

2023 Mojave Desert Tortoise Drone Surveys in Zones 2-5 of the Red Cliffs Desert Reserve

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March 28, 2024

1 Introduction

- Background
- Drone Surveys
- Computer Vision

2 Red Cliffs Desert Reserve Surveys

- Red Cliffs Desert Reserve
- *go* surveys
- Distance analysis - DRONEDISTANCE
- Results

3 Conclusions

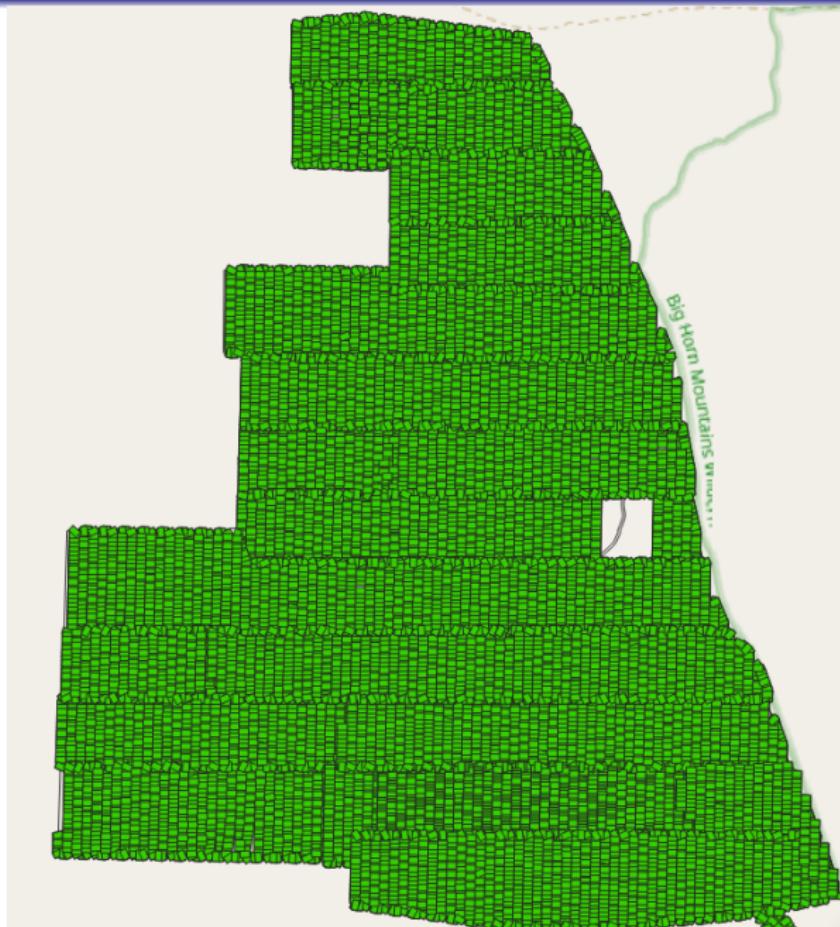
History:

- 2021
 - Experiments with surrogates
- 2022
 - USFWS Arena test
 - Red Cliffs Desert Reserve survey,
1st season (Zone 6)
- 2023
 - Red Cliffs Desert Reserve survey
2nd season (Zones 2-5)

Drone Surveys



Drone Surveys



Object Detection

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

PyTorch





Tortoise Model:

- $n = 562$
- Trained on both Mojave desert ($n=265$) and Bolsón (237) tortoises, as well as some styrotorts ($n=30$)
- Segregate training (75%) and validation (25%) sets
- Recall $\sim 84\%$

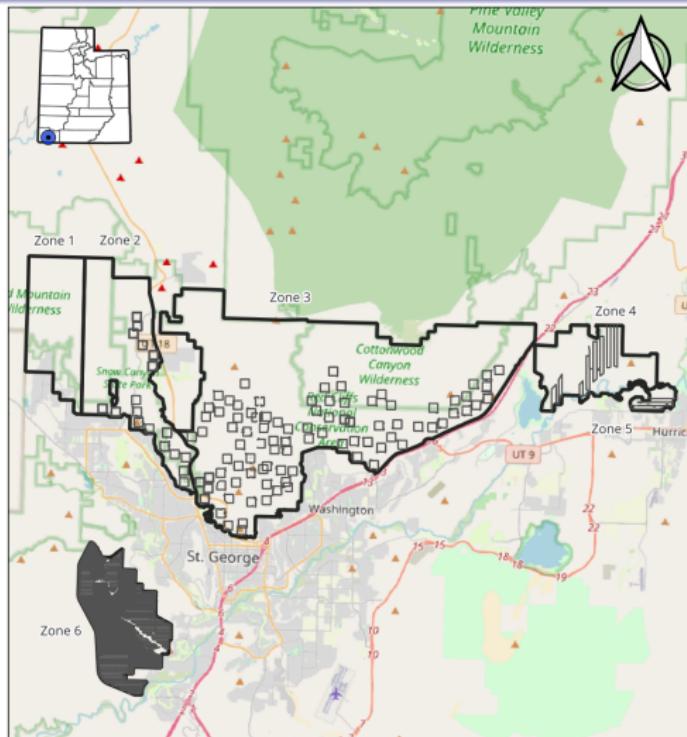




- 2022 and 2023
- Red Cliffs Desert Reserve
- Washington County, Utah
- g_0 surveys performed by Utah DNR
- Drone/AI surveys performed in conjunction with pedestrian surveys



Red Cliffs Desert Reserve



- 88,000 photographs
- 1.75 million image tiles
- Block surveys, rectangular and linear transects
- > 7,100 acres (11 square miles)
- ~28 pilot-days

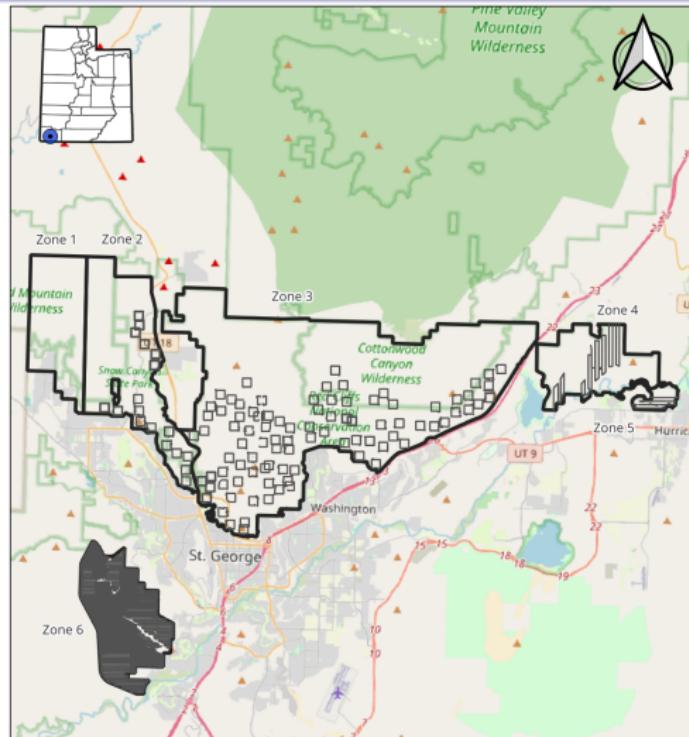
RCDR Tortoise Surveys
Drone Transects
Resi-2023-014

Photos (2022/2023)



0 2.5 5 7.5 k

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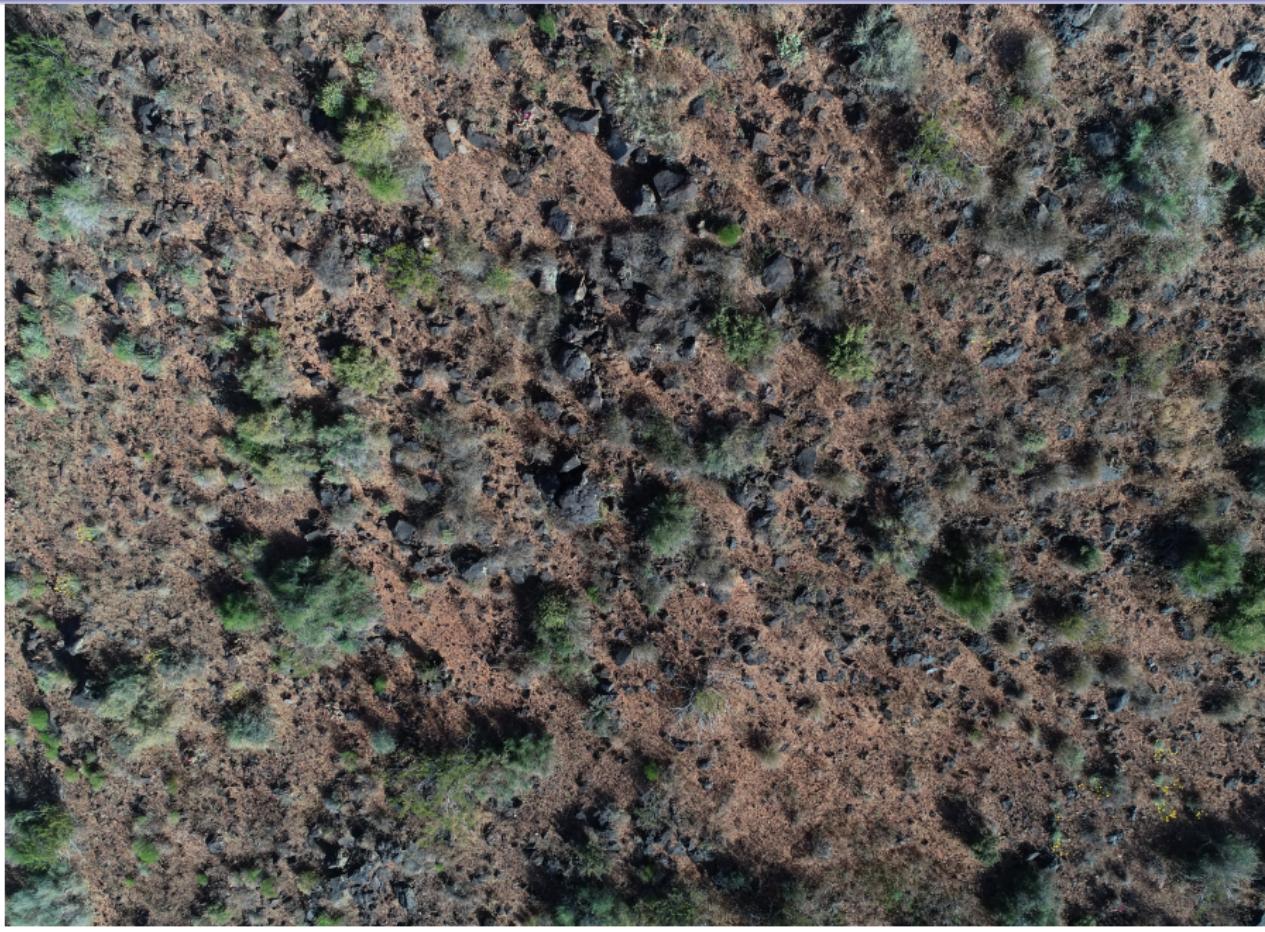
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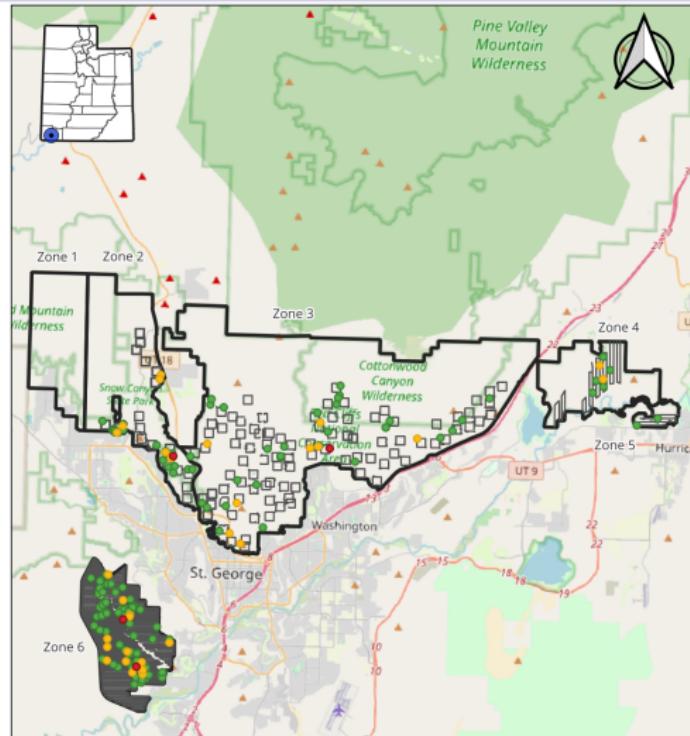
Red Cliffs Desert Reserve



Red Cliffs Desert Reserve



Red Cliffs Desert Reserve



RCDR Tortoise Surveys
Drone Detections
Resi-2023-014

Drone detections
● Adult
● Juvenile
● Carcass
■ RCDR Zones

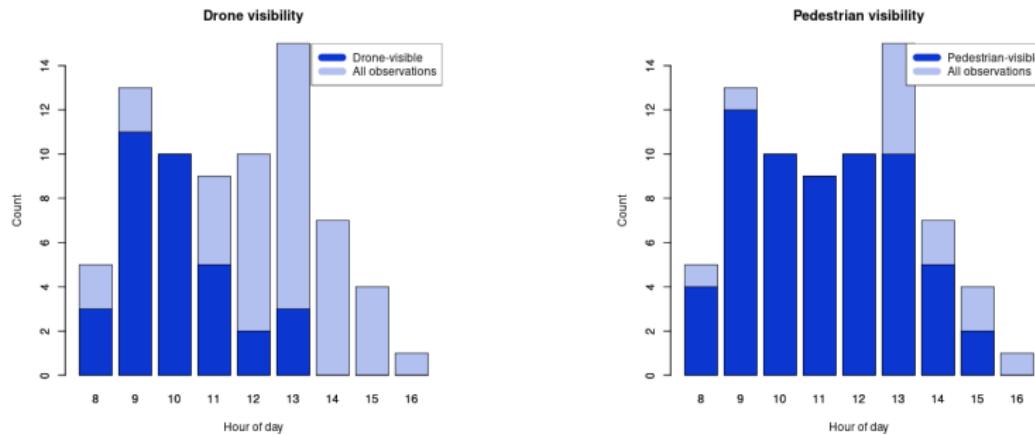
0 2.5 5 7.5 km

- 190 unique tortoise detections
 - 155 adults
 - 31 juvenile
 - 4 carcasses
- 6.7 detections / pilot-day

Resi

g_0 surveys

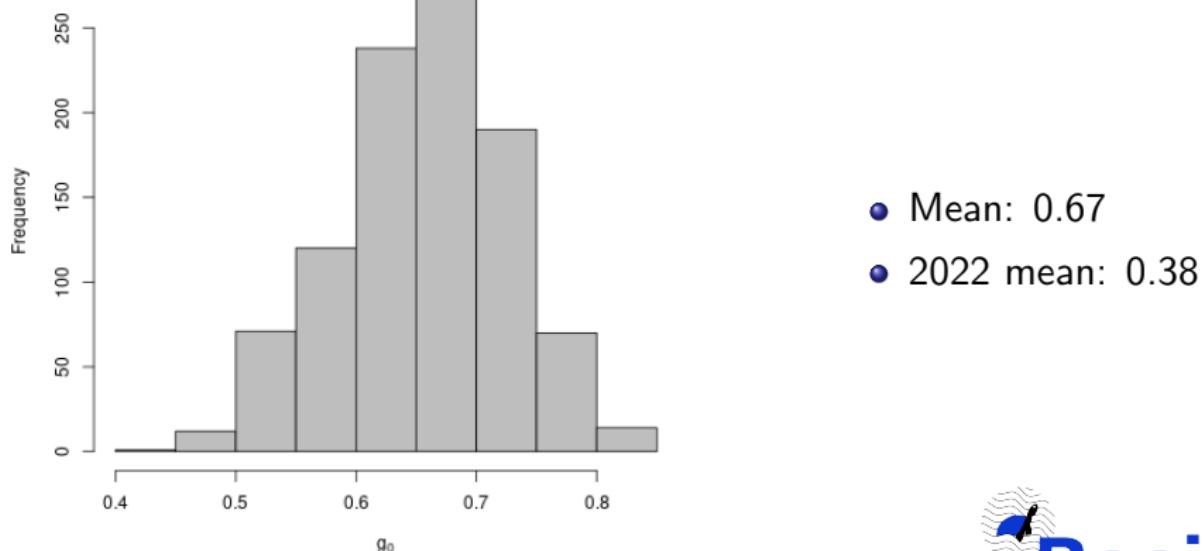
Surface Activity - 2024



Date	Drone Surface Activity (g_0)		Pedestrian Surface Activity (g_0)	
	Morning Obs	Afternoon Obs	Morning Obs	Afternoon Obs
May 8	0.77	0.25	1.00	1.00
May 9	0.85	0.15	0.85	0.77
May 11	0.58	0.09	0.83	0.55
Average	0.73	0.16	0.89	0.77

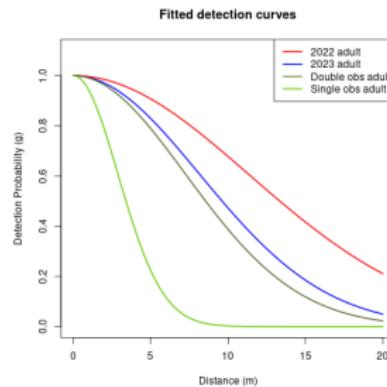
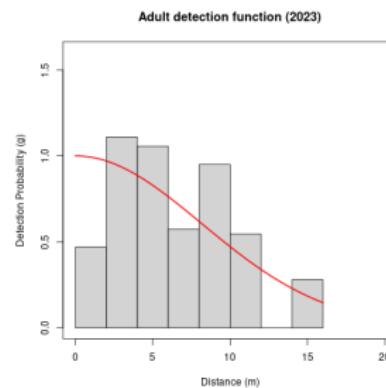
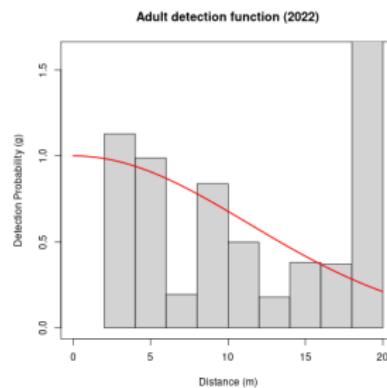
g_0 surveys

g_0 estimate

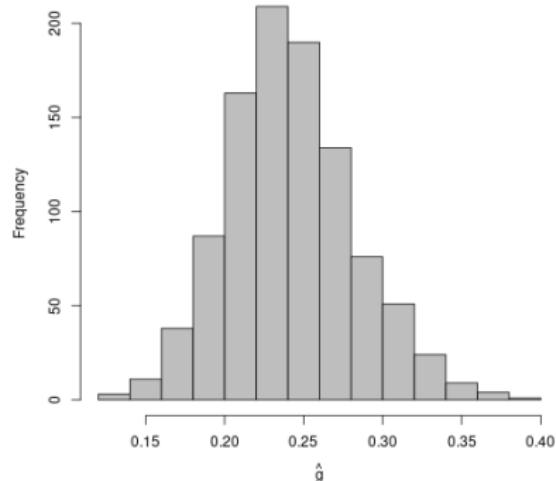


Distance analysis - DRONEDISTANCE

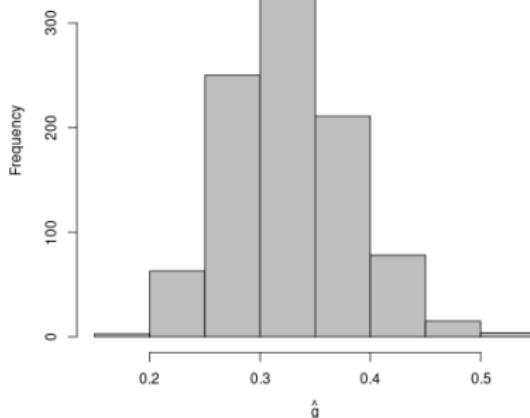
Detection curves



Distance analysis - DRONEDISTANCE

Overall detection rate (\hat{g})

Mean ~ 0.25
2022



Mean ~ 0.3
2023

Results

Density and abundance

Zone	Density (N/km^2)	km^2	Total	Abundance
2-5	20.1 [13.8, 28.9]	138.14	2779 [1908, 3995]	
6	28.0 [18.9, 41.7]	27.56	772 [521, 1149]	
Total	21.4 [14.7, 31.1]	165.70	3550 [2429, 5144]	

Results

Comparison with 2024 pedestrian survey results

	Density	(N / km^2)	km^2	Abundance	
Drone, Zones 2,3,5	19.0	[12.7-28.4]	116.94	2221	[1480-3316]
Pedestrian, Zones 2,3,5	20.7	[16.3-26.3]	116.94	2425	[1908-3081]
Drone, Zone 3	12.8	[8.2-19.8]	95.86	1223	[790-1898]
Pedestrian, Zone 3	17.5	[13.3-23.1]	95.86	1681	[1274-2218]

- 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
- Pedestrian interactions can affect visibility to drones
- Drone/AI surveys must not be performed at the same time as pedestrian surveys.

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- Advantages of drone/AI surveys:
 - No surface disturbance
 - Approximately 10 times more efficient (80 ac/hr)
 - With better cameras this could 25x or greater (200 ac/hr)
 - Quantitative density and abundance estimates with confidence intervals
 - Within 8% of pedestrian estimates
 - Can be used for more than one resource, further increasing cost effectiveness
 - Permanent record, can be reanalyzed with improved models
- Disadvantages of the drone method
 - No detailed observation or measurements



Resi

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