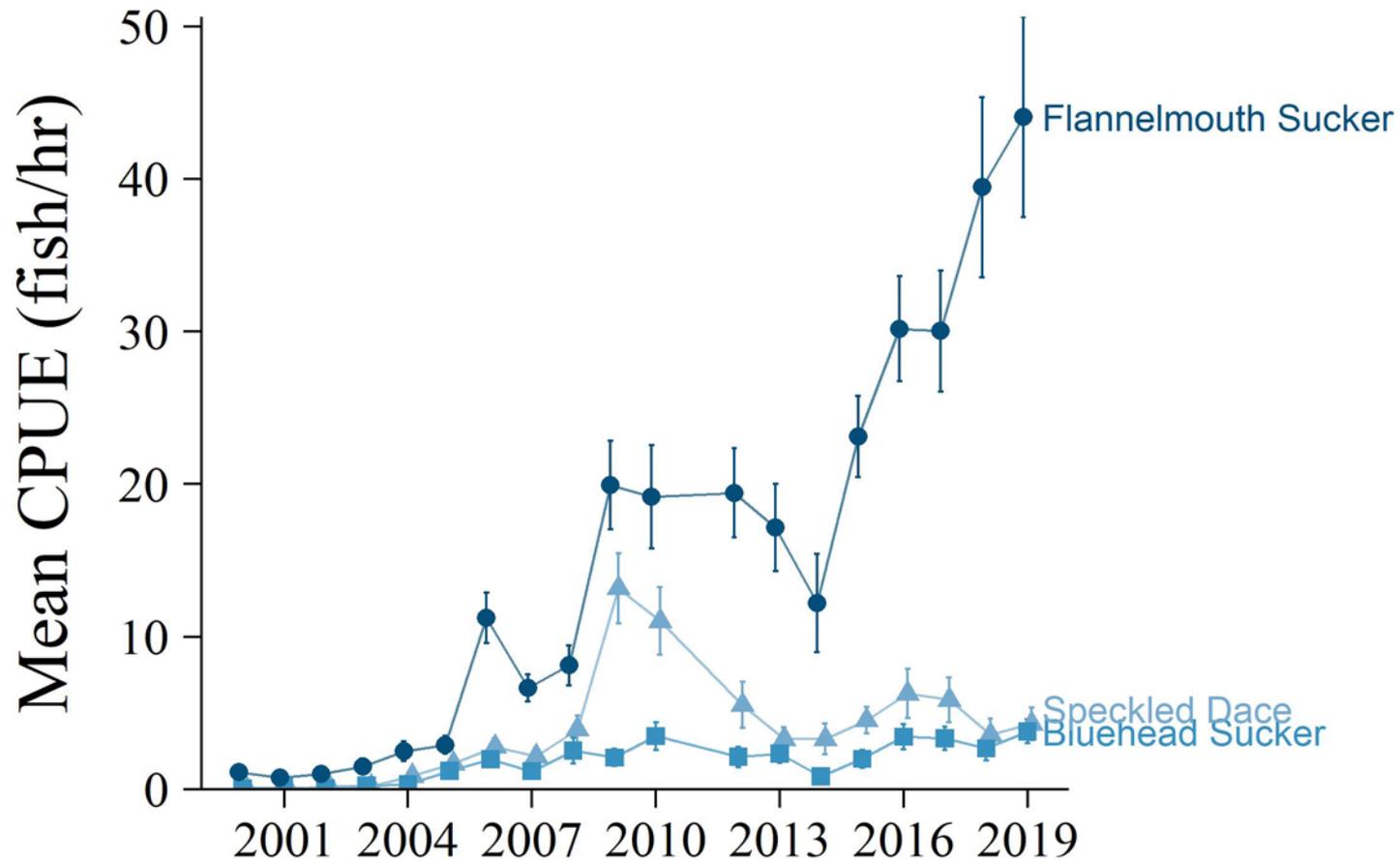




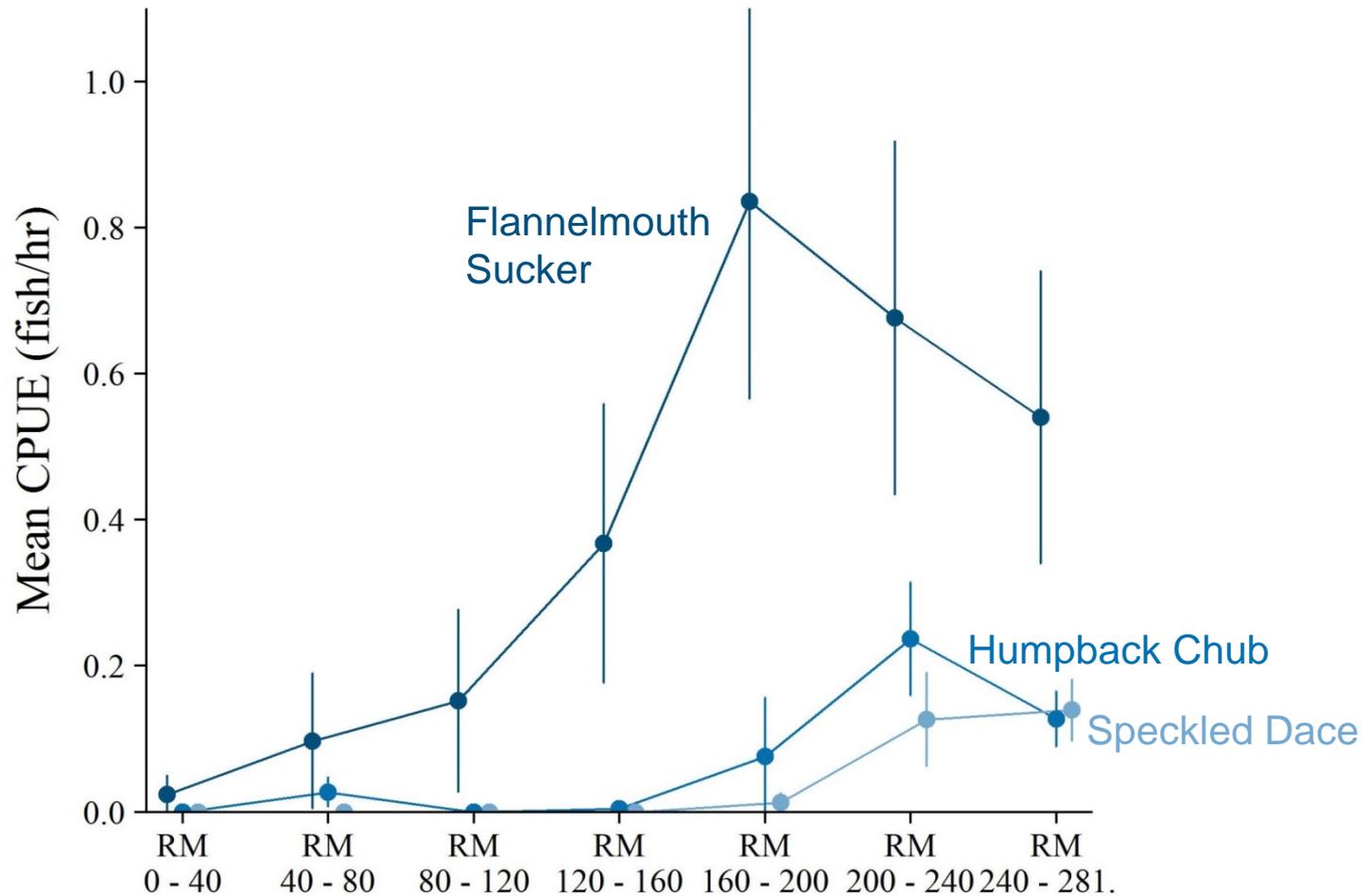
Falling Water, rising temperatures,  
growing fish?

Jan Boyer | 2020 CRAB Meeting

# Native fish abundance: increasing over time



# Native fish: more abundant in downstream reaches



# Why?



# Hypothesis

Warmer water



Increased growth, recruitment



Increased native fish abundance

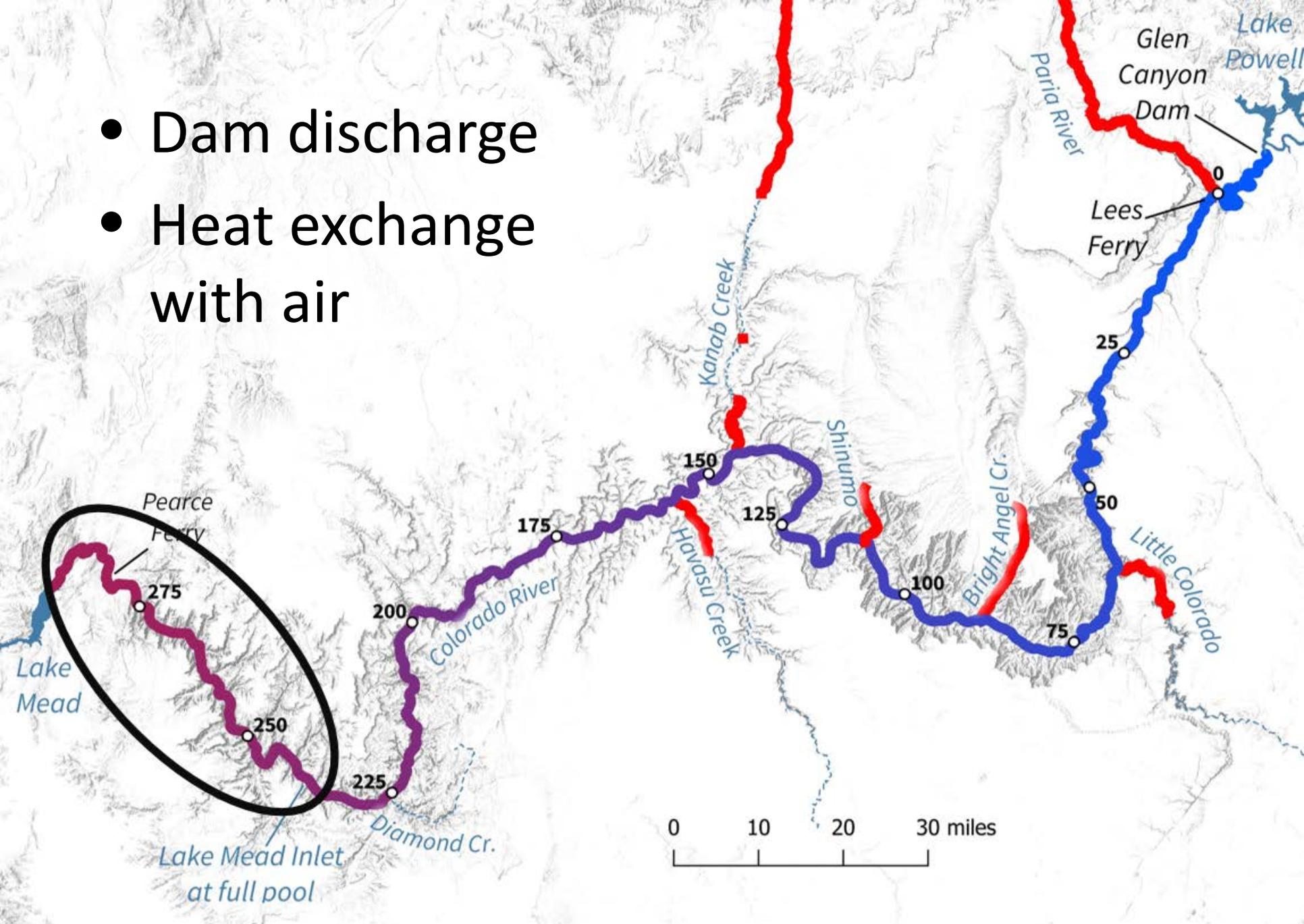


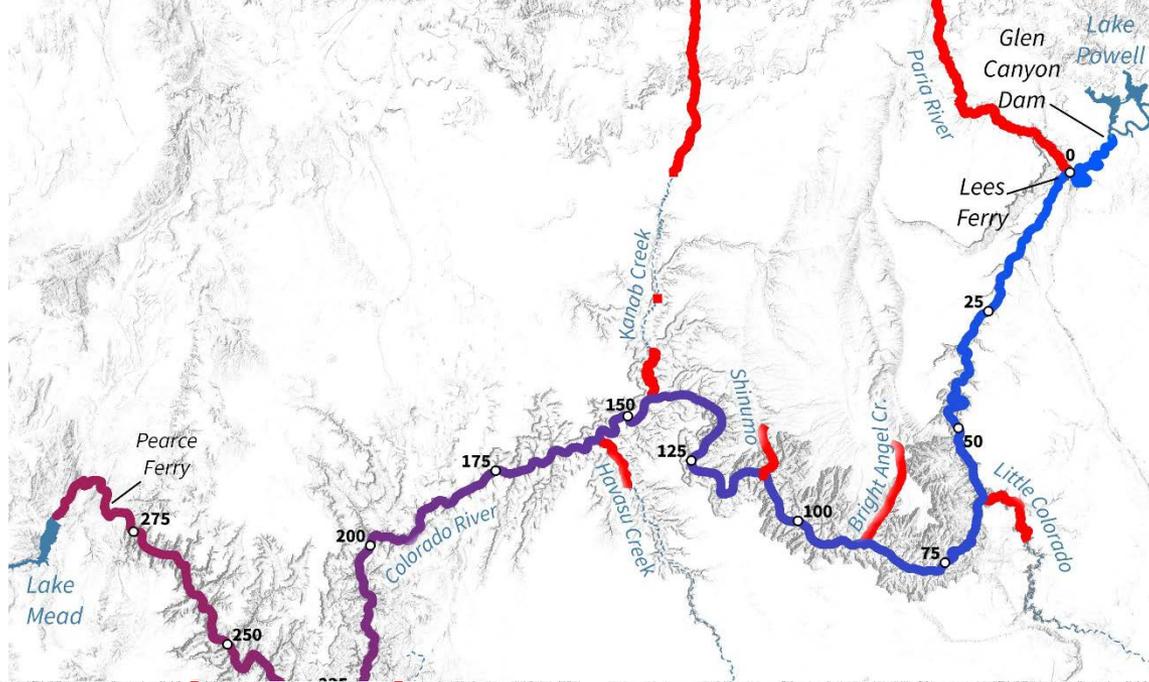


Colorado River  
Cold, slow growth

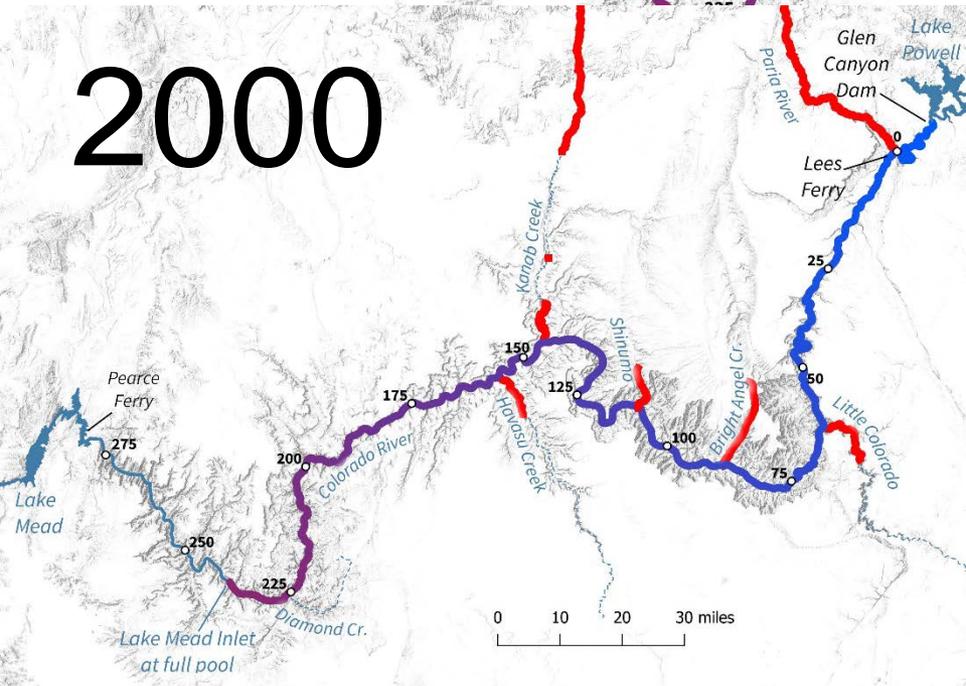
Little Colorado River  
Warm, fast growth

- Dam discharge
- Heat exchange with air

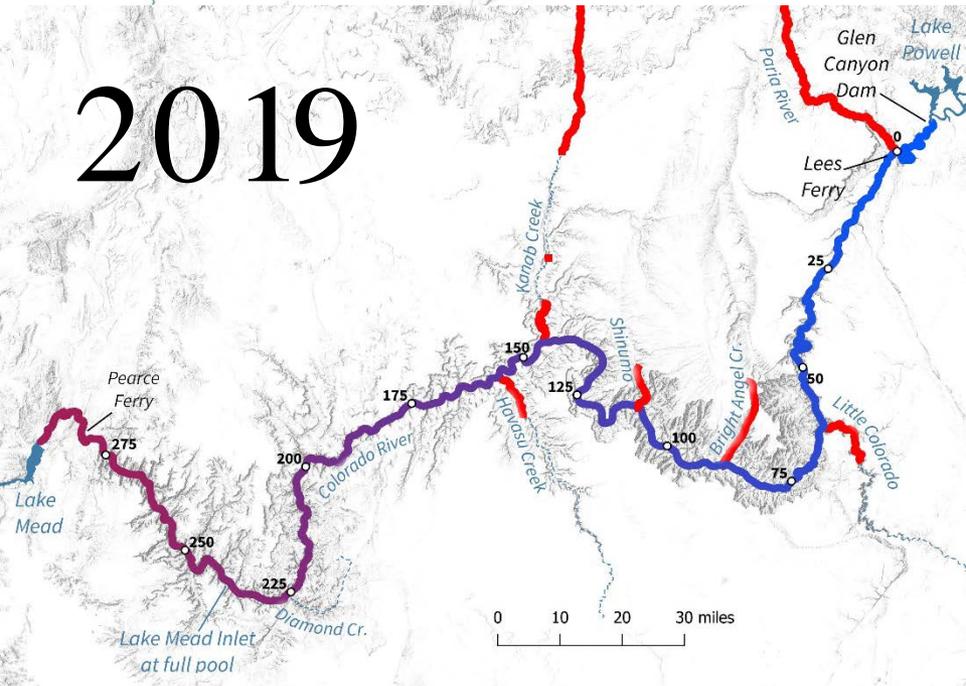




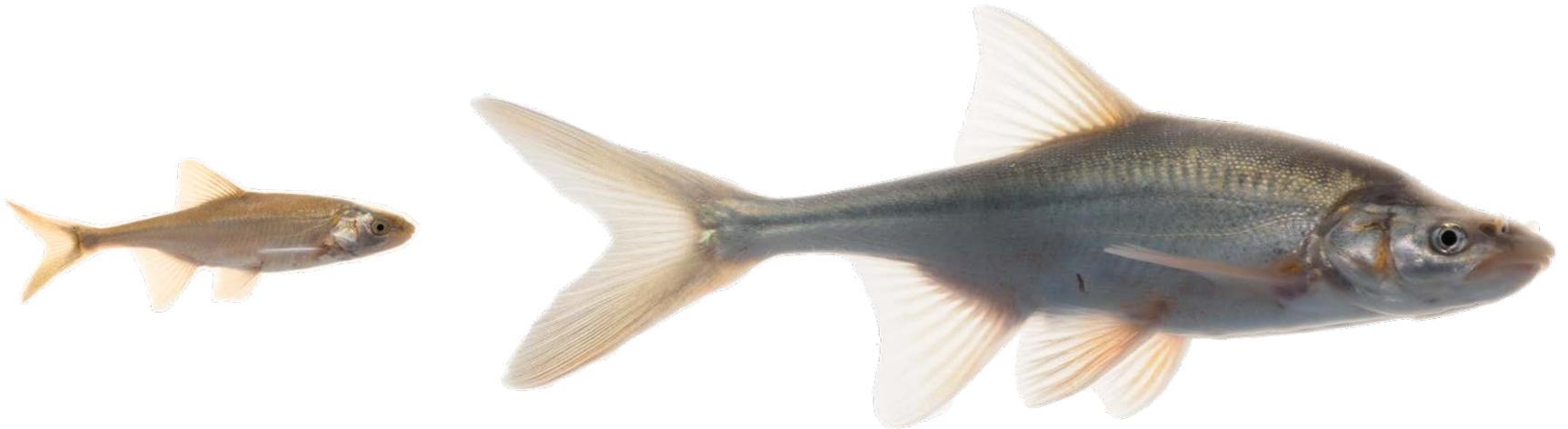
2000



2019



Western Canyon: warm enough  
to improve growth, recruitment?



# Hypothesis

Warmer water



Increased growth, recruitment



Increased native fish abundance



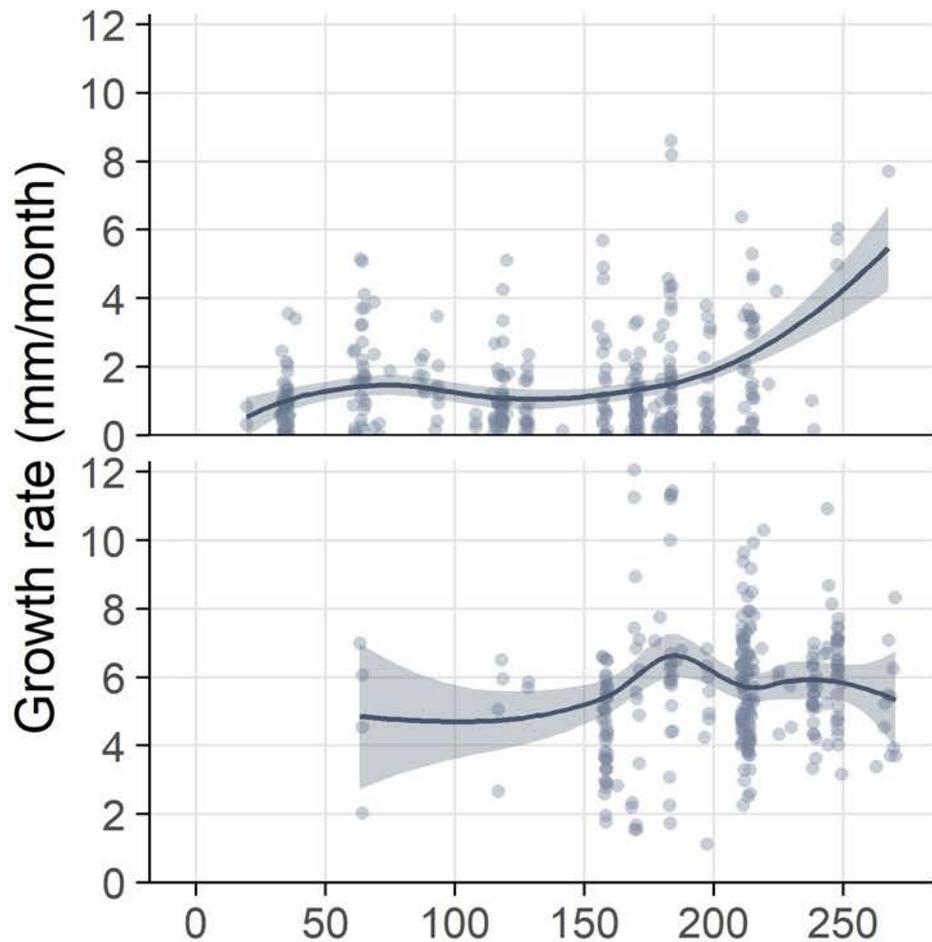
# Methods

- Growth rates (PIT tag recaptures)
- CPUE: juvenile and adult

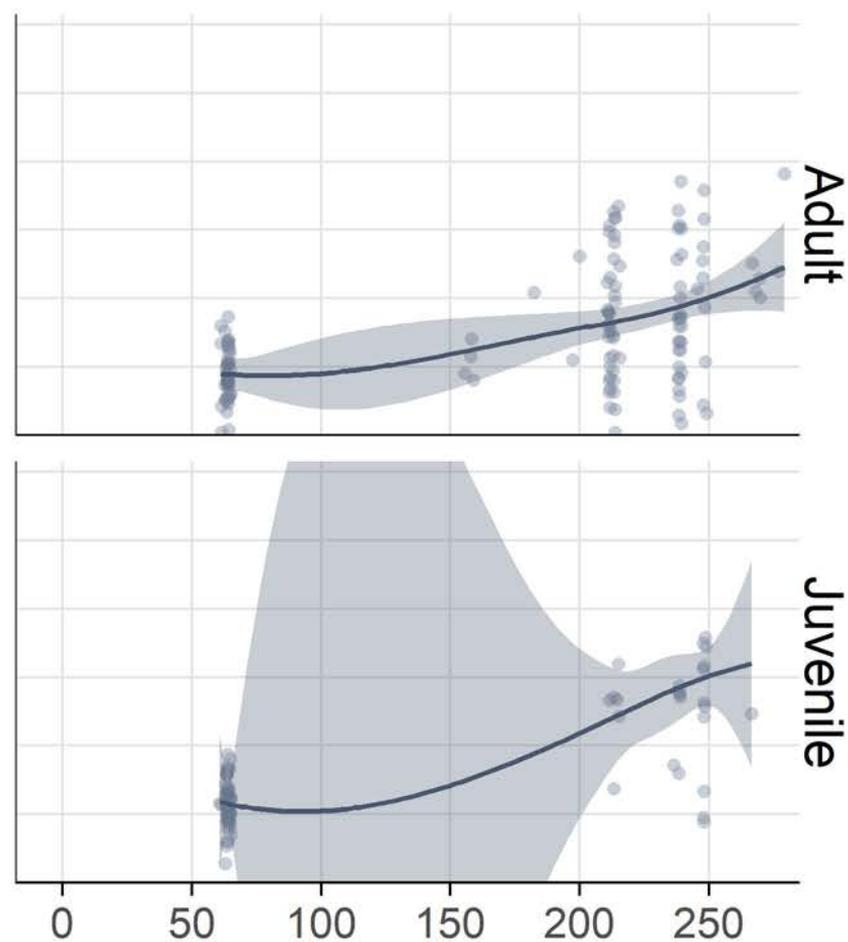
By river mile, matched with:

- Temperature records
- Literature on temperature

# Flannelmouth Sucker

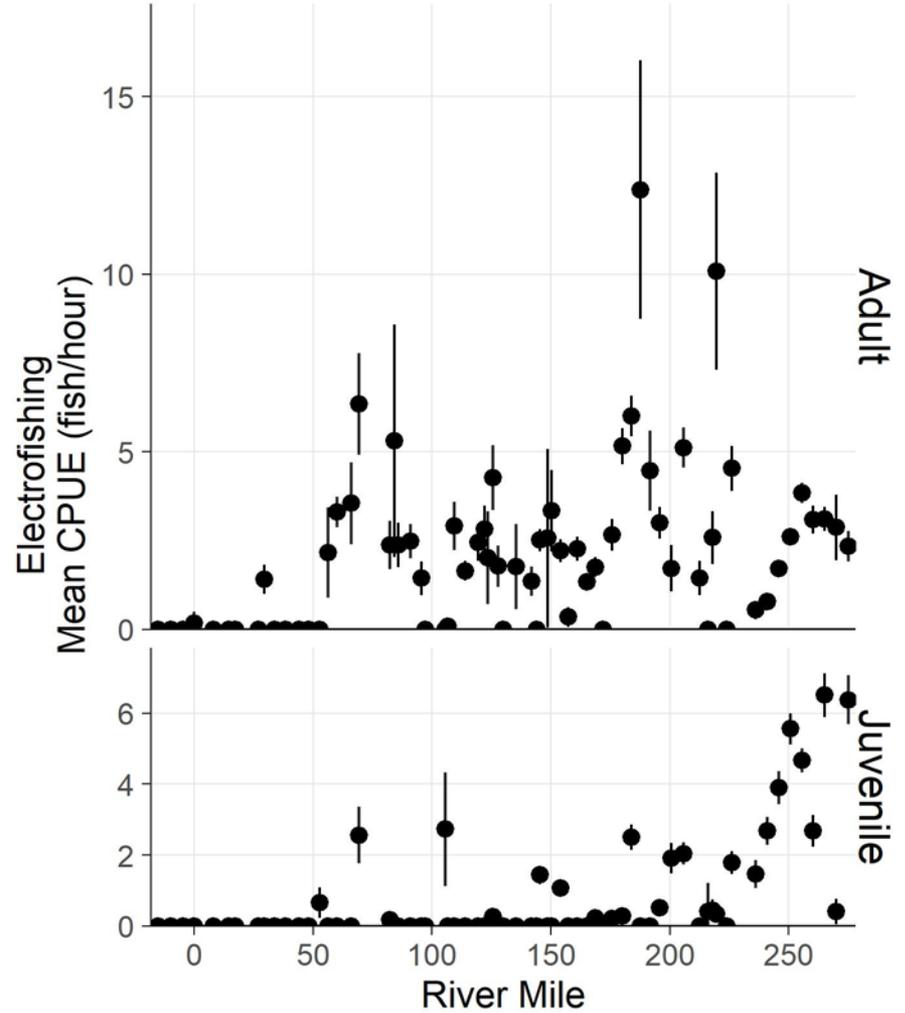
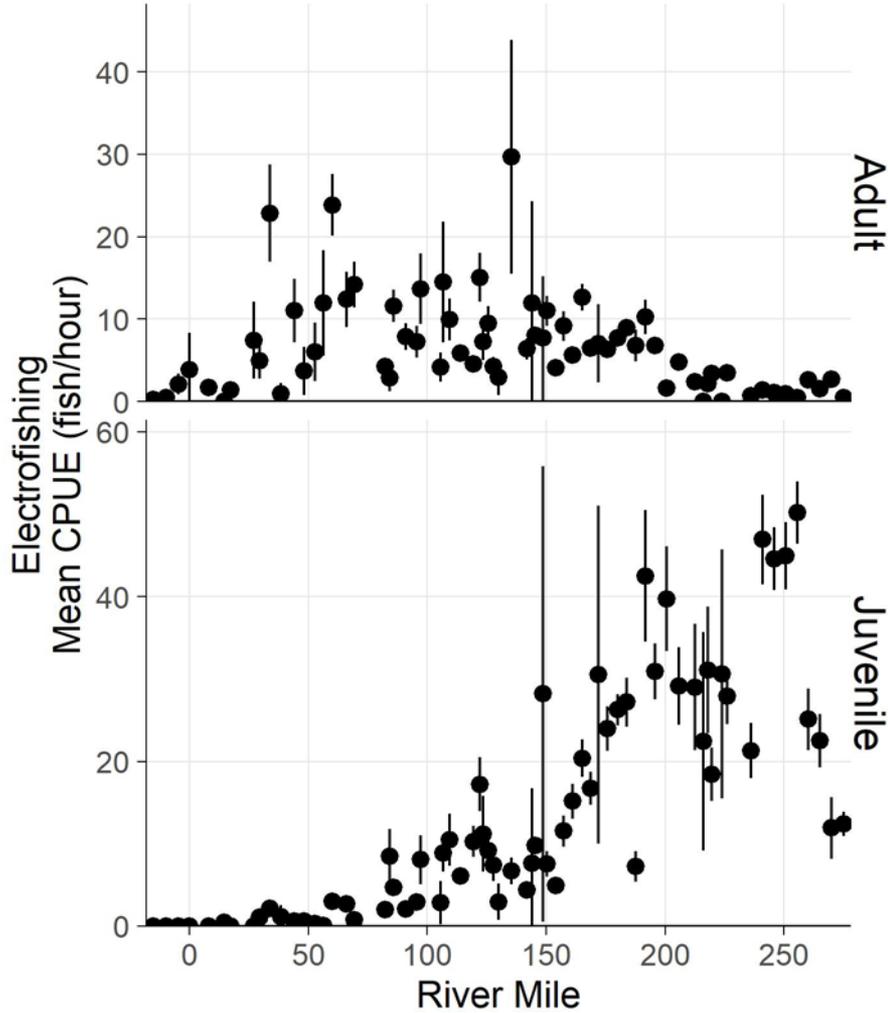


# Humpback Chub



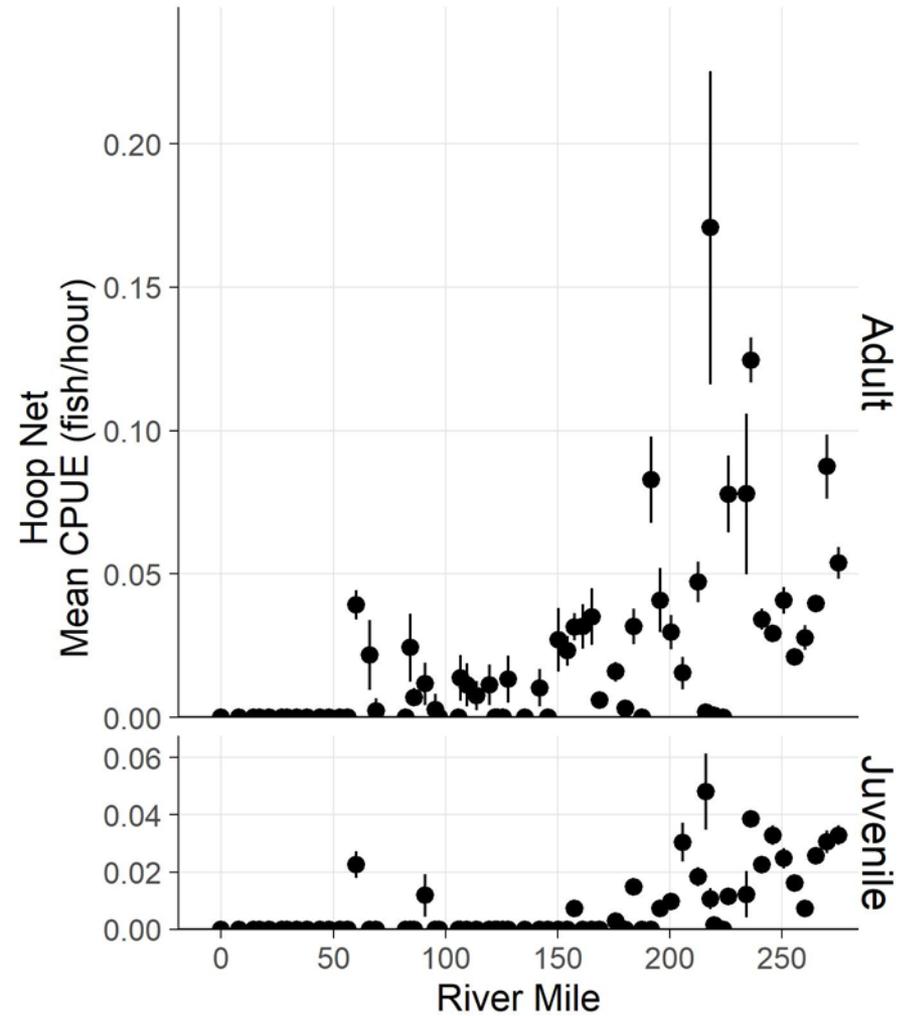
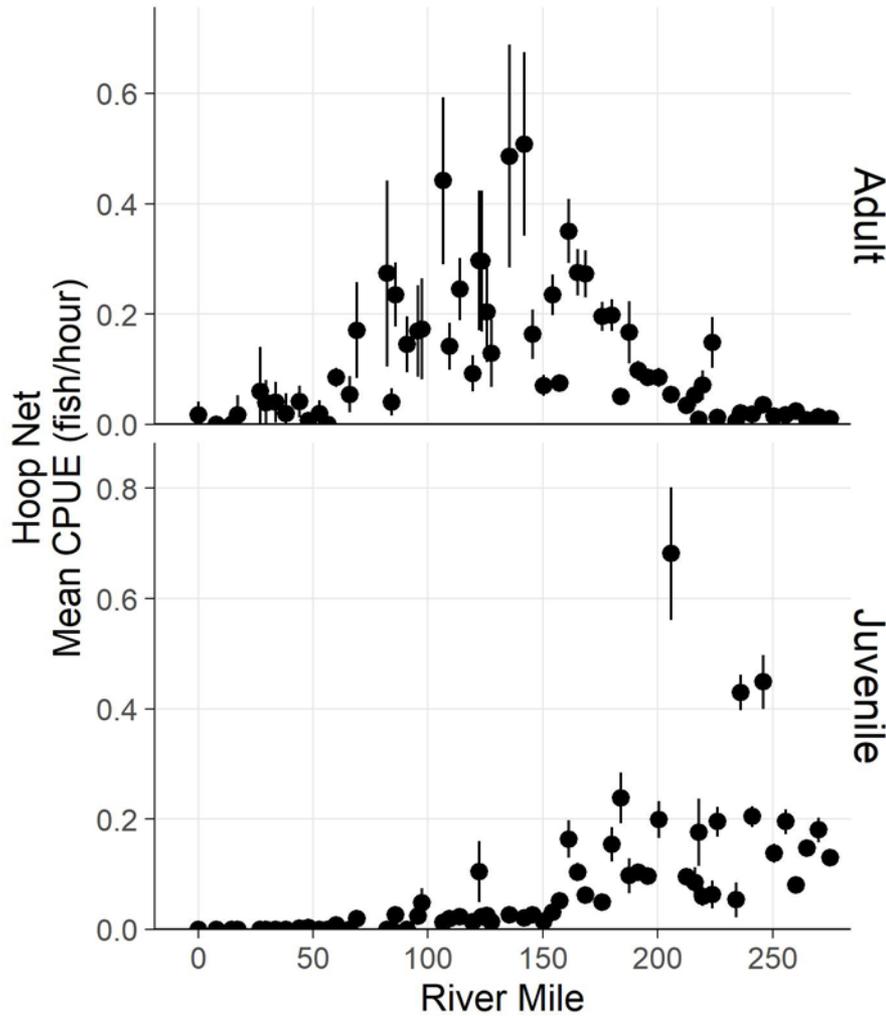
# Flannelmouth Sucker

# Bluehead Sucker

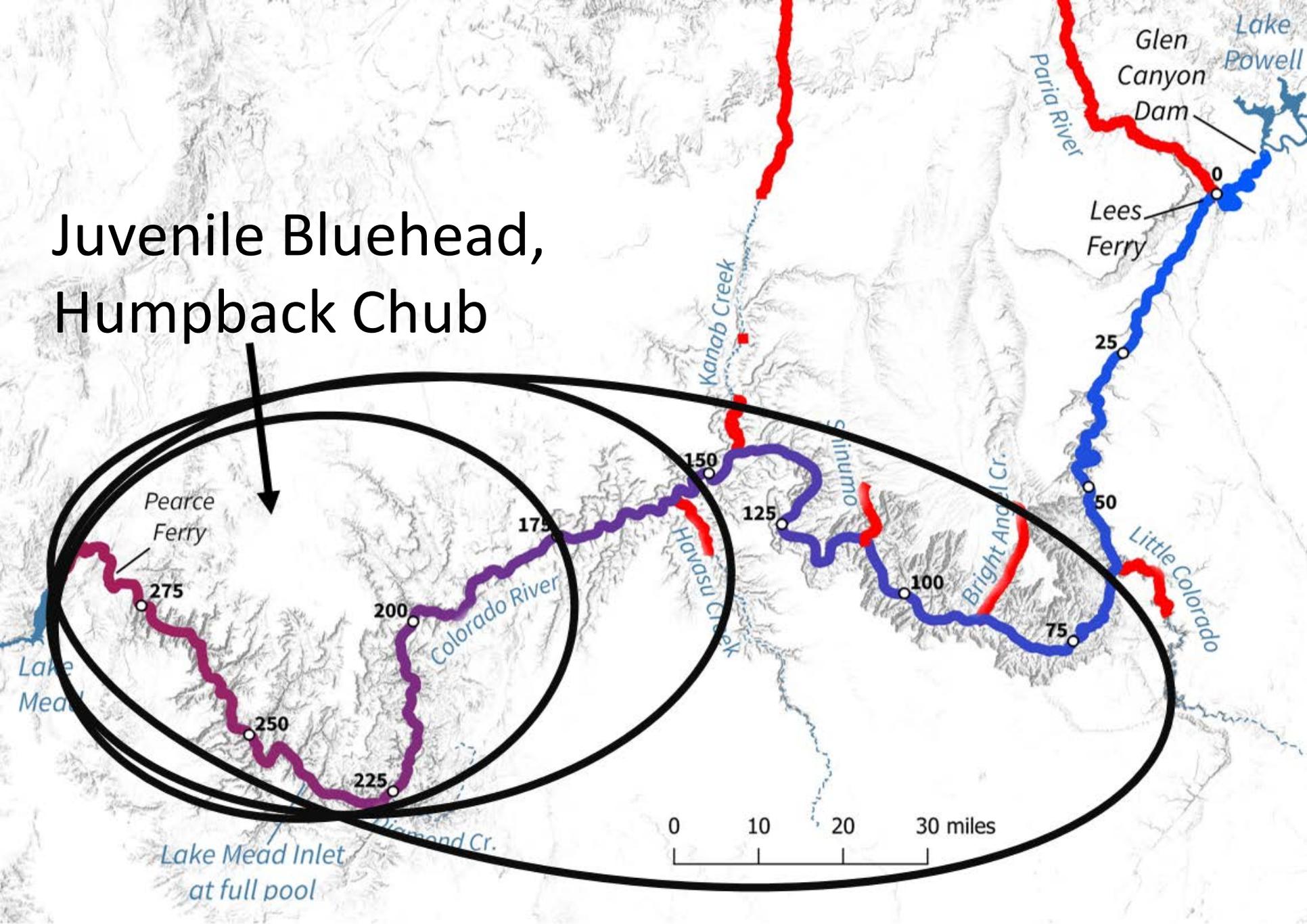


# Flannelmouth Sucker

# Humpback Chub



# Juvenile Bluehead, Humpback Chub



# Temperature literature

- Field Comparisons

- Temperature Colorado (8-12<sup>o</sup>C) vs. Little Colorado (5-26<sup>o</sup>C)
- Fish growth, size class transition rates as much as 3x higher in Little Colorado

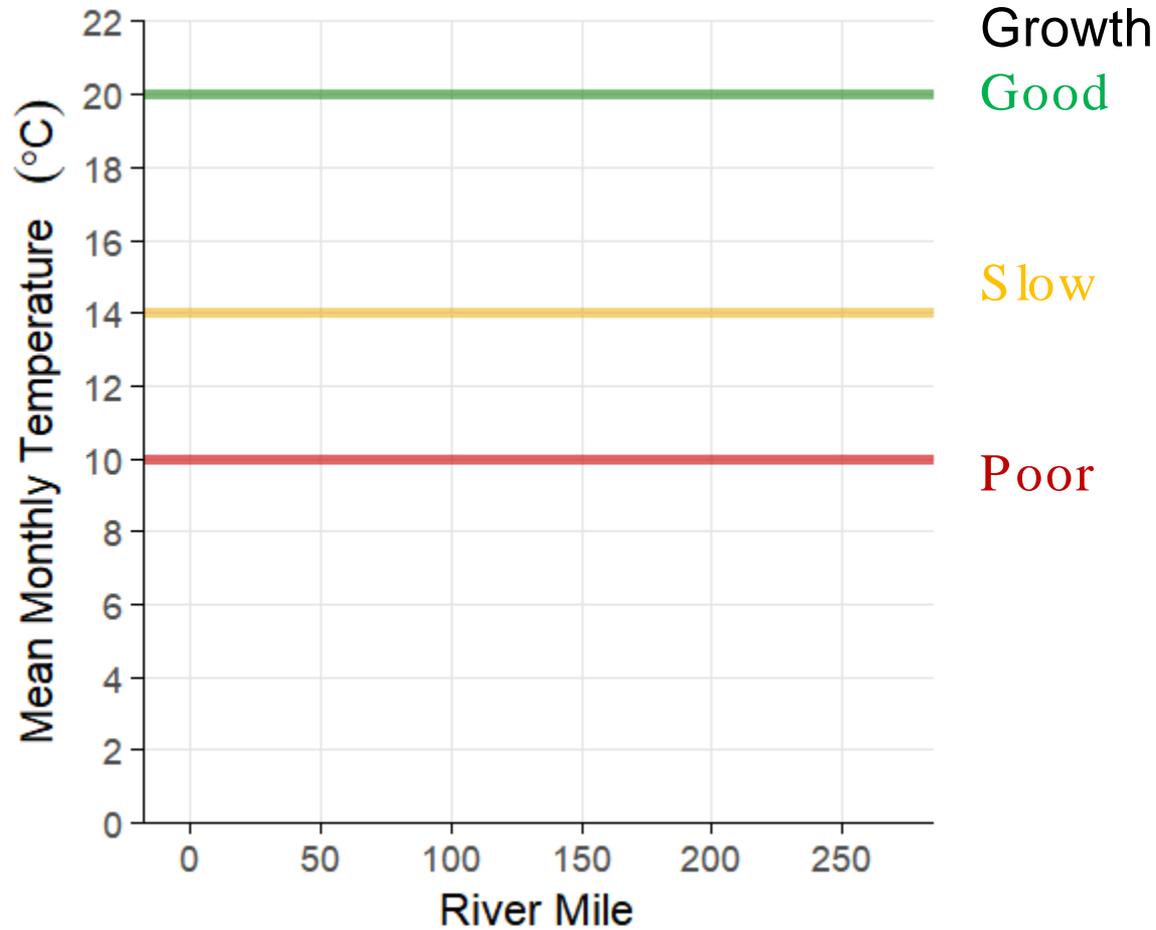
Peterson and Paukert 2005, Yackulic et al. 2014, Dzul et al. 2016

- Laboratory comparisons

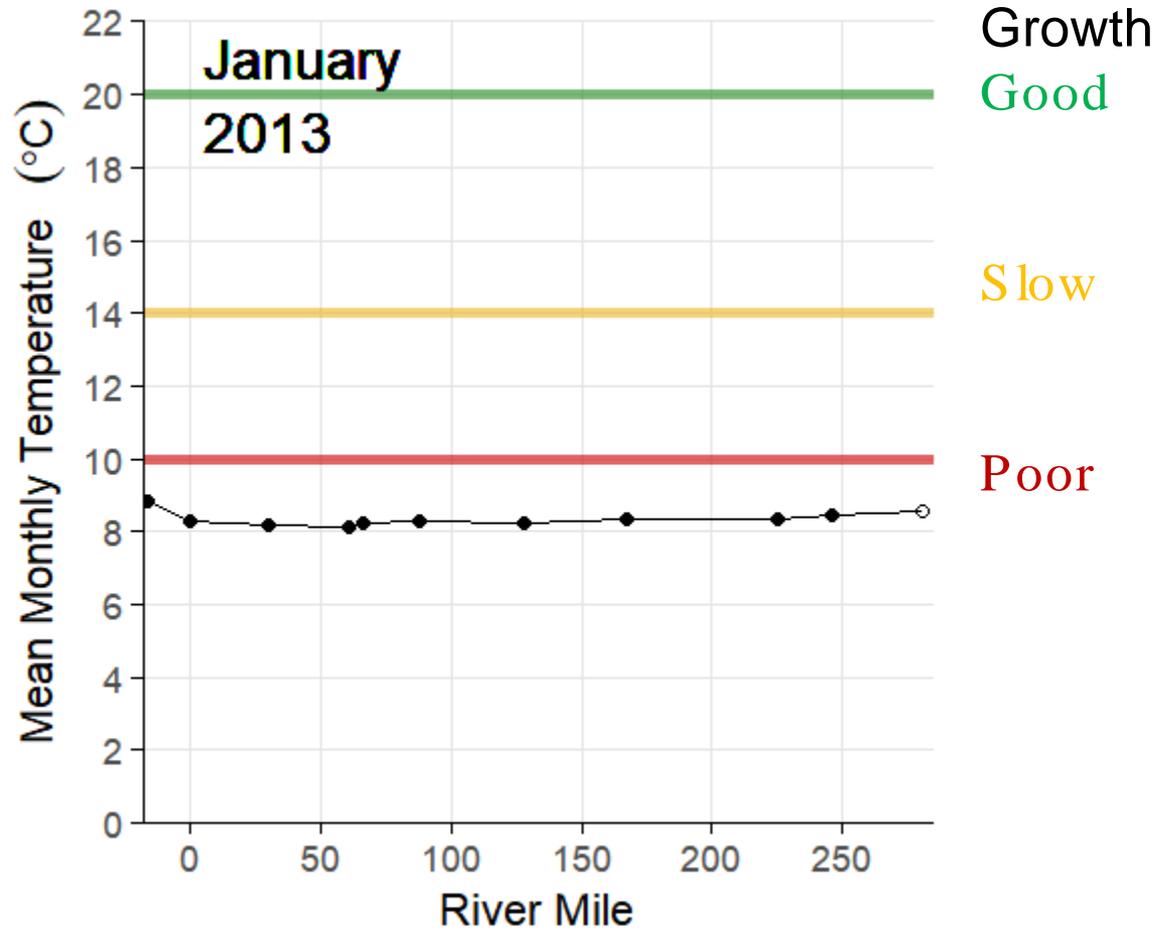
- Temperatures of 10<sup>o</sup>C, 14 <sup>o</sup>C, 20 <sup>o</sup>C
- Fish Swimming ability, growth, increase

Clarkson and Childs 2000, Ward et al 2002

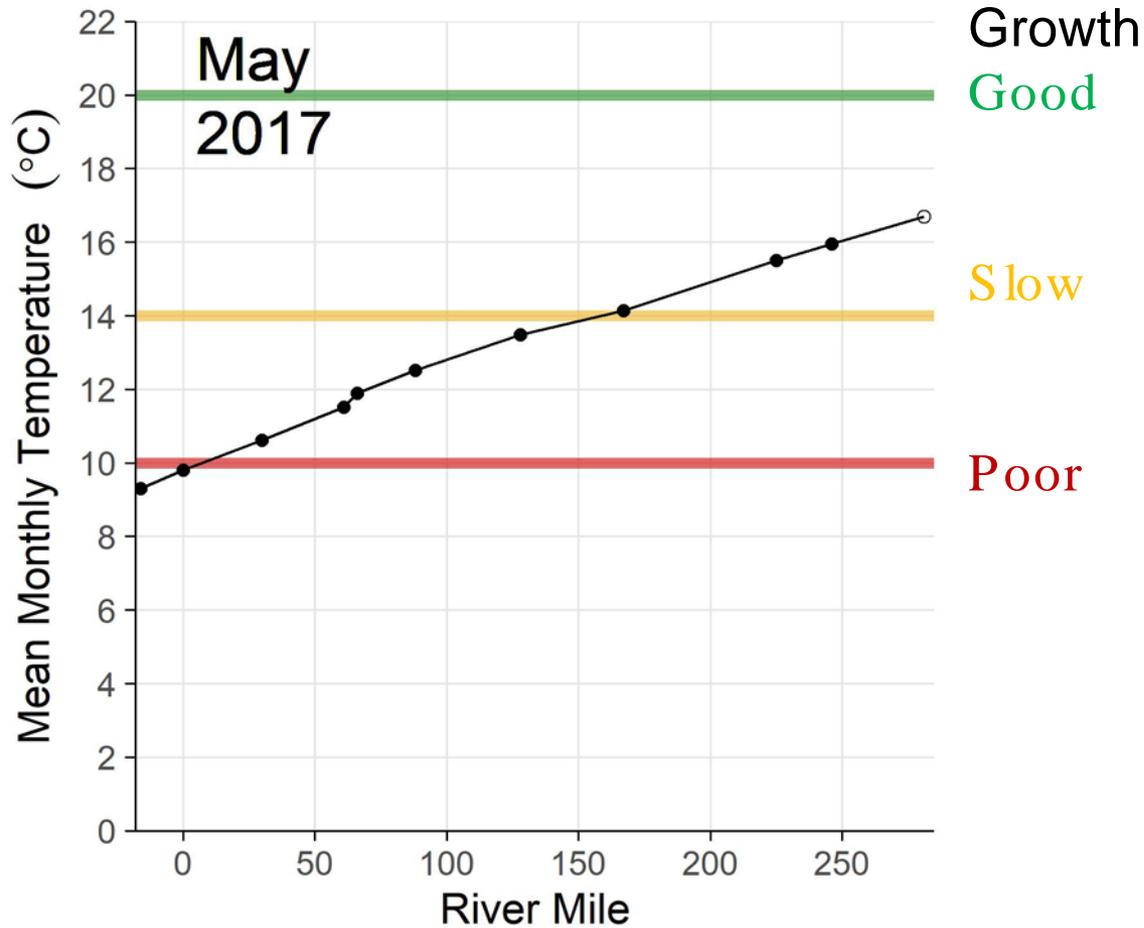
# Colorado Water Temperature



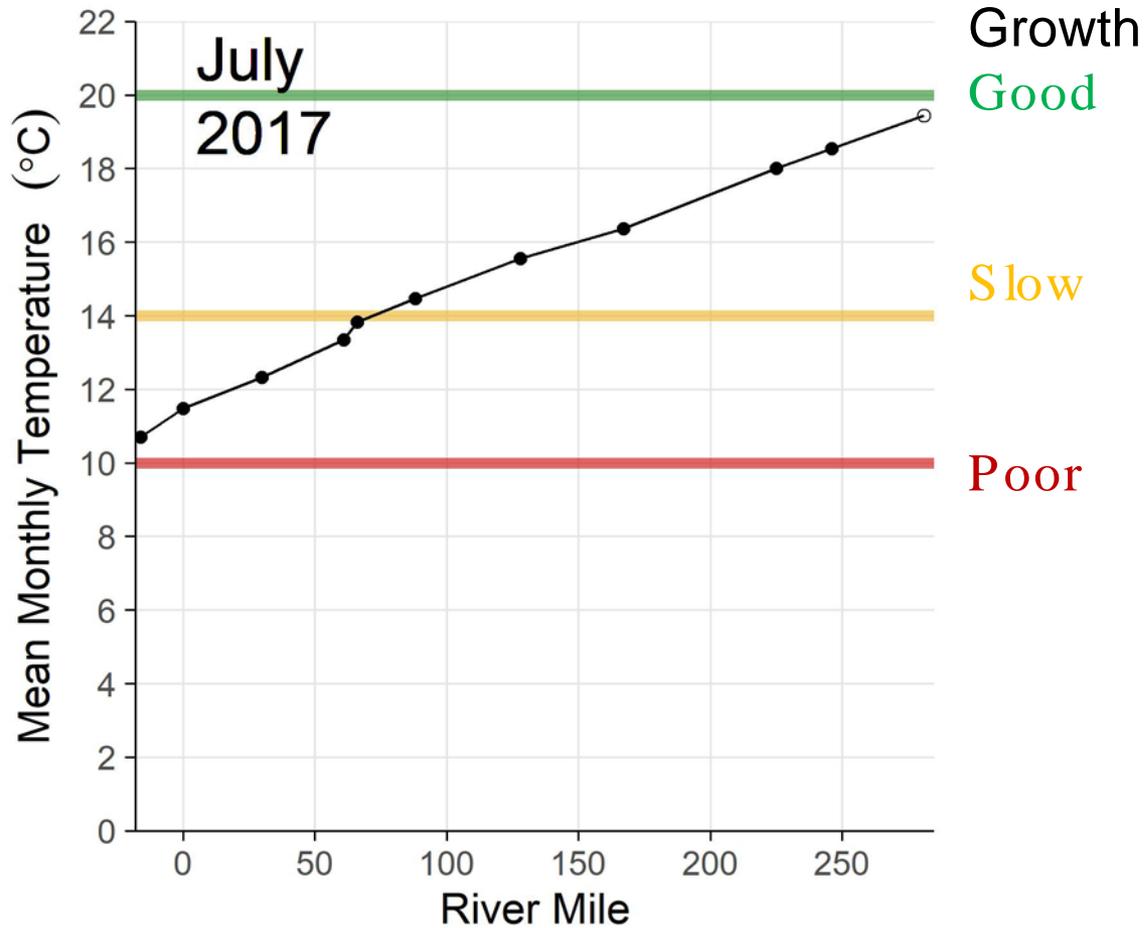
# Colorado Water Temperature



# Colorado Water Temperature



# Colorado Water Temperature





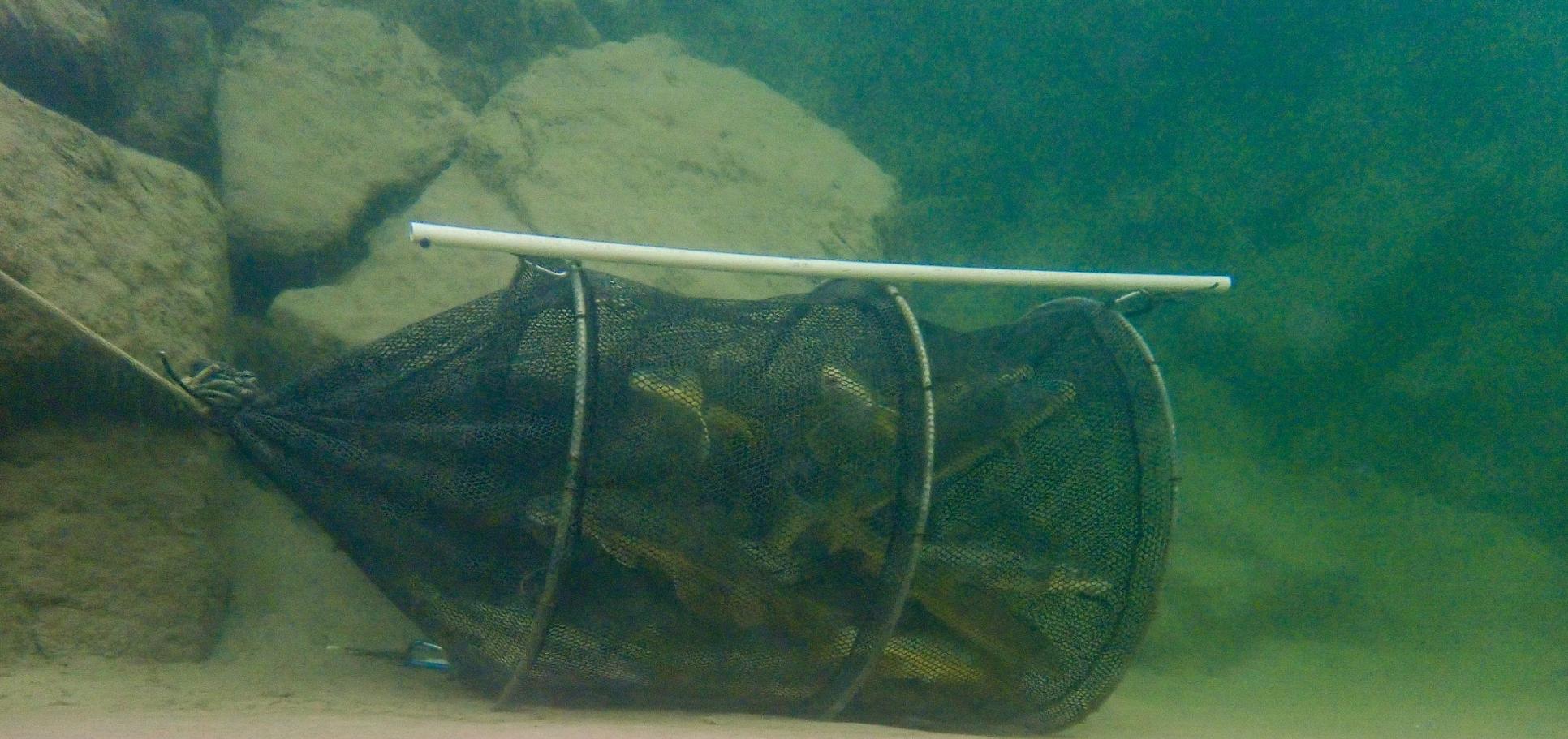
Upstream:  
Too cold

Tributaries:  
Very warm

Lower  
mainstem:  
Just warm  
enough

# Tradeoff: Native growth vs. nonnative exclusion





Flannelmouth Sucker

Most abundant, further upstream?

More cold tolerant?

# Far downstream areas

A photograph showing a person standing on a rocky riverbank. The person is wearing a blue shirt, shorts, and a cap. The background is a large, eroded cliff face with visible horizontal layers of rock. The river is in the foreground, and the sky is clear and blue.

Warmest, but mediocre habitat

- Juveniles abundant
- Adult flannelmouth less abundant

# Repatriation?



# Acknowledgements

A scenic view of a river canyon with layered rock formations and a raft on the water. The canyon walls are composed of reddish-brown and tan rock, showing distinct horizontal strata. The sky is a clear, bright blue. In the foreground, a white and black inflatable raft is on the water, with a person visible on board. The lighting suggests late afternoon or early morning, with long shadows and warm tones.

Funding: GCDAMP

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AGFD: Dave Rogowski, Pilar Wolters,  
Cory Nielson

Boatmen: Humphrey's Summit , St.  
Judes LLC, Ceiba

Photos: Susan Allen, Laura Lothrop

