Research Element 2 Mechanisms - Trout





What is a redband trout?







Rainbow trout are native to western North America

Two major subspecies – coastal and inland



Coastal rainbow trout subspecies (O. mykiss irideus)





Inland rainbow trout (*O. mykiss gairdneri*), commonly called redband trout



Cutthroat trout also have coastal and inland populations



However, where redband trout exist, they dominate the habitat. Distribution of two species doesn't overlap much. Cutthroat dominate in areas where migratory barriers keep redband trout out.



Rainbow trout subspecies characteristics

- Coastal and inland forms look different but are the same species and can be crossed.
- Both subspecies have non-anadromous (resident) and anadromous (migrate to the ocean) life history forms – these are steelhead trout
- Great diversity is found in inland subspecies
 - Phenotypic characteristics such as temperature tolerance, age at maturity, certain physical characteristics
 - Habitats
 - Perhaps genetic diversity

Phylogeny of western trout (from Benke)



FIGURE 1.—Hypothesized phylogeny of western trout. Unconnected lines have uncertain connecting points.

Here is our fish



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Distribution of redband trout



Western boundary

is the Cascade

Mountain range

Eastern boundary is the Rocky Mountain range

Distribution of redband trout



Western boundary

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Our primary study area



Redband trout as a model species





Redband trout field sites for previous studies of temperature tolerance



Desert

Cool Montane

Cold Montane

Aug

May

Oxygen solubility in water deceases with increasing water temperature



0,

Thermal tolerance has been assessed by measuring cardiac function using ECG



Fish are cold-blooded, so physiological and metabolic functions increase with water temperature

Pörtner and Farrell 2008

Critical thermal maximum (CT_{MAX}) & Max heart rate



Manhattan plots of SNPs associated with cardiac function





Chen et al. 2018, Evolutionary applications

Color points represent markers within a 50-kb genomic region around a significant loci. Names above blue line are genes within each significant genomic region.

CT_{max} adaptive capacity predictive model based on genomic markers



Chen et al. 2018, Molecular Ecology

Common garden experiments are designed to compare populations reared at three temperatures







Common garden experiments - trout

- Collect eggs/fry from populations living in normal and extreme environments
- Rear fish from each population at three water temperatures (10°C, 15°C and 20°C)
- Measure phenotypic characteristics
 - Growth, FCR, hematocrit, blood gas levels, age at maturation, fecundity
 - Performance testing (CT_{max}, heart rate, swimming performance, O₂ consumption, etc.)
- Sequence, discover genetic markers
- Examine other populations for presence of markers and correlate these to habitat features (water temperature, precipitation, elevation, etc.)
 - Will use legacy samples and additional samples collected in the project from populations found in areas with differing landscape characteristics

Our team is experienced in this area

Schematic depiction of sequencing data used for SNP discovery for seasonal migration time of chinook salmon populations

Narum et al., 2018. Genomic variation underlying complex life history traits revealed by genomic sequencing in chinook salmon. Proc. Royal Soc.



Anticipated products from trout mechanisms

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