

Up, Up, and Away!

Marine Robotics and Remote Sensing
@ Duke University Marine Laboratory

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On deck

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





<http://marineuas.net>

@marineuas

Unmanned Aerial Systems in Marine Science and Conservation: A Facilities Scoping Workshop

Duke University Marine Laboratory
Marguerite Kent Repass Ocean Conservation Center
9:00am to 5:00pm, June 29-30, 2015

Marine Conservation Ecology
Unmanned Aerial Systems

Duke | SCHOOL OF THE ENVIRONMENT
DUKE UNIVERSITY MARINE LAB



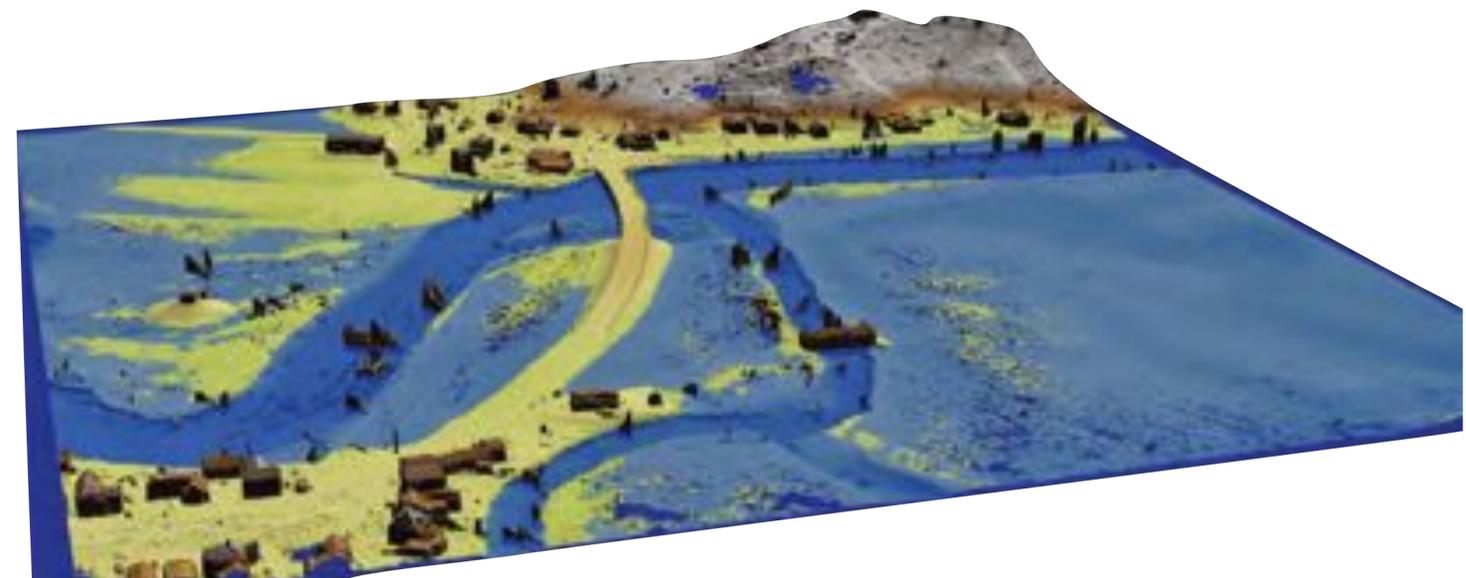
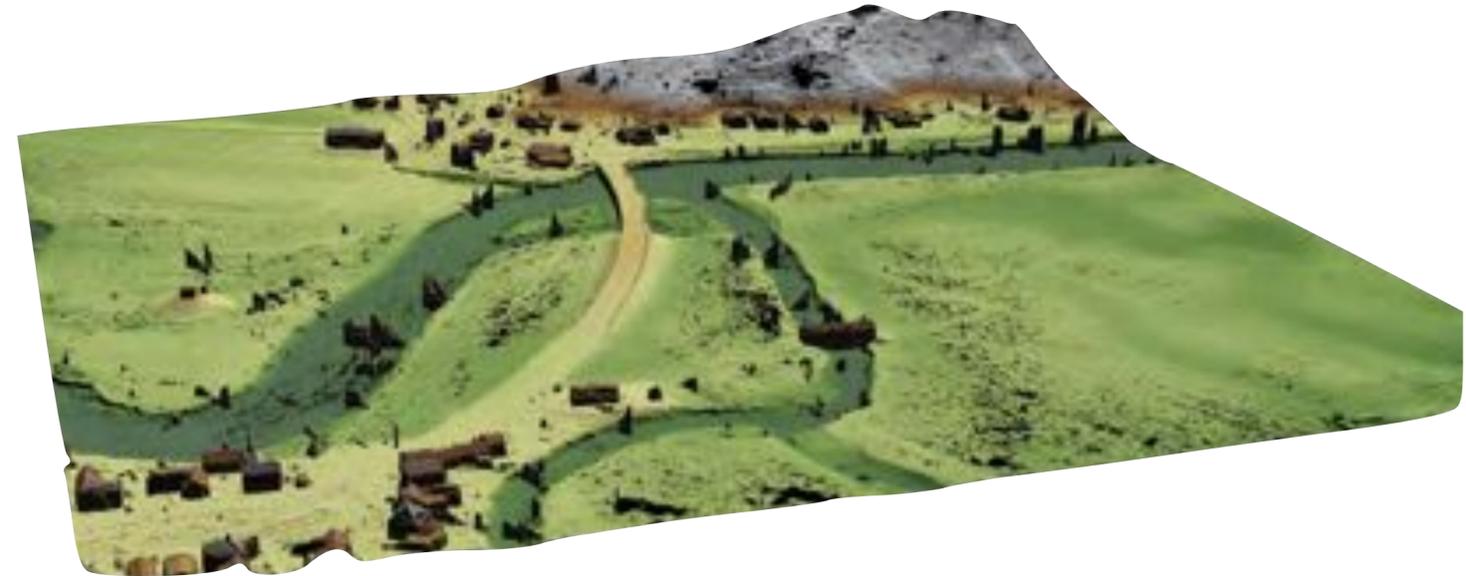
Current Platform Capabilities

- **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

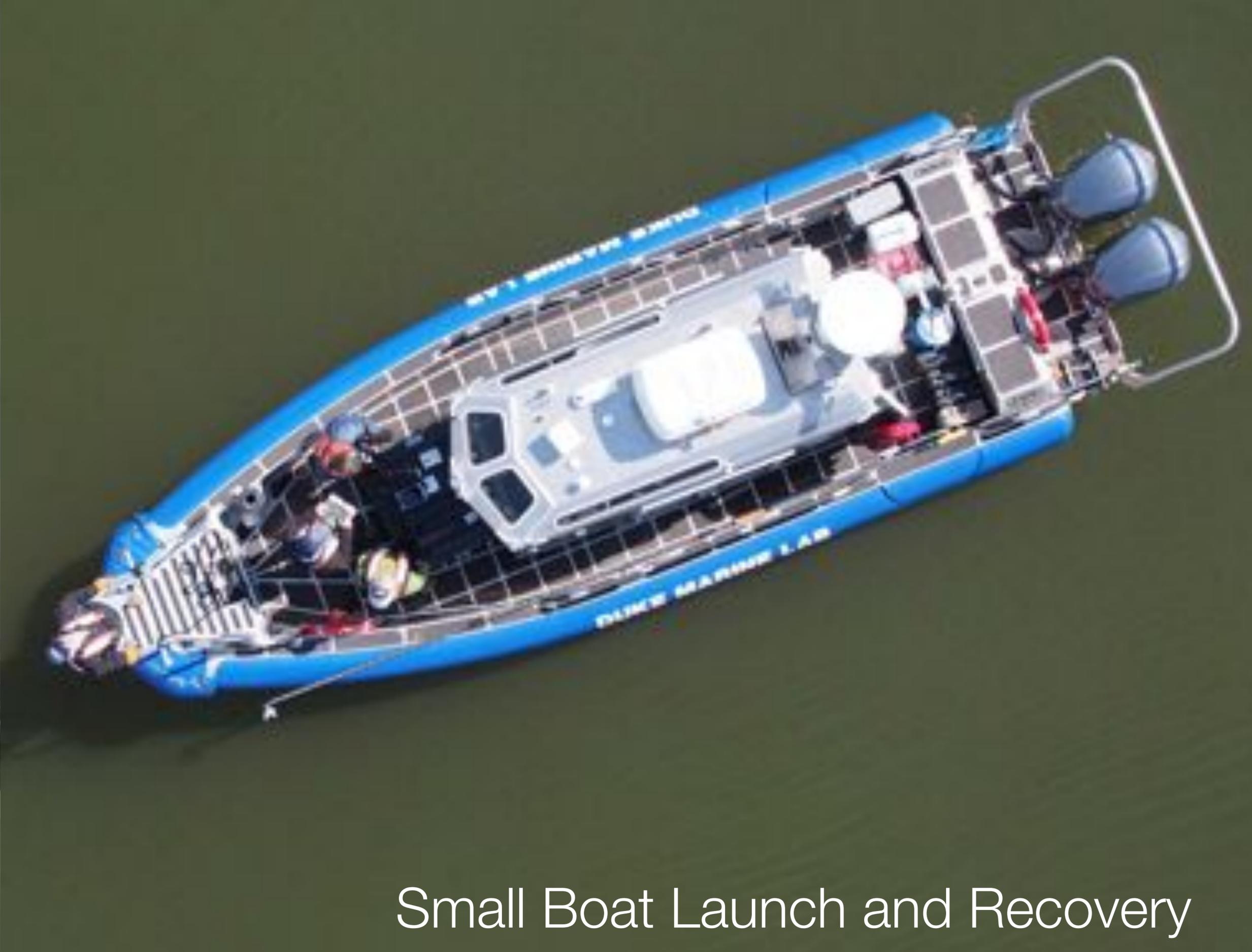
NGAT Consortium

The screenshot shows the Duke DroneLogbook dashboard. At the top, the Duke University logo and 'NICHOLAS SCHOOL OF THE ENVIRONMENT' are visible. The user is logged in as 'Duke tester1' from the 'Nicholas School of the Environment'. The dashboard features a navigation menu with options like 'Dashboard', 'Reports', 'Profile', 'FAQ / Guide', and 'BLOG'. Below this is a secondary menu with 'Projects', 'Plan Mission', 'Flights', 'Documents', 'Incidents', 'Maintenance', 'Inventory', 'Customers', and 'Personnel'. The main content area displays several key statistics: a large circular icon representing 450 flights, a 'Flying Time' of 69:23:51, 7 drone(s), 31 batteries, 14 pieces of equipment, 0 incidents, 5 maintenance records, and 11 locations. Below these statistics is a section titled 'Latest Flights' with an 'Add a flight >' button. A table with columns for Name, Pilots, Landings, Drone, Type, Location, and Project/Job is partially visible at the bottom.

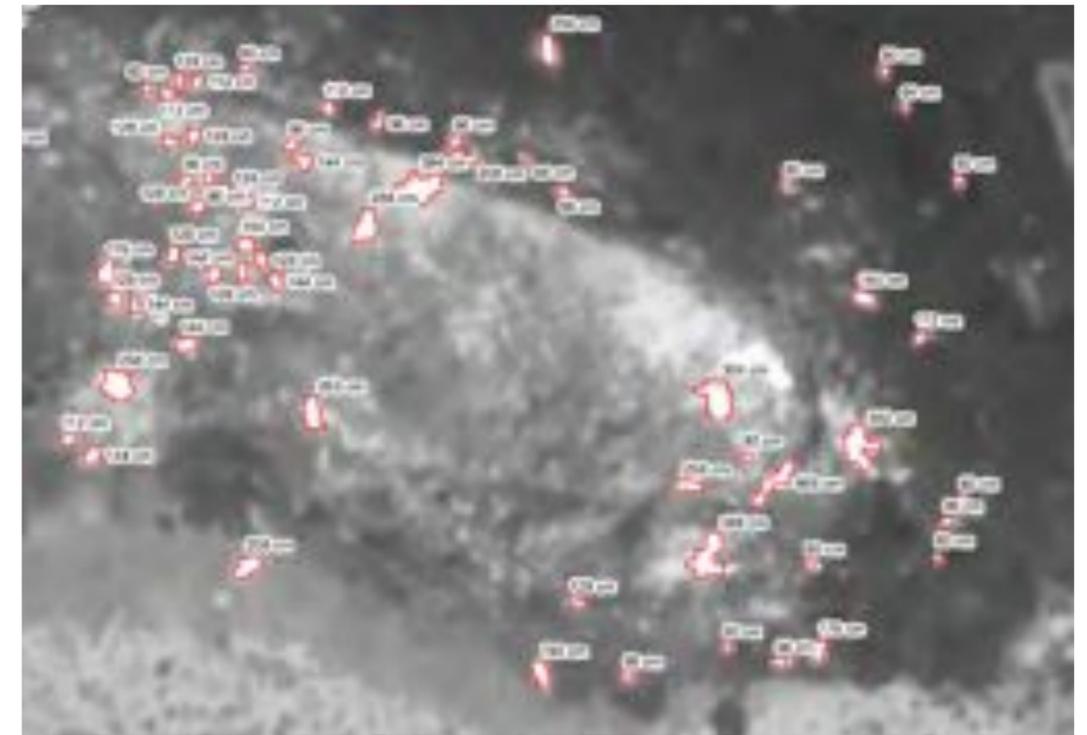
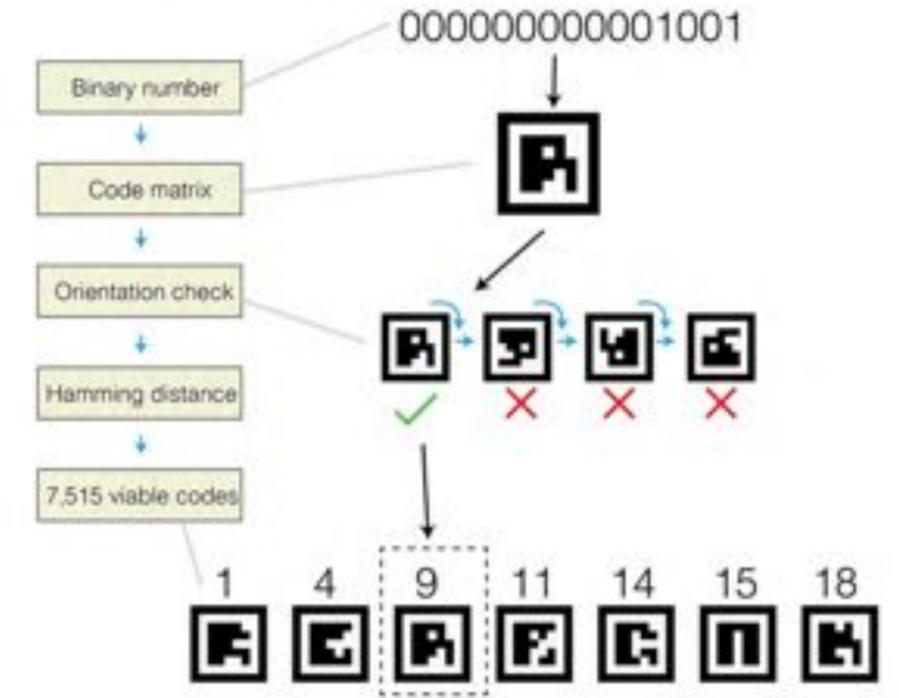
People & Partners

- 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

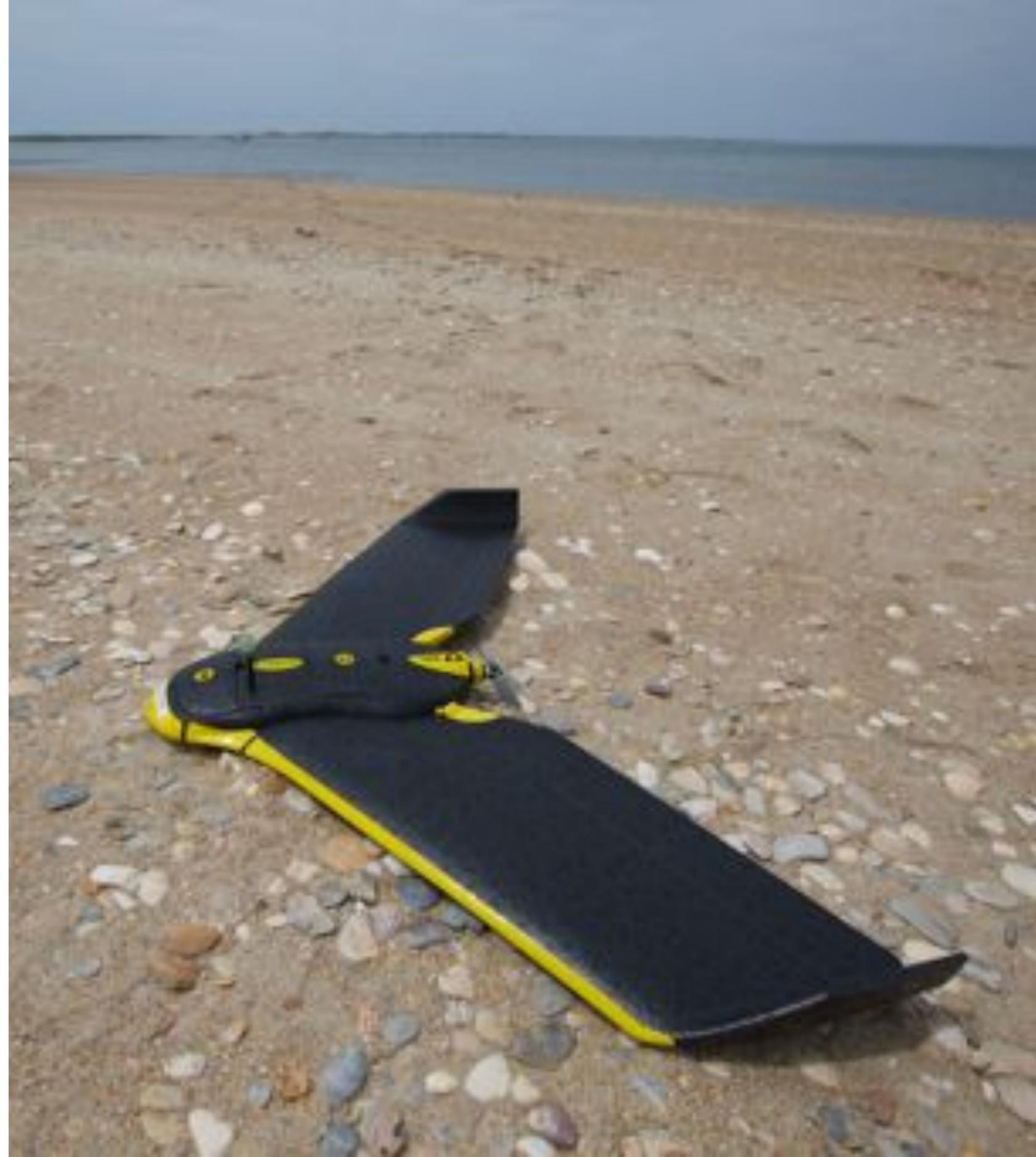
Incoming!

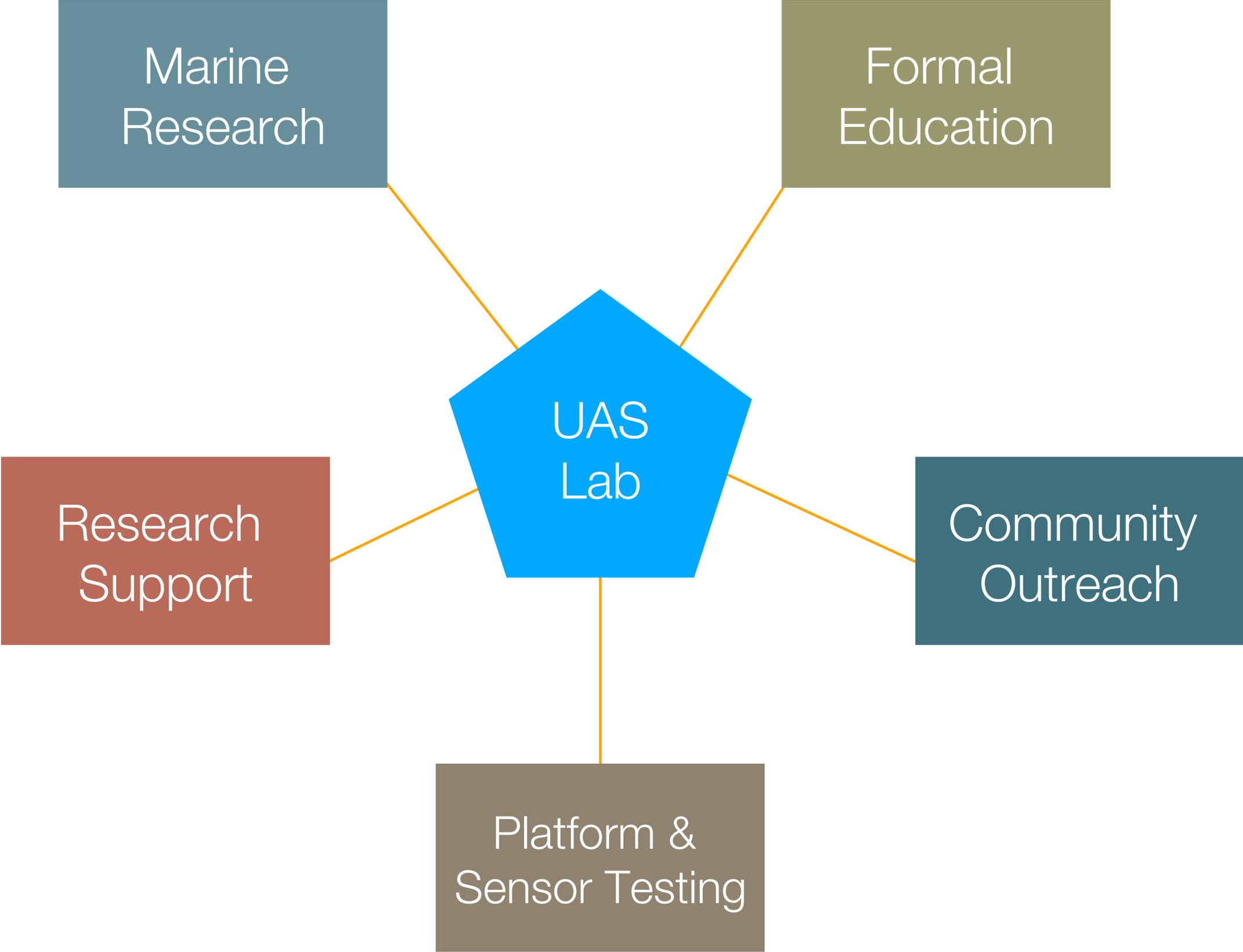
- Improvements in Facilities, Communications and Equipment at Biological Field Stations and Marine Laboratories (FSML) - National Science Foundation: Recommended \$310K
 - Renovate building
 - Obtain new platforms
 - RTK, amphibious/environmentally sealed
 - Develop Computing Infrastructure
 - Object-oriented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

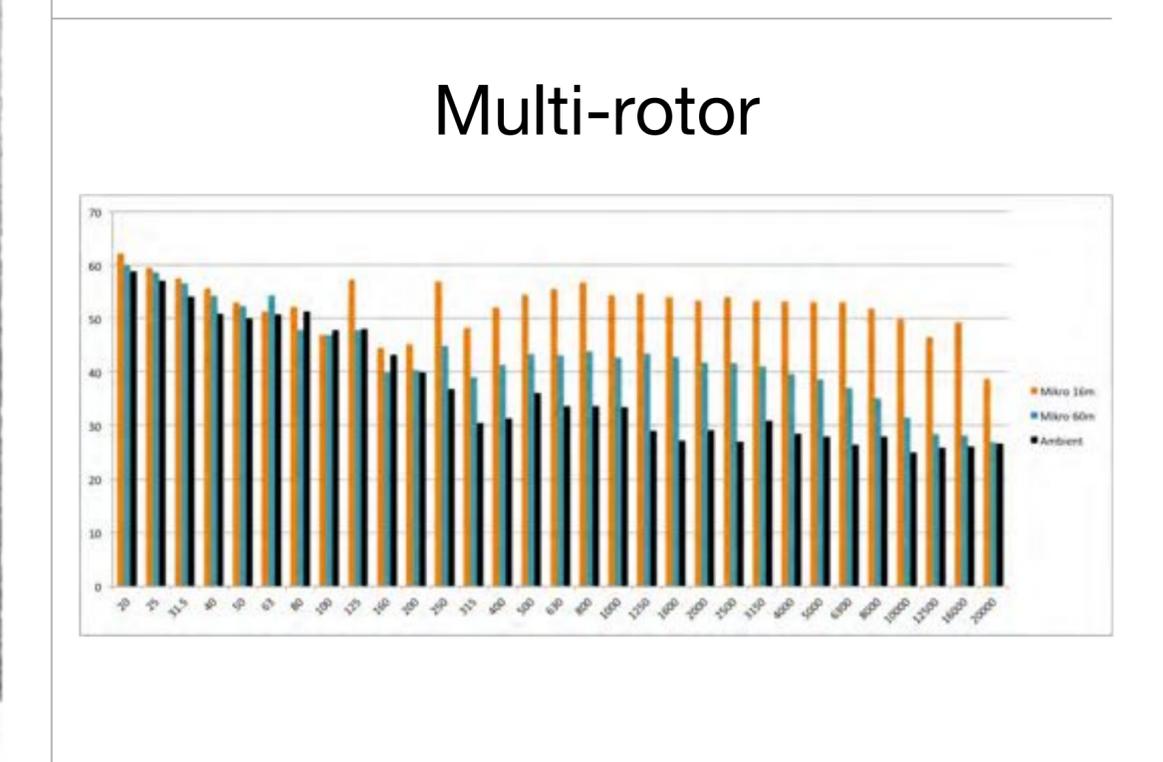
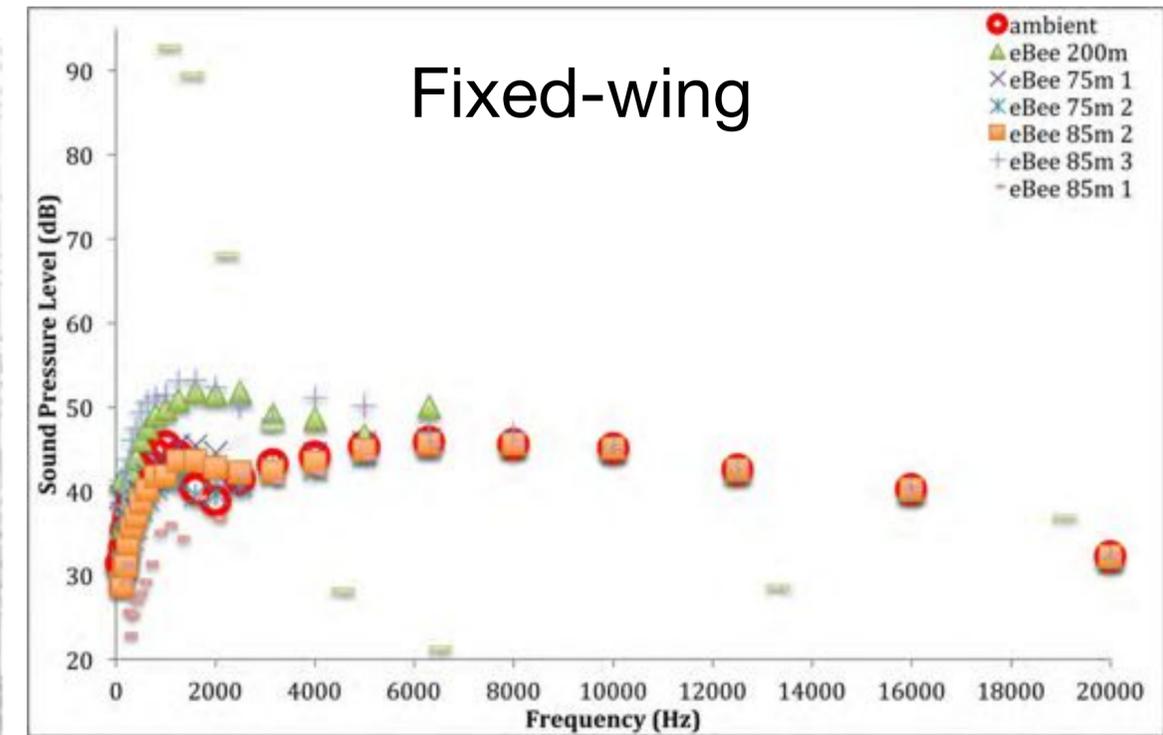
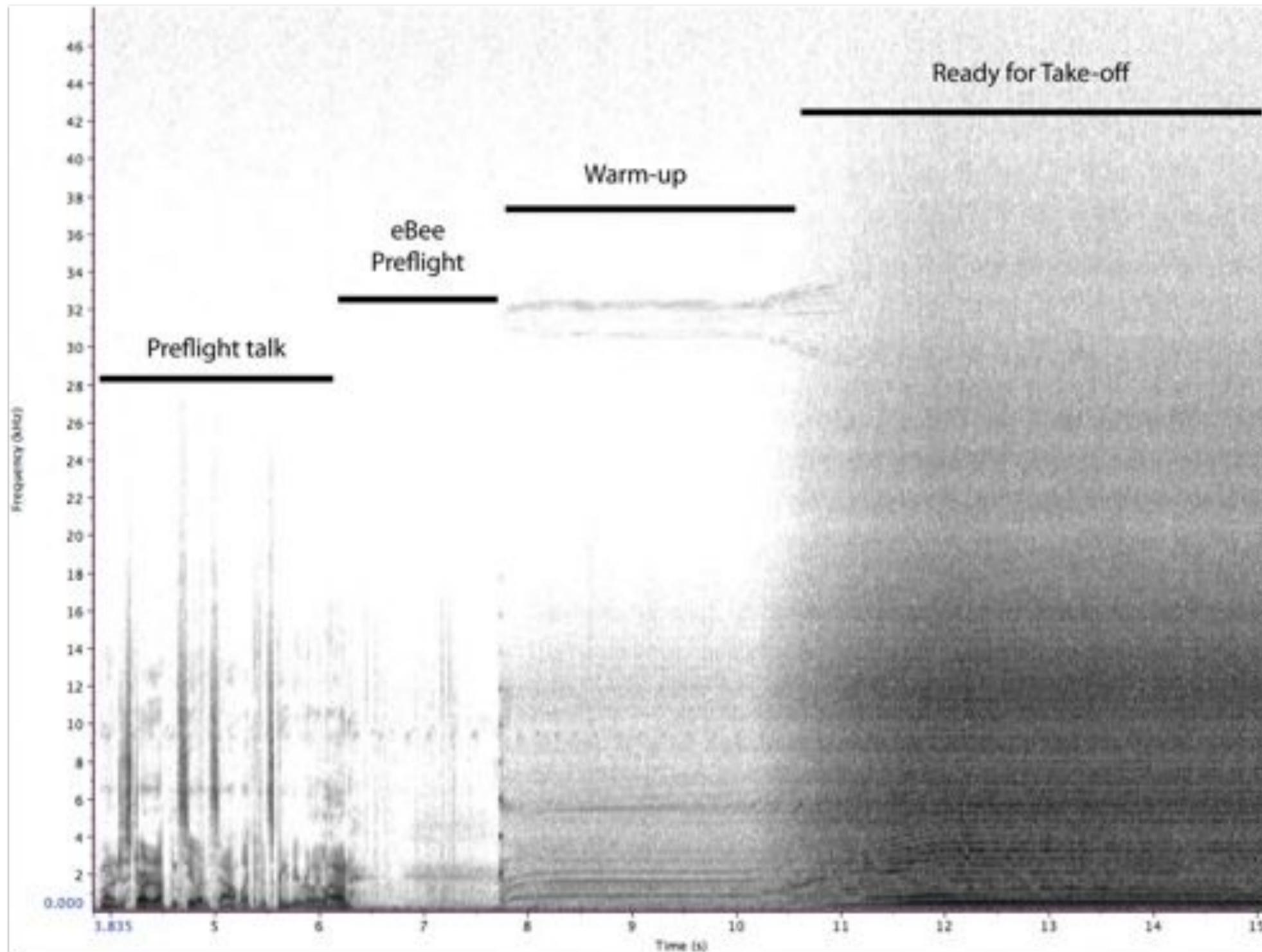




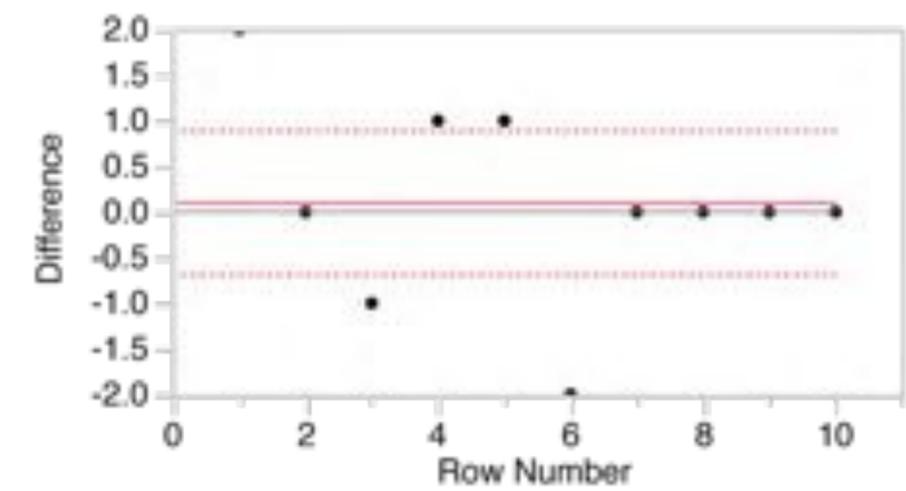
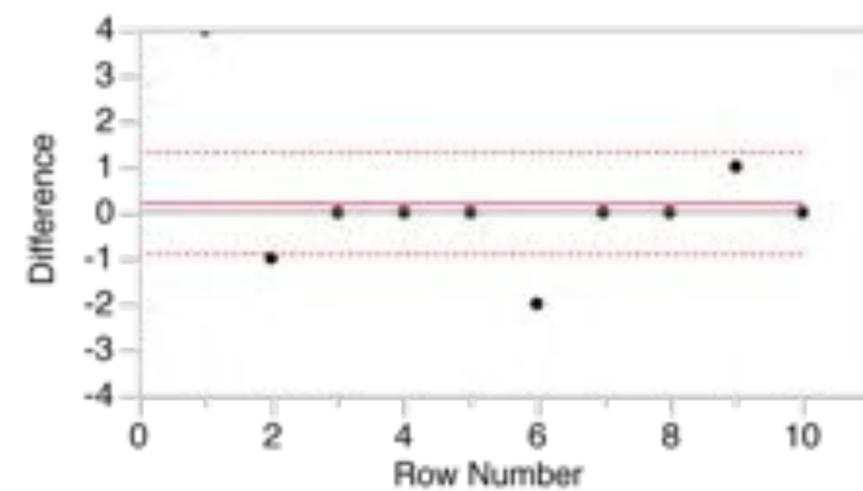
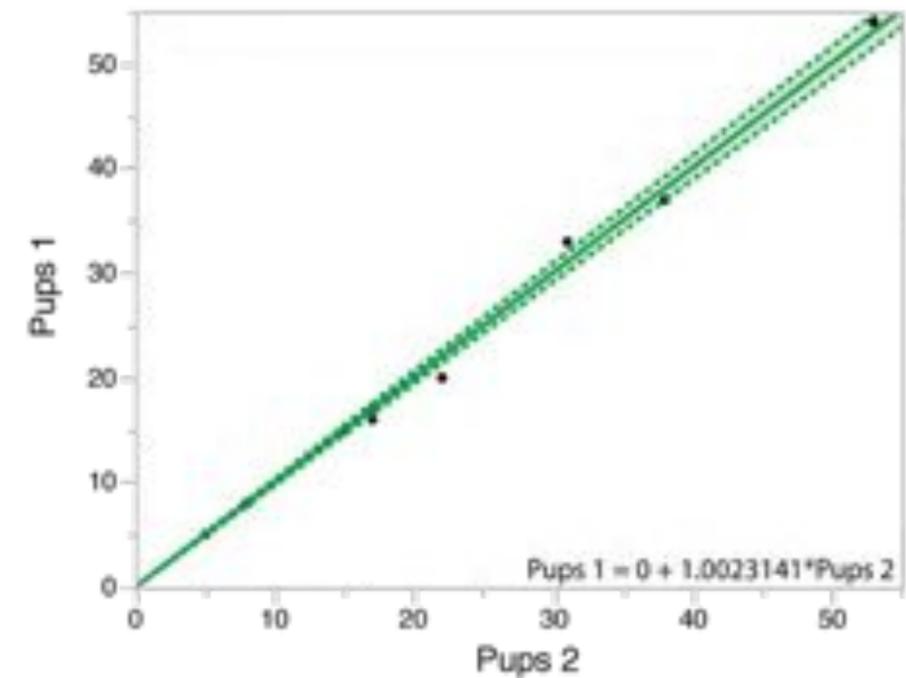
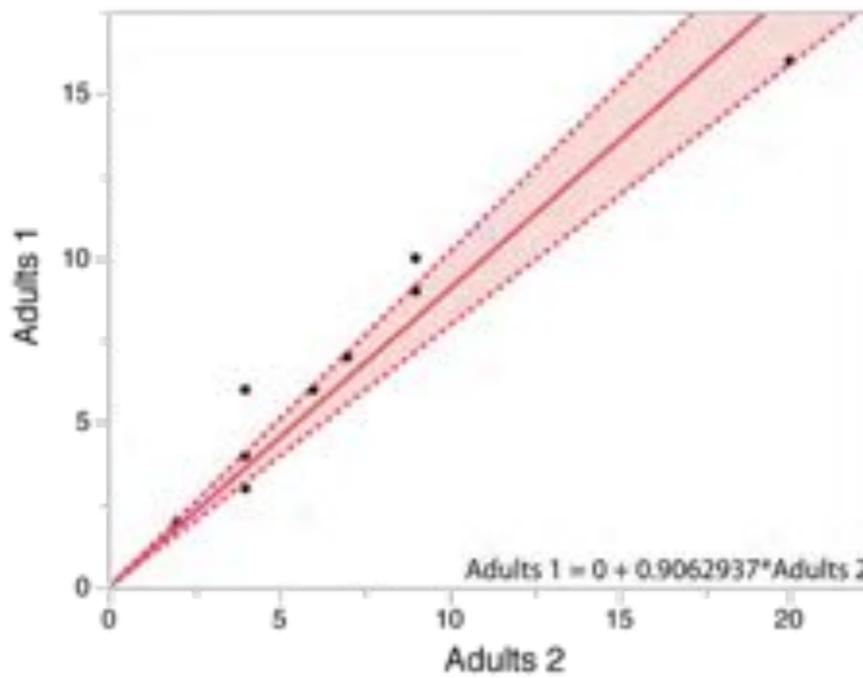
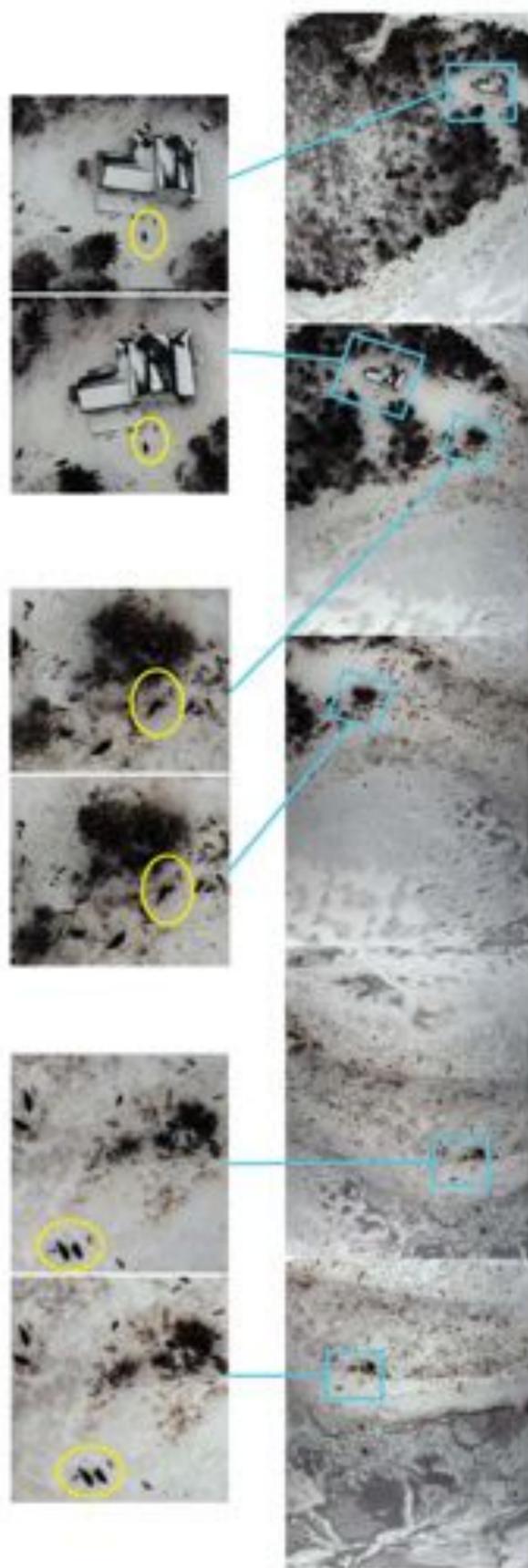
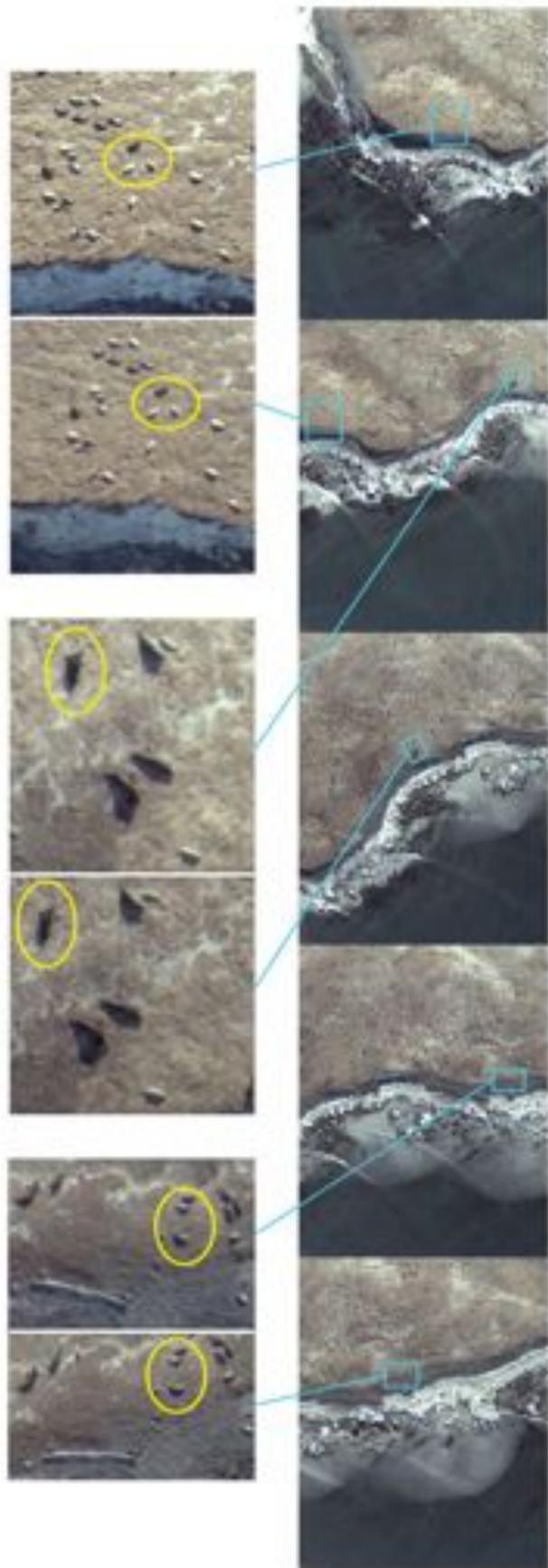
Detection and Calibration

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





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		

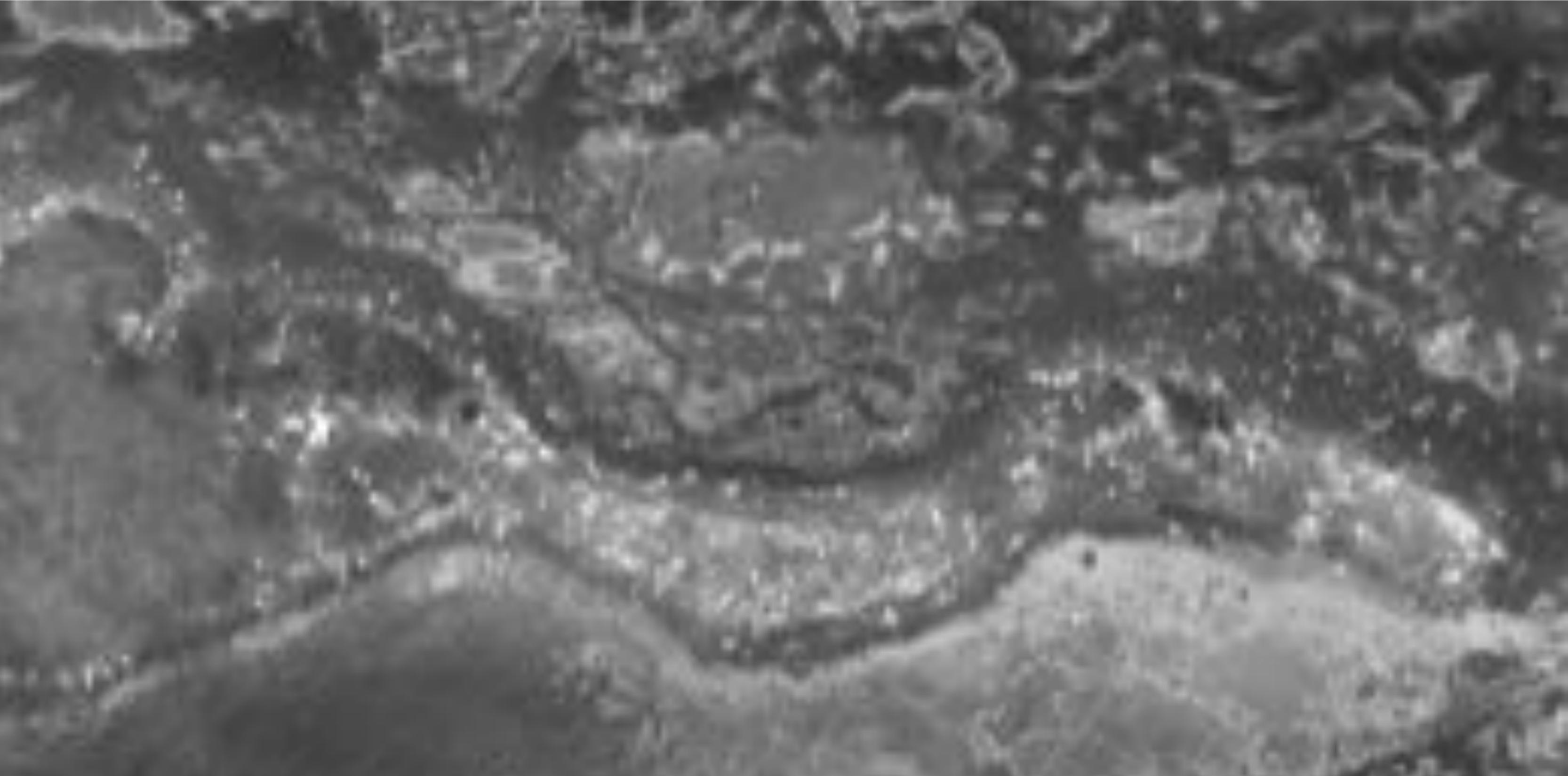
Mean Difference	0.1	Prob > t	0.7804
Std Error	0.34801	Prob > t	0.3902
Upper 95%	0.88725	Prob < t	0.6098
Lower 95%	-0.6873		

Disturbance Effects

Animal Distribution and Density



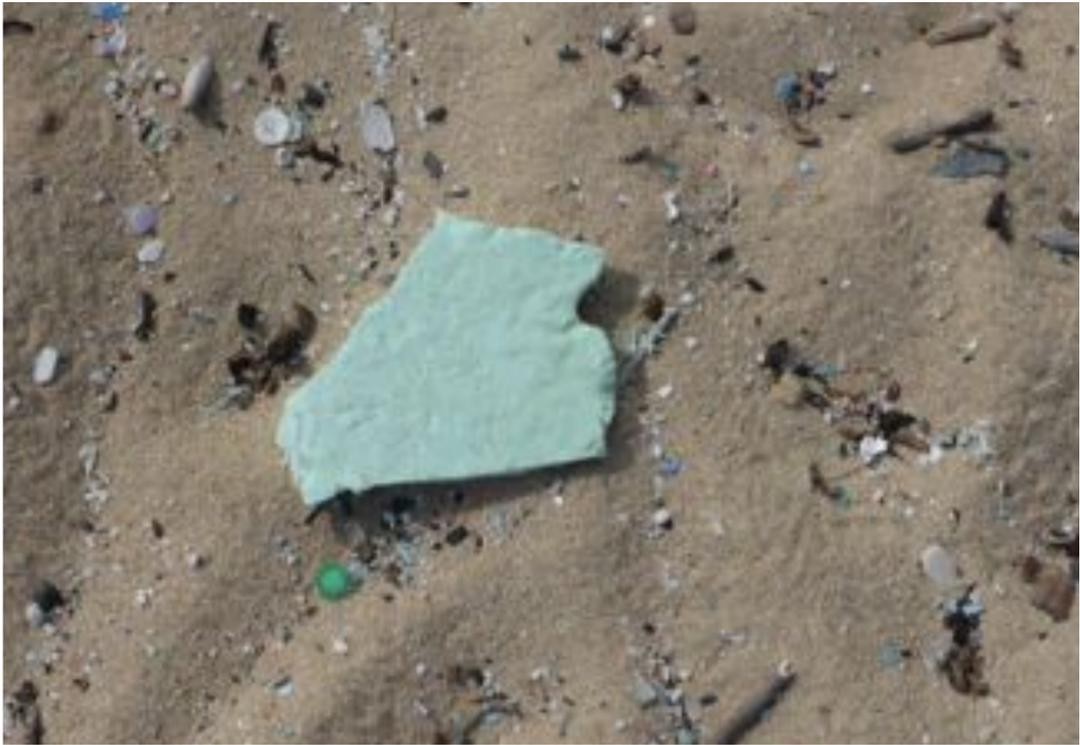




Thermal Imaging

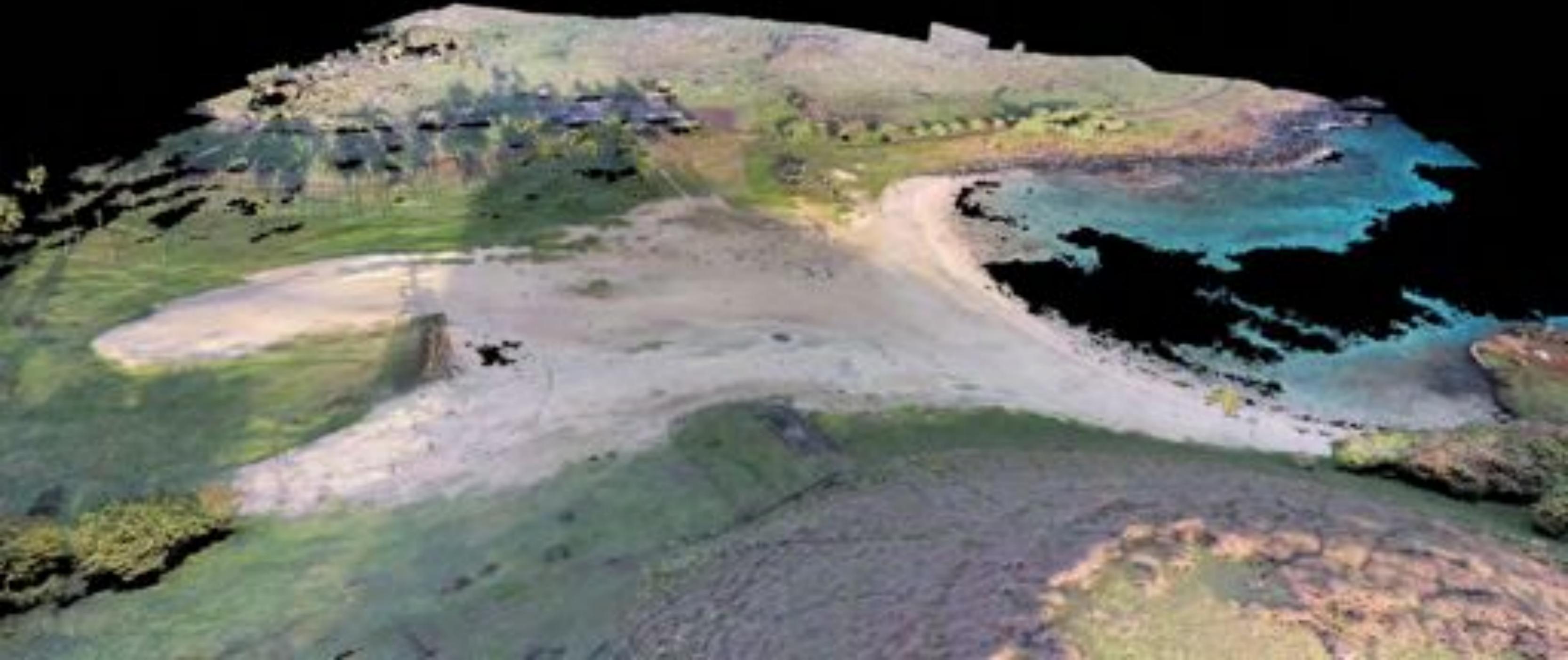


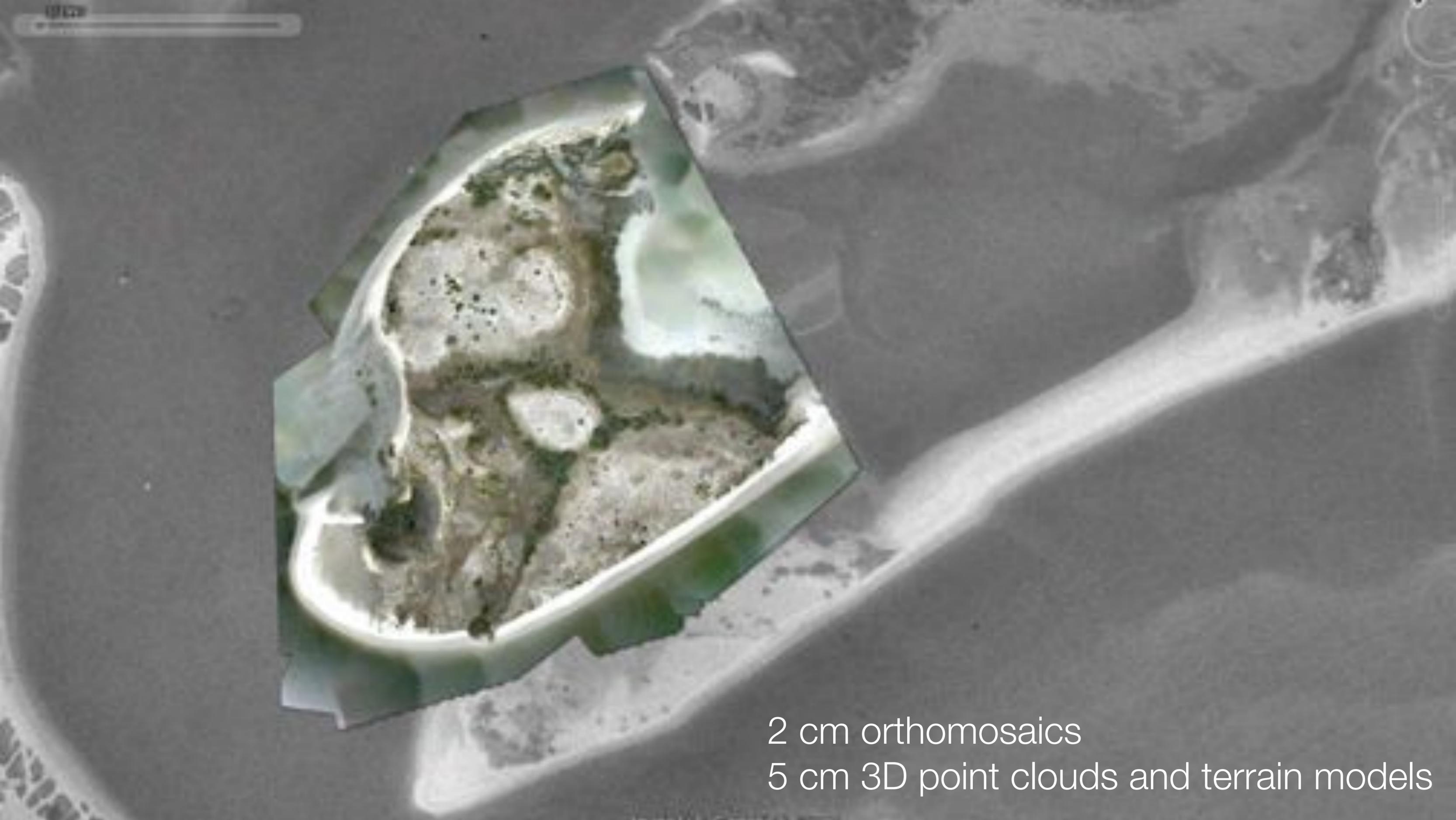
Right whale surveys in Florida: Health assessments and snot sampling



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

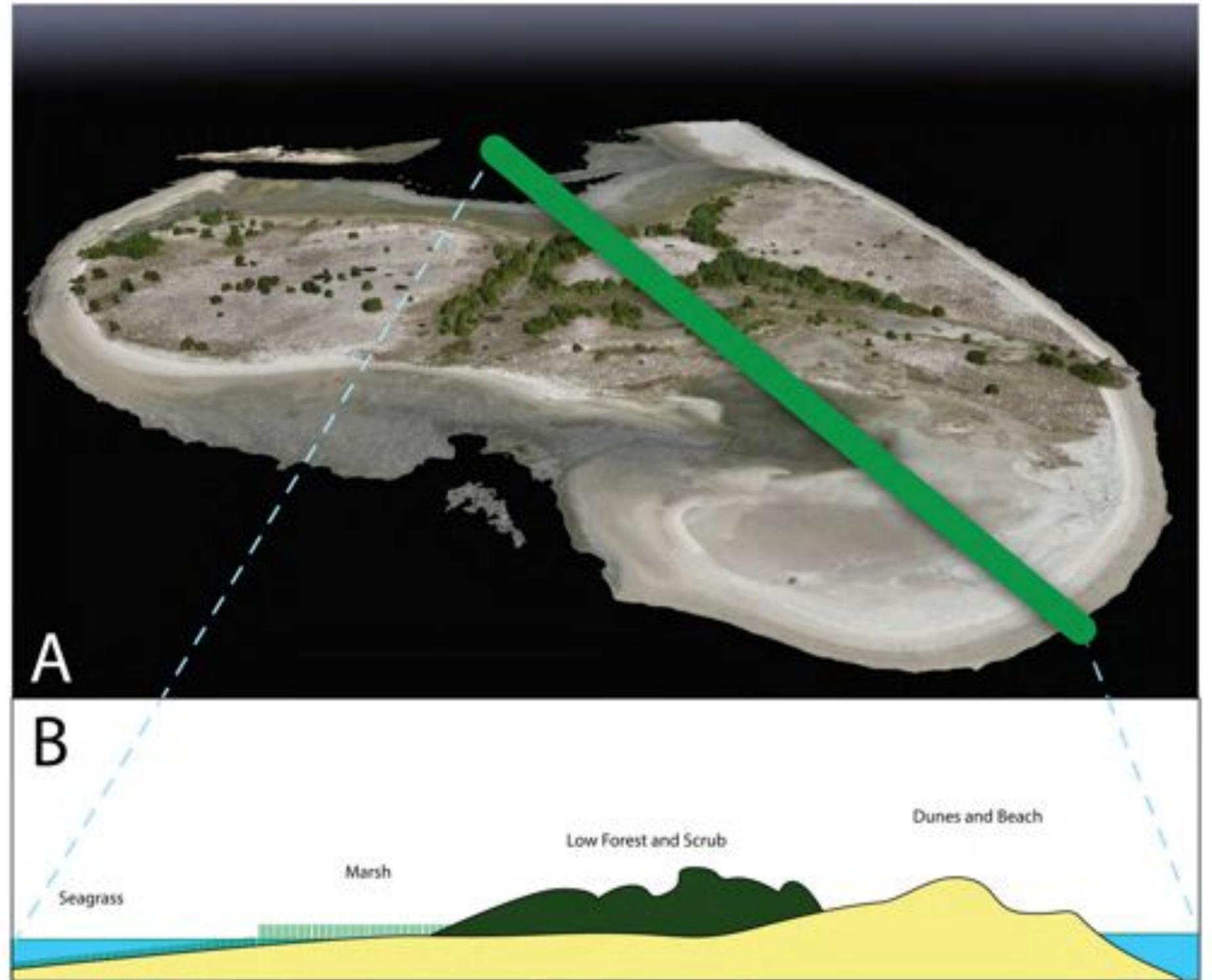
Affordable aircraft, sensors and software minimize entrance barrier

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



Unoccupied Aircraft Systems (UAS) in Scientific Research

Duke University Marine Laboratory



Course Description

Comprehensive exploration of current UAS technologies in coastal and marine research, including aeronautical concepts, rules and regulations, safety, mission planning, aircraft design, payload selection, operational procedures, maintenance, data management and data analysis. Includes a full overview of current and emerging remote sensing applications for monitoring marine species and habitats. Lab component includes building, operating and maintenance of fixed wing and/or rotary wing aircraft, programming for manual and autonomous flight, active participation in scientific research and data analysis, and in-depth discussion on future of UAS in science.

Registration begins February 22, 2016

Space is limited, register early

Course Details

- Course # ENV 335LA or ENV 735LA
- Lectures and discussion of current topics
- Hands-on mission planning, data analysis and maintenance of platforms
- Learn senseFly and 3D Robotics systems
- Build your own UAS and take it home

When: July 11- Aug 12, 2016

Where: Duke University Marine Laboratory
135 Duke Marine Lab Rd.
Beaufort, NC 28516

Contact: Katie.Wood@Duke.edu
252 504 7586
www.dukemarinelab.net



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

