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Mapping eelgrass (Zostera sp.) habitat in Padilla Bay, WA, using an unmanned aerial system (UAS)

David Wallin
Western Washington Univ., United States, david.wallin@wwu.edu

Sylvia Yang
Western Washington Univ., United States, sylvia.yang@wwu.edu

Jefferson Emm
Western Washington Univ., United States, jeffersonemm@wwu.edu

Jude K. Apple
Padilla Bay National Estuarine Research Reserve, United States, JAPP461@ECY.WA.GOV

Suzanne Shull
Padilla Bay National Estuarine Research Reserve, United States, sshull@padillabay.gov

See next page for additional authors

Speaker
David Wallin, Sylvia Yang, Jefferson Emm, Jude K. Apple, Suzanne Shull, and Heath Bohlmann

Mapping eelgrass (*Zostera sp.*) habitat in Padilla Bay, WA using small Unmanned Aerial system (sUAS)

David Wallin, Sylvia Yang, Jefferson Emm,
Western Washington University
Bellingham, WA
david.wallin@wwu.edu

Jude Apple, Suzanne Shull, Heath Bohlmann
Padilla Bay National Estuarine Research Reserve
Mt Vernon, WA

Ecosystem Services provided by Eelgrass

- Eelgrass provides critical habitat for a wide range of species including salmon and Dungeness crab
- Carbon sequestration ("Blue Carbon")
- Moderation of storm surge

Alternative Approaches: Why UAS?

Method	Cost	Tidal "noise"	Spatial Resolution	Spatial Extent	Data Richness
Satellite Imagery	Free-moderate	High	1-30 m	10,000s km^2	Low: Cover type only
Manned aircraft	High	Moderate	cm – m	100s-1000s km^2	Low-moderate: Cover type +
sUAS	Low	Low?	cm	10s-100s ha	??
Ground Survey	High	None	cm	1-2 m^2 plots	High: Species ID, % cover, biomass, stem density….

Objectives

- Evaluate the potential for using sUAS to quantify seasonal and interannual variation in eelgrass beds. Ideally:
  - Species ID; *Zostera marina* vs. *Zostera japonica*, kelp, algae
  - % Cover
  - Stem density
  - Biomass

- Methodological Issues:
  - Altitude (image resolution)
  - Quadcopter vs. Fixed-wing
  - Cameras
  - Image processing
  - Adequate Ground Control Points to facilitate linkage of imagery to ground survey plots

UAS platforms

- 3DRobotics Solo
  - ~2 kg with 0.5 kg payload
  - 12-15 minutes flight time
- Aeromao Aeromapper
  - ~3-4 kg including payload
  - ~50 minutes of flight time
  - 2 m wingspan

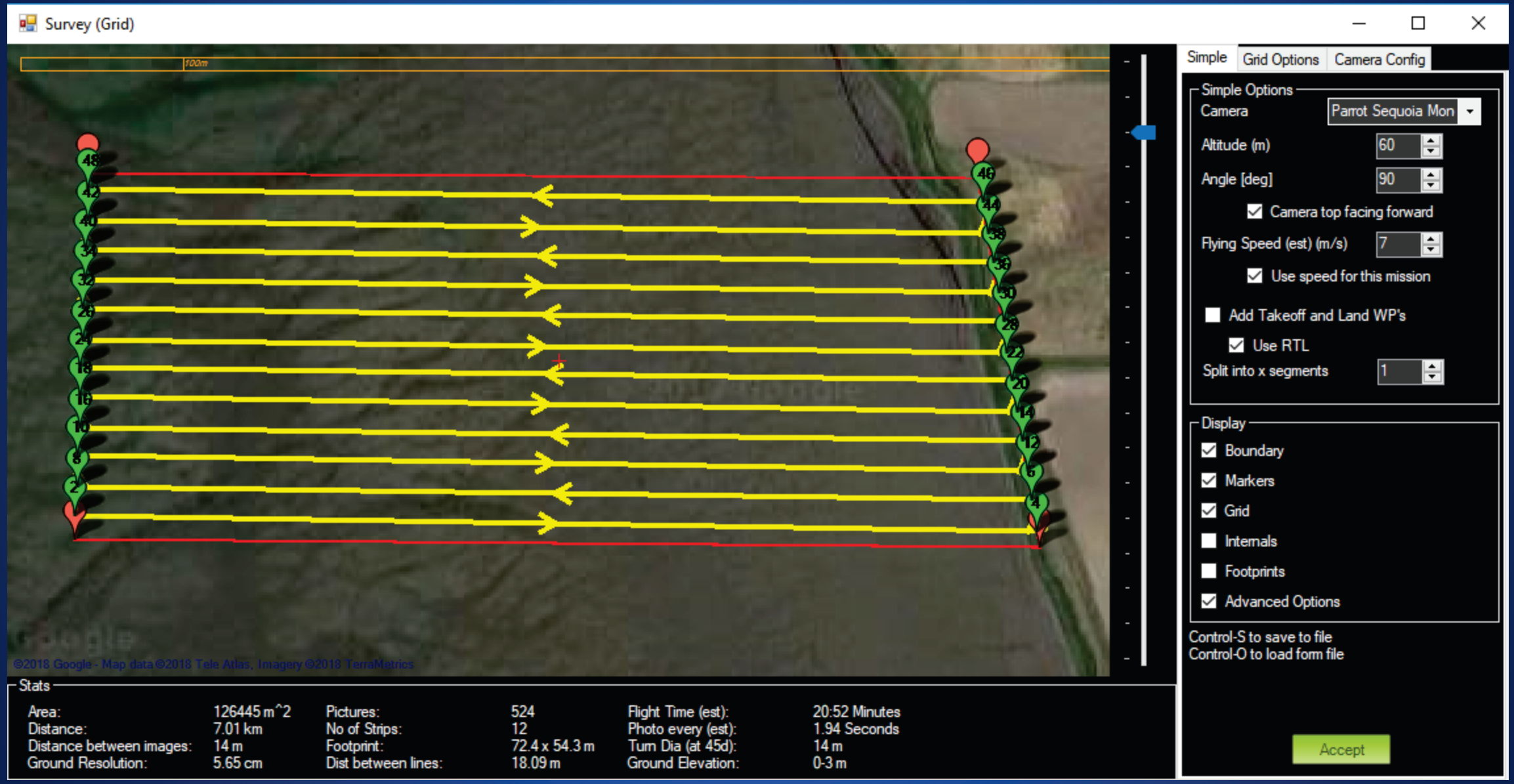
Cameras

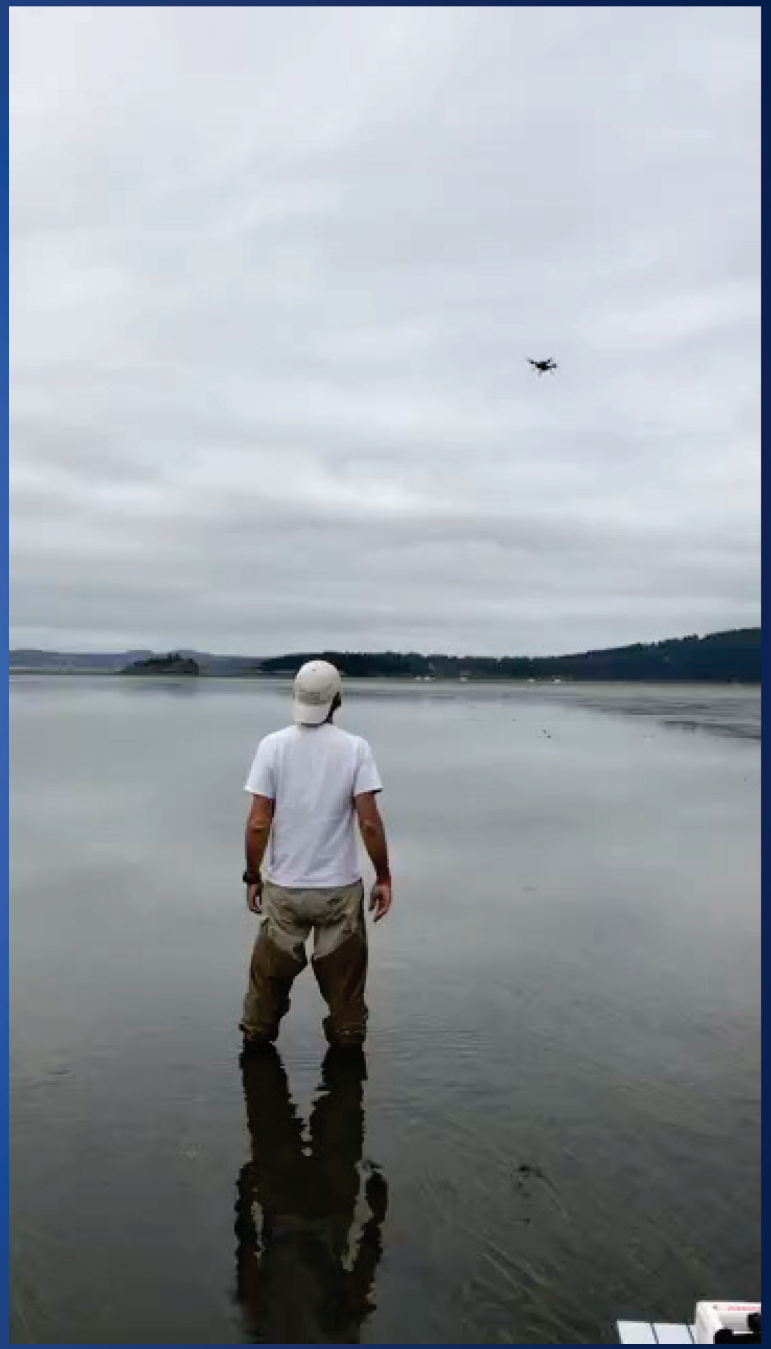
- Canon S100: 12 mp modified for "red edge" and near IR
- Parrot Sequoia: 4-band multispectral @1.2 mp

Padilla Bay National Estuarine Research Reserve

Padilla Bay

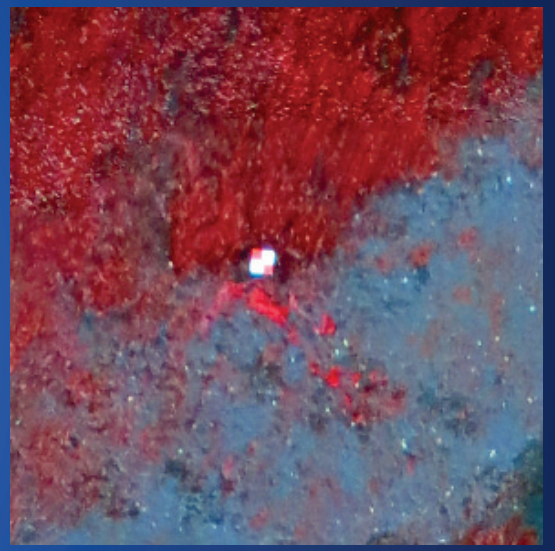
- PBNERR maintains three long term biomonitoring transects; series of 0.5 by 2 m plots where they record species, % cover, stem density, plant height
- UAS Flights were conducted over these transects in June and July 2017 timed to occur during extreme low tide events with ~4 hour window each day
- Quadcopter flights cover a 300 m by 2500 m area
  - flown in 500 m sections due to flight time limitations
  - first 500 m section flown from the beach
  - established launch/landing sites at 1000 and 2000 m from beach to cover remainder
  - 2 days of flights required to cover entire 2500 m transect
  - flights at 60 m AGL
- Fixed-wing flights can cover the entire transect in a single flight
  - more consistent water levels and illumination
  - flights at 120 m AGL


Survey (Grid)
Simple
Grid Options
Camera Config
Simple Options
Camera
Parrot Sequoia Mon
Altitude (m)
60
Angle [deg]
90
Camera top facing forward
Flying Speed (est) (m/s)
7
Use speed for this mission
Add Takeoff and Land WP's
Use RTL
Split into x segments
1
Display
Boundary
Markers
Grid
Internals
Footprints
Advanced Options
Control-S to save to file
Control-O to load form file
Accept
©2018 Google - Map data ©2018 Tele Atlas, Imagery ©2018 TerraMetrics
Stats
Area: 126445 m^2
Distance: 7.01 km
Distance between images: 14 m
Ground Resolution: 5.65 cm
Pictures: 524
No of Strips: 12
Footprint: 72.4 x 54.3 m
Dist between lines: 18.09 m
Flight Time (est): 20:52 Minutes
Photo every (est): 1.94 Seconds
Turn Dia (at 45d): 14 m
Ground Elevation: 0-3 m



Padilla Bay Color IR mosaic

- 300 m by 2500 m transect
- 3DR Solo quadcopter; 60 m flying height
- ~2300 images, 2 cm resolution
- Mosaic generated using Agisoft Photoscan
- GCP panels used to facilitate georeferencing
- Uneven glare from one 500 m section to the next due to varying water levels and sun angle

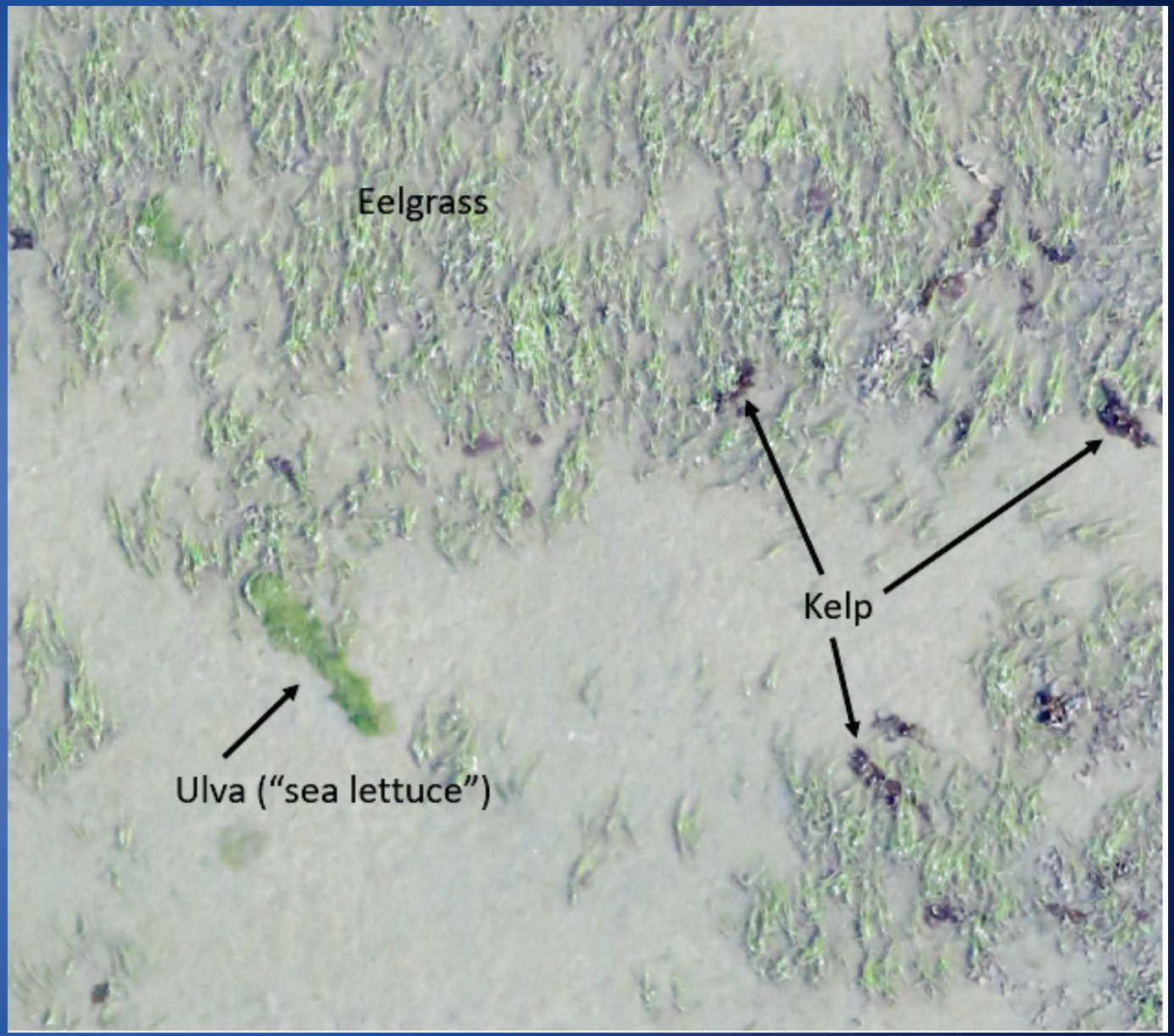


Ebb:
-0.5
MLLW

Low:
-1.5
MLLW

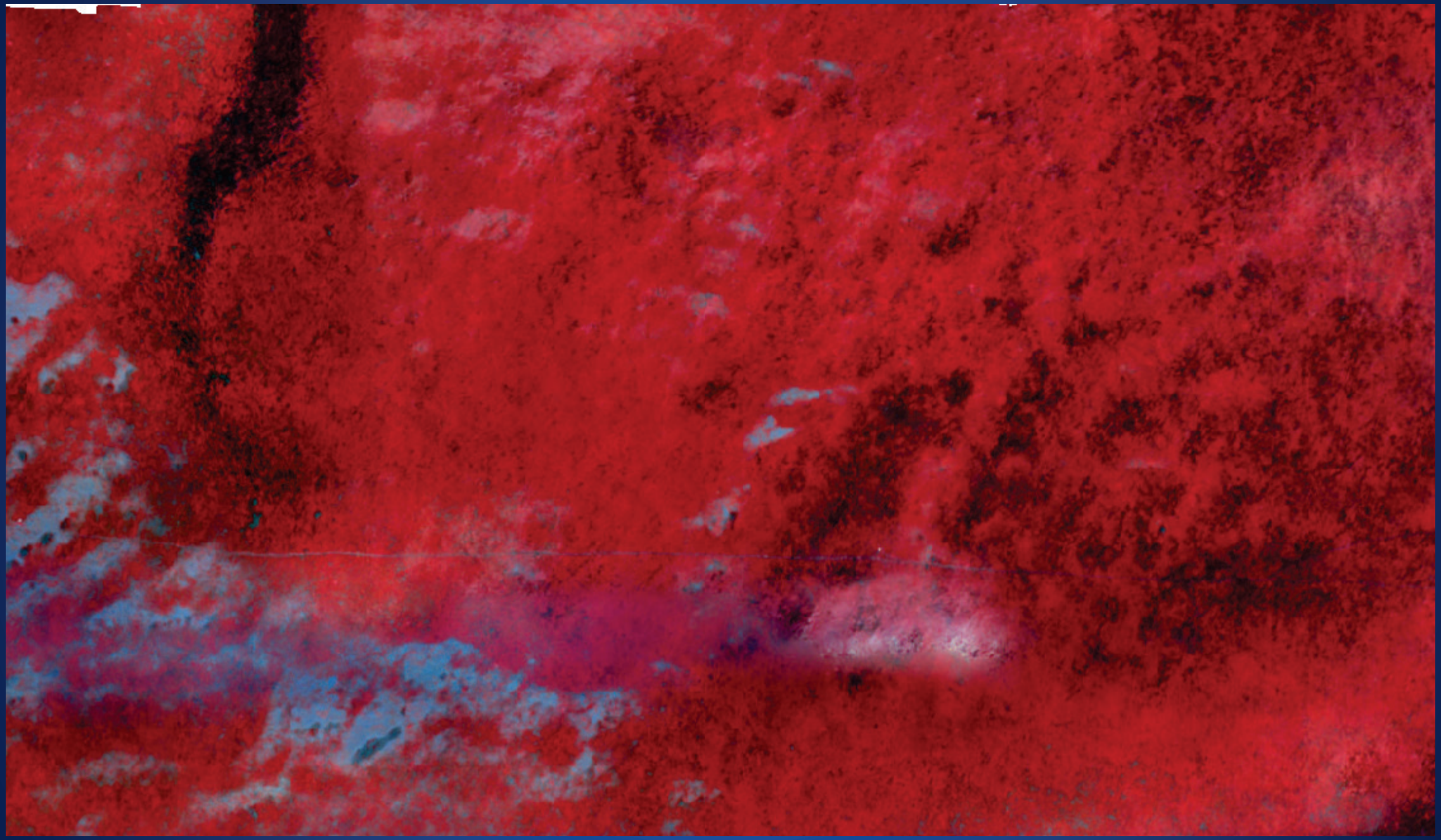
Flood:
-0.5
MLLW

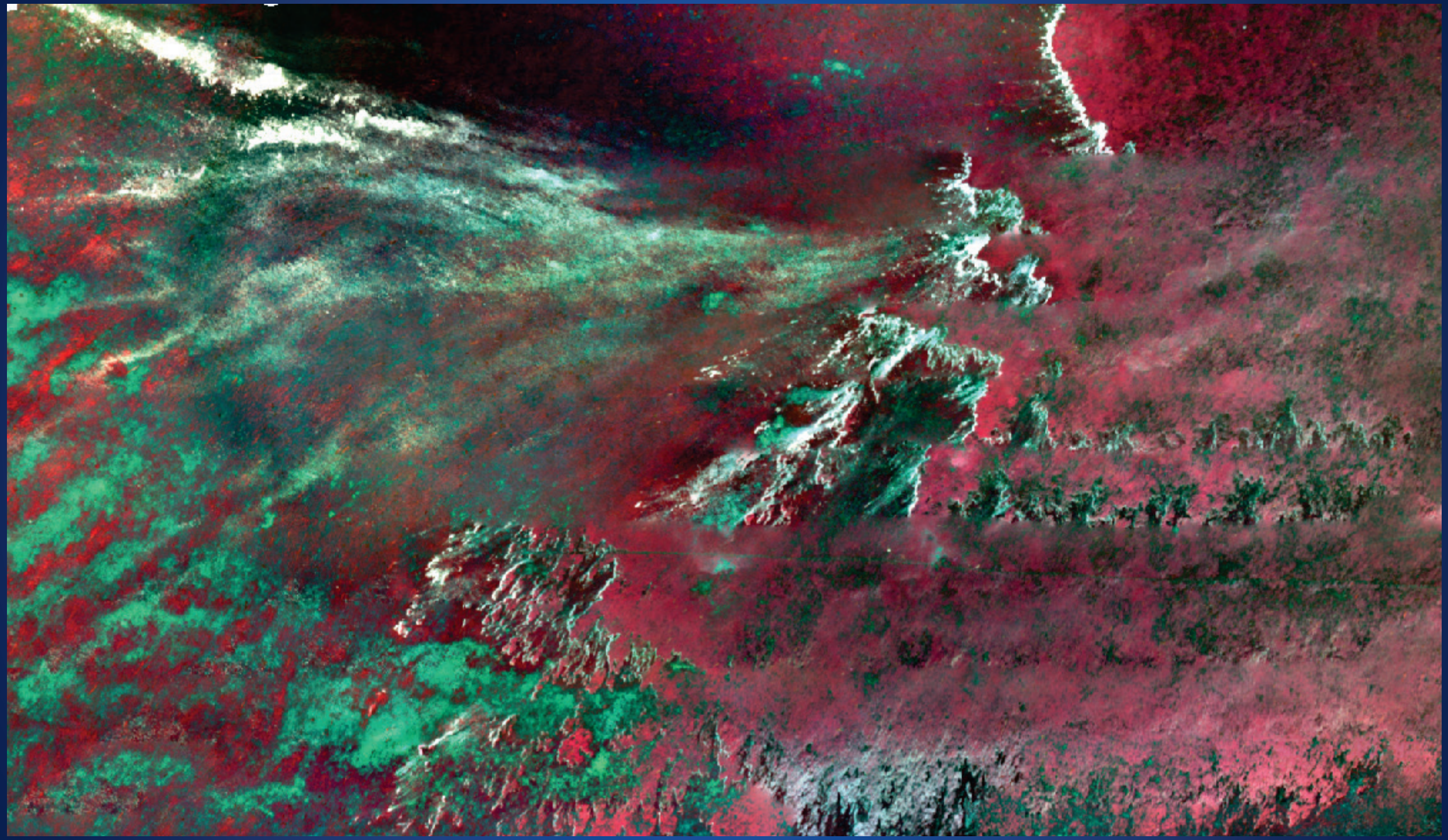
Color IR



True color

Canon S100; 40 m AGL; 1.5 cm pixel size





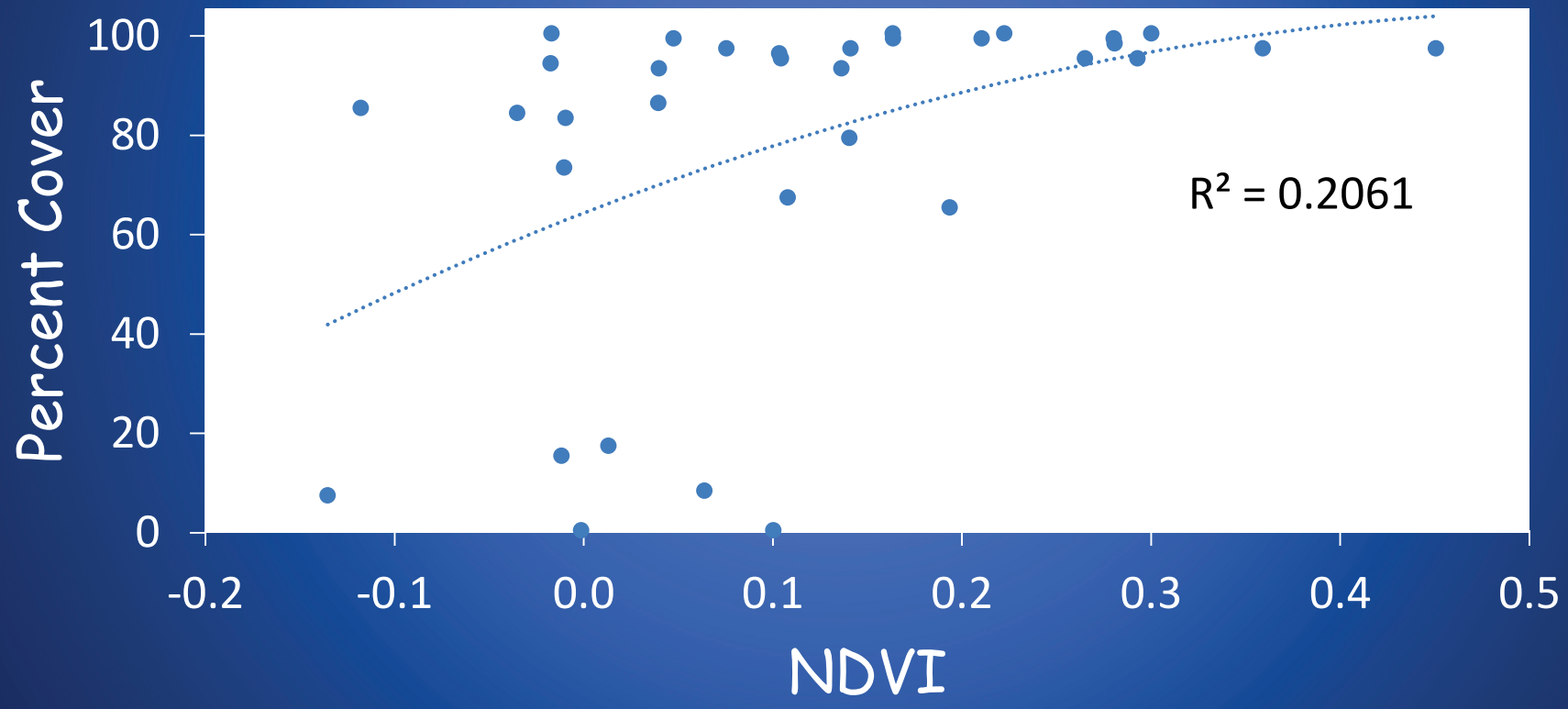
Preliminary Analysis

- Used imagery obtained with Parrot Sequoia carried by quadcopter to Generate a Normalized Difference Vegetation Index
  - NDVI = (NIR – red)/(NIR+red)
  - NDVI has been shown to be correlated with photosynthetic rate

- Extract NDVI for biomonitoring plots

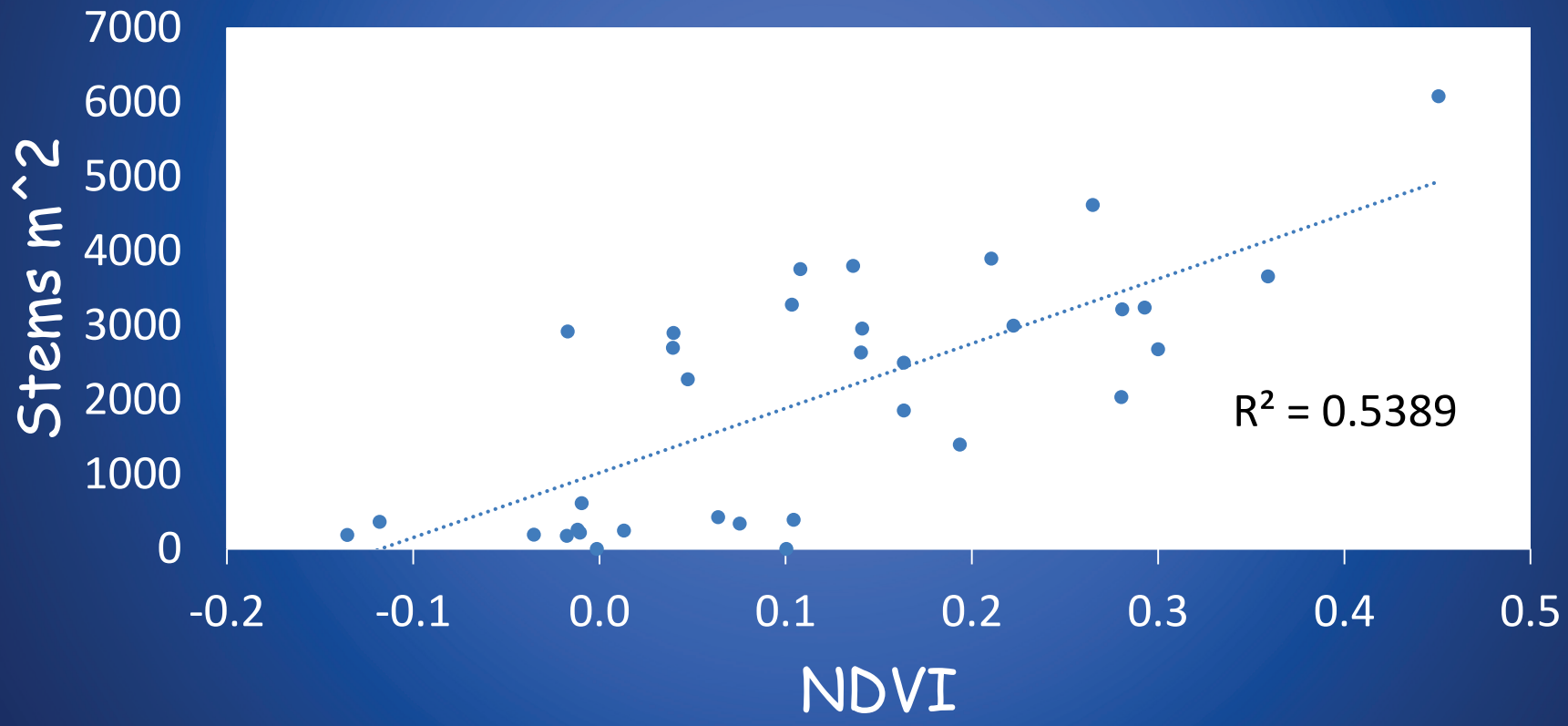
Preliminary Results

Total *Zostera* % Cover vs. NDVI



Preliminary Results

Zostera Density vs. NDVI



Next Steps

- Refine coordinates for GCPs
- Lots of additional imagery to be processed
- Compare results from different cameras
- Quadcopter (lower altitude, higher resolution, multiday flights under variable illumination)
- Fixed-wing (higher altitude, lower resolution, single day flight under more constant illumination)
- Species ID: can we distinguish *Z. marina* vs. *Z. japonica*
- *Other cover types: algae, kelp*

The learning curve for using UAS

- FAA regulations !@#$#@???
- How do you fly these darn things? Many crashes later……
- How do you get decent imagery?
- What the heck do you do with the imagery?

Dan Saul; GIS Manager WA Dept. of Ecology

End