NORTH CAROLINA
Department of Transportation

NCDOT - Division of Aviation
UAS Program Office

Darshan Divakaran, UAS Program Engineer

August 31st, 2017

Welcome

Important Information

- Check in at the booth and collect raffle ticket
- Visit the sponsor booth
- Drone Raffle
- Ask a question to our UAS panel

- Visit DOA booth to collect free aeronautical chart of NC, balsa wood airplane.
- Post on social media about the Drone workshop

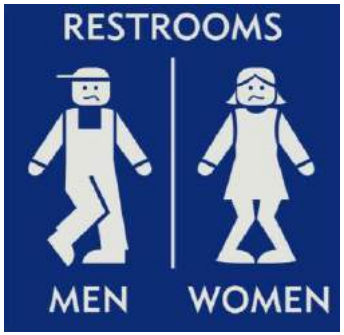
House Rules


NO DRONE ZONE


SILENCE
YOUR
CELL PHONE


Don't be mean.
Keep it clean.


EMERGENCY
EXIT


RESTROOMS
MEN
WOMEN

Social Media

Search – NCDivisionofAviation

Go ahead click a picture or post and use **#ncdroneworkshop** on social media

DOA Website

https://www.ncdot.gov/aviation/uas/

NC Drone Safe

#ncdronesafe

Presentations

- Division of Aviation
- Precision Hawk
- RTI International
- Seymour Johnson AFB
- Fly4Pix
- City of Wilson
- WithersRavenel
- Duke University Marine Lab
- Montgomery Community College

Sponsors


DIVISION OF AVIATION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Fly4Pix
RTI
INTERNATIONAL

Thomasville Workshop

Location – Davidson County Community College

Address - Mary E. Rittling Conference Center
297 DCC Road, Thomasville, NC 27360

Date - October 12th, 2017

Visit - https://www.ncdot.gov/aviation/uas/

Reminders

- Check in and take raffle ticket.
- Visit sponsor tables.
- Maintain house rules.
- Social media #ncdroneworkshop & #ncddronesafe
- Write your questions for the our UAS panel
- Don’t miss the networking session after the presentations.

Welcome!

Bobby Walston

Director

NCDOT - Division of Aviation

NORTH CAROLINA
Department of Transportation









For more information visit-
https://www.ncdot.gov/aviation/uas/
UAS Program Office
Email - UAS@ncdot.gov
Phone - 919-814-0550

NORTH CAROLINA
Department of Transportation

UAS Regulatory Landscape

Basil Yap, UAS Program Manager

September 28, 2017

Drone Regulations

- Critical to UAS Program Development
  - Constantly Evolving
- Federal Regulations
  - Airspace Safety for Manned and Unmanned Aircraft
- State and Local Regulations
  - Privacy, Safety, Launch and Recovery

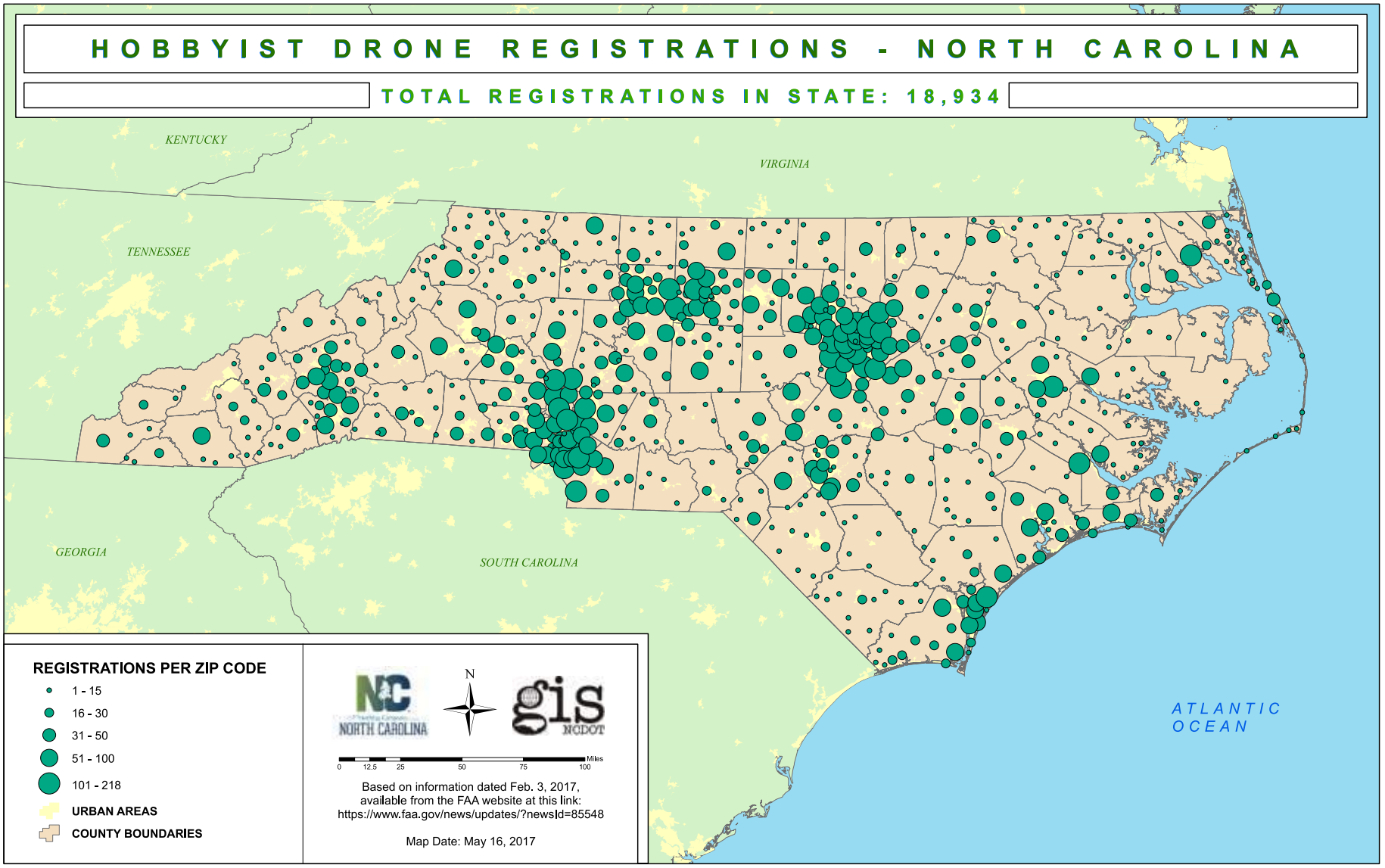
UAS Operator Permits

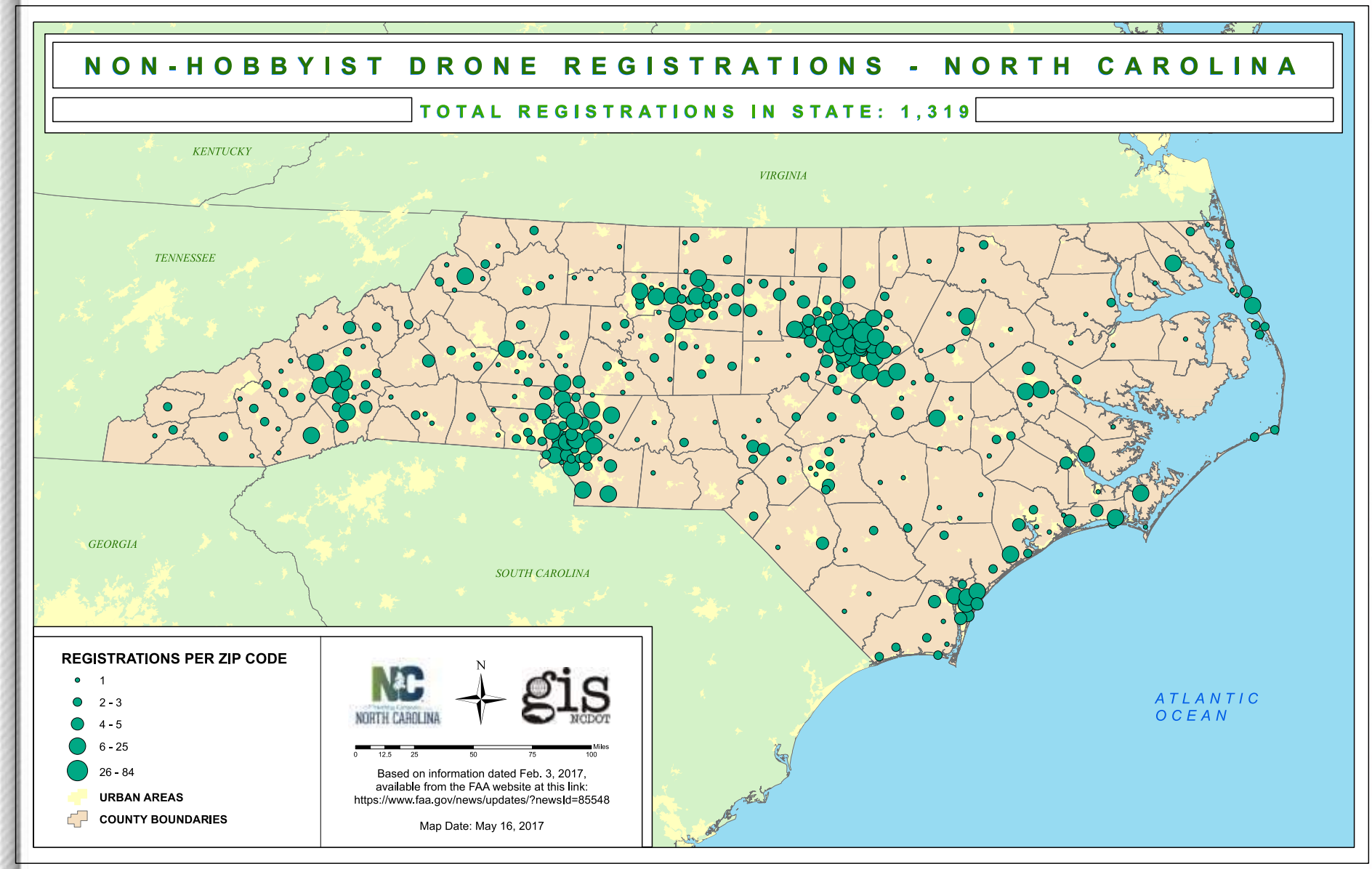
Federal

- Pass a UAS knowledge test at FAA testing center and TSA background check
- Apply for Remote Pilot Certificate

North Carolina

- Pass NC UAS Knowledge test online
- Apply for commercial or government NC Operator Permit online
- www.ncdot.gov/aviation/uas


HOBBYIST DRONE REGISTRATIONS - NORTH CAROLINA
TOTAL REGISTRATIONS IN STATE: 18,934
KENTUCKY
VIRGINIA
TENNESSEE
GEORGIA
SOUTH CAROLINA
ATLANTIC OCEAN
REGISTRATIONS PER ZIP CODE
1 - 15
16 - 30
31 - 50
51 - 100
101 - 218
URBAN AREAS
COUNTY BOUNDARIES
N
NORTH CAROLINA
gis NCDOT
0 12.5 25 50 75 100 Miles
Based on information dated Feb. 3, 2017, available from the FAA website at this link: https://www.faa.gov/news/updates/?newsId=85548
Map Date: May 16, 2017

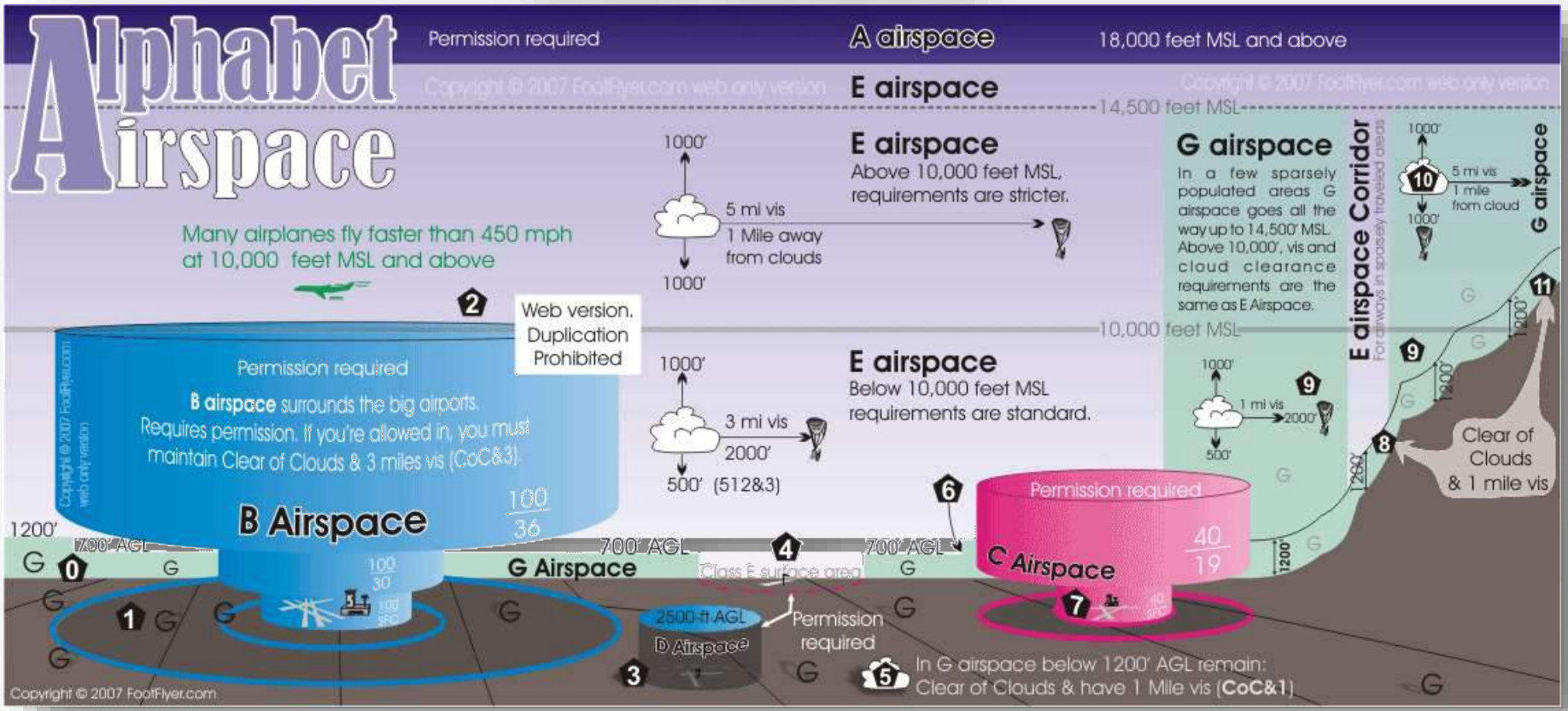

NON-HOBBYIST DRONE REGISTRATIONS - NORTH CAROLINA
TOTAL REGISTRATIONS IN STATE: 1,319
KENTUCKY
VIRGINIA
TENNESSEE
GEORGIA
SOUTH CAROLINA
ATLANTIC OCEAN
REGISTRATIONS PER ZIP CODE
1
2 - 3
4 - 5
6 - 25
26 - 84
URBAN AREAS
COUNTY BOUNDARIES
N
NORTH CAROLINA
gis NCDOT
0 12.5 25 50 75 100 Miles
Based on information dated Feb. 3, 2017, available from the FAA website at this link: https://www.faa.gov/news/updates/?newsId=85548
Map Date: May 16, 2017

North Carolina's Airport System

72 Publicly Owned Airports in North Carolina

Federal UAS Regulations

Airspace Management



Federal UAS Regulations

Airspace Management

Federal UAS Regulations

Hobbyist or Recreational

- 14 CFR Part 101 (E) – Special Rule for Model Aircraft
- Must fly within line of sight
- Must notify an airport of operations within 5 statute miles
- Must not interfere with manned aircraft
- Must follow community based standards
- Must fly solely for hobby or recreation

- 14 CFR Part 107 – Small Unmanned Aircraft Systems
- Obtain Remote Pilot Certificate from FAA (2 years)
- 16 years or older
- Fly during day and civil twilight
- Max altitude of 400 ft. AGL
- Max speed of 100 mph
- Must fly within line of sight
- Cannot fly over people not involved with the operation
- Class G airspace

Federal UAS Regulations

Commercial and Government

- 14 CFR Part 107 – Small Unmanned Aircraft Systems
- Obtain Remote Pilot Certificate from FAA (2 years)
- 16 years or older
- Aircraft weighs less than 55 lbs.
- Fly during day and civil twilight*
- Max altitude of 400 ft. AGL*
- Max speed of 100 mph
- Must fly within line of sight*
- Cannot fly over people not involved with the operation*
- Class G airspace*

Other options

- 333 Exemptions
- Certificate of Authorization (COA)

*Waivers for certain small UAS operating rules

Future of Airspace Authorizations

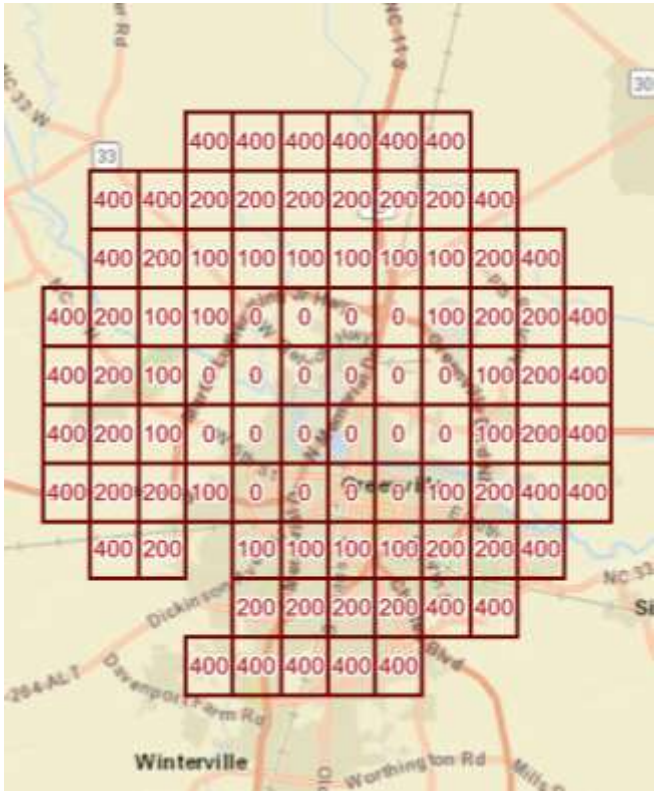
Waiver/Airspace

Currently

- Online Portal
- 90 days or less

Future

- LAANC should help with Airspace Authorizations
- Test run this fall



Federal UAS Regulations

- UAS over .55 lbs. must be registered with the FAA*
- https://registermyuas.faa.gov
- $5 registration fee
- UAS must be labeled
- Hobbyist – One number for all aircraft
- Non-Hobbyist – Each aircraft has unique number

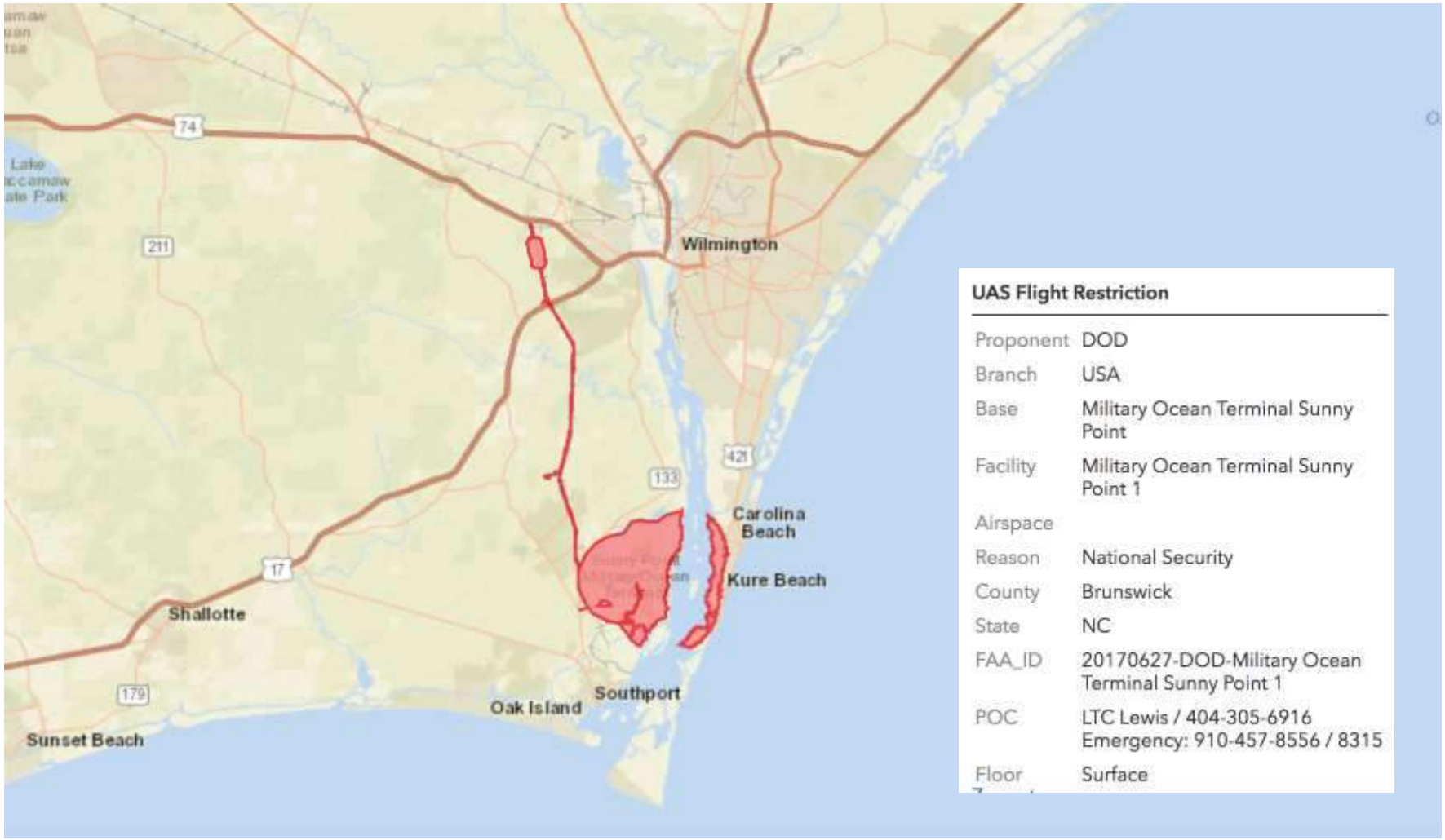
*As of May 19,2017, hobbyist operating under the Special Rule for Model Aircraft no longer are required to register their drone

Military Airspace

- National Security UAS Flight Restrictions
- FAA and DoD have restricted UAS operations over 132 military facilities.
- The restrictions are up too 400’ AGL, 24 hours a day, 7 days a week.
- Facilities can be found here: http://uas-faa.opendata.arcgis.com/
- Other FAA restricted areas for civil operations apply to UAS operators

County	Base	FAA ID
Onslow	Marine Corps Air Station New River	20170410-DOD-New River-MCAS New River 2
Carteret	MCALF Bogue, Marine Corps Air Station Cherry Point	20161222-DOD-MCALF Bogue-Auxiliary Landing Field (ALF) Bogue CDSA by NOTAM during scheduled operations only.
Jones	MCOLF Oak Grove, Marine Corps Air Station Cherry Point	20161222-DOD-Oak Grove-Outlying Landing Field (OLF) Oak Grove CDSA by NOTAM. Heavy use as an uncontrolled airport.
Richmond	Fort Bragg, NC	20161222-DOD-Fort Bragg-Mackall AAF
Cumberland	Fort Bragg, NC	20161222-DOD-Fort Bragg-Simmons AAF
Stanly	Stanly County, NC	20161222-DOD-Stanly County-Stanly County
Onslow	MCB Camp Lejeune	20170508-DOD-MCB Camp Lejeune

Military Airspace



Congressional Action

- Drone Federalism Act
  - S.1272
- Drone Innovation Act
  - H.R. 2930
- Both bills shift the regulatory authority to local and state governments while preserving defined parts of federal preemption
- Bard College released a study stating 135 local governments in 31 states enacted drone legislation

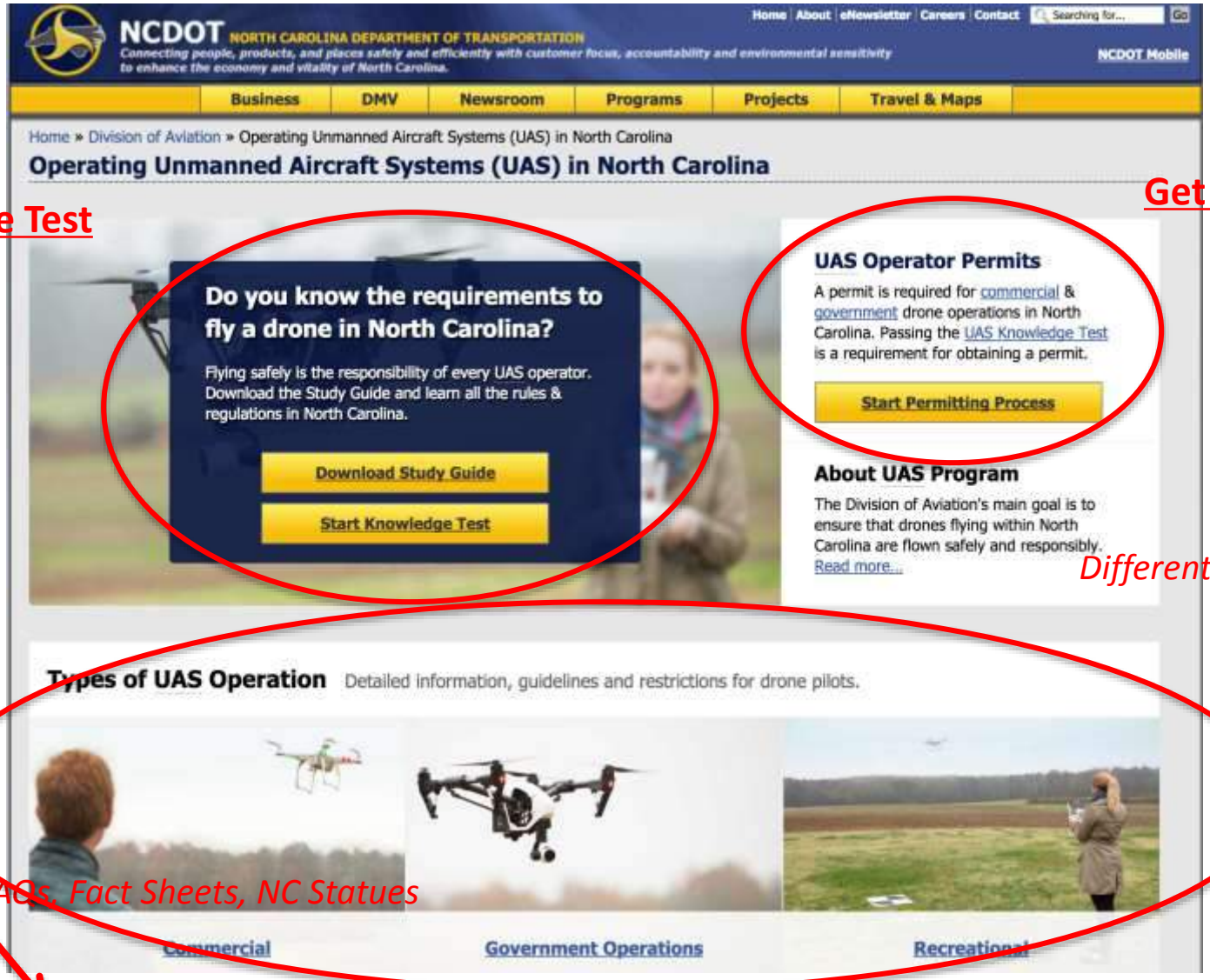
State UAS Regulations

- North Carolina General Assembly passed UAS bills into law in 2013, 2014, 2015, 2016, 2017
- Chapter 14 – Criminal Law
  - § 14-7.45 Crimes committed by use of UAS
  - § 14.280.3 Interference with manned aircraft by UAS
  - § 14.401.24 Unlawful possession and use of UAS (Weapon attached)
  - § 14.401.25 Unlawful distribution of images
- Chapter 15A – Criminal Procedure
  - § 15A-300.1 Restrictions on use of UAS
  - § 15A-300.2 Regulation of launch and recovery sites
  - " § 15A-300.3. Use of an unmanned aircraft system near a confinement or correctional facility prohibited.
- Chapter 63 – Aeronautics
  - § 63-95 Training required for operations of UAS (Knowledge Testing)
  - § 63-96 Permit required for commercial operation of UAS
- Chapter 113 – Conservation and Development
  - § 113-295 Unlawful harassment of persons taking wildlife resources

State UAS Regulations

- § 63-95 Training required for operations of UAS (Knowledge Testing)
  - The Division of Aviation will develop and administer a UAS Knowledge Test
  - Applicable to both government and commercial operators who operate in North Carolina
  - The test can be completed online and is the first part of the permitting process
- § 63-96 Permit required for commercial operation of UAS
  - Must be 16 years of age
  - Must provide a drivers license number
  - Must meet the federal requirements for access to the airspace (Remote pilot certificate)
  - Applies to commercial operators only
  - Application for permit is completed online

NCDOT Aviation UAS Website – One Stop



Take the Test

Get Permit

Learn

Different types of UAS operations

Help

Access FAQs, Fact Sheets, NC Statues

State UAS Regulations

HB337

- Clarifies model aircraft applicability
- Remove restrictions around special imaging
- Adds emergency management exception
- Brings the NC UAS Permit in line with Federal requirements (age and Identification)
- Signed into law July 21, 2017
- Effective December 1, 2017

HB128

- Establishes § 15A-300.3. Use of an unmanned aircraft system near a confinement or correctional facility prohibited.
- Exceptions for commercial operators
- Signed into law July 25, 2017
- Effective December 1, 2017

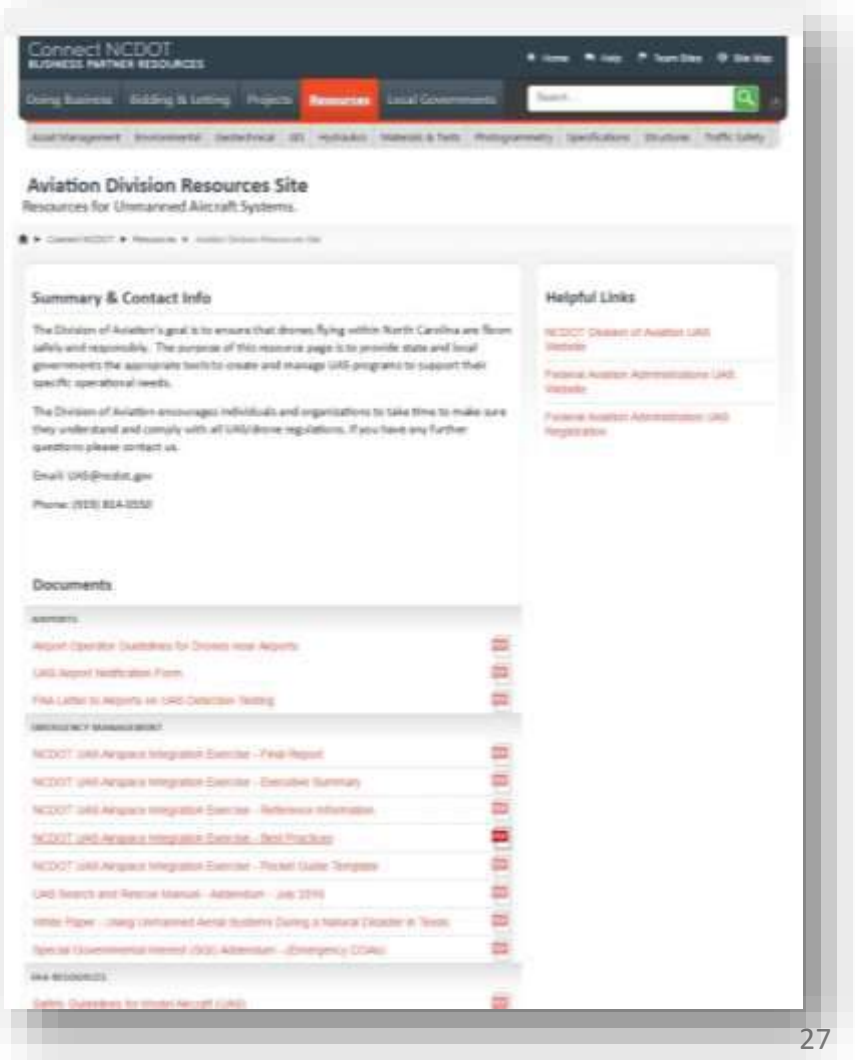
NC UAS Operator Checklist

- ✓ FAA Authorization – Must obtain:
  - Remote Pilot Certificate (under Part 107)
  - Or hold a 333 exemption
- ✓ FAA UAS Registration
  - All UAS/Drones above .55lbs
- ✓ NC Knowledge Test
  - Take and pass the test on the NCDOT Division of Aviation website
- ✓ NC Government Operator Permit or NC Commercial Operators Permit
  - Once you have passed your NC UAS Knowledge Test, you may obtain a permit
  - Need to have an airman certificate to complete the process
  - No fee charged at this time
- ✓ Insurance (best practice)

NCDOT UAS Resource Page

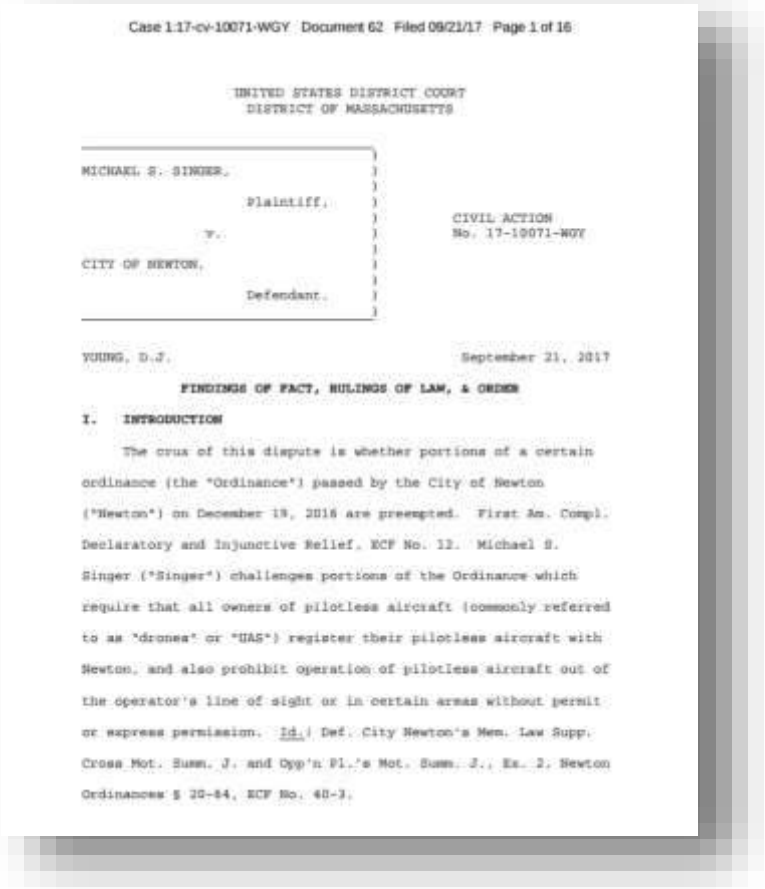
Publicly available online:

- List of NC General Statutes
- Best Practices
- UAS Research Reports
- UAS Related Links
- FAA Resources
- Law Enforcement Resources
- Emergency Management Resources
- Airport Operator Resources
- https://connect.ncdot.gov/resources/Pages/Aviation-Division-Resources.aspx



Local Ordinance Ruling

- Singer vs Newton
- Ruling September 21, 2017
- Four ordinances were conflict preempted
- Registration of UAS
- Altitude restrictions over private property without permission
- Altitude restrictions over public property
- Restriction on beyond visual line of sight operations



Case 1:17-cv-10071-WGY Document 62 Filed 09/21/17 Page 1 of 16

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

MICHAEL S. SINGER,
Plaintiff,
v.
CITY OF NEWTON,
Defendant.

CIVIL ACTION
No. 17-10071-WGY

YOUNG, D.J. September 21, 2017

FINDINGS OF FACT, RULINGS OF LAW, & ORDER

I. INTRODUCTION

The crux of this dispute is whether portions of a certain ordinance (the "Ordinance") passed by the City of Newton ("Newton") on December 19, 2016 are preempted. First Am. Compl. Declaratory and Injunctive Relief, ECF No. 12. Michael S. Singer ("Singer") challenges portions of the Ordinance which require that all owners of pilotless aircraft (commonly referred to as "drones" or "UAS") register their pilotless aircraft with Newton, and also prohibit operation of pilotless aircraft out of the operator's line of sight or in certain areas without permit or express permission. Id.; Def. City Newton's Mem. Law Supp. Cross Mot. Summ. J. and Opp'n Pl.'s Mot. Summ. J., Ex. 2, Newton Ordinances § 20-64, ECF No. 40-3.

Questions

www.ncdot.gov/aviation/uas

Basil Yap

UAS Program Manager

(919) 814-0572

bkyap@ncdot.gov

DIVISION OF AVIATION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

Fly4Pix

Drone Services

A picture is worth a 1,000 words…

But an aerial photo can be worth ***1 Million*** words!

The Great Pyramids of Giza

Photography can be deceiving…

But drones can capture it all.

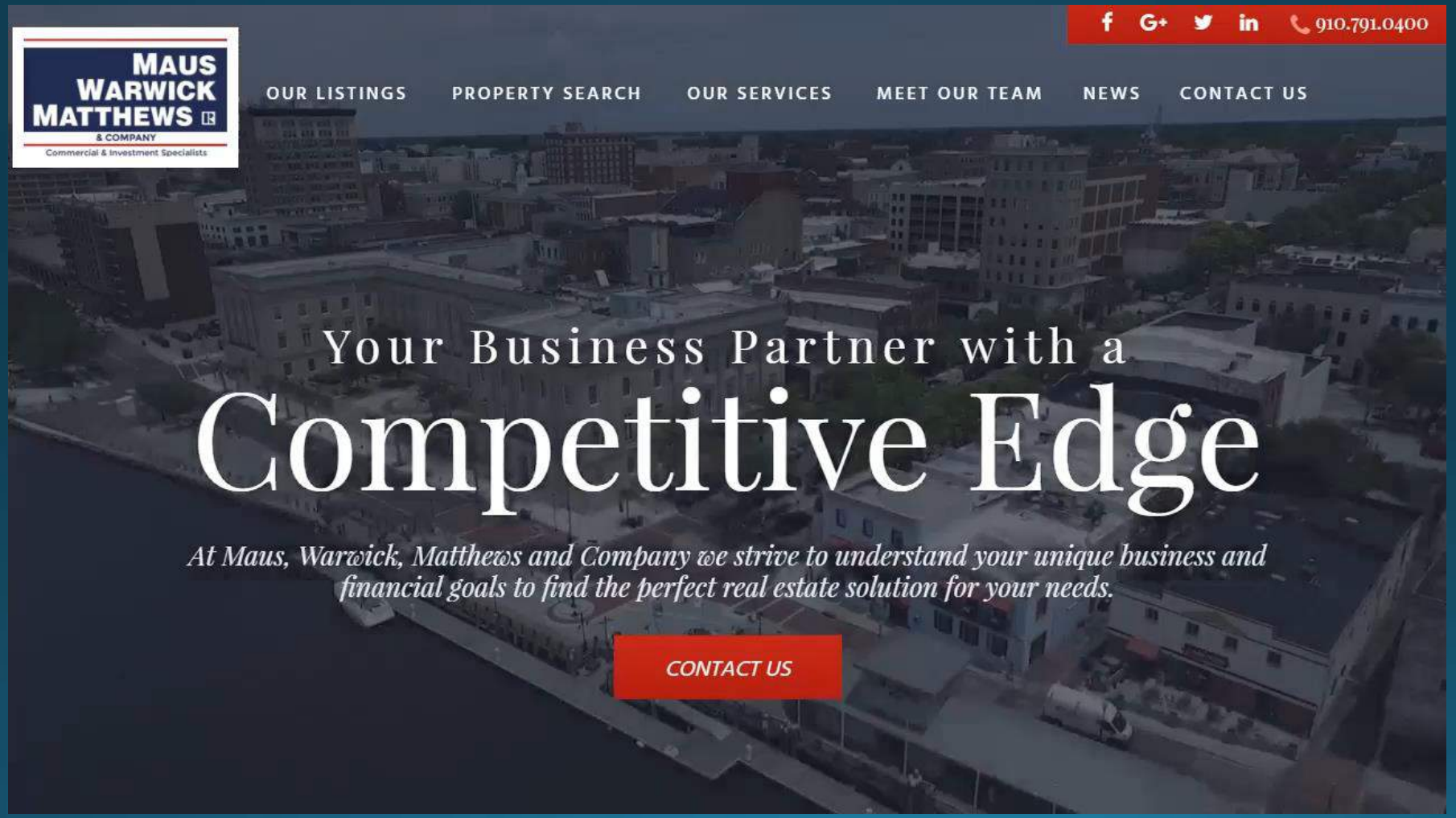
Santorini Greece

Real Estate

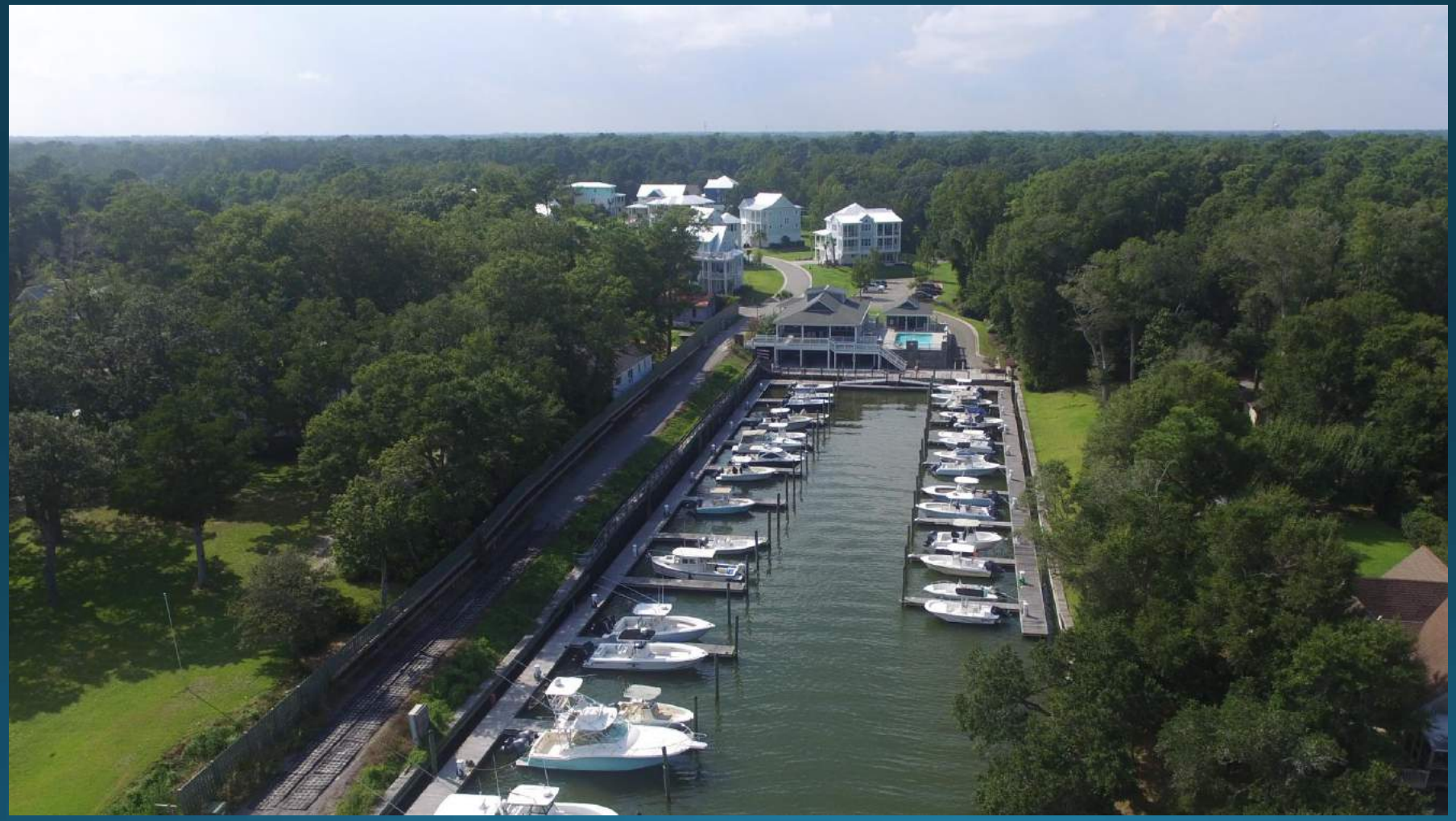
Real Estate

Commercial Real Estate

Website Integration



Community Promotion



Community Promotion

Golf Course Layouts

Economic Development

Complex Development

Municipal Use

Beach replenishment project in the town of Holden Beach.

Tourism

Tourism

Tourism

Tourism

Shipping Companies

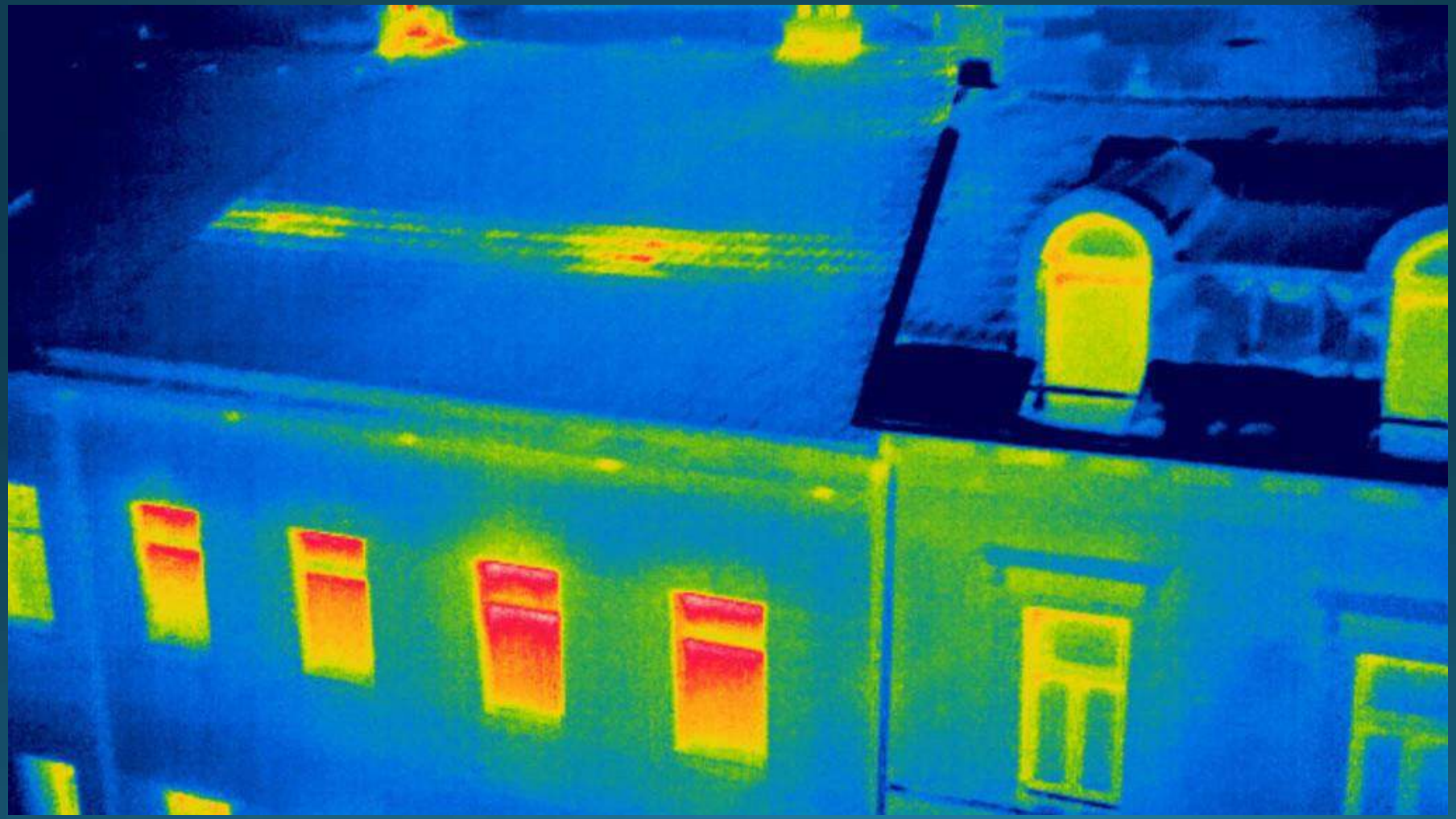
Shipping / Ports

Disaster Recovery

Disaster Inspections

Cell Tower/Stack Inspection

Heat Mapping



Fly4Pix is part of a local family of companies that have been in business since 1989. For all your technology needs.

www.Fly4Pix.com

LATAS

FLY SAFER

Why LATAS?

1. LATAS will enable the safe integration of drones into the airspace today

2. Quickly identify users who are breaking regulations.

3. See tracked drone flights in real time, quickly alerting air traffic controllers of potential conflict

4. Open new revenue streams to local regulators from a “pay for use” model.

Regulatory Leadership

US FAA PATHFINDER PROGRAM

Partnered with the FAA to enabled Beyond Visual Line of Sight (BVLOS) regulations

NASA

Partnering with NASA Standards Development team to create standards for UTM systems

STANDARDS DEVELOPMENT

Working directly with ASTM and RTCA to develop UTM and BVLOS technical standards

How it works

1

Pre-Flight Planning

Today:

- Alerts drone operator about potential conflicts with physical obstacles and no- fly zones

Coming soon:

- Alert operator about potential micro-weather issues
- Allow operator to purchase insurance policy for flight based on pre-flight safety analysis

2

In-Flight

Today:

- Notifies of potential hazards before they occur
- Displays real-time manned & unmanned air traffic

Coming soon:

- Weather alerts
- Integration into native flight software

3

Post Flight

Today:

- Replays flight path, conditions, alerts sent, and obstacles

Coming soon:

- Integrates fleet management systems for seamless operation

LATAS Air

Manned aircraft in 128 countries

Real-time tracking of manned aircraft direct from the FAA Radar/ADS-b network.

No-Fly Zones Simplified

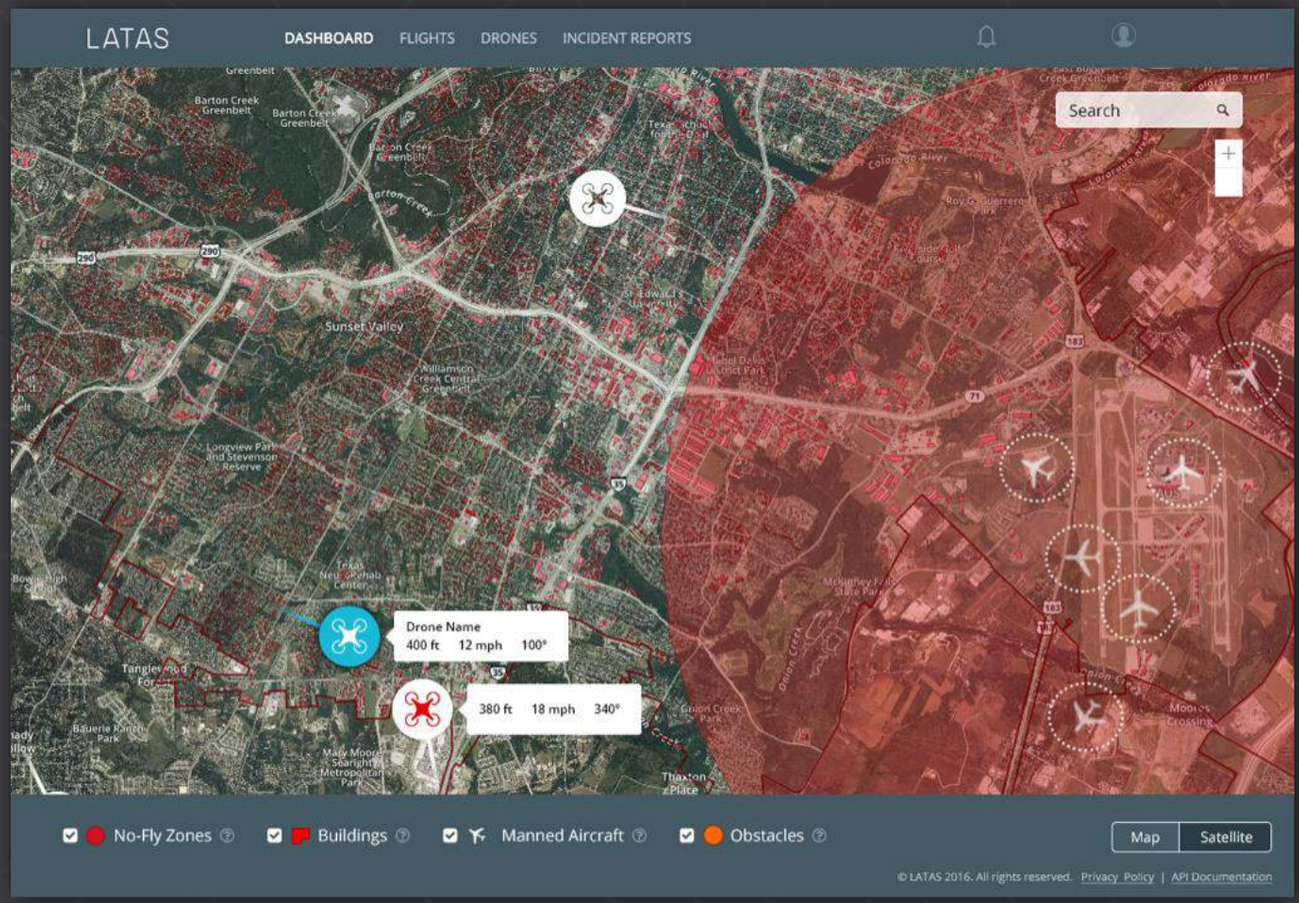
Easy to understand no-fly zones, air-space classes, geofences, temporary restrictions.

Drone tracking (anonymized)

Real-time feed of LATAS equipped drones.

Built with commercial/consumer regulations

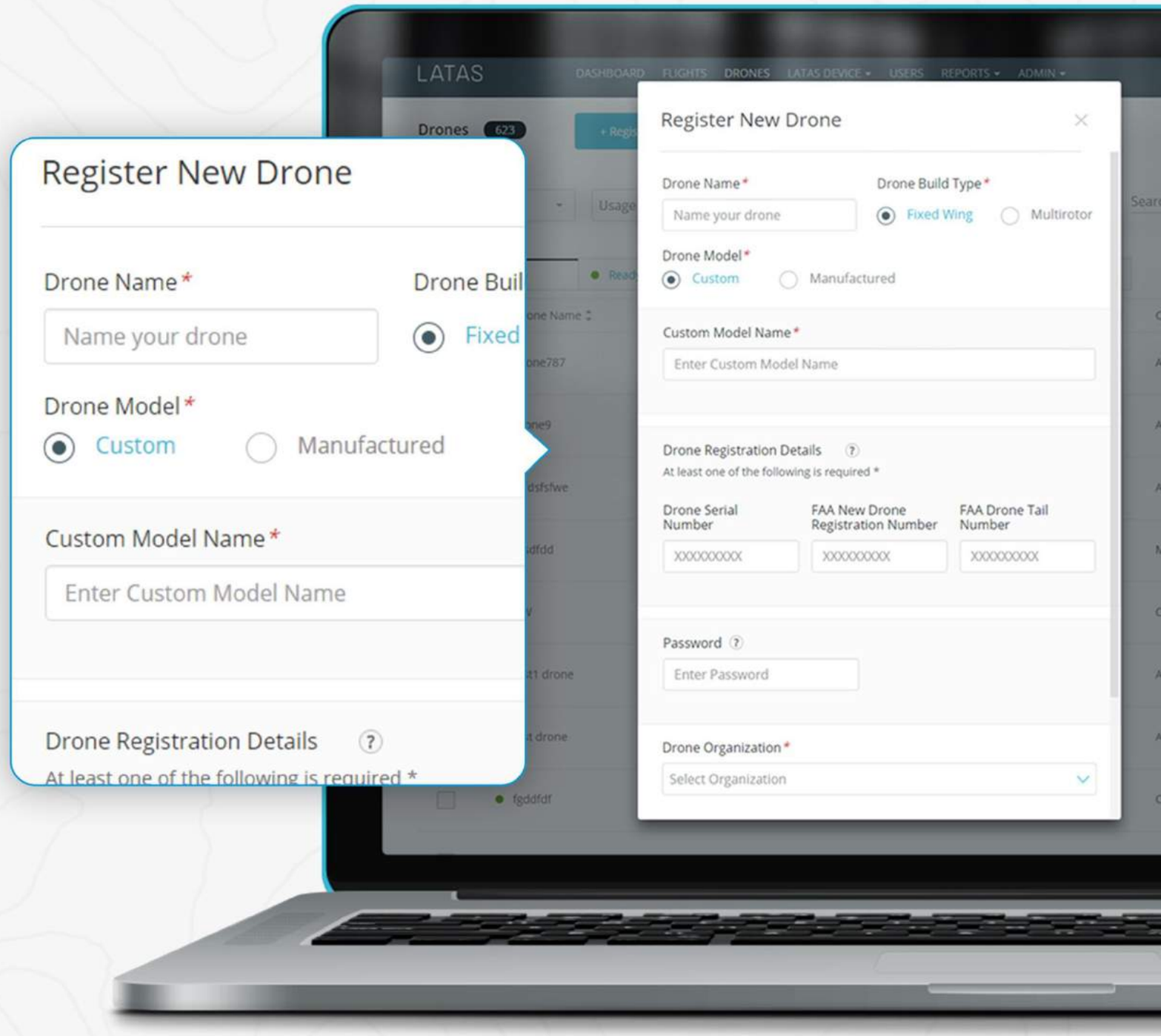
Partners include FAA, Harris, NASA.



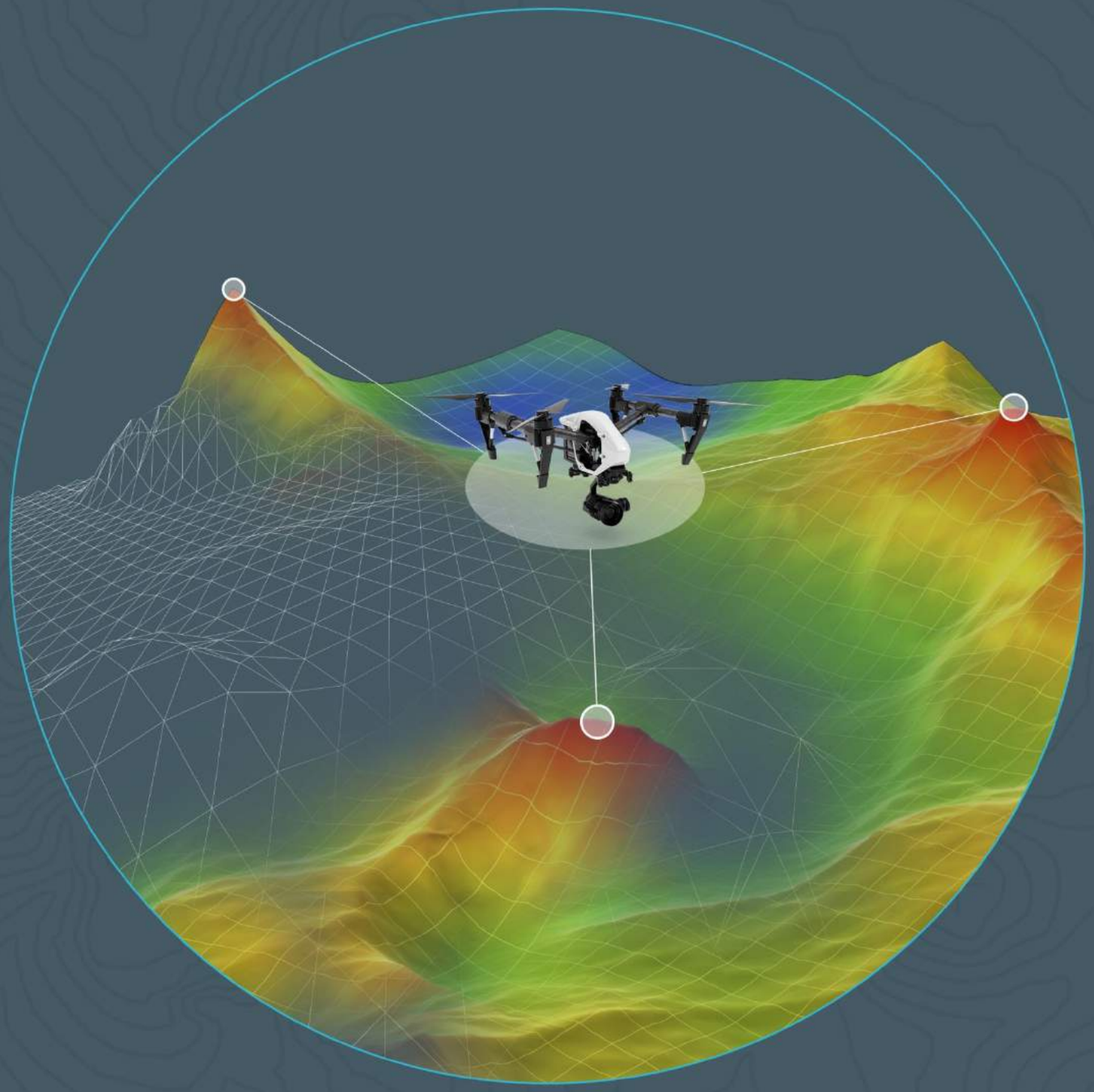
Features

DRONE REGISTRATION

A portal for drone operators to easily register themselves, and their drones.



Features



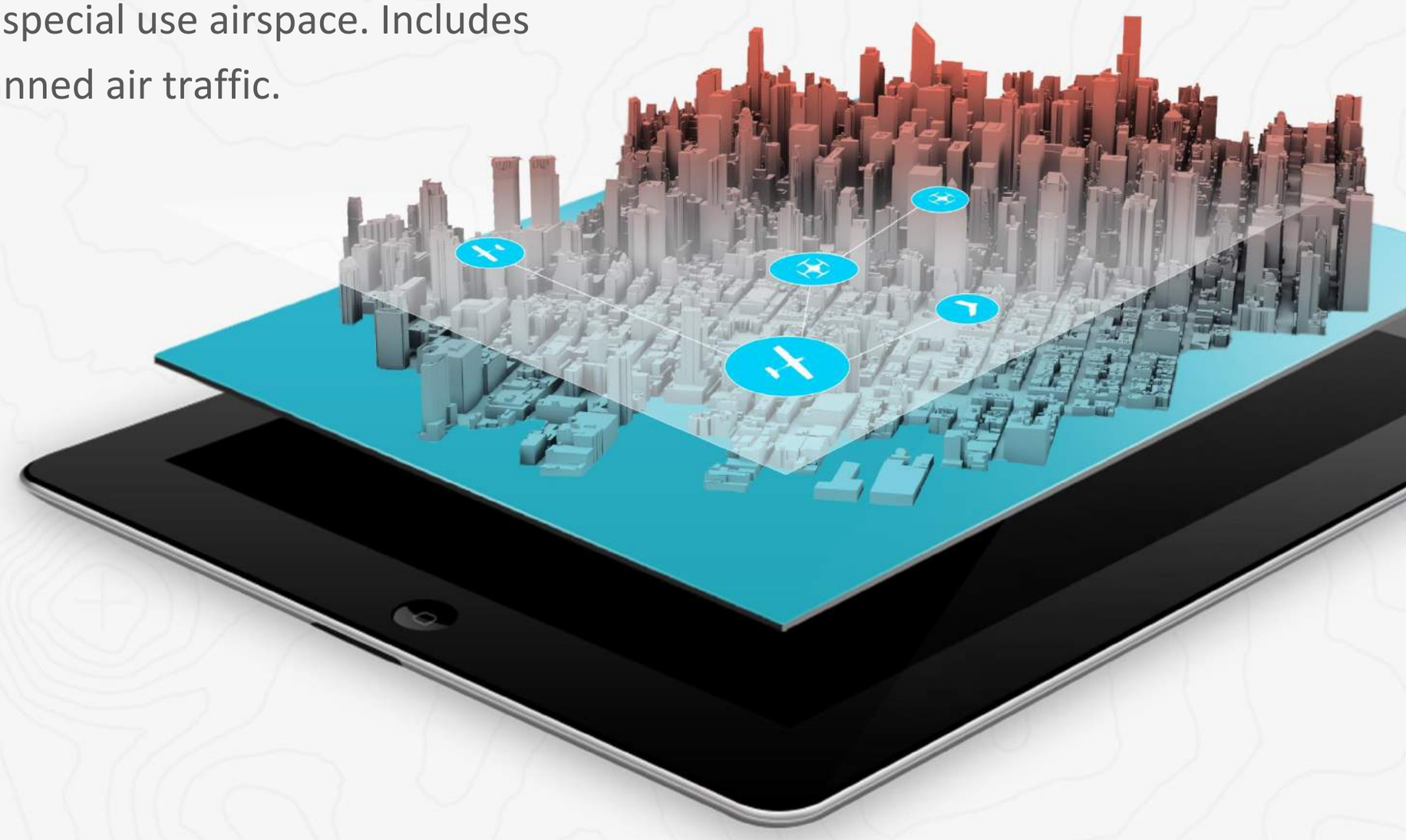
FLIGHT AUTHORIZATION SYSTEM

Regulators can easily define parameters to allow and deny flights in certain areas based on multiple geospatial layers.

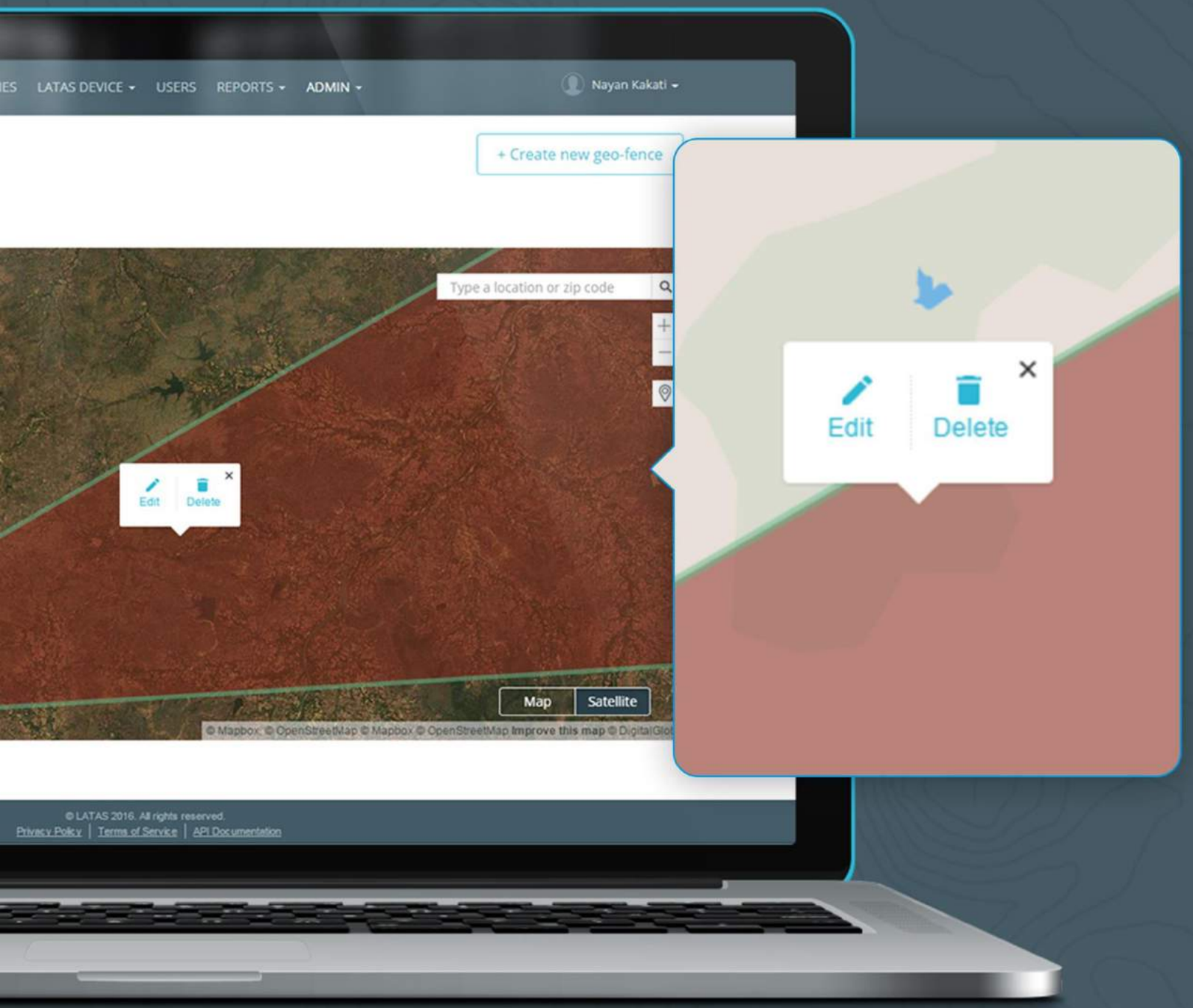
Features

AIRSPACE INFORMATION SYSTEM

Local, authenticated airspace layer including up-to-date restrictions and special use airspace. Includes real time feeds of manned air traffic.



Features



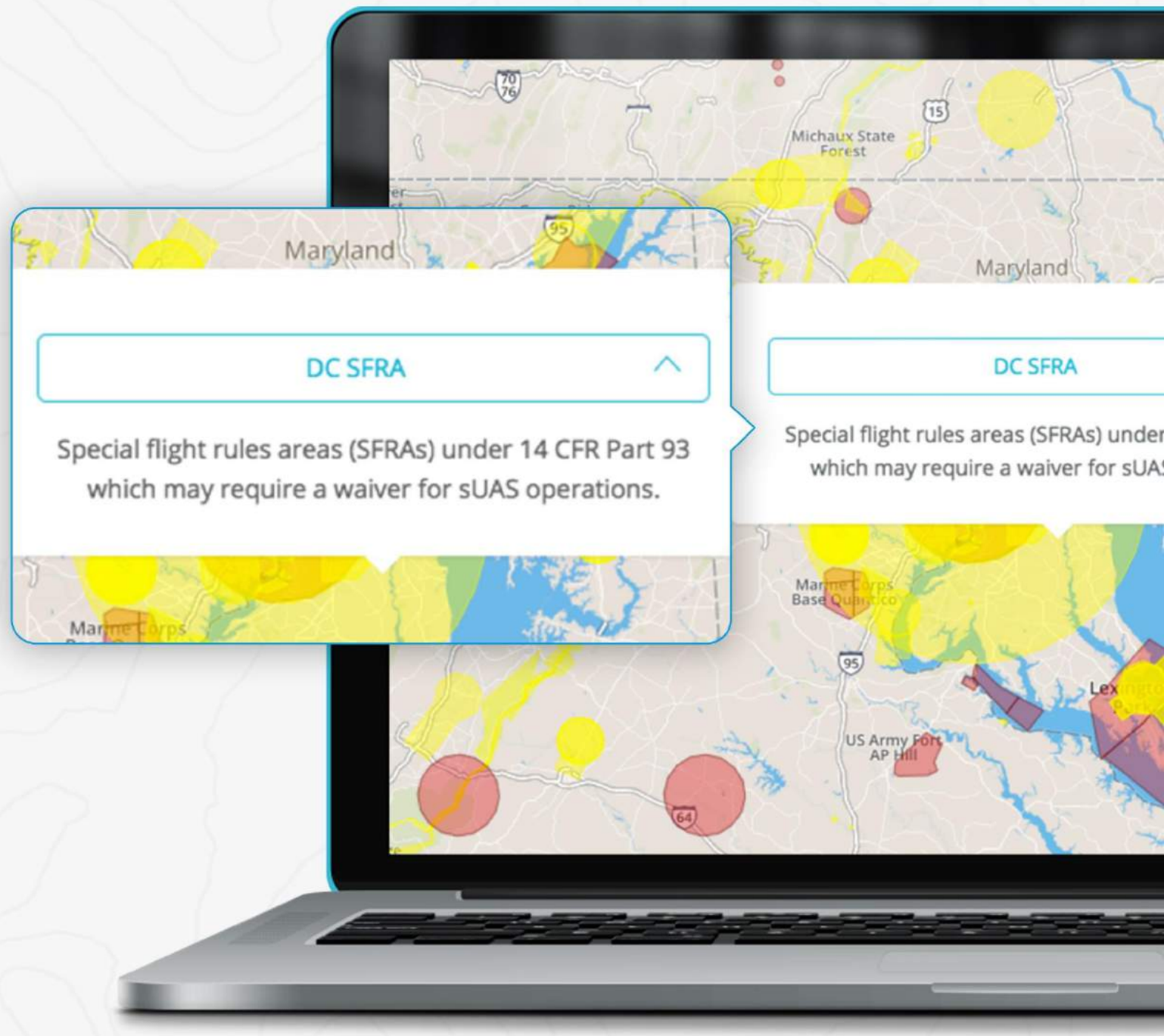
GEO-FENCING SYSTEM

Quickly and easily add and remove geo-fences anywhere in the airspace. Geofences are then communicated to operators who may be flying near the area.

Features

OPERATOR NOTIFICATION SYSTEM

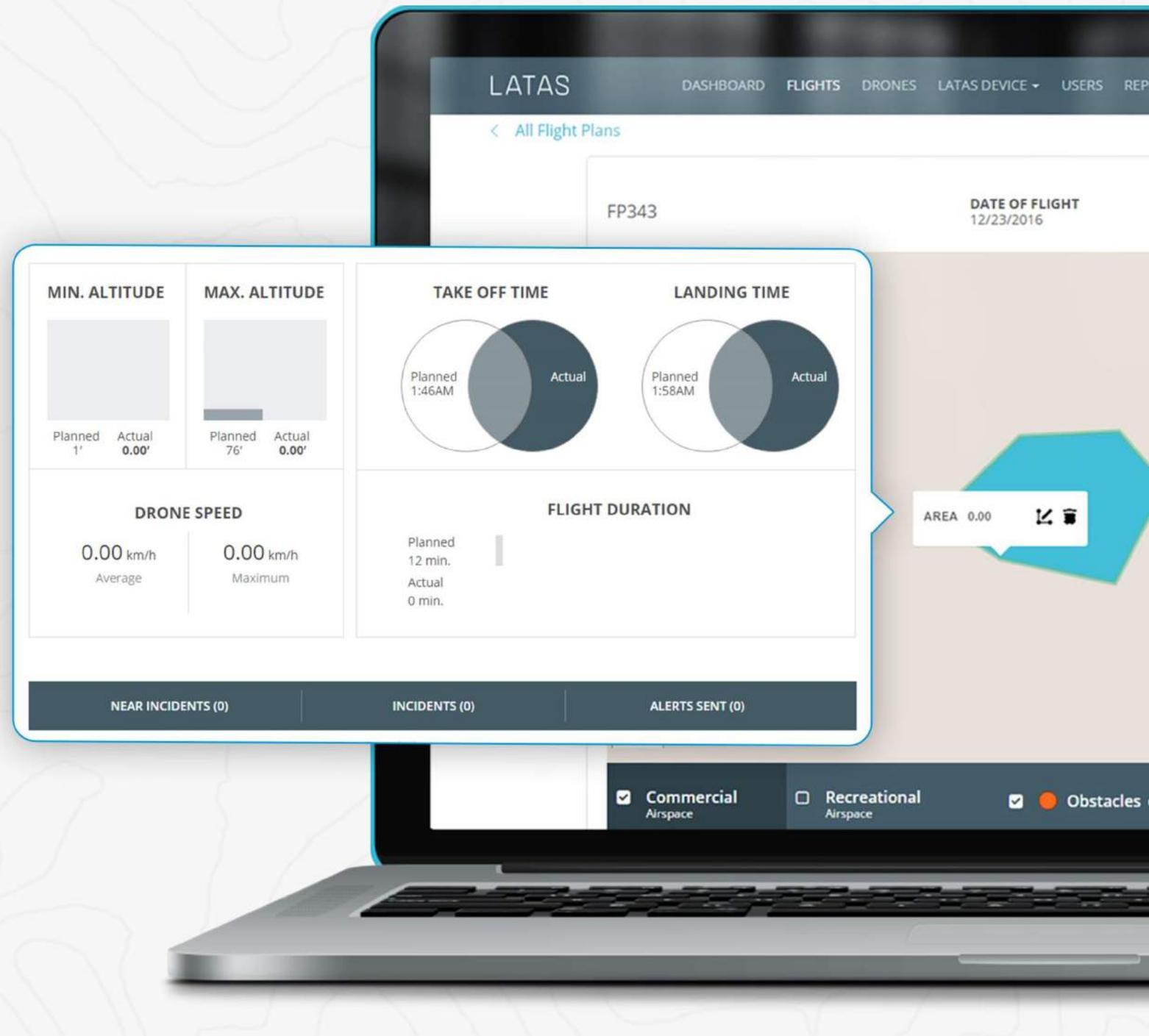
Portal for regulators to quickly communicate restrictions and authorizations to drone operators.



Features

REPORTING SYSTEM

Historical data referring back to each individual flight; contains location, time, altitude and notification records. Quickly identify if rules were broken during the flight.



Features

TRACKING DEVICE

LATAS unit, GPS and cellular device that transmits location information to the cloud. Mounted on the drone like a black box.

Drone Operator Features

AIRSPACE INFORMATION

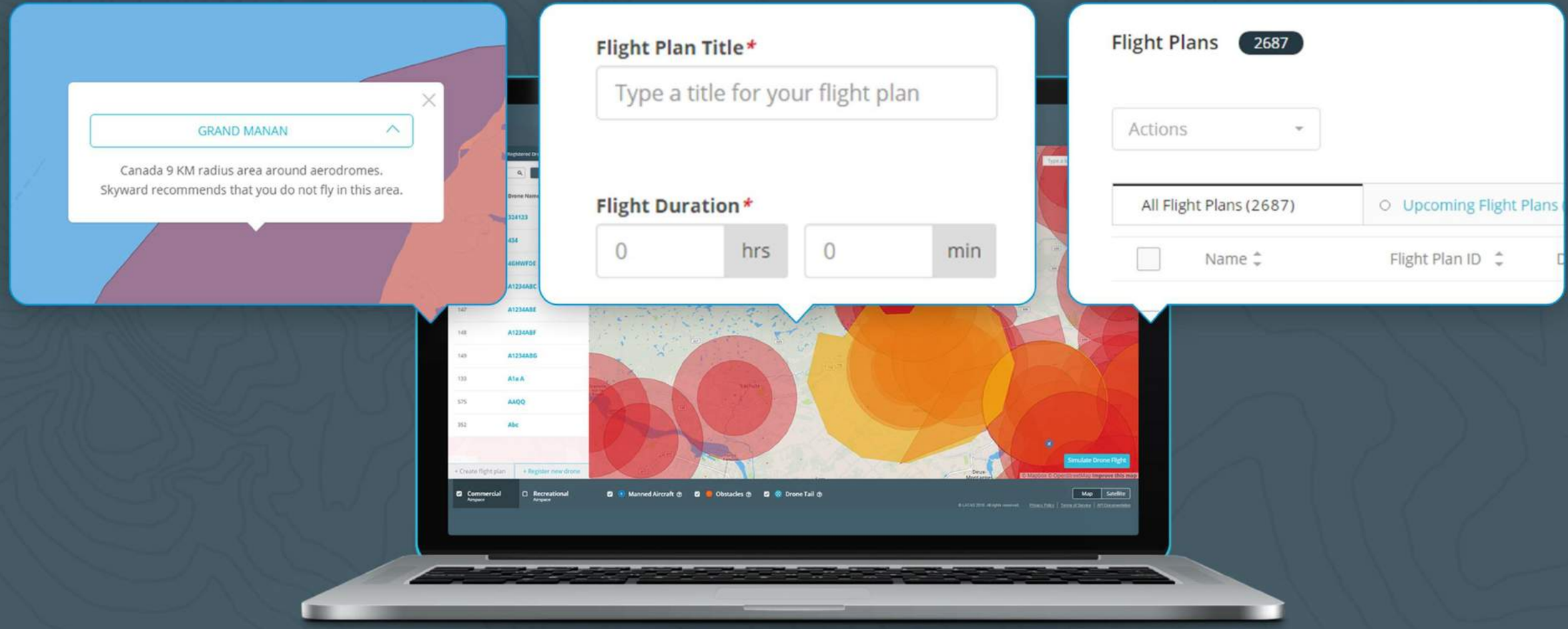
✓ User will quickly see where they are allowed to fly and where they are not allowed to fly.

FLIGHT PLAN SUBMISSION

✓ Users can quickly and easily submit a flight plan to ask for authorization to fly in certain airspaces. The authorization may be automatically approved based on a number of parameters.

COMMUNICATION TO REGULATOR

✓ Regional administrative account that provides visibility to all operations in the region, as well as data records of flight plans of their own flights.



LATAS provides a safe and efficient operation environment and a simple platform for communication between regulators and operators.

Our Investors

intel Capital

Verizon Ventures

MILLENNIUM

YAMAHA

USAA®

DUPONT

NTT docomo
NTT DOCOMO Ventures, Inc.

INNOVATE INDIANA FUND
INDIANA UNIVERSITY

PATENT PENDING

WithersRavenel
Our People. Your Success.

Whats Up with Drones

@ WithersRavenel

WithersRavenel
Our People. Your Success.

WE ARE

PLACEMAKERS

33+ YEARS

160+ EMPLOYEE OWNERS

10k+ PROJECTS

ENVIRONMENTAL

GEOMATICS

LAND DEVELOPMENT

LAND PLANNING

WATER RESOURCES

EXPERIENCED STAFF

SETH SWAIM, PLS, GISP

- Vice-President of Geomatics
- Project Manager
- Licensed UAS Remote Pilot
- Lessons Learned

EXPERIENCED STAFF

TRAVIS HOWELL, RF

- NC Registered Forester
- Licensed UAS Remote Pilot
- Remote Sensing/GIS Technician
- UAS Specialist

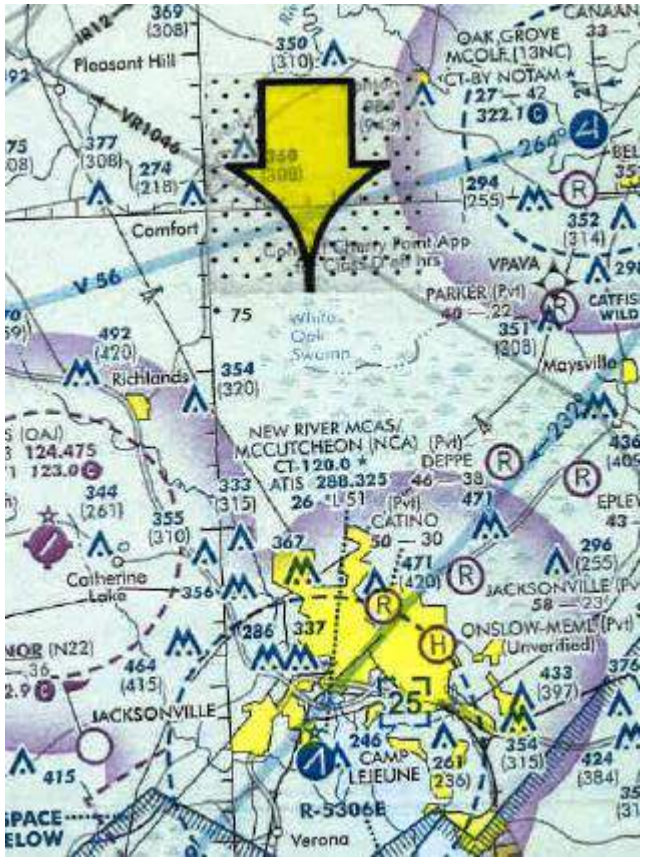
Regulations for Commercial Operations

DIVISION OF AVIATION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

FAA Part 107

- sUAS < 55 lbs.
- VLOS
- max alt 400ft
- Remote Pilot Certificate

NCDOT Aviation Division Permit



UAS Projects

- NC State Ports Authority
- 3D Modeling
- Volumetric Calculations
- Lessons Learned

Port of Wilmington

- +/- 650 acers
- ~ 2 linear miles
- Updated Aerials & Site Planimetric's
- Specific Access
- Surveyed GCP's

Wilmington International Airport – ILM

- ½ of Port in Class D
- Contacted ATC
- Visual Observer
- Monitored Radio

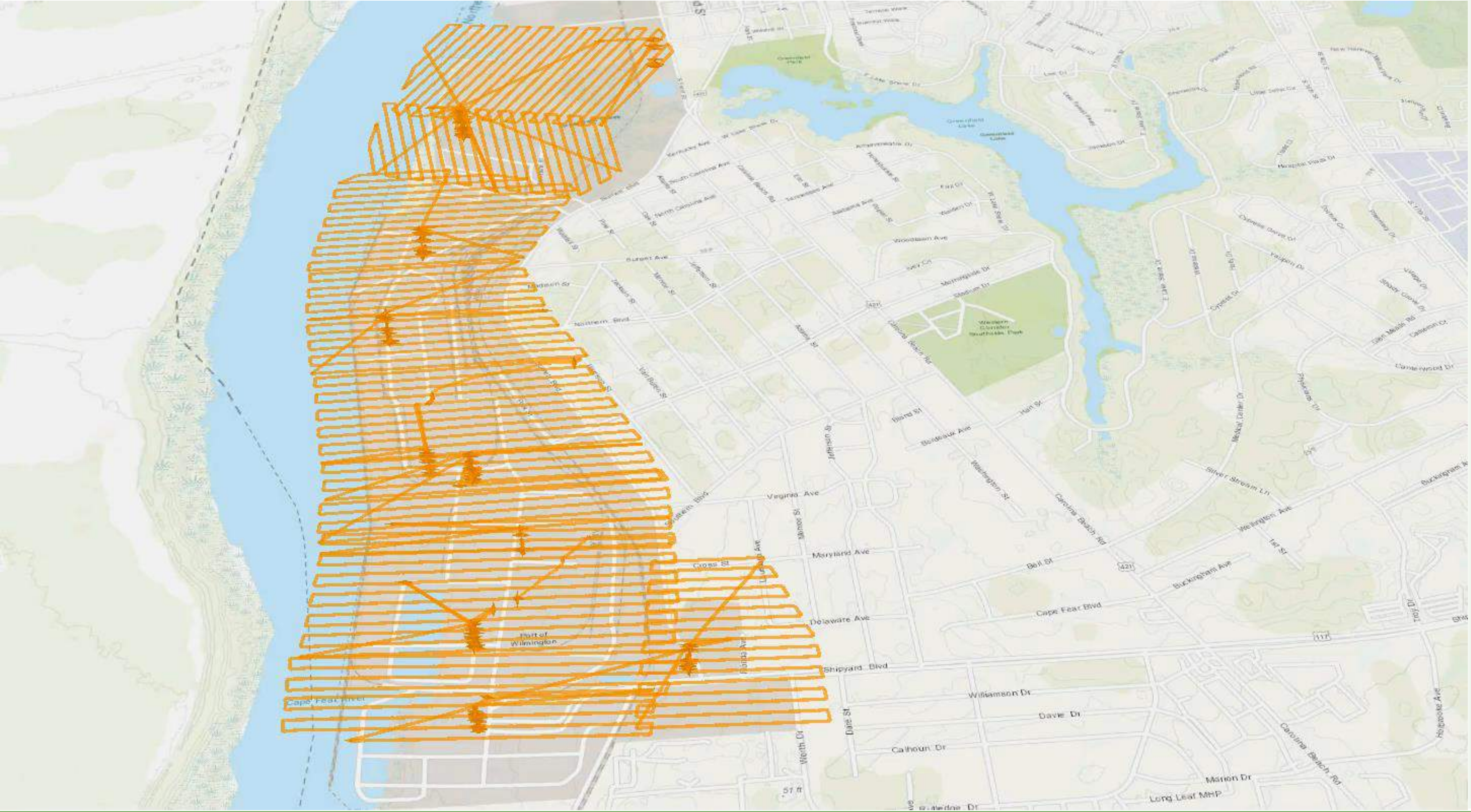
UAS Hardware

DJI Matrice 100

- Zenmuse X5 RGB
  - ~ 3,600 photos
- 24 Matrice 100 flights
  - 14 different launch areas

Phantom 4 Pro

- ~ 600 photos



WithersRavenel
Our People. Your Success.

Data Processing

Mapping

3D Modeling

Surveying

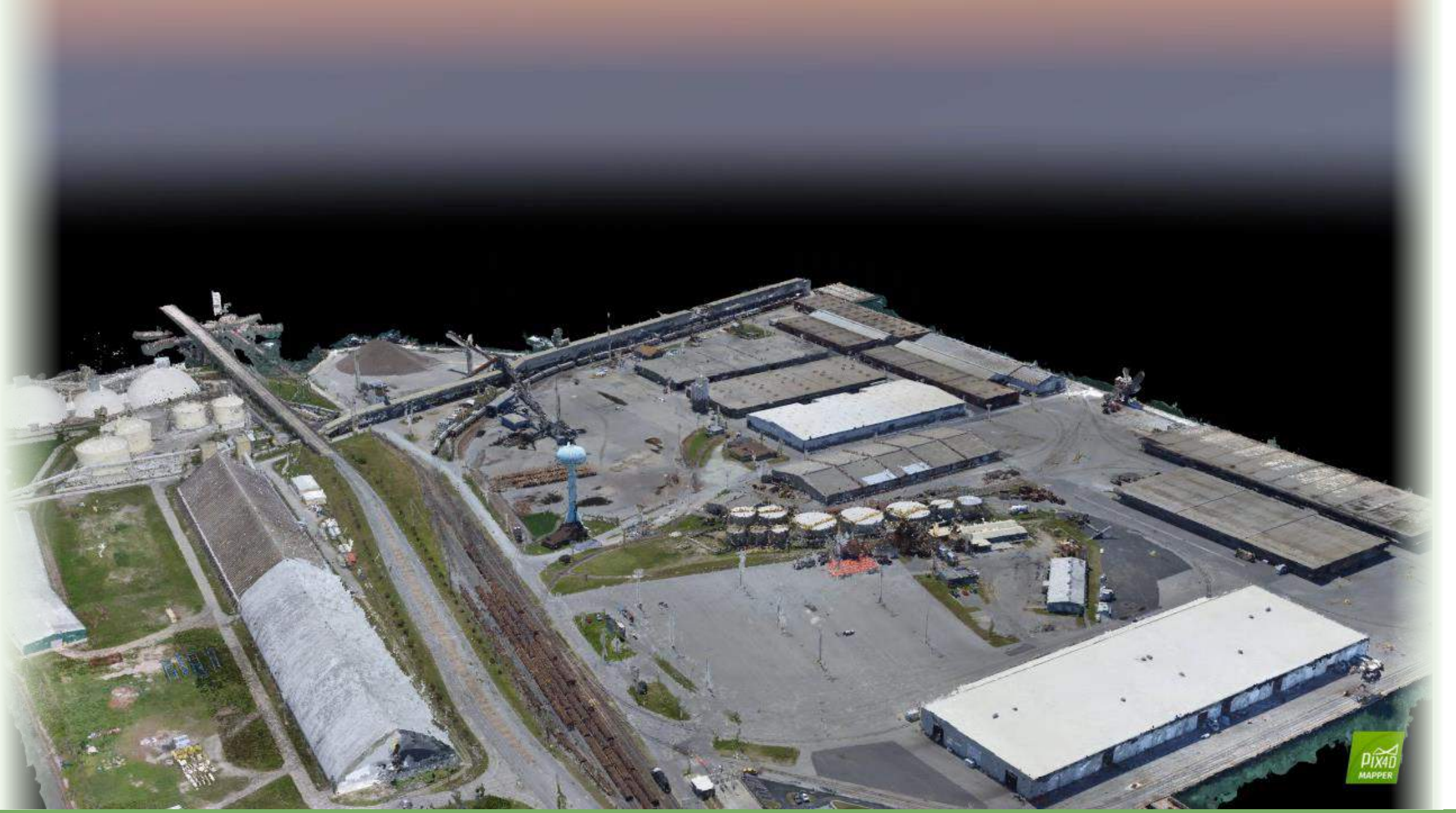
Photogrammetry

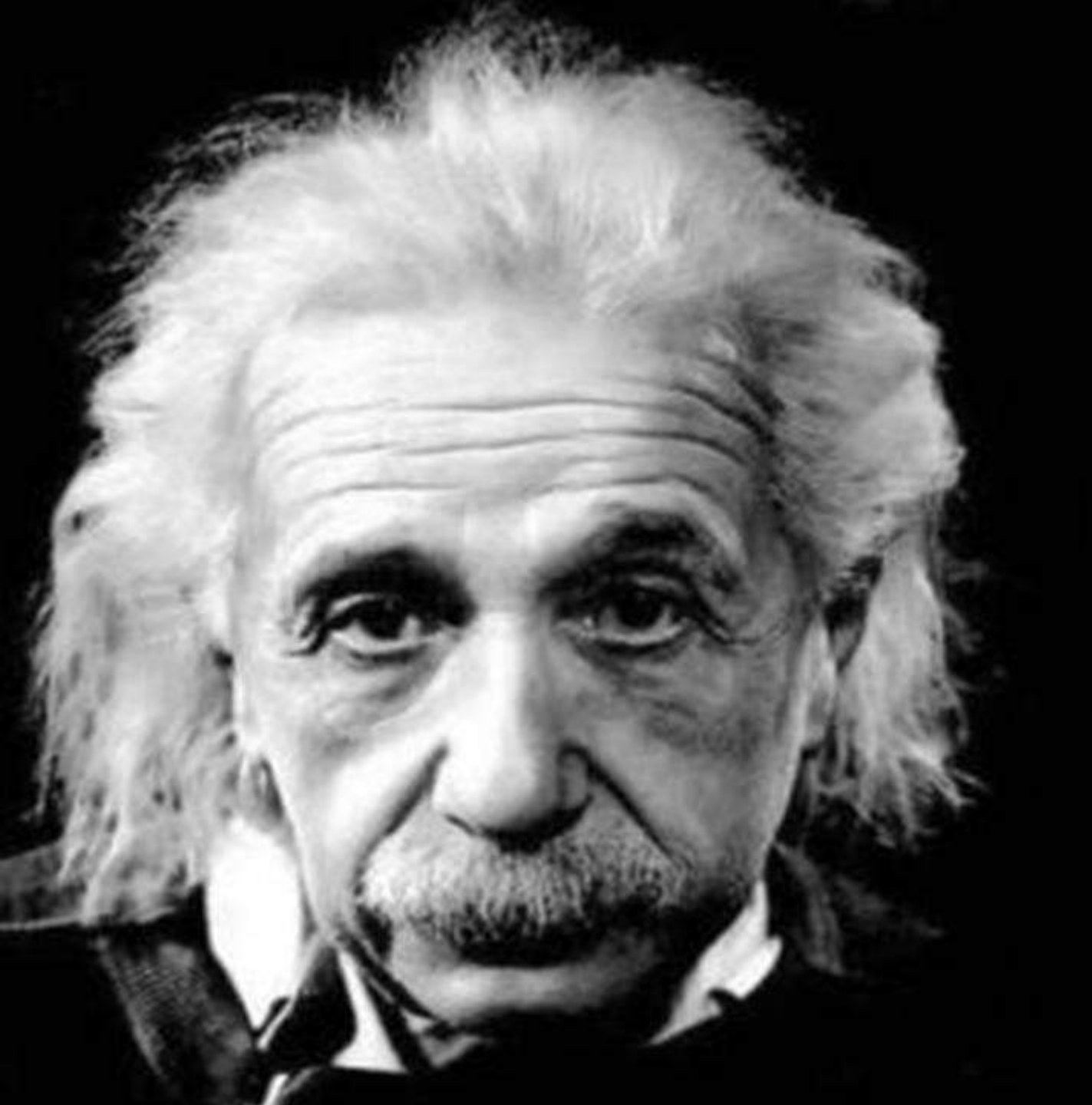
Port of Morehead

- +/- 250 acres
- Two project areas
- Updated Aerials & Site Planimetric's
- Specific Access
- Surveyed GCP's

Smith - MRH

- ~ 2 nm away
- Visual Observer
- Monitored Traffic & Radio
- Planned Flights Accordingly


PIX4D
MAPPER



ONCE YOU STOP
LEARNING,
YOU START
DYING
-ALBERT EINSTEIN

Volumetric Analysis

- Safe Inventory
- Same Day Deliverable
- Compaction Factor
- Updated Orthophoto
- Repeatable & Reliable

Oblique Photo

3D Point Cloud

What's in Store for our Future?

- Innovation
- Integrated Sensors
  - LiDAR
  - Multispectral
- Desktop & Cloud Processing

QUESTIONS?

CLEARED FOR TAKE OFF

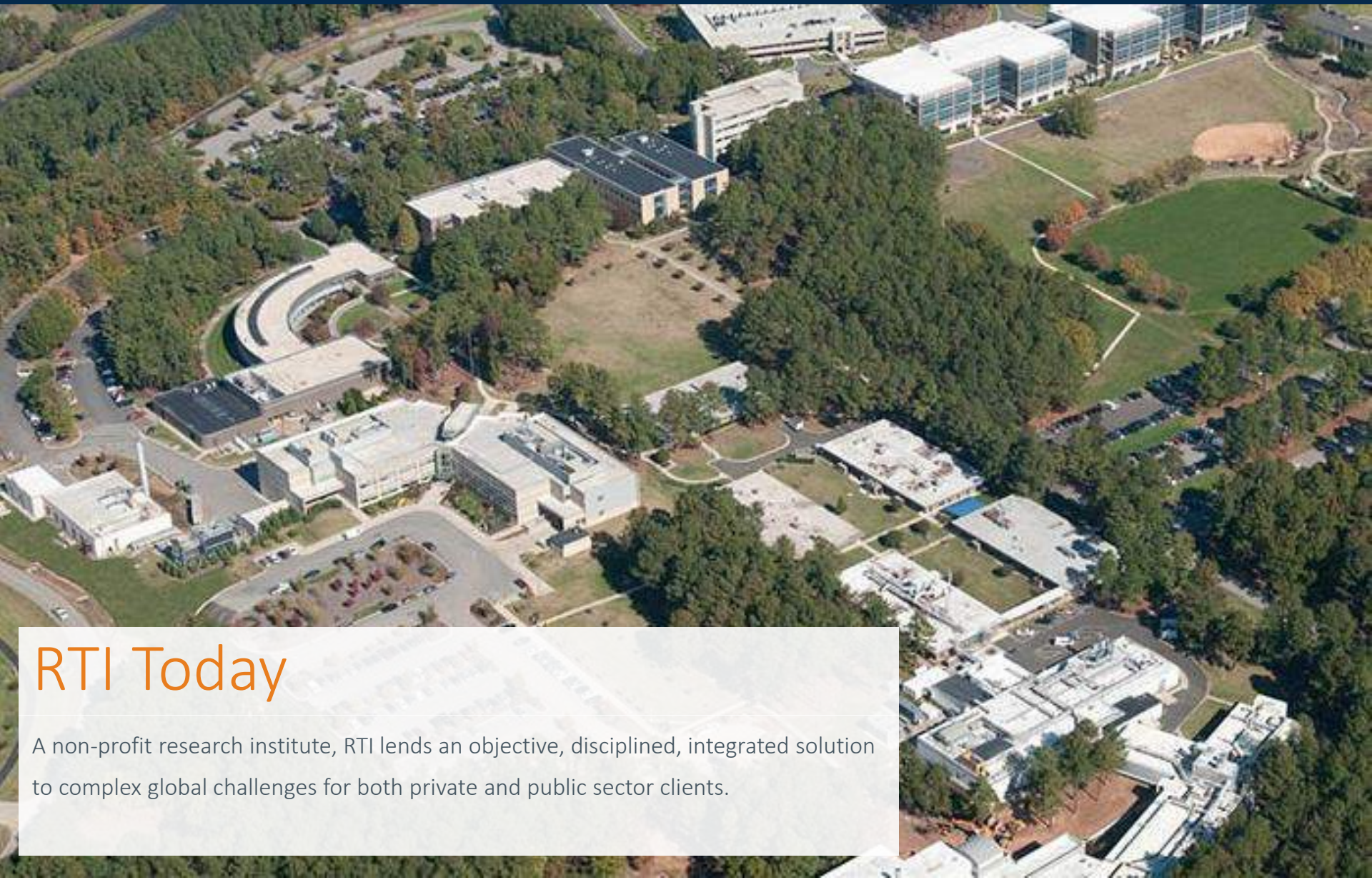
LETS GO FLY!

Using drones to support vector control

Presentation for NCDOT Drone Workshop - Wilmington
September 28, 2017

Brad Mooring

Introduction to RTI International



RTI Today

A non-profit research institute, RTI lends an objective, disciplined, integrated solution to complex global challenges for both private and public sector clients.

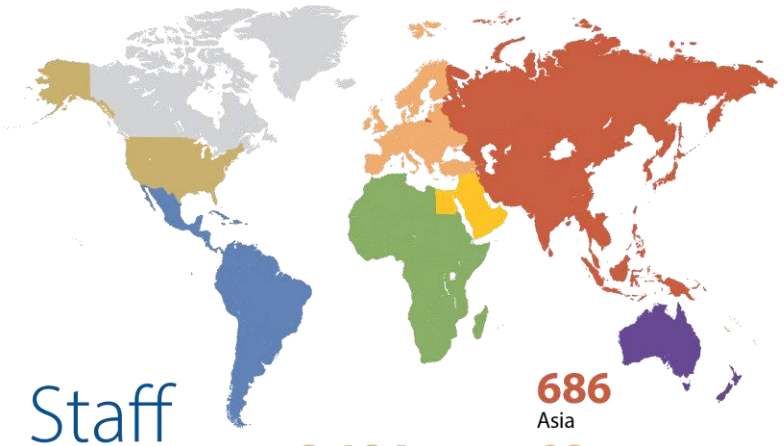
We have global reach

5,032 Staff Members
Worldwide

90 Languages

250 Degree Fields

105 Nationalities



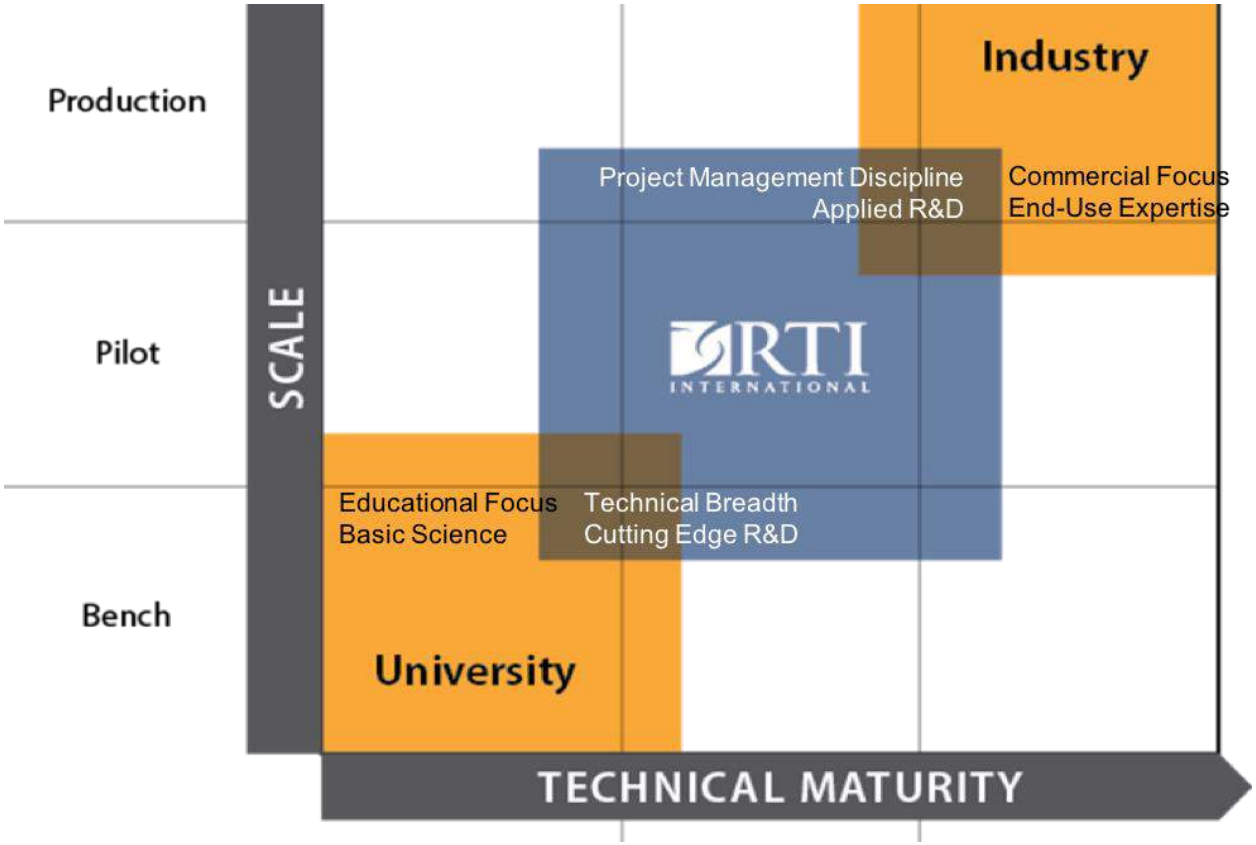
Staff By Region

3,184 United States	**686** Asia
131 Latin America and the Caribbean	**92** Europe
883 Africa	**54** Middle East and North Africa
	2 Australia

and our workforce is diverse.

Introduction to RTI International

RTI's position in the marketplace enables "best of both worlds" attributes from academia and industry.



Drones are disruptive to research and technical assistance

RTI International Applications

- Vector control
- Emergency response
- Environmental monitoring
- Energy research
- Sensor development and integration
- Artificial Intelligence
- Surveys

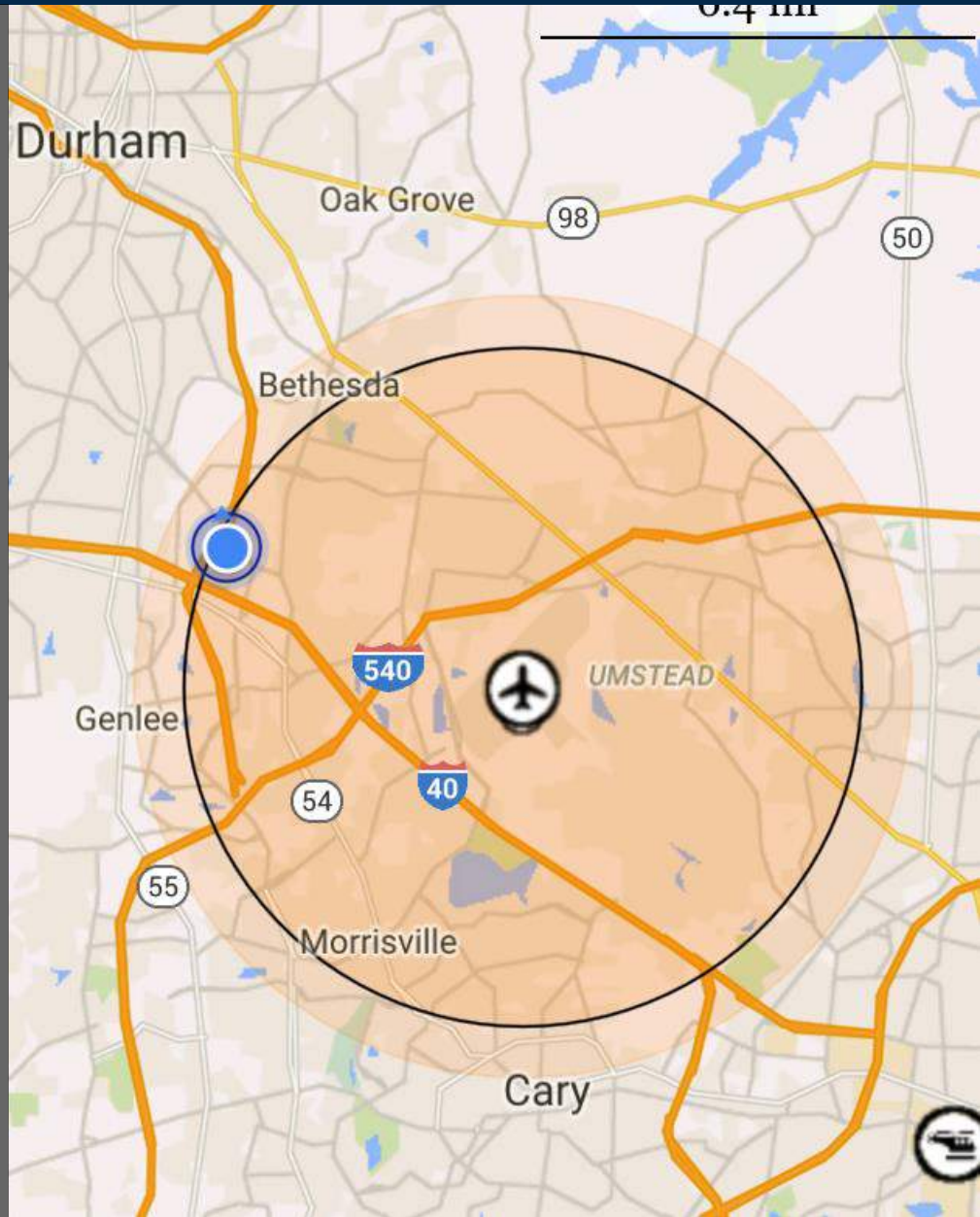
FLIR Tau 2 on Zenmuse

RTI has the capabilities and processes necessary to test solutions safely, legally, and ethically.

RTI International's mission:

Integrate UAS into RTI research and technical assistance projects

- Proof of concept testing
  - Visual line of sight testing on-site at our headquarters in Research Triangle Park (180 acre campus) and across North Carolina
  - Fully autonomous beyond visual line of sight testing at international test sites
  - FAA Part 107 waiver and Section 333 exemption
  - Nighttime flight waiver
- Development of machine learning algorithms



RTI Case Study: Mosquito vector control

Guatemala 2016 (completed)

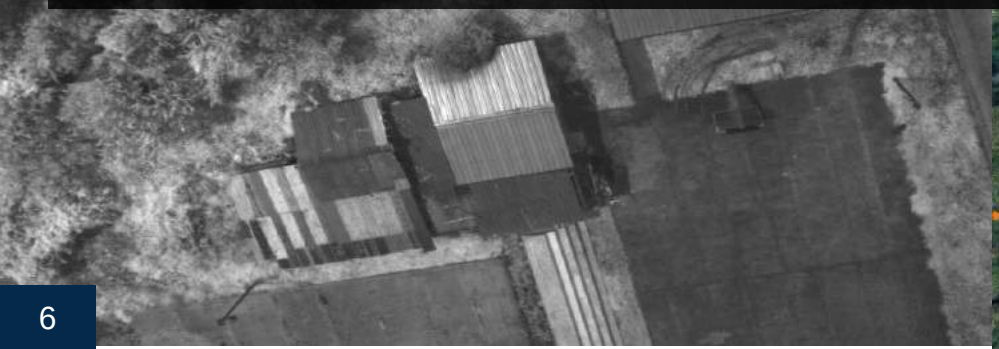
- Pilot study to develop methods for finding mosquito breeding sites

Guatemala 2017 (ongoing)

- Ground truth study to verify mosquito abundance

North Carolina 2017 (ongoing)

- High density controlled testing to identify environmental correlates



Guatemala 2016: POC study in Guatemala to assess value of UAS data to support mosquito vector control

Data Collection via Drone:

- La Democracia
- Fully autonomous flight
- 200 meters above ground level
- 1 day to fly

Collaborated with M. of Health and regional health authorities

Goals:

- To improve the ability of mosquito control teams to find mosquito breeding sites
- Find secondary applications for drone data (safety, sanitation, outreach, etc.)

Guatemala 2017: Ground truth to assess the predictability of mosquito breeding sites

Goal:
To measure the positive predictive value of the algorithm used to identify potential Aedes breeding sites from drone maps

Method:

- Drone generated maps
- Algorithms that identify potential Aedes breeding sites
- Field team will visit each site to collect data on mosquito abundancy
- Correlations between algorithms and field team visits

North Carolina 2017: POC to learn if environmental factors contribute to mosquito abundance

Goal:
To understand potential environmental correlates of mosquito breeding

Method:

- Install ~200 small mosquito ovitraps
- Fly over traps to identify environmental factors
- Determine if environmental factors can be correlated to areas of mosquito abundance

Conclusions and the future of vector control

Conclusions:

- Vector control is a unique area where drones can help
- Turning data into actionable insights is critical

What might the future hold?

- Autonomous flight over villages at risk of transmission of arboviral diseases
- Artificial Intelligence locating high volume / relevant mosquito breeding sites
- Spraying drone applying larvacide

Source: DJI website

Contact Information

Brad Mooring

BMooring@rti.org

Phone: 919-248-4239

www.rti.org/drones

Enterprise Use of Drones & Remote Sensing in Local Government

Presented by:

Jim Campbell – Assistant Deputy Chief, Wilson Fire and Rescue

Shannon McKinnon – GIS Technician, Wilson Energy

Donald Richardson – Headend and IT Engineering Manager, Greenlight

Hunt Bowers – Director of Flight Operations, Triangle UAS

Hunt Bowers - Director of Flight Operations, Triangle UAS

- BS-Aerospace Engineering, NCSU (minor Computer Science)
- Long time drone and RC enthusiast with 10+ years building and flying fixed-wing and multirotor platforms
- Primary interests include VTOL fixed-wing platforms and drone automation
- Worked closely with the City of Wilson for the past 6 months

Jim Campbell - Deputy Chief, Wilson Fire and Rescue

- Wilson Fire and Rescue 16+ years
- Director of Wilson Fire and Rescue's Special Operations, which includes their drone program
- Wilson Fire and Police departments have identified numerous usage cases, many of which produce cross-department savings (ex, accident reconstructions no longer requiring the Fire Department's tower trucks)

Wilson Police Department – Intended Usage Cases

- Accident reconstructions (with ability to view in VR environment)
- Search and Rescue
- Crowd monitoring/event control
- SWAT raids/hostage situations

Wilson Fire and Rescue – Usage Cases

- Before BLOS approval:
  - On scene evaluation of roof conditions during fires
  - Using InfraRed technology to visualize fire distribution within a structure
  - Using InfraRed technology to locate trapped persons in burning buildings and rubble
  - To gain situational awareness in incidents involving water towers and cell towers (infrequent, but it happens)
  - Evaluating incidents involving hazardous materials
  - Monitoring of forest fires from above to track the spread and movement of the fire
  - Use in accident reconstructions (by Wilson PD) frees up Tower Trucks and saves $3000-$5000 per incident… drone will quickly pay for itself from this alone

Wilson Fire and Rescue – Usage Cases

- After BLOS approval (you can do it FAA!):
  - Drone deployed to scene of fire as soon as call comes in
  - Will be tested in a specific area of Wilson County where Fire and Rescue response times are almost double the city average – almost 8 minutes as opposed to about 4 minutes on average
  - Video live streamed to Fire Truck and other emergency responders in real time
  - Provides unparalleled situational awareness before arriving on scene
  - With this information, an emergency response can be upscaled or downscaled as needed to meet the requirements of the situation… improves efficiency and saves money and lives!

Shannon McKinnon- GIS Technician, Wilson Energy

- North Carolina native, Working in GIS field in Wilson County/City of Wilson for the past 8 years
- Part 107/NCDOT Licensed Commercial Drone Operator, owns DJI Phantom 4 Pro and 3DR solo
- Has 50+ hours on City of Wilson's newly purchased DJI Matrice 100 using Zenmuse X3 visible camera
- Have already validate several usage cases – Drone expected to pay for itself within the first year


STADIUM
A+ GRAPHICS
apluswilson.com
POWERED BY greenlight
252-296-1174
WILSON Tobs
ADAMS CARPET ONE
Stone Creek
Evening Optimist Club
DEANS
OIL COMPANY, INC.
JEFF ANDRAS
252-883-6951

Wilson Energy – Future Usage Modes

- Use of thermal IR camera to evaluate ‘hot spots’ on power infrastructure
- Autonomous 3D mapping and 3D modeling of critical infrastructure for shared use
- Volumetric analysis of debris in roads, water volumes, etc

Donald Richardson - Headend and Engineering Manager, City of Wilson/Greenlight

- North Carolina native, Been with City of Wilson for 10 years, telecommunications for 19 years
- Have a 3DR solo, drone enthusiast for 3-4 years
- Responsible for the Headend, Network, Server, and Fiber Infrastructure for the City of Wilson
- Server Storage is used to store and maintain the drone data collected from the various City departments. Pix4D will be the enterprise software used for 3D mapping across all departments
- Fiber and Network Infrastructure is used to transmit live video with little to no latency

US Ignite – Smart Cities Initiative

- The City of Wilson, with Greenlight taking a leadership role, has applied to become a Smart City Community member through a US Ignite Smart City Grant
- Greenlight is assisting with IT integration and support. A primary goal is to create a unified common operating picture across the entire municipality.
- Wilson Police, Fire & Rescue, and Energy Leadership can all have access to the same real-time information. This will have an immediate impact on decision making and coordination between departments
- Long term goal - work with other smart city community members to utilize their super-computing resources to perform post-processing on remote sensing data. This is true 'state-level' infrastructure.
- Release all data and findings on initial drone usage to the Smart City Community and the public

Special Thanks To NCDOT and the City of Wilson !

Drones in Marine Science and Conservation

Marine Robotics
& Remote Sensing

NMFS PERMT #14809-03
ACA PERMIT #2016-024, 2017-034

Duke University Marine Laboratory

Marine Research

Formal Education

Research Support

Community Outreach

Platform & Sensor Testing

Marine Robotics & Remote Sensing

> 1,500 flights

Current Platform Capabilities

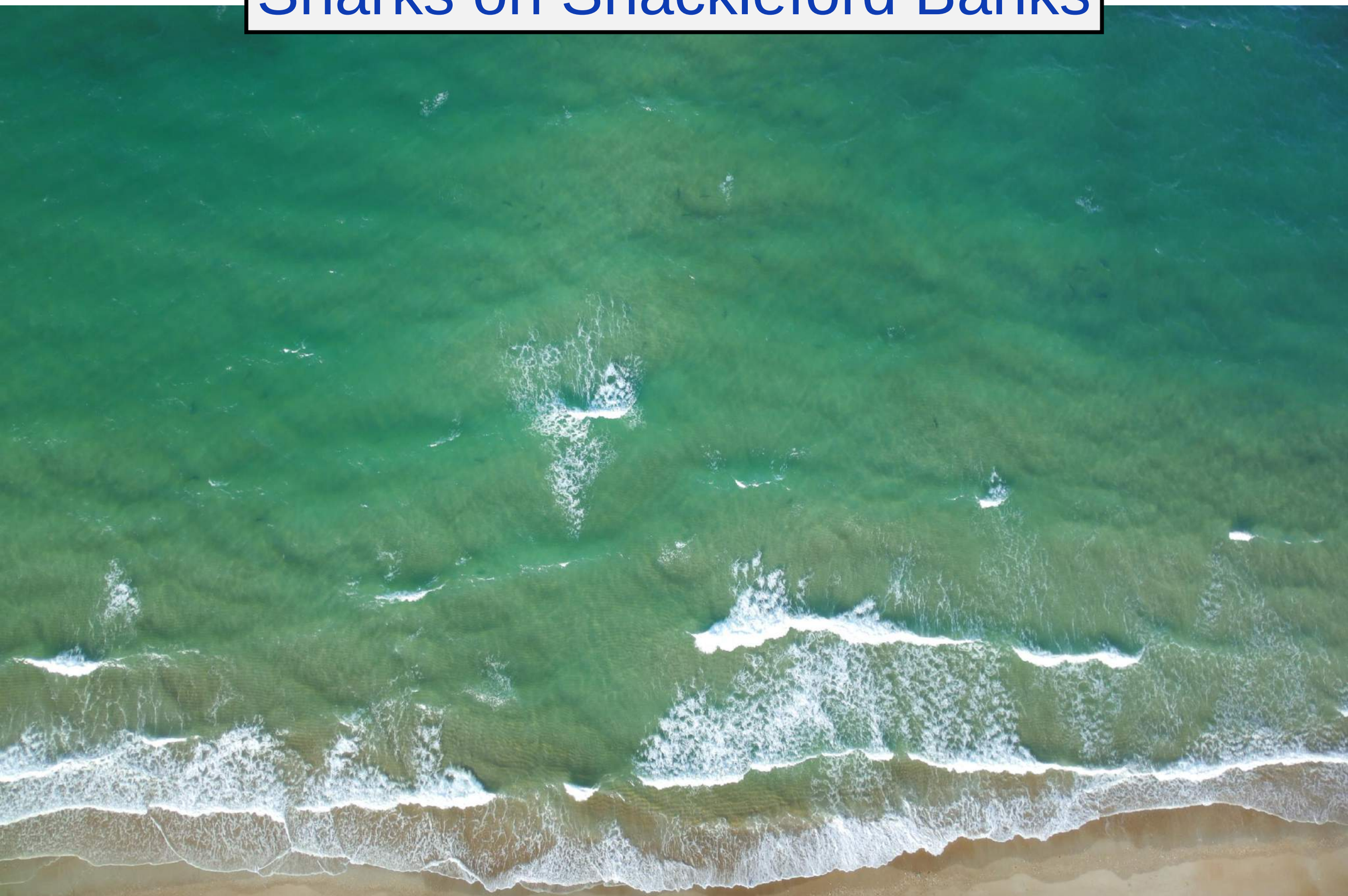
- **5 fixed-wing aircraft:**
  - Mapping at 2.5 cm per pixel
  - NIR, RE, IR and RGB sensors
  - Autonomous operation
  - 1 Amphibious platform
  - Up to 1.5 hr flight times
- **6 multi-rotor aircraft**
  - Sub-centimeter ground resolution
  - RGB, IR sensors, 4K video
  - Streaming video
  - Up to 35 minute flight times

Detection and Calibration

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

Sharks on Bulkhead Shoal

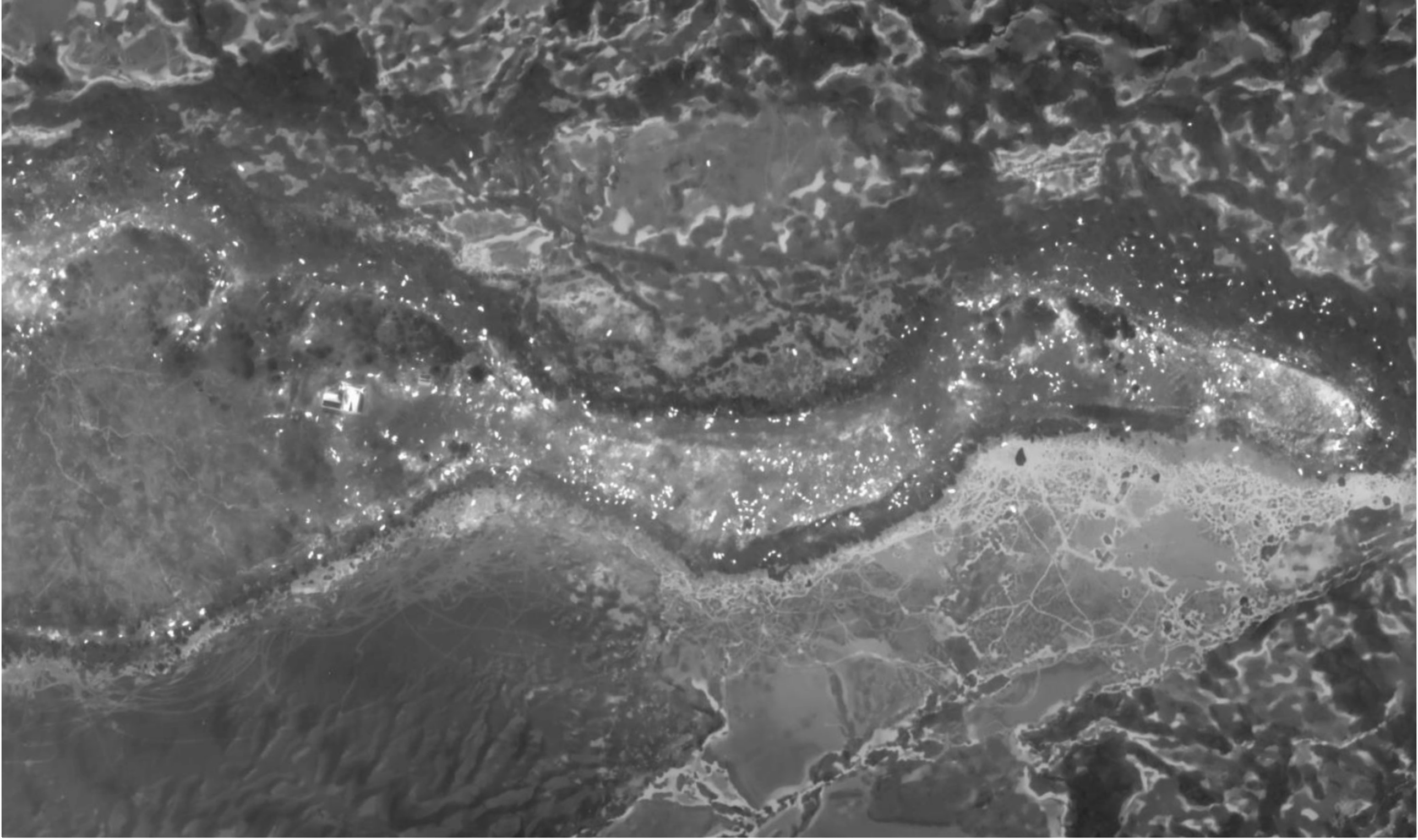
Sharks on Shackleford Banks



Marine Robotics
& Remote Sensing

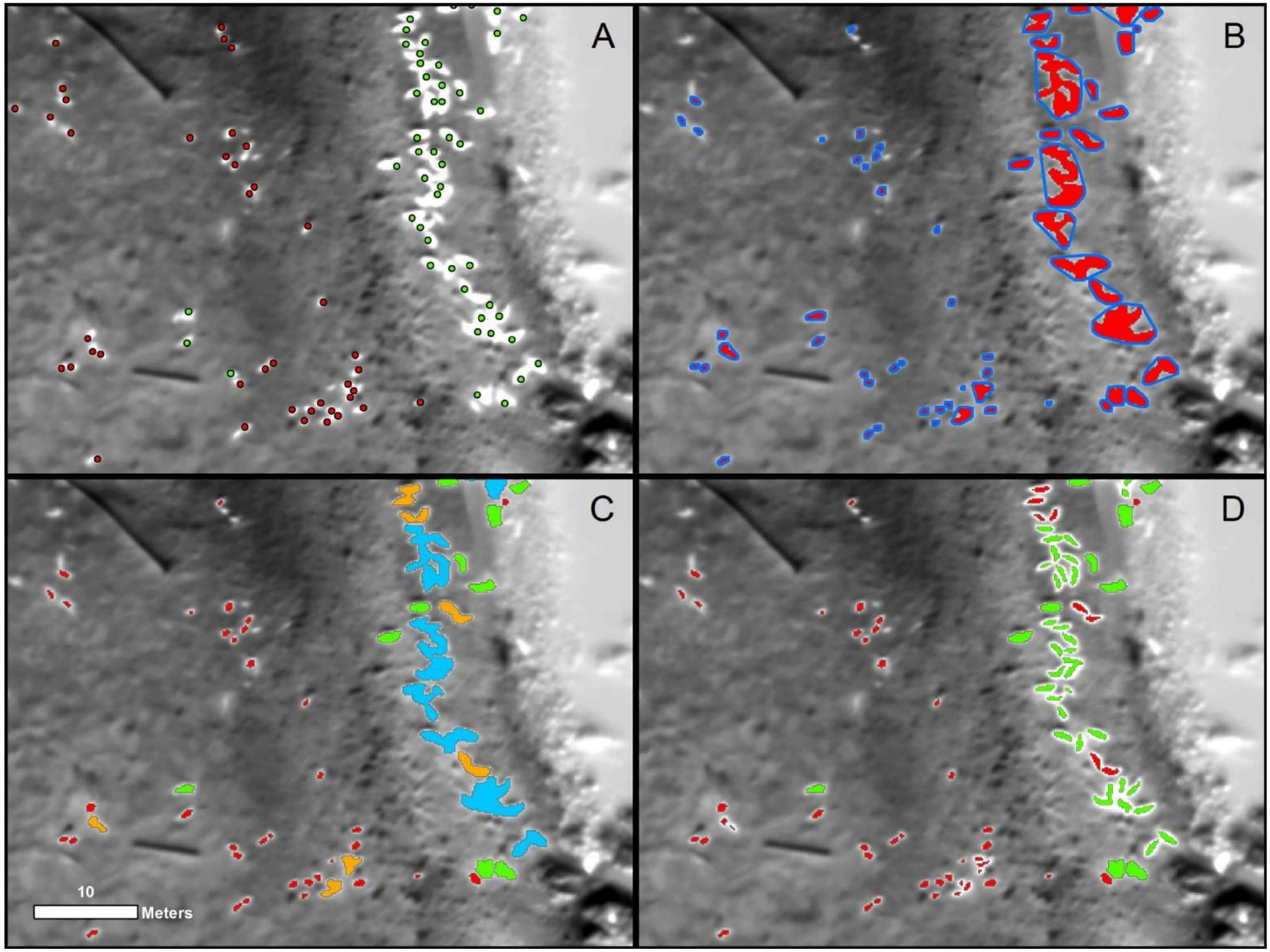
RGB Imagery

[See some data…]



Thermal Imaging

Detection of animals in low contrast or obscured by vegetation.



Computer Vision

Automated detection and enumeration of seals, sharks and sea turtles in drone imagery

Thermal imagery and seals
Open Source ArcGIS toolbox

Seymour et al. 2017, Published in Scientific Reports

Seal Count Estimates

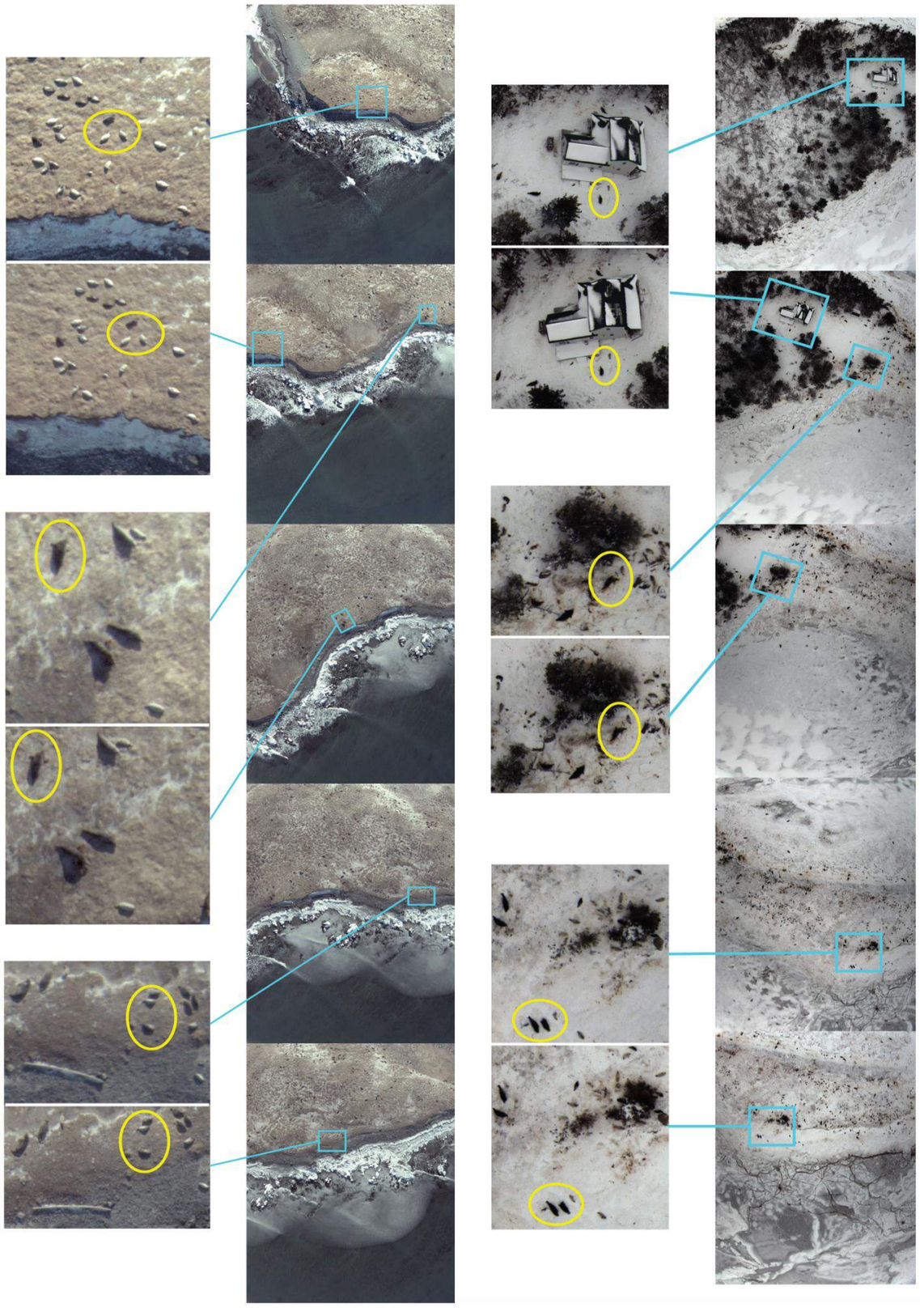
	Detection Model			ITag (human-generated)	
Category	Hay Island	Saddle Island (Simple)	Saddle Island (Complex)	Hay Island	Saddle Island
Total Juveniles	1652	648	592	1743	660
Total Adults	536	246	302	568	253
Total Seals:	2188	894		2311	913

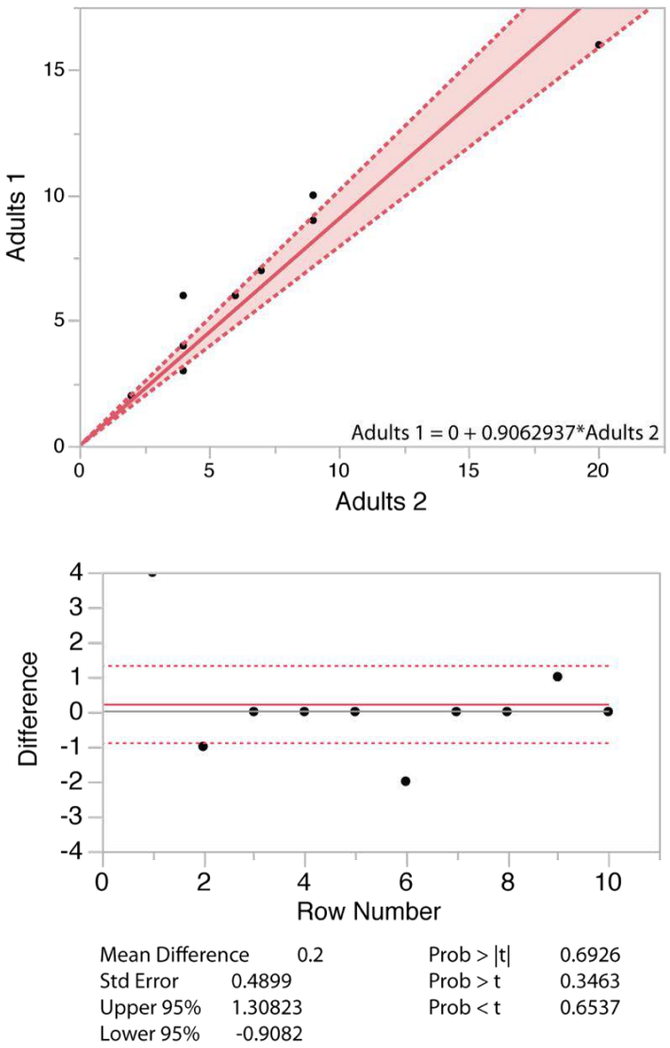
Counts With UAS and Computer Vision

Counts with Traditional Methods

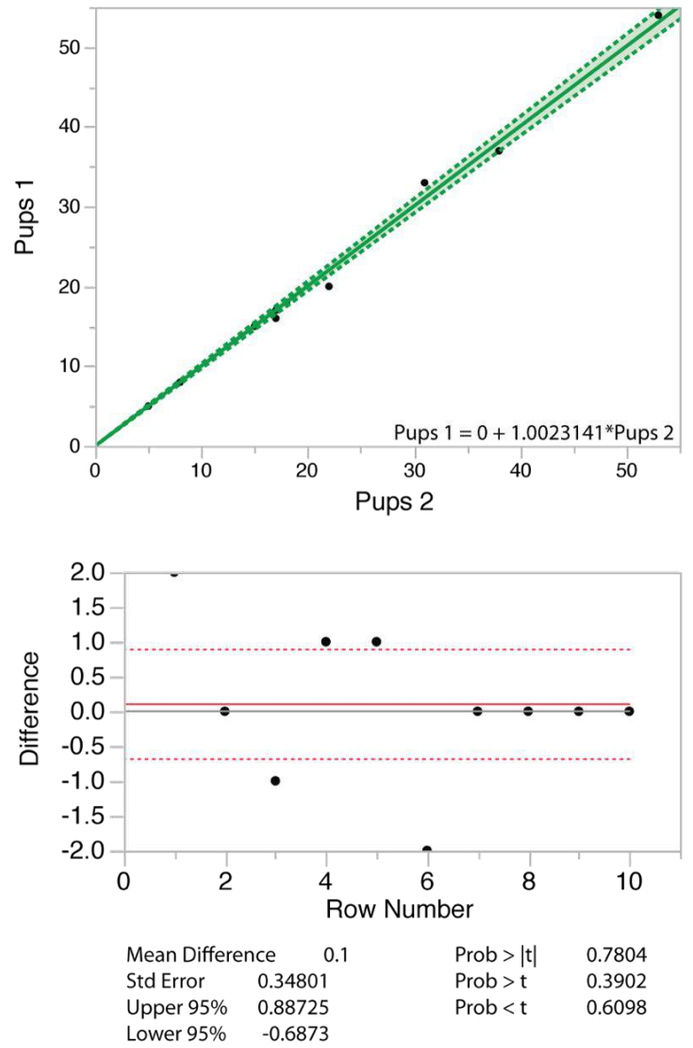
Efficient & accurate counting

Increased precision for trend analysis





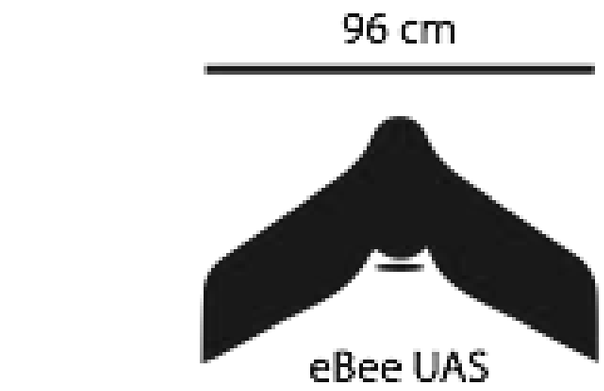
Mean Difference	0.2	Prob > |t|	0.6926
Std Error	0.4899	Prob > t	0.3463
Upper 95%	1.30823	Prob < t	0.6537
Lower 95%	-0.9082		

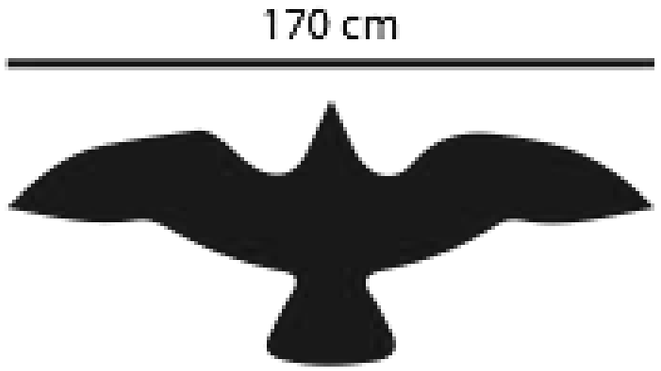


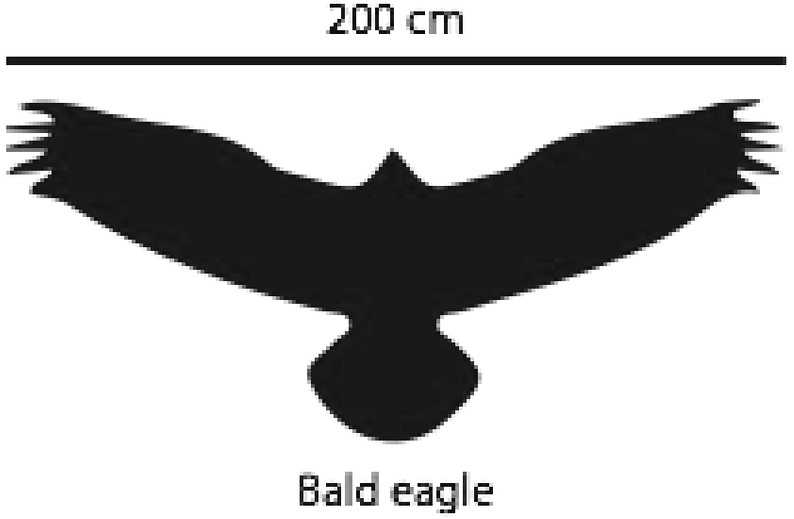
Mean Difference	0.1	Prob > |t|	0.7804
Std Error	0.34801	Prob > t	0.3902
Upper 95%	0.88725	Prob < t	0.6098
Lower 95%	-0.6873		

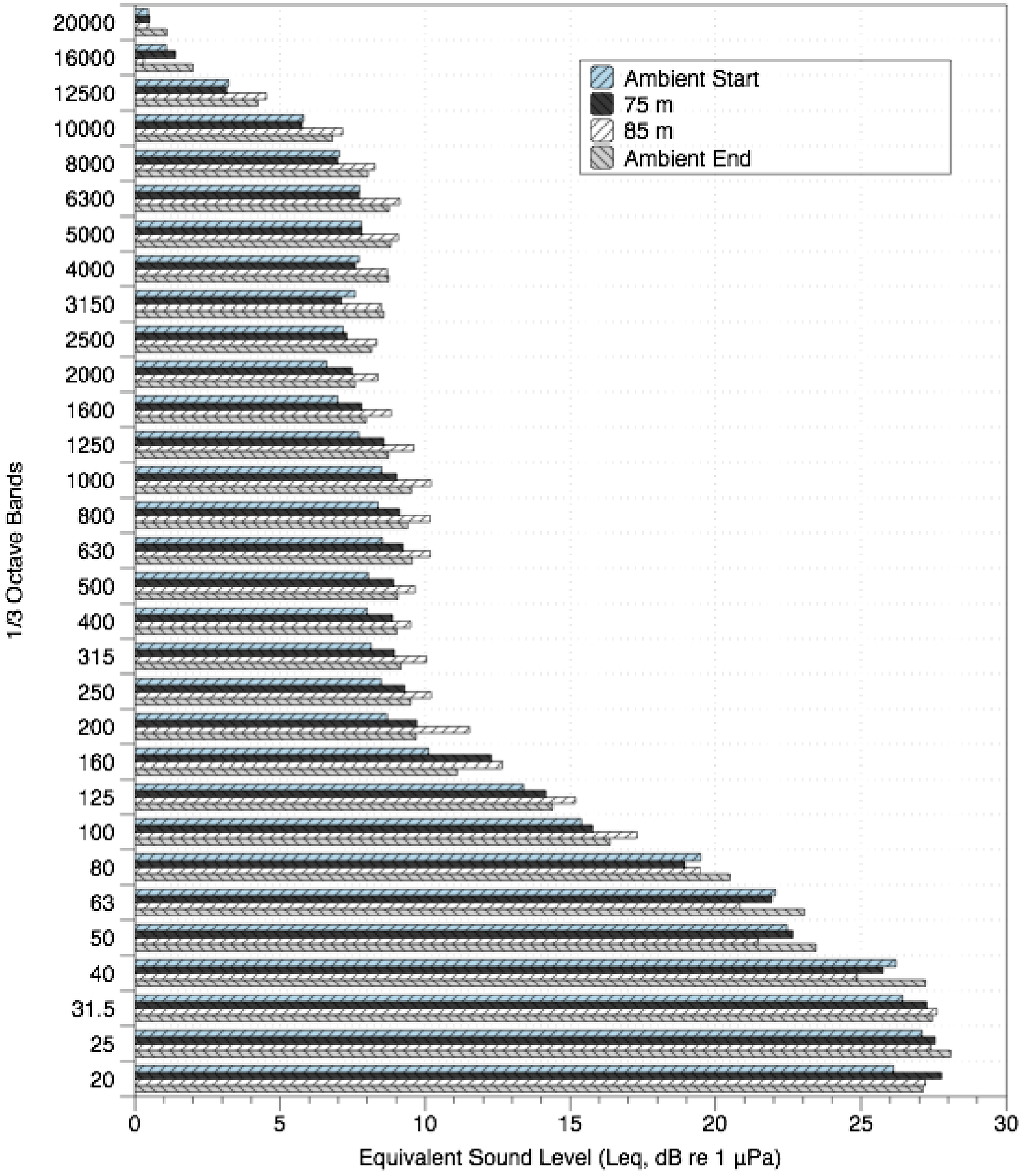
Disturbance Effects?

Arona et al. *In Revision*, PeerJ


96 cm
eBee UAS


170 cm
Great black-backed gull


200 cm
Bald eagle

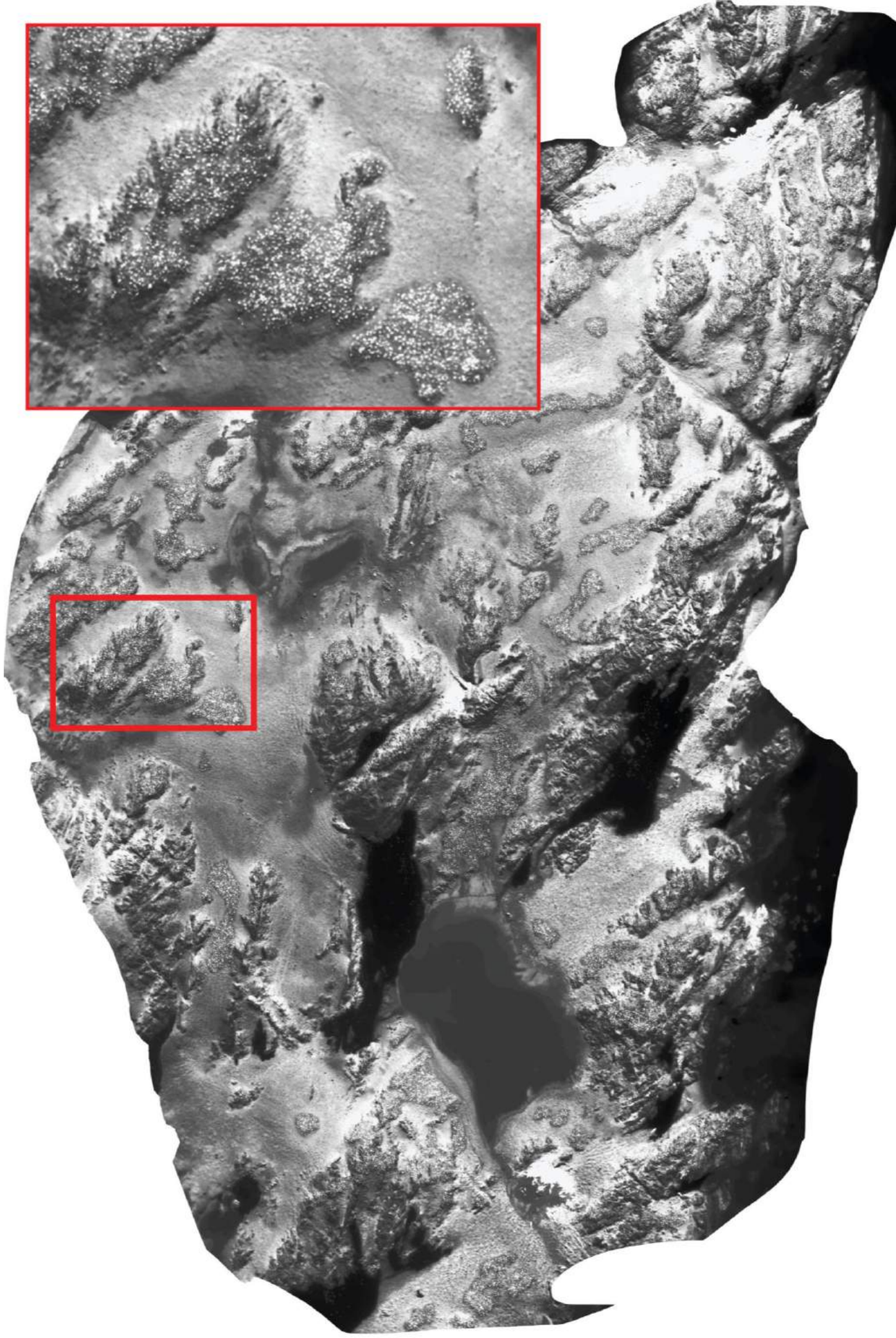

Ambient Start
75 m
85 m
Ambient End
1/3 Octave Bands
20000
16000
12500
10000
8000
6300
5000
4000
3150
2500
2000
1600
1250
1000
800
630
500
400
315
250
200
160
125
100
80
63
50
40
31.5
25
20
0
5
10
15
20
25
30
Equivalent Sound Level (Leq, dB re 1 µPa)

Avian Island Fixed Wing Operations

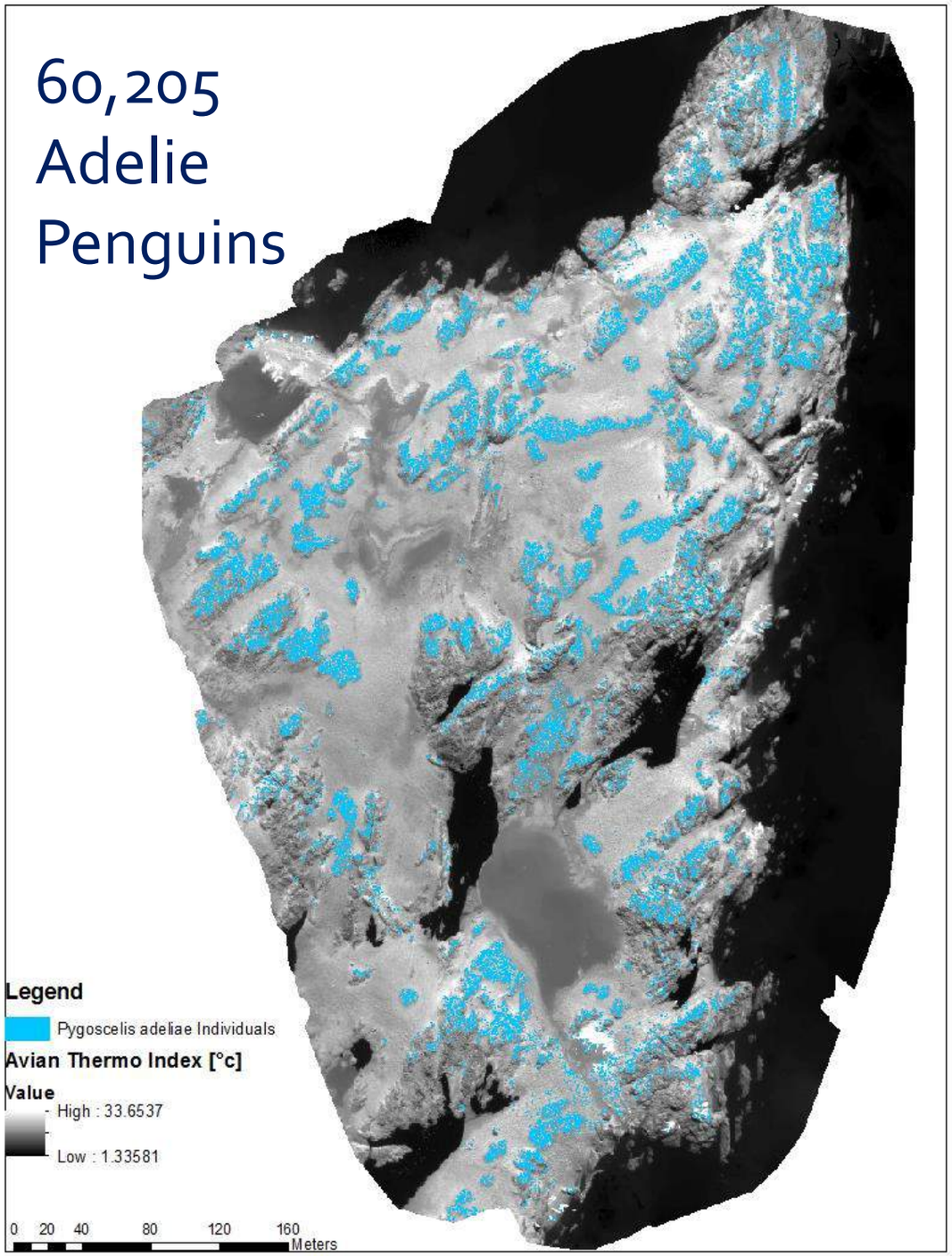
Hand Launch

Colonial Seabirds

Thermal orthomosaic of Adelie penguin colonies at Avian Island, Western Antarctic Peninsula

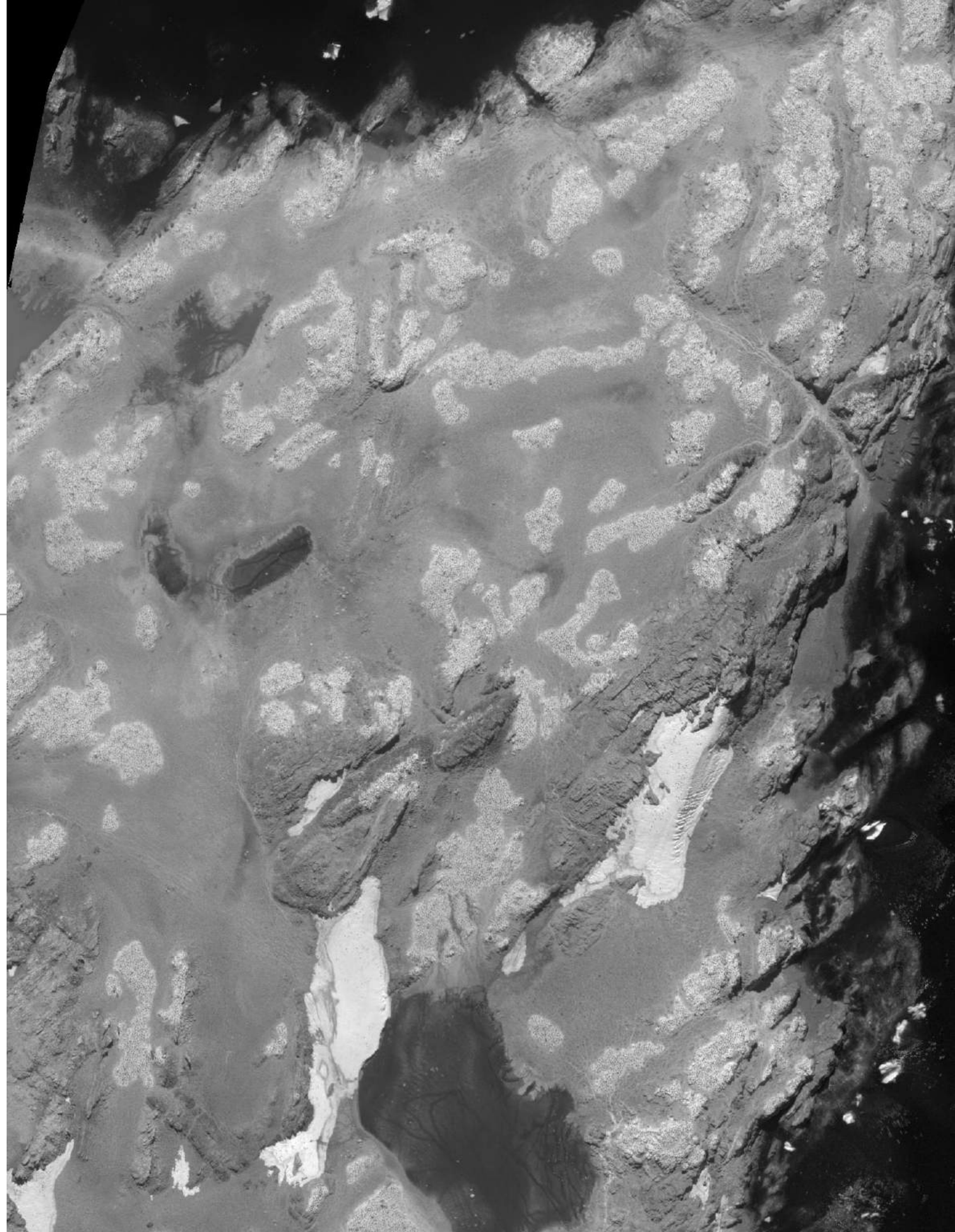


Adelie Penguin Population Counts using Thermal Imagery on Avian Island



Seabird Colony Habitats

Near Infrared (NIR) of Adelie penguin colonies at Avian Island, Western Antarctic Peninsula



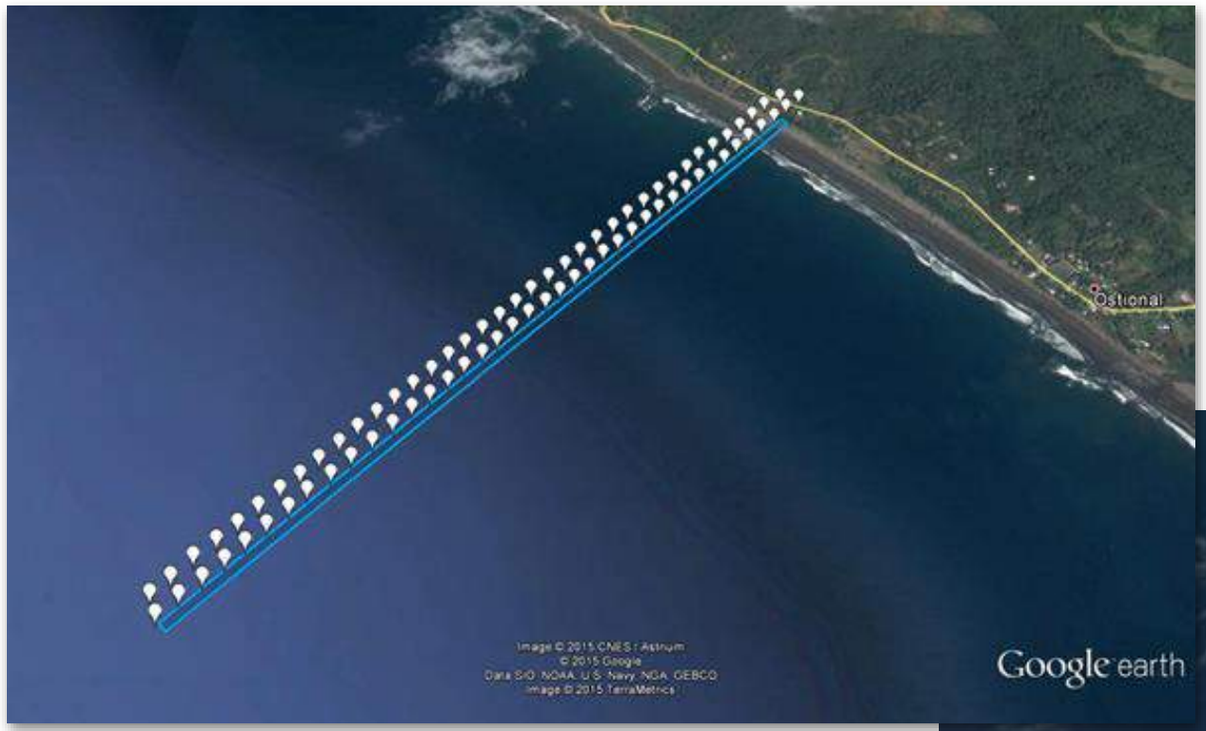
3D Habitat Assessments

Elevation, slope, aspect.

Sea Turtles

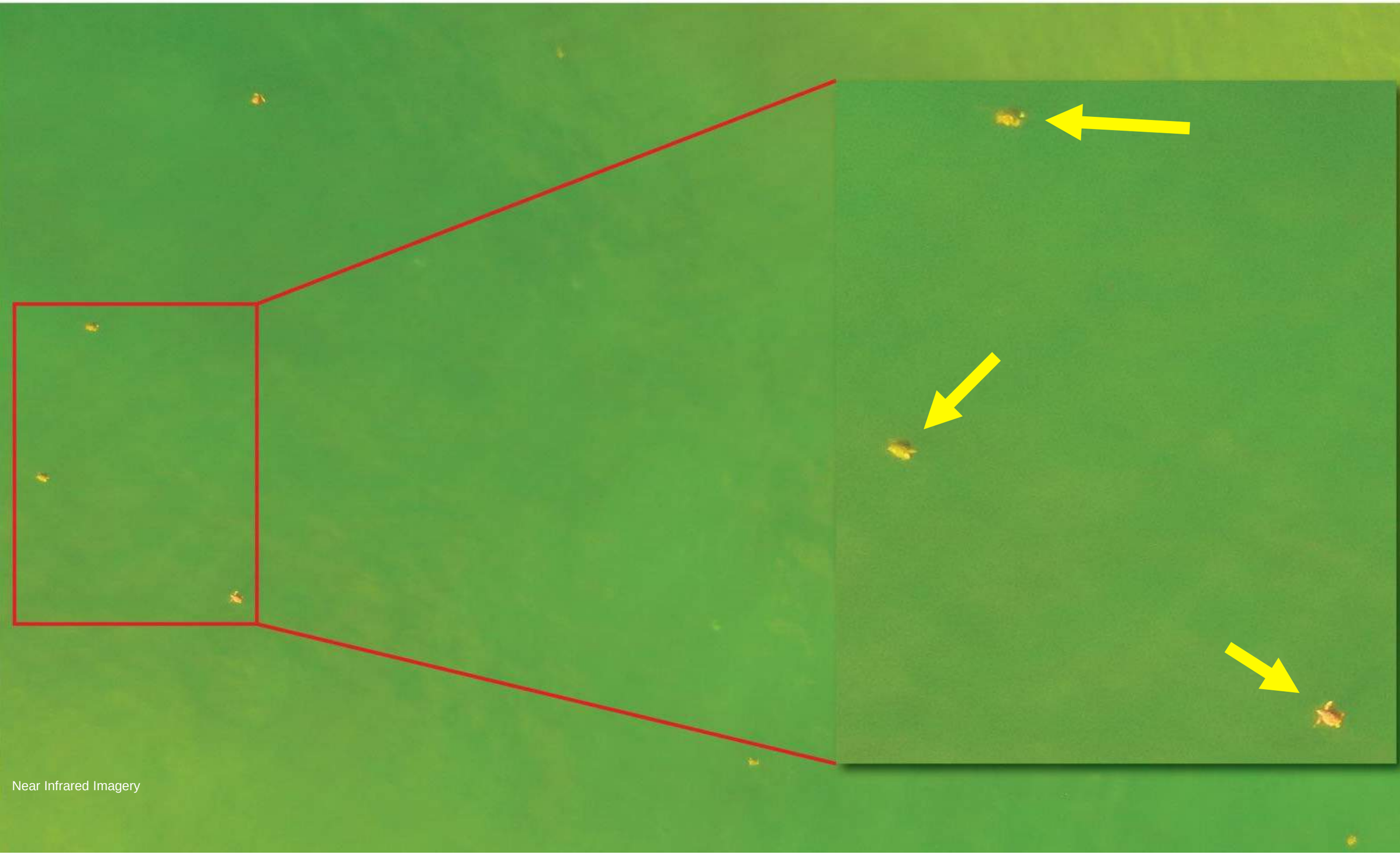
At Sea Surveys - Costa Rica

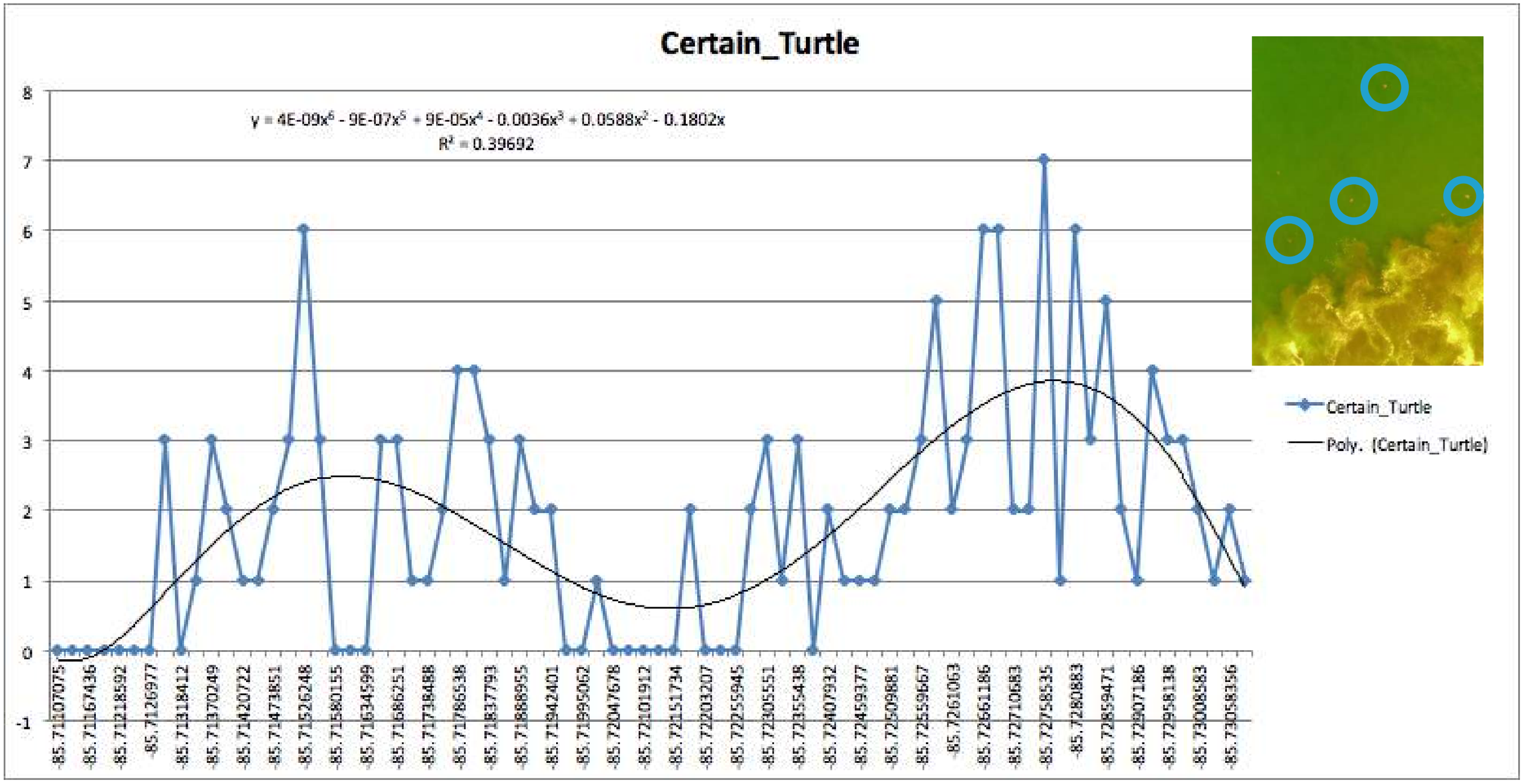
Simple flight plans



Client: Ken Lohman,
UNC Chapel Hill

Near Infrared Imagery


Near Infrared Imagery

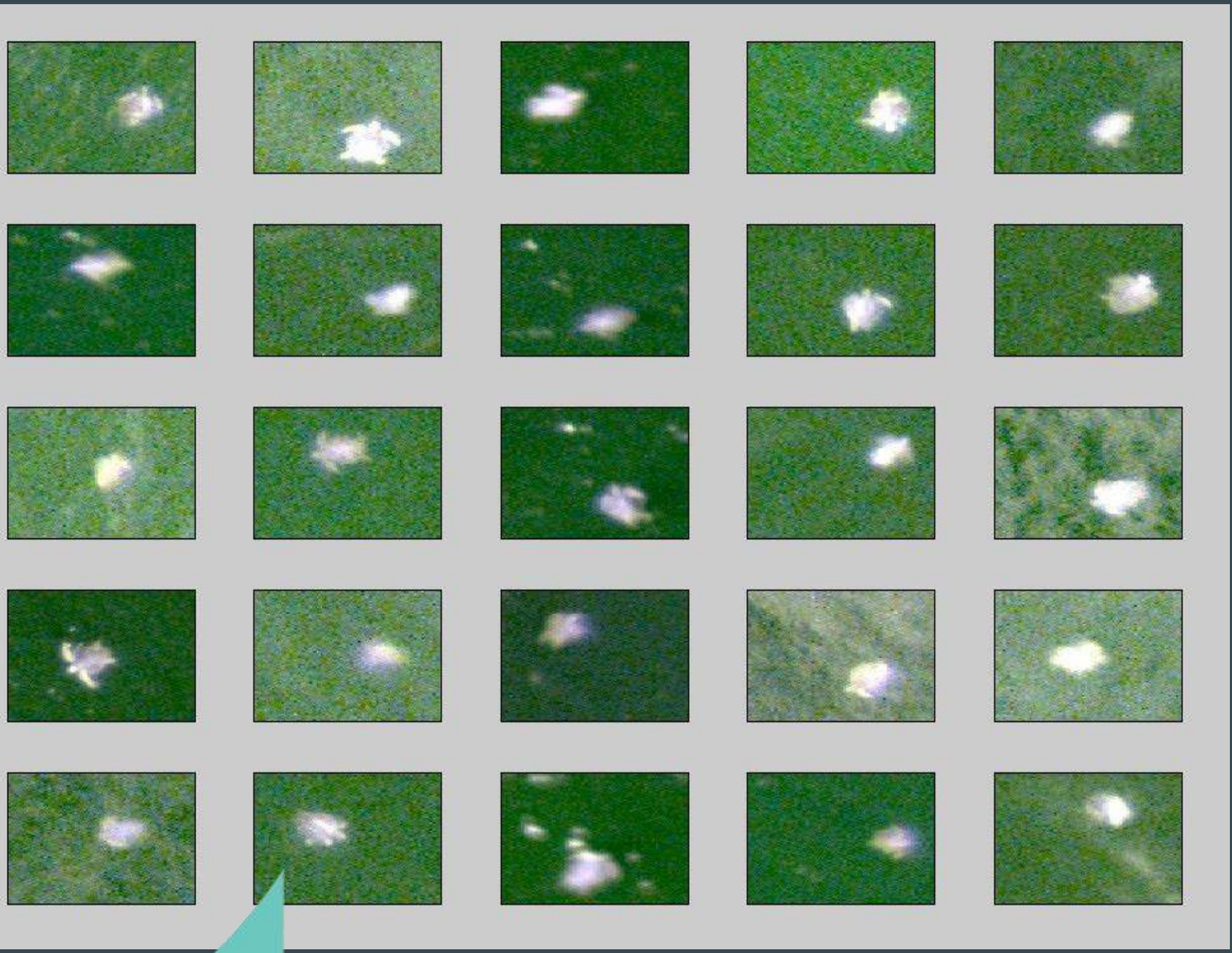


Sea Turtles

At Sea Surveys - Costa Rica

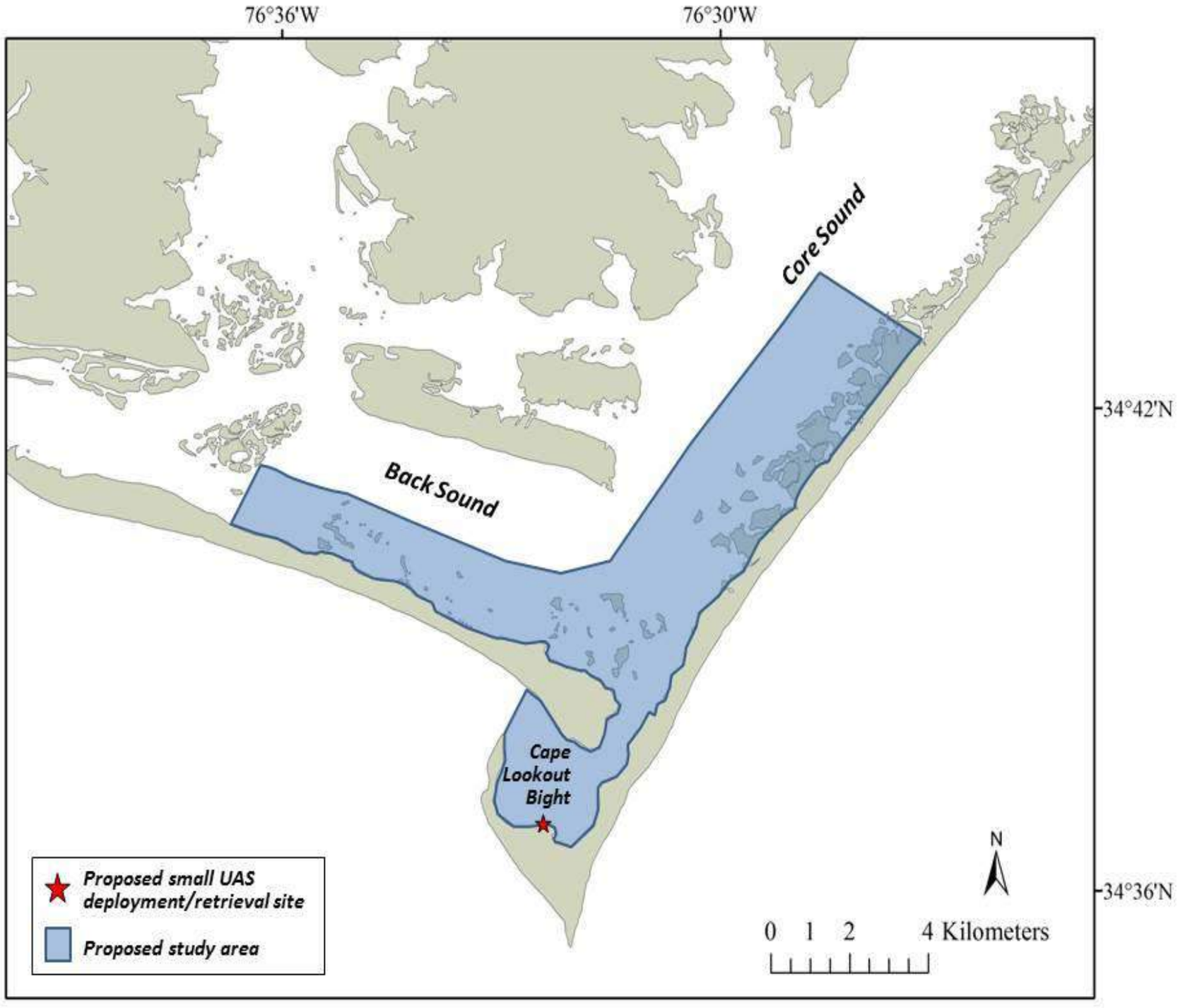
Results: Deep Convolutional Neural Nets

Using a custom 8-layer architecture, 100x100 pixel regions containing a turtle were detected with 96.5% precision @ 95% recall (F=0.96)



Conservation Metrics

Improving conservation through better monitoring

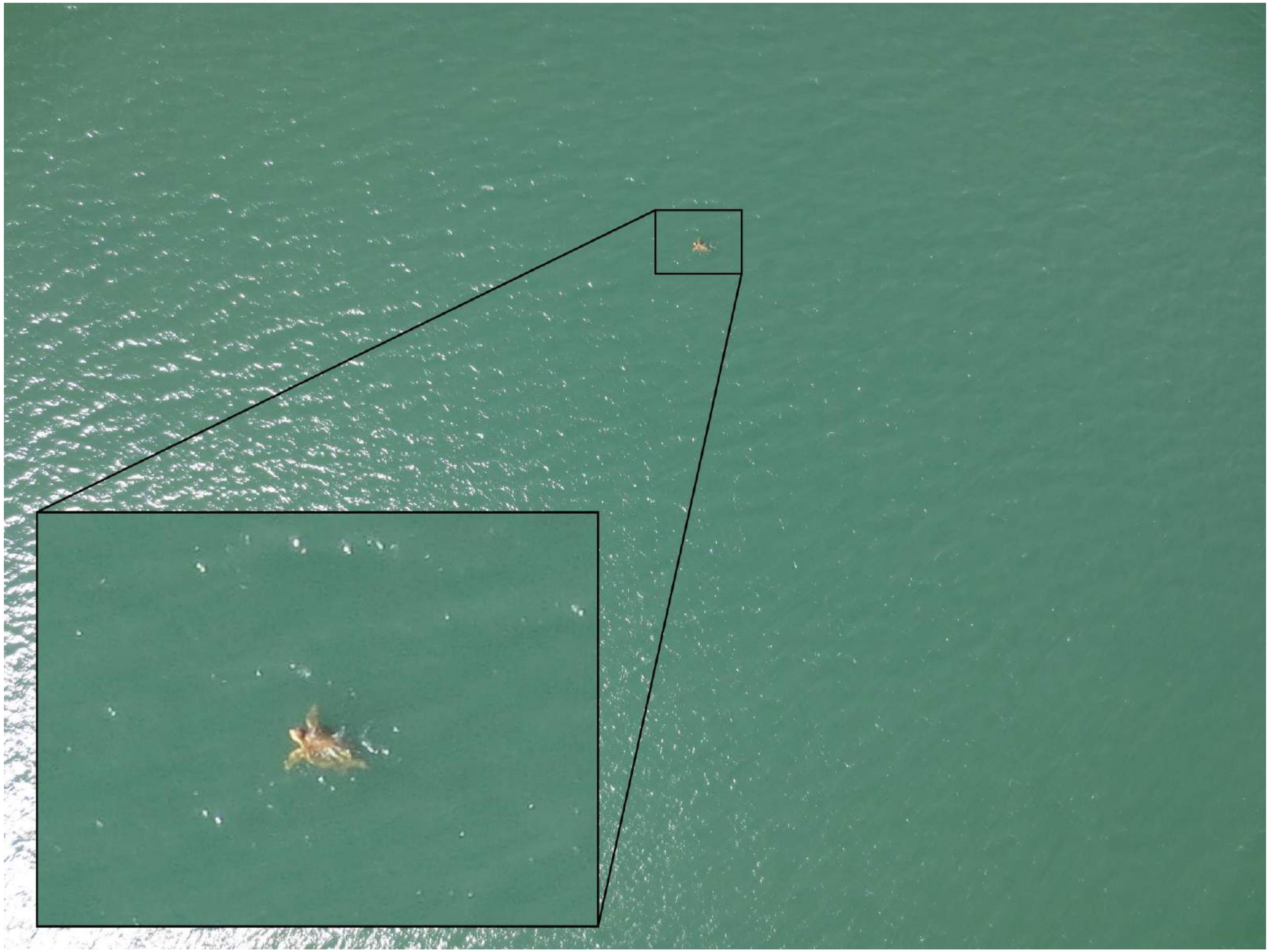


Sea Turtles

At Sea Surveys – Cape Lookout

Sea Turtles

At Sea Surveys – Cape Lookout



Sea Turtles

At Sea Surveys – Cape Lookout

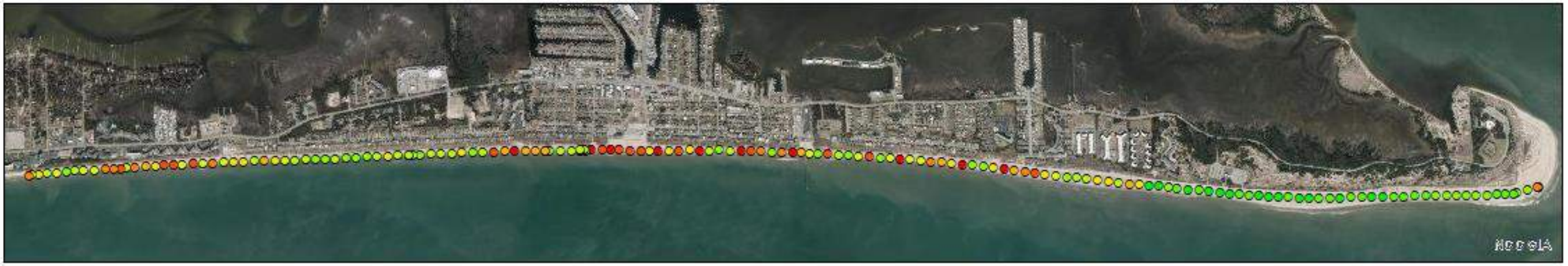
Sea Turtles

At Sea Surveys – Cape Lookout

Sea Turtles and Light Sensitivity

Light Pollution and Sea Turtle Nesting Trends on Atlantic Beach & Fort Macon State Park, NC

N

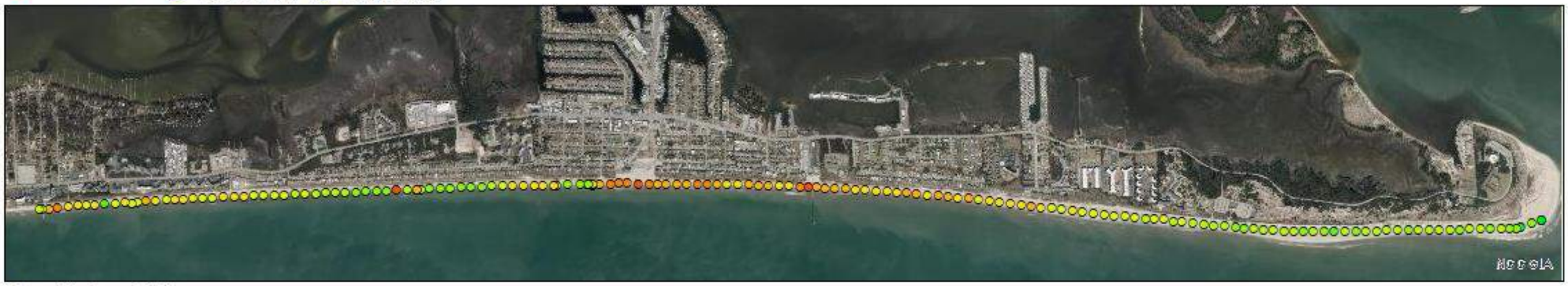


Sideways facing SQM

MPAS

- 10.130 - 12.200
- 12.201 - 13.990
- 13.991 - 15.140
- 15.141 - 16.360
- 16.361 - 17.100
- 17.101 - 17.630
- 17.631 - 18.080
- 18.081 - 18.490
- 18.491 - 18.900
- 18.901 - 19.590

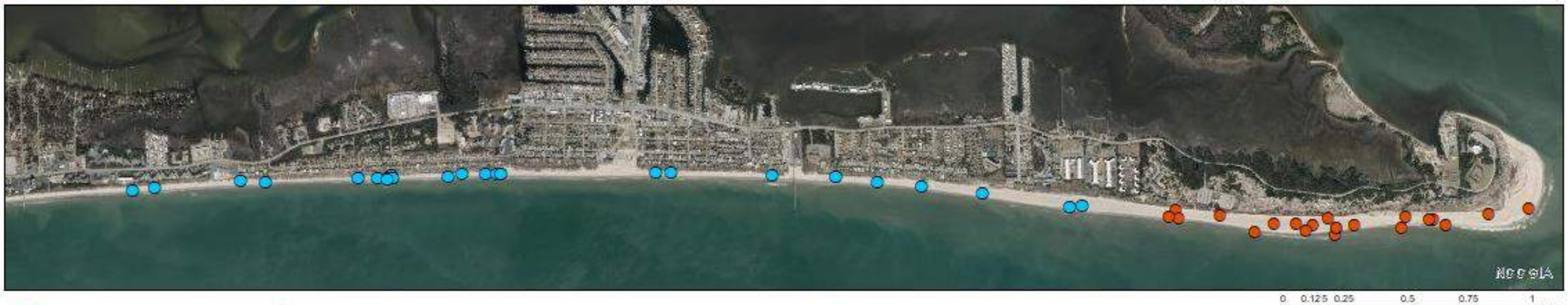
Light was recorded by a Sky Quality Meter (Unihedron) every minute. Units are in magnitudes per arc second (MPAS)



Front facing SQM

MPAS

- 10.130 - 12.200
- 12.201 - 13.990
- 13.991 - 15.140
- 15.141 - 16.360
- 16.361 - 17.100
- 17.101 - 17.630
- 17.631 - 18.080
- 18.081 - 18.490
- 18.491 - 18.900
- 18.901 - 19.590



- Atlantic Beach nests
- Fort Macon nests

Sea turtle nests are recorded from 2011- 2016

0 0.125 0.25 0.5 0.75 1 Miles

Photogrammetry, Behavior, Thermal Ecology

Cetacean body condition and foraging behavior

Foraging Behavior

Lunge feeding of humpback whales

Foraging Behavior

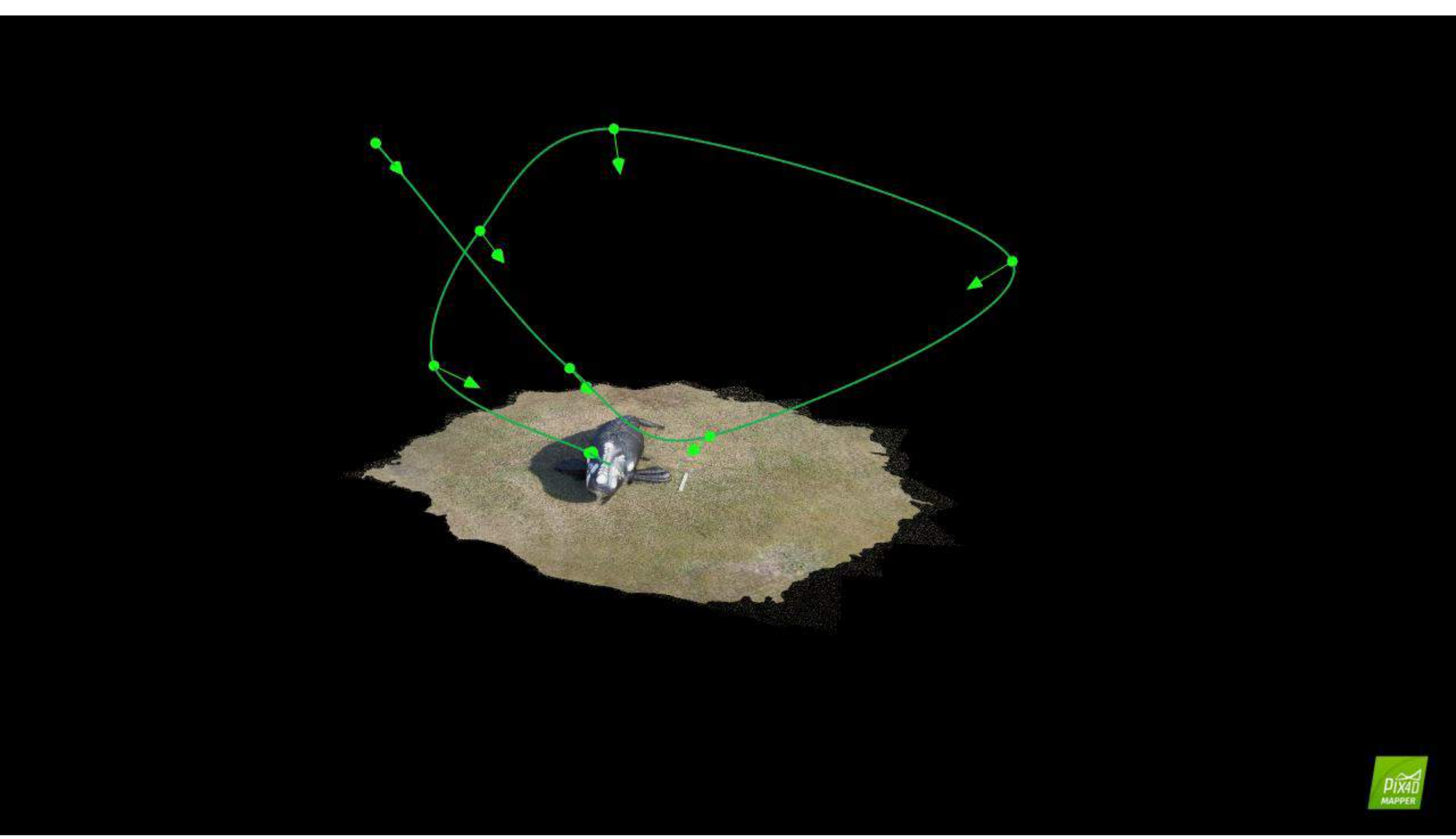
Coordinated feeding amongst individuals, using bubble nets to corral krill

Length and Girth

Body condition - a fat whale is a happy whale

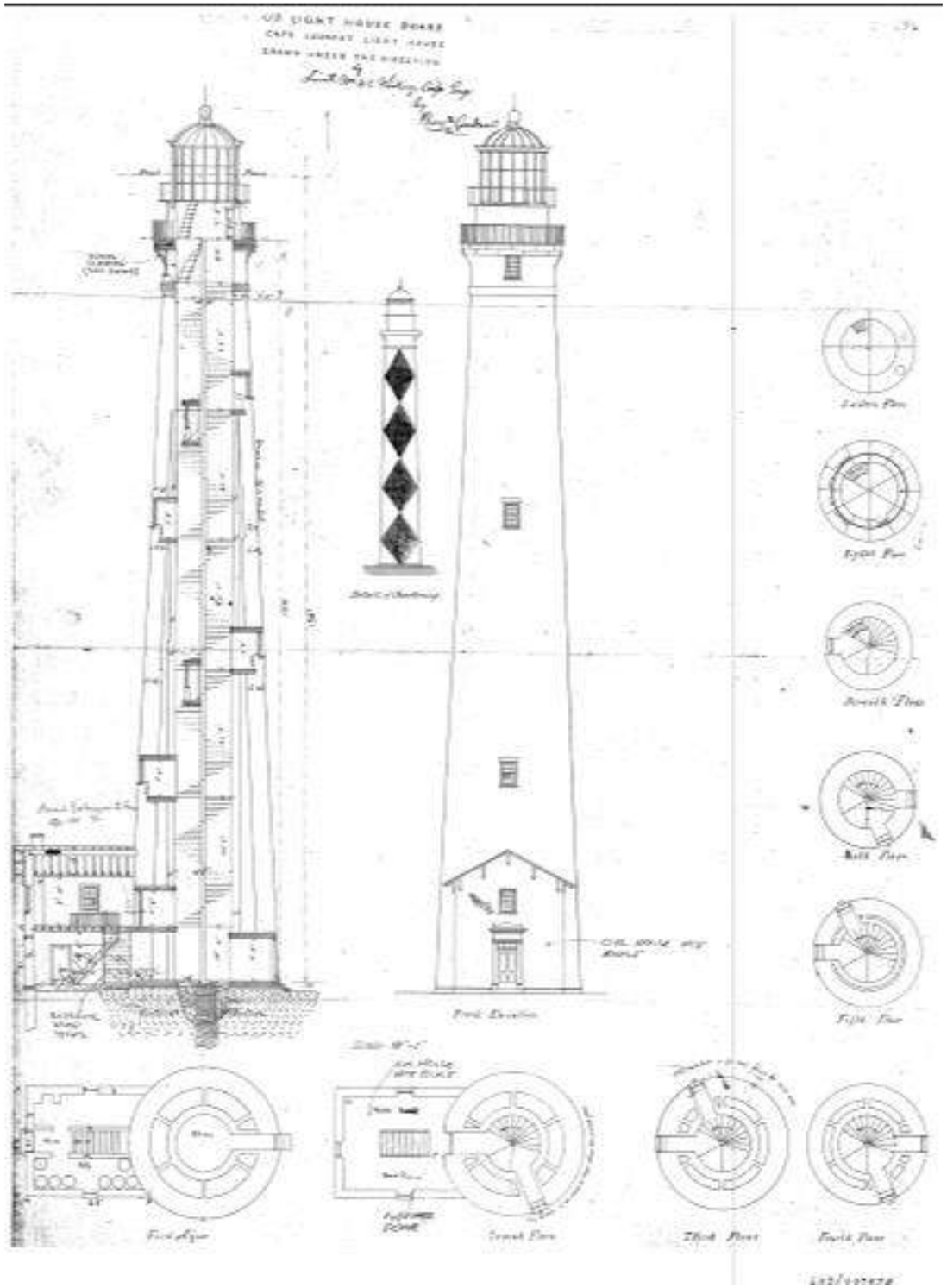
Thermal Ecology

Thermoregulation and metabolism



Volumetric measurements

Even underwater with fluid lensing



Infrastructure

Cape Lookout Lighthouse

eMotion X

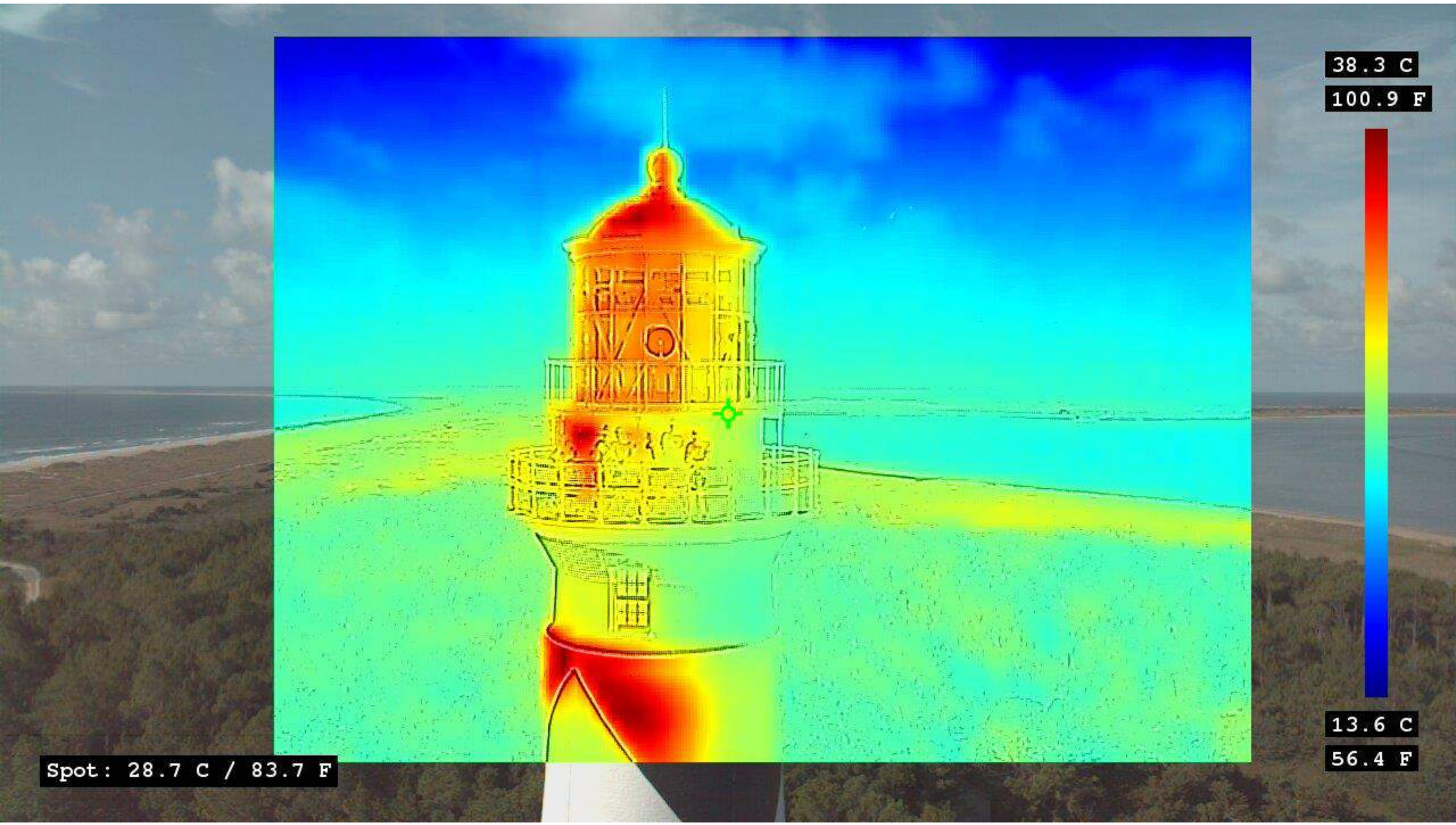
senseFly Satellite

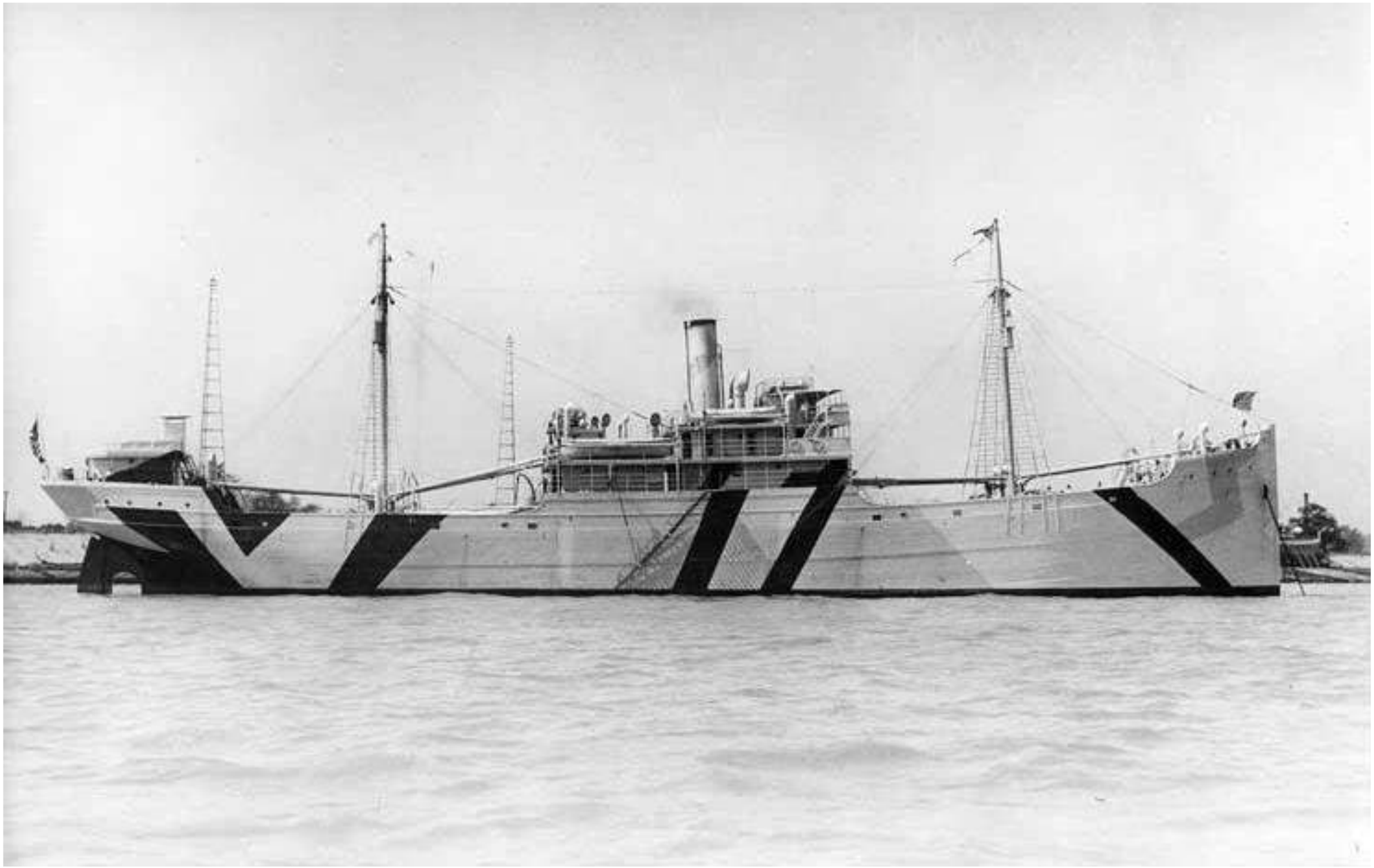
Mission: CapeLookout

CapeLookout ▶ Lighthouse-cyl ▶

Description:	Lighthouse-cyl
Camera:	albris (eXom) maincam 38.4 MP
Cylinder diameter:	9 m
Cylinder height:	52 m
Cylinder latitude:	34.6227320°
Cylinder longitude:	-76.5245282°
Cylinder base:	0.3 m/AMSL
Resolution:	0.50 cm/px
Overlap:	75.0 %
Head angle:	0.0 °
Min. No. of lines:	20
With dome:	Yes
Arc start:	0.0 °
Arc angle:	360.0 °
Arc direction:	Clockwise
Keep:	10 m
Above:	Elevation data
Trajectory:	Vertical
Number of photos:	201
Altitude:	0 m/AED
Estimated flight time:	00:26:10
Estimated flight distance:	1695 m
Picture interval:	18.0 °
Stop heading:	0.0 °
Distance to object:	29 m

Marine Robotics & Remote Sensing


38.3 C
100.9 F
13.6 C
56.4 F
Spot: 28.7 C / 83.7 F

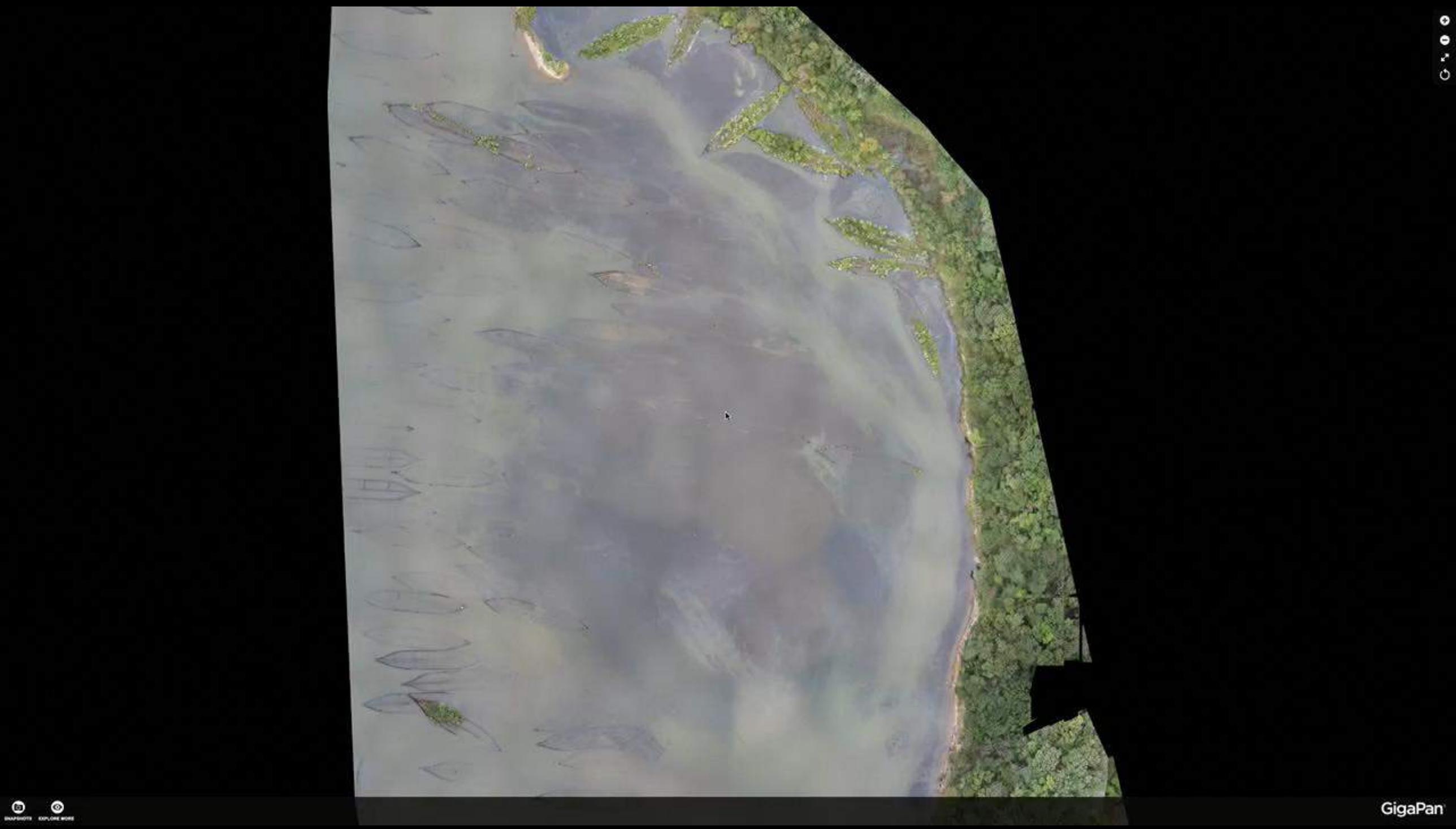


Archiving our Maritime Heritage

Digital Conservation: Ghost Fleet of Mallows Bay

Marine Robotics & Remote Sensing

Maritime Heritage meets Environmental Science: Ghost Fleet of Mallows Bay



Marine Robotics
& Remote Sensing

Italy Archeology Support - Vulci

N

Meters
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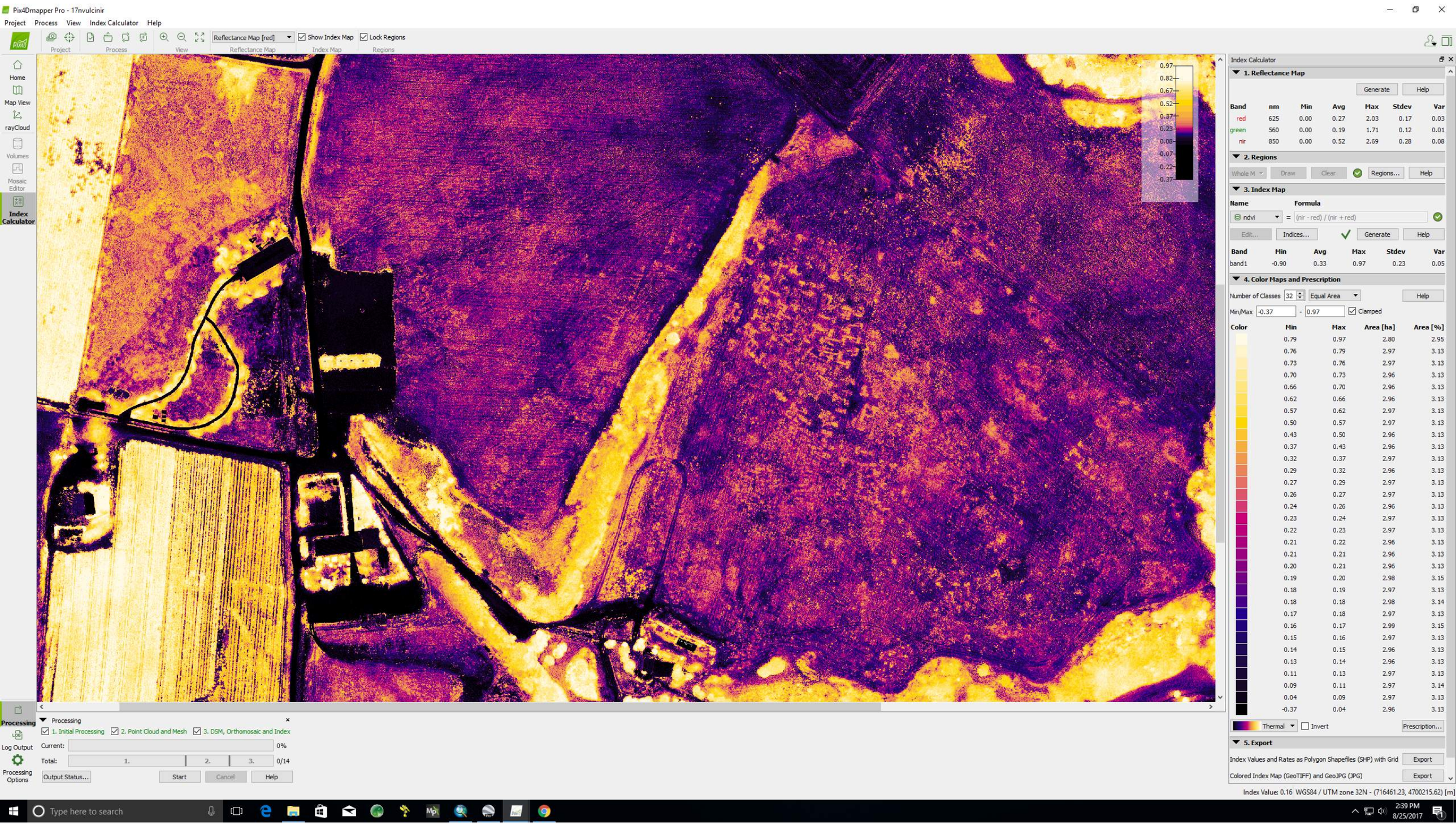
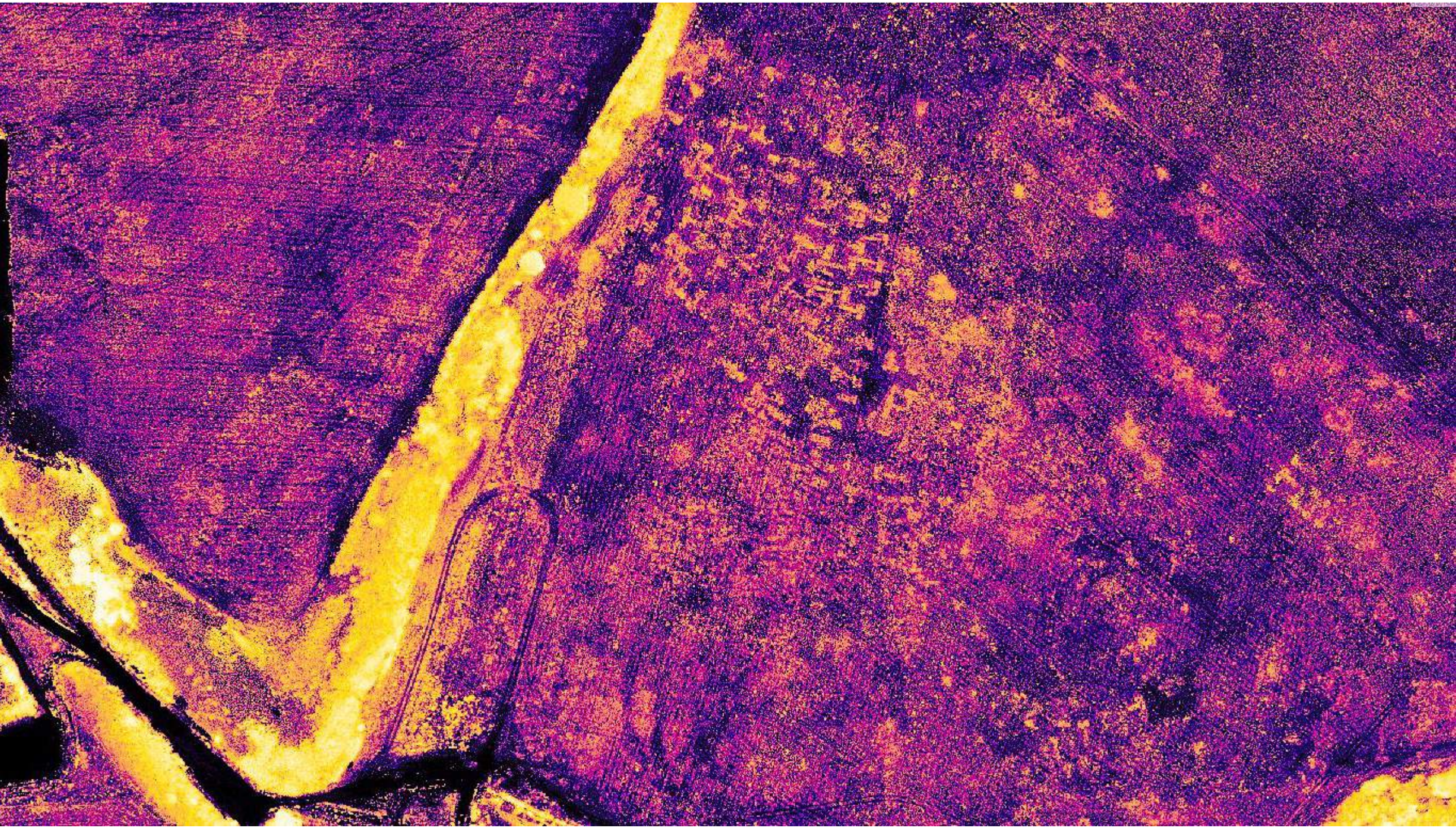
Italy Archeology Support - Vulci

Italy Archeology Support - Vulci



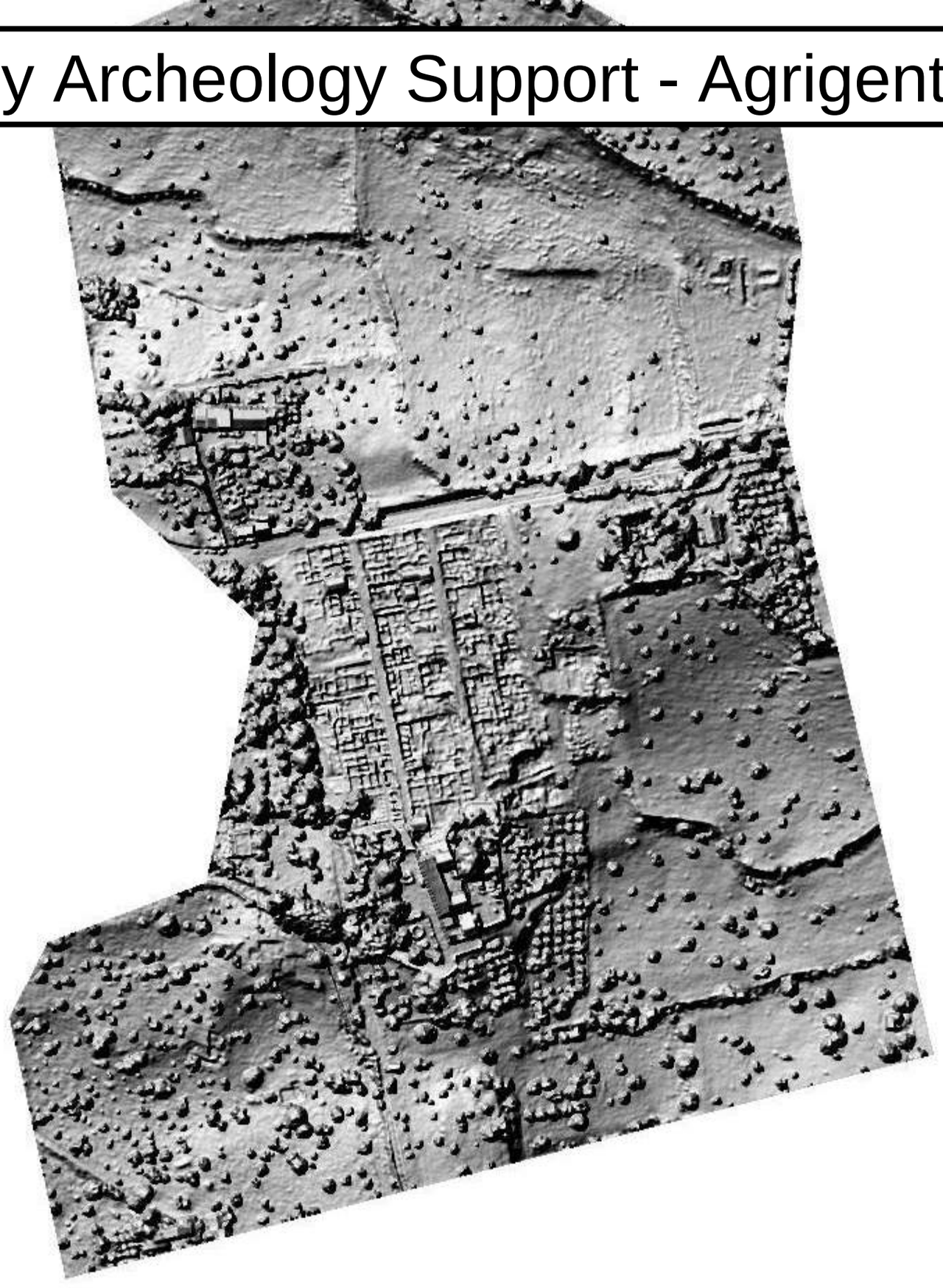
Italy Archeology Support - Vulci



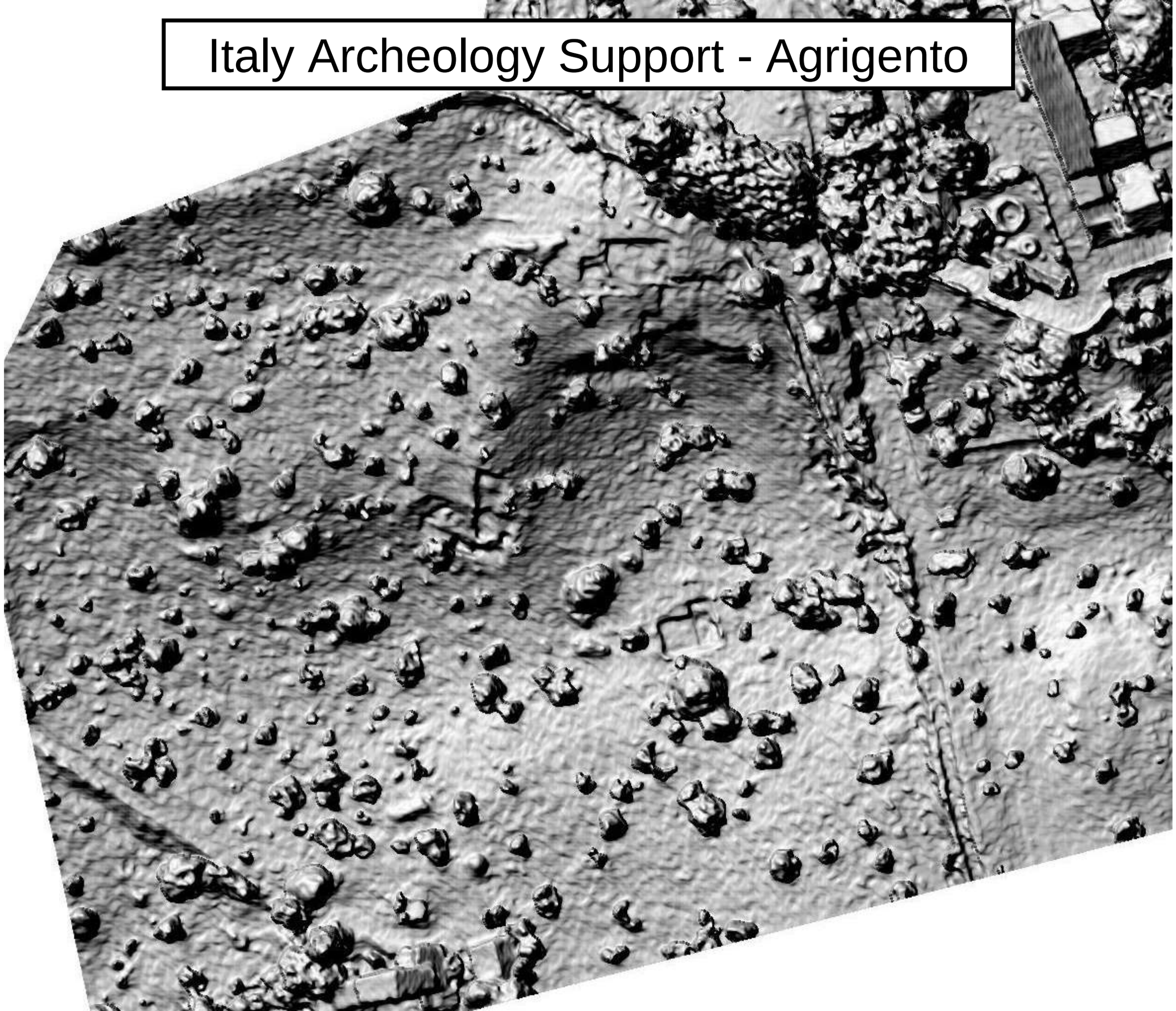
Archaeology: Vulci Etruscan/Roman Site

Marine Robotics & Remote Sensing

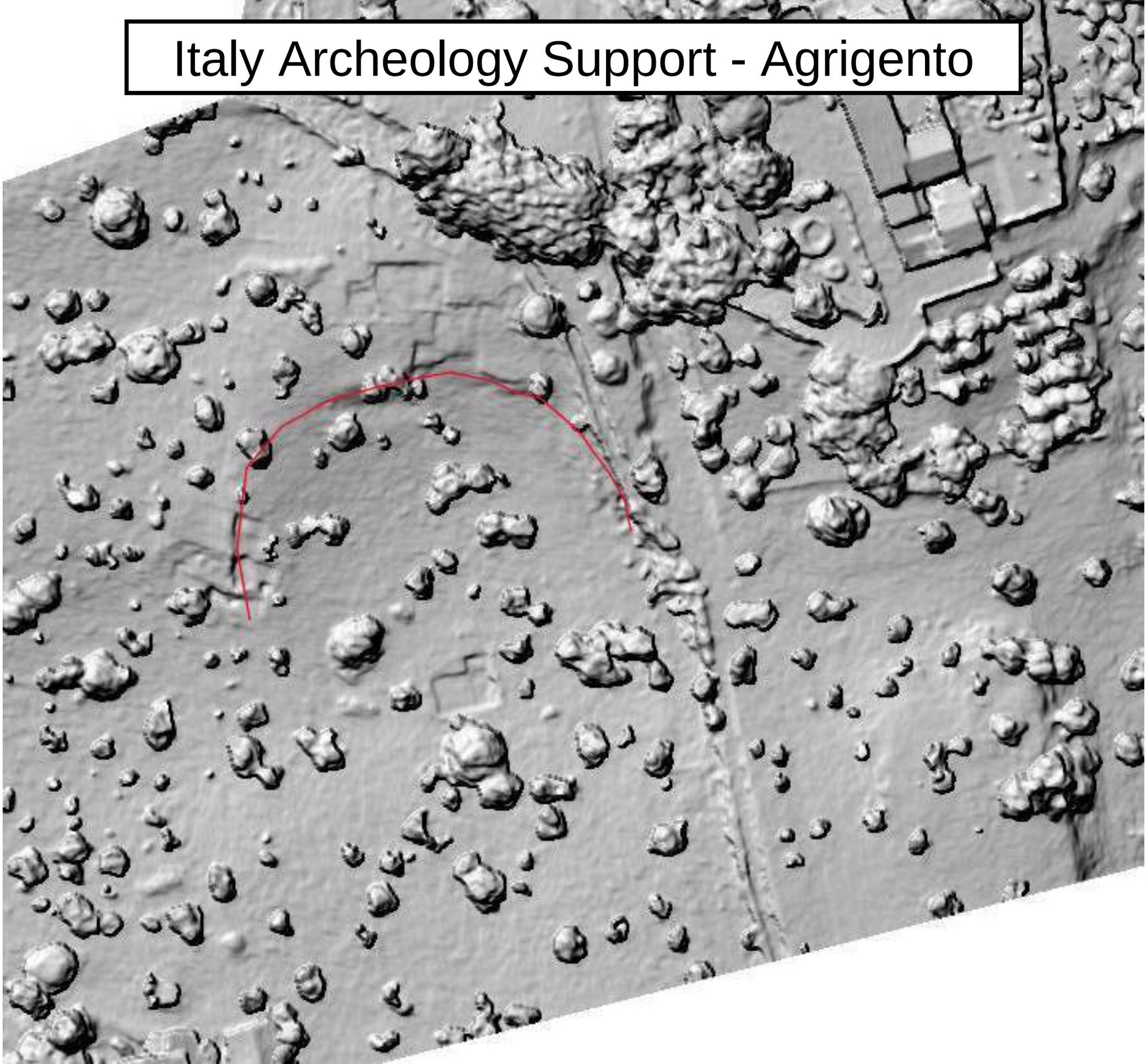
Italy Archeology Support - Agrigento



Italy Archeology Support - Agrigento

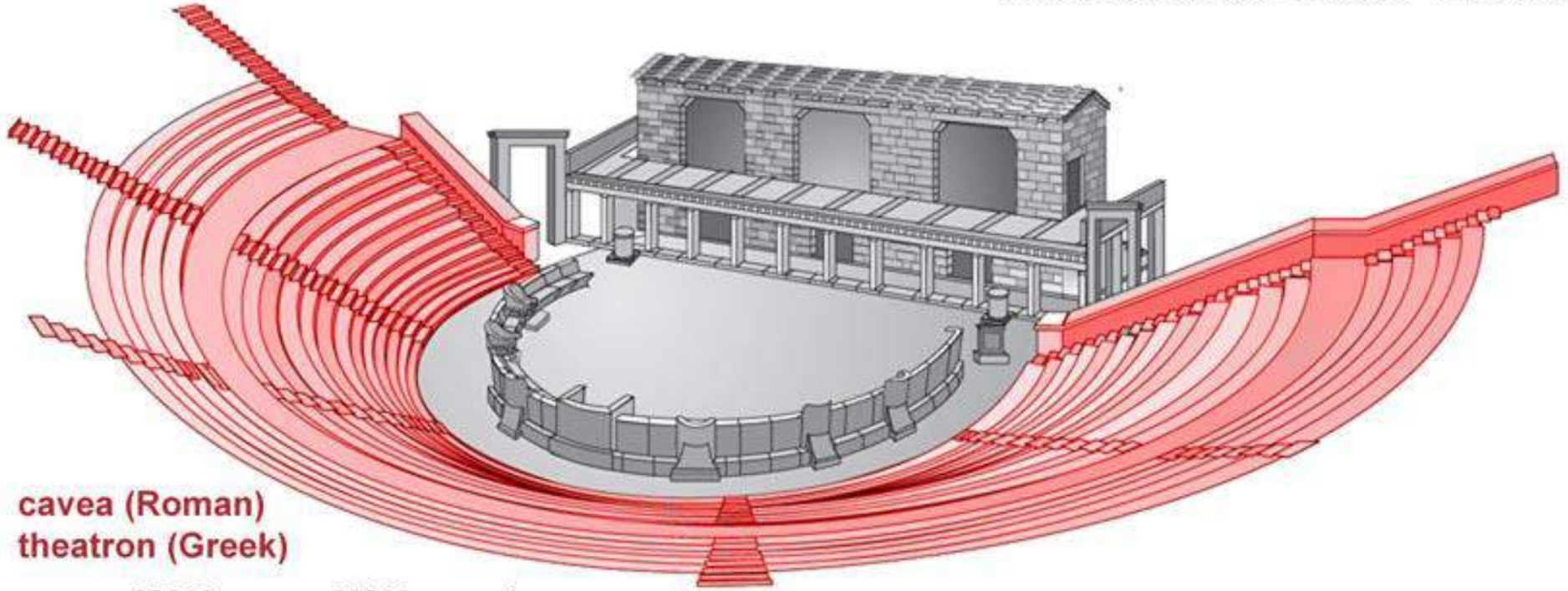


Italy Archeology Support - Agrigento



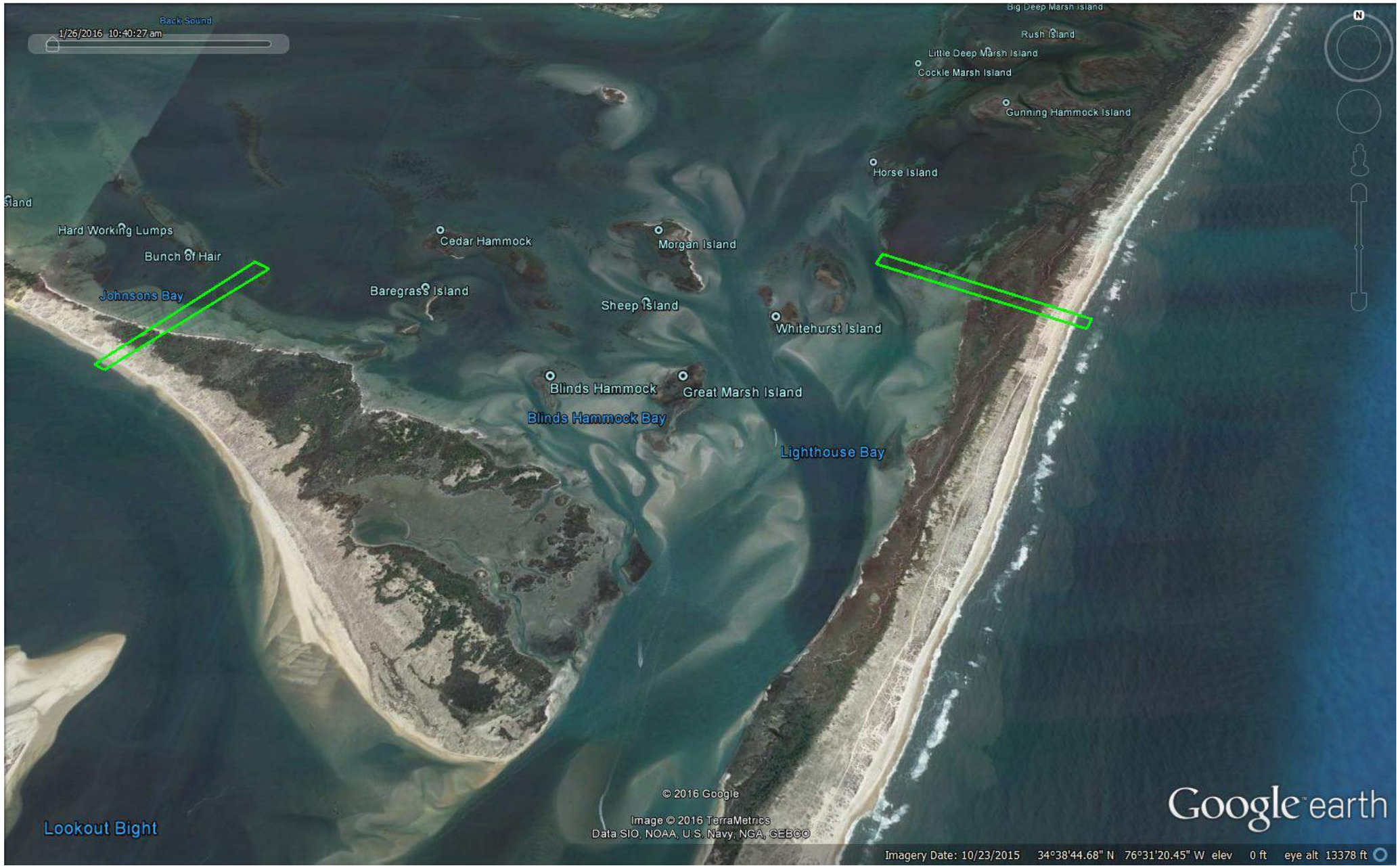
Italy Archeology Support - Agrigento

The Greek Theatre at Epidaurus - Theatron View



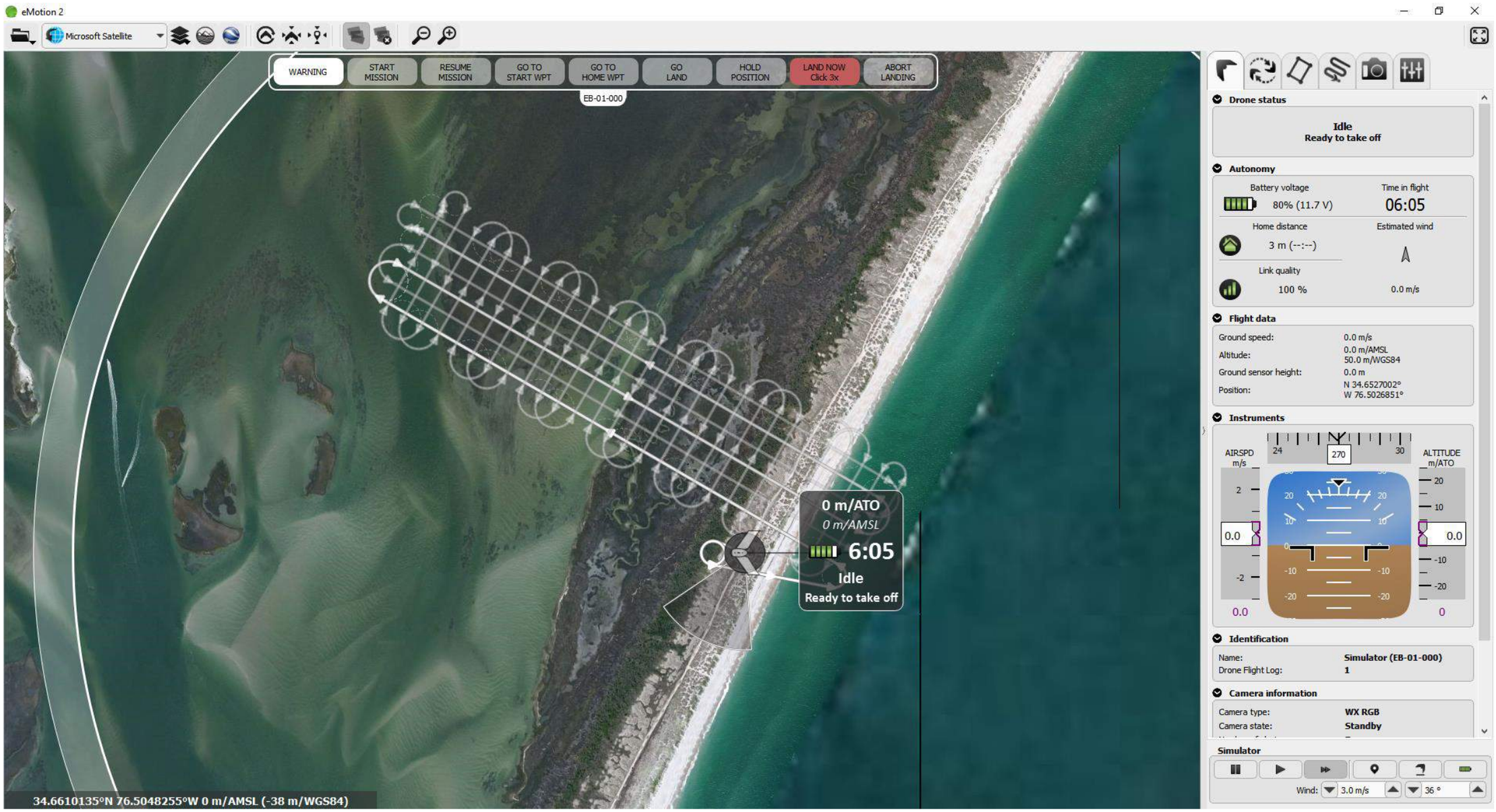
cavea (KAH-vay-a; KAH-vee-a)
(Latin: enclosure or den) Auditorium/theatre or seats/audience; the audience seating portion of the Roman theatre; corresponds to Greek theatron.

theatron (thay-AH-tron)
(Greek: viewing-place) Originally referred to the audience space of the Greek theatre, but later became synonymous with the entire auditorium consisting of the spaces for both the audience as well as the performance; corresponds to Roman cavea.



Habitat Health

Sea Grass – Cape Lookout



Habitat Health

Sea Grass – Cape Lookout

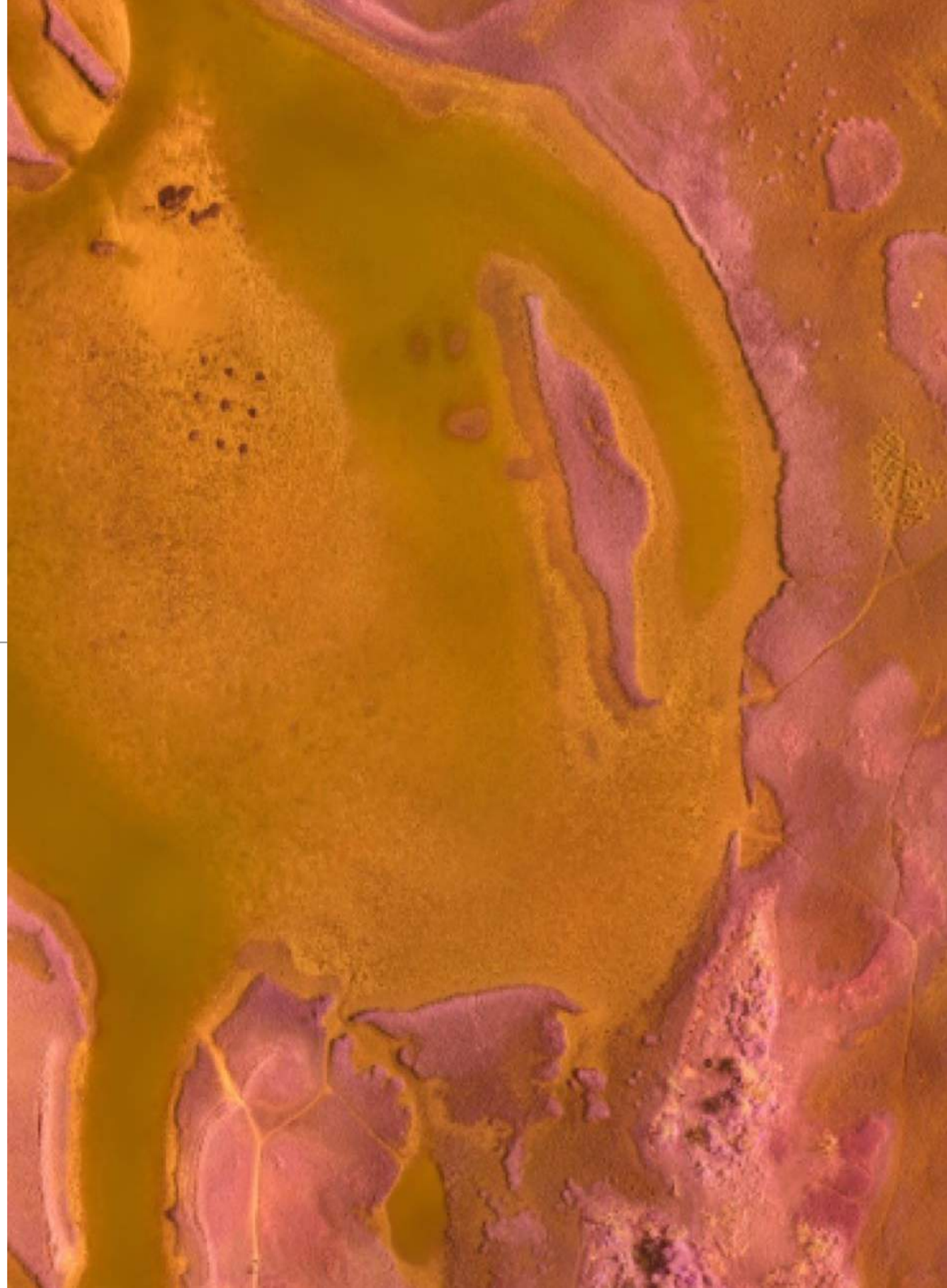
Temperature Index [°C]
High : 37.5801
Low : 29.807

Multispectral Marsh Mapping

Habitat quality and ecosystem services

NIR and RE wavelengths
NDVI calculations

See CIR data…



Marine Debris Identification and Distribution

School Outreach

Google Earth Pro

Sign in

Bird Shoal

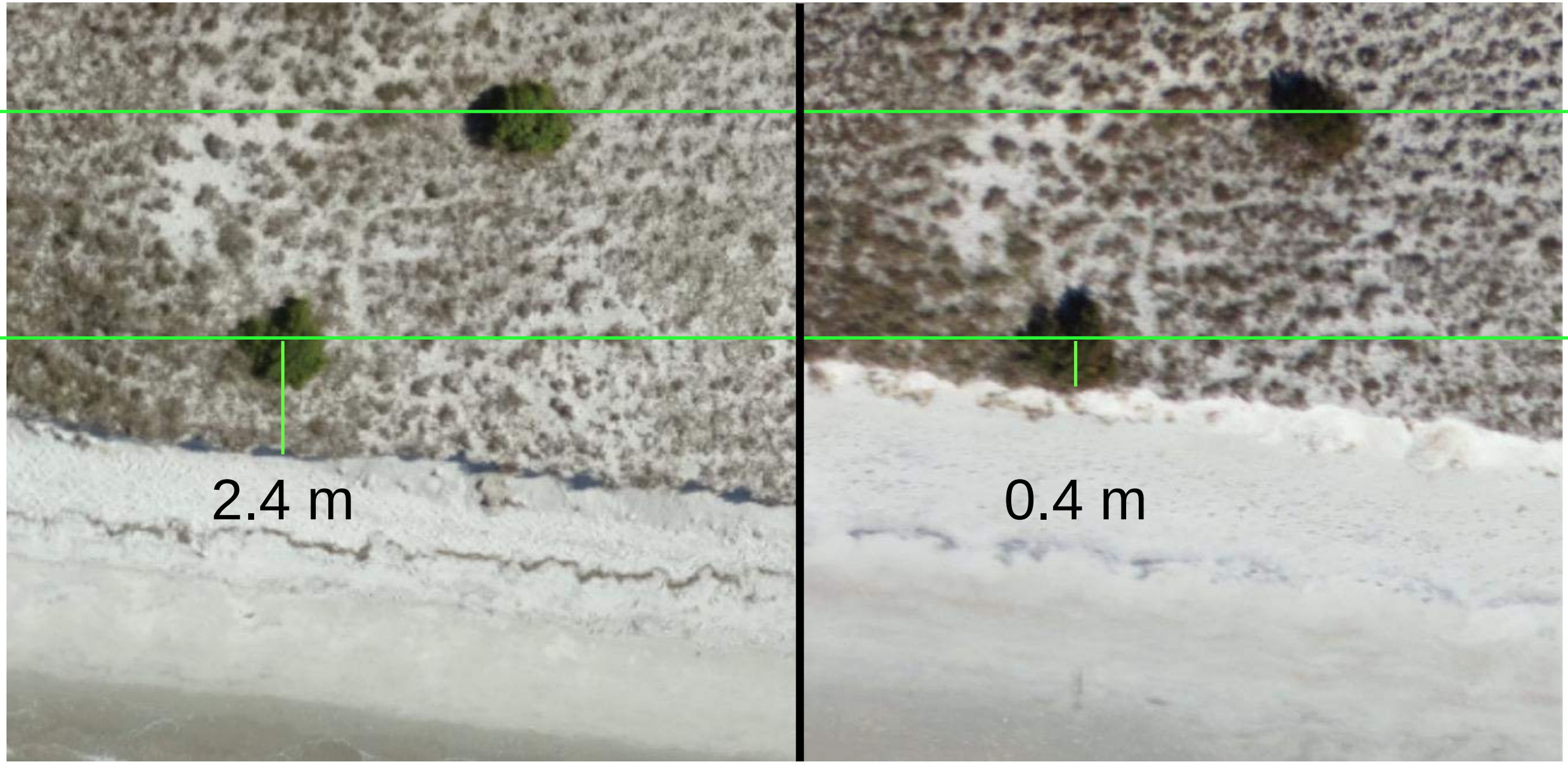
Rachel Carson Reserve

High Tide Meets Cresting Flood Waters

Hurricane Matthew and the Rachel Carson Reserve

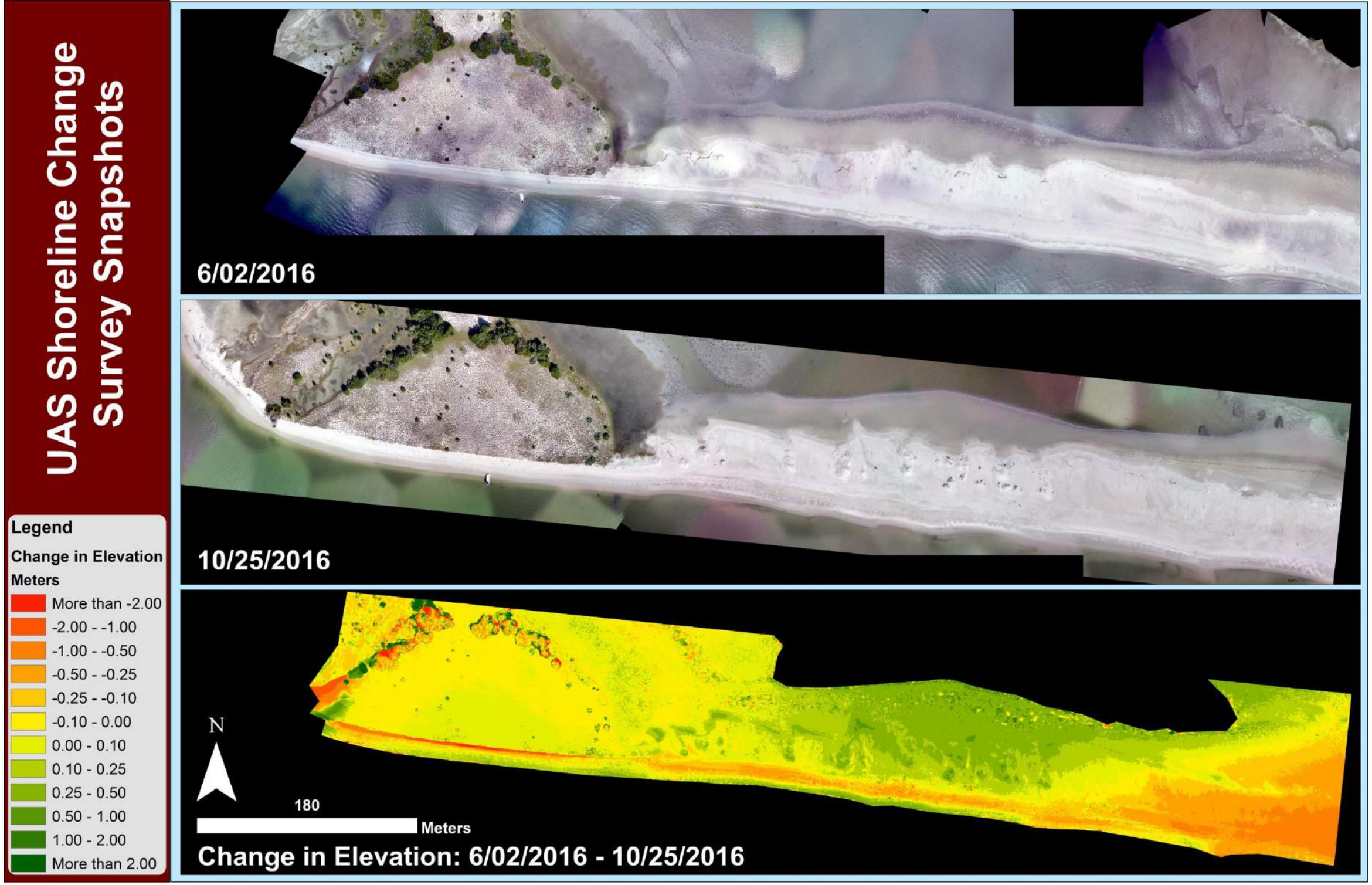
Before Hurricane Matthew

After Hurricane Matthew



Bird Shoal Scarp

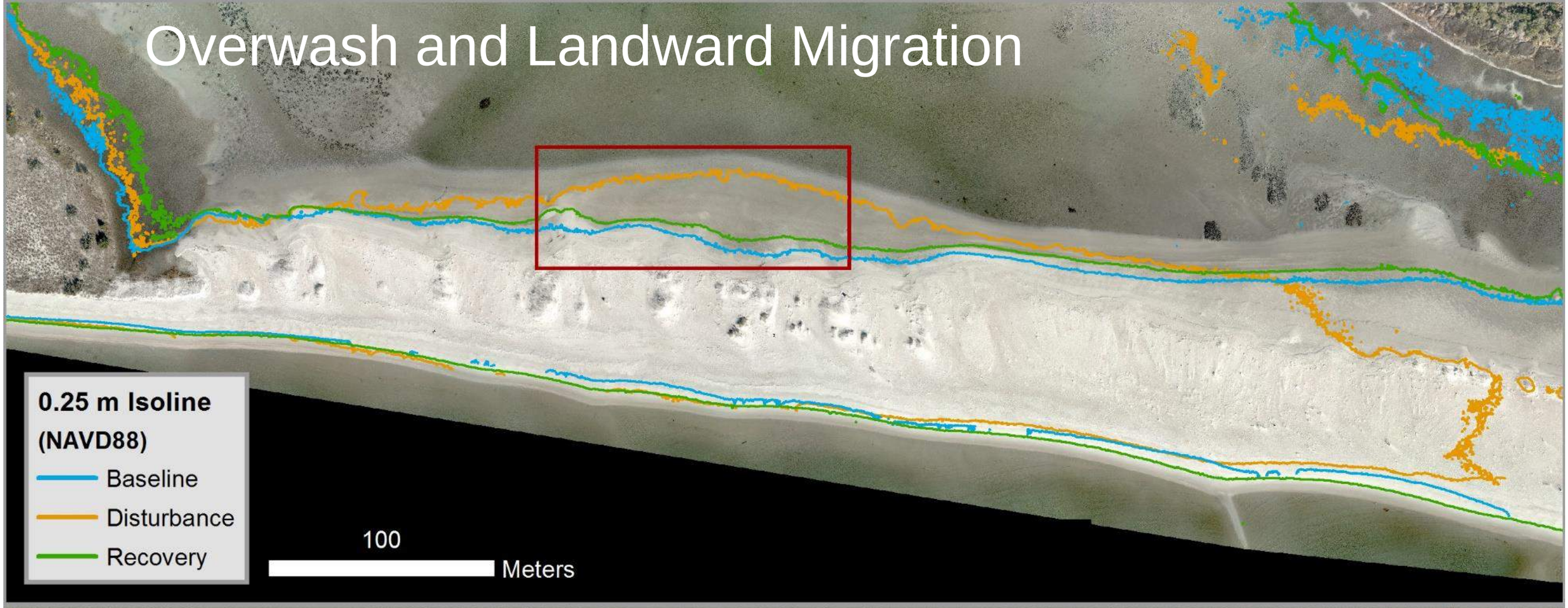
~ 2m northward procession

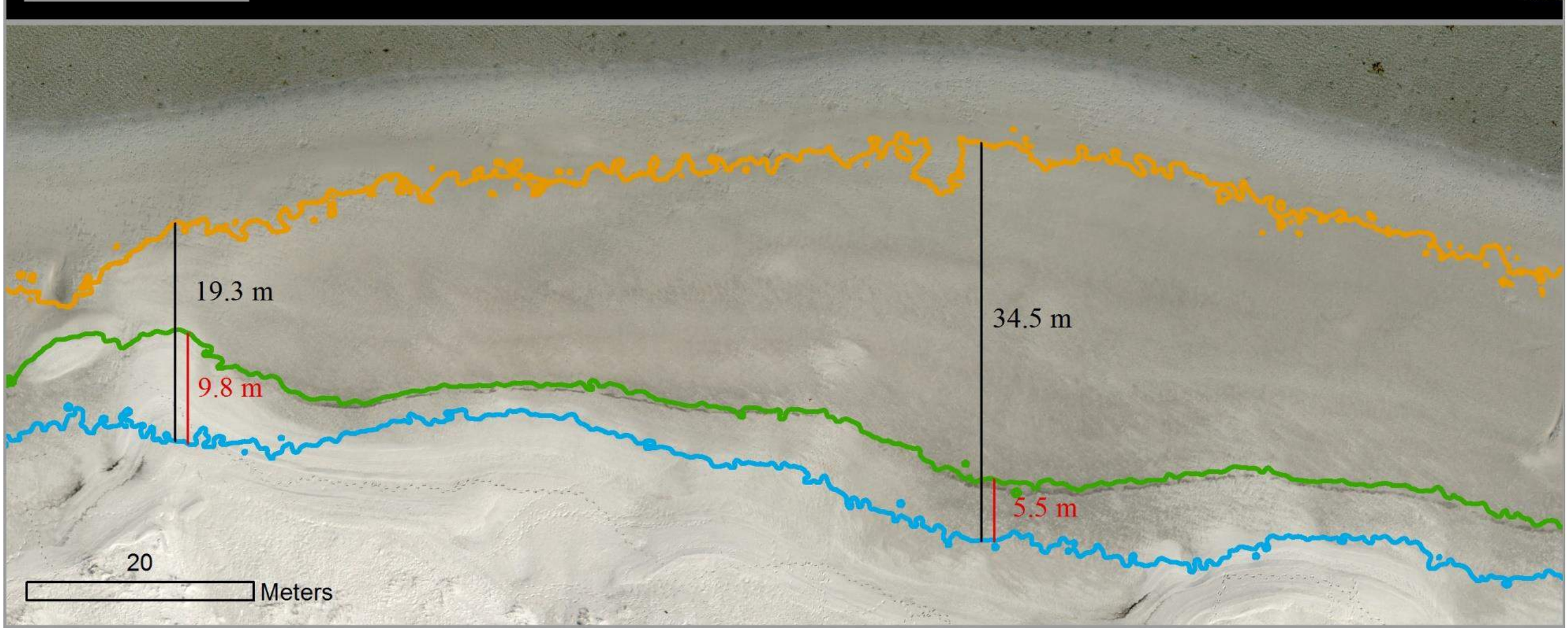


Dramatic changes in elevation

RTK surveys, with 3D GCPs, sub-decimeter accuracy

Overwash and Landward Migration





Significant change in context

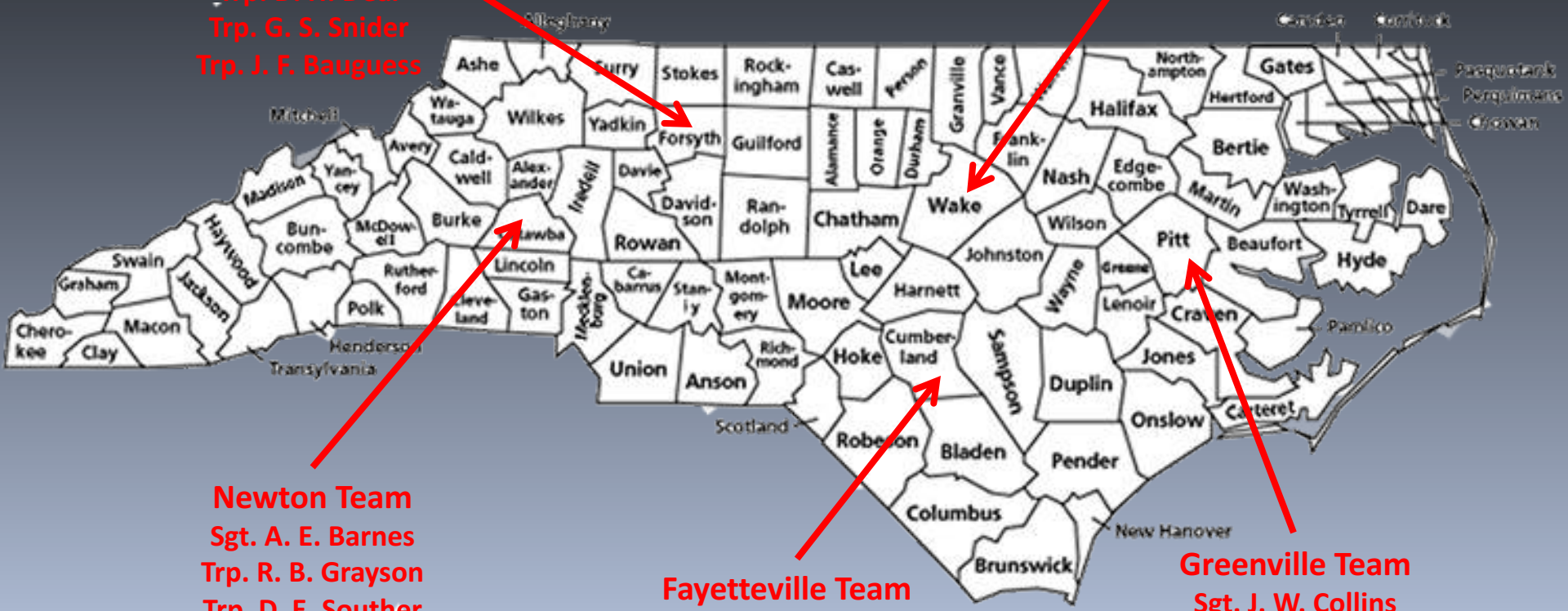
Storms, dredging…

DISCUSSION

Marine Robotics
& Remote Sensing

NCSHP
Collision Reconstruction Unit
Trooper Brian Leventhal

Collision Reconstruction Unit



Winston Team
F/Sgt. A. A. Justice
Sgt. B. K. Palmiter
Trp. D. H. Deal
Trp. G. S. Snider
Trp. J. F. Bauguess

Cary Team
Sgt. W. C. Johnson
Trp. B. N. Leventhal
Trp. R. W. Murphy
Trp. J. O. Melton

Newton Team
Sgt. A. E. Barnes
Trp. R. B. Grayson
Trp. D. E. Souther
Trp. J. P. Contas
Trp. C. J. Rogers

Fayetteville Team
Sgt. S. F. Canady
Trp. J. C. Toon
Trp. J. H. Dixon
Trp. X. S. McPherson

Greenville Team
Sgt. J. W. Collins
Trp. R. L. Cummings
Trp. D. W. Emory

What we do…

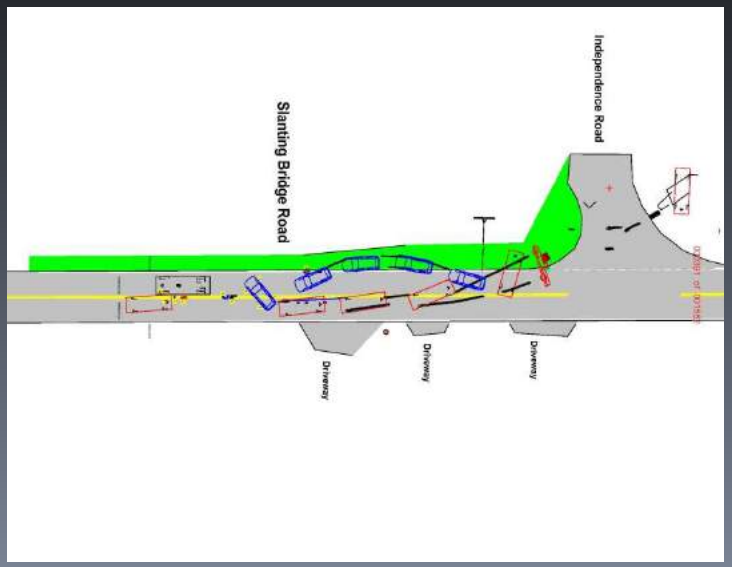
- Collision Reconstruction
- Crime Scene Documentation
- Respond to Natural Disasters
- Respond to Public Disturbances

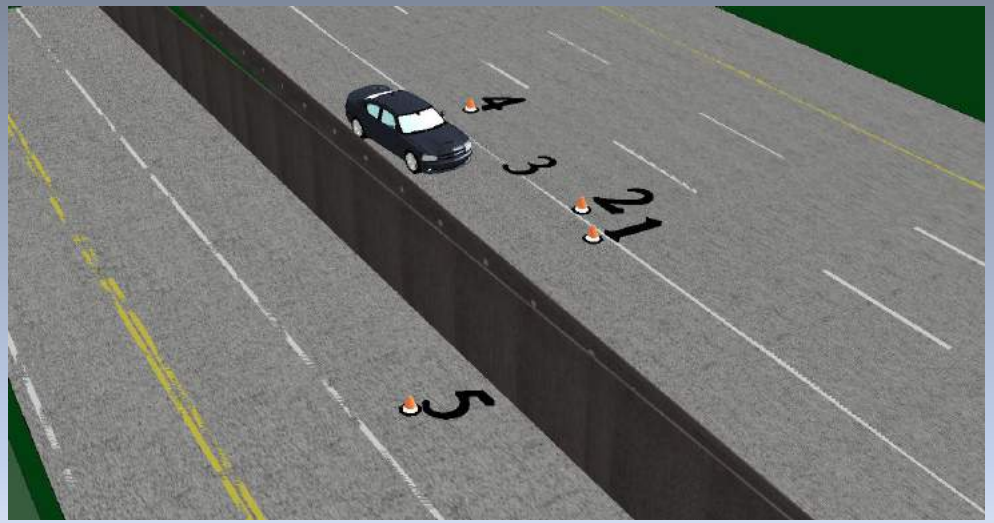
Previous Methods of Measurement & Documentation

200’ Measuring Tape

Nikon Total Station

Finished Product





Current Method of Measurement & Documentation

- Accurate
- Detailed
- 3D Images

FARO Focus3D X330
Laser Scanner

Finished Product

More Efficient Method of Measurement & Documentation

Finished Product

Images and data provided by the UAS Program Office
Division of Aviation – NCDOT from the
Collision Scene Reconstruction using
Unmanned Aircraft Systems Study

A New Perspective

Study of Collision Scene Reconstruction using Unmanned Aircraft Systems

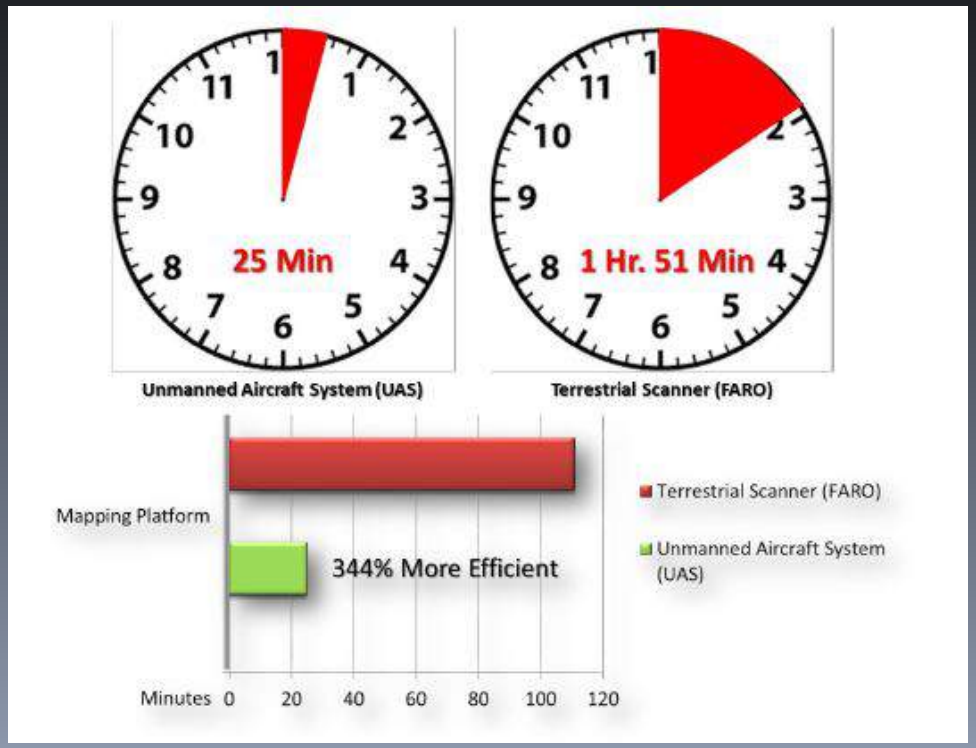
- Study conducted on May 22, 2017 at the Buncombe County Public Safety Training Facility
- UAS Program Office, Division of Aviation – NCDOT
- NCSHP Collision Reconstruction Unit
- 40 mph head-on collision
- Scene was mapped by NCDOT DOA UAS Flight Team using 3 different UAS's (DJI Mavic Pro, Phantom 4, & Inspire 2)
- NCSHP Collision Reconstruction Unit mapped the same scene with the FARO Focus3D X330 Laser Scanner

Accuracy

- Determined using 6 ground control points
- Points were surveyed by NCDOT Field Survey Office
- Accuracy was found to be within .03 ft. (.36 in.)

Skid comparison

Time to Map Comparison



Trooper Brian Leventhal
NCSHP Collision Reconstruction Unit
Cary Team
336-407-8917
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