



Deforestation vs. forest degradation: Why degraded ecosystem function is of greater concern in the Apalachicola

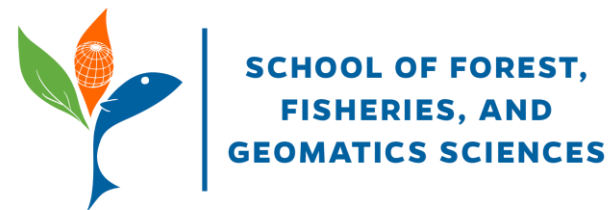
John Tracy, PhD

Louisiana State University – AgCenter

Apalachicola National Estuarine Research Reserve

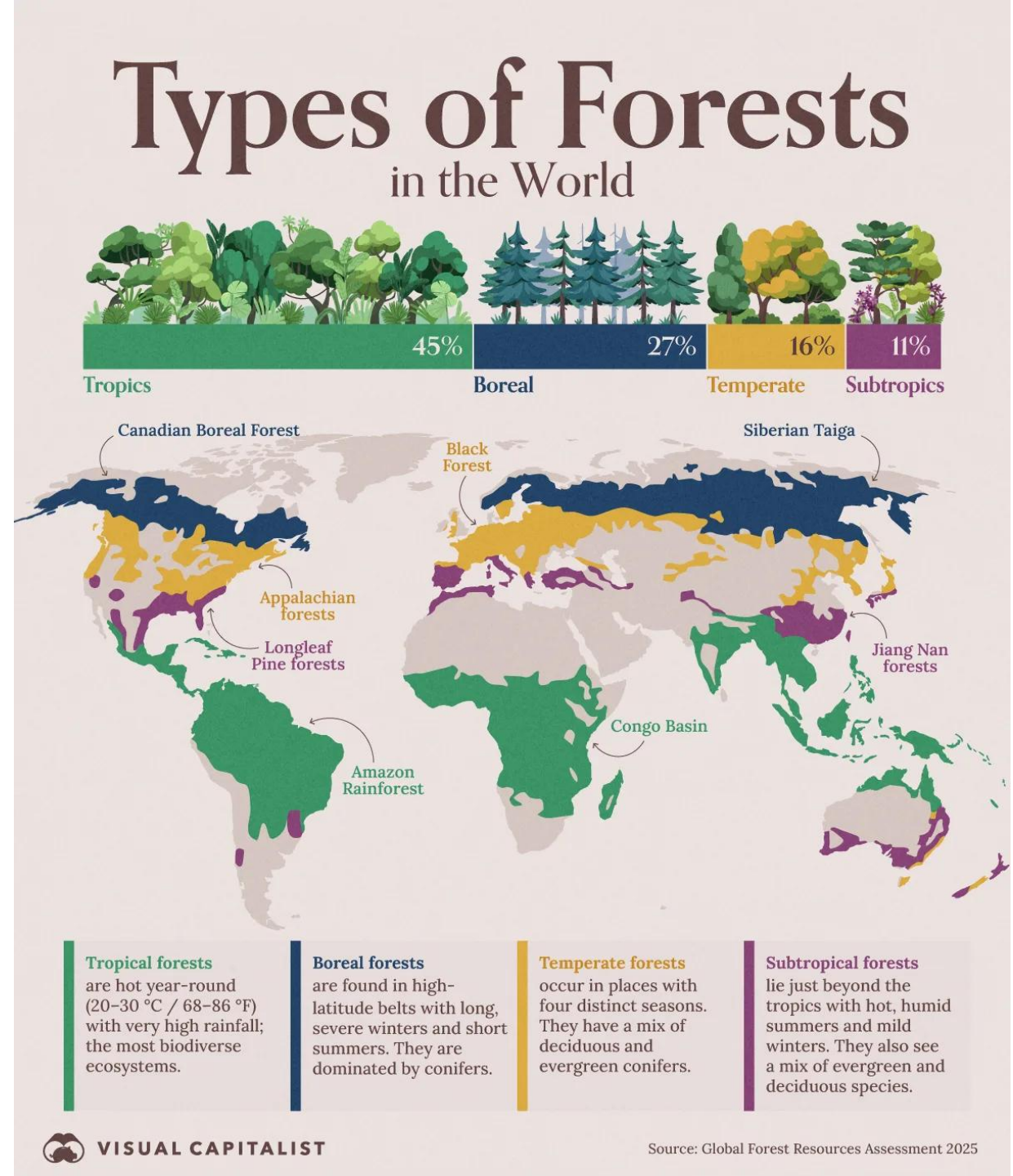
Sci-Café - August 21, 2026

First, gratitude.

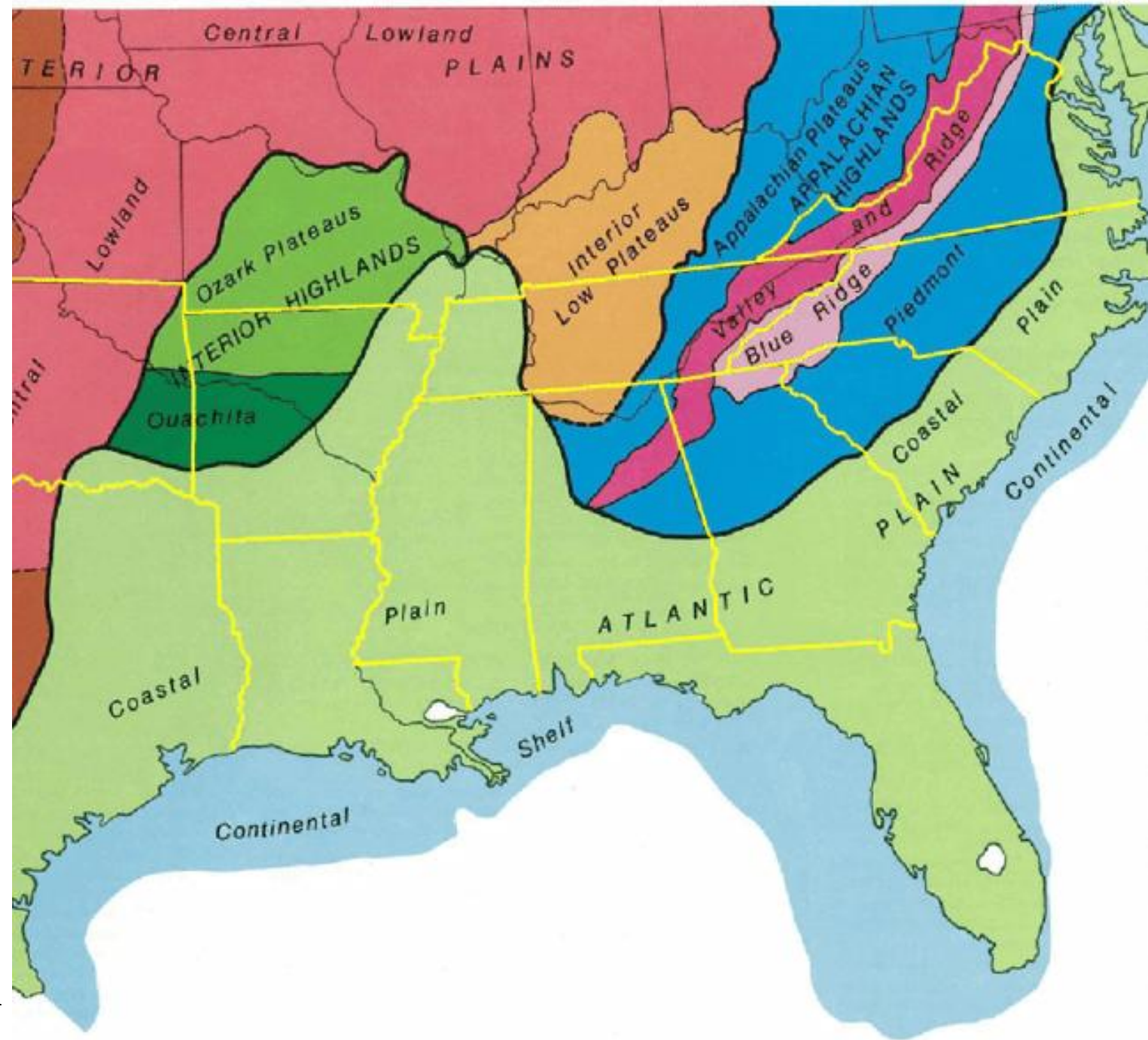


Now, let's orient ourselves

Today, we are focusing on forests, particularly in the southeastern U.S.



Physiographic regions help us understand soil and forest type distributions



J.W. Reynolds (2011)

(modified from National Atlas sheet 59, Geological Survey, U.S. Department of the Interior, 1969)

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Soil Properties

About Properties Location

Select a Property: Clear Map

▼ Chemical

▲ Physical

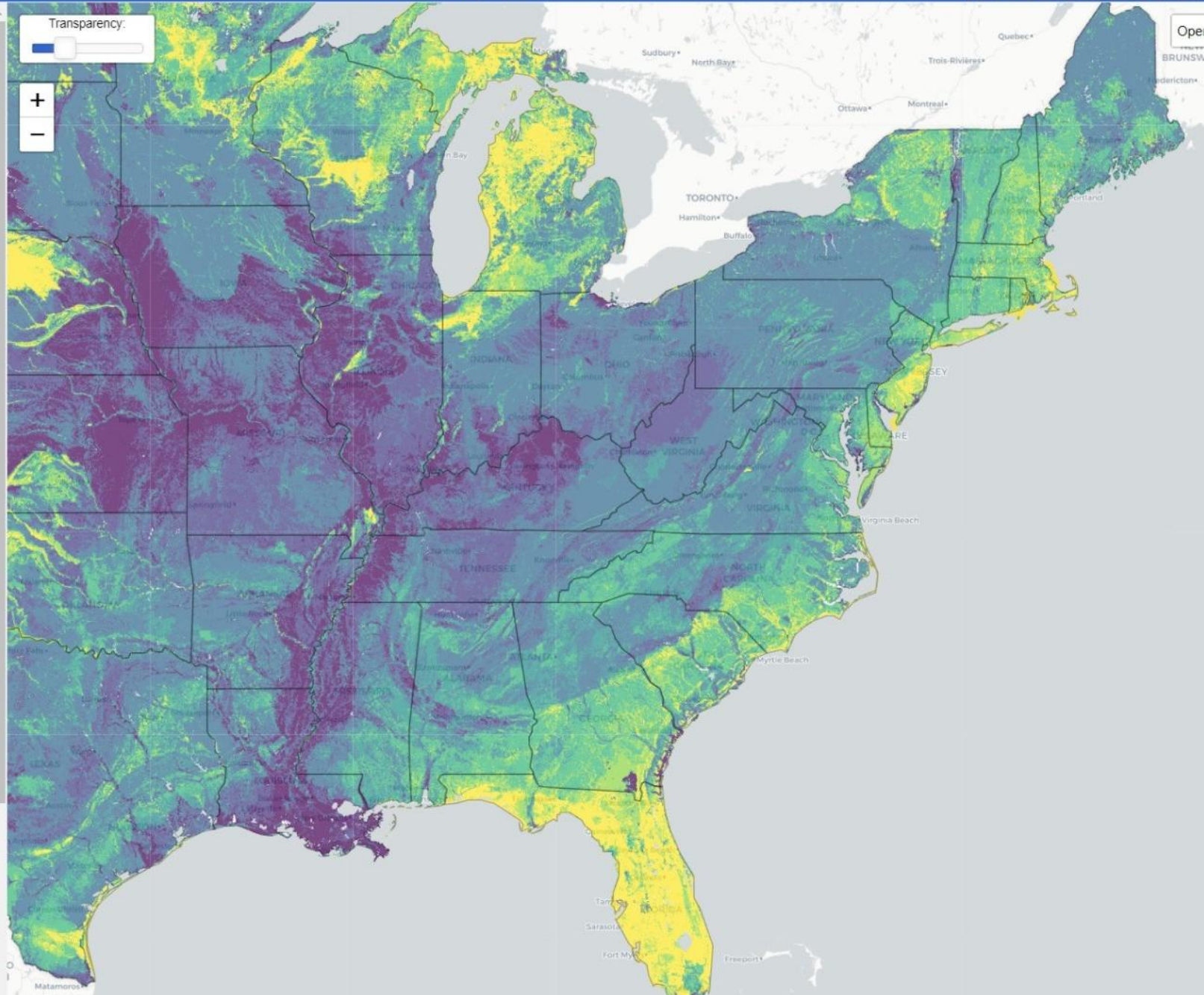
- Avail. Water Holding Capacity
- Avail. Water Holding Cap. (0 - 25 cm)
- Avail. Water Holding Cap. (0 - 50 cm)
- Bulk Density, 1/3 bar
- Drainage Class
- Rock Fragments (0 - 25 cm)
- Sat. Hyd. Conductivity (Ksat) - Mean
- Sat. Hyd. Conductivity (Ksat) - Min
- Sat. Hyd. Conductivity (Ksat) - Max
- Sat. Hyd. Conductivity (Ksat) (0 - 5 cm)
- Soil Texture (0 - 5 cm)
- Soil Texture (0 - 25 cm)
- Soil Texture (25 - 50 cm)

Sand ?

Percent Sand



- Sand (0 - 5 cm)
- Sand (0 - 25 cm)
- Sand (25 - 50 cm)
- Sand (30 - 60 cm)
- Silt
- Silt (0 - 5 cm)

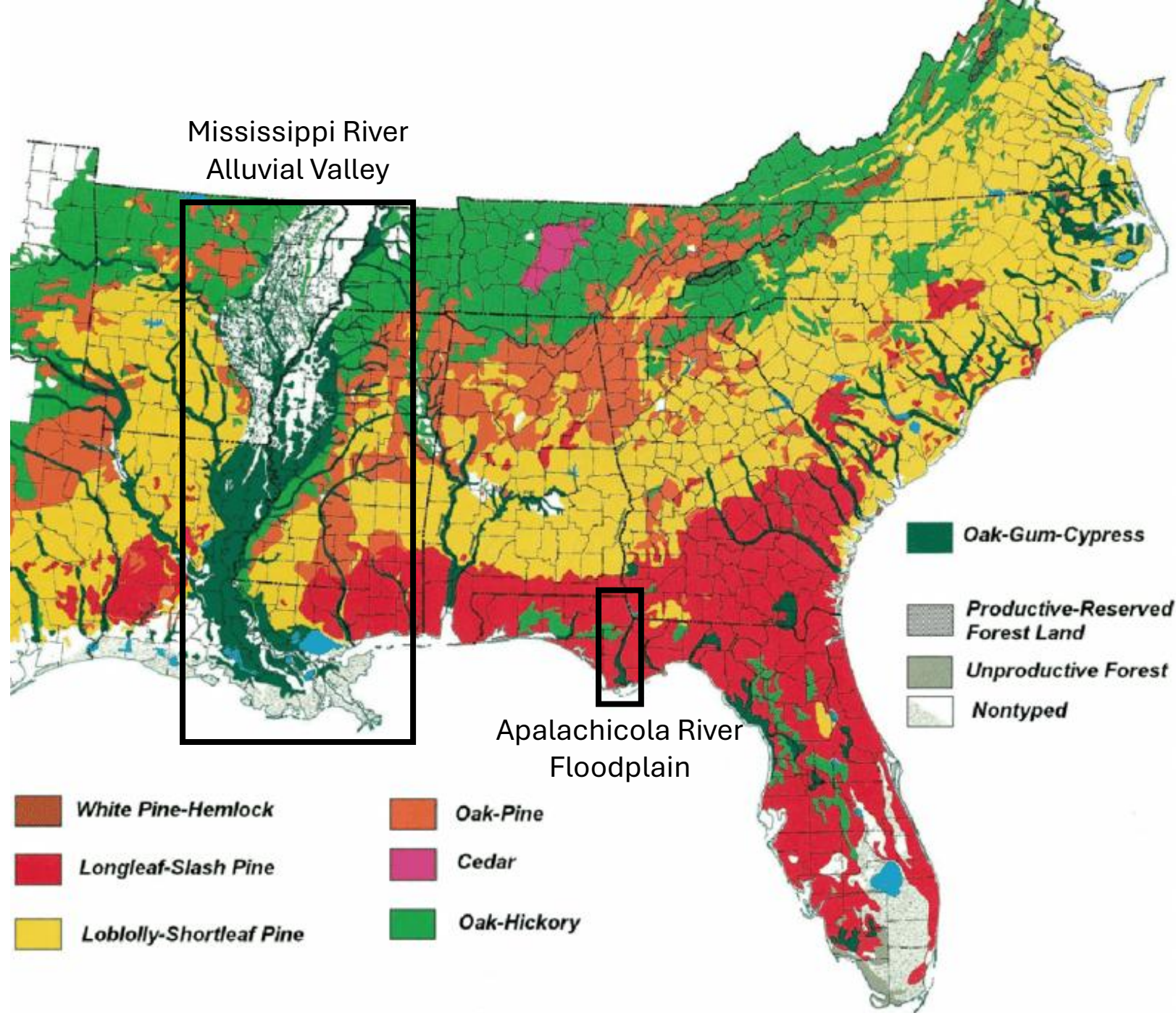


Look at the
areas of oak-
gum-cypress

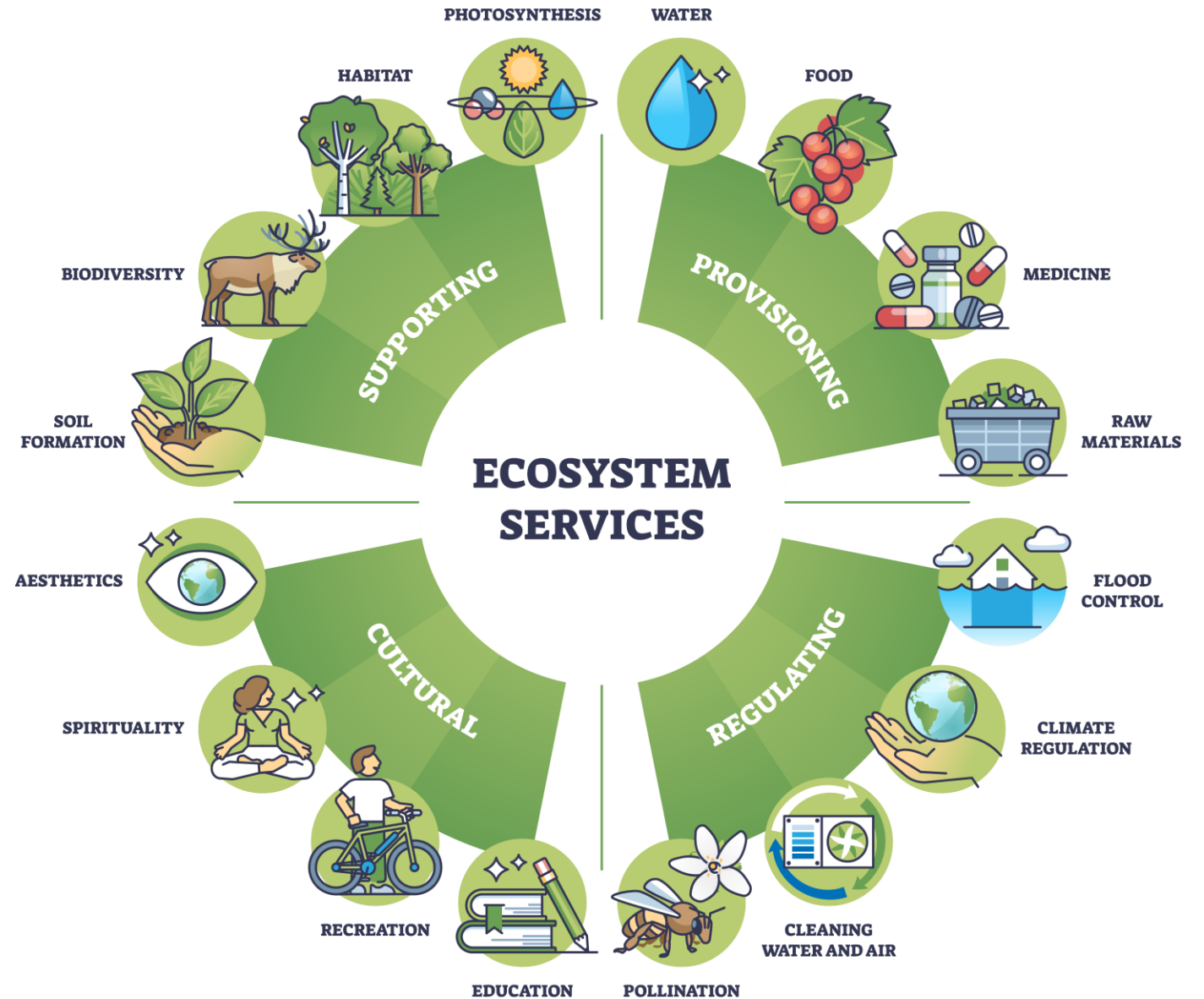
These are our
floodplain
forests

J.W. Reynolds (2011)

(modified from Nelson and Zillgitt,
1969)



All forests
provide varying
levels of
ecosystem
services

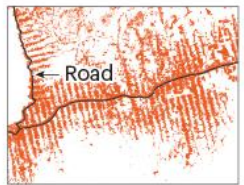


Credit: City of Boulder



FOREST LOSS

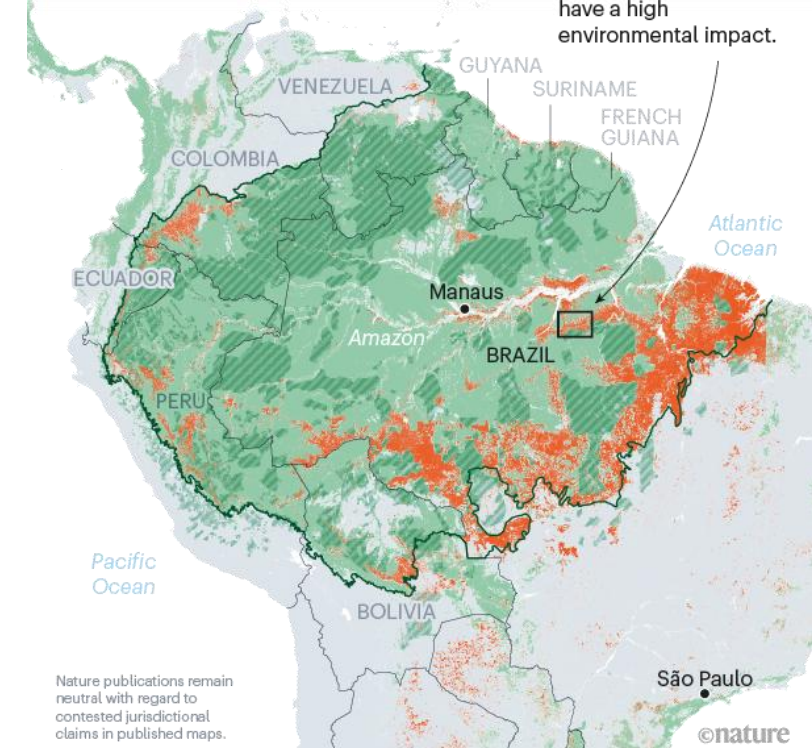
The Amazon rainforest covers some 5 million square kilometres of land across nine countries; more than half is in Brazil, where more than 19% of the forest has been cleared. Brazil reduced deforestation after 2004, but amid political turmoil tree clearing is rising again.



Deforestation often follows a fishbone pattern, as loggers clear trees perpendicular to main roads. Opening a single new road can have a high environmental impact.

Map key

- Deforestation (since 1988)
- Forest cover
- Amazon rainforest biome
- Indigenous territories



When we deforest an area, we exchange all of those services for an alternative use

Most often for agriculture and urbanization

In the Mississippi
River Alluvial Valley,
we exchanged many
services to make
use of highly fertile
soils for agriculture



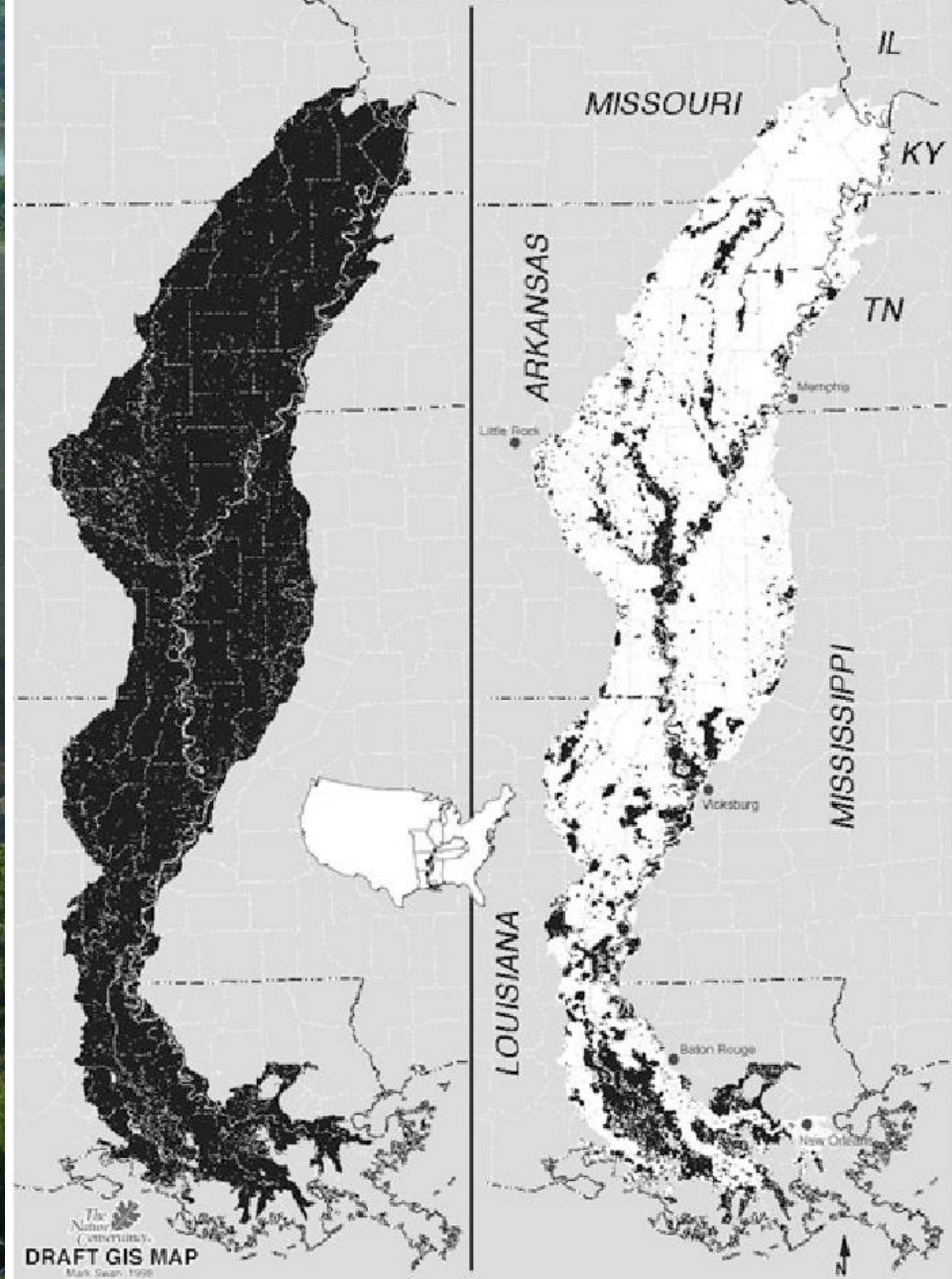
LOWER MISSISSIPPI RIVER BASIN



BEFORE 1600

■ FOREST OR OTHER ORIGINAL TYPES
□ CROPLAND, PASTURE, OR URBAN

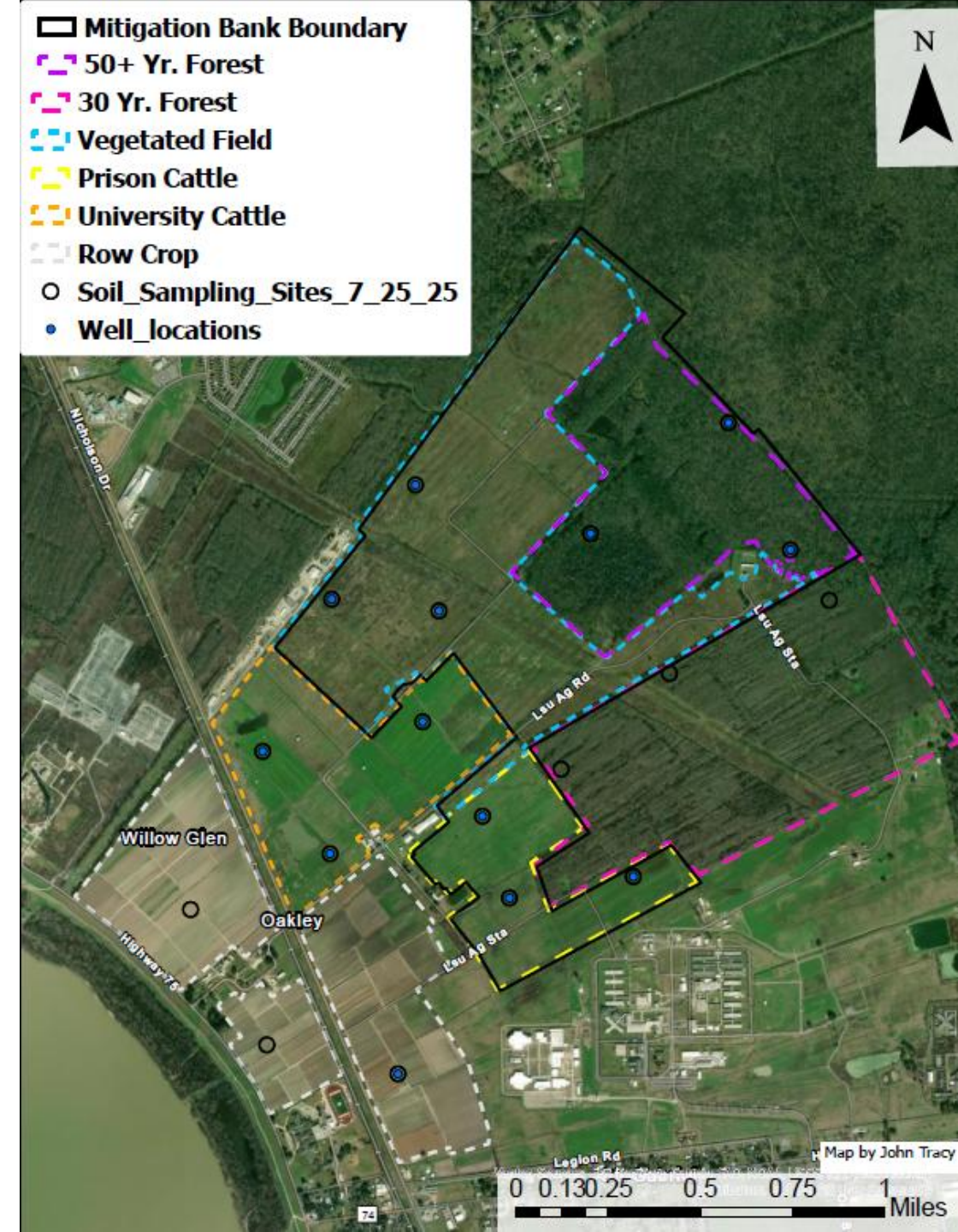
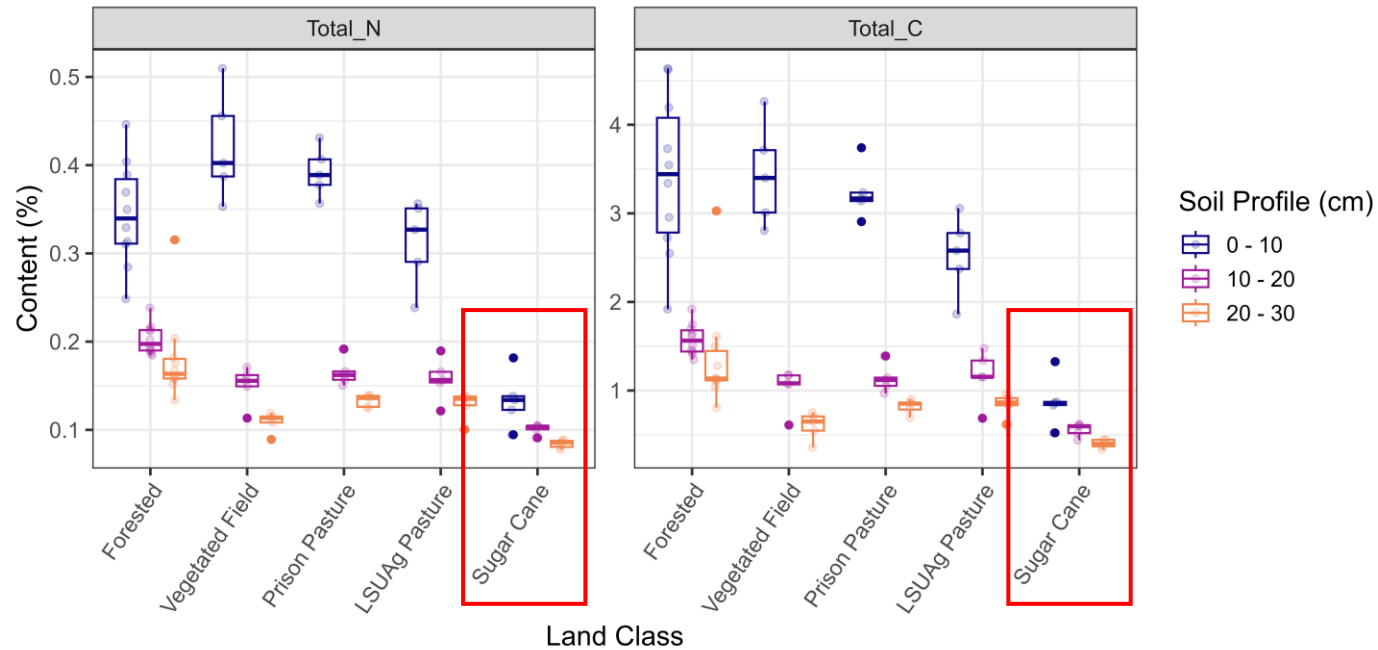
CURRENT (1992)

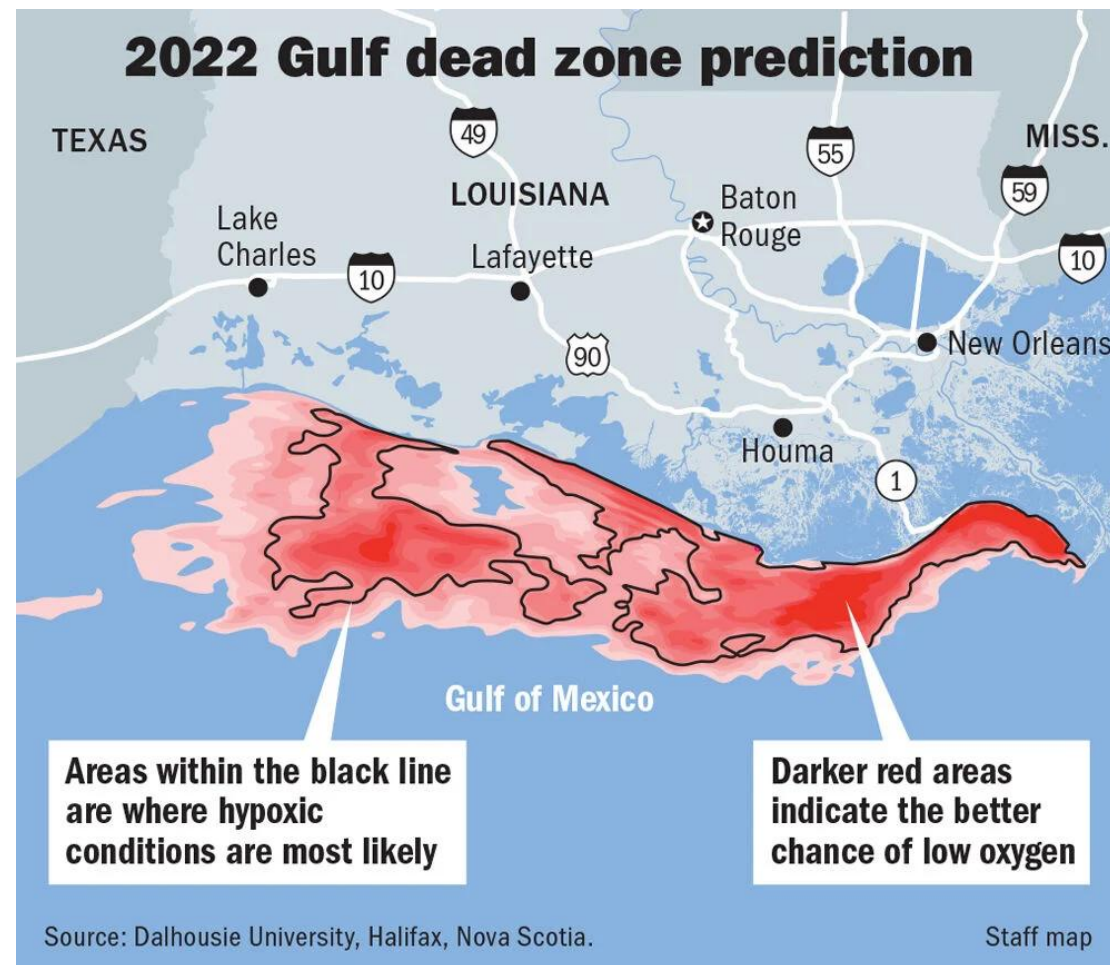
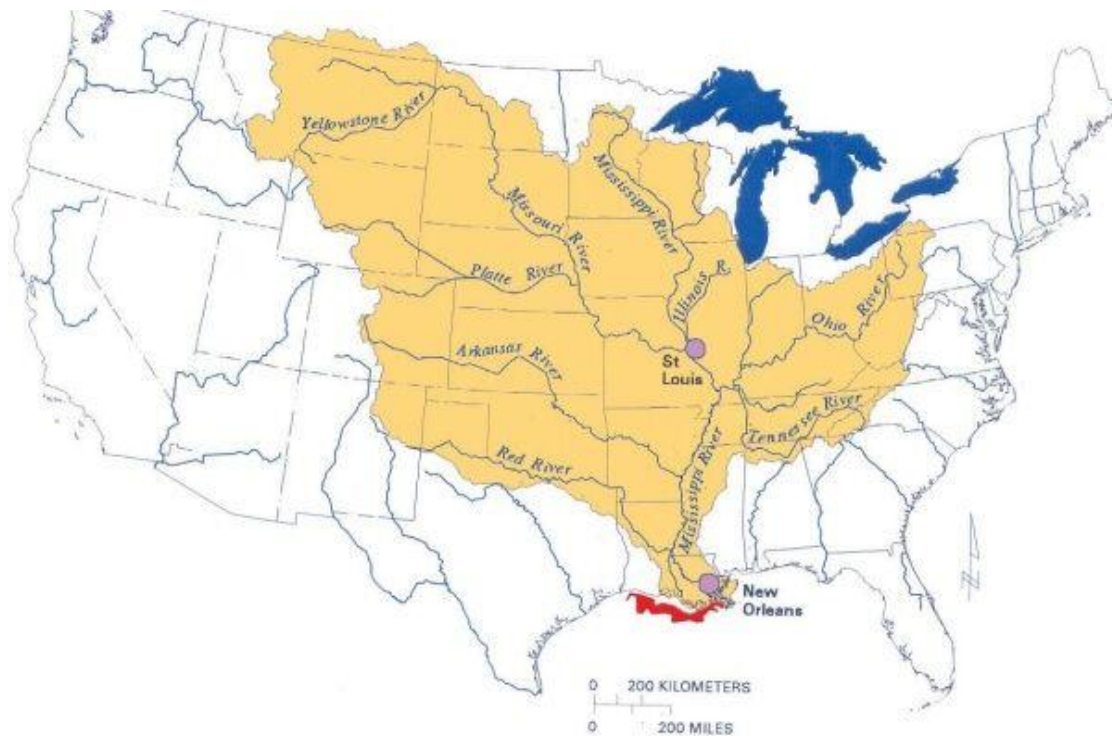


LOWER MISSISSIPPI RIVER BASIN, UNITED STATES

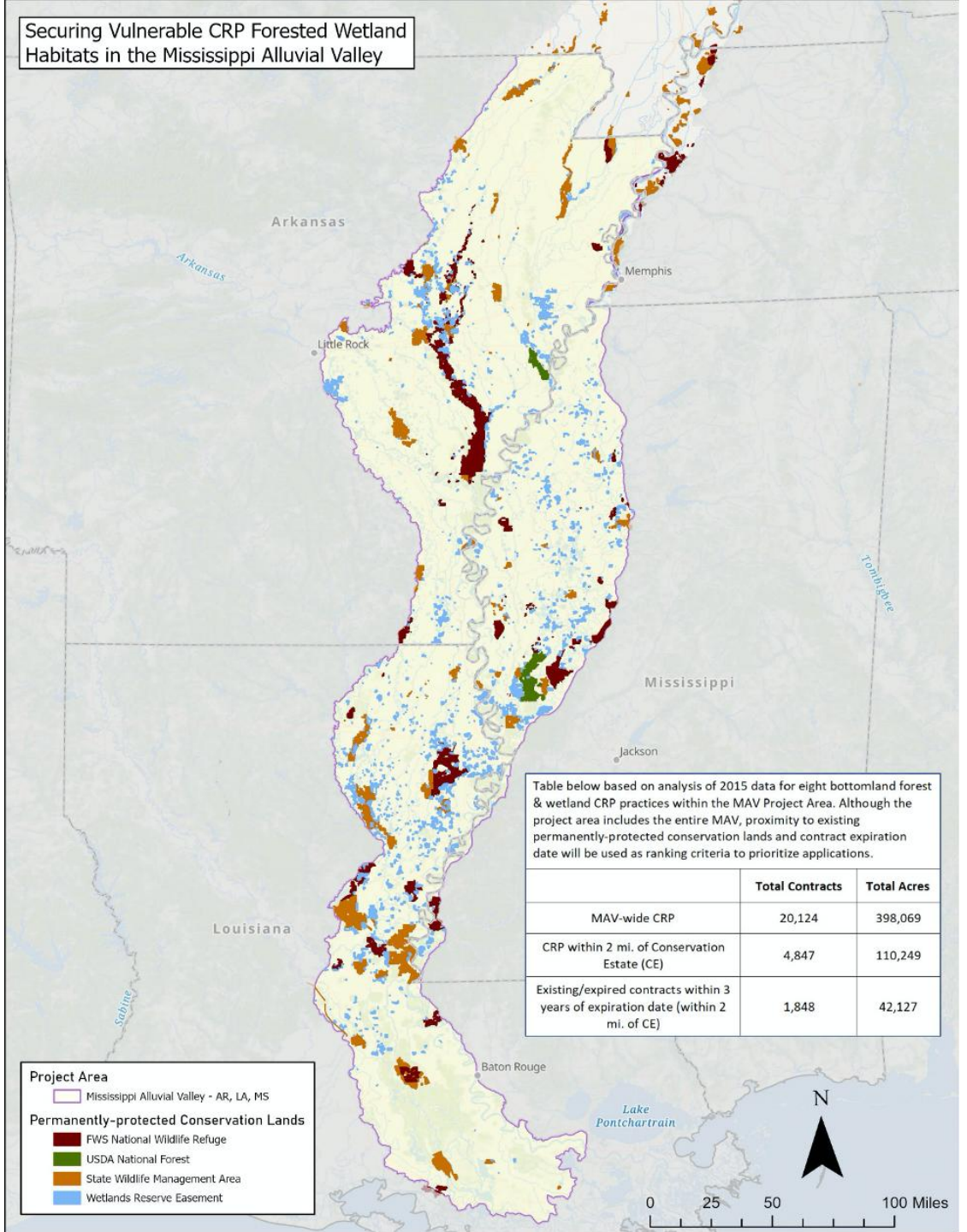
- 2,203 miles of levees along main stem system
- 75% of bottomland hardwood forests lost since European settlement
- The M.R. basin produces 92% of the nation's agricultural exports, 78% of the world's exports in feed grains and soybeans, and most of the livestock produced nationally (NPS 2017)
- However, this comes with a tradeoff...

Agricultural cycles degrade soil fertility, requiring input of nutrients



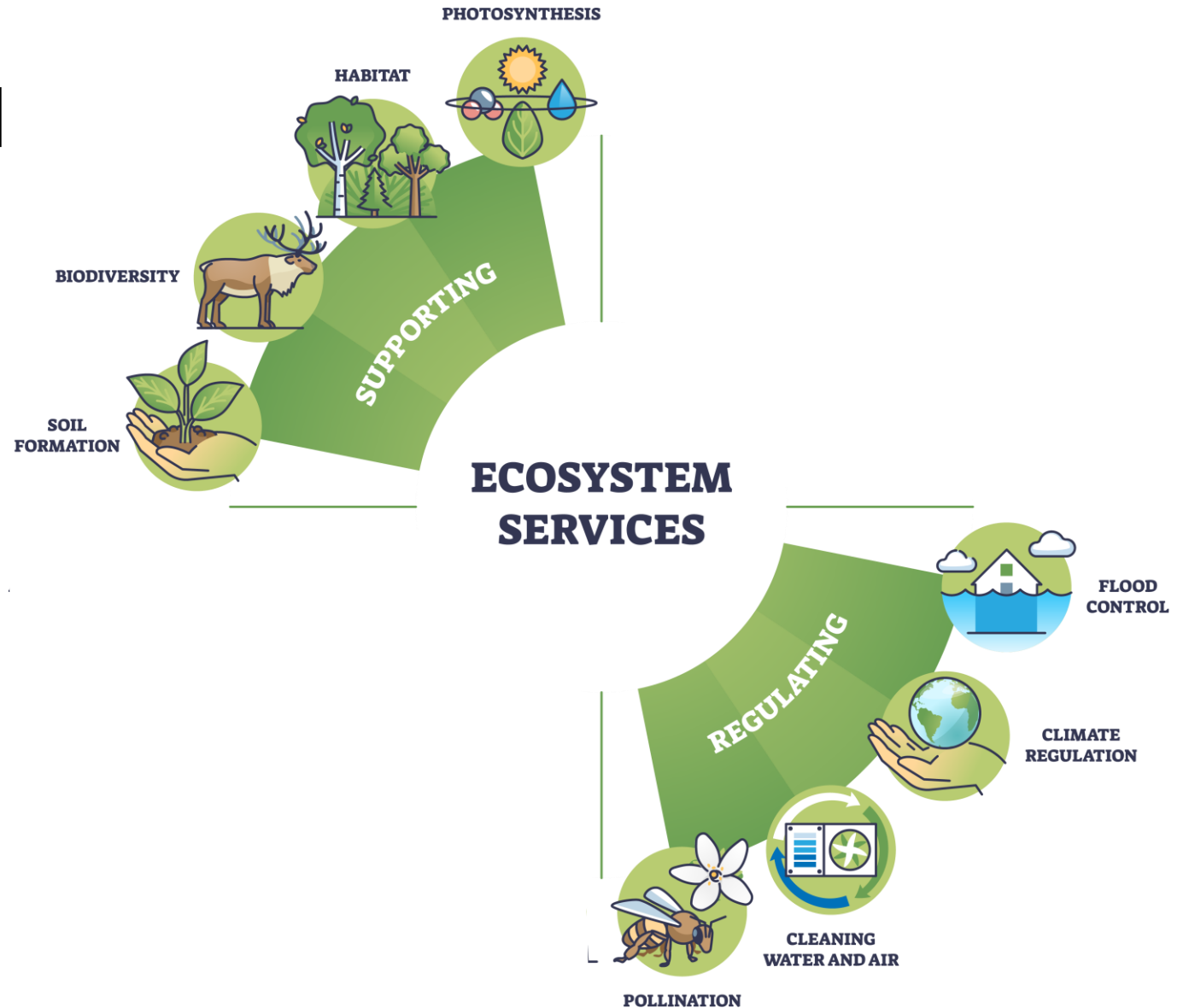


Thankfully, we now recognize the services from hydrologically connected floodplain forests and have been working to restore them

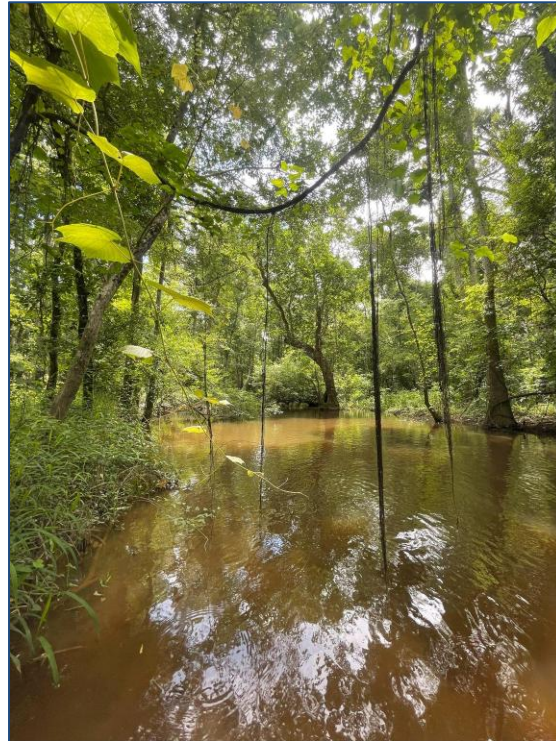


The Apalachicola remains an intact and hydrologically connected floodplain

- But hydrologic alterations threaten the supporting and regulating services provided by its forests

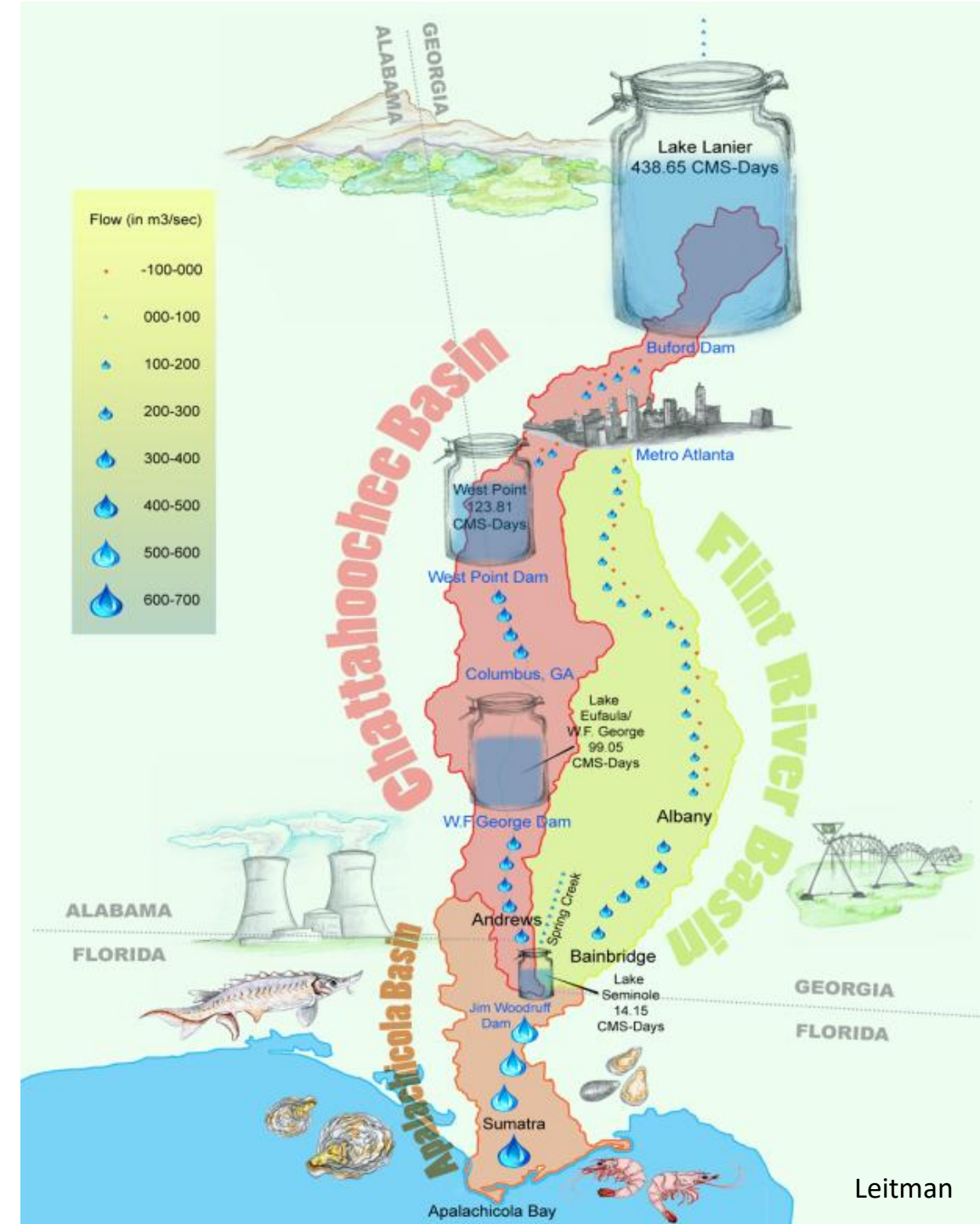


The Apalachicola River Floodplain and Bay

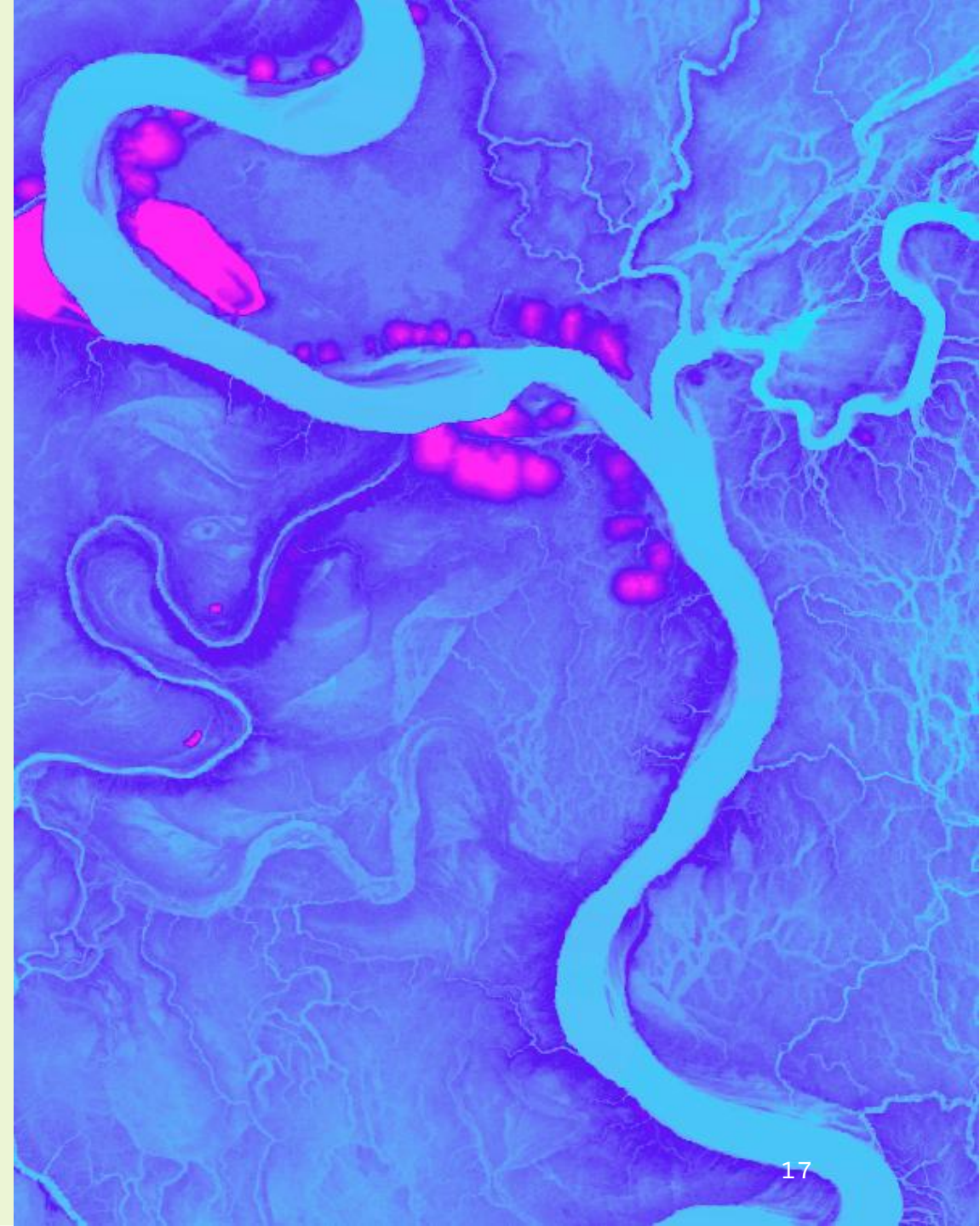


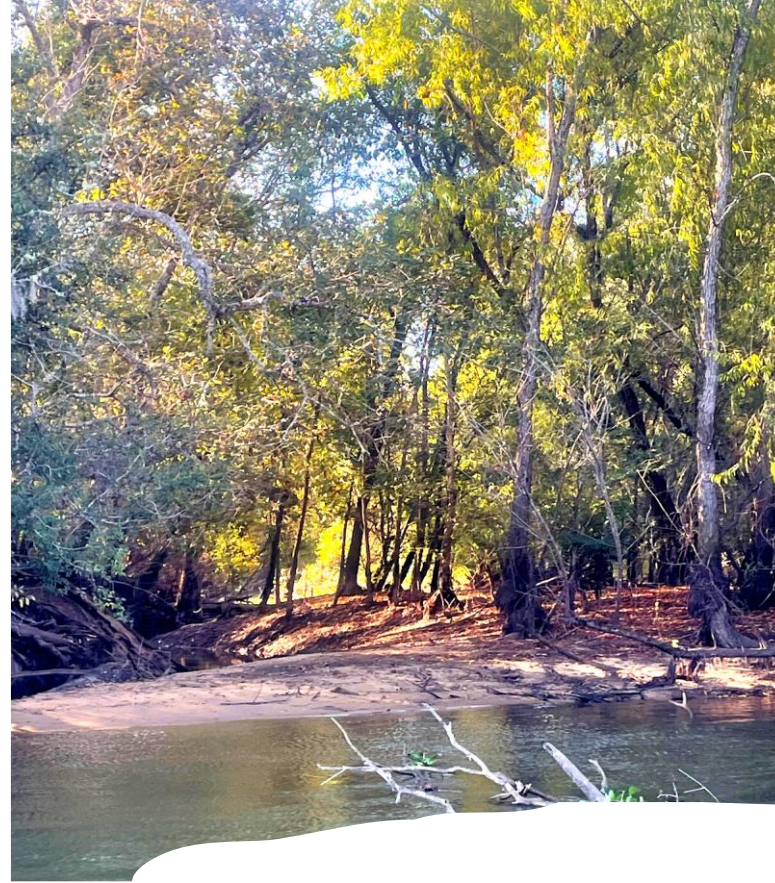
Water demand and use in the Apalachicola-Chattahoochee-Flint River Basin remains an ongoing challenge...

And the Apalachicola has been on the losing end of negotiations



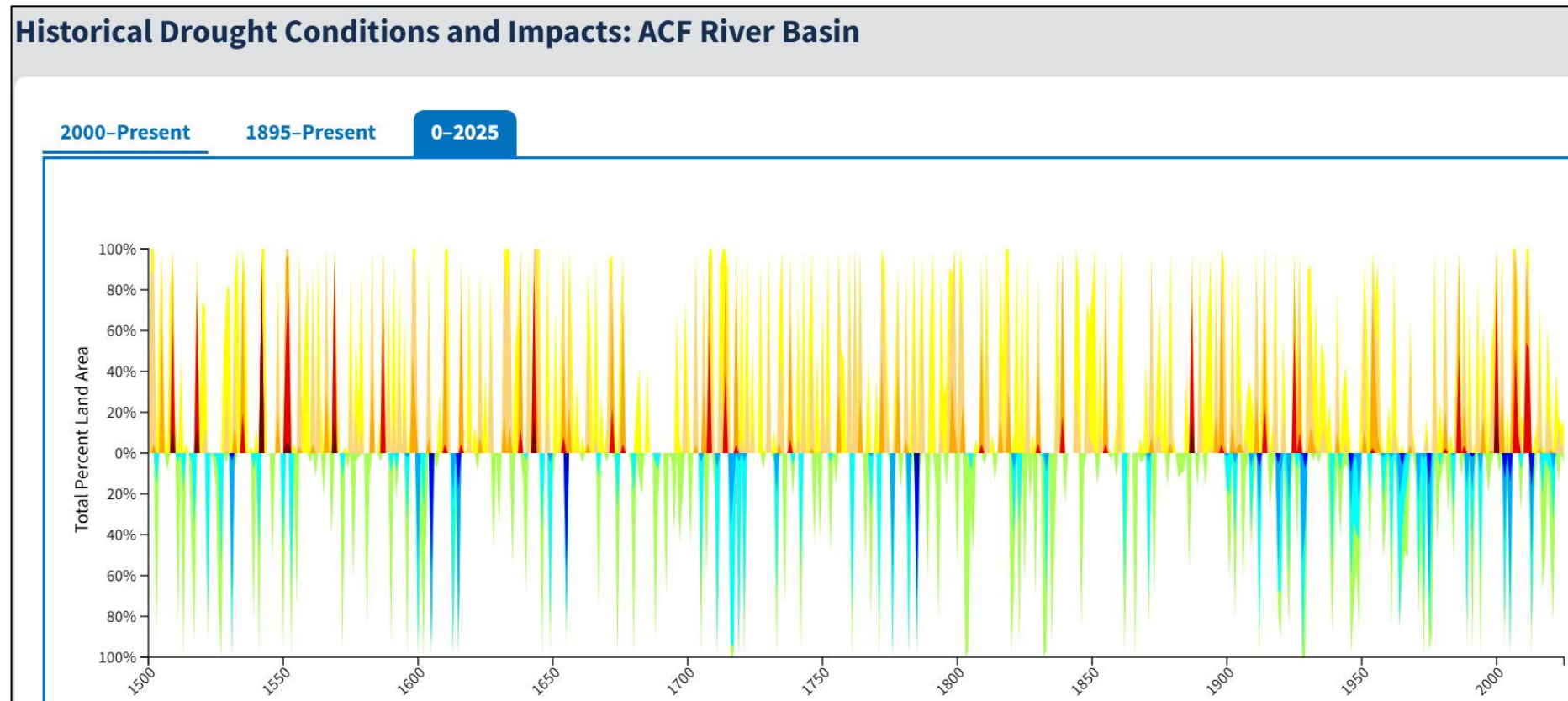
**THIS IS IN ADDITION TO
WITHIN-STREAM
CHALLENGES SUCH AS
NAVIGATIONAL DREDGING
AND CHANNEL
STRAIGHTENING**

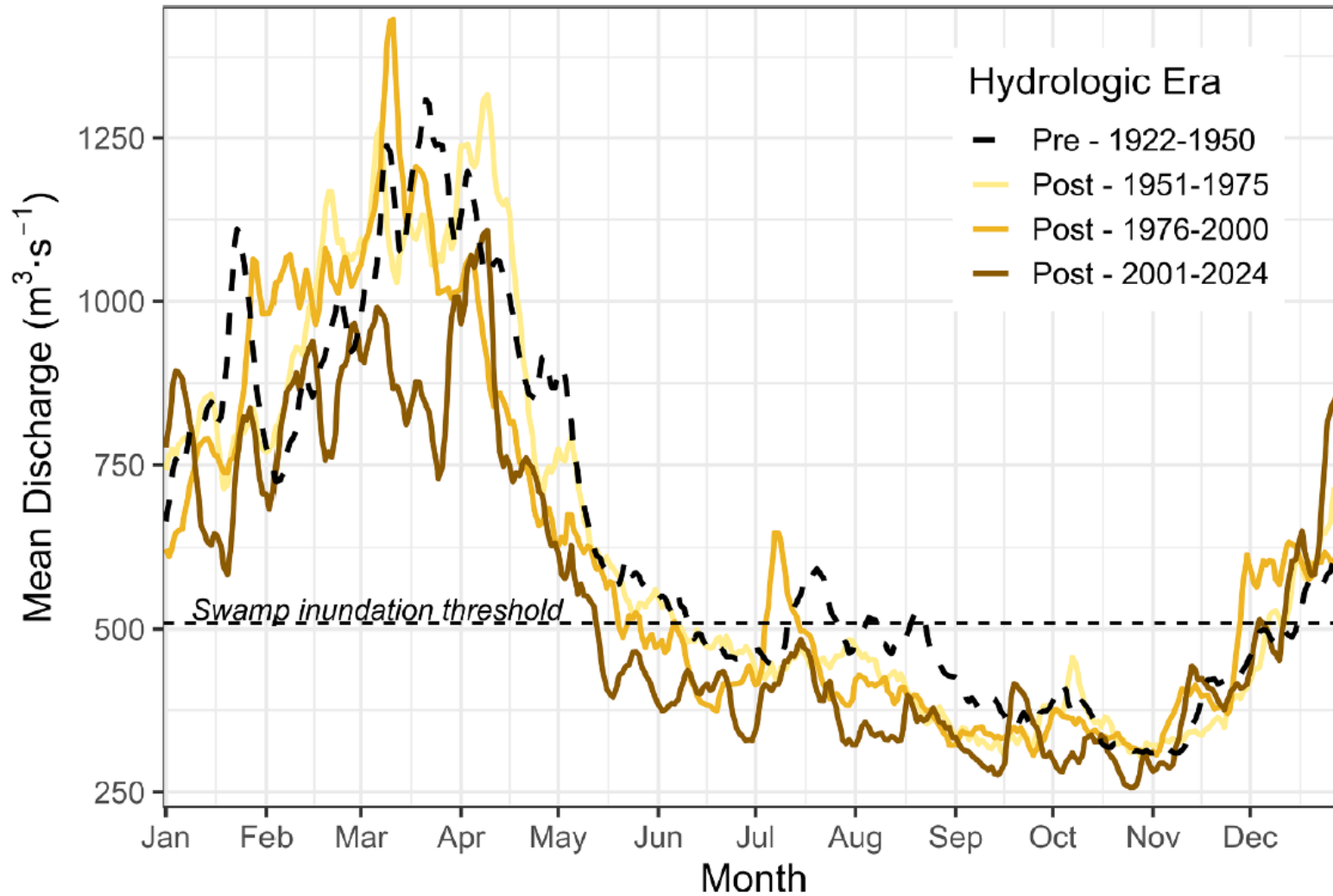




Dredge sand deposits along
the river and in slough systems

A notable issue is that water policy in the region developed during an abnormally wet climatic period (the 20th century), assuming that this pattern was typical.





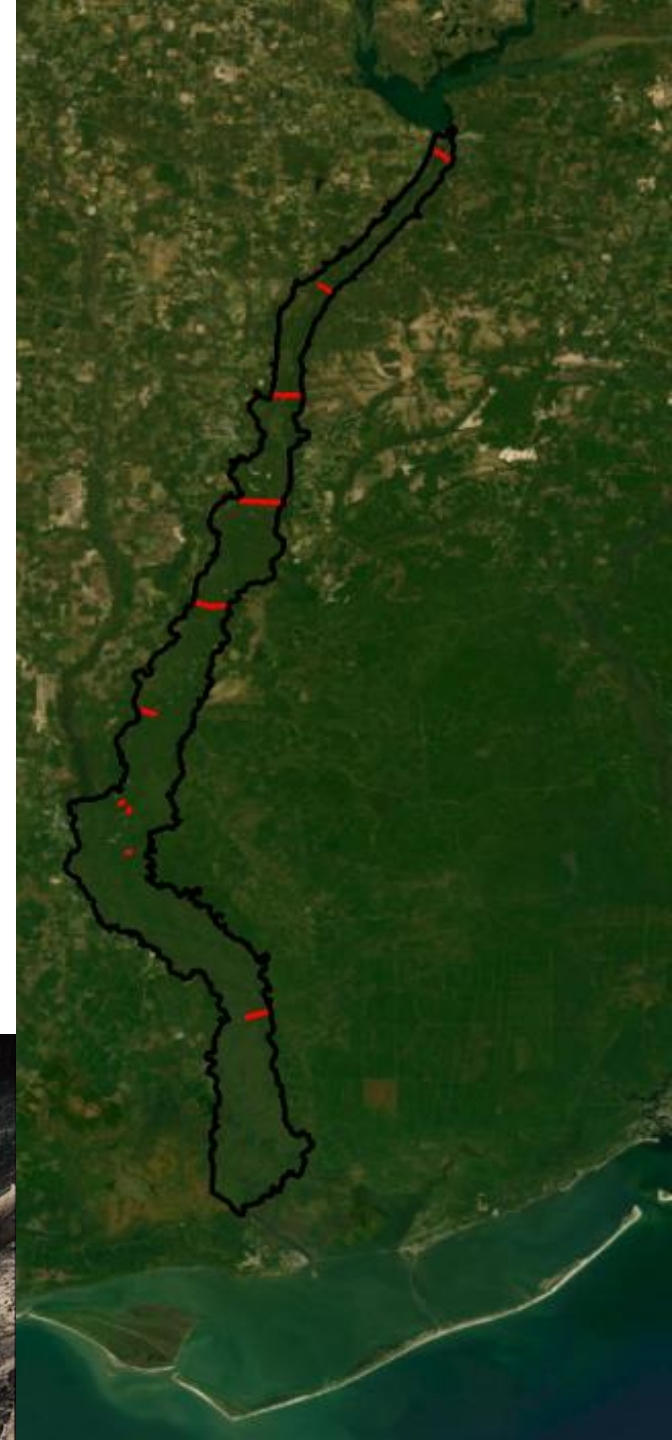
So far, the 21st century has been drier, and now our water policy and hydrologic alterations are affecting ecosystems

Annual hydrographs of mean daily flows for eras representing the period of record before anthropogenically altered hydrology (1922 - 1950) and after (1951 - 2024) in the Apalachicola River. Hydrographs were generated from raw data in cubic meters per second ($\text{m}^3 \cdot \text{s}^{-1}$) available from the U.S. Geological Survey gauge station at Apalachicola River, Chattahoochee FL (02,358,000). An inundation threshold of $509 \text{ m}^3 \cdot \text{s}^{-1}$ for the lowest 50 % of swamps (Light et al., 1998) is described.

Significant Forest Composition Change (1976 - 2004)

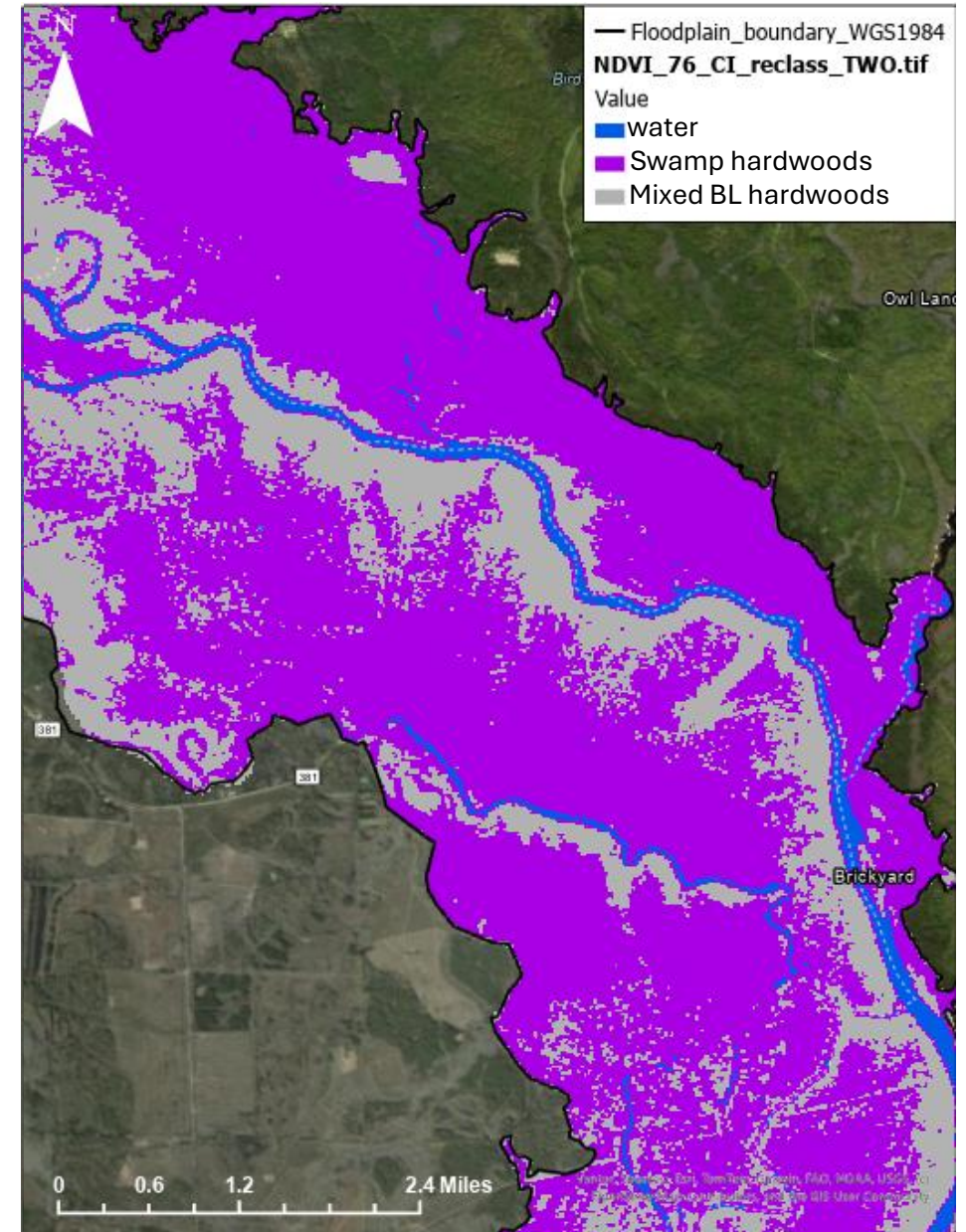
- 17% fewer floodplain trees
- **Swamp tree density decreased by 37%**
- Water tupelo (*N. aquatica*) density decreased 20%
- Ogeechee tupelo (*N. ogeche*) density decreased 44%
- Pop ash (*F. caroliniana*) density decreased 38%

Darst, M.R. and Light, H.M. (2008). Drier forest composition associated with hydrologic change in the Apalachicola River Floodplain, Florida. Scientific Investigations Report 2008-5062. Reston, Virginia: U.S. Department of the Interior, U.S. Geological Survey.



Why are swamp forests critical to floodplain systems?

- Wetland vegetation in connected floodplains filter and mediate flood waters, then deliver nutrients and freshwater to bays, estuaries, oceans, etc.
- Biogeochemical processes are greatly influenced by varying terrain and elevation that predict vegetation species composition
- Presence of thriving tupelo-cypress trees **indicate** a healthy swamp ecosystem
 - Much like prothonotary warblers that indicate a well-functioning bottomland hardwood ecosystem



Why are swamp forests critical to floodplain systems?

- Leaf fall and nutrient return in litter are higher in forested wetlands receiving fluvial subsidies than in most non-wetland deciduous forests (Shure & Gottschalk, 1985)
- The most poorly drained floodplain sites can have the greatest net primary productivity (Clawson et al., 2001)
- Contributions of nutrients and detritus from leaf litter to floodwaters are important for bay crustaceans and bivalves (Chanton et al., 2010; Elder & Mattraw, 1982)
- Nutrient contributions can vary by forest type and species (Elder & Cairns, 1982)
- Tupelo decompose faster compared to other floodplain species (Elder & Cairns, 1982)
 - Also accumulate nutrients and release during spring floods (Brinson, 1977)

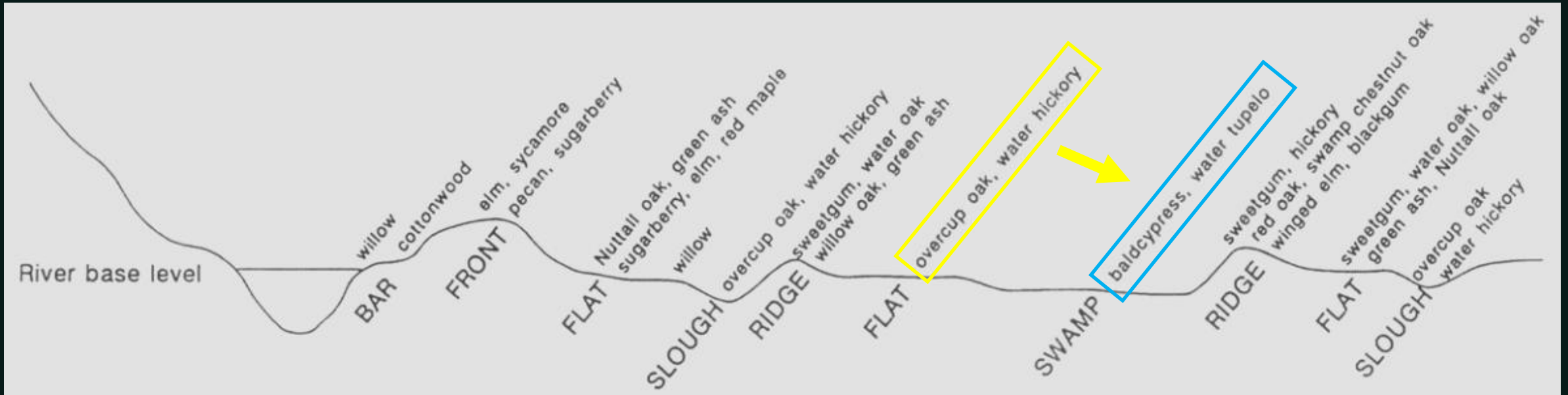


“...economically
important bivalves and
crustaceans are being
fueled by terrestrial
organic matter
supplied by river
flooding...”

Wilson, R. M., Chanton, J., Lewis, F. G., & Nowacek, D. (2010). Concentration-dependent Stable Isotope Analysis of Consumers in the Upper Reaches of a Freshwater-dominated Estuary: Apalachicola Bay, FL, USA. *Estuaries and Coasts*, 33(6), 1406–1419. <http://www.jstor.org/stable/40928538>

The problem:

Low bottomland hardwoods are encroaching upon swamp hardwoods



Species associated with topographic variations within a major stream valley. After Hodges and Switzer (1979).

What do we mean by light versus heavy-seeded species?

- Seed weight is arguably the most critical life history characteristic that influences recruitment success in trees (Gross, 1984; Howe et al., 1985; Paz et al., 1999; Tripathi & Khan, 1990; Turnbull et al., 1999)
- Seed weight determined by thickness of **pericarp (husk)** and **embryo** inside
- However, the amount of stored carbohydrates in the embryo determines germination strategy and resilience

Low BLH

water hickory



overcup oak



Swamp

tupelo spp.

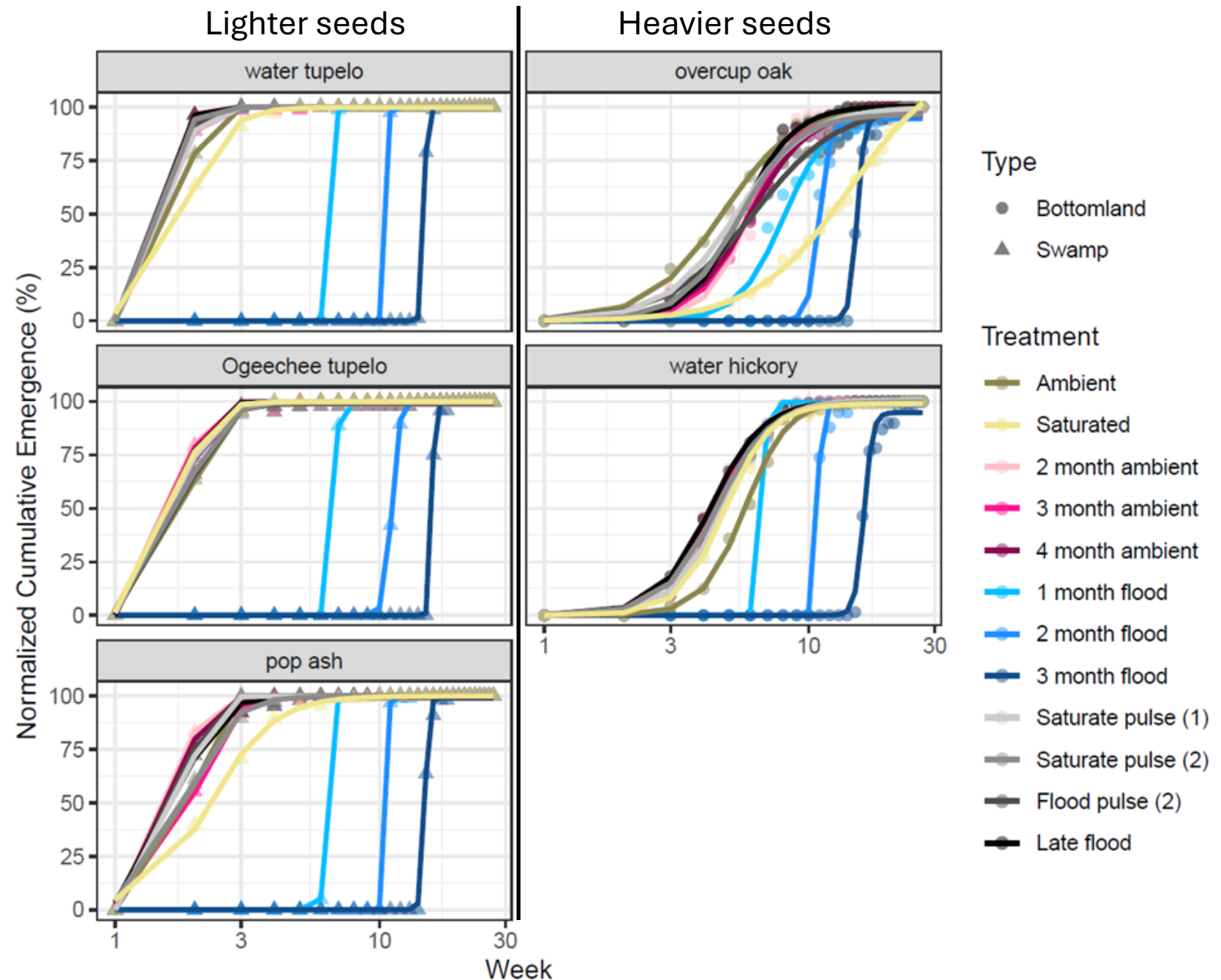


pop ash



What do we mean by light versus heavy-seeded species?

- Light-seeded floodplain species must germinate early in the growing season to build root structure and resilience
- However, this leaves them susceptible to early-season stressors
 - flood, heat, predation

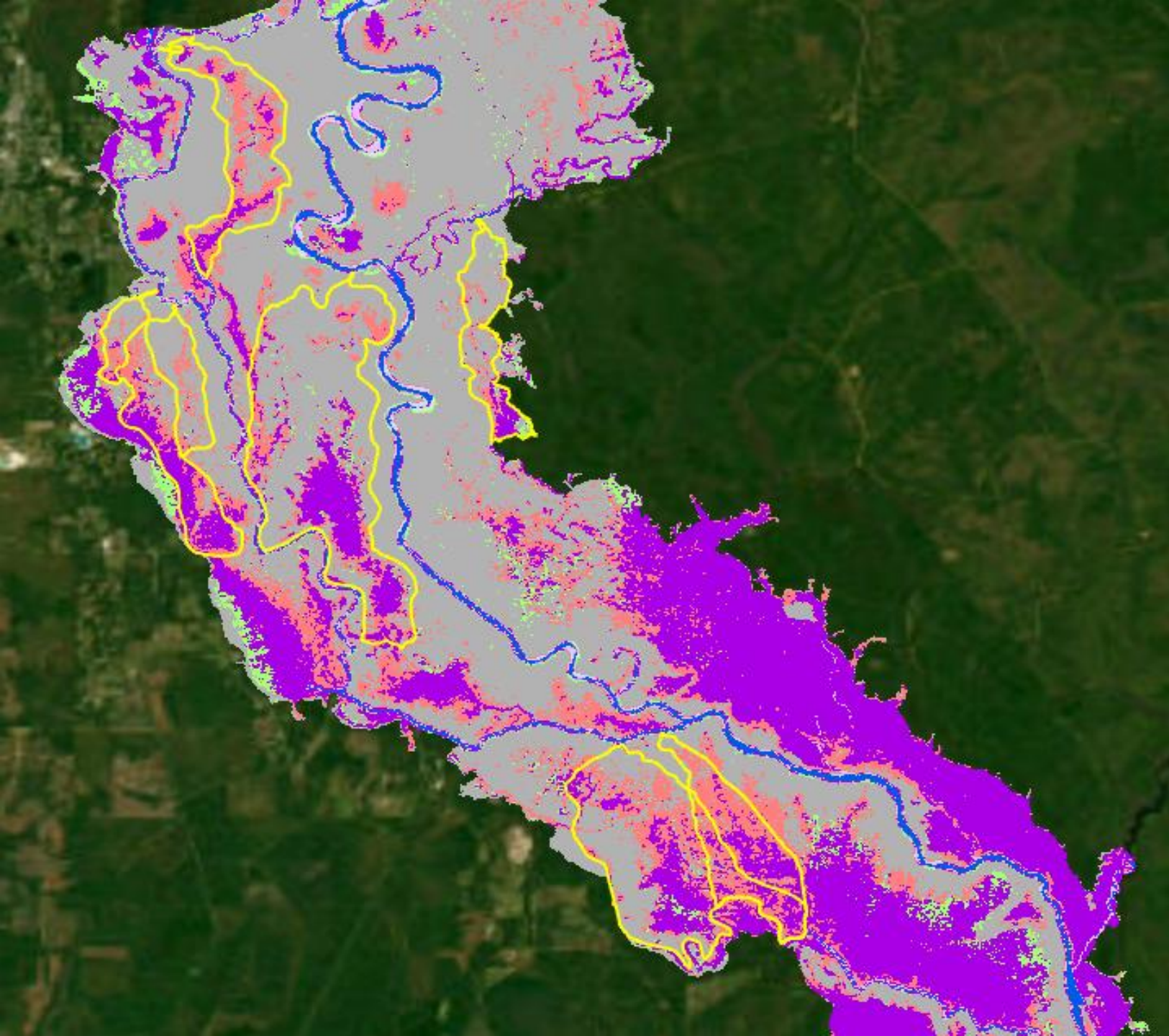


In a frequently flooded swamp, hardwood competitors are suppressed, allowing swamp species to establish in the mid-canopy and advance after disturbance



However, in a now drier swamp,
competitors advance and compete for
canopy dominance

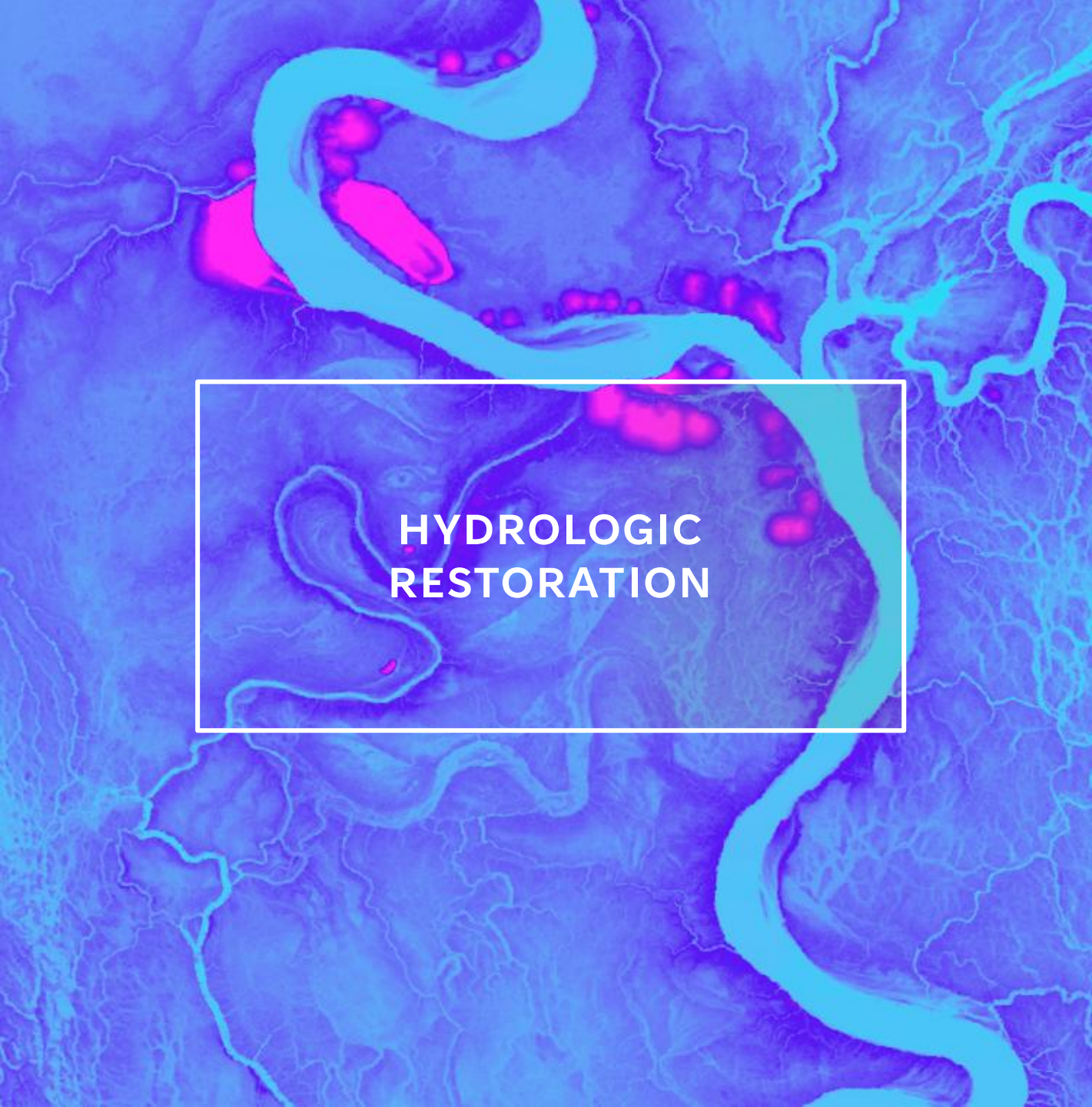




CHANGE DETECTION AND PRIORITIZATION

- tup/cyp -> tup/cyp
- BLH -> BLH
- Water -> Water
- CypTup -> BLH
- BLH -> CypTup

So, this floodplain has become
hydrologically degraded and
compositionally degraded



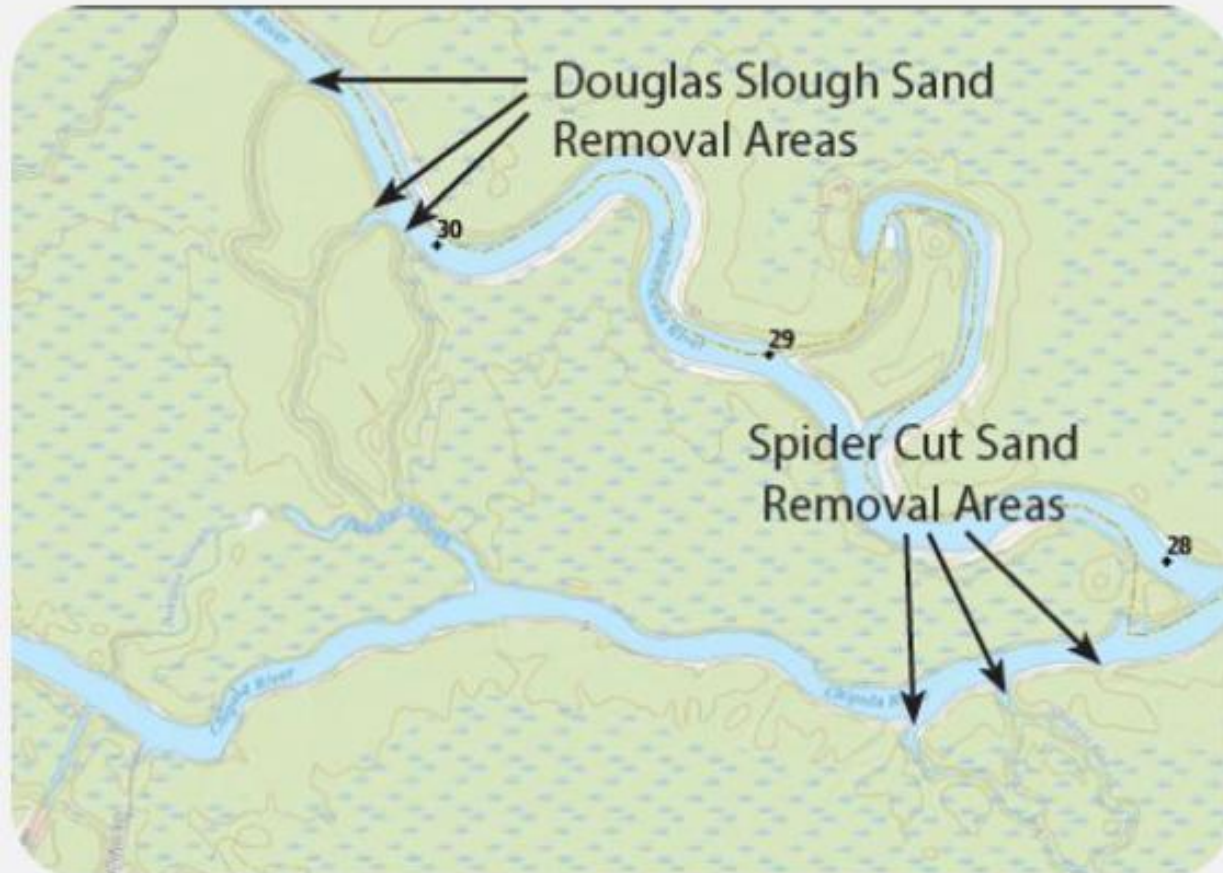
HYDROLOGIC RESTORATION



Began in 2020

What the project will accomplish

- Sand removal in three sloughs
- Documenting the benefits for this type of restoration
- Develop and test methods for the cost effective and environmentally sound way in which to conduct this work.



- Conduct monitoring and analysis that specifically relates the benefits of slough restoration and hydrologic connectivity of the mainstem of the river to the floodplain
- Develop a Geomorphic/Hydrologic Restoration Plan
- Provide public outreach and education.

An aerial photograph of a lush green swamp forest. A dark, winding river or stream flows through the dense canopy of trees. The water reflects the surrounding greenery. The overall scene is a healthy, natural ecosystem.

RECENTLY SELECTED NFWF PROPOSAL:

**WATER QUALITY IMPROVEMENT THROUGH
RESTORATION OF SWAMP FOREST ECOSYSTEMS
IN THE APALACHICOLA RIVER FLOODPLAIN**

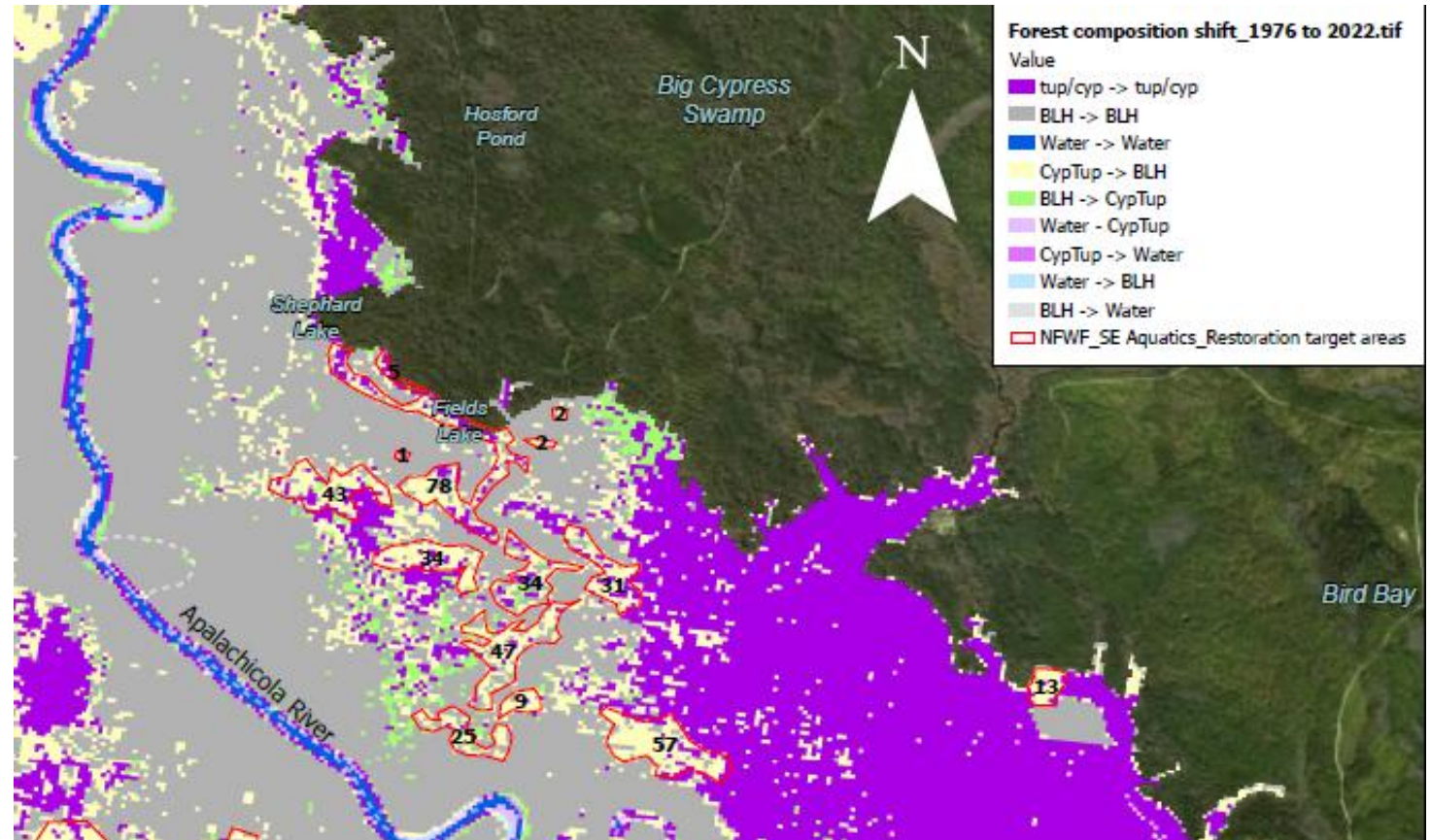
Background:

- In drier braided slough systems, mixed BLH species have been able to encroach into the slough hollows and deeper swamps.
 - Now have had multiple decades to establish
- Recent research has revealed that hydrologic restoration will impede establishment and competitiveness of BLH competitors in swamps
- However, it will **struggle to eliminate established competitors** in the mid and upper canopy.



Objectives:

- Reduce competitor BLH stems (>3ft) in slough hollows and deep swamp (~100 acres)
- Plant 1-yr-old Ogeechee tupelo, water tupelo, and cypress seedlings in new openings. Monitor success
- Improve water quality by replacing invading oaks and hickories with swamp species that contribute leaf litter and detritus more efficiently to flood waters and ultimately the coastal estuary

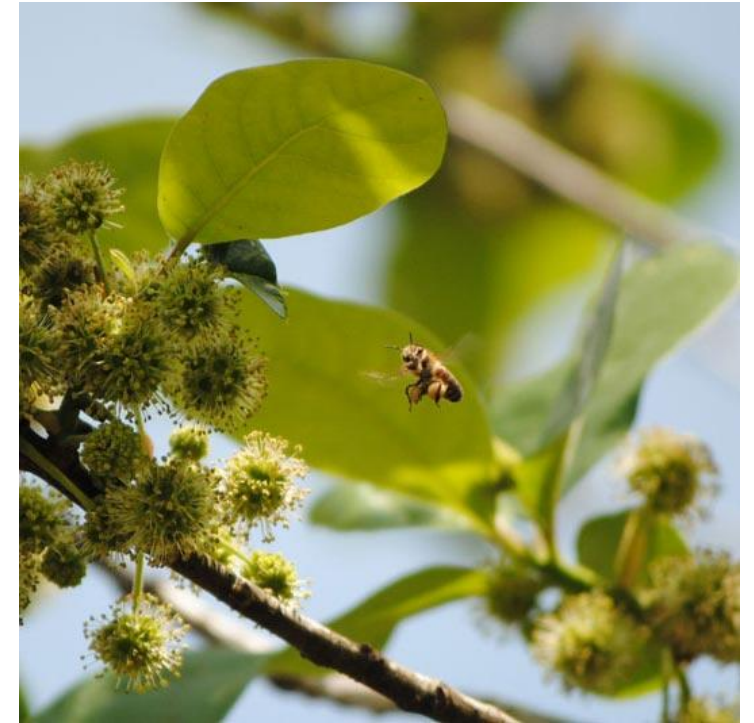


This year's
focus has been
seedling
production:



To conclude: Why is forest degradation of greater concern in the Apalachicola?

- Shifting forest species composition signals a drier floodplain
 - Directly affects tupelo-dependent market
- A drier floodplain means less hydrologic connection, water filtration, and transport of critical nutrients and organic matter
- Freshwater inputs affect coastal estuarine health and local economies



Smiley Honey



WFSU



Thank you for listening!

- Please reach out with any questions or comments:
 - jtracy@agcenter.lsu.edu