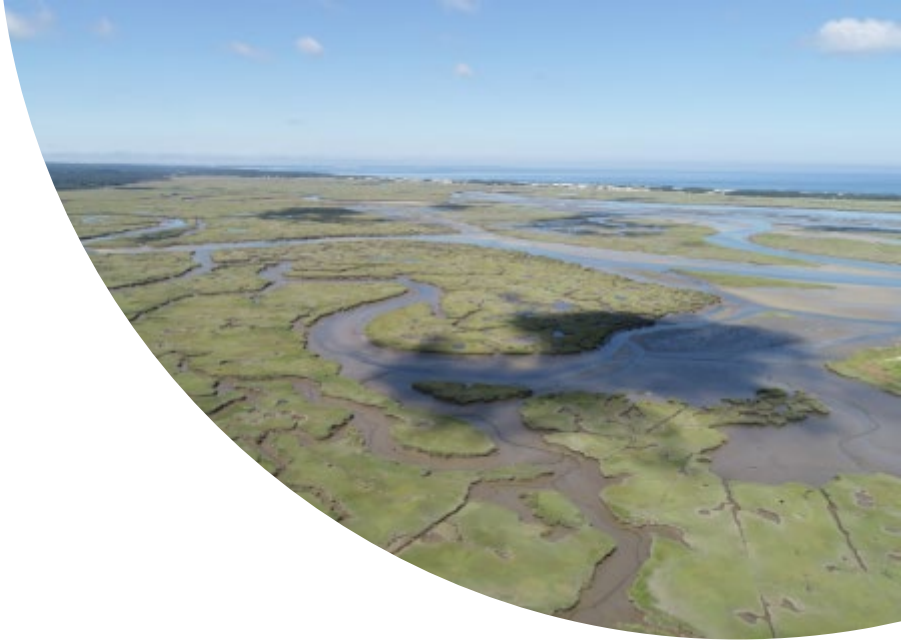
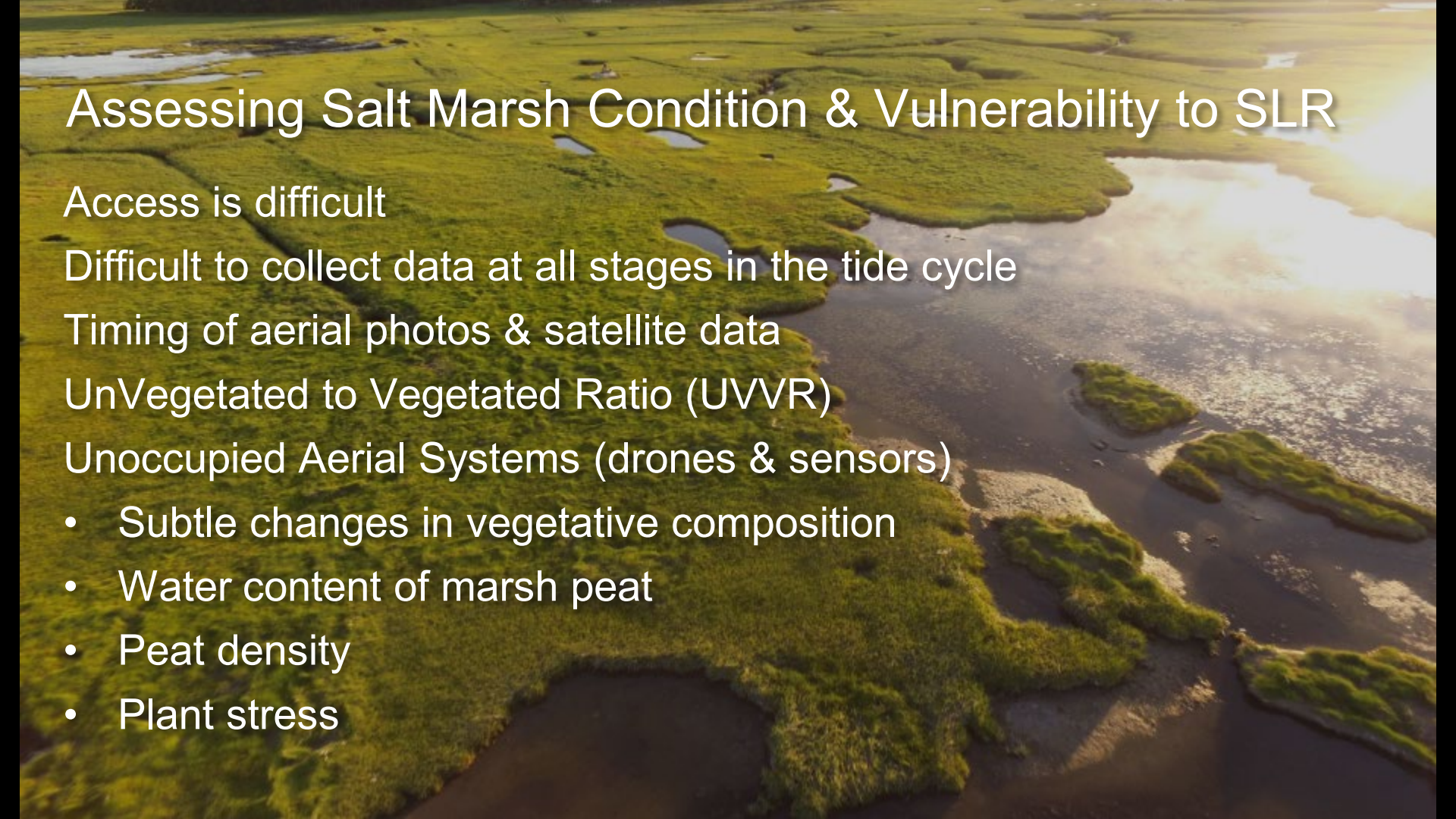
UMassAmherst



Using Remote Sensing Techniques to Assess and Monitor Salt Marsh Condition in Massachusetts

Threats to Salt Marshes

- Coastal Development
- Invasive species (nutria, green crabs, *Phragmites*)
- Freshwater intrusion
- Tidal restrictions
- Sea level rise
- Nutrient enrichment
- Sediment starvation
- Crab herbivory/trophic cascade
- Salt marsh die back



Assessing Salt Marsh Condition & Vulnerability to SLR

Access is difficult

Difficult to collect data at all stages in the tide cycle

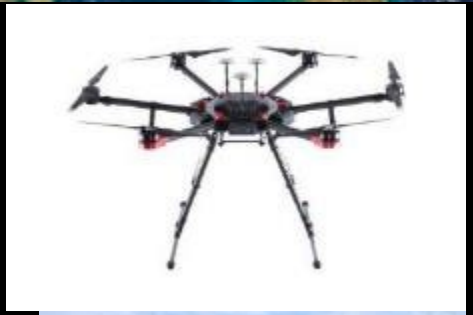
Timing of aerial photos & satellite data

UnVegetated to Vegetated Ratio (UVVR)

Unoccupied Aerial Systems (drones & sensors)

- Subtle changes in vegetative composition
- Water content of marsh peat
- Peat density
- Plant stress

Combination of remote sensing and ground truthing to comprehensively assess salt marsh condition



Objectives

- ❑ Create an automated classification model
  - Vegetation
  - Water features
  - Bare ground
- ❑ Assess salt marsh condition
  - Identify areas of degradation
  - Identify areas of stress
  - Characterized tidal hydrology
- ❑ Protocol and tools that can used by researchers & practitioners
  - Condition assessment
  - Assist in planning and implementation of conservation action
  - Monitor responses to natural disturbance and ecological restoration

Tools in the toolbox: UAS platforms

DJI Matrice 600 Pro
(Carries heavier sensor payload)

DJI 210
(Carries medium
sensor payload)

Visible Blue, Green, Red
RedEdge
Near Infrared (NIR)

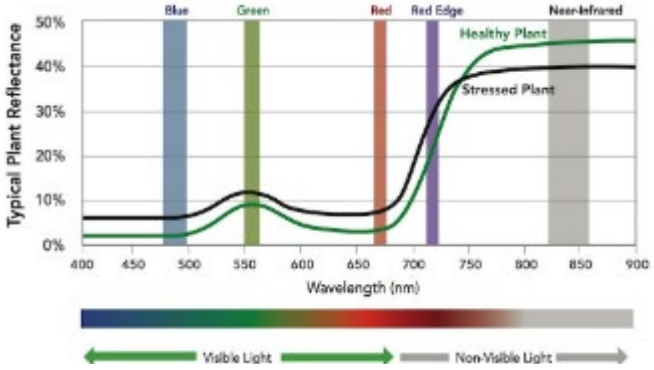
Shortwave Infrared

UAS Spectral Resolution

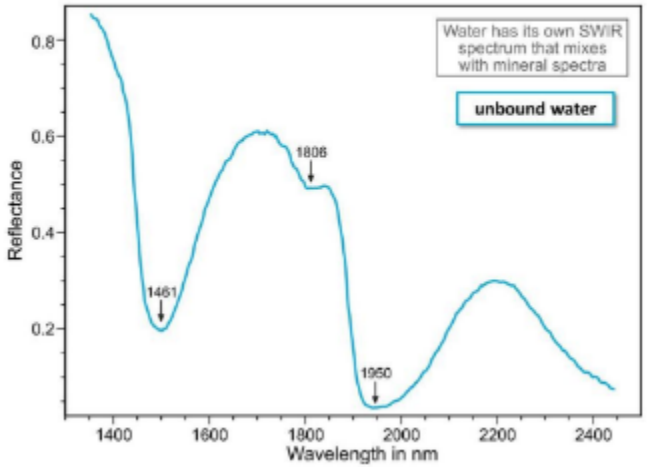
Landsat

UAS

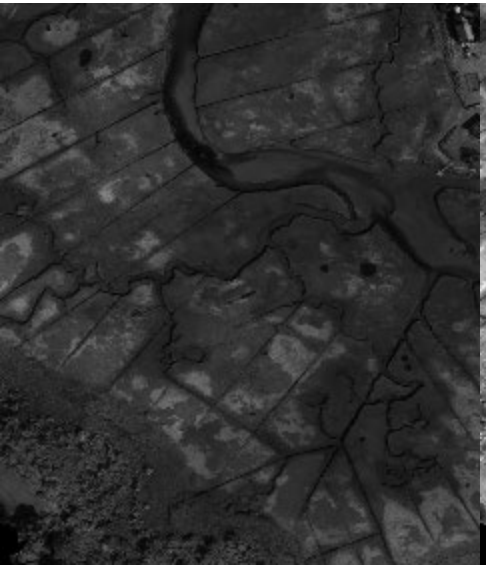
MicaSense RedEdge



SWIR Water Spectrum



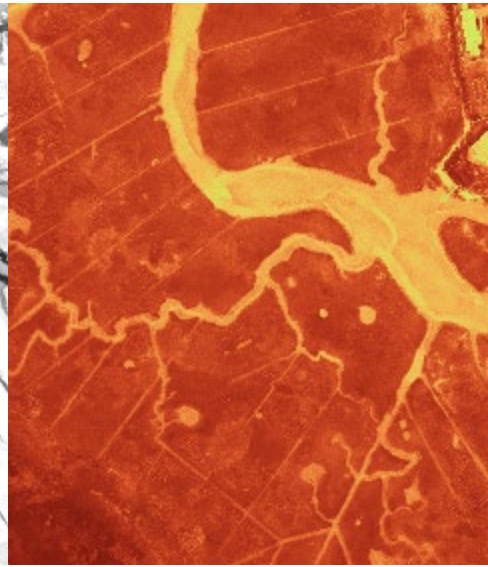
South River
(South Shore)



Rededge

NIR

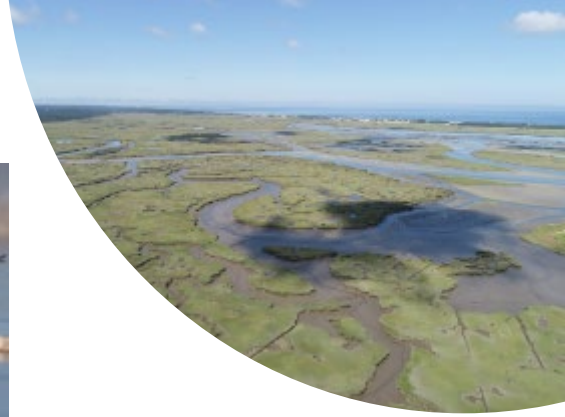
SWIR

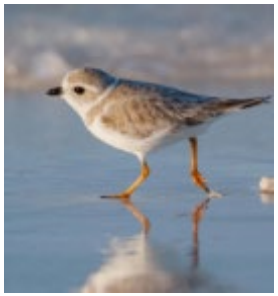


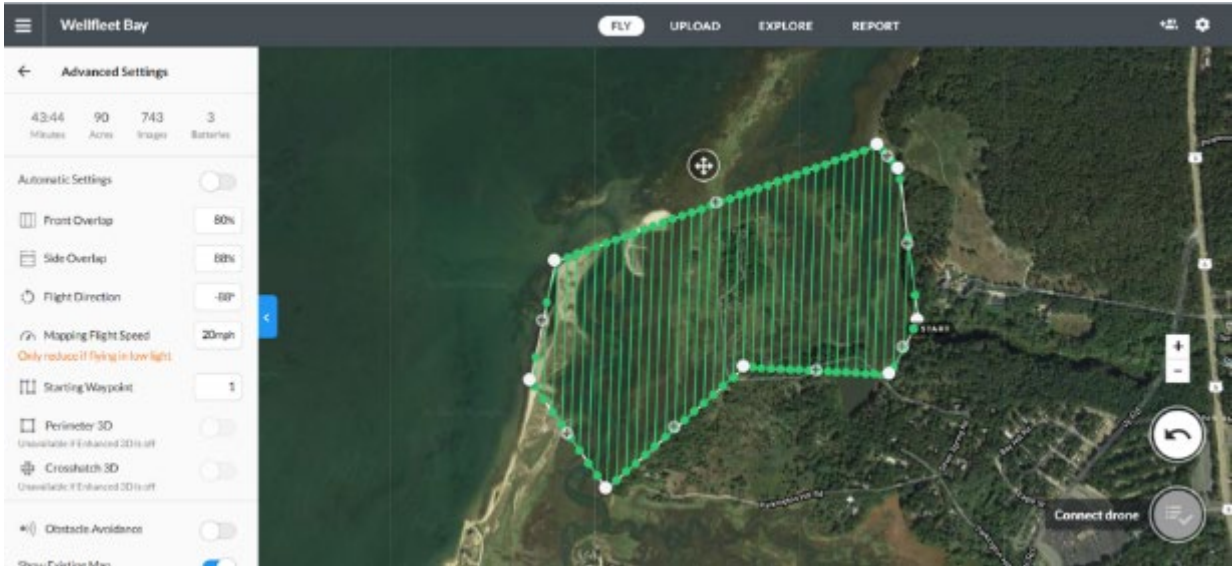
NDVI
(calculated)

Flight Information

- Receive permissions from nearby airports, land owners, and conservation commissions, MassWildlife & USFWS (for endangered birds)
- Fly at 400 feet
- 70% Overlap
- 100 acre footprints

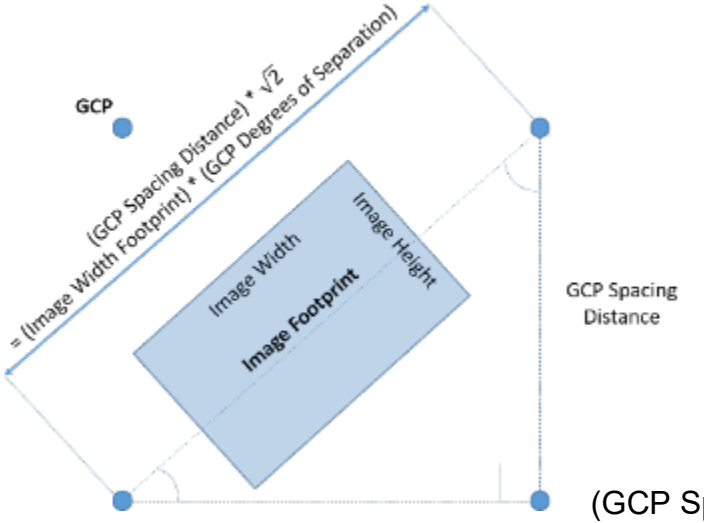






Ground Control Points

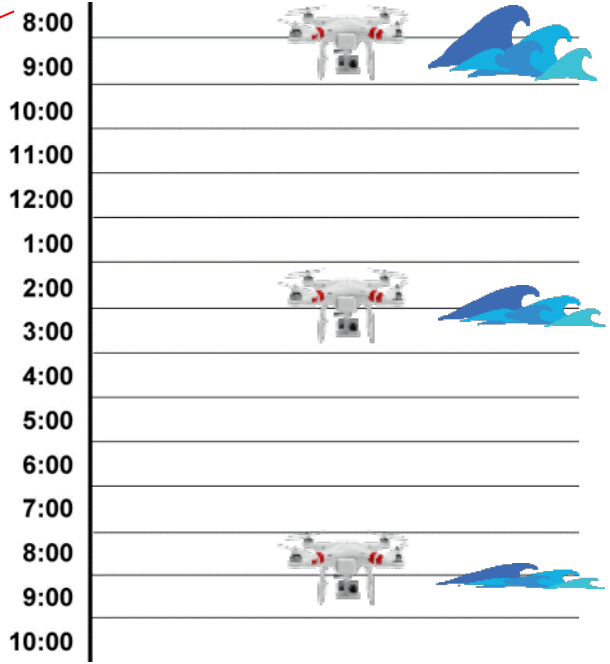
- Strategically placed throughout the salt marsh
- Appear in all bands
- Allows remote sensing data to be accurately stacked



(GCP Spacing [m]) = (camera-GCP degrees of separation) Image Footprint Width m^2

UAS Temporal Resolution

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2



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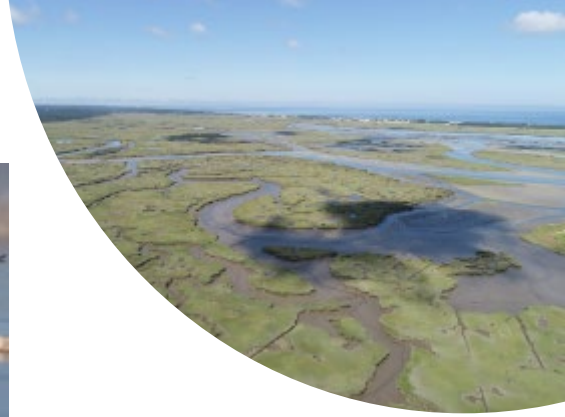

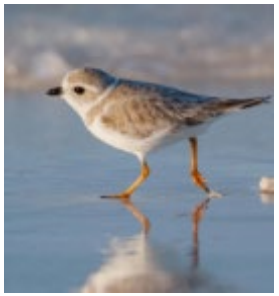

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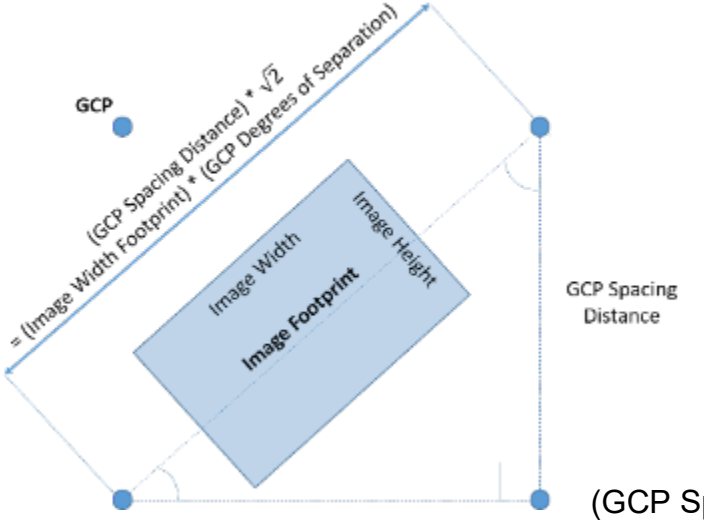


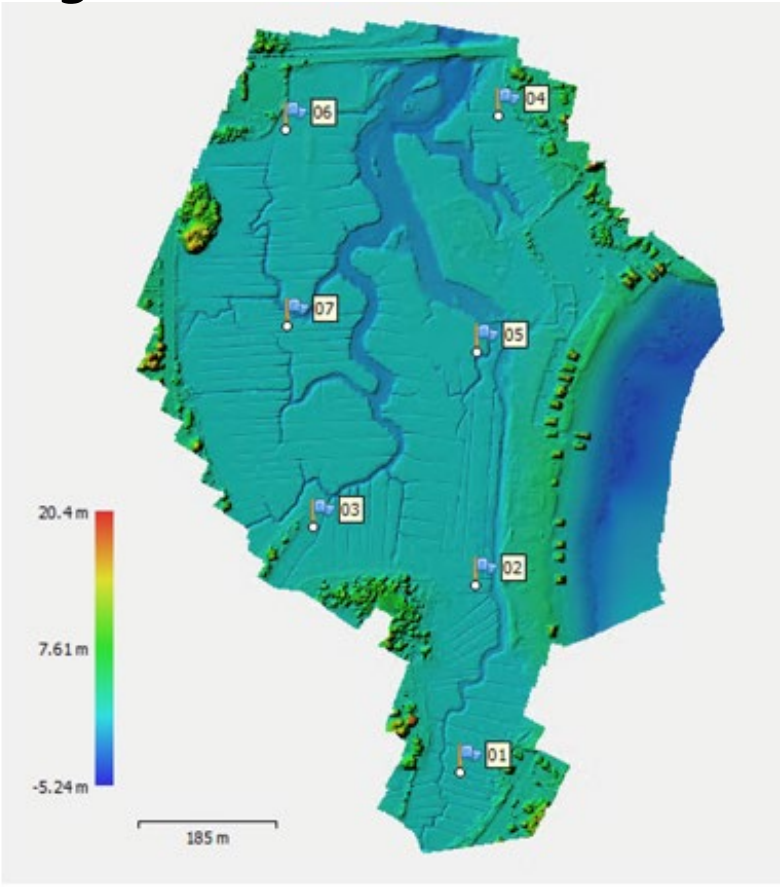
(GCP Spacing [m]) = (camera-GCP degrees of separation) Image Footprint Width m^2

Data Products

Orthomosaics

Peggotty Beach, Scituate

Digital Elevation Models *(DEMs)*



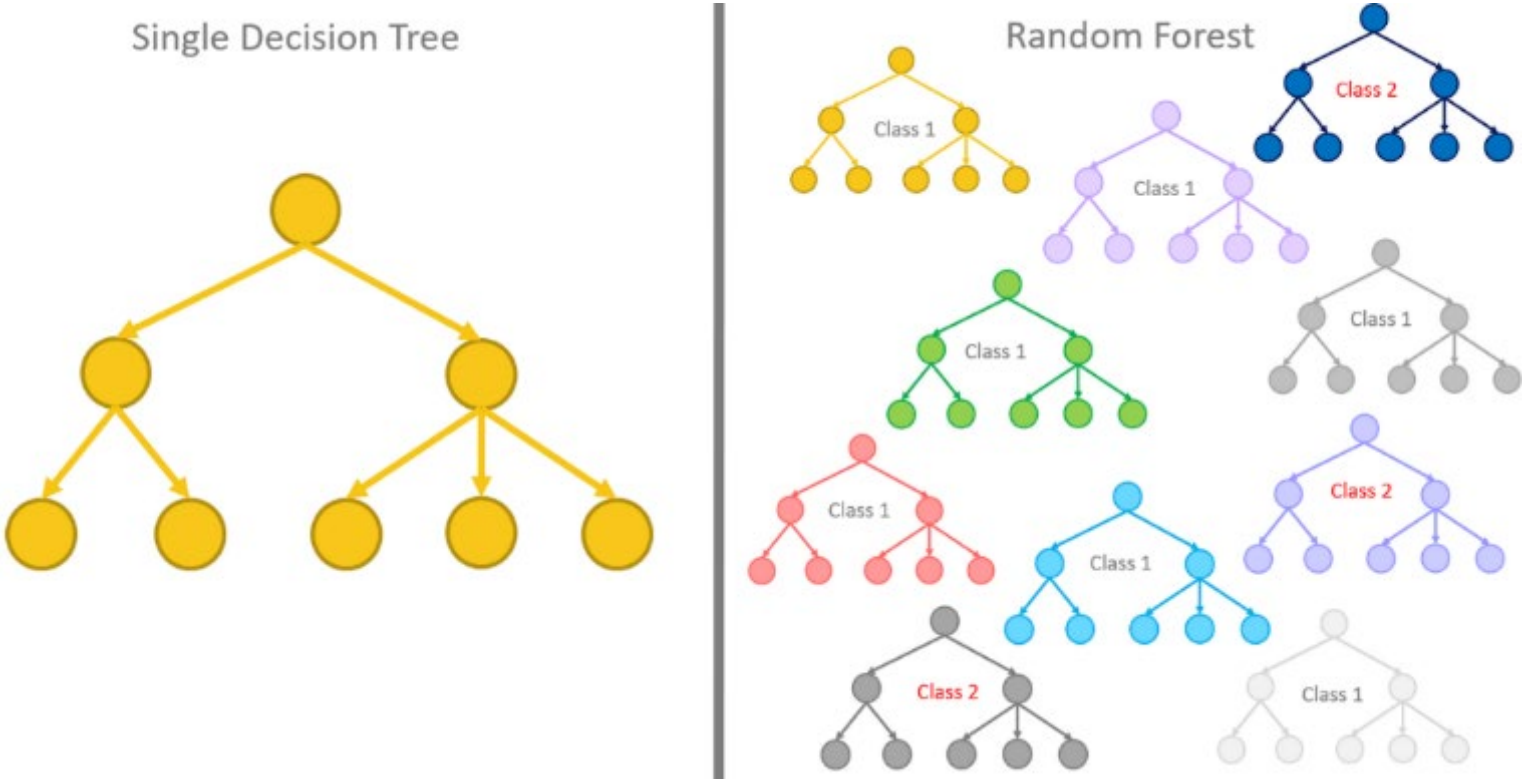
Essex Bay
(North Shore)

6 bands, 3 tidal cycles =

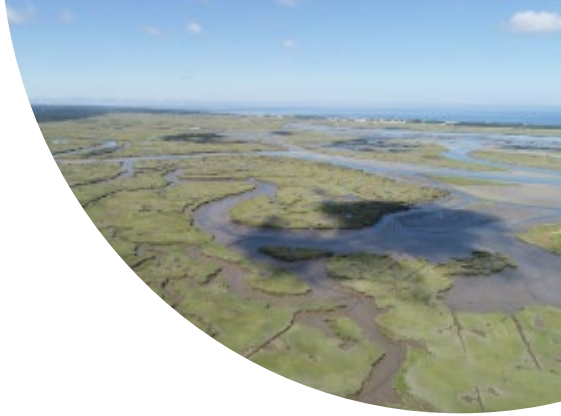
18 features per pixel, per day

1,458,000,000 data points per site per day!

Decision Trees and Machine Learning



Vegetation Classification



Salt Marsh Classification

First Level: Class (first digit - number)

1 - Vegetated: > 30% vegetation cover

2 - Water feature: 100% inundated at typical high tide with < 30% vegetation cover

3 - Bare ground: Exposed at typical high tide with < 30% vegetation cover

Salt Marsh Classification

Subclass

1 - Vegetated: > 30% vegetation cover

01 - Low marsh (tall form *Spartina alterniflora* dominant)

02 - Intermediate marsh (mix of high marsh vegetation and tall form *S. alterniflora*)

03 - Transitional marsh 1: short form *S. alterniflora* dominant (> 80%) mixed with typical high marsh species

04 - Transitional marsh 2: short form *S. alterniflora* common or dominant (30-80%) mixed with typical high marsh species

05 - Transitional marsh 3: *S. patens* & *D. spicata* dominant but mixed with 5-30% short form *S. alterniflora*

06 - High marsh 1: > 90% plant cover in *S. patens* & *D. spicata* and < 5% short form *S. alterniflora*

07 - High marsh 2: < 90% plant cover in *S. patens* & *D. spicata*, mixed with other high marsh species but < 10% shrub species and < 5% short form *S. alterniflora*

08 - *Juncus gerardii* band: > 50% of marsh vegetation is *Juncus gerardii*

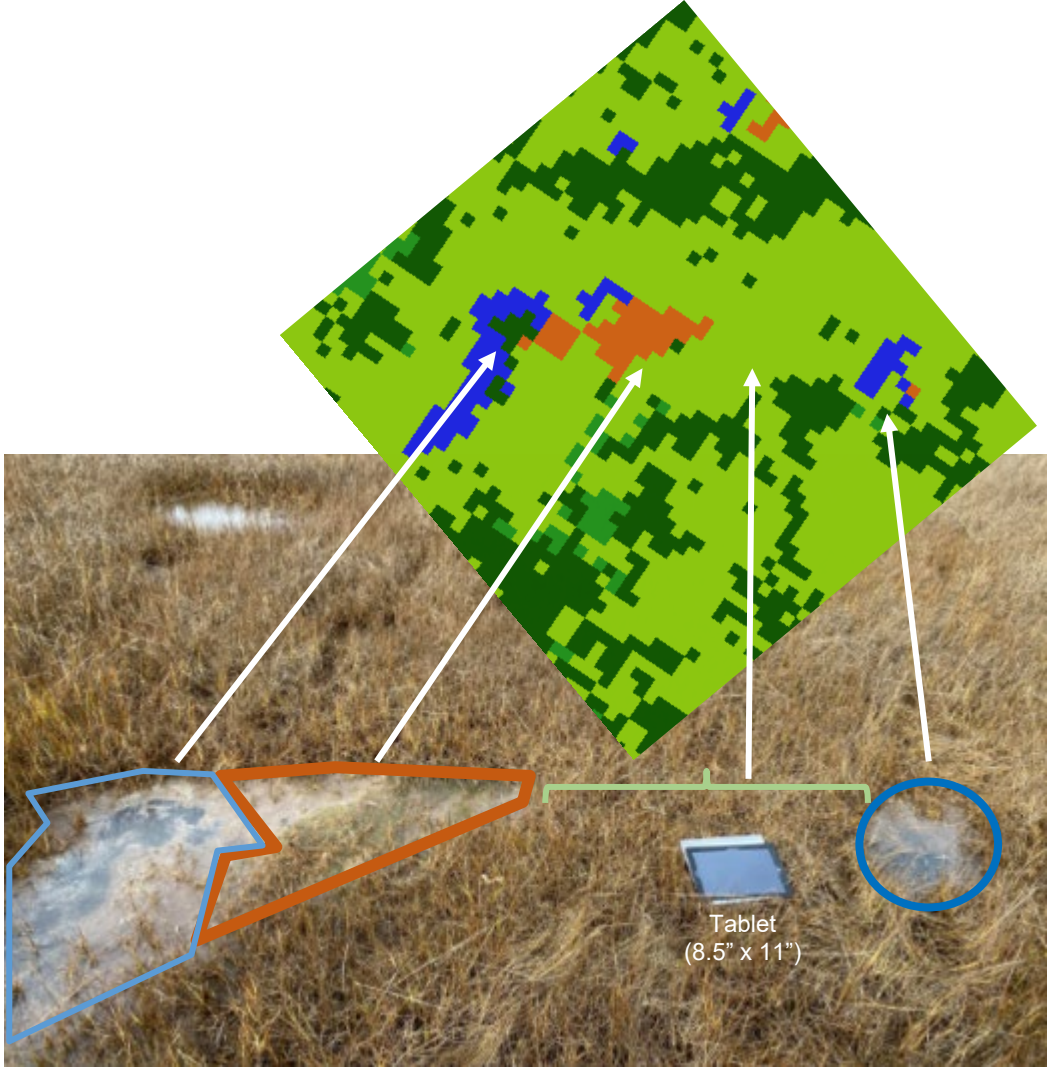
09 - Salt-shrub marsh (high marsh vegetation mixed with shrub species)

10 - *Salicornia* or *Suaeda* marsh

11 - Brackish marsh

12 - Brackish marsh - Phragmites: > 30% vegetative cover of *Phragmites australis*

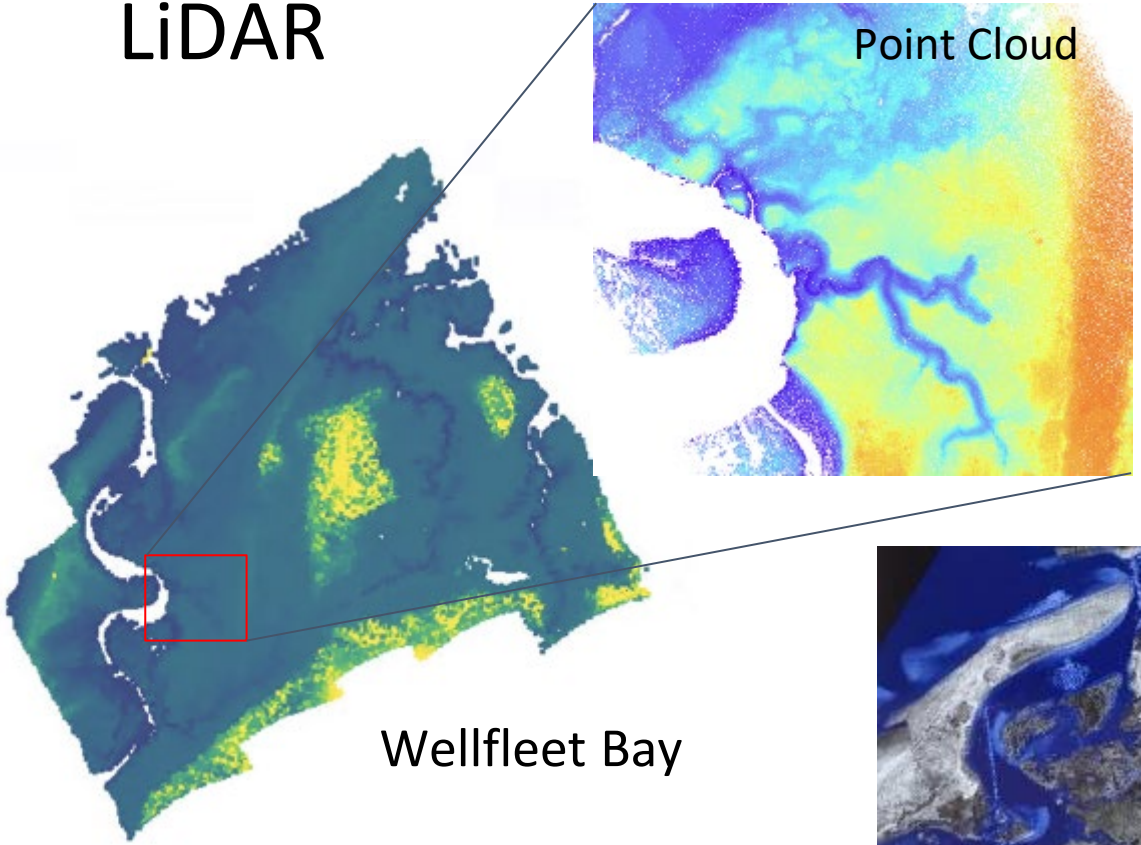
13 - Vegetated ditch edges: mix of high marsh vegetation and intermediate form (neither tall nor short) *Spartina alterniflora* as linear features along the edges of water features (typically along the crown of ditch banks)


Tablet
(8.5” x 11”)

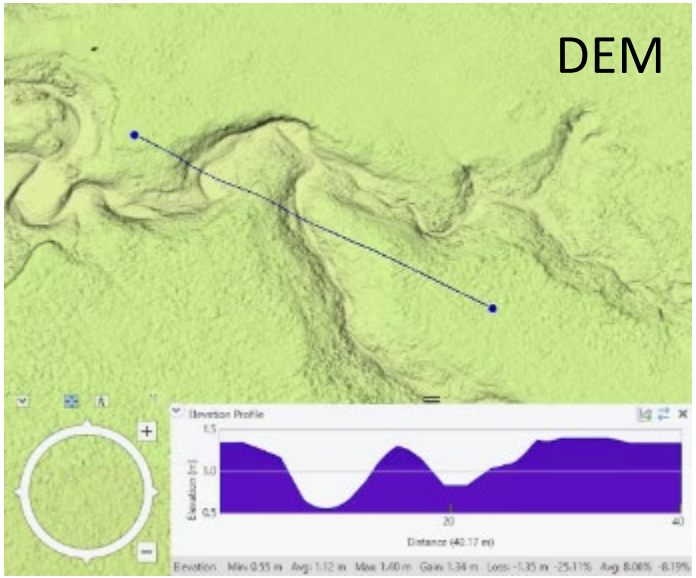
Inertial Labs RESEPI with HESAI XT32

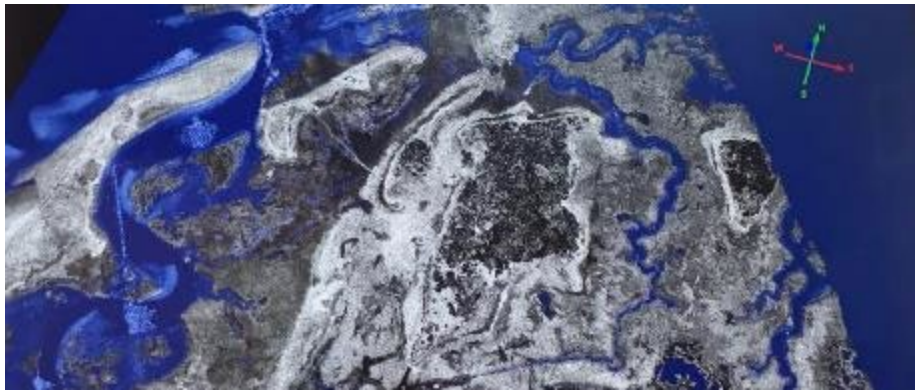
HESAI

LiDAR

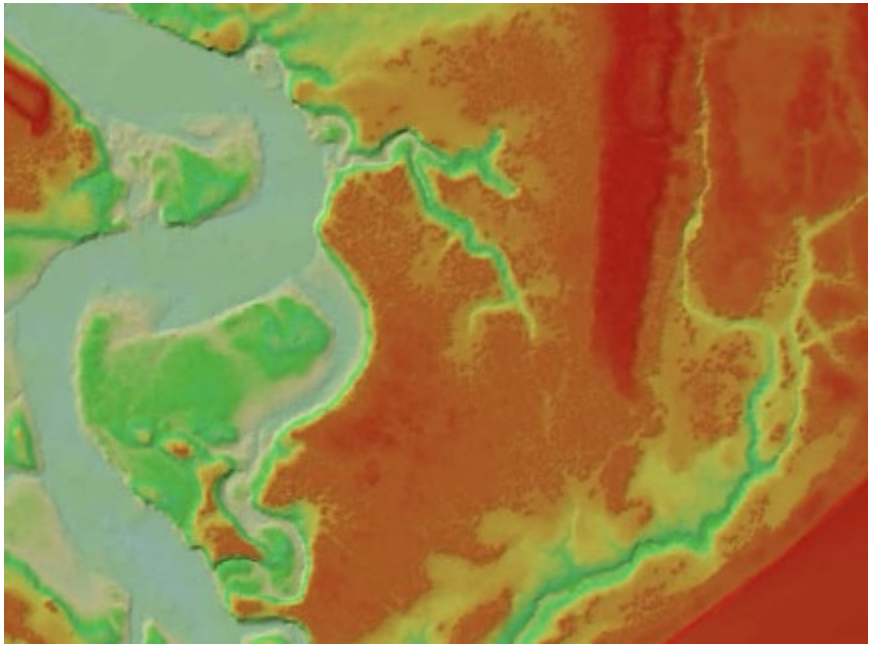


Wellfleet Bay





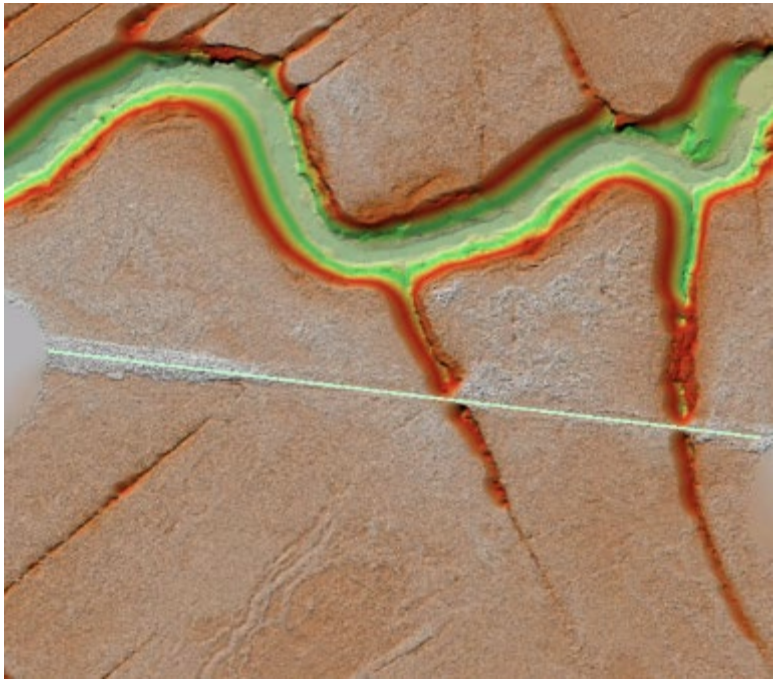
LiDAR DTMs



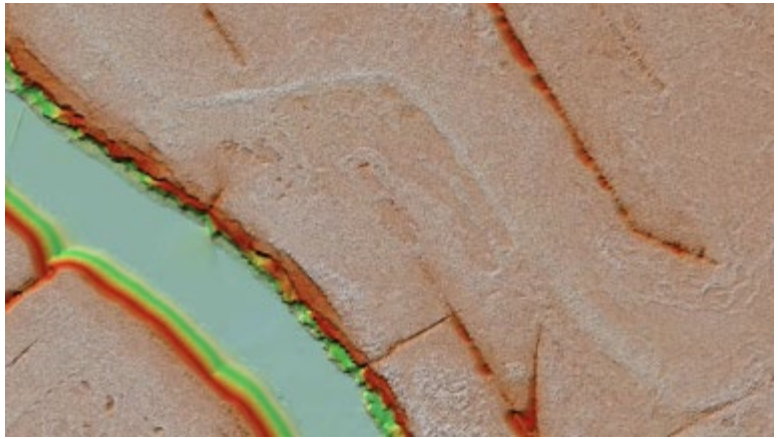
Filtered LiDAR
Digital Terrain Model

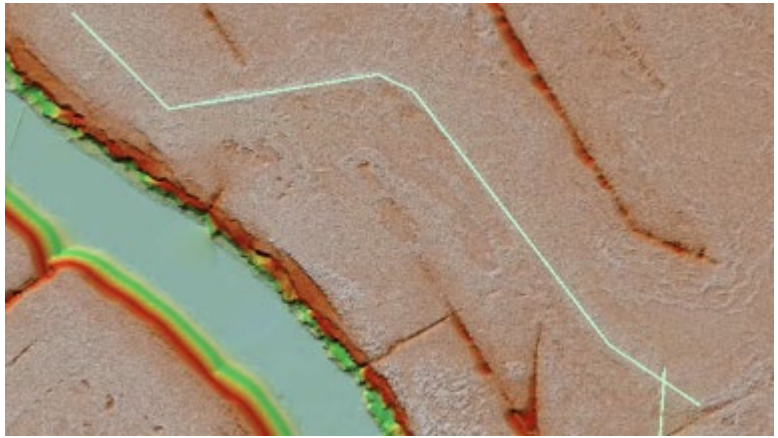
RGB Orthomosaic

Identification of Historical Embankments



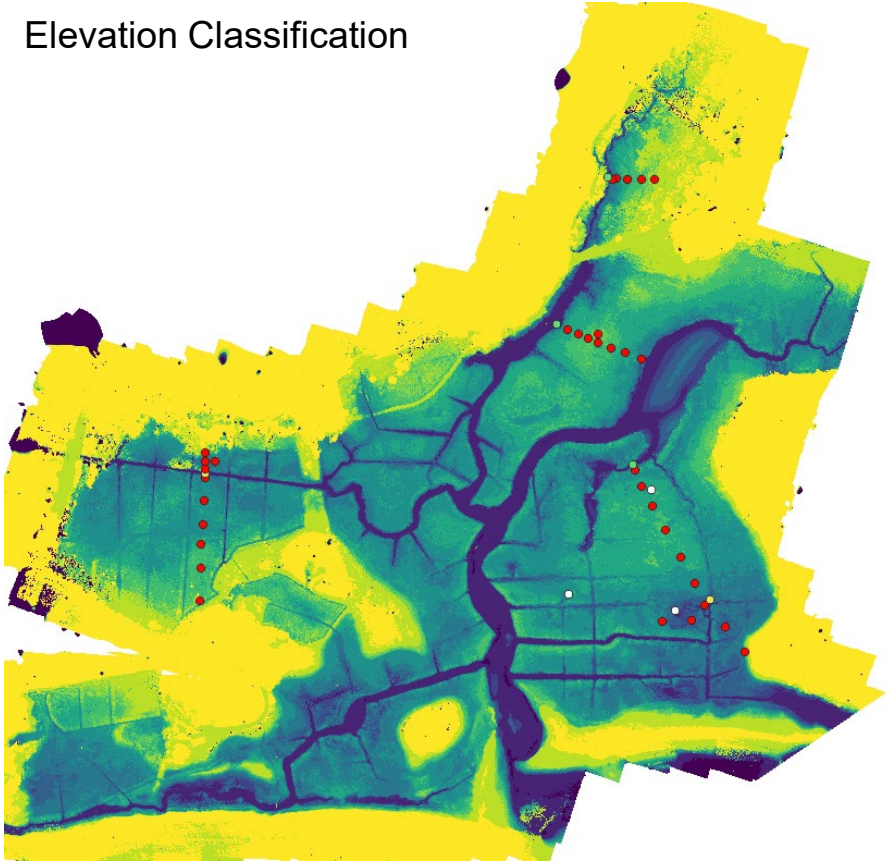
Filtered LiDAR DTMs



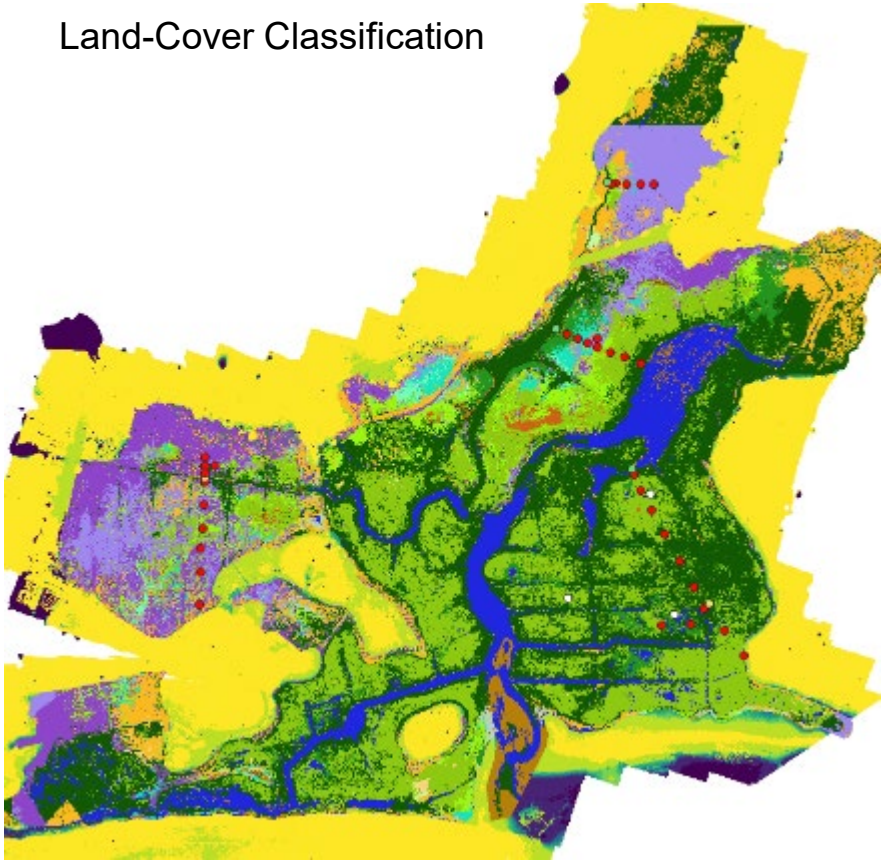


HOBO Water Logger Array

Elevation Classification



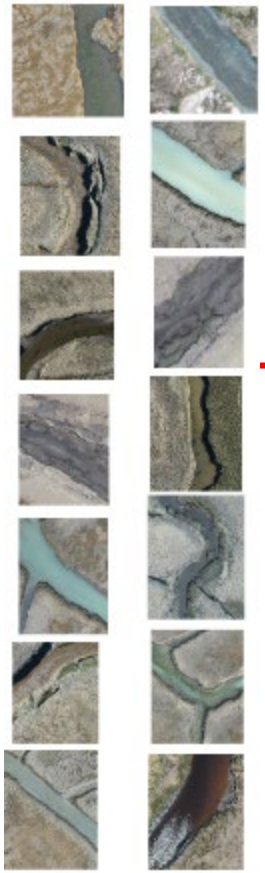
Land-Cover Classification



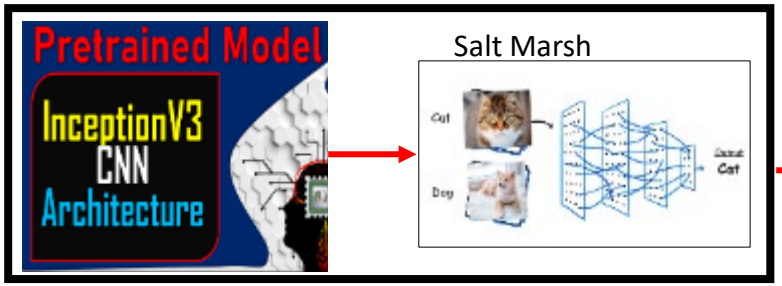
Creek Channel Erosion

Zoom in to show extent of 300x300 tiles

Training set: 50/50 300x300 tiles, multiple sites. 1



2

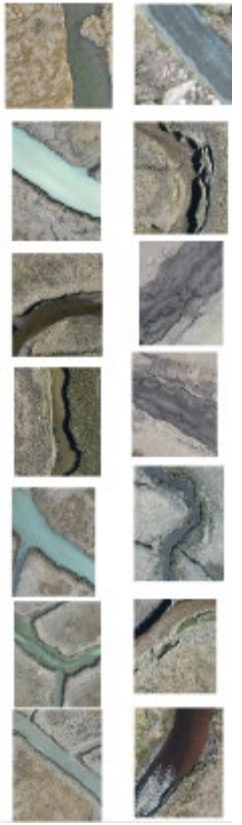


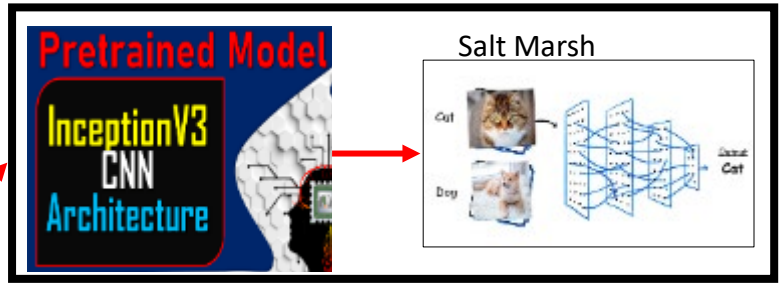
3

Classification

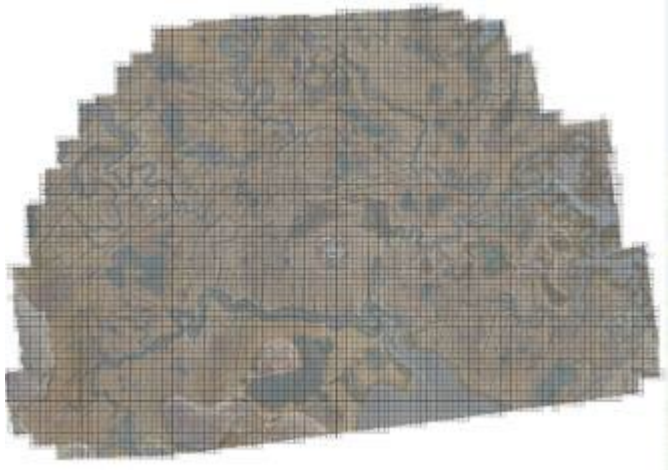
97% Accuracy

Healthy Unhealthy



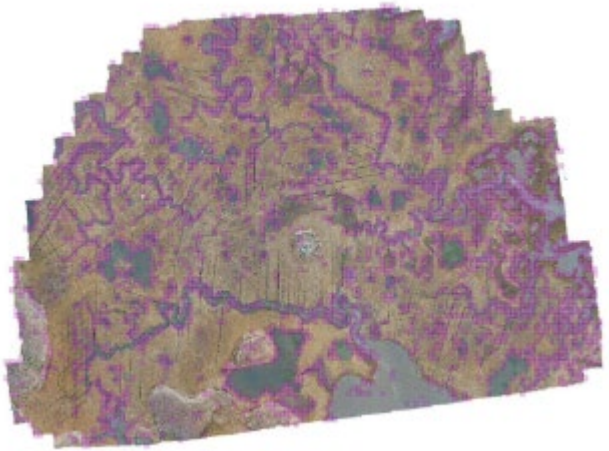


Classification



Essex Bay with tiling showing

Unhealthy tiles (purple)



Funding

Access and Field Support

Towns: Newbury, Essex, Scituate, Marshfield, Westport, Harwich, Chatham, Barnstable, Wellfleet