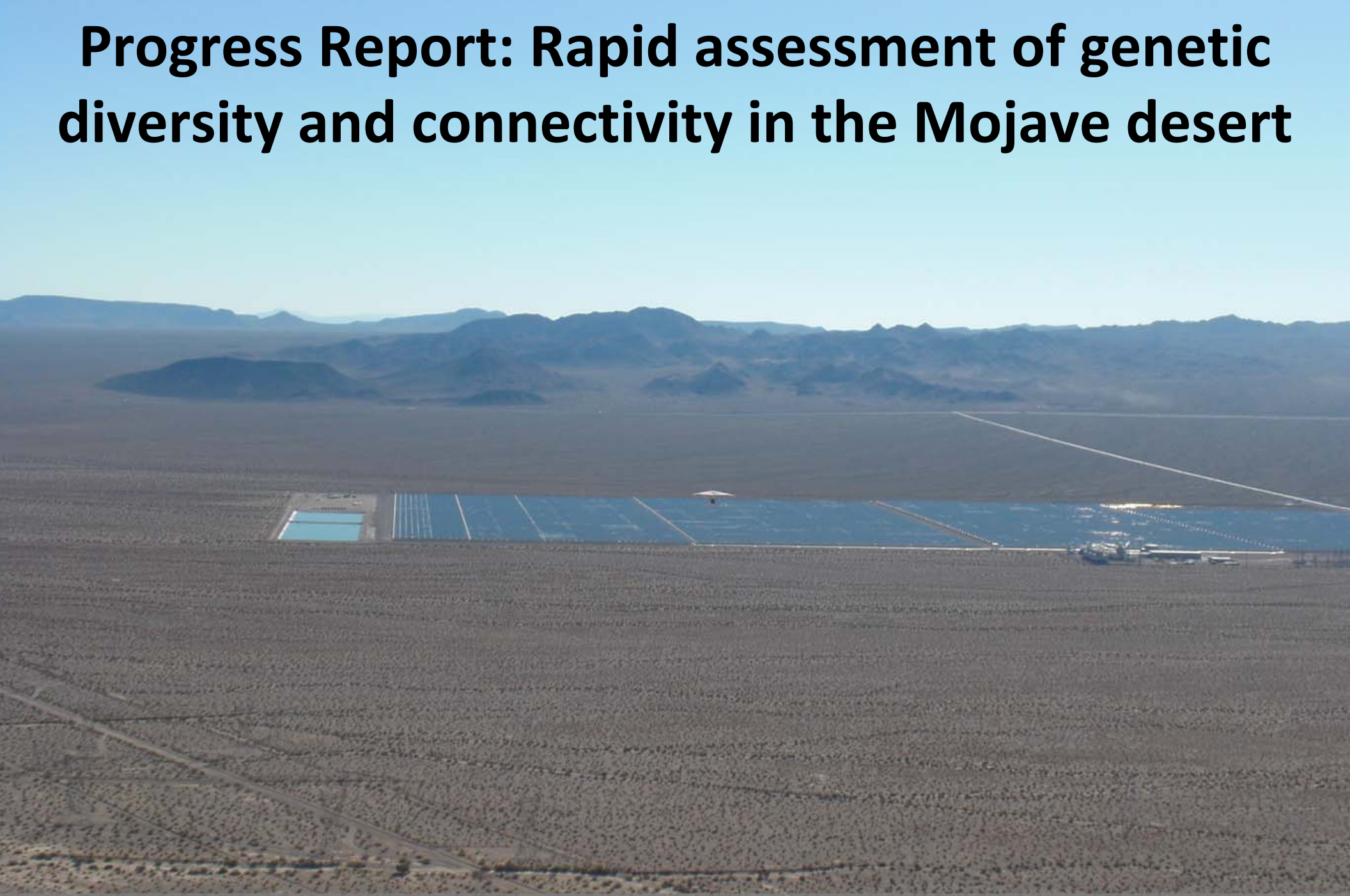
Progress Report: Rapid assessment of genetic diversity and connectivity in the Mojave desert



USGS science for a changing world

Amy Vandergast, Ken Nussear, Todd Esque, Robert Fisher, Kelly Barr, Stacie Hathaway, Rich Inman

USGS Research Team

- Ken Nussear (co-PI, Desert Ecologist)
- Todd Esque (co-PI, Desert Ecologist)
- Robert Fisher (co-PI, Ecologist)
- Stacie Hathaway (GIS)
- Megan Lahti (GIS)
- Kelly Barr (Geneticist)
- Rich Inman (GIS, Modeler)

Anthropogenic Impacts

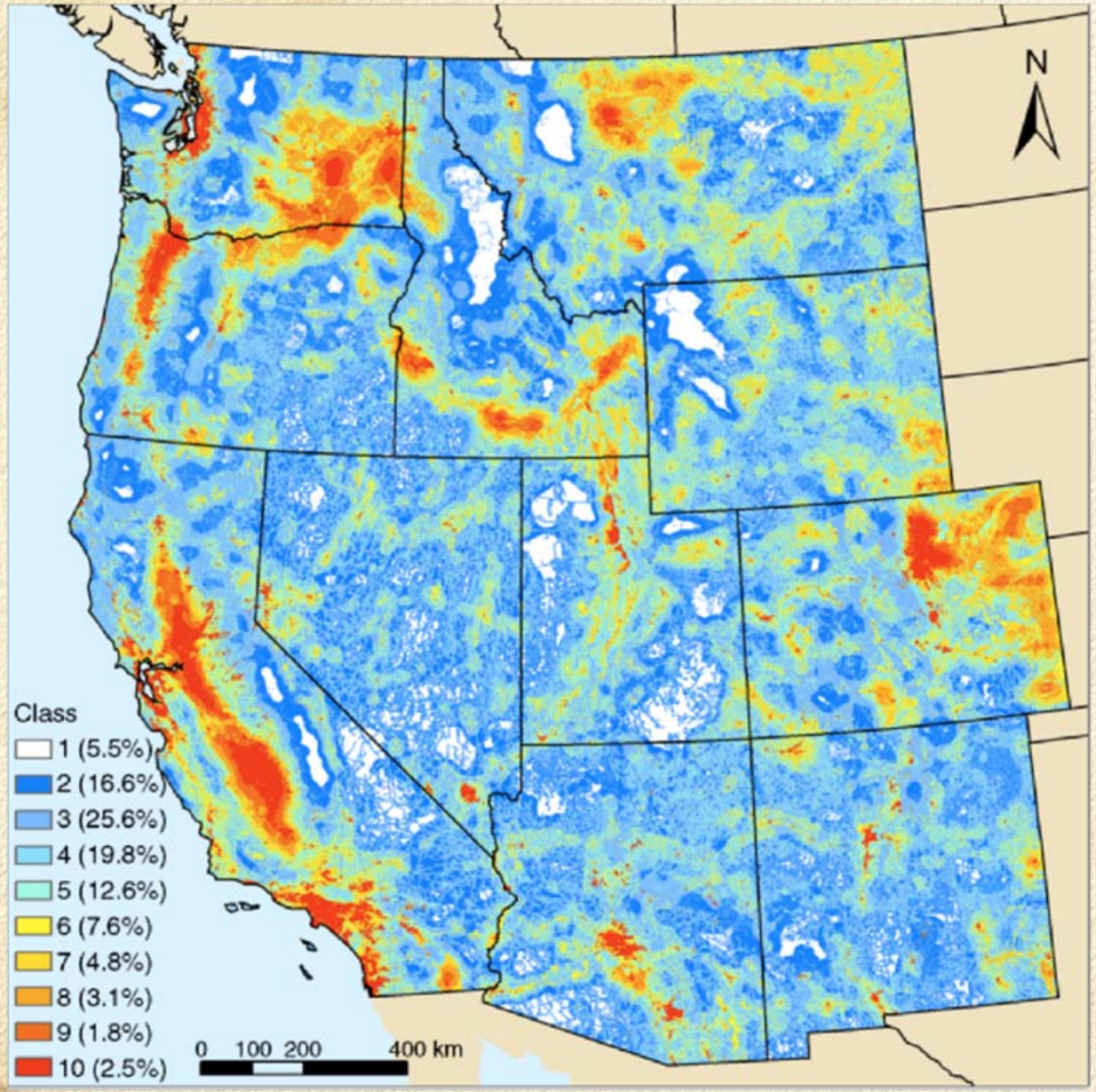


FIG. 3. The human footprint in the western United States in 2001. Human footprint intensity ranges from minimal (class 1, white) to high (class 10, red). The percentage of land covered by each human footprint class within the western United States is provided in parentheses as part of the figure key.

Leu et al . 2008

Utility Scale Renewabale Energy development

- Utility-scale solar energy development under review and study in 6 western states: AZ, CA, CO, NV, NM, UT

- Mojave identified as one of the best locations for solar development, particularly in the western Mojave where transmission line access is greater.

Questions

Is dispersed renewable energy and other development compatible with the conservation of desert species and their habitats?

What are the best areas to conserve to reduce habitat fragmentation and conserve genetic diversity for multiple species that are at risk?

Genetic Approach

- Genetic data provide information on gene flow (movement + successful breeding)
- Determine natural and anthropogenic barriers that impede gene flow
- Measures genetic diversity (the raw material for adaptation)

<u>Evolutionary perspective</u>

- Genetic data contain signatures of past population processes, revealing responses to past episodes of climate and landscape change
- Locate evolutionary “hotspots”-- regions with high adaptive potential

Research Objectives

1. Gather population genetic data from completed studies of desert species
2. Map and compare patterns of genetic divergence and diversity among species to locate evolutionary hotspots
3. Develop habitat suitability models for selected species
   - Gather species presence data
   - Environmental data layers
4. Combine habitat suitability with genetic distance data to map gene flow corridors and evaluate in conjunction with current and proposed land use.

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Species

Habitat Strata	Species	Common Name
Low elevation creosote scrublands	*Gopherus agassizii*	Desert Tortoise
	Homalonychus spp.	Spider
	Chaetodipus penicillatus	Desert Pocket Mouse
	Spermophilus mohavensis	Mohave Ground Squirrel
	Chionactus occipitalis	Western Shovel-nosed Snake
	Dipsosaurus dorsalis	Desert Iguana
	Phrynosoma playtyrhinos	Desert Horned Lizard
High elevation woodlands & rocks	*Sceloporus magister*	Desert Spiny Lizard
	Xantusia vigilis	Desert Night Lizard
	Lichanura trivirgata	Rosy Boa
	Crotaphytus spp.	Collared Lizards
	Tegeticula spp.	Yucca Moth
	Yucca brevifolia	Joshua Tree
	Crotalus mitchelli	Speckled Rattlesnake
Desert riparian (seeps & springs)	*Bufo punctatus*	Red Spotted Toad
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	Perognathus longimembris	Little Pocket Mouse
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Generalists	*Masticophis spp.*	Whip snakes
	Canis latrans	Coyote
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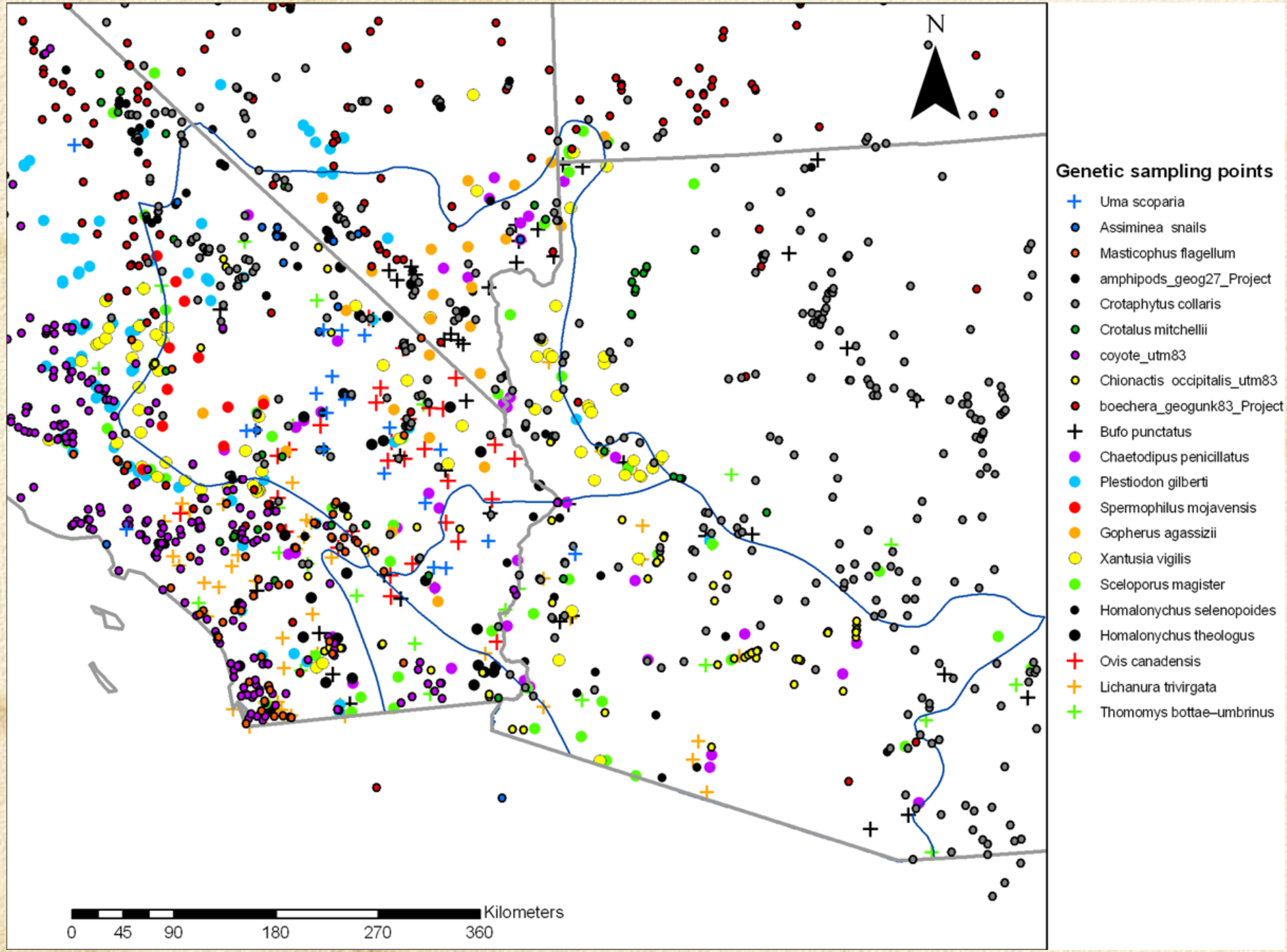
Distribution of Mojave Species



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Genetic Mapping Methods

1. Raw genetic data and collection coordinates requested from authors or pulled from Genbank/literature

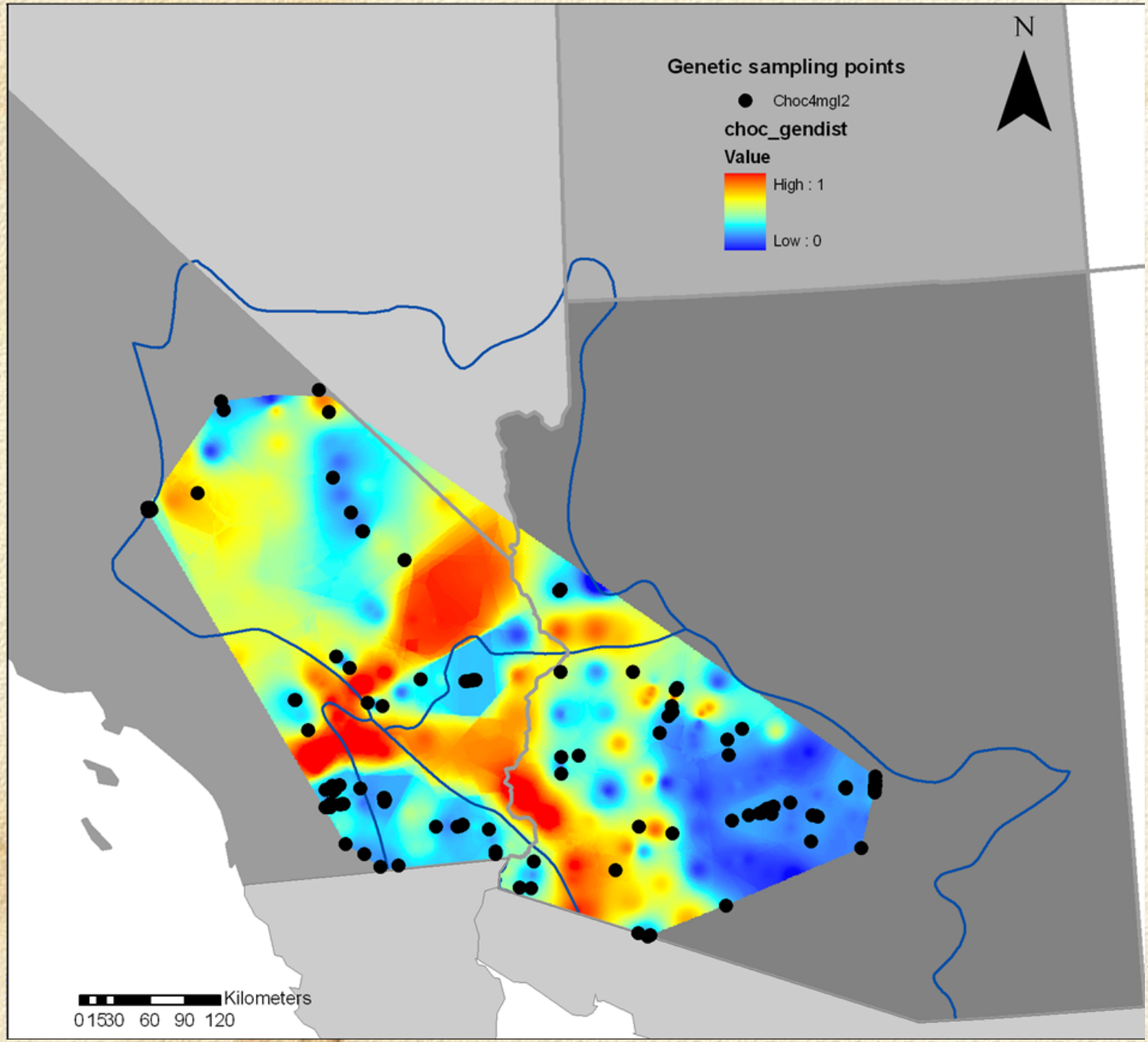
2. Each dataset verified and formatted

3. Genetic distances calculated between all collection locations.

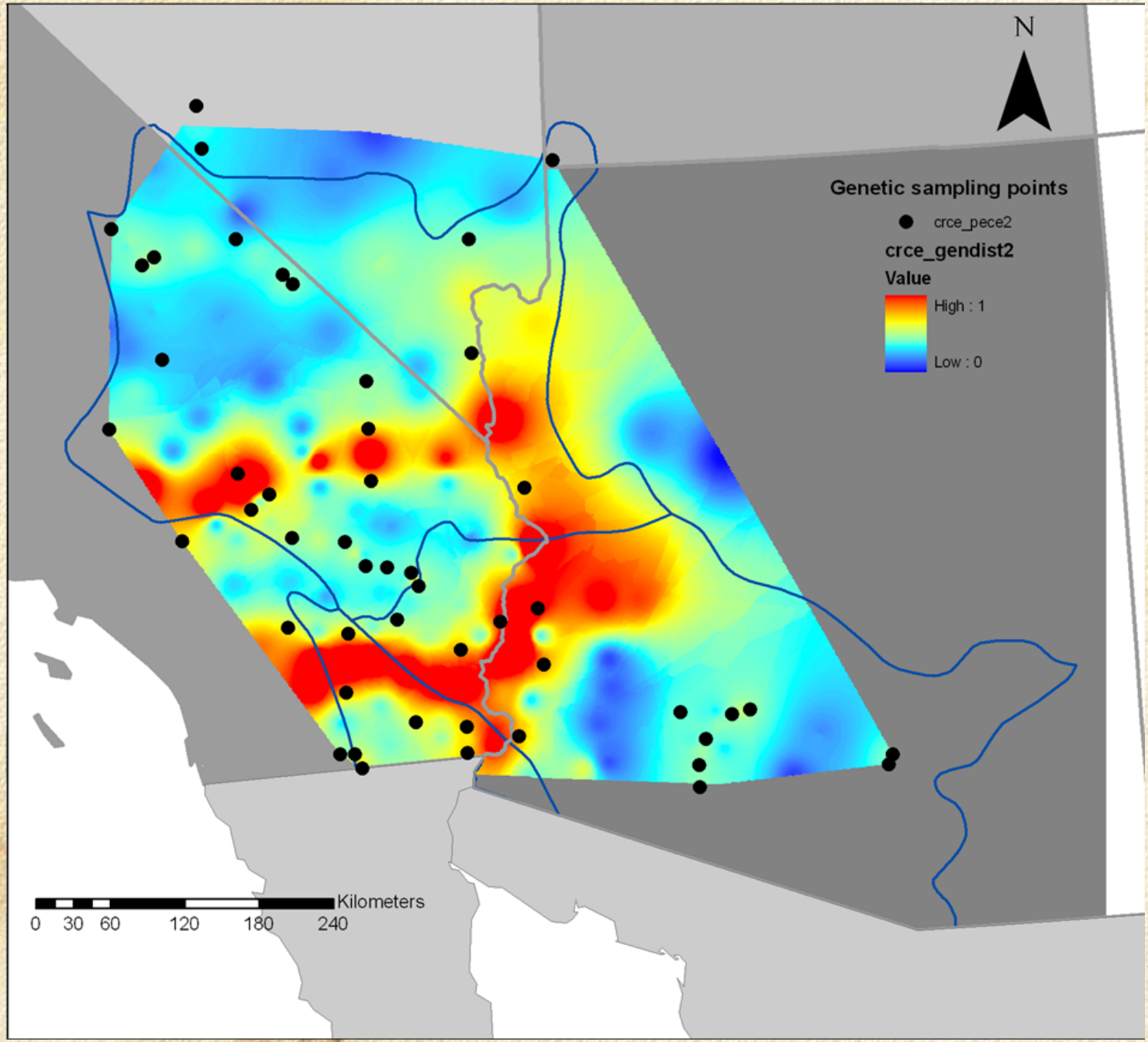
4. Regression of genetic & geographic distance– residuals retained for analysis– to remove the effects of distance alone.

5. Genetic distance residuals mapped at midpoints between collection locations and interpolated to create a surface in ArcGIS.

Shovel nosed snake



Sidewinder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Low : 0
Kilometers
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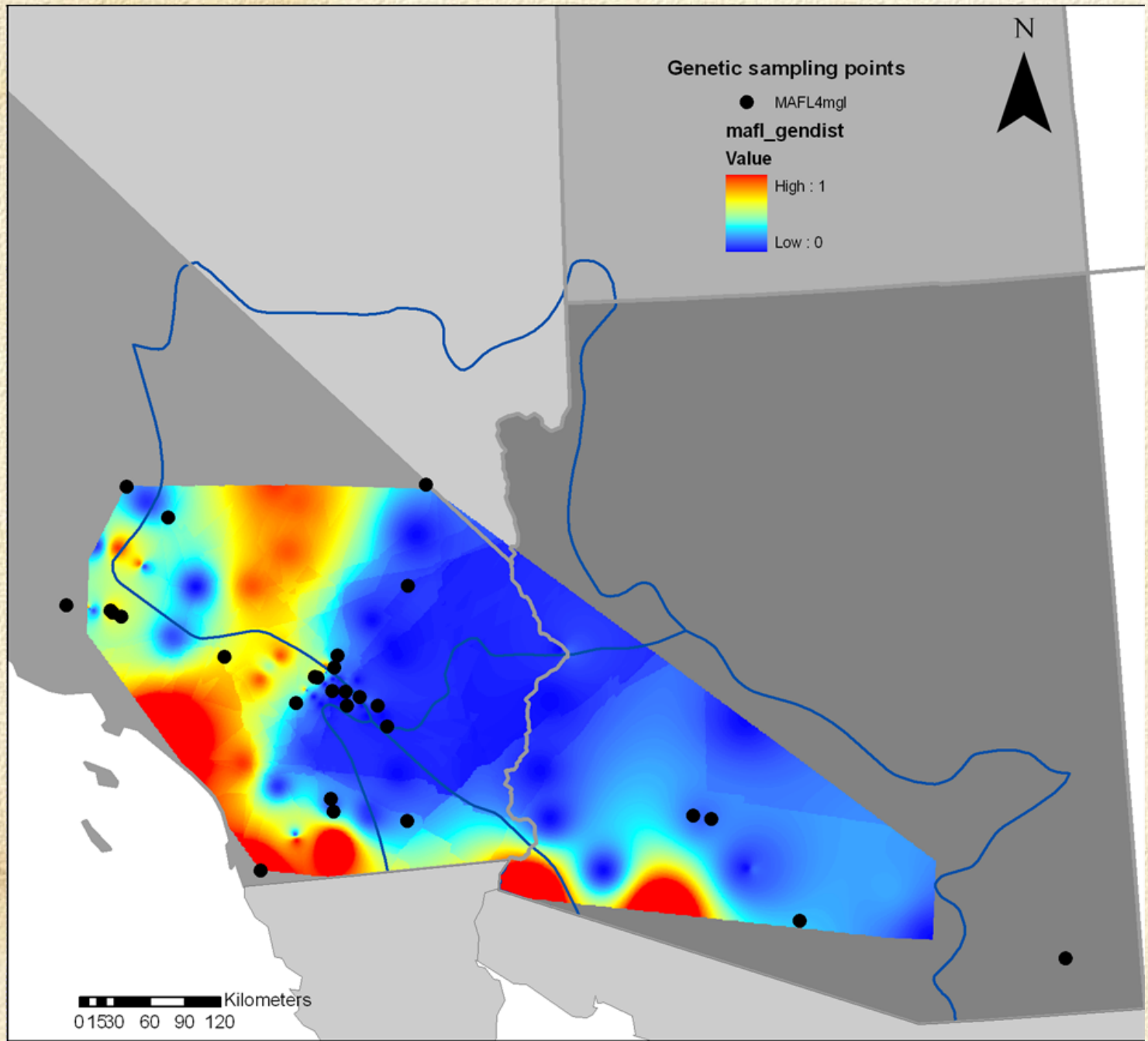
Whipsnake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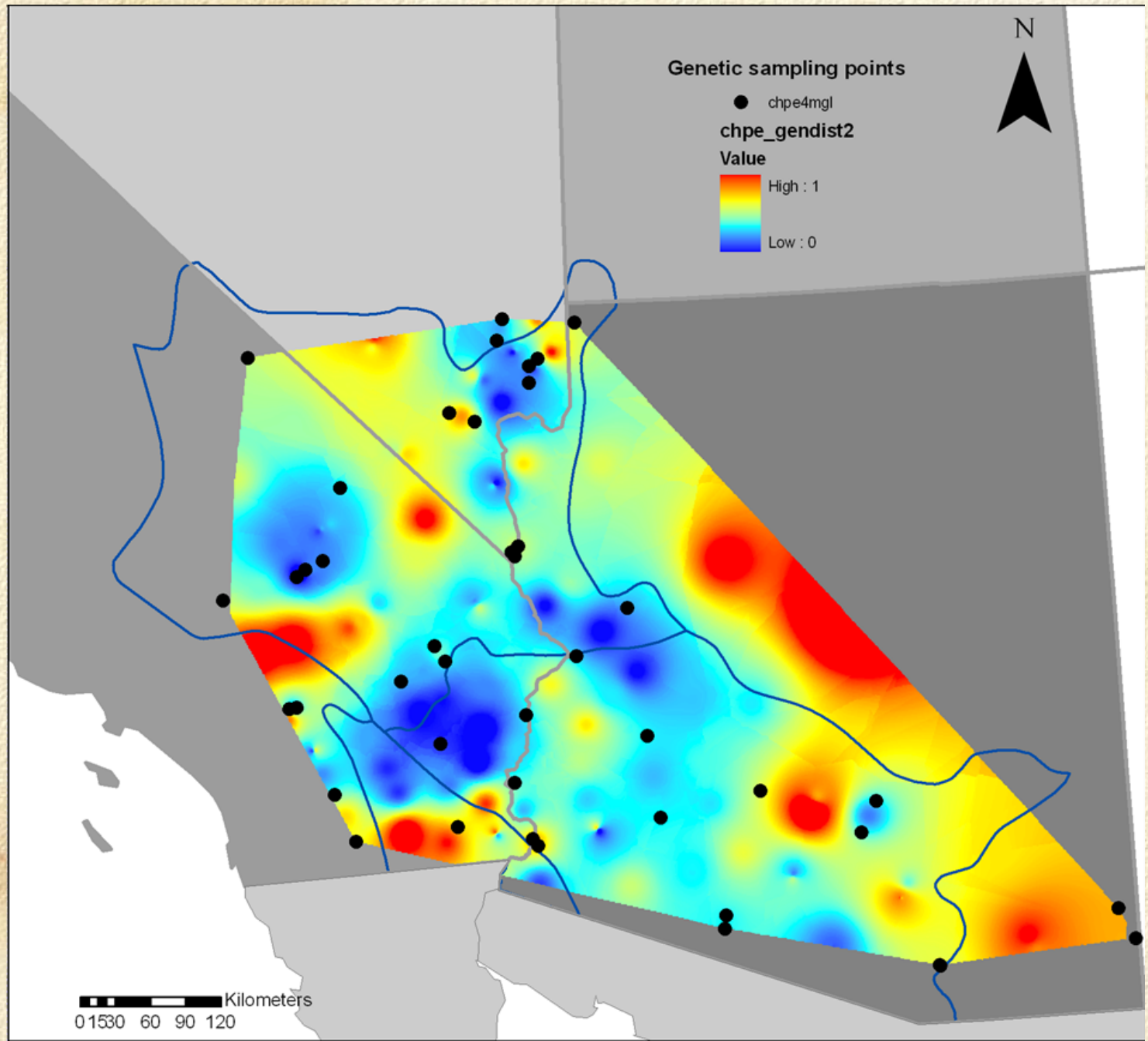
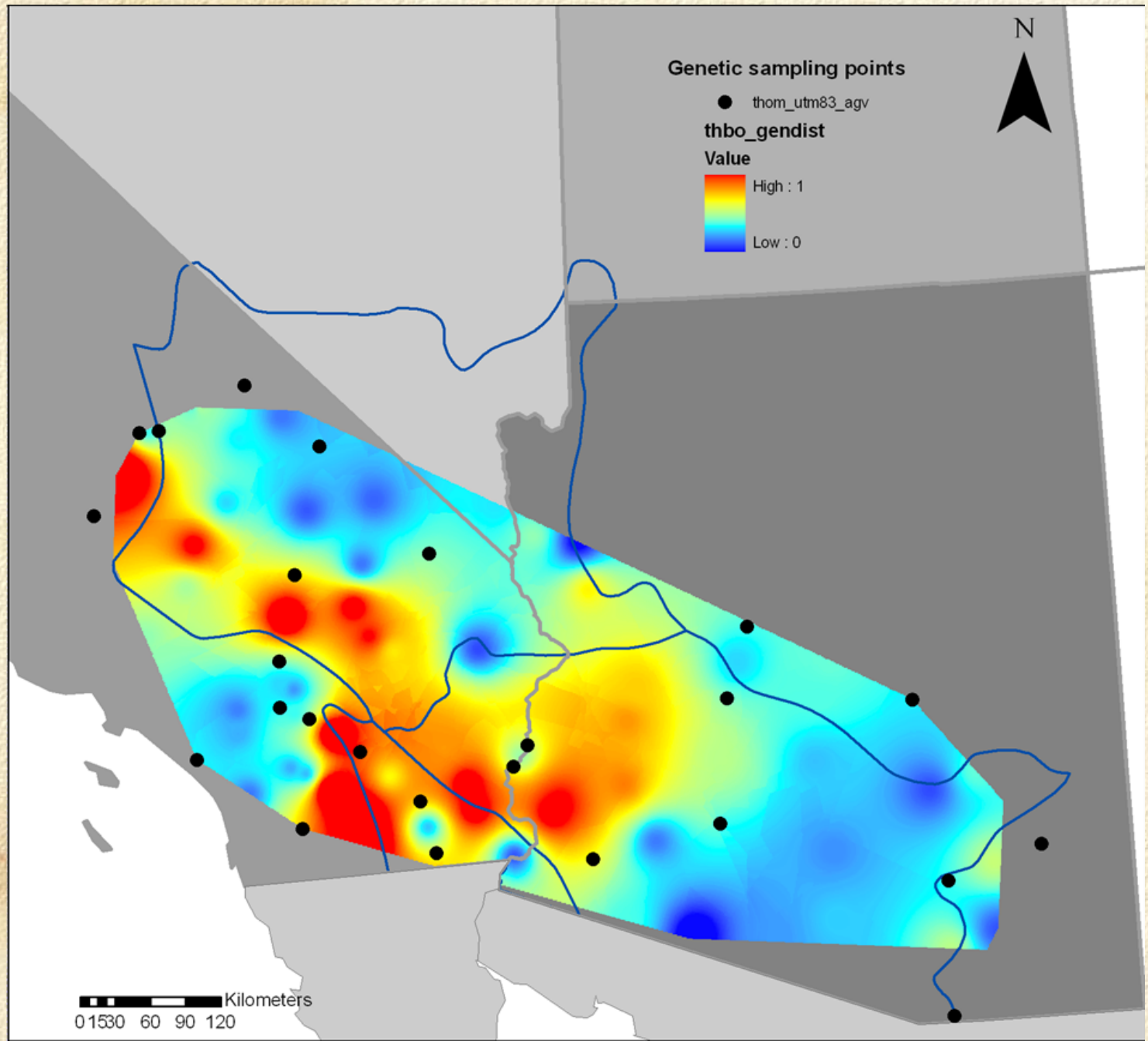
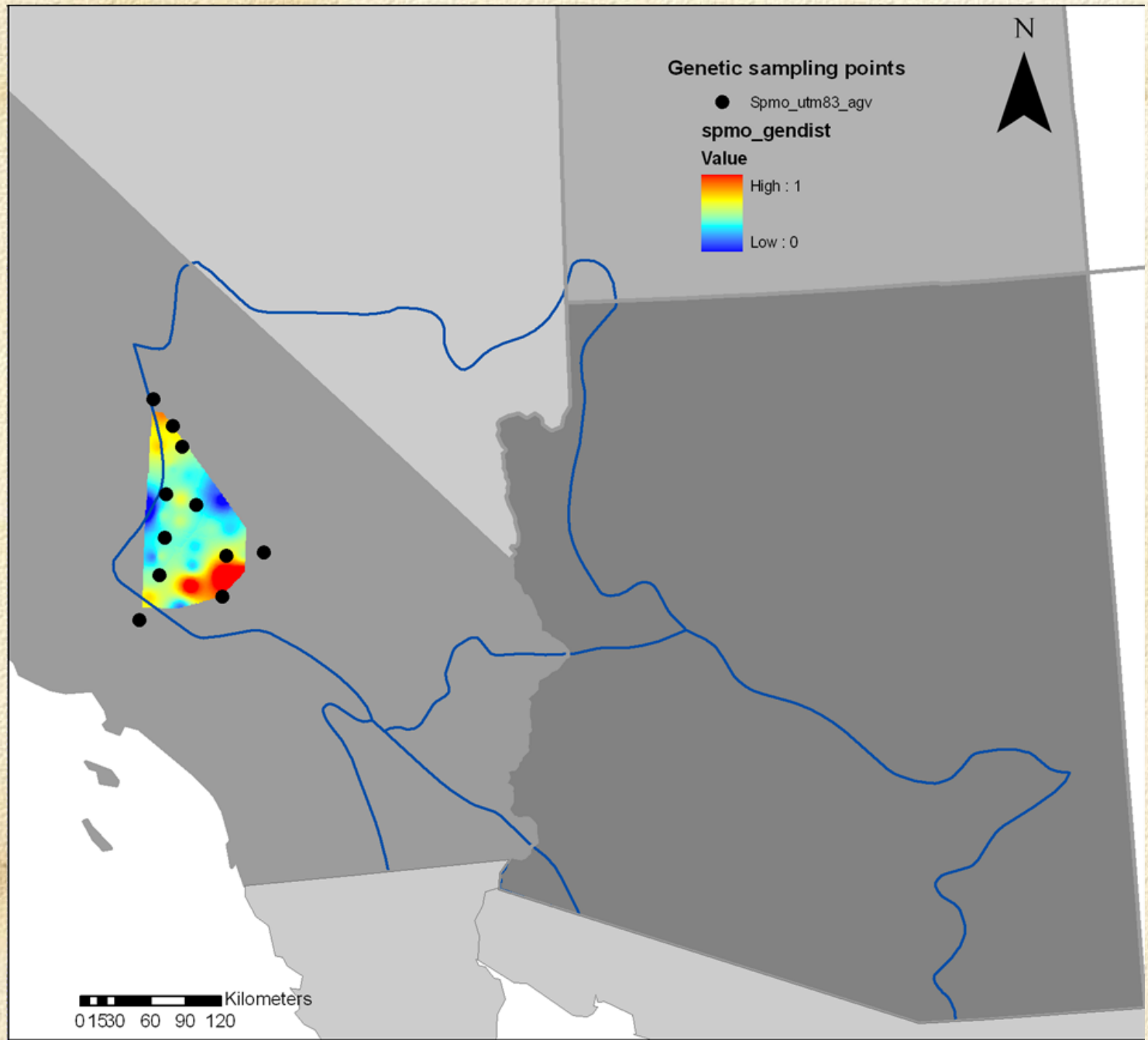
Desert Pocket Mouse



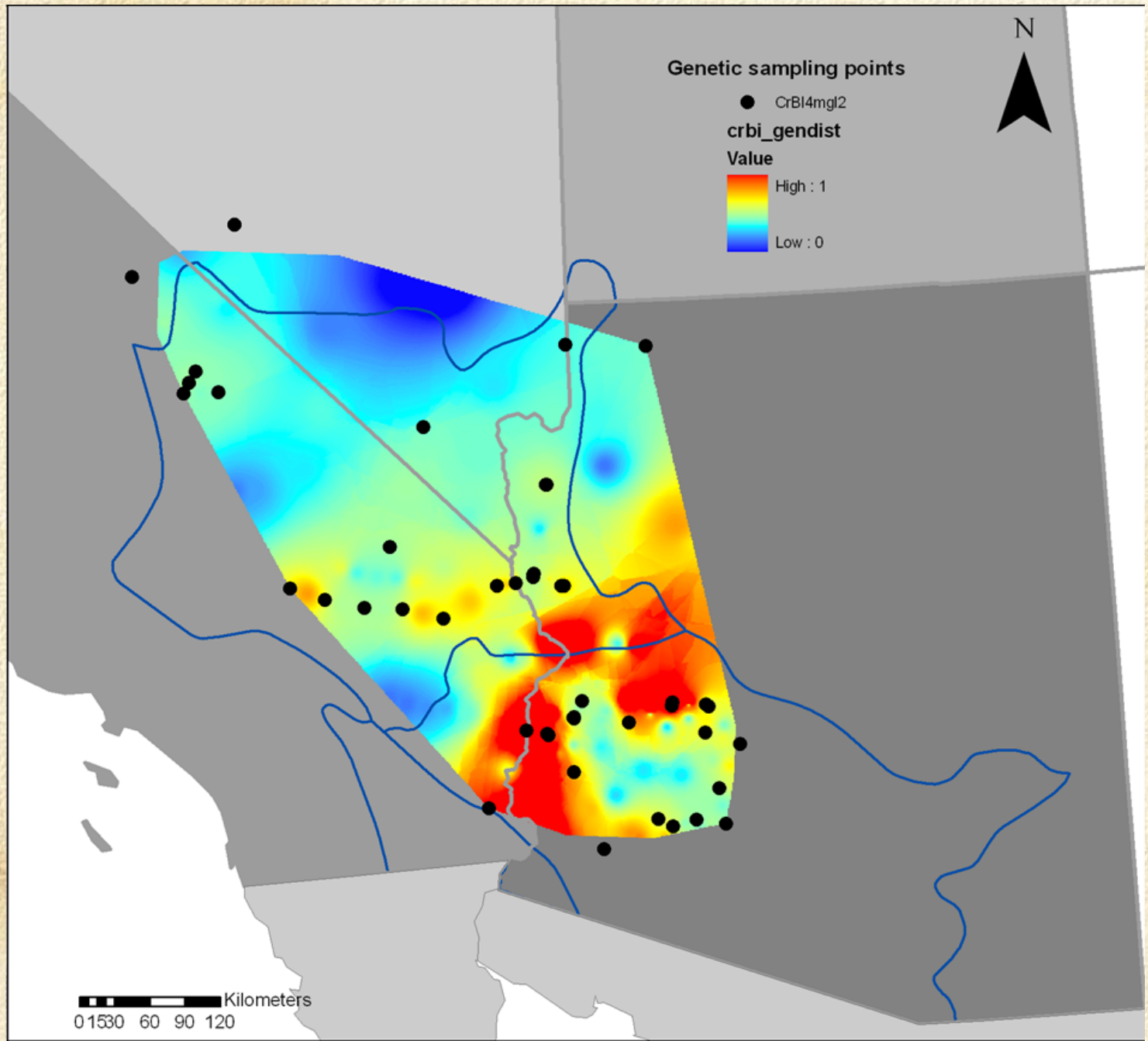
Pocket Gopher



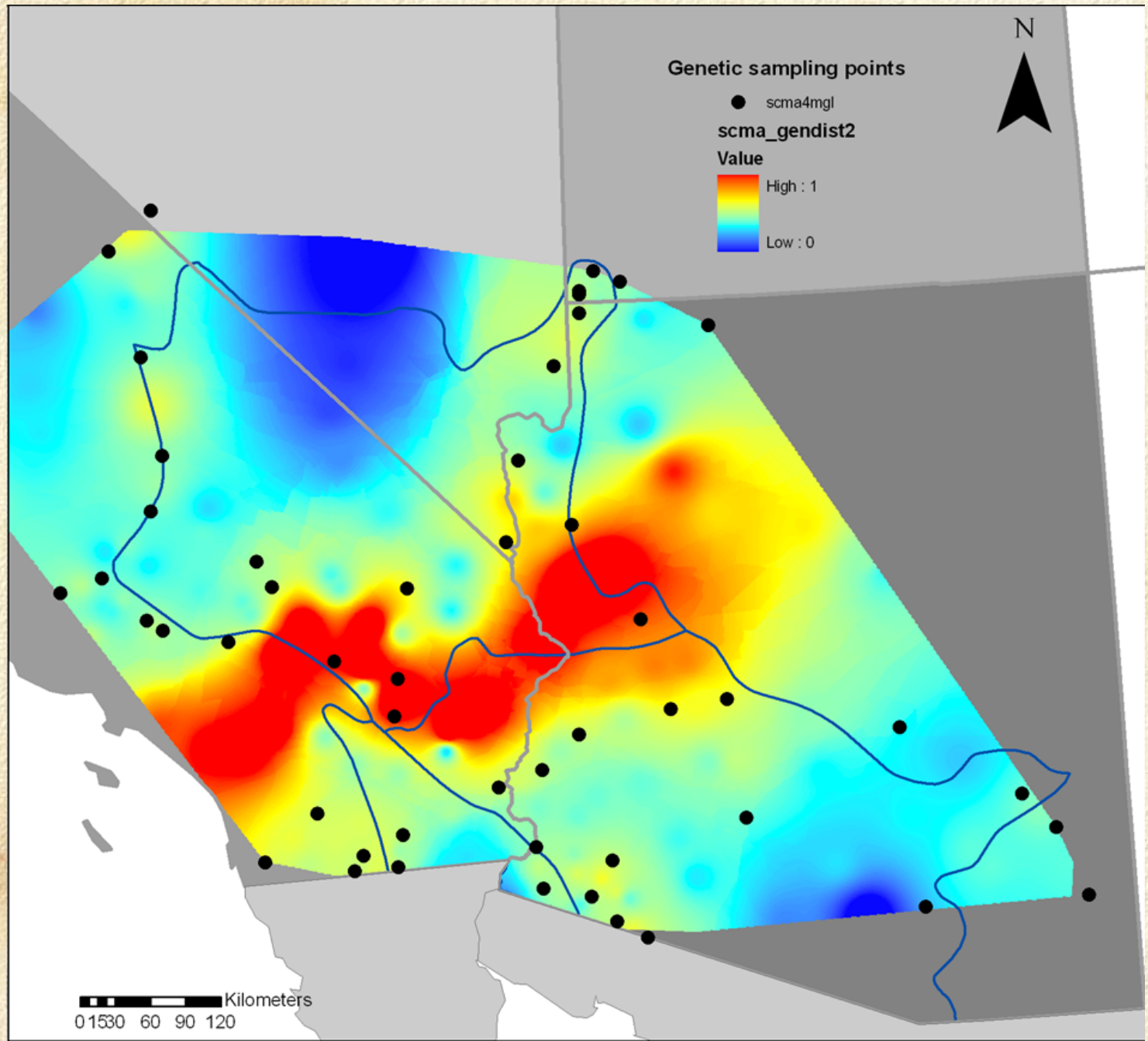
Mohave Ground Squirrel



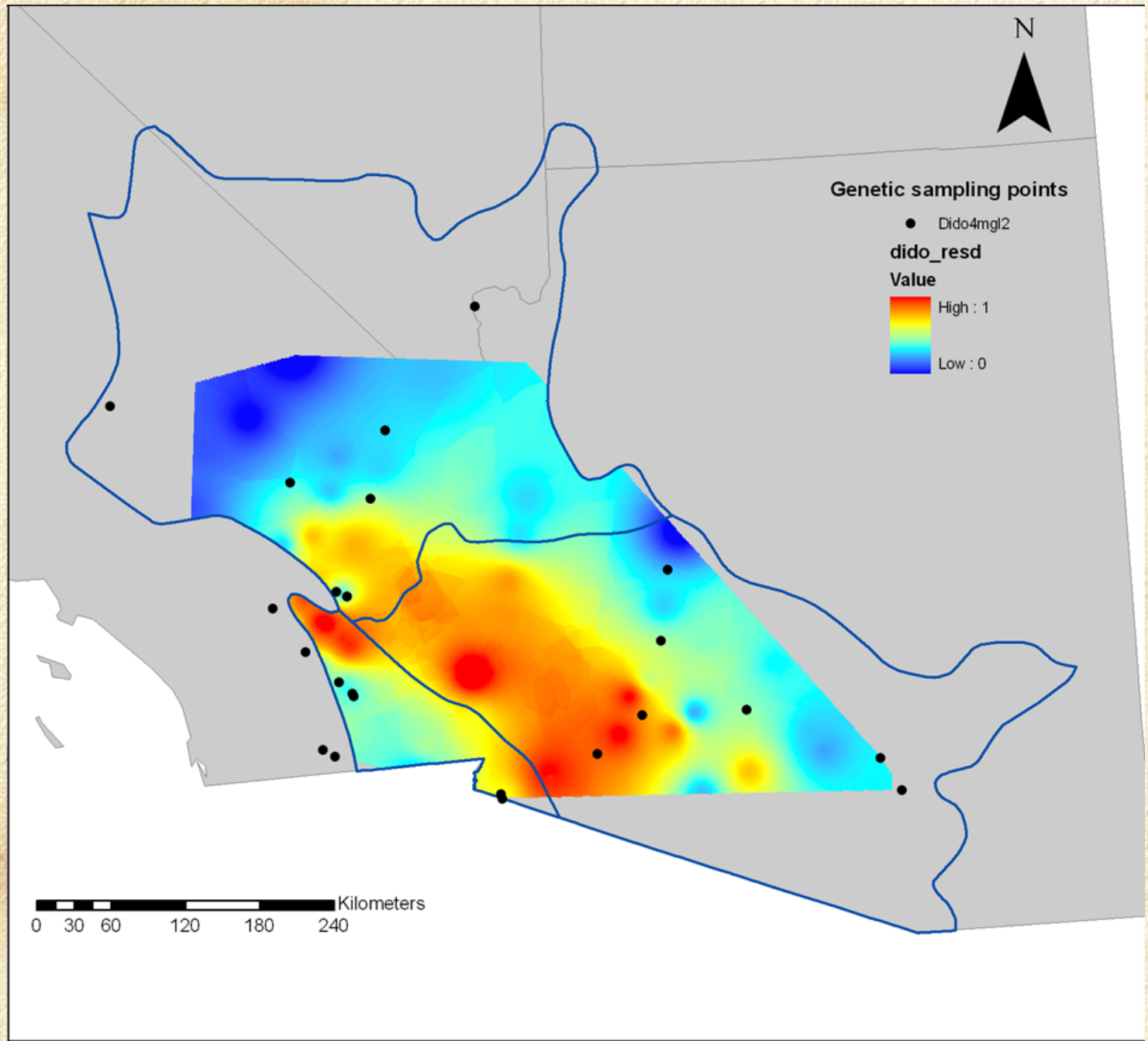
Collared Lizard



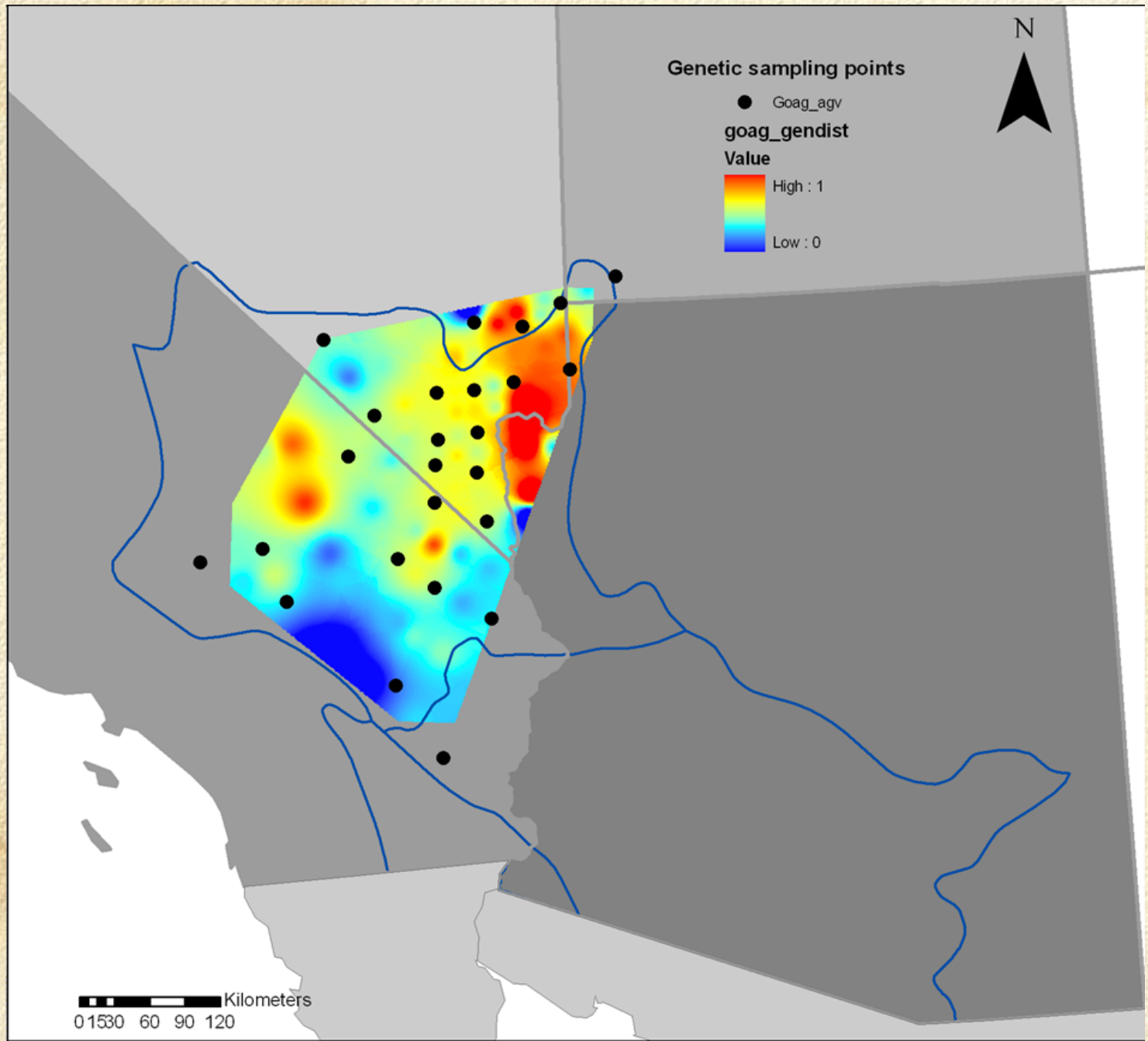
Desert Spiny Lizard



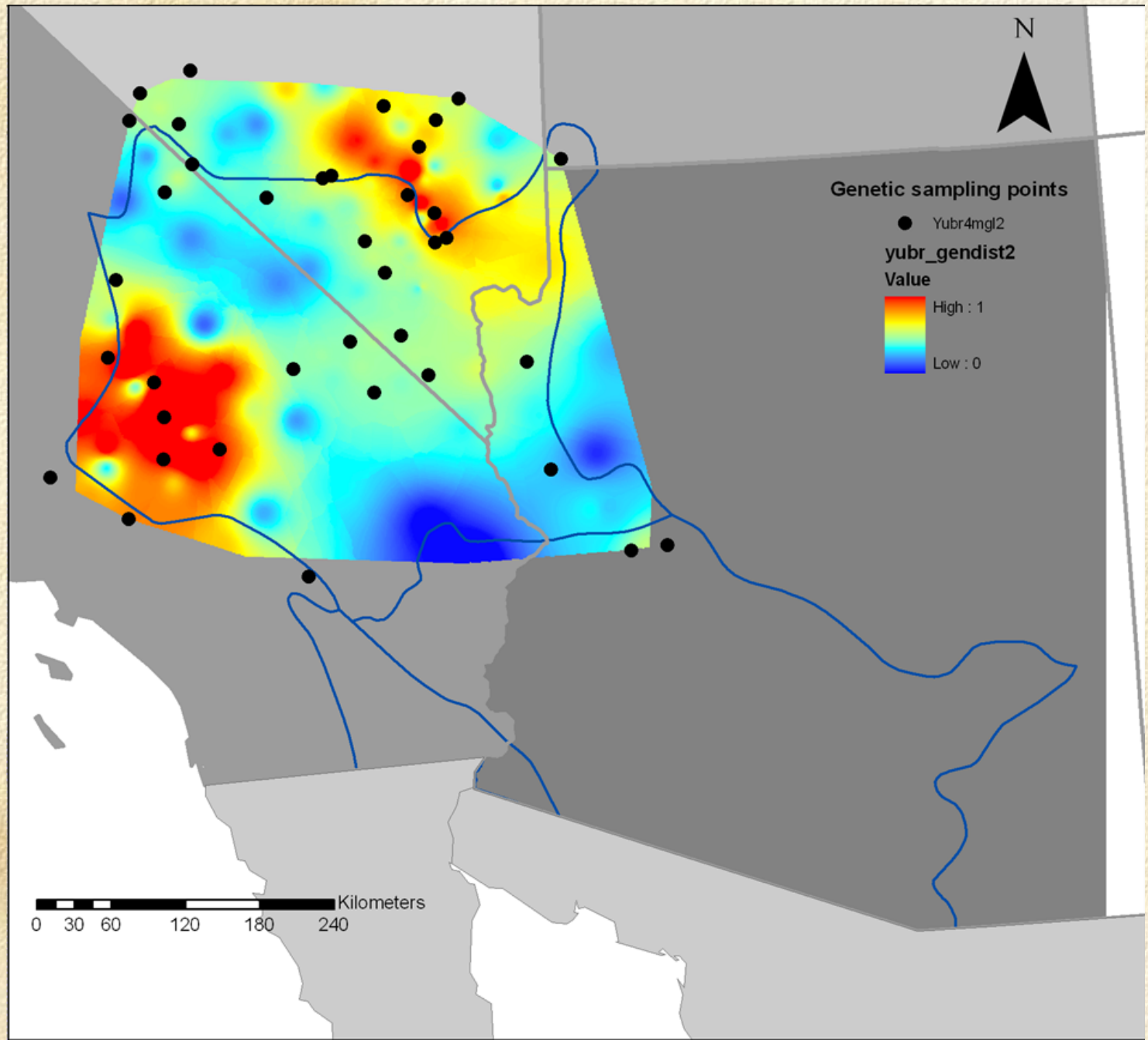
Desert Iguana



Desert Tortoise



Joshua Tree


N
Genetic sampling points
Yubr4mgl2
yubr_gendist2
Value
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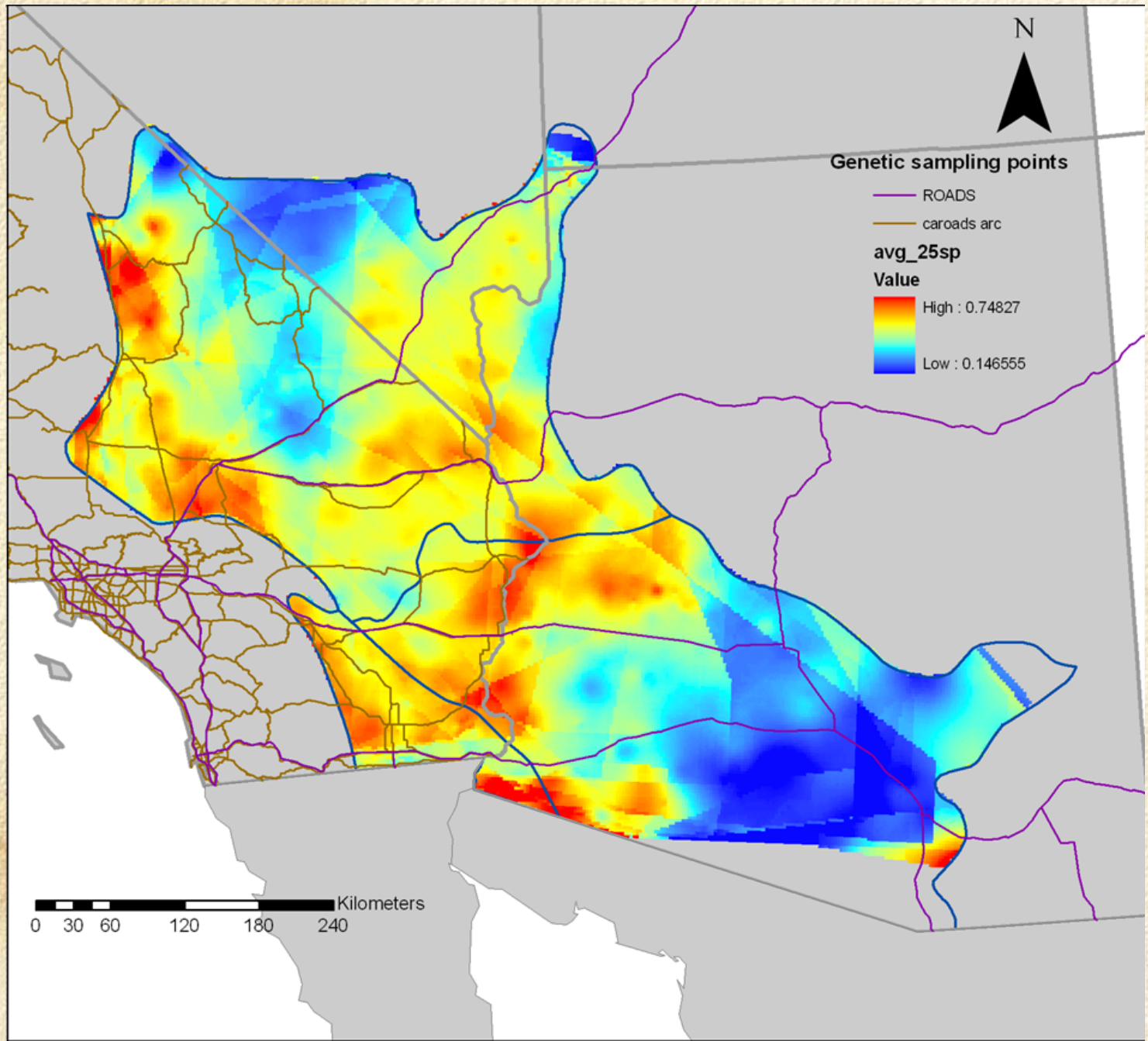
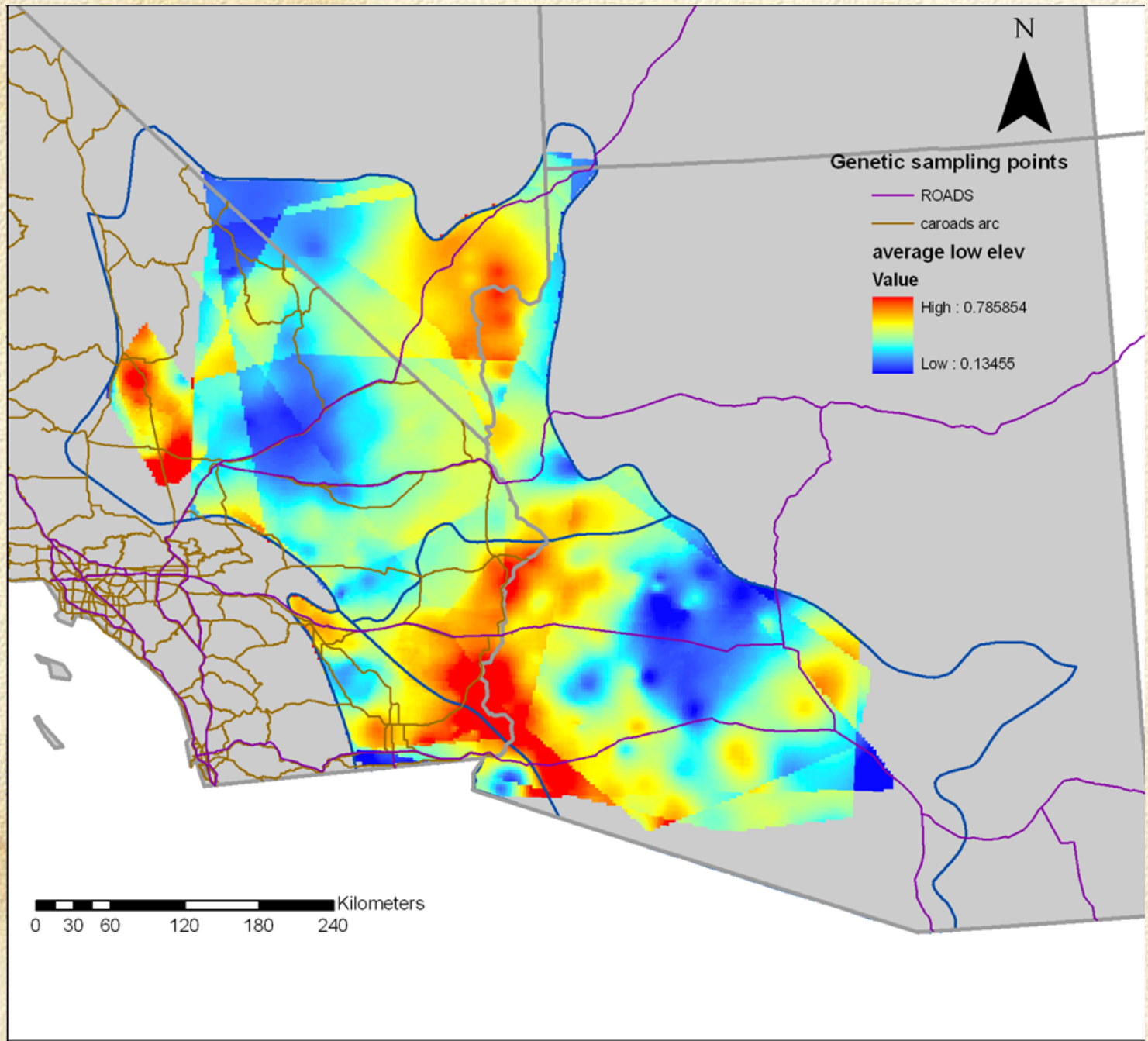
25 Species Average



Lowland scrub (8 species)



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Point Data

Point data were sought from a variety of sources:

- Individual researchers
- Museum records were searched using distributed database networks (VertNet which includes MaNIS for targetting mammals and HerpNET for targeting reptiles and amphibians) –All three were accessed for data
- USGS
- Inquiries were made to other agencies resulting in either no new data or suggestions to contact individual researcher or find grey literature.

Point Data continued

Within the VertNet, MaNIS, and HerpNET Databases data relevant to the study area were available from

- ASU Arizona State University
- CAS California Academy of Sciences, San Francisco, CA
- CM Carnegie Museum of Natural History, Pittsburgh, PA
- LACM Natural History Museum of Los Angeles County
- LSUMZ Louisiana State University Museum of Natural Science
- MCZ Museum of Comparative Zoology, Harvard University
- MHP Museum of the High Plains - Fort Hays State University, Sternberg Museum of Natural History, Fort Hays, KS
- MSB Museum of Southwestern Biology, University of New Mexico
- MVZ Museum of Vertebrate Zoology, University of California, Berkeley
- NMMNH *New Mexico Museum of Natural History* and Science
- OMNH Sam Noble Oklahoma Museum, University of Oklahoma
- ROM Royal Ontario Museum, Toronto, Ontario
- SBMNH Santa Barbara Natural History Museum, Santa Barbara, CA
- SDNHM San Diego Natural History Museum, San Diego, CA
- TTU *Texas Tech University*
- UAZ Amphibian and Reptile Collection, University of Arizona
- UCM University of Colorado Museum
- USNM Smithsonian National Museum of Natural History, Washington, D.C.
- UTEP The Centennial Museum, University of Texas at El Paso
- UWBM The Burke Museum of Natural History and Culture, University of Washington, Seattle
- YPM Peabody Museum, Yale University

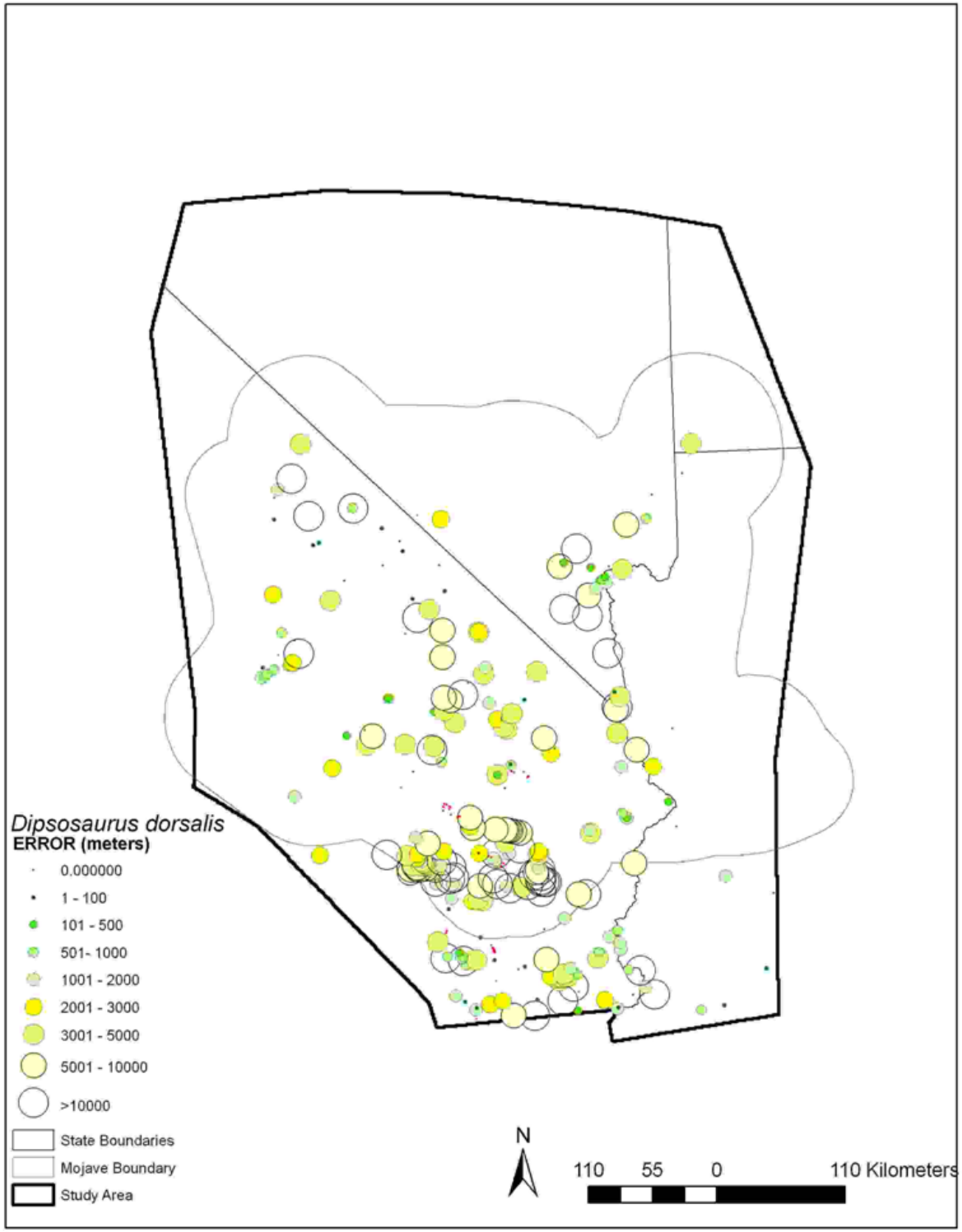
Point Data continued

- Queries for priority species data were conducted with all sources.
- Data from all sources were combined into one database.
- Data were examined for duplicate locations and duplicates were removed.
- Data with coordinates were mapped according to location error associated with each point.
- Mapped data available were summarized and visually examined to determine whether mapping additional records that only had location descriptions would be necessary.

Point Data continued

Anaxyrus (Bufo) punctatus	**226**	**89**
Chaetodipus penicillatus	**135**	**91**
Chionactis occipitalis	**666**	**203**
Crotaphytus bicinctores	**311**	**139**
Dipsosaurus dorsalis	**354**	**73**
Lichanura trivirgata	**231**	**76**
Perognathus longimembris	**941**	**385**
Plestiodon gilberti	**220**	**138**
Plestiodon skiltonianus	**434**	**334**
Sceloporus magister	**725**	**254**
Thomomys bottae	**707**	**361**
Uma scoparia	**205**	**95**
Xantusia vigilis	**682**	**252**

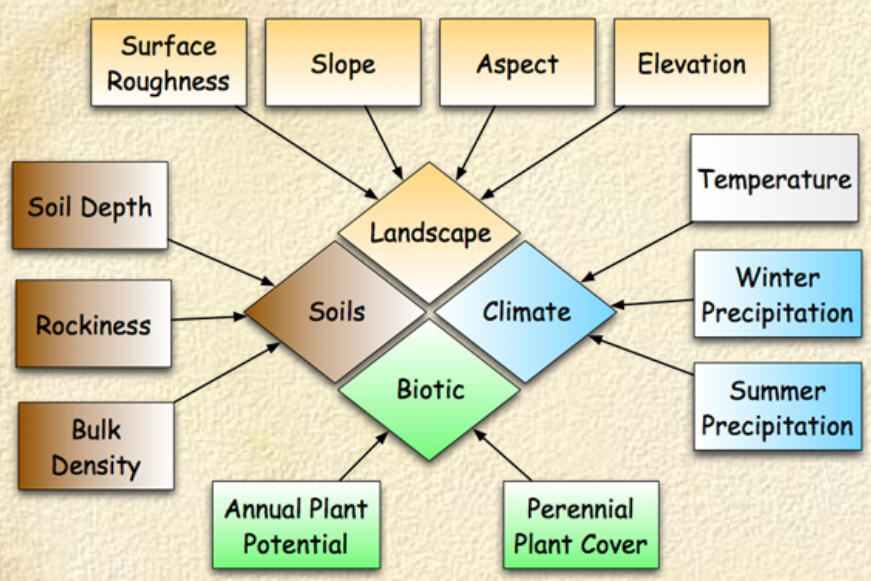
- Georeferenced point data ranged from 135-941 records within the study area
- Records with less than 1000m positional error associated with the points ranged from 73 to 385 records



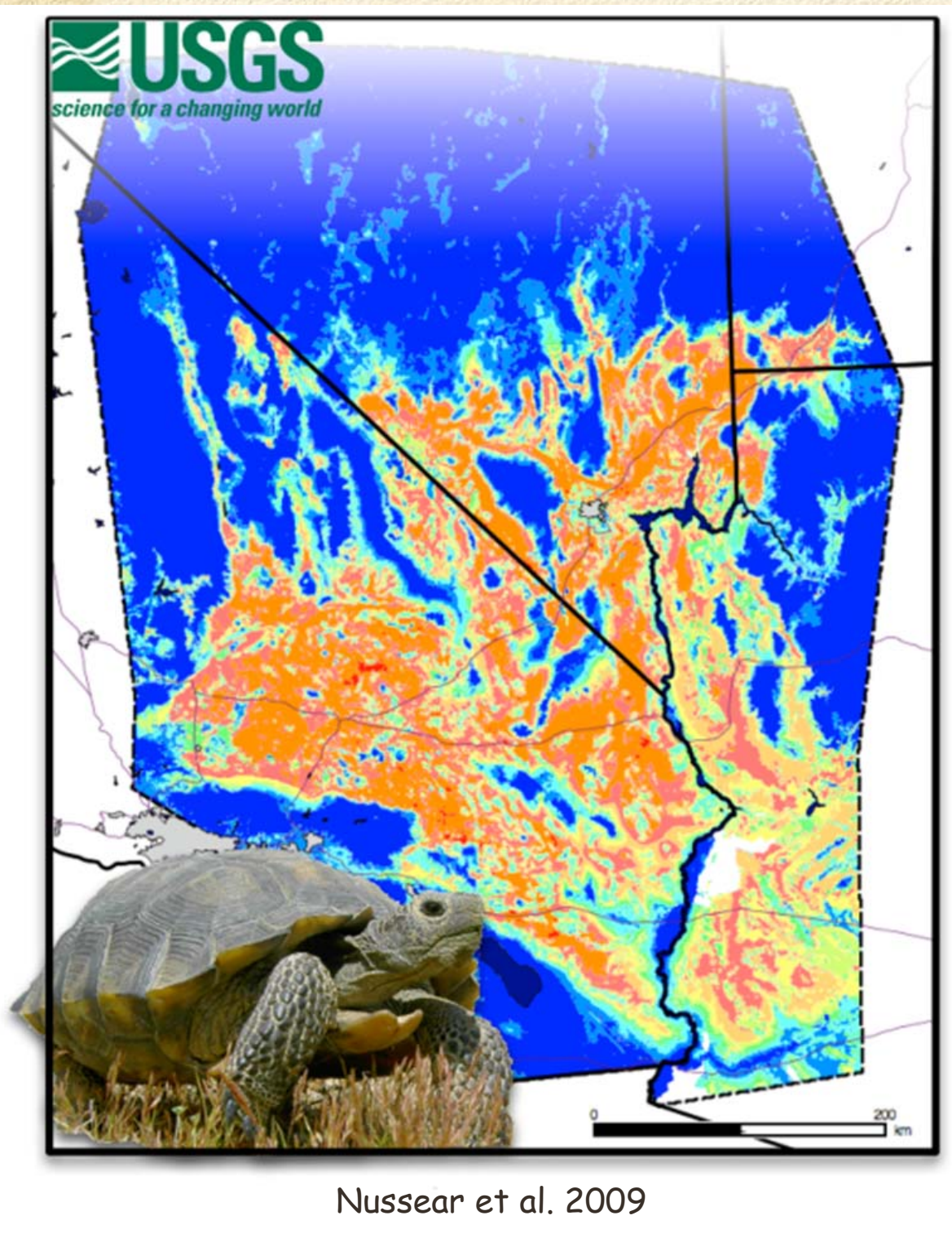
- ***Dipsosaurus dorsalis*** **point data distribution across the study area.**
- **354 total points**
- **73 have positional error less than 1000m**

More Location Data Please!

Habitat Suitability Model



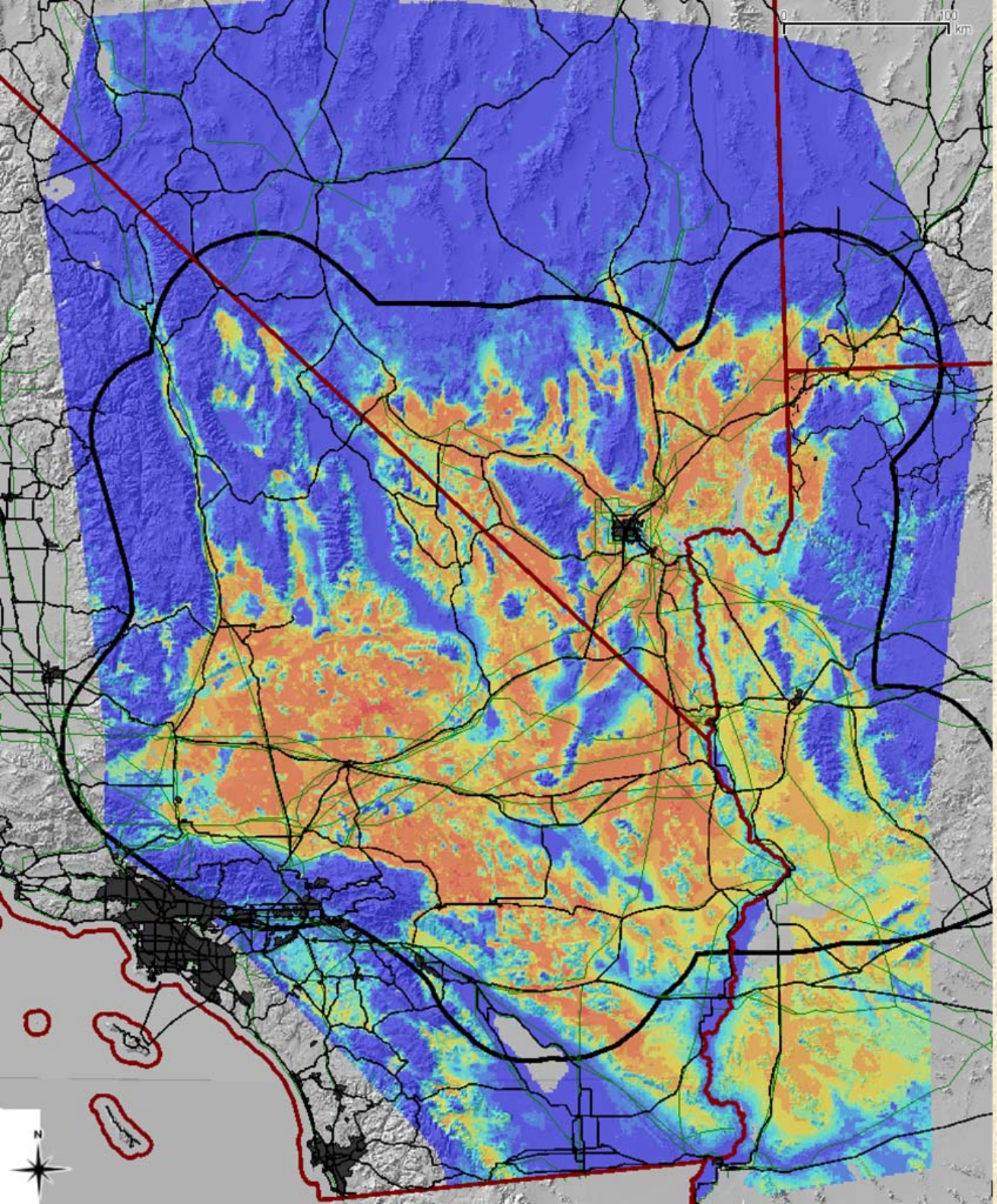
Blainey et al. 2007, Wallace and Thomas 2008, Wallace et al. 2008



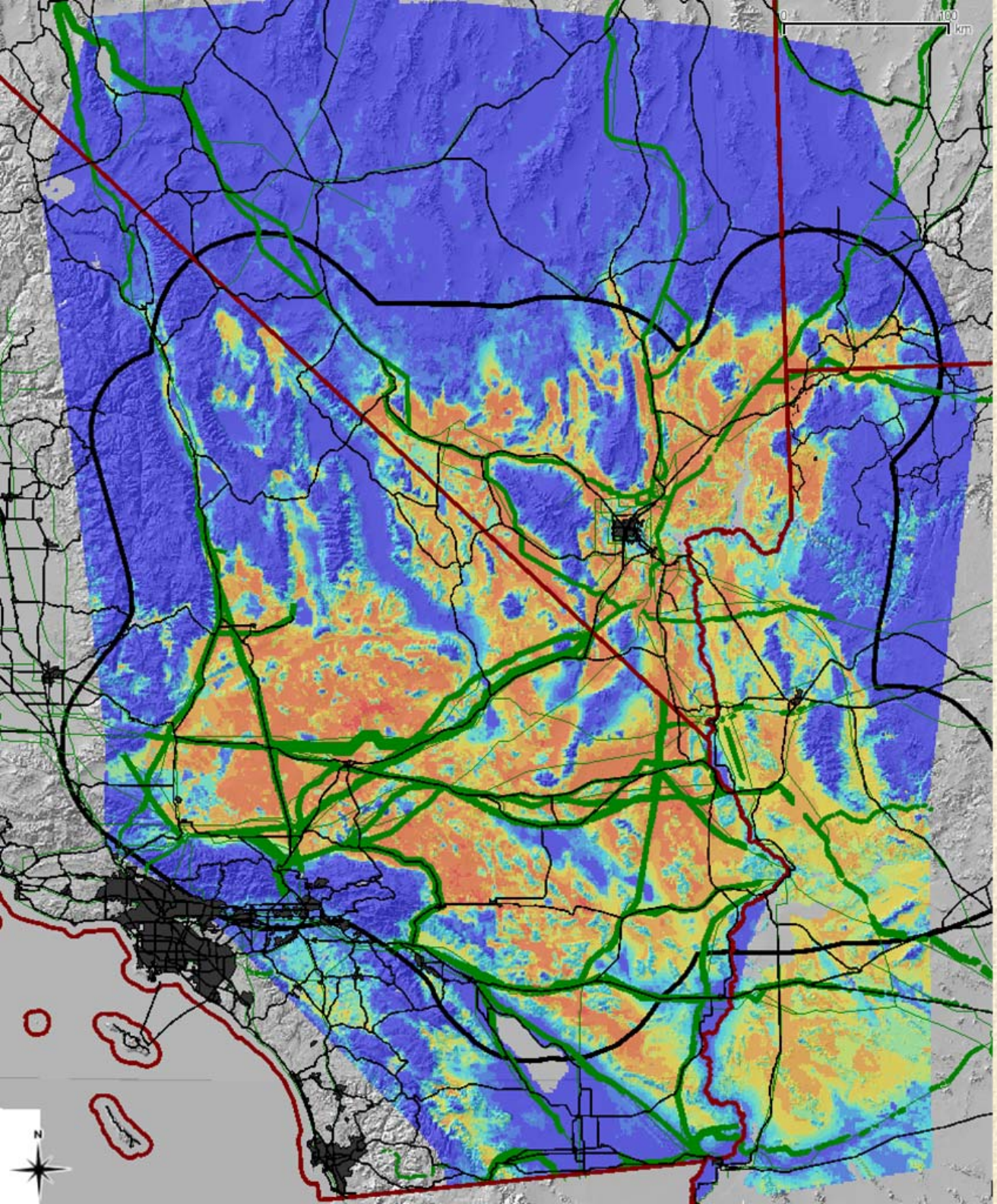
Nussear et al. 2009

Renewable Energy Potential Development Footprint

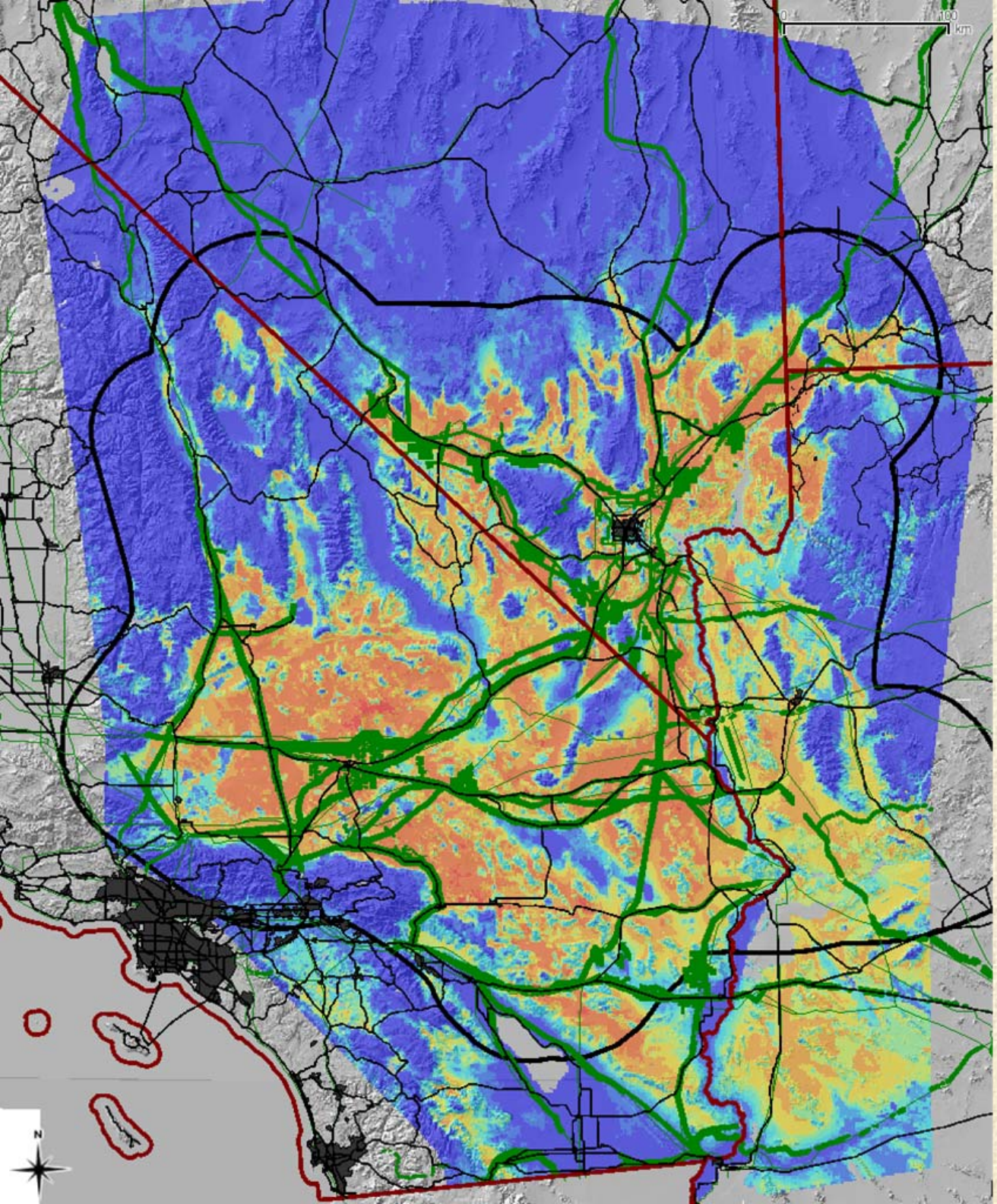
- Gathering location data from pending applications, transmission lines and corridors, right of ways, study areas, CREZ



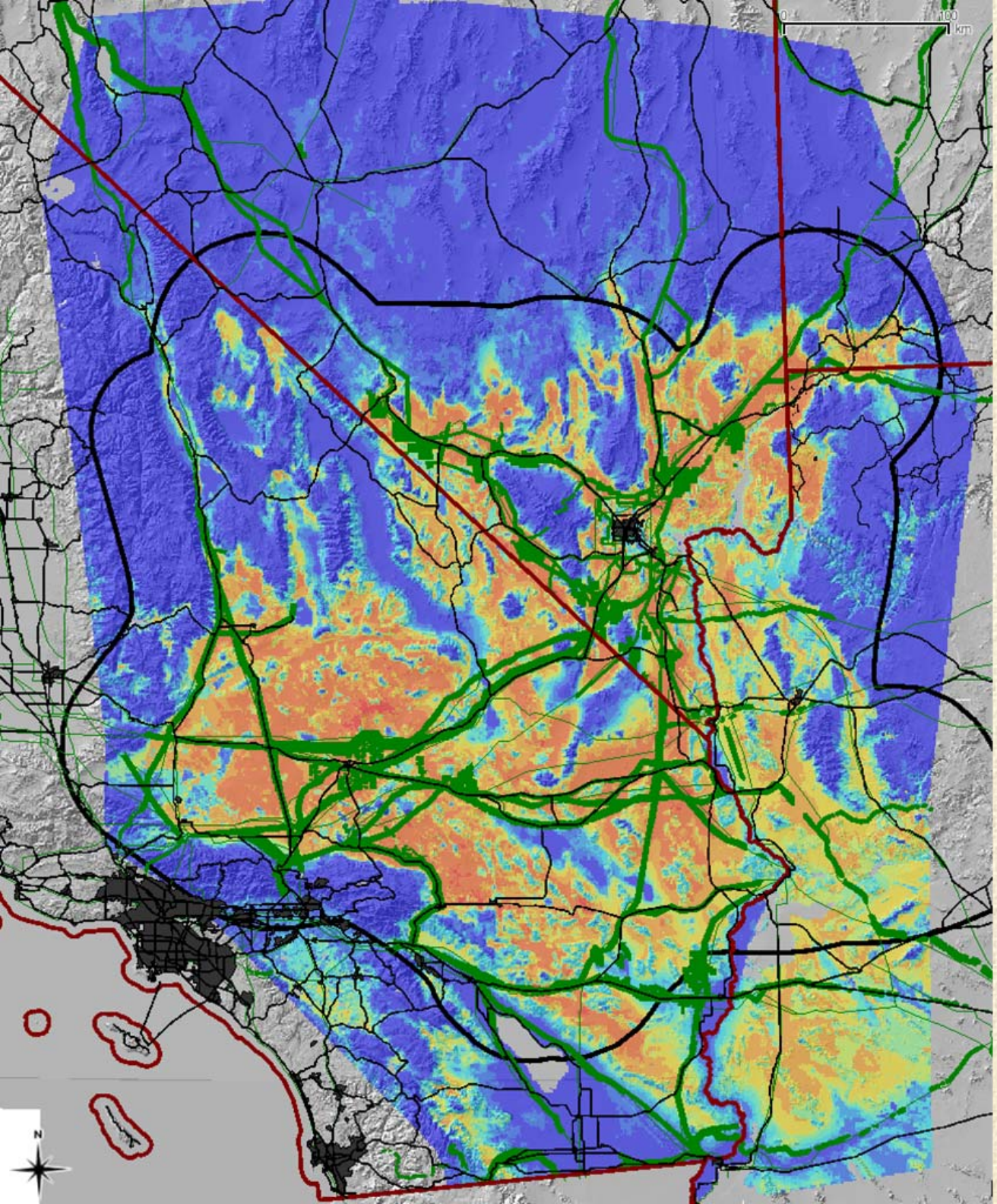
Transmission lines



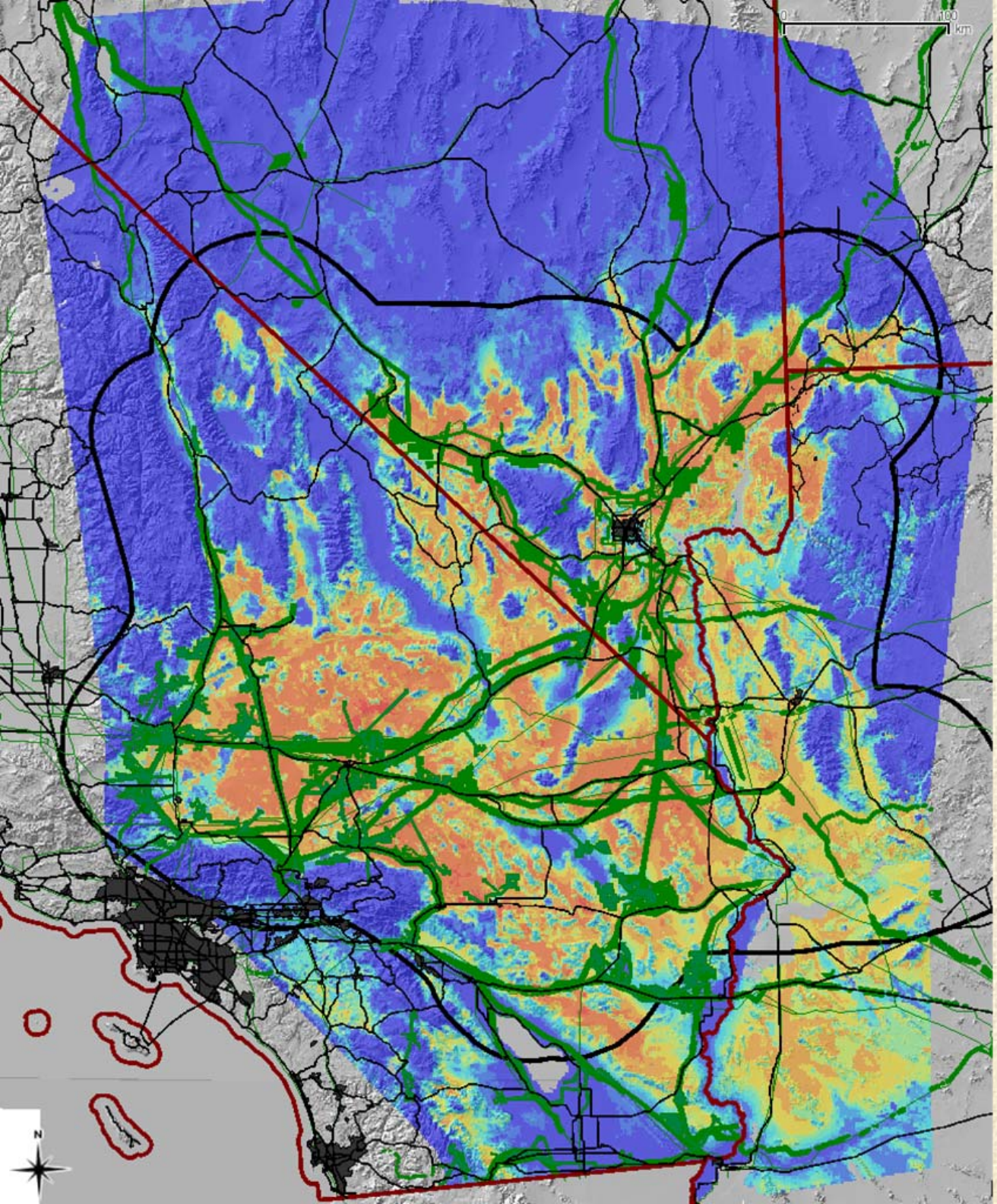
Transmission lines & corridors



Transmission lines & corridors & right of ways

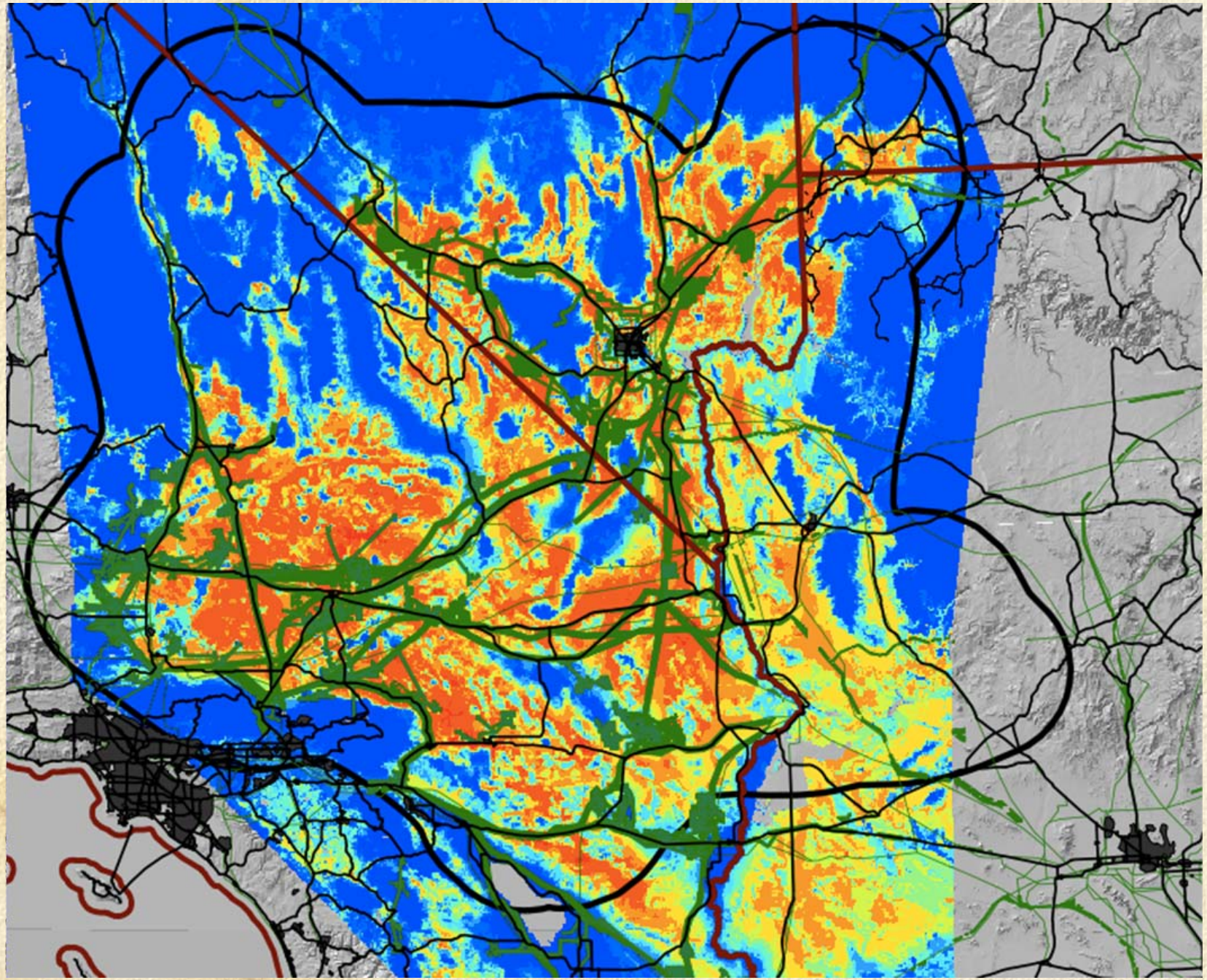


Transmission lines, corridors, right of ways & fast track



Transmission lines, corridors, right of ways, fast track, CREZ & study areas

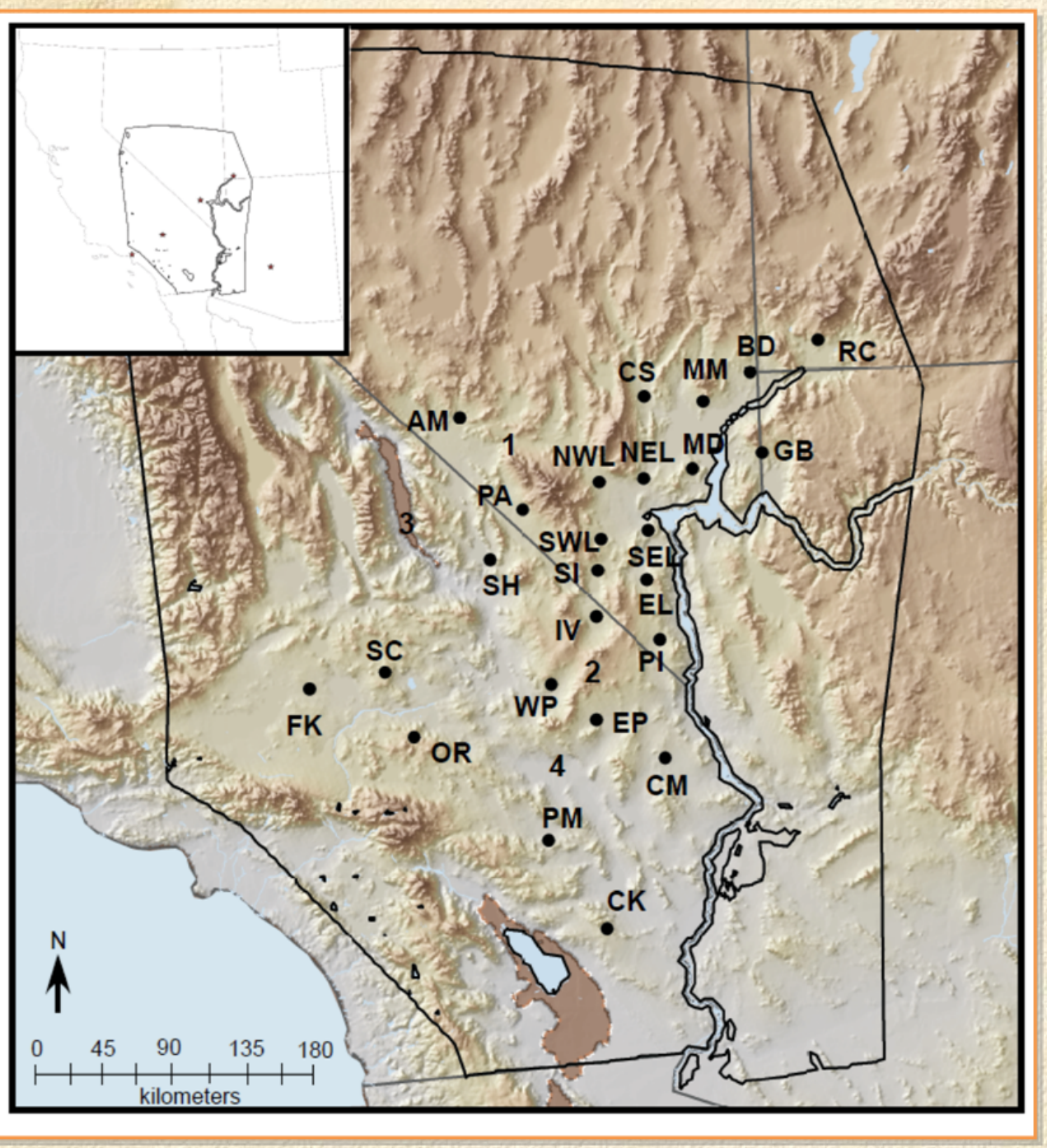
Habitat Connectivity?



Adapted from Nussear et al. 2009

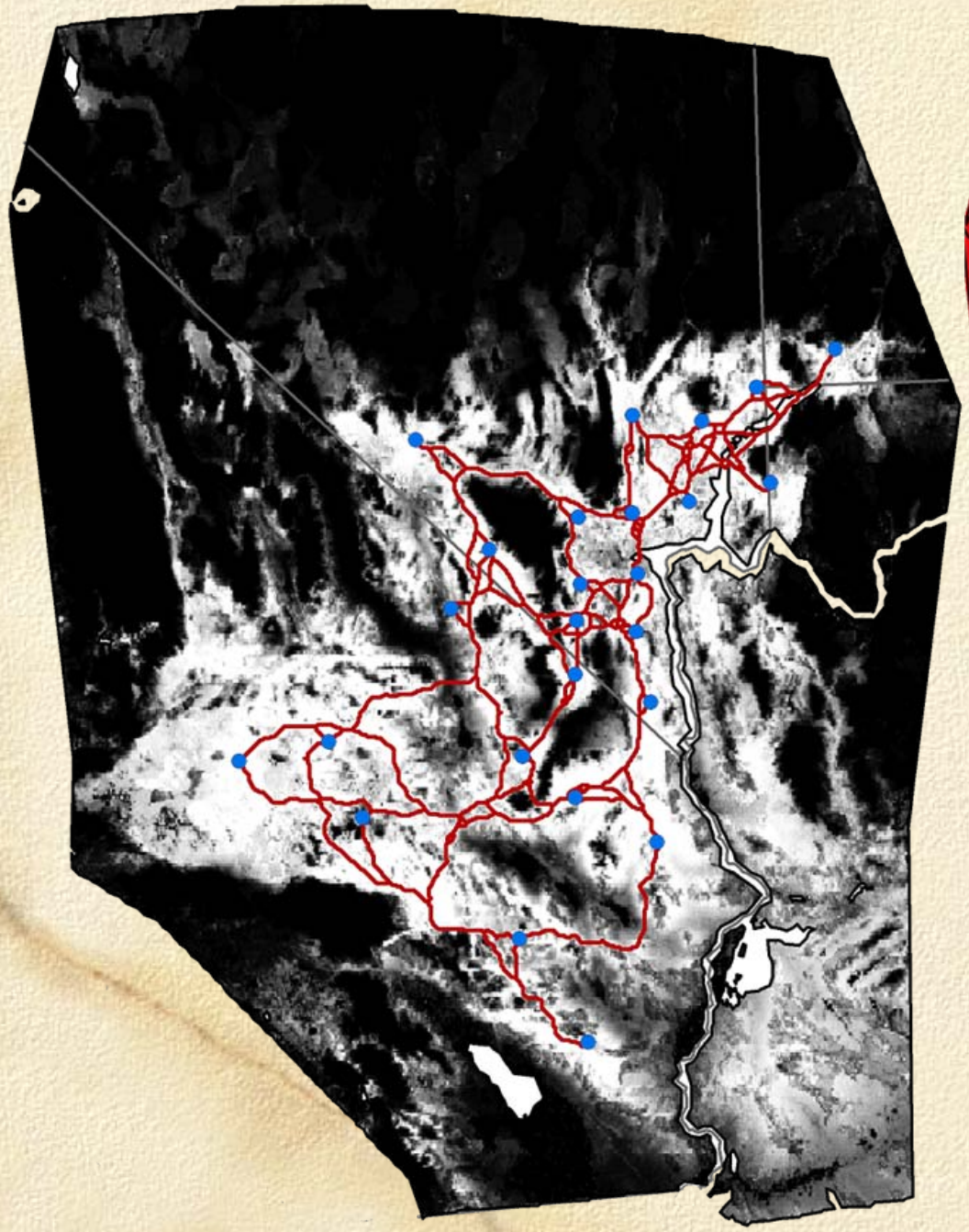
Landscape Genetics

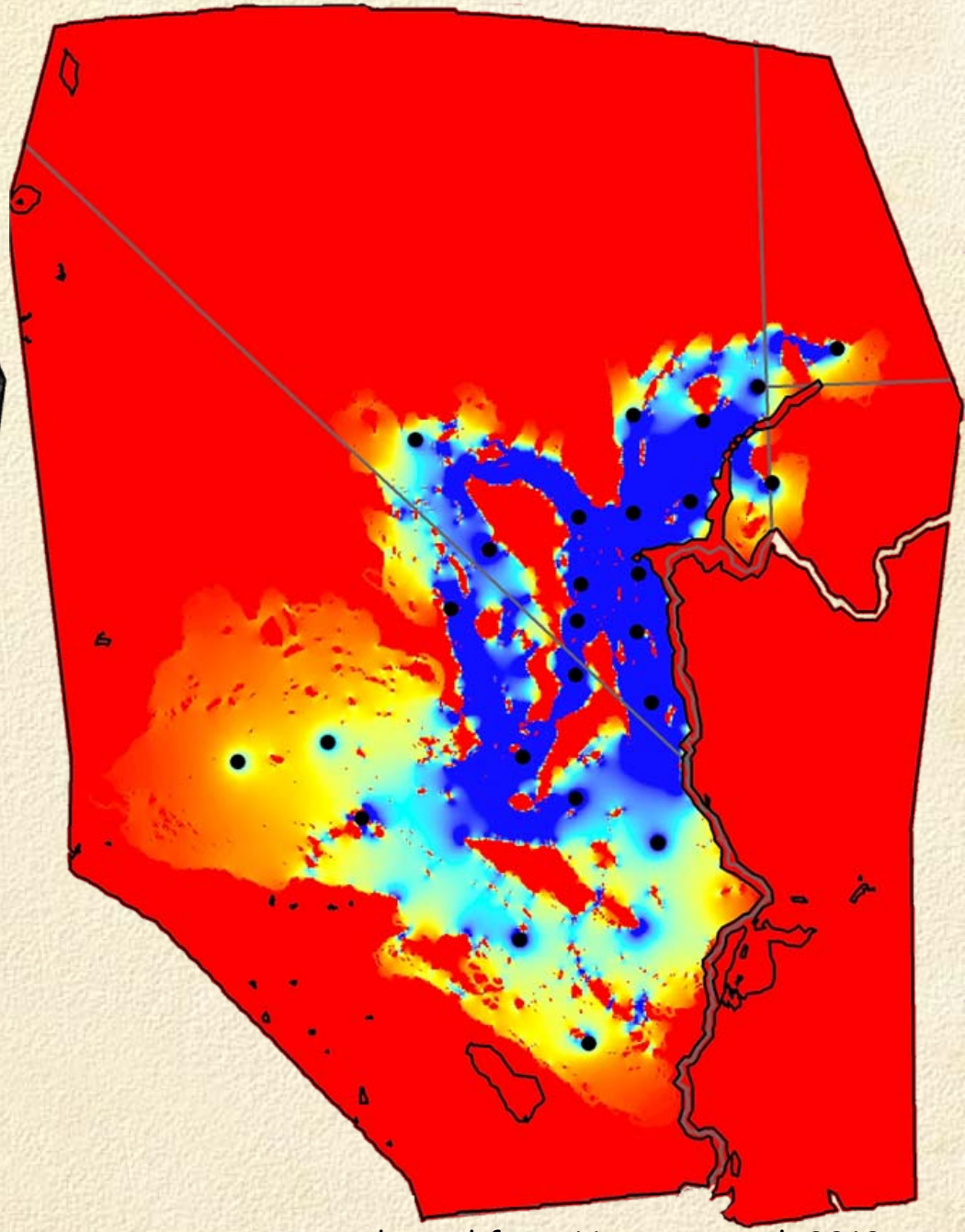
Help prioritize linkages



Adapted from Hagerty et al. 2010

Landscape Genetics





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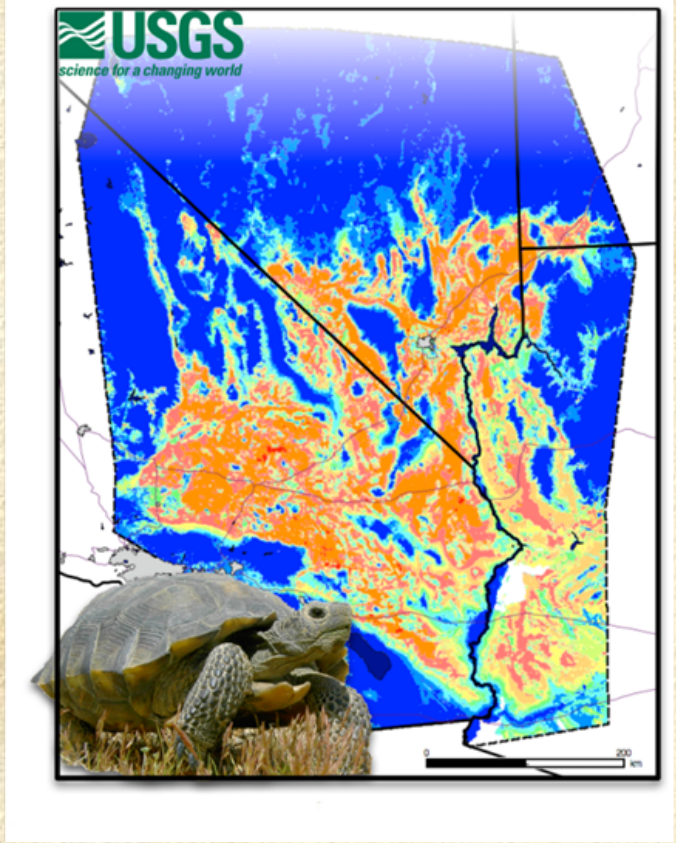
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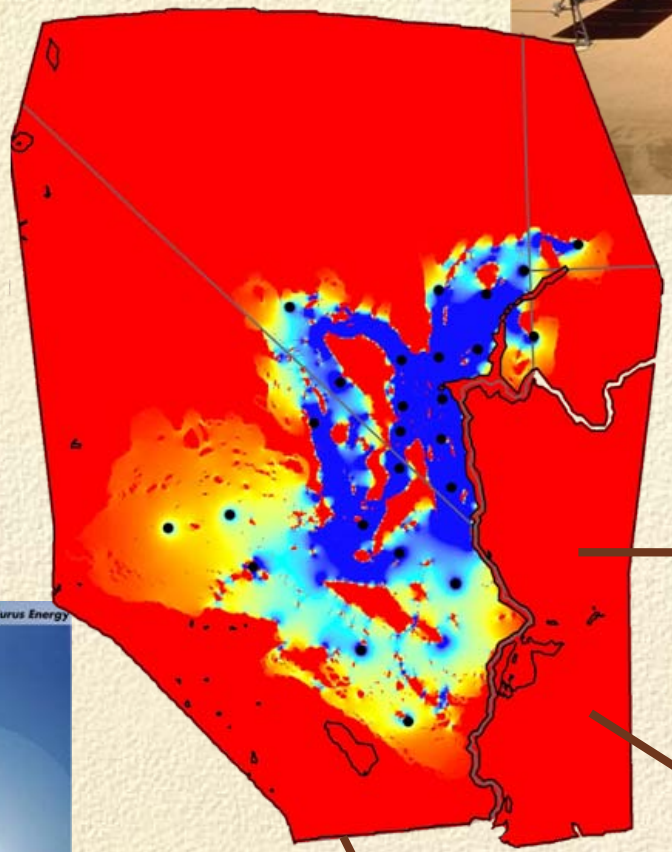
science for a changing world




Eurus Energy

To Be Continued….

- Mapping genetic diversity
- Completing habitat suitability mapping
- Landscape genetic analysis to prioritize corridors
- Completion in September 2011








To Be Continued….

- 5 year funds from USGS to further study the impacts of solar energy development in the desert
- Adding genetic datasets
- Initiate site-specific studies to look at direct impacts on species persistence