A NATIONAL SYSTEM TO MAP AND QUANTIFY TERRESTRIAL VERTEBRATE BIODIVERSITY

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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)
EnviroAtlas data are organized into 7 ecosystem service benefit categories.
The EnviroAtlas is multi-scaled

• National: Wall-to-wall coverage for conterminous US; summarized by ~85,000 drainage basins (12-digit HUCs- approx. 40 mi² or 105 km² 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 ($n = 1,699$).

Range Delineation
- Hydrologic Unit (12-digit)

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

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertebrate species richness</td>
<td>Number of terrestrial vertebrate species (i.e., amphibians, birds, mammals, reptiles) as measured by predicted habitat present within a pixel (Boykin et al., 2007).</td>
</tr>
<tr>
<td>Amphibian richness</td>
<td>Number of amphibian species as measured by predicted habitat present within a pixel.</td>
</tr>
<tr>
<td>Bird richness</td>
<td>Number of bird species as measured by predicted habitat present within a pixel.</td>
</tr>
<tr>
<td>Mammal richness</td>
<td>Number of mammal species as measured by predicted habitat present within a pixel.</td>
</tr>
<tr>
<td>Reptile richness</td>
<td>Number of reptile species as measured by predicted habitat present within a pixel.</td>
</tr>
<tr>
<td>Bat richness</td>
<td>Number of bat species as measured by predicted habitat present within a pixel.</td>
</tr>
<tr>
<td>All species of greatest conservation need richness</td>
<td>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; CDO, 2005; NDOW, 2006; UDWR, 2005; NMDGF, 2006).</td>
</tr>
<tr>
<td>Amphibian SGCN richness</td>
<td>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.</td>
</tr>
<tr>
<td>Bird SGCN richness</td>
<td>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.</td>
</tr>
<tr>
<td>Mammal SGCN richness</td>
<td>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.</td>
</tr>
<tr>
<td>Reptile SGCN richness</td>
<td>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.</td>
</tr>
<tr>
<td>Bat SGCN richness</td>
<td>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.</td>
</tr>
<tr>
<td>Threatened and endangered species richness</td>
<td>Number of Federally listed Threatened and Endangered Species as measured by predicted habitat present within a pixel (USFWS, 2011)</td>
</tr>
<tr>
<td>Harvestable species</td>
<td>Number of harvestable terrestrial vertebrate species (defined by each states hunting regulations) as measured by predicted habitat present within a pixel.</td>
</tr>
<tr>
<td>Furbearers</td>
<td>Number of furbearer species as measured by predicted habitat present within a pixel. Examples include beaver, badger, and marten.</td>
</tr>
<tr>
<td>Big game</td>
<td>Number of big game species as measured by predicted habitat present within a pixel. Examples include Elk, mule deer, and pronghorn.</td>
</tr>
<tr>
<td>Small game</td>
<td>Number of small game species as measured by predicted habitat present within a pixel. Examples include sandhill crane, scaled quail and dusky grouse.</td>
</tr>
<tr>
<td>Upland game</td>
<td>Number of upland game species as measured by predicted habitat present within a pixel. Examples include desert cottontail, red squirrel, wild turkey.</td>
</tr>
<tr>
<td>Waterfowl</td>
<td>Number of waterfowl species as measured by predicted habitat present within a pixel. Examples include mallards, Canada goose, and trumpeter swan.</td>
</tr>
<tr>
<td>Ecosystem diversity</td>
<td>Number of land cover types within a 1-km neighborhood by pixel.</td>
</tr>
</tbody>
</table>
Species Richness & Mapping Approach by Scale

<table>
<thead>
<tr>
<th>Taxon</th>
<th>San Pedro</th>
<th>Southwest</th>
<th>Southeast</th>
<th>Nation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphibians</td>
<td>16</td>
<td>37</td>
<td>124</td>
<td>304</td>
</tr>
<tr>
<td>Birds</td>
<td>287</td>
<td>435</td>
<td>259</td>
<td>686</td>
</tr>
<tr>
<td>Mammals</td>
<td>88</td>
<td>215</td>
<td>99</td>
<td>475</td>
</tr>
<tr>
<td>Reptiles</td>
<td>61</td>
<td>130</td>
<td>124</td>
<td>322</td>
</tr>
<tr>
<td><strong>Total Species</strong></td>
<td><strong>452</strong></td>
<td><strong>817</strong></td>
<td><strong>606</strong></td>
<td><strong>1787</strong></td>
</tr>
</tbody>
</table>
Example: Total species richness
Radar Graphs


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)
- 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)

Total Economic Effect (San Pedro) = $24,130,389/annum


Mean Bird Richness for New Mexico at 12-digit HUC scale

Legend

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

Kilometers
Bird Richness for New Mexico at 30-m pixel scale
Audubon Climate-Threatened Bird Species Richness

Legend
Birds - Climate Threatened (Audubon) Value
High: 43
Low: 1

Scale: 0 to 2,000 Kilometers
Total Mammal Species Richness

Legend

Mammals Value

High: 71
Low: 0

0 170 340 680 Kilometers
Total Harvestable Species Richness
Total Waterfowl Species Richness

Legend

All Waterfowl Value

High: 30
Low: 0

Kilometers

0 170 340 680
Total ESA Threatened & Endangered Species Richness

Legend
ESA Listed Species
Value
0 - 1
2 - 3
4 - 5
6
7 - 8

Kilometers
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/