

Drone Occupancy Surveys on the BCCE

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1 Introduction

- Resi
- Drone Surveys
- Computer Vision

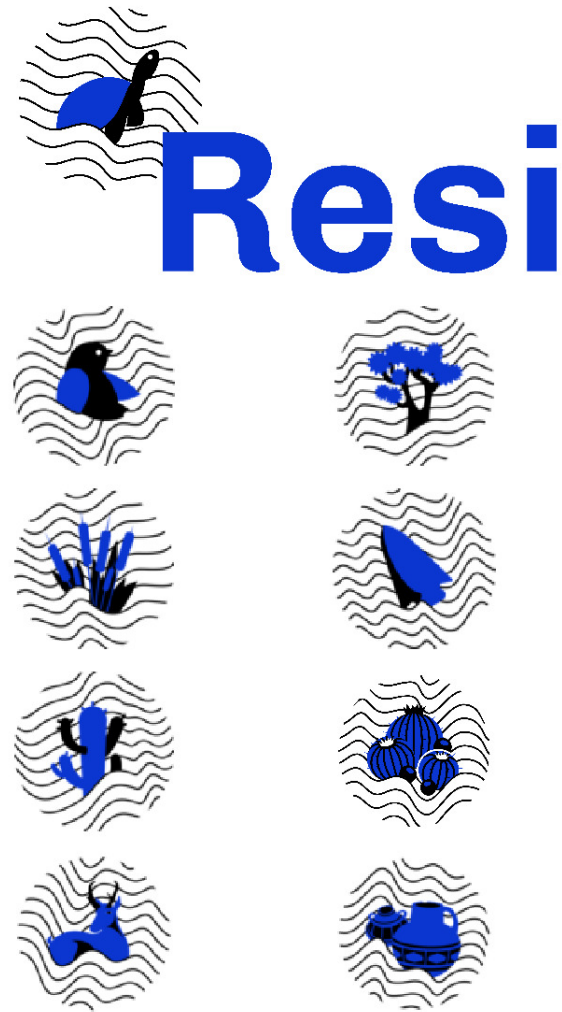
2 BCCE Surveys

- Boulder City Conservation Easement
- Weather
- g_0 estimate
- Distance analysis - DRONEDISTANCE
- Results

3 Conclusions

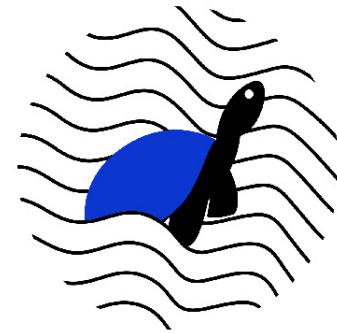


We apply 21st-century tools like drones, artificial intelligence, and computer vision to make data collection better, faster, safer, and more efficient.



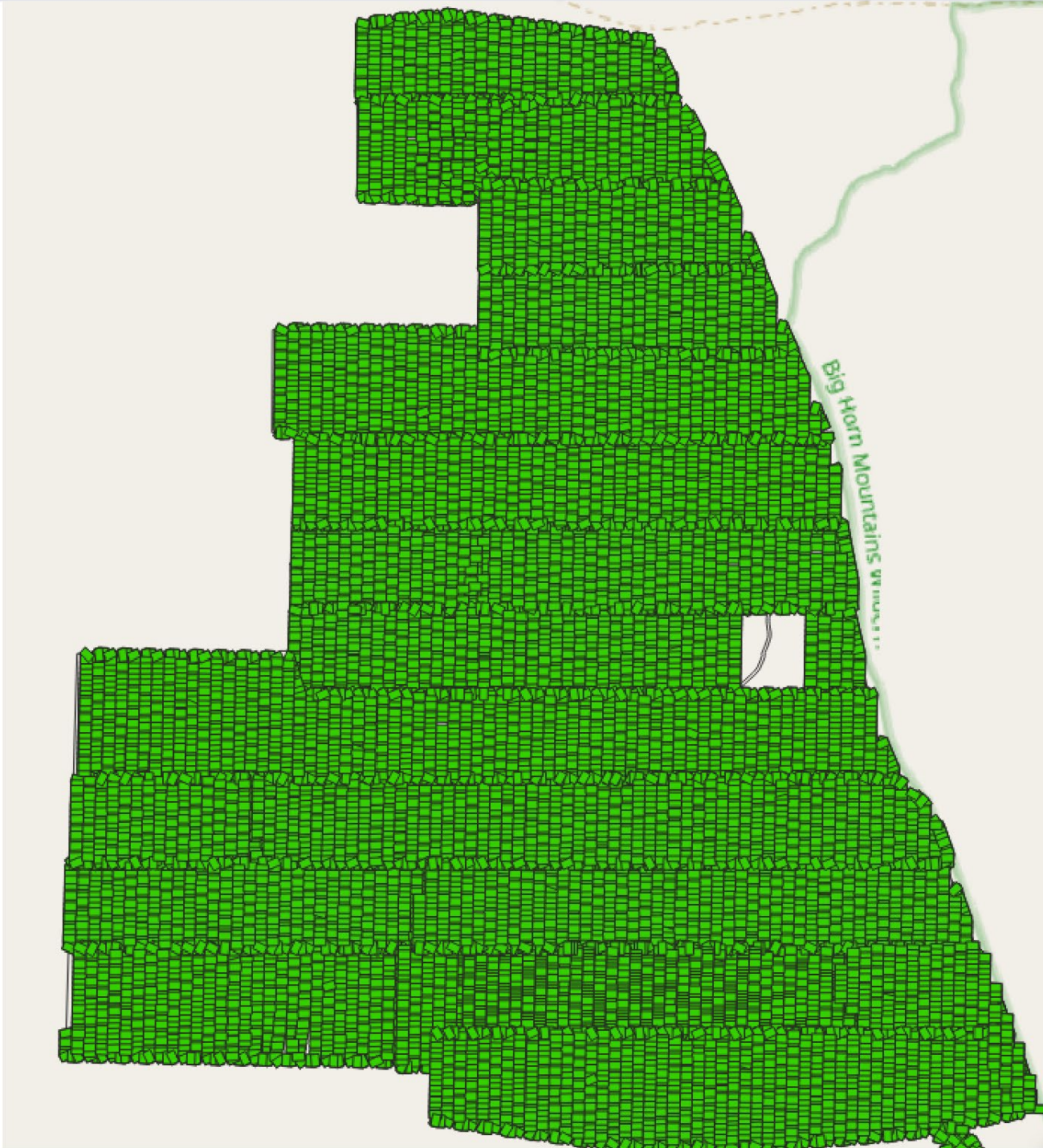
History:

- 2021
 - Experiments with styrotorts
- 2022
 - USFWS Arena test (NV)
 - Red Cliffs Desert Reserve, 5000 ac (UT)
- 2023
 - Red Cliffs Desert Reserve, 2600 ac (UT)
 - Bolsón de Mapimi, 8600 ac (Mexico)
 - Tortoise surveys, 1100 ac (CA)
 - Joshua Trees (CA)
- 2024
 - Indian Springs site, 5000 ac (NV)
 - BCCE, 2244 ac (NV)



Drone Surveys

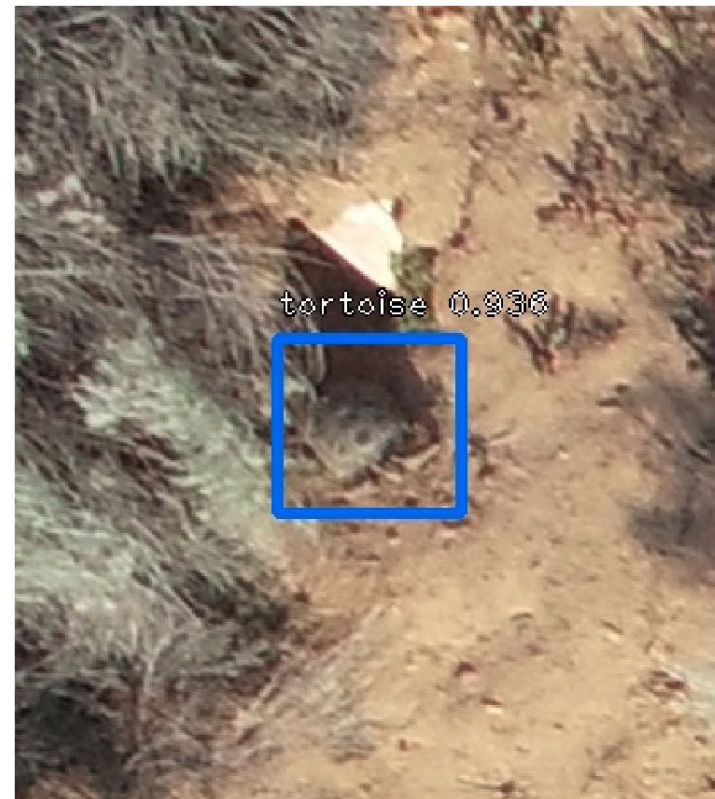




Object Detection

- Manually tag images to assemble training data
- Train a neural network to detect tortoises and burrows

 PyTorch

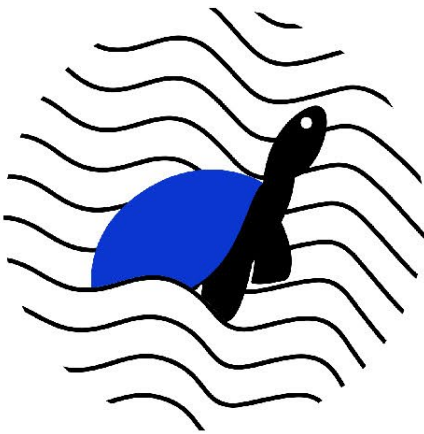




Tortoise Model:

- n=657
- Trained on *agassizii* (n=384), *flavomarginatus* (243), and some styrotorts (n=30)
- Segregate training (80%) and validation (20%) sets
- Recall=89% (+5%)





- Drone flown by Bio Logical
- Training and analysis provided by Resi
- Performed in conjunction with pedestrian surveys
 - One day earlier
- 70 established 200x200 m plots
- Typically 6/day



Boulder City Conservation Easement

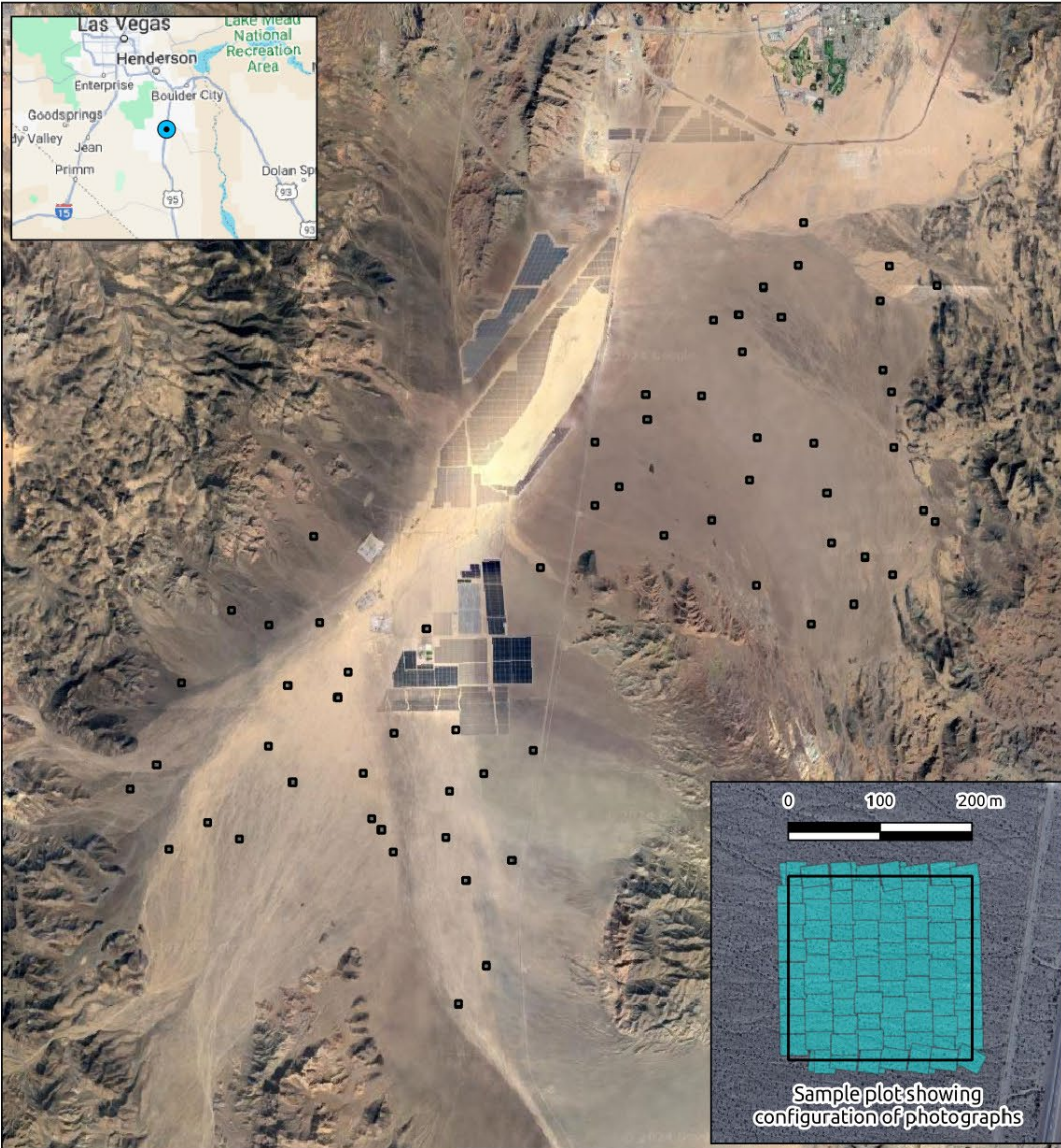


- 59 plots + 5 partial
- 17,294 photographs
- 350,000 image tiles
- Each plot ~ 12.1 ac
- Each plot was flown 3 times
- 34 survey days
- Key point - drone surveys should be conducted before 1 PM

BCCE Tortoise Surveys
Project Location
Resi-2024-015

0 4 8 km

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□ Survey plots
■ Drone photos



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Boulder City Conservation Easement



Boulder City Conservation Easement



Boulder City Conservation Easement



- 7 unique tortoise detections
 - 6 adults
 - 1 juvenile
 - 0 carcasses
- 0.2 detections / pilot-day
- Located in south and northeast

BCCE Tortoise Surveys
Tortoise Detections
Resi-2024-015

Tortoise detections

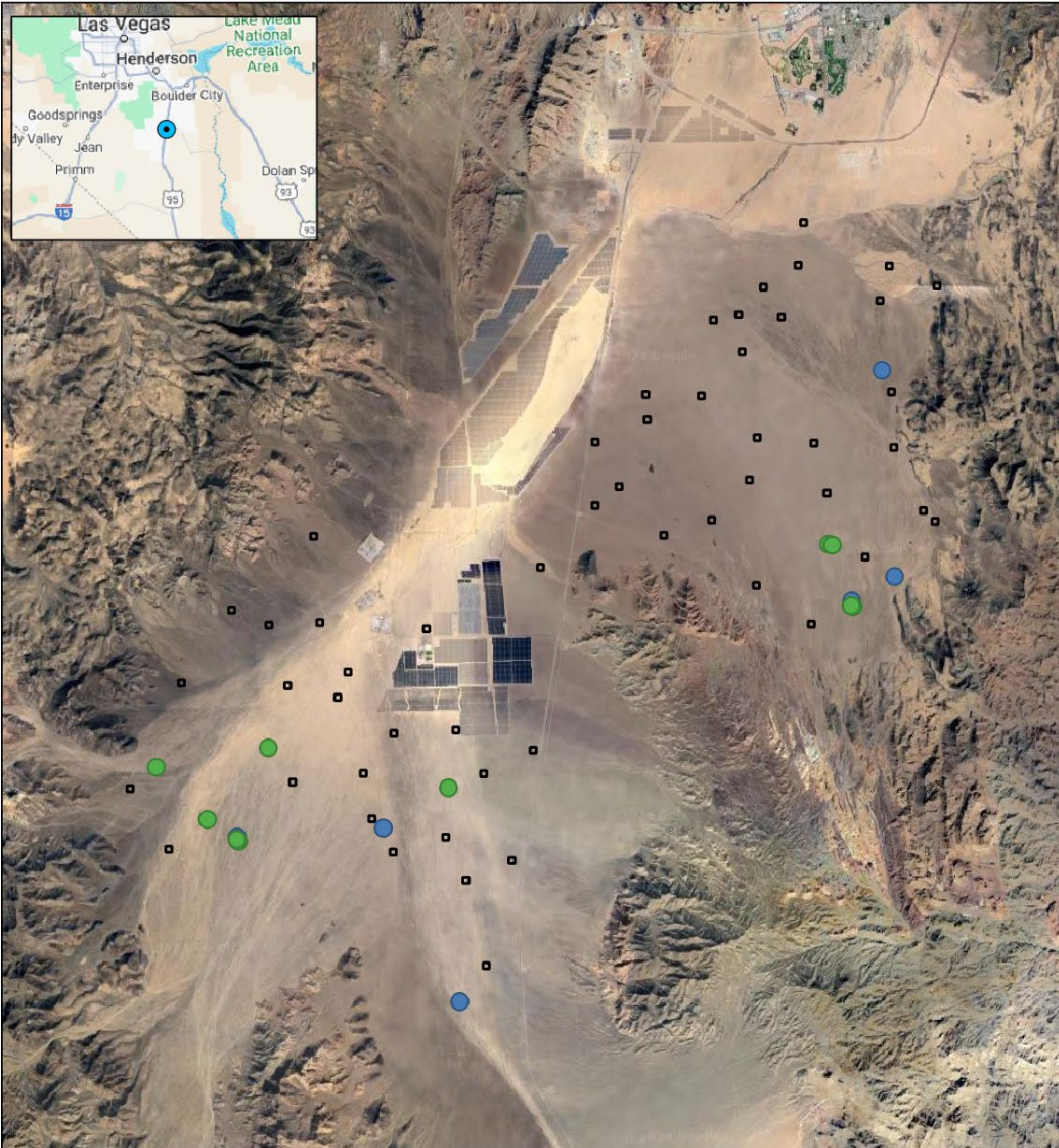
- Adult
- Juvenile
- Survey plots



0 4 8 km



Boulder City Conservation Easement



- Soil burrows
- 16 active and/or in good condition
- Also in south and northeast

BCCE Tortoise Surveys
Burrow detections
Resi-2024-015

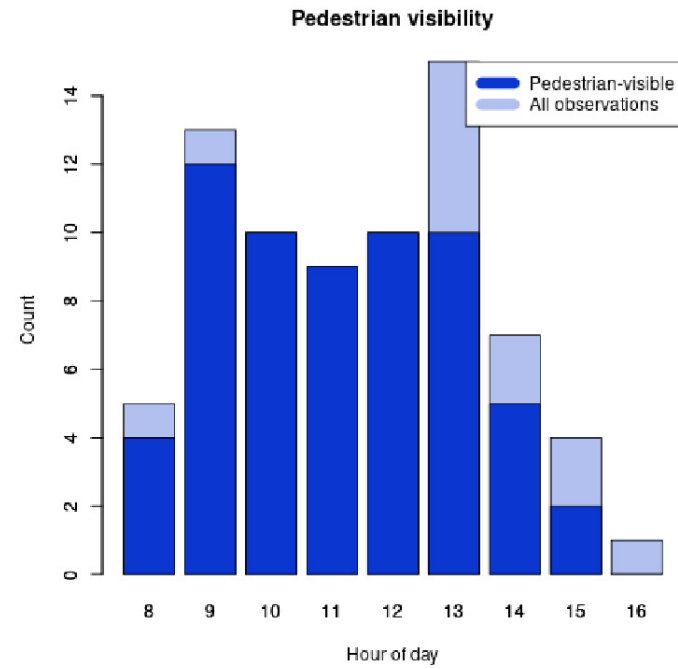
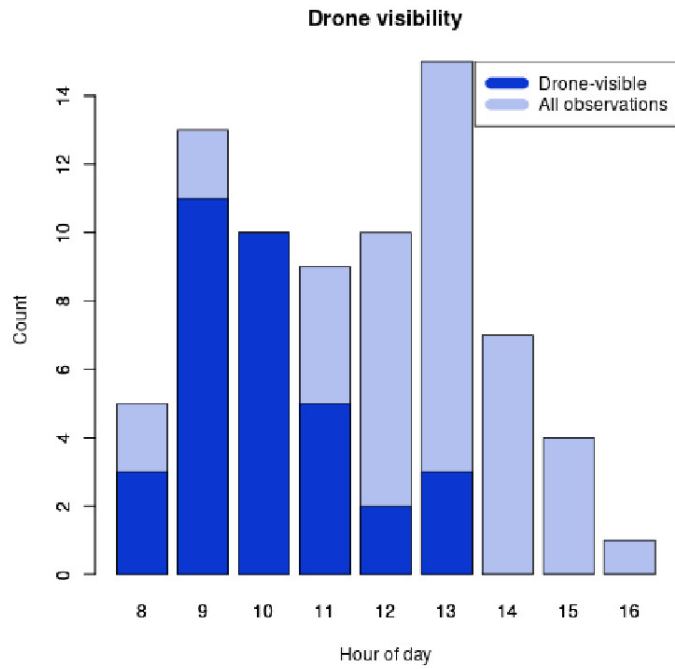
Burrow detections
● Active
● Good
□ Survey plots



- Cold spring
- Pedestrian crews did not see aboveground animals until 4/19
- Mojave Max emerged on 4/23
- Earliest drone adult tortoise detection on 4/29
- Analysis limited to survey period on or after 4/19
- 18/34 survey days
- 1171 acres flown



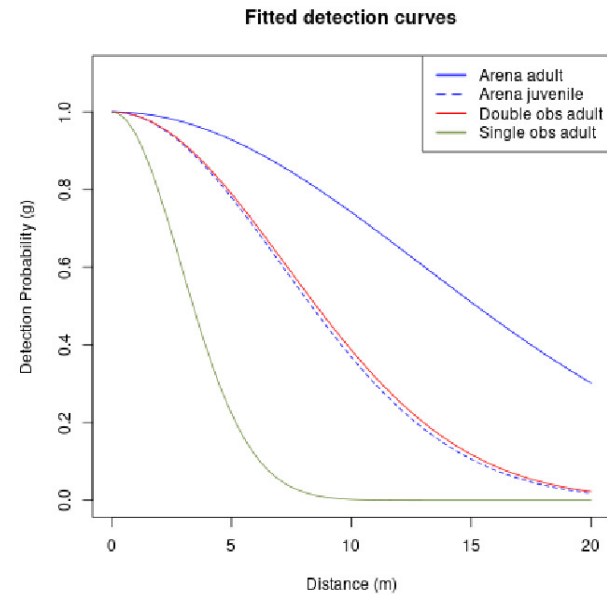
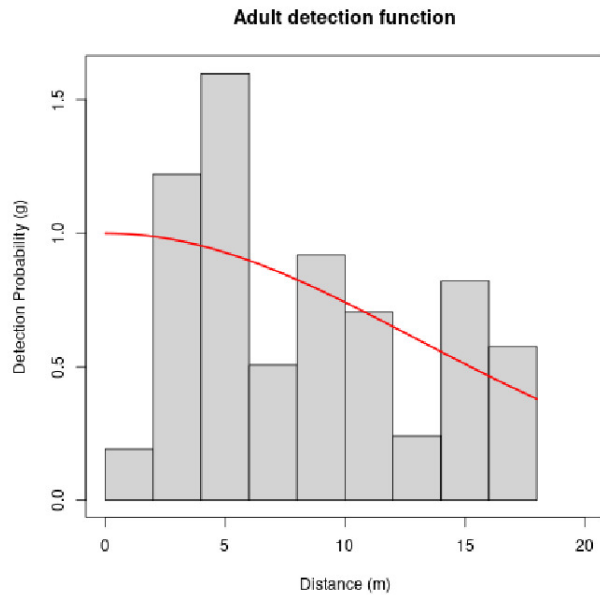
g_0 estimate



	Drone g_0	Pedestrian g_0	Ratio
UT 2022	0.58	0.75	0.77
UT 2023	0.73	0.89	0.82
Mean			0.80

$$g_0: 0.73 * 0.80 = 0.58$$

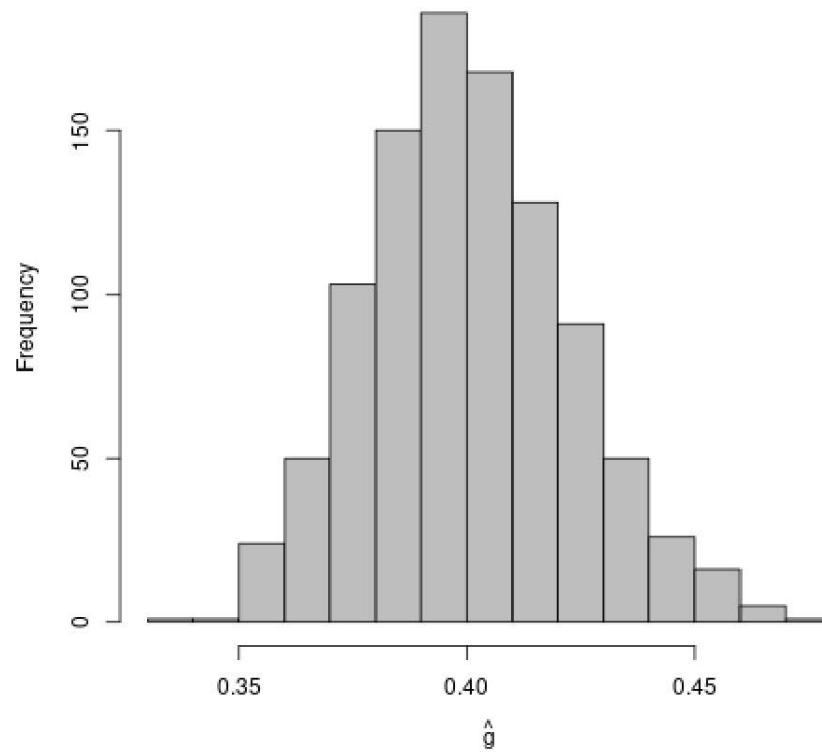
Detection curve



Detection function calculated from flights at USFWS training arena in 2022



Overall detection rate (\hat{g})



Mean ~ 0.4

Density and abundance

Density (N/km^2)	km^2 sampled	Abundance
3.2 [1.7, 5.5]	4.74	15 [8, 6]

Density (N/km^2)	km^2 Total	Abundance
3.2 [1.7, 5.5]	349.8	1107 [591, 1920]

- The drone/AI method is very successful at locating tortoises when they are available for detection
- Surveys must be performed when animals are available for detection: 9 AM - 1 PM
- Survey was very inefficient - ca 70 ac/day
- Optimal kit and survey area - up to 1000 ac/day
- In 34 days with an optimal study design we could have surveyed about 30,000 acres, or a third of the BCCE



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