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

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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: $X \times Y \times \lambda$

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

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

![Diagram of spectral library and data acquisition for vegetation and topography]
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 ANALYTIC 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 ANALYTIC ROUTINES**

**Spectral Library**
- Topography
- Water
- Trees
- Plant1
- Plant2
- Plant3

**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

- Topography
- Water
- Trees
- Plant1
- Plant2
- Plant3

DataCube

Survey wetlands test protocols & analytics

OUTPUT: maps & statistics

Filters

Dialogs

UAS PO Science Review, March 8-10, 2017
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

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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

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