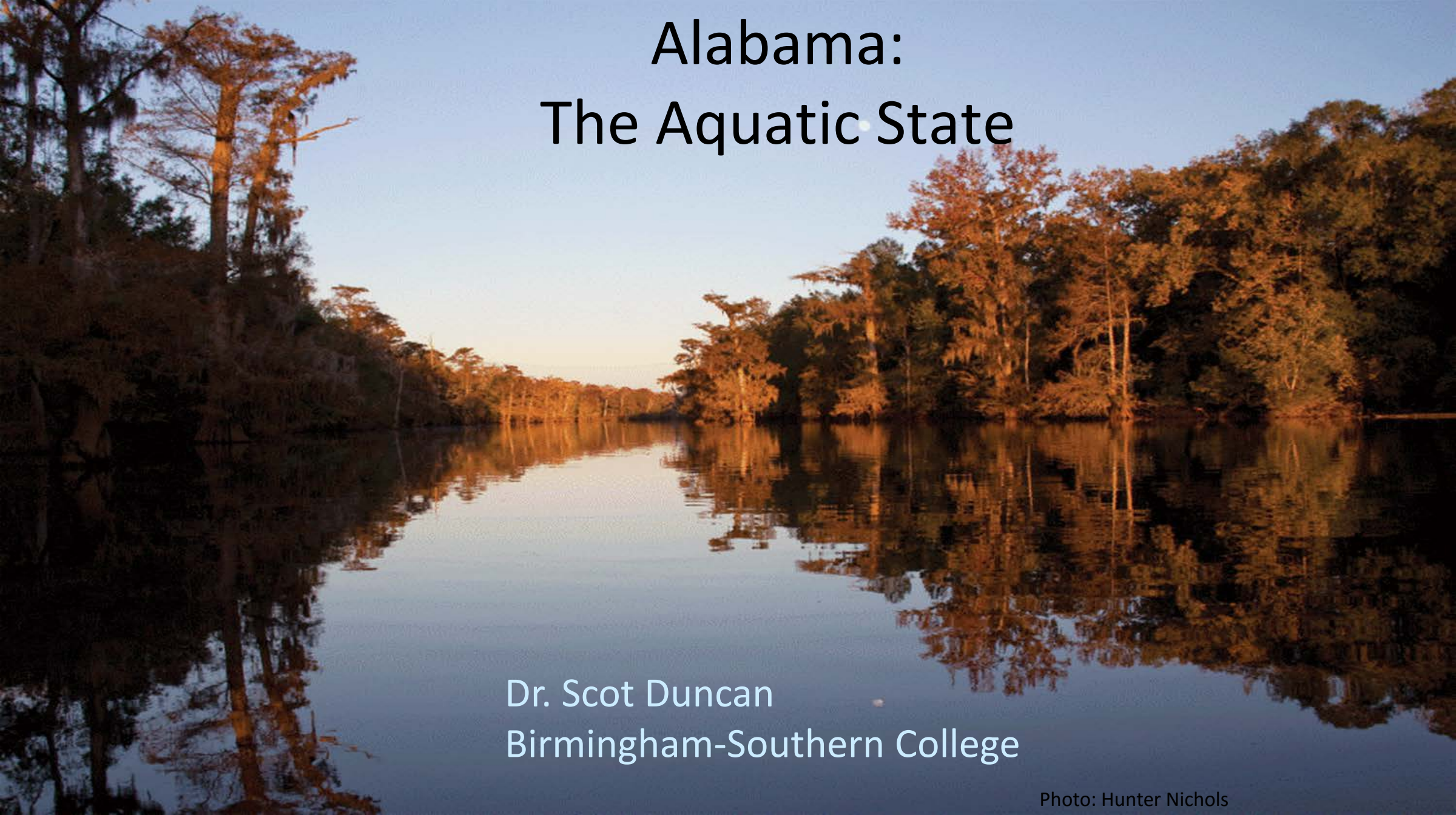
Alabama:
The Aquatic State

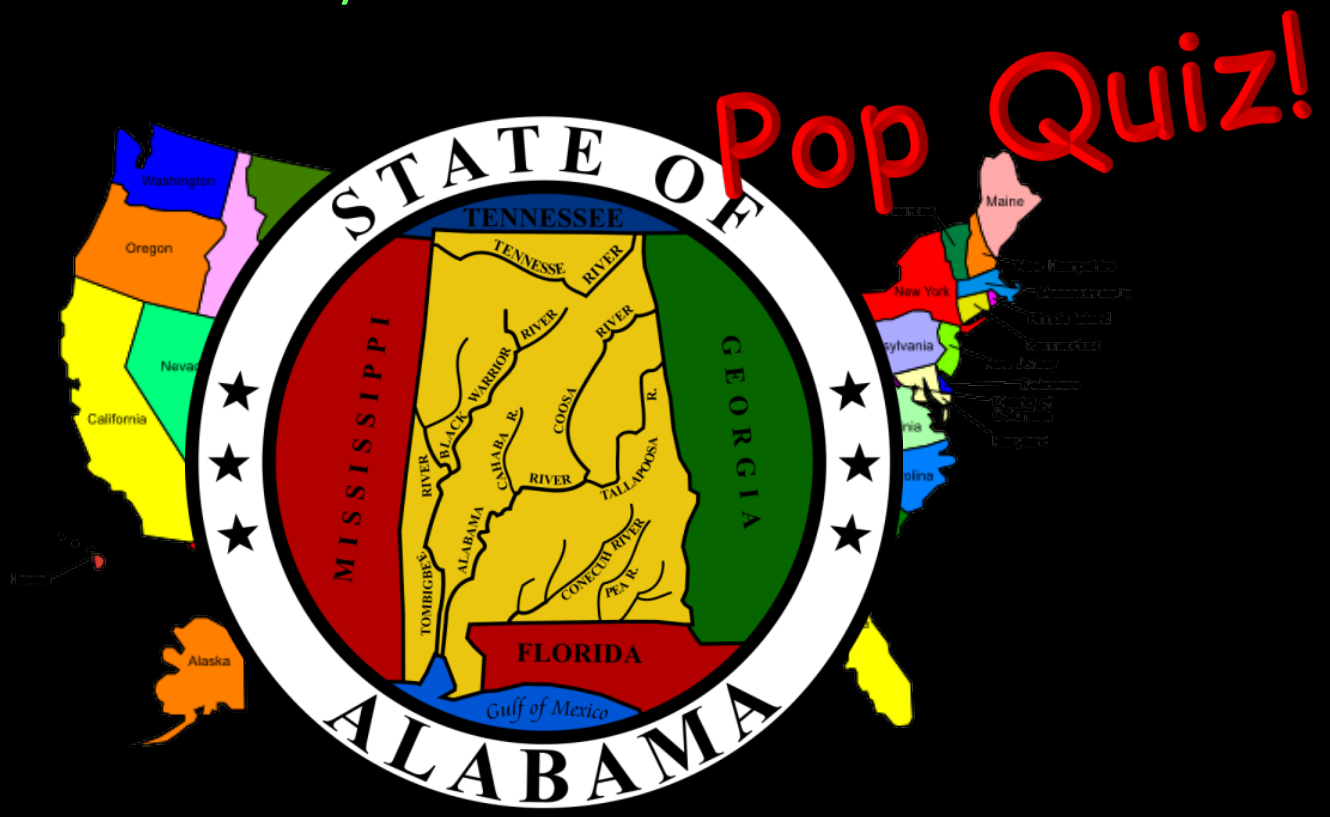


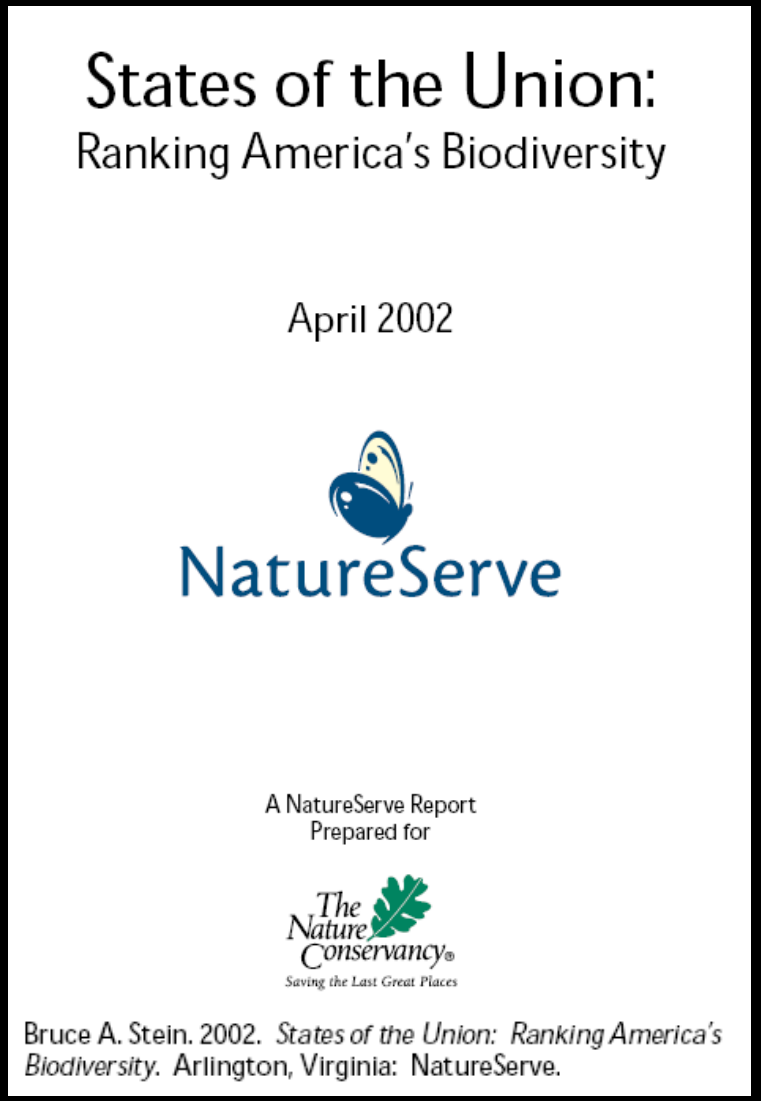
Dr. Scot Duncan
Birmingham-Southern College

Photo: Hunter Nichols

Alabama's Surprising Biodiversity

Which of the 50 states ranks #1 for aquatic species diversity in the US?





Species Diversity by State

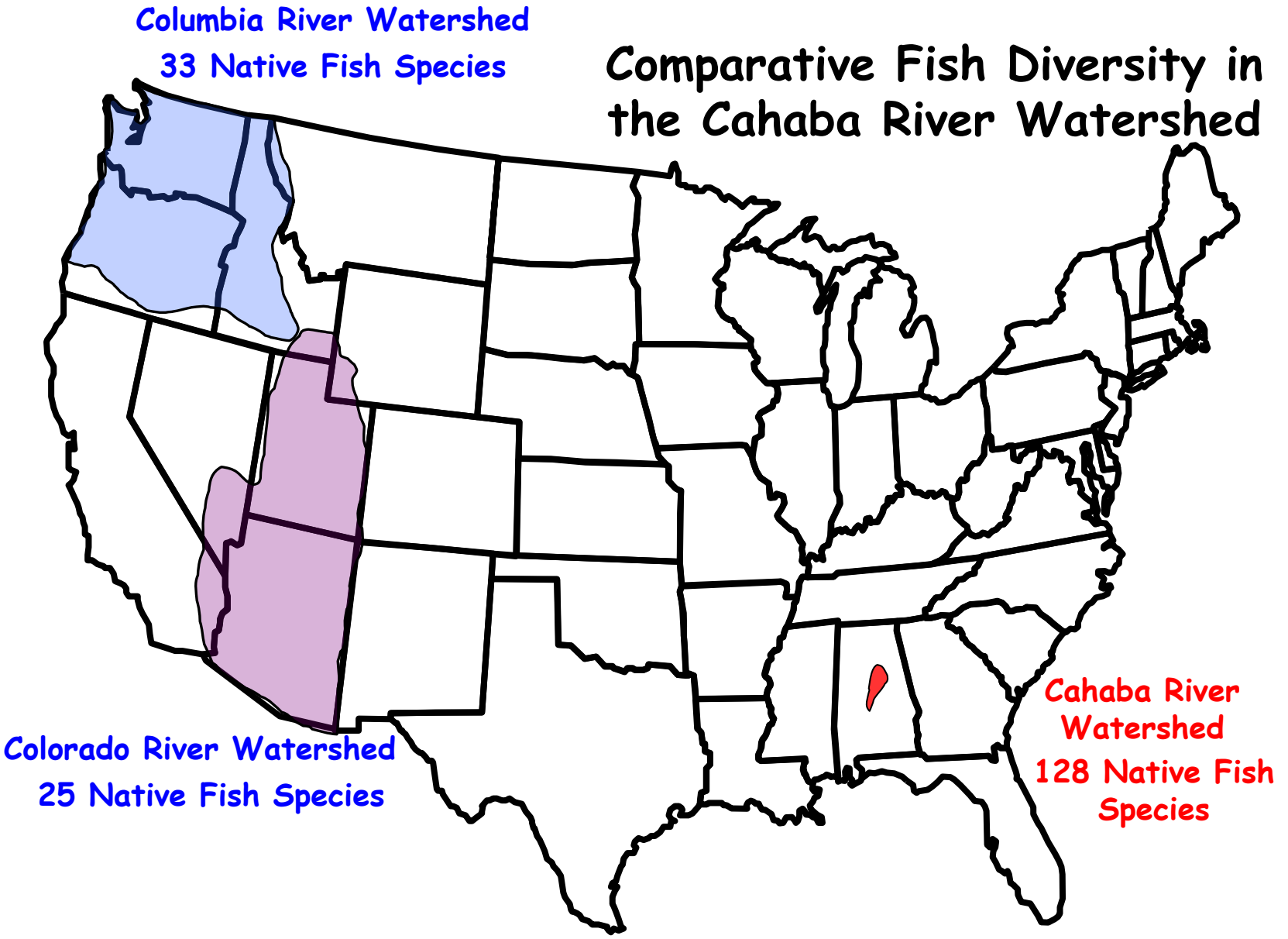
Rank	State	# of Species*
1	California	6,717
2	Texas	6,273
3	Arizona	4,759
4	New Mexico	4,583
5	Alabama	4,533
6	Georgia	4,436
7	Florida	4,368
8	Oregon	4,136
9	North Carolina	4,131
10	Utah	3,892

* Includes vertebrates, vascular plants, freshwater mussels, crayfishes, freshwater snails, large branchiopods, butterflies, underwing moths, tiger beetles, dragonflies, damselflies.

Alabama's Freshwater Fish Data

- Ranked #1 state in the US for fish diversity
- #1 North American Hotspot for species
- 303+ species
- 38%+ of N. Am. species
- 20+ AL endemic species
- 120+ near-endemic species

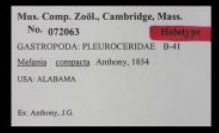
Comparative Fish Diversity in the Cahaba River Watershed



Slide courtesy of Dr. Paul Johnson, Alabama Aquatic Biodiversity Center

Alabama's Freshwater Snails

- The #1 global hotspot [4]
- #1 US state [1]
- 147 spp. [2]
- 43% of N. Am. gill-breathing species [2]



- Mobile River Basin:
  - Epicenter for N. Am. diversity[3]
  - 93% of species are basin endemics! [3]

1 Stein (2002); 2 Lydeard and Mayden 1995; 3 Tolley-Jordan et al 2015; 4 Johnson 2009 VCE

Alabama's Mussel Power!

- The #1 global hotspot! [1]
- 22% of the world's species
- # 1 US state
- 182 species
- 34+% endemic/near-endemic
- 60% of N. Am mussel species

1 USFWS 2015 url here.

Alabama's Crawfish/Crayfish/Crawdads/Mudbugs

- The #1 global hotspot [2]
- #1 US state
- 84+ native species (+11 undescribed species)[1]
- Poorly studied

Tennessee Bottlebrush Crayfish

Undescribed species

1 Schuster et al 2011; 2 Crandall and Buhay 2008 Hydrobiologia

Alabama's Aquatic Herp Diversity

- #1 in US for Freshwater Turtles (33 spp) [1]
- Mobile-Tensaw Delta – highest turtle diversity on Earth! [1]
- #2 in US for frogs (31 spp) [1]
- Near top for salamander diversity [1]


Barking Tree Frog


Alabama Red-bellied Turtle


Red Hills Salamander

[1] J. Stiles, pers. comm.

Question: Why do we have so many species?

Answer: Because we have so many ecosystems….

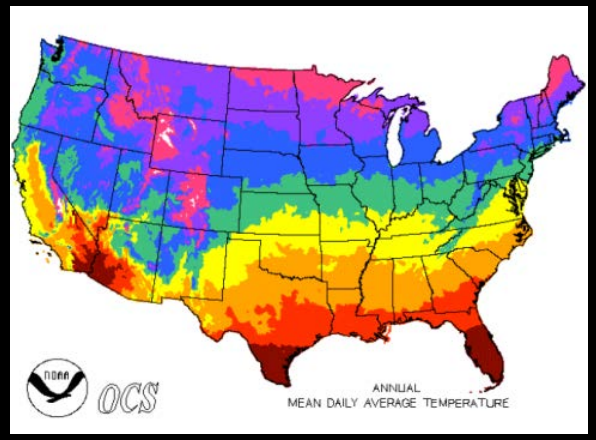
- Begi

- begin

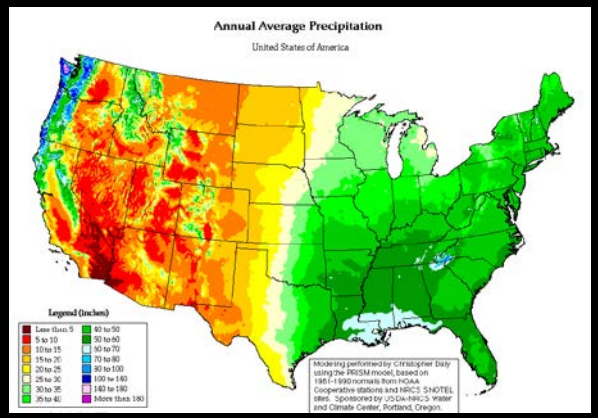

Alabama has
132,419 river and
stream miles

Question: Why are there so many ecosystems in Alabama?

1. Climate



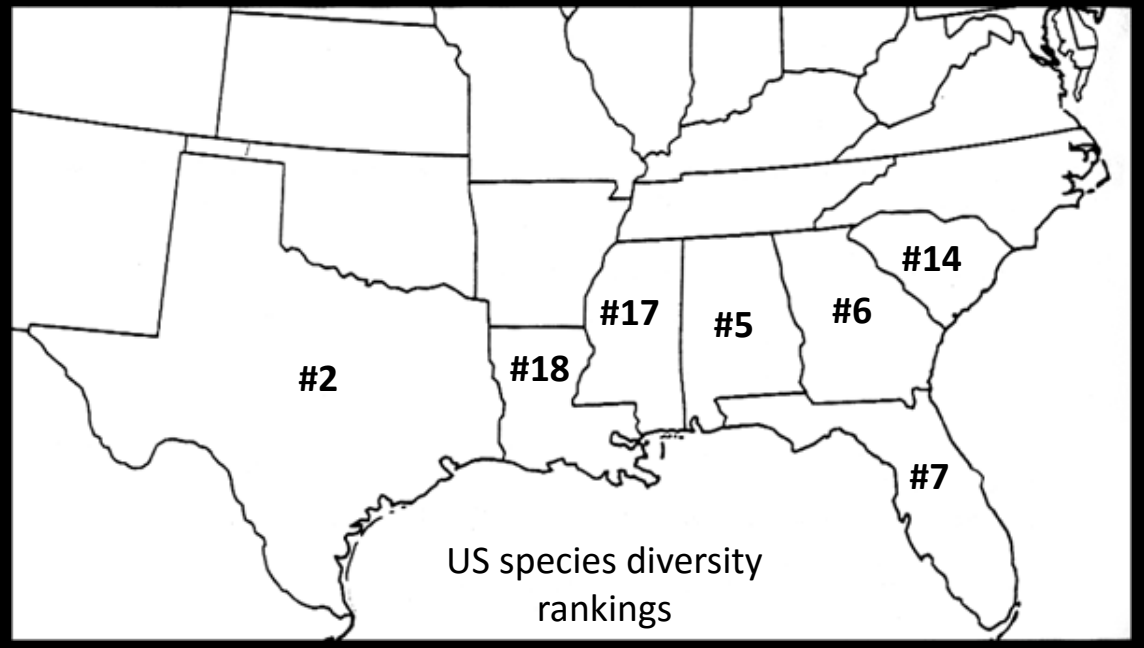
Lots of Sunlight and Heat



Lots of rain

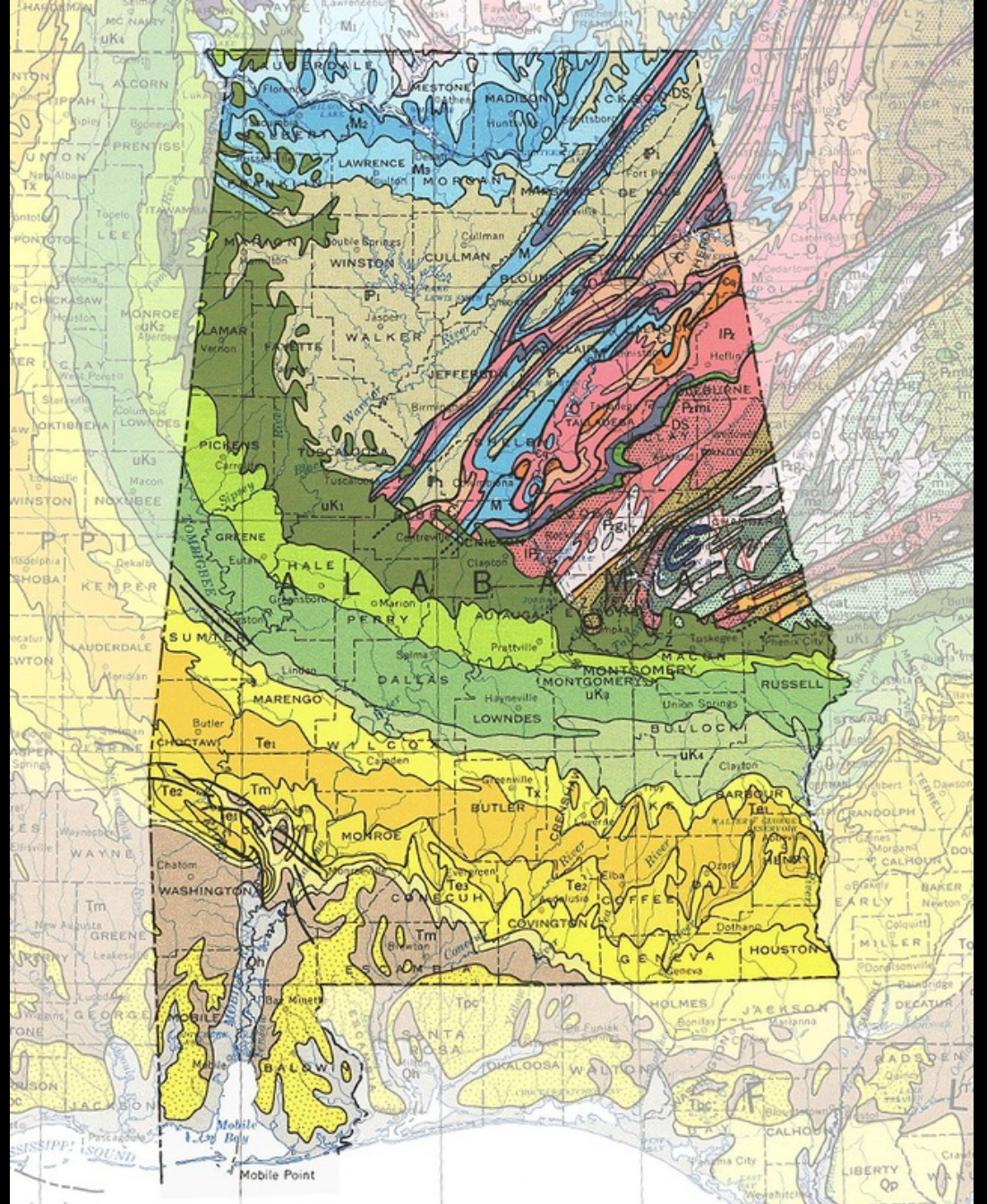
Lots of lightning

The Role of Climate in Alabama's Biodiversity



2. High geologic diversity

Spectacular variation in surface rocks and soils in Alabama



2. High geologic diversity

Geology influences:

- Surface bedrock
- Soils
- Topography

These factors create ecological diversity

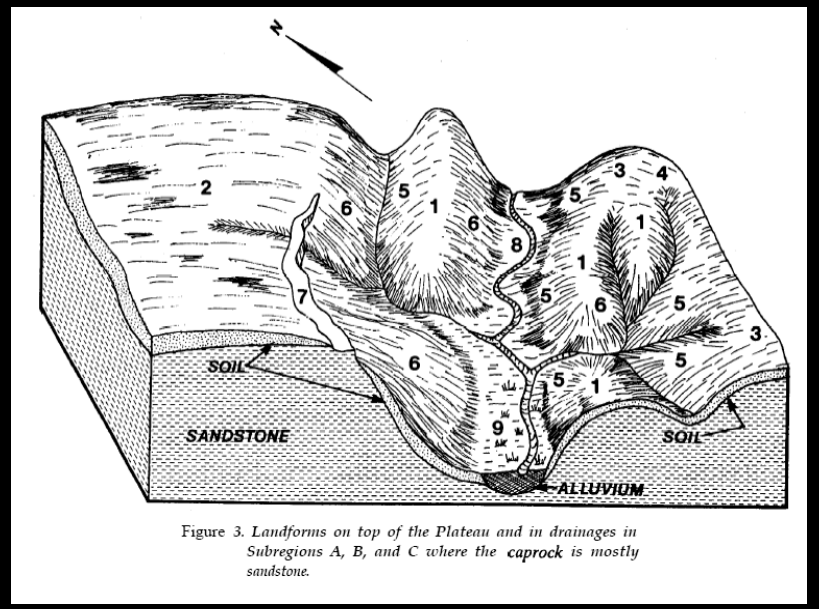
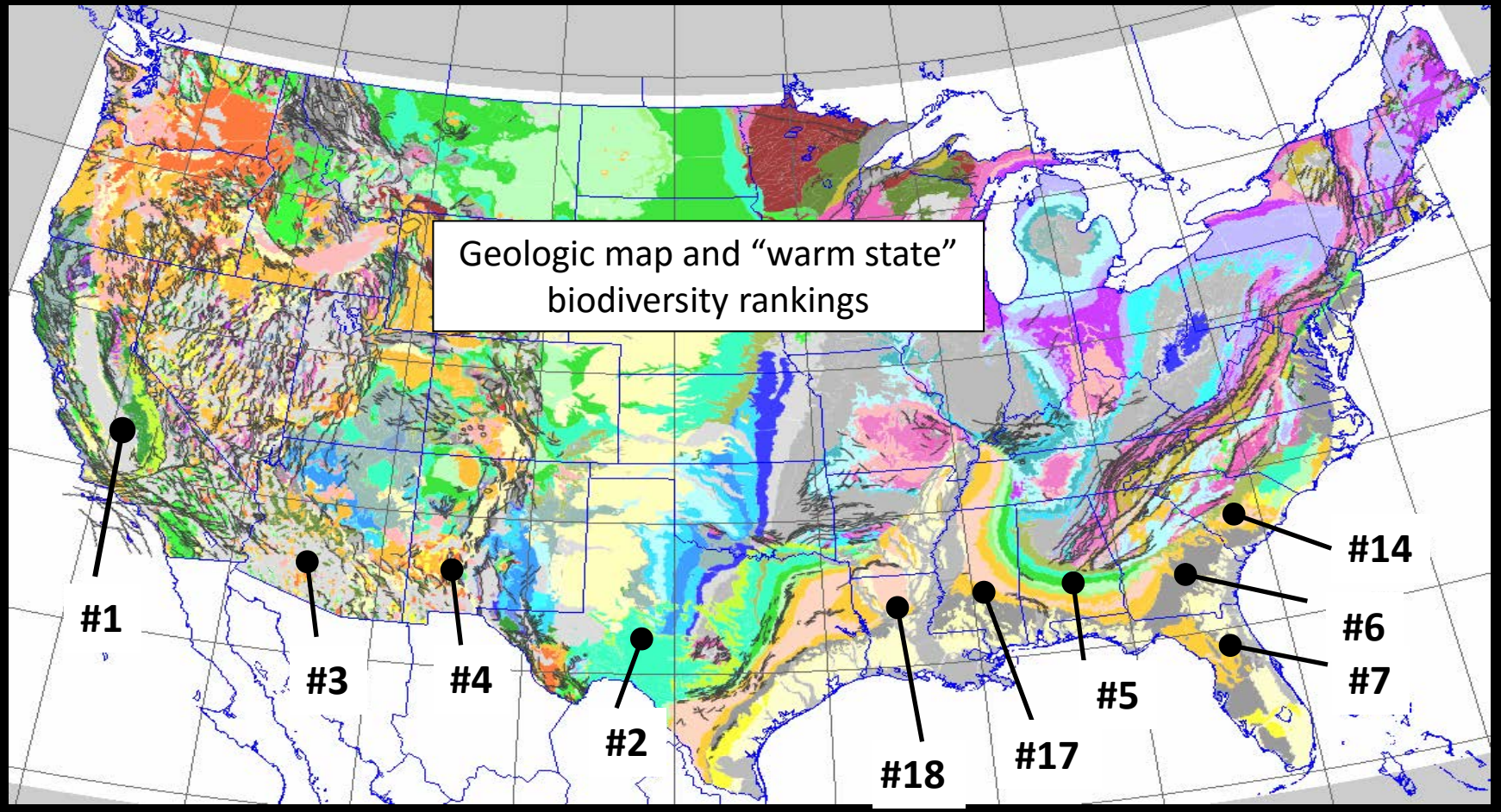


Figure 3. *Landforms on top of the Plateau and in drainages in Subregions A, B, and C where the* **caprock** *is mostly sandstone.*

2. Geologic Diversity
(thus, bedrock, topographic, and soil diversity)



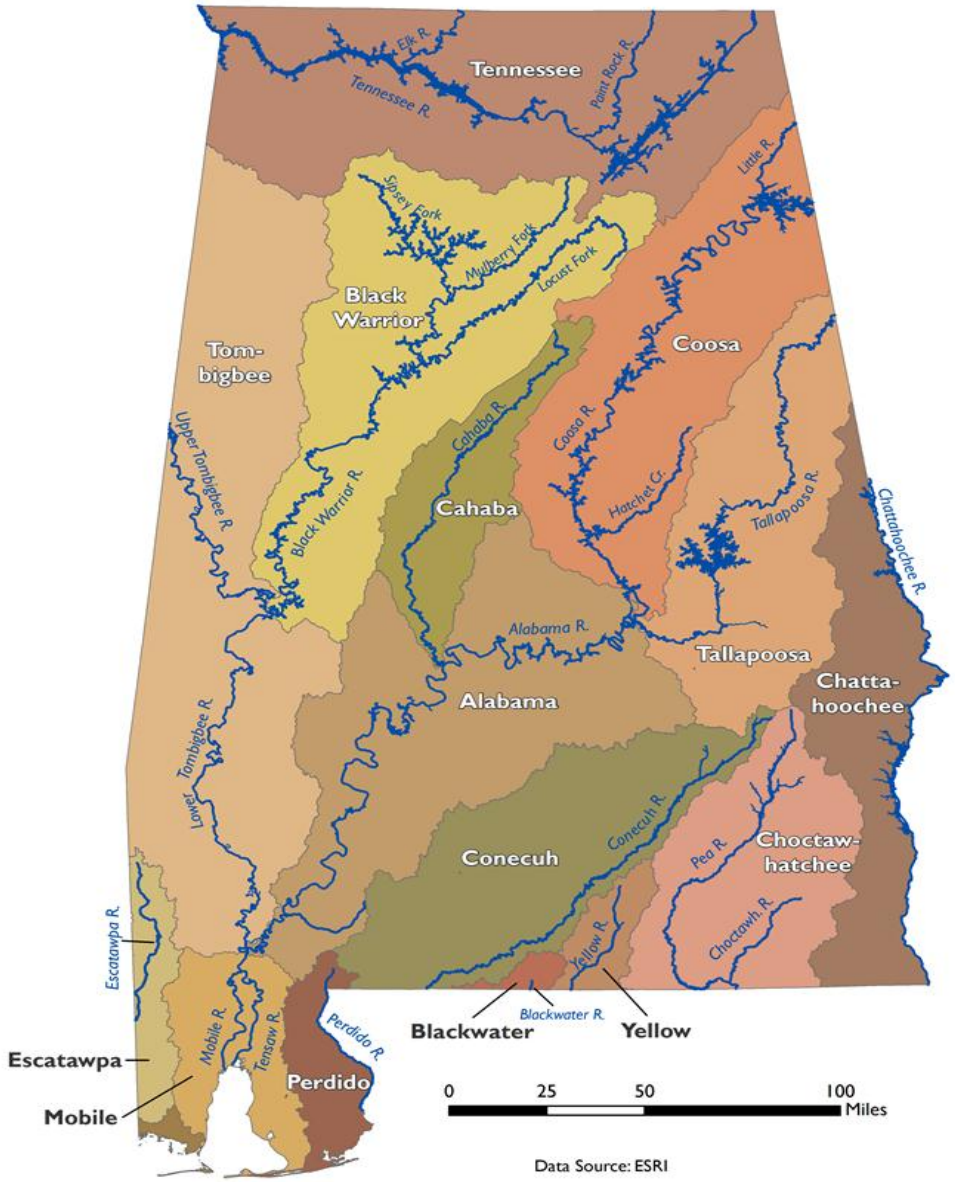
3. Rich evolutionary past


North America
Appalachians
Alabama
Africa
South America
Early Permian (290Ma)

- Southern Appalachian Mountains provide…

- Topographic diversity
- Surface bedrock diversity
- Climate variation
- A landscape fractured into multiple watersheds…

- Populations of small aquatic animals become isolated in headwaters
- Over long periods of time they adapt genetically to local conditions and become new species
- No glaciation during ice ages to wipe them out



Map by Dr. Ed Brands

The Bad News…

The bad news…

- Alabama #2 for total extinction[1]
  - #1 US state on continent
  - 2 fishes
  - 31 snails (+2 extirpated)[2]
  - 11 mussels (+2 extirpated) [2]

Species Extinctions by State

Rank	State	Total Extinct
1	Hawaii	217
2	Alabama	90
3	California	53
4	Texas	27
5	Georgia	26
6	Florida	23
7	Tennessee	22
8	Virginia	20
9	Kentucky	18
10	Ohio	15

[1] Stein 2002; [2] Lydeard and Mayden 1995

The bad news…

105 federally listed (T&E) species[2]

- 81% freshwater aquatic species[2]
- Ranked #2 in 2015 for number endangered animals[3], #2 overall
- Ranked #4 in 2002 for at risk species[1]

Vermilion Darter

At risk species by State

Rank	State	% at risk
1	Hawaii	63
2	California	29
3	Nevada	16
4	Alabama	14.8
5	Utah	14.7
6	Florida	14.3
7	Arizona	14
8	Georgia	13
9	Oregon	11
10	Tennessee	10

[1] Stein 2002; [2] ECOS May 2016; [3] MNN 2015

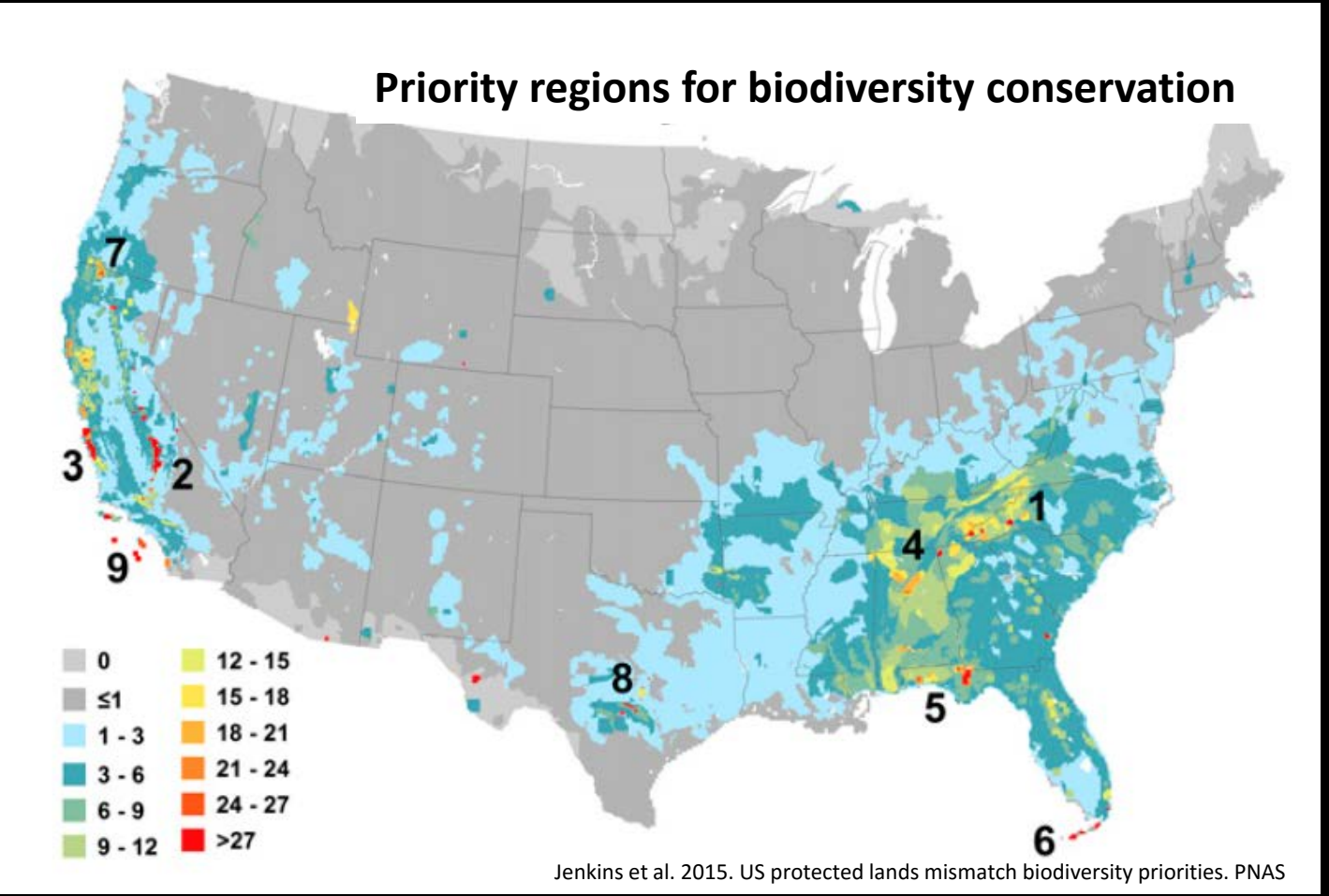
The Good News…

…is that we can fix this.

Conservation Strategy

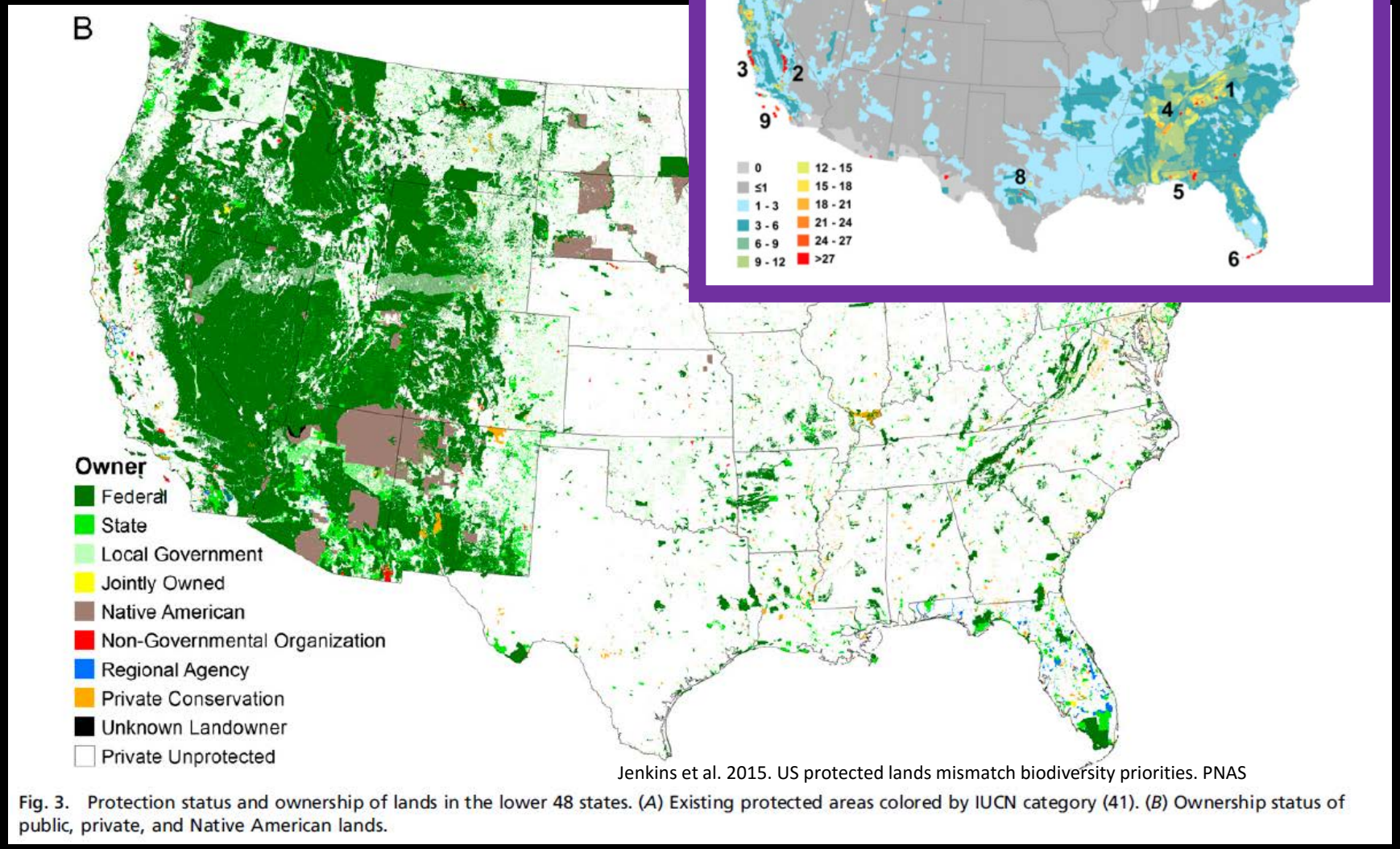
1. Safeguard biodiversity
2. Enable conservation
3. Empower with Education
4. Motivate with Inspiration

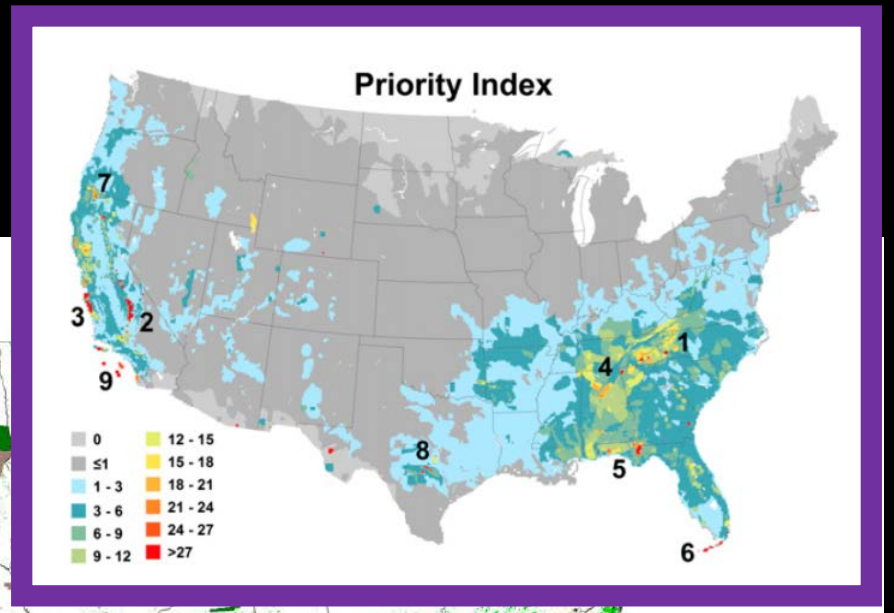
1. Safeguard Biodiversity: Land preservation



Jenkins et al. 2015. US protected lands mismatch biodiversity priorities. PNAS

Protected lands





Jenkins et al. 2015. US protected lands mismatch biodiversity priorities. PNAS

Fig. 3. Protection status and ownership of lands in the lower 48 states. (*A*) Existing protected areas colored by IUCN category (41). (*B*) Ownership status of public, private, and Native American lands.

Safeguard Biodiversity: Species Recovery

Alabama Aquatic Biodiversity Center

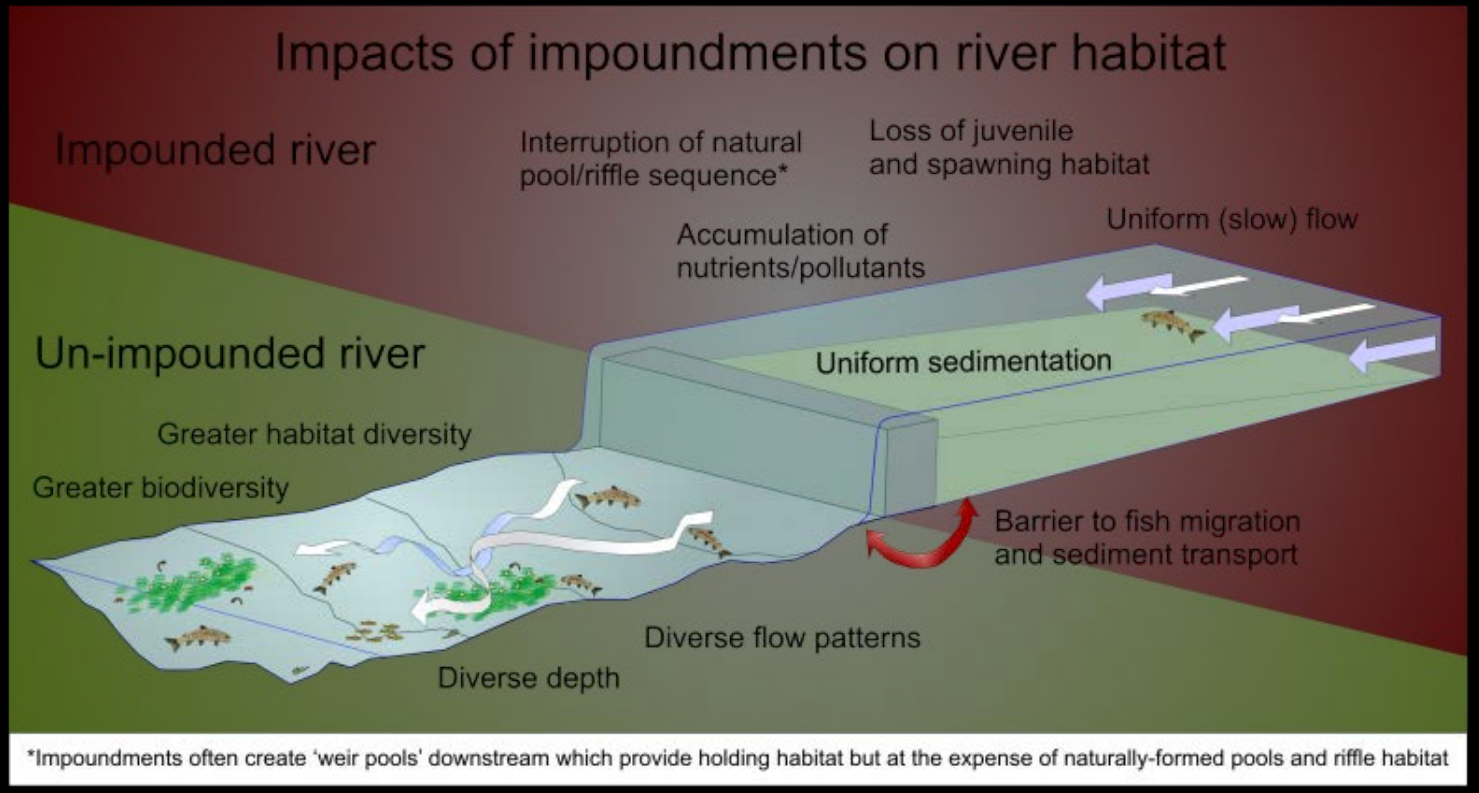
Safeguard Biodiversity: Species Passage at Dams

Benefits of dams…

- Hydropower
- River Navigation
- Flood control
- Economic development
- Some forms of recreation

Safeguard Biodiversity: Species Passage at Dams

Negative impacts of dams on rivers…



Safeguard Biodiversity: Species Passage at Dams

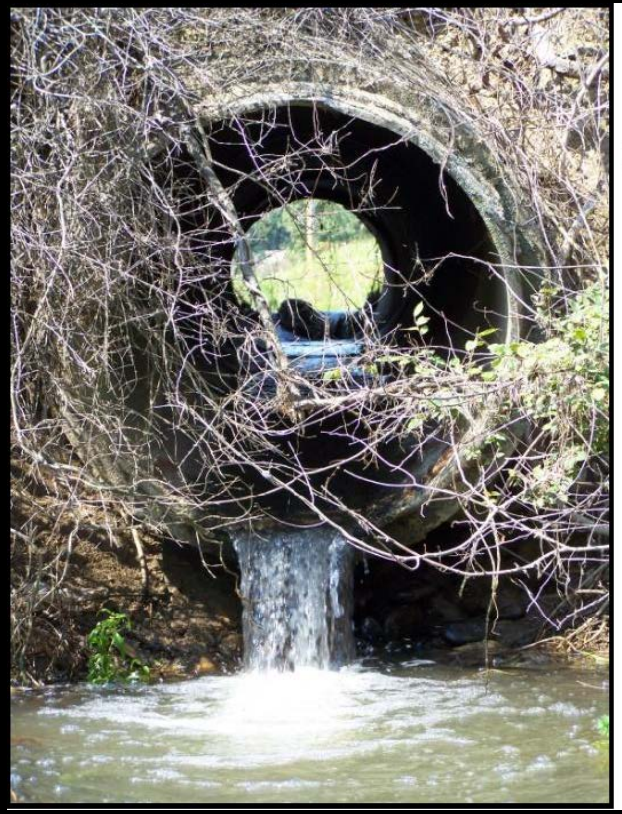
Passage facilitation

Bring down dead-beat dams

60 of Alabama's fish species would benefit by restoring fish migration routes through our rivers.

Safeguard Biodiversity: Species Passage at Road Crossings

Bad



Perched pipe culvert; Eric Prowell, USFWS

Beautiful!

Arch-span culvert; Will Duncan, USFWS

Safeguard Biodiversity: Tackle Sediment Pollution

- Greatest pollution threat
- Non-point source
- Negative effects:
  - habitat
  - plant growth
  - oxygen
  - feeding, mating
  - tissue abrasion
  - excessive nutrients

Safeguard Biodiversity: Tackle Sediment Pollution

Low-impact parking lots

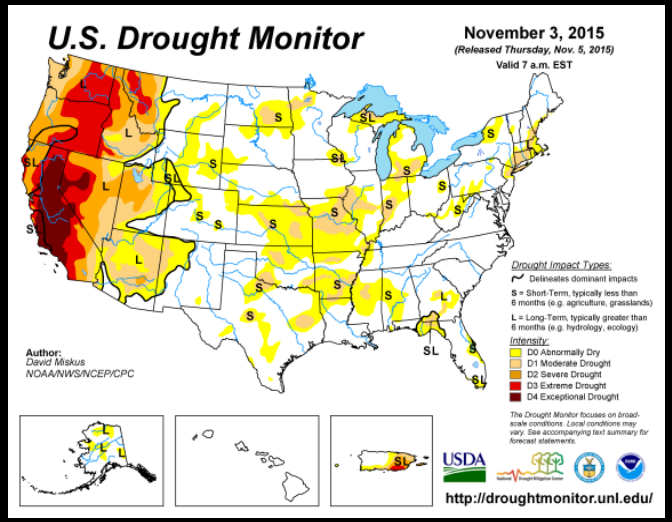
Green Roofs

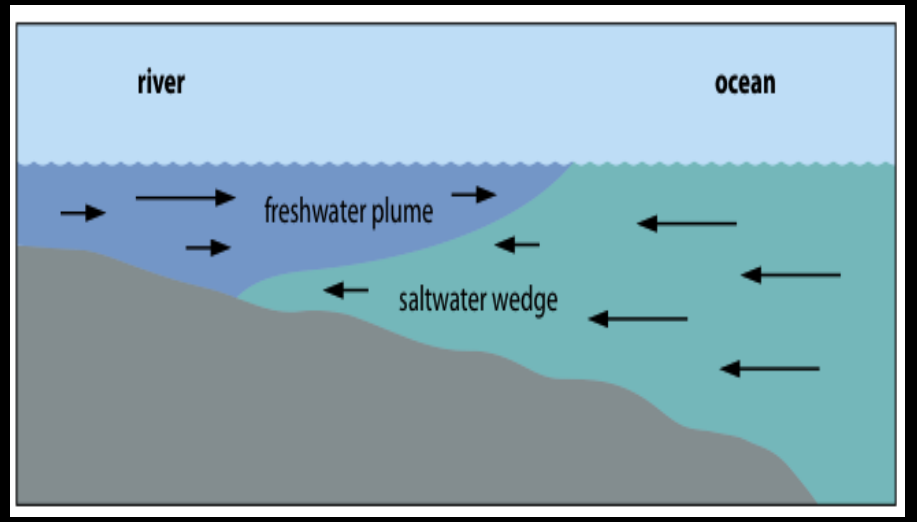
Soil Conservation in Agriculture

Reduce bank collapse caused by
urban storm water runoff

Safeguard Biodiversity: Mitigate Climate Change

- Threats to river systems
  - Rising creek/river temperatures
  - Salt water wedging
  - Estuary erosion
  - Agricultural expansion to Alabama





Safeguard: Modernize Policies

Alabama needs a comprehensive water management plan

Protect water for…

- Drinking water
- Agriculture
- Fisheries
- Transportation
- Recreation
- Industry
- Biodiversity

Safeguard: Modernize Policies

ADECA
building better alabama communities
Alabama Department of Economic and Community Affairs

ABOUT DIVISIONS NEWS

Divisions

- Floodplain Management
- Drought Planning and Management in Alabama
- Water Management
- Interstate Water Issues
- Alabama Water Resources Commission
- *Alabama Water Agencies Working Group*
  - AWAWG Subcommittees
  - Stakeholder Comments

ADECA > Divisions > Office of Water Resources > Alabama Water Agencies Working Group

Alabama Water Agencies Working Group

Alabama is blessed with many natural resources, but none is more important than water. Our rivers, lakes and streams sustain our communities, support industry and jobs, generate power, irrigate crops, provide critical transportation links, maintain wildlife and supply boundless opportunities for recreation.

When the Alabama territory was organized in 1817, Governor William Wyatt Bibb determined that the most suitable image for the official seal would be a map of our extensive rivers. Today, the Great Seal of Alabama continues to attest to the importance of these vital arteries.

Accustomed to an environment with abundant water, most of us assume that an adequate supply will be available to meet our needs. In recent years, however, large sections of our state have experienced periods of extreme drought, highlighting the need for responsible water management plans, which will help us ensure a plentiful supply in years to come.

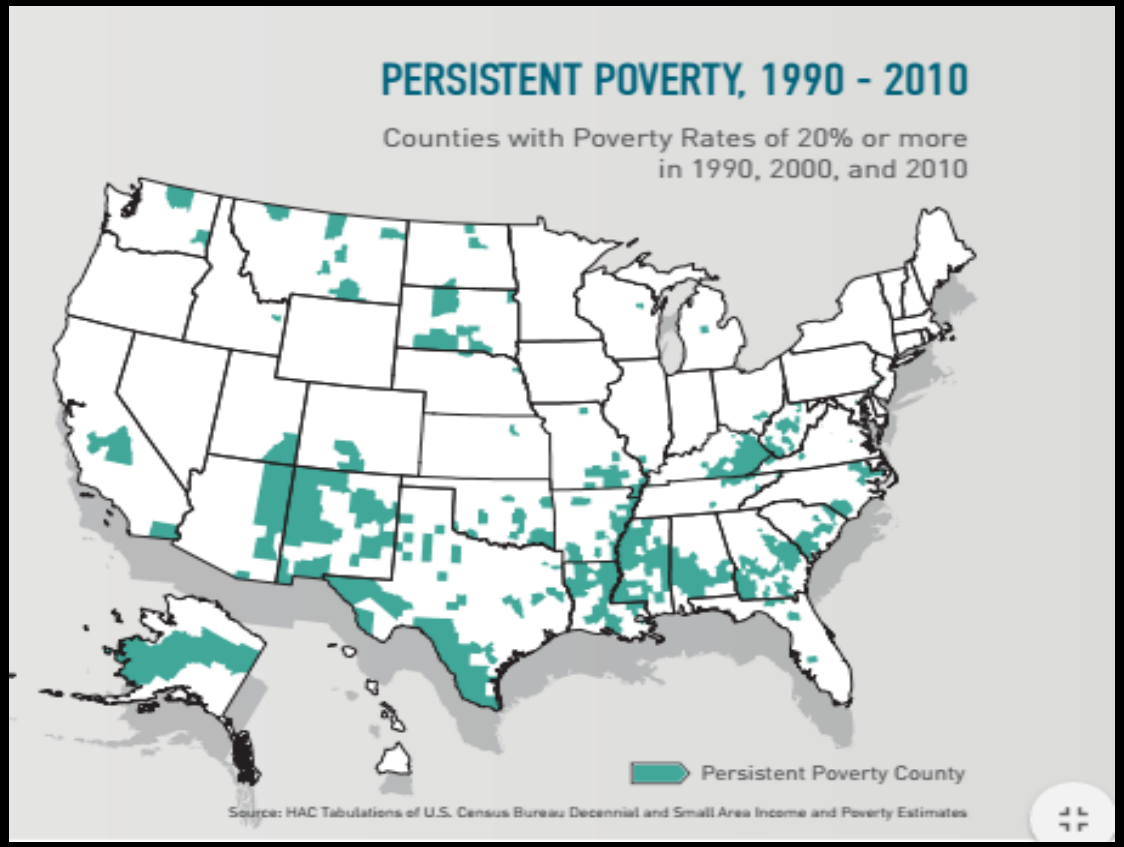
As Alabama's population grows and our economy expands, so does the demand for water. Our water resources are substantial, but not limitless. As we harness this resource for the needs of today, we must do so with an eye toward tomorrow.

Conservation Strategy

1. Safeguard biodiversity
2. Enable conservation
3. Empower with Education
4. Motivate with Inspiration

2. Enable conservation

Alleviating basic insecurities (health, safety, economic) gives people a hopeful future, and this and enables them to value and contribute to conservation efforts.



Conservation Strategy

1. Safeguard biodiversity
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3. Empower with Education

Ecosystem Services Support Human Well-Being

Supporting Services

- Nutrient cycling
- Soil formation
- Photosynthesis

Provisioning Services

Food, Fresh water

Wood, Fiber, Fuel

Regulating Services

Climate and Flood Regulation,

Disease Control, Water Cleansing

Cultural Services

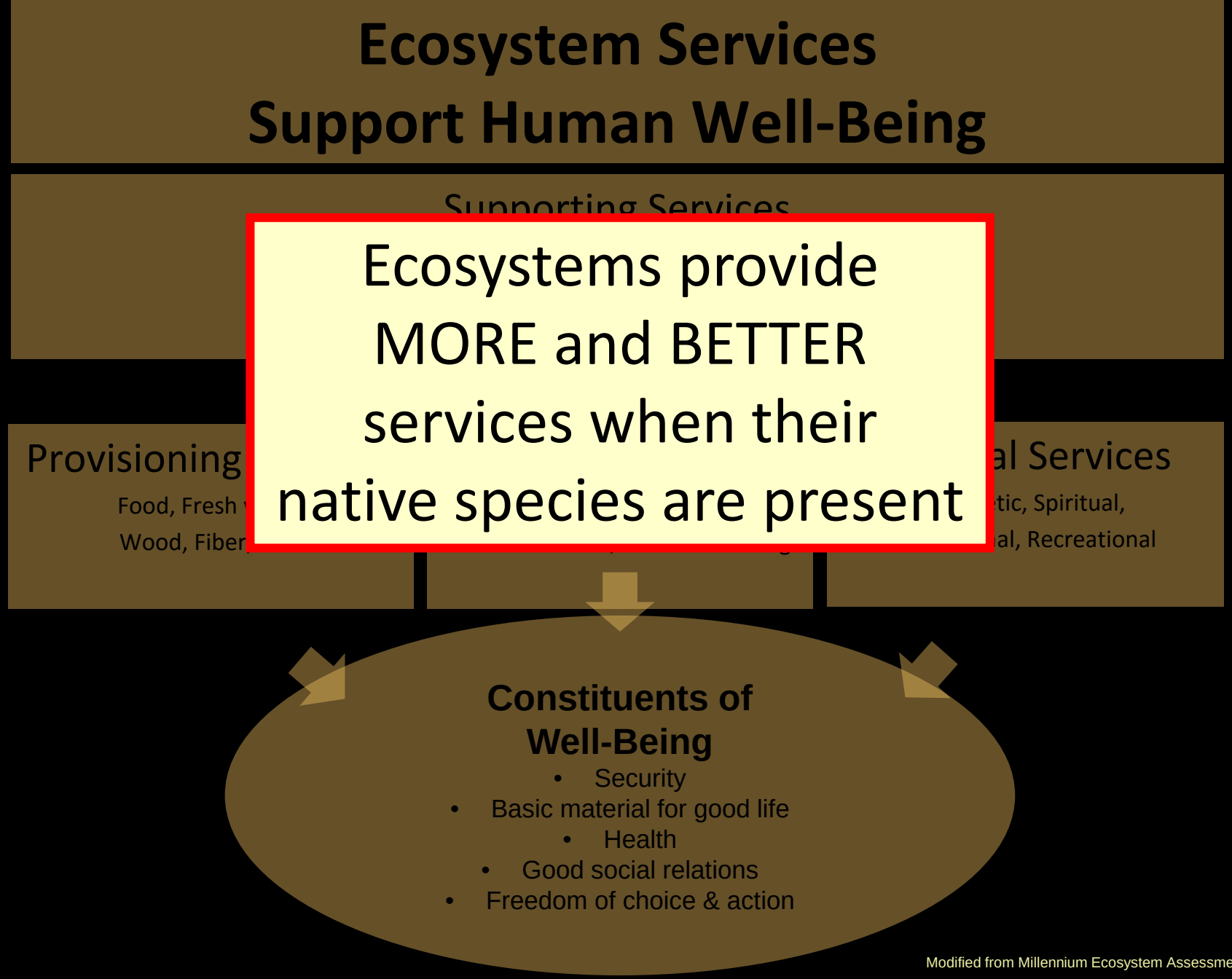
Aesthetic, Spiritual,

Educational, Recreational

Constituents of Well-Being

- Security
- Basic material for good life
- Health
- Good social relations
- Freedom of choice & action

Modified from Millennium Ecosystem Assessment



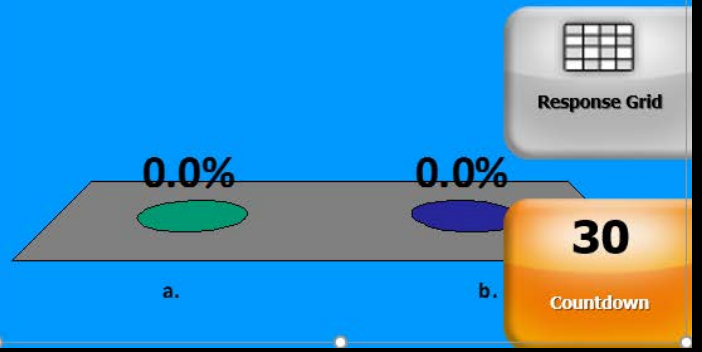
Modified from Millennium Ecosystem Assessment

3. Empower with Education

The Coosa Moccasinshell is endangered from human activities and is restricted to the Coosa and Cahaba Rivers. If you were to now learn it is now extinct, would you feel at least just a little sense of disappointment, loss, or sadness?

a. Yes
b. No

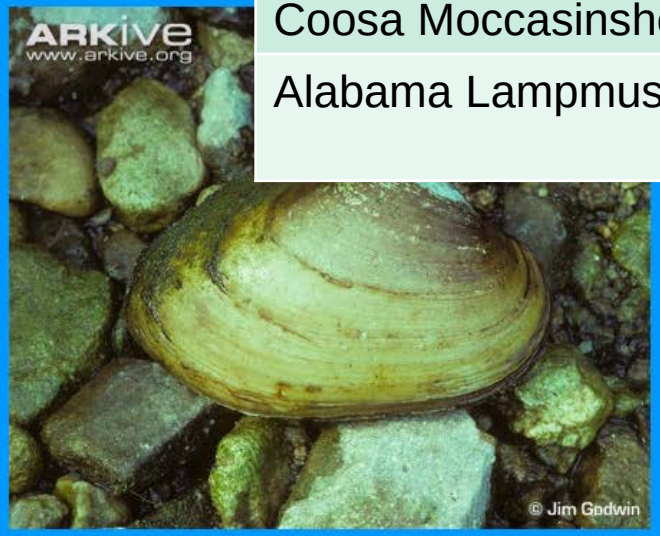
Question	Yes	No
Coosa Moccasinshell	46%	54%



The Alabama Lampmussel, like all mussels, helps clean river water of pollution so it keeps river ecosystems healthier. Mussels provide cleaner waters for recreation, extraction for drinking water, both of which have economic value. If you were to learn it is now extinct due to human causes, would you feel <u>at least</u> just a little sense of disappointment, loss, or sadness?

a. Yes
b. No

Question	Yes	No
(previous question about Coosa Moccasinshell	46%	54%
Alabama Lampmussel	76%	24%



Response Grid

0.0%

a.

30

Countdown

3. Empower with Education

We need better statewide public education efforts about the importance of our aquatic resources…

Instead of this….

This!!!

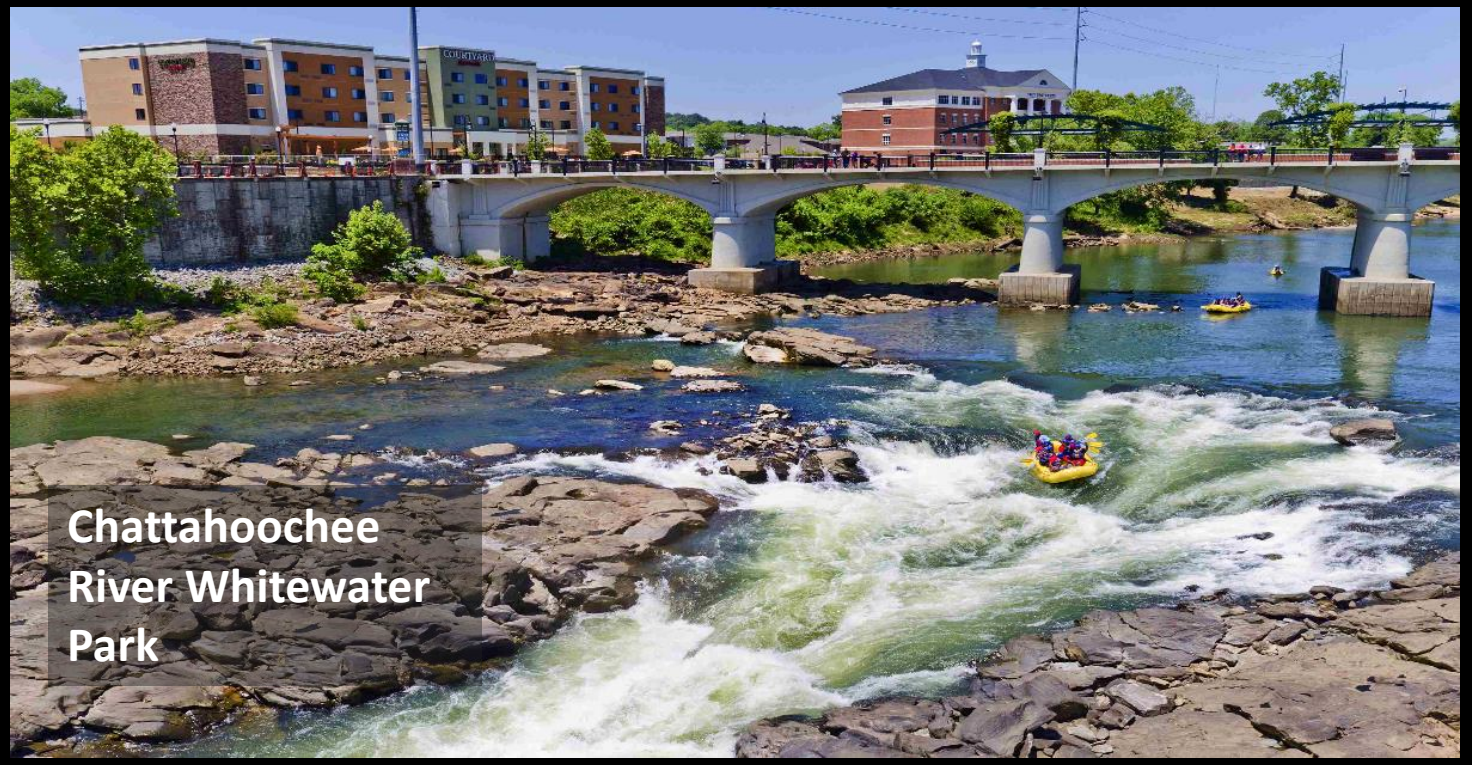

Alabama's
Plicate Rocksnail
Is headed for
Extinction!
So What?
Visit
www.yourALaquatics.org

Conservation Strategy

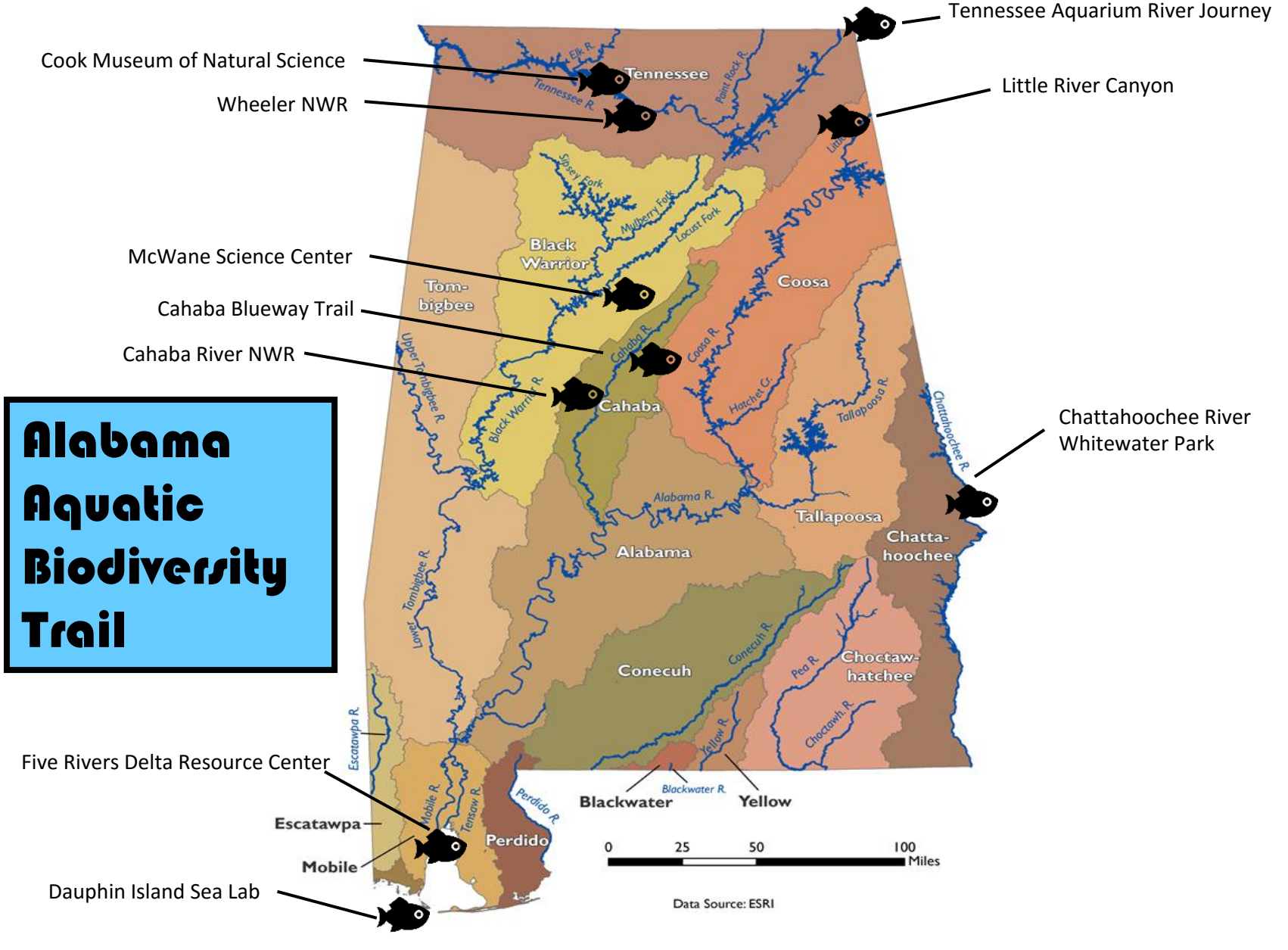
1. Safeguard biodiversity
2. Enable conservation
3. Empower with Education
4. Motivate with Inspiration

4. Motivate with Inspiration

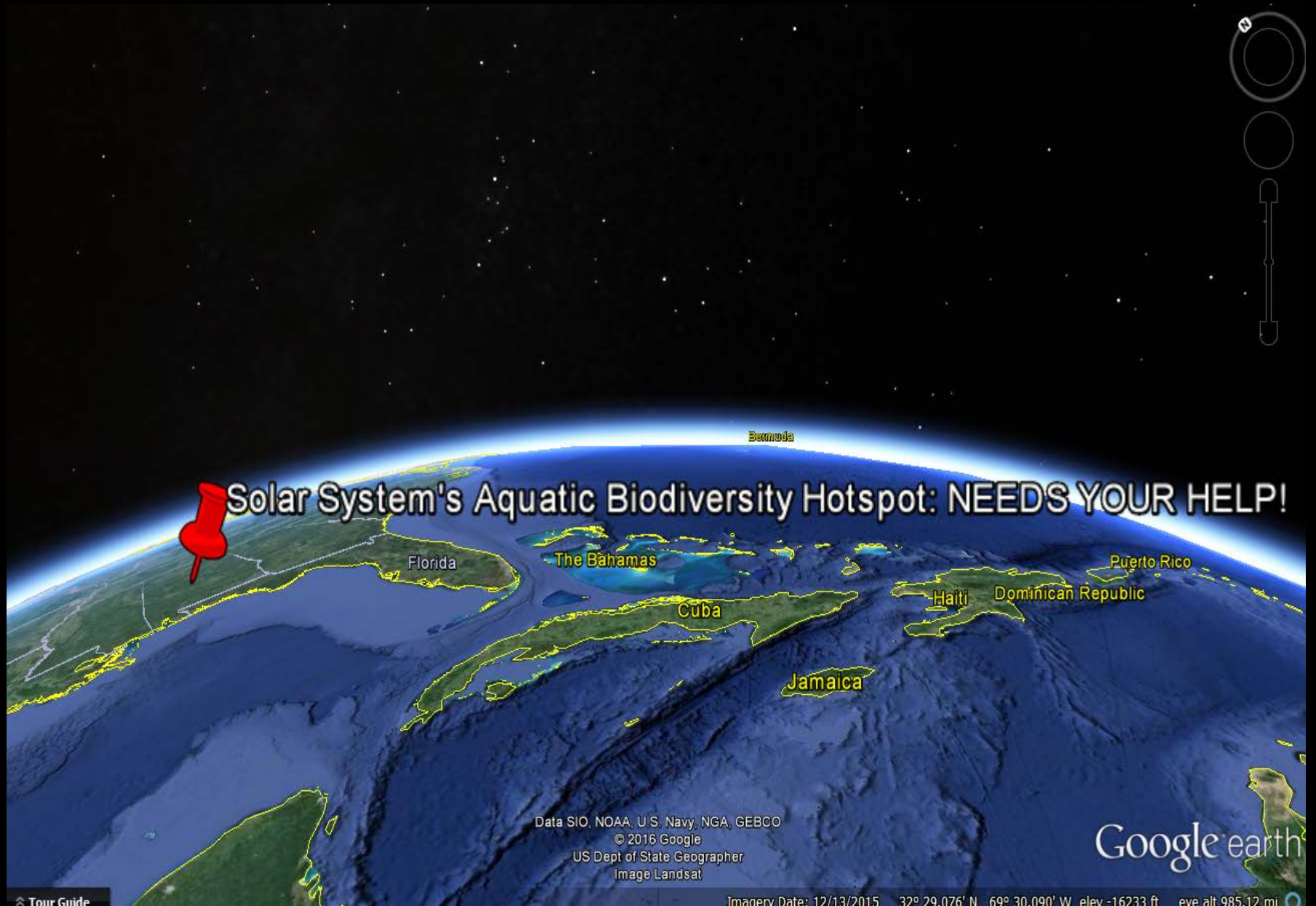
- Craft an *inclusive* vision of our *shared* future
  - All people and species are healthy and prosperous
  - Motivate people to work towards this goal

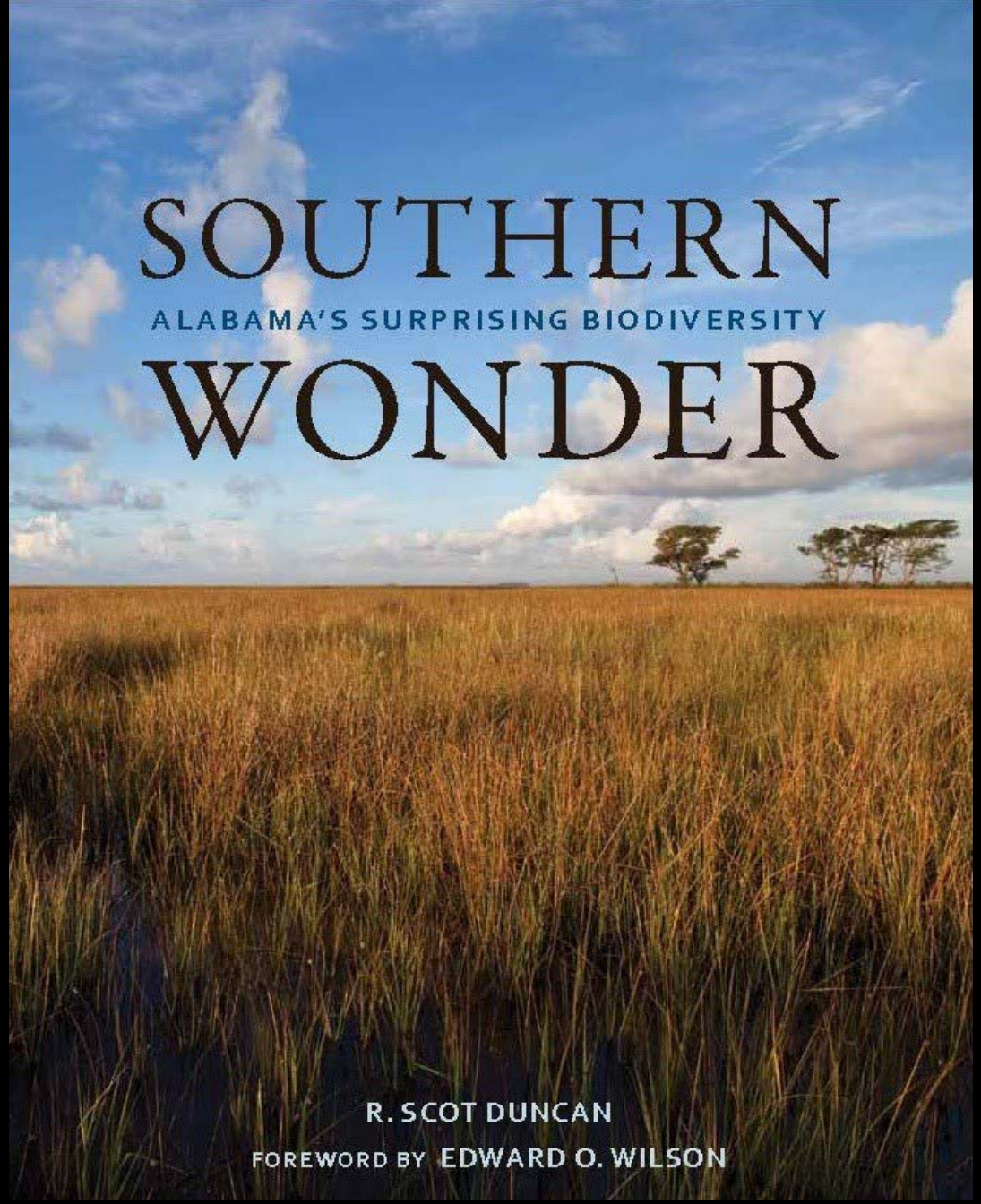


Alabama Aquatic Biodiversity Trail



Autumn Duncan, age 4, spontaneously dancing in Turkey Creek


Solar System's Aquatic Biodiversity Hotspot: NEEDS YOUR HELP!
Bermuda
Florida
The Bahamas
Cuba
Haiti
Dominican Republic
Puerto Rico
Jamaica
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2016 Google
US Dept of State Geographer
Image Landsat
Google earth
Tour Guide
Imagery Date: 12/13/2015 32° 29.076' N 69° 30.090' W elev -16233 ft eye alt 985.12 mi


SOUTHERN
ALABAMA'S SURPRISING BIODIVERSITY
WONDER
R. SCOT DUNCAN
FOREWORD BY EDWARD O. WILSON

Predicted climate changes for Alabama this century [1]

- Summer maximum temperatures will increase 3–7° F.
- Winter minimum temperatures will increase 5–10° F.
- Relative sea level will rise 15-44 inches.
- Tropical cyclones will be more powerful.
- Droughts will be more frequent and longer.
- Marine waters will acidify, endangering marine ecosystems.

How will these change affect our native species?

[1] Sources: Twilley, 2001; Davenport, 2007; and Primack, 2010.

Alabama's Eventual Ranking?

Species Diversity by State		
Rank	**State**	**# of Species***
1	California	6,717
2	Texas	6,273
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4	New Mexico	4,583
5	Alabama	4,533
6	Georgia	4,436
7	Florida	4,368
8	Oregon	4,136
9	North Carolina	4,131
10	Utah	3,892

Alabama's fishes

85+ species of shiner (Cyprinidae)

Alabama's fishes

80+ species of darter (Percidae)

Vermilion Darter

Alabama's fishes

Two species of cavefish (f. Amblyopsidae)

Alabama Cavefish

Alabama's fishes

19+ species of catfish (f. Ictaluridae)

Frecklebelly Madtom

Courtesy of: http://www.flmnh.ufl.edu

Alabama's Carnivorous Plant Diversity

#1 in US and
global hotspot
for carnivorous
plants.

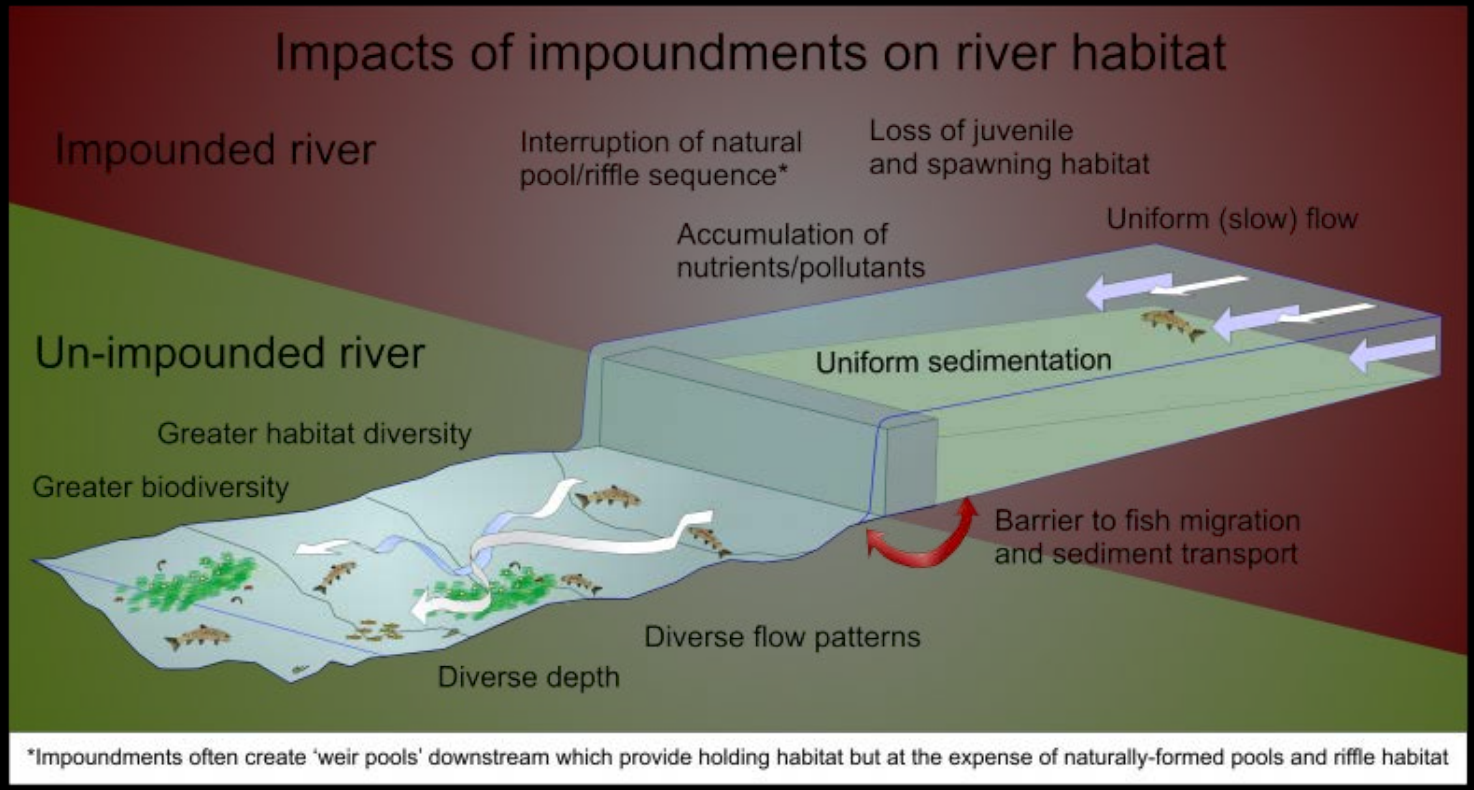
Alabama's Herp Diversity

Eastern Diamondback Rattlesnake

3 in US for herpetological diversity[1]

Cave Salamander

[1] ALAPARC


Impacts of impoundments on river habitat
Impounded river
Interruption of natural pool/riffle sequence*
Loss of juvenile and spawning habitat
Accumulation of nutrients/pollutants
Uniform (slow) flow
Uniform sedimentation
Un-impounded river
Greater habitat diversity
Greater biodiversity
Barrier to fish migration and sediment transport
Diverse flow patterns
Diverse depth
*Impoundments often create 'weir pools' downstream which provide holding habitat but at the expense of naturally-formed pools and riffle habitat