Use of drones and hyperspectral imagery to remotely sense vegetation patterns at wetland restoration sites

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Evaluation of Restoration Projects

1. Each restoration project is essentially an experiment with its own particular variables:
   1. History/age
   2. Forcing functions (hydraulic reach)
   3. Desire outcome / goals
2. Hydrology and landscape so altered that there is no going back to past conditions
   1. Freshet/ disturbance, sedimentation levels all reduced and timing changed

- Ecological engineering requires post-restoration evaluations to determine Restoration trajectories
  1. Time series data of key metrics for change analysis and adaptive management
  - ✓ Hydrological Data
  - ❑ Fish habitat utilization –PIT/Acoustic tags
  - ❑ Vegetation –from transect t remote sensing

Monitoring restoration trajectories

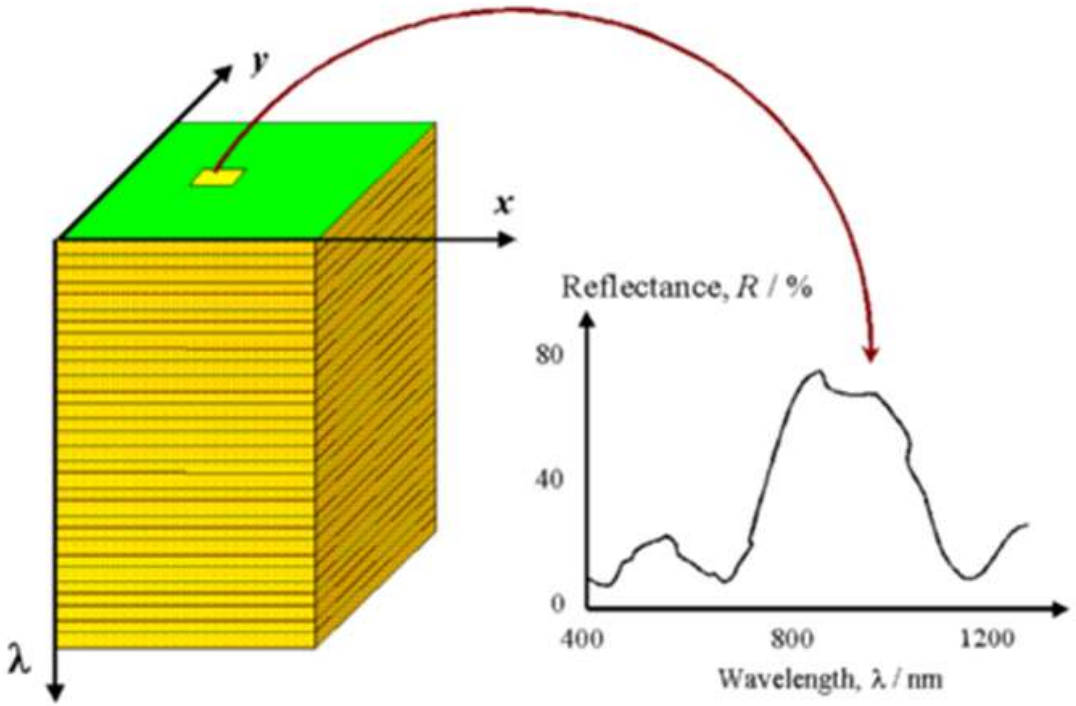
Key metrics:

- ❑ Structural
  - tidal channel geometry
  - Topography
- ✓ Vegetation community
  - Salmo –centric: prey production

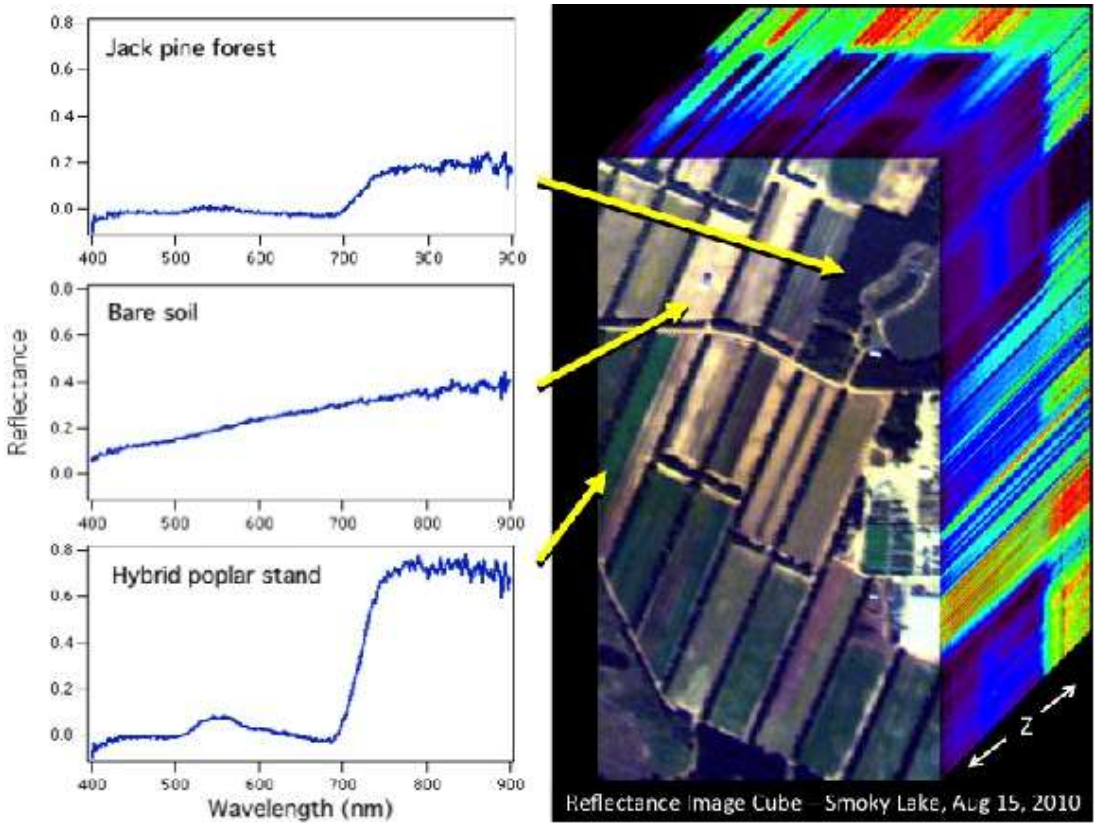
➢ Equip a drone system with a hyperspectral imager and develop methods to measure restoration trajectories.

Principals of Hyperspectral Imagery

Hyperspectral Datacube:
(Spatial pixels) * spectral channels
(X * Y) * λ



Spectral signatures used for object identification



Principles of Remote Sensing - Centre for Remote Imaging, Sensing
...www.crisp.nus.edu.sg

Colewort Creek National Historical Park

PROJECT GOALS

1. Equip and test a UAV system with a hyperspectral imager.

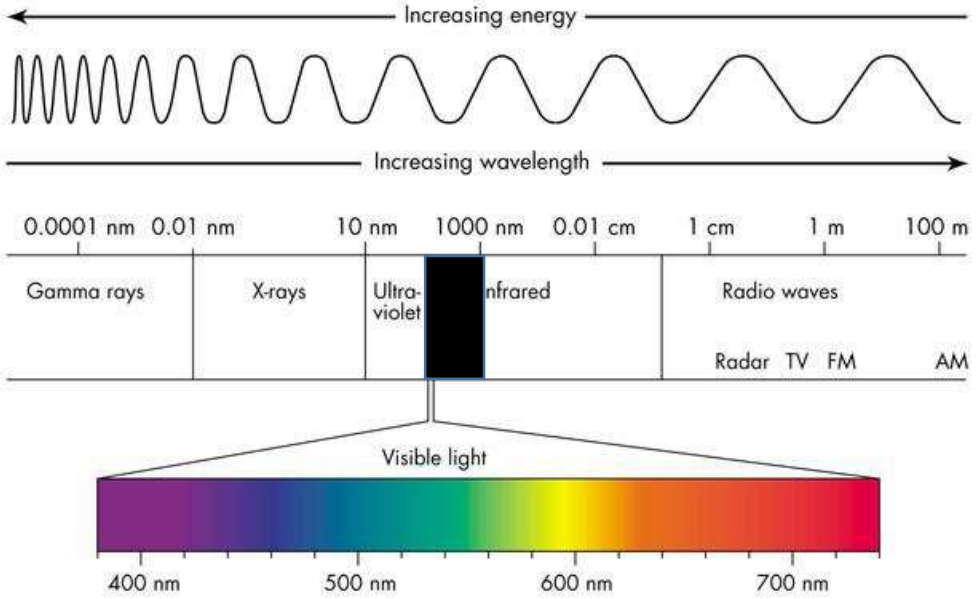
2. Conduct field measurements, and build Spectral Library

3. Develop data analysis routines and analytics for critical metrics.

4. Test Procedures at other Field Sites

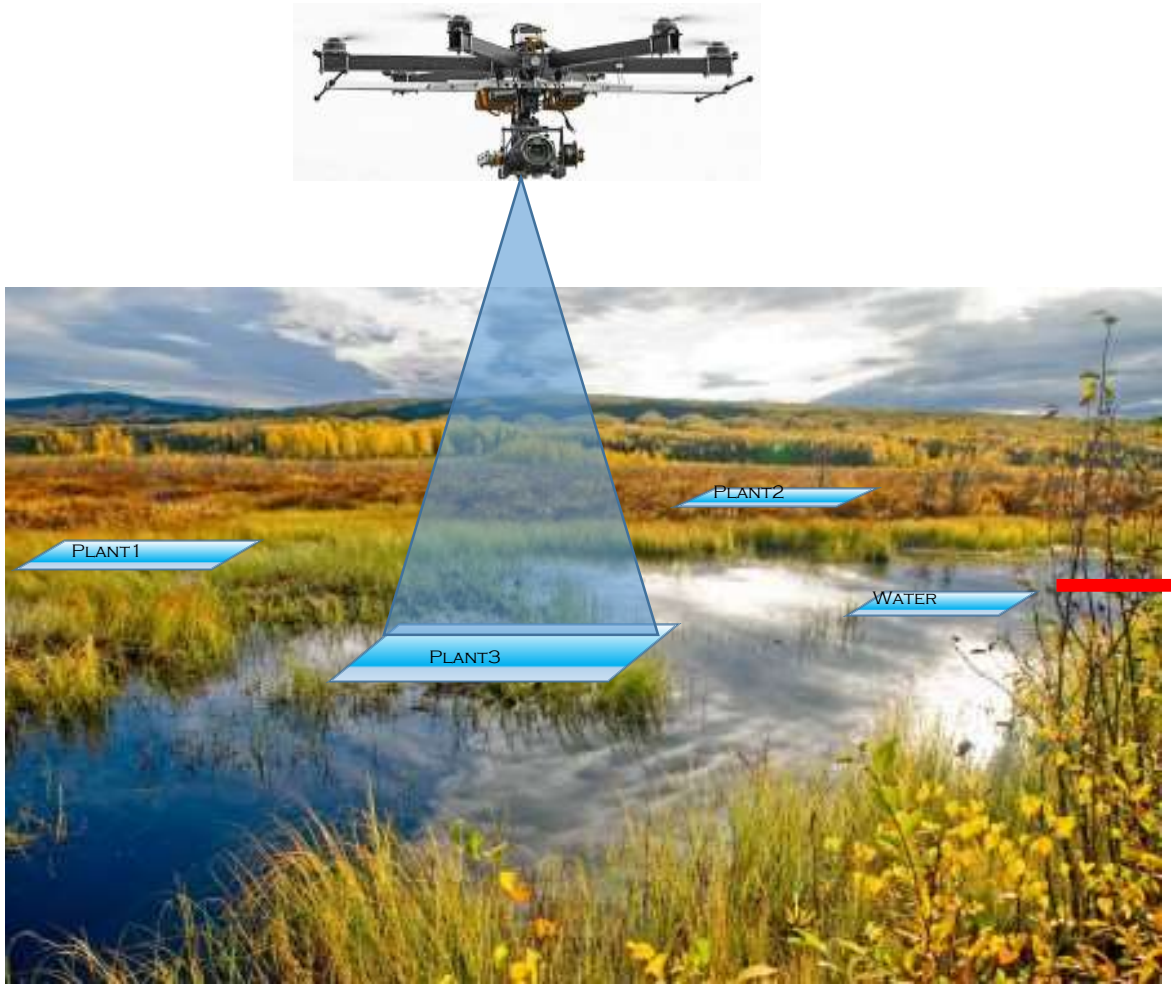
Hyperspectral Camera Characteristics

- BaySpec OCI-100 BP150
  - Pushbroom Hyperspectral Imager
  - Spatial Pixels: 2000 pix x scan-length
  - Spectral Range: 450-970nm
  - Spectral Resolution: 5nm
  - Spectral Bands: 104
  - Speed: 120 fps



SPECTRAL LIBRARY

Catalog of object-specific spectra



Data Acquisition

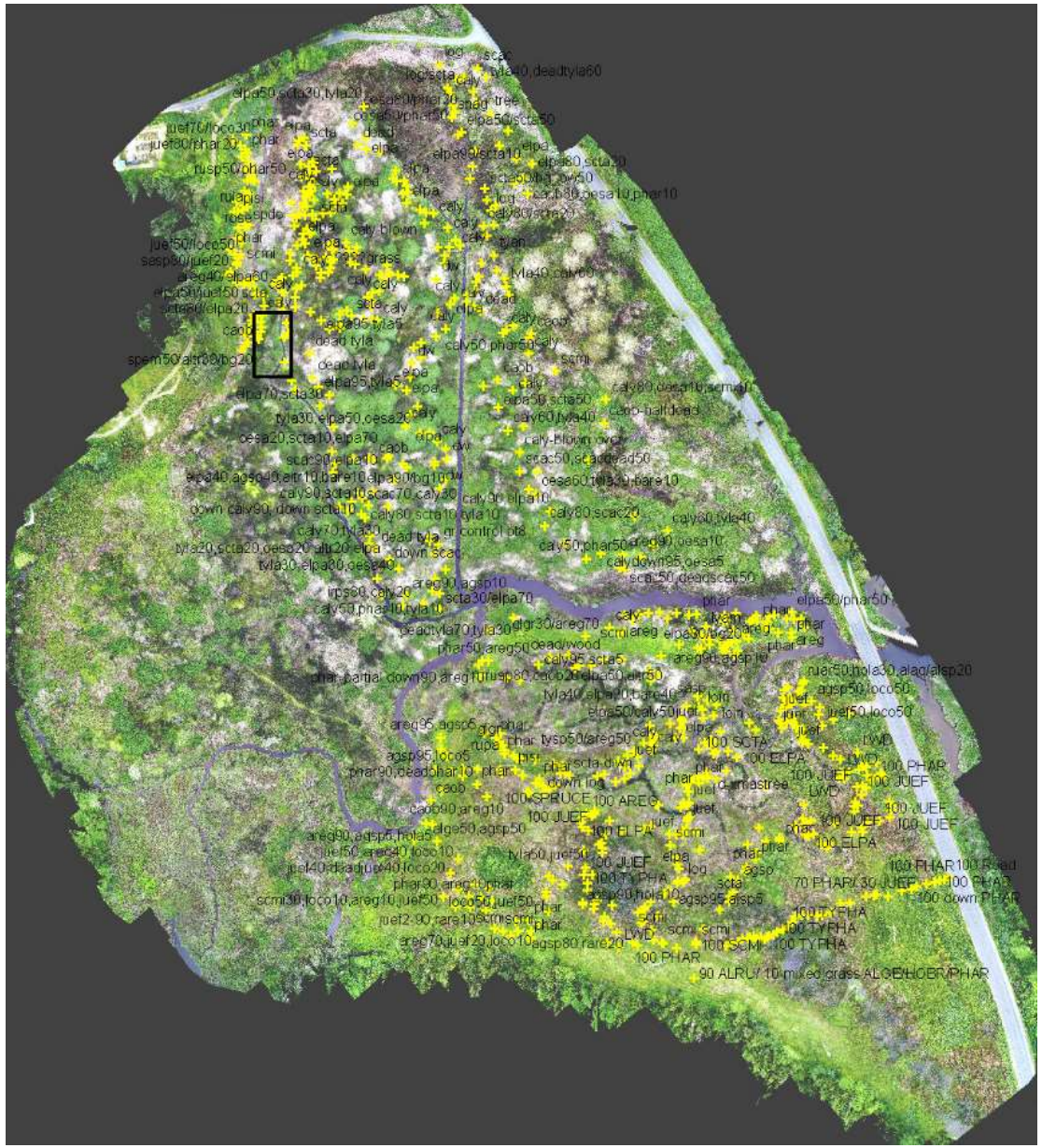
Spectral signatures of vegetation and topographic features:

Herb	Shrub	Tree	Other Object
Sps 1	Sps1	Sps 1	Bare Ground
Sps 2	Sps 2	Sps 2	Water
Sps 3…	Sps 3…	Sps 3…	Structure

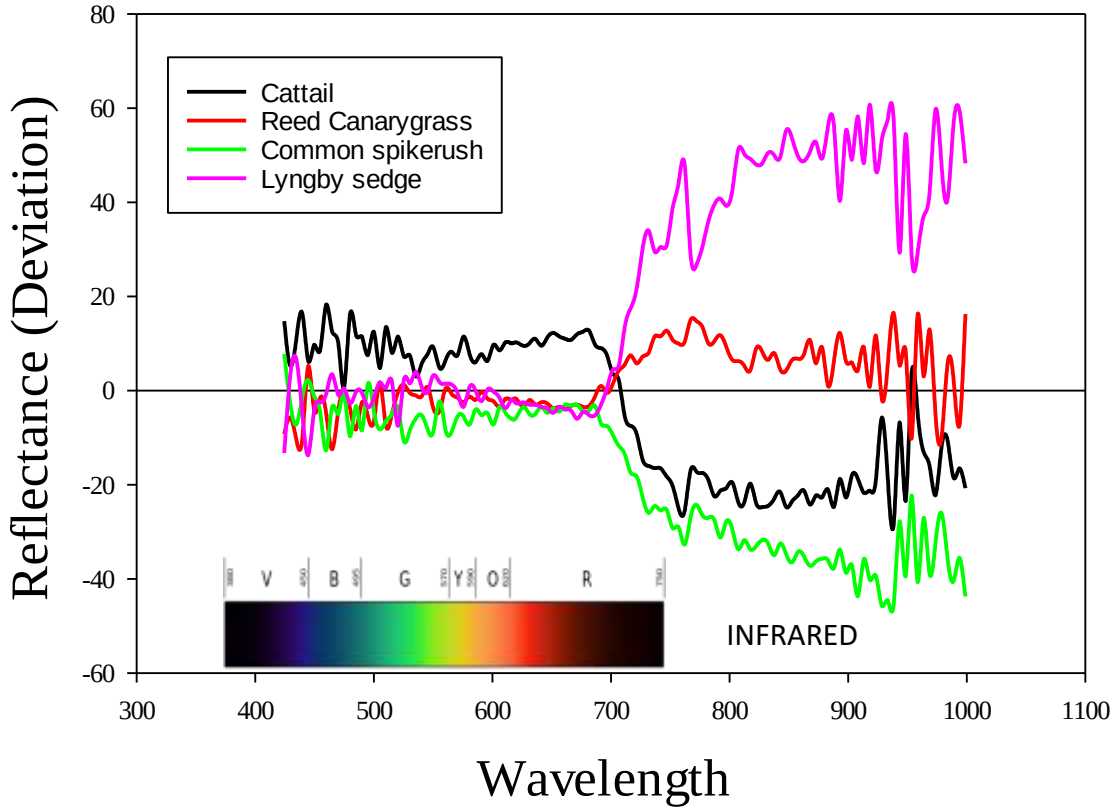
Spectral Library

1. Ground-truthed for PNW habitats
2. Open sourced

Colewort Creek Ground truth stations



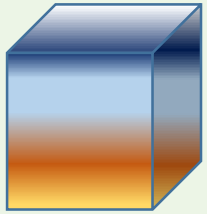
Spectral signatures of Key vegetation Types



Automation of Object Identification

Data Collection

Survey wetlands



DataCube

Analytics

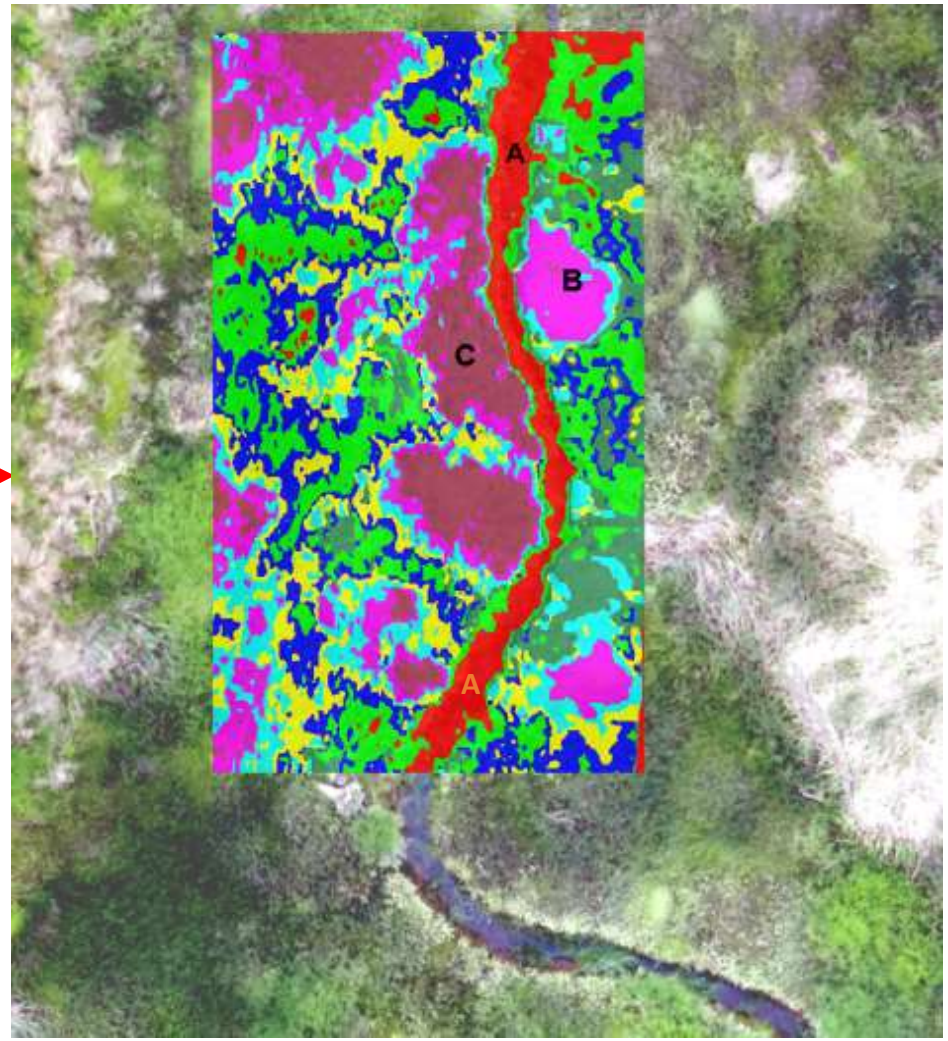
Spectral Library

Herb	Shrub	Tree	Other Object
Sps 1	Sps1	Sps 1	Bare Ground
Sps 2	Sps 2	Sps 2	Water
Sps 3...	Sps 3...	Sps 3...	Structure

Filters

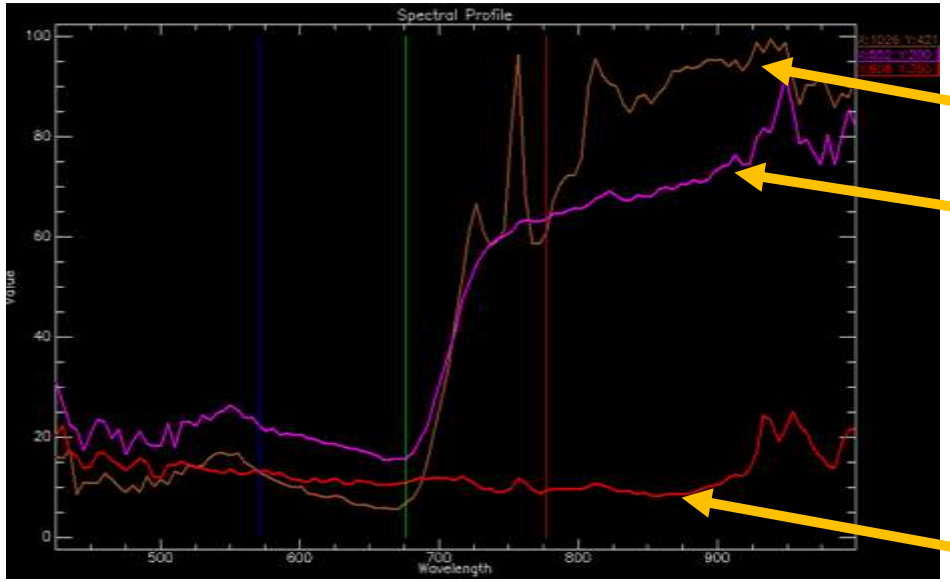
Dialogs

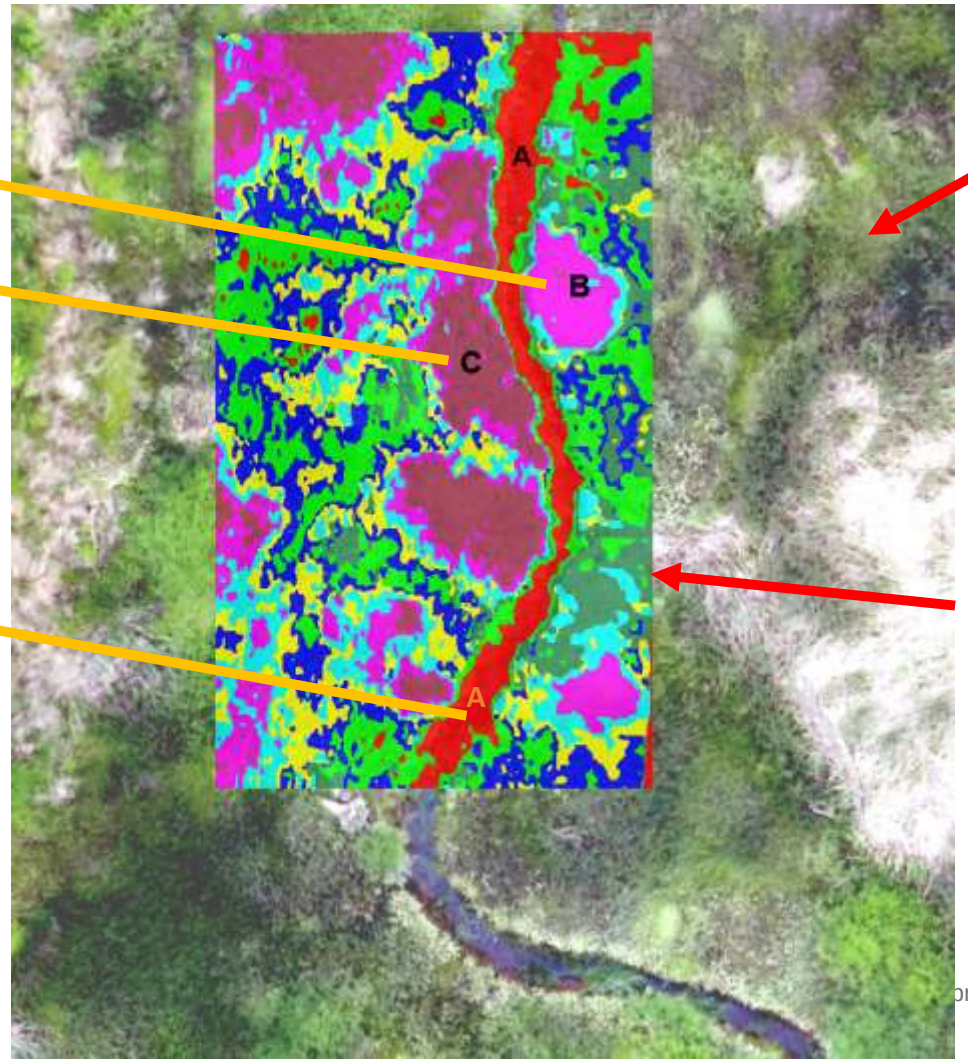
Output (categorized maps & statistics)



Hyperspectral Processing: Colewort Creek NHP test site

- Example Hyperspectral Classification
  - Distinct spectral signature





RBG IMAGE

CATEGORIZED IMAGE

- A = Water
- B = Common spikerush & bentgrass
- C = Lyngby sedge

True Color (RGB)

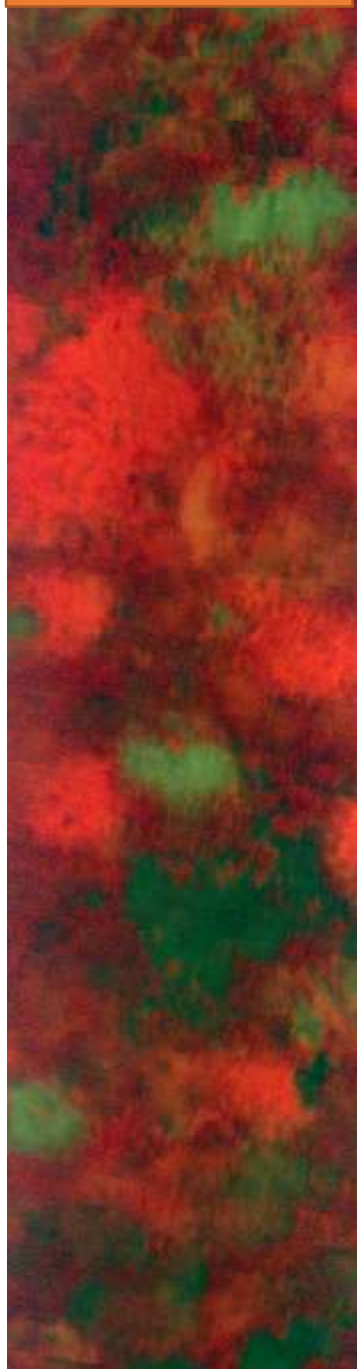
Dead Typha latifolia
(common cattail)

Carex lyngbyei
(Lyngby sedge)

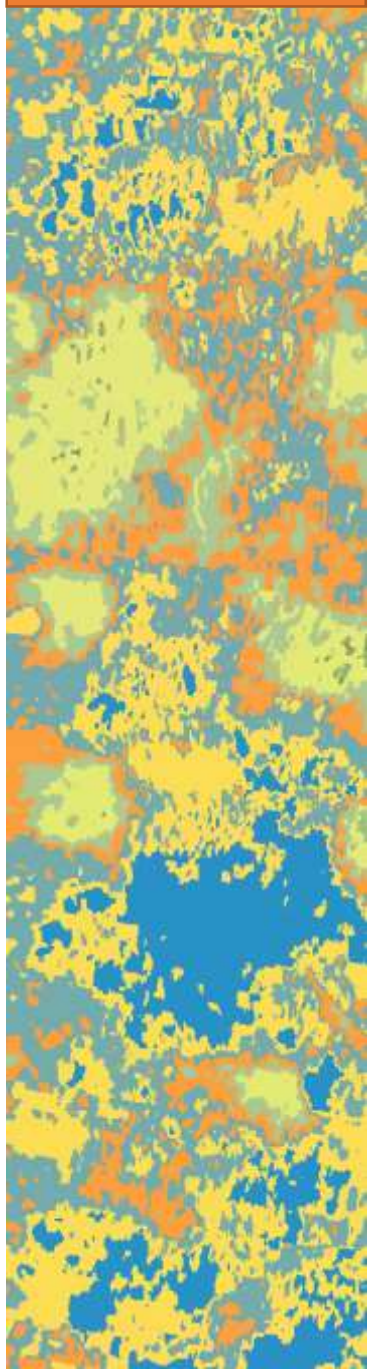
Eleocharis palustris
(Common spikerush)

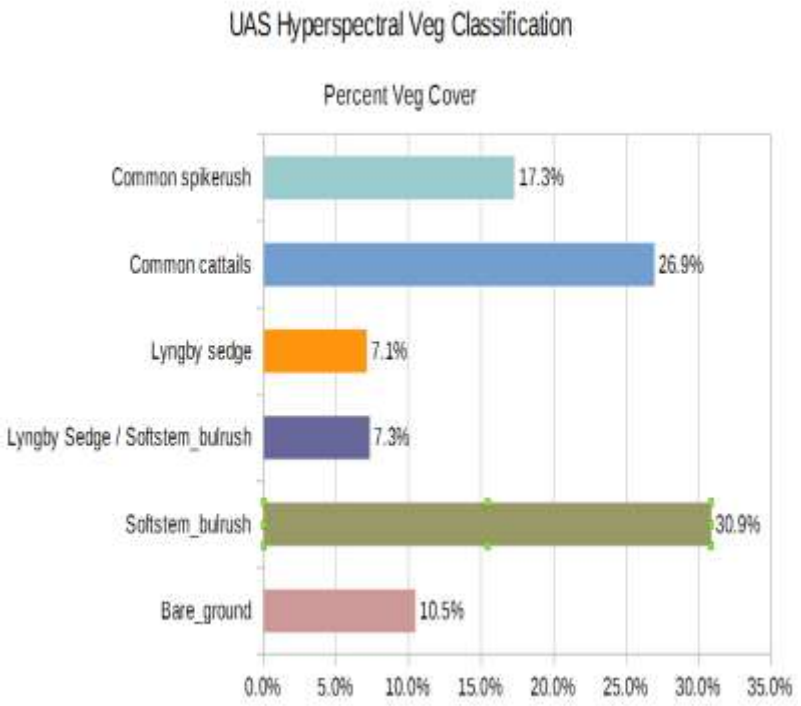
Bare Ground &
20% Eleocharis palustris
(Common spikerush)

Hyperspectral



Classified





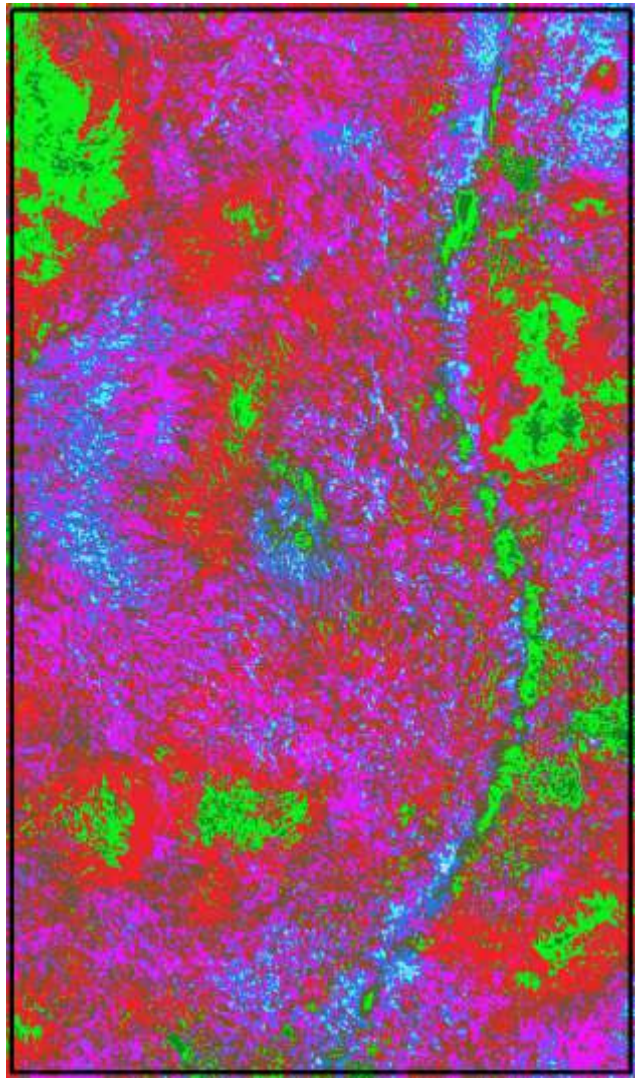
Utility

1. Mapping habitats
2. Restoration trajectory
3. Tidal channel evolution
4. Invasive monitoring
5. Spatial modeling
6. ....others!

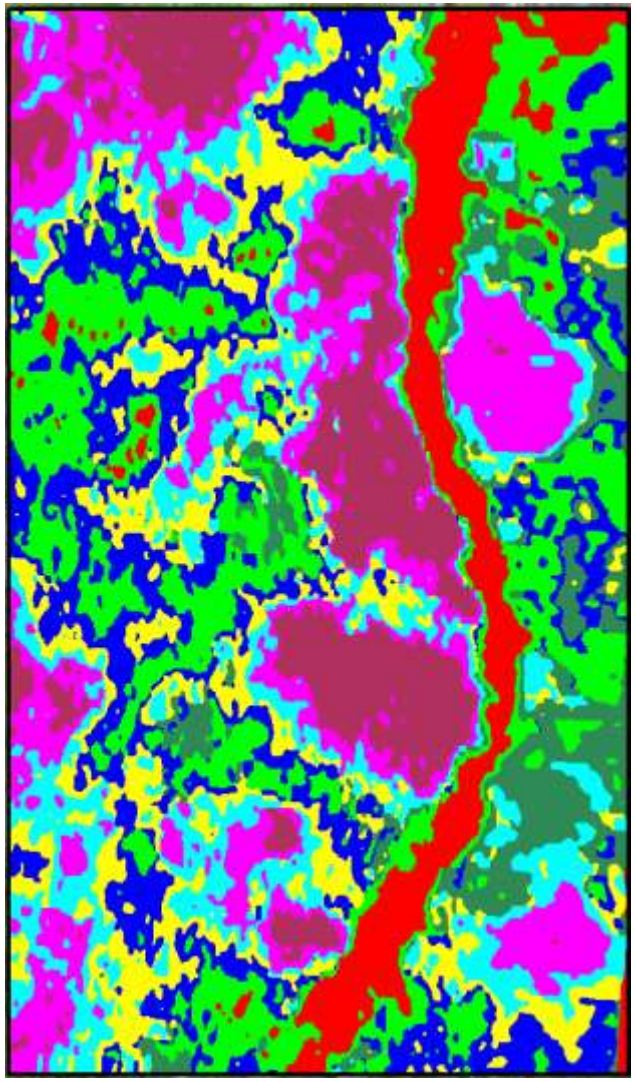
RGB True Color Classification

- Limited spectral information in RGB data leads to poor discrimination in classification

True Color



Hyperspectral

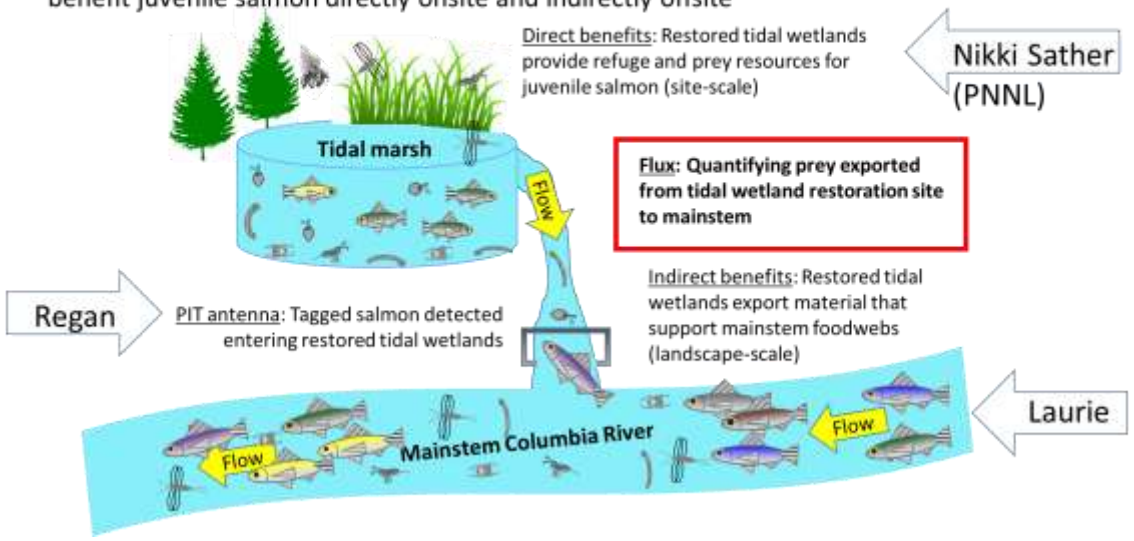


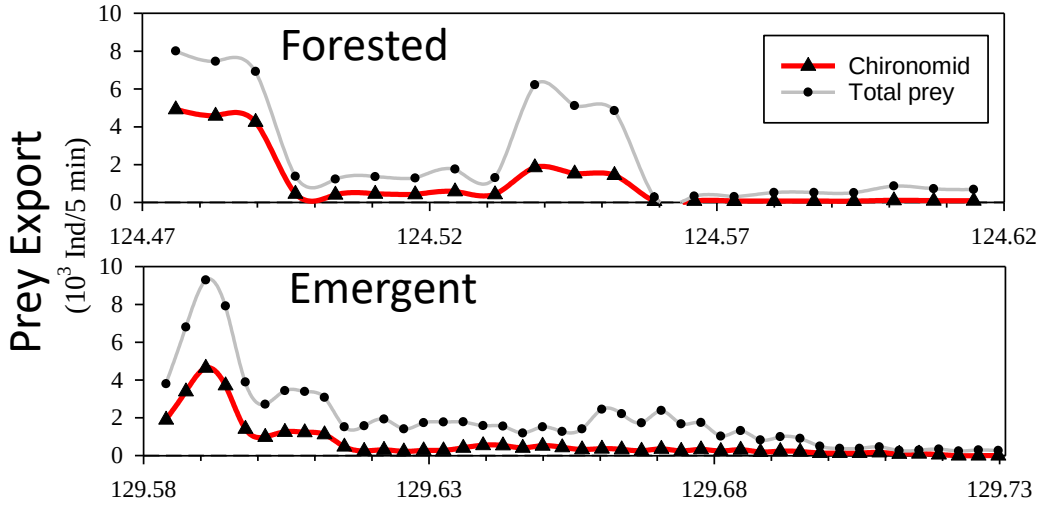
Orthophotogammetry

KARLSON

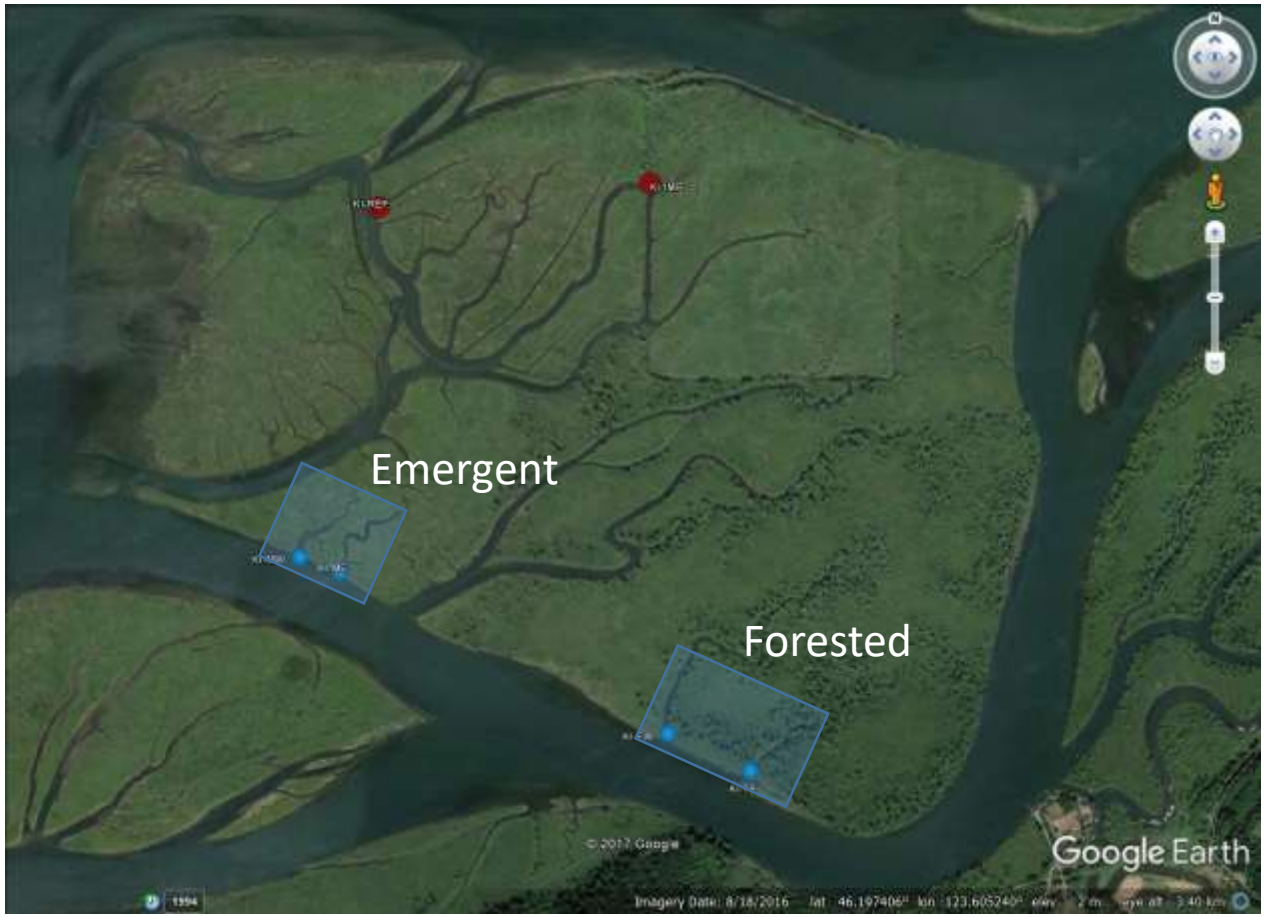
Action Effectiveness Monitoring Research (AEMR)

Conceptual model: Prey production in restored tidal wetlands benefit juvenile salmon directly onsite and indirectly offsite



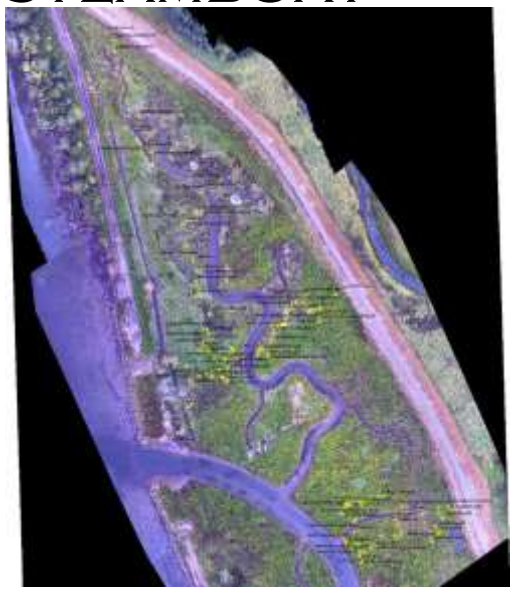


Day of year 201



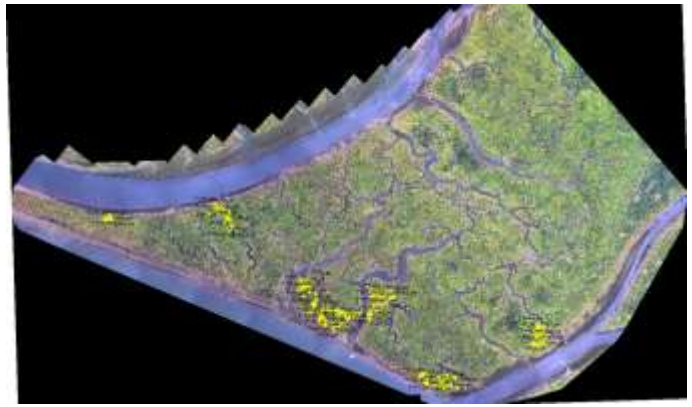
COLEWORT

STEAMBOAT



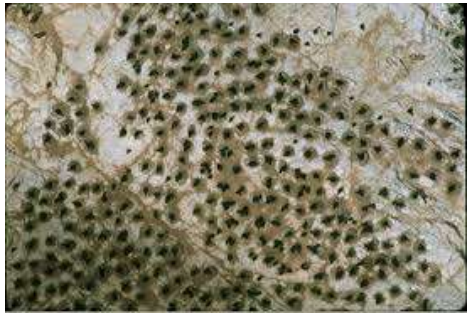
NOAA UAS PROJECT

KARLSON



OTHER APPLICATIONS

Algal Blooms



Bird colonies & Sea lion Haul-outs

Seagrasses// Oyster culture

Funding from NOAA UAS and NOAA Fisheries