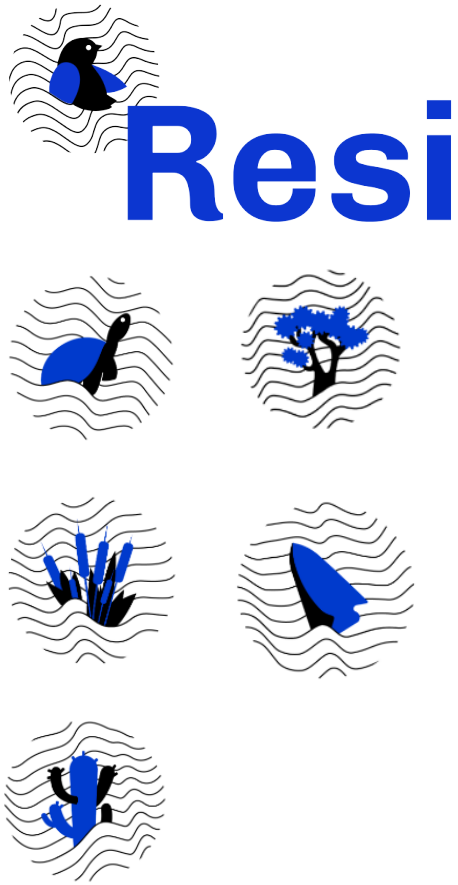
A Full-Scale Test of AI-Assisted Drone Surveys for the Mojave Desert Tortoise

Resi

History:

- 2020 – Experiments with styrotorts
- 2021 – Armendaris Ranch, Ivanpah sites, discussions with DTRO
- 2022 – Arena test, Red Cliffs Desert Reserve survey (ca. 5000 acres), MTCF-TFTF grant
- 2023 (Q1) – discussions with DTRO, CDFW, Mexico fieldwork

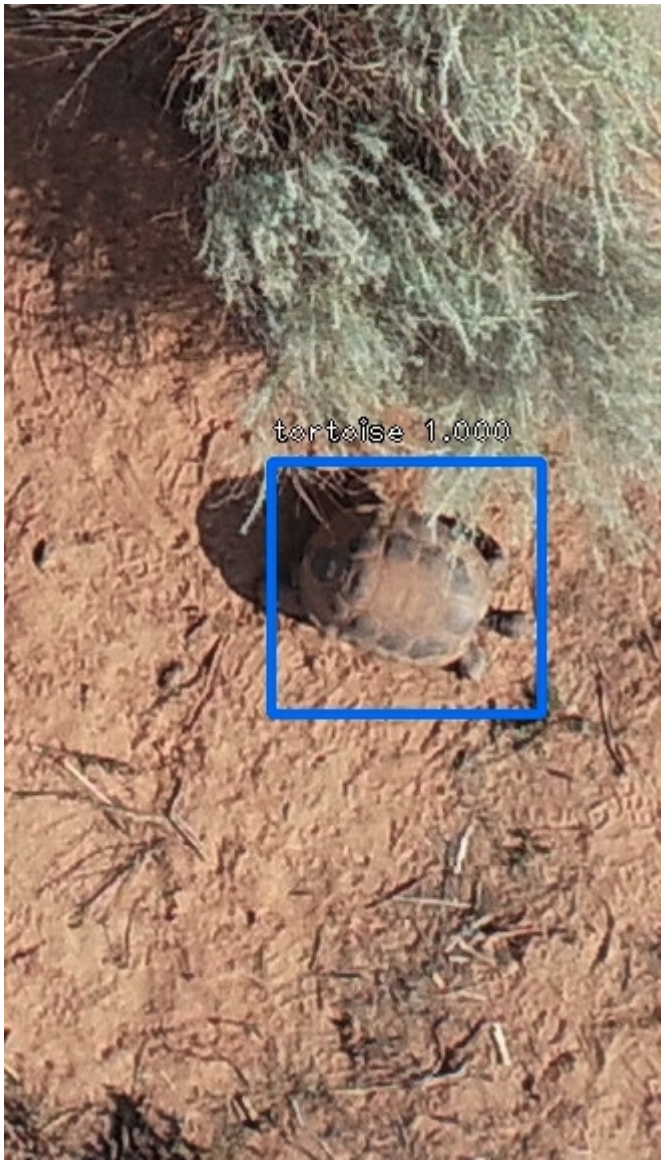


Object Detection

- Manually tag images to give models some samples
- Train a neural network to detect tortoises and burrows
- Two models – tortoise and burrow

PyTorch

Tortoise Model

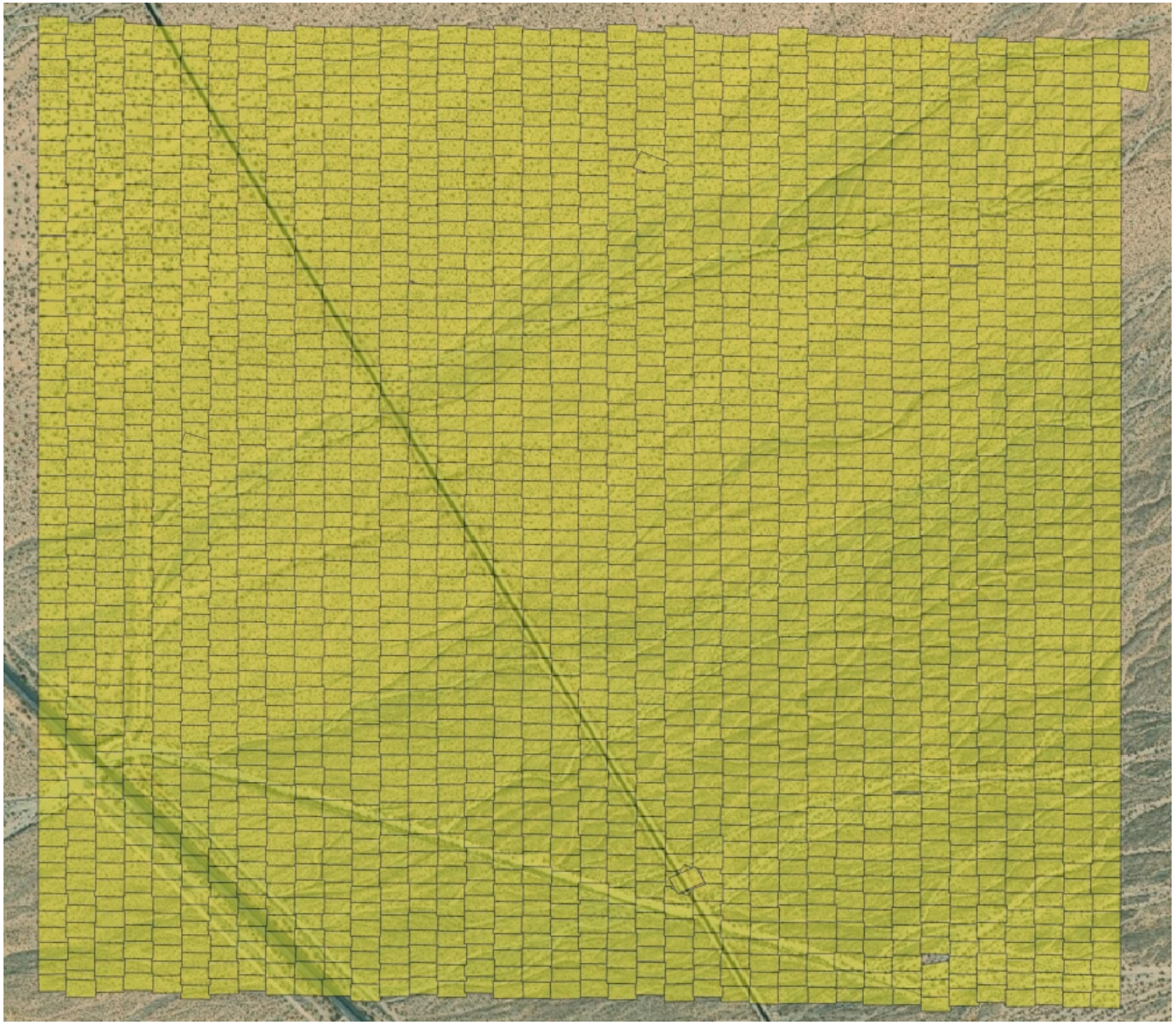


Tortoise Model

Burrow Model

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



2022 Fieldwork

- Fly USFWS styrotort arena in Las Vegas
- g_0 surveys to study surface activity in RCDP
- Paired drone and pedestrian survey of non-ACEC portions of Zone 6 of RCDR
- Drone survey of ACEC portion of Zone 6 of RCDR

REDCLIFFS
DESERT RESERVE

Resi

U.S.
FISH & WILDLIFE
SERVICE

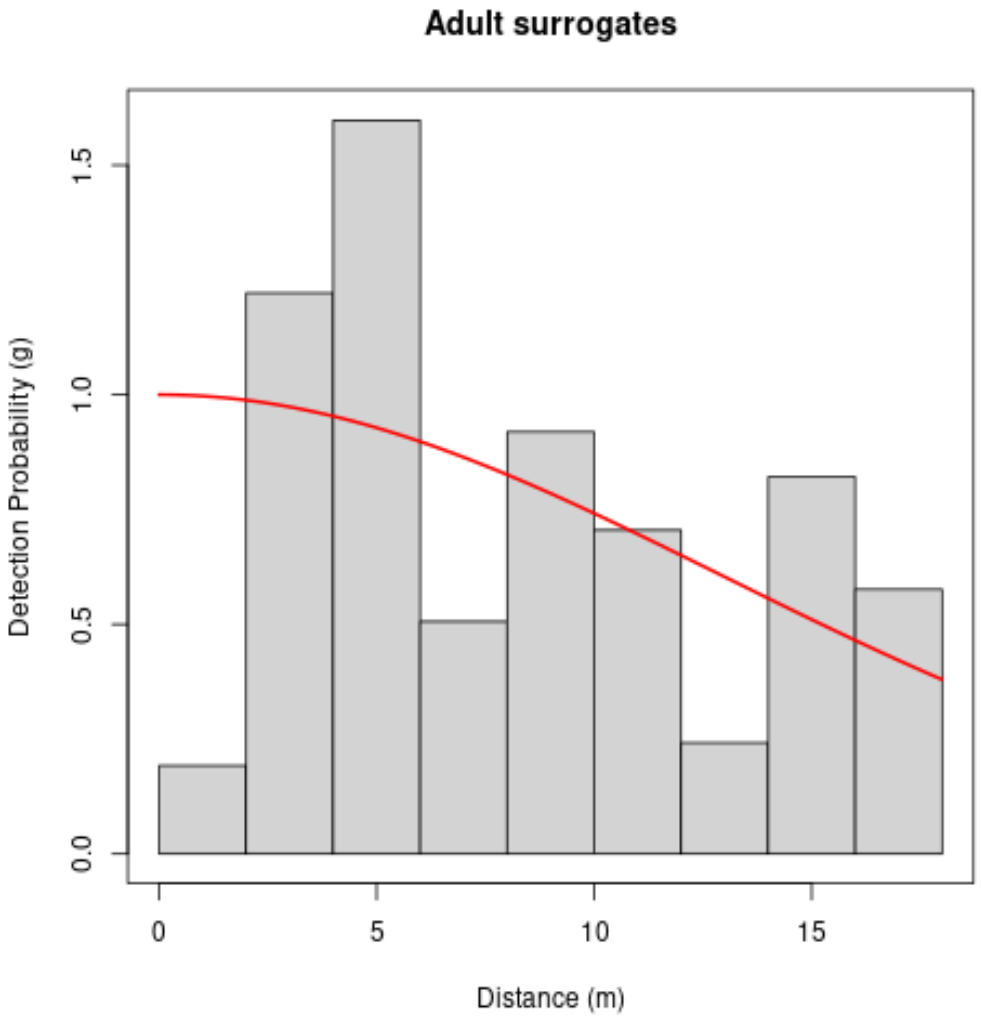
Great Basin
Institute

UTAH
DNR
WILDLIFE RESOURCES

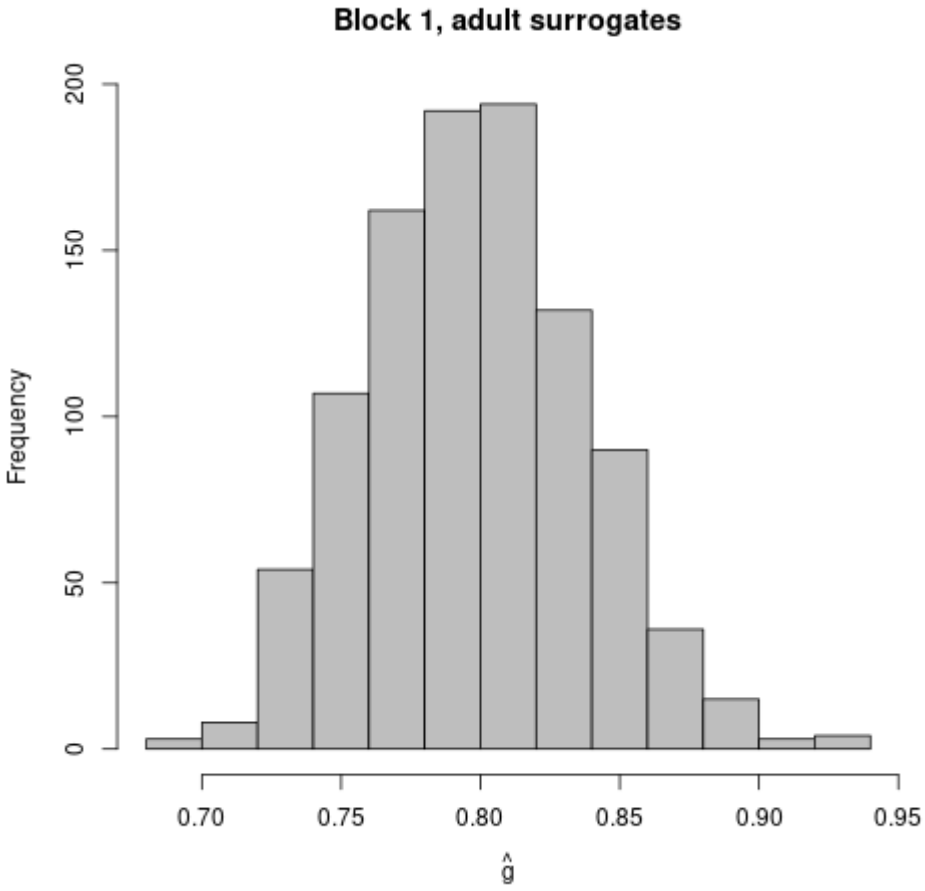
USFWS Arena surveys

Available	Detected	Percent
288	233	81%

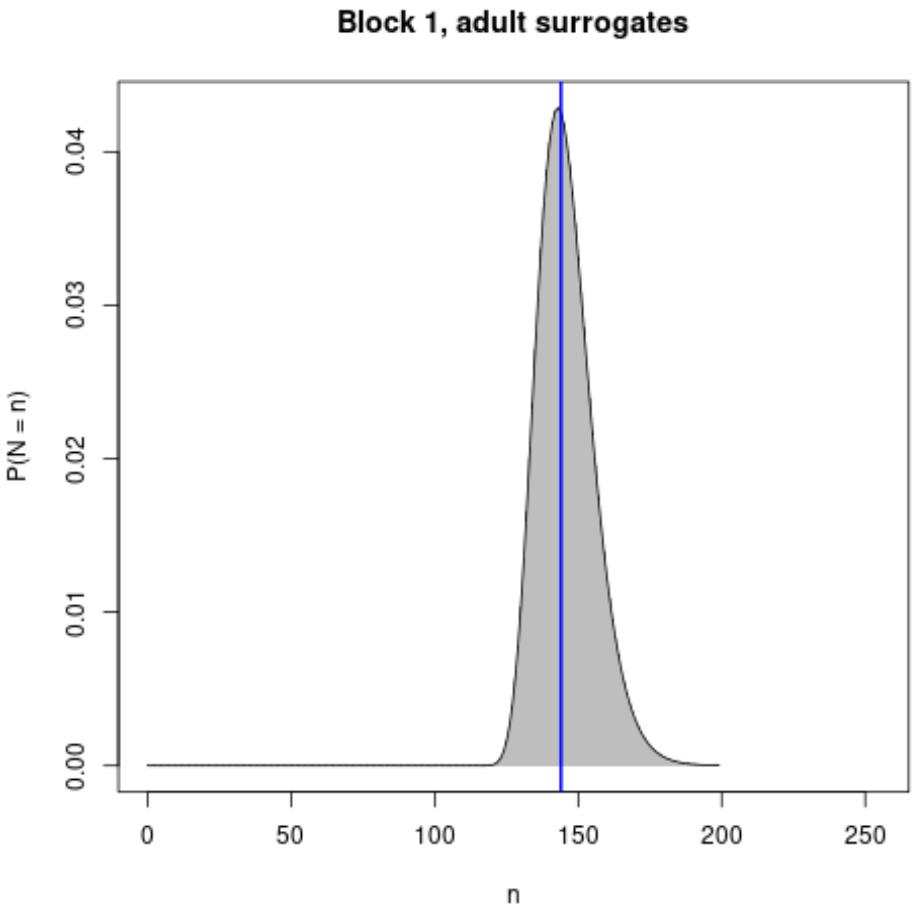
Distance analysis - droneDistance

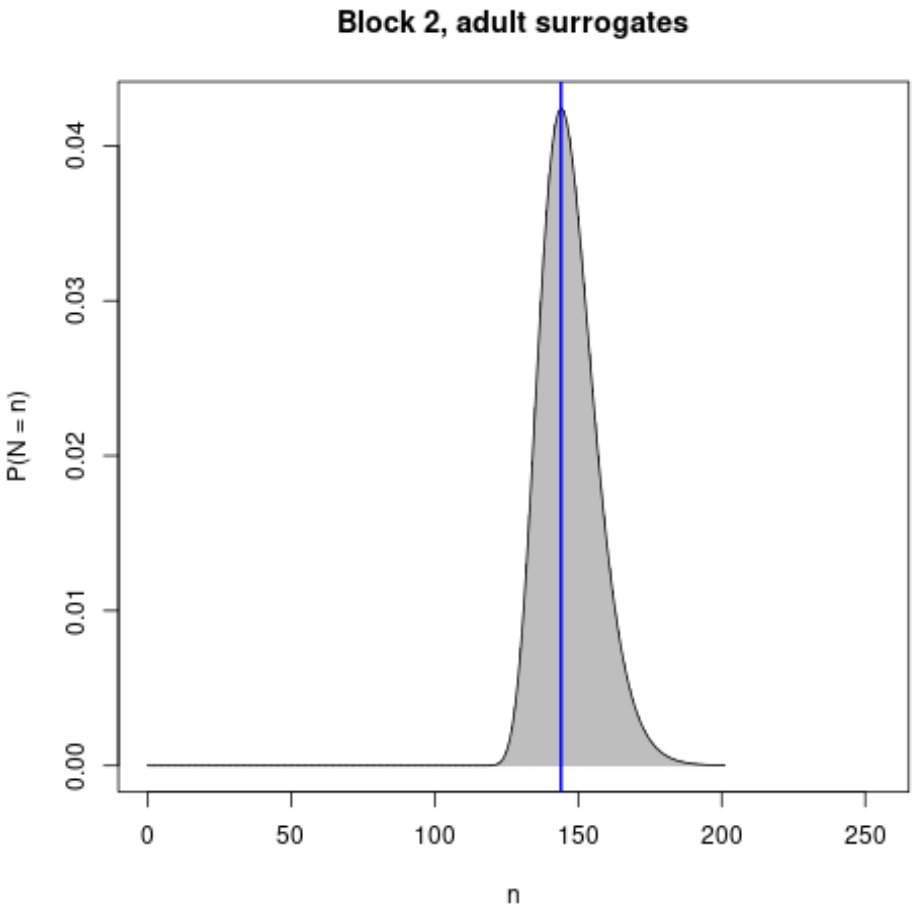


USFWS Arena surveys



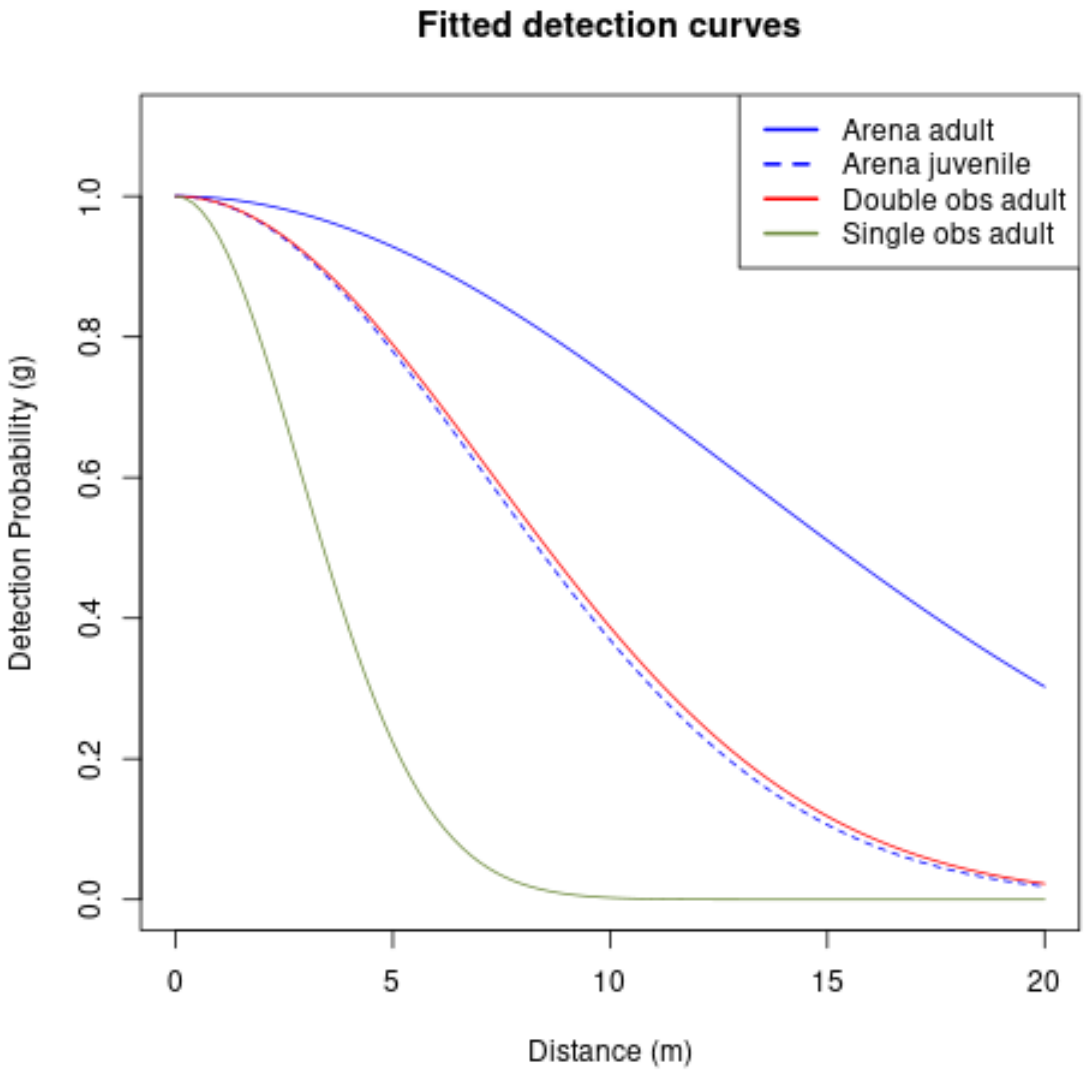
USFWS Arena surveys





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

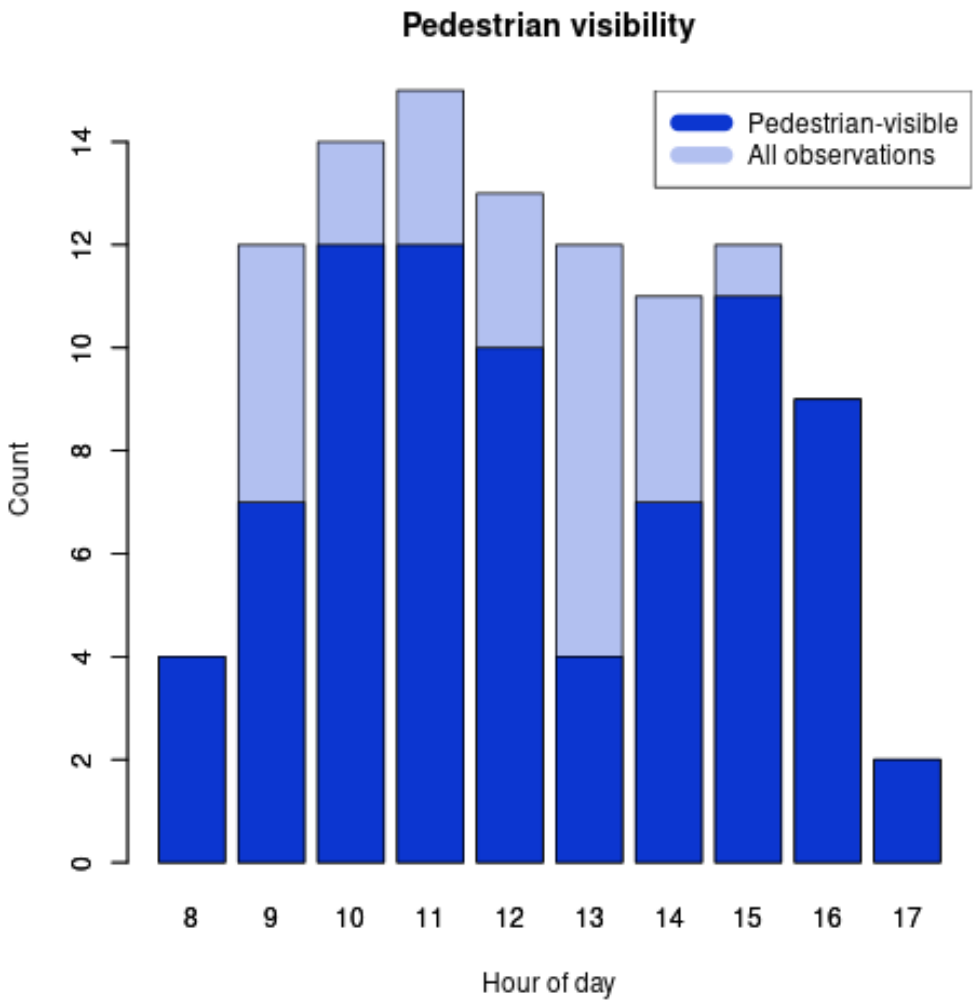
USFWS Arena surveys

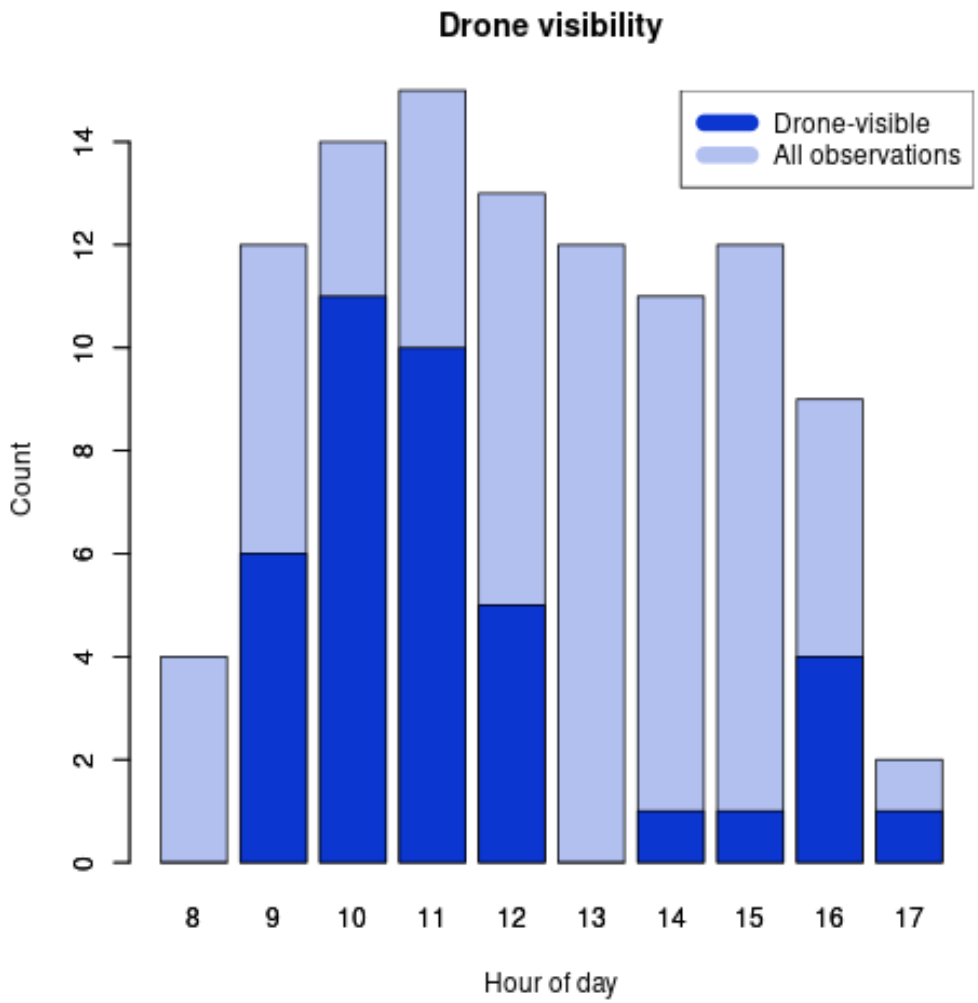


g_0 surveys

Week	Dates	Ground visibility	Drone visibility
1	April 16-22	0.71	0.37
2	April 23-29	0.79	0.38
Mean	April 16-29	0.75	0.38

g_0 surveys


Pedestrian visibility
Pedestrian-visible
All observations
Count
0
2
4
6
8
10
12
14
8
9
10
11
12
13
14
15
16
17
Hour of day


Drone visibility
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9
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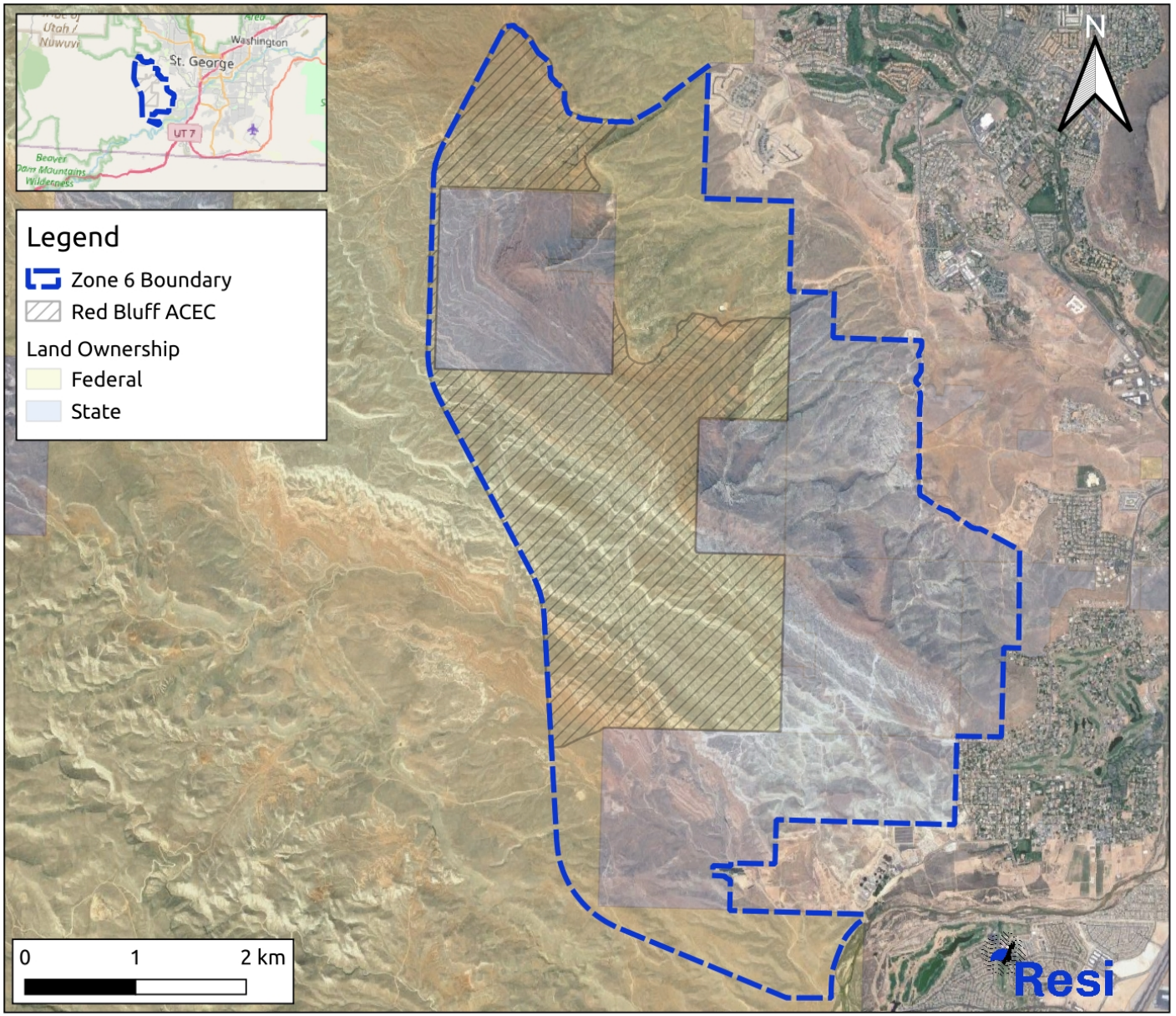
Hour of day

Project

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

- Transects surveyed by drones and pedestrian crews

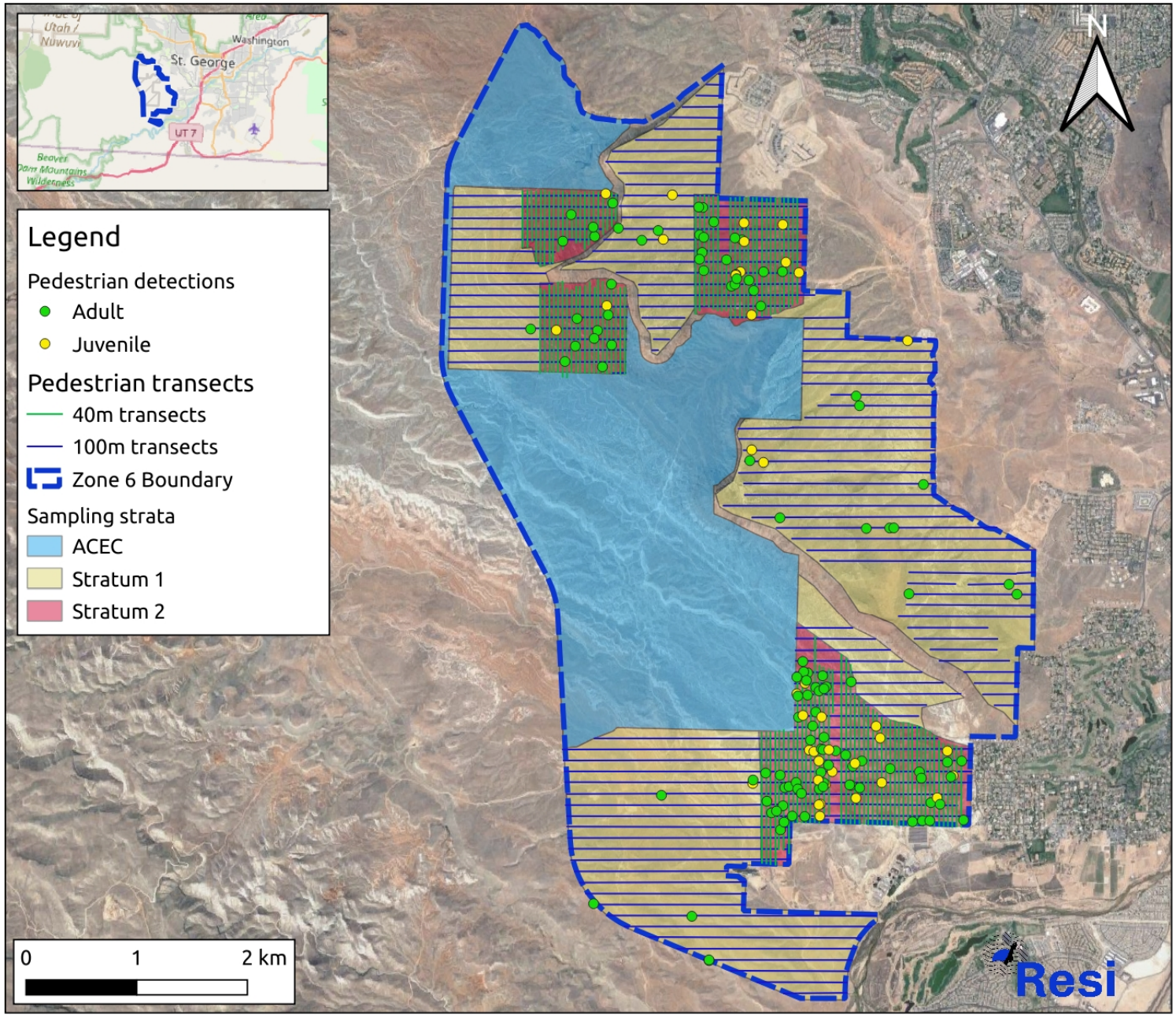


Zone 6 - pedestrian

254 km surveyed

Detections:

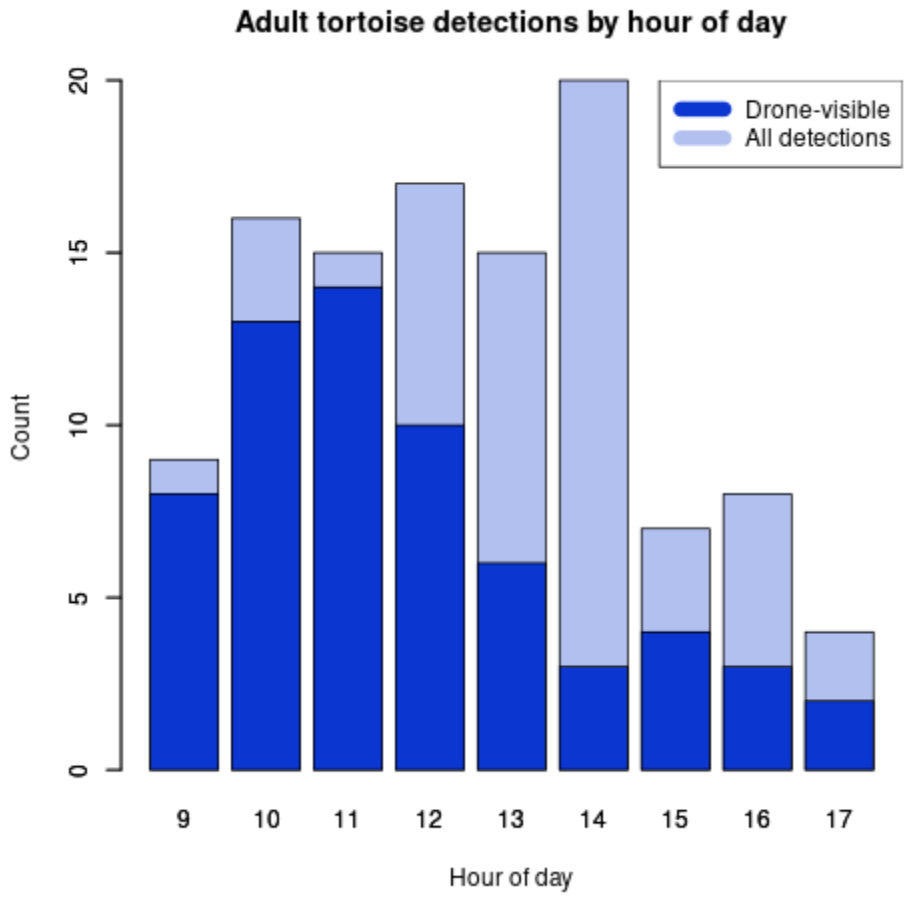
113 adult
40 juvenile



Zone 6 - pedestrian

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

Zone 6 - pedestrian

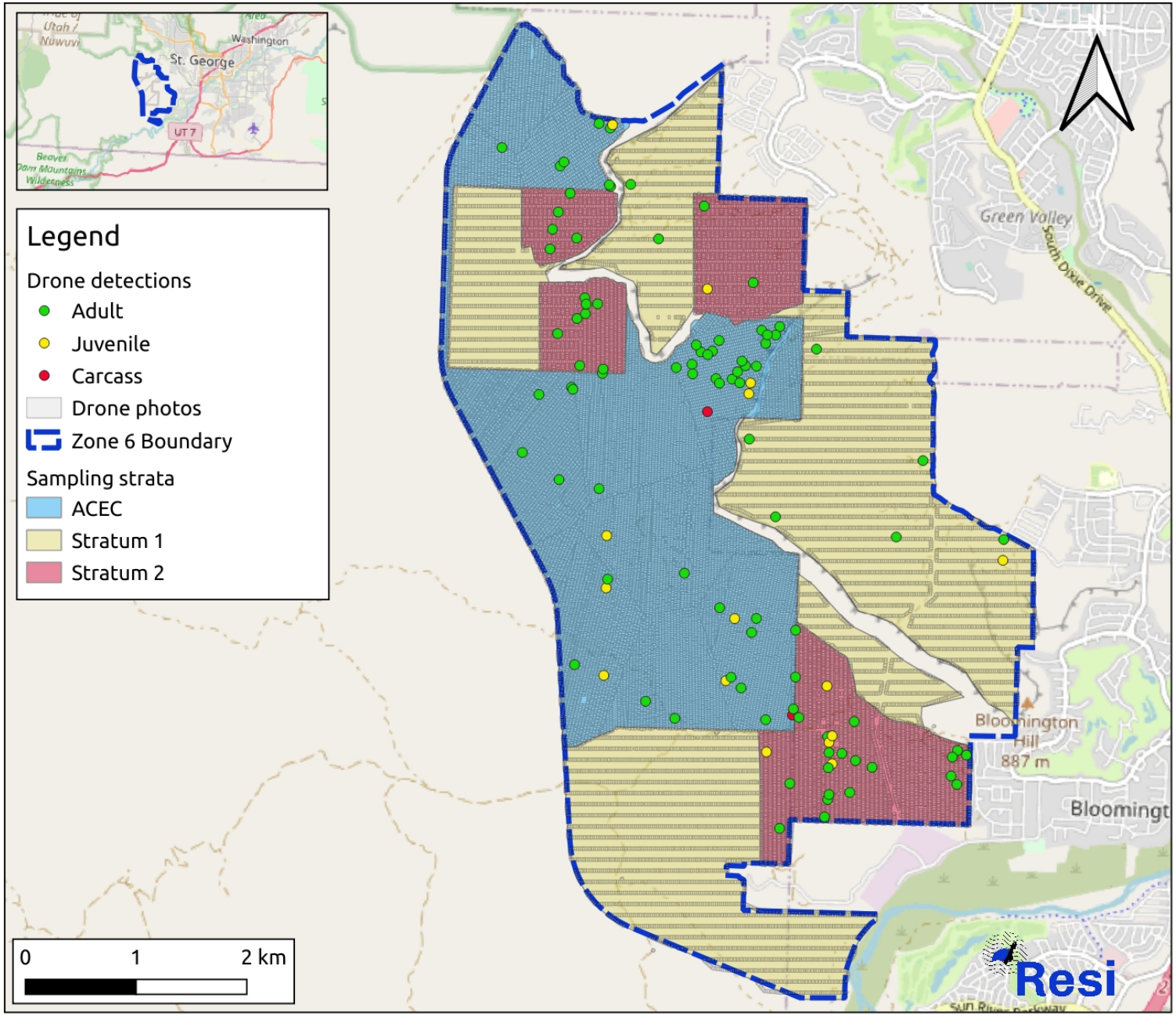


Zone 6 - drone

27.6 km² surveyed

Detections:

90 adult
15 juvenile
2 carcasses



Zone 6 - drone

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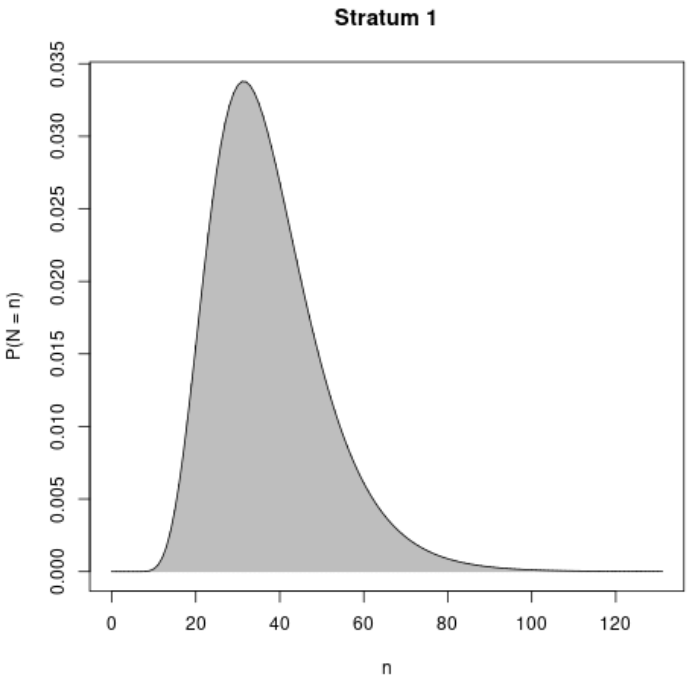

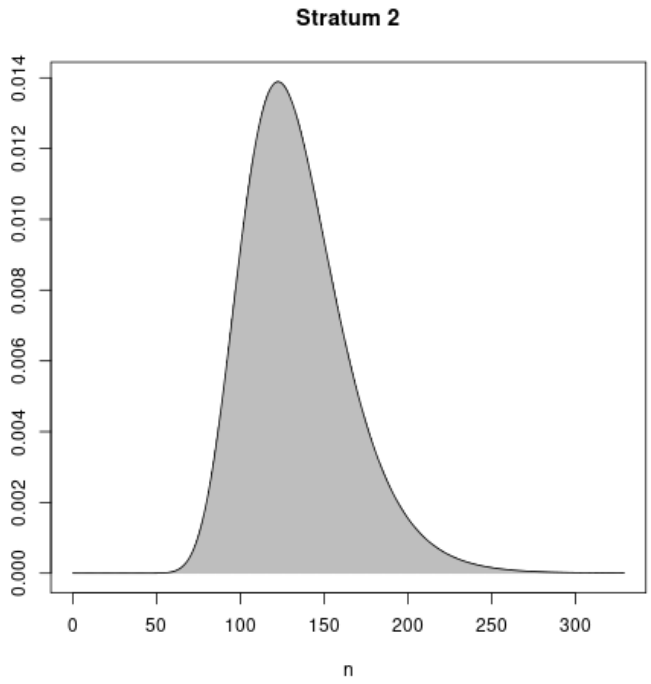

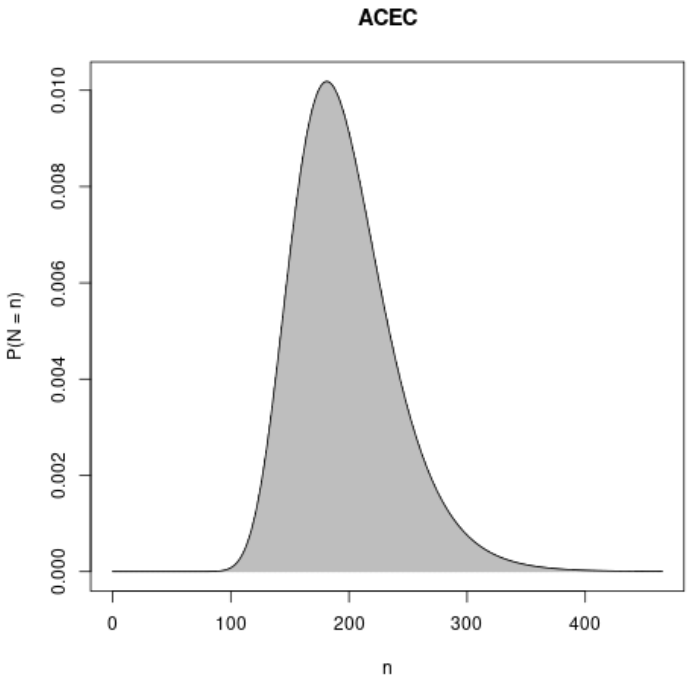

	N	95% CI	D	95% CI
Stratum 1	132	62, 240	9.7	4.6, 17.7
Stratum 2	169	105, 262	40.0	24.8, 61.7
ACEC	197	129, 297	20.2	13.2, 30.5
Total	498	297, 799	18.1	10.8, 29.0

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

Difference in means may be due to:

1) sampling error
2) observer effect

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)

Conclusions

- Advantages of the drone method:
  - No surface disturbance
  - Less than ½ the cost per km^2
  - Quantitative abundance estimates with CI
  - Can be used for additional resources, further increasing cost effectiveness

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