A Community on Ecosystem Services
December 8, 2016
Jacksonville, FL
Total Species

Reptile Spp = 322

What about Reptiles?
EnviroAtlas -- Nature’s Benefits Categories

- Clean Air
- Clean & Plentiful Water
- Biodiversity Conservation
- Natural Hazard Mitigation
- Climate Stabilization
- Food, Fiber & Materials
- Recreation, Culture & Aesthetics
Gap Analysis Products and Data Sources

- Land Cover
  - 583 classes
  - 556 Natural
  - 27 Land use

- Species Distribution Models
  - Knowledge based/expert based
  - Wildlife Habitat Relationships
  - Habitat based
  - Top down - general to specific
  - 322 Reptile Models

- Protected Areas Database

http://gapanalysis.usgs.gov/
Biodiversity

Food, fuel and materials

Food: Turtles, Alligators

Medicine: Blood thinning drugs, Asthma

Clothing

Natural hazard mitigation

Disease

Pest outbreaks

Recreation, culture, aesthetics

Awareness

Art

Regulatory (Endangered Species Act)

Biodiversity Conservation

Food Web

Altering Physical Habitat
<table>
<thead>
<tr>
<th>Protection status</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status 1 and 2</strong> Lands managed to maintain biodiversity (i.e., protected areas network)</td>
<td>Yellowstone National Park, Wyoming</td>
</tr>
<tr>
<td><strong>Status 2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Status 3</strong> Lands managed for multiple-use, including conservation</td>
<td>Kaibab National Forest, Arizona</td>
</tr>
<tr>
<td><strong>Status 4</strong> Lands with no permanent protection from conversion, but may be managed for conservation</td>
<td>Fort Irwin, California</td>
</tr>
<tr>
<td><strong>No Status</strong></td>
<td>Private Land</td>
</tr>
</tbody>
</table>
Analysis

- Species Richness
- Aiche Biodiversity (17% protected area)
Reptile Ecosystem Services

Biodiversity

Regulatory (Endangered Species Act)

Recreation, culture, aesthetics

All Reptiles
Lizards
Snakes
Turtles
G1, G2, G3
IUCN
Threatened and Endangered
Snakes

Lizard Species Richness by GAP Protection Status

- Status 1 & 2
- Status 1,2,3
- Status 4+
- Aichi
Turtles

Turtle Richness by GAP Protection Status

Legend
- GAP Status 1 & 2
- GAP Status 1,2,3
- Aiche
- Status 4+

Hectares

Status 1 & 2
Status 1,2,3
Aiche
Status 4+
G1, G2, and G3 listed Species Richness by GAP Protection Status

- **Legend**
  - GAP Status
  - Value
    - High: 9
    - Low: 1

- **Graph**
  - Hectares
  - Status 1 & 2
  - Status 1,2,3
  - Status 4+
  - Aichi
IUCN Species Richness by GAP Protection Status

Legend
- IUCN listed Reptiles Value
  - Low: 1
  - High: 10

Map: IUCN listed Species Richness by GAP Protection Status

- Status 1 & 2
- Status 1, 2, 3
- Status 4+
- Aichi

Graph: IUCN listed Species Richness by GAP Protection Status

- Hectares
- Status 1 & 2
- Status 1, 2, 3
- Status 4+
- Aichi
PARC Listed Species Richness by GAP Protection Status

Hectares

- Status 1 & 2
- Status 1, 2, 3
- Status 4+
- Aichi
T & E Species
Threatened and Endangered

Threatened and Endangered Species Richness by GAP Protection Status
Other Metrics

Rare - Area modeled
Rare – Number of HUCs

Venomous Reptiles
Richness by Land Cover
Conclusions

• Metrics suggest current Protected Lands system are not sufficient;
  • For all metrics

• Metrics suggest current Status 1-3 Lands are sufficient
  • All Reptiles, Lizards, Snakes, G1G2G3 and PARC
  • Marginally Turtles and IUCN

• Other Lands (not Status 1,2, and 3) are sufficient
Conclusions

• Semi-Desert has the most richness
• Forest/Woodlands and Shrubs/Grasslands next
• Turtles are high in aquatics
• Relatively high richness is modified lands
  • Snakes
• Reptiles are an interesting ES model because:
  • Understudied
  • General fear and loathing
• Ecosystem Services can play an important part in Conservation
# Reptile Ecosystem Services

<table>
<thead>
<tr>
<th>Benefit Category EnviroAtlas</th>
<th>Function, Service, Goods</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, fuel and materials</td>
<td>Food</td>
<td>Turtles and tortoises are eaten across the world. Alligators. Snakes and lizards in some degree</td>
</tr>
<tr>
<td>Medicine</td>
<td>Anti-venom and blood thinning drugs. melanoma (Gila monster; Hailey et al. 2012), blood thinning (snakes), cardiovascular disease (snakes), pain (snakes), diabetes (Gila monster), and Alzheimer's disease (Gila monster (Lewis and Garcia 2003))</td>
<td></td>
</tr>
<tr>
<td>Medicine</td>
<td>Traditional medicinal ingredients in Brazil from Alves et al 2009</td>
<td></td>
</tr>
<tr>
<td>Clothing</td>
<td>Boots, belts, hats</td>
<td></td>
</tr>
<tr>
<td>Recreation, culture, aesthetics</td>
<td>Pet Trade</td>
<td>Reptile collectors and breeders</td>
</tr>
<tr>
<td>Natural hazard mitigation</td>
<td>Disease transmission</td>
<td>Regulating disease carrying rodents. Ostfield and Holt (2004) suggest the complexities of this are &quot;largely untested&quot;</td>
</tr>
<tr>
<td>Pest outbreaks</td>
<td>Regulating rodent populations</td>
<td></td>
</tr>
<tr>
<td>Recreation, culture, aesthetics</td>
<td>Awareness</td>
<td>Poison/venomous Snake hunting in OK</td>
</tr>
<tr>
<td>Art</td>
<td>Art/books/mythology, music -</td>
<td></td>
</tr>
<tr>
<td>Regulatory</td>
<td>Federally and state listed species are of concern to agencies and organizations.</td>
<td></td>
</tr>
<tr>
<td>Religious</td>
<td>Used in various religious ceremonies</td>
<td></td>
</tr>
<tr>
<td>Biodiversity Conservation</td>
<td>Food web</td>
<td>Community structure and effect on trophic cascade</td>
</tr>
<tr>
<td></td>
<td>Altering physical habitats</td>
<td>Ecosystem engineering such as tortoise burrows</td>
</tr>
<tr>
<td></td>
<td>Cycling nutrients</td>
<td>Decomposition and primary production</td>
</tr>
</tbody>
</table>
Acknowledgements

Southwest Stakeholders
Southeast Stakeholders
National Stakeholders
Other stakeholders representing:
  – BLM
  – NRCS
  – NMDGF
  – DoD
  – NGOs

USGS SWReGAP Project
  (http://fws-nmcfwru.nmsu.edu/swregap/)

USGS SEGAP Project  (http://www.basic.ncsu.edu/segap/)
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http://case.nmsu.edu/  
https://www.epa.gov/enviroatlas/  
http://gapanalysis.usgs.gov/
Rare Species

Rare (modeled habitat based) Species Richness by GAP Protection Status

Legend
- PADUS 1.3
- GAP Status
- Reptile Rare Area
  - High: 9
  - Low: 1

- total
- Status 4 %
- Status 1 & 2 %
- Status 1-3 &
- Aichi
Habitat Modeling: Deductive vs. Inductive

- **Deductive (GAP Standard)**
  - Knowledge based/expert based
  - Habitat based
  - Top down - general to specific

- **Inductive (Maximum Entropy)**
  - Species occurrence based
  - Bottom up - specific to general

- **Merge the two types**
- **Ensemble models**
General Conclusions

- Process allows many perspectives;
- Responsive to needs of users;
- National level with moderate scale;
- Establish common sense *indicators of ES* for end-user and decision maker needs, e.g.
  - Landscape Conservation Cooperatives
  - State Wildlife Action Plans
  - Potentially also for IPBES, TEEB, GEO BON, DIVERSITAS, etc.
Project Related Personnel

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Modeling Process

Model Variables
- Land cover
- Patch Size
- Edge
- Forest Interior
- Canopy Cover
- Hydrography
  - Flowing water
  - Open/Standing Water
  - Wet Vegetation
- Soils
- Human Impacts/Road Density
- Elevation
- Land Forms