

Simulating Across-Highway Connectivity for Mojave Desert Tortoises



JODI BERG
TARITA HARJU
ALTA SCIENCE &
ENGINEERING

SETH HARJU
HERON ECOLOGICAL
DANNA HINDERLE
IRONWOOD CONSULTING

SCOTT CAMBRIN
CLARK CO. DESERT
CONSERVATION PROGRAM

Gopherus agassizii

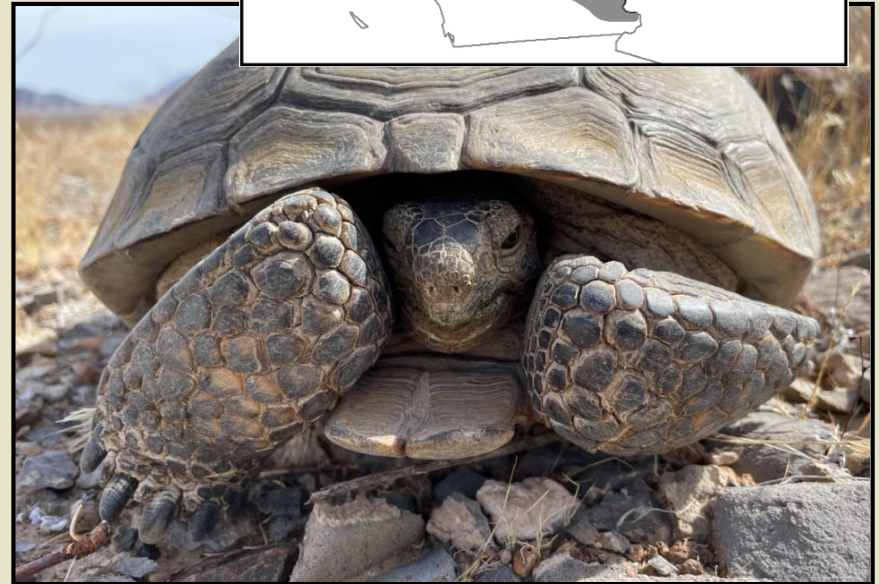
Gray et al. 2019

Threatened – 1990

- Urbanization
- Renewable energy
- Habitat destruction/fragmentation
- Invasive plants
- **Road mortality**

USFWS Recovery Plan – 2011:

- Connect functional habitat
- Importance of corridors and barriers to distribution and gene flow



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Current Management Practice

Exclusionary fencing

- Mortality reduced by 90%

Culverts

- Occasional use documented
- Currently untested

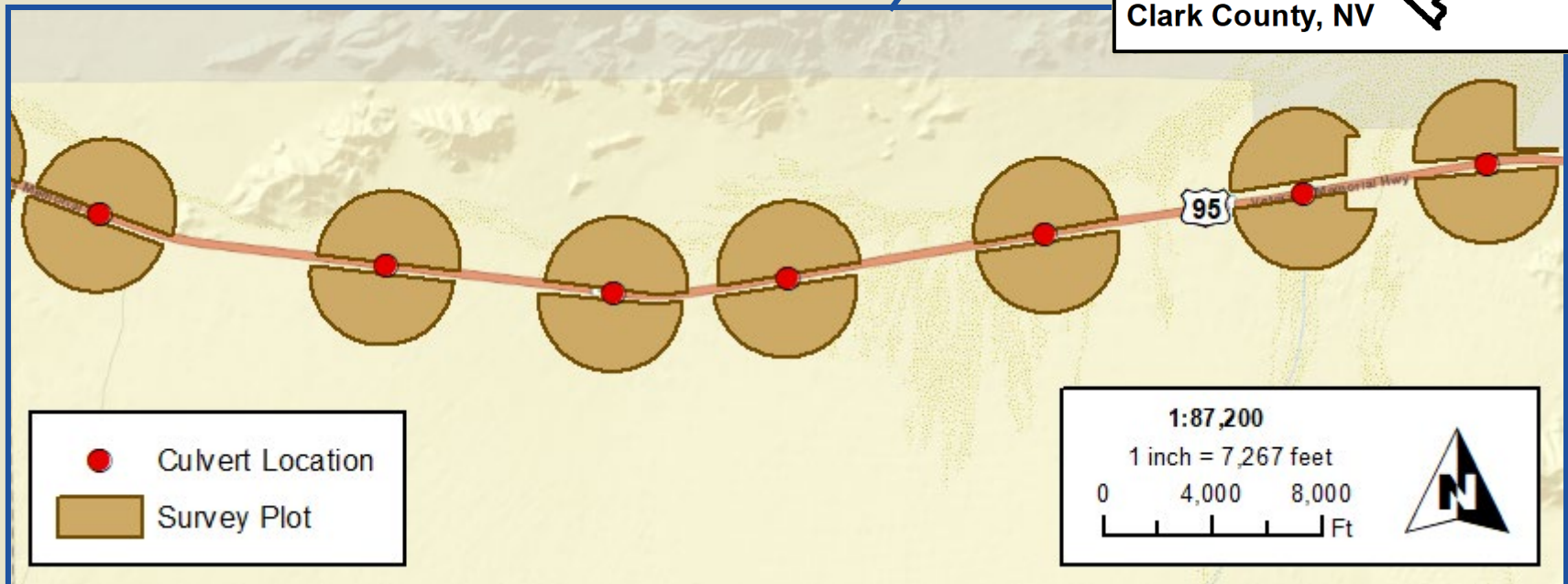
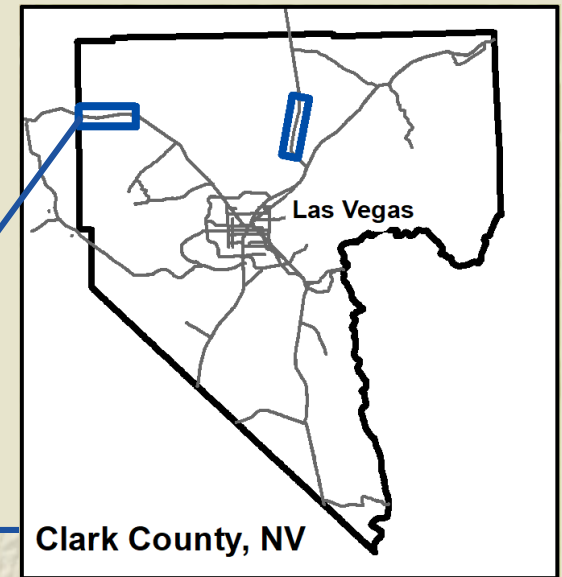


www.aminexfencing.com

Objective

Clark Co. Desert Conservation Program:

- Culvert study – Hwys 95 and 93
- Population densities with mark-recapture
- Movement through culverts

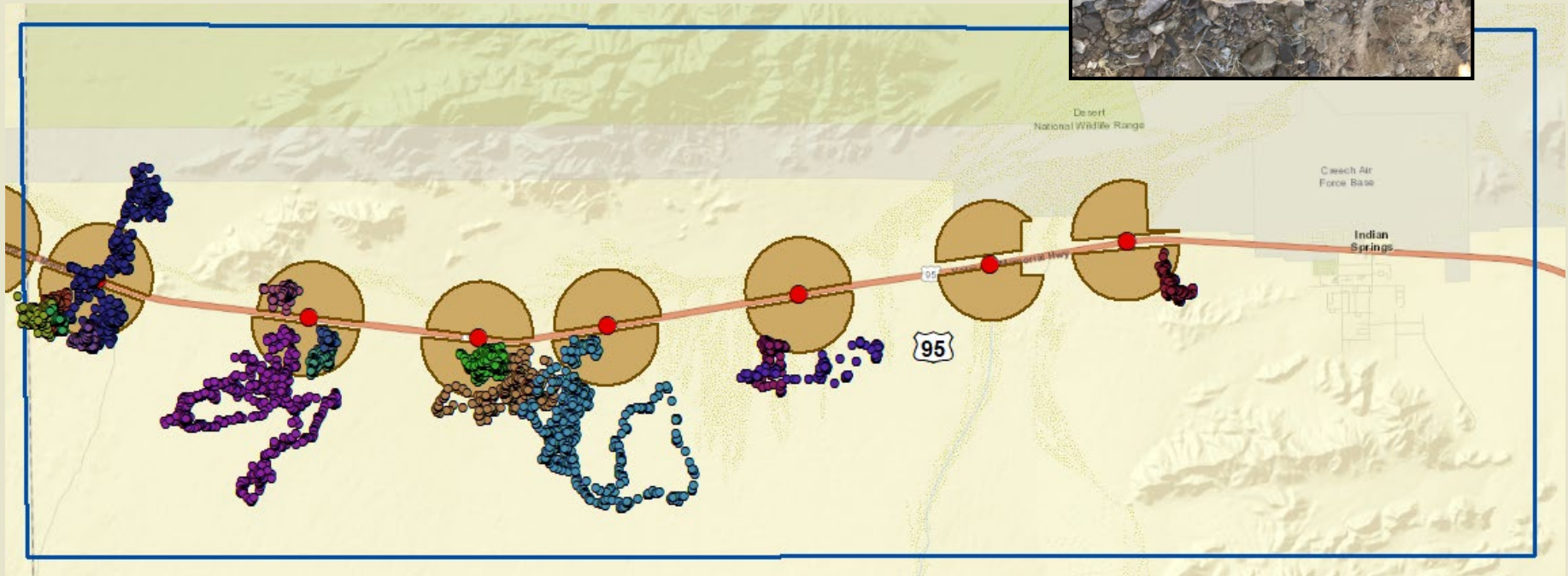


Tortoise Capture

Clark Co. Desert Conservation Program:

- Surveyed plots
- Radio-tagged wild residents (9 M, 6 F)
- Locations every 30 mins.
- ~2,740 locs/tortoise (range: 469 – 4,796)

Desert Conservation Program



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Problems

- Low sample sizes
- Mortality
- Short monitoring window



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Simulations: approximate tortoise movement and culvert crossings

SiMRiv (Quaglietta & Porto 2019)

Multi-state movements in heterogeneous environments

Resting:

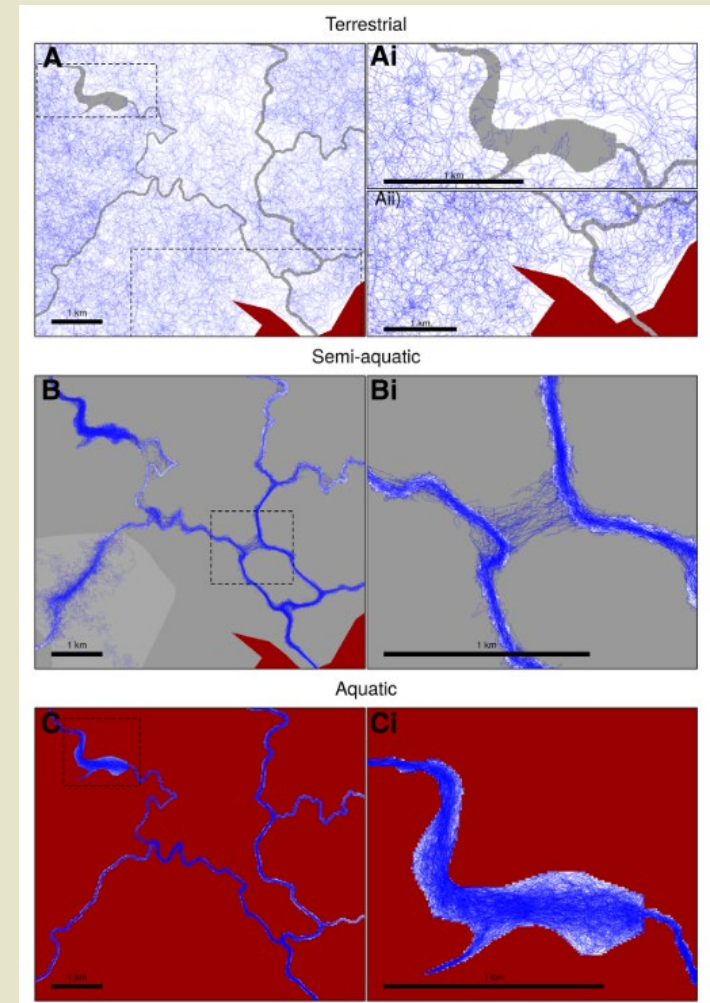
- True random walk, 1-unit step length, random turning angles

Moving:

- Correlated random walk, max step = 37, correlation = 0.707
- Perceptual range – Gaussian kernel centered on loc with SD of 25

Transition rates

- Resting to moving = 0.098
- Moving to resting = 0.228



Landscape Resistance

Gray et al. 2019

Re-scaled connectivity:

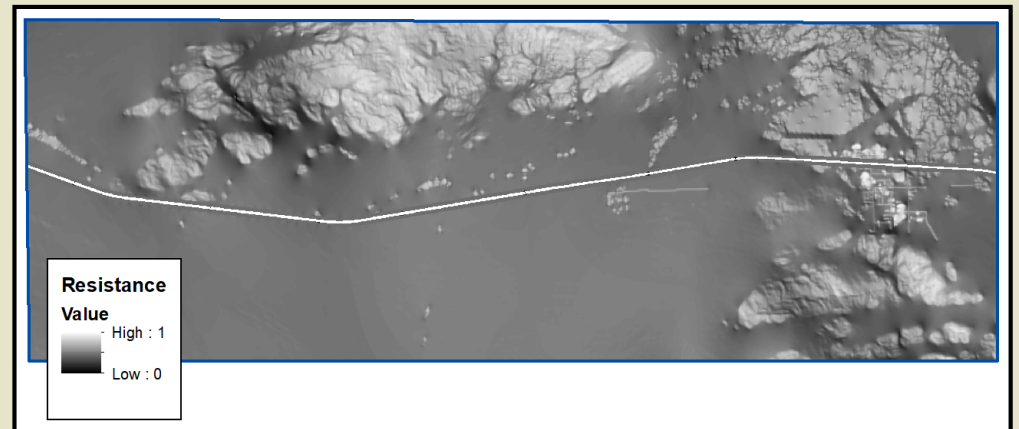
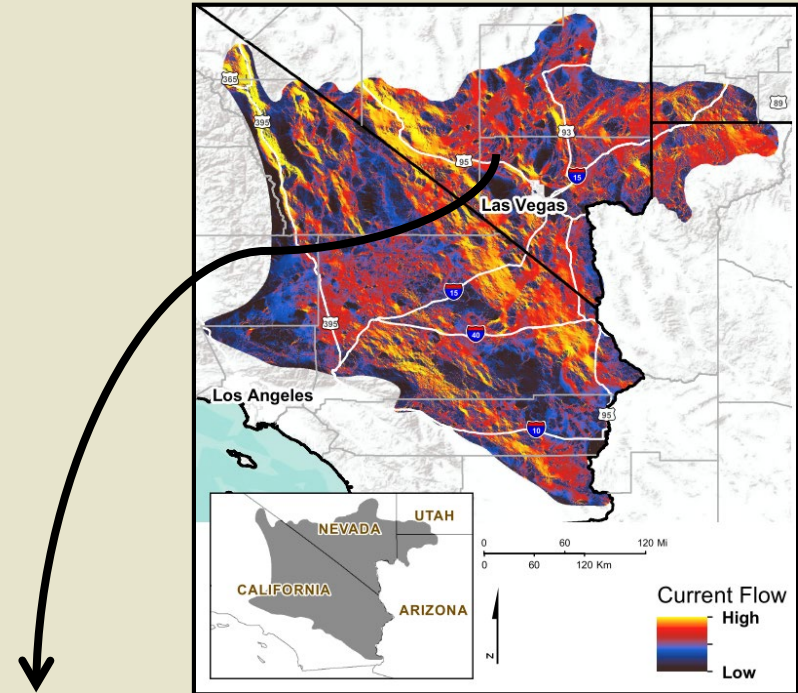
- 0 = low resistance
- 1 = high resistance/impermeable

Roads:

- 1 = impermeable

Culverts:

- 0.5 – 0.25 = attractive burrow



Simulations

Mark-recapture estimates

- 37 total

1000 simulations

- 30-min steps for 730 days

Culvert density:

- 0.65 – 2.58 per mile (7, 14, 28)
- Single vs double

Culvert width:

- 24 vs 72 in



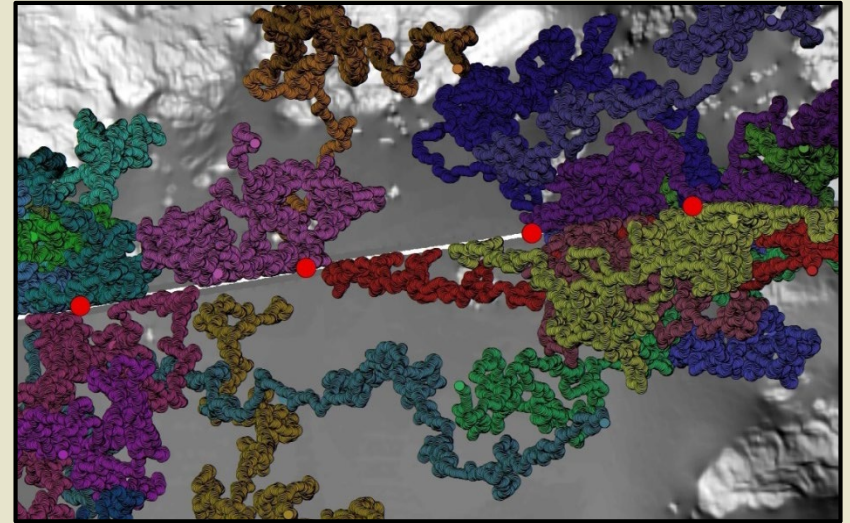
Results

Free-ranging, tagged:

- 2 / 41,089 (0.005%) steps

Expected:

- ~64 / simulation



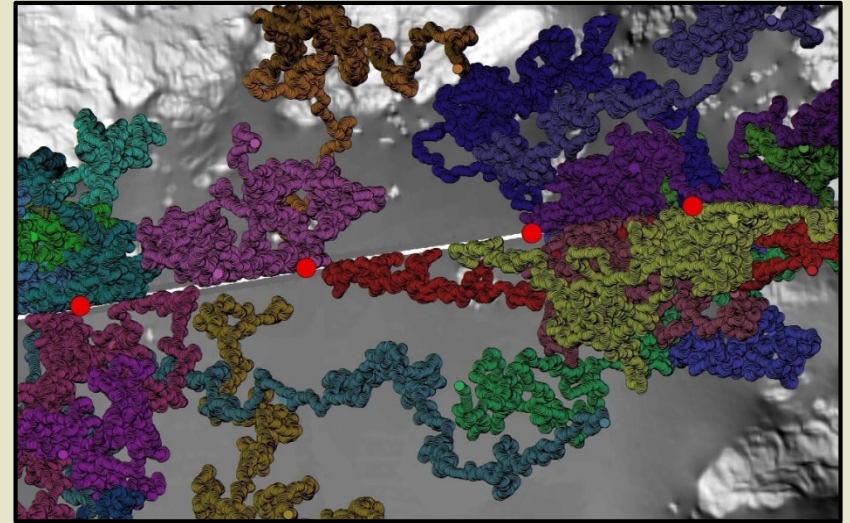
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Simulated average (range) %:

		Culvert Width (in)	
		24	72
# Culverts	7	0.00002 (0 – 0.00023)	0.00007 (0 – 0.00039)
	14	0.00004 (0 – 0.00023)	0.00014 (0 – 0.00062)
	28	0.00007 (0 – 0.00039)	0.00023 (0 – 0.00085)
	Dbl 7 (14 total)	0.00005 (0 – 0.00039)	0.00016 (0 – 0.00062)
	Dbl 14 (28 total)	0.00008 (0 – 0.00039)	0.00031 (0 – 0.00085)

Discussion

Tagged tortoises:

- Pre-established territories
- Highways = danger
- Culverts = small and inconspicuous



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Simulated tortoises:

more steps, more culverts

≠

higher crossing rates



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more, wider culverts

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Historically:

1 cross/gen = 0.00023%

28, 72" = 0.00023%

14 dbl (28), 72" = 0.00031%

Management Implications

Roads and fences fragment habitat and impede connectivity

Densities/widths of culverts should be considered

- **USFWS 2014:** 670 m (0.4 mile) \approx 2.58 culverts/mile
- Maximize where/when possible
- Increase size when replacing/retrofitting
- Additional culverts at key locations (e.g., desert dry washes)
- More frequent placements



Endangered Species International

Thank you!



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