science for a changing world

Predator and Prey Dynamics in the Boulder City Conservation Easement

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

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Acknowledgements

Clark County DCP
Scott Cambrin
Kimberly Jenkins
John Ellis

desert conservation
PROGRAM

Great Basin Institute
Terry Christopher
Brent Sparks

Great Basin
Institute

USGS, Western Ecological Research Center, Boulder City Field Station

Christian Franco
Katie Soltysiak
Eddie Gaylord
Felicia Chen

Brent Cunningham
Sabrina Lewicki
Sarah Mendoza
Ben Nolan

Caitlin Poage
Carleen Silva
Ross Van Gaalen

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Goal & Research Objectives

"The goal of this project is to gain a better understanding of the predator-prey dynamics of one of the desert tortoises' main predator species toward a strategy to limit translocations from being severely impacted by coyote predation."

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

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Phase II Methods Overview

Building from Phase I (2018-2021), primary fieldwork components include:

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

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Camera Trap Background

Phase I → Random Encounter Model (REM)

<u>Problems:</u>

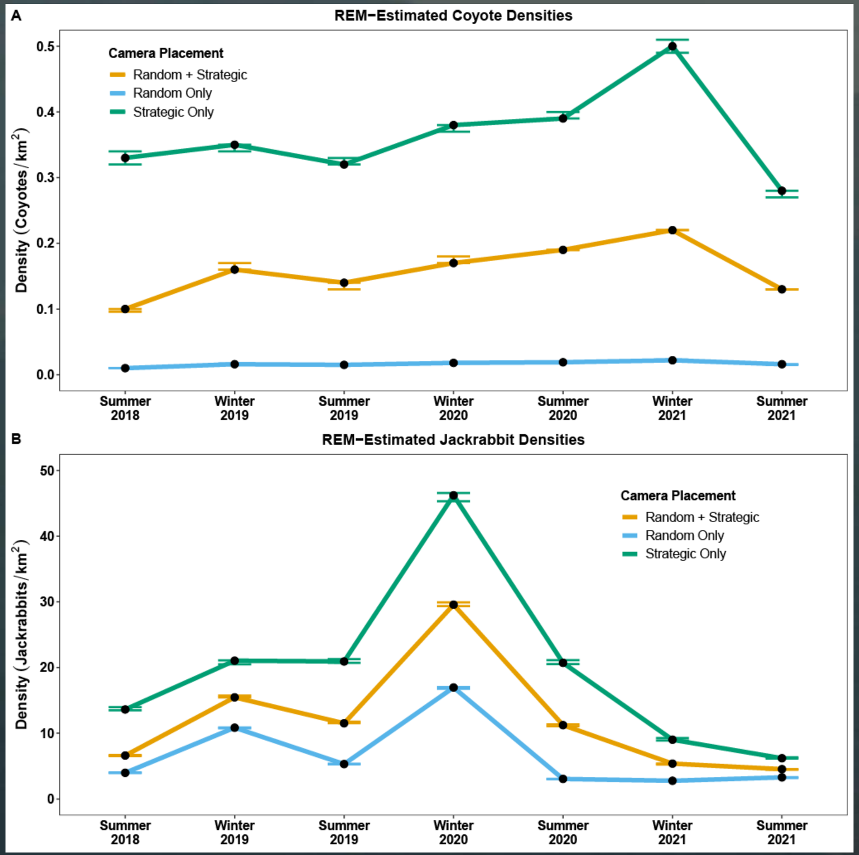
1. Assumptions too strict (often violated)
2. Only uses camera-trap data
3. Ignores individual-level variation
4. Ignores ecological processes
5. Substantial discrepancies in estimates depending on which data were used
6. Uncertain estimate reliability/validity

Journal of Applied Ecology
British Ecological Society
Journal of Applied Ecology 2008, **45**, 1228–1236 doi: 10.1111/j.1365-2664.2008.01473.x

Estimating animal density using camera traps without the need for individual recognition

J. Marcus Rowcliffe[1]*, Juliet Field[2], Samuel T. Turvey[1] and Chris Carbone[1]

A key underlying assumption is that animals behave like ideal gas particles, moving randomly and independently of one another. This is clearly unrealistic for animals in a natural setting, where individuals respond to one another and their physical environment.



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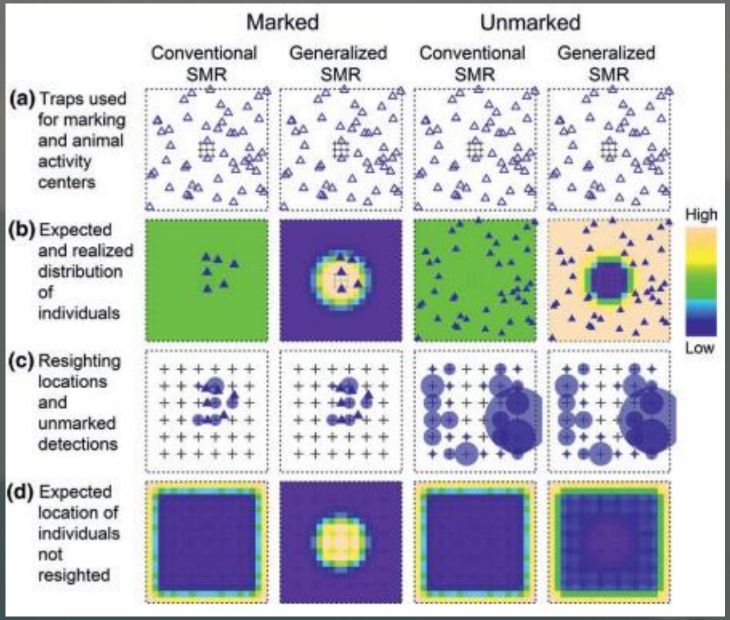
Camera Trap Background

Phase II → Generalized spatial mark-resight (gSMR) models

<u>Solutions:</u>

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

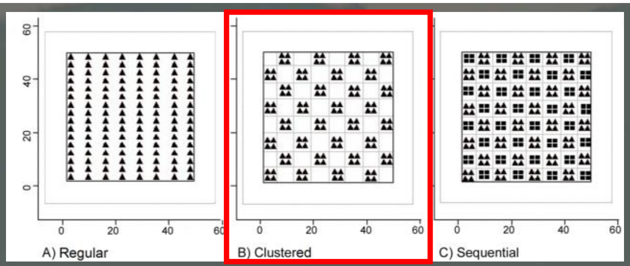
<u>Clustered Sampling Design:</u>

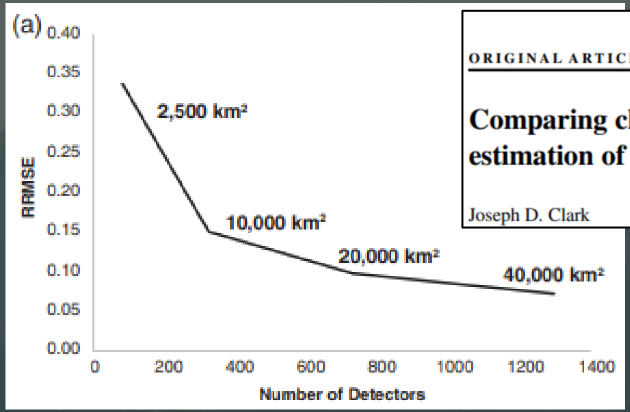
1. gSMR models are spatially explicit → easily accommodate irregular spatial and temporal sampling designs
2. Survey larger area with fewer cameras = more total detections and spatial recaptures = improve estimate accuracy and precision
3. Model density as a function of habitat or landscape covariates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

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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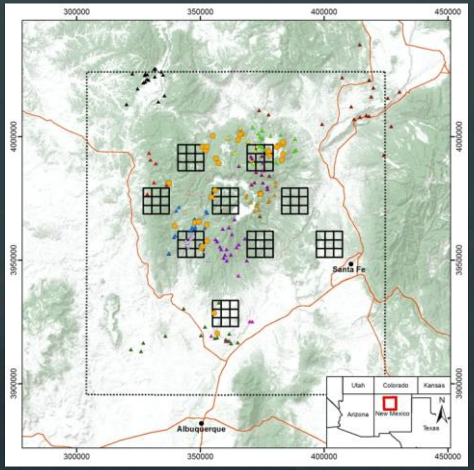

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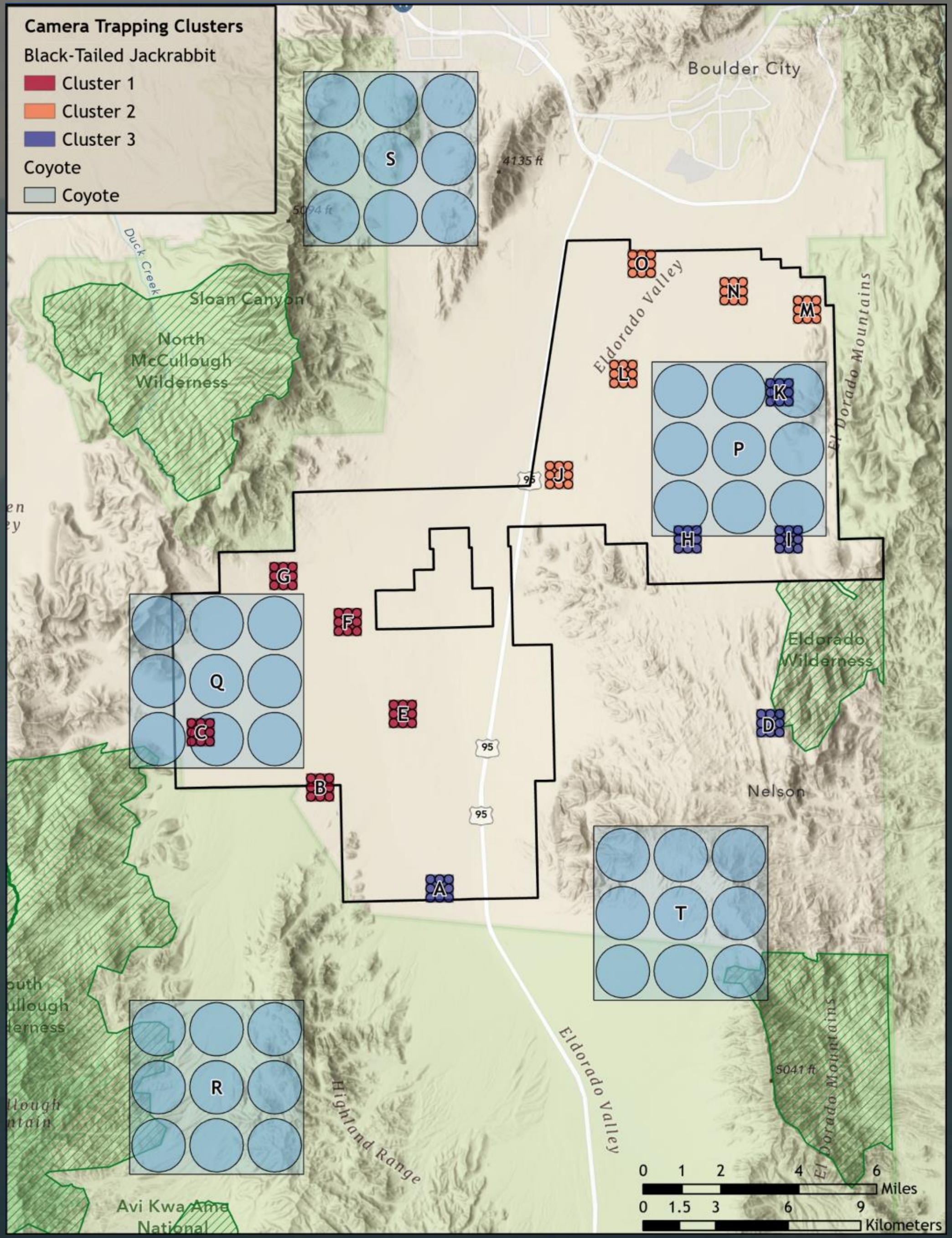
Camera Trap Methods

- **Within and among cluster spacings based on mean female home range sizes estimated in Phase I**

- **<u>Rabbits:</u> 15 clusters of 9 cameras, spaced ~360 m apart**
  - 5 clusters surveyed for 8 weeks, then pulled and rotated to the next set of 5 clusters.
  - Each cluster sampled for 2 months in both summer and winter

- **<u>Coyotes:</u> 5 clusters of 9 cameras, spaced ~2.2 km apart**
  - Cameras are stationary and not rotated.
    - Can be moved within sampling cell to optimize detections as needed
  - Cameras equipped with solar panels = transmit station status and images via cellular network

- **Data from ALL cameras will be used for the analyses of both species.**



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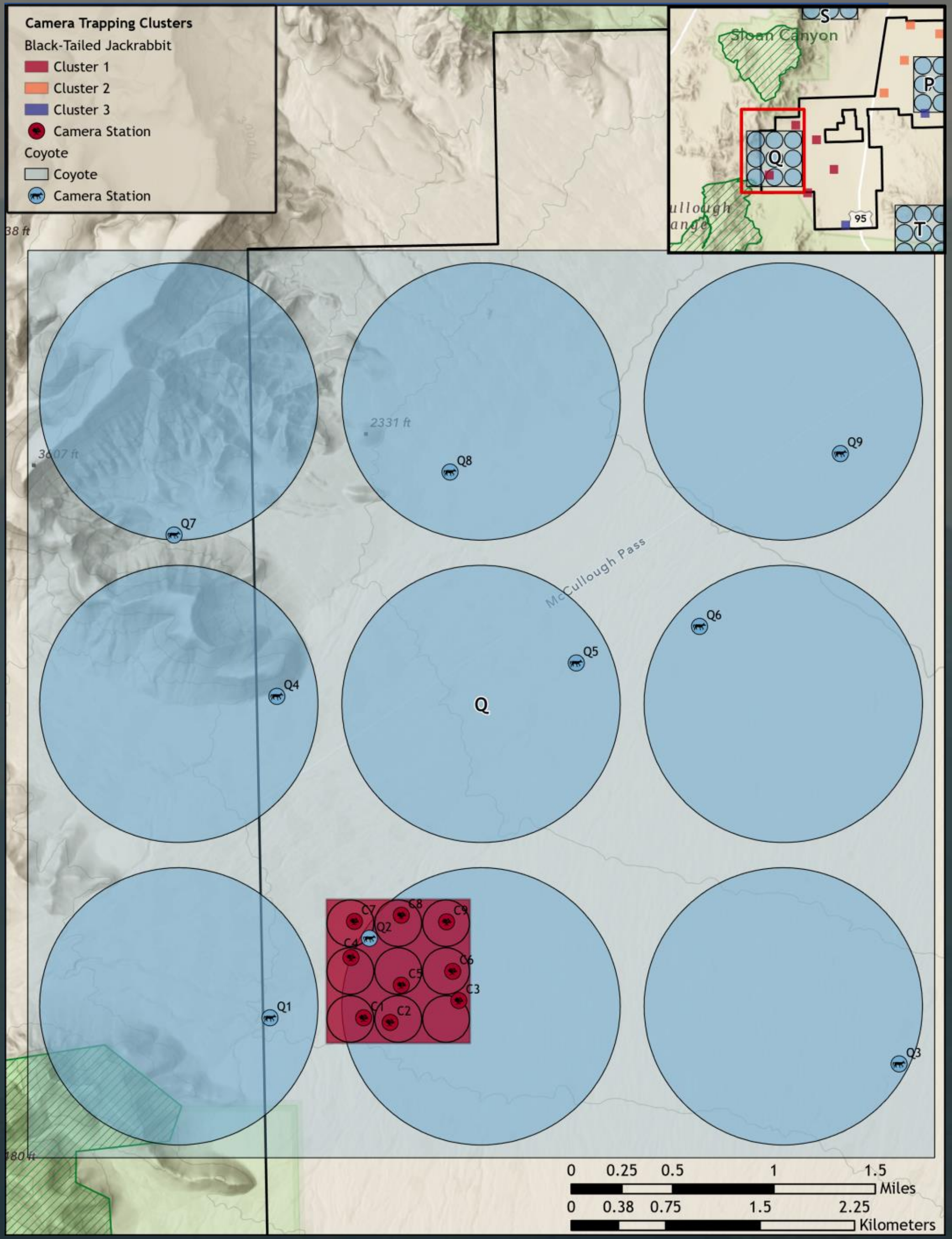

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Camera Trap Early Results

- Trap effort
  - Coyote cameras: 6/22/2023 – present
  - Rabbit cameras
    - Rotation 1: 6/9/2023 – 8/1/2023
    - Rotation 2: 8/3/2023 – present
- Summary from rabbit (rotation 1) processing:
  - 22,600 photos sorted
  - 38/45 cameras captured rabbits
  - 2/45 cameras captured marked rabbits
  - 1/45 cameras captured marked coyote

Jackrabbit Methods

Capture:

- Baiting Traps – Requires ~9-20 days to condition rabbits so they enter freely.
- Trapping – Adults are weighed, fitted with a collar and ear tags with unique ID number, sexed, and released.
  - Individuals < 1.81 kg are too small for a collar

Collars:

- Holohil (“Short-term”): 30-minute GPS fix interval/ 4-6 weeks of data collection per collar.
- Telonics (“Long-term”): 3-hour GPS fix interval/ 1 year of data collection per collar

Telemetry:

- Individuals tracked biweekly – If collars found, effort expended to determine if the collar dropped or the animal is dead. If animal is dead, attempt to discern cause.

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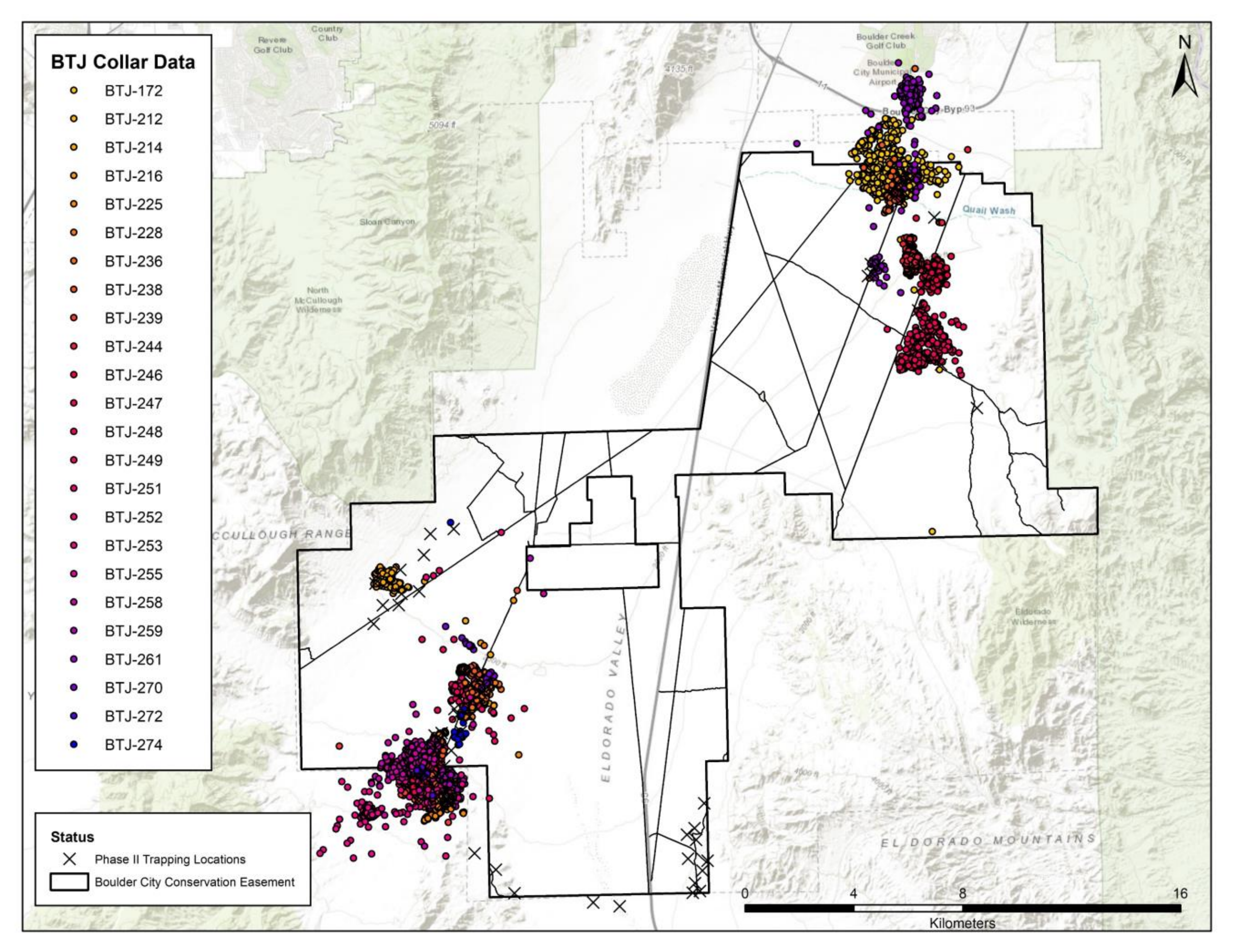
Jackrabbit Early Results

Phase II trapping effort (Oct 2022 – Present):

- 186 days of baiting across 13 trapping events
- 20 nights of trapping for 82 total trap nights
- Captured 58 Black-tailed Jackrabbits
    - 40 new individuals
    - 18 recaptures
    - 39 collars placed on 38 individuals

Phase II Telemetry effort:

- Tracked & Searched for 47 total individuals 552 times.
- 33 collars from 28 individuals retrieved from field.



Retrieval Reason	Number of Collars
Collar Drop	2
Capture Related Injury	4
Captured Animal (removed collar)	6
Predation	19
Other	1
Unknown	1

Predation Type	Number
Coyote	5
Kit Fox	4
Raptor	2
Unknown	8

Coyote Methods

Capture:

- Occurs during winter season (November-March)
- Baiting trap sites – required 15-73 days (mean: 27 days) for coyotes to become acclimated to trapping site
- Trapping – Coyotes are captured in padded foothold traps, then processed while chemically immobilized:
  - Fitted with a GPS collar
  - Given ear tags with unique ID
  - Collection of morphometric and biological data, including sex & age
  - Conduct visual health assessment
  - Collection of fur and toe pad samples for genetic analyses

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Coyote Methods

Collars:

- Lotek GPS collars: 3-hour GPS fix interval/ 2 years of data collection.
  - Location data and mortality alerts transmitted via satellite for regular monitoring.
  - Programmed to release before battery life ends, allowing recovery for downloading complete GPS dataset.

Telemetry:

- Collars also 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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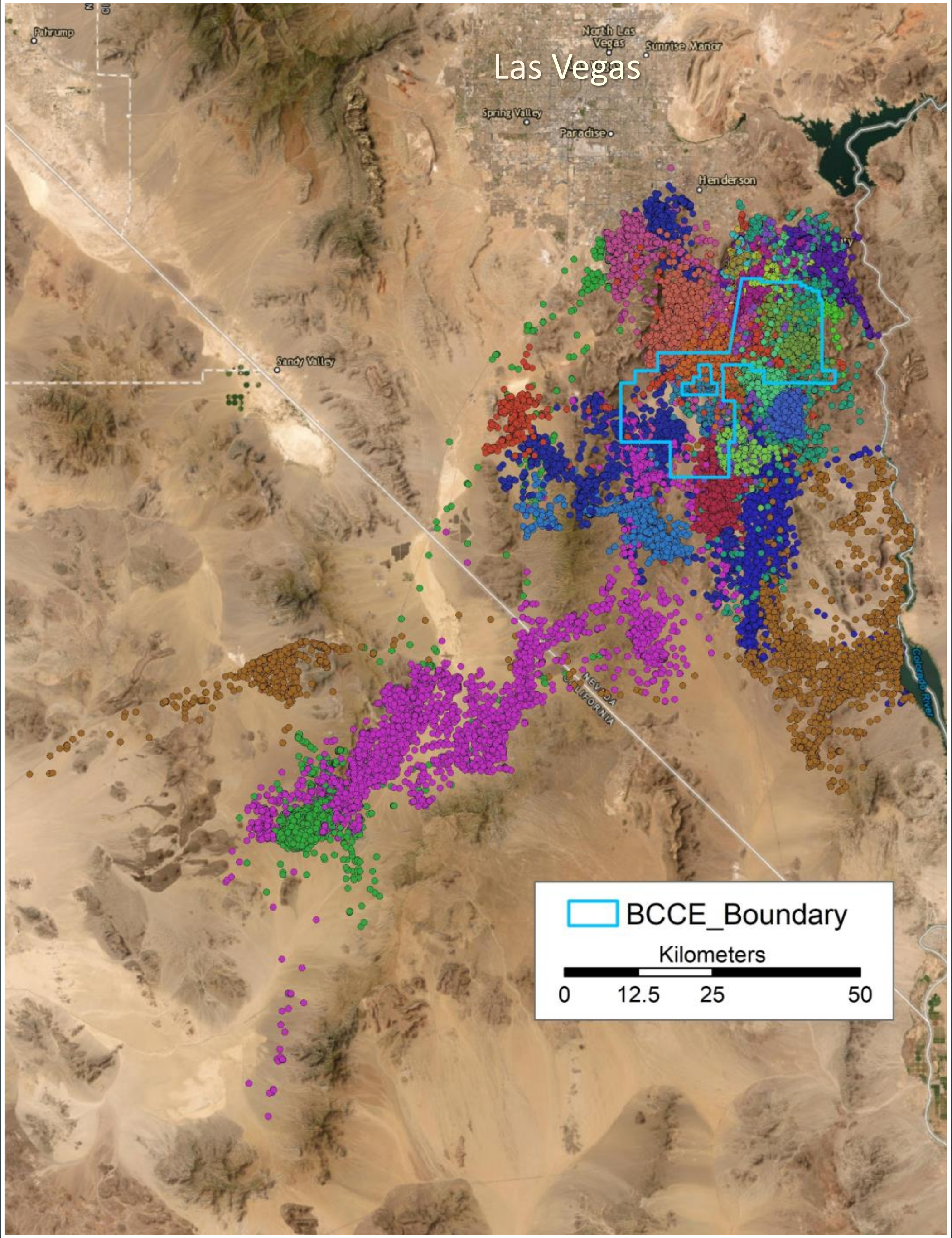
Coyote Early Results

Phase II trapping effort (Nov 2022 – Present):

- 78 days of baiting across 22 sites
- 15 nights of trapping for 24 total trap nights
- Captured 14 coyotes from 11 sites
    - 12 new individuals
    - 2 recaptures (1 received new collar)
    - Collared 12 individuals (6 males; 6 females)

Phase II GPS data:

- 25 collared coyotes monitored
- 10,125 coyote days of data (x8 points/day)
- 6 timed-release collars retrieved



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Future Work / Predation impact on Tortoises

Publish REM paper

Investigate spatial cluster analysis to identify coyote dens

Investigate predator deterrence
- other agencies also interested

Publish population status, habitat relationships, and relationships between jackrabbit resource selection and coyote movements

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Questions?