Harris Action Team 3 Meeting Summary
June 2, 2020
1:00 pm to 3:00 pm
Conference Call

Participants:
See Attachment A

Action Items:

- Alabama Power will distribute the Draft Aquatic Resources Study Report to the HAT in July 2020.

Meeting Summary:
Angie Anderegg (Alabama Power) opened the meeting by introducing everyone and described the meeting purpose: for Auburn University to present its research to date and to inform the HAT of remaining work on the Aquatic Resources Study. Jason Moak (Kleinschmidt Associates) stated this meeting was intended to be held March 19, 2020 but was rescheduled due to COVID-19. This study has two main components: 1) a desktop assessment of current and historic information to describe the broad range of effects of the Harris Project (Project); and 2) Auburn University's research, which includes a literature review of temperature requirements of the target fish species, historical water temperature data, fish community surveys, and bioenergetics modeling.

Dennis Devries (Auburn University) summarized the first study objective and described the target species: Alabama Bass, Tallapoosa Bass, Redbreast Sunfish, and Channel Catfish. The Tallapoosa Bass was described several years ago and was formerly known as Redeye Bass in the study area[1]. There are not currently any temperature preference data available for Tallapoosa Bass. The Alabama Bass was also described several years ago and was split from Spotted Bass. Dennis stated that most of the available data are for Channel Catfish, but the majority of these data were gathered from ponds and aquaculture systems instead of moving water.

Ehlana Stell (Auburn University) summarized the second study objective. Historical temperature data below Harris Dam was gathered from three sites: the Harris tailrace, Malone, and Wadley. There were no significant temperature differences between pre- and post-Green Plan. Temperatures at the three sites only differ significantly in the summer. Releases from Harris Dam can cause temperature decreases of about 4°C in the summer but only 1-2°C in the fall.

Eli Lamb (Auburn University) summarized the third study objective. The fish community is being assessed at three sites downstream of Harris Dam (the Harris tailrace, Wadley, and Horseshoe Bend) and at one reference site (Lee's Bridge on the upper Tallapoosa River). Eli described the four sites in terms of location (river kilometers from Harris Dam) and available habitat. Each site is sampled every other month by electrofishing, and all fish are transported back to the lab. Eli described the information gathered from both non-target and target species. Genetic information was also gathered from Alabama Bass and Tallapoosa Bass for identification. Eli showed all the species found at multiple sites and all species unique to each site. He stated that a new species is added to the list each time they sample, so this information is

[1] The study area is the Tallapoosa River from the Harris Dam downstream through Horseshoe Bend.

constantly changing. The growth curves of Alabama Bass, Redbreast Sunfish, and Tallapoosa Bass were presented. This study objective is ongoing.

Ehlana summarized the first part of the fourth study objective. Static respirometry is used to measure the standard metabolic rate. Fish are not swimming during static respirometry, and temperature is held constant. To date, trials have been conducted at 21°C. Swimming respirometry and performance work was also described, which will measure active metabolic rates. The critical swimming speed, or U_{crit}, is being measured. U_{crit} can be described as an assessment of the swimming abilities of fish using the time and velocity at which the fish becomes fatigued. Preliminary U_{crit} data was presented. Alabama Bass showed the highest U_{crit} values. Larger fish can typically swim faster at absolute speeds. Ehlana described VO_2 as the metabolic rate during increases of speed; VO_2 increases with increasing speed. Ehlana detailed the remaining static and swimming respirometry and performance work to be completed in 2020.

Rusty Wright (Auburn University) summarized the second part of the fourth study objective. Rusty defined bioenergetics and stated that much of the energy gained from consumption is lost as metabolic waste and used for respiration and activity. A bioenergetics model can integrate all these factors to determine what energy is left for growth. The bioenergetics model is focusing on habitat effects on growth. Rusty described the components needed to run the bioenergetics model. Small fish have higher consumption and respiration rates per gram than large fish. Consumption increases as water temperature increases until conditions get too warm and consumption decreases. The bioenergetics model can help determine what temperatures could potentially provide the best growth (which is species specific). Growth data is being gathered from otoliths, and caloric density can be gathered from published literature. Currently there is no model for Tallapoosa Bass or Redbreast Sunfish so literature on similar species is being utilized. Previous Channel Catfish models have been constructed from specimens from lakes and ponds instead of lotic systems, so some additional information for that species must be gathered. Rusty noted that simulations will be run in the summer 2020. See presentation in Attachment A.

There was a break for questions. Todd Fobian (Alabama Department of Conservation of Natural Resources (ADCNR)) asked if the Snail Bullhead identification was correct since that species has previously been described in Alabama as only existing in the Chattahoochee River. Eli replied that the identification is likely correct, and Dr. Carol Johnston of Auburn University has been sent these specimens to confirm identification. Todd also wanted to confirm the Skipjack Herring record. Eli stated that both Skipjack Herring and Blueback Herring have been confirmed by Dr. Johnston.

Next, Donna Matthews (Tallapoosa River Heritage) asked if the model that Auburn is making could be used by other researchers and applied to other situations. Rusty said fish are being used from the Tallapoosa River specifically and this population may differ from other populations, but this model could be used in similar studies. Diets of fish in other populations may need to be adjusted, but the basic bioenergetics model should be applicable to other populations. Auburn University stated that bi-monthly sampling will continue through winter 2021 (February 2021); however, the minimum number of fish required for modeling will likely be acquired around August 2020. Eli will also be looking at tagging and tracking fish in the field to monitor their movement in the river. Sarah Salazar (Federal Energy Regulatory Commission (FERC)) reminded HAT 3 participants to check the schedule in the study plan if there is any confusion. Allan Creamer (FERC) asked how the bioenergetics information would be integrated into all the other study plans. Auburn University stated that the sampling in early 2021 will provide

information on the fish community, but all the required information for the bioenergetics work will have already been gathered at that time. Allan asked if the data gathered in early 2021 will be added into the final model. Rusty said it is possible it could feed into the model, but they will likely have enough temperature, diet, and growth data to generate simulations. Angie added that ultimately, the results of this study will be summarized and added to the Preliminary Licensing Proposal. HAT meetings will be held to provide updates as each component of the study is completed.

Martha Hunter (Alabama Rivers Alliance) asked if the 30-minute flushing cycle used in the static respirometry tests was the same length of time as the dam releases. Rusty said the chambers are just flushed to give fish fresh oxygenated water. That is the intermittent approach that allows multiple measurements on one fish. There is also a "pulse" flushing during the swimming tests to simulate the effect of a pulse of water released from the dam, that will be applied along with an exchange of cooler water (4-5 degrees C), simulating the actual environment below Harris Dam. The timing is more about how long it takes to get a good respirometry measurement and is not exactly mimicking the full variation in the river. Martha asked for clarification on whether this study will be mimicking what is happening in the Tallapoosa River. Ehlana said water is being exchanged for about 10-15 minutes to drop the temperature while maintaining a constant speed so the fish are subjected to a change in temperature but not a change in water velocity. Auburn University then monitors changes in the fish caused by changes in temperature, but there is no way to completely mimic the conditions of the Tallapoosa River and all the effects of Harris Dam operations.

Sarah asked about the lack of information on the Tallapoosa Bass and the use of the Alabama Bass as a surrogate species. Is it a concern that there is not enough data on a lotic species? Auburn University stated it would be preferable to have a surrogate lotic species, but there are limitations on what can be used as a surrogate. Rusty said they are looking at temperature parameters in the literature and a surrogate with similar life histories is sufficient. Sarah asked if there were any other surrogate species to be considered as a lotic species. Dennis said these surrogate species were determined after discussion with Alabama Power and ADCNR. A closely related species is ideal, but there is not much physiological data on any Redeye Bass species.

Donna asked if spawning and hatching data will be used in any capacity. Eli said they will be looking at some reproductive measures so they will be looking at gonads but will not be looking directly at spawning and hatching. Jason said as part of the desktop assessment, some spawning and recruitment literature was reviewed, so that portion of the Draft Aquatic Resources Study Report will have some information on those topics.

In addition, Jimmy Traylor (downstream property owner) asked how the feeder creeks (i.e., tributaries on the Tallapoosa River) vary from the mainstem as far as species diversity. Ehlana said other researchers at Auburn University are looking at tributaries but all research for this study is being done in the mainstem of the Tallapoosa River. Rusty said in general, these tributaries may or may not have higher diversity. Jimmy noted that the fish population in the feeder creeks is much less than what it was since the dam was built. Jimmy also noted there is an overall reduction in bugs and frogs. He thinks it would be worth studying. Rusty agreed that there is a link between the mainstem of the Tallapoosa River and tributaries, but other variables have contributed to changes in the aquatic community, including development in the watershed. Jimmy said since construction of Harris Dam, the temperature difference between the creeks and

the dams has reversed with cooler water now in the mainstem of the Tallapoosa River and warmer water in the tributaries.

Next, Drew Morgan (stakeholder) asked if the study scope includes assessing the species above Harris Dam. Eli said that it is not within the scope of this study. Dennis noted there is not enough information, with just one upstream sampling site, to conclude that there is more diversity upstream. Jason said the desktop assessment includes both regulated and unregulated upstream portions of the mainstem of the Tallapoosa River.

Jimmy asked if Elise Irwin (United States Geological Survey) would present data from the study she conducted prior to Harris relicensing. Angie stated that all available information, including Elise Irwin's research, was included in the Summary of R. L. Harris Downstream Flow Adaptive Management and History Research (Appendix E), filed with the Preliminary Application Document (PAD) and this current study will compliment that work. Jimmy then asked who was doing a study on bugs. Angie replied that macroinvertebrate data was included in Appendix E of the PAD. Jason commented that the gut content analysis of collected fish will provide insight into which macroinvertebrates are being utilized for food.

Jason stated that the next step is to release the Draft Aquatic Resources Study Report to the HAT in July 2020. Additional HAT 3 meetings will be held in the fall. Angie will schedule another HAT meeting once everyone has had time to review the Draft Aquatic Resources Study Report and the meeting summary and presentation will also be on the Harris relicensing website. Angie reminded everyone that any comments on the Initial Study Report and Draft study reports should be filed with FERC by June 11, 2020.

ATTACHMENT A
HARRIS ACTION TEAM 3 MEETING ATTENDEES

Angie Anderegg – Alabama Power
Dave Anderson – Alabama Power
Jeff Baker – Alabama Power
Evan Collins – United States Fish and Wildlife Service
Jason Carlee – Alabama Power
Keith Chandler – Alabama Power
Allan Creamer – Federal Energy Regulatory Commission (FERC)
Dennis Devries – Auburn University
Colin Dinken – Kleinschmidt Associates
Jeff Duncan – National Park Service
Amanda Fleming – Kleinschmidt Associates
Todd Fobian – Alabama Department of Conservation of Natural Resources
Chris Goodman – Alabama Power
Lisa Gordon – Environmental Protection Agency
Martha Hunter – Alabama Rivers Alliance (ARA)
Elise Irwin – United States Geological Survey
Carol Knight – Downstream Property Owner
Eli Lamb – Auburn University
Donna Matthews – Tallapoosa River Heritage
Lydia Mayo – Environmental Protection Agency
Ashley McVicar – Alabama Power
Tina Mills – Alabama Power
Jason Moak – Kleinschmidt Associates
Drew Morgan - Stakeholder
Barry Morris – Lake Wedowee Property Owners Association
Sarah Salazar – FERC
Kelly Schaeffer – Kleinschmidt Associates
Ehlana Stell – Auburn University
Jimmy Traylor – Downstream Property Owner
Jack West – ARA
Russell Wright – Auburn University

Using Bioenergetics to Address the Effects of Temperature and Flow on Fishes in the Harris Dam Tailrace

HAT-3 Aquatic Resources Update Meeting

~~19 March 2020~~ 2 June 2020

Study Species

Alabama Bass

Micropterus henshalli

- Habitat generalist
- Omnivore

Joseph Tomellari

Tallapoosa Bass

Micropterus tallapoosae

- Lotic Specialist
- Omnivore

Joseph Tomellari

Redbreast Sunfish

Lepomis auritus

- Lentic Specialist
- Invertivore

Duane Raver

Channel Catfish

Ictalurus punctatus

- Benthic specialist
- Omnivore

Maynard Reece

Project Objectives

1. Summarize the data that are available in the literature concerning temperature requirements for target species, including spawning and hatching temperatures, lethal limits, and thermal tolerance.

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    - Tallapoosa Bass
        - Redeye bass
        - Described in 2013: limited data available

Project Objectives

1. Summarize the data that are available in the literature concerning temperature requirements for target species, including spawning and hatching temperatures, lethal limits, and thermal tolerance.

    - Tallapoosa Bass
        - Redeye bass
        - Described in 2013: limited data available
    - Alabama Bass
        - Similar species, possible surrogate
        - Described in 2008: limited data available
        - Spotted bass next possible surrogate?

	Thermal Minima	Optimal Temp Range	Preferred Temps[1]	Thermal Maxima	Ideal Spawning	Sources
Redbreast Sunfish	15	27-29, 25-30	18-32	36	21,20-25,22-26	Mathur et al. 1981; Aho et al. 1986; Sammons and Maceina 2009; Beauchene et al. 2014
Tallapoosa Bass	--	--	--	--	--	nothing currently available
Alabama Bass/Spotted Bass	10	23.5-24.4		34?	14-15	McMahon et al. 1984
Channel Catfish	6.5, 18	26-29	15-31	33.5,38.7; 28-30 for fry	21	Mathur et al. 1981; McMahon and Terrell 1982
			[1]=depends on acclimation temps			

	Thermal Minima	Optimal Temp Range	Preferred Temps[1]	Thermal Maxima	Ideal Spawning	Sources
Red Su						
Talla B						
Ala Bass/ B						
Ch Ca						
			[1]=depends on acclimation temps			

Some takeaways . . .

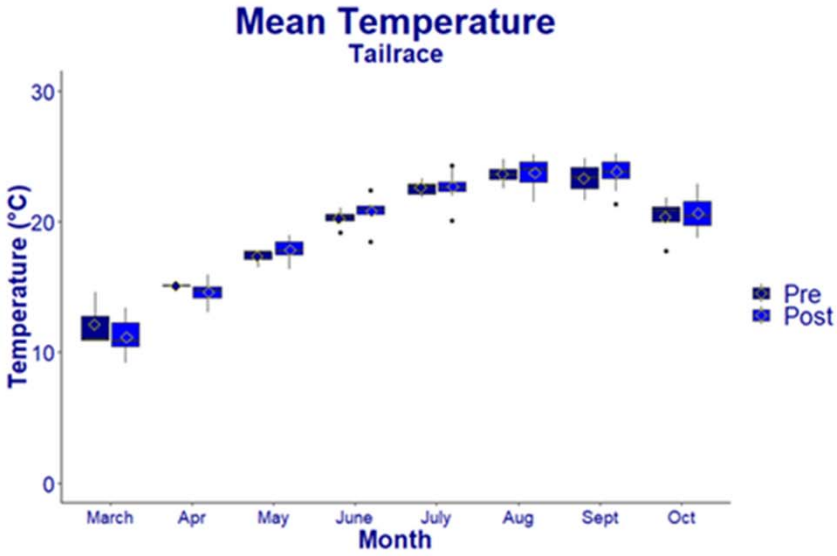
- Most data are available for channel catfish (but not from moving waters)
- There are no lethal temperature trial data
- Acclimation temperatures can be important . . .

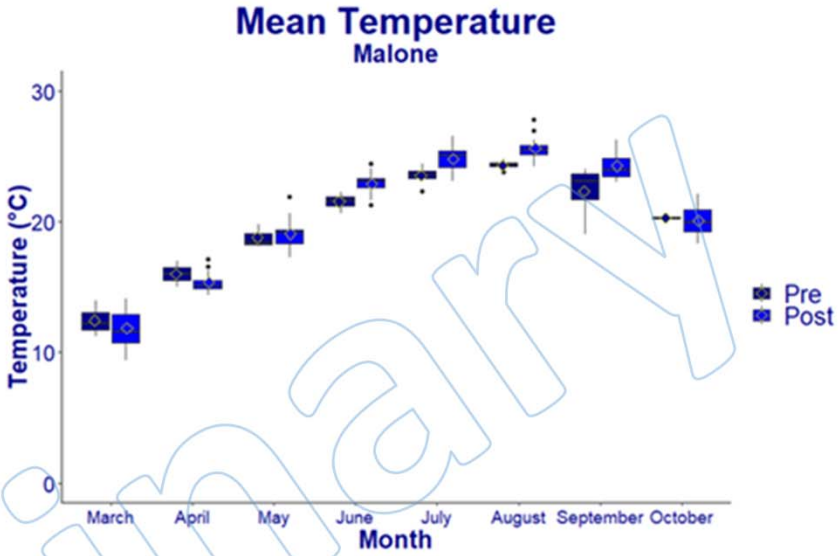
Project Objectives

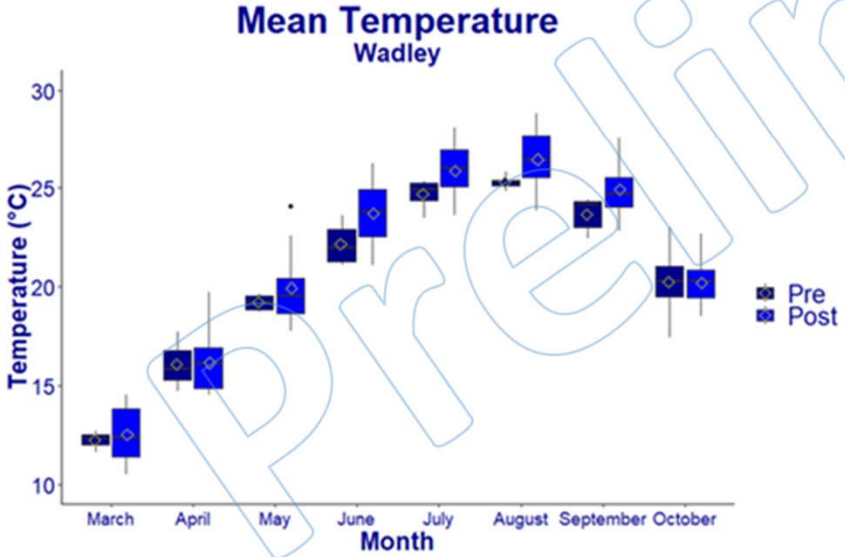
2. Summarize the data that are available in reports and from relevant agencies for water temperatures across a gradient downstream from the Harris Dam tailrace and compare those data with similar data from reference sites upstream of Harris Reservoir.

    - Results presented previously at the 19 March 2019 HAT 3 meeting.
    - 3 sites (Tailrace, Malone, Wadley)
    - 2000-2018 data from the Alabama Power Company
    - 111,366 temperature measurements

There are a LOT of data!!



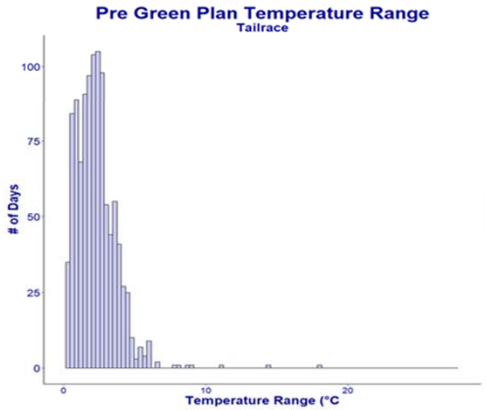


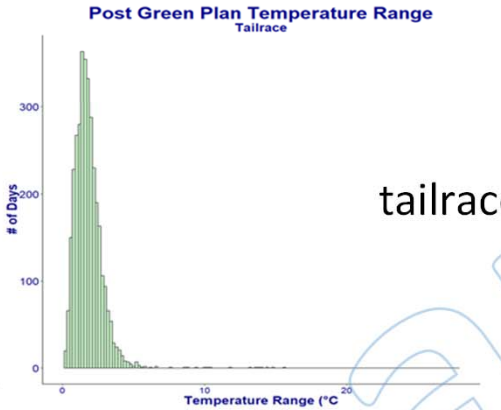


Preliminary

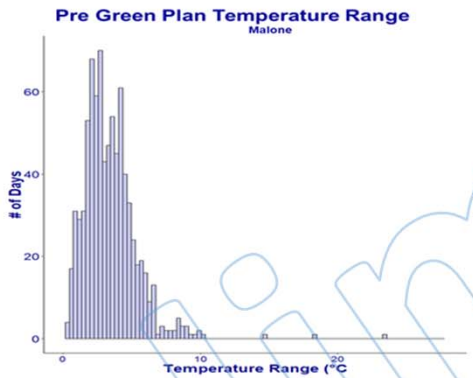
Pre Green Plan

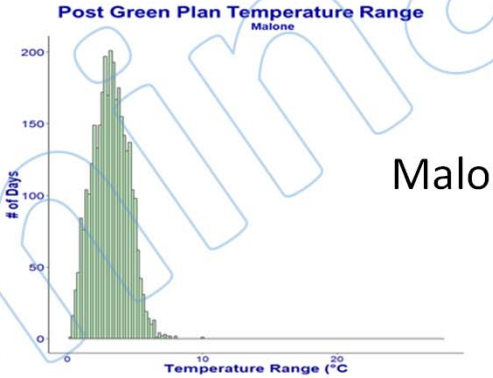
Post Green Plan



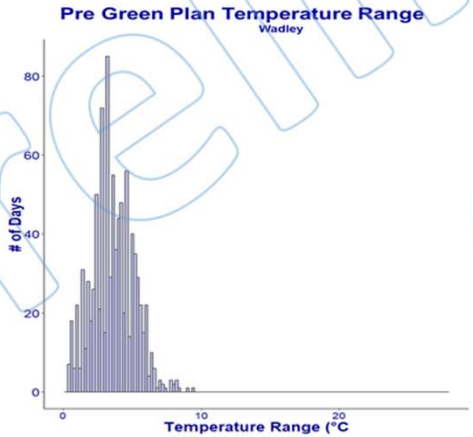


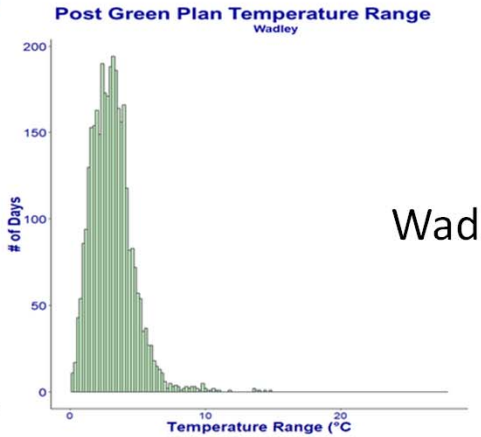
tailrace





Malone



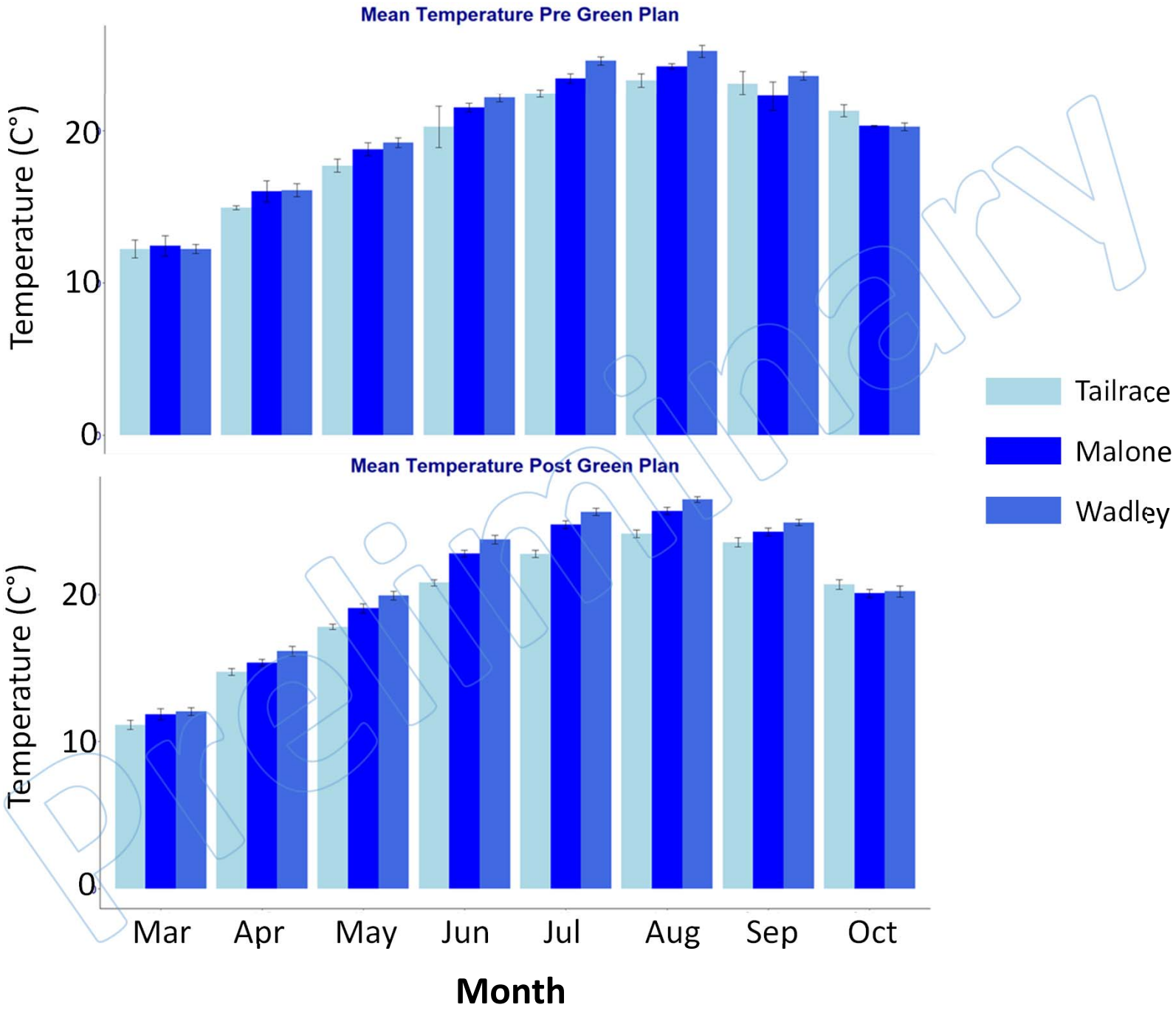


Wadley

# of days

Temperature Range (C)

Preliminary



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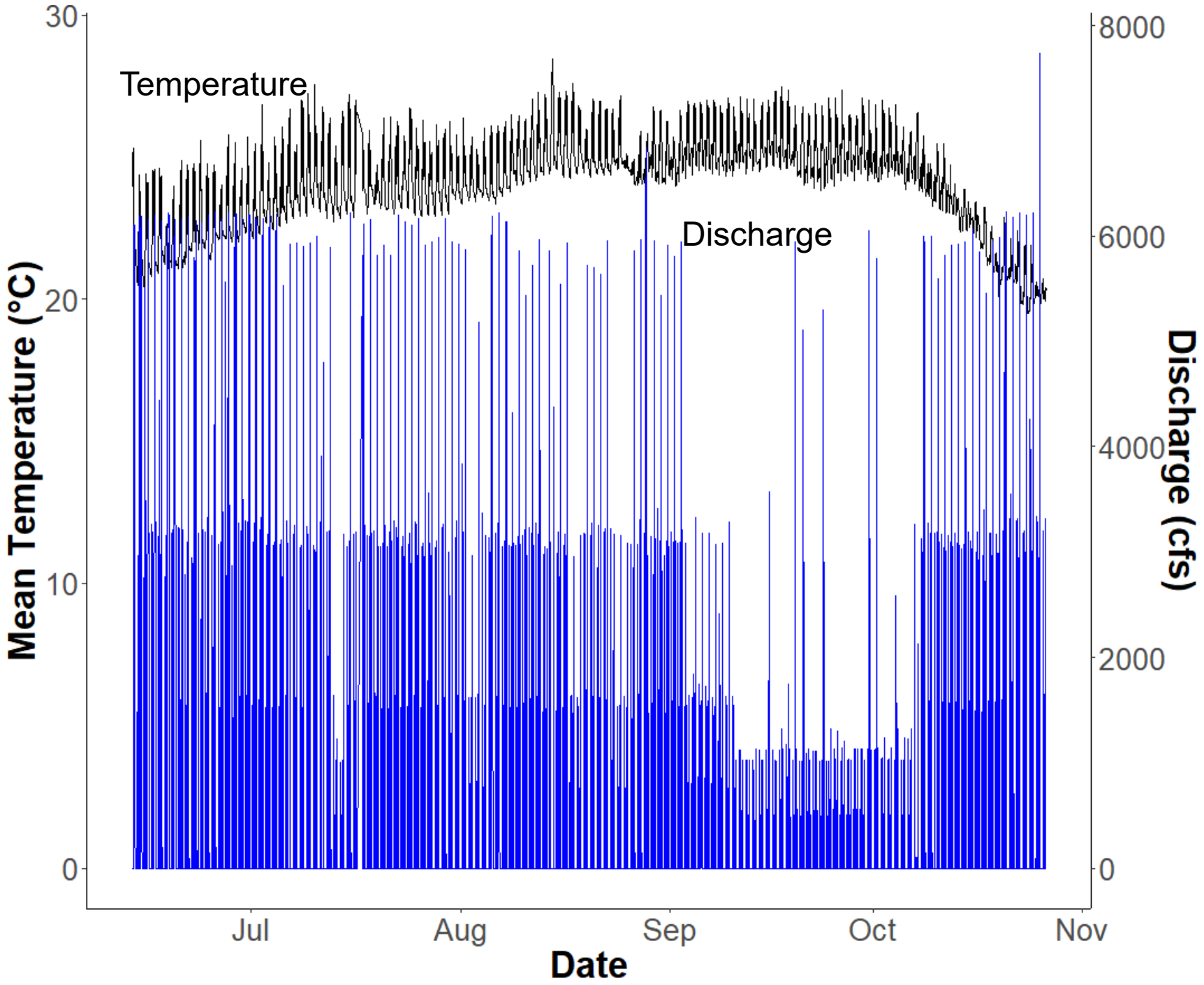
Temperature
Discharge
Mean Temperature (°C)
Discharge (cfs)
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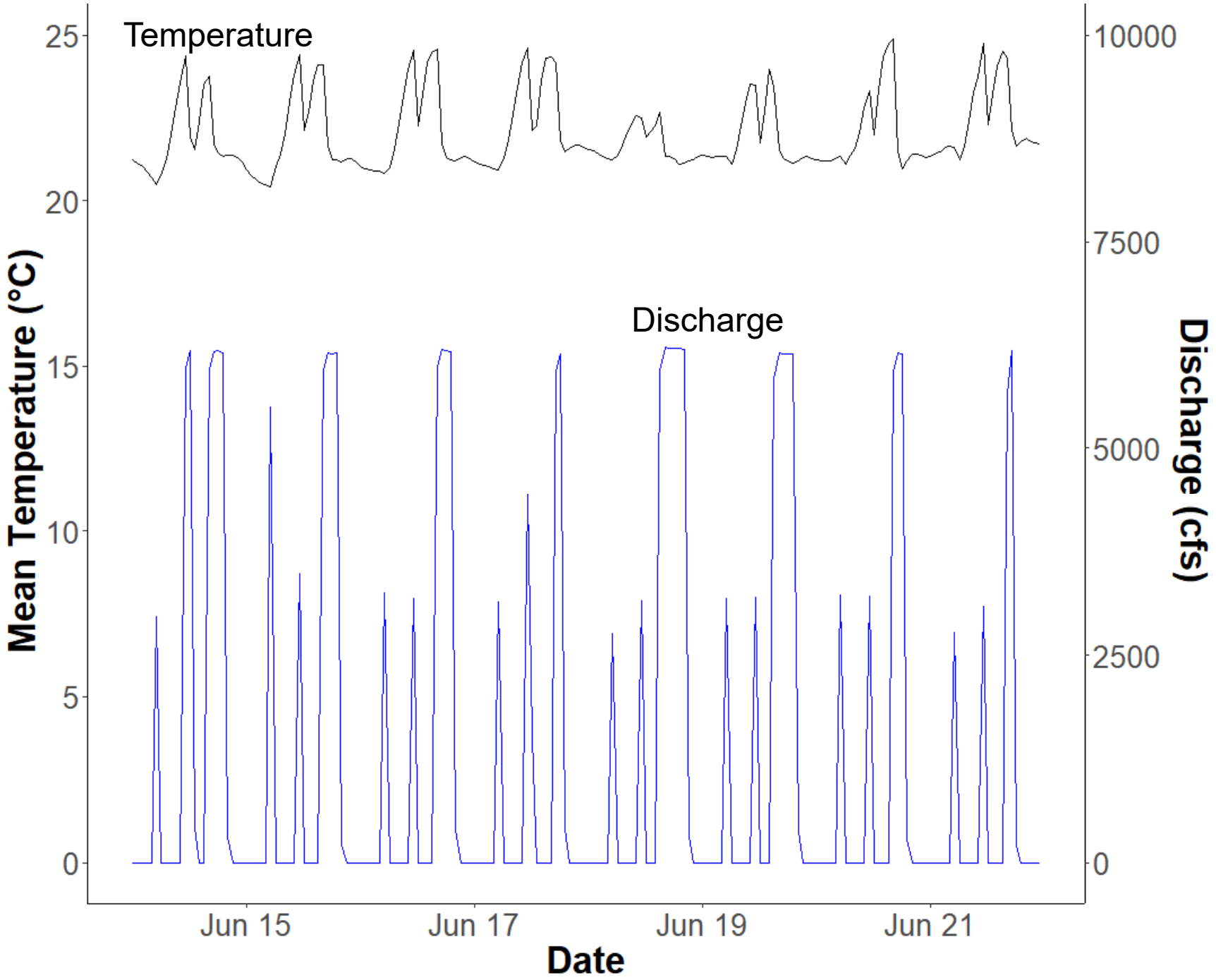
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Mean Temperature (°C)
Discharge (cfs)
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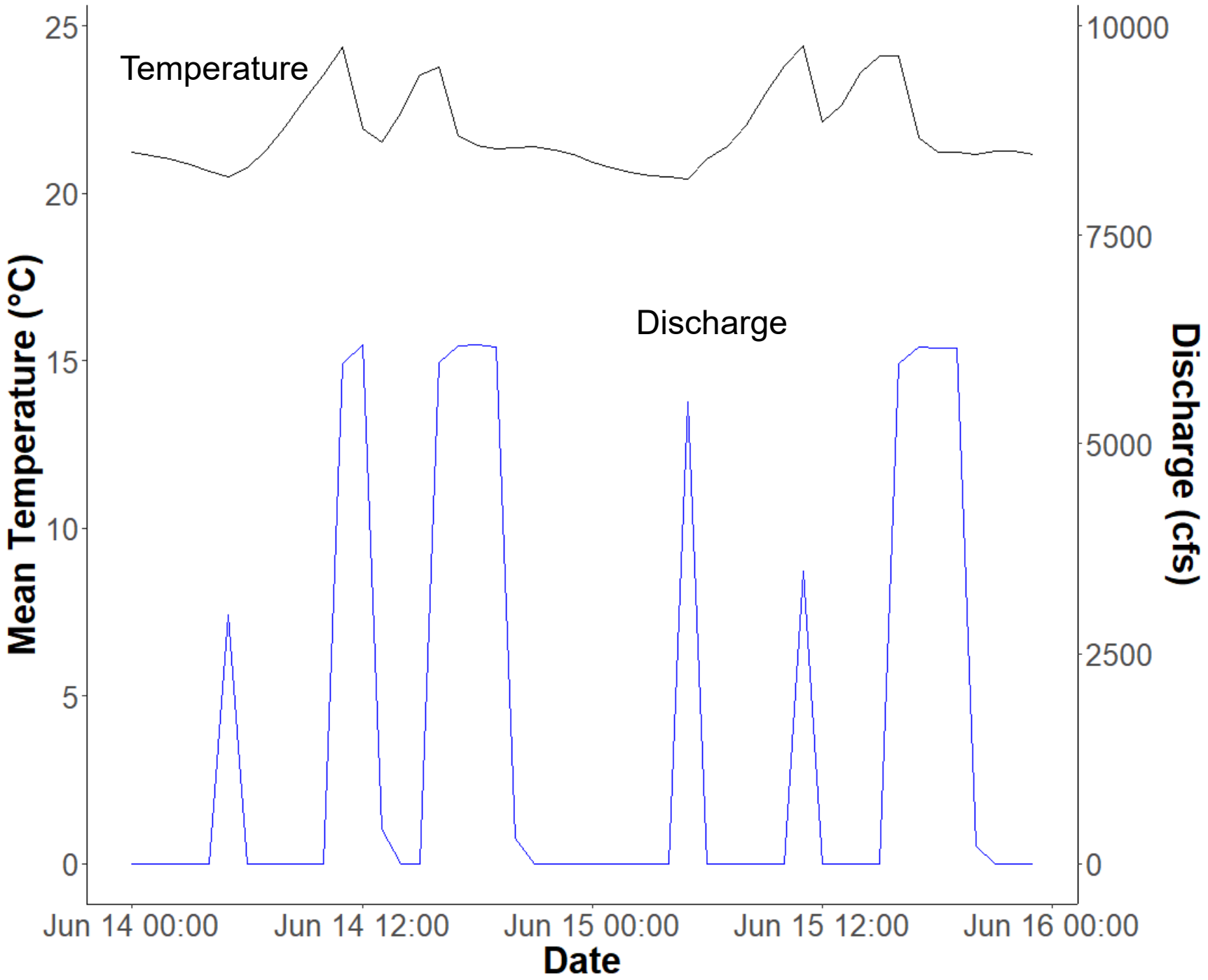
Jun 17
Jun 19
Jun 21
Date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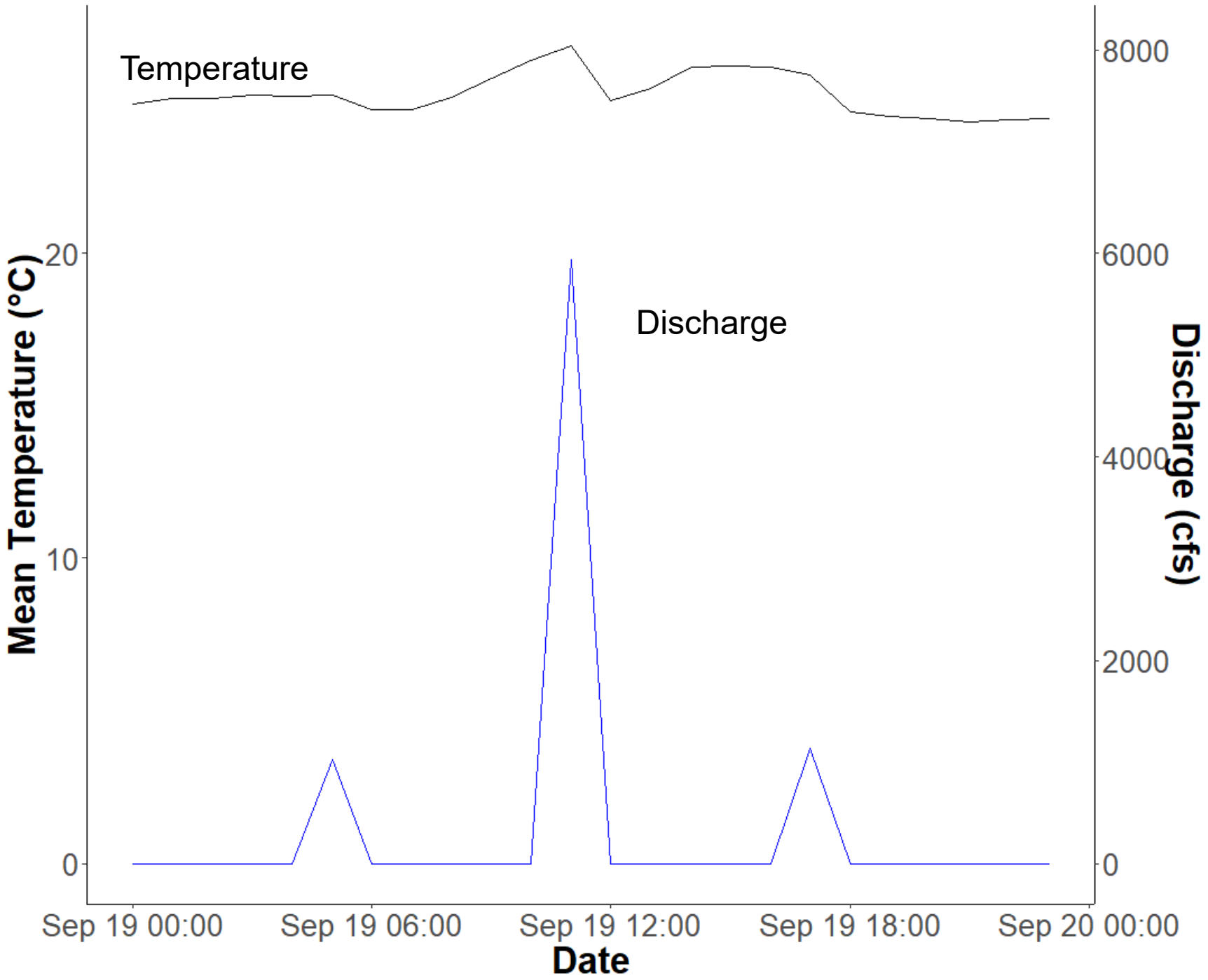
Date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Discharge
Mean Temperature (°C)
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Sep 19 06:00
Sep 19 12:00
Sep 19 18:00
Sep 20 00:00
Date

Some Take-Home Points . . .

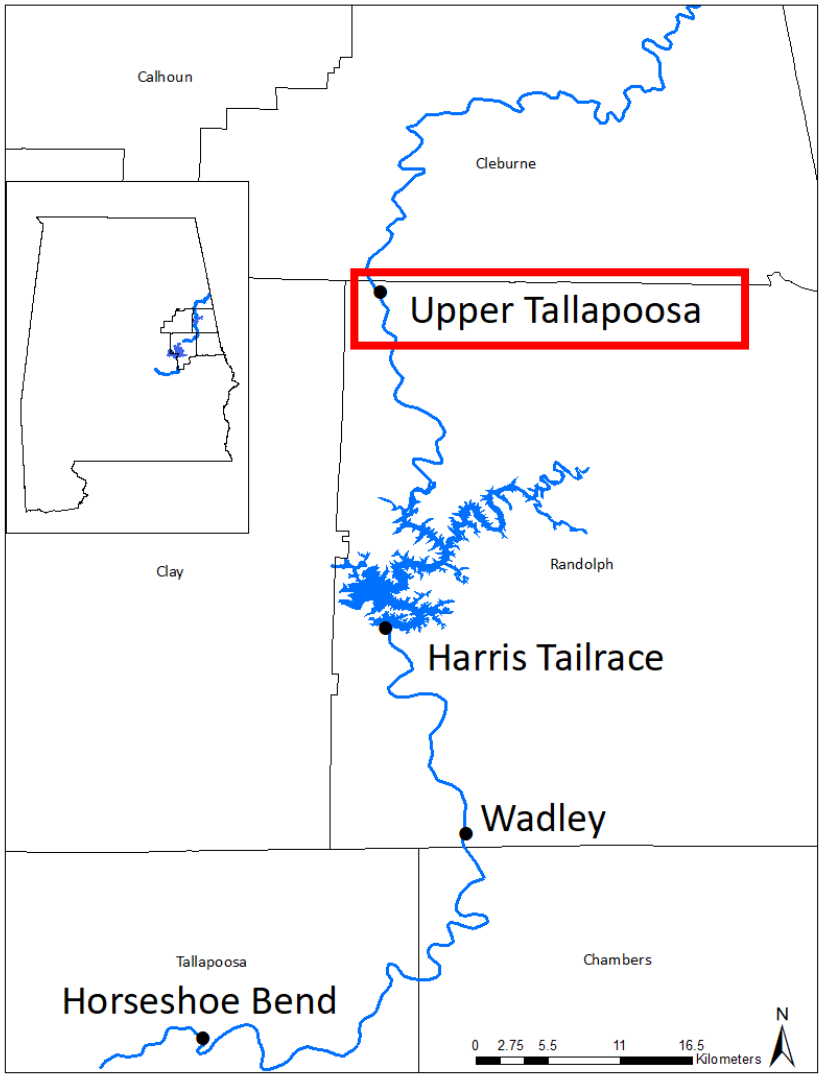
- No significant difference between temperatures before/after Green Plan
- Large variation in temperature during certain times
- Need winter temperature data
- Limited temperature tolerance data for riverine fish of interest
- Discharge changes water temperature over small time scales

Project Objectives

3. Quantify the fish community across a gradient downstream from the Harris Dam tailrace and in a reference site upstream of Harris Reservoir.

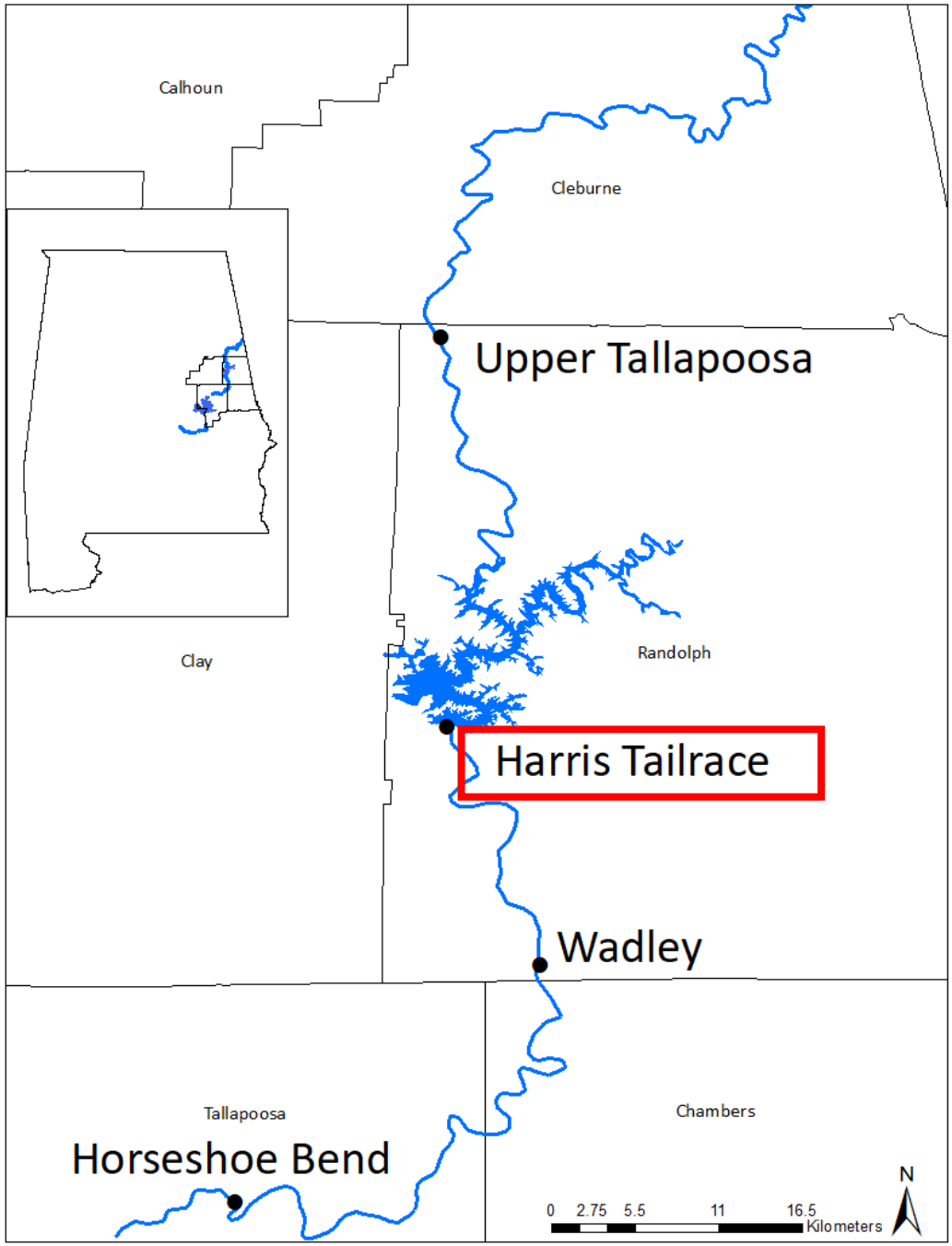
Study Sites

- Mainstem Tallapoosa River
- Three sites regulated by Harris Dam
  - Tailrace
  - Wadley
  - Horseshoe Bend
- One unregulated, upstream site
  - Upper Tallapoosa/Lee's Bridge



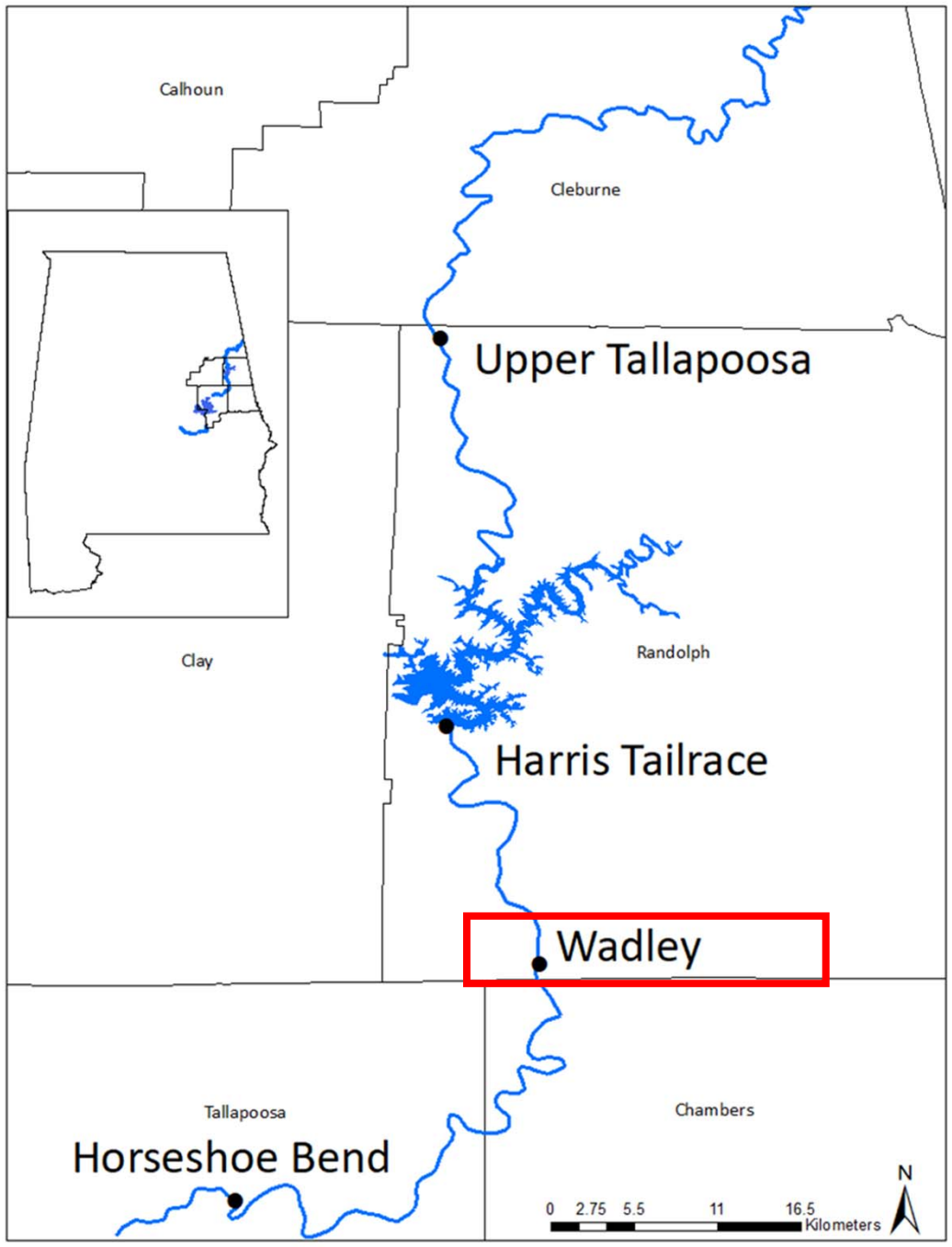
Upper Tallapoosa/Lee's Bridge

- ~45 RKM upstream of Harris Dam
- Small shoal complex at upstream boundary
- Deep, turbid water
- Accessed via ramp on CR-88


Calhoun
Cleburne
Upper Tallapoosa
Clay
Randolph
Harris Tailrace
Wadley
Tallapoosa
Chambers
Horseshoe Bend
N
0 2.75 5.5 11 16.5
Kilometers

Harris Tailrace

- The immediate tailrace of Harris Dam
- Bedrock dominated shoal habitat
- Shallow and clear
- Sampling coordinated with dam release schedule
- Accessed via dam facility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Cleburne
Upper Tallapoosa
Clay
Randolph
Harris Tailrace
Wadley
Tallapoosa
Chambers
Horseshoe Bend
N
0 2.75 5.5 11 16.5
Kilometers

Wadley

- ~23 RKM downstream of Harris Dam
- Upstream and downstream shoal complexes
- Deep, clear water
- Abundant woody debris
- Accessed via bank launch at AL-77

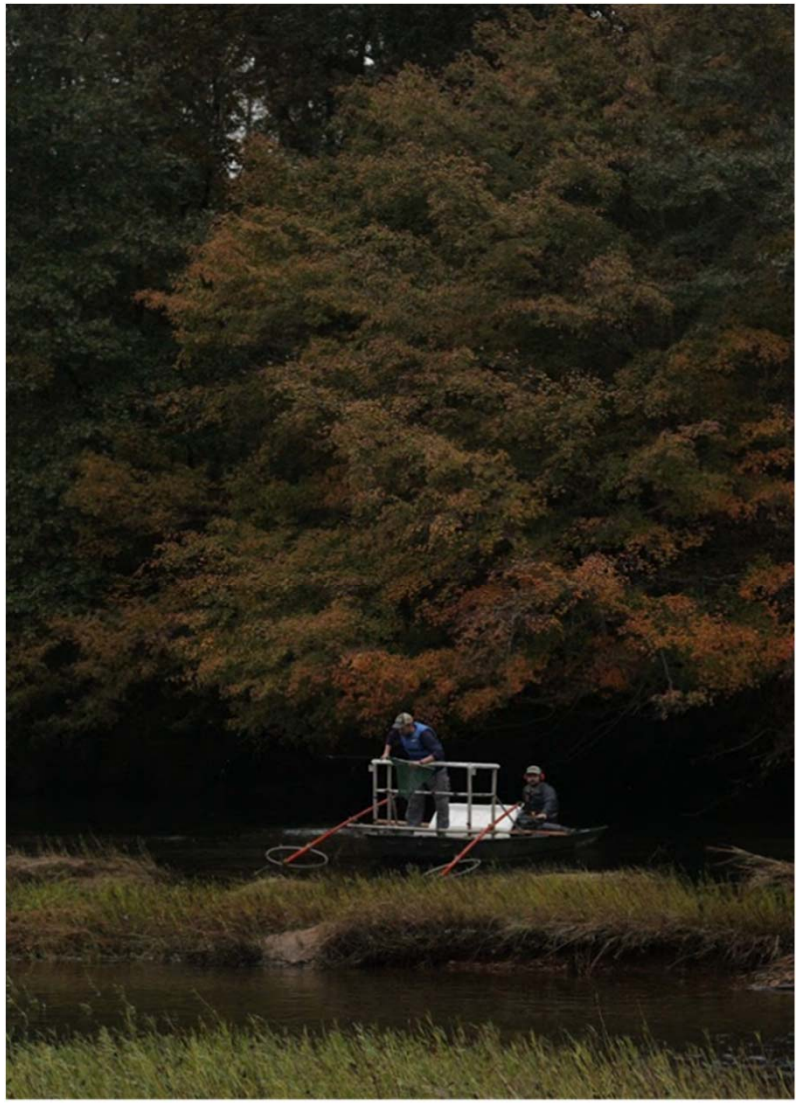
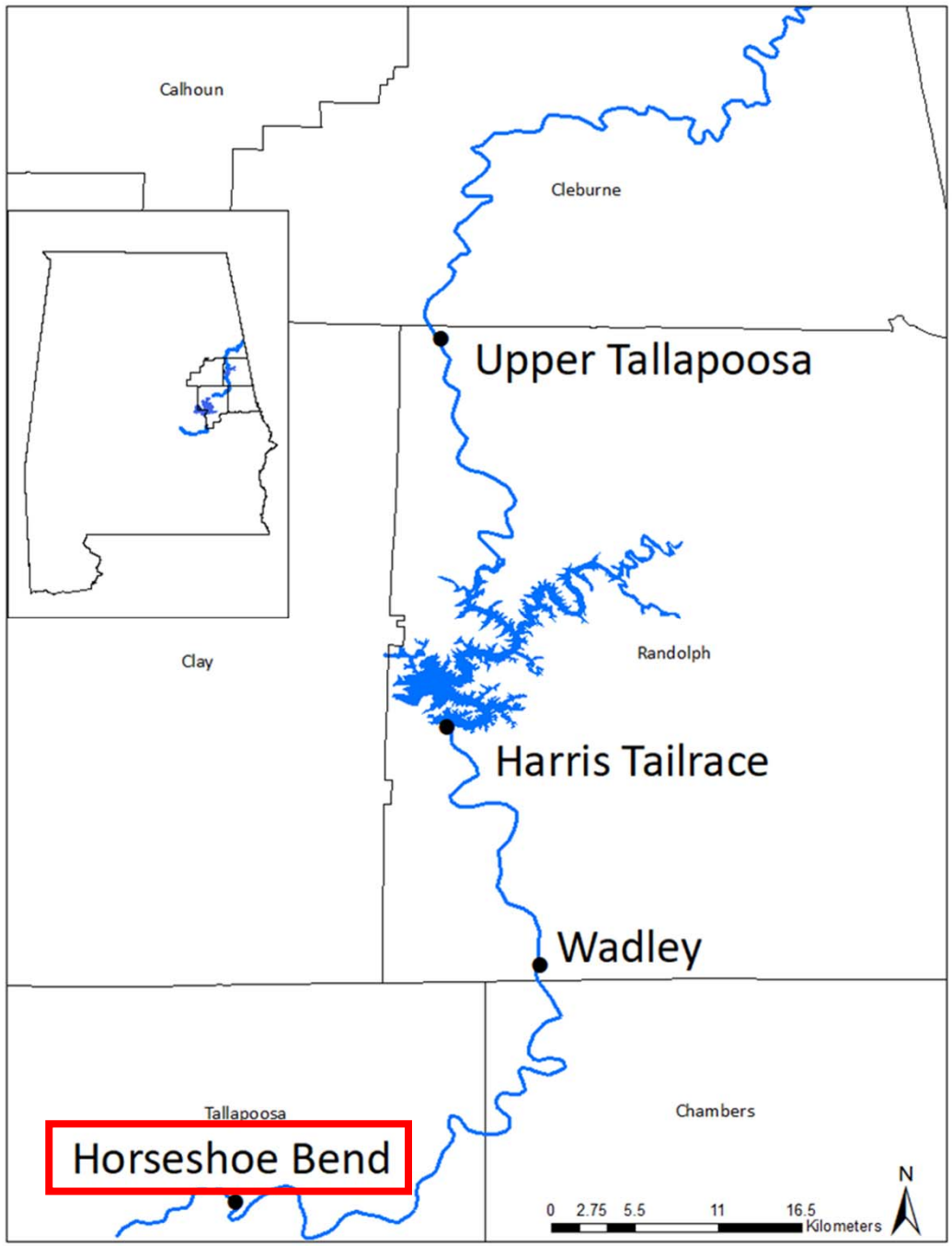


Photo Courtesy of Henry Hershey

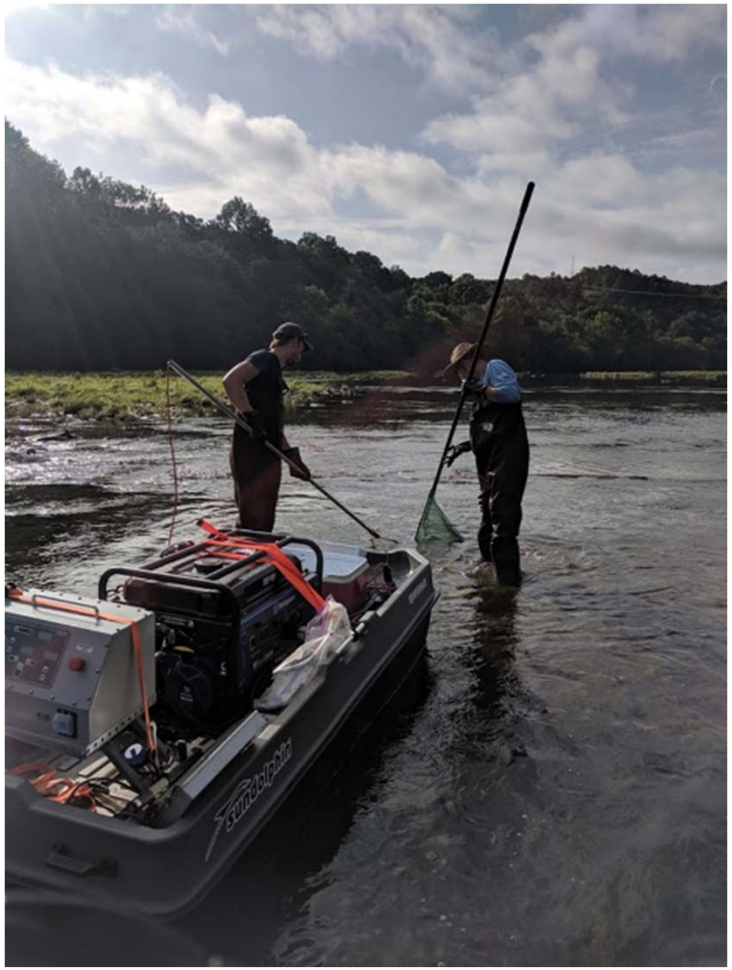

Calhoun
Cleburne
Upper Tallapoosa
Clay
Randolph
Harris Tailrace
Wadley
Tallapoosa
Chambers
Horseshoe Bend
N
0 2.75 5.5 11 16.5
Kilometers

Horseshoe Bend

- ~66 RKM downstream of Harris Dam
- Deep pools bounded by shoal complexes
- Clear, flowing water
- Accessed via Horseshoe Bend National Military Park

Field Methods

- All sites sampled every-other month
- Standardized boat/barge electrofishing
  - 6, 10-minute transects
  - Barge used in the tailrace
  - Fish transported to lab



Lab Methods

- All fish identified to species
- Non-target species
  - 10 of each non-target species weighed/measured
  - Remaining individuals weighed as a group
- Target species
  - Otoliths, gonads, and diets extracted
  - Fin clips collected from Alabama bass and Tallapoosa bass
  - Ages estimated, annuli measured

Species found at more than 1 site

Largescale stoneroller

Alabama shiner

Blacktail shiner

Striped shiner

Silverstripe shiner

Weed shiner

Coosa shiner

Common Carp*

Alabama hogsucker

Black redhorse

Blacktail redhorse

Yellow bullhead

Blue catfish

Channel catfish

Flathead catfish

Blackstripe topminnow

Bold indicates found at all sites; *Non-native

Preliminary

Species found at more than 1 site

Shadow bass

Redbreast sunfish

Green sunfish

Bluegill

Redear sunfish

Hybrid sunfish

Black crappie

Largemouth bass

Tallapoosa bass

Alabama bass

Lipstick darter

Speckled darter

Mobile logperch

Bronze darter

Muscadine darter

Preliminary

Bold indicates found at all sites; *Non-native

Species unique to Lee's Bridge

- Bowfin
- Threadfin shad
- Pretty shiner
- Spotted sucker
- River redhorse
- Total species richness: 28

www.outdooralabama.com/redhorse/river-redhorse

www.outdooralabama.com/other-species/threadfin-shad

Preliminary

Species unique to Harris tailrace

- Snail bullhead
- Tallapoosa darter
- Striped bass
- Rough shiner
- Rosyface shiner
- Total species richness: 33

www.outdooralabama.com/darters/tallapoosa

Preliminary

Species unique to Wadley

- Brown bullhead
- Speckled madtom
- Tallapoosa shiner
- Redbreast sunfish hybrid
- Total species richness: 30

www.outdooralabama.com/shiners/tallapoosa

Preliminary

Species unique to Horseshoe Bend

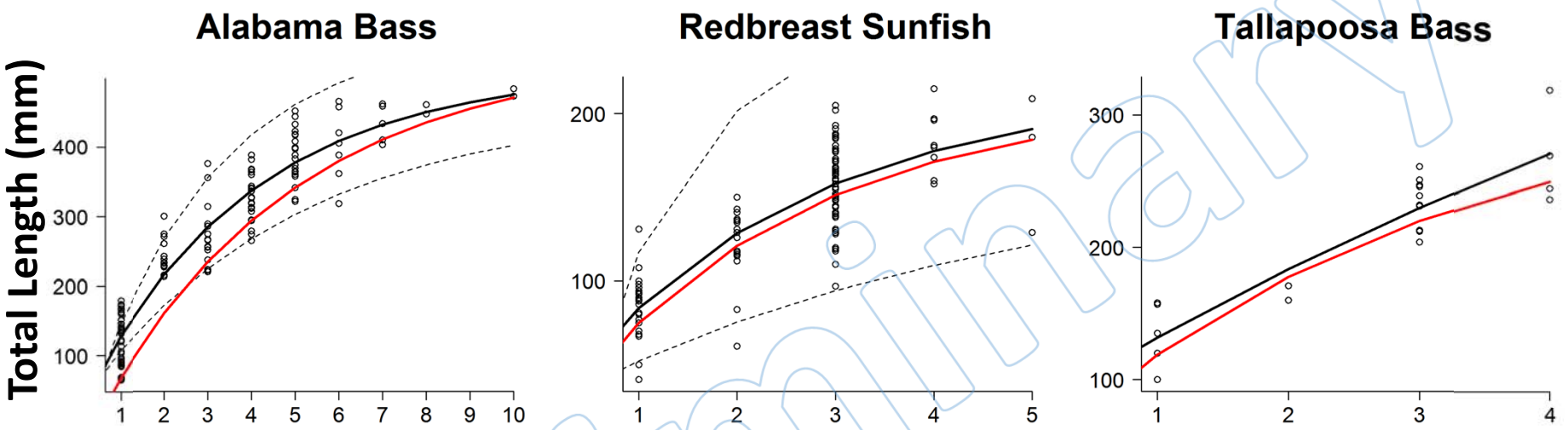
- Blueback herring*
- Skipjack herring
- Blackspotted topminnow
- Warmouth
- Total species richness: 33

*Non-native

www.outdooralabama.com/other-species/skipjack-herring

Preliminary

Preliminary Results – von Bertalanffy Growth Curves



L_∞=507.17
K=0.26
T_0=0.91
CPUE: 12.0hr^{-1}

L_∞=216.05
K=0.41
T_0=0.83
CPUE: 9hr^{-1}

L_∞=633.39*
K=0.11
T_0=0.32
CPUE: 1.2hr^{-1}

Preliminary

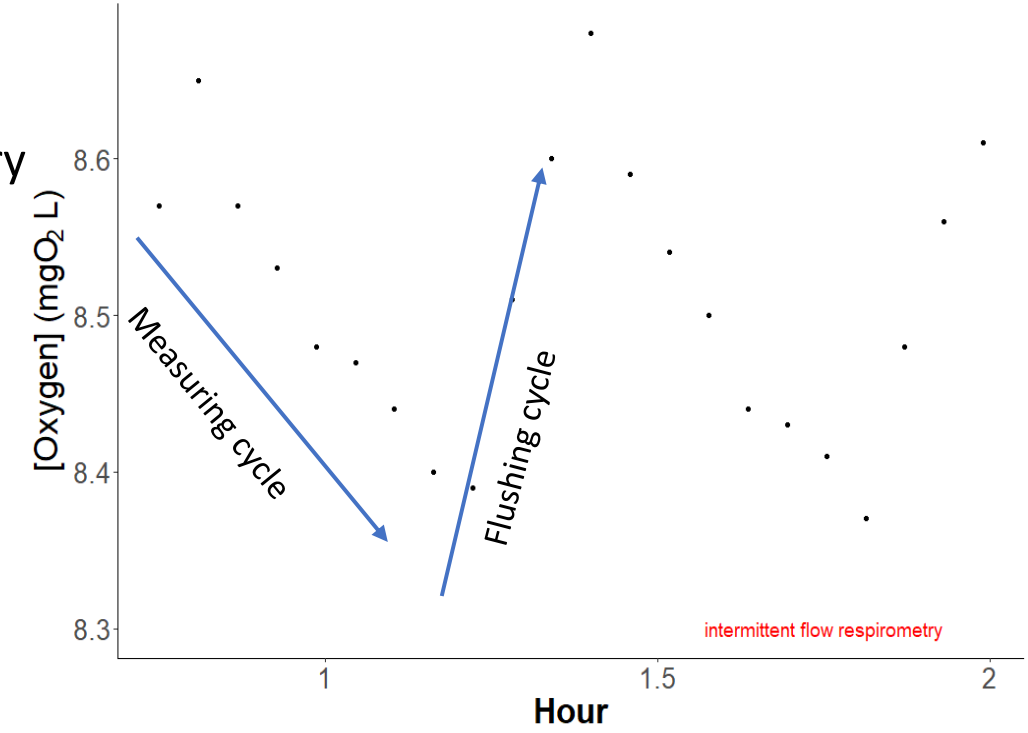
Objective 4

- Quantify effects of temperature and flow variation on target fish species energy budgets using bioenergetics modeling

  - Part 1: Respirometry
    - Static Respirometry
    - Swimming Respirometry

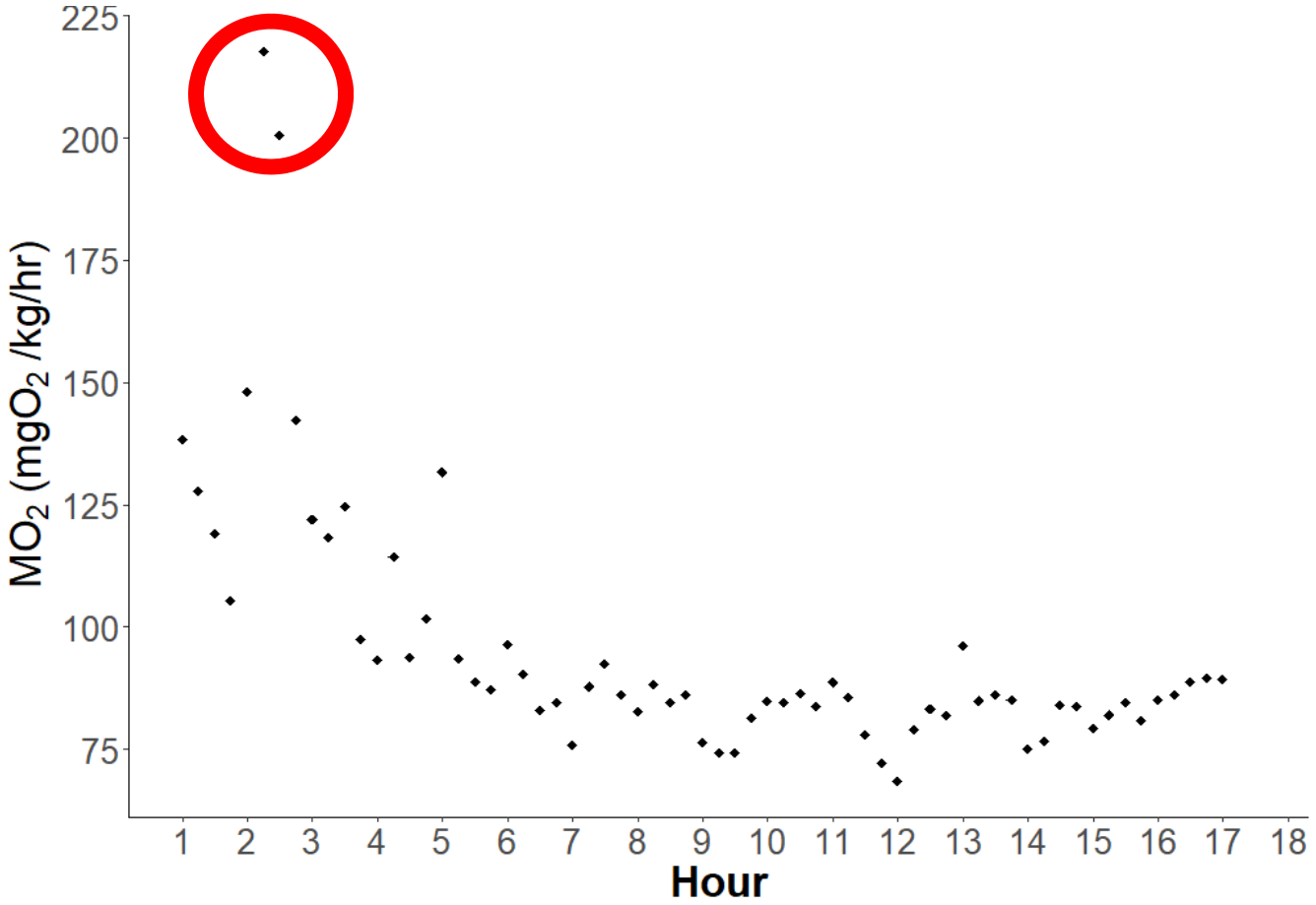
Static Respirometry

- Standard metabolic rate
  - Stationary, no swimming
    - Intermittent flow respirometry
    - Closed respirometry
- MO_2 ($mgO_2kg^{-1}hr^{-1}$)
  - (initial $[O_2]$ – final $[O_2]$) * (V_c/t) / W
- Requires acclimation time



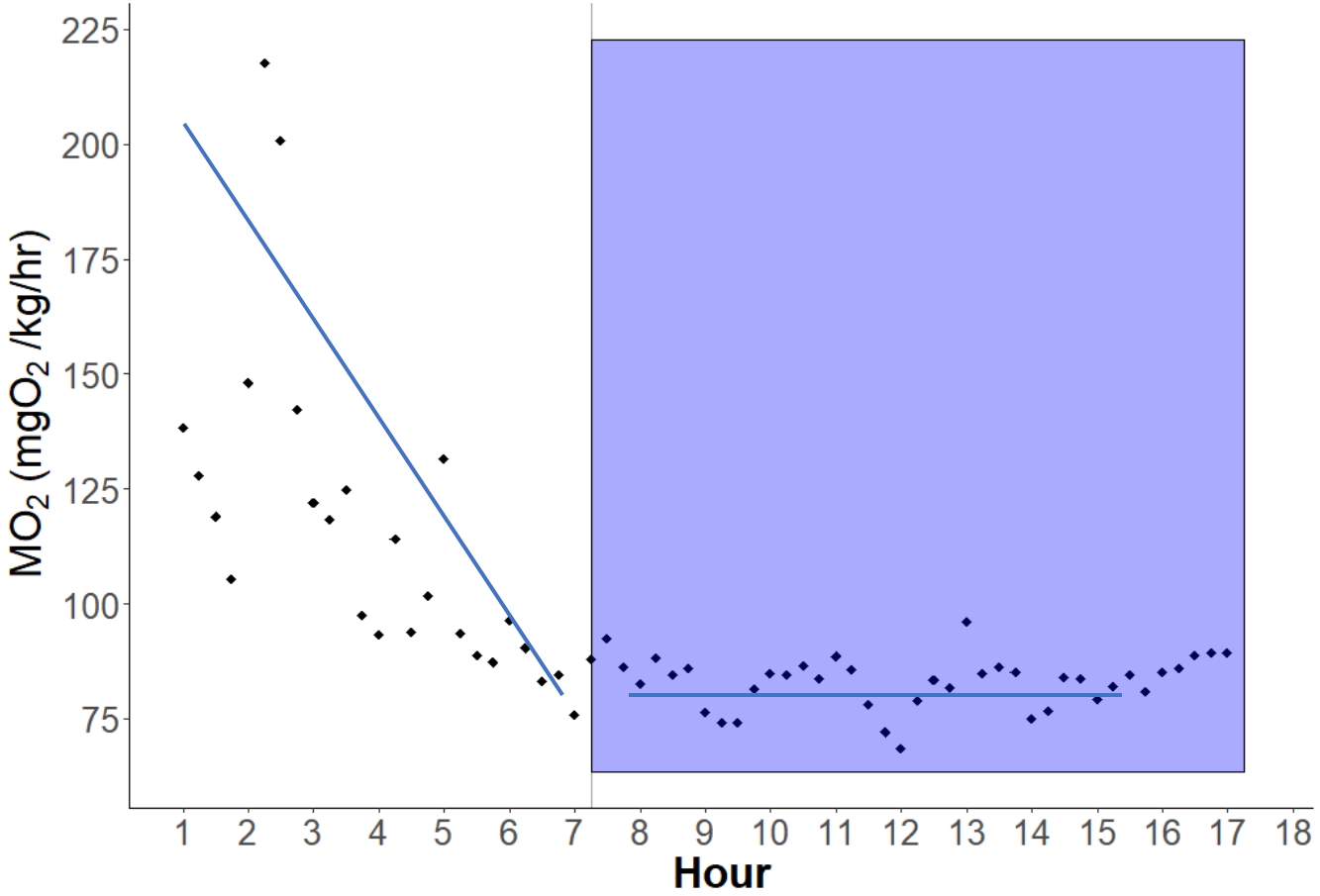
Static Respirometry

- Point stress event
- Determine acclimation



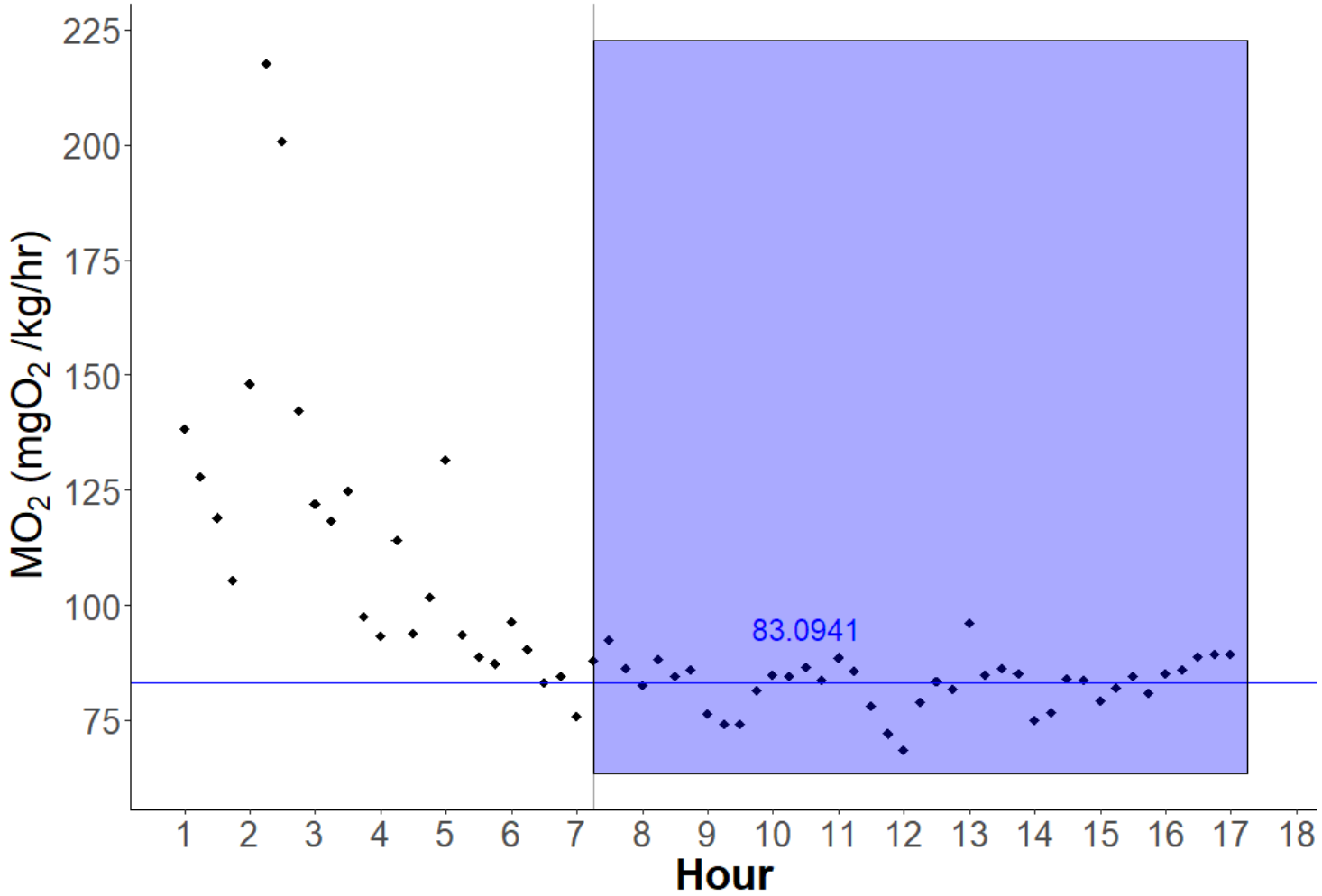
Static Respirometry

- Acclimation determination
  - Break point
    - Differs per individual



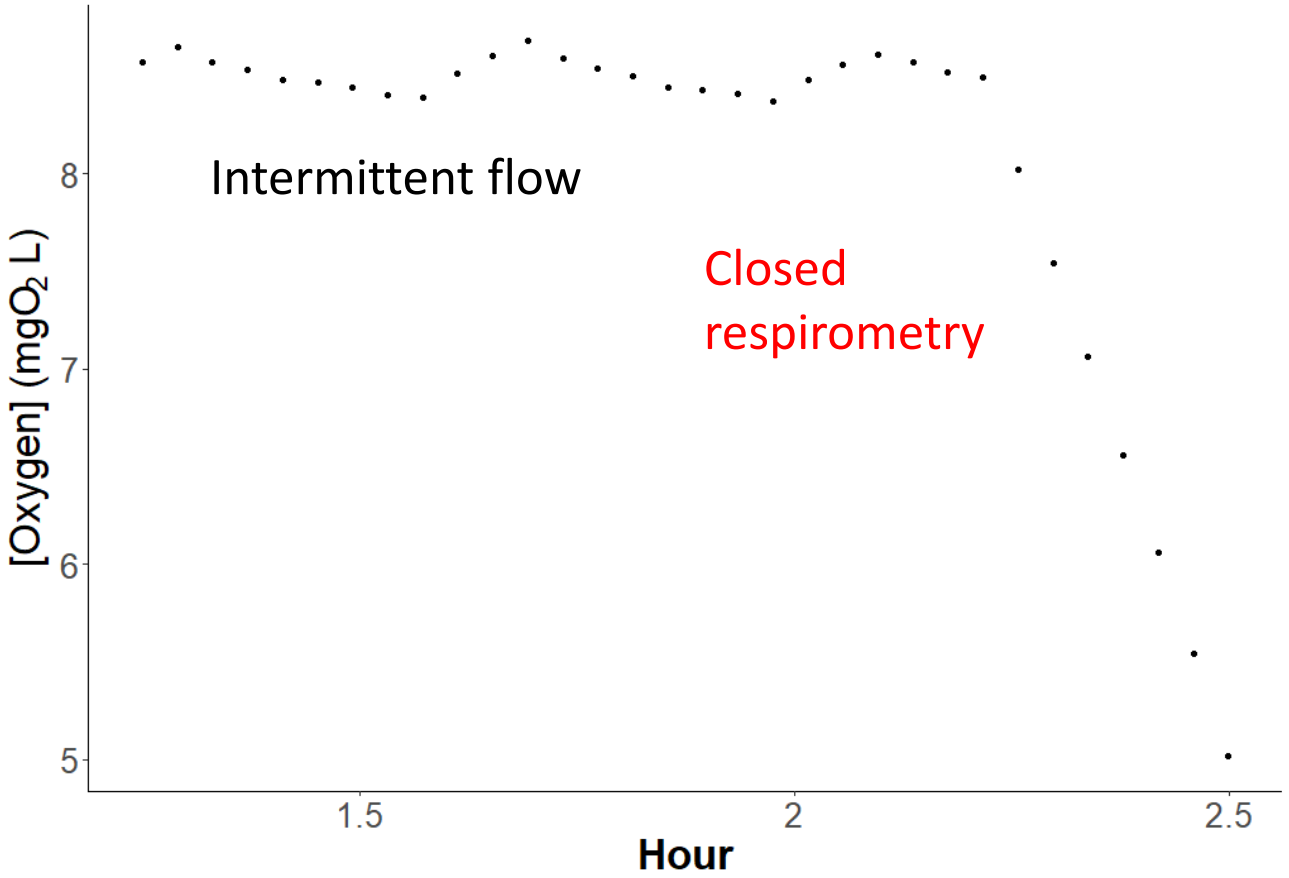
Static Respirometry

- Acclimation determination
  - MO_2 = 83.094



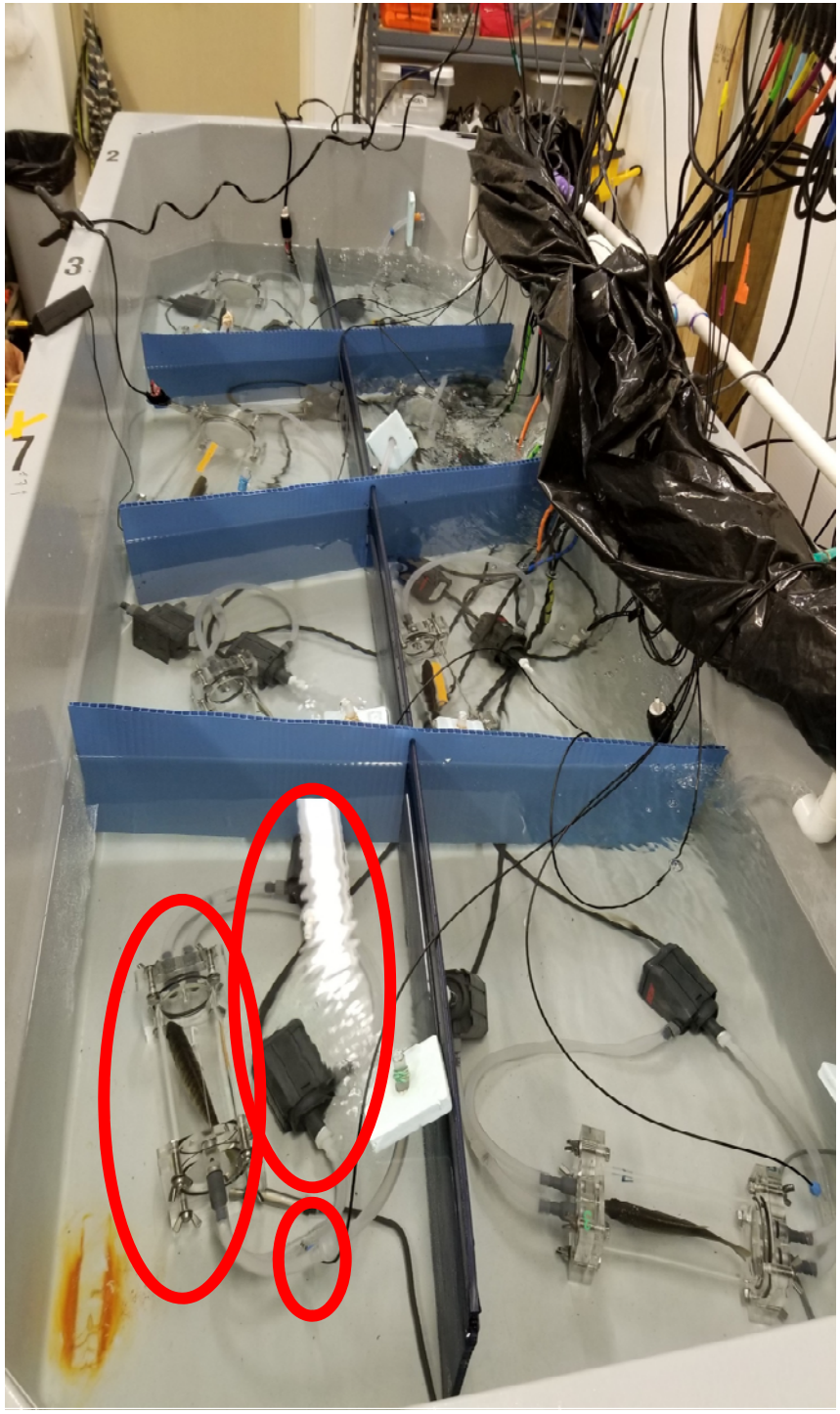
Static Respirometry

- Closed respirometry
  - No flushing
  - Final measurement
- Calculate overall MO_2



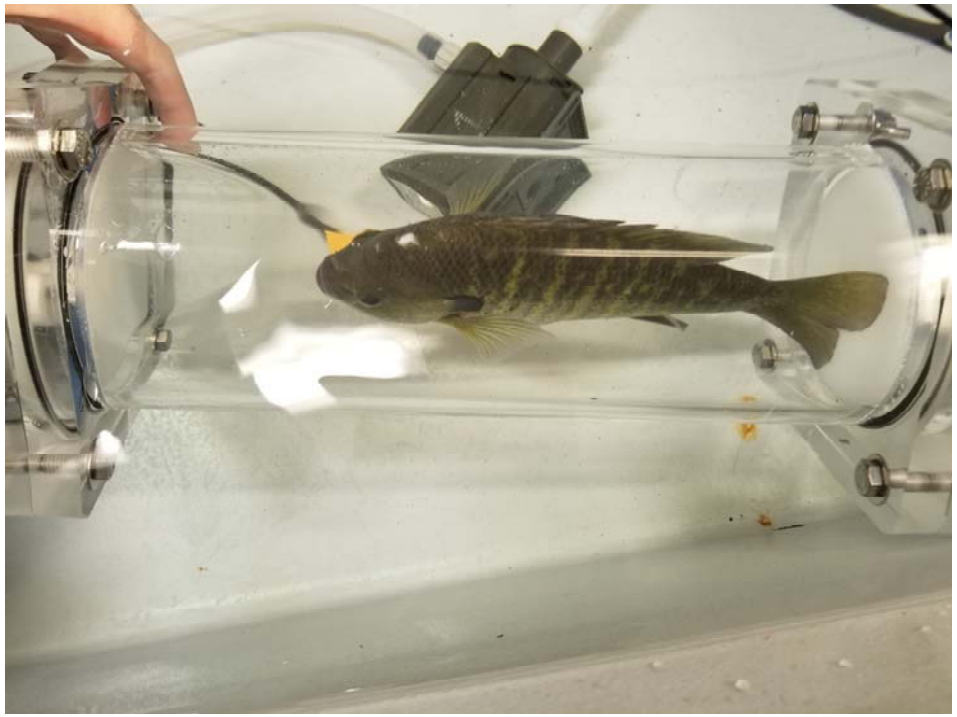
Static Respirometry

- 8 chamber system (Loligo)
  - Medium chambers: ~600 ml
  - Large chambers: ~2600 ml
- Intermittent flow respirometry
  - Automated
- Temperature controlled
- Oxygen measured electronically



Static Respirometry

- Standard metabolic rate 21°C
  - Channel Catfish (n=2)
    - Weight range: 306 – 314 g
  - Alabama Bass (n=7)
    - Weight range: 17.36 -158.2 g
  - Redbreast Sunfish (n=14)
    - Weight range: 17.14 – 87.8 g
  - Tallapoosa Bass (n=1)
    - Weight range: 103.5 g



Static Respirometry

- Fish weighed
- Acclimated in chamber
  - 12 hr + 1
  - Intermittent flow respirometry
    - 1200/180 s
- Closed respirometry

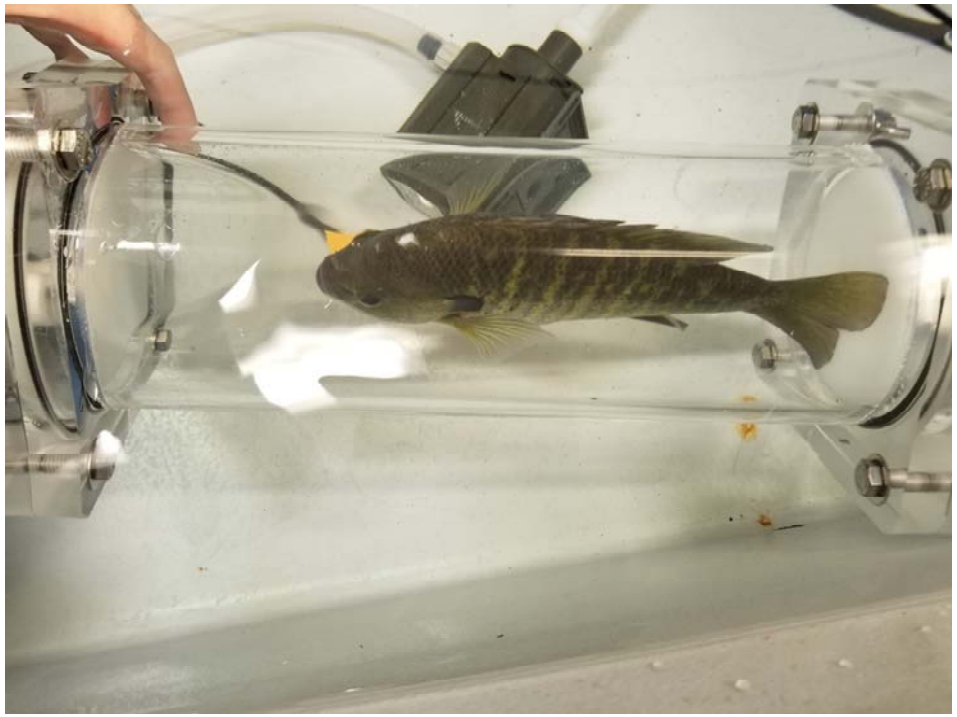
Preliminary Static Respirometry 21°C

Size (g)	Redbreast Sunfish	Alabama Bass	Channel Catfish	Tallapoosa Bass
14-34	104.570 (2)	120.917 (3)		
34.1-54	89.299 (4)	114.736 (1)		
54.1-74	114.267 (4)	97.993 (1)		
74.1-94	85.518 (4)	54.176 (1)		
94.1-114				78.029 (1)
294.1-314			89.373 (2)	
354.1-374		68.598 (1)		

Preliminary

Work in 2020

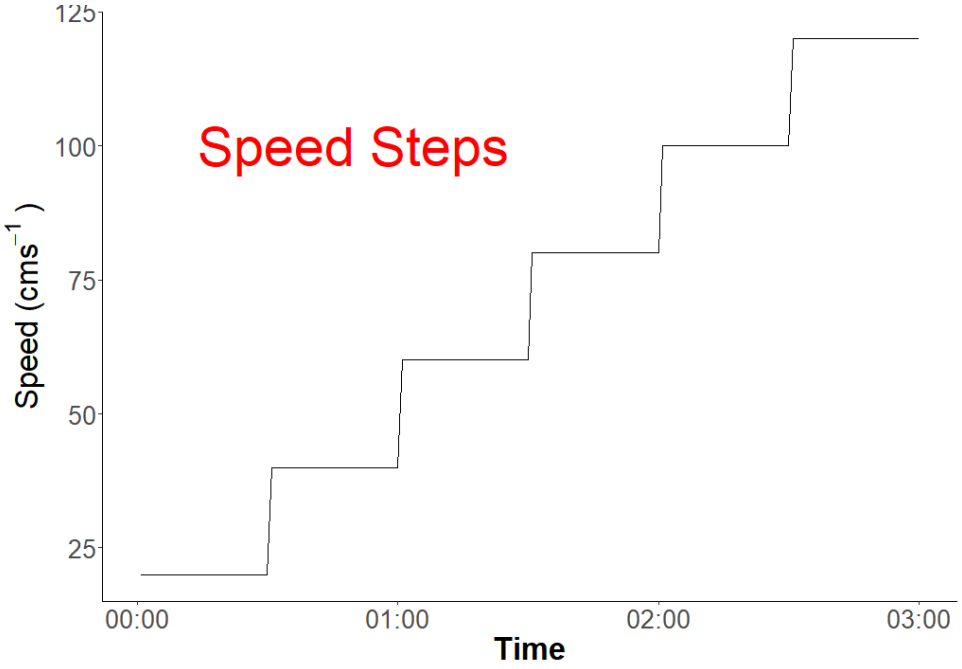
- Test fish from all species from all sites
- Add 10°C temperature trials



Swimming Respirometry & Performance

- Active metabolic rates
  - Metabolic rate of fish at given swimming speed
- Swimming performance
  - Critical swimming speed

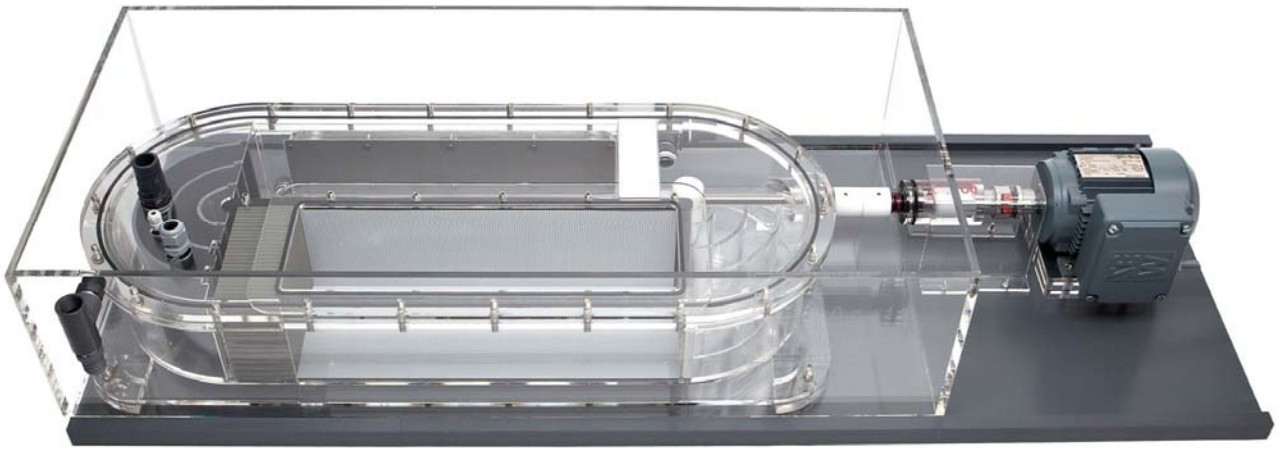
Swimming Performance



- Critical Swimming Speed
- $U_{crit} = U_1 + U_2(\frac{t_1}{t_2})$
  - U_1 - last completed bout
  - U_2 - velocity increment
  - $\frac{t_1}{t_2}$ - proportion of time at last step
- Bass – 30 min
- Redbreast Sunfish – 45 min
- Channel Catfish – 30 min

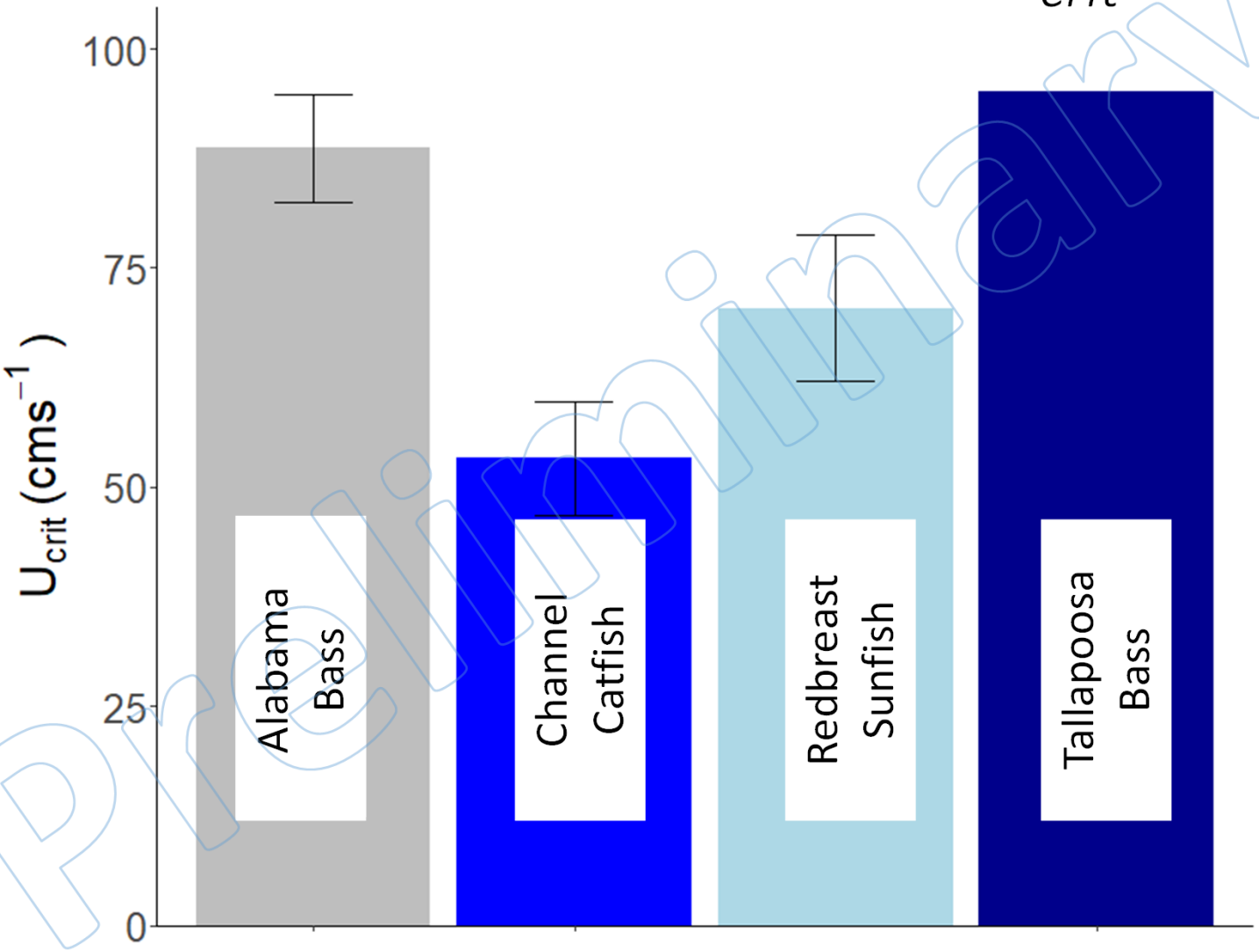
Swimming Respirometry & Performance

- 90 L Loligo swimming respirometer
- Temperature controlled
  - Water reservoirs
- Oxygen measured electronically
- Speed control automated



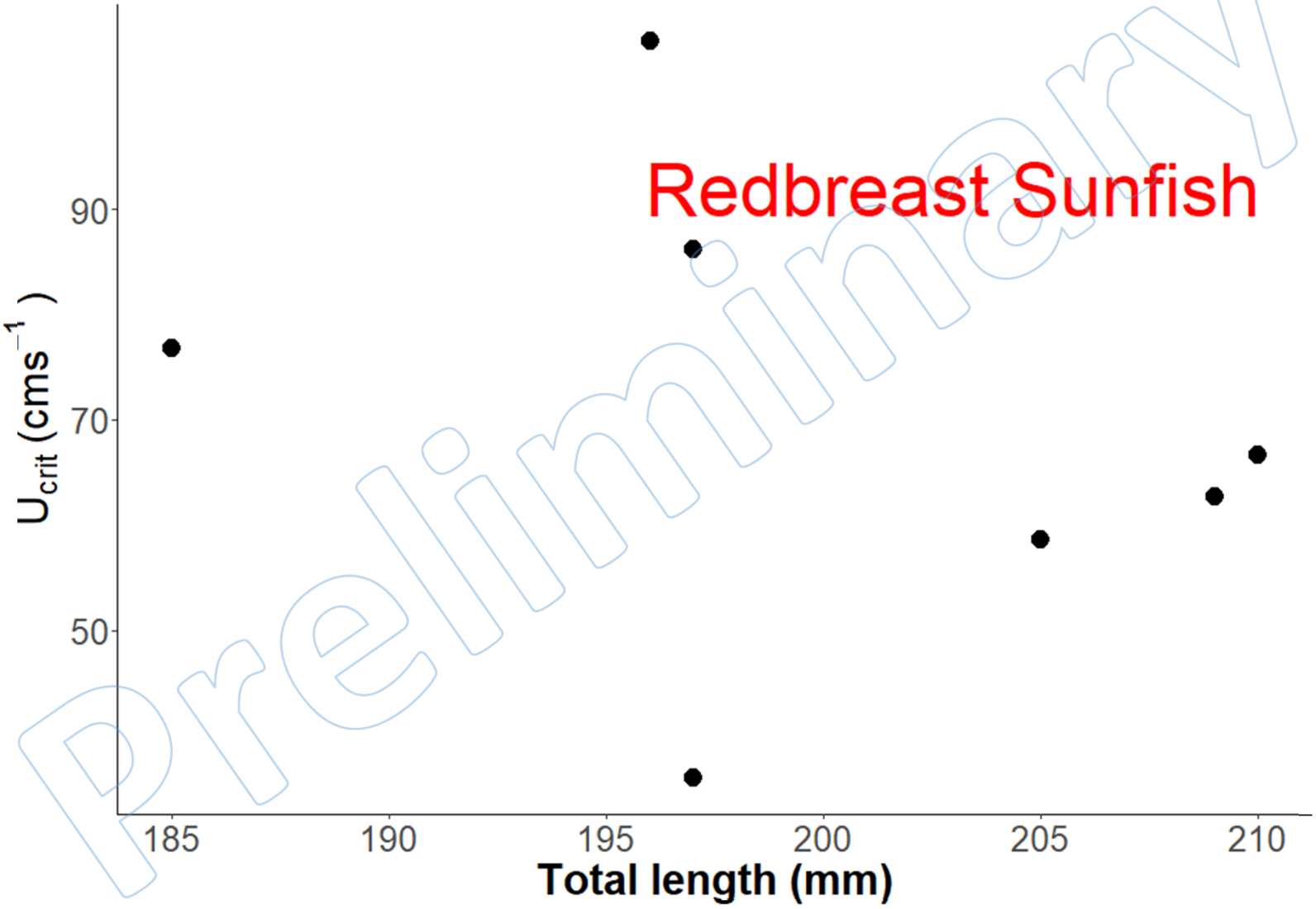
PRELIMINARY DATA

Swimming Performance: U_{crit}



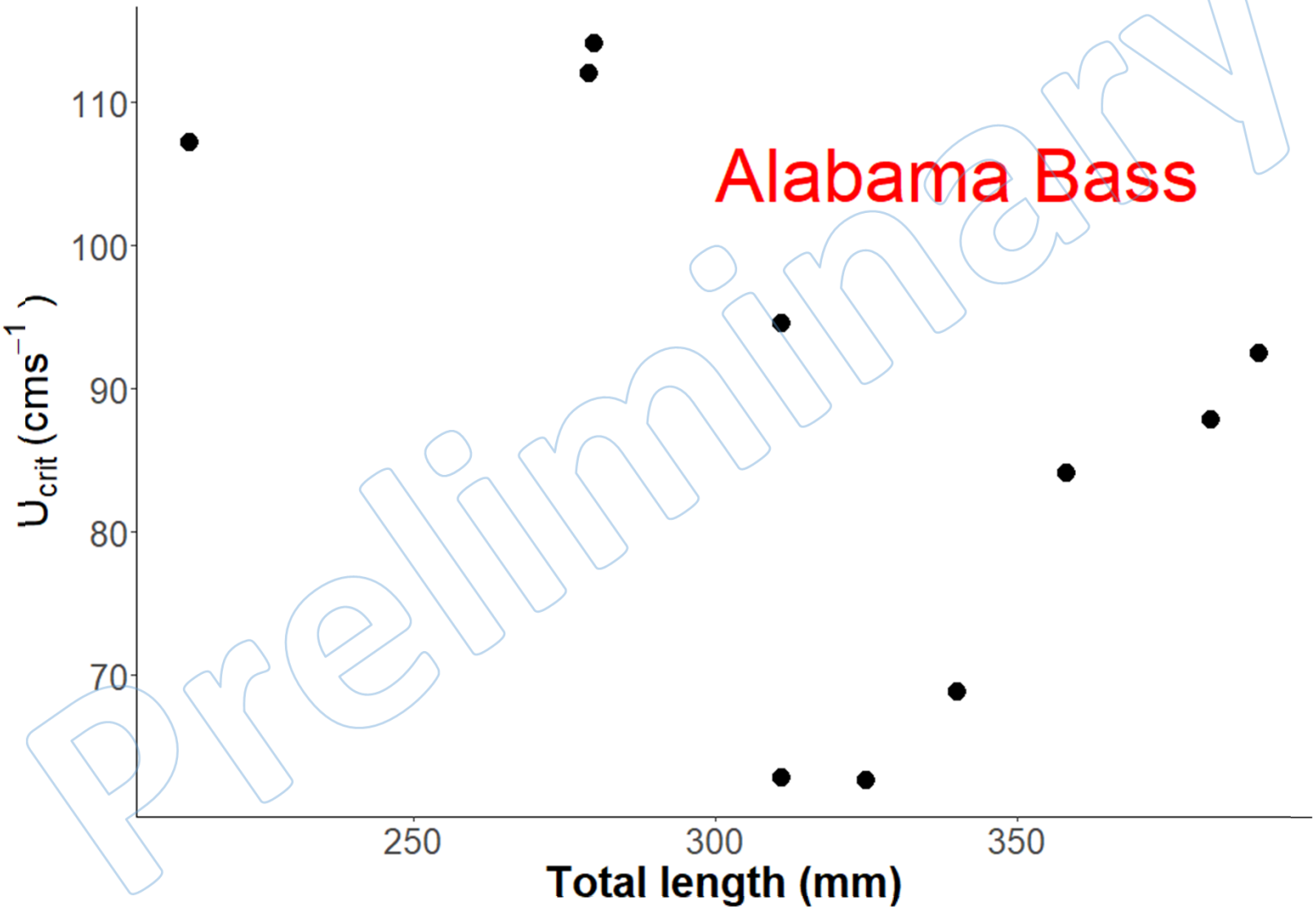
Preliminary

Swimming Performance: U_{crit}



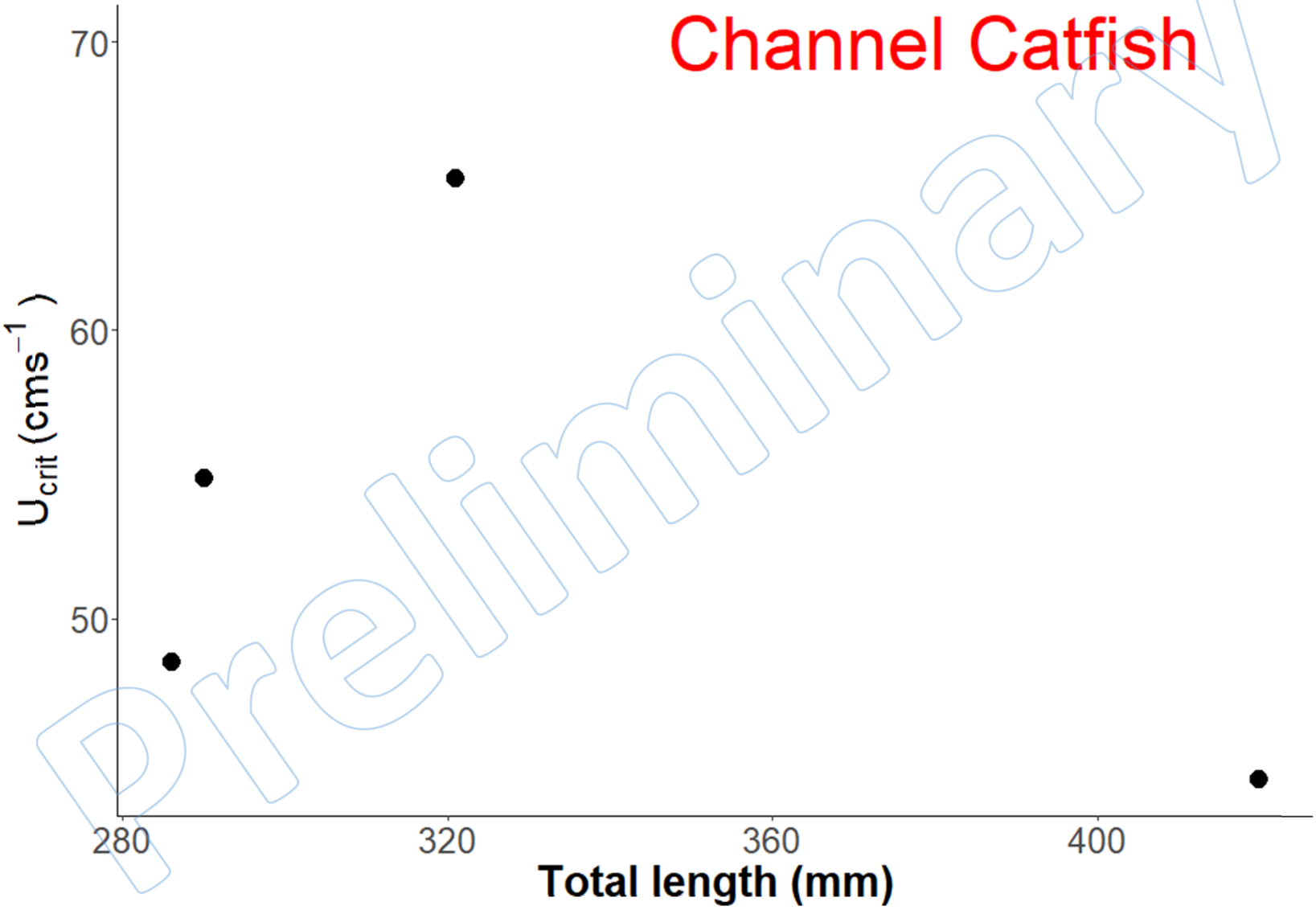
Preliminary

Swimming Performance: U_{crit}



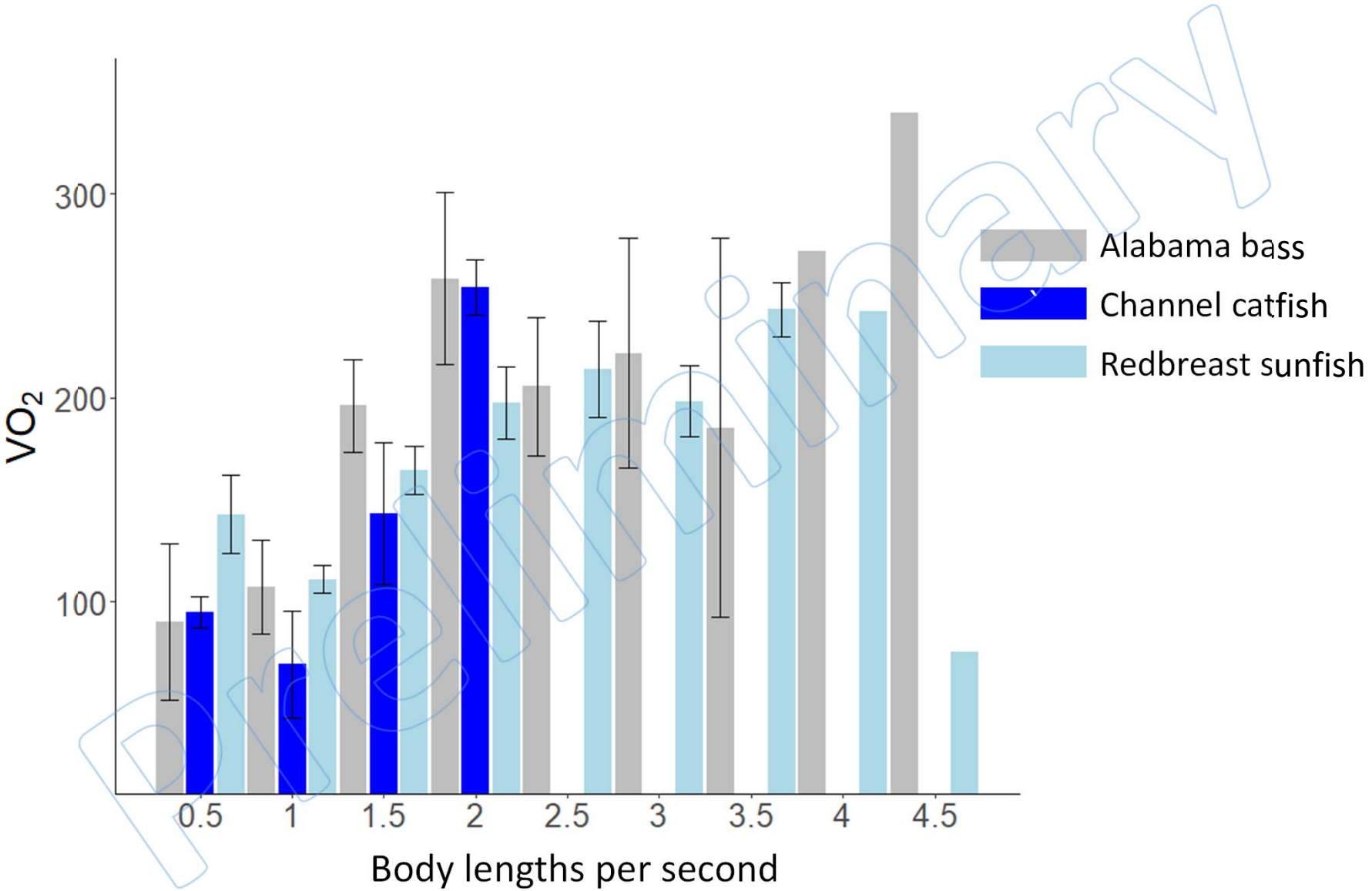
Preliminary

Swimming Performance: U_{crit}



Preliminary

Swimming Respirometry VO_2



Preliminary

Experimental Work in 2020

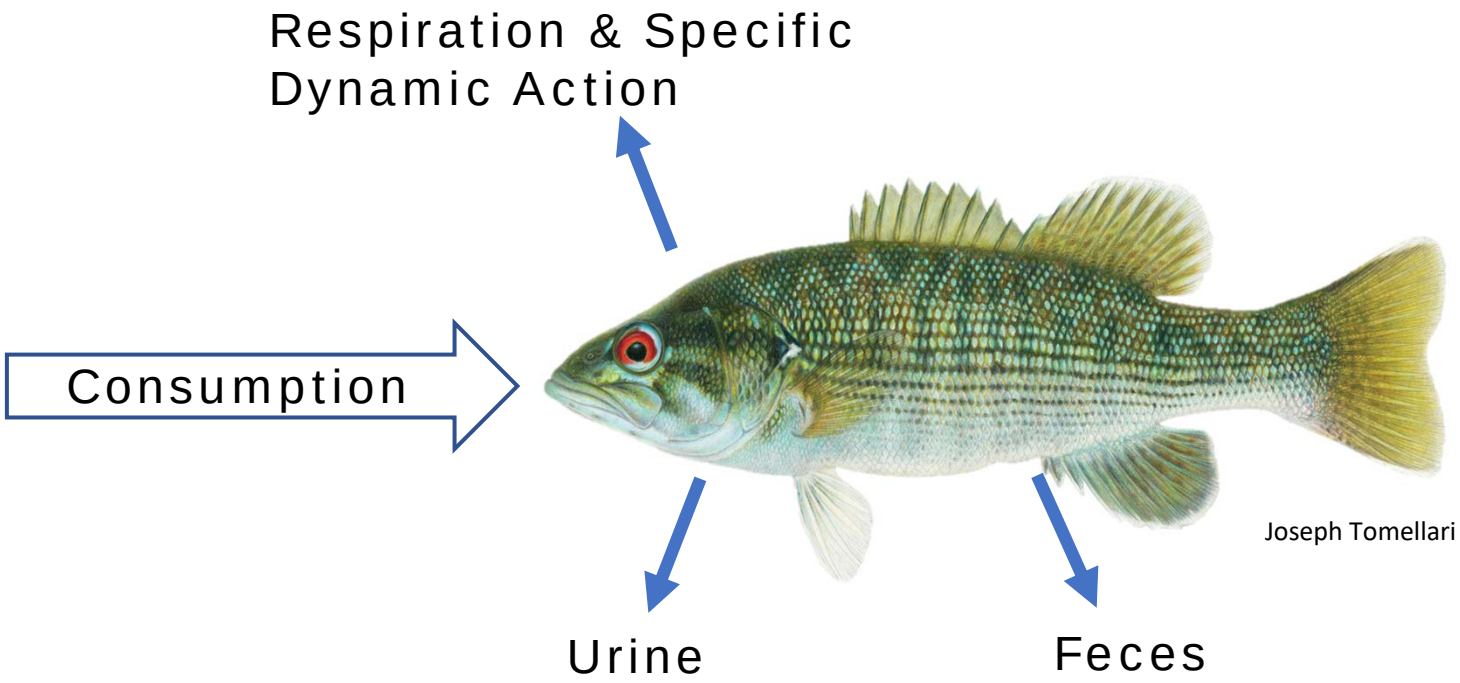
- Complete trials to determine bioenergetics parameters
- Conduct swimming trials with rapid temperature and flow change
- Complete tailbeat analysis

Objective 4

- Quantify effects of temperature and flow variation on target fish species energy budgets using bioenergetics modeling

  - Part 2: Bioenergetics modeling

Basic Fish Bioenergetics Model



Growth = Consumption - (R + F + U + SDA)

Growth = Consumption - (Costs)

Costs = Respiration + Feces + Urine + Cost of Digestion

Uses of Bioenergetics Models

- evaluation of stocking
- nutrient recycling
- contaminant accumulation
- aquaculture
- exploring evolutionary influence**s**

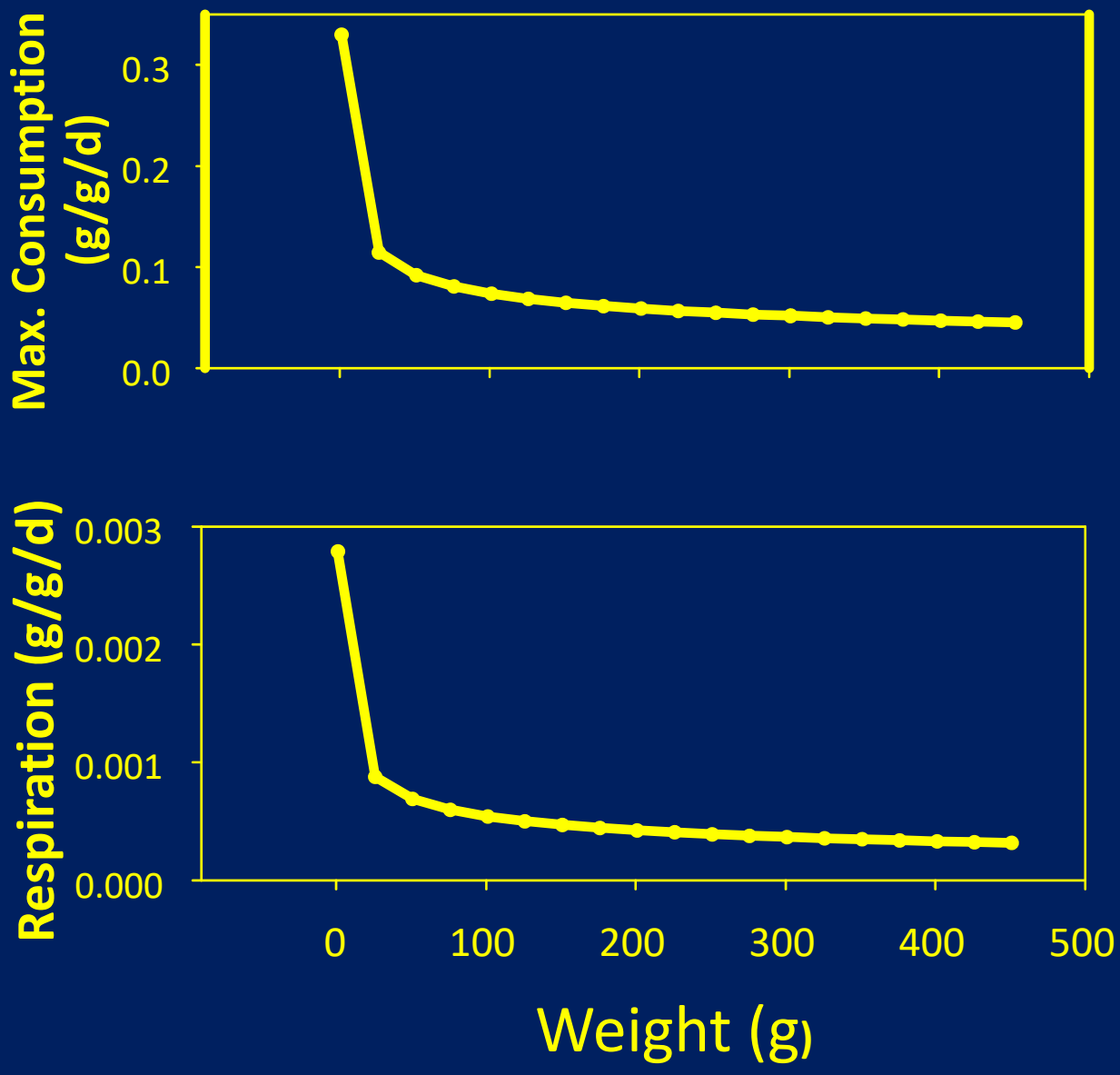
Uses of Bioenergetics Models

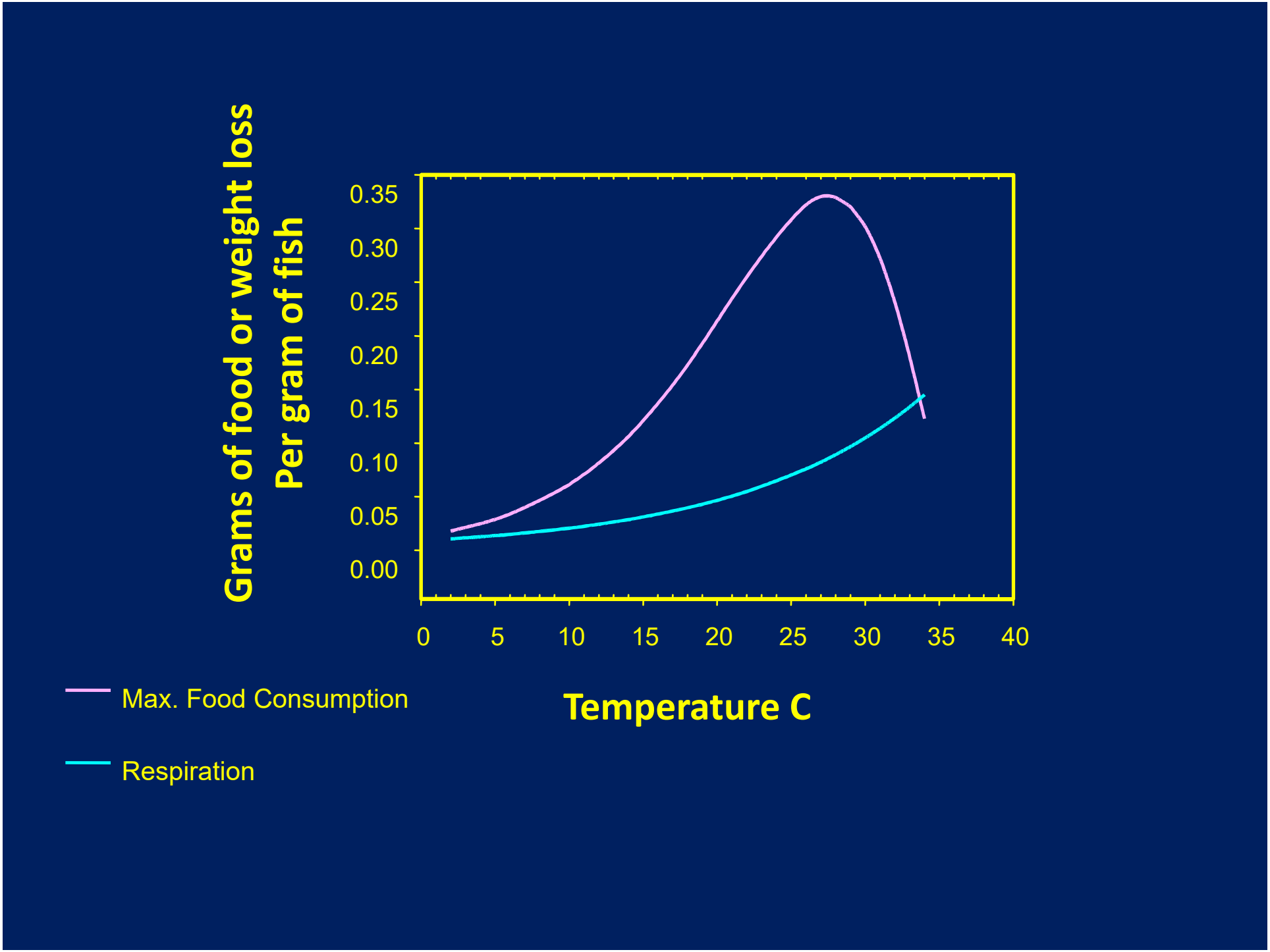
- evaluation of stocking
- nutrient recycling
- contaminant accumulation
- aquaculture
- exploring evolutionary influences
- **habitat effects on growth**
- **effects of environmental stress**

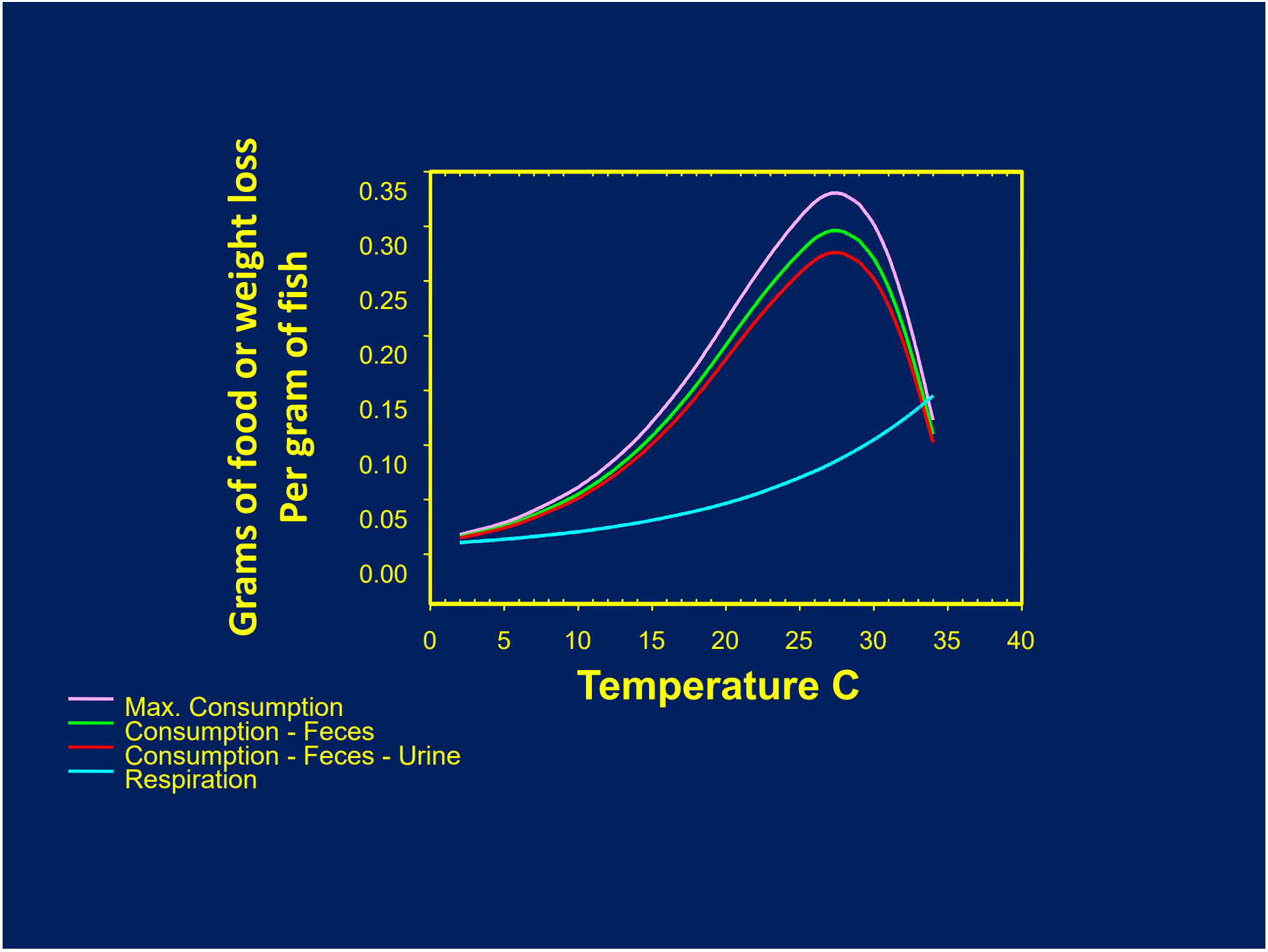
What functional relationships do we need to construct and run bioenergetics models?

- The effect of temperature on respiration and food consumption
- The effect of body weight on respiration and food consumption
- The effect of activity (swimming) on respiration

Effect of weight on respiration & consumption




Grams of food or weight loss
Per gram of fish
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
25
30
35
40
Temperature C
Max. Food Consumption
Respiration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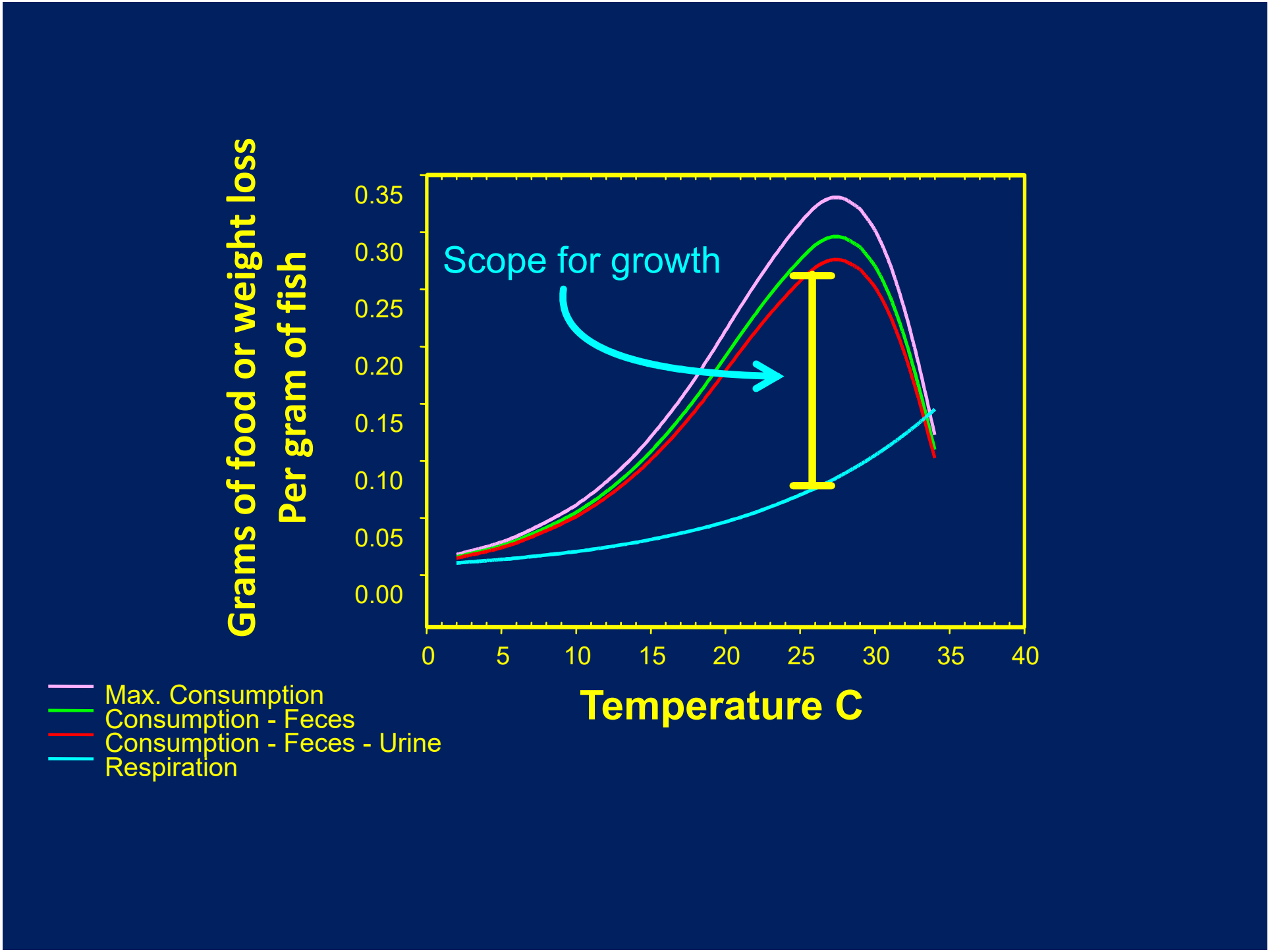
0.05
0.00
0
5
10
15
20
25
30
35
40
Temperature C
Max. Consumption
Consumption - Feces
Consumption - Feces - Urine
Respiration


Grams of food or weight loss
Per gram of fish
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Scope for growth
0
5
10
15
20
25
30
35
40
Temperature C
Max. Consumption
Consumption - Feces
Consumption - Feces - Urine
Respiration

Model Data Inputs

- Growth
  - body size, caloric density, reproduction
- Diet
  - prey type, caloric density
- Temperature
- Velocity

Application of Bioenergetics Approaches to Harris Dam Impact Assessment

- Temperature fluctuation effect on metabolism
- Flow impact on activity rate – metabolism
- Downstream shifts on community structure and food availability

Current Limitations of the "Wisconsin" Bioenergetics Model

- Currently no model for Tallapoosa Bass or Redbreast Sunfish
- Channel Catfish model parameters from lentic systems
- Temperature and activity operate on a daily time step

Current Status and Plans for Bioenergetics Modeling

- Field data (growth, diets, water temperature) are being collected
- Respiration parameters for temperature and weight dependence are being determined
- Consumption parameters will be “borrowed” from related species
- Simulations will be run starting this summer comparing variable temperature and activity rates