Critical Thermal Maximum of Stream Fishes from the Arbuckle Mountains Ecoregion

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Problem

- Streams are altered via:
  - Damming
  - Groundwater pumping
  - Riparian removal
  - Converting landscape to urban and agriculture
- Reduction in biodiversity and abundance of stream fish

Influences of Stream Temperature on Fishes

- Metabolic processes
- Geographic distribution
- Reproduction
- Survival

Photo by Brandon Brown

Factors Influencing Temperature

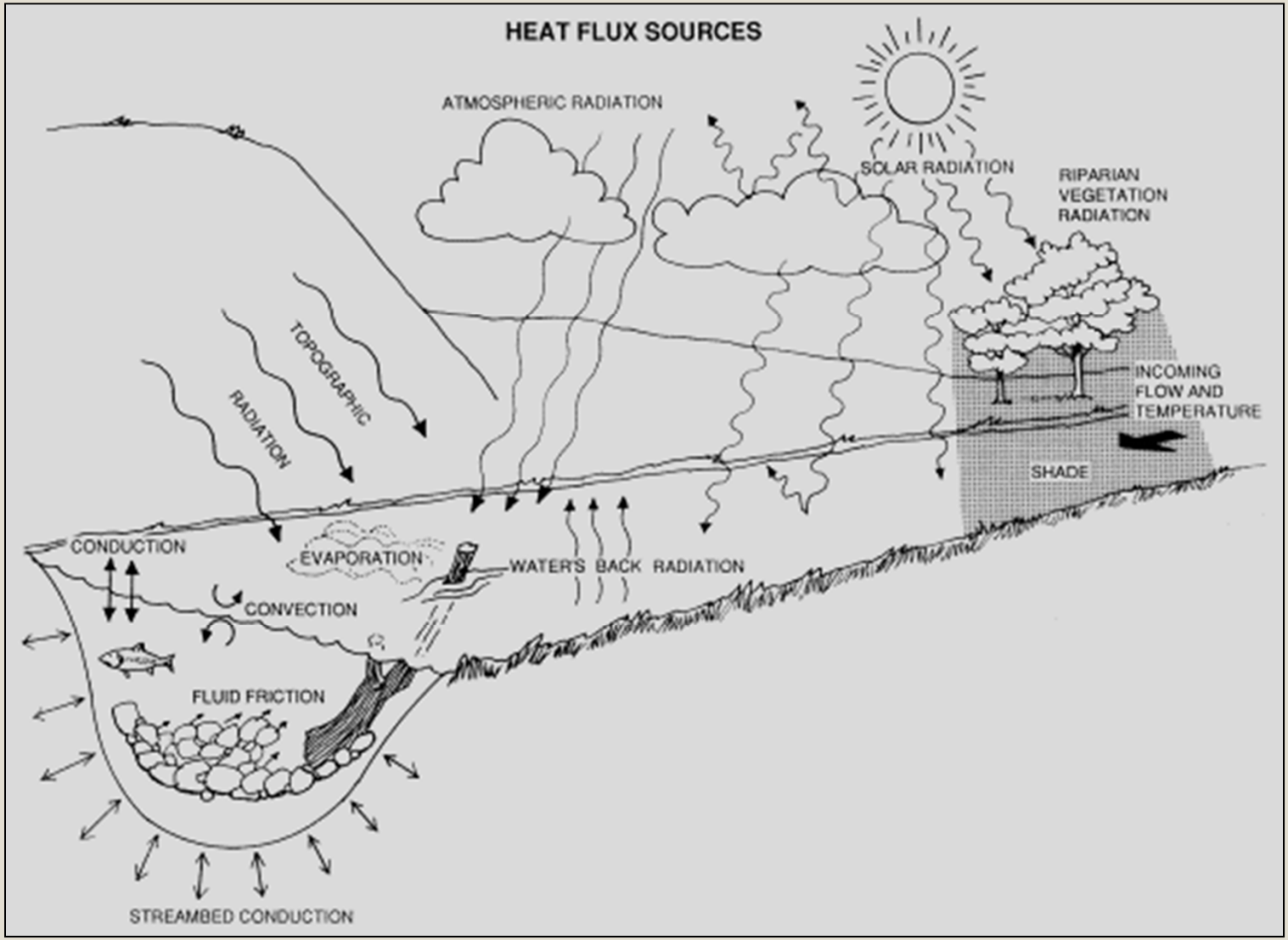


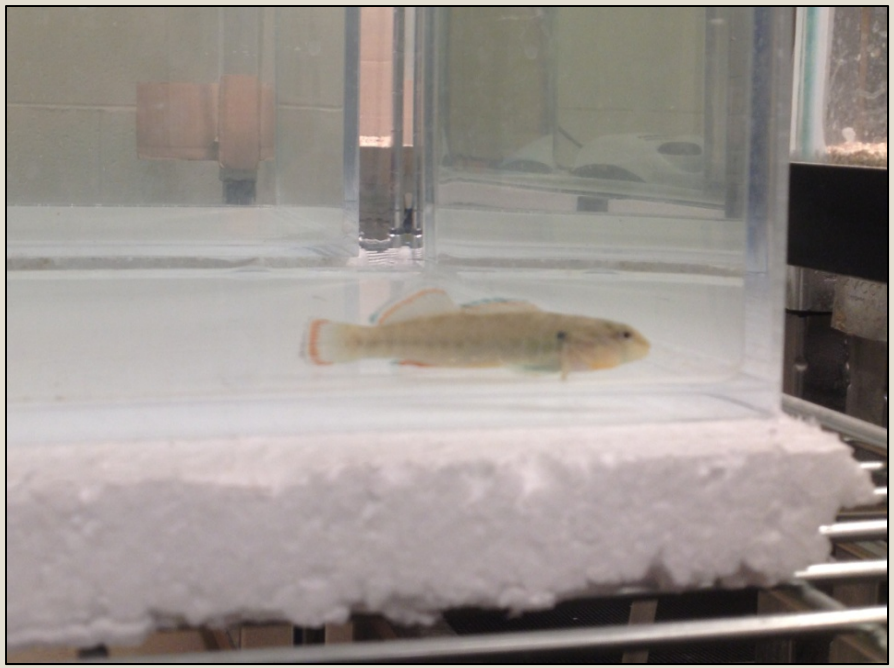
Figure by Bartholow 1999

Increased Temperature

- Stream temperature expected to increase 2 – 3 °C
  - Climate change
  - Flow alteration
  - Increased groundwater pumping
  - Reduction in riparian zone

Temperature Tolerance of Fishes

- Stream temperature could increase past thermal tolerance of many stream fishes



Importance of Groundwater Inputs

- Non spring-fed streams are more susceptible to increases in stream temperature
- Groundwater inputs provide a temperature buffer to spring-fed streams
  - Groundwater pumping makes spring-fed streams more susceptible to increases in temperature

Objective

- Determine the Critical Thermal Maximum of stream fishes from the Arbuckle Mountains Ecoregion

Study Area

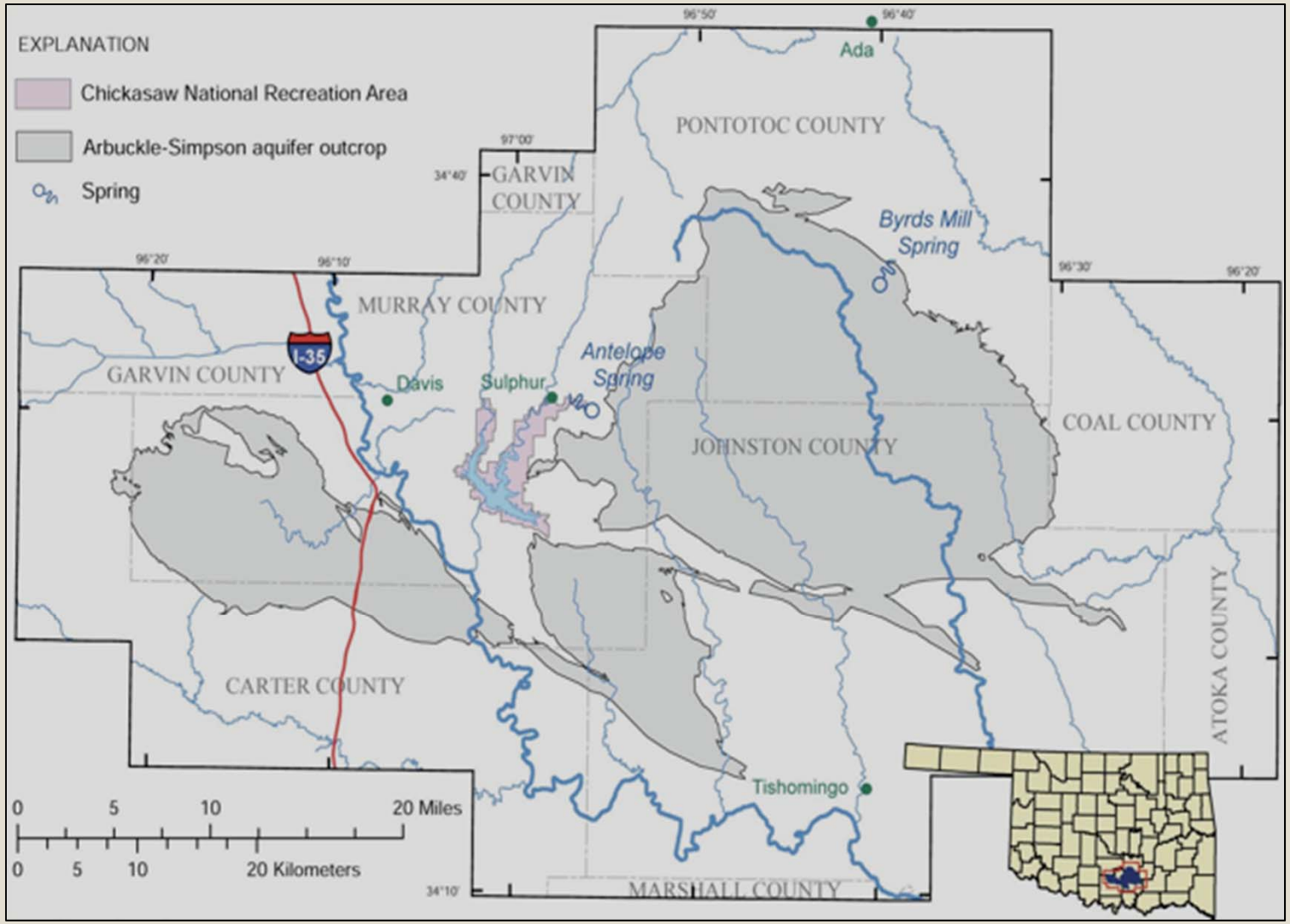


Figure by ridenbaugh.com

Critical Thermal Maximum (CTM)

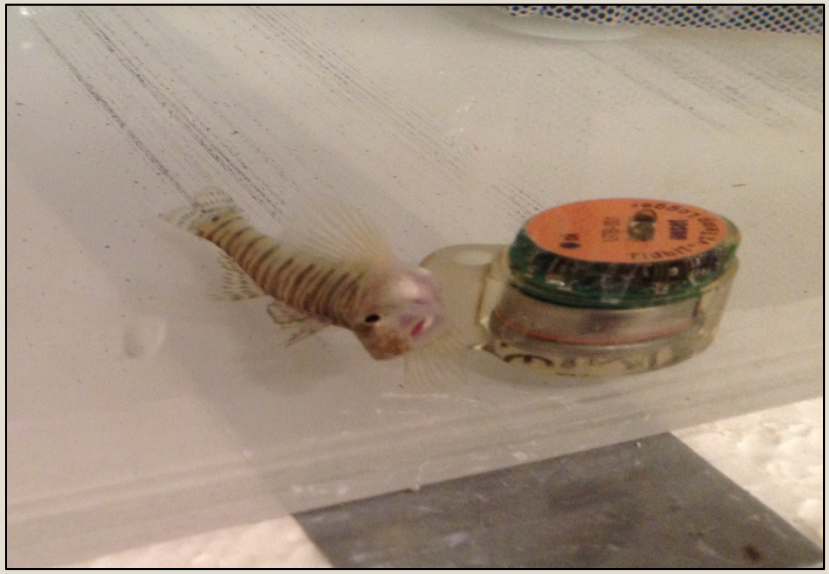
- Developed by Cowles and Bogert in 1944
- CTM- Increase temperature at a constant rate, fast enough to prevent acclimation until fishes reaches critical endpoint

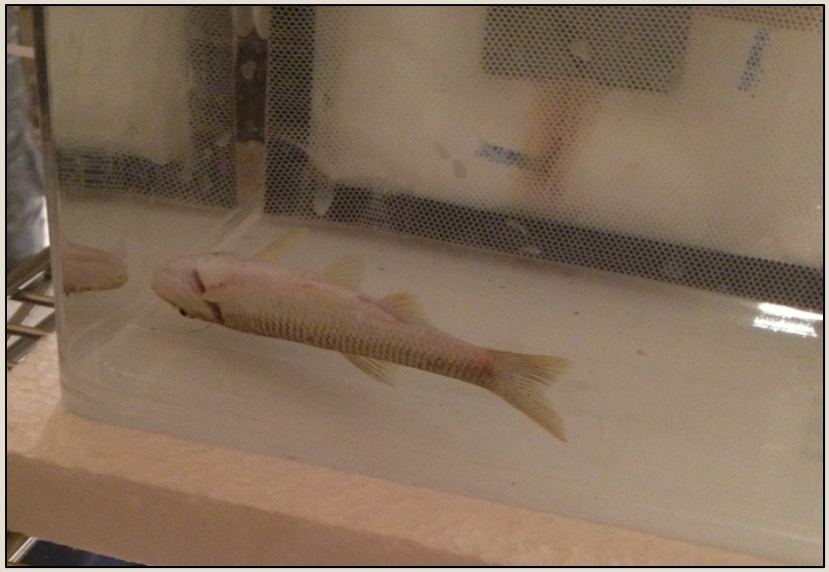
Photo by Brandon Brown

Photo by tucsonherpsociety

Critical Thermal Maximum Endpoints

1. Loss of equilibrium
2. Muscular spasms
3. Death





CTM of 15 Species

Arbuckle Mountain Species

1. Logperch
2. Orangethroat Darter
3. Juvenile Golden Redhorse
4. Bigeye Shiner
5. Central Stoneroller
6. Brook Silverside
7. Striped Shiner
8. Blacktail Minnow
9. Juvenile Bluegill
10. Bluntnose Minnow
11. Silverband Shiner

ODWC Species of Greatest Concern

12. Orangebelly Darter

Spring-Fed Obligates

13. Southern Redbelly Dace

ODWC Species of Greatest Concern and Spring-Fed Obligate

14. Least Darter
15. Redspot Chub

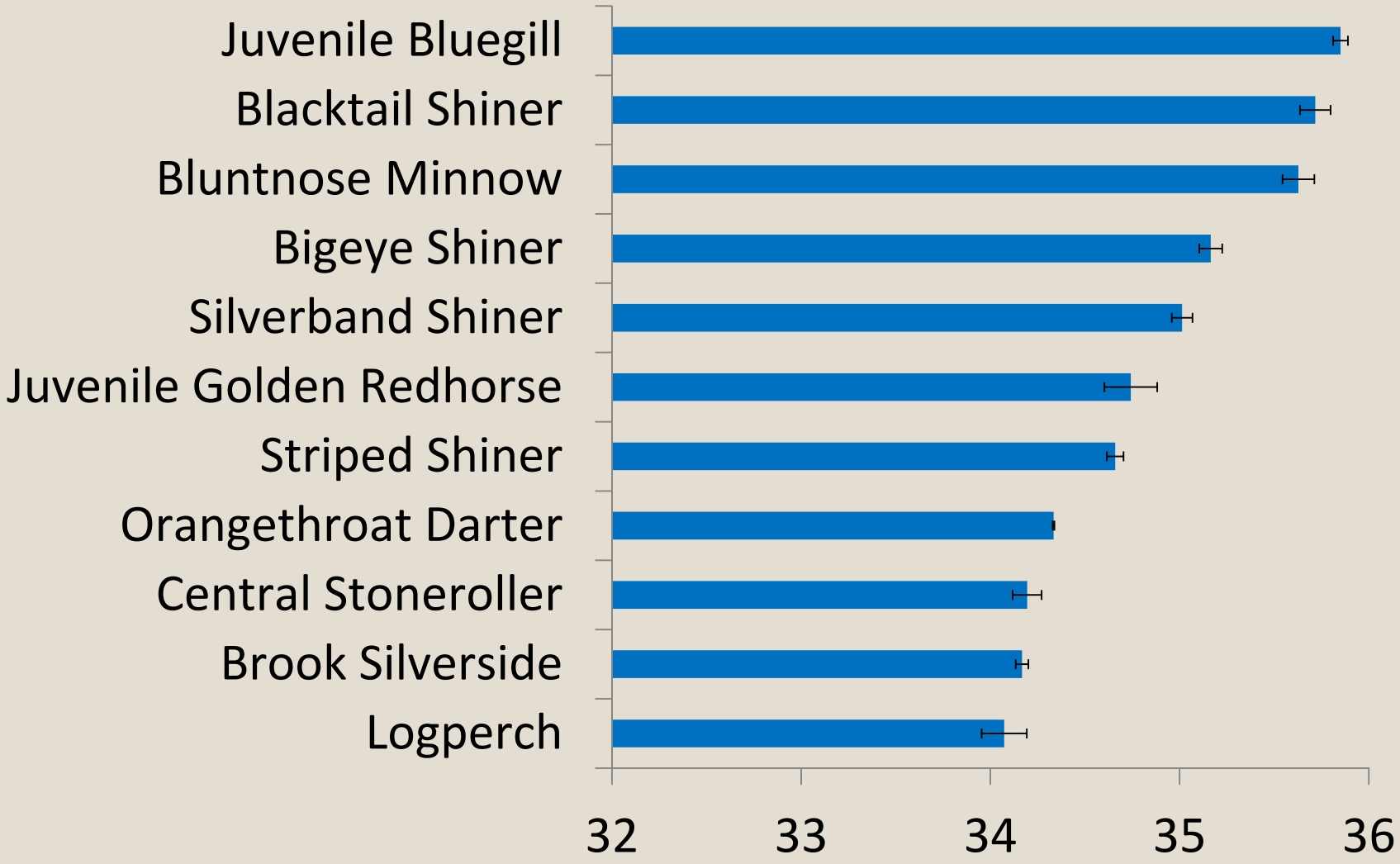
Fish Sampling

Critical Thermal Maximum

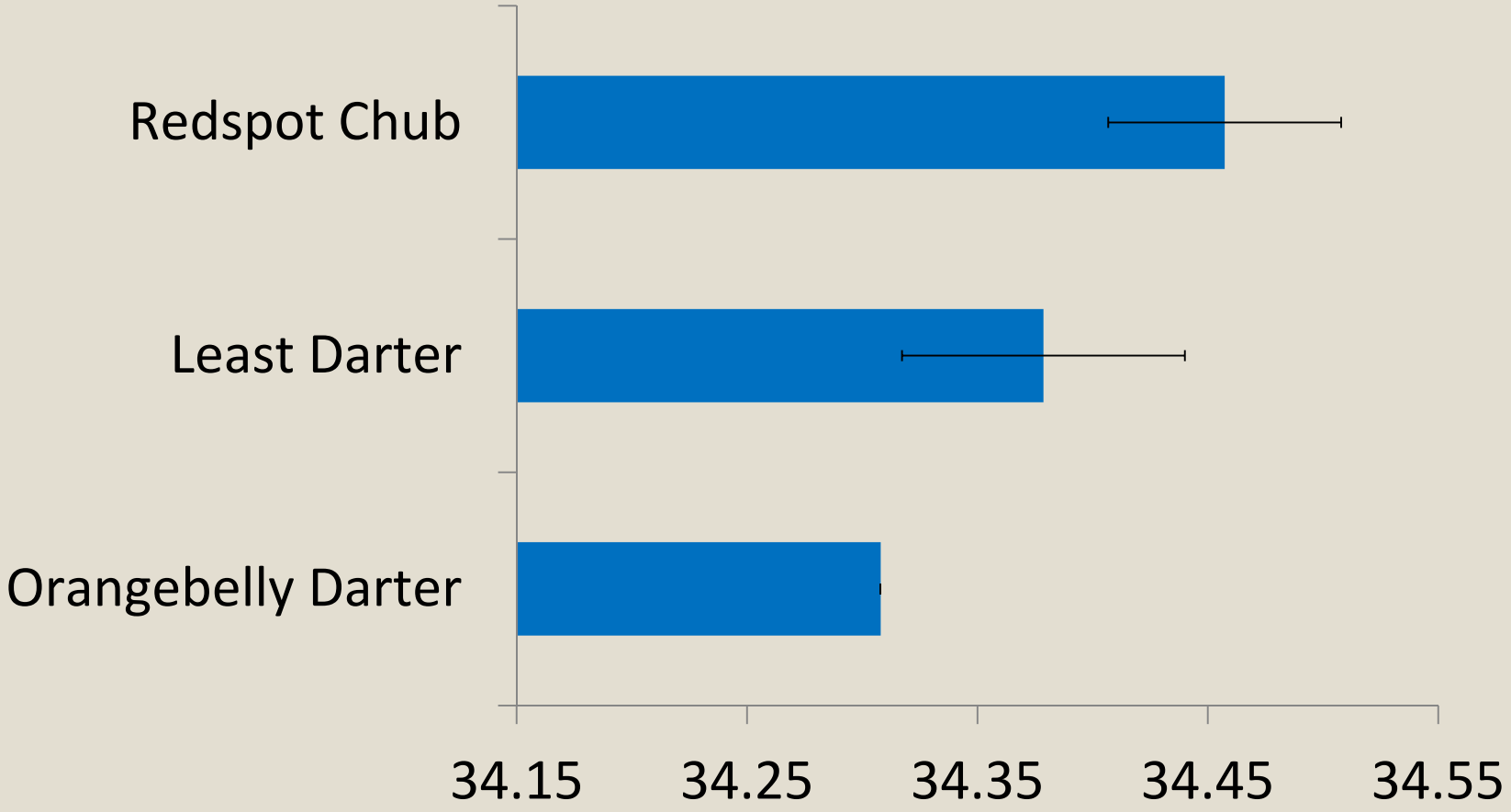
- Acclimate 2 – 4 weeks at 20°C
- Transfer to experimental tank
  - Acclimate 24 h at 20°C
- Increase temperature 2° C per h until:
  1. Loss of equilibrium
  2. Muscular spasms
  3. Death

Experimental Design

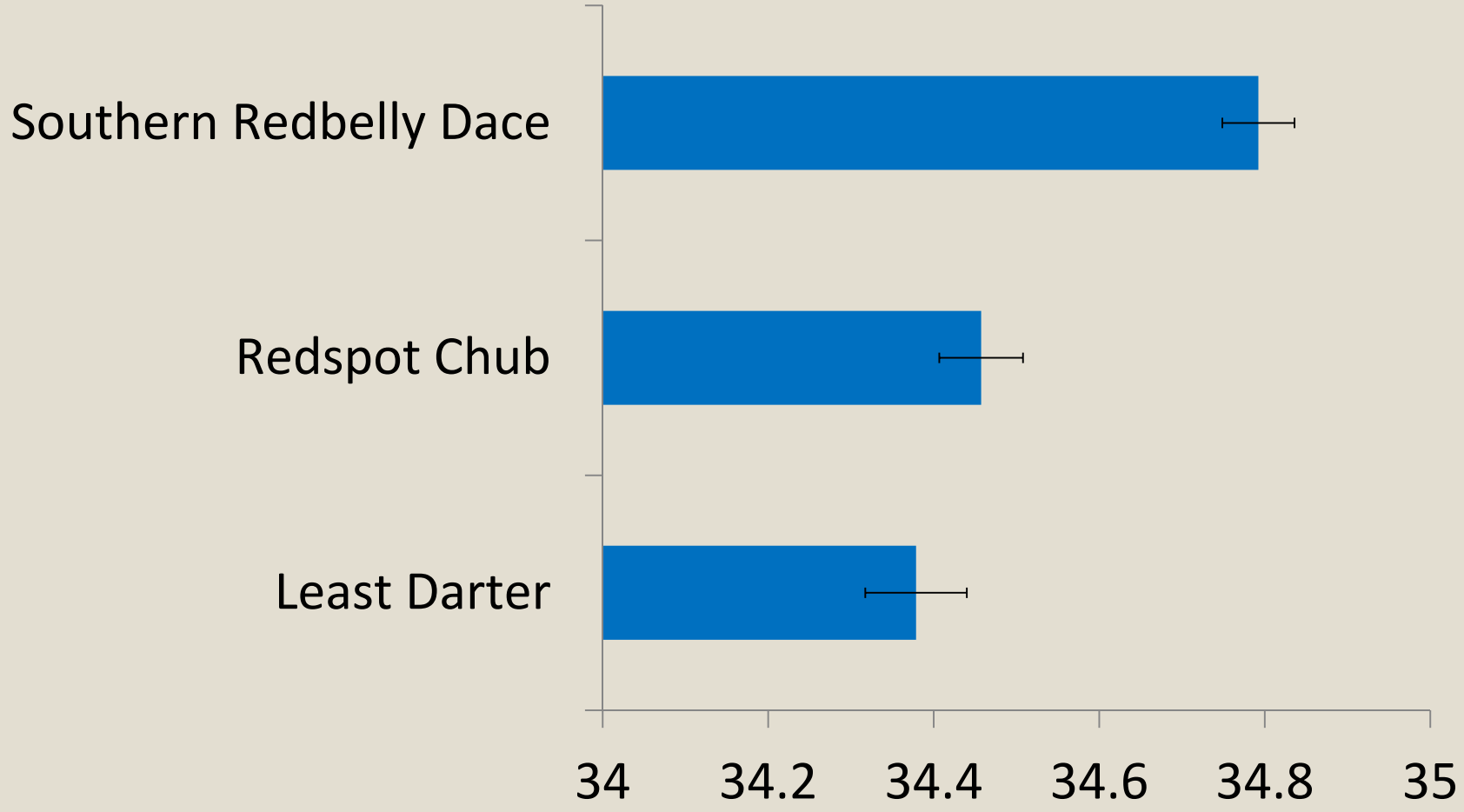
Loss of Equilibrium Results



ODWC Species of Greatest Concern



Spring-Fed Obligates



Discussion

- Temperature range of loss of equilibrium CTM is 34° C – 36° C
  - Maximum temperature of Blue River is 32° C
- Fish are living close to their thermal tolerances
  - Predicted increases in stream temperature will increase the thermal stress of fishes
- CTM rate of increase is much faster than streams typical rate of increase

Implications

- Help managers decide what species should be listed as species of greatest concern

- Determine sites that would be appropriate for reintroduction of fishes based on their thermal tolerances

Future Studies

- Long-term temperature tolerance study that allows for acclimation and includes a diel fluctuation
  - Spring-fed v non spring-fed
- Model the temperature of Blue River using Stream Segment Temperature Model (SSTEMP)
- Predict how future increases in stream temperature will influence the fish assemblage

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Questions?