A NATIONAL SYSTEM TO MAP AND QUANTIFY TERRESTRIAL VERTEBRATE BIODIVERSITY

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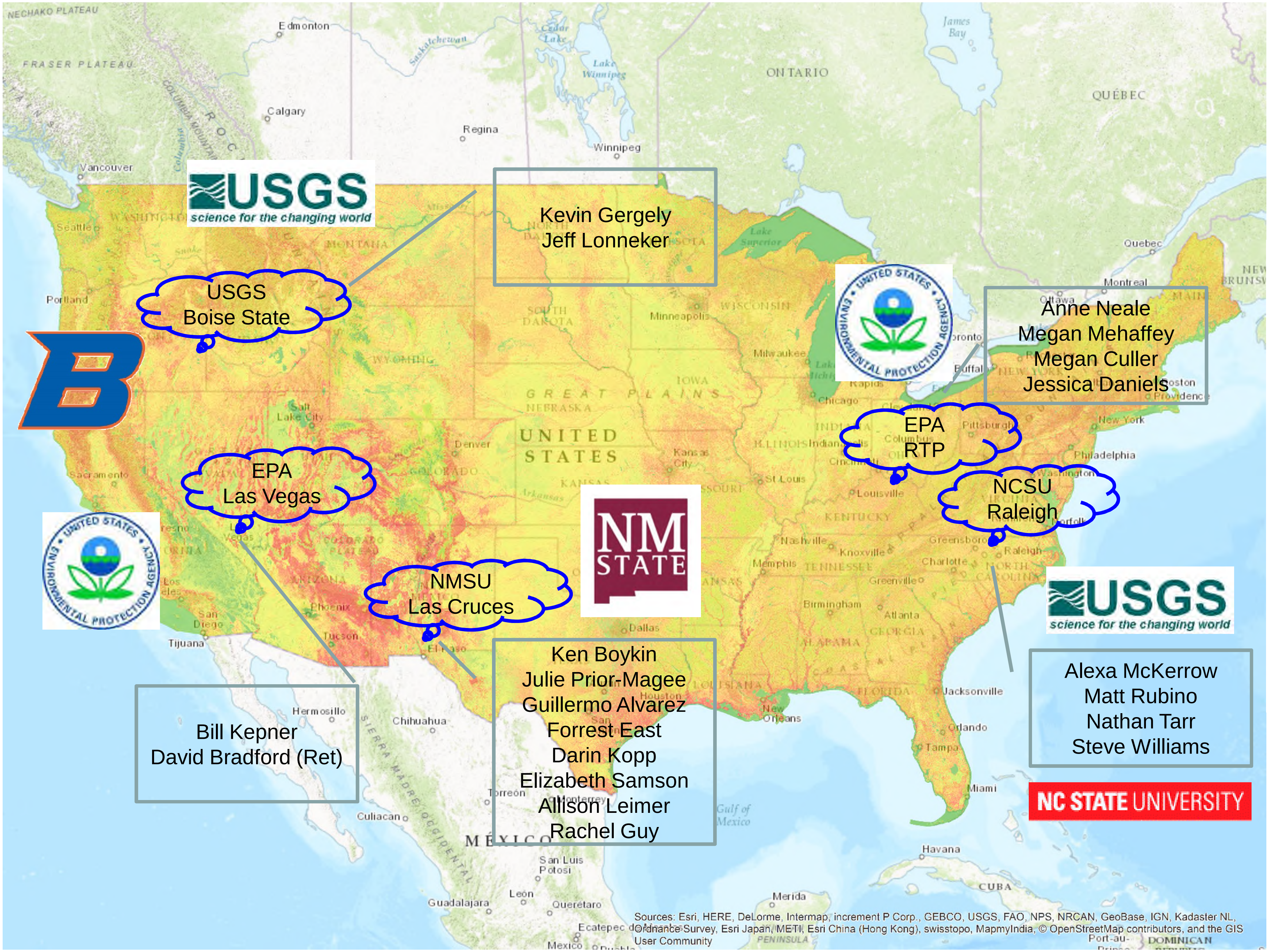
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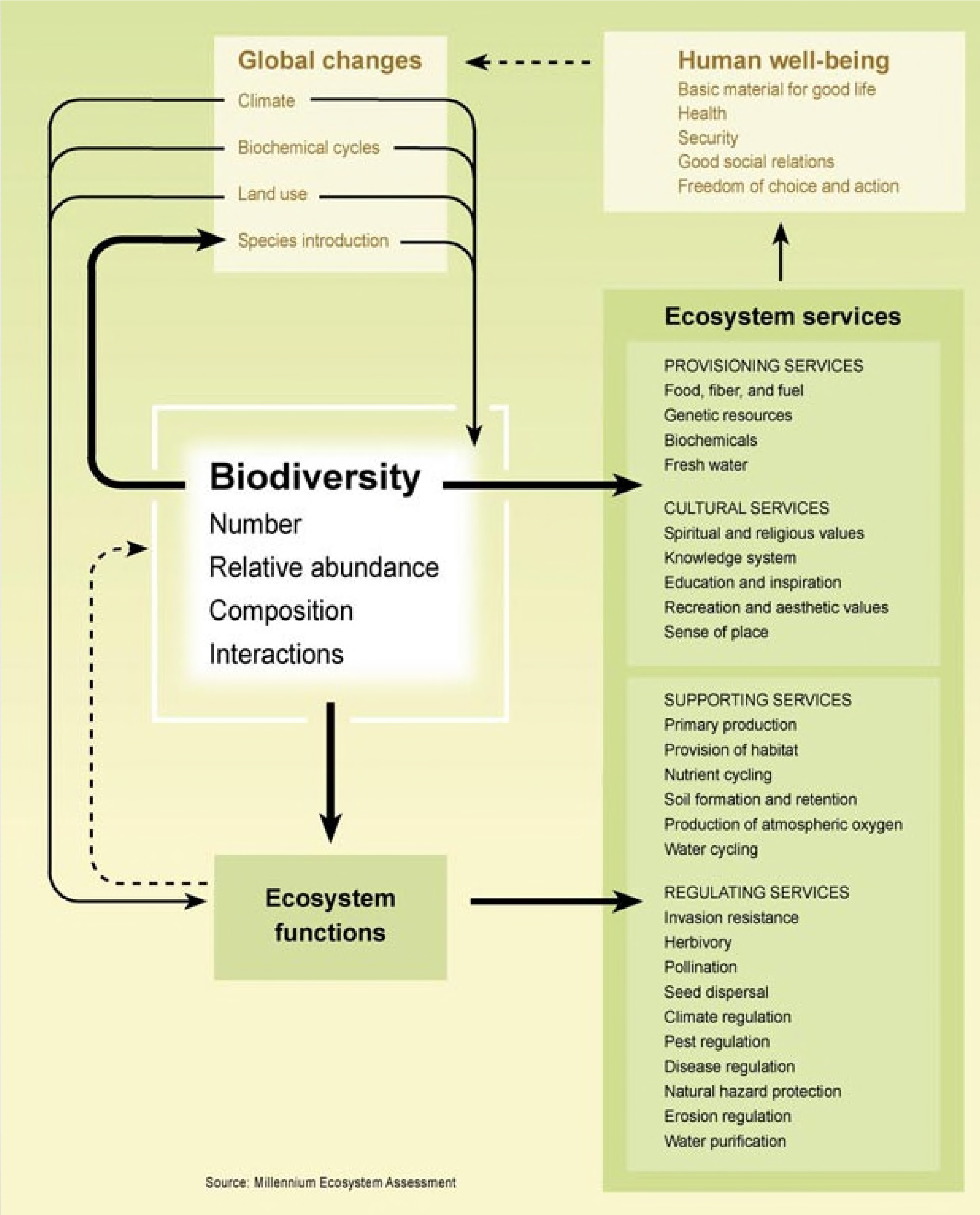
Biodiversity is both a response variable affected by global change drivers and a factor modifying ecosystem processes and services and human well-being.



A web-based national decision support tool designed to inform decision-making. It allows users to view and analyze the geographical description of the supply and demand for ecosystem services, as well as the drivers of change.

It includes geospatial indicators/metrics; interpreted spatial data; and analytic and interpretive tools.

www.epa.gov/enviroatlas (EPA/600/C-14/372)


Clean Air
Clean & Plentiful Water
Biodiversity Conservation
Food, Fuel, & Materials
Natural Hazard Mitigation
Climate Stabilization
Recreation, Culture, & Aesthetics
EnviroAtlas data are organized into 7 ecosystem service benefit categories.

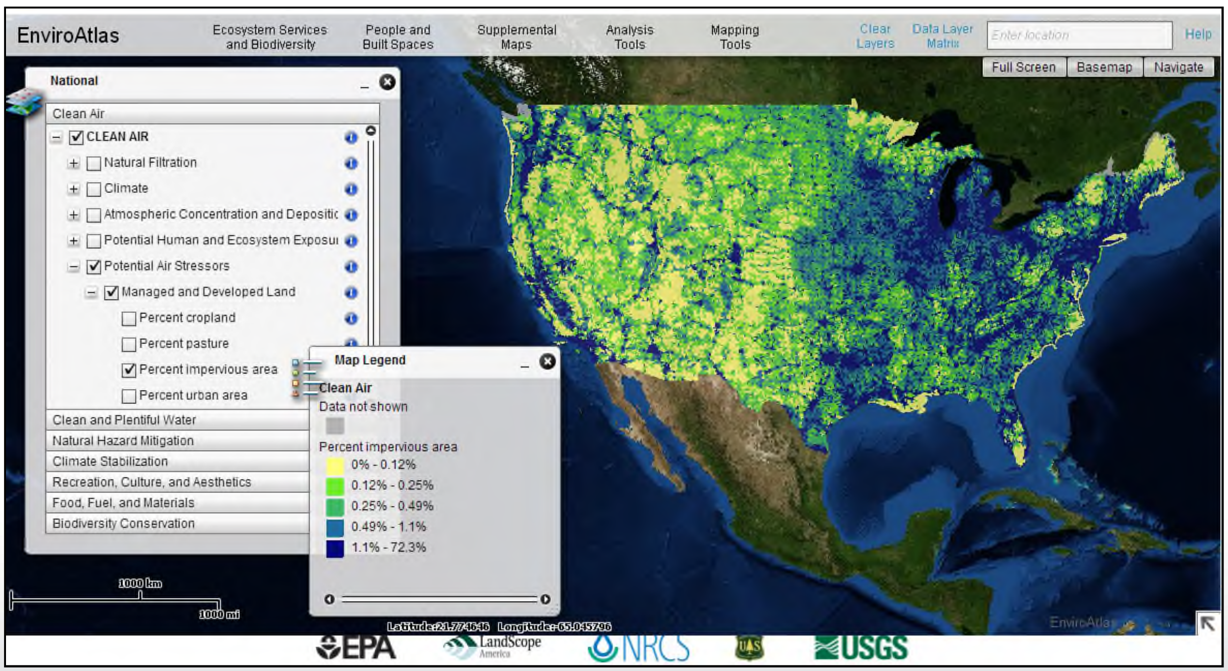
EnviroAtlas

The EnviroAtlas is multi-scaled

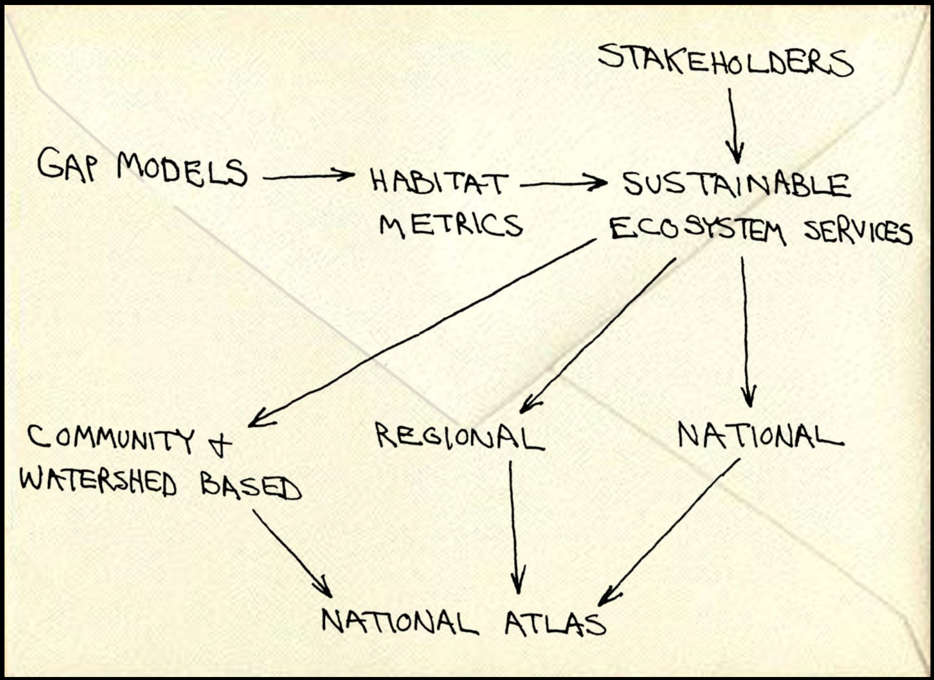
- National: Wall-to-wall coverage for <u>conterminous</u> US; summarized by ~85,000 drainage basins

(12-digit HUCs- approx. 40 mi^2 *or* **105 km^2 in size**)

- Over 160 data layers



Our Conceptual Model for Incremental Approach to Multi-scale Analysis



Develop and produce quantifiable habitat metrics & maps based on ecosystem services and available data for place-based, regional, and national scales of interest.

Biodiversity Conservation, Recreation, & Food Resources

Gap Analysis Products and Data Sources

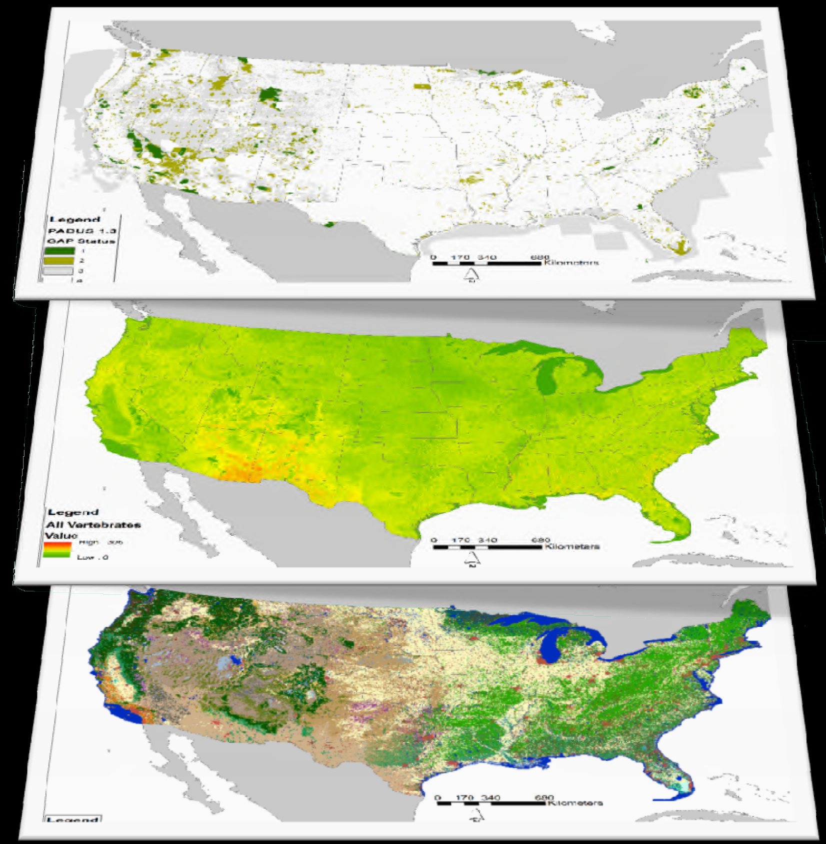
Deductive Habitat Models/Terrestrial Vertebrates (1699 spp)

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

Land Ownership/Stewardship

Terrestrial
Vertebrate
Habitat Models

Land Cover (583 classes)
556 Natural; 27 Land use



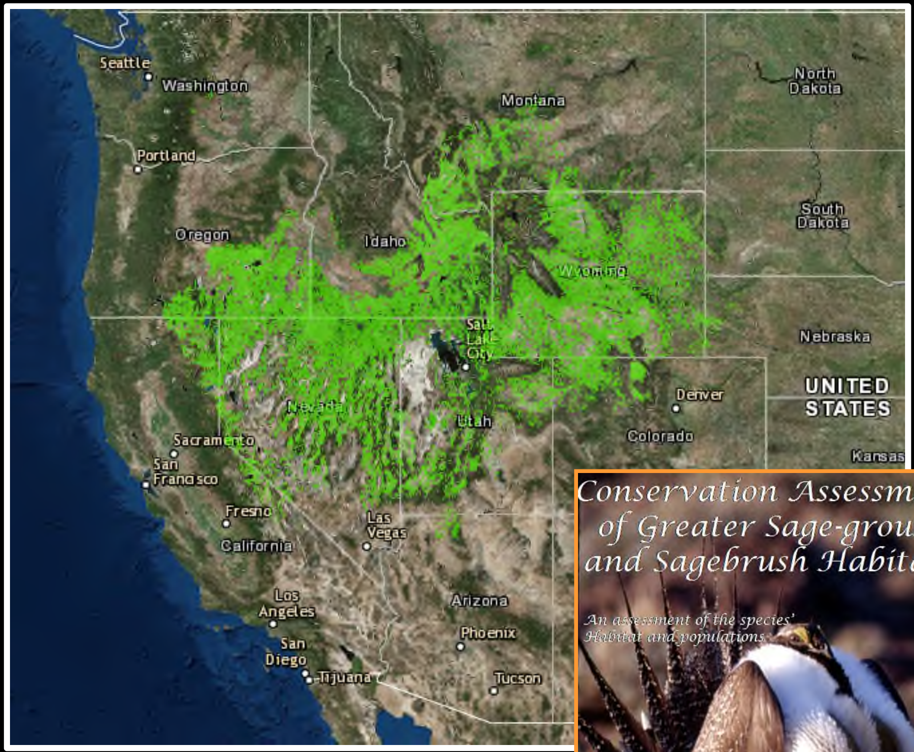
Collect and compile information on habitat associations and develop deductive habitat model for each species that *historically reside, breed, or use habitat in the conterminous U.S.* for a substantial portion of their life history **(*n* = 1,699).**

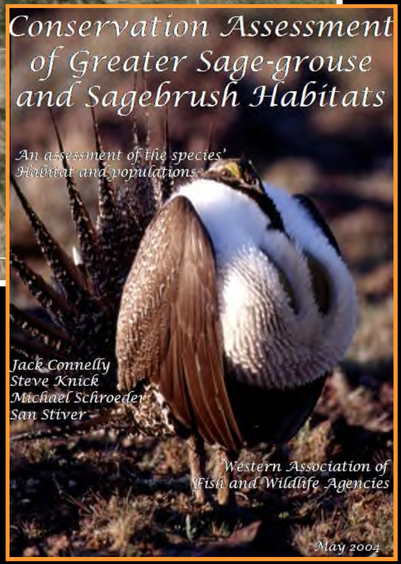
<u>Range Delineation</u>

- Hydrologic Unit (12-digit)

<u>Habitat Variables</u>

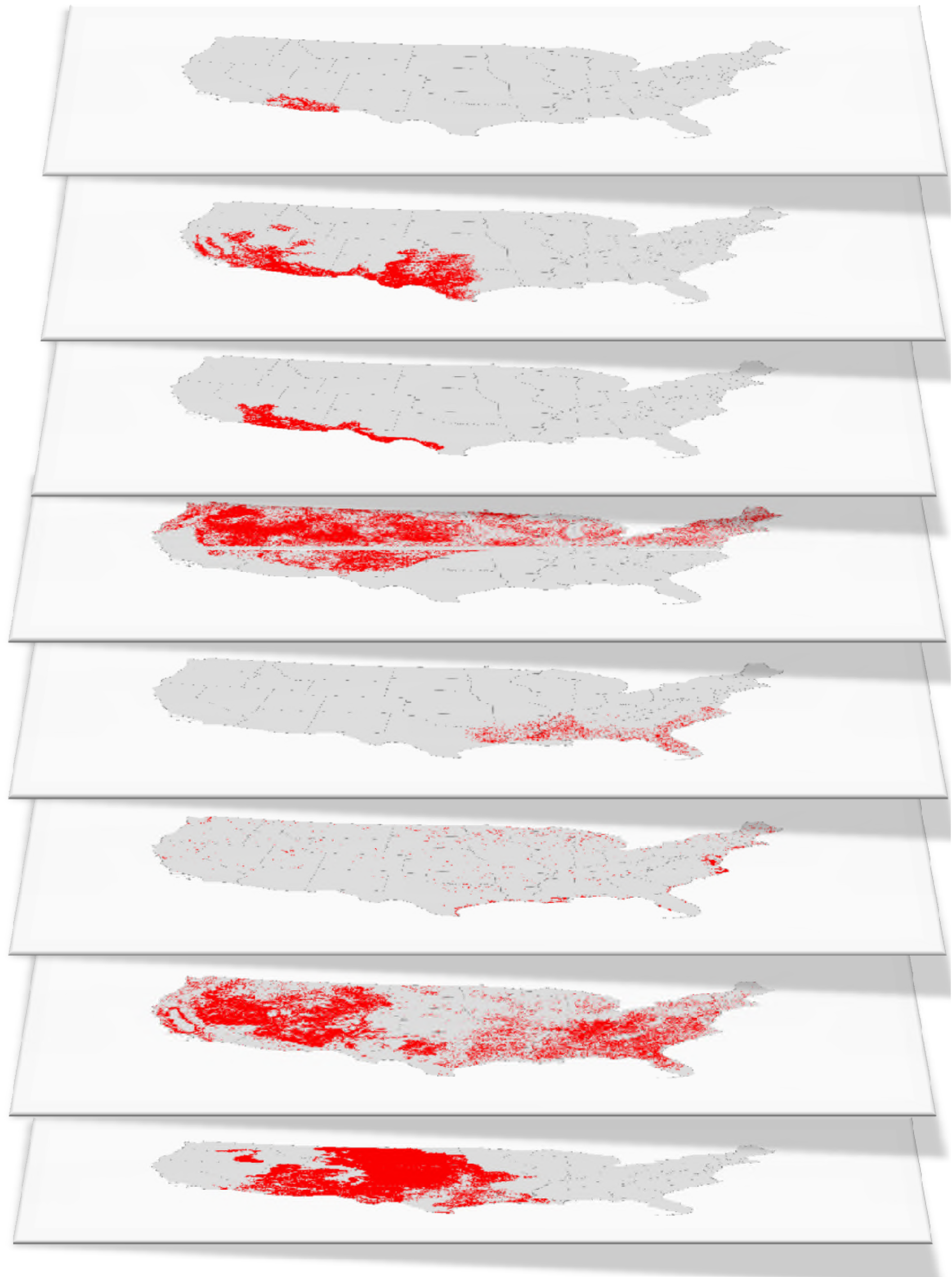
- Land Cover, Landsat-based
- Elevation (min/max)
- Slope/Aspect
- Hydrology (Proximity)
  - Streams, lakes, springs
- Patch Size





Terrestrial Vertebrate Species Distribution Models

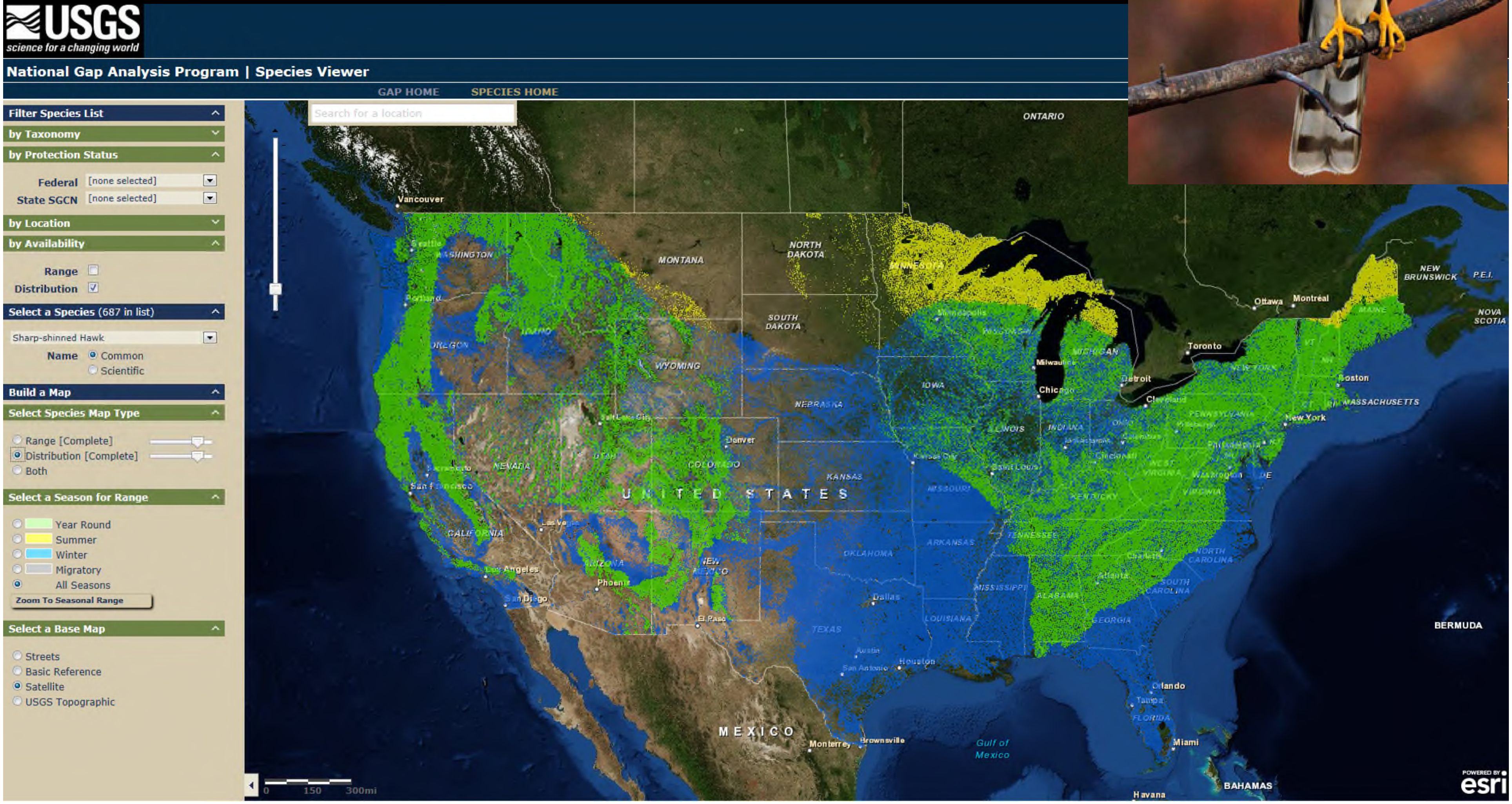
- 1699 Species
- 684 Birds
- 434 Mammals
- 259 Amphibians
- 322 Reptiles



Gap Analysis Program (GAP) Species Viewer

(http://gapanalysis.usgs.gov/species/viewer/)

Potential Habitat (Complete U.S. distribution) for
Sharp-shinned Hawk (Accipiter striatus)



Evaluation Factors for Selecting Metrics

- **Focus on Clients**,
  - *e.g.* BLM, USFS, DoD, EPA Regions, FWS, NGOs, & State Departments of Environment and Natural Resources
- Include decision makers
- Include a suite of metrics to inform tradeoffs
- Select scale best needed to inform the decision
- Select metrics that can easily be interpreted by non-scientists

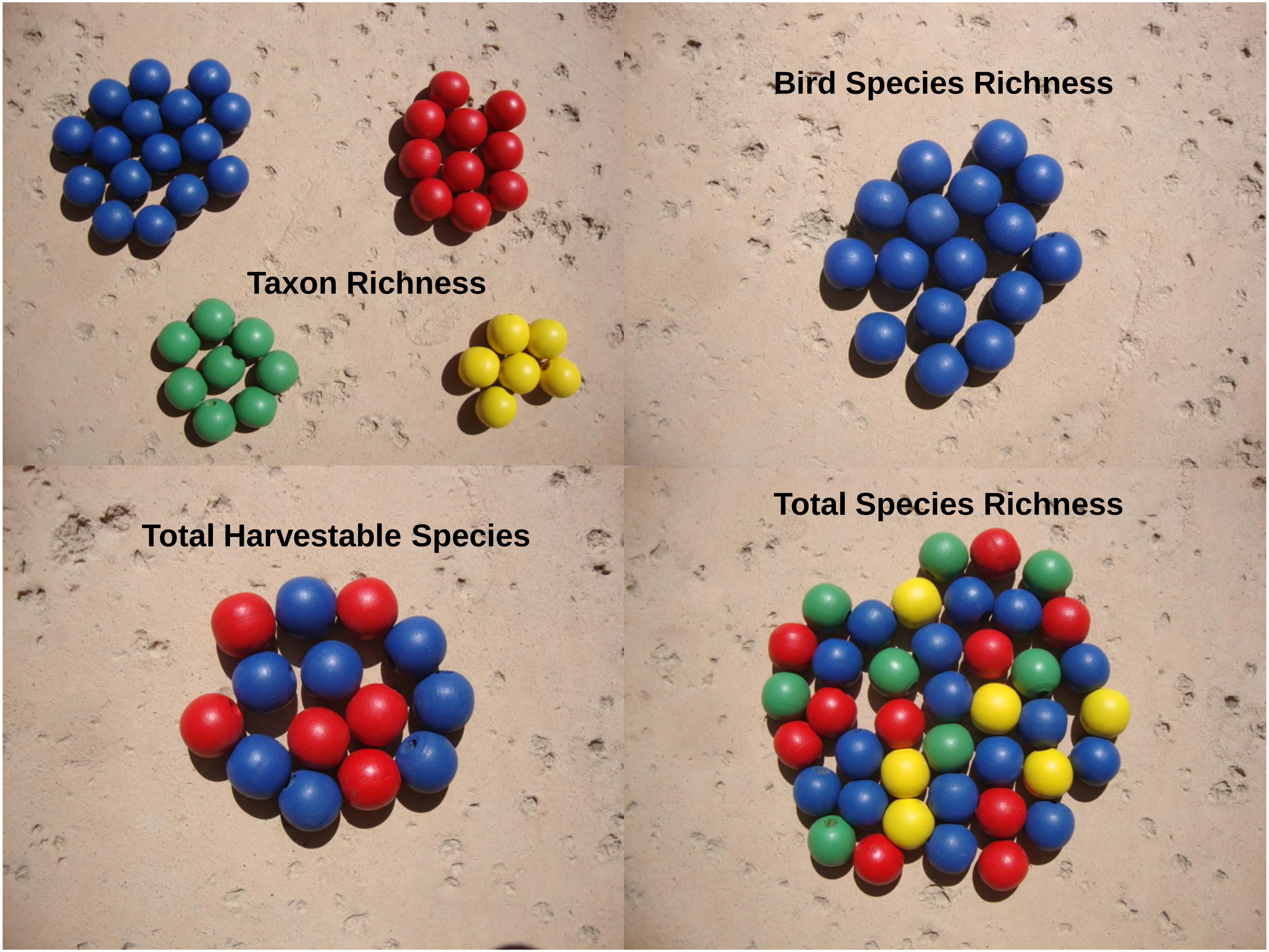
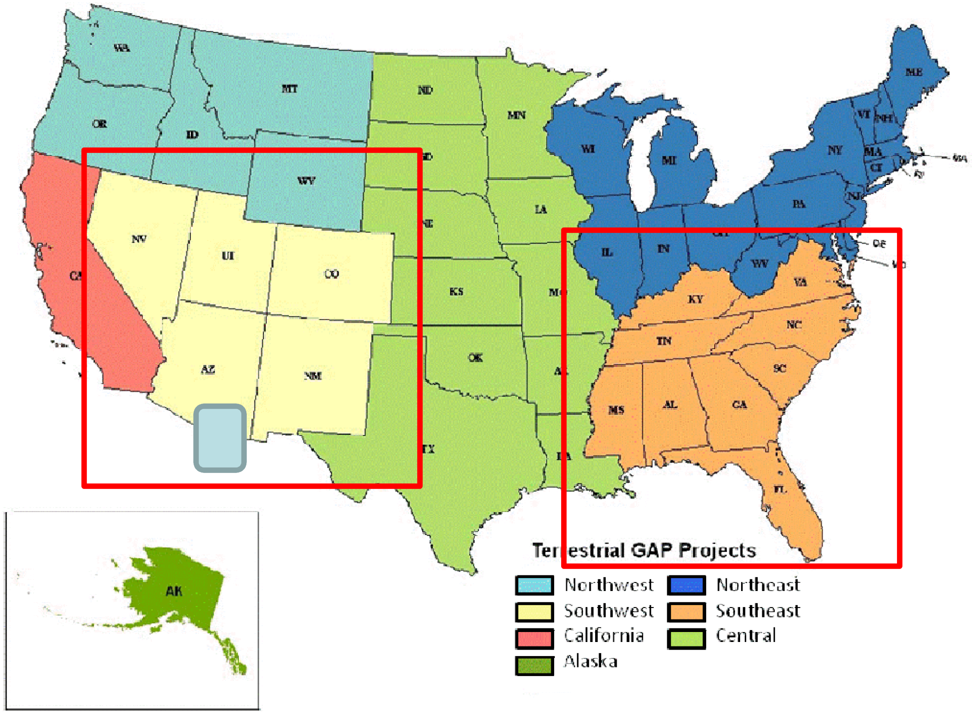

Taxon Richness
Bird Species Richness
Total Harvestable Species
Total Species Richness

Table 1
Description of 20 biodiversity metrics reflecting ecosystem services or resources of conservation concern.

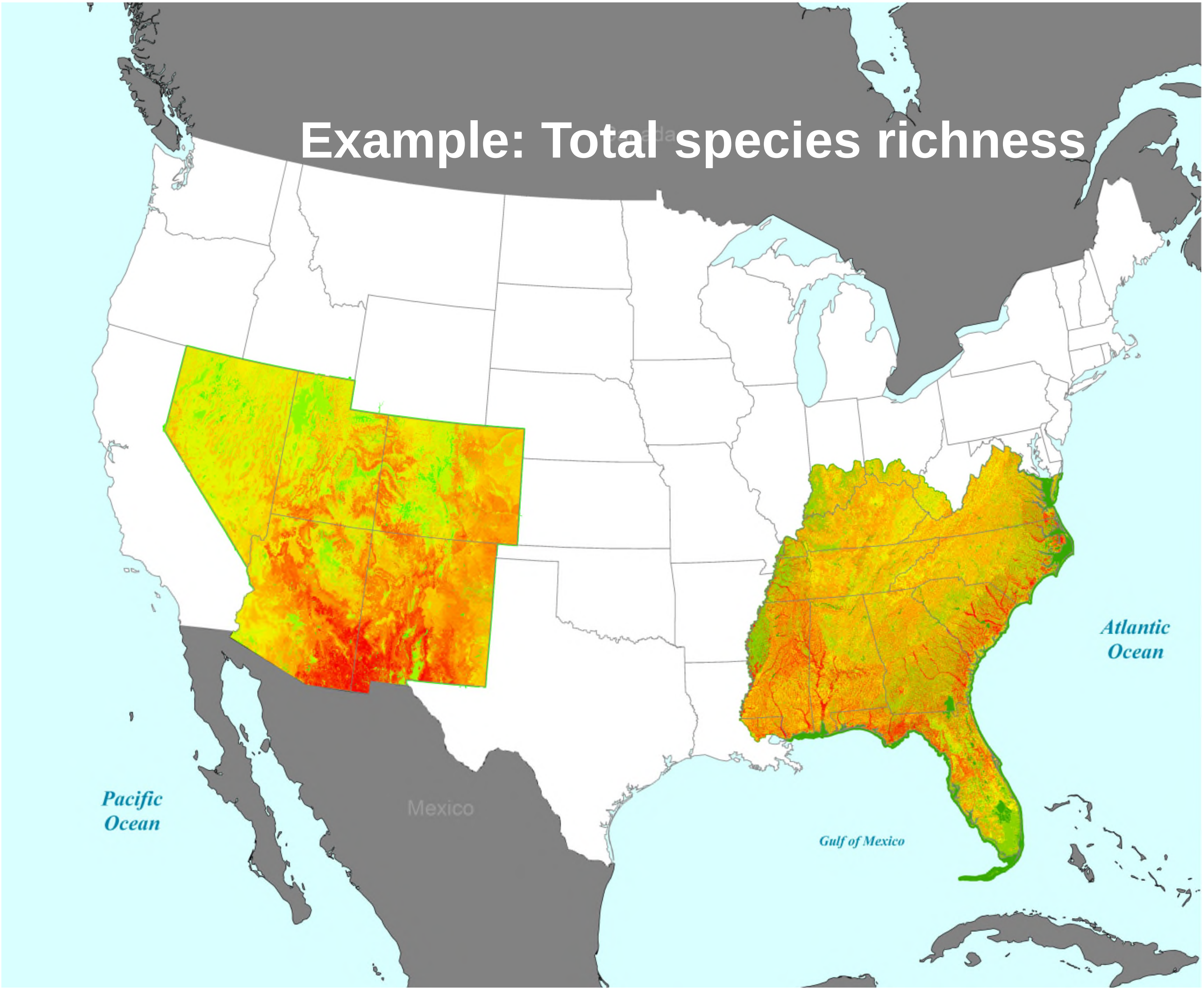
Metric	Description
Vertebrate species richness	Number of terrestrial vertebrate species (i.e., amphibians, birds, mammals, reptiles) as measured by predicted habitat present within a pixel (Boykin et al., 2007).
Amphibian richness	Number of amphibian species as measured by predicted habitat present within a pixel.
Bird richness	Number of bird species as measured by predicted habitat present within a pixel.
Mammal richness	Number of mammal species as measured by predicted habitat present within a pixel.
Reptile richness	Number of reptile species as measured by predicted habitat present within a pixel.
Bat richness	Number of bat species as measured by predicted habitat present within a pixel.
All species of greatest conservation need richness	Number of terrestrial vertebrate species identified as Species of Greatest Conservation Need by a southwestern US state as measured by predicted habitat present within a pixel (AGFD, 2005a,b; CDOW, 2005; NDOW, 2006; UDWR, 2005; NMDGF, 2006).
Amphibian SGCN richness	Number of amphibian species identified as Species of Greatest Conservation Need by a southwestern US state as measured by predicted habitat present within a pixel.
Bird SGCN richness	Number of bird species identified as Species of Greatest Conservation Need by a southwestern US state as measured by predicted habitat present within a pixel.
Mammal SGCN richness	Number of mammal species identified as Species of Greatest Conservation Need by a southwestern US state as measured by predicted habitat present within a pixel.
Reptile SGCN richness	Number of reptile species identified as Species of Greatest Conservation Need by a southwestern US state as measured by predicted habitat present within a pixel.
Bat SGCN richness	Number of bat species identified as Species of Greatest Conservation Need by a southwestern US state as measured by predicted habitat present within a pixel.
Threatened and endangered species richness	Number of Federally listed Threatened and Endangered Species as measured by predicted habitat present within a pixel (USFWS, 2011)
Harvestable species	Number of harvestable terrestrial vertebrate species (defined by each states hunting regulations) as measured by predicted habitat present within a pixel
Furbearers	Number of furbearer species as measured by predicted habitat present within a pixel. Examples include beaver, badger, and marten.
Big game	Number of big game species as measured by predicted habitat present within a pixel. Examples include Elk, mule deer, and pronghorn.
Small game	Number of small game species as measured by predicted habitat present within a pixel. Examples include sandhill crane, scaled quail and dusky grouse.
Upland game	Number of upland game species as measured by predicted habitat present within a pixel. Examples include desert cottontail, red squirrel, wild turkey.
Waterfowl	Number of waterfowl species as measured by predicted habitat present within a pixel. Examples include mallards, Canada geese, and trumpeter swan.
Ecosystem diversity	Number of land cover types within a 1-km neighborhoodby pixel.

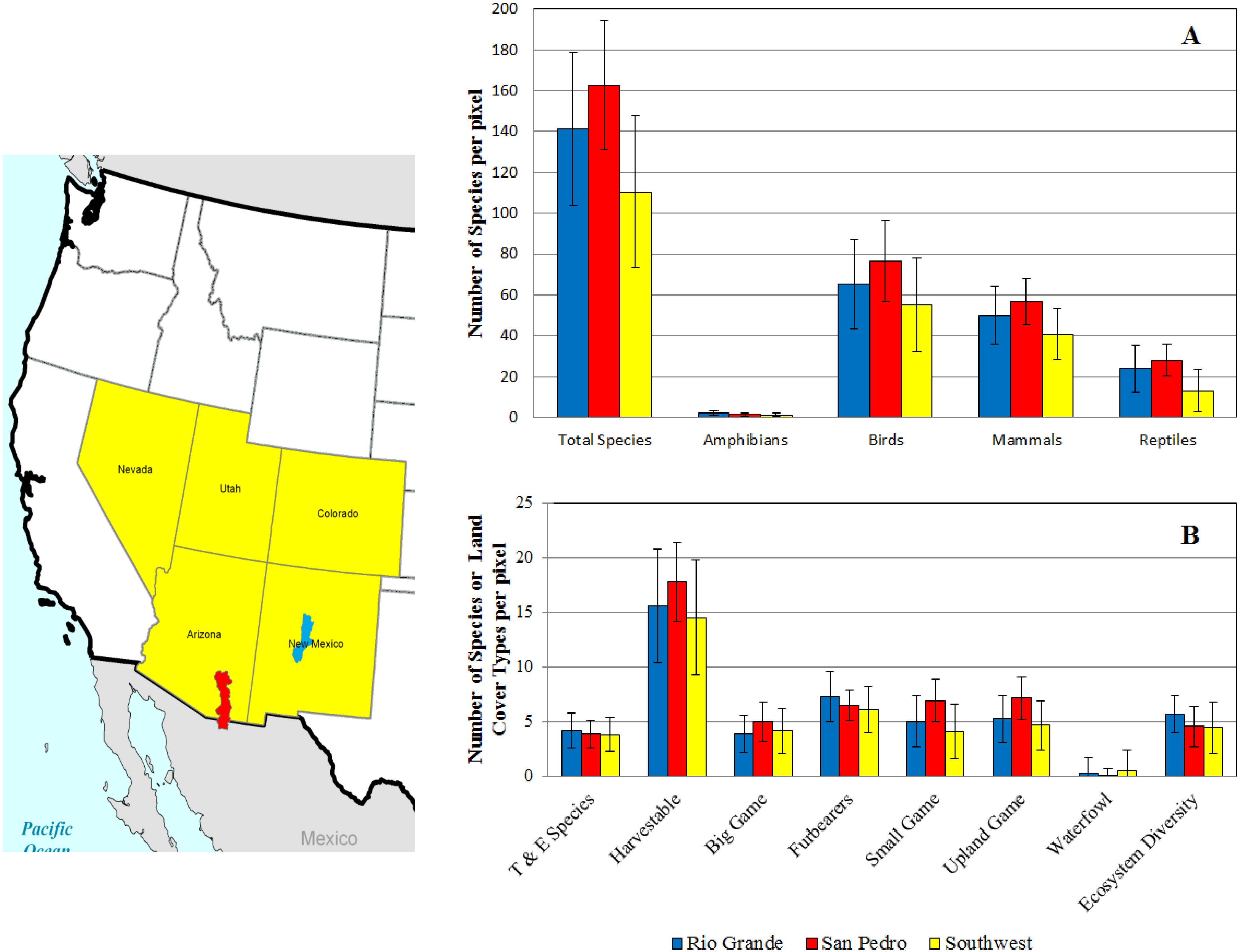
Species Richness & Mapping Approach by Scale



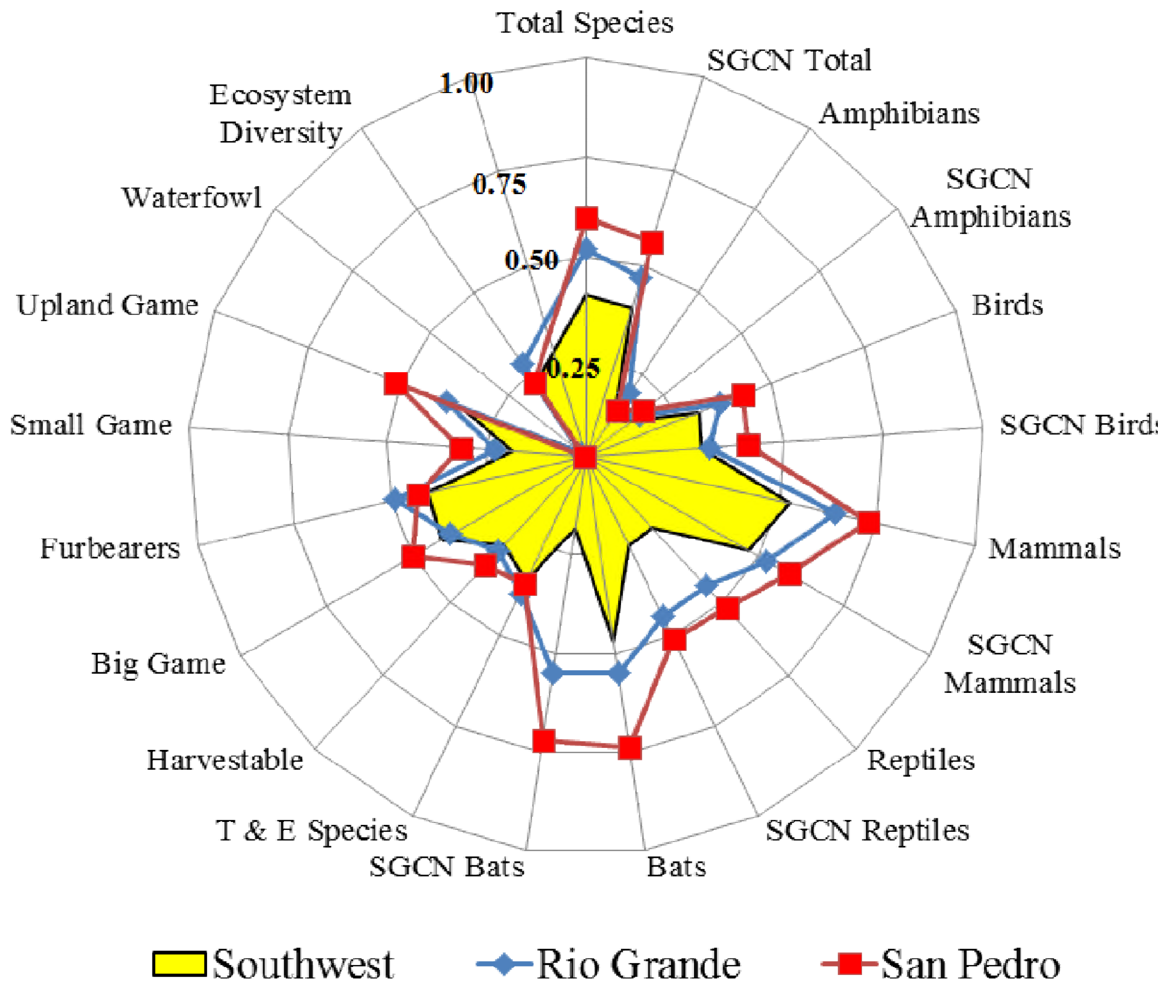
Taxon	San Pedro	Southwest	Southeast	Nation
Amphibians	16	37	124	304
Birds	287	435	259	686
Mammals	88	215	99	475
Reptiles	61	130	124	322
Total Species	452	817	606	**1787**

Example: Total species richness




Nevada
Utah
Colorado
Arizona
New Mexico
Pacific
Mexico
A
Number of Species per pixel
200
180
160
140
120
100
80
60
40
20
0
Total Species
Amphibians
Birds
Mammals
Reptiles
B
Number of Species or Land Cover Types per pixel
25
20
15
10
5
0
T & E Species
Harvestable
Big Game
Furbearers
Small Game
Upland Game
Waterfowl
Ecosystem Diversity
Rio Grande
San Pedro
Southwest

Radar Graphs



Boykin, K.G., et al., ***A National Approach for Mapping and Quantifying Habitat-based Biodiversity Metrics across Multiple Spatial Scales.*** **Ecol. Indicators (2013). 33: 139-147.**

Normalized Index of Biodiversity

Average of each metric pixel value in study area **/** highest mapped pixel value in Southwest Region.

Draft National Biodiversity Metrics

A) Biodiversity Conservation; B) Food, Fiber, and Materials; and C) Recreation, Culture, and Aesthetics:

Total Terrestrial Vertebrate Richness (A, C)
Total Bird Richness (A, C)
Total Mammal Richness (A)
Total Reptile Richness (A)
Total Amphibian Richness (A)

Total Economic Effect (San Pedro)
= **$24,130,389/annum**
Fish & Wildlife Economics and Statistics, Southwick Associates, 2013

Rarity Index; Total Terrestrial Vertebrates (A)
Rarity Index; Total Mammals (A)
Rarity Index; Total Birds (A)
Rarity Index; Total Reptiles (A)
Rarity Index; Total Amphibians (A)

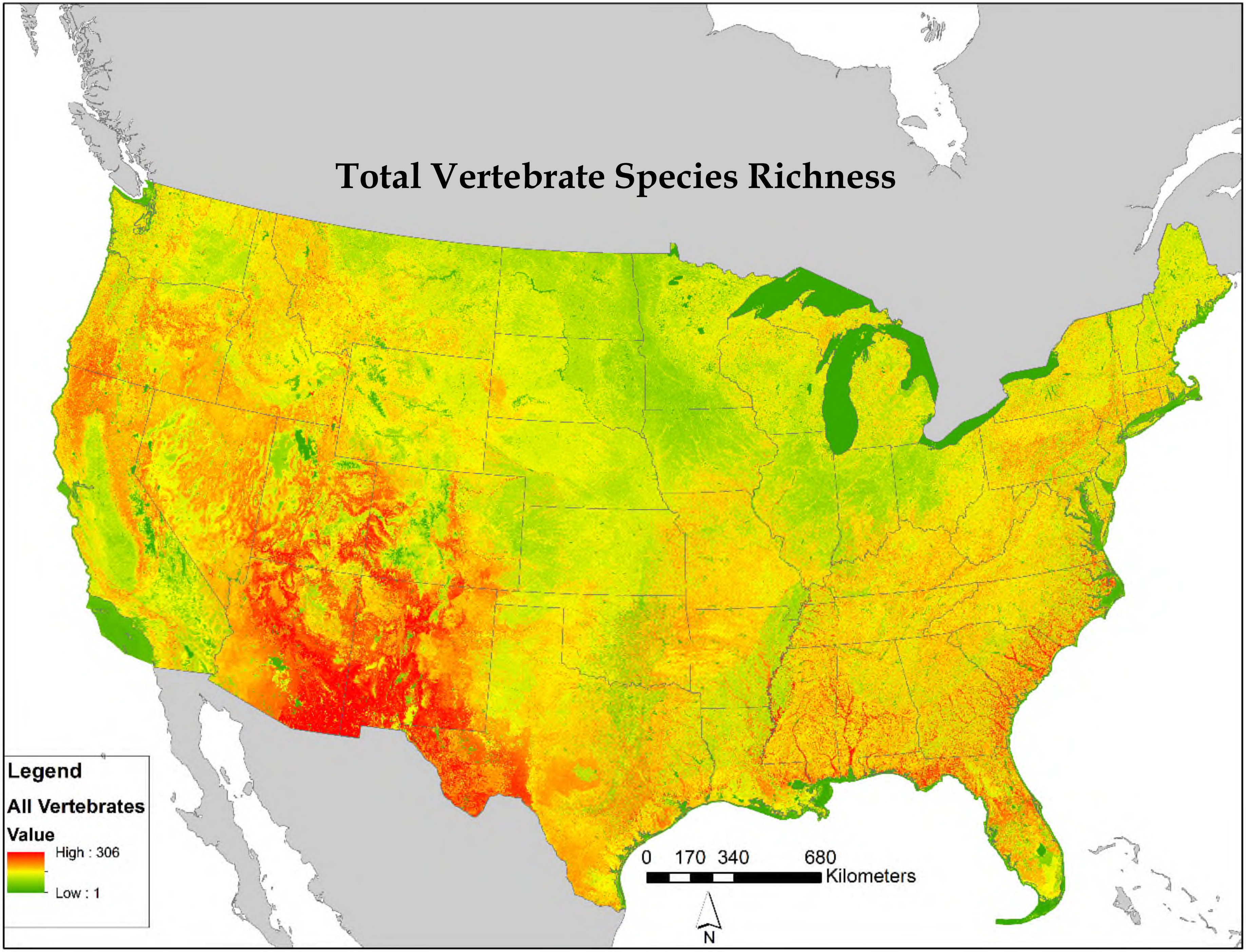
Total Harvestable Species Richness (B, C)
Total Big Game Species Richness (B, C)
Total Small Game Species Richness (B, C)
Furbearer Species Richness (B, C)
Waterfowl Species Richness (B, C)

T & E Terrestrial Vertebrate Richness (A, C)
Global Rank Species Richness; G1, G2, *and* G3 (A)
IUCN Threatened Terrestrial Vertebrate Species Richness (A)

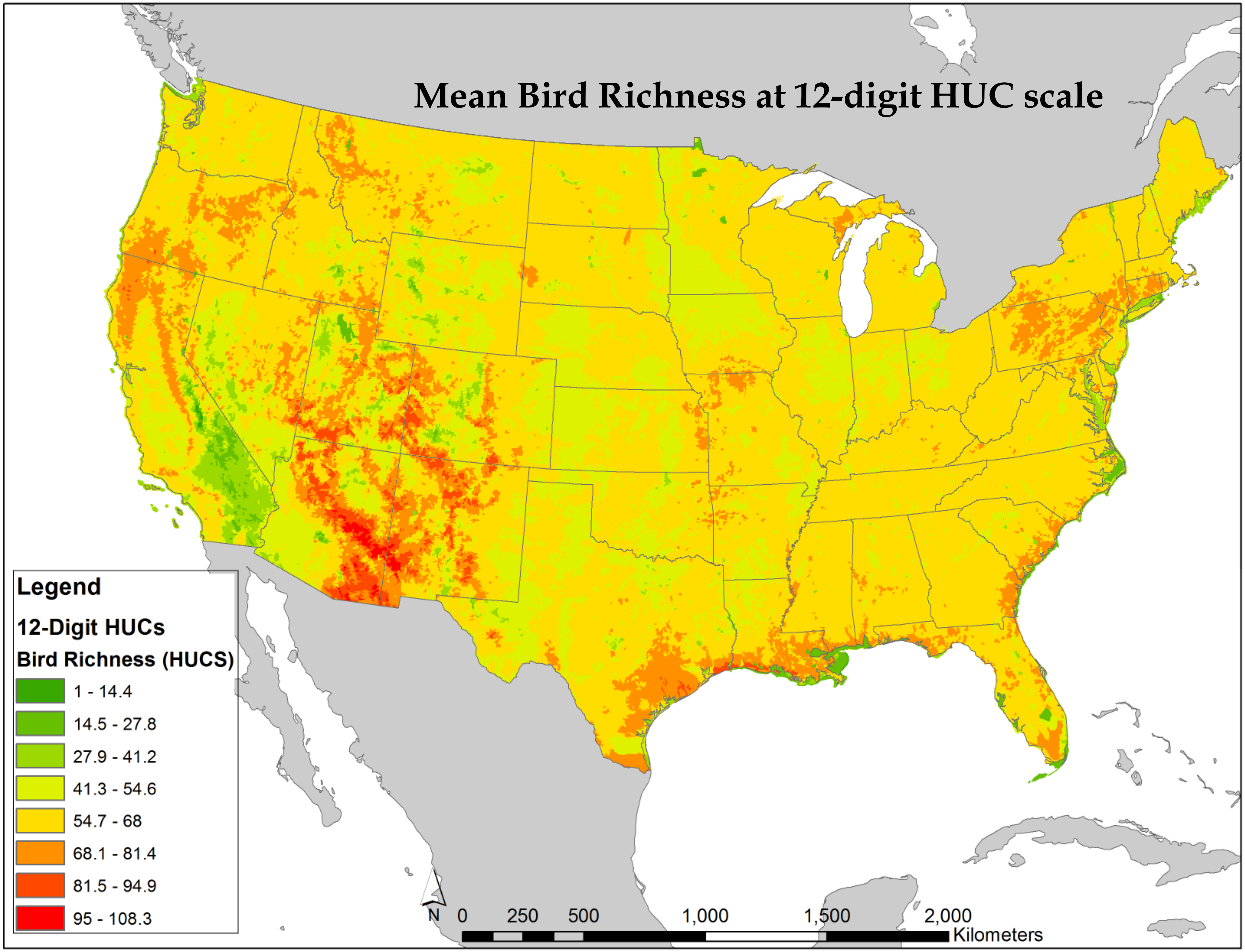
Partners in Amphibian and Reptile Conservation (PARC) Species Richness (A)

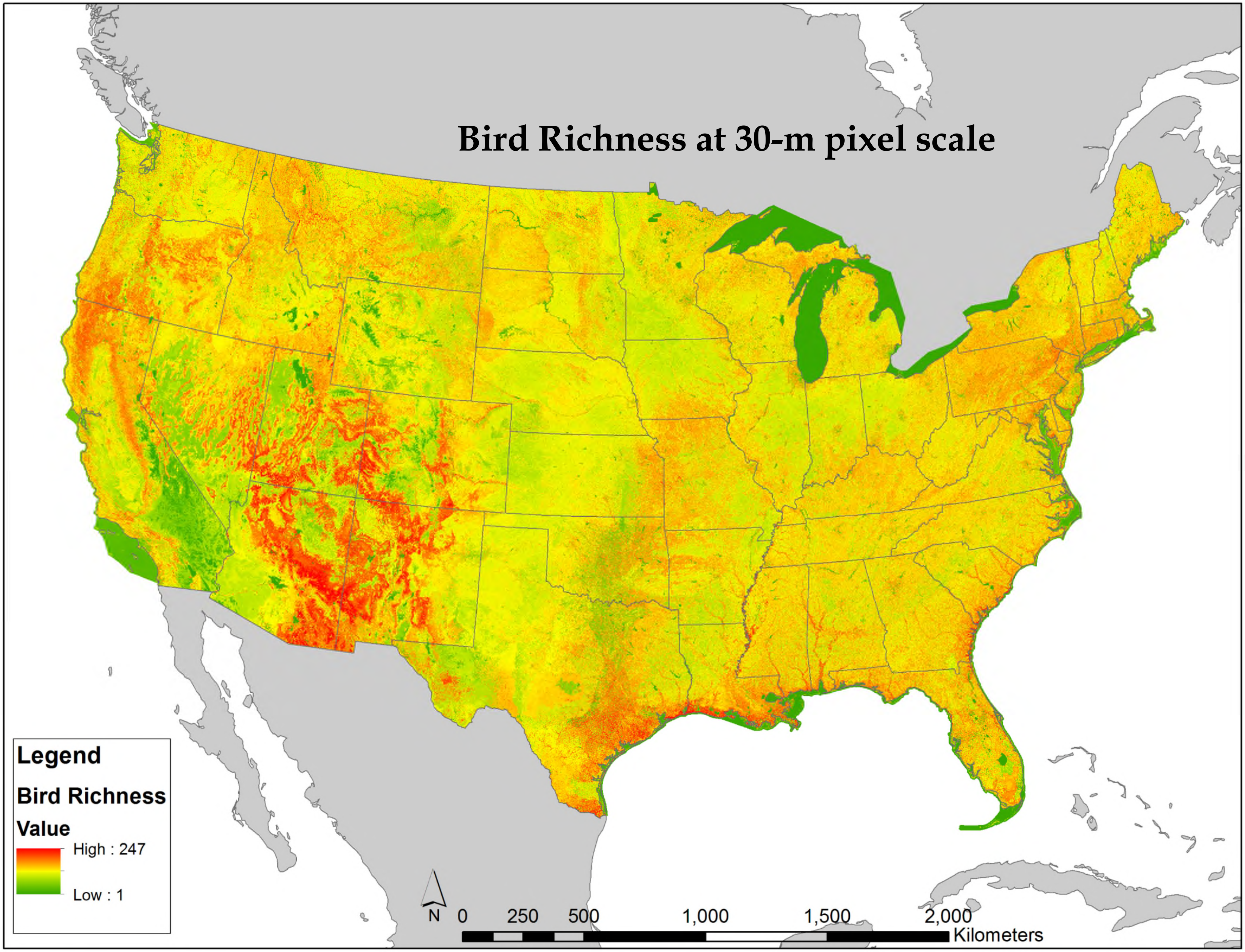
Audubon Climate-Endangered Bird Species Richness (A)
Audubon Climate-Threatened Bird Species Richness (A)
GAP Migratory Bird Species Richness (A, C)
Partners in Flight Species Richness (A, C)
Birds of Conservation Concern Species Richness; State of the Birds 2016 (A, C)

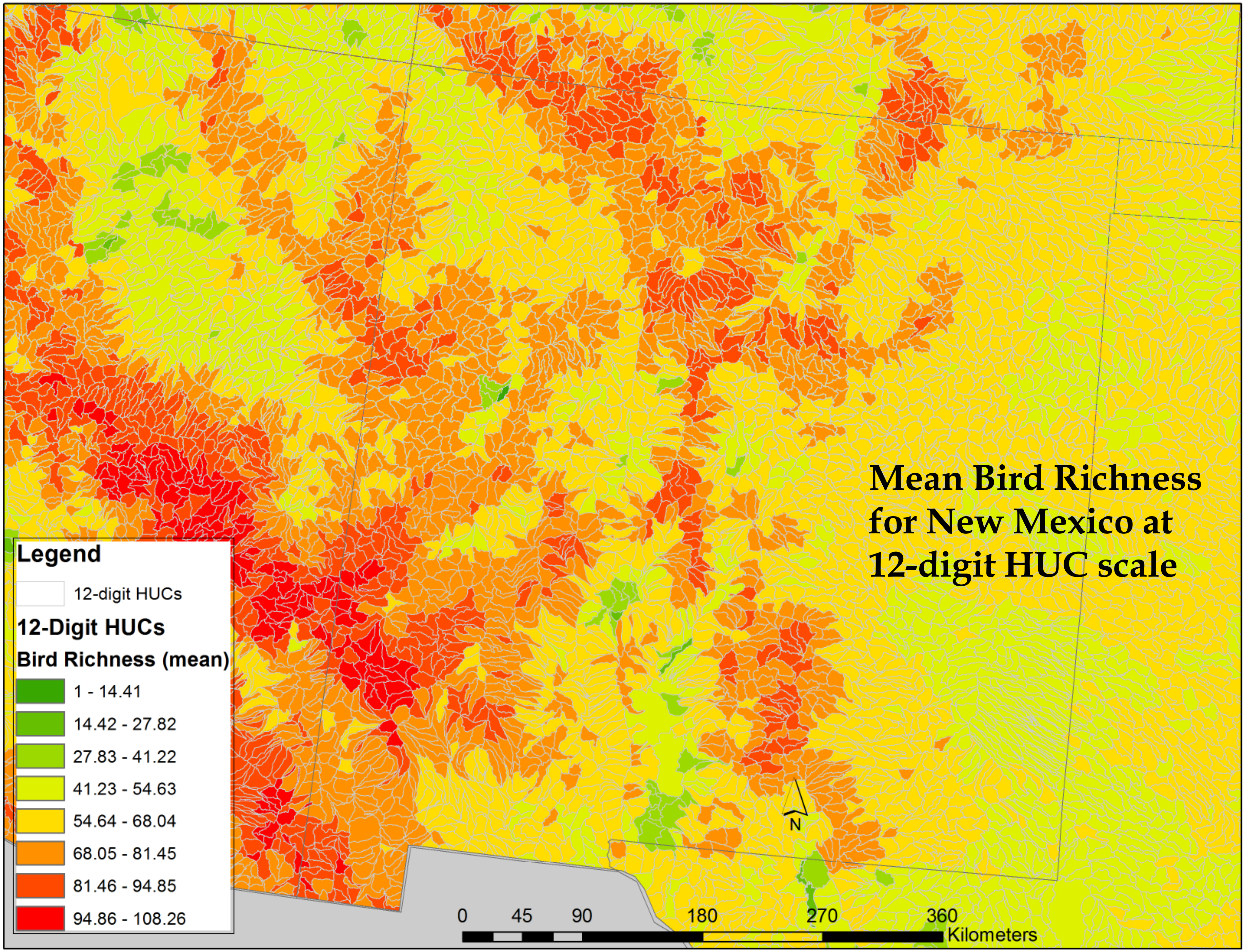
Currently includes 66 separate fact sheets for the Biodiversity Metrics in the ***EnviroAtlas***; https://www.epa.gov/enviroatlas/enviroatlas-dynamic-data-matrix

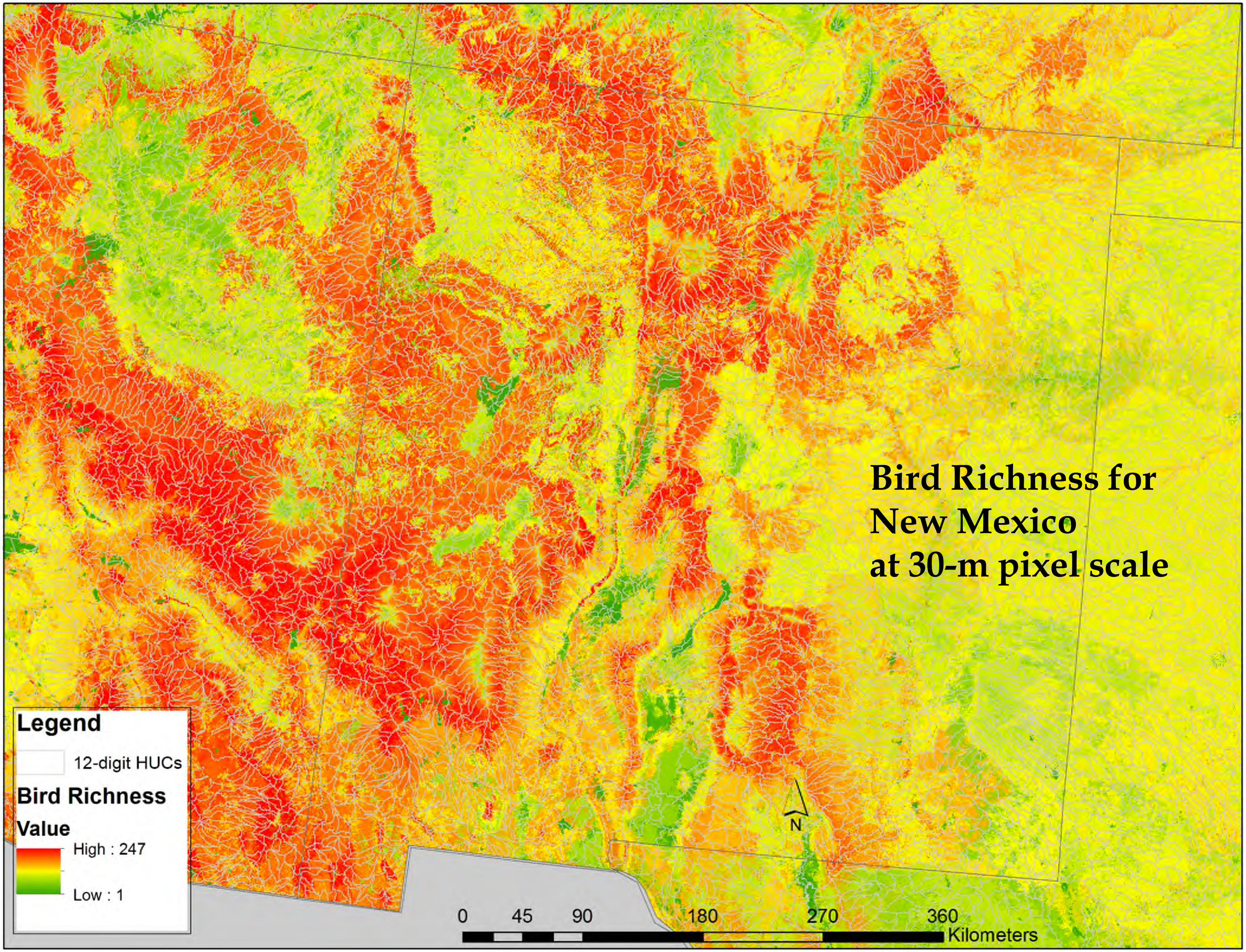


Total Vertebrate Species Richness
Legend
All Vertebrates
Value
High : 306
Low : 1
0 170 340 680
Kilometers
N

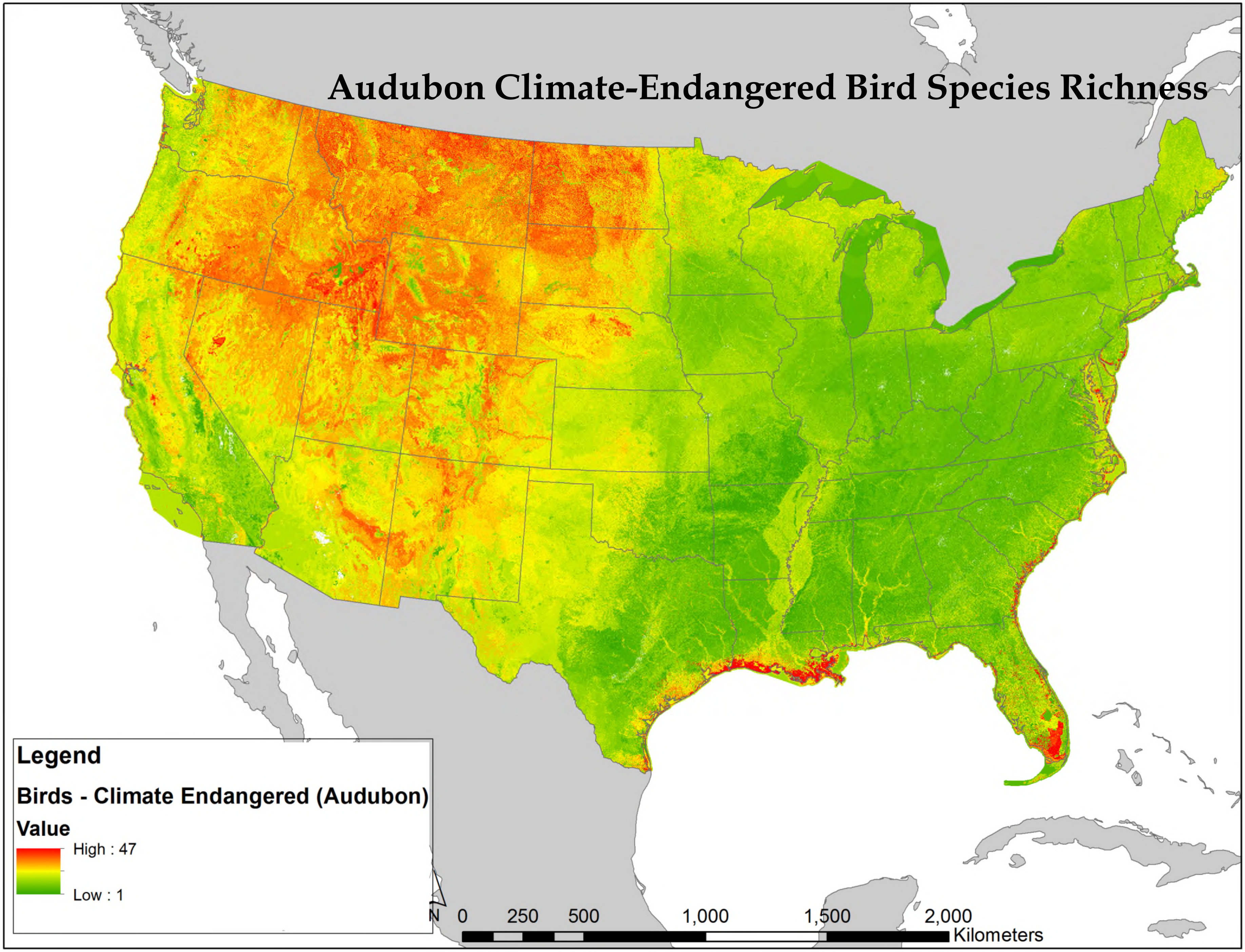

Mean Bird Richness at 12-digit HUC scale
Legend
12-Digit HUCs
Bird Richness (HUCS)
1 - 14.4
14.5 - 27.8
27.9 - 41.2
41.3 - 54.6
54.7 - 68
68.1 - 81.4
81.5 - 94.9
95 - 108.3
N
0
250
500
1,000
1,500
2,000
Kilometers


Bird Richness at 30-m pixel scale
Legend
Bird Richness
Value
High : 247
Low : 1
N
0 250 500 1,000 1,500 2,000
Kilometers

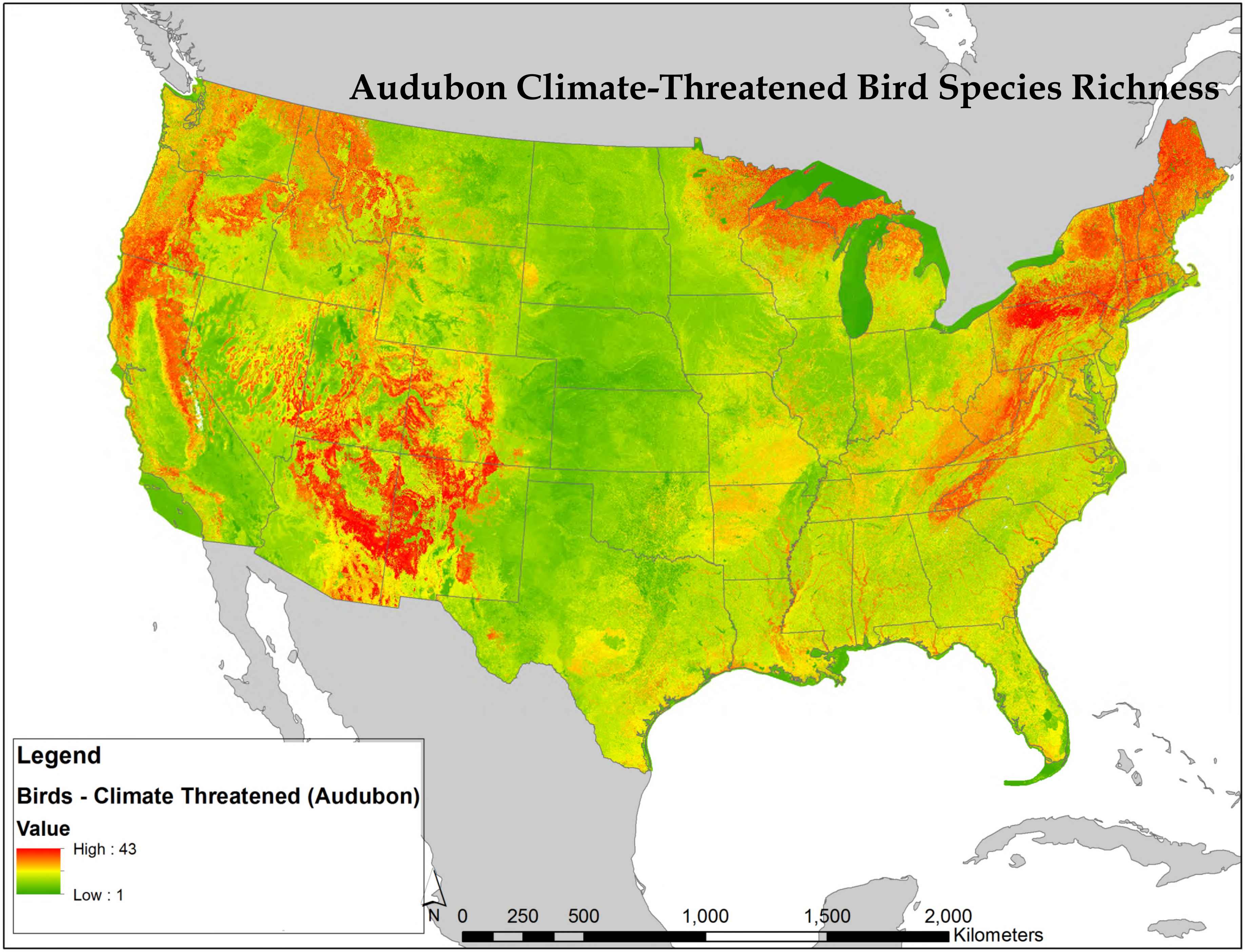

Mean Bird Richness for New Mexico at 12-digit HUC scale
Legend
12-digit HUCs
12-Digit HUCs
Bird Richness (mean)
1 - 14.41
14.42 - 27.82
27.83 - 41.22
41.23 - 54.63
54.64 - 68.04
68.05 - 81.45
81.46 - 94.85
94.86 - 108.26
N
0 45 90 180 270 360
Kilometers

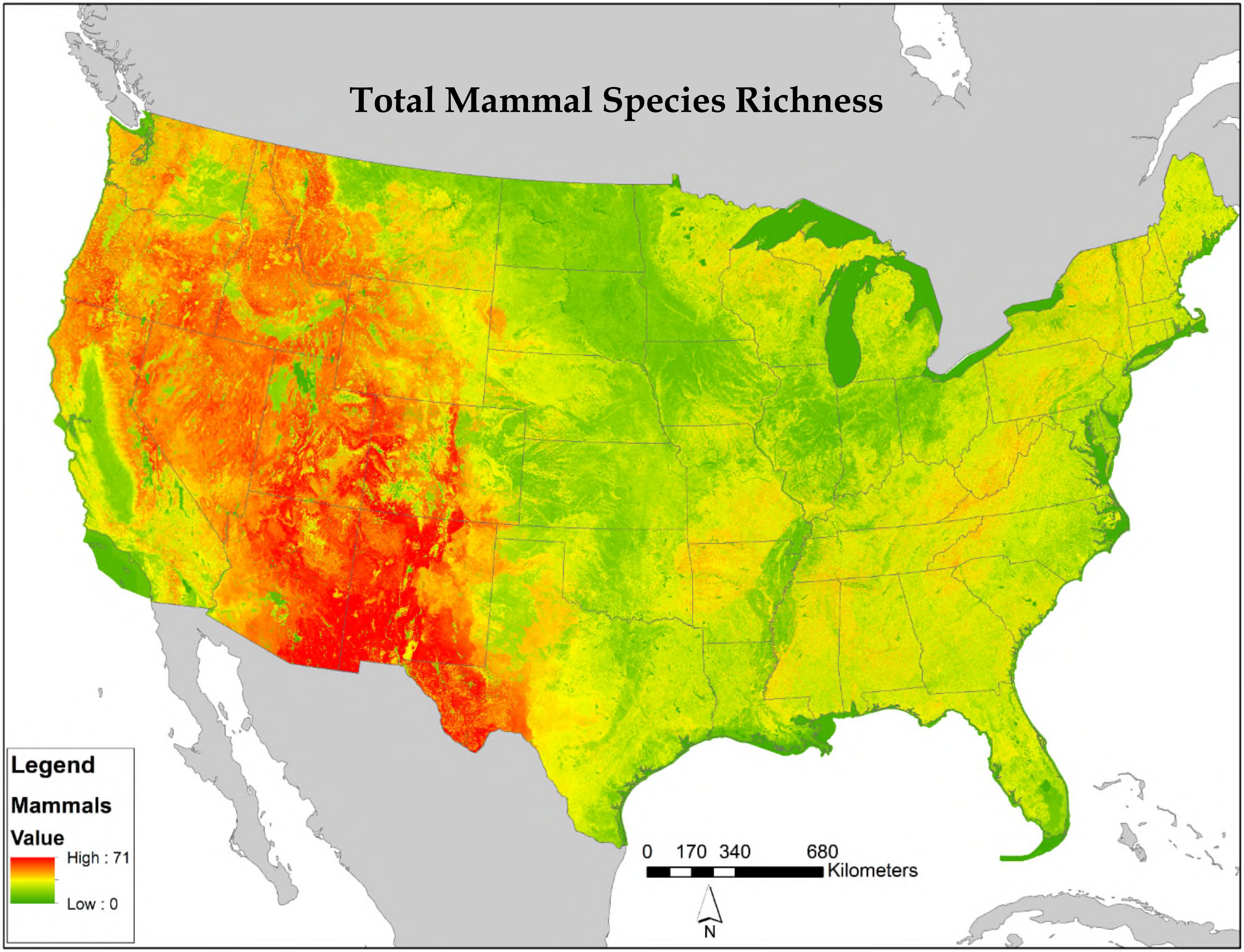


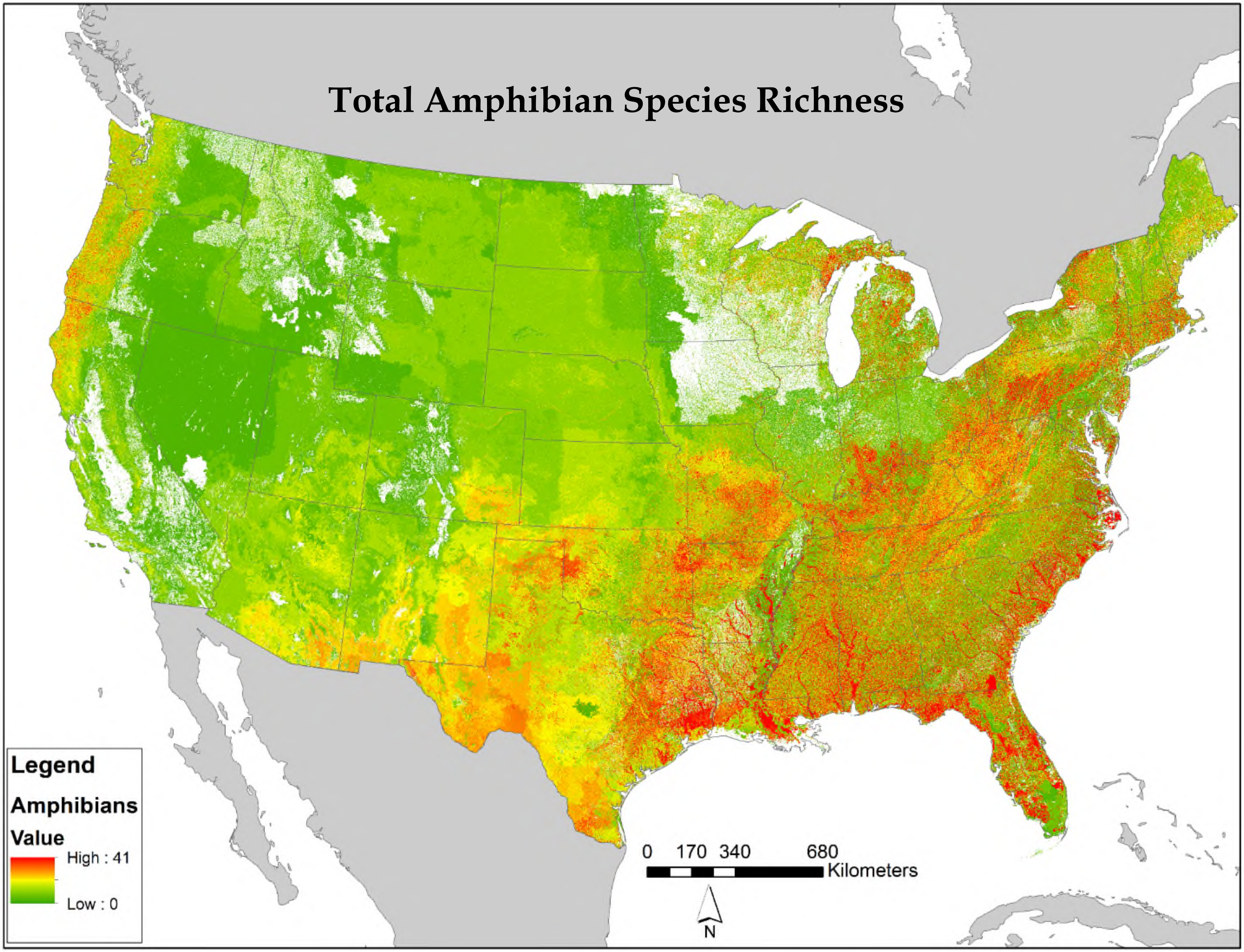
Bird Richness for
New Mexico
at 30-m pixel scale
Legend
12-digit HUCs
Bird Richness
Value
High : 247
Low : 1
N
0
45
90
180
270
360
Kilometers

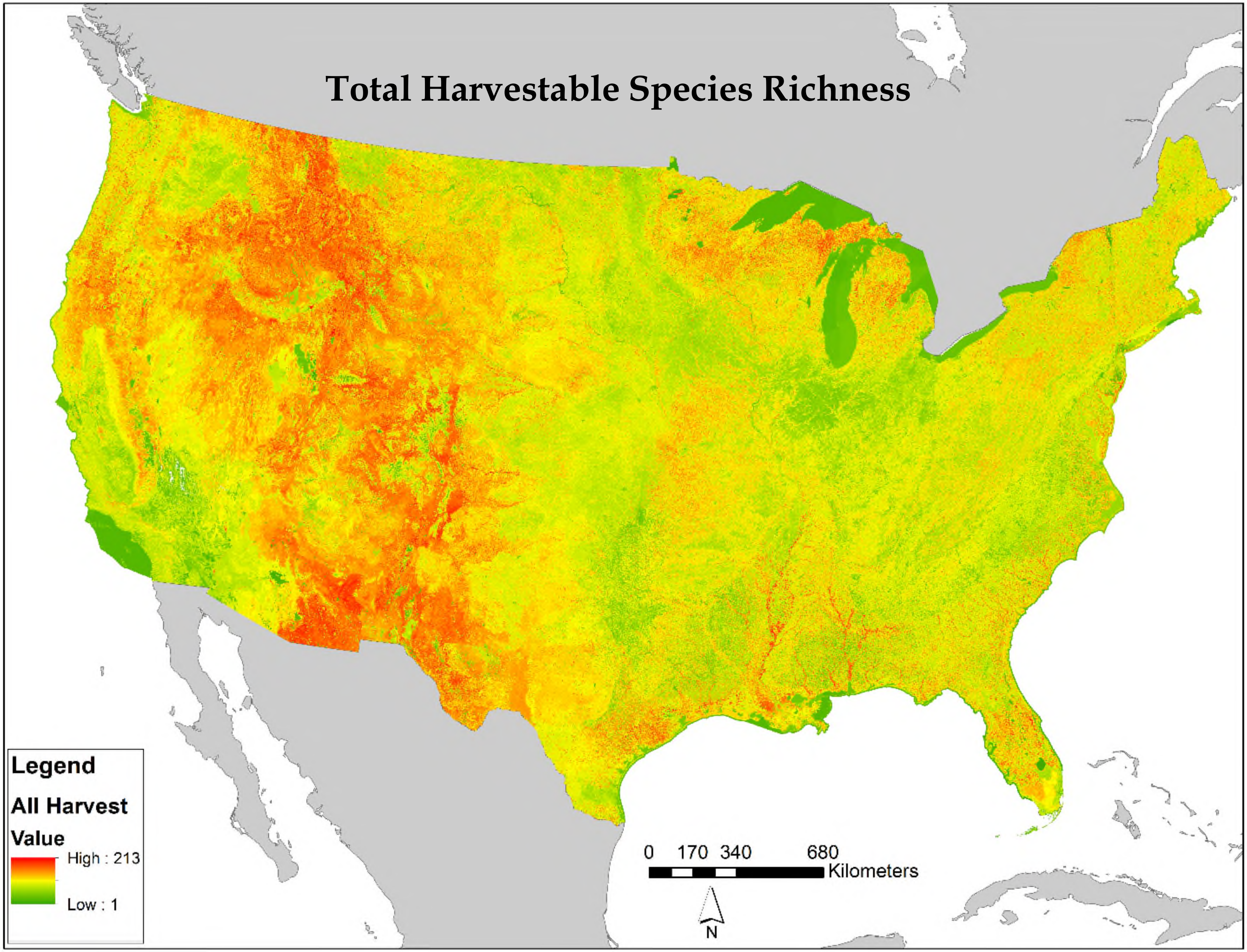


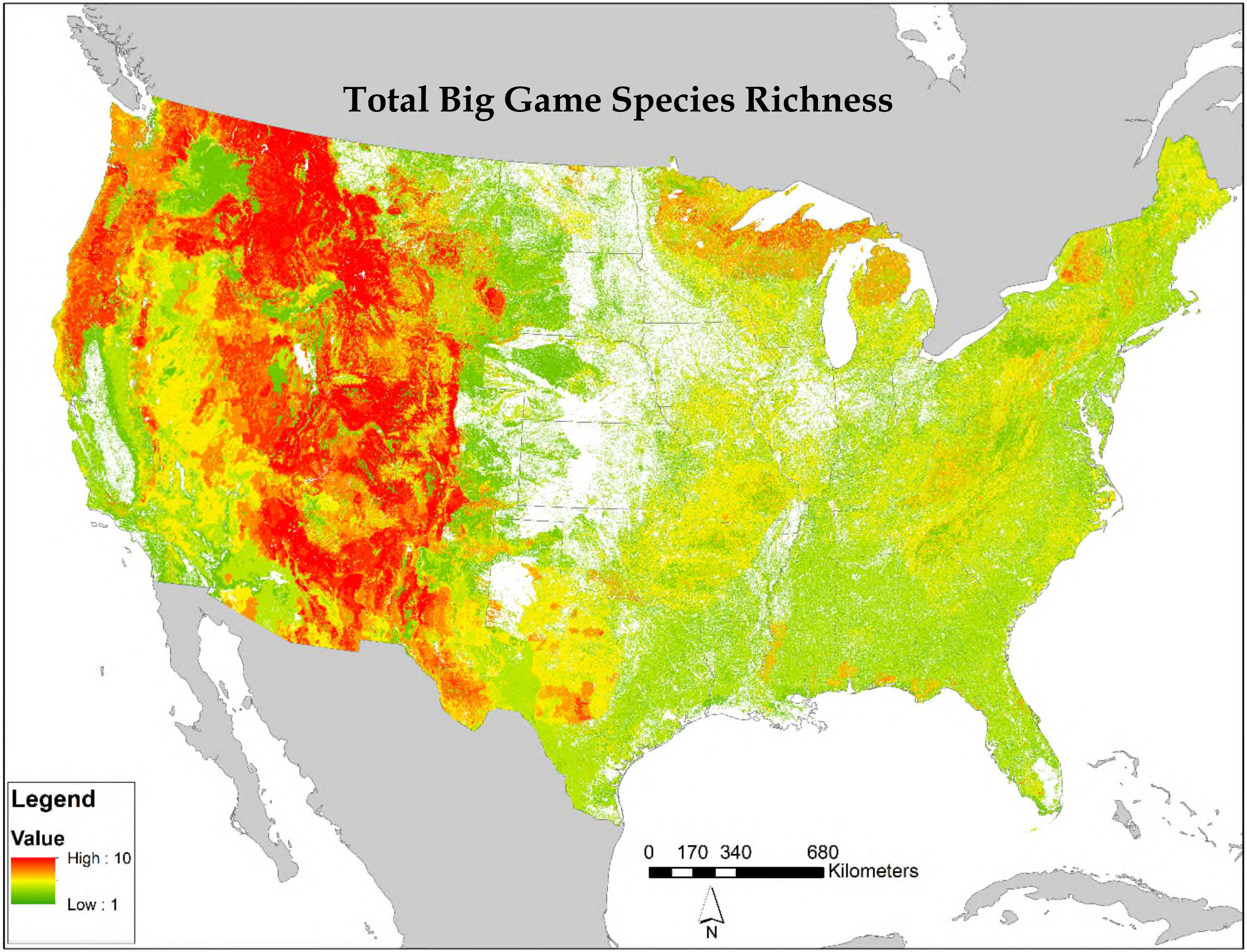
Audubon Climate-Endangered Bird Species Richness
Legend
Birds - Climate Endangered (Audubon)
Value
High : 47
Low : 1
N
0 250 500 1,000 1,500 2,000
Kilometers


Audubon Climate-Threatened Bird Species Richness
Legend
Birds - Climate Threatened (Audubon)
Value
High : 43
Low : 1
N
0
250
500
1,000
1,500
2,000
Kilometers

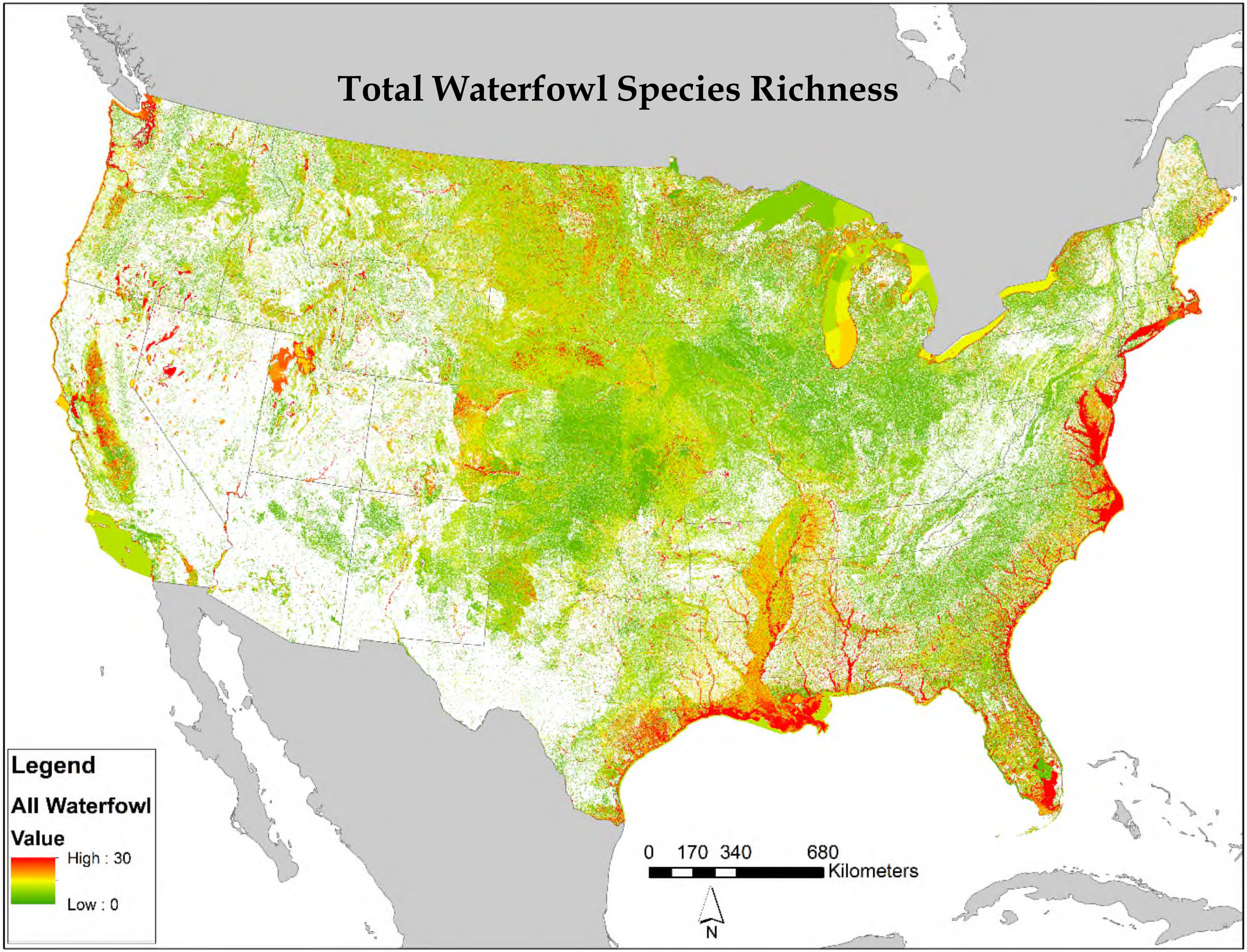

Total Mammal Species Richness
Legend
Mammals
Value
High : 71
Low : 0
0 170 340 680
Kilometers
N

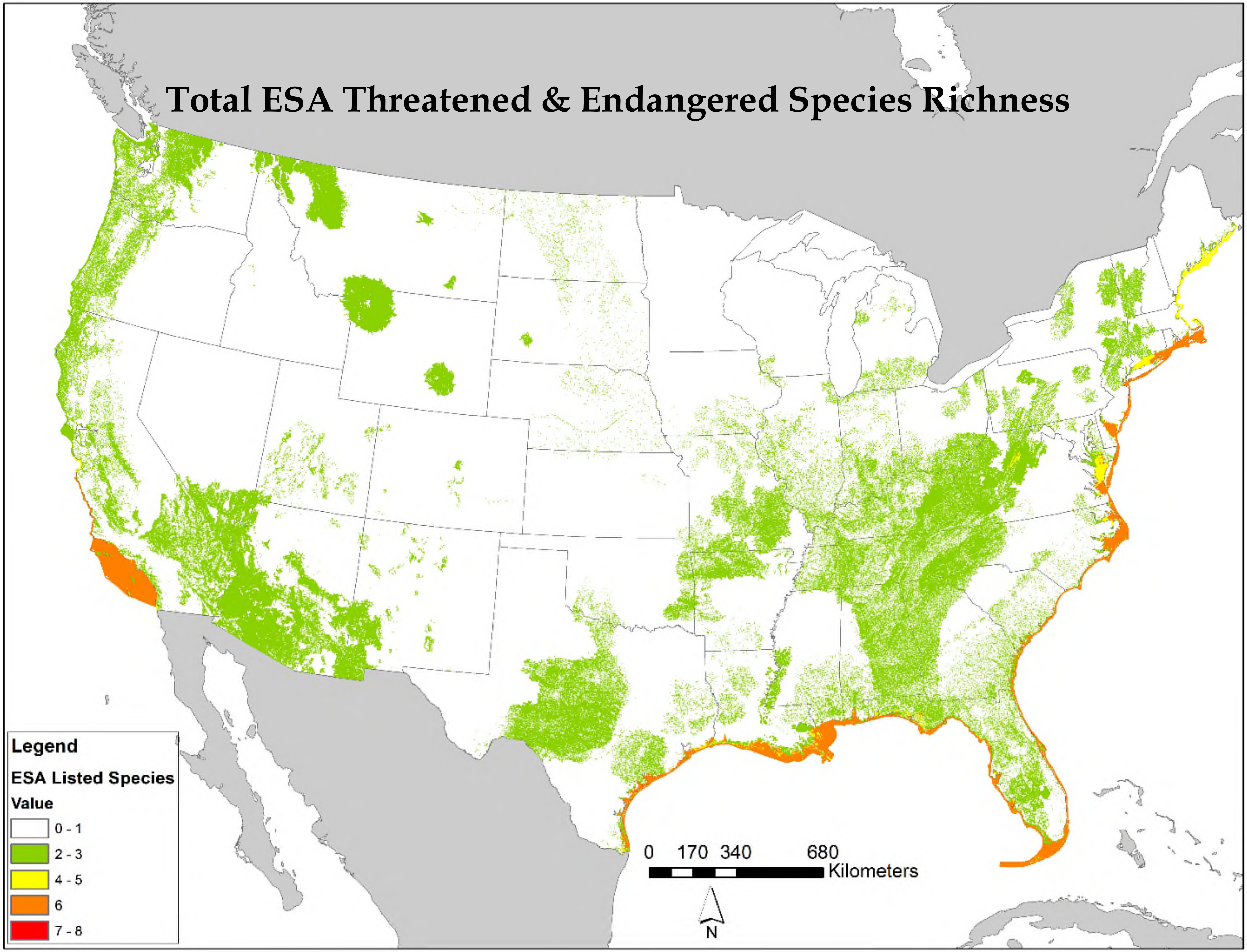

Total Amphibian Species Richness
Legend
Amphibians
Value
High : 41
Low : 0
0 170 340 680
Kilometers
N


Total Harvestable Species Richness
Legend
All Harvest
Value
High : 213
Low : 1
0 170 340 680
Kilometers
N



Total Big Game Species Richness
Legend
Value
High : 10
Low : 1
0 170 340 680
Kilometers
N


Total Waterfowl Species Richness
Legend
All Waterfowl
Value
High : 30
Low : 0
0 170 340 680
Kilometers
N


Total ESA Threatened & Endangered Species Richness
Legend
ESA Listed Species
Value
0 - 1
2 - 3
4 - 5
6
7 - 8
0 170 340 680
Kilometers
N

Some general observations

- Ecosystem Services paradigm useful organizing framework for characterizing and assessing biodiversity conservation;
- Deductive modeling provides great utility for mapping and quantifying metrics of biodiversity conservation at multiple scales and within a reasonable timeframe;
- First level effort to cluster species distribution models into functional groups (metrics) is complete at local and regional scales and has moved to the **national** scale via EPA EnviroAtlas & USGS/GAP platforms. All national deductive habitat species models complete (**1699 spp**);
- Provides baseline or reference conditions for alternative future scenarios (e.g. climate change, urbanization, trend analysis);
- Establishes common sense *indicators of ES* for national, regional, and local end-user and decision-maker needs;
- Flexible enough to add & test new metrics as they are identified;
- Also potentially useful for global initiatives (IPBES, TEEB, GEO BON, DIVERSITAS, etc.).

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www.epa.gov/enviroatlas

http://case.nmsu.edu/case/es/