



# Effects of Water Temperature on Predation Vulnerability of Humpback Chub

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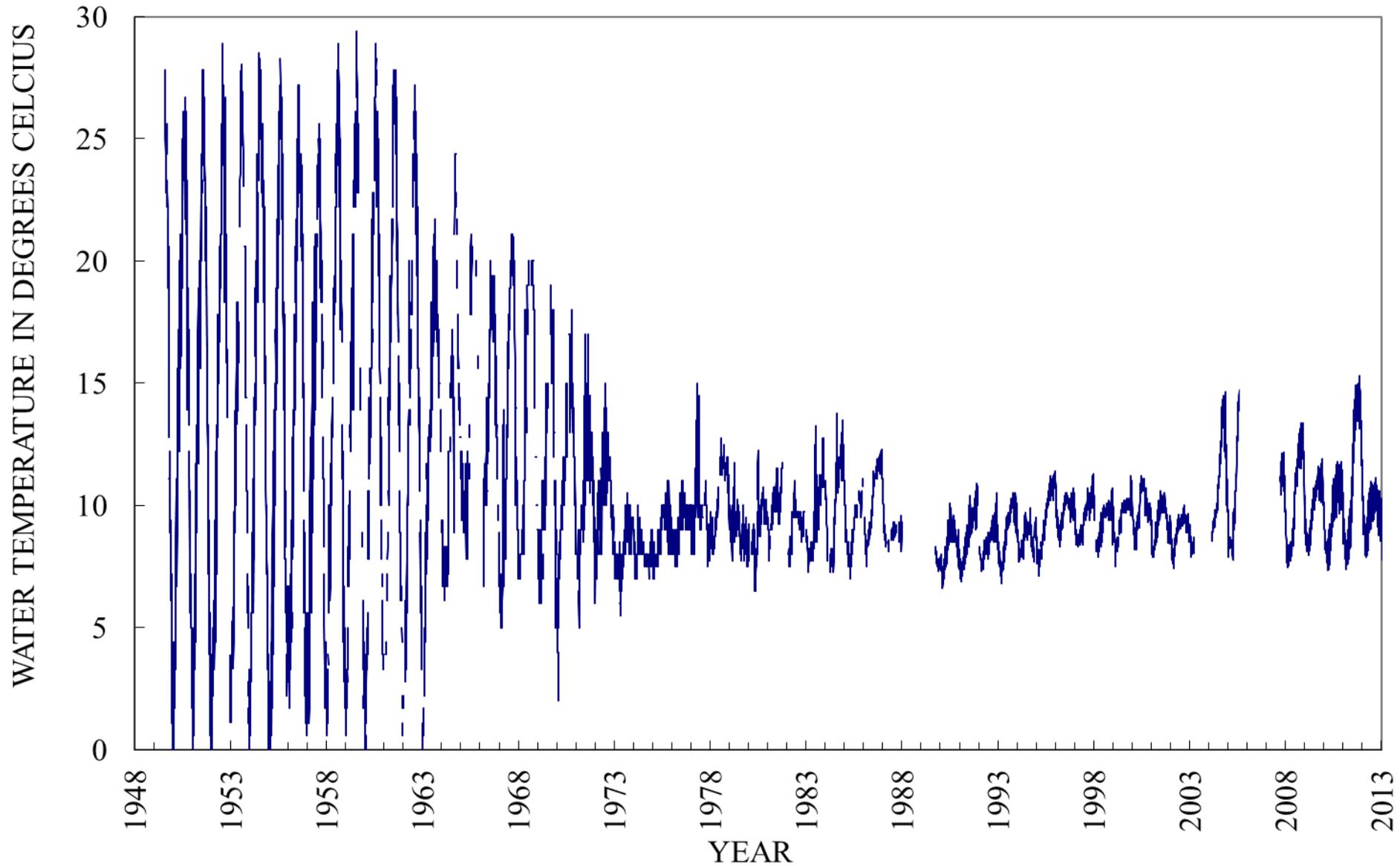
Grand Canyon Monitoring and Research Center  
Southwest Biological Science Center

# Dams effect fish in Four Primary ways



- Change timing and magnitude of flows
- Reduce turbidity
- Impede fish movement
- Alter water temperature

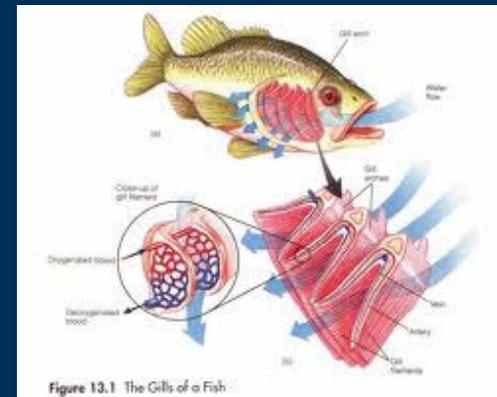
# Lees Ferry Water temperature



# Water temperature affects all aspects of fish life



- Gamete development
- Egg hatching
- Bioenergetics/Metabolism
- Growth
- Swimming ability
- Predation Vulnerability



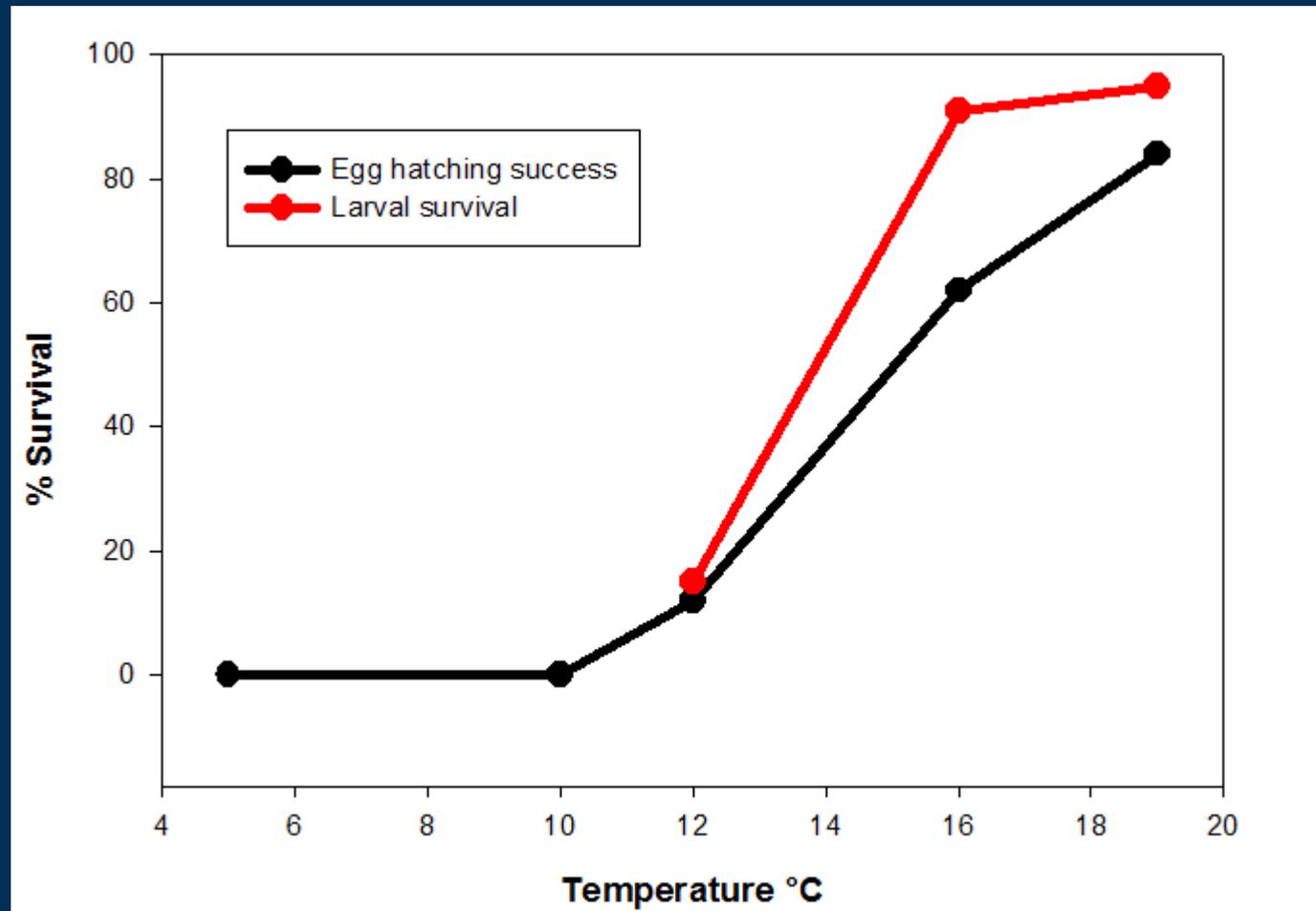
# What we know

- Grand Canyon native fish are warm water fish (20° C)
- Current Mainstem Colorado River Water in Grand Canyon is not warm!
- Continuous cold water is detrimental to native fish

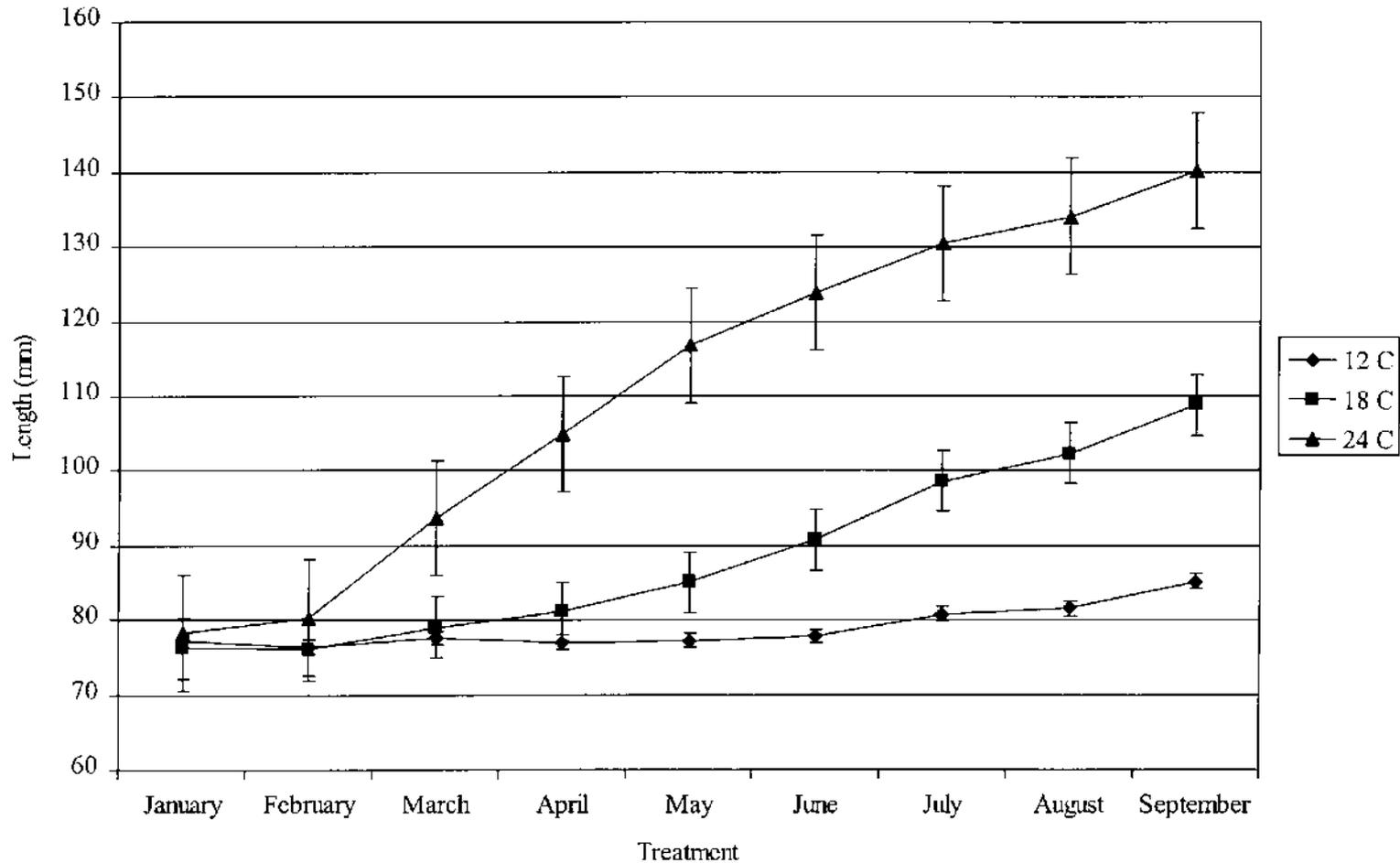




# Egg/larval survival



# Growth of Juvenile Humpback Chub in the Laboratory



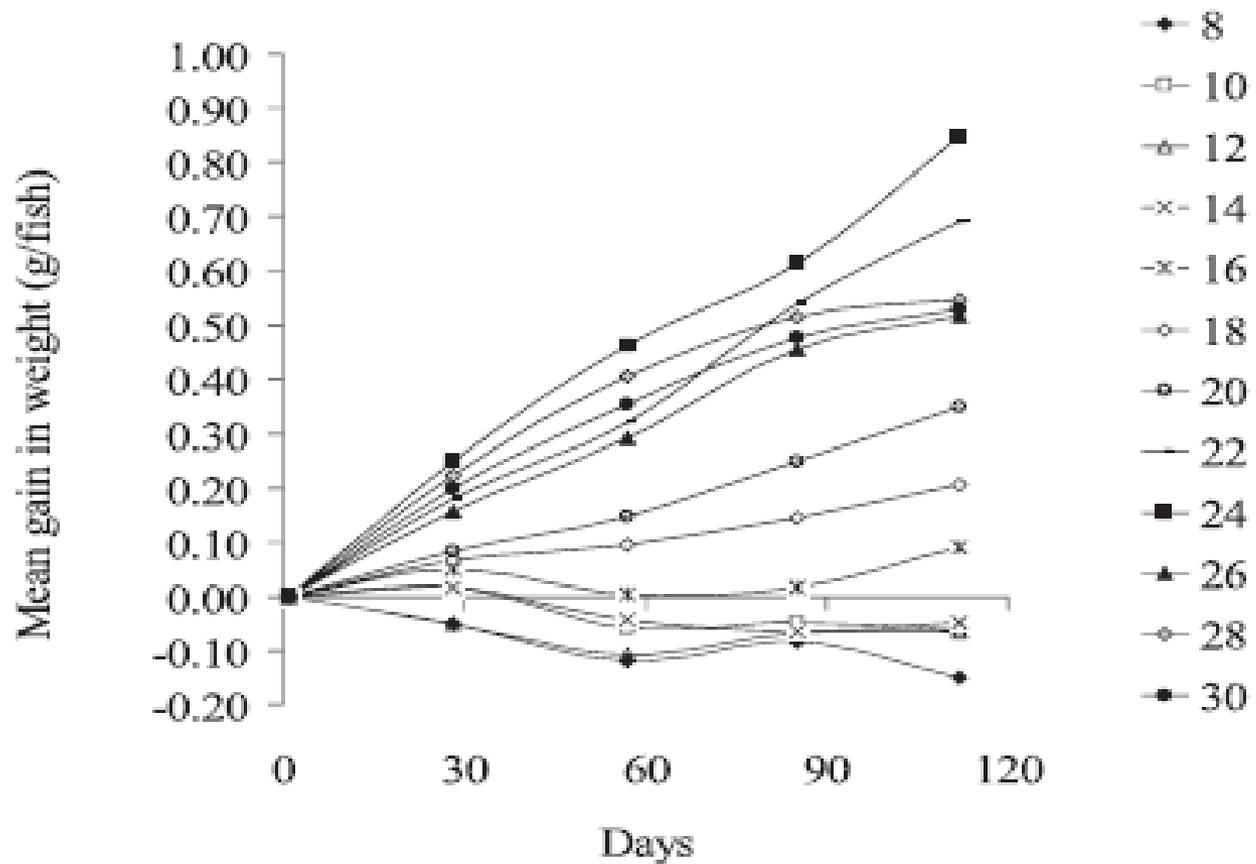
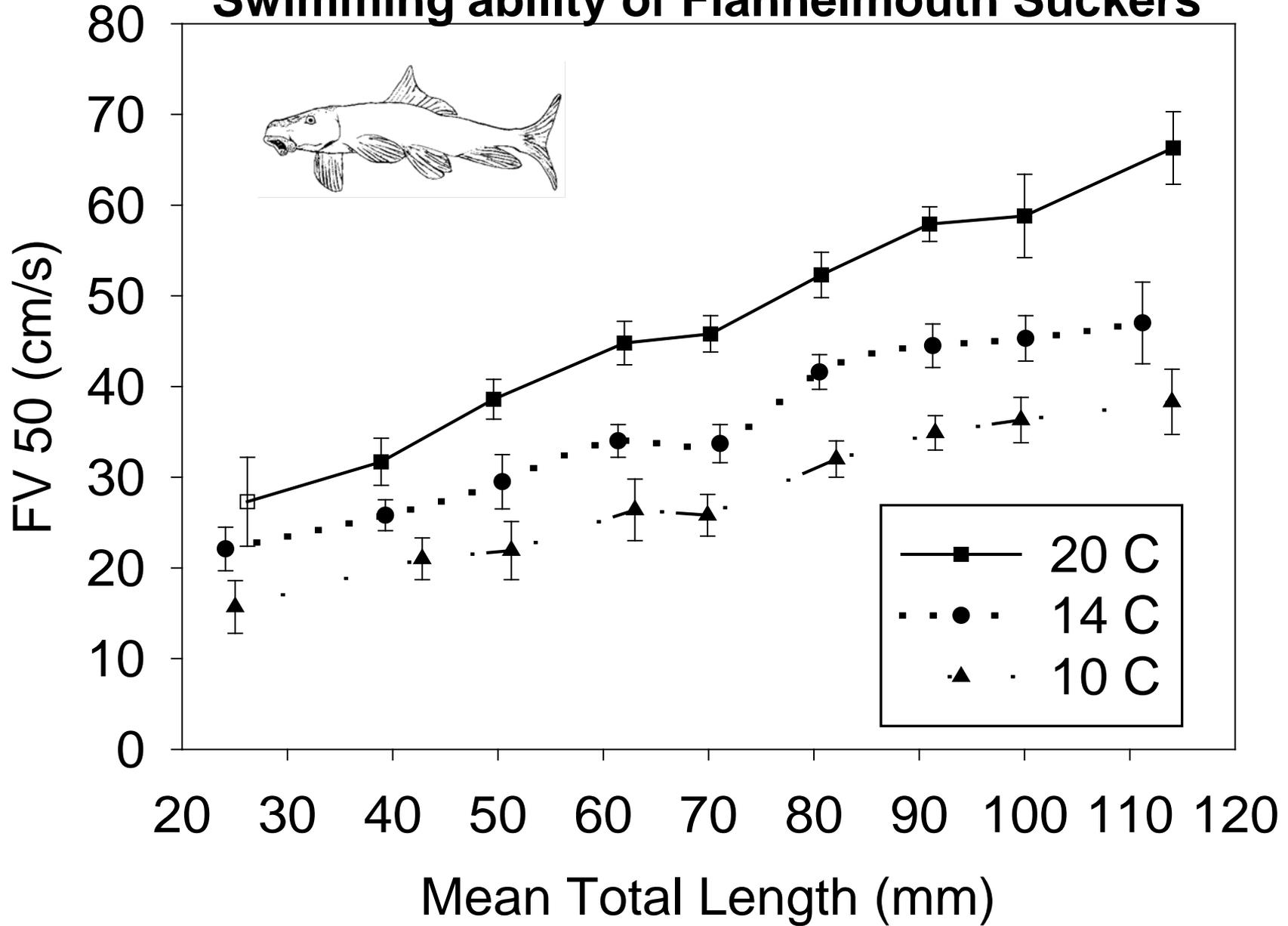


FIG. 1—Growth in mean weight (g/fish) of age-0 juvenile bonytails (*Gila elegans*) after 27, 55, 88, and 112 days of captive rearing at 12 temperatures (8–30°C). Symbols represent mean gain in weight for each treatment connected by smoothed lines.

# Swimming ability of Flannelmouth Suckers



# How does water temperature affect predation vulnerability?



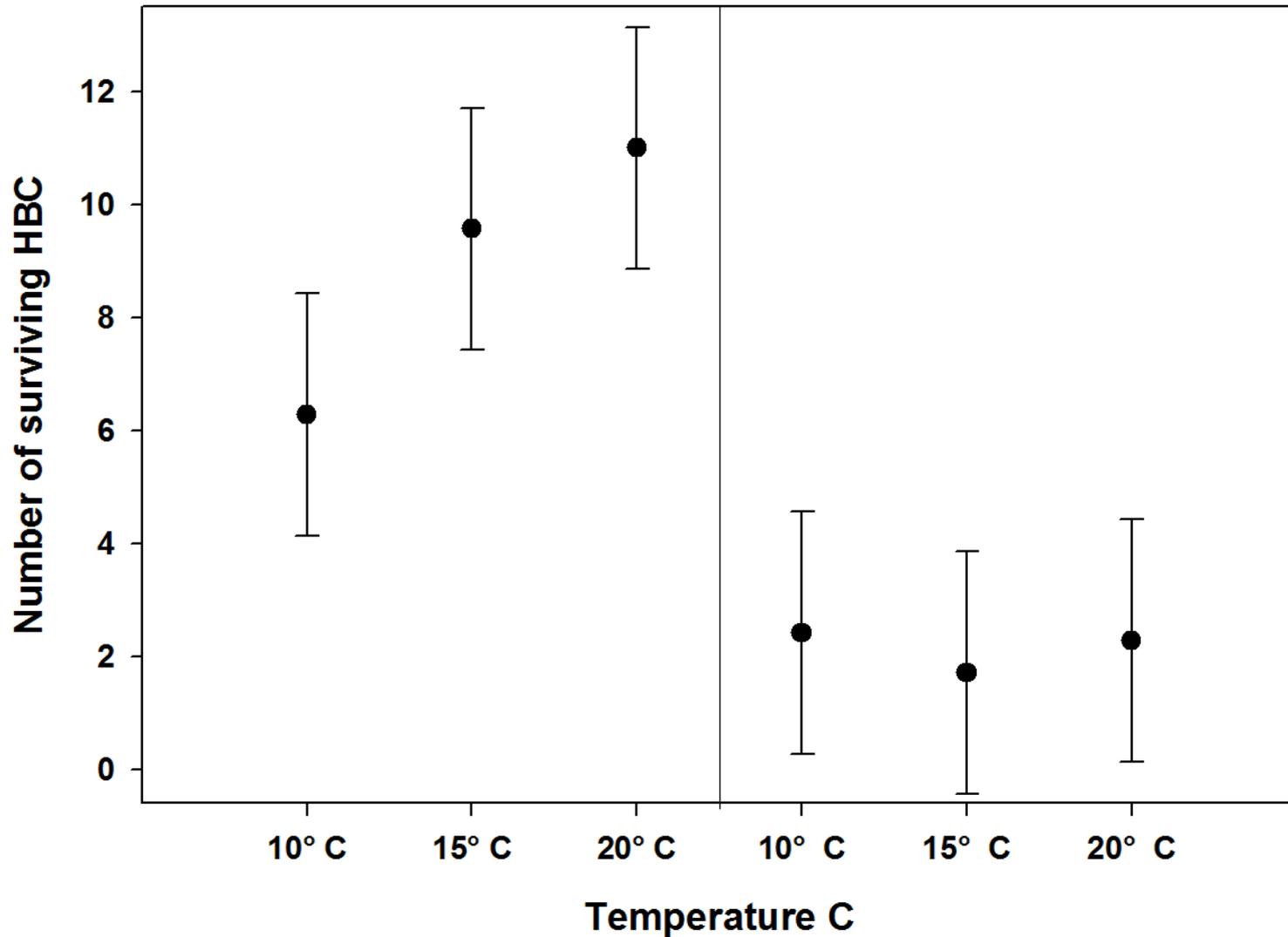






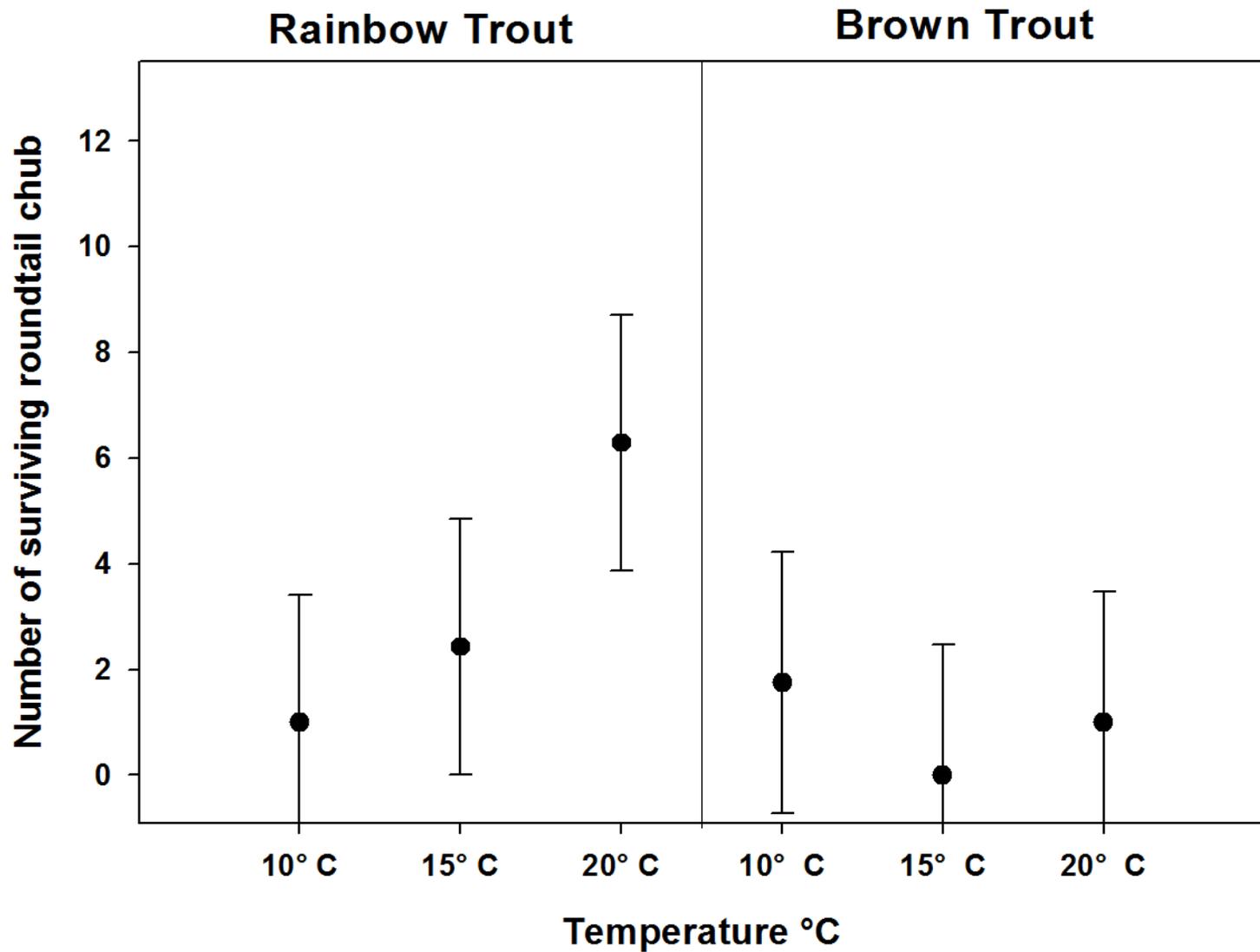
### Rainbow Trout

### Brown Trout



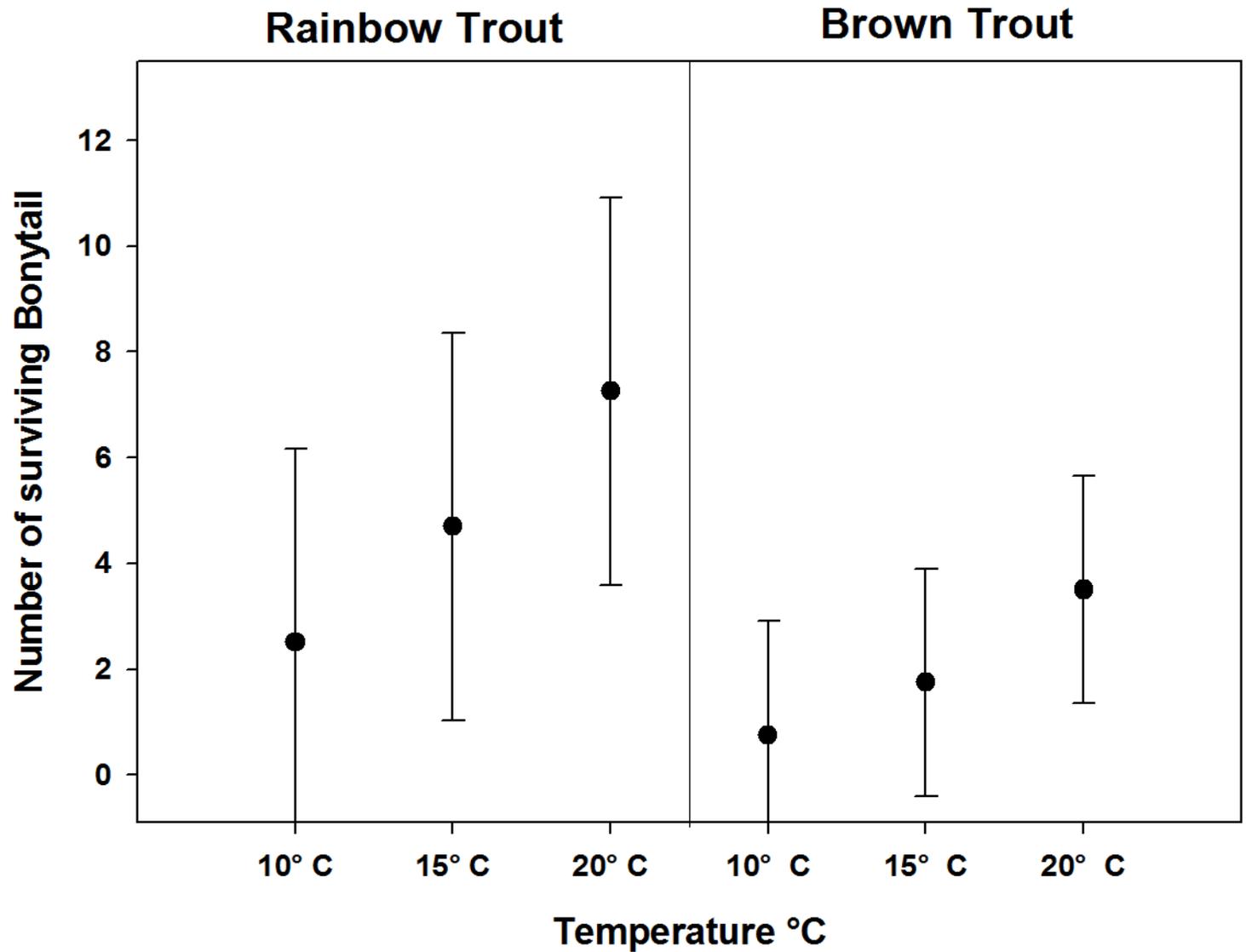
Each point = 10 overnight trials, Error bars = 95% confidence intervals

HBC mean size = 63 mm, Rainbow trout mean size = 328 mm, Brown trout mean size = 280 mm



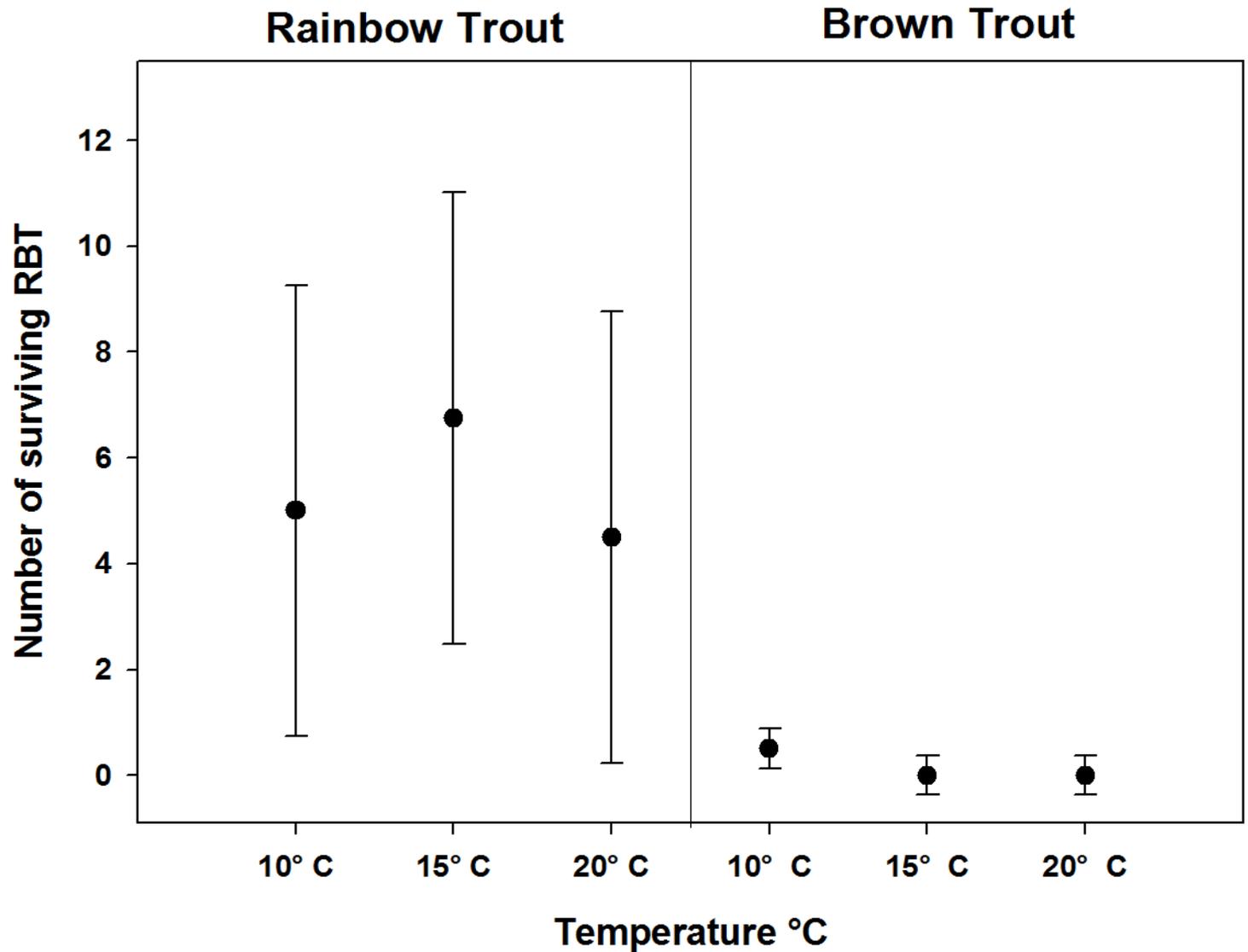
Each point = 4 overnight trials, Error bars = 95% confidence intervals

RTC mean size = 55 mm



Each point = 4 overnight trials, Error bars = 95% confidence intervals

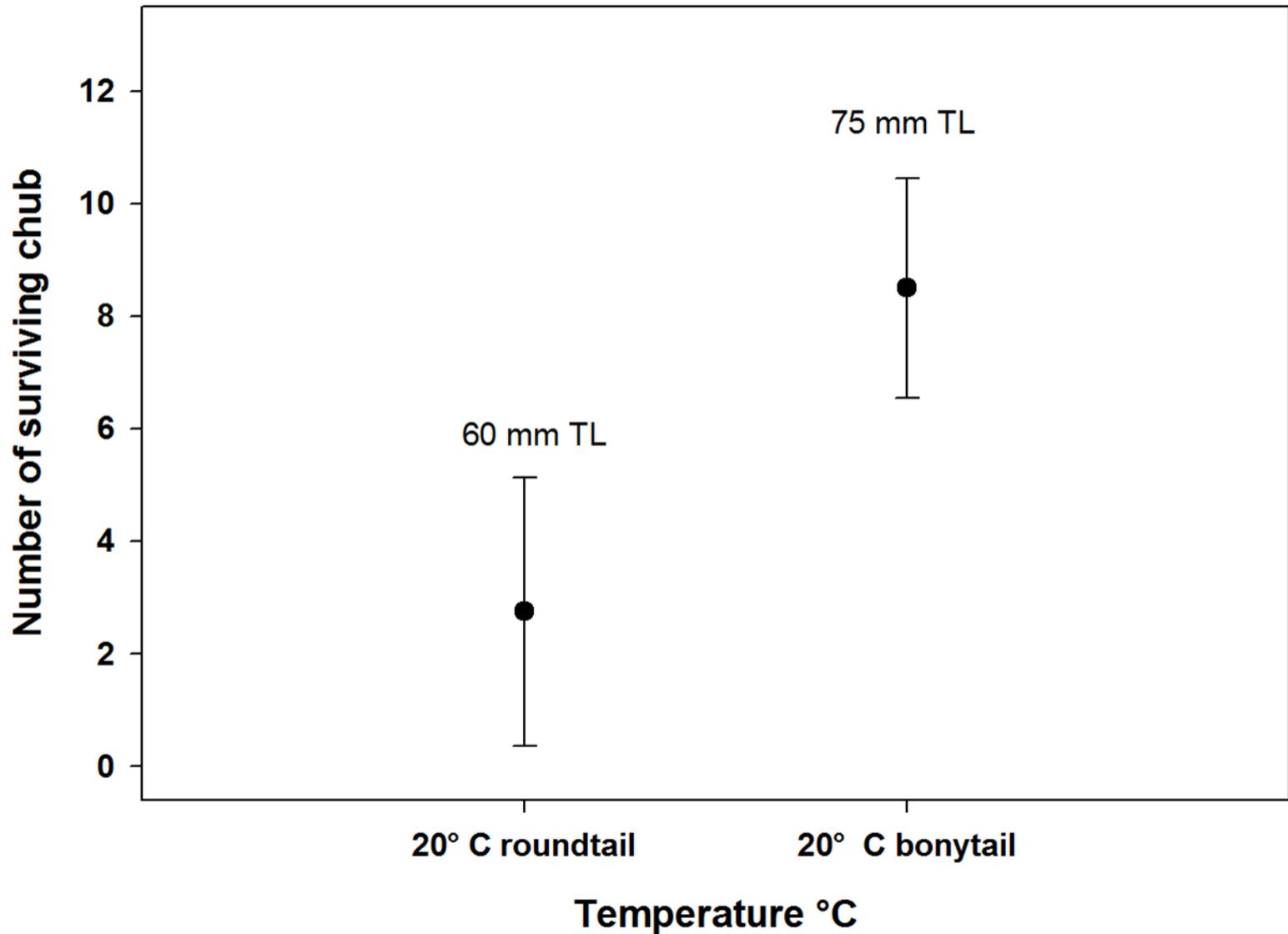
BTC mean size = 75 mm,



Each point = 4 overnight trials, Error bars = 95% confidence intervals

RBT prey mean size = 65 mm,

# Roundtail chub



Each point = 4 overnight trials, Error bars = 95% confidence intervals

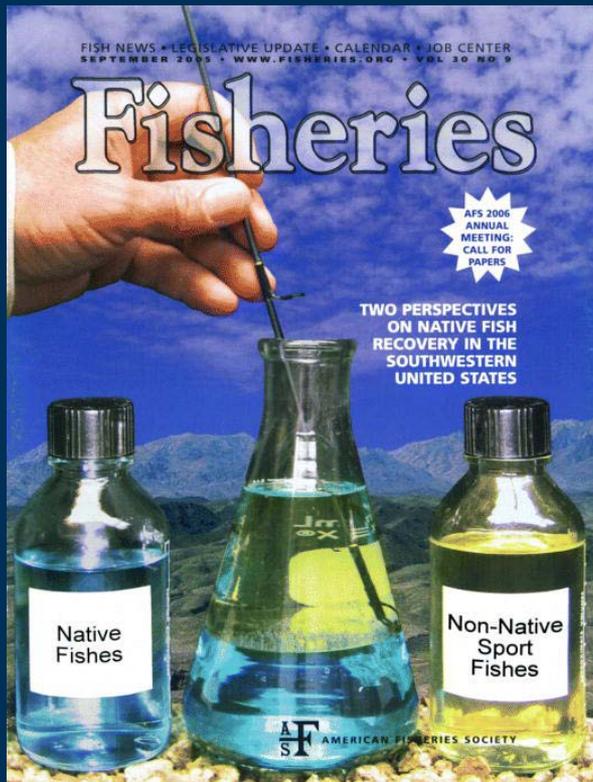
# What we know

- Water Temperature effects predation vulnerability
- Continuous cold water is detrimental to native fish
- Warmer water will benefit native fish
- Warmer water will also benefit non-native warm water fishes



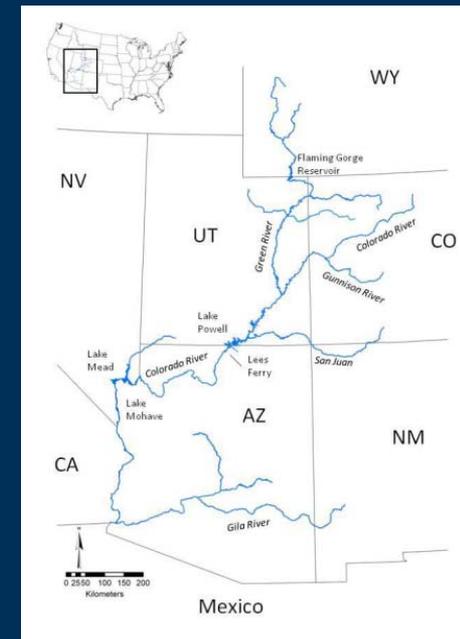
# What we know

- Warm water non native fish and warm water native fish will not coexist at the same location for very long!



Marsh and Pacey 2005  
Clarkson et al. 2005  
Mueller 2005

Lots of examples  
Reservoirs and rivers



# Temperature Conundrum for Colorado River Native Fishes

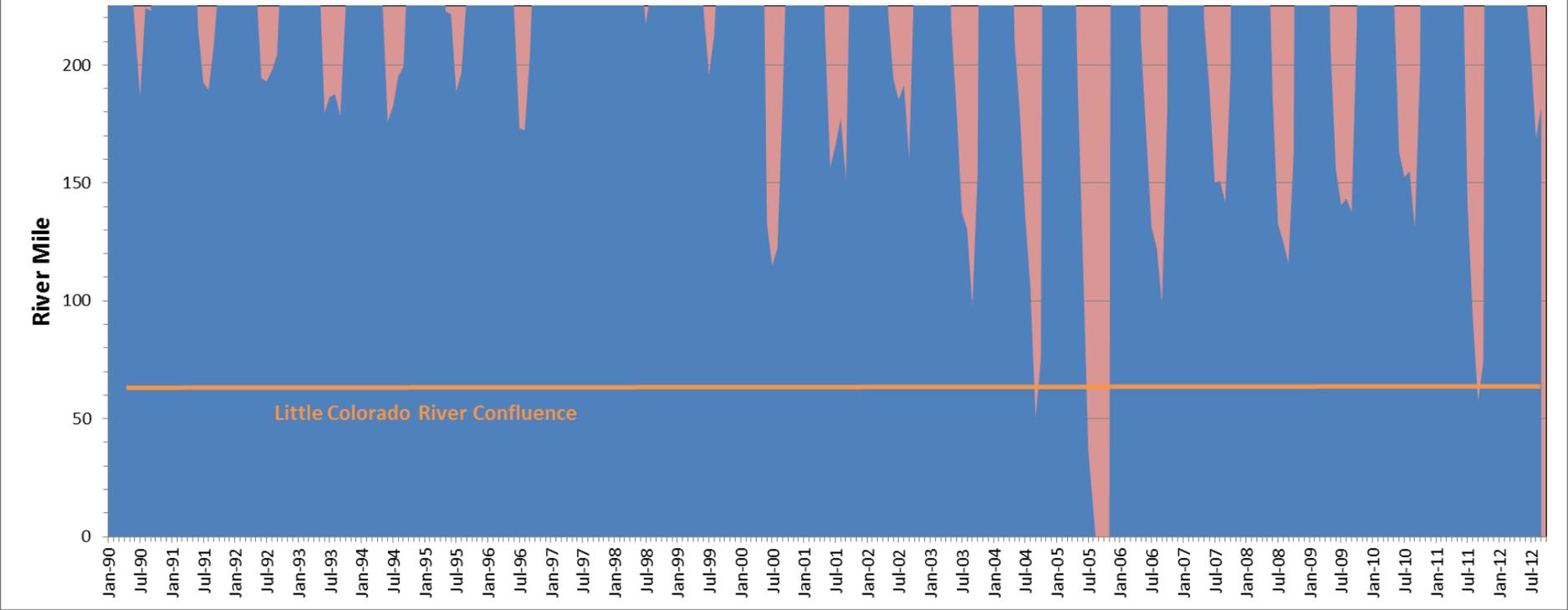
**Cold Water is Bad**  
**(physiological effects)**

VS

**Warm Water is Bad**  
**(Invasive fish effects)**

**What about warm water every once in a while ?**

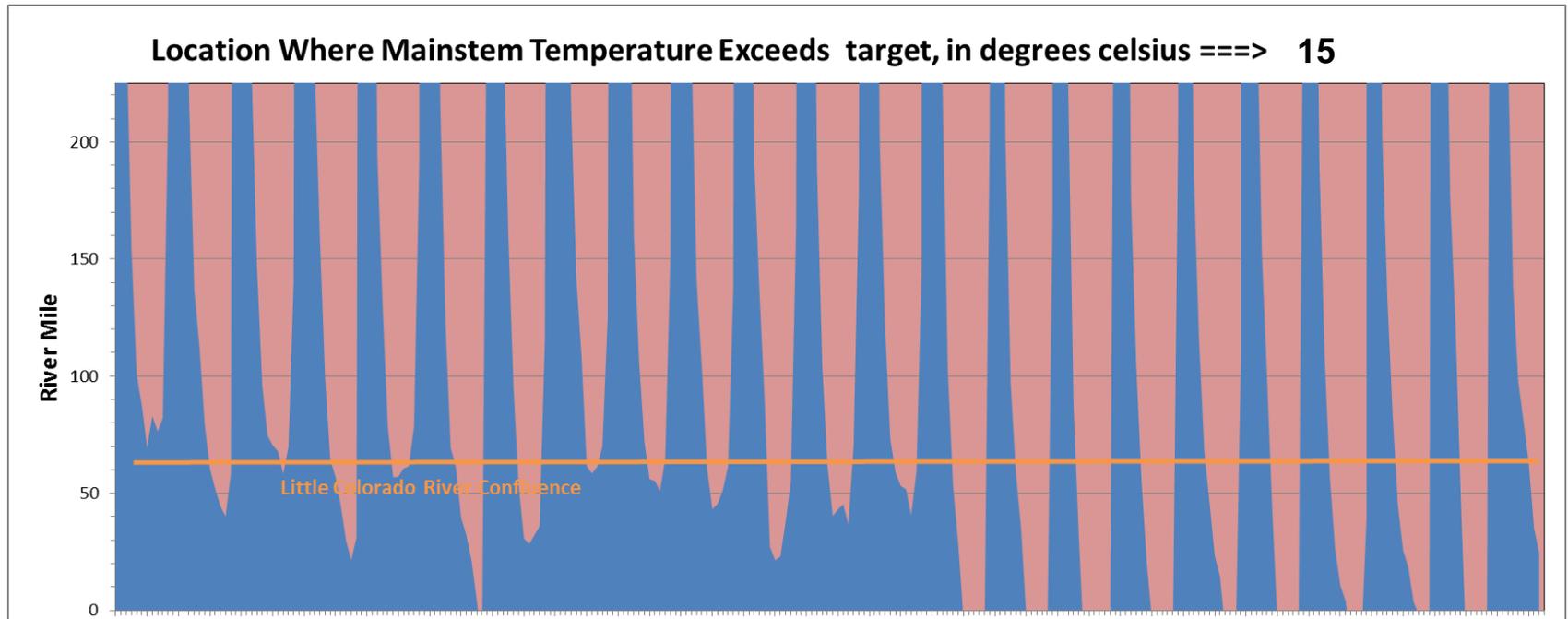
**Location Where Mainstem Temperature Exceeds target, in degrees celsius ==> 15**



**Long life span of Colorado River Native fishes allows for interval between warm water events to be relatively long**



# What about climate change and drought Induced warming?



# Conclusions

- **Cold water although detrimental to Grand Canyon native Fishes may act to conserve them**
- **Interval of drought induced warming may play a critical role in the persistence of native fish in Grand Canyon**