

Rainbow Trout Fishery Update – What Does Warming Water Mean for the Fishery?

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Work Group,
Glen Canyon Dam Adaptive
Management Program
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Josh Korman

1962-2026



Crossman and others, 2026

<https://doi.org/10.1093/fshmag/vuag043>

Background & Outline

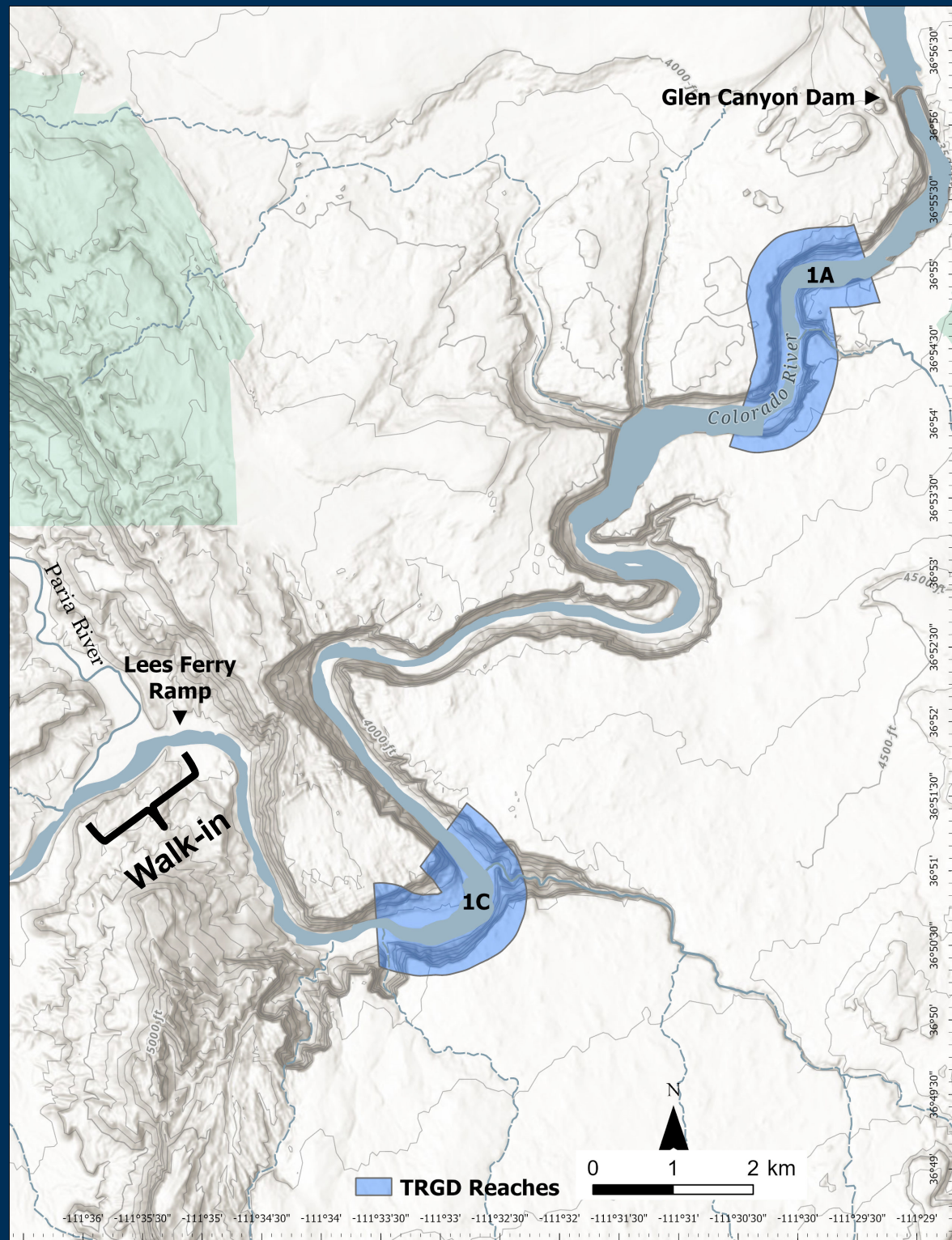
- Are we meeting the Long-term Experimental and Management Plan (LTEMP) goal?
 - *“Achieve a healthy high-quality recreational Rainbow Trout fishery in Glen Canyon National Recreation Area...”*
- Part 1 - status of the Rainbow Trout fishery – metrics review –
 - Angler catch rate – Arizona Game and Fish Department (AZGFD) creel survey
 - Abundance – Trout Growth and Recruitment Dynamics (TRGD) project
- Part 2 - how might the status of the fishery change with warmer water?

Rainbow Trout Fishery - Status

- Angler catch rates
 - AZGFD management goal of 1 fish/hour catch rate
 - Methods – creel survey, boat-in and walk-in anglers



Study Area – Glen Canyon



Results – Angler Surveys (Creel)

2026 Data including 42 creel days (through July 2026) –

- Walk-in interviews (n=209)
- Boat ramp interviews (n=262)

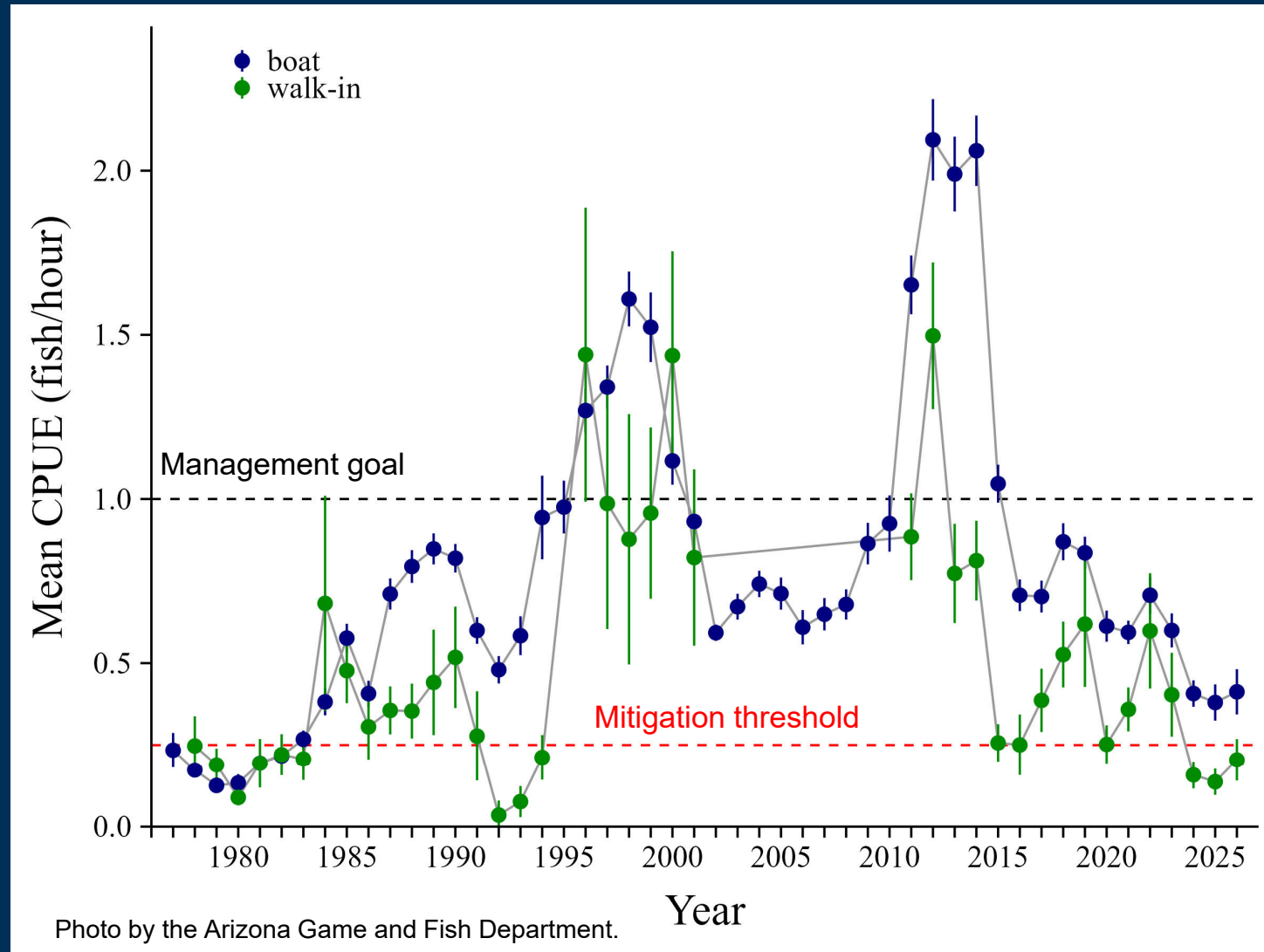


Photo by the Arizona Game and Fish Department.



Results – Angler Catch Rate

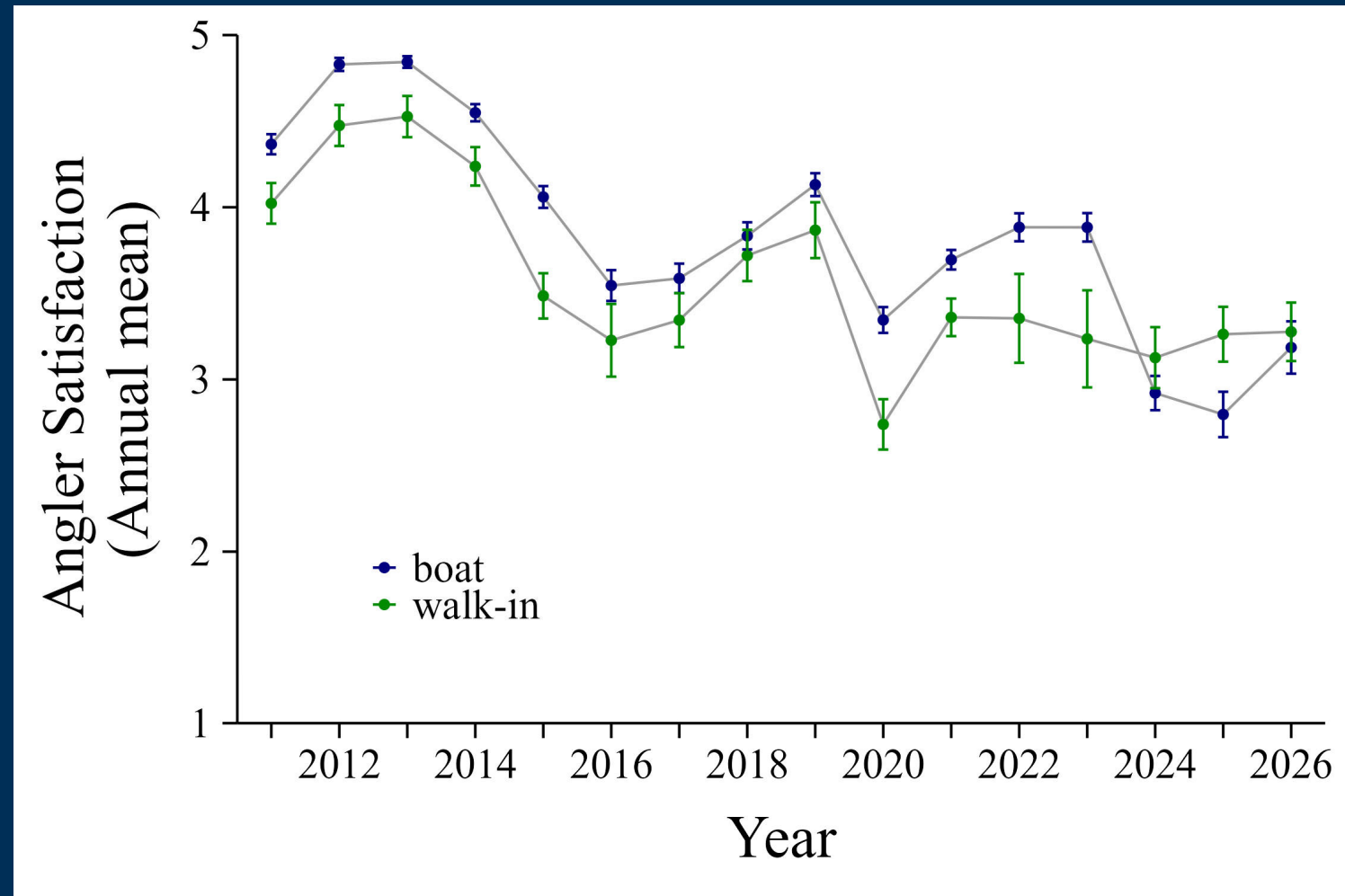
- Rainbow Trout Angler catch per unit effort (fish/hour)
- January-July for all years (1977-2026)



Preliminary AZGFD unpublished data, do not cite

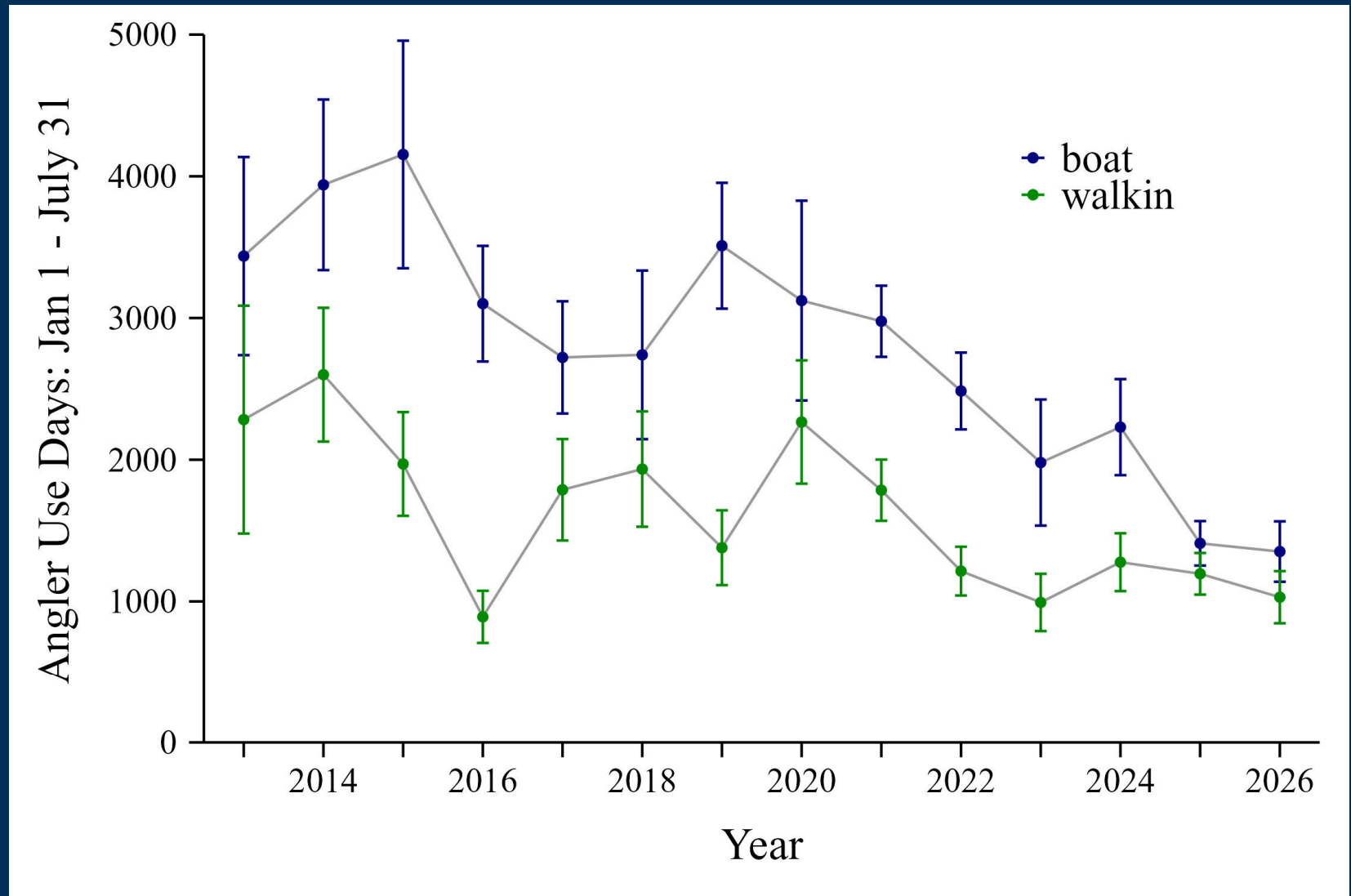
Results – Angler Satisfaction

- Anglers are asked to rate the quality of the fishery on a scale of 1-5
- 2011-2026



Preliminary AZGFD unpublished data, do not cite

Results – Angler Use



Preliminary AZGFD unpublished data, do not cite

Methods – TRGD

- Metric - abundance
 - Sampling
 - 4 trips per year
 - Design allows for monitoring of seasonal dynamics
 - 2 sites
 - Upper – near Dam
 - Lower – ~4 miles above Lees Ferry*
- *Longest time series

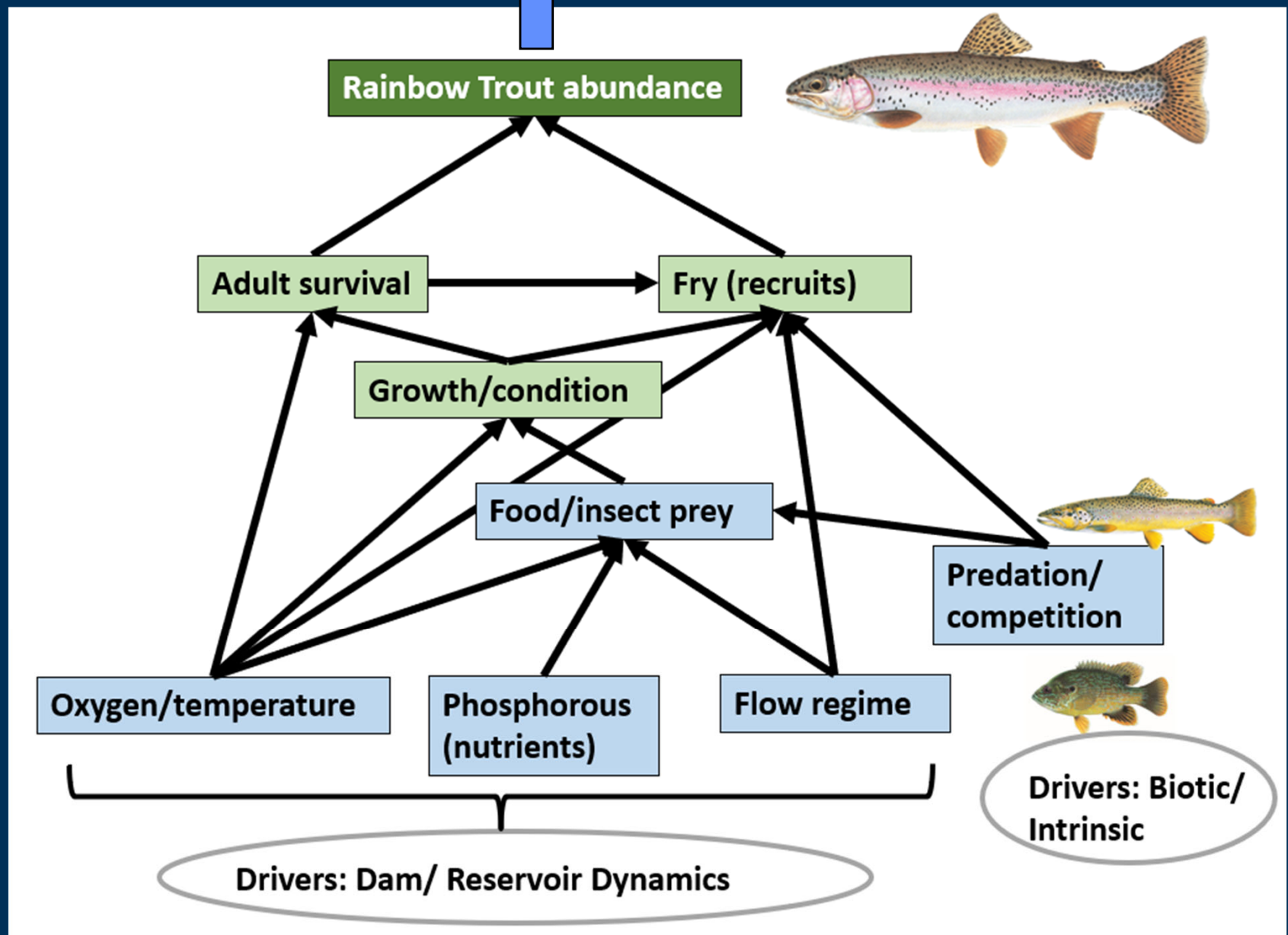


Photo by Lindsay Hansen/U.S. Geological Survey

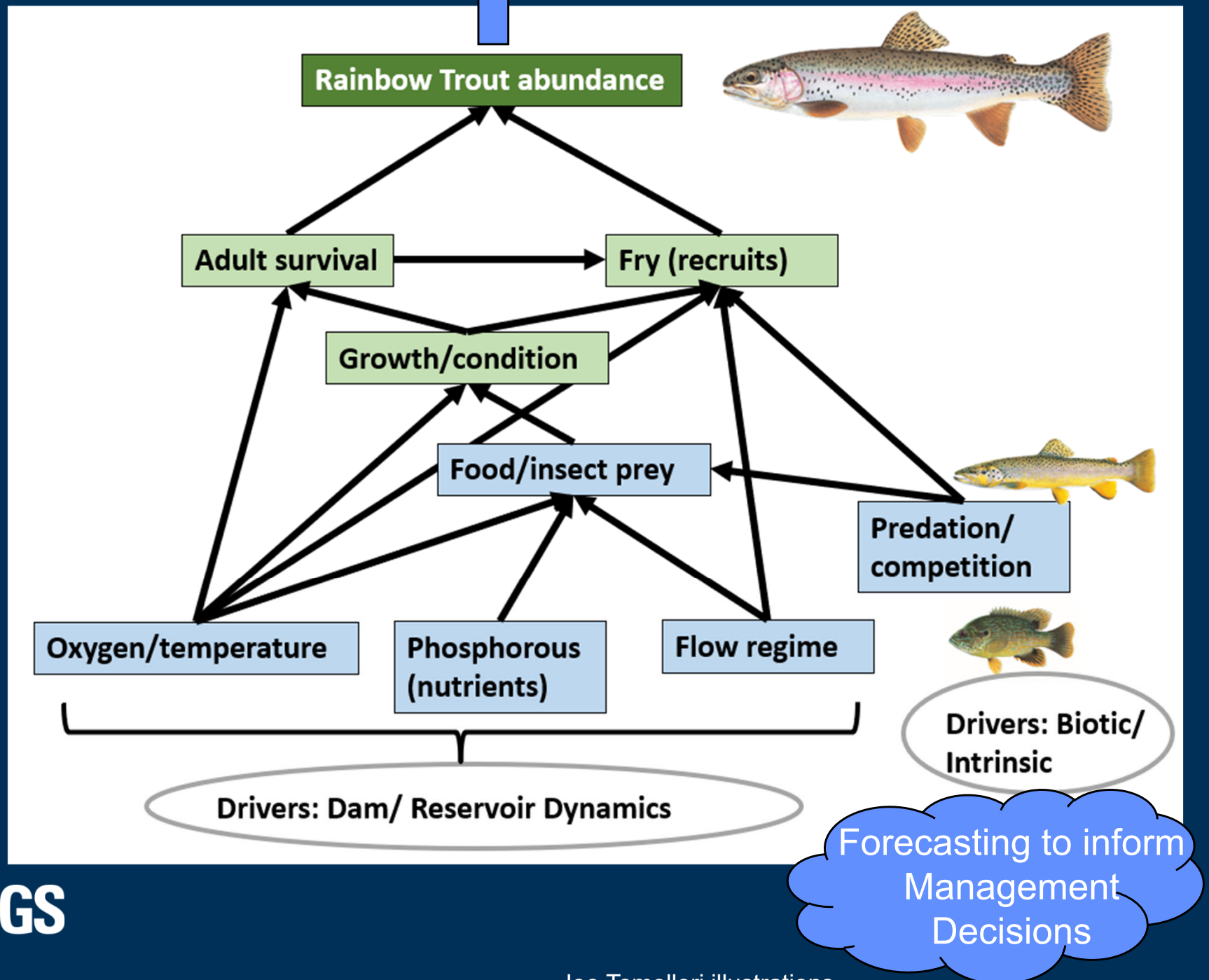


Photos by Lindsay Hansen/U.S. Geological Survey

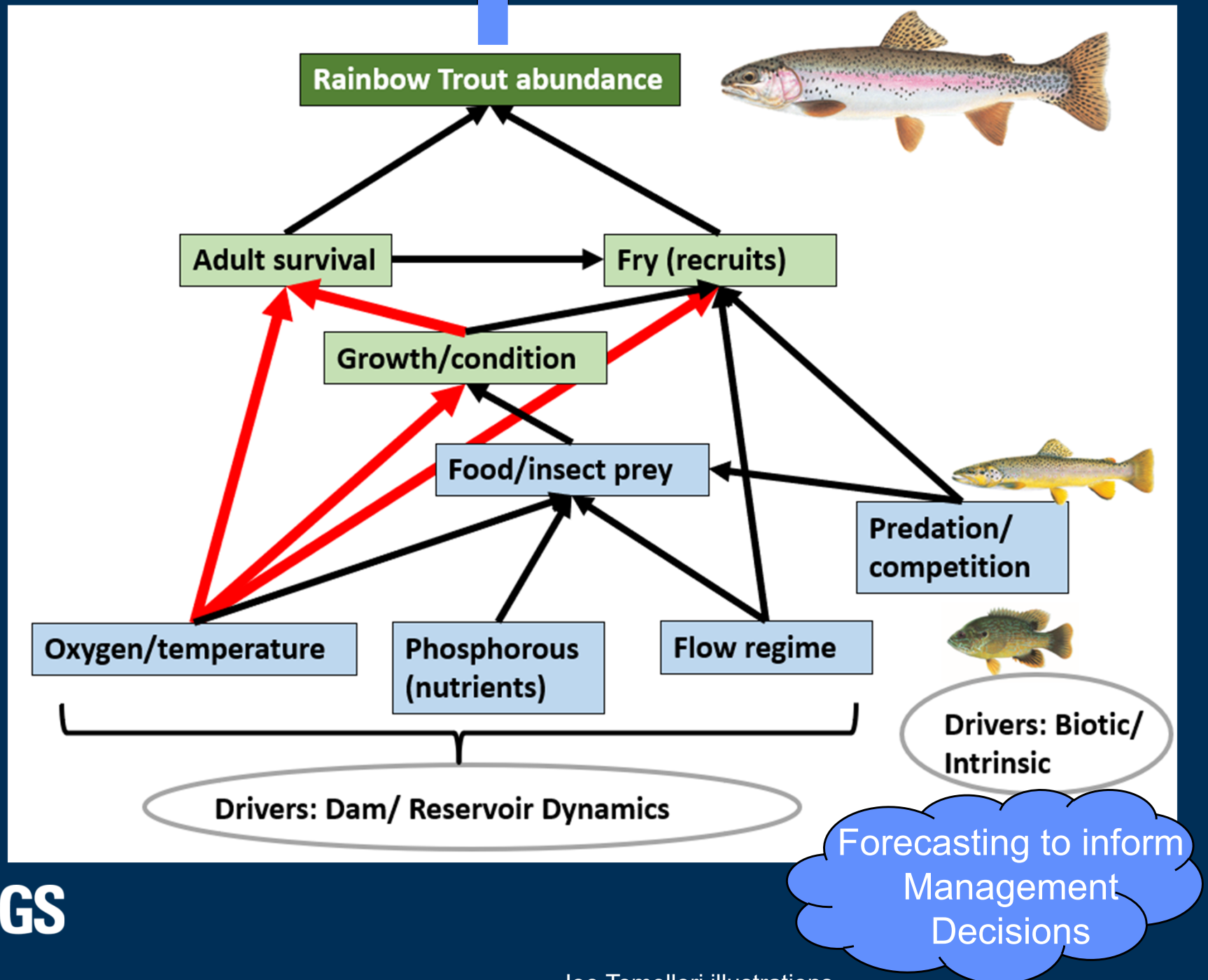
Angler catch rates (1 fish/hour)



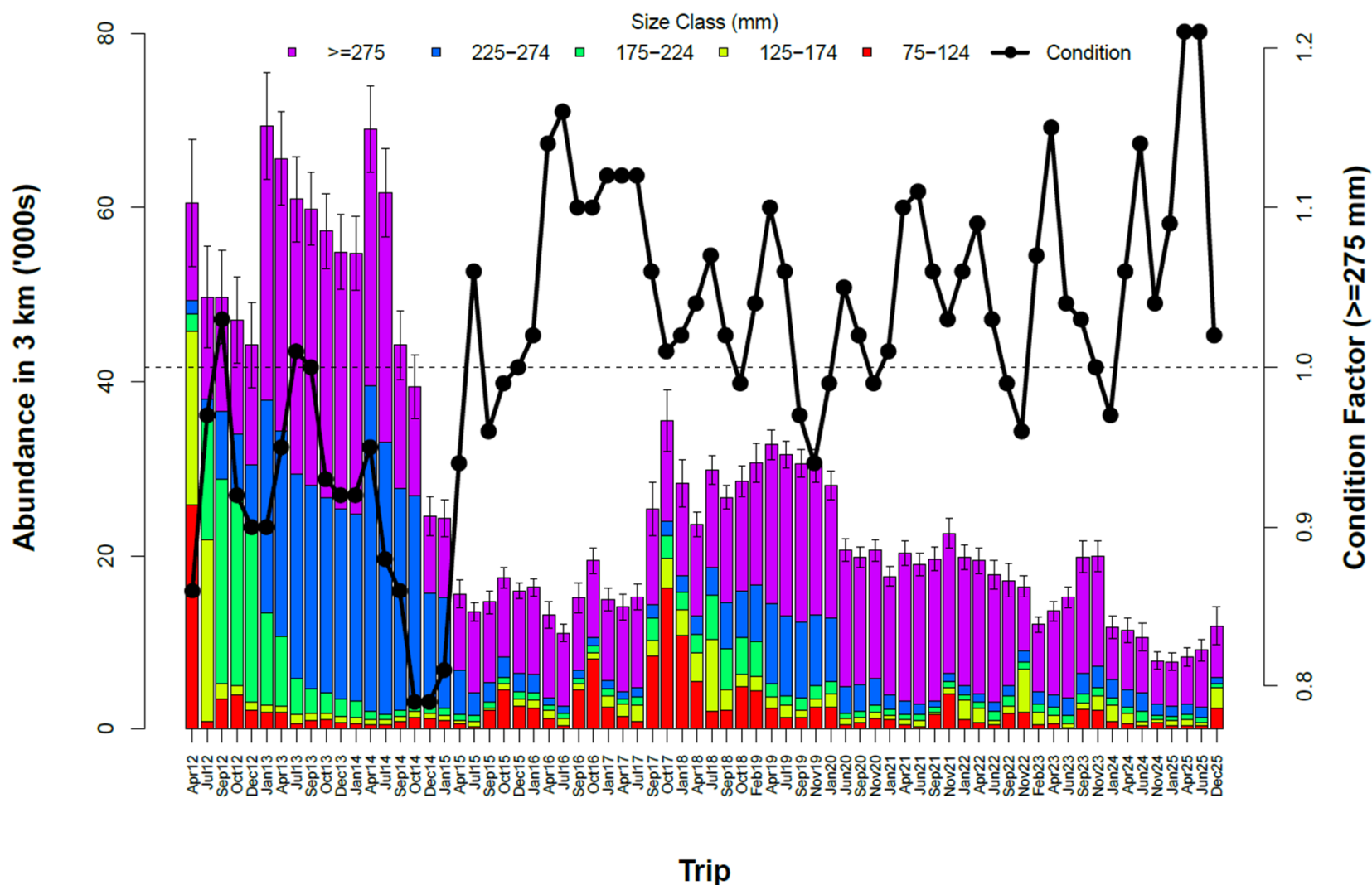
Angler catch rates (1 fish/hour)



Angler catch rates (1 fish/hour)



Rainbow Trout Abundance – Glen Canyon Lower Site (1C)



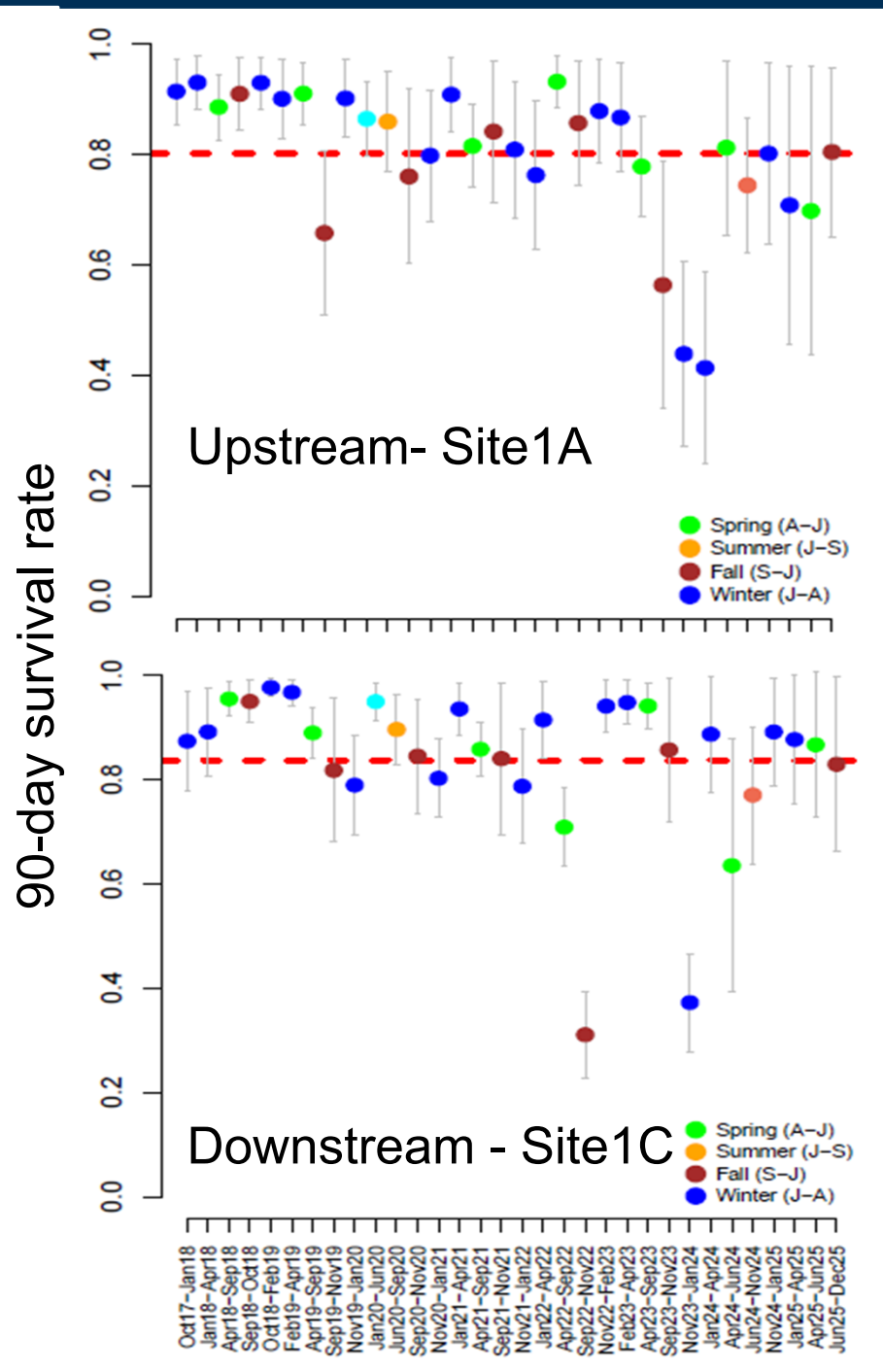


2024

Preliminary unpublished data, do not cite

Rainbow Trout Survival

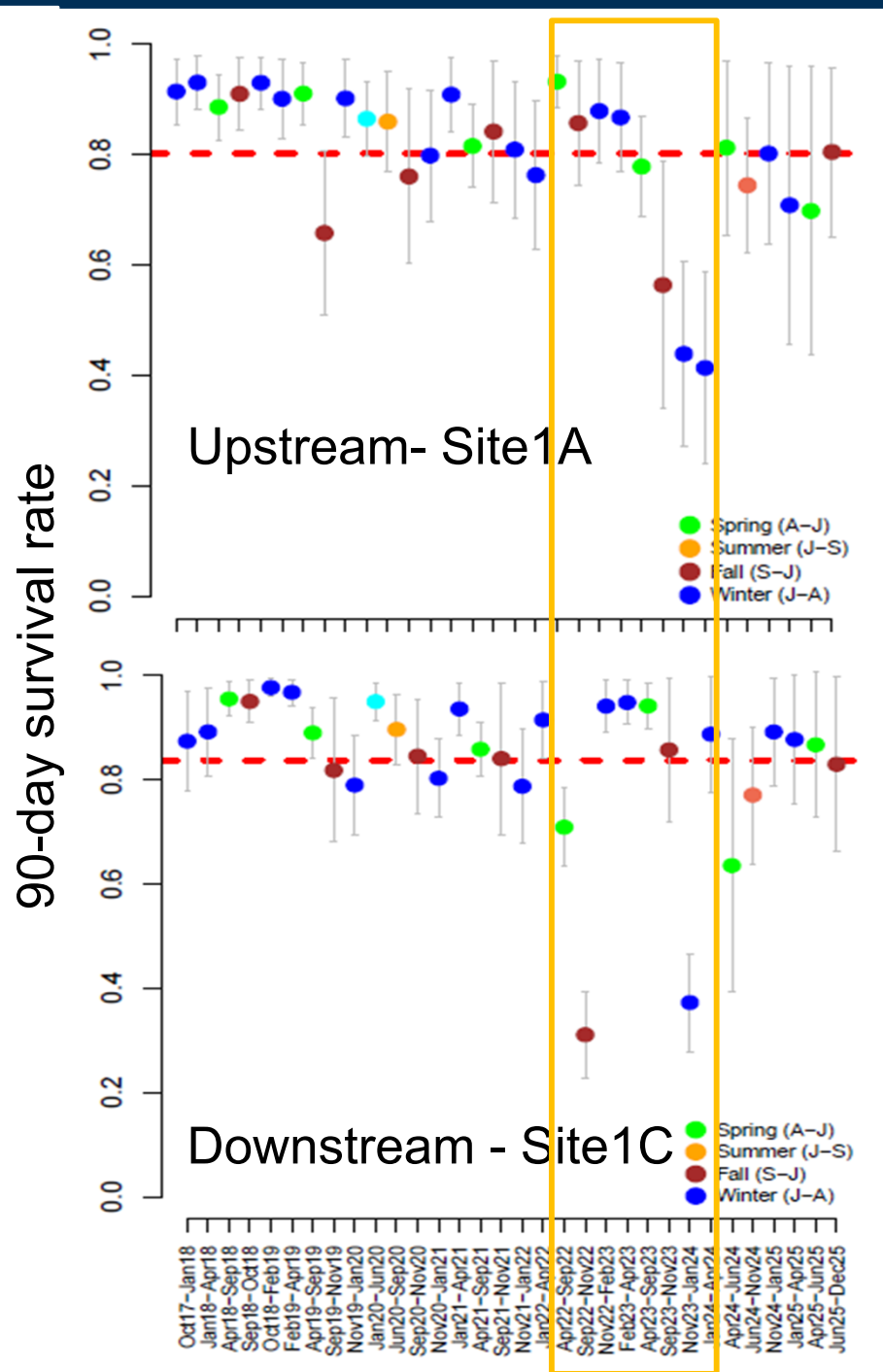
- Seasonal survival of larger fish (300 mm) October 2017 through December 2025



Preliminary unpublished data, do not cite

Rainbow Trout Survival

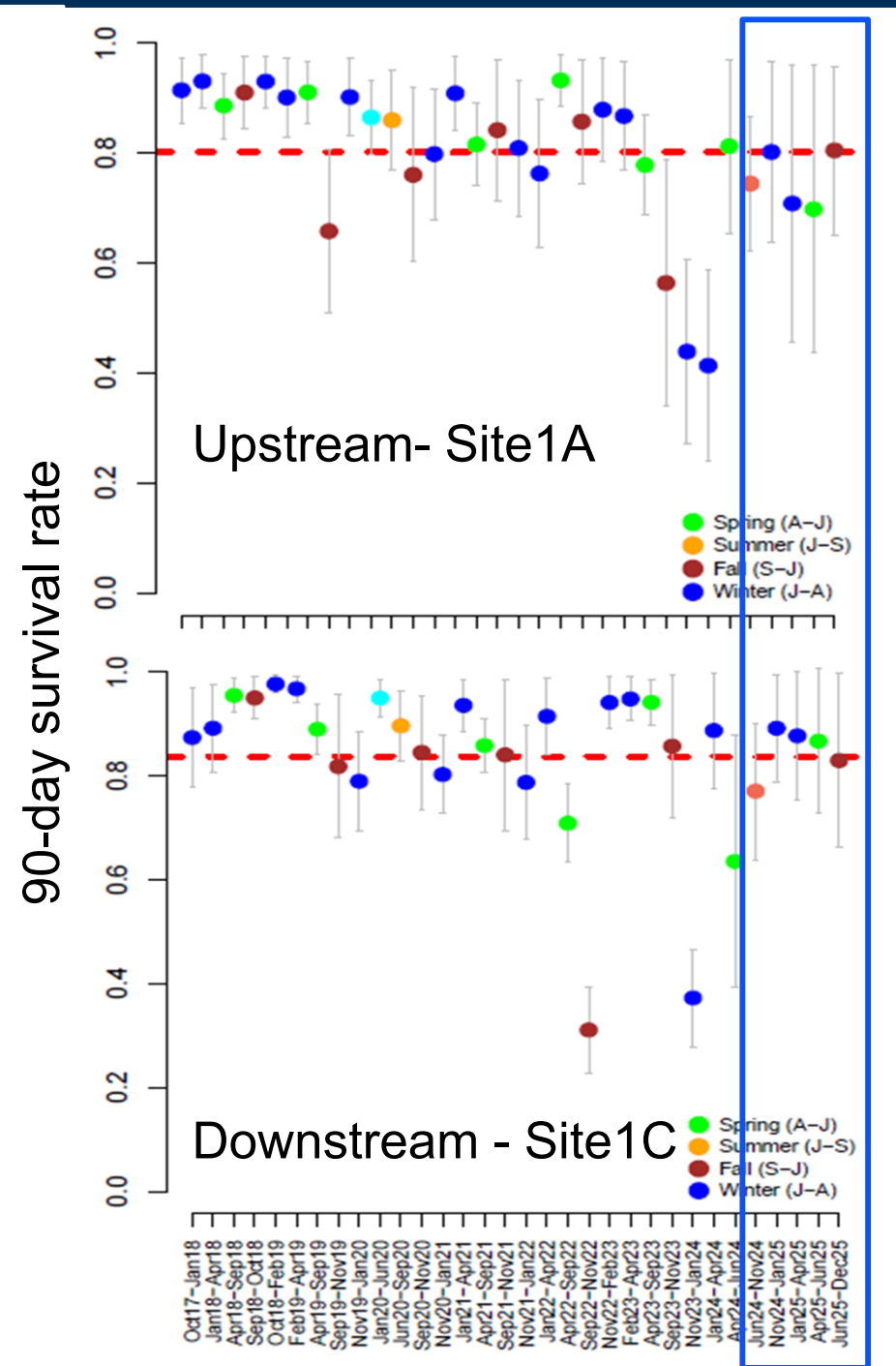
- Seasonal survival of larger fish (300 mm) October 2017 through December 2025
- Reduced survival – summer-fall 2022-23



Preliminary unpublished data, do not cite

Rainbow Trout Survival

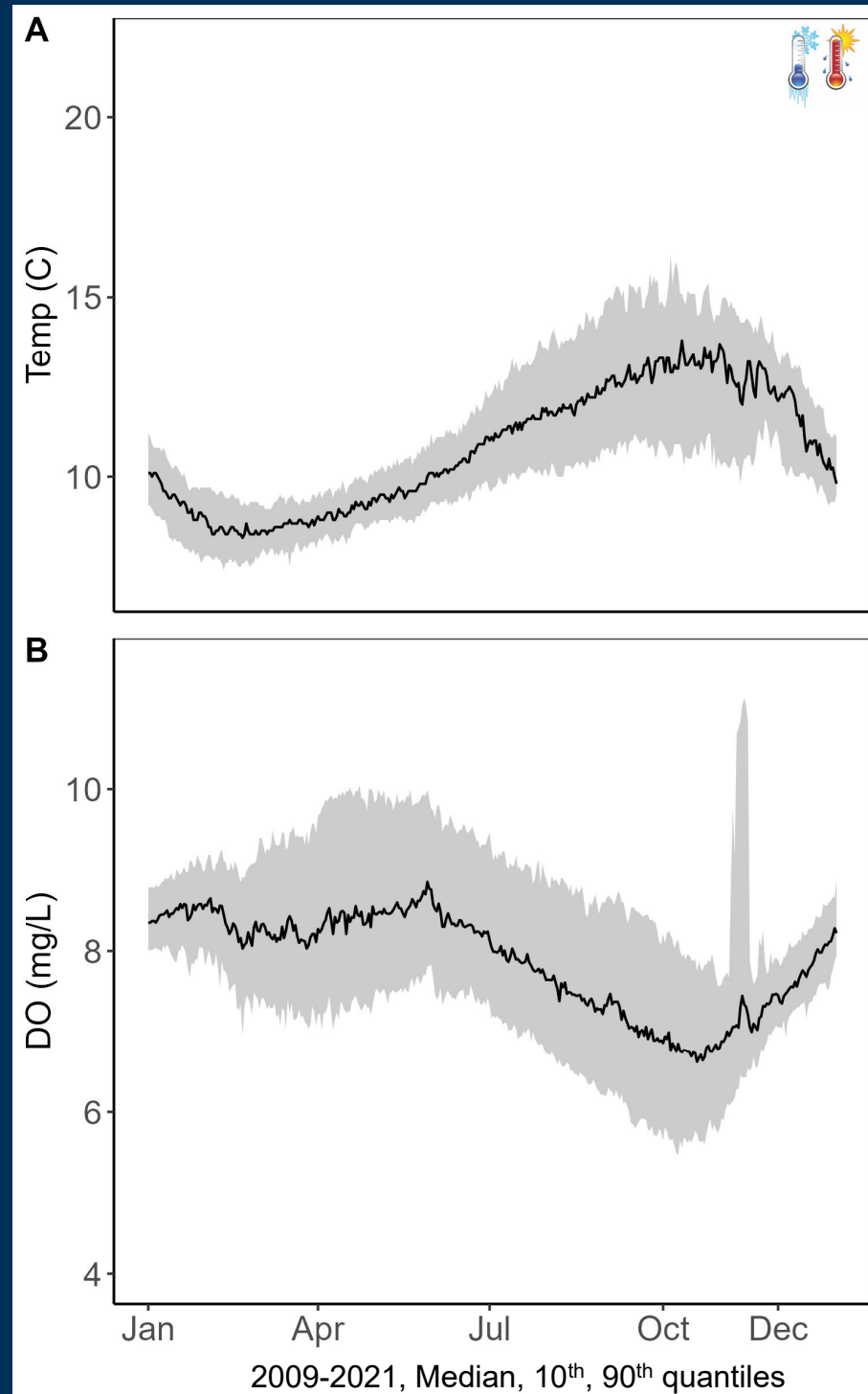
- Seasonal survival of larger fish (300 mm) October 2017 through December 2025
- Higher survival after Spring 2024



Preliminary unpublished data, do not cite

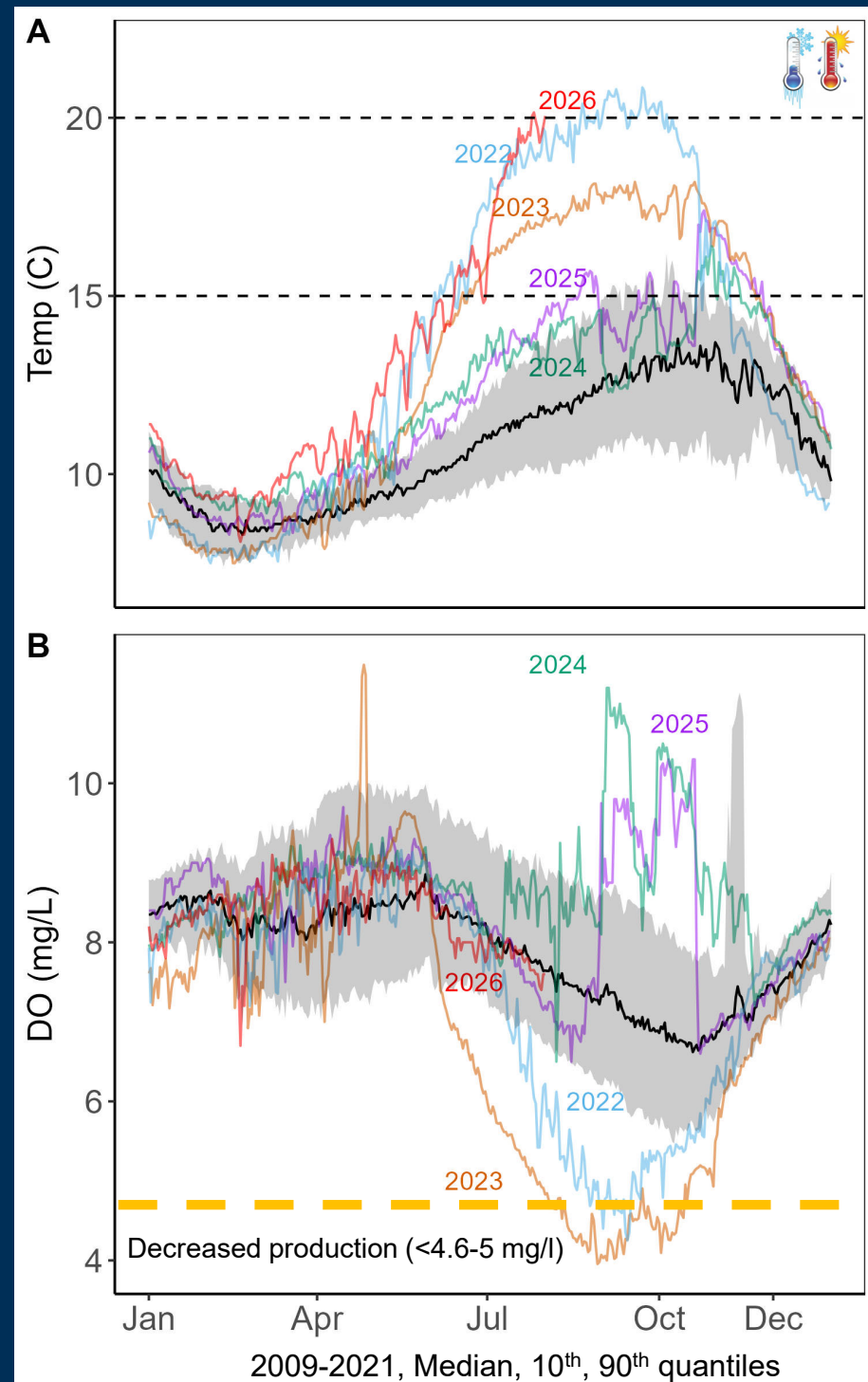
Potential Drivers of Declines

- Temperature, dissolved oxygen, 2009-2021



Potential Drivers of Declines

- Low survival corresponding to warm temperatures, low dissolved oxygen (fall 2022-2023)
- 2026 expected to be as warm or warmer than 2022-2023

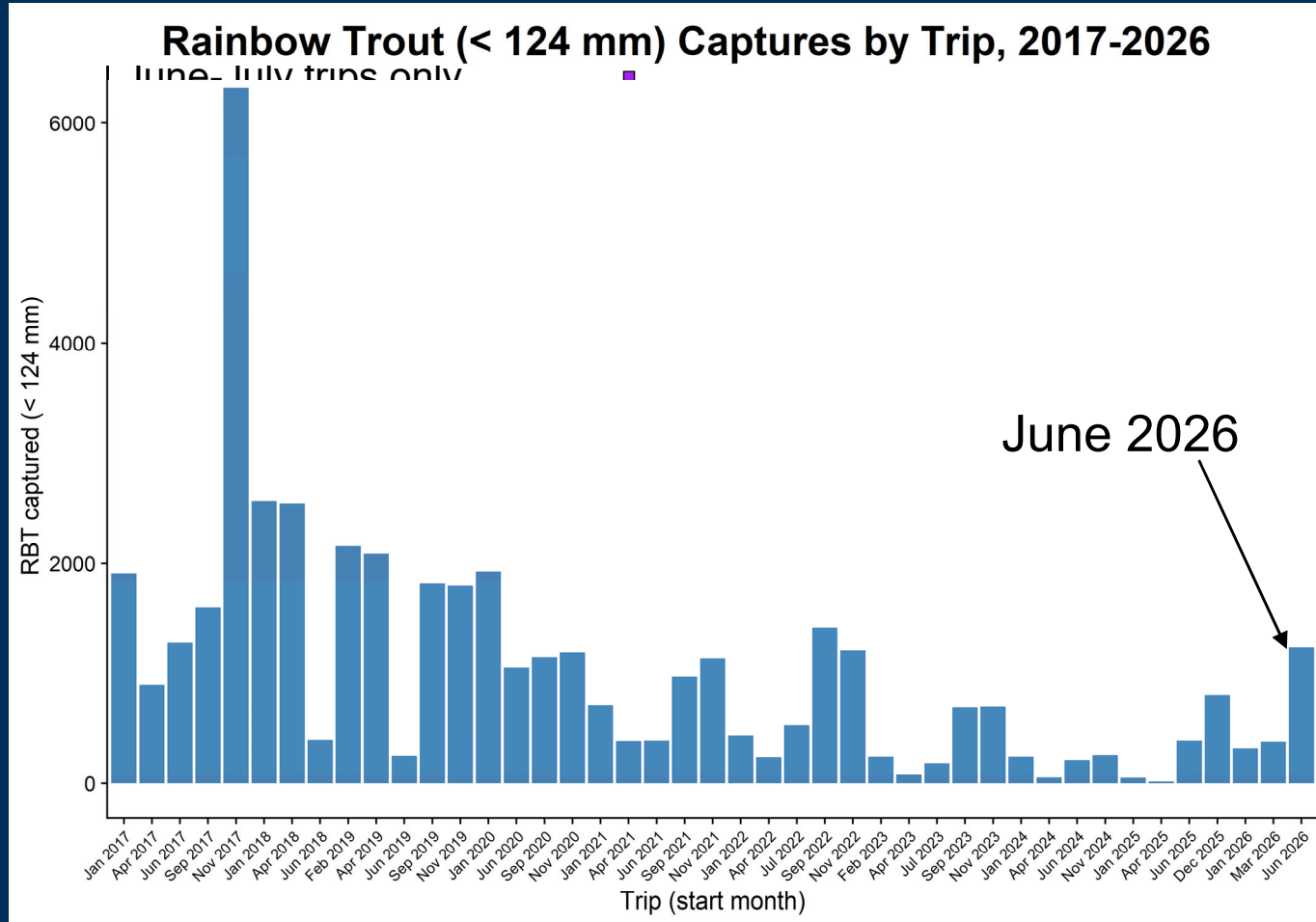


Rainbow Trout Recruitment

- Catch rates (raw) – 2017 through 2026*
- Indicator of recruitment (fish < 124 mm)



Photo by Lindsay Hansen/U.S. Geological Survey



Preliminary unpublished data, do not cite

*Interpretation of raw catch data may be subject to variation in capture probability

2026 Conditions and Potential Effects to the Trout Fishery

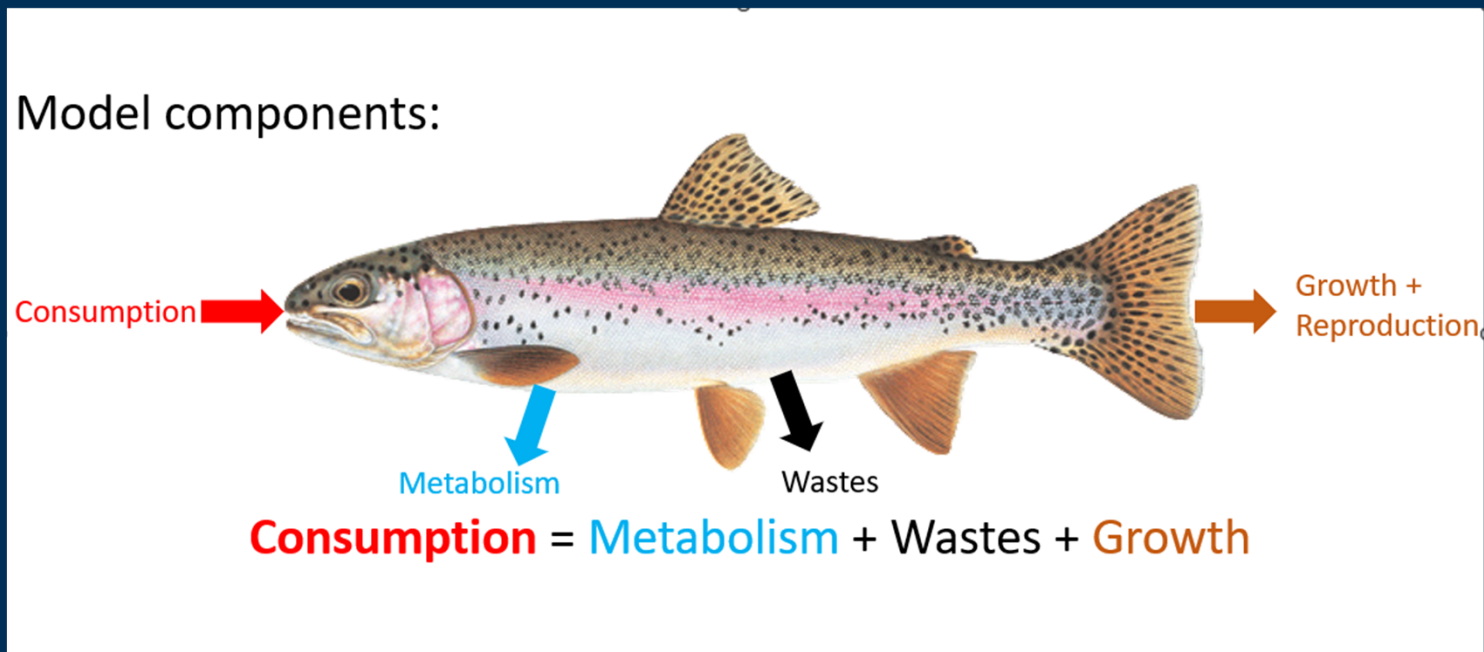


DAVID HERASIMTSCHUK

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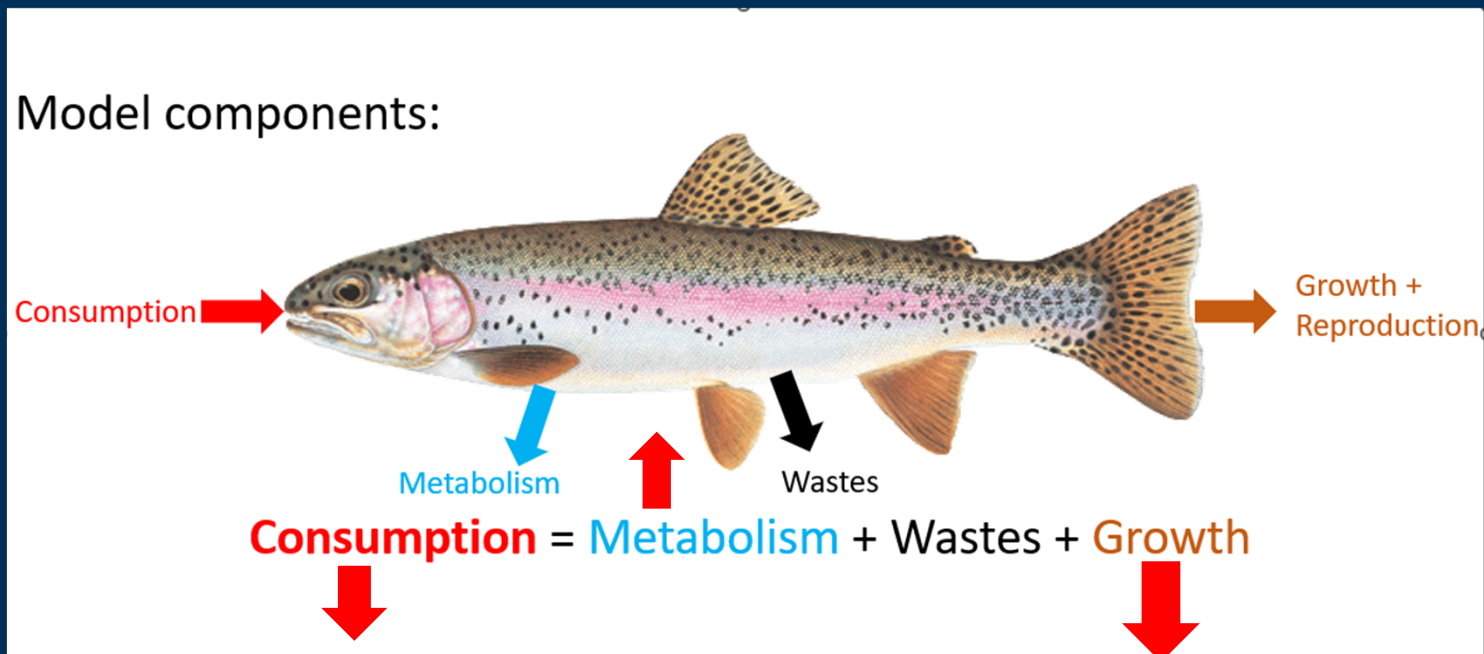
Bioenergetics Modeling

- Model accounts for what comes in and what (must) go out
- Order of energy allocation
 1. Resting + Active metabolism + Digestion
 2. Wastes
 3. Growth + Reproduction (allocated last!)



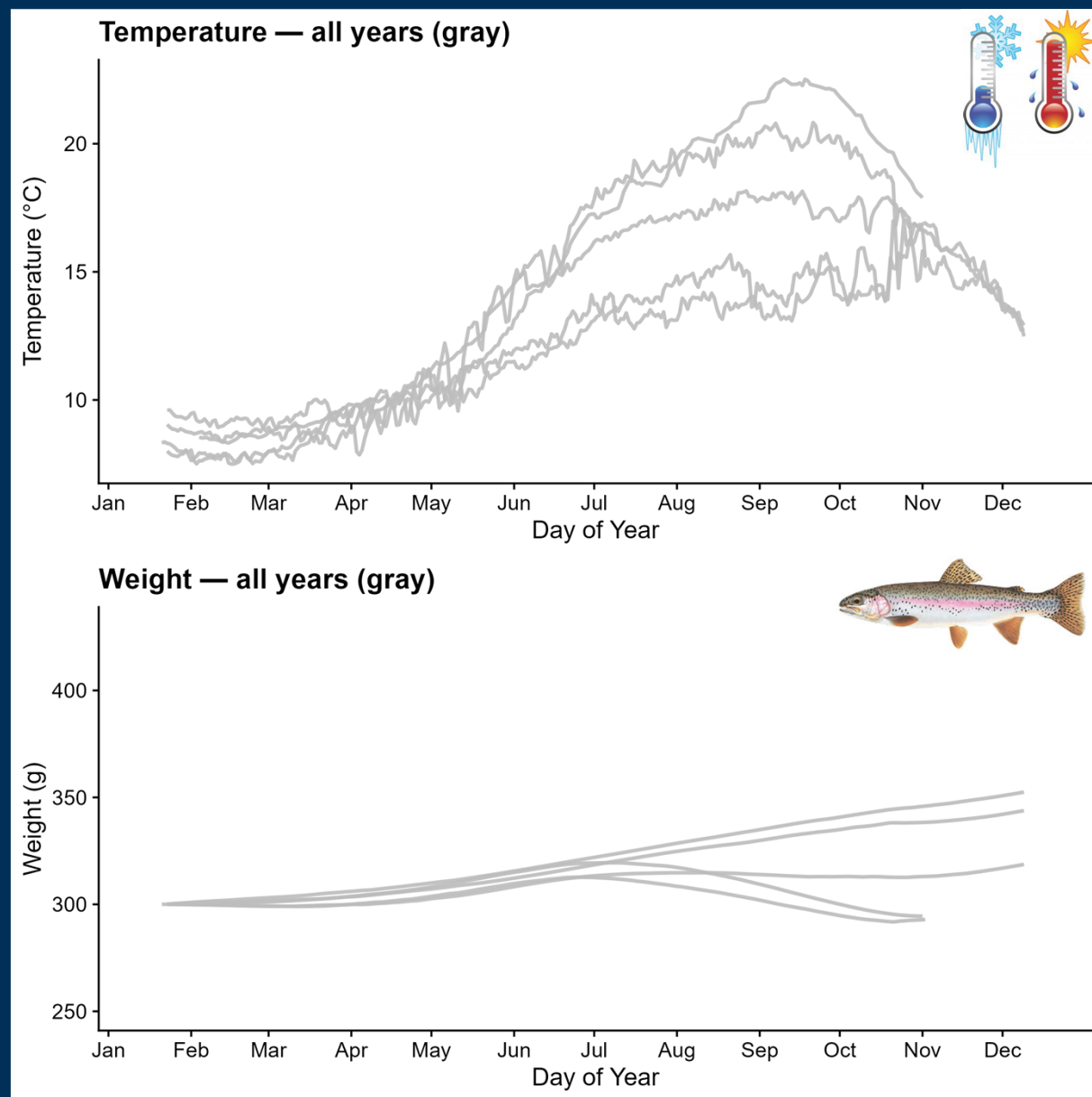
Bioenergetics Modeling

- Low dissolved oxygen and high temperature
 - Reduced feeding, increased metabolic costs
- ➔ Reduced energy allocated to growth, reproduction



Bioenergetics Results

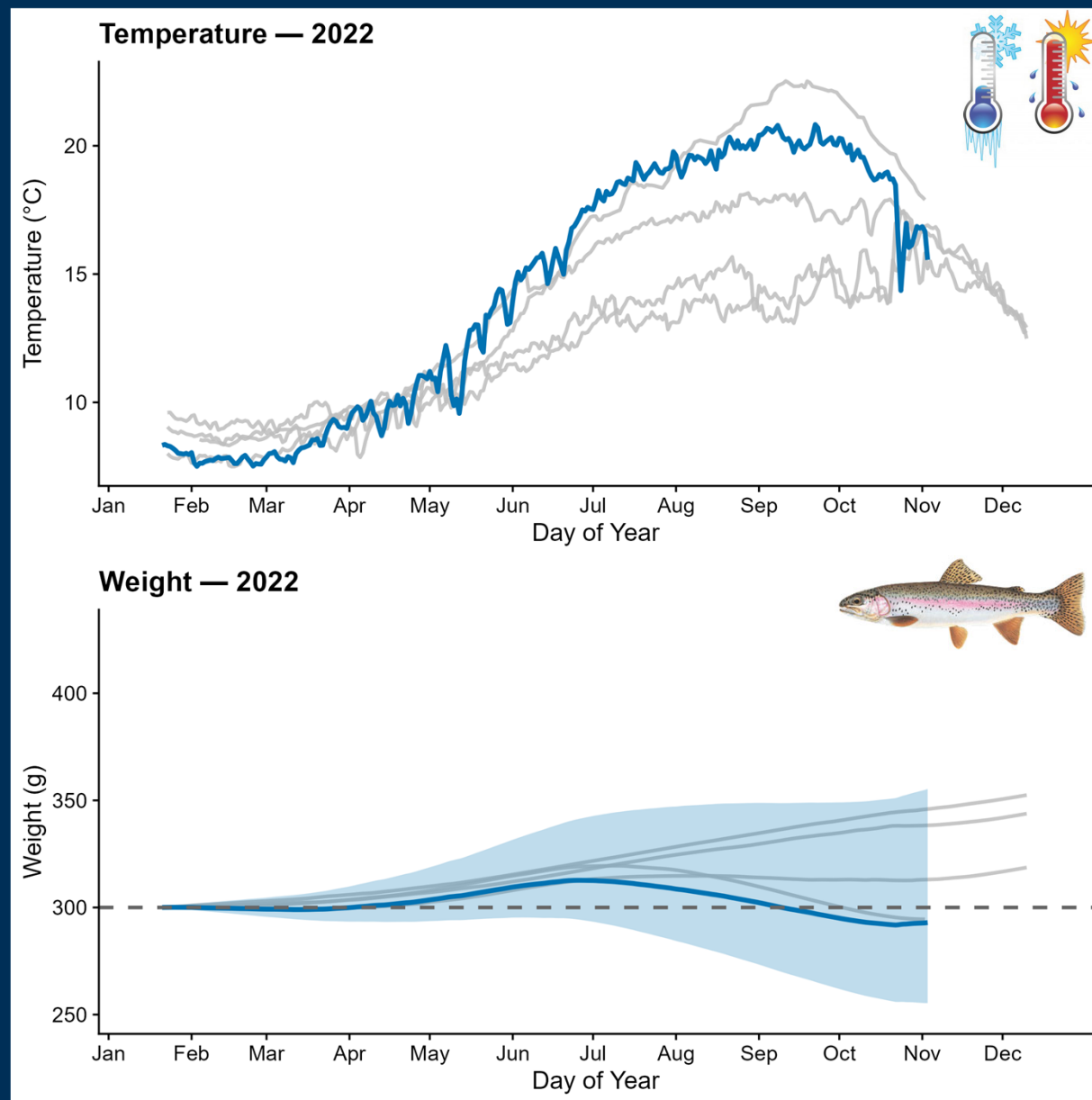
- Compare growth rates and weight gain/loss between years
 - 2022-2026
- Caveats –
 - observed start/ending weights are from fish that survived, leading to potentially optimistic projections of growth/weight
 - Uncertainty in individual fish and temperature projections



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

Bioenergetics Results – 2022

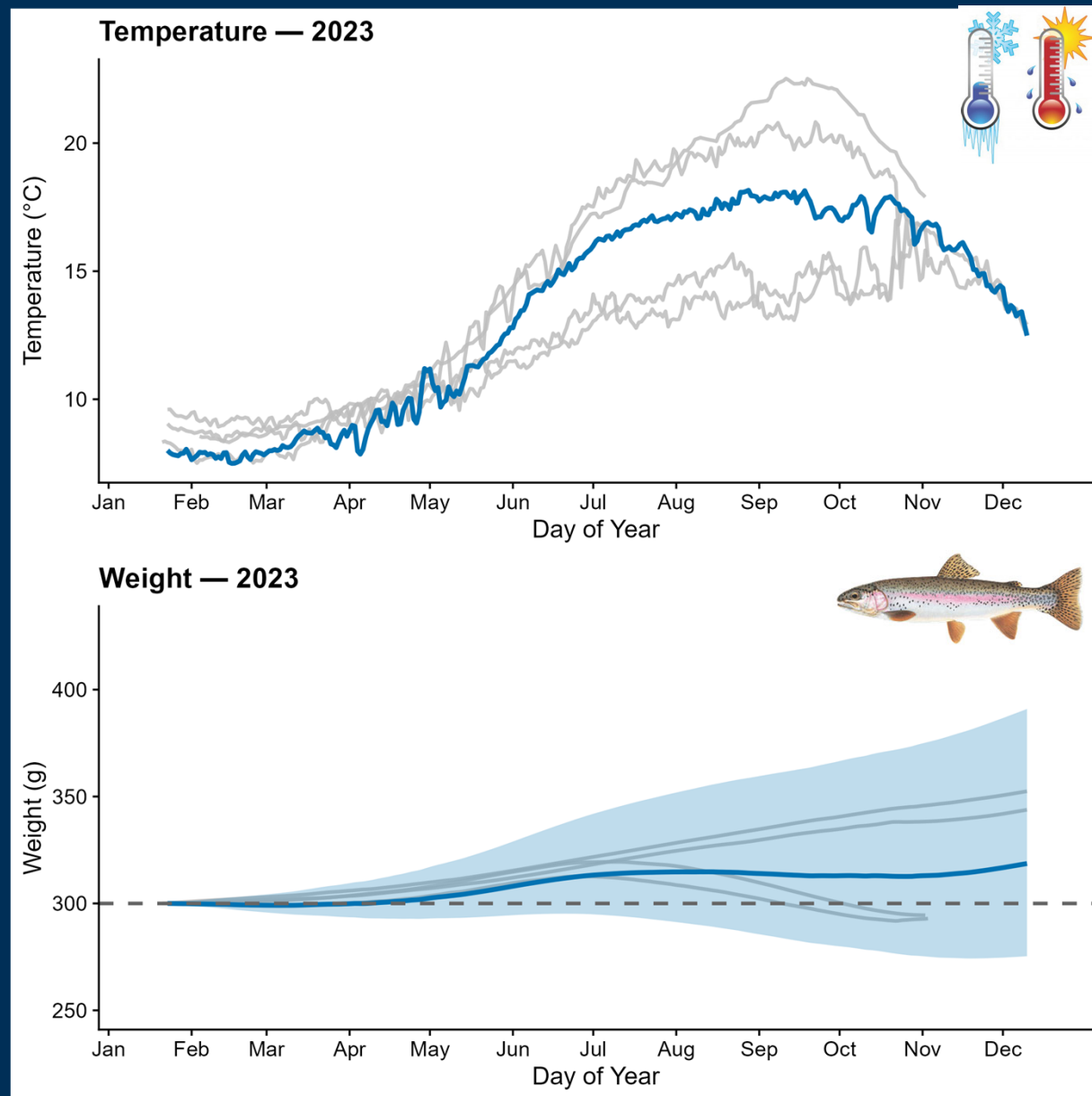
- Warmer observed temperatures
- Growth rate declines at ~14 degrees C
- Lost weight, reduced survival of average fish



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

Bioenergetics Results – 2023

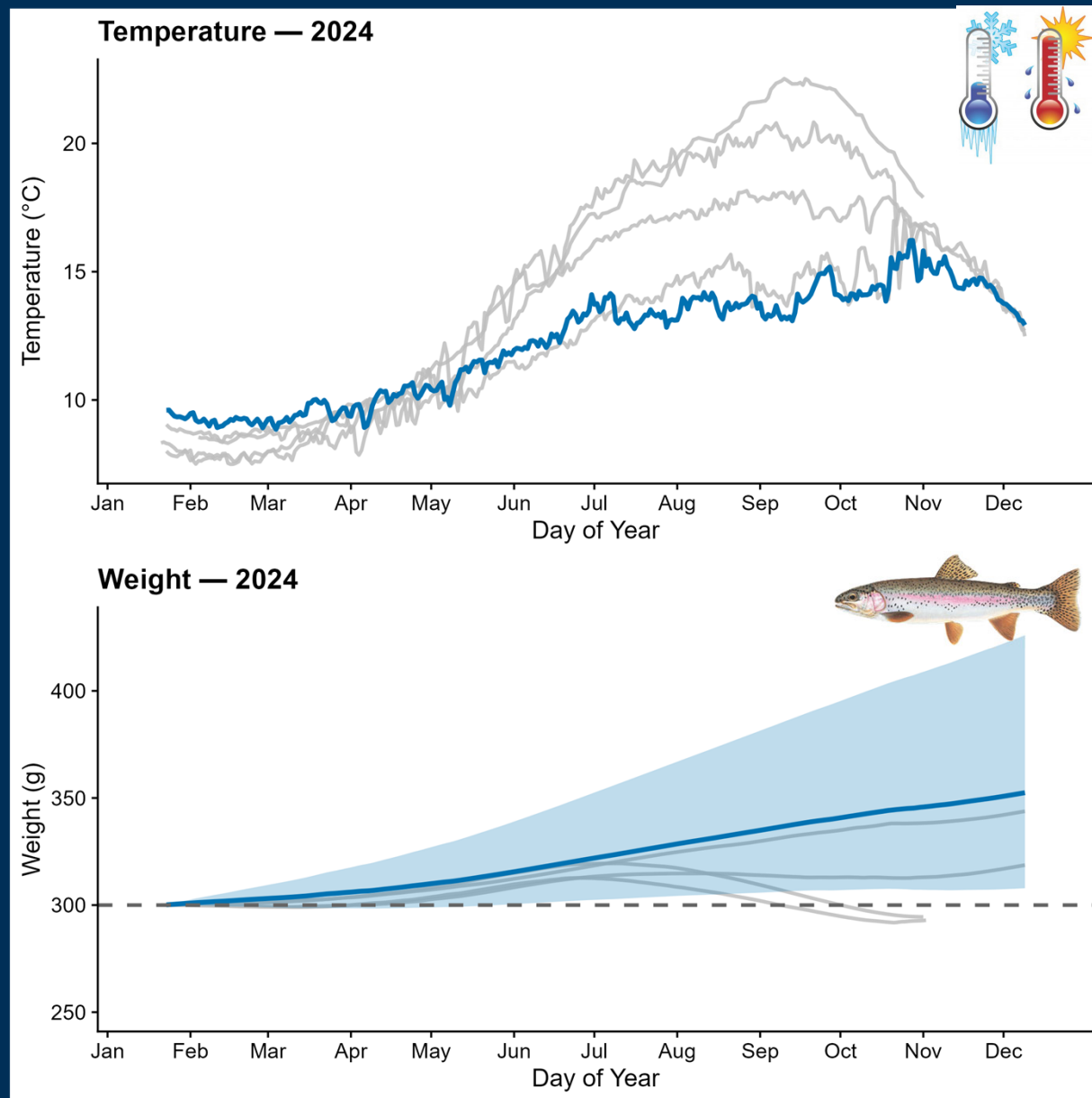
- Warmer observed temperatures
- Growth rate declines at ~14 degrees C
- Lost weight, reduced survival



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

Bioenergetics Results – 2024

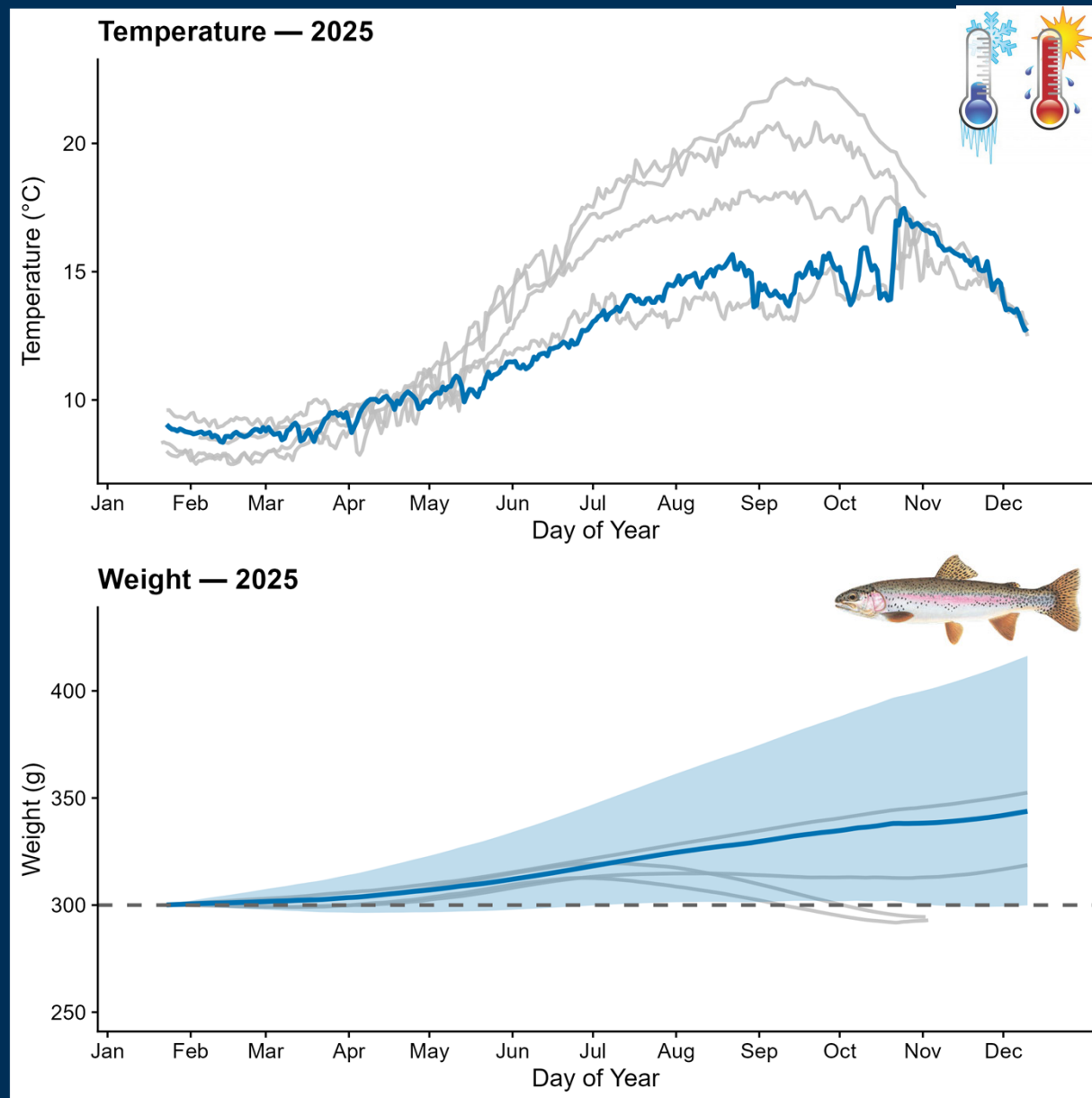
- Cooler temperatures
- Positive growth maintained throughout summer-fall



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

Bioenergetics Results – 2025

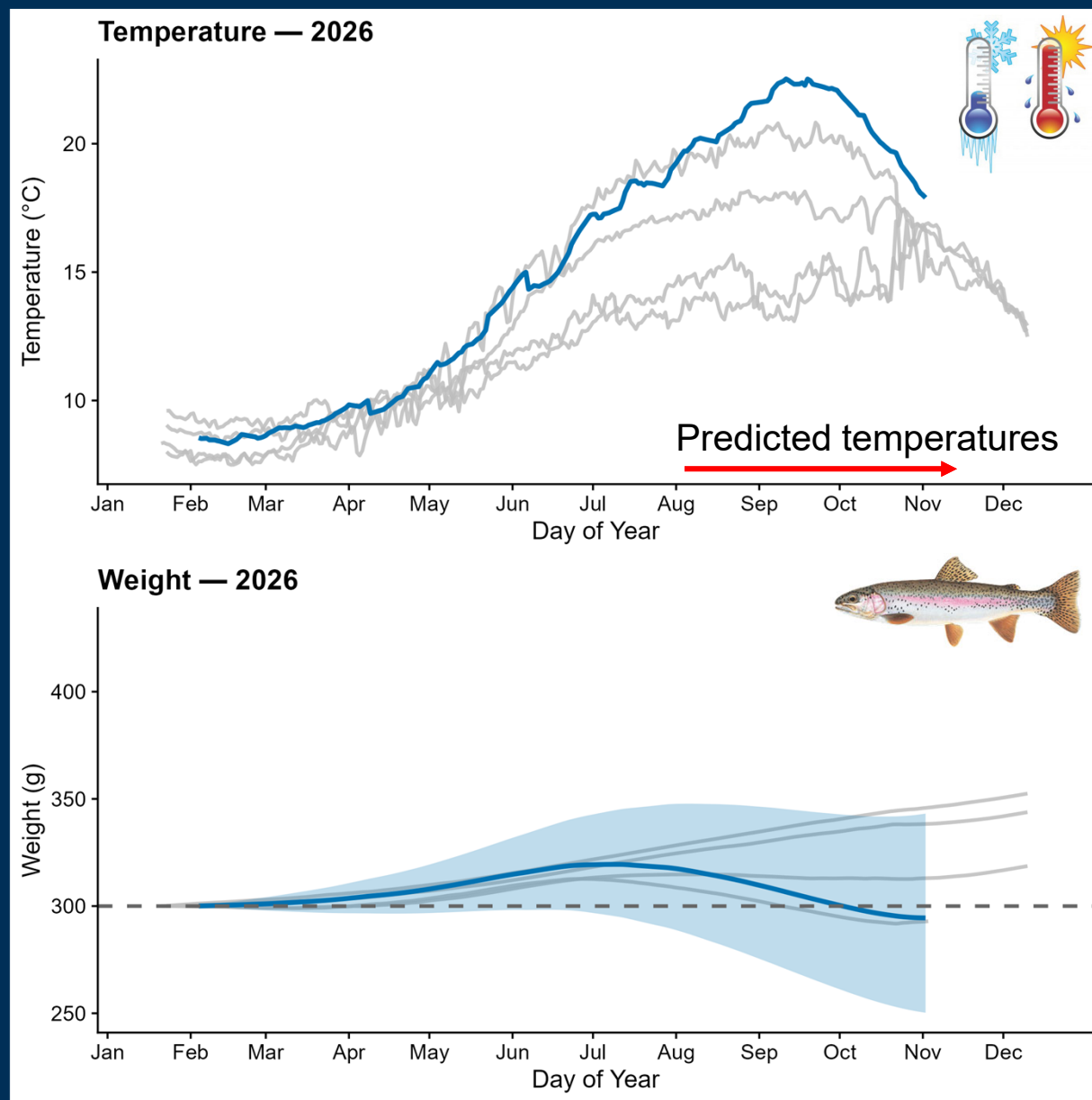
- Cooler temperatures
- Positive growth maintained throughout summer-fall



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

Bioenergetics Results – 2026

- Predicted warmer temperatures (up to ~23 degrees C)
- Growth rate declines at ~14 degrees C
- Lost weight and reduced survival are likely



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

Summary

- The Rainbow Trout fishery has not been meeting LTEMP goals
- Evidence indicates water quality likely caused recent decline
- Coolmix flows in 2024-2025 likely offset potential negative effects of warm temperatures on Rainbow Trout
 - Growth
 - Recruitment
 - Survival
- Predicted warm water in 2026 (~23C/73F) and potential for low dissolved oxygen will likely result in lost weight and reduced Rainbow Trout survival (particularly in larger fish), as in 2022-2023
- Negative biotic interactions with warmwater introduced fishes may compound negative effects of warm water

Questions?

Acknowledgements
Funded by:



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Extra Slides

Bioenergetics Methods

- Simulate effects of 2026 temperatures on Rainbow Trout growth
 - Used published model for Rainbow Trout (Railsback and Rose 1999*)
 - Parameterized with -
 - Starting, ending weights of 16 fish 250-350g captured and recaptured between spring and fall trips 2022-2025 – used to estimate proportion of max. consumption values (“P-values”; a measure of food availability)
 - Observed temperatures (2022-2025)
 - 2026 temperature predictions (Eppehimer model)
 - Compare growth rates and weight gain/loss between years
 - Caveat – observed start/ending weights are from fish that survived → potentially optimistic projections of growth/weight

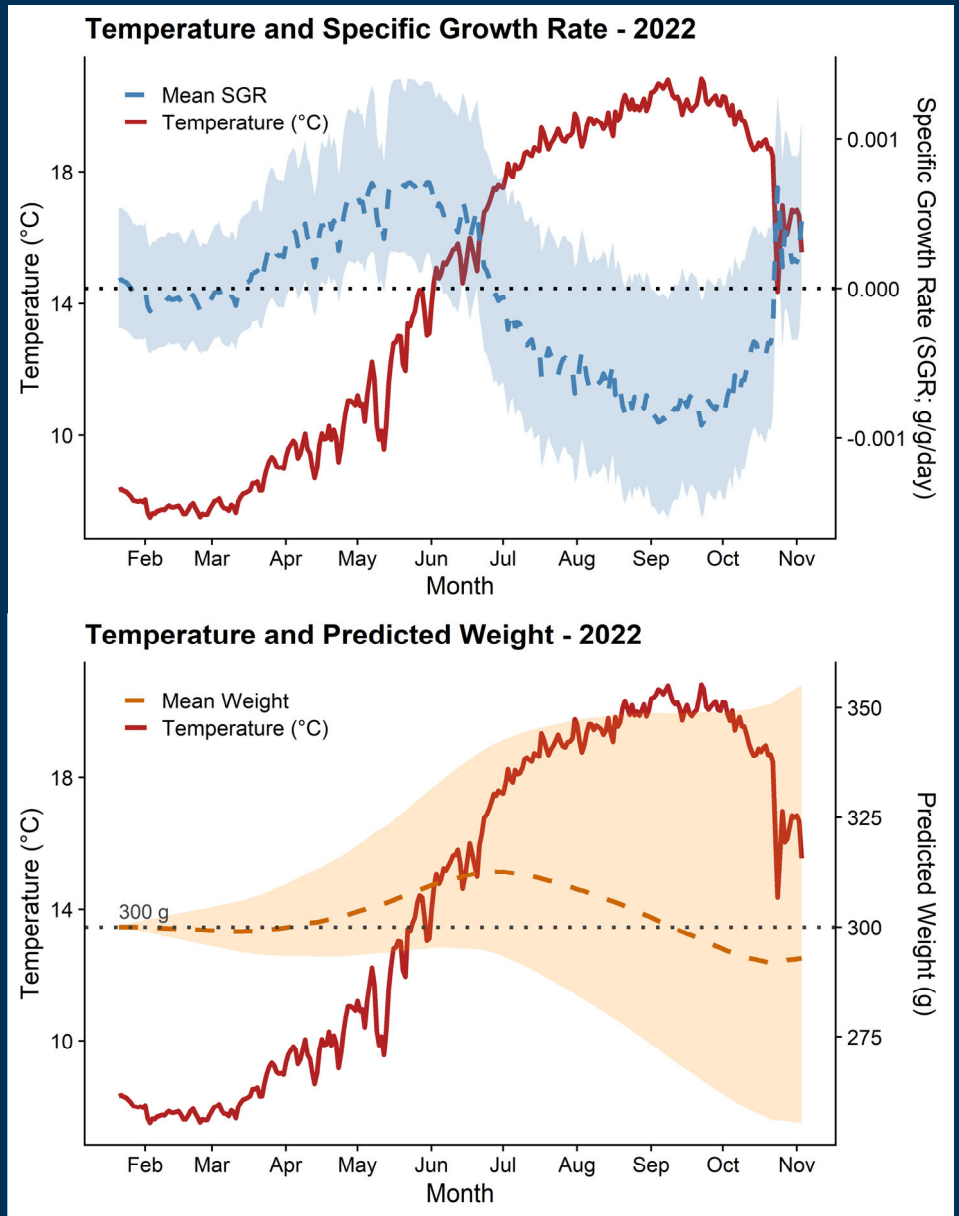


*Implemented in Fish Bioenergetics v4.0 (“Wisconsin Model”), Deslauriers and others, 2017

Eppehimer and others, (2025) DOI: 10.1139/cjfas-2024-0187

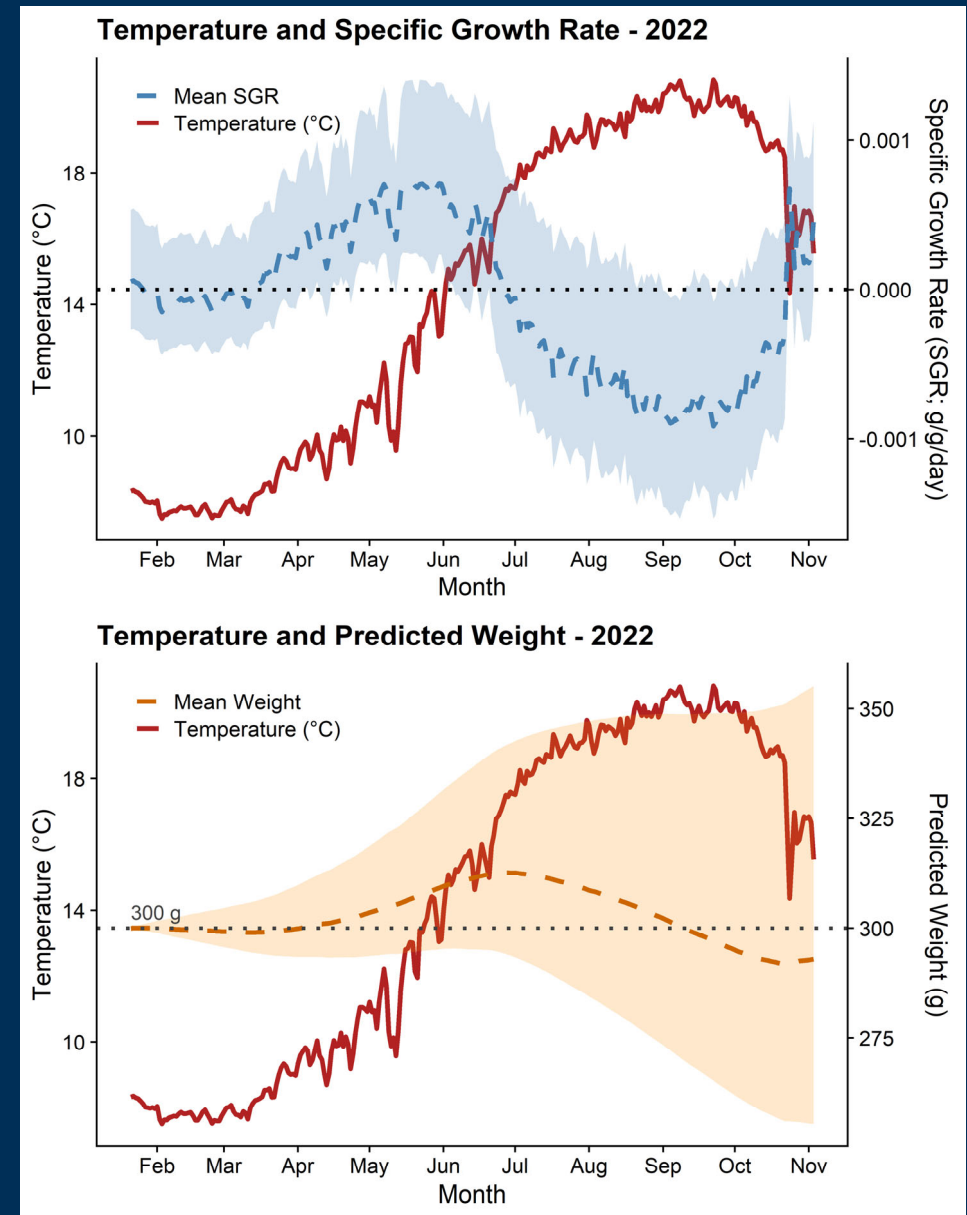
Bioenergetics Results – 2022

- Pre-coolmix
- Top panel –
 - daily growth rates and observed temperature
- Growth rate declines at ~14 degrees C



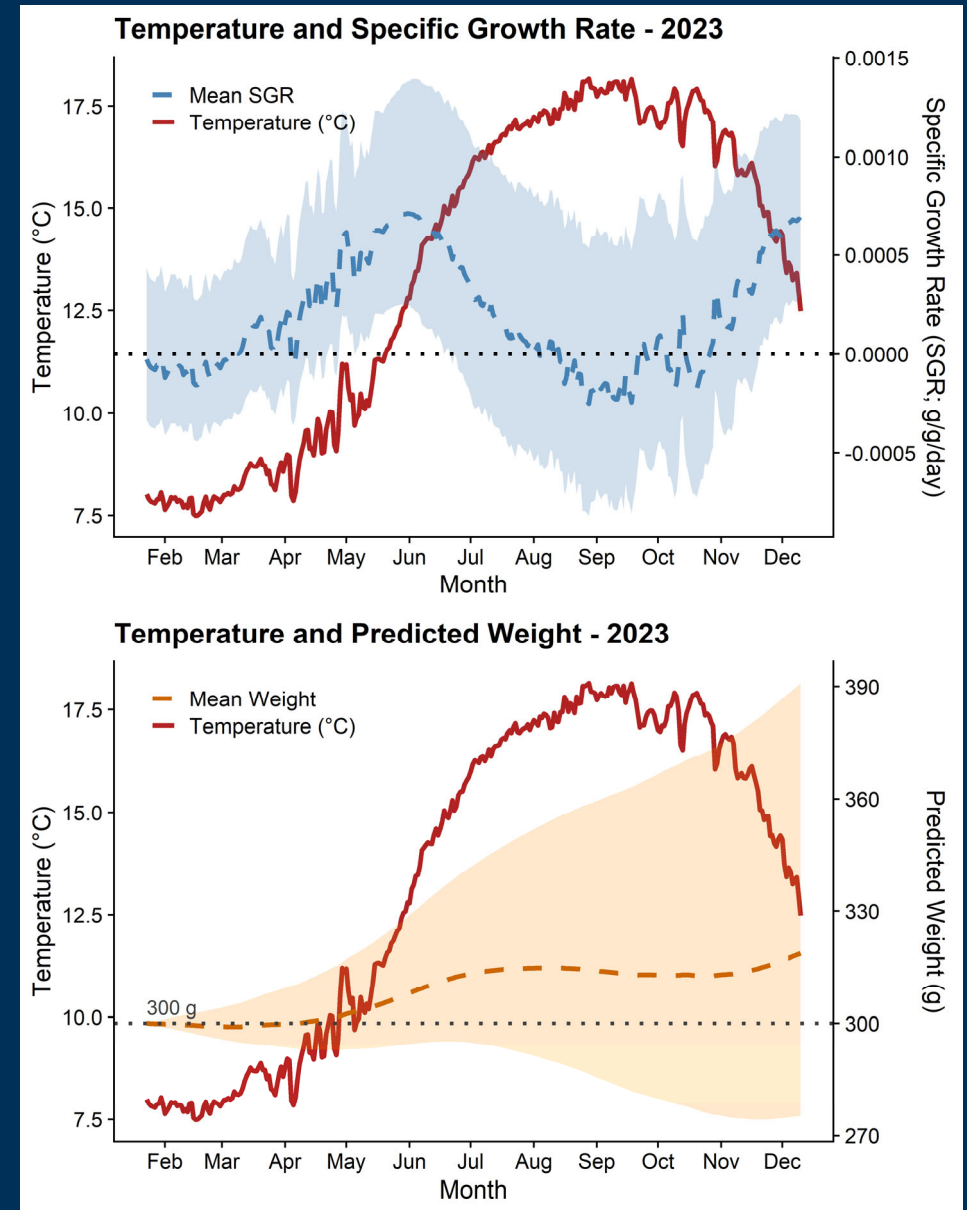
Bioenergetics Results – 2022

- Pre-coolmix
- Top panel –
 - daily growth rates and observed temperature
- Growth rate declines at ~14 degrees C
- Bottom panel –
 - simulated fish with 300g starting weights



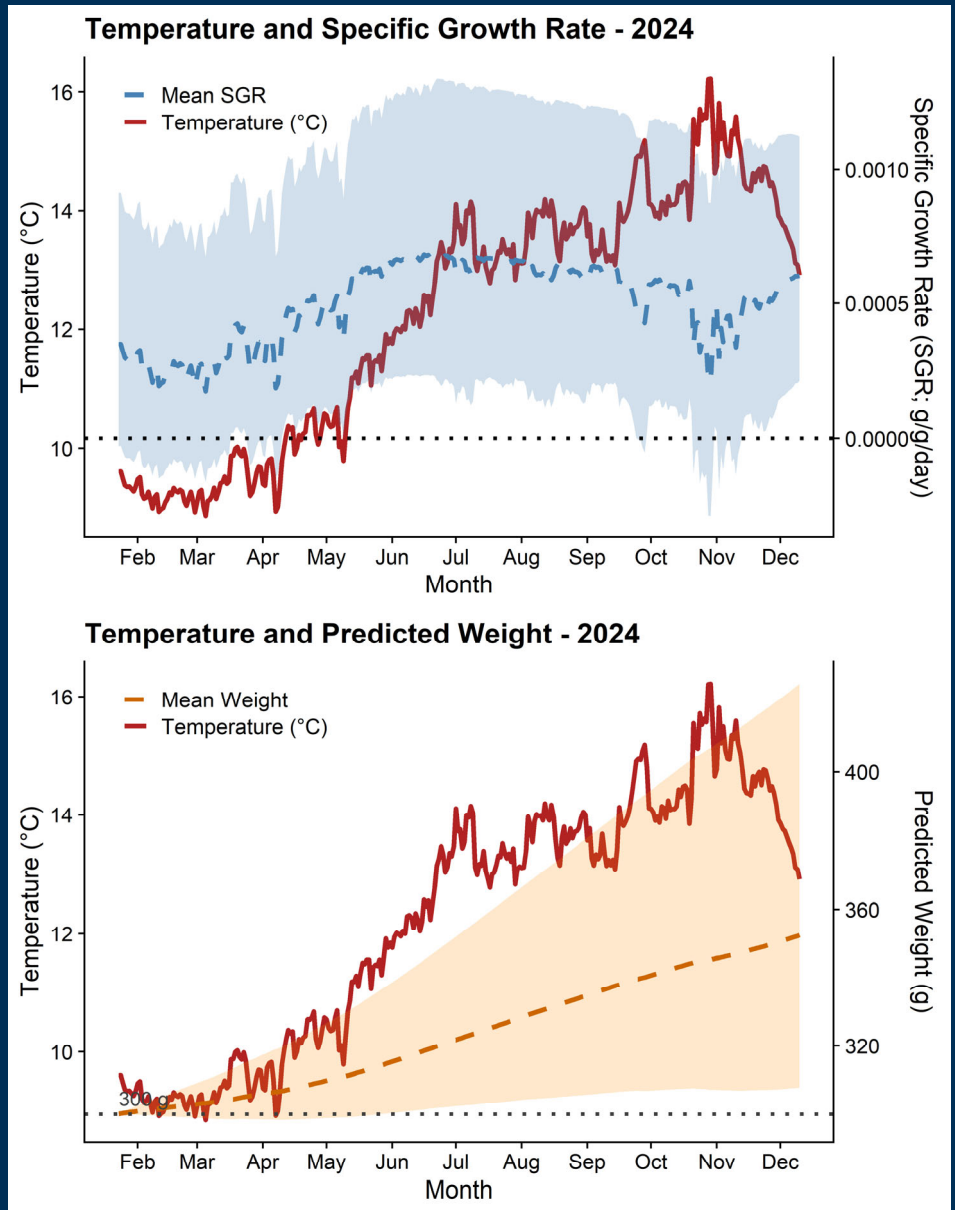
Bioenergetics Results - 2023

- Pre-coolmix
- Daily growth rates and observed temperature
- Growth rate declines at ~14 degrees C



Bioenergetics Results - 2024

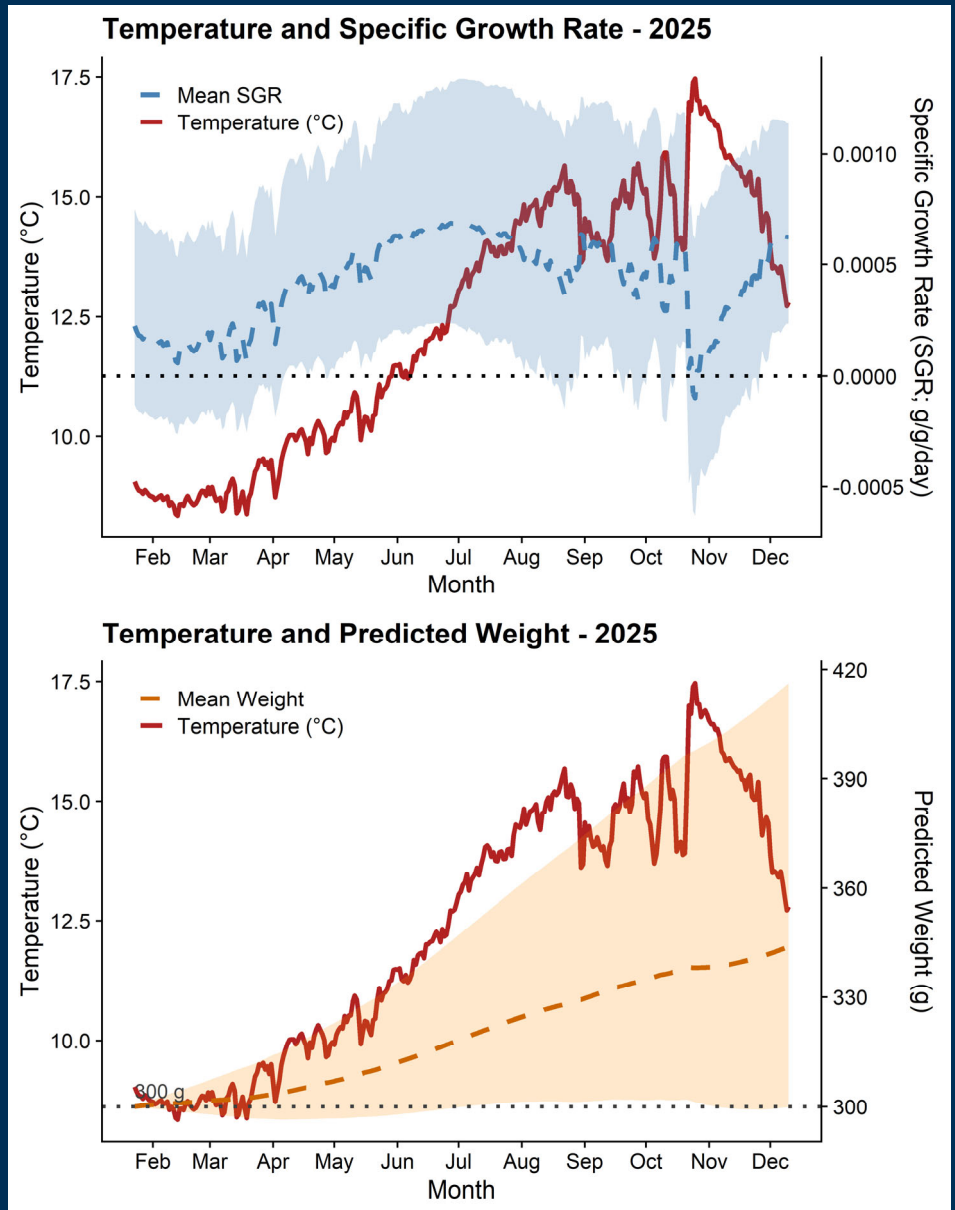
- Coolmix
- Positive growth rates throughout summer-fall
- Gain in weight across range of P-values



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

Bioenergetics Results - 2025

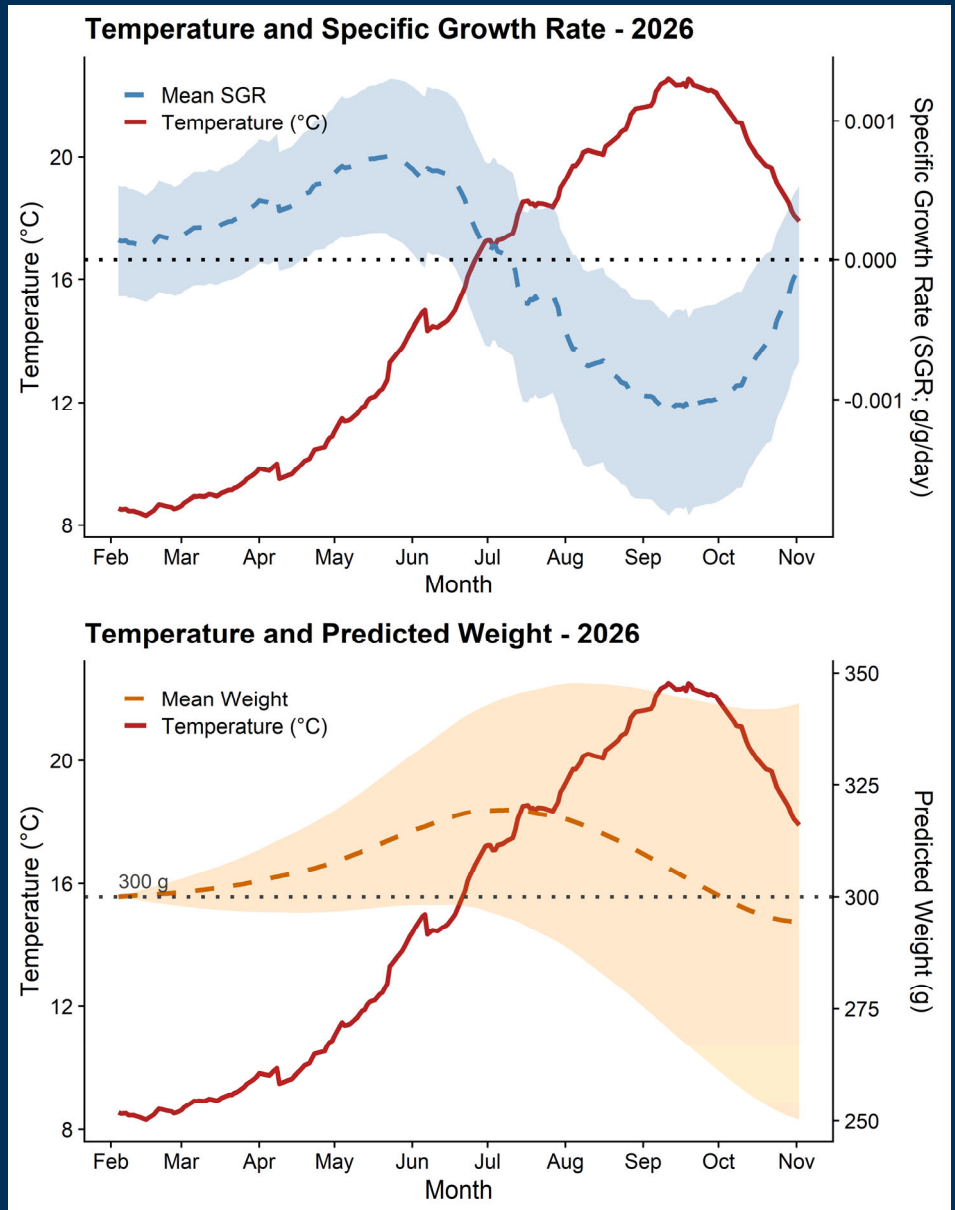
- Coolmix (early off-ramp)
- Positive growth, with some negative growth after off-ramping



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

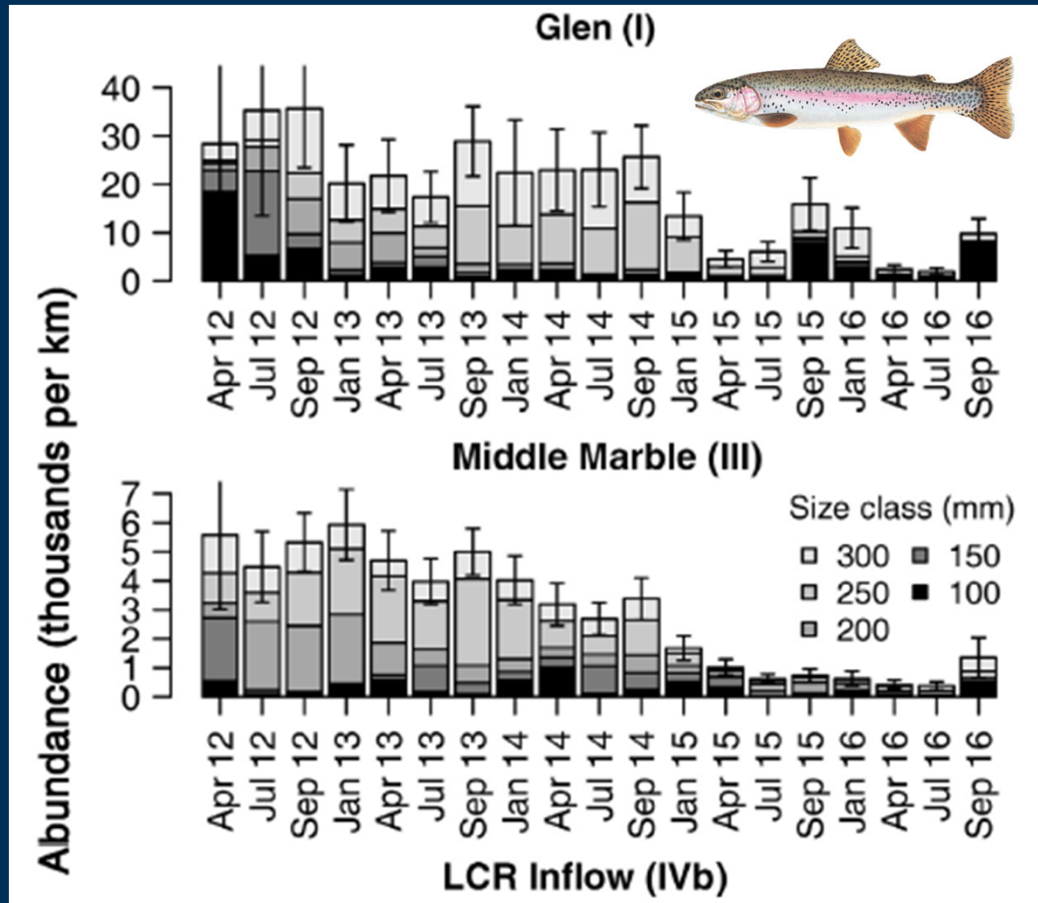
Bioenergetics Results - 2026

- Max. temperature ~23 degrees C
- Negative growth rates and weight loss
- Caveats –
 - Uncertainty in temperature predictions and trout mortality threshold, but reduced survival is expected



Preliminary unpublished data, do not cite
USGS temperature data, gaging station: 09380000

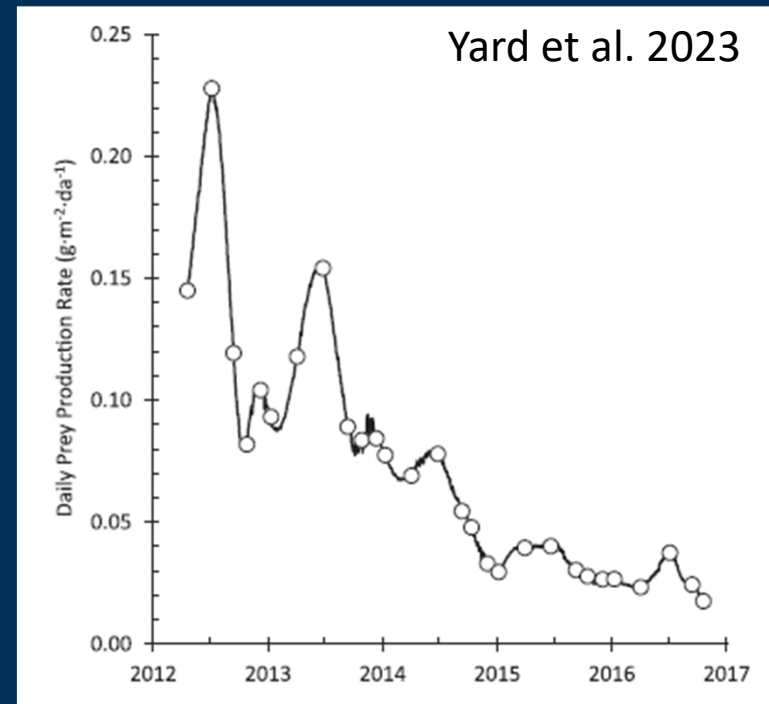
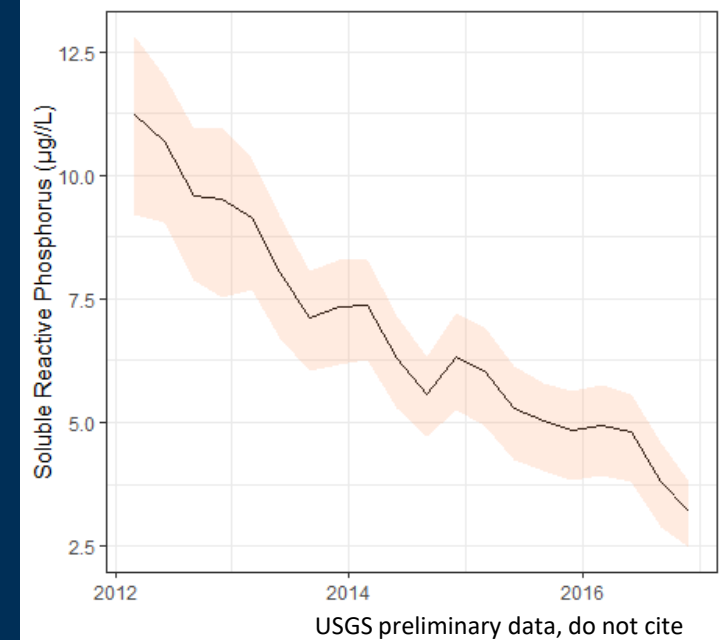
Prey Production and Trout Decline with Phosphorous



Korman et al. 2021



Fish Illustration by Joe Tomelleri



References

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- Railsback, S. F., and K. A. Rose, 1999, Bioenergetics modeling of stream trout growth: temperature and food Consumption effects: Transactions of the American Fisheries Society v. 128 no. 2, pp. 241-256.
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