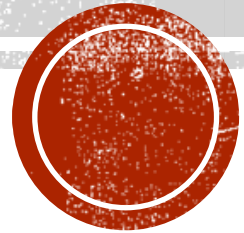
LAND MANAGEMENT IMPACTS TO CRAYFISHES AND AQUATIC INVASIVE SPECIES DETECTION



Zanethia Barnett, PhD

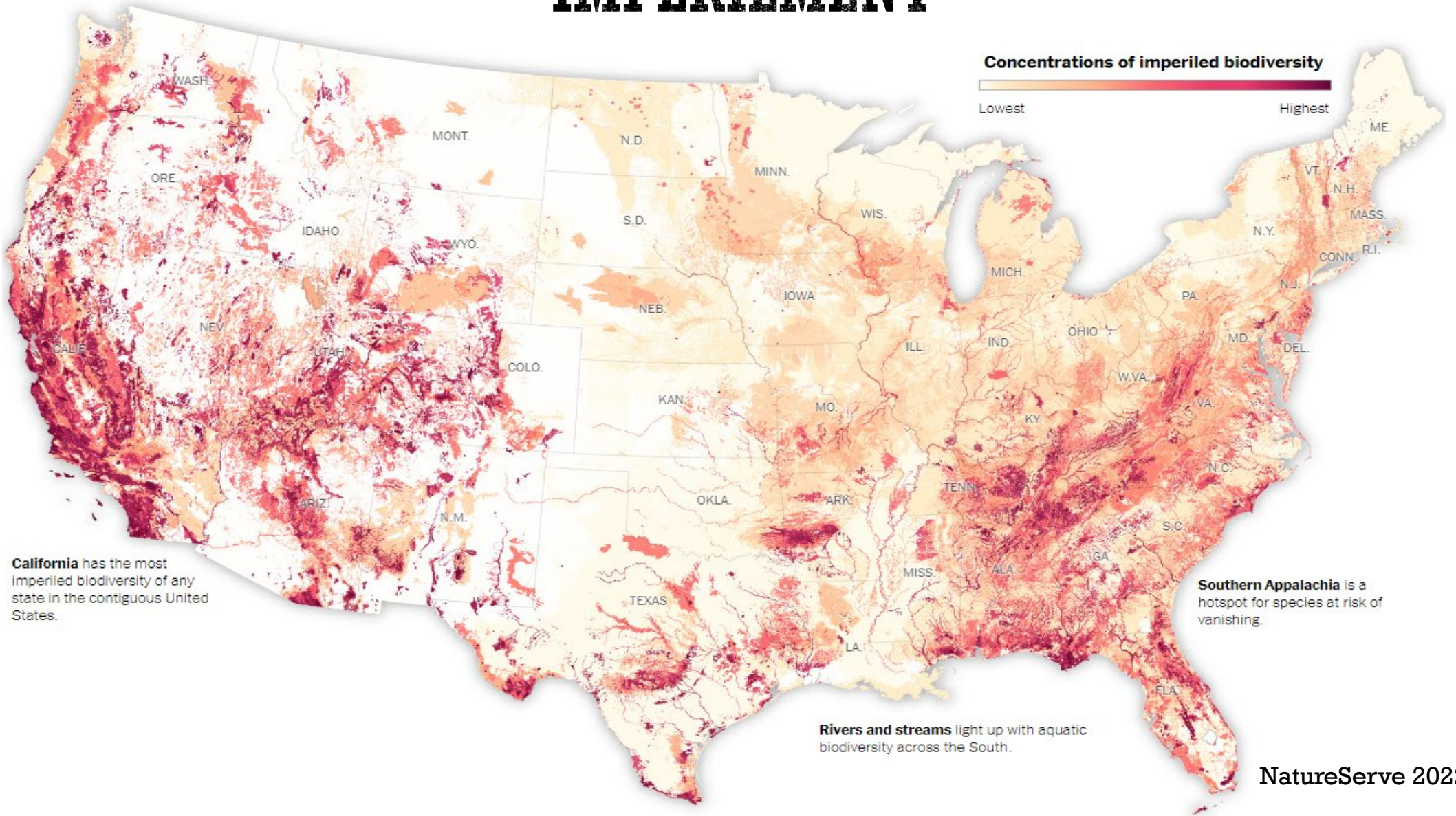
Research Fisheries Biologist

USDA Forest Service, Southern Research Station

GSARP annual Meeting

May 2024

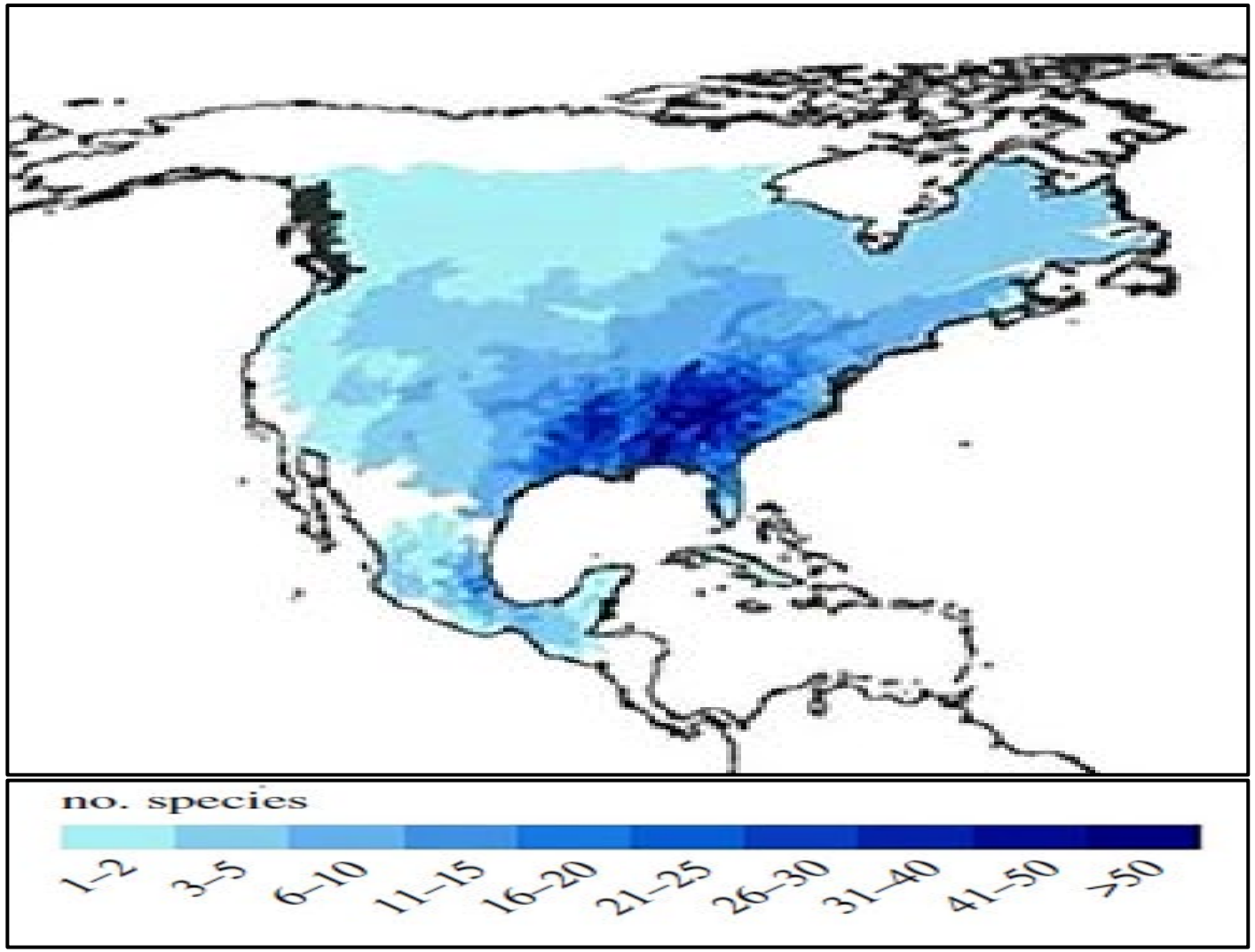
SOUTHEAST FRESHWATER SYSTEMS HAS HIGH RISK OF IMPERILMENT



NatureServe 2022

Threats to freshwater systems

- Urban development
- Pollution
- Logging
- Damming and water management
- Agriculture

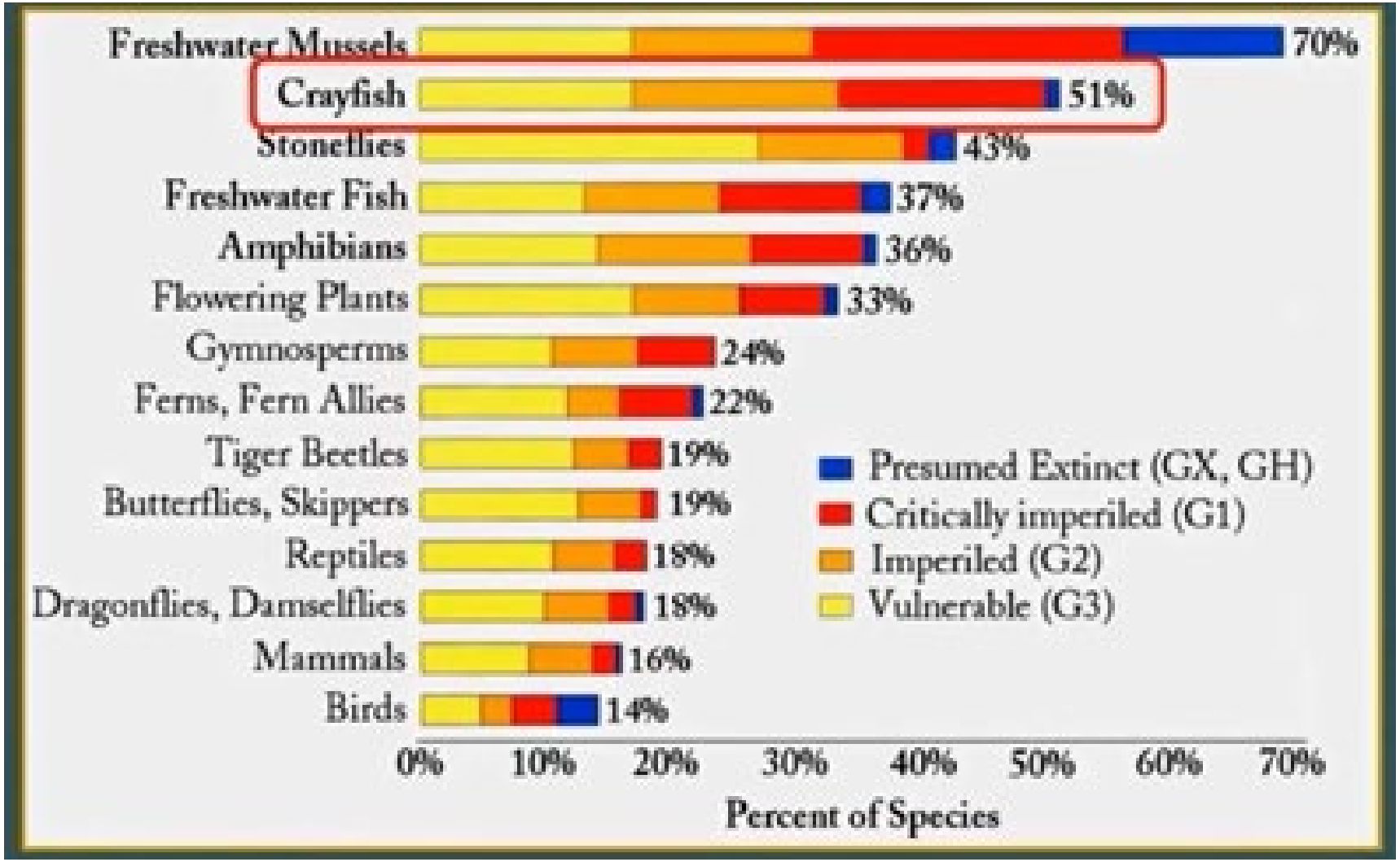


Crayfish Diversity

More than 300 crayfish species in US

- 80% of those in the southeastern US

CONSERVATION CONCERN



Stein *et al.* 2000. Precious Heritage: The Status of Biodiversity in the United States

HABITAT TYPES

Lotic

Lentic

Terrestrial/Subterranean

IMPORTANCE OF LAND MANAGEMENT

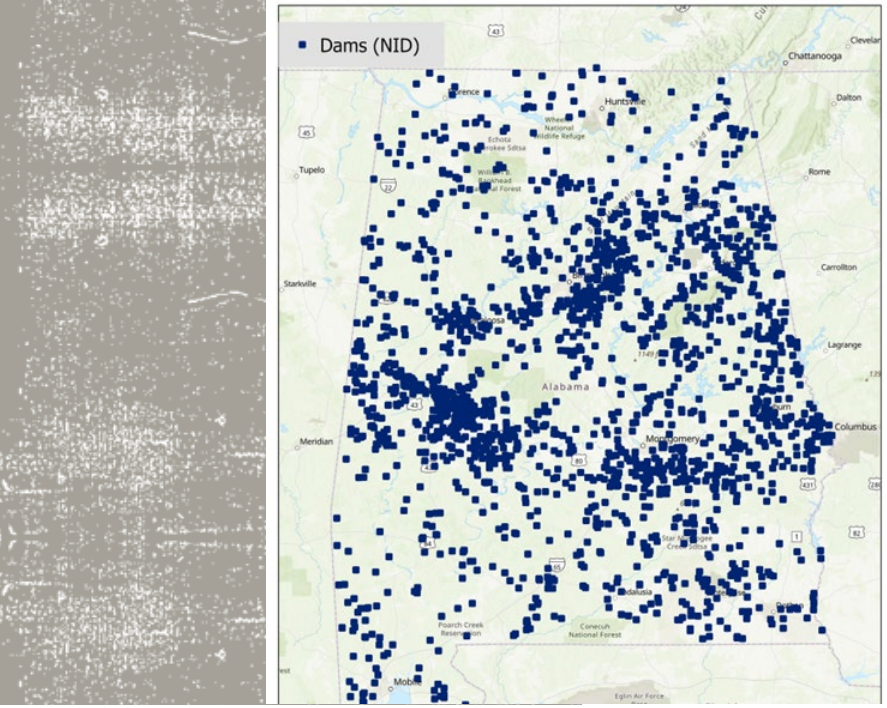
- Forest and freshwater ecosystems are inextricably linked
  - Exchanging flows of water, energy, and organic and inorganic material structure aquatic communities
    - Woody debris and leaf litter support a diversity of habitat niches and are important in crayfish diets
    - Larger substrate sizes
  - Floodplains and vernal pool habitats are important to burrowing crayfishes
  - Ground water levels are important to terrestrial crayfishes and are dependent on the type of forest or vegetation cover

IMPORTANCE OF CRAYFISHES

- Crayfish are Support systems to Aquatic Ecosystems
  - Prey
  - Omnivores
  - Ecosystem Engineer
    - Process Detritus
    - Sediment Manipulation
      - Burrowing
  - Bioindicators
    - Sensitivity to Pollution

Habitat Fragmentation

- Aquatic
  - Impoundments
  - Culverts
  - Weirs
  - Rail Lines

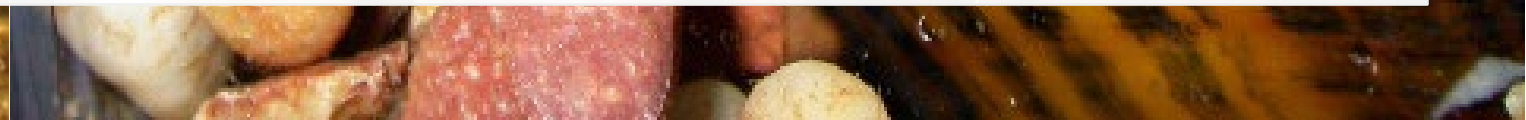


FRAGMENTATION WITHIN AQUATIC SYSTEMS

- United States
  - ~87,000 dams > 3m tall
  - Over 2 million dams < 3m tall
  - Alabama has >10,000 dams

Biological Impacts

- Spawning
- Larval survival
- Growth patterns



Studies assessing effects of large impoundment to crayfish

Received: 15 February 2019 | Revised: 13 November 2019 | Accepted: 22 November 2019
DOI: 10.1111/fwb.13466

ORIGINAL ARTICLE

Freshwater Biology WILEY

Crayfish populations genetically fragmented in streams impounded for 36–104 years

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Email: zanethia.c.barnett@usda.gov

Abstract
1. Dams and
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Effects of impoundments on stream crayfish assemblages

Zanethia C. Barnett[1,2,4], Susan B. Adams[1,5], Jason D. Hoeksema[2,6], Gregory L. Easson[3,7], and Clifford A. Ochs[2,8]

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[3]University of Mississippi, School of Engineering, 227 Brevard Hall, University, Mississippi 38677 USA

Abstract: Life-history timing, trophic interactions, and colonization potential of stream benthos are linked to a
ter the composition of benthic assemblages. We as-
height, >400-ha impoundments) on crayfish assem-
a, USA. We sampled crayfishes at multiple sites in
pounded streams and along similar lengths of 2 un-
inages. We analyzed at 2 scales: within and between
e effects of impoundments on crayfish assemblages
could be generalized across drainages. We compared
l streams and examined changes in crayfish assem-
use history as a potential confounding factor. Adult
stream sections of unimpounded streams compared

Received: 17 June 2022 | Revised: 19 April 2023 | Accepted: 21 April 2023
DOI: 10.1002/rra.4149

RESEARCH ARTICLE

WILEY

Crayfish assemblages correlate with dam-induced effects on abiotic factors and predatory fish assemblages in Alabama streams

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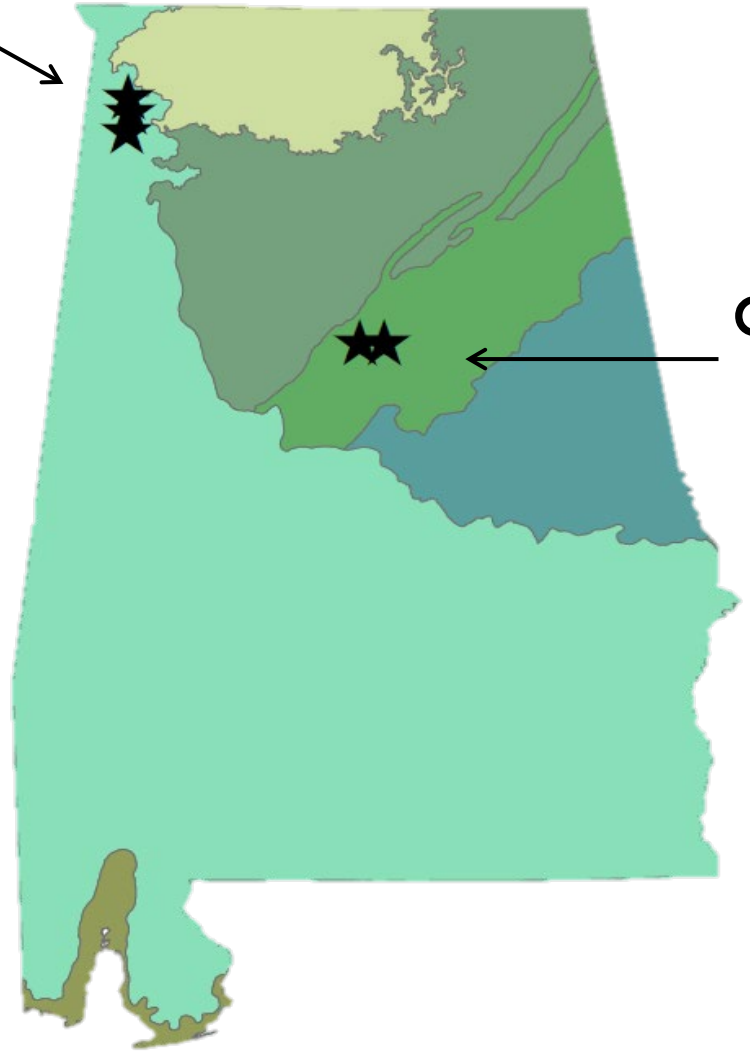
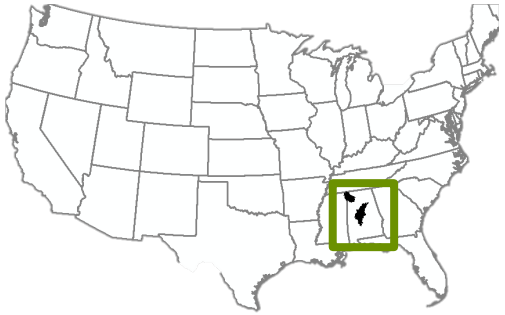
Abstract
Stream faunal assemblage structure is tied closely to hydrology and associated physiochemical properties. By altering natural flows, dams and their impoundments impact faunal assemblages over long distances. Although numerous studies have assessed the effect of dams on stream fauna, information is lacking for crayfishes. In this study, we characterized the effects of relatively large storage dams on crayfish assemblage structures. Over 2 years, we sampled three impounded and two unim-

Study Sites

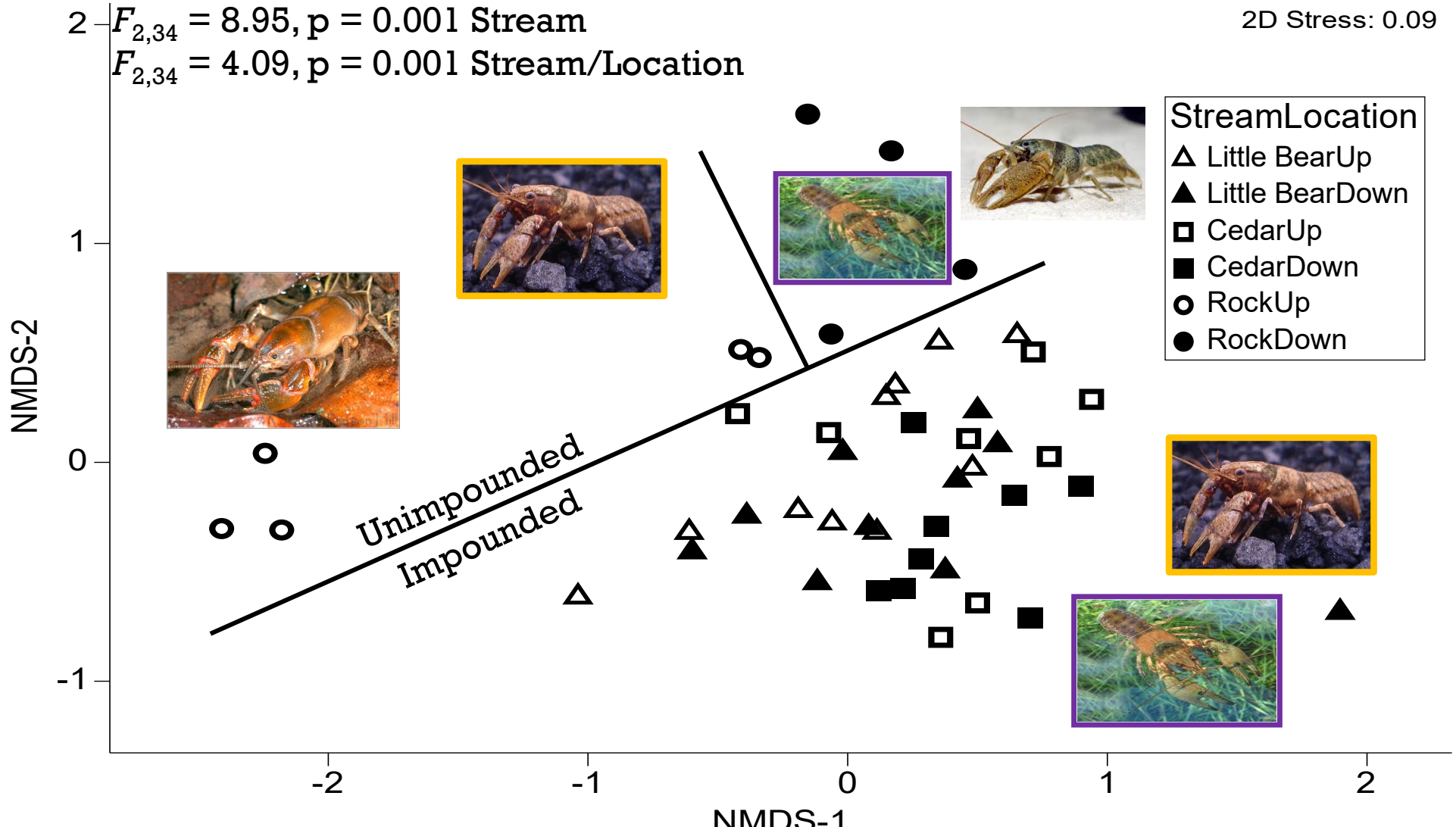
Bear Creek Drainage

Cahaba River Drainage



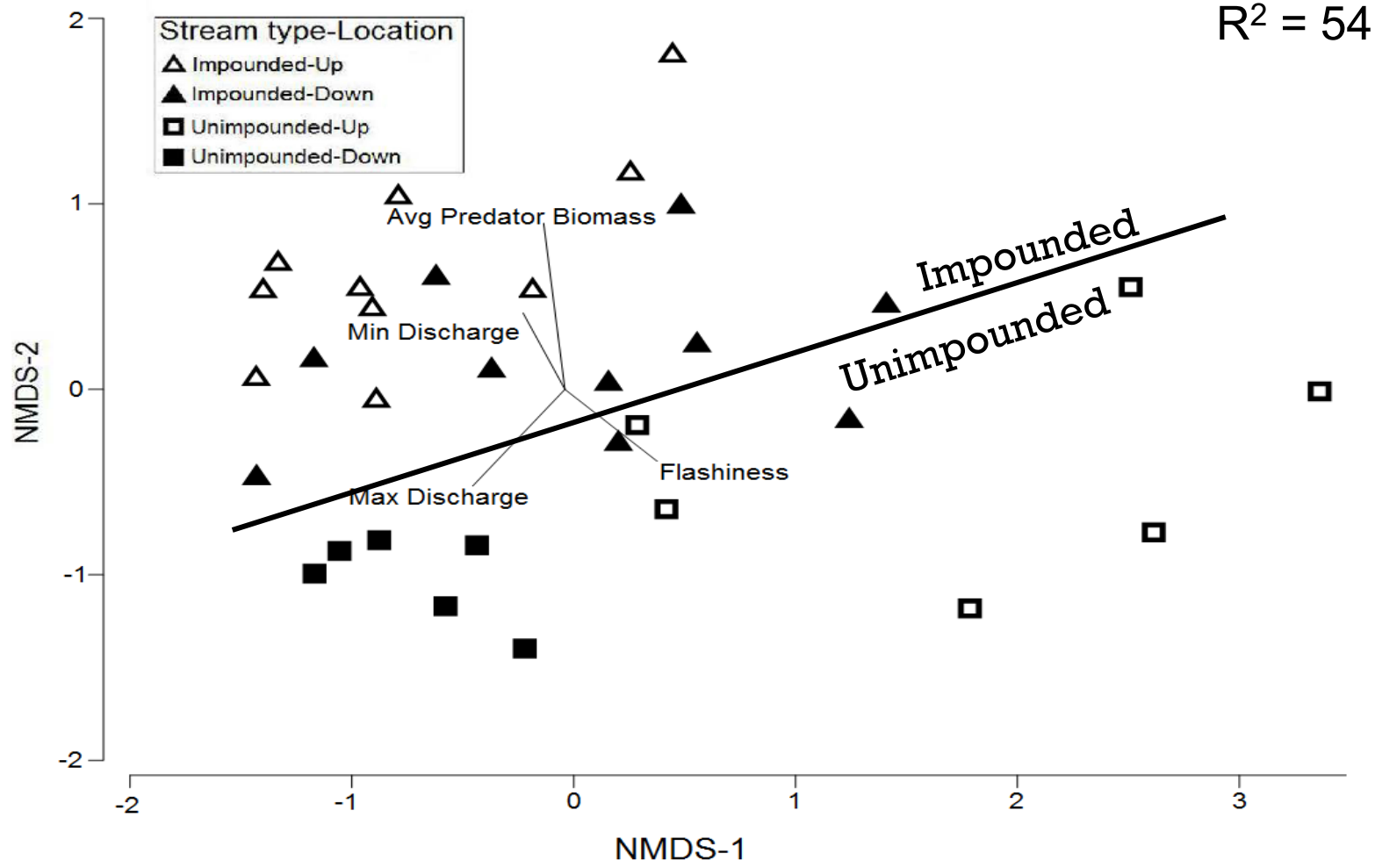


IMPOUNDED AND UNIMPOUNDED STREAM ASSEMBLAGES DIFFERED IN BEAR CREEK DRAINAGE

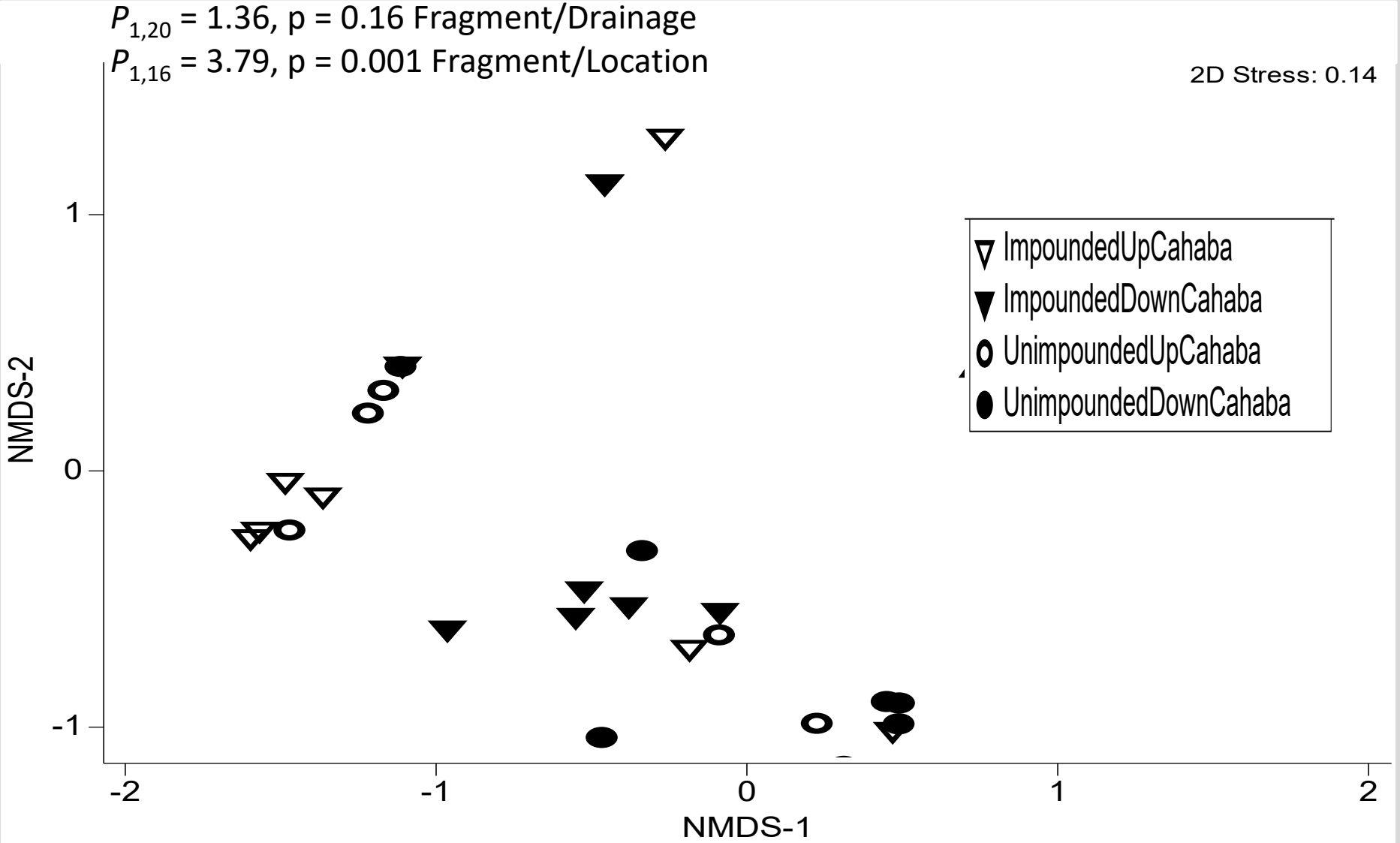


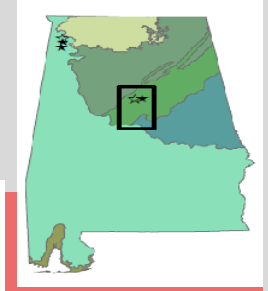
ENVIRONMENTAL VARIABLES EXPLAIN DIFFERENCES BETWEEN CRAYFISH ASSEMBLAGES

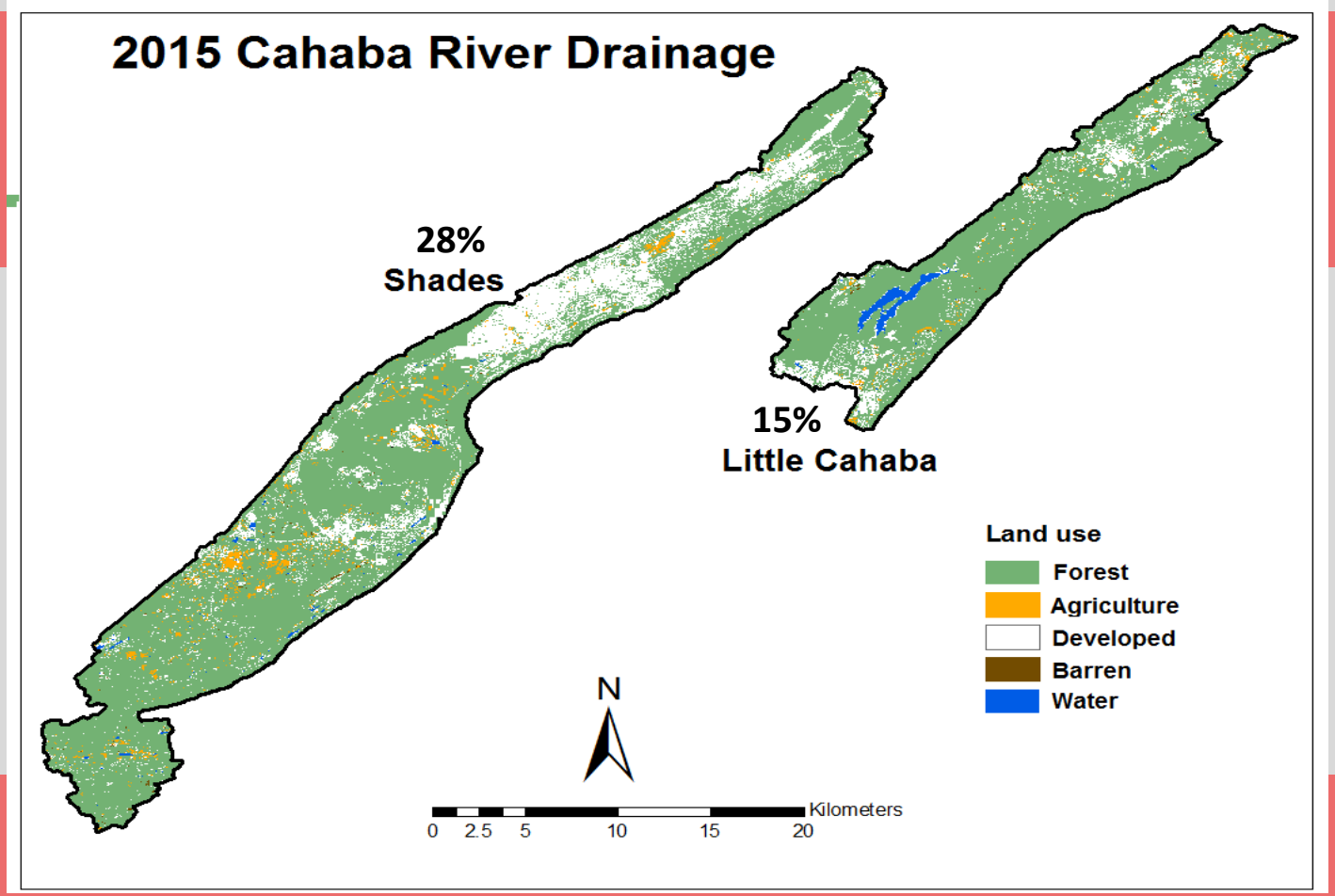
R^2 = 54%



No Differences Between Crayfish Assemblages in Cahaba River Drainage Streams

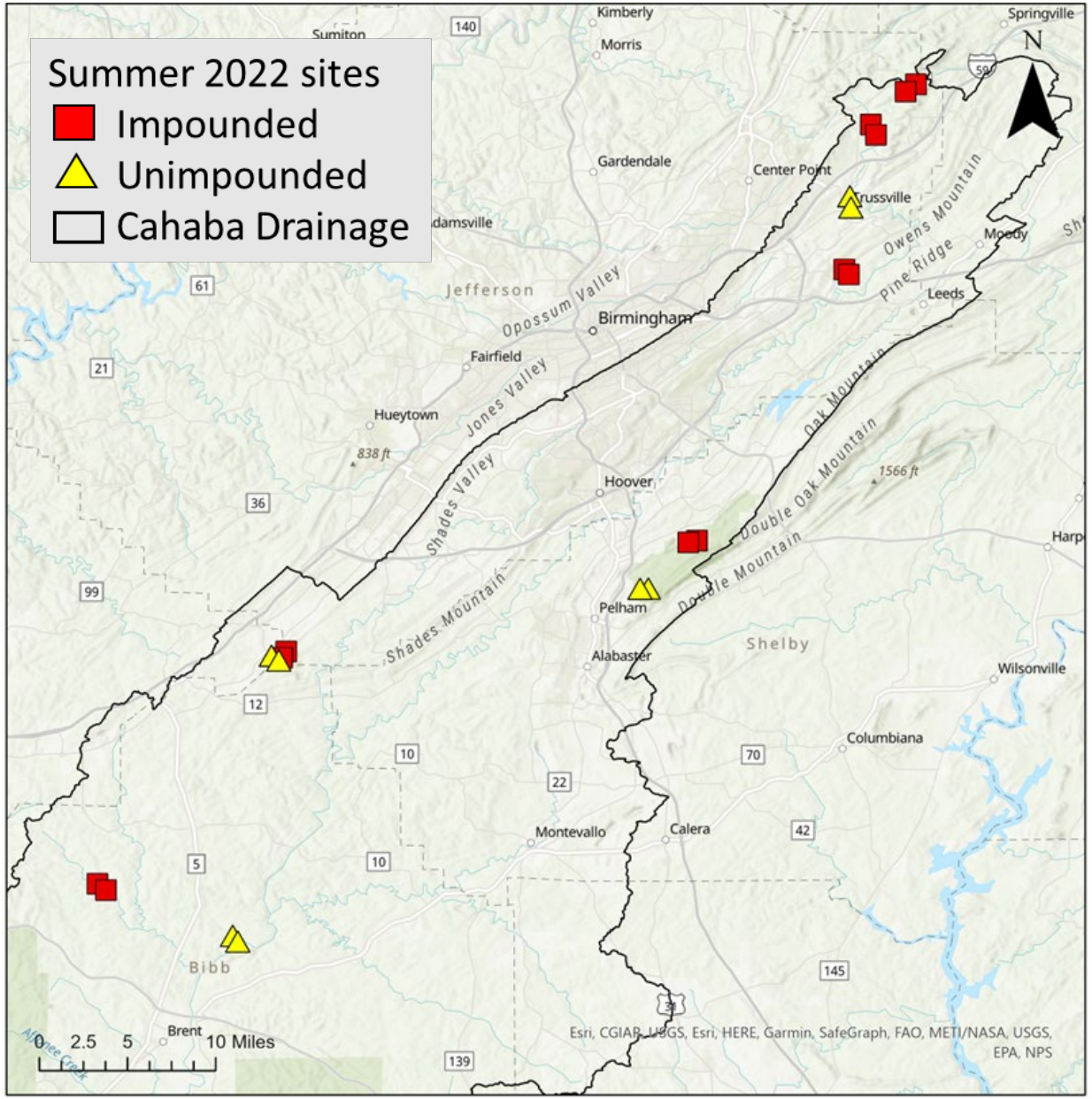






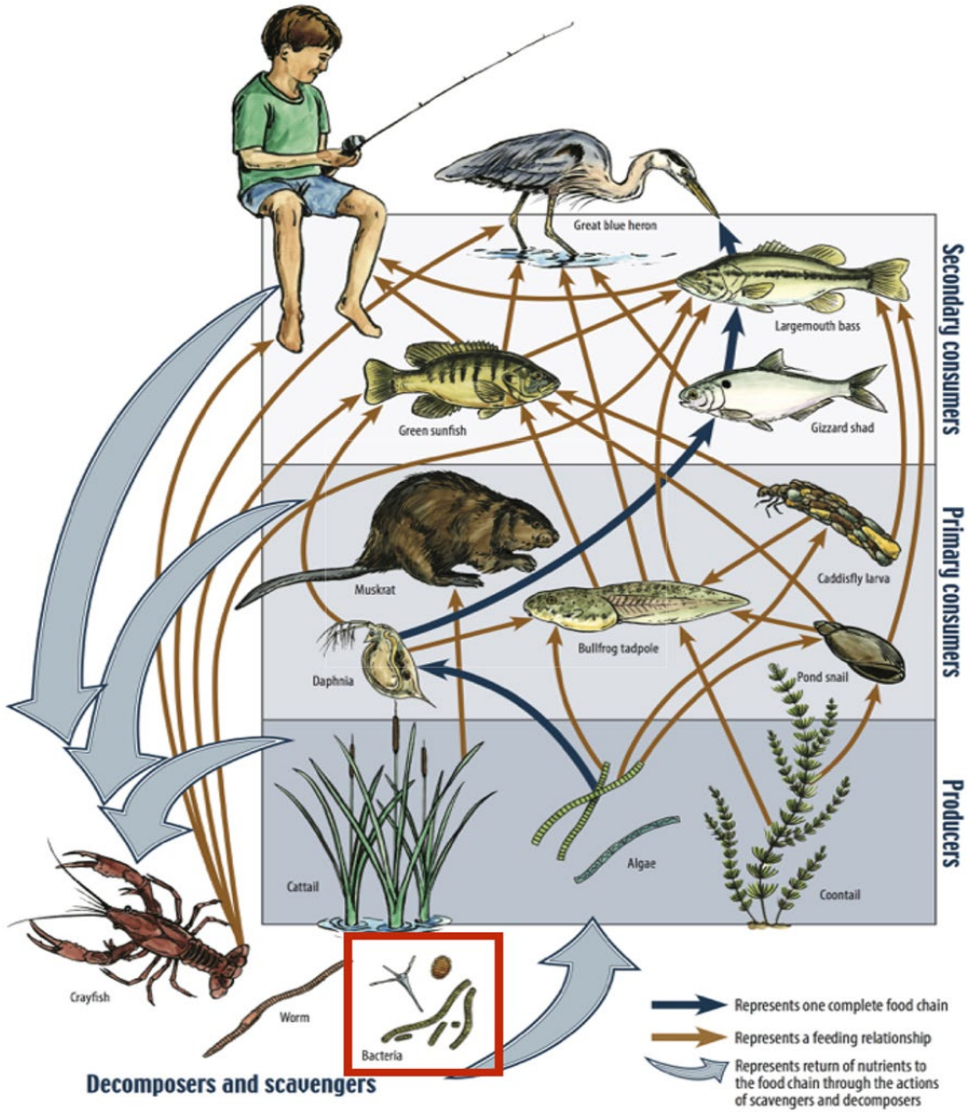
Developed lands: Cahaba River (22%)
Bear Creek (3%)

Effects of dams and *F. virilis* (invasive) on the trophic interactions of native crayfishes



TROPHIC ECOLOGY

- Species-specific natural histories
  - Functional role of organism
- Community-level interactions
  - Food Webs
  - Flow of energy and nutrients



Impoundments impact crayfish trophic positions

Preliminary Results

- Native crayfish trophic position differed between site types (*C. coosae*, $F_{3,27} = 4.7$, $p < 0.01$; *C. striatus*, $F_{3,47} = 5.1$, $p < 0.005$).
- Nonnative crayfish trophic position strongly differed between site types ($F_{3,38} = 83.18$, $p < 0.001$) (Fig. 1).

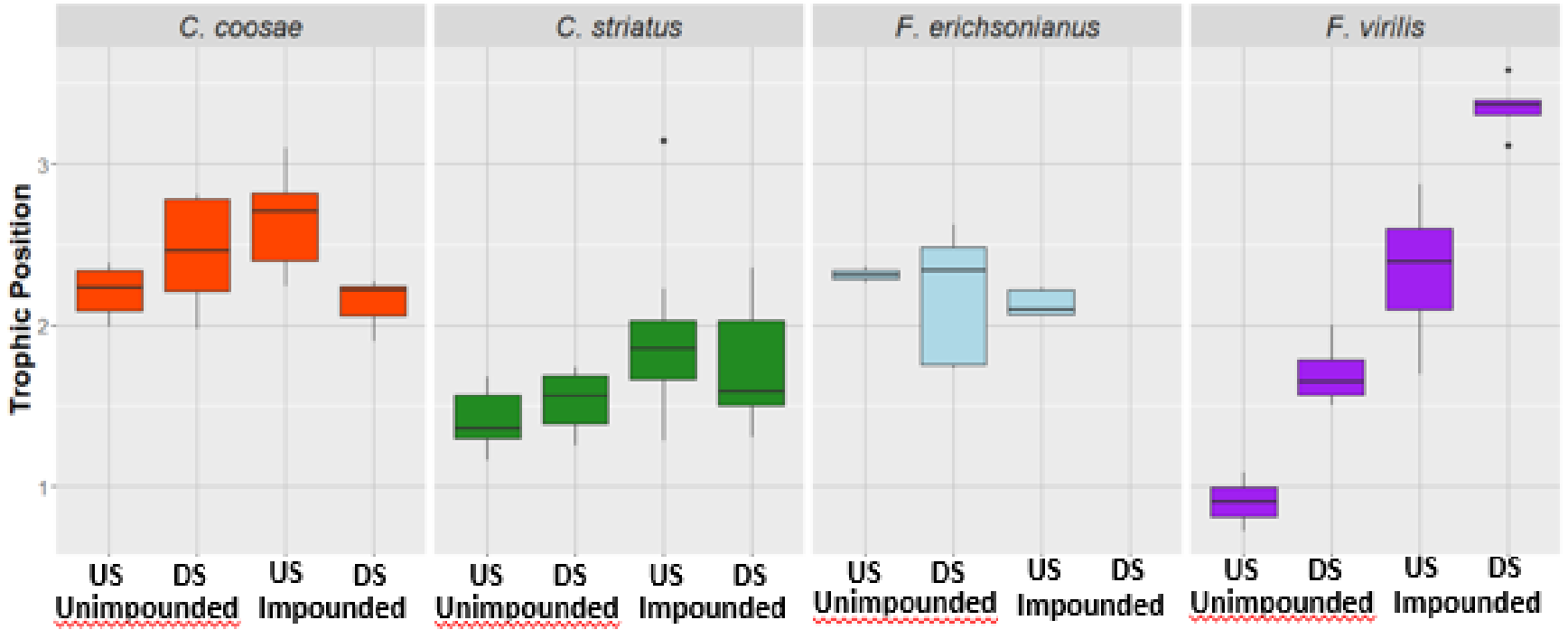


Figure 1. Boxplot showing trophic position of dominant crayfish species by site type (Upstream, US; Downstream, DS).

Invasive species trophic position shifts in the presence of natives

- Native mean trophic position is not influenced by presence of *F. virilis* (*C. coosae*, $F_{1,27} = 15$, $p = 0.7$; *C. striatus*, $F_{1,47} = 2.2$, $p = 0.15$)
- *F. virilis* trophic position is reduced when sympatric with natives ($F_{3,38} = 107.4$, $p < 0.001$)

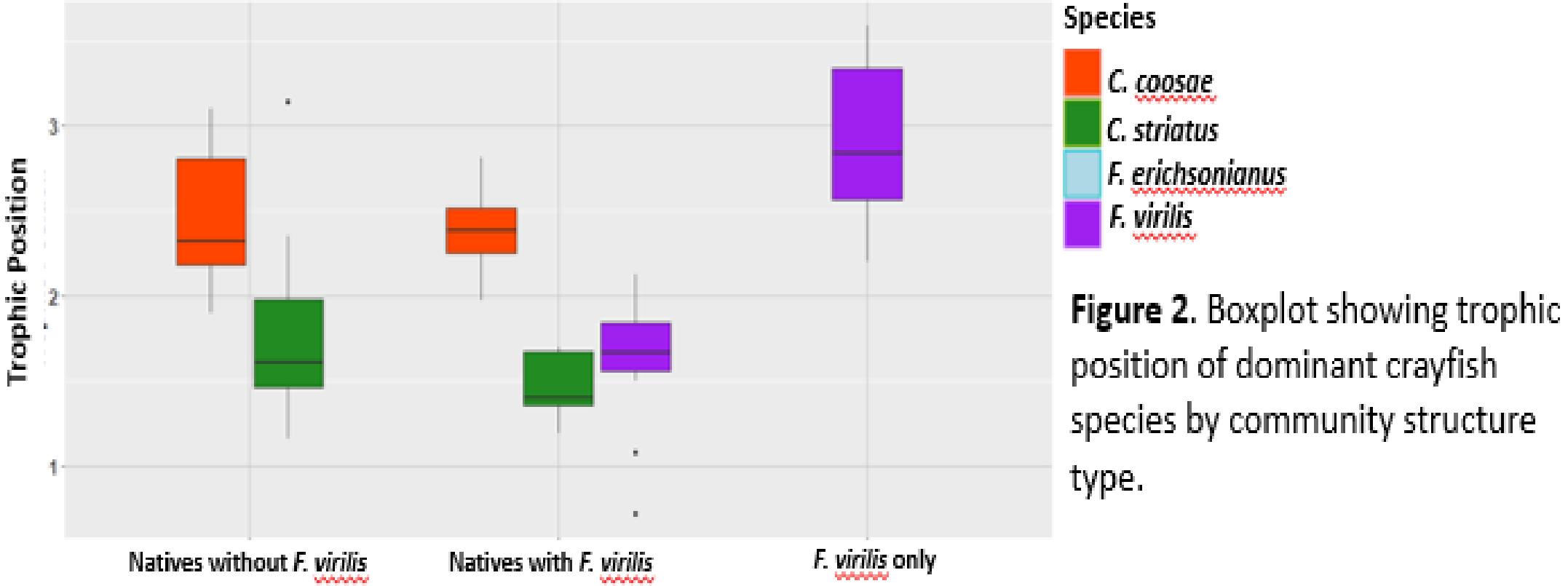


Figure 2. Boxplot showing trophic position of dominant crayfish species by community structure type.

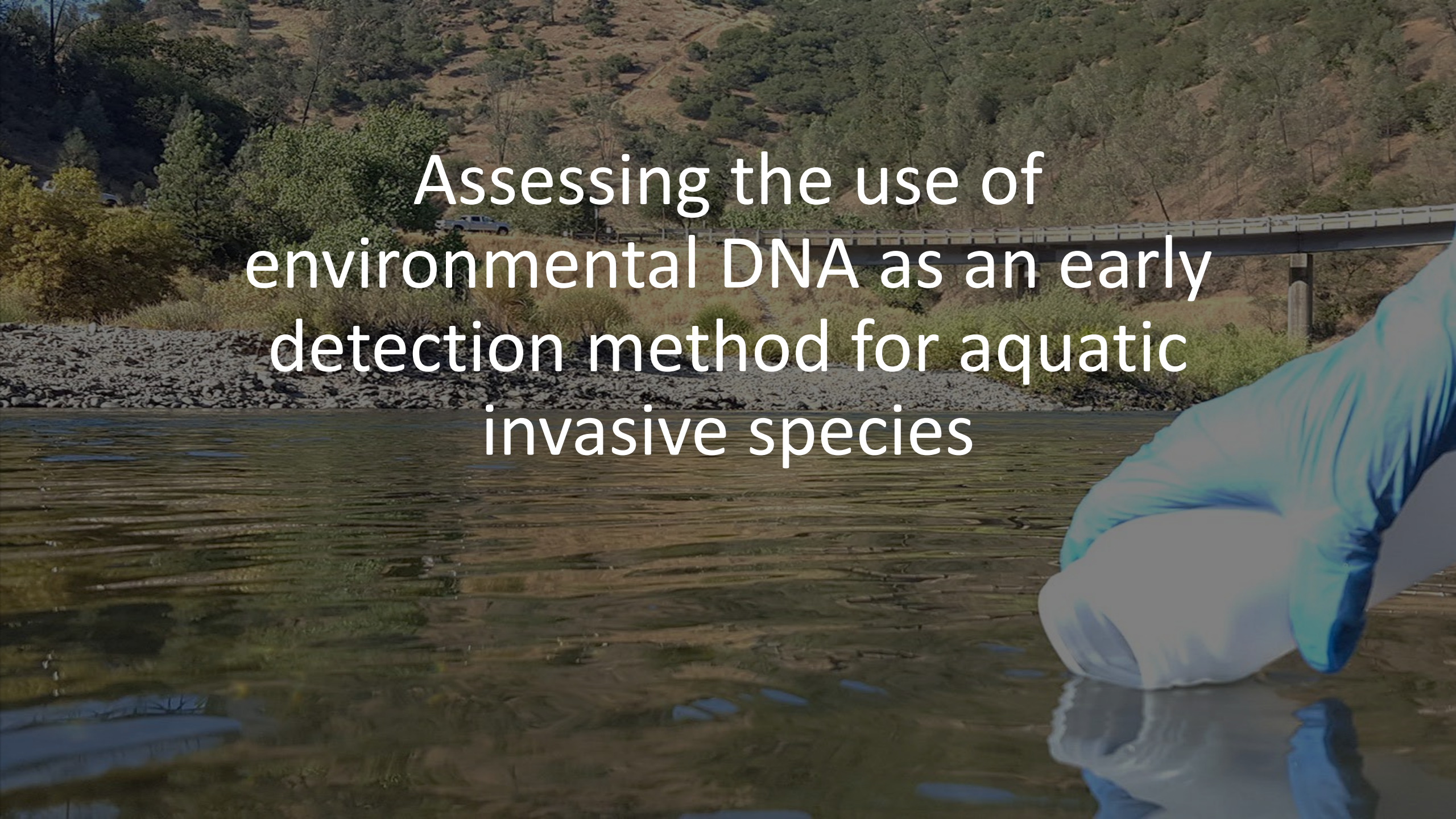
Impoundments and Invasive Species

1

Homogenizing crayfish assemblage

2

Causing shifts in trophic position



Assessing the use of environmental DNA as an early detection method for aquatic invasive species

Southeastern National Forests

- Important refugia for aquatic biodiversity with high species diversity and endemism
- NFs provide critical habitats for threatened and endangered aquatic species
- NFs provide numerous recreational opportunities
  - Highest-risk locations for potential invasion are the places most frequented by fishers, boaters, and campers

Currently No Aquatic Invasive Species Monitoring Protocol

Goals

1. Evaluate effectiveness of eDNA to detect AIS in wadeable streams
2. Assess detection probabilities for multiple AIS
    - Fish
    - Crayfish
    - Mollusk
3. Develop multi-species/multi-gear occupancy models to guide future sampling
4. Identify and characterize high priority areas for AIS introductions
5. Develop an early surveillance protocol for the southeastern region

Study Plan

- 2024
  - Pilot Study
    - Francis Marion National Forest—South Carolina
- 2025
  - Develop protocol
  - Create species distribution and occupancy models
- 2026
  - Test protocol on additional NFs
    - Bankhead NF--Alabama
    - George Washington/Jefferson NF---Virginia
    - Ocala NF--Florida
- 2027
  - Revise Protocols

Other lands around these NFs will be included.

If there are areas of interests near these forests that can be sampled please let me know.

Aquatic Invasive Species Early Detection Monitoring Protocols

- For who?
  - Managers Throughout the Southeastern Region
    - Forest Service
    - Other Federal and State Agencies
    - Private Landowners

- Data dissemination
  - Workshops
  - Webinars
  - Presentations
  - Publications

KEY POINTS

- Crayfish play important roles within our aquatic systems
- Impoundments impact crayfish assemblage and trophic positions
  - Degree of impact dependent on
    - Other anthropogenic impacts
    - Presence of invasive species
    - Species dispersal tendency and habitat preferences
- Invasive species have wide trophic niches and can shift their food sources based on presence of other species
- AIS early detection monitoring protocols are needed within the southeastern US

ACKNOWLEDGMENTS

- Forest Service team
  - Susan Adams
  - Mickey Bland
  - Gordon McWhirter
  - Carl Smith
- SC National Forest
- University partners
  - University of Mississippi
  - West Liberty University
  - Troy University
- Numerous others

QUESTIONS