Up, Up, and Away!

Marine Robotics and Remote Sensing @ Duke University Marine Laboratory

David W. Johnston

Assistant Professor of the Practice of Marine Conservation & Ecology
Division of Marine Science and Conservation,
Nicholas School of the Environment
Duke University Marine Laboratory

Marine Conservation Ecology
Unoccupied Systems Facility

On deck

- Getting started
- Current & future capabilities
- Research
- Planning & emergency response
- Education & outreach

Marine Conservation Ecology
Unoccupied Systems Facility

UAS in Marine Science Workshop

6 Commercial Companies

7 Universities Represented

55 Participants

7 Federal Agencies/ Divisions

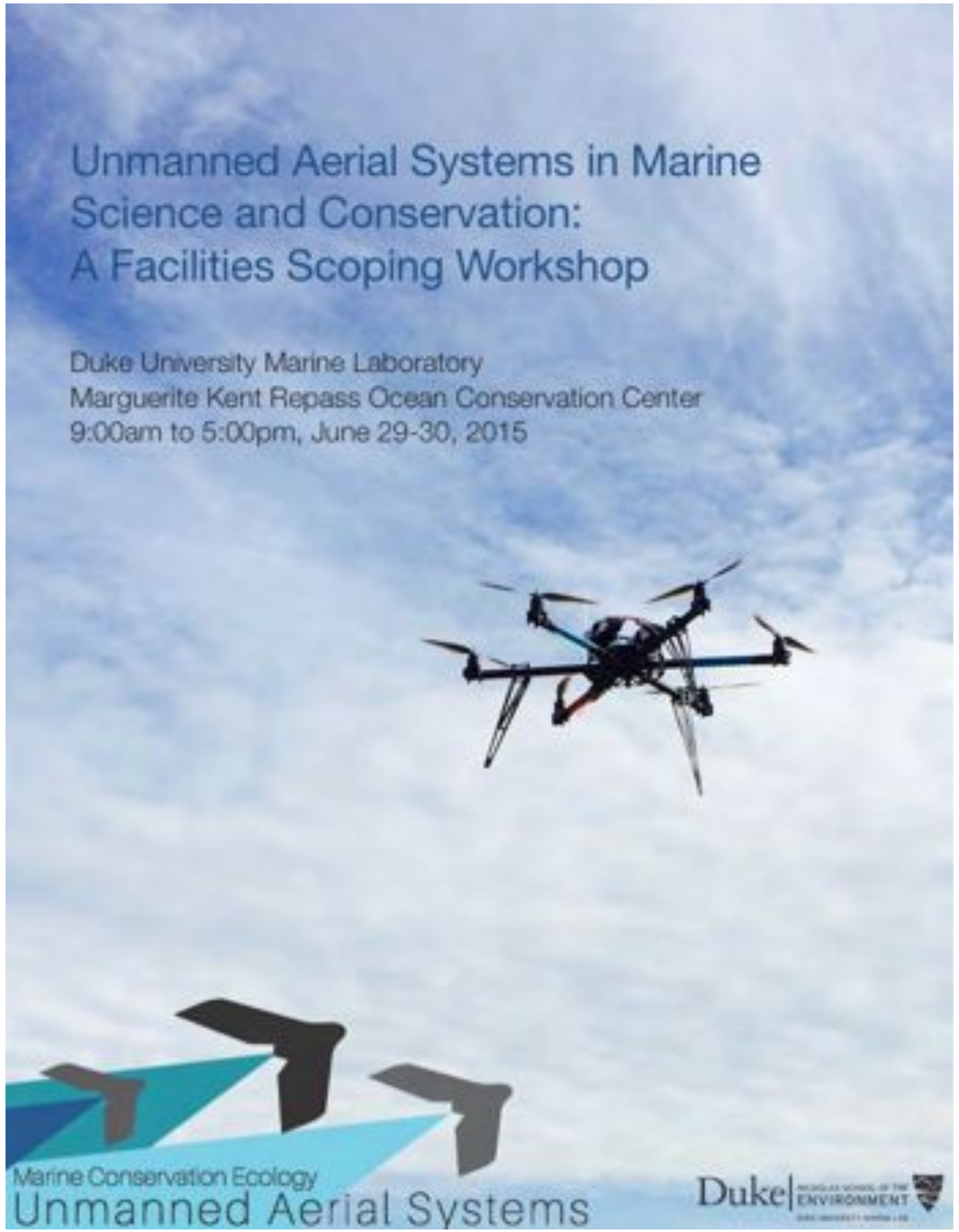
4 State Agencies

13 Briefings or presentations

3 New Facility Collaborations

3 UAS Platforms Presented/ Demoed

http://marineuas.net @marineuas

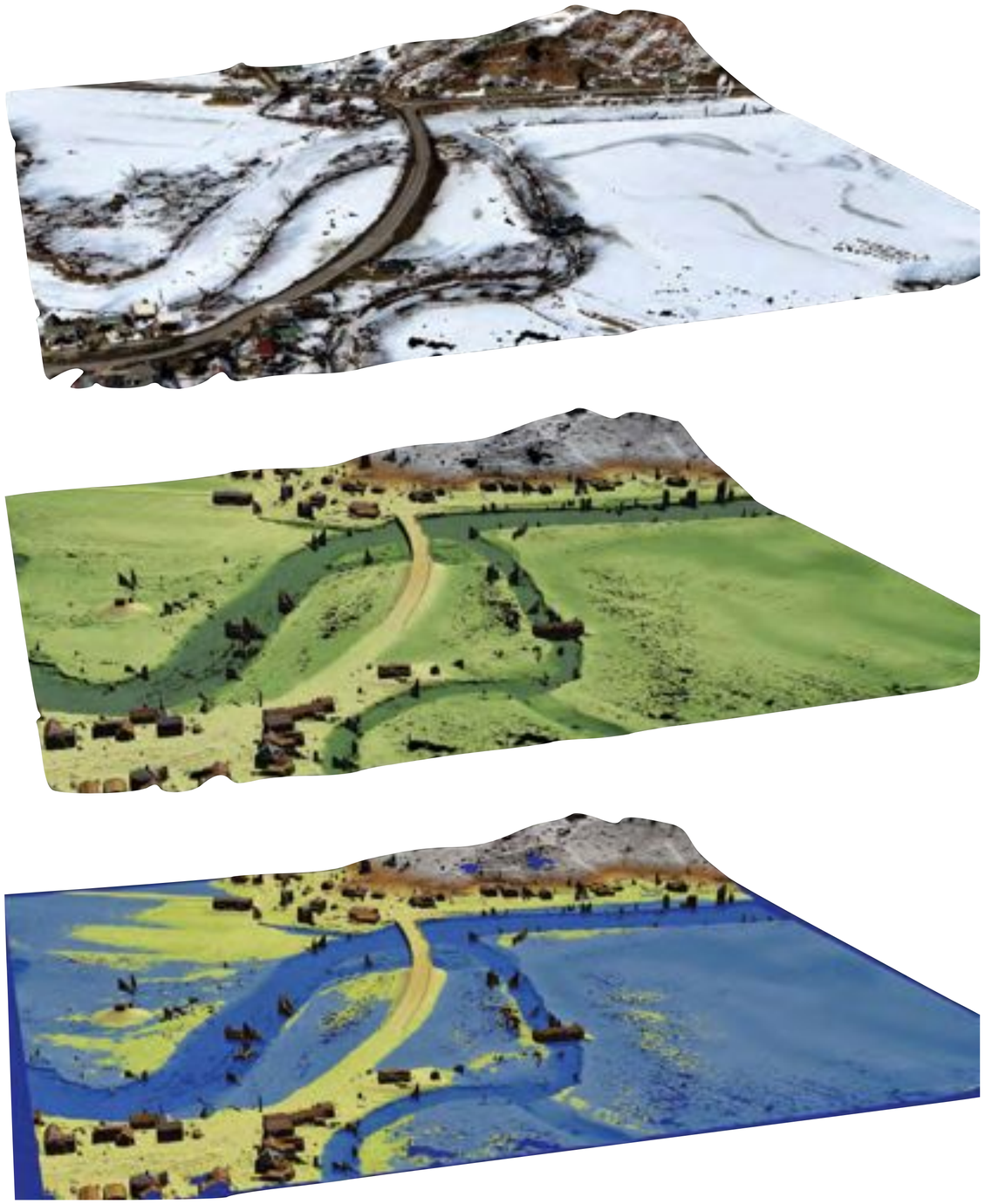


Current Platform Capabilities

- **2 fixed-wing aircraft:**
  - Mapping at 2.5 cm per pixel
  - NIR, RE, IR and RGB sensors
  - Autonomous operation
  - 45 minute flight times
- **5 multi-rotor aircraft**
  - Sub-centimeter ground resolution
  - RGB, IR sensors, 4K video
  - Streaming video
  - 30 minute flight times

Current Computing Capabilities

- PCs with GPU compute
- Image analysis and photogrammetry
  - Pix4D, ArcGIS, ImageJ
  - Orthomosaics
  - Digital surface models and terrain models through Structure From Motion techniques



> 450 flights

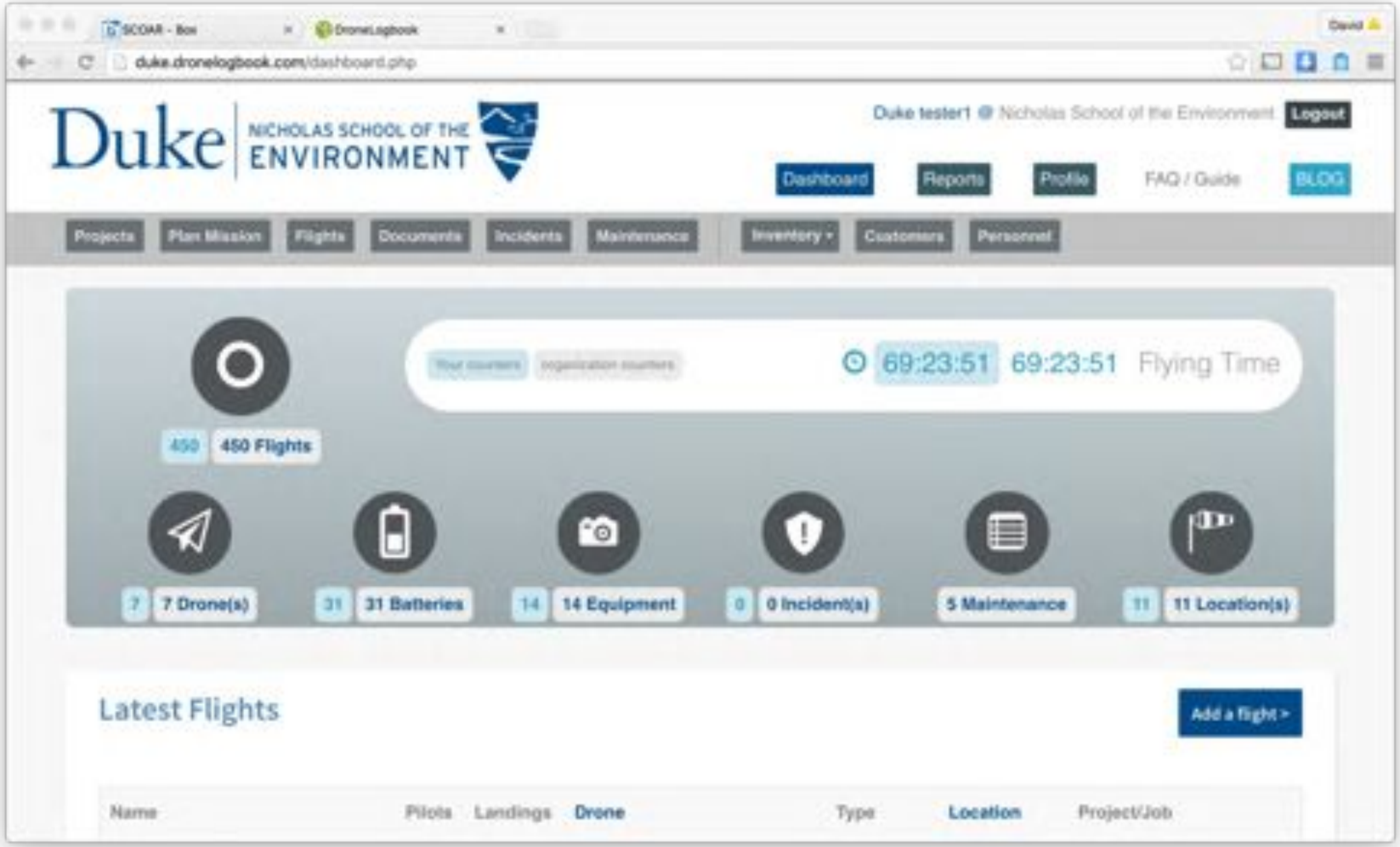
> 70 hours flight time

3 countries

Section 333 Exemption

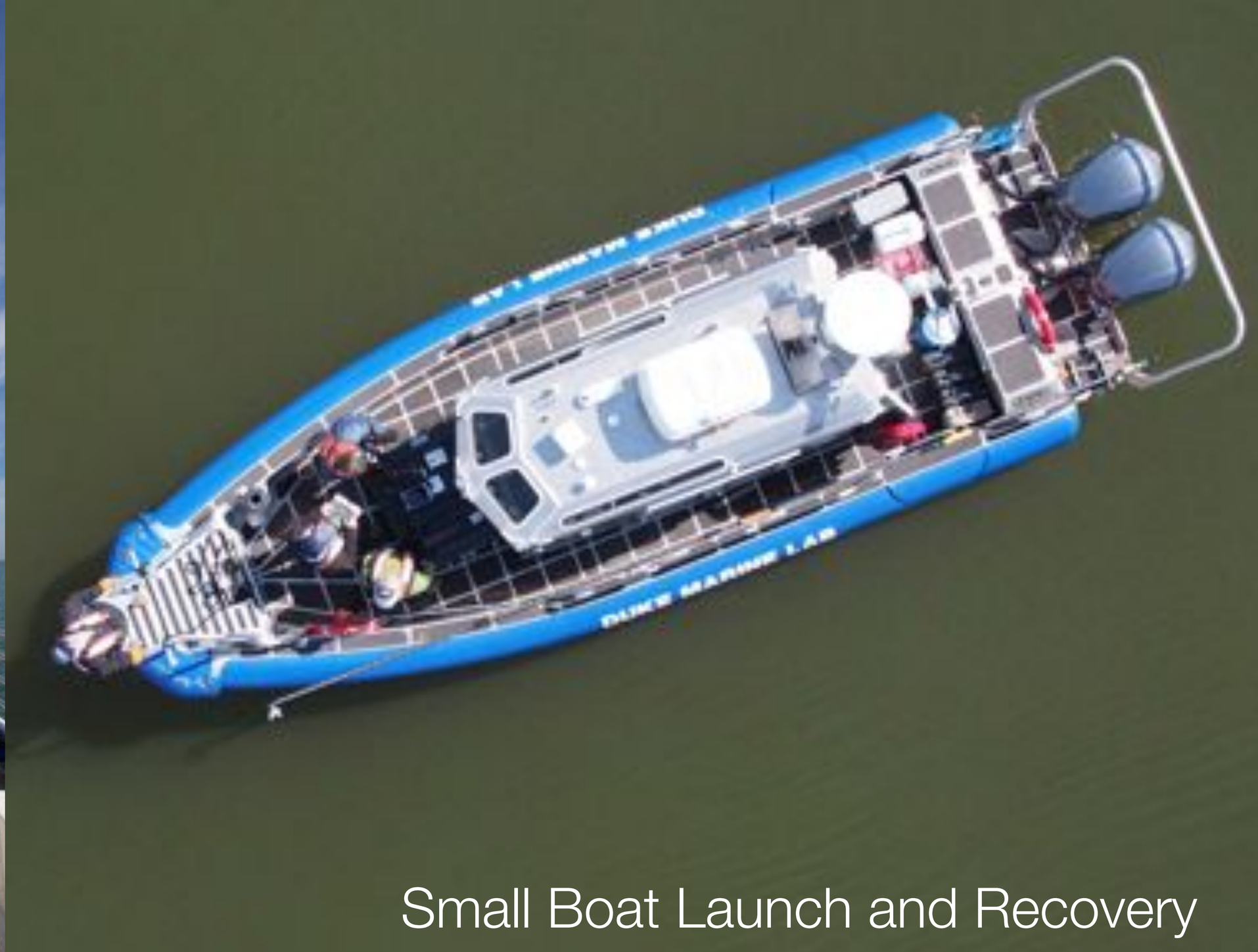
Blanket COA

NGAT Consortium

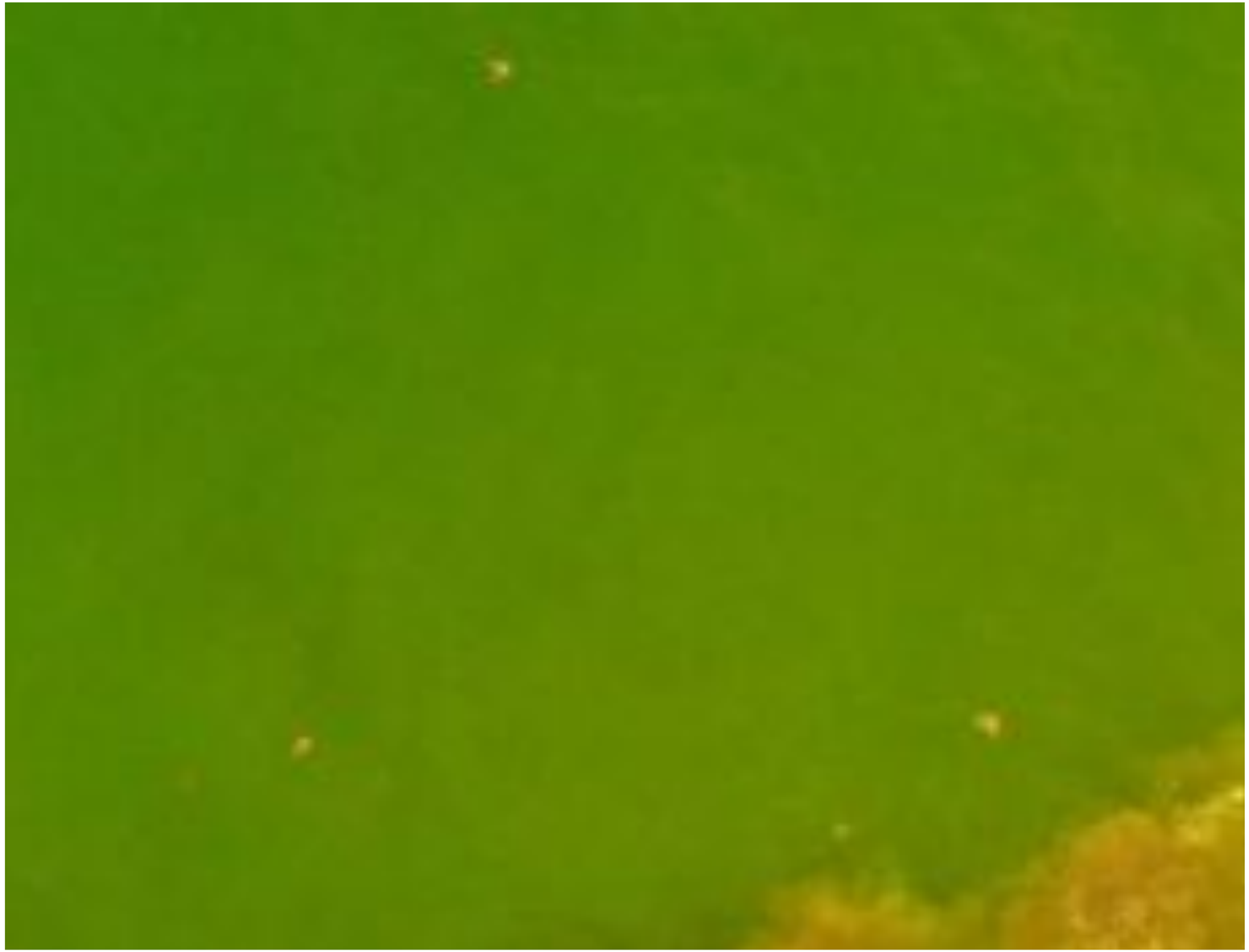


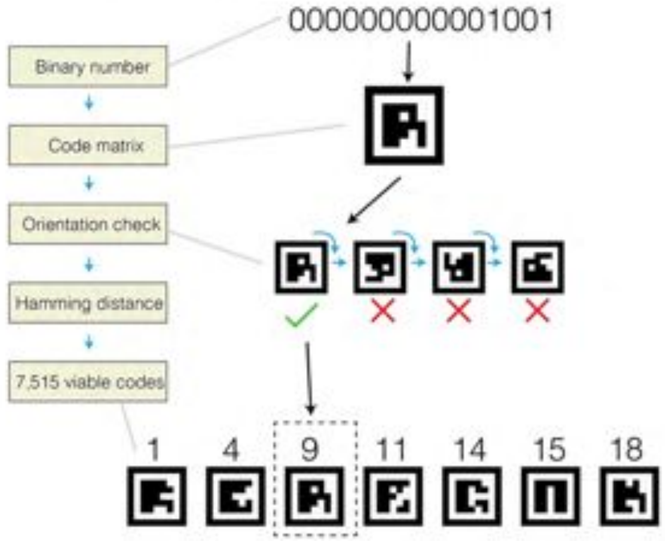
People & Partners

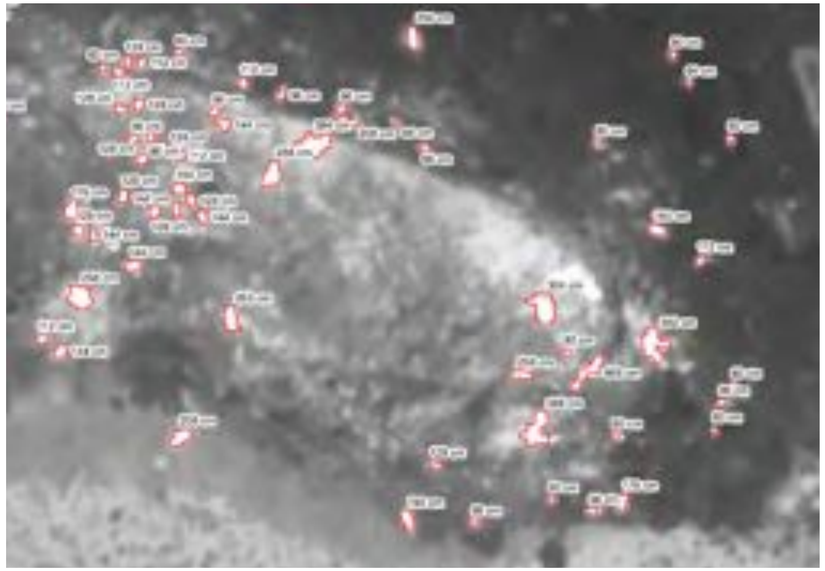
- Rt. Colonel Rett Newton: 25yr US Air Force, combat, trainer, Attache to Egypt - Program Manager
- Julian Dale: Marine electronics engineer, UAV builder and operator
- John Wilson, Lead Pilot, Marine Operations
- Affiliated faculty: Nowacek, Halpin, Van Dover
- Sponsored by senseFly and 3D Robotics through software and hardware
- Member of the Next Generation Air Transport Consortium in NC (FAA ASSURE Program)



Small Boat Launch and Recovery







Computer Vision Studies: Students and Collaborators

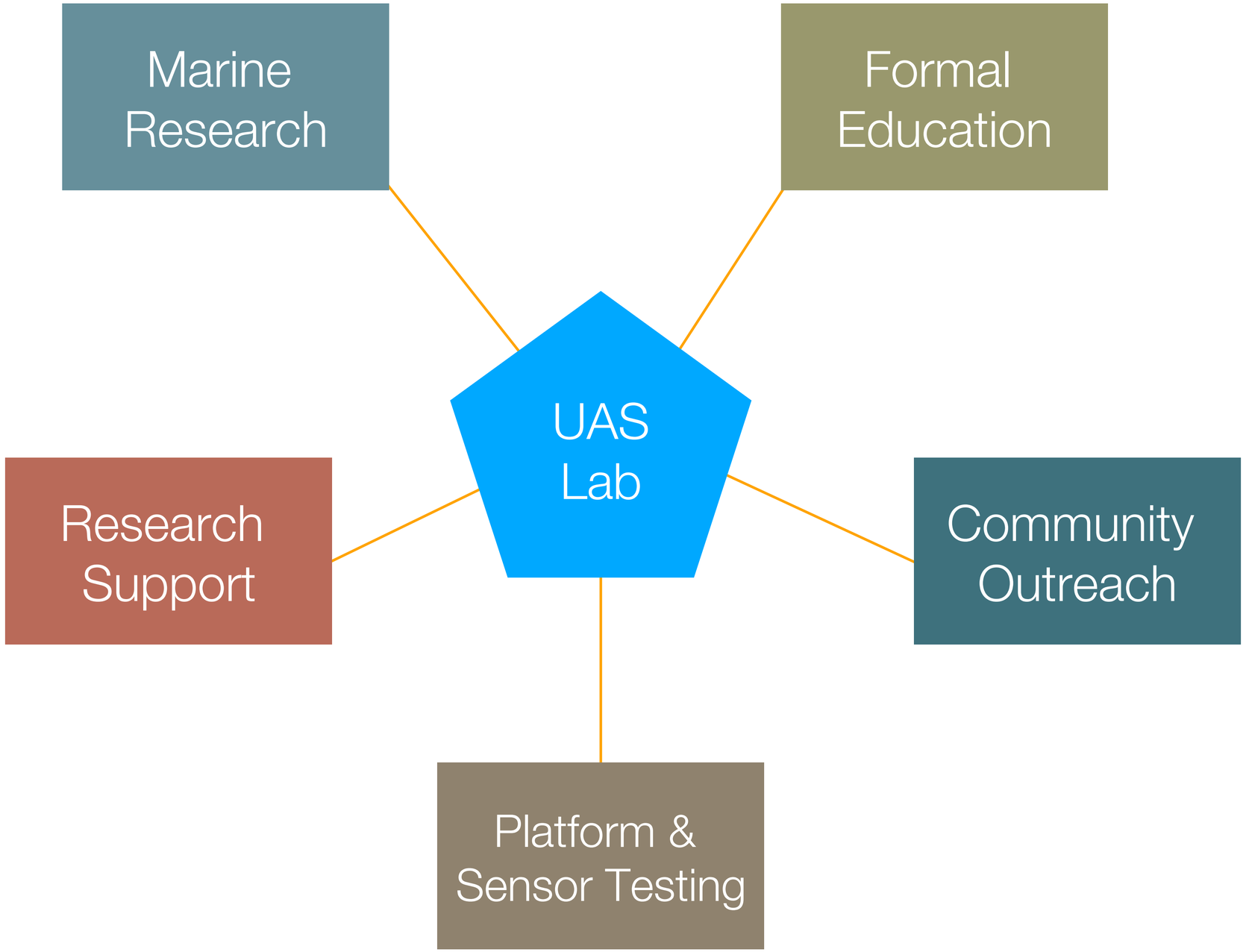
Incoming!

- Improvements in Facilities, Communications and Equipment at Biological Field Stations and Marine Laboratories (FSML) - National Science Foundation: Recommended $310K
  - Renovate building
  - Obtain new platforms
    - RTK, amphibious/environmentally sealed
  - Develop Computing Infrastructure
    - Object-oriented storage
    - GPU compute nodes
    - Marine Lab and Main Campus

Incoming!

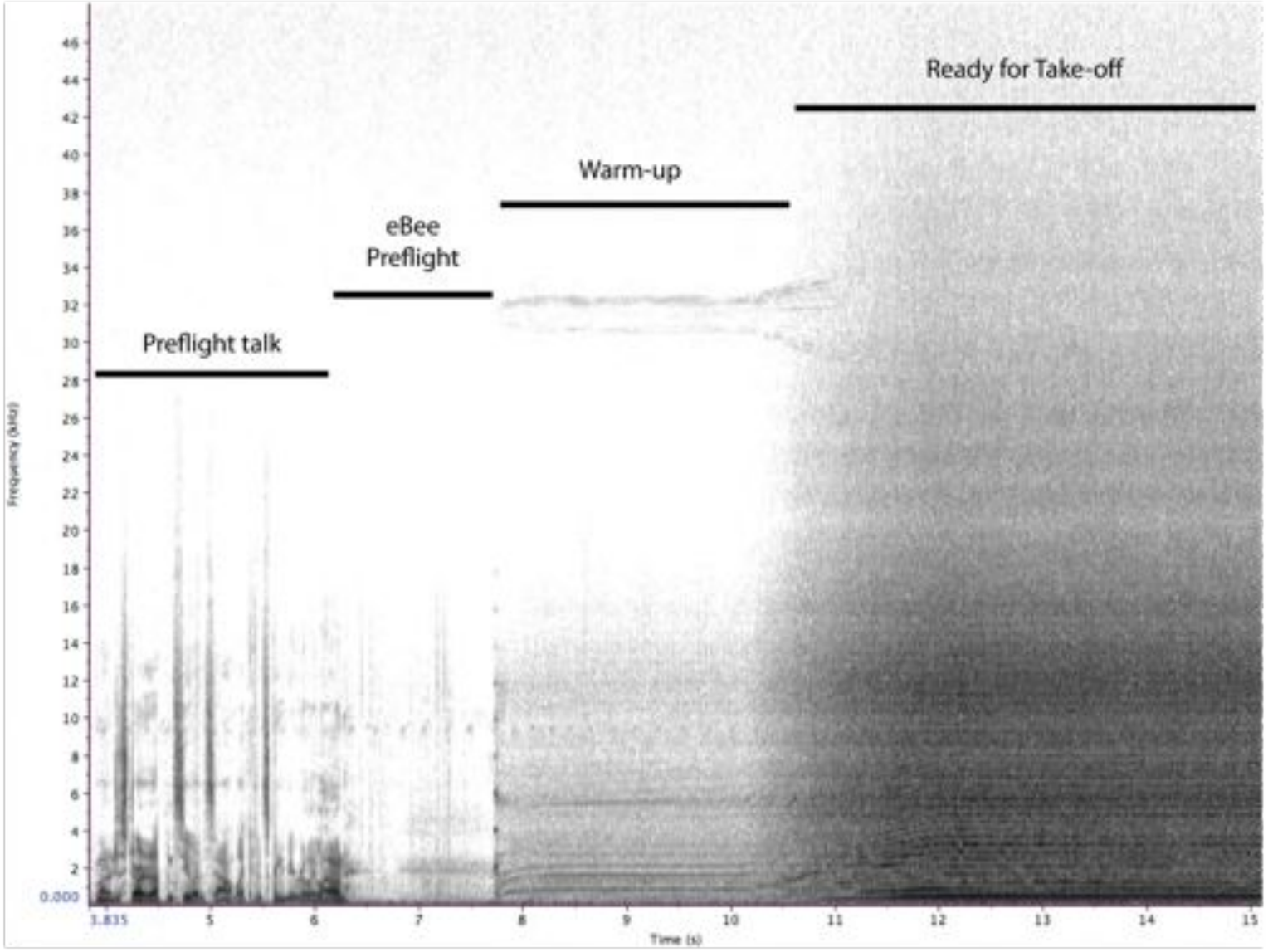
- Matching Funds from Oak Foundation - Marine Conservation Summer Institute: $268K
  - Salary for engineering
  - 2 year Post-doctoral fellow
  - 2 year Global Fellows Program
    - Attend classes, award mini-grants
  - Support outreach program

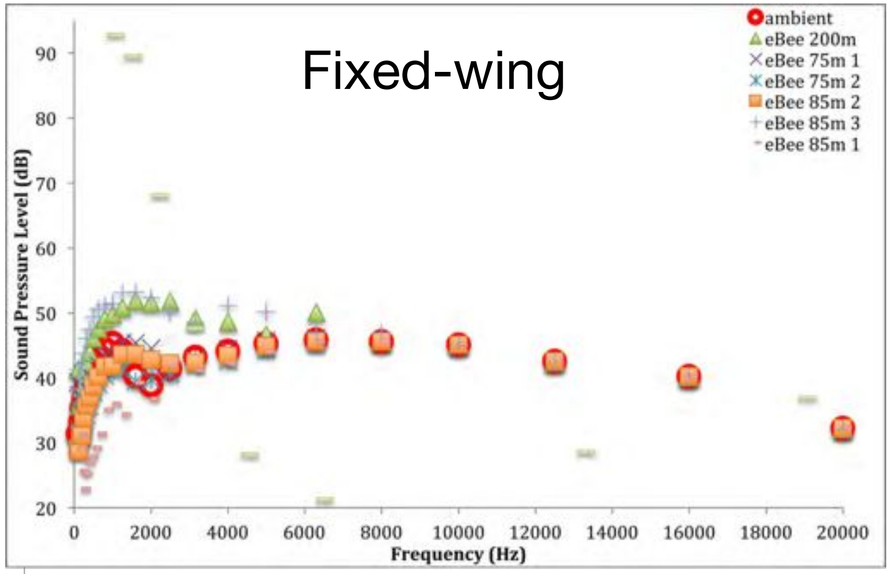
OAK FOUNDATION


Marine Research
Formal Education
UAS Lab
Research Support
Community Outreach
Platform & Sensor Testing

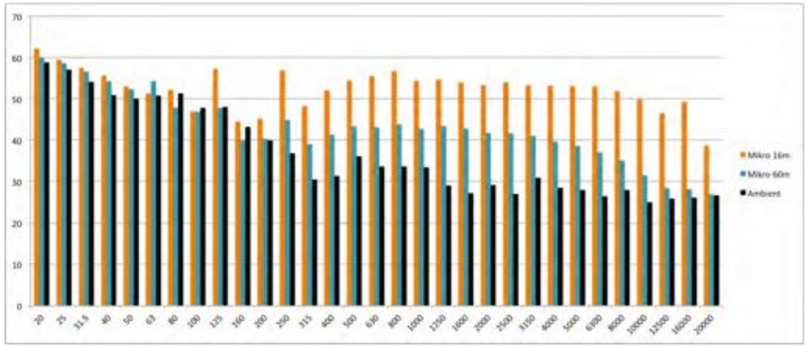
Detection and Calibration

- Sharks, sea turtles, seabirds
- Use of decoys and models
- Employ multiple sensors
- Experiments across environmental conditions

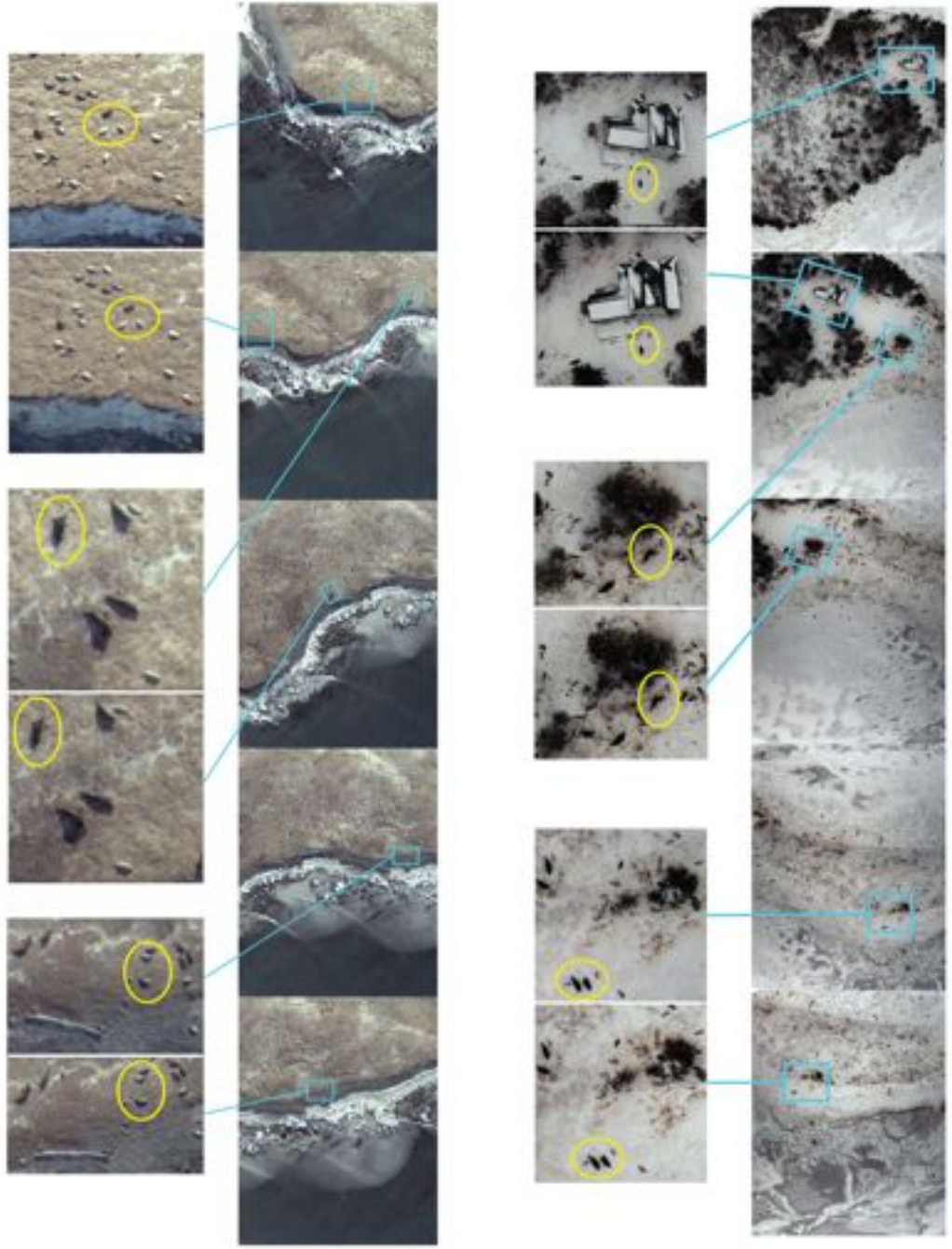


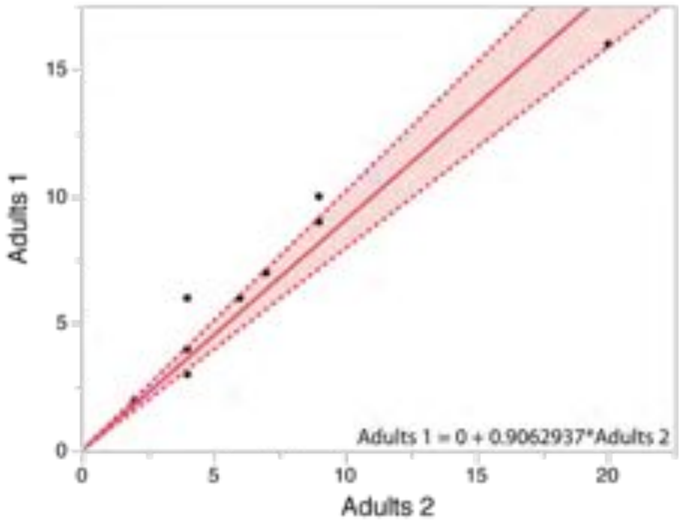


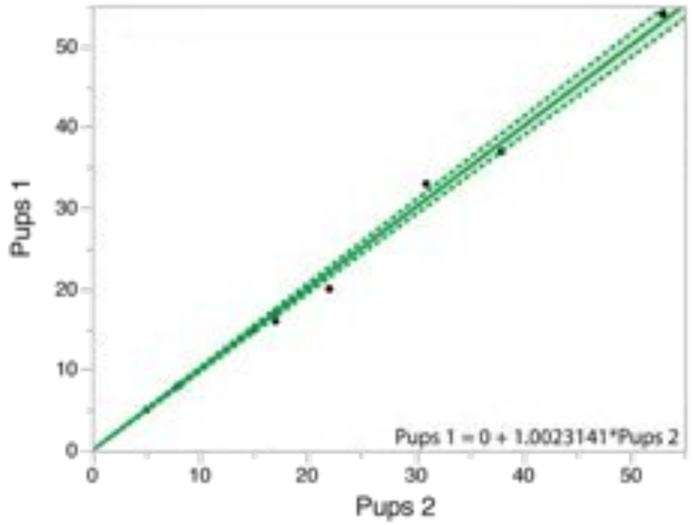
Multi-rotor

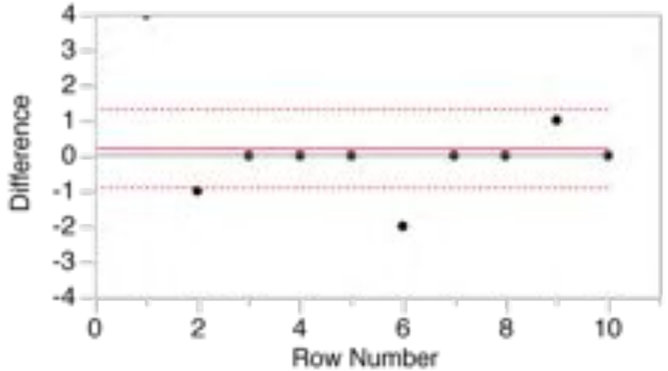


Acoustic Measurements

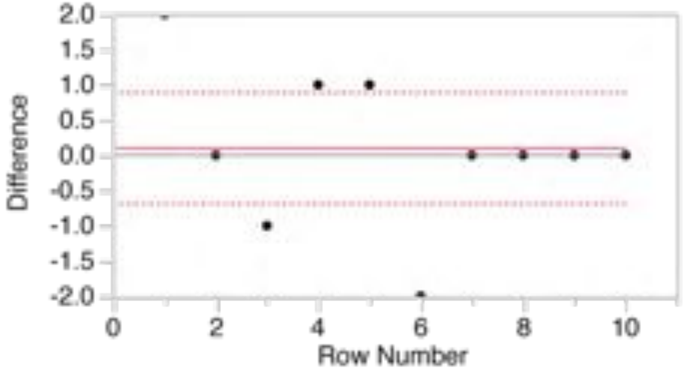








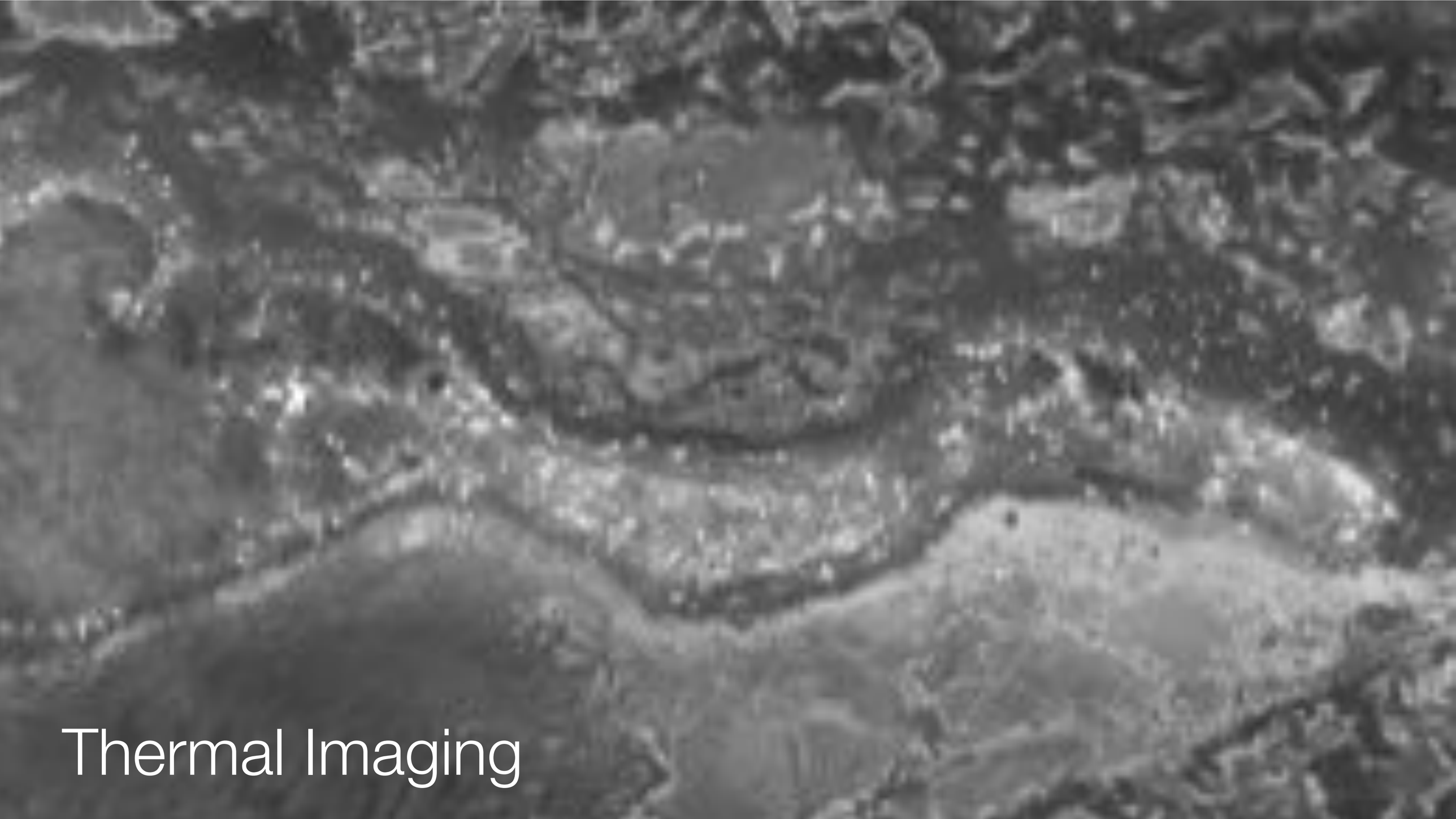
Mean Difference	0.2	Prob > |t|	0.6926
Std Error	0.4899	Prob > t	0.3463
Upper 95%	1.30823	Prob < t	0.6537
Lower 95%	-0.9082		



Mean Difference	0.1	Prob > |t|	0.7804
Std Error	0.34801	Prob > t	0.3902
Upper 95%	0.88725	Prob < t	0.6098
Lower 95%	-0.6873		

Disturbance Effects

Animal Distribution and Density

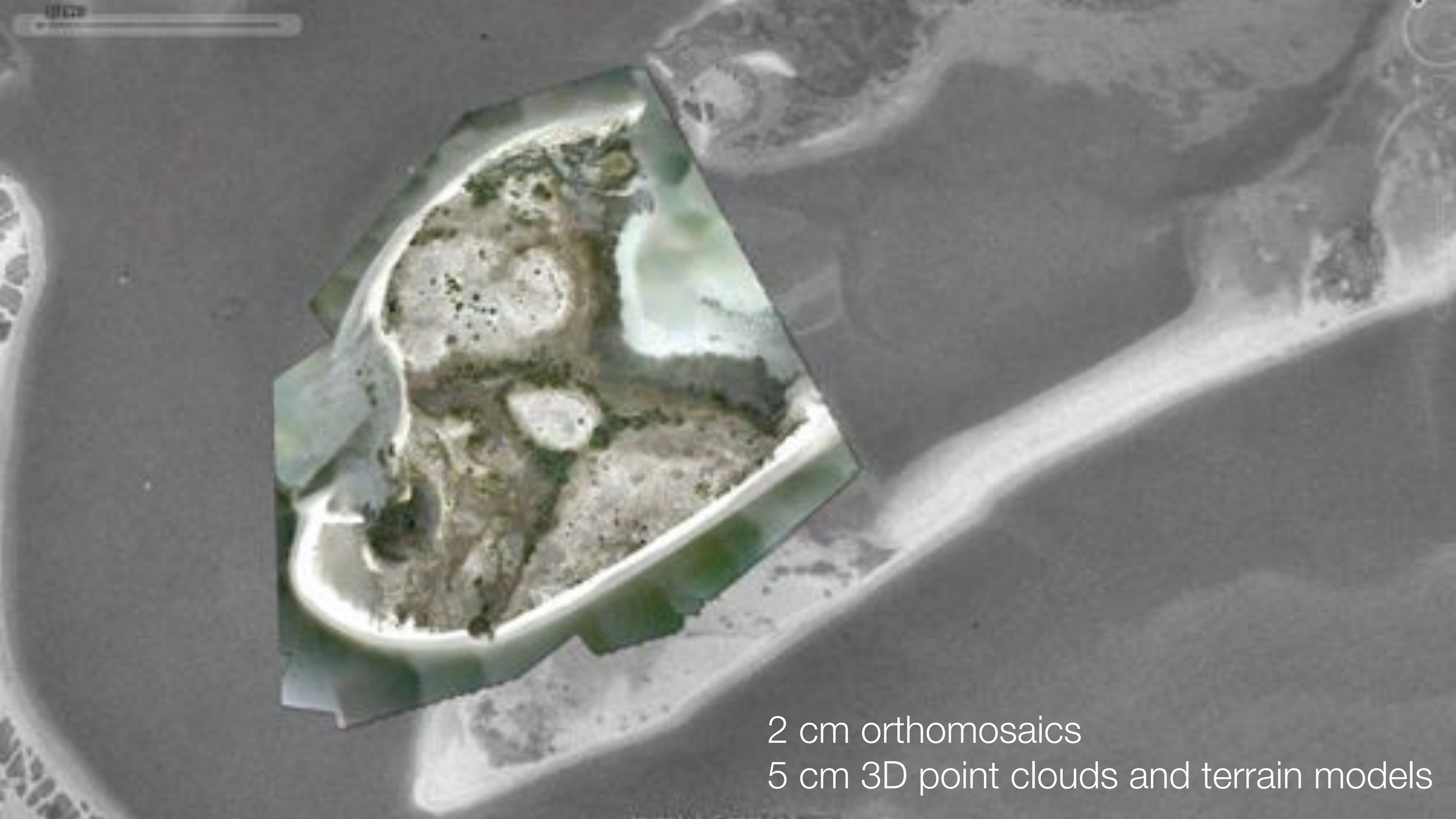


Thermal Imaging

Right whale surveys in Florida: Health assessments and snot sampling

Marine Debris Identification and Distribution

Coastal geomorphology



2 cm orthomosaics
5 cm 3D point clouds and terrain models

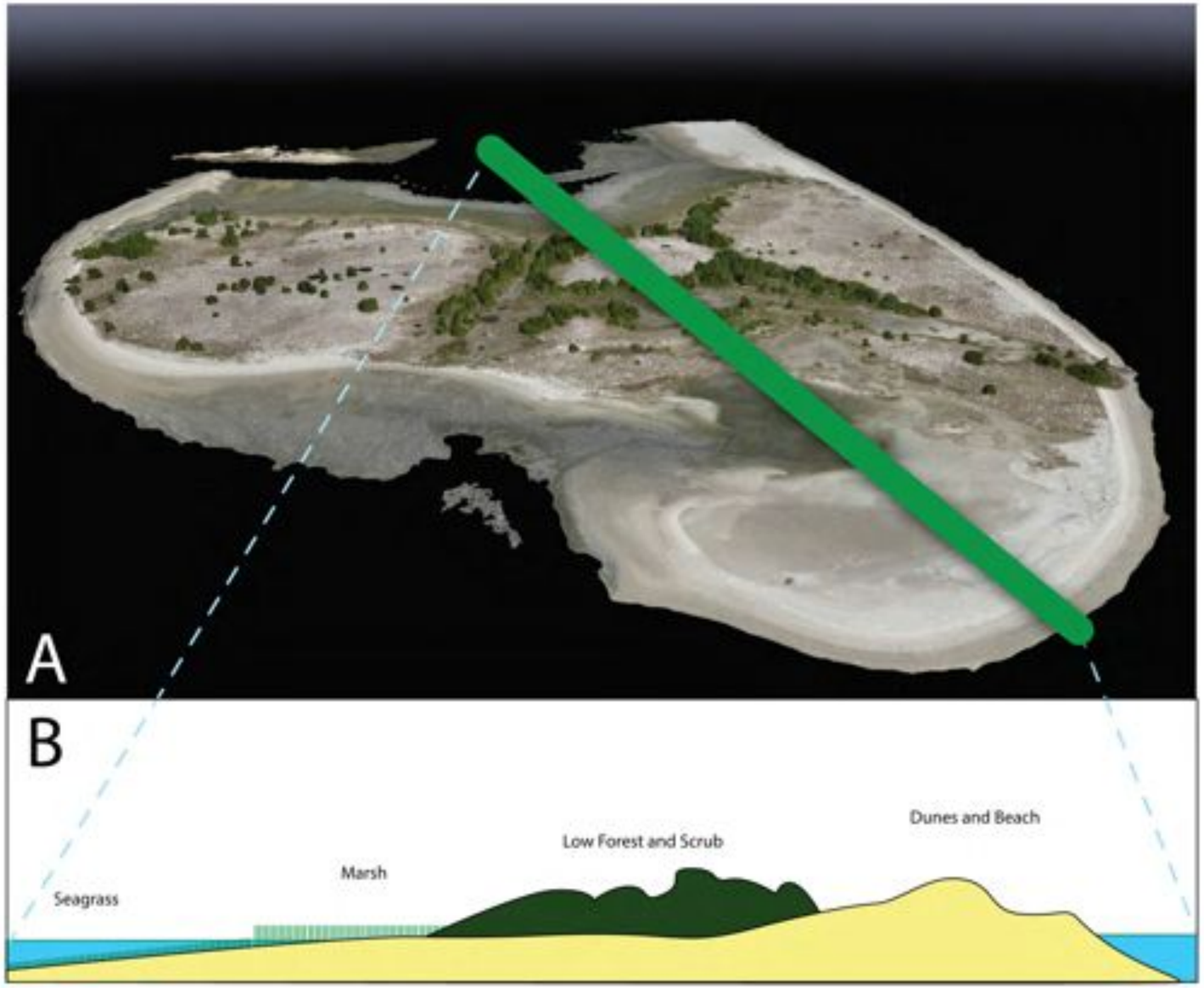
Democratization of spatial data collection - Social Science

Affordable aircraft, sensors and software minimize entrance barrier

Working with Tla-o-qui-aht First Nation on goose-neck barnacle stock assessment program

Current Grants, Contracts & Collaborations

- NOAA grey seal assessments
- DFO grey seal assessments
- NOAA sea turtle surveys
- NERR marine debris mapping and post-removal habitat assessments
- NERR coastal erosion assessments
- NPS submerged aquatic vegetation and coastal habitat mapping
- UNCW multispectral marsh mapping



Student Projects

- 3 Phd, 4 Masters and 5 undergraduate students engaged in research through thesis projects and independent study
- New client MP for NC Coastal Federation and North River Farms restoration site
- Bass Connections: Digital Cities and Poli-Sensing Environments with Art, Art History & Visual Studies (with Forte, Seaman and Kopper)

Workshop on UAS in Coastal Emergency Response

- October 2016 at Duke Marine Lab
- TTX format
- Focused on marine turtle and coastal erosion emergencies
- Develop best practices and procedures for State sponsored responses
- Combination of classroom and field experiences
- Focused participation by State and Federal agencies responsible for marine resource management

Unoccupied Aircraft Systems (UAS) in Scientific Research

Summer Course at Duke Marine Lab

Marine Conservation Ecology
Unoccupied Systems Facility


Outreach

AP Environmental Science

Thanks!

- senseFly, 3D Robotics
- Marine Ventures Foundation
- International Fund for Animal Welfare
- DFO Canada
- UNC Chapel Hill
- Race for Water Foundation
- Doug Nowacek Julian Dale, Rett Newton, Susan Heaslip, Ari Friedlaender

Marine Conservation Ecology
Unoccupied Systems Facility