LOS ANGELES COUNTY SANITATION DISTRICTS
Converting Waste Into Resources

Santa Clara River Temperature Study

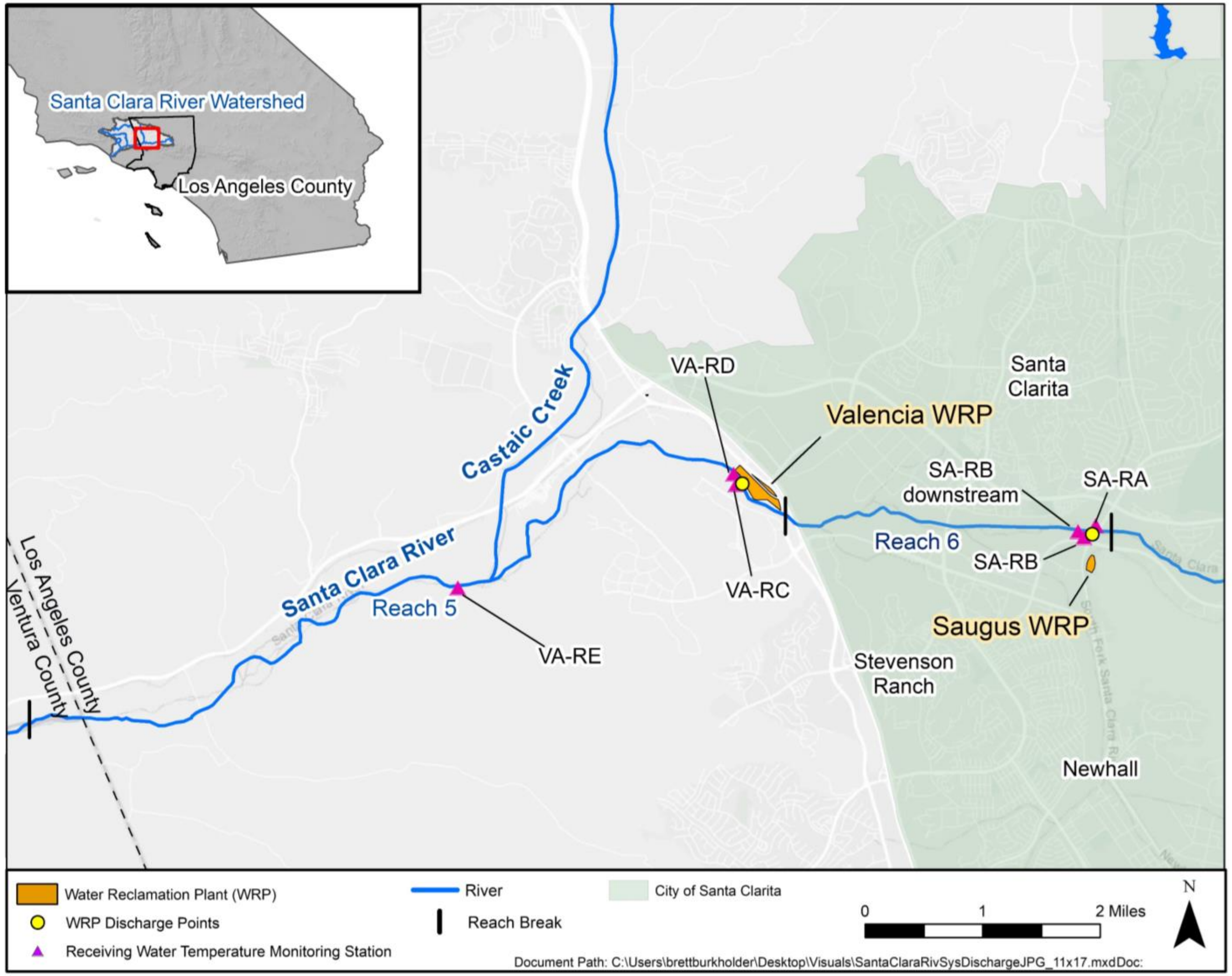
Thermal Physiology Study Review

December 18, 2024

Today’s Agenda

- Introductions
- Project Background
- Phase 1 Study Results
- Phase 2 Proposed Scope of Work
- Feedback
- Next Steps

Santa Clarita Valley Sanitation District
Water Reclamation Plants



September 2023

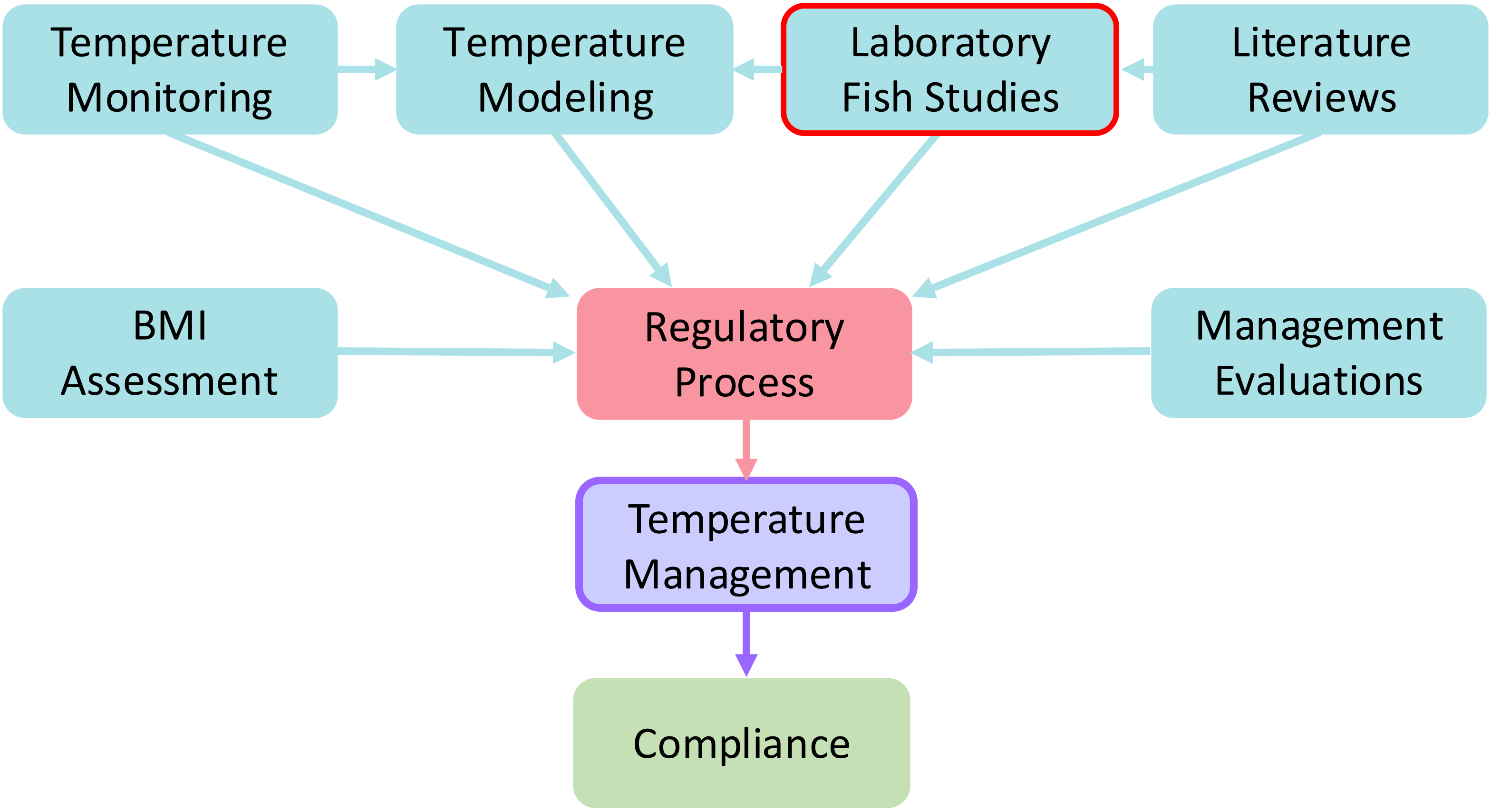
January 2024

September 2024

Santa Clara River Temperature Study

- New temperature limits in discharge permits (80°F and cannot alter river >5°F)
- Technical studies initiated to evaluate limit and support compliance by 2030
- Literature review on aquatic-dependent species (presence, thermal tolerances) **–>** ***Unarmored threespine stickleback*** (UTS) proposed **focal species**
- Data gaps for UTS thermal tolerances identified
- Lab thermal physiology studies at UC Davis proposed using partially-armored threespine stickleback (PATS) surrogate
  - Phase 1 (2024): Adult thermal tolerance
  - Phase 2 (2025): Sensitive life stages and temperature cycling

Santa Clara River Temperature Study



Santa Clara River Temperature Study

NPDES Permit Compliance Milestones	
Submit and Begin Implementation of Pollution Prevention Plan (PPP) for Source Control	8/1/2022
Convene TAC and SAG	10/1/2022
Release the Request for Proposal to Retain Consultant to Evaluate Temperature Impacts in the Watershed and Management Options	2/28/2023
Finalize the Technical Workplan	2/28/2024
Prepare a Technical Workplan Progress Report	2/28/2025
Complete Implementation of Technical Workplan	2/28/2026
Notify LA Water Board of selected preferred project and identify regulatory approval process and present results of technical workplan at next scheduled board meeting	4/1/2026
Complete Preliminary Design	4/1/2027
Complete Environmental Review	10/1/2027
Design Preferred Project	7/1/2028
Issue Notice to Proceed for Project Work	7/1/2029
Complete Preferred Project	7/1/2030

Preliminary Steps

Technical Studies

Regulatory Process

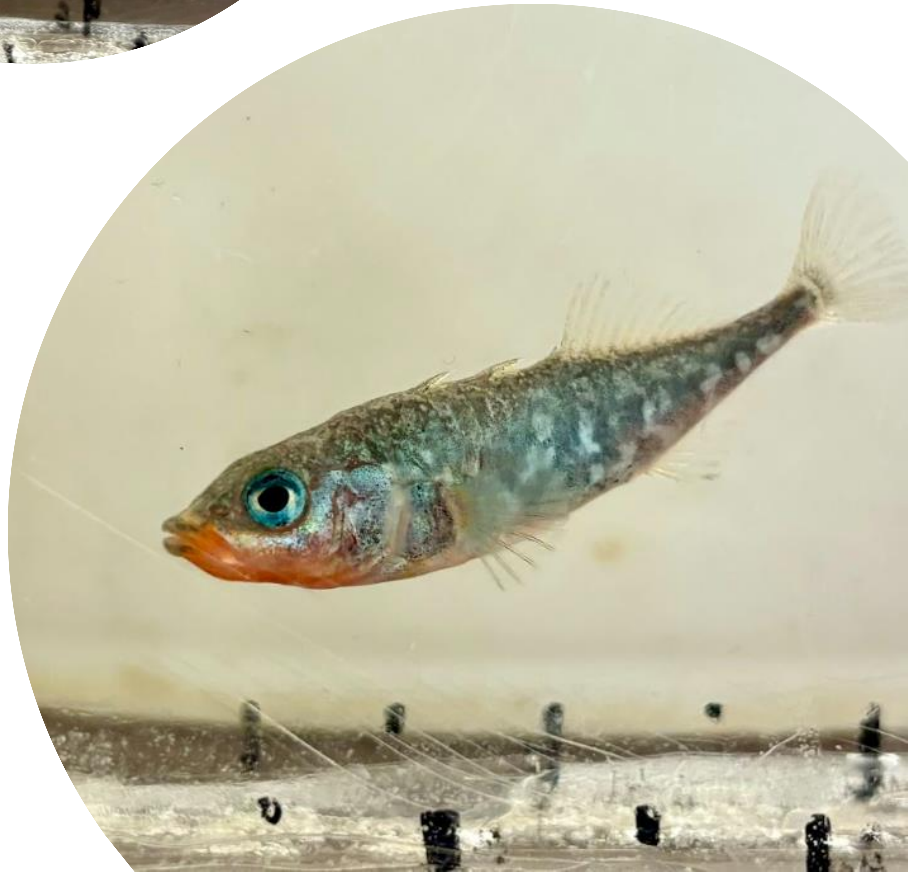
Project Design

Construction

Goals for Today

- Ensure Phase 1 lab studies are clearly communicated and questions on methods/results are addressed
- Ensure no outstanding concerns regarding scope of Phase 2
- Discuss next steps and timeline

Thermal Physiology Study



Conducted By:

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UCDAVIS
DEPARTMENT OF WILDLIFE, FISH AND CONSERVATION BIOLOGY

Study Objectives

1. Collect data on thermal tolerance limits for Threespine Stickleback in the Santa Clara River

2. Characterize the fundamental thermal physiology and assess direct temperature effects

3. Assess comparability of surrogate PATS as an indication for UTS thermal physiology

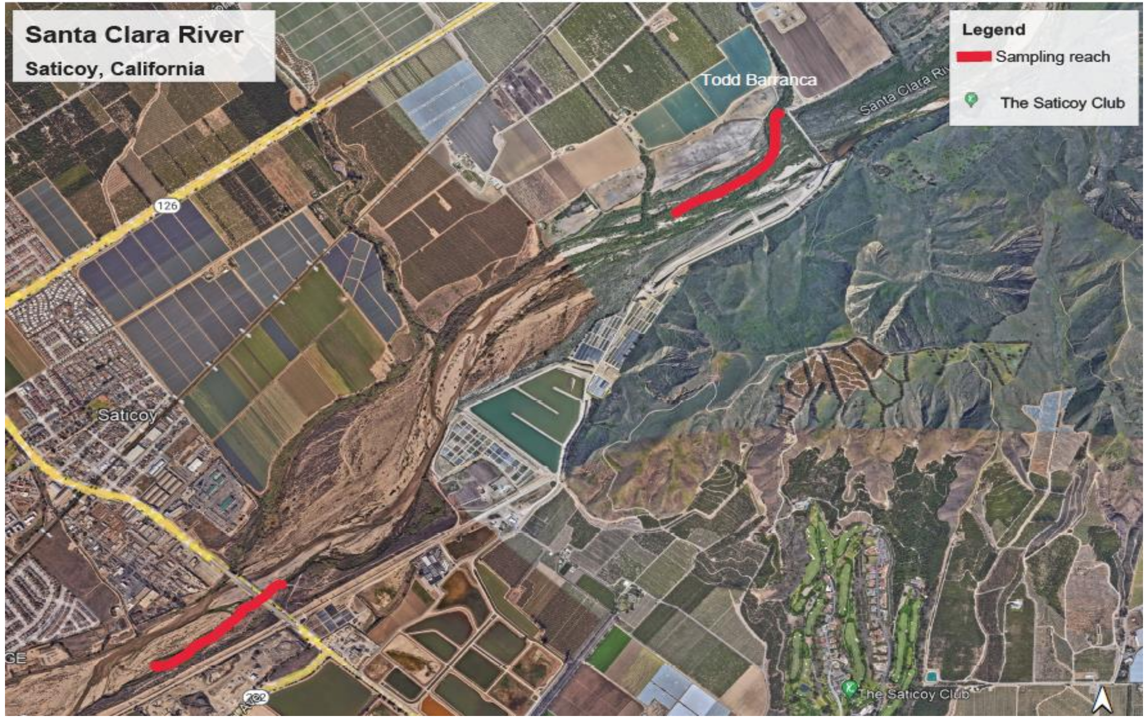
2024 Experimental Overview

<u>April 15th - 18th: Field Collection</u>

- Adult Partially Armored Threespine Stickleback (PATS) were collected from lower Santa Clara River

- Location – Saticoy, CA at United Water Conservation District property (near Freeman Diversion)

- Team from UC Davis, ESA and UWCD



2024 Experimental Overview

April 15th - 18th: Field Collection

- Found in shallow, vegetated side channel with slow, consistent flow
- Water temperatures:
  - Side channel habitat (4/16, 1pm) 24.1°C (75°F)
  - Diversion channel (4/18, 8:14 am) 17.8°C (64°F)
- Captured via dip net and seine net

2024 Experimental Overview

<u>April 15th - 18th: Field Collection</u>

- Mature males, gravid females and small juveniles present
- Kept adults and avoided small juveniles or fish with distended bellies.
  - Mean Total Length: 4.7 ± 0.5 cm
  - Mean Mass: 1.0 ± 0.3 grams
- 295 PATS transported to UC Davis Center for Aquatic Biology and Aquaculture (CABA) on 4/19

2024 Experimental Overview

<u>May 1st - 19th: Acclimation to Treatments</u>

- Range of four temperatures: 60, 65.5, 73, and 77°F

60°F

65.5°F

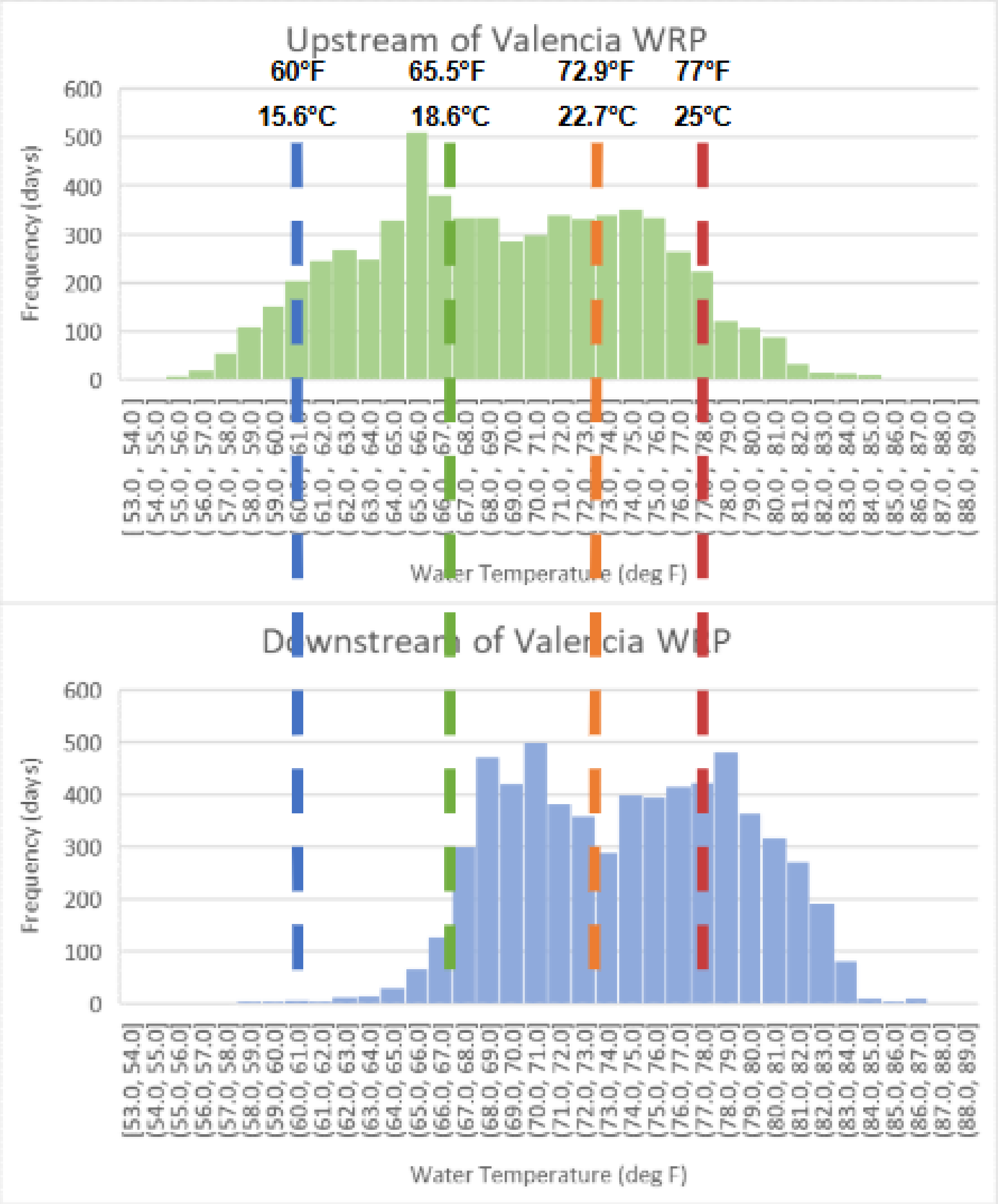
73°F

77°F

2024 Experimental Overview

May 1st - 19th: Acclimation to Treatments

- Range of four temperatures: 60, 65.5, 73, and 77°F
  - Mimic past work on UTS (60 and 72.9°F)
  - Capture breadth of conditions relevant to local system and management



Phase 1 (2024) Experimental Overview

May 20th - September 7th: Experiments and Data Collection

CT_{MAX}: May 20th & 21st

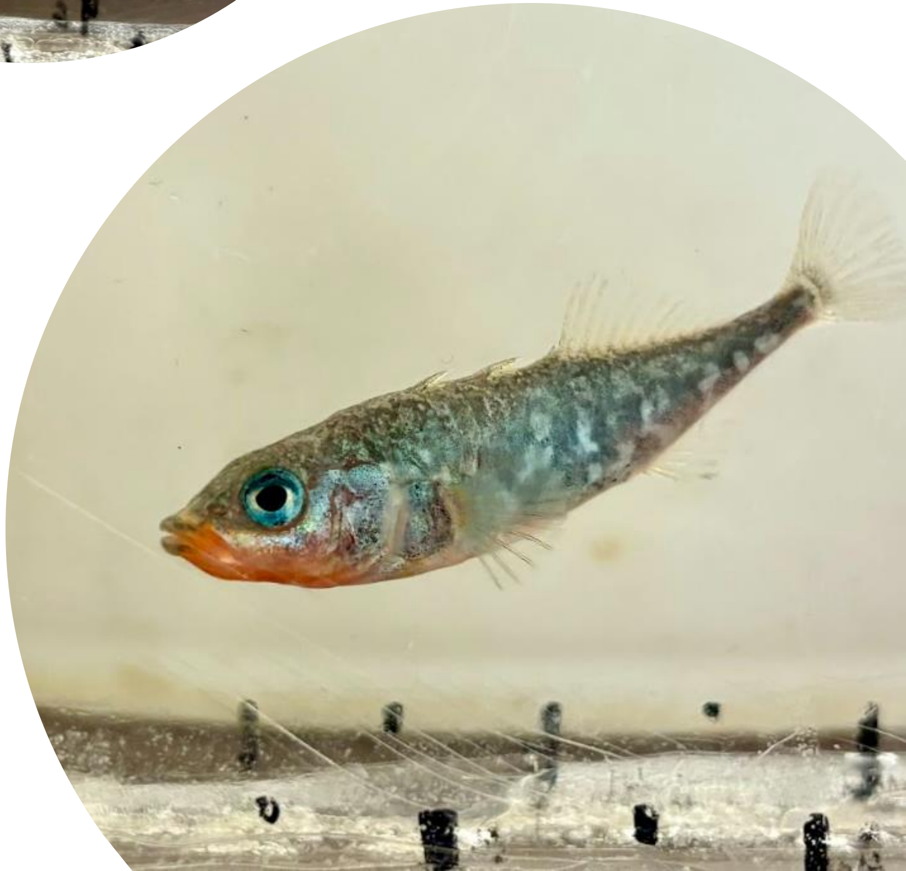
UILT: May 23rd - 26th

Aerobic Scope: May 24th - June 1st

Temperature Preference: July 20th - Sept 7th

June - November: Data Analysis

Results



CT_{MAX}: "Critical Thermal Maxima"

May 20th & 21st

N = 48 fish measured across 4 trials

Tested all 4 acclimation temperatures:

60, 65.5, 73, and 77°F

Measured by rapidly increasing temperature

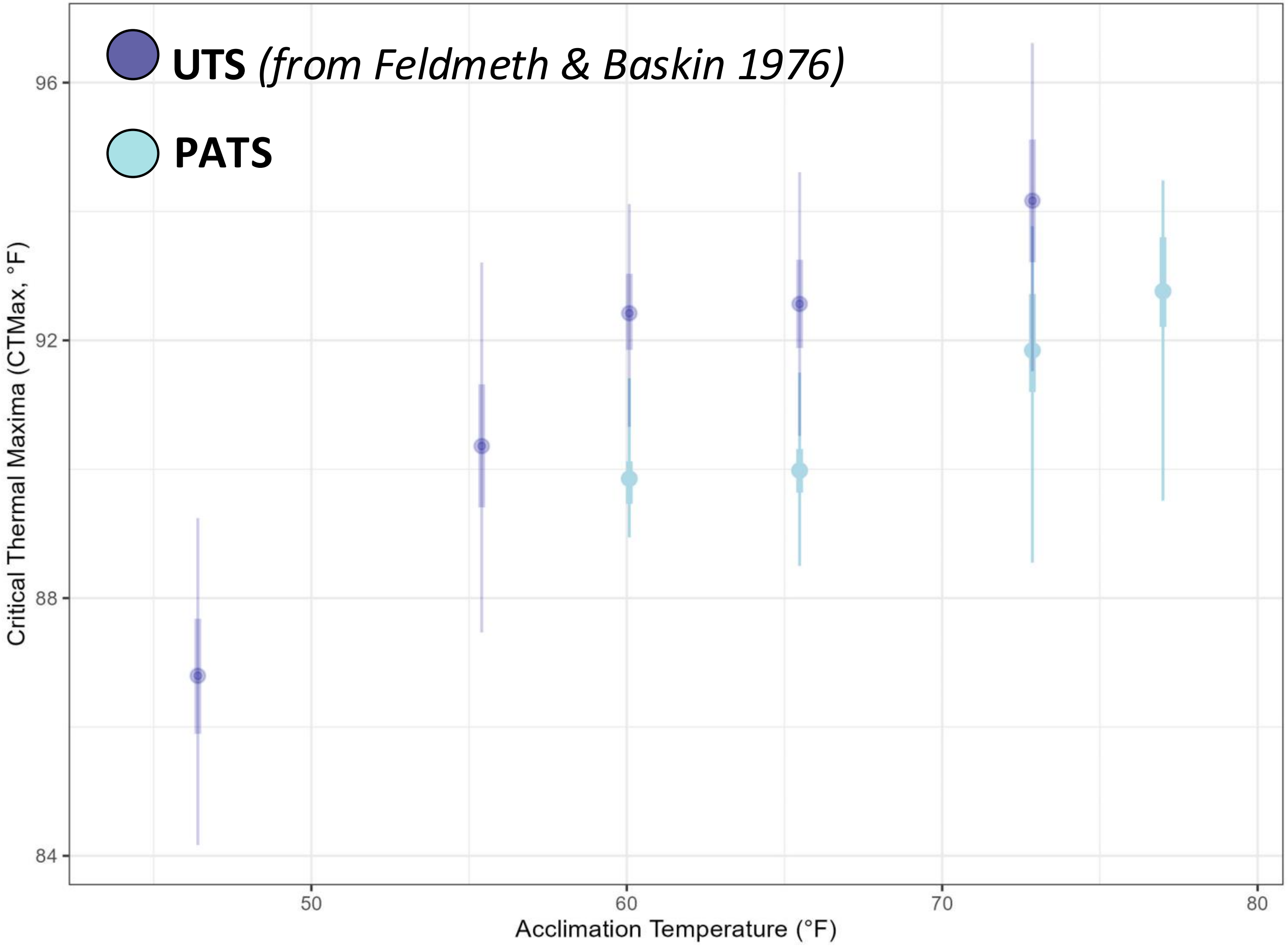
0.54 °F/min over ~1 hour

Assess changes in acute thermal tolerance

CT_{MAX}

Acc. Temp (°F)	CTM (°F)	95% C.I. (°F)
60	89.9	(88.9 - 90.7)
65.5	90.0	(88.9 - 91.0)
73	91.8	(89.7 - 93.7)
77	92.7	(90.9 - 94.4)

CT_{MAX} measured for PATS are similar to UTS measurements in Feldmeth & Baskin (1976)



UILT: “Upper Incipient Lethal Temperature”

May 23rd - 26th

N = 96 fish measured over 72 hours

Fish acclimated to 73°F

Measured by plunging fish into temperatures

8 test temperatures ranging 78.8 – 87.8°F

Measure resistance times and calculate LT50 for chronic exposure

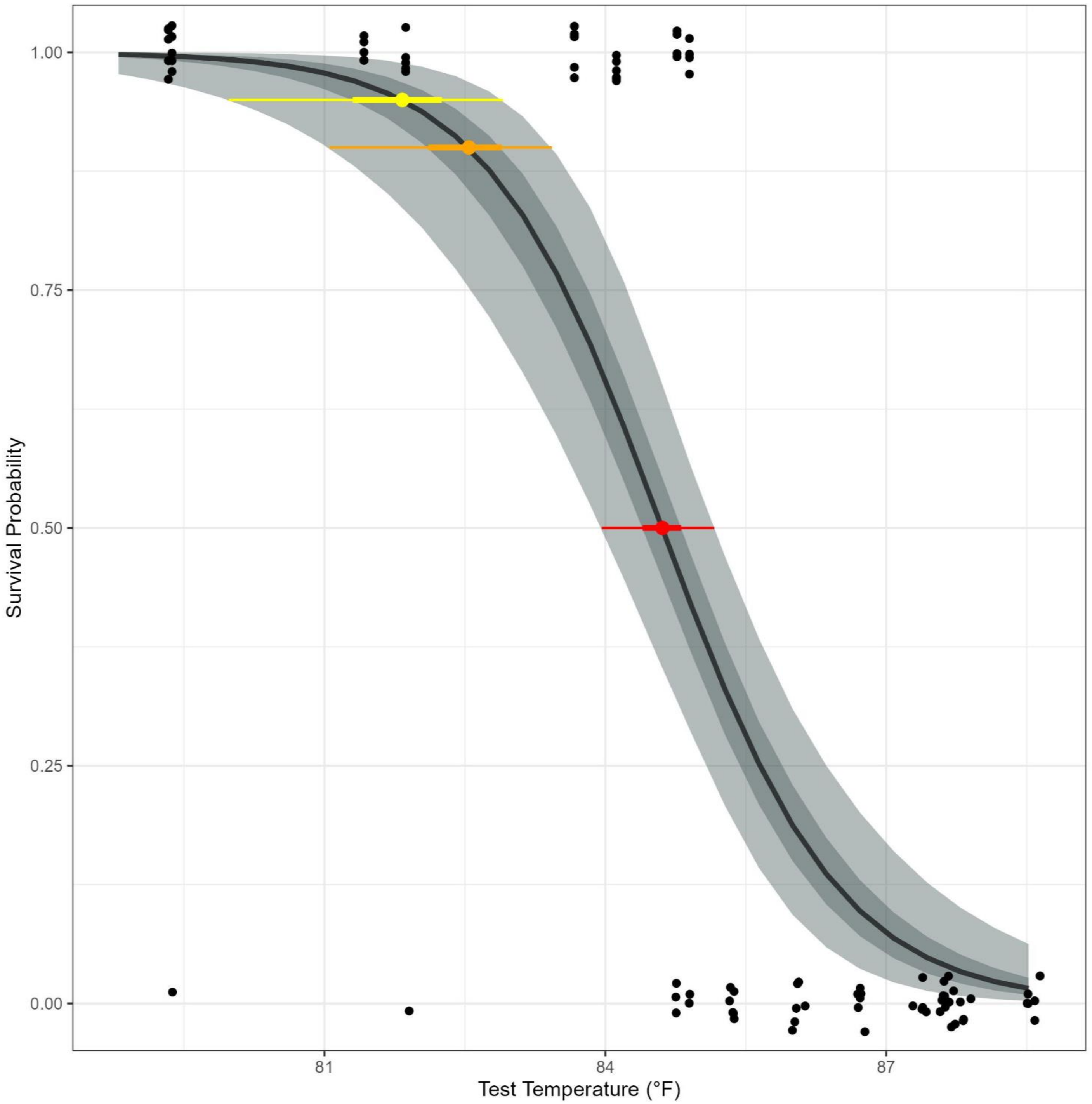
UILT - LT_{50}

Estimates of chronic thermal tolerance:

LT95: 81.7°F [80.2 83.0, 95% C.I.]

LT90: 82.5°F [81.2 83.5, 95% C.I.]

LT50: 84.6°F [84.0 85.2, 95% C.I.]



UILT - Duration of Thermal Tolerance

Estimates of chronic thermal tolerance:

6 hr Tolerance:

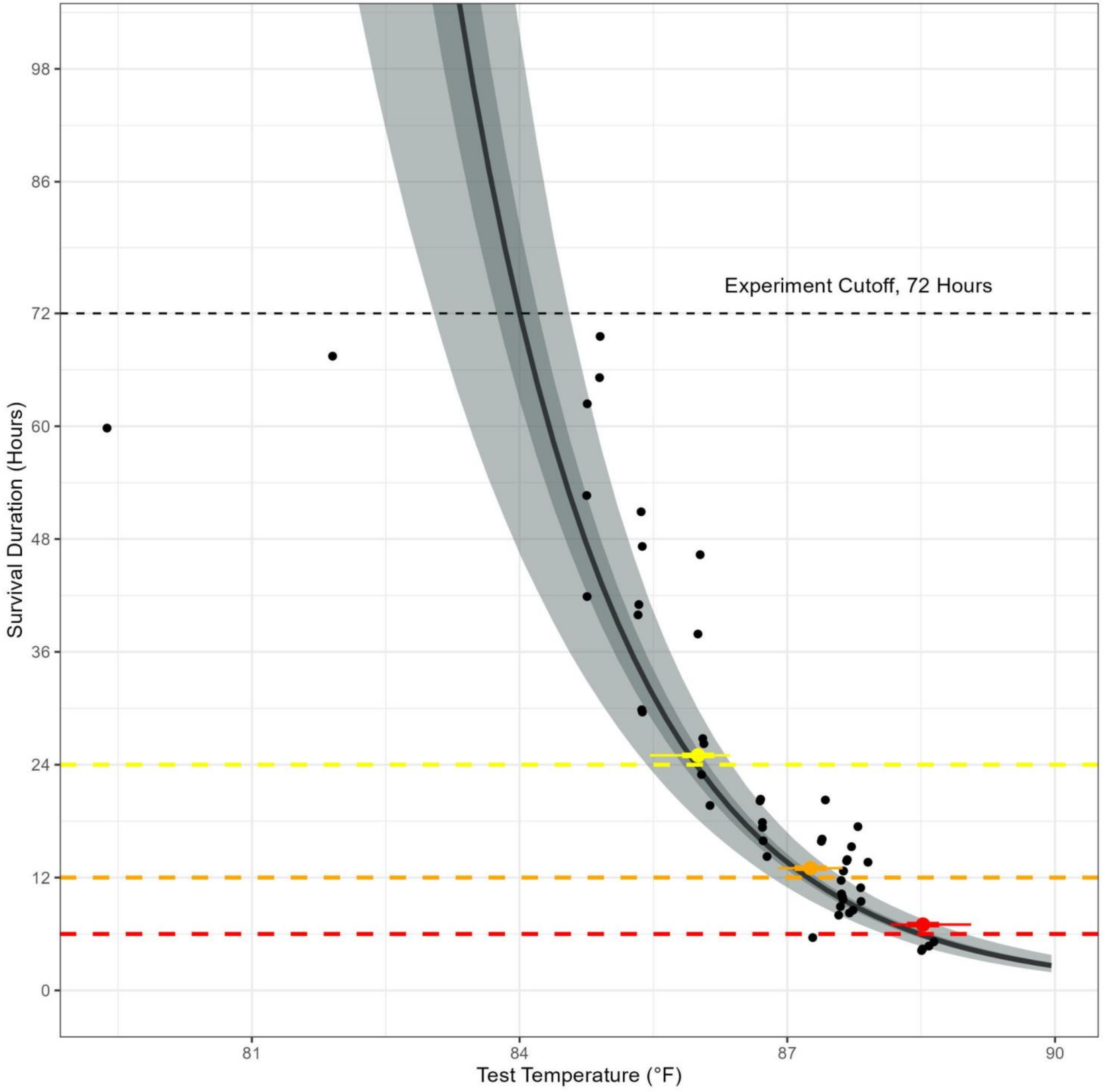
88.5°F [88.3 - 89.1, 95% C.I.]

12 hr Tolerance:

87.2°F [86.9 - 87.6, 95% C.I.]

24 hr Tolerance:

86.0°F [85.5 - 86.2, 95% C.I.]



Temperature Preference

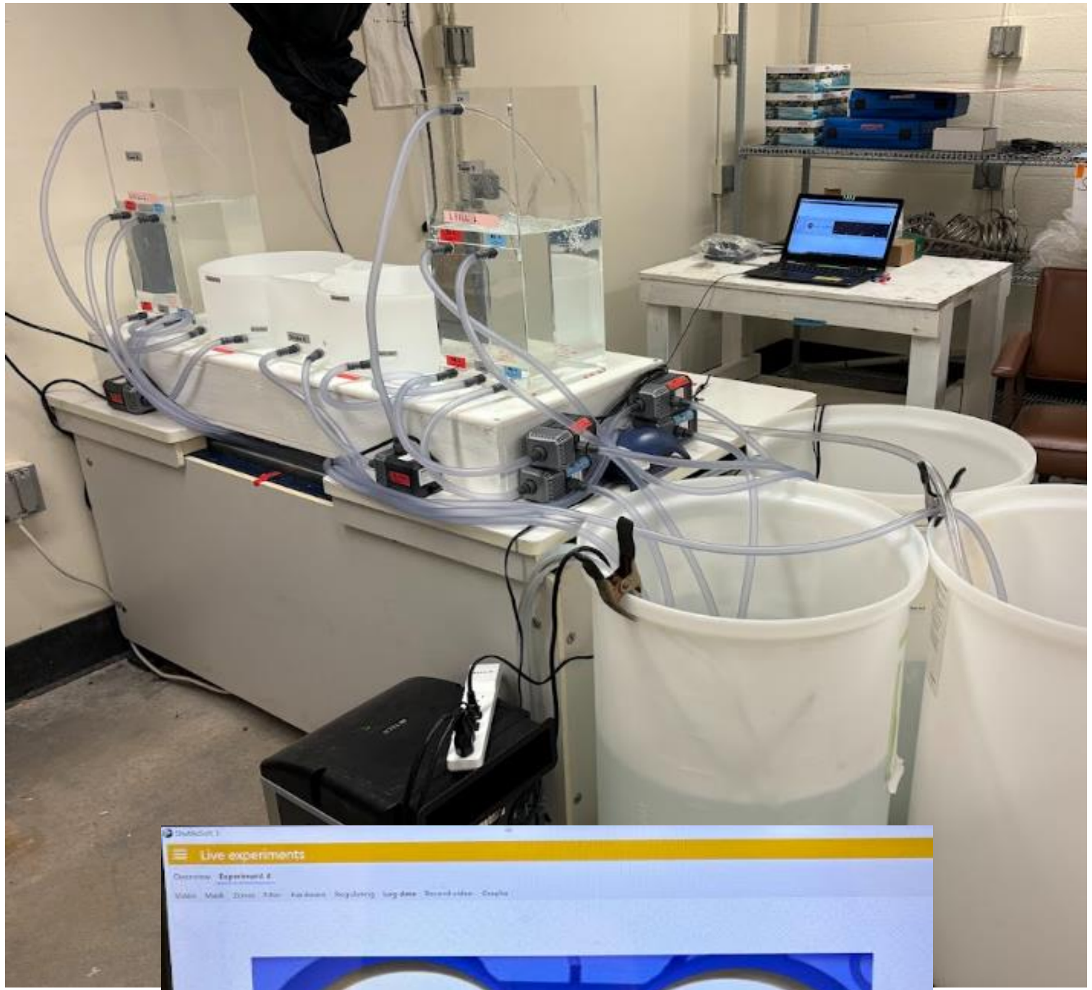
July 20th - Sept 7th

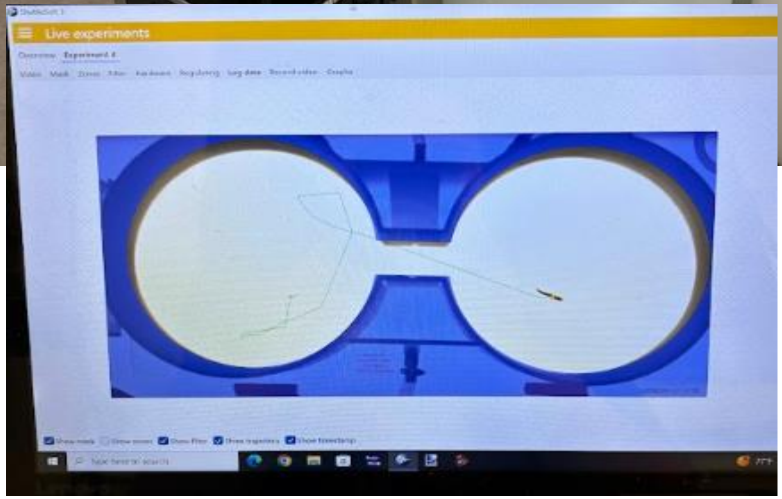
N = 20 fish measured

Fish acclimated to 66°F

Measured by allowing fish to behaviorally select temperatures using a dynamic shuttle box

Assess preference temperature





Temperature Preference

Set Allowable Temperature Limits:

Maximum: 86°F

Minimum: 50°F

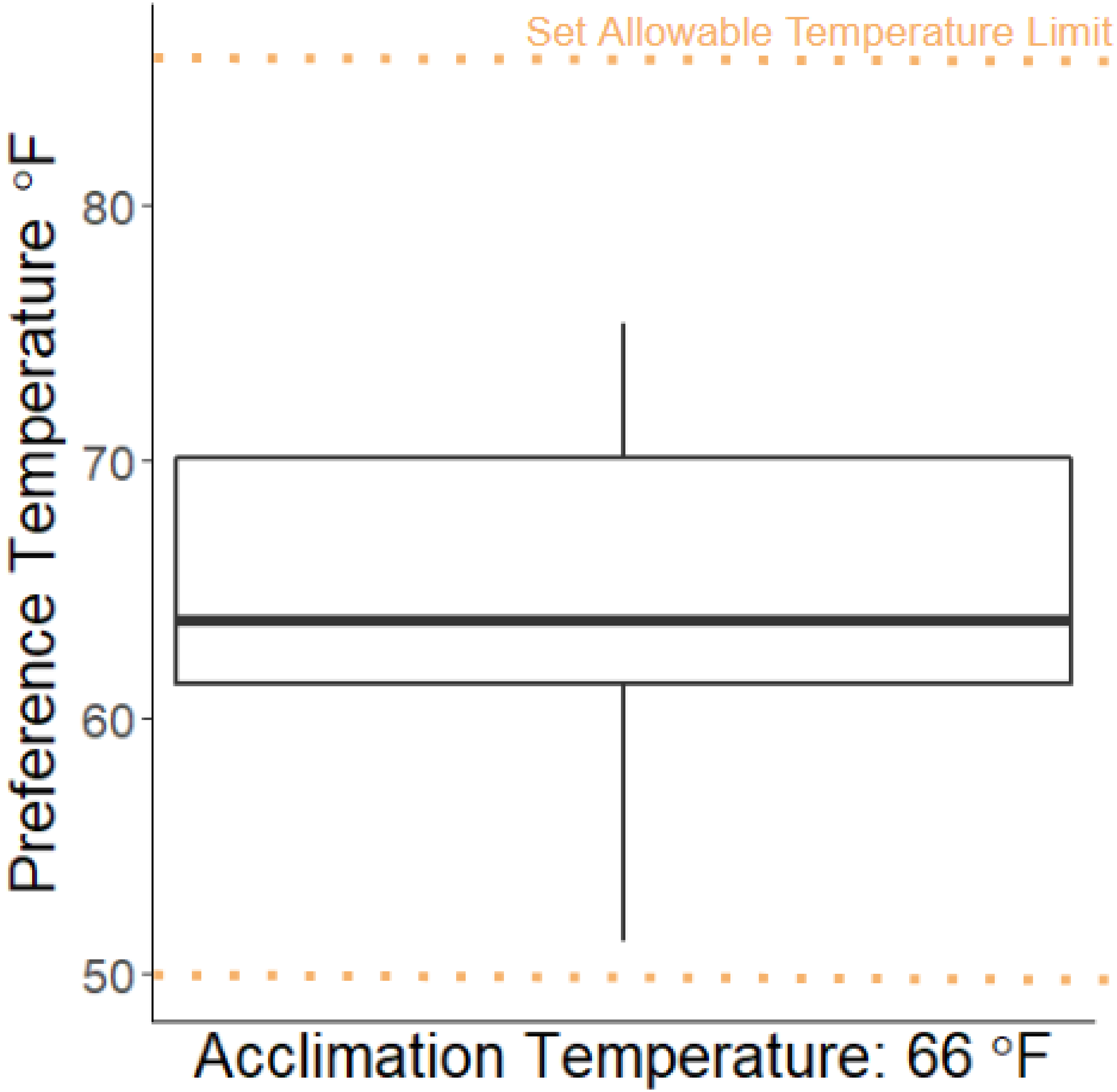
Preference Temperature:

Mean: 64.4°F

Max: 75.4°F

Min: 51.3°F

SD: ±6.4°F



Aerobic Metabolic Performance

May 24th - June 1st

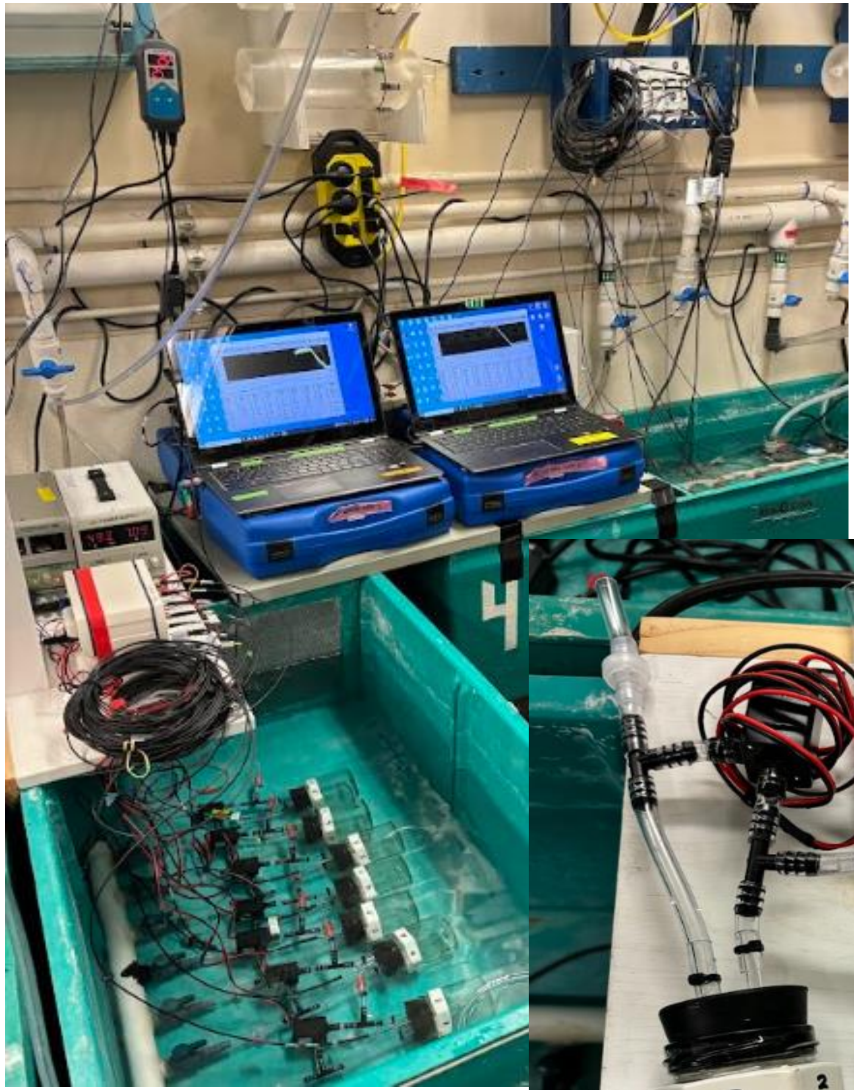
N = 101 fish measured across 16 trials

Fish acclimated to 65.5 or 77°F

Fish tested at 8 temperatures:

61, 65.5, 70, 71.5, 74.3, 77, 80.6, and 83.3°F

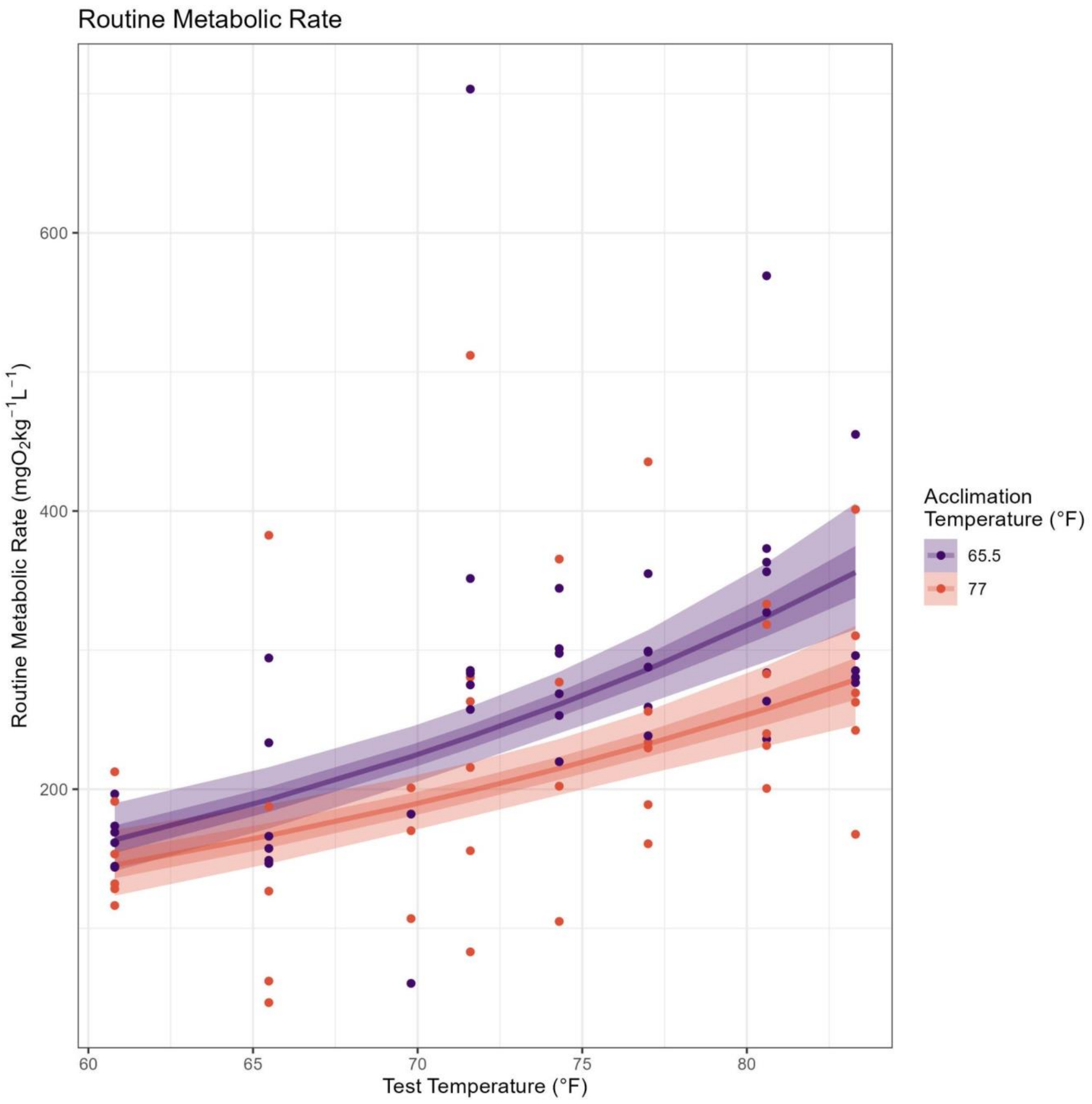
Assess resting metabolic rate (RMR), maximum metabolic rate (MMR), absolute aerobic scope (AS), and factorial aerobic scope (FAS).



RMR: Resting Metabolic Rate

Routine metabolic activity increased with test temperature.

Routine metabolic activity decreased with acclimation temperature.

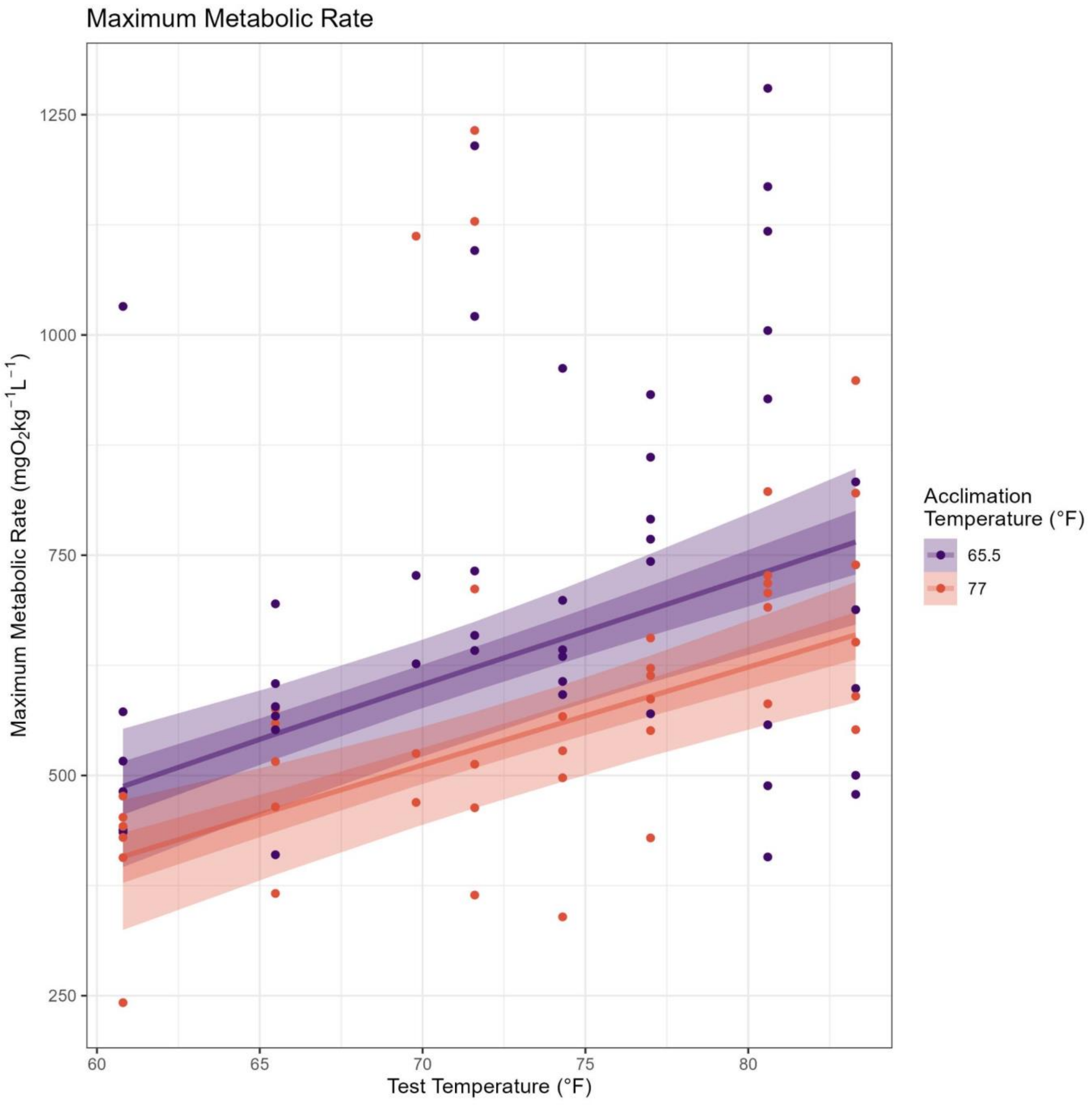


MMR: Maximum Metabolic Rate

Maximum metabolic rate was variable among fish

MMR generally increased with acclimation temperature

MMRs were higher among fish acclimated to 65.5°F



AAS: Absolute Aerobic Scope

AAS is the difference between MMR and RMR

T_{OPT}:

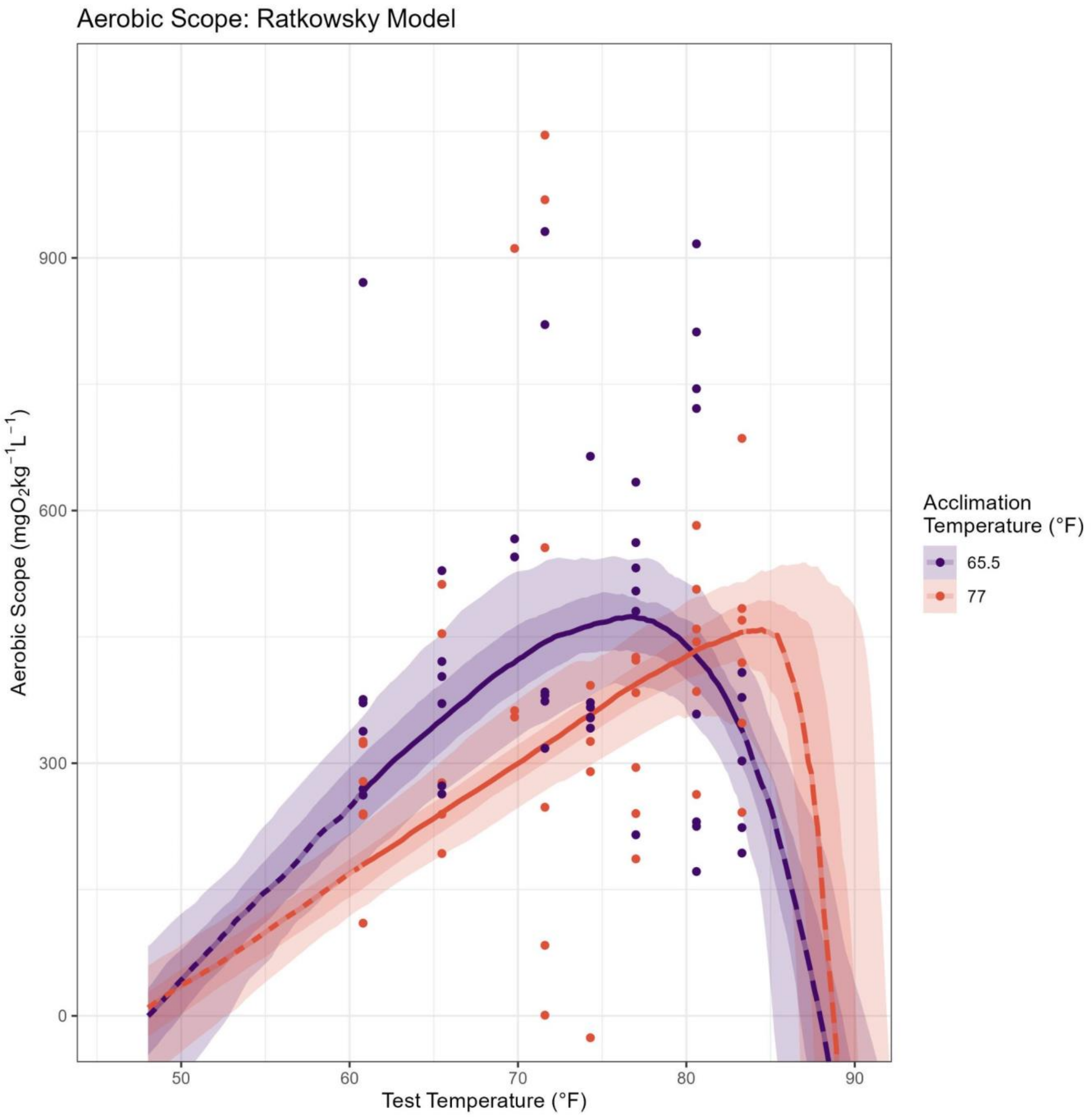
65.5 | 76.2°F

77.0 | 84.0°F

Pejus Range (90% of Optimal):

65.5 | 70.3 - 80.7°F

77.0 | 79.3 - 86.1°F

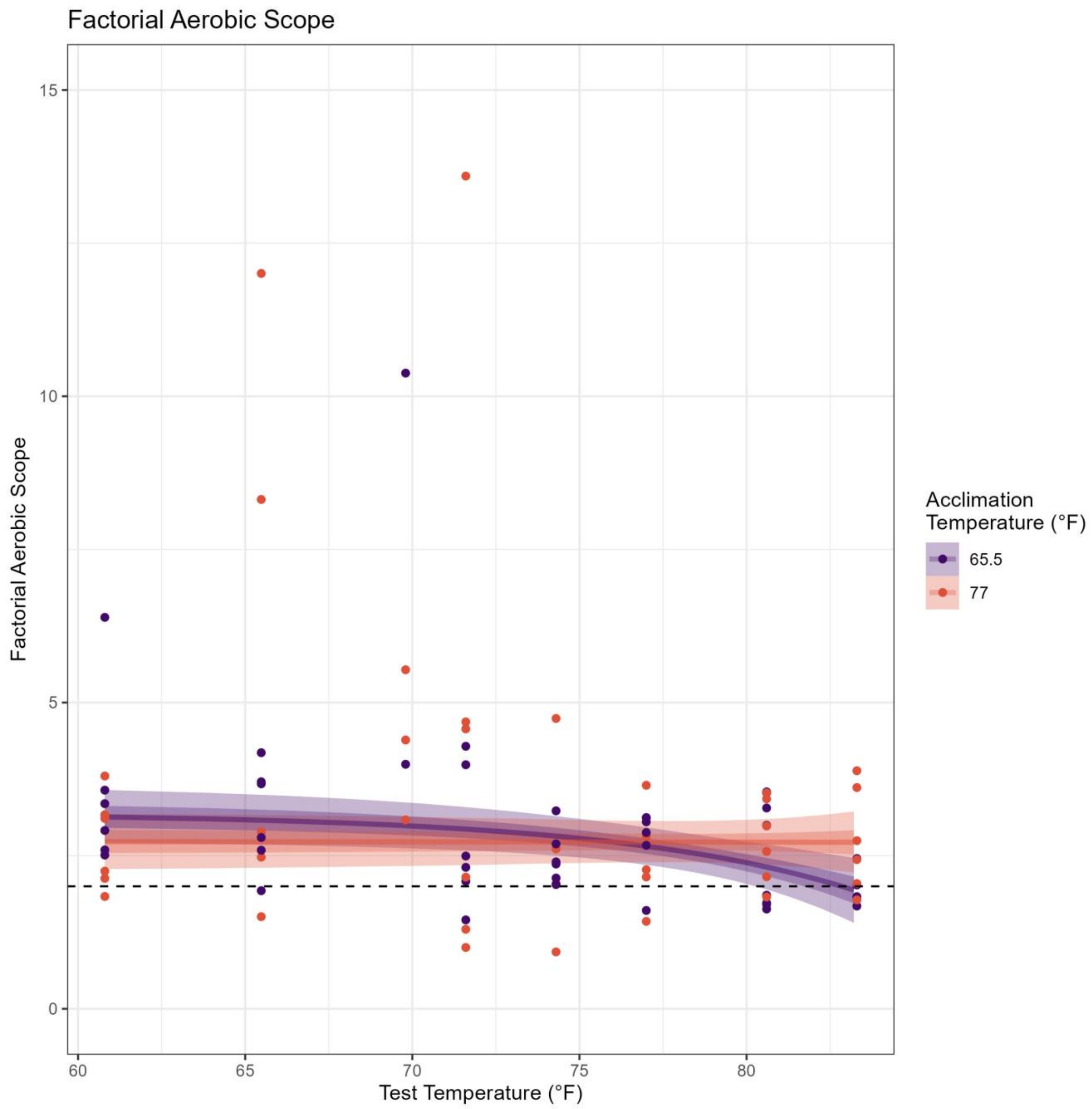


FAS: Factorial Aerobic Scope

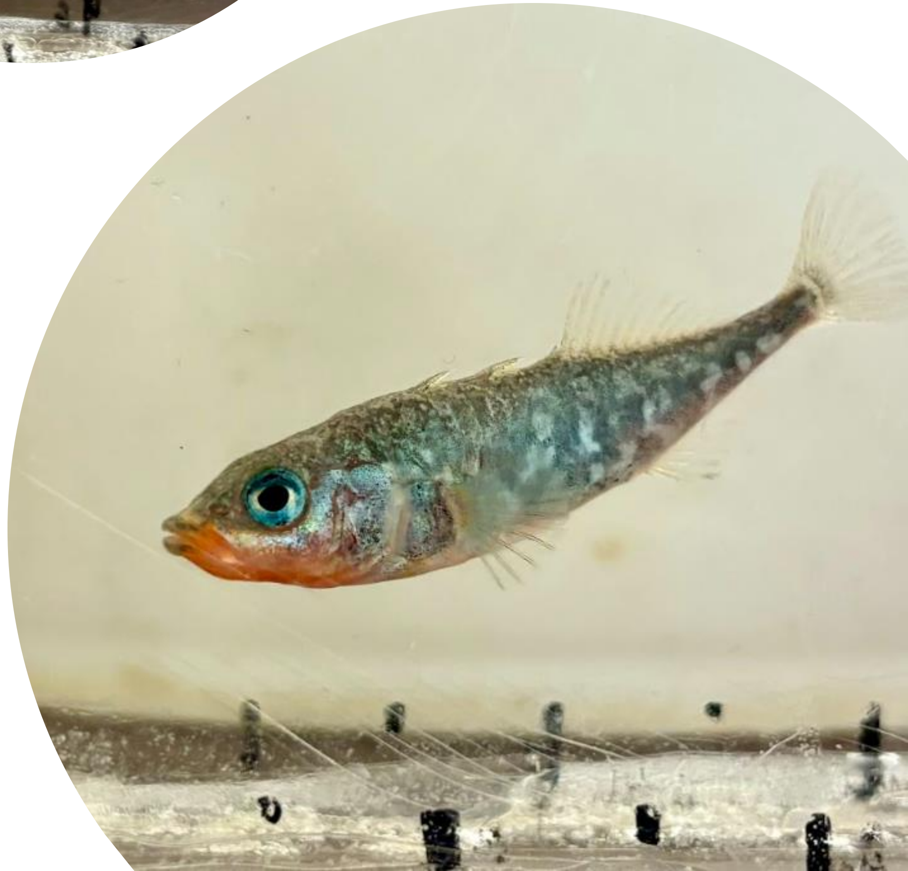
FAS is a ratio of MMR/RMR

FAS = 2 is a coarse guideline for viability (does not account for chronic exposure)

PATS maintain a FAS > 2 throughout the tested temperature range



Conclusions



Summary of Phase 1 Findings

CT_{MAX} ranged between 89.9 - 92.7°F

UILT showed impacted survival at chronic temperatures >81.7°F

Resistance times show ability to withstand high temperatures (~86°F) for 12-24 hrs

Temperature Preference: behavioral-selection of cooler temperatures when available (mean: 64.4°F, range: 51.3°F - 75.4°F)

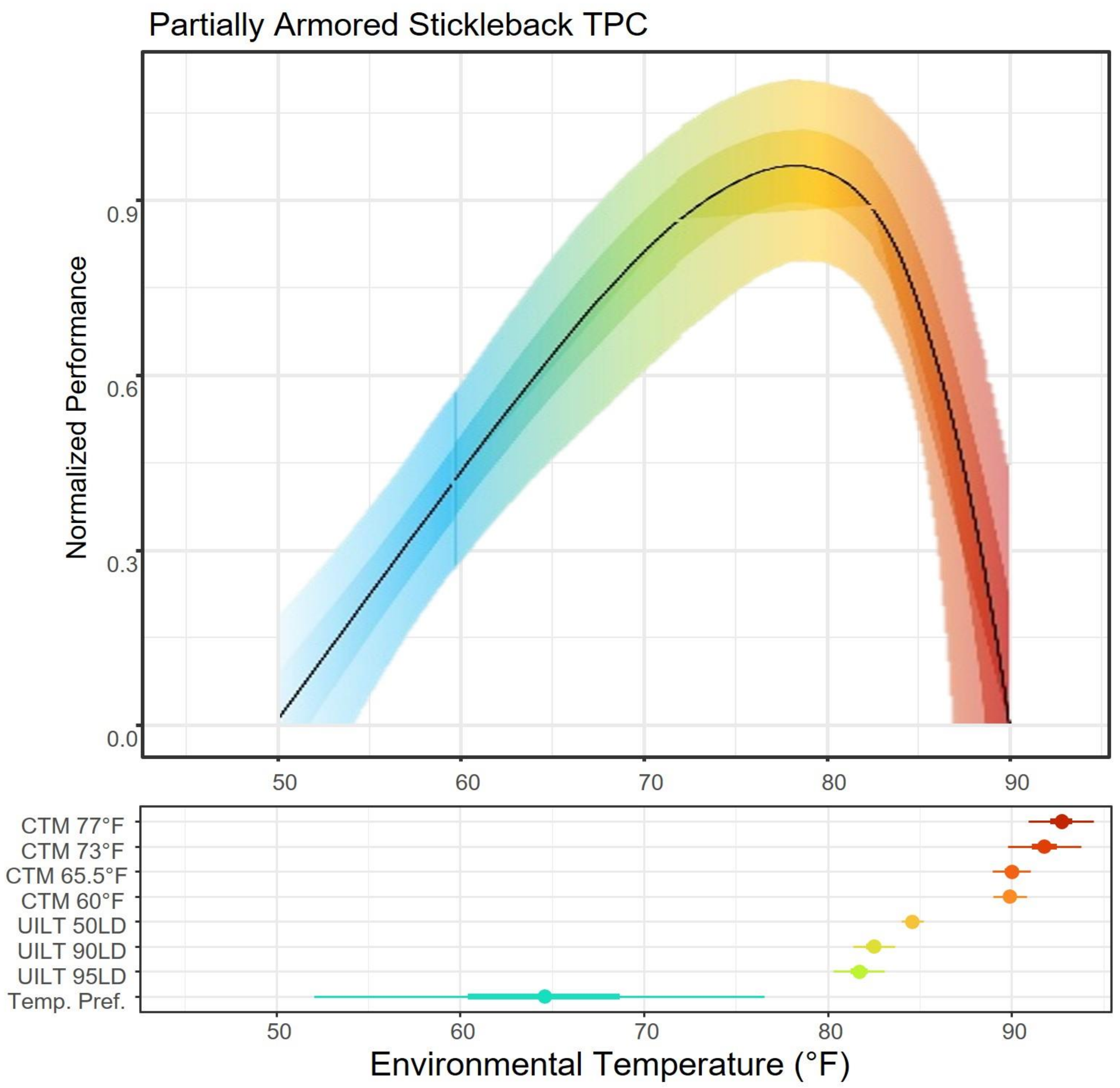
Aerobic Scope reveals metabolic capacity is maximized at temperatures above 70°F but precipitously declines as temperatures approach lethal thermal limits.

PATS Fundamental Thermal Physiology

Integration of multiple physiological measures to describe the fundamental thermal physiology

Red: Temperatures are lethal, survival depends upon exposure time

Blue/Green/Orange: Ecological drivers may be important



Remaining Questions

“Phase 1” study focused on classic, fundamental thermal physiology

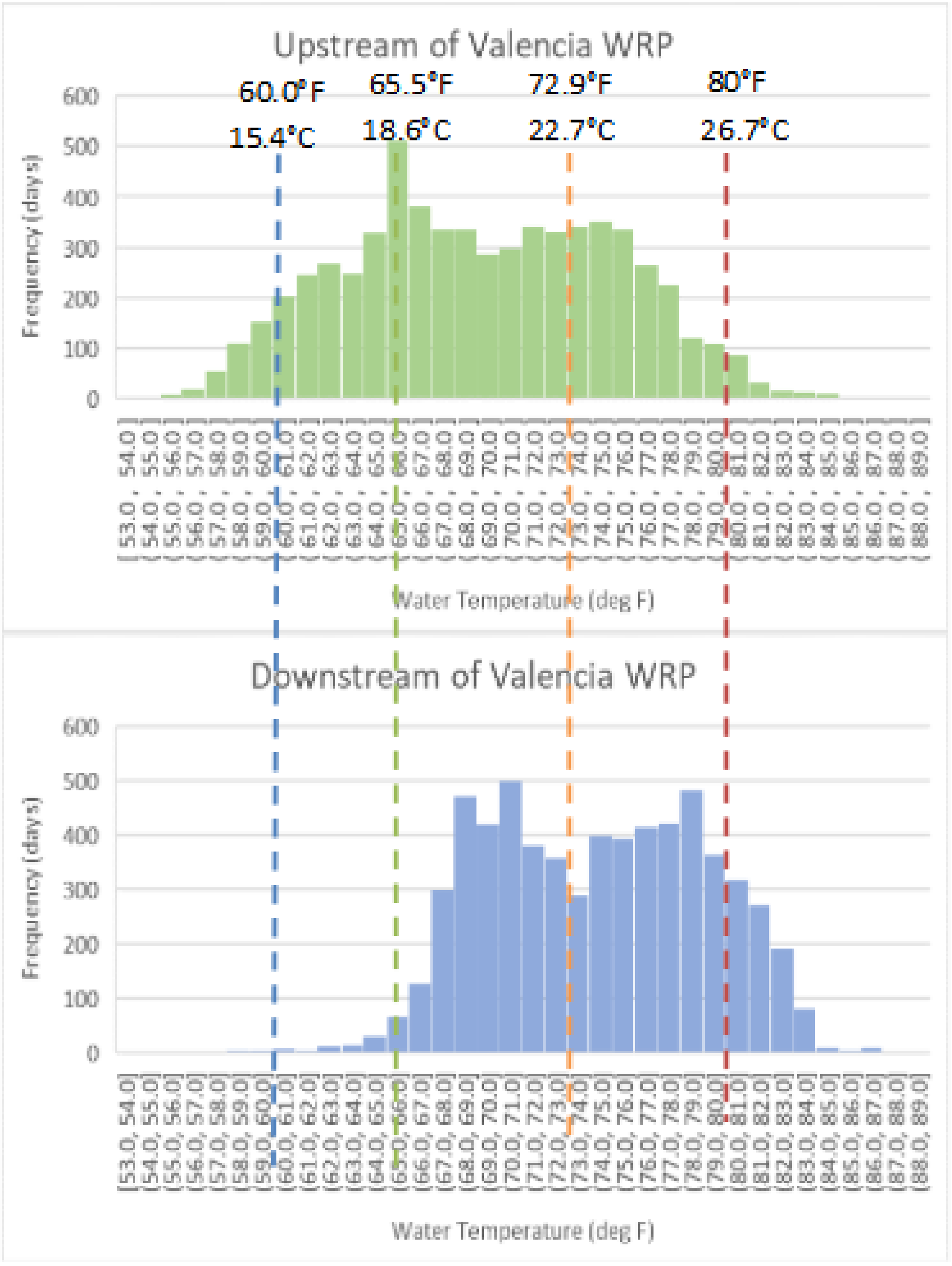
E.g. Baseline “routine maintenance costs” and directly lethal limits of tolerance

EPA guidelines also identify importance of ecological, temperature-dependent traits (e.g. reproduction)

Question: How will temperature affect other life stages? Or spawning and recruitment?

Remaining Questions

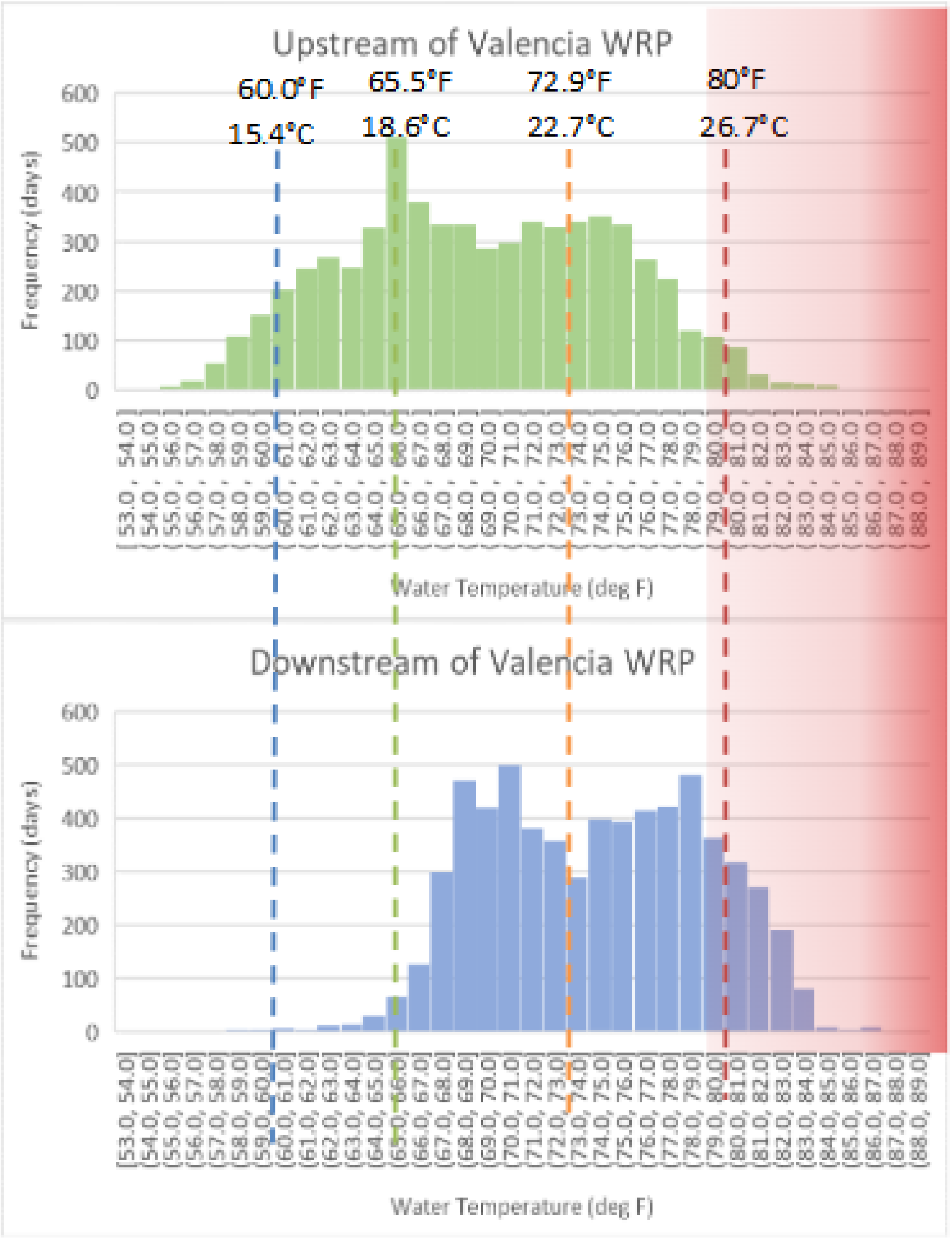
Original planned acclimation at 80°F was unsustainable



Remaining Questions

Original planned acclimation at 80°F was unsustainable

20 fish lost (23% of treatment); corroborated with UILT results



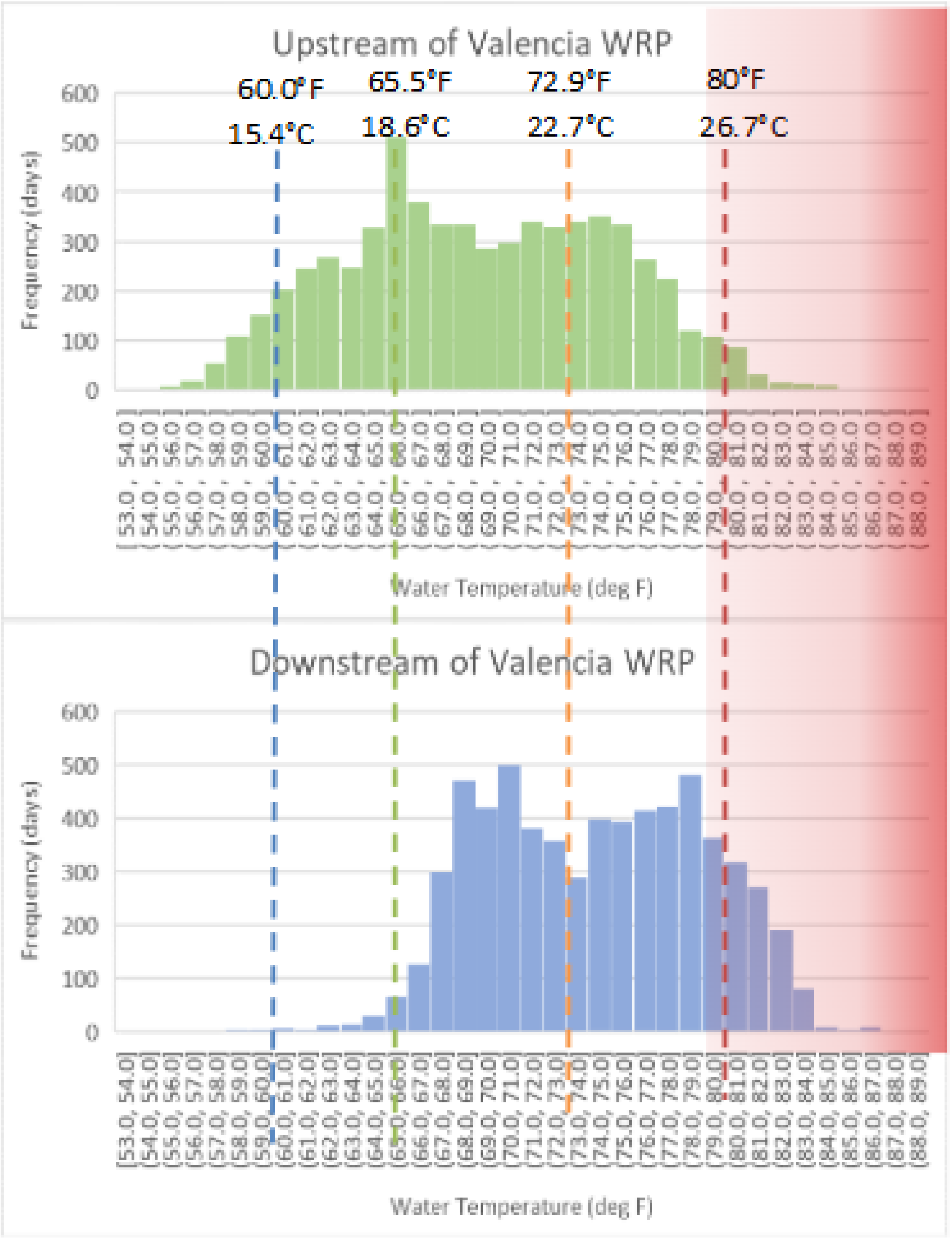
Remaining Questions

Original planned acclimation at 80°F was unsustainable

20 fish lost (23% of treatment); corroborated with UILT results

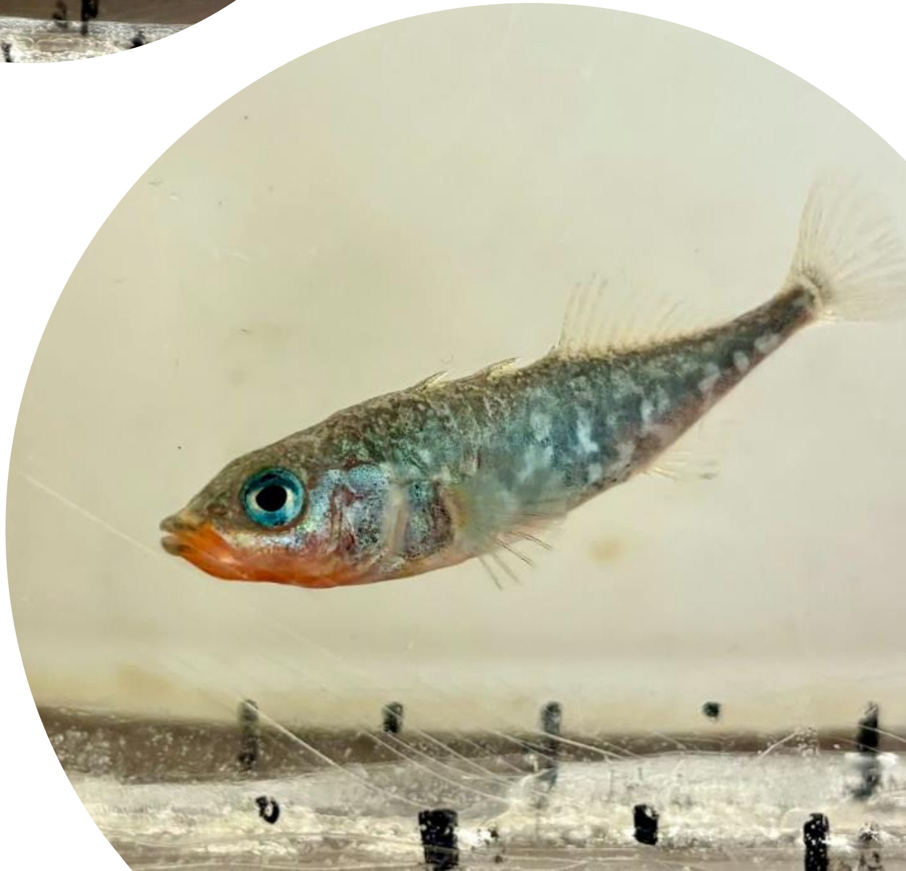
Refugia in natural system: daily cycling, and spatial changes

Question: What is the role of recovery periods and refugia under natural, dynamic conditions?



Phase 2

Proposed Projects



Phase 2 Research Objectives

Questions:

1. Reproduction and early life stages
2. Effects of dynamic thermal environment

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1. Reproduction and early life stages
2. Effects of dynamic thermal environment

What Phase 2 will add:

Increase understanding of fundamental thermal physiology across life-stages

Increase understanding of role of thermal refugia and physiological acclimation

Additional traits to inform habitat suitability model and management action

Summary of Phase 2 Projects

Objectives in Scope of Work:

Collect new cohort of adult fish for spawning and experiments

Effects of temperature on male parental care behavior and spawning

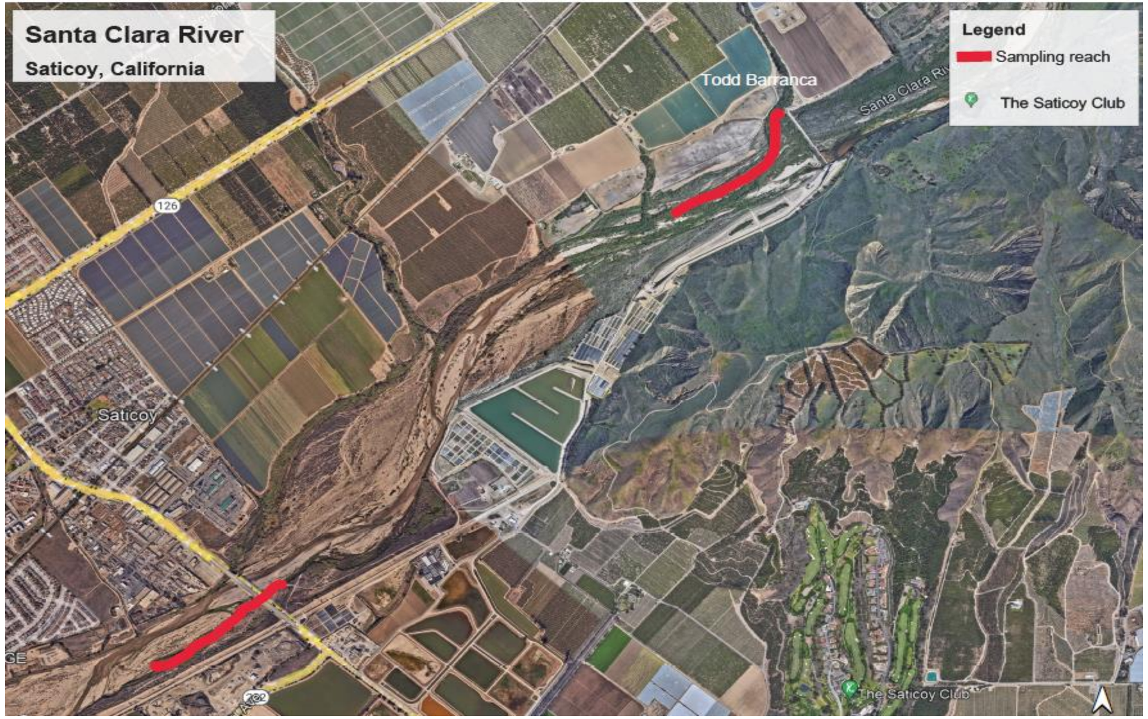
Characterize effects of natural thermal cycle on thermal tolerance and acclimation

Determine temperature effects on incubation of embryos, survival, and development

Collections

<u>Proposed January - February 2025</u>

- Goal: collect 650 Adult PATS
- Introducing additional capture methods to increase take (minnow traps)
- Target Location: lower Santa Clara River, United Water Conservation District property
- Transition fish to captivity over ~4 weeks



Male Parental Care and Spawning

<u>Proposed Spring - Summer 2025</u>

- Naturally spawn and expose adult males protecting eggs to 4-6 temperatures

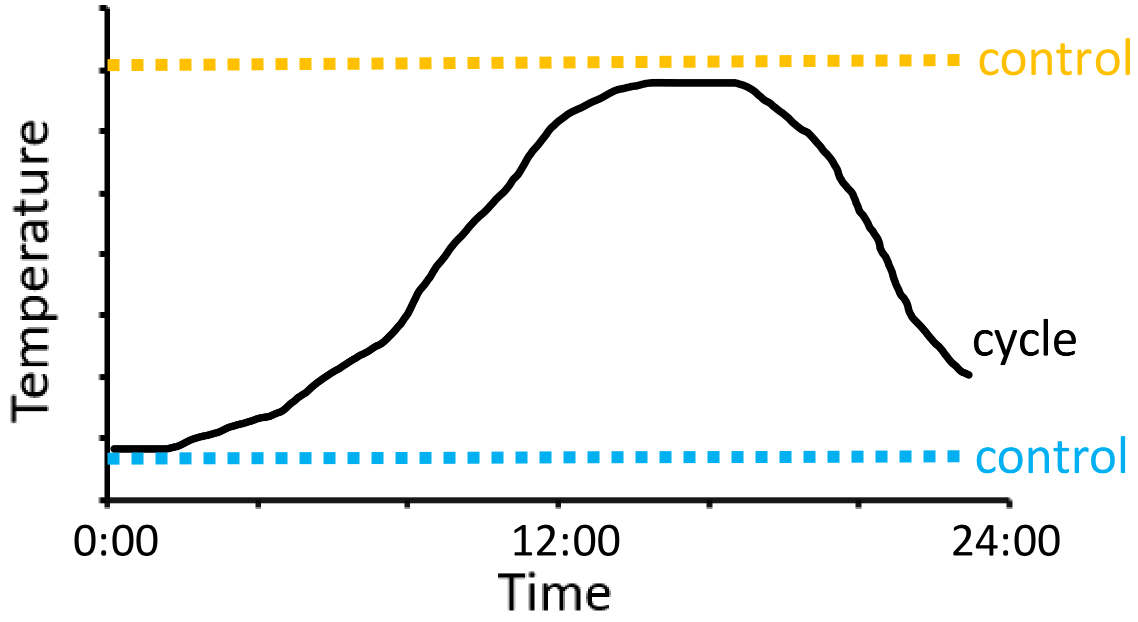
- Measure changes in adult male behavioral traits (e.g. fin fanning)

- Measure changes in embryo hatching success

Thermal Cycling

Proposed Spring - Summer 2025

- Acclimate adult fish to cycle (replicating 'natural' range) and constant control temperatures
- Measure acclimation survival
- Characterize changes in CT_{MAX} at 2-4 timepoints throughout daily cycle



Embryo Incubation

Proposed Spring - Summer 2025

- Artificially spawn and produce >750 viable embryos
- Incubate groups of embryos to 6-8 temperatures
- Measure hatch success, time to hatch and length at hatch

Timeline Overview: Proposed Phase 2 Projects

Jan – Feb 2025: Fish collections and transition to captivity

Spring – Summer 2025: Experimental acclimation and data collection

Fall 2025: Data analysis

Winter 2025: Remaining experimental wrap up, present overall findings

Feedback and Next Steps

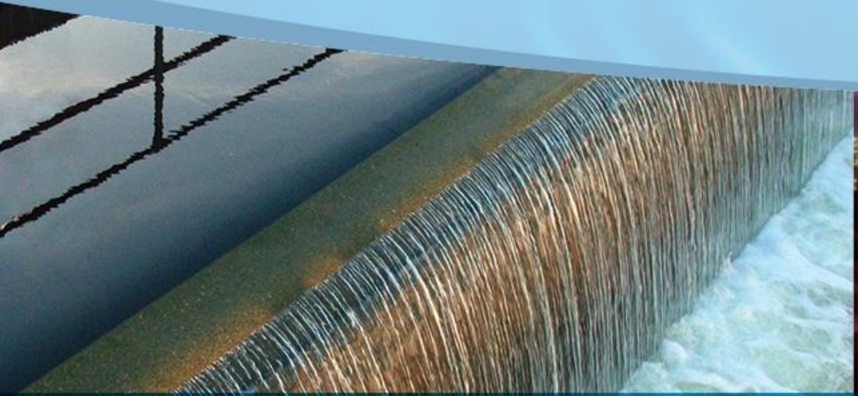
- Get concurrence Phases 1 and 2 lab studies have been clearly communicated and no issues foreseen with proceeding
- Seek SCVSD Board approval for Phase 2; fish collection and lab testing tentatively to begin early 2025
- Continue temperature monitoring and modeling through 2025 (in-stream sensors and spatial surveys)
- Continue approval process for BMI sample collection (CDFW MOU required)
- Next TAC meeting anticipated Q1 2025 to review temperature monitoring results

LOS ANGELES COUNTY SANITATION DISTRICTS

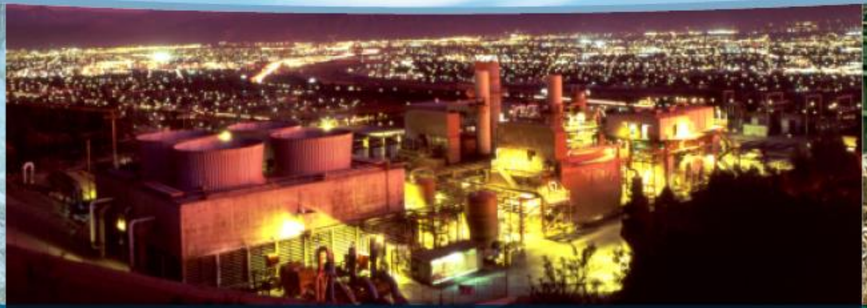
Converting Waste Into Resources

OUR MISSION

To protect public health and the environment through innovative and cost-effective wastewater and solid waste management and, in doing so, convert waste into resources such as recycled water, energy, and recycled materials.



WATER RECYCLING



GREEN ENERGY

MATERIALS RECYCLING