

MAPPING BIODIVERSITY METRICS REPRESENTING ECOSYSTEM SERVICES AT THE LANDSCAPE SCALE IN THE AMERICAN SOUTHWEST

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CASE

Center for Applied
Spatial Ecology



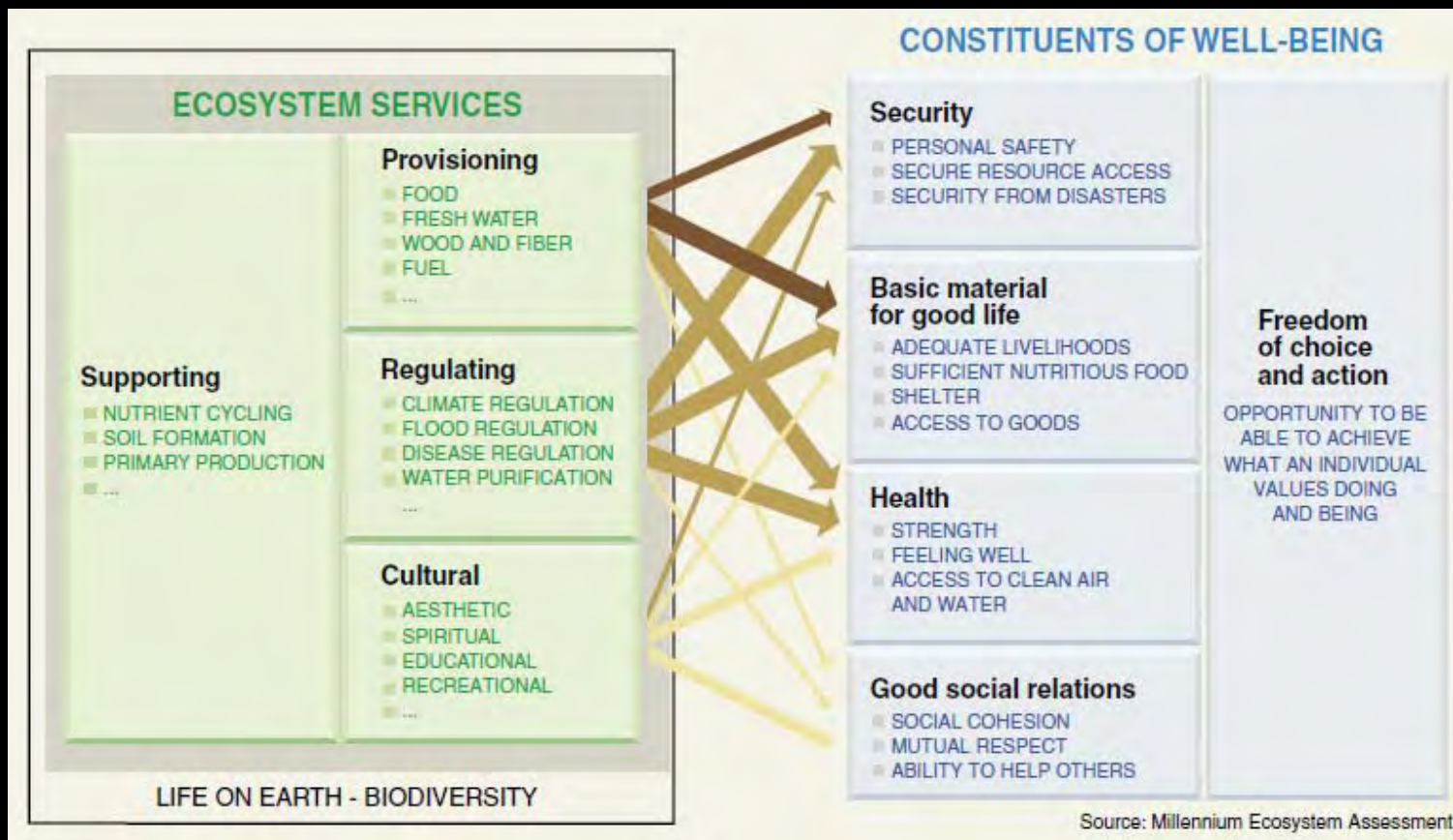
KEEPING COMMON SPECIES COMMON



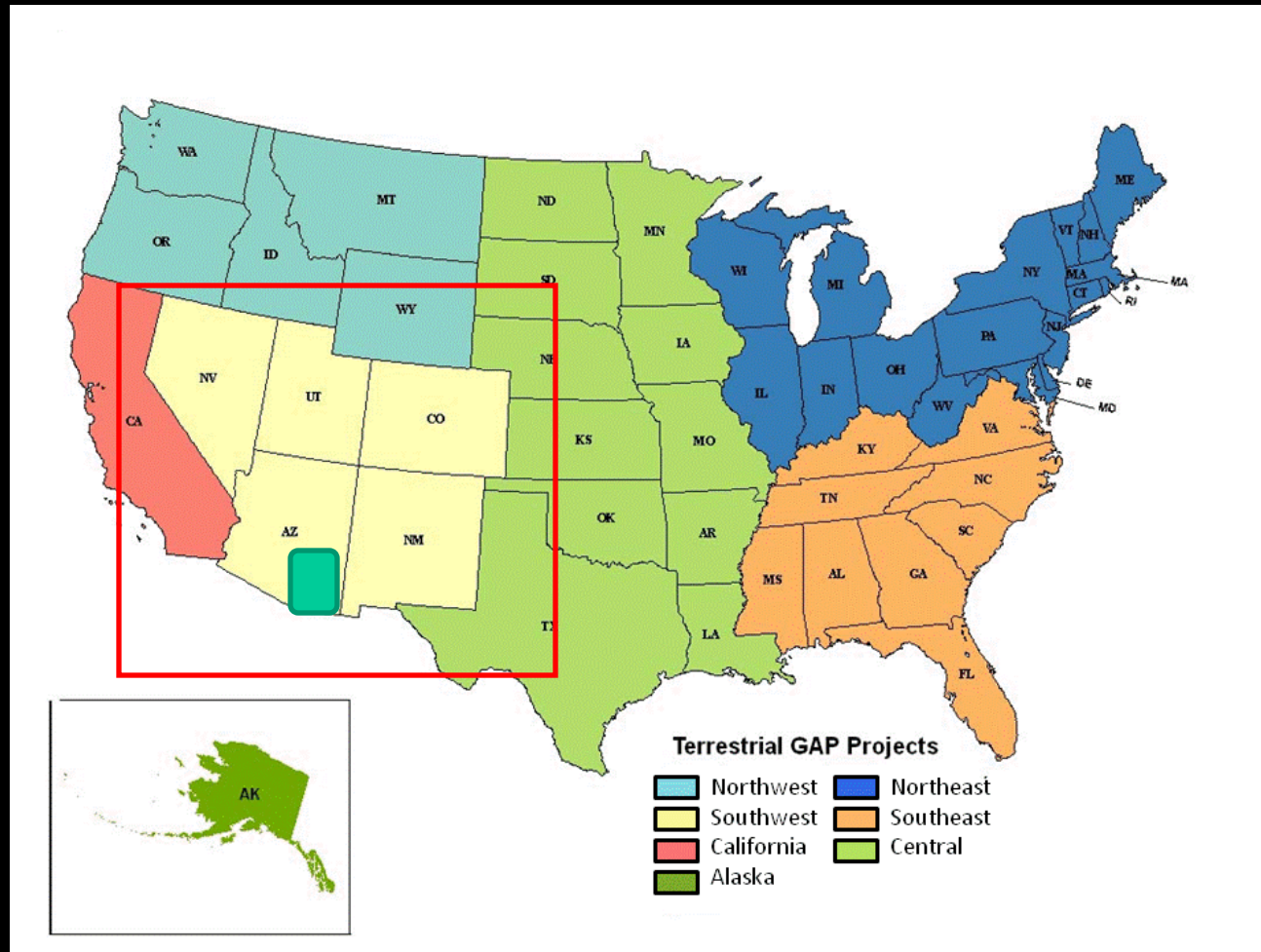
Photo by Adriel Heisey

Ecosystem Services

- The benefits humans derive from ecosystems (MEA 2005)
- *Provisioning services* such as food, water, timber, habitat, and fiber
- *Regulating services* that affect climate, floods, disease, wastes, and water quality
- *Cultural services* that provide recreational, aesthetic, and spiritual benefits
- *Supporting services* such as soil formation, photosynthesis, and nutrient cycling



Scaling of Services

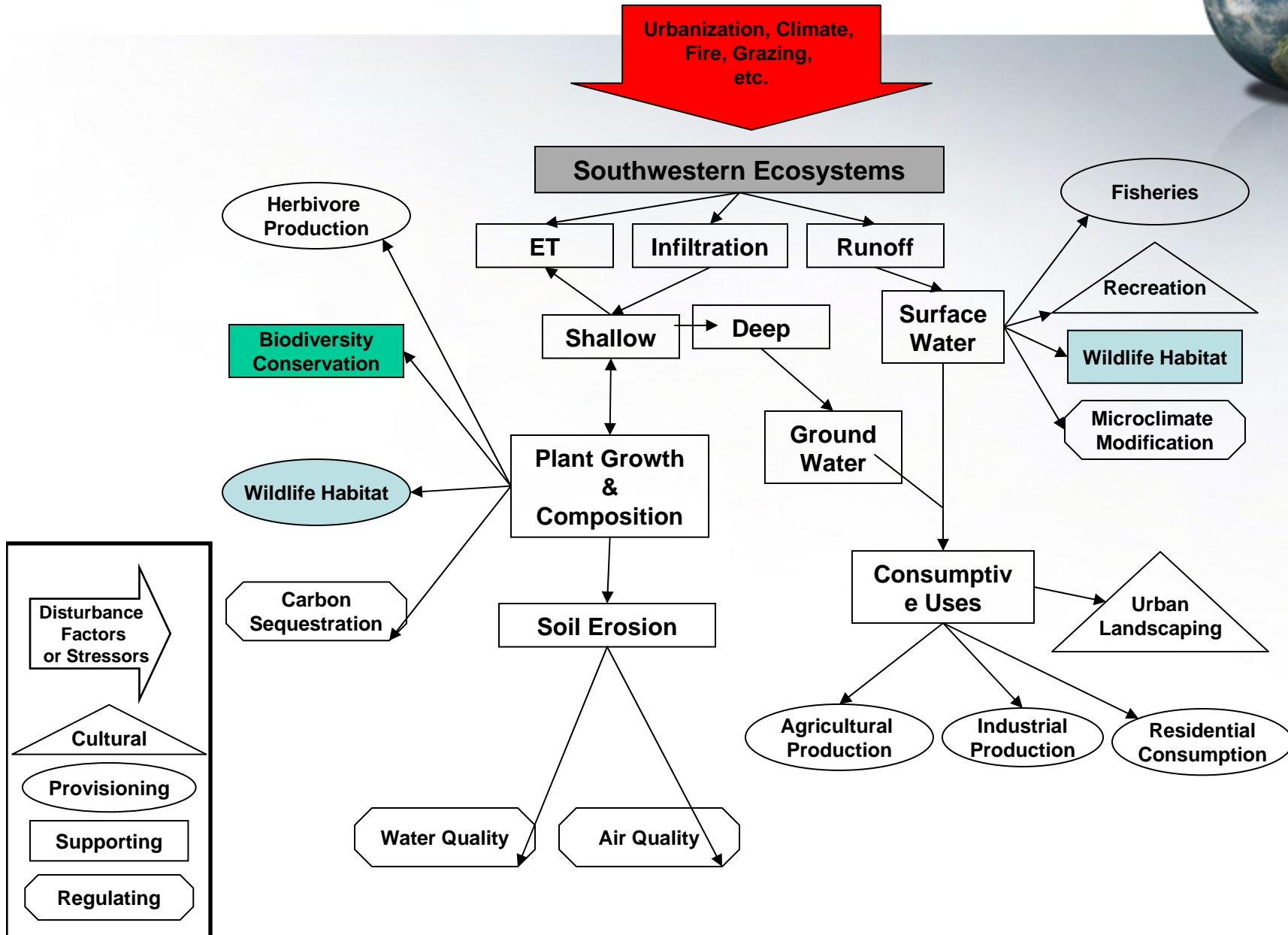


Objective

Develop and produce maps of an ecosystem service (e.g., habitat provisioning...a surrogate measure of biodiversity) based on current condition and available data for the a U.S./Mexico borderland watershed, The American Southwest and the Nation.

General Conceptual Model

(based on Havstad et al., 2007)





Short Term Biodiversity Metrics

Quick Biodiversity Metrics

Species Richness
Taxon Richness
T&E Richness
Harvestable Species
Ecosystem Diversity

Long Term Biodiversity Metrics

Species Richness
Taxon Richness
T&E Richness
Harvestable Species
Assemblage Richness
Ecosystem Diversity
Resiliency
Redundancy
Representation
Additional Indices

Local
San Pedro

San Pedro Land
Cover

GAP Habitat Models

National Land Cover

Southwest

National Land Cover

Regional GAP Habitat
Models

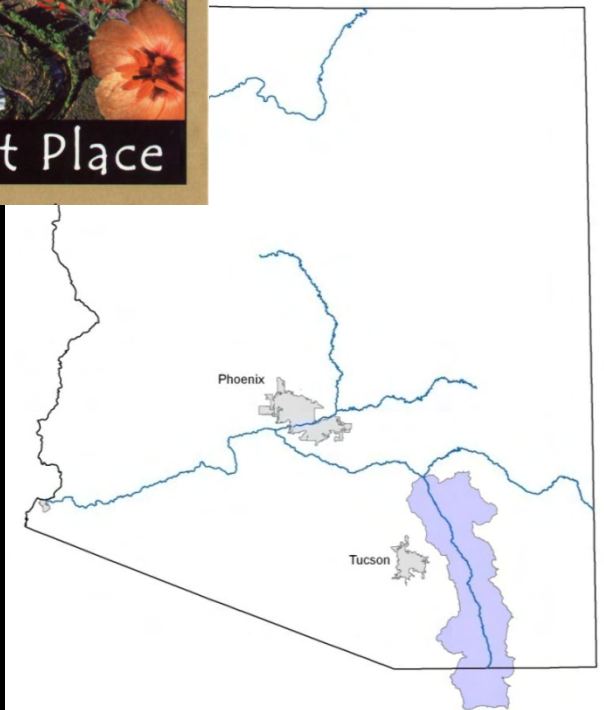
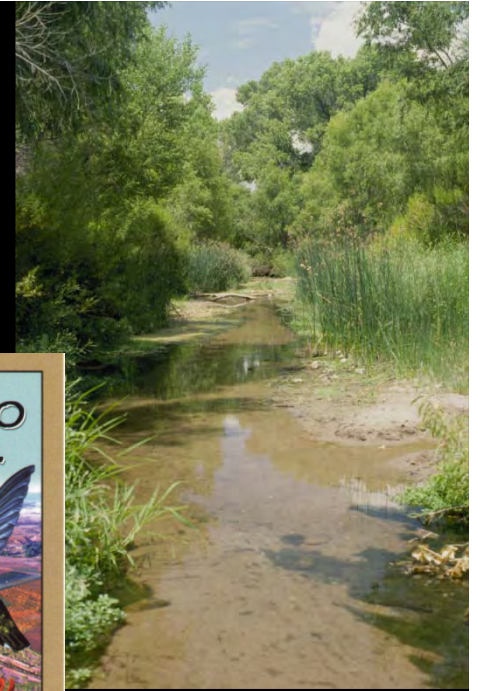
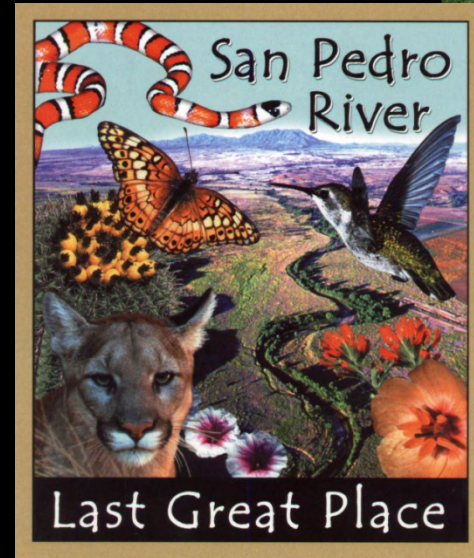
Nation

National Land Cover

National GAP
Habitat Models

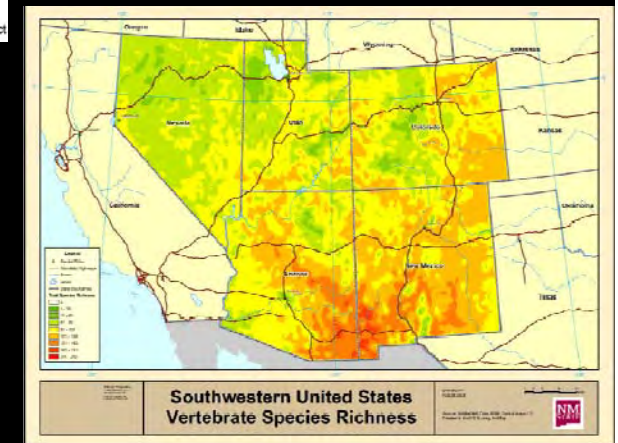
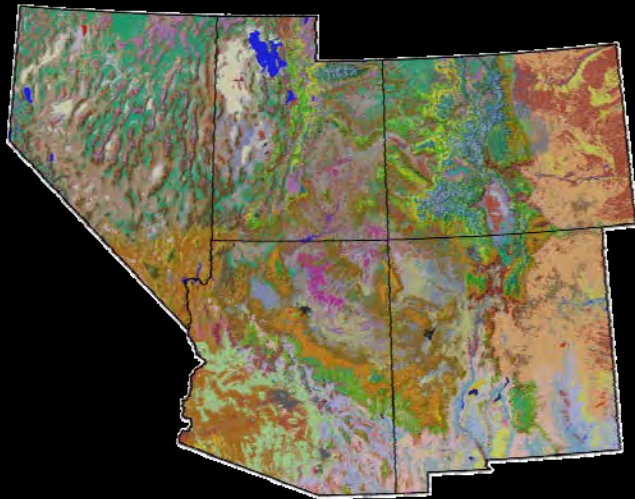
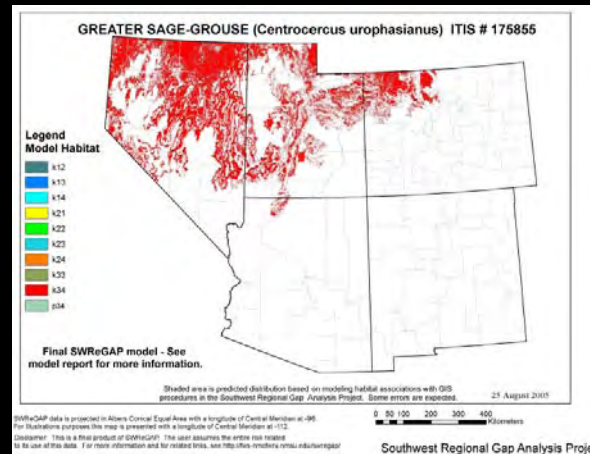
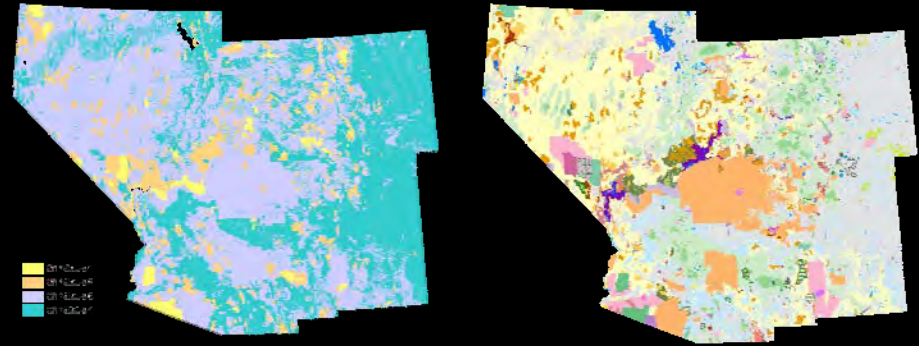
San Pedro River Basin

- One of world's eight Last Great Places (TNC) – 6 preserves
- Most Endangered River System (American Rivers)
- First designated Globally Important Bird Area in U.S. (American Bird Conservancy)
- First designated National Riparian Conservation Area by Congress (1988)
- First application of environmental law accords (Article 14 of NAAEC) against the U.S. (NEPA and ESA)
- AGAVES (Assessment of Goods and Valuation of Ecosystem Services)



Southwest Regional Gap Analysis Project

- Land cover dataset
- Terrestrial vertebrate models
- Land stewardship
- Gap analysis



Variables Used for Deductive Habitat Modeling (SWReGAP)

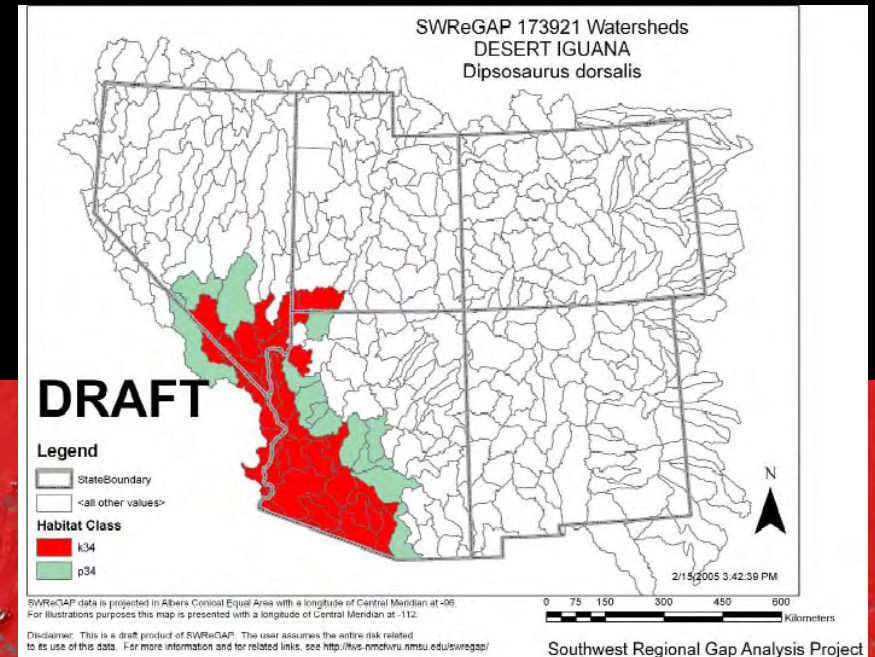
n = 817 spp

Range Delineation

- Hydrologic Unit (8-digit)

Habitat Variables

- **Land Cover**
- Elevation (min/max)
- Slope/Aspect
- Hydrology (Proximity)
 - Streams, lakes, springs
- Soils (STATSGO)
- Landform
- Patch Size



Examples of applications – working with and informing the NVC

Upper		
Level 1 – Formation Class (NLCD)	Shrublands and Grasslands	
Level 2 – Formation Subclass	Temperate and Boreal Shrubland and Grassland	U.S. Army Corps of Engineers – Stewardship (FGDC 1997)
Level 3 - Formation	Temperate Shrubland and Grassland	U.S. Army Corps of Engineers & EPA - Mitigation EPA – National Wetland Condition Assessment, TNC - Conservation Planning (WWF Major Habitat Type)
Mid		
Level 4 – Division	North American Great Plains Grassland and Shrubland	
Level 5 – Macrogroup	Great Plains Tall Grassland and Shrubland	LandFire* (fire modeling), GAP* (habitat modeling) , NE Assoc Fish & Wildlife Agencies (habitat classification)
Level 6 – Group	Great Plains Mesic Tallgrass Prairie	NOAA - Coastal Wetlands (classification), NPS Veg Mapping Program (mapping and classification), USFS FIA Program (classification)
Lower		
Level 7 – Alliance	Wet-mesic Tallgrass Prairie	USFS FIA Program, GAP, NPS Veg Mapping Program, State Heritage Programs (classification, inventory)
Level 8 – Association	Central Wet-mesic Tallgrass Prairie	NPS Veg Mapping Program, State Heritage Programs(classification, inventory)

*Working with Ecological Systems

Ecological Systems

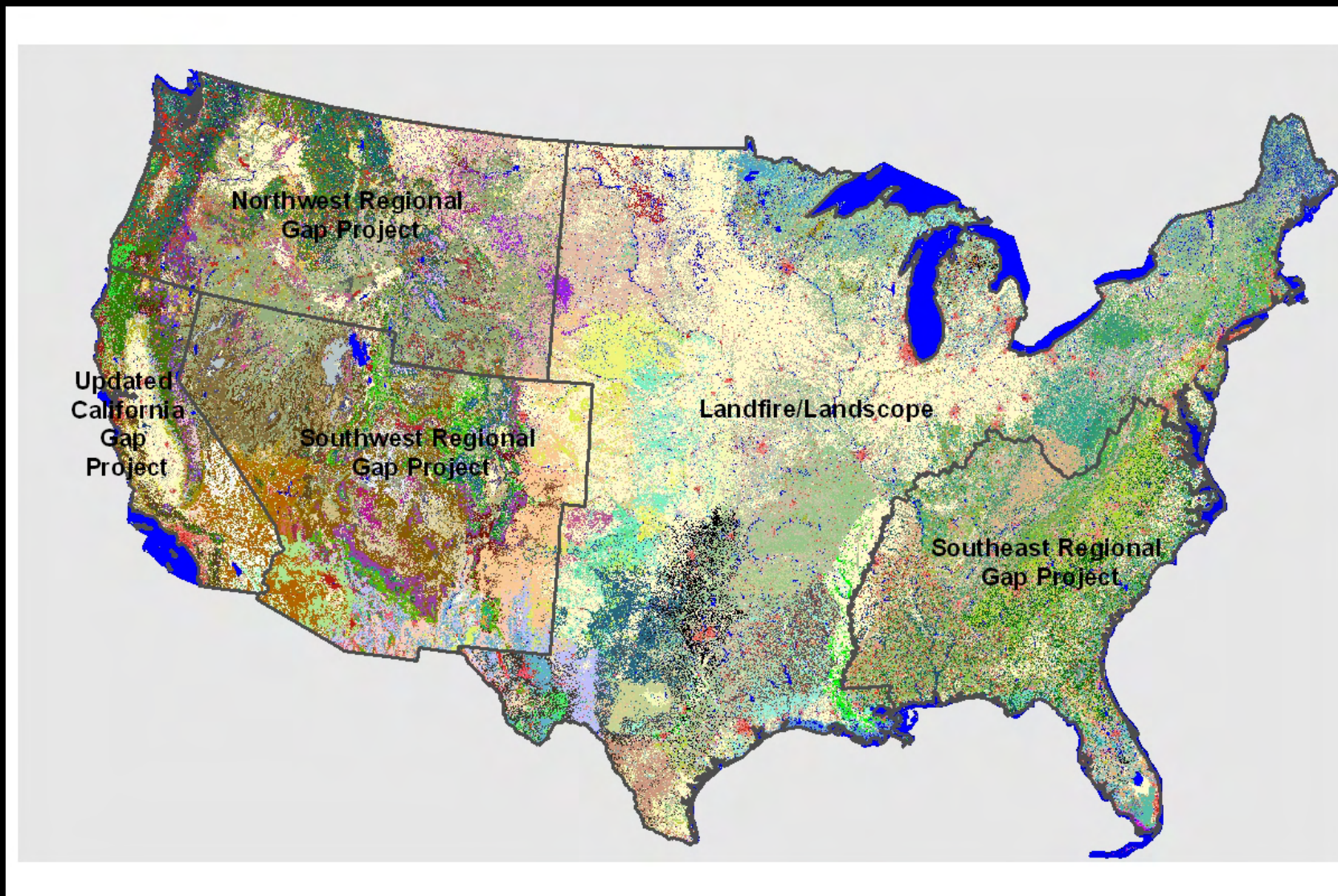
Sonoran Paloverde-Mixed Cacti
Desert Scrub



North American Warm Desert
Riparian Woodland and Shrubland

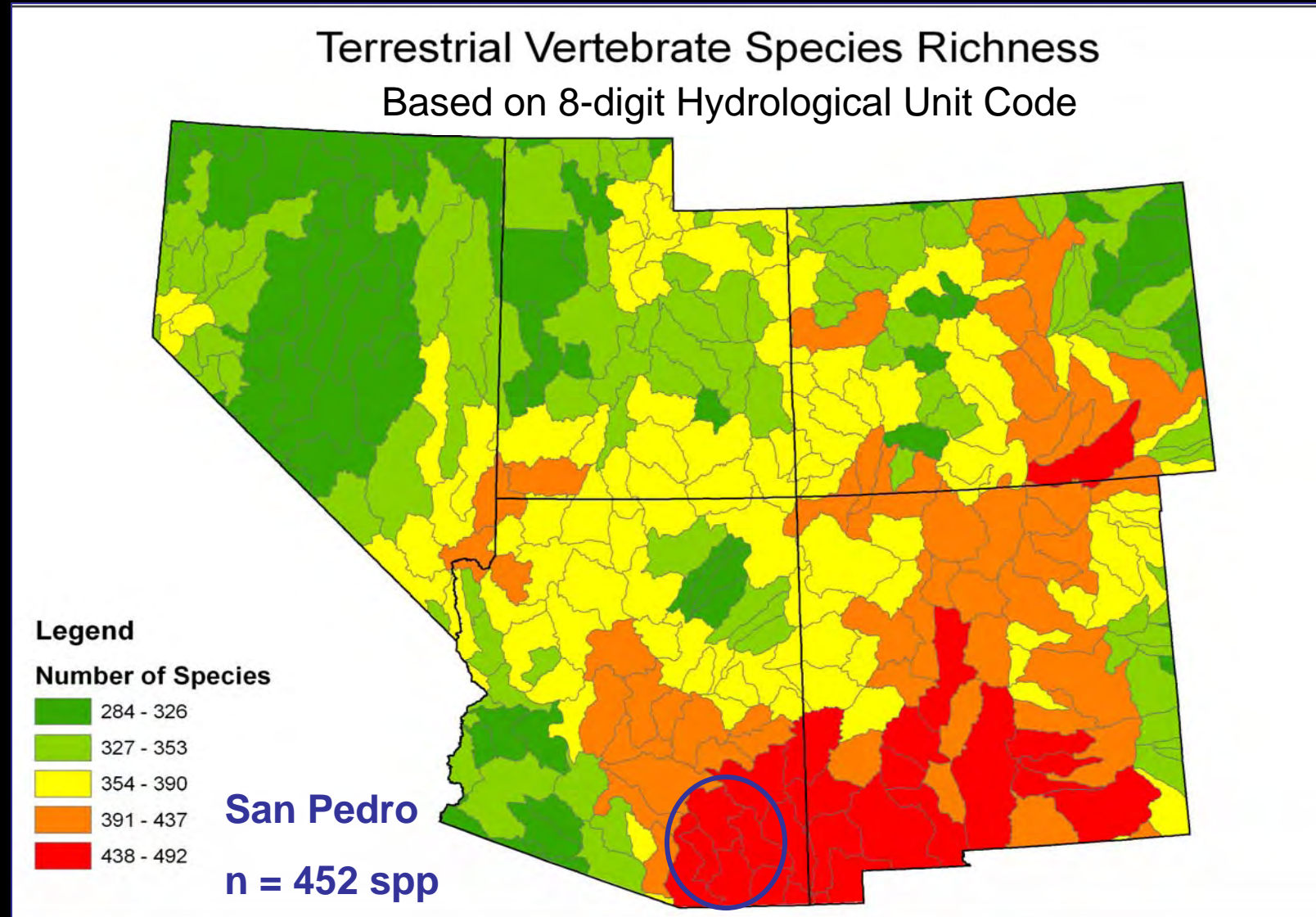
Groups of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, *and/or* environmental gradients (and *spectral characteristics*); Comer et al. 2003.

Sources used in GAP Land cover data

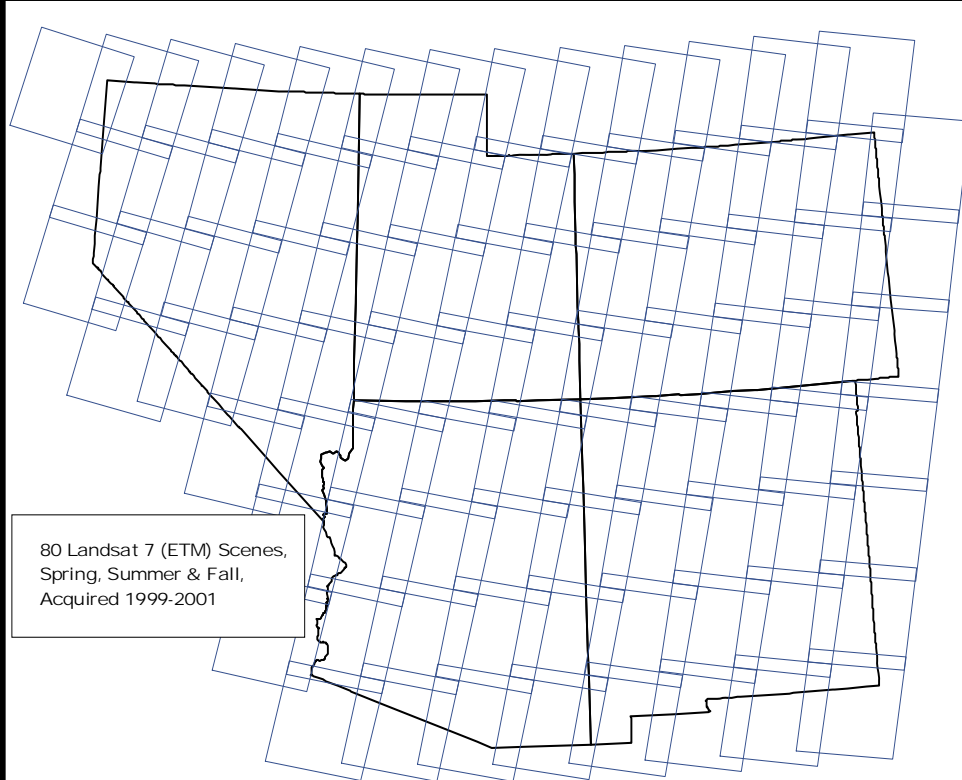


<http://gap.uidaho.edu/Landcover.html>

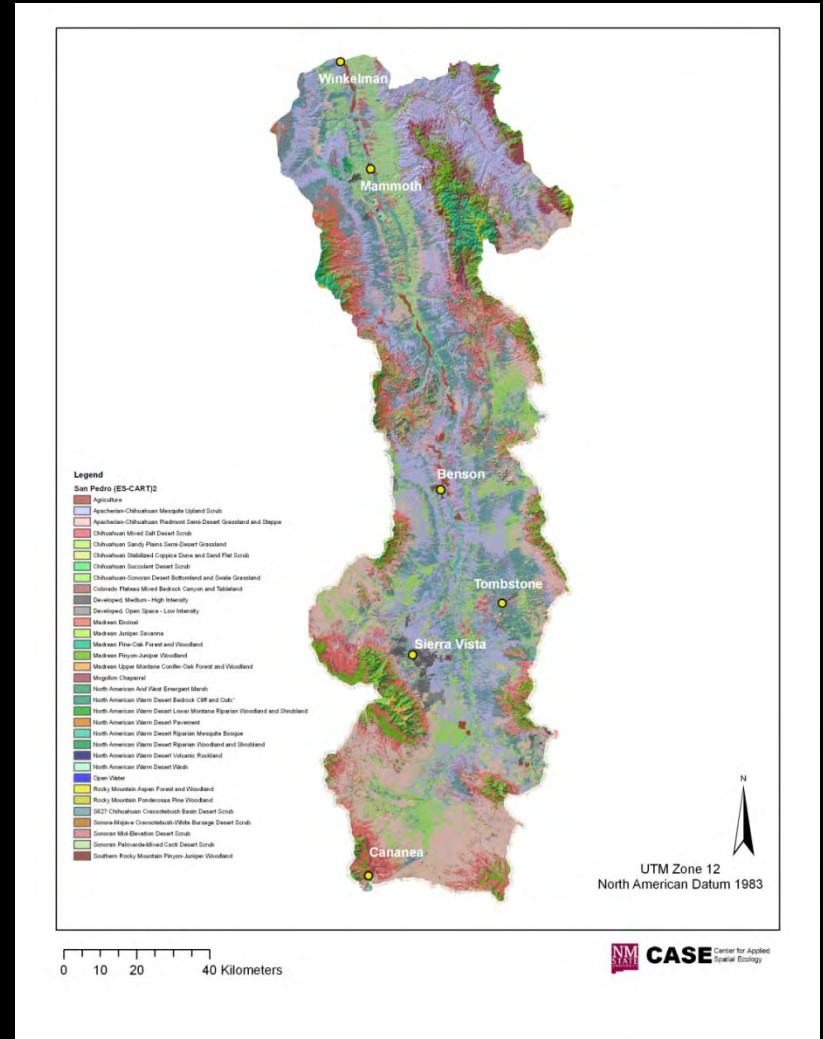
Southwest Terrestrial Vertebrate Richness



San Pedro River Basin Digital Land Cover, U.S./Mexico



Landsat 7- 1999-2001; Spring, Summer & Fall Imagery



Ecological System (SWReGAP)
n = 30 classes

Metrics to Measure Biodiversity

Category

Recreational Hunting

Wildlife –cultural, spiritual,
intrinsic

Biodiversity for its intrinsic value,
ecosystem resilience

Species Composition Intactness

Rarity/scarcity of ecological
systems

Indices of Richness

All Species

Species of Greatest Conservation
Need

Harvestable species

T & E species

Specific Taxon

Radar Graphs

Ecosystem Services

San Pedro
Data

SWReGAP
Data

Metrics

Ecological System
Richness

Endemics

Game Species

Species Richness

SGCN Richness

T&E Species

Bird Richness

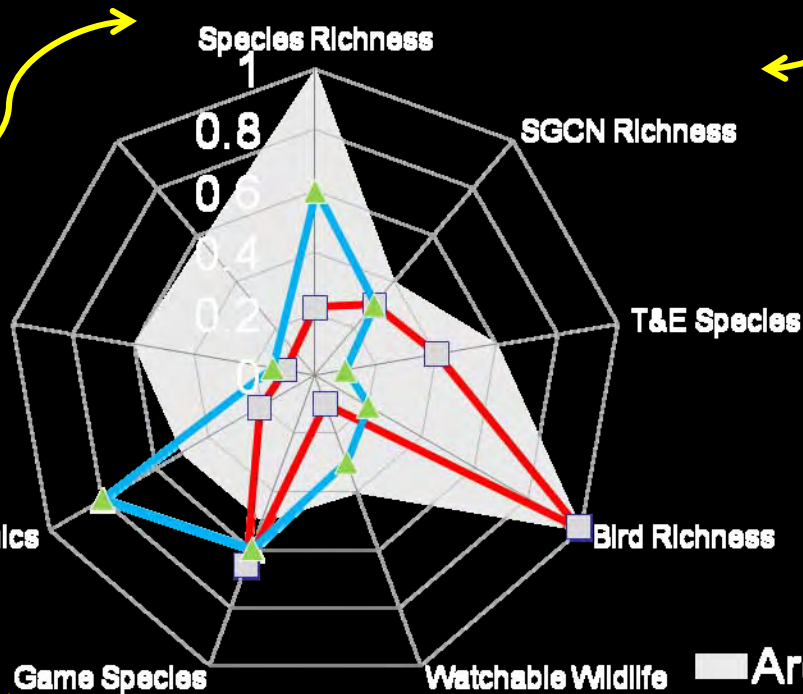
Watchable Wildlife

Area Average

Area 1

Area 2

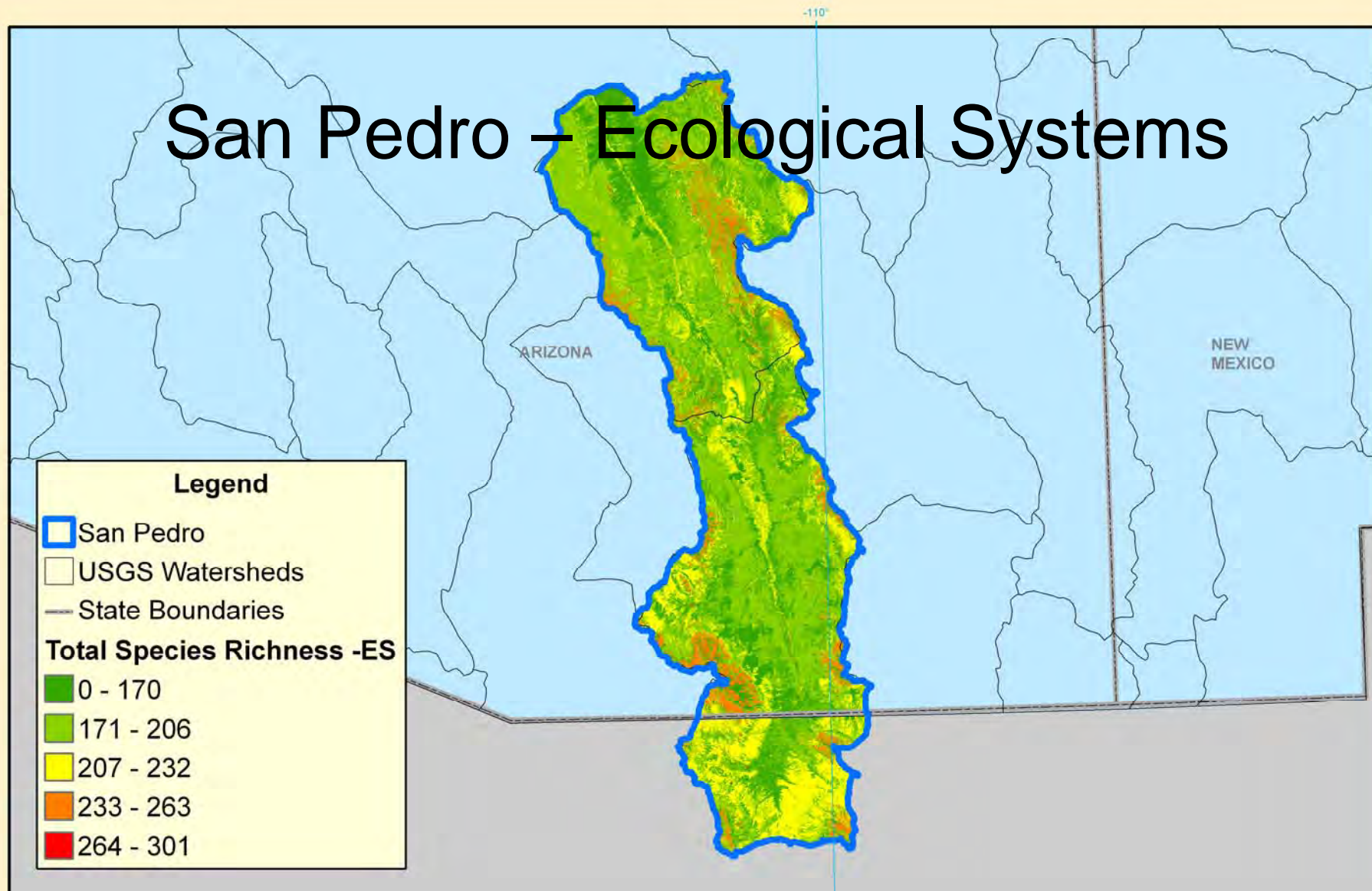
Stakeholder
Input



Metrics (Richness Indices)

Terrestrial Vertebrates	Species of Greatest Conservation Need	Harvestable Species	Ecological Systems
All Species	All Species	Big Game	Richness
Amphibians	Amphibians	Upland Game	
Birds	Birds	Furbearers	
Mammals	Mammals	Waterfowl	
Reptiles	Reptiles		
Bats			
T & E Species			

San Pedro – Ecological Systems

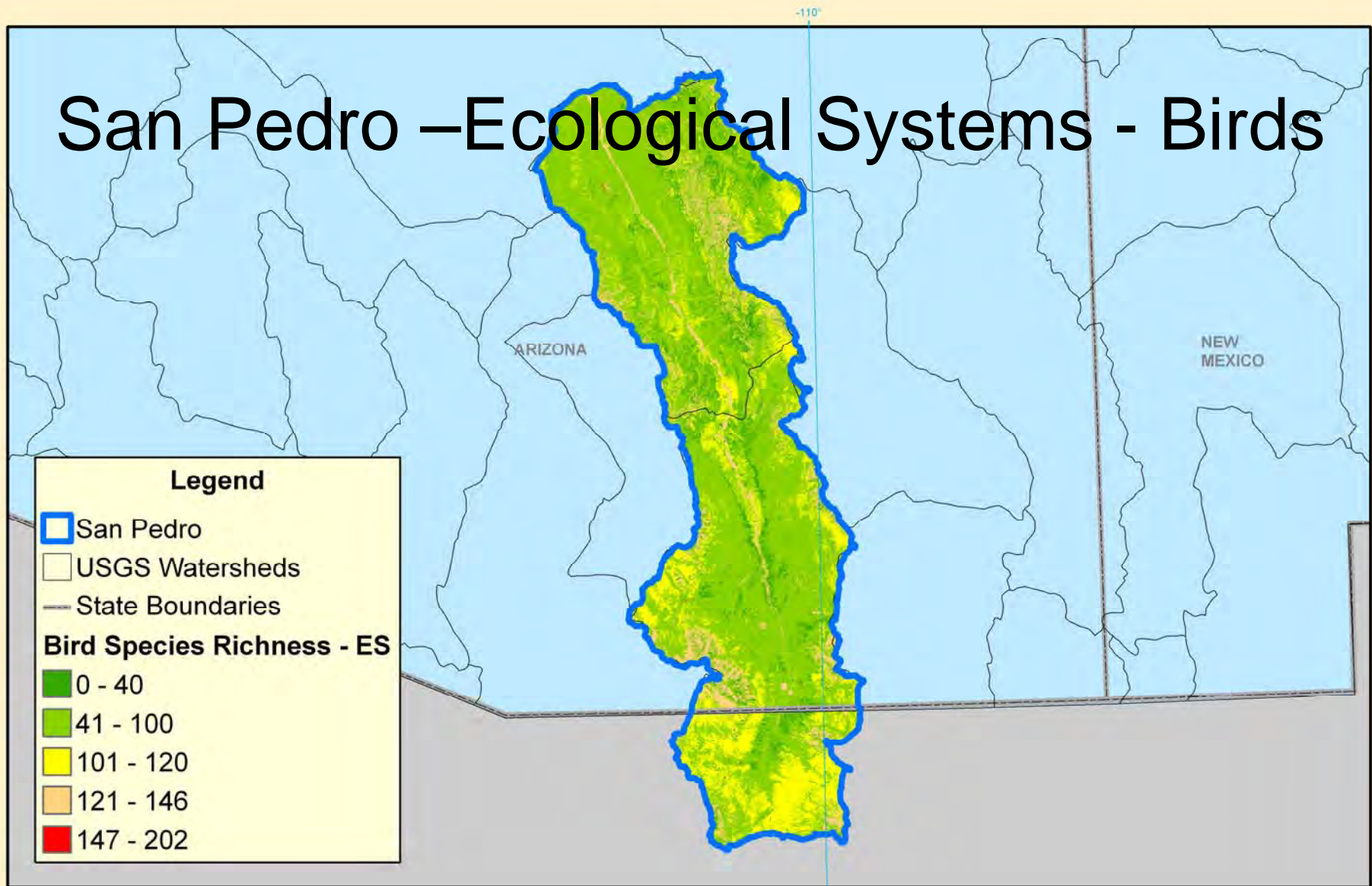


**Total Species Richness by Ecological System
(SWReGAP)**
N = 452

Albers Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 60
Latitude of Origin: 40

0 5 10 20 30 40
Miles

San Pedro –Ecological Systems - Birds



**Bird Species Richness by Ecological System
(SWReGAP)**

N = 287

Albers Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 60
Latitude of Origin: 40

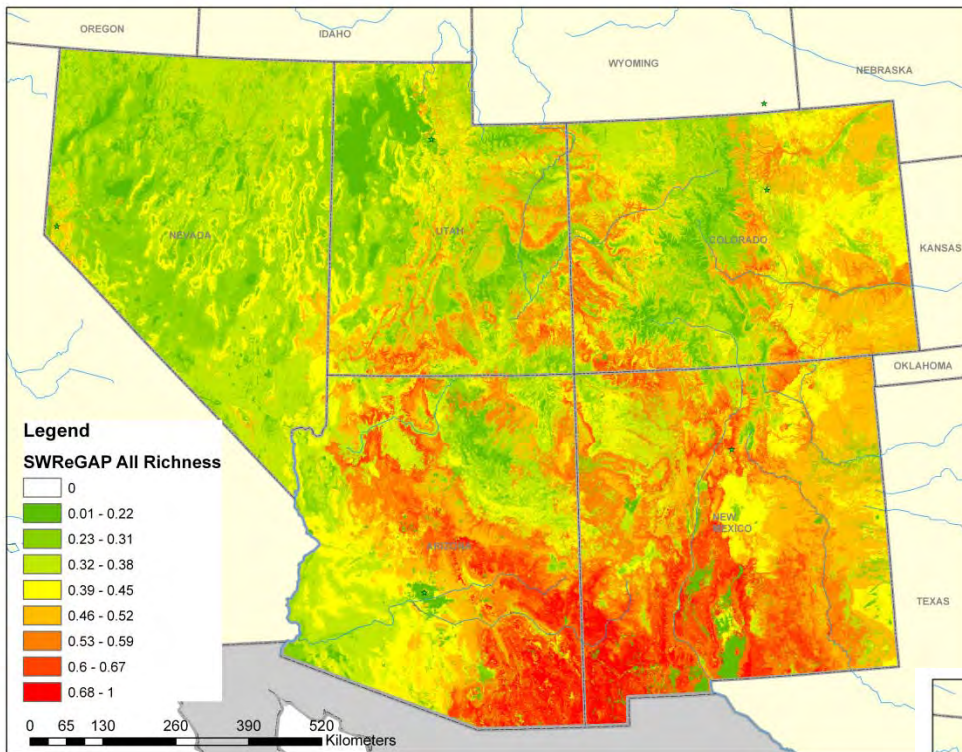
0 5 10 20 30 40
Miles

SW Richness



Photo by Jason Bak

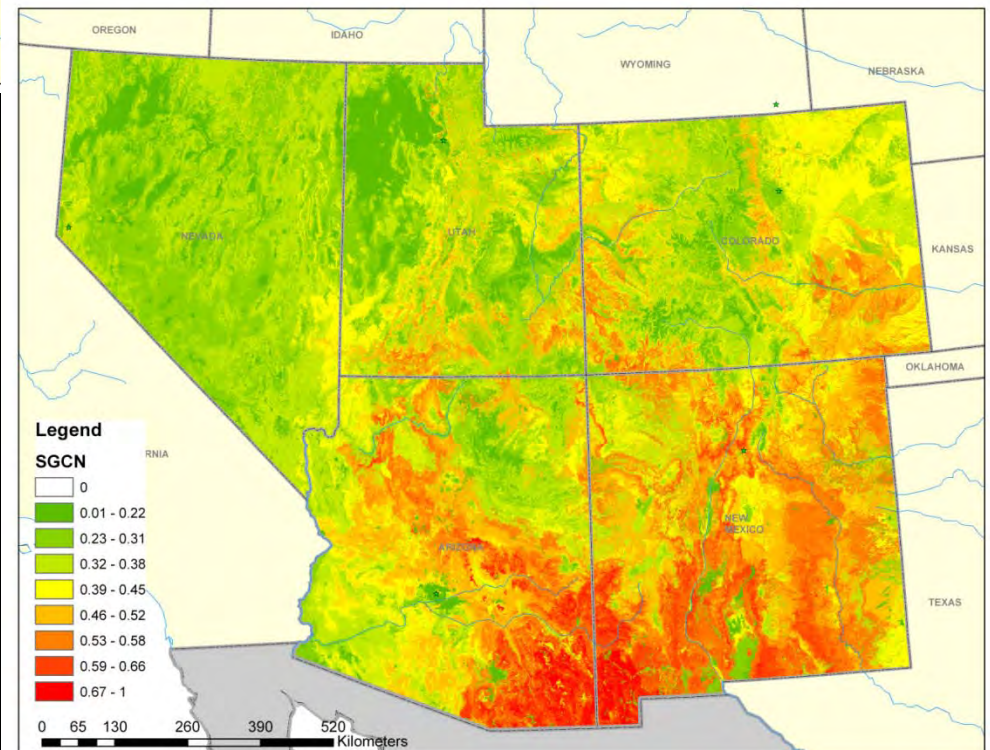
SGCN - 435 species

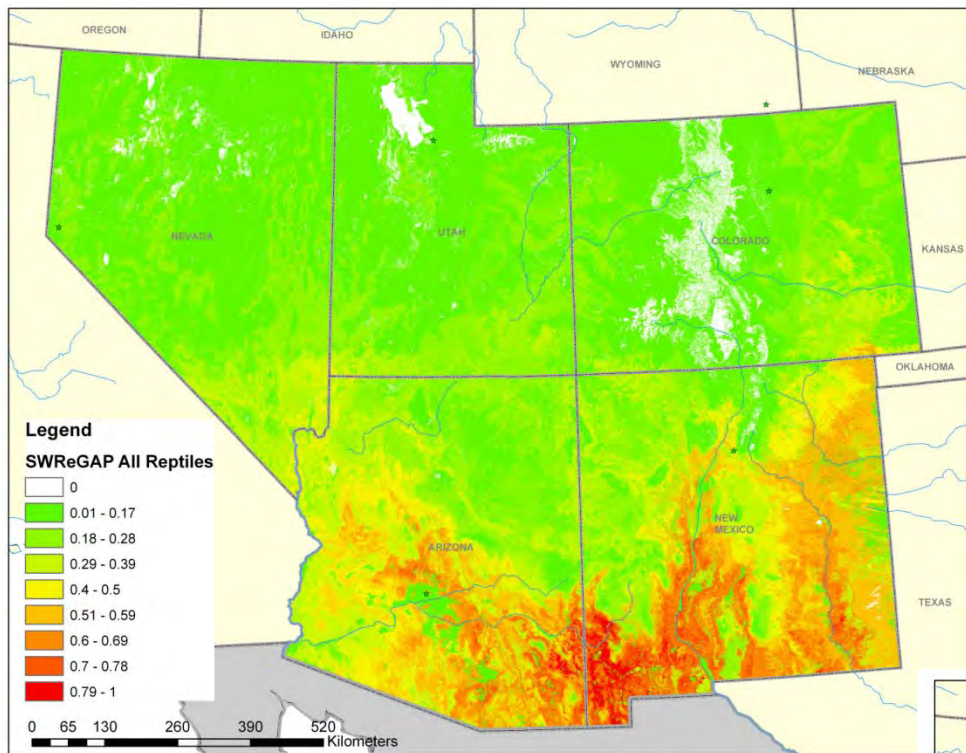


All Species - 817 species



Photo by Jason Bak



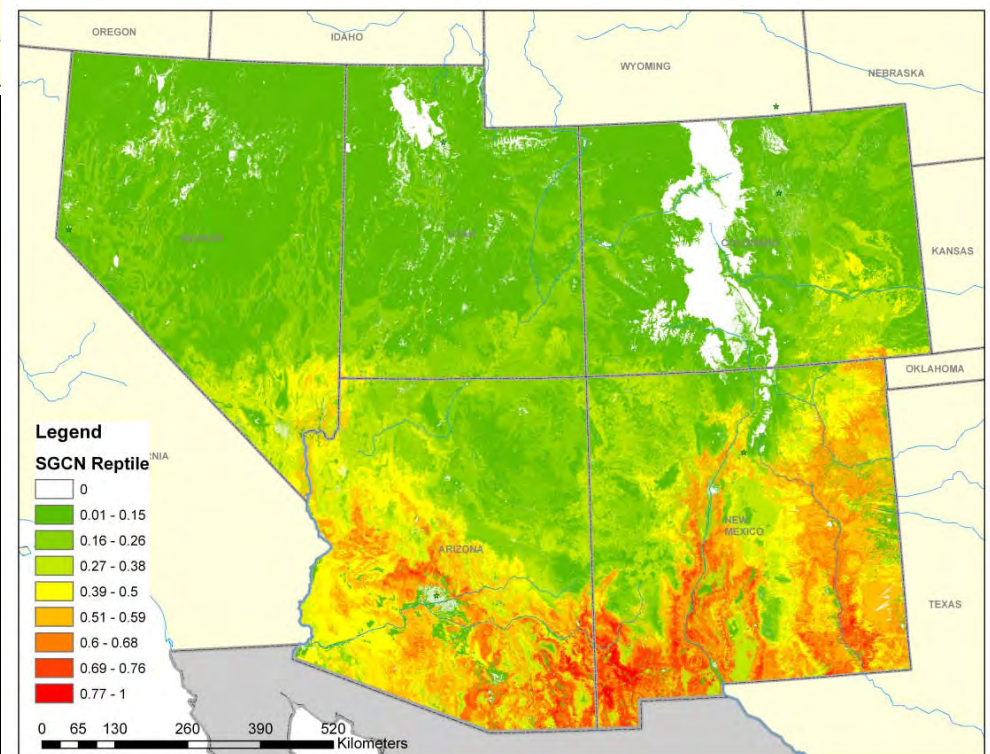


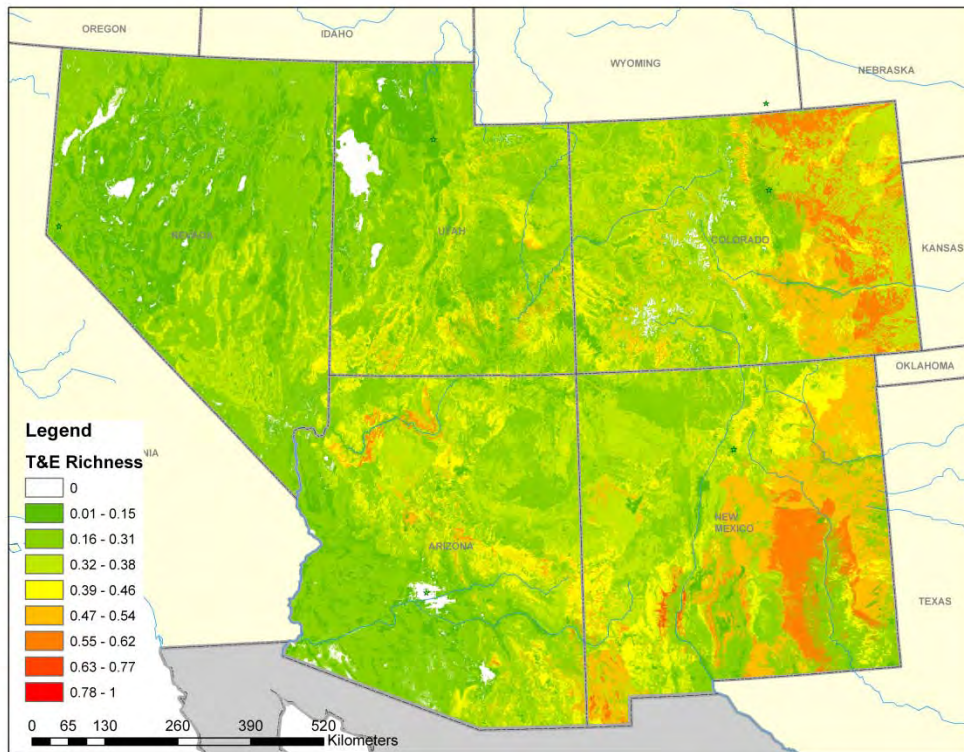
SW Richness Reptiles

SGCN – 86 Species



Total – 130 Species





Richness



Bats – 19 SGCN Species

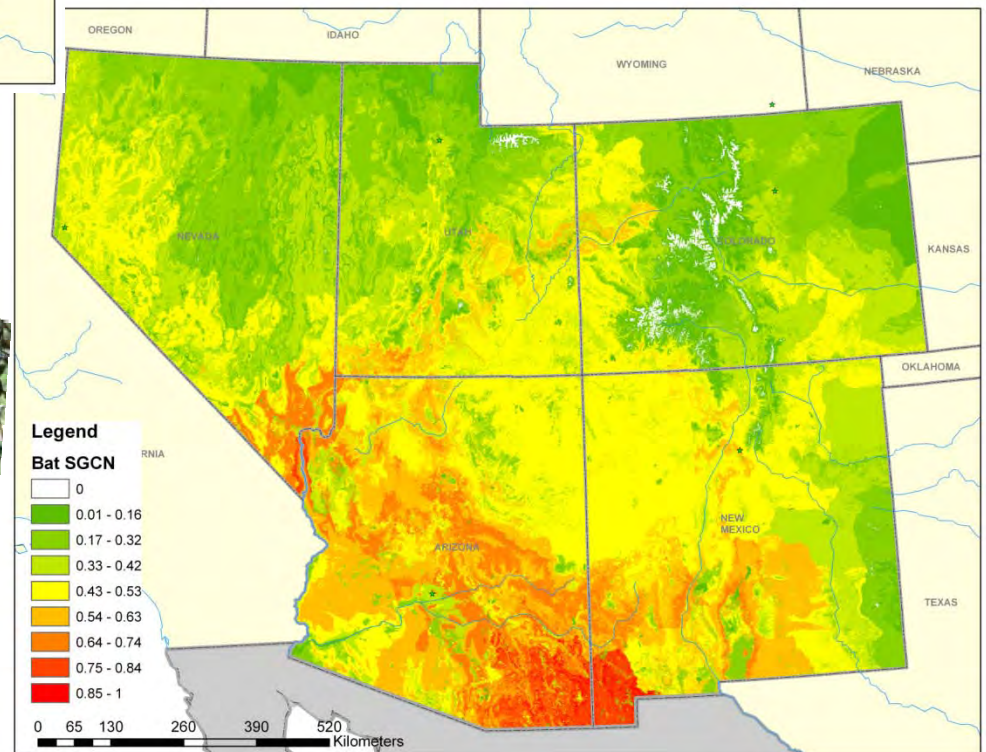
T&E Species – 24 Species



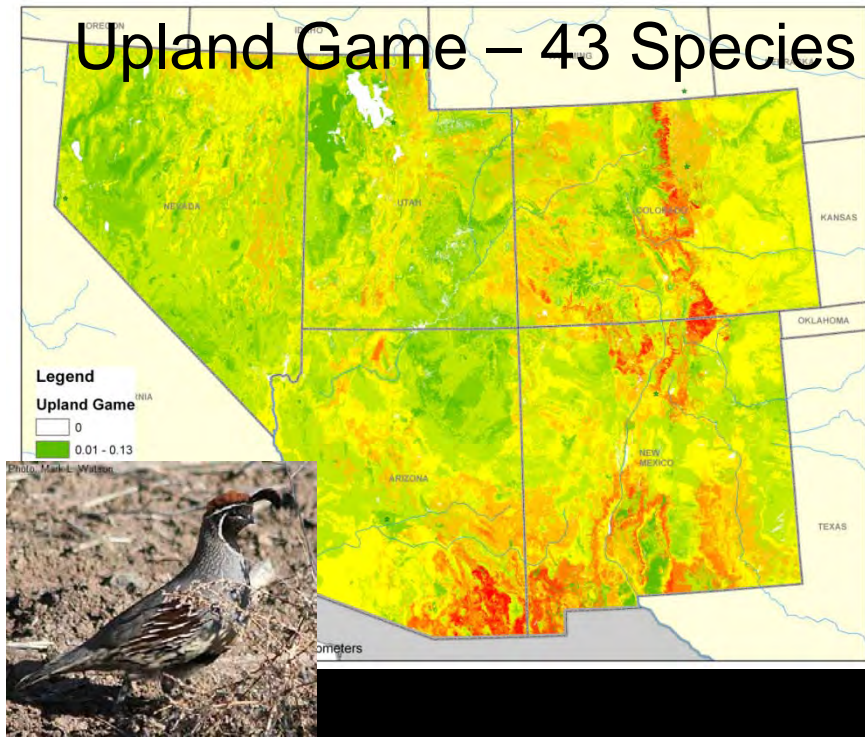
Credit: Jim Rorabaugh/USFWS



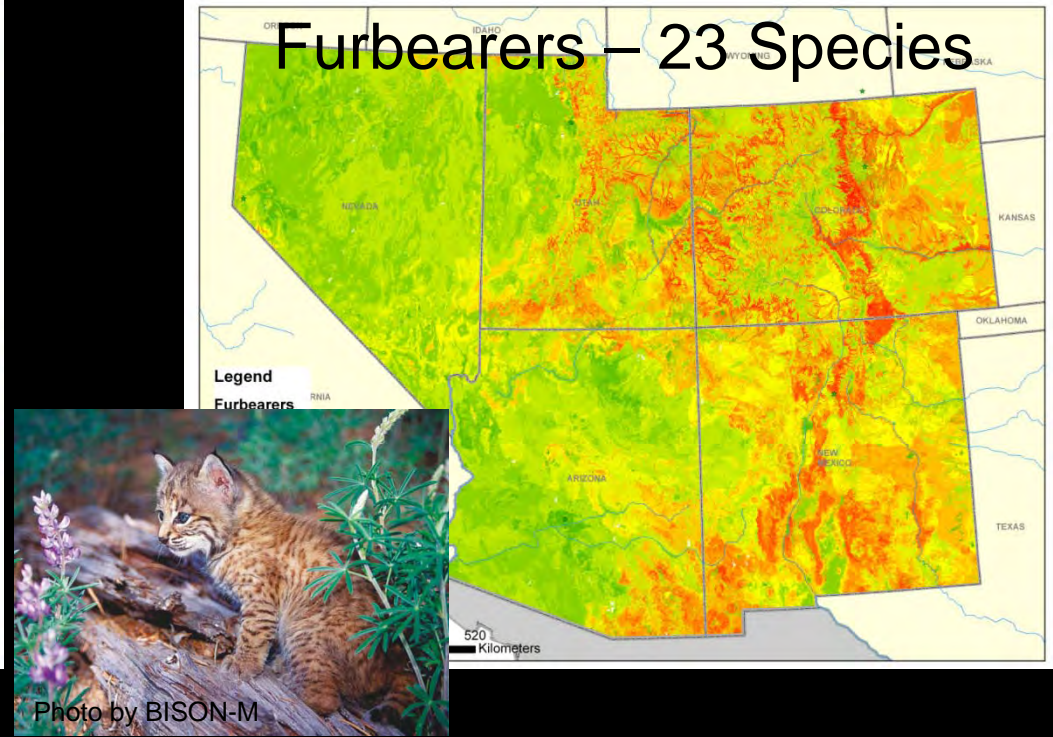
Credit: Jim Rorabaugh/USFWS



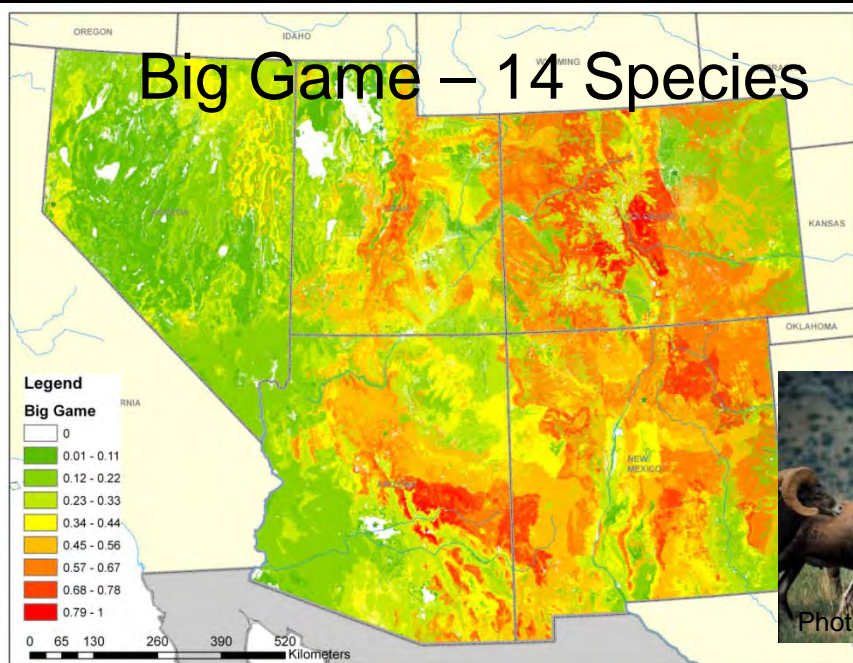
Upland Game – 43 Species



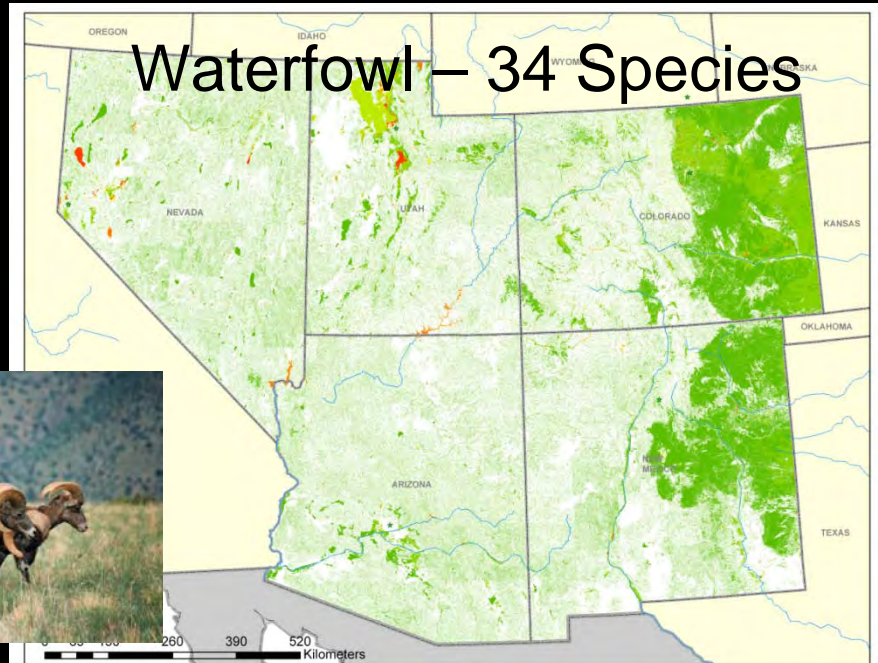
Furbearers – 23 Species



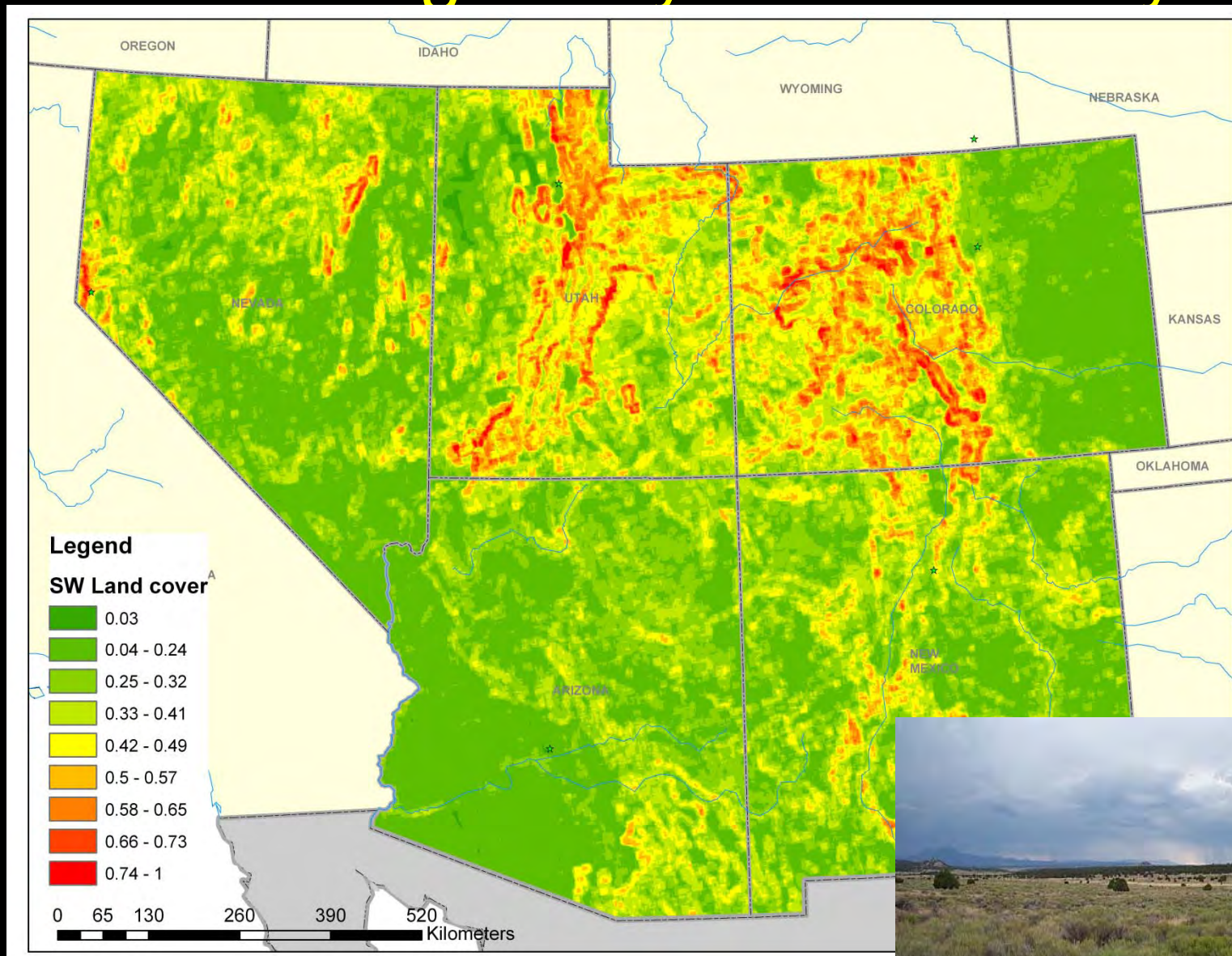
Big Game – 14 Species



Waterfowl – 34 Species



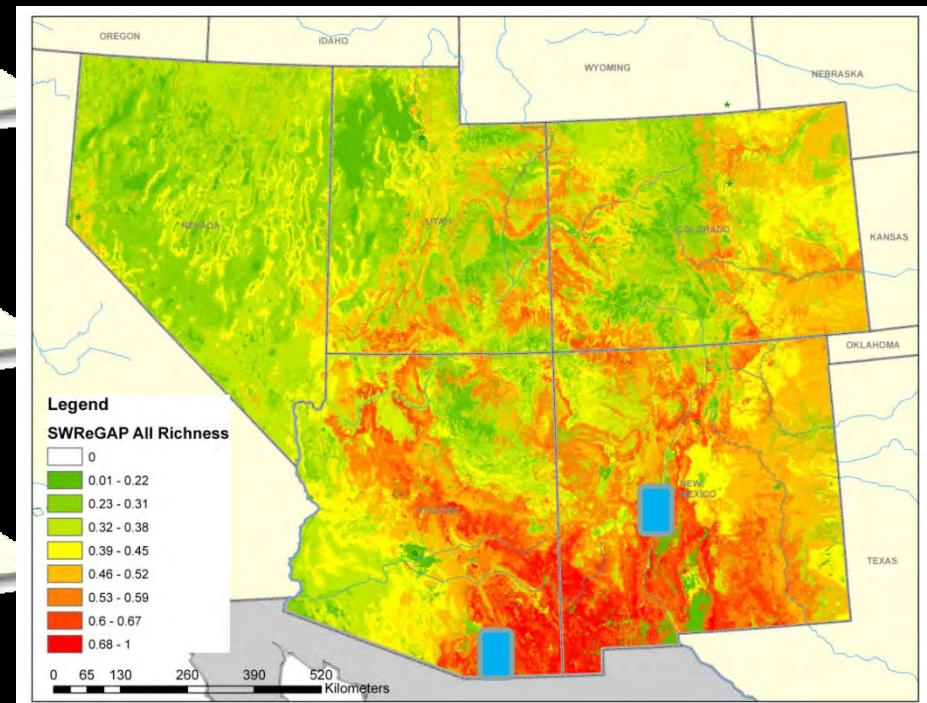
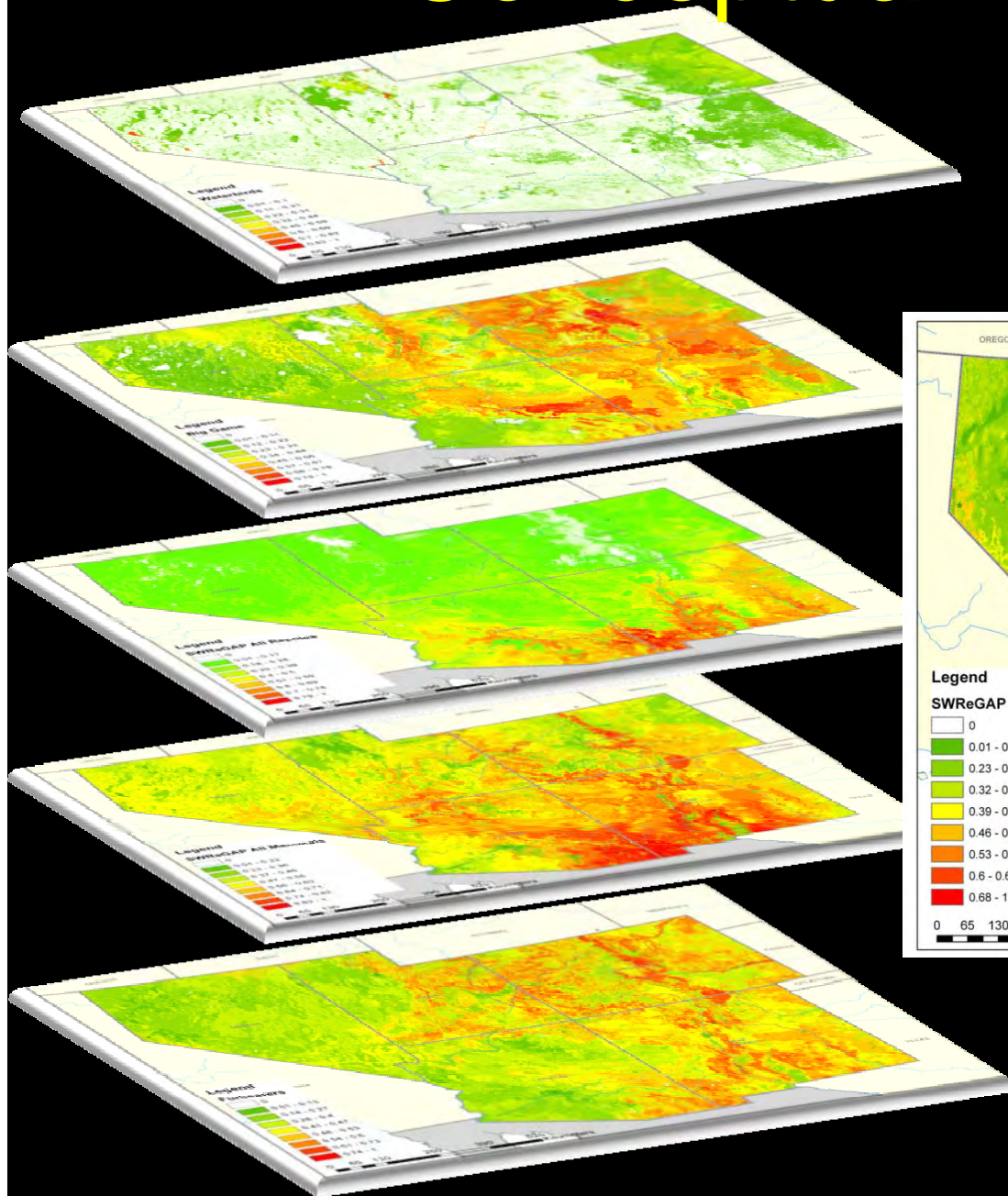
SW Ecological System Diversity



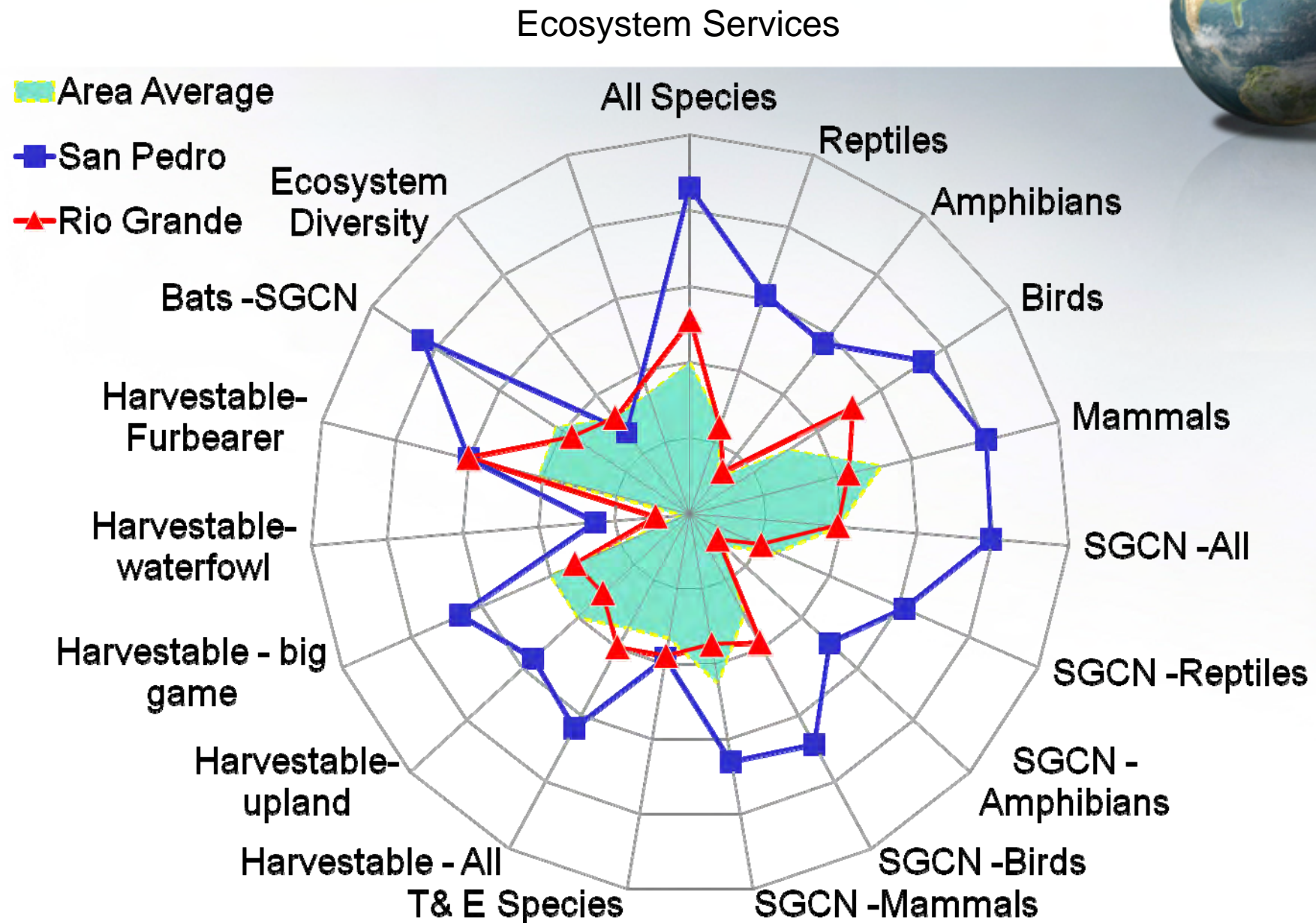
125 classes



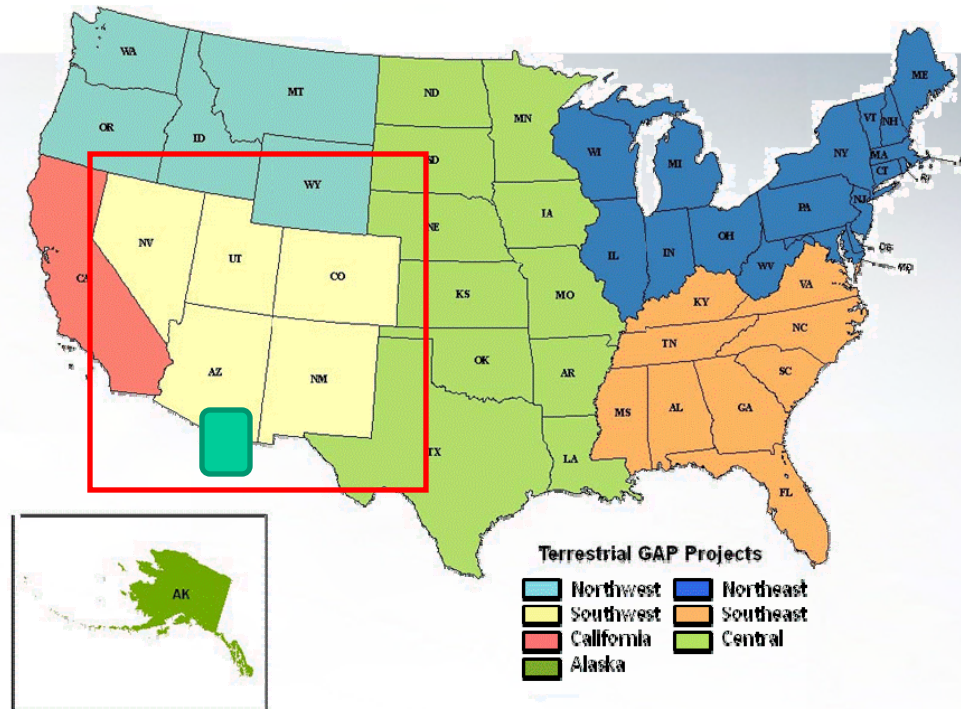
Conceptual Analysis



Radar Graphs



Species Richness by Scale



Taxon	San Pedro	Southwest	Nation
Amphibian Spp	16	37	?
Bird Spp	287	435	?
Mammal Spp	88	215	?
Reptile Spp	61	130	?
Total Species	452	817	?

General Conclusions



- Deductive modeling appears promising for mapping and quantifying metrics of habitat provisioning at multiple scales
 - Evaluating metrics (e.g., indices, species groups, keystone species, or guilds)
- First level effort and further work is underway
 - Application at national scale (GAP)
 - Ability to map wildlife as an Ecosystem Service (EPA)
- Provides reference conditions for alternative future scenarios (e.g. climate change, urbanization)
- Establish common sense *indicators of ES* for end-user and decision maker needs (e.g., Landscape Conservation Cooperatives, State Wildlife Action Plans)

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<http://gapanalysis.nbii.gov>
<http://fws-nmcfwru.nmsu.edu/swregap/>
<http://www.epa.gov/nerlesd1/land-sci/gap.htm>

