DRONE SYMPOSIUM: DRONE APPLICATIONS IN WILDLIFE AND SPATIAL ECOLOGY

Abstracts and Presentations – Part 1

NOVEMBER 10, 2022

The Wildlife Society Annual Conference
November 6-10, 2022
Spokane, WA

Sponsored by:
TWS Drone Working Group

and

Spatial Ecology & Telemetry Working Group

Organizers: Rick Spaulding, ManTech Advanced Systems International, Bainbridge Island, WA; Chair, TWS Drone Working Group; rick.spaulding@ManTech.com.

Jeff Jenness, Jenness Enterprises, GIS Analysis and Application Design, Flagstaff, AZ; Chair, TWS Spatial Ecology & Telemetry Working Group; jeffj@jennessent.com.

Abstract: Wildlife biologists are relying on an ever-increasing suite of tools to answer questions and solve problems related to wildlife ecology, management, and conservation. The use of unoccupied aerial vehicles, UAVs or drones, has exploded in popularity in ecological studies in general, and in wildlife biology in particular. Drones have many advantages over traditional research techniques. They eliminate safety risks associated with fixed-wing and helicopter surveys, reduce cost and disturbance, increase accuracy, and allow the collection of high-resolution data over large or otherwise inaccessible areas. Some of the major areas of application of drones that have emerged in wildlife ecology include, but are not limited to: (1) population surveys, including breeding colonies and non-breeding aggregations and the use of different types of sensors (e.g.); (2) nest monitoring; (3) radio-tracking surveys; (4) acoustic surveys; (5) wildlife habitat research and monitoring; (6) the use of different drone sensors (e.g., visible, thermal IR, multi- and hyperspectral); and (7) wildlife dispersal, either for nuisance or invasive species or to deter from hazards. This symposium provides highlights of the use of drones in wildlife and spatial ecology and a forum for discussion among both experts and potential users of drones that may result in future research collaborations between wildlife biologists in academic, government, and private sectors.

LIST OF PRESENTATIONS

PART 1

***Introduction to the Drone Working Group and Spatial Ecology & Telemetry Working Group* – Spaulding & Jenness**
***Developing a Drone Program for Wildlife and Habitat in an Academic Setting* – Perotto-Baldivieso et al.**
***Overview of the University of Florida Uncrewed Aircraft Systems Research Program (UFUASRP): Two Decades of Drones for Natural Resource Applications* – Carthy et al.**
***Drones and Computer Vision as a Potential Method for Bird Carcass and Bird Nest Detection at Solar Energy Facilities* – Gerringer et al.**
***Using Drones & AI for Wildlife Surveys: Detecting Avian Carcasses & Desert Tortoises* – M. Bandy**
***UAS as Wildlife Hazing Tools: Considerations for Reducing Negative Human-Wildlife Interactions* – Pfeiffer & Blackwell**
***Using Drones to Detect and Quantify Wild Pig Damage and Yield Loss in Corn Fields Throughout Multiple Growth Stages* – Friesenhahn* et al.**

PART 2
Spraying Drones: Efficacy of Applying an Avian Repellent to Elicit Blackbird Flock Dispersion in Commercial Sunflower Fields – Duttenhefner* et al.
Benefits and Limitations of Using an Uncrewed Aerial Vehicle to Survey Large Mammals in Forest Fragments – Magee* et al.
Evaluation of UAS Surveys for Ungulates in South Texas Rangelands – Foley et al.
White-tailed Deer Surveys with Thermal Drones and Distance Sampling – Massey* et al.
Controllable Factors Affecting Accuracy of Human Identification of Birds in Images Obtained during UAS Surveys – Jones et al.
AI for Detection and Classification of Wildlife from sUAS Imagery – Boopalan et al.
A Systematic Map of Utilizing Small Unoccupied/Uncrewed Aircraft Systems (UAS) to Monitor Wildlife – Elmore et al.
Measuring Bat Occupancy and Abundance Using Drone-based Line Transect Surveys – Bishop-Boros et al.
PART 3
Guidelines to Sampling Aerial Canopy Arthropods with UAVs – Madden et al.
Small Uncrewed Aircraft Systems and Artificial Intelligence: A New Approach for Monitoring Waterfowl Response to Wetland Restoration – Loken* & Ringelman
Drones, Structure from Motion, and the Digital Twin: Lessons Learned Trying to Model Spring Habitats – Jenness et al.
Using 3D Photogrammetry to Measure Vegetation Recovery and Gopher Tortoise (Gopherus polyphemus) Response to Re-Introduction on Reclaimed Mine Lands – Hancock* et al.
Hornets, Bats & Bears: Real-time Drone Radio-telemetry for Wildlife and Invasive Species Managers – D. Saunders
Re-Inventing VHF Tracking: How to Avoid the Pitfalls of Aerial Wildlife Monitoring – C. Muller*
Use of Drones to Advance and Scale Invasive Species Eradications on Islands – Sullivan et al.

*Student presentation.

(*Note*: presenters in **bold**)

Introduction to the Drone Working Group and Spatial Ecology & Telemetry Working Group

Rick Spaulding[1] and **Jeff Jenness**[2]
[1]Chair, Drone Working Group; ManTech Advanced Systems International, rick.spaulding@mantech.com
[2]Chair, Spatial Ecology & Telemetry Working Group; Springs Stewardship Institute; jeff.jenness@nau.edu

The primary mission of the Drone Working Group (WG) is to provide support and information to those TWS members that use small unoccupied aircraft systems (sUAS), more commonly called drones, in natural resources/wildlife research and management and to see the use of this technology in our profession move forward professionally, ethically, and legally. The Drone WG works to increase awareness of drones for conducting wildlife management and survey activities and to promote their safe and ethical use by users in universities, federal and state governments, and the private sector, including non-governmental organizations. We provide networking and communication opportunities for wildlife professionals working with drones in wildlife management, research, and education and any other facet of drone use that would benefit from discussion and transfer of information between like-minded users.

The Spatial Ecology and Telemetry WG promotes the use of spatial technologies and analytical approaches when managing and studying wildlife and their habitats. Our members are interested in GIS, Remote Sensing, Telemetry and Spatial Ecology. Our focus is on the spatial aspects of wildlife species behavior, habitat requirements and interactions with other species. We do this by promoting symposia and workshops such as this one, and by supporting travel costs for students and early-career individuals who are working in this field. We also publish a newsletter that focuses on spatially-oriented research, and we honor people who have provided some spatial function, tool or service that has significantly enhanced the field of wildlife conservation and management.

DRONE SYMPOSIUM

DRONE APPLICATIONS IN WILDLIFE AND SPATIAL ECOLOGY

TWS Annual Conference, Spokane, WA

November 10, 2022

Sponsored by the

Drone Working Group

and

Spatial Ecology and Telemetry Working Group

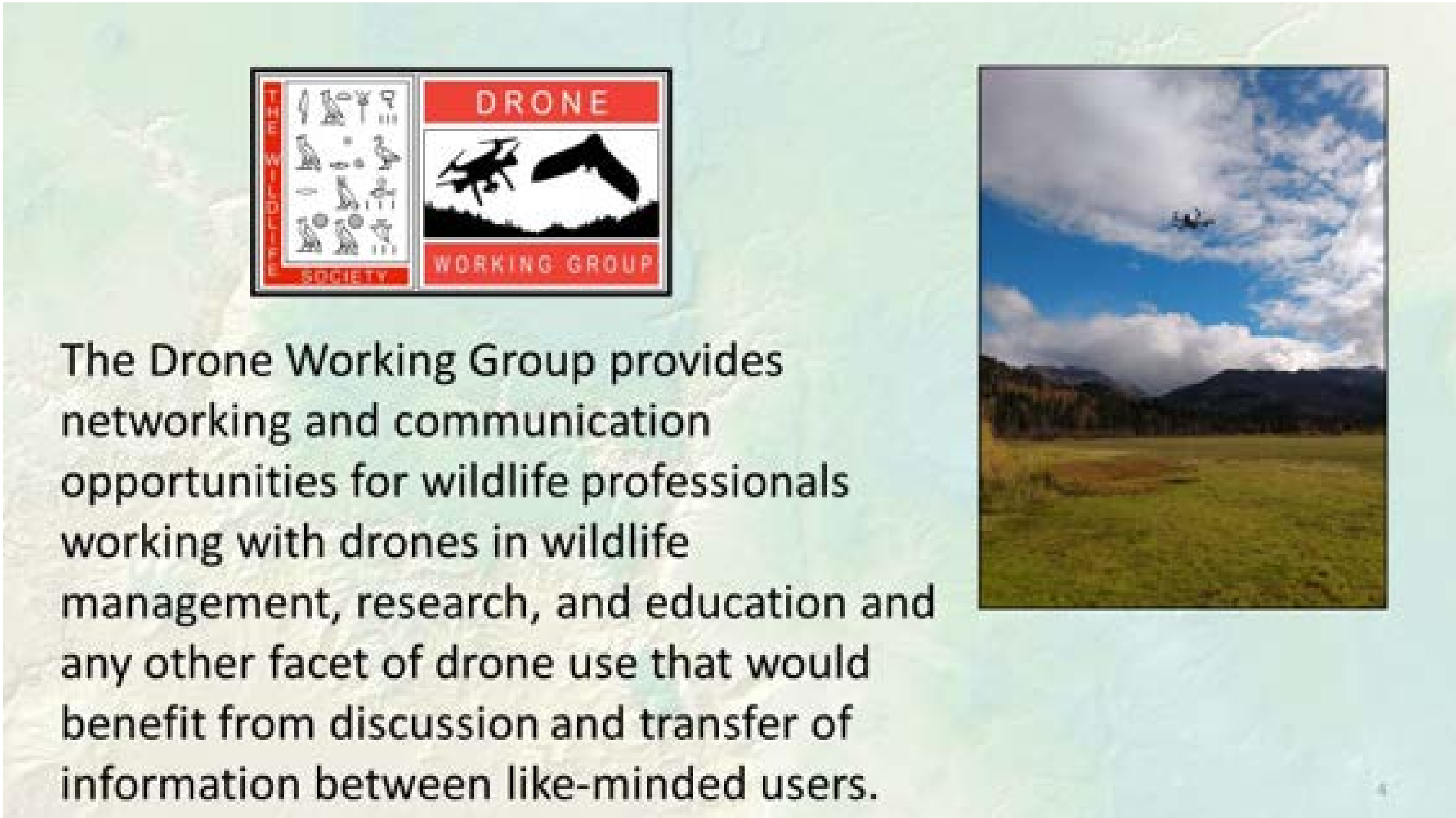
Rick Spaulding, Chair

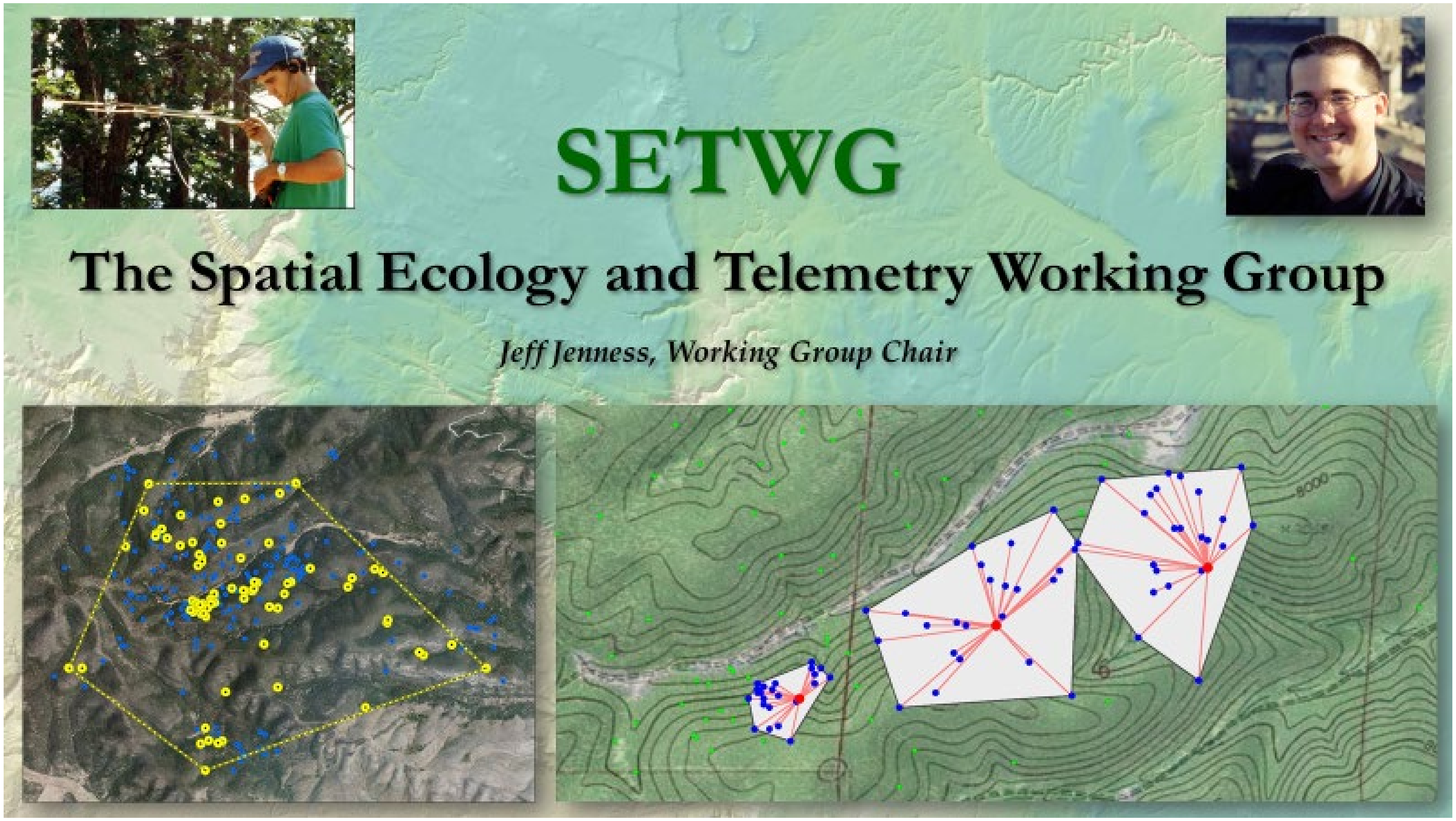
The primary mission of the Drone Working Group is to provide support, guidance, and education to wildlife professionals regarding the safe, ethical, legal, and professional use of small unoccupied aircraft systems (sUAS), also known as drones, as they pertain to wildlife research, management, and conservation.

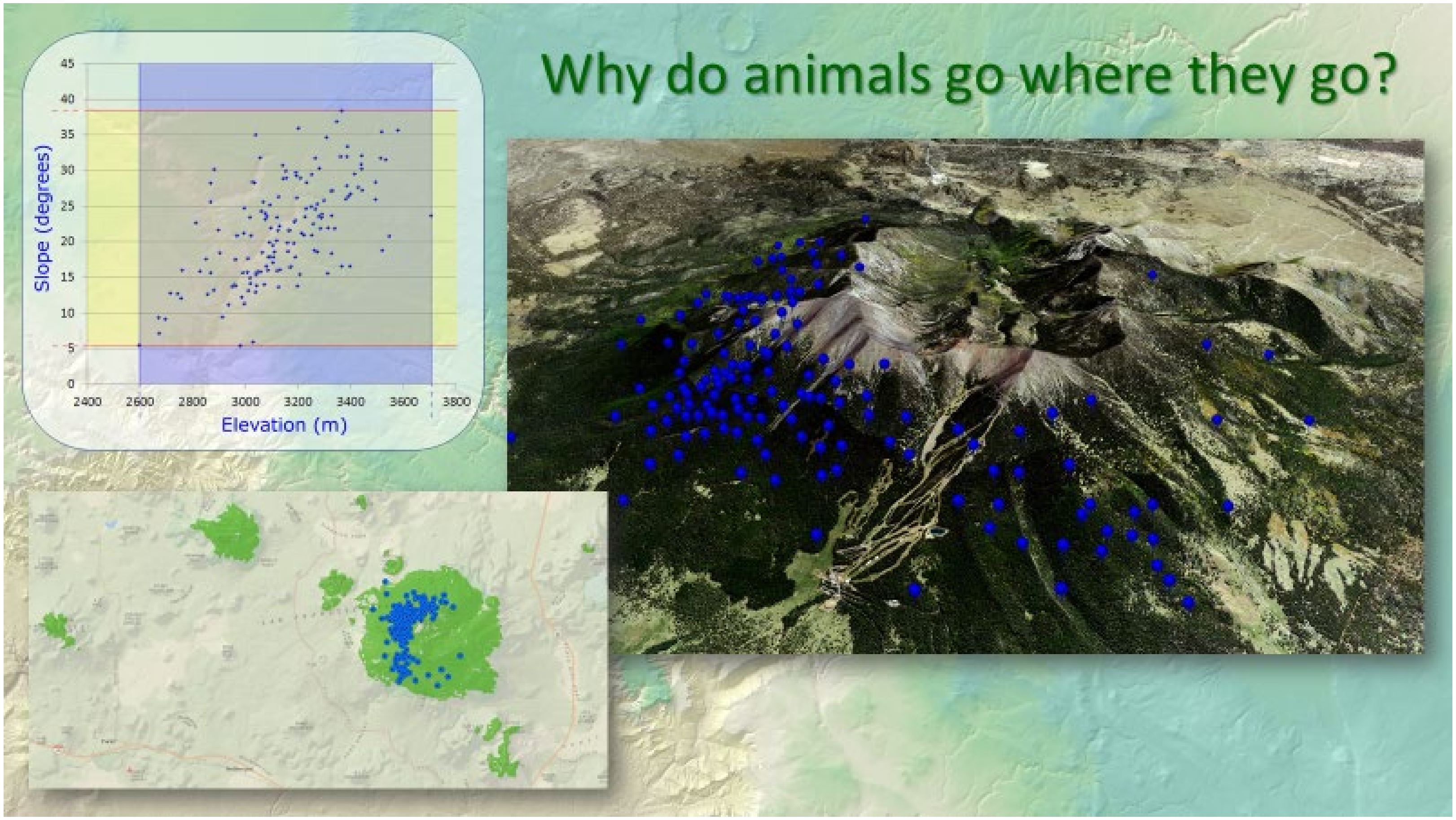
2

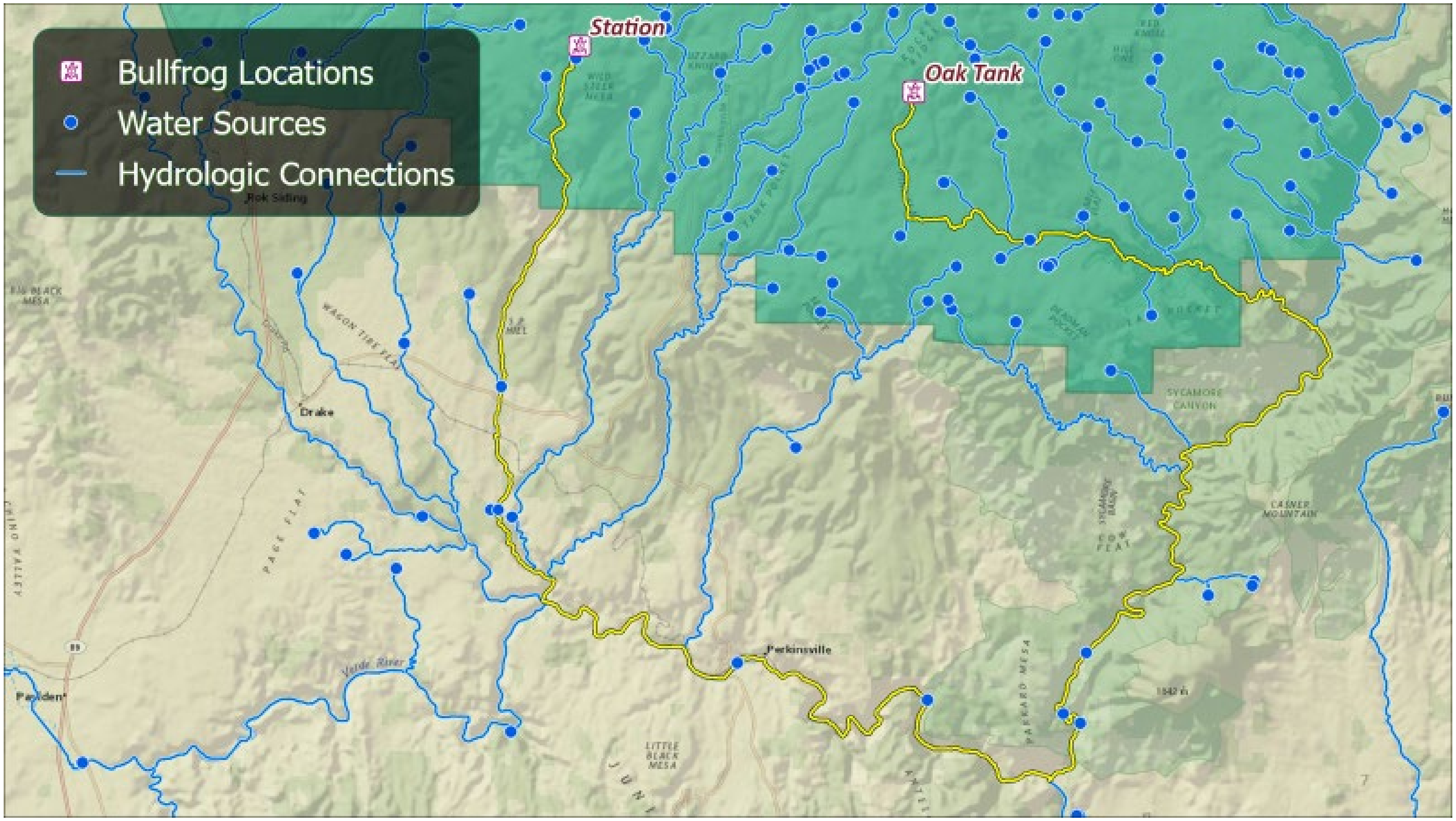
The Drone Working Group works to increase awareness of drones for conducting wildlife management and survey activities and to promote their safe and ethical use by users in universities, federal and state governments, and the private sector, including non-governmental organizations.

3

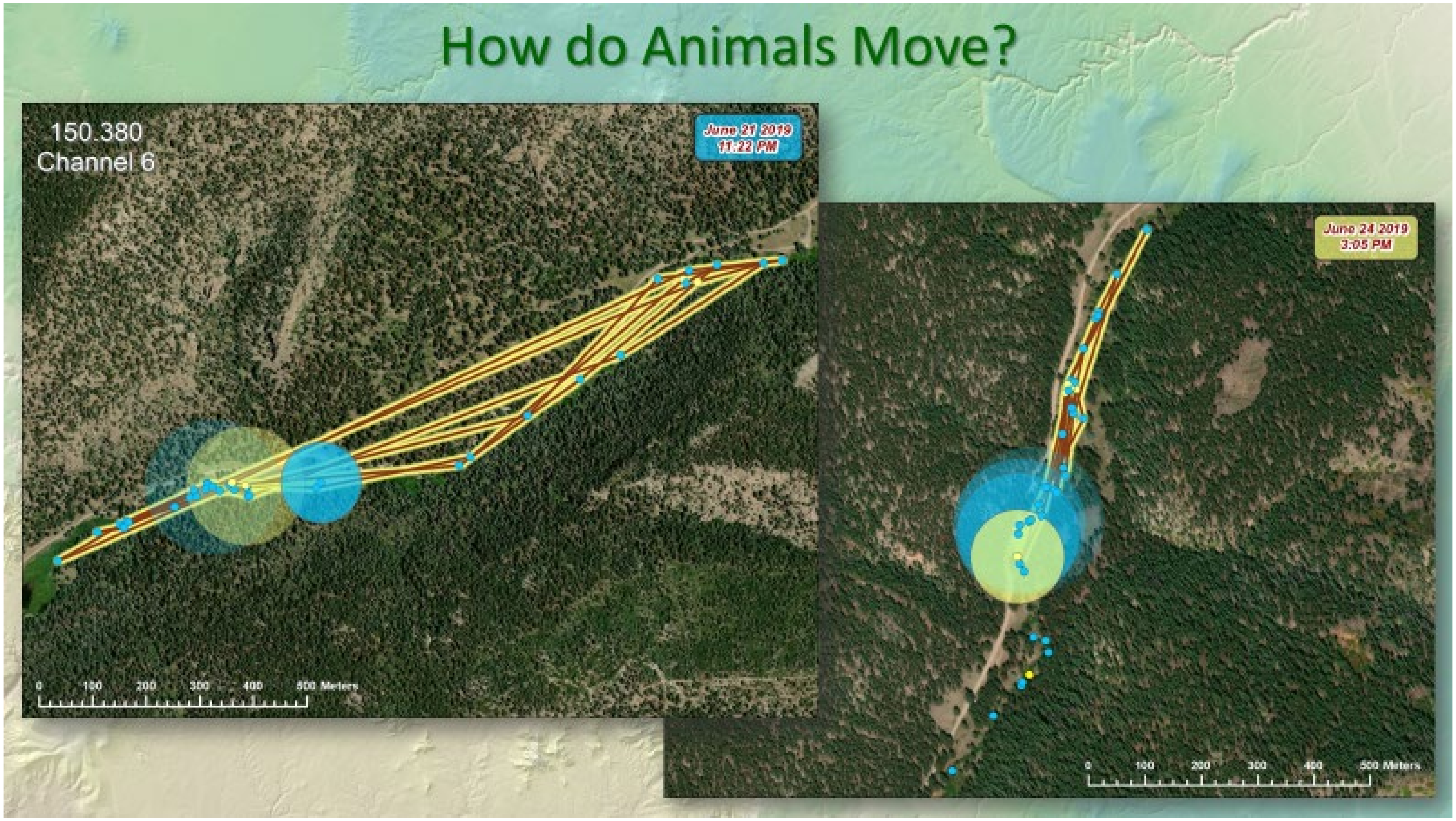

THE WILDLIFE SOCIETY
DRONE
WORKING GROUP
The Drone Working Group provides networking and communication opportunities for wildlife professionals working with drones in wildlife management, research, and education and any other facet of drone use that would benefit from discussion and transfer of information between like-minded users.

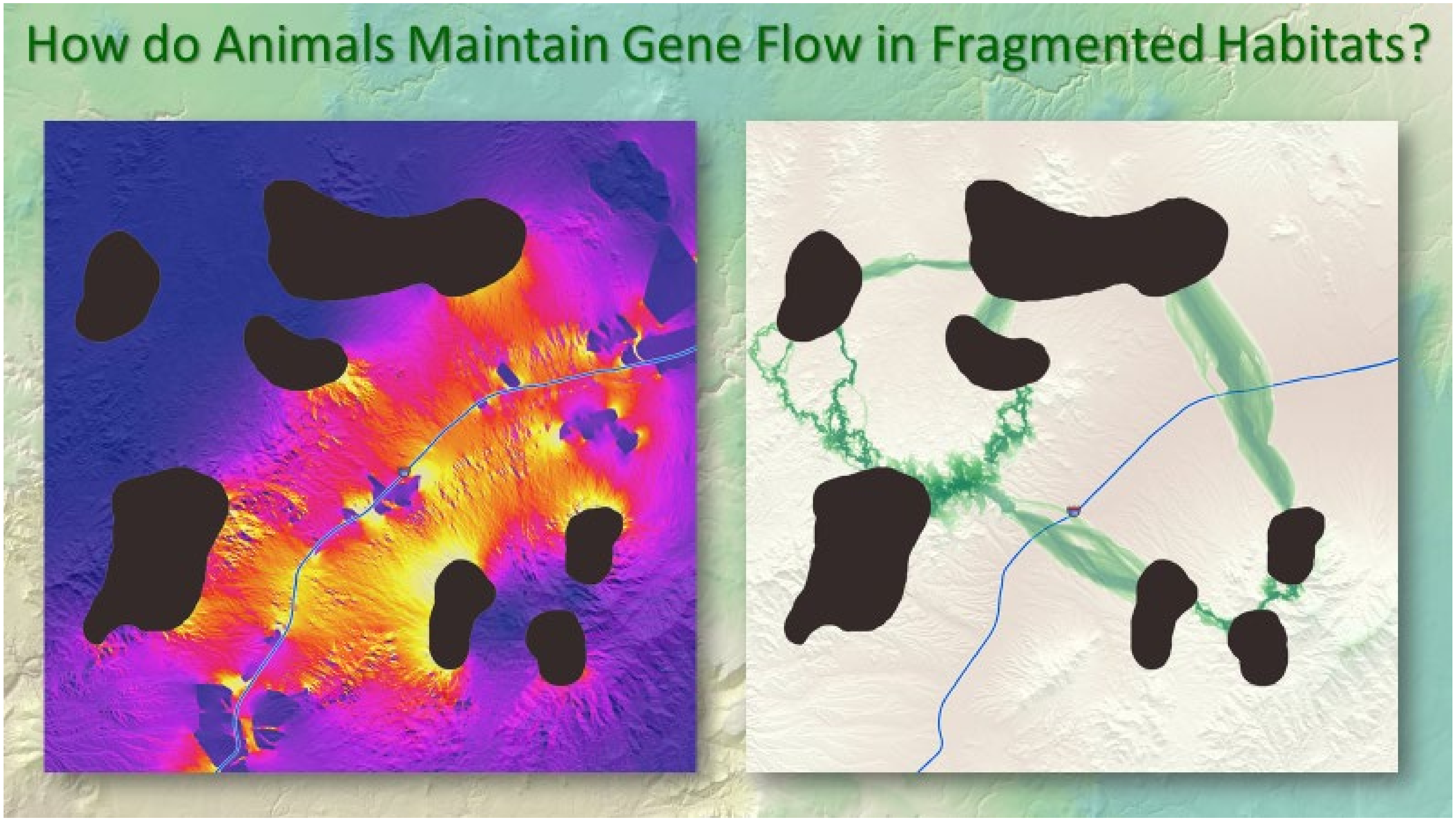

SETWG
The Spatial Ecology and Telemetry Working Group
Jeff Jenness, Working Group Chair

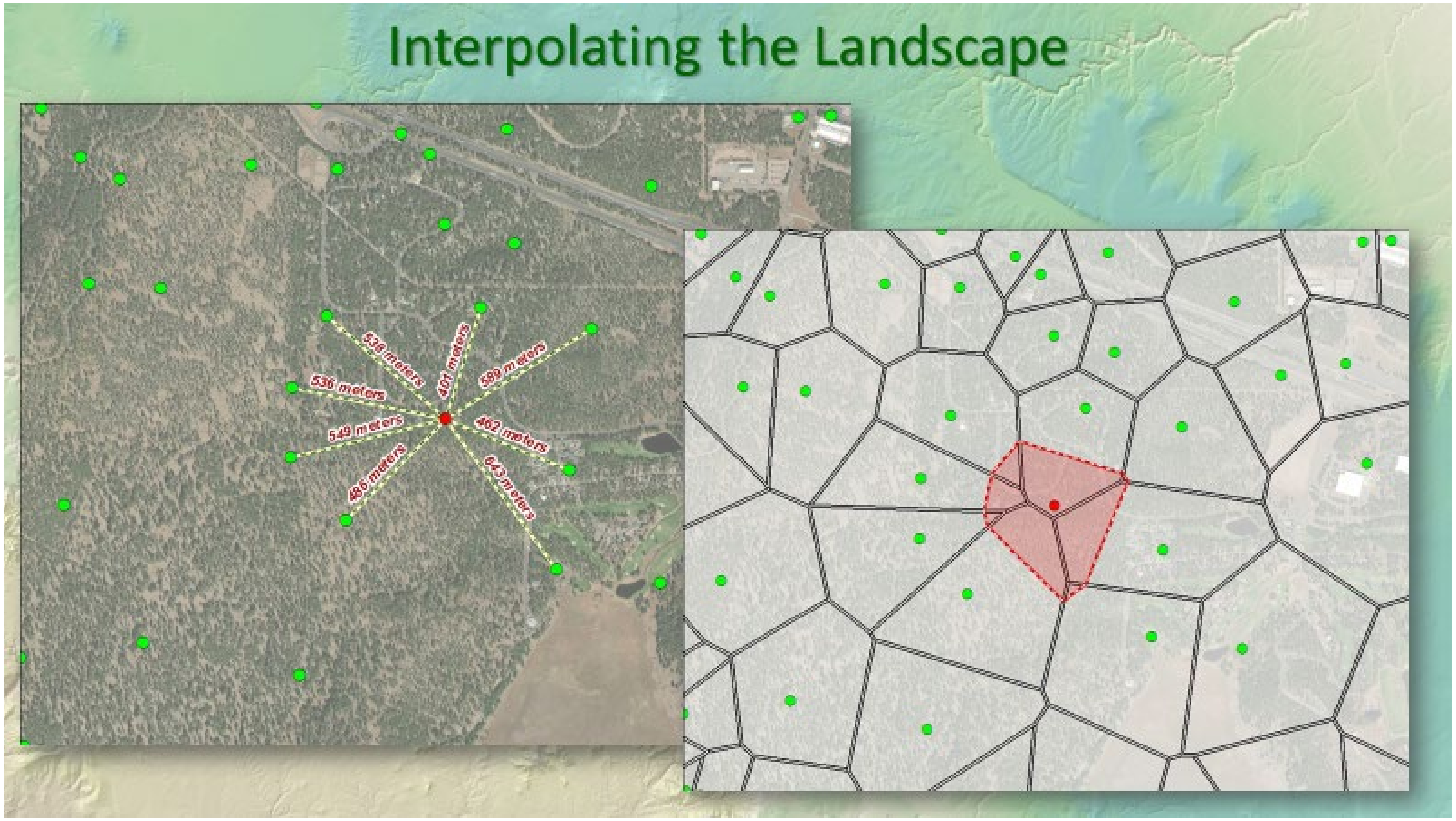

Why do animals go where they go?
Slope (degrees)
Elevation (m)
0
5
10
15
20
25
30
35
40
45
2400
2600
2800
3000
3200
3400
3600
3800

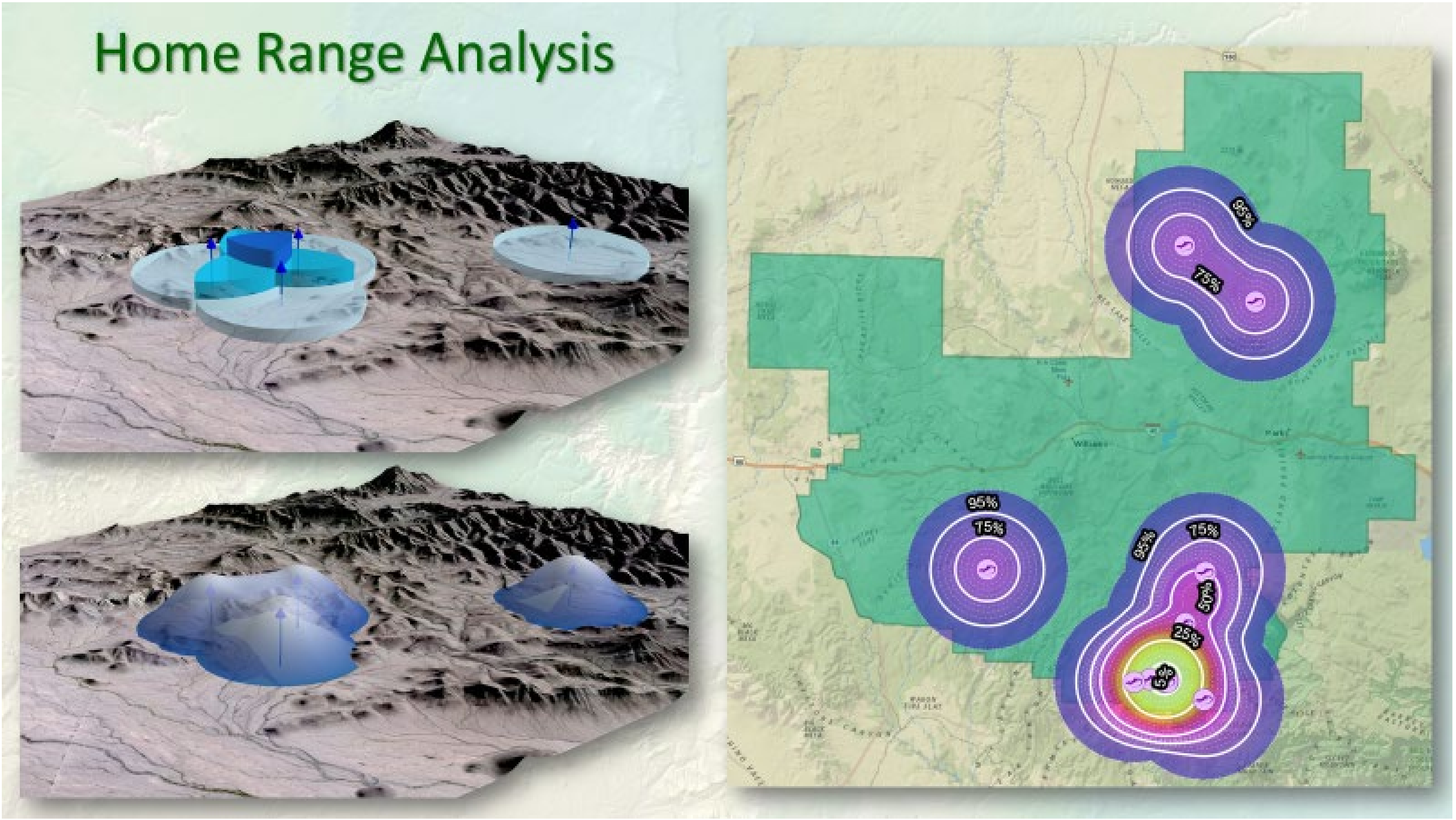


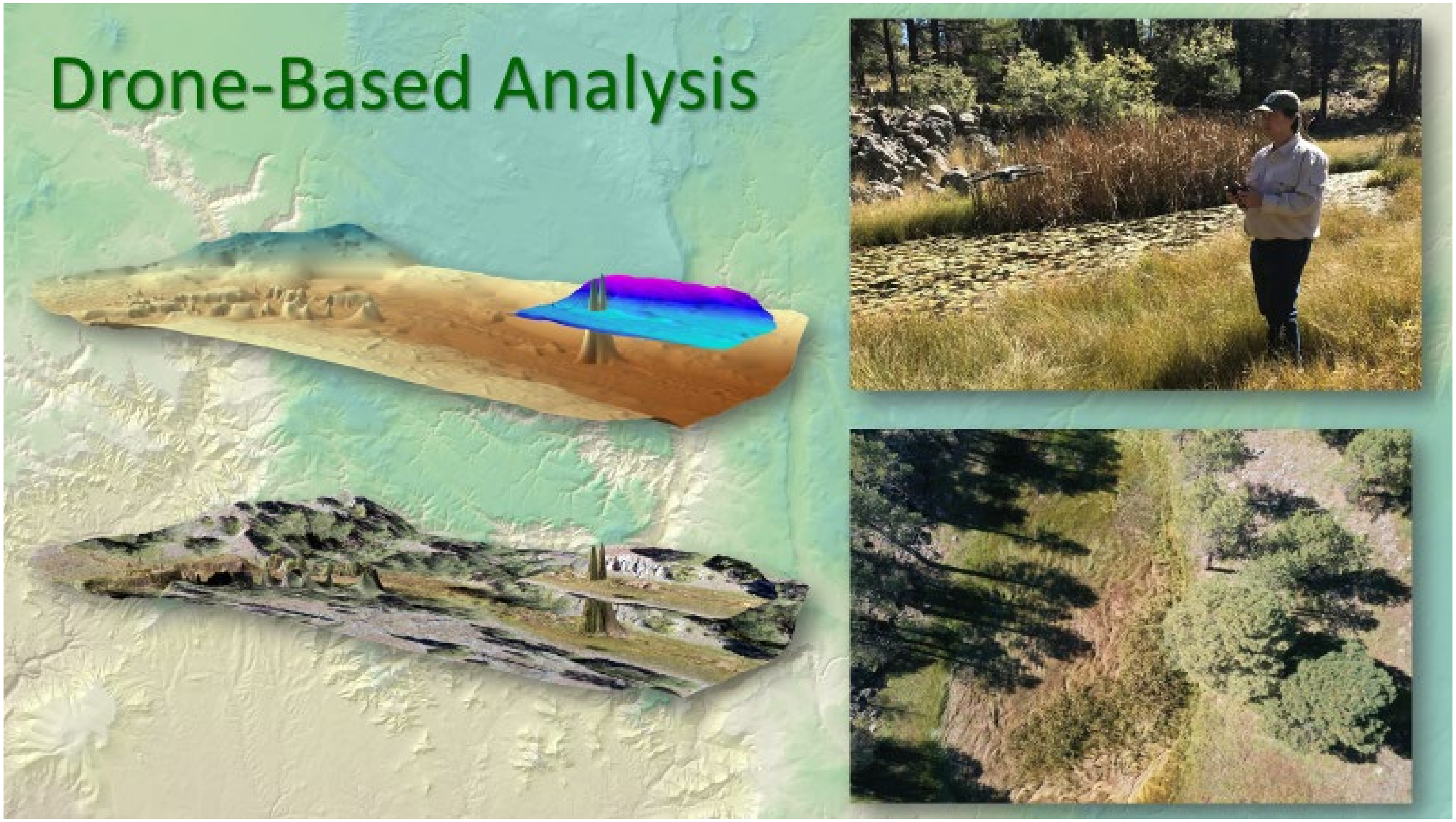
Bullfrog Locations
Water Sources
Hydrologic Connections
Station
Oak Tank
Drake
Perkinsville
Paulden
Verde River
SYCAMORE CANYON
CASNER MOUNTAIN
LITTLE BLACK MESA
PAGE FLAT
WAGON TIRE FLAT

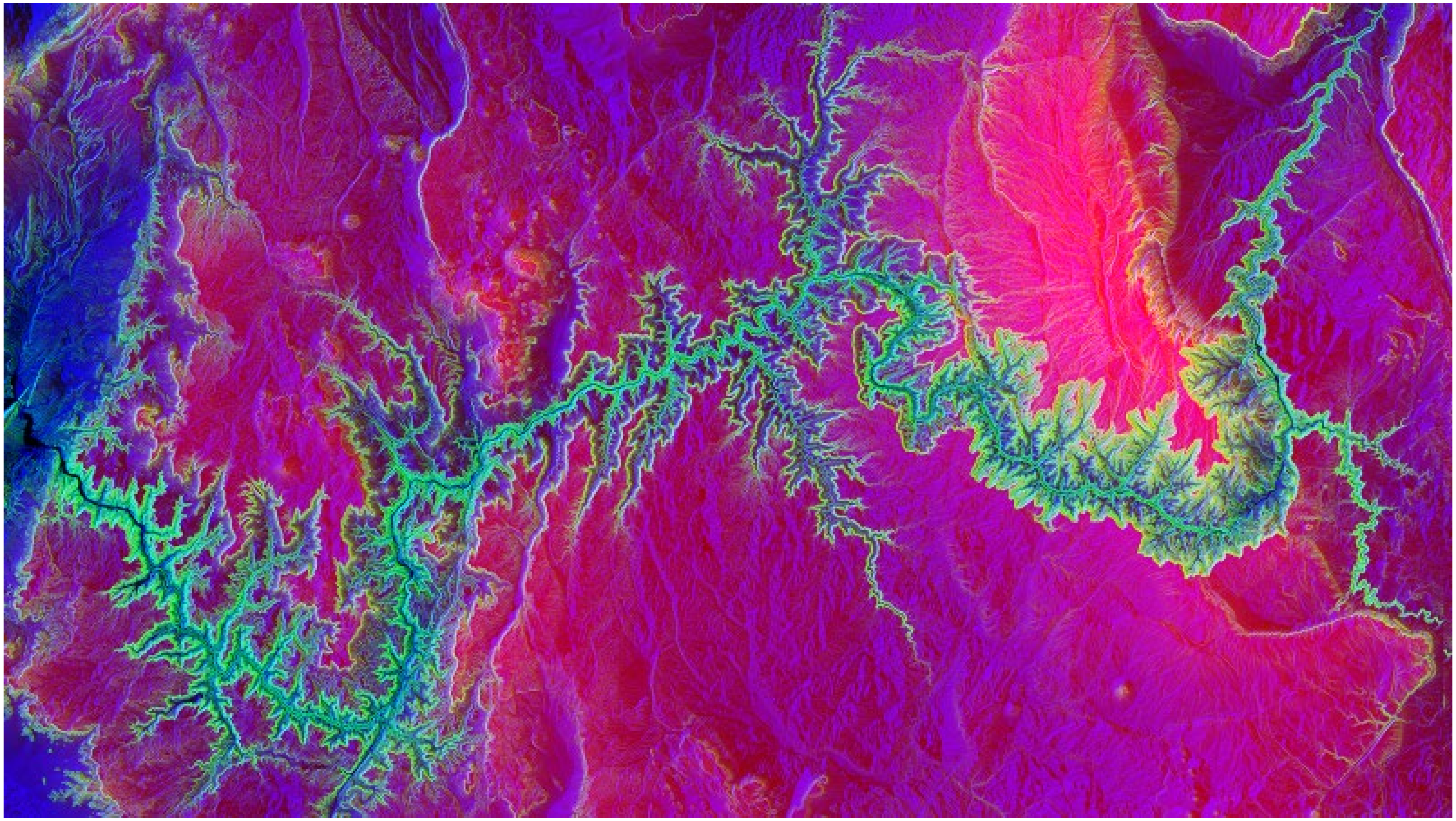

How do Animals Move?
150.380
Channel 6
June 21 2019
11:22 PM
0 100 200 300 400 500 Meters
June 24 2019
3:05 PM
0 100 200 300 400 500 Meters


How do Animals Maintain Gene Flow in Fragmented Habitats?

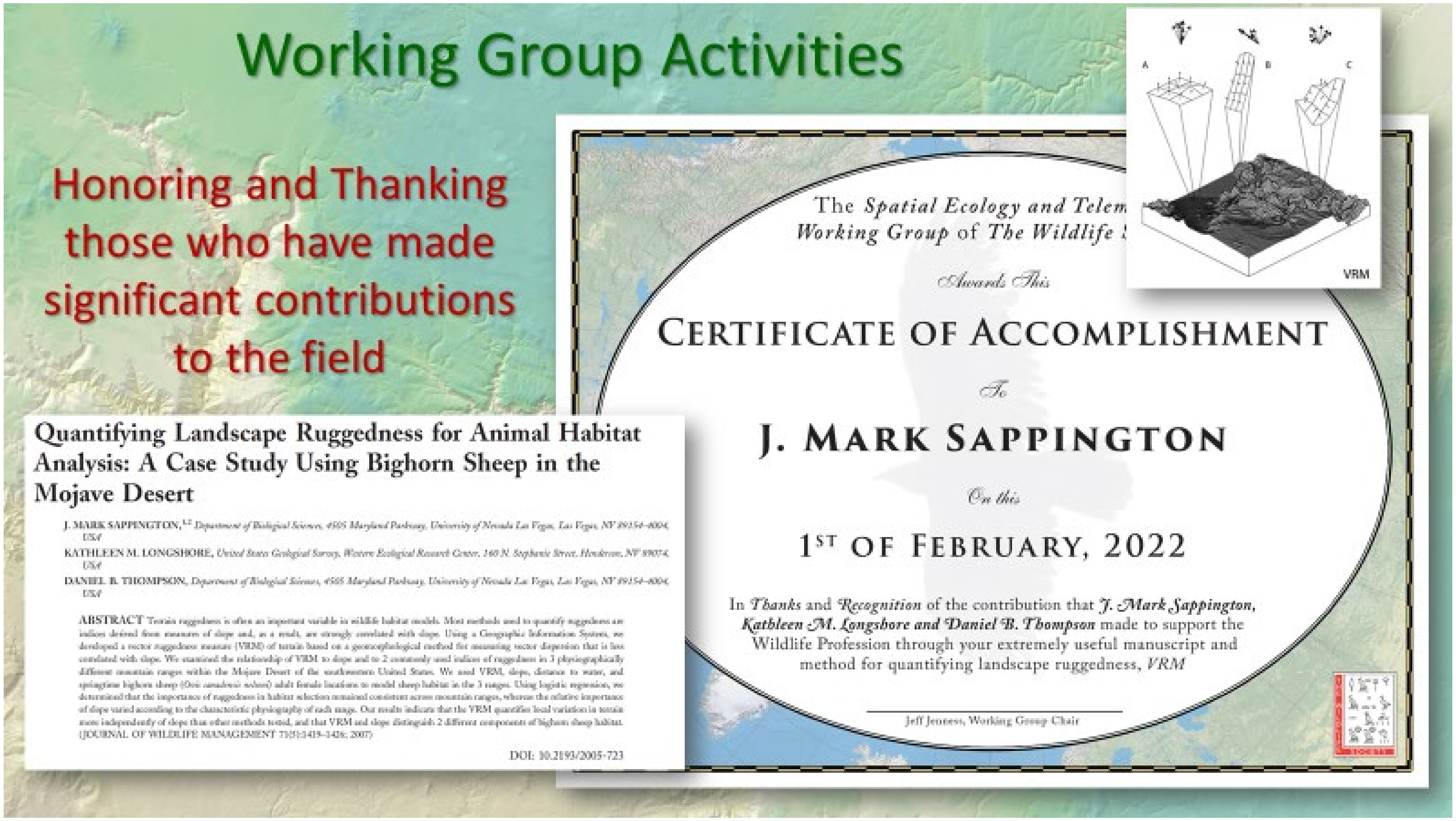

Interpolating the Landscape
538 meters
401 meters
589 meters
536 meters
549 meters
462 meters
486 meters
643 meters

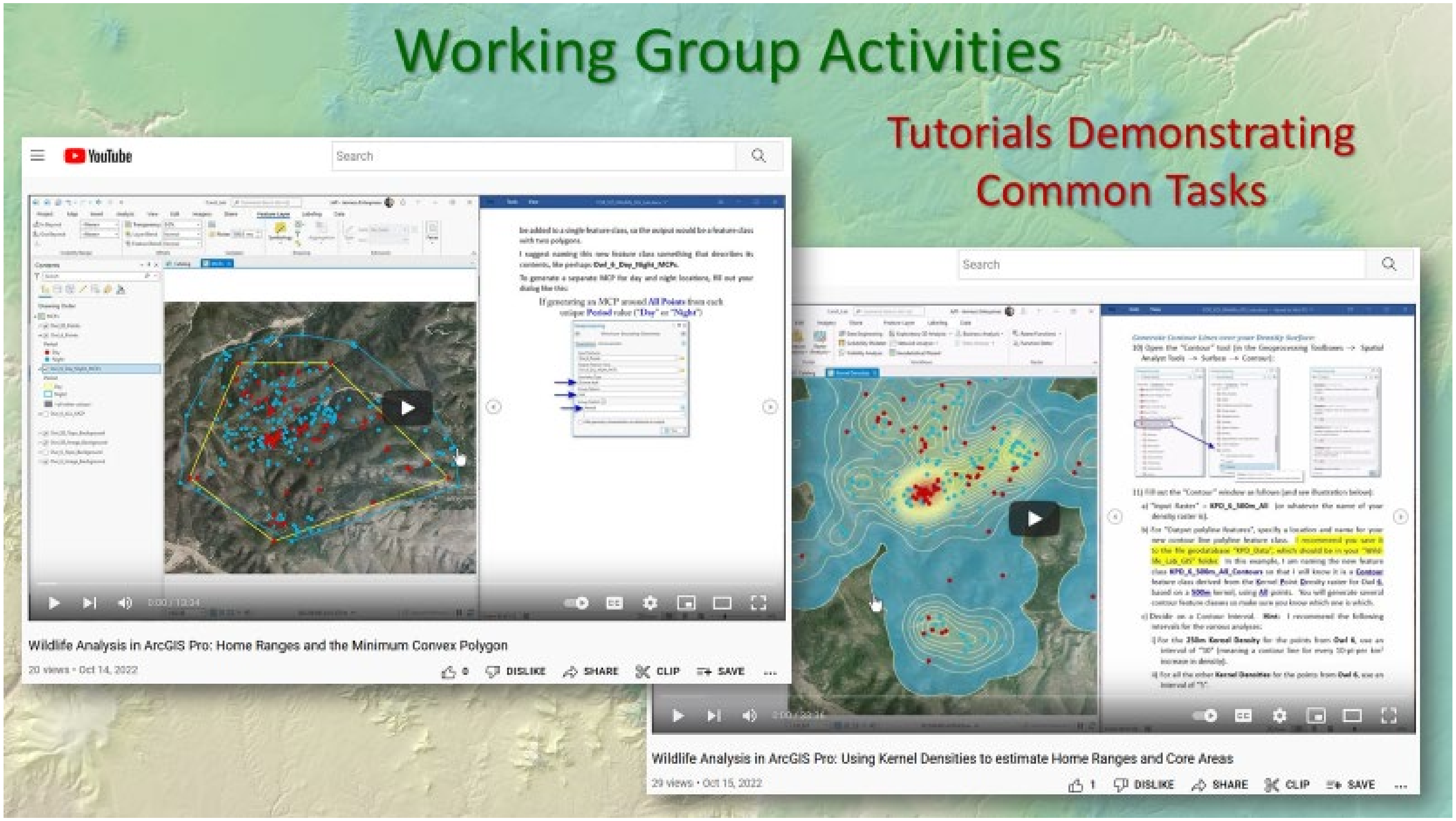

Home Range Analysis
95%
75%
95%
75%
95%
75%
50%
25%
5%


Drone-Based Analysis




Salt Lake City
Las Vegas
Areas with Extirpated Species
3 Species
2 Species
1 Species
Areas with Highly Endemic Species
(Occuring at only 1 or 2 springs)
NatureServe's Conservation Status Ranks of Springsnail Species.
NX: Presumed Extirpated
N1: Critically Imperiled
N2: Imperiled
N3: Vulnerable
N5: Secure
Unclassified
2%
2% 1%
82 Pyrgulopsis Species
74%
11%
9%
16 Tryonia, Fluminicola, Assiminea, Eremopyrgus, Amnicola, Physa, and Juga Species
63%
12%


Working Group Activities
Honoring and Thanking those who have made significant contributions to the field
Quantifying Landscape Ruggedness for Animal Habitat Analysis: A Case Study Using Bighorn Sheep in the Mojave Desert
J. MARK SAPPINGTON
KATHLEEN M. LONGSHORE
DANIEL B. THOMPSON
ABSTRACT
DOI: 10.2193/2005-723
The Spatial Ecology and Telem
Working Group of The Wildlife
Awards This
CERTIFICATE OF ACCOMPLISHMENT
To
J. MARK SAPPINGTON
On this
1ST OF FEBRUARY, 2022
In Thanks and Recognition of the contribution that J. Mark Sappington, Kathleen M. Longshore and Daniel B. Thompson made to support the Wildlife Profession through your extremely useful manuscript and method for quantifying landscape ruggedness, VRM
Jeff Jenness, Working Group Chair
A
B
C
VRM


Working Group Activities
Tutorials Demonstrating Common Tasks
YouTube
Search
Wildlife Analysis in ArcGIS Pro: Home Ranges and the Minimum Convex Polygon
20 views • Oct 14, 2022
0 DISLIKE SHARE CLIP SAVE
Search
Wildlife Analysis in ArcGIS Pro: Using Kernel Densities to estimate Home Ranges and Core Areas
29 views • Oct 15, 2022
1 DISLIKE SHARE CLIP SAVE


Thanks again for attending!
Drone WG
https://wildlife.org/drone
Chair: rick.spaulding@mantech.com
Spatial Ecology & Telemetry WG
https://wildlife.org/setwg
Chair: jeff.jenness@nau.edu

Developing a Drone Program for Wildlife and Habitat in an Academic Setting

Humberto Perotto-Baldivieso[1], Michael T. Page[1], Annalysa M. Camacho[1], Alexandria DiMaggio[1], Rider Combs[1], Brandon Palmer[1], Jacob Dykes[1], Bethany Friesenhahn1, Jesse Exum[1], Zachary Pearson[1], Lori Massey[1], Jose S. Avila[1], J. Alfonso, Ortega-S.[1], Leonard Brennan[1], Randy DeYoung[1], Aaron Foley[1], Dwain Daniels[2], Tony Kimmet[3], Jose de la Luz "Pepe" Martinez[4], Tim Fulbright[1], and David Hewitt[1]
[1]Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Humberto.Perotto@tamuk.edu
[2]Central National Technology Support Center, NRCS
[3]Geospatial Enterprise Operations Branch, USDA
[4]Rangeland Management Specialist, NRCS-Texas

Drones are the fastest growing market in the geospatial industry, and they are changing the way we collect, manage, and analyze wildlife and habitat data. Drone training and drone data analytics will be key for the next generation of wildlife professionals and more broadly for people working in natural resources research and extension. The objective of this presentation is to show the evolution of the drone program at the Caesar Kleberg Wildlife Research Institute and how we are shaping a program that provides research, education, and training opportunities for our students. The program was started in 2017 with 1 drone and 1 pilot. In 2022, the program has acquired 11 drones, has trained 16 pilots, and has completed over 250 missions. The program focuses on developing state-of-the art research and providing hands-on training to our students with a focus on laws and regulations, safety, and data analytics. The projects conducted in the last 5 years include thermal ecology, land cover classification and analysis, forage estimation, white-tailed deer detection, rangeland crude protein estimation, and spectral signature analysis. In 2021, the drone program received a USDA grant award to develop a training program for the next generation of women pilots. This program aims at training students in drone operations, data analytics and offering the professional market with 20 students with a complete set of skills in the next 5 years. In addition, we are training graduate students and strengthening our capabilities as technology develops and new research ideas emerge.

Developing a Drone Program for Wildlife and Habitat in an Academic Setting

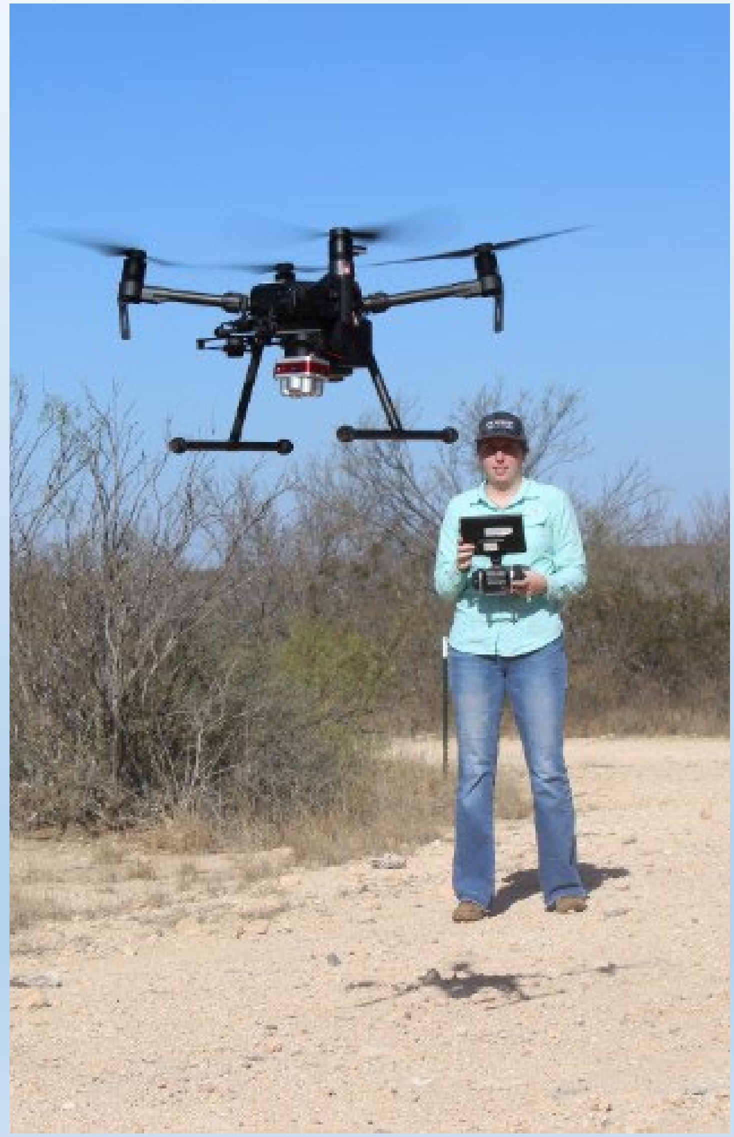
Humberto L. Perotto -Baldivieso[1], Michael T. Page[1], Annalysa M. Camacho[1], Alexandria DiMaggio[1], Rider Combs[1], Brandon Palmer[1], Jacob Dykes[1], Bethany Friesenhahn[1], Jesse Exum[1], Zachary Pearson[1], Lori Massey[1], Jose S. Avila[1], J. Alfonso, Ortega-S. [1], Leonard Brennan[1], Randy DeYoung[1], Aaron Foley[1], Dwain Daniels[2], Tony Kimmet[3], Jose de la Luz "Pepe" Martinez [4], Tim Fulbright[1], David Hewitt[1].

[1] Caesar Kleberg Wildlife Research Institute, Texas A&M University Kingsville
[2] Central National Technology Support Center, NRCS
[3] Geospatial Enterprise Operations Branch, USDA
[4] Rangeland Management Specialist, NRCS -Texas

Humberto L. Perotto -Baldivieso
Associate Professor and Research Scientist
Humberto.Perotto@tamuk.edu
361-593-3977

Why a drone program?

- Drones are the fastest growing market in the geospatial industry.
- Drones have change the way data is collected, managed and displayed.
- Opportunities in every field: oil industry, conservation, real state, insurance, fire, law enforcement, geospatial intelligence, etc.



Why a drone program?

- Key to prepare a new generation of competitive professionals in the market.
- Huge opportunities in natural resources from research to extension.

Drone program at CKWRI

- The drone program is an Institute wide program designed to meet research needs in range and wildlife.

- Our activities include research on:
  - Very high resolutionmapping (1/5 inch)
  - Image classification
  - 3D analysis
  - Wildlife Aerial surveys
  - 2D and 3D Visualization
  - Videography
  - Biomass estimation

3D Mapping

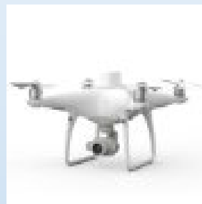
2D Mapping

Projects

- Forage mass estimation.
- Pig damage in crops.
- Vegetation classification (mesquite).
- Aerial wildlife surveys.
- Crude protein.
- Spectral signatures (bunch grasses).
- Spectral signatures (thornscrub communities).
- Quail detection.
- Thermal ecology.
- Pilot trainings (USDA).


Photo by A. Mesa

The drone Program Timeline

2017	2018	2019	2020	2021	2022
Phantom IV	**Phantom IV Pro**	**Phantom IV Pro RTK**	**Matrice 210 V2 (2)**	**Matrice 210 V2RTK**	**Phantom IV Pro (5)**
					
1 Pilot	2 Pilots	3 Pilots	5 Pilots	10 Pilots	15 Pilots (+ 6 pilots in training)
	RGB		Thermal	Multispectral	
			2 publications	1 publication	2 publications + 2 in review
					Drone Wave Program

Key considerations for a successful drone program

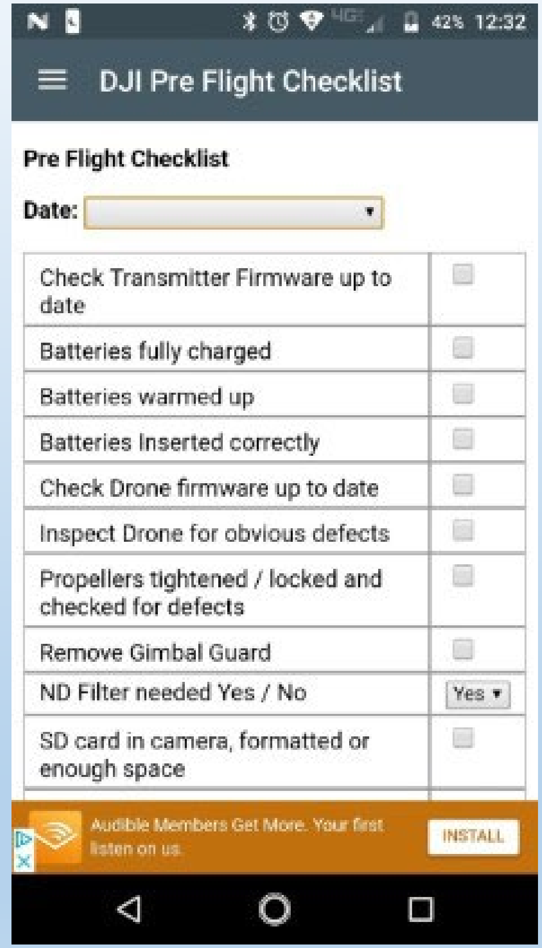
- Team effort.
- Safety
- Understanding of laws and regulations.
- Continuous training for all pilots (software/hardware/regulations).
- Protocol development for drones safety and fleet management.
- Development of a long-term strategy for funding.

Important regulations to follow

- Federal regulations
  - Part 107
  - FAA regulations
  - USFWS regulations
- State regulations
  - Regulations over urban areas
  - Texas Parks and Wildlife Department
- University regulations
  - Drone policies
  - Risk management
  - Insurance
  - Compliance.

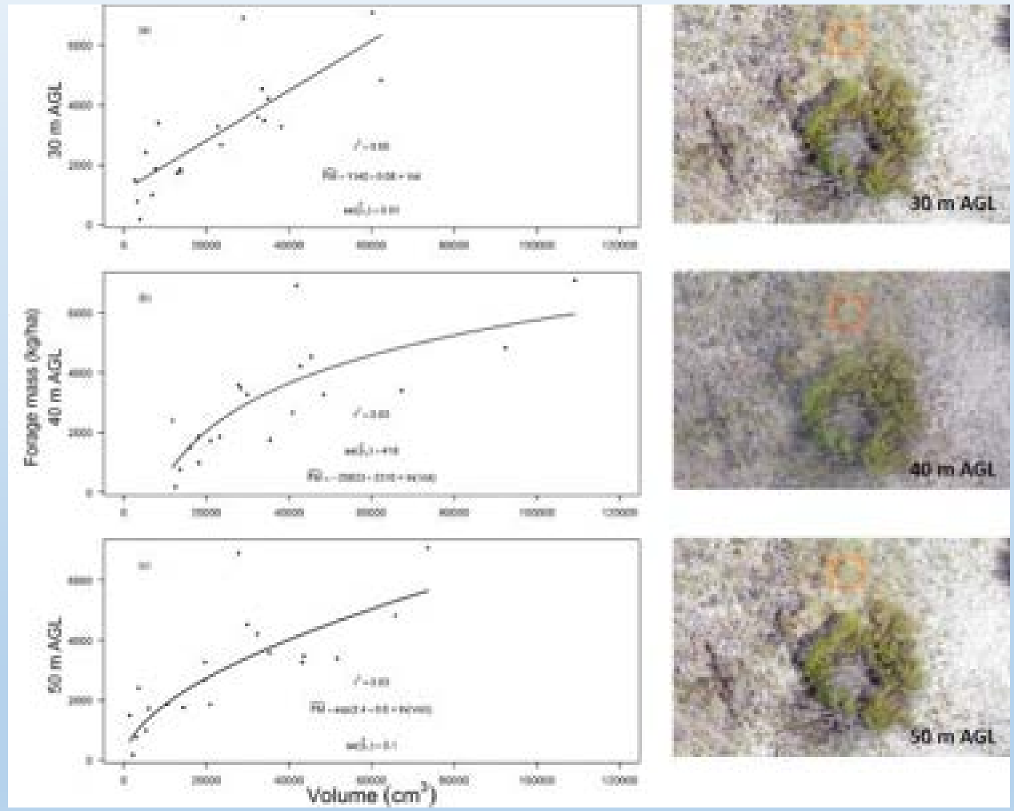
Hardware and software

- Batteries
- Replacement propellers
- Anemometers
- Cones
- Strobes
- Flashlights
- night light systems
- Two-way radio communications



Mission planning

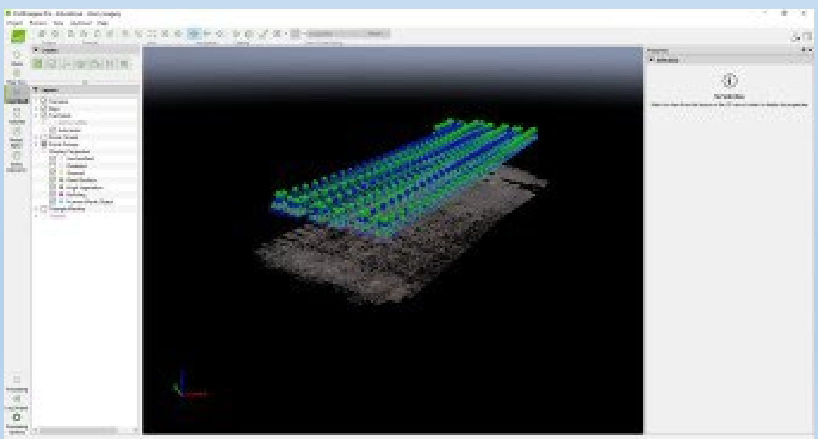
- Flight altitude
- Flight area
- Time of the year
- Ambient temperature
- Topography



DiMaggio et al. 2020

Data storage and processing

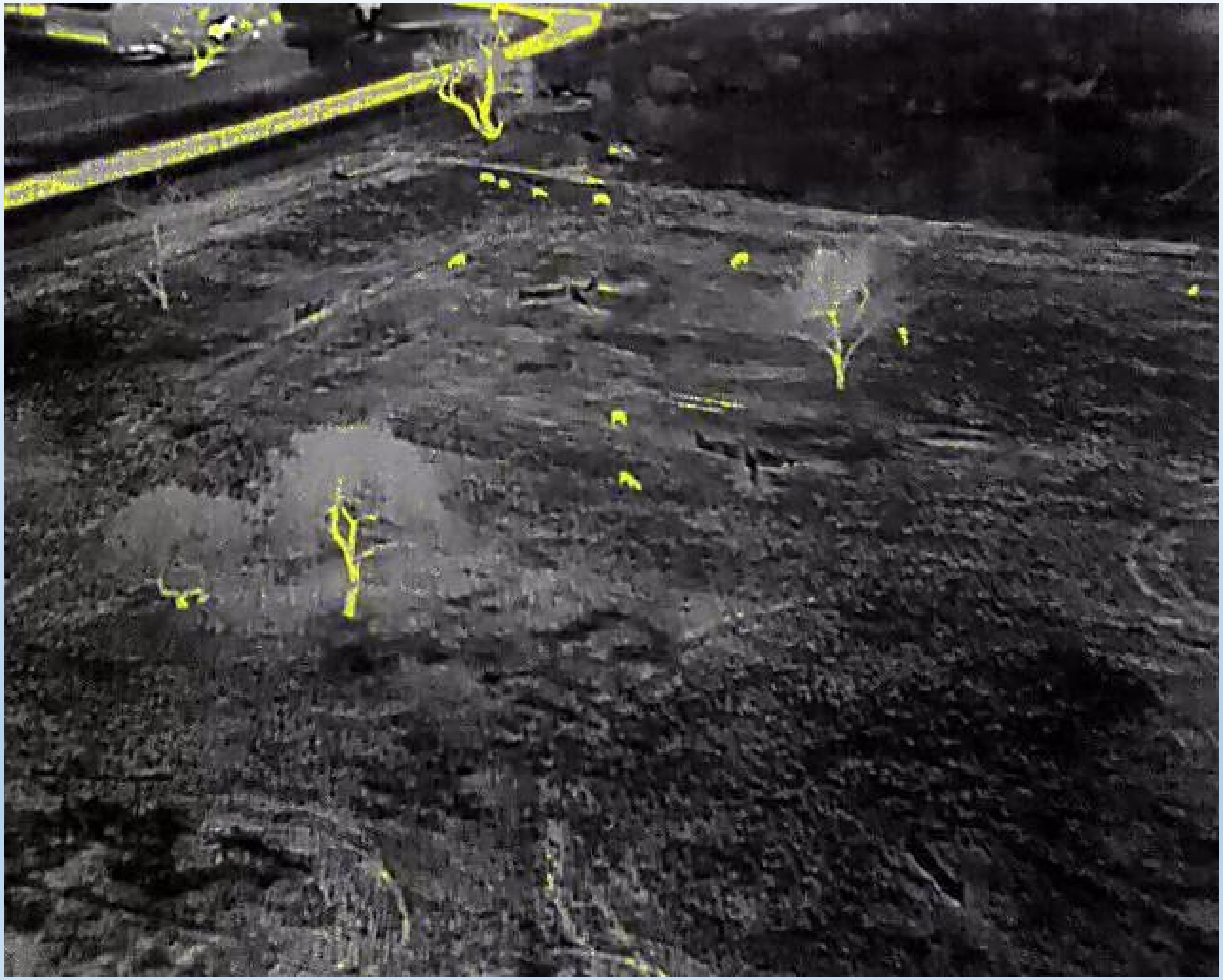
- backups
- Storage infrastructure
- Processing software



Challenges

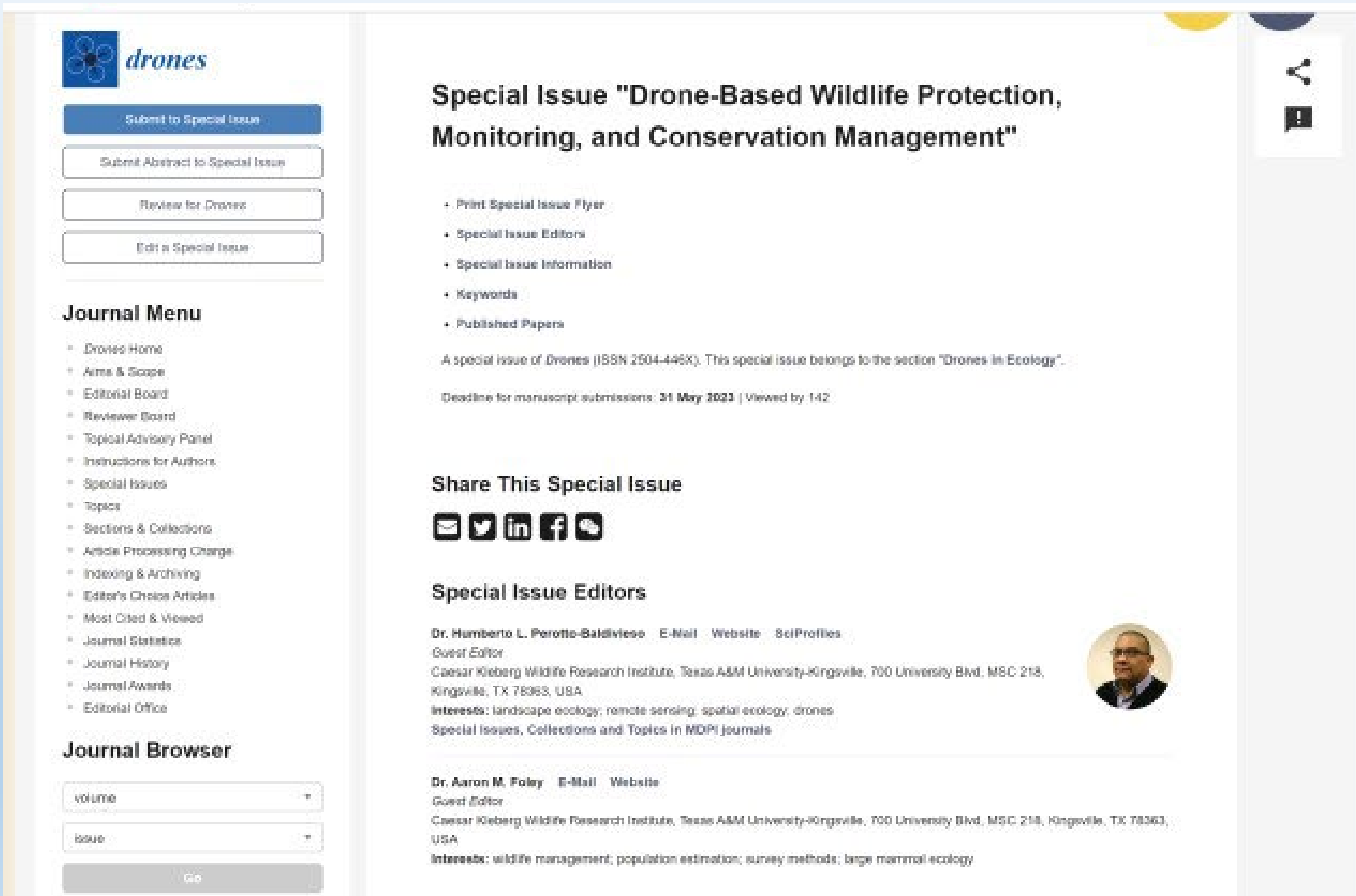
- Backup network infrastructure
- HPC
- Cloud storage

Wildlife surveys



The Drone wave program

Special Issue: Drones and wildlife



drones

Submit to Special Issue

Submit Abstract to Special Issue

Review for Drones

Edit a Special Issue

Journal Menu

- Drones Home
- Aims & Scope
- Editorial Board
- Reviewer Board
- Topical Advisory Panel
- Instructions for Authors
- Special Issues
- Topics
- Sections & Collections
- Article Processing Charge
- Indexing & Archiving
- Editor's Choice Articles
- Most Cited & Viewed
- Journal Statistics
- Journal History
- Journal Awards
- Editorial Office

Journal Browser

volume

issue

Go

Special Issue "Drone-Based Wildlife Protection, Monitoring, and Conservation Management"

- **Print Special Issue Flyer**
- **Special Issue Editors**
- **Special Issue Information**
- **Keywords**
- **Published Papers**

A special issue of *Drones* (ISSN 2504-446X). This special issue belongs to the section "**Drones in Ecology**".

Deadline for manuscript submissions: **31 May 2023** | Viewed by 142

Share This Special Issue

Special Issue Editors

Dr. Humberto L. Perotto-Baldivieso **E-Mail** **Website** **SciProfiles**
Guest Editor
Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, 700 University Blvd, MSC 218, Kingsville, TX 78363, USA
Interests: landscape ecology; remote sensing; spatial ecology; drones
Special Issues, Collections and Topics in MDPI journals

Dr. Aaron M. Foley **E-Mail** **Website**
Guest Editor
Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, 700 University Blvd, MSC 218, Kingsville, TX 78363, USA
Interests: wildlife management; population estimation; survey methods; large mammal ecology

THANK YOU!

Funding for this projects were provided by:

- The Houston Livestock Show and Rodeo
- Dallas Safari Club
- The Harvey Weil Rotary Club of Corpus Christi
- Rene R. Barrientos Educational Assistance Fund for Wildlife Graduate Students
- Texas Alliance for Graduate Education and the Professoriate
- Elizabeth Huth Coates Charitable Foundation of 1992
- King Ranch Inc.
- Ken Leonard Fund for Cattle Wildlife Interactions
- NRCS grant # NR183A750015C017
- National Science Foundation CREST Grant #2019 -38422 -25543
- USDA-APHIS
- South Texas Chapter of the Quail Coalition
- East Foundation
- Vaughan Foundation

We are in deep gratitude to the landowners in Texas and CKWRI partners who graciously granted us access to their properties

CKWRI:
https://www.ckwri.tamuk.edu/

Questions?

Humberto L. Perotto -Baldivieso
Associate Professor and Research Scientist
Humberto.Perotto@tamuk.edu
361-593-3977

Overview of the University of Florida Uncrewed Aircraft Systems Research Program (UFUASRP): Two Decades of Drones for Natural Resource Applications

Ray Carthy[1], Peter Ifju[2], Benjamin Wilkinson[3], Andrew Ortega[2], and Matthew Burgess[4]
[1]USGS, University of Florida, Gainesville, FL; ngosi@ufl.edu
[2]Mechanical and Aerospace Engineering Department, University of Florida, Gainesville, FL
[3]Geomatics, University of Florida, Gainesville, FL
[4]USGS, National UAS Project Office, Geosciences and Environmental Change Science Center, Denver, CO.

In the early 2000s, University of Florida (UF) researchers from the U.S. Geological Survey Florida Cooperative Fish and Wildlife Research Unit, Geomatics, and Mechanical and Aerospace Engineering Department established the Unoccupied Aircraft Systems Research Program (UASRP) with the goal of developing drones to perform aerial surveys for natural resource applications. At the time, autonomous multirotor drones were not readily available, and we developed our own series of fixed-wing, hand-launched vehicles that performed autonomous aerial photogrammetric surveys of wading bird populations, documented the spread of invasive plants, and provided data with higher spatial and temporal resolution than previously available. The diverse expertise of the group allowed us to address natural resource questions using a combination of commercial-off-the-shelf solutions and those engineered to specification, in-house. The team has implemented numerous sensors on drones, such as traditional cameras, multi/hyperspectral imagers, and lidar. Since the early years, the group has expanded our applications and custom platform development to include many unique research vehicles. Recent work with the UF Center for Coastal Solutions has led to the development of hybrid drone platforms to collect water samples for the assessment of harmful algal blooms and red tide. The research team has also developed a unique drone-based bathymetry system that has many advantages over autonomous watercraft. This presentation outlines milestones in the history of the UFUASRP and highlights our latest projects and advances in the field of drone-based natural resource research.


Overview of the University of Florida Uncrewed Aircraft Systems Research Program (UFUASRP): Two Decades of Drones for Natural Resource Applications
Ray Carthy[1], Peter Ifju[2], Benjamin Wilkinson[3], Andrew Ortega[2], and Matthew Burgess[4]
1 USGS, University of Florida, Gainesville, FL; ngosi@ufl.edu
2 Mechanical and Aerospace Engineering Department, University of Florida, Gainesville, FL
3 Geomatics, University of Florida, Gainesville, FL
4 USGS, National UAS Project Office, Geosciences and Environmental Change Science Center, Denver, CO.
USGS
science for a changing world
UF UNIVERSITY of FLORIDA

Brief Overview of the UFUASRP

- In our 20th year of existence
- Natural resource-based applications from the very beginning
- Approach from the natural resource scientist point of view; simplicity of use and budget-friendly
- Truly interdisciplinary research program
- Over last 14 years, interest in sUAS for natural resources has grown exponentially

UF UNIVERSITY of FLORIDA

Unmanned Aircraft Systems Research Program

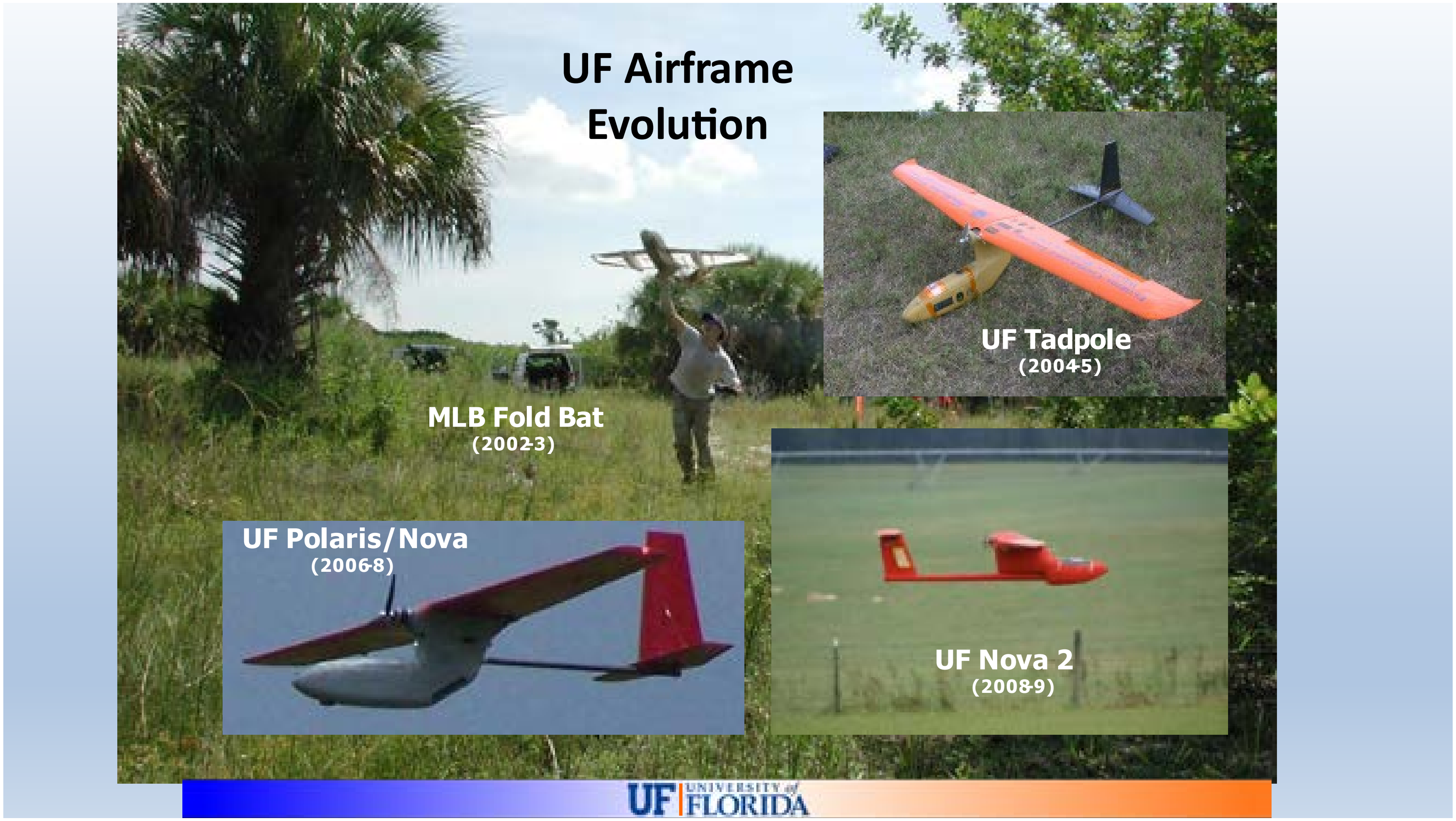
Start With the Question

- What is your *SCIENTIFIC QUESTION*? Define your target.
- What is your desired *END PRODUCT*? Individual images (samples), a mosaic (contiguous map or layer), a video (documentation of behavior), etc.
- What *KINDS OF DATA* do you need to collect to produce your end product? Identify the platforms and sensors that can deliver those data.

ALSO CONSIDER:

- Statistical inference, post-processing, and archiving of data

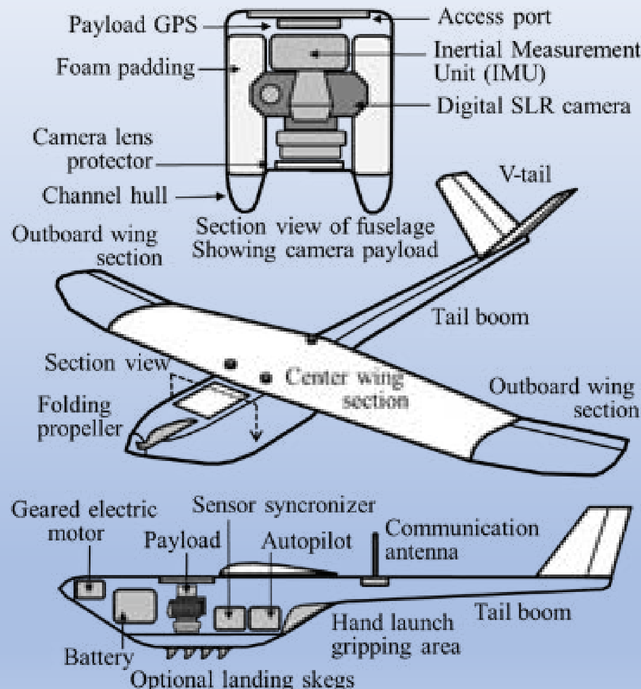

MLB Fold Bat
(2002-3)


UF Airframe Evolution
MLB Fold Bat
(2002-3)
UF Tadpole
(2004-5)
UF Polaris/Nova
(2006-8)
UF Nova 2
(2008-9)
UF UNIVERSITY of FLORIDA

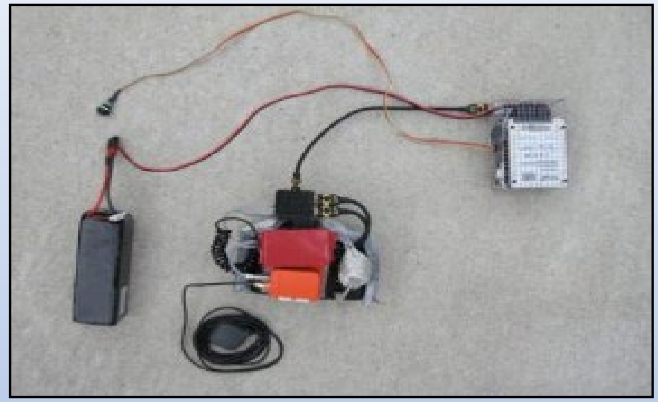
Nova 2.1 sUAS
(2009-2013)

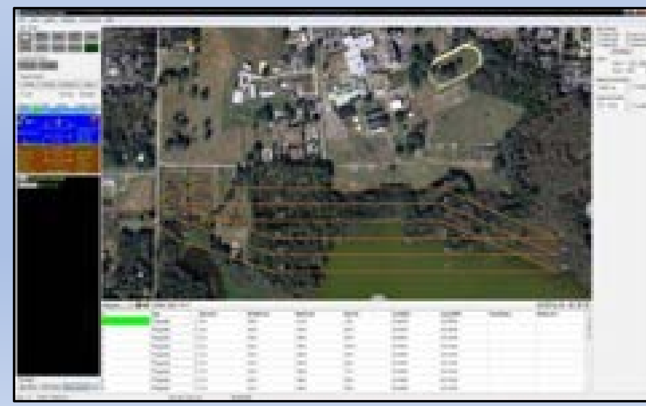
- 9 ft wingspan
- 11 lb AUW
- 1.25 hr duration
- 50 linear miles per flight

Nova 2.1 – Uncrewed Aircraft System



Nova 2.1 – Optical Payload and GCS





Authorizations/Regulations/Approvals

-Certificate of Authorization

-Aircraft Airworthiness

-Local Permission

-Notices to Airmen

-Crew Certifications

-Flight Restrictions

-Failsafe Approvals

-FCC Approvals

-International Traffic in Arms Regulations

» United States Munitions List

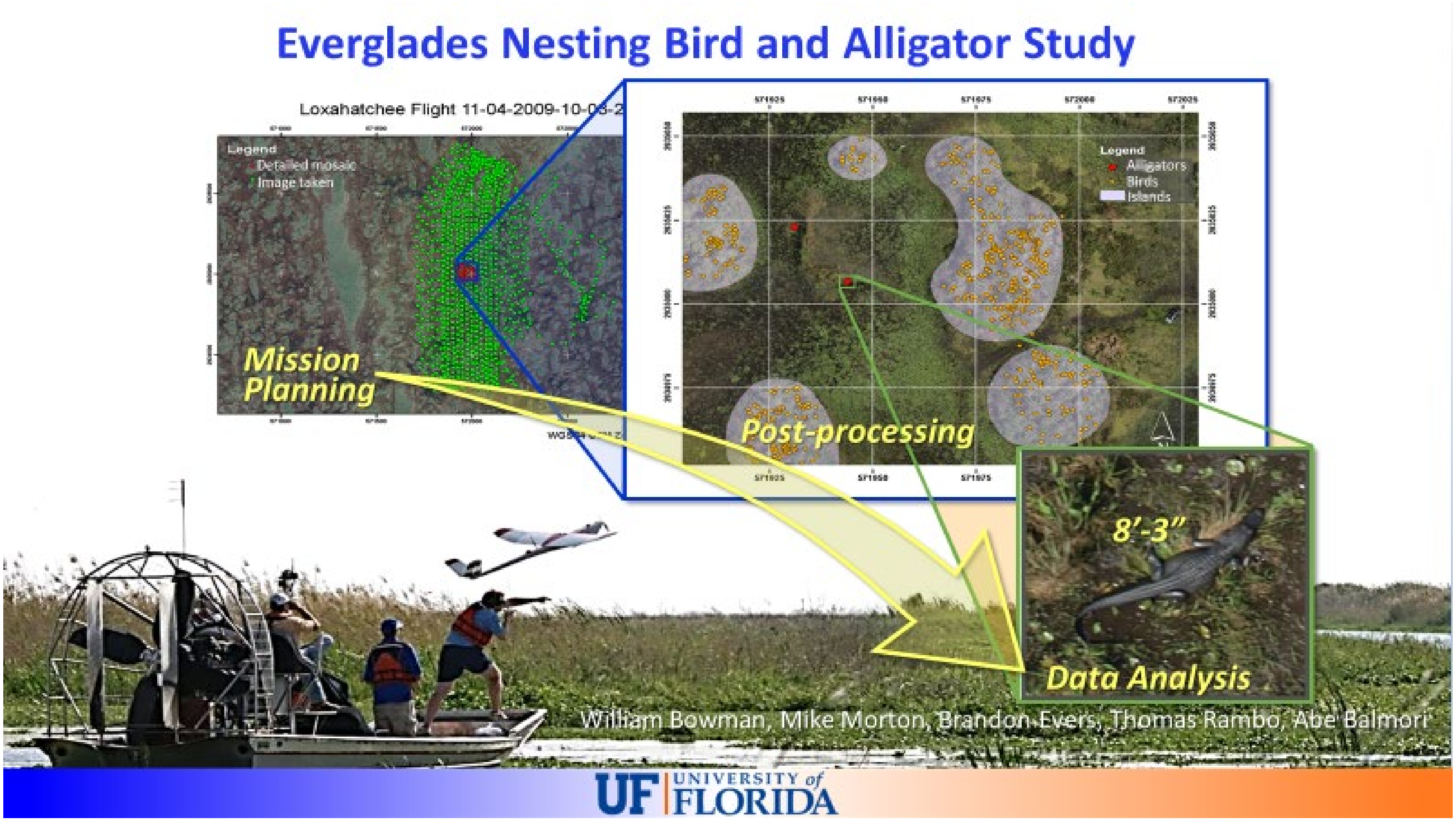
Launch

UF UNIVERSITY of FLORIDA

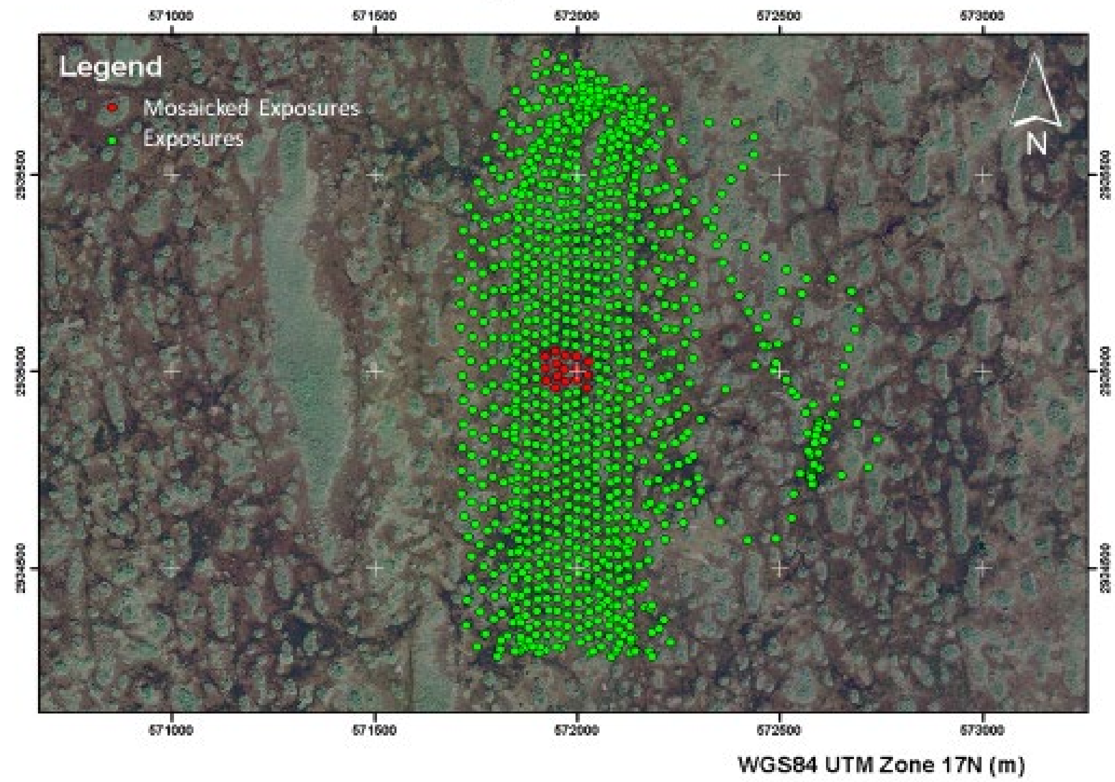

UF UNIVERSITY of FLORIDA


UF UNIVERSITY of FLORIDA

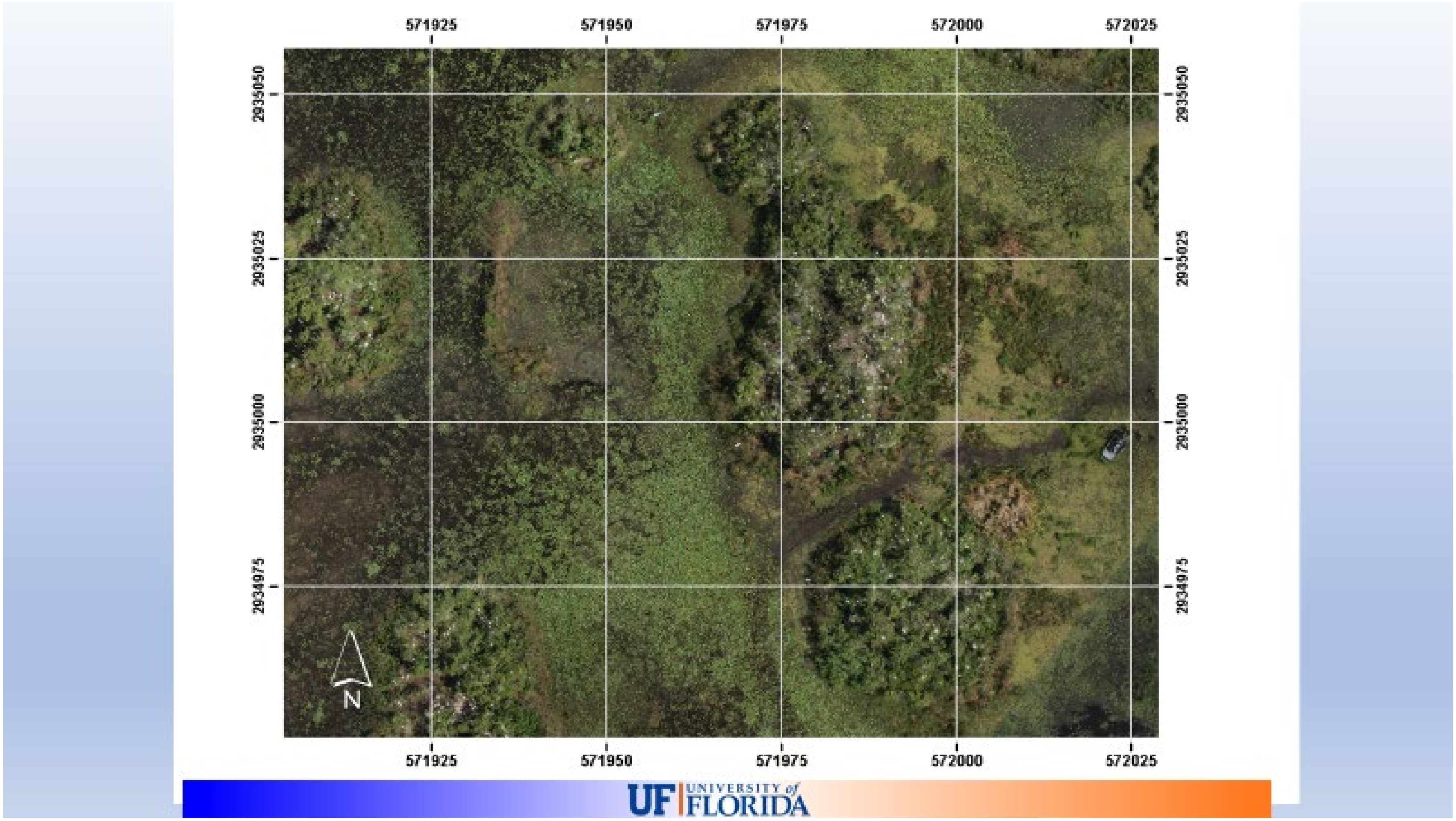
Recovery

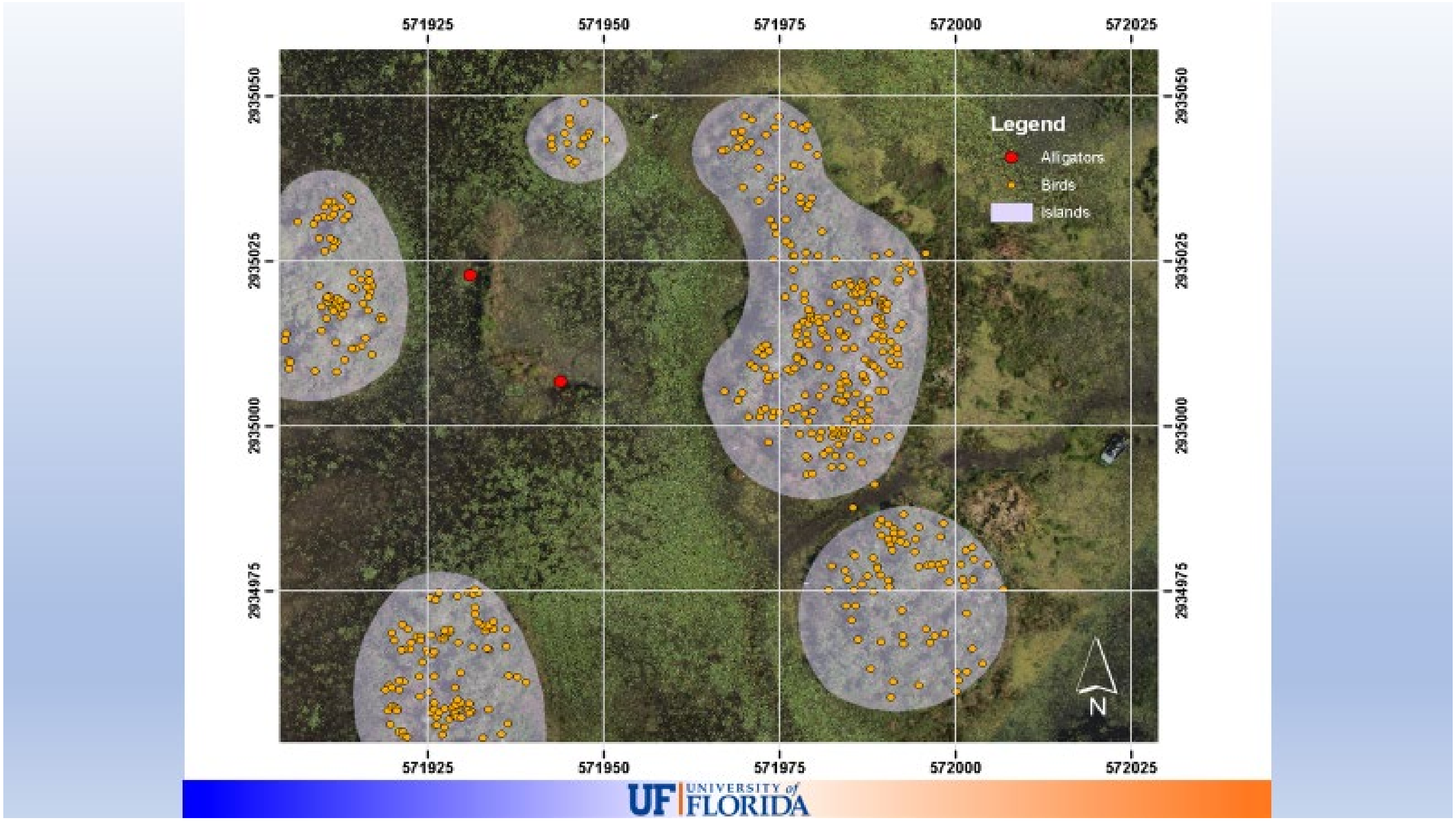

Everglades Nesting Bird and Alligator Study
Loxahatchee Flight 11-04-2009-10-0
Legend
Detailed mosaic
Image taken
Mission Planning
Legend
Alligators
Birds
Islands
Post-processing
8'-3"
Data Analysis
William Bowman, Mike Morton, Brandon Evers, Thomas Rambo, Abe Balmori
UF UNIVERSITY of FLORIDA

Loxahatchee Flight 11-04-2009-10-03-20

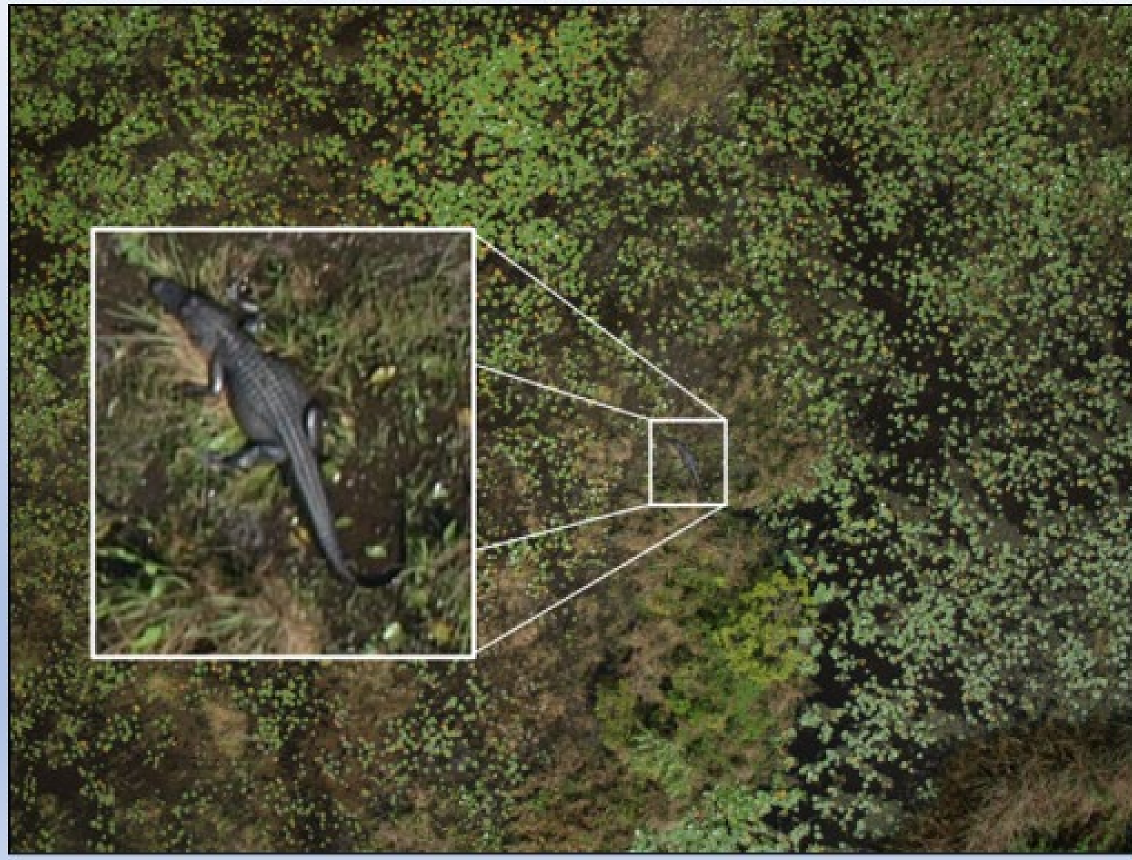


UF UNIVERSITY of FLORIDA


571925
571950
571975
572000
572025
2935050
2935025
2935000
2934975
N
UF UNIVERSITY of FLORIDA

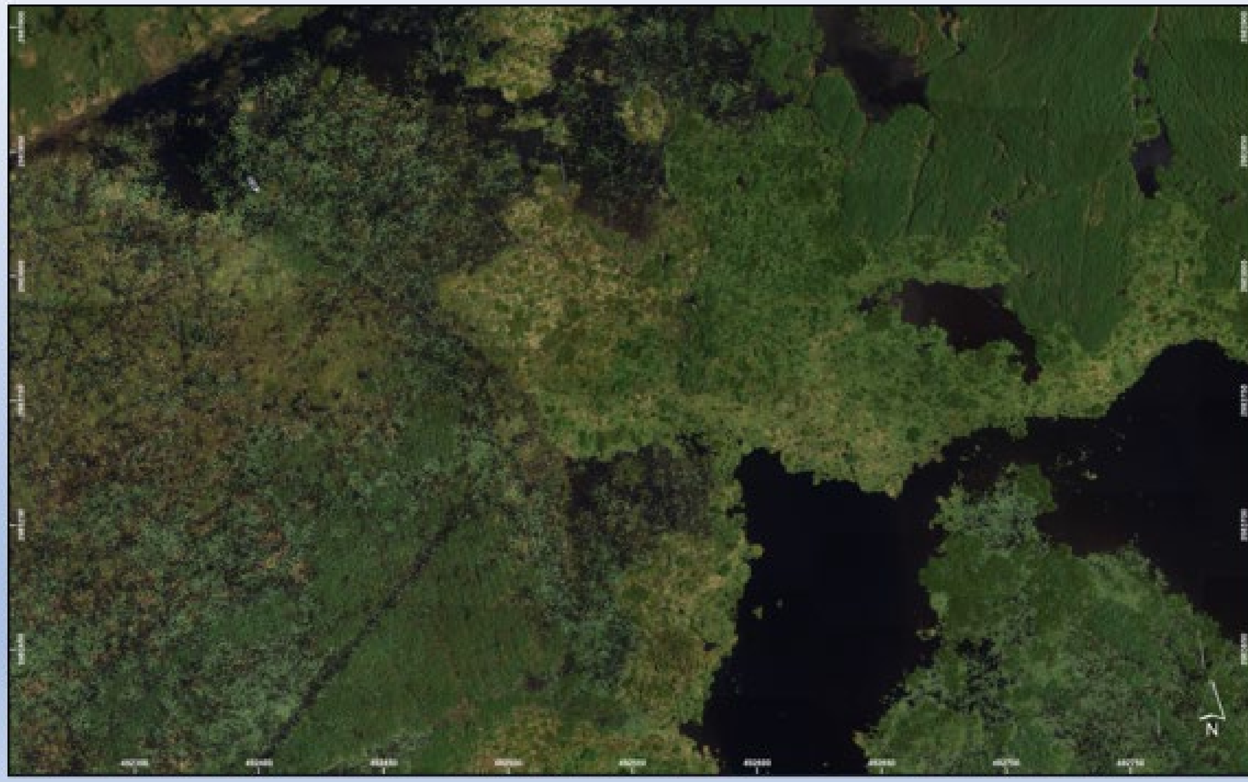

571925
571950
571975
572000
572025
2935050
2935025
2935000
2934975
Legend
Alligators
Birds
Islands
N
UF UNIVERSITY of FLORIDA

Nova 2.1 – Raw Image

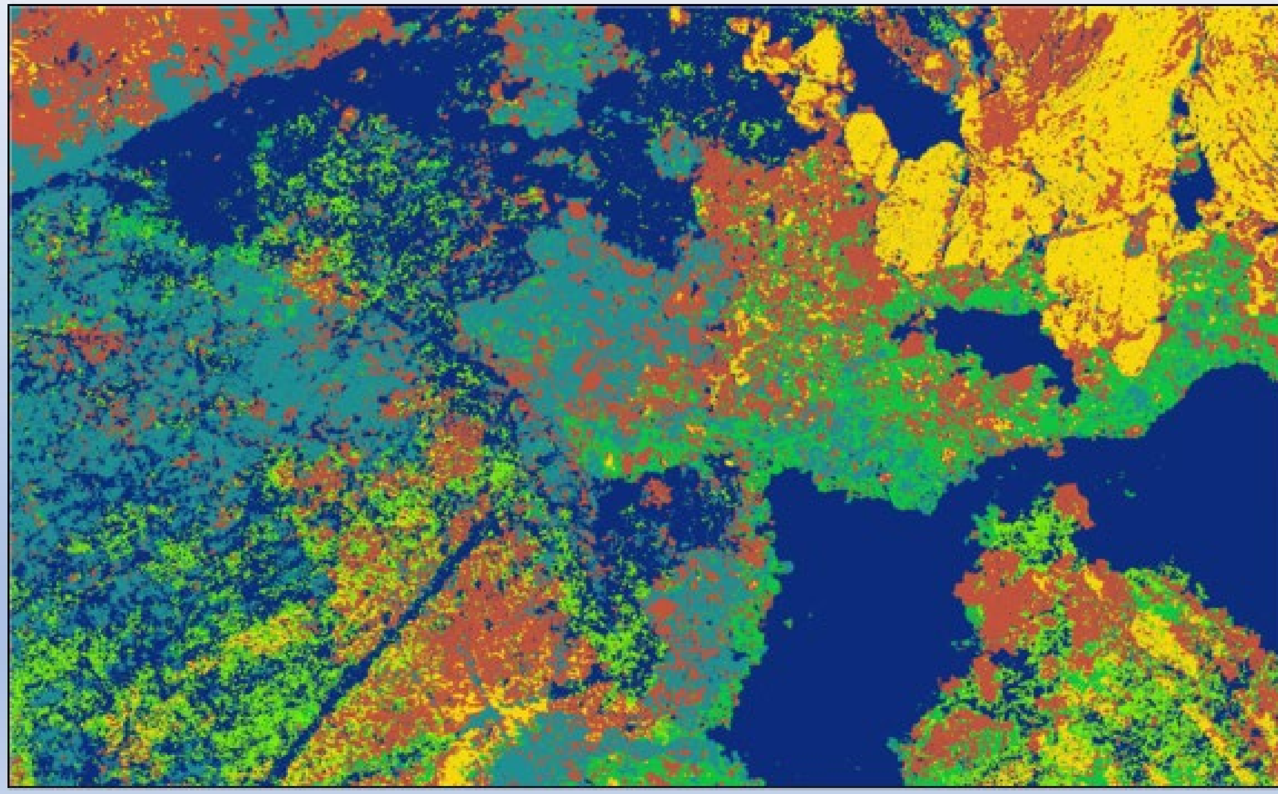


Nova 2.1 – Mosaic

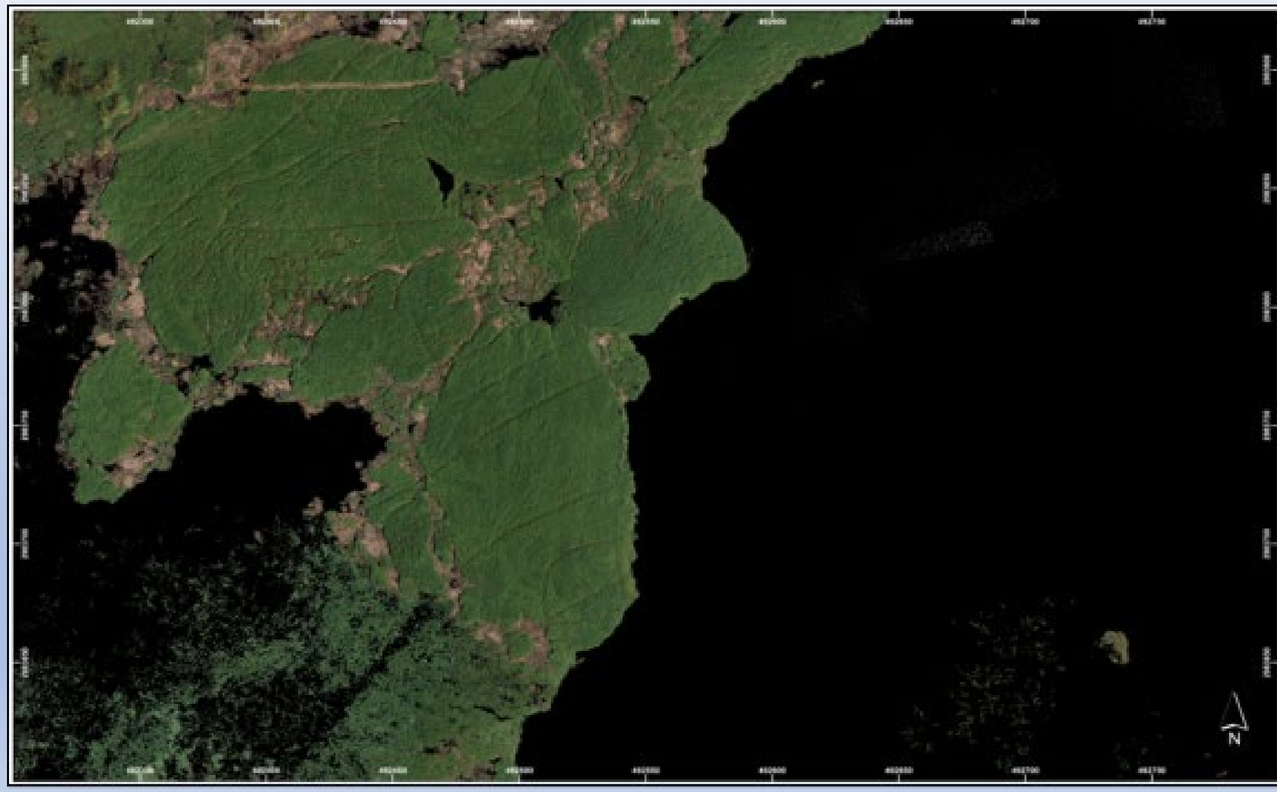
Nova 2.1 – Veg. Pre-treatment Mosaic



Nova 2.1 – Veg. Classified Mosaic

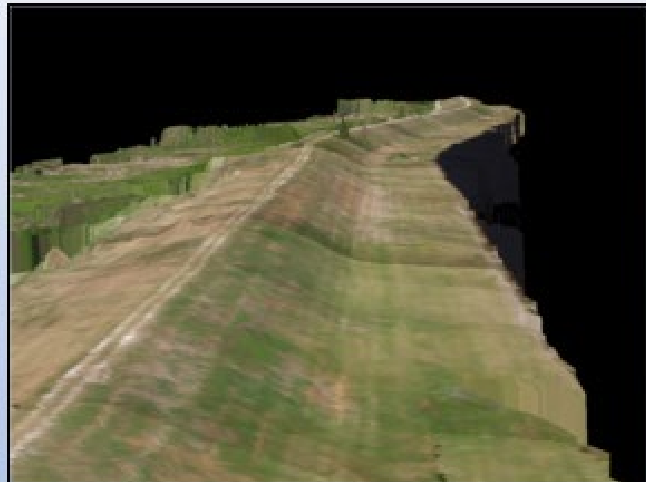


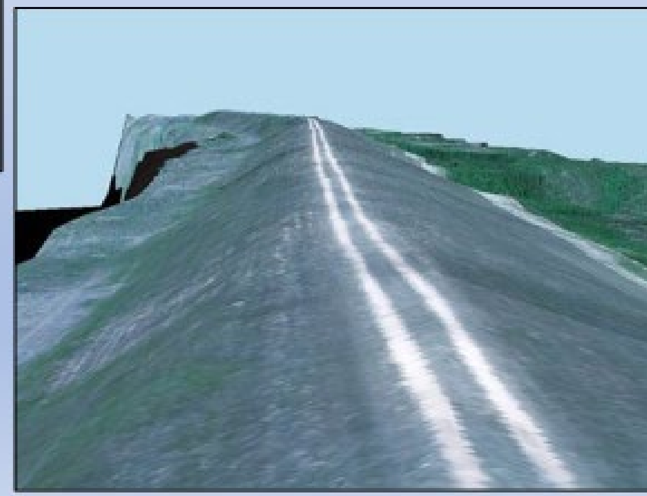
Nova 2.1 - Veg. Post-treatment Mosaic



Nova 2.1 – Multispectral Mosaics

Nova 2.1 – Three-dimensional Mosaics





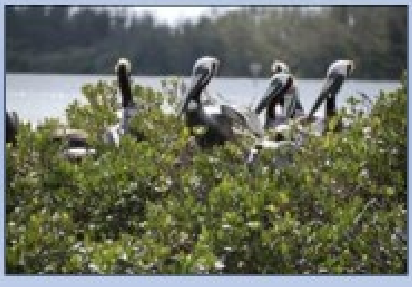
Idaho - Chinook Salmon Redds

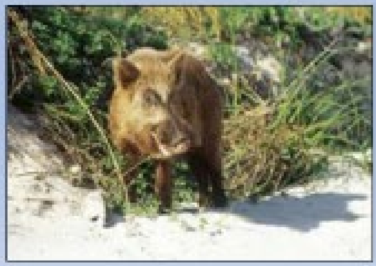
Idaho - Pygmy Rabbit Habitat

Idaho - American White Pelicans

Lower Suwannee River and Cedar Keys National Wildlife Refuges

- Brown Pelican Reproduction and Nest Turnover
- Feral Hog Damage Locations and Assessments
- Florida Saltmarsh Voles
- Climate Change Projects





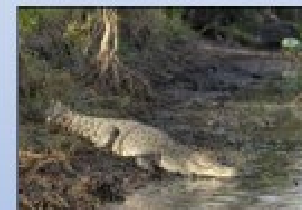
Canaveral National Seashore and Archie Carr National Wildlife Refuge –Sea Turtle Nesting Tracks

Additional Florida Applications

Sarasota Bay:
- Dolphins, Spotted Eagle Rays, Seagrasses, Manatees

Cape Sable:
- Mangroves, Diamondback Terrapins, Saltwater Crocodiles

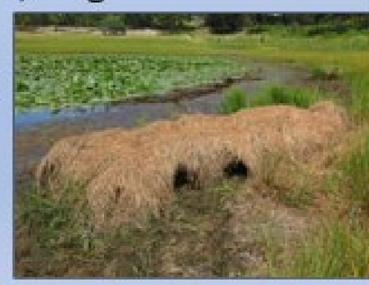
Florida Bay:
- Sawfish, Sea Turtles



Tampa Bay:
- Manatees, Water Quality

North Florida Wetlands:
- Round-tailed Muskrats, Vegetation

Central Florida:
- Precision Agriculture

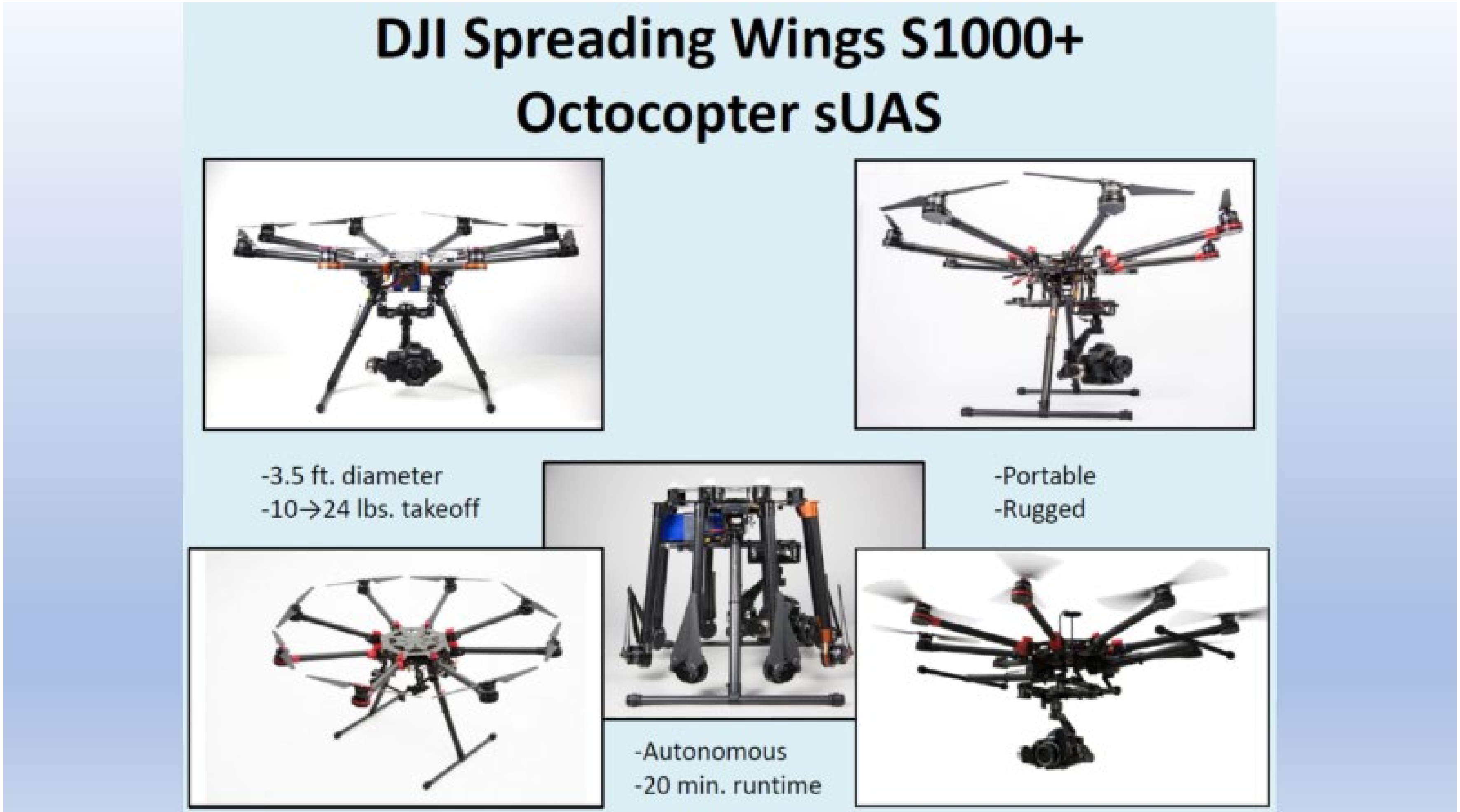


Apalachicola Bay:
- Oyster Reefs

St. Joseph Bay:
- Sea Turtles, Seagrasses

Payload Option – Crewed Aircraft

FL DOT bridge inspection


DJI Spreading Wings S1000+
Octocopter sUAS
-3.5 ft. diameter
-10→24 lbs. takeoff
-Portable
-Rugged
-Autonomous
-20 min. runtime

S1000+ LiDAR integration

Fire Ecology Research

- U.S. EPA
- Canadian Forest Service
- Univ. of Dayton Research Institute

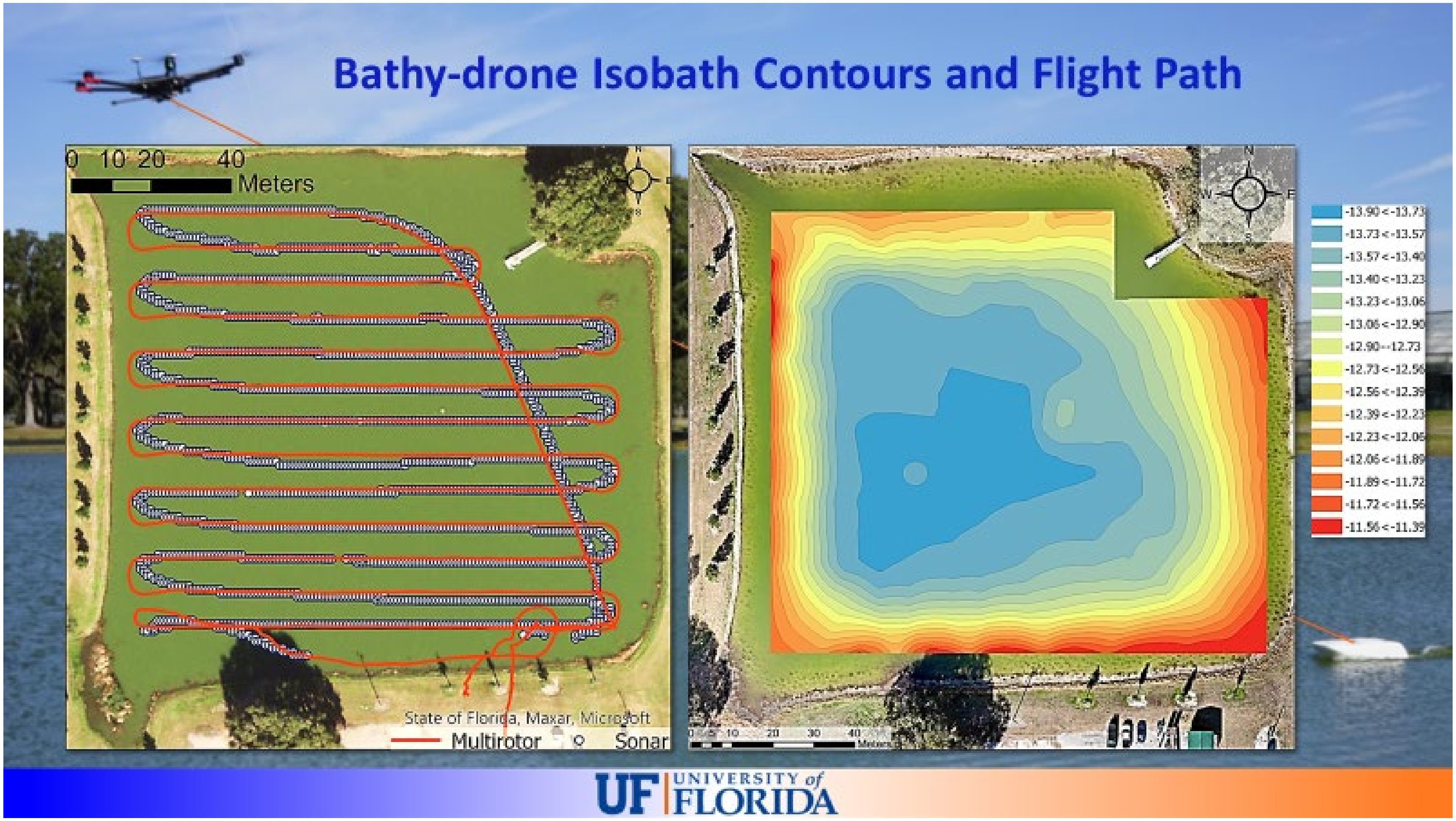
(fire emissions, thermal spectra, hi-res video)

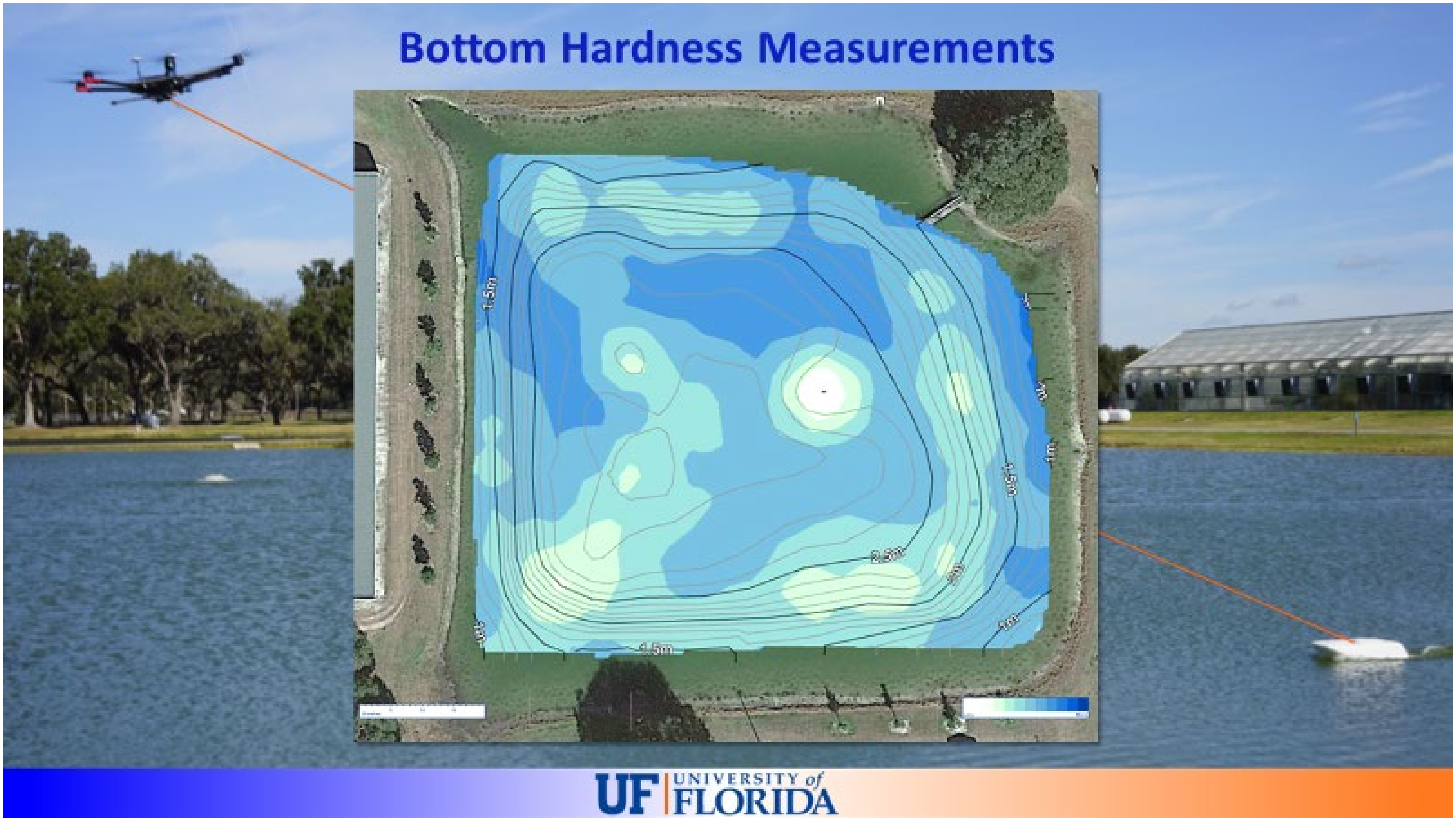

Water Sampling Drone...."Sipper"
UF University of Florida SIPPER
Land-based operation
Attributes of the Sipper System
• Collects water without cross-contamination
• Collect samples from ½ to 10 feet below the surface
• Can be operated from land or boat
• Large water samples of 1 to 2 liters per sample
• Handles choppy water, currents and wind (up to 25 mph)
• Any drone with the payload capacity is compatible
• Quick turn-around time between samples
• Time and location of samples are logged
Boat-based operation
Andrew Ortega, Henry Tingle, Chad Trip, Malory Johnson, Matt Snyder, Jordan Bernstein
UF UNIVERSITY of FLORIDA

Electric Uncrewed Hydrofoil Watercraft

UF UNIVERSITY of FLORIDA


The "Bathy-drone" for Bathymetric Mapping
UF BATHY DRONE
BATHY-DRONE
Gainesville, FL
Tony Diaz, Andrew Ortega, Marisa Nelson,Henry Tingle, Nic Cocoves, Andres Pulido
UF UNIVERSITY of FLORIDA


Bathy-drone Isobath Contours and Flight Path
0 10 20 40
Meters
State of Florida, Maxar, Microsoft
Multirotor
Sonar
-13.90 < -13.73
-13.73 < -13.57
-13.57 < -13.40
-13.40 < -13.23
-13.23 < -13.06
-13.06 < -12.90
-12.90 -- -12.73
-12.73 < -12.56
-12.56 < -12.39
-12.39 < -12.23
-12.23 < -12.06
-12.06 < -11.89
-11.89 < -11.72
-11.72 < -11.56
-11.56 < -11.39
UF UNIVERSITY of FLORIDA


Bottom Hardness Measurements
1.5m
1.5m
2.5m
2m
1m
1.5m
1m
UF UNIVERSITY of FLORIDA

Bathy-drone Advantages

- Easy to deploy (one person operation)
- Easy to transport to the site
- Cost effective
- No boats are required for nearshore applications
- Quick, high-resolution solution for small areas
- Optical or sonar sensor compatible
- Floating vegetation is not a problem
- Can be used to precisely disperse mitigants
- Can accommodate a variety of sensors
- Can collect water samples

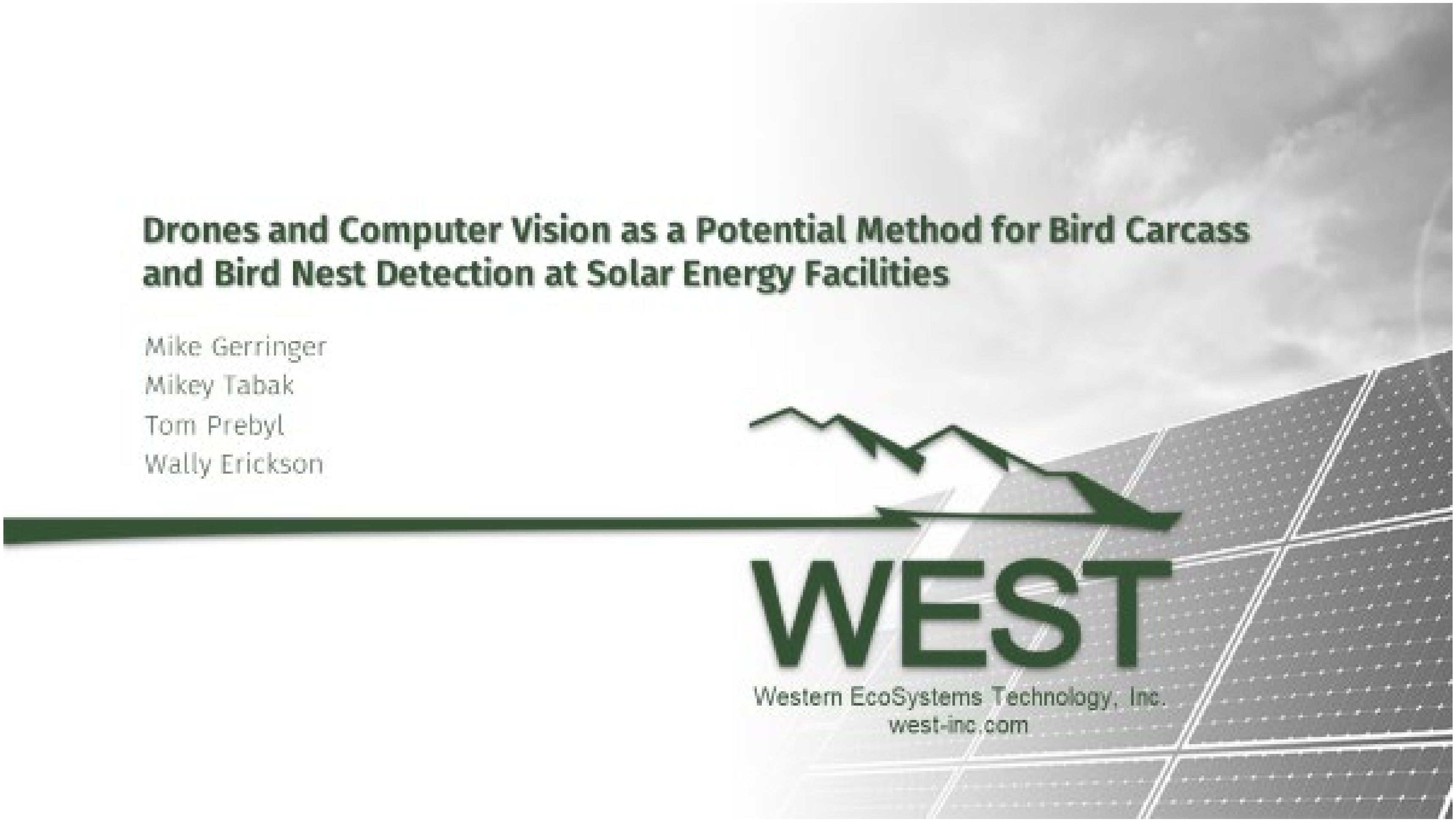

Uncrewed Aircraft Systems Research Program Labs
4.5 inch MAV
Wildlife UAV
TACMAV
eVTOL
Uncrewed Hydrofoil
Foldable Wing MAV
Buzzard Surveillance UAV
Bridge Inspections
Falcon Crop Protection UAV
Flying/Walking MAV
Flying/Walking MAV
Morphing
UF UNIVERSITY of FLORIDA


SCHOOL OF FOREST, FISHERIES, AND GEOMATICS SCIENCES
UF DEPARTMENT OF MECHANICAL & AEROSPACE ENGINEERING
UF UNIVERSITY of FLORIDA
IFAS
Questions?
Ray Carthy
ngosi@ufl.edu
U.S. Geological Survey– Florida Cooperative Fish and Wildlife Research Unit
Department of Wildlife Ecology and Conservation
University of Florida
UF UNIVERSITY of FLORIDA
Unmanned Aircraft Systems Research Program
USGS
science for a changing world

Drones and Computer Vision as a Potential Method for Bird Carcass and Bird Nest Detection at Solar Energy Facilities

Mike Gerringer[1], Mikey Tabak[3], Tom Prebyl[2], and Wally Erickson[1]
[1]Western EcoSystems Technology, Inc.; mgerringer@west-inc.com
[2]University of Georgia
[3]Natural Capital Exchange, Canada

The use of small uncrewed aircraft systems (sUAS) for renewable energy inspections (e.g., solar panel inspection) is becoming more common and there are opportunities to use sUAS for environmental compliance monitoring. Large solar energy projects have costly environmental compliance requirements including avian mortality monitoring surveys, which presently rely on human observers. During this study, we developed and evaluated an efficient sUAS and computer vision methodology for automated detection of bird carcasses and bird nests. We tested our approach using avian carcasses and nest surrogates (electric hand-warmers) of multiple sizes placed systematically at solar arrays. We collected drone imagery at two flight heights, 20 m and 30 m above ground level. We then trained convoluted neural network models using 70% of the imagery and withheld 30% for validation. Our initial results indicate nest-detection rates of 93% and 86% at 20-m and 35-m flight heights, respectively. The false positive rate was zero at both flight heights. Carcass detection rates were 53–85% for small birds and 79–97% for large birds depending on flight height and vegetation cover. The false positive rate for carcasses ranged from 0–2% depending on flight height and vegetation cover. Because the developed methods are largely autonomous, this approach for nest and carcass monitoring could be conducted simultaneously with operation inspections (e.g., panel defects) or other environmental compliance monitoring requirements (e.g., weed monitoring, vegetation restoration monitoring). Our research is conducted in partnership with the Electric Power Research Institute and funded by the Department of Energy.


Drones and Computer Vision as a Potential Method for Bird Carcass and Bird Nest Detection at Solar Energy Facilities
Mike Gerringer
Mikey Tabak
Tom Prebyl
Wally Erickson
WEST
Western EcoSystems Technology, Inc.
west-inc.com

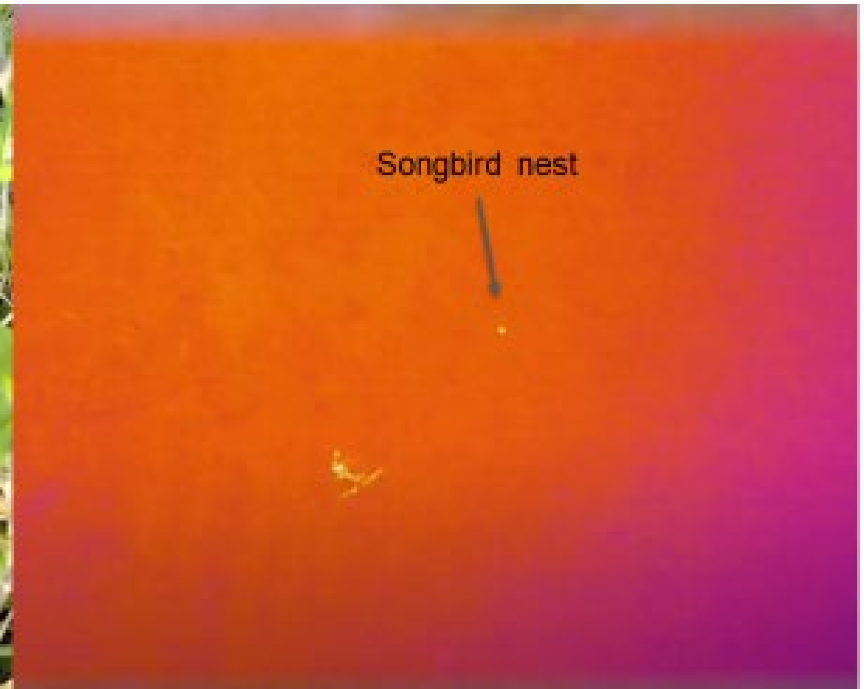
DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Introduction

WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Introduction



WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Methods Overview

Data Collection

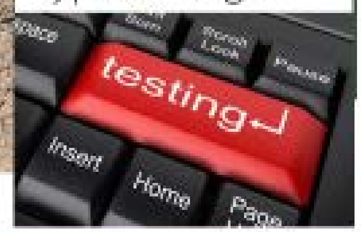
Used a drone to collect images of bird carcasses and bird on nest surrogates

Network Training

Used the images to train a neural network to detect each type of target

Network Testing

Test network detection and false positive rates for each type of target



WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Methods – Study Site & Timing

- **Where:** Solar energy project in southern California
- **When**
  - Nest: May 17 – 21, 2021
  - Carcass: October 18 – 29, 2021

WEST

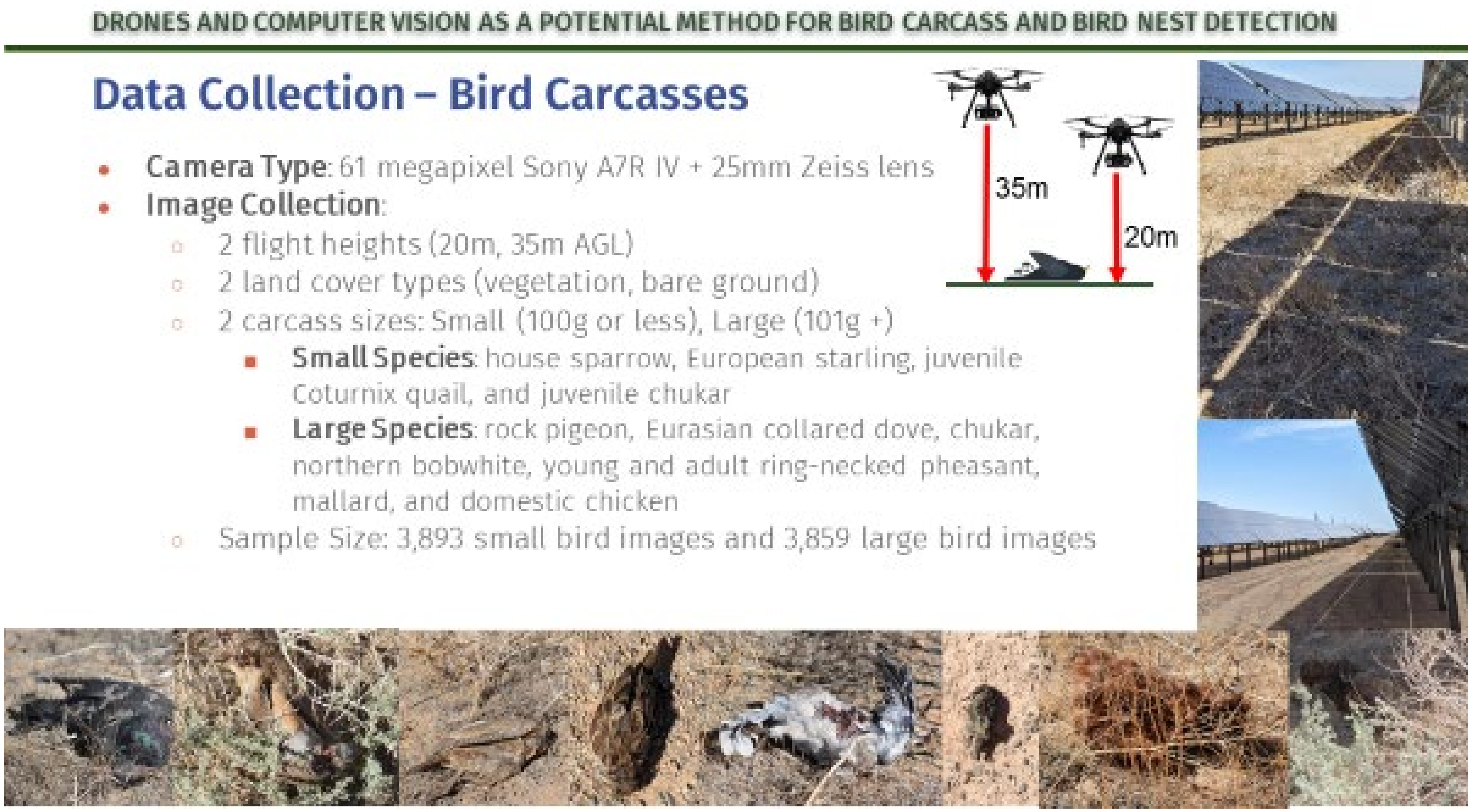
DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Data Collection – Nests

Drone: Skyfish M4
Camera Type: FLIR 19mm Thermal
Bird on nest surrogate: electric hand warmers
Sample Size Collected:

- 20m AGL: 1,092 images
- 35m AGL: 944 images

WEST


DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION
Data Collection – Bird Carcasses
• Camera Type: 61 megapixel Sony A7R IV + 25mm Zeiss lens
• Image Collection:
○ 2 flight heights (20m, 35m AGL)
○ 2 land cover types (vegetation, bare ground)
○ 2 carcass sizes: Small (100g or less), Large (101g +)
▪ Small Species: house sparrow, European starling, juvenile Coturnix quail, and juvenile chukar
▪ Large Species: rock pigeon, Eurasian collared dove, chukar, northern bobwhite, young and adult ring-necked pheasant, mallard, and domestic chicken
○ Sample Size: 3,893 small bird images and 3,859 large bird images
35m
20m

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Computer Vision Deep Learning Methods

- We used Instance Segmentation to find bird on nest surrogates and bird carcasses in images; We experimented with three Convolutional Neural Network architectures
  - U-Net, Deeplab Version 3 (with Resnet-101 backbone), Mask R-CNN
- Models trained with half of the images using PyTorch
  - Other half to be incorporated during the Phase 2 study
  - (70% of images for training, 30% for validation)
- Mask R-CNN was the most effective at finding bird on nest surrogates and bird carcasses

- **Network Testing**
- Detection (True Positive) Rate: True positives/total positives
- False Positive Rate: False positives/total # of images
  - Carcass model included 500 blank images for each carcass size/land cover/height category

PyTorch

WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Computer Vision Deep Learning Results - Nests

Flight height	Results -True Positive Rate	Results - False Positive Rates	# Training Images + # Validation Images
20m	93%	0%	280 + 119
35m	86%	0%	246 + 106

original image

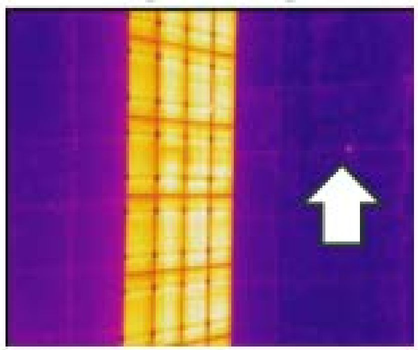
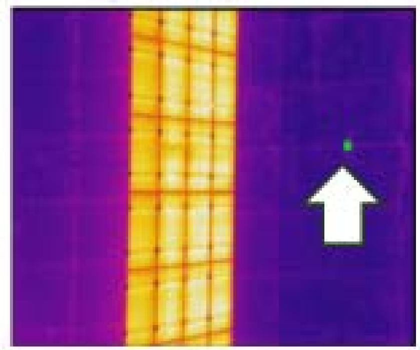


image with prediction

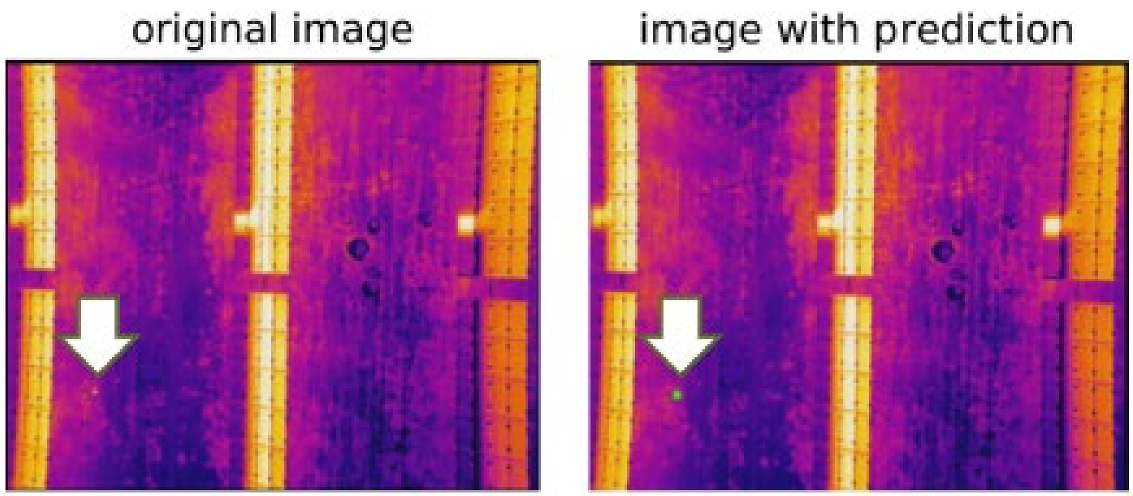


WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Computer Vision Deep Learning Results - Nests

35-m Flight Height



WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Computer Vision Deep Learning Results – Bird Carcasses

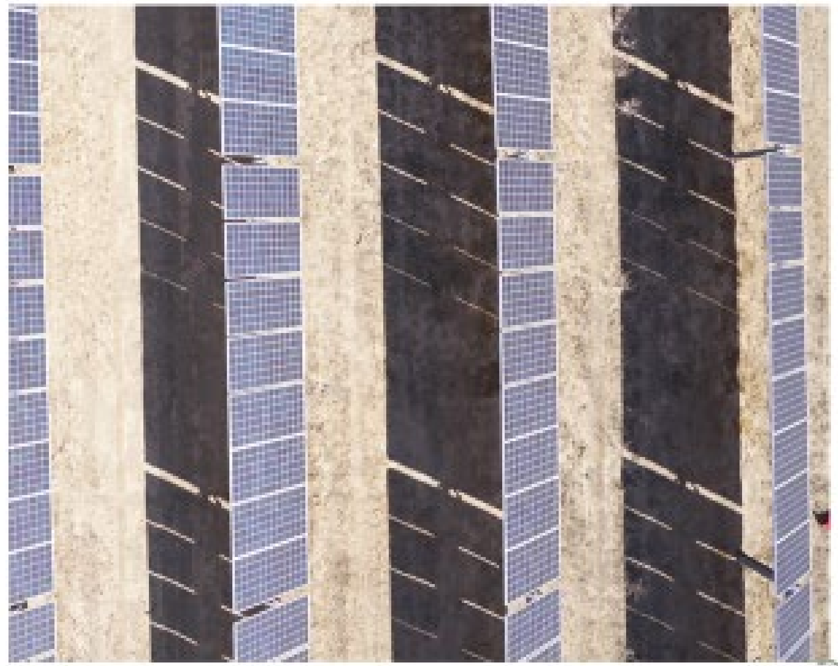
- True Positive Rates:

	Bare Ground 20m	Bare Ground 35m	Vegetation 20m	Vegetation 35m
Small Bird Carcasses	82%	85%	71%	53%
Large Bird Carcasses	97%	89%	87%	79%

WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

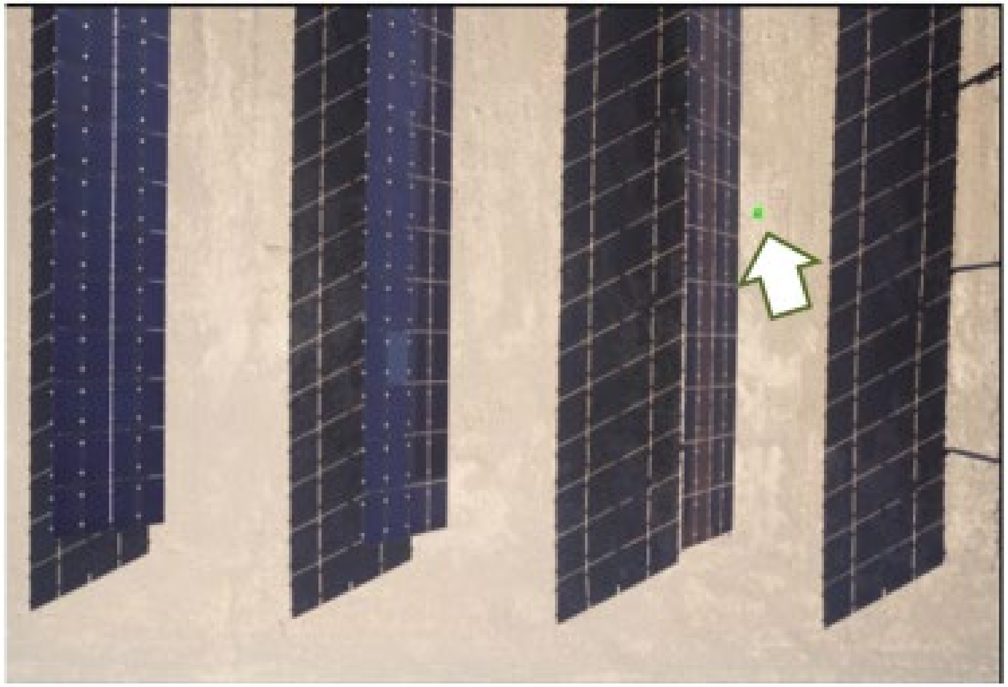
Carcasses - Results



WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Computer Vision Deep Learning Results - Carcasses



WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Computer Vision Deep Learning Results - Carcasses

WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Computer Vision Deep Learning Results - Carcasses

- False Positive Rates:

	Bare Ground 20m	Bare Ground 35m
All Bird Carcasses	0%	0%

	Vegetation 20m	Vegetation 35m
All Bird Carcasses	0.89%	0.52%

image with prediction

WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Discussion

Study Limitations

- Feather spots and partial carcasses account for 54% of fatalities
  - Plan to incorporate in the future
- Habitat
  - Desert southwest landscape
  - To apply to other habitats, additional network training required

Next Steps

- Phase 2 Study (Nov 2022 - Dec 2023)
  - Train network with the other half of the images collected to improve
  - Comparison Study: Drone Method to Traditional Method for carcass searches
    - Detection rate, survey time, cost

WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Acknowledgements

NextEra Energy

United States Department of Energy

Electric Power Research Institute

Acknowledgment: "This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technology Office Award Number DE-EE0009006"

WEST

DRONES AND COMPUTER VISION AS A POTENTIAL METHOD FOR BIRD CARCASS AND BIRD NEST DETECTION

Questions

Mike Gerringer – Drone Program Manager (mgerringer@west-inc.com)
Tom Prebyl – AI Program Manager (tprebyl@west-inc.com)

WEST

west-inc.com

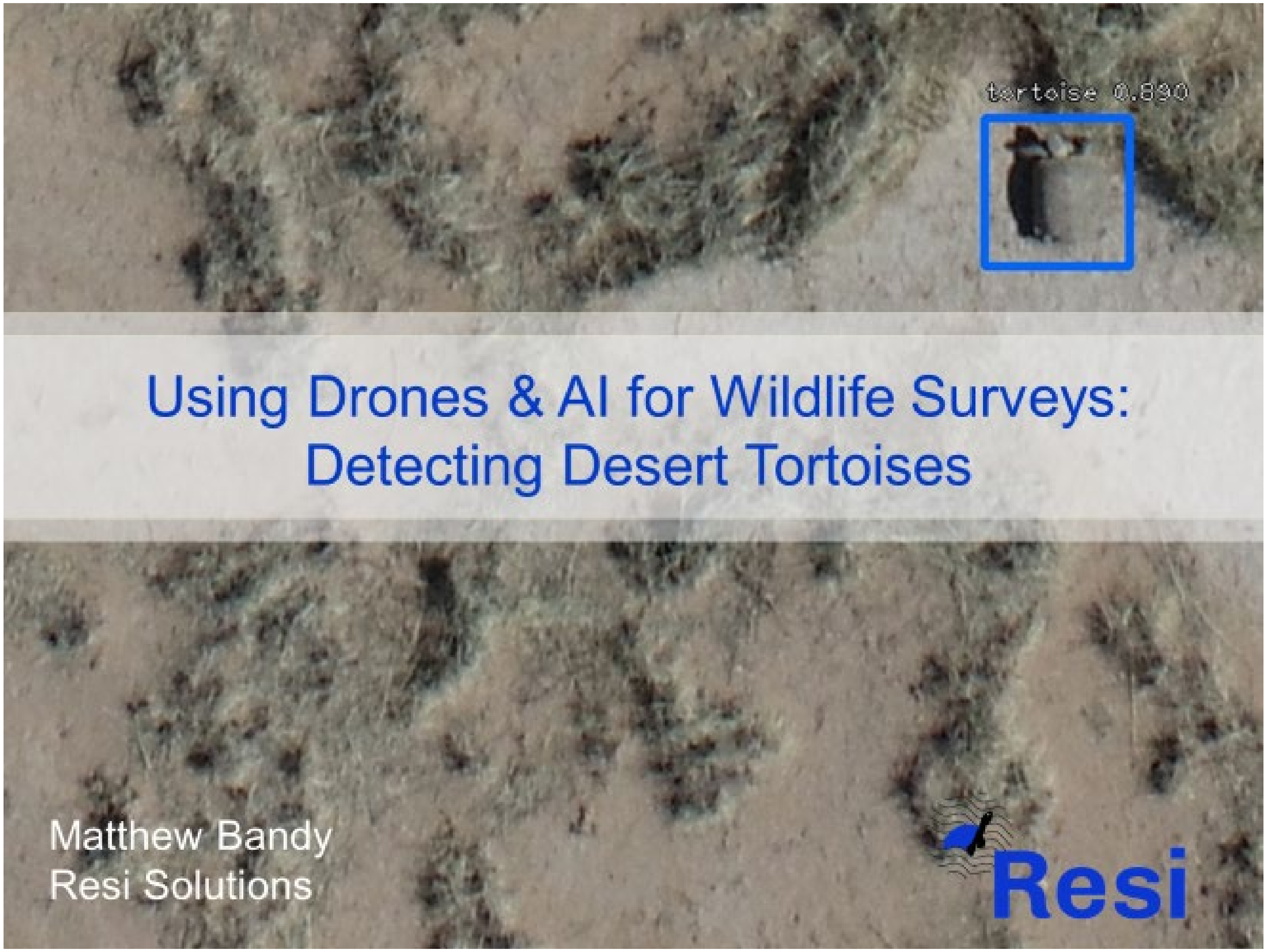
WEST Headquarters | 415 West 17th Street, Suite 200, Cheyenne, Wyoming 82001 | 307-634-1756

WEST, ULC Headquarters | Suite 303, 1000 9th Avenue SW, Calgary, Alberta T29 2Y6 | 403-629-6741

Using Drones & AI for Wildlife Surveys: Detecting Desert Tortoises

Matthew Bandy, Resi Solutions, matt@resi.solutions

Small uncrewed aircraft (drones) and computer vision techniques have the potential to revolutionize the field surveys used to evaluate project impacts on wildlife and their habitats. Hyperspatial image acquisition combined with artificial intelligence (AI) object detection methods promises faster and safer collection of better data at a lower cost than traditional methods. Resi has developed a data collection methodology based on convolutional neural networks and commodity aerial platforms. This presentation reports on a series of preliminary detection trials on desert tortoises and desert tortoise burrows. Trials were undertaken in early 2022 in Utah and Nevada. The novel AI-assisted aerial survey approach is compared to traditional pedestrian methodologies in terms of effectiveness (detection rates/searcher efficiency), speed (rate of survey coverage), and efficiency (relative cost). The results indicate that the drone/AI methodology is characterized by detection rates roughly comparable to traditional methodologies. The drone/AI methodology is also shown to be faster and significantly more cost-effective than legacy approaches. Finally, we review prospects for future applications of this technology to renewable energy projects and to adaptive management programs more broadly.


tortoise 0.890
Using Drones & AI for Wildlife Surveys:
Detecting Desert Tortoises
Matthew Bandy
Resi Solutions
Resi

Computer vision detects objects of interest in low elevation drone photographs.

PyTorch

Currently working with

- bird/bat/eagle carcasses
- Saguaros
- Joshua trees
- **desert tortoises**

Why Drones?

-Fast
-Cheap

Why Deep Learning?

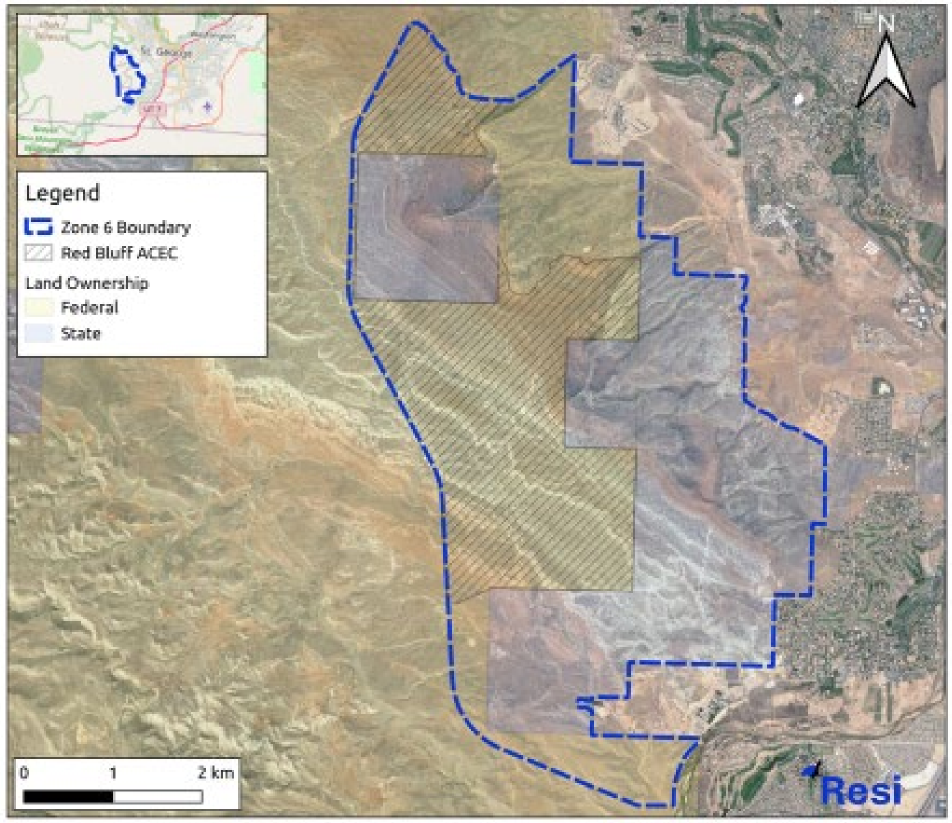
-Fast

-Cheap

Project

- St George, UT
- April, 2022
- Mojave desert tortoise
- ~5,000 acres
- 2 weeks

- Transects surveyed by drones and pedestrian crews



REDCLIFFS DESERT RESERVE

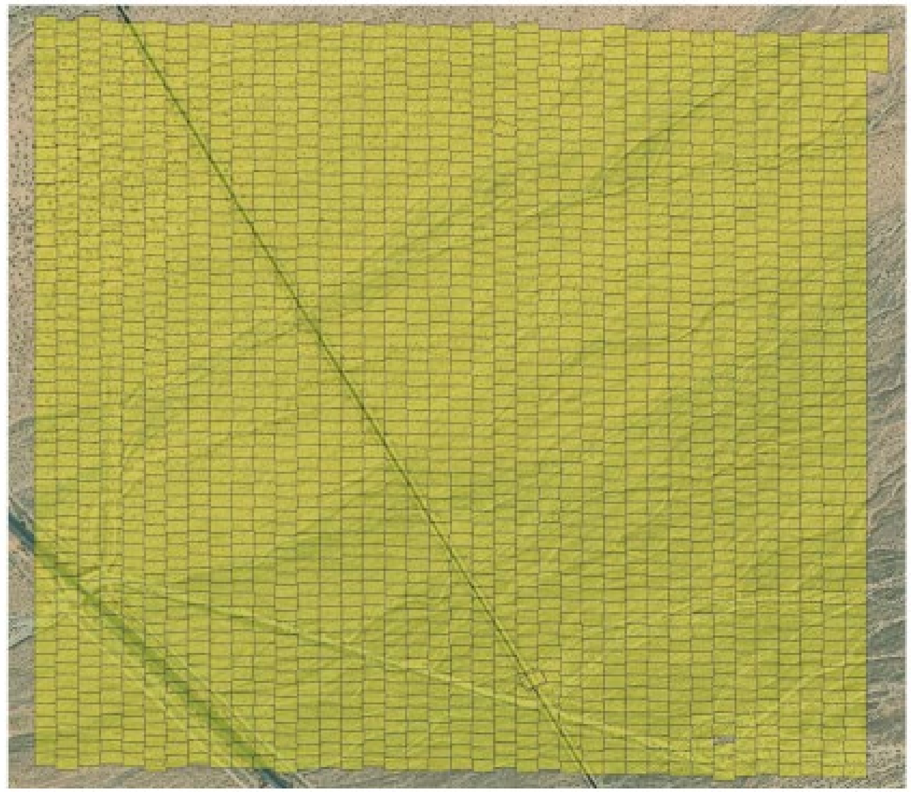
Resi

Great Basin Institute

UTAH DNR

Drone Surveys

- Program drones to photograph areas of interest
  - 20 m flight elevation
  - 1 sq mile/day
  - Does not require surface access
  - Approx 9 times walking speed
  - Correspondingly cheaper



Tortoise Model

- n = 490
- Trained on both bolson and desert tortoises
- Segregate training (n=392) and validation (n=98) sets
- Recall ~ 84%
  - 84% of tagged tortoises were detected by the model

Two components

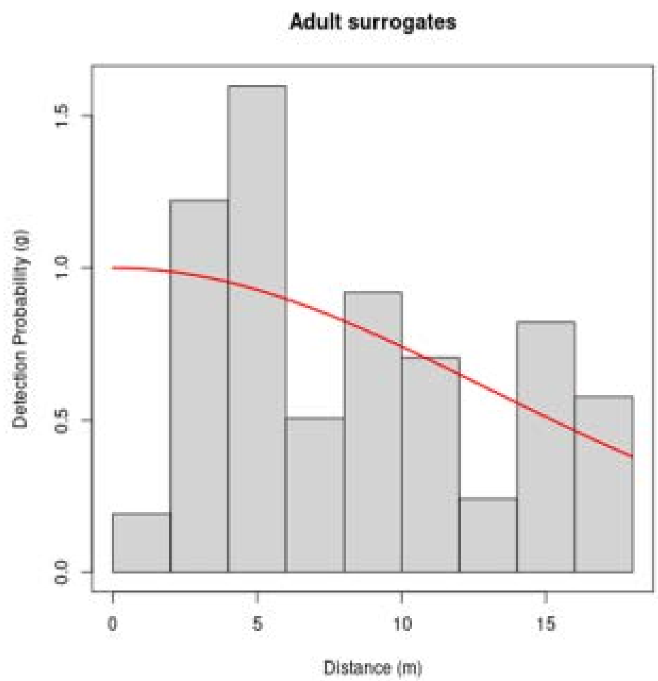
- USFWS training arena in Las Vegas
- Paired drone and pedestrian surveys in SW Utah

USFWS Arena surveys

Available	Detected	Percent
288	233	81%

USFWS Arena surveys

Distance analysis

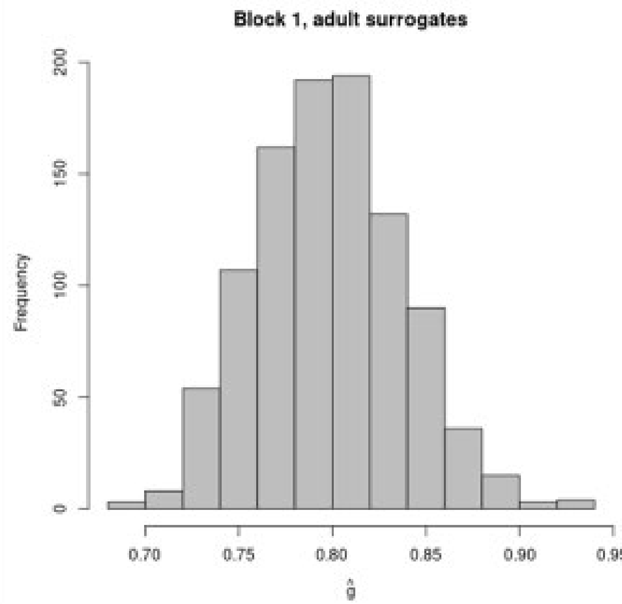


Distance Analysis

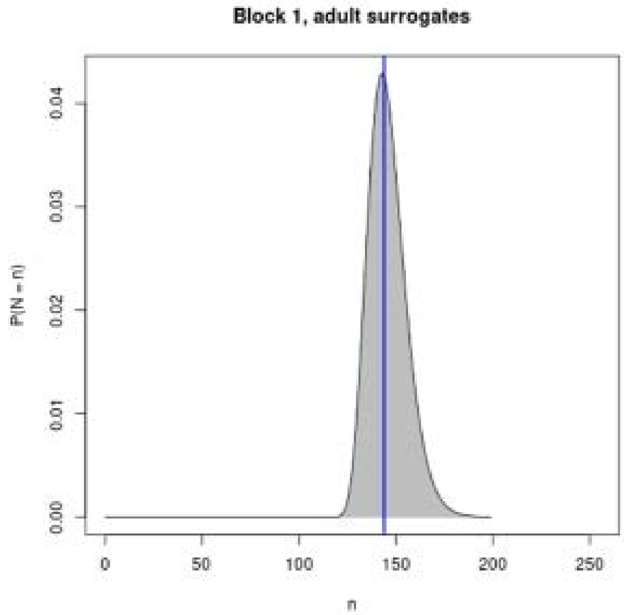
droneDistance

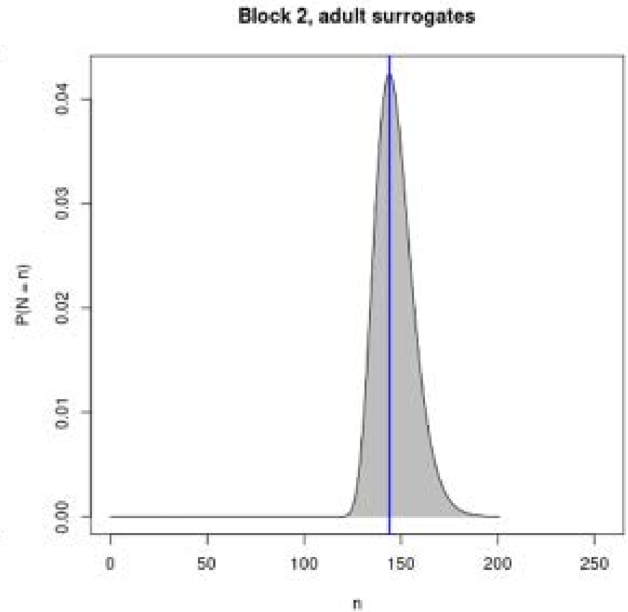
A custom R package for distance analysis using aerial photographs

USFWS Arena surveys



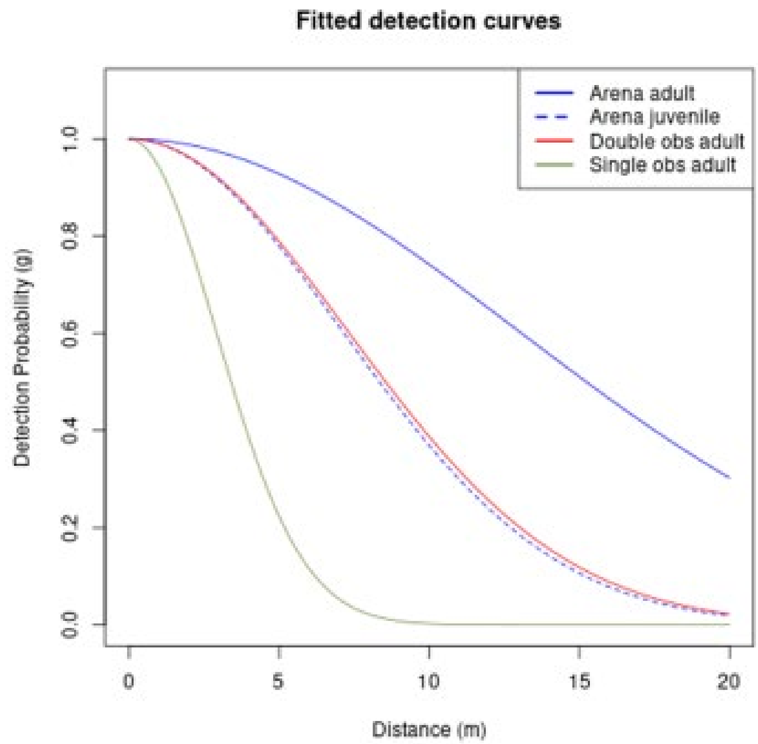
USFWS Arena surveys





	Known	Estimate	Error
Block 1	144	146 ± 9.8	1.4%
Block 2	144	147 ± 9.9	2.1%

USFWS Arena surveys

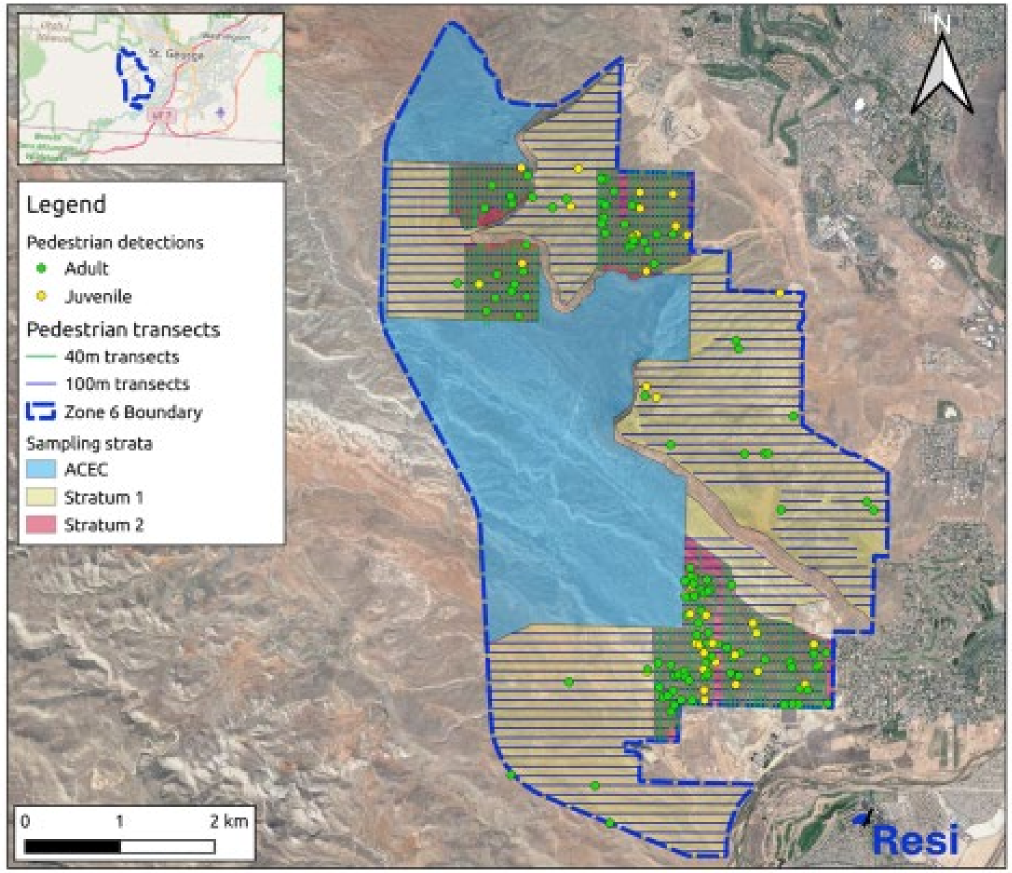


Zone 6 - pedestrian

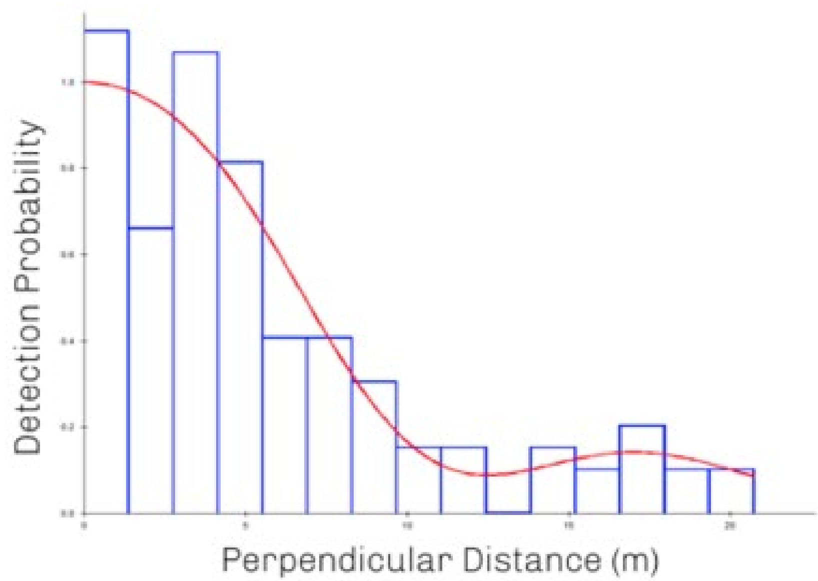
254 km
surveyed

Detections:

113 adult
40 juvenile



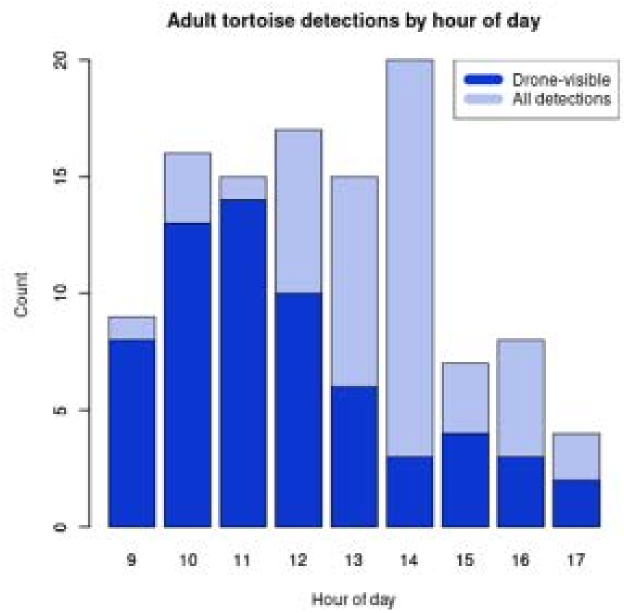
Zone 6 - pedestrian



Zone 6 - pedestrian

N	95% CI	D	95% CI
411	303, 556	26.14	19.27, 35.36

Zone 6 - pedestrian



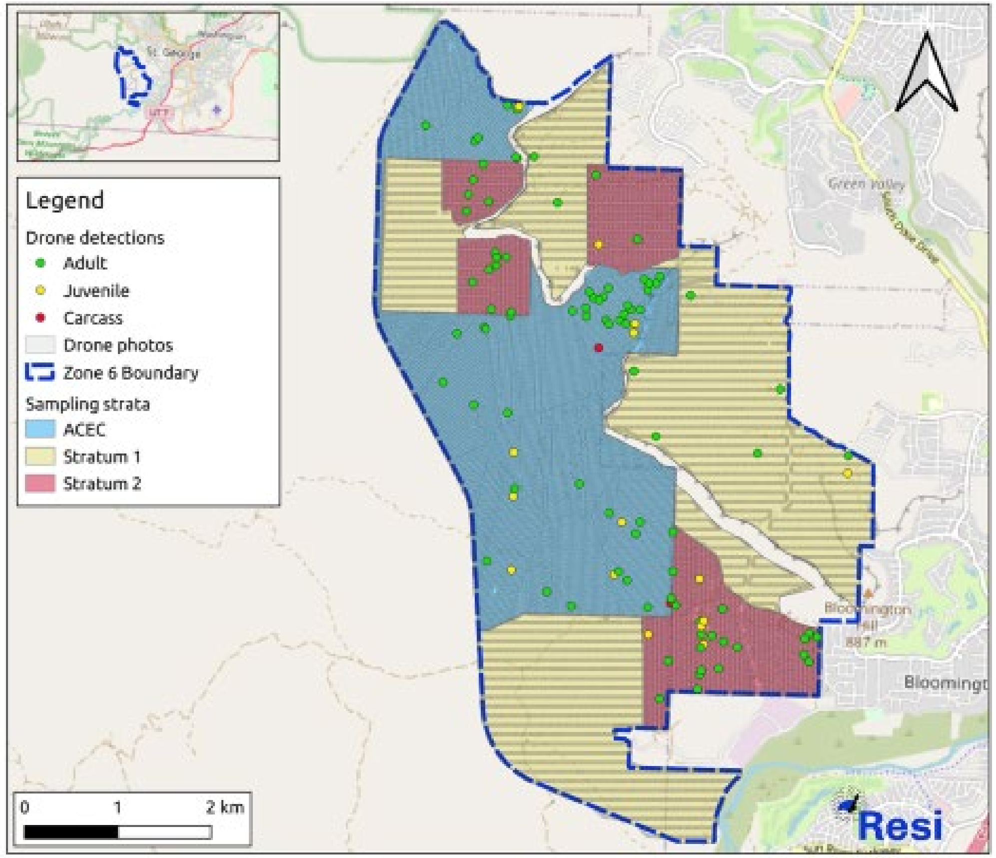
Zone 6 - drone

About 5,000
acres surveyed

About 43,000
usable photos

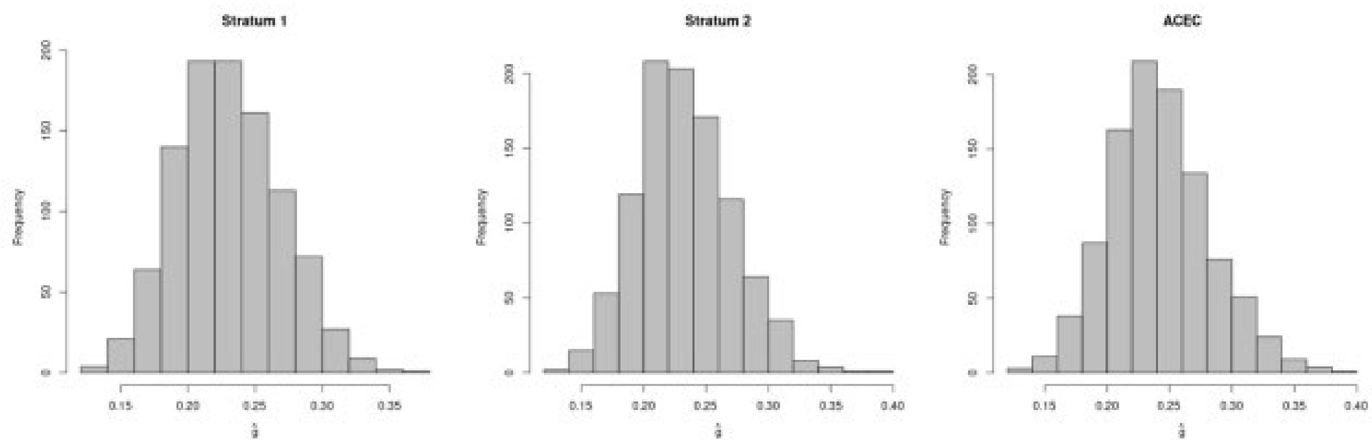
Detections:

90 adult
15 juvenile
2 carcasses

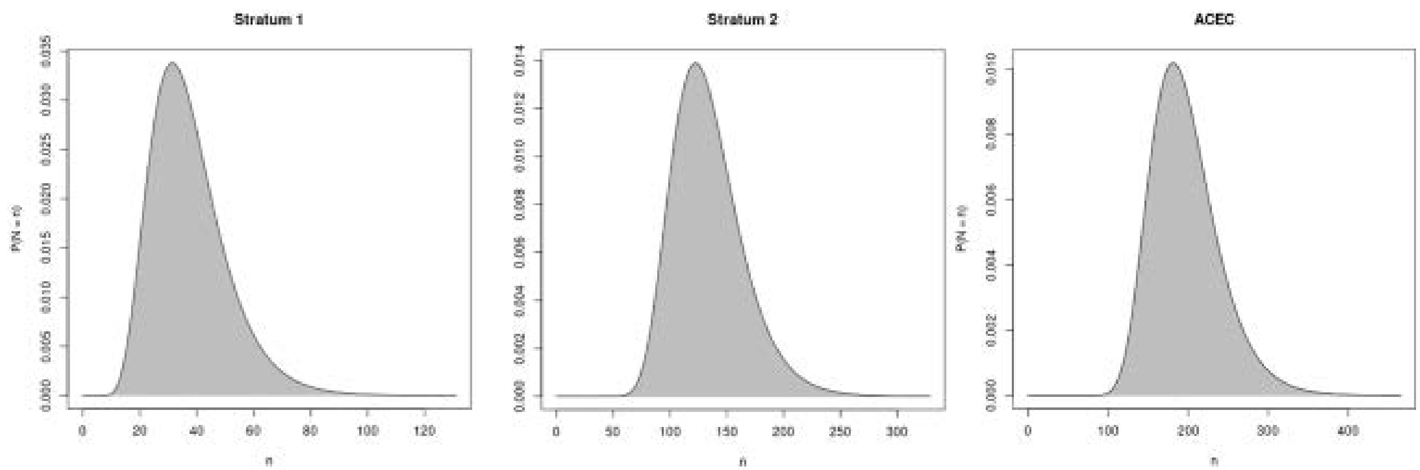


Zone 6 - drone

Zone 6 - drone


Stratum 1
Stratum 2
ACEC
Frequency
0
50
100
150
200
0.15
0.20
0.25
0.30
0.35
0.40

Zone 6 - drone



	N	95% CI	D	95% CI
Stratum 1	132	62, 240	9.7	4.6, 17.7
Stratum 2	169	105, 262	40.0	24.8, 61.7
ACEC	197	129, 297	20.2	13.2, 30.5
Total	498	297, 799	18.1	10.8, 29.0

Zone 6 - drone

	N	95% CI	D	95% CI
Pedestrian	411	303,556	26.1	19.3, 35.4
Drone	301	168, 502	16.9	9.4, 28.2

Estimates overlap significantly

Different in means may be due to:

1) sampling error
2) observer effect

Zone 6 - drone

	Transect Width	Acres / person-hour
Single Observer	12	6
Double Observer	30	7.5
Drone	30	63

Survey methods compared in terms of transect width (meters) required to achieve an adult tortoise detection rate (ĝ) of 23% and corresponding efficiency

Conclusions

- The drone method is very successful at locating tortoises when they are available for detection
- Fewer tortoises are available for drone detection than for pedestrian detection, leading to lower overall detection rates and wider confidence intervals
- This can be ameliorated by:
  - Increased survey acreage
  - limiting drone surveys to periods of high availability (9 AM to 1 PM)
- Advantages of the drone method:
  - No surface disturbance or access
  - Less than ½ the cost per km^2
  - Quantitative abundance estimates with CI

UAS as Wildlife Hazing Tools: Considerations for Reducing Negative Human-Wildlife Interactions

Morgan Pfeiffer* and Bradley Blackwell*
*USDA, Wildlife Services, National Wildlife Research Center, Sandusky, OH; morgan.b.pfeiffer@usda.gov

Negative human-bird interactions occur in both rural (e.g., agricultural crop destruction) and urban (e.g., bird-vehicle collisions) environments. Drones, given their operational reach and customization, offer a novel means to disperse birds from select areas in a non-lethal manner. Antipredator behavior theory offers a framework by which we can assess bird perceived risk toward drone approach, and relative to clearly defined management goals. Birds are generally assumed to respond to an approaching object (i.e., drone) as if they were assessing risk (e.g., predation risk) in the context of a cost-benefit model (i.e., the cost of escape compared to the cost associated with loss of foraging and other vital activities). However, perceived risk is also informed by characteristics of the drone (e.g., form and flight pattern). Here we present experimental and observational field case studies that inform our knowledge of bird response to drones, based on context, airframe type, and flight characteristics. We emphasize which behavioral metrics should be included in field studies to evaluate efficacy of drones in hazing applications against birds.

USDA
United States Department of Agriculture

UAS as Wildlife Hazing Tools: Considerations for Reducing Negative Human-Wildlife Interactions

Morgan B. Pfeiffer and Bradley F. Blackwell
Drone Applications in Wildlife and Spatial Ecology Symposium
The Wildlife Society 2022 Annual Conference

Wildlife Services
Protecting People • Protecting Agriculture • Protecting Wildlife

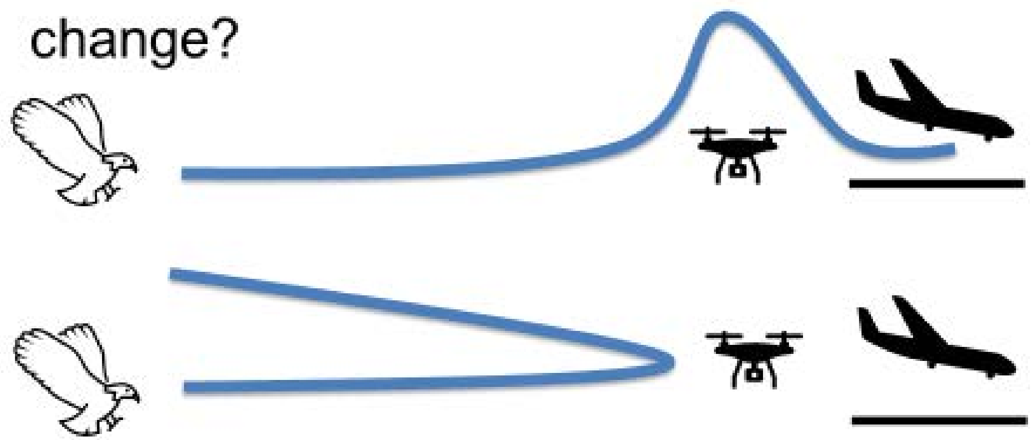
- Drone hazing applications
- Management goals
- Antipredator theory
- Perceived risk is influenced by…
- Behavioral metrics for future studies

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife


Drone hazing applications
Agriculture
Natural resources
Property
Human health and safety
Wildlife Services
Protecting People • Protecting Agriculture • Protecting Wildlife

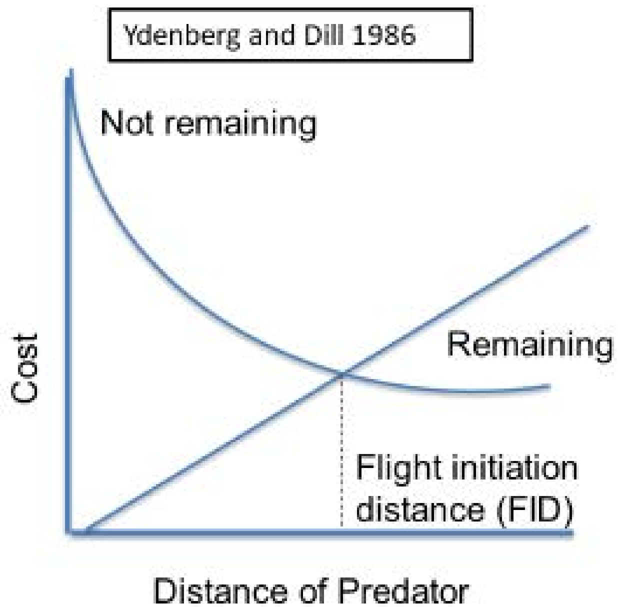
Management goals

- Clear definition of what is "success"
  - To what extent must the animal's behavior change?



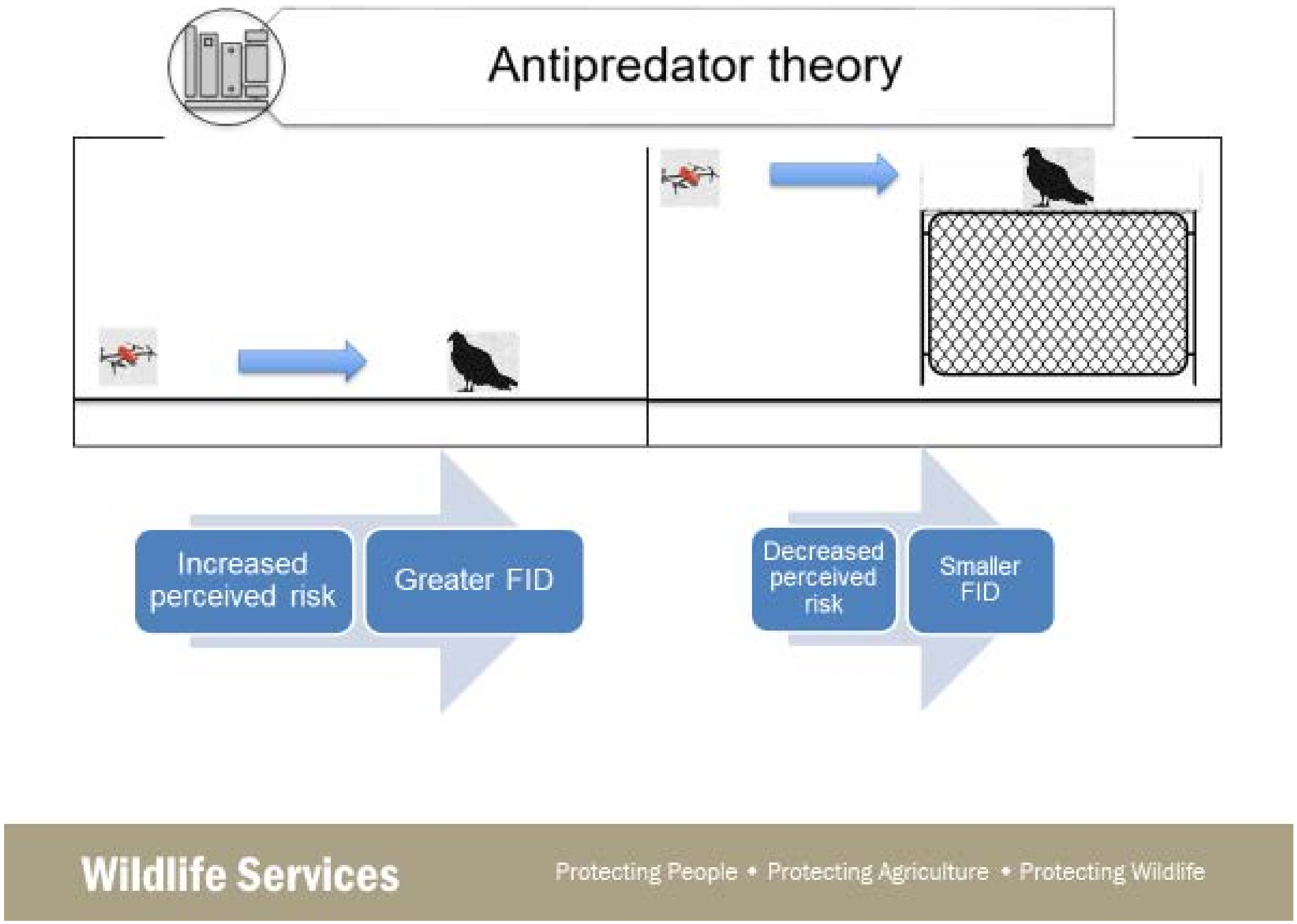
Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Antipredator theory



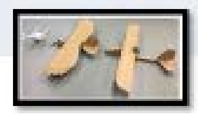
- Economics of prey escape decisions
- Limitations to vehicle applications (Lunn et al. 2022)
- Best available framework

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife


Antipredator theory
Increased perceived risk
Greater FID
Decreased perceived risk
Smaller FID
Wildlife Services
Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Response	Waterbirds McEvoy et al. 2016	Vultures Pfeiffer et al. 2021	Passerines Egan et al. 2020
Highest escape response	Delta shaped fixed-wing	Multirotor and fixed-wing	Predator
Fastest reactions	Not measured	Fixed-wing	None
Fewest birds remaining	Not measured	Multirotor	Not measured
Greatest FID	Not measured	None	Not measured



<u>Drone type</u>

Wildlife Services

Protecting People • Protecting Agriculture • Protecting Wildlife

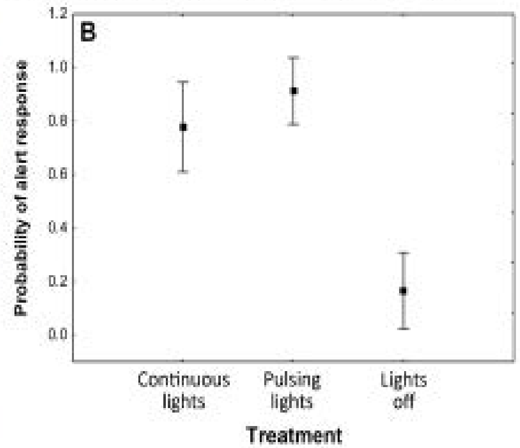
Perceived risk is influenced by…

Enhancing drone type

Geese alerted sooner with pulse light (Blackwell et al. 2012)

Cowbirds were more likely to become alert with lights (Doppler et al. 2015)

Blackwell et al. 2012



Doppler et al. 2015

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Altitude

Lower altitudes were perceived as riskier in terms of higher escape reactions, but not as measured by FID

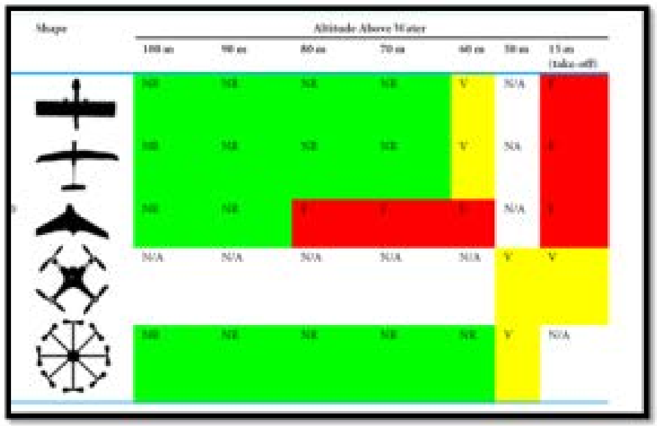


Figure from McEvoy et al. 2016. Also see: Collins et al. 2019; Egan et al. 2020; Weston et al. 2020; Pfeiffer et al. 2021

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Angle of approach

90° approaches were perceived as riskier than other angles to waterbirds (Vas et al. 2015)

0° approaches were perceived as riskier than overhead to vultures (Pfeiffer et al. 2021)

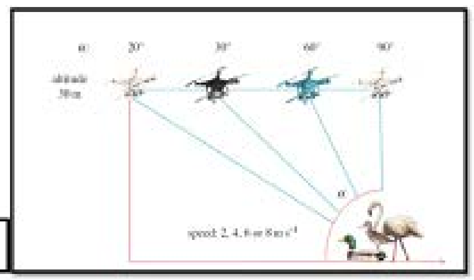


Figure from Vas et al. 2015

Wildlife Services

Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Angle of approach

Video Wildlife Services New York

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Starting distance

Higher probability of escape when launched closer

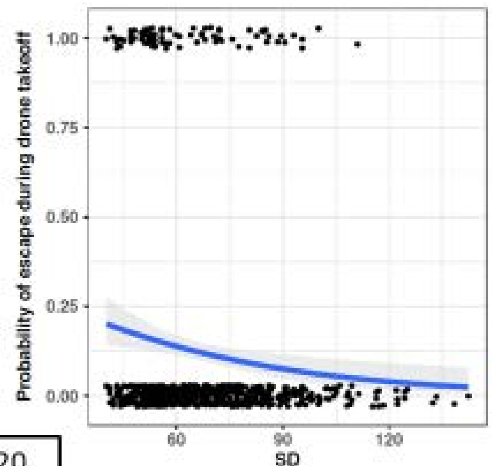


Figure from Weston et al. 2020

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Context

Waterbirds responded more in coastal/AG than lochs (Jarrett et al. 2020)

Gulls initiated escape at night, but continued to nest (Pfeiffer et al. *in prep*)

Figure from Pfeiffer et al. *in prep*

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Flock characteristics

Information exchanged about vehicle approach (Blackwell et al. 2019)

Vultures did not weigh escape decisions by flock number (Pfeiffer et al. 2021)

Waterbird flocks >25 birds were more likely to react (Jarrett et al. 2020)

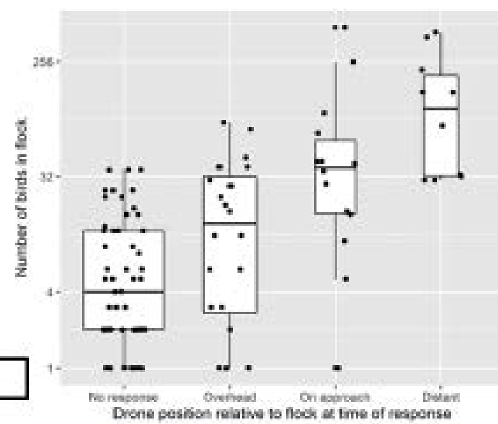


Figure from Jarrett et al. 2020

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Perceived risk is influenced by…

Individual variation

DeVault et al. 2017; 2018

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Behavioral metrics for future studies

- Probability of reaction and alert (Yes/No)
- Reaction and alert time
- Flight-initiation distance
- Bird remaining index
- Latency to return

4. Species counts *after* treatment

General gull reaction: ☐No reaction ☐All flush ☐Half flush ☐ ¼ flush ☐Other:		
#HERG:	#RBGU:	#Gull spp:
Time gulls return to treatment area:		

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Behavioral metrics for future studies

Future directions

- Interactions of factors on bird response
- Context of management goals
- Flock escape patterns

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

Behavioral metrics for future studies

Future directions

Wildlife Services   Protecting People • Protecting Agriculture • Protecting Wildlife

Acknowledgements

- FAA for funding
- USDA APHIS WS IL Program
- K. Franklin from Wildlife and Environmental Solutions
- General Dynamics and AERIUM Analytics for logistical and flight support
- Erie County Landfill
- J. Crumpton, R. Iglay, J. Elmore, K. Evans, L. Jones, S. Samiappan
- B. Blackwell, T. DeVault, E. Fernández-Juricic, T. Seamans, B. Buckingham, J. Hoblet, and S. Lima
- J. Connor, M. Lutman, M. Wilson, M. Beverick, A. Bowe, J. Kougher, I. Hemphill, M. White, B. Cross, B. Robinson, and M. S. Drabik-Hamshare

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

USDA
United States Department of Agriculture

Ohio Field Station

Last Modified: Jun 7, 2021

Print

Field Station and Project Leader: Bradley F. Blackwell, PhD
USDA/APHIS/WS — National Wildlife Research Center
Ohio Field Station
6100 Columbus Avenue
Sandusky, Ohio 44870
(419) 625-0242— phone
(419) 625-8465— fax
bradley.f.blackwell@usda.gov

Field Station Research Staff:
Brian Washburn, Research Biologist
Morgan Drabik-Hamshare, Research Wildlife Biologist
Joshua Hoblet, Wildlife Biologist
Betsy Poggiali, Budget Technician
Bruce Buckingham, Wildlife Technician

Morgan B. Pfeiffer[1] and Bradley F. Blackwell[1]

Morgan.b.Pfeiffer@usda.gov
Morgan.Drabik-Hamshare@usda.gov

Wildlife Services Protecting People • Protecting Agriculture • Protecting Wildlife

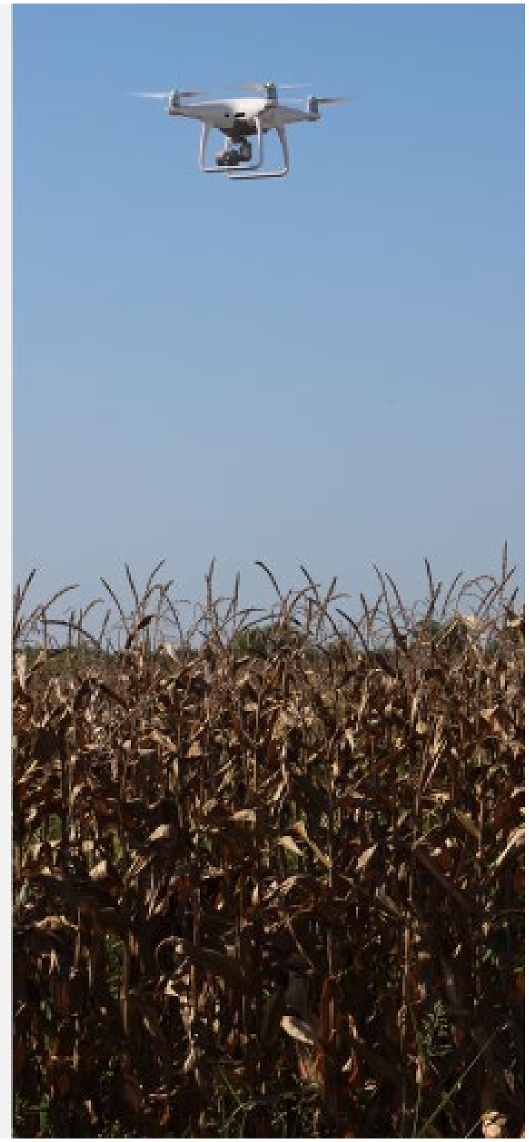
Using Drones to Detect and Quantify Wild Pig Damage and Yield Loss in Corn Fields Throughout Multiple Growth Stages

Bethany A. Friesenhahn[1], Lori D. Massey[1], Randy W. DeYoung[1], Michael J. Cherry[1], Justin W. Fischer[2], Nathan P. Snow[2], Kurt C. VerCauteren[2], & Humberto L. Perotto-Baldivieso[1]
[1]Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Bethany.Friesenhahn@tamuk.edu
[2]USDA, Wildlife Services, National Wildlife Research Center, Fort Collins, CO

There are an estimated 6.9 million wild pigs (WP; *Sus scrofa*) in the US, which cause >1 billion US$ annually in damage to agriculture, environmental impacts, and control costs. However, estimates of damages vary widely, creating a need for consistent and accurate monitoring to estimate the economic costs of direct WP damage. The goal of this study was to integrate remotely sensed imagery from small uncrewed aircraft vehicles (sUAVs) and harvest data to quantify WP damage in corn fields. We used sUAVs with natural color cameras to monitor corn fields at different growth stages in Delta County, Texas, US during 2019–2020. We flew 36 sUAV missions and classified WP damage in 28 orthomosaics by a combination of manually digitizing and deep-learning algorithms. We compared estimates of damage from sUAV imagery to those derived from ground transect surveys. Finally, we compared damaged areas of fields to maps of collected real-time yields at harvest to estimate yield loss. All classified sUAV orthomosaics had >80% overall accuracy. Ground transect surveys, which subsampled 2.6-4.1% of the field, underestimated damage compared to sUAVs. Most damage occurred in latter growth stages when corn ears were maturing and most nutritious. WPs damaged up to 9.2% of the area of a field, resulting in a cost loss to producers of \$17.18–48.24 per ha of damage. sUAV imagery combined with spatially explicit harvest yield data provides an accurate assessment of crop damage and yield loss due to WPs in the currency required for the cost-benefit evaluation of management actions.

USING DRONES TO DETECT AND QUANTIFY WILD PIG DAMAGE AND YIELD LOSS IN CORN FIELDS THROUGHOUT MULTIPLE GROWTH STAGES

Bethany A. Friesenhahn, Lori D. Massey, Randy W. DeYoung, Michael J. Cherry, Justin W. Fischer, Nathan P. Snow, Kurt C. VerCauteren, & Humberto L. Perotto-Baldivieso



Biography of an invasive species

Wild pigs vs. Agriculture

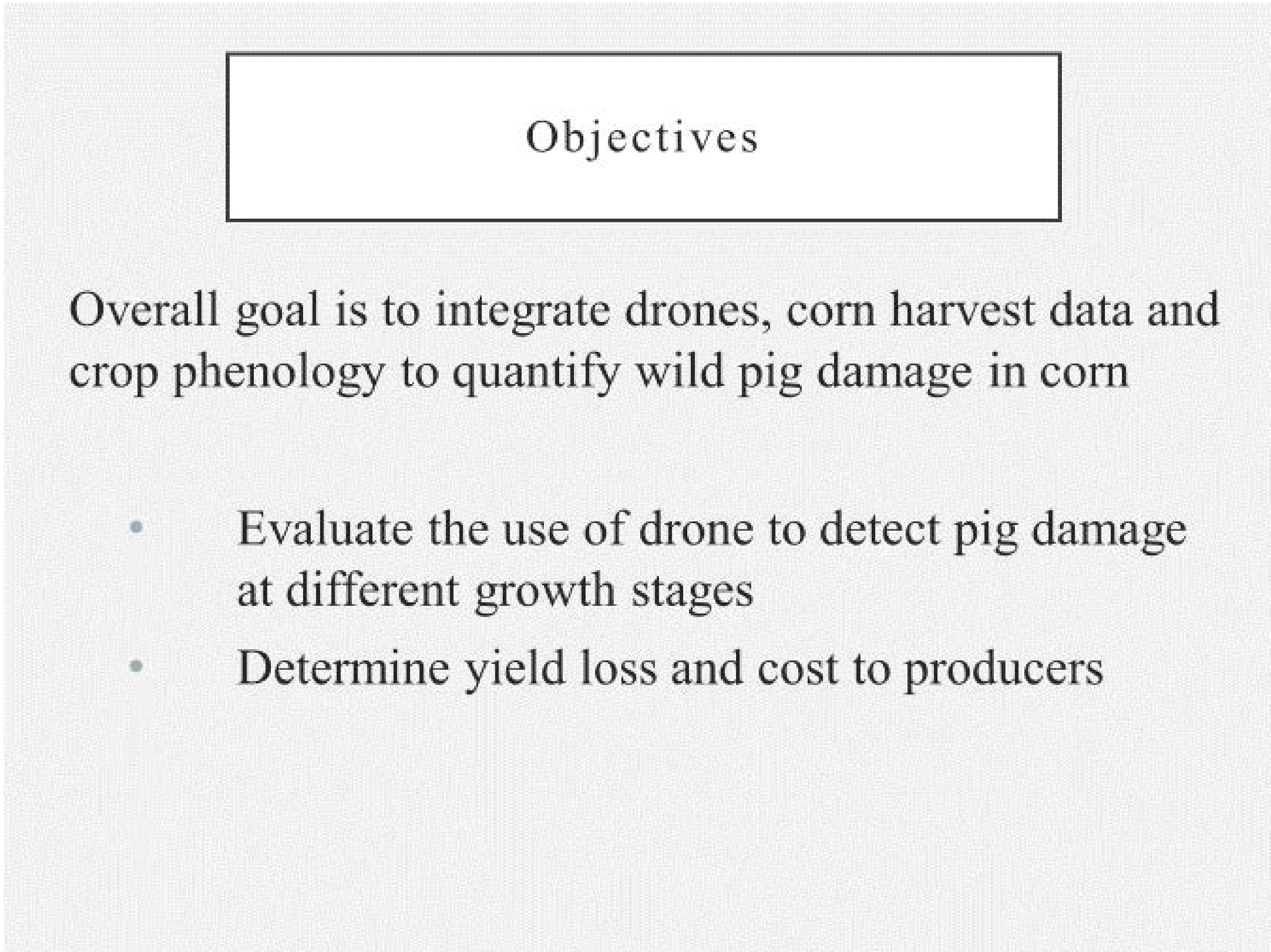
- Crops can be an important part of a wild pigs' diet when available
- Wild pig range expansion = greater negative impacts to agriculture
- Damage to agriculture already costs millions of US dollars annually

How do we know how much wild pig damage costs the farmer?

- Traditionally, assessment of wild pig damage and economic costs relies on producer surveys and ground sampling
- More recently, drones have been used as a tool for wild pig and wildlife damage assessments
- Drones provide high-resolution data at a field scale

Research Needs

- Standardized metrics to quantify impacts
- Data gaps in extent and cost of damage
- No study has combined precision agriculture and drones to classify and estimate accurate yield loss


Objectives
Overall goal is to integrate drones, corn harvest data and crop phenology to quantify wild pig damage in corn
• Evaluate the use of drone to detect pig damage at different growth stages
• Determine yield loss and cost to producers

Study Area

Methods: Drone Flights

- DJI Phantom IV RTK
  - 100 m altitude
  - Pix4D image processing
- Corn Growth Stages
  - Establishment (VE)
  - Vegetative
  - Blister-milk (R2)
  - Dent-mature (R6)

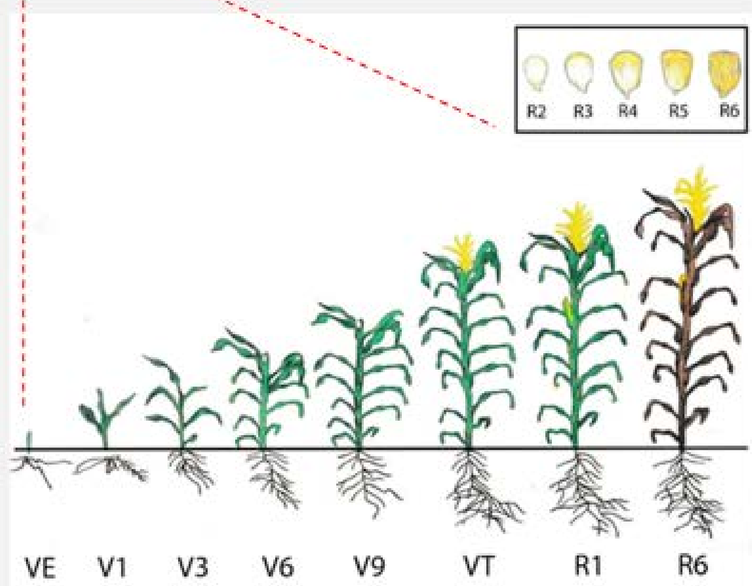
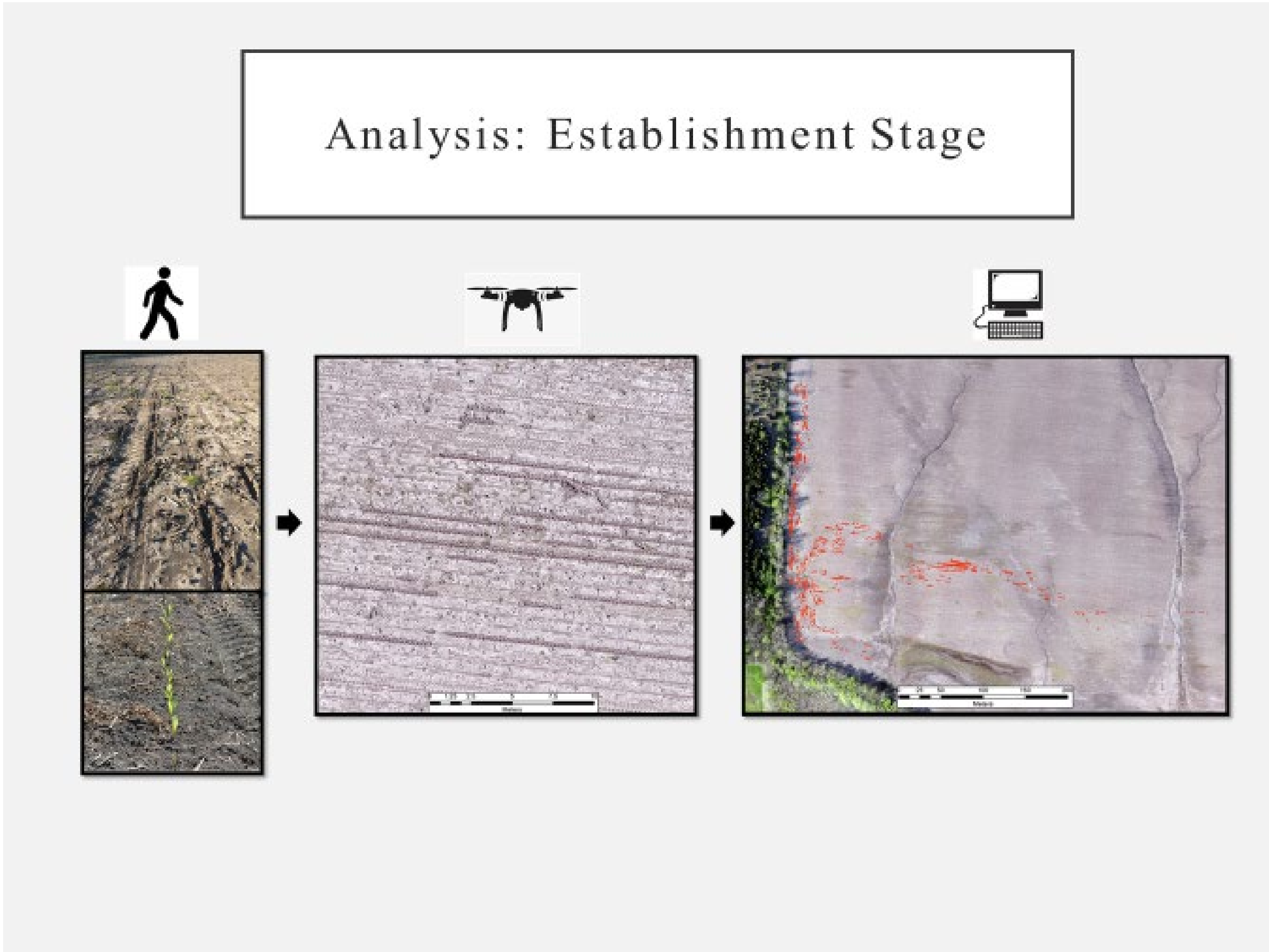
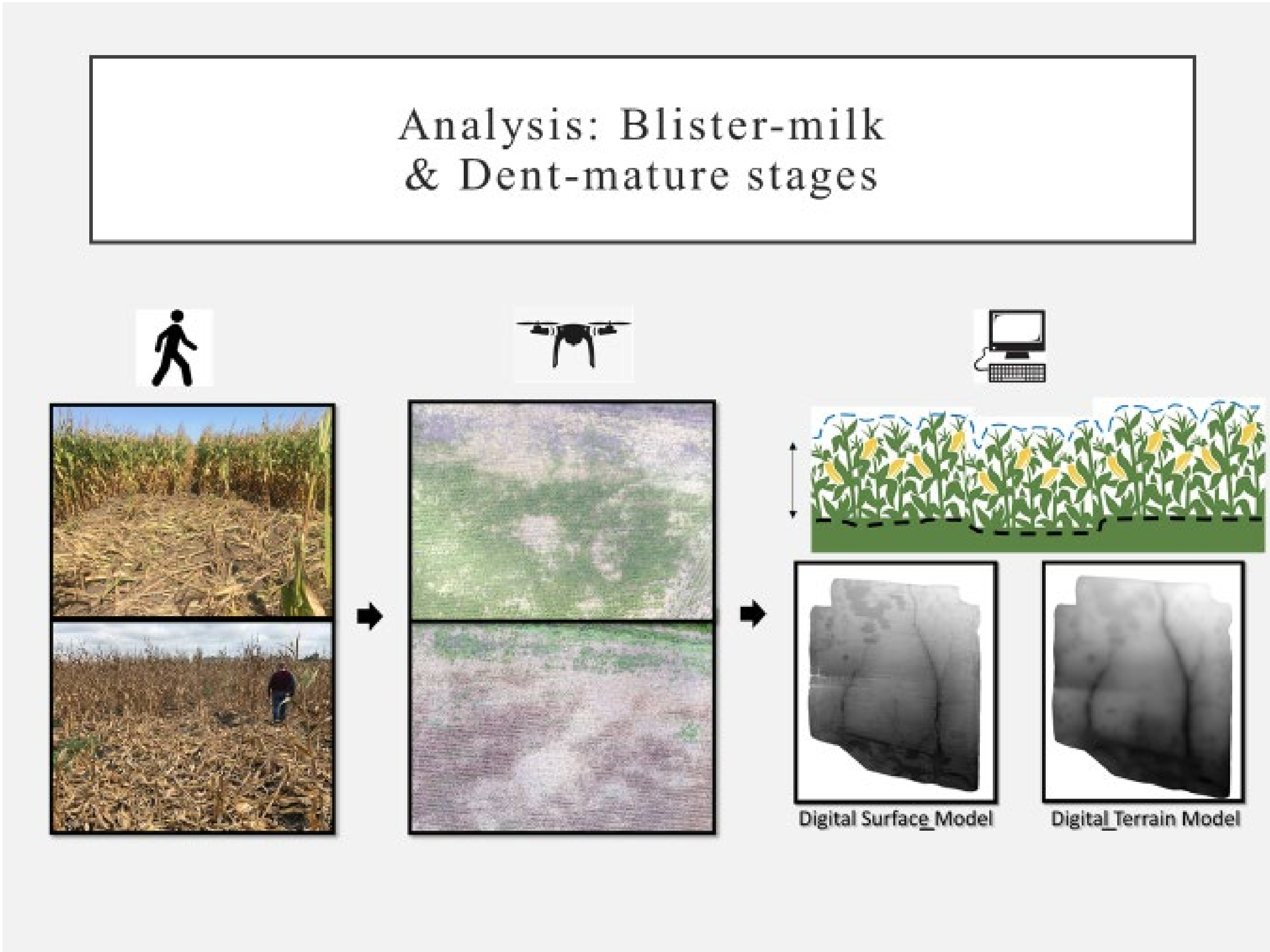


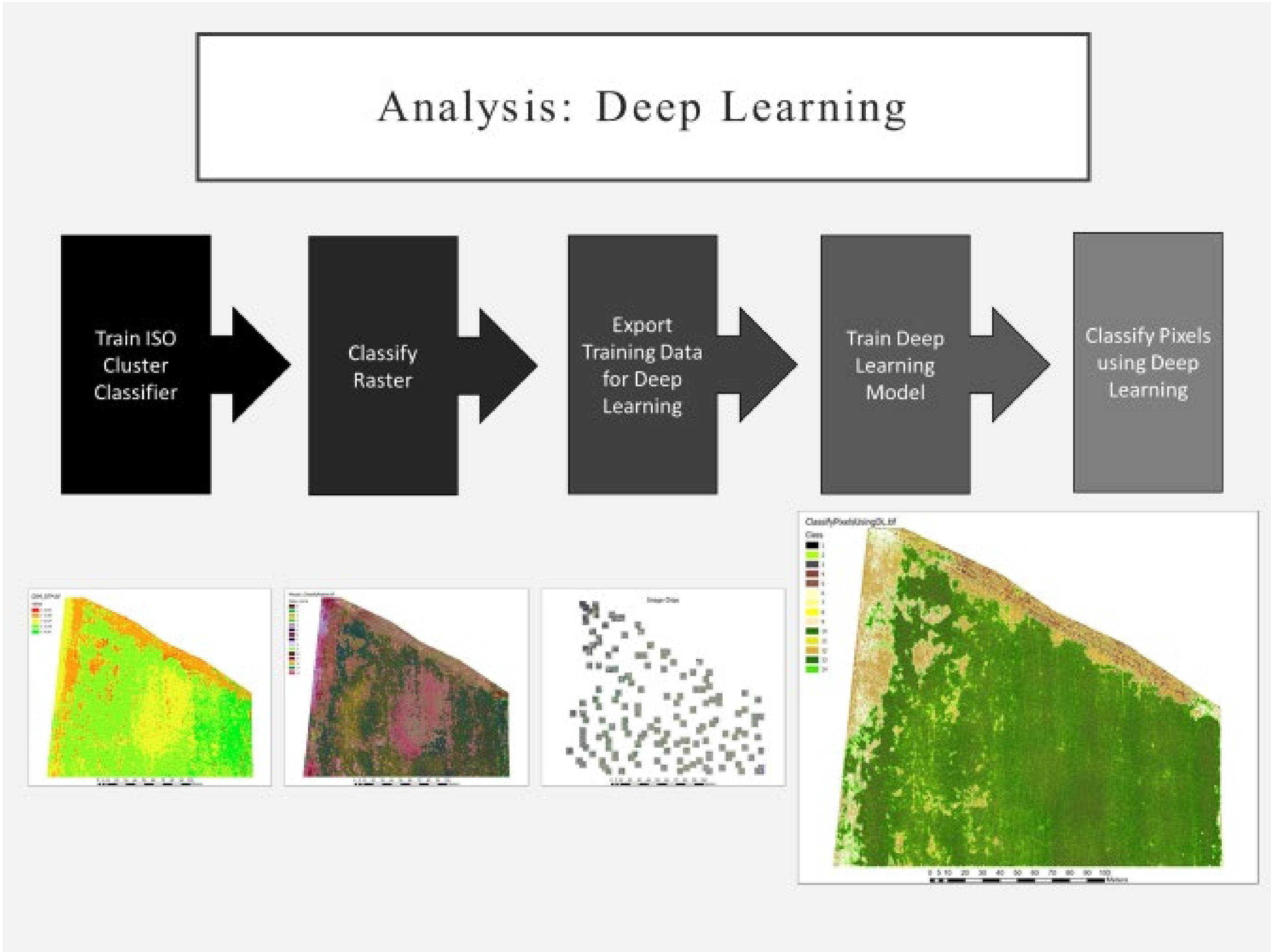
Figure by Victoria Cavazos

Methods: Ground Surveys

Methods: Harvest Yield Map


Analysis: Establishment Stage


Analysis: Blister-milk
& Dent-mature stages
Digital Surface Model
Digital Terrain Model

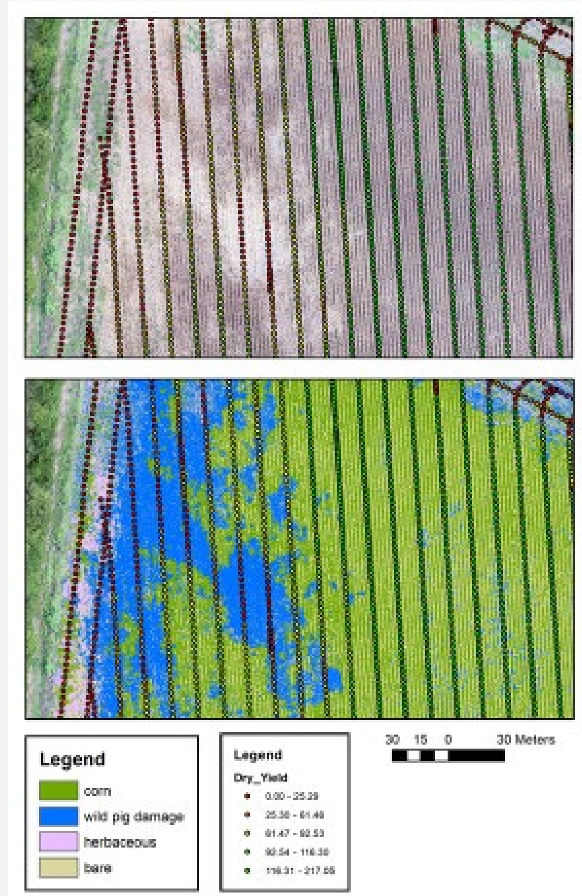

Analysis: Deep Learning
Train ISO Cluster Classifier
Classify Raster
Export Training Data for Deep Learning
Train Deep Learning Model
Classify Pixels using Deep Learning

Analysis: Accuracy Assessments

- Reclassified to 4 classes
- 400 random points
- Confusion matrix
- Overall accuracy $\geq$80%

Analysis: Final classified image and harvest data

- Extract multi-values tool in ArcMap 10.8
- Mean yield of corn and damage
- Estimated Cost of Damage:
  - *Corn mean yield – Damage mean yield = Loss in yield*
  - *Loss in yield * Corn prices = Cost*
  - *Cost * area of wild pig damage (ha) = Total Loss*



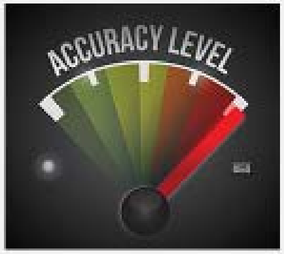
Results: Flights Table

- Establishment: 4 flights
- Blister-milk: 3 flights
- Dent-mature: 3 flights

Year	Field	Planting Date	Establishment	Vegetative	Blister-milk	Dent-mature
2019	1	21-Mar	**1-Apr**	22-May 19-Jun	9-Jul	13-Aug
	2	22-Mar	**1-Apr**	22-May 19-Jun	9-Jul	13-Aug
	3	22-Mar	**1-Apr**	22-May 19-Jun	9-Jul	13-Aug
	9	19-Mar	**2-Apr**	22-May	**9-Jul**	**26-Jul**
	14	2-Apr	3-Apr	22-May 20-Jun	**9-Jul**	**23-Aug**
2020	1	19-Apr	6-May		16-Jul	4-Aug
	2	19-Apr	6-May			
	3	8-Apr	6-May		16-Jul	
	8	17-Apr	6-May		16-Jul	4-Aug
	11	27-Mar, 10 - Apr, 16-Apr	6-May		**16-Jul**	**4-Aug**

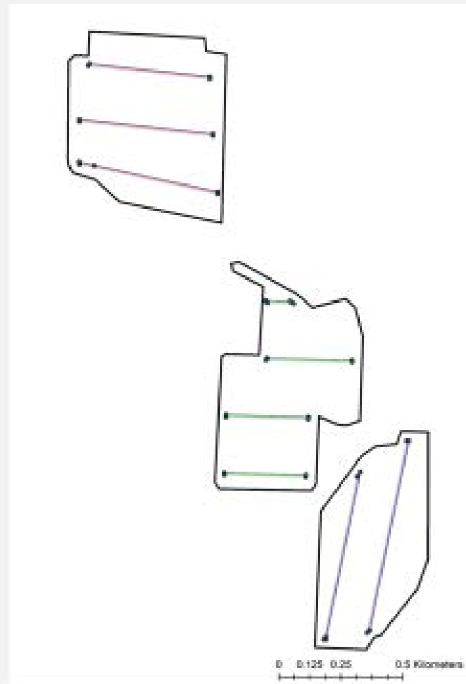
Results: Accuracy Assessment

Year	Site	Stage	Overall accuracy
2019	Field 9	Blister-milk	**87.6%**
		Dent-mature	**86.5%**
		Combination	**80.0%**
	Field 14	Blister-milk	**87.4%**
		Dent-mature	**88.0%**
		Combination	**83.5%**
2020	Field 11	Blister-milk	**90.3%**
		Dent-mature	**87.9%**
		Combination	**88.4%**



Results: Establishment

- No damage recorded during ground surveys
- Drone imagery:
  - Field 1: 2,454 linear m (0.20 ha, 0.47% of the field)
  - Field 2: 137 linear m (0.009 ha, 0.02% of the field)
  - Field 3: 3 linear m (0.0002 ha, 0.00% of the field)
  - Field 9: no damage



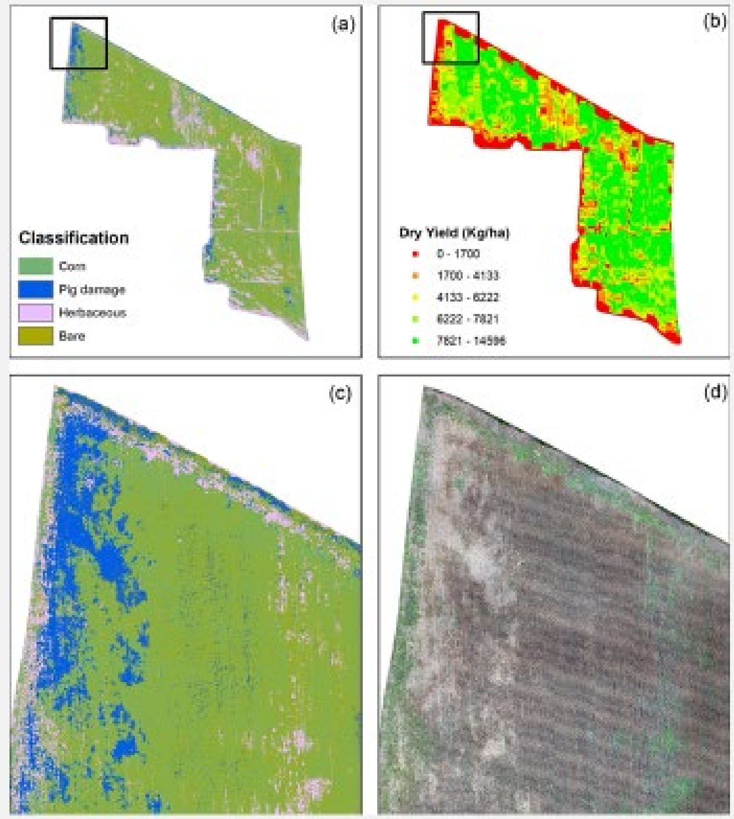
Results: Blister-milk & Dent-mature

- Ground surveys estimated less damage than drones

Year	Site	Field ha	Stage	Ground %	Drone %
2019	9	21 ha	Blister-milk	0.57%	2.50%
	9		Dent-mature	1.73%	2.10%
	14	112 ha	Blister-milk	0.75%	1.06%
	14		Dent-mature	3.80%	4.14%
2020	11	59 ha	Blister-milk	0.62%	3.26%
	11		Dent-mature	1.57%	2.62%
			$\bar{x}$ =	1.51%	2.56%

Results: Yield Loss

- Damaged ranged from 0.98 to 10.3 ha per field
- Damaged areas caused >50% loss in yield compared to undamaged
- Total loss: \$17.18 - \$48.24 per ha

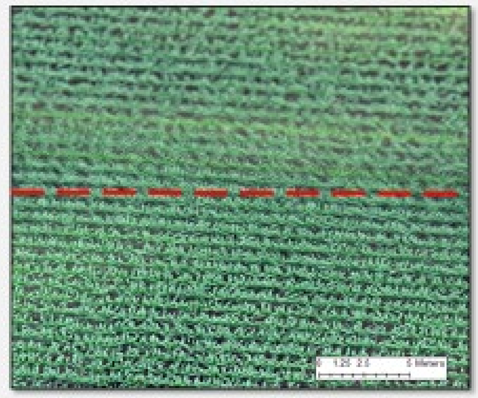


Conclusion

- Overall, drones are an efficient tool for mapping extent of pig damage throughout 100% of the field, covering >95% area that our ground surveys
- We were able to detect damage at all stages using drones
- Most damage occurred in the blister-milk and dent-mature stages
- Producers are losing income to wild pigs

Drone Imagery Challenges

- Drone flight conditions
- Image processing
- Differentiating pig damage from other types of damage



Management Implications

- Methods can be used for other crops
- User friendly
- Accurately estimate loss in yield - insurance compensation and justify cost-benefit of control efforts

Acknowledgements

- USDA APHIS NWRC crew – Mike Lavelle, Joe Halseth, Michael Glow, Eric VanNatta, Christine Ellis
- Texas Wildlife Services – Mike Bodenchuk, Bruce Leland, Kyle Patterson, Kade Kennemer
- CKWRI faculty, staff, & students
- The Rotary Club of Corpus Christi Harvey Weil Sportsman Conservationist Award
- Private landowners and producers in Delta County, TX

TEXAS A&M UNIVERSITY KINGSVILLE

CAESAR KLEBERG WILDLIFE RESEARCH INSTITUTE TEXAS A&M UNIVERSITY-KINGSVILLE

USDA APHIS

Wildlife Services NWRC National Wildlife Research Center


Questions?
bethany.friesenhahn@tamuk.edu