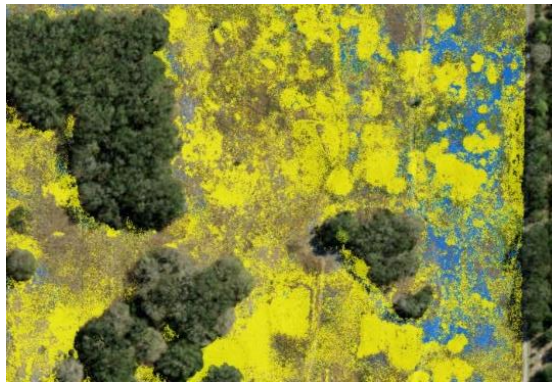




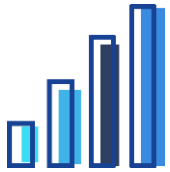


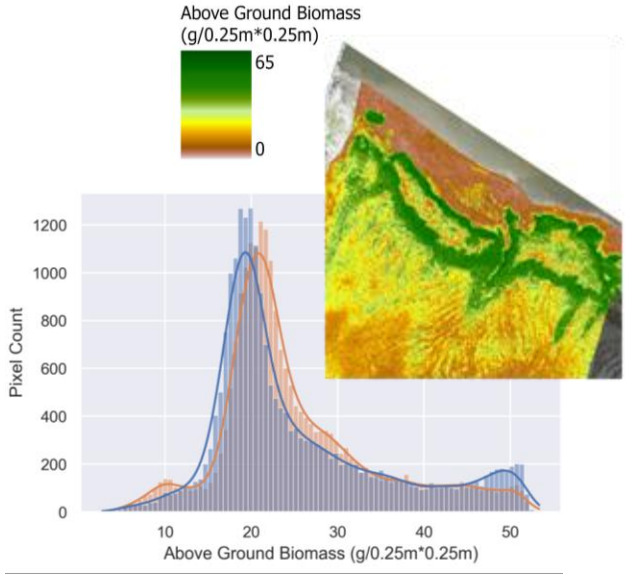
Case Studies

Classify/Locate

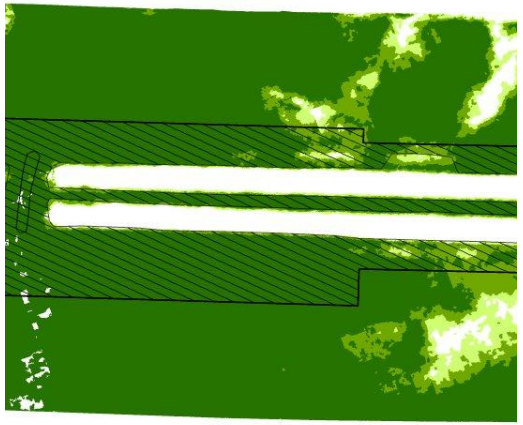


Quantify



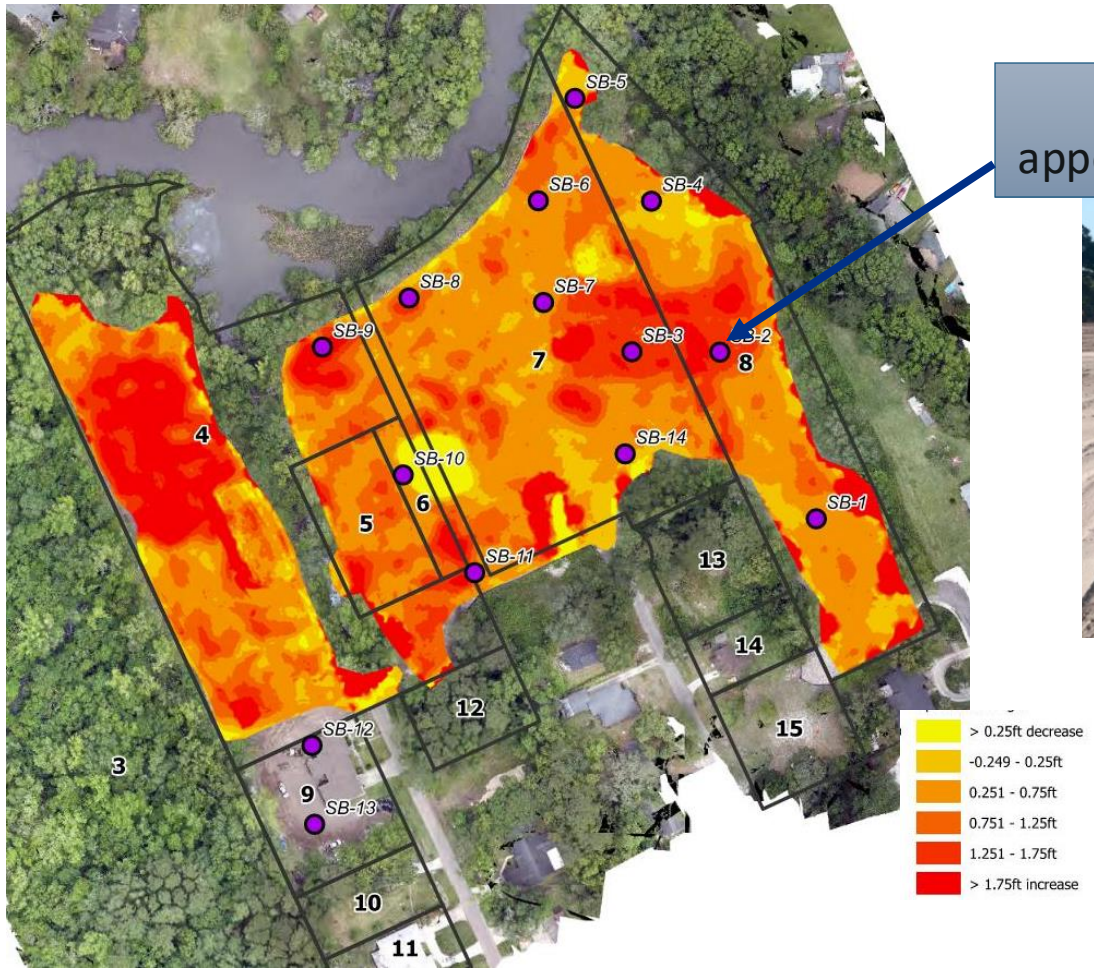


Segment



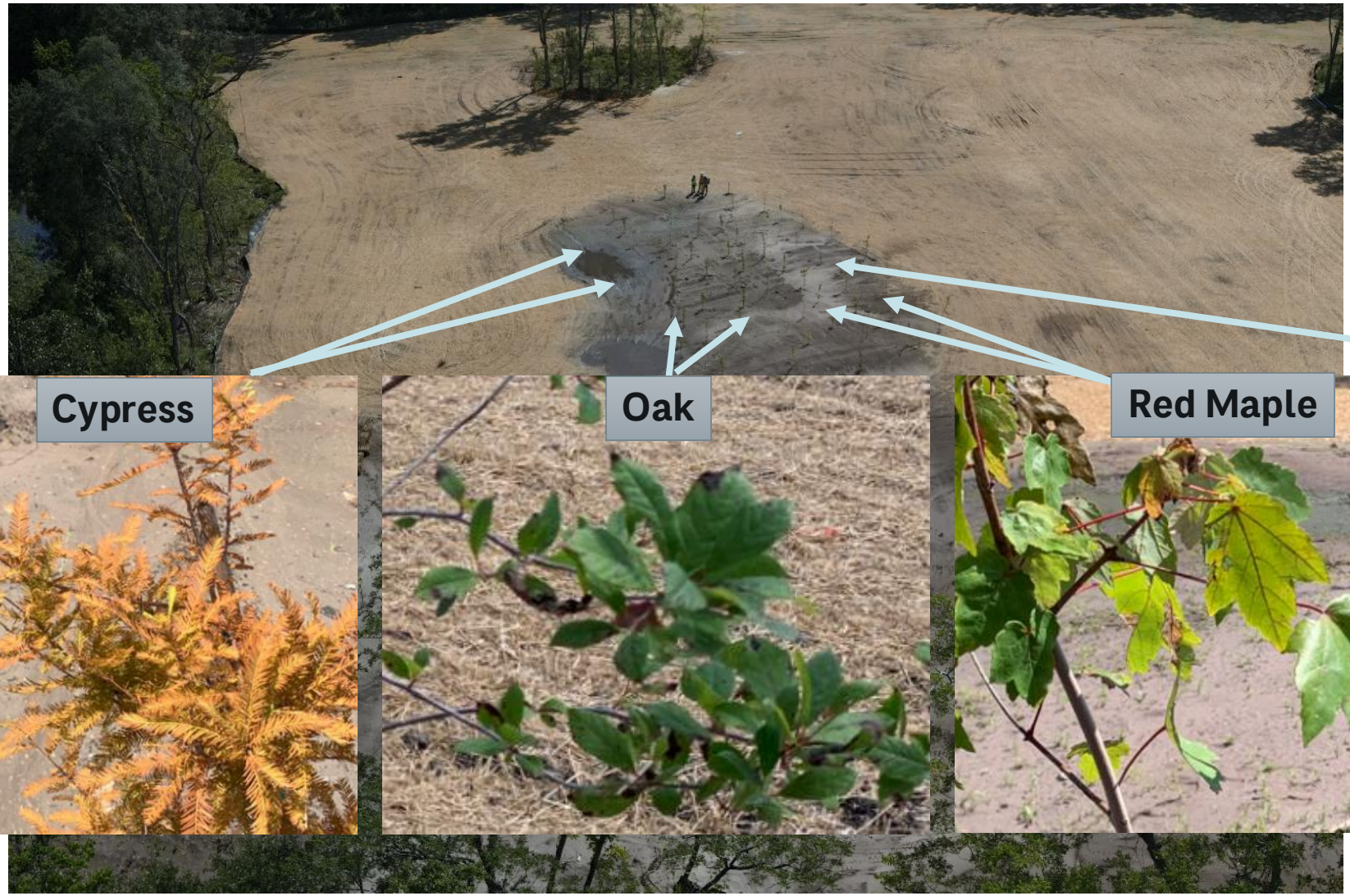
Vegetative Species Identification

Elevation data helps guide field efforts for verification sampling



Random samples apportioned by elevation change

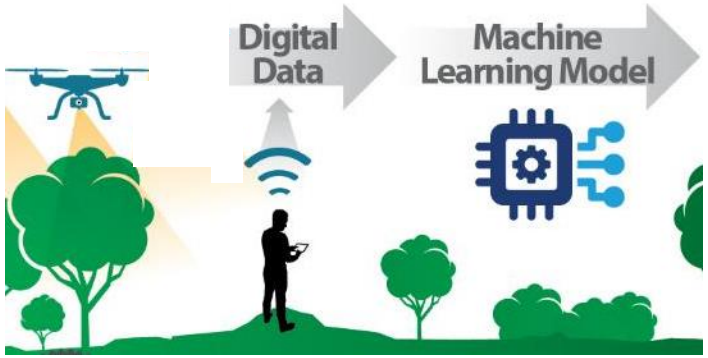
Wetland trees planted after capping to comply with state and federal permit requirements



Phase I	=	470 trees
Phase II	=	1,370 trees
Total	=	1,840 trees

Ground truthing data collection for model training

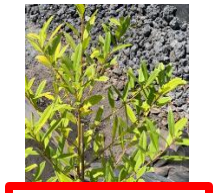
60 individual trees were ground truthed



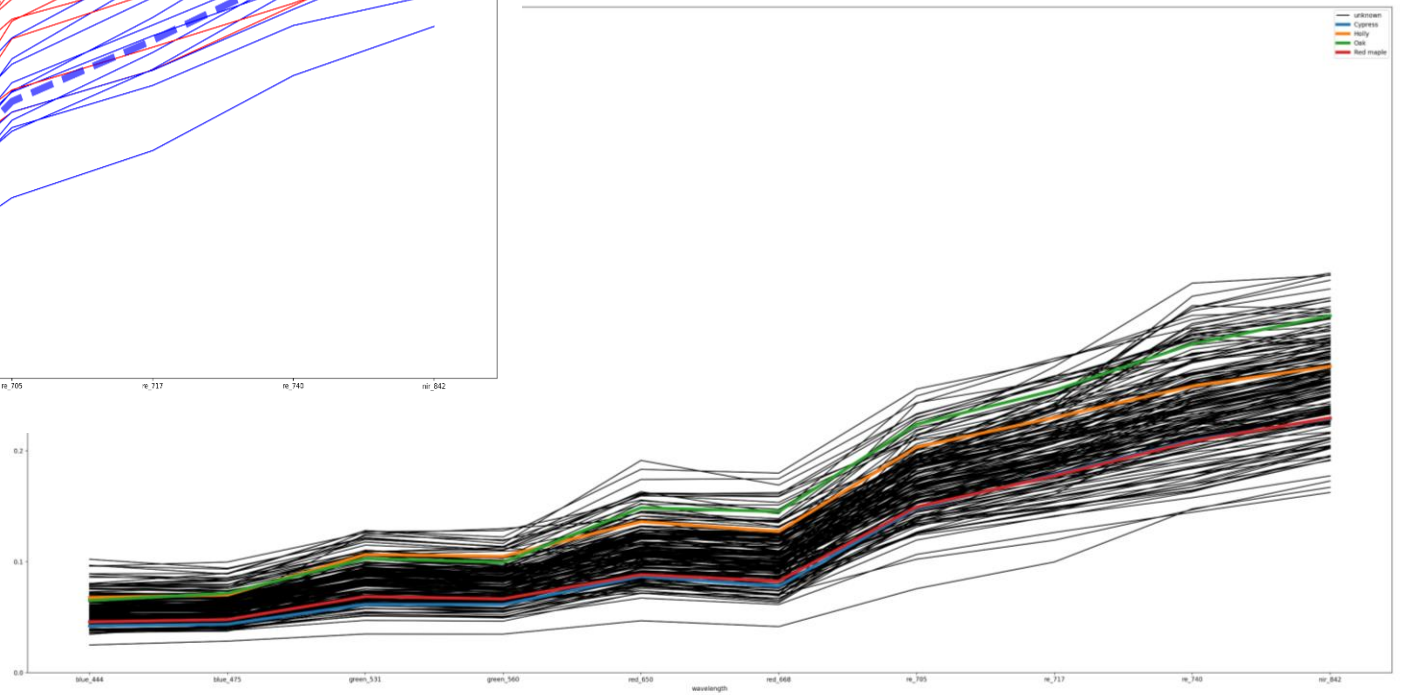
Spectral signatures of species

10-band Multispectral Drone Data

Red Maple



Holly

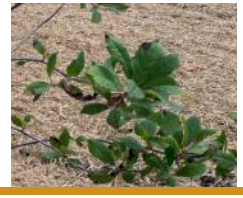


Machine learning model species predictions in the restoration area

Holly

Cypress

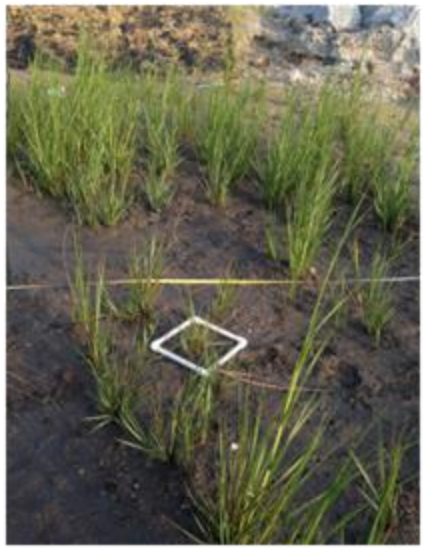
Red Maple

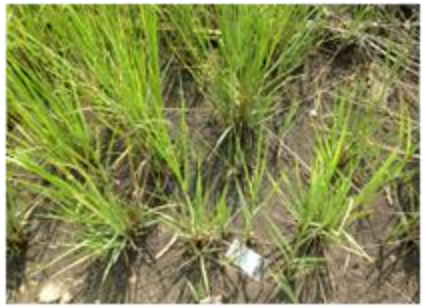


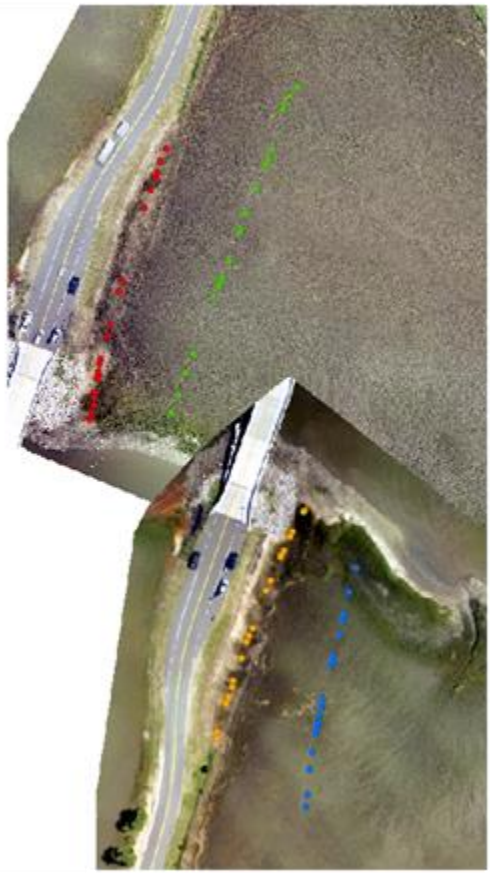
Oak

Biomass for Restoration

Established approach for tidal marsh biomass

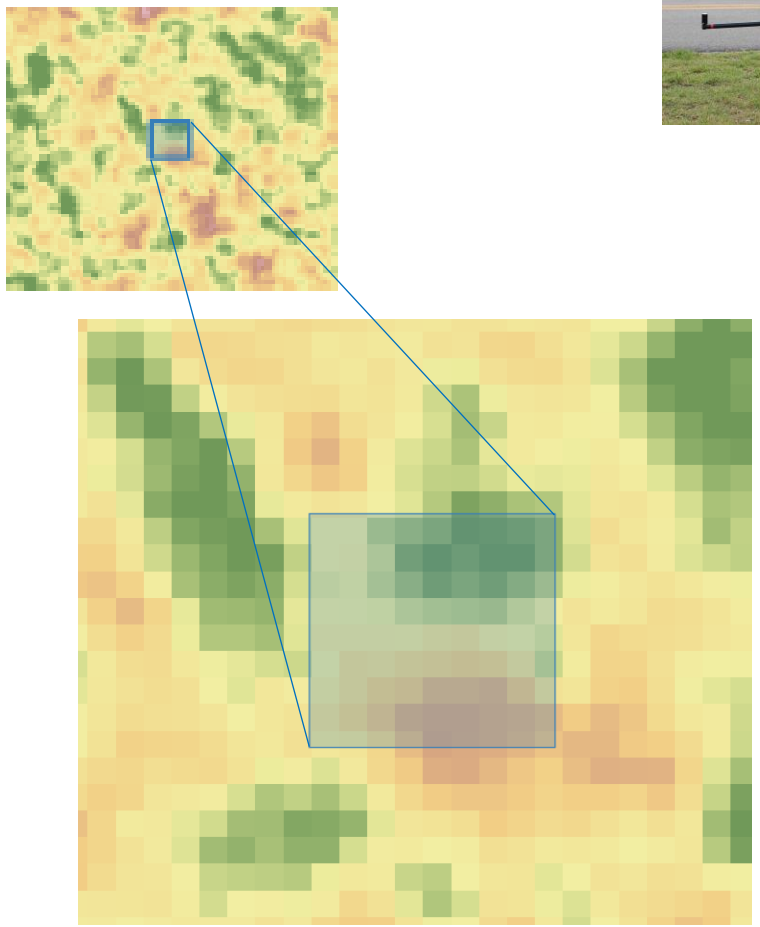




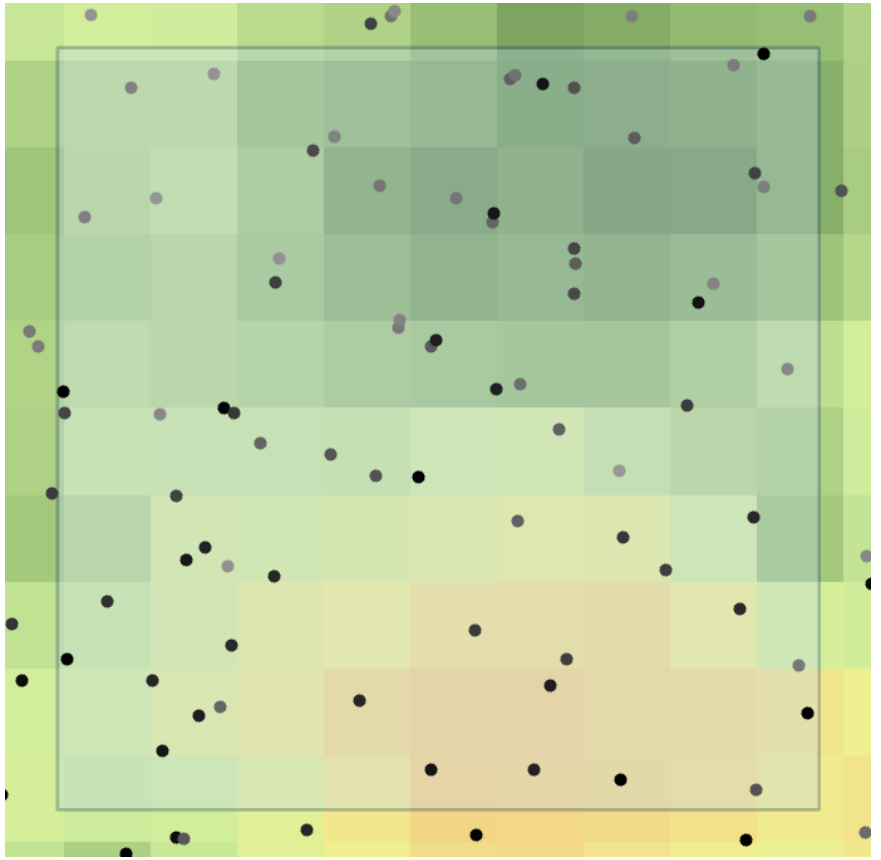


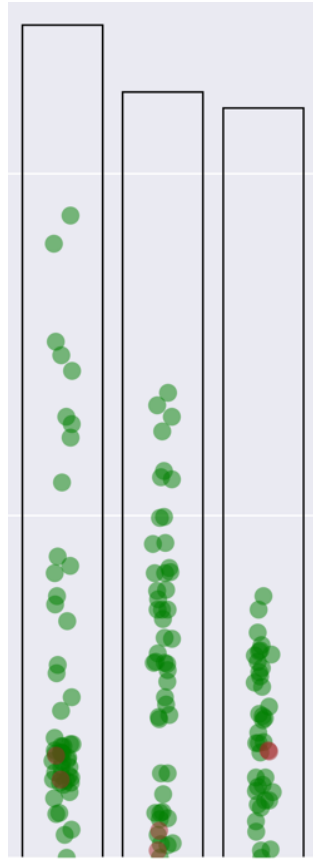
Features to predict biomass

- 3 multispectral indices

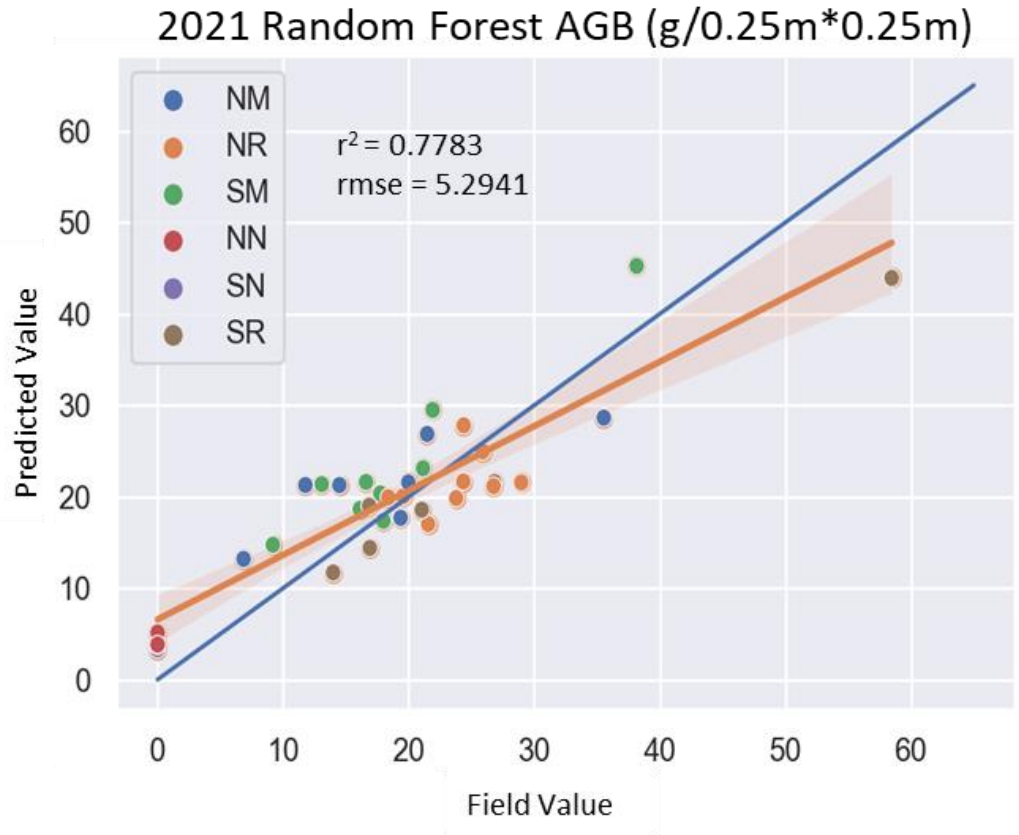


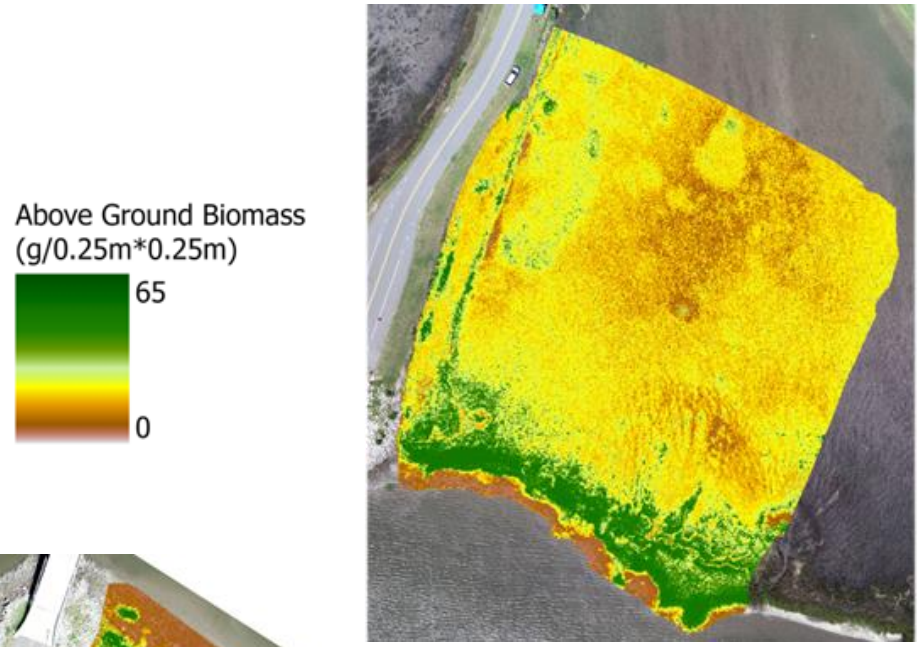
Elevations from surface model

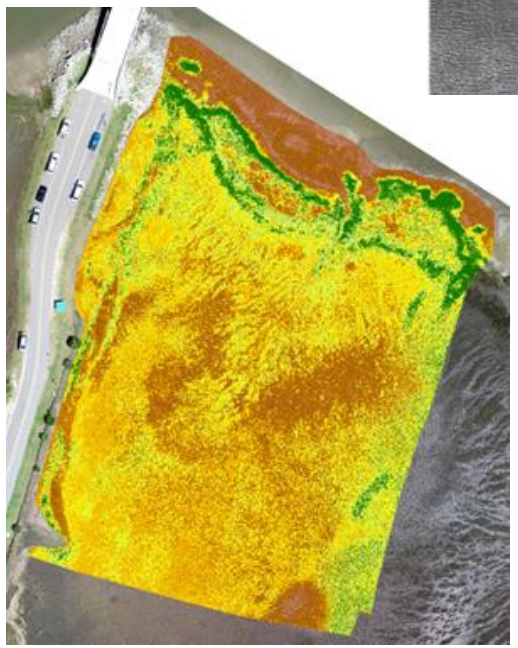




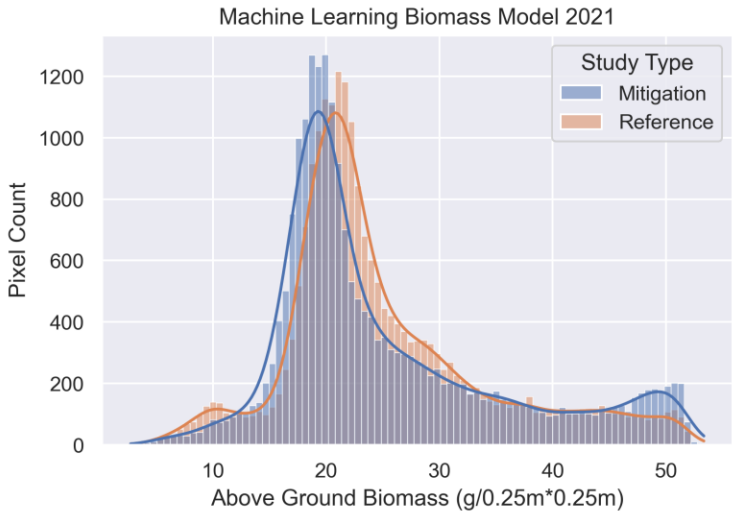
Biomass model results

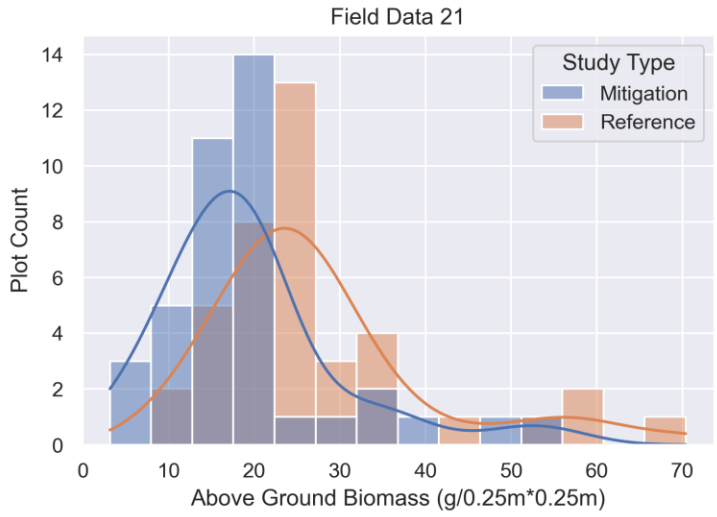


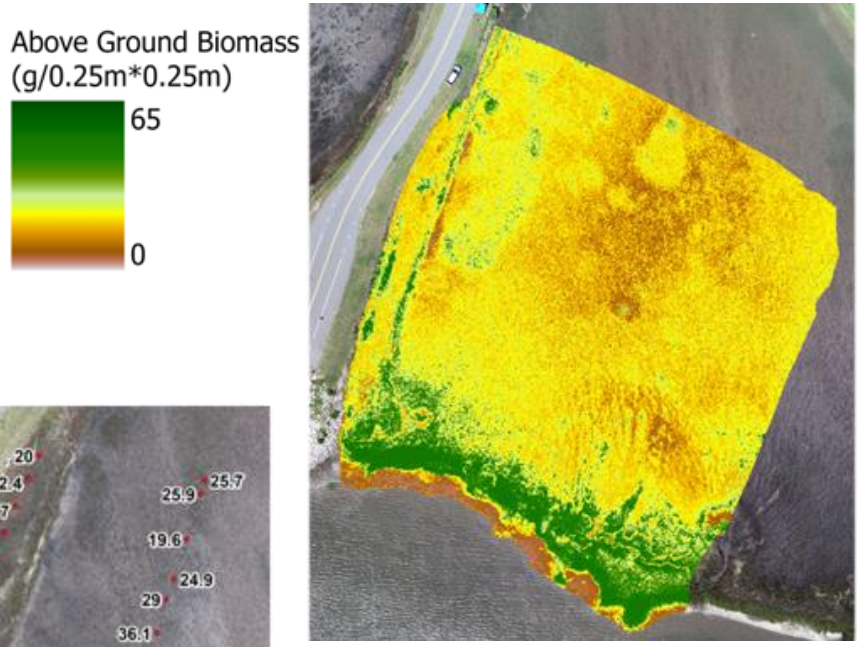


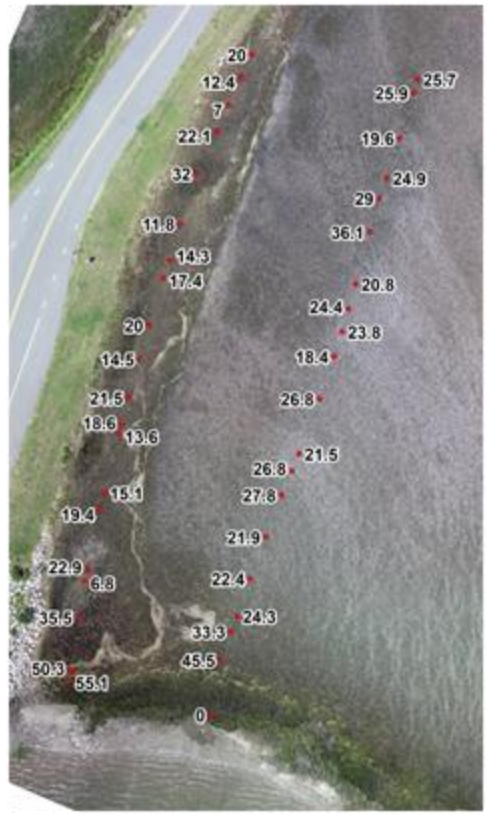


Biomass distributions









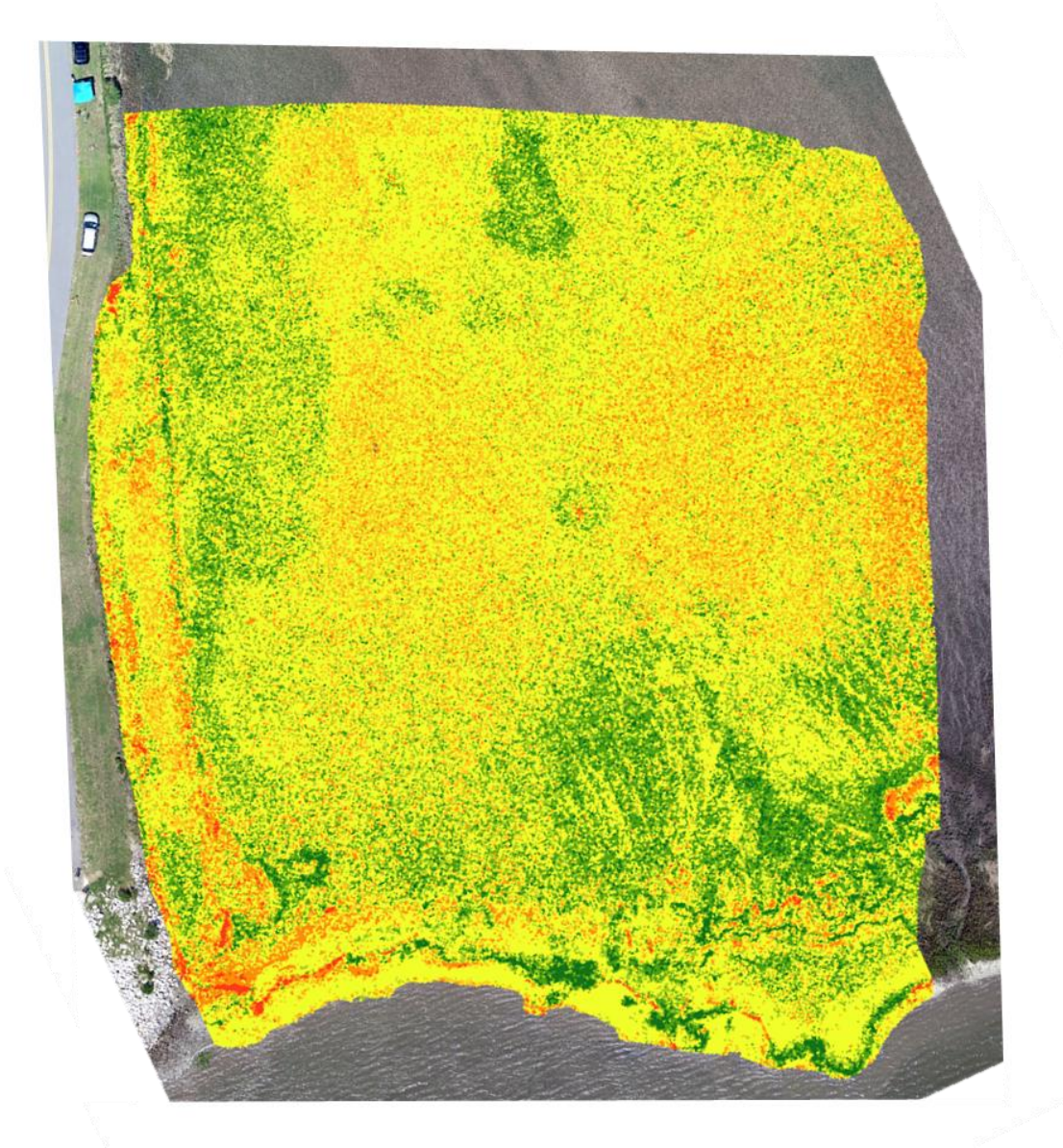
Biomass change over time

2022 - 2021

Biomass Loss

Biomass Stable

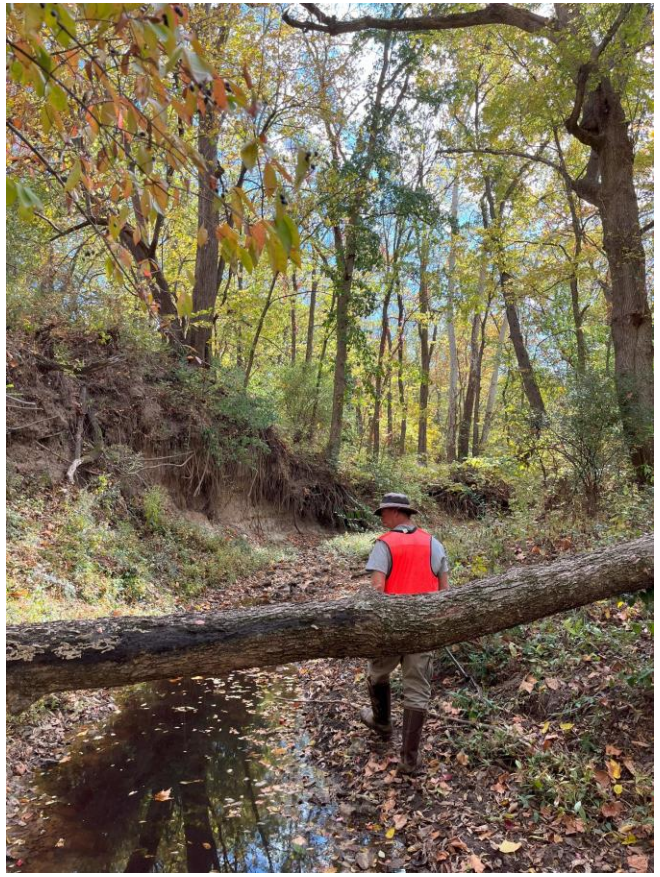
Biomass Gain

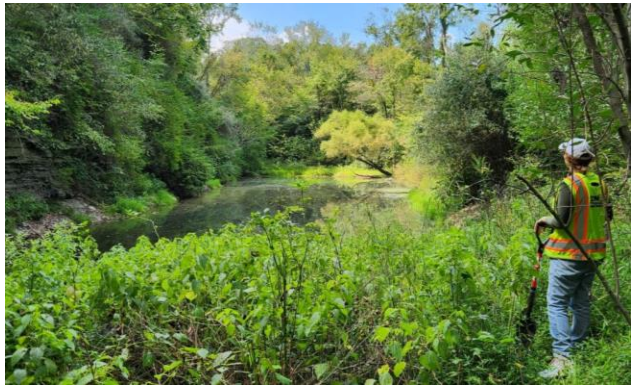


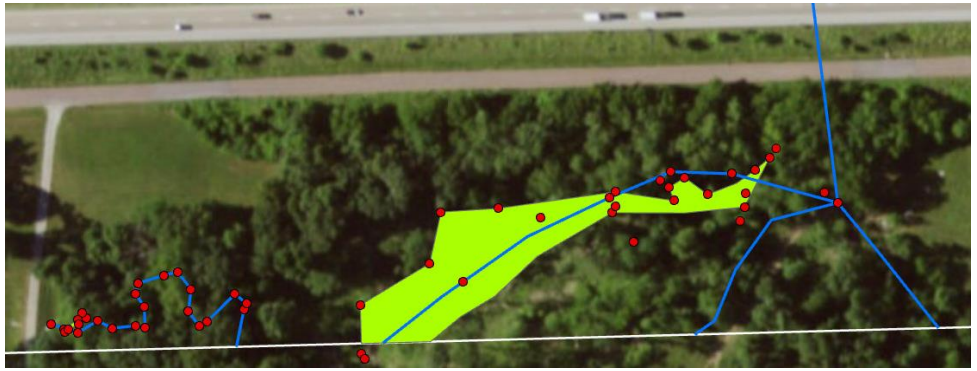
Wetland and Stream Identification

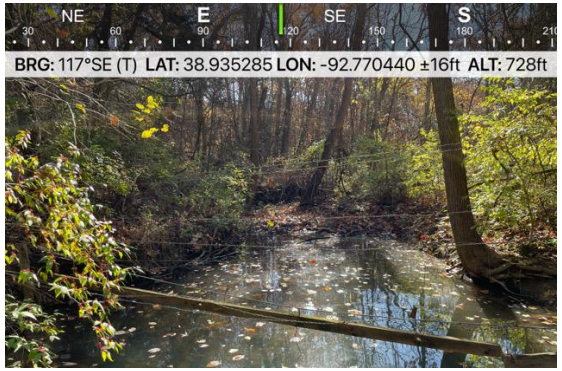
Wetland and Stream Identification

- Planning
- Access
- Conditions
- Omission
- GPS + photo







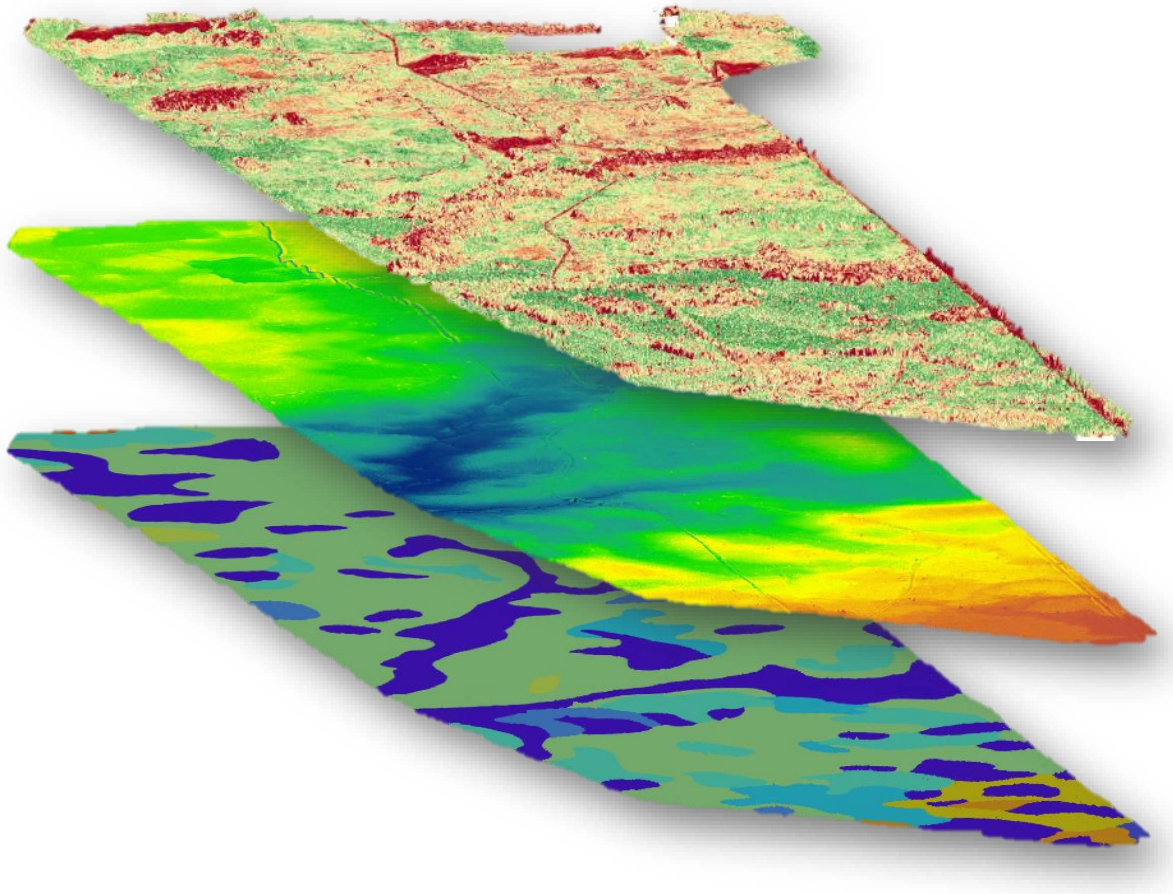


What defines a wetland and how can we predict their location?

Vegetation

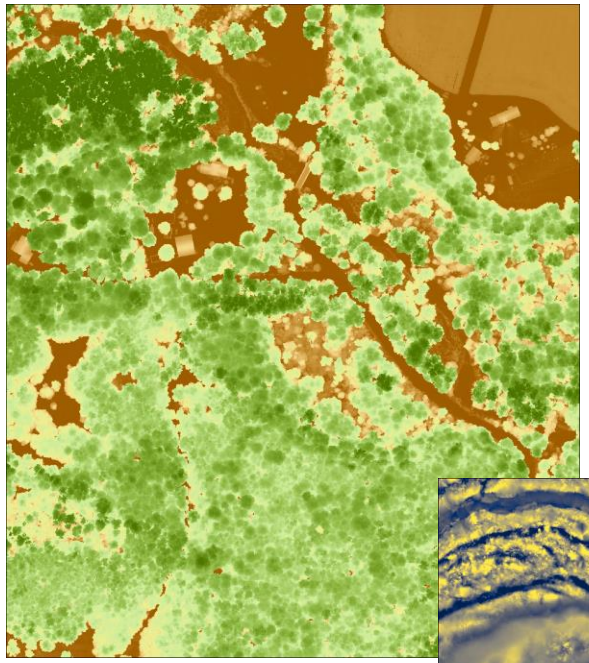
Hydrology

Soil

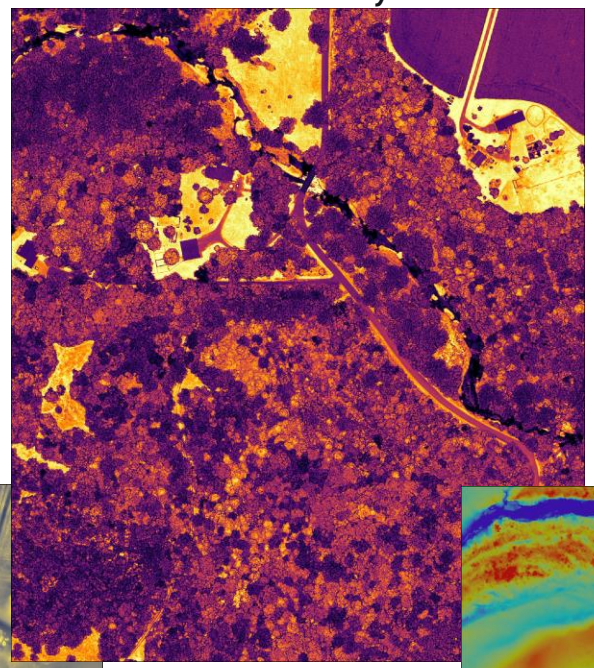


Remote sensing features

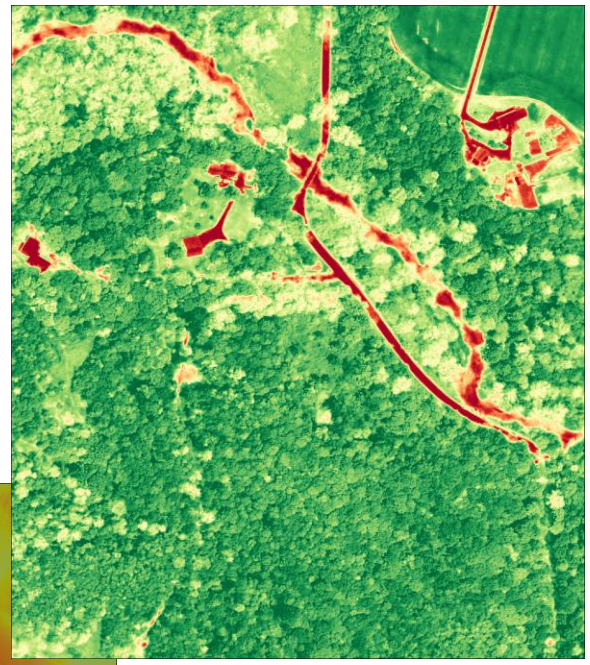
Canopy Height

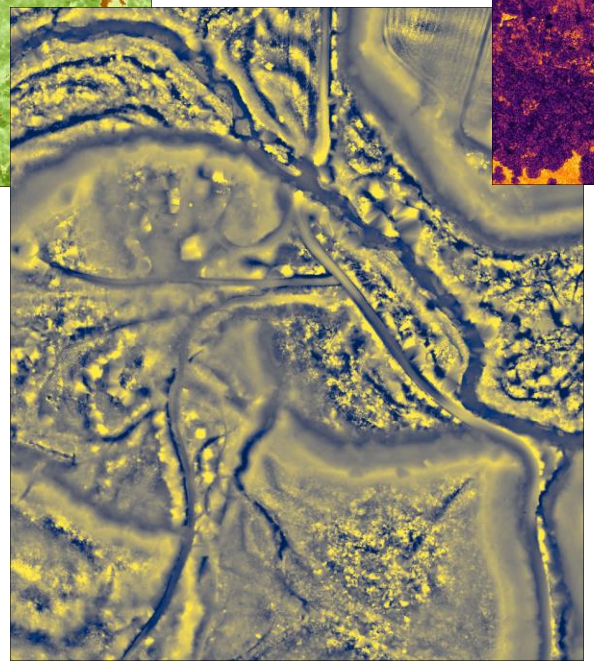


Intensity

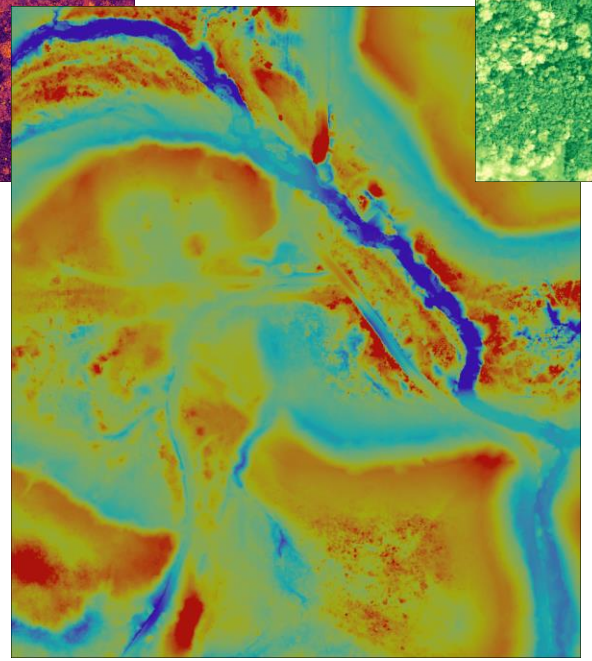


NDVI





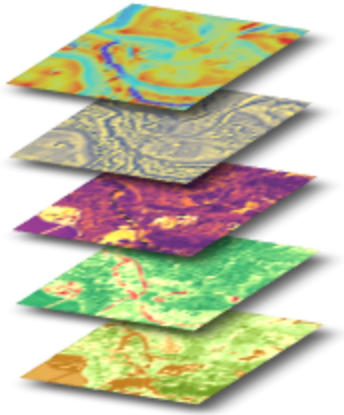
Hydrology



Data Inputs

Ground Truthing

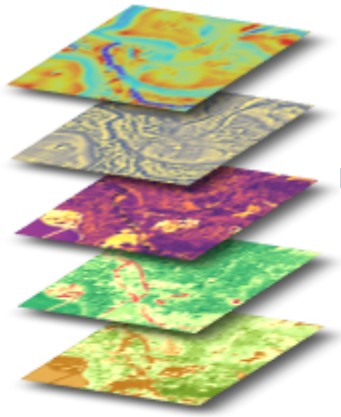
Deep Learning Model

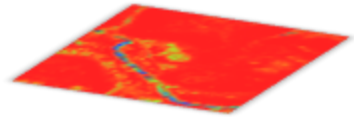


Ground Truthing

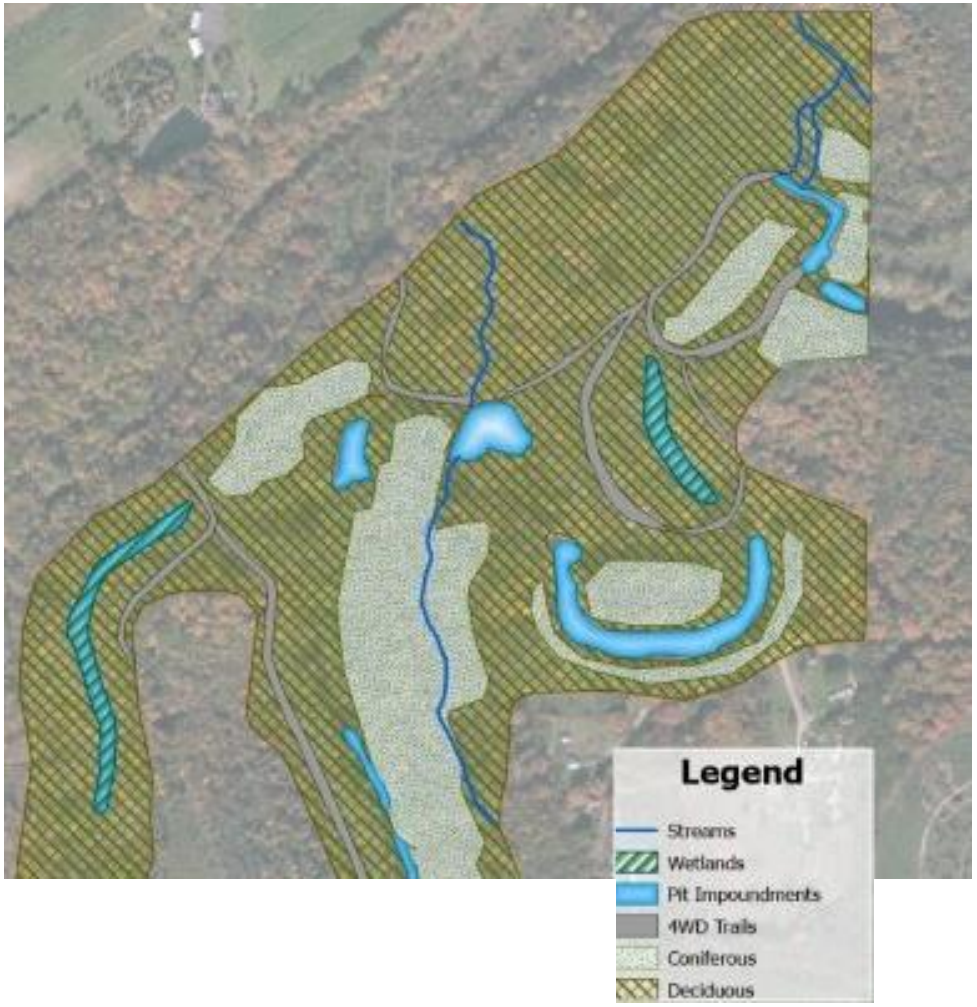
Data Inputs

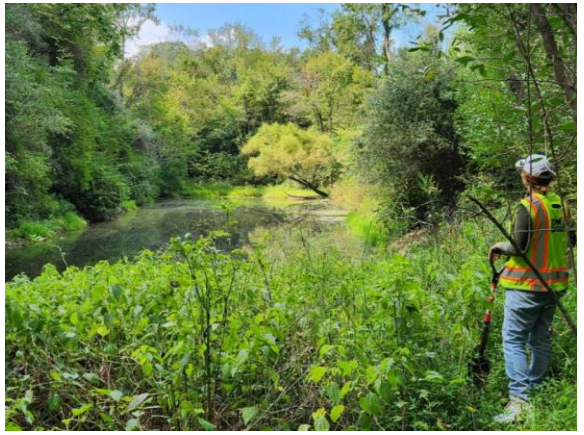
Deep Learning Model

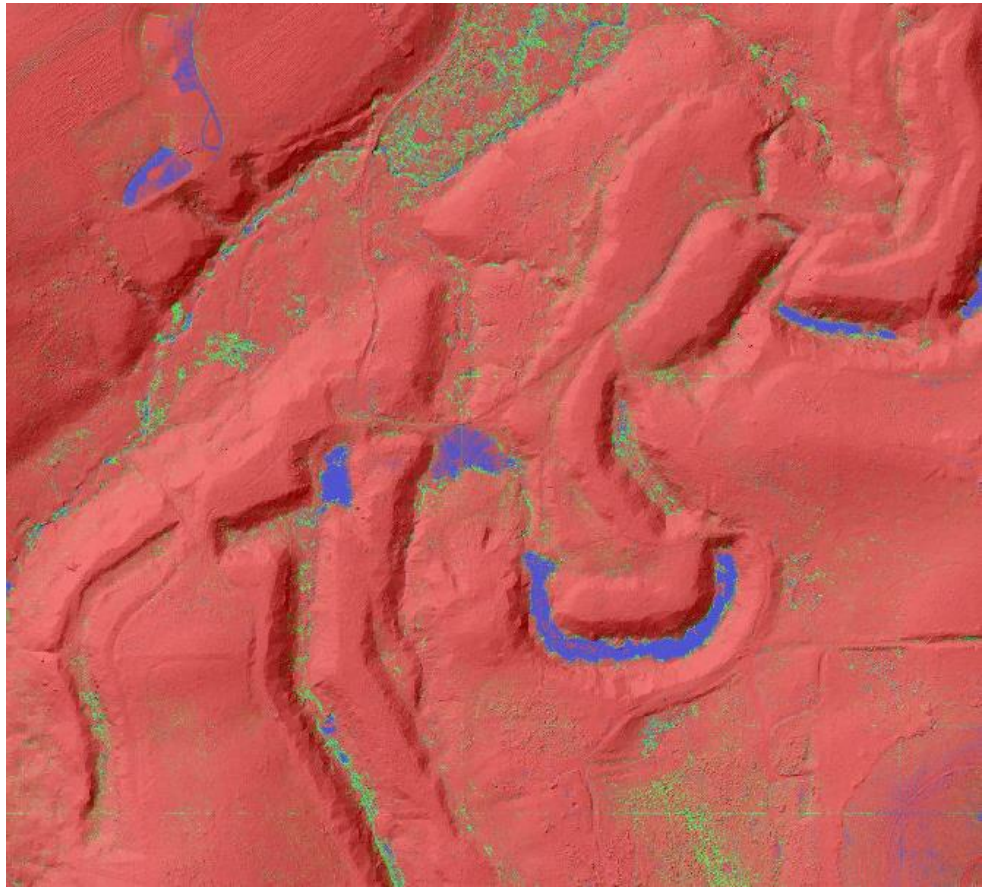




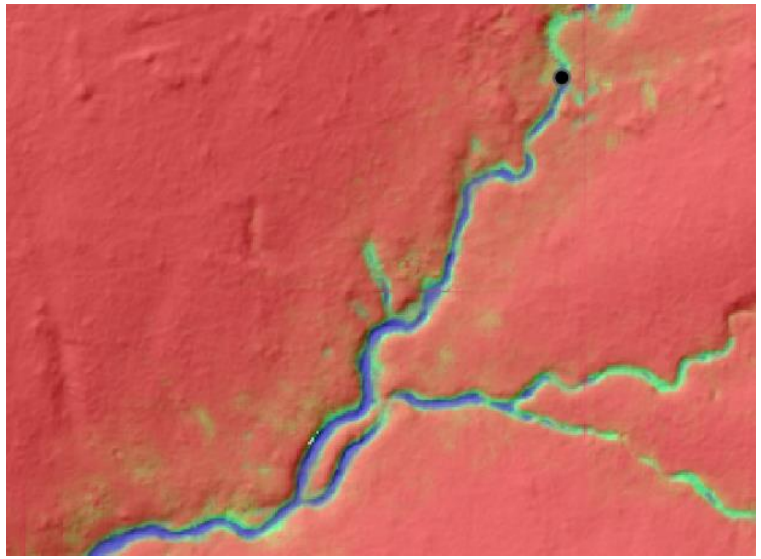
Abandoned Mine Lands

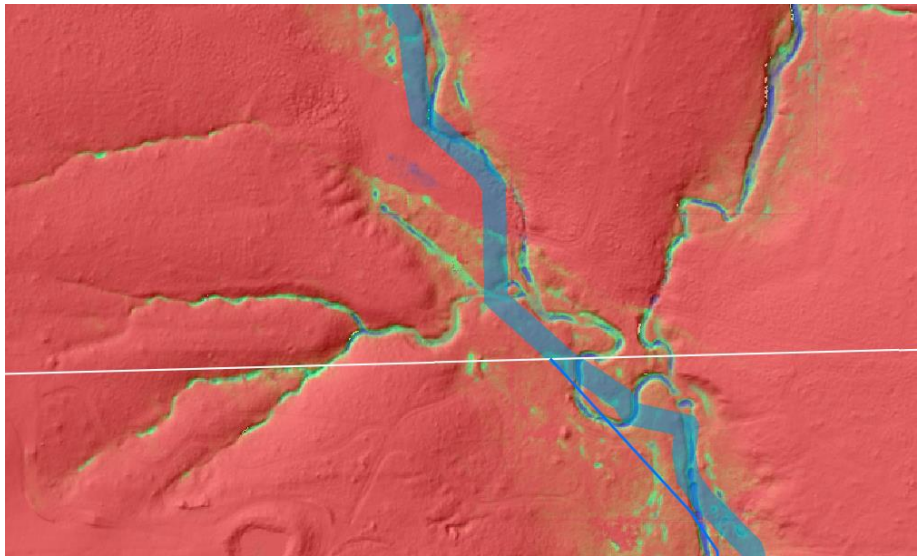


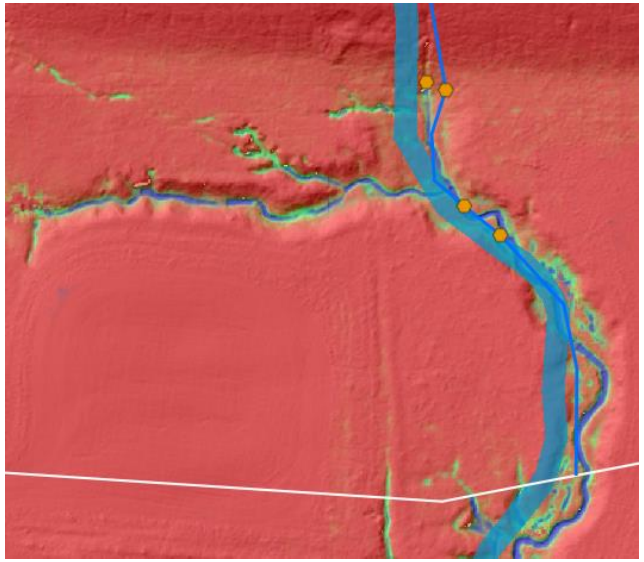




Stream Assessments





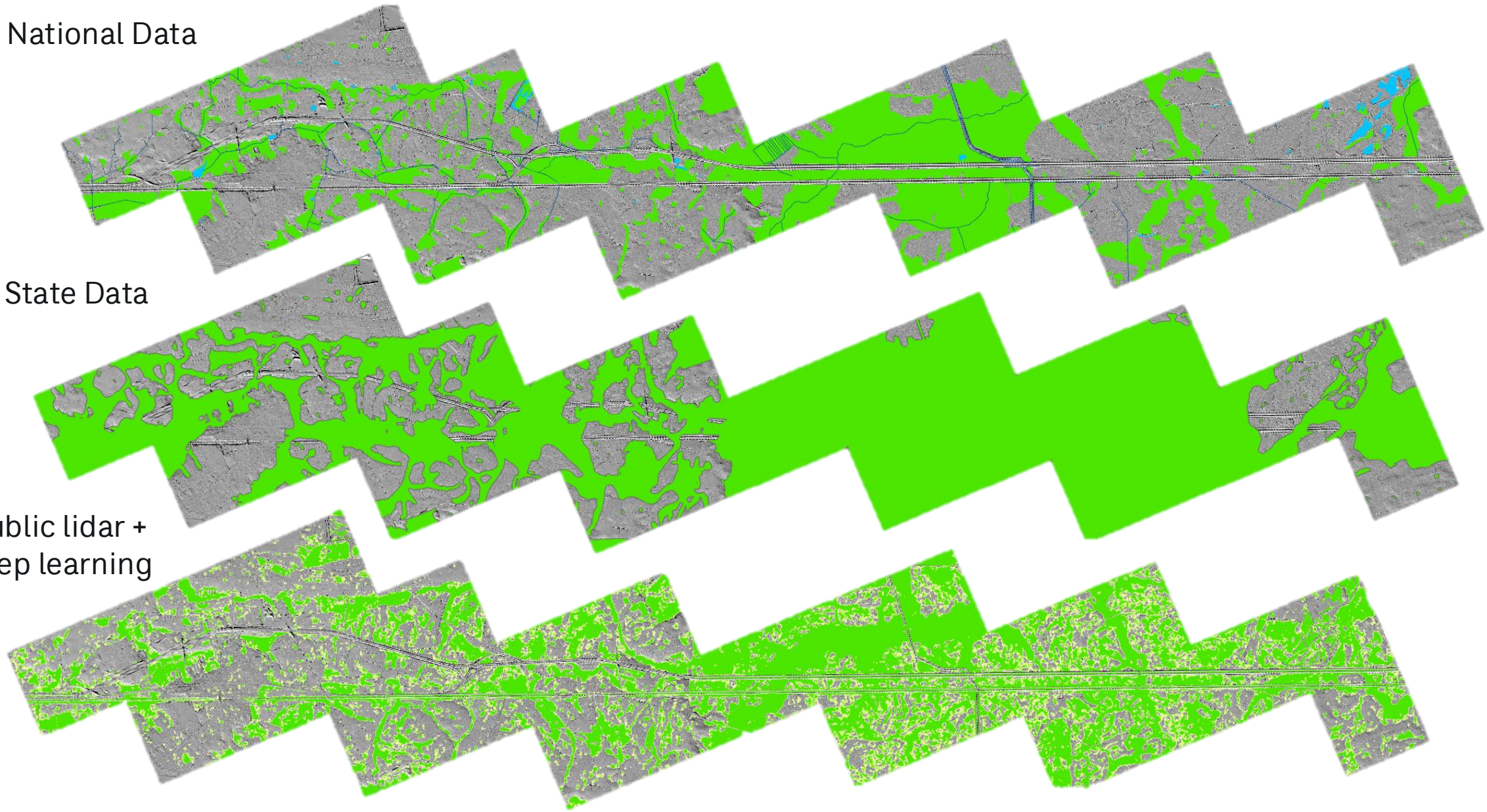


Planning to Regulatory

National Data

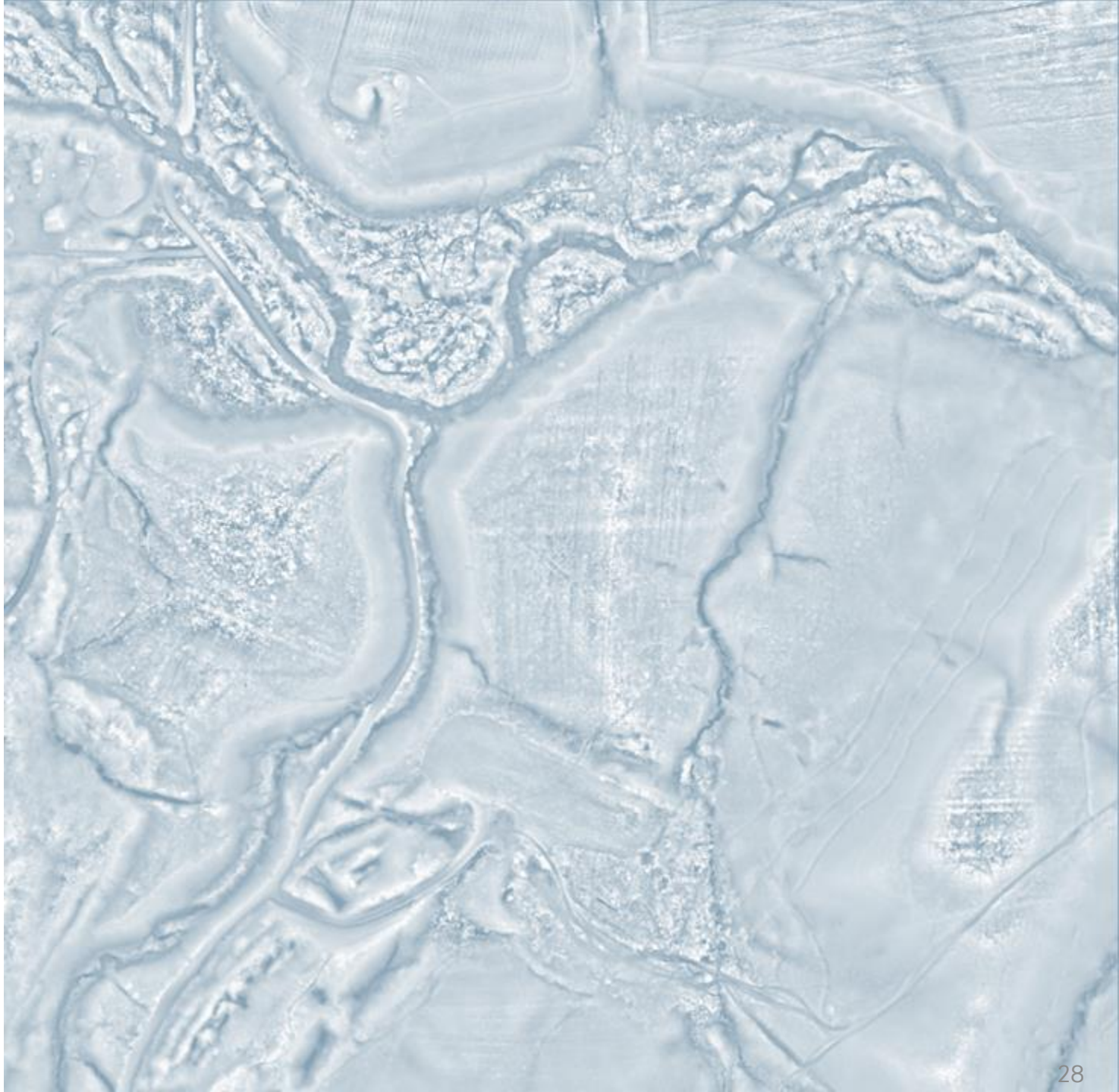
State Data

Public lidar + deep learning



Questions

- drew.reicks@trinnex.io



trinnex®
a CDM Smith company

sky wave® at CDM Smith