

# The Southeast's Aquatic Biodiversity: Why it Rocks!

Bernie Kuhajda



TENNESSEE  
AQUARIUM

CONSERVATION INSTITUTE







**To ensure the conservation  
of native aquatic animals  
and their habitats**

# Aquatic Threats in the Southeast

- Factors jeopardizing southeastern fish include:
  - Alteration of waterways





**Hanging culverts**

**Barrier to small fish  
movement upstream**



# Aquatic Threats in the Southeast

- Factors jeopardizing southeastern fish include:
  - **Alteration of waterways**
  - **Nonpoint-source pollution**





# Point Source Pollution



# Nonpoint Source Pollution - Dirt

- Sedimentation
- Poor forestry & agriculture practices, construction
- Vegetation buffer along a waterway can control sedimentation







## Soddy Creek







Soddy Creek

Google earth

© 2014 Google

305

1999

Imagery Date: 11/27/2013 lat 35.391376° lon -85.268812° elev 1938 ft eye alt 7083 ft

Harvey Cemetery Rd

Wolf Bridge Rd



# Nonpoint Source Pollution

- Pollutants from impervious surfaces



# Nonpoint Source Pollution

- **Plastics**











**Tennessee River aquatic habitat  
recovered for Lake Sturgeon**

**TNACI receives  
2,000+ Lake Sturgeon  
early June**

**About ½ inch long**







Release when > 6 inches long  
September - October





Over 250,000 Lake Sturgeon released since 2000 by TNACI and its many partners



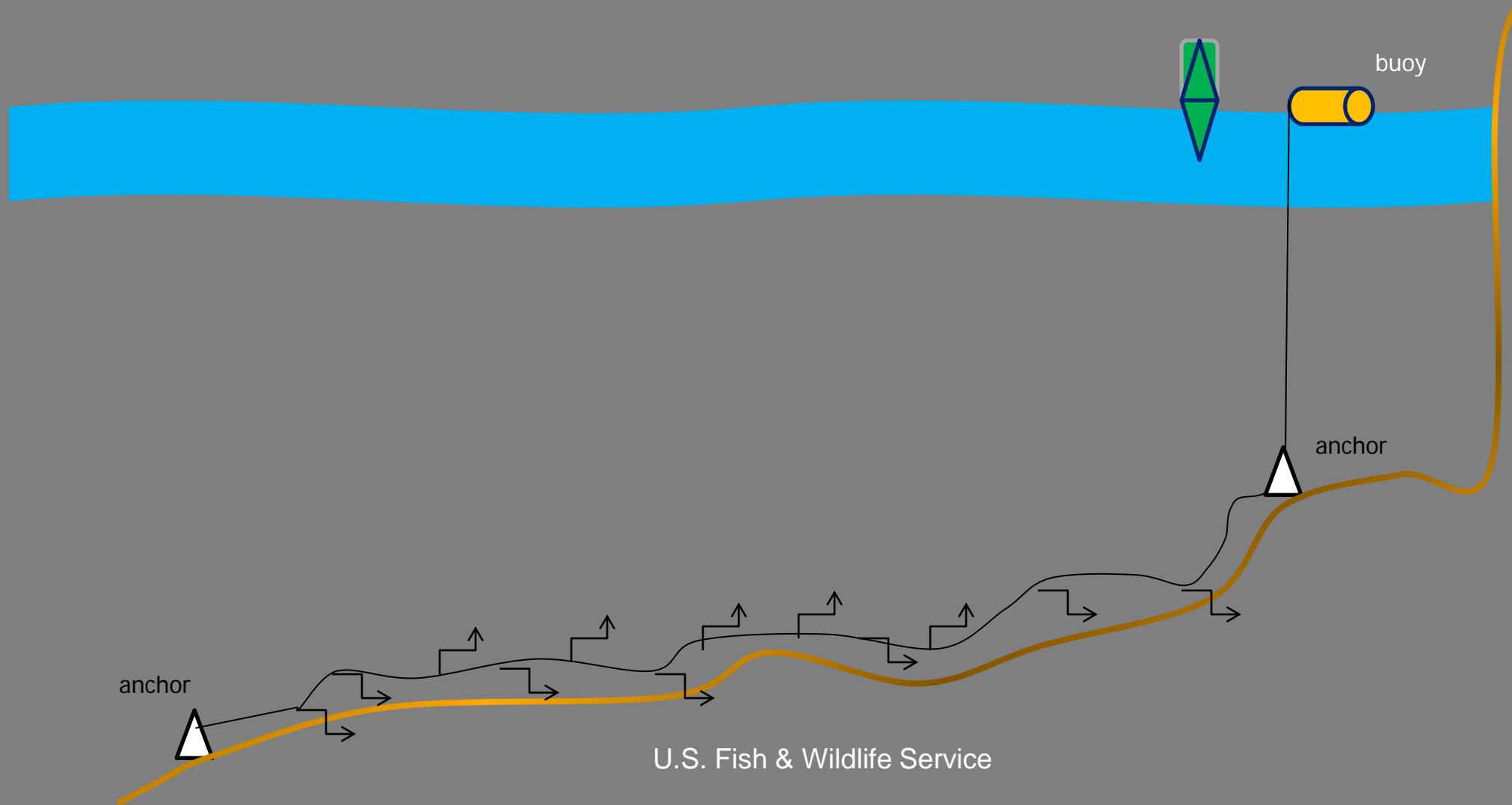


**Almost 300  
Lake Sturgeon  
captured over  
last  
eight years**

**Fin clip taken  
for genetics**



# Typical Trotline Set

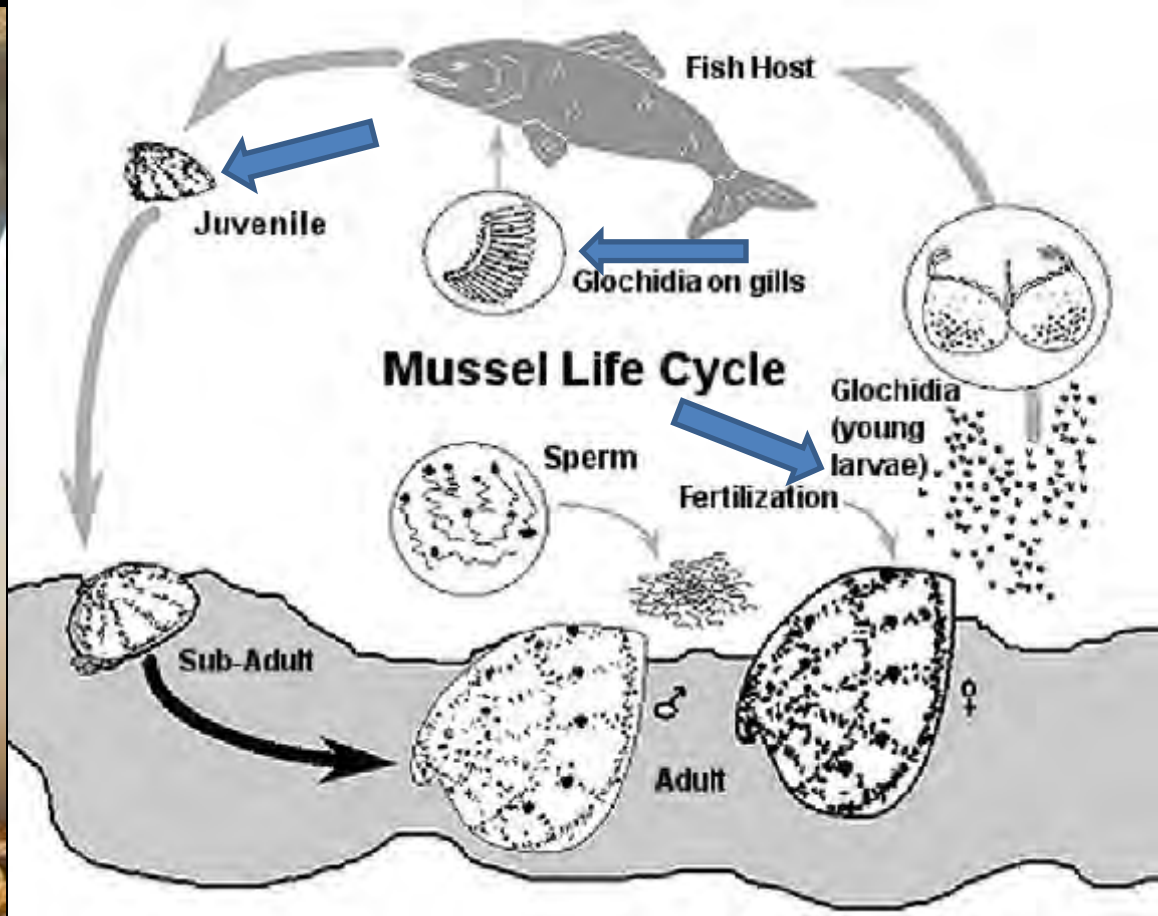






Tangerine Darter  
*Percina aurantiaca*





40 Tangerine  
Darter juveniles  
2022

400 juveniles 2023

Cracking  
Pearlymussel











ARTIFICIAL STREAM 4



Brook Trout x 3



Rainbow Trout x3



Low Flow



High Temp



# Microhabitat Data

3 sites, 10 pools per site

Pool length

Stream width

Pool width

Water depth

Substrate composition

Silt present

Silt depth

Flow

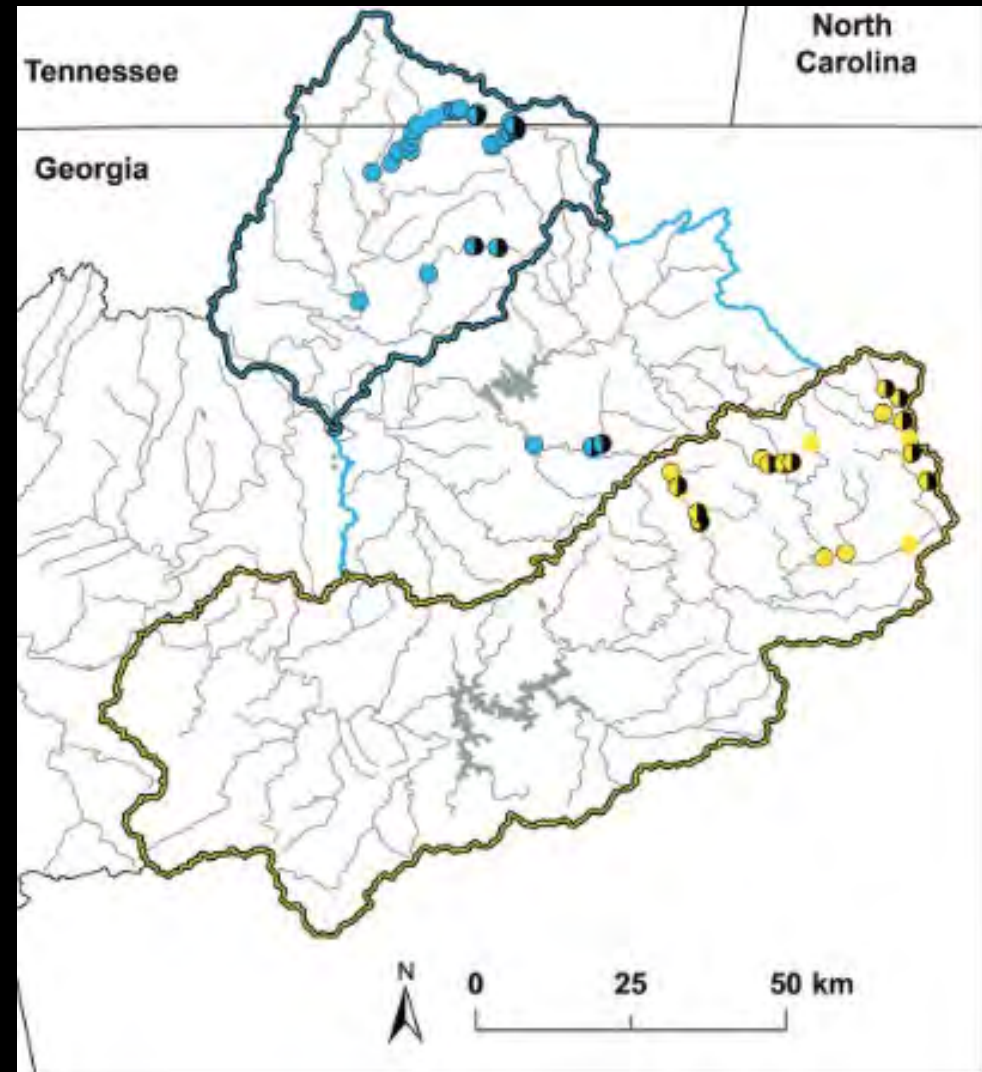


Blue Shiner presence

Blue Shiner abundance



# Distribution of Bridled Darters and Etowah Bridled Darters



Adapted from Near et al. 2021



# Methodology- Population Genetics



1). Identify a sampling location



2). Snorkel and search for Bridled Darters



3). Herd fish into the seine and lift



# Methodology- Population Genetics



4). Fish measurements



5). Take fin clip



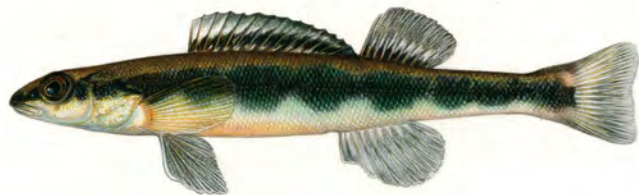
6). Insert VIE tag





PCA Axis 2 (11.4%)

- Amicalola Creek
- Long Swamp Creek
- Holly Creek
- Upper Etowah
- Upper Conasauga



*Percina kusha*

*Percina freemanorum*

PCA Axis 1 (20.4%)





## Environmental DNA (eDNA)

- Goal: to determine full range of Bridled Darters and Etowah Bridled Darters
- Why?
  - Determine presence when population is below detectable limits
  - Determine presence in difficult areas to sample





# Methodology-eDNA Collection



1. Collect water quality data with YSI probe



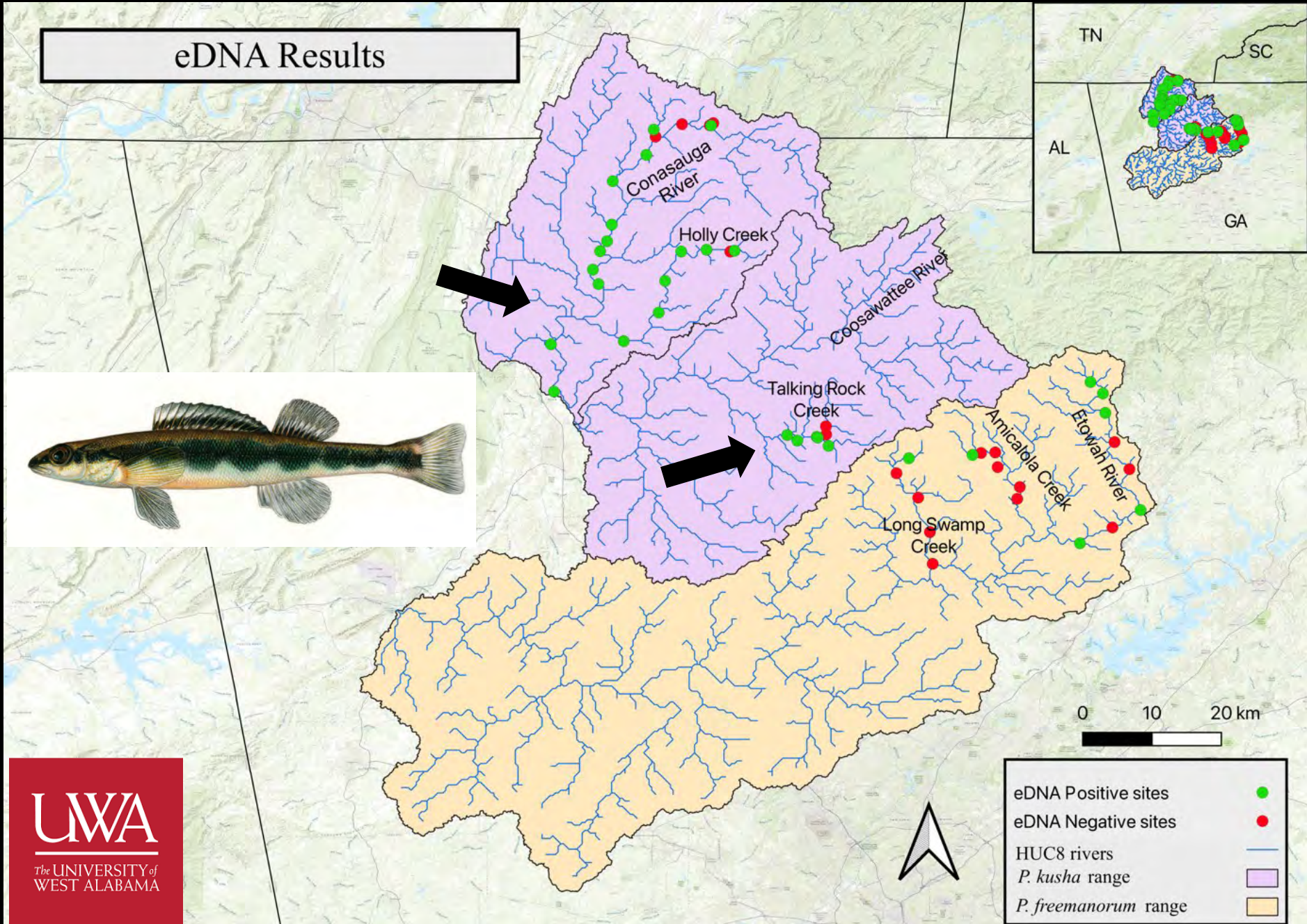
2). Filter 1 liter of water from stream



3). Samples sent to UWA for analysis



# eDNA Results





# Trispot Darters





# *Etheostoma trisella* spawning habitat



February



August





**Trispot Darter**  
***Etheostoma trisella***

**Mill Creek**  
**Upper Conasauga**  
**Tennessee**





# Laurel Dace Surveys









# Laurel Dace Surveys





# Laurel Dace Surveys





# Fish Passage



Moccasin Creek



Duskin Creek

## Vented Fords



# Duskin Creek





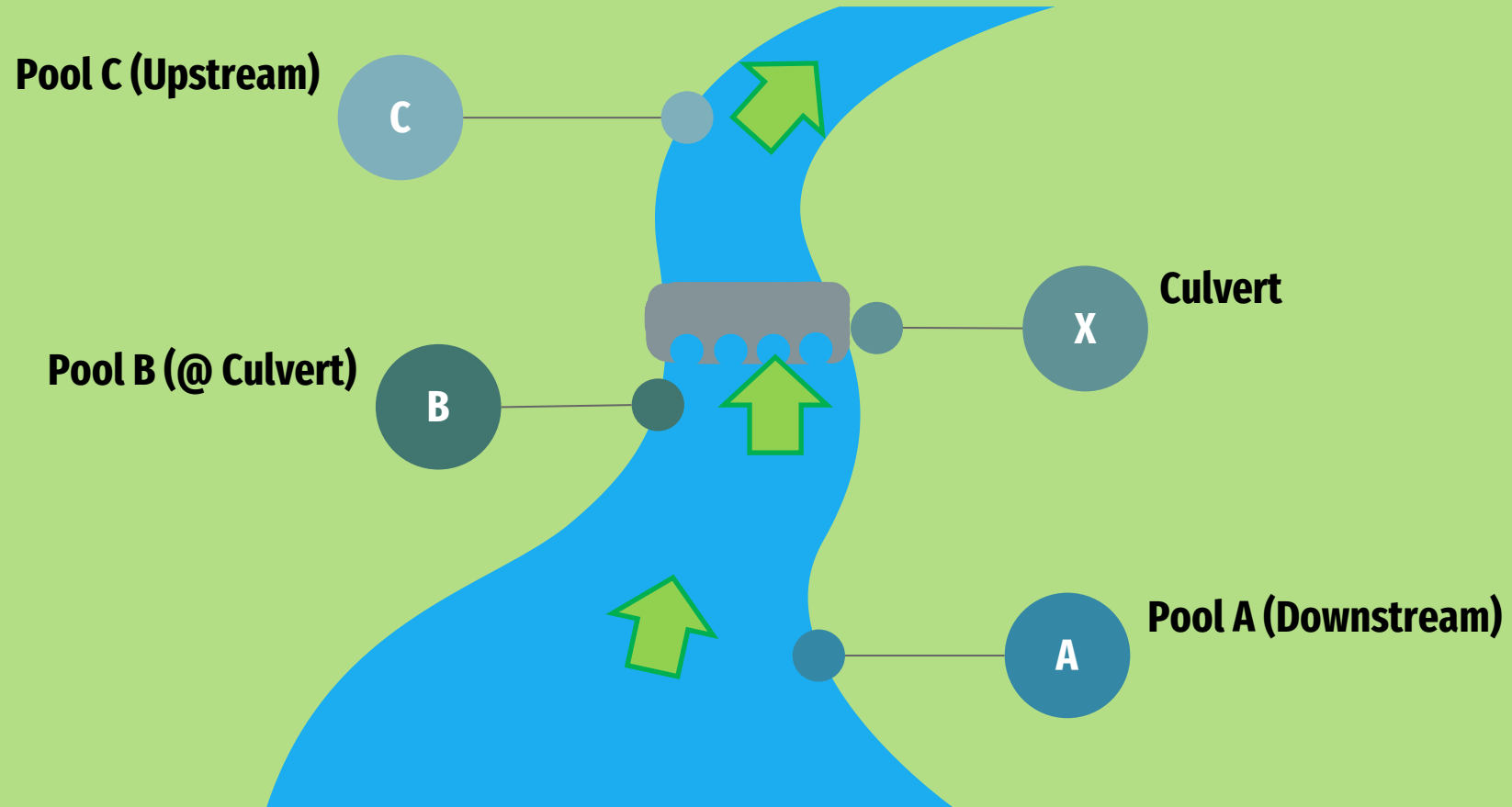
# Fish Passage

## Bumbee Creek





# Upstream Movement







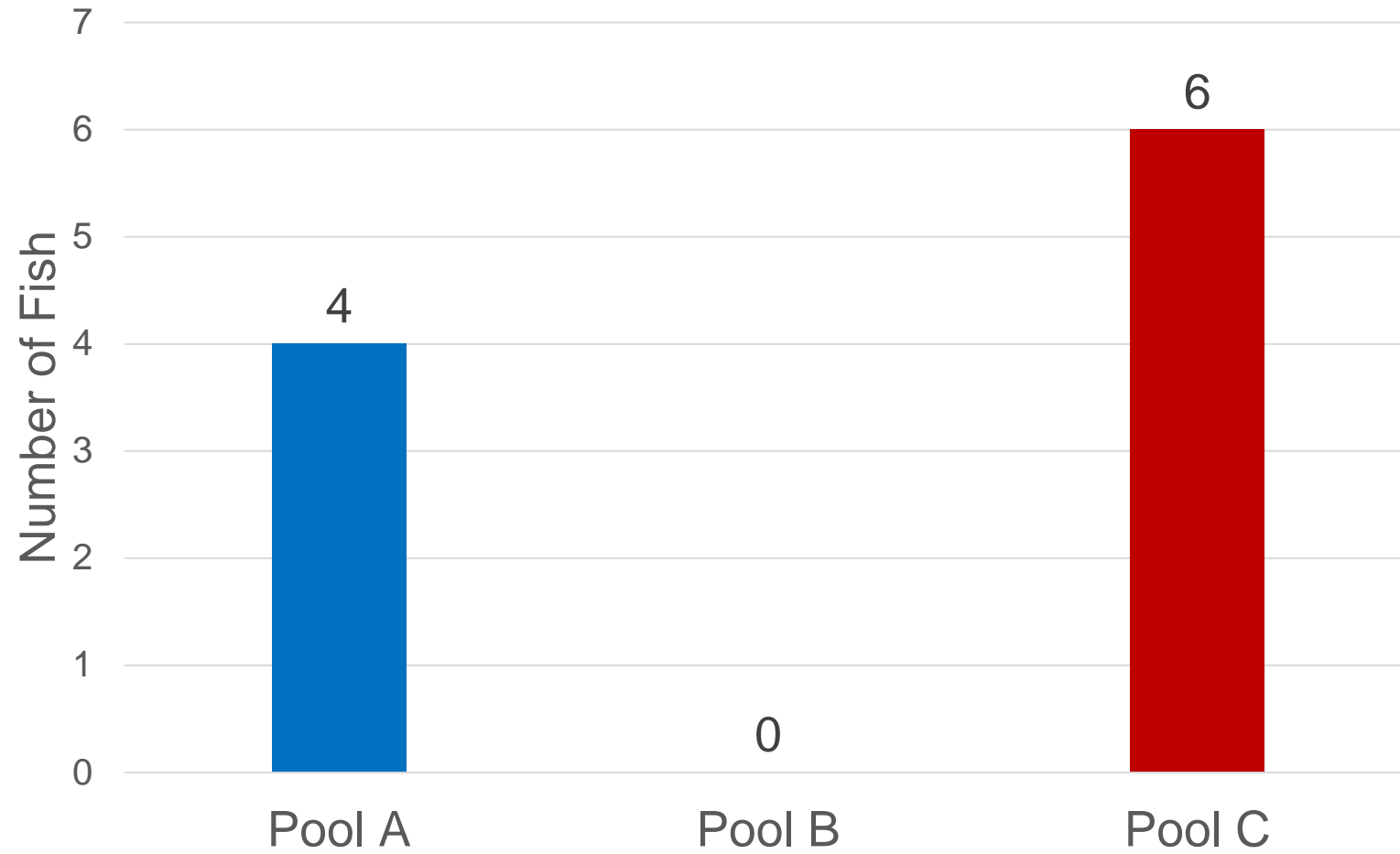
VIE Tag







# Recaptures Upstream of Each Pool









# The Race to Save the Laurel Dace



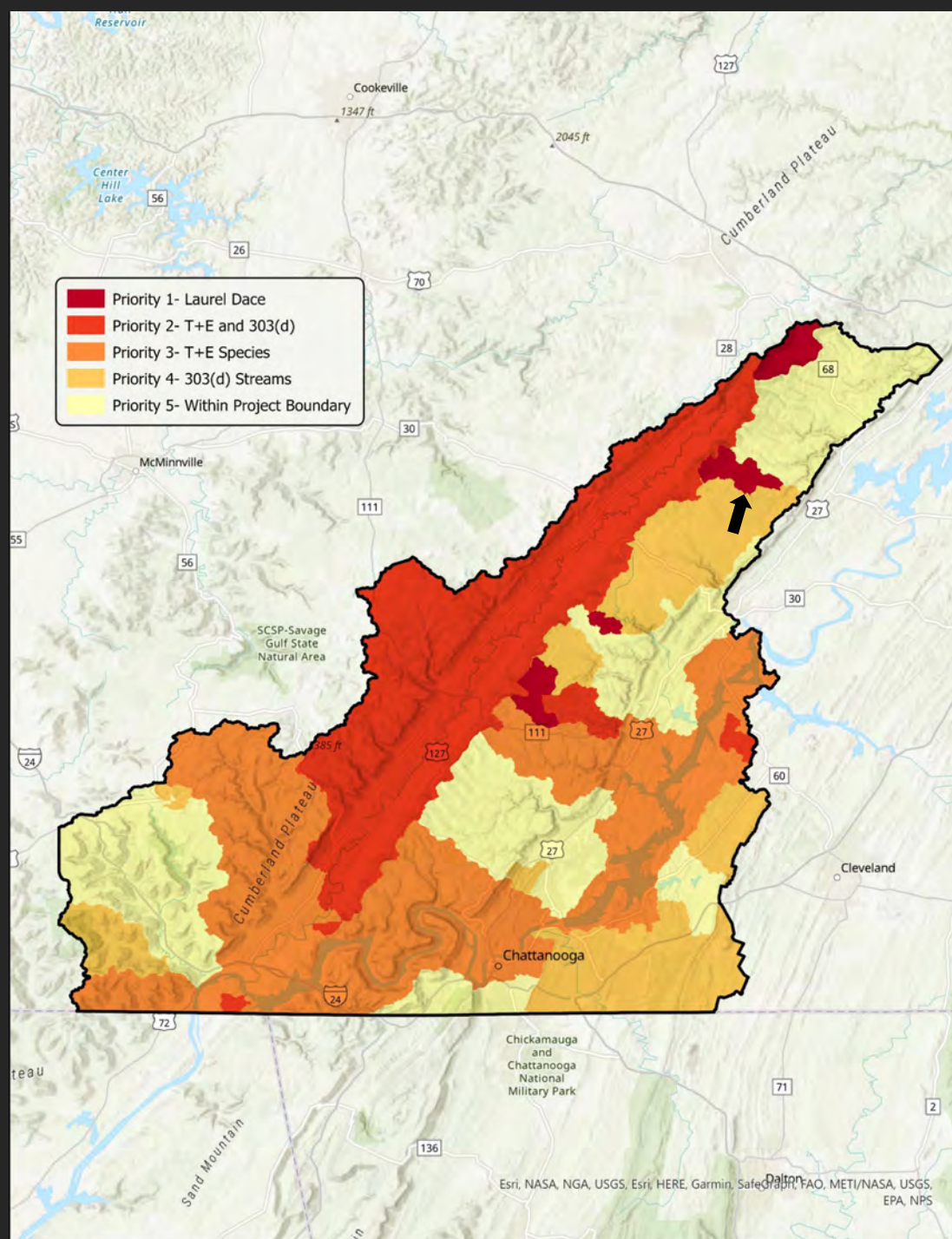
**Ridges to  
Rivers**

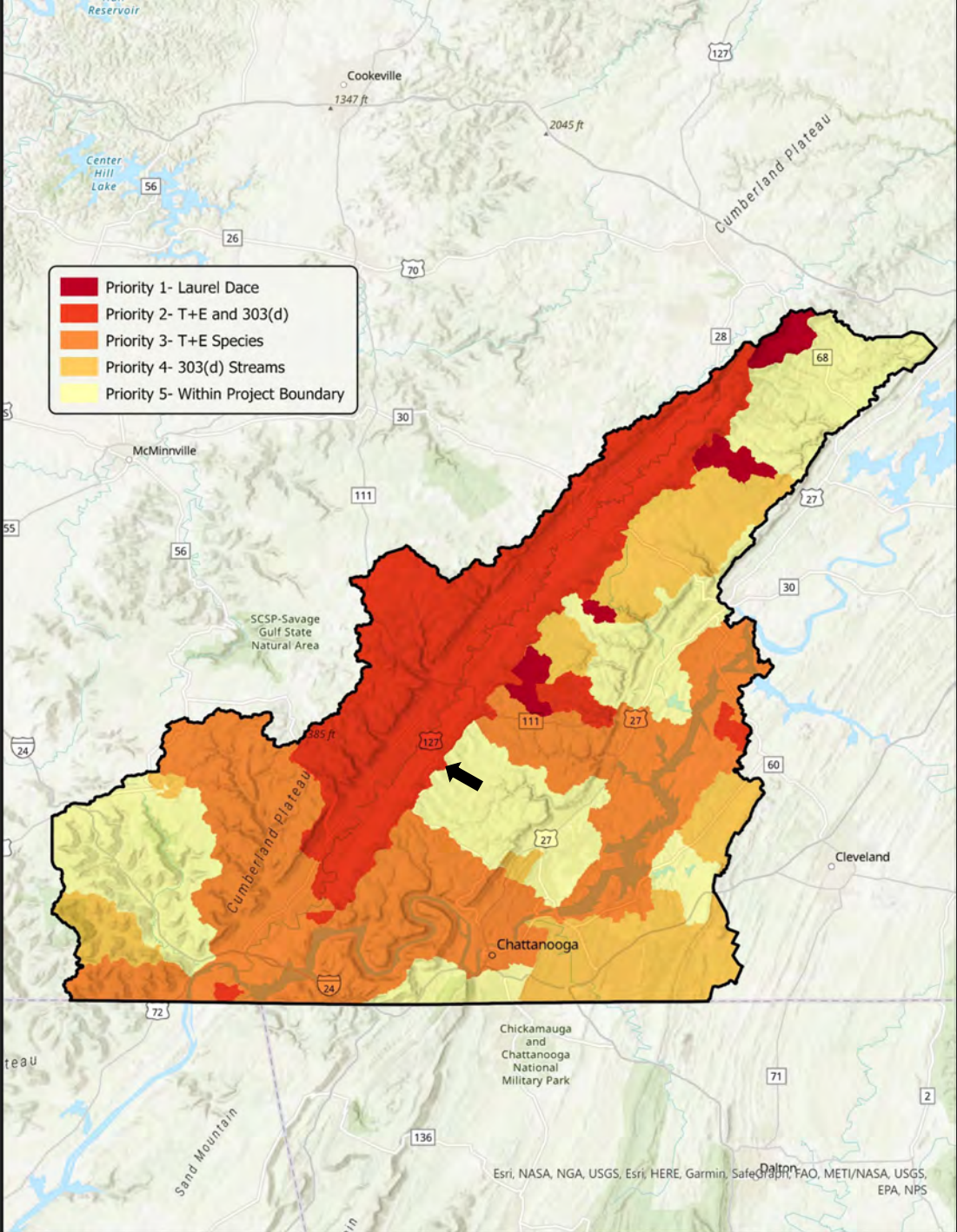
**Regional Conservation  
Partnership Program**

**Program with  
NRCS funded  
through the  
Farm Bill  
\$10 million**















TEAM AQUARIUM  
STAFF

PEL PPL 04015 1 PVC 1120 SCH 40 PR 450









Appalachian Chapter  
of Trout Unlimited  
P.O. Box 22401  
Chattanooga, TN 37422



NOV

TENNESSEE

13  
TENN



TICHTH

Class Code  
2550  
Issue Year  
2009  
255091 CTH

CONSERVATION





# Do No Harm

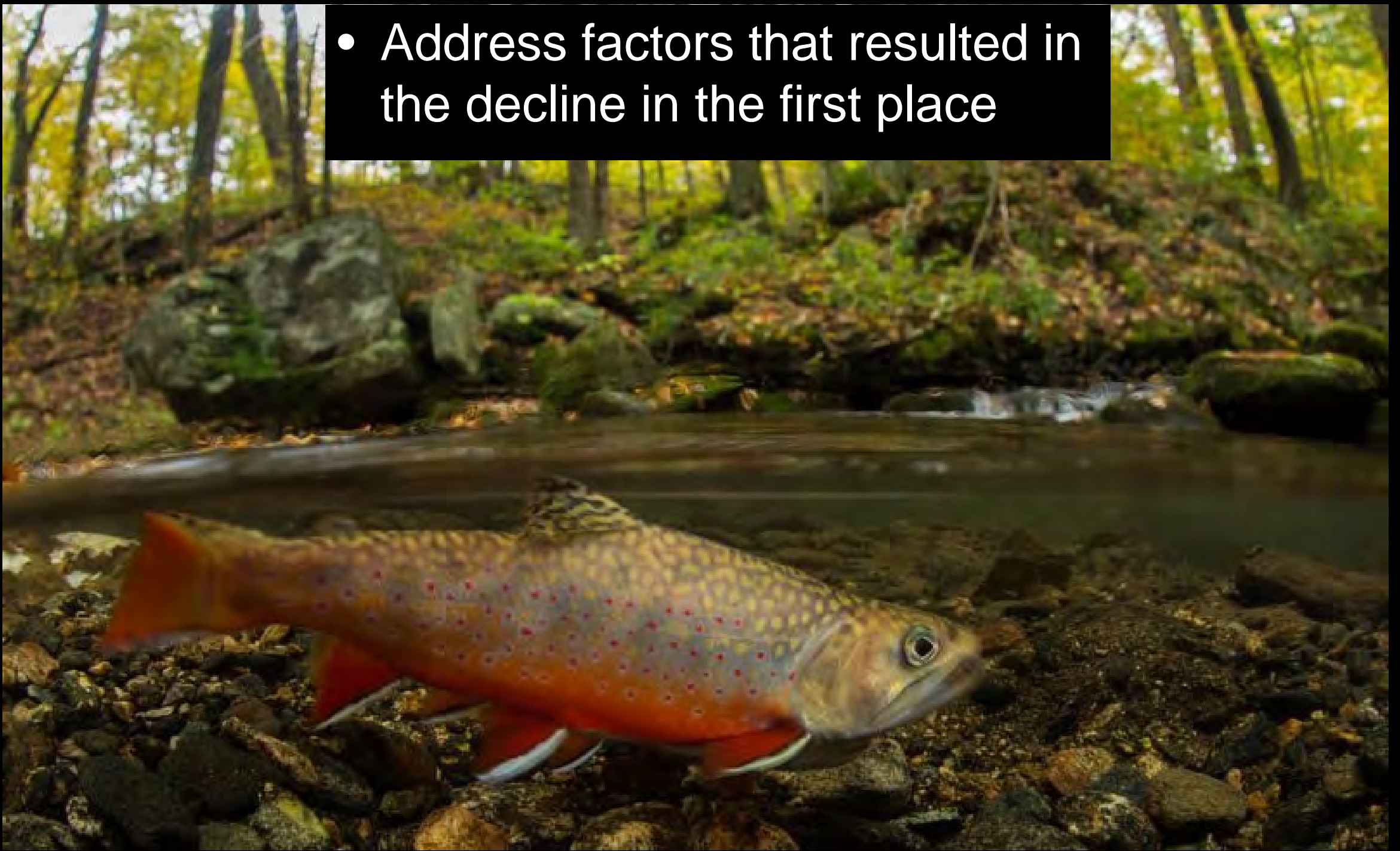
- These actions carry risks
- Not a substitute for addressing factors that resulted in the decline in the first place
- But with good guidance and the right conditions, it can be an effective recovery tool



Greenback Cutthroat  
Joe Tomelleri



- Address factors that resulted in the decline in the first place









# Non-native Trout





# Hampton Creek











**Hampton Creek**



# Find a Source Population



**Appropriate Genetics**  
**No Harm to Donor Population**





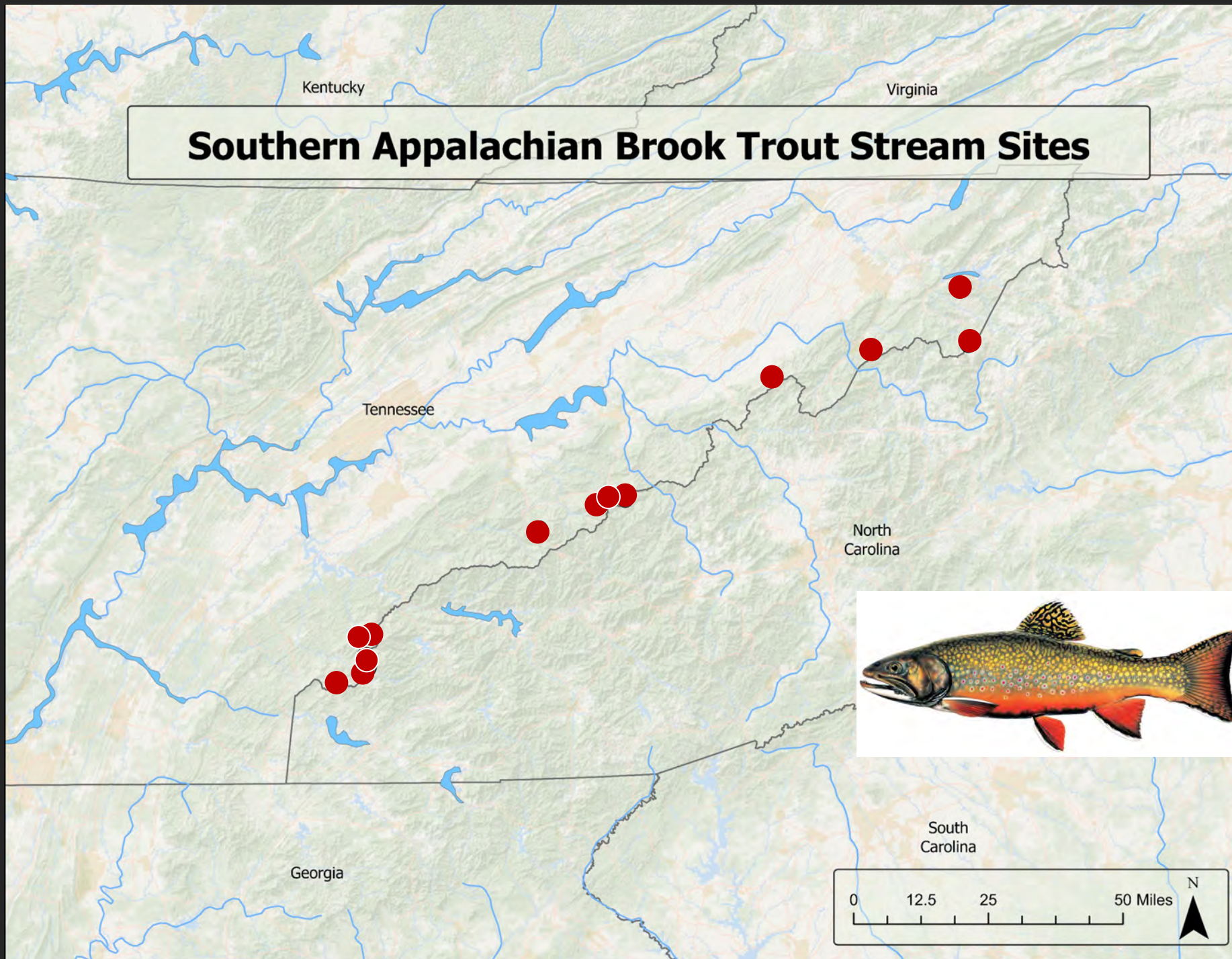


## Hatchery Propagation, Rearing, & Stocking





# Southern Appalachian Brook Trout Stream Sites





# Southern Appalachian Brook Trout Stream Sites: Northern Population

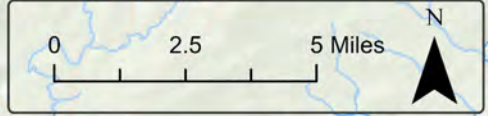
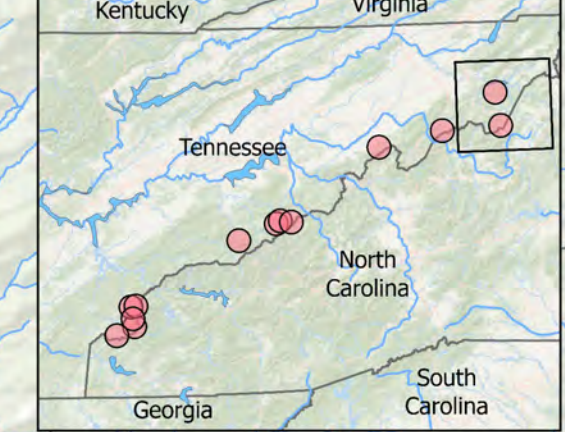
## Stream Type

- Stocked
- ▲ Source and Stocked
- Doe River
- Watauga River

Little Stony Creek

Hampton Creek

Tennessee  
North Carolina







**Southern Appalachian Brook Trout only propagated at hatchery once – 1990s**

**Propagating Southern Appalachian Brook Trout at TNACI & Tellico Hatchery (TWRA) to understand growth and survival**

**Stocked 400 tagged SABT**





# Southern Appalachian Brook Trout Stream Sites: Northern Population

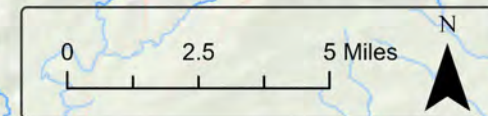
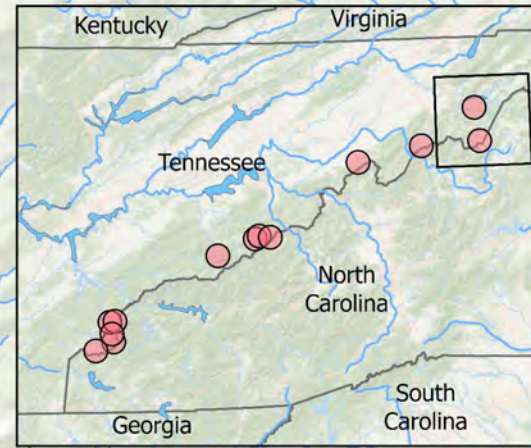
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Tennessee  
North Carolina





# Partners

TU

TWRA

USFS

GSMNP

USFWS

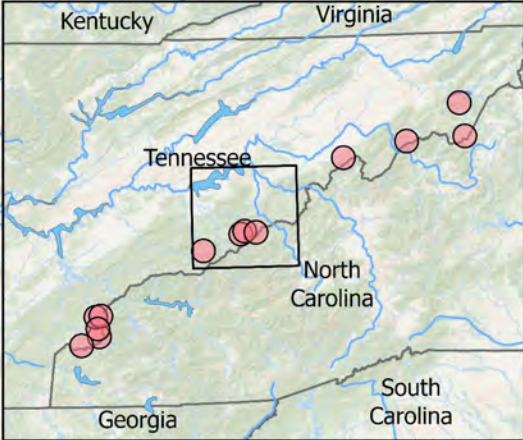




# Southern Appalachian Brook Trout Stream Sites: Park Population

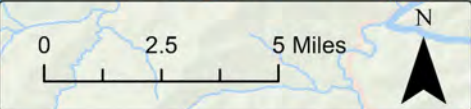
## Stream Type

- Other
- Source
- Pigeon River



**Greenbriar**  
**Indian Camp** **Cosby**

**Leconte Creek**

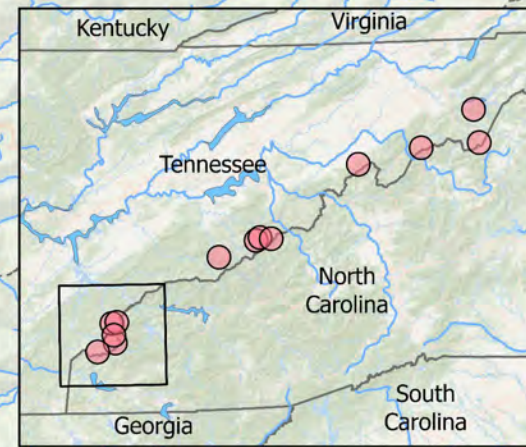




# Southern Appalachian Brook Trout Stream Sites: Southern Population

## Stream Type

- Source
- Stocked
- ▲ Source and Stocked
- Tellico River



Ike Camp Branch



North Fork Citico Creek



Sugar Cove Branch



Sycamore Creek



Brookshire Creek



Tennessee  
North Carolina

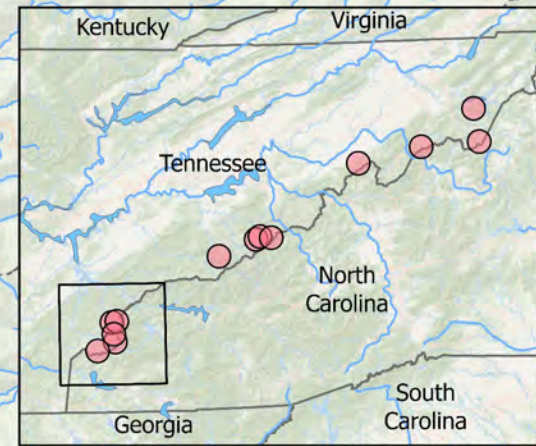




# Southern Appalachian Brook Trout Stream Sites: Southern Population

## Stream Type

- Source
- Stocked
- Source and Stocked
- Tellico River



Ike Camp Branch

North Fork Citico Creek

Sugar Cove Branch

Sycamore Creek

Brookshire Creek

Tennessee  
North Carolina

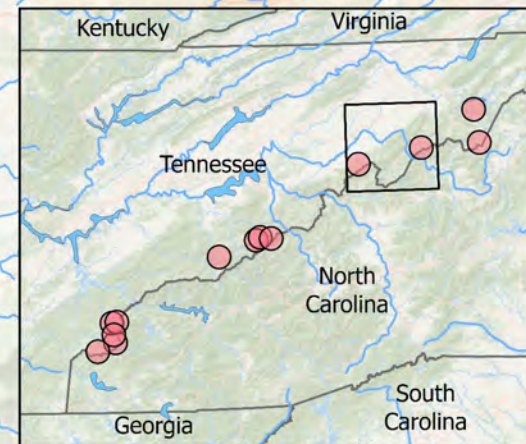




# Southern Appalachian Brook Trout Stream Sites: 2024 Population

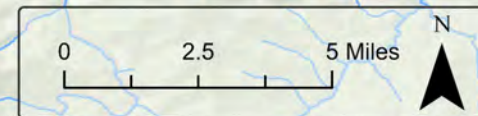
## Stream Type

- Source
- Stocked
- Nolichucky River



**Phillips  
Hollow**

**Right Prong  
Rock Creek**

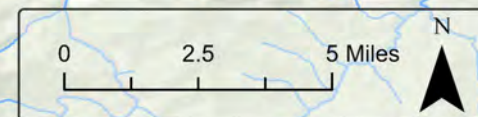
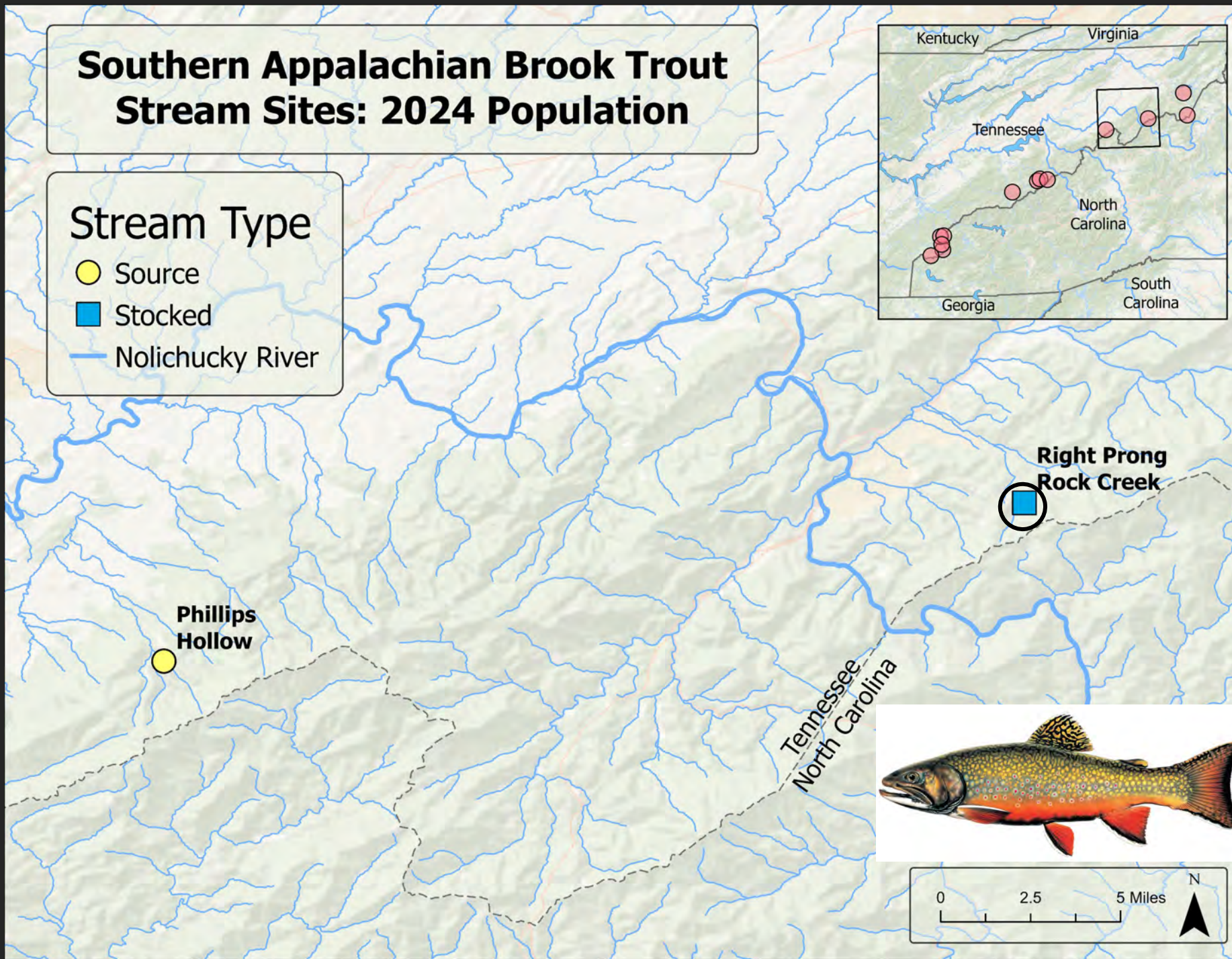
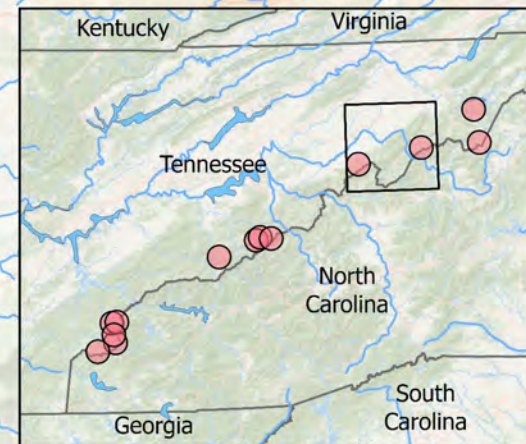




# Southern Appalachian Brook Trout Stream Sites: 2024 Population

## Stream Type

- Source
- Stocked
- Nolichucky River

















# Broodstock quarantine

Smelt, Silversides,  
Krill, Enriched Pellets

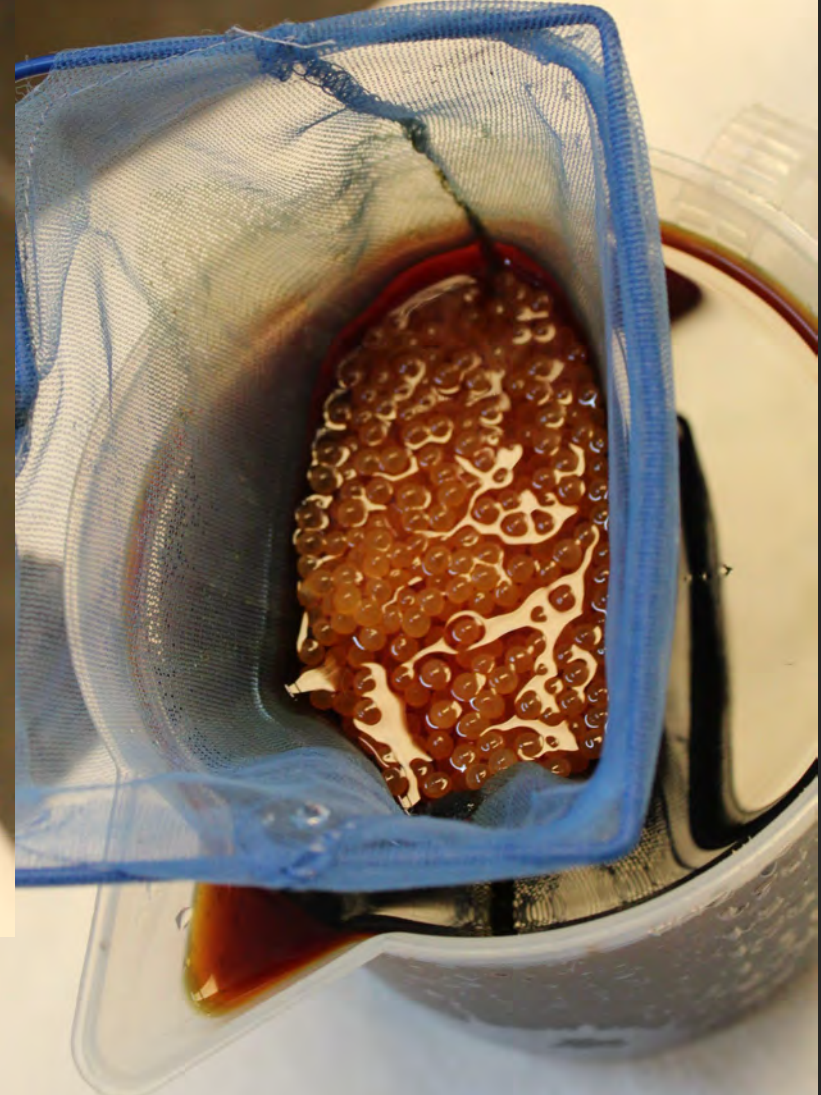




**1 female with 2 males**



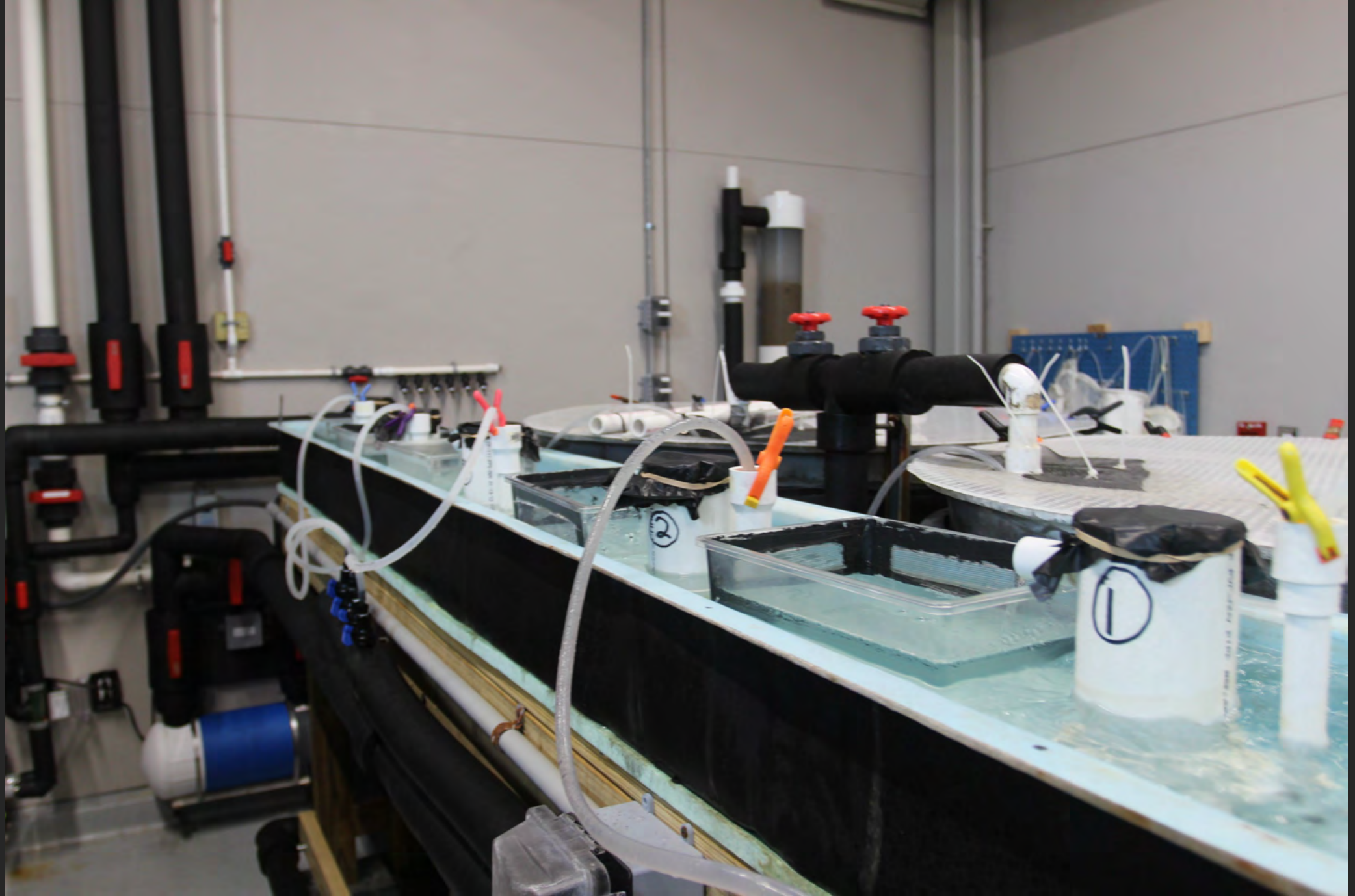




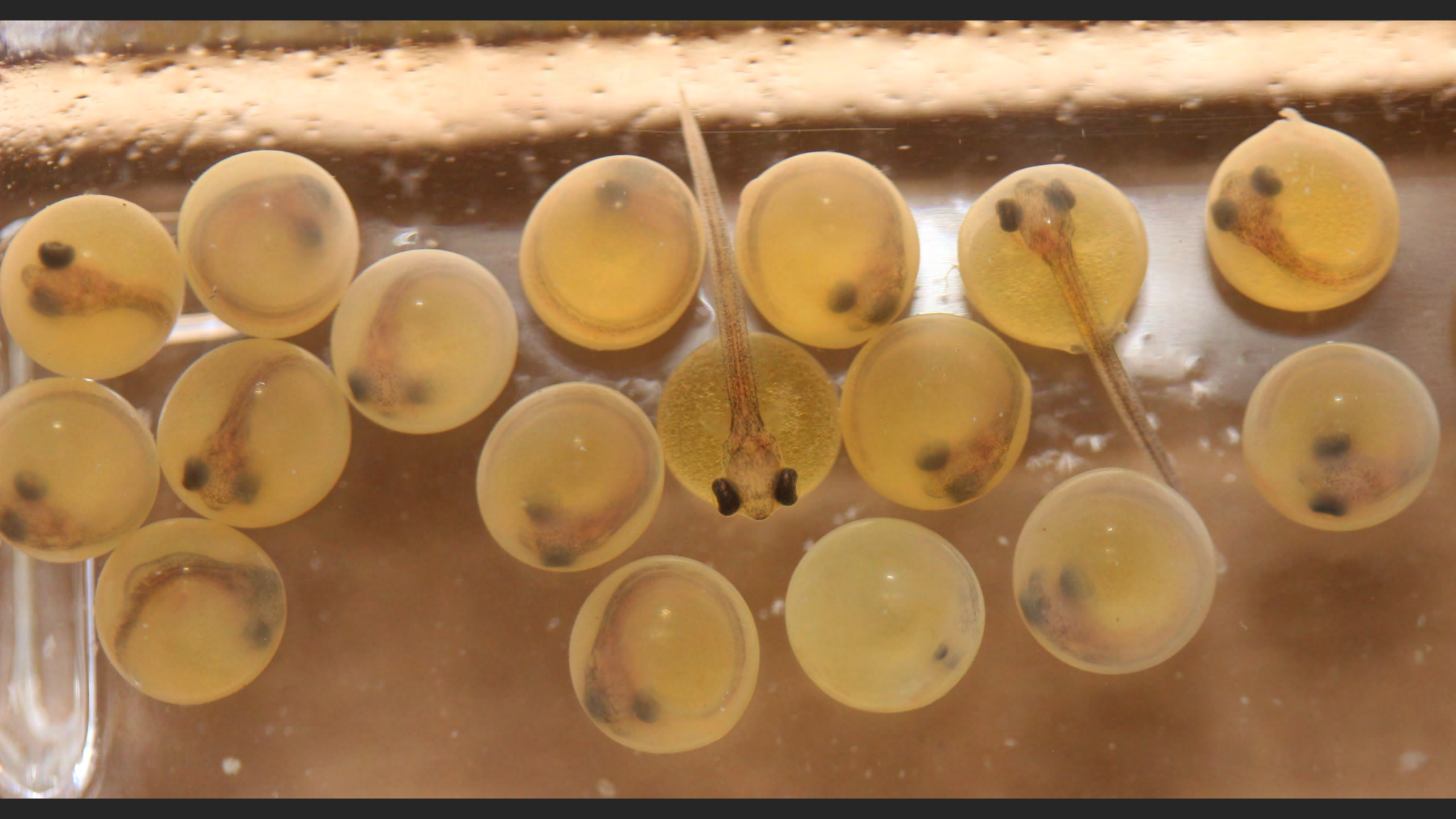
















**Live Brine  
Shrimp**







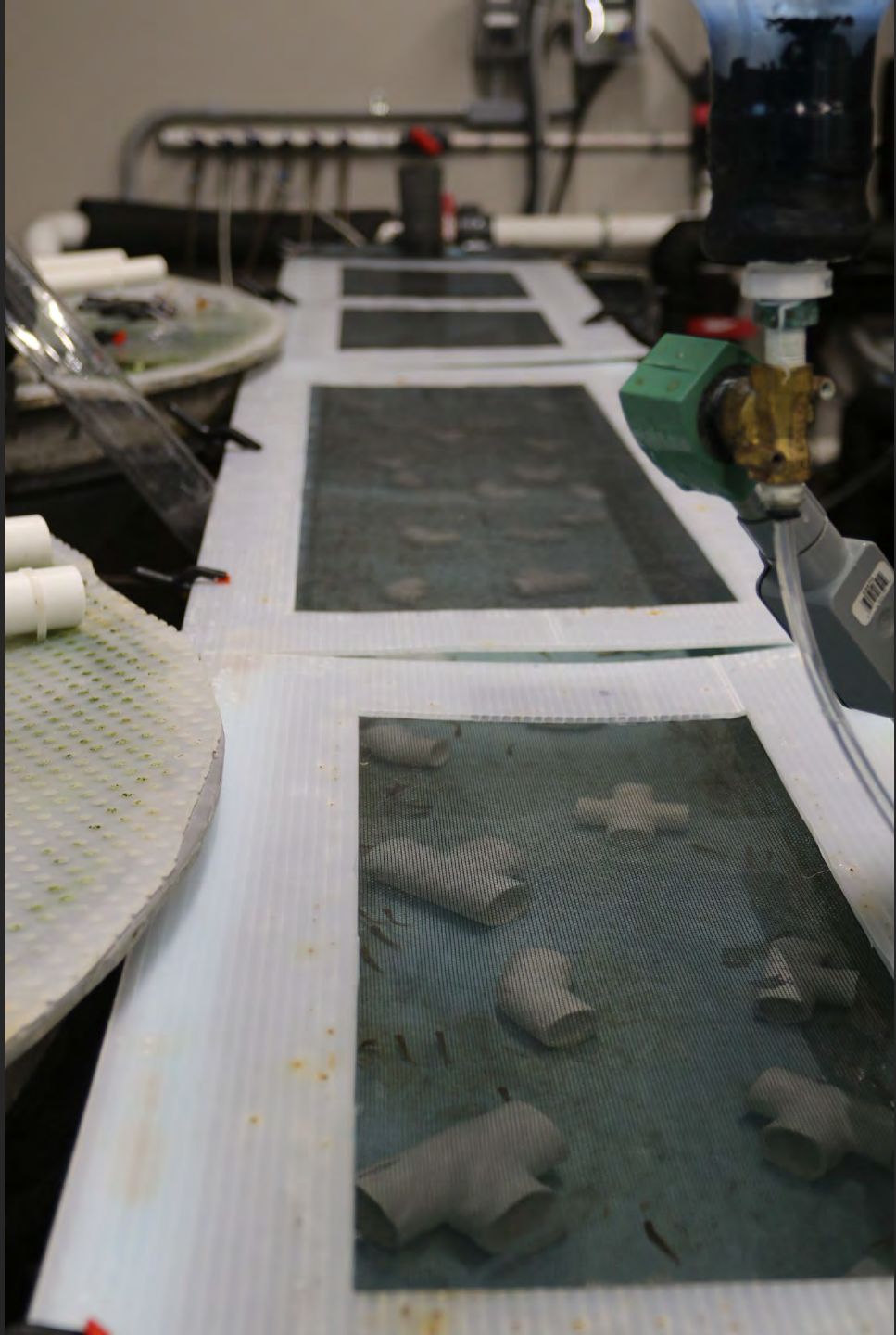
**Live Brine Shrimp  
Frozen Rotifers &  
Daphnia  
Enriched Flakes**













**Socks**



**Fluidized beds**





**Disease Screening  
Warm Springs NFH**



















# Genetic Diversity

- Only use broodstock 2x
- At least 3 years of stocking
- Equalize family units – example 2023
  - 1,333 from 10 families
  - Culled a total of 400 to be stocked below barrier
  - 933 to be stocked in restored streams









# The Southeast's Aquatic Biodiversity: Why it Rocks!

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# Fresh Water Is Life!

- We depend on 0.01% of Earth's water for our existence
- Roughly 25% of all vertebrate species are found in these same freshwater habitats

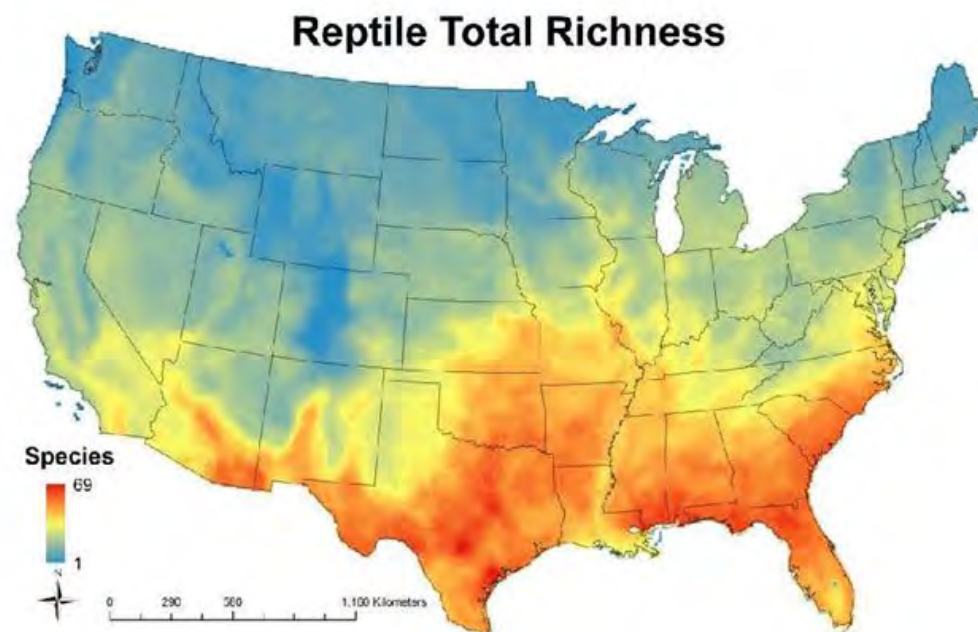
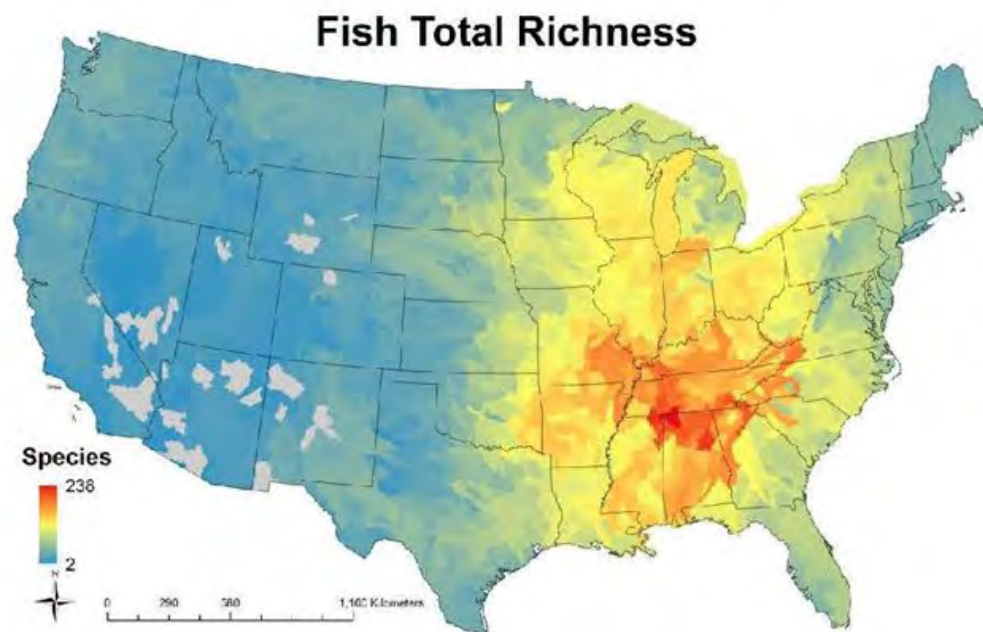




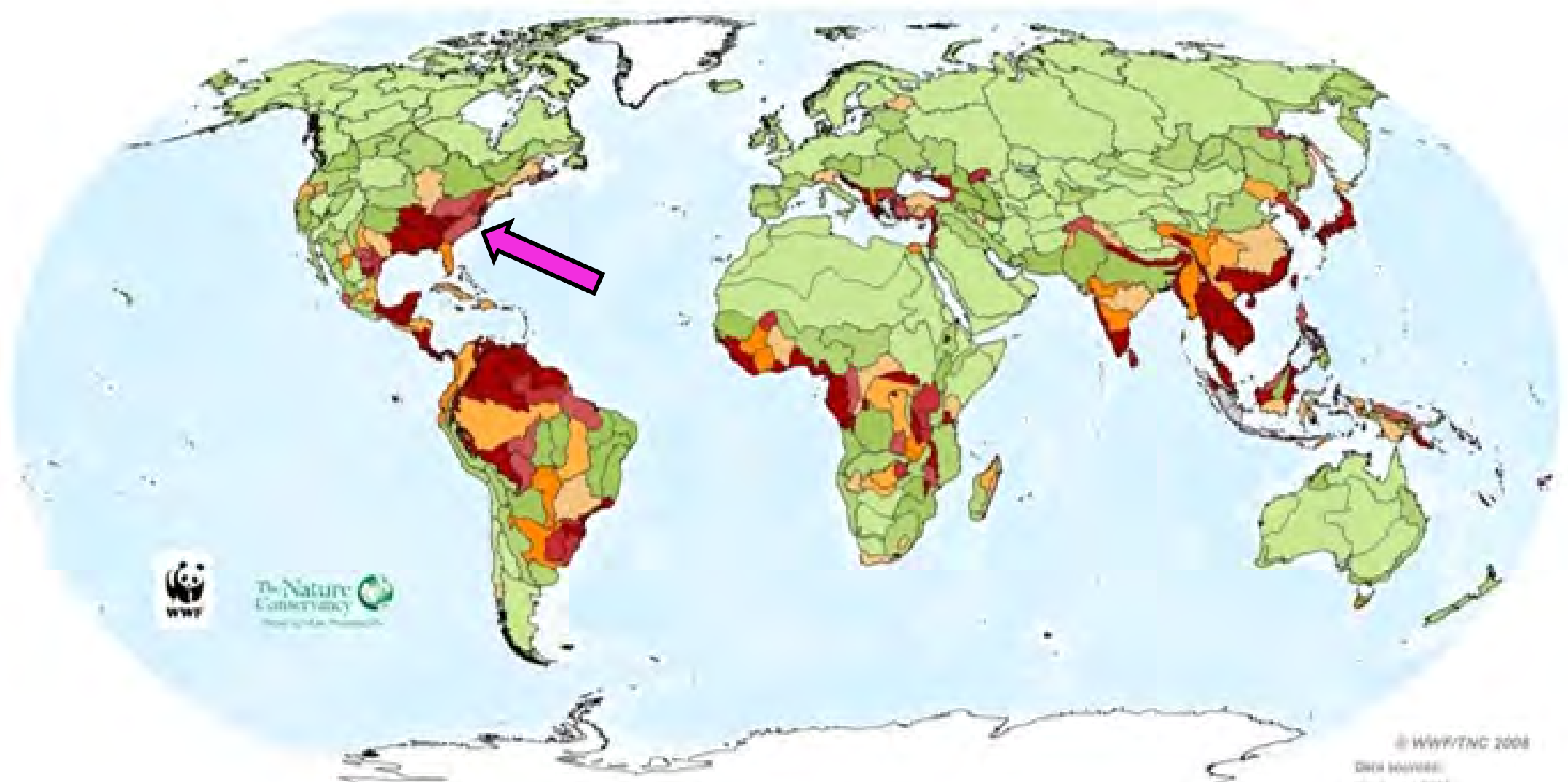
# Southeastern Biodiversity

Rich diversity of freshwater fishes, mussels, snails, crayfishes, turtles, salamanders, & others

Most species poorly understood







Freshwater fish species per ecoregion area

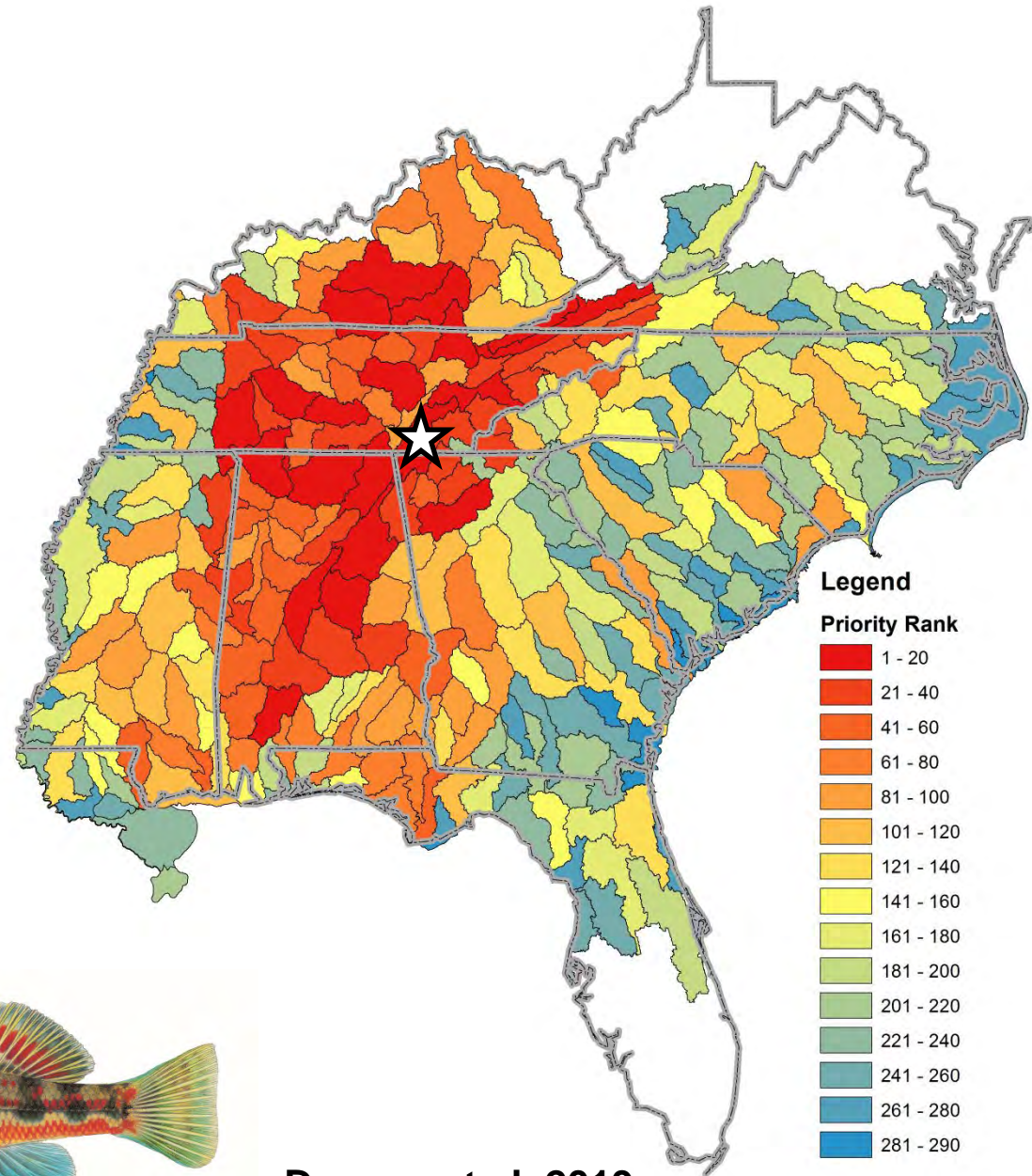


number of species /  $10^4$  km<sup>2</sup>



# HUC 8 Priority Watersheds

1. Wheeler Lake
2. Pickwick Lake
3. Upper Clinch River
4. Lower Duck River
5. Cahaba River
6. Caney Fork
7. Lake Cumberland
8. Middle Coosa River
9. Etowah River
10. South Fork Cumberland



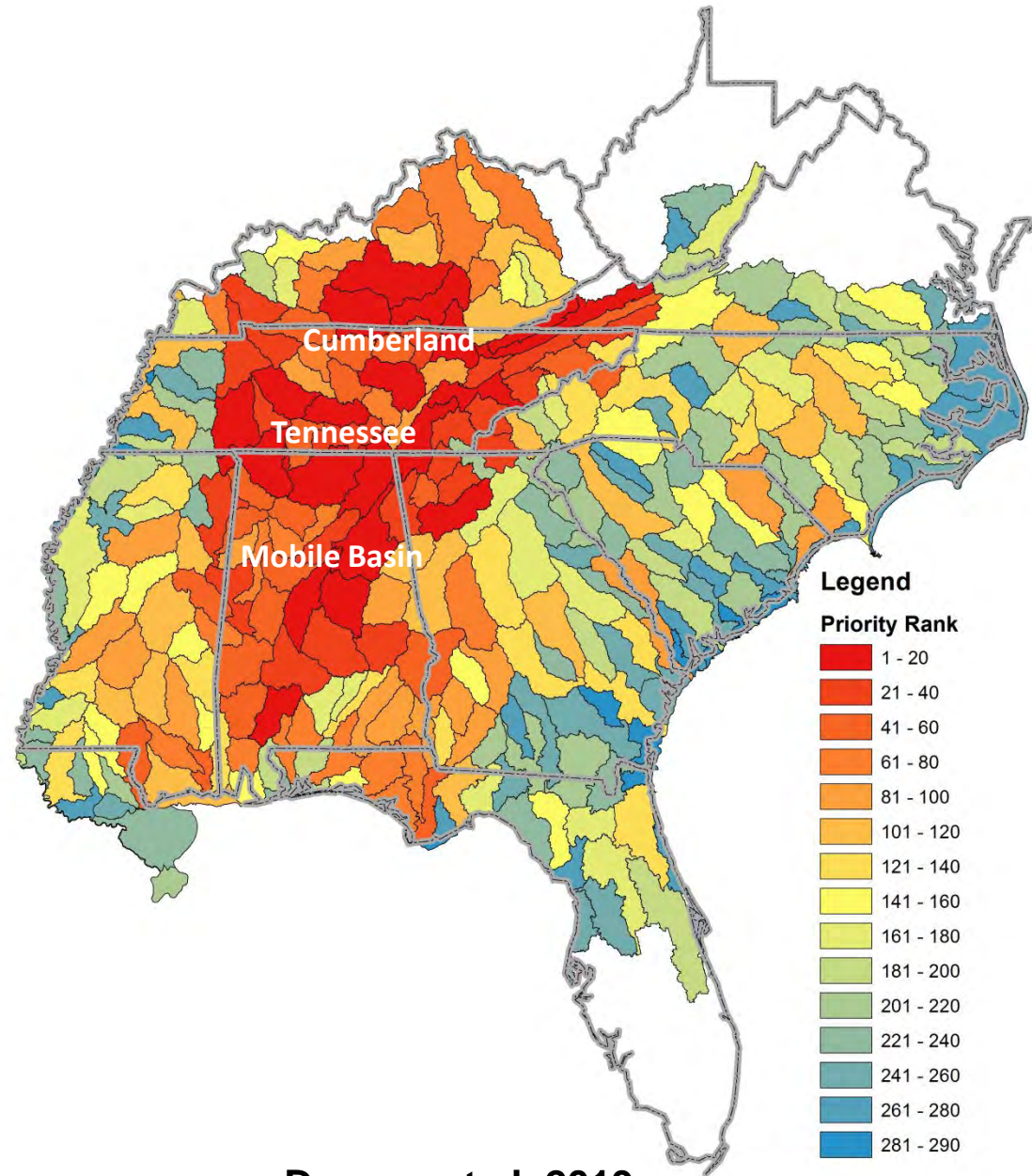
Duncan et al. 2019



Over 400 fish species  
Cumberland, Tennessee,  
and Mobile Basin

48% of fish diversity in U.S  
& Canada

1.4% of area



Duncan et al. 2019













B. Peoples



















Dang! I think he's going to reach the water.

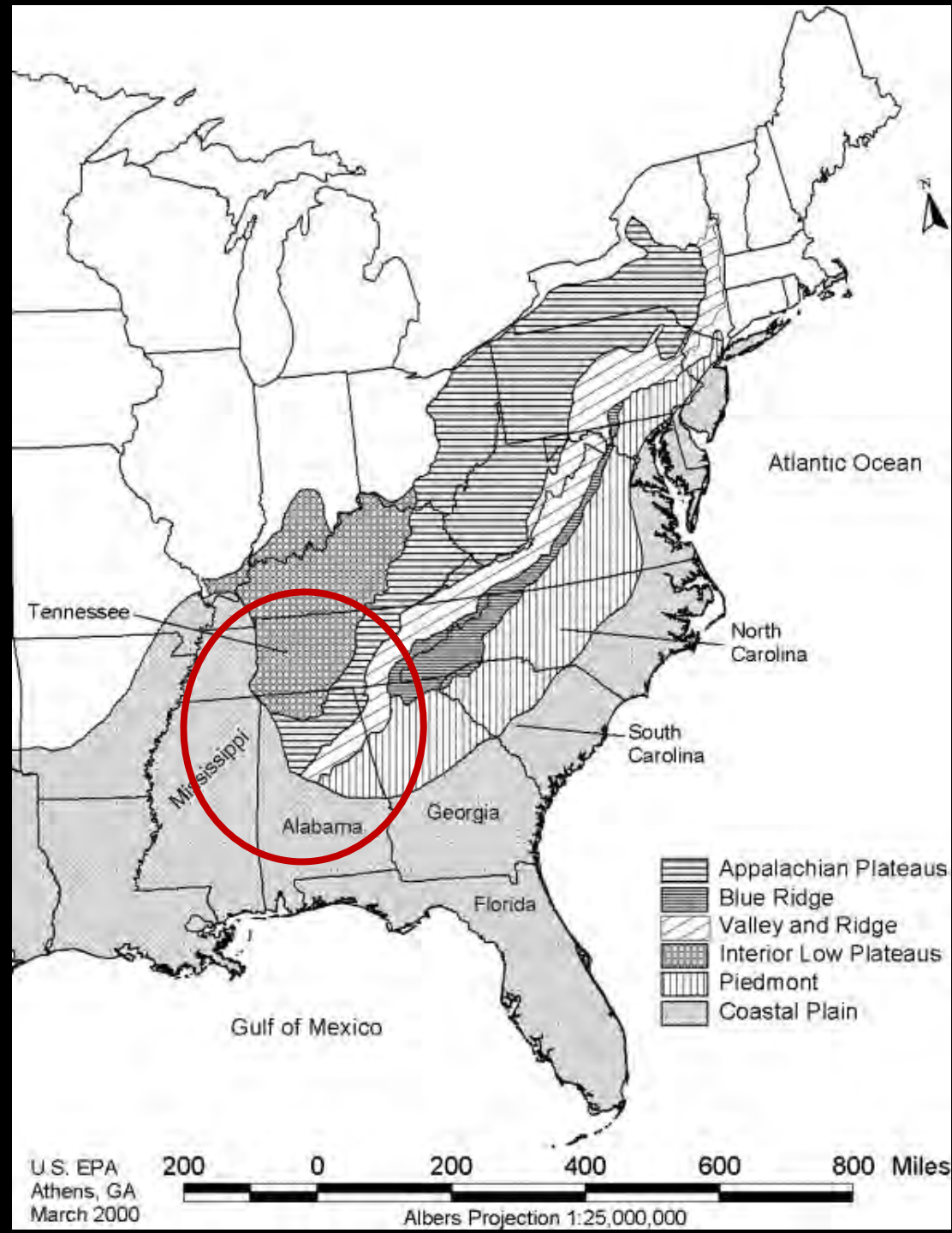
Oh no, he's not.



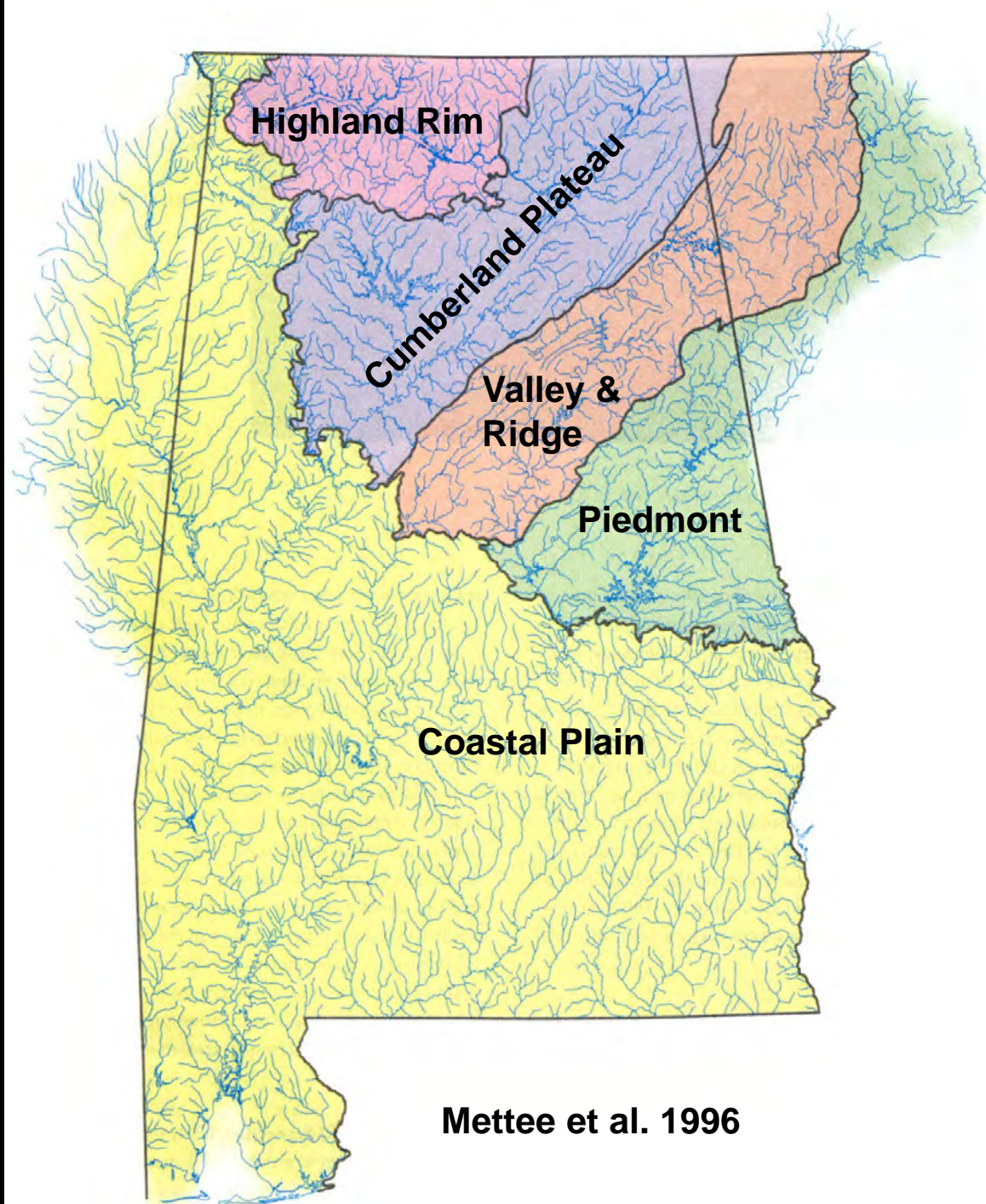
Larson



# Physiographic Provinces of Southeastern U.S.

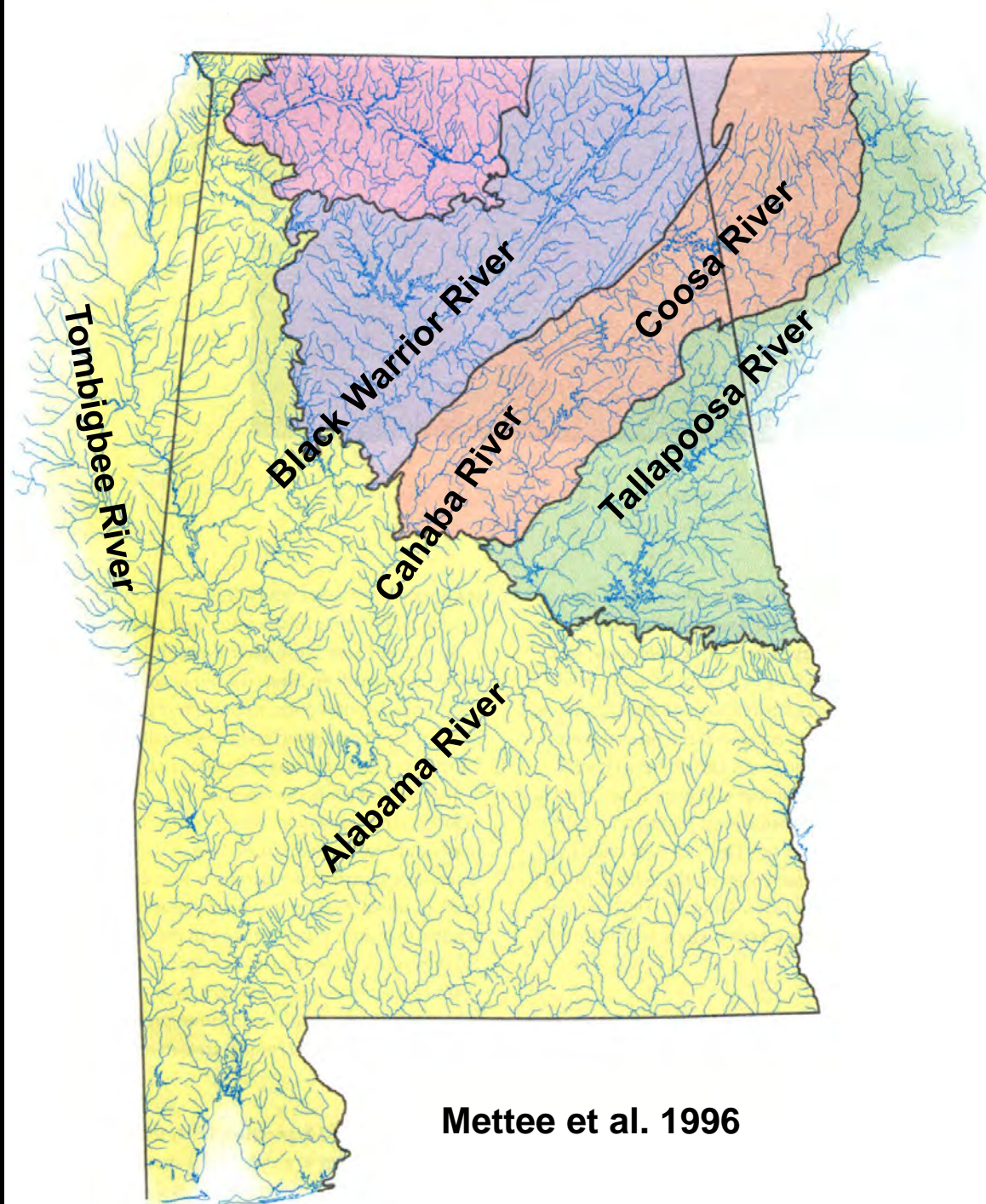






**Mettee et al. 1996**





**Mettee et al. 1996**





**Redeye Bass** – *Micropterus coosae*



**Tallapoosa Bass** – *Micropterus tallapoosae*



**Cahaba Bass** – *Micropterus cahabae*



**Warrior Bass** – *Micropterus warriorensis*

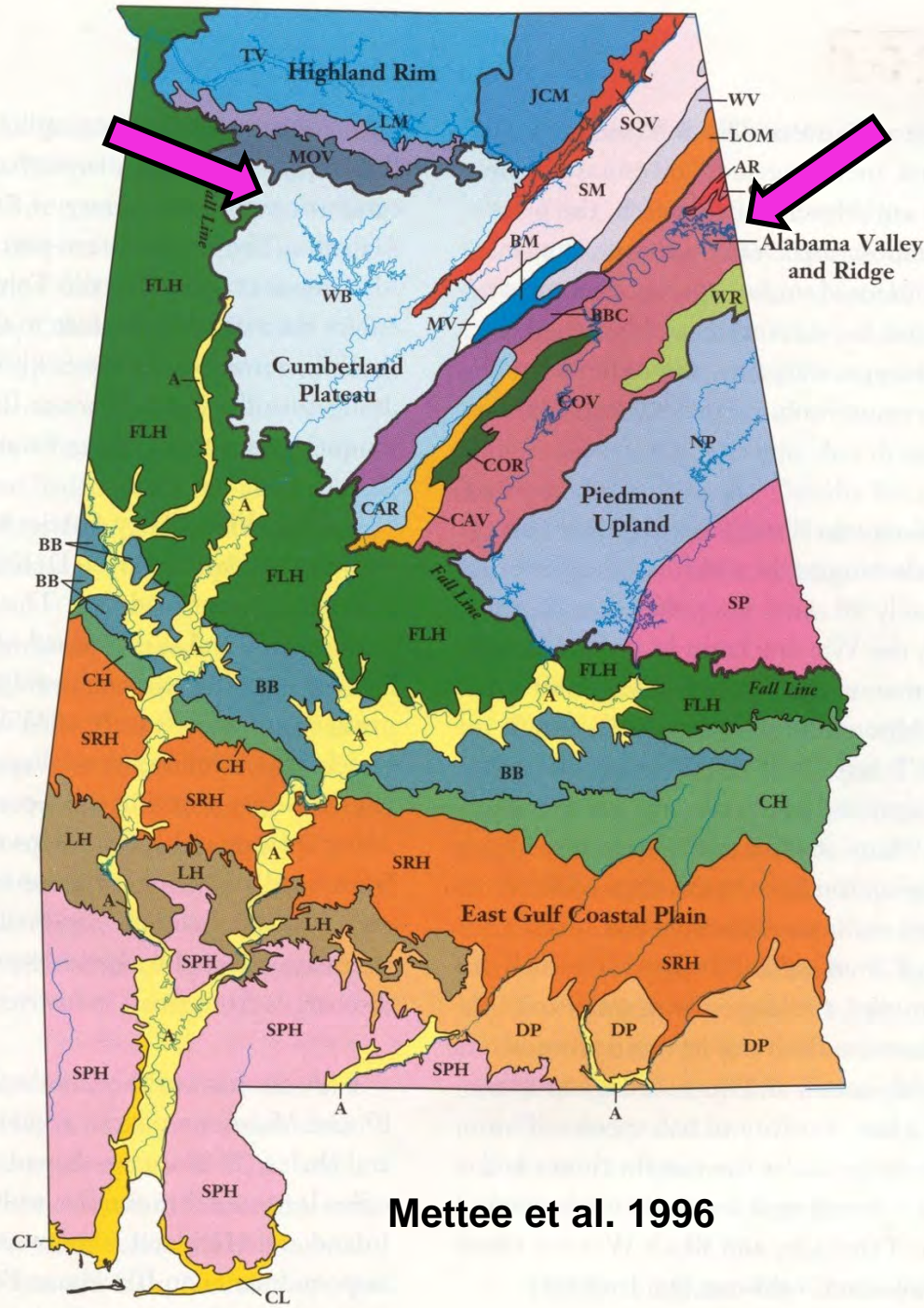




Joe Tomelleri

**Alabama Bass – *Micropterus henshalli***







*Etheostoma trisella* localities

- Tissue collections
- \* Type locality
- Historical sites

Hydrology

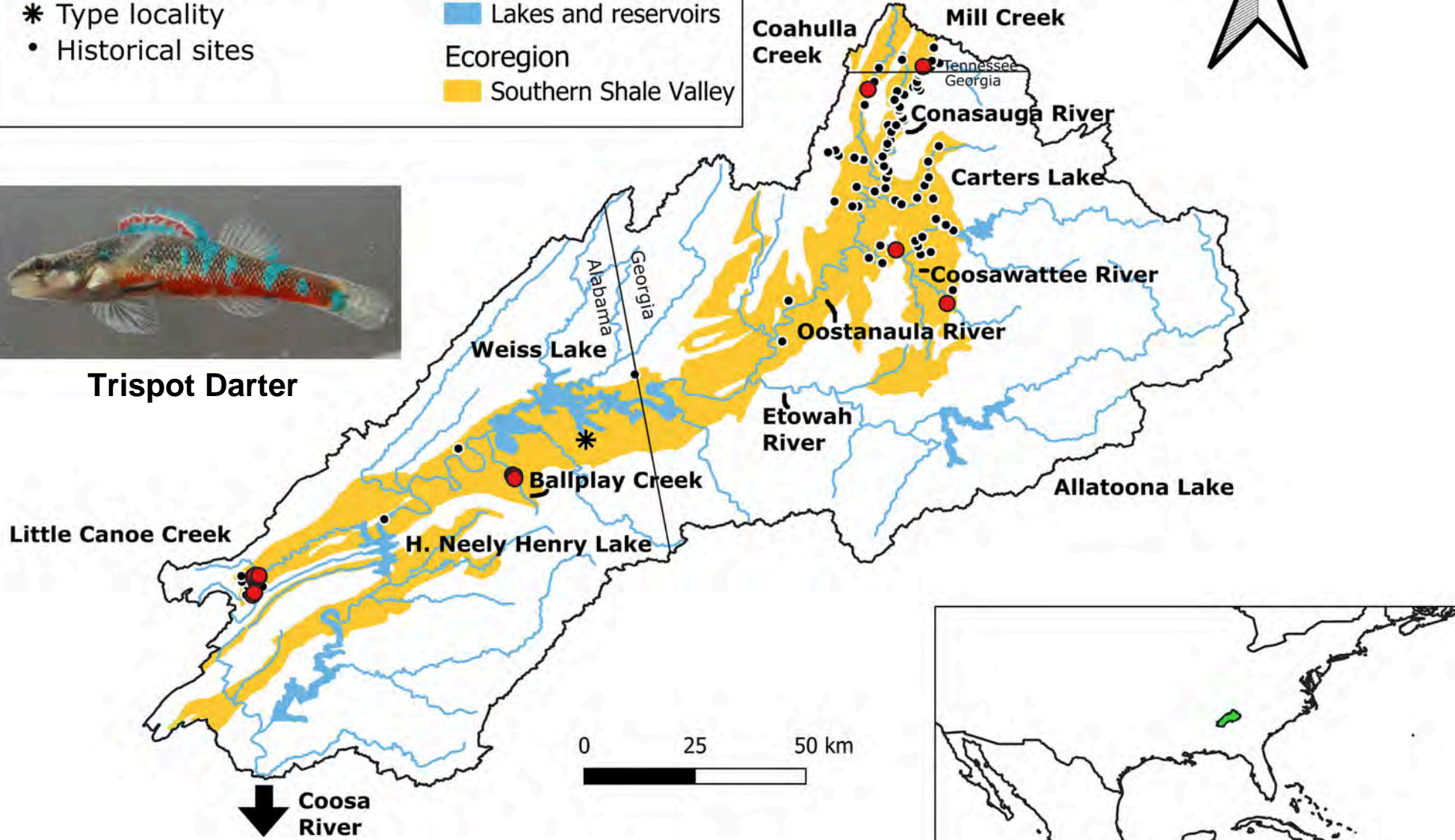
- Streams
- Lakes and reservoirs

Ecoregion

- Southern Shale Valley



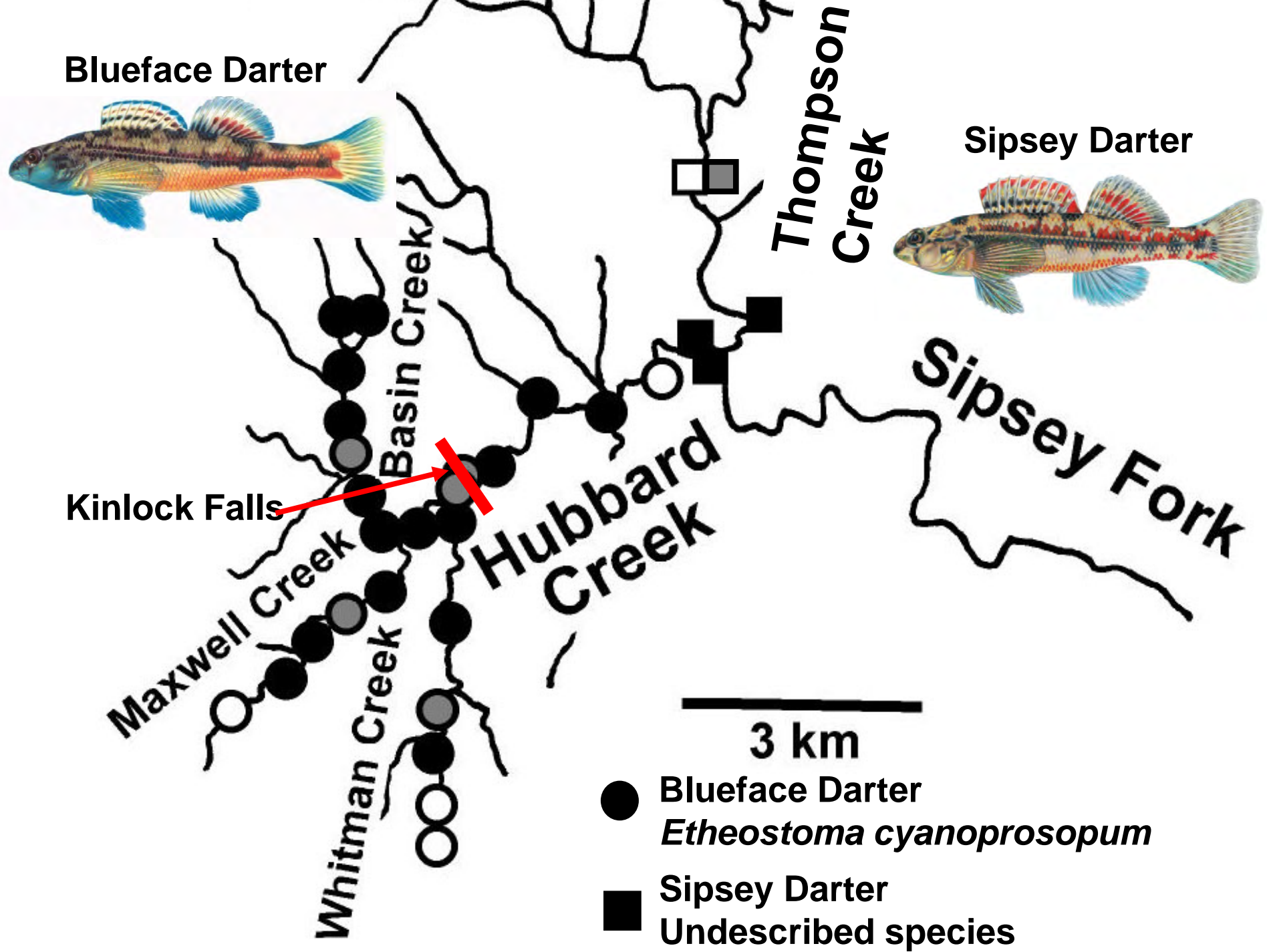
Trispot Darter



↓ Coosa River

Fast et al 2023







**Blueface Darter**



**Parkwood Formation**

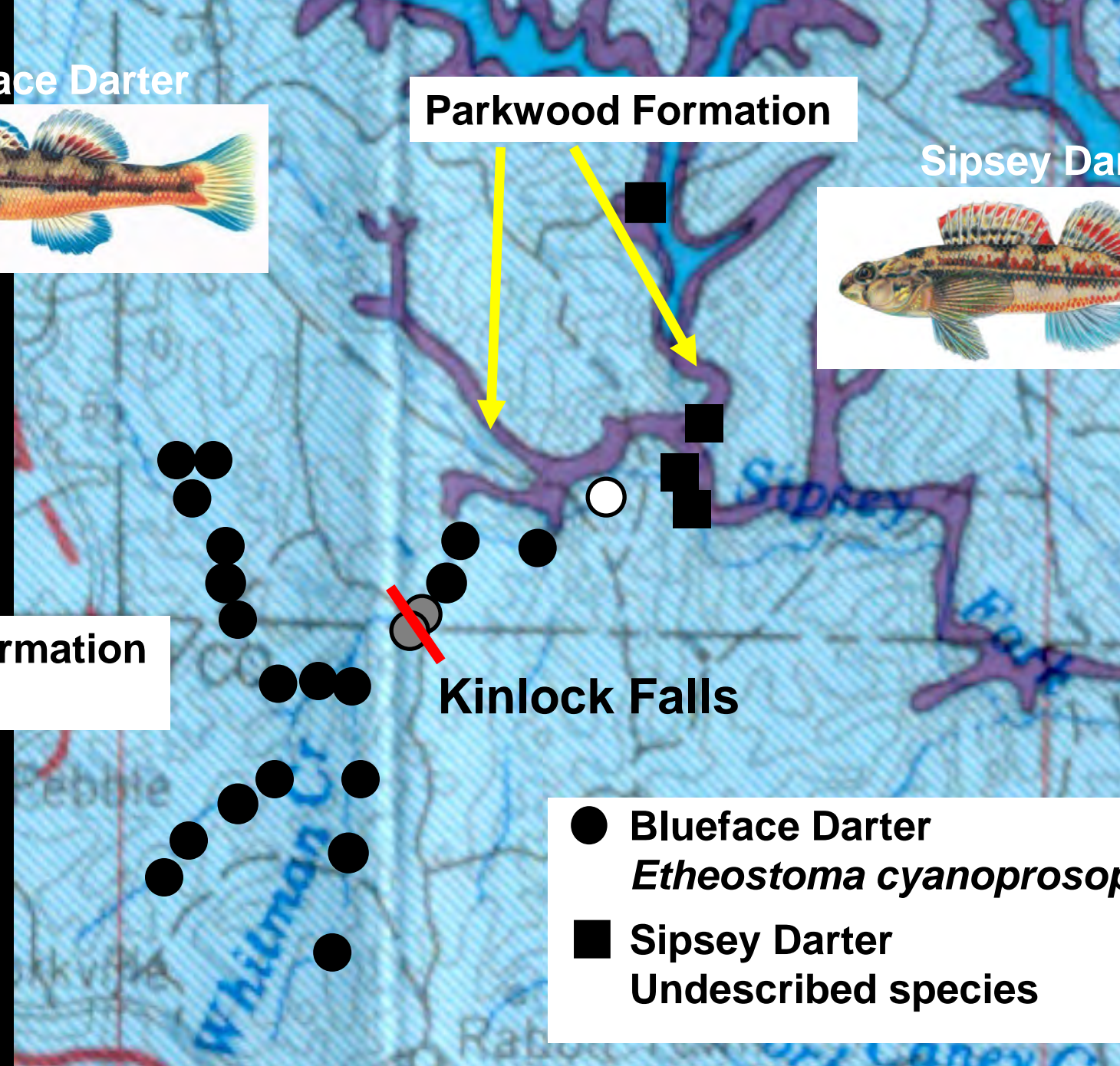
**Sipsey Darter**



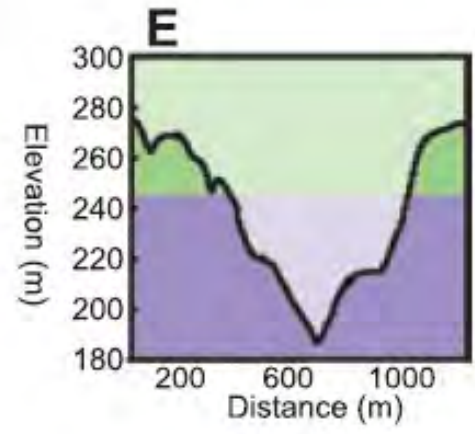
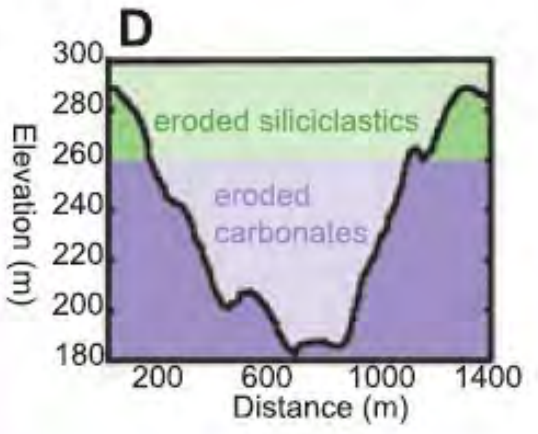
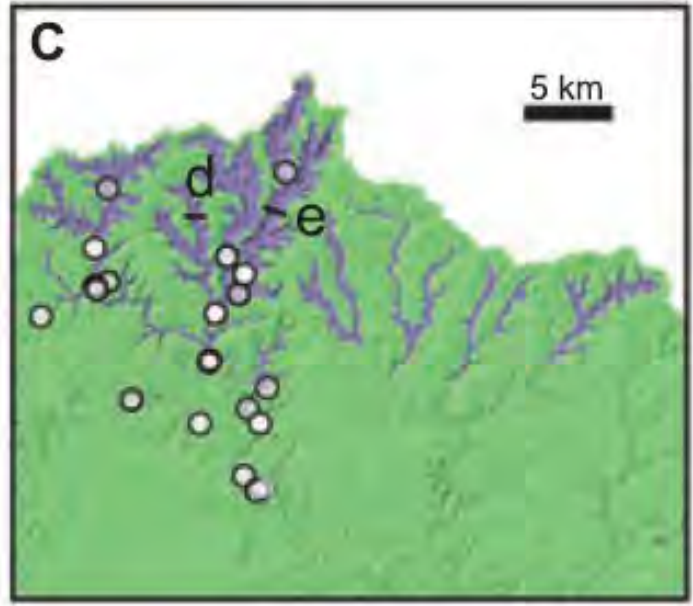
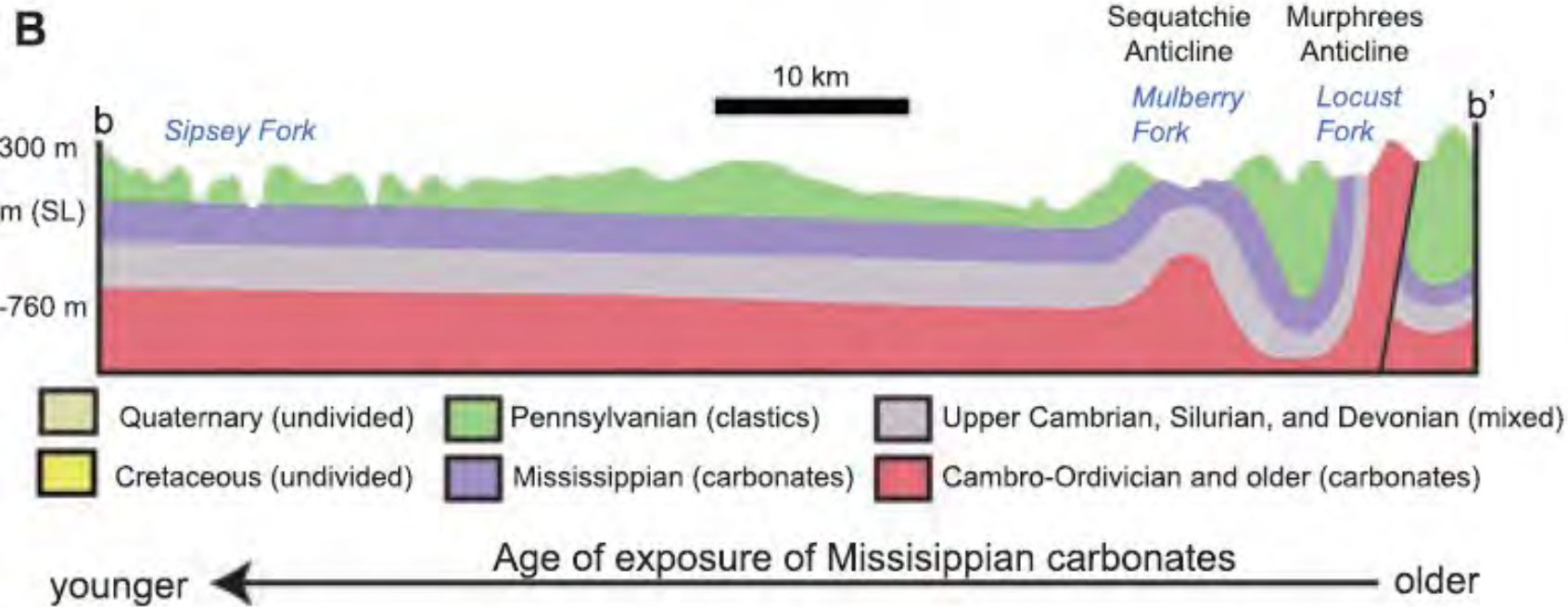
**Pottsville Formation  
(lower part)**

**Kinlock Falls**

- Blueface Darter  
*Etheostoma cyanoprosopum*
- Sipse Darter
- Undescribed species











**25 Species  
Freshwater Turtles**



# 100 Species Crayfishes



Guenter Schuster



Guenter Schuster



# 178 Species Freshwater Mussels







S. Ghesquiere



Robert Kreisler



S. Ghesquiere



Heather Lynch



S. Ghesquiere

# 300+ Species Freshwater Snails





**338 Species  
Freshwater  
Fishes**



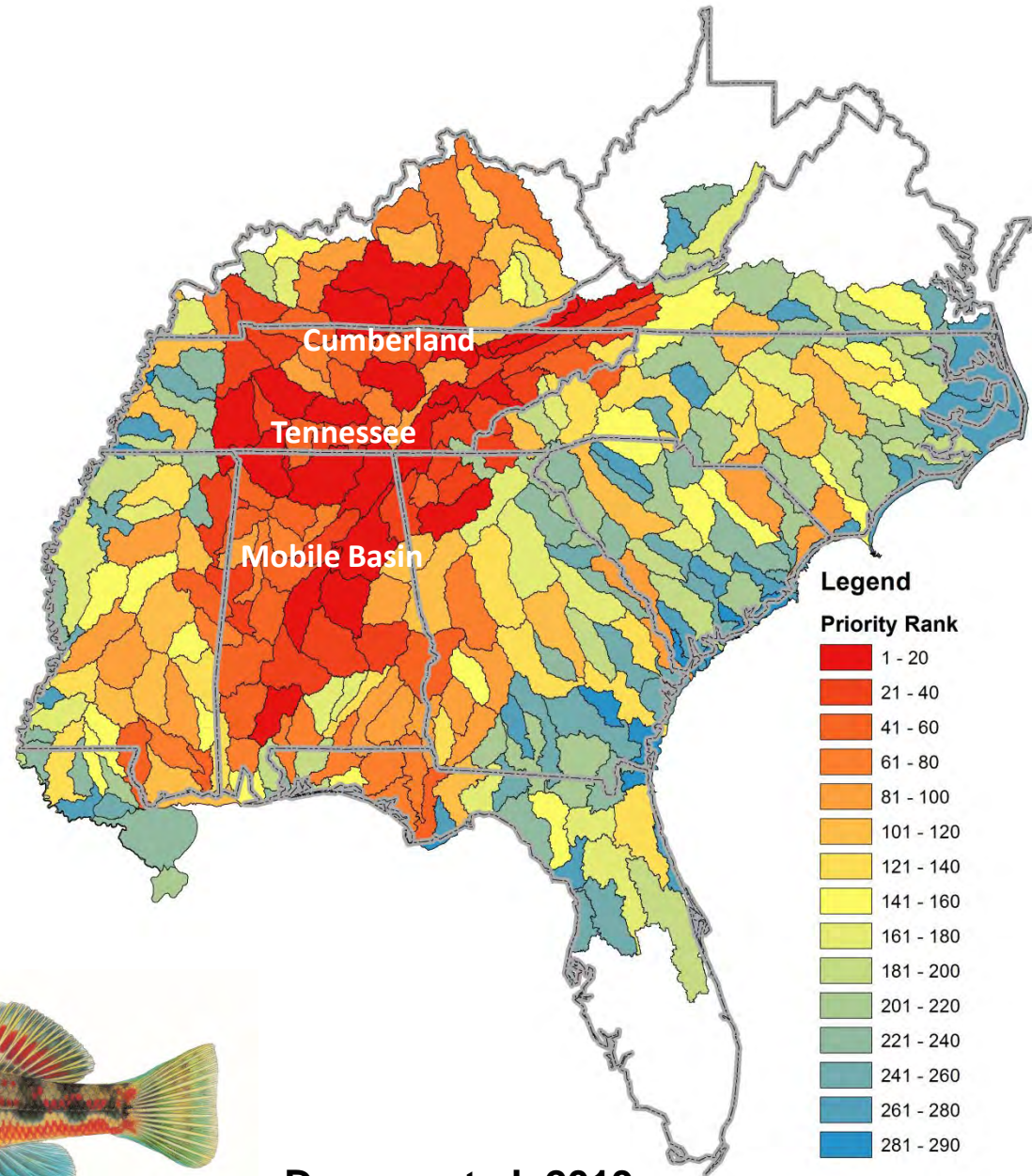
**Joe Tomelleri**





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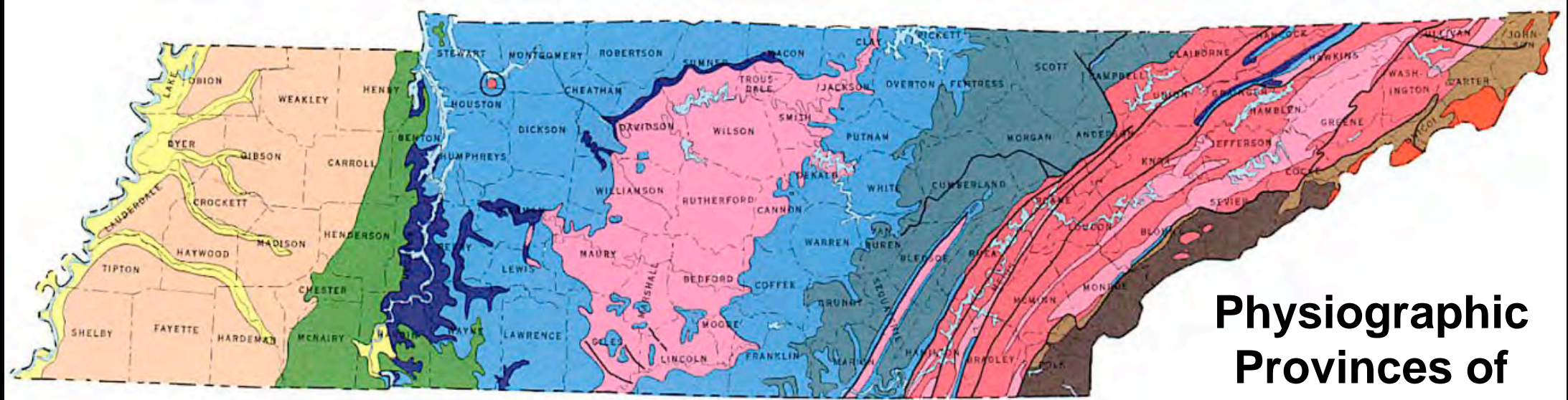
Duncan et al. 2019



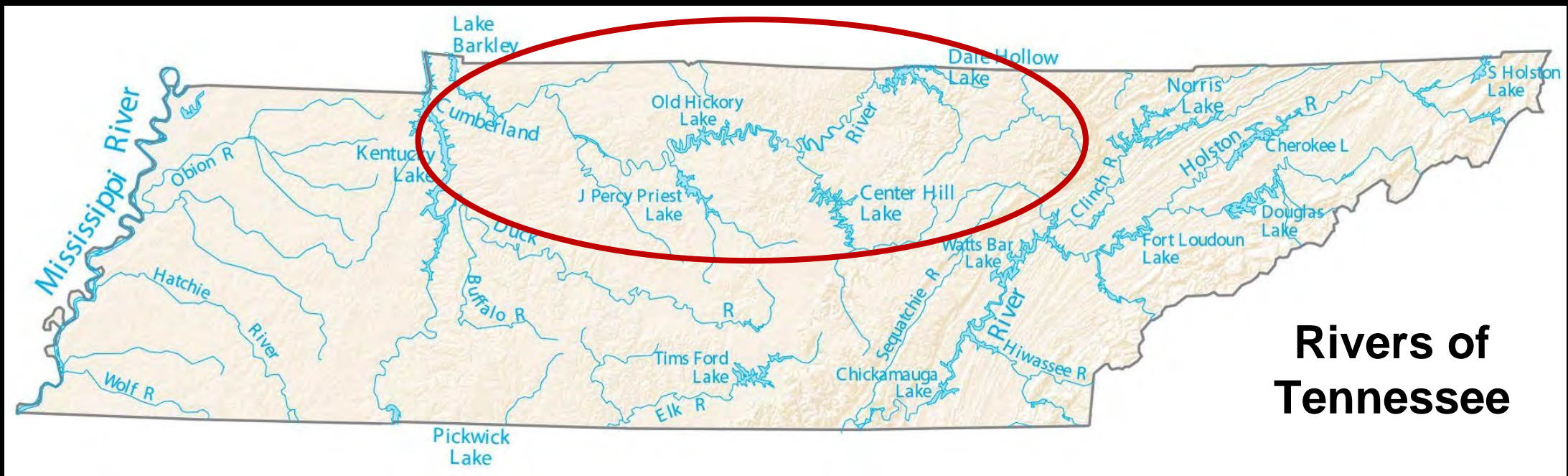
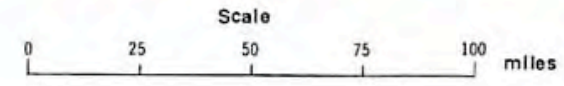








**Physiographic Provinces of Tennessee**



**Rivers of Tennessee**



# Snubnose Darter Complex

(*Etheostoma simoterum*)

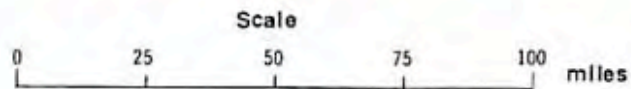
Westrim Darter  
*Etheostoma occidentale*



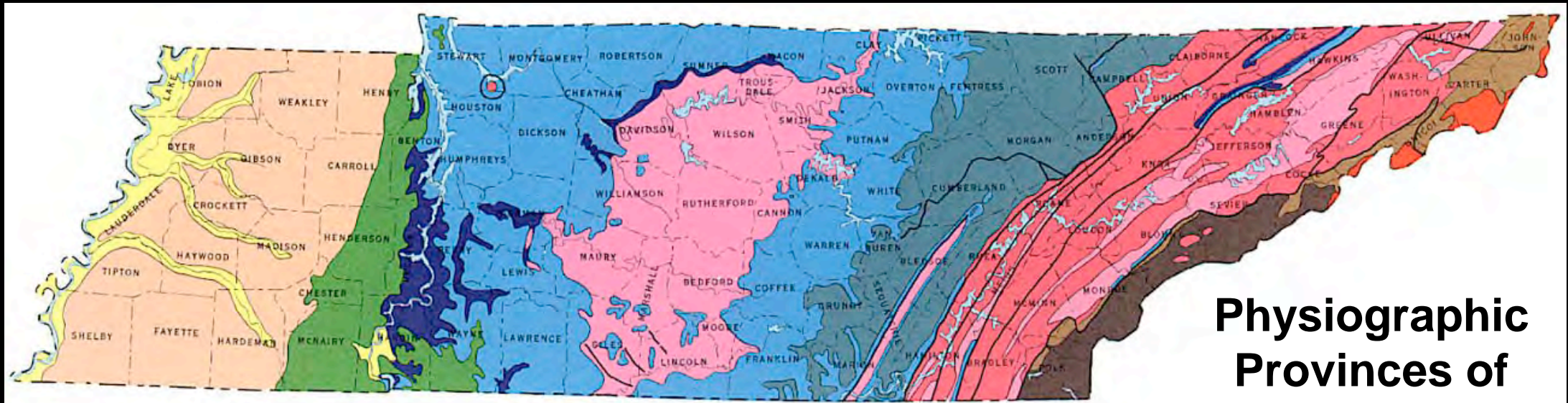
Cumberland Snubnose Darter  
*Etheostoma atripinne*



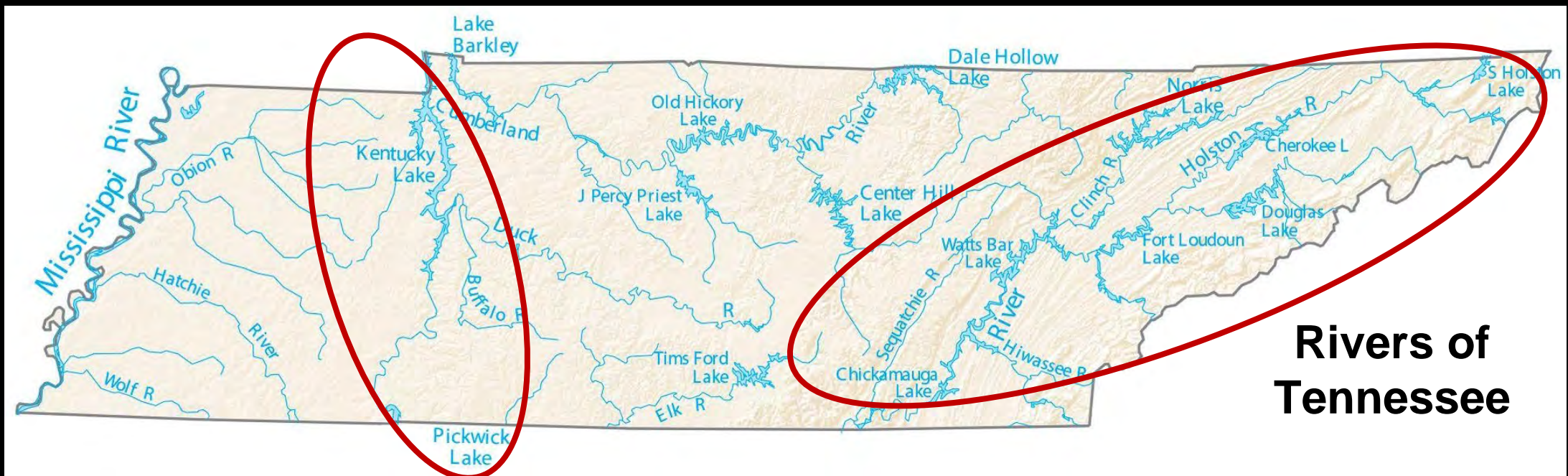
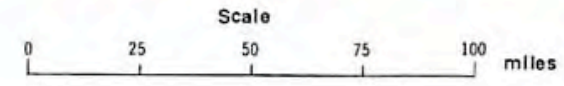
Eastrim Darter  
*Etheostoma orientale*







**Physiographic Provinces of Tennessee**



**Rivers of Tennessee**





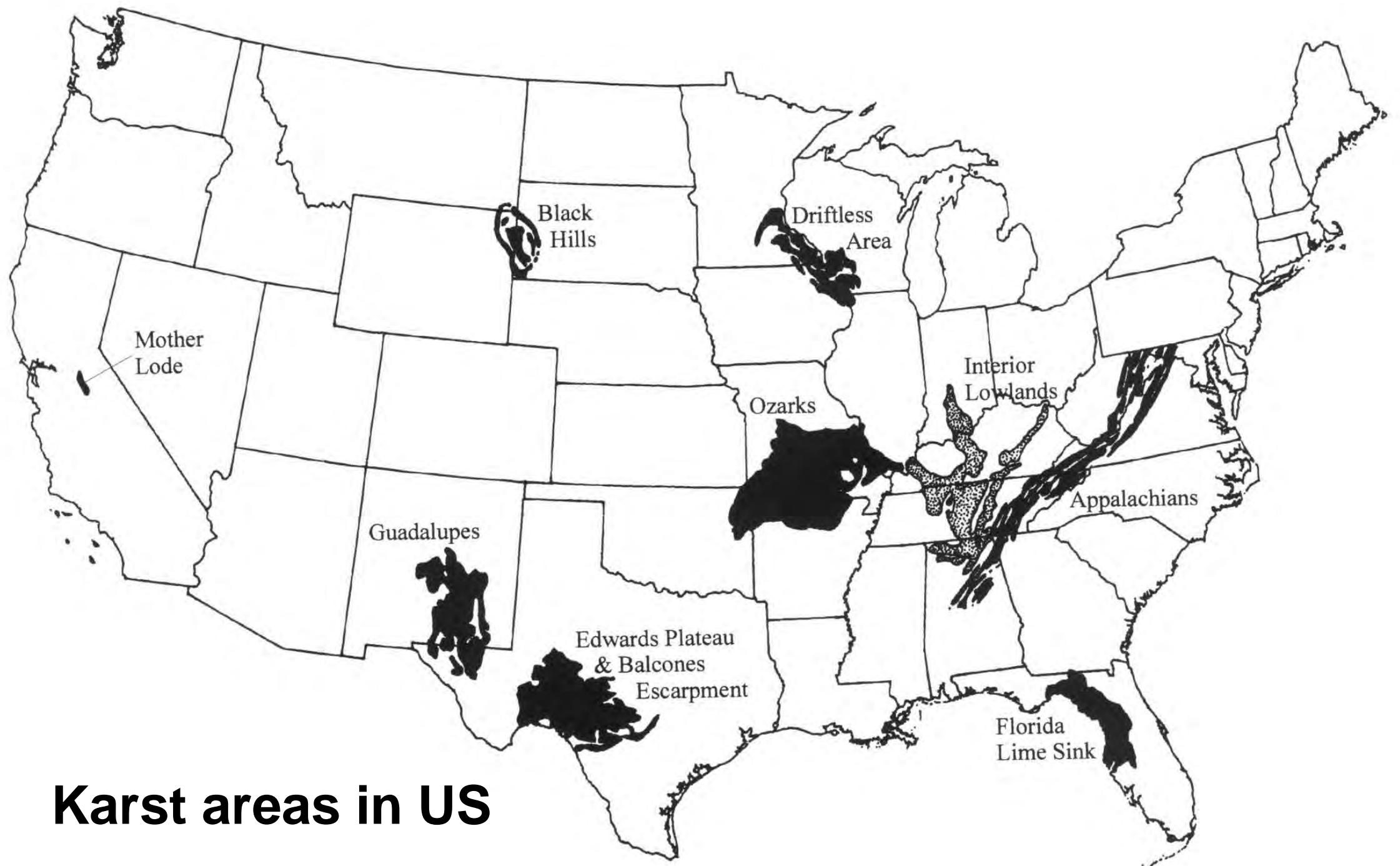
Guenter Schuster



# Stream & River Species







**Karst areas in US**



# Groundwater Habitats

**Springs**

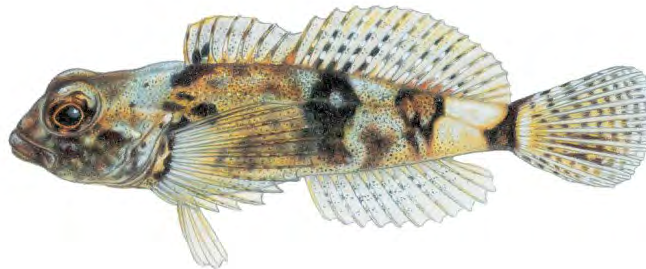
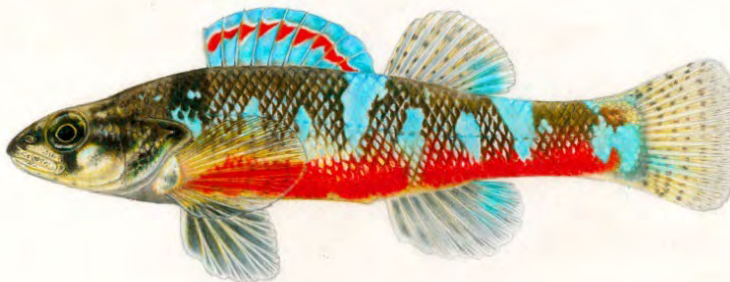
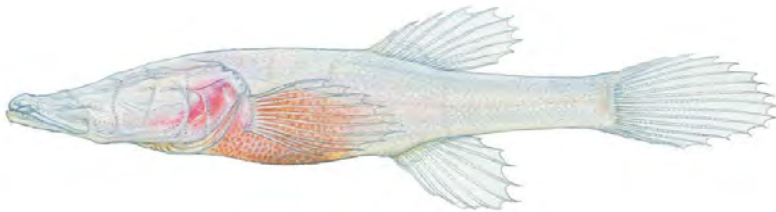


**Caves**





# Groundwater-dependent Species



Joe Tomelleri



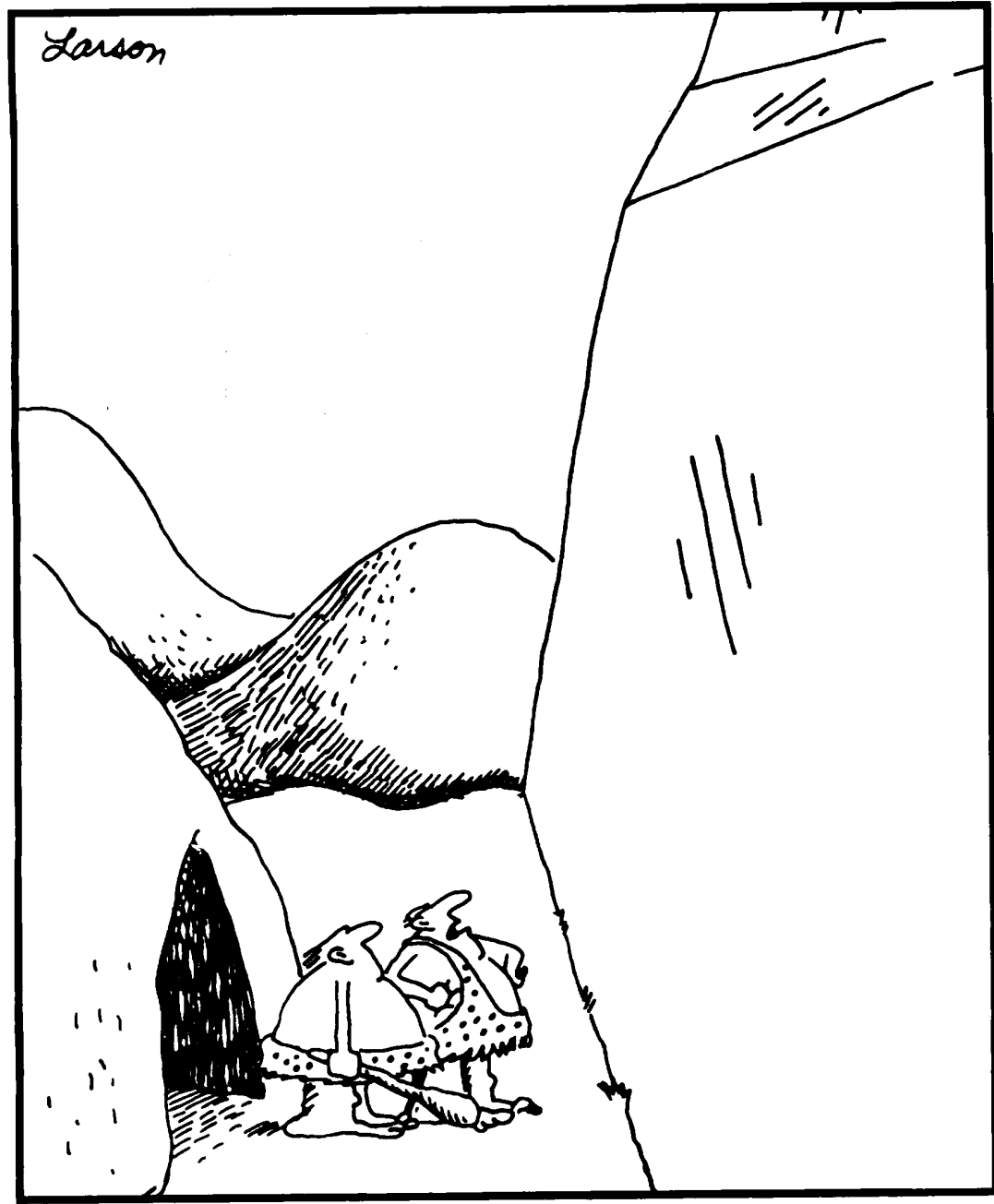




**Alabama Cavefish**  
***Speoplatyrhinus poulsoni***

Photos by Danté Fenolio





"Say, Thag ... wall of ice closer today?"



# Preglacial Watersheds

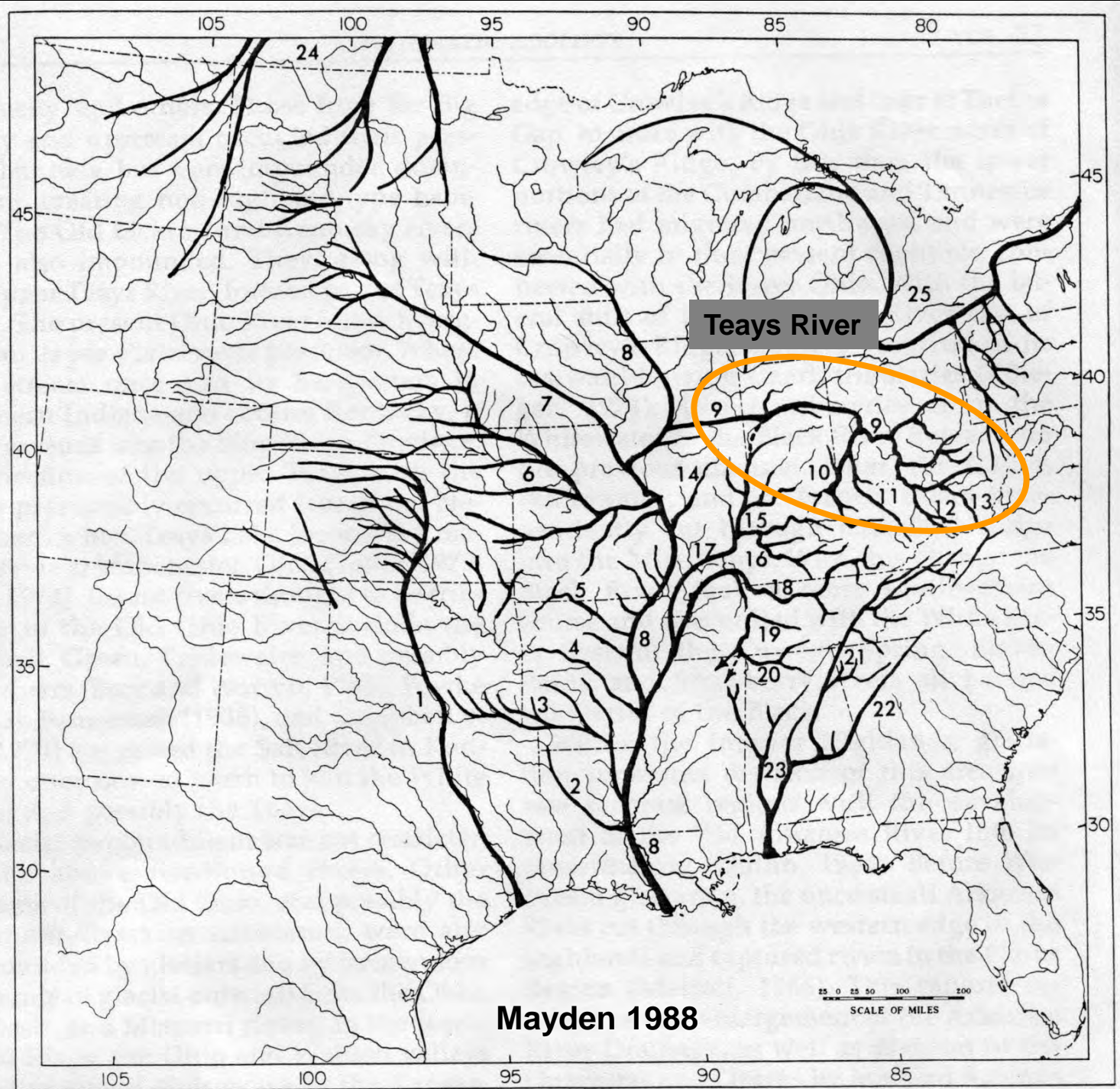
- 8. Old Mississippi River
- 9. Old Teays River
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- 12. Old Big Sandy River
- 13. Kanawha River
- 15. Wabash River
- 16. Green River
- 17. Old Ohio River
- 18. Old Cumberland River
- 19. Old Duck River
- 20. Old Tennessee River
- 21. Appalachian River
- 22. Old Tallapoosa River
- 23. Mobile Basin





# Preglacial Watersheds

- 8. Old Mississippi River
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# Preglacial Watersheds

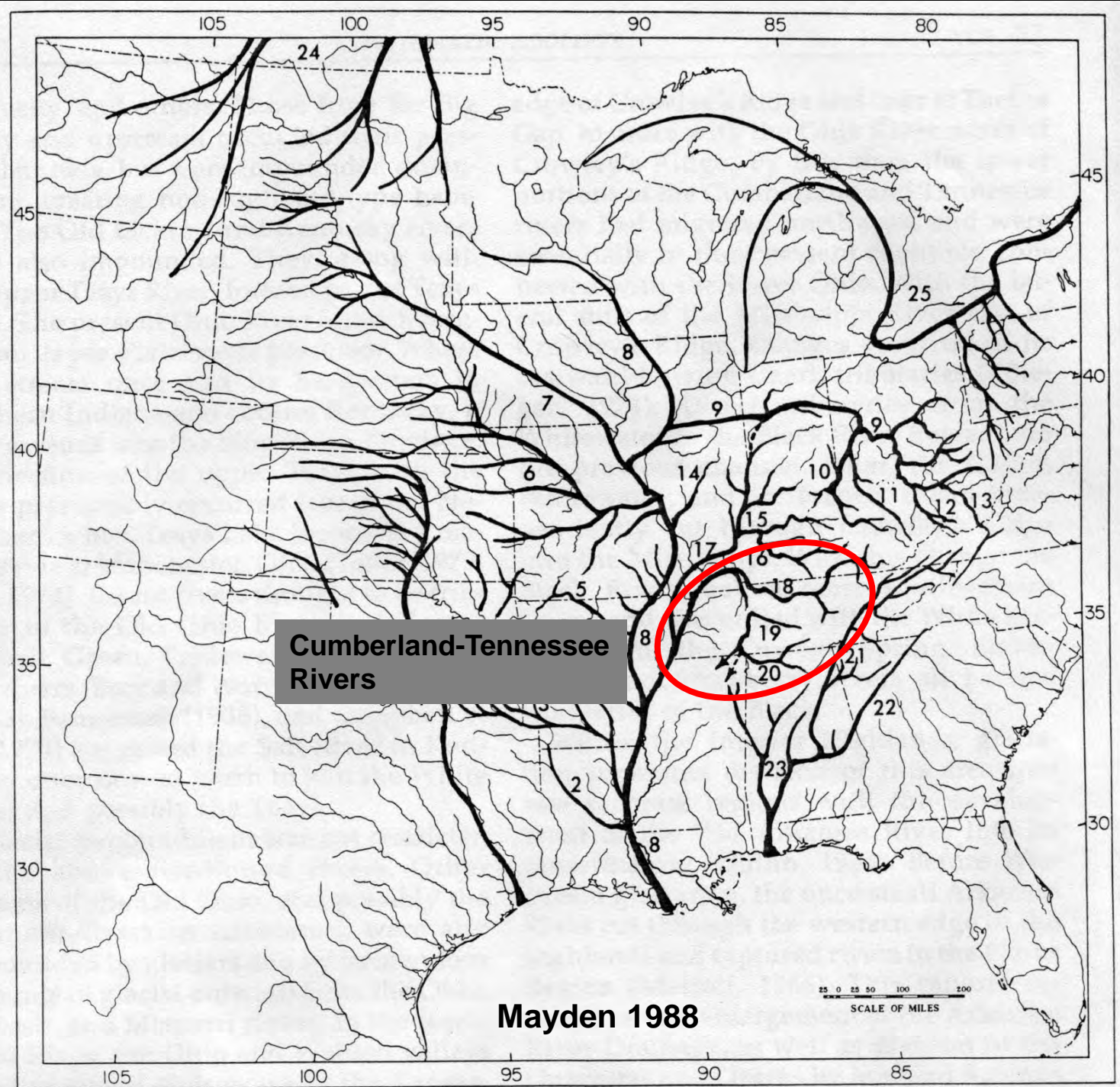
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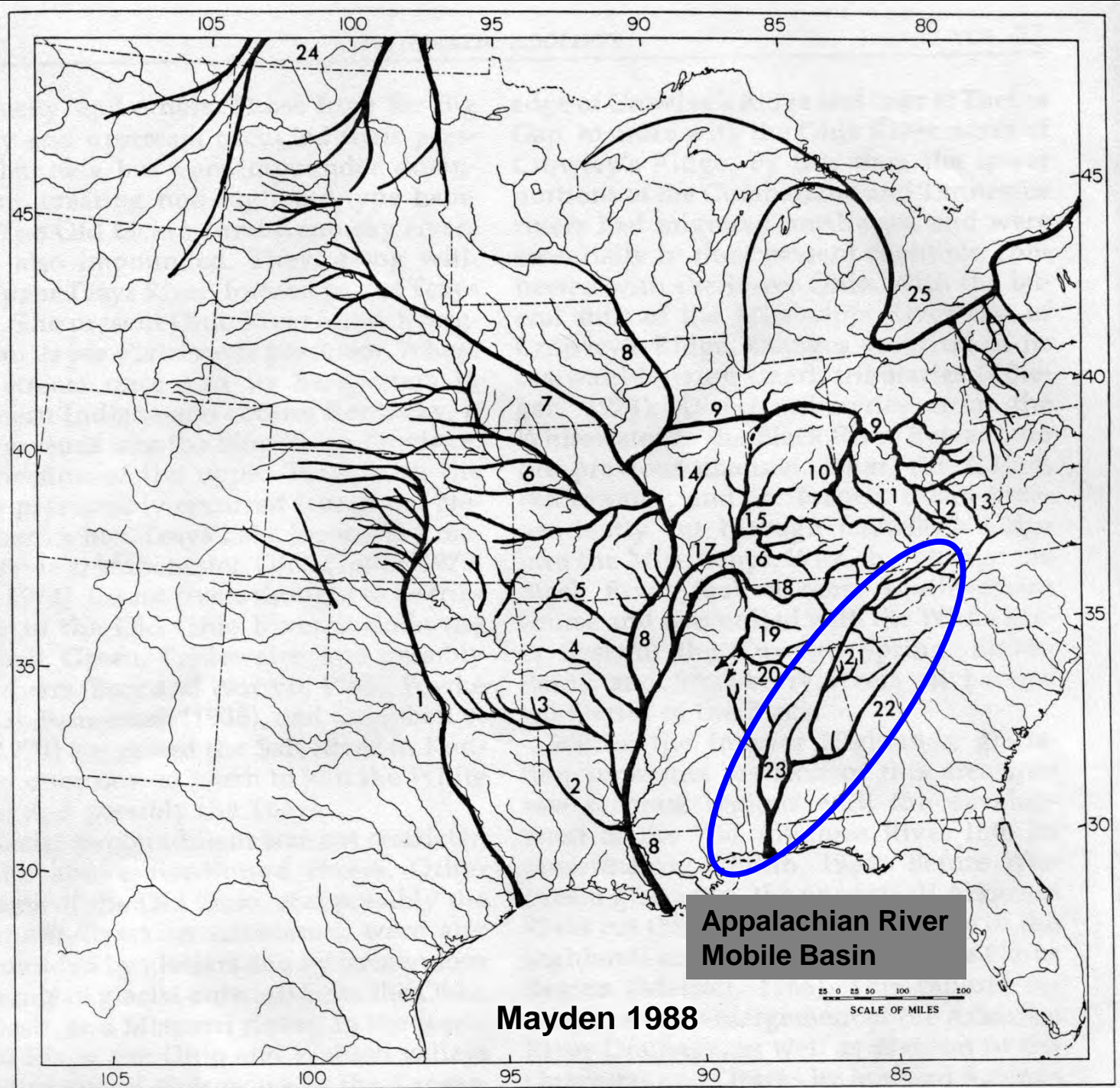
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# Preglacial Watersheds

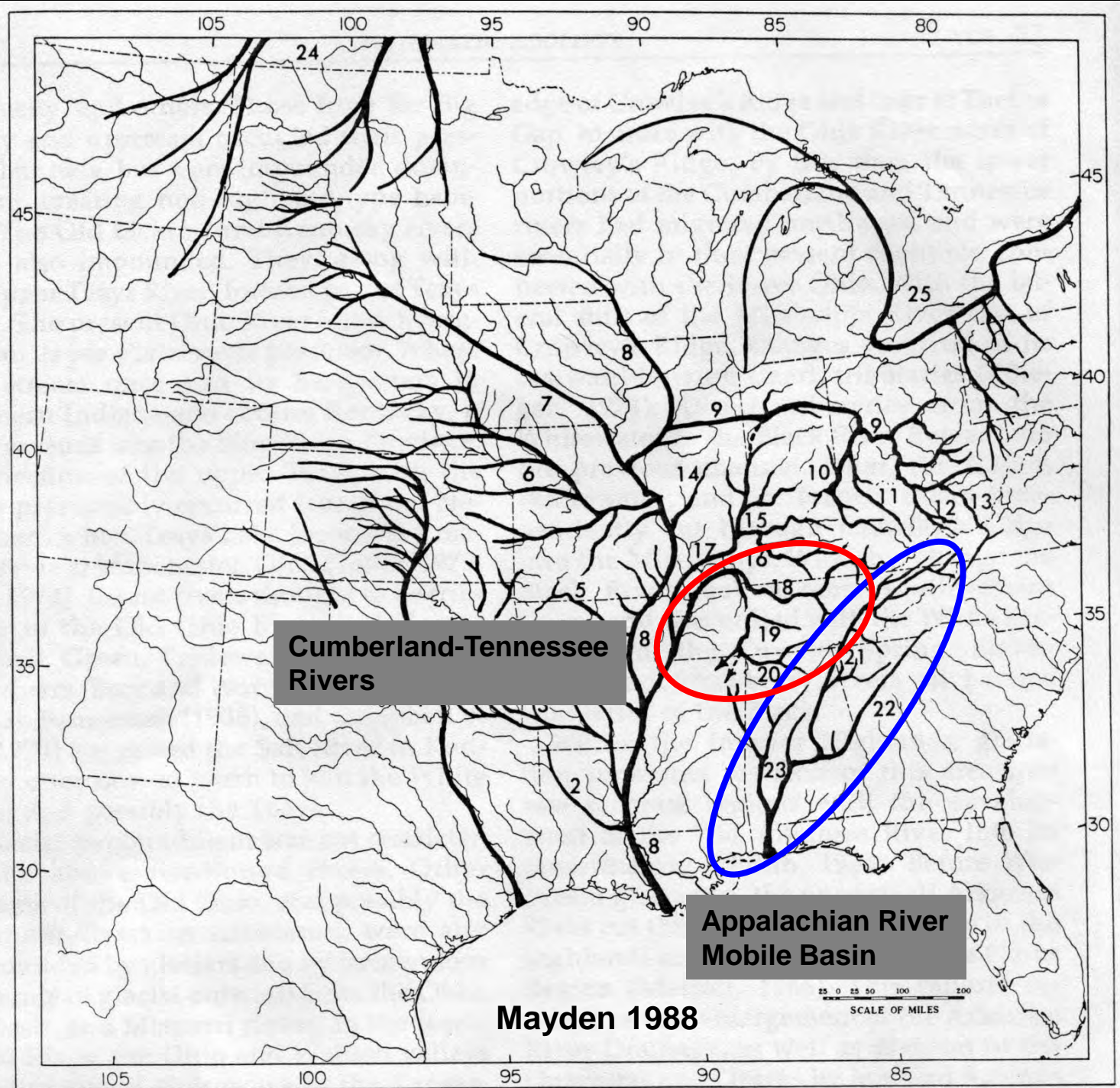
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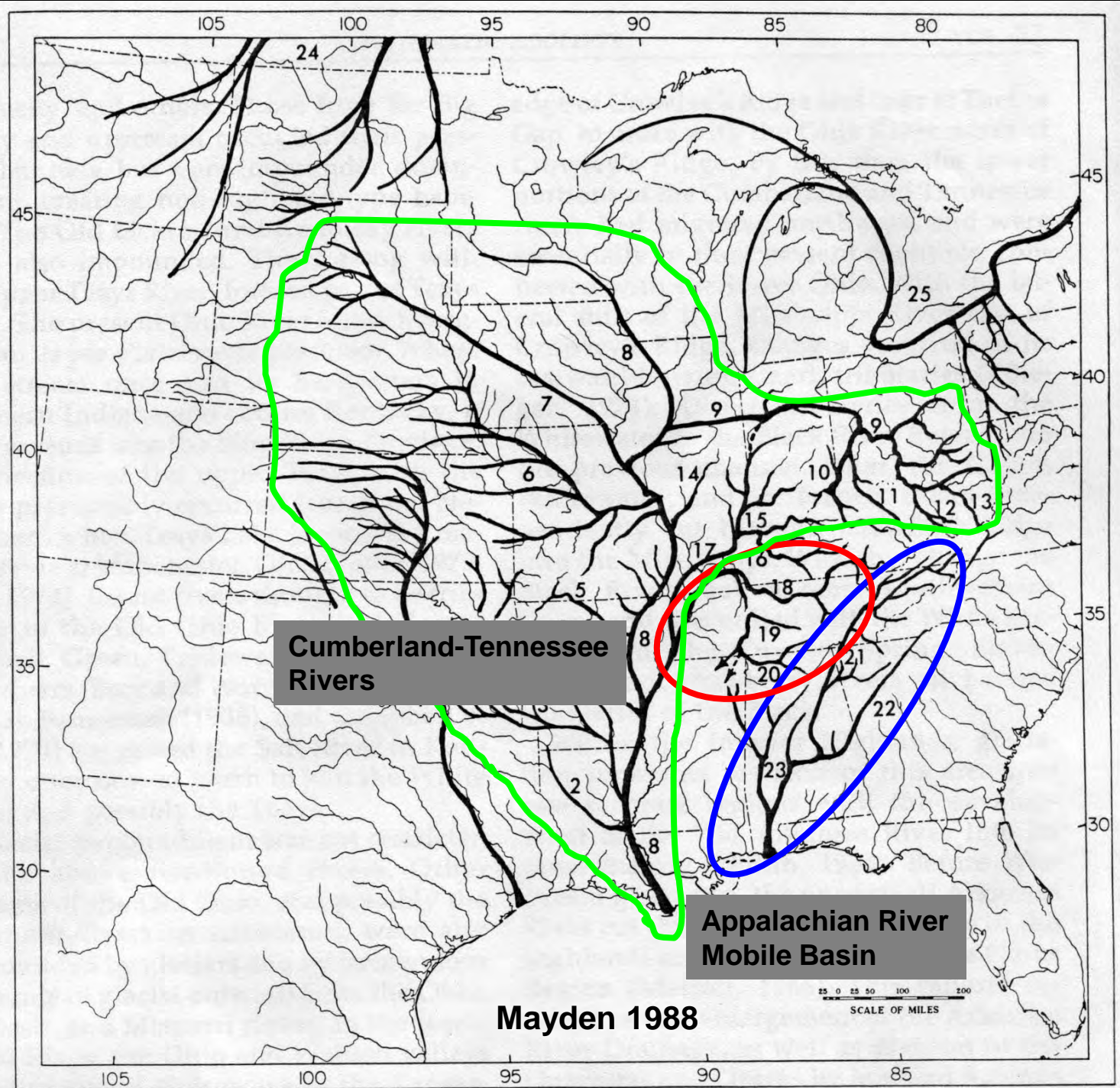
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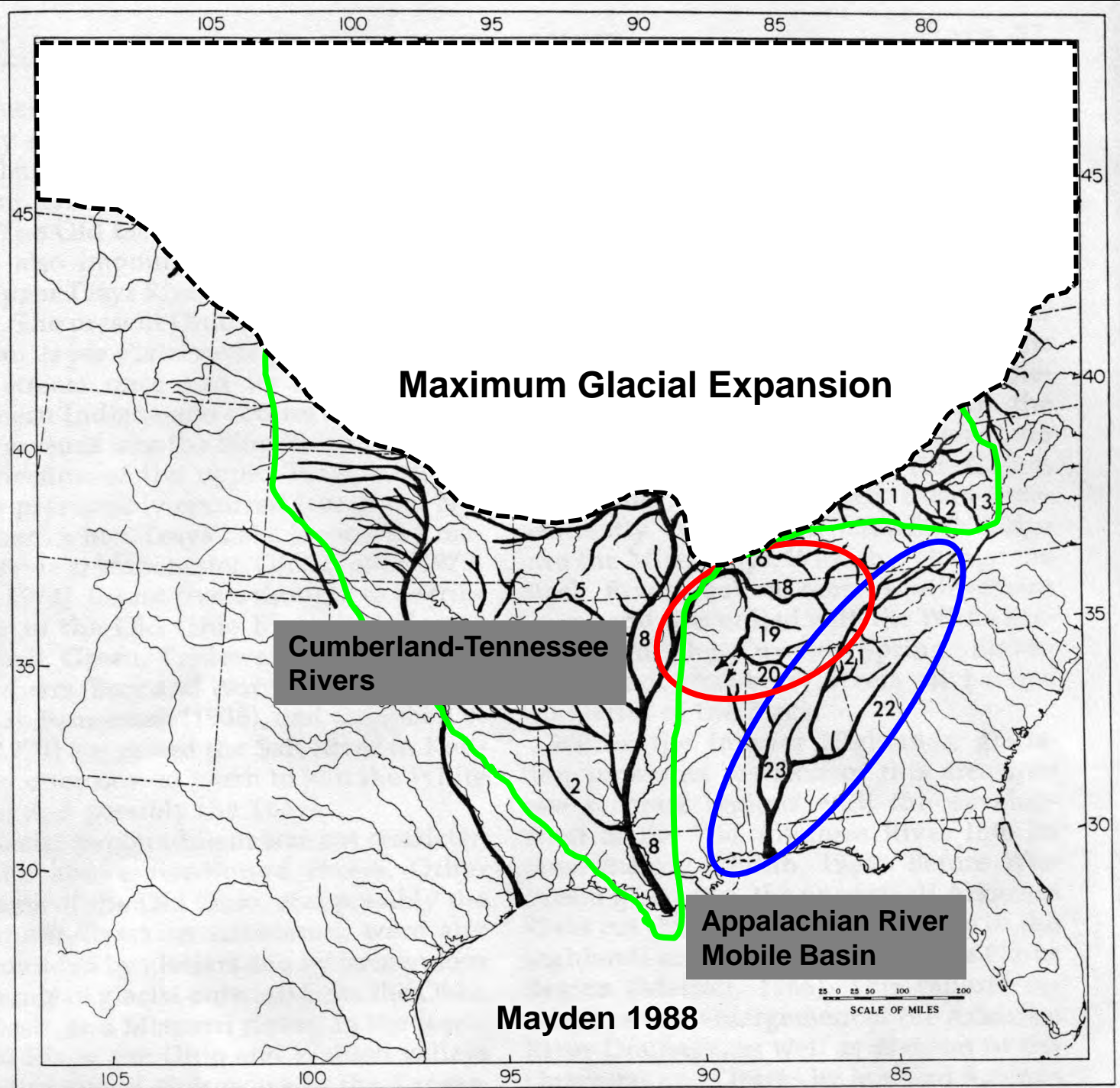
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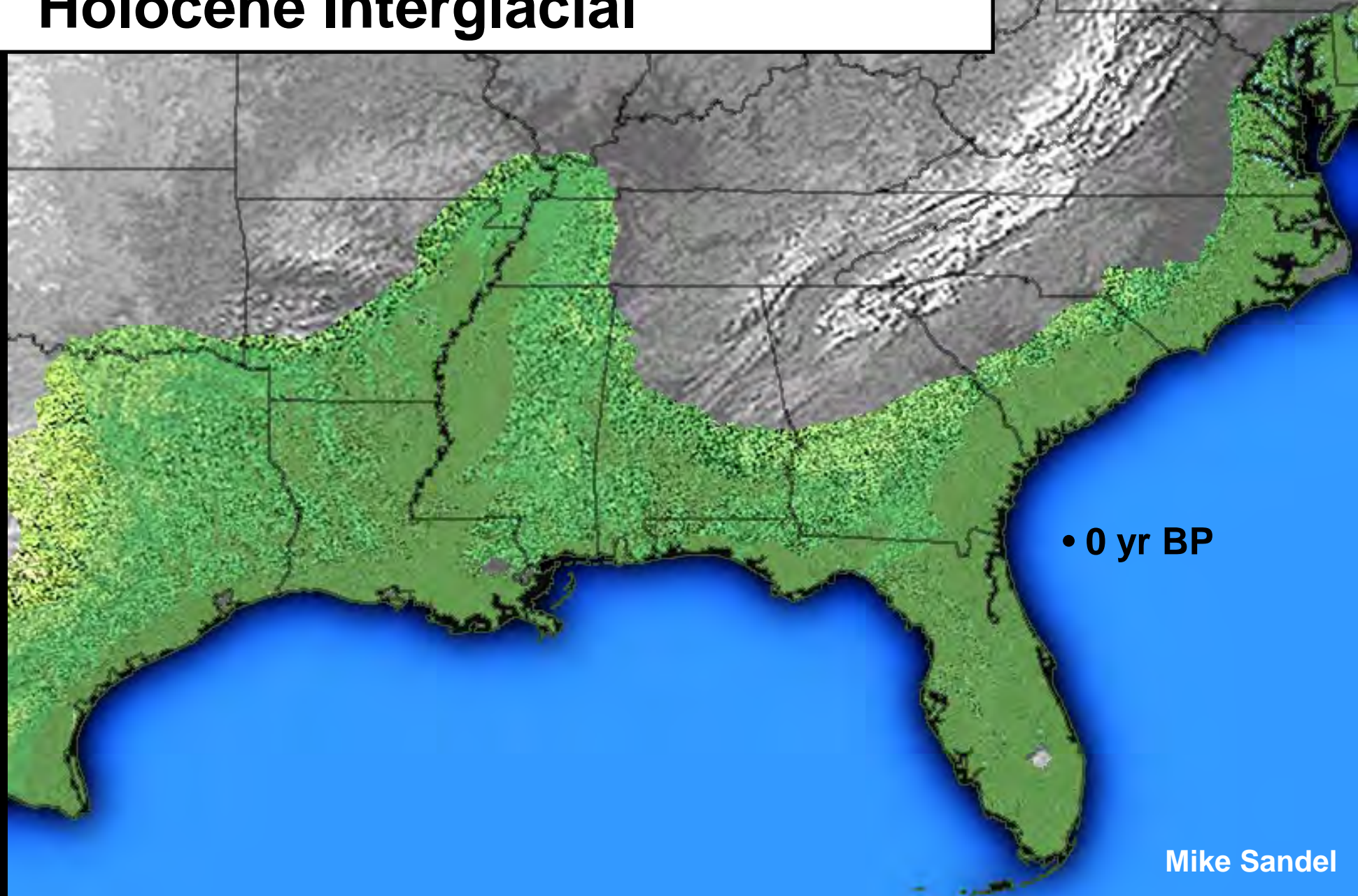
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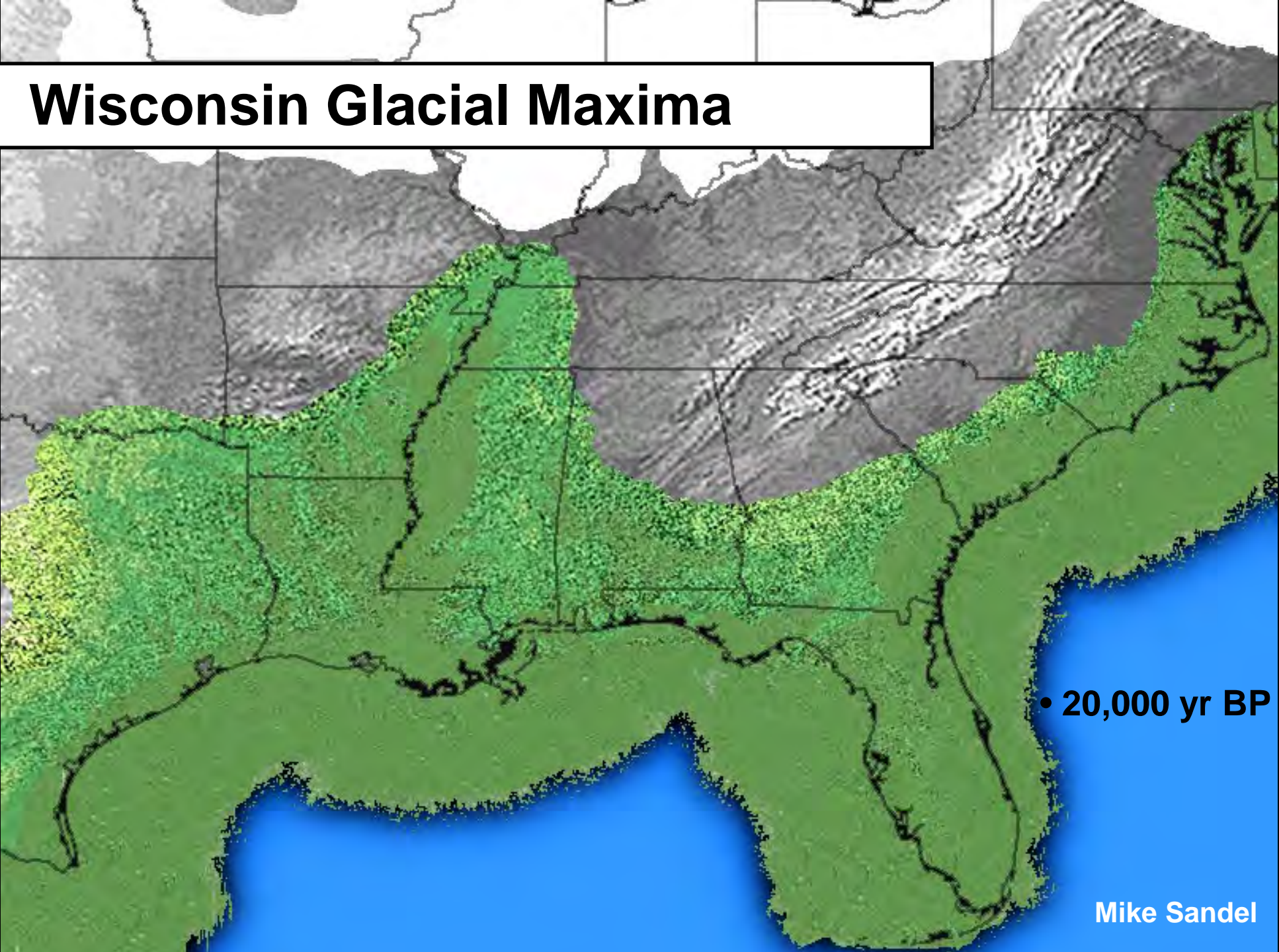
# Holocene Interglacial







# Wisconsin Glacial Maxima

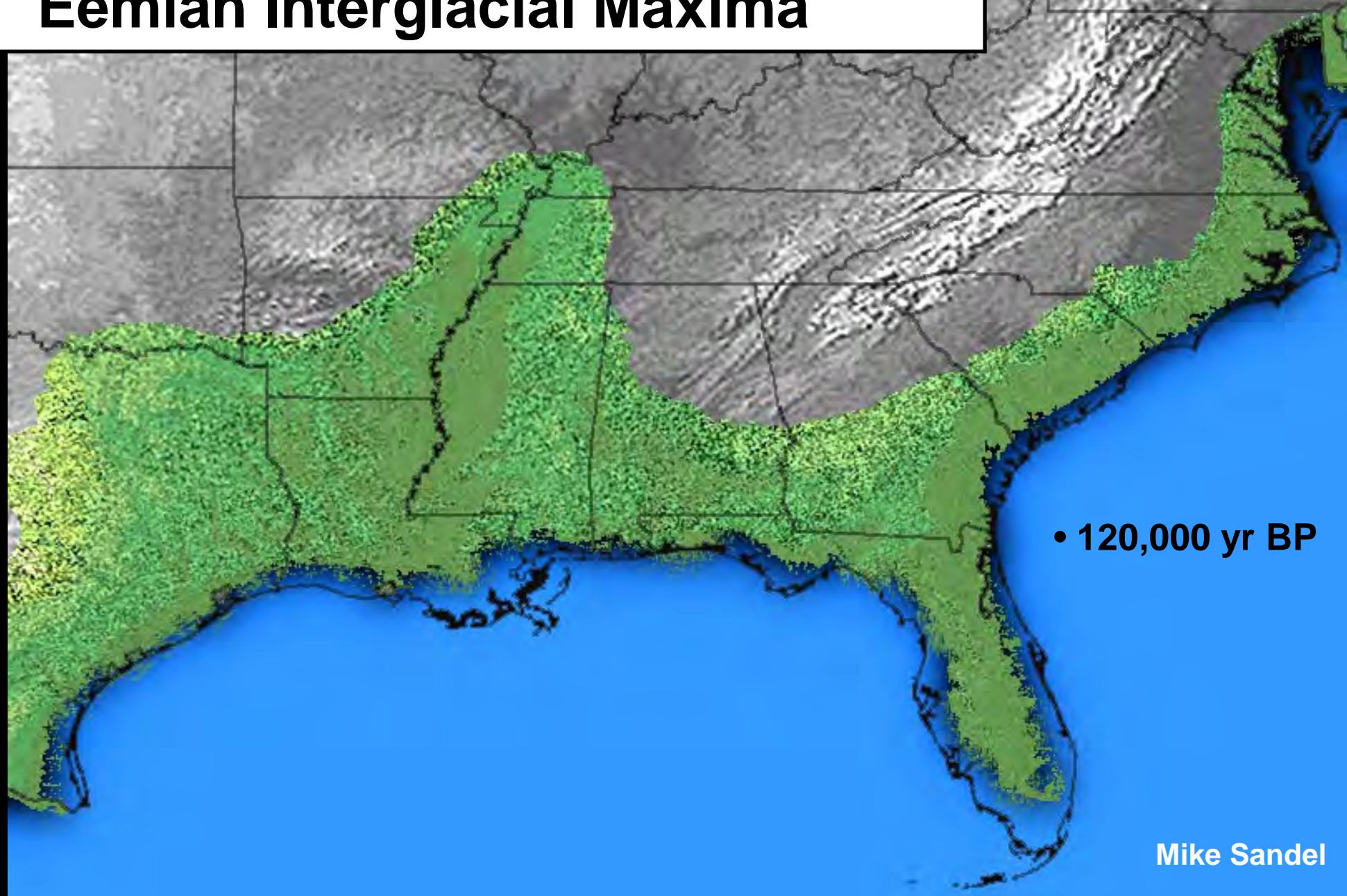


• 20,000 yr BP

Mike Sandel



# Eemian Interglacial Maxima

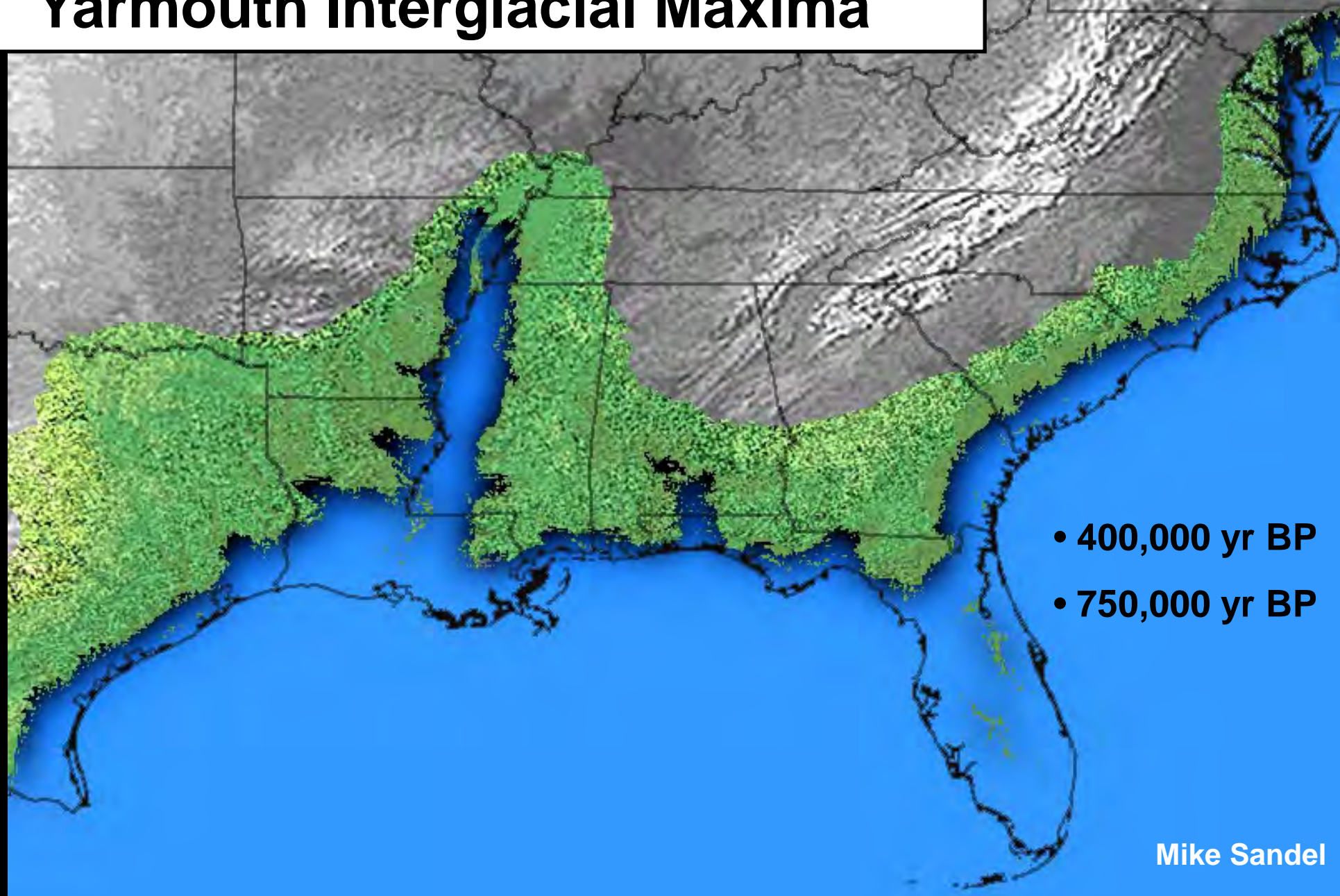


• 120,000 yr BP

Mike Sandel

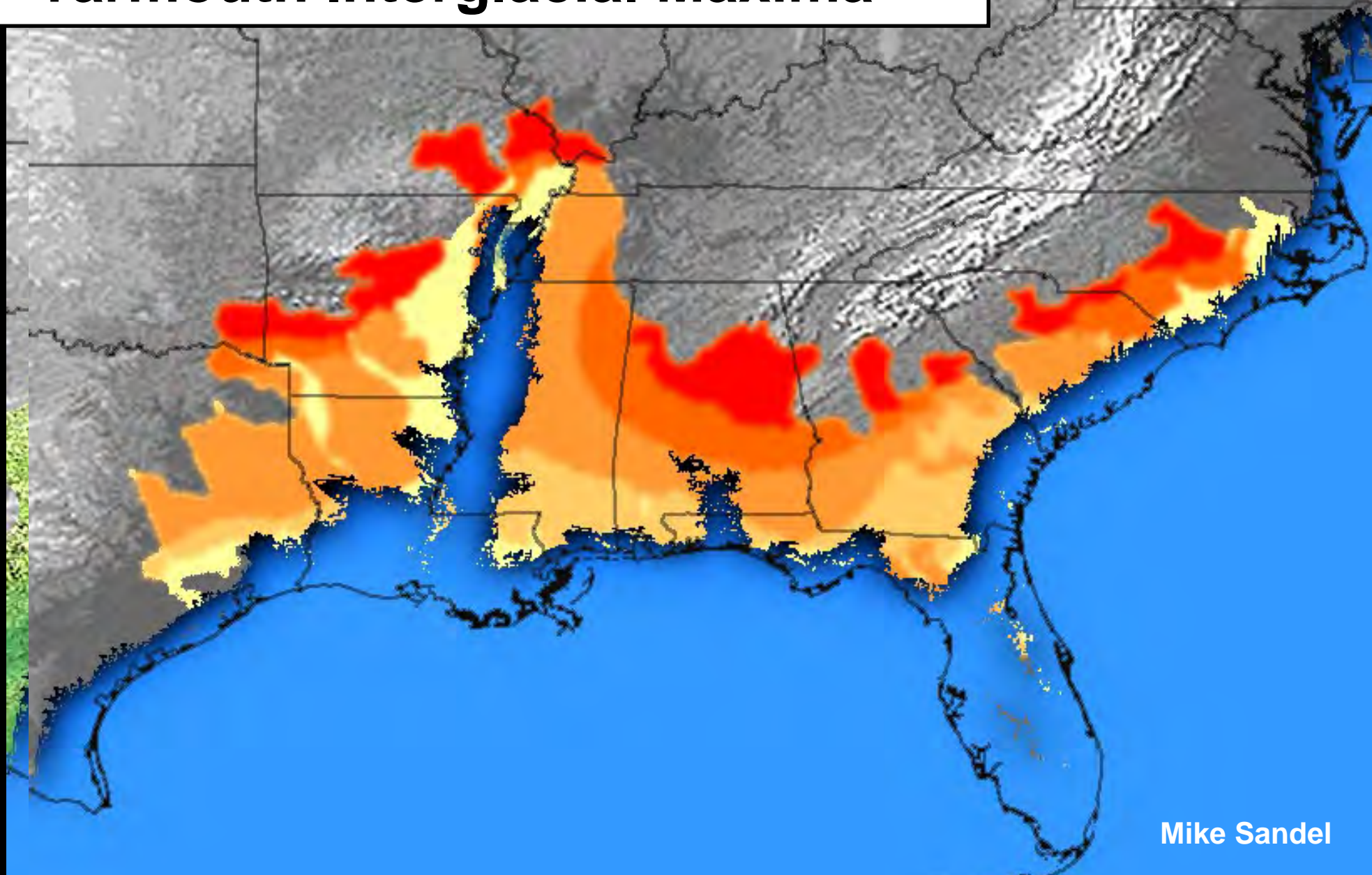


# Yarmouth Interglacial Maxima





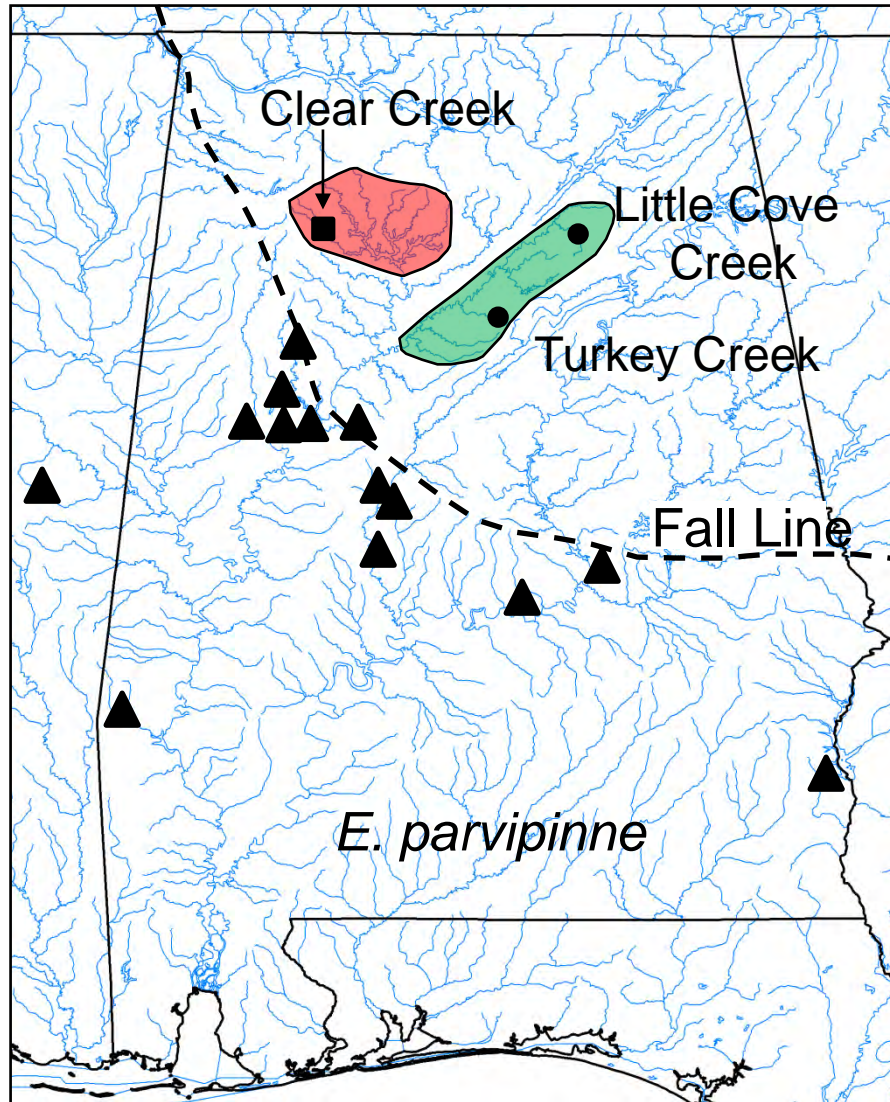
# Yarmouth Interglacial Maxima



Mike Sandel



# Species Distributions



● Rush Darter  
*E. phytophilum* - Locust Fork



■ Rush Darter  
*E. phytophilum* - Sipsev Fork



▲ Goldstripe Darter  
*E. parvipinne*





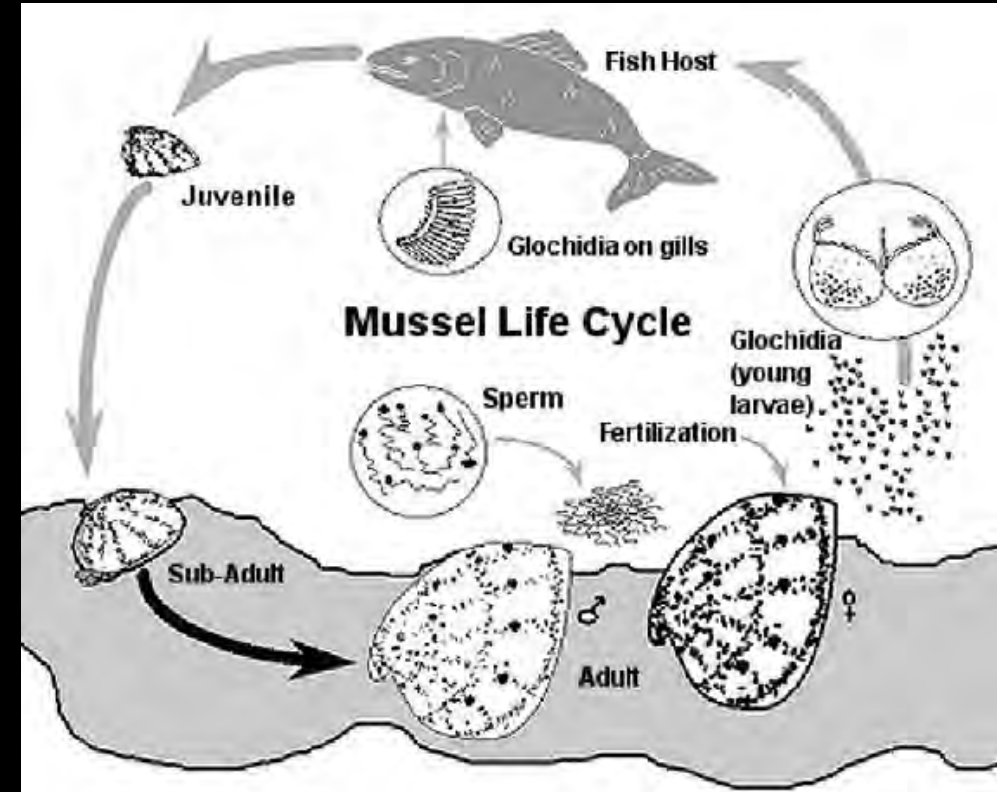




















**Ridges to Rivers**



# Ridges to Rivers







TENNESSEE  
AQUARIUM



