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

Curtis Roegner

NOAA Fisheries

8 March 2017

Project Background

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.

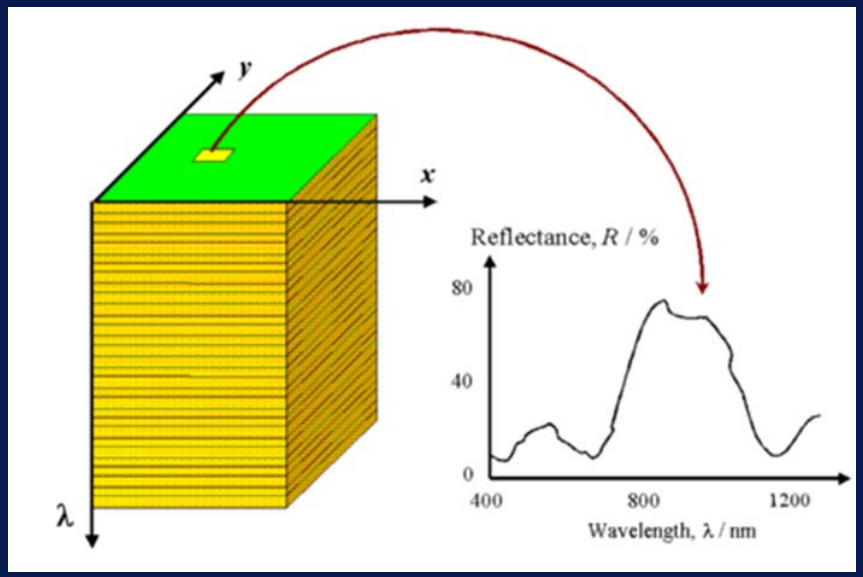
3. Develop data analysis routines and analytics for critical metrics.

4. Conduct flight optimization and evaluation missions at selected tidal wetland systems.

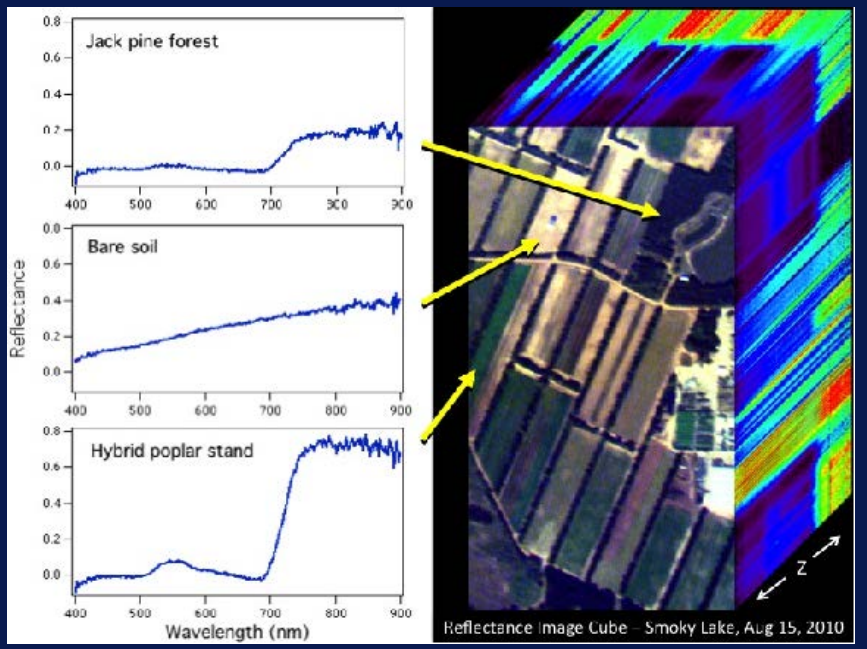
5. Codify protocols for remote sensing to aid evaluation of wetland restoration trajectories and management decision making

Principals of Hyperspectral Imagery

Hyperspectral Datacube: X * Y * λ



Spectral signatures used for object identification



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

TASK 1: Equip UAS with a 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

UAS SPECIFICS

RYKA UAS

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)
- Flight time- 18 Minutes (fully loaded)/50-65 Acres at 1.3cm Ground sampling distance
- Closed looped Geo-tagging
- Battery – 16,000mah max amps 20c

UAS SPECIFICS

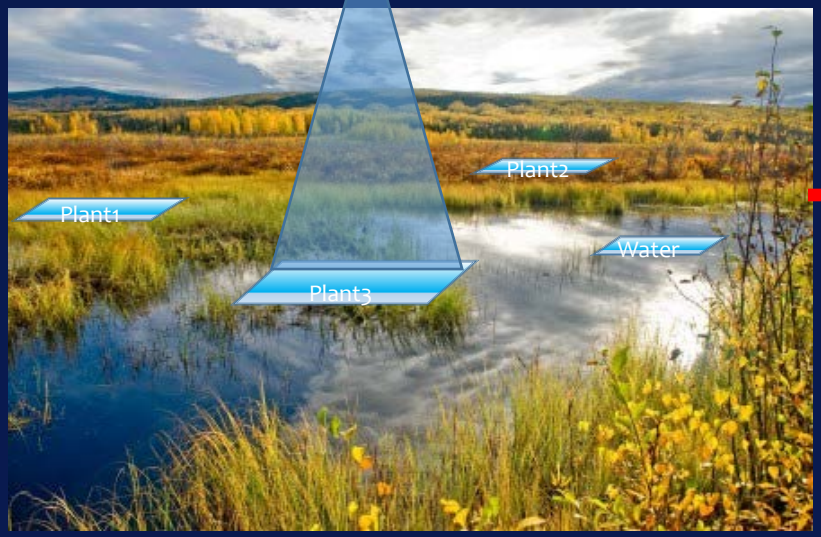
TASK 1 Progress:

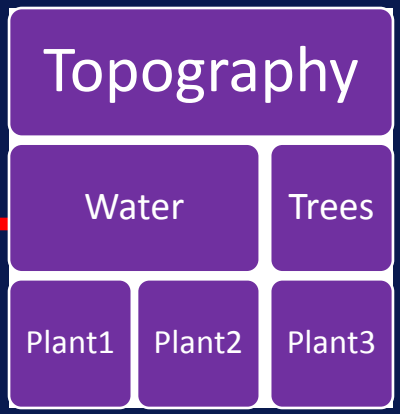
- Integrated imager & gimbal onto UAS
- Performed initial test flights
- Ready for field trials

TASK 2: CONSTRUCT A SPECTRAL LIBRARY

Data Acquisition of Vegetation and Topographic features: Spectral signatures

Spectral Library: Catalog of object-specific spectra



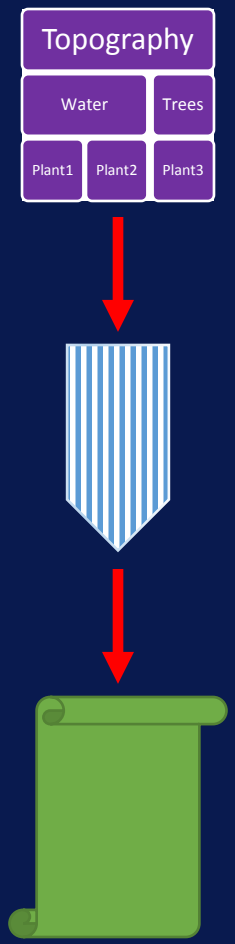


TASK 2: CONSTRUCT A SPECTRAL LIBRARY

TASK 2 Progress:

- Acquired /submitted permits including:
- FAA approvals for restricted airspace
- Certificate of authority (COA) Approved for Lewis and Clark National Park
- Awaiting on NPS approval flight
- First field trials scheduled for March-April

TASK 3: DEVELOP ANAYLTIC ROUTINES



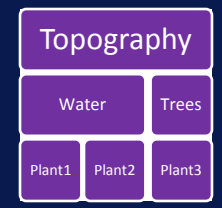
Spectral Library:
Catalog of object-specific spectra

Filtering:
Identification of unique spectral signatures

Dialogs for Output Metrics:

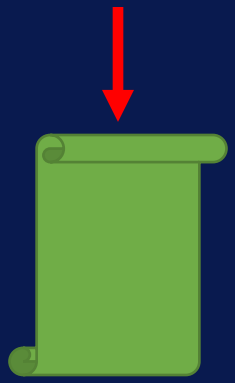
- Vegetation species/community
- Introduced species
- Channel morphometrics
- Tidal inundation extent
- Change analysis – Pre / post restoration
  – Seasonal-interannual

TASK 3: DEVELOP ANAYLTIC ROUTINES

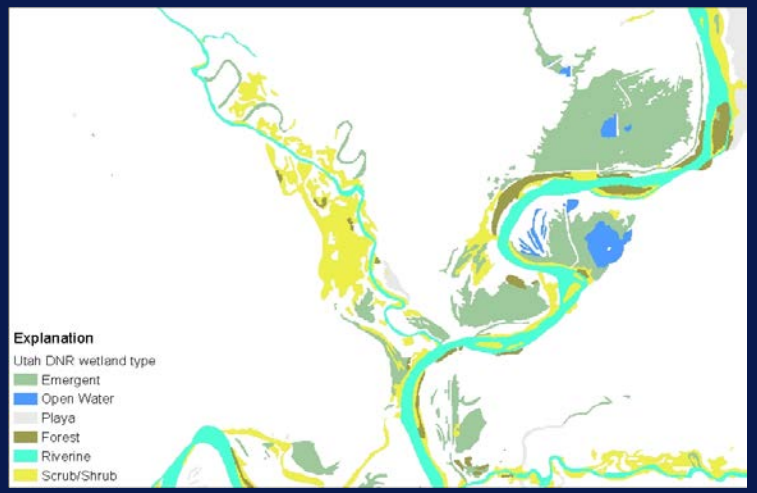


Spectral Library

Filters



Dialogs

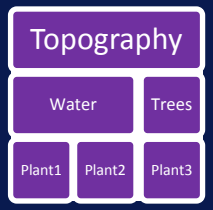


OUTPUT: maps & statistics

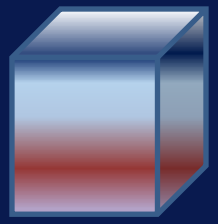
- Vegetation maps overlaid with terrain maps in GIS
- Percent cover of plants/terrain
- Input for models

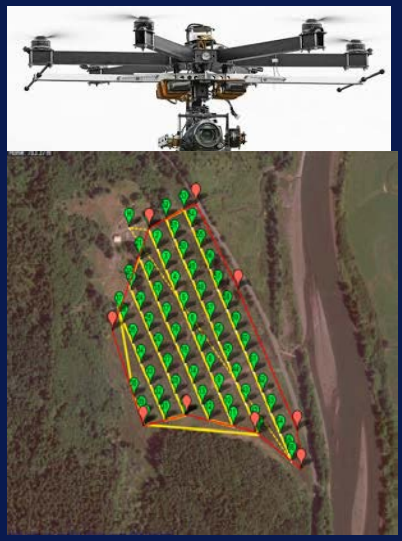
TASK 4: Verification field trials

Spectral Library



DataCube

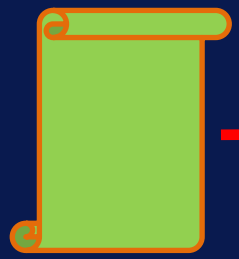




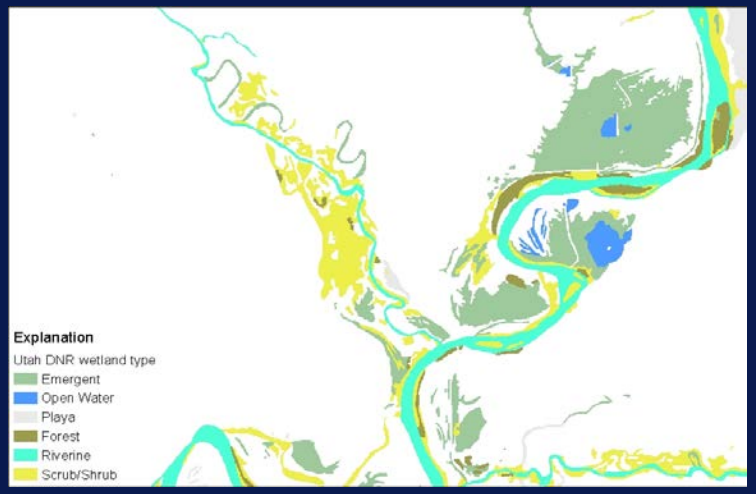
Survey wetlands
test protocols
& analytics

Filters

Dialogs



OUTPUT: maps & statistics



TASK 5: Project deliverables

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

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

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

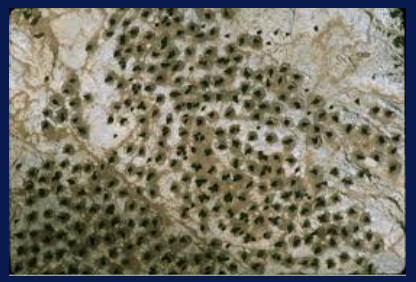
End-user & technology transfer:
Remote sensing of varied wetland systems

End-user & technology transfer:

Techniques applicable to wide variety of environments

Algal Blooms

Seagrasses



Bird colonies
Sealion haulouts

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: 6/ 2016

CURRENT STATUS

Collaborators

Dr. Curtis Roegner – Principal Investigator

Joe Aga – Pilot and aircraft fabrication
George Pierce – Pilot
Robert Erdt – GIS and image analysis

Amy Borde – Senior Scientist wetlands naturalist
Andre Coleman – Remote sensing and spatial modeling

Carla Cole – Natural Resources Manager

Funding and Support

UASPO: Robbie Hood
Justyna Nicinska
John Coffey