Investigating hydrologic alteration as a main driver of forest composition shifts in a Florida river

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APALACHICOLA RIVERKEEPER

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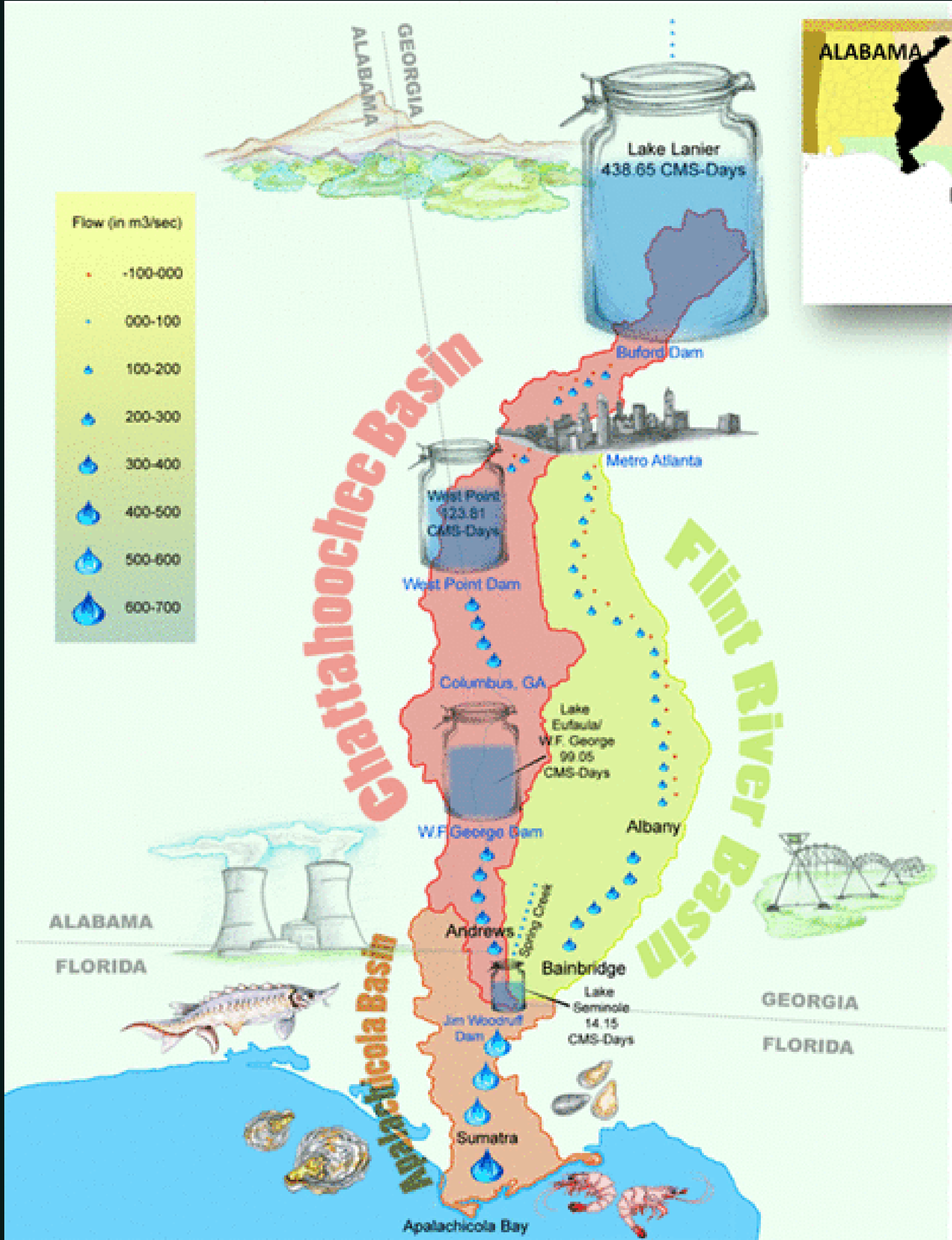
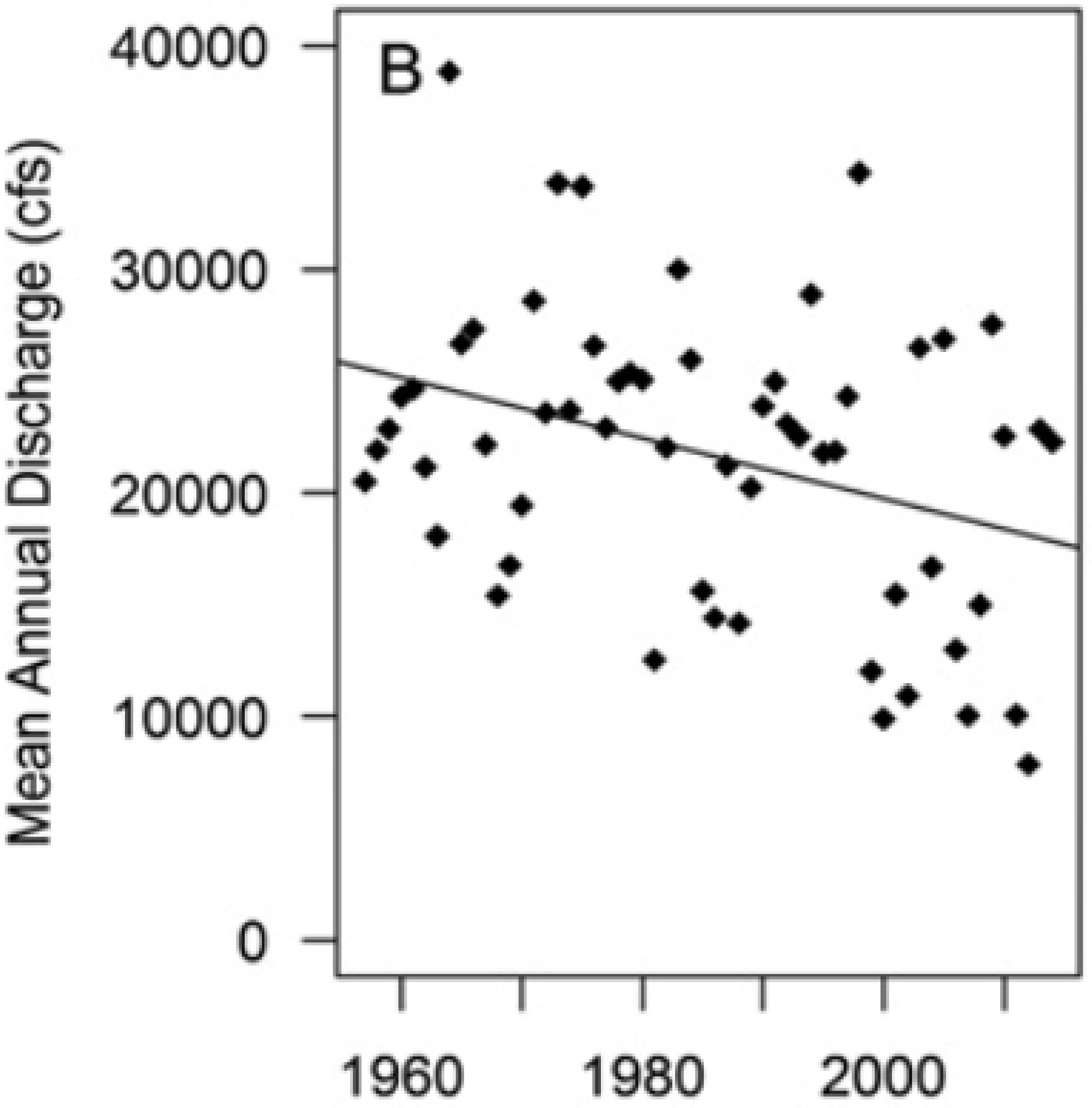
What influences seasonal flows and connectivity in the Apalachicola River and floodplain?



Leitman, Pine, and Kiker (2016)

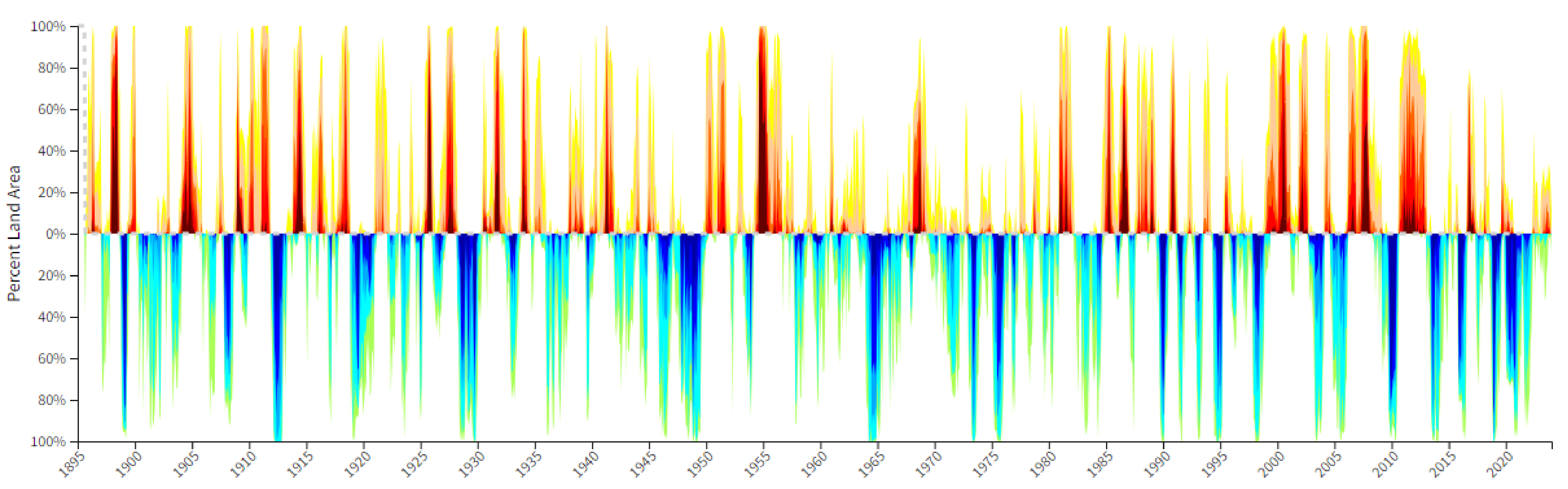
Fisch, N. C., & Pine, W. E. (2016). A Complex Relationship between Freshwater Discharge and Oyster Fishery Catch Per Unit Effort in Apalachicola Bay, Florida: an Evaluation from 1960 to 2013. *Journal of Shellfish Research*, *35*(4), 809–825. https://doi.org/10.2983/035.035.0409

Mean daily discharge (cfs) of the Apalachicola River from 1958 to 2014, measured at USGS gauge 02358700 in Blountstown, FL. The trend line is a simple linear regression of mean annual discharge regressed on year as a reference.



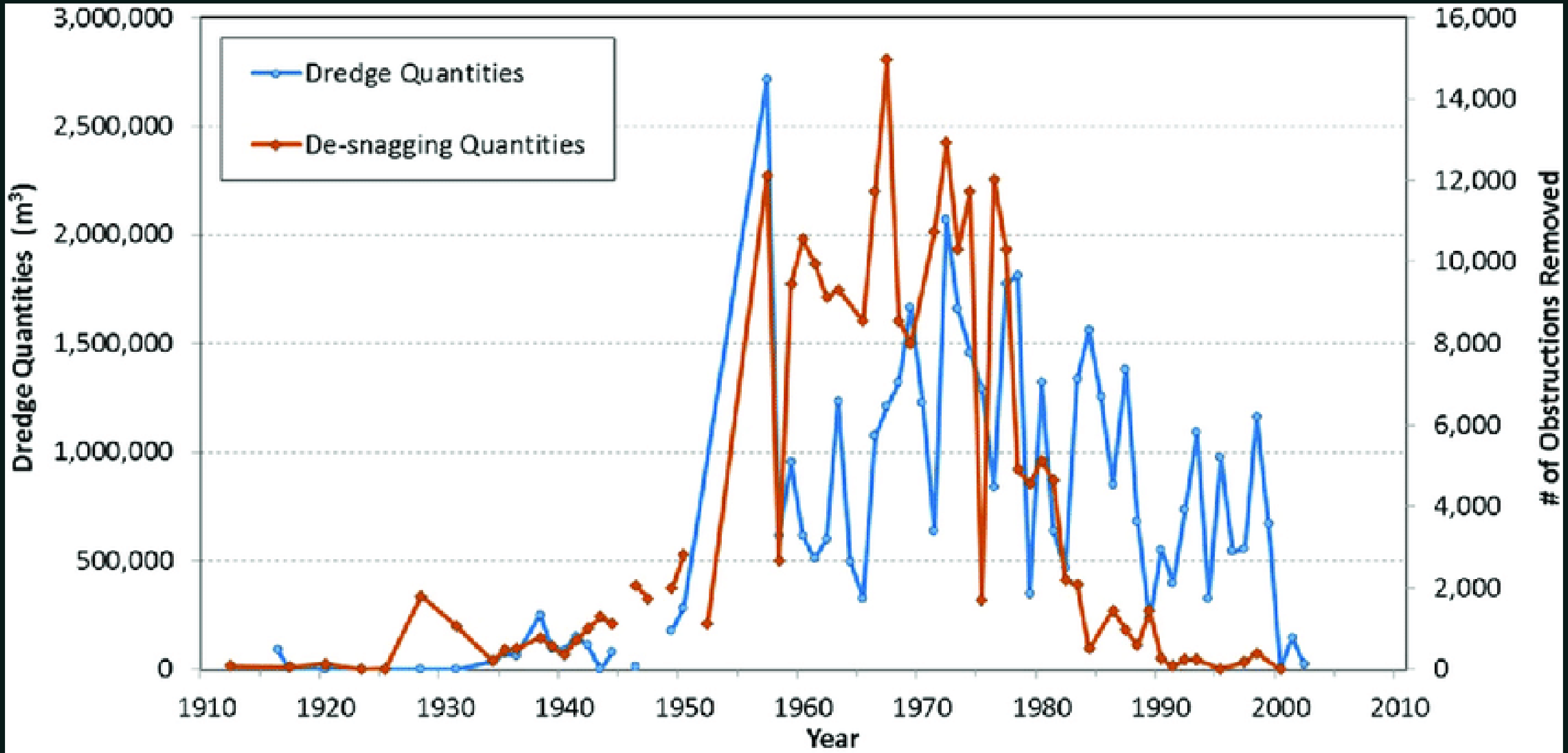
ACF Basin Drought Record

1895 to 2023



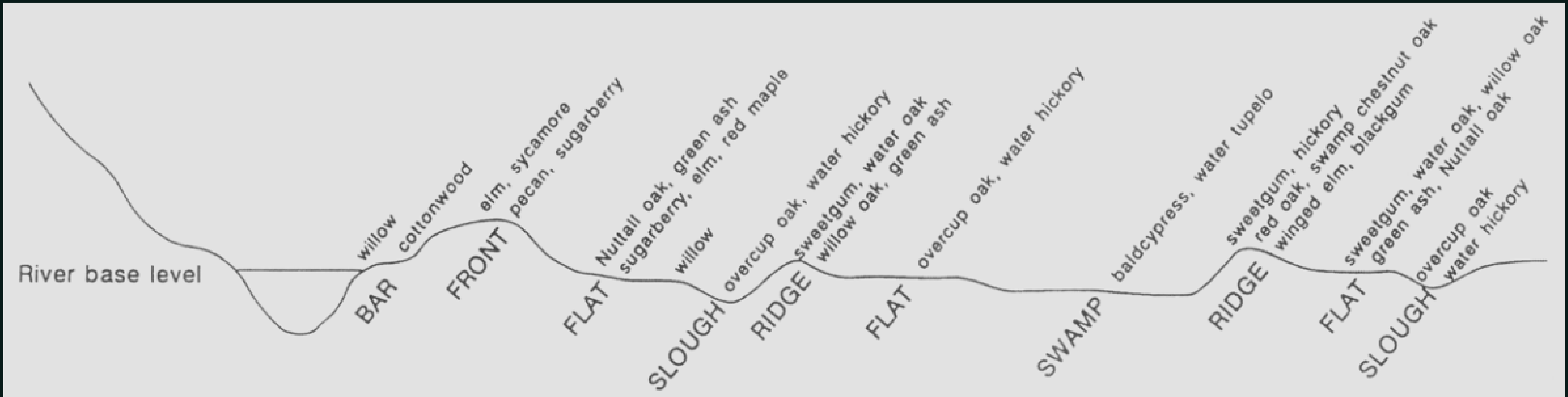
Drought.gov/watersheds/acf-dashboard

Navigational Dredging (1957 - 2002)



Mossa, J. Chen, Y.H., Walls, S., Kondolf, G.M. & Wu, C.Y. (2017). Anthropogenic landforms and sediments from dredging and disposing sand along the Apalachicola River and its floodplain. Geomorphology 294. 10.1016/j.geomorph.2017.03.010.

How are forest species responding?

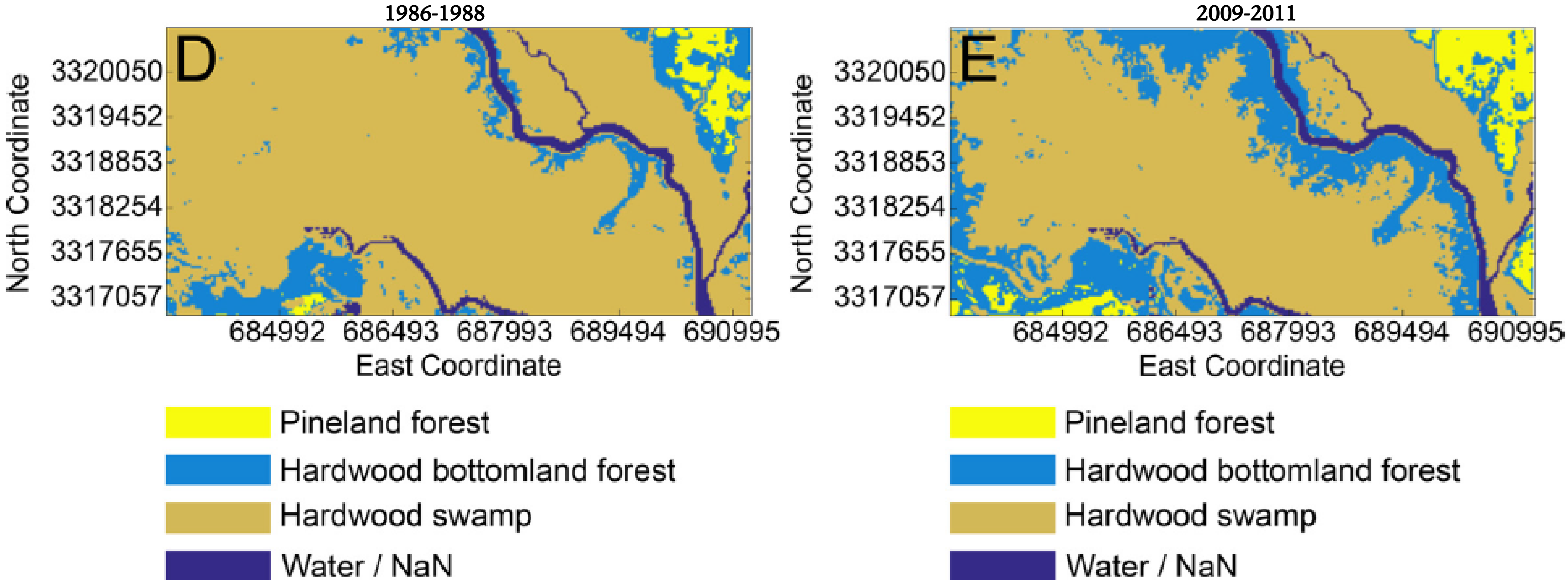


Species associated with topographic variations within a major stream valley. After Hodges and Switzer (1979).

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.



Cecilia, D.L., Toffolon, M., Woodcock, C. E., & Fagherazzi, S. (2016). Interactions between river stage and wetland vegetation detected with a seasonality index derived from LANDSAT images in the Apalachicola Delta, Florida. *Advances in Water Resources*, *89*, 10–23. https://doi.org/10.1016/j.advwatres.2015.12.019

Why is species composition change important?

Production and Decomposition of Forest Litter Fall on the Apalachicola River Flood Plain, Florida

John F. Elder & Duncan J. Cairns (1982)

U.S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER 2196

- Leaf decomposition was highly species dependent. Tupelo (*Nyssa spp.)* and sweetgum (*Liquidambar styraciflua*) leaves decomposed completely in 6 months when flooded by river water.
- Leaves of baldcypress (*Taxodium distichum*) and diamond-leaf oak (*Quercus laurifolia*) were much more resistant.
- Water hickory (*Carya aquatica*) leaves showed intermediate decomposition rates.

- **Decomposition of all species was greatly reduced in dry environments.**

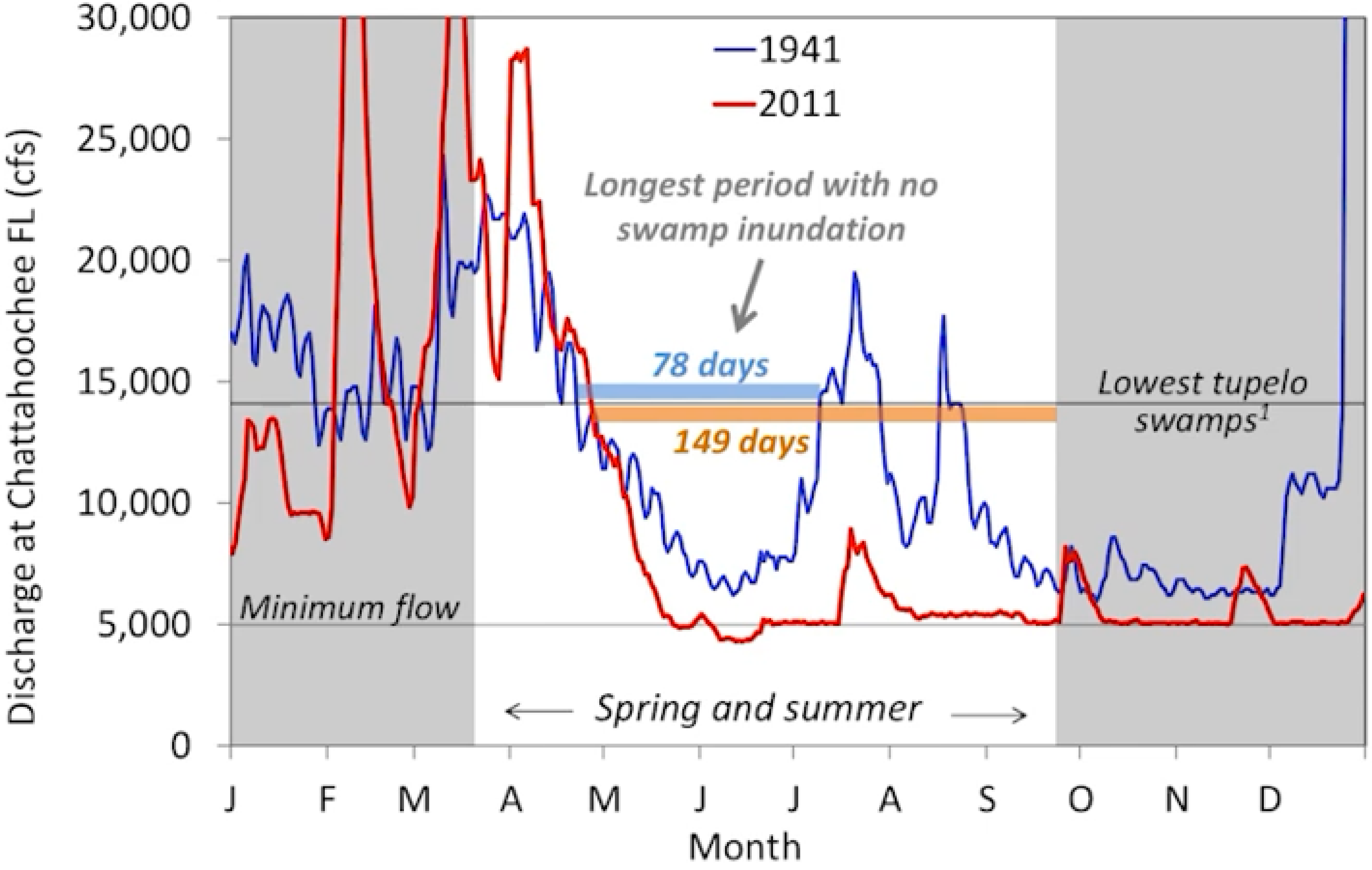
“…economically important bivalves and crustaceans are being fueled by terrestrial organic matter supplied by river flooding…"

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

What are specific drivers of species shifts?

Typical low-flow year in earlier and later periods

Earlier=1923-1955; later=1985-2017



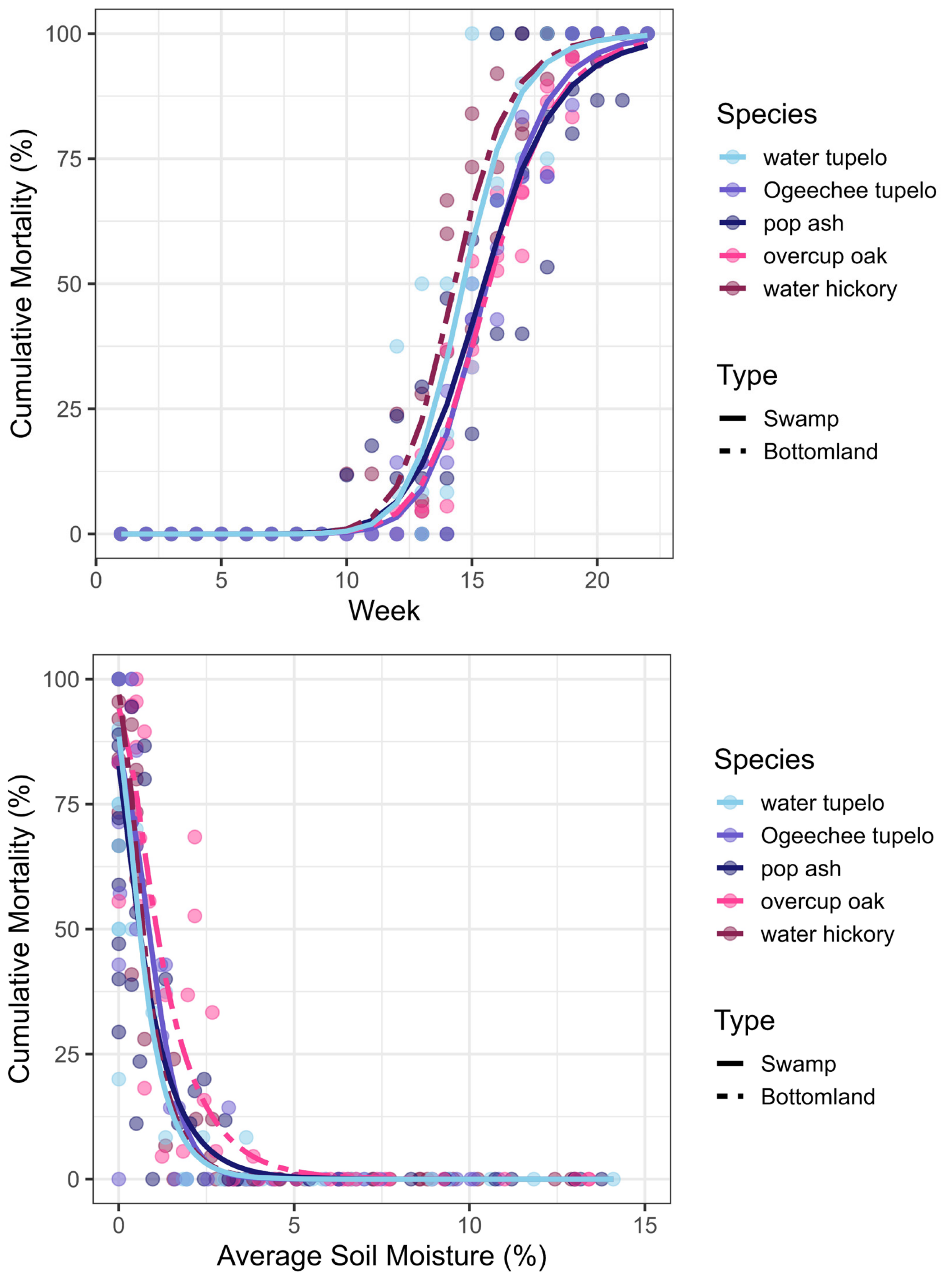
[1]Flow currently required to inundate lowest 10% of swamps=14,100 cfs; 50% of swamps=18,000 cfs

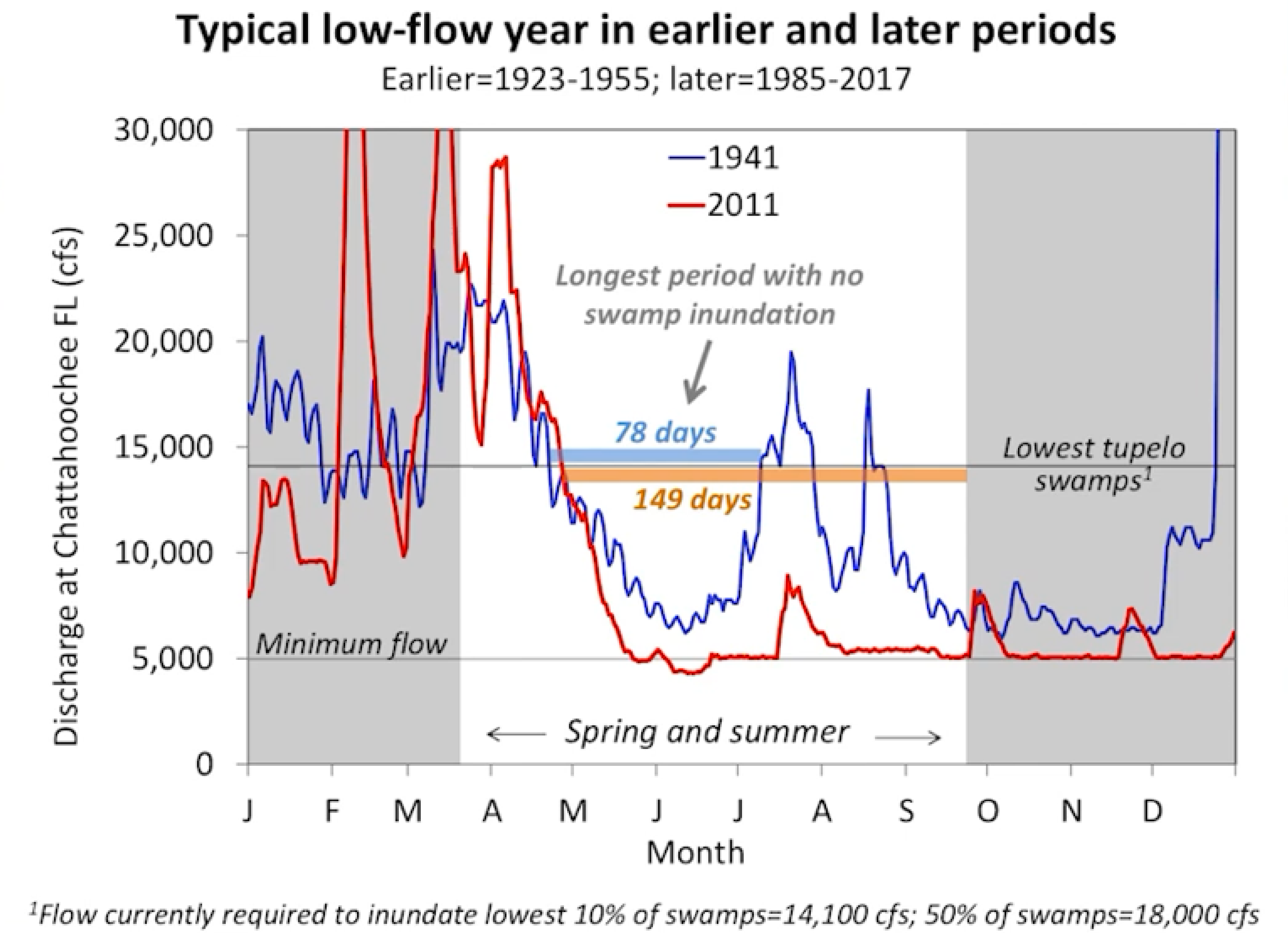
Helen Light (2018)

Are swamp species less tolerant of drought than low bottomland species?

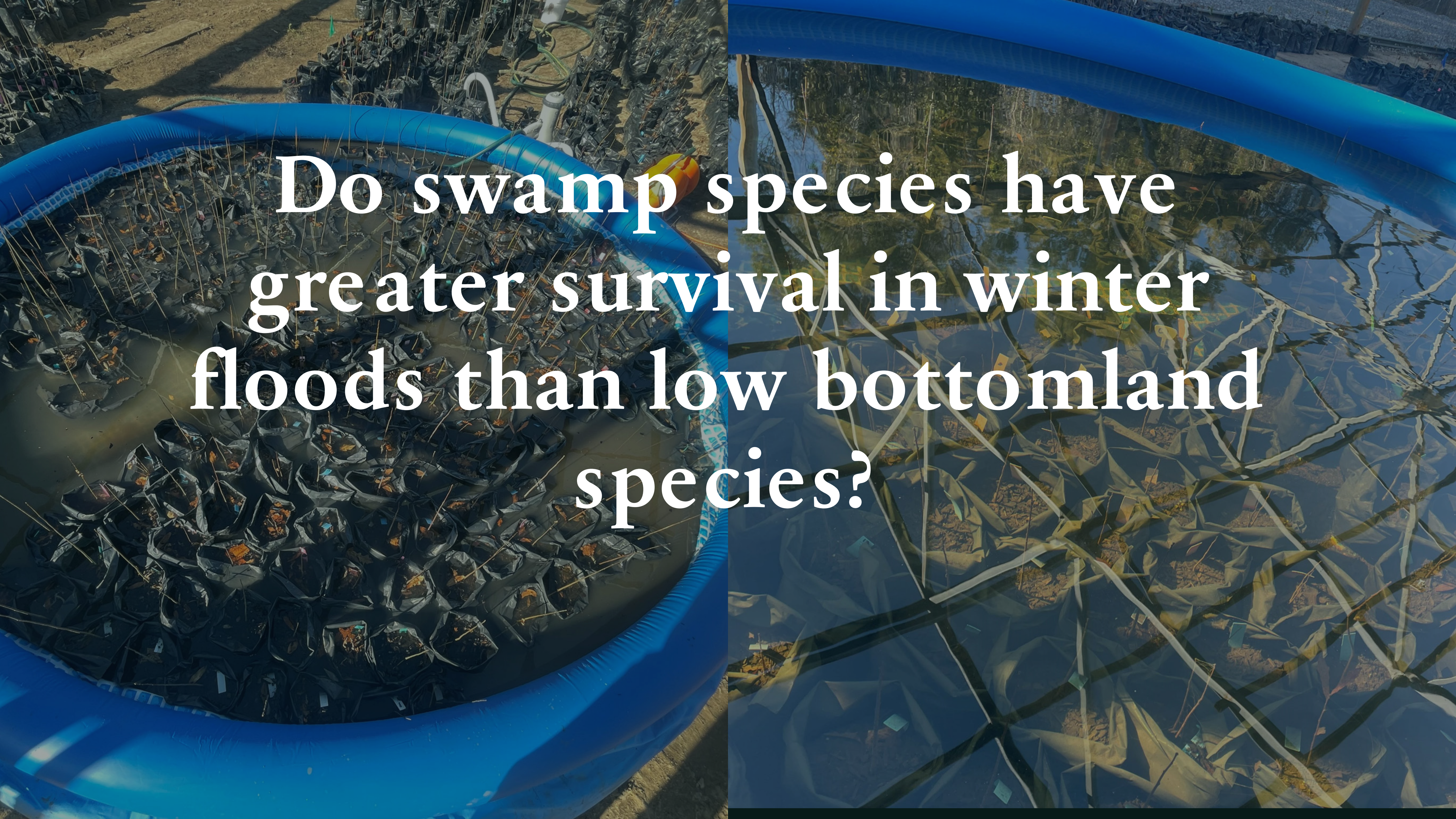
Drought Resistance Thresholds in Floodplain Forests: Testing Seedling Mortality of Five Tree Species under Increasing Moisture Deficiency.

Tracy et al. (2024)





Helen Light (2018)


Do swamp species have greater survival in winter floods than low bottomland species?

Seasonal Flood Duration: A Poor Indicator of One-Year-Old Floodplain Tree Seedling Survival

Tracy et al. (2024)

Table 1. Final survival and sample sizes by treatment and species. Use of successful individuals from a previous experiment resulted in varying sample sizes (n) of species within blocks.

Treatment	Species	Type	Live	Total (n)	Block (n)
1 month flood	water tupelo	Swamp	10	10	3x3x4
	pop ash	Swamp	12	12	4x4x4
	water hickory	Bottomland	16	16	5x5x6
	overcup oak	Bottomland	16	17	6x5x6
2 month flood	pop ash	Swamp	12	12	4x4x4
	water hickory	Bottomland	16	16	5x5x6
	overcup oak	Bottomland	17	17	6x5x6
3 month flood	pop ash	Swamp	12	12	4x4x4
	water hickory	Bottomland	16	16	5x5x6
	overcup oak	Bottomland	17	17	6x5x6
4 month flood	water tupelo	Swamp	9	9	3x3x3
	pop ash	Swamp	11	11	4x3x4
	water hickory	Bottomland	18	18	7x6x5
	overcup oak	Bottomland	18	18	7x6x5
Control	water tupelo	Swamp	18	18	11x7
	pop ash	Swamp	31	34	21x13
	water hickory	Bottomland	42	43	19x24
	overcup oak	Bottomland	44	45	23x22

Germination strategies differ: heavy vs. light seed species

water hickory

overcup oak

tupelo spp.

pop ash

Flood Dynamics and Tree Resilience: First-Year Seedlings of Five Floodplain Forest Species Responding to Diverse Inundation Scenarios

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[b]Auburn University, College of Forestry, Wildlife and Environment Bldg, 602 Duncan Dr, Auburn, AL 36849, USA

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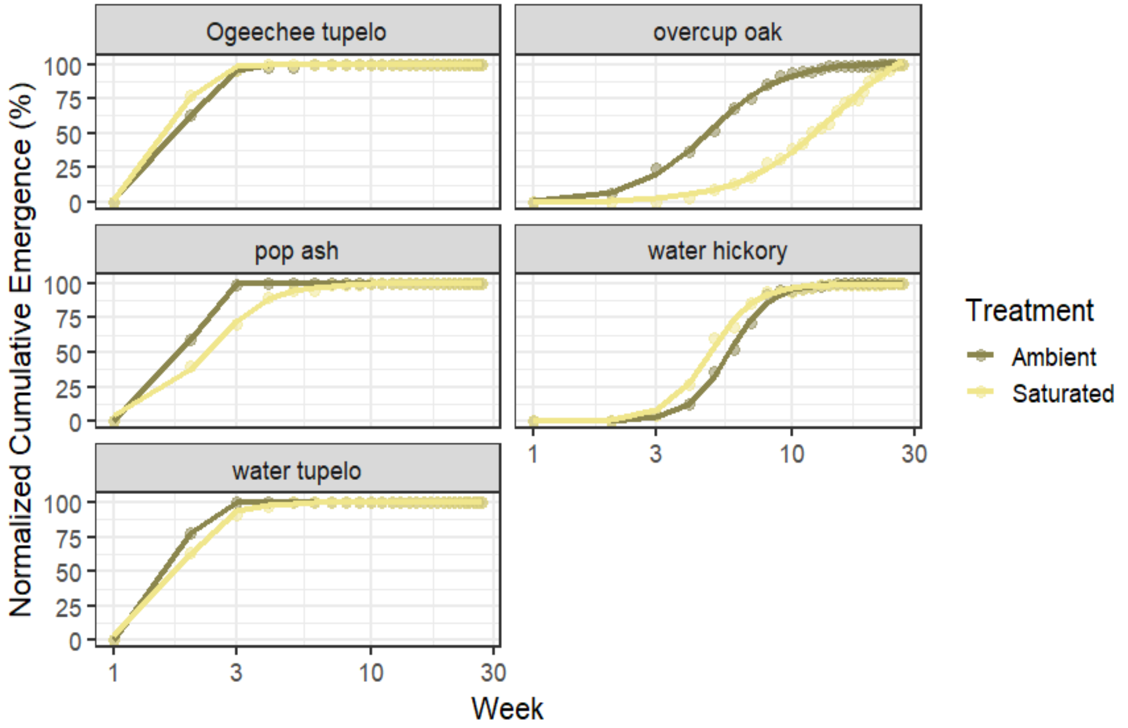
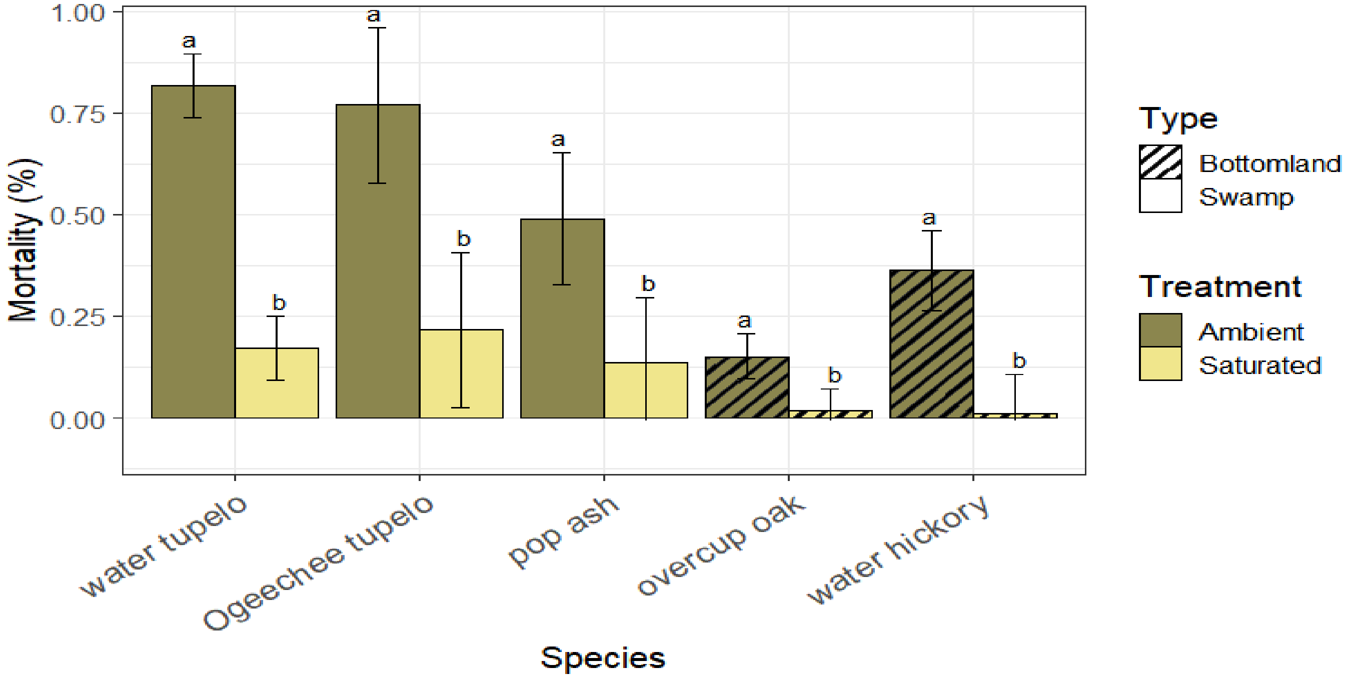
Recent publication in:

Forest Ecology and Management





What have we learned and how can we apply it?

- Limiting duration of drought is important
  - Suppresses oak establishment
  - Reduces mortality
- Focus more on early-season stressors for light-seeded species establishment
  - Flood pulses
  - Dam water control

We have the tools to improve adaptive management

Biological & Ecological Metrics

- vegetation
  - tupelo & ash (*Nyssa* & *Fraxinus* spp.)
    - Determine hydrologic requirements for successful regeneration year
- mussels
- fish
- oysters

Modeled River Flows (STELLA)

- tupelo & ash (*Nyssa* & *Fraxinus* spp.)
  - Determine inundation flow threshold for floodplain swamps
  - Germination event: flow 1st drops below for >7 days between March – July
  - Mortality event: flow exceeds threshold within 21 days after germination and remains above for >15 days

Adjust Water Control Manual

- Does current procedure increase mortality events?
- Can procedure adapt to climate, water demand, ecological needs?

Mortality years based on tupelo seedling metrics & Spider's Cut Slough inundation thresholds (Kumar)

Jim Woodruff Dam: Outflows 1939 - 2020

(STELLA 1939 - 2012)

	Pre-Restoration (16,400 cfs)	Post-Restoration (12,500 cfs)
Seedling Age	Total Events	Total Events
3 weeks	25	19
9 weeks	18	12

Slough restoration proves effective