



University of Idaho

Aquaculture Research Institute

Thermal adaptation in redband trout: integrating physiology and genomics



Oncorhynchus mykiss gairdneri

2019 ARI Affiliates Meeting, Moscow ID

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Hagerman Fish Culture Experiment Station

University of Idaho



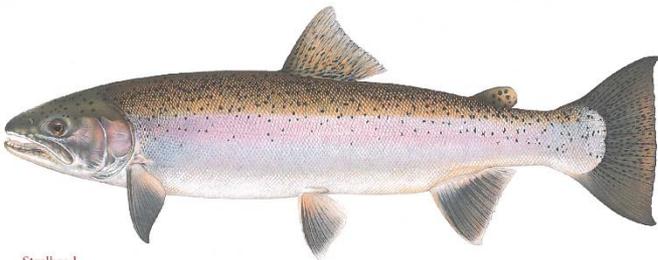
Two major forms of rainbow trout

Coastal Rainbow trout

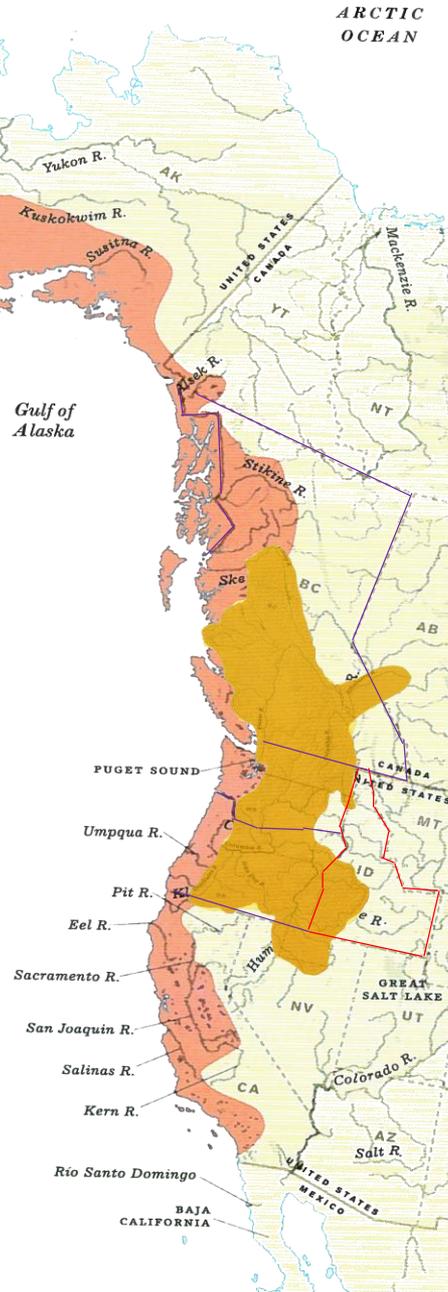
Oncorhynchus mykiss irideus



© Joseph Stedler

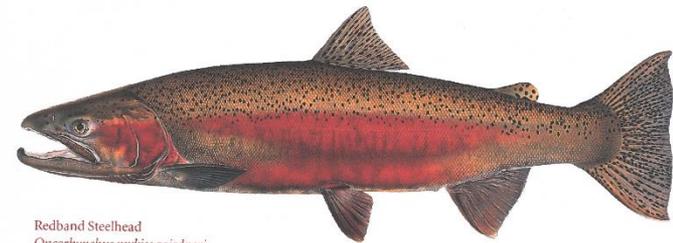


Steelhead



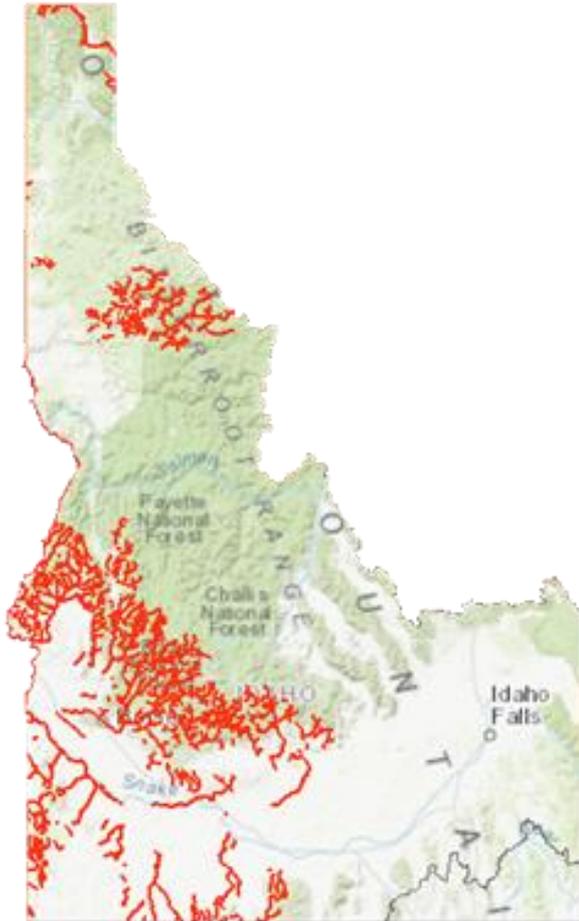
Inland Redband trout

Oncorhynchus mykiss gairdneri

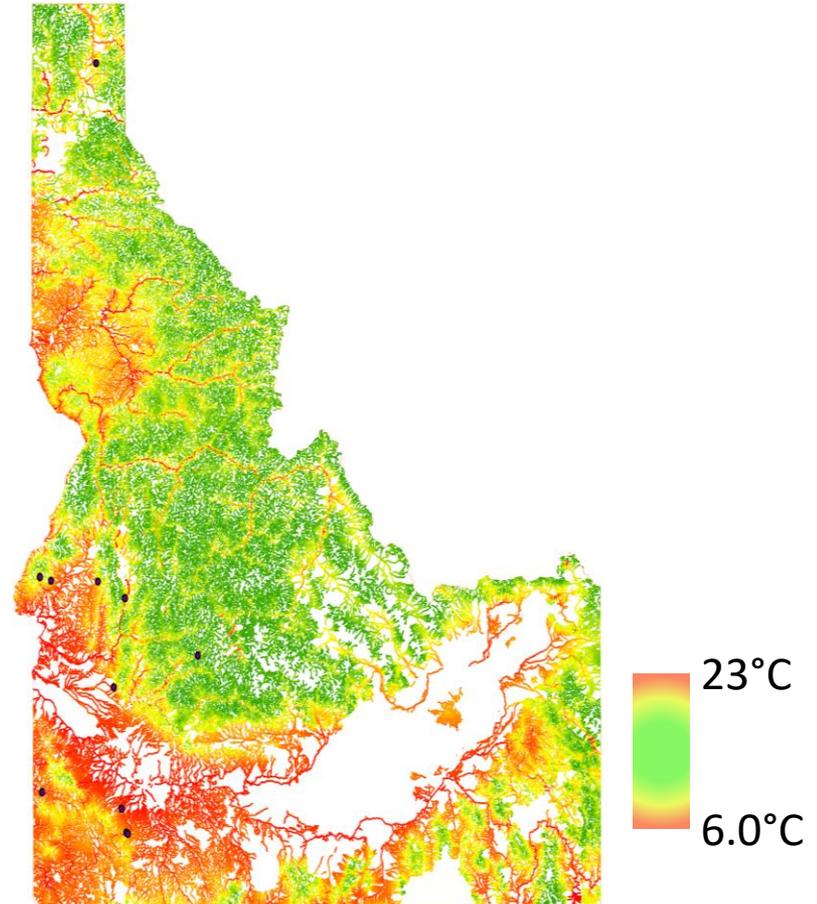


Redband Steelhead
Oncorhynchus mykiss gairdneri

Redband trout in Idaho



Redband trout distribution



Stream temperature
(Modeled mean of August 1993–2011)

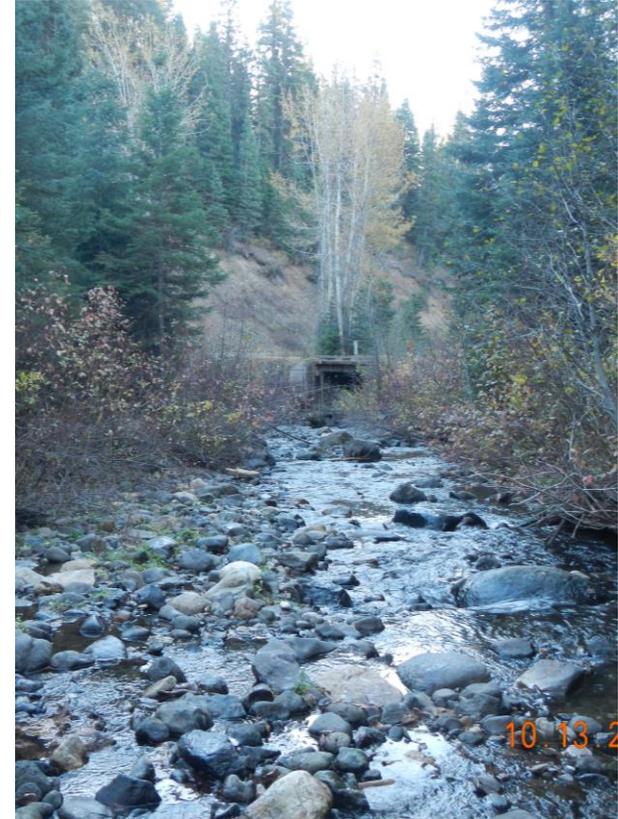
Redband trout ecotypes



Desert



Cool Montane



Cold Montane

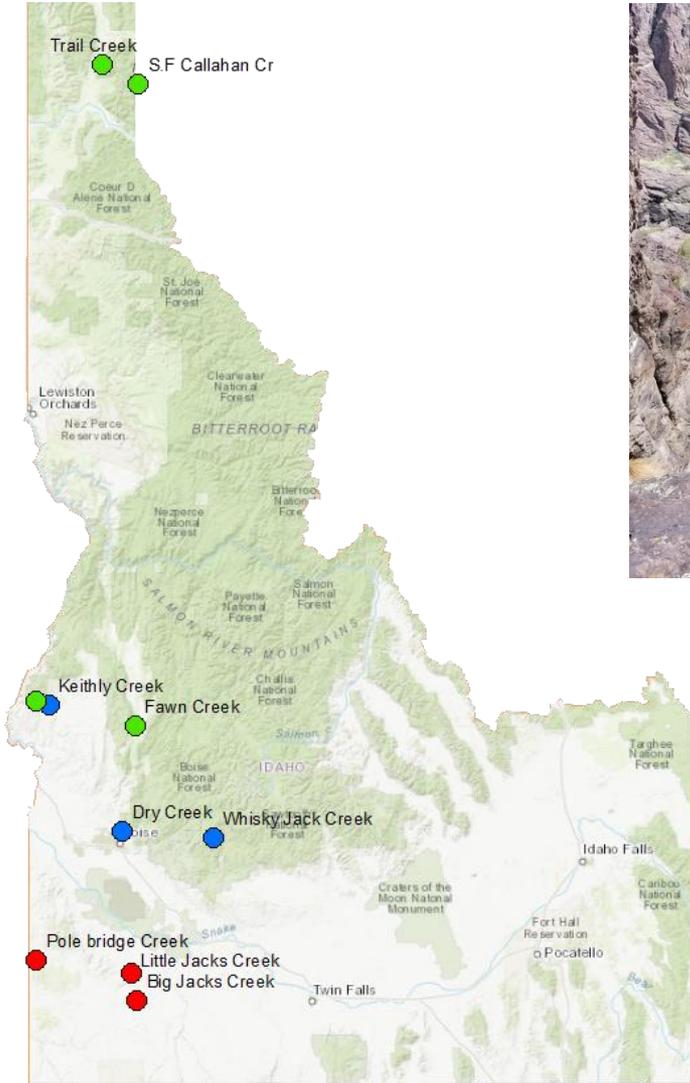
Idaho EPSCoR GEM3



Objectives:

1. Identification of **mechanisms** by which fish populations adapt to environmental challenges
2. Identification of **genetic markers** associated with adaptive capacity
3. Estimates of **phenotypic plasticity** of fish populations –ability to cope with environmental conditions –and how it relates to genetic diversity of populations
4. Extensive datasets to use in the **Modelling and Mapping** research thrusts

Field sampling for common garden



Hagerman Fish Culture Experiment Station

Hagerman, Idaho

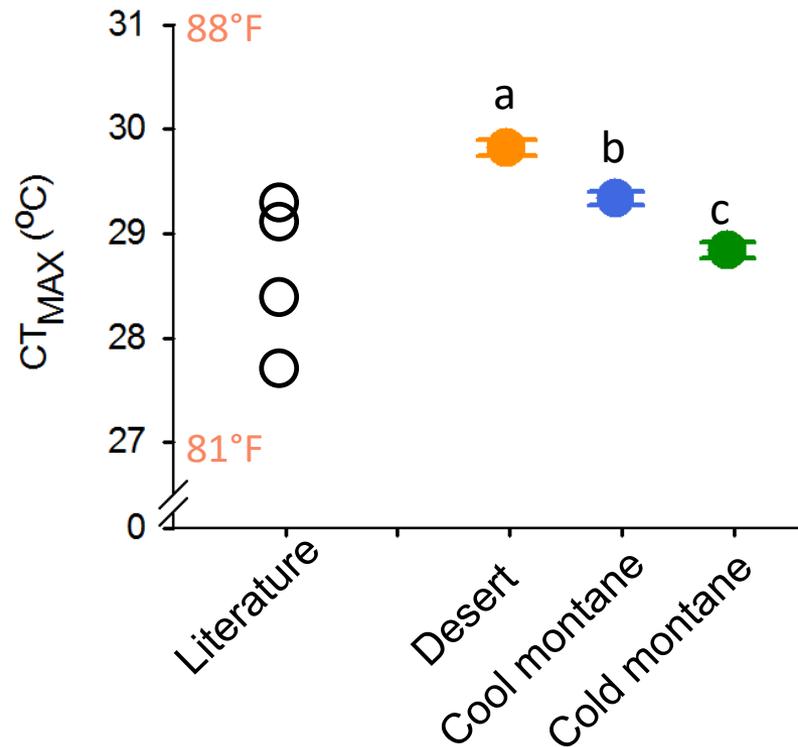


15°C spring water year around



Common Garden facilities

Critical thermal maximum (CT_{MAX})

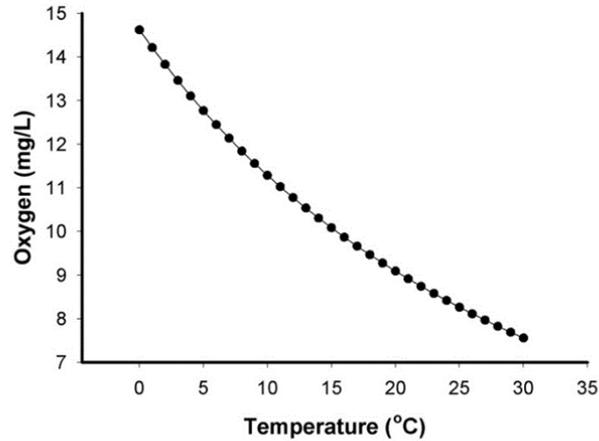


All acclimated at 15°C

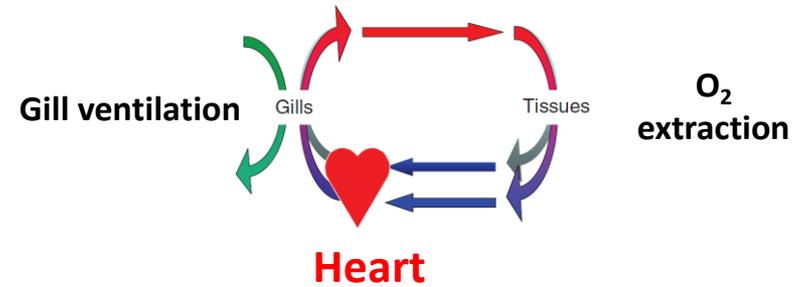
Desert redband trout can tolerate higher temperatures than montane redband trout

Oxygen limitation at high temperature

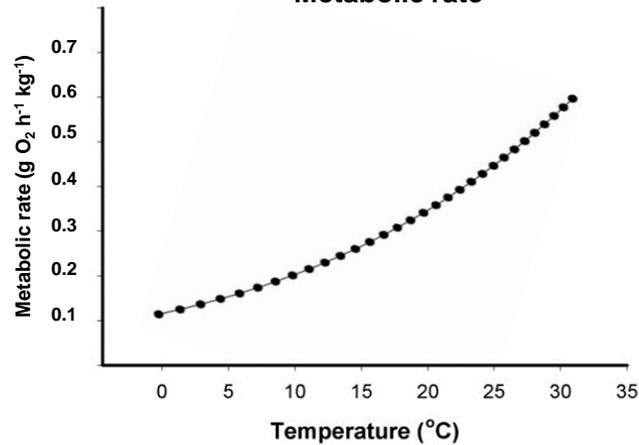
Solubility of oxygen with temperature



O₂ Supply

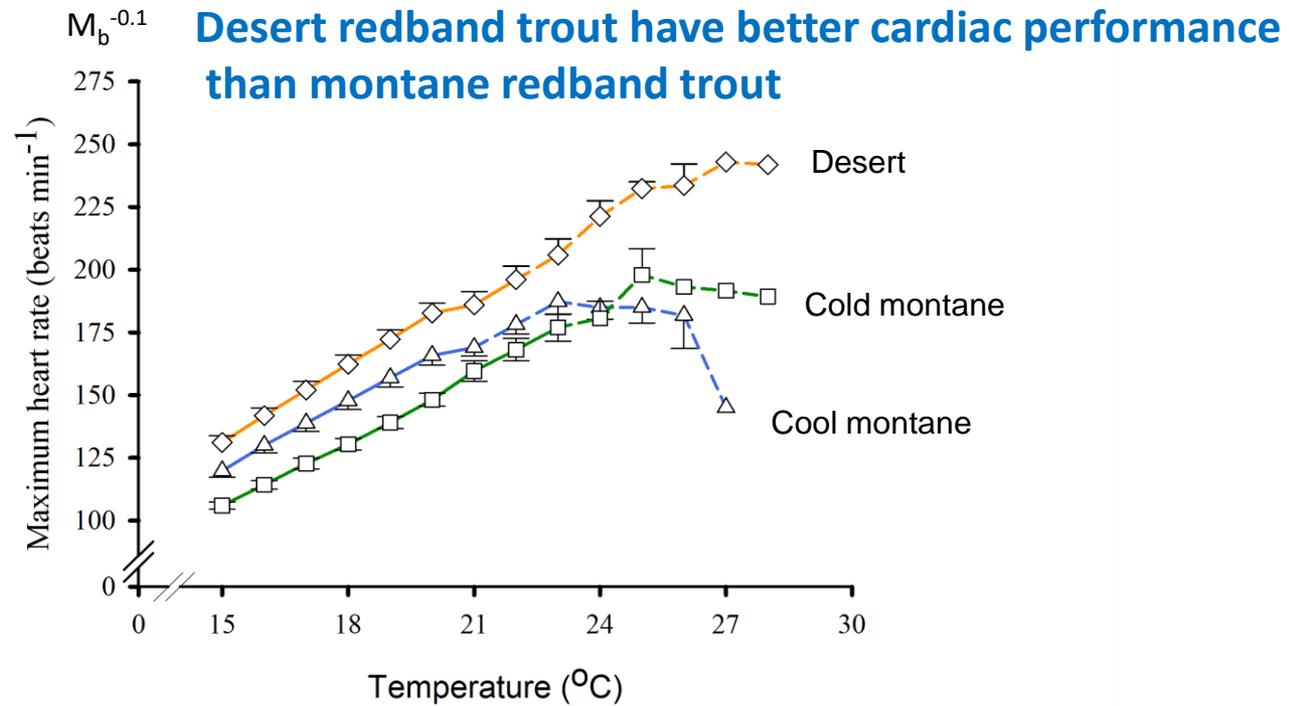
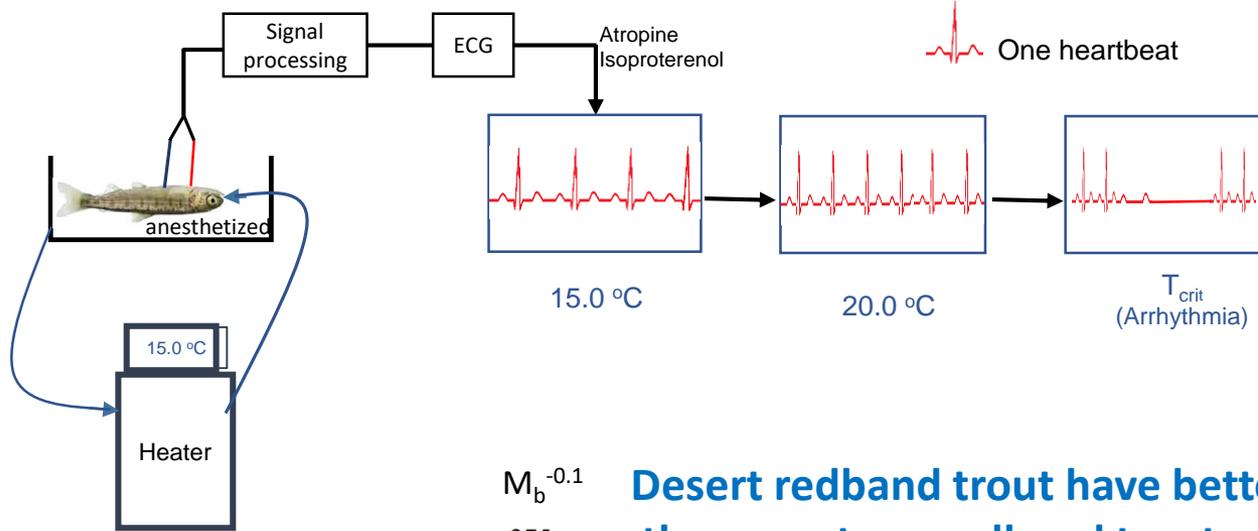
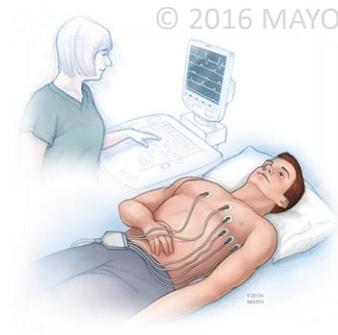


Metabolic rate

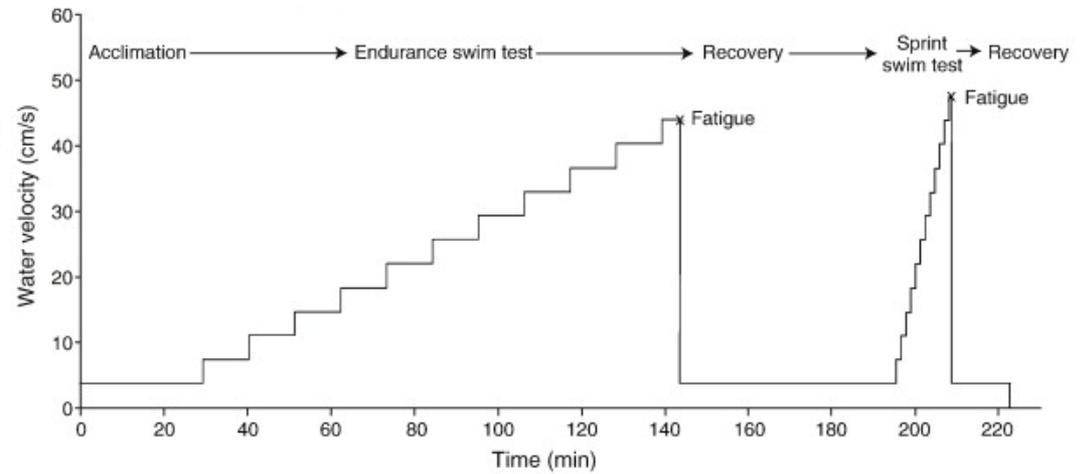
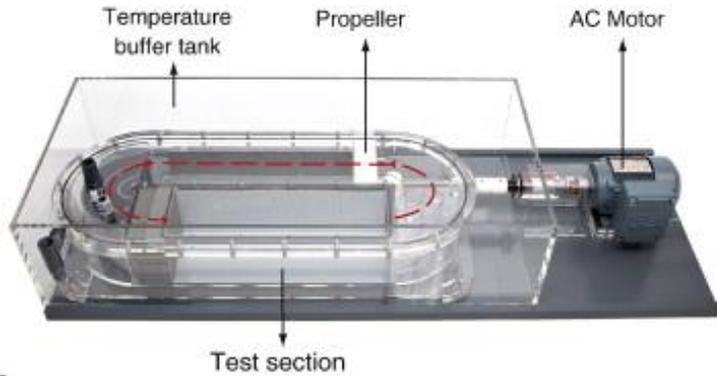


O₂ Demand

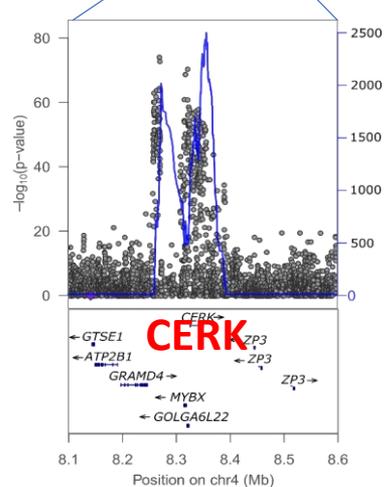
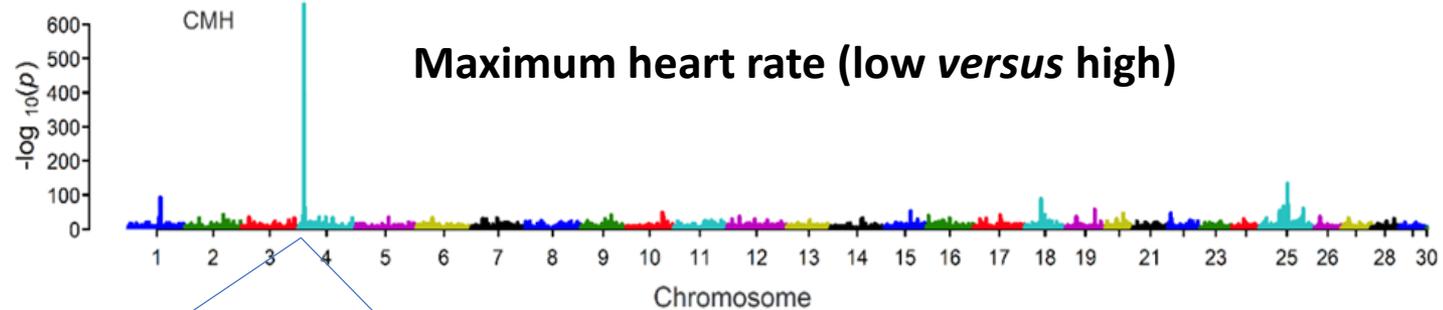
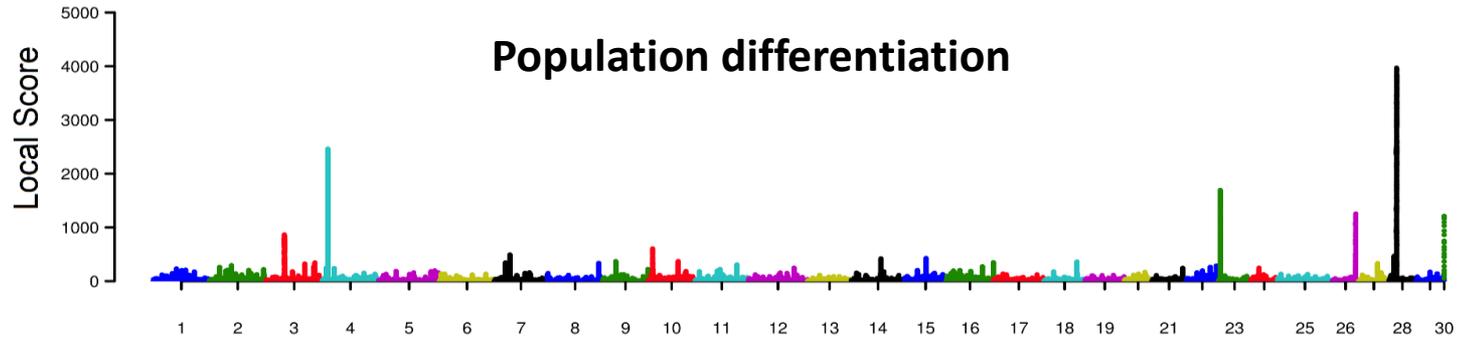
Maximum heart rate



Swimming performance (In prep)



Genomic markers of thermal adaptation



- Over 5 million SNPs
- Over 50% genome coverage
- **Chromosome4: 8.2M – 8.6M (CERK gene)** is significantly differentiated between desert and montane populations; it is also significantly associated with cardiac function.

zona_pellucida_sperm-binding_protein_3-like (LOC110521318)

Summary and Implications

- Desert redband trout has the best overall thermal performance and tolerance
- “Winners” of future climate change may need a “strong” heart to deliver O₂ for sustained aerobic performance
- Identified putative genetic markers for thermal tolerance and adaptation are identified

Acknowledgements

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Columbia River
Inter-Tribal Fish Commission



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GEM3
Genes by Environment
Modeling · Mechanisms · Mapping



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Thank you!