



# **DoD Natural Resources Program**

## **Enabling the Mission, Defending the Resources**

**Integrating Drones into DoD Natural Resource Management**  
**Susan Cohen**

April 21, 2022

***Please mute your phones.***



Audio Dial-In: 800-300-3070

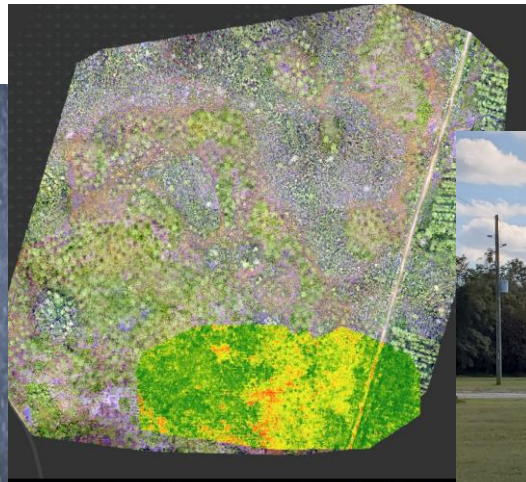
Participant Code: 642-508-534

[www.denix.osd.mil/nr/](http://www.denix.osd.mil/nr/)

Twitter: @DoDNatRes

# Agenda

- Structure and approach of the ESTCP project that launched a regional USMC drone program (Regional Drone Demonstration for Installations and Environment, REDDIE; RC19-5218)
- Natural resource applications
- Opportunities for DoD civilians



(L to R: Vesper, Blue UAS; Westervelt LLC, FL; MCLB Albany)

# REDDIE Project Team

- Salinda Bachelor, Duke University Marine Lab
- Susan Cohen, UNC Institute for the Environment
- David Johnston, Duke University Marine Lab
- Jonathan Putney, Attollo LLC
- Justin Ridge, Duke University Marine Lab
- Antonio Rodriguez, UNC Institute for Marine Science
- Joey Trotsky, NAVFAC EXWC
- Troy Walton, Attollo LLC



# REDDIE



## Problem

➤ Lack of strategic UAS protocols result in one-off approvals or none at all, no real time capabilities, and no process for incorporating the capabilities, efficiency, and safety of UASs into DoD natural resources management.

## Why we care

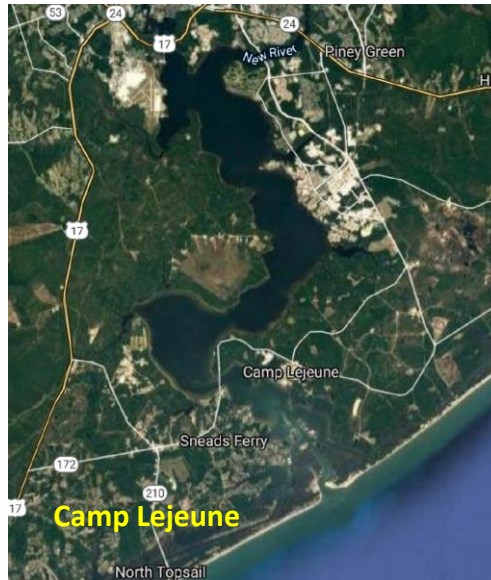
➤ Having the capability to collect, process, & interpret on-demand, high-resolution remotely-sensed data can transform DoD land-management by providing the latest information for optimizing decision-making.

## Solution

➤ Demonstrate and deploy a unified, strategic, and operational framework of training, mission kits, protocols, and demonstrations on a regional level to incorporate sUAS into the civilian workflow.



# MCIEAST Demonstration Sites share climate and resilience challenges due their coastal setting.



# Operational Framework – training, gear, protocols, demos

Development of a mobile **training** platform to facilitate adoption of the technology across MCIEAST installations (Part 107 FAA standard compliant and BUQ II Level DoD standard compliant)



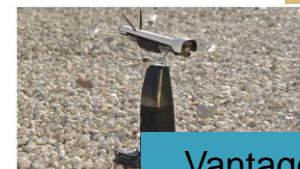
Photos:  
MCLB  
Albany

Creation of a sUAS **mission kit** for regional dissemination to installations. A comprehensive suite of multi-platform/multi-sensor missions to answer a wide array of environmental management questions.

Parrot Anafi  
Thermal



senseFly  
eBee X



Vantage Robotics  
Vesper



# Operational Framework

Develop and codify sUAS **protocols** and program framework. Integrate with MCIEAST leadership, installation staff, airspace managers, etc...to develop pathways.

The USMC MCIEAST order provides a formal pathway for the non-POR program.

The first version (Sept 2020) was a collaboration between MCIEAST leadership and REDDIE.

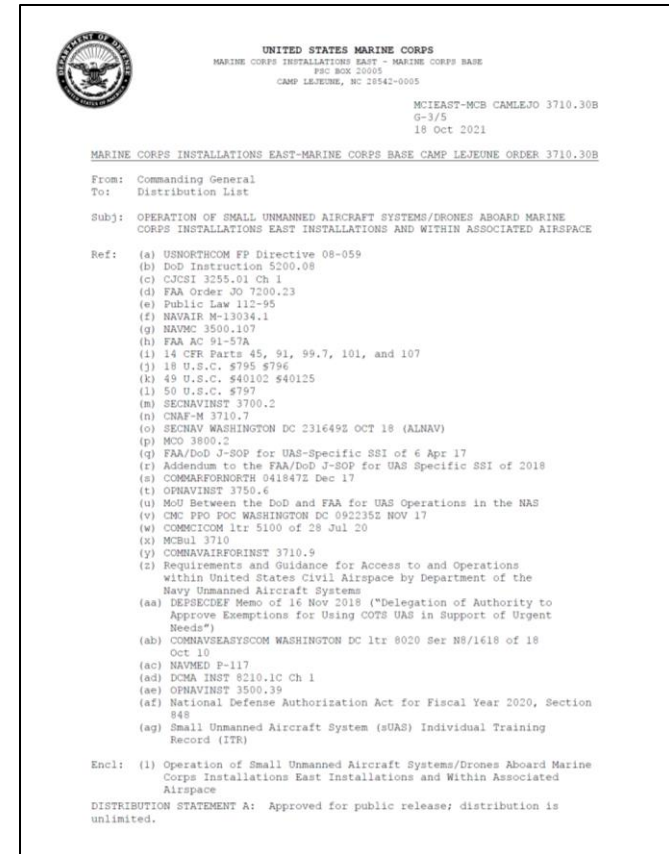
The order was revised and updated Fall 2021!

Institutionalize civilian drone use, longevity beyond revolving door...



## SOPs and Guidance

- Demonstration reports
- Remote sensing user guides
- Practical application templates



# Operational Framework


Use demonstrations to teach and highlight applications

### Using Drones to Quantify Coastal Change

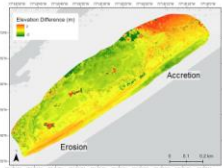
**RGB Orthomosaic Generation**

The UAS collected overlapping imagery in parallel transects with 70% overlap across the study area, capturing approximately 500 images (5472 x 3648 pixels over a total flight time of ~30 minutes and covering a total area of approximately 0.068km<sup>2</sup> or 160 acres with an average Ground Sampling Distance (GSD) of 2.6cm/pixel.

Individual optical, or Red-Green-Blue (RGB) images were collected by the UAS and processed in photogrammetry software Pix4DMapper Pro (v. 4.2.26). High overlap between images allowed Pix4D to stitch images into an orthomosaic, full-resolution.



### Using Drones to Quantify Coastal Change



**Subtraction Raster**

Elevation difference across the site from 2018 to 2019 was computed by subtracting the 2018 DEM from the 2019 DEM in ArcGIS Pro. Elevation differences within the Root Mean Square (RMS) error of each SIM project were masked to zero to represent true changes in elevation.

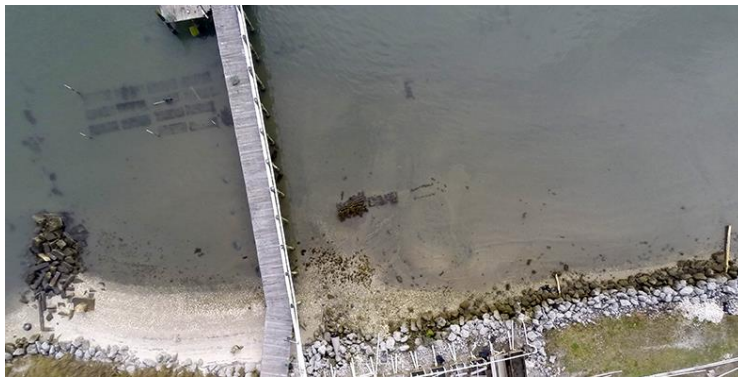
The subtraction raster demonstrates that the beach appears to be accreting on the southeastern end of the site and eroding on the northeastern end of the site. This supports the patterns of shoreline recession and advancement in the 2D shoreline change analysis and explains the disappearance of the exposed sand deposits (black surfaces) seen on the beach in the 2019 imagery.

This study provides an example of the potential to use consumer-grade UAS to understand short-term coastal change. The methods presented in this report can be scaled up to quantify changes (positional/spatial movement, volume differences) in specific areas of interest to inform long term monitoring efforts.

The project was carried out in partnership with Duke University Marine Lab, University of North Carolina at Chapel Hill, and the Institute of Marine Sciences and Coastal Sciences at Virginia Commonwealth University.



Photos: UNC Institute of Marine Science




12/5/14; Saltmarsh = 0 m<sup>2</sup>



5/29/19; Saltmarsh = 203 m<sup>2</sup>



## Progress (and lessons learned)

- If you want to fly drones on your installation, you have to be the expert on rules and educate leadership, one person at a time.
- Success relies on leadership and staff, engage early – a change can move you back several steps each time or an obstacle can retire.
- Socializing civilian flown drones and incorporation into workflows requires continuous communications, briefs, and outreach
- Each installation's implementation is different with its own set of sensitivities.
- But the training, gear, and basic protocols can be codified. 
- Continuous changes in DoD policy (e.g. NDAA) can stop or challenge a UAS program without strong advocates; remain flexible!
- **Nothing guarantees the Bases will figure out some of the remaining pieces, but they are going to be set-up to finish strong!**

# Natural resource applications

UAS systems allow for high-resolution mapping (~3cm/pixel) on a user defined temporal scale

## Long-term monitoring

Invasive species detection/ monitoring

Herbicide applications

Coastal habitat resilience

Sea level rise/beach erosion

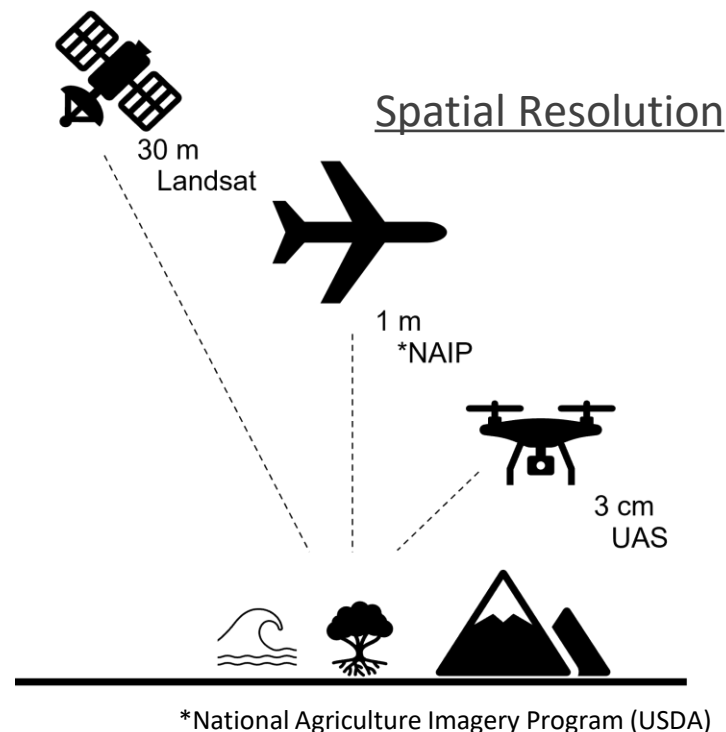
Marsh mitigation

Pre/post major storm event

Habitat restoration mapping

T&E habitat monitoring

Forest health and growth monitoring



## Situational Awareness

Forestry

Prescribed fire

Hotspot detection

Live personnel tracking

Post storm assessment

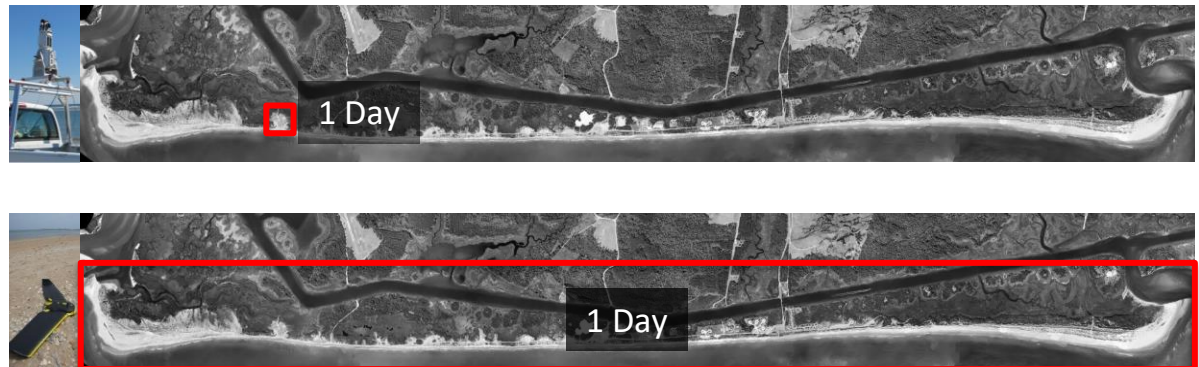
# Natural resource applications

- Safety of personnel
- Inexpensive when compared to the logistics tied with occupied aircraft or satellite imagery
- Increased efficiency over ground methods
- Increased spatial and temporal resolution
- Accessibility - impact areas, rough terrain, limiting disturbance, etc.

## Benefits of UAS



Onslow Beach,  
MCBCL

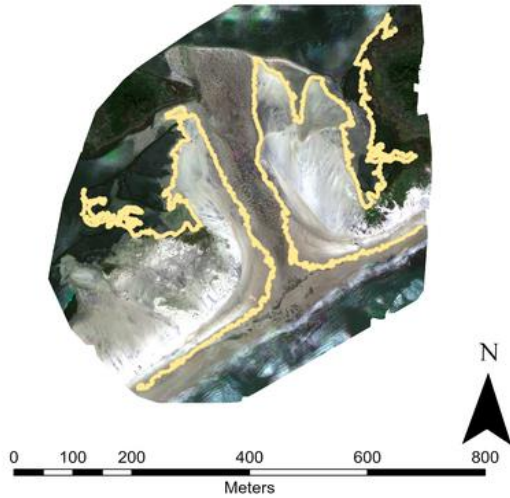


# Natural resource applications

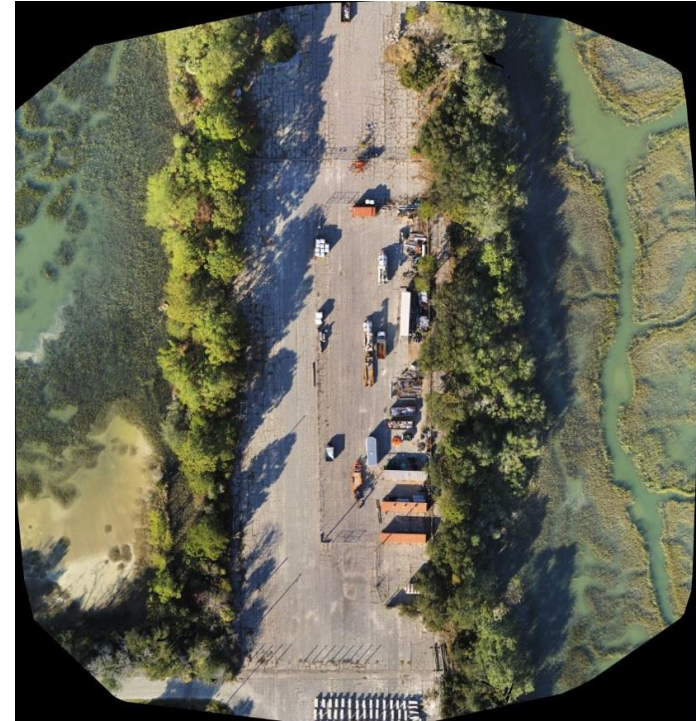
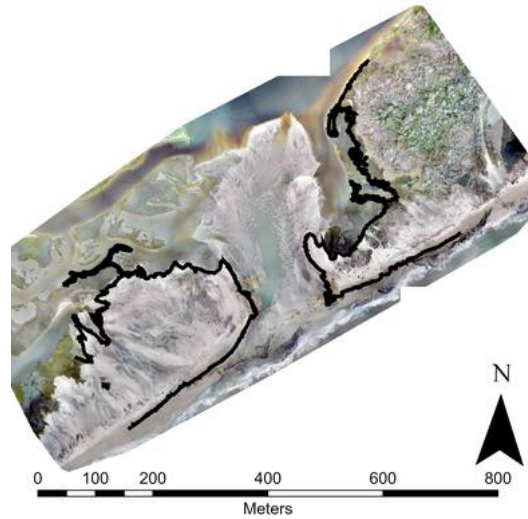
Pre-Hurricane Florence

Post-Hurricane Florence

— 0.5 m Contour



— 0.5 m Contour



Dr. Tony Rodriguez, UNC Institute for Marine Science  
Onslow Beach, MCB Camp Lejeune

Infrastructure (training areas, facilities), ecosystem benefits,  
and T&E threatened by sea level rise and extreme events



**Natural resource applications**

# Natural resource applications

Penny's Bend at Falls Lake, NC



# Natural resource applications

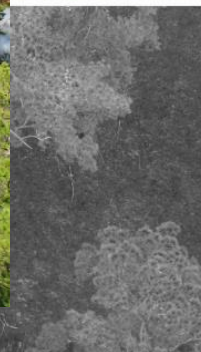


2.7cm/pixel flying at 400 ft.

Falls Lake, NC

## Natural resource applications - Fire

- Assess burn effectiveness by mapping pre and post burn
- Fuel assessment
- Provide assistance to burn boss in tracking progress of prescribed fire
- Wildland firefighter tracking
- Hotspot detection
- Infrastructure checks





# Natural resource applications?

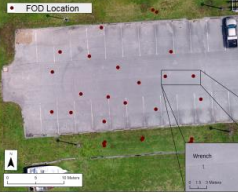
## FOD/Runway Condition

### Using Drones to Evaluate Airstrip

**Object Identification**

Seventeen common Foreign Object and Debris (FOD) items were distributed throughout a paved surface to simulate debris on an airstrip.

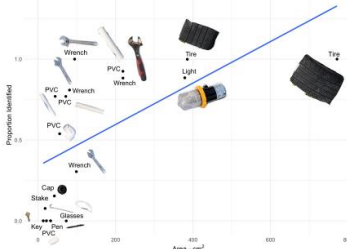
Orthomosaics generated in Pix4D were examined for FOD identification in ArcGIS Pro (v. 2.5.0). Three independent observers examined the study area, progress altitude (and lowest associated ground sampling distance) to low identifying point locations of each FOD object. An example ortho T flight at altitude 50 meters, displays the true locations of the FOD site and shows example objects identified by zooming in.



### Using Drones to Evaluate Airstrip Hazards

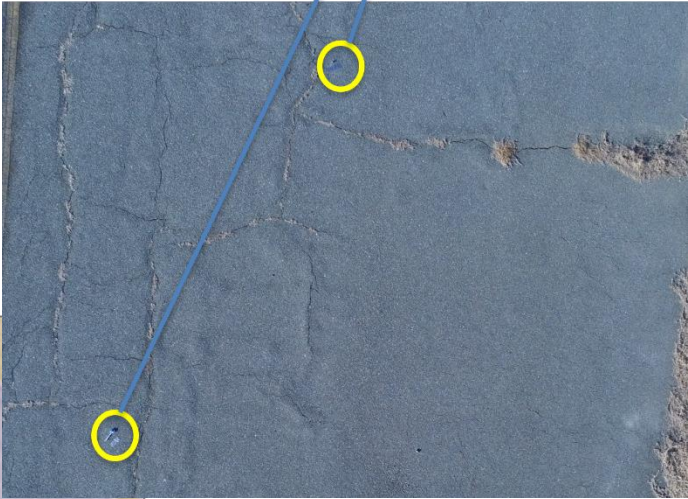
**Size Comparison**

Object surface area was calculated and assessed in relation to detectability. Larger objects were detected often across sensors and altitudes while smaller objects were detected less often. Four of the smallest objects, the key, small PVC piece, pen, and safety glasses, were never identified by observers. On the other hand, the largest objects, including the two tire pieces and the light, were identified 100% and 88% of the time, respectively. FOD with a visible surface area greater than 500cm<sup>2</sup> tended to have high levels of detectability across sensors and altitudes while smaller objects, with visible surface area <200cm<sup>2</sup>, had varied detectability that may be explained by differing shapes, sizes and colors.



REDDI

UNITED STATES MARINE CORPS  
 3715.1B  
 21 OCT 18  
 WING ORDER 3715.1B AND AIR STATION ORDER 3715.1B  
 From: Commanding Officer, Marine Corps Air Station, Cherry Point  
 To: Distribution List  
 Subj: FOREIGN OBJECT DAMAGE (FOD) PREVENTION PROGRAM  
 Ref: (a) ORNAVST 150.68 WCMC  
 (b) Airstrip 3715.1B  
 (c) General, FOD regulations aboard MCAS Cherry Point  
 (d) Airstrip FOD Walk Procedures and Responsibilities  
 (e) Airstrip Prevention Sampling Schedule  
 1. **Purpose:** To emphasize the Marine Corps Air Station (MCAS) Cherry Point mission, safety and with minimal financial impact, MCAS Cherry Point, for include all contractors, vendors, and contractors) and all tenant activities must control the migration of Foreign Object Damage (FOD) - FOD is damage caused by inspection, impact or simple location of objects in aeronautical equipment rendering engine or equipment inoperative or unsafe for operation. FOD is also the term commonly used to describe objects that may cause or have actually caused damage. FOD is the leading cause of premature removal of jet engines in Marine Corps aircraft. FOD causes maintenance costs, requires excessive maintenance man-hours, increases workload, and results in critical shortages of engines. Controlling this costly hazard requires a constant awareness of the problem by all personnel, particularly those involved in aircraft maintenance and operations. All actions occurring on the airfield must always be conducted with FOD mitigation in mind. This order establishes guidelines for the effective management of a FOD prevention program, and a structure for reporting FOD incidents and other  
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United States Department of Transportation

**Federal Aviation Administration**

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AIRCRAFT AIR TRAFFIC AIRPORTS PILOTS & AIRMEN DATA & RESEARCH REGULATION

FAA Foreign Object Debris (FOD) Program  
 FAA Guidance on FOD  
 FOD Resources

**FAA Guidance on FOD**

**FOD-related Advisory Circulars and Part 139 CertAlerts**

The links below point to the current versions of these documents.

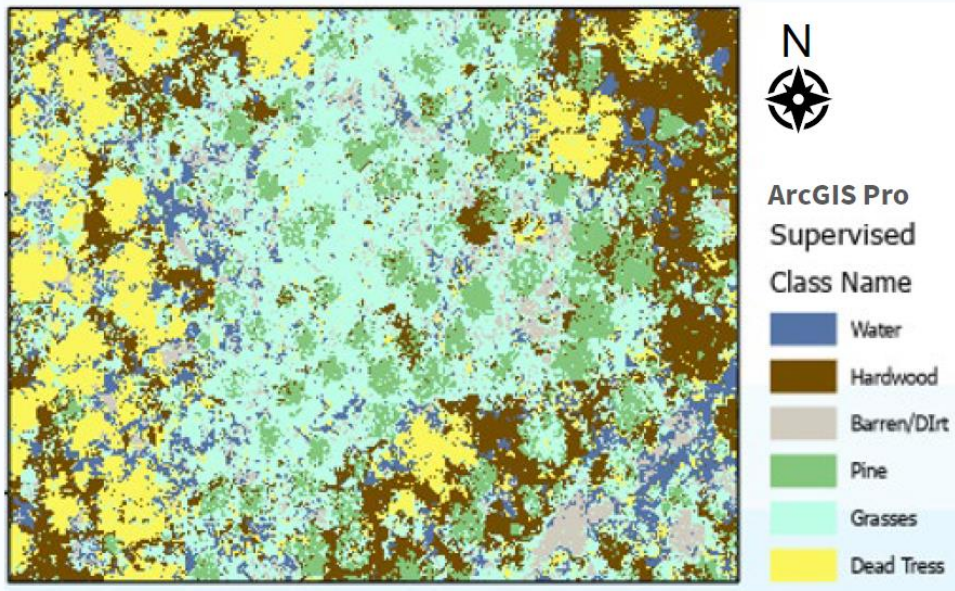
- AC 150/5210-24 Airport Foreign Object Debris (FOD) Management
- AC 150/5220-24 Foreign Object Debris Detection Equipment
- AC 150/5200-18 Airport Safety Self-Inspection
- AC 150/5200-37 Introduction to Safety Management Systems (SMS) for Airport Operators
- AC 150/5380-6 Guidelines and Procedures for Maintenance of Airport Pavements

**Top Tasks**

- View airport program statistics
- Search airport data
- Find an airport AC
- Airport Diagrams and Spots
- Learn about the Air Improvement Program

Marine Corps Outlying Field Atlantic  
 Atlantic, NC

# Natural resource applications



## Machine Learning

### Supervised Classification

- an expedited supervised
- classification via ArcGIS Pro using the RGB imagery for accurate classification of pine trees

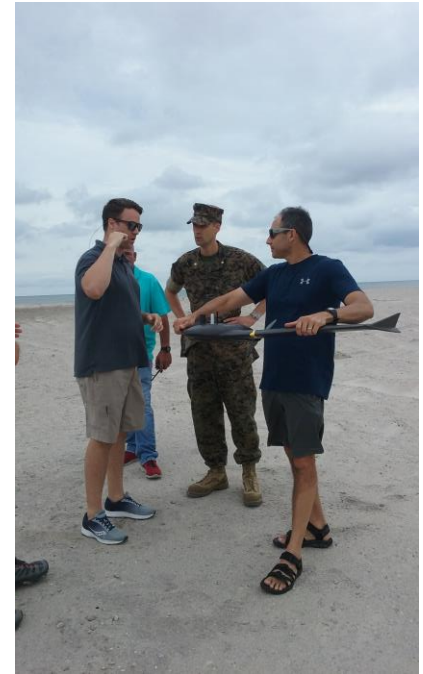
Python machine learning via DeepForest to identify trees (<https://doi.org/10.1111/2041-210X.13472>)

Untrained model using National Ecological Observatory Network

# Opportunities for DoD civilians

## The Basics

1. Become an expert
2. There are **NO** DoD memorandum or orders that prevent federal civilians from flying drones on installations
3. Get to know range control!
4. Two avenues to flying a UAS on an installation
  - BlueUAS
  - Receive cyber waiver for Commercial-off-the-shelf system
5. Cyber waivers do not give permission to fly on installation, it simply starts the process
6. The process to fly varies by service and installation, Installations/Services largely set their own requirements for flying. But the process is discoverable!
7. Allow plenty of time to accomplish one piece at a time.



# Opportunities - DoD Concerns and Mitigations

- Cybersecurity and data leakage is a top concern for all DoD entities
- Contractors do not get to bypass the rules.
- National Defense Authorization Act (NDAA) 2020, Sect 848 “Prohibition on Operation or Procurement of Foreign-Made Unmanned Aircraft Systems”
  - Main components cannot be manufactured in China and other covered countries
  - Batteries and non-computing equipment still allowed to be manufactured in China
  - Approvals required by service waiver board
- Enter “BlueUAS” by Defense Innovation Unit

1. Freefly Alta X
2. Sensefly eBee TAC
3. Skydio X2D
4. FLIR ION M440
5. Parrot Anafi USA GOV
6. Teal Golden Eagle
7. Vantage Robotics Vesper



# Opportunities - Waiver Process

- You can still fly Commercial-Off-The-Shelf drones on installations that are not on the BlueUAS list!
- Naval (Navy & Marine Corps) Waiver Board
  - Guidance for the operations of DON Group 1 and 2 UAS < COMNAVFORINST 3710.9 Nov 17 (Ref: ALNAV074)
  - Interim Flight Clearance (IFC) required for non BlueUAS
  - Flag Officer/SES endorsement required
- Army Board
  - Consolidated DoD – Army COTS UAS Cyber Security Waiver Business Rules ALARACT 039/2020
  - Flag Officer/SES endorsement required



Freefly Atla X

# Opportunities for DoD civilians

## Waiver Process

- Air Force Board
  - MANUAL 11-50229. Flying operations sUAS Air Force Acquisition, Technology and Logistics (SAF/AQ) and AF Deputy, Chief Information Officer (SAF/CN) approval is required
- USACE
  - Engineering Research & Development Center (ERDC) developed “S-UAS Cyber Threat Management – FY21” to address mitigation strategies
- **Common Practices By All**
  - No internet connection
  - No bluetooth
  - Dedicated ground control station (GCS)
  - “Air gap” firmware updates



Downloaded from [Vertava](#)



Inspiration....

