QUANTIFYING RESTORATION OF JUVENILE SALMON HABITAT WITH AN UNMANNED AERIAL VEHICLE SYSTEM

~Mission Concept Review~

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3 August 2016

Project Scope

1. Wetlands directly benefit endangered juvenile salmon by supporting diverse vegetation communities.

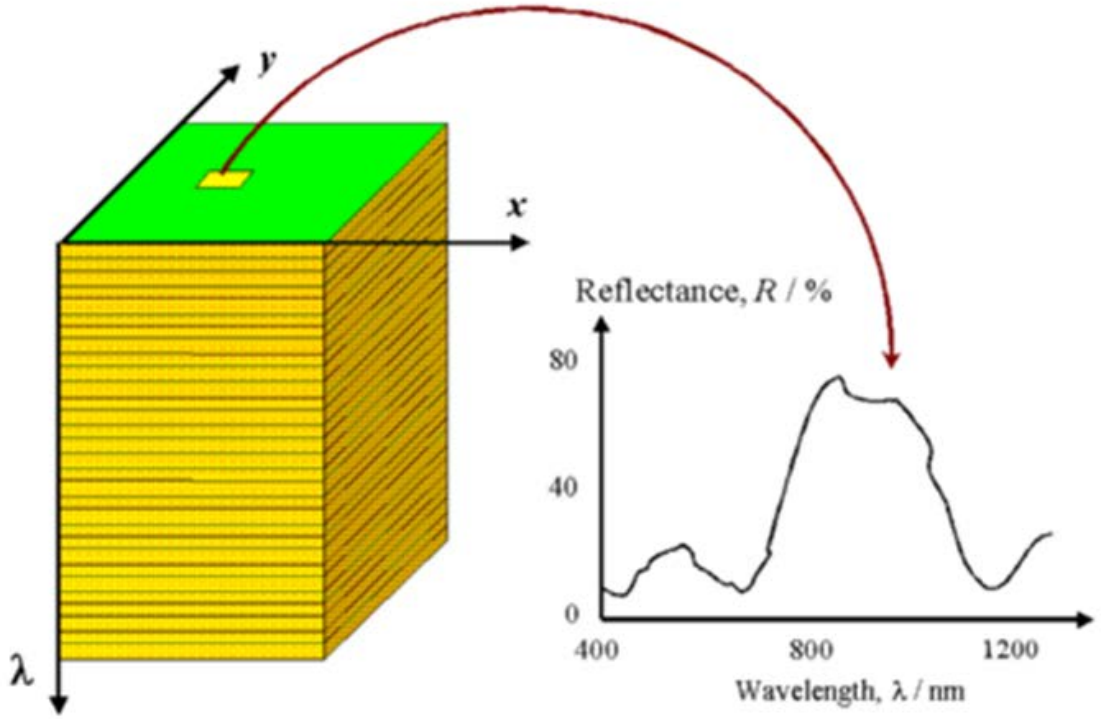
2. Restoration of degraded wetlands leads to vegetation and topographic changes that require comprehensive monitoring – difficult to accomplish w/traditional means.

3. Our project: Develop remote sensing techniques employing hyperspectral imagery on a UAS to monitor wetland restoration trajectories.

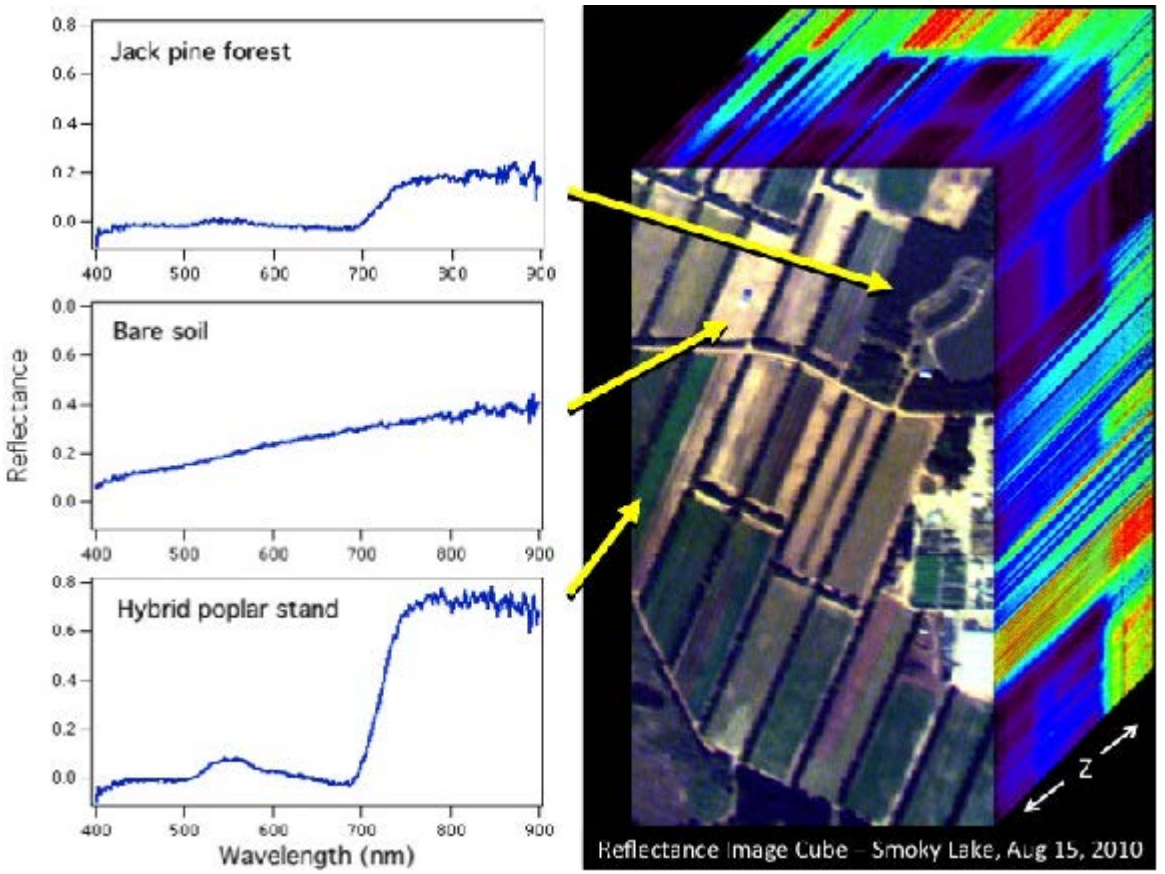
Project Goals

1. *Equip* a UAV system with a hyperspectral imager.
2. *Construct* a spectral library of plant communities and environmental attributes.
3. *Develop* data analysis routines and analytics for critical metrics.
4. *Conduct* flight optimization and evaluation missions at selected tidal wetland systems.
5. *Codify* protocols for remote sensing to aid evaluation of wetland restoration trajectories and management decision making.

Hyperspectral Datacube: X * Y * λ



Spectral signatures



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

TASK 1: EQUIP UAS WITH HYPERSPECTRAL IMAGER

BaySpec *OCI*-F (www.bayspec.com)

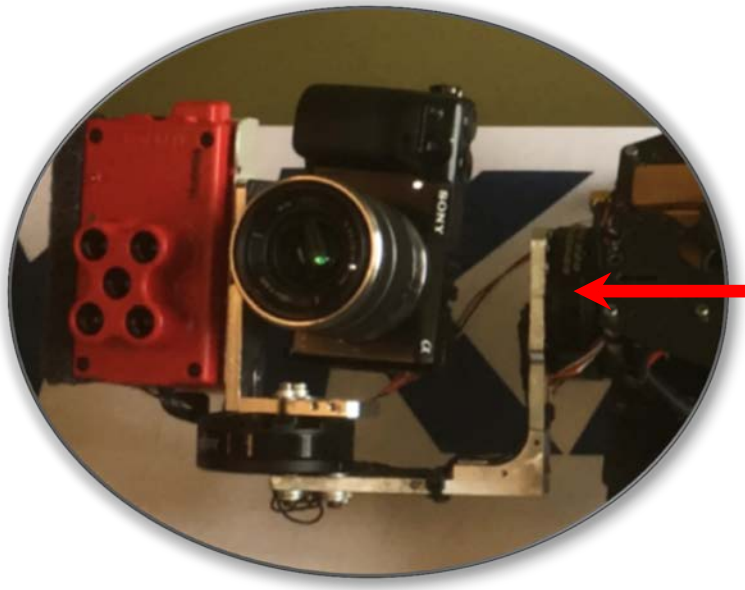
- PUSH-BROOM HYPERSPECTRAL CAMERA
- 14 CM X 7 CM X 7 CM; ~570 G
- 400-1000 NM VNIR WAVELENGTH RANGE
- 110 SPECTRAL BANDS

	Specifications
Operation Mode	Push-broom
Spectral Range	400-1000 nm
Number of Spectral Bands	Up to 110
Spectral Resolution	5-7 nm FWHM
Spatial Pixels	800 px X scan-length
Standard Lens2	16 mm (21° FOV)
Exposure Time	20 µs - 1 s
Wavelength Calibration	Factory calibrated (calibration fixed permanently)
Objective Lens Interface	C-mount
Frame Rate	Up to 50 frames/sec
Software	Included with BaySpec's SpecGrabber for camera control and data acquisition, and CubeCreator for hyperspectral data processing
Data Format	Hyperspectral cube (ENVI-BSQ), Color image (BMP), Band image (BMP), ROI spectra (CSV format)
Operating Temperature	0°C to 50°C
Power Consumption	< 3 W (USB 3.0 power)
Weight	~ 570 g (including standard lens)
Size	14 cm x 7 cm x 7 cm (including standard lens)
Camera Interface	USB 3.0

Matrix Quad – N52RY

Control

- APM Autopilot
- U-Blox Neo-M8 GPS (with redundancy)
- Mission Planner & UGCS flight controller
- Dual Channel GPS logger



Payload Capabilities

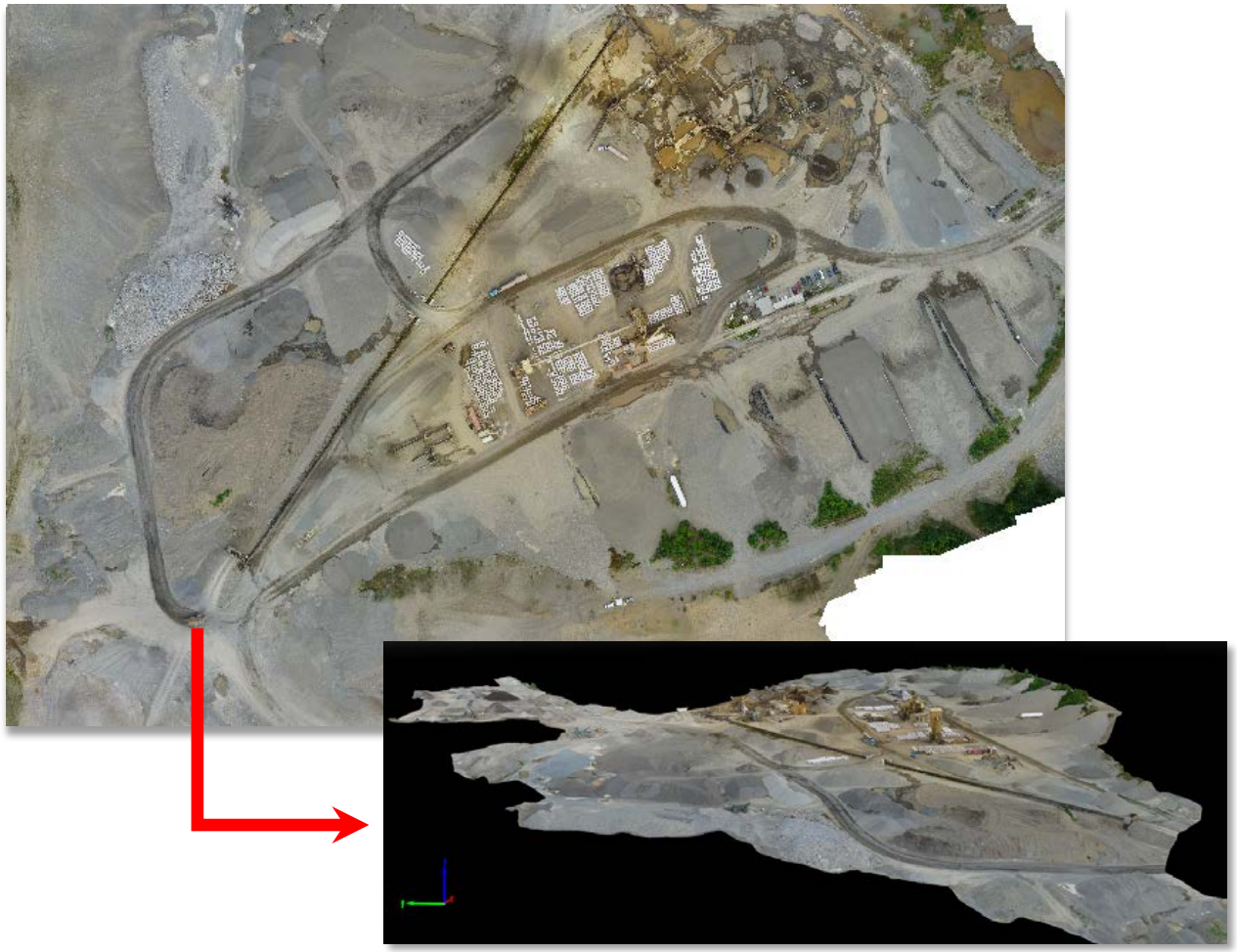
- Modified Gimbal to allow multiple cameras
- Synced images (Stereo image capture)
- Closed looped Geo-tagging

Flight time- 18 Minutes (fully loaded)/50-65 Acres at 1.3cm Ground sampling distance

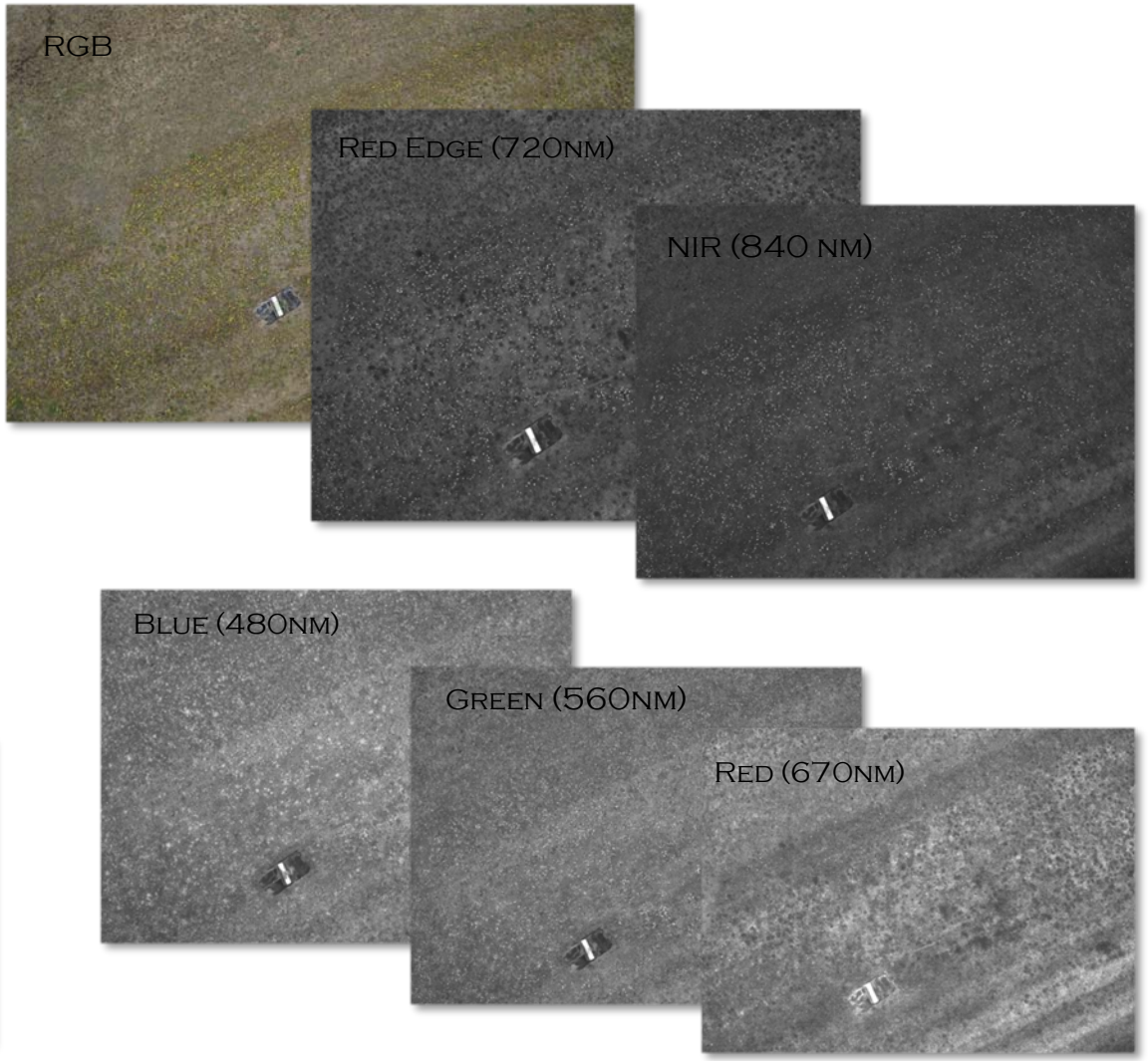
Battery – 16,000mah max amps 20c

Hi-Resolution 2D Ortho (<1.5cm GSD)

- >200 Acres
- .5in US survey Ft. RMS Error.

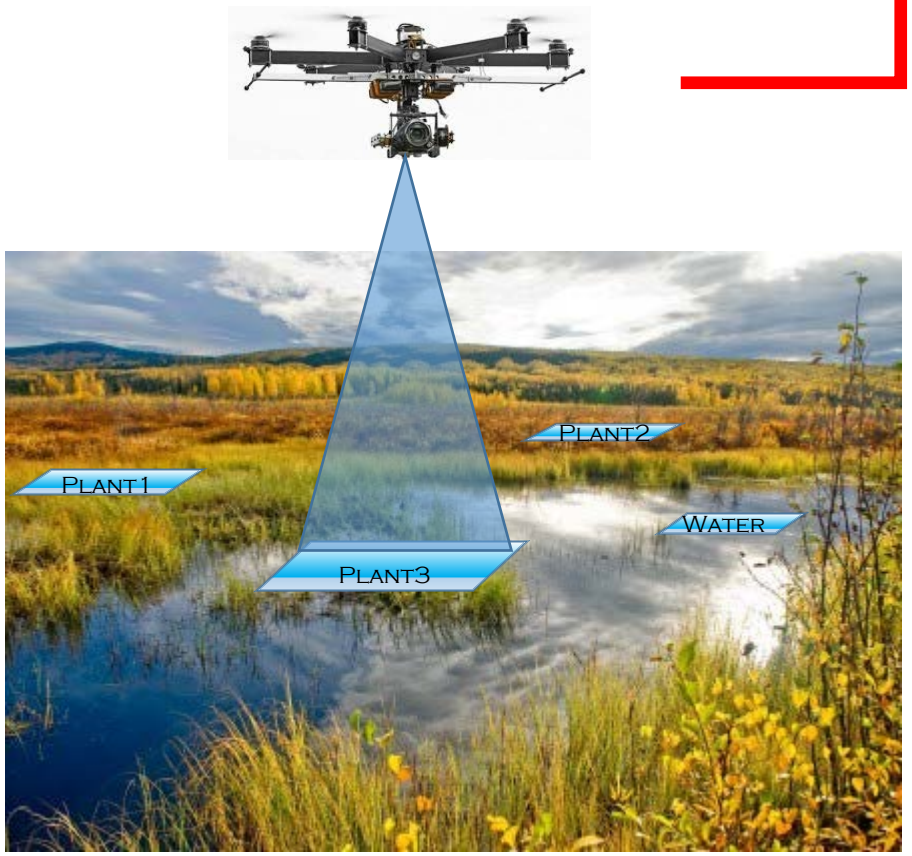


Stereo Data Set from Matrix/Multi-Spectral

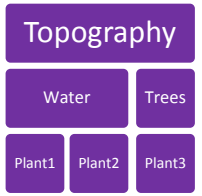


TASK 2: SPECTRAL LIBRARY

Data Acquisition of Vegetation and Topographic features

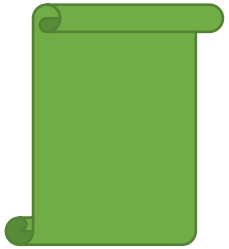


TASK 3: ANALYTICS



Spectral Library: Catalog of object-specific spectra

Filtering: Identification of unique spectral signatures



Dialogs for Output metrics:

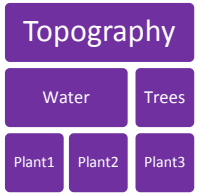
- Vegetation species/community
- Channel morphometrics
- Tidal inundation extent
- Quantification of large woody debris
- Change analysis - seasonal, interannual

TASK 4: VERIFICATION FIELD TRIALS

SURVEY WETLANDS

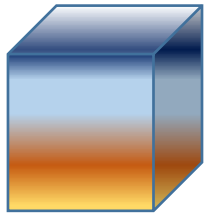
TEST PROTOCOLS & ANALYTICS

SPECTRAL LIBRARY

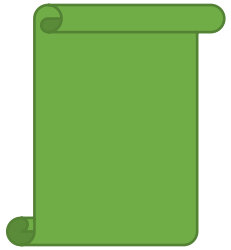


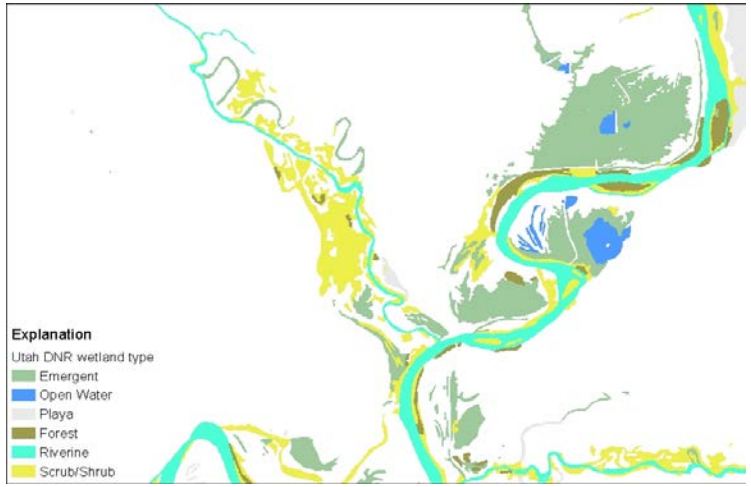
FILTERS

DATACUBE



DIALOGS

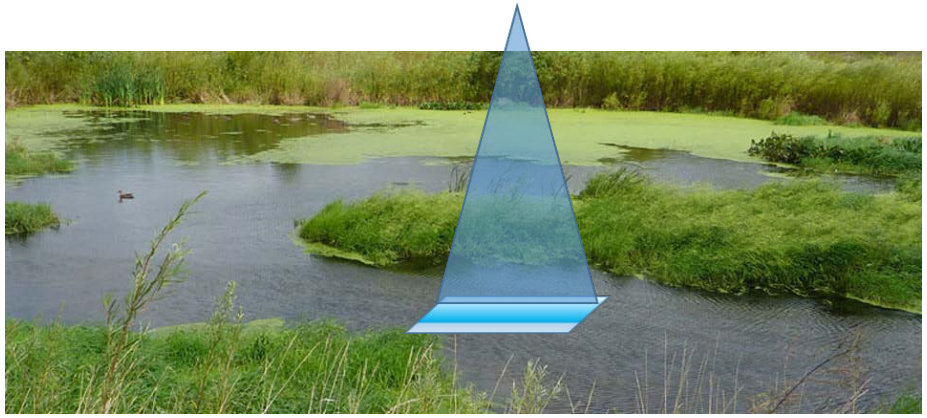




OUTPUT: MAPS & STATISTICS

VEGETATION MAPS OVERLAID WITH TERRAIN MAPS IN GIS (BUT MUCH HIGHER RESOLUTION THAN THIS EXAMPLE!!)

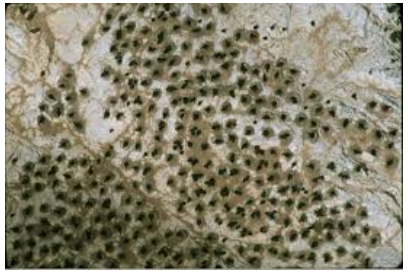
End-user & technology transfer: Remote sensing of varied wetland systems



NOTE: Techniques applicable to wide variety of environments

Algal Blooms

Seagrasses



Bird colonies

TASK 5: Project deliverables:

1) establishment of an updateable, open source *spectral library* for estuarine/wetland environments;

2) *protocols for flight operations* including appropriate flight speed and scale impacts due to sample altitude

3) *protocols for image processing*, *analytics, and applications* to wetland feature extraction, vegetation classification, and hydrologic characterization

Summary of flight ops

- TASK 2: Directed flight missions to image specific object classes (vegetation, water, woody debris, ect)

- TASK 4: Survey flight pattern with GPS waypoints.

Technology Readiness Level

Transition Index	Technology Readiness Level	Description
Research	TRL 1	Basic or fundamental research
Research	TRL 2	Technology concept and/or application
Development	TRL 3	Proof-of-concept
Development	TRL 4	Concept validated in laboratory
Development	TRL 5	Concept validated in relevant environment
Demonstration	TRL 6	Prototype demonstration in relevant environment
Demonstration	TRL 7	Prototype demonstration in operational environment
Demonstration	TRL 8	System demonstration in an operational environment
Application	TRL 9	System totally operational

PROJECT START

YEAR 1

YEAR 2 (if funded)