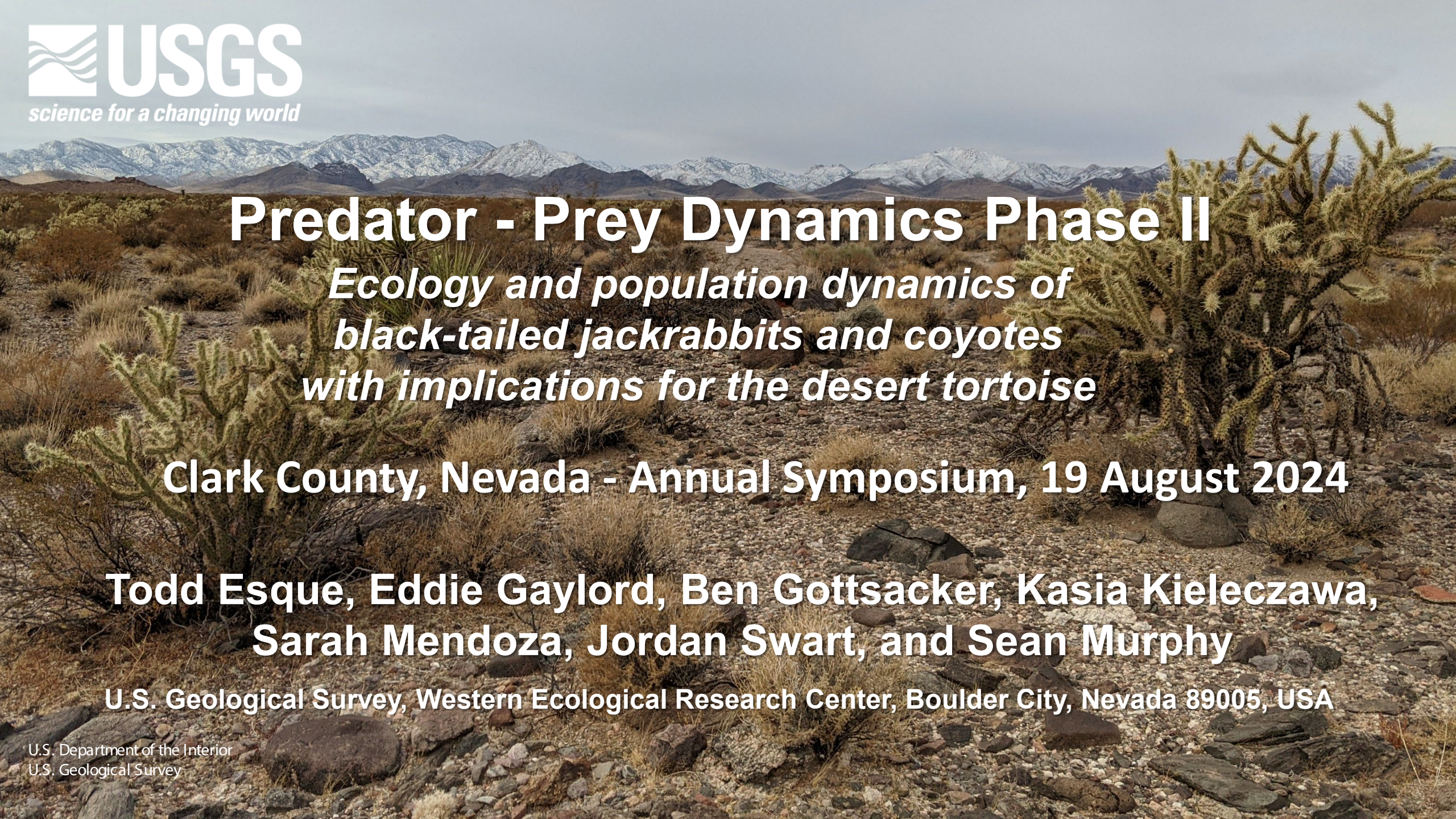

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science for a changing world

Predator - Prey Dynamics Phase II

Ecology and population dynamics of black-tailed jackrabbits and coyotes with implications for the desert tortoise

Clark County, Nevada - Annual Symposium, 19 August 2024

Todd Esque, Eddie Gaylord, Ben Gottsacker, Kasia Kieleczawa, Sarah Mendoza, Jordan Swart, and Sean Murphy

U.S. Geological Survey, Western Ecological Research Center, Boulder City, Nevada 89005, USA

U.S. Department of the Interior
U.S. Geological Survey

Goal & Research Objectives

Gain a better understanding of the predator-prey dynamics between black-tailed jackrabbits and coyotes and inform a strategy to reduce tortoise predation associated with translocations.

Objectives

- Determine coyote and black-tailed jackrabbit:
  - Demographic variation across space and time
  - Home range and habitat use patterns
  - Health status and mortality rates
- Develop reliable, cost-efficient methods for estimating density
- Synthesize black-tailed jackrabbit and coyote spatial ecology

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Phase II Methods Overview

Primary components:

- Camera trap grids
- GPS/VHF collars on jackrabbits
- GPS/VHF collars on coyotes

Timeline

- Phase I: 2018 - 2021
- Phase II: Oct 2022 - end of 2026
  - This talk summarizes work completed in the past year (1 Aug 2023 - 31 Jul 2024)

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Camera Trap Background

Phase I: Random Encounter Model (REM)

Problems

1. Assumptions too strict (often violated)
2. Only uses camera-trap data
3. Ignores individual-level variation
4. Ignores ecological processes
5. Substantial discrepancies in estimates depending on which data were used
6. Uncertain estimate reliability/validity

Preliminary Information, subject to revision.
Not for citation or distribution.

animals — In Review — MDPI

Article

Most random encounter model density estimates in camera-based predator-prey studies are unreliable

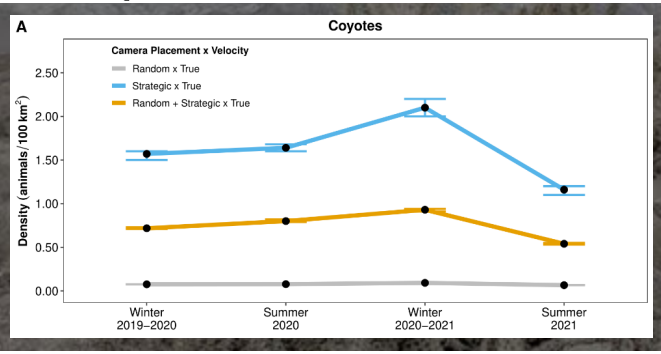
Sean M. Murphy [1,*], Benjamin S. Nolan [1,2], Felicia C. Chen [1], Kathleen M. Longshore [1], Matthew T. Simes [1,3], Gabrielle A. Berry [1], and Todd C. Esque [1,*]

Cameras

Strategically placed

Randomly / Strategic

Randomly placed

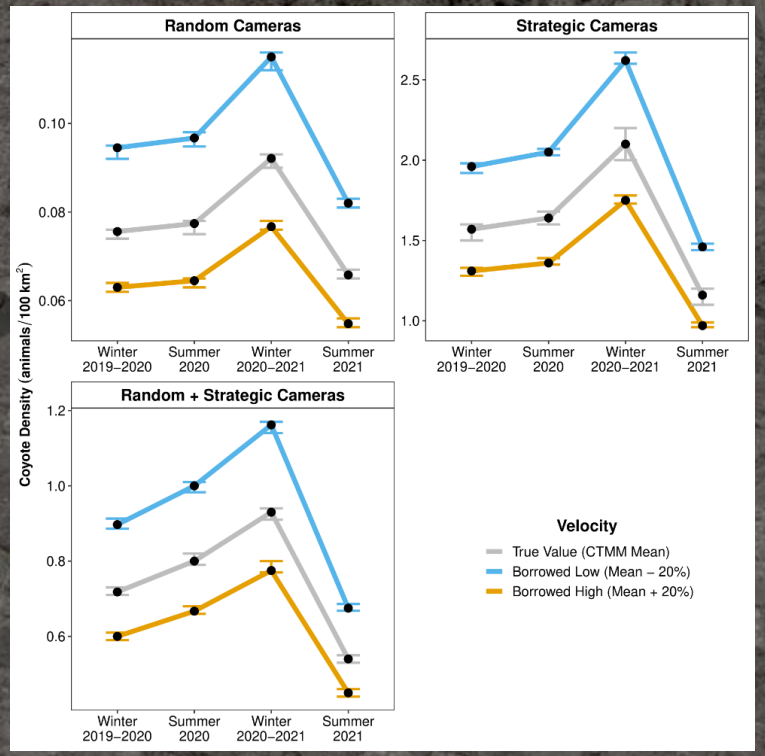


Estimated Velocities

Borrowed - Low

True

Borrowed High



Camera Trap Background

Phase II: Generalized Spatial Mark-Resight (gSMR) models

Solutions

1. Relaxed assumptions
2. Incorporates ALL data (live-capture + marking, camera-trapping, GPS collars)
3. Explicitly links demographic and ecological processes = testable hypotheses
4. Validated across multiple species and systems to produce unbiased densities
5. Estimate reliability is quantifiable


RESEARCH ARTICLE*

Journal of Applied Ecology

Generalized spatial mark–resight models with an application to grizzly bears

Jesse Whittington[1] | Mark Hebblewhite[2] | Richard B. Chandler[3]

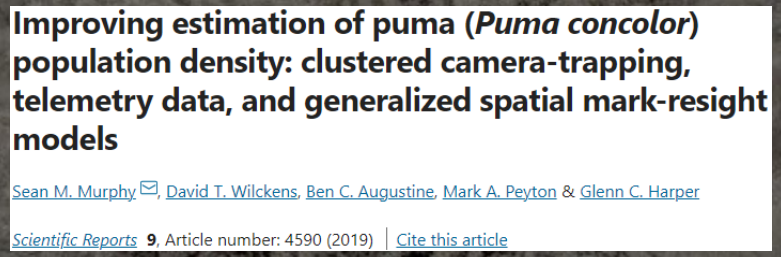

ECOSPHERE

AN ESA OPEN ACCESS JOURNAL

Methods, Tools, and Technologies | Open Access

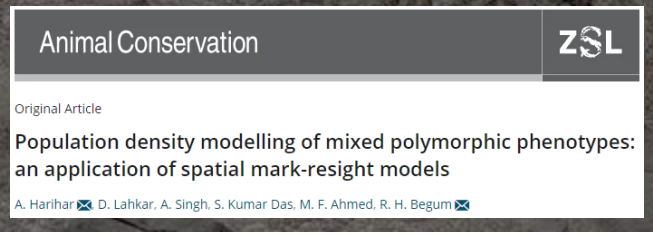
Density estimates for Canada lynx vary among estimation methods

D. Doran-Myers, A. J. Kenney, C. J. Krebs, C. T. Lamb, A. K. Menzies, D. Murray, E. K. Studd, J. Whittington, S. Boutin


Improving estimation of puma (*Puma concolor*) population density: clustered camera-trapping, telemetry data, and generalized spatial mark-resight models

Sean M. Murphy, David T. Wilckens, Ben C. Augustine, Mark A. Peyton & Glenn C. Harper

Scientific Reports **9**, Article number: 4590 (2019) | Cite this article


Animal Conservation

ZSL

Original Article

Population density modelling of mixed polymorphic phenotypes: an application of spatial mark-resight models

A. Harihar, D. Lahkar, A. Singh, S. Kumar Das, M. F. Ahmed, R. H. Begum


ORIGINAL RESEARCH

WILEY Ecology and Evolution

Generalized spatial mark–resight models with incomplete identification: An application to red fox density estimates

Jose Jimenez[1] | Richard Chandler[2] | Jorge Tobajas[1] | Esther Descalzo[1] | Rafael Mateo[1] | Pablo Ferreras[1]


ECOLOGICAL APPLICATIONS

ECOLOGICAL SOCIETY OF AMERICA

ARTICLE

Monitoring partially marked populations using camera and telemetry data

Lydia L. S. Margenau, Michael J. Cherry, Karl V. Miller, Elina P. Garrison, Richard B. Chandler

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Camera Trap Methods

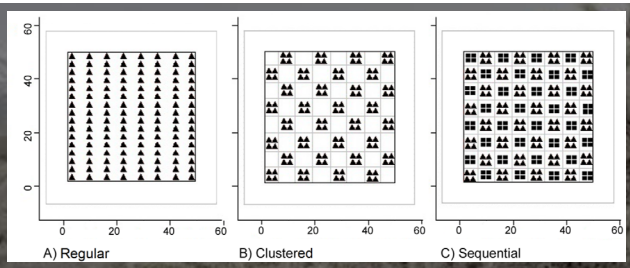
Clustered Sampling Design

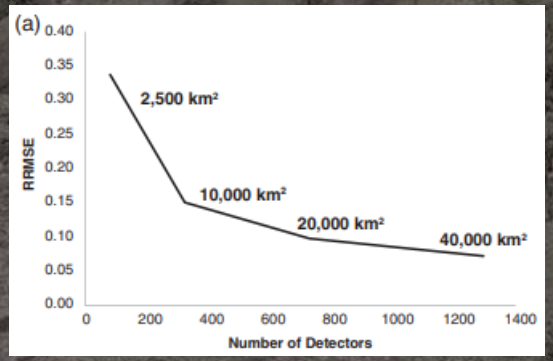
1. gSMR models are spatially explicit → easily accommodate irregular spatial and temporal sampling designs
2. Survey larger area with fewer cameras = more total detections and spatial recaptures = improve estimate accuracy and precision
3. Model density as a function of habitat or landscape covariates to further improve estimation

OPEN ACCESS Freely available online PLOS ONE

Trap Configuration and Spacing Influences Parameter Estimates in Spatial Capture-Recapture Models

Catherine C. Sun[1]*, Angela K. Fuller[2], J. Andrew Royle[3]





WILEY Population Ecology
ORIGINAL ARTICLE

Comparing clustered sampling designs for spatially explicit estimation of population density

Joseph D. Clark

Improving estimation of puma (*Puma concolor*) population density: clustered camera-trapping, telemetry data, and generalized spatial mark-resight models

Sean M. Murphy, David T. Wilckens, Ben C. Augustine, Mark A. Peyton & Glenn C. Harper

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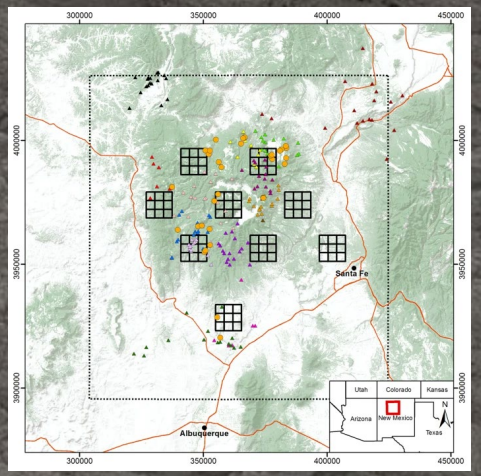

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Camera Trap Methods

Spacing within and among clusters based on mean female home range sizes estimated in Phase I

Rabbits: 15 clusters of 9 cameras, ~360 m intervals

- Cameras are rotated so each cluster is active for 8 weeks in summer and again in winter (cameras placed in 5 clusters for 8 weeks, then moved to next set of 5 clusters) ~135 cameras

Coyotes: 5 clusters of 9 cameras, ~2.2 km intervals

Cameras stationary and not rotated

- Positioned anywhere within cell to optimize detections
- Equipped with solar panels, transmits status and images via cellular network
- ~45 cameras

ALL cameras used to analyse both species

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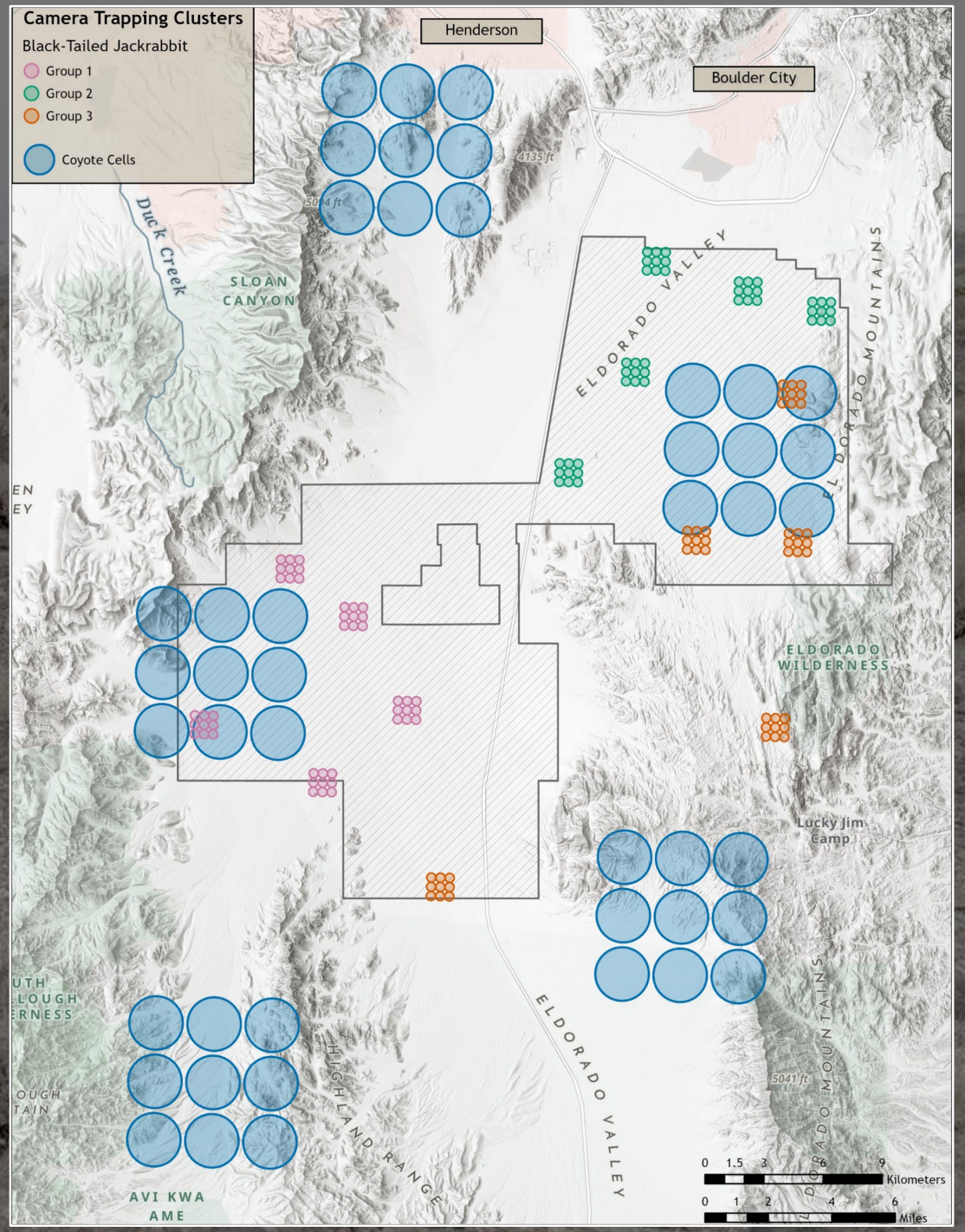
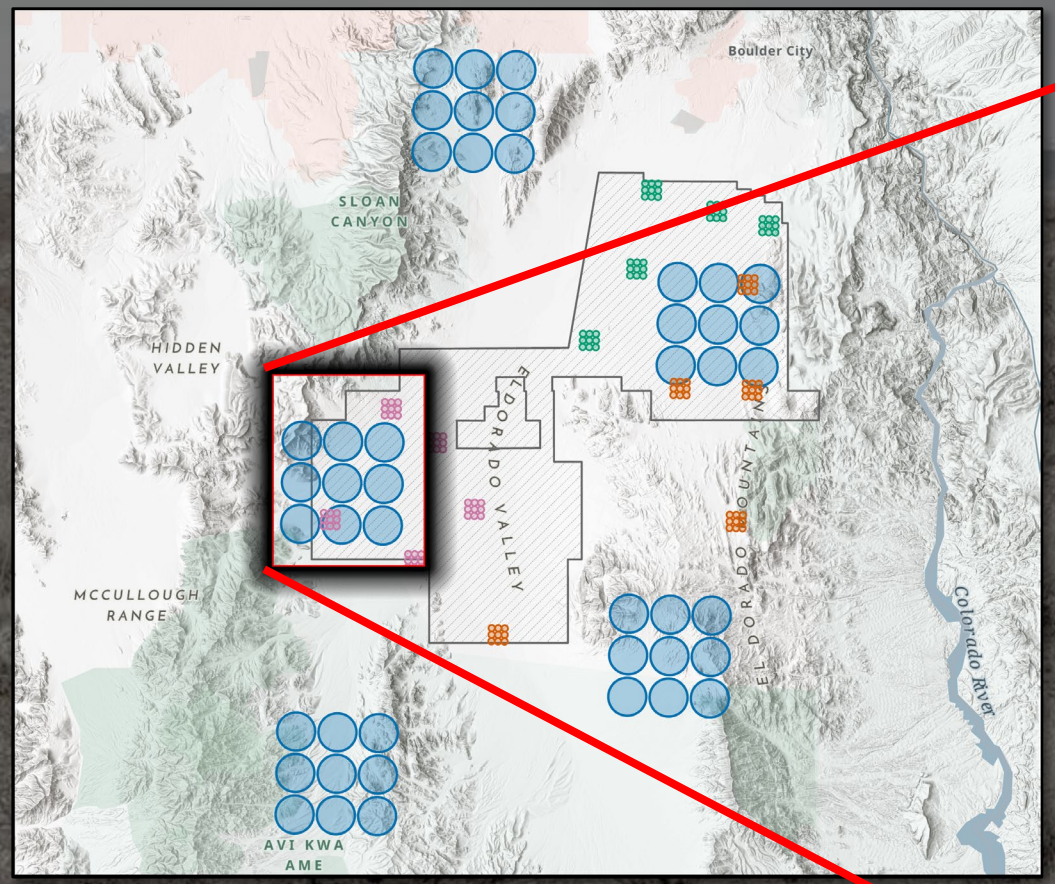
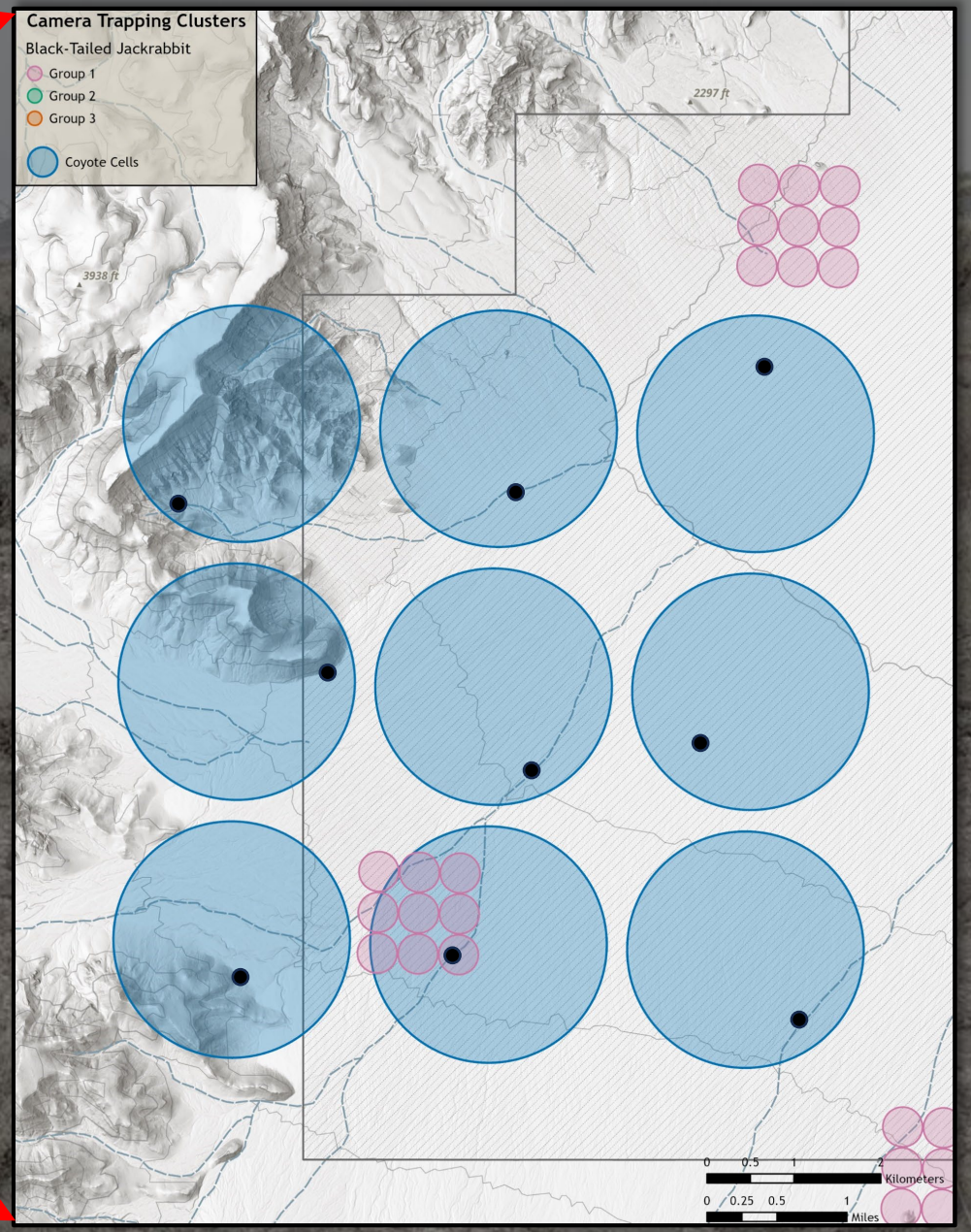


Camera Trap Methods





Jackrabbit cells

Group 1 Group 2 Group 3

Coyote cells Coyote cameras

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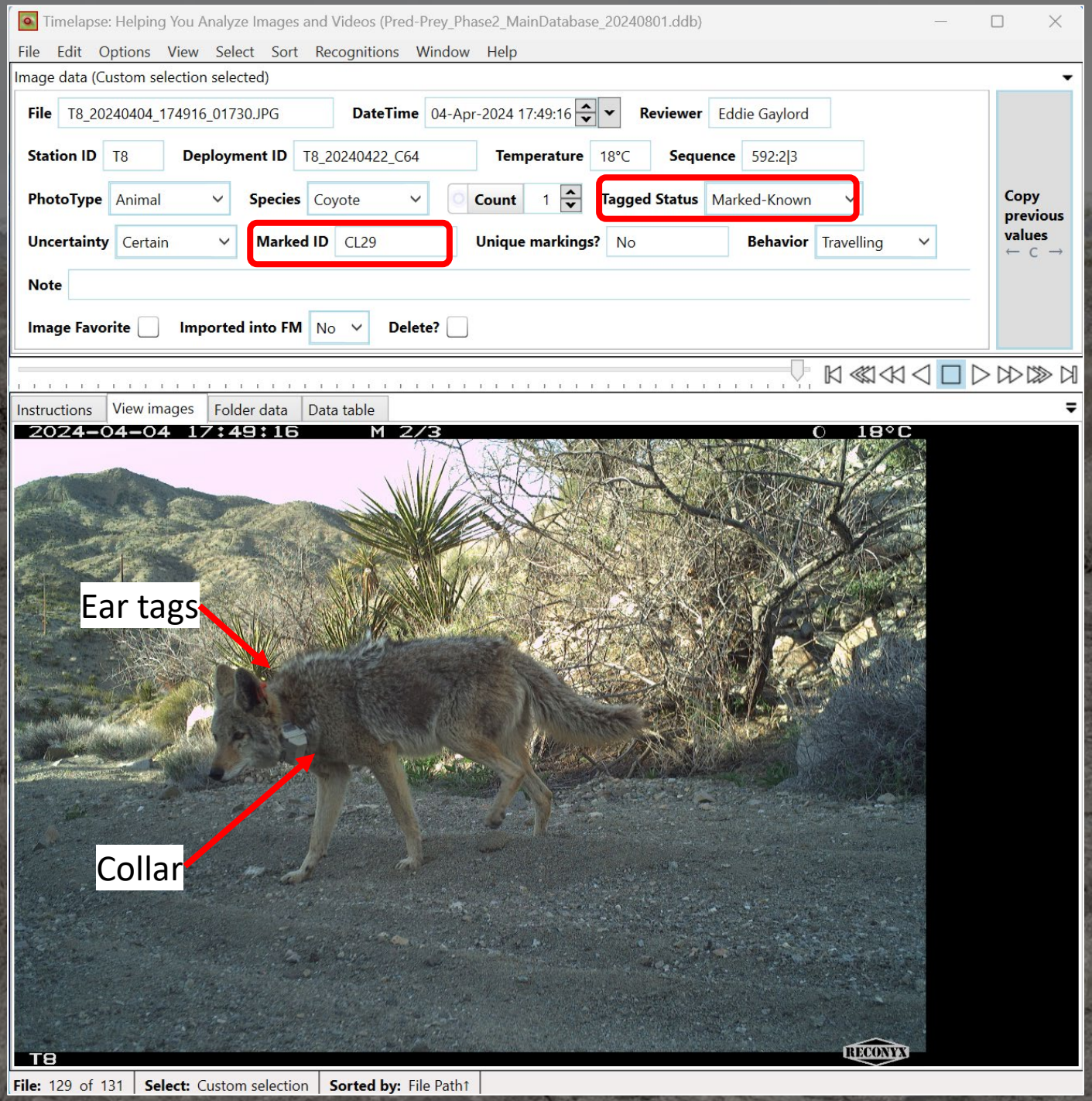
Image Processing

- Biologists examined and annotated each image
- Animals identified to species level when possible
- Coyote and jackrabbits classified by whether they're marked
- Marked animals further classified by individual ID



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Camera Trap Results

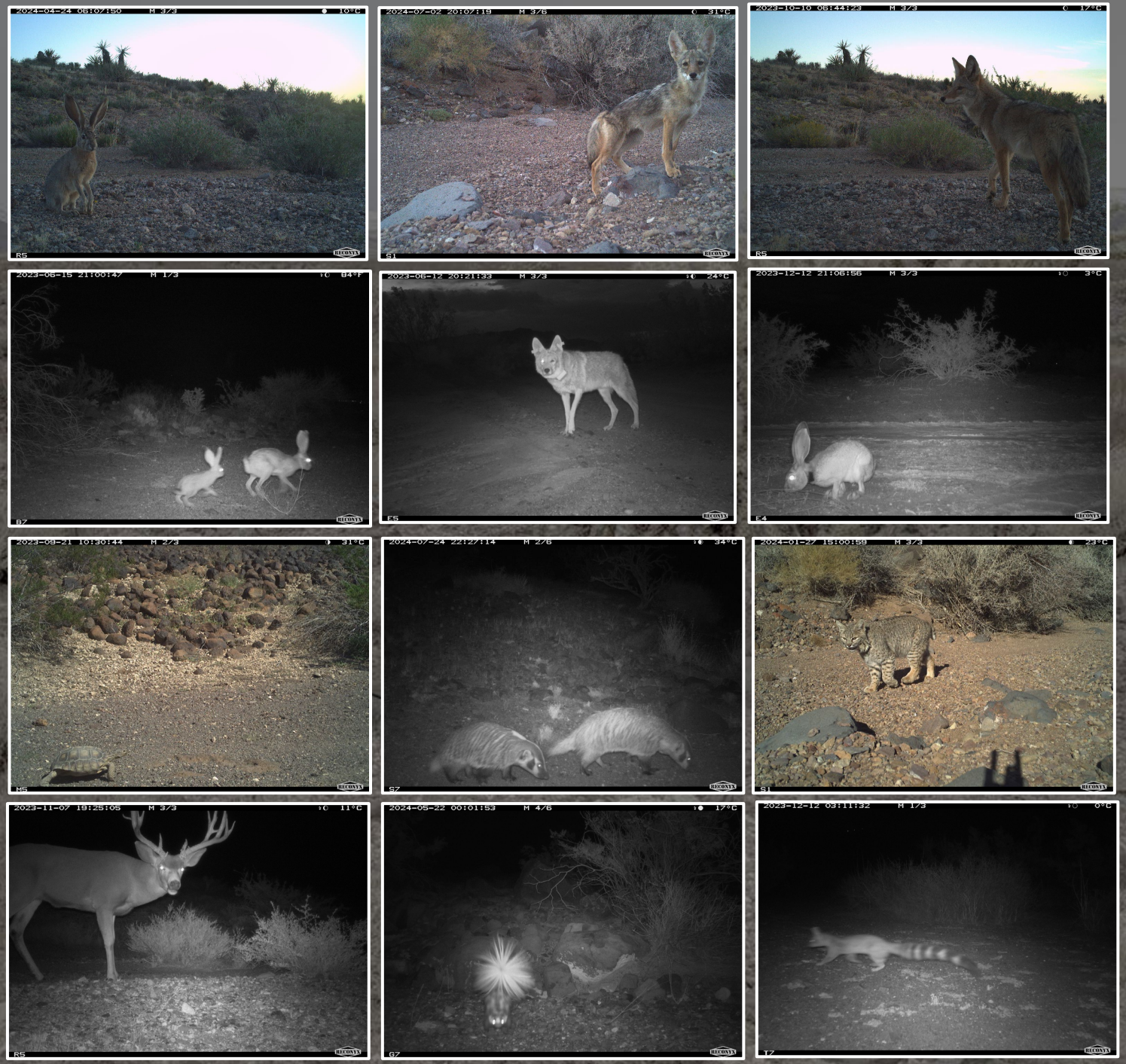
Total photos: 476,672

Jackrabbits

Total detections: 20,750
169 cameras with BTJ
28 cameras with marked BTJ

Coyotes

Total detections: 2,167
112 cameras with coyotes
40 cameras with marked coyotes



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Jackrabbit Methods

Trapping

- Year round - pre-baited traps
- Animals weighed, sexed, marked with unique ear tags
- Individuals ≥ 1.75 kg fitted with GPS/VHF collar
  - 0.5 - 3 hr GPS fix interval, store on board, lasts up to 1 year

Telemetry

- Used to monitor animals at least biweekly

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Jackrabbit Results

Trapping

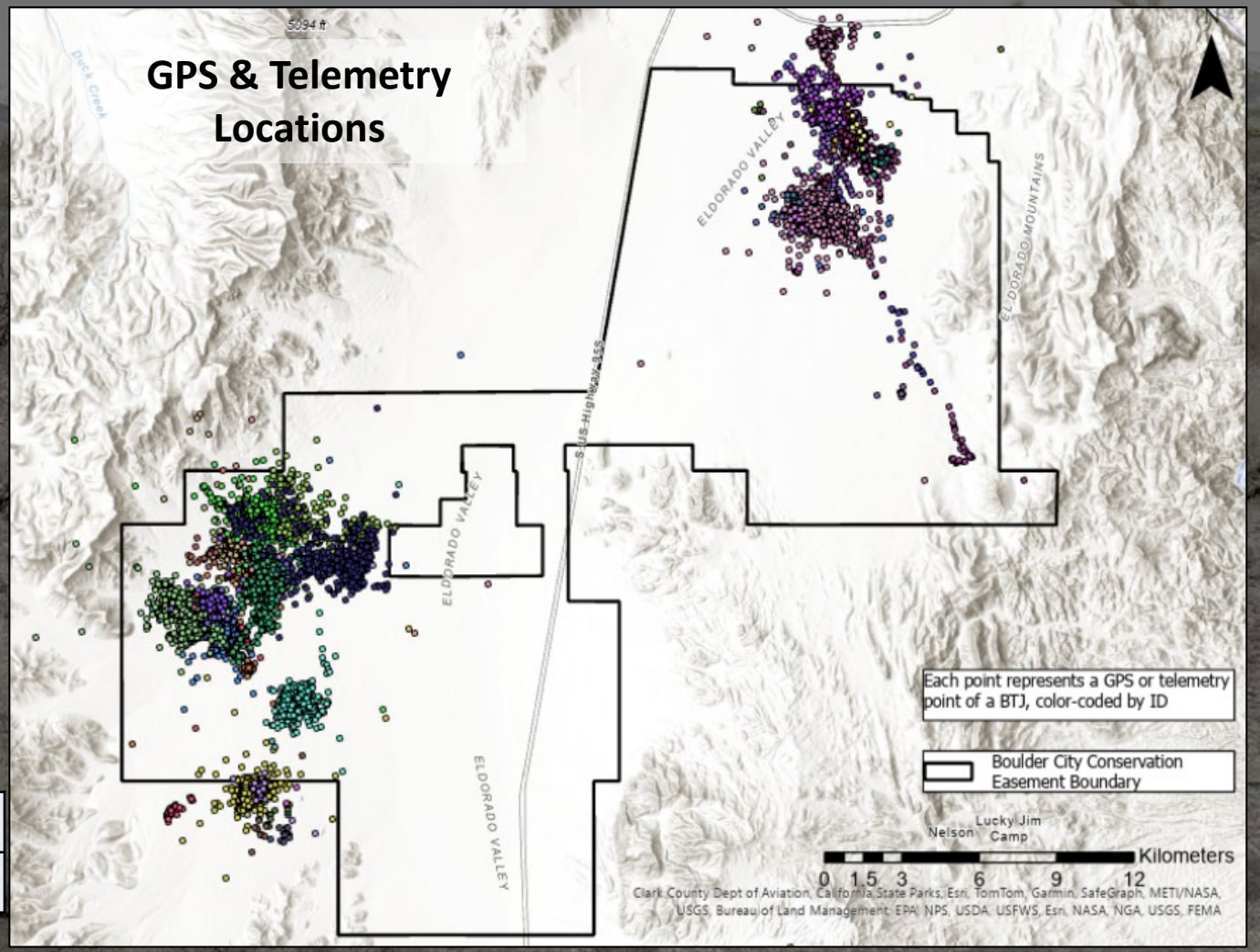
- 131 baiting days
- 149 total trap nights
- 74 captures
- Placed 43 collars on 40 unique jackrabbits

Telemetry

- Tracked 46 jackrabbits, 346 times

September 2023,
began recording jackrabbit shelter type

	Burrow	Vegetation	Open	Rock	Unknown
# BTJ	9	170	9	3	67



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Jackrabbit Results

Determining survival when retrieving collar

Collar Retrieval Reason	Num. of Collars
Collar Drop	6
Capture Related Injury	12
Captured / removed collar	7
Predation	12
Other (RHDV2)	1
Unknown	2

Predation Type	Num.
Coyote	2
Kit Fox	7
Raptor	0
Unknown	3

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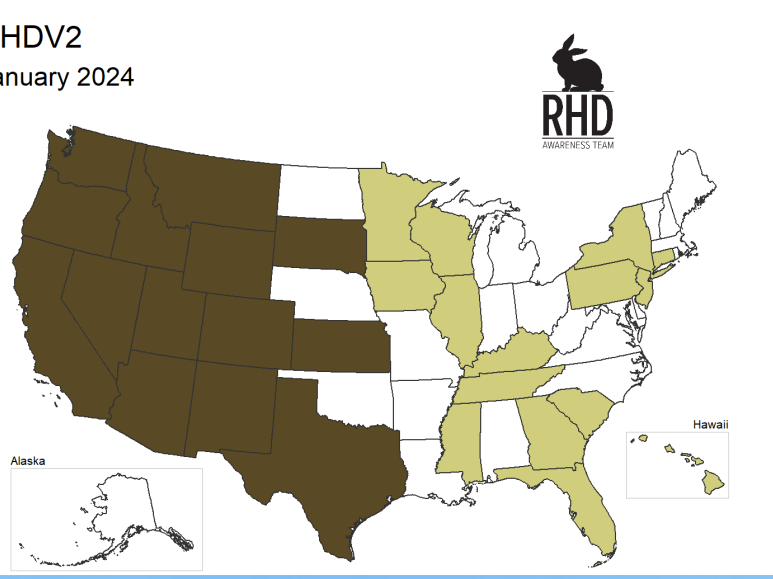
RHDV2

Rabbit Hemorrhagic Disease Virus 2

- RHDV2 first detected in wild in U.S. in 2020
- Mortality rates exceed 80%
- Spreads via contaminated bodily secretions (e.g., blood, saliva, feces)
- Extremely durable in environment (3-6 months)
- No outward signs, but death usually within 4-6 days

RHDV2 in BCCE

- Surveillance for cases in 2020 (false positives)
- First positive April 2024
  - Found intact, fresh carcass
  - NDOW necropsied; lab test confirmed positive for RHDV2



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Coyote Capture Methods

1. Site evaluation
2. Sites baited – coyotes visit 18 -144 days
3. Trapping – winter (November –April)
   padded foothold traps
4. Coyotes chemically immobilized & monitored
5. Fitted with collar and ear tags
6. Evaluate - age/sex/health
7. Given chemical antagonist and released

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Coyote Monitoring Methods

Collars

- 3-hour GPS fix interval/ 1.5-2.5 years of data collection
- Location data and mortality alerts via satellite
- Automated release mechanism allows recovery of collar with complete GPS dataset

Telemetry

- Collars have VHF beacon that is active 4 hours/day
- Radio telemetry is used to locate coyotes and perform health checks as needed

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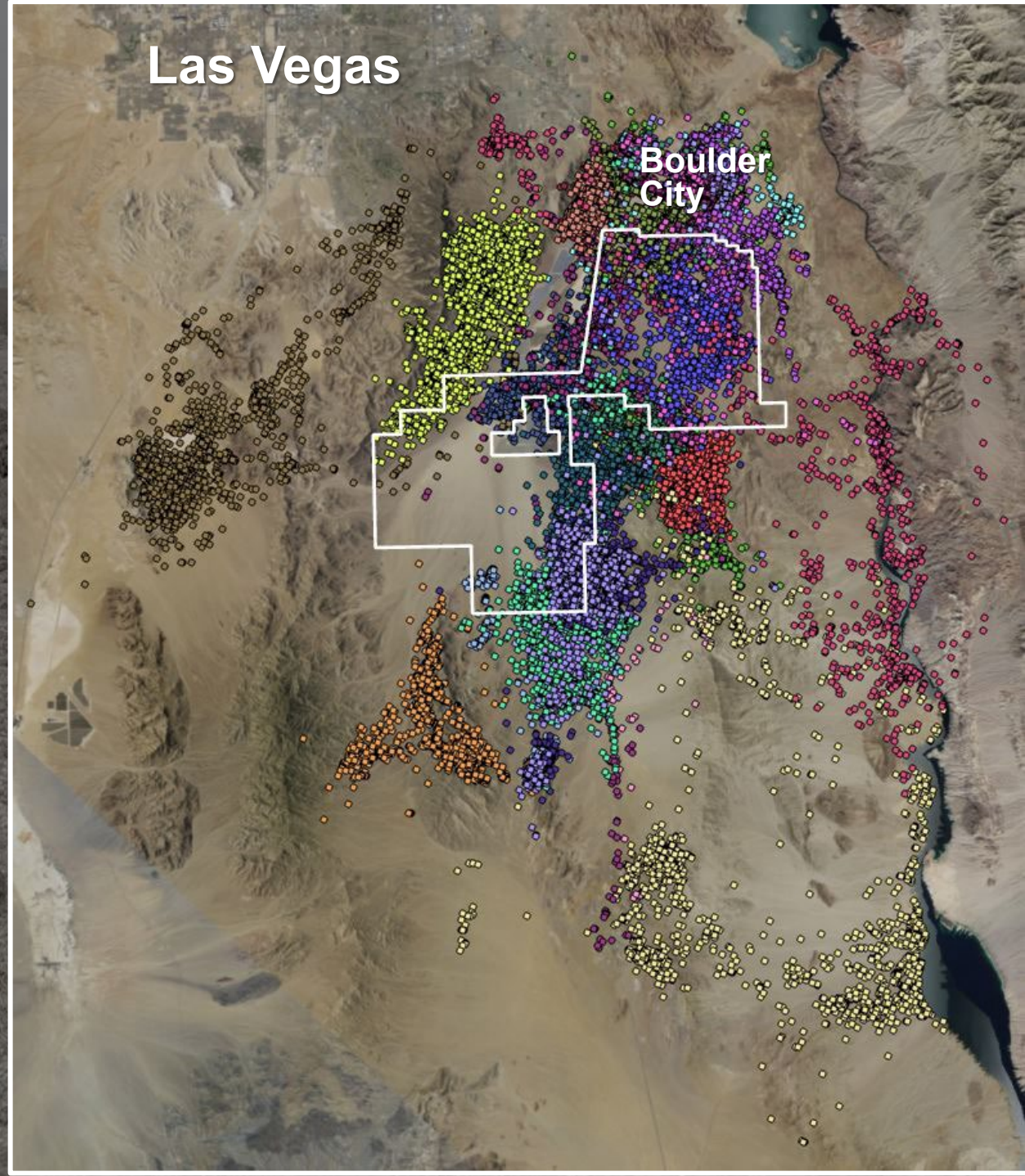
Coyote Results

Trapping

- Baited 106 days across 22 sites
- 63 total traps nights
- 10 captures at 8 sites
- Collared 8 individuals: 5 male / 3 female

GPS monitoring

- 22 collared coyotes monitored
- 6,014 coyote days @ 8 points/day
- 14 active collars deployed



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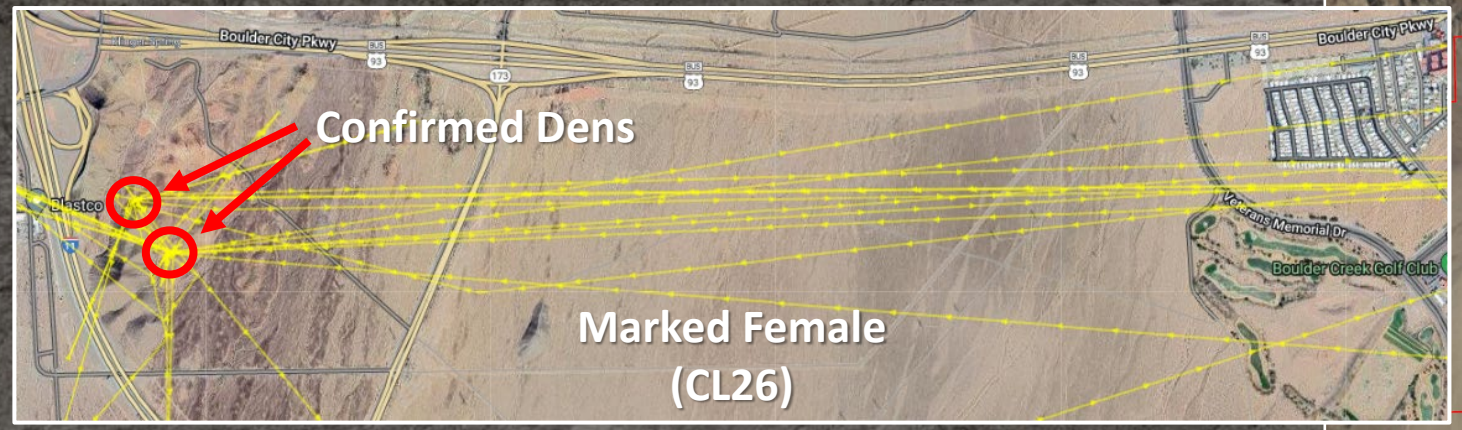
Coyote Dens

GPS data greatly assisted finding dens

- Satellite: Identify clusters & frequented areas for biologists to visit
- In field: Search for occupied dens, observe coyote behavior, detect pup sign (tracks and scat), place den cameras



BCCE Den Checks
Spring 2024

N

Confirmed Active

Unconfirmed

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Coyote Dens

15 potential dens checked, 10 confirmed as active dens

- 7 litters confirmed, at least 21 pups
- 1 pup tagged
- 1 dead pup found in den
- 1 dead pup found on highway, litter unknown

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Future Work / Predation impact on Tortoises

1. Predator-prey REM paper in journal peer-review

2. Analysis and drafting of jackrabbit spatial ecology paper currently underway

3. Next – analyze and report

Space use:

- Coyote spatial ecology
- Effects of coyote predation on jackrabbit habitat selection
- Coyote den site selection
- Landscape-scale spatial risk of coyote predation to desert tortoises

Demographics:

- Spatially explicit density, abundance, and pop. growth for coyotes and jackrabbits
- Survival and cause-specific mortality

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Acknowledgements

Clark County DCP
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Sabrina Lewicki
Ben Nolan
Caitlin Poage
Ross Van Gaalen

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Questions?