Internal Structural Cover and Ledges Facilitate the Use of Large Underpasses by Multiple Wildlife Species and Groups

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Western Ecological Research Center U. S. Geological Survey

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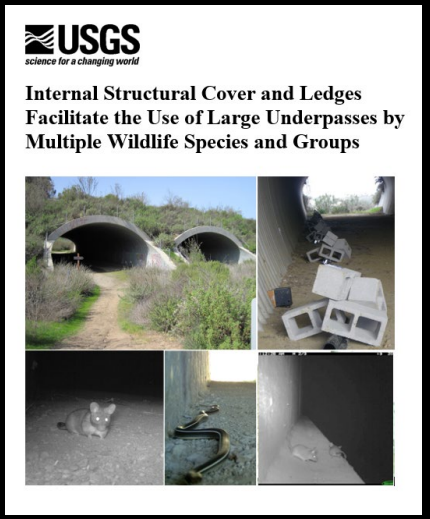

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Report Reference: Brehme, C.S., Tracey, J.A, Gould, P.R., Rochester, C.J. and R.N. Fisher. 2022. Internal Structures and Ledges Facilitate the Use of Large Underpasses by Multiple Wildlife Species and Groups. USGS Cooperator Report to Nevada Department of Transportation, Transportation Pooled Fund Program Project P200-20-803. https://www.pooledfund.org/details/study/610

STUDY AREA:
San Diego County

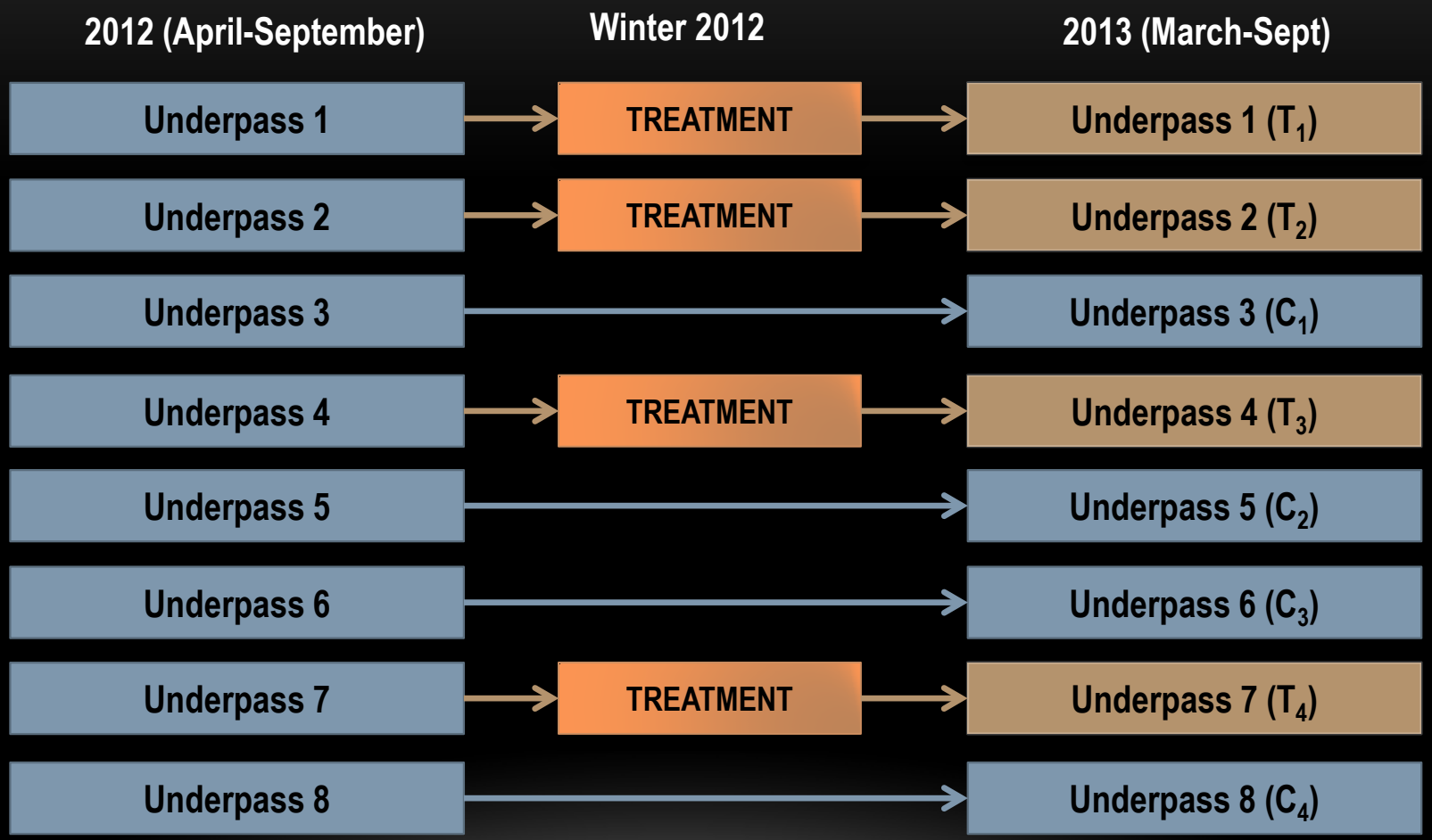
Problem Statement:

- A number of large wildlife underpasses built in uplands to mitigate road barrier effects in San Diego County
- Built with consideration of large mammals
- Assume use by small and medium animals
- Little data to show if these are effective

Questions

- How permeable are underpasses to animal species in the CSS community?
- How does permeability vary by species/ species group?
- Does adding internal structural cover increase permeability to smaller species?

STUDY DESIGN- BEFORE AND AFTER CONTROL-IMPACT (BACI)



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8 UNDERPASSES

Site (Site ID)	Length (m)	Width (m)	Group
Valley Center North (VCN)	34	4.5	Control
Valley Center Middle (VCM)	45	4.5	Treat
Valley Center South (VCS)	37	4.5	Control
Carmel Country Road North(CCN)	51	9	Treat
Carmel Country Road South(CCS)	51	9	Control
Sorrento Valley Road (SVR)	46	6	Treat
Scripps Poway Parkway (SPP)	62	9	Control
Highway 52 (HFT)	87	5	Treat

4 underpasses with ledges

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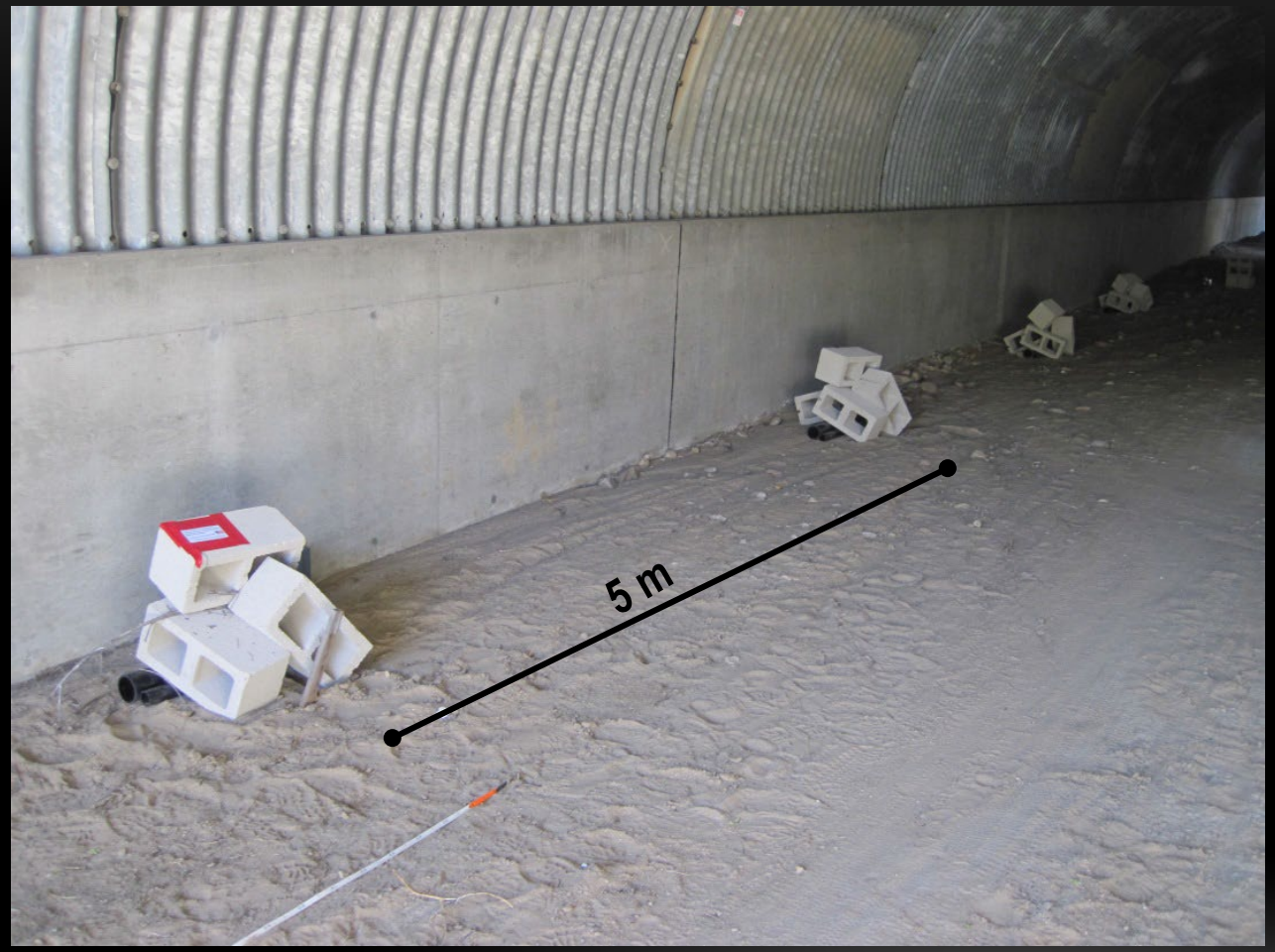
STRUCTURE COVER TREATMENT



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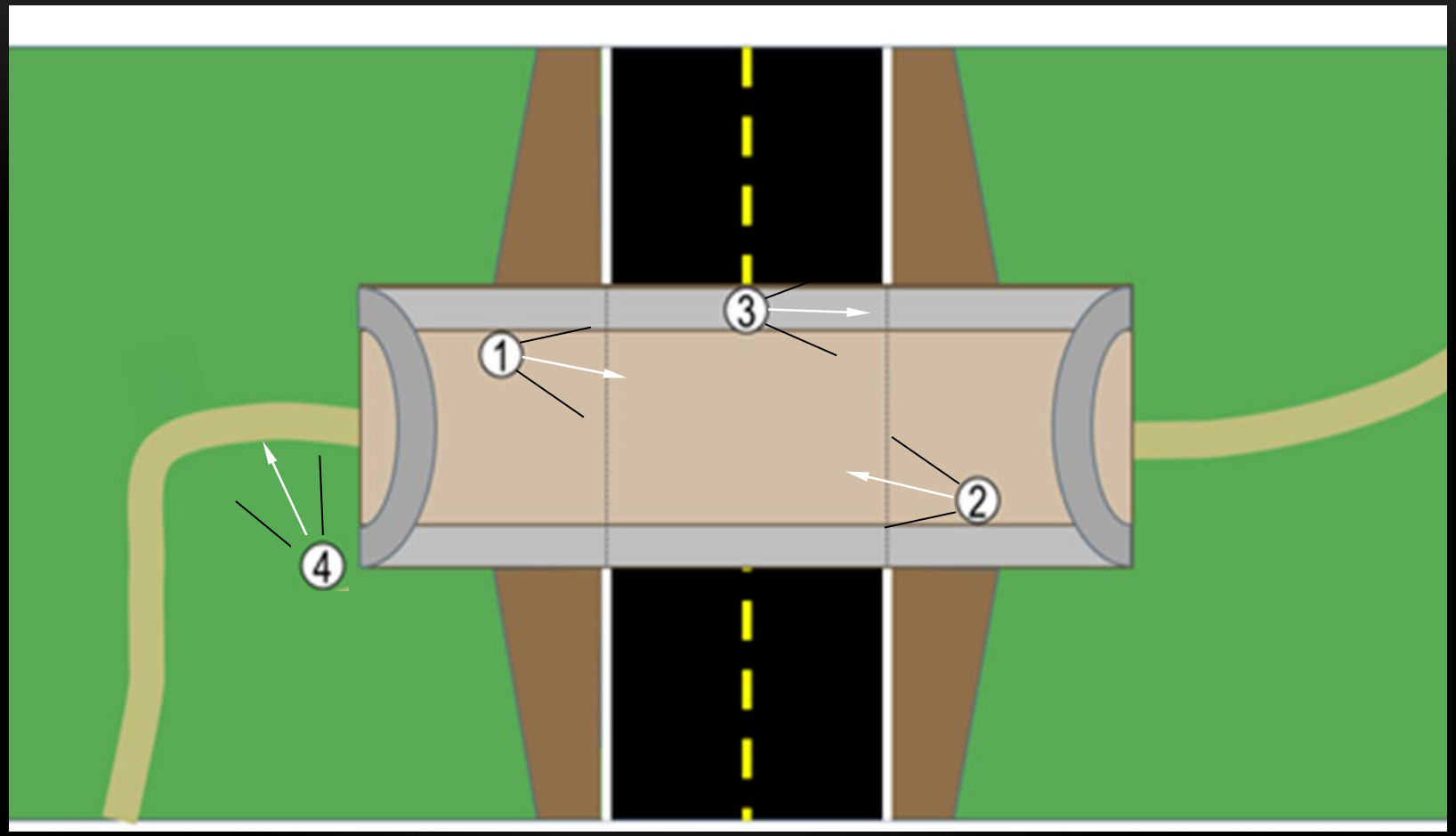
LEDGES

No ramps
height ~ 4 feet
width ~ 5-6 inches

CAMERA INSTALLATION & PLACEMENT



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CAMERA INSTALLATION & PLACEMENT

- Reconyx Hyperfire
  - Increased sensitivity
  - Decreased focal length
- Placed close to the ground
  - Approx. 2 inches
- Trigger Mechanisms:
  - Motion Detection
  - Time Lapse- 5 min (288/day)

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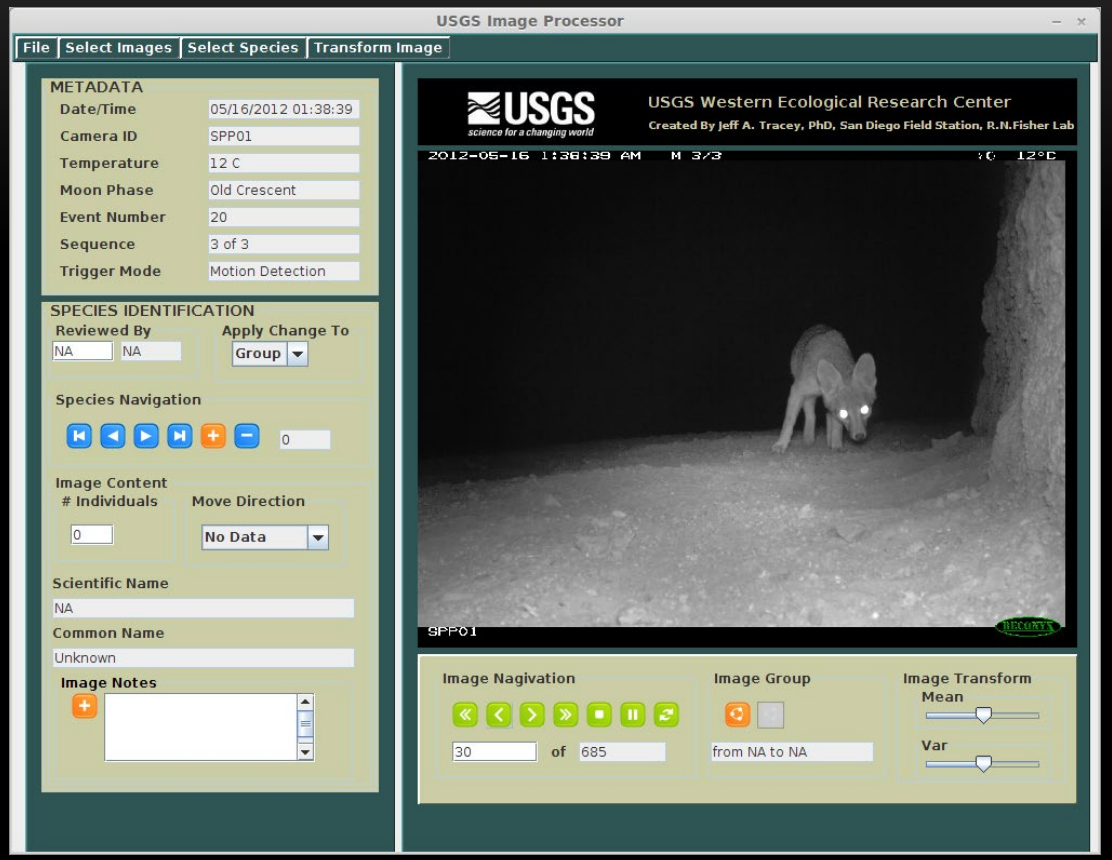
DATA:



- Motion >975,000 images
- Time Lapse >2,200,000 images
- Animals Identified

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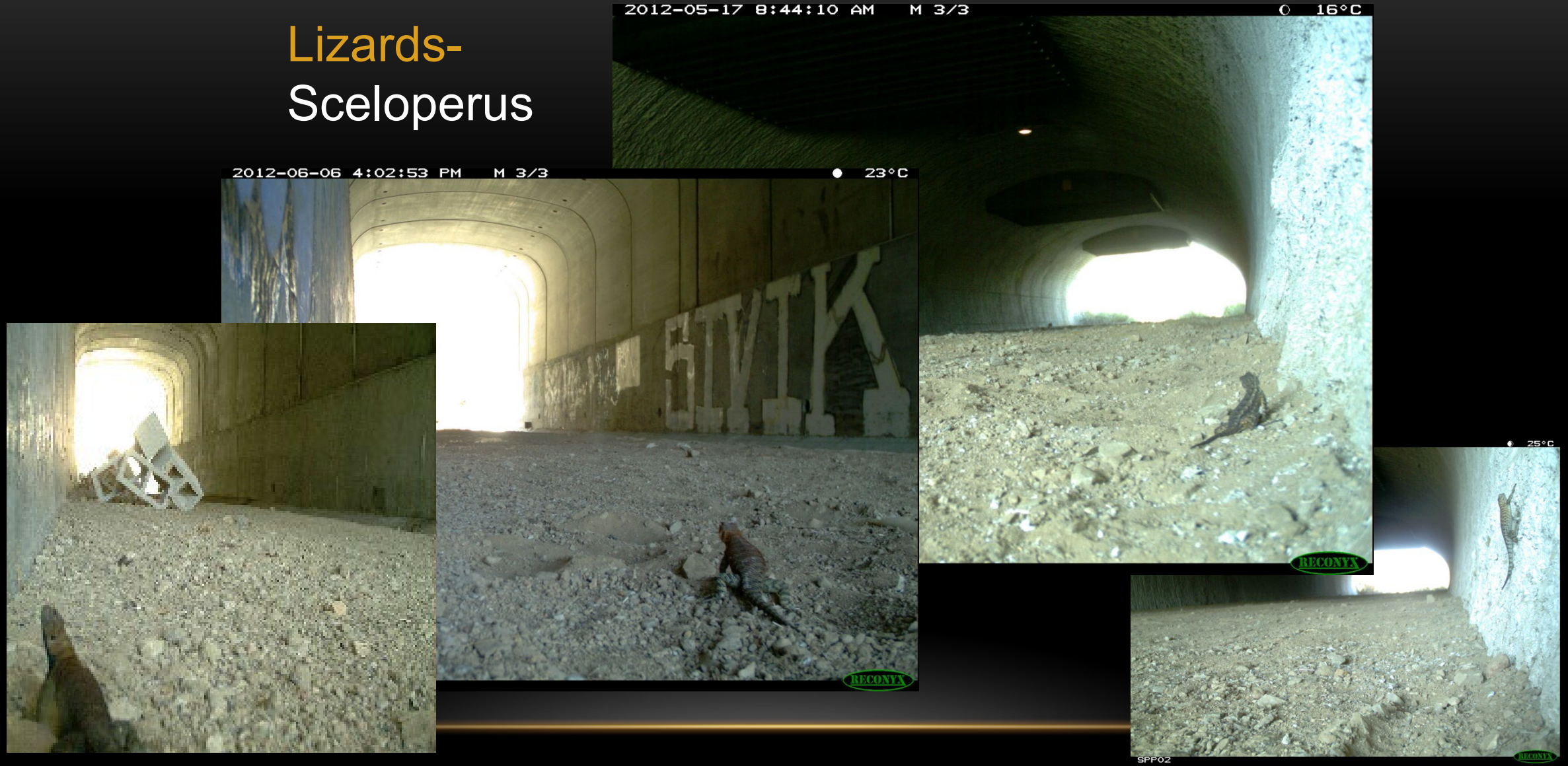
12 SPECIES/ SPECIES GROUPS- SMALL>LG

Lizards-
Sceloperus



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Snakes-

Rattlesnakes, King Snakes, Gopher snakes, Gartersnakes

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Mice-
Peromyscus

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Woodrat

Ground Squirrel

Rabbit

Racoon

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Skunks

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Bobcat

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Mule Deer

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OTHER ANIMALS- ROADRUNNER

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DATA ANALYSIS: MACHINE LEARNING

- Initial Training set of >200,000 images suggested high sensitivity (mean = 0.983) and specificity (0.975) for 6 species groups tested
- Applied across the entire remaining dataset, approximately half of all photos (~1.5 million) were predicted to be target animal groups.
- Many “None” images classified as animals
- Due to time constraints, we classified all photos using humans
- After human classification, only 2.2% of the amount predicted by the model. were target species groups (31,575).
- Hypothesis- algorithm learned backgrounds where species were most likely to occur.

DATA ANALYSIS: MACHINE LEARNING

MODEL - IDENTIFIED	HUMAN - IDENTIFIED												
	BOBCAT	COYOTE	DEER	FOX	LIZARD	MOUSE	RABBIT	RACOON	RAT	ROADRUNNER	SKUNK	SNAKE	SQUIRREL
BIRD	0%	1%	1%	1%	17%	0%	11%	0%	0%	3%	0%	30%	6%
BOBCAT	**83%**	14%	5%	29%	0%	10%	14%	36%	0%	0%	9%	0%	1%
COYOTE	12%	**66%**	9%	5%	3%	0%	3%	11%	1%	2%	2%	0%	5%
DEER	3%	11%	**81%**	6%	0%	3%	3%	0%	0%	0%	4%	0%	0%
FOX	0%	1%	0%	**42%**	1%	0%	1%	1%	0%	0%	2%	0%	0%
LIZARD	0%	1%	1%	4%	**69%**	0%	1%	0%	0%	0%	0%	21%	4%
MOUSE	0%	0%	0%	0%	0%	**81%**	0%	0%	19%	0%	0%	1%	0%
RABBIT	0%	4%	2%	6%	2%	0%	**64%**	7%	5%	2%	4%	10%	1%
RACOON	1%	1%	0%	1%	0%	0%	0%	**33%**	1%	0%	6%	0%	0%
RAT	0%	0%	0%	0%	0%	2%	3%	1%	**70%**	0%	0%	1%	0%
ROADRUNNER	0%	1%	0%	0%	1%	0%	1%	0%	0%	**94%**	0%	0%	1%
SKUNK	0%	1%	0%	4%	0%	5%	0%	11%	3%	0%	**73%**	0%	0%
SNAKE	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**34%**	0%
SQUIRREL	0%	0%	0%	3%	7%	0%	0%	0%	0%	0%	0%	3%	**82%**

75% of images containing target species groups were correctly identified

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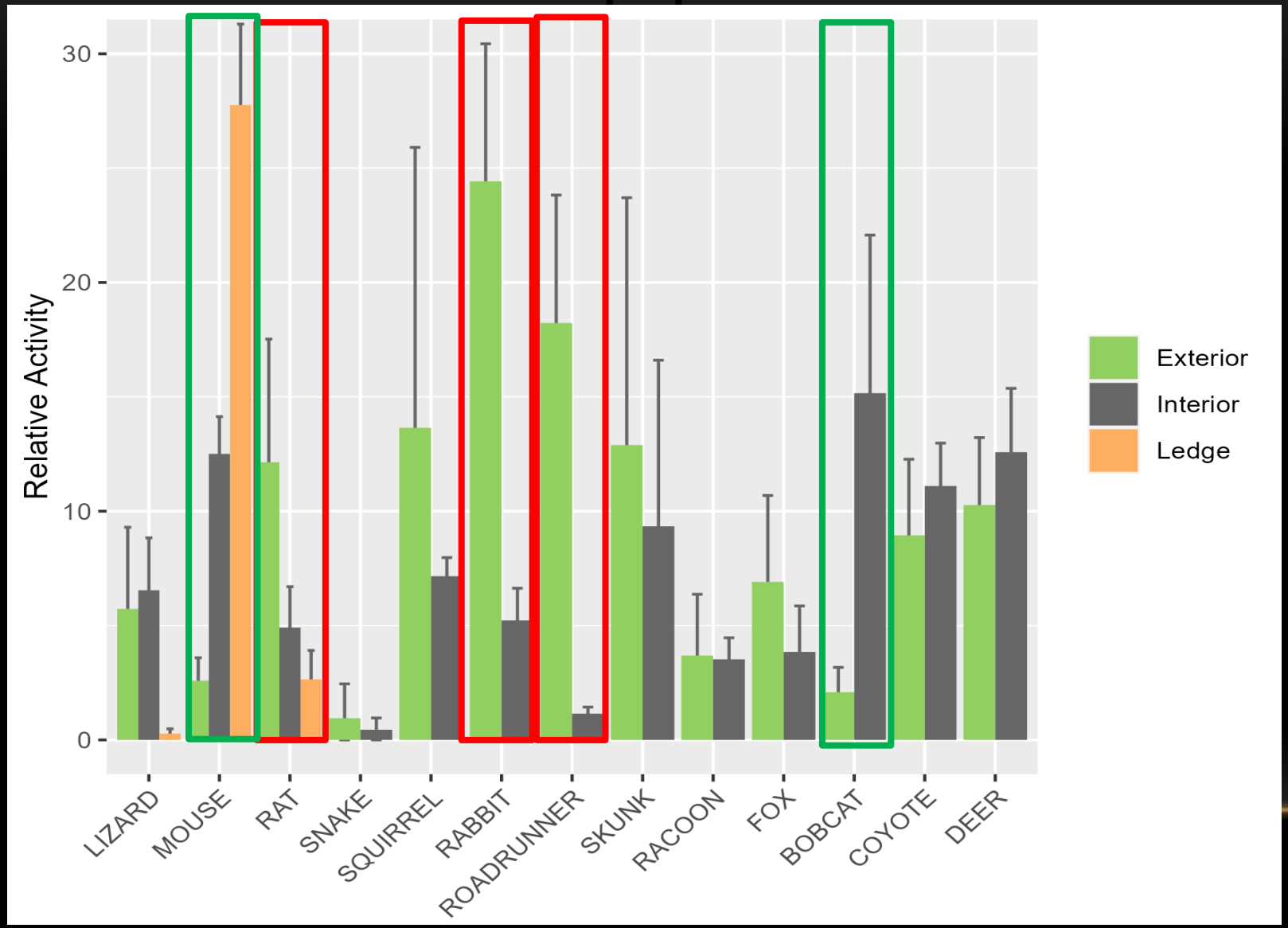
DATA ANALYSIS:

- Relative Animal Activity (Exterior vs. Interior vs. Ledges)
  - Closed Population N-mixture model (Royle 2004)
  - Factors: Placement, Site
- Effect of Structure Treatment on Activity
  - Open-Population generalized N-mixture model (Dail & Madsen 2010)
  - Factors = Site, Treatment (Txt side only for small animals), Year
- Incorporate imperfect detection probabilities (active trigger/ time lapse)
- Response Variable = # events per week
- 10 min window for single event (~14,000 unique use events)

Results: Exterior vs. Underpass- Relative Activity



Underpass Avoidance

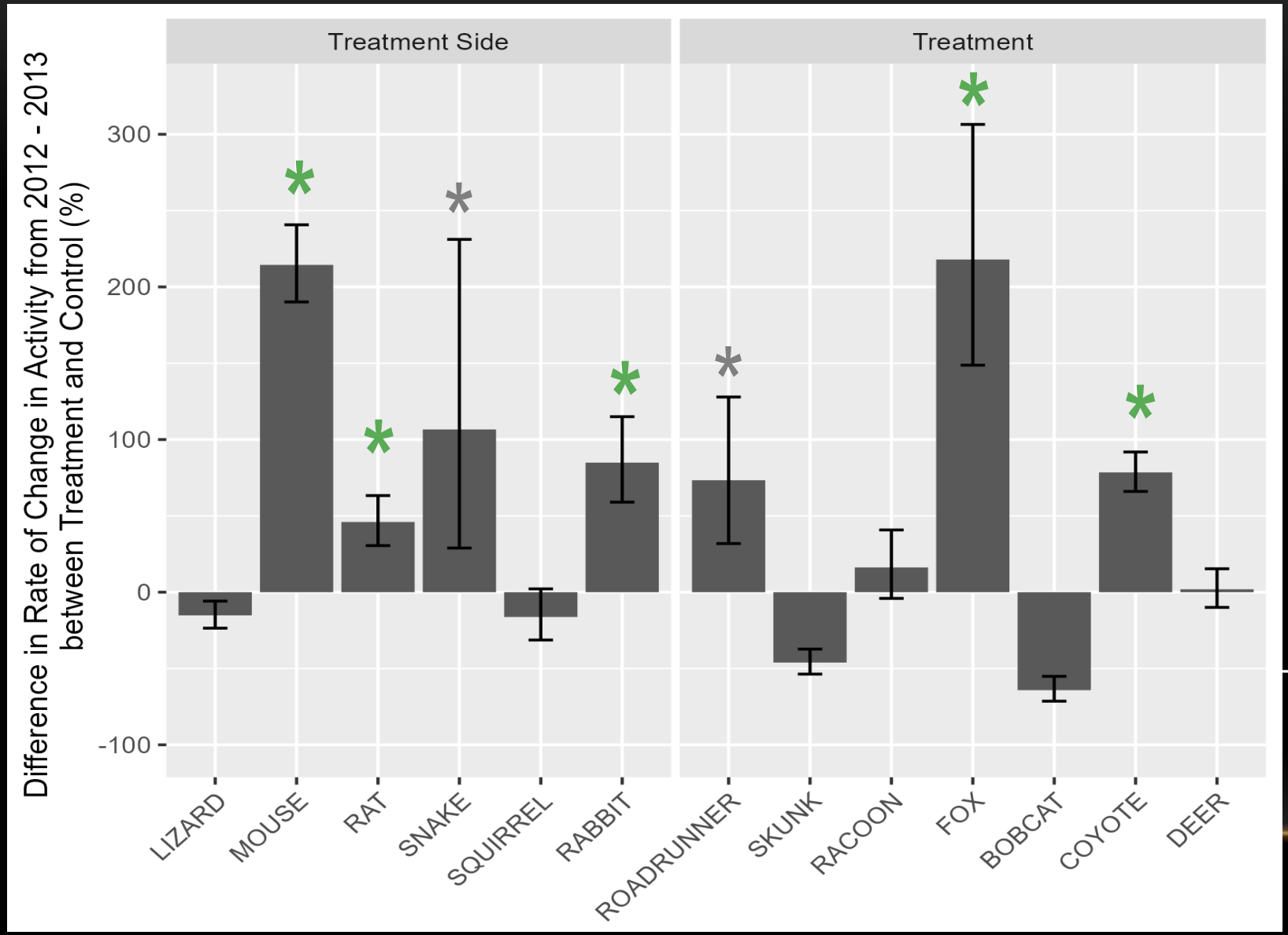
- Woodrats*
- Rabbits*
- Roadrunners*
- Snakes
- Squirrels
- Fox

Underpass Preference

- Mice*
- Bobcats*

Brehme et al. 2022

Results: Effects of Structure Treatment- Relative Activity

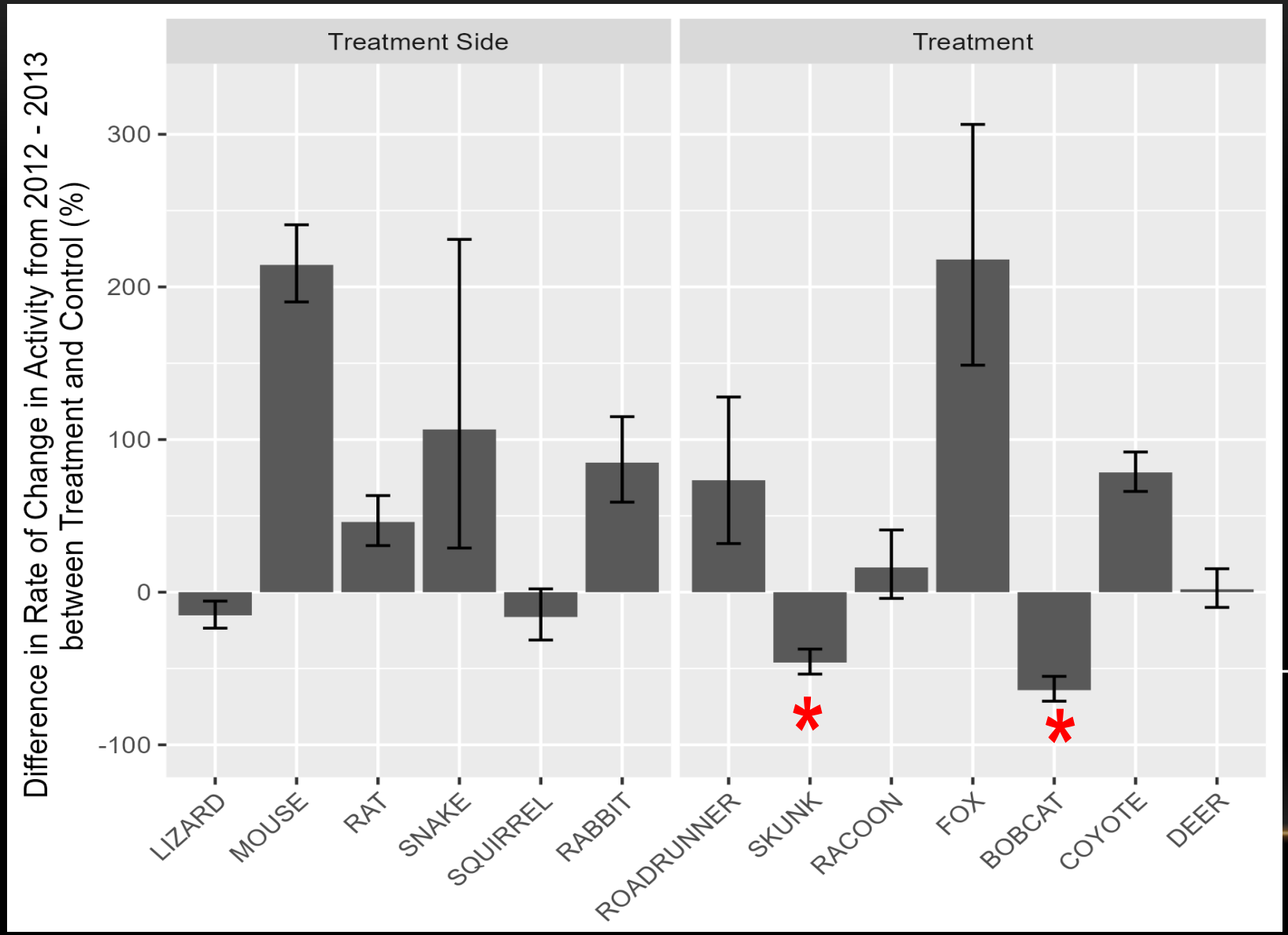


Increased Underpass Use

- Mice*
- Rats*
- Rabbits*
- Fox*
- Coyote*
- Snakes
- Roadrunners

Brehme et al. 2022

Results: Effects of Structure Treatment- Relative Activity



Decreased Underpass Use

- Skunk
- Bobcat

No difference

- Lizards
- Squirrel
- Racoon
- Deer

Brehme et al. 2022

TROPHIC EFFECTS?

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TROPHIC EFFECTS?

Competitors

Coyote

Coyote dominant

Bobcat

Fox

Deer

fawns only

Skunk

Raccoon

Snakes

Roadrunner

Squirrel

Rabbits

Woodrats

Mice

Lizards

?

Arthropods

Seeds, vegetation

Not feasible for many underpasses

Structure Treatments

Cover from predators

Increased moisture?

microbial communities?

FUTURE:

- **Repeat Study: 10 years since addition of treatments in 2013 (i.e. long-term vs. short-term responses)**
  - Survey for Arthropod density
  - Add track surveys- validation
  - Increase # of exterior cameras

- **Analyze Relationship between Human and Wildlife Use of Underpasses**
  - hikers, bicyclists, motor bikes, horses, domestic dogs

- **Species permeability of wider array of underpass types**
- **Continued development of machine learning (USGS)**

SUMMARY OF FINDINGS

- Underpass Avoidance
  - Lizard group, snake group, woodrats, and rabbits showed lower activity within underpasses in comparison to exterior (predation risk/ closed habitat preference, other?).
  - Permeability of underpasses high for most medium and large mammals studied.
- Response to Structure Cover Treatments
  - 3 out of 4 of underpass avoidance species/groups increased use of underpass with addition of structure treatments (125% or greater- snakes, woodrats, rabbits)
  - Additional significant increases in use by mice, fox, and coyote.
  - Decreased underpass activity (25-40%) for bobcats and skunk.
  - Lizards, ground squirrels, raccoons, and deer- no effect of treatment
- Very high use of narrow ledges by small mammals (esp. Peromyscus)

Brehme et al. 2022