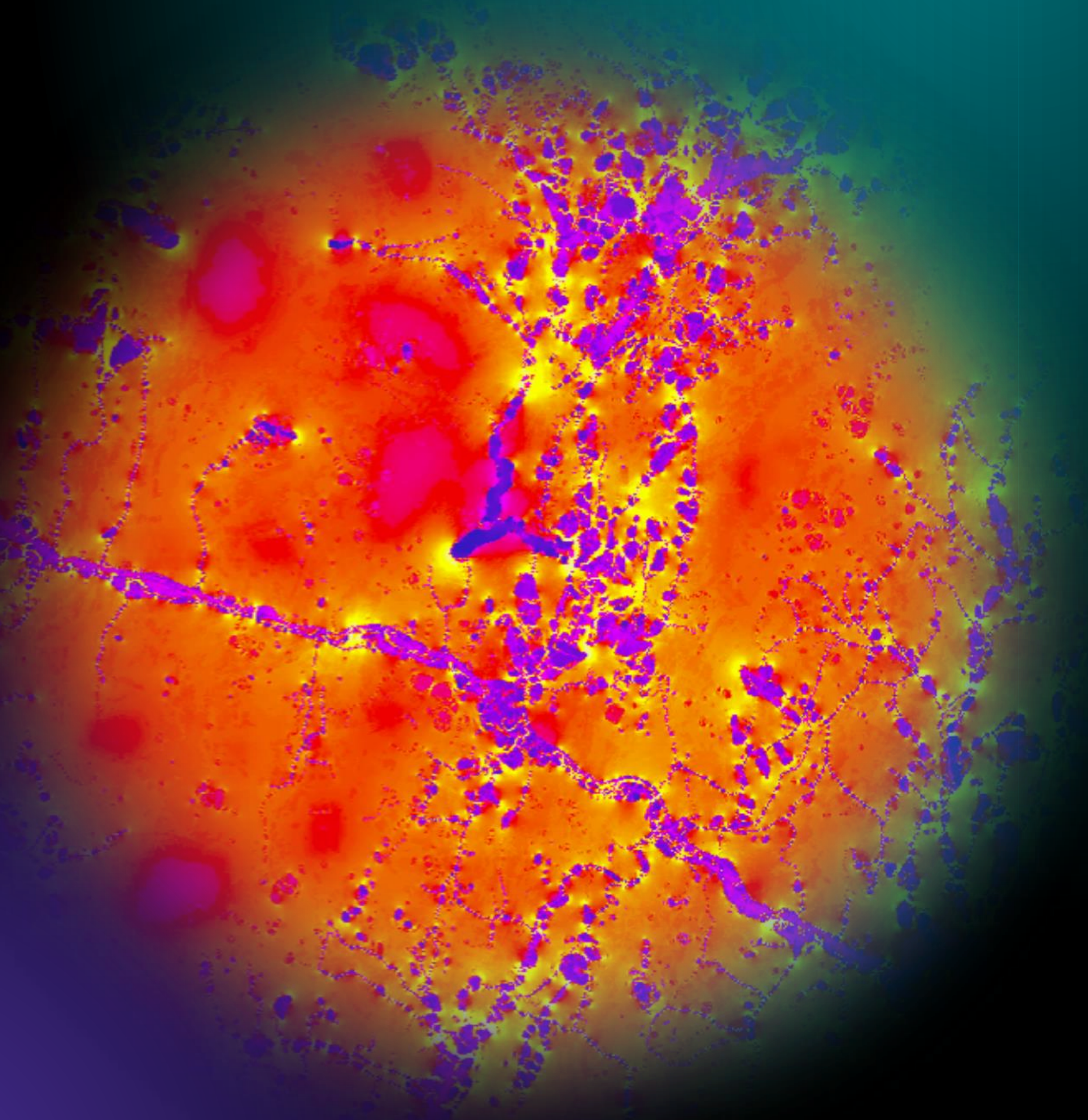

Where will wildlife cross the road?

USING ELECTRICAL CIRCUIT ANALYSIS TO MAP WILDLIFE MOVEMENT AND INFORM TRANSPORTATION MANAGEMENT IN VERMONT

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Acknowledgments

FUNDING: Vermont Agency of Transportation

PARTNERS:

VT Agency of Transportation - Glenn Gingras, Chris Slesar

The Nature Conservancy - Paul Marangelo, Ann Ingerson, Dr. Kim Hall

VT Fish and Wildlife Department - Jens Hilke

University of Vermont - Dr. James Murdoch

Conservation Science Partners - Vincent Landau

DATA: Wildlife occurrence data from Pearman-Gillman et al. (2020), landcover data from NLCD (2016) and VCGI (2019). Expert opinion data from regional wildlife experts. Computations performed on the Vermont Advanced Computing Core.

VERMONT AGENCY OF TRANSPORTATION

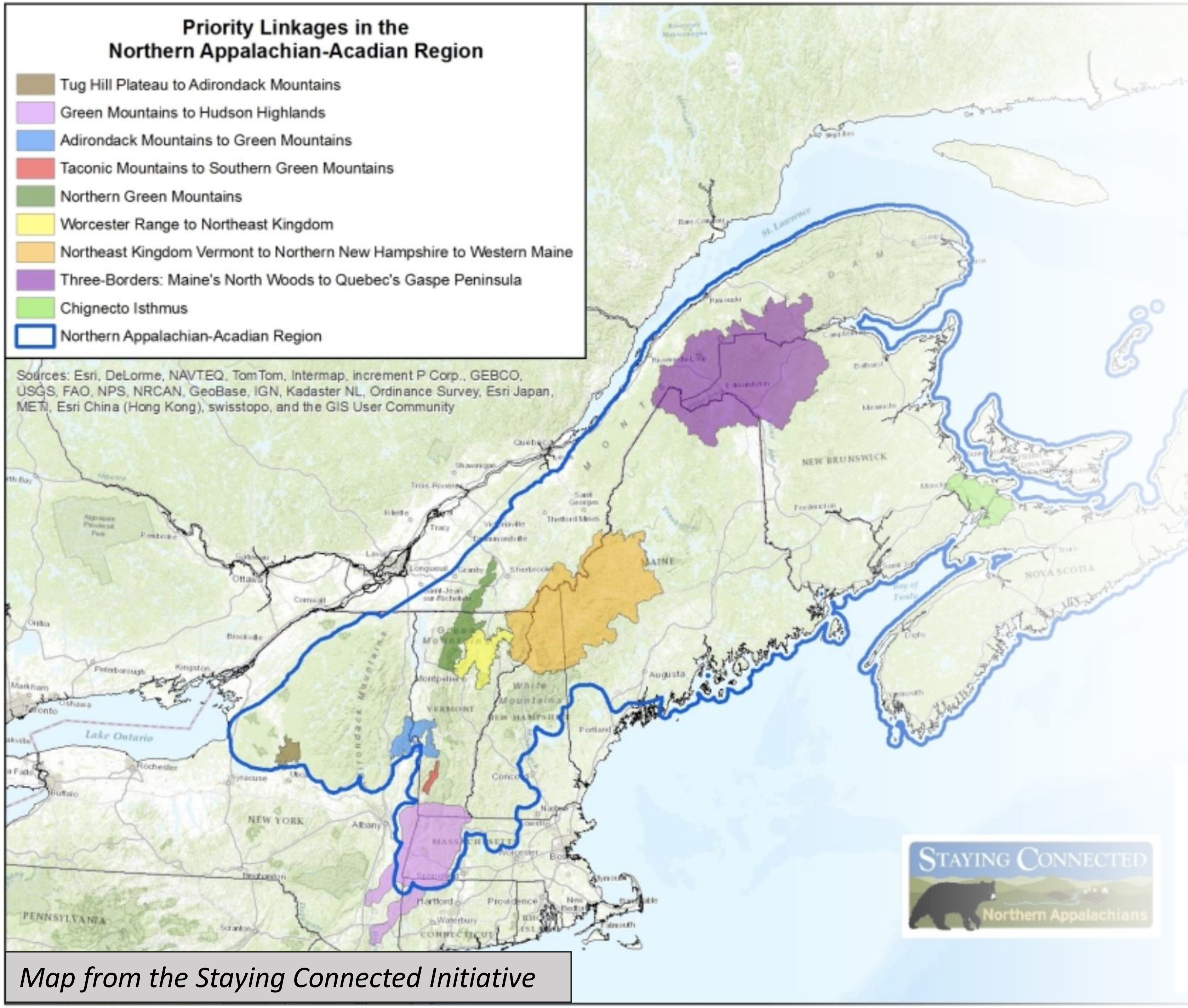
The UNIVERSITY of VERMONT
RUBENSTEIN SCHOOL
OF ENVIRONMENT AND NATURAL RESOURCES

VERMONT FISH & WILDLIFE

The Nature Conservancy

CONSERVATION SCIENCE PARTNERS

Regional Context



Map from the Staying Connected Initiative

Northern Appalachian/ Acadian Region

- 330,000 km^2
- Important forest blocks, coastline, mountain ranges
- Wildlife corridors

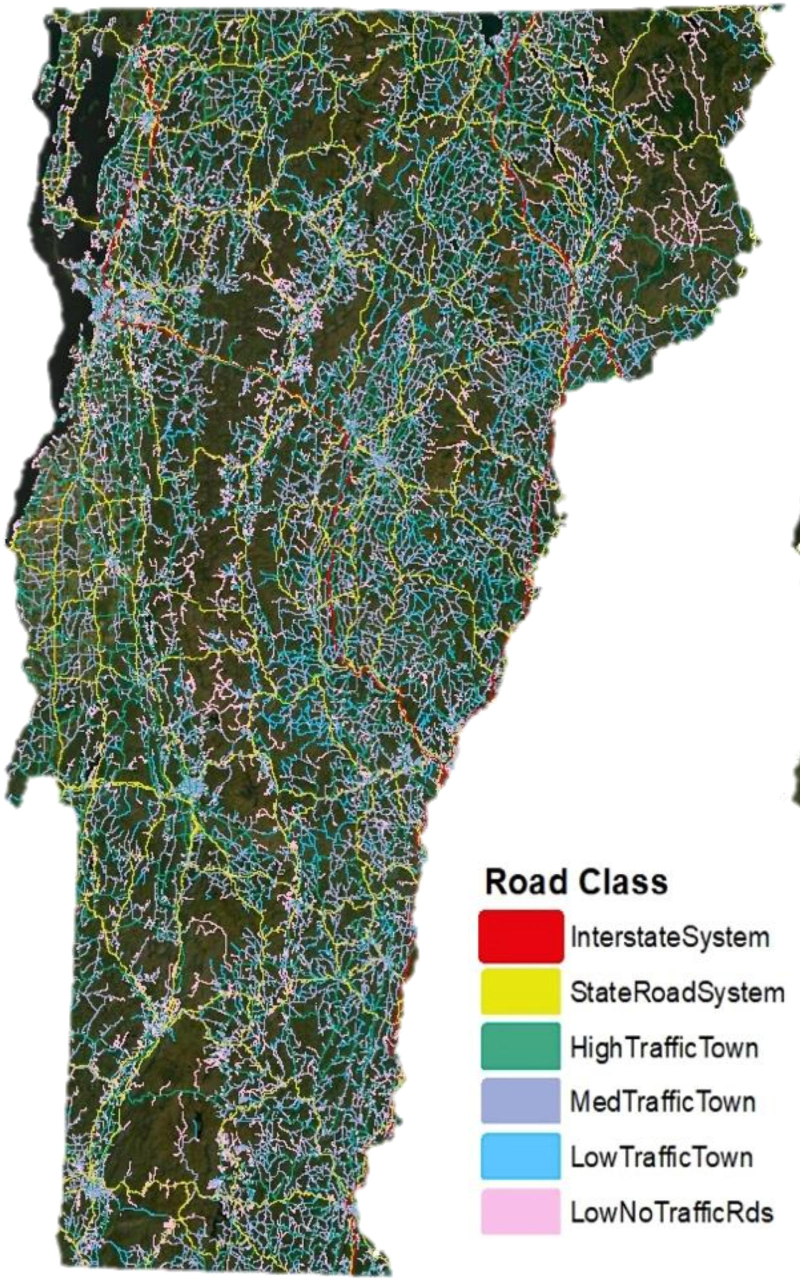
Vermont Roadways & Impacts

Vermont:

- 78% forested
- 25,429 km of roadway
- >88,000 transportation structures
  - 5,913 structures >3ft diameter

Road concerns:

- Direct mortality (vehicle collisions)
- Habitat fragmentation
- Decreased dispersal, genetic exchange
- Impedes range shifts in response to climate change



Which transportation structures are important for wildlife?

Image: Paul Marangelo

Focal Species




- Eight terrestrial mammal species
- Cultural, ecological, economic importance
- Generally wide-ranging, encountering roadways frequently




Images from VT Fish & Wildlife website

Problem and Approach

Goal:

- Rank transportation structures by connectivity value for terrestrial wildlife in Vermont.

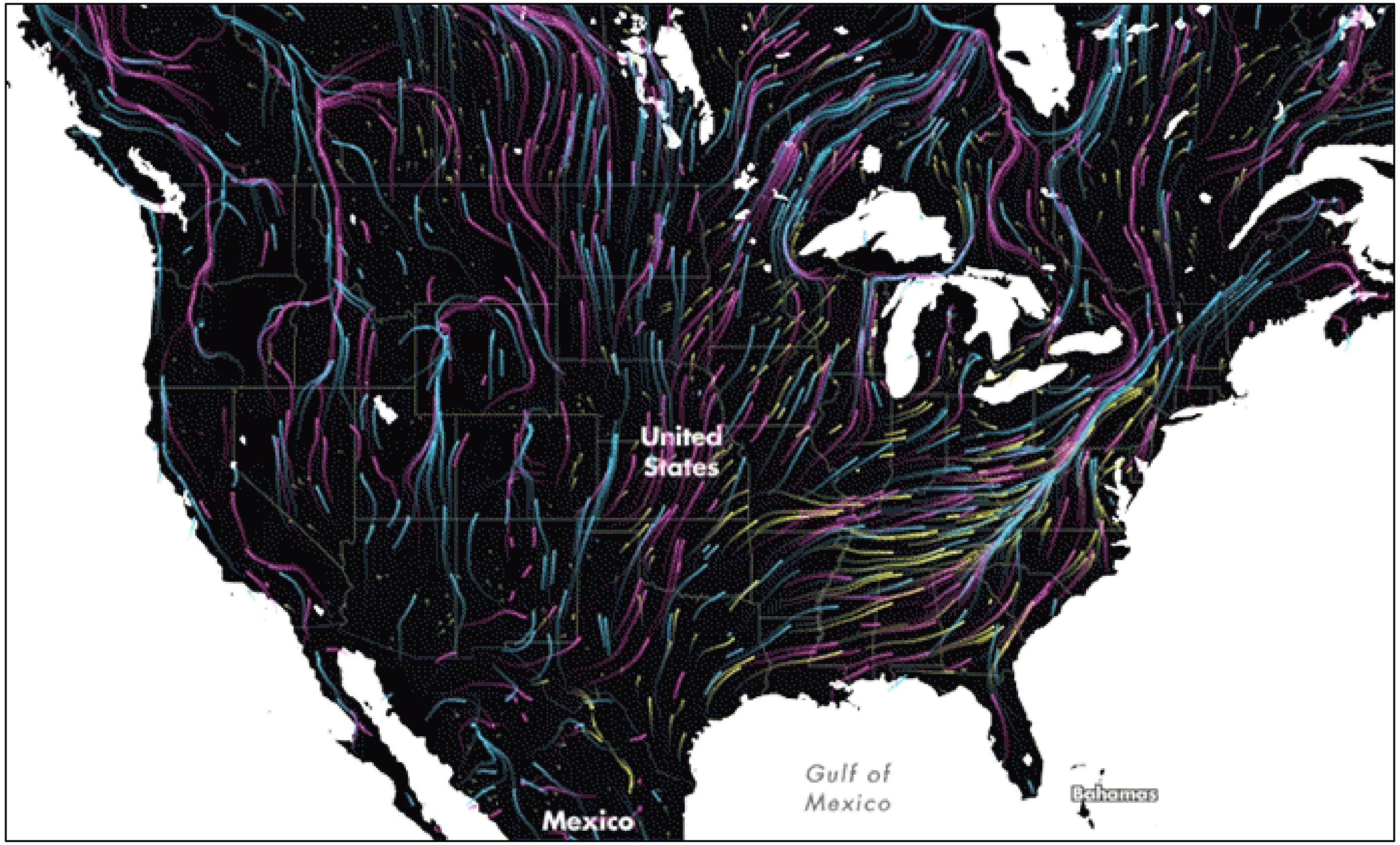
Approach:

1. Model movement of 8 species statewide and around structures.
2. Compile data on structure attributes, human development, and protected lands near state-managed structures.
3. Rank structures according to above metrics for focal species using a decision-making framework: *Vermont Terrestrial Passage Screening Tool*

Image: Paul Marangelo

Connectivity Models

- Models of species movements created using electrical circuit theory
- Wildlife movement = electricity
- Landscape = circuit



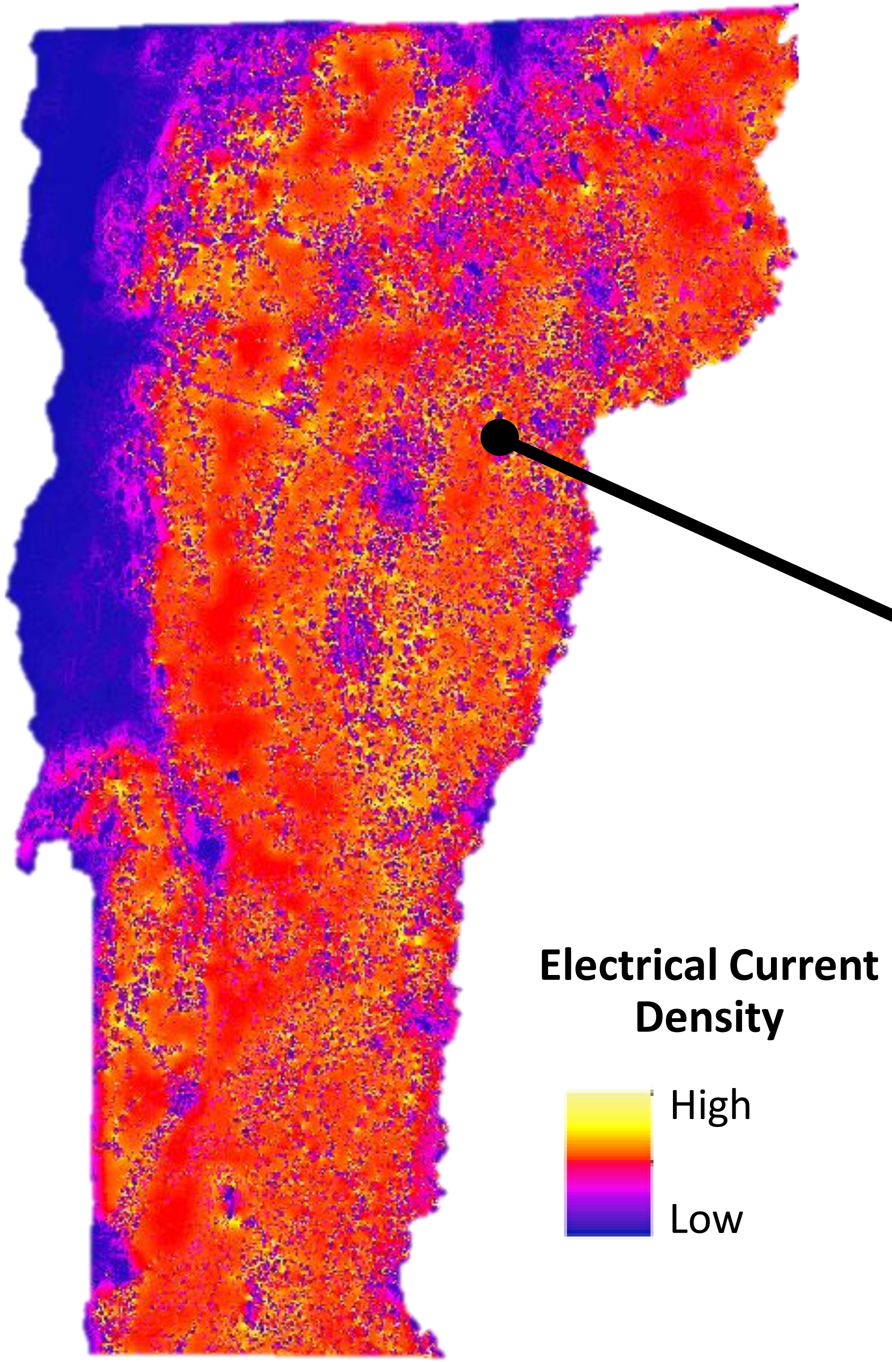
Circuit models used to map predicted movement paths of 2,954 species under climate change projections, (Lawler et al. 2013, McGuire et al. 2016). "Migrations in Motion" map created by Dan Majika, TNC.

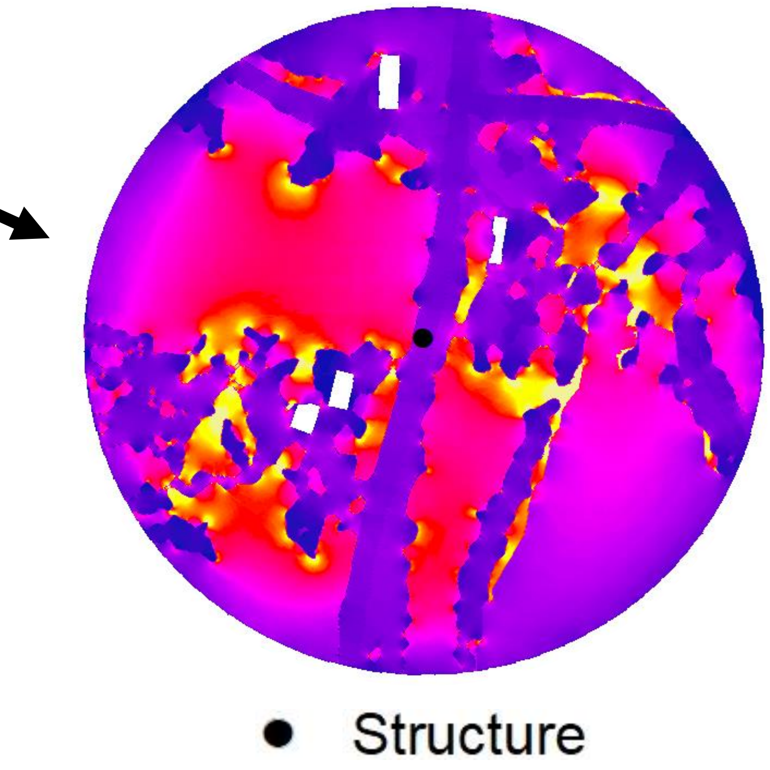
Omniscape.jl

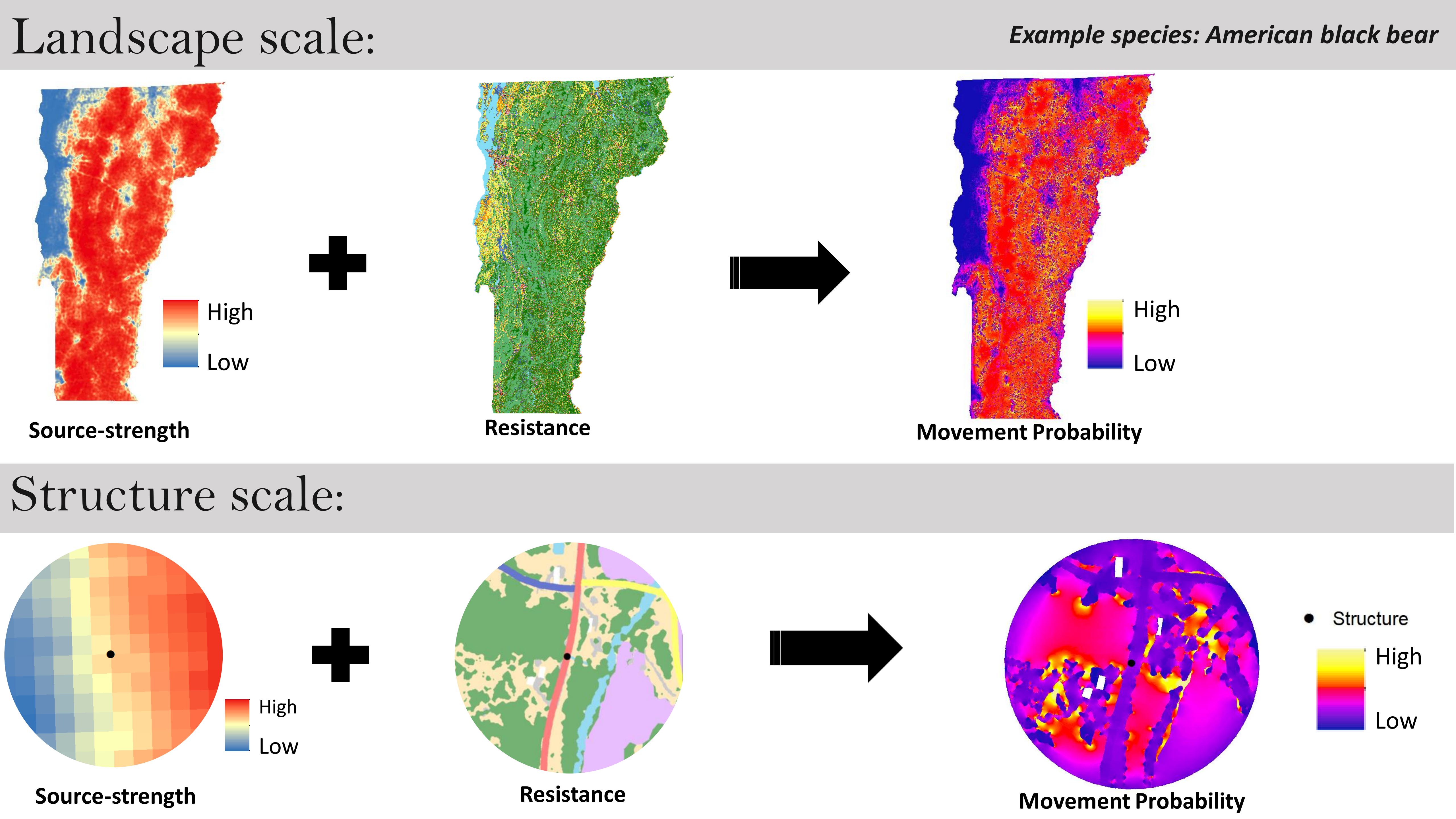
(Landau et al. 2021, McRae et al. 2016)

Connectivity Models

Two spatial scales:
landscape scale, structure scale



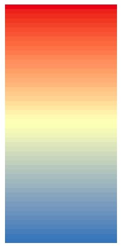


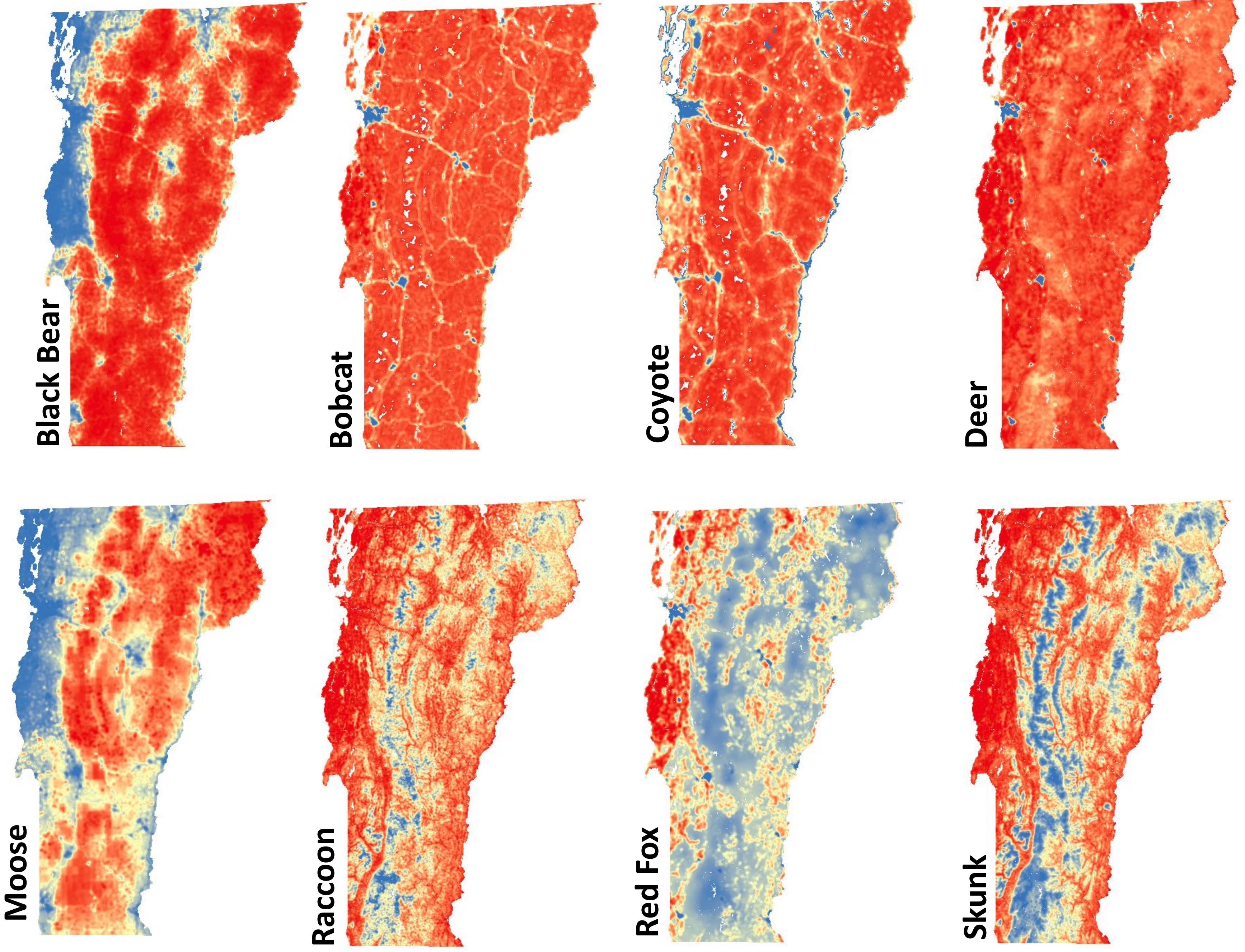


Landscape scale:
Example species: American black bear
High
Low
Source-strength
Resistance
High
Low
Movement Probability
Structure scale:
High
Low
Source-strength
Resistance
Structure
High
Low
Movement Probability

Data Inputs: Source-strength Layer

Probability of Occurrence





Data from Pearman-Gillman et al. 2020

Data Inputs: Landscape Resistance Layer

Step 1: Online Expert Opinion Survey

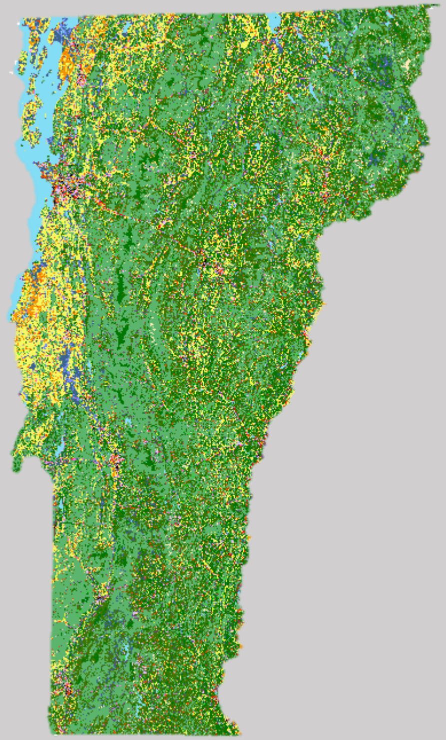
- Experts scored 2 landcover datasets (30m NLCD for *Landscape Scale*, 0.5m VCGI for *Structure scale*)
- Scores based on 1-100 scale: 1 = least resistant, 100 = most resistant.

Step 2: Average Expert Values, Create Preliminary Maps

- Average expert opinion values for each variable
- Draft resistance inputs for each species/each scale
- Use draft resistance inputs to create preliminary Omniscape maps
  - Statewide map for *Landscape Scale*, 5 test structures for *Structure scale.*

Step 3: Follow-up Interviews, Create Final Resistance Inputs

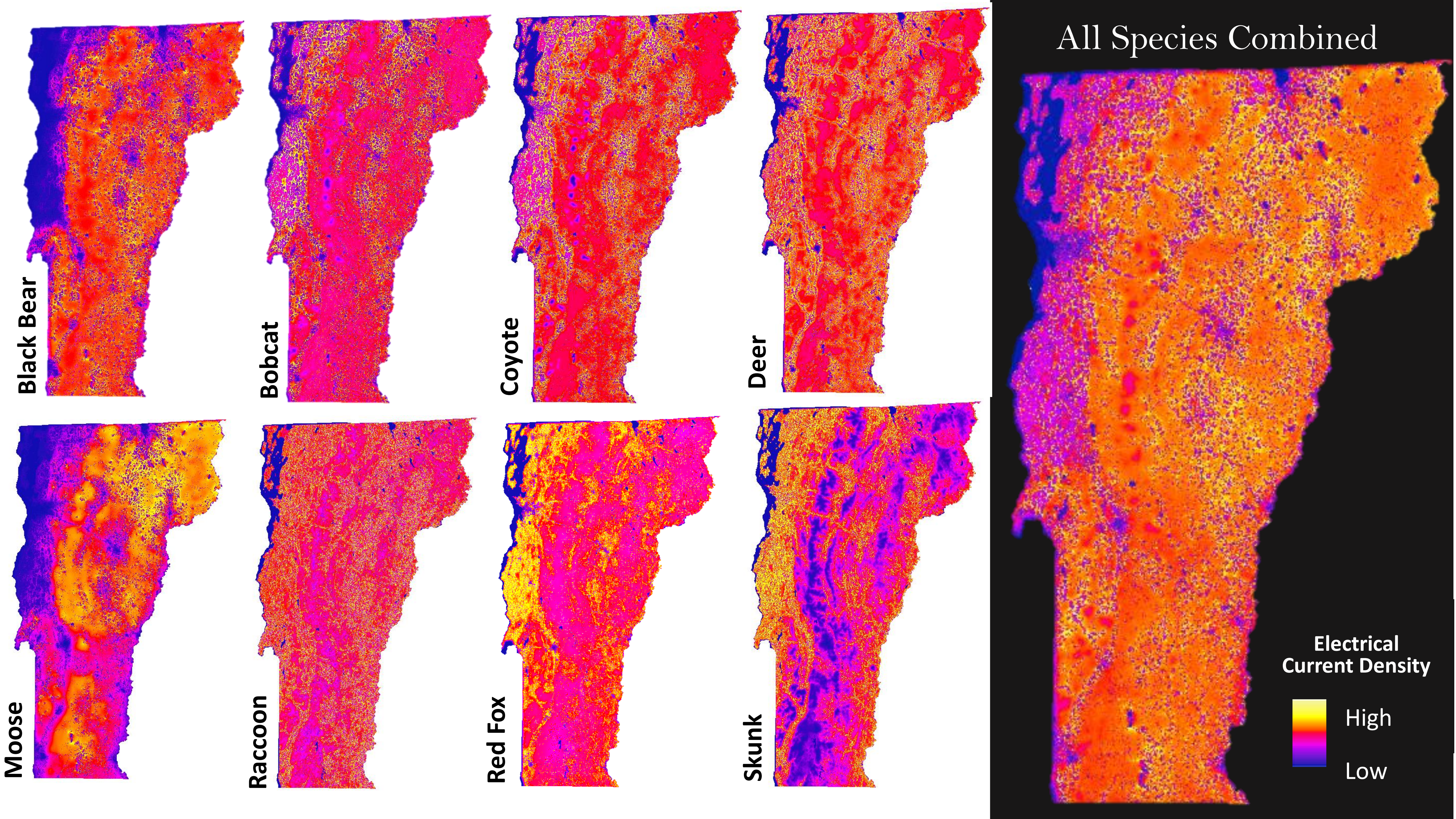
- Meet with experts, discuss draft maps for their species
  - Option to re-score variables
- Average final expert values to create final resistance inputs for each species/scale.
- Final resistance inputs used in species-specific Omniscape analyses.



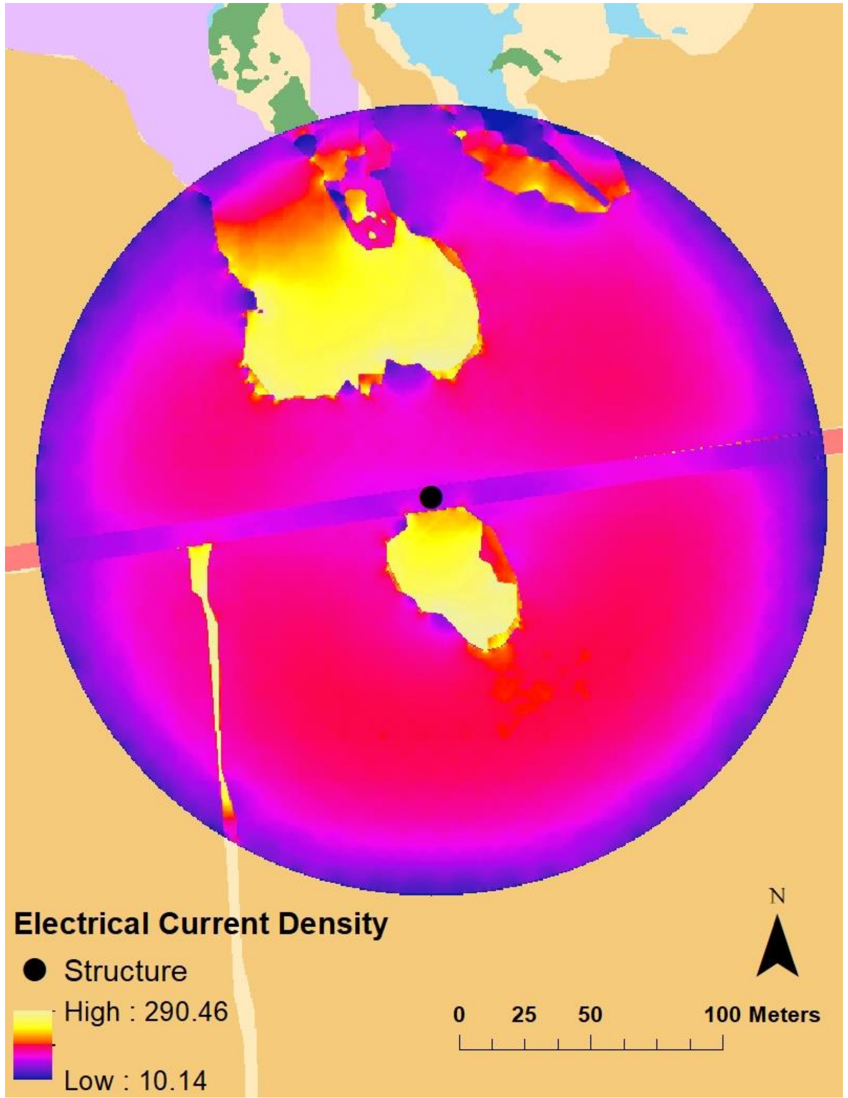
NLCD dataset (2019)

VCGI dataset (2019)

Special thanks to the contributing wildlife experts!


Black Bear
Bobcat
Coyote
Deer
All Species Combined
Moose
Raccoon
Red Fox
Skunk
Electrical
Current Density
High
Low

Structure-scale results



BLUEMOON

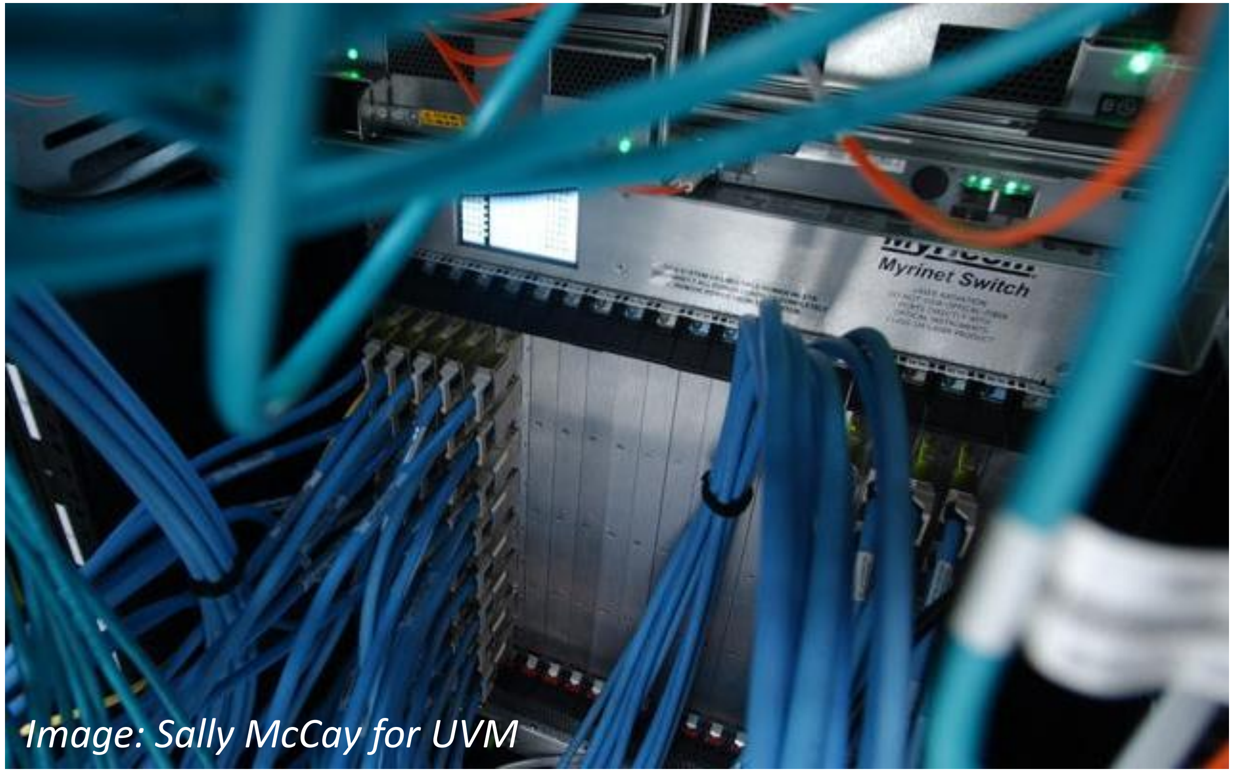
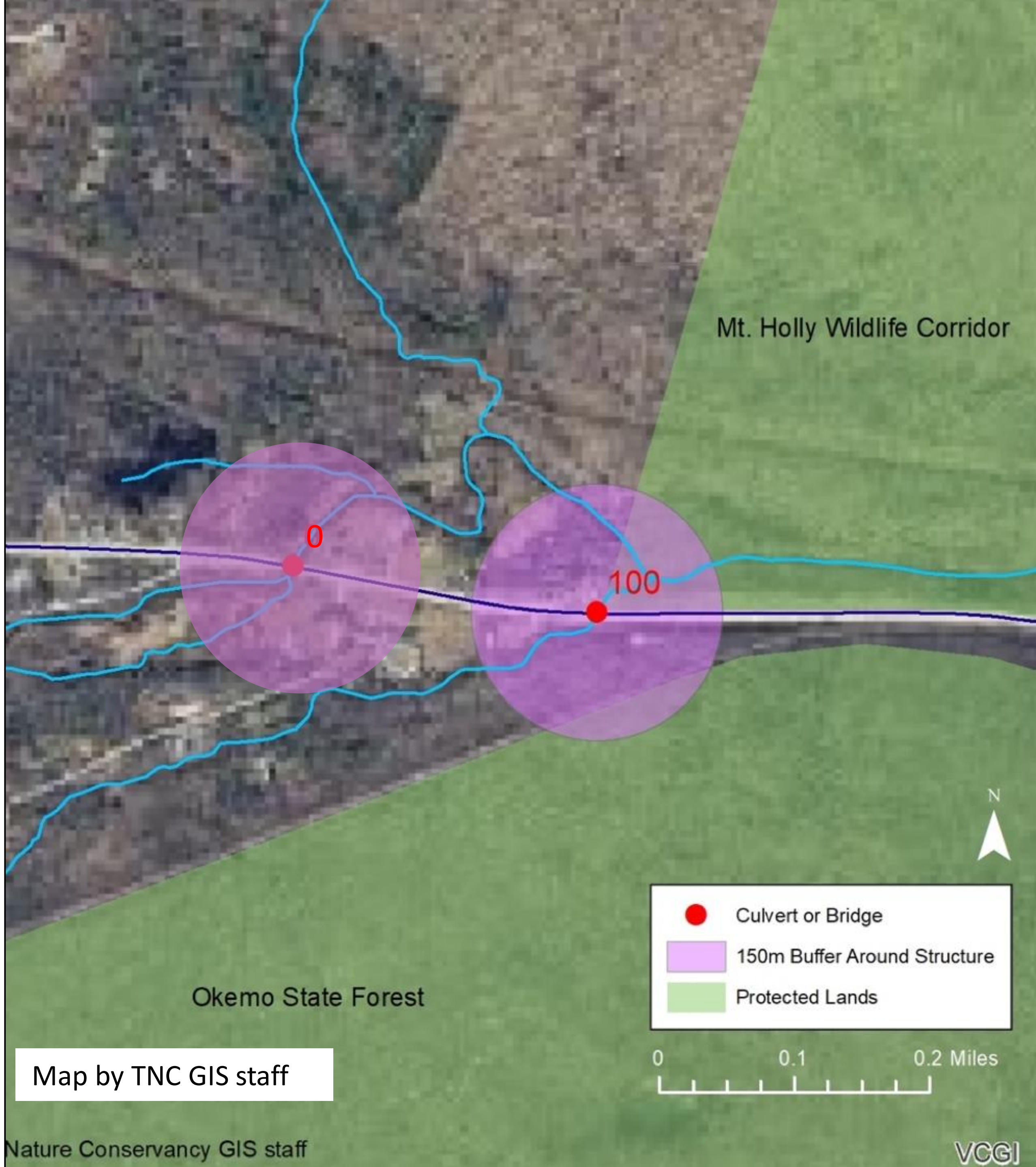


Image: Sally McCay for UVM

Special thanks to the Vermont Advanced Computing Core!

Other Analyses/Metrics

- **Structure attributes:** Length, bankfull width ratio.
- **Human Development Influence:** Percent human development within connectivity corridor around structure.
- **Protected Lands:** Acres of protected land on one or both sides of roadway.



Vermont Terrestrial Passage Screening Tool

Rank 1: Wildlife Movement Priority

- Landscape-scale and fine-scale species movements
- % human development around structures

Rank 2: Structure Characteristics

- Structure length, bankfull width ratio

Rank 3: Protected Lands

- Amount of protected lands on 0, 1, 2 sides of roadway

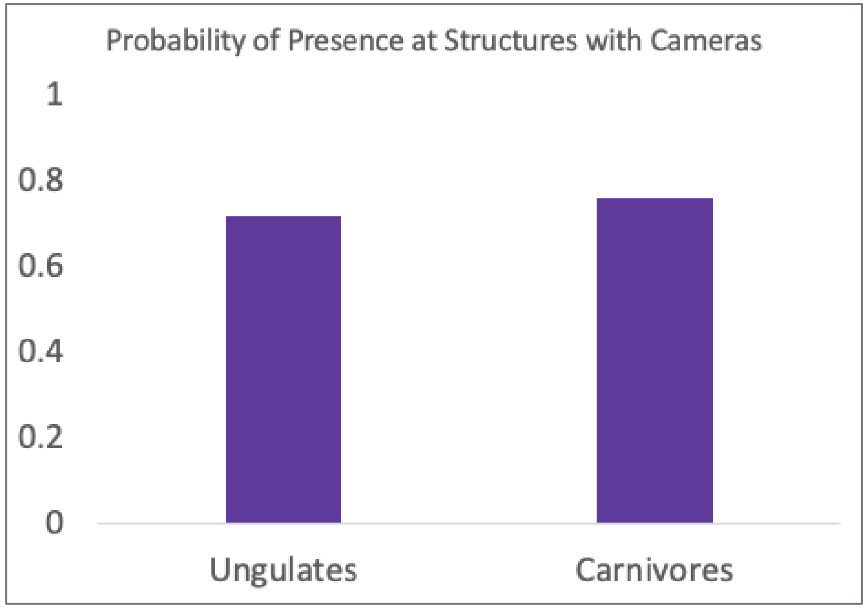
ACTIONS					
Wildlife Movement Priority		Structure Characteristics Rank		Protected Lands Rank	
SCORE 1	RANK 1	SCORE 2	RANK 2	SCORE 3	RANK 3
8877.464956	70	93.09	4429	0.00	1082
8051.471593	1060	95.95	3494	62.50	323
6664.918088	3735	98.68	2187	0.00	1082
8226.805274	764	99.30	1836	0.00	1082
5723.507312	4774	98.45	2320	0.00	1082
7287.274219	2645	95.55	3665	0.00	1082
5481.047104	4969	99.07	1967	0.00	1082
9001.680657	34	100.70	870	0.00	1082
7618.00273	1945	99.00	1989	0.00	1082
3863.539994	5637	97.42	2791	0.00	1082
7672.414222	1828	94.69	3972	0.00	1082
7163.180845	2876	98.01	2499	62.50	323
7690.930348	1784	94.69	3972	0.00	1082
5081.531491	5224	98.17	2443	0.00	1082
8495.224282	412	97.92	2542	0.00	1082
7023.402247	3143	90.84	4801	62.50	323
5193.093507	5164	95.41	3722	0.00	1082
8815.560998	103	93.62	4305	100.00	1
7005.20066	3187	96.33	3338	0.00	1082
8115.627479	946	97.11	2964	0.00	1082
8279.519859	681	96.52	3257	0.00	1082
7847.936704	1476	94.98	3877	100.00	1
5685.263403	4813	98.55	2244	0.00	1082
7150.51803	2901	93.18	4408	0.00	1082
8459.997735	453	95.95	3494	0.00	1082
8120.749046	933	98.01	2499	62.50	323
7216.548277	2773	91.64	4674	0.00	1082
8309.637158	634	90.72	4821	0.00	1082

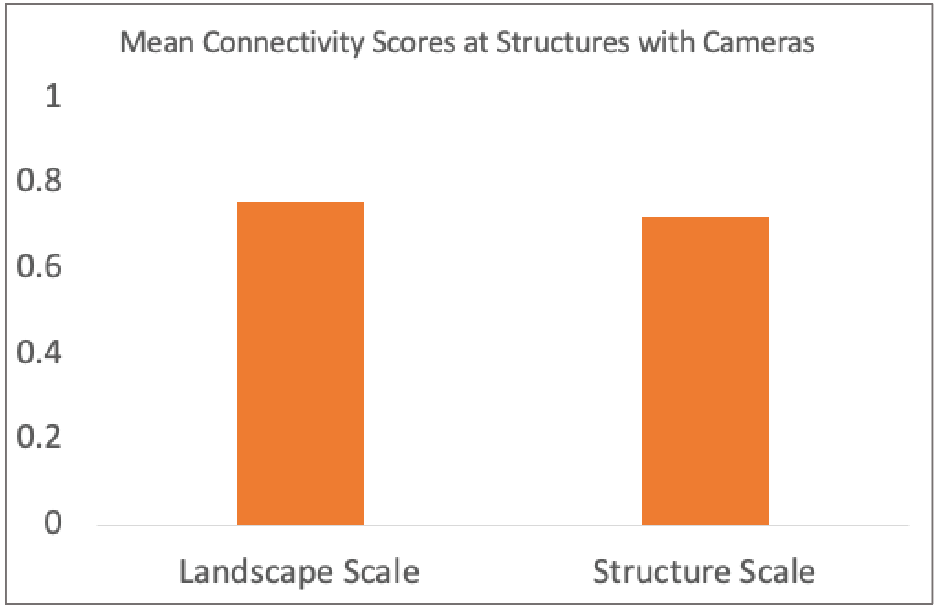
Top 100 Structures: Wildlife Movement Priority Rank

(With no weights or additional constraints applied)

Structure Rank Evaluation

- Game camera data collected from 2015-2021
- Structure rankings for species-specific models checked against camera data





Implications

- **Structure improvements:** shelving, substrate, shape/size/type of culvert, vegetation near structure, etc.
- Funding prioritized to structures with the greatest impact on wildlife connectivity

Literature & Data Sources

Dewitz, J., 2019 . National Land Cover Database (NLCD) 2016 Products (ver. 2.0, July 2020): U.S. Geological Survey data release, https://doi.org/10.5066/P96HHBIE.

Landau, V., V.B. Shah, R. Anantharaman, and K.R. Hall. 2021. Omniscape.jl: Software to compute omnidirectional landscape connectivity. Journal of Open Source Software, 6(57), 2829, https://doi.org/10.21105/joss.02829

McRae, B.H., K. Popper, A. Jones, M. Schindel, S. Buttrick, K. Hall, R.S. Unnasch, & J. Platt. 2016. Conserving Nature's Stage: Mapping Omnidirectional Connectivity for Resilient Terrestrial Landscapes in the Pacific Northwest. The Nature Conservancy, Portland Oregon. 47 pp. Available online at: http://nature.org/resilienceNW . June 30, 2016.

Pearman-Gillman, S.B., J.E. Katz, R.M. Mickey, J.D. Murdoch, and T.M. Donovan. 2020. Predicting wildlife distribution patterns in New England USA with expert elicitation techniques. Glob. Ecol. Conserv. 21:e00853.

Vermont Center for Geographic Information. 2019. Vermont High Resolution Land Cover (Beta Release 2019A). Montpelier, Vermont, USA. <https://geodata.vermont.gov/pages/land-cover>.