#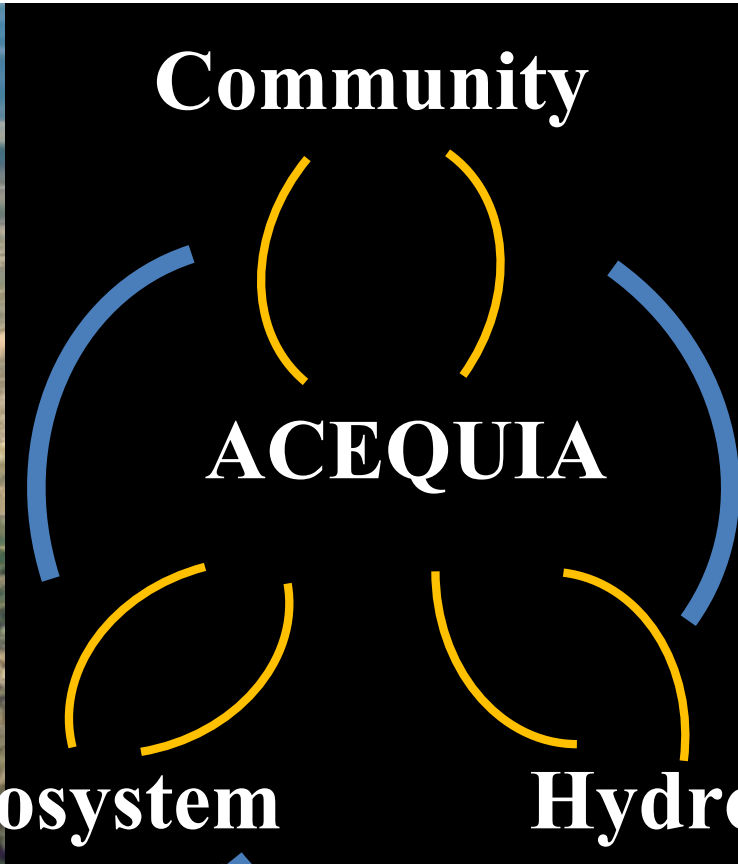 Ecosystem Services, Faunal Biodiversity and Vegetation Dynamics in Response to Forecasted Land-Use and Climate Change within the Upper Rio Grande

Photo by Jason Bak

Kenneth G Boykin

Elizabeth A. Samson

New Mexico State University

NSF

NM STATE UNIVERSITY CASE Center for Applied Spatial Ecology

Community

ACEQUIA

Ecosystem   **Hydrology**

Ecosystem Services

The benefits humans derive from ecosystems (MEA 2005)
as soil formation, photosynthesis, and nutrient cycling

Provisioning	Regulating	Cultural	Supporting	Biodiversity
Food, Water, Fiber, Fuel	Climate, Flood, Disease, Water	Aesthetic, Spiritual, Educational, Recreational	Nutrient cycling, soil formation, primary production	Life on Earth Species Richness

Photo: Mark L. Watson

Photo by Mike Alm

Photo by BISON-M
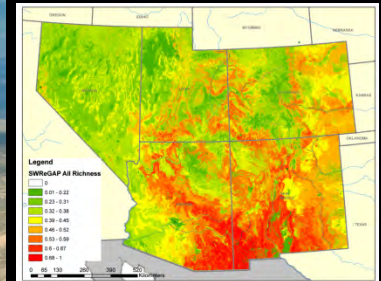
USGS Gap Analysis Program
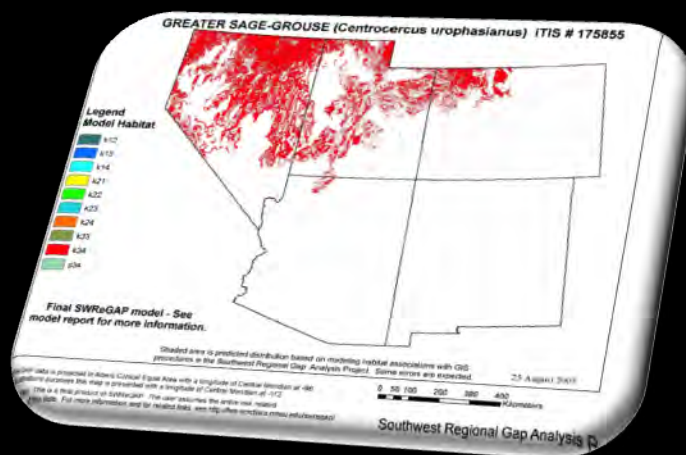# Products and Data - Southwest Region

Deductive Terrestrial Vertebrate Habitat Models (**817 spp**)

- Knowledge based/expert based
- Wildlife Habitat Relationships
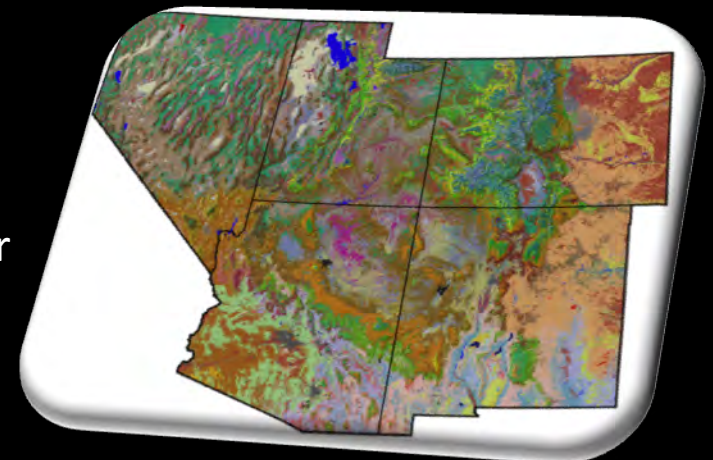- Habitat based
- Top down - general to specific

Habitat Models

Land Ownership/Stewardship

Land Cover

20 Biodiversity Metrics
(Boykin et al. 2013)

All Species - 817 species

Legend
SWReGAP All Richness
- 0
- 0.01 - 0.22
- 0.23 - 0.31
- 0.32 - 0.38
- 0.39 - 0.45
- 0.46 - 0.52
- 0.53 - 0.59
- 0.6 - 0.67
- 0.68 - 1

0 65 130   260   390   520
                                    Kilometers

Photo by Jason Bak

Total Vertebrate Species
- Reptiles
- Amphibians
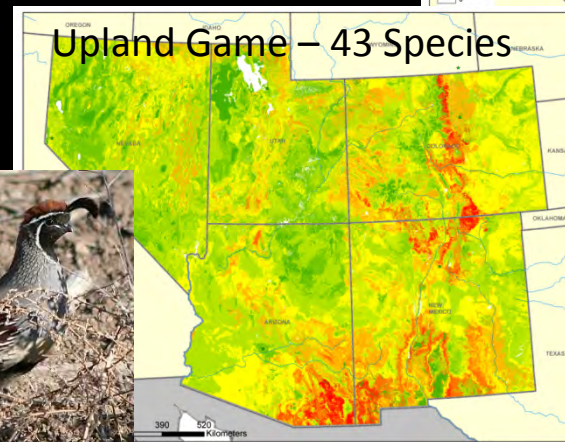- Birds
- Mammals
- Bats

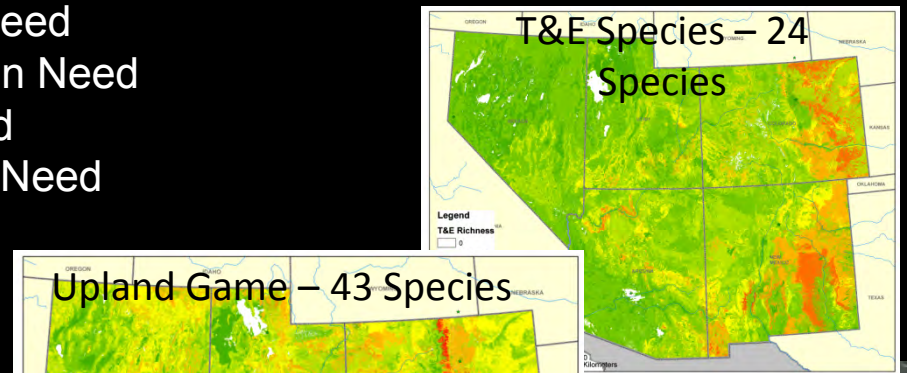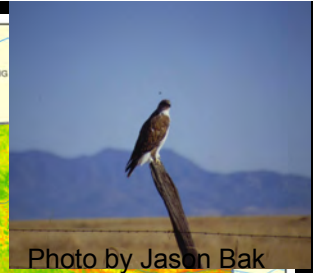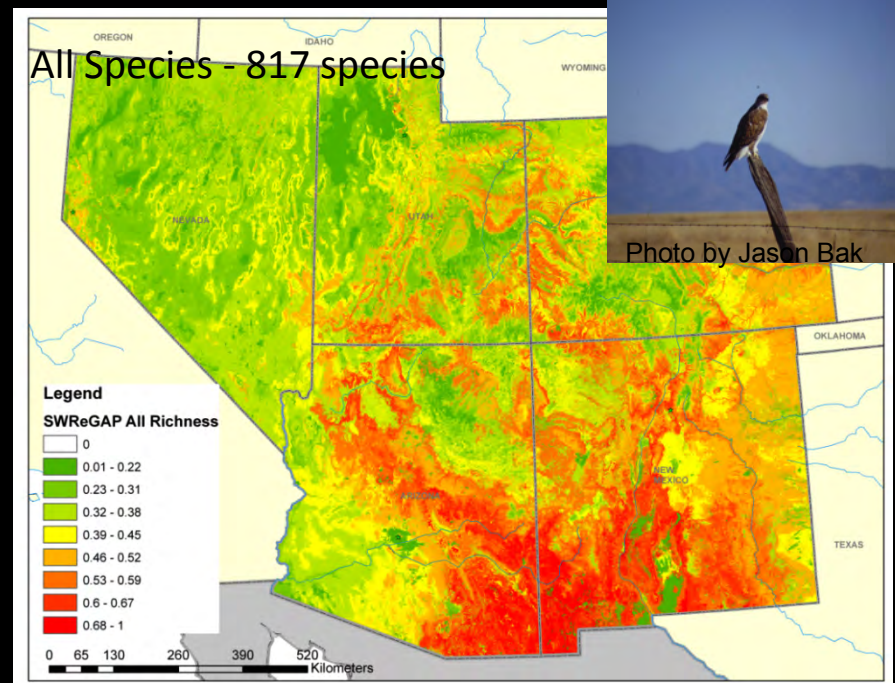*Threatened and Endangered Species*

Total Species of Greatest Conservation Need
- Reptile Species of Greatest Conservation Need
- Amphibian Species of Greatest Conservation Need
- Bird Species of Greatest Conservation Need
- Mammal Species of Greatest Conservation Need
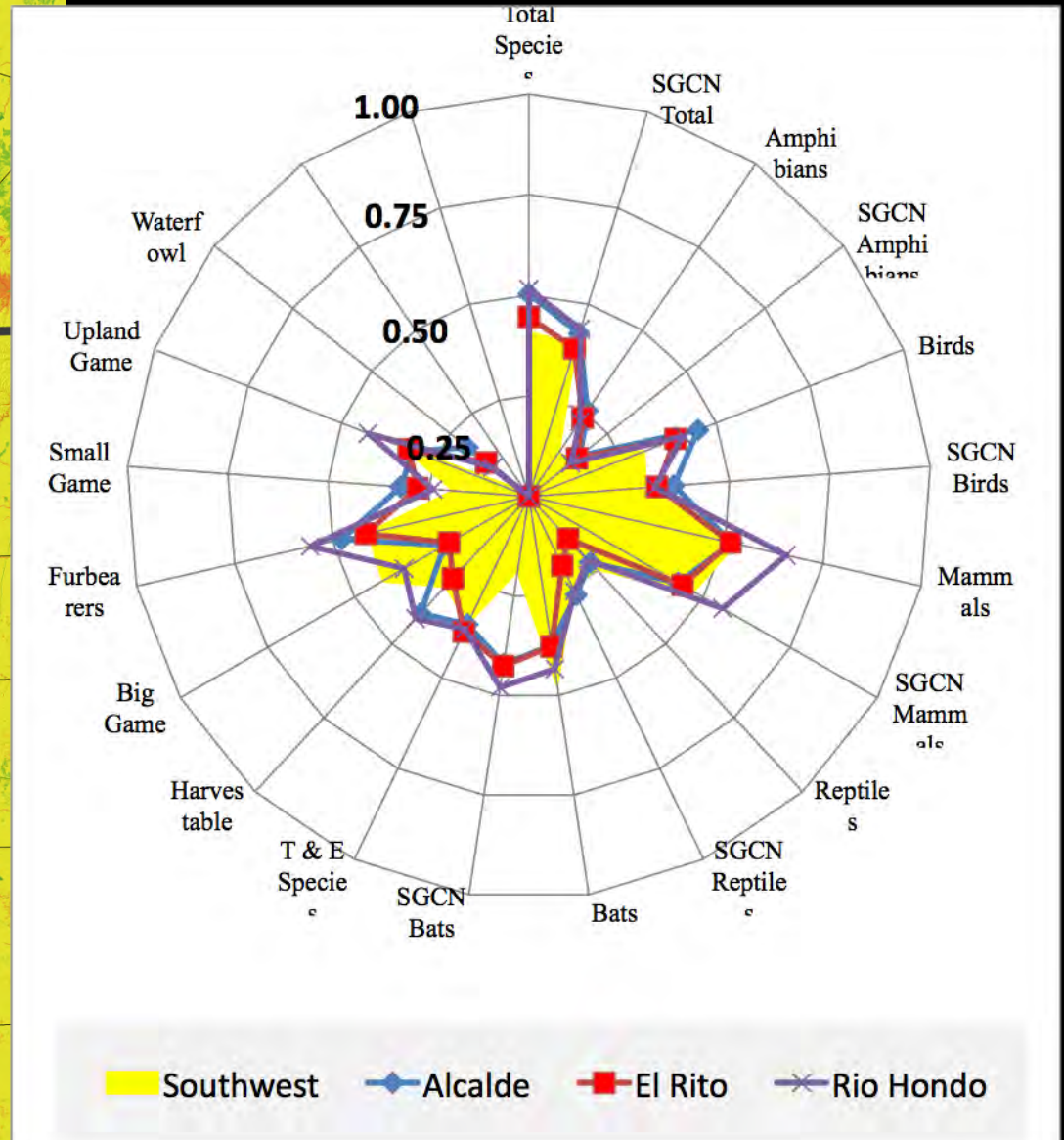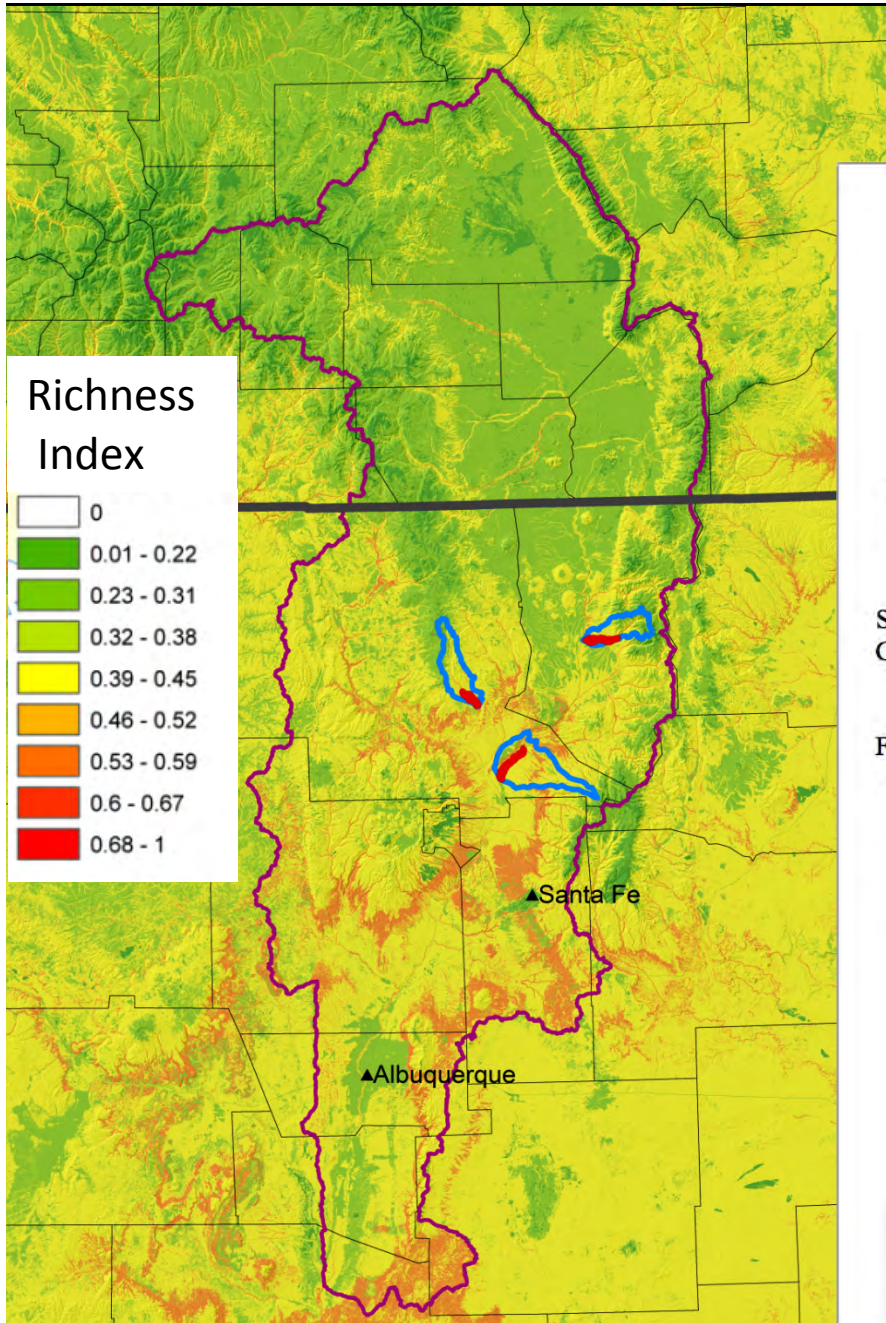- Bat Species of Greatest Conservation Need

Total Harvestable Species
- Harvestable Upland Game Species
- Harvestable Big Game species
- Harvestable Small Game Species
- Harvestable Furbearer Species
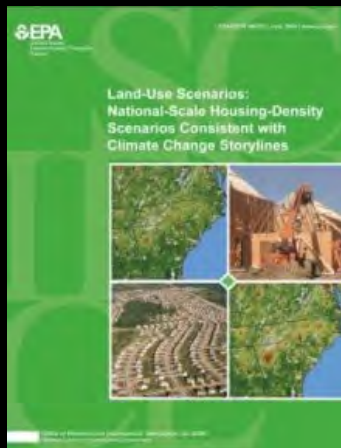- Harvestable Waterfowl Species

Ecosystem Diversity

T&E Species – 24 Species

Legend
T&E Richness
0

Upland Game – 43 Species

Photo: Mark L. Watson

Radar Graph

Richness Index

	0
	0.01 - 0.22
	0.23 - 0.31
	0.32 - 0.38
	0.39 - 0.45
	0.46 - 0.52
	0.53 - 0.59
	0.6 - 0.67
	0.68 - 1

▲Santa Fe

▲Albuquerque

Total Species
SGCN Total
Amphibians
SGCN Amphibians
Birds
SGCN Birds
Mammals
SGCN Mammals
Reptiles
SGCN Reptiles
Bats
SGCN Bats
T & E Species
Harvestable
Big Game
Furbearers
Small Game
Upland Game
Waterfowl

1.00
0.75
0.50
0.25

Southwest   Alcalde   El Rito   Rio Hondo

Average Index Value
Average of each mapped pixel value in study area /highest mapped pixel value in area.
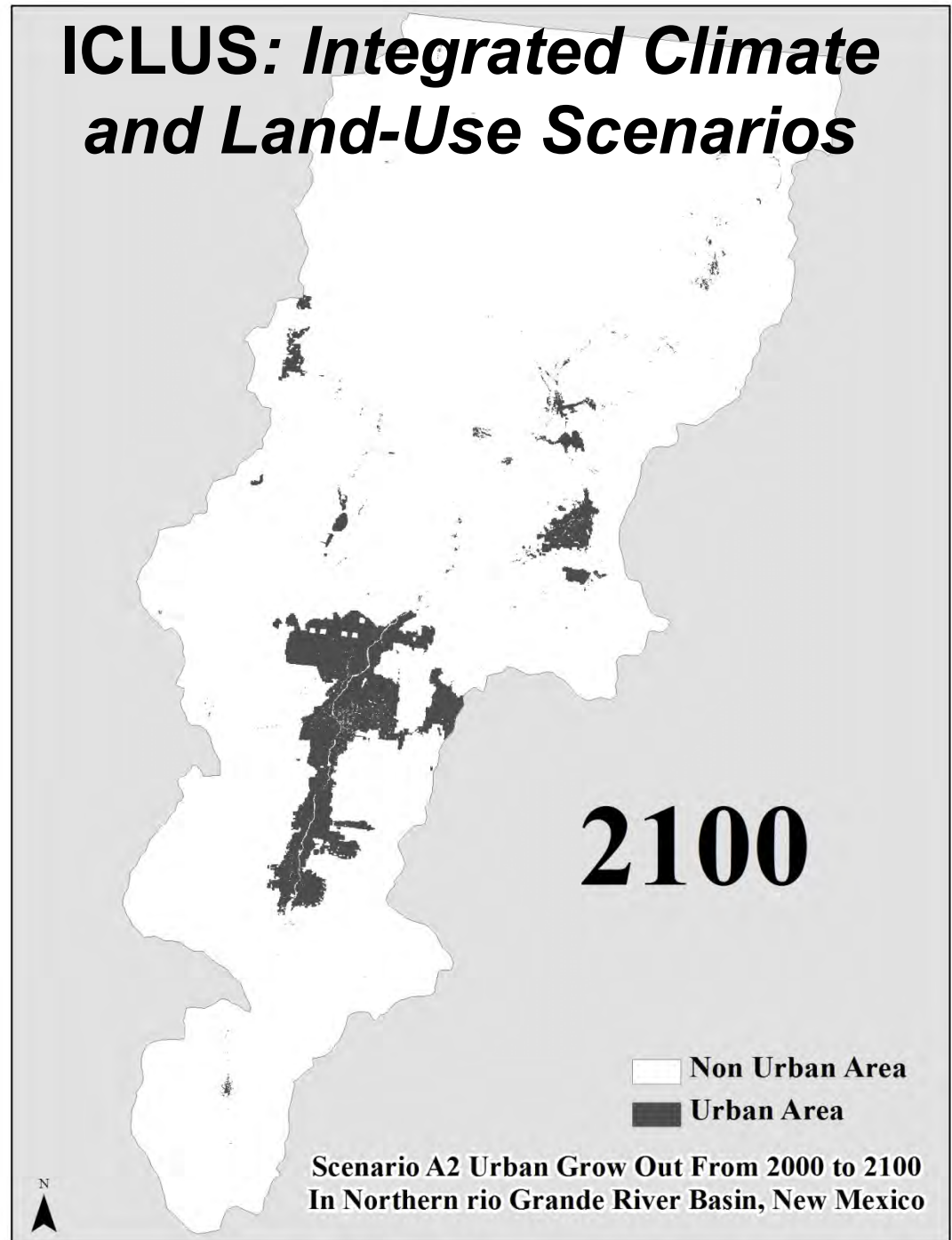
- Provides seamless land use scenarios for the **conterminous United States** consistent with IPCC emission storylines.

- Demography and population at county level

- Housing density allocated at 1 ha resolution
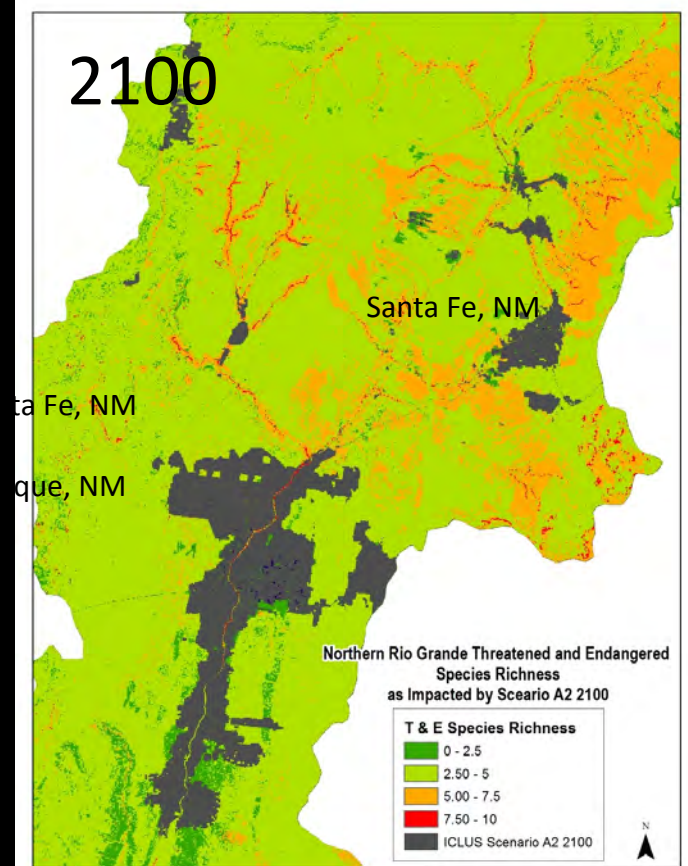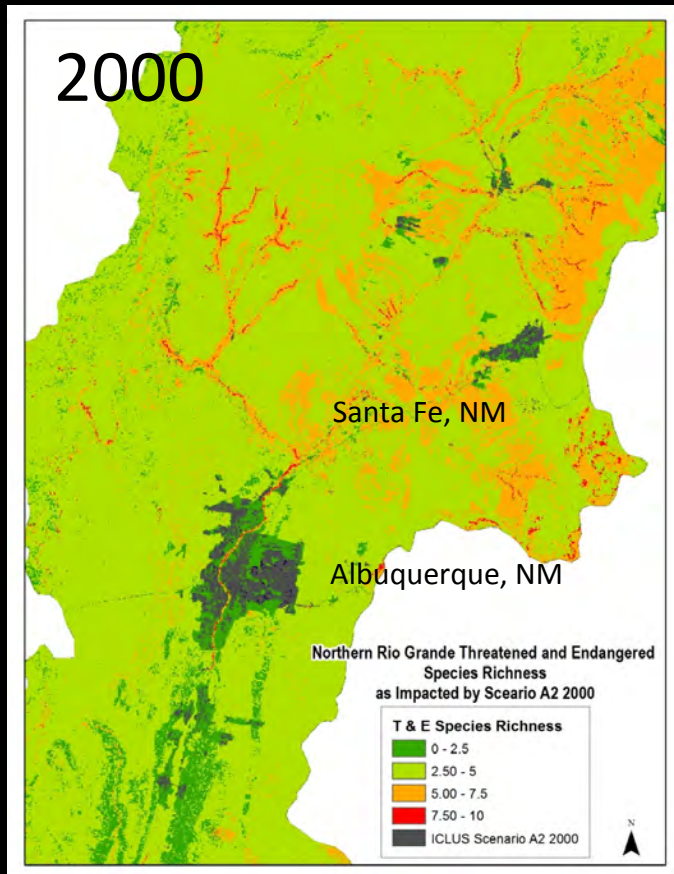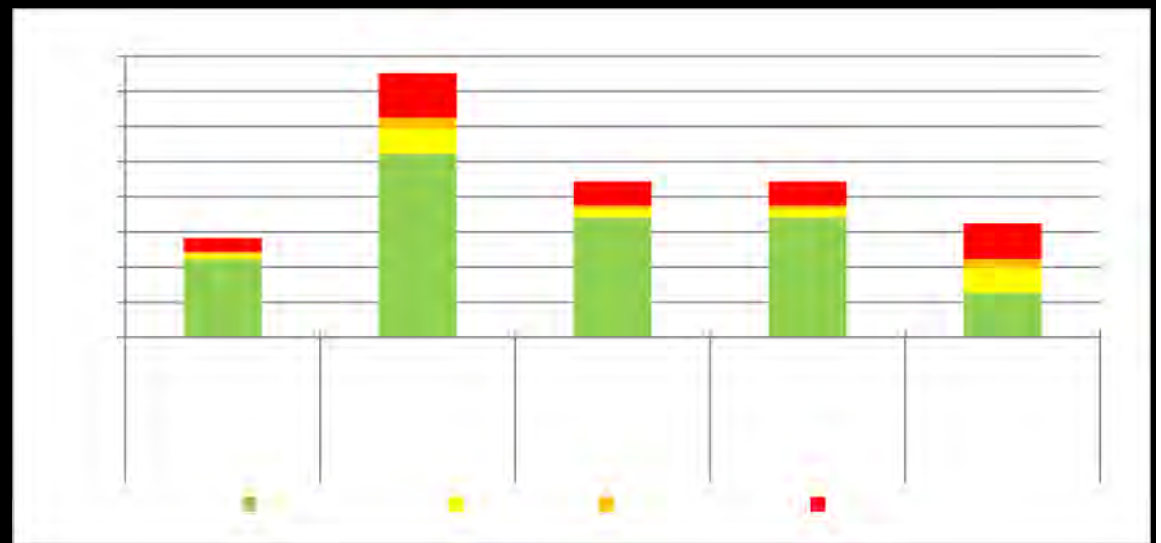- Estimated % impervious surface at 1 km² resolution

(EPA Global Change Research Program EPA/600/R-08/076F June 2009)

ICLUS*: Integrated Climate and Land-Use Scenarios*

2100

☐ Non Urban Area
■ Urban Area

Scenario A2 Urban Grow Out From 2000 to 2100 In Northern rio Grande River Basin, New Mexico
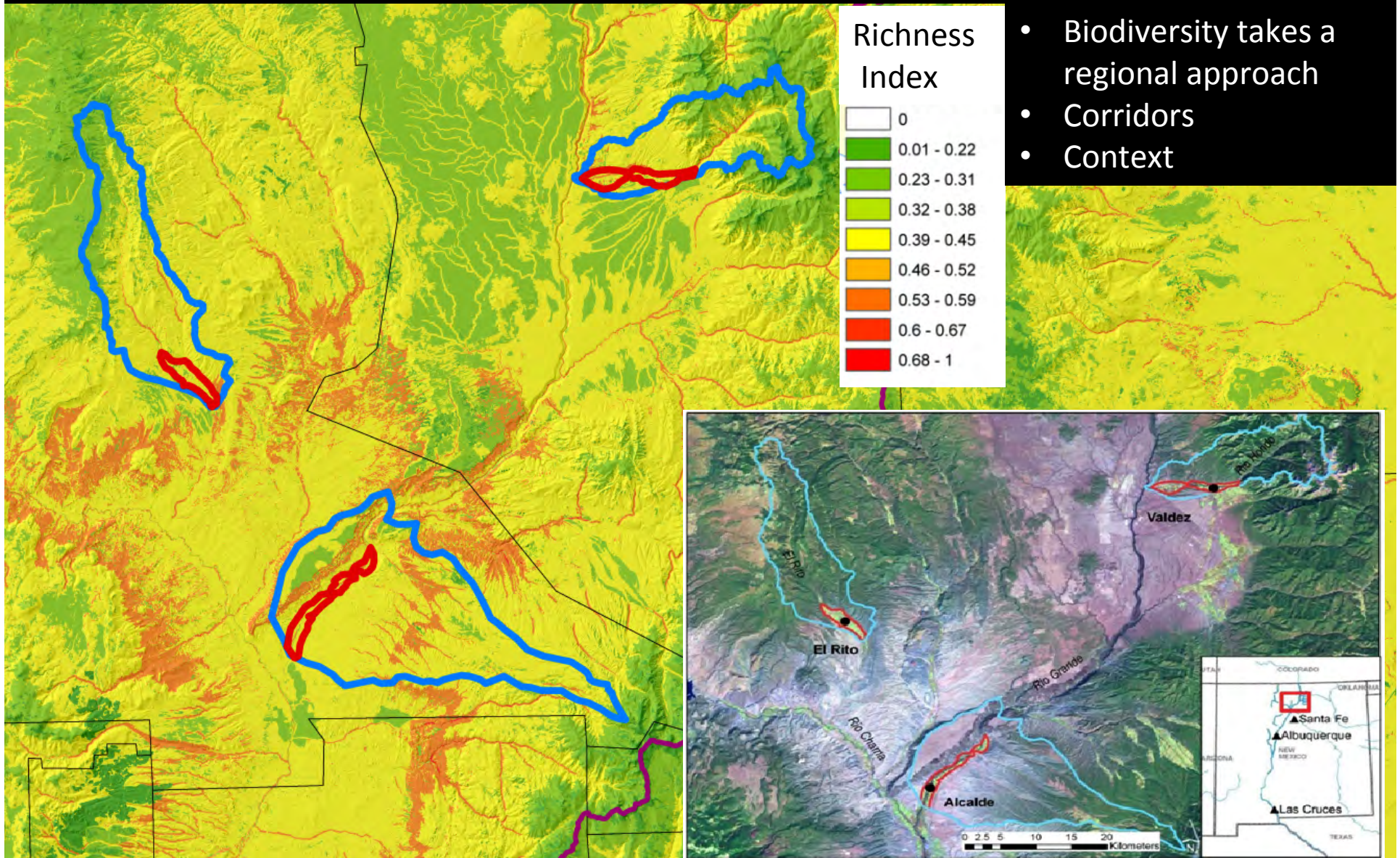
N

Total Threatened and Endangered Species Richness as Affected by Scenario A2

Across Scales

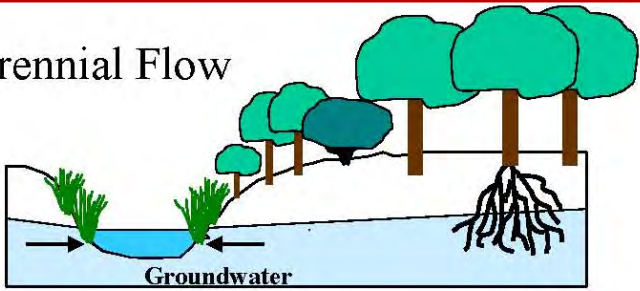## Alcalde, Rio Hondo, and El Rito Watersheds, New Mexico

Richness Index

☐	0
■	0.01 - 0.22
■	0.23 - 0.31
■	0.32 - 0.38
■	0.39 - 0.45
■	0.46 - 0.52
■	0.53 - 0.59
■	0.6 - 0.67
■	0.68 - 1

- Biodiversity takes a regional approach
- Corridors
- Context

Ecosystem Component:
Coupled Natural and Human Systems Project

Perennial Flow

Groundwater

Intermittent Flow

Groundwater

Ephemeral Flow

Groundwater

Groundwater Decline

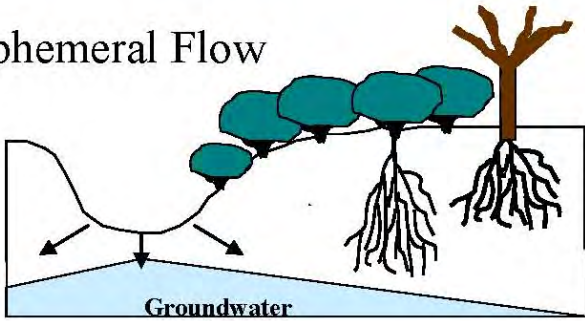*Tamarix*   *Populus* or *Salix*   Riverine marsh
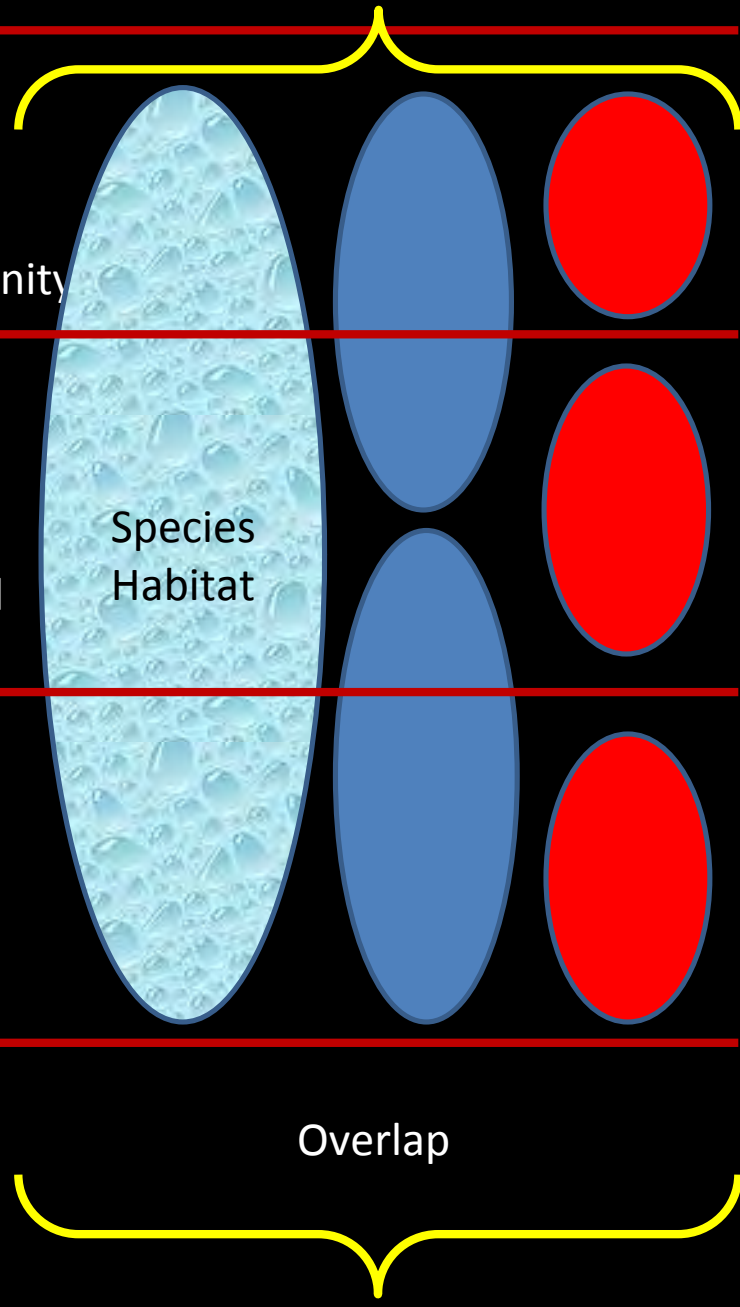
Figure from Brand et. al (2010)
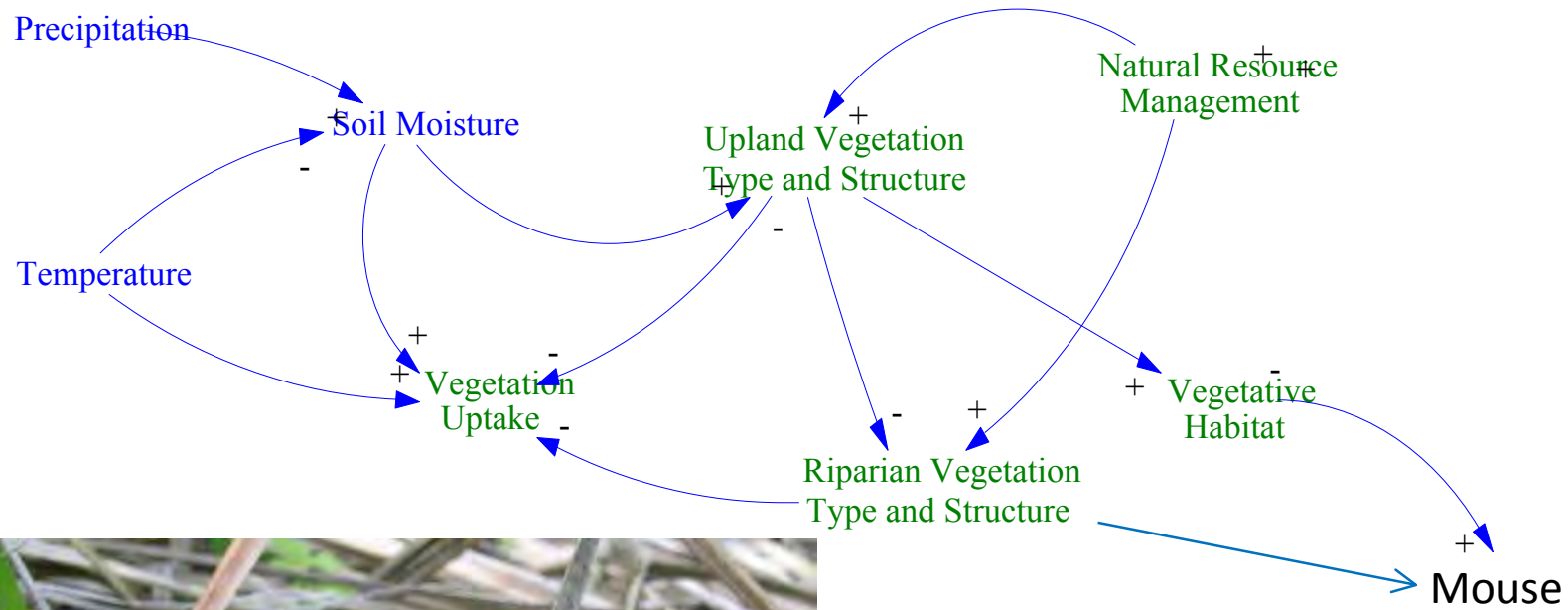
Mesic Riparian Faunal Community

Intermediate Riparian Faunal Community

Xeric Riparian Faunal Community

Species Habitat

Overlap

New Mexico meadow jumping mouse
(*Zapus hudsonius luteus*)

Precipitation

Temperature

Soil Moisture

Upland Vegetation Type and Structure

Natural Resource Management

Vegetation Uptake

Riparian Vegetation Type and Structure

Vegetative Habitat

Mouse

Current Perspectives

- USGS Gap Analysis Program data provides the regional perspective on wildlife, biodiversity, and related ecosystem services
- ICLUS provides the regional perspective on climate change and urban grow-out
- Systems Dynamic Model provides the information necessary at fine scales.
- What ecosystem services do acequias provide for wildlife?

Acknowledgements

EPA
Britta Bierwagen

Philip Morefield

NSF Team
Sam Fernald

CNH Team Members

CASE, NMSU
Forrest East

Darin Kopp

Rachel Guy

Concurrent Projects

- *Mapping Biodiversity Metrics at Multiple Scales*

- *Developing Spatially Explicit Biodiversity Metrics in Support of CEAP: A Focus on Wildlife*
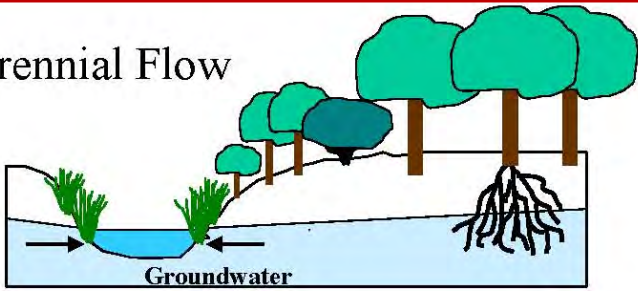
Center for Applied Spatial Ecology
New Mexico Cooperative Fish and Wildlife Research Unit
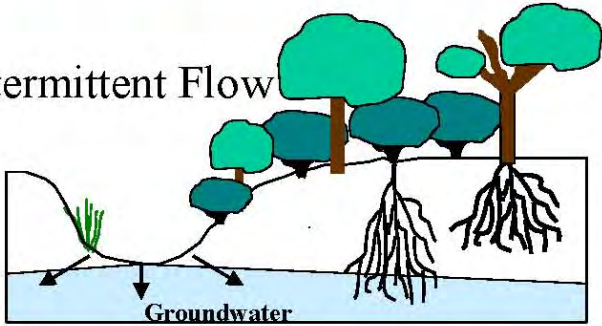**Department of Fish, Wildlife, and Conservation Ecology**
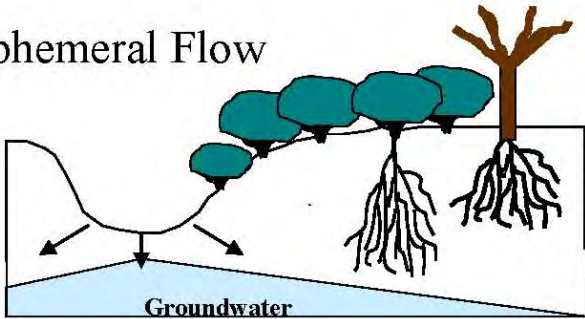**New Mexico State University**

Regional Study Area
Upper Rio Grande River
Basin
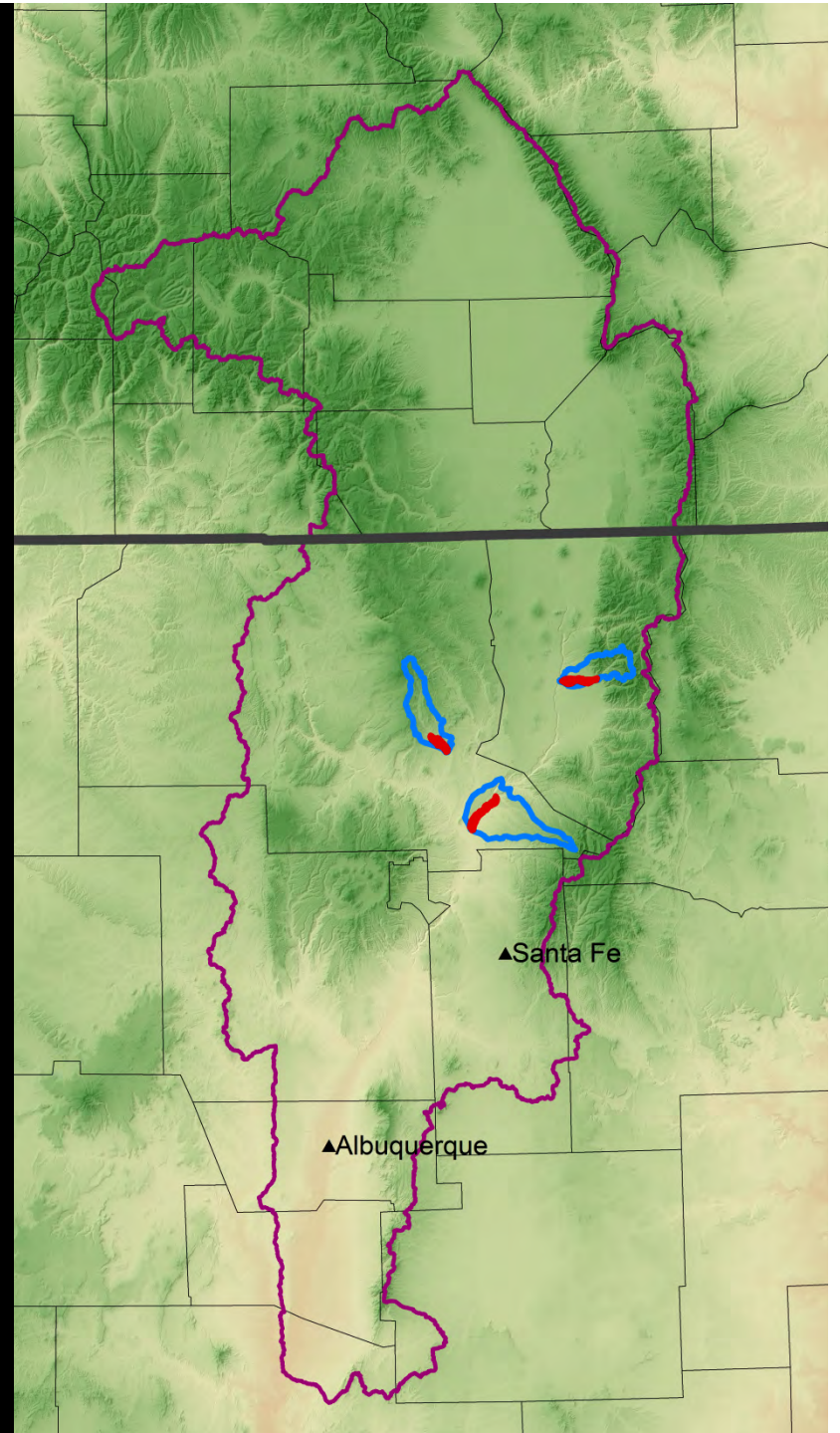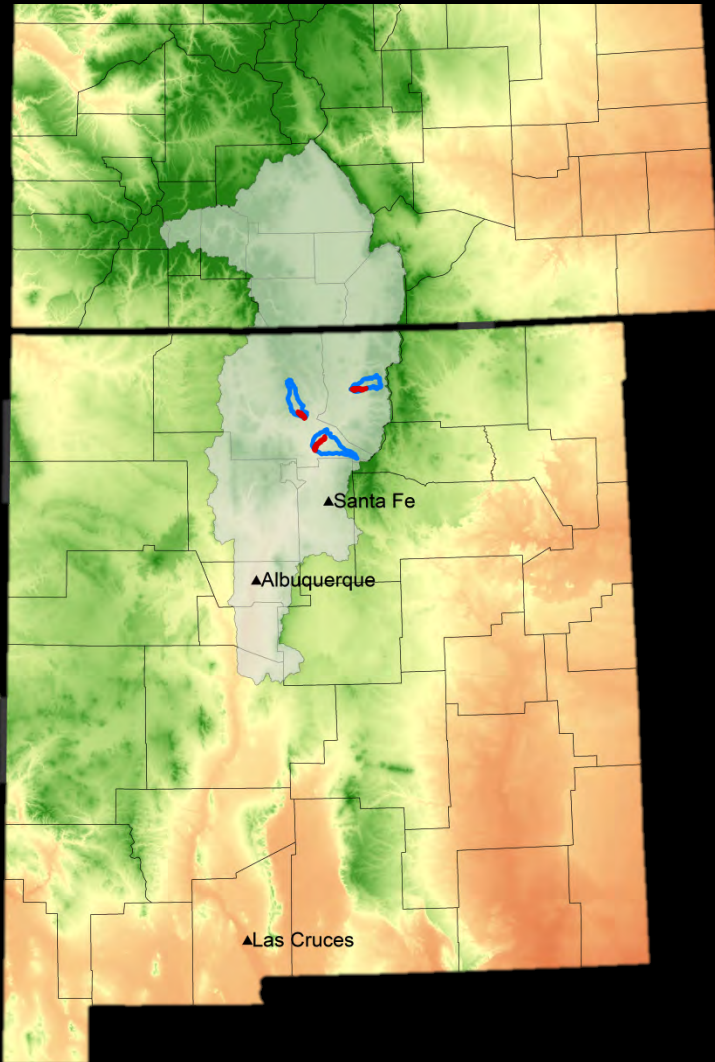
Perennial Flow

Intermittent Flow

Ephemeral Flow

Groundwater

Groundwater Decline

Tamarix   Populus or Salix   Riverine marsh

Figure from Brand et. al (2010)

Mesic Riparian Faunal Community

Intermediate Riparian Faunal Community

Xeric Riparian Faunal Community

Overlap