Deer Detection in a Nature Preserve: Applying Geospatial Analysis

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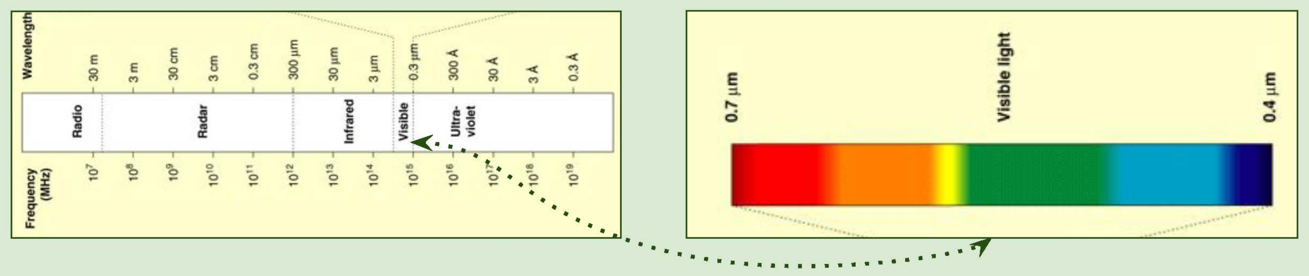
Introduction

- Dense deer populations threaten human and environmental health, serving as vectors of Lyme disease and destroyers of the forest understory.
- Obtaining a population estimate is vital to manage deer impact.
- Use of applied geospatial techniques can assist in assessing deer populations at a reduced cost to Binghamton University.
- **Purpose: to determine if pairing UAVs, ground surveillance, and thermal cameras can produce a deer population estimate.**

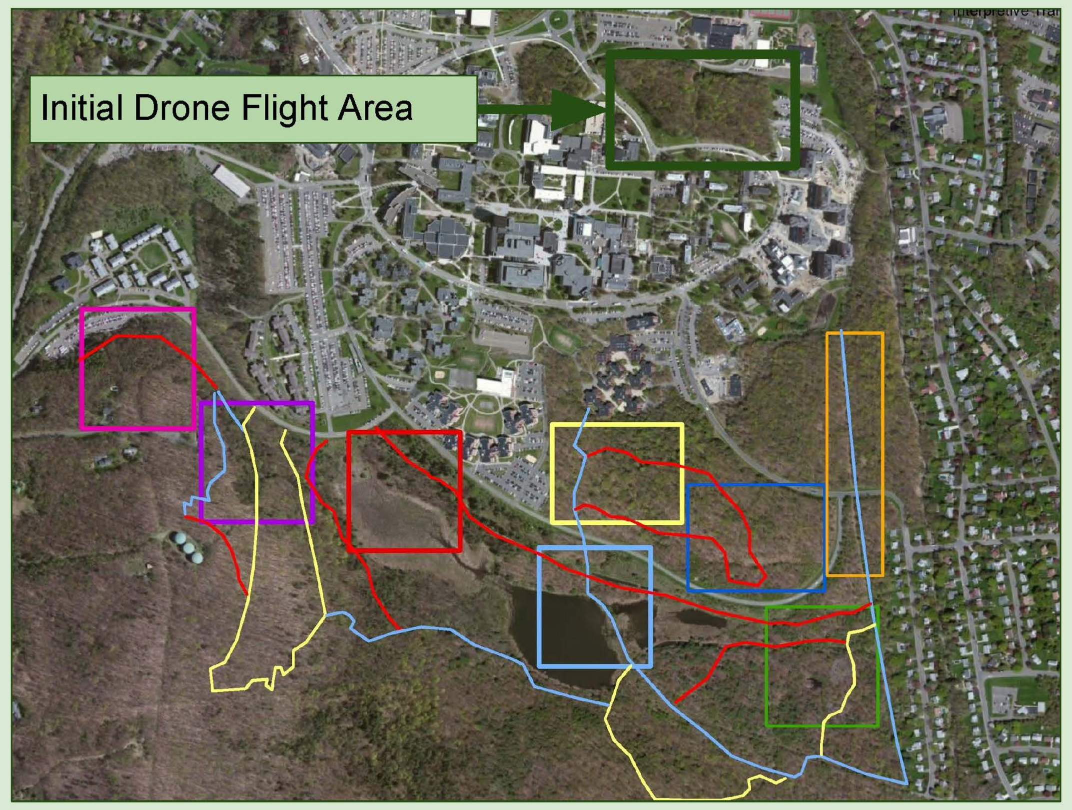
Electromagnetic Spectrum



Study Area

- Binghamton University nature preserve was established in 1969 as a protected designated area for recreational and instructional use.
- Located near a large urban population, contains a sizeable known deer population, and campus resources provide the technology for thermographic aerial surveillance.
- 20 tax parcels over 182 acres varying in size, grade, and deer density.
- Owned by Binghamton University and associated State agencies.
- Dense tree canopy and thick vegetative cover, leading researchers to utilize thermal imaging and UAVs during the winter.
- Densest deer populations in the winter are found in edge habitats at lower elevations, with gentle slopes, and close to human habitation.

Areas of Interest



Methodology

- Map tax parcels and trails owned by Binghamton University
- Map cross sectional diagrams of parcels to illustrate gradient.
- Ground level reconnaissance utilizing winter snow-cover to estimate deer density by geocoding location of tracks, droppings, and animal sightings.
- Collected ground level thermal images (Flir One for iOS 80x60 resolution) and panchromatic images of deer, tracks, and droppings.
- Ground level thermal images to obtain thermal signature of deer.
- Used thermal signature of deer to calibrate UAV thermal camera.
- Prioritize overflights in areas with the densest population.
- Created flight plans to capture both still photos and videos.
- Performed flights to test the effectiveness of Zenmuse XT infrared camera (640/30 FPS) and low light camera (1920 x 1080p / 30 FPS).
- Used Drone2Map software to process images for detection of deer.
- Created story map to illustrate findings.

Literature Review

- Different species in the same area led to difficulties identifying animals, especially white tailed deer.[3]
- Population density for population management.[3]
- Detecting wildlife in agricultural fields.[4]
- Far red/near infrared wavelengths most effective for detecting mule deer; detection error minimized by snow cover.[5]
- Combining RGB and TIR spectral bands produced the most accurate deer count; low thermal contrast between air temperature and deer reduced accuracy.[6]
- Air temperature below thermal signature of deer (70°F), snow cover on ground, and lack of vegetation are optimal conditions.[7]

Conceptual Framework

Deer Identification

Environmental Factors
- vegetation
- animal behavior
- snowcover
- weather limitations

Technology
- UAV/Drone
- thermal cameras

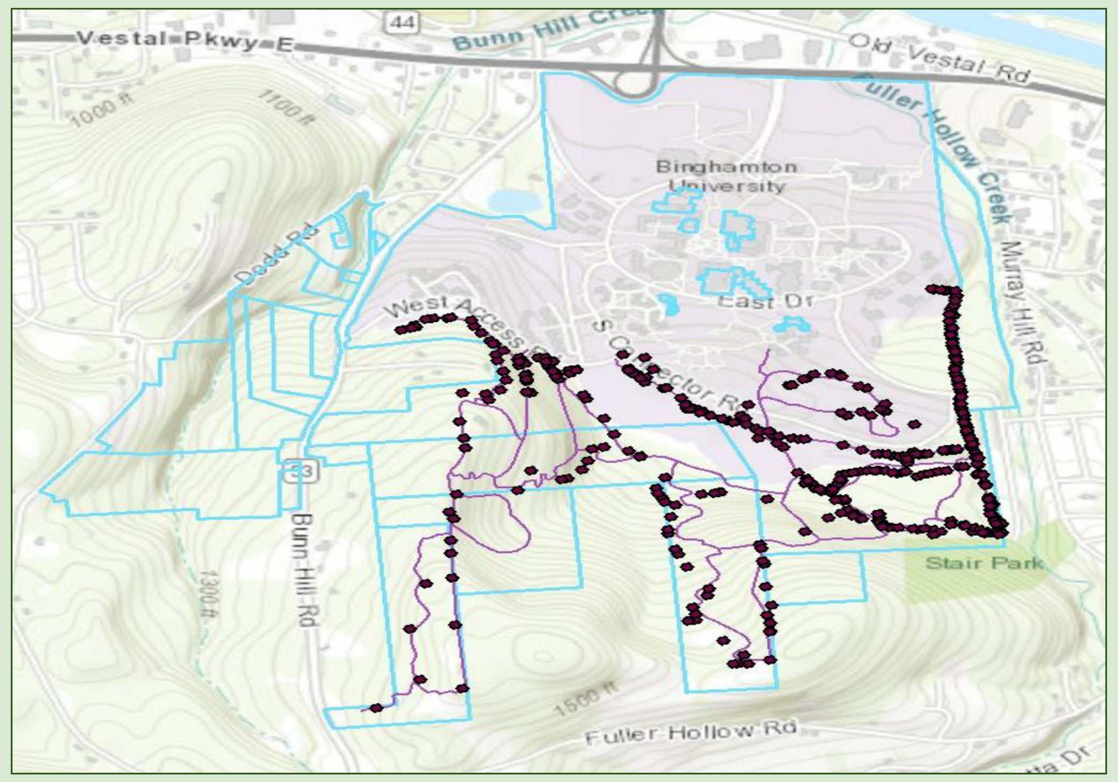
Human Spatial Factors
- people as a food source
- edge habitats

Hypothesis

- UAV overflights/ground surveillance paired with thermal cameras are viable strategies to obtain deer population density in the Binghamton University nature preserve.

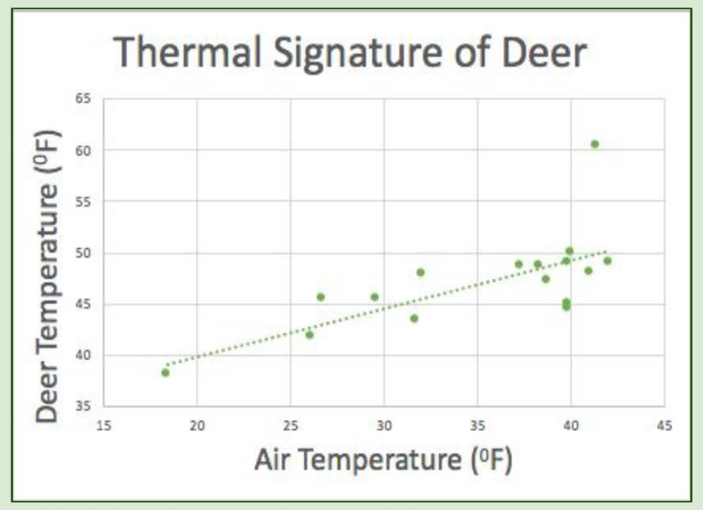
Results and Analysis

Tax Parcels, Topography, & Geocoded Deer Density Determined by Ground Surveillance



- Approximately 400 signs of deer (tracks/droppings/sightings) were recorded through ground level surveillance in the tax parcel located closest to campus.
- The most remote tax parcel at the highest elevation in the nature preserve contained only 9 signs of deer.
- Snow cover aided ground detection of deer, tracks, and droppings.
- Lack of snow or muddy conditions made detection extremely difficult.
- Use of FlirOne thermal camera concluded that thermal signature of deer follows a near linear trend based on air temperature.
- Inclement weather inhibited collection of aerial and ground data.
- The drone's thermal camera detected heat signatures at an altitude of 150 feet.
- The low light, high resolution camera proved to be most effective in identification of objects on the ground.
- Varying tree height and changes in elevation created hazardous flying situations.
- Drone battery life was reduced by cold weather, limiting flight times.
- Litchi's 100 waypoint maximum restricts the total area and the number of pictures that can be collected during each flight.
- https://arcg.is/DHTKq

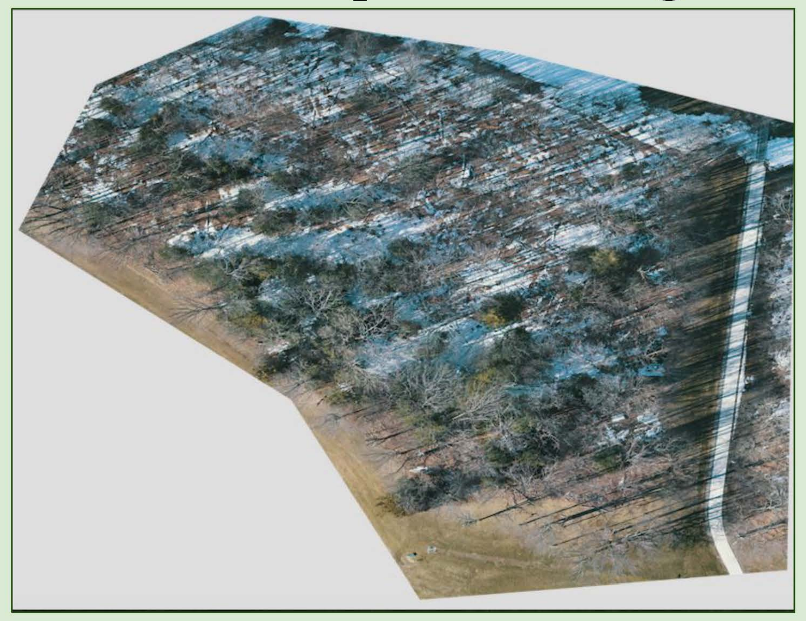
Ground Level Thermal/Panchromatic Comparison



Aerial Thermal/Panchromatic Comparison

Litchi Flight Plan

Drone2Map Aerial Image



Conclusions

- Densest deer populations are found closest to human habitation and at lower elevations.
- Inclement weather (precipitation and high wind speeds) prevented ground level reconnaissance and UAV overflights.
- Ideal conditions for data collection include dry days with snow cover on ground, low wind speed, and below freezing temperatures.
- Extreme caution must be taken when flying drones over the tree canopy.
- Low light and standard cameras were more effective when identifying objects from the air.
- Thermal cameras and ground observation were more effective when identifying deer on the ground.
- Battery life of the UAV and Federal Aviation Administration's restrictions imposed on Drone users limited area surveyed during each flight.

Future Research

- Future research using collected data will include more UAV overflights to determine deer density from the air.
- Calibration of the drone's thermal camera using thermal signature of the deer will increase chances of detection.
- Utilizing high resolution Zenmuse XT thermal camera and flying during times of low light (early morning or late evening) may aid identification of deer with thermal cameras.

Credits

1. Michael Davis assisted with an earlier form of the project.
2. Geography 581D assisted with the collection of ground level thermal images of deer.
3. L.-P. Chrétien, et al. "WILDLIFE MULTISPECIES REMOTE SENSING USING VISIBLE AND THERMAL INFRARED IMAGERY ACQUIRED FROM AN UNMANNED AERIAL VEHICLE (UAV)." *The International Archives of the Photogrammetry*, 2015, pp. 241–248.
4. Peter Christiansen, et al. "Automated Detection and Recognition of Wildlife Using Thermal Cameras." *Sensors*, vol. 14, no. 8, 2014, pp. 13778–13793.
5. Terletzky, Patricia, et al. "Spectral Characteristics of Domestic and Wild Mammals." *GIScience & Remote Sensing*, July 2012, doi:10.2747/1548-1603.49.4.597.
6. Chretien, Louis-Phillipe, et al. "Visible and Thermal Infrared Remote Sensing for the Detection of White-Tailed Deer Using an Unmanned Aerial System." *Wildlife Society Bulletin*, vol. 40, no. 1, 2016, pp. 181–191., doi:10.1002/wsb.629.
7. Nau, Philip. "A Study of the Deer Herd on the RIT Campus and the Relationship of Herd Activity and Habitat to the Incidence of Deer-Vehicle Collisions." *RIT Scholar Works*, May 2013.